PHOENIX TESTLAB

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Test Report

Report Number:

F212286E5 2nd Version

Equipment under Test (EUT):

VCUNM1

Applicant:

Robert Bosch Car Multimedia GmbH

Manufacturer:

Robert Bosch GmbH

ilac-MRA
DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.4:2014** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

[2] **FCC 47 CFR Part 2:** General Rules and Regulations

[3] **FCC 47 CFR Part 15:** Radio Frequency Devices (Subpart B)

[4] **ICES-003 Issue 7: (October 2020)** Spectrum Management and Telecommunications. Interference-Causing Equipment Standard. Information Technology Equipment (Including Digital Apparatus) —Limits and Methods of Measurement

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.

Tested and written by:	Signature	Michael DINTER 16.02.2022
Reviewed and approved by:	Signature	Bernd STEINER 16.02.2022

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Contents: Page

1 Identification 4
1.1 Applicant 4
1.2 Manufacturer 4
1.3 Production facility 4
1.4 Test Laboratory 4
1.5 EUT (Equipment under Test) 5
1.6 Technical Data of Equipment 6
1.7 Dates 7
2 Operational States 8
3 Additional Information 19
4 Overview 20
5 Results 22
5.1 Radiated emissions 22
5.1.1 Test method 22
5.1.2 Test results final measurement 30 MHz to 1 GHz 26
5.1.3 Test results final measurement above 1 GHz 28
5.2 Conducted emissions at antenna port receiver 31
5.2.1 Test method 31
5.2.2 Test results final measurement 30 MHz to 1 GHz 32
6 Test Equipment used for Tests 35
7 Test site Verification 36
8 Report History 36
9 List of Annexes 36

1 Identification

1.1 Applicant

Name:	Robert Bosch GmbH
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Country:	Germany
Name for contact purposes:	Mr. Tilman ALMSTEDT
Phone:	+49 5121 49-4226
eMail address:	Eike-Tilman.Almstedt@de.bosch.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Robert Bosch GmbH
Address:	Robert-Bosch-Str. 200, 31139 Hildesheim
Country:	Germany
Name for contact purposes:	Mr. Dirk ZAMOW
Phone:	+49 5121 49-2608
eMail address:	Dirk.Zamow@de.bosch.com
Manufacturer represented during the test by the following person:	-

1.3 Production facility

Name:	Robert Bosch (Malaysia) Sdn Bhd
Address:	Free Industrial Zone 1, 11900 Bayan Lepas, Penang
Country:	Malaysia
Name for contact purposes:	Mr. Dr. Siegfried SKIRL
Phone:	-
eMail address:	Siegfried.Skirl@my.bosch.com
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-17186-01-06 and D-PL-17186-01-05, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.5 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	2
Serial number: *	1121322A10000060	1121322A10000070
PCB identifier: *	8638912015 8638912040 8638912111	8638912015 8638912040 8638912111
Hardware version: *	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
Lable		

* Declared by the applicant

EUT 1 was used for the radiated tests.
EUT 2 was used for the conducted tests.

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	BIAS-T	2m	Yes
J2 56 way STAK50H SYSTEM	Harness	LOADBOX	2m	No
J3 AMEC Mixed 12 way	Harness	Optical system	2m	No
J4 HSAL-II	Harness	Optical system	2m	Yes
J6 HSAL-II	Harness	Optical system	2m	Yes
J7 Double-HFM	Harness	Video Generator	2m	Yes
J8 Single-HFM	Harness	WIFI Antenna	2m	Yes
J9 Quad-HFM	Harness	Video Generator	2m	Yes
J10 Quad-HFM	Harness	Video Generator	2m	Yes

Equipment used for testing	
Loadbox*1	GM VCU LOADBOX #03

*1 Provided by the applicant
*2 Provided by the laboratory

Ancillary equipment	
WIFI Antenna 84610506	TE Connectivity

*1 Provided by the applicant

1.7 Dates

Date of receipt of test sample:	17.12.2021
Start of test:	17.12.2021
End of test:	10.01.2022

2 Operational States

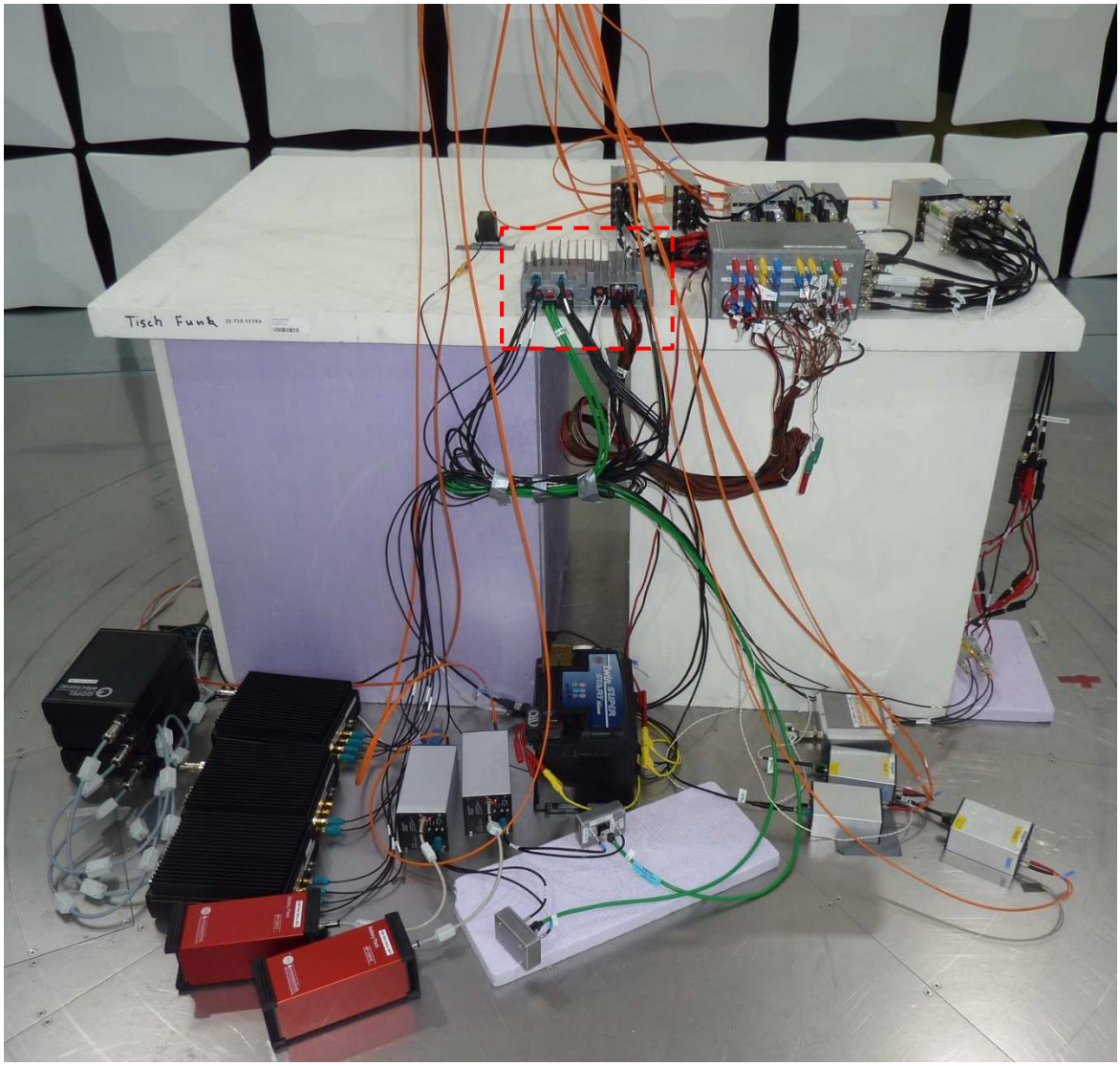
Description of function of the EUT:

The EUT is a car infotainment PC running in normal operation mode.

The following states were defined as the operating conditions:

The EUT was supplied by 12 V DC during all tests.
During all tests, software BITS TML and Eclipse for TML (delivered by the applicant) was used to control the functions of the EUT.

