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Test Report

Report Number: F151496E7

Applicant:

u-blox Malmö AB

Manufacturer:

u-blox Malmö AB

Equipment under Test (EUT):

ODIN-W2

Laboratory accredited by
Deutsche Akkreditierungsstelle GmbH (DAkkS)
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. D-PL-17186-01-02,
FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1

REFERENCES

[1] **ANSI C63.10-2013** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[2] **FCC CFR 47 Part 15 (June 2015)** Radio Frequency Devices

[3] **RSS-247 (May 2015)** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen Issue 4 (November 2014)** General Requirements for Compliance of Radio Apparatus

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

	Name	Signature	Date
Test engineer:	Paul NEUFELD		16 October 2015
Authorized reviewer:	Bernd STEINER		16 October 2015

RESERVATION

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

Contents: Page

1 IDENTIFICATION 5
1.1 Applicant 5
1.2 Manufacturer 5
1.3 Test laboratory 5
1.4 EUT (Equipment Under Test) 6
1.5 Dates 9
2 OPERATIONAL STATES 9
3 ADDITIONAL INFORMATION 11
4 OVERVIEW 12
5 TEST RESULTS 13
5.1 Duty cycle 13
5.1.1 Method of measurement 13
5.1.2 Test results 14
5.2 Maximum peak output power 16
5.2.1 Method of measurement 16
5.2.2 Test results 17
5.3 DTS Bandwidth 18
5.3.1 Method of measurement 18
5.3.2 Test result 19
5.4 Peak Power Spectral Density 20
5.4.1 Method of measurement 20
5.4.2 Test result 21
5.5 Band-edge compliance 22
5.5.1 Method of measurement (band edges next to unrestricted bands (conducted)) 22
5.5.2 Test result (band edges next to unrestricted bands (conducted)) 23
5.5.3 Method of measurement (band edges next to restricted bands (conducted)) 24
5.5.4 Test result (band edges next to restricted bands (conducted)) 24
5.6 Maximum unwanted emissions 27
5.6.1 Method of measurement (conducted emissions in the restricted bands) 27
5.6.1.1 Limit calculations 28
5.6.2 Method of measurement (conducted emissions in the unrestricted bands) 29
5.6.2.1 Reference level measurement 29
5.6.2.2 Emission level measurement 29
5.6.3 Test results (conducted emissions) 30
5.6.3.1 Emissions below 1 GHz 30
5.6.3.2 Emissions above 1 GHz 33
5.6.4 Method of measurement (radiated emissions) 40
5.6.5 Test results (radiated emissions) – cabinet emissions 47
5.6.5.1 Preliminary radiated emission measurement 47

5.6.5.2 Final radiated emission measurement (9 kHz to 1 GHz).....51
5.6.5.3 Final radiated emission measurement (1 GHz to 25 GHz).....51
5.7 Conducted emissions on power supply lines (150 kHz to 30 MHz).....58
5.7.1 Method of measurement.....58
5.7.2 Test results (conducted emissions on power supply lines) 59
6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS.....62
7 REPORT HISTORY 64
8 LIST OF ANNEXES 64

1 IDENTIFICATION

1.1 Applicant

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Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	u-blox Malmö AB
Address:	Östra varvsgatan 4, SE-211 75 Malmö
Country:	Sweden
Name for contact purposes:	Mr. Mats ANDERSSON
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	mats.andersson@u-blox.com
Manufacturer represented during the test by the following person:	None

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under the Reg. No. D-PL-17186-01-02, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	WLAN / Bluetooth module
Model / PMN: *	ODIN-W2
FCC ID: *	PVH0965
IC Company number / UPN: *	5325A-0965
HVIN: *	ODIN-W260 ODIN-W262
Serial number: *	#13, #5
PCB identifier: *	0965-02
Hardware version: *	2.1
Software version / FVIN: *	0.11

Classic Bluetooth Mode

Channel 00	RX:	2402 MHz	TX:	2402 MHz
Channel 39	RX:	2441 MHz	TX:	2441 MHz
Channel 78	RX:	2480 MHz	TX:	2480 MHz

Bluetooth Low Energy Mode

Channel 00	RX:	2402 MHz	TX:	2402 MHz
Channel 19	RX:	2440 MHz	TX:	2440 MHz
Channel 39	RX:	2480 MHz	TX:	2480 MHz

Fulfills Bluetooth version: *	Classic Bluetooth with EDR and Bluetooth Low Energy					
Antenna type: *	See Table 1					
Antenna gain: *	See Table 1					
Antenna connector: *	See Table 1					
Power supply - EUT	3.3 V DC					
Power supply Host	U_{nom}=	3.3 V DC	U_{min}=	3.0 V DC	U_{max}=	3.6 V DC
Type of modulation: *	Bluetooth classic– 1 Mbps: GFSK Bluetooth classic– 2 Mbps: π/4-DQPSK Bluetooth classic– 3 Mbps: 8DPSK Bluetooth Low Energy – 1 Mbps: GFSK					
Operating frequency range:*	Bluetooth classic and Low Energy: 2402 – 2480 MHz					
Number of channels: *	Bluetooth classic: 79 Bluetooth Low Energy : 40					
Temperature range: *	-40 °C to +85 °C					
Lowest / highest internal clock frequency: *	24.000 MHz / 26.000 MHz					

* declared by the applicant.

Table 1 Antenna specifications

Antenna name	Manufacturer	Type	Comment	Gain [dBi]
WCR-2400 -IP04 -IP10 -SMRP	Centurion	Monopole	10cm flying lead U.FL 25cm flying lead U.FL RSMA	2 dBi @ 2.4 GHz
SDM2-2400/1575	Mobile Mark	Patch	cable/U.FL	2 dBi @ 2.4 GHz
PSTG0-2400HS -RSMA	Mobile Mark	Monopole	RSMA	0 dBi @ 2.4 GHz
FlatWhip-2400	ProAnt	Monopole	RSMA	3 dBi @ 2.4 GHz
InSide-2400	ProAnt	Patch	10cm cable/U.FL	3 dBi @ 2.4 GHz
InSide-WLAN	ProAnt	Patch	dual band 10cm cable/U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
Outside-2400	ProAnt	Patch	7 cm flying lead U.FL 10 cm flying lead U.FL 25 cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT 2400 -RP-SMA 28-001 - MHF 28-001	ProAnt	Monopole	RSMA 10 cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT WLAN - RP-SMA -MHF	ProAnt	Monopole	dual band RSMA 10cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
Ex-IT 2400 -MHF 70-001	ProAnt	Monopole	10cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT 2400 -RP-SMA 70-002	ProAnt	Monopole	RSMA	3 dBi @ 2.4 GHz
InSide Fold-2400	ProAnt	Patch	10 cm cable/U.FL	3 dBi @ 2.4 GHz
InSide Fold-WLAN	ProAnt	Patch	10 cm flying lead U.FL	2.5 dBi @ 2.4 GHz' 3 dBi @ 5 GHz
InSide-WLAN Square	ProAnt	Patch	Dual band; 10 cm cable/U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
OnBoard SMD 2400	ProAnt	Patch	SMD PIFA antenna on ODIN-W262	3 dBi @ 2.4 GHz <3 dBi @ 5 GHz
R380.500.125 R380.500.124 R380.500.139	Pulse	Monopole	.125: RSMA .124: RSMA+SEAL .139: RSMA+SEAL	2 dBi @ 2.4 GHz
SOA 2400/360/3/20/V	Huber+Suhner	Monopole	150 cm cable / RSMA (P/N 1324.99.033) 150 cm cable/MCX (P/N 1324.99.0036)	3 dBi @ 2.4 GHz
NanoBlue-IP04	Laird Technologies	Patch	10 cm cable/U.FL	2 dBi @ 2.4 GHz

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
DC in (carrier board)		-	2 m *
USB interface (carrier board)	USB plug	Laptop PC	-

*: Length during the test if not other specified.

1.5 Dates

Date of receipt of test sample:	10 March 2015
Start of test:	31 March 2015
End of test:	23 July 2015

2 OPERATIONAL STATES

The equipment under test (EUT) is a WLAN dual band and Bluetooth dual mode module soldered onto a carrier board. The WLAN / Bluetooth module is equipped with an U.FL. antenna connector (Model ODIN-W260) or an integral antenna (Model ODIN-W262). The module version with the U.FL antenna connectors is able to operate in MIMO mode. The MIMO mode is only possible for 2.4 GHz operation with 802.11n modulation with 20MHz. The EUT with internal antenna has no MIMO. MIMO is also not possible in 5 GHz mode for both versions of the EUT nor for Bluetooth operation.

Because the ODIN-W2 is a module, which will be implemented in a final application, it was mounted on a carrier board (EVB-W26) to connect it to a Laptop with the test software. All tests were carried out with an unmodified sample.

With test software which was provided by the applicant the EUT could be set to a continuous transmit mode with a certain modulation scheme and data rate on a certain frequency. Furthermore the equipment could be set to receive mode on a certain frequency. This software was installed on a laptop PC, which was connected to the Equipment under test via the carrier board.

For this test report the EUT was tested as a Bluetooth device in the 2.4 GHz band which was able to operate in classic Bluetooth mode and Bluetooth Low Energy mode according to the specification Bluetooth 4.0 . The table below shows the worst case modulation and data rate for appropriate test cases.

The following operation modes were identified as worst case condition and used during the tests:

Operation mode	Description of the operation mode	BT mode	BT channel	Modulation	Data rate
1	Continuous transmitting on 2402 MHz	classic	0	GFSK	1 MBit/s
2	Continuous transmitting on 2441 MHz	classic	39	GFSK	1 MBit/s
3	Continuous transmitting on 2480 MHz	classic	78	GFSK	1 MBit/s
4	Continuous transmitting on 2402 MHz	classic	0	π/4-DQPSK	2 MBit/s
5	Continuous transmitting on 2441 MHz	classic	39	π/4-DQPSK	2 MBit/s
6	Continuous transmitting on 2480 MHz	classic	78	π/4-DQPSK	2 MBit/s
7	Continuous transmitting on 2402 MHz	classic	0	8DPSK	3 MBit/s
8	Continuous transmitting on 2441 MHz	classic	39	8DPSK	3 MBit/s
9	Continuous transmitting on 2480 MHz	classic	78	8DPSK	3 MBit/s
10	Continuous transmitting on 2402 MHz	Low energy	0	GFSK	1 MBit/s
11	Continuous transmitting on 2440 MHz	Low energy	19	GFSK	1 MBit/s
12	Continuous transmitting on 2480 MHz	Low energy	39	GFSK	1 MBit/s

Each test case was performed in the following operation modes:

Test case	Operation mode
Maximum Peak Output Power	1 - 12
DTS Bandwidth	1 - 9
Peak Power Spectral Density	1 - 9
Band Edge Compliance	1, 3, 4, 6, 7, 9
Maximum Unwanted Emissions	1 - 12

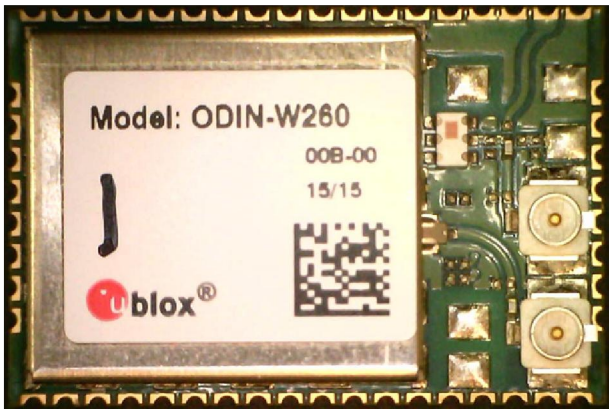
3 ADDITIONAL INFORMATION

The power of the EUT:

Classic Bluetooth mode: 0x07 (highest possible power level)
Bluetooth Low Energy mode has only one fixed power level which can not be changed.

This report contains the results of the EUT operating in the Bluetooth mode only.

ODIN-W262 as marketed



ODIN-W260 as marketed

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 3 [4]	Status	Refer page
Maximum Peak Output Power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (2) [3]	Passed	13 et seq
DTS Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (1) [3]	Passed	18 et seq
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (2) [3]	Passed	20 et seq
Band edge compliance	2400.0 - 2483.5	15.247 (d)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	22 et seq.
Radiated emissions (transmitter)	0.009 – 26,500	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	27 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Passed	58 et seq.

5 TEST RESULTS

5.1 Duty cycle

5.1.1 Method of measurement

The measurement was performed as a conducted measurement.

The measurement procedures described herein are based on the use of radiated measurements.

The method described in chapter 11.6.0 b) of document [1] was used to perform the following test.

The measurement was only performed on only one frequency, because the timing behaviour was found to be independent of the selected channel.

