PHOENIX TESTLAB

Königswinkel 10
32825 Blomberg, Germany
Phone: +49 (0) 52 35 / 95 00-0
Fax: +49 (0) 52 35 / 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number:

F191161E1

Equipment under Test (EUT):

omlox Satellite

Applicant:

TRUMPF Werkzeugmaschinen GmbH + Co. KG

Manufacturer:

TRUMPF Werkzeugmaschinen GmbH + Co. KG

ilac-MRA

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.4:2014** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

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

[3] **FCC 47 CFR Part 15:** Radio Frequency Devices (Subpart B)

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.

Tested and written by:	Bernward ROHDE	0.5.0.	07.09.2020
	Name	Signature	Date
Reviewed and approved by:	Bernd STEINER	11.02.2021 12:45	07.09.2020
	Name	Signature	Date

This test report is only valid in its original form.

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

Contents: Page

1 Identification

1.1 Applicant

Name:	TRUMPF Werkzeugmaschinen GmbH + Co. KG
Address:	Johann-Maus-Str. 2, 71254 Ditzingen
Country:	Germany
Name for contact purposes:	Mr. Guido Schönhardt
Phone:	07156-303-36117
Fax:	-
eMail Address:	Guido.schoenhardt@trumpf.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	TRUMPF Werkzeugmaschinen GmbH + Co. KG
Address:	Johann-Maus-Str. 2, 71254 Ditzingen
Country:	Germany
Name for contact purposes:	Mr. Guido Schönhardt
Phone:	07156-303-36117
Fax:	-
eMail Address:	Guido.schoenhardt@trumpf.com
Applicant 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-17186-01-06 and D-PL-17186-01-05, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

EUT	
Test object: *	Satellite for indoor localization
Model name: *	Omlox Satellite
FCC ID: *	2AVYV-2554432-01
Serial number: *	204744044
PCB identifier: *	1901154A00102B90
Hardware version: *	Rev D
Software version: *	3.0.6

* Declared by the applicant

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 technical EUT data						
Power supply EUT: *	DC (by POE or USB)					
Supply voltage EUT POE: *	U_{nom}=	48.0 V_{DC}	U_{min}=	42.5 V_{DC}	U_{max}=	57.0 V_{DC}
Supply voltage EUT (USB): *	U_{nom}=	5.0 V_{DC}	U_{min}=	4.45 V_{DC}	U_{max}=	5.25 V_{DC}
Temperature range: *	-10 °C to +39 °C					
Lowest / highest internal clock frequency: *	32 kHz / 4500 MHz					

Ports / Connectors				
Identification	EUT	Ancillary	Length during test	Shielding (Yes / No)
USB	USB-C	USB-A	2 m	Yes
Ethernet (with POE)	RJ45	RJ45	3 m	Yes

Remark:
USB was used during AC-Powerline emissions testing only
Ethernet was used for in all other testcases.

1.5.1 802.11 WLAN mode

IEEE 802.11 WLAN mode		
Fulfils radio specification: *	IEEE 802.11 b/g/n (HT20/HT40)	
Radio module: *	WL18MODGB, Texas Instruments	
FCC ID: *	Z64-WL18SBMOD	
Antenna type: *	Inverted F PCB antenna	
Antenna name: *	ANT1	
Antenna gain: *	2 dBi	
Antenna connector: *	n/a	
Power supply EUT: *	DC (by POE or USB)	
Conducted output power: *	IEEE 802.11 b	17.96 dBm
	IEEE 802.11 g	20.59 dBm
	IEEE 802.11 n20	20.56 dBm
	IEEE 802.11 n40	20.22 dBm
Type of modulation: *	IEEE 802.11 b	DSSS (DBPSK, DQPSK, CCK) (1/2/5.5/11 Mbit/s)
	IEEE 802.11 g	OFDM (BPSK, QPSK, 16-QAM, 64-QAM) (6/9/12/18/24/36/48/54 Mbit/s)
	IEEE 802.11 n20	OFDM (BPSK, QPSK, 16-QAM, 64-QAM) (up to 72.2 Mbit/s)
	IEEE 802.11 n40	OFDM (BPSK, QPSK, 16-QAM, 64-QAM) (up to 150 Mbit/s)
Operating frequency range: *	IEEE 802.11 b	2412 – 2462 MHz
	IEEE 802.11 g	2412 – 2462 MHz
	IEEE 802.11 n20	2412 – 2462 MHz
	IEEE 802.11 n40	2422 – 2452 MHz
Number of channels: *	IEEE 802.11 b	11 (5 MHz channel spacing)
	IEEE 802.11 g	11 (5 MHz channel spacing)
	IEEE 802.11 n20	11 (5 MHz channel spacing)
	IEEE 802.11 n40	7 (5 MHz channel spacing)

* Declared by the applicant

IEEE 802.11 b/g/n20 frequencies				
Channel 01	RX	2412 MHz	TX	2412 MHz
Channel 02	RX	2417 MHz	TX	2417 MHz
Channel 03	RX	2422 MHz	TX	2422 MHz
Channel 04	RX	2427 MHz	TX	2427 MHz
Channel 05	RX	2432 MHz	TX	2432 MHz
Channel 06	RX	2437 MHz	TX	2437 MHz
Channel 07	RX	2442 MHz	TX	2442 MHz
Channel 08	RX	2447 MHz	TX	2447 MHz
Channel 09	RX	2452 MHz	TX	2452 MHz
Channel 10	RX	2457 MHz	TX	2457 MHz
Channel 11	RX	2462 MHz	TX	2462 MHz

IEEE 802.11 n40 frequencies				
Channel 03	RX	2422 MHz	TX	2422 MHz
Channel 04	RX	2427 MHz	TX	2427 MHz
Channel 05	RX	2432 MHz	TX	2432 MHz
Channel 06	RX	2437 MHz	TX	2437 MHz
Channel 07	RX	2442 MHz	TX	2442 MHz
Channel 08	RX	2447 MHz	TX	2447 MHz
Channel 09	RX	2452 MHz	TX	2452 MHz

