EMC – TEST REPORT

Type / Model Name : vSECC

Product Description : Communication Controller for Charging Stations

Applicant : Vector Informatik GmbH

Address : Franz-Mayer-Straße 8

93053 Regensburg

Manufacturer : Vector Informatik GmbH

Address : Franz-Mayer-Straße 8

93053 Regensburg

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. :	**M46673-00-02GR**	10. February 2021 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

Bundesnetzagentur

BNetzA-CAB-13/21-07

Contents

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 ☒ Class B
☒	Part 15, Subpart B, Section 15.109	Radiated emission, general requirements ☐ Class A ☒ Class B
☒	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.
☒	CISPR 16-4-2: 2011 + A1: 2014 EN 55016-4-2: 2011	Uncertainty in EMC measurement

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
SER3	Radiated emission (>1 GHz)	Fulfilled

2.3 Final assessment

The equipment under test **fulfills** the EMC requirements cited in clause 1 test standards.

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

Testing commenced on : 29. July 2020

Testing concluded on : 10. February 2021

Checked by:

Eduard Stangl
Dipl. Ing. (FH)
Technical Director

Tested by:

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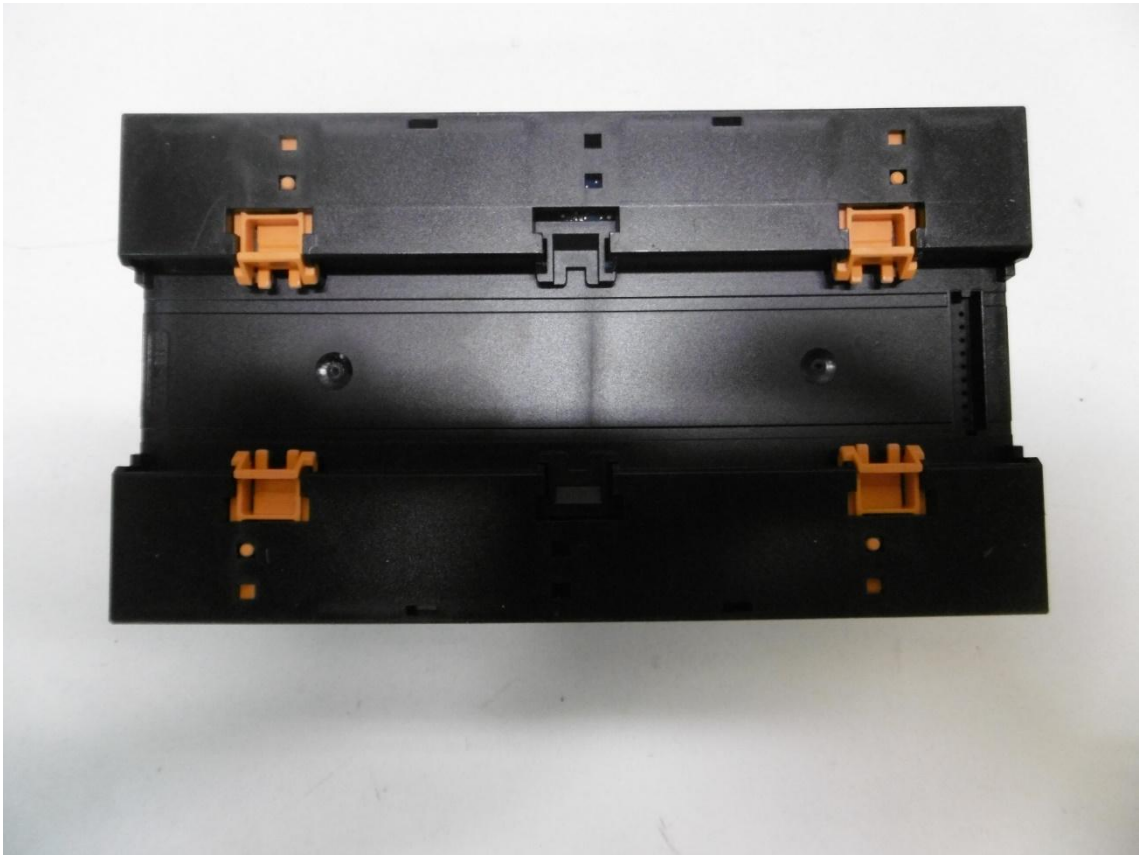
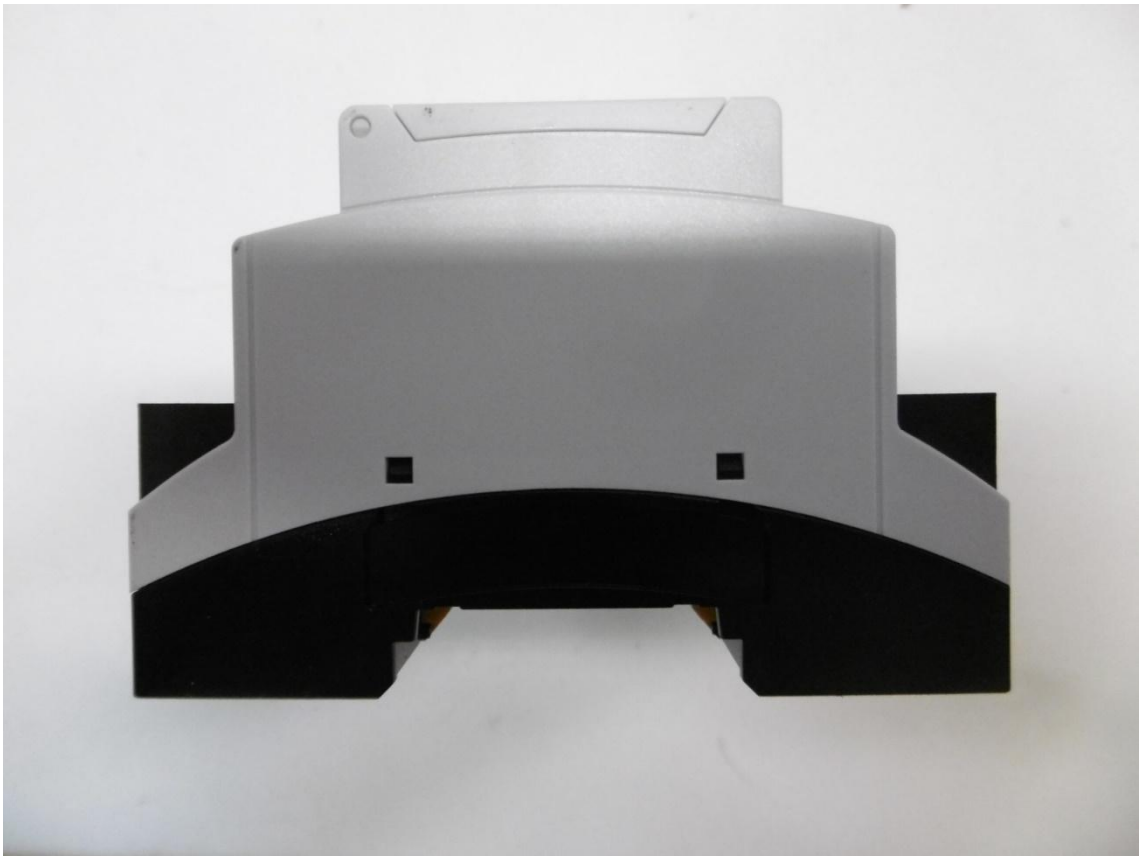
Rüdiger Gramsch

