

Test Report

Report Number:

F220459E1

Equipment under Test (EUT):

**Bluetooth Module
LVIV-B2**

Applicant:

SE Spezial-Electronic GmbH

Manufacturer:

SE Spezial-Electronic GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **558074 D01 15.247 Meas Guidance v05r02 (April 2019)**, GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

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.

“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in clause 1.3 of ANSI C63.10 (2013). However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

This test report is only valid in its original form.

Any reproduction of its contents in extracts without written permission of the accredited test laboratory PHOENIX TESTLAB GmbH is prohibited.

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 Technical Data of Equipment	7
1.6 Dates	9
2 Operational States	10
2.1 Description of function of the EUT	10
3 Additional Information	11
4 Overview.....	12
5 Results.....	13
5.1 Test setups.....	13
5.2 Duty cycle.....	25
5.3 Transmit antenna performance considerations.....	25
5.4 DTS fundamental emission output power	26
5.5 DTS bandwidth.....	28
5.6 DTS band-edge emission measurements.....	30
5.7 Radiated emissions	30
6 Measurement Uncertainties	41
7 Test Equipment used for Tests	42
8 Test site Verification.....	43
9 Report History.....	43
10 List of Annexes	43

1 Identification

1.1 Applicant

Name:	SE Spezial-Electronic GmbH
Address:	Friedrich-Bach-Straße 1, 31675 Bückeburg
Country:	Germany
Name for contact purposes:	Mr. Peter FORAITA
Phone:	+49 5722-203-143
eMail address:	peter_foraita@spezial.com
Applicant represented during the test by the following person:	Partly: Mr. Peter FORAITA

1.2 Manufacturer

Name:	SE Spezial-Electronic GmbH
Address:	Friedrich-Bach-Straße 1, 31675 Bückeburg
Country:	Germany
Name for contact purposes:	Mr. Peter FORAITA
Phone:	+49 5722-203-143
eMail address:	peter_foraita@spezial.com
Manufacturer represented during the test by the following person:	Partly: Mr. Peter FORAITA

1.3 Test Laboratory

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

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-06 and D-PL-17186-01-05, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

Test object: *	Bluetooth Module
Model name: *	LVIV-B2
Model number: *	n.a.
Order number: *	see table below
FCC ID: *	2A54FLVIVB2
IC certification number: *	28382-LVIVB2
PMN: *	LVIV-B2 Series
HVIN: *	SE-NOBS-B2i-A3; SE-NOBS-B2X-A3; SE-NOBS-B2i-B3; SE-NOBS-B2X-B3
FVIN: *	-

	EUT number			
	1	2	3	4
Description: *	Internal antenna + LDO	Internal antenna + No LDO	Antennaport + LDO	Antennaport + No LDO
Serial number: *	6009C390CDBC	6009C390CD84	6009C390D4C0	6009C390CD80
Order number: *	SE-NOBS-B2i-A3	SE-NOBS-B2i-B3	SE-NOBS-B2X-A3	SE-NOBS-B2X-B3
EUT marking: *	#41	#52	#48	#44
PCB identifier: *	se18062021_1v01	se18062021_1v01	se18062021_1v01	se18062021_1v01
Hardware version: *	1.0	1.0	1.0	1.0
Software version: *	4.0.0-003	4.0.0-003	4.0.0-003	4.0.0-003
Photograph:				

* Declared by the applicant

4 EUTs were used for the tests. In the overview (chapter 4) is shown which EUT was used for each test case.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

General EUT data			
Power supply EUT (All): *	DC		
Supply voltage EUT (#41, #48): *	$U_{nom} = 5.0 \text{ V}_{DC}$	$U_{min} = 3.3 \text{ V}_{DC}$	$U_{max} = 5.5 \text{ V}_{DC}$
Supply voltage EUT (#52, #44): *	$U_{nom} = 3.3 \text{ V}_{DC}$	$U_{min} = 3.0 \text{ V}_{DC}$	$U_{max} = 3.6 \text{ V}_{DC}$
Supply voltage Eval Board: *	$U_{nom} = 12.0 \text{ V}_{DC}$	$U_{min} = 6.0 \text{ V}_{DC}$	$U_{max} = 15.0 \text{ V}_{DC}$
Temperature range: *	-40°C to +85°C		
Lowest / highest internal clock frequency: *	40 MHz / 2480 MHz		

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	Eval Board	Ancillary		
USB interface	USB-B	USB-A @ Laptop	~2m	Yes
DC connector	Screw Terminal	Lab Power Supply	~2m	No
-	-	-	-	-

Bluetooth® low energy frequencies			
Channel 00	2402 MHz	Channel 01	2404 MHz
Channel 02	2406 MHz	Channel 03	2408 MHz
...	...	...	...
...	...	...	...
Channel 18	2438 MHz	Channel 19	2440 MHz
...	...	...	...
...	...	...	...
Channel 36	2474 MHz	Channel 37	2476 MHz
Channel 38	2478 MHz	Channel 39	2480 MHz

Bluetooth® classic+EDR frequencies			
Channel 00	2402 MHz	Channel 01	2403 MHz
Channel 02	2404 MHz	Channel 03	2405 MHz
...	...	...	...
...	...	...	...
Channel 38	2440 MHz	Channel 39	2441 MHz
...	...	...	...
...	...	...	...
Channel 75	2477 MHz	Channel 76	2478 MHz
Channel 77	2479 MHz	Channel 78	2480 MHz

Bluetooth® radio mode		
Fulfills radio specification: *	Bluetooth® 4.0 (classic + EDR + Low Energy)	
Antenna type: *	EUT 1+2: chip antenna EUT 3+4: flexible antenna	
Antenna name: *	EUT 1+2: COMPACT REACH Xtend™ EUT 3+4: Dromus SRF2W012	
Antenna gain: *	EUT 1+2: 1.7 dBi EUT 3+4: 3.0 dBi	
Antenna connector: *	EUT 1+2: None EUT 3+4: U.FL	
Type of modulation: *	BLE (1 Mbps PHY)	GFSK
	BT classic (1 Mbps PHY)	GFSK
	BT EDR (2 Mbps PHY)	$\pi/4$ DQPSK
	BT EDR (3 Mbps PHY)	8DPSK
Operating frequency range: *	BLE (1 Mbps PHY)	2402 – 2480 MHz
	BT classic (1 Mbps PHY)	2402 – 2480 MHz
	BT EDR (2 Mbps PHY)	2402 – 2480 MHz
	BT EDR (3 Mbps PHY)	2402 – 2480 MHz
Number of channels: *	BLE (1 Mbps PHY)	40 (2 MHz channel spacing)
	BT classic (1 Mbps PHY)	79 (1 MHz channel spacing)
	BT EDR (2 Mbps PHY)	79 (1 MHz channel spacing)
	BT EDR (3 Mbps PHY)	79 (1 MHz channel spacing)

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
DC power supply* ²	Power Supply TOE8752-32 (DC) (PM. No. 480009)
USB fibre optic converter* ²	Opto USB2.0, MK Messtechnik (PM. No. 482617)
Laptop PC* ²	Fujitsu S26391-K326-V110 (PM. No. 200784)
Evaluation board (carrier PCB): * ¹	SE04012022smt 1V0 Testadapter
Evaluation board (base PCB): * ¹	SE04012022b 1V0 Basisplatine

*¹ Provided by the applicant

*² Provided by the laboratory

Ancillary Equipment	
-	-
-	-
-	-

*¹ Provided by the applicant

*² Provided by the laboratory

1.6 Dates

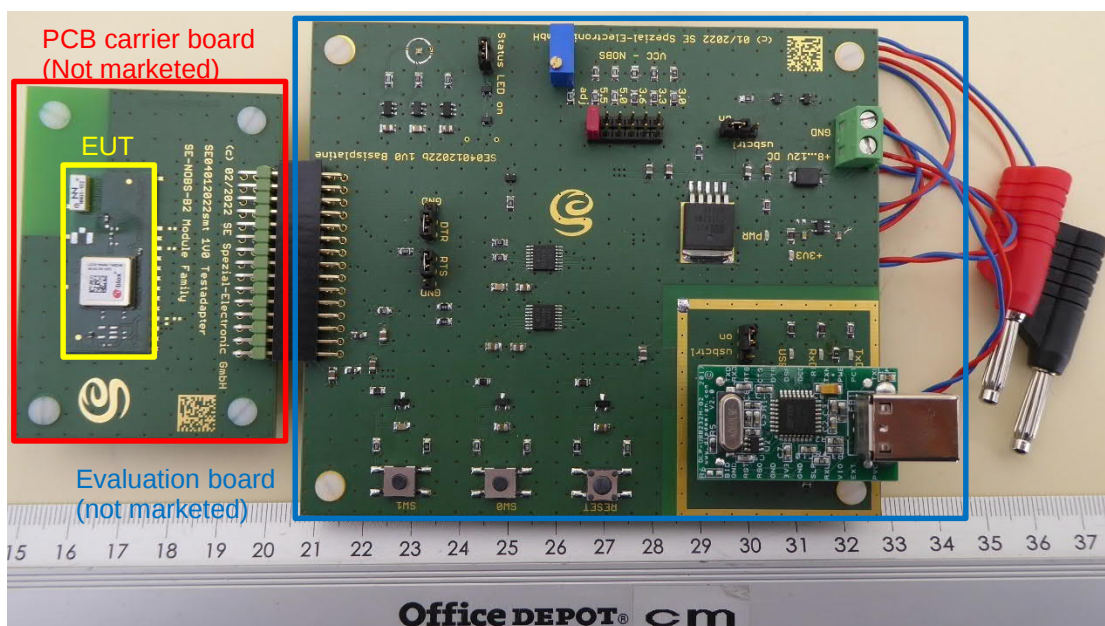
Date of receipt of test sample:	11.03.2022
Start of test:	11.03.2022
End of test:	22.03.2022

2 Operational States

2.1 Description of function of the EUT

The EUT is a Bluetooth classic + EDR and Bluetooth Low Energy radio module intended for integration into various applications.

