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Test report

274939-2TRFWL

Date of issue: February 10, 2015

Applicant:

Avaya Inc.

Product:

9600 Series IP Deskphone

Model:

9641GS

FCC ID:

TYM-9641GS

IC Registration number:

3794C-9641GS

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

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

- RSS-210, Issue 8, December 2010, Annex 8

  Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

Test location

Company name:	Nemko Canada Inc.
Address:	303 River Road
City:	Ottawa
Province:	Ontario
Postal code:	K1V 1H2
Country:	Canada
Telephone:	+1 613 737 9680
Facsimile:	+1 613 737 9691
Toll free:	+1 800 563 6336
Website:	www.nemko.com
Site number:	FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by:	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by:	Kevin Rose, Wireless/EMC Specialist
Date:	February 10, 2015
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

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Avaya Inc
Address	250 Sidney Street
City	Belleville
Province/State	Ontario
Postal/Zip code	K8P 3Z3
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
RSS-210, Issue 8 Annex 8	Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

1.3 Test methods

FCC Public Notice DA 00-705	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems|
ANSI C64.3 v 2003	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

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 Antennas are 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	Pass
§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-210, Issue 8, test results

Part	Test description	Verdict
A8.1	Frequency hopping systems	
A8.1 (a)	Bandwidth of a frequency hopping channel	Not applicable
A8.1 (b)	Minimum channel spacing for frequency hopping systems	Not applicable
A8.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
A8.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
A8.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
A8.2	Digital modulation systems	
A8.2 (a)	Minimum 6 dB bandwidth	Not applicable
A8.2 (b)	Maximum power spectral density	Not applicable
A8.3	Hybrid systems	
A8.3 (1)	Digital modulation turned off	Not applicable
A8.3 (2)	Frequency hopping turned off	Not applicable
A8.4	Transmitter output power and e.i.r.p. requirements	
A8.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
A8.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
A8.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
A8.4 (4)	Systems employing digital modulation techniques	Not applicable
A8.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
A8.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
A8.5	Out-of-band emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	December 16, 2014
Nemko sample ID number	1, 2

3.2 EUT information

Product name	9600 Series IP Deskphone
Model	9641GS
Serial number	14N543614533, 14N543614504

3.3 Technical information

Operating band	2400–2483.5 MHz
Operating frequency	2402–2480 MHz
Modulation type	GFSK ,QPSK, 8 DPSK
Occupied bandwidth (99 %)	0.990 MHz (GFSK), 1.370 MHz (QPSK), 1.356 (8 DPSK)
Emission designator	990KF1E (GFSK), 1M37G1E (QPSK), 1M36G1E (8 DPSK)
Power requirements	PoE powered from 120 V_{AC}, 60 Hz
Antenna information	Internal non-detachable antenna to the intentional radiator

3.4 Product description and theory of operation

The EUT is an IP Deskphone. It features a Bluetooth capability.

3.5 EUT exercise details

Bluetooth module was connected via service adapter to a PC and controlled using TeraTerm session. EUT was modified to connect directly to the antenna port in order to perform testing conducted.

3.6 EUT setup diagram

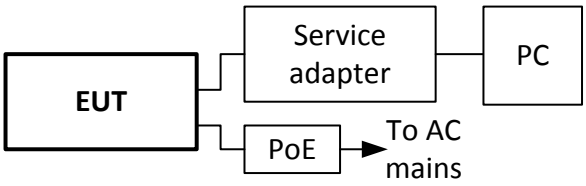


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Service adapter	Avaya		11WZ3965028S
PoE	Avaya	SPPOE-1A	C11526559000003316

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

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

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.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Mar. 18/15
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power source	California Instruments	3001i	FA001021	1 year	June 04/15
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Oct. 24/15
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 27/15
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Mar. 12/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Mar. 10/15
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 21/15
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	2 year	Sept. 06/15
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Oct. 28/15
50 Ω coax cable	Huber + Suhner	None	FA002394	1 year	June 27/15

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:	December 18, 2014	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1006 mbar
Verdict:	Pass	Relative humidity:	31 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

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.

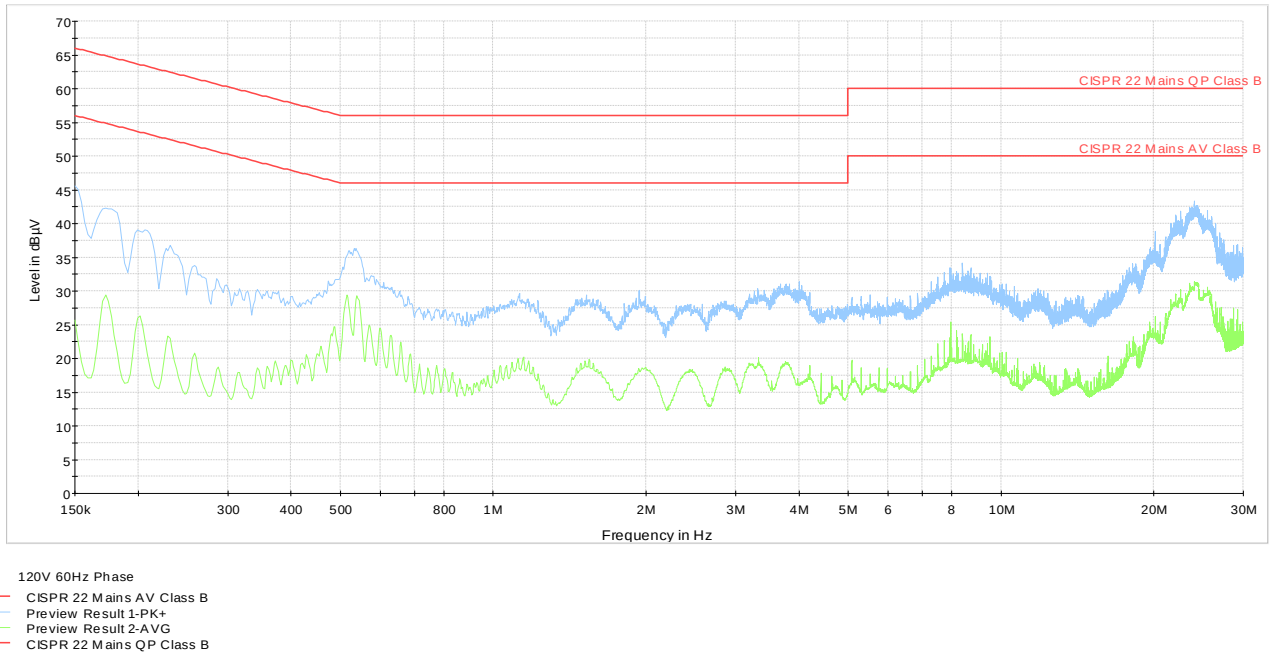
Receiver settings for preview measurements:

Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak and Average
Trace mode:	Max Hold
Measurement time:	1000 ms

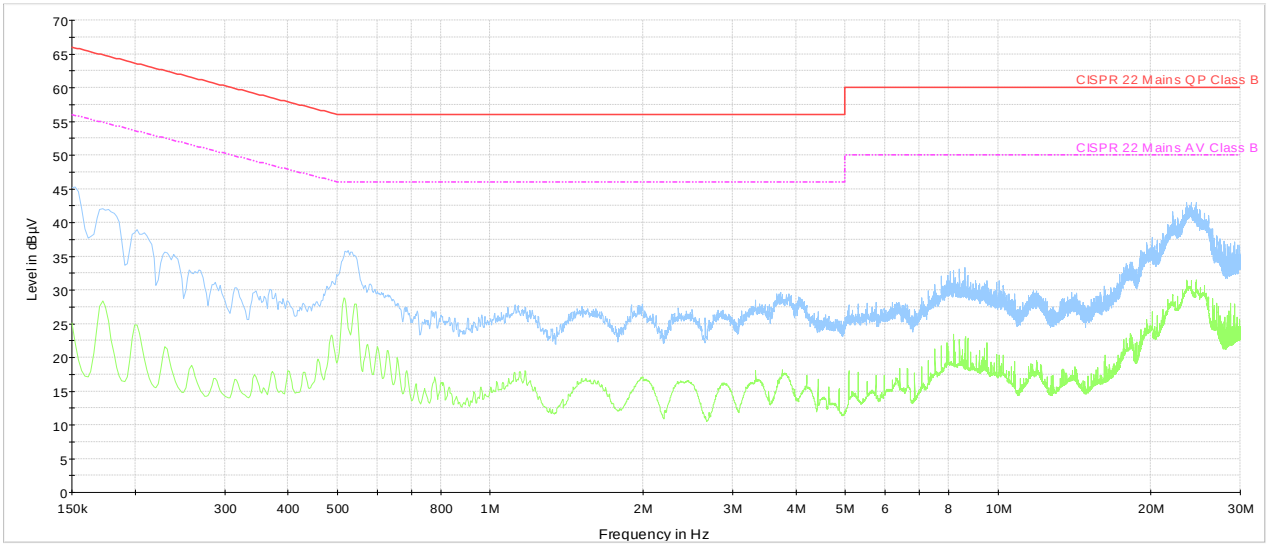
Receiver settings for final measurements:

Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Quasi-Peak and Average
Trace mode:	Max Hold
Measurement time:	1000 ms

8.1.4 Test data



Plot 8.1-1: *Conducted emissions on phase line*



Plot 8.1-2: *Conducted emissions on neutral line*

8.2 FCC 15.247(a)(1)(iii) and RSS-210 A8.1 Frequency hopping requirements

8.2.1 Definitions and limits

FCC/IC:

(a/b) 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 (21 dBm). 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.