1.5.2 802.15.4 Radio mode

IEEE 802.15.4 radio mode		
Fulfils radio specification: *	IEEE 802.15.4	
Radio chip: *	Atmega256RFR2	
Antenna type: *	Chip-Ceramic	
Antenna name: *	RFANT3216120A5T	
Antenna gain: *	2 dBi (Typical)	
Antenna connector: *	MM8030-2610RJ3	
Conducted output power: *	IEEE 802.15.4	-14.1 dBm (Peak)
		-14.3 dBm (Average)
Type of modulation: *	IEEE 802.15.4	O-QPSK (250 kbit/s)
Operating frequency range: *	IEEE 802.15.4	2405 – 2480 MHz
Number of channels: *	IEEE 802.15.4	16 (5 MHz channel spacing)

IEEE 802.15.4 frequencies				
Channel 11	RX	2405 MHz	TX	2405 MHz
Channel 12	RX	2410 MHz	TX	2410 MHz
Channel 13	RX	2415 MHz	TX	2415 MHz
Channel 14	RX	2420 MHz	TX	2420 MHz
Channel 15	RX	2425 MHz	TX	2425 MHz
Channel 16	RX	2430 MHz	TX	2430 MHz
Channel 17	RX	2435 MHz	TX	2435 MHz
Channel 18	RX	2440 MHz	TX	2440 MHz
Channel 19	RX	2445 MHz	TX	2445 MHz
Channel 20	RX	2450 MHz	TX	2450 MHz
Channel 21	RX	2455 MHz	TX	2455 MHz
Channel 22	RX	2460 MHz	TX	2460 MHz
Channel 23	RX	2465 MHz	TX	2465 MHz
Channel 24	RX	2470 MHz	TX	2470 MHz
Channel 25	RX	2475 MHz	TX	2475 MHz
Channel 26	RX	2480 MHz	TX	2480 MHz

1.5.3 BLE Radio mode

Bluetooth® Low Energy radio mode		
Fulfils radio specification: *	BLE 4.2 (1 Mbit/s only)	
Radio chip: *	Nordic nRF52840	
Antenna type: *	Internal PCB antenna	
Antenna name: *	ANT2	
Antenna gain: *	2 dBi	
Antenna connector: *	none	
Conducted output power: *	BLE 1 Mbit/s	-1.3 dBm (Peak)
		-1.8 dBm (Average)
Type of modulation: *	BLE 1 Mbit/s	GFSK (1 Mbit/s)
Operating frequency range: *	BLE 1 Mbit/s	2402 – 2480 MHz
Number of channels: *	BLE 1 Mbit/s	40 (2 MHz channel spacing)

Bluetooth® Low Energy frequencies				
Channel 0	RX	2402 MHz	TX	2402 MHz
Channel 1	RX	2404 MHz	TX	2404 MHz
…	…	…	…	…
Channel 19	RX	2440 MHz	TX	2440 MHz
…	…	…	…	…
Channel 38	RX	2478 MHz	TX	2478 MHz
Channel 39	RX	2480 MHz	TX	2480 MHz

1.5.4 UWB Radio mode

UWB radio mode	
Channel 1	f_C = 3.575 GHz, 500 MHz bandwidth
Channel 4	f_C = 4.000 GHz, 500 MHz bandwidth
Channel 3	f_C = 4.500 GHz, 500 MHz bandwidth
Channel 4	f_C = 4.000 GHz, 1000 MHz bandwidth

Rated rf-output power: *	-41.3 dBm (e.i.r.p.)
Antenna type: *	Internal PCB antenna only
Antenna gain: *	2 dBi
Antenna connector: *	None

* declared by the applicant.

1.5.5 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
POE switch *1	TP link; TLSG108PE
Assistant BLE BLE (ancillary)	Trumpf Number #: 2400144_06/204731657 Module Number #: 1901154A00102B8C Marking 657
Assistant UWB UWB (ancillary)	Trumpf Number #: 2400144_06/204731656 Module Number #: 1901154A00102BCE Marking 656
Assistant WiFi WiFi (ancillary)	Trumpf Number #: 2105 Module Number #: 1901154A001046EA Marking 2105
Laptop with applications server: *1	Dell Inspiron 15 S/N: GB6H4P2
Laptop for remote access: *2	Fujitsu NS751-018; SN: DSBW019318
POE switch/injector:*1	PowerSine 3001
USB power supply: *1	Samsung travel adapter EP-TA20EBE

*1 Provided by the applicant
*2 Provided by the laboratory

1.6 Dates

Date of receipt of test sample:	13.09.2019
Start of test:	02.06.2020
End of test:	31.07.2020

2 Operational States

Description of function of the EUT:

The EUT is intended to be used as transceiver for locating of machine tools inside a factory building. It will be fixed mounted inside the factory building. Therefore, it is defined as fixed indoor equipment.
All radiated tests were carried out with an unmodified test sample powered with 48 V_{DC} via PoE from a PoE switch. Because the EUT also could be supplied with 5.0 VDC via USB, the conducted emission measurement on the power supply line was additionally carried out with this kind of power supply.

The following states were defined as the operating conditions:

EUT is communicating with an application server via Ethernet, frequently reporting the distance between EUT and Assistant UWB.

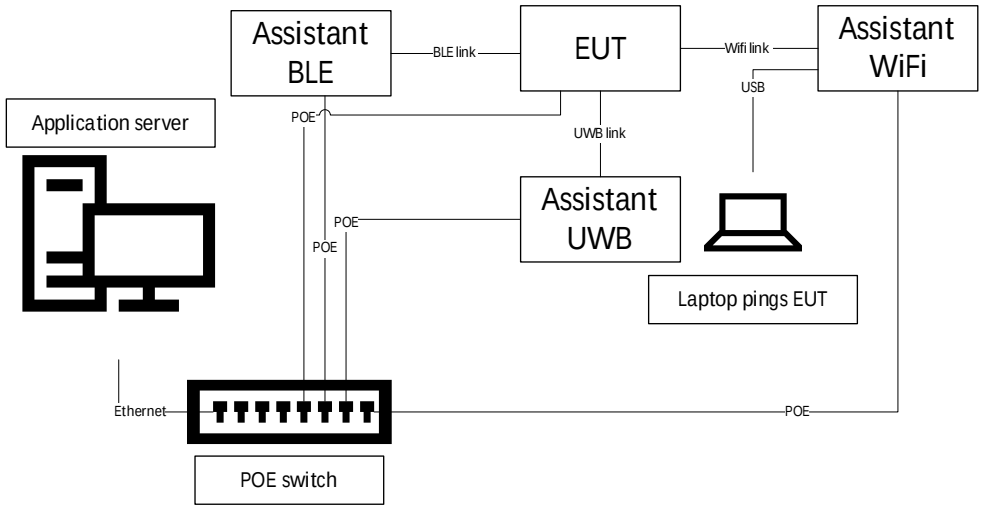
A BLE link was initially set up, no data exchange on BLE.

