ONE WORLD ○ OUR APPROVAL

Test report

312742-6TRFWL

Date of issue: November 24, 2016

Applicant:

Seiko Epson Corporation

Product:

Smart Glasses

Model:

H756A (BT-300)

FCC ID: SKSH756A

IC Registration number: 1052D-H756A

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

- RSS-247, Issue 1, May 2015, Section 5

  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

Company name	Nemko Canada Inc.
Address	292 Labrosse Avenue
City	Pointe-Claire
Province	QC
Postal code	H9R 5L8
Country	Canada
Telephone	+1 514 694 2684
Facsimile	+1 514 694 3528
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: 722545; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Yong Huang, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	November 24, 2016
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Table of contents **3**

Section 1. Report summary **4**

1.1 Applicant and manufacturer 4

1.2 Test specifications 4

1.3 Test methods 4

1.4 Statement of compliance 4

1.5 Exclusions 4

1.6 Test report revision history 4

Section 2. Summary of test results **5**

2.1 FCC Part 15 Subpart C, general requirements test results 5

2.2 FCC Part 15 Subpart C, intentional radiators test results 5

2.3 IC RSS-GEN, Issue 4, test results 5

2.4 IC RSS-247, Issue 1, test results 6

Section 3. Equipment under test (EUT) details **7**

3.1 Sample information 7

3.2 EUT information 7

3.3 Technical information 7

3.4 Product description and theory of operation 8

3.5 EUT exercise details 8

3.6 EUT setup diagram 8

Section 4. Engineering considerations **9**

4.1 Modifications incorporated in the EUT 9

4.2 Technical judgment 9

4.3 Deviations from laboratory tests procedures 9

Section 5. Test conditions **10**

5.1 Atmospheric conditions 10

5.2 Power supply range 10

Section 6. Measurement uncertainty **11**

6.1 Uncertainty of measurement 11

Section 7. Test equipment **12**

7.1 Test equipment list 12

Section 8. Testing data **13**

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits 13

8.2 FCC 15.247(a)(1) and RSS-247 5.1(1) Frequency Hopping Systems requirements 17

8.3 FCC 15.247(b) and RSS-247 5.4 (1) Transmitter output power and e.i.r.p. requirements 24

8.4 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions 28

Section 9. Block diagrams of test set-ups **38**

9.1 Radiated emissions set-up for frequencies below 1 GHz 38

9.2 Radiated emissions set-up for frequencies above 1 GHz 39

9.3 Conducted emissions set-up 39

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Seiko Epson Corporation
Address	6925 Tazawa, Toyoshina, Azumino-shi, Nagano 399-8285 Japan

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz
RSS-247, Issue 1, May 2015, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

DA 00-705 Released March 30, 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2] The Antenna is located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Not applicable
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Not applicable
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Not applicable
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
7.1.2	Receiver radiated emission limits	Not applicable
7.1.3	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 IC RSS-247, Issue 1, test results

Part	Test description	Verdict
5.1	Frequency Hopping Systems (FHSs)	
5.1 (1)	Bandwidth of a frequency hopping channel	Pass
5.1 (2)	Minimum channel spacing for frequency hopping systems	Pass
5.1 (3)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.1 (4)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
5.1 (5)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2	Digital Transmission Systems (DTSs)	
5.2 (1)	Minimum 6 dB bandwidth	Not applicable
5.2 (2)	Maximum power spectral density	Not applicable
5.3	Hybrid Systems	
5.3 (1)	Digital modulation turned off	Not applicable
5.3 (2)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
5.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (4)	Systems employing digital modulation techniques	Not applicable
5.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Out-of-band emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	October 4, 2016
Nemko sample ID number	133-003152 (Conducted sample) and 133-003139 (Radiated sample)

3.2 EUT information

Product name	Smart Glasses
Model	H756A (BT-300)
Serial number	TCW27560112

3.3 Technical information

Applicant IC company number	1052D
IC UPN number	H756A
All used IC test site(s) Reg. number	2040G-5
RSS number and Issue number	RSS-247 Issue 1, May 2015
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Min (W), Conducted	N/A
RF power Max (W), Conducted	4.1 dBm (0.0026)
Field strength, Units @ distance	N/A
Measured BW (kHz) (20 dB)	1334.83
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK/ 8DPSK/DQPSK
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, Units @ distance	45 dBµV/m @ 3m
Power requirements	5 VDC (Powered via external AC-DC adapter 100–240 VAC 50–60 Hz) and via battery
Antenna information	The EUT uses a non-detachable antenna to the intentional radiator. As per customer the antenna gain is 2.1 dBi at 2.4 GHz band

3.4 Product description and theory of operation

EUT is a smart glass with see-through lenses, which allows to overlay images on actual view. The virtual images were provided by a controller.

3.5 EUT exercise details

EUT was set to test modes during tests, by software drivers provided by customer.

3.6 EUT setup diagram

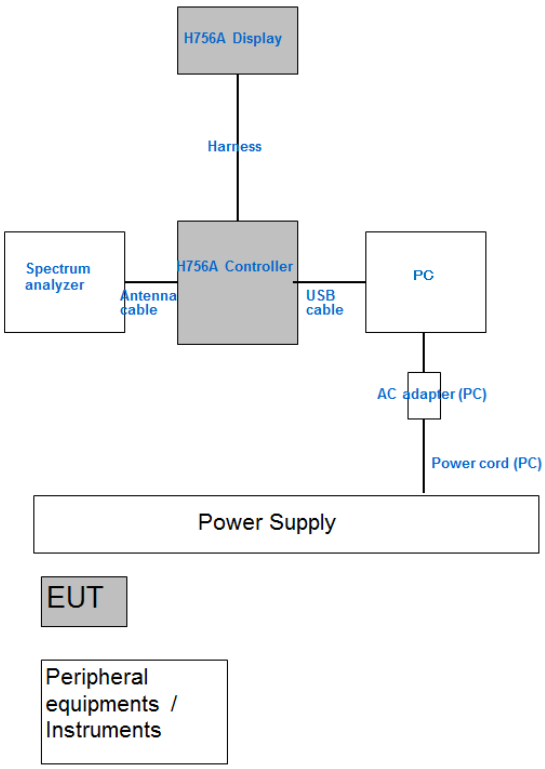


Figure 3.6-1: *Setup diagram*

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
spectrum analyzer	Rohde & Schwarz	FSV 40	FA002731	1 year	Apr 06/17
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002607	—	VOU
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Oct. 5/17
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	Feb. 22/17
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/17
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	May 6/17
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	May 6/17
2400-2483 MHz Notch Filter	Microwave Circuits	N0324413	FA002693	—	VOU
50 Ω coax cable	HUBER+SUHNER	SUCOFLEX 100	FA002564	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	Nov. 20/16
Power source	California Instruments	5001ix	FA002494	1 year	Apr 29/17

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.1.2 Test summary

Test date	October 7, 2016	Temperature	24 °C
Test engineer	Yong Huang	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	53 %

8.1.3 Notes

None

8.1.4 Setup details

Port under test	AC input (External adapter)
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak and Average (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak and Average preview measurement) – 1000 ms (Quasi-peak final measurement) – 160 ms (CAverage final measurement)

8.1.5 Test data

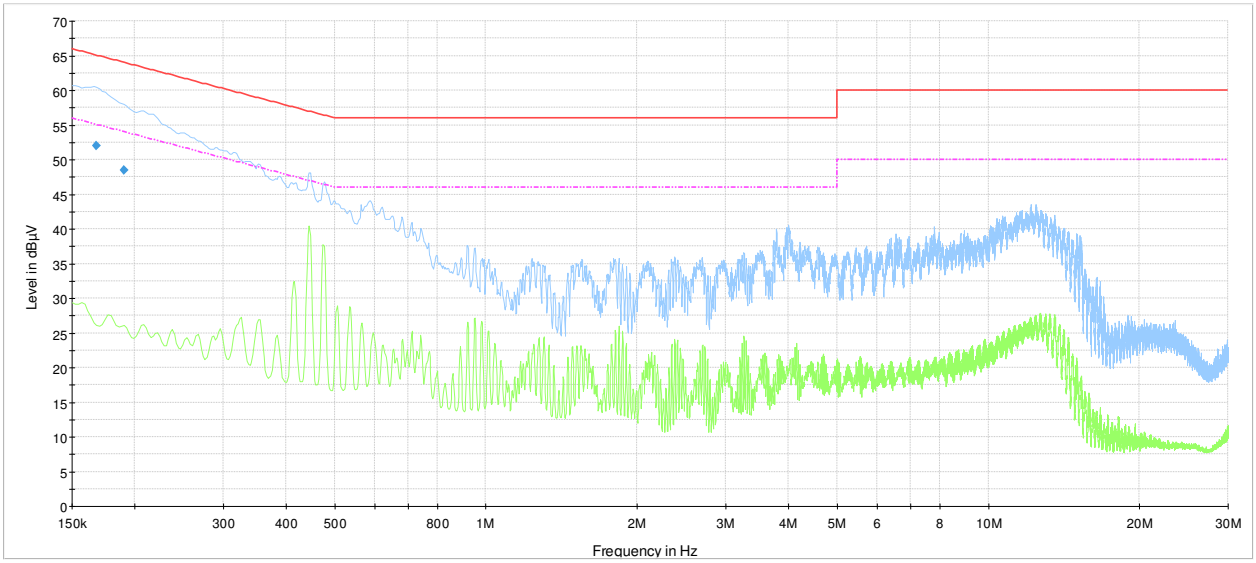


Figure 8.1-1: AC power line conducted emissions limits – phase line

Table 8.1-2: Quasi-Peak results AC power line conducted emissions limits – phase line

Frequency (MHz)	Quasi-Peak result[1 and 3] (dBµV)	Quasi-Peak limit (dBµV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor[2] (dB)
0.168000	52.1	65.1	13.0	100.0	9	L1	ON	10.2
0.190500	48.5	64.0	15.5	100.0	9	L1	ON	10.1

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 48.5 dBµV (result) = 38.4 dBµV (receiver reading) + 10.1 dB (Correction factor)