For the test the EUT was mounted on a PCB and connected to an evaluation board. See photographs of the EUT, PCB and Evaluation board below.



To start the test mode, two pins on the EUT PCB have to be shortened and the reset button on the evaluation board has to be pressed simultaneously. During the tests, a test laptop was connected to the EUT via USB to fiber-optic-converters. The test firmware was loaded to the EUT, using a command in the command prompt. The test commands were sent to the EUT via a terminal application. The test firmware and the test commands were provided by the applicant.

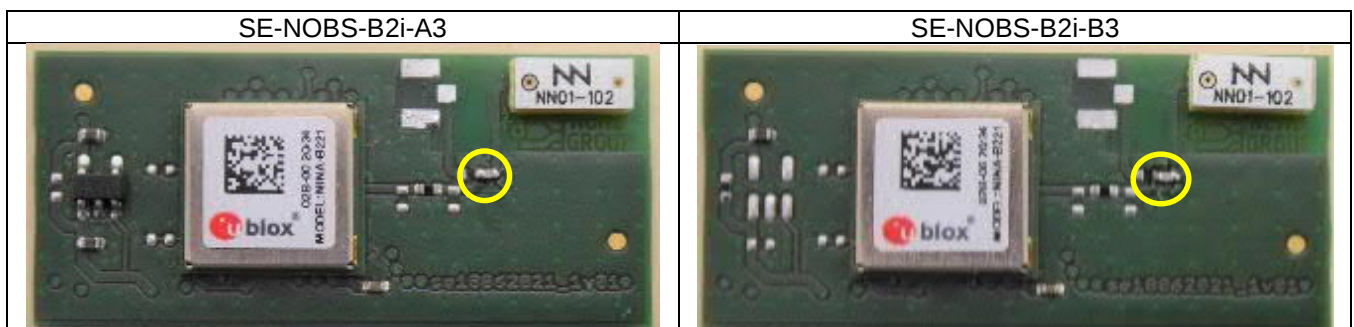
2.1.1 Operation modes

Operation mode #	EUT	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	Power setting*
1	3	Bluetooth® classic+EDR	2402	0	GFSK	1 Mbit/s	+6
2	3	Bluetooth® classic+EDR	2480	78	8DPSK	3 Mbit/s	+6
3	3	Bluetooth® LE	2402	19	GFSK	1 Mbit/s	+9
4	3	Bluetooth® LE	2440	19	GFSK	1 Mbit/s	+9
5	4	Bluetooth® classic+EDR	2402	0	GFSK	1 Mbit/s	+6
6	4	Bluetooth® classic+EDR	2441	39	GFSK	1 Mbit/s	+6
7	4	Bluetooth® classic+EDR	2480	78	8DPSK	3 Mbit/s	+6
8	4	Bluetooth® LE	2402	19	GFSK	1 Mbit/s	+9
9	4	Bluetooth® LE	2440	19	GFSK	1 Mbit/s	+9
10	1	Bluetooth® classic+EDR	2402	0	GFSK	1 Mbit/s	+6
11	1	Bluetooth® LE	2402	19	GFSK	1 Mbit/s	+9

* Original

3 Additional Information

At the EUTs with the internal antenna the capacitor Z1i with wrong value was replaced by capacitor Z1i with correct value = Murata GRT1555C2A8R2DA02D by the applicant. See photographs of the modifications below (yellow circle around the modified capacitor). Apart from this modification, all tests were performed with unmodified samples. The EUTs were not labelled as required by the FCC / IC during the tests.



4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [4] RSS-Gen [5]	Tested EUT	Status
Maximum peak conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [4]	3, 4	Passed* ³
Maximum conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [4]	-	-
DTS Bandwidth / 99% Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (a) [4]	3, 4	Passed* ⁴
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [4]	-	Not tested* ²
Average Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [4]	-	-
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [4]	-	Not tested* ⁵
Maximum unwanted emissions	0.009 – 26,500*	15.247 (d) 15.205 (a) 15.209 (a)	8.9 [5]	1, 3, 4	Passed* * ³
Antenna Requirement	-	15.203 15.247 (b)	6.8 [5] 5.4 (f) (ii) [4]	-	Passed
Conducted emissions on supply line	0.15 – 30	15.207 (a)	8.8 [5]	-	Not tested* ²

- *: As declared by the applicant the highest radio clock frequency is 2.48 GHz. Therefore, the radiated emission measurement must be carried out up to 10th of the highest radio clock frequency in this case 25 GHz.
- *² Not tested, because not ordered by the applicant
- *³ Only the worst-case results from the original report (F170297E8 by Phoenix Testlab GmbH) were tested.
- *⁴ Test was only performed to determine the minimum 6-dB-bandwidth for the maximum conducted output power test.
- *⁵ No significant emissions were found near the band edges in the original report, therefore these tests were not repeated in this report.

5 Results

5.1 Test setups

5.1.1 Test setup (radiated)

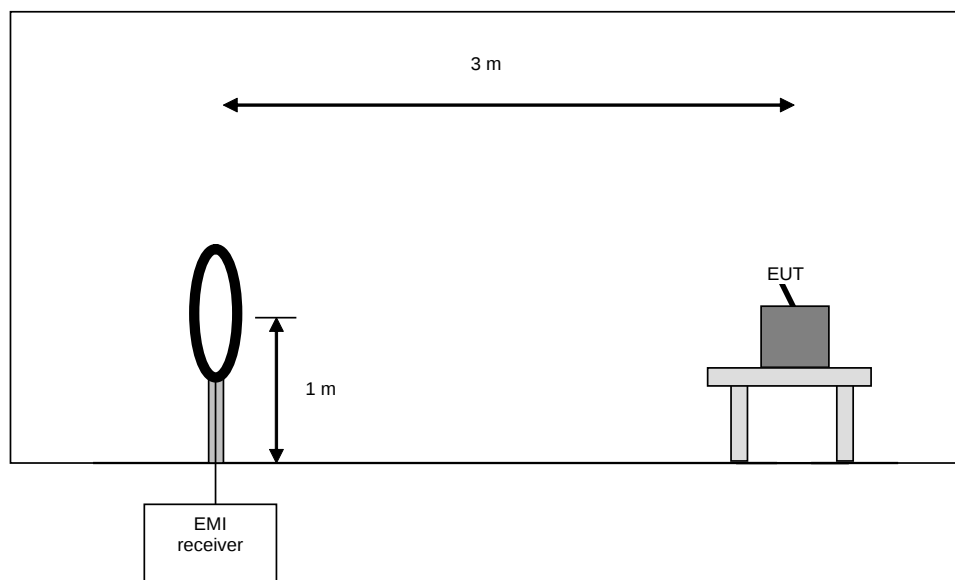
5.1.1.1 Preliminary measurement 9 kHz to 30 MHz

In the first stage a preliminary measurement is performed in an anechoic chamber with a measuring distance of 3 meters. Table-top and portable devices are 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 are placed directly on the turntable / ground plane. The setup of the equipment under test is in accordance to [1].

The frequency range 9 kHz to 30 MHz is monitored with an EMI receiver while the system and its cables are manipulated to find out the configuration with the maximum emission levels if applicable. The EMI receiver is set to MAX hold mode. The EUT and the measuring antenna are rotated around their vertical axis to find the maximum emission levels.

The resolution bandwidth of the EMI receiver is set to the following values:

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



Procedure preliminary measurement:

Pre-scans are performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure is used:

- 1) Monitor the frequency range with the measuring antenna facing the EUT and an EUT / turntable azimuth of 0 °.
- 2) Manipulate the system cables to produce the maximum levels of emissions.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Measure the frequencies of the highest detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency values.
- 5) If the EUT is portable or ceiling mounted, repeat steps 1 to 4 with other orientations (x,y,z) of the EUT.
- 6) Rotate the measuring antenna and repeat steps 1 to 5.