The EUT was connected via WLAN to an WiFi Assistant, from an ancillary laptop console connected to the Assistant a frequent ping request was sent via radio link.

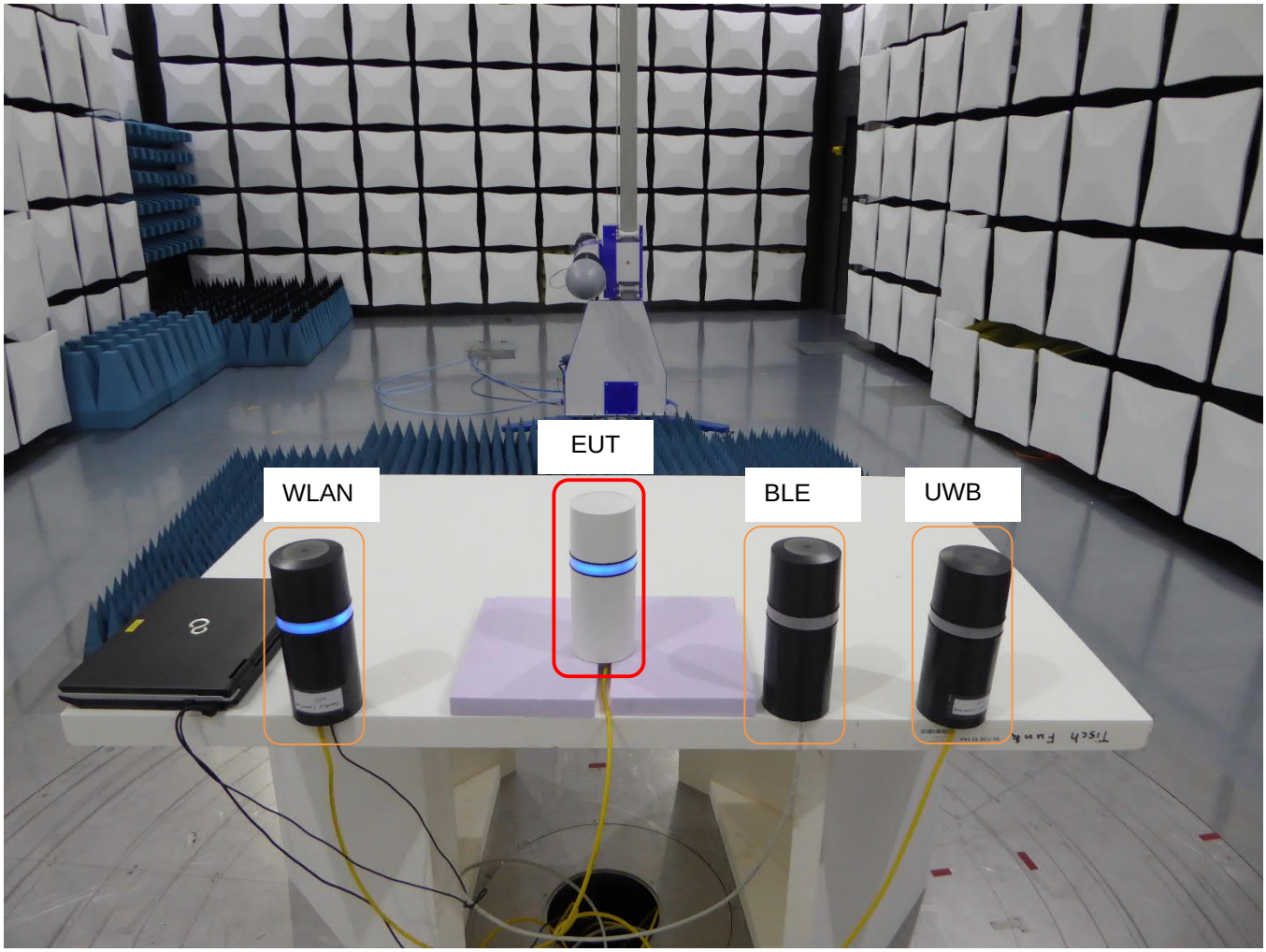
Zigbee was not used.

Radio technology	Frequency [MHz]	Channel / Band
UWB	4000	2
BLE	2402-2480	Hopping
WiFi	2437	6

Setup:



The physical boundaries of the EUT are shown below.



3 Additional Information

General information:

- none

Classification of cables:

- none

Maximum length of cables, declared by the manufacturer:

- no maximum length declared

Type of cables, declared by the manufacturer:

- no special type of cable declared

Deviation of the standard or test plan:

none

Special EMC measures, as a result of the tests:

- none

4 Overview

Conducted emissions FCC 47 CFR Part 15 section 15.107 (b) [3]					
Application	Frequency range	Limits	Reference standard	Remark	Status
AC supply line	0.15 to 0.5 MHz 0.5 to 30 MHz	79 dBµV (QP) 66 dBµV (AV) 73 dBµV (QP) 60 dBµV (AV)	ANSI C63.4	Class A	-
AC supply line	0.15 to 0.5 MHz 0.5 to 5 MHz 5 to 30 MHz	66 to 56 dBµV (QP)* 56 to 46 dBµV (AV)* 56 dBµV (QP) 46 dBµV (AV) 60 dBµV (QP) 50 dBµV (AV)	ANSI C63.4	Class B	Passed
*: Decreases with the logarithm of the frequency					
Radiated emissions FCC 47 CFR Part 15 section 15.109 (b) [3]					
Application	Frequency range	Limits	Reference standard	Remark	Status
Radiated Emission	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz above 1000 MHz	39.0 dBµV /m QP at 10 m 43.5 dBµV /m QP at 10 m 46.5 dBµV /m QP at 10 m 49.5 dBµV /m QP at 10 m 49.5 dBµV /m AV at 10 m and 69.5 dBµV /m PK at 10 m	ANSI C63.4	Class A	-
Radiated Emission	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz above 1000 MHz	40.0 dBµV/m QP at 3 m 43.5 dBµV/m QP at 3 m 46.0 dBµV/m QP at 3 m 54.0 dBµV/m QP at 3 m 54.0 dBµV/m AV at 3 m and 74.0 dBµV/m PK at 3 m	ANSI C63.4	Class B	Passed

Remark: As declared by the applicant the highest internal clock frequency is 4.5 GHz.
Therefore the radiated emission measurement must be carried out up to 5th of the highest internal clock frequency in this case 25 GHz.

