

Test Report

Report Number:

F230142E4 2nd Version

Equipment under Test (EUT):

NICP-EM30-IOL-H1141

Applicant:

Turck Beierfeld GmbH

Manufacturer:

Turck Beierfeld GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

References

- [1] **ANSI C63.10-2020 + Cor. 1-2023 + C63.10a-2024 + Errata to C63.10a-2024***, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
*Remark: This standard is not in accreditation scope of the laboratory yet
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **558074 D01 15.247 Meas Guidance v05r02 (April 2019)**, GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
- [4] **RSS-210, Issue 11 (2024-06)** Licence-Exempt Radio Apparatus: Category I Equipment
- [5] **RSS-Gen, Issue 5 2018-04 + AMD 1 2019-03 + AMD 2 (2021-02)** General Requirements for Compliance of Radio Apparatus

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in clause 1.4 of ANSI C63.10 (2020). However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:



Paul Neufeld
30.09.2025

Signature

Reviewed and
approved by:



Bernd STEINER
06.10.2025

Signature

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1 Identification

1.1 Applicant

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Name for contact purposes:	Michael Siegel
Phone:	+49 3774-135-153
eMail address:	Michael.siegel@turck.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Turck Beierfeld GmbH
Address:	Am Bockwald 2, 08344 Grünhain-Beierfeld
Country:	Germany
Name for contact purposes:	Michael Siegel
Phone:	+49 3774-135-153
eMail address:	Michael.siegel@turck.com
Manufacturer represented during the test by the following person:	-

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: *	Inductive Coupler, NICP*
Model name: *	NICP-EM30-IOL-H1141
Model number: *	-
Order number: *	100018258
FCC ID: *	YQ7-NICP-EM30
IC certification number: *	8821A-NICPEM30
PMN: *	NICP-EM30-IOL-H1141
HVIN: *	7630/08
FVIN: *	V1
HMN: *	NA

	EUT number		
	1 (All tests)	2 (AC powerline conducted)	3
Serial number: *	V2_B7_EMV_02	230413_1	-
PCB identifier: *	07763008	07763107	-
Hardware version: *	2.1.0	2.0.0	-
Software version: *	0.2.1.2	1.0.4.0	-

* Declared by the applicant

Two EUTs were 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: *	$U_{nom} = 24.0 \text{ V}$	$U_{min} = 8.0 \text{ V}$	$U_{max} = 32.0 \text{ V}$
Temperature range: *	-25 °C to +55 °C		
Lowest / highest internal frequency: *	16 MHz / 2472 MHz		

* Declared by the applicant

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
NICP-EM30-IOL-H1141 24V SDCI	M12 - Code A	M12 - Code A	~ 2 m	yes
-	-	-	-	-
-	-	-	-	-

EUT frequencies	
20 MHz	
Channel 1	2412 MHz
Channel 2	2417 MHz
Channel 3	2422 MHz
Channel 4	2427 MHz
Channel 5	2432 MHz
Channel 6	2437 MHz
Channel 7	2442 MHz
Channel 8	2447 MHz
Channel 9	2452 MHz
Channel 10	2457 MHz
Channel 11	2462 MHz
Channel 12	2467 MHz
Channel 13	2472 MHz

Proprietary radio mode	
Fulfil radio specification: *1	None (Proprietary)
Radio chip: *1	Semtech SX1281
Antenna type: *1	-
Antenna name: *1	Custom design
Antenna gain: *2	_*2
Antenna connector: *1	-
Supply voltage radio module: *1	$U_{nom} = 24.0 \text{ V}_{DC}$ $U_{min} = 8.0 \text{ V}_{DC}$ $U_{max} = 32.0 \text{ V}_{DC}$
Type of modulation: *1	FSK 2 Mbps
Operating frequency range: *1	2412 MHz – 2472 MHz
Number of channels: *1	13 (5 MHz channel spacing)

*1 declared by the applicant

*2 All tests power end emissions tests were done radiated. Therefore, the antenna gain is not necessary.

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Laptop*2	Fujitsu E751

*1 Provided by the applicant

*2 Provided by the laboratory

Ancillary Equipment	
Fieldbus master*1	TBEN-L5-8IOL

*1 Provided by the applicant

*2 Provided by the laboratory

1.6 Dates

Date of receipt of test sample:	31.07.2023
Start of test:	22.08.2023
End of test:	27.11.2023

2 Operational States

2.1 Description of function of the EUT

The NICP-EM30-IOL-H1141 coupler transmits power and data contact-free over an air gap of a few millimeters. For contactless transmission at least two devices are needed: a primary part (base coupler) and a secondary part (remote coupler). The primary part (base coupler) transfers the energy inductively to the secondary part (remote coupler) which could feed a sensor. During the tests the EUT was connected to a field bus

All tests (apart from the AC powerline-conducted tests) were performed only with the primary part (base coupler).

2.2 The following states were defined as the operating conditions

2.2.1 Radio tests

For the radio tests the following settings were used:

During the radio tests the EUT was connected to a fieldbus master type "TBEN-L5-8IOL", which was provided by the applicant. The fieldbus master was supplied with 24 V DC by a laboratory power supply and was connected to a laptop computer via Ethernet. Using the laptop computer an excel script "Sensor-Configurator-EMV.xlsm" provided by the applicant was used to set the test modes for the radio tests

2.2.2 Operation modes

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	Power setting
1	Proprietary	2412	01	FSK	2 Mbit/s	"-18"
2	Proprietary	2442	07	FSK	2 Mbit/s	"-18"
3	Proprietary	2472	13	FSK	2 Mbit/s	"-18"

3 Additional Information

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

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-210 [4] RSS-Gen [5]	Tested EUT	Status
Radiated emissions (Fundamental field strength and spurious emissions)	0.009 – 26,500*	15.249 (a) 15.205 (a) 15.209 (a)	B.10 [4] 8.9 and 8.10 [5] 7.1 and 7.3 [5]	1	Passed
20 dB Bandwidth	2400.0 - 2483.5	15.215 (c)	-	1	Passed
99% Bandwidth	2400.0 - 2483.5	-	6.7 [3]	1	Passed
Band edge compliance	2400.0 - 2483.5	15.249 (a) 15.205 (a) 15.209 (a)	B.10 [4]	1	Passed
Maximum unwanted emissions	0.009 – 26,500*	15.249 (a)(d)(e) 15.205 (a) 15.209 (a)	B.10 [4] 8.9 [5]	1	Passed*
Antenna Requirement	-	15.203	6.8 [5]	1	Passed
Conducted emissions on supply line	0.15 – 30	15.207 (a)	8.8 [5]	1	Passed

*: As declared by the applicant the highest radio clock frequency is 2.472 GHz.
Therefore, the radiated emission measurement must be carried out up to 10th of the highest radio clock frequency in this case 26.5 GHz.