8.1.5 Test data, continued

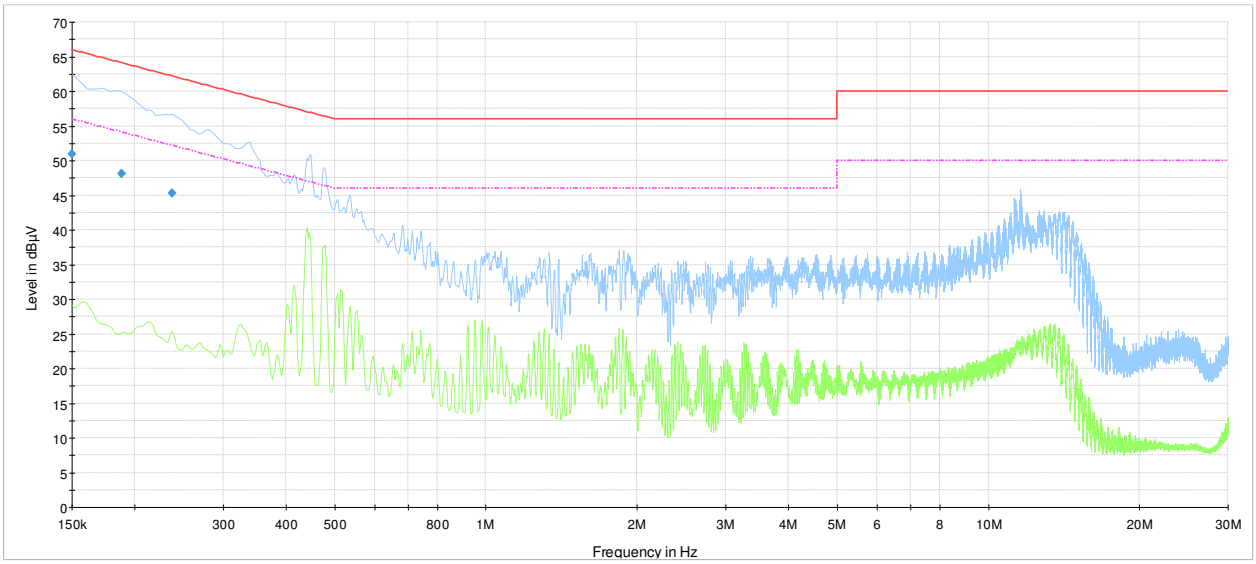


Figure 8.1-2: AC power line conducted emissions limits – neutral line

Table 8.1-3: Quasi-Peak results AC power line conducted emissions limits – neutral line

Frequency (MHz)	Quasi-Peak result[1 and 3] (dBµV)	Quasi-Peak limit (dBµV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor[2] (dB)
0.150000	51.0	66.0	15.1	100.0	9	N	ON	9.9
0.188250	48.1	64.1	16.0	100.0	9	N	ON	10.1
0.237750	45.3	62.2	16.9	100.0	9	N	ON	9.8

Notes:
[1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 48.5 dBµV (result) = 38.4 dBµV (receiver reading) + 10.1 dB (Correction factor)

8.2 FCC 15.247(a)(1) and RSS-247 5.1(1) Frequency Hopping Systems requirements

8.2.1 Definitions and limits

FCC:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals..

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

IC:

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

2. FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals

3. FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used

8.2.2 Test summary

Test date	November 14, 2016	Temperature	22 °C
Test engineer	Yong Huang	Air pressure	1000 mbar
Verdict	Pass	Relative humidity	46 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings for carrier frequency separation:

Resolution bandwidth	≥ 1 % of the span
Video bandwidth	≥ RBW
Frequency span	wide enough to capture the peaks of two adjacent channels
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for number of hopping frequencies:

Resolution bandwidth	≥ 1 % of the span
Video bandwidth	≥ RBW
Frequency span	the frequency band of operation
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for time of occupancy (dwell time):

Resolution bandwidth	30 kHz
Video bandwidth	10 kHz
Frequency span	Zero span
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for 20 dB bandwidth:

Resolution bandwidth	≥ 1% of the 20 dB bandwidth
Video bandwidth	≥ RBW
Frequency span	approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *20 dB bandwidth results*

Modulation scheme	Frequency, MHz	20 dB bandwidth, kHz
1	2402	823.35
	2441	824.35
	2480	825.03
2	2402	1333.90
	2441	1334.83
	2480	1334.08
3	2402	1293.84
	2441	1296.02
	2480	1279.65

Table 8.2-2: *Carrier frequency separation results*

Modulation scheme	Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
1	994.56	550.02	444.54
2	995.56	889.89	105.67
3	1000.89	864.01	136.88

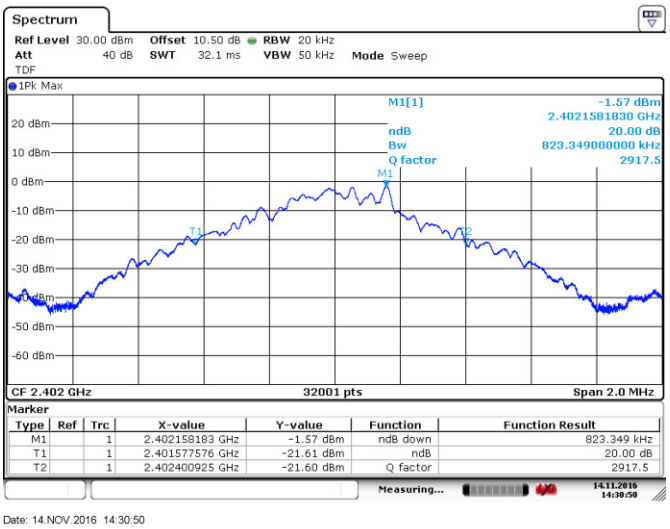
Table 8.2-3: *Number of hopping frequencies results*

Number of hopping frequencies	Minimum limit	Margin
79	15	64

Table 8.2-4: *Average time of occupancy results*

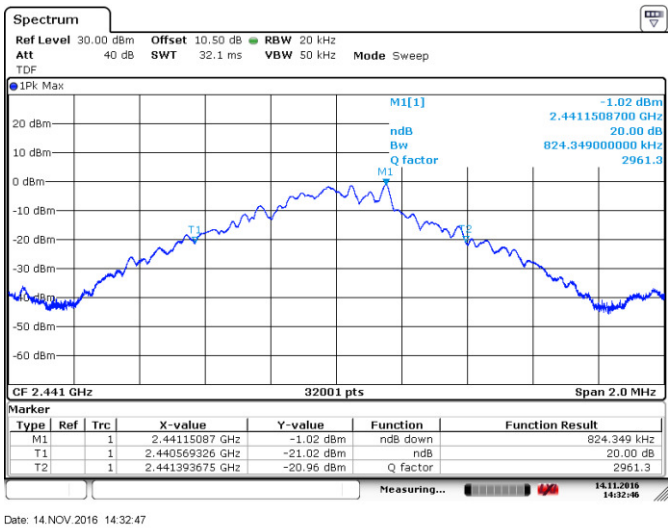
Package mode	Dwell time of each pulse, ms	Number of pulses within period	Total dwell time within period, ms	Limit, ms	Margin, ms
DH1	0.428	308	131.8	400	268.2
DH3	1.665	152	253.1	400	146.9
DH5	2.929	119	348.6	400	51.4

