



# EMC - TEST REPORT

Type / Model Name : VC-EVCC Evaluation

Product Description : Vector Controller - Electric Vehicle Communication  
Controller

Applicant : Vector Informatik GmbH

Address : Ingersheimer Straße 24,  
70499 Stuttgart, Germany

Manufacturer : Vector Informatik GmbH

Address : Ingersheimer Straße 24,  
70499 Stuttgart, Germany

Test Result according to the standards listed in clause 1 test standards:	<b>POSITIVE</b>
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Test Report No. : <b>80086015-01 Rev_0</b>	05. July 2021 Date of issue
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Deutsche  
Akkreditierungsstelle  
D-PL-12030-01-01  
D-PL-12030-01-02



Bundesnetzagentur

BNetzA-CAB-13/21-07

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# 1 TEST STANDARDS

The tests were performed according to following standards:

## **FCC Rules and Regulations Part 15 Subpart B - Unintentional Radiators (October, 2020)**

Part 15, Subpart B, Section 15.107

AC Line conducted emission

Class A device

Class B device

Part 15, Subpart B, Section 15.109

Radiated emission, general requirements

Class A device

Class B device

ANSI C63.4: 2014

Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

## 2 SUMMARY

### 2.1 General remarks

None

### 2.2 Summary for all EMC tests

Type of test	Test result
Emission:	
A4 Conducted emission (AC mains power / DC power)	FULFILLED
A5 Radiated emission (< 1 GHz)	FULFILLED
SER 3 Radiated emission (> 1 GHz)	FULFILLED

### 2.3 Final assessment

Date of receipt of test sample : acc. to storage records

Testing commenced on : 28. May 2021

Testing concluded on : 07. June 2021

Checked by:

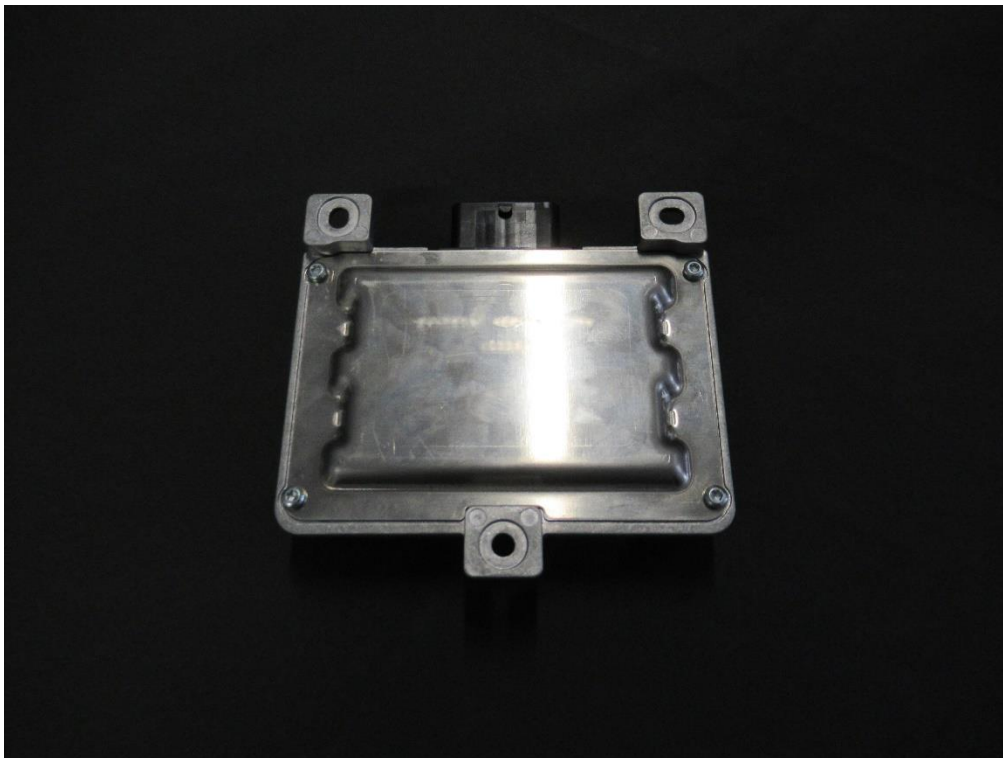
Tested by:

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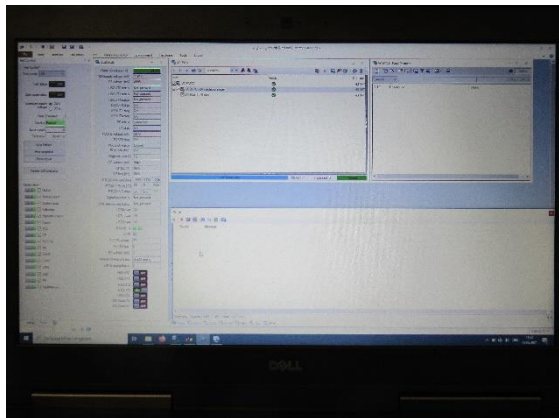
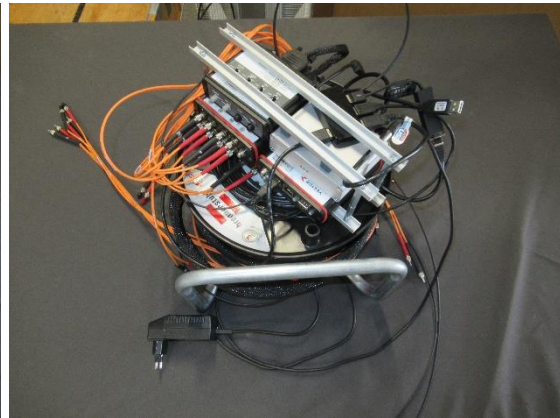
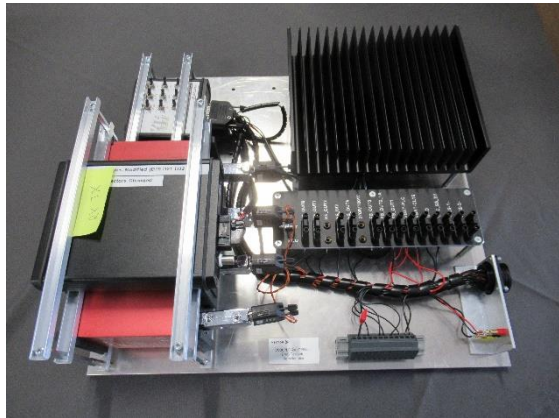
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### 3 EQUIPMENT UNDER TEST

#### 3.1 Photo documentation of the EuT



### Photo documentation of Periphery





### 3.2 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

### 3.3 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

### 3.4 Power supply system utilised

Power supply voltage : 24 V DC

All tests were carried out with a supply voltage of 24 V DC unless otherwise stated.

### 3.5 Highest internal frequency

Highest internal frequency : 120 MHz

### 3.6 Short description of the Equipment under Test (EuT)

The Vector Controller - Electric Vehicle Communication Controller (VC-EVCC) is a generic ECU for 24V environments. It realizes electrical charging according to DIN SPEC 70121 and ISO 15118 for power line communication (PLC) with the infrastructure. The hardware is the VP-EVCC with an integrated flash bootloader. VC-EVCC includes a modern MICROSAR stack with all relevant application modules to realize electrical charging communication.

Number of tested samples : 1  
Serial number : 089523-000018

### 3.7 EuT operation mode

The equipment under test was operated during the measurement under the following conditions:

- Operation mode 1: V2G (Simulated V2G charging mode with 5% DC PWM on CP and additional very high PLC traffic).
- Operation mode 2: LIN (Simulated charging with LIN on CP).

### 3.8 EuT configuration

(The CDF filled by the applicant can be viewed at the test laboratory.)

The following peripheral devices and interface cables were connected during the measurements:

- Fibre Optical Interface Cable Drum Model: None
- Load- and Simulation Setup Model: None
- Laptop Model: Dell Precision 7520

1	24V DC supply	unshielded	analogue	active	4 m
2	CAN0 excl. CAN_shield	unshielded	digital	active	4 m
3	CAN1 excl. CAN_shield	unshielded	digital	active	4 m
4	CAN1 incl. CAN_shield	unshielded	digital	active	4 m
5	CP / PE	unshielded	digital	active	4 m
6	Vehicle inlet connection	unshielded	analogue/digital	active	4 m
7	Clamp 15	unshielded	analogue/digital	active	4 m

**Modifications during the EMC test: None**



## 4 TEST ENVIRONMENT

### 4.1 Address of the test laboratory

**CSA Group Bayern GmbH  
Ohmstrasse 1-4  
94342 STRASSKIRCHEN  
GERMANY**

### 4.2 Accreditation and Recognition of the test laboratory

Within the framework of the Mutual Recognition Agreement (MRA) between the European Community and the USA the EMC test laboratory listed above has been approved as a Conformity Assessment Body (CAB) designated by the EU member states through the conclusion of the MRA on the basis of Article 133 of the treaty

The site is accredited/registered by

- the German accreditation body DAkkS-Registration No.: D-PL-12030-01-04
- the Federal Communications Commission (FCC) Registration Number: 0013864798
- the Bundesnetzagentur (German Federal Network Agency) as Conformity assessment body (CAB) Registration No: BnetzA-CAB-13/21-07

### 4.3 Statement regarding the usage of logos in test reports

The accreditation and notification body logos displayed in this test report are only valid for standards listed in the accreditation or notification scope of CSA Group Bayern GmbH.