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

8.2.2 Test summary

Test date:	December 17, 2014	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1006 mbar
Verdict:	Pass	Relative humidity:	32 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings for carrier frequency separation:

Resolution bandwidth:	100 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for number of hopping frequencies:

Resolution bandwidth:	100 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	The frequency band of operation
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for time of occupancy:

Resolution bandwidth:	1 MHz
Video bandwidth:	≥3 × RBW
Frequency span:	Zero, 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	Frequency, MHz	20 dB bandwidth, kHz	2/3 of 20 dB BW, kHz
GFSK	2402	985.58	657.05
	2440	990.38	660.25
	2480	985.58	657.05
QPSK	2402	1370.19	913.46
	2440	1370.19	913.46
	2480	1370.19	913.46
8 DPSK	2402	1355.77	903.85
	2440	1355.77	903.85
	2480	1355.77	903.85

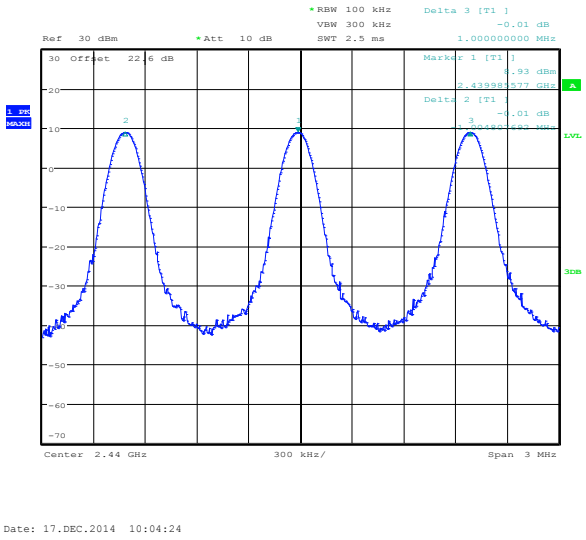


Figure 8.2-1: *Carrier frequency separation, no modulation*

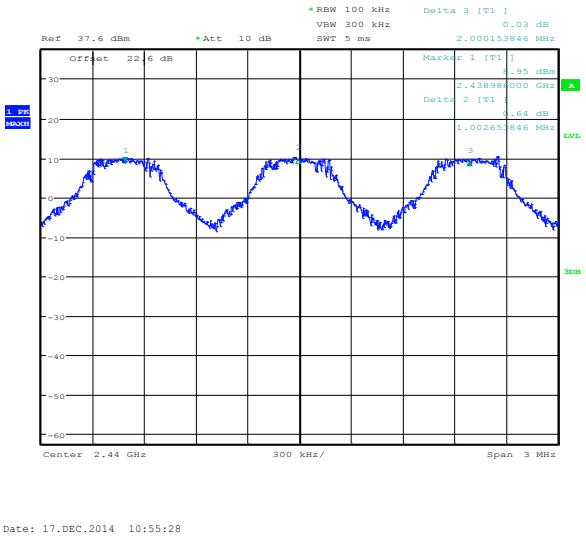


Figure 8.2-2: *Carrier frequency separation, with modulation*

Table 8.2-2: *Carrier frequency separation results*

Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
1000	913	87

Note: Minimum requirement is 2/3 of 20 dB BW (for systems with an output power less than 21 dBm) which is 913 kHz.