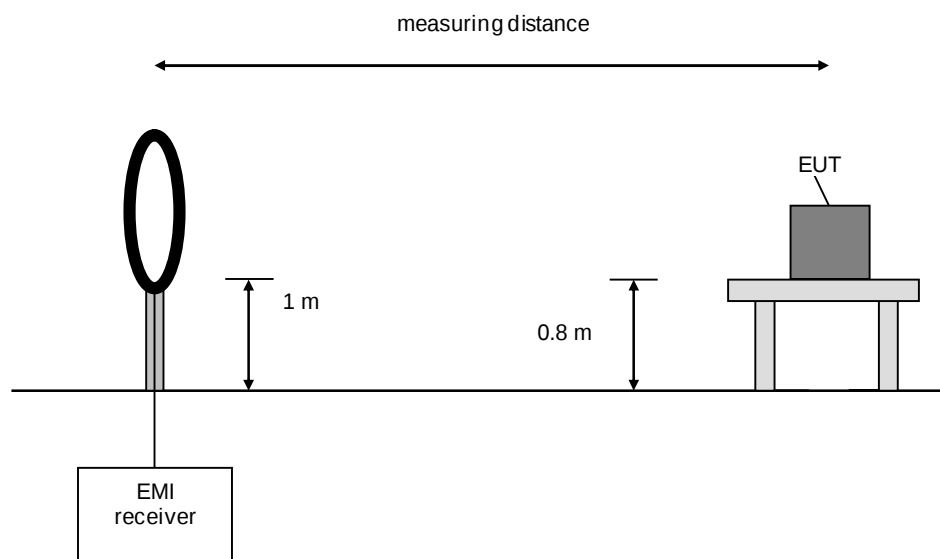
5.1.1.2 Final measurement 9 kHz to 30 MHz

In the second stage a final measurement is performed on an open area test site with no conducting ground plane in measuring distances of 3 m, 10 m or 30 m. In the case where larger measuring distances are required the results are extrapolated based on the values measured on the closer distances according to section 15.31 (f) (2) [2]. The final measurement is performed with an 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 is used according to section 15.209 (d) [2].

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

The resolution bandwidth of the EMI receiver is set to the following values:

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



Procedure final measurement:

The following procedure is used:

- 1) Monitor the selected frequencies from the preliminary measurement with the measuring antenna facing the EUT and an EUT azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals.
- 3) Rotate the measuring antenna and repeat steps 1 to 2 until the maximum value is found and note it.
- 4) If the EUT is portable or ceiling mounted, repeat steps 1 to 3 with other orientations (x,y,z) of the EUT.

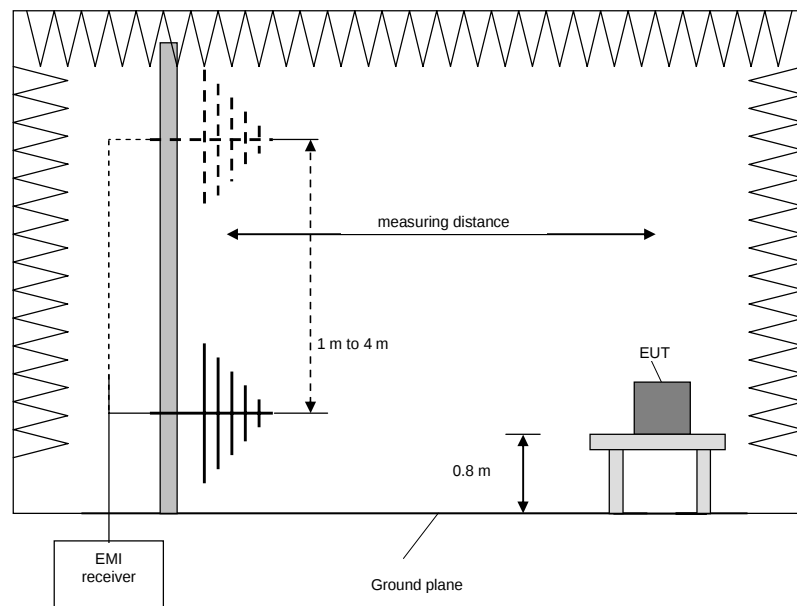
5.1.1.3 Preliminary and final measurement 30 MHz to 1 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber with a metal ground plane in a 3 m distance. Table-top and portable devices are 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 are placed directly on the turntable / ground plane.

During the tests the EUT is rotated in the range of 0 ° to 360 °, the measuring antenna is set to horizontal and vertical polarization 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 is set to the following values:

Test	Frequency range	Step-size	Resolution bandwidth	Detector
Preliminary measurement	30 MHz to 1 GHz	30 kHz	120 kHz	Peak Average
Frequency peak search	± 120 kHz	10 kHz	120 kHz	Peak
Final measurement	30 MHz to 1 GHz	-	120 kHz	QuasiPeak



Procedure preliminary measurement:

The following procedure is used:

- 1) Set the measuring antenna to 1 m height.
- 2) Monitor the frequency range at horizontal polarization of the measuring antenna and an EUT / turntable azimuth of 0 °.
- 3) Rotate the EUT by 360° to maximize the detected signals.
- 4) Repeat steps 2 to 3 with the vertical polarization of the measuring antenna.
- 5) Increase the height of the measuring antenna for 0.5 m and repeat steps 2 to 4 until the final height of 4 m is reached.
- 6) The highest values for each frequency are saved by the software, including the measuring antenna height and polarization and the turntable azimuth for that value.

Procedure final measurement:

The following procedure is used:

- 1) Select the highest frequency peaks (lowest margin to the limit) for the final measurement.
- 2) The software determines the exact peak frequencies by doing a partial scan with reduced step size of the pre-scan of the selected peaks.
- 3) If the EUT is portable or ceiling mounted, find the worst-case EUT orientation (x,y,z) for the final test.
- 4) The worst-case measuring antenna height is found via varying the height by ± 0.5 m from the value obtained in the preliminary measurement while monitoring the emission level.
- 5) The worst-case turntable position is found via varying the turntable azimuth by $\pm 30^\circ$ from the value obtained in the preliminary measurement while monitoring the emission level.
- 6) The final measurement is performed at the worst-case measuring antenna height and the worst-case turntable azimuth.
- 7) Steps 2 to 6 are repeated for each frequency peak selected in step 1.

5.1.1.4 Preliminary and final measurement > 1 GHz (Normal procedure 6.6.4 in [1])

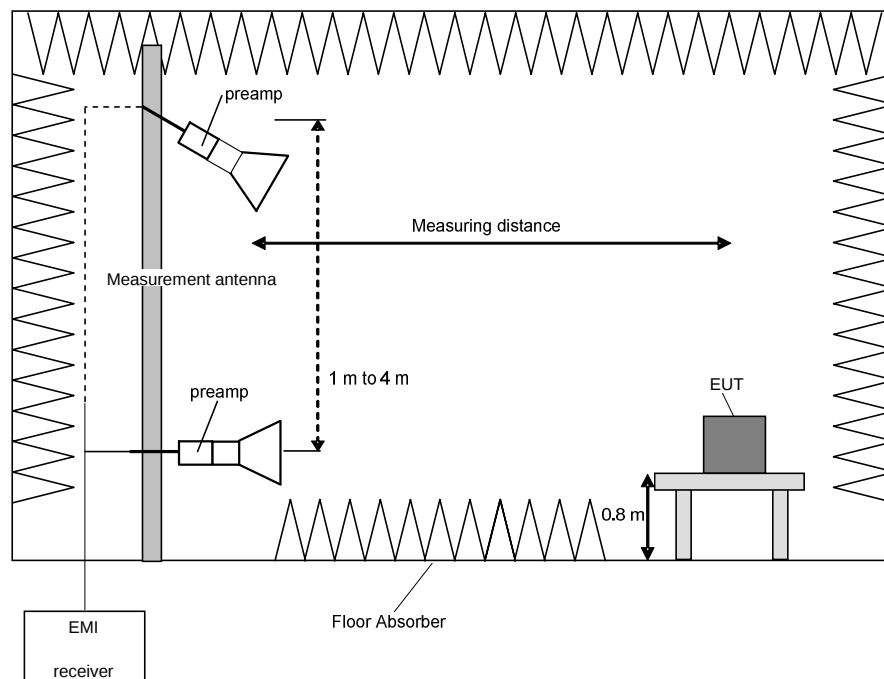
This measurement will be performed in a fully anechoic chamber or in a semi-anechoic chamber with ground absorbers between antenna and EUT. Tabletop and portable devices will set up on a non-conducting turn device on the height of 1.5 m. Floor standing devices will be placed directly on the turntable. 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 on the frequency range of the used antenna. The spectrum analyzer set to MAX Hold mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated with antenna-height-steps of 0.5 m starting from 1 m up to 4 m. When the EUT is manipulated through three different orientations, the scan height upper range for the measurement antenna is limited to 2.5 m or 0.5 m above the top of the EUT, whichever is higher. At the different height positions, the EUT is always directed at the EUT.

