

# Test Report

Report Number:

**F191161E1**

Equipment under Test (EUT):

**omlox Satellite**

Applicant:

**TRUMPF Werkzeugmaschinen GmbH + Co. KG**

Manufacturer:

**TRUMPF Werkzeugmaschinen GmbH + Co. KG**



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<br>written by:       | Bernward ROHDE | <i>O. S. O. J. Li</i> | 07.09.2020 |
|                                 | Name           | Signature             | Date       |
| Reviewed<br>and approved<br>by: | Bernd STEINER  |                       | 07.09.2020 |
|                                 | Name           | Signature             | Date       |

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# 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 <sub>nom</sub> = | 48.0 V <sub>DC</sub> | U <sub>min</sub> = | 42.5 V <sub>DC</sub> | U <sub>max</sub> = | 57.0 V <sub>DC</sub> |
| Supply voltage EUT (USB): *                  | U <sub>nom</sub> = | 5.0 V <sub>DC</sub>  | U <sub>min</sub> = | 4.45 V <sub>DC</sub> | U <sub>max</sub> = | 5.25 V <sub>DC</sub> |
| Temperature range: *                         | -10 °C to +39 °C   |                      |                    |                      |                    |                      |
| Lowest / highest internal clock frequency: * | 32 kHz / 4500 MHz  |                      |                    |                      |                    |                      |

| Ports / Connectors  |       |           |                    |                      |
|---------------------|-------|-----------|--------------------|----------------------|
| Identification      |       |           | Length during test | Shielding (Yes / No) |
|                     | EUT   | Ancillary |                    |                      |
| 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           |                               |                                                                     |
|---------------------------------|-------------------------------|---------------------------------------------------------------------|
| Fulfills 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)<br>(1/2/5.5/11 Mbit/s)                     |
|                                 | IEEE 802.11 g                 | OFDM (BPSK, QPSK, 16-QAM, 64-QAM)<br>(6/9/12/18/24/36/48/54 Mbit/s) |
|                                 | IEEE 802.11 n20               | OFDM (BPSK, QPSK, 16-QAM, 64-QAM)<br>(up to 72.2 Mbit/s)            |
|                                 | IEEE 802.11 n40               | OFDM (BPSK, QPSK, 16-QAM, 64-QAM)<br>(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        |                 |                            |
|---------------------------------|-----------------|----------------------------|
| Fulfills 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 |                         |                            |
|----------------------------------|-------------------------|----------------------------|
| Fulfills 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 * <sup>1</sup>                          | TP link; TLSG108PE                                                                        |
| Assistant BLE<br>BLE (ancillary)                   | Trumpf Number #: 2400144_06/204731657<br>Module Number #: 1901154A00102B8C<br>Marking 657 |
| Assistant UWB<br>UWB (ancillary)                   | Trumpf Number #: 2400144_06/204731656<br>Module Number #: 1901154A00102BCE<br>Marking 656 |
| Assistant WiFi<br>WiFi (ancillary)                 | Trumpf Number #: 2105<br>Module Number #: 1901154A001046EA<br>Marking 2105                |
| Laptop with applications<br>server: * <sup>1</sup> | Dell Inspiron 15 S/N: GB6H4P2                                                             |
| Laptop for remote access: * <sup>2</sup>           | Fujitsu NS751-018; SN: DSBW019318                                                         |
| POE switch/injector: * <sup>1</sup>                | PowerSine 3001                                                                            |
| USB power supply: * <sup>1</sup>                   | Samsung travel adapter EP-TA20EBE                                                         |

\*<sup>1</sup> Provided by the applicant

\*<sup>2</sup> 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<sub>DC</sub> 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.