Measurement Period is 20 s



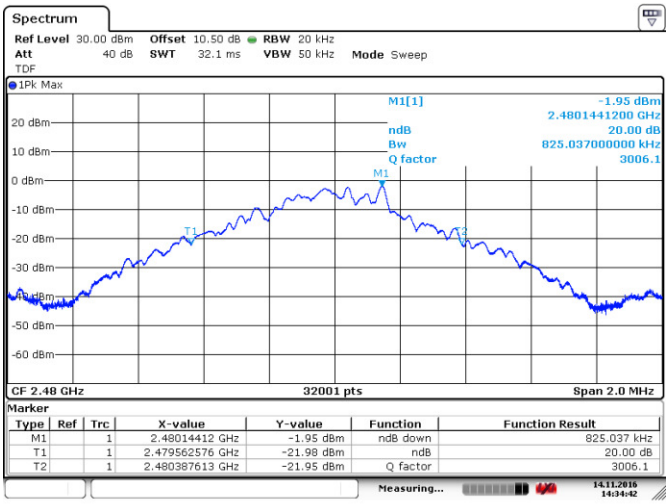
Date: 14.NOV.2016 14:30:50

Figure 8.2-1: *20 dB bandwidth on low channel- Modulation 1*



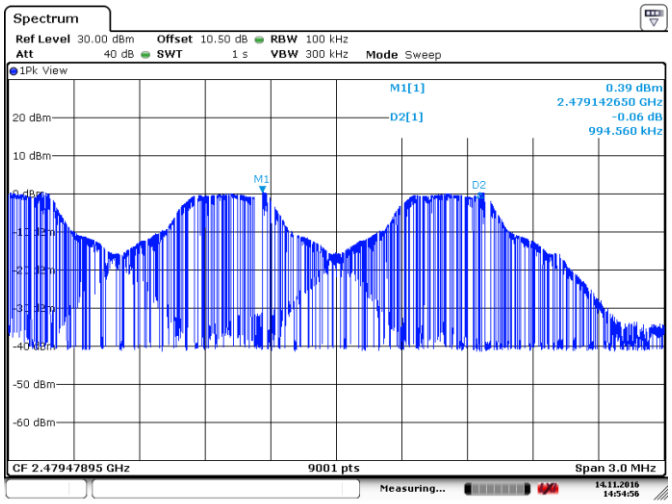
Date: 14.NOV.2016 14:32:47

Figure 8.2-2: *20 dB bandwidth on mid channel Modulation 1*



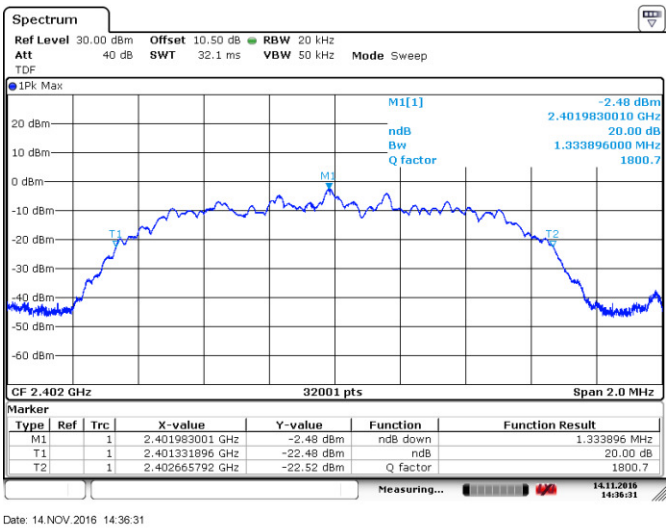
Date: 14.NOV.2016 14:34:42

Figure 8.2-3: *20 dB bandwidth on high channel Modulation 1*



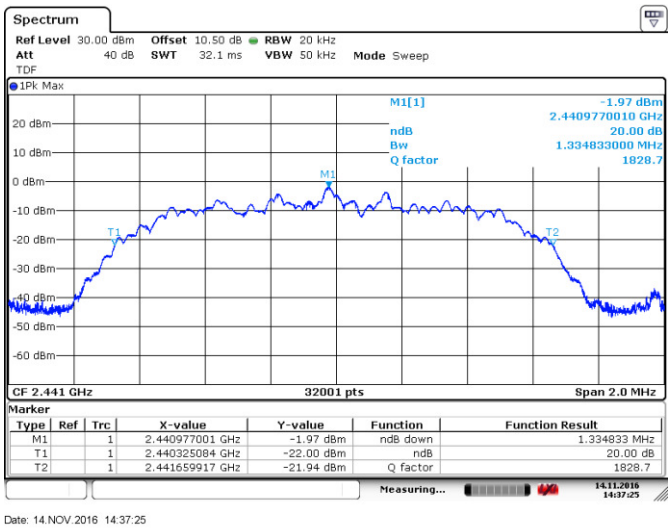
Date: 14.NOV.2016 14:54:56

Figure 8.2-4: *Carrier frequency separation Modulation 1*



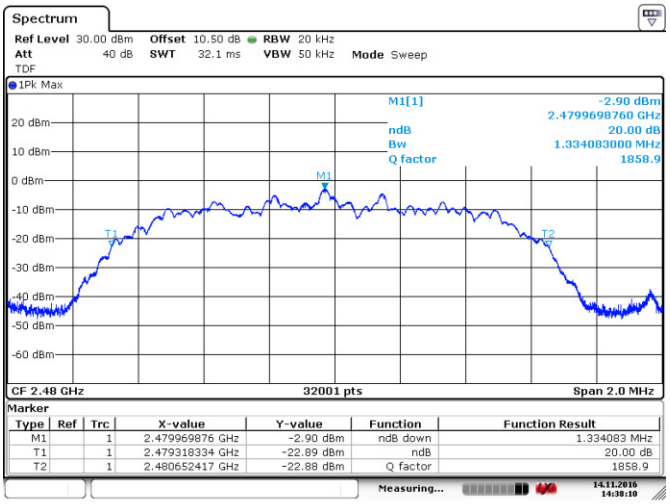
Date: 14.NOV.2016 14:36:31

Figure 8.2-5: *20 dB bandwidth on low channel- Modulation 2*



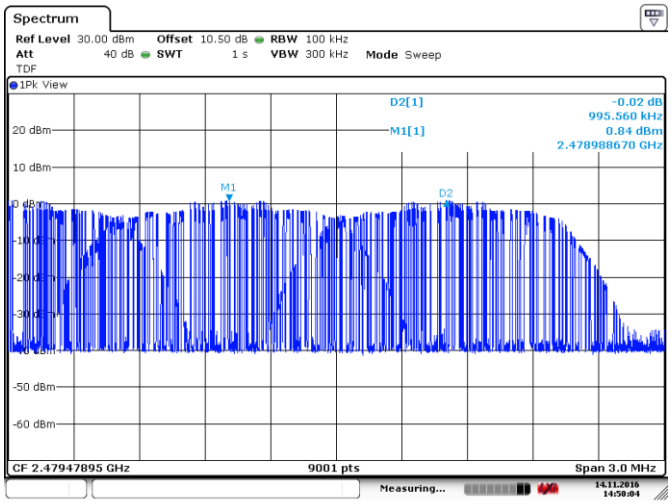
Date: 14.NOV.2016 14:37:25

Figure 8.2-6: *20 dB bandwidth on mid channel Modulation 2*



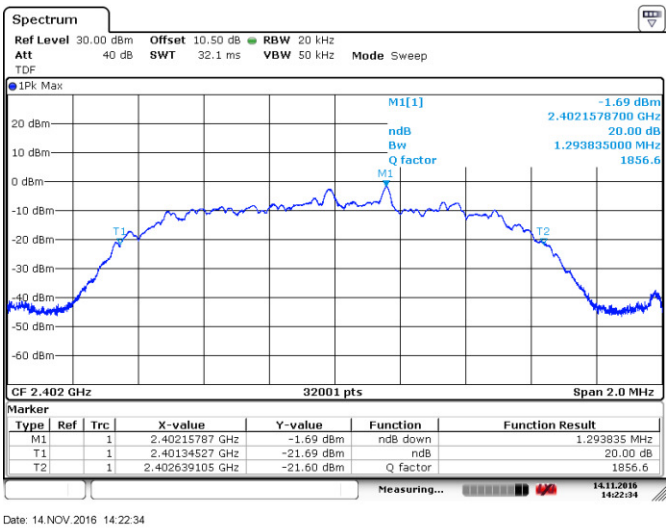
Date: 14.NOV.2016 14:38:10

Figure 8.2-7: *20 dB bandwidth on high channel Modulation 2*



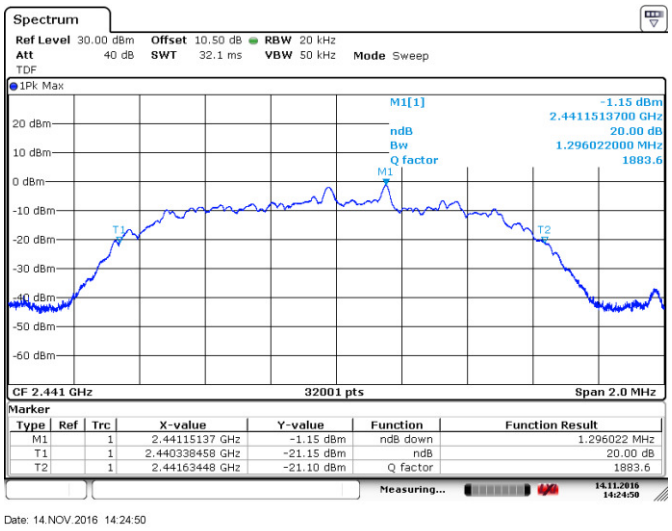
Date: 14.NOV.2016 14:50:04

Figure 8.2-8: *Carrier frequency separation Modulation 2*



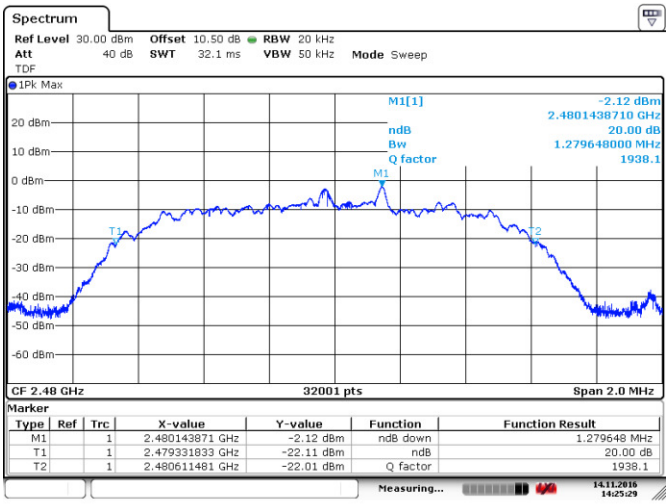
Date: 14.NOV.2016 14:22:34

Figure 8.2-9: *20 dB bandwidth on low channel- Modulation 3*



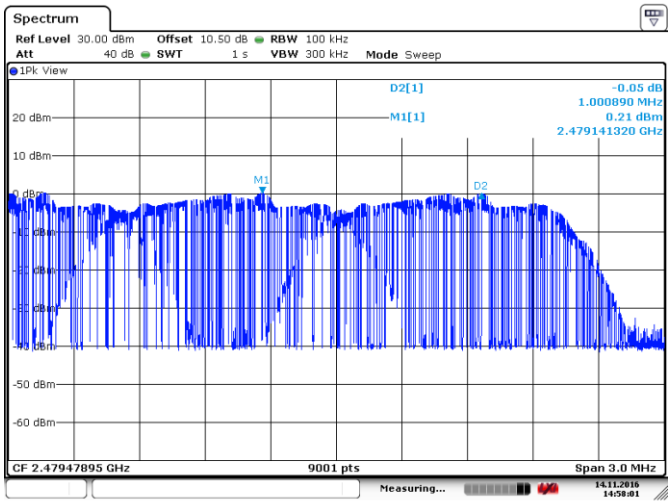
Date: 14.NOV.2016 14:24:50

Figure 8.2-10: *20 dB bandwidth on mid channel Modulation 3*



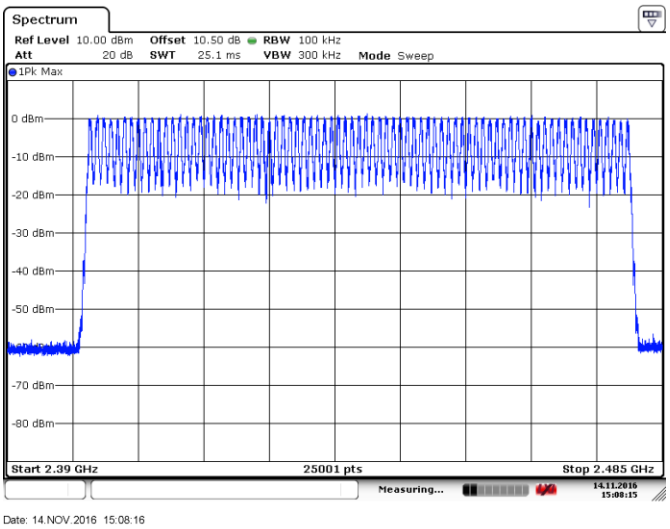
Date: 14.NOV.2016 14:25:30

Figure 8.2-11: *20 dB bandwidth on high channel Modulation 3*



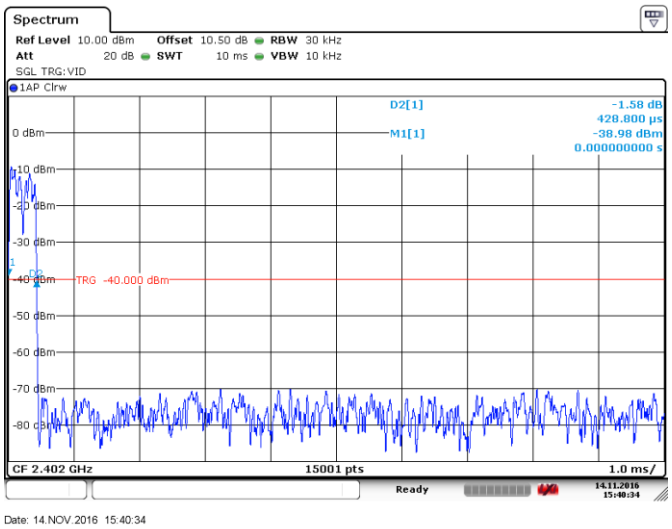
Date: 14.NOV.2016 14:58:02

Figure 8.2-12: *Carrier frequency separation Modulation 3*



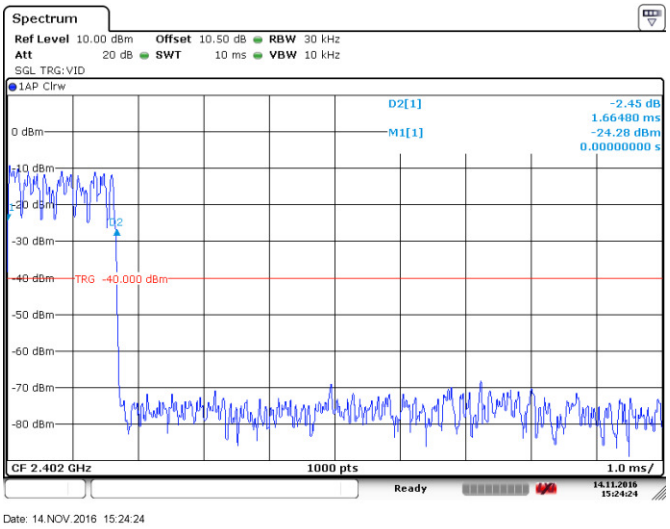
Date: 14.NOV.2016 15:08:16