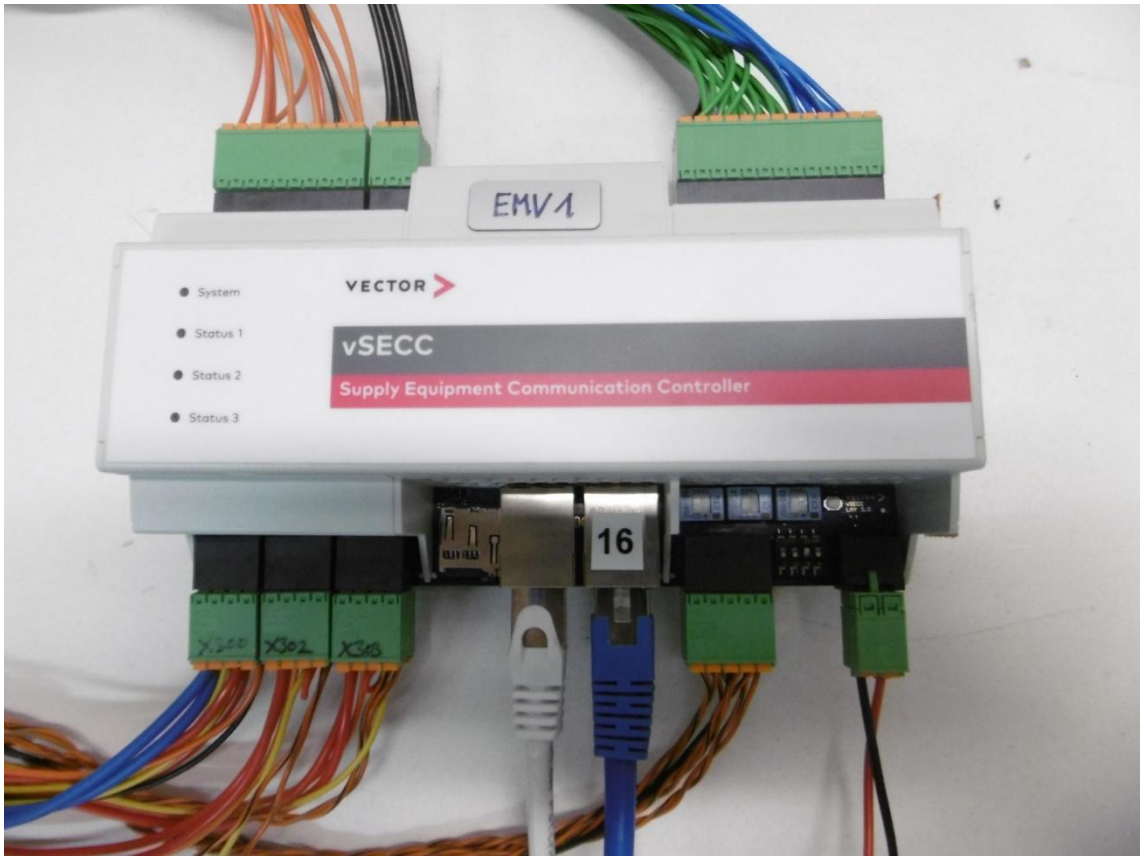
3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EuT

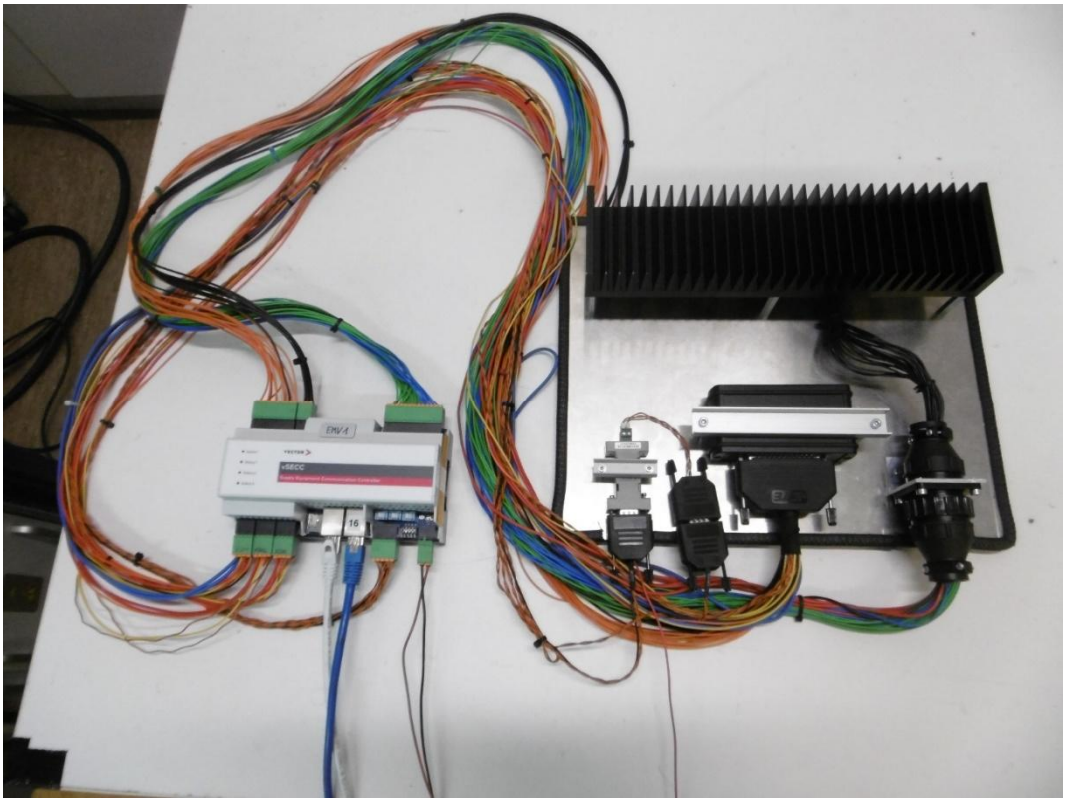


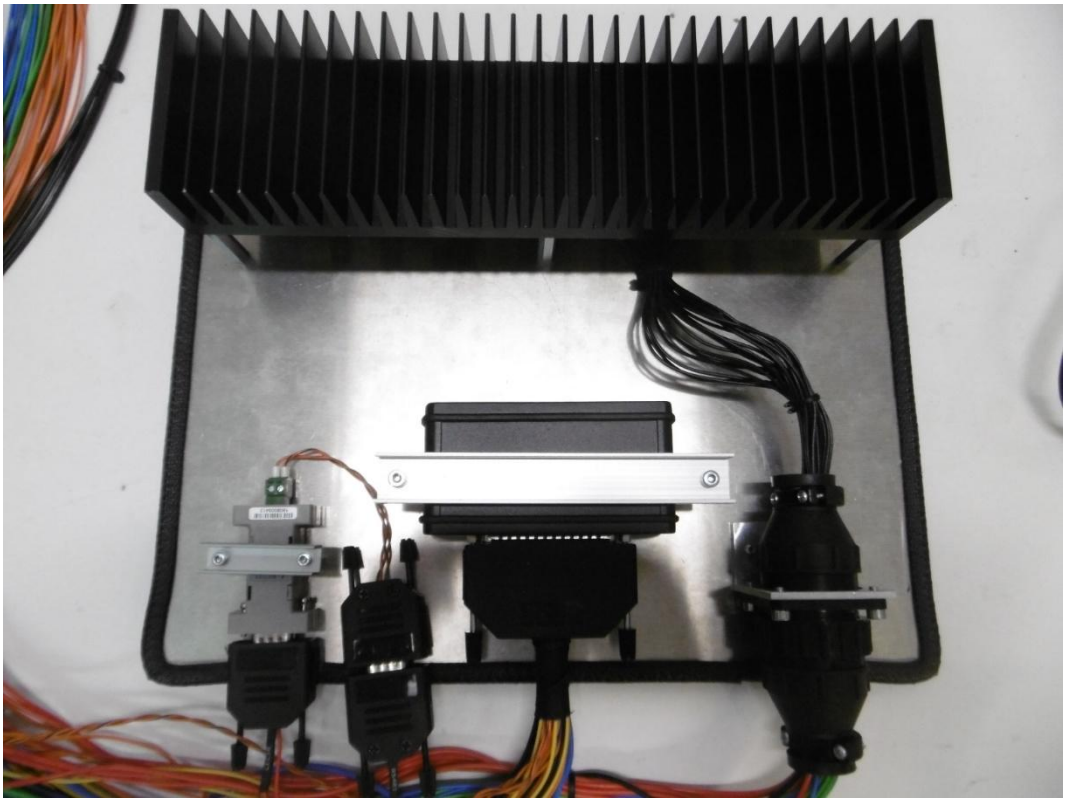


CSA Group Bayern GmbH
Ohmstrasse 1-4 ž 94342 STRASSKIRCHEN ž GERMANY
Tel.:+49(0)9424-94810 ž Fax:+49(0)9424-9481440



3.2 Photo documentation of the EuT - Test setup





3.3 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.

3.4 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.

3.5 Power supply system utilised

Power supply voltage : 24 V DC / 120 V, 60 Hz

All tests were carried out with a supply voltage of 120 V, 60 Hz unless otherwise stated.
Exceptions are described in the detailed test conditions.