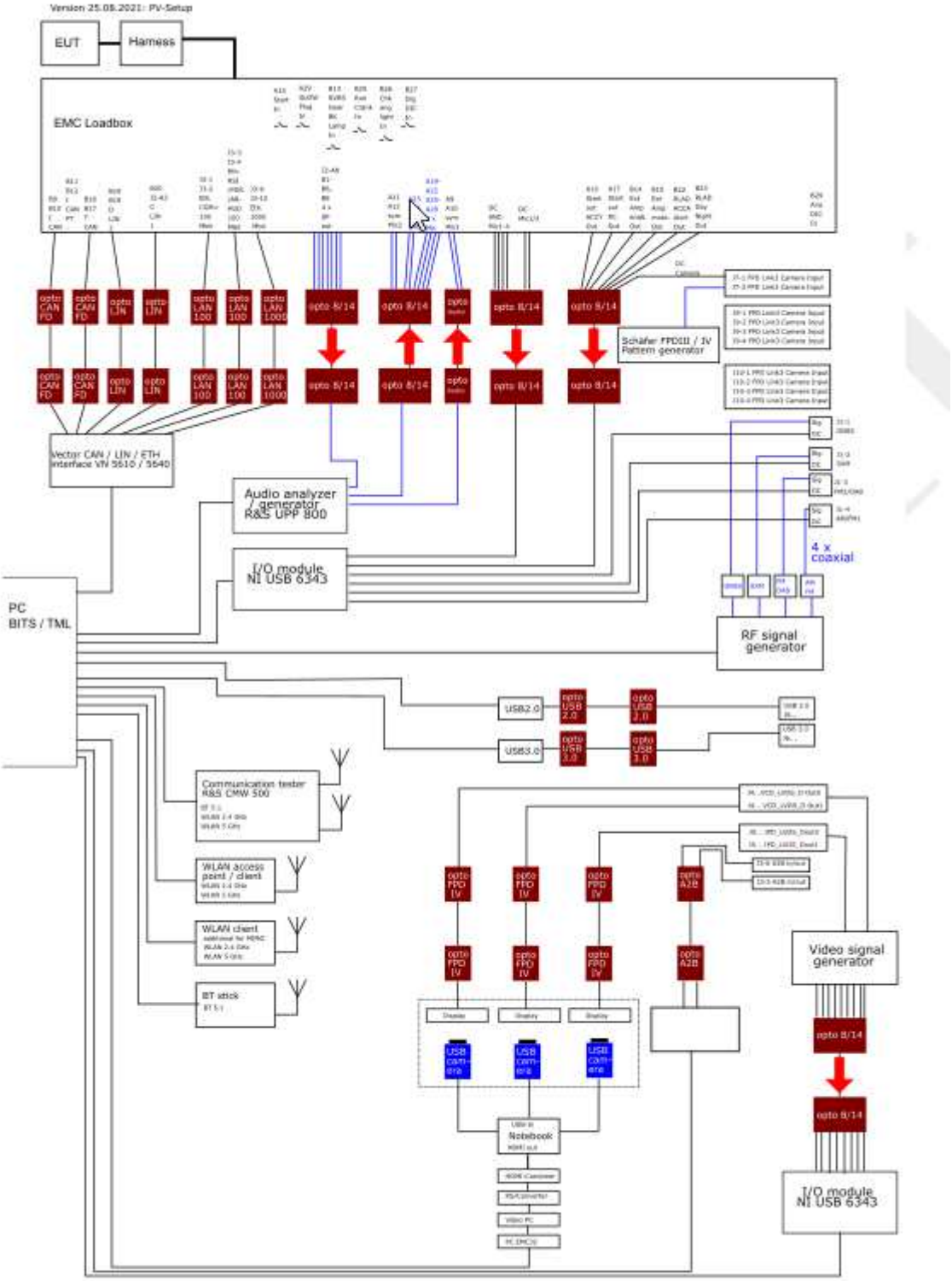
The system was setup as follows:



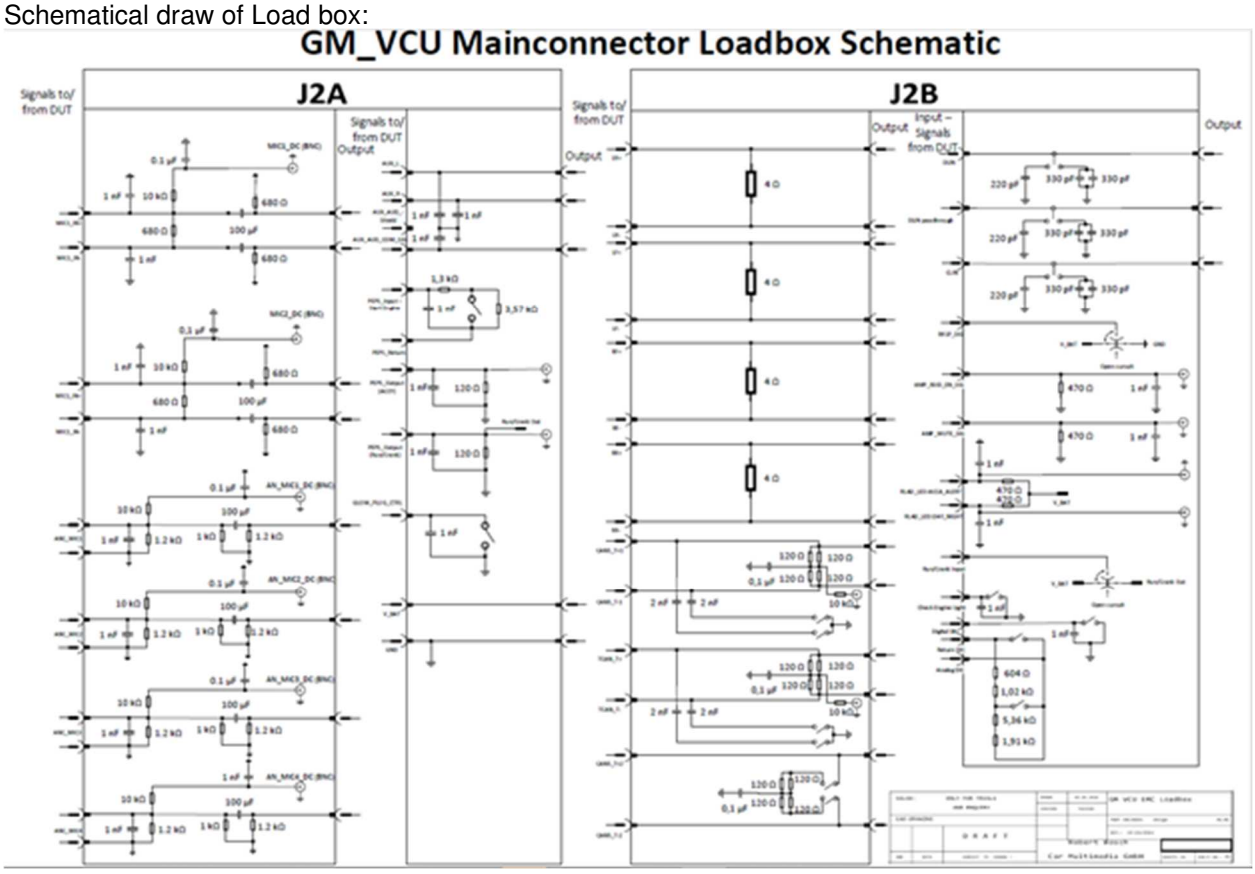
Information of the test setup provided by the applicant:

```
-----------------------------------------------------------------------------------------------------

> Test tool: TML Framework 30.09.2020 / V 1.15.0.4 (1350) - for G3g:utf-8

             For support please contact TML Support Group (TMLSupportGroup@bcn.bosch.com)

             Contribute to TML: https://sourcecode.socialcoding.bosch.com/projects/TML/
             TML Community    : https://connect.bosch.com/communities/community/TML

-----------------------------------------------------------------------------------------------------

> This is Python 2.7.9 (default, Dec 10 2014, 12:24:55) [MSC v.1500 32 bit (Intel)] on Windows

-----------------------------------------------------------------------------------------------------

> [Test tool configuration: 'default']

  * Test file.....: 'C:/AutoTest/Project/GM_VCU_PV1_MID_21.50.4/TestSpecific/EMC/LoopTest.tml'
  * Log file path.: 'C:/AutoTest/Project/GM_VCU_PV1_MID_21.50.4/Reports/20220131_161939_LoopTest'
  * Log file mode.: 10/7:'a'
  * Ctrl file path: 'C:/AutoTest/ctrlfiles'
  * Config file...: 2:'C:/AutoTest/Project/GM_VCU_PV1_MID_21.50.4/config/Variant.Default.atc'
    Local config..: +:'C:/AutoTest/Project/GM_VCU_PV1_MID_21.50.4/_ConfigSpecific/__BITS.LocalConfig.atc'
  * Persist. path : 'C:/Users/bhd1hi/AppData/Local/Temp'
  * UUID..........: '6a798371-fcb8-4010-ab0c-82073b4cce8e'

-----------------------------------------------------------------------------------------------------

> [Test file header]

  * Author.............: 'Andreas Hoeper CM-CI1/ESW3, Reiner Flemming BMS, Dattatrya Raghunath Bhosle Hi 460/EG'
  * Project............: 'BOSCH Electrical-EMC Test: GM VCU'
  * Source file date...: '24.01.2022'
  * Source file version: 'GM_VCU_PV1_MID / 21.50.4 / 0'
  * Keyword............: ''
  * Short description..: 'Examples FTS'
```