Figure 8.2-13: *Number of hopping channels*



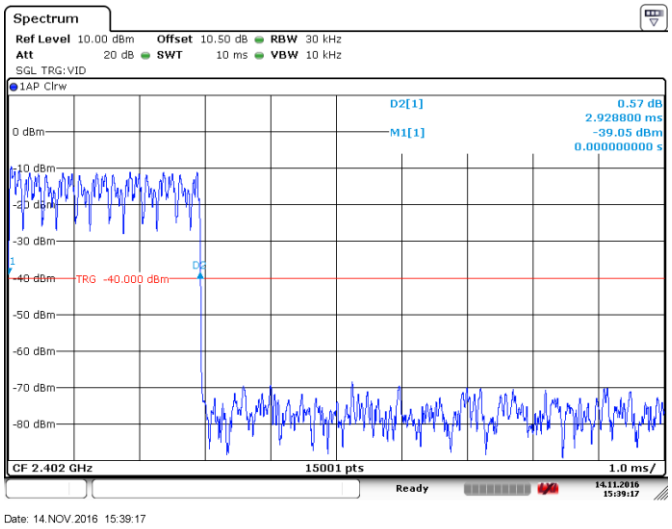
Date: 14.NOV.2016 15:40:34

Figure 8.2-14: *Dwell time- Modulation 1*



Date: 14.NOV.2016 15:24:24

Figure 8.2-15: *Dwell time- Modulation 2*



Date: 14.NOV.2016 15:39:17

Figure 8.2-16: *Dwell time- Modulation 3*

8.3 FCC 15.247(b) and RSS-247 5.4 (1) Transmitter output power and e.i.r.p. requirements

8.3.1 Definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

IC:

For FHSs operating in the band 902–928 MHz, the maximum peak conducted output power shall not exceed 1.0 W (30 dBm), and the e.i.r.p. shall not exceed 4 W (36 dBm) if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W (24 dBm) and the e.i.r.p. shall not exceed 1 W (30 dBm) if the hopset uses less than 50 hopping channels.

8.3.2 Test summary

Test date	November 14, 2016	Temperature	22 °C
Test engineer	Yong Huang	Air pressure	1000 mbar
Verdict	Pass	Relative humidity	46 %

8.3.3 Observations, settings and special notes

Spectrum analyser settings for output power:

Resolution bandwidth	> the 20 dB bandwidth of the emission being measured
Video bandwidth	≥ RBW
Frequency span	approximately 5 times the 20 dB bandwidth, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

8.3.4 Test data

Table 8.3-1: *Output power and EIRP results*

Modulation scheme	Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
1	2402	1.2	30	28.8	2.1	3.3	36	32.7
	2441	1.8	30	28.2	2.1	3.9	36	32.1
	2480	0.8	30	29.2	2.1	2.9	36	33.1
2	2402	3.3	30	26.7	2.1	5.4	36	30.6
	2441	3.7	30	26.3	2.1	5.8	36	30.2
	2480	2.8	30	27.2	2.1	4.9	36	31.1
3	2402	3.7	30	26.3	2.1	5.8	36	30.2
	2441	4.1	30	25.9	2.1	6.2	36	29.8
	2480	3.3	30	26.7	2.1	5.4	36	30.6