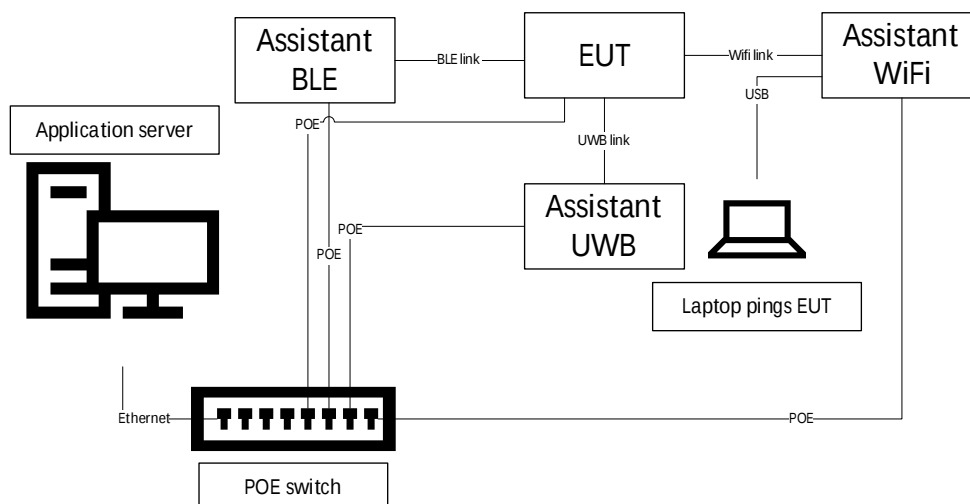
A BLE link was initially set up, no data exchange on BLE.

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.

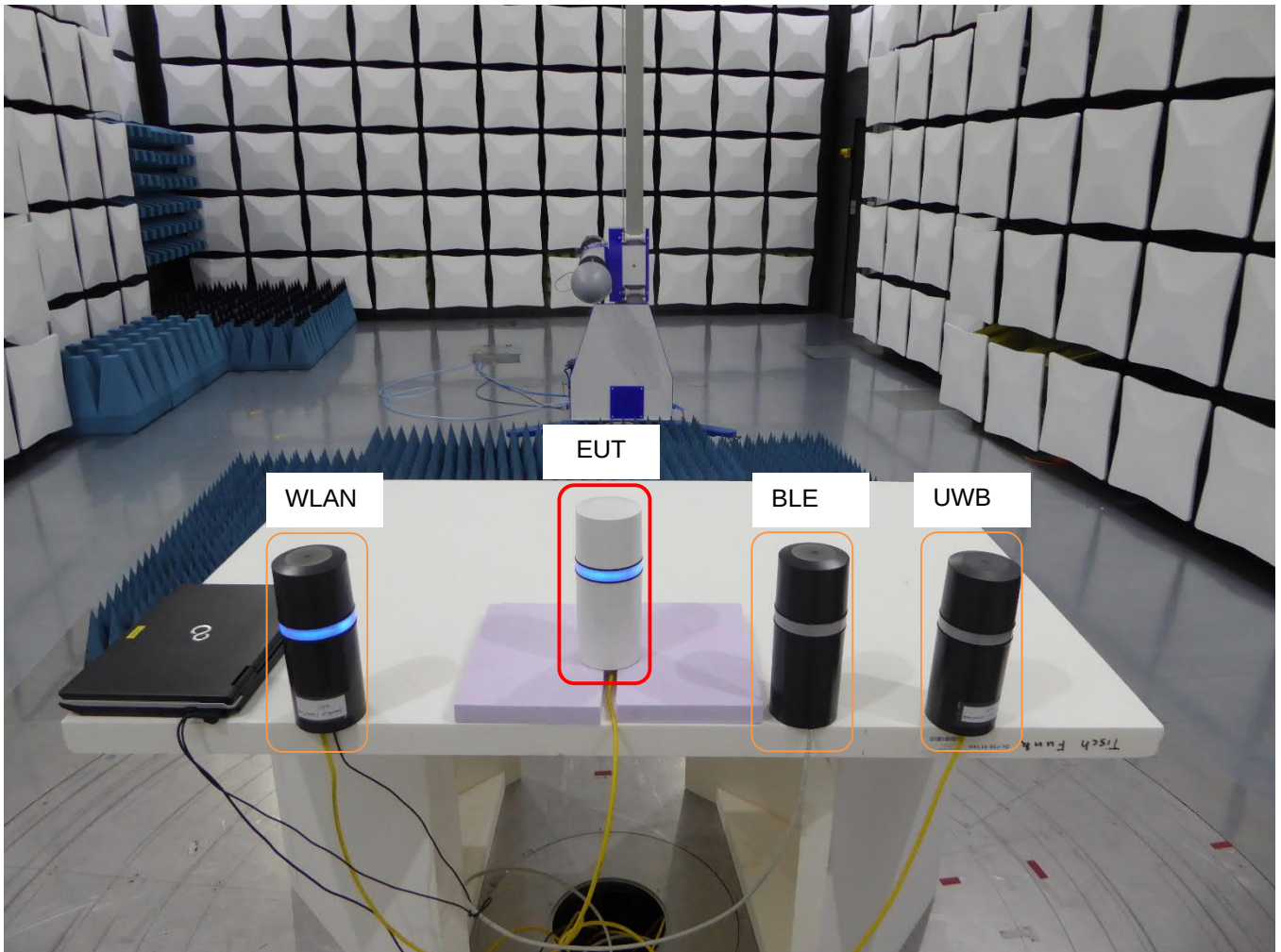
Zigbee was not used.