The EUT was classified by the applicant as CLASS B equipment.

5 Results

5.1 Conducted emissions on power supply lines (150 kHz to 30 MHz)

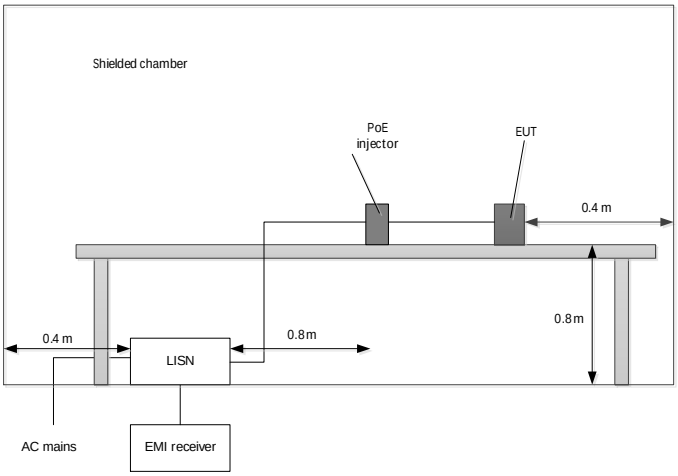
5.1.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop devices will 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 will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

Test setup for measurement with the EUT supplied via PoE:



Test setup for measurement with the EUT supplied via USB:

5.1.2 Test results (conducted emissions on power supply lines)

5.1.2.1 Test results with EUT supplied via PoE

Ambient temperature	21 °C
Relative humidity	71 %

Date	02.06.2020
Tested by	Y. KHALEK

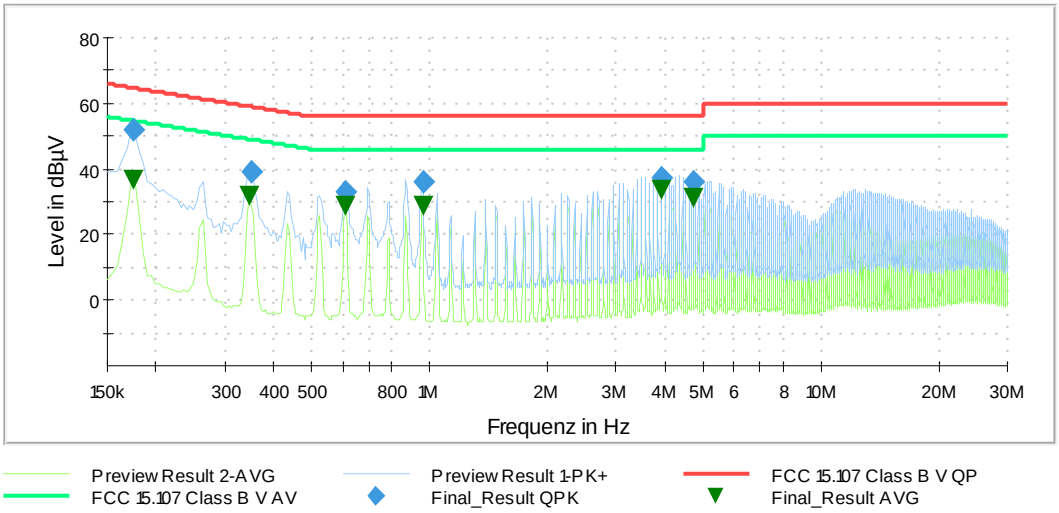
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During this test the EUT was powered with 48 V_{DC} by the power injector PowerSine 3001, which was itself supplied with 120 V_{AC} / 60 Hz.

The curves in the diagram 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 ◆, the average measured points with▼.



Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Line	PE	Corr. [dB]
0.174300	---	36.72	54.75	18.03	5000.0	9.000	L1	GND	9.8
0.174300	51.65	---	64.75	13.10	5000.0	9.000	N	GND	9.8
0.348000	---	31.57	49.01	17.44	5000.0	9.000	L1	FLO	9.9
0.348900	39.33	---	58.99	19.66	5000.0	9.000	L1	FLO	9.9
0.609900	---	28.70	46.00	17.30	5000.0	9.000	N	FLO	9.9
0.610800	32.90	---	56.00	23.10	5000.0	9.000	N	GND	9.9
0.958200	35.99	---	56.00	20.01	5000.0	9.000	N	FLO	9.9
0.958200	---	29.05	46.00	16.95	5000.0	9.000	N	FLO	9.9
3.919200	37.32	---	56.00	18.68	5000.0	9.000	N	GND	10.3
3.920100	---	33.47	46.00	12.53	5000.0	9.000	N	FLO	10.3
4.703100	35.99	---	56.00	20.01	5000.0	9.000	N	GND	10.3
4.704000	---	31.35	46.00	14.65	5000.0	9.000	N	FLO	10.3
Measurement uncertainty			±2.8 dB						

5.1.2.2 Test results with EUT supplied via USB

Ambient temperature	21 °C	Date	02.06.2020
Relative humidity	71 %	Tested by	Y. KHALEK