Schematical draw of setup:

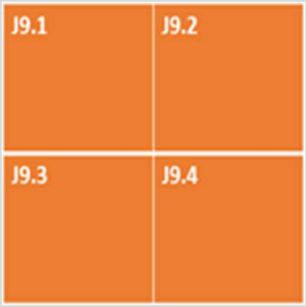


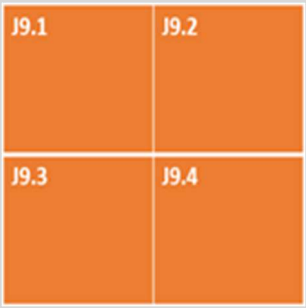
Schematical draw of Load box:

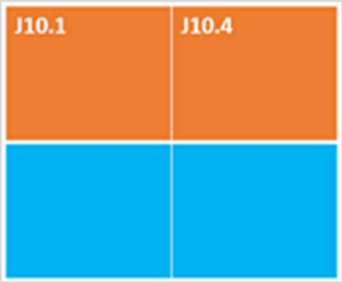
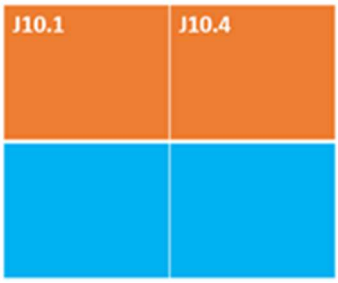


Function description of connectors:

Function	Input Values / Connection e.g. audio signal 220mV sinus 900Hz via coaxial cable	Output Values		
		Monitoring Parameter	Actual condition	
			101(NAR)	04(NAR)
Video Output 1 DSI	Display 1 See video input Parallel monitoring system: Master: Visual→ human eye Data rate: 10.8 Gb/s	No influence: No blank display or OFF No Freezing No Flickering	**OK**	**OK**
Video Output 2 DP0 **<u>Note:</u> data rate refer to the free form display.**	Display 2 See Video input Parallel monitoring system: Master: Visual→ human eye Data rate: 12,528 Gb/s	No influence: No blank display or OFF No Freezing No Flickering	**OK**	**OK**
USB 2.0 (SW update only no Audio)	Simulation of USB 2.0 data traffic between VCU and control PC. Data Rate/ Iteration Error monitoring via Diagnostic over CAN Stick with file to make data transfer	Byte error count = 0 Average read / write speed ≥ 10 Mb/s	**OK**	**OK**
USB 3.0	Simulation of USB 3.0 data traffic between VCU and control PC. Data Rate/ Iteration Error monitoring via Diagnostic over CAN Stick with file to make data transfer.	Byte error count = 0 Average read / write speed ≥ 10 MB/s	**NOK (sample not in host mode)**	**NOK (sample not in host mode)**
Bluetooth 5.0	Permanent Bluetooth loopback test: Text file will be sent from a BT USB dongle to the VCU.	1. data rate ≥ 400 Kb/s 2. data integrity → Pass	**OK** **Not active during Emission test**	**OK** **Not active during Emission test**

WLAN 2.4 / 5 GHz **802.11 b, g, n (ax)** **Note:3**	Permanent TCP/IP connection between DUT and access point (AP). Continuous data transfer. DUT shall be configured to 2.4GHz Antenna configuration: Internal & external antennas shall be used at the same time.	2.4 GHz - No interruption of the data transfer during the test ≥ ~ 120 Mb/s 5 GHz - No interruption of the data transfer during the test ≥ ~ 600 Mb/s	**OK** **Not active during Emission test**	**OK** **Not active during Emission test**
Video in 1 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J9 (pin 1): Fed via video shielded signal generator inside the chamber.  Display 1		**OK**	**OK**
Video in 2 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J9 (pin 2): Fed via video shielded signal generator inside the chamber. Display 1		**OK**	**OK**

Video in 3 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J9 (pin 3): Fed via video shielded signal generator inside the chamber.  Display 1		**OK**	**OK**
Video in 4 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J9 (pin 4): Fed via video shielded signal generator inside the chamber. Display 1		**OK**	**OK**

Video in 5 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J10 (pin 1): Fed via video shielded signal generator inside the chamber.  Display 1		**OK** **Not active**	**OK** **Not active**
Video in 6 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J10 (pin 4): Fed via video shielded signal generator inside the chamber  Display 1		**OK** **Not active**	**OK** **Not active**
Video in 7 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J7 (pin 1): Fed via video shielded signal generator inside the chamber Display 2		**OK**	**OK**

Video in 8 **<u>Note</u>:** **Required for PV: 4k resolution** **Sync-Mode**	Connector J7 (pin 2): Fed via video shielded signal generator inside the chamber Display 2		**OK**	**OK**
Hand Free Mic 1	Route audio signal to amplifier Test frequency: 600 Hz. Monitoring of the phantom DC voltage	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 3. Phantom voltage MIC 4. Phantom voltage ANC 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. 6,8 ±10% 4. 3.1 ±10%	**OK**	**OK**
Hand Free Mic 2	Route audio signal to amplifier Test frequency: 650 Hz. Monitoring of the phantom DC voltage	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 3. Phantom voltage MIC 4. Phantom voltage ANC 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. 6,8 ±10% 4. 3.1 ±10%	**NOK (no phantom voltage)**	**NOK (no phantom voltage)**
ANC Mic 1	Route audio signal via amplifier to loudspeakers Test frequencies: ANC: 800 Hz Monitoring of the phantom DC voltage	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 3. Phantom voltage MIC 4. Phantom voltage ANC 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. 6,8 ±10% 4. 3.1 ±10%	**OK**	**OK**

ANC Mic 2	Route audio signal via amplifier to loudspeakers Test frequencies: ANC: 850 Hz Monitoring of the phantom DC voltage	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 3. Phantom voltage MIC 4. Phantom voltage ANC 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. 6,8 ±10% 4. 3.1 ±10%	**OK**	**OK**
ANC Mic 3	Route audio signal via amplifier to loudspeakers Test frequencies: ANC: 900 Hz Monitoring of the phantom DC voltage	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 3. Phantom voltage MIC 4. Phantom voltage ANC 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. 6,8 ±10% 4. 3.1 ±10%	**OK**	**OK**
ANC Mic 4	Route audio signal via amplifier to loudspeakers Test frequencies: ANC: 950 Hz Monitoring of the phantom DC voltage	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 3. Phantom voltage MIC 4. Phantom voltage ANC 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. 6,8 ±10% 4. 3.1 ±10%	**OK**	**OK**
LIN 1 (SWC/UGDO)	Permanent data transfer (LIN Protocol), between VCU and Control PC via Verctor CANoe tool (RBS).	undisturbed LIN bus communication undisturbed Bus Load ≤ 44%	**OK**	**OK**
LIN 3 (Power Volume Switch Bank)	Permanent data transfer (LIN Protocol), between VCU and Control PC via Vector CANoe tool (RBS).	undisturbed LIN bus communication undisturbed Bus Load ≤ 44%	**OK**	**OK**
ICAN	Permanent data transfer (CAN Protocol), between VCU and Control PC via Vector CANoe tool (RBS)	undisturbed CAN bus communication Bus Load ≤ 44%	**OK**	**OK**
TCAN	Permanent data transfer (CAN Protocol), between VCU and Control PC via Vector CANoe tool (RBS).	undisturbed CAN bus communication Bus Load ≤ 44%	**OK**	**OK**

