

Test Report

Report Number:

F212286E3 2nd Version

Equipment under Test (EUT):

VCUNM1

Applicant:

Robert Bosch Car Multimedia GmbH

Manufacturer:

Robert Bosch 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] **789033 D02 General UNII Test Procedures New Rules v02r01**
- [4] **662911 D01 Multiple Transmitter Output v02r01 (October 2013)**, Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)
- [5] **RSS-247, Issue 2 (2017-02)** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- [6] **RSS-Gen, Issue 5 (2021-02)** General Requirements for Compliance of Radio Apparatus
- [6] **789033 D02 General UNII Test Procedures New Rules v02r01 (December 2017)**, GUIDELINES FOR COMPLIANCE TESTING OF UNLICENSED NATIONAL INFORMATION INFRASTRUCTURE (U-NII) DEVICES PART 15, SUBPART E

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

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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.

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1 Identification

1.1 Applicant

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Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Robert Bosch GmbH
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Phone:	+49 5121 49-2608
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Manufacturer represented during the test by the following person:	-

1.3 Production facility

Name:	Robert Bosch (Malaysia) Sdn Bhd
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Name for contact purposes:	Mr. Dr. Siegfried SKIRL
Phone:	-
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Manufacturer represented during the test by the following person:	-

1.4 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-17186-01-05 and D-PL-17186-01-06, FCC Test Firm Accreditation designation number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.5 EUT (Equipment under Test)

EUT	
Test object: *	Virtual Cockpit Unit
Model name: *	VCUNM1
Model number: *	7.515.400.919-22
Order number: *	NA
FCC ID: *	2AUXS-VCUNM1
IC certification number: *	25847-VCUNM1
PMN: *	Virtual Cockpit Unit
HVIN: *	VCUNM1
FVIN: *	NA
HMN: *	NA

	EUT number		
	1 (conducted)	2 (radiated)	3 (radiated)
Serial number: *	1121322A10000190 (marked #C1* ²)	1121322A10000120 (marked #R1* ²)	1121322A10000130 (marked #R2* ²)
PCB identifier: *	8638912015 8638912040 8638912111	8638912015 8638912040 8638912111	8638912015 8638912040 8638912111
Hardware version: *	C1.2	C1.2	C1.2
Software version: *	162.4.10 my23_main_2021.45.7 built SW 43.8	162.4.10 my23_main_2021.45.7 built SW 43.8	162.4.10 my23_main_2021.45.7 built SW 43.8

* Declared by the applicant

*² marked by the test laboratory to unambiguously identify the EUTs

3 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.

1.6 Technical Data of Equipment

General EUT data			
Power supply EUT: *	DC		
Supply voltage EUT: *	U _{Nom} = 13.5 V _{DC}	U _{Min} = 6.0 V _{DC}	U _{Max} = 16.0 V _{DC}
Temperature range: *	-40°C to +85°C		
Lowest / highest internal clock frequency: *	1 Hz / 6.264 GHz		

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
J1 Quad-HFM	Harness	_*	_*	_*
J2 56 way STAK50H SYSTEM	Harness	Laboratory power supply	~ 1.5 m	No
J3 AMEC Mixed 12 way	Harness	_*	_*	_*
J4 HSAL-II	Harness	_*	_*	_*
J6 HSAL-II	Harness	Laptop computer* ²	~ 1.5 m	Yes
J7 Double-HFM	Harness	_*	_*	_*
J8 Single-HFM	Harness	_*	_*	_*
J9 Quad-HFM	Harness	_*	_*	_*
J10 Quad-HFM	Harness	_*	_*	_*

* Interface was not connected during the radio tests.

*² Only the USB 3.0 interface was connected during the tests.

IEEE 802.11 frequencies (5 GHz)					
20 MHz		40 MHz		80 MHz	
Channel 36	5180 MHz	Channel 38	5190 MHz	-	-
Channel 40	5200 MHz	-	-	Channel 42	5210 MHz
Channel 44	5220 MHz	Channel 46	5230 MHz	-	-
Channel 48	5240 MHz	-	-	-	-
Channel 149	5745 MHz	-	-	-	-
Channel 153	5765 MHz	Channel 151	5755 MHz	-	-
Channel 157	5785 MHz	-	-	Channel 155	5775 MHz
Channel 161	5805 MHz	Channel 159	5795 MHz	-	-
Channel 165	5825 MHz	-	-	-	-

IEEE 802.11 radio mode (5GHz)	
Fulfils radio specification: *	IEEE 802.11 a IEEE 802.11 n (20 MHz) IEEE 802.11 n (40 MHz) IEEE 802.11 ac (20 MHz) IEEE 802.11 ac (40 MHz) IEEE 802.11 ac (80 MHz) IEEE 802.11 ax (20 MHz) IEEE 802.11 ax (40 MHz) IEEE 802.11 ax (80 MHz)
Radio chip: *	Qualcomm QCA6696 / Alps UGKZDA2001AB
Antenna type: *	Internal antenna: Inverted F-antenna External antenna: Dipole printed (passive unfiltered)
Antenna name: *	Internal antenna: NA External antenna: WIFI Antenna Part Number 2310901
Antenna gain: *	Internal antenna: 4.9 dBi (typical) External antenna: 2.8 dBi (typical) Combined antenna gain: 6.9 dBi (typical)
Antenna connector: *	Internal antenna: - (none) External antenna: FAKRA
Type of modulation: *	IEEE 802.11 a BPSK, QPSK, 16-QAM, 64-QAM (6/9/12/18/24/36/48/54 Mbit/s)
	IEEE 802.11 n20 BPSK, QPSK, 16-QAM, 64-QAM (up to 72.2 Mbit/s 1 spatial stream) (up to 144.4 Mbit/s 2 spatial stream)
	IEEE 802.11 n40 BPSK, QPSK, 16-QAM, 64-QAM (up to 150 Mbit/s 1 spatial stream) (up to 300 Mbit/s 2 spatial stream)
	IEEE 802.11 ac20 BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (up to 86.65 Mbit/s 1 spatial stream) (up to 173.3 Mbit/s 2 spatial stream)
	IEEE 802.11 ac40 BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (up to 200 Mbit/s 1 spatial stream) (up to 400 Mbit/s 2 spatial stream)
	IEEE 802.11 ac80 BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (up to 433.35 Mbit/s 1 spatial stream) (up to 866.7 Mbit/s 2 spatial stream)
	IEEE 802.11 ax20 BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM (up to 143.4 Mbit/s 1 spatial stream) (up to 286.8 Mbit/s 2 spatial stream)
	IEEE 802.11 ax40 BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM (up to 286.8 Mbit/s 1 spatial stream) (up to 573.5 Mbit/s 2 spatial stream)

IEEE 802.11 radio mode (5GHz)	
Type of modulation: * (cont.)	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM IEEE 802.11 ax80 (up to 600.5 Mbit/s 1 spatial stream) (up to 1201 Mbit/s 2 spatial stream)
Operating frequency range: *	IEEE 802.11a 5180 – 5240 MHz, 5745 – 5825 MHz
	IEEE 802.11n 20 MHz 5180 – 5240 MHz, 5745 – 5825 MHz
	IEEE 802.11n 40 MHz 5190 – 5230 MHz, 5755 – 5795 MHz
	IEEE 802.11ac 20 MHz 5180 – 5240 MHz, 5745 – 5825 MHz
	IEEE 802.11ac 40 MHz 5190 – 5230 MHz, 5755 – 5795 MHz
	IEEE 802.11ac 80 MHz 5210, 5755 MHz
	IEEE 802.11ax 20 MHz 5180 – 5240 MHz, 5745 – 5825 MHz
	IEEE 802.11ax 40 MHz 5190 – 5230 MHz, 5755 – 5795 MHz
IEEE 802.11ax 80 MHz 5210, 5755 MHz	

* Declared by the applicant

1.6.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Laboratory power supply *1	Toellner TOE 8752 (PM. NO. 480009); additionally 12 V vehicular battery
Test Laptop*1	Fujitsu Lifebook S760 (PM. No: 200759)

*1 Provided by the laboratory

*2 Provided by the applicant

Ancillary equipment	
-	-

1.7 Dates

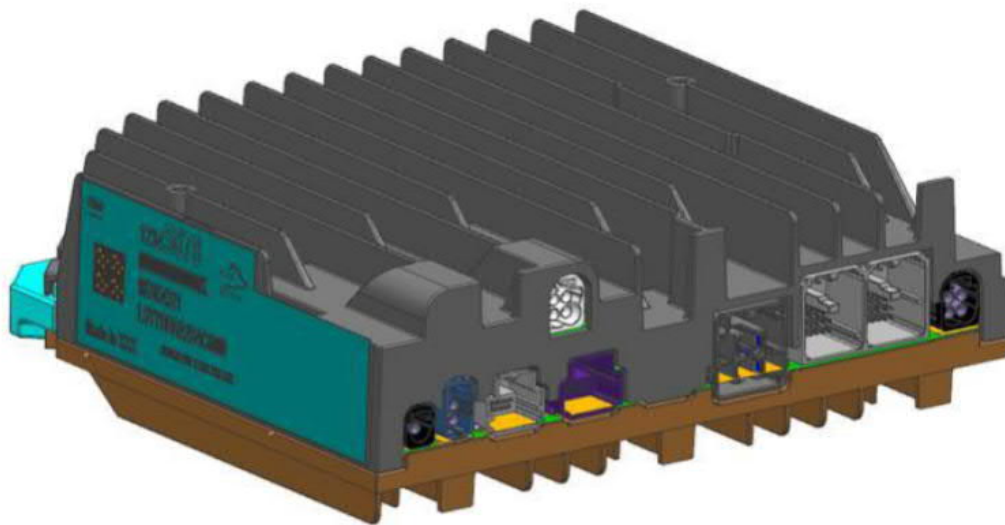
Date of receipt of test sample:	10.12.2021
Start of test:	10.12.2021
End of test:	17.01.2022

2 Operational States

2.1 Description of function of the EUT

The EUT is a Virtual Cockpit Unit (VCU), providing interfaces to Displays, Speakers, Sensors and optional components of the VCS and includes Bluetooth and WiFi capabilities. This is a product produced in collaboration with OEM. This device will be fitted in different OEM vehicles.

The EUT:



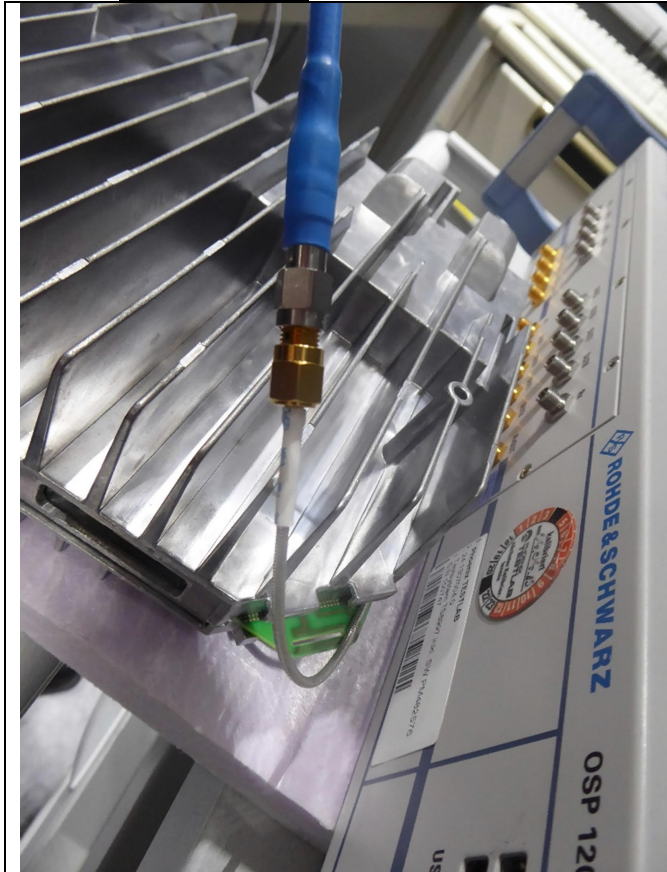
During all test the EUT was supplied with 13.5 V DC via a laboratory power supply. During the tests, a USB connection was established to the EUT via USB-2-optic converter. All relevant HF parameters could be set with a Laptop.

All operation modes for WLAN were set with a software called "GM VCU WLAN RTA Tool", as provided by the applicant.

The antenna port conducted tests on the internal antenna were performed using the temporary SMA antenna connector, which was provided by the applicant.

The antenna port conducted tests on the external antenna connector were performed using a Fakra-to-SMA cable (length ~ 1m), which was provided by the applicant. As declared by the applicant, the length of this cable corresponds to the length of the cable between the mounted EUT in the vehicle and the external antenna. See the photographs of the temporary antenna connector and the Fakra-to-SMA cable.

2.1.1.1 Modifications



Internal antenna: Temporary antenna connector



External antenna: Fakra-to-SMA cable

No difference in power setting or output power (at one port) when transmitting one antenna port or when transmitting on both antenna ports. Therefore, all tests were performed with both antenna ports active.

The EUT has different power settings for the U-NII-1 band (5.15 – 5.25 GHz) for FCC and ISSED. As declared by the applicant, the power settings will be set automatically, depending on the location of the vehicle. For U-NII-3 band (5.725 – 5.85 GHz), the EUT has the same power settings for FCC and ISSED.

The EUT has incorporated TPC functionality with at least 3 dB power reduction, as declared by the applicant. This allows the use of the maximum of 30 mW / 14.77 dBm for ISSED in the U-NII-1 band (5.15 – 5.25 GHz).

2.1.2 Operation modes 5 GHz (FCC)

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate*	Power setting
1	IEEE 802.11a	5180	36	16-QAM	36 Mbit/s	12.1 dBm
2	IEEE 802.11a	5200	40	16-QAM	36 Mbit/s	12.1 dBm
3	IEEE 802.11a	5240	48	16-QAM	36 Mbit/s	12.1 dBm
4	IEEE 802.11n20	5180	36	64-QAM	MCS7	12.1 dBm
5	IEEE 802.11n20	5200	40	64-QAM	MCS7	12.1 dBm
6	IEEE 802.11n20	5240	48	64-QAM	MCS7	12.1 dBm
7	IEEE 802.11n40	5190	36	64-QAM	MCS7	12.1 dBm
8	IEEE 802.11n40	5230	40	64-QAM	MCS7	12.1 dBm
9	IEEE 802.11ac20	5180	36	64-QAM	MCS7	12.1 dBm
10	IEEE 802.11ac20	5200	40	64-QAM	MCS7	12.1 dBm
11	IEEE 802.11ac20	5240	48	64-QAM	MCS7	12.1 dBm
12	IEEE 802.11ac40	5190	36	256-QAM	MCS8	12.1 dBm
13	IEEE 802.11ac40	5230	40	256-QAM	MCS8	12.1 dBm
14	IEEE 802.11ac80	5210	42	QPSK	MCS2	12.1 dBm
15	IEEE 802.11ax20	5180	36	64-QAM	MCS5	12.1 dBm
16	IEEE 802.11ax20	5200	40	64-QAM	MCS5	12.1 dBm
17	IEEE 802.11ax20	5240	48	64-QAM	MCS5	12.1 dBm
18	IEEE 802.11ax40	5190	36	256-QAM	MCS8	12.1 dBm
19	IEEE 802.11ax40	5230	40	256-QAM	MCS8	12.1 dBm
20	IEEE 802.11ax80	5210	42	16-QAM	MCS4	12.1 dBm

* As pre-tests have shown, these data rated produced the highest output power.

2.1.3 Operation modes 5 GHz (ISED)

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate*	Power setting
21	IEEE 802.11a	5180	36	16-QAM	36 Mbit/s	5.9 dBm
22	IEEE 802.11a	5200	40	16-QAM	36 Mbit/s	5.9 dBm
23	IEEE 802.11a	5240	48	16-QAM	36 Mbit/s	5.9 dBm
24	IEEE 802.11n20	5180	36	64-QAM	MCS7	5.9 dBm
25	IEEE 802.11n20	5200	40	64-QAM	MCS7	5.9 dBm
26	IEEE 802.11n20	5240	48	64-QAM	MCS7	5.9 dBm
27	IEEE 802.11n40	5190	36	64-QAM	MCS7	5.9 dBm
28	IEEE 802.11n40	5230	40	64-QAM	MCS7	5.9 dBm
29	IEEE 802.11ac20	5180	36	64-QAM	MCS7	5.9 dBm
30	IEEE 802.11ac20	5200	40	64-QAM	MCS7	5.9 dBm
31	IEEE 802.11ac20	5240	48	64-QAM	MCS7	5.9 dBm
32	IEEE 802.11ac40	5190	36	256-QAM	MCS8	5.9 dBm
33	IEEE 802.11ac40	5230	40	256-QAM	MCS8	5.9 dBm
34	IEEE 802.11ac80	5210	42	QPSK	MCS2	5.9 dBm
35	IEEE 802.11ax20	5180	36	64-QAM	MCS5	5.9 dBm
36	IEEE 802.11ax20	5200	40	64-QAM	MCS5	5.9 dBm
37	IEEE 802.11ax20	5240	48	64-QAM	MCS5	5.9 dBm
38	IEEE 802.11ax40	5190	36	256-QAM	MCS8	5.9 dBm
39	IEEE 802.11ax40	5230	40	256-QAM	MCS8	5.9 dBm
40	IEEE 802.11ax80	5210	42	16-QAM	MCS4	5.9 dBm

* As pre-tests have shown, these data rated produced the highest output power.

2.1.4 Operation modes 5 GHz (FCC&ISED)

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate*	Power setting
41	IEEE 802.11a	5745	149	16-QAM	36 Mbit/s	19.0 dBm
42	IEEE 802.11a	5785	157	16-QAM	36 Mbit/s	19.0 dBm
43	IEEE 802.11a	5825	165	16-QAM	36 Mbit/s	19.0 dBm
44	IEEE 802.11n20	5745	149	64-QAM	MCS7	19.0 dBm
45	IEEE 802.11n20	5785	157	64-QAM	MCS7	19.0 dBm
46	IEEE 802.11n20	5825	165	64-QAM	MCS7	19.0 dBm
47	IEEE 802.11n40	5755	151	64-QAM	MCS7	19.0 dBm
48	IEEE 802.11n40	5795	159	64-QAM	MCS7	19.0 dBm
49	IEEE 802.11ac20	5745	149	64-QAM	MCS7	19.0 dBm
50	IEEE 802.11ac20	5785	157	64-QAM	MCS7	19.0 dBm
51	IEEE 802.11ac20	5825	165	64-QAM	MCS7	19.0 dBm
52	IEEE 802.11ac40	5755	151	256-QAM	MCS8	19.0 dBm
53	IEEE 802.11ac40	5795	159	256-QAM	MCS8	19.0 dBm
54	IEEE 802.11ac80	5775	155	QPSK	MCS2	19.0 dBm
55	IEEE 802.11ax20	5745	149	64-QAM	MCS5	19.0 dBm
56	IEEE 802.11ax20	5785	157	64-QAM	MCS5	19.0 dBm
57	IEEE 802.11ax20	5825	165	64-QAM	MCS5	19.0 dBm
58	IEEE 802.11ax40	5755	151	256-QAM	MCS8	19.0 dBm
59	IEEE 802.11ax40	5795	159	256-QAM	MCS8	19.0 dBm
60	IEEE 802.11ax80	5775	155	16-QAM	MCS4	19.0 dBm

* As pre-tests have shown, these data rated produced the highest output power.

