

Test Report

Report Number:

F231078E4

Equipment under Test (EUT):

KOSTAL COM2020 EMC0

Applicant:

KOSTAL Engineering CR, spol. s r.o.

Manufacturer:

KOSTAL Engineering CR, spol. s r.o.



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

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.

“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 10.2.8.2 of ANSI C63.4 (2014). However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

This test report is only valid in its original form.

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

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

Contents:	Page
1 Identification	5
1.1 Applicant.....	5
1.2 Manufacturer	5
1.3 Test Laboratory	5
1.4 EUT (Equipment under Test)	6
1.5 Technical Data of Equipment	7
1.6 Dates	7
2 Operational States	8
3 Additional Information	8
4 Overview.....	9
5 Results.....	10
5.1 Test setups	10
5.1.1 Radiated: 30 MHz to 1 GHz.....	10
5.1.1.1 Preliminary and final measurement 30 MHz to 1 GHz	10
5.1.2 Radiated: 1 GHz to 2 GHz	12
5.1.2.1 Preliminary and final measurement 1 to 2 GHz	12
5.2 Radiated emissions	14
5.2.1 Test setup (Maximum unwanted emissions)	14
5.2.2 Test method (Maximum unwanted emissions).....	14
5.2.3 Test results (Maximum unwanted emissions)	14
5.2.3.1 Test results (30 MHz – 1 GHz)	14
5.2.3.2 Test results (radiated 1 to 2 GHz)	16
6 Measurement Uncertainties	18
7 Test Equipment used for Tests	19
8 Test site Verification.....	19
9 Report History.....	19
10 List of Annexes	19

1 Identification

1.1 Applicant

Name:	KOSTAL Engineering CR, spol. s r.o.
Address:	Revnicka 170/4, 155 21 Praha-Trebonice
Country:	Czech Republic
Name for contact purposes:	Lucia SKUTOVA
Phone:	+42 0271197497
eMail address:	l.skutova@kostal.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	KOSTAL Engineering CR, spol. s r.o.
Address:	Revnicka 170/4, 155 21 Praha-Trebonice
Country:	Czech Republic
Name for contact purposes:	Libor KOPECKY
Phone:	+42 0271197451
eMail address:	l.kopecky@kostal.com
Manufacturer represented during the test by the following person:	None

1.3 Test Laboratory

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

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

1.4 EUT (Equipment under Test)

Test object: *	Steering column module (KOSTAL COM2020 EMC0)
Model name: *	PSA COM2020
Model number: *	10538719-07
Order number: *	9852618980

	EUT number		
	1	2	3
Serial number: *	93905WG400015	-	-
PCB identifier: *	12171357-01	-	-
Hardware version: *	8.5	-	-
Software version: *	9.4	-	-

* Declared by the applicant

One EUT was used for all tests.



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

1.5 Technical Data of Equipment

General			
Power supply EUT: *	DC		
Supply voltage EUT: *	$U_{nom} = 13.5 \text{ V}$	$U_{min} = 8 \text{ V}$	$U_{max} = 16 \text{ V}$
Temperature range: *	-40 °C to +85 °C		
Lowest / highest internal frequency: *	125 kHz / 16 MHz		
Receiver frequency: *	433 MHz		

* Declared by the applicant

RFID part	
Operating frequency: *	125 kHz
Number of channels: *	1
Type of modulation: *	ASK
Data rate: *	N/A
Antenna type: *	Loop antenna
Antenna connector: *	Customized

* Declared by the applicant

Equipment used for testing	
Ignition lock * ¹	Equipped with a coil antenna for 125 kHz communication
SilverBoxV2 * ¹	Sets the EUT in operation mode

*¹ Provided by the applicant

Ancillary equipment	
-	-

1.6 Dates

Date of receipt of test sample:	13.07.2023
Start of test:	21.09.2023
End of test:	21.09.2023

2 Operational States

Description of function of the EUT:

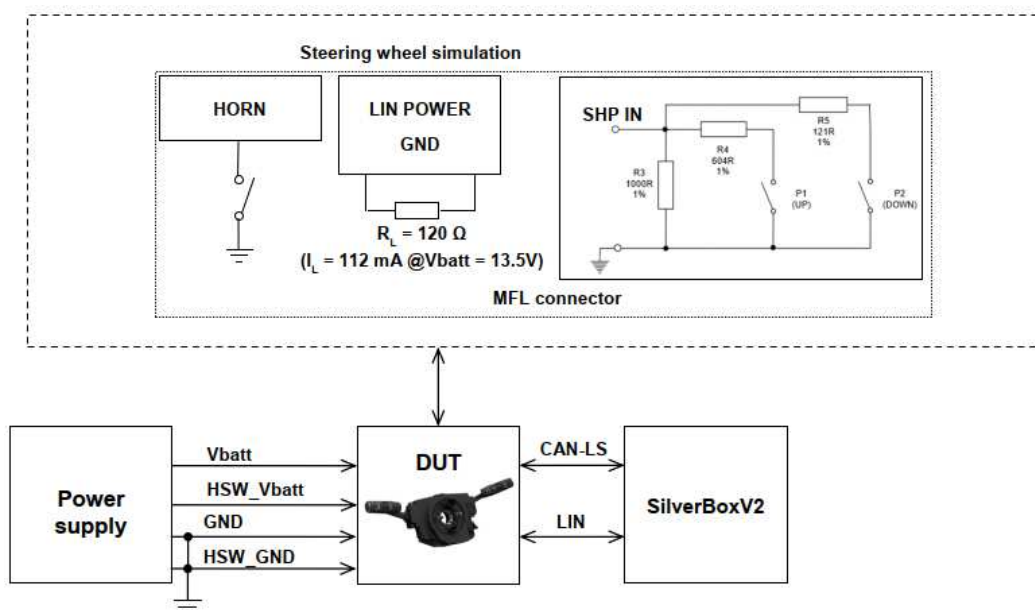
The EUT is a main unit of the steering wheel (steering column module) with an implemented 125 kHz RFID system used as an immobilizer. The TAG is a car key. If the EUT doesn't detect the correct key, the car cannot be started.

The following states were defined as the operating conditions:

This test was carried out to address the spurious emissions of the 433 MHz receiver.

During all tests the EUT was supplied by 13.5 V DC a laboratory power supply.
An ignition lock with key and a SilverBoxV2 were connected to the EUT. The 125 kHz transmitter was shut off during the tests.

The system was setup as follows:



3 Additional Information

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

4 Overview

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 B	30 to 88 MHz	40.0 dB(μ V/m) QP at 3 m	ANSI C63.4	1	Passed
	88 to 216 MHz	43.5 dB(μ V/m) QP at 3 m			
	216 to 960 MHz	46.0 dB(μ V/m) QP at 3 m			
	960 to 1000 MHz	54.0 dB(μ V/m) QP at 3 m			
	above 1000 MHz	54.0 dB(μ V/m) AV at 3 m and 74.0 dB(μ V/m) PK at 3 m			

Radiated emissions ICES-003 Issue 7 section 3.2.2 [4]					
Application	Frequency range	Limits	Reference standard	Tested EUT	Status
Radiated Emission Class B	30 to 88 MHz	40.0 dB(μ V/m) QP at 3 m	ANSI C63.4	1	Passed
	88 to 216 MHz	43.5 dB(μ V/m) QP at 3 m			
	216 to 230 MHz	46.0 dB(μ V/m) QP at 3 m			
	230 to 960 MHz	47.0 dB(μ V/m) QP at 3 m			
	960 to 1000 MHz	54.0 dB(μ V/m) QP at 3 m			
	above 1000 MHz	54 dB(μ V/m) AV at 3 m and 74 dB(μ V/m) PK at 3 m			

Remark: Because the receiver of the EUT operates at 433 MHz, the radiated emission must be carried up to 2 GHz.

Remark: Because the EUT is for vehicular use, no conducted emissions on supply line were carried out.