A2B	Route an analog audio input to the loudspeakers. signal 1KHz.	Undisturbed audio signal: 1. Audio volume 2. Audio frequency 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz]	**OK** **Active audio mode during test run**	**OK** **Active audio mode during test run**
AM	Audio signal: AM signal with 60 dBµV - AF: 1KHz, mod: 30% Analog output - 1.4 VRMS / 4Ω A sinusoidal audio tone at 1KHz is generated from the test environment and fed as modulation: 30 % into antenna input line on VCU, which is routed to the internal amplifier then to loudspeaker output.	1. Audio volume 2. Audio frequency 3. Phantom voltage 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. [9V – n/a]	**OK** **Background scan**	**OK** **Background scan**
FM1	A sinusoidal audio tone at 1kHz is generated from the Test Environment and fed as modulation on 96.1 MHz into antenna input line on VCU. Output to be monitored at VCU loudspeaker output. Monitoring of the phantom DC voltage	1. Audio volume 2. Audio frequency 3. Phantom voltage 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. [9V – n/a]	**OK** **Background scan**	**OK** **Background scan**
FM2	A sinusoidal audio tone at 1kHz is generated from the Test Environment and fed as modulation on 96.1 MHz into antenna input line on VCU. Output to be monitored at VCU loudspeaker output. Monitoring of the phantom DC voltage.	1. Audio volume 2. Audio frequency 3. Phantom voltage 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. [9V – n/a]	**NOK (phantom supply – no voltage)**	**NOK (phantom supply – no voltage)**
SXM	A sinusoidal audio tone of -65 dBm is generated from the Test Environment and fed as modulation on 2,333.47 GHz into antenna input line on VCU, which is routed within DUT to internal amplifier then to VCU loudspeaker output. Monitoring of the phantom DC voltage. BER test will be performed in addition.	. Audio volume 2. Audio frequency 3. BER 4.Phantom status 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz] 3. [na – 500 ppm] 4. 1 (Boolean)	**OK** **Background scan**	**OK** **Background scan**
AUX	Route audio signal to amplifier Test frequencies: L: 700 Hz, R: 750 Hz Audio signal is routed to amplifier then to loudspeakers.	1. Audio volume 2. Audio frequency 1. [1.1V – 1.7V] 2. [f_in +/- 10Hz]	**OK**	**OK**
1st Ethernet T100	After TCP/IP connection has been established: Continuous data transfer between VCU and control PC via 100BASE-T MediaConverter box.	Continuous Ethernet communication No interruption of the data transfer during the test ≥ ~ 20% of max data rate	**OK**	**OK**

2nd Ethernet T100	After TCP/IP connection has been established: Continuous data transfer between VCU and control PC via 100BASE-T MediaConverter box.	Continuous Ethernet communication No interruption of the data transfer during the test ≥ ~ 20% of max data rate	**OK**	**OK**
Ethernet T1000	After TCP/IP connection has been established: Continuous data transfer between VCU and control PC via 1000BASE-T MediaConverter box.	Continuous Ethernet communication No interruption of the data transfer during the test ≥ ~ 20% of max data rate	**OK**	**OK**
System Temperature	SiP module temperature will be read continuously the results will be monitored during the tests.	1. t_SoC T° sensor 1. < 107 °C SiP module temperature Checked for limit (107°C),	**OK**	**OK**
RLAD DAY_NIGHT	Output: Low	Voltage Output low side correct state: test cycle time low 0.5 s high	**OK**	**OK**
RLAD FCA_ALERT	Output: Low	Voltage Output low side correct state: test cycle time low 0.5 s high	**OK**	**OK**
GLOW PLUG	Input: Fixed key Low	Voltage correct state: Fixed key Low	**OK**	**OK**
Backup Lampe	Input: Fixed key High	Voltage Fixed key High	**OK**	**OK**
AMP Enable	Output: High	Voltage Output High side correct state: test cycle time high 0.5 s low	**OK**	**OK**

The radiated emission measurement is divided into three stages:

1. A preliminary measurement inside a semi anechoic chamber with 3 m distance.
2. A final measurement inside a semi anechoic chamber with 3 m distance for frequencies above 30 MHz;
3. A final measurement on an outdoor test site without reflecting ground plane and 3 m / 10 m distance for frequencies below 30 MHz.

3 Additional Information

The EUT was not labeled as required by FCC / IC.

4 Overview

Conducted emissions FCC 47 CFR Part 15 section 15.107 (a),(b) [3] ICES-003 Issue 7 section 3.2.1[4]					
Application	Frequency range	Limits	Reference standard	Tested EUT	Status
AC supply line Class A	0.15 to 0.5 MHz 0.5 to 30 MHz	79 dB(µV) QP 66 dB(µV) AV 73 dB(µV) QP 60 dB(µV) AV	ANSI C63.4	-	Not applicable
AC supply line Class B	0.15 to 0.5 MHz 0.5 to 5 MHz 5 to 30 MHz	66 to 56 dB(µV) QP* 56 to 46 dB(µV) AV* 56 dB(µV) QP 46 dB(µV) AV 60 dB(µV) QP 50 dB(µV) AV	ANSI C63.4	-	Not applicable
*: Decreases with the logarithm of the frequency					

Conducted emissions FCC 47 CFR Part 15 section 15.111 (a),(b) [3]					
Application	Frequency range	Limits	Reference standard	Tested EUT	Status
Antenna power conduction limits for receivers	30 MHz to 2 GHz	-57 dBm	ANSI C63.4	2	Passed

Radiated emissions FCC 47 CFR Part 15 section 15.109 (a),(b) [3]					
Application	Frequency range	Limits	Reference standard	Tested EUT	Status
Radiated Emission Class A	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz above 1000 MHz	39.0 dB(µV/m) QP at 10 m 43.5 dB(µV/m) QP at 10 m 46.5 dB(µV/m) QP at 10 m 49.5 dB(µV/m) QP at 10 m 49.5 dB(µV/m) AV at 10 m and 69.5 dB(µV/m) PK at 10 m	ANSI C63.4	-	Not applicable
Radiated Emission Class B	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz above 1000 MHz	40.0 dB(µV/m) QP at 3 m 43.5 dB(µV/m) QP at 3 m 46.0 dB(µV/m) QP at 3 m 54.0 dB(µV/m) QP at 3 m 54.0 dB(µV/m) AV at 3 m and 74.0 dB(µV/m) PK at 3 m	ANSI C63.4	1	Passed

Radiated emissions ICES-003 Issue 7 section 3.2.2 [4]					
Application	Frequency range	Limits	Reference standard	Tested EUT	Status
Radiated Emission Class A	30 to 88 MHz 88 to 216 MHz 216 to 230 MHz 230 to 960 MHz 960 to 1000 MHz above 1000 MHz	50.0 dB(µV/m) QP at 3 m 54.0 dB(µV/m) QP at 3 m 56.9 dB(µV/m) QP at 3 m 57.0 dB(µV/m) QP at 3 m 60.0 dB(µV/m) QP at 3 m 60 dB(µV/m) AV at 3 m and 80 dB(µV/m) PK at 3 m	ANSI C63.4	-	Not applicable
Radiated Emission Class B	30 to 88 MHz 88 to 216 MHz 216 to 230 MHz 230 to 960 MHz 960 to 1000 MHz above 1000 MHz	40.0 dB(µV/m) QP at 3 m 43.5 dB(µV/m) QP at 3 m 46.0 dB(µV/m) QP at 3 m 47.0 dB(µV/m) QP at 3 m 54.0 dB(µV/m) QP at 3 m 54 dB(µV/m) AV at 3 m and 74 dB(µV/m) PK at 3 m	ANSI C63.4	1	Passed

Remark: As declared by the applicant the highest internal clock frequency is 6.264 GHz.
Therefore the radiated emission measurement must be carried out up to 5th of the highest internal clock frequency in this case 40 GHz.

The EUT was classified by the applicant as CLASS B equipment.