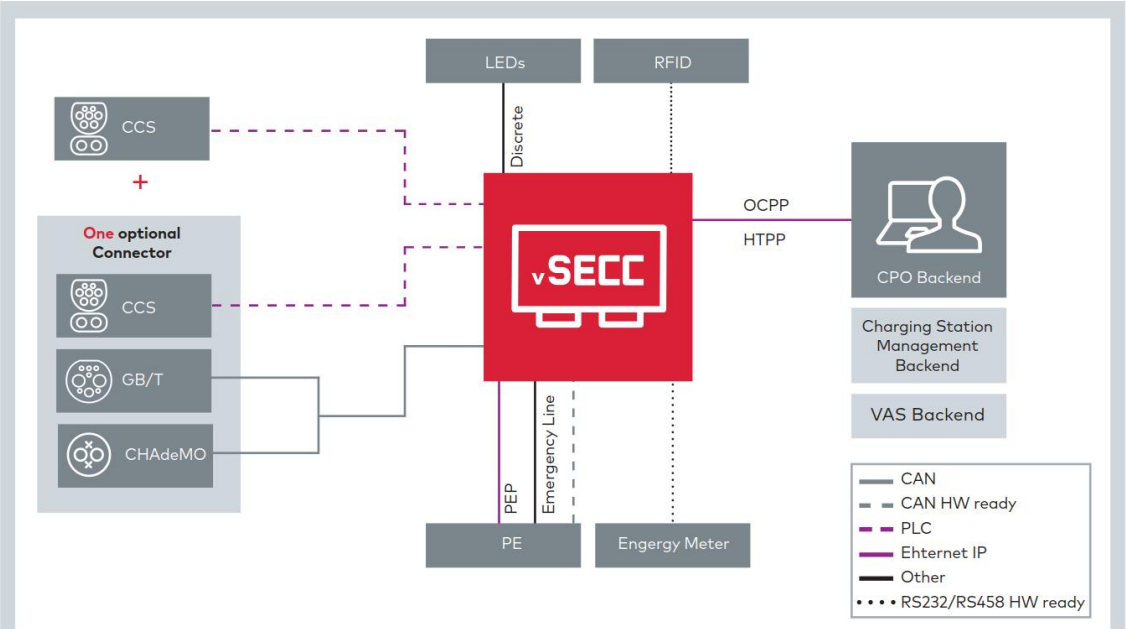
3.6 Highest internal frequency

Highest internal frequency : Controller 1 GHz

3.7 Short description of the Equipment under Test (EuT)

vSECC (Supply Equipment Communication Controller) is a communication controller for charging stations and charge points. It serves as a communication interface between the electric vehicle, the Charging Station Management System (CSMS) and the power electronics. vSECC supports the charging communication over Combined Charging System (CCS), CHAdeMO (Japanese Charging Consortium) and GB/T (Chinese Charging Standard) according to ISO 15118 and DIN SPEC 70121. Moreover it controls the power electronics that provide AC or DC for charging.
vSECC is suitable for both overnight and opportunity charge points along with wireless power transfer and pantographs using external WiFi module. Typical use cases could be charge points in public ares, residential facilities, fleet depots and companies.

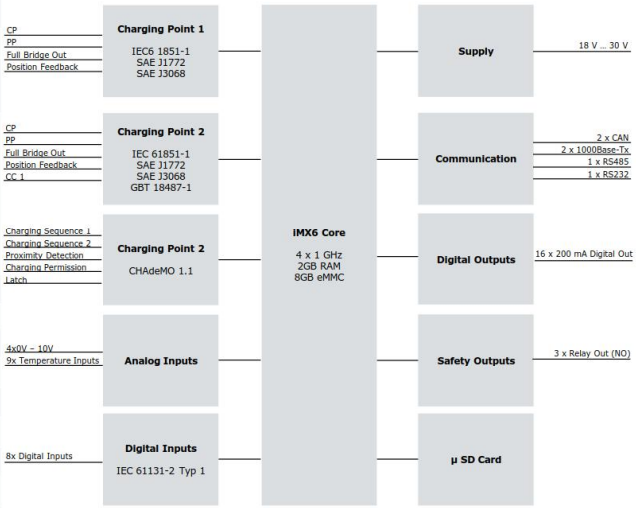
Feature	vSECC			
Main CPU	i.MX 6 Quad Core 4 x 1 GHz, 2 GB RAM, 8GB eMMC			
Power Supply	18 V - 30 V DC			
Communication	2 x CAN	2 x 1000Base-Tx	1 x RS232	1 x RS485
Charging Interfaces	2 charge points managed simultaneously			
Supported Standards	IEC 61851-1	DIN 70121	ISO 15118-2/-3	
Under Development	SAE J1772	CHAdeMO	GB/T 27930	GB/T 18487
Charging Environment	2 x fullbridge out (Imax = 1A)		2 x analog input position feedback	
Digital Inputs	8 x IEC 61131-2 Type 1 digital input			
Analog Inputs	2 x 0 - 10 V analog input		9 x temperature sensor input	
Safety Output	3x relay output (NO)			
Digital Output	16 x digital out (Imax = 200mA)			
Housing Dimensions (L/W/H)	162 mm x 89,7 mm x 62,2 mm (plastic)			
Operating temperature	–40 °C ... +70 °C			
IP Protection Class	IP 20			



Highest flexibility for all use cases: Connectivity interfaces of vSECC.

Hardware details

Main-CPU	i.MX 6Quad Core 4x 1GHz, 2 GB RAM, 8GB eMMC
Power Supply	18 V – 30 V DC
Communication	2x CAN 2x 1000Base-Tx 1x RS232 1x RS485
Charging Interfaces	Max. 2 charging points simultaneously Supported Standards: IEC61851-1 DIN 70121 ISO 15118-2/-3 Under development: SAE J1772 CHAdcMO GB/T 18487 GB/T 27930
Charging Environment	2x Fullbridge Out (Imax = 1A) 2x Analog Input Position Feedback
Digital Inputs	8x IEC 61131-2 Type 1 Digital Input
Analog Inputs	2x 0-10V Analog Input 9x Temperature Sensor Input
Safety Output	3x Relay Output (NC)
Digital Output	16x Digital Out (Imax = 200mA)
Housing Dimensions (L/B/H)	162 mm x 89,7 mm x 62,2 mm (plastic)
Operation Temperature	-40°C to +70°C
Connectors	2x RJ45 92x METZ AST Series (spring clamp)
IP Protection Class	IP20



Number of tested samples : 1
Serial number : 16

3.8 EuT operation mode

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

- Hardware test mode

3.9 EuT monitoring

The equipment under test was monitored during the measurement by following method:

The data transmission was controlled via Test-PC with an applicant specific test software.

3.10 EuT configuration

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

- VIR-EMCLAB-NOTEBOOK Model : DELL Precision 7510 (S/N: 10229419262)
- TP-LINK 8-Port Gigabit Desktop Switch Model : TL-SG1008D (S/N: 11B69501081)

Port	Cable	Screening	Transmission	Status	Length
1	DC power line (X307)	unshielded	analogue	active	1 m
2	ETH1	shielded	digital	active	3 m
3	ETH2	shielded	digital	active	3 m
4	X300	unshielded	digital/analogue	active	1.5 m
5	X301	unshielded	analogue	active	1.5 m
6	X302	unshielded	digital/analogue	active	1.5 m
7	X303	unshielded	digital/analogue	active	1.5 m
8	X304	unshielded	analogue	active	1.5 m
9	X305	unshielded	digital	active	1.5 m
10	X306	unshielded	digital	active	1.5 m