| 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<br>0.5 to 30 MHz                                                         | 79 dBμV (QP)<br>66 dBμV (AV)<br>73 dBμV (QP)<br>60 dBμV (AV)                                                                                                           | ANSI C63.4         | Class A | -      |
| AC supply line                                                | 0.15 to 0.5 MHz<br>0.5 to 5 MHz<br>5 to 30 MHz                                           | 66 to 56 dBμV (QP)*<br>56 to 46 dBμV (AV)*<br>56 dBμV (QP)<br>46 dBμV (AV)<br>60 dBμV (QP)<br>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<br>88 to 216 MHz<br>216 to 960 MHz<br>960 to 1000 MHz<br><br>above 1000 MHz | 39.0 dBμV /m QP at 10 m<br>43.5 dBμV /m QP at 10 m<br>46.5 dBμV /m QP at 10 m<br>49.5 dBμV /m QP at 10 m<br><br>49.5 dBμV /m AV at 10 m and<br>69.5 dBμV /m PK at 10 m | ANSI C63.4         | Class A | -      |
| Radiated Emission                                             | 30 to 88 MHz<br>88 to 216 MHz<br>216 to 960 MHz<br>960 to 1000 MHz<br><br>above 1000 MHz | 40.0 dBμV/m QP at 3 m<br>43.5 dBμV/m QP at 3 m<br>46.0 dBμV/m QP at 3 m<br>54.0 dBμV/m QP at 3 m<br><br>54.0 dBμV/m AV at 3 m and<br>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 5<sup>th</sup> 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)

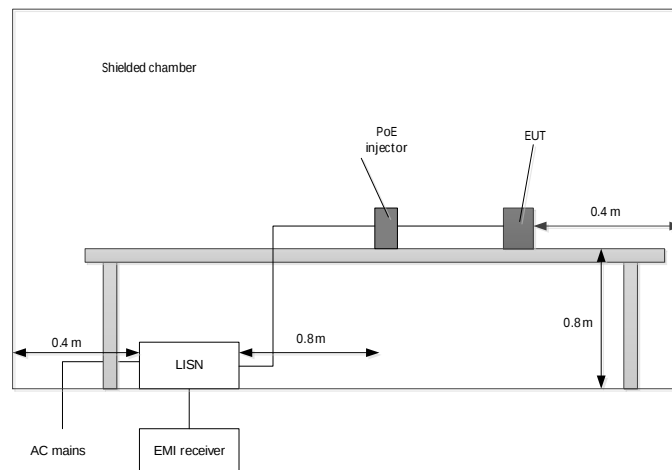
#### 5.1.1 Method of measurement

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 appropriate 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  |

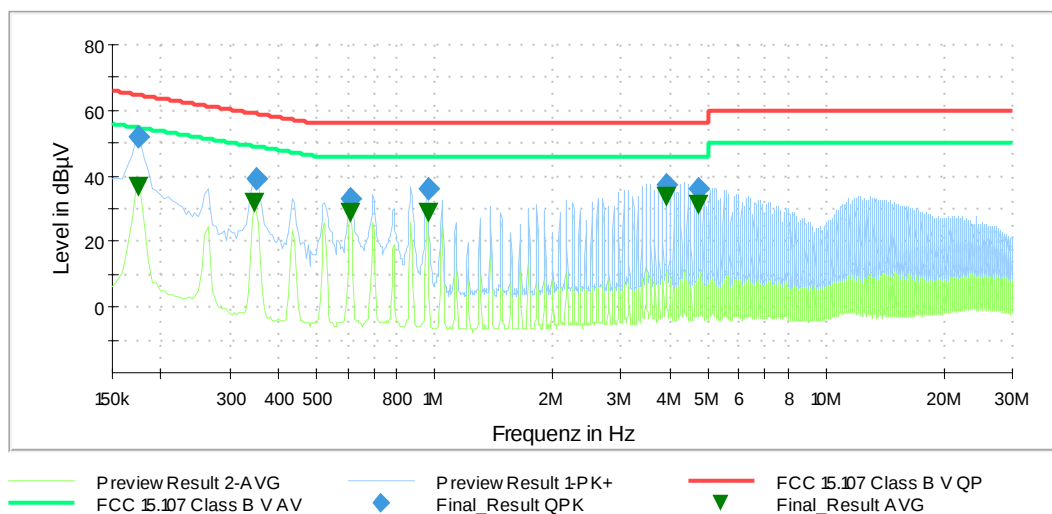
**Position of EUT:** The EUT was set-up on a non-conducting table of a height of 0.8 m.

