PHOENIX TESTLAB

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Test Report

Report Number:

F230859E4

Equipment under Test (EUT):

COM2016 CEM2

Applicant:

KOSTAL Engineering CR, spol. s r.o.

Manufacturer:

KOSTAL Bulgaria Automotive EOOD

ilac-MRA

DAkkS
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.

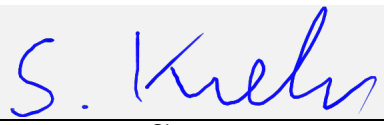
[2] **FCC 47 CFR Part 2:** General Rules and Regulations

[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:		Sebastian KREHS 25.04.2024
	Signature	
Reviewed and approved by:		Bernward ROHDE 25.04.2024
	Signature	

This test report is only valid in its original form.

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

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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:	Mrs. Lucia Skutova
Phone:	+420 271 197 497
eMail address:	l.skutova@kostal.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	KOSTAL Bulgaria Automotive EOOD
Address:	Sinitevska Str.4, 4400 Pazardzhik
Country:	Bulgaria
Name for contact purposes:	Mr. Atanas Kostov Apostolov
Phone:	+359 344 99 621
eMail address:	a.apostolov@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 (SCM)
Model name: *	COM2016 CEM2
Model number: *	12190182-01
Order number: *	98639722YX
FCC ID: *	2BCB9-COM2016
IC certification number: *	31740-COM2016
PMN: *	COM2016
HVIN: *	COM2016

	EUT number		
	1	2	3
Serial number: *	92910WHS0007M	-	-
PCB identifier: *	12095526-04	-	-
Hardware version: *	9.8	-	-
Software version: *	15	-	-

* Declared by the applicant

One EUT was used for all tests.

The EUT was labeled as follows:

As declared by the applicant, this is not the label of the final product. The final product will be labeled as follows:

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 V_{DC}	U_{min} = 8 V_{DC}	U_{max} = 16 V_{DC}
Temperature range: *	-40 °C to +85 °C		
Lowest / highest internal frequency: *	125 kHz / 16 MHz		
Receiver frequency: *	433 MHz		

* Declared by the applicant

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
CAN main connector with 12 V DC supply	Customized plug	D sub 9 pin and 4 mm laboratory plug (2x)	Appr. 2 m	No
SCR main connector	Customized plug	4 mm laboratory plug (4x)	0.30	No
TRSP immobilizer	Customized plug	Fixed at immobilizer	0.10 m	No
SCR airbag connector 1	Customized plug	Fixed	15 cm	No
SCR airbag connector 2	Customized plug	Fixed	15 cm	No

Equipment used for testing	
Vector CAN OE interface*[1]	VN7600
Vector CAN/LIN interface*[1]	VN1630A
433.92 MHz HF transmitter*[1]	Self-made by Kostal
CAN box*[1]	Sets the EUT's 125 kHz part into operation mode
Shift paddels loadbox*[1]	Self-made by Kostal
Testbox Horn*[1]	Self-made by Kostal
Laptop*[1]	Hp

*[1] Provided by the applicant

Ancillary equipment	
Ignition lock *[1]	Equipped with a coil antenna for 125 kHz communication
Key *[1]	-
Multi light switch*[1]	-

*[1] Provided by the applicant

1.6 Dates

Date of receipt of test sample:	15.12.2023
Start of test:	15.01.2024
End of test:	15.01.2024

2 Operational States

Description of function of the EUT:

The EUT is a Steering Column Module for vehicular use only with a 125 kHz key transponder and a 433 MHz immobilizer.

The following states were defined as the operating conditions:

These tests were carried out to address the spurious emissions of the 433 MHz receiver.

During all tests the EUT was supplied by 13.5 V_{DC} via a laboratory power supply.

An ignition lock, a test box for the horn, a loadbox for the shift paddles and a multi light switch were connected to the EUT.
A vector CANoe software “PSA COM2016” delivered by the applicant was running and monitored all functions of the Steering Column Module, especially the status of the 433 MHz receiver.

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 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 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: 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