Pin Allocation Table — vSECC

Drawing of Connector

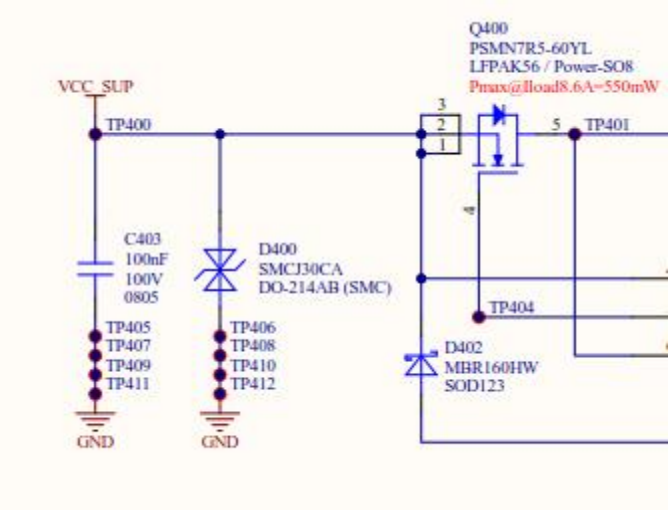
Pin	Name	Function	Assignment	Connector
X300				
X300_1	CHD SEQ1			1 CHD SEQ1 · 3 CHRG PER · 5 LATCH OUT · 7 GBT CC1
X300_2	CHD SEQ2			2 CHD SEQ2 · 4 PROX DET · 6 LATCH IN · 8 PE
X300_3	CHRG PER			
X300_4	PROX DET			
X300_5	LATCH OUT			
X300_6	LATCH IN			
X300_7	CC1			
X300_8	PE			
X301				
X301_1	0-10V 2			1 0-10V 2 · 3 AGND · 5 AGND · 7 TEMP 8 · 9 AGND · 11 TEMP 6 · 13 AGND · 15 TEMP 4 · 17 AGND · 19 TEMP 2
X301_2	0-10V 1			2 0-10V 1 · 4 TEMP 9 · 6 AGND · 8 TEMP 7 · 10 AGND · 12 TEMP 5 · 14 AGND · 16 TEMP 3 · 18 AGND · 20 TEMP 1
X301_3	AGND			
X301_4	TEMP 9			
X301_5	AGND			
X301_6	AGND			
X301_7	TEMP 8			
X301_8	TEMP 7			
X301_9	AGND			
X301_10	AGND			
X301_11	TEMP 6			
X301_12	TEMP 5			
X301_13	AGND			
X301_14	AGND			
X301_15	TEMP 4			
X301_16	TEMP 3			
X301_17	AGND			
X301_18	AGND			
X301_19	TEMP 2			
X301_20	TEMP 1			
X302				
X302_1	M2a			1 M2a · 3 FB2 · 5 PP2-PU · 7 CP2
X302_2	M2b			2 M2b · 4 GND · 6 PP2 · 8 PE
X302_3	FB2			
X302_4	GND			
X302_5	PP2-PU			
X302_6	PP2			
X302_7	CP2			
X302_8	PE			
X303				
X303_1	M1a			1 M1a · 3 FB1 · 5 PP1-PU · 7 CP1
X303_2	M1b			2 M1b · 4 GND · 6 PP1 · 8 PE
X303_3	FB1			
X303_4	GND			
X303_5	PP1-PU			
X303_6	PP1			
X303_7	CP1			
X303_8	PE			

Pin	Name	Function	Assignment
X304			
X304_1	REL1b		
X304_2	REL1a		
X304_3	REL2b		
X304_4	REL2a		
X304_5	REL3b		
X304_6	REL3a		
X305			
X305_1	CAN1 H		
X305_2	CAN2 H		
X305_3	CAN1 L		
X305_4	CAN2 L		
X305_5	GND		
X305_6	GND		
X305_7	RS485 B		
X305_8	RS232 TXD		
X305_9	RS485 A		
X305_10	RS232 RXD		
X306			
X306_1	24V		
X306_2	DIN8		
X306_3	DIN7		
X306_4	DIN6		
X306_5	DIN5		
X306_6	DIN4		
X306_7	DIN3		
X306_8	DIN2		
X306_9	DIN1		
X306_10	OUT16		
X306_11	OUT15		
X306_12	OUT14		
X306_13	OUT13		
X306_14	OUT12		
X306_15	OUT11		
X306_16	OUT10		
X306_17	OUT9		
X306_18	OUT8		
X306_19	OUT7		
X306_20	OUT6		
X306_21	OUT5		
X306_22	OUT4		
X306_23	OUT3		
X306_24	OUT2		
X306_25	OUT1		
X306_26	GND		
X307			
X307_1	Sup GND		
X307_2	Sup 24V		

Connector

1 REL1b	3 REL2b	5 REL3b											
2 REL1a	4 REL2a	6 REL3a											
1 CAN1 H	3 CAN1 L	5 GND	7 RS485 B	9 RS485 A									
2 CAN2 H	4 CAN2 L	6 GND	8 RS232 TXD	10 RS232 RXD									
1 REL1b	3 DIN7	5 DIN5	7 DIN3	9 DIN1	11 OUT15	13 OUT13	15 OUT11	17 OUT9	19 OUT7	21 OUT5	23 OUT3	25 OUT1	
2 DIN8	4 DIN6	6 DIN4	8 DIN2	10 OUT16	12 OUT14	14 OUT12	16 OUT10	18 OUT8	20 OUT6	22 OUT4	24 OUT2	26 REL1a	
1 Sup GND	2 Sup 24V												

Modifications during the EMC test:
I5 (SURGE) change the diode from Diodes SMCJ33CA to Bourns SMCJ30CA



Tolerances defined by the EUT manufacturer:

FBB CP

Set CP1 to 1kHz PWM, 5% Duty Cycle; disable PWM for CP2; disable LIN1/2

signal name	value
CP1_PWM	1kHz, 5% dutycycle
CP1_PWM_EN	HIGH
CP1_LOSS_THR_LIN	LOW
CP1_LIN_TCV_EN	LOW
CP1_LIN_SUP_EN	LOW
CP2_PWM	LOW
CP2_PWM_EN	LOW
CP2_LOSS_THR_LIN	LOW
CP2_LIN_TCV_EN	LOW
CP2_LIN_SUP_EN	LOW

FBB FB_OUT

Set FB_OUT1 to DIR 1->2, set FB_OUT2 to DIR 2->1, set FBB_Output voltage to 12V

signal name	value
FB_OUT_STBY	HIGH
FB_OUT_24V	LOW
FB_OUTA_DIR	HIGH
FB_OUTA_RUN	HIGH
FB_OUTB_DIR	LOW
FB_OUTB_RUN	HIGH

FBB Chademo

Enable Charge_Seq1, Charge_Seq2 and Latch_OUT

signal name	value
LATCH_EN_CPU	HIGH
CHRG_SEQ_1_CPU	HIGH
CHRG_SEQ_2_CPU	HIGH

FBB Safety Outputs

Enable all supervisor channels

signal name	value
nRELAY1_EN	LOW
nRELAY2_EN	LOW
nRELAY3_EN	LOW
nEN_CP1_LOSS	LOW
nEN_PP1_LOSS	LOW
nEN_CP2_LOSS	LOW
nEN_PP2_LOSS	LOW
nEN_CC1_LOSS_DC	LOW
nEN_CC1_LOSS_AC	HIGH
nEN_CHD_LATCH_ERROR	LOW
nEN_CHD_CHRG_PER	LOW

FBB Digital OUT

Enable Outputs OUT1,2,3,4 and 13,14,15,16

Disable Outputs OUT5,6,7,8 and 9,10,11,12

signal name	value
DIG_OUT_EN	HIGH

signal monitoring analog values

signal name	simulated value	measured value	tolerance
AIN_10V_1	1,96V	0,92V	+-100mV
AIN_10V_2	4,00V	1,88V	+-100mV
AIN_10V_3	6,00V	2,82V	+-100mV
AIN_10V_4	8,00V	3,76V	+-100mV
AIN_TEMP_1	1,00kOhm	0,40V	+-50mV
AIN_TEMP_2	1,00kOhm	0,40V	+-50mV
AIN_TEMP_3	1,00kOhm	0,40V	+-50mV
AIN_TEMP_4	499Ohm	0,20V	+-50mV
AIN_TEMP_5	1,00kOhm	0,40V	+-50mV
AIN_TEMP_6	1,50kOhm	0,60V	+-50mV
AIN_TEMP_7	2,00kOhm	0,80V	+-50mV
AIN_TEMP_8	2,49kOhm	1,00V	+-50mV
AIN_TEMP_9	3,01kOhm	1,20V	+-50mV
LOCK_POS1	2,60V	2,60V	+-100mV
LOCK_POS2	3,61V	3,61V	+-100mV
GBT1_CC1	1,00kOhm	1,64V	+-100mV
PP1	1,14kOhm	2,58V	+-100mV
PP2	1,14kOhm	2,58V	+-100mV
CP1 high level CP1 low level	6,00V -12,00V	1,50V 4,50V	+-200mV +-200mV
CP2 high level CP2 low level	6,00V -12,00V	1,50V 4,50V	+-200mV +-200mV
VCC_3V3_CORE	3,30V	3,30V	+-100mV
VCC_5V	5,00V	2,50V	+-100mV
VCC_12V_HP	12,00V	3,00V	+-200mV
VCC_12V	12,00V	3,00V	+-200mV
VCC_-12V	-12,00V	1,63V	+-200mV

signal monitoring digital values

signal name	expected value
CP1_PWM_FB	1kHz, 5% dutycylce
CP2_PWM_FB	1kHz, 5% dutycylce
nCP1_LOSS	HIGH
nCP2_LOSS	HIGH
nPP1_LOSS	HIGH
nPP2_LOSS	HIGH
FB_OUTA_ERR	HIGH
FB_OUTB_ERR	HIGH
nCC1_LOSS	HIGH
SUP_lim_FAULT	LOW
CHRG_PER_CPU	LOW
CHRG_PER_STG	HIGH
PROX_DET_CPU	LOW
LATCH_ERROR	HIGH
RELAY1_FB	HIGH
RELAY2_FB	HIGH
RELAY3_FB	HIGH
DIG_IN1	HIGH
DIG_IN2	HIGH
DIG_IN3	LOW
DIG_IN4	LOW
DIG_IN5	LOW
DIG_IN6	LOW
DIG_IN7	HIGH
DIG_IN8	HIGH
DIG_OUT_FAULT	HIGH