3 Additional Information

The EUT was not labeled as required by FCC / IC.
All radiated tests were performed using an unmodified EUT.

4 Overview

Application	Frequency range in MHz	FCC 47 CFR Part 15 section [2]	RSS-247 [5] RSS-Gen [6]	Tested EUT	Status
Maximum Output Power	5150 – 5250 5725 - 5850	15.407 (a)	6.2.1.1 [5] 6.2.4.1 [5]	1	Passed
UNII Bandwidth 99% Bandwidth	5150 – 5250 5725 - 5850	-	-	1	Performed
6 dB Bandwidth	5725 - 5850	15.407(e)	6.2.4.1 [5]	1	Passed
26 dB Bandwidth Emission Bandwidth	5150 – 5250 5725 - 5850	15.403	6.2.1.2	1	Performed
Maximum Power Spectral Density	5150 – 5250 5725 - 5850	15.407 (a)(5)	6.2.1.1 [5] 6.2.4.1 [5]	1, 2	Passed
Band edge compliance	5150 – 5250 5725 - 5850	15.407 (b)	6.2.1.2[5] 6.2.4.2[5]	1, 2, 3	Passed
Radiated emissions (transmitter)	0.009 - 40,000	15.407 (b) 15.205 (a) 15.209 (a)	6.13 [6], 6.2.1.2[5] 6.2.2.2[5] 6.2.3.2[5] 6.2.4.2[5]	2 > 1GHz 3 < 1GHz	Passed
Antenna Requirement	-	15.203 15.247 (b)	6.8 [6] 5.4 (f) (ii) [5]	-	Passed
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2 [6]	-	n/a*

* Not applicable, because the EUT is only used in vehicular environments.

5 Results

5.1 Test setup

5.1.1 Test Setup (radiated)

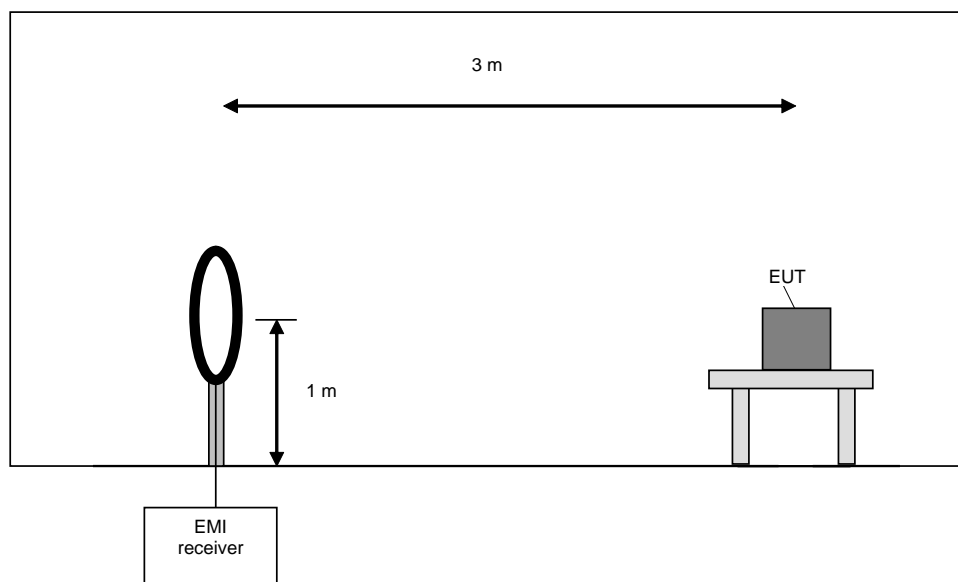
5.1.1.1 Preliminary measurement 9 kHz to 30 MHz

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.

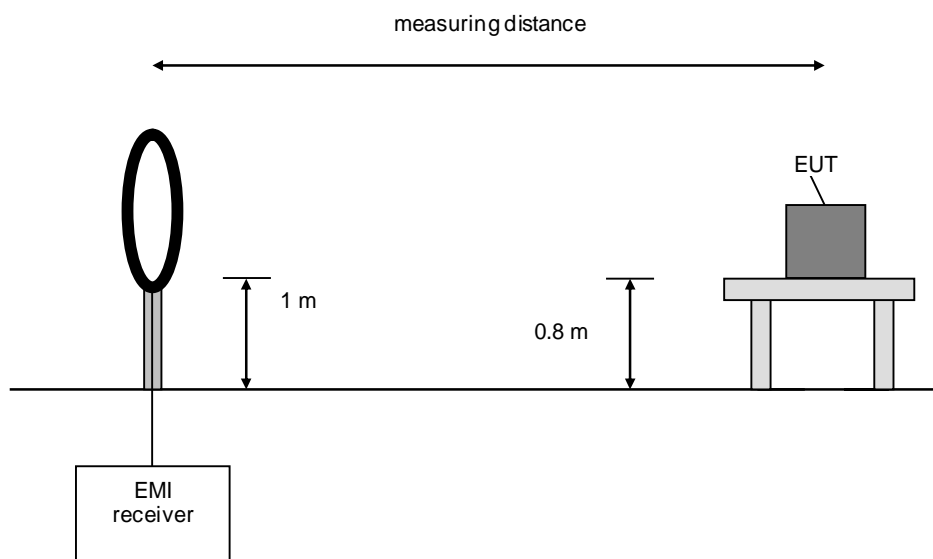
5.1.1.2 Final measurement 9 kHz to 30 MHz

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.

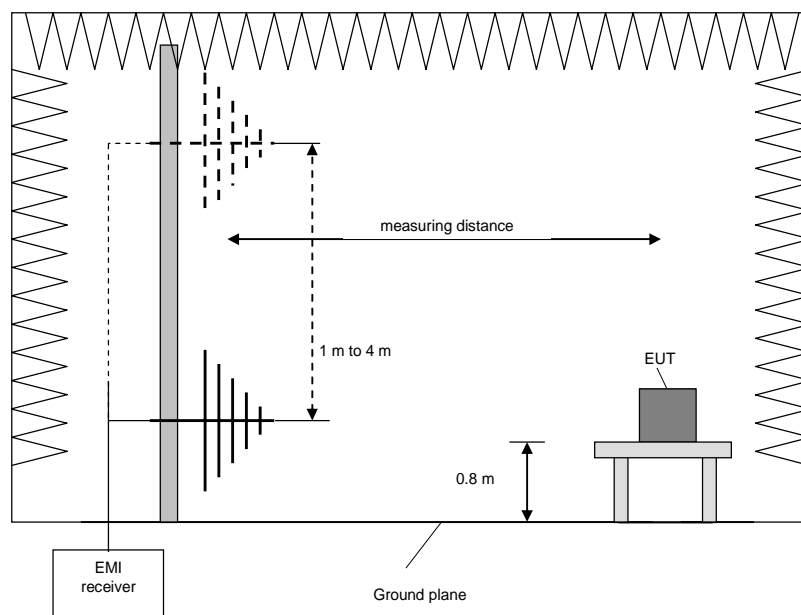
5.1.1.3 Preliminary and final measurement 30 MHz to 1 GHz

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 +/- 30° 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])

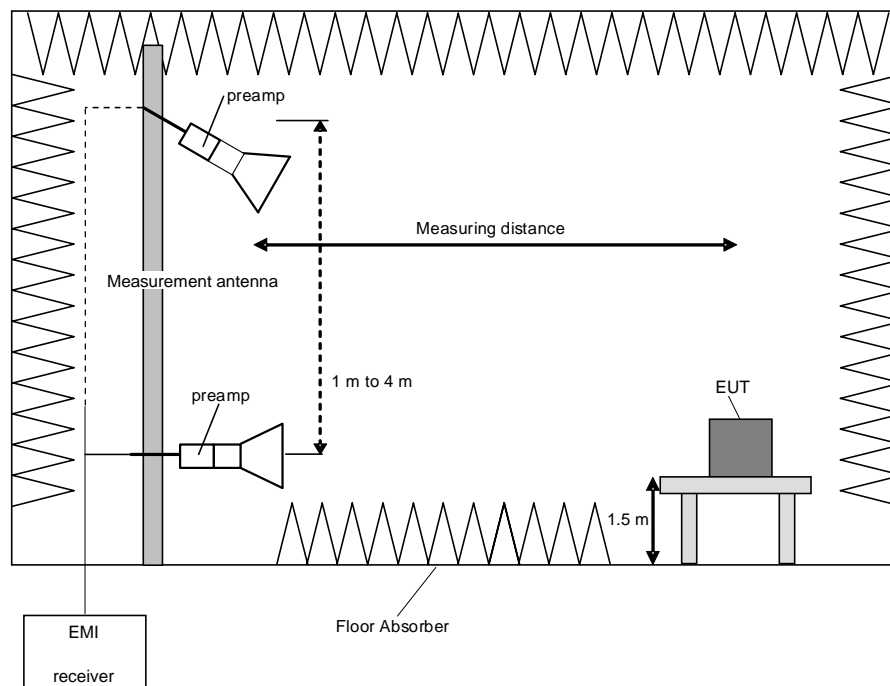
This measurement will be performed in a fully anechoic chamber or in a semi-anechoic chamber with ground absorbers between antenna and EUT. Tabletop and portable devices will set up on a non-conducting turn device on the height of 1.5m. Floor standing devices will be placed directly on the turntable. 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 analyser set to MAX Hold mode and a resolution bandwidth of 1 MHz. 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 with antenna-height-steps of 50 cm starting from 1 m up to 4m . 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:

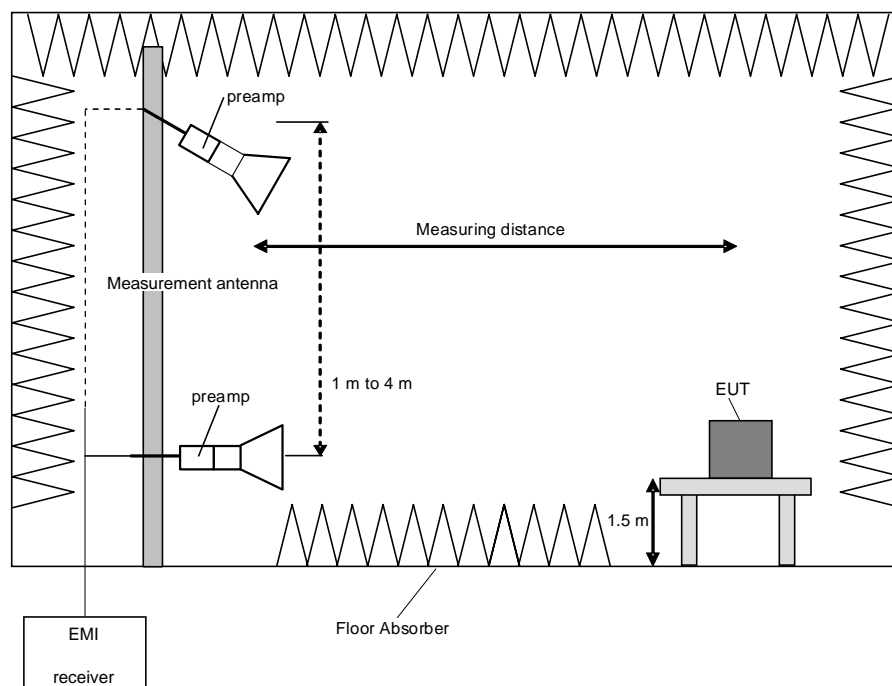
1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat steps 1. and 2. with the horizontal polarisation of the measuring antenna.
5. Increase the height of the 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 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 +/- 30° 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])

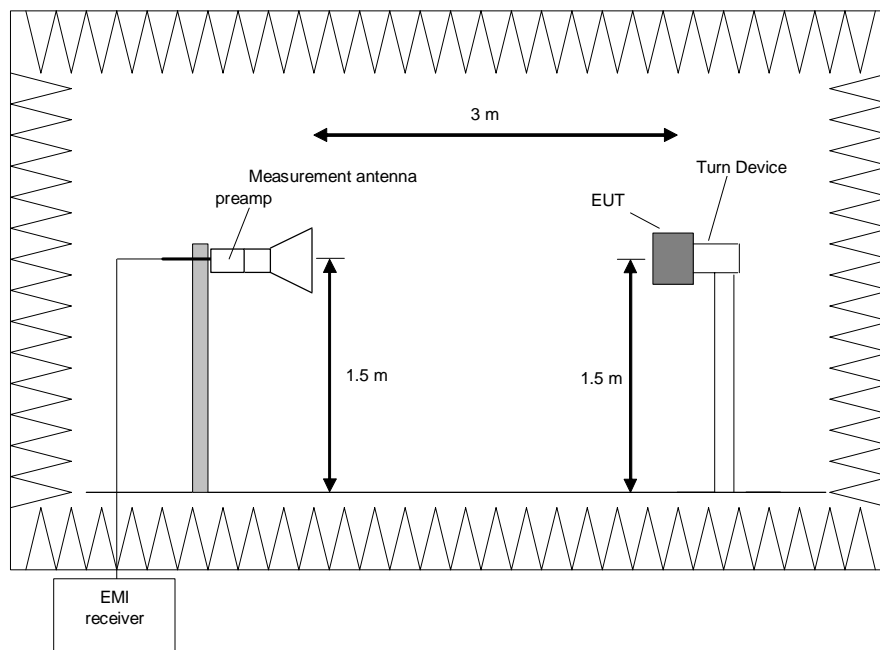
This measurement will be performed in a fully anechoic chamber or in a semi-anechoic chamber with ground absorbers between antenna and EUT. Tabletop and portable devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [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 analyser set to MAX Hold mode and a resolution bandwidth of 1 MHz. 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 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:

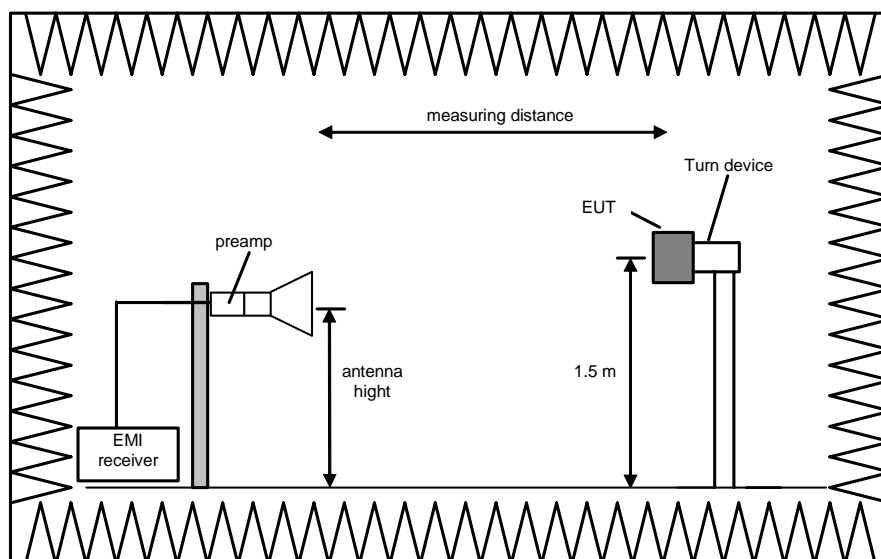
1. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an 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.

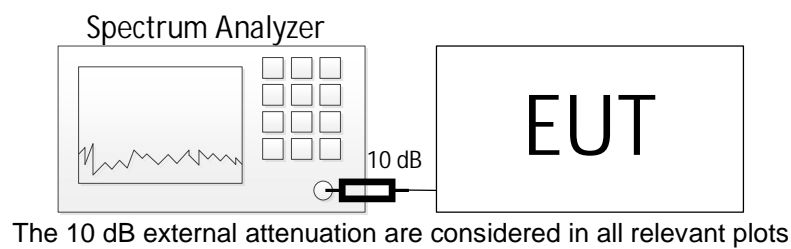
The following procedure will be used:

- 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 +/- 30° 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
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	Temporary antenna connector	As provided by the applicant
<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	Normal antenna connector	-

For test at the internal antenna, a temporary antenna connector was used, as provided by the applicant (see 2.1.1.1)
For test at the external antenna, the normal antenna connector was used.



Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

5.1.2.1 Test setup (AC powerline) with AC/DC adapter

5.2 Duty cycle

5.2.1 Test setup (Duty cycle)

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-

5.2.2 Test method (Duty cycle)

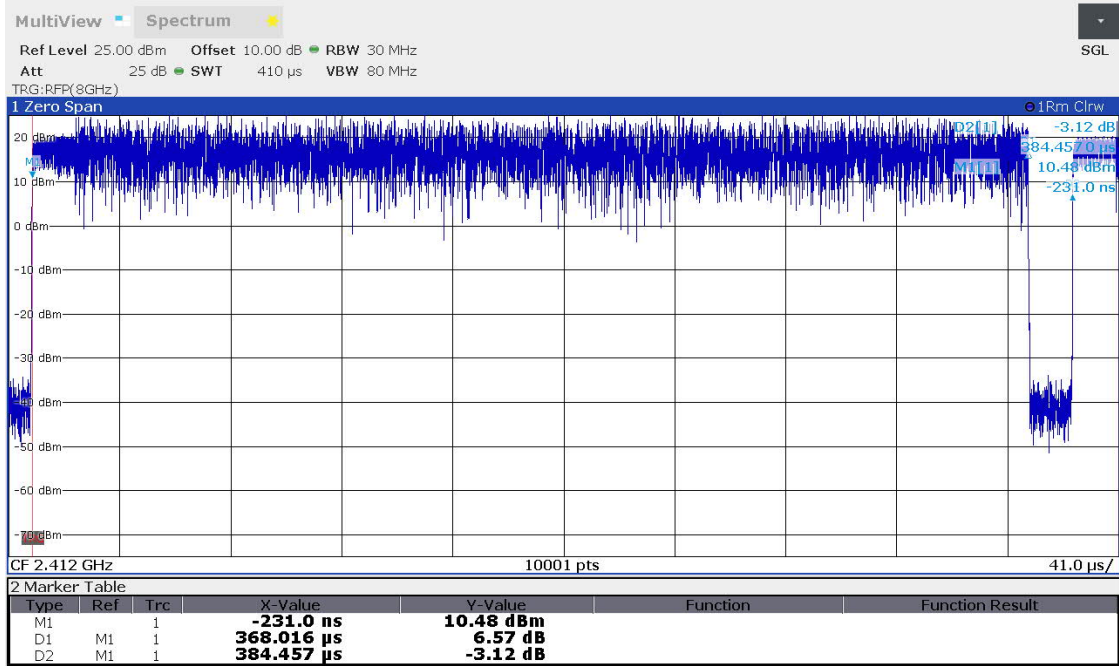
Test method (Duty cycle)				
Used	Sub-Clause [6]	Name of method	Applicability	Comment
<input type="checkbox"/>	II B. 2. a)	Diode detector	No limitation	-
<input checked="" type="checkbox"/>	II B. 2. b)	Zero span (analyzer or EMI receiver)	No limitation	-