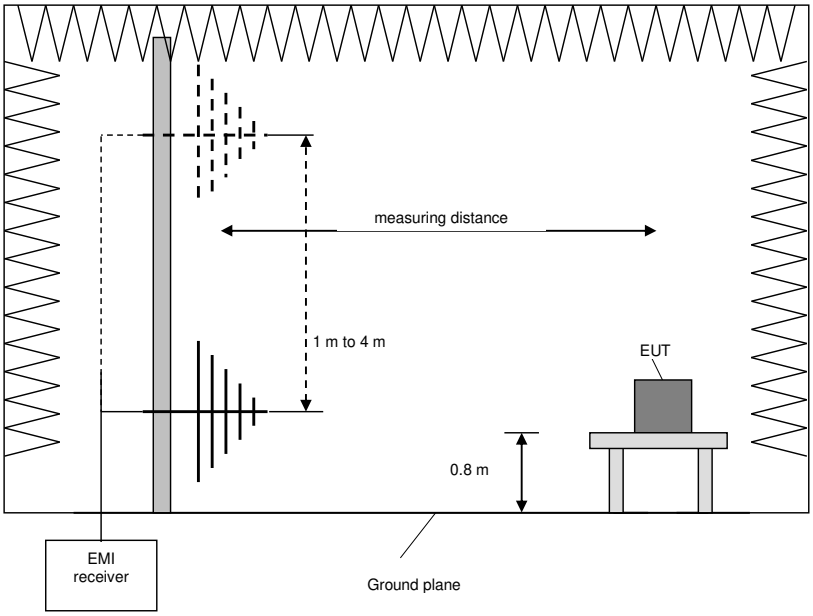
5.1.1.1 Preliminary and final measurement 30 MHz to 1 GHz

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.

5.1.2 Radiated: 1 GHz to 2 GHz

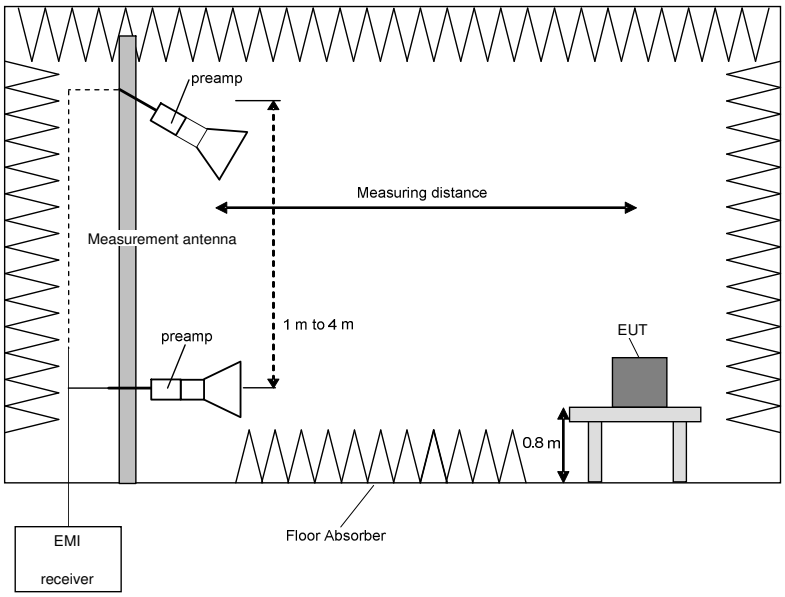
5.1.2.1 Preliminary and final measurement 1 to 2 GHz

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 - 40 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
☒	Radiated: 30 MHz to 1 GHz / 1 GHz to 2 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:	21 °C
Relative humidity:	24 %

Date:	15.01.2024
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:

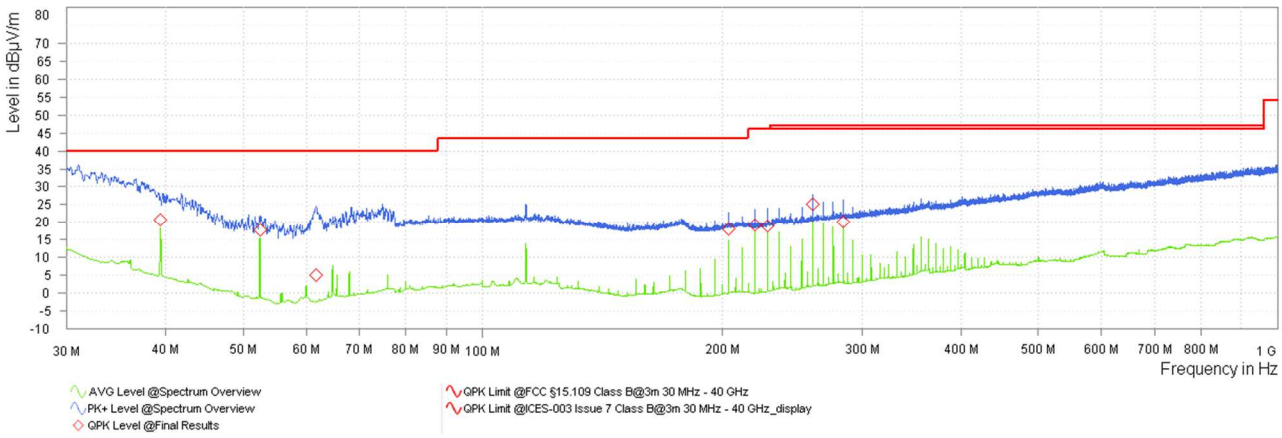
Result [dBµV/m] = Reading [dBµV] + Correction [dB/m]

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.