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

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 dBmV, 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 dBmV and mV, the following conversions apply:

dBmV = 20(log mV)
mV = Inverse log(dBmV/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 W / 50 mH (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 dBµV/m, is arrived at by taking the reading from the EMI receiver (Level dBµV) 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 (dBµV)	+	Correction Factor* (dB/m)	=	Level (dBµV/m)	-	CISPR Limit (dBµV/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	QuasiPeak reading including correction factor
AV	Average reading including correction factor
Margin	Measured value to limit delta

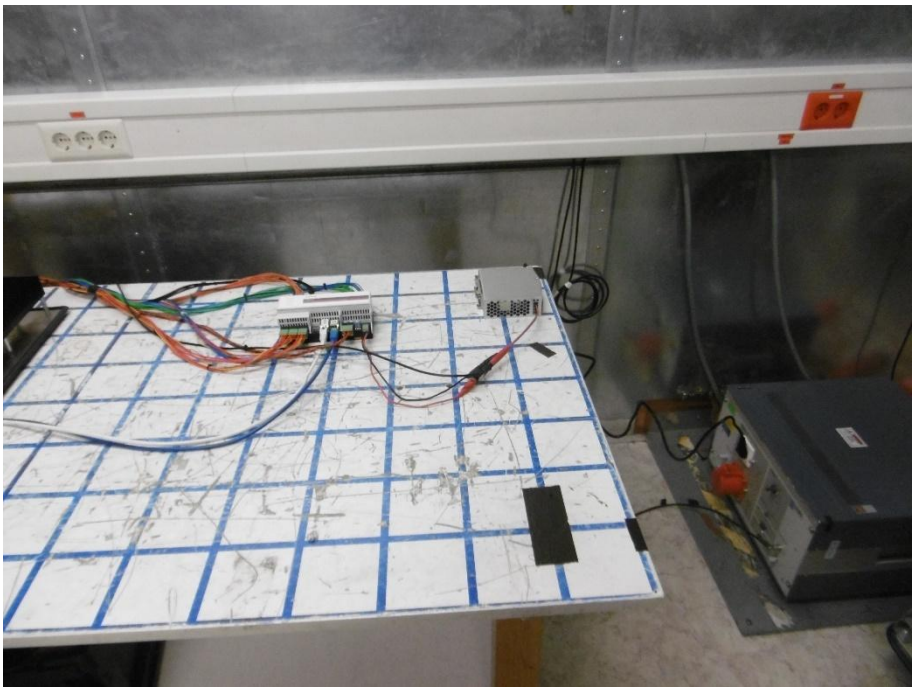
5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Environmental conditions

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

5.1.3 Photo documentation of the test setup



5.1.4 Test result

Frequency range:	0.15 MHz - 30 MHz
Min. limit margin	>5 dB

The requirements are **FULFILLED.**

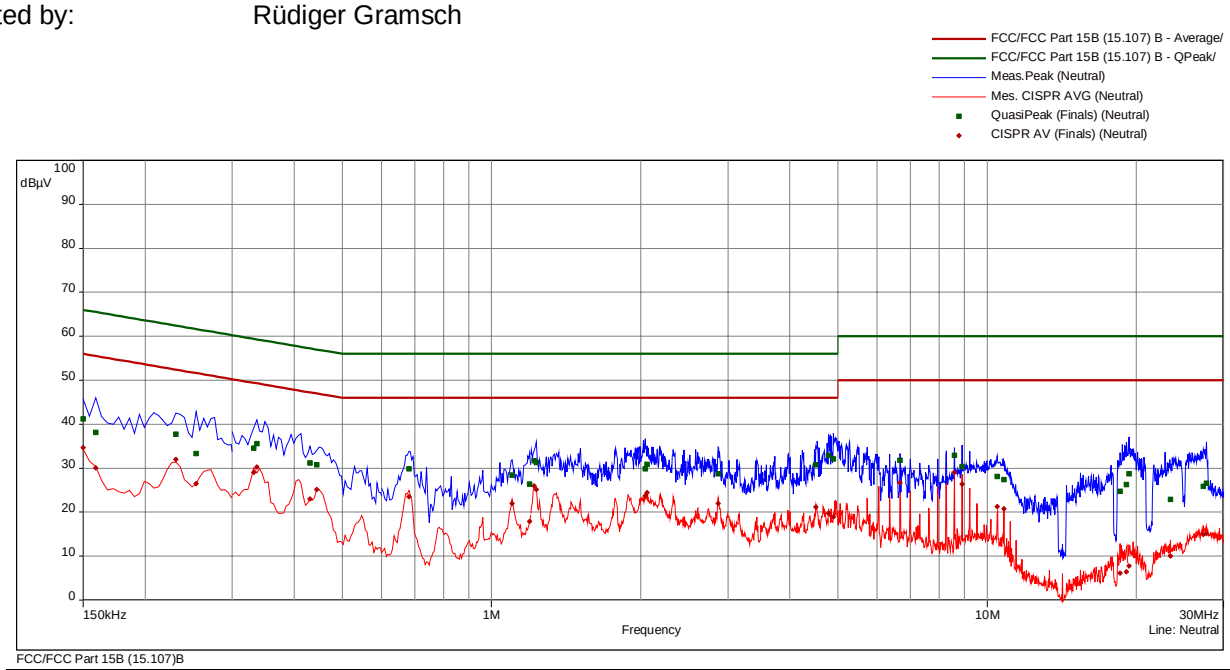
Remarks: For detailed results, please see the following page(s).

For description of the measurement see 4.7.3.

The test carried out with a power supply MEAN WELL SDR-120-24 (serial no.: EB98274040).

5.1.5 Test protocol

Test point:	N	Result: passed
Operation mode:	Hardware test mode	
Remarks:	None	
Date:	10. February 2021	
Tested by:	Rüdiger Gramsch	