### 4.4 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 °C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

The environmental conditions are recorded by data logger in the test locations.  
All data loggers used are regularly calibrated and verified.

### 4.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor  $k = 2$ . The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to

CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

## 4.6 Conformity Decision Rule

### Field of EMC:

The field of EMC includes testing of EMF / EMCU, EMC in general, telecommunications, motor vehicles, maritime and aviation EMC. With respect to measurement uncertainty and decision rules, EMC is divided into the sub-sections emission and immunity. For standards where the measurement uncertainty is not taken into account, decisions on the measurements documented in this report are based on "simple acceptance" (acceptance limit = specification limit) in accordance with ILAC G8 and IEC Guide 115 in their respective editions valid at the time of issuing this report. In the case of standards where measurement uncertainty has been taken into account, these standards are used in decisions made regarding measurements documented in this report.

All equipment needed to determine results were calibrated at the time of their use and were therefore within the specified measurement uncertainty.

### Sub-section Emission:

In accordance with the basic standard CISPR 16-4-2 in the version valid at the time of issuing this report, the measurement uncertainty was not taken into account in the conformity assessment as the measurement uncertainty of the laboratory Ulab is less than UCISPR.

### Sub-section Immunity:

The decision rule of "simple acceptance" (acceptance limit = specification limit) is adopted.

## 4.7 Measurement protocol for FCC

### 4.7.1 General information

#### 4.7.1.1 Test methodology

In compliance with 47 CFR Part 15 Subpart A Section 15.38 testing for FCC compliance may be done following the ANSI C63.4 procedures and using the CISPR 22 Limits.

#### 4.7.1.2 Justification

The Equipment under Test (EuT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

### 4.7.2 Details of test procedures

#### 4.7.2.1 General standard information

The test methods used comply with ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

### 4.7.3 Conducted emission

#### 4.7.3.1 Description of measurement

The final level, expressed in dB $\mu$ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC Limit or to the CISPR limit.

To convert between dB $\mu$ V and  $\mu$ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EuT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50  $\Omega$  / 50  $\mu$ H (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

### 4.7.4 Radiated emission (electrical field 30 MHz - 1 GHz)

#### 4.7.4.1 Description of measurement

Spurious emission from the EuT is measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.4. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area.

The antenna is positioned 3, 10 or 30 metres horizontally from the EuT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres, measurement scans are made with both horizontal and vertical antenna polarization planes and the EuT is rotated 360 degrees.

The final level, expressed in dB $\mu$ V/m, is arrived at by taking the reading from the EMI receiver (Level dB $\mu$ V) and adding the correction factors and cable loss factor (Factor dB) to it. This is done automatically in the EMI receiver where the correction factors are stored. The FCC or CISPR limit is subtracted from this result in order to provide the limit margins listed in the measurement protocols.

The resolution bandwidth during the measurement is as follows:

30 MHz – 1000 MHz: ResBW: 120 kHz

Example:

Frequency (MHz)	Reading level (dB $\mu$ V)	+	Correction Factor* (dB/m)	=	Level (dB $\mu$ V/m)	-	CISPR Limit (dB $\mu$ V/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

\*Correction Factor = Antenna Factor + Cable Attenuation = 30 dB/m + 2.6 dB = 32.6 dB/m

#### 4.7.4.2 Measurement Procedure

The test setup is prepared with the EUT at the desired EUT-Antenna separation.

The turntable is rotated 360° until the test receiver displays the maximum level at the observed frequency.

The antenna height is then adjusted from 1 m to 4 m maximizing the measured value.

The turntable is re-adjusted to re-affirm the maximum emission value which is then recorded.

This procedure is repeated for all frequencies of interest.

### 4.7.5 Radiated emission (electrical field 1 GHz - 30 GHz)

#### 4.7.5.1 Description of measurement

Radiated emission from the EuT are measured in the frequency range of 1 GHz to the maximum frequency as specified in 47 CFR Part 15 Subpart A section 15.33, using a tuned receiver (Spectrum Analyser) and appropriate linearly polarized antennas. Table top equipment is placed on a 0.65 X 1.5 metre non-conducting table 80 centimetres above the ground plane. The turntable must be fully covered with the appropriate absorber (Type VHP-12).

Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.4.

The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. The antenna is positioned 3 metres horizontally from the EuT.

Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyser set to a peak detector function and a resolution and video bandwidth of 1 MHz. All tests are performed at a test distance of 3 metres. Hand-held or body-worn devices are rotated around three orthogonal axes in order to determine the position, angle and configuration having the maximum emission. The cables and equipment are placed and moved within the range of their likely positioning to find the maximum emission. These conditions will then be used for the final measurements. The antenna height is then adjusted from 1 m to 4 m maximizing the measured value. The antenna is mounted to a boresight axis so the antenna centre always points to the EuT.

Other devices are placed according to their general purpose. The turntable is rotated 360° until the spectrum analyser displays the maximum level at the observed frequency. The antenna height is then adjusted from 1 m to 4 m maximizing the measured value. The turntable is re-adjusted to re-affirm the maximum emission value which is then recorded. This procedure is repeated for all frequencies of interest.

When the EuT is larger than the beamwidth of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to demonstrate that emissions are under the limits at the specified test distance.

## 5 TEST CONDITIONS AND RESULTS

### 5.1 Conducted emission

For test instruments and accessories used see section 6 Part A 4.

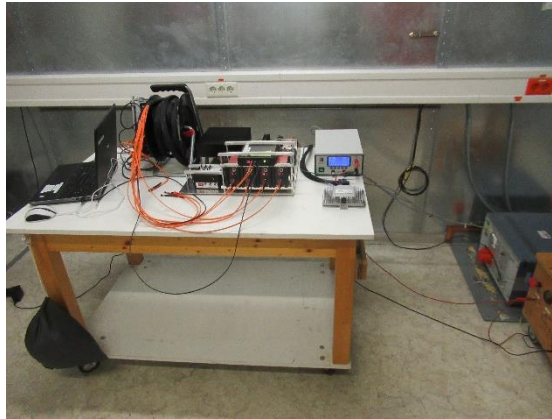
**Legend for tables:**

QP-L ... QuasiPeak reading including correction factor  
AV-L ... Average reading including correction factor  
D-Limit... Measured value to limit delta (margin)

#### 5.1.1 Description of the test location

Test location:                   Shielded Room S2

#### 5.1.2 Photo documentation of the test setup



#### 5.1.3 Test result

Frequency range:                   0.15 MHz - 30 MHz

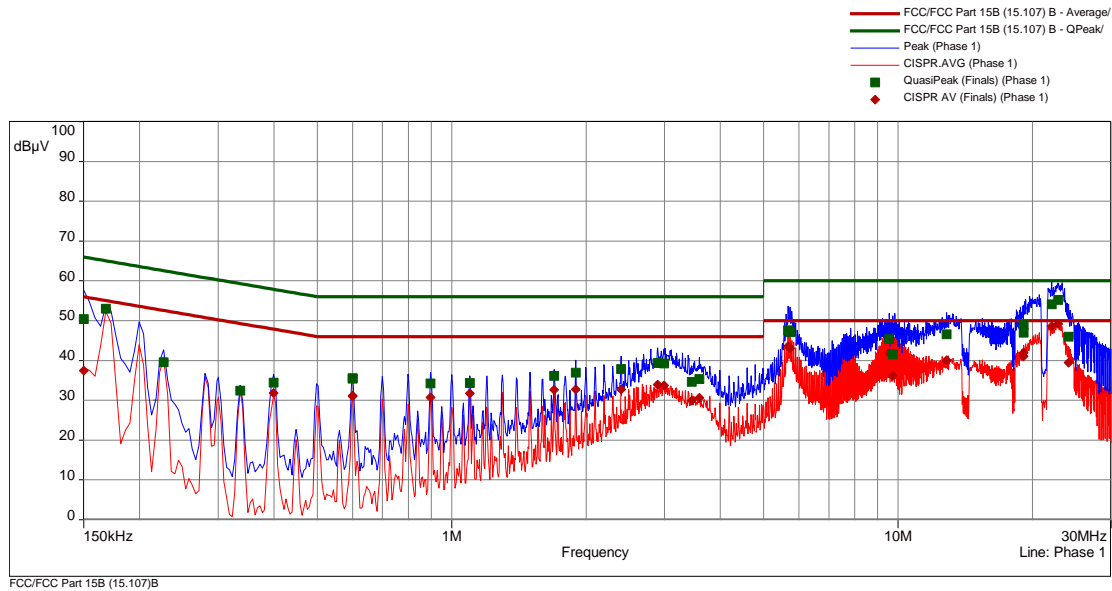
Min. limit margin                   0.82 dB at 22.84 MHz

The requirements are **FULFILLED**.