Spurious emissions from 30 MHz to 1 GHz:



Result tables:

Results according to FCC 47 CFR Part 15 section 15.109 (a), (b) [3]

Frequency [MHz]	Result (QP) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
39.360	20.74	40.00	19.26	0.39	20.35	107	55	V
52.500	17.63	40.00	22.37	5.04	12.59	177	55	V
61.710	5.17	40.00	34.83	-7.40	12.57	305	10	H
204.000	18.14	43.50	25.36	2.31	15.83	104	18	H
219.990	19.07	46.00	26.93	3.31	15.76	147	186	H
228.000	19.01	46.00	26.99	2.66	16.35	148	182	H
260.010	25.05	46.00	20.95	7.44	17.61	124	27	H
284.010	20.13	46.00	25.87	1.81	18.32	104	346	H

Results according to ICES-003 Issue 7 section 3.2.2 [4]

Frequency [MHz]	Result (QP) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
39.360	20.74	40.00	19.26	0.39	20.35	107	55	V
52.500	17.63	40.00	22.37	5.04	12.59	177	55	V
61.710	5.17	40.00	34.83	-7.40	12.57	305	10	H
204.000	18.14	43.50	25.36	2.31	15.83	104	18	H
219.990	19.07	46.00	26.93	3.31	15.76	147	186	H
228.000	19.01	46.00	26.99	2.66	16.35	148	182	H
260.010	25.05	47.00	21.95	7.44	17.61	124	27	H
284.010	20.13	47.00	26.87	1.81	18.32	104	346	H

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 8, 10, 11

5.2.3.2 Test results (radiated 1 to 2 GHz)

Ambient temperature:	21 °C
Relative humidity:	24 %

Date:	15.01.2024
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]

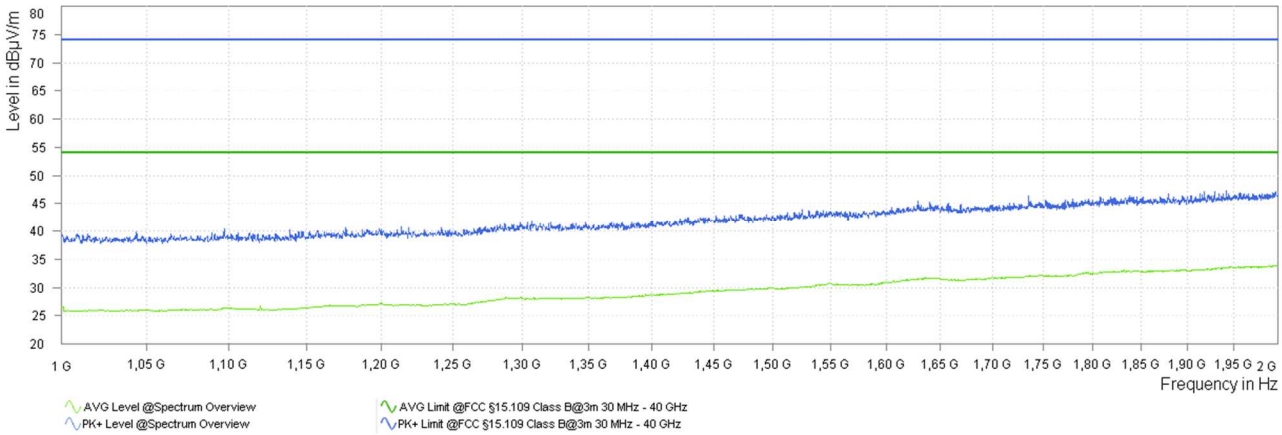
Correction [dB/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]+DCCF* [dB]
* (if applicable – only for Average values, that are fundamental related)

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)
3 - 11

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	Attenuator 6 dB	WA2-6	Weinschel	---	482793	Calibration not necessary	
2	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
3	Test Software M276	Elektra	Rohde & Schwarz	101381	483755	Calibration not necessary	
4	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
5	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
6	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
7	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
8	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	08.12.2021	02.2024
9	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	22.09.2022	09.2025
10	Power supply	TOE 8852 (DC)	Toellner Electronic Inst.	51712	480233	Calibration not necessary	
11	Digital multimeter	971A	Hewlett Packard	JP39009358	480721	07.09.2023	09.2024

8 Test site Verification

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA/RSM	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	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
F230859E4	25.04.2024	Initial Test Report
-	-	-
-	-	-

10 List of Annexes

Annex A Test Setup Photos 4 pages