The following measurement technique was used:

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

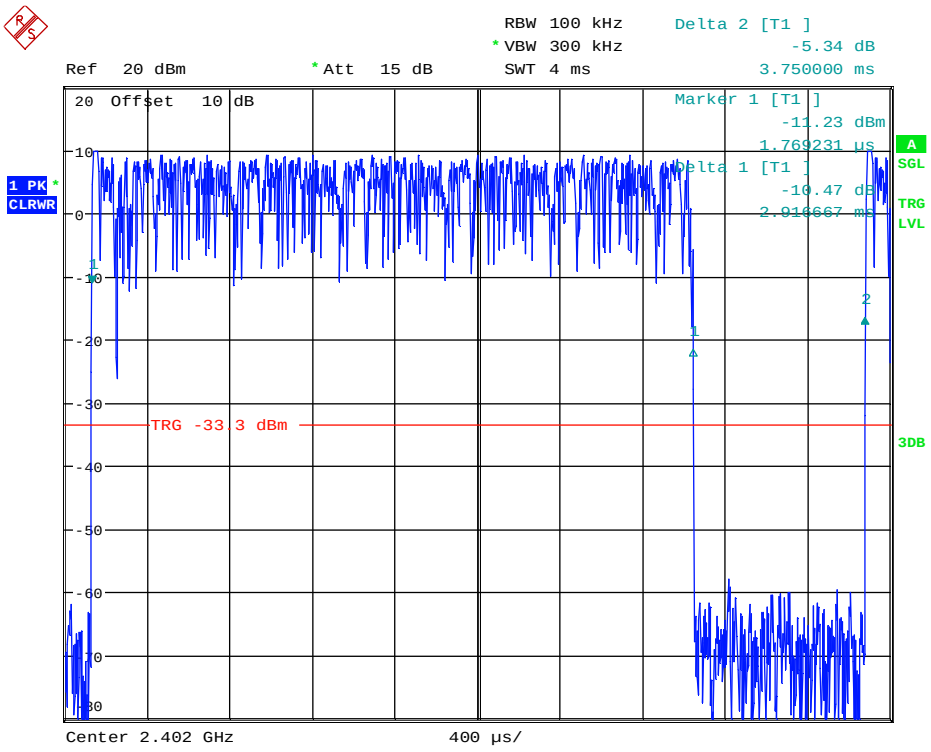
- Set the center frequency of the instrument to the center frequency of the transmission.
- Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
- Set VBW ≥ RBW.
- Set detector = peak or average.
- The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

5.1.2 Test results

Ambient temperature	22 °C	Relative humidity	25 %

The following plot only shows the worst case for the duty cycle correction, the other results are only submitted in the calculations below.

Odin_DutyCycle__BT_DH5.wmf: Duty cycle measurement on channel 1 in Bluetooth classic mode with 1 Mbps:



The following calculations for the settings are only submitted for the worst case, therefore the other results can be assumed to be passed as well.

$$T_{TX} = 2.917ms \quad (1)$$

$$\frac{50}{T_{TX}} = \frac{50}{2.917ms} = 17.140kHz \leq RBW \leq VBW \quad (2)$$

Measurement Points 5000 for 5 ms → 2.917 ms = 2971 measurement points → Signal has 2971 measurement points (and fulfils the requirement of at least 100 Points resolution for the signal)

$$T_{TX\_On} = 2.917ms \quad (3)$$

$$T_{TX\_Period} = 3.750ms \quad (4)$$

If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

$$x = \frac{2.917ms}{3.750ms} = 0.778 = 77.8\% \quad (5)$$

Correction factor: $10 \cdot \log\left(\frac{1}{x}\right) = 10 \cdot \log\left(\frac{1}{0.778}\right) = 10 \cdot \log\left(\frac{1}{0.778}\right) = 1.1dB$ (6)

Therefore, for average measurements a correction factor of 1.1 dB is use in all tests Bluetooth classic mode and 1.9 dB for Bluetooth Low Energy mode. The results for the other modulation are submitted without calculation below:

Classic Bluetooth– 1 Mbps: 1.1 dB correction factor
Classic Bluetooth– 2 Mbps: 1.1 dB correction factor
Classic Bluetooth– 3 Mbps: 1.1 dB correction factor
Bluetooth Low Energy : 1.9 dB correction factor

TEST EQUIPMENT USED FOR THE TEST:

7

5.2 Maximum peak output power

5.2.1 Method of measurement

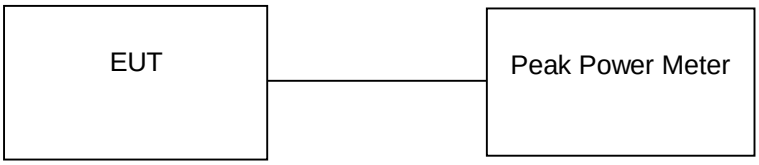
The EUT has to be connected to the power meter via a low loss cable.

The measurement procedures described herein are based on the use of an antenna-port conducted test configuration.

PKPM1 – Peak power meter method was used for this test. The procedure is described in chapter 11.9.1.3 of document [1].

The measurement was performed at the upper and lower end and the middle of the assigned frequency band.

Test set-up:



5.2.2 Test results

Ambient temperature	22 °C	Relative humidity	25 %

The highest antenna gain is 3.0 dBi. Therefore no reduction of the Peak power limit is necessary.

Operation Mode	Antenna gain combined [dBi]	Maximum peak output power Port 1 [dBm]	Margin [dB]	Peak power limit [dBm]
1	3.0	8.0	22.0	30.0
2	3.0	8.2	21.8	30.0
3	3.0	8.3	21.7	30.0
4	3.0	3.2	26.8	30.0
5	3.0	3.3	26.7	30.0
6	3.0	3.3	26.7	30.0
7	3.0	3.2	26.8	30.0
8	3.0	3.3	26.7	30.0
9	3.0	3.4	26.6	30.0
10	3.0	3.5	26.5	30.0
11	3.0	3.6	26.4	30.0
12	3.0	3.6	26.4	30.0
Measurement uncertainty			+0.66 dB / -0.72 dB	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

26, 27

5.3 DTS Bandwidth

5.3.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 11.8.1 of document [1].

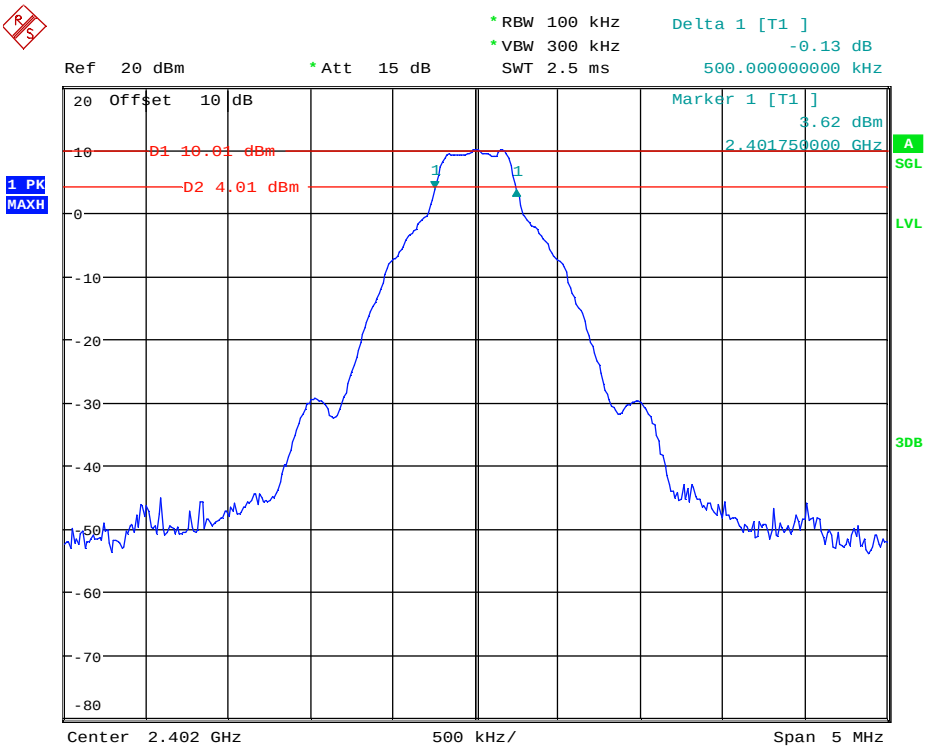
- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) ≥ 3 x RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.3.2 Test result

Ambient temperature	22 °C	Relative humidity	25 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

Odin_6dB-BW_BT_DH5_BT1: DTS Bandwidth (operation mode 1):



Operation Mode	Center Frequency [MHz]	Minimum 6-dB Bandwidth Limit [MHz]	6 dB Bandwidth [MHz]	Result
1	2402	0.5	0.500	Passed
2	2441	0.5	0.500	Passed
3	2480	0.5	0.500	Passed
4	2402	0.5	1.087	Passed
5	2441	0.5	1.087	Passed
6	2480	0.5	1.025	Passed
7	2402	0.5	1.087	Passed
8	2441	0.5	1.075	Passed
9	2480	0.5	1.087	Passed
10	2402	0.5	0.687	Passed
11	2441	0.5	0.687	Passed
12	2480	0.5	0.700	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.4 Peak Power Spectral Density

5.4.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 11.10.2 of document [1].

- Set analyser center frequency to DTS channel center frequency
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
- Set the VBW ≥ 3 x RBW.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- If measured value exceeds limit, reduce RBW (not less than 3 kHz) and repeat.

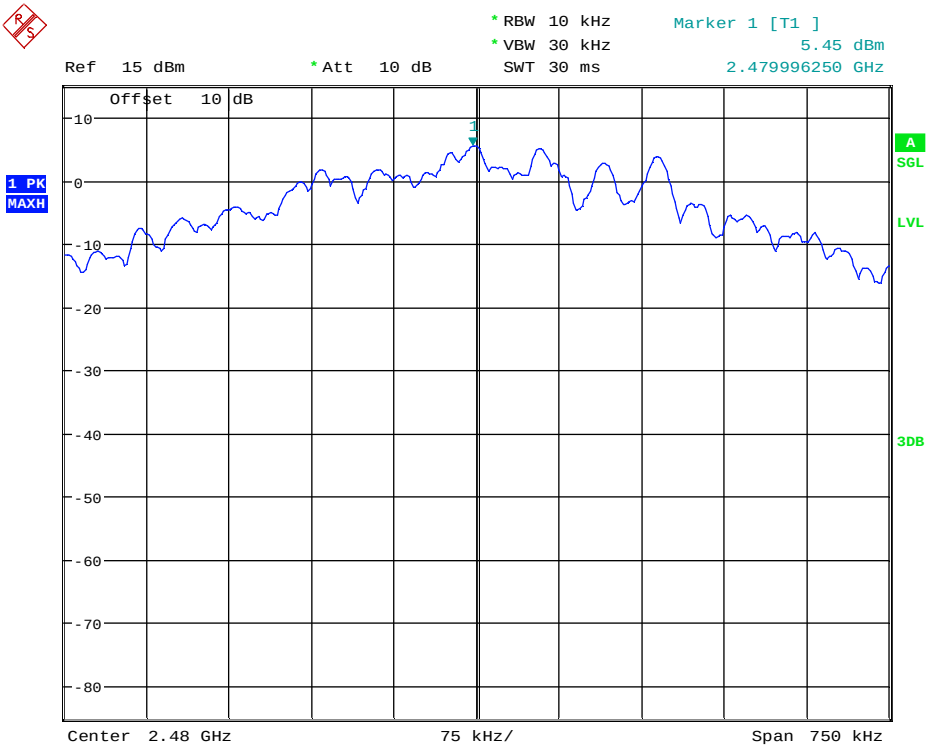
5.4.2 Test result

Ambient temperature	22 °C

Relative humidity	25 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

Odin_PwrSpecDens_BT_DH5_BT79.wmf: Power Spectral Density (operation mode 3):



Operation Mode	Peak Frequency [MHz]	Power Spectral Density Limit [dBm/3kHz]	Power Spectral Density Reading [dBm/10kHz]	Array Gain [dB]	Power Spectral Density Level [dBm/10kHz]	Margin [dB]	Result
1	2401.998	8	5.0	0.0	5.0	3.0	Passed
2	2440.998	8	5.4	0.0	5.4	2.6	Passed
3	2479.996	8	5.5	0.0	5.5	2.5	Passed
4	2402.000	8	-0.5	0.0	-0.5	8.5	Passed
5	2440.996	8	-0.5	0.0	-0.5	8.5	Passed
6	2479.996	8	0.5	0.0	0.5	7.5	Passed
7	2401.996	8	-0.8	0.0	-0.8	8.8	Passed
8	2440.996	8	-0.4	0.0	-0.4	8.4	Passed
9	2480.000	8	0.5	0.0	0.5	7.5	Passed
10	2401.992	8	-3.1	0.0	-3.1	11.1	Passed
11	2439.990	8	-2.7	0.0	-2.7	10.7	Passed
12	2479.992	8	-2.0	0.0	-2.0	10.0	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.5 Band-edge compliance

5.5.1 Method of measurement (band edges next to unrestricted bands (conducted))

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 11.11.2 and 11.11.3 of document [1].

Measurement Procedure Reference – Reference Level:

- RBW = 100 kHz.
- VBW ≥ 300 kHz.
- Set the span to ≥ 1.5 times the DTS Bandwidth.
- Detector = Peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilise.
- Use the peak marker function to determine the the maximum PSD level.

Measurement Procedure – Unwanted Emissions

- Set the center frequency and span to encompass the frequency range to be measured.
- RBW = 100 kHz.
- VBW ≥ 300 kHz.
- Detector = Peak.
- Ensure that the number of measurement points ≥ span/RBW.
- Sweep time = auto couple.
- Trace Mode = max hold.
- Allow the trace to stabilise.
- Use the peak marker function to determine the maximum amplitude level.