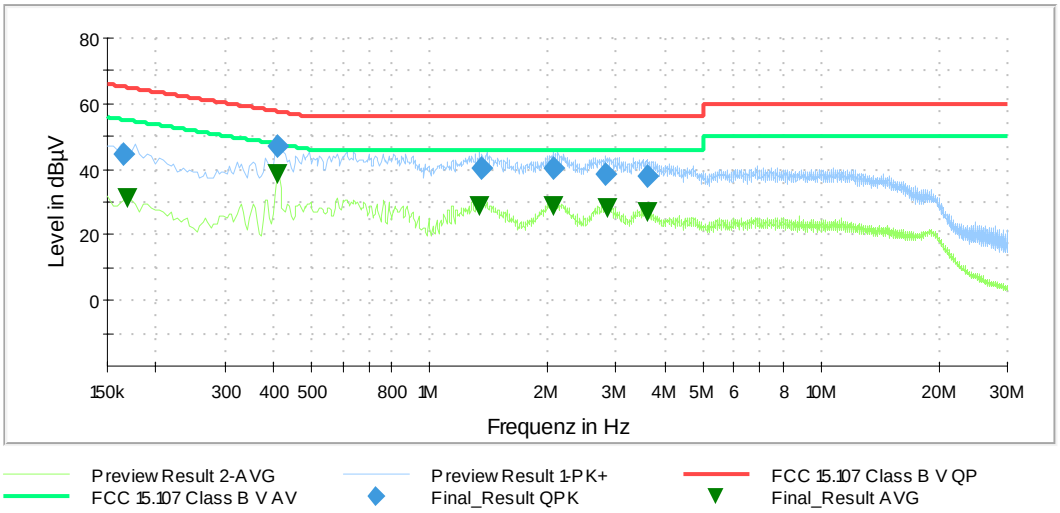
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During this test the EUT was powered with 5.0 V_{DC} by the Samsung travel adapter EP-TA20EBE, which was itself supplied with 120 V_{AC} / 60 Hz.

The curves in the diagram 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 ◆, the average measured points with ▼.



Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Line	PE	Corr. [dB]
0.164400	**44.37**	**---**	**65.24**	**20.87**	**5000.0**	**9.000**	**N**	**GND**	**9.8**
0.168000	**---**	**30.92**	**55.06**	**24.14**	**5000.0**	**9.000**	**L1**	**FLO**	**9.8**
0.409200	**---**	**38.60**	**47.66**	**9.06**	**5000.0**	**9.000**	**L1**	**FLO**	**9.9**
0.409200	**47.25**	**---**	**57.66**	**10.41**	**5000.0**	**9.000**	**L1**	**FLO**	**9.9**
1.340700	**---**	**29.00**	**46.00**	**17.00**	**5000.0**	**9.000**	**L1**	**FLO**	**9.9**
1.364100	**40.11**	**---**	**56.00**	**15.89**	**5000.0**	**9.000**	**L1**	**FLO**	**9.9**
2.061600	**---**	**28.97**	**46.00**	**17.03**	**5000.0**	**9.000**	**L1**	**GND**	**10.1**
2.074200	**40.32**	**---**	**56.00**	**15.68**	**5000.0**	**9.000**	**L1**	**FLO**	**10.1**
2.812200	**38.64**	**---**	**56.00**	**17.36**	**5000.0**	**9.000**	**L1**	**GND**	**10.2**
2.832900	**---**	**28.18**	**46.00**	**17.82**	**5000.0**	**9.000**	**L1**	**FLO**	**10.2**
3.606000	**---**	**26.78**	**46.00**	**19.22**	**5000.0**	**9.000**	**L1**	**FLO**	**10.3**
3.621300	**38.09**	**---**	**56.00**	**17.91**	**5000.0**	**9.000**	**L1**	**GND**	**10.3**
Measurement uncertainty			±2.8 dB						

Test equipment (please refer to chapter 6 for details)
21 - 26

5.2 Radiated emissions

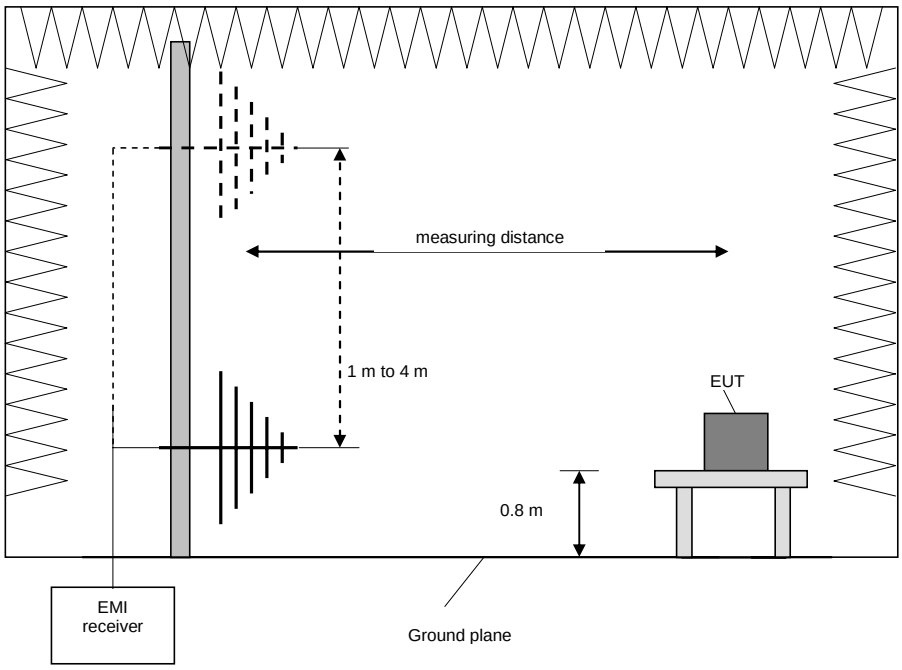
5.2.1 Test method

Preliminary and final measurement (30 MHz to 1 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with a metal ground plane in a 3 m distance.
During the test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be 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 will be set to the following values:

Test	Frequency range	Resolution bandwidth	Step size	Measurement time
Preliminary measurement	30 MHz to 1 GHz	120 kHz	30 kHz	100 ms
Frequency peak search	3 x RBW	120 kHz	10 kHz	1000 ms
Final measurement	30 MHz to 1 GHz	120 kHz	-	5 x 1000 ms



Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for that value.