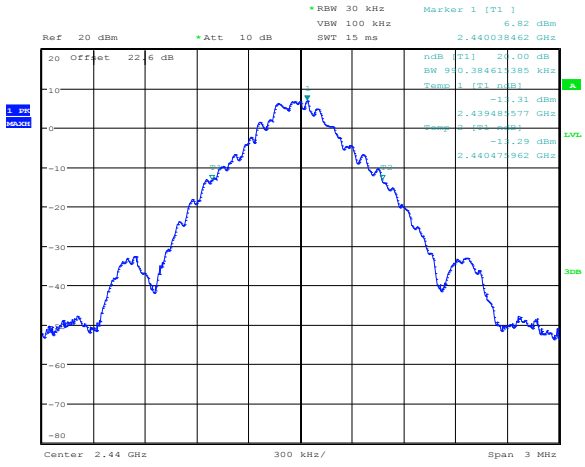


Figure 8.2-3: *20 dB BW, GFSK modulation, sample plot*

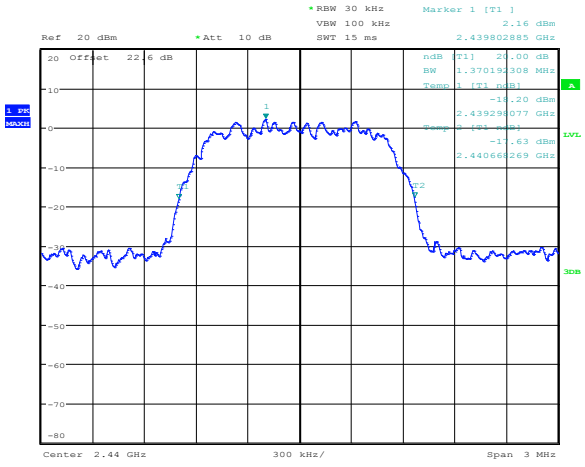


Figure 8.2-4: *20 dB BW, QPSK modulation, sample plot*

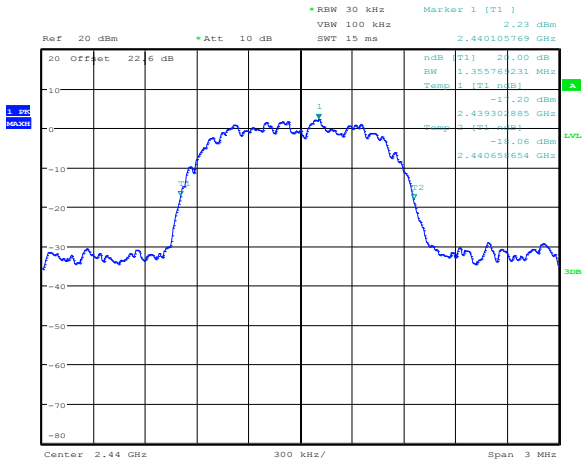


Figure 8.2-5: *20 dB BW, 8 DPSK modulation, sample plot*

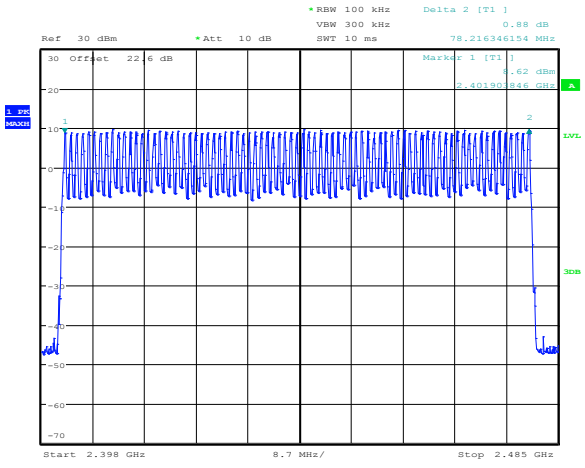


Figure 8.2-6: *Number of hopping channels (79)*

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

Number of hopping channels	Minimum requirement	Margin
79	25	64

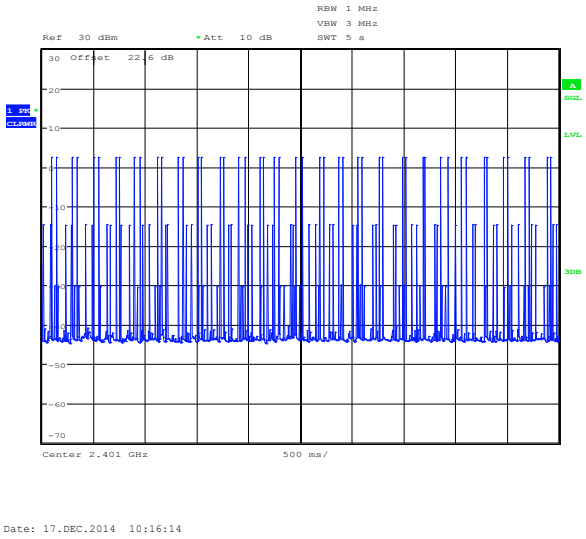


Figure 8.2-7: *Number of hop per single channel, DH1 (50)*

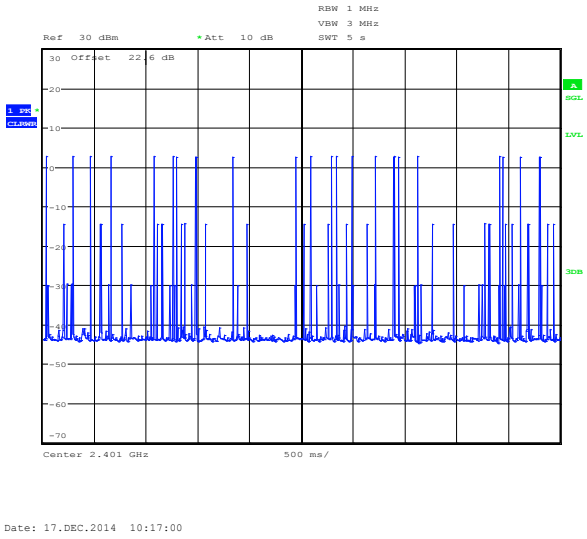


Figure 8.2-8: *Number of hop per single channel, DH3 (22)*

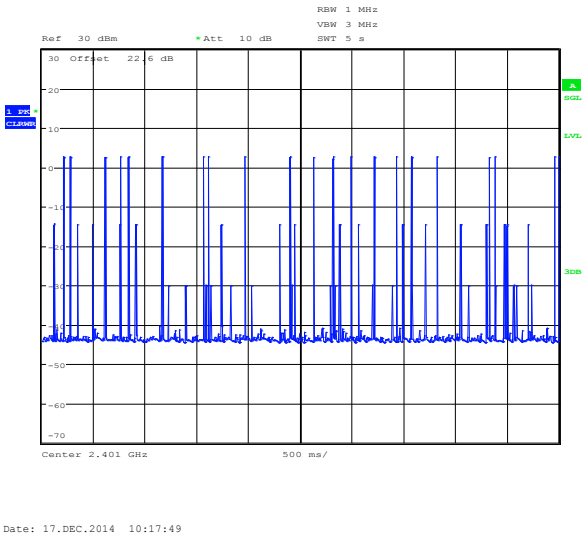


Figure 8.2-9: *Number of hop per single channel, DH5/2 DH5 (20)*

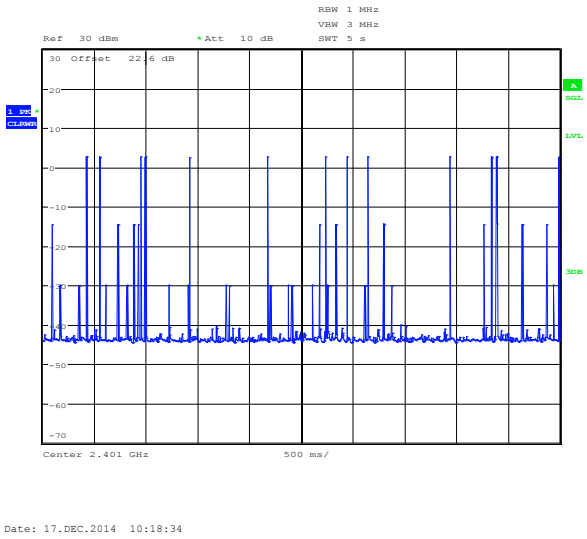


Figure 8.2-10: *Number of hop per single channel, DH5/3 DH5 (13)*

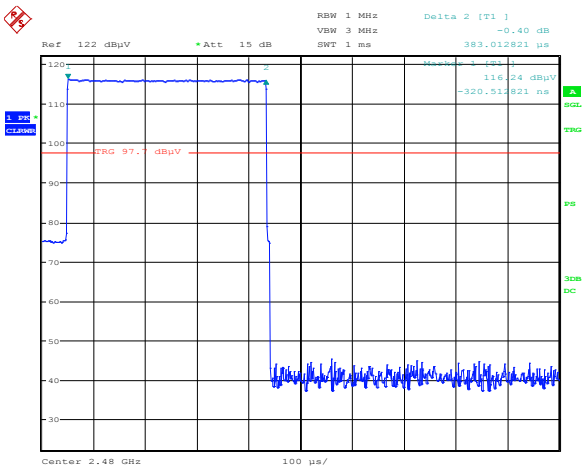


Figure 8.2-11: *Pulse width at DH1*

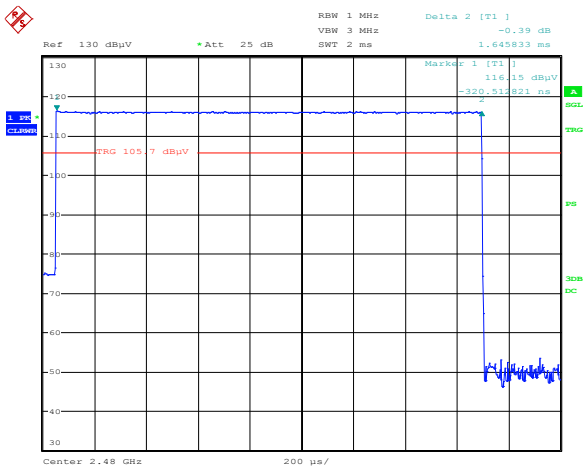


Figure 8.2-12: *Pulse width at DH3*

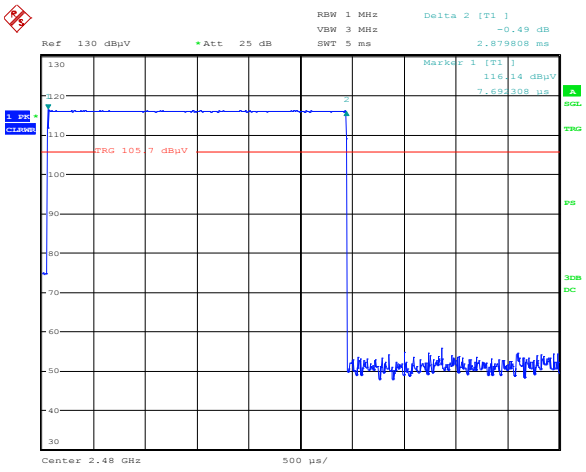


Figure 8.2-13: *Pulse width at DH5_2*

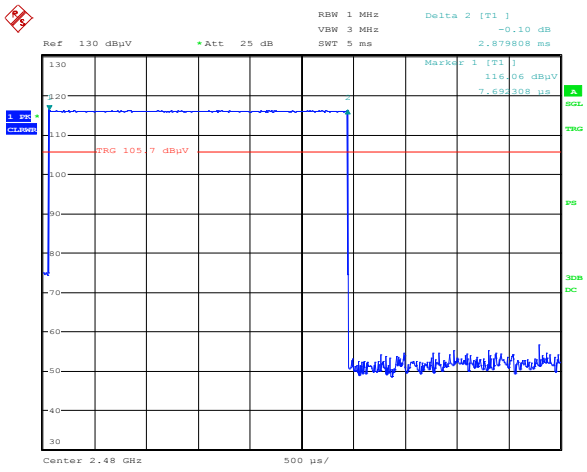


Figure 8.2-14: *Pulse width at DH5_3*

The measurement period is 0.4 s × 79 (channels) = 31.6 s. All measurements were performed within 5 s frame, therefore total repetitions have to be multiplied by 6.32 (= 31.6 ÷ 5).

Dwell time calculation.

For DH1/2–DH1: T_{DWELL} = 0.383 ms × 50 × 6.32 = 121.03 ms

For DH3/3–DH3: T_{DWELL} = 1.646 ms × 22 × 6.32 = 228.86 ms

For DM5/2 DH5: T_{DWELL} = 2.880 ms × 20 × 6.32 = 364.03 ms

For DM5/3 DH5: T_{DWELL} = 2.880 ms × 13 × 6.32 = 236.62 ms

Dwell time limit is 400 ms.

8.3 RSS-Gen 4.6.1 Occupied bandwidth

8.3.1 Definitions and limits

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 percent emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 percent of the selected span as is possible without being below 1 percent. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 percent of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded.

The span between the two recorded frequencies is the occupied bandwidth.

8.3.2 Test summary

Test date:	December 17, 2014	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1005 mbar
Verdict:	Pass	Relative humidity:	32 %

8.3.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	30 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

8.3.4 Test data

Table 8.3-1: *99 % bandwidth results*

Modulation	Frequency, MHz	99 % occupied bandwidth, kHz
GFSK	2402	908.65
	2440	908.65
	2480	908.65
QPSK	2402	1211.54
	2440	1211.54
	2480	1211.54
8 DPSK	2402	1216.35
	2440	1221.54
	2480	1221.15