The measurement procedure at the band edges was simplified by performing the measurement in just one plot. Both, the in-band-emission and the unwanted emission were be encompassed by the span. After trace stabilization, the maximum peak was be determined by a peak detector and the value was marked by an appropriate limit line. The second limit line, which is 20 dB below the first, marks the limit for the emissions in the unrestricted band. A maximum-peak-detector marks the highest emission in the unrestricted band next to the band edge.

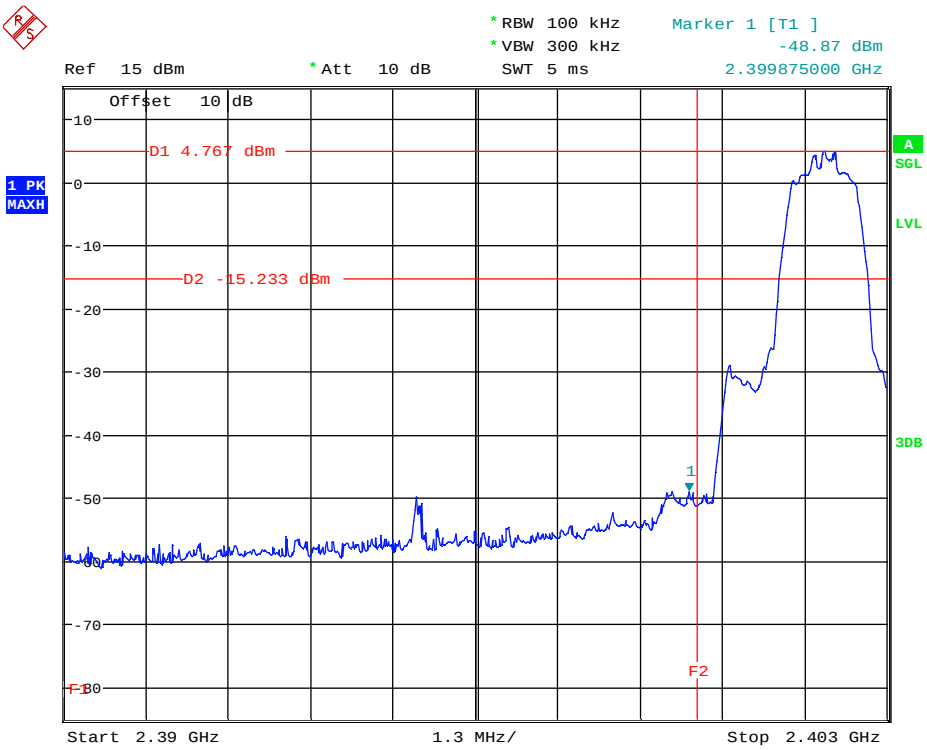
The measurements were performed at the lower end of the 2.4 GHz band.

5.5.2 Test result (band edges next to unrestricted bands (conducted))

Ambient temperature	22 °C	Relative humidity	59 %

The following results were measured at antenna port 1 of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

Odin_BandEdgeUnrestr_BT_2DH5_BT1.wmf: conducted band-edge compliance (operation mode 4):



Operation mode	BT Channel	Emission Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emisson Level [dBm]	Margin [dB]	Result
1	0	2395.583	11.0	-9.0	-43.0	33.9	Passed
4	0	2399.875	4.8	-15.2	-48.9	33.6	Passed
7	0	2399.500	4.5	-15.5	-50.3	34.8	Passed
10	0	2392.875	4.2	-15.8	-50.2	34.4	Passed

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7

5.5.3 Method of measurement (band edges next to restricted bands (conducted))

The same test set-up as used for the final conducted emission measurement shall be used (refer also subclause 5.6.1 of this test report).

After trace stabilisation the marker shall be set on the signal peak. The frequency line shall be set on the edge of the assigned frequency band. Now set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. The level of the measured field strength shall be compared to the the general limits specified in § 15.205.

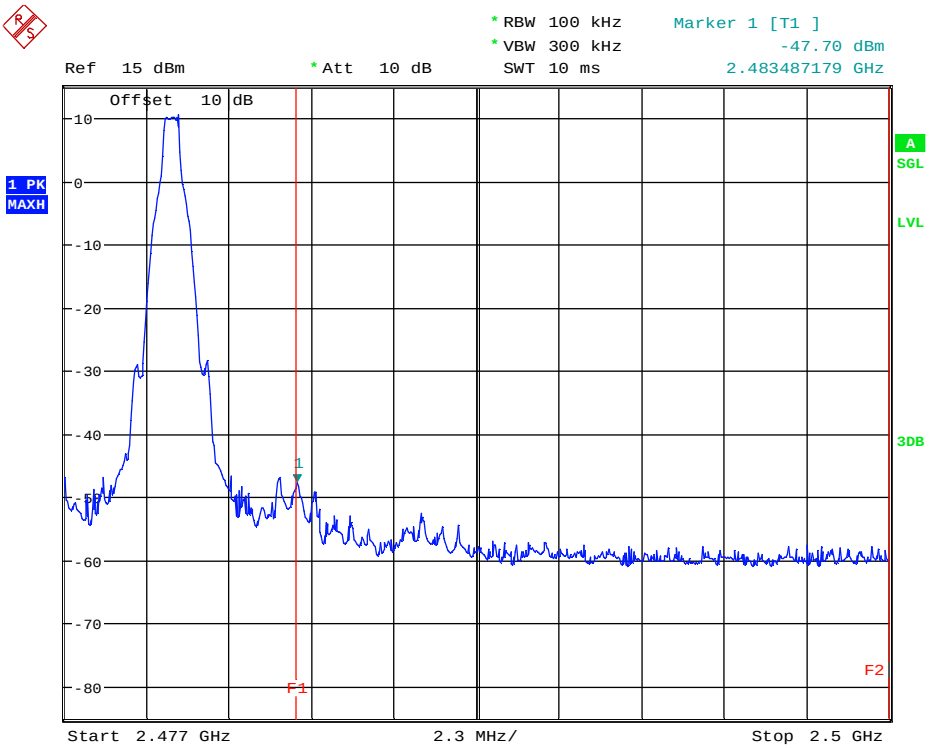
The measurement was performed at the lower and the upper end of the 2.4 GHz band.

5.5.4 Test result (band edges next to restricted bands (conducted))

Ambient temperature	22 °C	Relative humidity	25 %

The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

Odin_BandEdgeRestr_BT_DH5_BT79.wmf: conducted band-edge compliance (operation mode 3):



Band Edge Compliance, DH5-mode, channel 0 (Operation mode 1)									
Operation mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
1	0	2389.178	55.3	74.0	18.7	-42.9	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
1	0	2389.328	43.3	54.0	10.7	-56.0	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, DH5-mode, channel 78 (Operation mode 3)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
3	78	2483.500	66.3	74.0	7.7	-31.9	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
3	78	2483.500	47.7	54.0	6.3	-50.6	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, 2DH5-mode, channel 0 (Operation mode 4)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
4	0	2376.772	56.6	74.0	17.4	-41.7	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
4	78	2377.085	37.9	54.0	16.1	-61.4	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, 2DH5-mode, channel 78 (Operation mode 6)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
6	0	2484.120	58.0	74.0	16.0	-40.3	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
6	78	2484.120	43.9	54.0	10.1	-55.4	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, 3DH5-mode, channel 0 (Operation mode 7)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
7	0	2376.843	57.4	74.0	16.6	-40.8	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
7	78	2376.806	38.5	54.0	15.5	-60.8	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, 3DH5-mode, channel 78 (Operation mode 9)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
9	0	2484.195	59.8	74.0	14.2	-38.5	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
9	78	2484.120	44.2	54.0	9.8	-55.0	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, BTLE-mode, channel 0 (Operation mode 10)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
10	0	2376.696	57.3	74.0	16.7	-41.0	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
10	0	2376.784	40.2	54.0	13.8	-59.9	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, BTLE -mode, channel 39 (Operation mode 12)									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
12	39	2484.307	56.2	74.0	17.8	-42.1	3.0	Passed	Y
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
12	39	2484.157	40.2	54.0	13.8	-58.9	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7

5.6 Maximum unwanted emissions

5.6.1 Method of measurement (conducted emissions in the restricted bands)

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly mounted to a spectrum analyser. The measurement procedure refers to part 11.12.2.2 in document [1].

If emissions were detected during the preliminary measurements, they were measured using the following measurement procedures:

Procedure for average measurement: 11.12.2.5.2 – Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction:

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%), then the following procedure shall be used:

- The EUT shall be configured to operate at the maximum achievable duty cycle.
- Measure the duty cycle D of the transmitter output signal as described in 11.6 in [1].
- Set the RBW = 1 MHz (unless otherwise specified).
- Set the VBW ≥ 3 x RBW.
- Detector = power average (RMS).
- Ensure that the number of measurement points in the sweep to ≥ 2 x (span/RBW).
- Averaging type = power
- Sweep time = auto
- Perform a trace average of at least 100 traces
- Correct the resulting measurement value by adding the duty cycle correction value calculated in 5.1.2.

Peak measurement procedure: 11.12.2.4 in [1]

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = specified in Table 2.
- Set the VBW ≥ RBW.
- Set sweep time = auto.
- Detector = peak.
- Trace mode = max hold.
- Allow the trace to stabilize.
- Use the peak marker function to determine the peak power over the emission bandwidth.

Table 2 RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

5.6.1.1 Limit calculations

The following general procedure is described in chapter 11.12.2.2 in [1].

a) Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 11.12.2.3 through 11.12.2.5 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP (see 11.12.2.6 for guidance on determining the applicable antenna gain).
c) Add the appropriate maximum ground reflection factor to the EIRP (6 dB for frequencies ≤ 30 MHz; 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and 0 dB for frequencies > 1000 MHz).
d) For MIMO devices, measure the power of each chain and sum the EIRP of all chains in linear terms (i.e., watts and mW).
e) Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

$$E. = EIRP - 20\log(d) + 104.8 \qquad (1)$$

where

E is the electric field strength in dBµV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m

f) Compare the resultant electric field strength level with the applicable regulatory limit.
g) C Perform the radiated spurious emission test.

Chapter 14 in [1] states, that for transmitters with multiple outputs in the same band, summing of emissions and accounting for array gain have to be considered.

For combining emissions from multiple outputs, the spurious emissions at each output have to be measured and 10log(N) has to be added to the resulting value, whereby N refers to the number of outputs.

To account for directional gain which might occur in case of N transmit antennas, the directional has to be calculated as

$$G_{Dir} = G_{Ant} + 10\log(N)dBi\,,$$

whereby N is the number of antennas.

The actual EUT only has one antenna port active in Bluetooth mode. Therefore only the antenna gain is added to the values which were measured conducted.

5.6.2 Method of measurement (conducted emissions in the unrestricted bands)

In any 100 kHz outside the authorized frequency band, the power shall be attenuated by 20 dB, compared to the highest in band power in any 100 kHz. This shall be demonstrated by using the peak power procedure. The reference level shall be measured using the procedure described in 5.6.2.1 and the emission level according to procedure 5.6.2.2. The procedures are based on chapter 11.11.2 and 11.11.3 in [1].

5.6.2.1 Reference level measurement

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.+
i) Use the peak marker function to determine the maximum PSD level.