5.2.3 Test results (Duty cycle)

Ambient temperature:	21 °C
Relative humidity:	22 %

Date	11.12.2021
Tested by	P. NEUFELD

Worst case plot (operation mode 23 - Internal Antenna):



Operation Mode #	TX _{On} [μs]	TX _{Cycle} [μs]	RBW [MHz]	50/T [kHz]	50/T < RBW?
1 – 3, 21 – 23, 41 - 43	368	384	30	135.864	<input checked="" type="checkbox"/>
4 – 6, 24 – 26, 44 - 46	5429	5444	30	9.210	<input checked="" type="checkbox"/>
7 + 8, 27 + 28, 47 + 48	5429	5444	50	9.210	<input checked="" type="checkbox"/>
9 – 11, 29 – 31, 49 – 51	5429	5446	30	9.209	<input checked="" type="checkbox"/>
12 + 13, 32 + 33, 52 + 53	5429	5445	50	9.210	<input checked="" type="checkbox"/>
14, 34, 54	5429	5444	80	9.210	<input checked="" type="checkbox"/>
15 – 17, 35 – 37, 54 – 57	5445	5461	30	9.183	<input checked="" type="checkbox"/>
18 + 19, 38 + 39, 58 + 59	5444	5460	50	9.184	<input checked="" type="checkbox"/>
20, 40, 60	5444	5460	80	9.184	<input checked="" type="checkbox"/>

Operation Mode #	Sweep points	Sweep time [μs]	Meas points For TX _{On}	Meas points >100?	Duty cycle %	DCCF [dB]
1 – 3, 21 – 23, 41 - 43	10001	410	8977	<input checked="" type="checkbox"/>	95.7	0.2
4 – 6, 24 – 26, 44 - 46	10001	5600	9695	<input checked="" type="checkbox"/>	99.7	0.0
7 + 8, 27 + 28, 47 + 48	10001	5600	9695	<input checked="" type="checkbox"/>	99.7	0.0
9 – 11, 29 – 31, 49 – 51	10001	5600	9696	<input checked="" type="checkbox"/>	99.7	0.0
12 + 13, 32 + 33, 52 + 53	10001	5600	9695	<input checked="" type="checkbox"/>	99.7	0.0
14, 34, 54	10001	5600	9695	<input checked="" type="checkbox"/>	99.7	0.0
15 – 17, 35 – 37, 54 – 57	10001	5600	9724	<input checked="" type="checkbox"/>	99.7	0.0
18 + 19, 38 + 39, 58 + 59	10001	5600	9723	<input checked="" type="checkbox"/>	99.7	0.0
20, 40, 60	10001	5600	9723	<input checked="" type="checkbox"/>	99.7	0.0

The DCCF (duty cycle correction factor) is calculated by:

$$DCCF_{Power} = 10 * \log_{10} \left(\frac{1}{Duty\ cycle} \right)$$

$$DCCF_{Fieldstrength} = 20 * \log_{10} \left(\frac{1}{Duty\ cycle} \right)$$

For average measurements a correction factor of 0.2 dB is used for all tests in test mode 1 – 3, 21 – 23, 41 - 43. No DCCF is applied for all other test cases because the correction factor is 0.0.

Test equipment (please refer to chapter 6 for details)
1 - 3

5.3 Transmit Antenna Performance considerations

Test result (Transmit antenna requirements)			
Integral antenna	Antenna gain ≤ 6dBi	Result	Comment
☒	☒	Passed	No output power reduction necessary

As declared by the applicant for all WLAN modes (mode 1 – 18) “Maximum Ratio Transmission (MRT)” is used.

Antenna gain calculation for WLAN modes (mode 1 – 60) as described in [4], sub-clause F) 2) d) (i)

$$Directional\ gain = 10 \log_{10} \left[\frac{\left(10^{G_1/20} + 10^{G_2/20} \right)^2}{N_{Ant}} \right] dBi$$

Herein:

G_1 = gain_{external antenna} = 4.9 dBi
 G_1 = gain_{internal antenna} = 2.8 dBi
 N_{Ant} = number of antennas = 2
 Directional gain for correlated signals = **6.9 dBi** > 6 dBi

All conducted limits will be reduced by 0.9 dB.

5.4 Emission Bandwidth (EBW)

5.4.1 Test setup (EBW)

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-
<input type="checkbox"/>			

5.4.2 Test method (EBW)

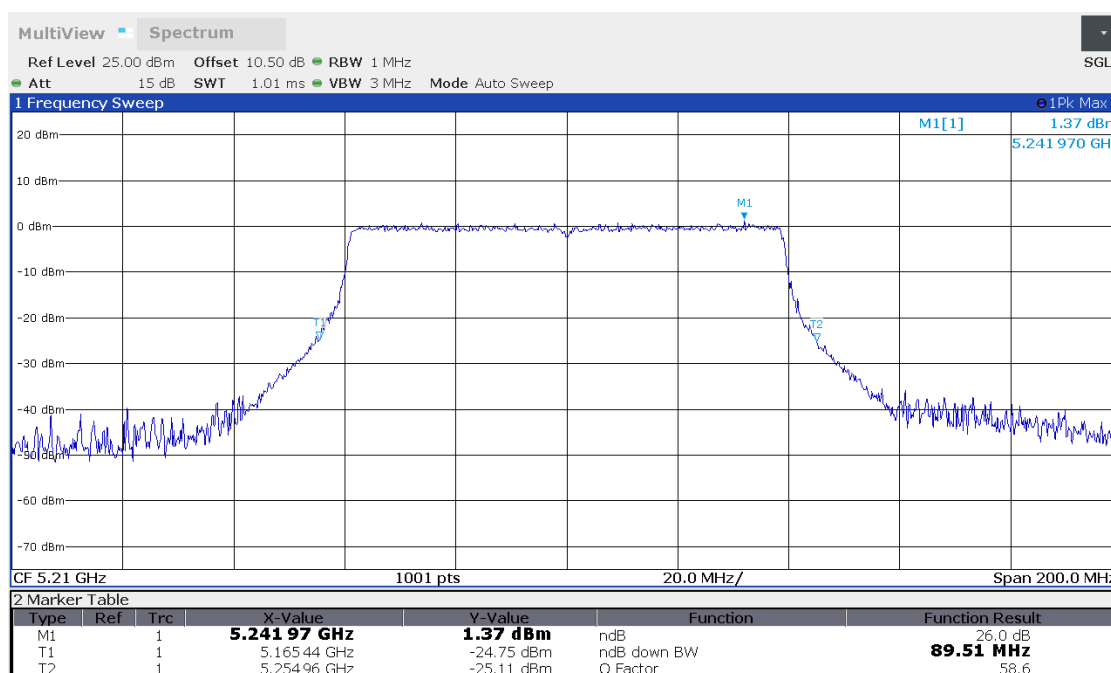
Test method (Maximum peak conducted output power)				
Used	Sub-Clause [6]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	II C. 1	26 dB Bandwidth	All but 5.725 – 5.85 GHz	-
<input checked="" type="checkbox"/>	II C. 2	6 dB Bandwidth	Only 5.725 – 5.85 GHz	-

5.4.3 Test results (EBW - 26 dB BW) for FCC - 5150 – 5250 MHz

Ambient temperature:	22 °C
Relative humidity:	26 - 45 %

Date	21.12.2021 – 06.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 20 – internal antenna):



Results internal antenna

Operation mode #	26 dB bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
1	22.877	5168.212	5191.089	5150.000	5250.000
2	22.727	5188.312	5211.039	5150.000	5250.000
3	22.378	5228.462	5250.839*	5150.000	5250.000
4	20.180	5169.910	5190.090	5150.000	5250.000
5	20.180	5189.860	5210.040	5150.000	5250.000
6	20.180	5229.860	5250.040*	5150.000	5250.000
7	42.760	5168.520	5211.280	5150.000	5250.000
8	43.060	5208.220	5251.280*	5150.000	5250.000
9	22.478	5168.811	5191.289	5150.000	5250.000
10	22.478	5188.861	5211.339	5150.000	5250.000
11	22.378	5228.911	5251.289*	5150.000	5250.000
12	43.360	5168.720	5212.080	5150.000	5250.000
13	43.560	5208.520	5252.080*	5150.000	5250.000
14	81.720	5168.840	5250.560*	5150.000	5250.000
15	22.627	5168.661	5191.289	5150.000	5250.000
16	22.677	5188.611	5211.289	5150.000	5250.000
17	22.577	5228.661	5251.239*	5150.000	5250.000
18	43.560	5168.220	5211.780	5150.000	5250.000
19	43.660	5208.020	5251.680*	5150.000	5250.000
20	89.510	5165.440	5254.960*	5150.000	5250.000

* As permitted in TCB Workshop 2017-05-03-3.1 Panel UNII Updates-DT, the 99 % Bandwidth instead of the 26 dB bandwidth is used to determine if the signal is inside an DFS band and subsequently must be implement DFS detection.

Test: Passed

Results external antenna

Operation mode #	26 dB bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
1	22.747	5168.357	5191.104	5150.000	5250.000
2	22.388	5188.402	5210.789	5150.000	5250.000
3	22.433	5228.447	5250.879*	5150.000	5250.000
4	21.778	5169.111	5190.889	5150.000	5250.000
5	21.628	5189.211	5210.839	5150.000	5250.000
6	21.479	5229.211	5250.689*	5150.000	5250.000
7	43.560	5167.920	5211.480	5150.000	5250.000
8	43.060	5208.120	5251.180*	5150.000	5250.000
9	22.253	5168.986	5191.239	5150.000	5250.000
10	22.073	5189.076	5211.149	5150.000	5250.000
11	22.253	5228.986	5251.239*	5150.000	5250.000
12	43.060	5168.620	5211.680	5150.000	5250.000
13	43.260	5208.720	5251.980*	5150.000	5250.000
14	81.920	5168.840	5250.760*	5150.000	5250.000
15	22.388	5168.851	5191.239	5150.000	5250.000
16	22.522	5188.671	5211.194	5150.000	5250.000
17	22.657	5228.626	5251.284*	5150.000	5250.000
18	43.060	5168.420	5211.480	5150.000	5250.000
19	43.460	5208.220	5251.680*	5150.000	5250.000
20	88.510	5165.440	5253.960*	5150.000	5250.000

* As permitted in TCB Workshop 2017-05-03-3.1 Panel UNII Updates-DT, the 99 % Bandwidth instead of the 26 dB bandwidth is used to determine if the signal is inside an DFS band and subsequently must be implement DFS detection.

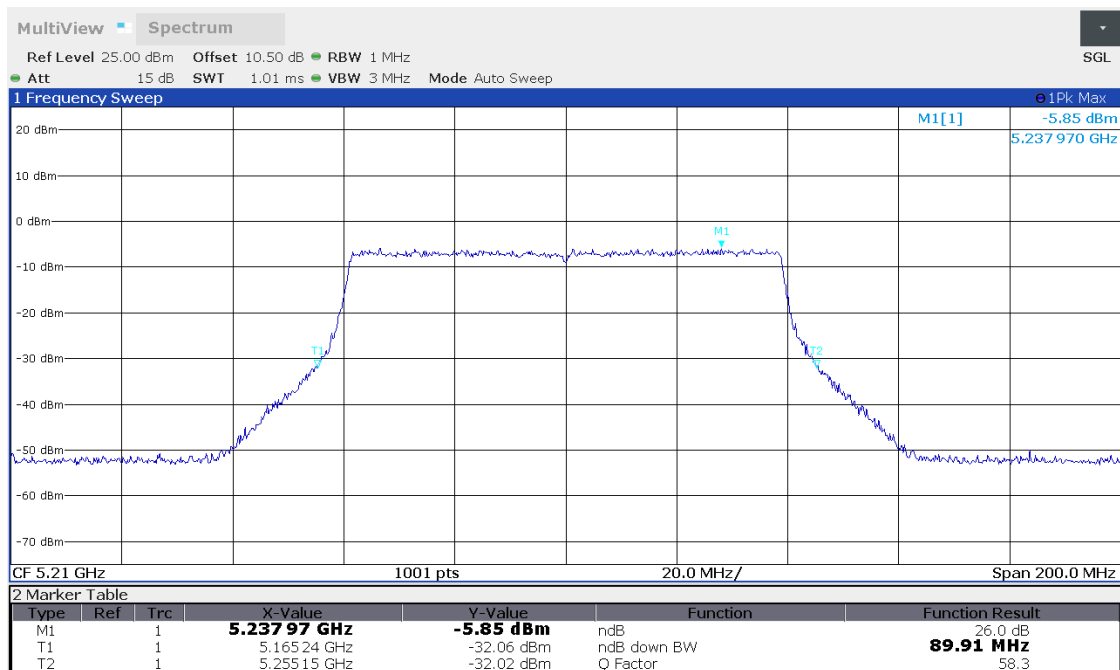
Test: Passed

5.4.4 Test results (EBW - 26 dB BW) for ISED – 5150 – 5250 MHz

Ambient temperature:	22 °C
Relative humidity:	26 - 31%

Date	07 – 10.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 40 – internal antenna):



Results internal antenna

Operation mode #	26 dB bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
21	22.727	5168.362	5191.089	5150.000	5250.000
22	22.527	5188.312	5210.839	5150.000	5250.000
23	22.428	5228.462	5250.889*	5150.000	5250.000
24	21.578	5169.211	5190.789	5150.000	5250.000
25	21.728	5189.111	5210.839	5150.000	5250.000
26	22.078	5229.011	5251.089*	5150.000	5250.000
27	42.760	5168.620	5211.380	5150.000	5250.000
28	43.160	5208.220	5251.380*	5150.000	5250.000
29	22.577	5169.011	5191.588	5150.000	5250.000
30	22.577	5188.911	5211.489	5150.000	5250.000
31	22.178	5229.061	5251.239*	5150.000	5250.000
32	43.760	5168.320	5212.080	5150.000	5250.000
33	43.360	5208.620	5251.980*	5150.000	5250.000
34	81.720	5169.040	5250.760*	5150.000	5250.000
35	22.478	5168.761	5191.239	5150.000	5250.000
36	22.777	5188.611	5211.389	5150.000	5250.000
37	22.777	5228.611	5251.389*	5150.000	5250.000
38	43.060	5168.320	5211.380	5150.000	5250.000
39	43.860	5208.020	5251.880*	5150.000	5250.000
40	89.910	5165.240	5255.150*	5150.000	5250.000

* As permitted in TCB Workshop 2017-05-03-3.1 Panel UNII Updates-DT, the 99 % Bandwidth instead of the 26 dB bandwidth is used to determine if the signal is inside an DFS band and subsequently must be implement DFS detection.

Results external antenna

Operation mode #	26 dB bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
21	22.627	5168.312	5190.939	5150.000	5250.000
22	22.627	5188.312	5210.939	5150.000	5250.000
23	22.428	5228.362	5250.789*	5150.000	5250.000
24	21.828	5168.961	5190.789	5150.000	5250.000
25	21.778	5189.061	5210.839	5150.000	5250.000
26	21.678	5229.061	5250.739*	5150.000	5250.000
27	43.360	5168.020	5211.380	5150.000	5250.000
28	42.860	5208.320	5251.180*	5150.000	5250.000
29	22.478	5168.761	5191.239	5150.000	5250.000
30	22.278	5189.061	5211.339	5150.000	5250.000
31	22.278	5228.911	5251.189*	5150.000	5250.000
32	43.260	5168.720	5211.980*	5150.000	5250.000
33	43.760	5208.120	5251.880*	5150.000	5250.000
34	81.720	5168.840	5250.560*	5150.000	5250.000
35	22.727	5168.661	5191.389	5150.000	5250.000
36	22.777	5188.561	5211.339	5150.000	5250.000
37	22.877	5228.511	5251.389*	5150.000	5250.000
38	43.460	5168.020	5211.480	5150.000	5250.000
39	43.260	5208.020	5251.280*	5150.000	5250.000
40	89.310	5165.040	5254.360*	5150.000	5250.000

* As permitted in TCB Workshop 2017-05-03-3.1 Panel UNII Updates-DT, the 99 % Bandwidth instead of the 26 dB bandwidth is used to determine if the signal is inside an DFS band and subsequently must be implement DFS detection.

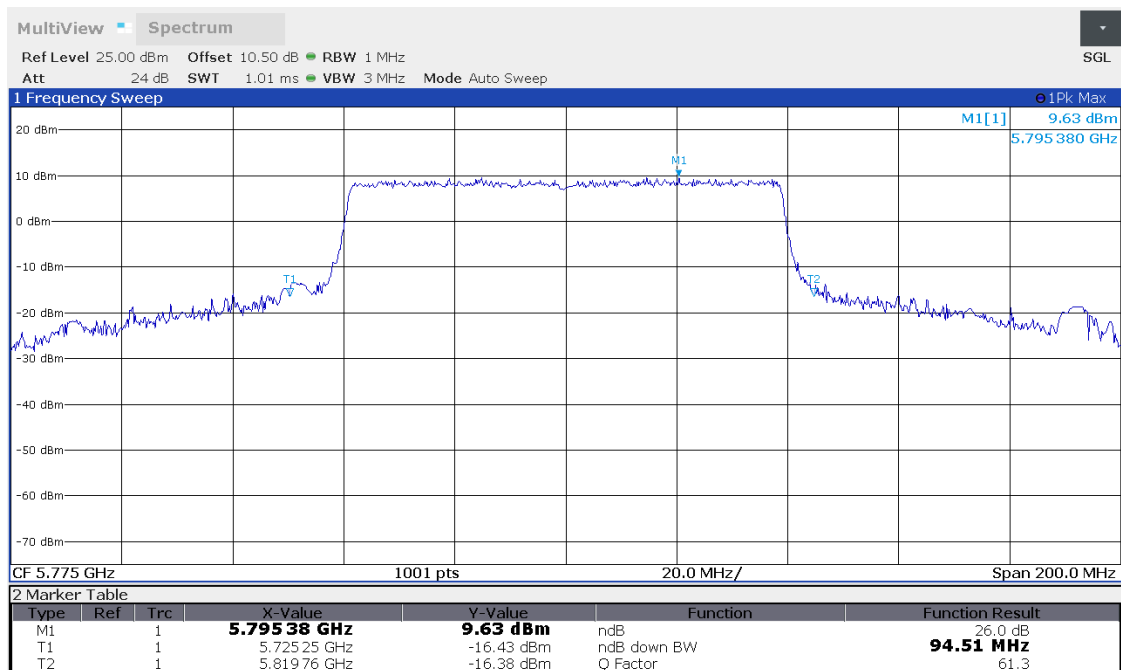
Test: Passed

5.4.5 Test results (EBW - 26 dB BW) for FCC&ISED – 5725 – 5850 MHz

Ambient temperature:	22 °C
Relative humidity:	26 %

Date	06+07.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 20 – internal antenna):