**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<sub>DC</sub> by the power injector PowerSine 3001, which was itself supplied with 120 V<sub>AC</sub> / 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  |

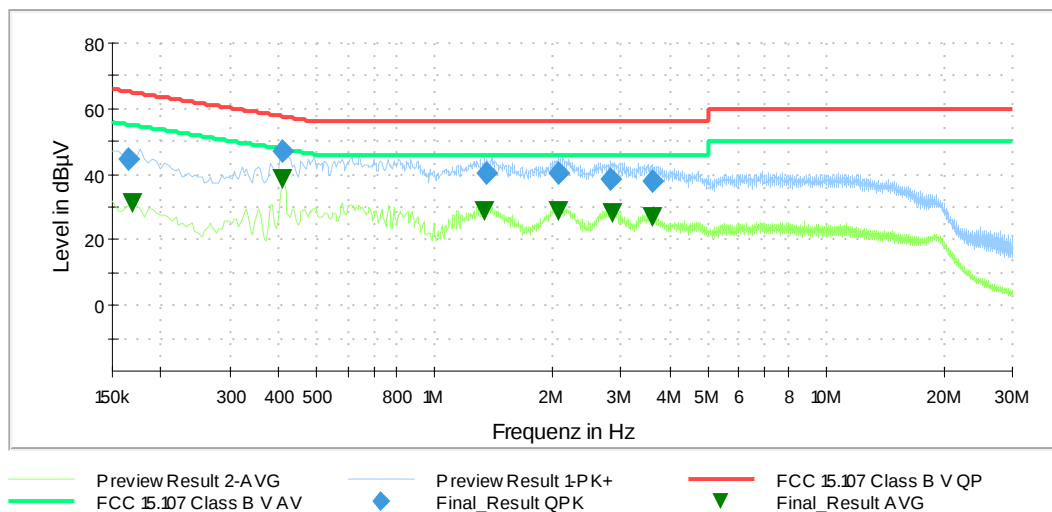
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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<sub>DC</sub> by the Samsung travel adapter EP-TA20EBE, which was itself supplied with 120 V<sub>AC</sub> / 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

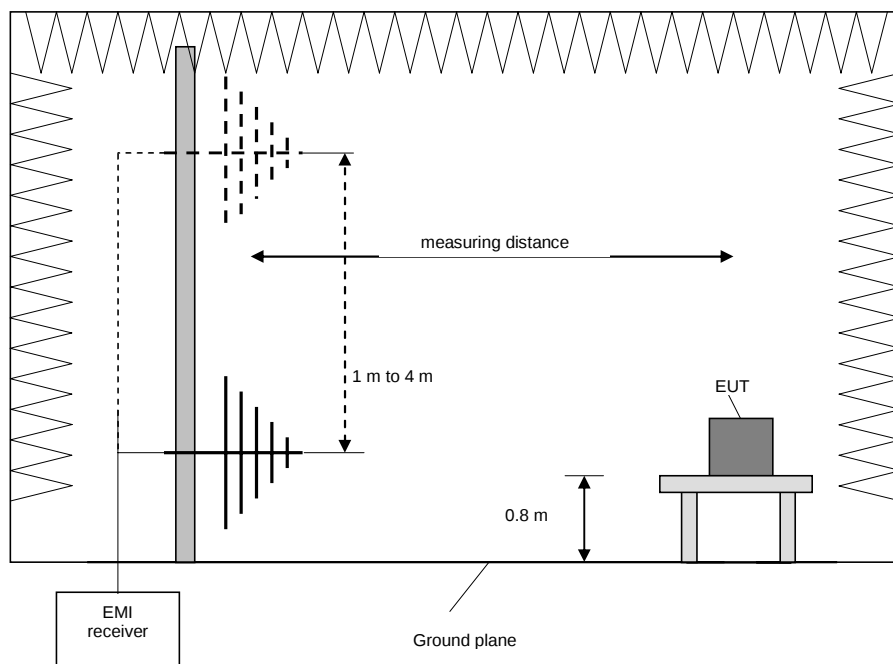
#### Preliminary and final measurement (30 MHz to 1 GHz)

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.