5 Results

5.1 Test setups

5.1.1 Radiated: 9 kHz to 30 MHz

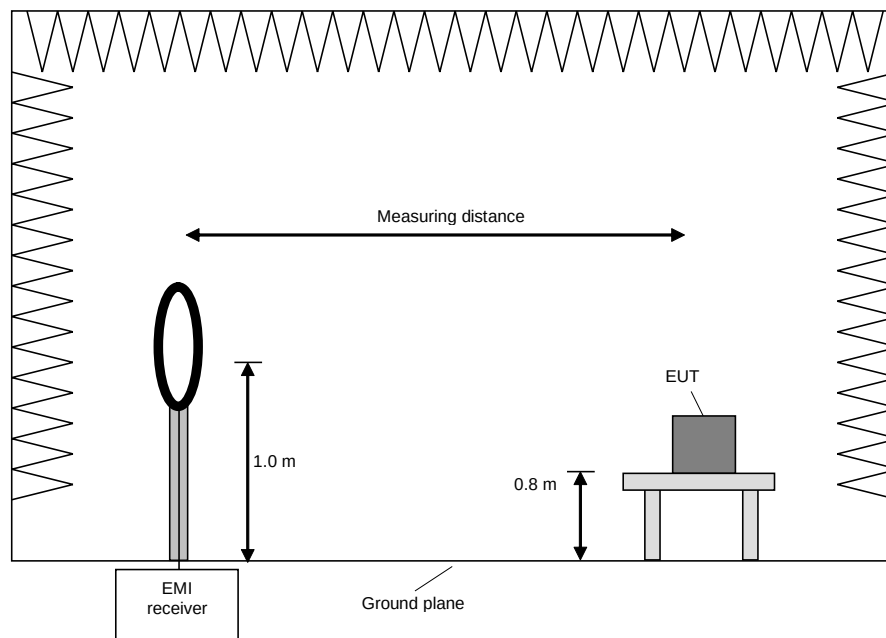
5.1.1.1 Preliminary measurement 9 kHz to 30 MHz

In the first stage a preliminary measurement is performed in a semi-anechoic chamber 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].

The frequency range 9 kHz to 30 MHz is monitored with an EMI receiver while the system and its cables are manipulated to find out the configuration with the maximum emission levels if applicable. The EMI receiver is set to MAX hold mode. The EUT and the measuring antenna are rotated around their vertical axis to find the maximum emission levels.

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

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Procedure preliminary measurement:

Pre-scans are performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure is used:

- 1) Monitor the frequency range with the measuring antenna facing the EUT and an EUT / turntable azimuth of 0°.
- 2) Manipulate the system cables to produce the maximum levels of emissions.
- 3) Rotate the EUT by 360° to maximize the detected signals.

- 4) Measure the frequencies of the highest detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency values.
- 5) If the EUT is portable or ceiling mounted, repeat steps 1 to 4 with other orientations (x,y,z) of the EUT.
- 6) Rotate the measuring antenna and repeat steps 1 to 5.

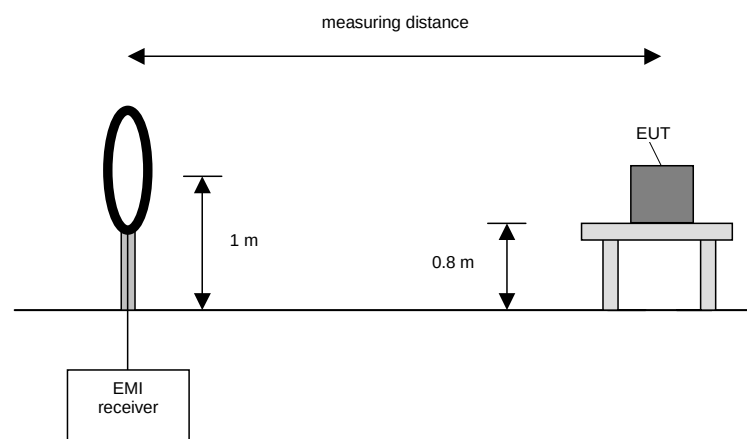
5.1.1.2 Final measurement 9 kHz to 30 MHz

In the second stage a final measurement is performed on an open area test site with no conducting ground plane at a measuring distance of 3 m, 10 m, or 30 m. If the standard requires larger measuring distances for a given frequency, the results are extrapolated according to section 15.31 (f) (2) [2]. The final measurement is performed with an EMI receiver set to Quasi-Peak detector, except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an Average detector is used according section 15.209 (d) [2].

At the frequencies, which were detected during the preliminary measurements, the final measurement is performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum level value is found.

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

Frequency range	Resolution bandwidth	Measuring time
9 kHz to 150 kHz	200 Hz	1 s
150 kHz to 30 MHz	9 kHz	1 s



Procedure final measurement:

The following procedure is used:

- 1) Monitor the selected frequencies from the preliminary measurement with the measuring antenna facing the EUT and an EUT azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals.
- 3) Rotate the measuring antenna and repeat steps 1 to 2 until the maximum value is found and note it.
- 4) If the EUT is portable or ceiling mounted, repeat steps 1 to 3 with other orientations (x,y,z) of the EUT.

5.1.2 Radiated: 30 MHz to 1 GHz

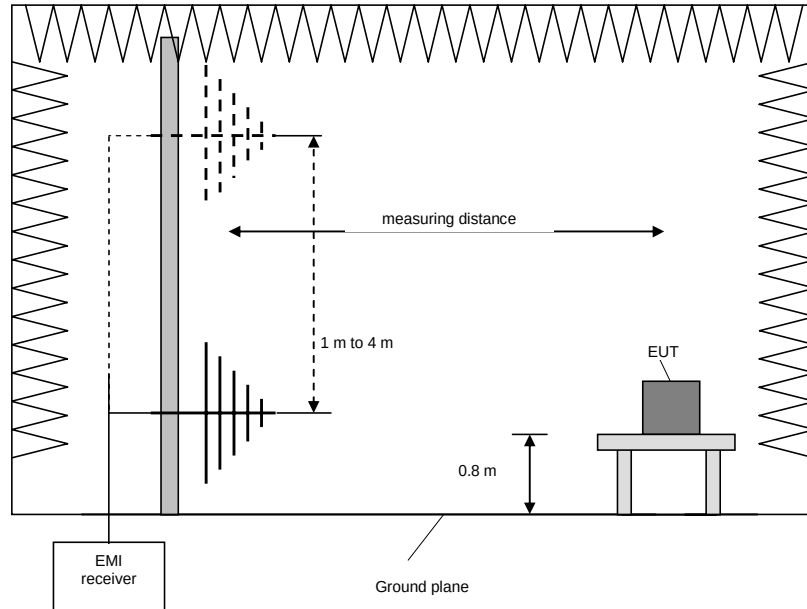
5.1.2.1 Preliminary and final measurement 30 MHz to 1 GHz

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.