Results internal antenna

Operation mode #	26 dB bandwidth [MHz]	f _{Low} [f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
41	23.601	5733.312	5756.913	5725.000	5850.000
42	22.972	5773.402	5796.374	5725.000	5850.000
43	22.972	5813.357	5836.329	5725.000	5850.000
44	22.837	5733.806	5756.643	5725.000	5850.000
45	22.837	5773.806	5796.643	5725.000	5850.000
46	22.837	5813.806	5836.643	5725.000	5850.000
47	45.950	5732.120	5778.080	5725.000	5850.000
48	45.850	5772.220	5818.080	5725.000	5850.000
49	23.926	5733.012	5756.938	5725.000	5850.000
50	23.726	5773.062	5796.788	5725.000	5850.000
51	24.376	5812.363	5836.738	5725.000	5850.000
52	46.950	5732.320	5779.280	5725.000	5850.000
53	45.150	5772.420	5817.580	5725.000	5850.000
54	82.120	5733.840	5815.960	5725.000	5850.000
55	22.777	5733.661	5756.439	5725.000	5850.000
56	22.627	5773.761	5796.389	5725.000	5850.000
57	22.877	5813.611	5836.489	5725.000	5850.000
58	44.260	5732.820	5777.080	5725.000	5850.000
59	43.060	5773.320	5816.380	5725.000	5850.000
60	94.510	5725.250	5819.760	5725.000	5850.000

Results external antenna

Operation mode #	26 dB bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
41	22.677	5733.362	5756.039	5725.000	5850.000
42	22.727	5773.312	5796.039	5725.000	5850.000
43	22.727	5813.362	5836.089	5725.000	5850.000
44	22.278	5733.761	5756.039	5725.000	5850.000
45	22.278	5773.761	5796.039	5725.000	5850.000
46	22.228	5813.811	5836.039	5725.000	5850.000
47	44.760	5732.520	5777.280	5725.000	5850.000
48	43.660	5772.520	5816.180	5725.000	5850.000
49	22.777	5733.761	5756.538	5725.000	5850.000
50	22.677	5773.761	5796.439	5725.000	5850.000
51	23.477	5813.162	5836.638	5725.000	5850.000
52	45.050	5732.420	5777.480	5725.000	5850.000
53	44.760	5772.320	5817.080	5725.000	5850.000
54	81.920	5733.840	5815.760	5725.000	5850.000
55	22.977	5733.511	5756.489	5725.000	5850.000
56	22.877	5773.611	5796.489	5725.000	5850.000
57	22.577	5813.711	5836.289	5725.000	5850.000
58	44.260	5732.820	5777.080	5725.000	5850.000
59	44.160	5772.720	5816.880	5725.000	5850.000
60	92.110	5729.450	5821.550	5725.000	5850.000

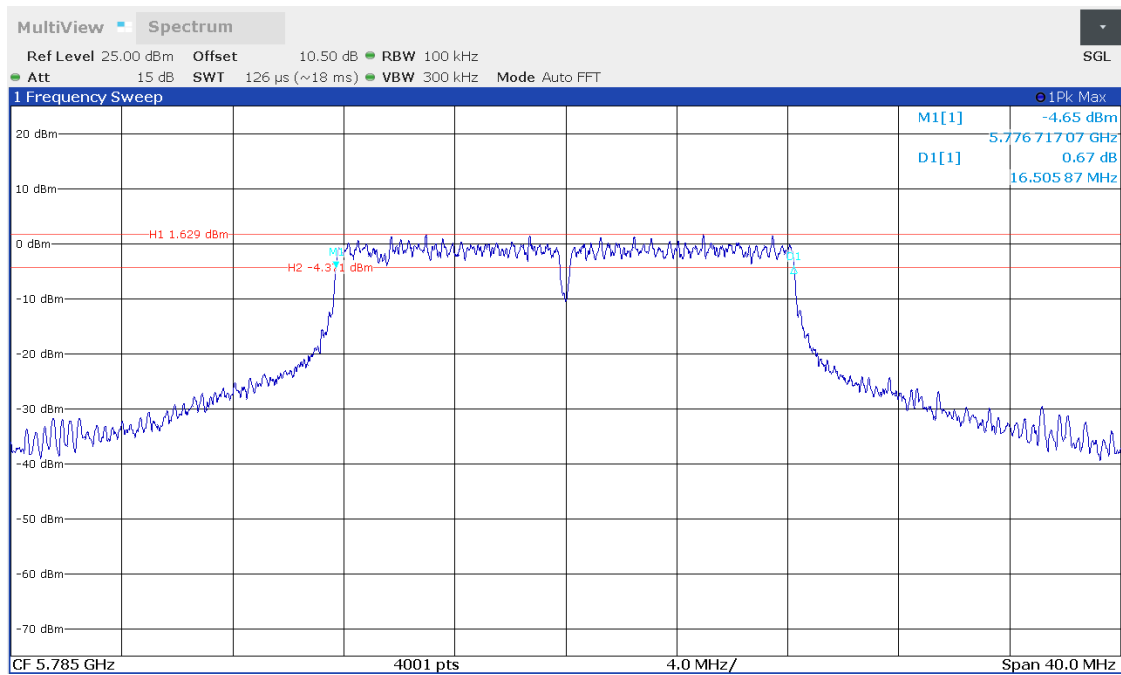
Test: Passed

5.4.6 Test results (EBW - 6 dB BW) for FCC&ISED – 5725 – 5850 MHz

Ambient temperature:	22 °C
Relative humidity:	26 %

Date	06+07.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 42 – internal antenna):



Operation mode #	6 dB bandwidth Internal antenna [MHz]	6 dB bandwidth External antenna [MHz]	Minimum 6 dB bandwidth [MHz]
41	16.547	16.526	0.5
42	16.529	16.506	0.5
43	16.529	16.516	0.5
44	17.834	17.826	0.5
45	17.825	17.816	0.5
46	17.834	17.826	0.5
47	36.551	36.551	0.5
48	36.551	36.551	0.5
49	17.836	17.836	0.5
50	17.836	17.836	0.5
51	17.826	17.846	0.5
52	36.511	36.531	0.5
53	36.531	36.531	0.5
54	75.700	75.600	0.5
55	19.155	19.155	0.5
56	19.135	19.155	0.5
57	19.145	19.165	0.5
58	38.290	38.290	0.5
59	38.290	38.270	0.5
60	78.250	78.275	0.5

Test: Passed

Test equipment (please refer to chapter 6 for details)

1 - 3

5.5 Occupied bandwidth – power bandwidth (99%)

5.5.1 Test Setup (Occupied bandwidth – power bandwidth (99%))

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-

5.5.2 Test method (Occupied bandwidth – power bandwidth (99%))

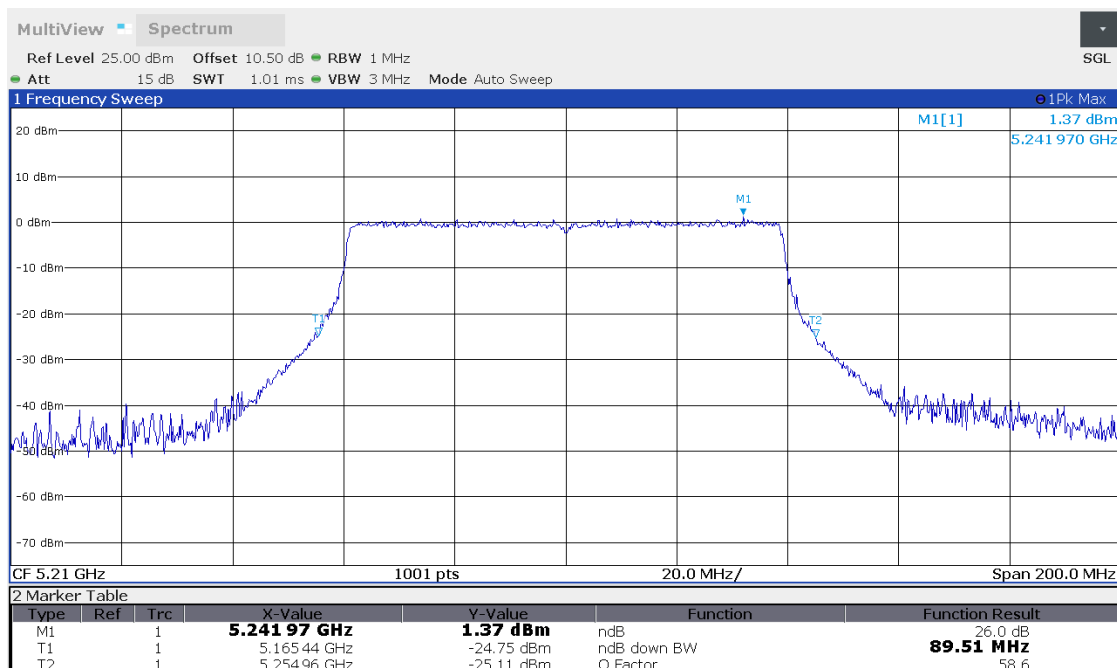
Test method (Maximum peak conducted output power)				
Used	Sub-Clause [6]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	II D	99% Occupied Bandwidth	No limitations	-

5.5.3 Test results (Occupied bandwidth – power bandwidth (99%)) for FCC - 5150 – 5250 MHz

Ambient temperature:	21 – 22 °C
Relative humidity:	20 – 26%

Date	21.12.2021 – 06.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 20 – internal antenna):



Results internal antenna

Operation mode #	99% bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
1	17.389	5171.230	5188.618	5150.000	5250.000
2	17.356	5191.246	5208.602	5150.000	5250.000
3	17.369	5231.247	5248.616	5150.000	5250.000
4	17.632	5171.146	5188.778	5150.000	5250.000
5	17.633	5191.149	5208.782	5150.000	5250.000
6	17.618	5231.164	5248.782	5150.000	5250.000
7	37.448	5171.215	5208.664	5150.000	5250.000
8	37.451	5211.199	5248.650	5150.000	5250.000
9	18.366	5170.802	5189.168	5150.000	5250.000
10	18.349	5190.810	5209.159	5150.000	5250.000
11	18.365	5230.805	5249.170	5150.000	5250.000
12	37.511	5171.200	5208.710	5150.000	5250.000
13	37.480	5211.222	5248.702	5150.000	5250.000
14	75.669	5172.071	5247.740	5150.000	5250.000
15	19.428	5170.261	5189.689	5150.000	5250.000
16	19.437	5190.256	5209.693	5150.000	5250.000
17	19.450	5230.251	5249.701	5150.000	5250.000
18	38.640	5170.619	5209.259	5150.000	5250.000
19	38.633	5210.595	5249.228	5150.000	5250.000
20	78.725	5170.583	5249.307	5150.000	5250.000

Results external antenna

Operation mode #	99% bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
1	17.381	5171.254	5188.635	5150.000	5250.000
2	17.398	5191.238	5208.636	5150.000	5250.000
3	17.382	5231.231	5248.614	5150.000	5250.000
4	18.380	5170.748	5189.128	5150.000	5250.000
5	18.349	5190.768	5209.117	5150.000	5250.000
6	18.372	5230.750	5249.122	5150.000	5250.000
7	37.425	5171.204	5208.628	5150.000	5250.000
8	37.379	5211.218	5248.598	5150.000	5250.000
9	18.360	5170.814	5189.174	5150.000	5250.000
10	18.345	5190.821	5209.166	5150.000	5250.000
11	18.352	5230.811	5249.162	5150.000	5250.000
12	37.457	5171.217	5208.673	5150.000	5250.000
13	37.453	5211.216	5248.669	5150.000	5250.000
14	75.658	5172.044	5247.702	5150.000	5250.000
15	19.425	5170.256	5189.681	5150.000	5250.000
16	19.448	5190.234	5209.681	5150.000	5250.000
17	19.460	5230.234	5249.694	5150.000	5250.000
18	38.607	5170.629	5209.235	5150.000	5250.000
19	38.614	5210.590	5249.204	5150.000	5250.000
20	78.458	5170.640	5249.098	5150.000	5250.000

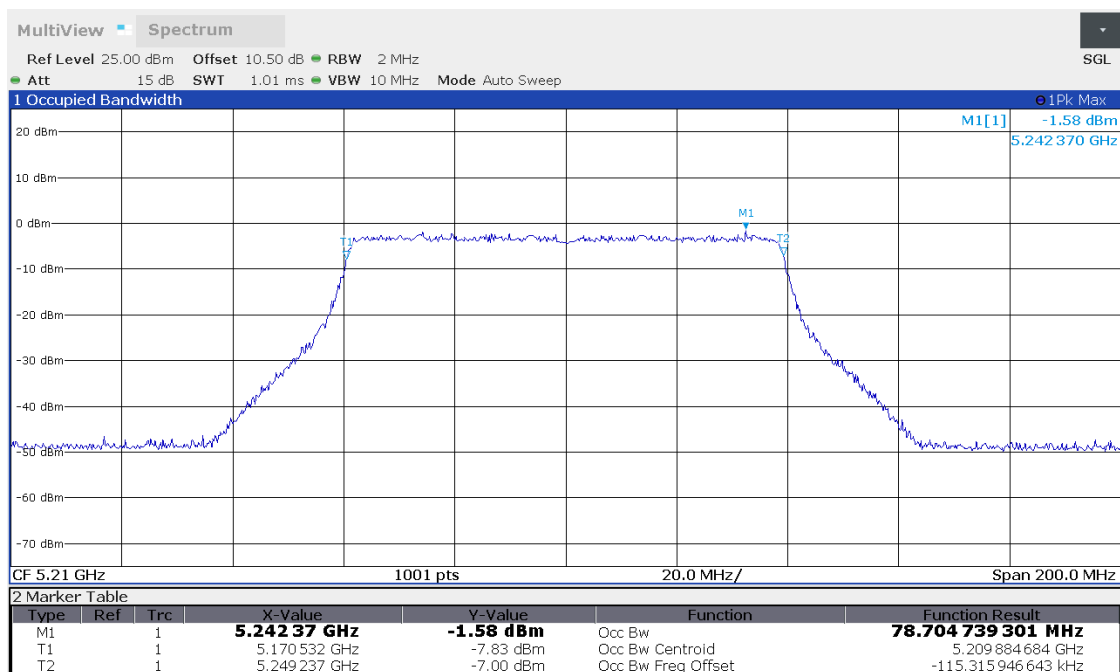
Test: Passed

5.5.4 Test results (Occupied bandwidth – power bandwidth (99%)) for ISED - 5150 – 5250 MHz

Ambient temperature:	21 – 22 °C
Relative humidity:	20 – 26%

Date	21.12.2021 – 06.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 40 – external antenna):



Results internal antenna

Operation mode #	99% bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
21	17.416	5171.221	5188.637	5150.000	5250.000
22	17.399	5191.219	5208.618	5150.000	5250.000
23	17.375	5231.238	5248.613	5150.000	5250.000
24	18.364	5170.767	5189.131	5150.000	5250.000
25	18.360	5190.769	5209.129	5150.000	5250.000
26	18.366	5230.766	5249.132	5150.000	5250.000
27	37.432	5171.251	5208.683	5150.000	5250.000
28	37.436	5211.241	5248.677	5150.000	5250.000
29	18.360	5170.820	5189.180	5150.000	5250.000
30	18.351	5190.819	5209.170	5150.000	5250.000
31	18.363	5230.825	5249.188	5150.000	5250.000
32	37.459	5171.253	5208.712	5150.000	5250.000
33	37.478	5211.253	5248.731	5150.000	5250.000
34	75.645	5172.112	5247.757	5150.000	5250.000
35	19.430	5170.256	5189.686	5150.000	5250.000
36	19.429	5190.268	5209.698	5150.000	5250.000
37	19.452	5230.254	5249.706	5150.000	5250.000
38	38.576	5170.667	5209.243	5150.000	5250.000
39	38.672	5210.616	5249.288	5150.000	5250.000
40	78.582	5170.672	5249.254	5150.000	5250.000

Results external antenna

Operation mode #	99% bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
21	17.483	5171.147	5188.630	5150.000	5250.000
22	17.410	5191.198	5208.608	5150.000	5250.000
23	17.348	5231.253	5248.601	5150.000	5250.000
24	18.373	5170.760	5189.133	5150.000	5250.000
25	18.350	5190.773	5209.122	5150.000	5250.000
26	18.370	5230.754	5249.124	5150.000	5250.000
27	37.458	5171.193	5208.651	5150.000	5250.000
28	37.411	5211.203	5248.615	5150.000	5250.000
29	18.362	5170.808	5189.169	5150.000	5250.000
30	18.355	5190.806	5209.161	5150.000	5250.000
31	18.368	5230.798	5249.166	5150.000	5250.000
32	37.438	5171.250	5208.688	5150.000	5250.000
33	37.463	5211.209	5248.672	5150.000	5250.000
34	75.629	5172.064	5247.693	5150.000	5250.000
35	19.428	5170.263	5189.691	5150.000	5250.000
36	19.429	5190.256	5209.686	5150.000	5250.000
37	19.447	5230.244	5249.691	5150.000	5250.000
38	38.634	5170.623	5209.257	5150.000	5250.000
39	38.625	5210.638	5249.263	5150.000	5250.000
40	78.705	5170.532	5249.237	5150.000	5250.000

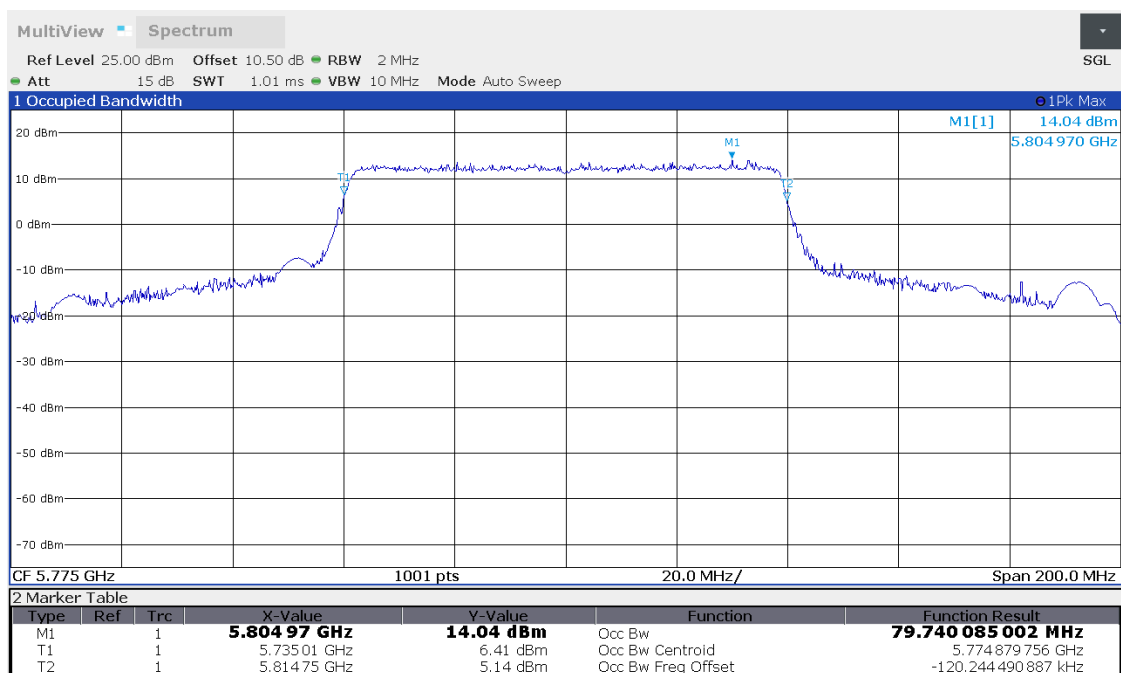
Test: Passed

5.5.5 Test results (Occupied bandwidth – power bandwidth (99%)) for FCC&ISED – 5725 – 5850 MHz

Ambient temperature:	22 °C
Relative humidity:	26 %

Date	06+07.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 60 – internal antenna):



