

Test Report

Report Number:

F221817E5

Equipment under Test (EUT):

CTP3NA

Applicant:

Robert Bosch GmbH

Manufacturer:

Robert Bosch GmbH



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.

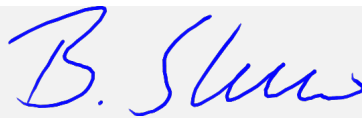
Tested and written
by:



Michael DINTER
05.03.2024

Signature

Reviewed and
approved by:



Bernd STEINER
05.03.2024

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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Phone:	+49 5121-49-7662
eMail address:	karin.silberhorn@de.bosch.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Robert Bosch GmbH
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Name for contact purposes:	Karin SILBERHORN
Phone:	+49 5121-49-7662
eMail address:	karin.silberhorn@de.bosch.com
Manufacturer represented during the test by the following person:	-

1.3 Factory

Name:	Bosch Car Multimedia Portugal, S.A.
Address:	Rua Max Grundig, 35-Lomar, 4705-820 Braga
Country:	Portugal
Name for contact purposes:	-
Phone:	-
eMail address:	-
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 Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.5 EUT (Equipment under Test)

Test object: *	Telematic Control Unit
Model name: *	CTP3NA
Model number	CTP3NA EXT
Order number: *	-

	EUT number
	1
Serial number: *	1150003406
PCB identifier: *	8157-01
Hardware version: *	C2
Software version: *	DAIMLER_CTP3_ISTANBUL_RC2_S.010
Type Plate	 The image shows a metal type plate for a Bosch CTP3NA Telematic Control Unit. It contains several labels: an ICCID label, an IMEI label, a label with '7 520 005 115-02 Made in Portugal', a 'HW2/SW3' label, a 'SER. NO.: 1150003406 Engineering Sample' label, a 'BOSCH' logo, a 'DC A 001 446 39 60 ZGS001 CTP3NA' label, a 'HW: 4138H04 10277515L 12V/24V DC / 2A/1A' label, and a 'Robert Bosch GmbH Business Unit CVD Robert - Bosch - Platz 1 70839 Gerlingen / Germany' label. There are also two QR codes and a CE mark.

* 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.

1.6 Technical Data of Equipment

General			
Power supply EUT: *	DC		
Supply voltage EUT: *	$U_{nom} = 12 / 24 \text{ V DC}$	$U_{min} = 8 \text{ V DC}$	$U_{max} = 32 \text{ V DC}$
Temperature range: *	-40 °C to +60 °C		
Highest internal frequency: *	radio frequency: WiFi 5GHz: 5825 MHz internal clock frequency: 125MHz		

* Declared by the applicant

The device contains three radio modules:

- GNSS receiver
 - Bluetooth™ / WiFi Combo module
 - Cellular Module in three regional variants
- UBX-M9140-KA from uBlox
ATC6NPL002 from LGIT (FCC/IC/RED certified)
MT2731 from WNC
(FCC/IC/EU/JP certified) having PTCRB and GCF approval,
depending on their region (TE, TN and TA)

WLAN part 2.4 / 5 Ghz (> 5725 MHz (SRD part))	
Fulfil WLAN specification: *	802.11b/g/n/ac/ax 802.11a/n/ac/ax
Operating frequency range: *	2412 to 2472MHz for 802.11b/g/n/ac/ax 2.4GHz (20/40 MHz) 5180 to 5825MHz for 802.11a/n/ac/ax 5GHz (20/40/80 MHz)
Number of channels: *	IEEE 802.11 b/g/n20/ax20: 13 IEEE 802.11 n40/ax40: 9 IEEE 802.11a/n20/axc20/ax20 5 IEEE 802.11n40/ac40/ax40 2 IEEE 802.11/ac80/ax80 1
Type of modulation: *	IEEE 802.11 b: DSSS (1Mbps DBPSK, 2Mbps DQPSK, 5.5/11Mbps CCK) IEEE 802.11 g: OFDM (6/9Mbps BPSK, 12/18Mbps QPSK, 24/36Mbps 16-QAM, 48/54Mbps 64-QAM) IEEE 802.11n (HT20): OFDM (BPSK, QPSK, 16-QAM, 64-QAM) IEEE 802.11n (HT40): OFDM (BPSK, QPSK, 16-QAM, 64-QAM) IEEE 802.11ax (HE20): OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM) IEEE 802.11ax (HE40): OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM) IEEE 802.11ax80 (HE80) BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM
Power supply WLAN module: *	DC
Supply voltage WLAN module: *	3.3 V & 1.8 V
Antenna type / name: *	External antenna (refer to antennas)

* Declared by the applicant

Bluetooth part	
Fulfills Bluetooth specification: *	Bluetooth 5.0 / Bluetooth Low Energy (BLE) 5.0
Operating frequency range: *	2402 to 2480 MHz
Number of channels: *	Bluetooth: 79 BLE: 40
Type of modulation: *	Bluetooth: 1 Mbps: GFSK, 2 Mbps: $\pi/4$ -DQPSK, 3 Mbps: 8DPSK BLE: GFSK (1 Mbit/s; 2 Mbit/s; 500 kbit/s; 125 kbit/s)
Power supply WLAN module: *	DC
Supply voltage WLAN module: *	3.3 V & 1.8 V
Antenna type / name: *	External antenna (refer to antennas)

* Declared by the applicant

Cellular part:			
Manufacturer: *	WNC (Module), MTK (Core)		
Model name: *	MT2731 (UMC-MT2731CDJ)		
Power supply module: *	DC by host		
Supply voltage module: *	$U_{nom} = 4.0 \text{ V DC}$	$U_{min} = 3.8 \text{ V DC}$	$U_{max} = 4.2 \text{ V DC}$
Hardware version: *	n.a.		
Firmware version: *	RX.40/41.12		
Supported bands: *	GSM/GPRS/EDGE: 900/1800 MHz LTE FDD: Band 1, 3, 7, 8, 20, 28**		
Max. output power: *	GSM/GPRS/EDGE: Class 4 (33 dBm) @ 900 MHz Class 1 (30 dBm) @ 1800 MHz LTE FDD: Class 3 (23 dBm)		
Antenna type / name: *	External antenna (refer to antennas)		