Procedure final measurement:

The following procedure is used:

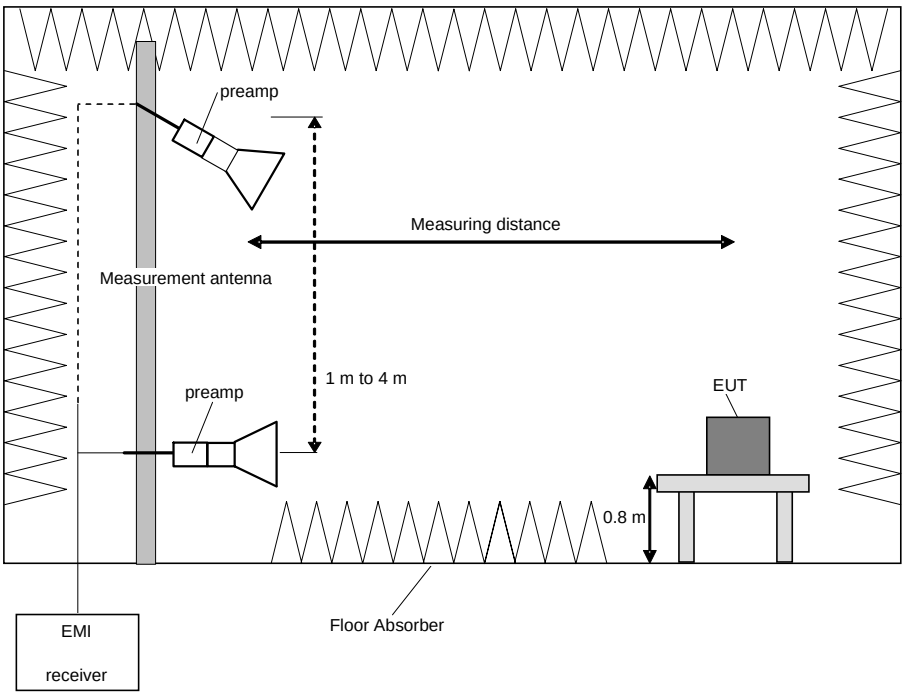
1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the worst case EUT position (x,y,z) for the final test.
4. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 30° from the value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst case antenna height and the worst case turntable azimuth
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

Preliminary and final measurement (1 – 40 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with floor absorbers between EUT and measurement antenna in a 3 m distance.
During the test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be 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. For each height the angle of the antenna will be tilted so that the measurement antenna is always aiming at the EUT.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Test	Frequency range	Resolution bandwidth	Step size	Measurement time
Preliminary measurement	1 - 40 GHz	1 MHz	250 kHz	10 ms
Frequency peak search	+ / - 1 MHz	1 MHz	50 kHz	100 ms
Final measurement	1 - 40 GHz	1 MHz	-	10 x 100 ms



Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for the highest value.

Procedure final measurement:

The following procedure is used:

1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW 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 measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the worst case value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 30° from the worst case value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst case antenna height and the worst case turntable azimuth.
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

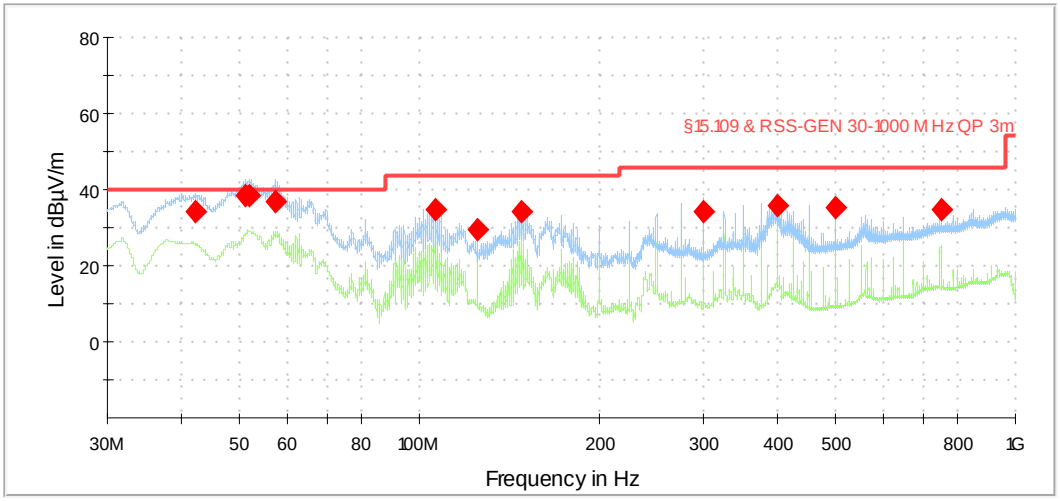
5.2.2 Result final measurement from 30 MHz to 1 GHz

Ambient temperature	21 °C
Relative humidity	71 %

Date	29.07.2020
Tested by	B. ROHDE

Test description:	Radiated emission measurement according to FCC PART 15
EUT:	omlox
Manufacturer:	TRUMPF Werkzeugmaschinen GmbH + Co. KG
Operating conditions:	UWB tracking, BLE communication standby, data communication (ping) via WiFi, IEEE802.15.4 inactive, data communication via Ethernet to application server, see 2
Test site:	PHOENIX TESTLAB GmbH, semi anechoic chamber M276
Operator:	B. Rohde
Power supply:	Via POE from switch
Limit FCC:	eCFR §15.109 Class B @3m

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.



The results of the standard subsequent measurement in a semi anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Result Table

Frequency [MHz]	Result QP [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Result
42.070000	34.1	40	5.9	12.7	21.4	100	-19	V	Passed
51.110000	38.3	40	1.7	22.3	16.0	103	171	V	Passed
51.830000	38.6	40	1.4	23.0	15.6	100	91	V	Passed
57.410000	36.9	40	3.1	23.8	13.1	100	247	V	Passed
106.740000	34.7	43.52	8.8	17.4	17.3	105	195	V	Passed
125.000000	29.5	43.52	14.0	10.9	18.5	100	103	V	Passed
148.120000	34.2	43.52	9.3	15.7	18.5	145	151	V	Passed
299.990000	34.4	46.02	11.6	13.4	21.0	180	172	V	Passed
400.000000	35.8	46.02	10.2	11.8	24.0	117	179	V	Passed
499.990000	35.2	46.02	10.8	9.1	26.1	103	142	V	Passed
749.470000	34.7	46.02	11.3	3.9	30.8	100	67	H	Passed
Measurement uncertainty				±5.5 dB					