Results internal antenna

Operation mode #	99% bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
41	17.705	5736.040	5753.746	5725.000	5850.000
42	17.624	5776.110	5793.734	5725.000	5850.000
43	17.610	5816.084	5833.694	5725.000	5850.000
44	18.544	5735.672	5754.216	5725.000	5850.000
45	18.516	5775.692	5794.208	5725.000	5850.000
46	18.515	5815.680	5834.195	5725.000	5850.000
47	38.090	5735.880	5773.971	5725.000	5850.000
48	38.049	5775.903	5813.952	5725.000	5850.000
49	18.625	5735.656	5754.281	5725.000	5850.000
50	18.574	5775.683	5794.257	5725.000	5850.000
51	18.564	5815.682	5834.247	5725.000	5850.000
52	38.377	5735.838	5774.215	5725.000	5850.000
53	38.233	5775.893	5814.126	5725.000	5850.000
54	75.765	5737.078	5812.843	5725.000	5850.000
55	19.743	5735.152	5754.896	5725.000	5850.000
56	19.702	5775.152	5794.854	5725.000	5850.000
57	19.703	5815.149	5834.853	5725.000	5850.000
58	39.196	5735.393	5774.589	5725.000	5850.000
59	39.053	5775.427	5814.479	5725.000	5850.000
60	79.740	5735.010	5814.750	5725.000	5850.000

Results external antenna

Operation mode #	99% bandwidth [MHz]	f _{Low} [MHz]	f _{High} [MHz]	Limit f _{Low} [MHz]	Limit f _{High} [MHz]
41	17.535	5736.144	5753.679	5725.000	5850.000
42	17.516	5776.143	5793.659	5725.000	5850.000
43	17.551	5816.140	5833.690	5725.000	5850.000
44	18.482	5735.700	5754.181	5725.000	5850.000
45	18.466	5775.701	5794.167	5725.000	5850.000
46	18.483	5815.685	5834.168	5725.000	5850.000
47	37.787	5736.039	5773.826	5725.000	5850.000
48	37.715	5776.056	5813.771	5725.000	5850.000
49	18.517	5735.713	5754.230	5725.000	5850.000
50	18.488	5775.727	5794.215	5725.000	5850.000
51	18.535	5815.695	5834.230	5725.000	5850.000
52	37.904	5736.034	5773.939	5725.000	5850.000
53	37.836	5776.036	5813.872	5725.000	5850.000
54	75.718	5737.006	5812.723	5725.000	5850.000
55	19.648	5735.162	5754.810	5725.000	5850.000
56	19.645	5775.150	5794.795	5725.000	5850.000
57	19.649	5815.164	5834.814	5725.000	5850.000
58	38.968	5735.466	5774.434	5725.000	5850.000
59	38.901	5775.471	5814.372	5725.000	5850.000
60	79.415	5735.106	5814.521	5725.000	5850.000

Test: Passed

Test equipment (please refer to chapter 6 for details)

1 - 3

5.6 Maximum (average) Conducted Output Power

5.6.1 Test setup (Maximum (average) Conducted Output Power)

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-

5.6.2 Test method (Maximum (average) Conducted Output Power)

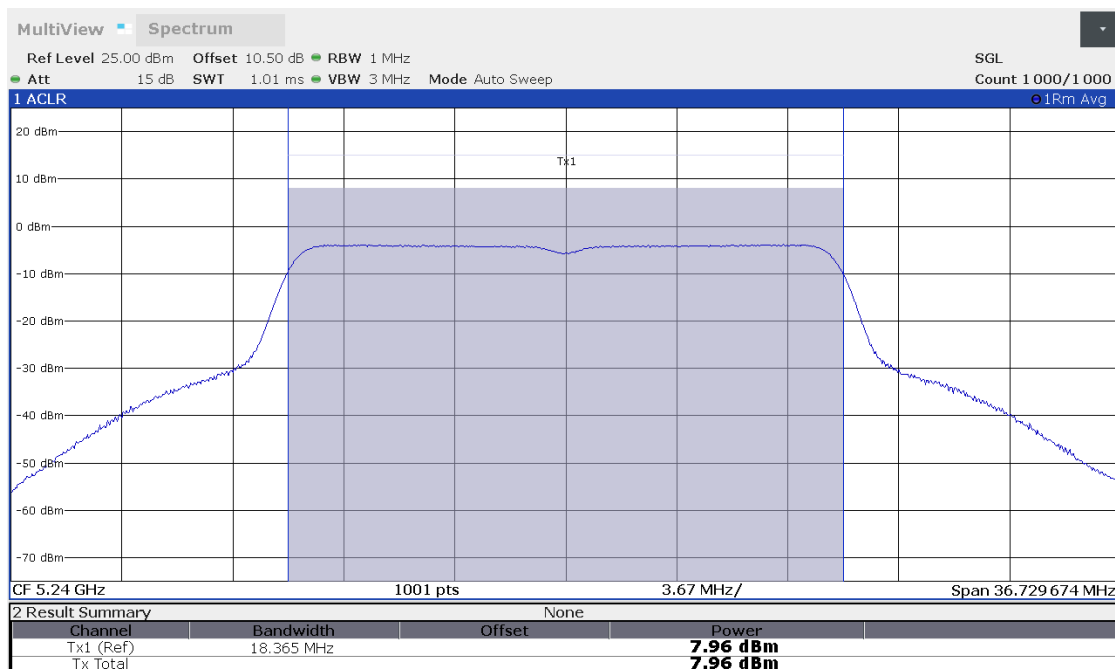
Test method (Maximum conducted (average) output power)				
Used	Sub-Clause [6]	Name of method	Applicability	Comment
<input type="checkbox"/>	II E 2. b)	Method SA-1	D ≥ 98% or video trigger	-
<input type="checkbox"/>	II E 2. c)	Method SA-1A (alternative)	D ≥ 98%	-
<input checked="" type="checkbox"/>	II E 2. d)	Method SA-2	Constant D (±2%)	-
<input type="checkbox"/>	II E 2. e)	Method SA-2A (alternative)	Constant D (±2%)	-
<input type="checkbox"/>	II E 2. f)	Method SA-3A	No limitations	-
<input type="checkbox"/>	II E 2. g)	Method SA-3A (alternative)	No limitations	-
<input type="checkbox"/>	II E 3 a)	Method Power Meter	D ≥ 98% or Constant D (±2%)	-
<input type="checkbox"/>	II E 3 a)	Method gated Power Meter	Measure only On time	-

5.6.3 Test results Maximum (Average) Conducted Output Power for FCC - 5150 – 5250 MHz

Ambient temperature:	21 – 22 °C
Relative humidity:	20 – 26%

Date	21.12.2021 – 06.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 11 –internal antenna):



Operation mode	Reading Internal Ant [dBm]	Reading External Ant [dBm]	Ext. Att.* [dB]	DCCF [dB]	Antenna gain [dBi]	Result Corr. Ant. [dBm]	Limit EIRP* ² [dBm]
1	7.8	7.2	0.0	0.2	6.9	17.8	21.0
2	7.7	7.1	0.0	0.2	6.9	17.7	21.0
3	7.8	7.1	0.0	0.2	6.9	17.8	21.0
4	7.6	7.0	0.0	0.0	6.9	17.2	21.0
5	7.5	7.0	0.0	0.0	6.9	17.2	21.0
6	7.5	7.0	0.0	0.0	6.9	17.2	21.0
7	7.9	7.0	0.0	0.0	6.9	17.4	21.0
8	7.9	7.1	0.0	0.0	6.9	17.4	21.0
9	7.9	7.3	0.0	0.0	6.9	17.5	21.0
10	7.9	7.2	0.0	0.0	6.9	17.5	21.0
11	8.0	7.3	0.0	0.0	6.9	17.6	21.0
12	8.0	7.0	0.0	0.0	6.9	17.4	21.0
13	7.9	7.1	0.0	0.0	6.9	17.4	21.0
14	7.7	6.7	0.0	0.0	6.9	17.1	21.0
15	8.0	7.2	0.0	0.0	6.9	17.5	21.0
16	7.9	7.2	0.0	0.0	6.9	17.5	21.0
17	8.0	7.2	0.0	0.0	6.9	17.5	21.0
18	8.0	7.1	0.0	0.0	6.9	17.5	21.0
19	8.0	7.2	0.0	0.0	6.9	17.5	21.0
20	7.8	6.8	0.0	0.0	6.9	17.2	21.0

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

*² 47 CFR 15.407(a)(1)(i) – 21 dBm EIRP (calculated)

Calculations:

Result Corr. Ant. [dBm]= $10 \times \log_{10}(\text{Reading Internal Ant [mW]} + \text{Reading External Ant [mW]}) + 2 \times \text{DCCF} + \text{Antenna gain [dBi]}$

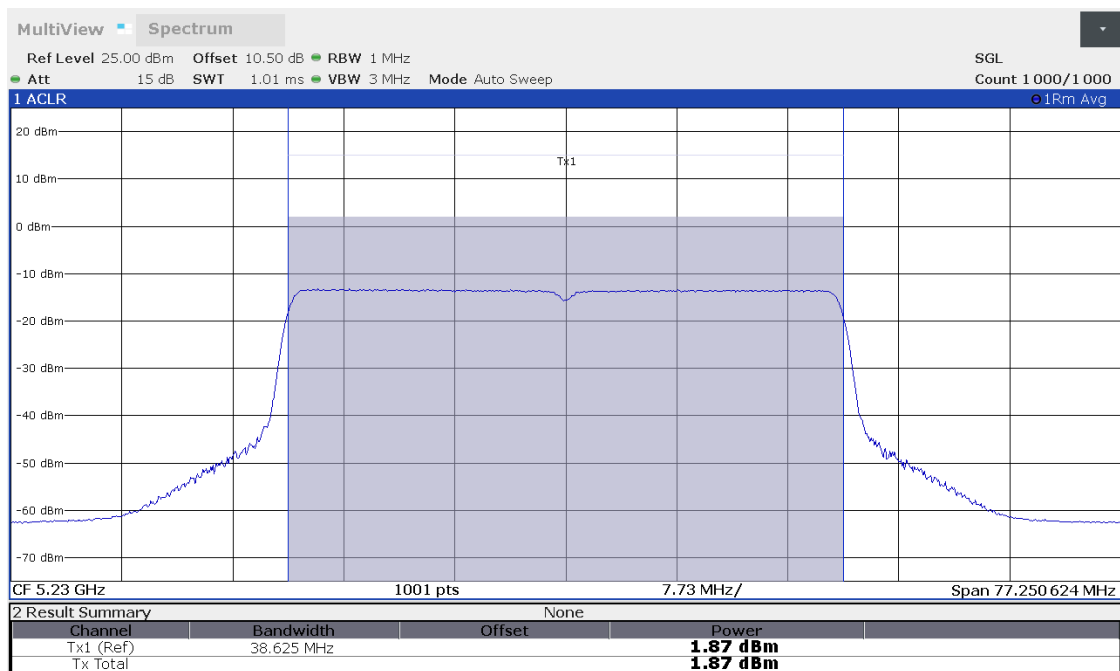
See [4] E 1) for details

5.6.4 Test results Maximum (Average) Conducted Output Power for ISED – 5150 – 5250 MHz

Ambient temperature:	21 – 22 °C
Relative humidity:	20 – 26%

Date	21.12.2021 – 06.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 39 – external antenna):



Operation mode	Reading Internal Ant [dBm]	Reading External Ant [dBm]	Ext. Att.* [dB]	DCCF [dB]	Antenna gain [dBi]	Result Corr. Ant. [dBm]	Limit* ² [dBm]
21	0.6	1.1	0.0	0.2	6.9	11.2	14.0
22	0.7	1.2	0.0	0.2	6.9	11.3	14.0
23	0.7	1.3	0.0	0.2	6.9	11.3	14.0
24	0.9	1.3	0.0	0.0	6.9	11.0	14.0
25	1.0	1.2	0.0	0.0	6.9	11.0	14.0
26	1.0	1.5	0.0	0.0	6.9	11.2	14.0
27	0.9	1.5	0.0	0.0	6.9	11.1	14.0
28	0.9	1.7	0.0	0.0	6.9	11.2	14.0
29	0.7	1.3	0.0	0.0	6.9	10.9	14.0
30	0.9	1.3	0.0	0.0	6.9	11.0	14.0
31	0.9	1.5	0.0	0.0	6.9	11.1	14.0
32	1.0	1.5	0.0	0.0	6.9	11.2	14.0
33	0.9	1.7	0.0	0.0	6.9	11.2	14.0
34	1.1	1.4	0.0	0.0	6.9	11.2	14.0
35	1.1	1.6	0.0	0.0	6.9	11.3	14.0
36	1.2	1.6	0.0	0.0	6.9	11.3	14.0
37	1.2	1.7	0.0	0.0	6.9	11.4	14.0
38	1.1	1.7	0.0	0.0	6.9	11.3	14.0
39	1.1	1.9	0.0	0.0	6.9	11.4	14.0
40	1.2	1.5	0.0	0.0	6.9	11.3	14.0

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

Calculations:

$$\text{Result Corr. Ant. [dBm]} = 10 \times \log_{10}(\text{Reading Internal Ant [mW]} + \text{Reading External Ant [mW]}) + 2 \times \text{DCCF} + \text{Antenna gain [dBi]}$$

See [4] E 1) for details

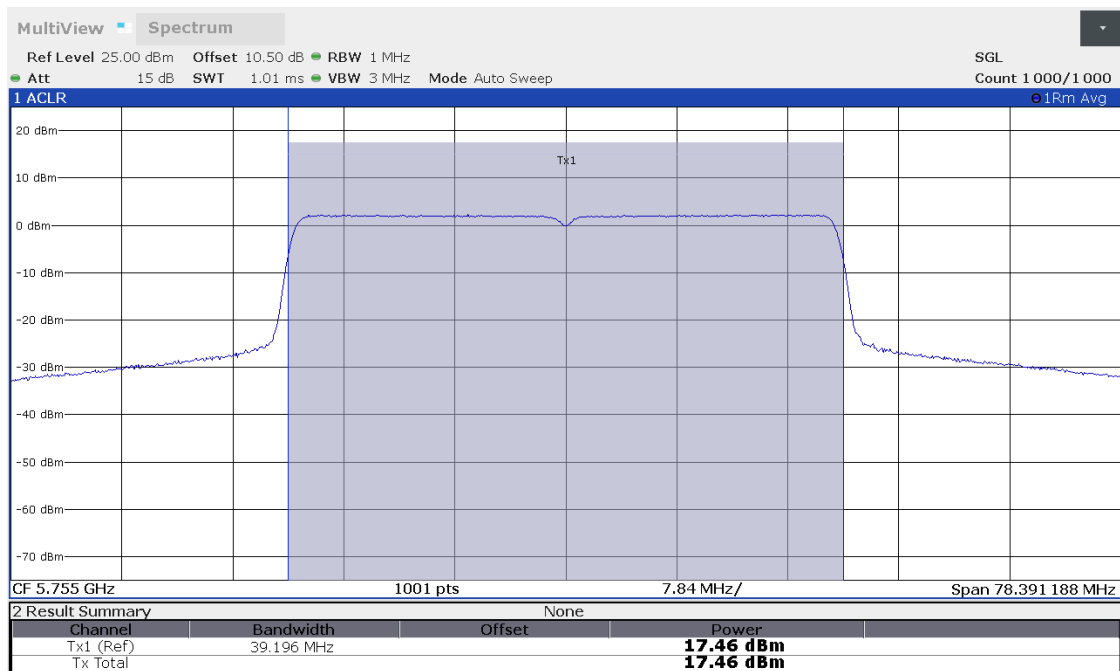
*² Limit acc. to [5]: "For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 log₁₀B, dBm, whichever is less."
Worst case (smallest OBW) was used to calculate the limit

5.6.5 Test results Maximum (Average) Conducted Output Power for FCC&ISED – 5725 – 5850 MHz

Ambient temperature:	21 – 22 °C
Relative humidity:	20 – 26%

Date	21.12.2021 – 06.01.2022
Tested by	P. NEUFELD

Worst case plot (operation mode 58 – internal antenna):



Operation mode	Reading Internal Ant [dBm]	Reading External Ant [dBm]	Ext. Att.* [dB]	DCCF [dB]	Result Corr. Ant. [dBm]	Limit* ² [dBm]
41	16.6	14.0	0.0	0.2	18.9	29.1
42	16.5	13.9	0.0	0.2	18.8	29.1
43	16.6	13.9	0.0	0.2	18.9	29.1
44	16.8	14.2	0.0	0.0	18.7	29.1
45	16.8	14.1	0.0	0.0	18.7	29.1
46	16.9	14.2	0.0	0.0	18.8	29.1
47	17.1	14.3	0.0	0.0	18.9	29.1
48	17.1	14.2	0.0	0.0	18.9	29.1
49	16.8	14.2	0.0	0.0	18.7	29.1
50	16.7	14.1	0.0	0.0	18.6	29.1
51	16.8	14.2	0.0	0.0	18.7	29.1
52	17.0	14.3	0.0	0.0	18.9	29.1
53	17.1	14.2	0.0	0.0	18.9	29.1
54	16.9	14.1	0.0	0.0	18.7	29.1
55	17.3	14.3	0.0	0.0	19.1	29.1
56	17.2	14.2	0.0	0.0	19.0	29.1
57	17.3	14.2	0.0	0.0	19.0	29.1
58	17.5	14.4	0.0	0.0	19.2	29.1
59	17.5	14.3	0.0	0.0	19.2	29.1
60	17.2	14.2	0.0	0.0	19.0	29.1

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

Calculations:

$$\text{Result Corr. Ant. [dBm]} = 10 \times \log_{10}(\text{Reading Internal Ant [mW]} + \text{Reading External Ant [mW]}) + 2 \times \text{DCCF}$$

See [4] E 1) for details

*²Limit = 30 dBm – 0.9 dB for Antenna gain correction, see Transmit Antenna Performance considerations for details

Test equipment (please refer to chapter 6 for details)
1 - 3

5.7 Maximum (average) Power Spectral Density

5.7.1 Test setup (Maximum (average) Power Spectral Density)

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-

5.7.2 Test method (Maximum (average) Power Spectral Density)

Test method (Maximum peak power spectral density level in the fundamental emission)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	II E 2. b)	Method SA-1	D ≥ 98% or video trigger	Peak Search*
<input type="checkbox"/>	II E 2. c)	Method SA-1A (alternative)	D ≥ 98%	Peak Search*
<input type="checkbox"/>	II E 2. d)	Method SA-2	Constant D (±2%)	Peak Search*
<input type="checkbox"/>	II E 2. e)	Method SA-2A (alternative)	Constant D (±2%)	Peak Search*
<input type="checkbox"/>	II E 2. f)	Method SA-3A	No limitations	Peak Search*
<input type="checkbox"/>	II E 2. g)	Method SA-3A (alternative)	No limitations	Peak Search*

* Use the peak search function on the instrument to find the peak of the spectrum and record its value.
(see II F 2 in document [3] for details.)

The result is the Maximum PSD over 1 MHz reference bandwidth.

For devices operating in the band 5.725–5.85 GHz, the rules specify a measurement bandwidth of 500 kHz.