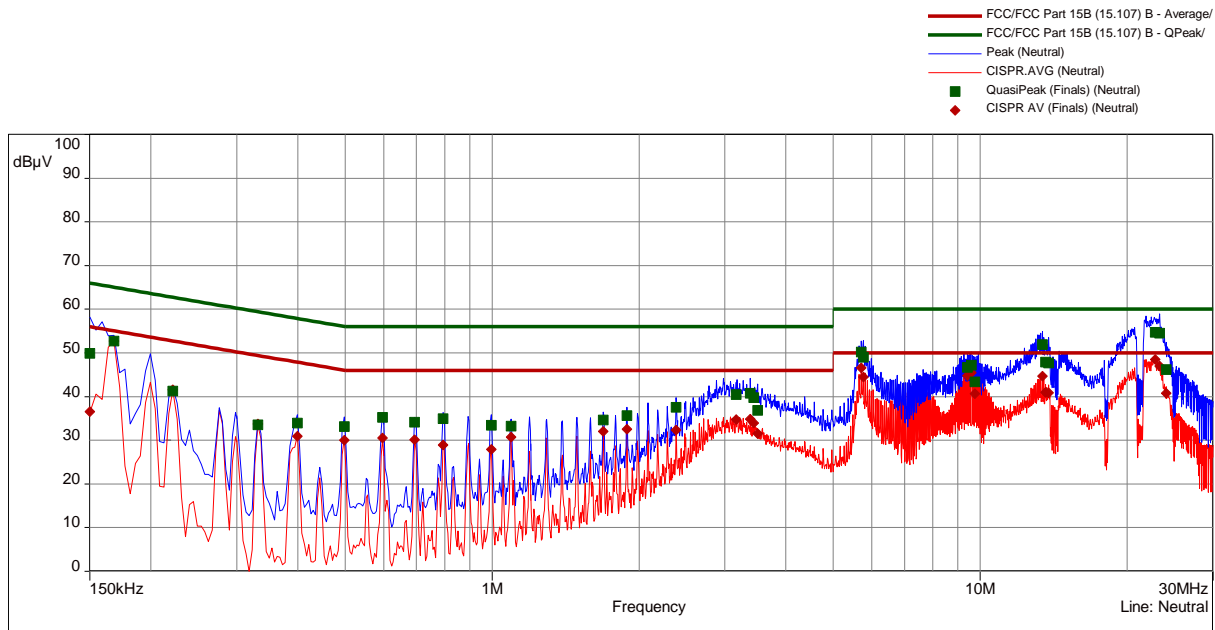
**Remarks:**     For detailed results, please see the following page(s).  
For description of the measurement see 4.7.3.  
The test was performed on a power supply unit, which was connected to the EuT.

### 5.1.4 Test protocol

<b>File No.:</b>	<b>80086015-00 Rev_0</b>	<b>Result</b>	<b>Passed</b>
<b>Operation mode:</b>	Operation mode 1(see 3.7)		
<b>Tested by:</b>	Leo Bikard		
<b>Location:</b>	Shielded Room S2	<b>Date:</b>	31.05.2021
<b>Remarks:</b>	120 V 60 Hz		



freq MHz	QP dB(µV)	margin dB	limit dB	AV dB(µV)	margin dB	limit dB	line	corr dB
0.15	50.37	-15.63	66.00	37.48	-18.52	56.00	Phase 1	10.09
0.168	52.97	-12.09	65.06	53.01	-2.05	55.06	Phase 1	10.10
0.2265	39.56	-23.02	62.58	39.80	-12.78	52.58	Phase 1	10.11
0.336	32.44	-26.86	59.30	32.67	-16.63	49.30	Phase 1	10.15
0.399	34.44	-23.44	57.87	31.85	-16.02	47.87	Phase 1	10.15
0.6	35.52	-20.48	56.00	31.17	-14.83	46.00	Phase 1	10.17
0.6	35.47	-20.53	56.00	31.04	-14.96	46.00	Phase 1	10.17
0.897	34.28	-21.72	56.00	30.72	-15.28	46.00	Phase 1	10.20
1.0995	34.39	-21.61	56.00	31.74	-14.26	46.00	Phase 1	10.22
1.695	36.14	-19.86	56.00	32.62	-13.38	46.00	Phase 1	10.27
1.8975	36.96	-19.04	56.00	32.69	-13.31	46.00	Phase 1	10.27
2.397	37.82	-18.18	56.00	32.73	-13.27	46.00	Phase 1	10.31
2.895	39.37	-16.63	56.00	33.98	-12.02	46.00	Phase 1	10.34
2.994	39.29	-16.71	56.00	33.72	-12.28	46.00	Phase 1	10.35
3.453	34.62	-21.38	56.00	29.92	-16.08	46.00	Phase 1	10.35
3.5925	35.40	-20.60	56.00	30.60	-15.40	46.00	Phase 1	10.36
5.673	47.61	-12.39	60.00	43.55	-6.45	50.00	Phase 1	10.50
5.727	47.05	-12.95	60.00	43.06	-6.94	50.00	Phase 1	10.50
9.561	45.37	-14.63	60.00	41.83	-8.17	50.00	Phase 1	10.72
9.7215	41.58	-18.42	60.00	36.19	-13.81	50.00	Phase 1	10.73
12.84	46.54	-13.46	60.00	40.06	-9.94	50.00	Phase 1	11.00
19.1085	49.02	-10.98	60.00	42.01	-7.99	50.00	Phase 1	11.42
19.113	46.97	-13.03	60.00	41.05	-8.95	50.00	Phase 1	11.42
22.0755	54.17	-5.83	60.00	48.57	-1.43	50.00	Phase 1	11.56
22.8495	55.20	-4.80	60.00	49.18	-0.82	50.00	Phase 1	11.60
24.0735	46.01	-13.99	60.00	39.46	-10.54	50.00	Phase 1	11.64