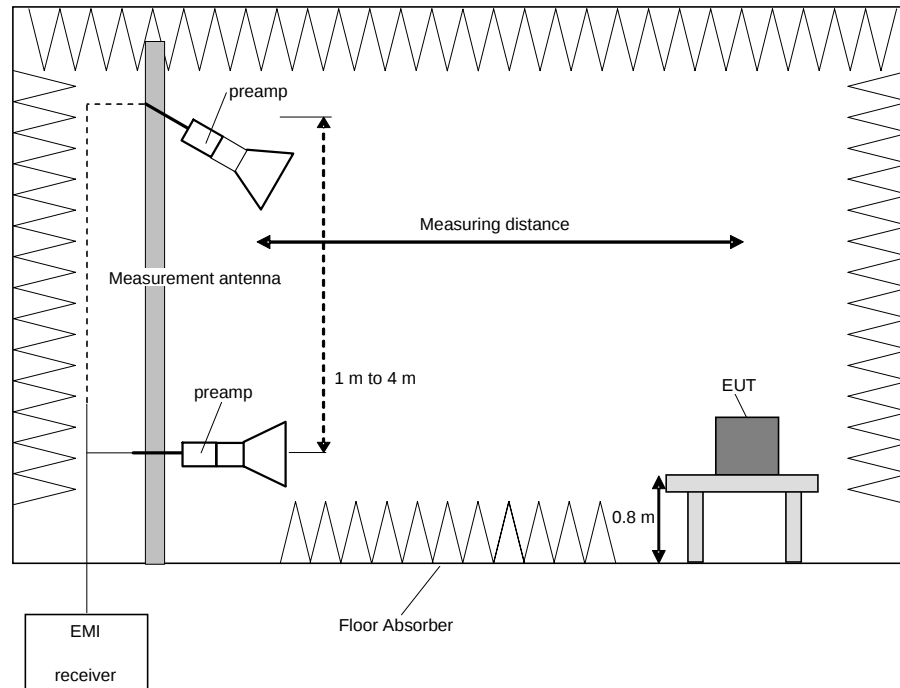
### **Preliminary and final measurement (1 – 40 GHz)**

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.

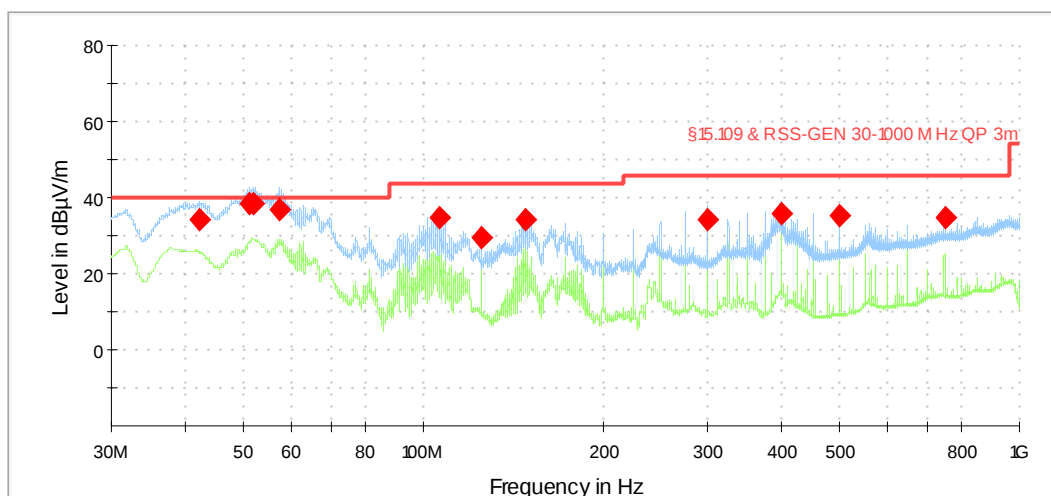
### 5.2.2 Result final measurement from 30 MHz to 1 GHz

|                     |       |
|---------------------|-------|
| 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<br>[MHz]      | Result<br>QP<br>[dBμV/m] | Limit<br>[dBμV/m] | Margin<br>[dB] | Readings<br>[dBμV] | Correction<br>[dB/m] | Height<br>[cm] | Azimuth<br>[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 |
| Relative humidity   | 71 %  |