5.1.3 Radiated: 1 GHz to 40 GHz

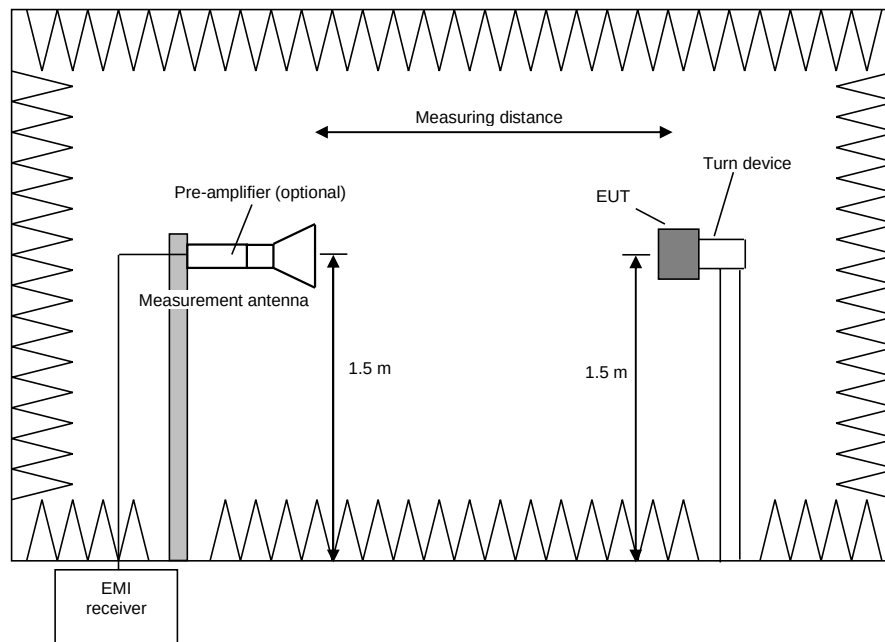
5.1.3.1 Preliminary and final measurement 1 to 40 GHz

The preliminary and final measurements are performed in a fully anechoic chamber at a measuring distance of 3 meters. Table-top devices are set up on a non-conducting turn device at the height of 1.5 m. 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 ° and the measuring antenna is set to horizontal and vertical polarization to find the maximum level of emissions. After these steps, the measurement is repeated after reorientating the EUT in 30 ° steps.

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
Final measurement	1 - 40 GHz	-	1 MHz	100 ms	Peak Average



Procedure preliminary measurement:

The following procedure is used:

- 1) Monitor the frequency range at horizontal polarisation of the measuring antenna and an EUT / turntable azimuth of 0 °.
- 2) Rotate the EUT by 360° to maximize the detected signals.
- 3) Repeat steps 1 to 2 with the vertical polarisation of the measuring antenna.
- 4) Repeat steps 1 to 3 with the EUT reorientated by an angle of 30° (60°, 90°, 120° and 150°), according to 6.6.5.4 in [1].
- 5) The highest values for each frequency are saved by the software, including the measuring antenna polarization, the turntable azimuth and the turn device elevation for that value.

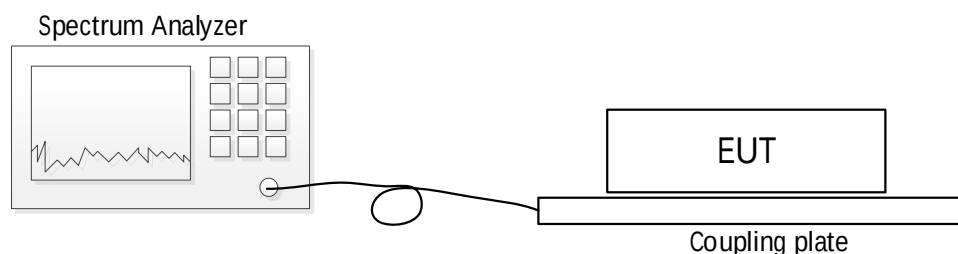
Procedure final measurement:

The following procedure is used:

- 1) Set the turntable and the turn device to the position which leads to the highest emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna to the polarisation which leads to the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with Peak and Average detector activated.
- 4) 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.
- 5) The final measurement is performed at the worst-case turntable azimuth.
- 6) Repeat steps 1 to 5 for each frequency detected during the preliminary measurements.

5.1.4 Conducted: Antenna port

Test setup (conducted)		
Used	Antenna connector	Comment
☐	Temporary antenna connector	As provided by the applicant
☐	Normal antenna connector	-
☒	Coupling plate	-



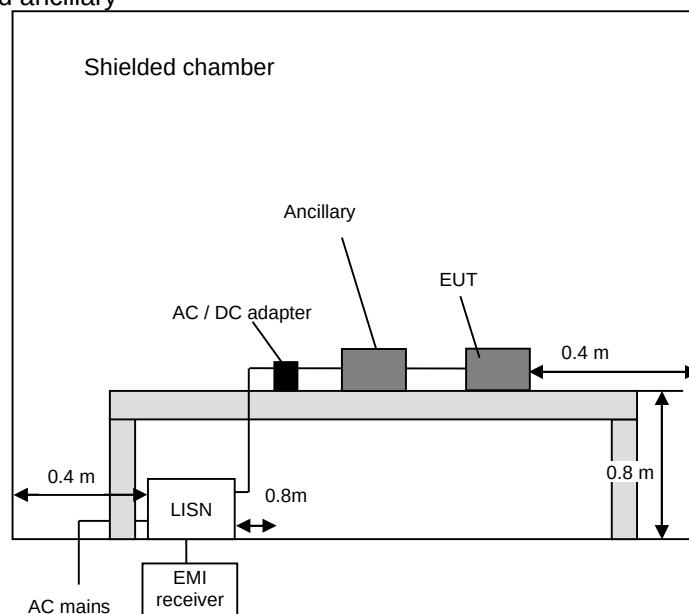
5.1.5 Conducted: AC power line

The test is carried out in a shielded chamber. 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 above the ground plane. Floor-standing devices are placed directly on the ground plane. In case of DC powered equipment, which is not exclusively powered by a battery, it is connected to the LISN via a suitable AC/DC adaptor. The setup of the equipment under test is in accordance with [1].

The frequency range 150 kHz to 30 MHz is measured with an EMI receiver set to MAX hold mode with Peak and Average detectors and a resolution bandwidth of 9 kHz. A scan is carried out on the phase and neutral line of the AC mains network. If emissions less than 10 dB below the appropriate limit are detected, these emissions are measured with an Average and Quasi-Peak detector on all lines.

Frequency range	Resolution bandwidth	Measuring time
150 kHz to 30 MHz	9 kHz	5 s

Option with AC adapter and ancillary



5.2 Duty cycle

5.2.1 Test setup (Duty cycle)

Test setup (Duty cycle)			
Used	Setup	See sub-clause	Comment
☐	Radiated: 1 GHz to 40 GHz	5.1.3	-
☒	Conducted: Antenna port	5.1.4	-