EIRP = Output power + Antenna gain

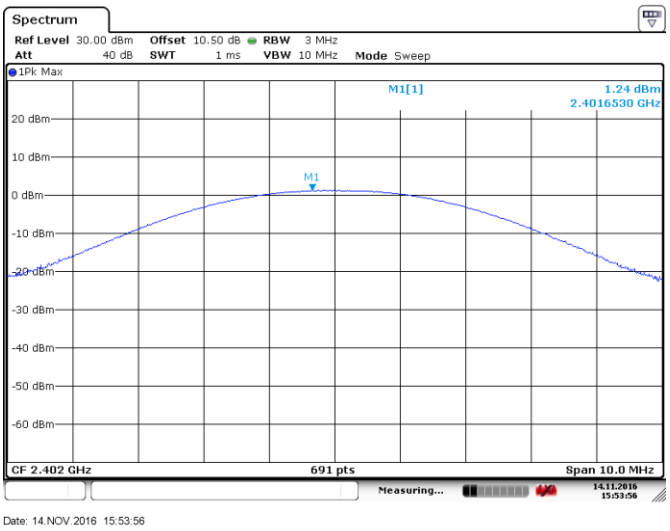


Figure 8.3-1: *Output power on low channel, Modulation 1*

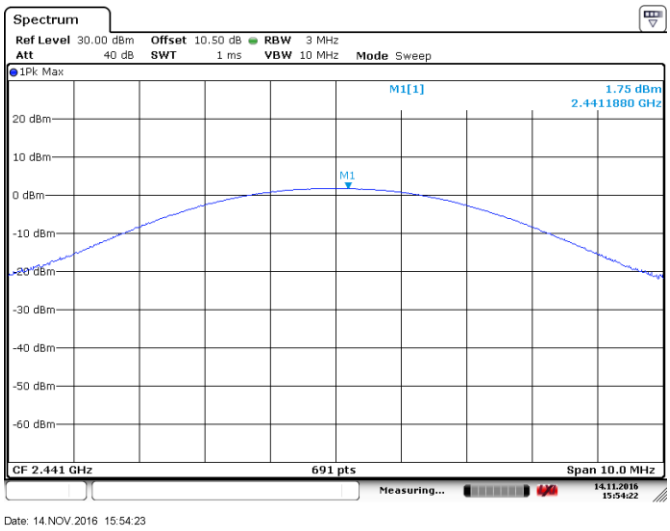


Figure 8.3-2: *Output power on mid channel, Modulation 1*

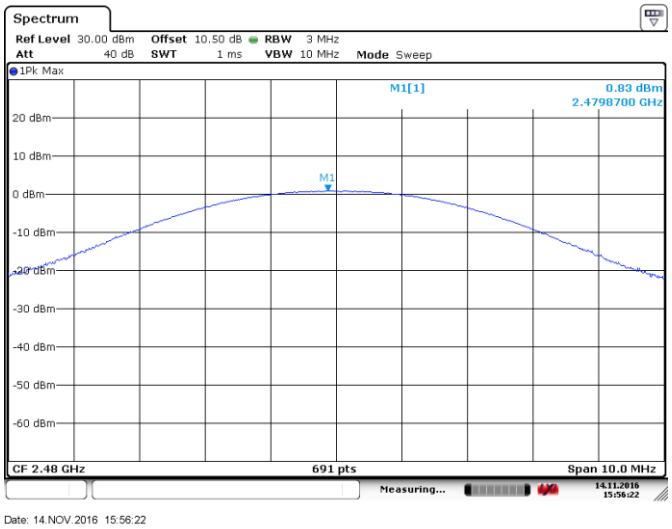


Figure 8.3-3: *Output power on high channel, Modulation 1*

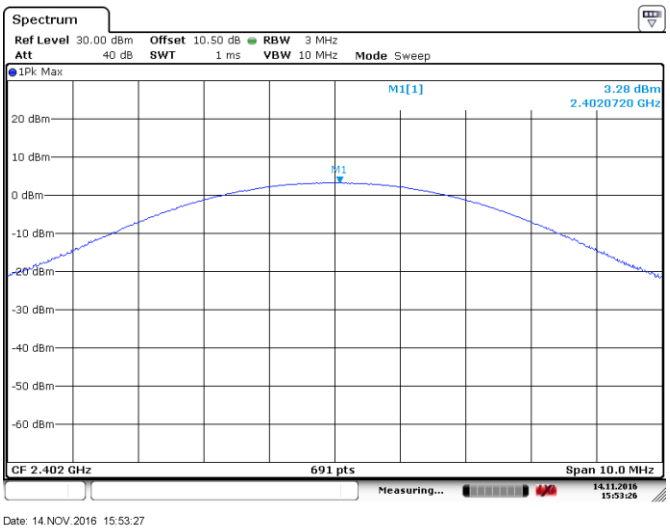


Figure 8.3-4: *Output power on low channel, Modulation 2*

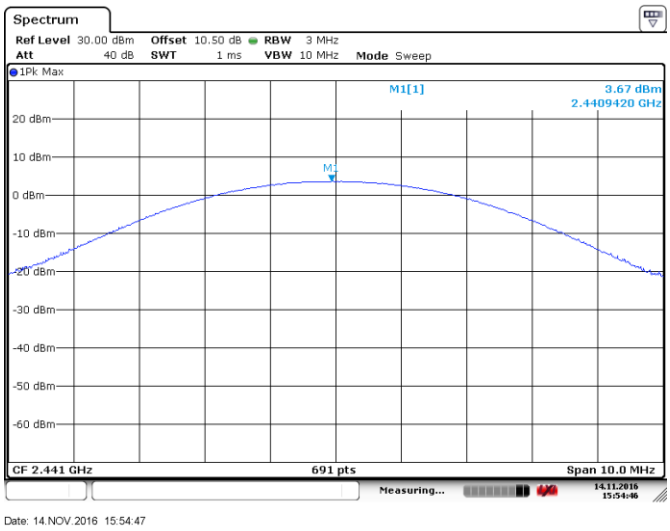


Figure 8.3-5: *Output power on mid channel, Modulation 2*

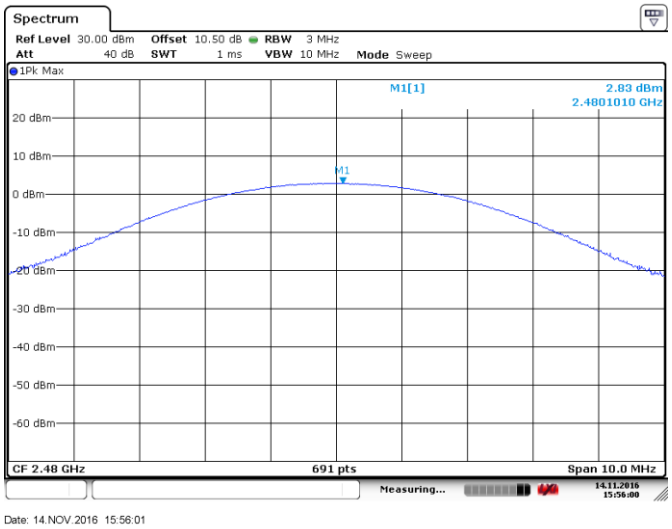


Figure 8.3-6: *Output power on high channel, Modulation 2*

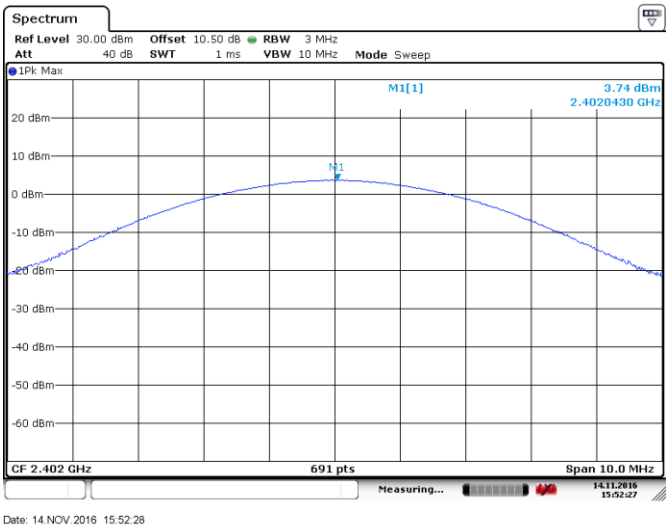


Figure 8.3-7: *Output power on low channel, Modulation 3*

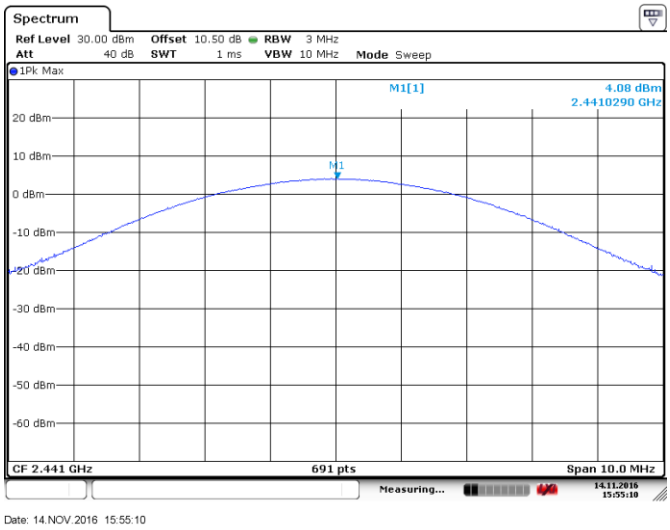


Figure 8.3-8: *Output power on mid channel, Modulation 3*

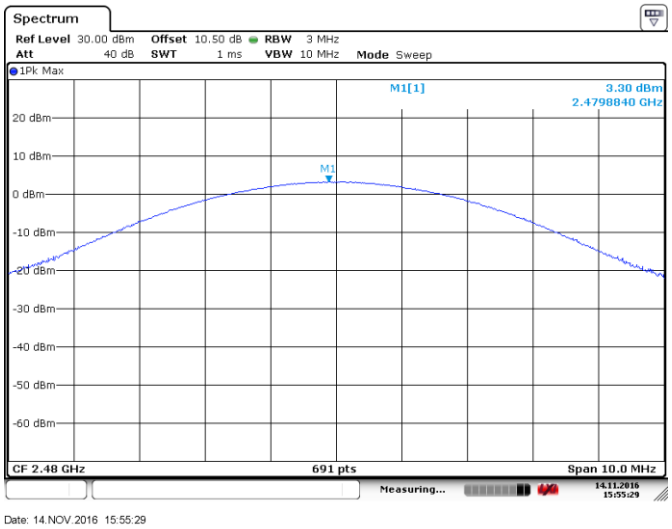


Figure 8.3-9: *Output power on high channel, Modulation 3*

8.4 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions

8.4.1 Definitions and limits

FCC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

IC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.4-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.4-2: *IC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677-5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

Table 8.4-3: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.4.2 Test summary

Test date	October 16, 2016to November 14, 2016	Temperature	22 °C
Test engineer	Yong Huang	Air pressure	1000 mbar
Verdict	Pass	Relative humidity	46 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit with 100 % duty cycle.

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for average radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data

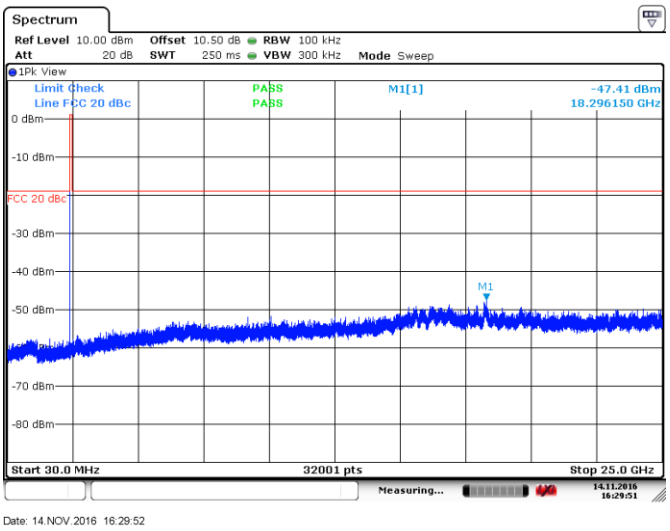


Figure 8.4-1: *Conducted spurious emissions for low channel, Modulation 1*

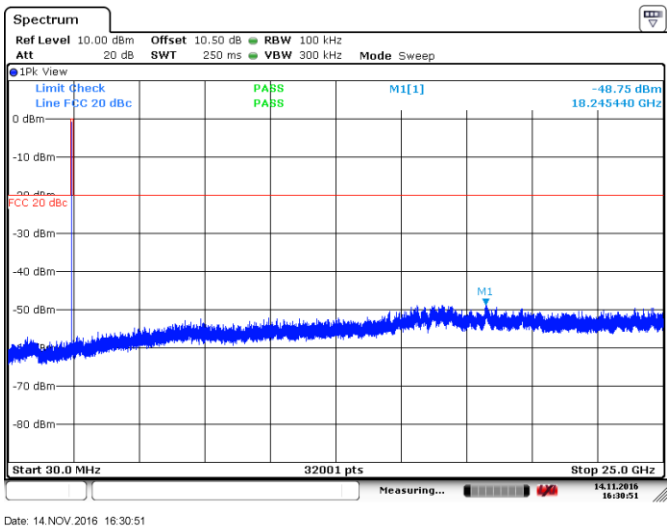


Figure 8.4-2: *Conducted spurious emissions for mid channel, Modulation 1*

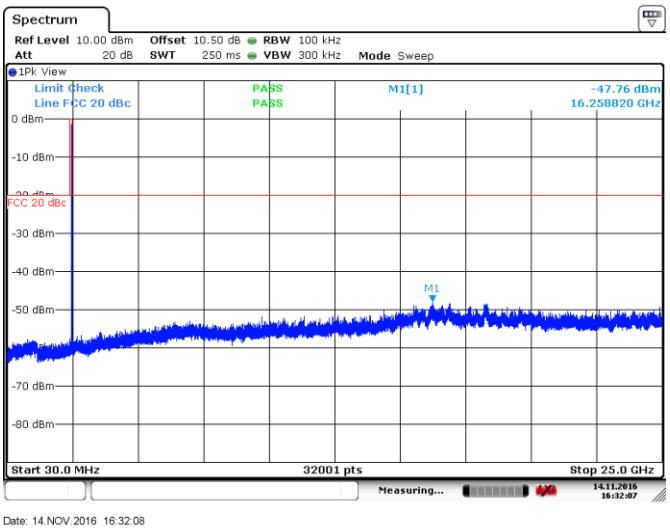
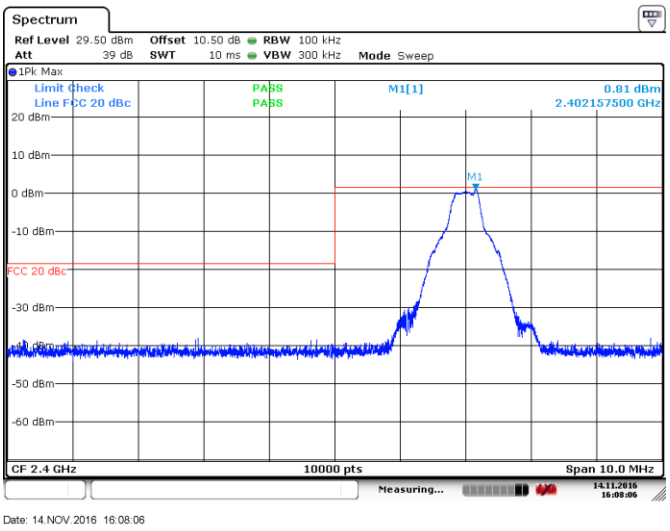
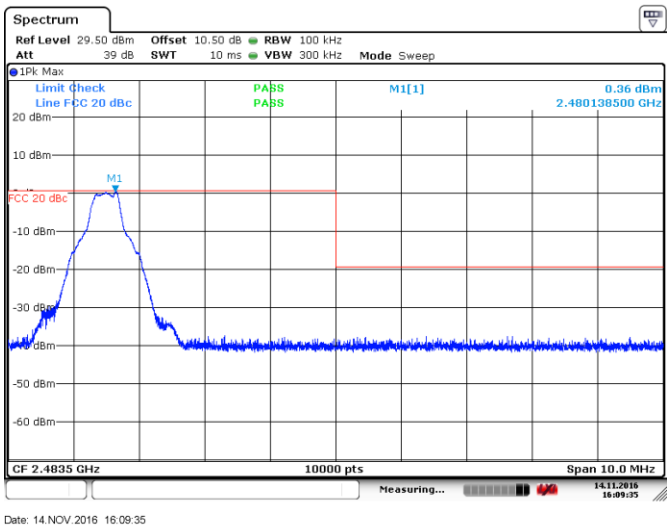