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 preliminary measurement:

Pre-scans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

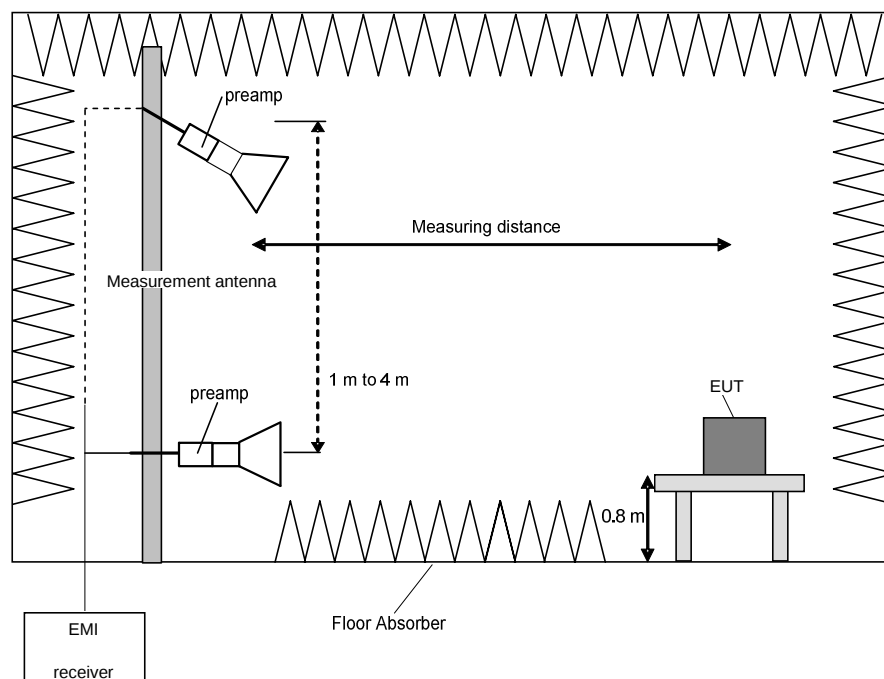
1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarization and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat steps 1. and 2. with the horizontal polarization of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
(If the EUT is tested in 3 orientations, the maximum height is 2.5 m or 0.5 m above the top of the EUT, whichever is higher.)
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for the for each frequency step.

Final measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending on the frequency range of the used 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 is used:

1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with ± 10 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the worst case EUT orientation (x,y,z) for the final test.
4. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by ± 0.5 m from the worst-case value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by $\pm 30^\circ$ from the worst-case value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst-case antenna height and the worst-case turntable azimuth.
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

5.1.1.5 Preliminary and final measurement > 1 GHz (Alternative procedure 6.6.5 in [1])

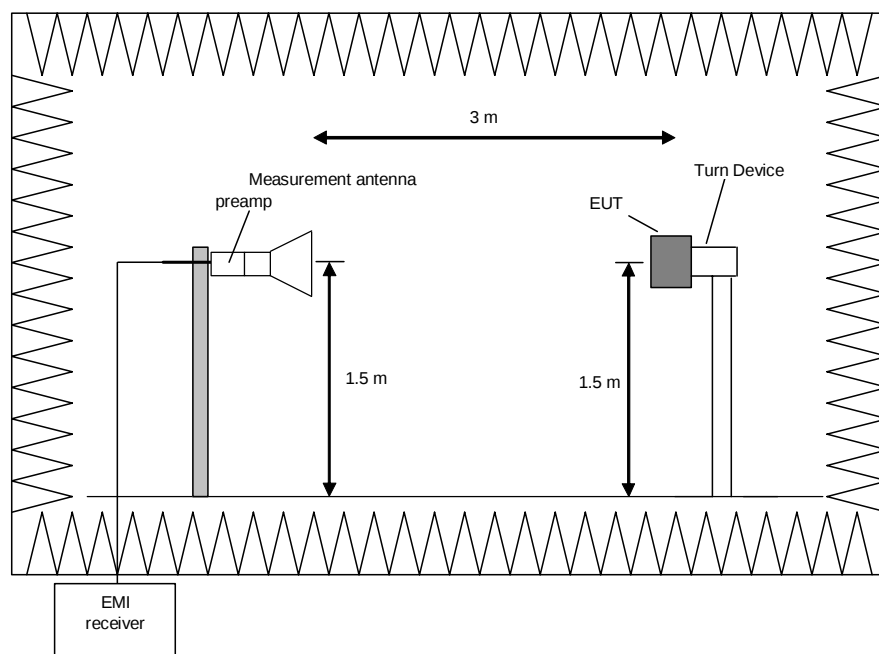
This measurement will be performed in a fully anechoic chamber or in a semi-anechoic chamber with ground absorbers between antenna and EUT. Tabletop and portable devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1]. Devices with any dimension larger than the beamwidth of the measurement antenna are not suitable for testing with this method; such devices shall be evaluated as tabletop equipment (see procedure 5.1.1.4 above).

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending on the frequency range of the used antenna. The spectrum analyzer set to MAX Hold mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarization 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 to 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	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 preliminary measurement:

Pre-scans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

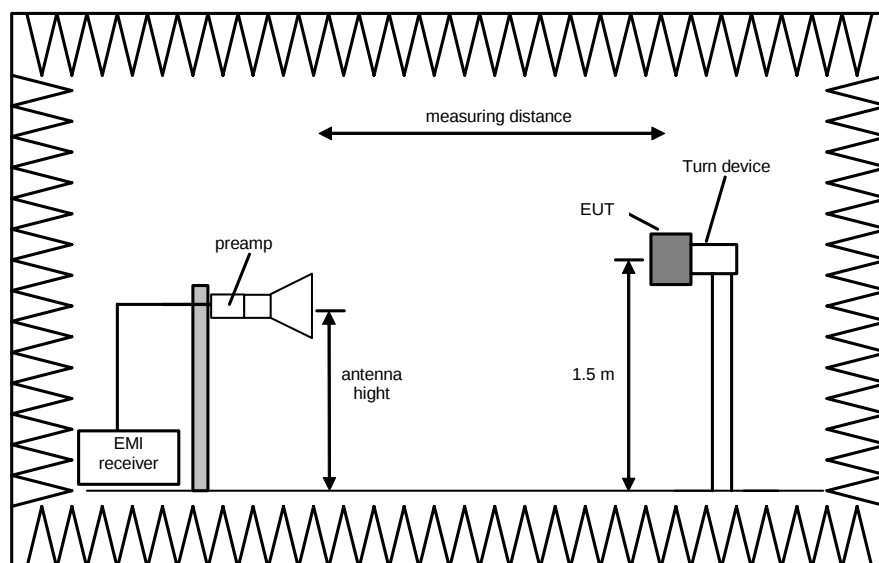
1. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an 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 polarization, 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 on the frequency range of the used 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) The worst-case turntable position is found via varying the turntable azimuth by $\pm 30^\circ$ from the value obtained in the preliminary measurement while monitoring the emission level.
- 3) Set the measurement antenna polarization to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 4) Set the spectrum analyzer to EMI mode with peak and average detector activated.
- 5) Rotate the turntable from 0° to 360° to find the TT Pos. that produces the highest emissions.
- 6) Note the highest displayed peak and average values
- 7) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

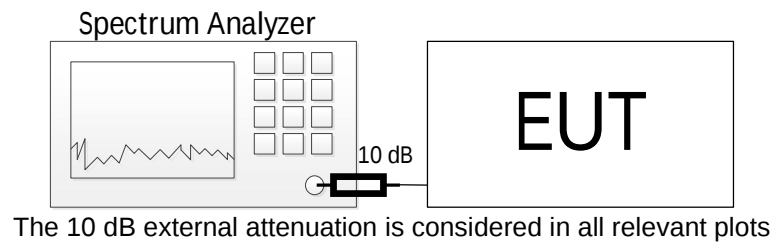
5.1.2 Test setup (conducted)

Test setup (conducted)		
Used	Antenna connector	Comment
☒	Temporary antenna connector* ¹	As provided by the applicant
☒	Normal antenna connector* ²	

*¹ for the internal antenna, a temporary antenna connector was used for the conducted tests

*² for the external antenna, the normal antenna connector was used for the conducted tests

5.1.2.1 Conducted (Spectrum Analyzer)



5.2 Duty cycle

The duty cycle correction factor of 1.8 dB for Bluetooth Low Energy and 2.4 dB for Bluetooth classic + EDR as measured in the original test report (F170297E8 by Phoenix Testlab GmbH) were used for the average measurement in the following test report.

5.3 Transmit antenna performance considerations

Test setup (Transmit antenna performance considerations)		
Integral antenna	Antenna gain $\leq 6\text{dBi}$	Comment
☒	☒	No output power reduction necessary

Test equipment (please refer to chapter 7 for details)
-

5.4 DTS fundamental emission output power

5.4.1 Test setup (DTS fundamental emission output power)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
☐	Test setup (radiated – normal procedure)	5.1.1.4	f < 1 GHz
☐	Test setup (radiated – alternative procedure)	5.1.1.5	f > 1 GHz
☒	Test setup (antenna port conducted)	5.1.2	-

5.4.2 Test method (DTS fundamental emission output power)

Test method (Maximum peak conducted output power)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	11.9.1.1	RBW ≥ DTS bandwidth	-	Zero span mode
☐	11.9.1.2	Integrated band power method	Not for DTS	-
☐	11.9.1.3	PKPM1 Peak power meter method* ¹	-	-

*¹ VBW of the peak power meter has to be > OBW of the fundamental.