* Declared by the applicant

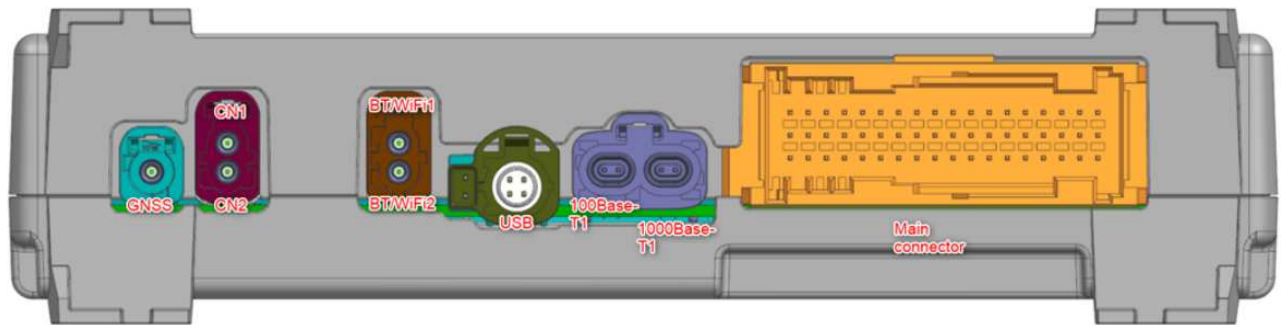
** Not all bands are used in the end application.

GNSS part			
GNSS module type: *	UBX-M9140-KA		
Power supply GNSS module: *	DC		
Supply voltage GNSS module: *	$U_{nom} = 3.3 \text{ V DC}$	$U_{min} = 1.65 \text{ V DC}$	$U_{max} = 3.6 \text{ V DC}$
Hardware version: *	Product revision: C1100A		
Firmware version: *	EXT Core 4.04 (7f89f7)		
Supported GNSS: *	GPS L1C/A, GLONASS L1OF, Galileo E1-B/C		
Antenna type / name: *	External antenna (refer to antennas)		

* Declared by the applicant

Used antennas	
Antenna 1	
Antenna type	Rooftop combined antenna
Antenna Model / Brand	LU Antenne F GNSS WLAN Bluetooth GSM (A 006 820 39 75)
Antenna gain	Cellular: 698 - 960 MHz: 3.4 dBi; 1444 - 1551 MHz: 4.0 dBi; 1710 - 2690 MHz: 5.0 dBi; 3300 - 4200 MHz: 6.1 dBi; 4400 - 5000 MHz: 5.7 dBi; WLAN & BT: 2400 - 2480 MHz: 6.2 dBi; 5150 - 5835 MHz: 8.2 dBi
Connector	3x Fakra male (GNSS coding C, cellular coding D, WLAN & BT coding I)
Antenna 2	
Antenna type	dashboard antenna BT & WiFi
Antenna Model / Brand	ZB Antenne WLAN (A 006 820 82 75)
Antenna gain	WLAN & BT: 2400 - 2480 MHz: 1dBi; 5150 - 5835 MHz: 6 dBi
Connector	Fakra male coding K
Antenna 3	
Antenna type	CN RX diversity antenna
Antenna Model / Brand	LU Antenne F GSM (A 006 820 40 75)
Antenna gain	Cellular: 698 - 960 MHz: 0 dBi; 1444 - 1551 MHz: - dBi; 1710 - 2690 MHz: 3 dBi; 3300 - 4200 MHz: 2 dBi; 4400 - 5000 MHz: 2 dBi
Connector	Fakra female coding D

* Declared by the applicant



Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
Main Connector	54 Pin Connector	Customized	Appr. 3 m	No
GNSS	Fakra HFM single coding C	Fakra (Antenna)	Appr. 2 m	Yes
CN1 / CN2	Fakra HFM double coding D	2 x Fakra (Antenna)	Appr. 2 m	Yes
BT/ WiFi 1 / BT/ WiFi 1	Fakra HFM double coding F	2 x Fakra (Antenna)	Appr. 2 m	Yes
USB	HSD+2 coding C	USB	Appr. 2 m	Yes
100 base T1 / 1000 Base T1	H-MTD	Customized	Appr. 2 m	Yes

Equipment used for testing*1				
Antenna	illustration	B- sample FAKRA Code	C- sample FAKRA Code	TE
GNSS +CN1+WiFi/BT		GNSS: C (Blue) CN: D (Bordeaux) WiFi/Bt: I (Beige)	GNSS: C (Blue) CN: D (Bordeaux) WiFi/Bt: I (Beige)	new Part Number-1
CN2		CN2: N (Pastell Green)	CN2: D (Bordeaux)	new Part Number-2
WiFi2		WiFi2: K (Curry)	WiFi2: K (Curry)	A1779052902