5.2.2 Test method (Duty cycle)

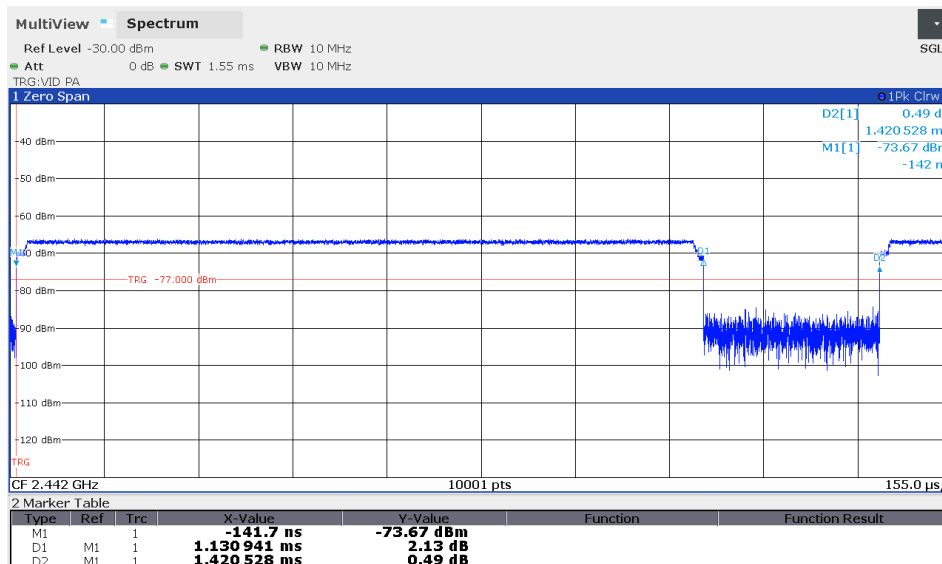
Test method (Duty cycle)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	11.6. a)	Diode detector	No limitation	-
☒	11.6. b)	Zero span	No limitation	-

5.2.3 Test results (Duty cycle)

Ambient temperature:	22°C
Relative humidity:	27%

Date:	27.11.2023
Tested by:	Paul Neufeld

Worst case plot (operation mode 2):



Operation Mode #	TX _{on} [μs]	TX _{ges} [μs]	RBW [MHz]	50/T [kHz]	50/T < RBW?
1 - 3	1131	1421	10	44.209	☒

Operation Mode #	Sweep points	Sweep time [μs]	Meas points	Meas points >100?	Duty cycle %	DCCF [dB]
1 - 3	10001	1555	7274	☒	0.7959	1.0

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

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

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

For average measurements a power correction factor of 1.0 dB is used for all tests in test mode 1 -3.

For average measurements a field strength correction factor of 2.0 dB is used for all tests in test mode 1 -3.

Test equipment (please refer to chapter 7 for details)
21

5.3 Transmit antenna performance considerations

The transmit antenna is on the PCB which is inside an encapsulated housing. Therefore, the requirement of the permanently attached antenna can be assumed to be fulfilled.

5.4 20 dB Bandwidth

5.4.1 Test setup (20 dB Bandwidth)

Test setup (DTS bandwidth)			
Used	Setup	See sub-clause	Comment
☐	Radiated: 1 GHz to 40 GHz	5.1.3.1	-
☐	Conducted: Antenna port	-	-
☒	Coupling plate	5.1.4	-

5.4.2 Test method (20 dB Bandwidth)

Test method (Occupied bandwidth – power bandwidth (99%))				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	6.9.2	Relative measurement procedure	-	n-dB down
☐	6.9.3	Power bandwidth (99%)	*1	99% power function

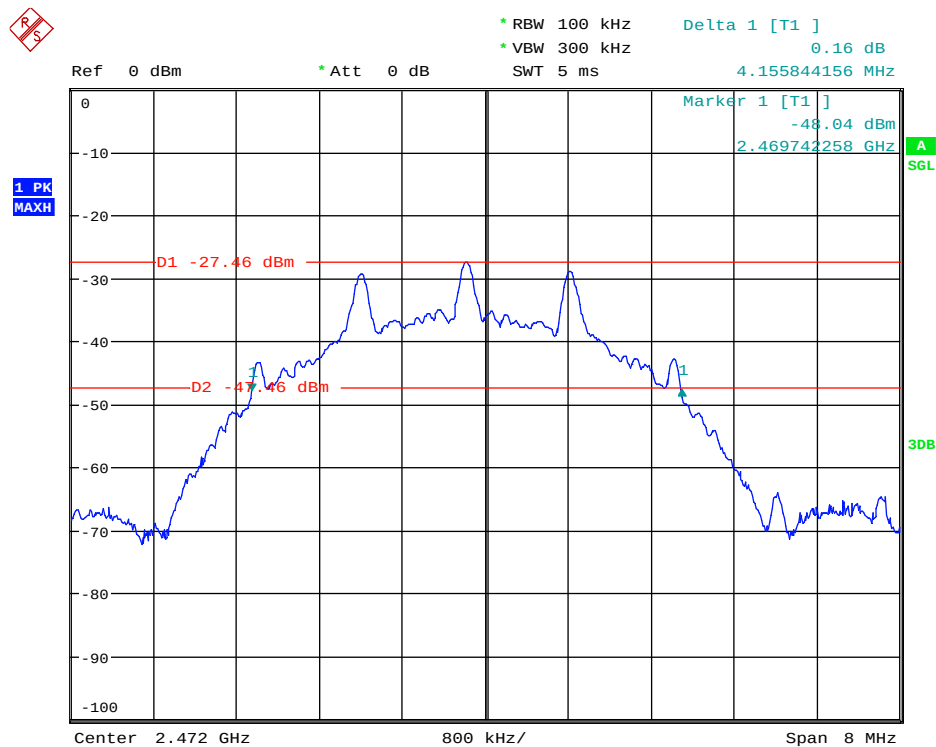
*1 See RSS-GEN Issue 5 [5] sub-clause 6.7 for details.

5.4.3 Test results (20 dB Bandwidth)

Ambient temperature:	22°C
Relative humidity:	50%

Date:	13.10.2023
Tested by:	Martin EPPINGER

Worst case plot (operation mode 3):



Operation mode	20 dB Bandwidth [MHz]	Lower Band-edge [MHz]	Upper Band-edge [MHz]	Lower Limit [MHz]	Upper Limit [MHz]
1	4.156	2409.742	2413.898	2400.000	2483.500
2	4.156	2439.742	2443.898	2400.000	2483.500
3	4.156	2469.742	2473.898	2400.000	2483.500

Test result: Passed

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

5.5 Occupied bandwidth – power bandwidth (99%)

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

Test setup (DTS bandwidth)			
Used	Setup	See sub-clause	Comment
☐	Radiated: 1 GHz to 40 GHz	5.1.3.1	-
☐	Conducted: Antenna port	-	-
☒	Coupling plate	5.1.4	-

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

Test method (Occupied bandwidth – power bandwidth (99%))				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☐	6.9.2	Relative measurement procedure	-	n-dB down
☒	6.9.3	Power bandwidth (99%)	*1	99% power function