5 Results

5.1 Radiated emissions

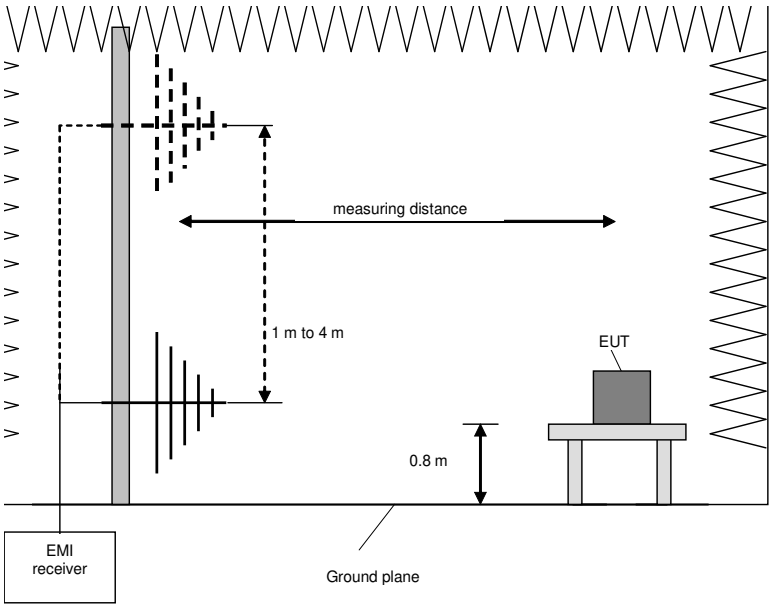
5.1.1 Test method

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.
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	Resolution bandwidth
Preliminary measurement	30 MHz to 1 GHz	100 kHz
Frequency peak search	+ / - 1 MHz	10 kHz
Final measurement	30 MHz to 1 GHz	120 kHz



Procedure preliminary measurement:

The following procedure is used:

1) Set the measuring antenna to 1 m height.
2) Monitor the frequency range at horizontal polarisation 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 polarisation 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:

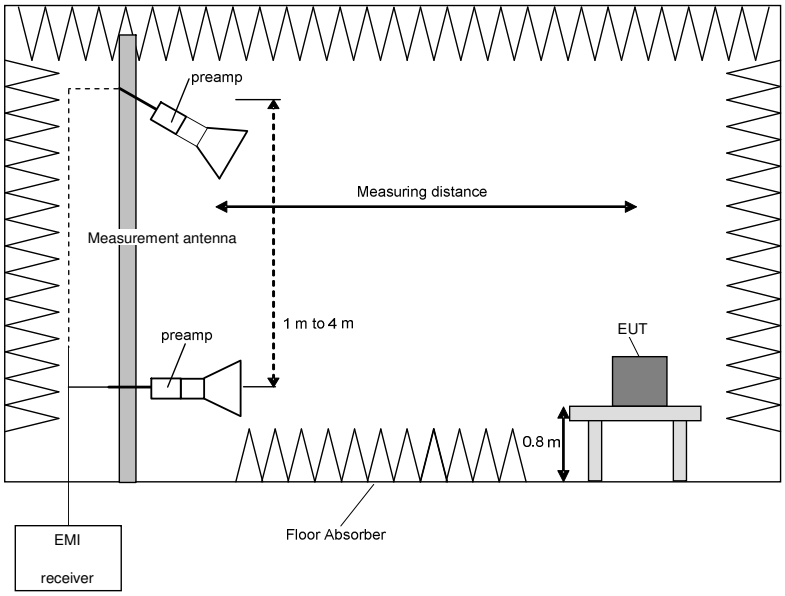
1) Select the highest frequency peaks (lowest margin to the limit) for the final measurement.
2) The software determines the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3) If the EUT is portable or ceiling mounted, find the worst-case EUT orientation (x,y,z) for the final test.
4) The worst-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.

Preliminary and final measurement > 1 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber with floor absorbers between EUT and measuring antenna. The measuring distance is 3 m.
During the tests the EUT is rotated in the range of 0 ° to 360 °, the measuring antenna is set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions. While changing the height, the measuring antenna gets tilted so that it is always aiming at the EUT.

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

Test	Frequency range	Resolution bandwidth
Preliminary measurement	1 - 40 GHz	1 MHz
Frequency peak search	+ / - 10 MHz	100 kHz
Final measurement	1 - 40 GHz	1 MHz



Procedure preliminary measurement:

The following procedure is used:

1) Set the measuring antenna to 1 m height.
2) Monitor the frequency range at horizontal polarisation 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 polarisation 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:

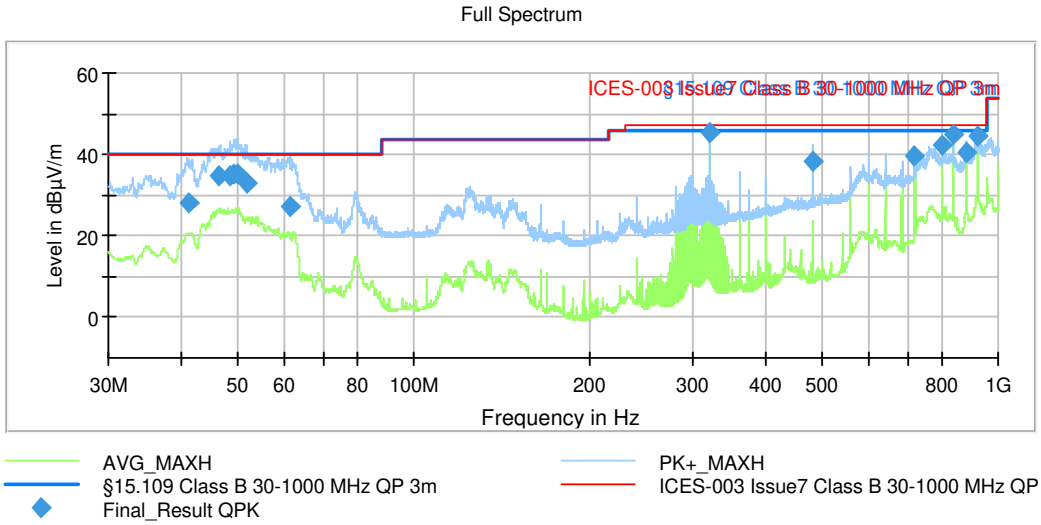
The following procedure is used:

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 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-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.

5.1.2 Test results final measurement 30 MHz to 1 GHz

Ambient temperature:	22 °C
Relative humidity:	26 %

Date:	10.01.2021
Tested by:	Dinter



The results of the standard subsequent measurement in a semi-anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Final result limit according to FCC 15.109 Class B

Frequency in MHz	QuasiPeak in dB(µV/m)	Limit in dB(µV/m)	Margin in dB	Meas. Time in ms	Bandwidth in kHz	Height in cm	Pol	Azimuth in deg	Corr. in dB
41.070	28.0	40.0	12.0	1000	120.000	121.0	V	69	19.4
46.540	34.6	40.0	5.4	1000	120.000	150.0	V	131	15.9
48.510	34.6	40.0	5.4	1000	120.000	104.0	V	94	14.7
49.170	35.2	40.0	4.8	1000	120.000	123.0	V	117	14.3
49.750	35.3	40.0	4.7	1000	120.000	100.0	V	110	14.0
51.720	33.0	40.0	7.0	1000	120.000	110.0	V	87	13.0
61.290	27.4	40.0	12.6	1000	120.000	142.0	V	112	12.6
320.000	45.4	46.0	0.6	1000	120.000	104.0	H	283	19.7
479.990	38.1	46.0	7.9	1000	120.000	129.0	H	49	24.0
719.990	39.4	46.0	6.6	1000	120.000	112.0	H	138	27.9
799.990	42.4	46.0	3.6	1000	120.000	103.0	H	182	28.8
839.990	44.9	46.0	1.1	1000	120.000	103.0	H	182	29.4
879.990	40.4	46.0	5.7	1000	120.000	103.0	H	229	29.7
919.990	44.3	46.0	1.7	1000	120.000	102.0	H	54	30.2