*1 Provided by the applicant

Ancillary equipment	
Laptop Siemens Fujitsu* ¹	Siemens Fujitsu CELSIUS H770
CAN OE 4 Port * ¹	Vector VN5620 Ethernet/CAN interface (Asset No.19933)
CAN OE 1 Port* ¹	Vector VN1610 CAN interface (Asset No.11866)
2 x ETHERNET to USB converter* ¹	Lenovo ModelPN:RTL8153
USB HUB 1* ¹	D-LINK DUB-H7 P/N:EUBH/EB.....F1E
USB HUB 2* ¹	BELKIN F5U404-BLK
WLAN Router* ¹	DIR-X5460 P/N:EIRX5460MEU..A1E
Loadbox* ¹	CTP3 EMC Loadbox (by Bosch)
K-Line to OBD Usb dongle* ¹	K ² L901 USB to OSD
Card reader with card* ¹	Daimler Truck AG ZB CHIP CARD READER CONTROL UNIT BOX GEN2 A 0088205426 ZGS 002
2 x optical LAN converter pair* ¹	optoLAN-88Q2112-Max WEEE-REG.-Nr. DE22419711
1 x optical USB converter pair* ¹	optoUSB-2.0 MK Messtechnik (PmNr:482028/482029)
2 x optical CAN converter pair* ²	optoCAN-FD MK Messtechnik (PmNr:482203/482204) Optical CAN Transceiver OPTOCAN 2000 (PmNr:482331/482332)

*¹ Provided by the applicant

*² Provided by the laboratory

1.7 Dates

Date of receipt of test sample:	08.08.2023
Start of test:	08.08.2023
End of test:	12.09.2023

2 Operational States

Description of function of the EUT:

The EUT is a telematic Unit to provide fleet management services, remote diagnostics, allows for remote measurement and serves as AP-Server for Internet via WiFi, it combines both multimedia and the following radio technologies.

WLAN: 2.4 GHz / 5 GHz / 5.8 GHz

Bluetooth: BT-classic, BT LE

Cellular: 2G / 4G (GSM / LTE)

GNSS: GPS, GLONASS, Galileo

The following states were defined as the operating conditions:

The EUT was supplied by 24 V DC during the tests, some tests as stated were carried out additionally with 12 V DC supply.

The EUT is connected to a laptop via USB for control and monitoring. Additionally, the interfaces are connected as following:

Automotive ethernet (100Base-T1 / 1000BaseT1) to Laptop via Vector interface box, dummy traffic

3x CAN to Laptop via Vector interface box, dummy traffic

3x RS232 in daisy chain, dummy traffic

Digital I/O to Loadbox, controlled by test script

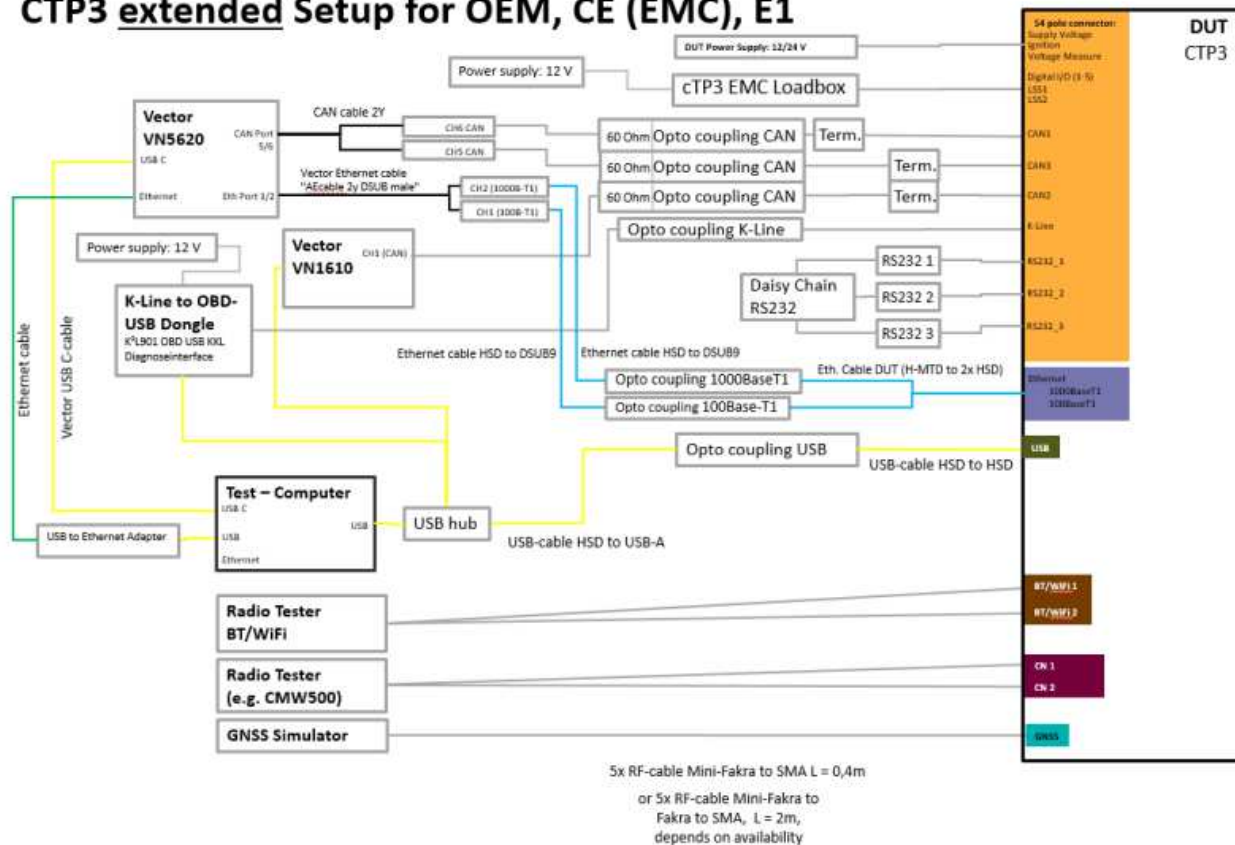
K-Line to Laptop via OBD2-Interface, dummy traffic

Radio Interfaces to the respective radio test equipment CMW500 Cellular (LTE Band 7 idle)