5.6.2.2 Emission level measurement

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Ensure that the number of measurement points ≥ span/RBW
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

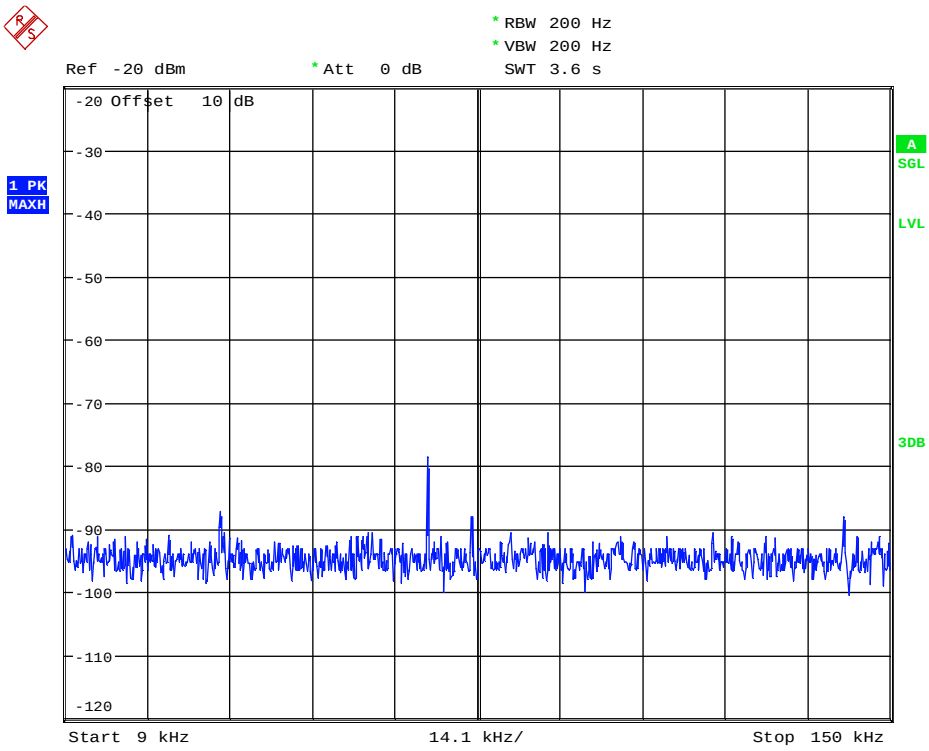
5.6.3 Test results (conducted emissions)

5.6.3.1 Emissions below 1 GHz

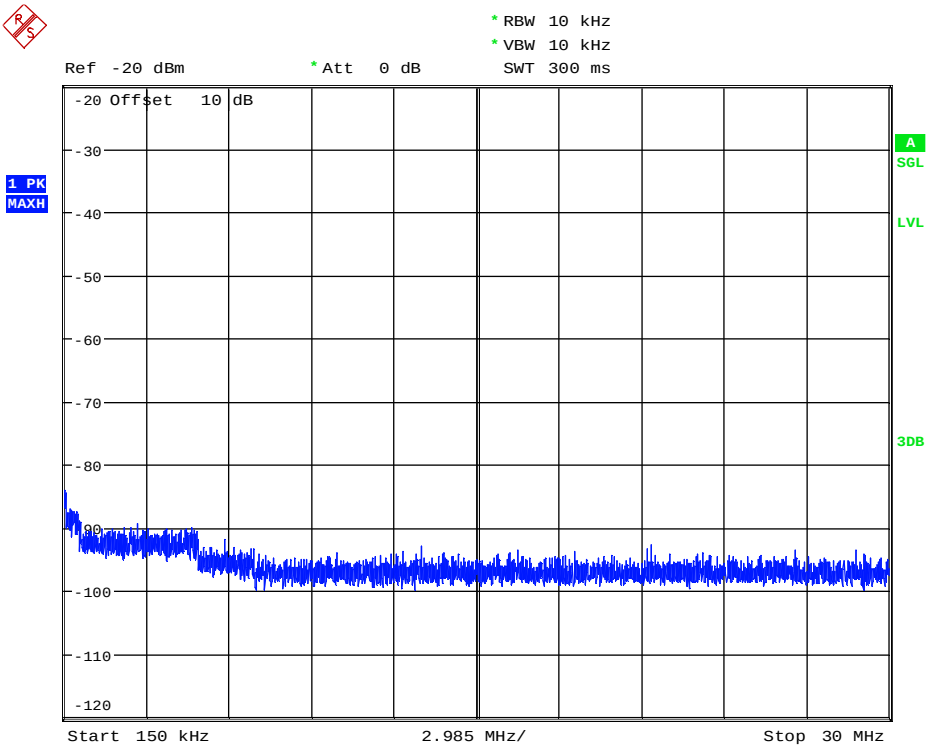
Ambient temperature	22 °C	Relative humidity	25 %

The Emissions below 1 GHz were similar for all, modulations and data rates. Therefore only the results of an exemplary test case are submitted below. Pretests have shown that the emissions were worst for the DH5 mode, therefore only these emissions are submitted below. Since the channel spacing is different in Bluetooth 4.0, these results are also submitted below.

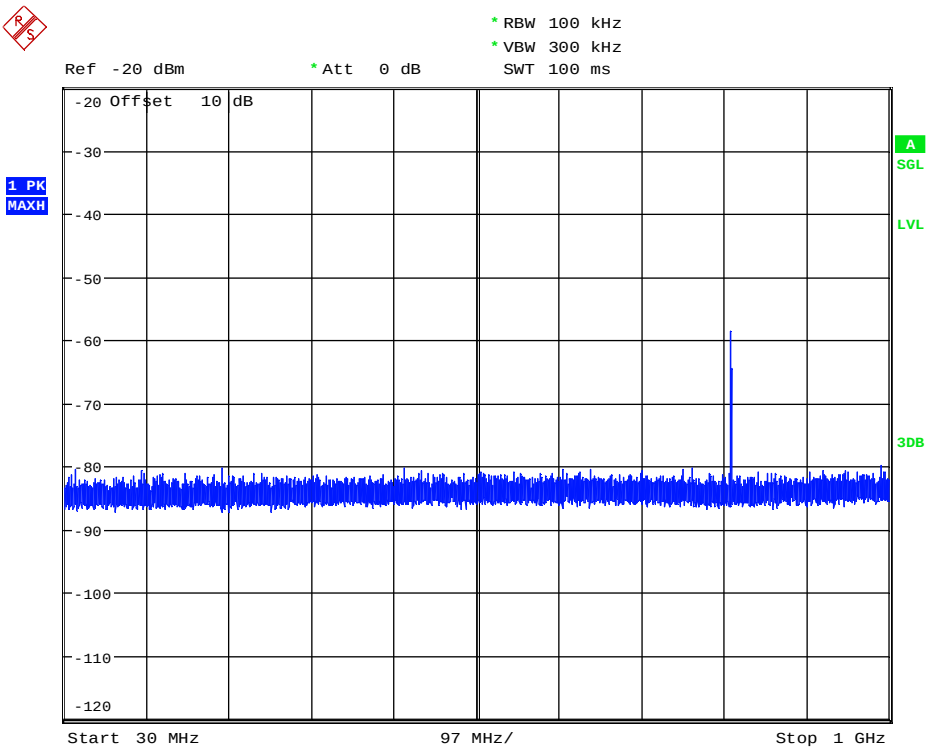
Odin_SpurEmiss9-150k_BT_DH5_BT39.wmf: conducted spurious emissions (operation mode 2):



Odin_SpurEmiss150k-30M_BT_DH5_BT39.wmf: conducted spurious emissions (operation mode 2):



Odin_SpurEmiss0.03-1G_BT_DH5_BT39.wmf: conducted spurious emissions (operation mode 2):



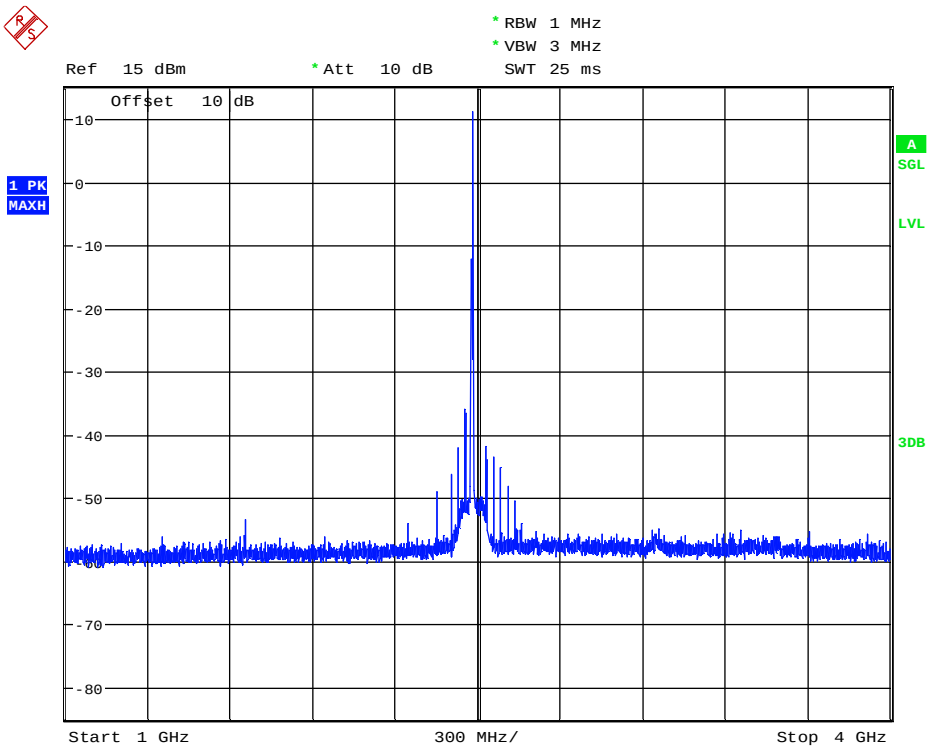
Spurious Emissions f < 1 GHz									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
Peak Emission – Restricted Band Operation Mode 1									
1	0	0.071	-13.3	30.6	43.9	-77.6	3.0	Passed	Y
1	0	0.078	-21.2	29.7	50.9	-85.4	3.0	Passed	Y
1	0	0.078	-21.7	29.7	51.4	-85.9	3.0	Passed	Y
1	0	800.661	43.7	46.0	2.3	-59.3	3.0	Passed	Y
Peak Emission – Restricted Band Operation Mode 2									
2	39	0.071	-14.0	30.6	44.6	-78.3	3.0	Passed	Y
2	39	0.078	-20.8	29.7	50.5	-85.0	3.0	Passed	Y
2	39	813.665	44.3	46.0	1.7	-58.7	3.0	Passed	Y
Peak Emission – Restricted Band Operation Mode 3									
3	78	0.071	-14.0	30.6	44.6	-78.3	3.0	Passed	Y
3	78	0.078	-20.7	29.7	50.4	-84.9	3.0	Passed	Y
3	78	0.037	-24.3	36.4	60.7	-88.6	3.0	Passed	Y
3	78	826.671	44.3	46.0	1.7	-58.7	3.0	Passed	Y
Peak Emission – Restricted Band Operation Mode 10									
10	0	0.071	-14.0	30.6	44.6	-78.3	3.0	Passed	Y
10	0	0.078	-20.9	29.7	50.7	-85.2	3.0	Passed	Y
10	0	0.142	-23.6	24.6	48.1	-87.8	3.0	Passed	Y
10	0	800.669	38.4	46.0	7.6	-64.5	3.0	Passed	Y
Peak Emission – Restricted Band Operation Mode 11									
11	19	0.071	-13.8	30.6	44.4	-78.1	3.0	Passed	Y
11	19	0.142	-23.5	24.6	48.0	-87.7	3.0	Passed	Y
11	19	0.078	-20.6	29.7	50.3	-84.9	3.0	Passed	Y
		813.325	39.6	46.0	6.4	-63.3	3.0	Passed	Y
Peak Emission – Restricted Band Operation Mode 12									
12	39	0.071	-14.1	30.6	44.7	-78.4	3.0	Passed	Y
12	39	0.079	-21.1	29.7	50.8	-85.4	3.0	Passed	Y
12	39	0.142	-23.6	24.6	48.1	-87.8	3.0	Passed	Y
12	39	826.666	40.3	46.0	5.7	-62.7	3.0	Passed	Y

5.6.3.2 Emissions above 1 GHz

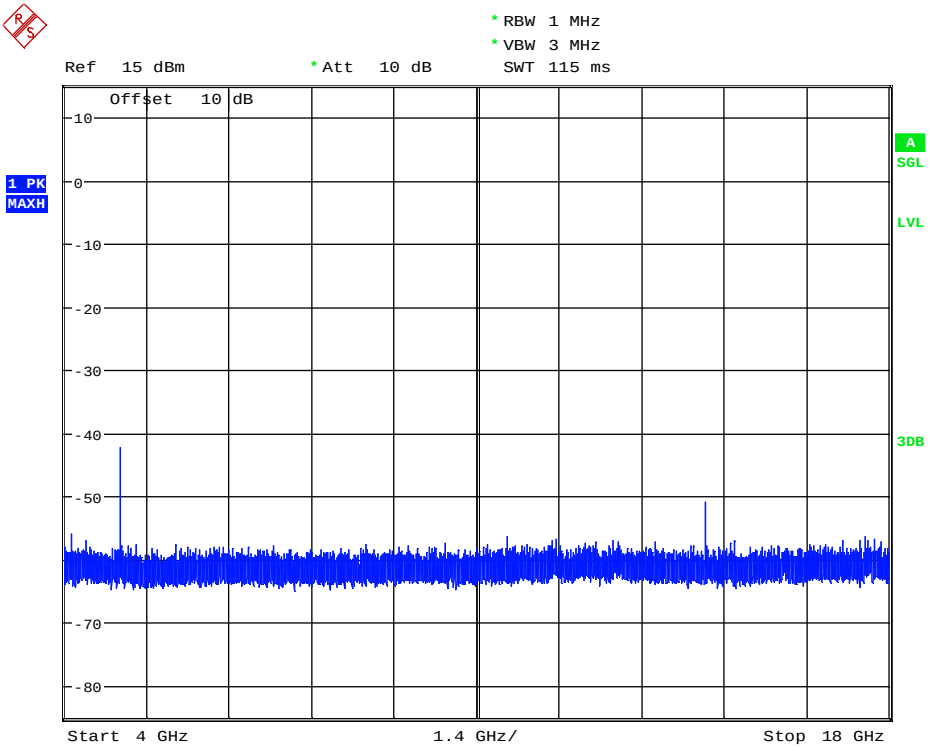
Ambient temperature	22 °C	Relative humidity	25 %

The following results were measured at antenna port of the EUT. Each plot shows an exemplary measurement results for the worst documented case. The other results are listed in the following tables.