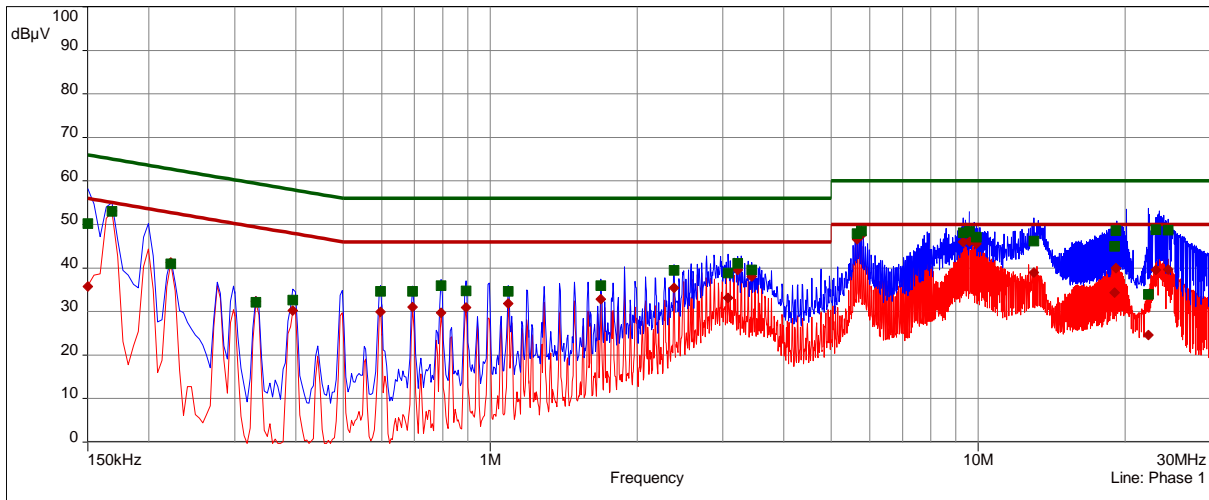
FCC/FCC Part 15B (15.107)B

freq MHz	QP dB(µV)	margin dB	limit dB	AV dB(µV)	margin dB	limit dB	line	corr dB
0.15	49.88	-16.12	66.00	36.57	-19.43	56.00	Neutral	10.09
0.168	52.68	-12.38	65.06	52.67	-2.39	55.06	Neutral	10.11
0.222	41.31	-21.43	62.74	41.57	-11.17	52.74	Neutral	10.13
0.3315	33.53	-25.88	59.41	33.72	-15.69	49.41	Neutral	10.15
0.399	33.93	-23.94	57.87	30.95	-16.92	47.87	Neutral	10.15
0.498	33.13	-22.90	56.03	30.02	-16.01	46.03	Neutral	10.16
0.597	35.29	-20.71	56.00	30.53	-15.47	46.00	Neutral	10.17
0.6945	34.19	-21.81	56.00	30.14	-15.86	46.00	Neutral	10.19
0.7935	34.97	-21.03	56.00	28.89	-17.11	46.00	Neutral	10.19
0.996	33.45	-22.55	56.00	27.93	-18.07	46.00	Neutral	10.20
1.095	33.20	-22.80	56.00	30.75	-15.25	46.00	Neutral	10.22
1.6905	34.66	-21.34	56.00	32.00	-14.00	46.00	Neutral	10.27
1.8885	35.62	-20.38	56.00	32.50	-13.50	46.00	Neutral	10.27
2.3835	37.55	-18.45	56.00	32.31	-13.69	46.00	Neutral	10.31
3.1605	40.48	-15.52	56.00	34.77	-11.23	46.00	Neutral	10.35
3.381	40.79	-15.21	56.00	34.89	-11.11	46.00	Neutral	10.35
3.435	39.78	-16.22	56.00	33.91	-12.09	46.00	Neutral	10.35
3.5025	36.87	-19.13	56.00	31.49	-14.51	46.00	Neutral	10.35
5.7045	50.24	-9.76	60.00	46.55	-3.45	50.00	Neutral	10.48
5.763	49.00	-11.00	60.00	44.49	-5.51	50.00	Neutral	10.49
9.417	46.72	-13.28	60.00	44.78	-5.22	50.00	Neutral	10.65
9.5835	47.17	-12.83	60.00	45.46	-4.54	50.00	Neutral	10.66
9.7485	43.42	-16.58	60.00	40.66	-9.34	50.00	Neutral	10.66
13.4025	51.89	-8.11	60.00	44.67	-5.33	50.00	Neutral	10.91
13.605	47.87	-12.13	60.00	40.95	-9.05	50.00	Neutral	10.92
13.803	47.70	-12.30	60.00	40.88	-9.12	50.00	Neutral	10.94
22.854	54.74	-5.26	60.00	48.46	-1.54	50.00	Neutral	11.27
23.286	54.50	-5.50	60.00	47.03	-2.97	50.00	Neutral	11.26
24.024	46.23	-13.77	60.00	40.79	-9.21	50.00	Neutral	11.26



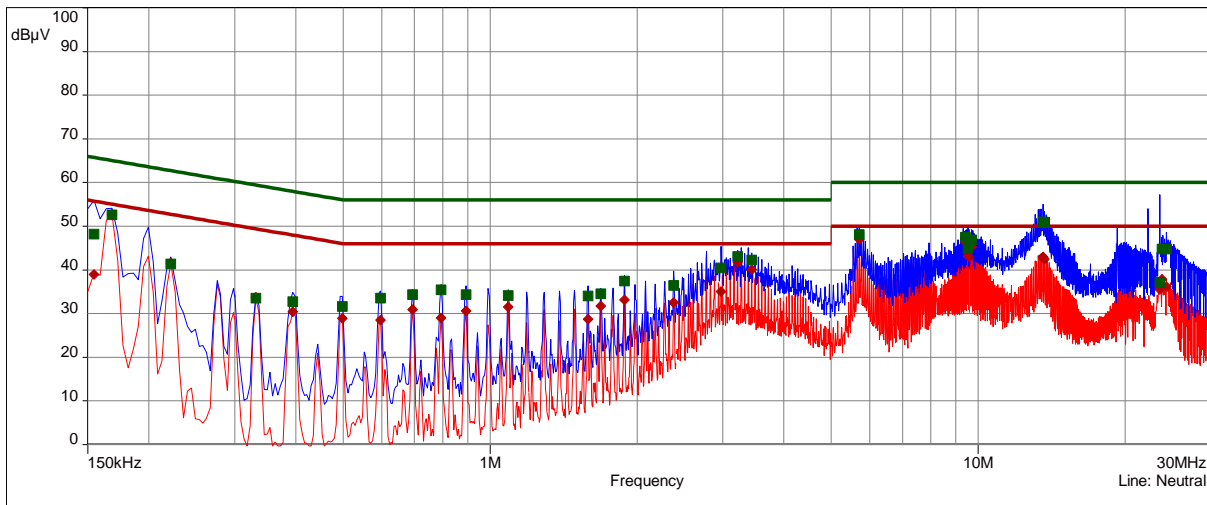
<b>File No.:</b>	<b>80086015-00 Rev_0_LB</b>	<b>Result</b>	<b>Passed</b>
<b>Operation mode:</b>	Operation mode 2(see 3.7)		
<b>Tested by:</b>	Leo Bikard		
<b>Location:</b>	Shielded Room S2	<b>Date:</b>	31.05.2021
<b>Remarks:</b>	120 V 60 Hz		

- FCC/FCC Part 15B (15.107) B - Average/
- FCC/FCC Part 15B (15.107) B - QPeak/
- Peak (Phase 1)
- CISPR AVG (Phase 1)
- QuasiPeak (Finals) (Phase 1)
- ◆ CISPR AV (Finals) (Phase 1)



FCC/FCC Part 15B (15.107)B

freq	QP	margin	limit	AV	margin	limit	line	corr
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.15	50.23	-15.77	66.00	35.74	-20.26	56.00	Phase 1	10.09
0.168	53.02	-12.04	65.06	53.07	-1.99	55.06	Phase 1	10.10
0.222	41.01	-21.73	62.74	41.28	-11.46	52.74	Phase 1	10.11
0.3315	32.15	-27.26	59.41	32.37	-17.04	49.41	Phase 1	10.15
0.3945	32.62	-25.34	57.97	30.22	-17.75	47.97	Phase 1	10.15
0.597	34.62	-21.38	56.00	29.89	-16.11	46.00	Phase 1	10.17
0.6945	34.68	-21.32	56.00	31.05	-14.95	46.00	Phase 1	10.19
0.7935	35.93	-20.07	56.00	29.69	-16.31	46.00	Phase 1	10.19
0.8925	34.77	-21.23	56.00	30.95	-15.05	46.00	Phase 1	10.20
1.0905	34.63	-21.37	56.00	31.86	-14.14	46.00	Phase 1	10.22
1.686	35.95	-20.05	56.00	32.85	-13.15	46.00	Phase 1	10.27
2.3835	39.42	-16.58	56.00	35.42	-10.58	46.00	Phase 1	10.31
3.075	38.90	-17.10	56.00	33.19	-12.81	46.00	Phase 1	10.35
3.2145	41.05	-14.95	56.00	39.61	-6.39	46.00	Phase 1	10.35
3.435	39.52	-16.48	56.00	38.08	-7.92	46.00	Phase 1	10.35
5.6505	47.95	-12.05	60.00	46.56	-3.44	50.00	Phase 1	10.50
5.763	48.51	-11.49	60.00	47.59	-2.41	50.00	Phase 1	10.51
9.309	48.15	-11.85	60.00	45.98	-4.02	50.00	Phase 1	10.71
9.588	48.37	-11.63	60.00	46.07	-3.93	50.00	Phase 1	10.72
9.9195	47.15	-12.85	60.00	45.56	-4.44	50.00	Phase 1	10.74
12.9885	46.24	-13.76	60.00	38.93	-11.07	50.00	Phase 1	11.02
19.041	45.01	-14.99	60.00	34.36	-15.64	50.00	Phase 1	11.42
19.1355	48.57	-11.43	60.00	40.02	-9.98	50.00	Phase 1	11.42
22.3185	33.97	-26.03	60.00	24.61	-25.39	50.00	Phase 1	11.57
23.1015	48.81	-11.19	60.00	39.61	-10.39	50.00	Phase 1	11.61
24.4875	48.66	-11.34	60.00	39.65	-10.35	50.00	Phase 1	11.66