Remark: The EUT was classified by the applicant as CLASS B equipment

5 Results

5.1 Test setups

5.1.1 Radiated: 30 MHz to 1 GHz

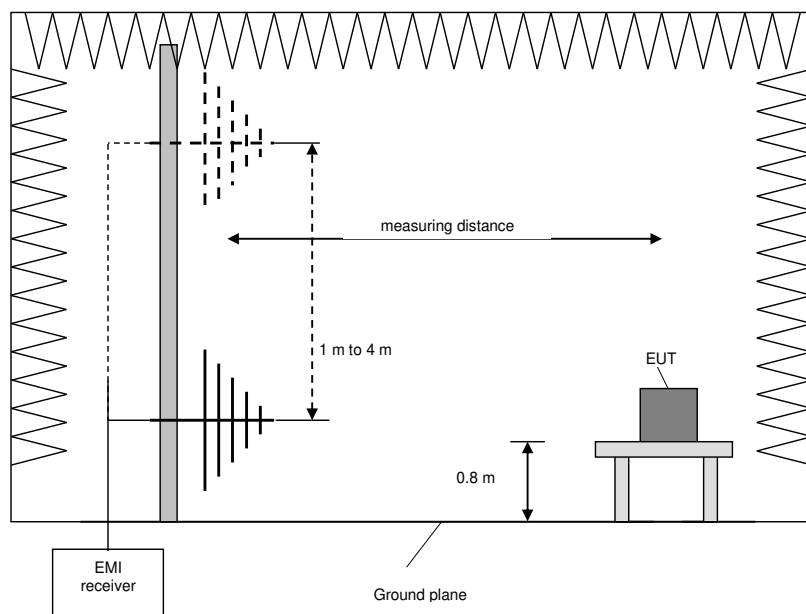
5.1.1.1 Preliminary and final measurement 30 MHz to 1 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber with a metal ground plane at a measuring distance of 3 meters. Table-top 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 with [1].

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	Measuring time	Detector
Preliminary measurement	30 MHz to 1 GHz	30 kHz	120 kHz	-	Peak Average
Frequency peak search	± 120 kHz	10 kHz	120 kHz	1 s	Peak
Final measurement	30 MHz to 1 GHz	-	120 kHz	1 s	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.

8)

5.1.2 Radiated: 1 GHz to 2 GHz

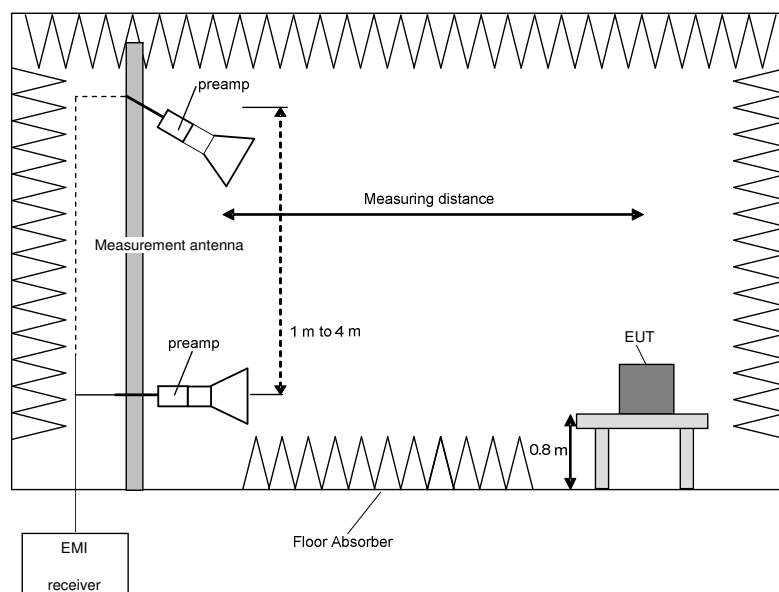
5.1.2.1 Preliminary and final measurement 1 to 2 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber at a measuring distance of 3 meters, with floor absorbers between EUT and measuring antenna. Table-top 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 with [1].