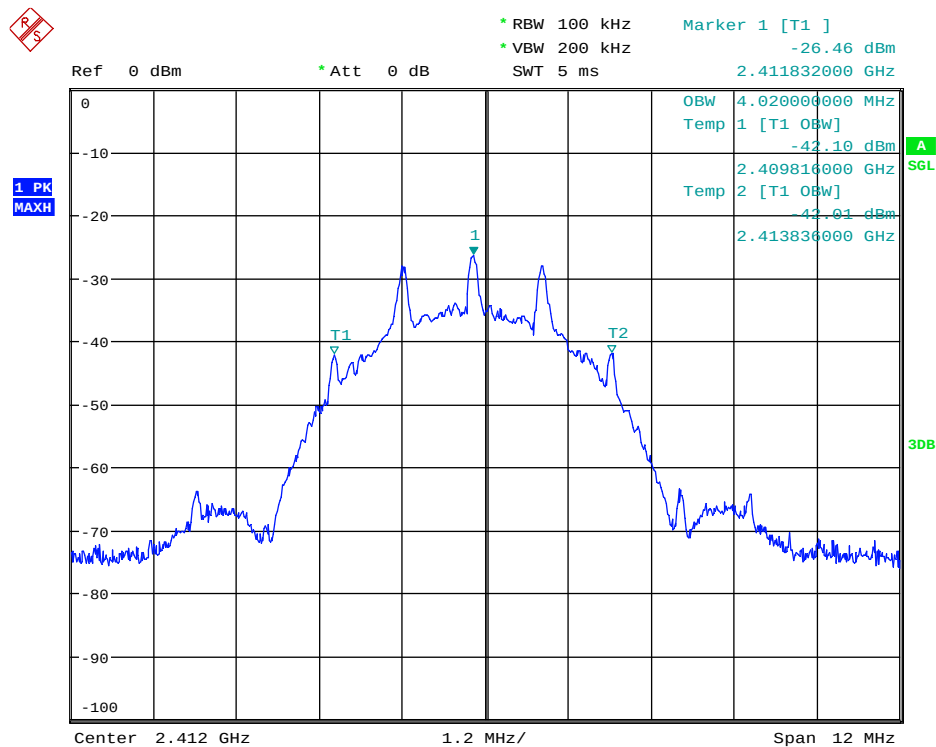
*1 See RSS-GEN Issue 5 [5] sub-clause 6.7 for details.

5.5.3 Test results (Occupied bandwidth – power bandwidth (99%))

Ambient temperature:	22 °C
Relative humidity:	50 %

Date:	13.10.2023
Tested by:	Martin EPPINGER

Worst case plot (operation mode 1):



Operation mode #	99% bandwidth [MHz]
1	4.020
2	4.020
3	4.020

Test result: Passed

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

5.6 DTS band-edge emission measurements

5.6.1 Test setup (Band edge – restricted bands)

Test setup (Band edge – restricted bands)			
Used	Setup	See sub-clause	Comment
☒	Radiated: 1 GHz to 40 GHz	5.1.3	
☐	Conducted: Antenna port	-	

5.6.2 Test method (Band edge – restricted bands)

Test method (Band edge – restricted bands)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	11.13.1	Standard method	No limitations	
☐	11.13.2	Marker-delta method		See 6.10.6 [3]
☐	11.13.3.2	Peak detection	Not for DTS testing	2 MHz from band
☐	11.13.3.3	Trace averaging with cont. EUT	D ≥ 98%	2 MHz from band
☐	11.13.3.4	Trace averaging with cont. EUT & D	Constant D (±2%)	2 MHz from band
☐	11.13.3.5	Reduced VBW		2 MHz from band

5.6.3 Test results (Band edge – restricted bands)

Since even the in-band emissions were below the 15.209 limits, band-edge tests do not make sense.

5.7 Radiated emissions

5.7.1 Test setup (Maximum unwanted emissions)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
☒	Radiated: 9 kHz to 30 MHz / 30 MHz to 1 GHz / 1 GHz to 40 GHz	5.1.1 / 5.1.2 / 5.1.3	-
☐	Conducted: Antenna port	-	-

5.7.2 Test method (Maximum unwanted emissions)

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

5.7.3 Test results (Maximum unwanted emissions)

5.7.3.1 Test results preliminary measurement 9 kHz to 30 MHz

Ambient temperature:	22°C	Date:	26.09.2023
Relative humidity:	48%	Tested by:	Paul NEUFELD

Position of EUT: For tests for f between 9 kHz to 30 MHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

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

Test record: The measurement value was already corrected by 40 dB/decade as described in 47 CFR 15.31(f)(2) regarding to the measurement distance as requested in 47 CFR 15.209(a)

Remark: All 3 orthogonal planes were tested separately

Calculations:

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

Result @ norm. dist. [dBμA/m] = Result @ norm. dist. [dBμV/m] – 20 x log₁₀ (377 Ω)

Margin [dB] = Limit [dB(μV|μA)/m] - Result [dB(μV|μA)/m]

Worst case plot:

Spurious emissions from 9 kHz to 30 MHz (operation mode 2 - standing):



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

Test result: Passed

Test equipment (please refer to chapter 7 for details)

2 - 9

5.7.3.2 Test results (30 MHz – 1 GHz)

Ambient temperature:	22°C
Relative humidity:	57%

Date:	27.09.2023
Tested by:	Paul NEUFELD

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

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

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

Remark: All 3 orthogonal planes were tested separately

Calculations:

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

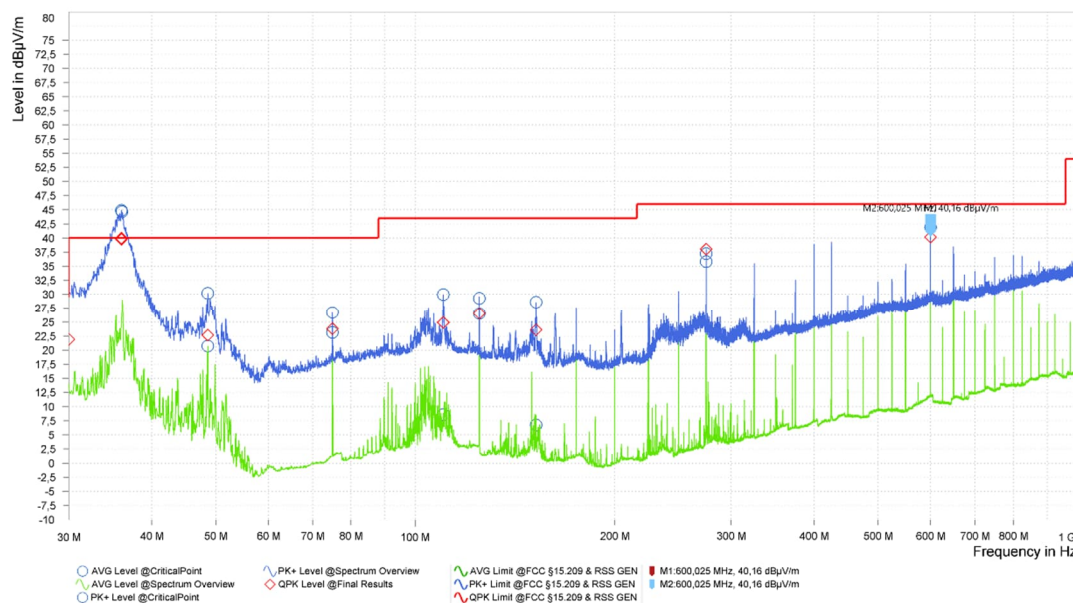
Correction [dBμV/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]

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 (operation mode 1 – Pos. Z):



Result tables:

(Operation mode 1):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Pol. (H/V)	Azimuth [deg]	Height [cm]	Position #
30.000	21.9	29.5	7.6	-4.1	26.0	V	349.0	1.1	Z
36.025	39.8	40.0	0.2	17.3	22.5	V	139.0	1.0	Z
36.025	39.9	40.0	0.1	17.5	22.5	V	162.0	1.0	Z
48.605	22.7	40.0	17.3	8.0	14.6	V	344.0	1.2	Z
75.005	23.8	40.0	16.2	8.2	15.6	V	163.0	1.1	Z
110.255	24.9	43.5	18.6	7.2	17.7	H	276.0	2.9	Z
125.005	26.5	43.5	17.0	9.3	17.2	H	279.0	3.0	Z
152.255	23.6	43.5	19.9	8.3	15.3	H	127.0	2.2	Z
275.015	38.0	46.0	8.0	19.7	18.3	V	5.0	1.2	Z
600.025	40.2	46.0	5.8	14.1	26.1	V	214.5	1.0	Z

(Operation mode 2):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Pol. (H/V)	Azimuth [deg]	Height [cm]	Position #
30.000	21.8	29.5	7.7	-4.2	26.0	V	19.0	1.2	X
35.805	38.8	40.0	1.2	16.3	22.6	V	285.0	1.1	X
36.015	39.0	40.0	1.0	16.5	22.5	V	160.0	1.0	X
49.395	21.9	40.0	18.1	7.7	14.2	V	348.0	1.1	X
104.185	20.5	43.5	23.0	2.9	17.6	H	306.0	2.8	X
275.015	36.4	46.0	9.6	18.1	18.3	H	338.0	1.0	X
400.015	38.4	46.0	7.6	16.4	22.0	H	341.0	1.0	X
425.025	40.1	46.0	5.9	17.7	22.4	V	126.0	1.1	X
600.025	39.9	46.0	6.1	13.8	26.1	V	229.0	1.0	X

(Operation mode 3):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Pol. (H/V)	Azimuth [deg]	Height [cm]	Position #
30.000	21.1	29.5	8.4	-4.9	26.0	V	277.0	2.1	Y
35.575	37.9	40.0	2.1	15.2	22.7	V	281.0	1.1	Y
35.805	38.2	40.0	1.8	15.7	22.6	V	139.0	1.1	Y
75.005	28.3	40.0	11.7	12.7	15.6	V	199.0	1.1	Y
250.005	36.5	46.0	9.5	19.2	17.3	H	104.0	1.0	Y
275.015	36.6	46.0	9.4	18.3	18.3	H	289.0	1.2	Y
400.015	37.5	46.0	8.6	15.5	22.0	V	320.0	1.1	Y
600.025	38.9	46.0	7.1	12.8	26.1	V	304.5	1.0	Y

Test result: Passed

Test equipment (please refer to chapter 7 for details)
3 - 11

5.7.3.3 Test results (radiated 1 GHz to 40 GHz)

Ambient temperature:	23°C
Relative humidity:	60%

Date:	28.09.2023
Tested by:	Paul NEUFELD

Position of EUT: For tests for f between 1 GHz and the 10th harmonic, the EUT was set-up on a positioner device with a height of 150 cm. The distance between EUT and antenna was 3 m.

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

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

Remark: -

Calculation:

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

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

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

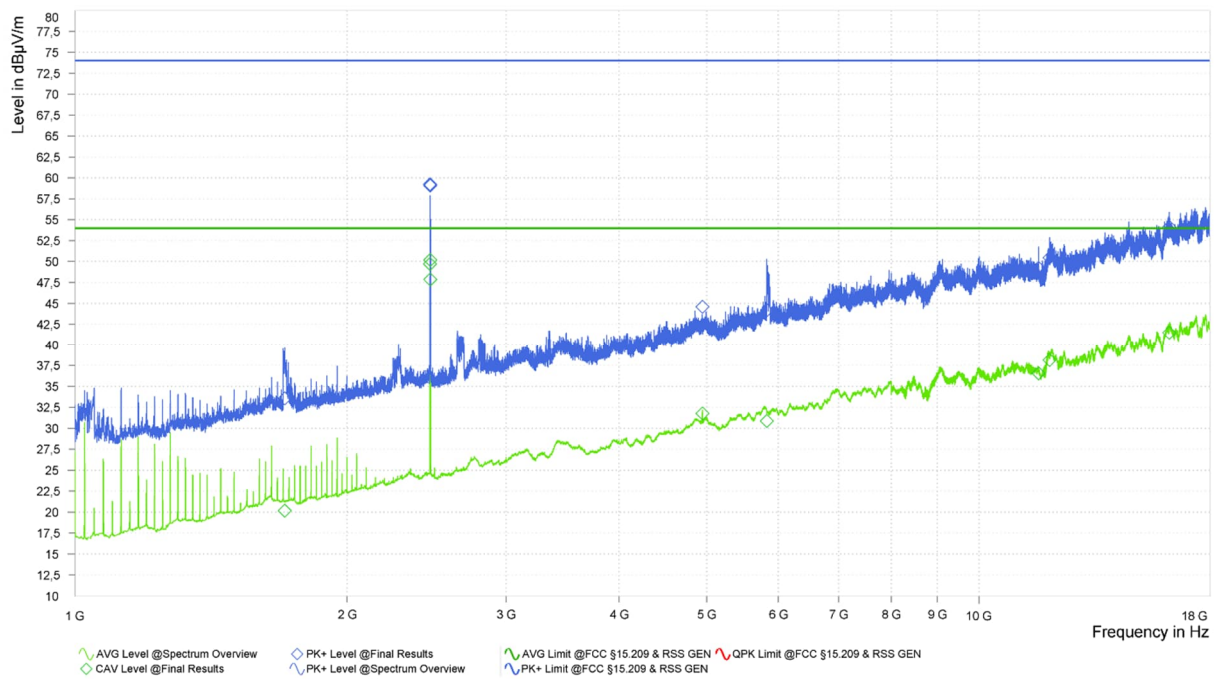
Margin [dB] = Limit [dBμV/m] – Max Peak | Average [dBμV/m]

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.