FCC/FCC Part 15B (15.107)B

freq MHz	QP dB(µV)	margin dB	limit dB	AV dB(µV)	margin dB	limit dB	line	corr dB
0.1545	48.20	-17.55	65.75	38.94	-16.82	55.75	Neutral	10.10
0.168	52.66	-12.39	65.06	52.70	-2.36	55.06	Neutral	10.11
0.222	41.33	-21.42	62.74	41.61	-11.14	52.74	Neutral	10.13
0.3315	33.49	-25.92	59.41	33.76	-15.65	49.41	Neutral	10.15
0.3945	32.78	-25.18	57.97	30.43	-17.53	47.97	Neutral	10.15
0.498	31.67	-24.36	56.03	28.97	-17.06	46.03	Neutral	10.16
0.597	33.50	-22.50	56.00	28.53	-17.47	46.00	Neutral	10.17
0.6945	34.37	-21.63	56.00	30.96	-15.04	46.00	Neutral	10.19
0.7935	35.48	-20.52	56.00	28.99	-17.01	46.00	Neutral	10.19
0.8925	34.33	-21.67	56.00	30.63	-15.37	46.00	Neutral	10.20
1.0905	34.11	-21.89	56.00	31.50	-14.50	46.00	Neutral	10.22
1.587	33.99	-22.01	56.00	28.75	-17.25	46.00	Neutral	10.27
1.686	34.59	-21.41	56.00	31.73	-14.27	46.00	Neutral	10.27
1.884	37.45	-18.55	56.00	33.18	-12.82	46.00	Neutral	10.27
2.379	36.43	-19.57	56.00	32.52	-13.48	46.00	Neutral	10.31
2.9715	40.51	-15.49	56.00	35.00	-11.00	46.00	Neutral	10.34
3.2145	43.13	-12.87	56.00	41.80	-4.20	46.00	Neutral	10.35
3.435	42.24	-13.76	56.00	40.08	-5.92	46.00	Neutral	10.35
5.709	48.12	-11.88	60.00	46.96	-3.04	50.00	Neutral	10.48
9.4215	47.45	-12.55	60.00	46.42	-3.58	50.00	Neutral	10.65
9.534	44.86	-15.14	60.00	43.17	-6.83	50.00	Neutral	10.66
9.699	46.86	-13.14	60.00	45.34	-4.66	50.00	Neutral	10.66
13.5735	50.99	-9.01	60.00	42.96	-7.04	50.00	Neutral	10.92
13.6725	50.79	-9.21	60.00	42.52	-7.48	50.00	Neutral	10.93
23.5515	37.11	-22.89	60.00	35.51	-14.49	50.00	Neutral	11.27
23.772	44.83	-15.17	60.00	37.85	-12.15	50.00	Neutral	11.26
24.2715	44.77	-15.23	60.00	36.16	-13.84	50.00	Neutral	11.26

## 5.2 Radiated emission < 1 GHz (electric field)

For test instruments and accessories used see section 6 Part A 5.

### Legend for tables:

Level vert. QuasiPeak reading including correction factor for vertically polarised antenna  
 Level hor. QuasiPeak reading including correction factor for horizontally polarised antenna  
 Limit Limit referred to the appropriate standard  
 DLimit... Delta between limit and result (margin)  
 Noise Characteristic of disturbance (narrowband or broadband)

### 5.2.1 Description of the test location

Test location: OATS 1

Test distance: 10 metres

### 5.2.2 Photo documentation of the test setup



### 5.2.3 Test result

Frequency range: 30 MHz - 1000 MHz

Min. limit margin 6.9 dB at 47.07 MHz

The requirements are **FULFILLED**.

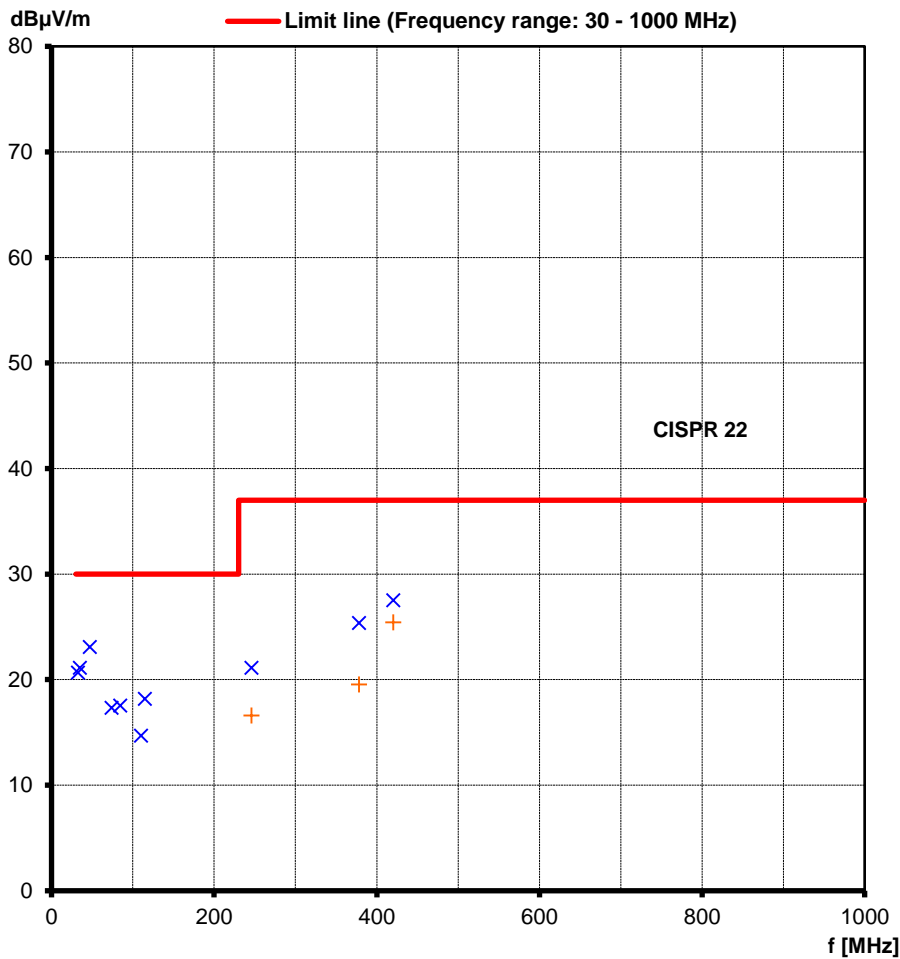
**Remarks:** For detailed results, please see the following page(s).  
For description of the measurement see 4.7.4.  
 \_\_\_\_\_  
 \_\_\_\_\_

### 5.2.4 Test protocol

Operation mode: Operation mode 1 (see 3.7)  
 Remarks: None  
 Date: 07.06.2021  
 Tested by: Leo Bikard

Result: Passed

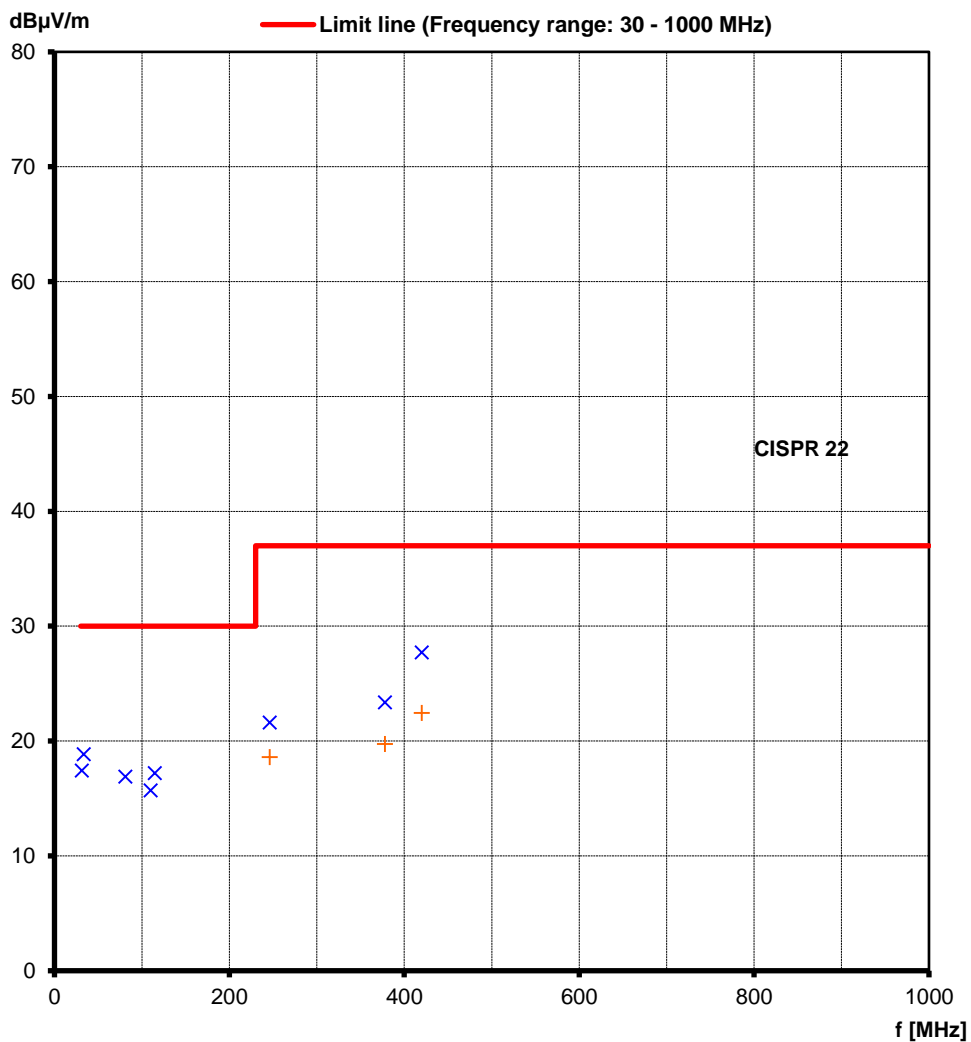
Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB/m)	Correct. Hor. (dB/m)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
32.65	8.0		12.7		20.7		30.0	-9.3
35.05	8.0		13.1		21.1		30.0	-8.9
47.07	8.5		14.6		23.1		30.0	-6.9
73.72	5.0		12.3		17.3		30.0	-12.7
84.64	7.0		10.6		17.6		30.0	-12.4
110.00	3.0		11.7		14.7		30.0	-15.3
114.70	6.0		12.2		18.2		30.0	-11.8
246.00	6.0	2.0	15.1	14.6	21.1	16.6	37.0	-15.9
378.01	6.0	0.3	19.4	19.3	25.4	19.6	37.0	-11.6
420.21	7.0	5.0	20.5	20.4	27.5	25.4	37.0	-9.5