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. 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	Step-size	Resolution bandwidth	Measuring time	Detector
Preliminary measurement	1 - 2 GHz	250 kHz	1 MHz	-	Peak Average
Frequency peak search	+ / - 1 MHz	50 kHz	1 MHz	100 ms	Peak
Final measurement	1 - 2 GHz	-	1 MHz	100 ms	Peak Average



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.

5.2 Radiated emissions

5.2.1 Test setup (Maximum unwanted emissions)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Radiated: 30 MHz to 1 GHz / 1 GHz to 40 GHz	5.1.1 / 5.1.2	-

5.2.2 Test method (Maximum unwanted emissions)

☒ Test method (radiated) see sub-clause 5.1.1 / 5.1.2 as described herein

5.2.3 Test results (Maximum unwanted emissions)

5.2.3.1 Test results (30 MHz – 1 GHz)

Ambient temperature:	22 °C
Relative humidity:	52 %

Date:	21.09.2023
Tested by:	S. KREHS

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: The EUT was measured in its normal position / orientation.

Calculations:

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

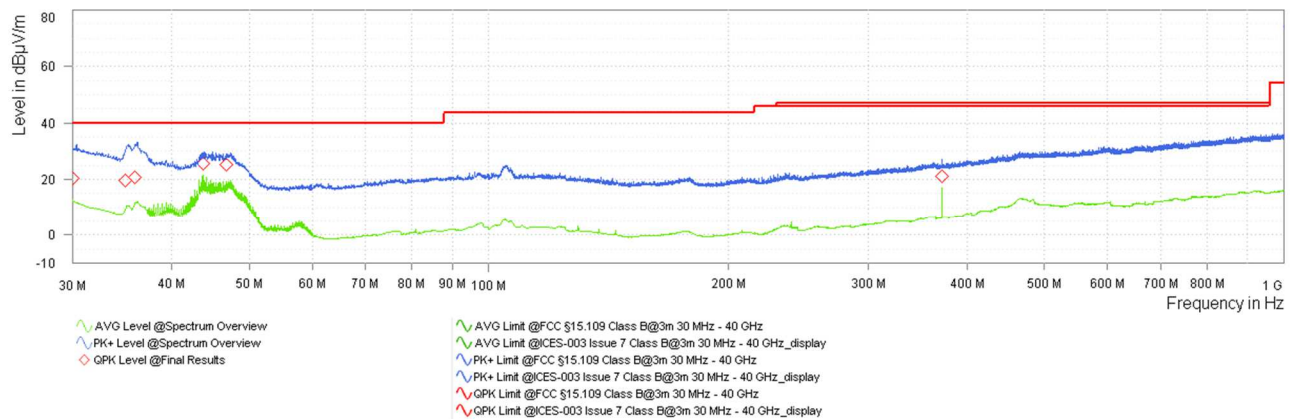
Correction [dB/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]

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

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

Worst case plot:

Spurious emissions from 30 MHz to 1 GHz:



Result tables:

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Correction [dB/m]	Height [m]	Azimuth [deg]	Pol. (H/V)
30.030	20.51	40.00	19.49	25.96	1.28	208	H
34.920	19.71	40.00	20.29	23.08	1.15	147	H
35.910	20.58	40.00	19.42	22.52	1.26	274	H
43.710	25.69	40.00	14.31	17.73	1.10	206	V
46.860	25.41	40.00	14.59	15.75	1.27	325	V
371.280	21.20	46.00	24.80	21.18	2.40	278	V

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 7, 9 - 12

5.2.3.2 Test results (radiated 1 to 2 GHz)

Ambient temperature:	22 °C
Relative humidity:	52 %

Date:	21.09.2023
Tested by:	S. KREHS

Position of EUT: For tests for f between 1 GHz and the 5th harmonic, 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: The EUT was measured in its normal position / orientation.