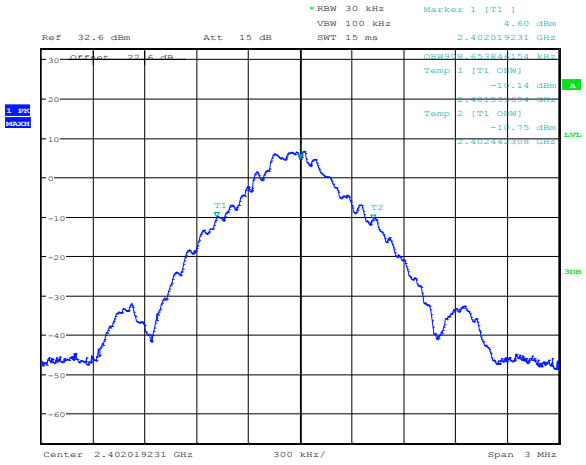


Figure 8.3-1: *99 % bandwidth on GFSK, sample plot*

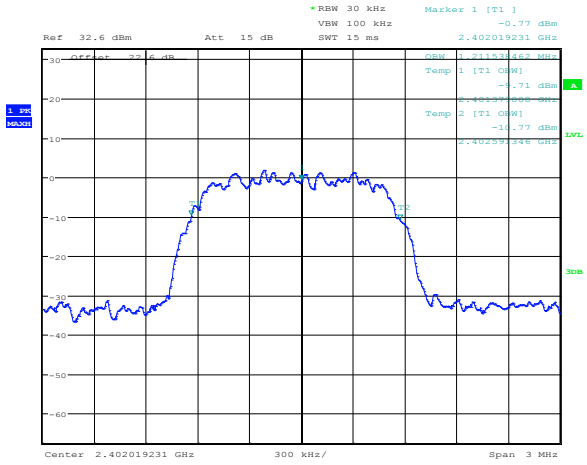


Figure 8.3-2: *99 % bandwidth on QPSK, sample plot*

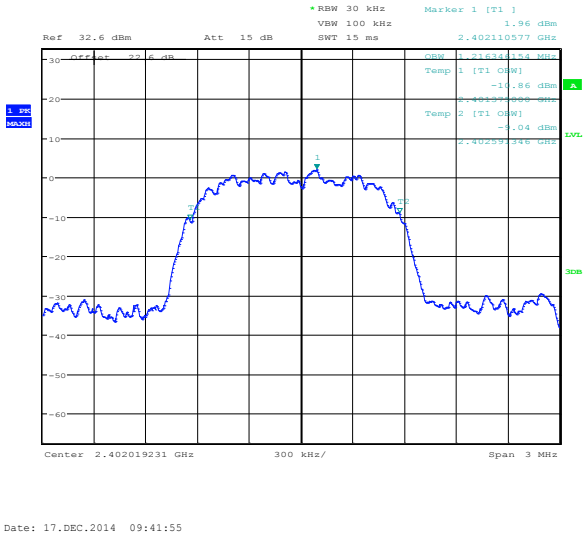


Figure 8.3-3: *99 % bandwidth on 8 DPSK, sample plot*

8.4 FCC 15.247(b)(1) and RSS-210 A8.4 (2) Transmitter output power and e.i.r.p. requirements

8.4.1 Definitions and limits

FCC:
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 W (30 dBm). For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 W (21 dBm).
IC:
A8.4 (2) Transmitter Output Power and e.i.r.p. Requirements for frequency hopping systems operating in the band 2400–2483.5 MHz
For frequency hopping systems operating in the band 2400–2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. Except as provided in Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

8.4.2 Test summary

Test date:	December 17, 2014	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1005 mbar
Verdict:	Pass	Relative humidity:	32 %

8.4.3 Observations, settings and special notes

Output power was performed on a specially modified sample with RF connector.
Spectrum analyser settings:

Resolution bandwidth:	≥2 MHz
Video bandwidth:	5 MHz
Frequency span:	10 MHz
Detector mode:	Peak
Trace mode:	Max hold

8.4.4 Test data

Table 8.4-1: *Output power measurements results*

Modulation	Frequency, MHz	Conducted output power, dBm		Margin, dB
		Measured	Limit	
GFSK	2402	9.93	30.00	20.07
	2440	10.14	30.00	19.86
	2480	10.07	30.00	19.93
QPSK	2402	10.48	30.00	19.52
	2440	10.69	30.00	19.31
	2480	10.67	30.00	19.33
8 DPSK	2402	10.95	30.00	19.05
	2440	11.08	30.00	18.92
	2480	10.97	30.00	19.03

Table 8.4-2: *EIRP measurements results*

Modulation	Frequency, MHz	Field strength, dBµV/m	Correction factor, dB	EIRP, dBm	Limit, dBm	Margin, dB
GFSK	2402	98.65	95.23	3.42	36.00	32.58
	2440	99.01	95.23	3.78	36.00	32.22
	2480	99.89	95.23	4.66	36.00	31.34
QPSK	2402	99.94	95.23	4.71	36.00	31.29
	2440	99.48	95.23	4.25	36.00	31.75
	2480	100.31	95.23	5.08	36.00	30.92
8 DPSK	2402	100.30	95.23	5.07	36.00	30.93
	2440	100.11	95.23	4.88	36.00	31.12
	2480	100.80	95.23	5.57	36.00	30.43

Note: EIRP = Field strength – Correction factor

Correction factor is a conversion from field strength measured at the distance of 3 m to EIRP using free space attenuation for calculation.

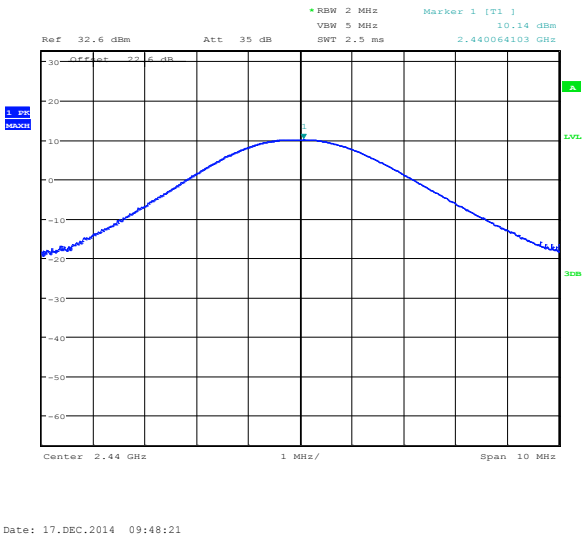


Figure 8.4-1: *Output power on GFSK, sample plot*

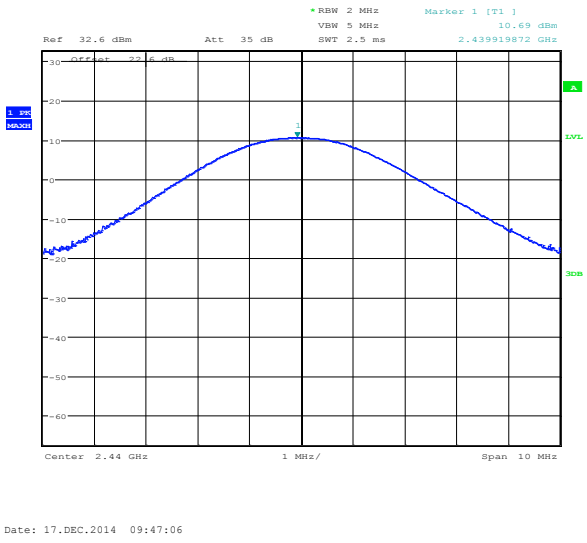


Figure 8.4-2: *Output power on QPSK, sample plot*

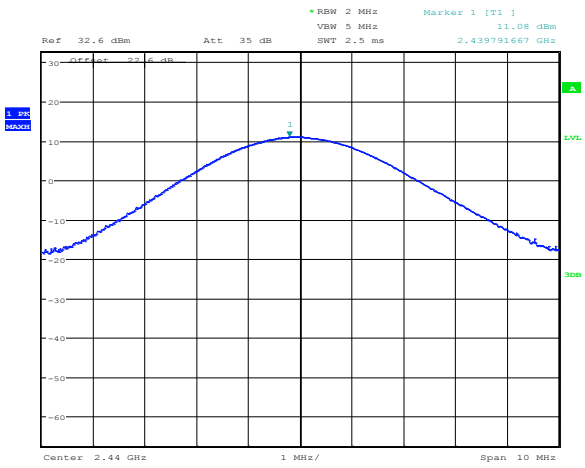


Figure 8.4-3: *Output power on 8 DPSK, sample plot*

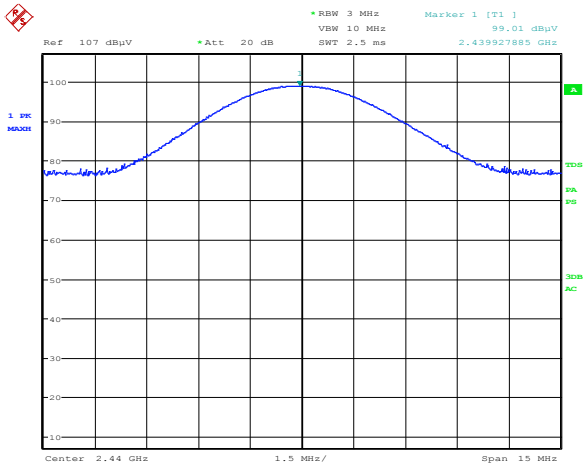


Figure 8.4-4: *Field strength on GFSK, sample plot*

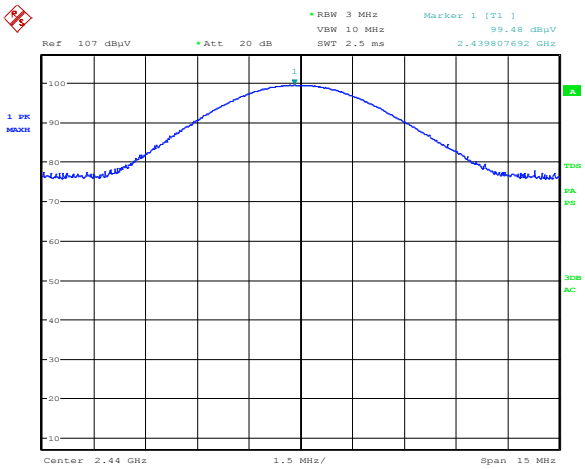


Figure 8.4-5: *Output power on QPSK, sample plot*

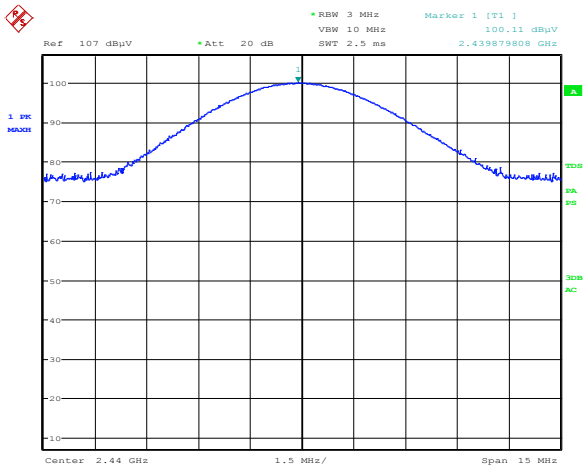


Figure 8.4-6: *Field strength on 8 DPSK, sample plot*

8.5 FCC 15.247(d) and RSS-210 A8.5 Spurious (out-of-band) emissions

8.5.1 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

IC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency 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 the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required.