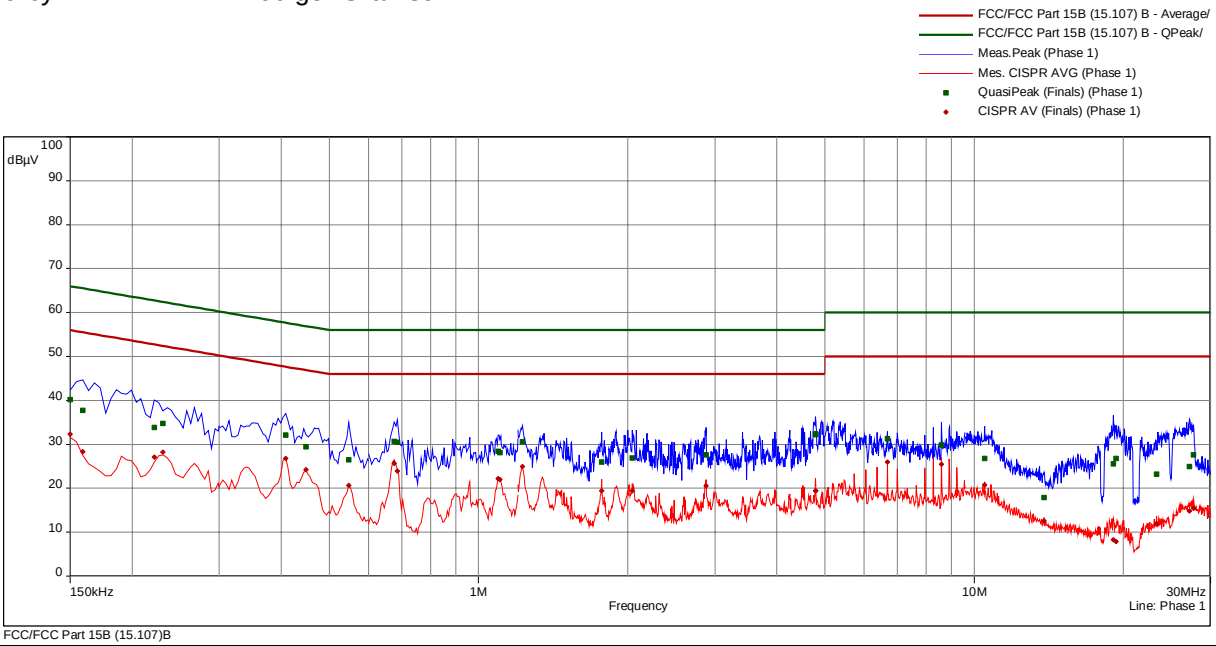


FCC/FCC Part 15B (15.107)B

freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.15	9	41.21	-24.79	66.00	34.64	-21.36	56.00	Neutral	10.09
0.159	9	38.16	-27.35	65.52	30.06	-25.46	55.52	Neutral	10.10
0.231	9	37.75	-24.66	62.41	32.03	-20.38	52.41	Neutral	10.13
0.2535	9	33.34	-28.31	61.64	26.49	-25.15	51.64	Neutral	10.13
0.3315	10	34.57	-24.84	59.41	29.08	-20.34	49.41	Neutral	10.15
0.336	10	35.57	-23.73	59.30	30.22	-19.08	49.30	Neutral	10.15
0.4305	10	31.22	-26.03	57.24	23.05	-24.19	47.24	Neutral	10.16
0.444	10	30.77	-26.21	56.99	25.16	-21.83	46.99	Neutral	10.16
0.681	11	29.86	-26.14	56.00	23.50	-22.50	46.00	Neutral	10.19
1.0995	11	28.44	-27.56	56.00	21.99	-24.01	46.00	Neutral	10.22
1.194	11	26.43	-29.57	56.00	17.95	-28.05	46.00	Neutral	10.23
1.218	12	31.75	-24.25	56.00	25.93	-20.07	46.00	Neutral	10.23
1.2315	12	31.32	-24.68	56.00	25.20	-20.80	46.00	Neutral	10.23
2.0415	12	29.89	-26.11	56.00	23.77	-22.23	46.00	Neutral	10.28
2.0595	12	30.85	-25.15	56.00	24.41	-21.59	46.00	Neutral	10.28
2.868	13	28.79	-27.21	56.00	22.01	-23.99	46.00	Neutral	10.34
4.5105	13	30.78	-25.22	56.00	21.18	-24.82	46.00	Neutral	10.42
4.785	13	32.97	-23.03	56.00	19.75	-26.25	46.00	Neutral	10.42
4.899	14	32.12	-23.88	56.00	18.94	-27.06	46.00	Neutral	10.43
6.6765	14	31.84	-28.16	60.00	26.74	-23.26	50.00	Neutral	10.55
8.5845	14	32.98	-27.02	60.00	29.09	-20.91	50.00	Neutral	10.63
8.8995	14	30.40	-29.60	60.00	26.40	-23.60	50.00	Neutral	10.64
10.491	15	28.13	-31.87	60.00	21.32	-28.68	50.00	Neutral	10.70
10.8105	15	27.42	-32.58	60.00	20.77	-29.23	50.00	Neutral	10.73
18.5415	15	24.79	-35.21	60.00	6.09	-43.91	50.00	Neutral	11.19
19.113	15	26.32	-33.68	60.00	6.48	-43.52	50.00	Neutral	11.22
19.3395	16	28.76	-31.24	60.00	7.79	-42.21	50.00	Neutral	11.23
23.448	16	22.87	-37.13	60.00	9.98	-40.02	50.00	Neutral	11.27
27.336	16	25.88	-34.12	60.00	14.98	-35.02	50.00	Neutral	11.18
27.732	16	26.61	-33.39	60.00	15.17	-34.83	50.00	Neutral	11.17

Test point: L1
Operation mode: Hardware test mode
Remarks: None
Date: 10. February 2021
Tested by: Rüdiger Gramsch

Result: passed



FCC/FCC Part 15B (15.107)B

freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.15	1	40.15	-25.85	66.00	32.32	-23.68	56.00	Phase 1	10.09
0.159	1	37.70	-27.82	65.52	28.30	-27.21	55.52	Phase 1	10.10
0.222	1	33.84	-28.91	62.74	27.06	-25.68	52.74	Phase 1	10.11
0.231	1	34.73	-27.68	62.41	28.24	-24.18	52.41	Phase 1	10.12
0.408	2	32.11	-25.58	57.69	26.80	-20.88	47.69	Phase 1	10.16
0.4485	2	29.41	-27.49	56.90	24.28	-22.62	46.90	Phase 1	10.16
0.5475	2	26.45	-29.55	56.00	20.68	-25.32	46.00	Phase 1	10.16
0.6765	3	30.72	-25.28	56.00	25.63	-20.37	46.00	Phase 1	10.18
0.6855	3	30.43	-25.57	56.00	23.90	-22.10	46.00	Phase 1	10.19
1.095	3	28.44	-27.56	56.00	22.24	-23.76	46.00	Phase 1	10.22
1.104	3	28.17	-27.83	56.00	21.99	-24.01	46.00	Phase 1	10.22
1.227	4	30.58	-25.42	56.00	24.91	-21.09	46.00	Phase 1	10.23
1.7715	4	26.03	-29.97	56.00	19.48	-26.52	46.00	Phase 1	10.27
2.0415	4	26.85	-29.15	56.00	19.47	-26.53	46.00	Phase 1	10.28
2.877	5	27.66	-28.34	56.00	20.56	-25.44	46.00	Phase 1	10.34
4.7895	5	32.44	-23.56	56.00	19.47	-26.53	46.00	Phase 1	10.43
4.8	6	32.17	-23.83	56.00	19.42	-26.58	46.00	Phase 1	10.43
6.6855	6	31.24	-28.76	60.00	25.98	-24.02	50.00	Phase 1	10.58
8.598	6	29.82	-30.18	60.00	25.44	-24.56	50.00	Phase 1	10.68
10.5045	7	26.85	-33.15	60.00	20.81	-29.19	50.00	Phase 1	10.79
13.83	7	17.94	-42.06	60.00	12.58	-37.42	50.00	Phase 1	11.09
19.0905	7	25.61	-34.39	60.00	8.31	-41.69	50.00	Phase 1	11.42
19.3575	8	26.81	-33.19	60.00	7.87	-42.13	50.00	Phase 1	11.43
23.34	8	23.24	-36.76	60.00	11.99	-38.01	50.00	Phase 1	11.61
27.1875	8	24.96	-35.04	60.00	14.82	-35.18	50.00	Phase 1	11.70
27.732	8	27.60	-32.40	60.00	15.49	-34.51	50.00	Phase 1	11.70

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 polarized antenna
Level hor. QuasiPeak reading including correction factor for horizontally polarized antenna
Limit Limit referred to the appropriate standard
DLimit Delta between limit and result (margin)