5.7.3 Test results (Maximum (average) Power Spectral Density) for FCC - 5150 – 5250 MHz

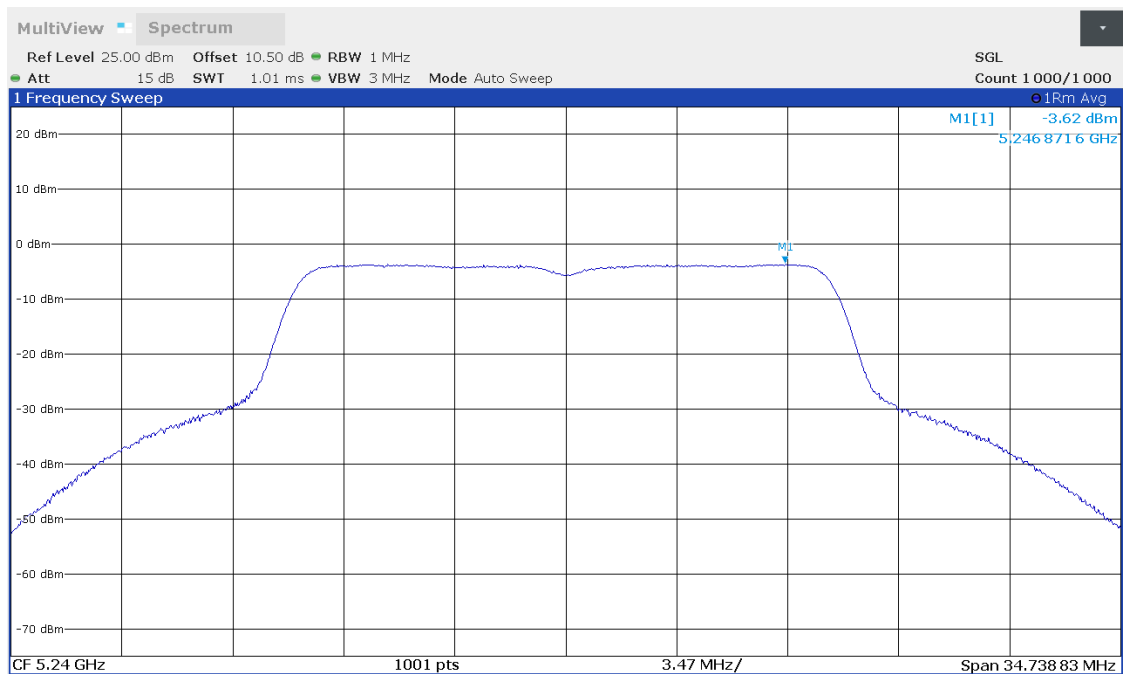
Ambient temperature:	22 °C
Relative humidity:	26 %

Date	06+07.01.2022
Tested by	P. NEUFELD

Calculations:

$$\text{Result [dBm/MHz]} = \text{Reading [dBm/MHz]} + \text{Correction 2 Antennas [dB]} + \text{Ext. Att [dB]} + \text{DCCF [dB]}$$

Worst case plot (operation mode 3):



Internal antenna

Operation mode	Reading [dBm/MHz]	Correction 2 Antennas [dB]	Ext. Att.* [dB]	DCCF [dB]	Result [dBm/MHz]	Limit conducted* ² [dBm/MHz]
1	-3.7	3.0	0.0	0.2	-0.5	10.1
2	-3.7	3.0	0.0	0.2	-0.5	10.1
3	-3.6	3.0	0.0	0.2	-0.4	10.1
4	-3.8	3.0	0.0	0.0	-0.8	10.1
5	-4.1	3.0	0.0	0.0	-1.1	10.1
6	-3.9	3.0	0.0	0.0	-0.9	10.1
7	-7.0	3.0	0.0	0.0	-4.0	10.1
8	-7.0	3.0	0.0	0.0	-4.0	10.1
9	-3.8	3.0	0.0	0.0	-0.8	10.1
10	-3.9	3.0	0.0	0.0	-0.9	10.1
11	-3.8	3.0	0.0	0.0	-0.8	10.1
12	-6.9	3.0	0.0	0.0	-3.9	10.1
13	-6.9	3.0	0.0	0.0	-3.9	10.1
14	-10.0	3.0	0.0	0.0	-7.0	10.1
15	-4.0	3.0	0.0	0.0	-1.0	10.1
16	-4.2	3.0	0.0	0.0	-1.2	10.1
17	-4.1	3.0	0.0	0.0	-1.1	10.1
18	-7.1	3.0	0.0	0.0	-4.1	10.1
19	-7.1	3.0	0.0	0.0	-4.1	10.1
20	-10.4	3.0	0.0	0.0	-7.4	10.1

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

*² Limit = 11 dBm/MHz – 0.9 dB for Antenna gain correction, see Transmit Antenna Performance considerations for details

External antenna

Operation mode	Reading [dBm/MHz]	Correction 2 Antennas [dB]	Ext. Att.* [dB]	DCCF [dB]	Result [dBm/MHz]	Limit conducted* ² [dBm/MHz]
1	-4.2	3.0	0.0	0.2	-1.0	10.1
2	-4.3	3.0	0.0	0.2	-1.1	10.1
3	-4.3	3.0	0.0	0.2	-1.1	10.1
4	-4.7	3.0	0.0	0.0	-1.7	10.1
5	-4.8	3.0	0.0	0.0	-1.8	10.1
6	-4.8	3.0	0.0	0.0	-1.8	10.1
7	-7.9	3.0	0.0	0.0	-4.9	10.1
8	-7.7	3.0	0.0	0.0	-4.7	10.1
9	-4.4	3.0	0.0	0.0	-1.4	10.1
10	-4.5	3.0	0.0	0.0	-1.5	10.1
11	-4.5	3.0	0.0	0.0	-1.5	10.1
12	-7.9	3.0	0.0	0.0	-4.9	10.1
13	-7.8	3.0	0.0	0.0	-4.8	10.1
14	-11.1	3.0	0.0	0.0	-8.1	10.1
15	-4.8	3.0	0.0	0.0	-1.8	10.1
16	-4.9	3.0	0.0	0.0	-1.9	10.1
17	-4.8	3.0	0.0	0.0	-1.8	10.1
18	-8.0	3.0	0.0	0.0	-5.0	10.1
19	-7.9	3.0	0.0	0.0	-4.9	10.1
20	-11.5	3.0	0.0	0.0	-8.5	10.1

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

*² Limit = 11 dBm/MHz – 0.9 dB for Antenna correction, see Transmit Antenna Performance considerations for details

Test: Passed

5.7.4 Test results (Maximum (average) Power Spectral Density) for ISED – 5150 – 5250 MHz

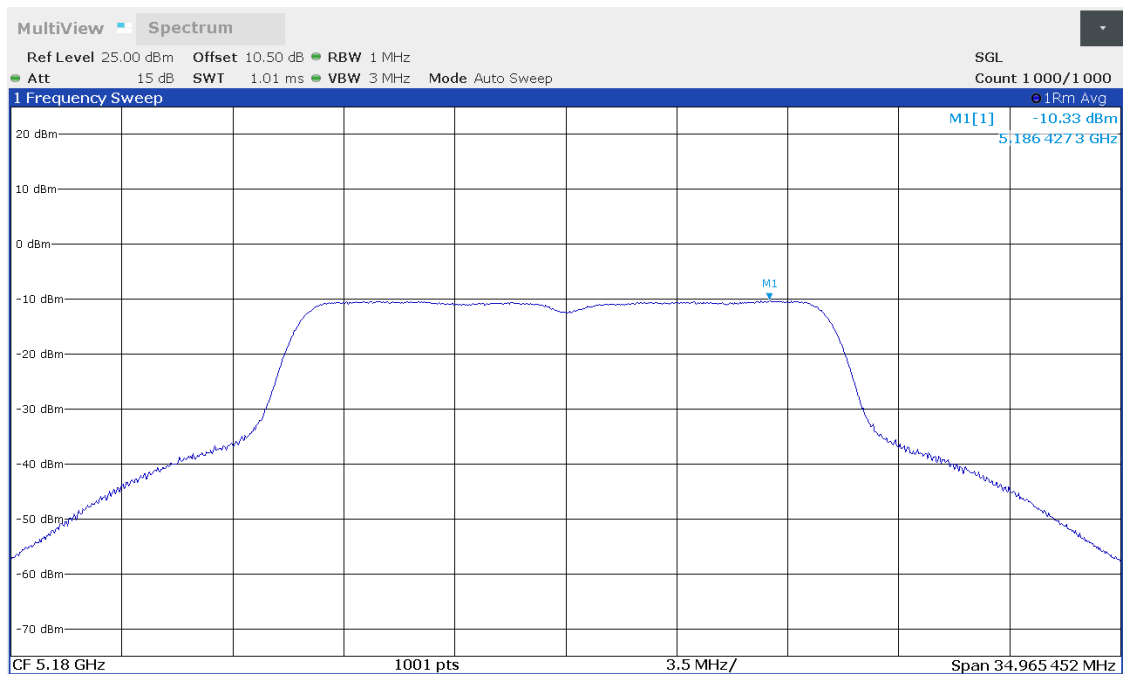
Ambient temperature:	22 °C
Relative humidity:	26 %

Date	06+07.01.2022
Tested by	P. NEUFELD

Calculations:

Result [dBm/MHz]= Reading [dBm/MHz] + Correction 2 Antennas [dB]
+ Ext. Att [dB] + DCCF [dB] + Antenna gain [dBi]

Worst case plot (operation mode 21):



Internal antenna

Operation mode	Reading [dBm/MHz]	Correction 2 Antennas [dB]	Ext. Att.* [dB]	DCCF [dB]	Antenna gain [dBi]	Result [dBm/MHz]	Limit EIRP [dBm/MHz]
21	-10.8	3.0	0.0	0.2	6.9	-0.7	10.0
22	-10.7	3.0	0.0	0.2	6.9	-0.6	10.0
23	-10.8	3.0	0.0	0.2	6.9	-0.7	10.0
24	-10.9	3.0	0.0	0.0	6.9	-1.0	10.0
25	-10.7	3.0	0.0	0.0	6.9	-0.8	10.0
26	-10.7	3.0	0.0	0.0	6.9	-0.8	10.0
27	-14.0	3.0	0.0	0.0	6.9	-4.1	10.0
28	-13.9	3.0	0.0	0.0	6.9	-4.0	10.0
29	-11.0	3.0	0.0	0.0	6.9	-1.1	10.0
30	-10.9	3.0	0.0	0.0	6.9	-1.0	10.0
31	-10.8	3.0	0.0	0.0	6.9	-0.9	10.0
32	-13.9	3.0	0.0	0.0	6.9	-4.0	10.0
33	-14.0	3.0	0.0	0.0	6.9	-4.1	10.0
34	-16.6	3.0	0.0	0.0	6.9	-6.7	10.0
35	-10.9	3.0	0.0	0.0	6.9	-1.0	10.0
36	-10.7	3.0	0.0	0.0	6.9	-0.8	10.0
37	-10.8	3.0	0.0	0.0	6.9	-0.9	10.0
38	-14.0	3.0	0.0	0.0	6.9	-4.1	10.0
39	-13.9	3.0	0.0	0.0	6.9	-4.0	10.0
40	-17.0	3.0	0.0	0.0	6.9	-7.1	10.0

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

Internal antenna

Operation mode	Reading [dBm/MHz]	Correction 2 Antennas [dB]	Ext. Att.* [dB]	DCCF [dB]	Antenna gain [dBi]	Result [dBm/MHz]	Limit EIRP [dBm/MHz]
21	-10.3	3.0	0.0	0.2	6.9	-0.2	10.0
22	-10.3	3.0	0.0	0.2	6.9	-0.2	10.0
23	-10.2	3.0	0.0	0.2	6.9	-0.1	10.0
24	-10.5	3.0	0.0	0.0	6.9	-0.6	10.0
25	-10.6	3.0	0.0	0.0	6.9	-0.7	10.0
26	-10.3	3.0	0.0	0.0	6.9	-0.4	10.0
27	-13.4	3.0	0.0	0.0	6.9	-3.5	10.0
28	-13.2	3.0	0.0	0.0	6.9	-3.3	10.0
29	-10.5	3.0	0.0	0.0	6.9	-0.6	10.0
30	-10.5	3.0	0.0	0.0	6.9	-0.6	10.0
31	-10.3	3.0	0.0	0.0	6.9	-0.4	10.0
32	-13.4	3.0	0.0	0.0	6.9	-3.5	10.0
33	-13.2	3.0	0.0	0.0	6.9	-3.3	10.0
34	-16.3	3.0	0.0	0.0	6.9	-6.4	10.0
35	-10.5	3.0	0.0	0.0	6.9	-0.6	10.0
36	-10.5	3.0	0.0	0.0	6.9	-0.6	10.0
37	-10.3	3.0	0.0	0.0	6.9	-0.4	10.0
38	-13.5	3.0	0.0	0.0	6.9	-3.6	10.0
39	-13.2	3.0	0.0	0.0	6.9	-3.3	10.0
40	-16.8	3.0	0.0	0.0	6.9	-6.9	10.0

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

Test: Passed

5.7.5 Test results (Maximum (average) Power Spectral Density) for FCC&ISED – 5725 – 5850 MHz

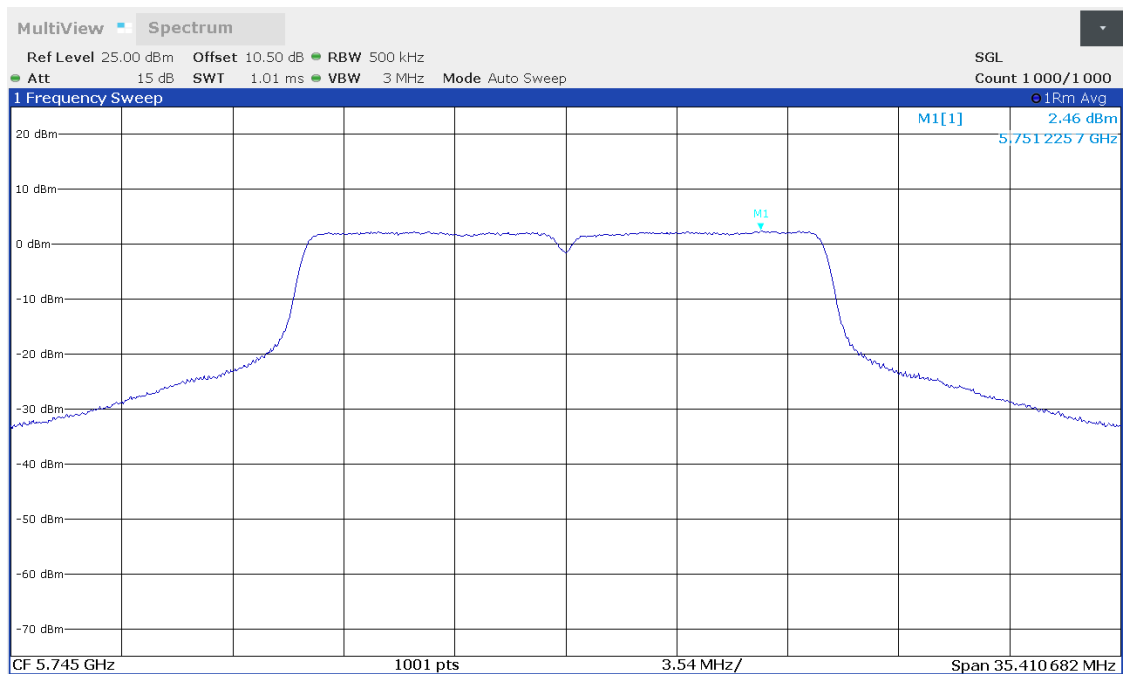
Ambient temperature:	22 °C
Relative humidity:	26 %

Date	06+07.01.2022
Tested by	P. NEUFELD

Calculations:

$$\text{Result [dBm/MHz]} = \text{Reading [dBm/MHz]} + \text{Correction 2 Antennas [dB]} + \text{Ext. Att [dB]} + \text{DCCF [dB]}$$

Worst case plot (operation mode 41):



Internal antenna

Operation mode	Reading [dBm/500kHz]	Correction 2 Antennas [dB]	Ext. Att.* [dB]	DCCF [dB]	Result [dBm/500kHz]	Limit conducted* ² [dBm/500kHz]
41	2.5	3.0	0.0	0.2	5.7	29.1
42	2.2	3.0	0.0	0.2	5.4	29.1
43	2.3	3.0	0.0	0.2	5.5	29.1
44	2.0	3.0	0.0	0.0	5.0	29.1
45	2.2	3.0	0.0	0.0	5.2	29.1
46	2.1	3.0	0.0	0.0	5.1	29.1
47	-0.9	3.0	0.0	0.0	2.1	29.1
48	-0.7	3.0	0.0	0.0	2.3	29.1
49	1.9	3.0	0.0	0.0	4.9	29.1
50	1.9	3.0	0.0	0.0	4.9	29.1
51	2.1	3.0	0.0	0.0	5.1	29.1
52	-0.8	3.0	0.0	0.0	2.2	29.1
53	-0.7	3.0	0.0	0.0	2.3	29.1
54	-3.2	3.0	0.0	0.0	-0.2	29.1
55	2.3	3.0	0.0	0.0	5.3	29.1
56	2.2	3.0	0.0	0.0	5.2	29.1
57	2.2	3.0	0.0	0.0	5.2	29.1
58	-0.7	3.0	0.0	0.0	2.3	29.1
59	-0.7	3.0	0.0	0.0	2.3	29.1
60	-3.9	3.0	0.0	0.0	-0.9	29.1

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

*² Limit = 30 dBm/MHz – 0.9 dB for Antenna correction, see Transmit Antenna Performance considerations for details

External antenna

Operation mode	Reading [dBm/500kHz]	Correction 2 Antennas [dB]	Ext. Att.* [dB]	DCCF [dB]	Result [dBm/500kHz]	Limit conducted* ² [dBm/500kHz]
41	-0.5	3.0	0.0	0.2	2.7	10.1
42	-0.4	3.0	0.0	0.2	2.8	10.1
43	-0.4	3.0	0.0	0.2	2.8	10.1
44	-0.5	3.0	0.0	0.0	2.5	10.1
45	-0.7	3.0	0.0	0.0	2.3	10.1
46	-0.6	3.0	0.0	0.0	2.4	10.1
47	-3.5	3.0	0.0	0.0	-0.5	10.1
48	-3.7	3.0	0.0	0.0	-0.7	10.1
49	-0.5	3.0	0.0	0.0	2.5	10.1
50	-0.7	3.0	0.0	0.0	2.3	10.1
51	-0.5	3.0	0.0	0.0	2.5	10.1
52	-3.6	3.0	0.0	0.0	-0.6	10.1
53	-3.6	3.0	0.0	0.0	-0.6	10.1
54	-6.7	3.0	0.0	0.0	-3.7	10.1
55	-0.7	3.0	0.0	0.0	2.3	10.1
56	-0.8	3.0	0.0	0.0	2.2	10.1
57	-0.7	3.0	0.0	0.0	2.3	10.1
58	-3.8	3.0	0.0	0.0	-0.8	10.1
59	-3.7	3.0	0.0	0.0	-0.7	10.1
60	-7.1	3.0	0.0	0.0	-4.1	10.1

* The external attenuation is already taken into account with the reference 10.5 dB level offset in the spectrum analyzer plot, which represents the attenuation of the 10 dB external attenuator and the measurement cable.