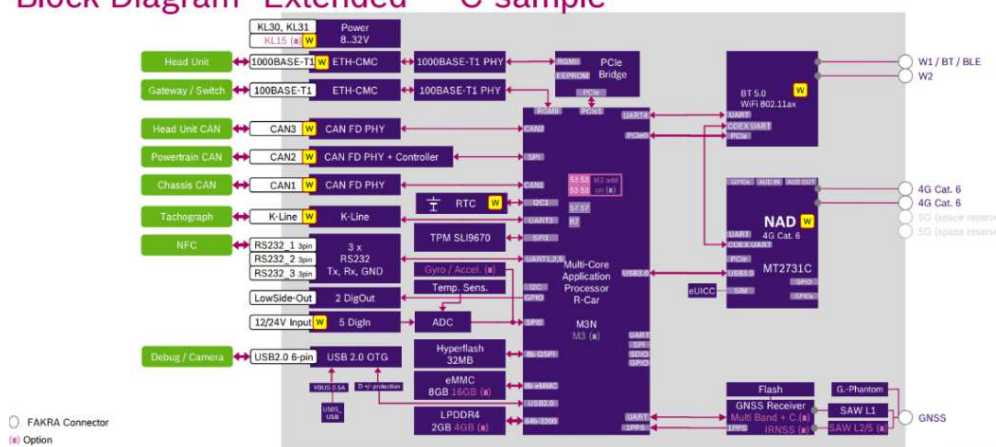
During all tests software (delivered by the applicant) based of "CTP3 Homologation" from 06-Dec-2022 is running and used to monitor the functions of the EUT.(PC FOR HW2/SW3)

The system was setup as follows:

CTP3 extended Setup for OEM, CE (EMC), E1



Daimler Truck CTP3 C-sample Block Diagram "Extended" – C-sample



Overview of operation mode:

CN	WLAN	BT	GNSS	All non radio functions
LTE Band 7	Idle Mode	Bluetooth active, no Surveillance Idle Mode	GPS, GLONASS, Galileo	yes

Definition of settings

Function	Check
CTP3 Ping	Laptop with applicant's software*
CANoe connections CAN 1 CAN 2 CAN 3	Laptop with applicant's software*
ETH1 (100 Mbit)	Laptop with applicant's software*
Power & Temp	Laptop with applicant's software*
Digital Inputs and LowSideSwitches	Laptop with applicant's software*
1000BaseT1 Ethernet	Laptop with applicant's software*
K-Line	Laptop with applicant's software*
RS 232	Laptop with applicant's software*
Security Chip	Laptop with applicant's software*
GNSS	Laptop with applicant's software*
BLE	idle
BT EDR	idle
LTE Band 7	CMW 500 CH21100 @ 2535MHz Idle mode
WLAN	idle

Detailed description of test setups for different test scenarios

Author: Widera Matthias (XC-CT/ECP5) Date: 06-Dec-2022

CTP3 Homologation

Author: Kuhns Gernot (XC-CT/ECP4) Date: 06-Dec-2022

cTP3 Homologation: Test-SW Manual - Bluetooth and BLE

Author: Prenzel Ralf (XC-CT/ECP3) Date: 25-Jan-2023

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 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					

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: As declared by the applicant the highest internal clock frequency is 5.825 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 Test setups

5.1.1 Radiated: 30 MHz to 1 GHz

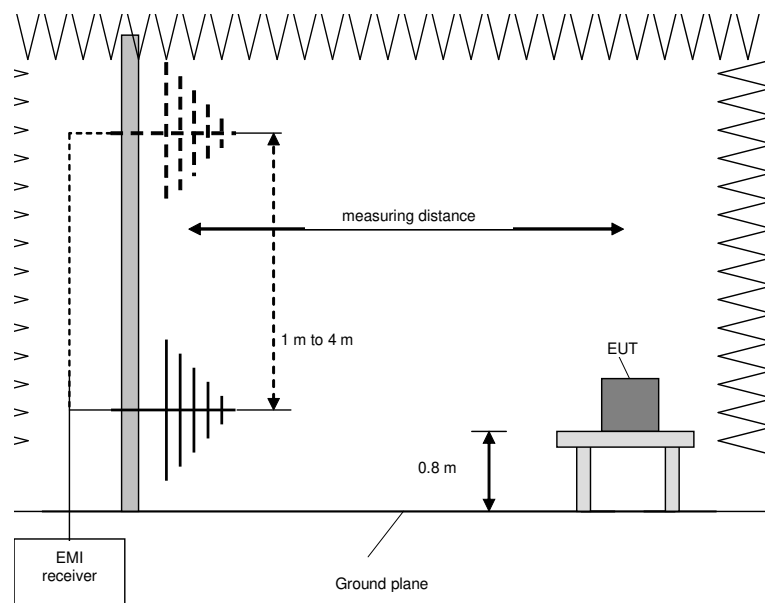
5.1.1.1 Preliminary and final measurement 30 MHz to 1 GHz

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 40 GHz

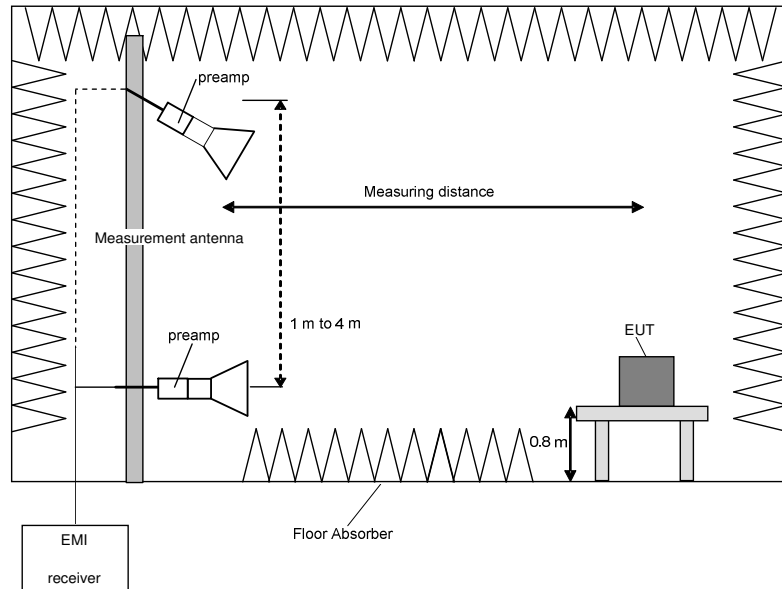
5.1.2.1 Preliminary and final measurement 1 to 40 GHz