5.2.1 Description of the test location

Test location: OATS 1

Test distance: 10 metres

5.2.2 Environmental conditions

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

5.2.3 Photo documentation of the test setup

5.2.4 Test result

Frequency range: 30 MHz - 1000 MHz

Min. limit margin by 3.5 dB at 750 MHz

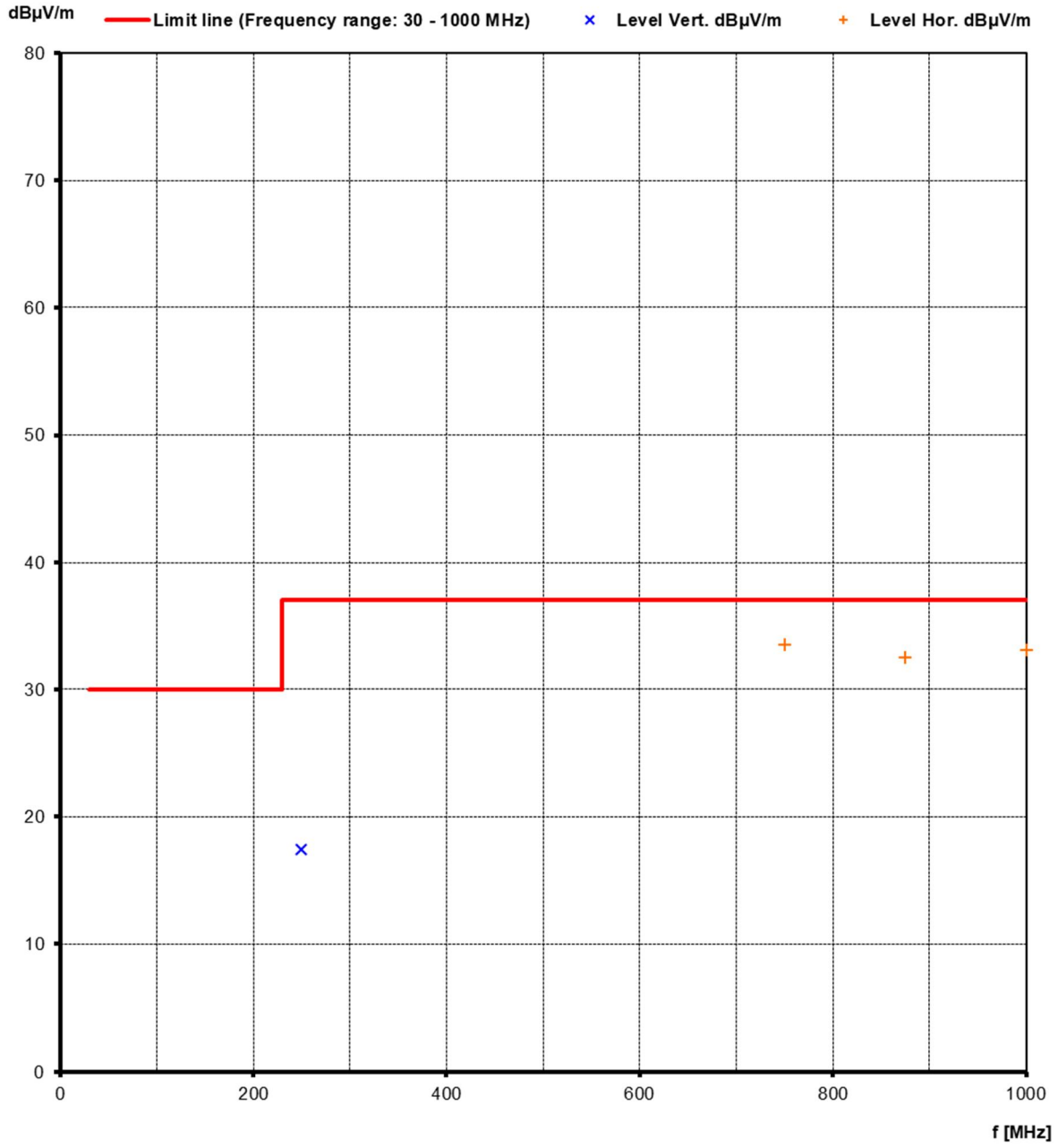
The requirements are **FULFILLED.**

Remarks: For detailed results, please see the following page(s).

For description of the measurement see 4.7.4.

5.2.5 Test protocol

Operation mode:	Hardware test mode	Result: passed
Remarks:	None	
Date:	30. July 2020	
Tested by:	Rüdiger Gramsch	



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)
250.00	3.0		14.4		17.4		37.0	-19.6
750.00		7.0		26.5		33.5	37.0	-3.5
875.00		4.0		28.5		32.5	37.0	-4.5
1000.00		3.0		30.1		33.1	37.0	-3.9

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 A1

Test distance: 3 metres

ETS Lindgren 3117:
Dimension of the line tangent to the EUT according to CISPR 16-2-3: 2010

Note: The Q 3 dB min values were given by the antenna manufacturer

Frequency GHz	Q 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

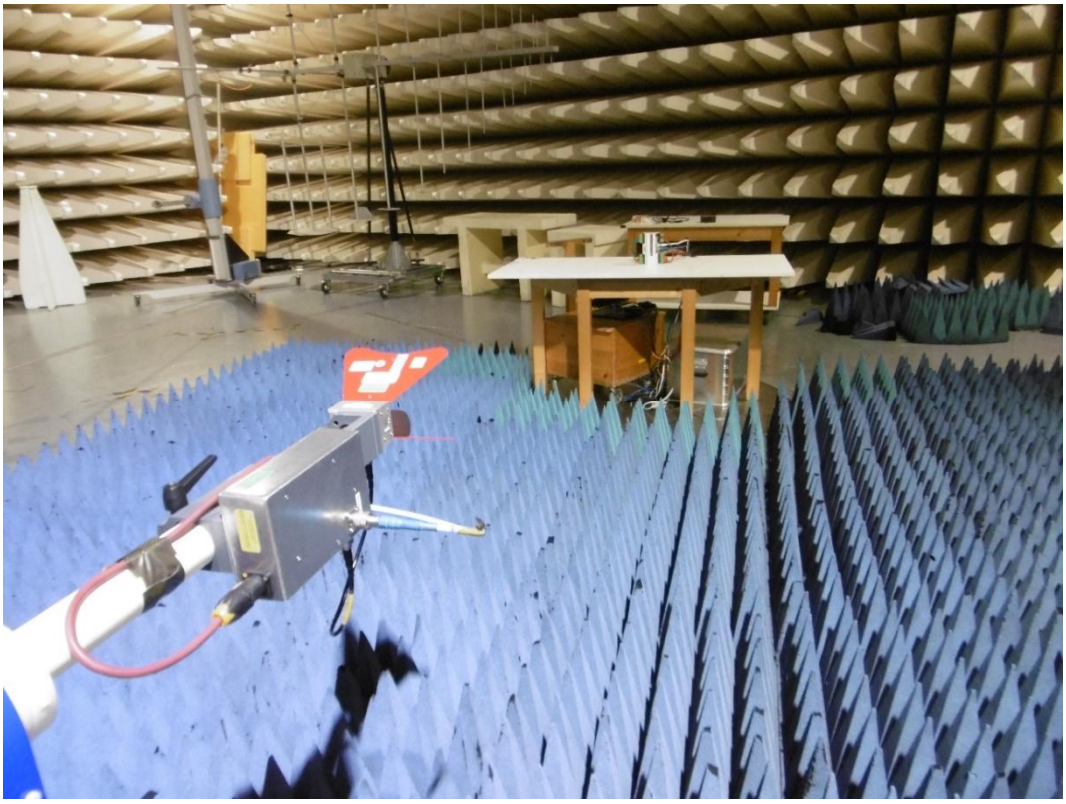
5.3.2 Environmental conditions

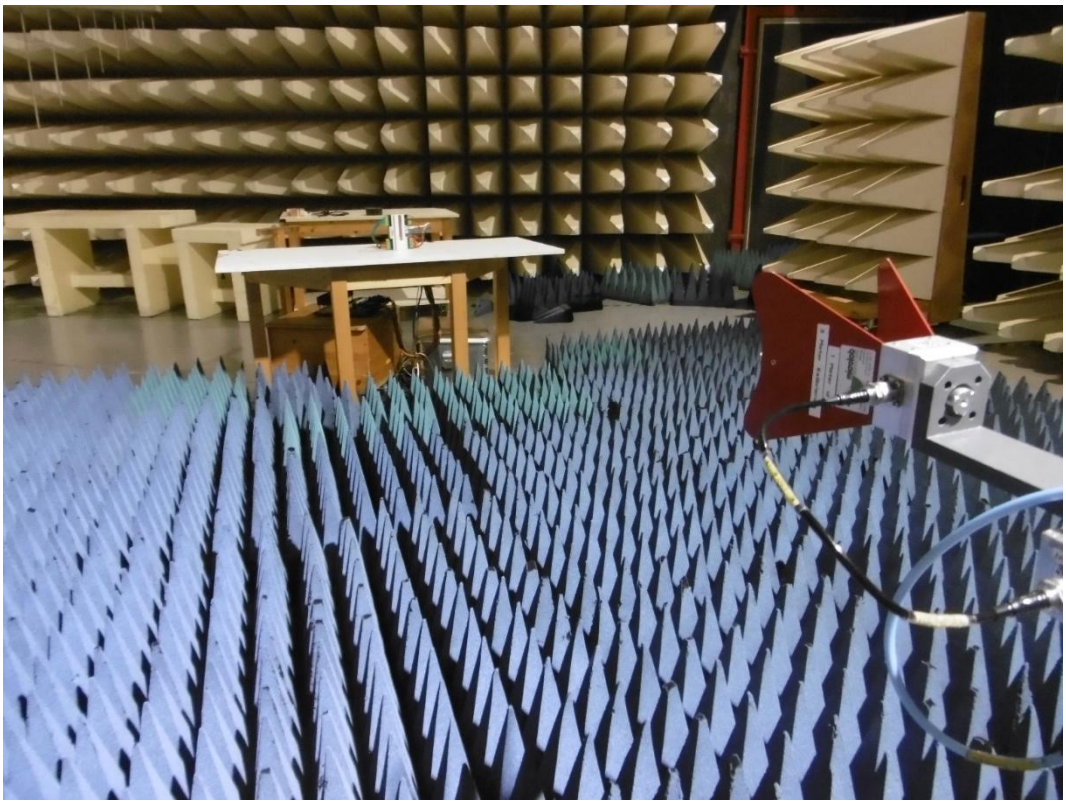
Temperature: 15-35 °C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