Operation mode: Operation mode 2(see 3.7)  
 Remarks: None  
 Date: 07.06.2021  
 Tested by: Leo Bikard

Result: Passed

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB/m)	Correct. Hor. (dB/m)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
31.24	5.0		12.4		17.4		30.0	-12.6
33.54	6.0		12.9		18.9		30.0	-11.1
81.00	6.0		10.9		16.9		30.0	-13.1
110.00	4.0		11.7		15.7		30.0	-14.3
114.70	5.0		12.2		17.2		30.0	-12.8
246.19	6.5	4.0	15.1	14.6	21.6	18.6	37.0	-15.4
378.01	4.0	0.5	19.4	19.3	23.4	19.8	37.0	-13.6
420.19	7.2	2.0	20.5	20.4	27.7	22.4	37.0	-9.3



### 5.3 Radiated emission > 1 GHz (electric field)

For test instruments and accessories used see section 6 Part SER 3.

#### 5.3.1 Description of the test location

Test location: Anechoic chamber A 1

Test distance: 3 metres

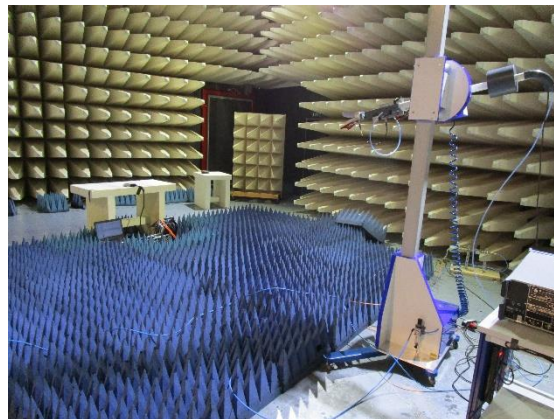
ETS Lindgren 3117:

Dimension of the line tangent to the EUT according to CISPR 16-2-3:2010

Note: The  $\ominus$  3dB min values were given by the antenna manufacturer

Frequency GHz	$\ominus$ 3 dB min	Measurement distance	w min
1	88	3 m	5.79 m
2	67	3 m	3.97 m
4	69	3 m	4.12 m
6	53	3 m	2.99 m
10	40	3 m	2.18 m
18	36	3 m	1.95 m

#### 5.3.2 Photo documentation of the test setup



#### 5.3.3 Test result

Frequency range: 1 GHz to 5 GHz

Min. limit margin 8.73 dB at 2787 MHz

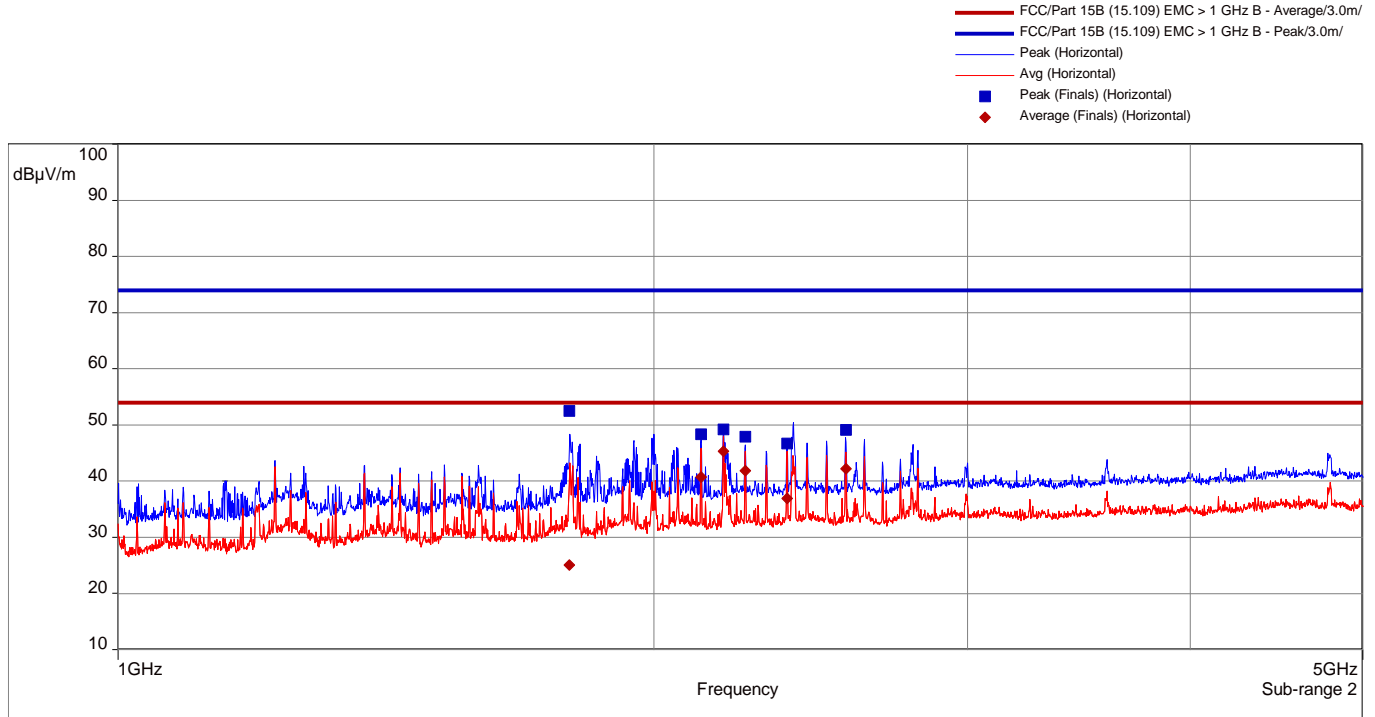
The requirements are **FULFILLED**.

**Remarks:** For detailed results, please see the following page(s).  
For description of the measurement see 4.7.5.  
 \_\_\_\_\_  
 \_\_\_\_\_

### 5.3.4 Test protocol

Operation mode: Operation mode 1 (see 3.7)  
 Remarks: None  
 Date: 07.06.2021  
 Tested by: Leo Bikard

Result: Passed

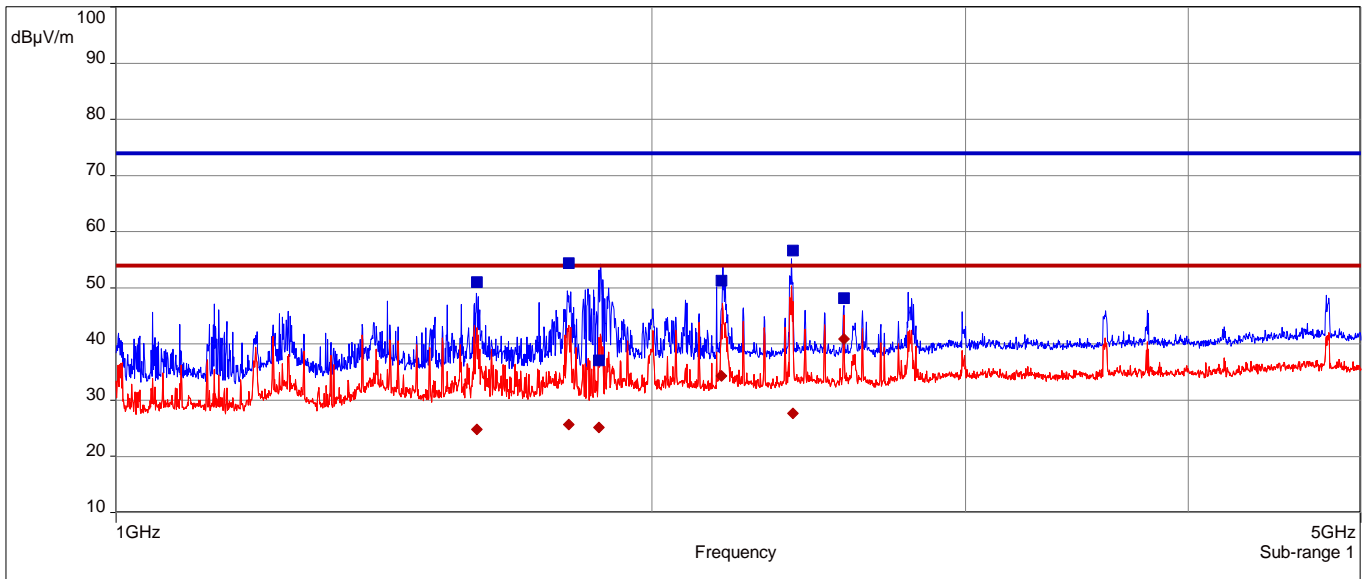


Date:06/09/2021 15:56 Operator: Operation mode:

Frequency (MHz)	Peak (dBµV/m)	Peak Margin (dB)	Peak Limit (dBµV/m)	Average (dBµV/m)	AV margin (dB)	AV limit (dBµV/m)	height	polarisation	Correction (dB)
1791.962717	52.51	-21.49	74.00	25.03	-28.97	54.00	2.22	Horizontal	-9.58
2124.988014	48.36	-25.64	74.00	40.77	-13.23	54.00	1.22	Horizontal	-7.98
2187.488703	49.23	-24.77	74.00	45.27	-8.73	54.00	1.00	Horizontal	-8.17
2249.988409	47.92	-26.08	74.00	41.88	-12.12	54.00	1.66	Horizontal	-7.74
2374.987572	46.71	-27.29	74.00	36.89	-17.11	54.00	2.09	Horizontal	-7.02
2562.252587	49.09	-24.91	74.00	42.17	-11.83	54.00	2.38	Horizontal	-7.05



- FCC/Part 15B (15.109) EMC > 1 GHz B - Average/3.0m/
- FCC/Part 15B (15.109) EMC > 1 GHz B - Peak/3.0m/
- Peak (Vertical)
- Avg (Vertical)
- Peak (Finals) (Vertical)
- ◆ Average (Finals) (Vertical)



Date:06/09/2021 15:56 Operator: Operation mode:

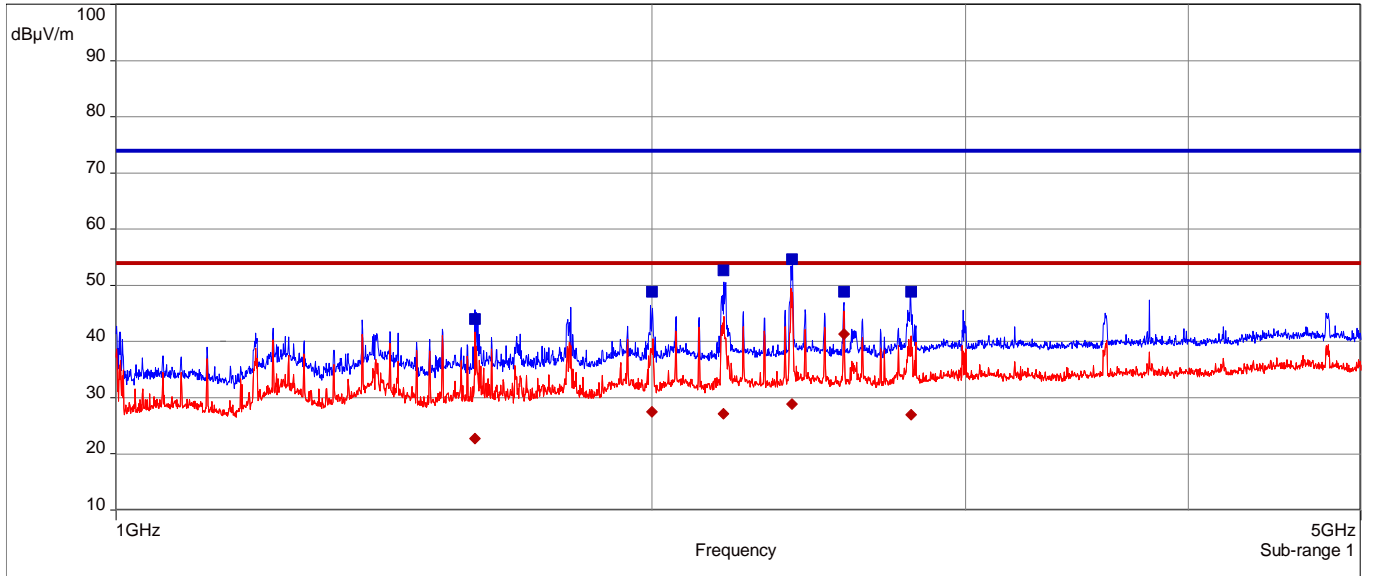
Frequency (MHz)	Peak (dBµV/m)	Peak Margin (dB)	Peak Limit (dBµV/m)	Average (dBµV/m)	AV margin (dB)	AV limit (dBµV/m)	height	polarisation	Correction (dB)
1594.237013	51.04	-22.96	74.00	24.82	-29.18	54.00	3.00	Vertical	-11.64
1795.241268	54.38	-19.62	74.00	25.70	-28.30	54.00	1.97	Vertical	-9.49
1866.64947	37.12	-36.88	74.00	25.17	-28.83	54.00	2.74	Vertical	-8.78
2187.492855	51.26	-22.74	74.00	34.31	-19.69	54.00	3.03	Vertical	-8.17
2399.765541	56.63	-17.37	74.00	27.65	-26.35	54.00	3.65	Vertical	-6.95
2562.250371	48.17	-25.83	74.00	40.92	-13.08	54.00	3.14	Vertical	-7.05

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Operation mode: Operation mode 2(see 3.7)  
 Remarks: None  
 Date: 07.06.2021  
 Tested by: Leo Bikard

Result: Passed

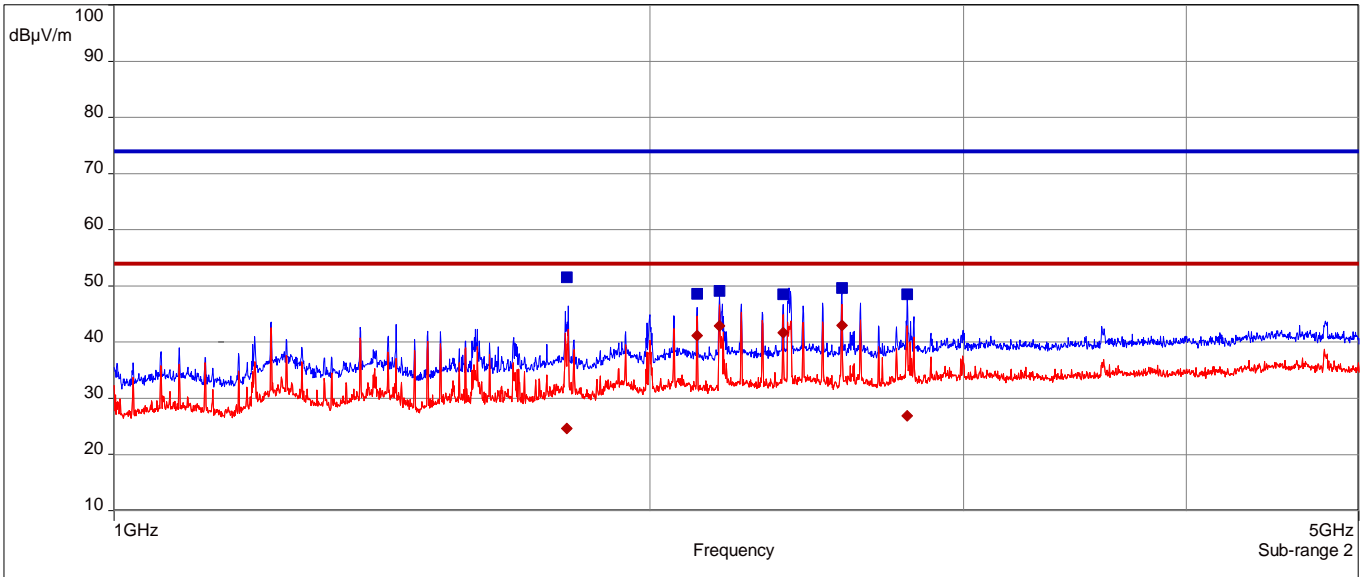
- FCC/Part 15B (15.109) EMC > 1 GHz B - Average/3.0m/
- FCC/Part 15B (15.109) EMC > 1 GHz B - Peak/3.0m/
- Peak (Vertical)
- Avg (Vertical)
- Peak (Finals) (Vertical)
- ◆ Average (Finals) (Vertical)