Test method (Maximum conducted (average) output power)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☐	11.9.2.2.2	Method AVGSA-1	D ≥ 98%	-
☐	11.9.2.2.3	Method AVGSA-1A (alternative)	D ≥ 98%	-
☐	11.9.2.2.4	Method AVGSA-2	Constant D (±2%)	-
☐	11.9.2.2.5	Method AVGSA-2A (alternative)	Constant D (±2%)	-
☐	11.9.2.2.6	Method AVGSA-3A	-	-
☐	11.9.2.2.7	Method AVGSA-3A (alternative)	-	-
☐	11.9.2.3.1	Method AVGPM	Constant D (±2%)	-
☐	11.9.2.3.2	Method AVGPM-G	-	-

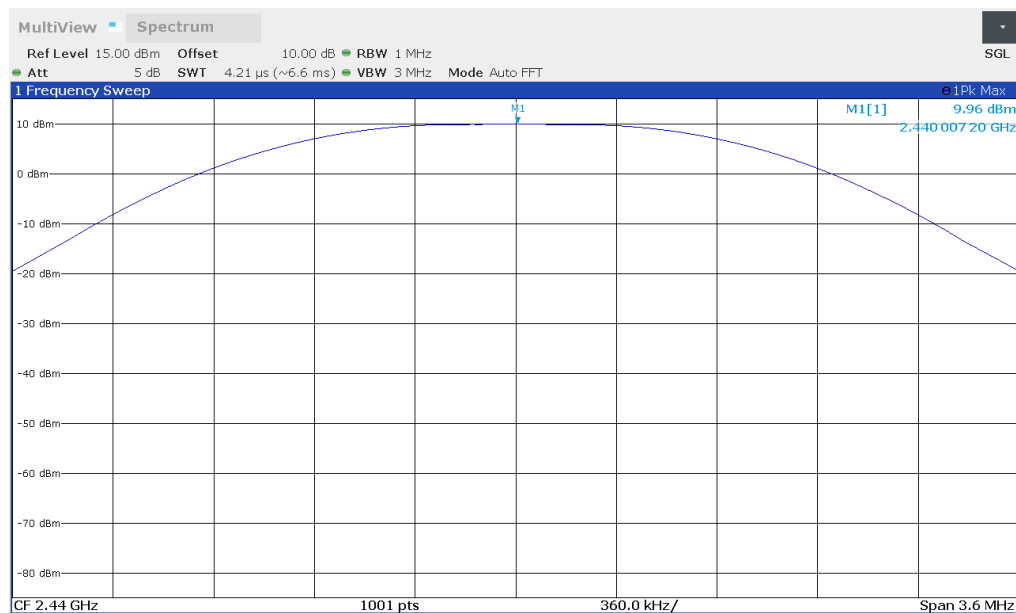
5.4.3 Test results (DTS fundamental emission output power)

Ambient temperature:	22 °C
Relative humidity:	16 %

Date:	11.03.2022
Tested by:	P. Neufeld

5.4.3.1 Maximum peak conducted output power:

Worst case plot (operation mode 4):



Operation mode	Reading [dBm]	Corr. Fact. [dB]	Result [dBm]	Limit [dBm]
2	7.8	0.0	7.8	30
4	10.0	0.0	10.0	30
7	7.0	0.0	7.0	30
9	9.0	0.0	9.0	30

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1

5.5 DTS bandwidth

5.5.1 Test setup (DTS bandwidth)

Test setup			
Used	Setup	See sub-clause	Comment
☐	Test setup (radiated – normal procedure)	5.1.1.4	-
☐	Test setup (radiated – alternative procedure)	5.1.1.5	-
☒	Test setup (antenna port conducted)	5.1.2	-

5.5.2 Test method (DTS bandwidth)

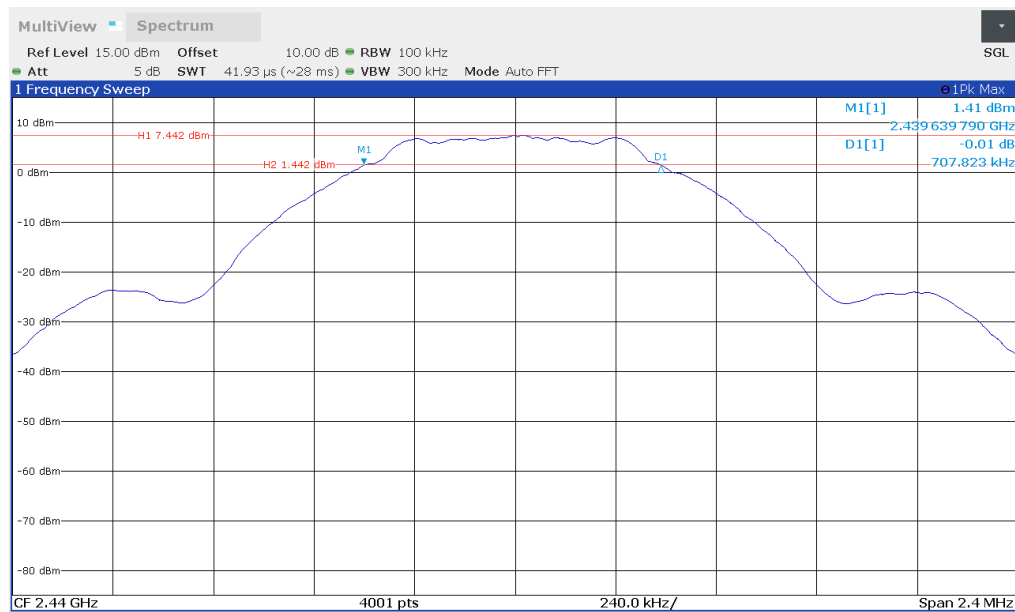
Test method (Maximum peak conducted output power)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	11.8.1	Option 1	No limitations	-
☐	11.8.2	Option 2	No limitations	6 dB down function

5.5.3 Test results (DTS bandwidth)

Ambient temperature:	22 °C
Relative humidity:	16 %

Date	11.03.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 9 - Internal Antenna):



Operation mode #	DTS bandwidth IntAnt [MHz]	DTS bandwidth ExtAnt [MHz]	Minimum DTS bandwidth Limit [MHz]	Result
2	1.077331	-	0.5	Passed
4	0.719820	-	0.5	Passed
7	1.096226	-	0.5	Passed
9	0.707823	-	0.5	Passed

Test: Passed

Test equipment (please refer to chapter 7 for details)
1

5.6 DTS band-edge emission measurements

No significant emissions were found near the band edges in the original report, therefore these tests were not repeated in this report.

5.7 Radiated emissions

5.7.1 Test setup (Maximum unwanted emissions)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
☒	Test setup (radiated – normal procedure)	5.1.1.4	f < 1 GHz
☒	Test setup (radiated – alternative procedure)	5.1.1.5	f > 1 GHz
☒	Test setup (antenna port conducted)	5.1.2	-

5.7.2 Test results (Maximum unwanted emissions)

5.7.2.1 Test results antenna port conducted

Test method (Band edge – restricted bands)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	11.12.2	Standard method	No limitations	-

5.7.2.2 Test results (1 – 25 GHz)

Ambient temperature:	22°C
Relative humidity:	16 %

Date:	11.03.2022
Tested by:	P. Neufeld

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

Remark: Only the worst-case emission from the original report was tested.

Calculations:

Peak level [dBm] = Reading level from the analyzer

Peak level [dBμV/m] = Peak level [dBm] - 20log(d) + 104.8 (d = nominal distance EUT – antenna)

Peak level corr. [dBμV/m] = Peak level [dBμV/m] + antenna gain (dBi) + Ant. Port. Corr.* + DC corr (dB)*²

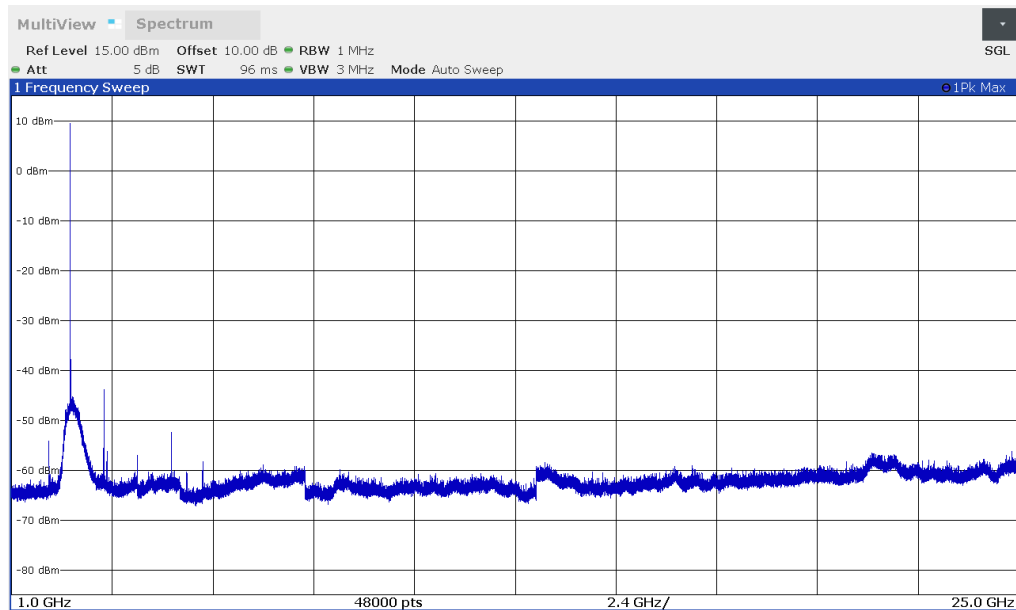
Margin [dB] = Limit [dBμV/m] - Peak level corr. [dBμV/m]

* Antenna port correction for number of antenna port on the EUT (i.e. 2 antennas -> 3 dB correction)

*² Duty cycle correction only applicable for average measurements.