Figure 8.4-3: *Conducted spurious emissions for high channel, Modulation 1*



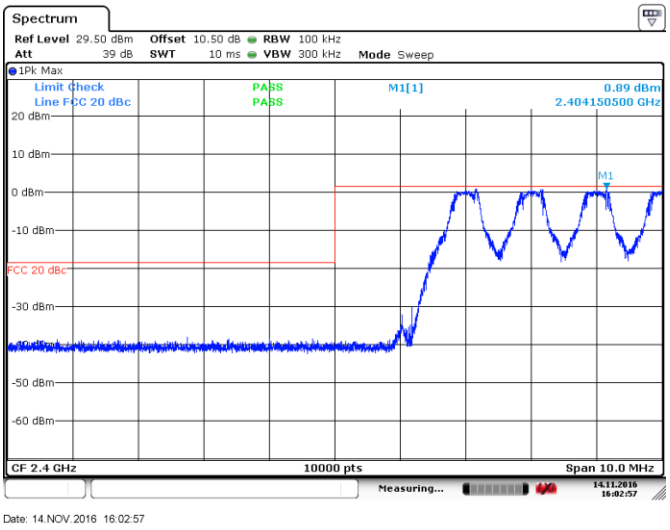
Date: 14.NOV.2016 16:08:06

Figure 8.4-4: *Conducted spurious emissions at the lower band edge, Modulation 1*



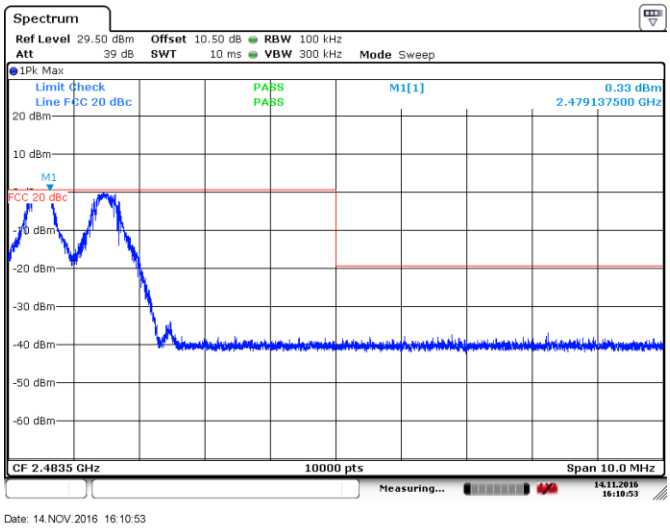
Date: 14.NOV.2016 16:09:35

Figure 8.4-5: *Conducted spurious emissions at the upper band edge, Modulation 1*



Date: 14.NOV.2016 16:02:57

Figure 8.4-6: *Conducted spurious emissions at the lower band edge hopping, Modulation 1*



Date: 14.NOV.2016 16:10:53

Figure 8.4-7: *Conducted spurious emissions for high channel hopping, Modulation 1*

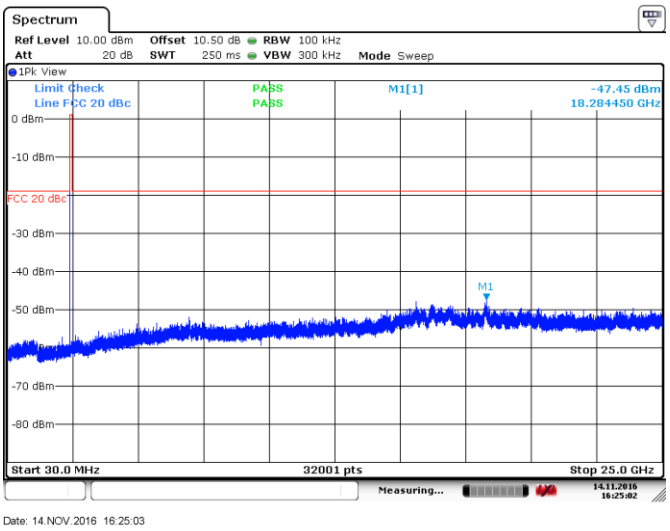


Figure 8.4-8: *Conducted spurious emissions for low channel, Modulation 2*

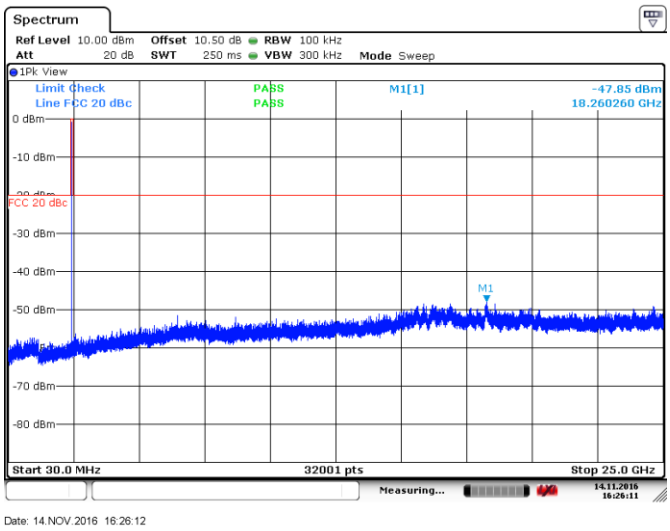


Figure 8.4-9: *Conducted spurious emissions for mid channel, Modulation 2*

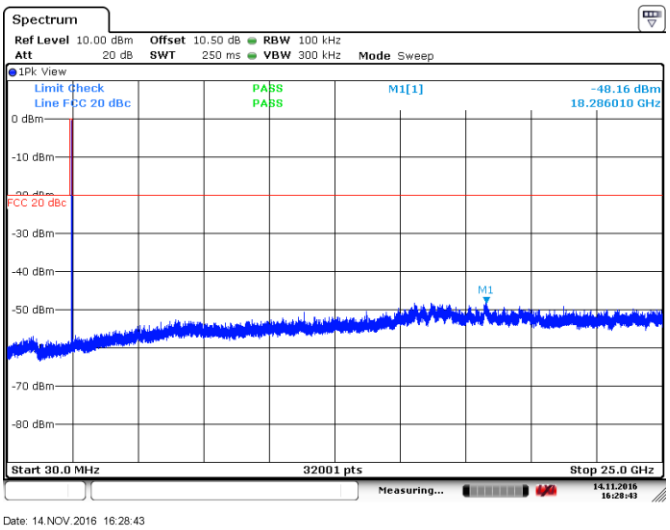


Figure 8.4-10: *Conducted spurious emissions for high channel, Modulation 2*

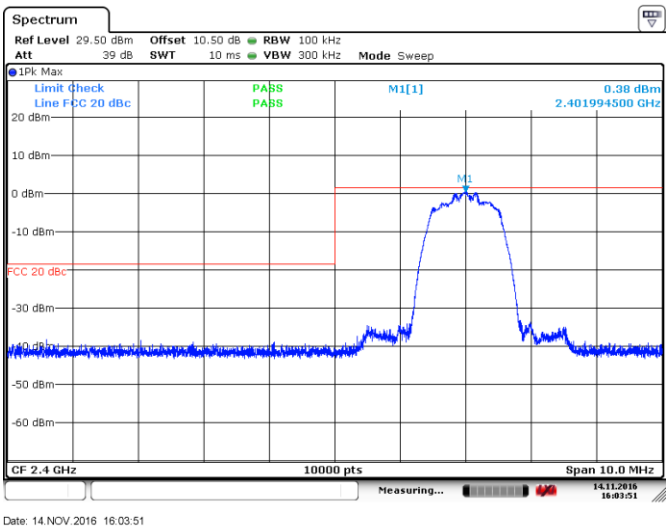


Figure 8.4-11: *Conducted spurious emissions at the lower band edge, Modulation 2*

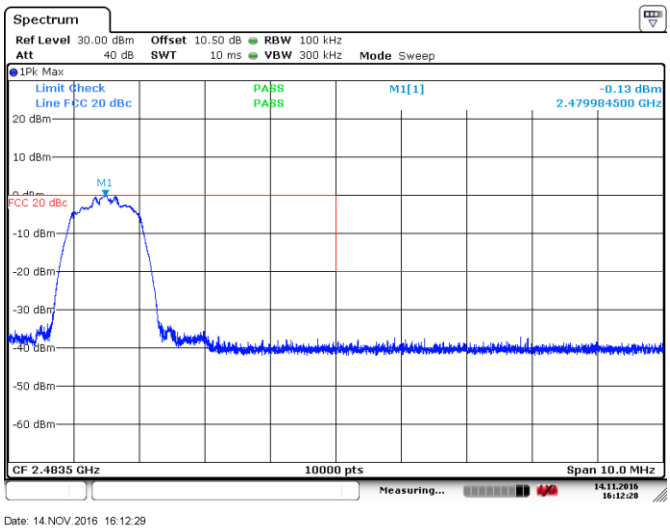


Figure 8.4-12: *Conducted spurious emissions at the upper band edge, Modulation 2*

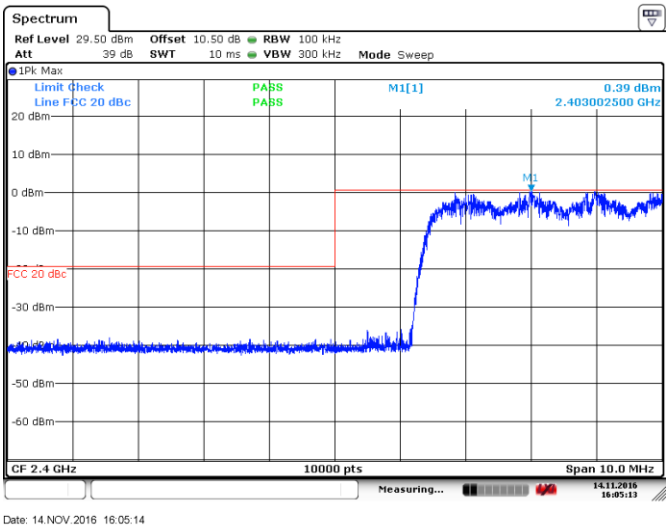


Figure 8.4-13: *Conducted spurious emissions at the lower band edge hopping, Modulation 2*

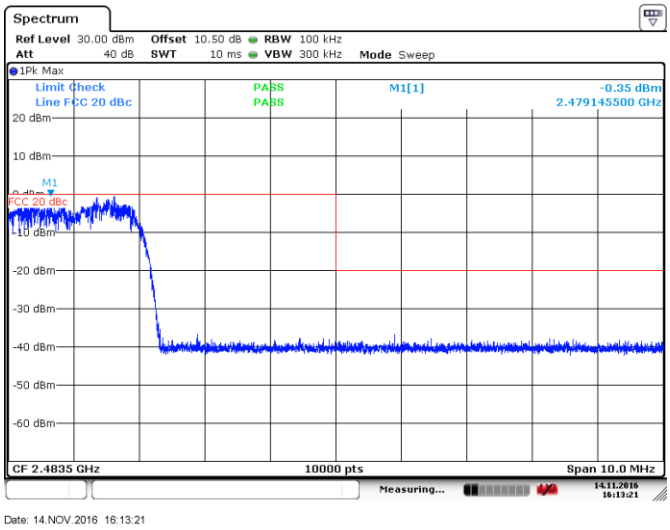


Figure 8.4-14: *Conducted spurious emissions for high channel hopping, Modulation 2*