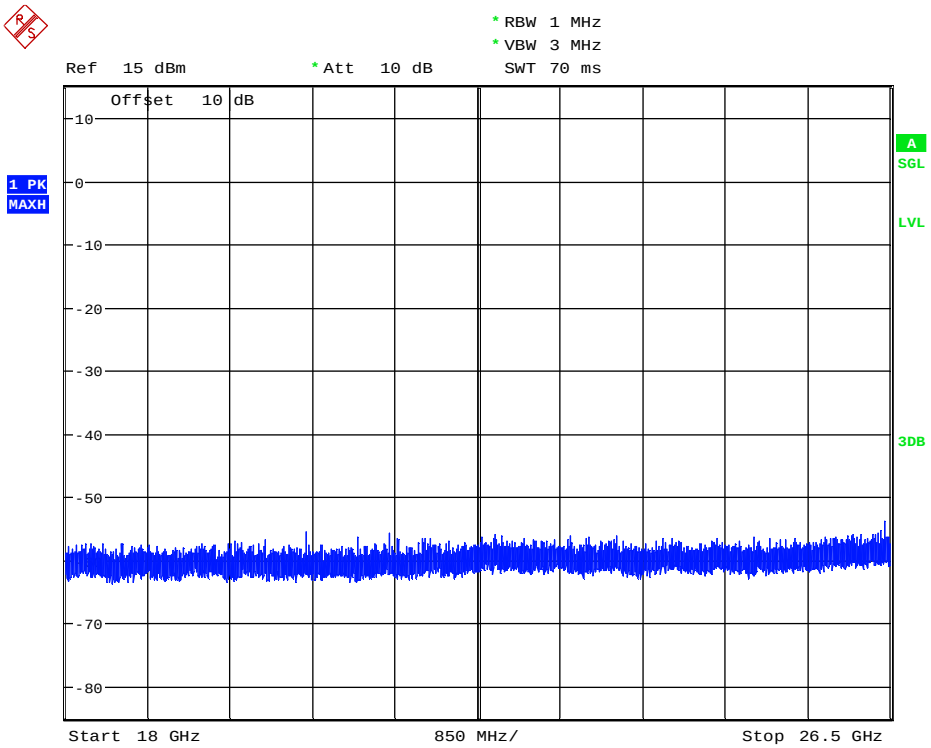
Odin_SpurEmiss1-4G_BT_DH5_BT79.wmf: conducted spurious emissions (operation mode 3):



Odin_SpurEmiss4-18G_BT_DH5_BT79.wmf: conducted spurious emissions (operation mode 3):



Odin_SpurEmiss18-26,5G_BT_DH5_BT79.wmf: conducted spurious emissions (operation mode 3):



Spurious Emissions, DH5-mode, channel 0 (Operation mode 1)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
1	0	4.804.363	56.0	74.0	18.0	-42.3	3.0	Passed	Y
1	0	20818.800	33.5	74.0	40.5	-64.8	3.0	Passed	Y
1	0	19214.800	33.3	74.0	40.7	-64.9	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
1	0	4.803.937	53.3	54	0.7	-46.0	3.0	Passed	Y
1	0	20818.600	25.1	54	28.9	-75.2	3.0	Passed	Y
1	0	19214.700	25.4	54	28.6	-75.0	3.0	Passed	Y
Emissions in the non-restricted Bands									
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
1	0	2402.000	10.3	-	-	Passed	No		
1	0	21619.450	-63.0	-9.7	53.3	Passed	No		

Spurious Emissions, DH5-mode, channel 39 (Operation mode 2)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
2	39	4882.250	55.8	74.0	18.2	-42.5	3.0	Passed	Y
2	39	4068.175	45.4	74.0	28.6	-52.8	3.0	Passed	Y
2	39	21154.000	35.8	74.0	38.2	-62.5	3.0	Passed	Y
2	39	19529.300	35.1	74.0	38.9	-63.2	3.0	Passed	Y
2	39	22784.100	34.9	74.0	39.1	-63.3	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
2	39	4881.850	53.6	54	0.4	-45.8	3.0	Passed	Y
2	39	4068.187	37.9	54	16.1	-61.4	3.0	Passed	Y
2	39	21154.100	28.5	54	25.5	-71.8	3.0	Passed	Y
2	39	19526.900	27.7	54	26.3	-72.7	3.0	Passed	Y
1	39	22781.300	26.1	54	27.9	-74.2	3.0	Passed	Y
Emissions in the non-restricted Bands									
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
2	39	2441.000	10.7	-	-	Passed	No		
2	39	21969.000	-67.1	-9.3	57.8	Passed	No		

Spurious Emissions, DH5-mode, channel 78 (Operation mode 3)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
3	78	4959.725	56.7	74.0	17.3	-41.5	3.0	Passed	Y
3	78	22318.300	36.9	74.0	37.1	-61.4	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
3	78	4959.925	53.9	54	0.1	-45.5	3.0	Passed	Y
3	78	22321.300	27.6	54	26.4	-72.8	3.0	Passed	Y

Emissions in the non-restricted Bands							
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
3	78	2480.000	10.7	-	-	Passed	No
3	78	14879.962	-51.9	-9.3	42.6	Passed	No

Spurious Emissions, 2DH5-mode, channel 0 (Operation mode 4)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
4	0	4804.525	48.1	74.0	25.9	-50.2	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
4	0	4804.012	40.8	54	13.2	-59.6	3.0	Passed	Y

Emissions in the non-restricted Bands							
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
4	0	2402.000	4.5	-	-	-	No
4	0	16813.963	-59.4	-15.5	43.9	Passed	No
4	0	14411.975	-61.7	-15.5	46.2	Passed	No
4	0	13830.937	-65.3	-15.5	49.8	Passed	No
4	0	21619.450	-63.8	-15.5	48.3	Passed	No

Spurious Emissions, 2DH5-mode, channel 39 (Operation mode 5)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
5	39	4881.738	49.3	74.0	24.7	-48.9	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
5	39	4881.863	42.1	54	11.9	-58.3	3.0	Passed	Y

Emissions in the non-restricted Bands							
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
5	39	2441.000	4.9	-	-	-	No
5	39	14645.975	-61.2	-15.1	46.1	Passed	No
5	39	21969.000	-65.2	-15.1	47.1	Passed	No

Spurious Emissions, 2DH5-mode, channel 78 (Operation mode 6)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
6	78	4959.675	52.7	74.0	21.3	-45.6	3.0	Passed	Y
6	78	22318.400	39.5	74.0	34.5	-58.7	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
6	78	4959.913	45.8	54	8.2	-54.5	3.0	Passed	Y
6	78	22321.300	31.1	54	22.9	-69.2	3.0	Passed	Y
No emissions were found in the non-restricted Bands									

Spurious Emissions, 3DH5-mode, channel 0 (Operation mode 7)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
7	0	4804.225	50.4	74.0	23.6	-47.8	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
7	0	4803.875	41.6	54	12.4	-58.9	3.0	Passed	Y
Emissions in the non-restricted Bands									
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
7	0	2402.000	4.9	-	-	-	No		
7	0	21619.450	-63.2	-15.1	48.1	Passed	No		

Spurious Emissions, 3DH5-mode, channel 39 (Operation mode 8)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
8	39	4881.837	51.6	74.0	22.4	-46.7	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
8	39	4882.012	43.3	54	10.7	-56.9	3.0	Passed	Y
Emissions in the non-restricted Bands									
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
8	39	2441.000	5.4	-	-	-	No		
8	39	21968.950	-64.8	-14.6	50.2	Passed	No		

Spurious Emissions, 3DH5-mode, channel 78 (Operation mode 9)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
9	78	4959.575	53.2	74.0	20.8	-45.1	3.0	Passed	Y
9	78	22320.100	39.4	74.0	34.6	-58.9	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
9	78	4959.925	45.3	54	8.7	-54.6	3.0	Passed	Y
9	78	22318.700	30.7	54	23.3	-69.7	3.0	Passed	Y
No emissions were found in the non-restricted Bands									

Spurious Emissions, BTLE-mode, channel 0 (Operation mode 10)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
10	0	4803.675	47.6	74.0	26.4	-50.6	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
10	0	4803.875	40.7	54	13.3	-60.5	3.0	Passed	Y

Emissions in the non-restricted Bands							
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
10	0	2402.000	4.6	-	-	-	No
10	0	21618.000	-62.8	-15.4	47.4	Passed	No

Spurious Emissions, BTLE -mode, channel 19 (Operation mode 11)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
11	19	4879.625	48.0	74.0	26.0	-50.2	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
11	19	4879.875	41.1	54	12.9	-60.1	3.0	Passed	Y

Emissions in the non-restricted Bands							
Operation Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
11	19	2440.000	5.1	-	-	-	No
11	19	21959.950	-64.6	-14.9	49.7	Passed	No

Spurious Emissions, BTLE -mode, channel 39 (Operation mode 12)									
Peak Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
12	39	4959.575	50.5	74.0	23.5	-47.7	3.0	Passed	Y
12	39	22322.300	39.8	74.0	34.2	-58.5	3.0	Passed	Y
Average Emission – Restricted Band									
Operation Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
12	39	4959.825	45.1	54	8.9	-56.1	3.0	Passed	Y
12	39	22317.900	33.5	54	20.5	-67.8	3.0	Passed	Y
No emissions were found in the non-restricted Bands									

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7, 28, 32

5.6.4 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 25 / 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 / 40 GHz.

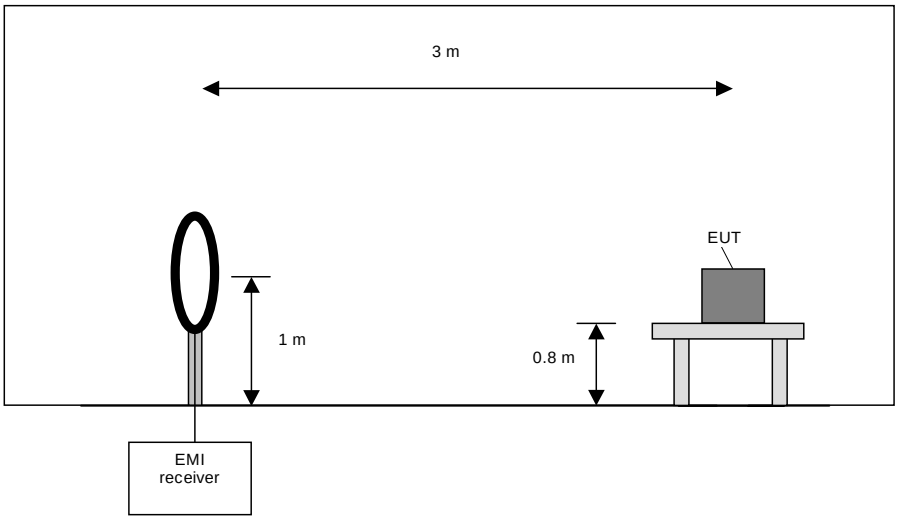
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2) Manipulate the system cables within the range to produce the maximum level of emission.
3) Rotate the EUT by 360 ° to maximize the detected signals.
4) Make a hardcopy of the spectrum.
5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
7) Rotate the measuring antenna and repeat steps 1) to 5).

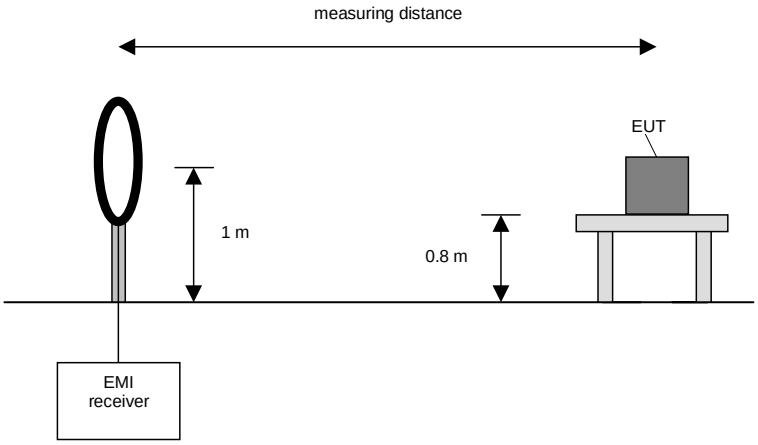
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the frequencies, which were detected during the preliminary measurements, the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
3) Rotate the measuring antenna to find the maximum and note the value.
4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (if the EUT is a module and might be used in a handheld equipment application).