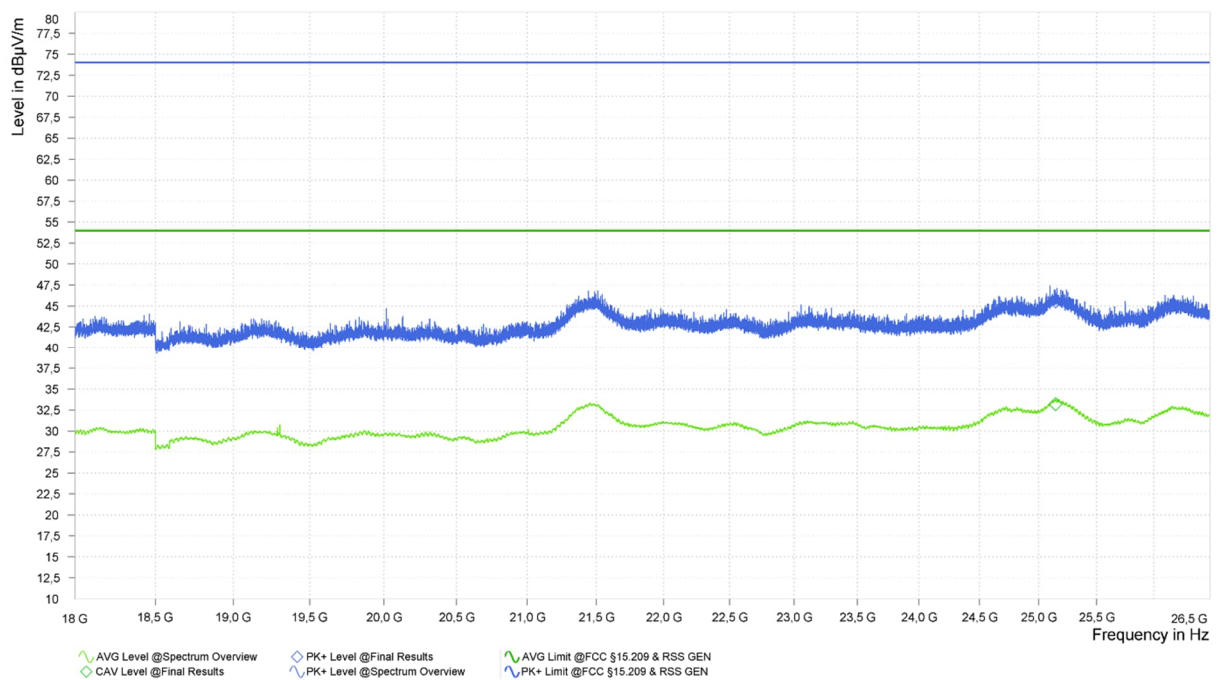
The top measured curve represents the peak measurement. The measured points marked with "◇" are frequency points for the final peak detector measurement. These values are indicated in the following table. The bottom measured curve represents the average measurement. The measured points marked with "◇" are frequency points for the final average detector measurement.

Worst case plots:

Spurious emissions from 1 GHz to 18 GHz (operation mode 3):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 1):



Result tables (Maximum field strength of the fundamental):

The average measurement values below are corrected with a 2.0 dB DCCF as described in 5.2.3.

Operation mode 1:

Frequency [MHz]	PK+ [dBμV/m]	Pk+ Limit [dBμV/m]	PK+ Margin [dB]	AV [dBμV/m]	AV Limit [dBμV/m]	AV Margin [dB]	Corr. [dB/m]	Pol	Elevation [deg]	Azimuth [deg]
2411.000				50.5	94	43.5	-0.4	H	0	229
2411.750	57.9	114.0	56.1	48.7	94	45.3	-0.4	H	0	230
2412.750				51.1	94	42.9	-0.4	H	0	231

Operation mode 2:

Frequency [MHz]	PK+ [dBμV/m]	Pk+ Limit [dBμV/m]	PK+ Margin [dB]	AV [dBμV/m]	AV Limit [dBμV/m]	AV Margin [dB]	Corr. [dB/m]	Pol	Elevation [deg]	Azimuth [deg]
2440.750				50.3	94.0	43.7	-0.3	H	0	158
2442.000	57.0	114.0	57.0	48.4	94.0	45.6	-0.3	H	0	156
2442.750				51.0	94.0	43.0	-0.3	H	0	158

Operation mode 3:

Frequency [MHz]	PK+ [dBμV/m]	Pk+ Limit [dBμV/m]	PK+ Margin [dB]	AV [dBμV/m]	AV Limit [dBμV/m]	AV Margin [dB]	Corr. [dB/m]	Pol	Elevation [deg]	Azimuth [deg]
2470.750	59.2	114.0	54.8	51.7	94.0	42.3	-0.3	H	0	156
2471.750	59.2	114.0	54.8	49.9	94.0	44.1	-0.3	H	0	156
2472.750	59.1	114.0	54.9	52.2	94.0	41.8	-0.3	H	0	154

Result tables:

The average measurement values below are corrected with a 2.0 dB DCCF as described in 5.2.3.

Operation mode 1:

Frequency [MHz]	PK+ [dBμV/m]	Pk+ Limit [dBμV/m]	PK+ Margin [dB]	AV [dBμV/m]	AV Limit [dBμV/m]	AV Margin [dB]	Corr. [dB/m]	Pol	Elevation [deg]	Azimuth [deg]
1025.250	34.0	74.0	40.0	29.8	54.0	24.2	-10.6	H	90.0	16.0
1125.250	33.8	74.0	40.2	26.7	54.0	27.3	-9.9	H	30.0	156.0
1273.500	29.8	74.0	44.2	18.5	54.0	35.5	-8.4	H	120.0	172.0
1398.500	29.9	74.0	44.1	19.1	54.0	34.9	-7.5	H	120.0	189.0
1675.250	34.6	74.0	39.4	25.9	54.0	28.1	-4.8	H	150.0	30.0
4821.500	43.2	74.0	30.8	32.1	54.0	21.9	9.8	V	120.0	170.0
25144.500	45.6	74.0	28.4	35.2	54.0	18.8	11.5	V	150.0	366.0

Operation mode 2:

Frequency [MHz]	PK+ [dBμV/m]	Pk+ Limit [dBμV/m]	PK+ Margin [dB]	AV [dBμV/m]	AV Limit [dBμV/m]	AV Margin [dB]	Corr. [dB/m]	Pol	Elevation [deg]	Azimuth [deg]
1150.750	31.3	74.0	42.8	17.9	54.0	36.1	-9.5	H	120.0	259.0
1174.750	32.9	74.0	41.1	26.6	54.0	27.4	-9.1	V	30.0	170.0
1497.250	30.6	74.0	43.4	19.9	54.0	34.1	-6.7	V	60.0	187.0
1652.750	32.8	74.0	41.2	21.5	54.0	32.5	-4.8	H	120.0	160.0
1866.000	32.3	74.0	41.8	21.6	54.0	32.4	-4.0	V	120.0	238.0
4885.750	44.5	74.0	29.5	33.0	54.0	21.0	10.0	H	0.0	254.0
12005.750	50.1	74.0	24.0	39.8	54.0	14.2	23.4	V	60.0	272.0
25128.500	47.0	74.0	27.0	35.1	54.0	18.9	11.6	V	60.0	51.0

Operation mode 3:

Frequency [MHz]	PK+ [dBμV/m]	Pk+ Limit [dBμV/m]	PK+ Margin [dB]	AV [dBμV/m]	AV Limit [dBμV/m]	AV Margin [dB]	Corr. [dB/m]	Pol	Elevation [deg]	Azimuth [deg]
1706.750	33.6	74.0	40.5	22.2	54.0	31.8	-4.8	V	150.0	182.0
4945.750	44.6	74.0	29.4	33.8	54.0	20.2	10.1	H	150.0	139.0
5827.000	44.2	74.0	29.8	32.9	54.0	21.1	12.1	V	150.0	200.0
11641.000	49.3	74.0	24.8	38.6	54.0	15.4	21.2	H	150.0	8.0
11970.750	50.5	74.0	23.5	40.2	54.0	13.8	23.3	V	150.0	224.0
16239.000	54.1	74.0	19.9	43.5	54.0	10.5	29.3	V	150.0	289.0
25186.750	46.1	74.0	27.9	35.1	54.0	18.9	11.5	V	90.0	236.0

Test result: Passed

Test equipment (please refer to chapter 7 for details)
3 – 9, 12 - 16

5.8 AC power-line conducted emissions (Only primary part)

5.8.1 Test setup (Conducted emissions on power supply lines)

Test setup (Conducted emissions on power supply lines)			
Used	Setup	See sub-clause	Comment
☒	Conducted: AC power line	5.1.5	-
☐	Not applicable, because ...	-	-

5.8.2 Test method (Conducted emissions on power supply lines)

Test setup (Conducted emissions on power supply lines)				
Used	Clause [3]	Name of method	Sub-clause	Comment
☒	6.2.3.2	Tabletop equipment testing	5.1.5	
☐	6.2.3.3	Floor-standing equipment testing	-	-

The AC power adaptor provided by the test laboratory was used for the tests:
bel Power Solutions & Protection.