5.3.3 Photo documentation of the test setup





5.3.4 Test result

Frequency range: 1000 MHz - 6000 MHz

Min. limit margin >5 dB

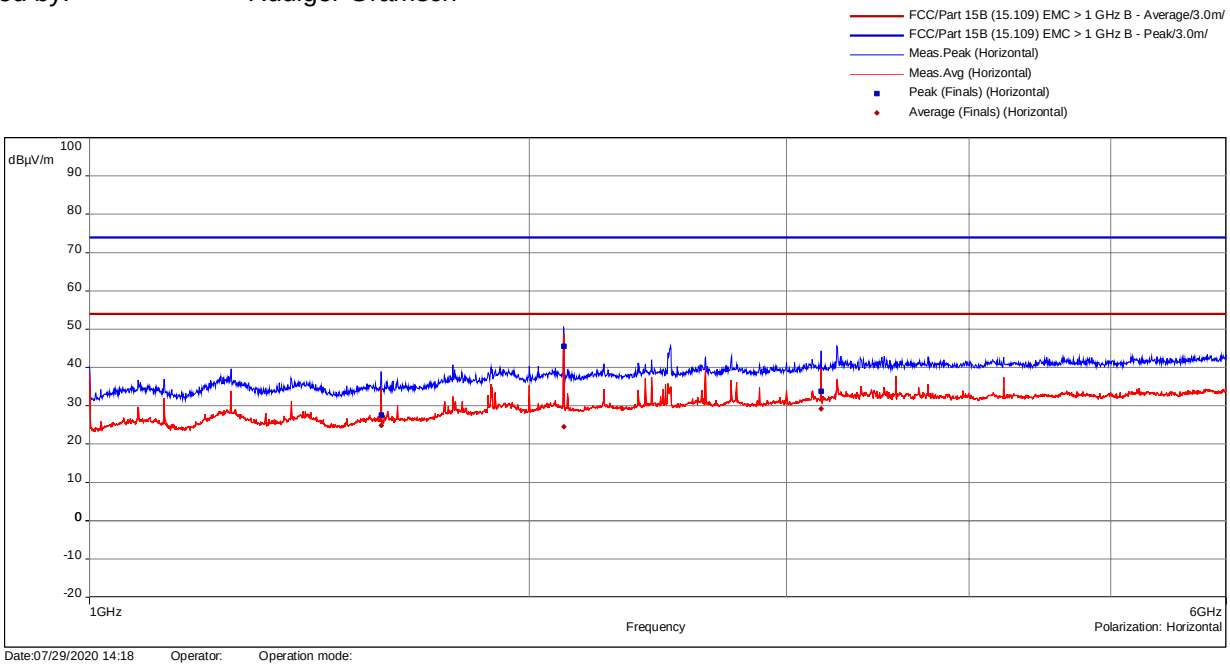
The requirements are **FULFILLED.**

Remarks: For detailed results, please see the following page(s).

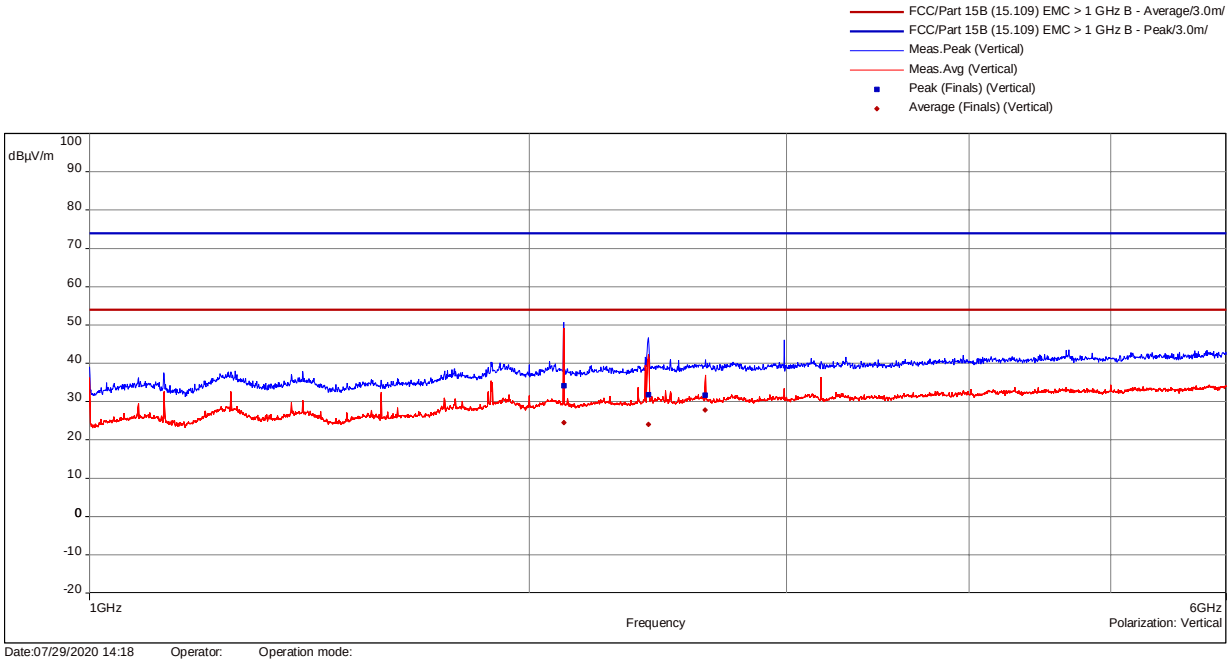
For description of the measurement see 4.7.5.

5.3.5 Test protocol

Operation mode:	Hardware test mode	Result: passed
Remarks:	FCC part 15	
Date:	30. July 2020	
Tested by:	Rüdiger Gramsch	



Date:07/29/2020 14:18 Operator: Operation mode:



Date:07/29/2020 14:18 Operator: Operation mode:

frequency	SR	Peak	margin	limit Peak	Average	margin	limit AV	angle	antenna high	antenna polarisation	correction
MHz		dBµV/m	dB	dBµV/m	dBµV/m	dB	dBµV/m	°	m		dB
2111.9779	1	34.15	-39.85	74.00	24.54	-29.46	54.00	156.80	2.55	Vertical	-7.80
2412.7379	1	31.78	-42.22	74.00	24.05	-29.95	54.00	291.30	1.24	Vertical	-7.15
2639.3081	1	31.71	-42.29	74.00	27.78	-26.22	54.00	338.30	4.00	Vertical	-6.45
1584.155	2	27.51	-46.49	74.00	24.87	-29.13	54.00	282.30	2.33	Horizontal	-12.05
2112.3059	2	45.59	-28.41	74.00	24.45	-29.55	54.00	307.80	2.05	Horizontal	-7.80
3168.2569	2	33.74	-40.26	74.00	29.20	-24.80	54.00	333.40	1.74	Horizontal	-6.46

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used, in addition to the test accessories, are calibrated and verified regularly.

Test ID	Model Type	Kind of Equipment	Manufacturer	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	BAT-EMC 3.19.1.24	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	05/05/2021	05/11/2020
	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				
	F-203I-DCN-32 mm	Absorbing Clamp	FCC Fischer Custom Comm.	02-02/50-05-144				
	ESH 3 - Z 2	Pulse Limiter	Rohde & Schwarz München	02-02/50-05-155	44878	43782	44326	44145
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	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	FSW43	Spectrum Analyser	Rohde & Schwarz München	02-02/11-15-001	02/04/2021	02/04/2020		
	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		
	18N-20	Coax Attenuator 20dB	Tactron Elektronik	02-02/50-17-003				
	BAM 4.5-P	Antenna Mast	maturo GmbH	02-02/50-17-024				
	NCD	Controller for Antenna Mast	maturo GmbH	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	RF Cable	Huber + Suhner	02-02/50-18-016				
	BAT-EMC 3.19.1.24	Nexio Software	EMCO Elektronik GmbH	02-02/68-13-001				