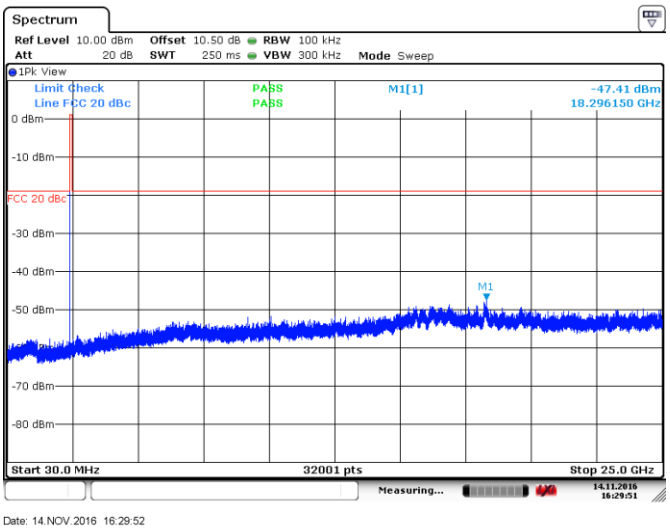


Figure 8.4-15: *Conducted spurious emissions for low channel, Modulation 3*

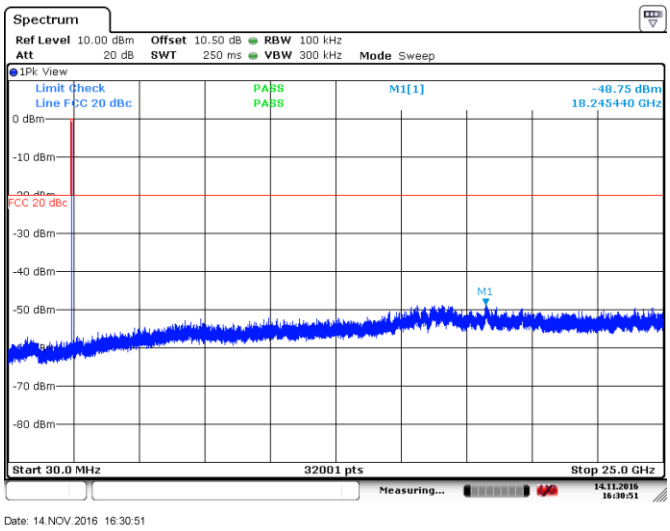


Figure 8.4-16: *Conducted spurious emissions for mid channel, Modulation 3*

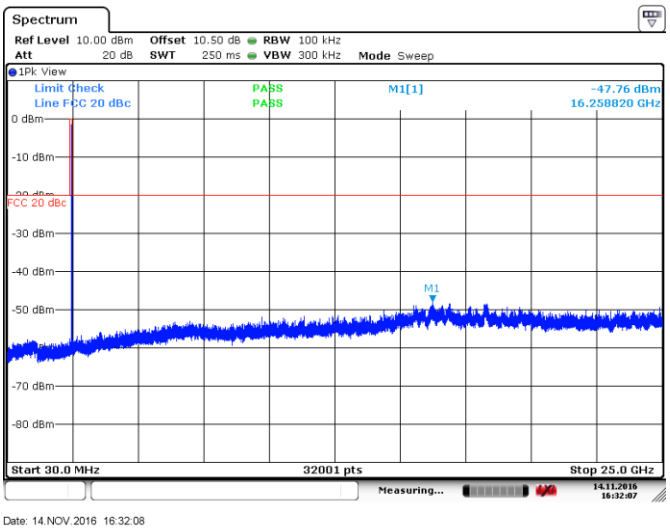


Figure 8.4-17: *Conducted spurious emissions for high channel, Modulation 3*

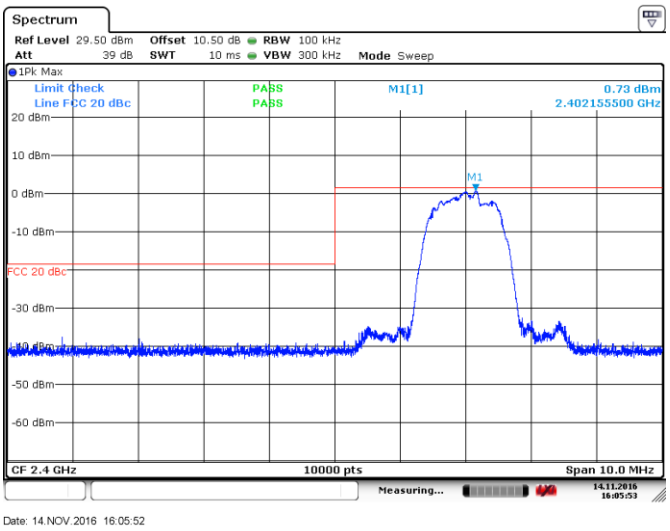


Figure 8.4-18: *Conducted spurious emissions at the lower band edge, Modulation 3*

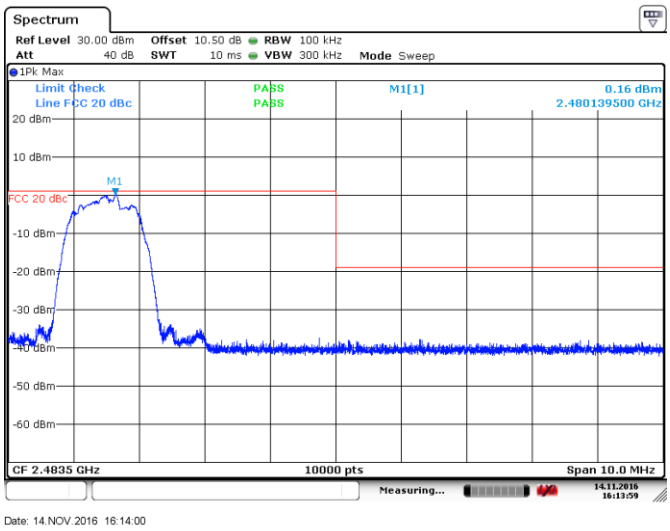


Figure 8.4-19: *Conducted spurious emissions at the upper band edge, Modulation 3*

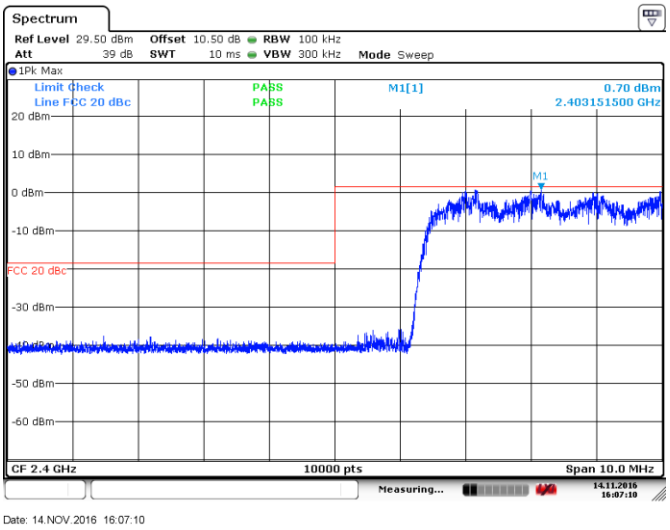


Figure 8.4-20: *Conducted spurious emissions at the lower band edge hopping, Modulation 3*

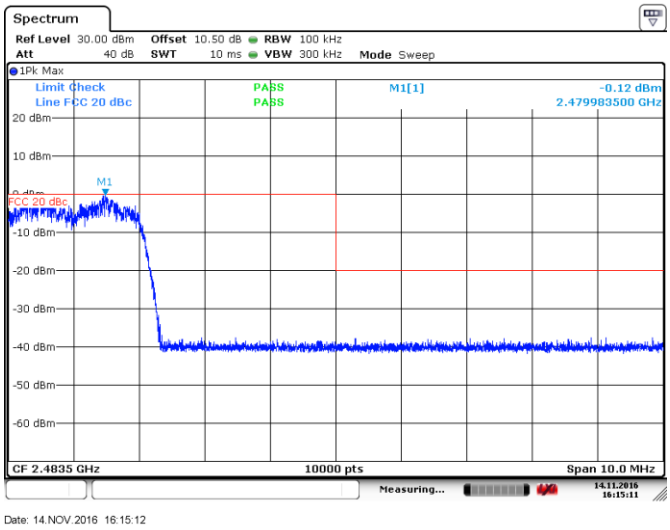


Figure 8.4-21: *Conducted spurious emissions for high channel hopping, Modulation 3*

Table 8.4-4: *Radiated field strength measurement results for band edge*

Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
	Measured	Limit		Measured	Limit	
2390	36.1	74	37.9	25.1	54	28.9
2483.5	36.1	74	37.9	24.4	54	29.6

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable. Peak reading is less than Average.