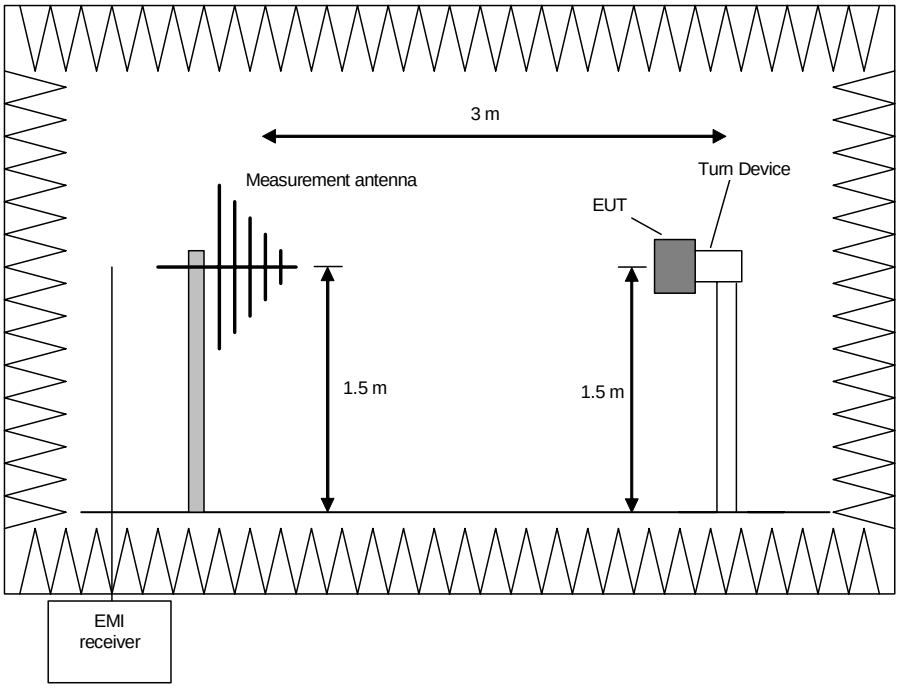
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Table top devices will set up on a non-conducting turn device on the height of 1.5m. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

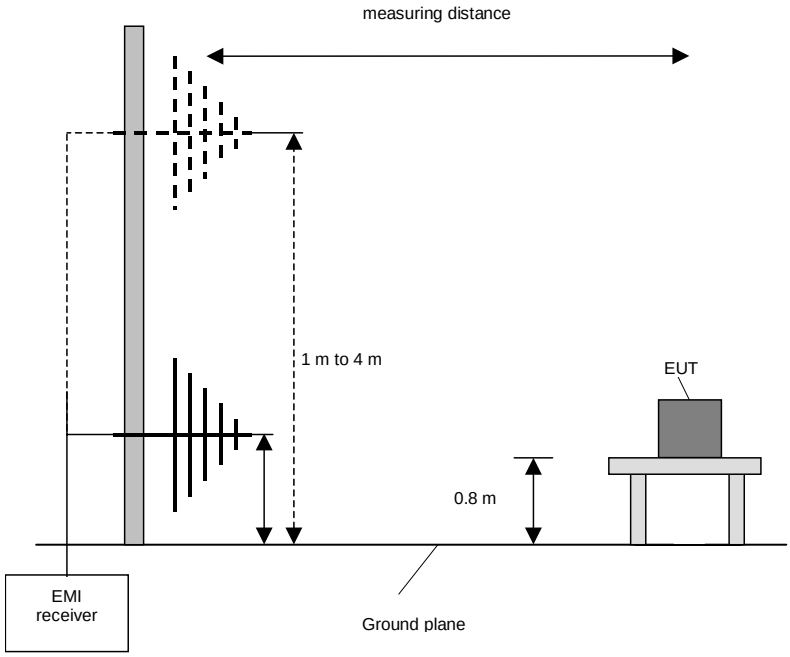
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring antenna.
5. Make a hardcopy of the spectrum.
6. Repeat 1) to 5) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
7. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
4) Repeat 1) to 3) for the other orthogonal antenna polarization.
5) Move the antenna and the turntable to the position where the maximum value is detected.
6) Measure while moving the antenna slowly +/- 1 m.
7) Set the antenna to the position where the maximum value is found.
8) Measure while moving the turntable +/- 45 °.
9) Set the turntable to the azimuth where the maximum value is found.
10) Measure with Final detector (QP and AV) and note the value.
11) Repeat 5) to 10) for each frequency.
12) Repeat 1) to 11) for each orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 40 GHz)

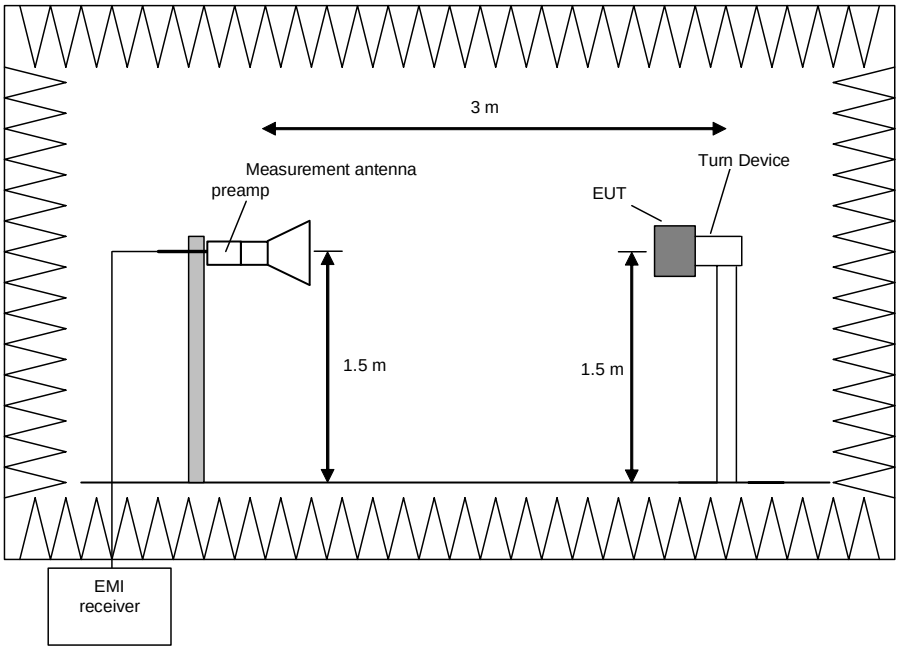
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.
The following procedure will be used:

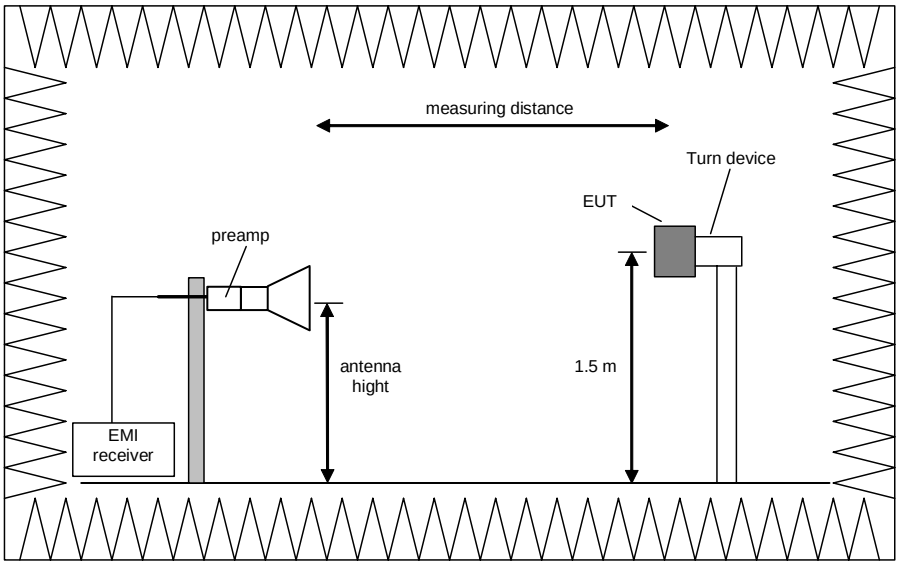
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 25 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 GHz.
The following procedure will be used:

1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
3) Set the spectrum analyser to EMI mode with peak and average detector activated.
4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
5) Note the highest displayed peak and average values
6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.6.5 Test results (radiated emissions) – cabinet emissions

5.6.5.1 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m or an EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures inTestset-up fotos.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 3.3 V via an laboratory power supply. Because the external filters of the anechoic chamber prevented the start and operation of the EUT, an electrolytic capacitor [100 µF] was implemented between the power supply lines.

Remark: Document [1] states in 11.12.2.1, that in case of conducted measurements, additional radiated cabinet emission measurements must be performed. The measurements were performed at the worst case modulation, namely Bluetooth classic with GFSK modulation on channels 0, 39 and 78, as well as Bluetooth Low Energy on the channels 0, 19 and 39..

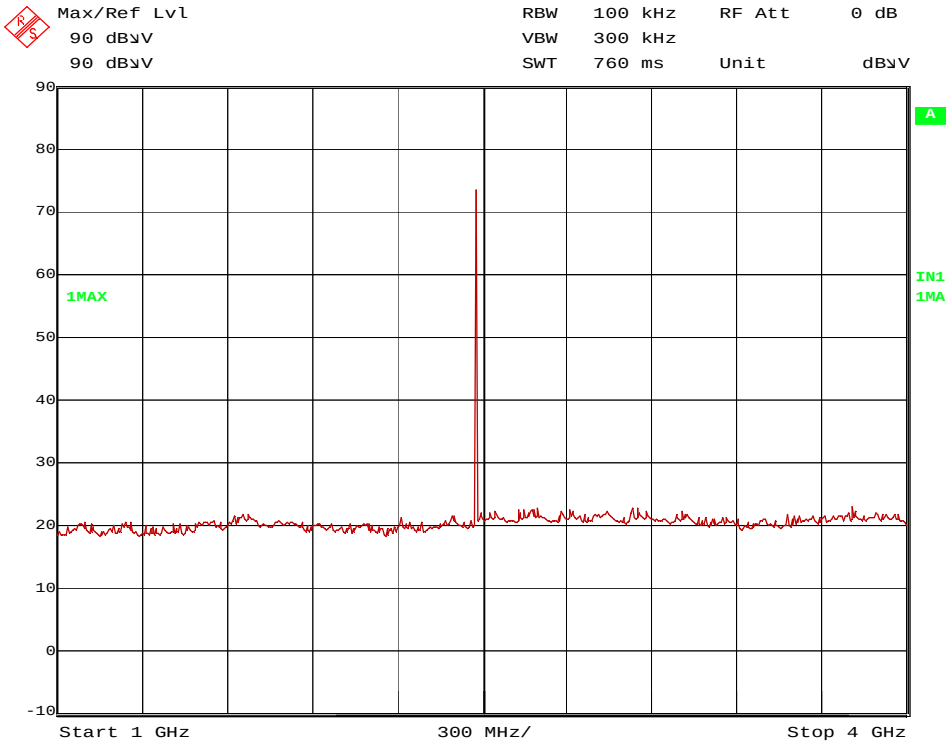
Only the plots of the worst case emissions are submitted for every frequency range above 1 GHz in the preliminary results.

The lowest internal clock frequency was 24 MHz therefore the radiated measurements were performed starting at 150 kHz.

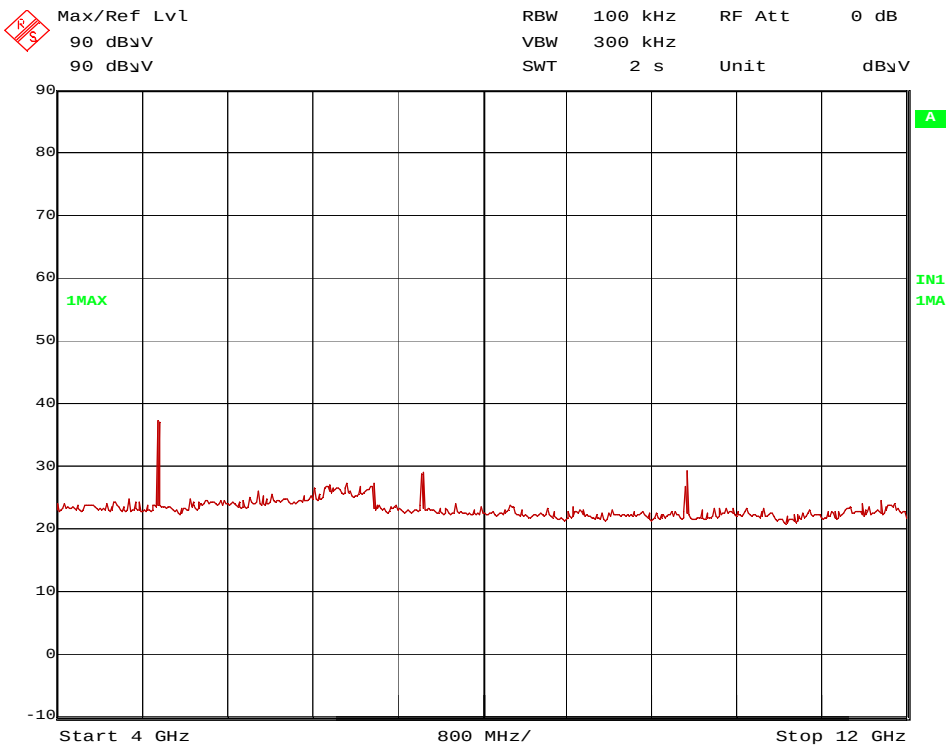
No emissions could be found in the frequency band below 1 GHz, therefore no plots for this frequency range are submitted below.