Worst case plot:

Spurious emissions from 1 - 25 GHz (operation mode 3):



Result tables:

Operation mode 1

Frequency [MHz]	Level (Pk) [dBm]	Level (Pk) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
1886.271	-69.3	26.0	0.0	3.0	29.0	74.0	45.0	Passed
2402.140	4.1	99.4	0.0	3.0	102.4	Fund.	-	-
3202.675	-45.3	50.0	0.0	3.0	53.0	74.0	21.0	Passed
4803.621	-60.9	34.4	0.0	3.0	37.4	74.0	36.6	Passed
13725.781	-62.0	33.3	0.0	3.0	36.3	74.0	37.7	Passed
21589.809	-57.0	38.3	0.0	3.0	41.3	74.0	32.7	Passed

Frequency [MHz]	Level (Av) [dBm]	Level (Av) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	DC corr. dB	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
1886.561	-78.8	16.5	0.0	3.0	2.4	21.9	54.0	32.1	Passed
2402.005	-0.5	94.8	0.0	3.0	2.4	Fund.	-	-	Fund.
3202.665	-48.6	46.6	0.0	3.0	2.4	52.0	54.0	2.0	Passed
4803.985	-66.9	28.3	0.0	3.0	2.4	33.7	54.0	20.3	Passed
13724.797	-72.1	23.1	0.0	3.0	2.4	28.5	54.0	25.5	Passed
21586.352	-68.0	27.3	0.0	3.0	2.4	32.7	54.0	21.3	Passed

Operation mode 3

Frequency [MHz]	Level (Pk) [dBm]	Level (Pk) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
1892.753	-61.7	33.6	0.0	3.0	36.6	74.0	37.4	Passed
2402.185	9.3	104.6	0.0	3.0	107.6	Fund.	-	-
3202.655	-44.8	50.5	0.0	3.0	53.5	74.0	20.5	Passed
4803.566	-53.8	41.4	0.0	3.0	44.4	74.0	29.6	Passed
21500.407	-56.4	38.9	0.0	3.0	41.9	74.0	32.1	Passed
24822.710	-56.5	38.8	0.0	3.0	41.8	74.0	32.2	Passed

Frequency [MHz]	Level (Av) [dBm]	Level (Av) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	DC corr. dB	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
1896.284	-78.8	16.4	0.0	3.0	2.4	21.8	54.0	32.2	Passed
2402.000	7.7	102.9	0.0	3.0	2.4	108.3	Fund.	-	-
3202.660	-47.3	47.9	0.0	3.0	2.4	53.3	54.0	0.7	Passed
4803.985	-59.4	35.8	0.0	3.0	2.4	41.2	54.0	12.8	Passed
21501.092	-67.9	27.4	0.0	3.0	2.4	32.8	54.0	21.2	Passed
24820.317	-68.0	27.3	0.0	3.0	2.4	32.7	54.0	21.3	Passed

Operation mode 5

Frequency [MHz]	Level (Pk) [dBm]	Level (Pk) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
2402.105	3.0	98.2	0.0	3.0	101.2	Fund.	-	-
3202.675	-46.1	49.1	0.0	3.0	52.1	74.0	21.9	Passed
5564.253	-58.6	36.7	0.0	3.0	39.7	74.0	34.3	Passed
13736.283	-61.5	33.8	0.0	3.0	36.8	74.0	37.2	Passed
21485.725	-56.3	39.0	0.0	3.0	42.0	74.0	32.0	Passed
24175.076	-57.5	37.7	0.0	3.0	40.7	74.0	33.3	Passed

Frequency [MHz]	Level (Av) [dBm]	Level (Av) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	DC corr. dB	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
2402.005	-1.0	94.3	0.0	3.0	2.4	99.7	Fund.	-	-
3202.665	-49.7	45.6	0.0	3.0	2.4	51.0	54.0	3.0	Passed
5565.262	-79.6	15.7	0.0	3.0	2.4	21.1	54.0	32.9	Passed
13736.837	-72.2	23.1	0.0	3.0	2.4	28.5	54.0	25.5	Passed
21484.311	-67.9	27.4	0.0	3.0	2.4	32.8	54.0	21.2	Passed
24176.849	-68.9	26.4	0.0	3.0	2.4	31.8	54.0	22.2	Passed

Operation mode 7

Frequency [MHz]	Level (Pk) [dBm]	Level (Pk) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
2402.235	8.3	103.6	0.0	3.0	106.6	Fund.	-	-
3202.675	-45.5	49.7	0.0	3.0	52.7	74.0	21.3	Passed
4803.834	-51.8	43.4	0.0	3.0	46.4	74.0	27.6	Passed
13518.144	-61.7	33.6	0.0	3.0	36.6	74.0	37.4	Passed
21677.716	-57.2	38.1	0.0	3.0	41.1	74.0	32.9	Passed
24996.807	-56.0	39.3	0.0	3.0	42.3	74.0	31.7	Passed

Frequency [MHz]	Level (Av) [dBm]	Level (Av) [dBμV/m]	Ant. Corr. [dB]	Ant. gain [dB]	DC corr. dB	Peak Level corr. [dB/m]	Limit [dBμV/m]	Margin [dB]	Result #
2402.000	5.9	101.1	0.0	3.0	2.4	106.5	Fund.	-	-
3202.665	-47.8	47.5	0.0	3.0	2.4	52.9	54.0	1.1	Passed
4803.979	-57.4	37.8	0.0	3.0	2.4	43.2	54.0	10.8	Passed
13517.994	-72.1	23.1	0.0	3.0	2.4	28.5	54.0	25.5	Passed
21676.332	-68.2	27.0	0.0	3.0	2.4	32.4	54.0	21.6	Passed
24997.536	-67.5	27.8	0.0	3.0	2.4	33.2	54.0	20.8	Passed

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1

5.7.2.3 Test results radiated

The minimum clock frequency of the EUT is 40 MHz, therefore emissions < 30 MHz don't need to be tested.

5.7.2.4 Test results (30 MHz – 1 GHz)

Ambient temperature:	21 - 22 °C
Relative humidity:	19 - 26 %

Date:	15 - 22.03.2022
Tested by:	R. Braun

Position of EUT: For tests for f between 30 MHz to 1 GHz, the EUT was set-up on a table with a height of 80 cm. 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 the annex A in the test report.

Test record: Plots for each frequency range are submitted below.

Remark: Only the worst-case position from the original test was repeated for the test.

Calculations:

Result [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]

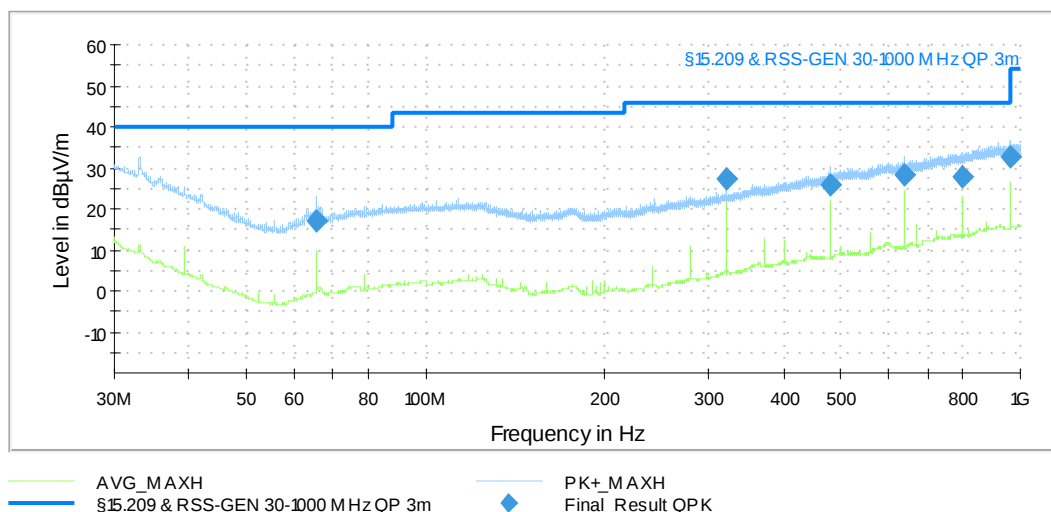
Correction [dBμV/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]

Margin [dB] = Limit [dBμV/m] - Result [dBμV/m]

The measured points and the limit line in the following diagram refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with "◆" are the measured results of the standard subsequent measurement in a semi-anechoic chamber.