The correction factor was calculated as follows.
Corr. (dB/m) = cable attenuation (dB) + 6 dB attenuator (dB) + antenna factor (dB/m)
Therefore the reading can be calculated as follows:
Reading (dBµV) = result QuasiPeak (dBµV/m) - Corr. (dB/m)

Test equipment (please refer to chapter 6 for details)
9 – 15, 17, 27

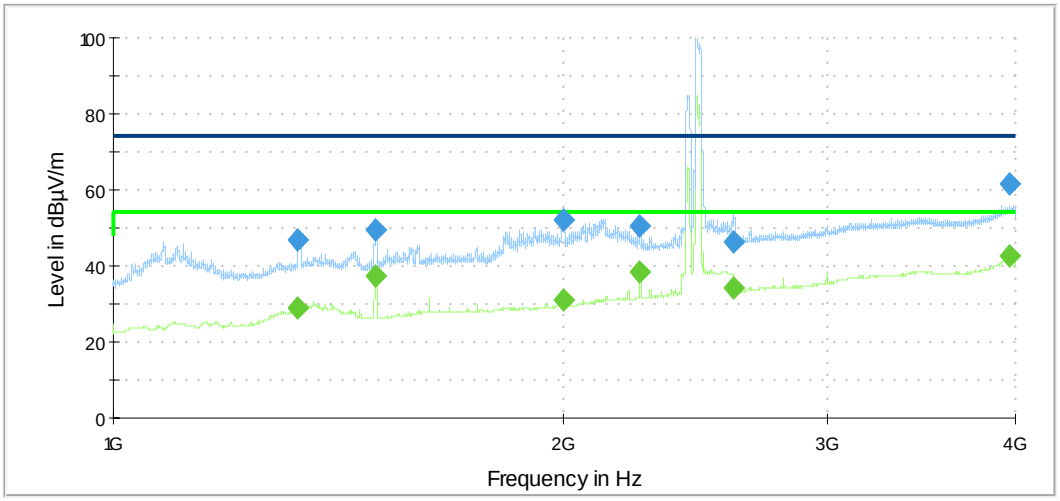
5.2.3 Result final measurement above 1 GHz

Ambient temperature	21 °C	Date	30.07.2020 31.07.2020
Relative humidity	71 %	Tested by	B. ROHDE

Test description:	Radiated emission measurement according to FCC PART 15
Operating conditions:	UWB tracking, BLE communication standby, data communication (ping) via WiFi, IEEE802.15.4 inactive, data communication via Ethernet to application server, see 2
Test site:	PHOENIX TESTLAB GmbH, semi anechoic chamber M276
Operator:	B. Rohde
Power supply:	Via POE from switch
Limit FCC:	eCFR §15.109 Class B @3m

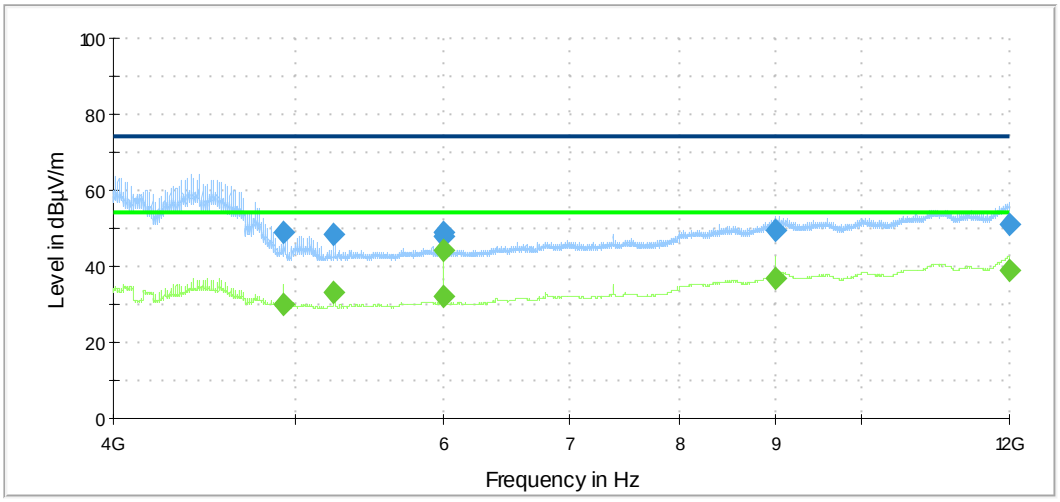
The curves in the diagram only represent the maximum measured value for each frequency point of all preliminary measurements, which were carried out with various EUT and antenna positions.
The top measured curve represents the peak measurement. The measured points marked with "◆" are frequency points 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.

Final Plot 1 – 4 GHz



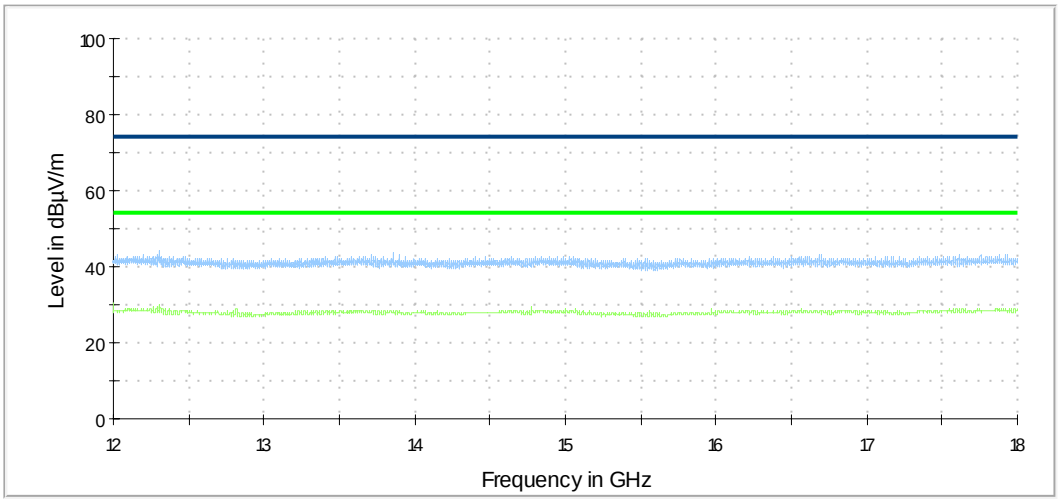
The emissions in the 2.4 GHz-band are wanted radio links, so they were excluded from evaluation.