Date:06/07/2021 20:14 Operator: Operation mode:

Frequency (MHz)	Peak (dBµV/m)	Peak Margin (dB)	Peak Limit (dBµV/m)	Average (dBµV/m)	AV margin (dB)	AV limit (dBµV/m)	height	polarisation	Correction (dB)
1590.802833	44.04	-29.96	74.00	22.72	-31.28	54.00	1.30	Vertical	-11.65
1999.809618	48.89	-25.11	74.00	27.52	-26.48	54.00	2.05	Vertical	-7.96
2193.334703	52.66	-21.34	74.00	27.10	-26.90	54.00	2.78	Vertical	-8.10
2396.872643	54.68	-19.32	74.00	28.87	-25.13	54.00	3.05	Vertical	-6.94
2562.252808	48.86	-25.14	74.00	41.34	-12.66	54.00	3.23	Vertical	-7.05
2795.857102	48.90	-25.10	74.00	26.94	-27.06	54.00	4.00	Vertical	-6.80

- FCC/Part 15B (15.109) EMC > 1 GHz B - Average/3.0m/
- FCC/Part 15B (15.109) EMC > 1 GHz B - Peak/3.0m/
- Peak (Horizontal)
- Avg (Horizontal)
- Peak (Finals) (Horizontal)
- ◆ Average (Finals) (Horizontal)



Date:06/07/2021 20:14 Operator: Operation mode:

Frequency (MHz)	Peak (dBµV/m)	Peak Margin (dB)	Peak Limit (dBµV/m)	Average (dBµV/m)	AV margin (dB)	AV limit (dBµV/m)	height	polarisation	Correction (dB)
1795.59282	51.54	-22.46	74.00	24.64	-29.36	54.00	2.53	Horizontal	-9.48
2124.988409	48.63	-25.37	74.00	41.18	-12.82	54.00	1.15	Horizontal	-7.98
2187.493281	49.12	-24.88	74.00	42.90	-11.10	54.00	1.95	Horizontal	-8.17
2374.987572	48.48	-25.52	74.00	41.71	-12.29	54.00	1.89	Horizontal	-7.02
2562.253202	49.61	-24.39	74.00	43.00	-11.00	54.00	2.59	Horizontal	-7.05
2787.766461	48.53	-25.47	74.00	26.88	-27.12	54.00	1.61	Horizontal	-6.82

## 6 USED TEST EQUIPMENT AND ACCESSORIES

Test ID	Model Type	Kind of Equipment	Manufacturer	Equipment No.	Next Calib.	Last Calib.
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A 4	BAT-EMC 3.20.0.23	Nexio Software	EMCO Elektronik GmbH	01-02/68-13-001		
	ESCI	EMI Test Receiver	Rohde & Schwarz München	02-02/03-15-001	24/06/2021	24/06/2020
	ESH 2 - Z 5	LISN	Rohde & Schwarz München	02-02/20-05-004	31/10/2021	31/10/2019
	N-4000-BNC	RF Cable	CSA Group Bayern GmbH	02-02/50-05-138		
	N-1500-N	RF Cable	CSA Group Bayern GmbH	02-02/50-05-140		
	ESH 3 - Z 2	Pulse Limiter	Rohde & Schwarz München	02-02/50-05-155	13/11/2022	13/11/2019

A 5	ESVS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-006	15/07/2021	15/07/2020
	VULB 9168	Trilog Broadband Antenna	Schwarzbeck Mess-Elektronik	02-02/24-05-005	18/12/2021	18/12/2020
	NW-2000-NB	RF Cable	Huber + Suhner	02-02/50-05-113		
	KK-EF393/U-16N-21N20 m	RF Cable 20m	Huber + Suhner	02-02/50-12-018		
	KK-SD_7/8-2X21N-33,0M	RF Cable 33 m	Huber + Suhner AG	02-02/50-15-028		

SER 3	ESW26	EMI Test Receiver	Rohde & Schwarz München	02-02/03-17-002	10/02/2022	10/02/2021
	AMF-6D-01002000-22-10P	RF Amplifier	MITEQ, Inc.	02-02/17-15-004		
	3117	Horn Antenna 1 - 18 GHz	EMCO Elektronik GmbH	02-02/24-05-009	18/06/2021	18/06/2020
	BAM 4.5-P	Antenna Mast	mature GmbH	02-02/50-17-024		
	NCD	Controller for Antenna Mast	mature GmbH	02-02/50-17-025		
	KK-SF106-2X11N-6,5M	RF Cable	Huber + Suhner	02-02/50-18-016		
	BAT-EMC 3.20.0.23	Nexio Software	EMCO Elektronik GmbH	02-02/68-13-001		

## 7 Detailed measurement uncertainty

Note: The following table provides an overview of all uncertainties for CSA Group Bayern GmbH

Measurement	Ucisp [dB]	Ulab comb. + [dB]	Ulab comb. - [dB]	Ulab exp. + [dB]	Ulab exp. - [dB]
<b>EMISSION</b>					
Conducted disturbance at AC mains and other port power using a V-AMN (150 kHz to 30 MHz)	3,4	1,48	1,58	2,96	3,16
Conducted disturbance at AC mains port using a voltage probe - 1500 Ohm (9 kHz - 30 MHz)	2,9	1,15	1,15	2,31	2,31
Conducted disturbance at telecommunication port using CP (9 kHz - 30 MHz)	2,9	1,08	1,09	2,17	2,18
Conducted disturbance at telecommunication port using CVP (150 kHz - 30 MHz)	3,9	1,57	1,57	3,13	3,13
Disturbance power (30 MHz to 300 MHz)	4,5	1,74	1,74	3,48	3,48
Radiated disturbance (disturbance current in a LLAS)	3,3	1,35	1,35	2,69	2,69
Radiated disturbance (disturbance current in a Loop antenna 10 kHz to 30 MHz)	na	0,00	0,00	0,00	0,00
Radiated disturbance (electrical field strength at an OATS / SAC; 30 MHz - 200 MHz; biconical antenna; 3 m or 10 m)	6,3	1,74	1,76	3,47	3,53
Radiated disturbance (electrical field strength at an OATS / SAC; 200 MHz - 1000 MHz; LPDA antenna; 3 m or 10 m)	6,3	2,14	2,14	4,29	4,28
Radiated disturbance (electrical field strength at an OATS / SAC; 30 MHz - 1000 MHz; Hybrid antenna; 3 m or 10 m)	6,3	2,08	2,07	4,17	4,13
Radiated disturbance (electrical field strength in a FAR; 1 GHz - 6 GHz)	5,2	2,54	1,87	5,07	3,73
Radiated disturbance (electrical field strength in a FAR; 6 GHz - 18 GHz)	5,5	2,70	2,15	5,40	4,30
Radiated disturbance (in a GTEM; 30 MHz - 1000 MHz)	6,3	1,44	1,47	2,87	2,94

Measurement	Influence factor	U(xi) (+- %)
Harmonic current emissions	<b>Class I</b>	
	Voltage $U_m \geq 1\% U_{nom}$	5 % $U_m$
	Voltage $U_m < 1\% U_{nom}$	0,05 % $U_{nom}$
	Current $I_m \geq 3\% I_{nom}$	5 % $I_m$
	Current $I_m < 3\% I_{nom}$	0,15 % $I_{nom}$
	Power $P_m \geq 150 W$	1 % $P_m$
	Power $P_m < 150 W$	1,5 W
	Phase shift (h=number of harmonic)	$< h \cdot 1^\circ$
	<b>Class II</b>	
	Voltage $U_m \geq 3\% U_{nom}$	5 % $U_m$
	Voltage $U_m < 3\% U_{nom}$	0,15 % $U_{nom}$
	Current $I_m \geq 10\% I_{nom}$	5 % $I_m$
Current $I_m < 10\% I_{nom}$	0,5 % $I_{nom}$	
Flicker	<b>Current</b>	
	Magnitude (active or reactive current)	$< (1\% I_m + 10mA)$
	Magnitude (if phase angle used)	$2^\circ$
	Direct measured parameters (clause 3 and 4) of limit or measured value whichever is higher	$< 8\%$

Measurement	Ucispr[dB]	Ulab comb. +[dB]	Ulab comb. - [dB]	Ulab exp. +[dB]	Ulab exp. - [dB]
<b>IMMUNITY</b>					
Radiated immunity (20 MHz to 6 GHz)	na	0,79	0,51	1,59	1,03
Conducted immunity (0,15 MHz - 230 GHz)	na	0,74	0,65	1,47	1,30
Power frequency magnetic field (50 Hz / 60 Hz)	na	2,69	2,69	5,39	5,39
Conducted, common mode disturbances	na	1,80	1,51	3,60	3,02
Transverse electromagnetic waveguides (IEC 61000-4-20)	na	0,51	0,51	1,03	1,03