Measurement uncertainty ±5.12 dB

Final result limit according to ICES-003 Issue 7 Class B

Frequency in MHz	QuasiPeak in dB(µV/m)	Limit in dB(µV/m)	Margin in dB	Meas. Time in ms	Bandwidth in kHz	Height in cm	Pol	Azimuth in deg	Corr. in dB
41.070	28.0	40.0	12.0	1000	120.000	121.0	V	69	19.4
46.540	34.6	40.0	5.4	1000	120.000	150.0	V	131	15.9
48.510	34.6	40.0	5.4	1000	120.000	104.0	V	94	14.7
49.170	35.2	40.0	4.8	1000	120.000	123.0	V	117	14.3
49.750	35.3	40.0	4.7	1000	120.000	100.0	V	110	14.0
51.720	33.0	40.0	7.0	1000	120.000	110.0	V	87	13.0
61.290	27.4	40.0	12.6	1000	120.000	142.0	V	112	12.6
320.000	45.4	47.0	1.6	1000	120.000	104.0	H	283	19.7
479.990	38.1	47.0	8.9	1000	120.000	129.0	H	49	24.0
719.990	39.4	47.0	7.6	1000	120.000	112.0	H	138	27.9
799.990	42.4	47.0	4.6	1000	120.000	103.0	H	182	28.8
839.990	44.9	47.0	2.1	1000	120.000	103.0	H	182	29.4
879.990	40.4	47.0	6.7	1000	120.000	103.0	H	229	29.7
919.990	44.3	47.0	2.7	1000	120.000	102.0	H	54	30.2

Measurement uncertainty ±5.12 dB

Test result: Passed

The correction factor was calculated as follows:
Corr. (dB) = cable attenuation (dB) + 6 dB attenuator (dB) + antenna factor (dB)

Therefore, the reading can be calculated as follows:
Reading (dBµV/m) = result QuasiPeak (dBµV/m) - Corr. (dB)

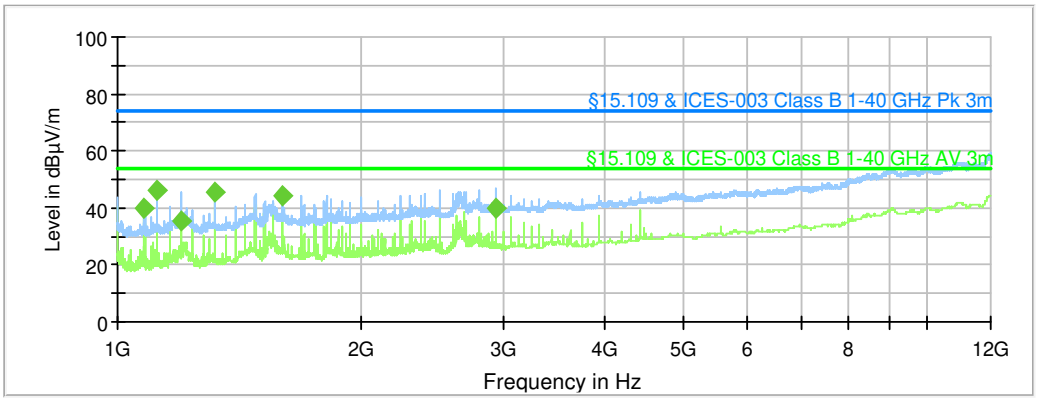
Test equipment (please refer to chapter 6 for details)
1 - 9

5.1.3 Test results final measurement above 1 GHz

Ambient temperature:	22 °C
Relative humidity:	22 %

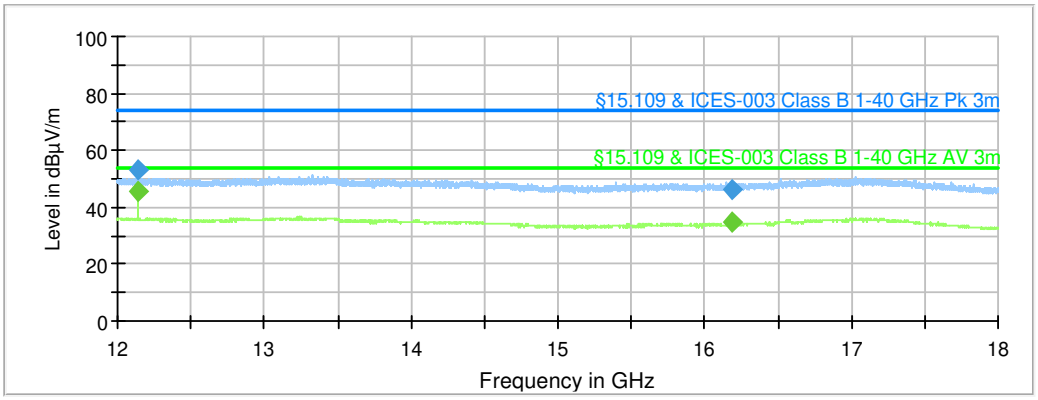
Date:	07.01.2022
Tested by:	Dinter/Kahlek

Full Spectrum



AVG_MAXH
§15.109 & ICES-003 Class B 1-40 GHz Pk 3m
Final_Result PK+
PK+_MAXH
§15.109 & ICES-003 Class B 1-40 GHz AV 3m
Final_Result CAV

Full Spectrum

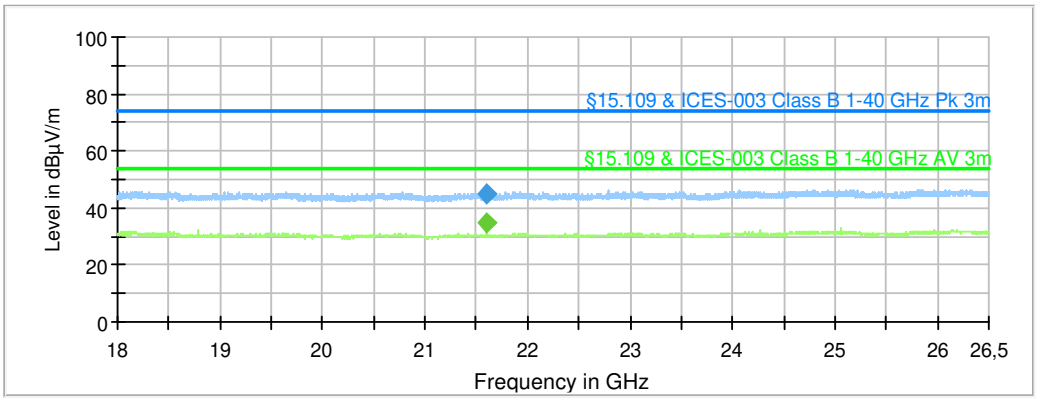


AVG_MAXH
§15.109 & ICES-003 Class B 1-40 GHz Pk 3m
Final_Result PK+
PK+_MAXH
§15.109 & ICES-003 Class B 1-40 GHz AV 3m
Final_Result CAV