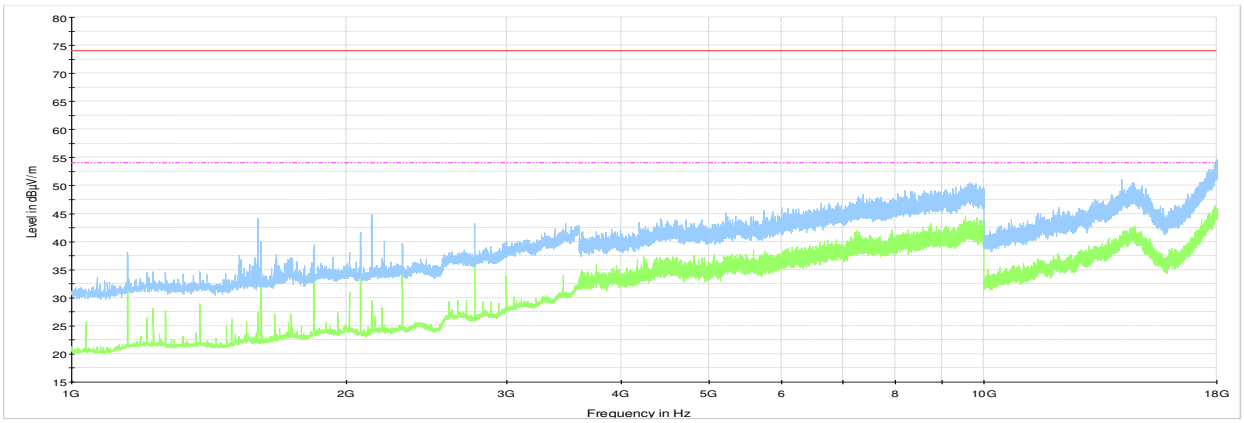


Figure 8.4-22: Radiated spurious emissions 1 to18 GHz, Low channel

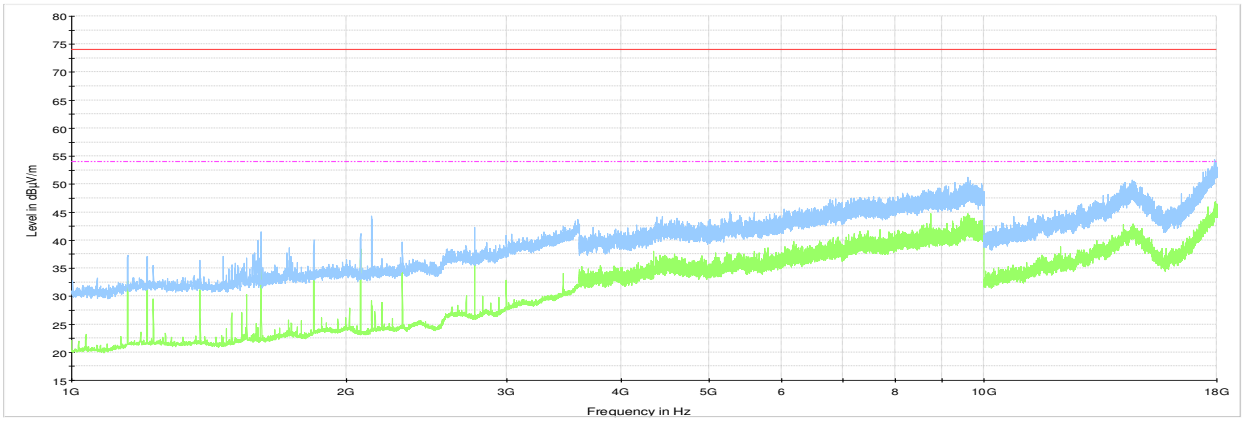


Figure 8.4-23: Radiated spurious emissions 1 to18 GHz, mid channel

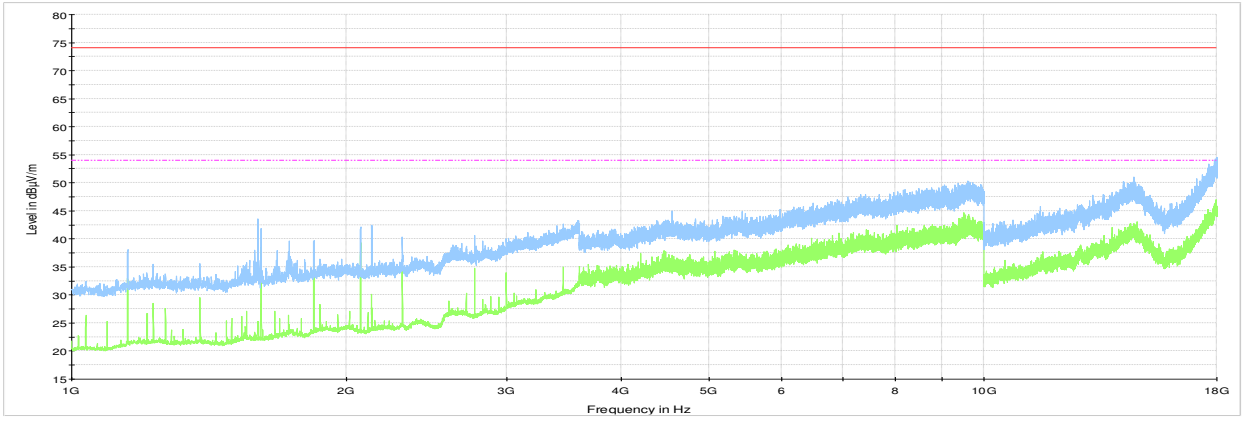
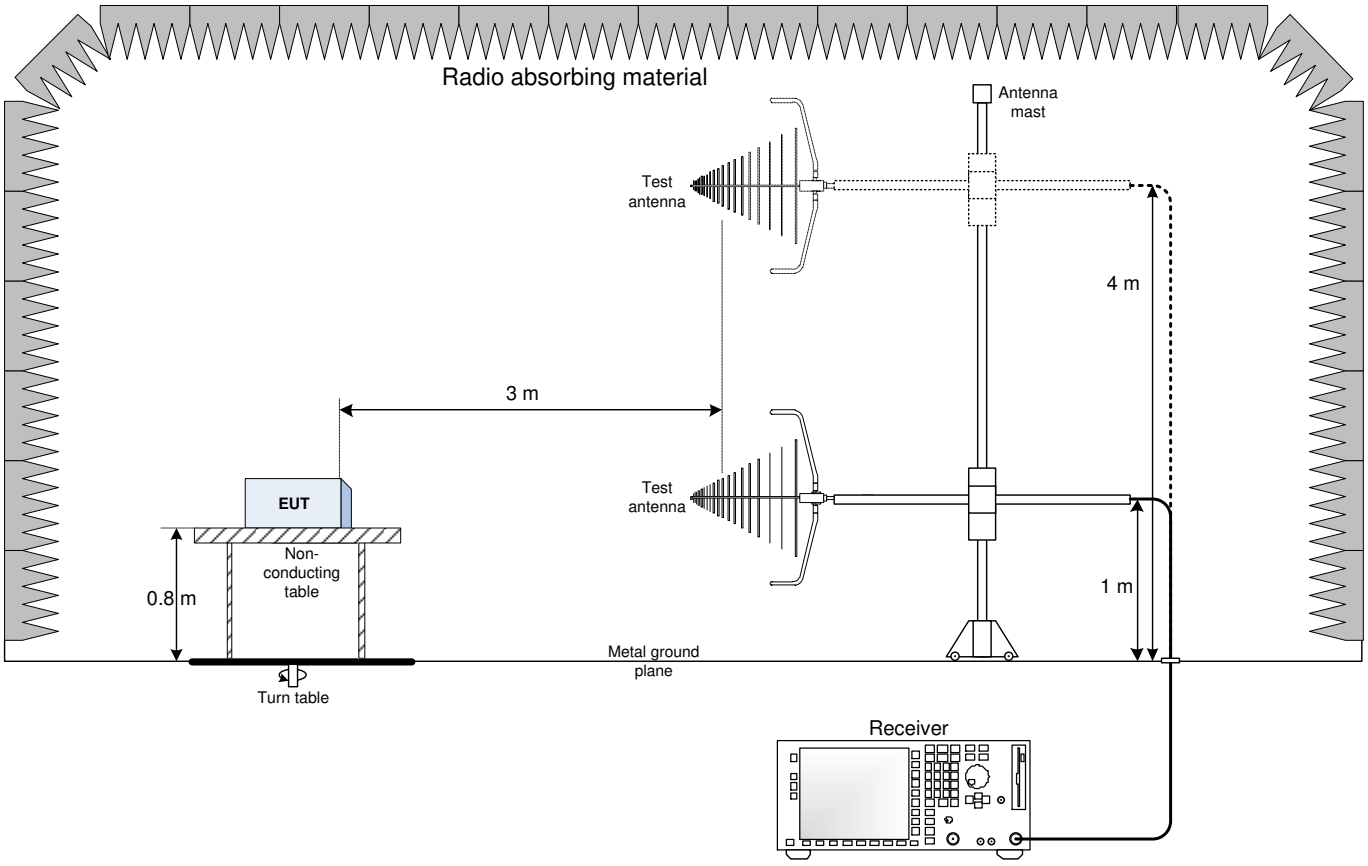


Figure 8.4-24: Radiated spurious emissions 1 to18 GHz, High channel

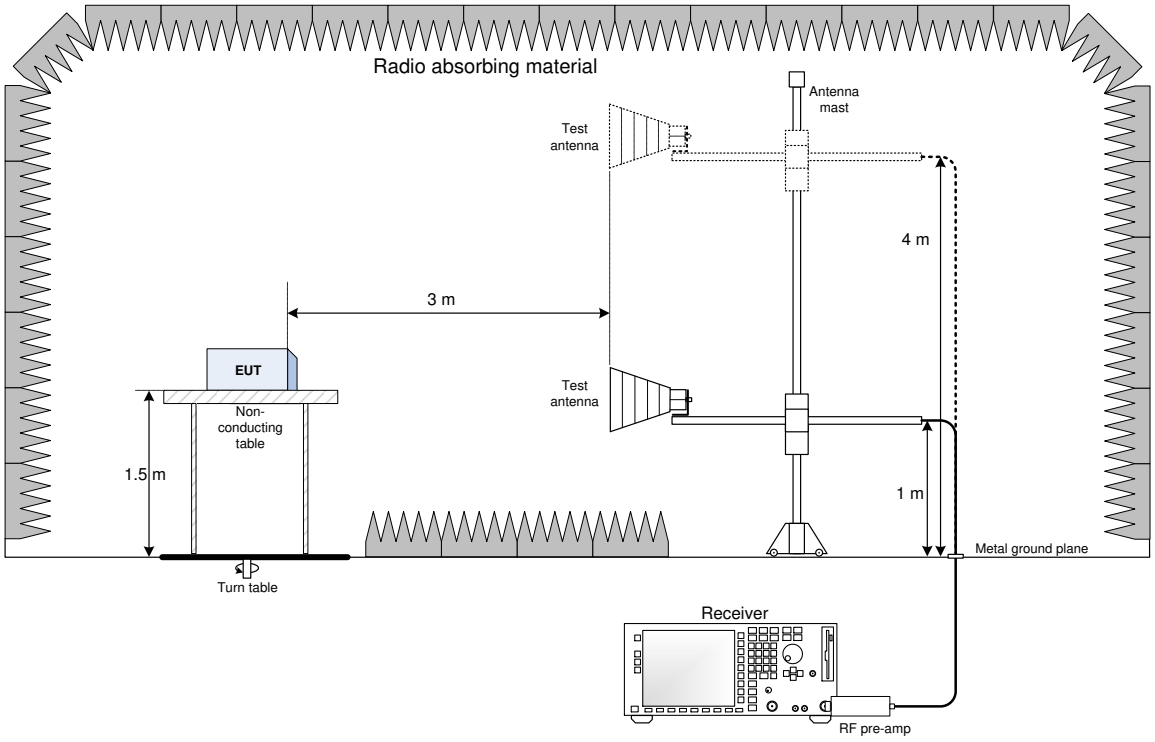
Note: The fundamental emissions were attenuated by notch filter in the plots above. Spectrum was investigated from 30 MHz to 25 GHz, below 1 GHz and above 18 GHz, no emission related to RF porting were detected within 6 dB below the limit.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up