Calculation:

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

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

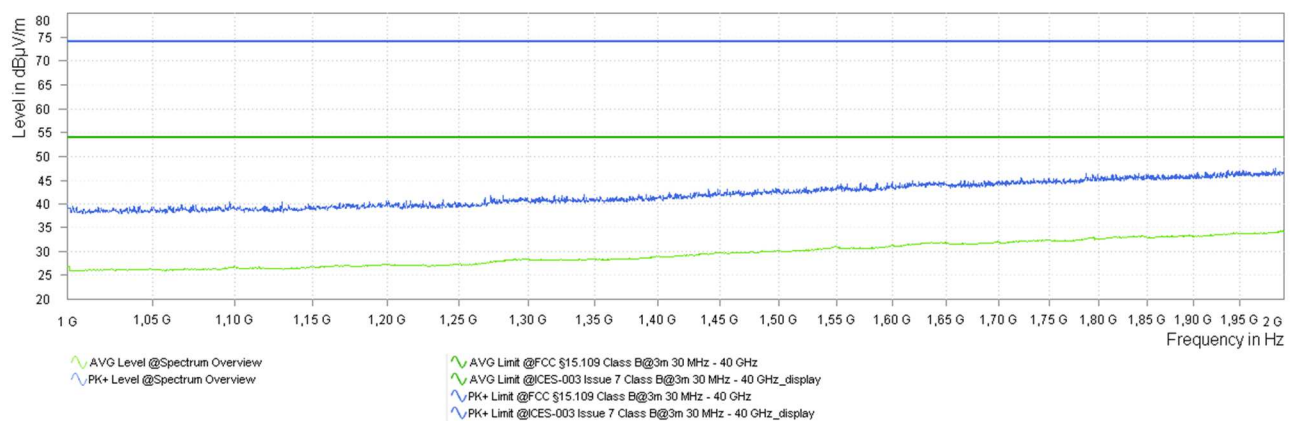
Correction [dB/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB] + DCCF* [dB]
* (if applicable – only for Average values, that are fundamental related)

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

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:

Spurious emissions from 1 GHz to 2 GHz:



Result tables:

Frequency [MHz]	MaxPeak [dB(µV/m)]	Average [dB(µV/m)]	Limit [dB(µV/m)]	Margin [dB(µV/m)]	Height [cm]	Pol [H/V]	Azimuth [deg]	Corr. [dB]
No significant emissions found.								

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 - 8, 11, 12

6 Measurement Uncertainties

Conducted measurements		
Measurement method	Standard used for calculating measurement uncertainty	Expanded measurement uncertainty (95 %) U_{lab}
Conducted emissions from 150 kHz to 30 MHz with LISN	CISPR 16-4-2	2.8 dB

Radiated measurements		
Radiated field strength M276		
R&S HL562E @ 3 m 30 MHz – 1 GHz	CISPR 16-4-2	4.8 dB
R&S HL050 @ 3 m	-	
1 – 6 GHz	CISPR 16-4-2	5.1 dB
6 – 18 GHz	CISPR 16-4-2	5.4 dB
Flann Standard Gain Horns 18 – 40 GHz	-	5.9 dB

7 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	RF Switch Matrix	OSP220	Rohde & Schwarz	--	482976	Calibration not necessary	
2	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
3	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
4	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
5	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
6	Test software M276	EMC32 V11.30	Rohde & Schwarz	100970	482972	Calibration not necessary	
7	EMI Test receiver	ESW44	Rohde & Schwarz	101828	482979	08.12.2021	12.2023
8	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	22.09.2022	09.2025
9	Attenuator 6 dB	WA2-6	Weinschel	--	482793	Calibration not necessary	
10	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
11	Digital multimeter	971A	Hewlett Packard	JP39009358	480721	07.09.2023	09.2024
12	Power supply	TOE 8852 (DC)	Toellner Electronic Inst.	51712	480233	Calibration not necessary	

8 Test site Verification

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val. Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA/RSM	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	01.03.2023	28.02.2026
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	28.02.2023	27.02.2026

9 Report History

Report Number	Date	Comment
F231078E4	19.12.2023	Initial Test Report
-	-	-
-	-	-

10 List of Annexes

Annex A Test Setup Photos

5 pages