Ambient temperature:	22 °C
Relative humidity:	23 %

Date:	06.01.2022
Tested by:	Dinter/Kahlek

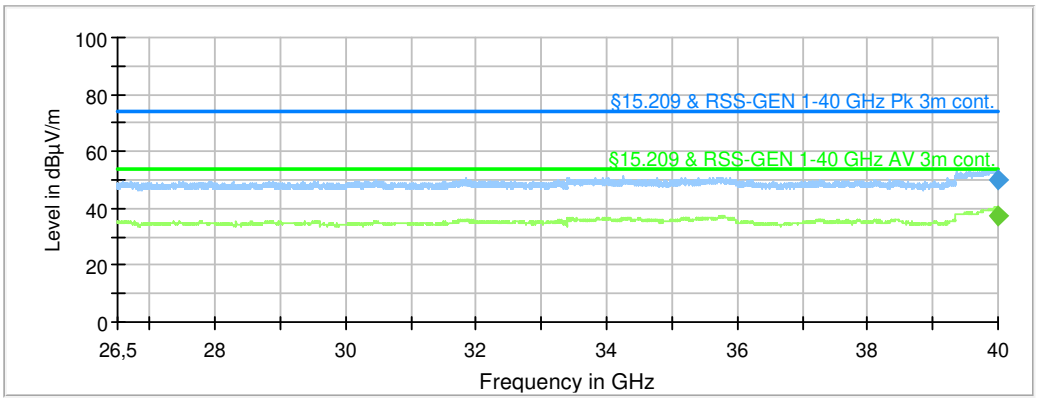
Full Spectrum



AVG_MAXH
§15.109 & ICES-003 Class B 1-40 GHz Pk 3m
Final_Result PK+

PK+_MAXH
§15.109 & ICES-003 Class B 1-40 GHz AV 3m
Final_Result CAV

Full Spectrum



AVG_MAXH
§15.209 & RSS-GEN 1-40 GHz Pk 3m cont.
Final_Result PK+

PK+_MAXH
§15.209 & RSS-GEN 1-40 GHz AV 3m cont.
Final_Result AVG

The results of the standard subsequent measurement above 1 GHz in a semi-anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Frequency in MHz	MaxPeak in dB(µV/m)	Average in dB(µV/m)	Limit in dB(µV/m)	Margin in dB	Meas. Time in ms	Bandwidth in MHz	Height in cm	Pol	Azimuth in deg	Corr. in dB
1080.000	---	39.6	54.0	14.4	100	1000.000	240.0	V	177	-10.2
1120.000	---	46.3	54.0	7.7	100	1000.000	387.0	H	213	-10.0
1200.000	---	35.7	54.0	18.3	100	1000.000	259.0	V	27	-9.1
1320.000	---	45.4	54.0	8.6	100	1000.000	298.0	H	205	-8.1
1600.000	---	44.0	54.0	10.0	100	1000.000	304.0	V	256	-5.4
2937.500	---	40.1	54.0	13.9	100	1000.000	293.0	V	307	2.2
12138.650	53.4	---	74.0	20.6	100	1000.000	189.0	V	178	16.2
12138.650	---	45.4	54.0	8.6	100	1000.000	189.0	V	178	16.2
16184.850	46.2	---	74.0	27.8	100	1000.000	352.0	V	33	16.6
16184.850	---	34.8	54.0	19.2	100	1000.000	352.0	V	33	16.6
21599.850	44.7	---	74.0	29.3	100	1000.000	133.0	H	10	15.5
21599.850	---	34.8	54.0	19.2	100	1000.000	133.0	H	10	15.5
39990.200	---	37.3	54.0	16.7	100	1000.000	100.0	V	225	20.0
39990.200	50.2	---	74.0	23.8	100	1000.000	100.0	V	225	20.0

Measurement uncertainty ±5.14 dB

Test result: Passed

The correction factor was calculated as follows:
Corr. (dB) = cable attenuation (dB) + preamplifier (dB) + antenna factor (dB)

Therefore, the reading can be calculated as follows:
Reading (dBµV/m) = result Peak or Average (dBµV/m) - Corr. (dB)

Test equipment (please refer to chapter 6 for details)
3 - 17

5.2 Conducted emissions at antenna port receiver

5.2.1 Test method

Preliminary and final measurement 30 MHz to 5 GHz

The preliminary and final measurements are performed at the antenna port of receivers that operate (tune) in the frequency range 30 to 960 MHz and CB receivers that provide terminals for the connection of an external receiving antenna.

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

Test	Frequency range	Resolution bandwidth
Preliminary measurement	30 MHz to 1 GHz	100 kHz
Final measurement	30 MHz to 1 GHz	120 kHz
Preliminary measurement	1 - 5 GHz	1 MHz
Final measurement	1 - 5 GHz	1 MHz

Spurious emission limits

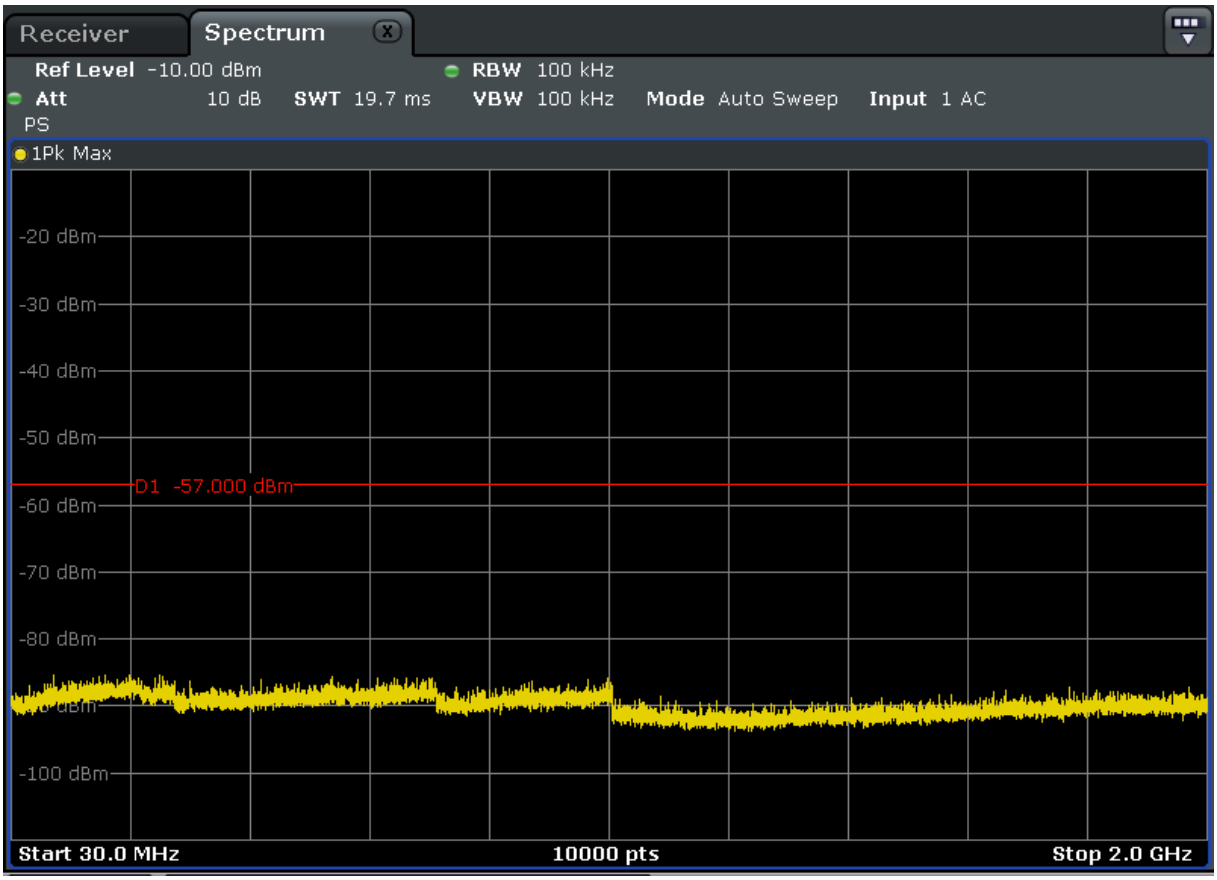
Frequency range	Maximum power	Bandwidth
30 MHz to 1 GHz	-57 dBm	120 kHz
1 GHz to 5 GHz	-57 dBm	1 MHz