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

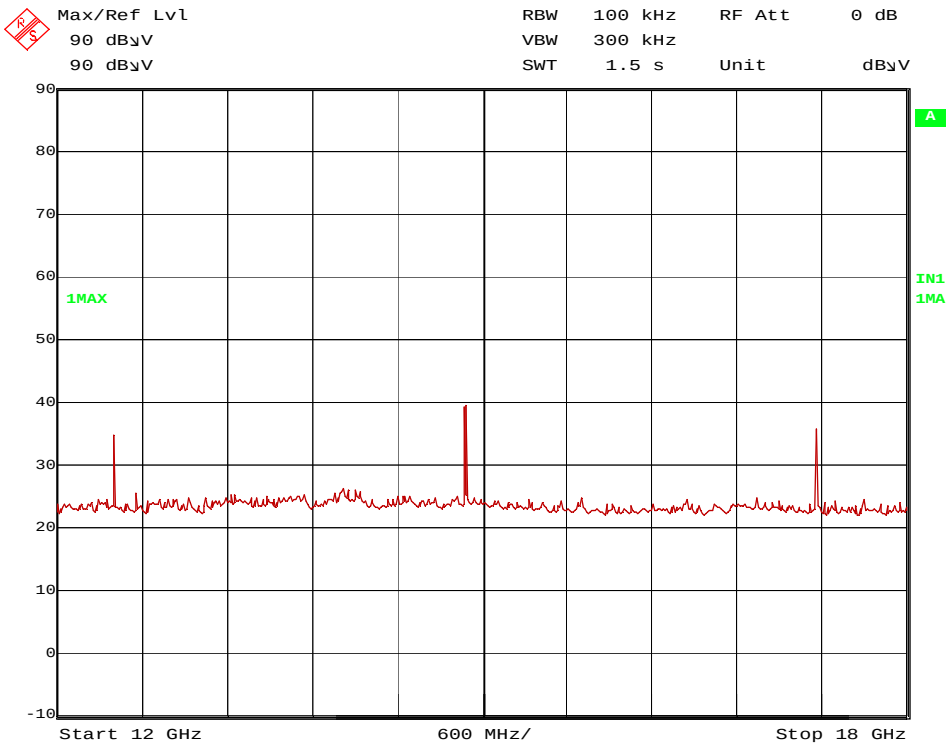
151496_DH5_ch78_1-4G_120°.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



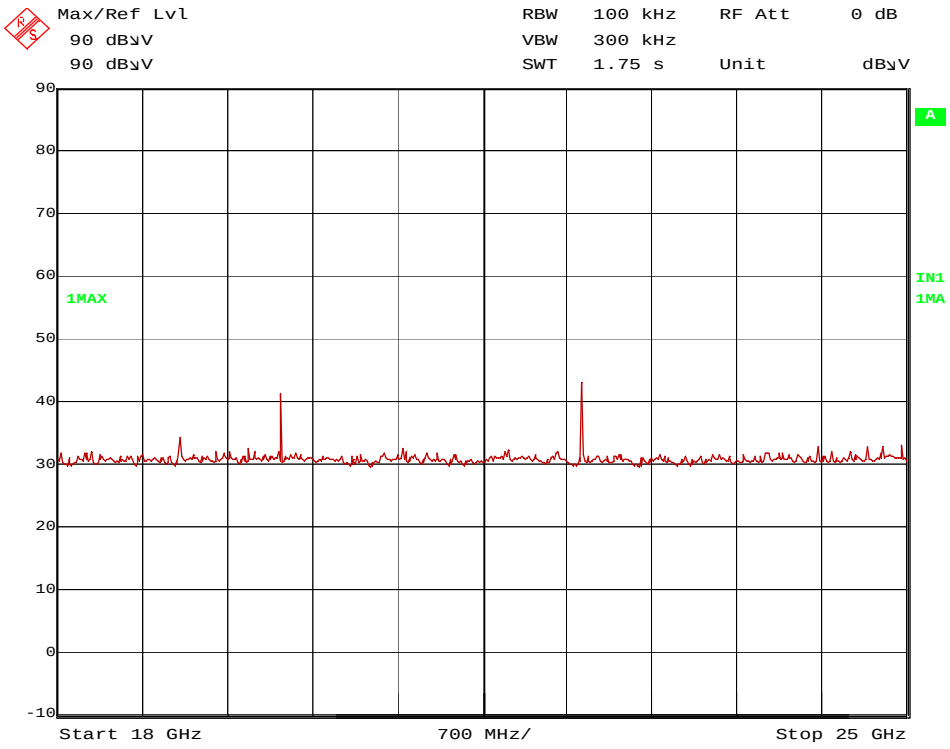
151496_DH5_ch78_4-12G_90°.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



151496_SpurEm12-18_DH5_ch78_Hor_30°.wmf: Spurious emissions from 12 to 18 GHz (operation mode 3):



151496_SpurEm18-25_DH5_ch78_Ver_150°.wmf: Spurious emissions from 18 – 25 GHz (operation mode 3):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 4960 MHz, 7440 MHz, 12400 MHz, 19840 MHz and 22320 MHz.

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 9920 MHz, 14880 MHz and 17360 MHz.

These frequencies have to be measured in a final measurement. The results are presented in the following.

TEST EQUIPMENT USED FOR THE TEST:
6, 8 - 15, 17-20, 22 - 25, 28, 29, 33

5.6.5.2 Final radiated emission measurement (9 kHz to 1 GHz)

No emissions were found during the preliminary measurements , therefore no results for the final measurements are submitted.

5.6.5.3 Final radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	22 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on an EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in test-setup photos.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 3.3 V via an laboratory power supply. Because the external filters of the anechoic chamber prevented the start and operation of the EUT, an electrolytic capacitor [100 µF] was implemented between the power supply lines.

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Additional information: For simplification all values were compared to the restricted band limits.
As pre-tests have shown, the DH5 mode is the worst case of the classic Bluetooth modes, therefore only the DH5 mode and the Bluetooth Low Energy modes were tested during radiated cabinet emission measurements.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4804	53.2	74	20.8	40.9	32.6	25.6	5.3	150	Hor.	60°
7206	58.1	74	15.9	40.4	35.6	24.7	6.8	150	Hor.	60°
9608	56.4	74	17.6	35.2	37.3	23.9	7.8	150	Vert.	90°
12010	53.5	74	20.5	44.6	33.6	26.3	1.6	150	Hor.	60°
14412	56.1	74	17.9	47.4	33.7	26.8	1.8	150	Hor.	120°
16814	55.2	74	18.8	47.8	33.8	28.4	2.0	150	Hor.	30°
19216	56.0	74	18.0	54.4	37.1	37.7	2.2	150	Hor.	90°
21618	48.1	74	25.9	46.3	37.2	37.8	2.4	150	Ver.	150°
24020	47.9	74	26.1	46.5	37.2	38.2	2.4	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4804	48.6	54	5.4	35.2	32.6	25.6	5.3	150	Hor.	60°
7206	51.8	54	2.2	33.0	35.6	24.7	6.8	150	Hor.	60°
9608	45.9	54	8.1	23.6	37.3	23.9	7.8	150	Vert.	90°
12010	43.5	54	10.5	33.5	33.6	26.3	1.6	150	Hor.	60°
14412	44.2	54	9.8	34.4	33.7	26.8	1.8	150	Hor.	120°
16814	42.1	54	11.9	33.6	33.8	28.4	2.0	150	Hor.	30°
19216	41.5	54	12.5	38.8	37.1	37.7	2.2	150	Hor.	90°
21618	33.5	54	20.5	30.6	37.2	37.8	2.4	150	Ver.	150°
24020	33.6	54	20.4	31.1	37.2	38.2	2.4	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Transmitter operates at the middle of the assigned frequency band (operation mode 2)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4882	53.7	74	20.3	41.2	32.8	25.6	5.3	150	Hor.	60°
7323	54.5	74	19.5	36.3	36.1	24.7	6.8	150	Hor.	60°
9764	57.4	74	16.6	36.1	37.3	23.9	7.9	150	Hor.	90°
12205	48.6	74	25.4	39.8	33.6	26.4	1.6	150	Hor.	60°
14646	55.4	74	18.6	46.8	33.7	27.0	1.9	150	Hor.	120°
17087	51.5	74	22.5	43.7	33.8	28.2	2.2	150	Hor.	30°
19528	53.3	74	20.7	51.9	37.1	38.0	2.3	150	Hor.	90°
21618	42.4	74	31.6	40.6	37.2	37.8	2.4	150	Ver.	150°
23660	42.2	74	31.8	40.6	37.2	38.1	2.5	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4882	49.3	54	4.7	35.7	32.8	25.6	5.3	150	Hor.	60°
7323	46.5	54	7.5	27.2	36.1	24.7	6.8	150	Hor.	60°
9764	48.2	54	5.8	25.8	37.3	23.9	7.9	150	Hor.	90°
12205.00	37.7	54	16.3	27.8	33.6	26.4	1.6	150	Hor.	60°
14646.00	43.7	54	10.3	34.0	33.7	27.0	1.9	150	Hor.	120°
17087.00	38.3	54	15.7	29.4	33.8	28.2	2.2	150	Hor.	30°
19528.00	38.9	54	15.1	36.4	37.1	38.0	2.3	150	Hor.	90°
21618.00	29.3	54	24.7	26.4	37.2	37.8	2.4	150	Ver.	150°
23660.00	29.2	54	24.8	26.5	37.2	38.1	2.5	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4960	55.4	74	18.6	42.8	32.9	25.6	5.3	150	Hor.	60°
7440	53.6	74	20.4	35.2	36.3	24.7	6.8	150	Hor.	60°
9920	57.2	74	16.8	35.8	37.4	23.9	7.9	150	Hor.	90°
12400	52.5	74	21.5	43.5	33.7	26.3	1.6	150	Hor.	60°
14880	57.9	74	16.1	49.5	33.7	27.2	1.9	150	Hor.	120°
17360	49.7	74	24.3	42.2	33.9	28.5	2.1	150	Hor.	30°
19840	51.4	74	22.6	49.7	37.0	37.6	2.3	150	Hor.	90°
22320	35.6	74	38.4	33.7	37.2	37.7	2.4	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4960	51.0	54	3.0	37.3	32.9	25.6	5.3	150	Hor.	60°
7440	45.4	54	8.6	25.9	36.3	24.7	6.8	150	Hor.	60°
9920	47.5	54	6.5	25.0	37.4	23.9	7.9	150	Hor.	90°
12400	42.3	54	11.7	32.2	33.7	26.3	1.6	150	Hor.	60°
14880	46.2	54	7.8	36.7	33.7	27.2	1.9	150	Hor.	120°
17360	36.3	54	17.7	27.7	33.9	28.5	2.1	150	Hor.	30°
19840	36.9	54	17.1	34.1	37.0	37.6	2.3	150	Hor.	90°
22320	52.5	54	1.5	49.5	37.2	37.7	2.4	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Transmitter operates at the lower end of the assigned frequency band (operation mode 10)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4804	47.0	74	27.0	34.7	32.6	25.6	5.3	150	Hor.	90°
7206	53.1	74	20.9	35.4	35.6	24.7	6.8	150	Hor.	90°
12010	53.9	74	20.1	45.0	33.6	26.3	1.6	150	Hor.	60°
16814	55.0	74	19.0	47.6	33.8	28.4	2.0	150	Hor.	30°
14412	56.1	74	17.9	47.4	33.7	26.8	1.8	150	Hor.	120°
19216	50.7	74	23.3	49.1	37.1	37.7	2.2	150	Hor.	90°
21618	48.7	74	25.3	46.9	37.2	37.8	2.4	150	Ver.	150°
24020.2	45.6	74	28.4	44.2	37.2	38.2	2.4	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4804	38.3	54	15.7	24.1	32.6	25.6	5.3	150	Hor.	90°
7206	42.6	54	11.4	23.0	35.6	24.7	6.8	150	Ver.	90°
12010	40.0	54	14.0	29.2	33.6	26.3	1.6	150	Hor.	60°
16814	41.8	54	12.2	32.5	33.8	28.4	2.0	150	Hor.	30°
14412	42.3	54	11.7	31.7	33.7	26.8	1.8	150	Hor.	120°
19216	36.5	54	17.5	33.0	37.1	37.7	2.2	150	Hor.	90°
21618	34.8	54	19.2	31.1	37.2	37.8	2.4	150	Ver.	150°
24020	32.2	54	21.8	28.9	37.2	38.2	2.4	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Transmitter operates at the middle of the assigned frequency band (operation mode 11)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4880.0	49.7	74	24.3	37.2	32.8	25.6	5.3	150	Hor.	90°
7320.0	54.3	74	19.7	36.1	36.1	24.7	6.8	150	Ver.	90°
12200	52.2	74	21.8	43.4	33.6	26.4	1.6	150	Hor.	60°
14640	50.7	74	23.3	42.1	33.7	27.0	1.9	150	Hor.	120°
17080	51.9	74	22.1	44.1	33.8	28.2	2.2	150	Hor.	30°
19520	47.2	74	26.8	45.8	37.1	38.0	2.3	150	Hor.	90°
21960	49.0	74	25.0	47.2	37.2	37.9	2.5	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4880.0	42.1	54	11.9	27.7	32.8	25.6	5.3	150	Hor.	90°
7320.0	43.5	54	10.5	23.4	36.1	24.7	6.8	150	Hor.	90°
12200	38.6	54	15.5	27.9	33.6	26.4	1.6	150	Hor.	60°
14640	36.5	54	17.5	26.0	33.7	27.0	1.9	150	Hor.	120°
17080	37.1	54	16.9	27.4	33.8	28.2	2.2	150	Hor.	30°
19520	33.7	54	20.3	30.4	37.1	38.0	2.3	150	Hor.	90°
21960	35.0	54	19.0	31.3	37.2	37.9	2.5	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Transmitter operates at the upper end of the assigned frequency band (operation mode 12)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4960	51.1	74	22.9	38.5	32.9	25.6	5.3	150	Hor.	90°
7440	56.0	74	18.0	37.6	36.3	24.7	6.8	150	Ver.	90°
12400	51.1	74	22.9	42.1	33.7	26.3	1.6	150	Hor.	60°
14880	44.2	74	29.8	35.8	33.7	27.2	1.9	150	Hor.	120°
17360	48.3	74	25.7	40.8	33.9	28.5	2.1	150	Hor.	30°
22317	49.3	74	24.7	47.4	37.2	37.8	2.5	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	EUT angle
4960	43.2	54	10.8	28.7	32.9	25.6	5.3	150	Hor.	90°
7440	45.5	54	8.5	25.2	36.3	24.7	6.8	150	Ver.	90°
12400	28.0	54	26.0	17.1	33.7	26.3	1.6	150	Hor.	60°
14880	32.8	54	21.2	22.5	33.7	27.2	1.9	150	Hor.	120°
17360	29.7	54	24.3	20.3	33.9	28.5	2.1	150	Hor.	30°
22317	22.3	54	31.7	18.5	37.2	37.8	2.5	150	Ver.	150°
Measurement uncertainty				+2.2 dB / -3.6 dB						