Table 8.5-1: *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 8.5-2: *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 8.5-2 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

8.5.1 Definitions and limits, continued

Table 8.5-3: *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			

8.5.2 Test summary

Test date:	December 17, 2014	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1005 mbar
Verdict:	Pass	Relative humidity:	32 %

8.5.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
Radiated measurements were performed at a distance of 3 m.

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

Resolution bandwidth:	120 kHz
Video bandwidth:	300 kHz
Detector mode:	Quasi-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

8.5.3 Observations, settings and special notes, continued

Spectrum analyser settings for conducted spurious emissions measurements:

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

8.5.4 Test data

Table 8.5-4: *Radiated field strength measurement results for GFSK*

Channel	Frequency, MHz	Peak Field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Average correction factor, dB	Average Field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
Low	2390.00	51.90	74.00	22.10	-24.79	27.11	54.00	26.89
Low	4804.50	60.17	74.00	13.83	-24.79	35.38	54.00	18.62
Mid	4880.00	55.35	74.00	18.65	-24.79	30.56	54.00	23.44
Mid	7319.60	63.11	74.00	10.89	-24.79	38.32	54.00	15.68
High	2483.50	52.03	74.00	21.97	-24.79	27.24	54.00	26.76
High	7440.00	62.26	74.00	11.74	-24.79	37.47	54.00	16.53

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.5-5: *Radiated field strength measurement results for QPSK*

Channel	Frequency, MHz	Peak Field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Average correction factor, dB	Average Field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
Low	2390.00	51.88	74.00	22.12	-24.79	27.09	54.00	26.91
Low	4804.00	61.89	74.00	12.11	-24.79	37.10	54.00	16.90
Mid	4880.00	55.56	74.00	18.44	-24.79	30.77	54.00	23.23
Mid	7319.57	61.95	74.00	12.05	-24.79	37.16	54.00	16.84
High	2483.50	52.48	74.00	21.52	-24.79	27.69	54.00	26.31
High	7439.70	60.43	74.00	13.57	-24.79	35.64	54.00	18.36

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.5-6: *Radiated field strength measurement results for 8 DPSK*

Channel	Frequency, MHz	Peak Field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Average correction factor, dB	Peak Field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
Low	2390.00	51.92	74.00	22.08	-24.79	27.13	54.00	26.87
Low	4804.00	61.63	74.00	12.37	-24.79	36.84	54.00	17.16
Mid	4881.00	55.53	74.00	18.47	-24.79	30.74	54.00	23.26
Mid	7320.00	63.21	74.00	10.79	-24.79	38.42	54.00	15.58
High	2483.50	53.27	74.00	20.73	-24.79	28.48	54.00	25.52
High	7440.00	64.26	74.00	9.74	-24.79	39.47	54.00	14.53

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Duty cycle/average correction factor calculations:
For DH1: $20 \times \log_{10}((0.383 \times 3) \div 100) = -38.79$ dB
For DH3: $20 \times \log_{10}((1.644 \times 2) \div 100) = -29.66$ dB
For DM5/2–DH5: $20 \times \log_{10}((2.88 \times 2) \div 100) = -24.79$ dB
For DM5/3–DH5: $20 \times \log_{10}((2.88 \times 2) \div 100) = -24.79$ dB
Lowest duty cycle/average correction factor was selected for average calculations as a worst case emissions scenario.