5.2.2 Test results final measurement 30 MHz to 1 GHz

Ambient temperature:	22 °C
Relative humidity:	20 %

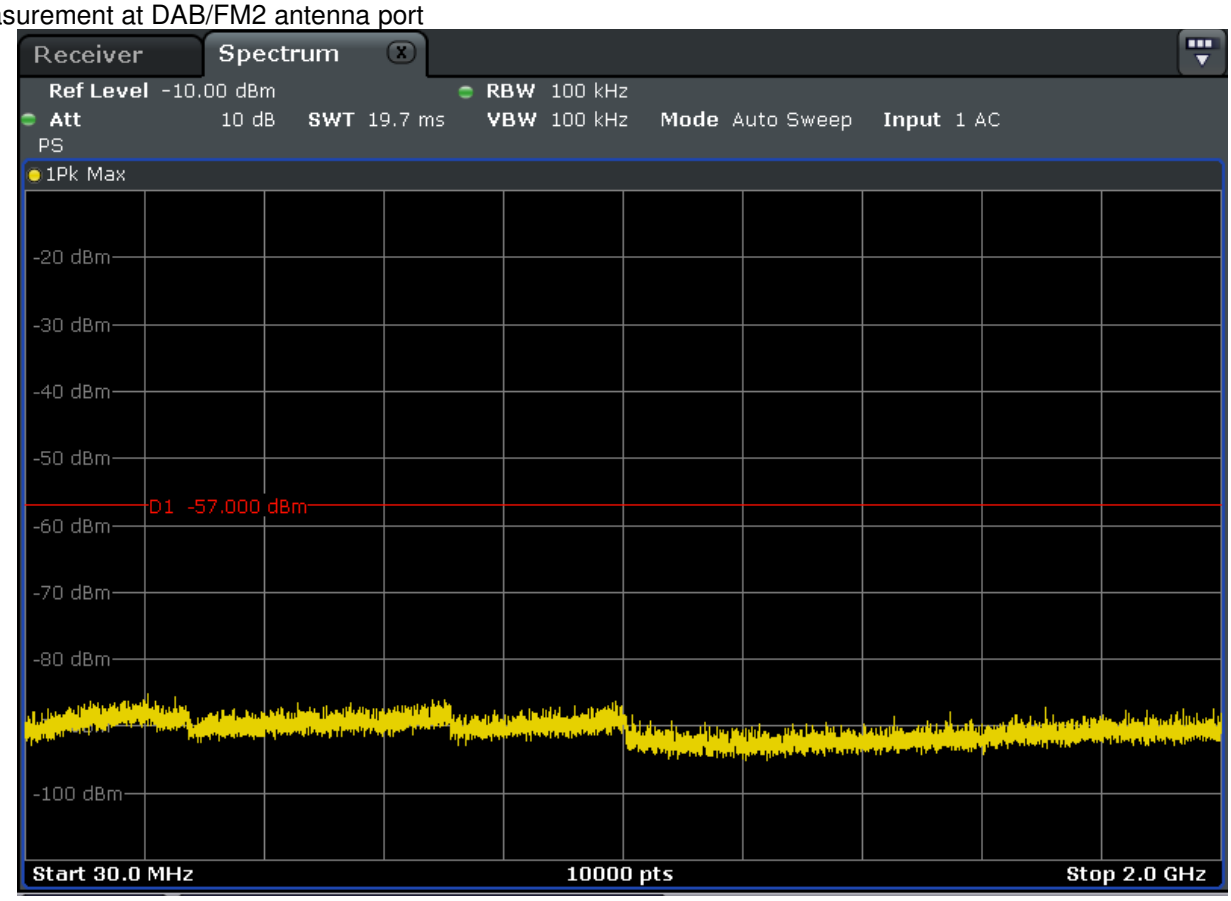
Date:	20.01.2021
Tested by:	M.DINTER

Measurement at FM1/AM antenna port



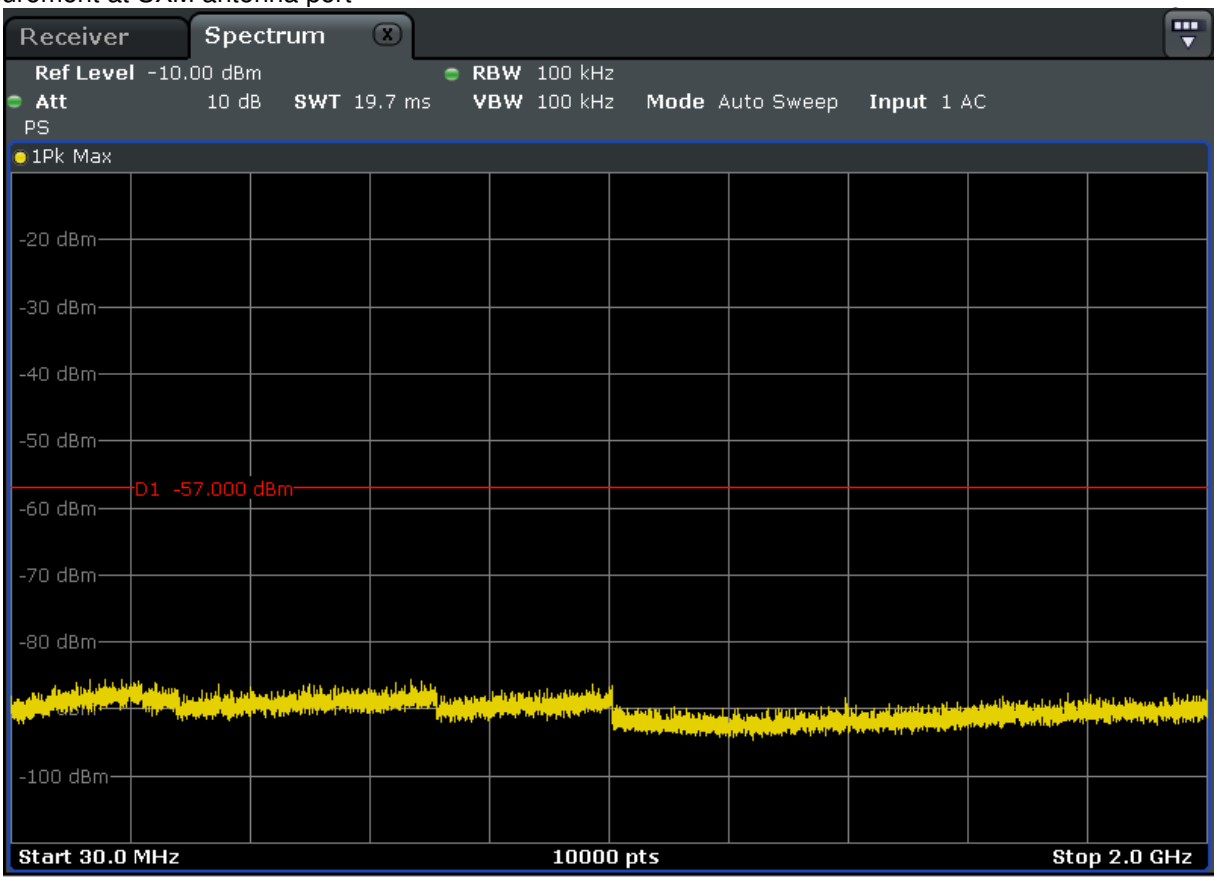
Spurious emissions level				
Frequency [MHz]	**Level [dBm]**	**Limit [dBm]**	**Margin [dB]**	**Result**
No significant emissions found, all emissions are more than 20 dB below the limit.				
Measurement uncertainty: +1.5 dB / -1.9 dB				

Measurement at DAB/FM2 antenna port



Spurious emissions level				
Frequency [MHz]	**Level [dBm]**	**Limit [dBm]**	**Margin [dB]**	**Result**
No significant emissions found, all emissions are more than 20 dB below the limit.				
Measurement uncertainty: +1.5 dB / -1.9 dB				

Measurement at SXM antenna port



Spurious emissions level				
Frequency [MHz]	**Level [dBm]**	**Limit [dBm]**	**Margin [dB]**	**Result**
	No significant emissions found, all emissions are more than 20 dB below the limit.			
Measurement uncertainty: +1.5 dB / -1.9 dB				

Test result: Passed

Test equipment (please refer to chapter 6 for details)
18 – 19

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Attenuator 6 dB	WA2-6	Weinschel	8254	410119	Calibration not necessary	
2	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
3	Software	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
4	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
5	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
6	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
7	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
8	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
9	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	08.12.2021	12.2023
10	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2020	02.2022
11	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda-Miteq	2089798	482968	Calibration not necessary	
12	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda-Miteq	2110911	482969	17.02.2020	02.2022
13	Low Noise Amplifier 26 MHz - 40 GHz	LNA-30-26004000-27-10P	Narda-Miteq	2110293	482970	17.02.2020	02.2022
14	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
15	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	
16	Standard Gain Horn 20 dB, 26 GHz - 40 GHz	22240-20	Flann	266405	483027	Calibration not necessary	
17	Standard Gain Horn 12 GHz - 18 GHz dBi	18240-20	Pro Nova	269813	483215	Calibration not necessary	
18	EMI Testreceiver	ESR7	Rohde & Schwarz	101939	482558	18.02.2020	02.2022
19	DC Block	7003	Weinschel	F6517	480712	Calibration not necessary	

7 Test site Verification

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

8 Report History

Report Number	Date	Comment
F212286E5	15.02.2022	Initial Test Report
F212286E5 2nd Version	16.02.2022	clause 1.1: name of applicant changed to Robert Bosch GmbH
-	-	-

9 List of Annexes

Annex A	Test Setup Photos	14 pages
Annex B	EUT External Photos	4 pages
Annex C	EUT Internal Photos	9 pages