*² Limit = 30 dBm/MHz – 0.9 dB for Antenna correction, see Transmit Antenna Performance considerations for details

Test: Passed

Test equipment (please refer to chapter 6 for details)
1 - 3

5.1 Band edge

5.1.1 Test setup (Band edge – unrestricted bands)

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input checked="" type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-

*1 Only worst-case modes from the antenna port conducted pretests were tested as radiated tests.

5.1.2 Test method (Band edge – unrestricted bands)

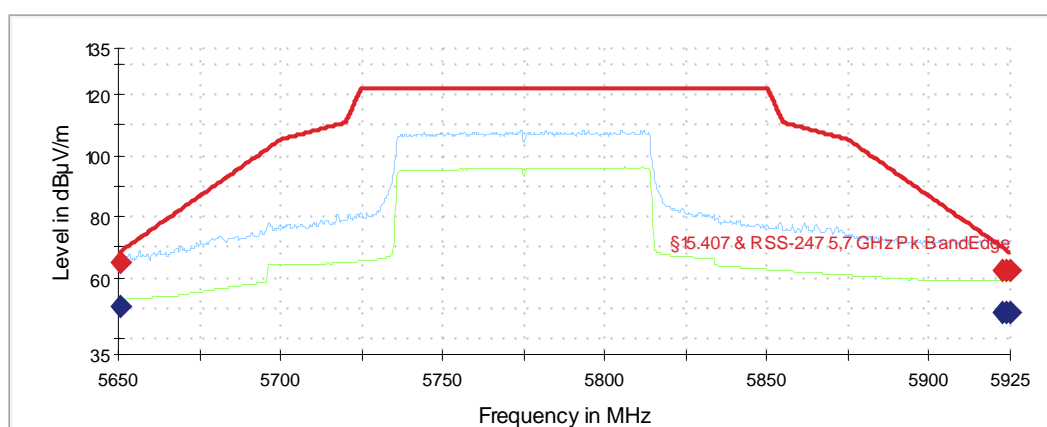
Test method (Band edge – unrestricted bands)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	II G 2, 3 & 5.	Unwanted emissions outside restricted bands	No limitations	-

5.1.3 Test results (Band edge – unrestricted bands) for FCC&ISED – 5725 – 5850 MHz

Ambient temperature:	21 °C
Relative humidity:	19 %

Date	22.12.2021
Tested by	P. NEUFELD

Worst case plot (operation mode 60):



— Preview Result 2-AVG
— §15.407 & RSS-247 5,7 GHz Pk BandEdge
— Preview Result 1-PK+
◆ Final_Result PK+

Lower+ upper band edge (operation mode 54):

Operation mode #	Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB/m]
54	5650.000	---	46.47	---	---	H	237.0	30.0	42.1
54	5650.000	60.83	---	68.20	7.37	H	237.0	30.0	42.1
54	5654.000	---	47.45	---	---	H	242.0	30.0	42.1
54	5654.000	62.55	---	71.16	8.61	H	242.0	30.0	42.1
-	-	-	-	-	-	-	-	-	-
54	5923.250	---	48.24	---	---	H	268.0	0.0	42.8
54	5923.250	61.31	---	69.50	8.18	H	268.0	0.0	42.8
54	5925.000	---	48.26	---	---	H	298.0	150.0	42.8
54	5925.000	61.43	---	68.20	6.77	H	298.0	150.0	42.8

Lower+ upper band edge (operation mode 60):

Operation mode #	Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB/m]
60	5650.500	---	50.48	---	---	H	242.0	30.0	42.1
60	5650.500	64.98	---	68.57	3.59	H	242.0	30.0	42.1
-	-	-	-	-	-	-	-	-	-
60	5922.500	---	48.92	---	---	H	323.0	150.0	42.8
60	5922.500	62.26	---	70.05	7.79	H	323.0	150.0	42.8
60	5923.750	---	48.86	---	---	H	260.0	30.0	42.8
60	5923.750	62.24	---	69.13	6.89	H	260.0	30.0	42.8
60	5924.750	---	49.05	---	---	H	257.0	0.0	42.8
60	5924.750	62.64	---	68.39	5.75	H	257.0	0.0	42.8

Test equipment (please refer to chapter 6 for details)

4 - 12

5.1.4 Test setup (Band edge – restricted bands)

Test setup			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	-
<input checked="" type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	-
<input type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	-

5.1.5 Test method (Band edge – restricted bands)

Test method (Band edge – restricted bands)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	II G 1 & 3 - 6	Unwanted Emissions in the restricted bands	No limitations	-

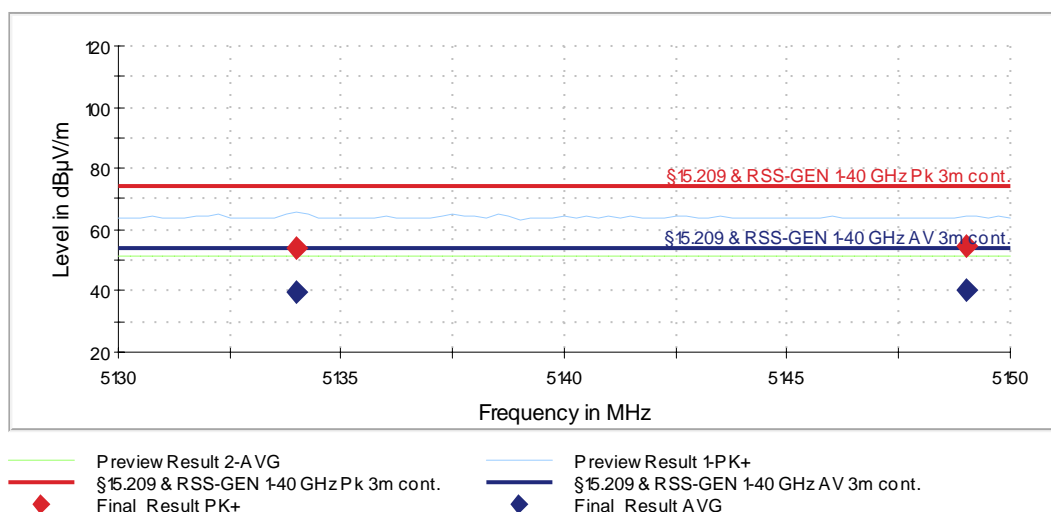
5.1.6 Test results (Band edge – restricted bands) for FCC - 5150 – 5250 MHz*

Ambient temperature:	22 °C
Relative humidity:	42 %

Date	15.12.2021
Tested by	P. NEUFELD

* The tests in this band-edge were only performed for FCC power settings, because test with the highest output power settings result in the worst case for the tests.

Worst case plot (operation mode 20):



Only the worst-case emissions from the antenna port conducted pre-tests were repeated as radiated tests.

Lower band edge (operation mode 20):

The peak limit is set to -27 dBm (68.3 dB μ V/m). Since if the stricter unrestricted peak limit is passed for all frequencies, the peak limit for restricted bands (74 dB μ V/m) is also fulfilled.

Operation mode #	Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB/m]
20	5134.000	---	39.44	54.00	14.56	V	20.0	60.0	40.7
20	5134.000	54.28	---	68.30	14.02	V	20.0	60.0	40.7
20	5149.000	---	40.35	54.00	13.65	H	257.0	150.0	40.8
20	5149.000	54.77	---	68.30	13.53	H	257.0	150.0	40.8

Test equipment (please refer to chapter 6 for details)

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5.2 Maximum unwanted emissions

5.2.1 Test setup (Maximum unwanted emissions)

Test setup			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	f < 1 GHz
<input type="checkbox"/>	Test setup (radiated – normal procedure)	5.1.1.4	f > 1 GHz
<input checked="" type="checkbox"/>	Test setup (radiated – alternative procedure)	5.1.1.5	f > 1 GHz
<input type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	No limitations

5.2.2 Test method (Maximum unwanted emissions)

Test method				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	II G 2, 3 & 5.	Unwanted emissions outside restricted bands	No limitations	-
<input checked="" type="checkbox"/>	II G 1 & 3 - 6	Unwanted Emissions in the restricted bands	No limitations	-

5.2.3 Test results (Maximum unwanted emissions)

5.2.3.1 Test results (9 kHz – 30 MHz)

Ambient temperature:	22 °C
Relative humidity:	28 %

Date	13.01.2022
Tested by	P. NEUFELD

Position of EUT: For tests for f between 9 kHz to 30 MHz, 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: The measurement value was already corrected by 40 dB/decade as described in 47 CFR 15.31(f)(2) regarding to the measurement distance as requested in 47 CFR 15.209(a)

Remark: All 3 orthogonal planes were tested separately

Calculations:

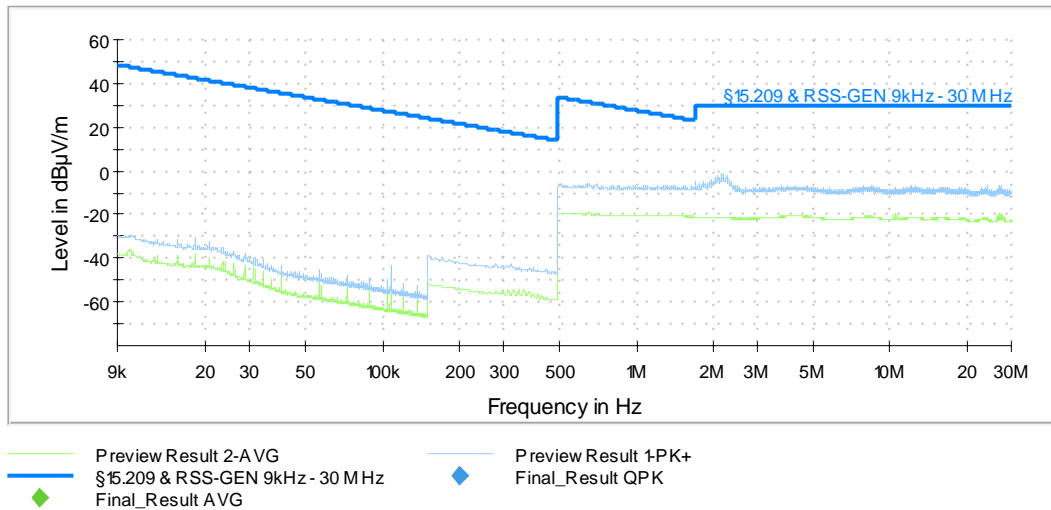
Result @ norm. dist. [dB μ V/m] = Reading [dB μ V] + AF [dB/m] + Distance corr. fact. [dB μ V/m]

Result @ norm. dist. [dB μ A/m] = Result @ norm. dist. [dB μ V/m] – 20 x log₁₀(377 Ω)

Margin [dB] = Limit [dB(μ V| μ A)/m] - Result [dB(μ V| μ A)/m]

Worst case plot:

Spurious emissions from 9 kHz to 30 MHz (operation mode 42 - Pos 3):



Remark: No emissions close than 20 dB to the limit, so no final measurement will be carried out.

Test equipment (please refer to chapter 6 for details)

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5.2.3.2 Test results (30 MHz – 1 GHz)

Ambient temperature:	22 °C
Relative humidity:	25 – 28 %

Date	11.01.2022 - 13.01.2022
Tested by	P. NEUFELD

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: All 3 orthogonal planes were tested separately

Calculations:

Result [dB μ V/m] = Reading [dB μ V] + Correction [dB μ V/m]

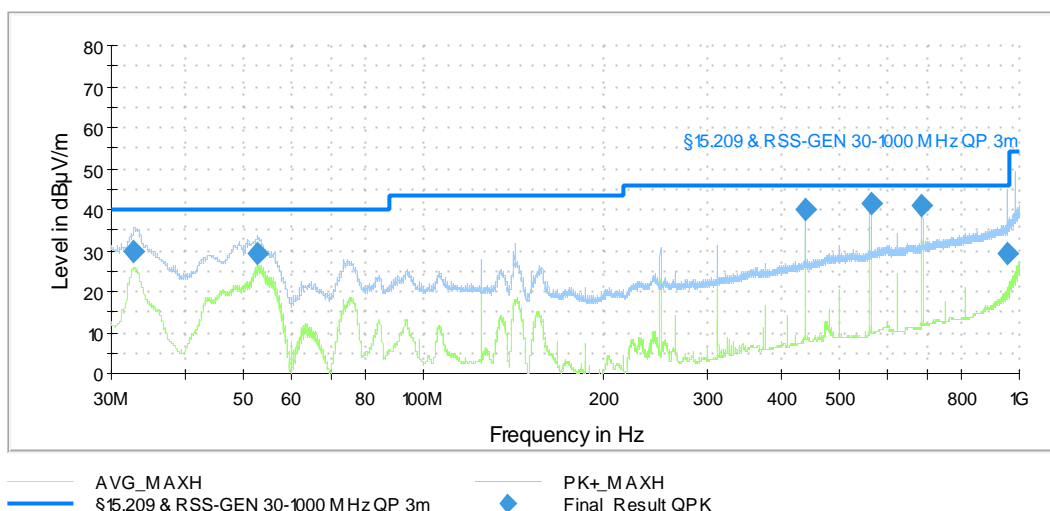
Correction [dB μ V/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]

Margin [dB] = Limit [dB μ V/m] - Result [dB μ V/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 42 – Pos 2):



Result tables

(operation mode 9):

Frequency [MHz]	Result (QP) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
36.360	31.6	40.0	8.4	9.3	22.3	102.0	-11	V	1
53.140	31.7	40.0	8.3	19.2	12.5	105.0	103	V	1
250.000	31.6	46.0	14.4	14.3	17.3	102.0	300	V	1
437.500	30.4	46.0	15.6	7.7	22.7	102.0	52	V	1
562.490	34.5	46.0	11.5	9.1	25.4	108.0	-4	V	1
687.490	40.0	46.0	6.0	12.9	27.1	102.0	157	V	1

(operation mode 2):

Frequency [MHz]	Result (QP) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
33.150	29.5	40.0	10.5	5.4	24.1	105.0	202	V	2
50.900	27.3	40.0	12.7	13.9	13.4	136.0	75	V	2
125.000	26.0	43.5	17.5	8.8	17.2	112.0	156	V	2
437.500	40.1	46.0	5.9	17.4	22.7	101.0	187	V	2
562.490	41.4	46.0	4.4	16.0	25.4	103.0	-2	V	2
687.490	40.4	46.0	5.6	13.3	27.1	168.0	287	H	2

(operation mode 7):

Frequency [MHz]	Result (QP) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
36.300	32.4	40.0	7.6	10.1	22.3	102.0	24	V	3
53.820	32.1	40.0	7.9	19.8	12.3	103.0	139	V	3
562.490	37.4	46.0	8.6	12.0	25.4	164.0	35	V	3
624.990	37.7	46.0	8.3	11.4	26.3	102.0	-17	V	3
687.490	39.1	46.0	6.9	12.0	27.1	118.0	23	V	3

(operation mode 52):

Frequency [MHz]	Result (QP) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
35.960	34.7	40.0	5.3	12.2	22.5	103.0	6	V	1
437.500	36.7	46.0	9.3	14.0	22.7	119.0	207	V	1
562.490	36.0	46.0	10.0	10.6	25.4	125.0	98	V	1
624.990	36.5	46.0	9.5	10.2	26.3	105.0	331	V	1
687.490	40.9	46.0	5.1	13.8	27.1	101.0	137	V	1

(operation mode 42):

Frequency [MHz]	Result (QP) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
32.700	29.9	40.0	10.1	5.5	24.4	100.0	-6	V	2
52.810	29.5	40.0	10.5	16.9	12.6	105.0	68	V	2
437.500	39.8	46.0	6.2	17.1	22.7	108.0	190	V	2
562.490	41.6	46.0	4.4	16.2	25.4	102.0	-2	V	2
687.490	40.9	46.0	5.1	13.8	27.1	100.0	157	V	2
956.270	29.2	46.0	16.8	-1.1	30.3	135.0	116	H	2

(operation mode 43):

Frequency [MHz]	Result (QP) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)	Position #
36.570	31.9	40.0	8.1	9.8	22.1	103.0	-10	V	3
53.930	32.0	40.0	8.0	19.7	12.3	106.0	160	V	3
125.000	31.9	43.5	11.6	14.7	17.2	107.0	200	V	3
562.490	36.8	46.0	9.2	11.4	25.4	157.0	22	V	3
687.490	40.4	46.0	5.6	13.3	27.1	103.0	24	V	3
984.330	30.9	54.0	23.1	0.1	30.8	148.0	114	V	3

Test result: Passed

Test equipment (please refer to chapter 6 for details)
20 - 28

5.2.3.3 Test results (above 1 GHz)

Ambient temperature:	21 - 22°C
Relative humidity:	20 – 32 %

Date	22.12.2021 - 17.01.2022
Tested by	P. NEUFELD

- 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:** For the frequency range 5.15 – 5.25 GHz, only the worst-case emissions from the antenna port conducted pre-tests were tested in the radiated tests, namely 802.11ax40 modulation.
In the frequency range 5.725 – 5.85 GHz, no spurious emissions were found in the antenna port conducted pre-tests. Therefore the emission with the highest PSD result was tested during the radiated measurements, namely the 802.11a modulation.
- The peak limit is set to -27 dBm (68.3 dB μ V/m). Since if the stricter unrestricted peak limit is passed for all frequencies, the peak limit for restricted bands (74 dB μ V/m) is also fulfilled.