Final Plot 4 -12 GHz



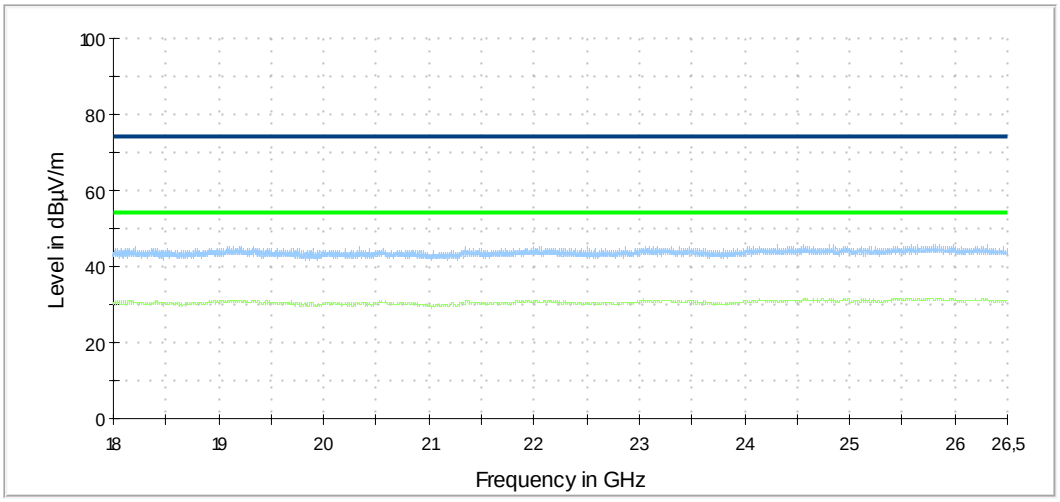
The emissions around 4 GHz are wanted radio links, so they were excluded from evaluation.

Plot 12 -18 GHz



No final measurement conducted

Plot 18 – 26.5 GHz



No final measurement conducted

The results of the standard subsequent measurement above 1 GHz in a semi anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Frequency [MHz]	Result (Pk) [dBµV/m]	Result (Av) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Reading [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Comment
1328.600000	47.1	---	74	26.9	27.7	19.3	201	70	V	Passed
1328.600000	---	28.7	54	25.3	27.7	1	201	70	V	Passed
1497.800000	---	37.5	54	16.5	29.1	8.4	102	38	H	Passed
1497.800000	49.7	---	74	24.3	29.1	20.6	102	38	H	Passed
1998.200000	52.2	---	74	21.8	32.1	20.1	150	75	V	Passed
1998.200000	---	30.9	54	23.1	32.1	-1.2	150	75	V	Passed
2246.550000	50.4	---	74	23.6	33.6	16.8	200	157	V	Passed
2246.550000	---	38.5	54	15.5	33.6	4.9	200	157	V	Passed
2595.450000	---	34.2	54	19.8	35.1	-0.9	218	119	V	Passed
2595.450000	46.3	---	74	27.7	35.1	11.2	218	119	V	Passed
3968.250000	61.5	---	74	12.5	40.3	21.2	242	117	V	Passed
3968.250000	---	42.8	54	11.2	40.3	2.5	242	117	V	Passed
4924.050000	---	30.2	54	23.8	9.1	21	150	284	V	Passed
4924.050000	49.2	---	74	24.8	9.1	40.1	150	284	V	Passed
5241.250000	48.7	---	74	25.3	9.6	39.1	128	167	V	Passed
5241.250000	---	33.0	54	21.0	9.6	23.4	128	167	V	Passed
5988.250000	47.9	---	74	26.1	11.1	36.7	116	67	H	Passed
5988.250000	---	32.3	54	21.7	11.1	21.2	116	67	H	Passed
6000.050000	48.9	---	74	25.1	11.1	37.8	103	6	V	Passed
6000.050000	---	44.4	54	9.6	11.1	33.3	103	6	V	Passed
8999.400000	---	36.6	54	17.4	17.8	18.8	128	78	V	Passed
8999.400000	49.2	---	74	24.8	17.8	31.4	128	78	V	Passed
11993.750000	51.0	---	74	23.0	21.9	29.1	150	60	V	Passed
11993.750000	---	39.2	54	14.8	21.9	17.3	150	60	V	Passed
Measurement uncertainty					±5.5 dB					

The correction factor was calculated as follows.
Corr. (dB/m) = cable attenuation (dB) + preamplifier (dB) + antenna factor (dB/m)
Reading (dBµV) + Corr. (dB/m) = Result (dBµV/m) [Peak or Average]

Test equipment (please refer to chapter 6 for details)
1 – 16, 18

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2020	02.2022
2	Log Per Antenna	HL050	Rohde & Schwarz	4062.4063.02-100908	482977	13.08.2019	08.2022
4	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda-Miteq	2110911	482969	17.02.2020	02.2022
5	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	
9	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
10	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
11	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
12	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
13	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
14	Measurment software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
15	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
16	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	13.02.2020	02.2022
17	Antenna (Bilog)	CBL6111D	Schaffner Elektrotest GmbH / Teseq GmbH	25761	480894	19.10.2017	10.2020
18	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda-Miteq	2089798	482968	17.02.2020	02.2022
21	Shielded chamber M4	-	Siemens	B83117-S1-X158	480088	Calibration not necessary	
22	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	12.02.2020	02.2022
23	LISN	NSLK8128	Schwarzbeck	8128161	480138	11.02.2020	02.2022
24	Transient Limiter	CFL 9206A	Teseq	38268	481982	Calibration not necessary	
25	Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
26	AC source	AC6803A	Keysight	JPVJ002509	482350	Calibration not necessary	
27	Attenuator 6 dB	WA2-6	Weinschel	-	482794	Calibration not necessary	

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4a-2017	19.09.2019	18.09.2021
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	19.09.2019	18.09.2021
Shielded chamber M4	480088	9 kHz – 30 MHz	GND-Plane	ANSI C63.4-2014	06.11.2018	05.11.2020

8 Report History

Report Number	Date	Comment
F191161E1	07.09.2020	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A	Test Setup Photos	7 pages