Worst case plot:

Spurious emissions from 30 MHz to 1 GHz (operation mode 8 - lying):



Result tables:

(Operation mode 10) – BT mode ch. 0- EUT 1 – SE-NOBS-B2i-A3:

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
52.500	17.1	40.0	22.9	4.4	12.7	220.0	-8	V	lying
65.630	16.0	40.0	24.0	2.3	13.7	158.0	169	V	lying
320.000	21.6	46.0	24.4	1.9	19.7	104.0	141	H	lying
640.000	29.0	46.0	17.1	2.4	26.6	128.0	284	H	lying
800.000	28.8	46.0	17.2	0.0	28.8	114.0	226	H	lying
960.000	28.4	46.0	17.6	-2.0	30.4	153.0	71	H	lying

(Operation mode 6) – BT mode ch. 39 - EUT 4 – SE-NOBS-B2X-B3:

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
39.380	17.1	40.0	22.9	-3.4	20.4	120.0	10	V	lying
65.620	15.6	40.0	24.4	1.9	13.7	150.0	157	V	lying
320.000	20.0	46.0	26.0	0.3	19.7	102.0	131	H	lying
640.000	27.4	46.0	18.7	0.8	26.6	149.0	311	H	lying
800.000	28.9	46.0	17.2	0.1	28.8	113.0	113	H	lying
960.000	33.0	46.0	13.1	2.5	30.4	150.0	113	H	lying

(Operation mode 8) – BLE mode ch. 0 - EUT 4 – SE-NOBS-B2X-B3:

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
65.620	17.0	40.0	23.0	3.3	13.7	147.0	162	V	lying
320.000	27.4	46.0	18.6	7.7	19.7	101.0	135	H	lying
480.000	26.0	46.0	20.0	2.0	24.0	182.0	95	H	lying
640.000	28.4	46.0	17.7	1.8	26.6	140.0	92	H	lying
800.000	27.7	46.0	18.3	-1.0	28.8	106.0	49	H	lying
960.000	32.9	46.0	13.1	2.4	30.4	139.0	112	H	lying

Test result: Passed

Test equipment (please refer to chapter 7 for details)
2 – 4, 13 - 18

5.7.2.5 Test results (radiated 1 to 40 GHz)

Ambient temperature:	21 - 22 °C
Relative humidity:	19 - 26 %

Date:	15 – 22.03.2022
Tested by:	R. Braun

Position of EUT: For tests for f between 1 GHz and the 10th harmonic, the EUT was set-up on a positioner device with a height of 150 cm. 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 the annex A in the test report.

Test record: Plots for each frequency range are submitted below.

Remark: As defined in Title 47 §15.247 (d) attenuation below the general limits specified in § 15.209(a) is not required. Therefore, all emissions will be tested according to the general limits specified in § 15.209(a), unless an emission exceeds the limit.

Calculation:

Max Peak [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]

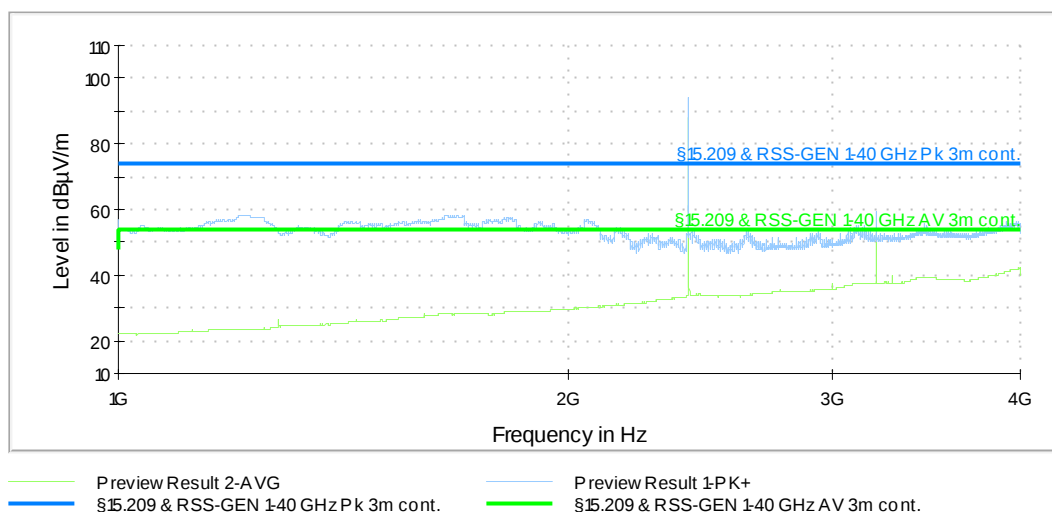
Average [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]

Correction [dBμV/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB] + DCCF* [dB]
* (if applicable – only for Average values, that are fundamental related)

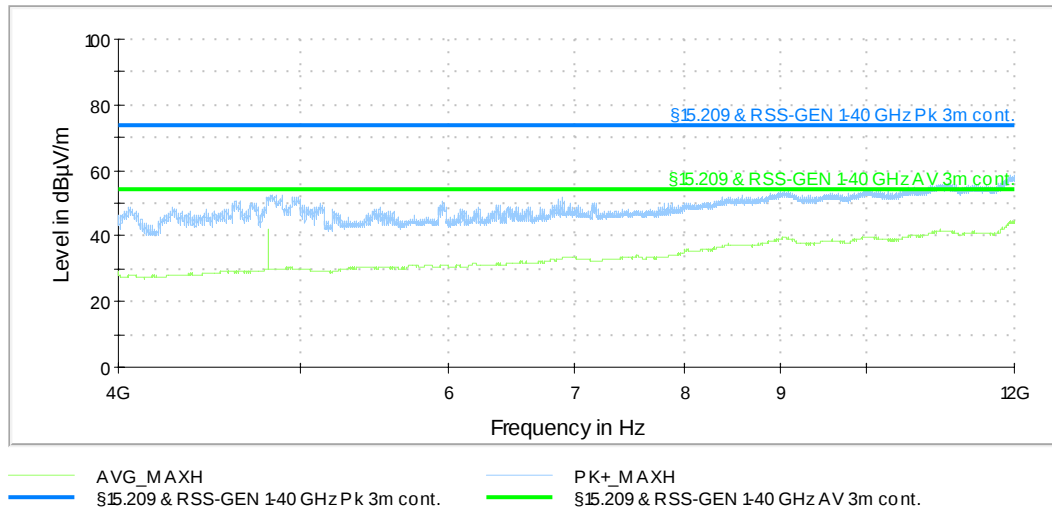
Margin [dB] = Limit [dBμV/m] – Max Peak | Average [dBμV/m]

Worst case plots:

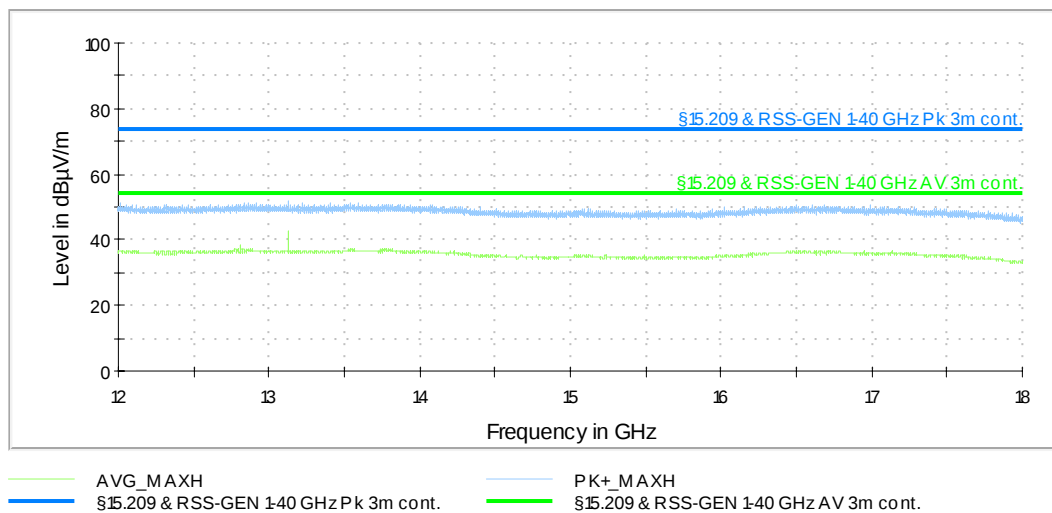
Spurious emissions from 1 GHz to 4 GHz (operation mode 5):