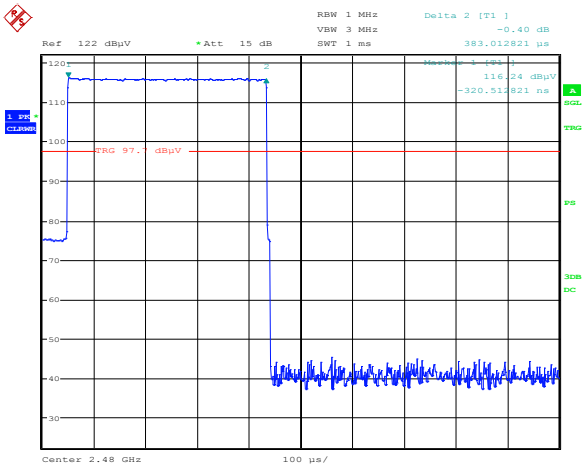


Figure 8.5-1: *DH1 pulse width*

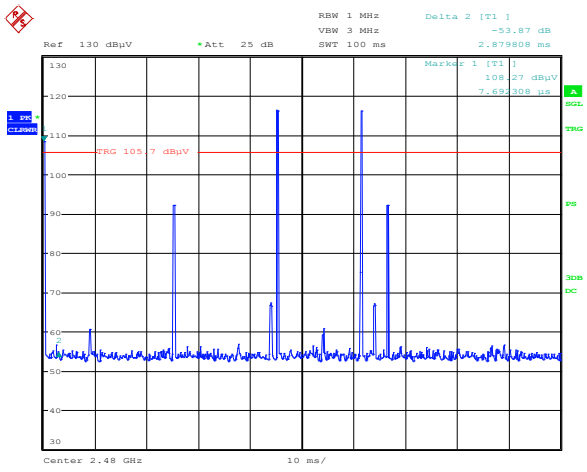


Figure 8.5-2: *Pulse repetition of DH1 within 100 ms*

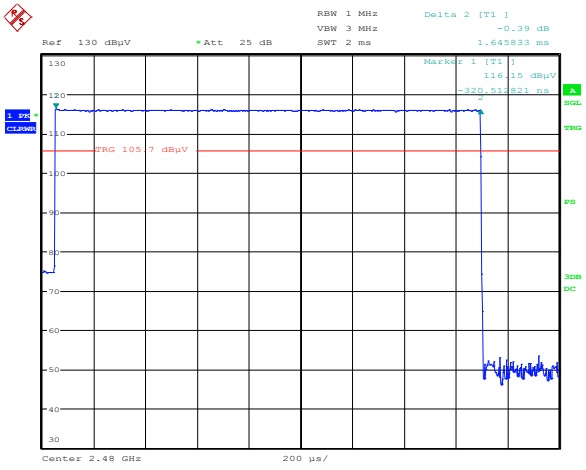


Figure 8.5-3: *DH3 pulse width*

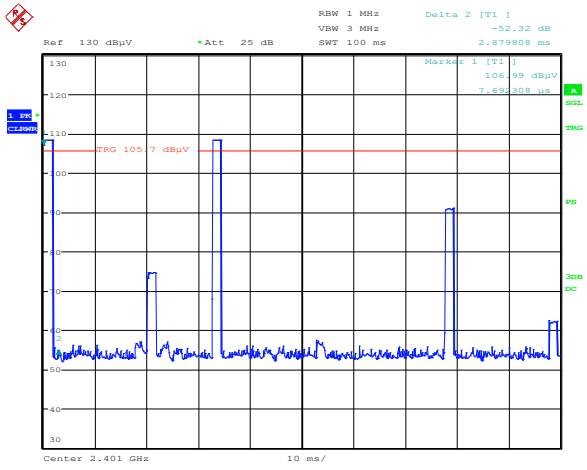


Figure 8.5-4: *Pulse repetition of DH3 within 100 ms*

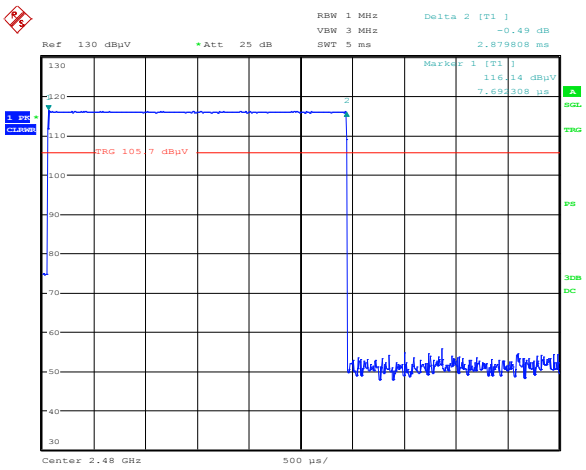


Figure 8.5-5: *DM5/2–DH5 pulse width*

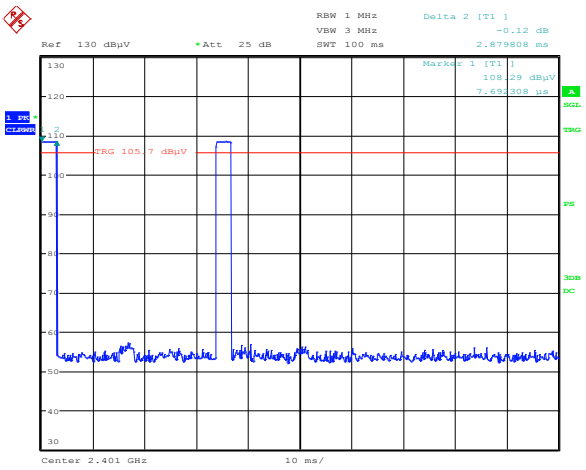


Figure 8.5-6: *Pulse repetition of DM5/2–DH5 within 100 ms*

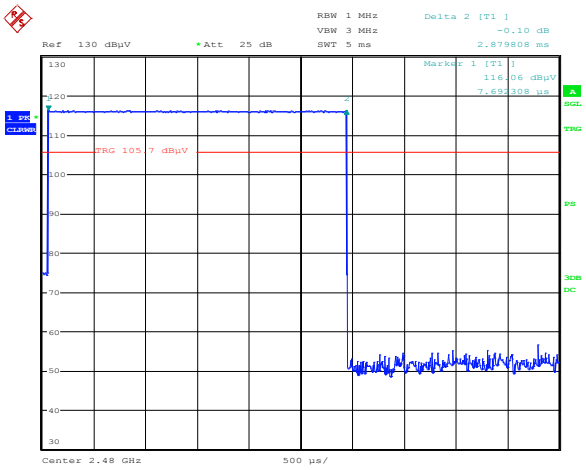


Figure 8.5-7: *DM5/3–DH5 pulse width*

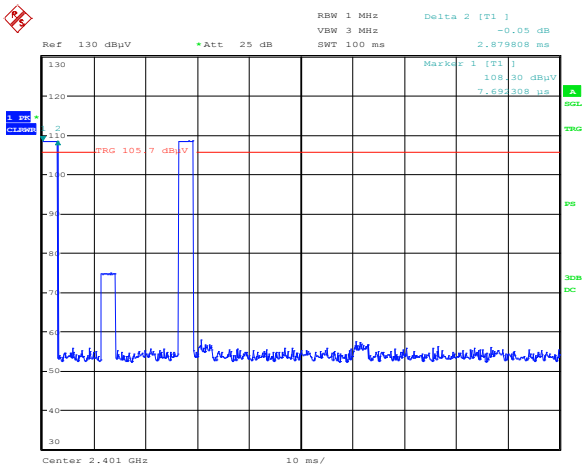


Figure 8.5-8: *Pulse repetition of DM5/3–DH5 within 100 ms*

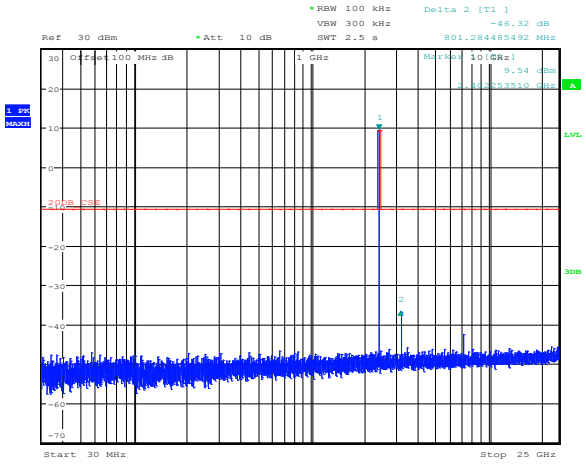


Figure 8.5-9: *Conducted spurious emissions for GFSK, low channel*

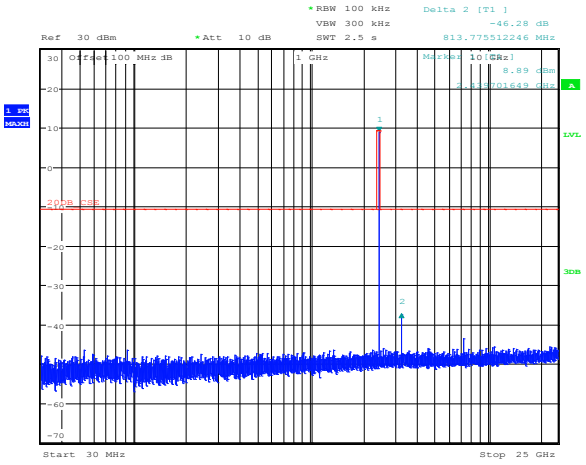


Figure 8.5-10: *Conducted spurious emissions for GFSK, mid channel*

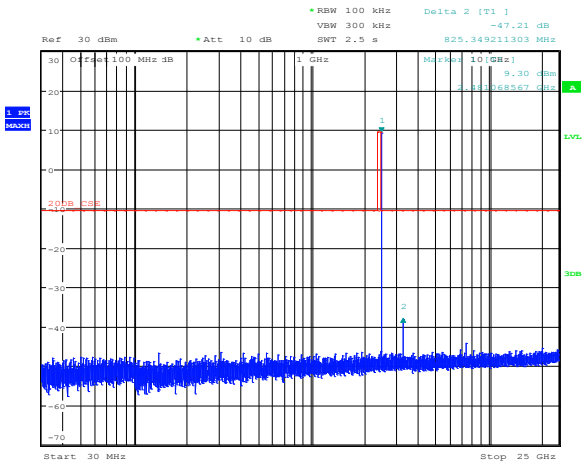


Figure 8.5-11: *Conducted spurious emissions for GFSK, high channel*

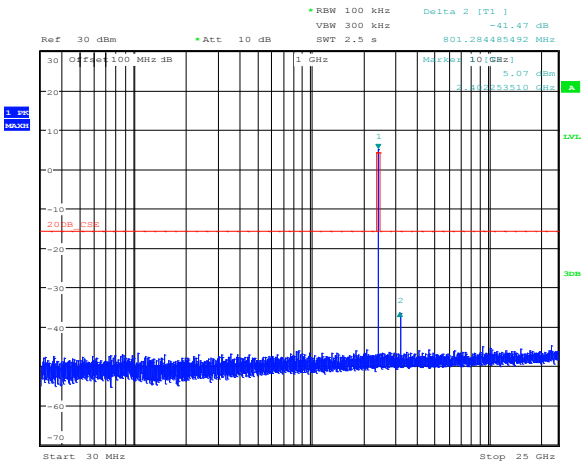


Figure 8.5-12: *Conducted spurious emissions for QPSK, low channel*

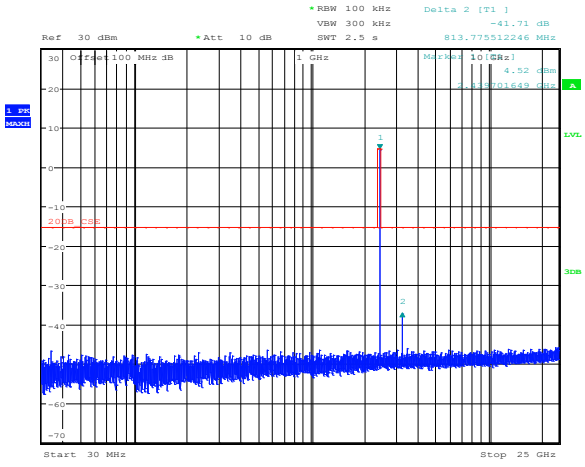


Figure 8.5-13: *Conducted spurious emissions for QPSK, mid channel*

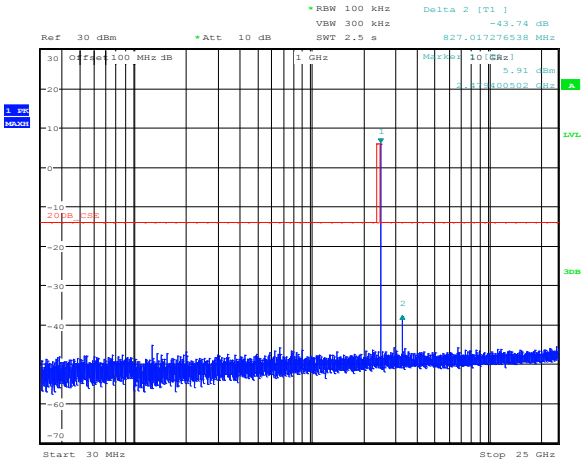