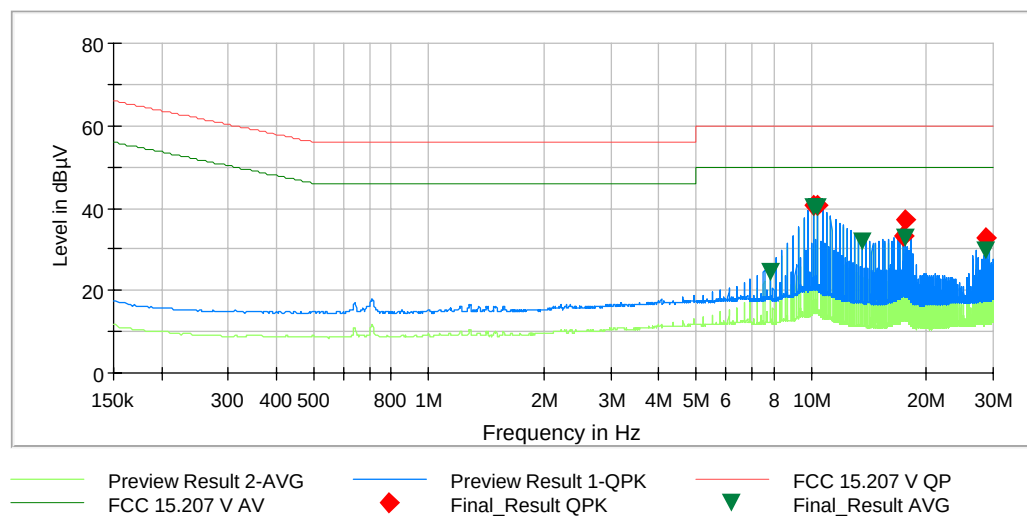
The power adaptor itself was supplied by 120V_{AC} 60Hz.

5.8.3 Test results (Conducted emissions on power supply lines)

Ambient temperature:	21°C
Relative humidity:	65%

Date:	22.08.2023
Tested by:	Paul NEUFELD

The curves in the diagrams below only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by ◆ and the average measured points by ▼.



Frequency [MHz]	QuasiPeak [dB(µV)]	Average [dB(µV)]	Limit [dB(µV)]	Margin [dB]	Line	PE	Corr. [dB]
7.831500	---	24.29	50.00	25.71	15000.0	9.000	L1
10.151250	40.56	---	60.00	19.44	15000.0	9.000	L1
10.151250	---	40.32	50.00	9.68	15000.0	9.000	L1
10.441500	40.67	---	60.00	19.34	15000.0	9.000	L1
10.441500	---	40.43	50.00	9.57	15000.0	9.000	L1
13.632000	---	32.12	50.00	17.88	15000.0	9.000	L1
17.400750	33.26	---	60.00	26.74	15000.0	9.000	N
17.693250	37.33	---	60.00	22.67	15000.0	9.000	N
17.693250	---	32.88	50.00	17.12	15000.0	9.000	N
28.686750	---	29.68	50.00	20.32	15000.0	9.000	N
28.686750	32.73	---	60.00	27.27	15000.0	9.000	N

Test result: Passed

Test equipment (please refer to chapter 7 for details)
17 - 20

6 Measurement Uncertainties

Conducted measurements		
Measurement method	Standard used for calculating measurement uncertainty	Expanded measurement uncertainty (95 %) U_{lab}
Frequency error	ETSI TR 100 028	4.5×10^{-8}
Bandwidth measurements	-	9.0×10^{-8}
Conducted emissions using a spectrum analyzer		
< 3.6 GHz	ETSI TR 100 028	2.3 dB
3.6 – 8 GHz	ETSI TR 100 028	2.8 dB
8 – 22 GHz	ETSI TR 100 028	3.2 dB
22 – 40 GHz	ETSI TR 100 028	3.6 dB
Power measurements		
Power meter	ETSI TR 100 028	0.9 dB
Conducted emissions from 150 kHz to 30 MHz with LISN		
	CISPR 16-4-2	2.8 dB

Radiated measurements		
Frequency error		
(Semi-) Anechoic chamber	ETSI TR 100 028	4.5×10^{-8}
OATS	ETSI TR 100 028	4.5×10^{-8}
Test fixture	ETSI TR 100 028	4.5×10^{-8}
Bandwidth measurements		
(Semi-) Anechoic chamber	-	9.0×10^{-8}
OATS	-	9.0×10^{-8}
Test fixture	-	9.1×10^{-8}
Radiated field strength M20		
CBL6112B @ 3 m 30 MHz – 1 GHz	CISPR 16-4-2	5.3 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 12 – 40 GHz	-	5.9 dB
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 12 – 40 GHz	-	5.9 dB
OATS		
Field strength measurements below 30 MHz on OATS without ground plane	-	4.4 dB

7 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Spectrum Analyser	FSU46	Rohde & Schwarz	200125	480956	21.06.2023	05.2025
2	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	22.02.2022	02.2024
3	Testsoftware M276	EMC32 V11.30	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	Antenna support	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	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
11	Attenuator 6dB	WA-2	Weinschel Corp	BG0931	483499	Calibration not necessary	
12	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	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 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda Miteq	2110917	482967	18.02.2022	02.2024
15	RF cable	SF 102	Huber+Suhner	510211/2	483032	Calibration not necessary	
16	Log.Per Antenna 850 MHz - 26 GHz	HL050	Rohde&Schwarz	100908	482977	22.09.2022	09.2025
17	V-LISN	NSLK8128RC	Schwarzbeck	0412	483186	15.02.2022	02.2024
18	Shielded chamber M155	SK3	Albatross Projects		482786	Calibration not necessary	
19	Software	EMC32	Rohde & Schwarz	100619	483182	Calibration not necessary	
20	EMI testreceiver	ESR7	Rohde & Schwarz	101939	482558	15.02.2022	02.2024
21	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	17.03.2023	03.2025

8 Test site Verification

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Shielded chamber M155	482784	9 kHz – 30 MHz	GND-Plane	ANSI C63.4-2014	14.11.2022	13.11.2025
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
F230142E4	28.02.2024	Initial Test Report
F230142E4 2 nd Version	30.09.2025	Page 2 Update new version of ANSI C63.10 & RSS-210 Page 6 Correction of a Typo in the Test object & HVIN according updated PoA Page 7 Adding 2 new frequencies to frequency table Page 8 Typo in test dates Page 19 Typo: subclause reference missing Page 20 Typo: 50/T value is missing Page 32 + 33 Separate tables for the fundamental emissions
-	-	-

10 List of Annexes

Annex A Test Setup Photos

11 pages