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 - 40 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 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:	64 %

Date:	11.09.2023
Tested by:	M. DINTER

Position of EUT: For tests for f between 30 MHz to 1 GHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

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

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

Remark: Only one position was tested as shown in the Annex.

Calculations:

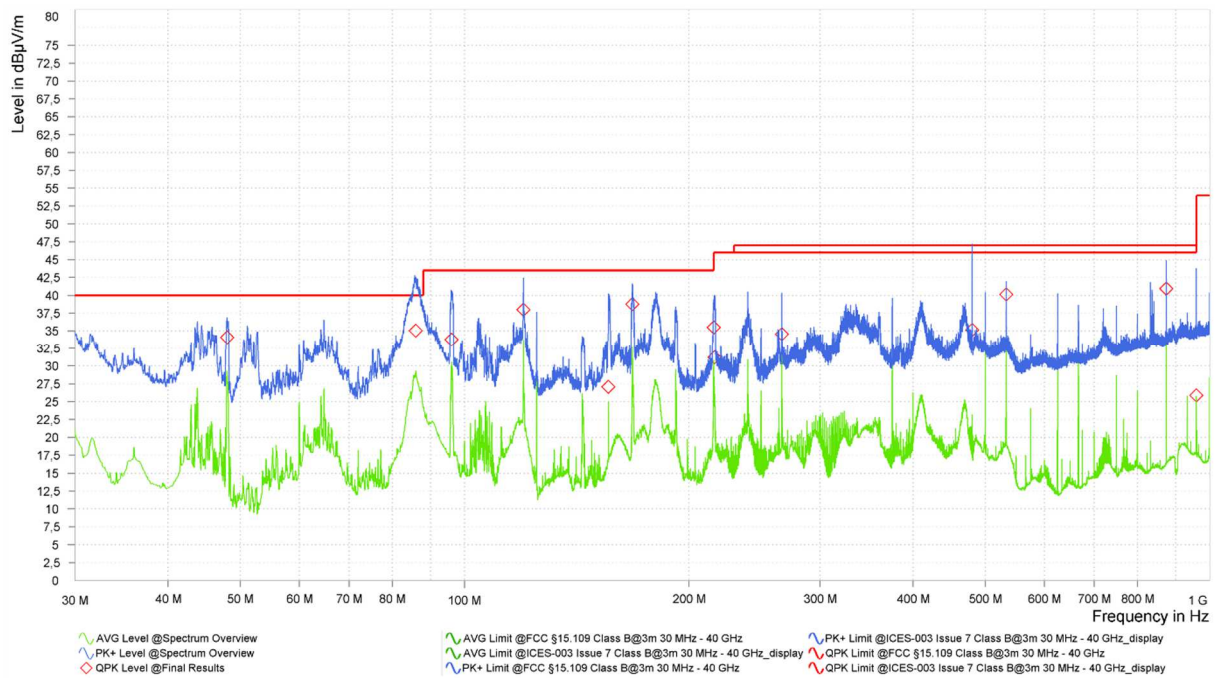
Result [dBμV/m] = Reading [dBμV] + Correction [dB/m]

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]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
48.030	34.08	40.00	5.92	14.98	1.10	356	V
86.040	35.04	40.00	4.96	17.04	1.31	158	V
96.060	33.77	43.50	9.73	17.14	1.50	327	H
120.000	38.00	43.50	5.50	17.61	1.09	92	V
156.000	27.07	43.50	16.43	15.28	1.18	206	V
168.000	38.74	43.50	4.76	15.60	1.01	32	V
216.000	35.47	43.50	8.03	16.24	1.02	327	V
216.480	31.22	46.00	14.78	16.21	1.21	334	H
266.670	34.56	46.00	11.44	18.10	1.00	325	V
480.000	35.15	46.00	10.85	23.98	2.34	346	V
533.310	40.13	46.00	5.87	24.91	1.50	8	V
874.980	40.94	46.00	5.06	29.56	1.00	45	V
959.760	25.88	46.00	20.12	30.43	1.10	117	H

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

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
48.030	34.08	40.00	5.92	14.98	1.10	356	V
86.040	35.04	40.00	4.96	17.04	1.31	158	V
96.060	33.77	43.50	9.73	17.14	1.50	327	H
120.000	38.00	43.50	5.50	17.61	1.09	92	V
156.000	27.07	43.50	16.43	15.28	1.18	206	V
168.000	38.74	43.50	4.76	15.60	1.01	32	V
216.000	35.47	43.50	8.03	16.24	1.02	327	V
216.480	31.22	46.00	14.78	16.21	1.21	334	H
266.670	34.56	47.00	12.44	18.10	1.00	325	V
480.000	35.15	47.00	11.85	23.98	2.34	346	V
533.310	40.13	47.00	6.87	24.91	1.50	8	V
874.980	40.94	47.00	6.06	29.56	1.00	45	V
959.760	25.88	47.00	21.12	30.43	1.10	117	H

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 - 10

5.2.3.2 Test results (radiated 1 to 40 GHz)

Ambient temperature:	23 °C
Relative humidity:	67 %

Date:	12.09.2023
Tested by:	M. DINTER

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: Only one position was tested as shown in the Annex.