Figure 8.5-14: *Conducted spurious emissions for QPSK, high channel*

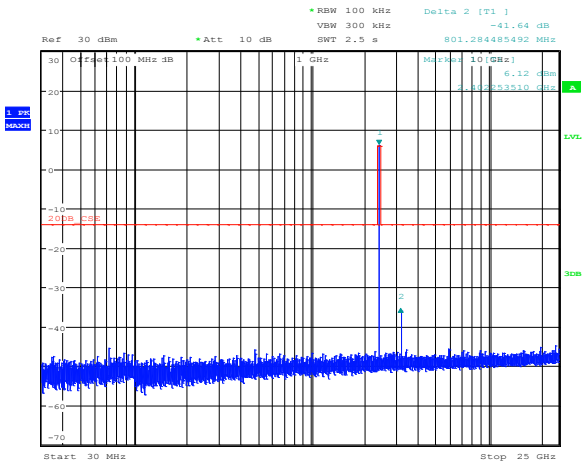


Figure 8.5-15: *Conducted spurious emissions for 8 DPSK, low channel*

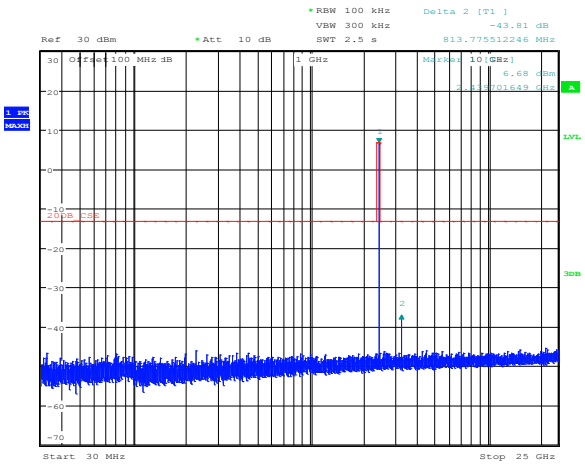


Figure 8.5-16: *Conducted spurious emissions for 8 DPSK, mid channel*

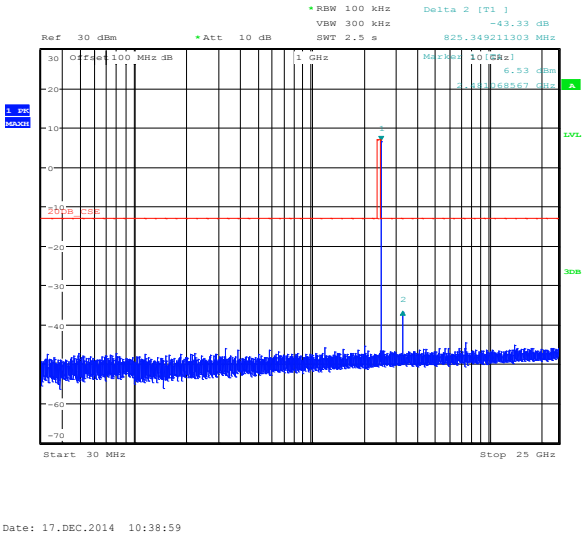


Figure 8.5-17: *Conducted spurious emissions for 8 DPSK, high channel*

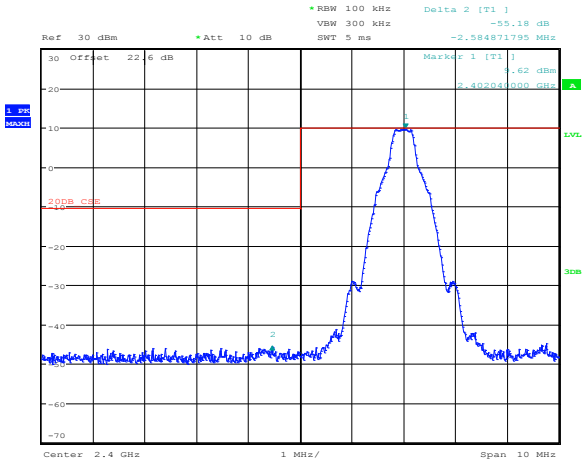


Figure 8.5-18: *Conducted band edge emission at 2400 MHz for GFSK, hopping sequence is off*

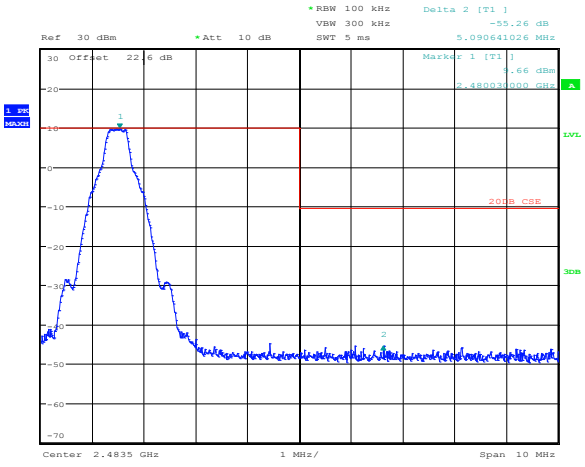


Figure 8.5-19: *Conducted band edge emission at 2483.5 MHz for GFSK, hopping sequence is off*

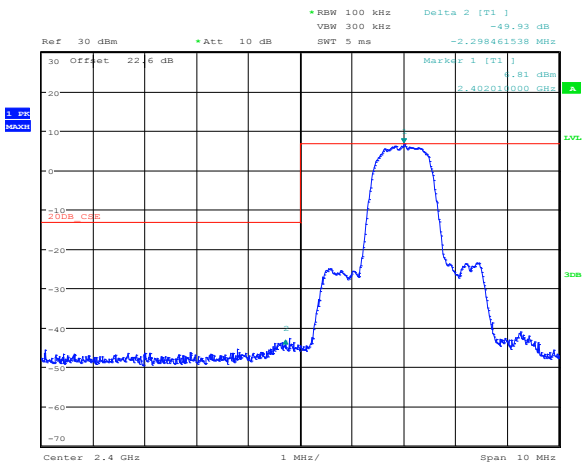


Figure 8.5-20: *Conducted band edge emission at 2400 MHz for QPSK, hopping sequence is off*

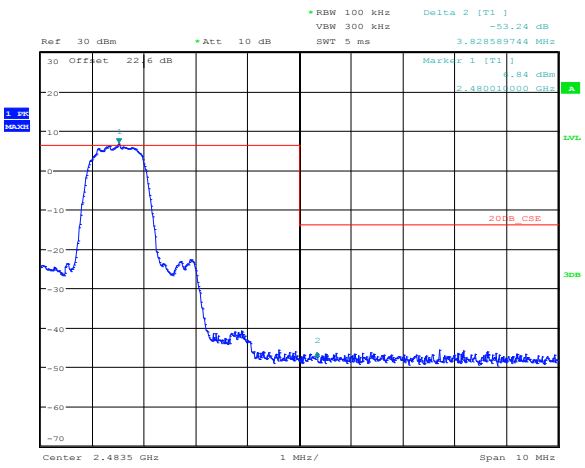


Figure 8.5-21: *Conducted band edge emission at 2483.5 MHz for QPSK, hopping sequence is off*

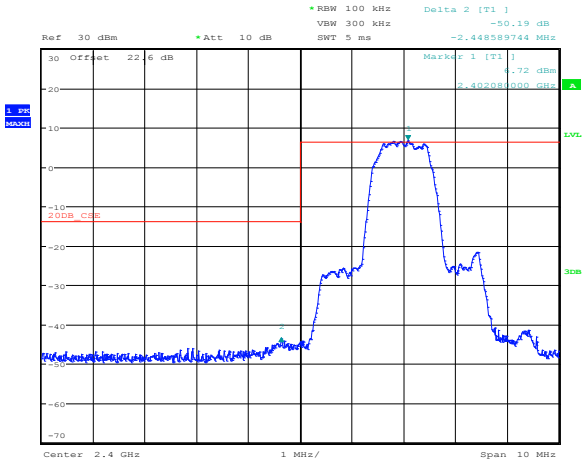


Figure 8.5-22: *Conducted band edge emission at 2400 MHz for 8 DPSK, hopping sequence is off*

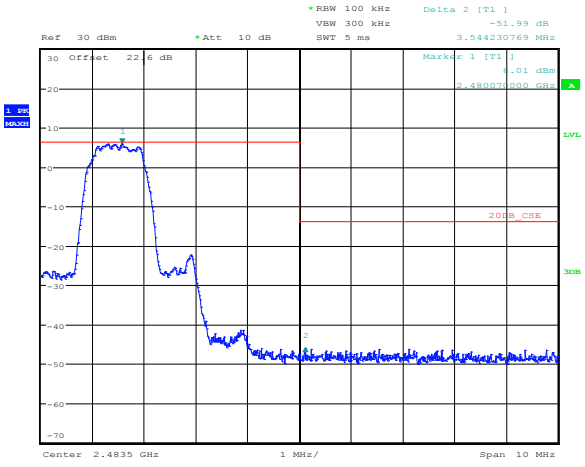


Figure 8.5-23: *Conducted band edge emission at 2483.5 MHz for 8 DPSK, hopping sequence is off*

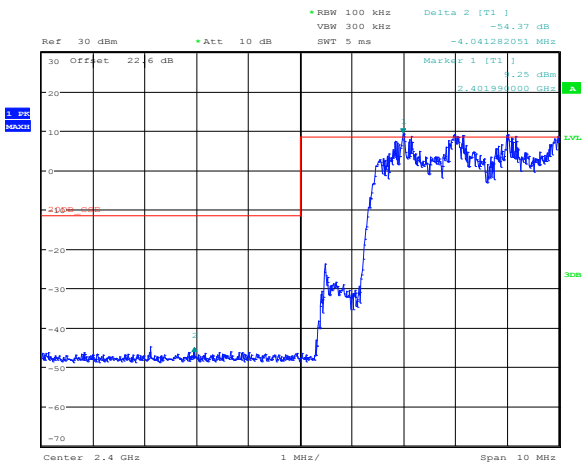


Figure 8.5-24: *Conducted band edge emission at 2400 MHz for DH1, hopping sequence is on*