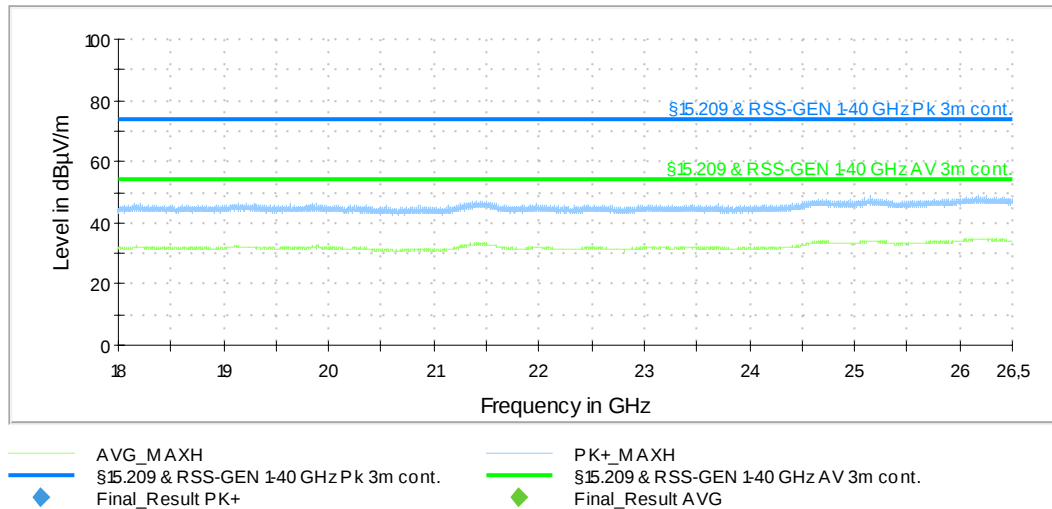
Spurious emissions from 4 GHz to 12 GHz (operation mode 11):



Spurious emissions from 12 GHz to 18 GHz (operation mode 10):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 10):



Result tables:

Operation mode 11:

Frequency [MHz]	MaxPeak [dB(μV/m)]	Average [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB(μV/m)]	Restr. Band Y/N	Pol [H/V]	Azimuth [deg]	Elevation [deg]	Corr. [dB]
2402.000	---	92.1	Fund.	-	-	H	216	0	35.3
2402.000	95.2	---	Fund.	-	-	H	216	0	35.3
3202.750	---	51.1	54.0	2.9	-	V	95	60	38.5
3202.750	57.7	---	74.0	16.3	-	V	95	60	38.5
4804.400	---	40.5	54.0	13.5	-	H	229	0	9.7
4804.400	50.3	---	74.0	23.8	-	H	229	0	9.7
12810.500	---	38.3	54.0	15.7	-	H	101	90	10.8
12810.500	49.4	---	74.0	24.6	-	H	101	90	10.8
13130.500	---	36.8	54.0	17.2	-	H	96	90	10.7
13130.500	51.8	---	74.0	22.2	-	H	96	90	10.7

Operation mode 10:

Frequency [MHz]	MaxPeak [dB(μV/m)]	Average [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB(μV/m)]	Restr. Band Y/N	Pol [H/V]	Azimuth [deg]	Elevation [deg]	Corr. [dB]
2402.000	---	84.4	Fund.	-	-	H	217	0	35.3
2402.000	89.8	---	Fund.	-	-	H	217	0	35.3
3202.750	---	46.6	54.0	7.4	-	H	269	30	38.5
3202.750	56.4	---	74.0	17.6	-	H	269	30	38.5
4804.300	---	30.6	54.0	23.4	-	H	242	0	9.7
4804.300	43.2	---	74.0	30.8	-	H	242	0	9.7
12810.650	---	37.7	54.0	16.3	-	H	108	90	10.8
12810.650	50.1	---	74.0	23.9	-	H	108	90	10.8
13130.650	---	40.5	54.0	13.5	-	H	105	90	10.7
13130.650	52.6	---	74.0	21.4	-	H	105	90	10.7

Operation mode 8:

Frequency [MHz]	MaxPeak [dB(μV/m)]	Average [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB(μV/m)]	Restr. Band Y/N	Pol [H/V]	Azimuth [deg]	Elevation [deg]	Corr. [dB]
2402.000	---	97.1	Fund.	-	-	V	240	90	35.3
2402.000	100.3	---	Fund.	-	-	V	240	90	35.3
3202.750	59.8	---	79.2*	19.4	-	V	106	120	32.6
4803.750	---	40.2	54.0	13.8	-	V	119	30	9.7
4803.750	49.1	---	74.0	24.9	-	V	119	30	9.7
12810.550	49.3	---	74.0	24.7	-	H	102	90	10.8
12810.550	---	38.1	54.0	15.9	-	H	102	90	10.8
13130.650	51.5	---	74.0	22.5	-	H	97	90	10.7
13130.650	---	36.8	54.0	17.2	-	H	97	90	10.7

* This emission was tested with the marker-peak-method, because the emission was in an unrestricted band and did not fulfil the requirements for a restricted band. The value was measured using 100 kHz RBW. The peak value of the wanted emission, measured using 100 kHz can be found in the table below.

Frequency [MHz]	MaxPeak [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB(μV/m)]	Restr. Band Y/N	Pol [H/V]	Azimuth [deg]	Elevation [deg]	Corr. [dB]
2402.000	99.2	-	-	N	V	234	90	29.8

Operation mode 5:

Frequency [MHz]	MaxPeak [dB(μV/m)]	Average [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB(μV/m)]	Restr. Band Y/N	Pol [H/V]	Azimuth [deg]	Elevation [deg]	Corr. [dB]
2402.000	---	88.0	Fund.	-	-	V	242	60	35.3
2402.000	93.7	---	Fund.	-	-	V	242	60	35.3
3202.750	---	52.7	54.0	1.3	-	V	90	120	38.5
3202.750	60.4	---	74.0	13.6	-	V	90	120	38.5
4803.800	---	31.3	54.0	22.7	-	V	118	30	9.7
4803.800	43.2	---	74.0	30.8	-	V	118	30	9.7
13130.750	---	40.3	54.0	13.7	-	H	101	90	10.7
13130.750	52.2	---	74.0	21.8	-	H	101	90	10.7

Test result: Passed

Test equipment (please refer to chapter 7 for details)

2 - 16

6 Measurement Uncertainties

Conducted measurements		
Measurement method	Standard used for calculating measurement uncertainty	Expanded measurement uncertainty (95 %) U_{lab}
Frequency error	ETSI TR 100 028	4.5×10^{-8}
Bandwidth measurements	-	9.0×10^{-8}
Conducted emissions using a spectrum analyzer		
< 3.6 GHz	ETSI TR 100 028	2.3 dB
3.6 – 8 GHz	ETSI TR 100 028	2.8 dB
8 – 22 GHz	ETSI TR 100 028	3.2 dB
22 – 40 GHz	ETSI TR 100 028	3.6 dB
Power measurements		
Power meter	ETSI TR 100 028	0.9 dB
Conducted emissions from 150 kHz to 30 MHz with LISN		
	CISPR 16-4-2	2.8 dB

Radiated measurements		
Frequency error		
(Semi-) Anechoic chamber	ETSI TR 100 028	4.5×10^{-8}
OATS	ETSI TR 100 028	4.5×10^{-8}
Test fixture	ETSI TR 100 028	4.5×10^{-8}
Bandwidth measurements		
(Semi-) Anechoic chamber	-	9.0×10^{-8}
OATS	-	9.0×10^{-8}
Test fixture	-	9.1×10^{-8}
Radiated field strength M20		
CBL6112B @ 3 m 30 MHz – 1 GHz	CISPR 16-4-2	5.3 dB
R&S HL050 @ 3 m		
1 – 6 GHz	CISPR 16-4-2	5.1 dB
6 – 18 GHz	CISPR 16-4-2	5.4 dB
Flann Standard Gain Horns 18 – 40 GHz	-	5.9 dB
Radiated field strength M276		
R&S HL562E @ 3 m 30 MHz – 1 GHz	CISPR 16-4-2	4.8 dB
R&S HL050 @ 3 m	-	
1 – 6 GHz	CISPR 16-4-2	5.1 dB
6 – 18 GHz	CISPR 16-4-2	5.4 dB
Flann Standard Gain Horns 18 – 40 GHz	-	5.9 dB
OATS		
Field strength measurements below 30 MHz on OATS without ground plane	-	4.4 dB

7 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	30.03.2021	03.2023
2	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
3	Testsoftware M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
4	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	08.12.2021	12.2023
5	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
6	Standard gain horn antenna	18240-20	Flann Microwave	483	480294	Calibration not necessary	
7	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	17.02.2022	02.2024
8	Standard gain horn antenna	20240-20	Flann Microwave	411	480297	Calibration not necessary	
9	Preamplifier 18 GHz - 26 GHz	JS4-18002600-20-5A	MITEQ Hauppauge N.Y.	658697	480342	17.02.2022	02.2024
10	Highpass Filter	WHK2.8/18G-10SS	Wainwright Instruments	1	480867	Calibration not necessary	
11	Microwave cable 2m	Insulated Wire Inc.	Insulated Wire	KPS-1533-800-KPS	480302	Calibration not necessary	
12	Preamplifier 100 MHz - 16 GHz	AFS6-00101600-23-10P-6-R	Narda MITEQ	2011215	482333	17.02.2022	02.2024
13	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
14	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
15	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
16	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
17	Attenuator 6 dB	WA2-6	Weinschel		482793	Calibration not necessary	
18	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024

8 Test site Verification

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA/RSM	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	03.03.2021	02.03.2023
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	25.02.2021	24.02.2023

9 Report History

Report Number	Date	Comment
F220459E1	15.08.2022	Initial Test Report
-	-	-
-	-	-

10 List of Annexes

Annex A	Test Setup Photos	12 pages
Annex B	EUT External Photos	8 pages
Annex C	EUT Internal Photos	1 page