Calculation:

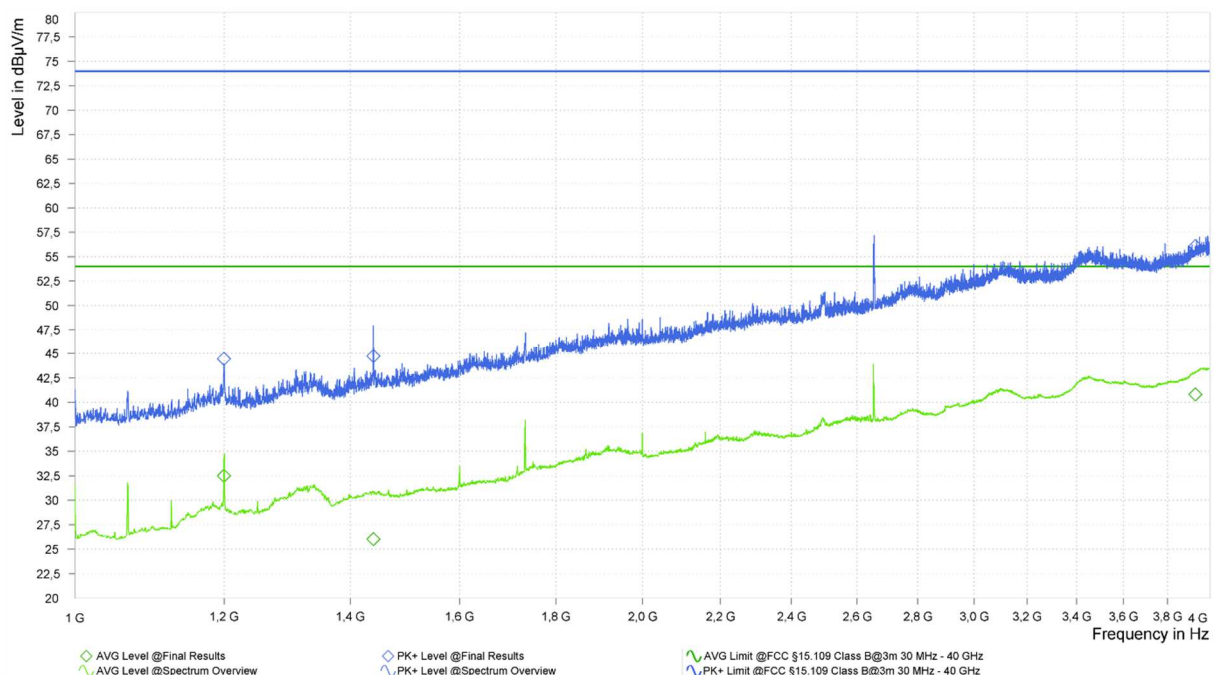
Max Peak [dBμV/m] = Reading [dBμV] + Correction [dB/m]

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)

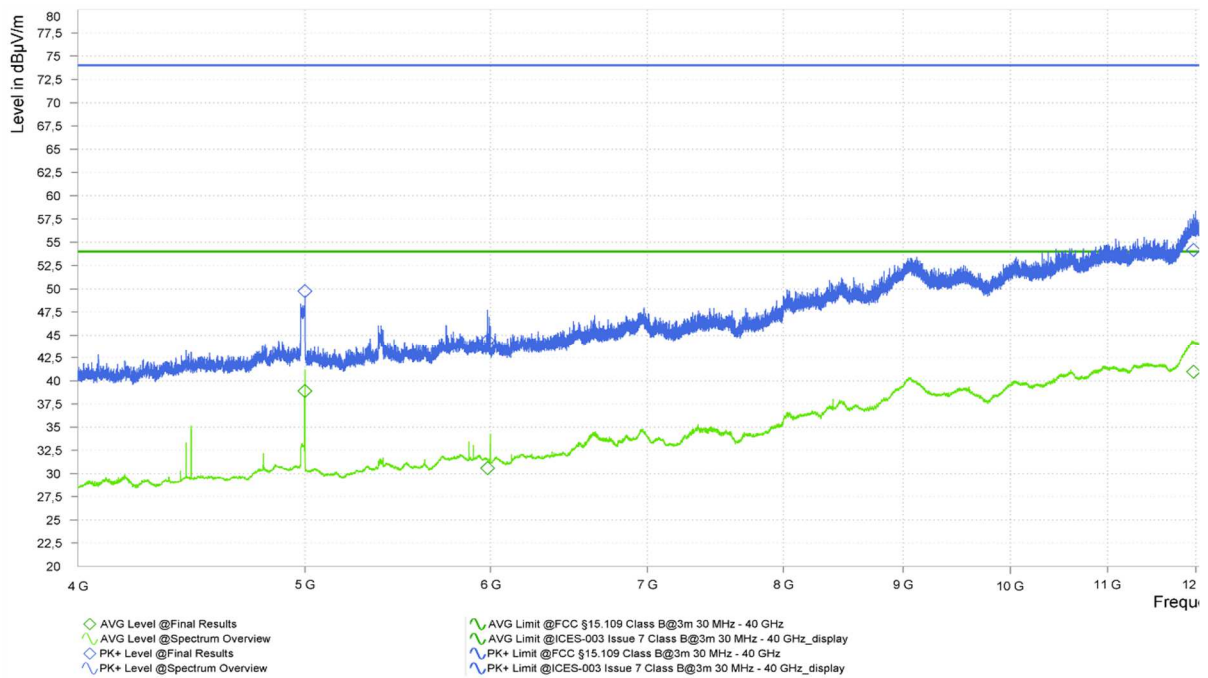
Margin [dB] = Limit [dBμV/m] – Max Peak | Average [dBμV/m]

Spurious emissions from 1 GHz to 4 GHz:

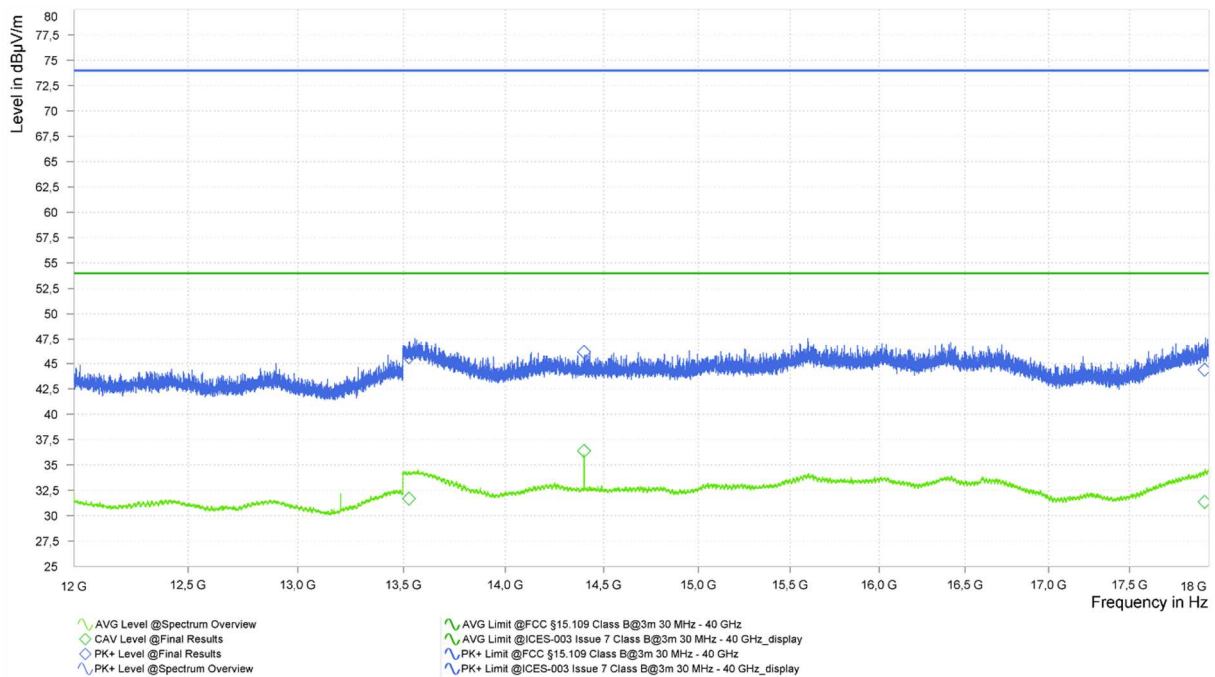


Remark*: The emissions around 2655 MHz are caused by the CMW 500 communication tester downlink channel and not rated for the test.

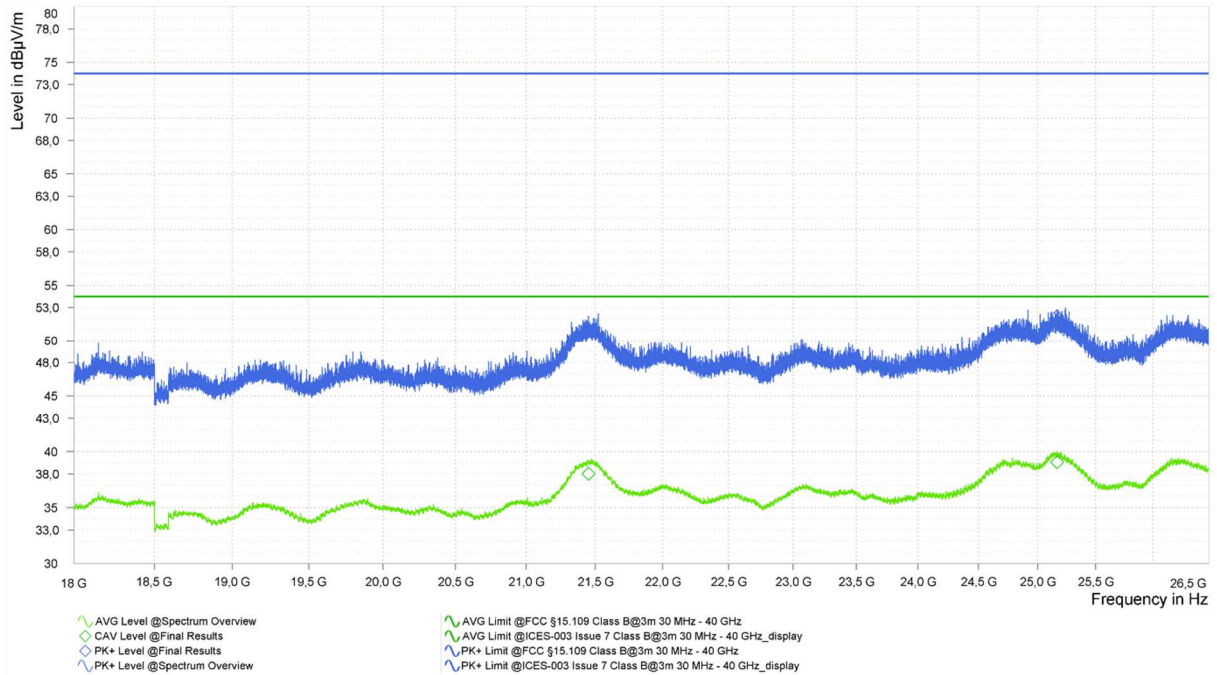
Spurious emissions from 4 GHz to 12 GHz:



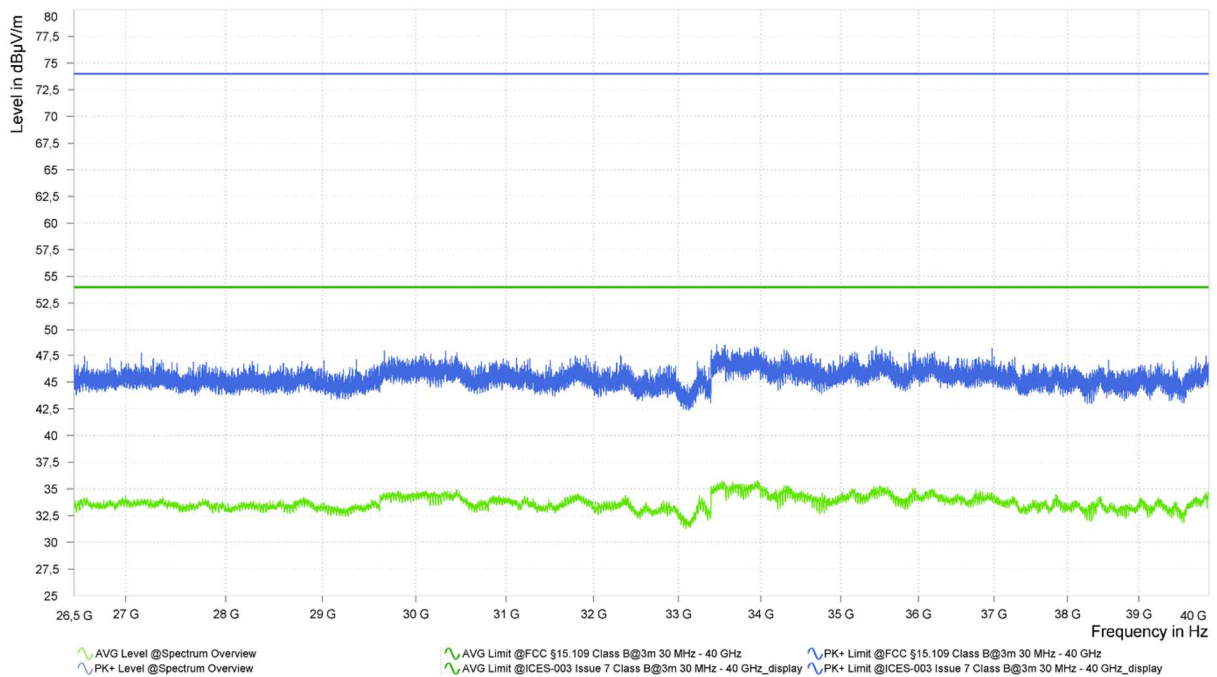
Spurious emissions from 12 GHz to 18 GHz:



Spurious emissions from 18 GHz to 26.5 GHz:



Spurious emissions from 26.5 GHz to 40 GHz:



Result tables:

Frequency [MHz]	MaxPeak [dB(μV/m)]	MaxPeak Limit [dBμV/m]	Peak Margin [dB(μV/m)]	Average [dB(μV/m)]	Average Limit [dB(μV/m)]	Average Margin [dB(μV/m)]	Height [cm]	Pol [H/V]	Azimuth [deg]	Corr. [dB]
1199.750	44.44	74.00	29.56	32.49	54.00	21.51	3.00	V	339	27.27
1440.000	44.74	74.00	29.26	26.04	54.00	27.96	2.50	V	155	29.33
3931.000	56.08	74.00	17.92	40.80	54.00	13.20	1.50	V	129	40.74
5000.000	49.73	74.00	24.27	38.88	54.00	15.12	3.03	V	-8	10.14
5983.250	44.43	74.00	29.57	30.58	54.00	23.42	2.40	V	311	11.96
11969.750	54.17	74.00	19.83	40.98	54.00	13.02	2.43	V	104	23.29
13526.500	45.61	74.00	28.39	31.67	54.00	22.33	2.79	V	255	7.46
14400.000	46.13	74.00	27.87	36.38	54.00	17.62	3.39	V	157	9.27
17974.250	44.36	74.00	29.64	31.36	54.00	22.64	1.82	H	192	10.97
21451.750	50.86	74.00	23.14	38.03	54.00	15.97	2.63	H	57	12.44
25165.750	52.21	74.00	21.79	39.06	54.00	14.94	2.94	V	356	12.65
21451.750	50.86	74.00	23.14	38.03	54.00	15.97	2.63	H	57	12.44
25165.750	52.21	74.00	21.79	39.06	54.00	14.94	2.94	V	356	12.65

Test result: Passed

Test equipment (please refer to chapter 7 for details)
3 - 18

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	8254	410119	Calibration not necessary	
2	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
3	Testsoftware M276	Elektra	Rohde & Schwarz	-	483755	Calibration not necessary	
4	RF Switch Matrix	OSP220	Rohde & Schwarz	101391	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	Wideband Radio Communication Tester	CMW500	Rohde&Schwarz	167339	483023	21.06.2021	06.2024
11	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2022	02.2024
12	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda-Miteq	2089798	482968	Calibration not necessary	
13	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda-Miteq	2110911	482969	18.02.2022	02.2024
14	Low Noise Amplifier 26 MHz - 40 GHz	LNA-30-26004000-27-10P	Narda-Miteq	2110293	482970	18.02.2022	02.2024
15	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	22.09.2022	09.2025
16	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	
17	Standard Gain Horn 20 dB, 26 GHz - 40 GHz	22240-20	Flann	266405	483027	Calibration not necessary	
18	Standard Gain Horn 12 GHz - 18 GHz dBi	18240-20	Pro Nova	269813	483215	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
F221817E1	05.03.2024	Initial Test Report
-	-	-
-	-	-

10 List of Annexes

Annex A	Test Setup Photos	7 pages
Annex B	EUT External Photos	6 pages