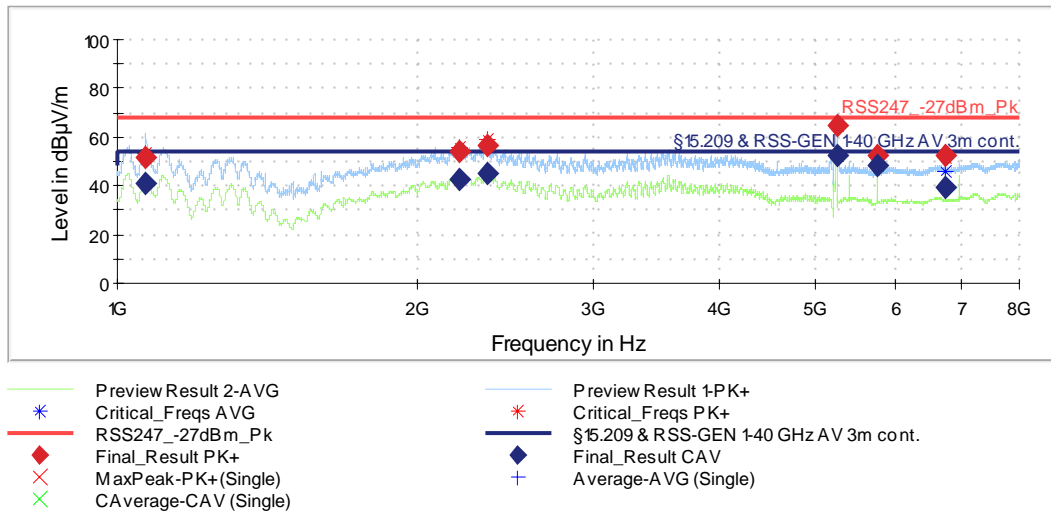
Calculation:

- Max Peak [dB μ V/m] = Reading (Pk+) [dB μ V] + Correction [dB μ V/m]
- Average [dB μ V/m] = Reading (Av) [dB μ V] + Correction [dB μ V/m]
- Correction [dB μ V/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 [dB μ V/m] – Max Peak | Average [dB μ V/m]

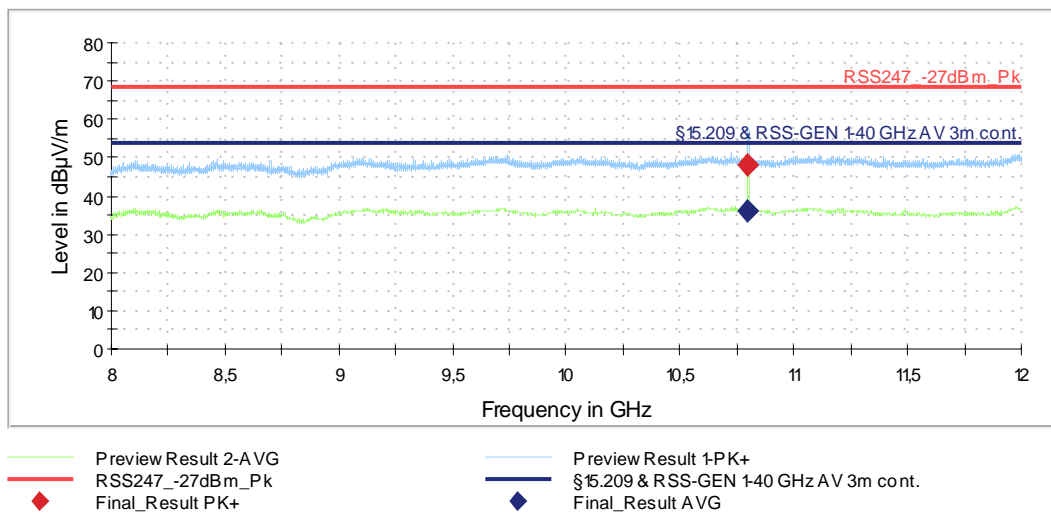
The curves in the diagram only represent the maximum measured value for each frequency point of all preliminary measurements, which were carried out with various EUT and antenna positions. The top measured curve represents the peak measurement. The measured points marked with "◆" are frequency points for the final peak detector measurement. These values are indicated in the following table. The bottom measured curve represents the average measurement. The measured points marked with "◆" are frequency points for the final average detector measurement.

Worst case plots WLAN:

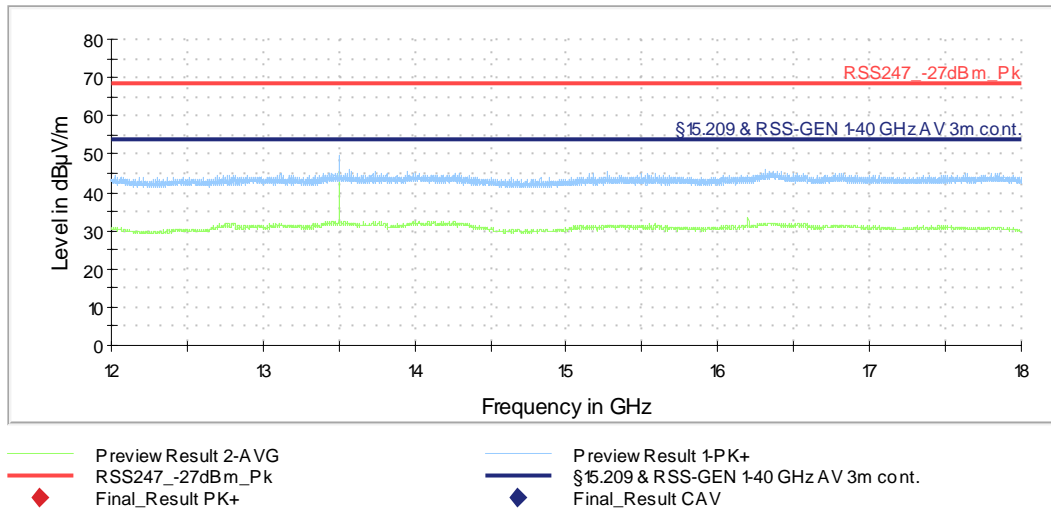
Spurious emissions from 1 GHz to 8 GHz (operation mode 19):



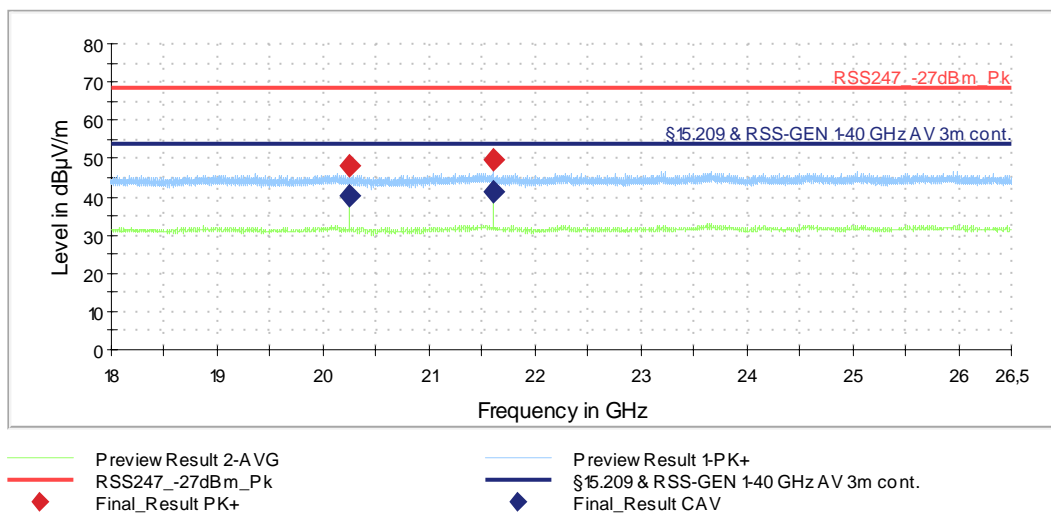
Spurious emissions from 8 GHz to 12 GHz (operation mode 41):



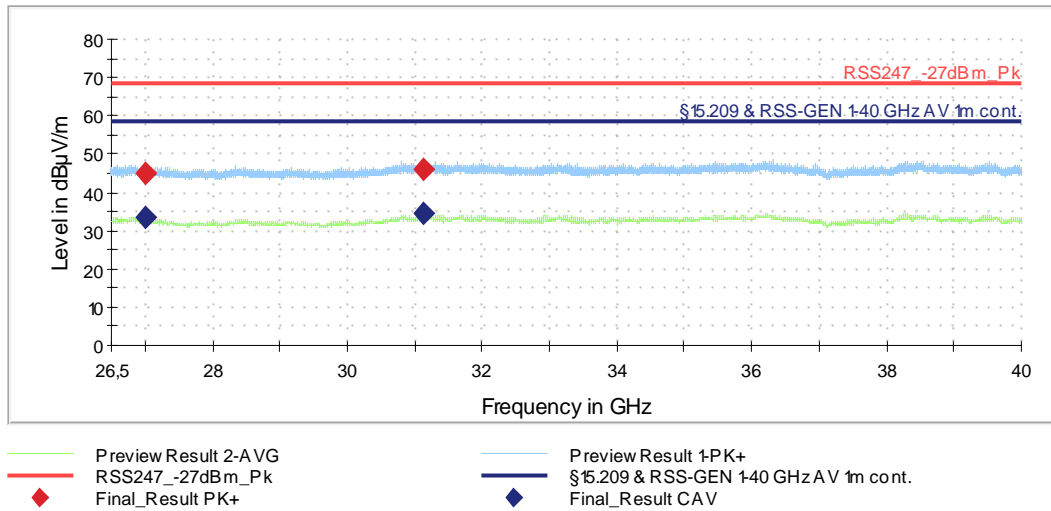
Spurious emissions from 12 GHz to 18 GHz (operation mode 42):



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



Spurious emissions from 26.5 GHz to 40 GHz (operation mode 18):



5.2.3.3.1 Result tables

Operation mode 18:

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Corr. [dB/m]	Elevation [deg]	Azimuth [deg]	Pol
2081.250	---	41.13	54.00	12.87	-11.1	0.0	72.0	H
2081.250	50.19	---	68.30	18.11	-11.1	150.0	112.0	V
2350.250	---	46.55	54.00	7.45	-9.9	0.0	74.0	H
2350.250	56.42	---	68.30	11.88	-9.9	0.0	76.0	H
3375.000	---	39.58	54.00	14.42	-5.8	30.0	85.0	H
3375.000	50.59	---	68.30	17.71	-5.8	0.0	17.0	V
5171.500	55.58	---	68.30	12.72	-1.0	0.0	282.0	H
5171.500	---	44.03	54.00	9.97	-1.0	0.0	286.0	H
5400.000	50.04	---	68.30	18.26	-0.2	30.0	346.0	V
5400.000	---	43.63	54.00	10.37	-0.2	30.0	353.0	V
5760.000	---	48.54	54.00	5.46	1.1	0.0	251.0	H
5760.000	52.21	---	68.30	16.09	1.1	0.0	252.0	H
10800.000	---	41.94	54.00	12.06	7.2	30.0	11.0	V
10800.000	51.33	---	68.30	16.97	7.2	30.0	11.0	V
13500.000	---	44.42	54.00	9.58	10.7	30.0	351.0	H
13500.000	48.88	---	68.30	19.42	10.7	30.0	351.0	H
20249.750	47.95	---	68.30	20.35	4.6	150.0	211.0	V
20249.750	---	40.10	54.00	13.90	4.6	150.0	211.0	V
21599.750	49.71	---	68.30	18.59	5.3	150.0	165.0	V
21599.750	---	41.48	54.00	12.52	5.3	150.0	165.0	V
26999.750	---	33.39	54.00	20.61	4.6	0.0	22.0	H
26999.750	44.79	---	68.30	23.51	4.6	0.0	22.0	H
31139.750	---	34.53	54.00	19.47	7.4	0.0	251.0	V
31139.750	45.97	---	68.30	22.33	7.4	0.0	251.0	V

Operation mode 19:

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Corr. [dB/m]	Elevation [deg]	Azimuth [deg]	Pol
1068.750	---	40.66	54.00	13.34	-16.8	90.0	139.0	V
1068.750	51.46	---	68.30	16.84	-16.8	90.0	139.0	V
2204.750	---	42.33	54.00	11.67	-10.4	30.0	76.0	H
2204.750	54.03	---	68.30	14.27	-10.4	30.0	76.0	H
2344.250	---	45.47	54.00	8.53	-10.0	0.0	72.0	H
2344.250	56.39	---	68.30	11.91	-10.0	0.0	72.0	H
5248.500	64.56	---	68.30	3.74	-0.6	0.0	269.0	H
5248.500	---	52.15	54.00	1.85	-0.6	0.0	269.0	H
5760.000	---	48.32	54.00	5.68	1.1	0.0	252.0	H
5760.000	52.15	---	68.30	16.15	1.1	0.0	252.0	H
6750.000	52.35	---	68.30	15.95	3.4	30.0	-4.0	V
6750.000	---	39.07	54.00	14.93	3.4	30.0	-4.0	V
10800.000	---	50.98	54.00	3.02	7.2	30.0	2.0	V
10800.000	55.86	---	68.30	12.44	7.2	30.0	2.0	V
13500.000	---	32.22	54.00	21.78	10.7	30.0	343.0	H
13500.000	43.37	---	68.30	24.93	10.7	30.0	343.0	H
20249.750	47.63	---	68.30	20.67	4.6	150.0	216.0	V
20249.750	---	33.27	54.00	20.73	4.6	150.0	216.0	V
21599.750	46.96	---	68.30	21.34	5.3	150.0	166.0	V
21599.750	---	37.14	54.00	16.86	5.3	150.0	166.0	V
26999.750	---	32.48	54.00	21.52	4.6	0.0	25.0	H
26999.750	46.33	---	68.30	21.97	4.6	0.0	25.0	H

Operation mode 41:

Frequency [MHz]	MaxPeak [dBµV/m]	Average [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Corr. [dB/m]	Elevation [deg]	Azimuth [deg]	Pol
1022.500	59.42	---	68.30	8.88	24.7	150.0	155.0	H
1022.500	---	48.22	54.00	5.78	24.7	150.0	155.0	H
1065.500	59.59	---	68.30	8.71	25.3	0.0	157.0	H
1065.500	---	48.37	54.00	5.63	25.3	0.0	157.0	H
2081.250	49.13	---	68.30	19.17	31.9	30.0	74.0	V
2081.250	---	36.74	54.00	17.26	31.9	30.0	74.0	V
2205.250	---	46.61	54.00	7.39	32.6	60.0	156.0	V
2205.250	57.62	---	68.30	10.68	32.6	60.0	156.0	V
3980.500	53.97	---	68.30	14.33	38.3	150.0	240.0	H
3980.500	---	40.11	54.00	13.89	38.3	150.0	240.0	H
10800.000	---	36.10	54.00	17.90	7.2	60.0	95.0	V
10800.000	47.93	---	68.30	20.37	7.2	60.0	95.0	V
13500.000	---	45.27	54.00	8.73	10.7	0.0	72.0	H
13500.000	49.46	---	68.30	18.84	10.7	0.0	72.0	H

Operation mode 42:

Frequency [MHz]	MaxPeak [dBµV/m]	Average [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Corr. [dB/m]	Elevation [deg]	Azimuth [deg]	Pol
1022.000	59.75	---	68.30	8.55	24.7	150.0	153.0	H
1022.000	---	47.76	54.00	6.24	24.7	150.0	153.0	H
1069.750	57.09	---	68.30	11.21	25.5	0.0	164.0	H
1069.750	---	46.54	54.00	7.46	25.5	0.0	164.0	H
1113.000	53.68	---	68.30	14.62	25.1	30.0	136.0	H
1113.000	---	41.86	54.00	12.14	25.1	30.0	136.0	H
2025.000	---	40.14	54.00	13.86	31.5	60.0	121.0	H
2025.000	51.38	---	68.30	16.92	31.5	60.0	121.0	H
2205.250	57.70	---	68.30	10.60	32.6	90.0	157.0	V
2205.250	---	46.38	54.00	7.62	32.6	90.0	157.0	V
2846.250	48.56	---	68.30	19.74	35.7	60.0	227.0	V
2846.250	---	33.90	54.00	20.10	35.7	60.0	227.0	V
3985.250	---	40.27	54.00	13.73	38.3	30.0	148.0	H
3985.250	54.35	---	68.30	13.95	38.3	30.0	148.0	H
7979.500	59.61	---	68.30	8.69	46.5	150.0	2.0	H
7979.500	---	47.47	54.00	6.53	46.5	150.0	2.0	H
10800.000	---	52.88	54.00	1.12	7.2	60.0	82.0	V
10800.000	56.87	---	68.30	11.43	7.2	60.0	82.0	V

Operation mode 43:

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Corr. [dB/m]	Elevation [deg]	Azimuth [deg]	Pol
1020.250	58.99	---	68.30	9.31	24.7	150.0	150.0	H
1020.250	---	47.93	54.00	6.07	24.7	150.0	150.0	H
1064.250	---	46.56	54.00	7.44	25.3	0.0	168.0	H
1064.250	57.72	---	68.30	10.58	25.3	0.0	168.0	H
1106.750	56.23	---	68.30	12.07	25.2	0.0	131.0	H
1106.750	---	45.22	54.00	8.78	25.2	0.0	131.0	H
2165.500	---	40.84	54.00	13.16	32.6	0.0	181.0	H
2165.500	52.81	---	68.30	15.49	32.6	0.0	181.0	H
3986.250	---	39.72	54.00	14.28	38.3	150.0	236.0	V
3986.250	54.01	---	68.30	14.29	38.3	150.0	236.0	V
6176.000	---	43.99	54.00	10.01	42.9	0.0	350.0	H
6176.000	57.20	---	68.30	11.10	42.9	0.0	350.0	H
7961.000	---	47.30	54.00	6.70	46.4	120.0	16.0	H
7961.000	59.63	---	68.30	8.67	46.4	120.0	16.0	H
10800.000	---	50.76	54.00	3.24	7.2	150.0	250.0	H
10800.000	54.91	---	68.30	13.39	7.2	150.0	250.0	H
13500.000	---	45.27	54.00	8.73	10.7	0.0	72.0	H
13500.000	49.46	---	68.30	18.84	10.7	0.0	72.0	H

Test result: Passed

Test equipment (please refer to chapter 6 for details)
4 - 19, 30, 31

6 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	Attenuator	WA54-10-12	Weinschel	1	481620	Calibration not necessary	
3	RF cable	SF 102	Huber & Suhner	510211/2	483032	Calibration not necessary	
4	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
5	Turntable	DS420 HE	Deisel	420/620/00	480315	Calibration not necessary	
6	Antenna support	AS620P	Deisel	620/375	480325	Calibration not necessary	
7	Multiple Control Unit	MCU	Maturo	MCU/043/971107	480832	Calibration not necessary	
8	Positioners	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
9	EMI Receiver / Spectrum Analyser	ESW44	Rohde & Schwarz	101635	482467	18.02.2020	02.2022
10	RF cable	SF106B/11N/11N/4500.0	Huber & Suhner	500218/6B	482415	Calibration not necessary	
11	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
12	Testsoftware M20	EMC32	Rohde & Schwarz		483261	Calibration not necessary	
13	Standard gain horn antenna	18240-20	Flann Microwave	483	480294	Calibration not necessary	
14	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	13.02.2020	02.2022
15	Standard gain horn antenna	20240-20	Flann Microwave	411	480297	Calibration not necessary	
16	Preamplifier 18 GHz - 26 GHz	JS4-18002600-20-5A	MITEQ Hauppauge N.Y.	658697	480342	13.02.2020	02.2022
17	Highpass Filter	WHK2.8/18G-10SS	Wainwright Instruments	1	480867	Calibration not necessary	
18	Microwave cable 2m	Insulated Wire Inc.	Insulated Wire	KPS-1533-800-KPS	480302	Calibration not necessary	
19	Preamplifier 100 MHz - 16 GHz	AFS6-00101600-23-10P-6-R	Narda MITEQ	2011215	482333	13.02.2020	02.2022
20	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
21	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
22	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
23	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
24	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
25	Measuring software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
26	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	08.12.2021	12.2023
27	Attenuator 6 dB	WA2-6	Weinschel		482793	Calibration not necessary	
28	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
29	loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	25.02.2021	02.2022

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
30	Standard gain horn antenna	22240-20	Flann Microwave	468	480298	Calibration not necessary	
31	Preamplifier 26 - 40 GHz	JDM2-26004000-25-10P	Narda MITEQ	-	482806	17.02.2020	02.2022

7 Test site Validation

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
Fully anechoic chamber M20	480303	1 -18 GHz	SVSWR	CISPR 16-1-4 Amd. 1	18.08.2020	17.08.2022

8 Report History

Report Number	Date	Comment
F212286E3	15.02.2022	Initial Test Report
F212286E3 2nd Version	16.02.2022	clause 1.1: name of applicant changed to Robert Bosch GmbH
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9 List of Annexes

Annex A Test Setup Photos

13 pages