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
6, 8 - 15, 17-20, 22 - 25, 28, 29, 33

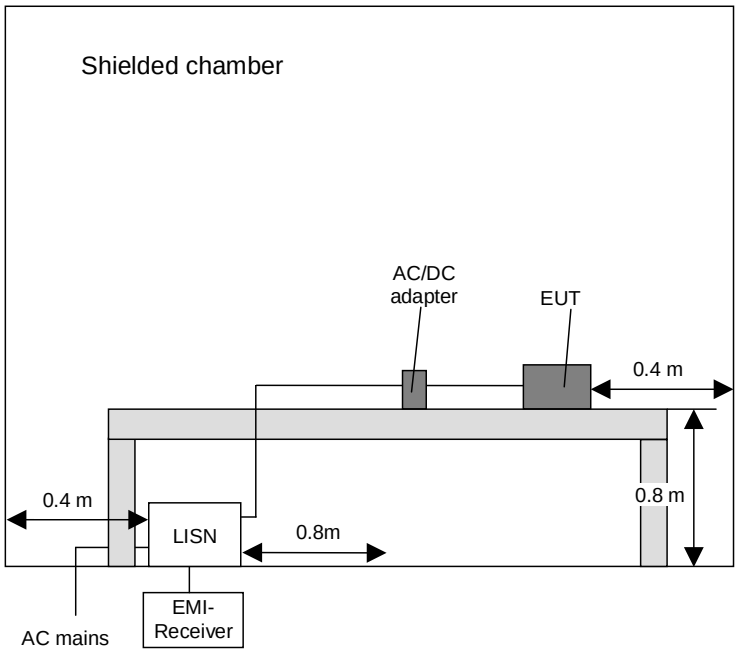
5.7 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.7.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriable limit. this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.7.2 Test results (conducted emissions on power supply lines)

Ambient temperature	21 °C	Relative humidity	42 %

Position of EUT: For the test the EUT was powered by a typical AC/DC power supply.

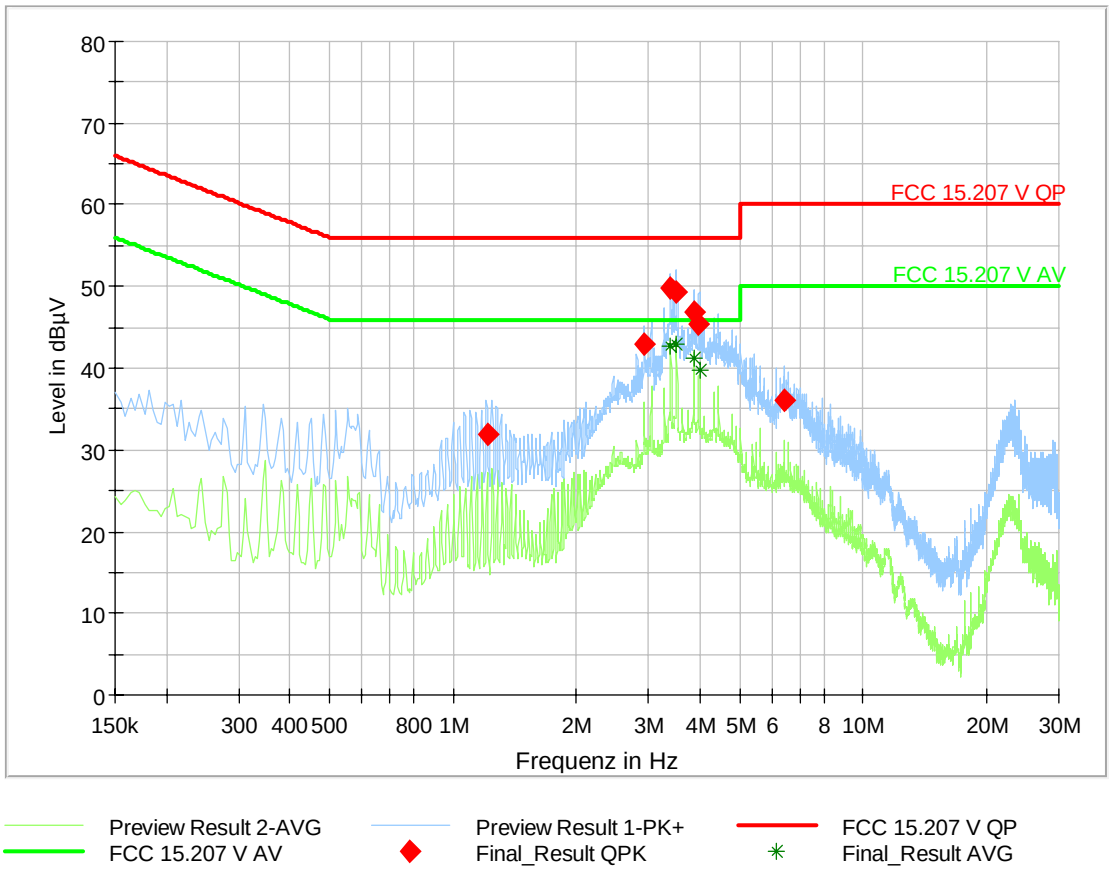
Operation Mode: Both the EUT carrier board and the AUX carrier board will be connected to the supervising PC. A Bluetooth communication link is set up between the EUT and the auxiliary unit using the PC software toolbox and a setup script. The toolbox will then be used to execute a data transmission between the devices, while the connection status of the devices is monitored.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: Measurement performed with US 120V/60Hz. For the test a power supply type 273-316 from enercell was used.

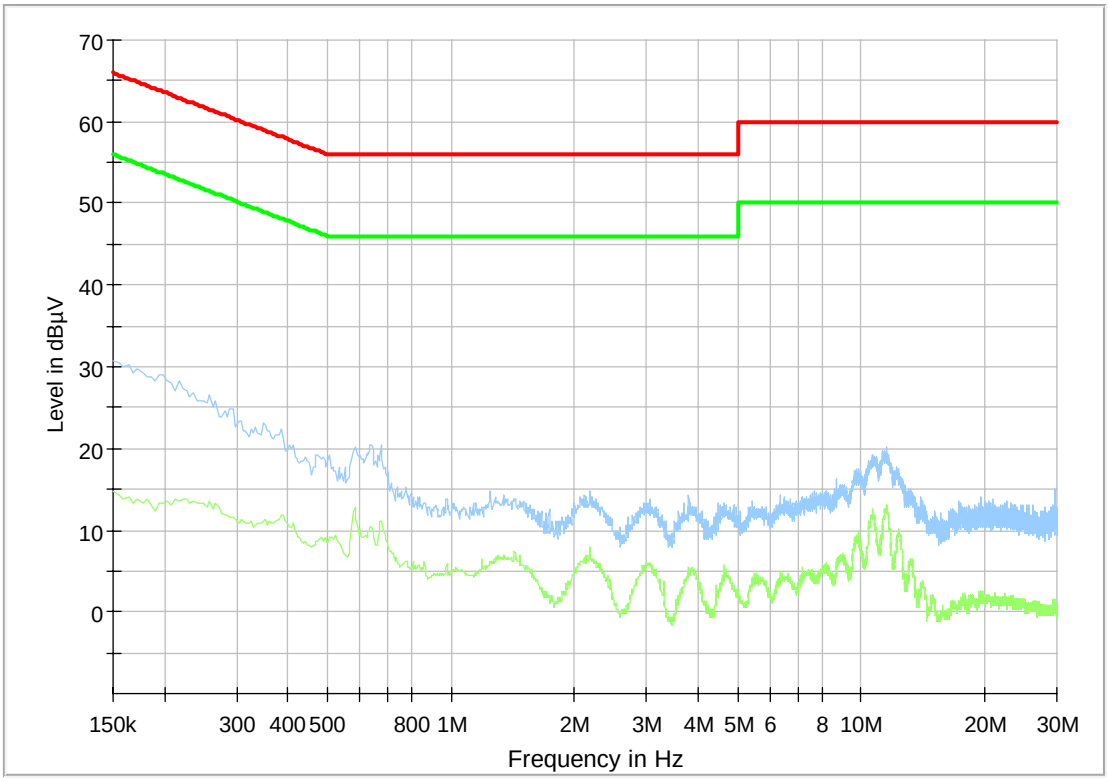
The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by "◊" and the average measured points by "+".



Data record name: 151496_BT_AC

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
1.212000	31.91	---	56.00	24.09	5000.0	9.000	L1	FLO	10.0
2.927400	43.05	---	56.00	12.95	5000.0	9.000	L1	FLO	10.3
3.395400	49.72	---	56.00	6.28	5000.0	9.000	N	FLO	10.3
3.398100	---	42.73	46.00	3.27	5000.0	9.000	L1	FLO	10.3
3.510600	49.39	---	56.00	6.61	5000.0	9.000	L1	FLO	10.3
3.512400	---	42.99	46.00	3.01	5000.0	9.000	L1	FLO	10.3
3.865200	---	41.11	46.00	4.89	5000.0	9.000	L1	FLO	10.3
3.867000	46.76	---	56.00	9.24	5000.0	9.000	L1	FLO	10.3
3.978600	45.28	---	56.00	10.72	5000.0	9.000	N	FLO	10.3
3.984000	---	39.64	46.00	6.36	5000.0	9.000	L1	FLO	10.3
6.411300	36.04	---	60.00	23.96	5000.0	9.000	N	FLO	10.6



Data record name: 151496_BLE_AC

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
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Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1 – 5

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	03/19/2015	03/2016
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
6	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
7	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	03/09/2015	03/2016
8	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/26/2014	02/2016
9	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
10	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
11	Antenna support	AS615P	Deisel	615/310	480187	-	-
12	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
13	Antenna	3115 A	EMCO	9609-4918	480183	10/11/2014	11/2017
14	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
15	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
16	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480229	Six month verification (system cal.)	
17	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
18	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
19	RF-cable No. 36	Sucoflex 106B	Huber&Suhner	500003/6B / Kabel 36-	481680	Weekly verification (system cal.)	
20	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480300	Six month verification (system cal.)	
21	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire		480302	Six month verification (system cal.)	
22	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
23	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (system cal.)	
24	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
25	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/2014	02/2016
26	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	03/2015	03/2016
27	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	03/2015	03/2016
28	4 GHz High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

29	Single Control Unit	SCU	Maturo GmbH	SCU/006/971107	480831	Calibration not necessary	
30	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	
31	Temperature Test Chamber	MK 240	Binder	05-79022	480462	02/18/2014	08/2015
32	Low Pass Filter	WLJ1.0G-5EE-300W	Wainwright Instruments GmbH	6	481298	Yearly verification (system cal.)	
33	Turn Device	TDF 1.5-10Kg	Maturo	-	482034	-	

7 REPORT HISTORY

Report Number	Date	Comment
F151496E7	16 October 2015	Document created

8 LIST OF ANNEXES

ANNEX A TEST SET-UP PHOTOS 5 pages

151496_19: Test setup - Radiated emission. Antennas terminated (fully anechoic chamber)
151496_16: Test setup - Radiated emission. Antennas terminated (fully anechoic chamber)
151496_17: Test setup - Radiated emission. Antennas terminated (fully anechoic chamber)
151496_18: Test setup - Radiated emission. Antennas terminated (fully anechoic chamber)
151496_20: Test setup – conducted emissions on power supply lines

ANNEX B EXTERNAL PHOTOGRAPHS 6 pages

151496_01.jpg: Carrier Board + EUT – Top View (Odin-W260)
151496_02.jpg: Carrier Board – Bottom View (Odin-W260)
151496_07.jpg: EUT – Top View (Odin-W260)
151496_06:jpg: Carrier Board + EUT – Top View (Odin-W262)
151496_02.jpg: Carrier Board – Bottom View (Odin-W262)
151496_08.jpg: EUT – Top View (Odin-W262)

ANNEX C INTERNAL PHOTOGRAPHS 4 pages

151496_03.jpg: EUT – Top View –Shielding removed (Odin-W260)
151496_04.jpg: EUT – Bottom View (Odin-W260)
151496_05.jpg: EUT – Top View –Shielding removed (Odin-W262)
151496_04.jpg: EUT – Bottom View (Odin-W262)