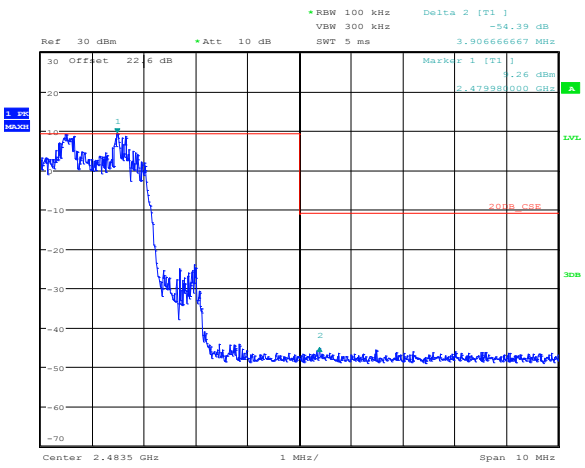


Figure 8.5-25: *Conducted band edge emission at 2483.5 MHz for DH1, hopping sequence is on*

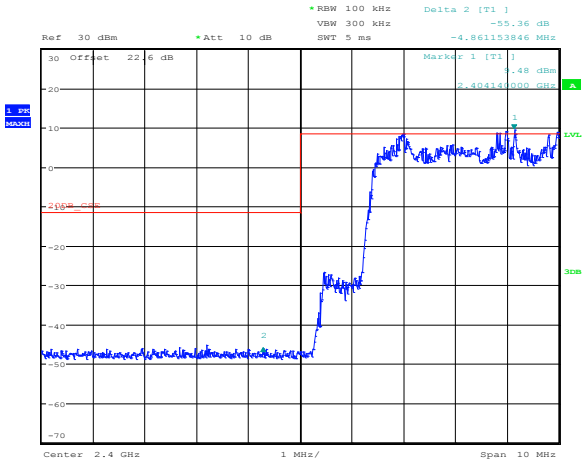


Figure 8.5-26: *Conducted band edge emission at 2400 MHz for DH3, hopping sequence is on*

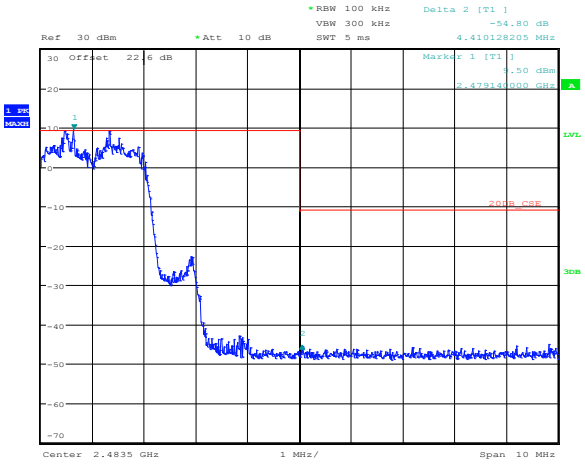


Figure 8.5-27: *Conducted band edge emission at 2483.5 MHz for DH3, hopping sequence is on*

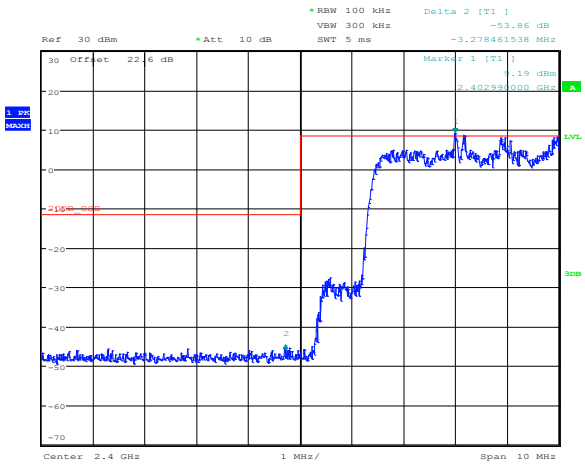


Figure 8.5-28: *Conducted band edge emission at 2400 MHz for DH5, hopping sequence is on*

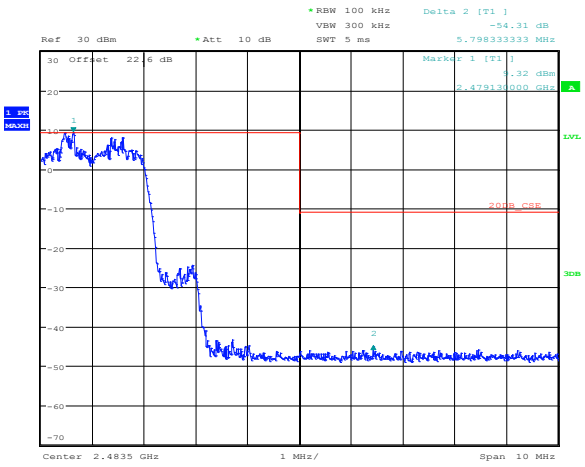
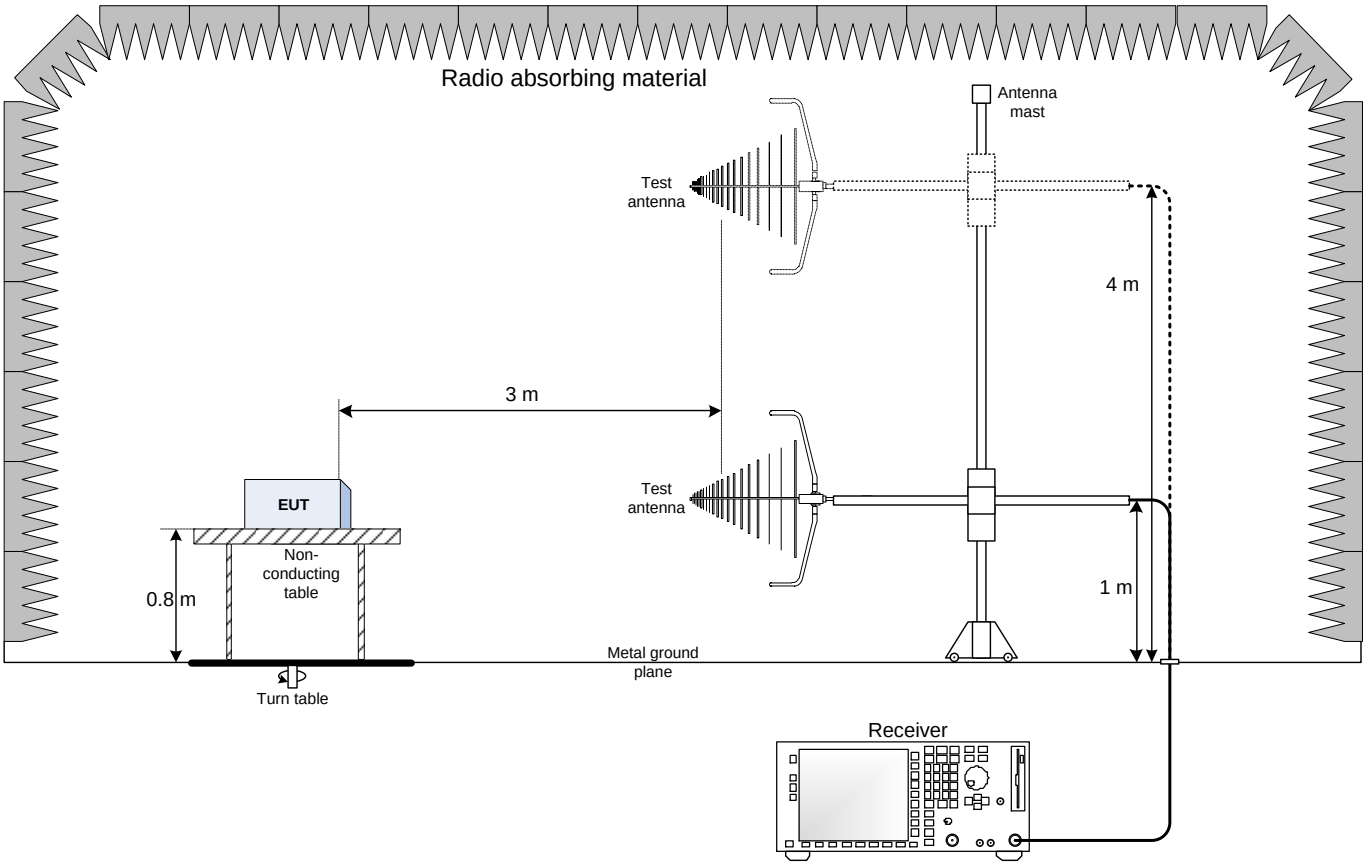


Figure 8.5-29: *Conducted band edge emission at 2483.5 MHz for DH5, hopping sequence is on*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up