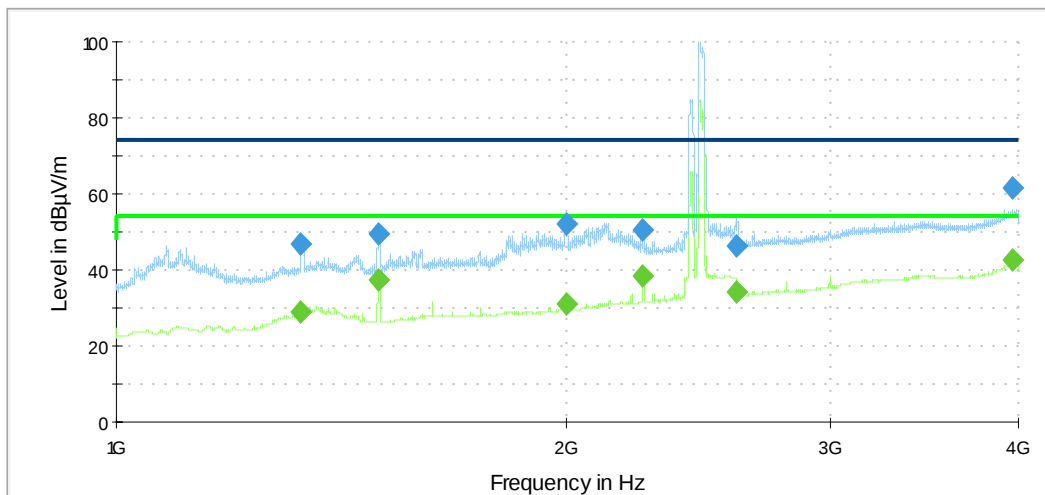
|           |                          |
|-----------|--------------------------|
| Date      | 30.07.2020<br>31.07.2020 |
| Tested by | B. ROHDE                 |

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.

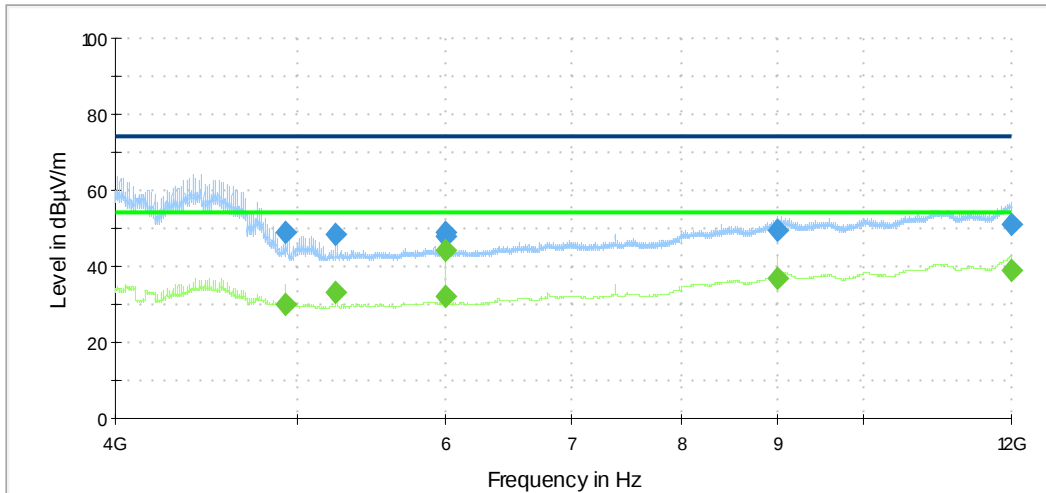
The top measured curve represents the peak measurement. The measured points marked with "◆" are frequency points for the final peak detector measurement. These values are indicated in the following table. The bottom measured curve represents the average measurement. The measured points marked with "◆"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

Final Plot 1 – 4 GHz



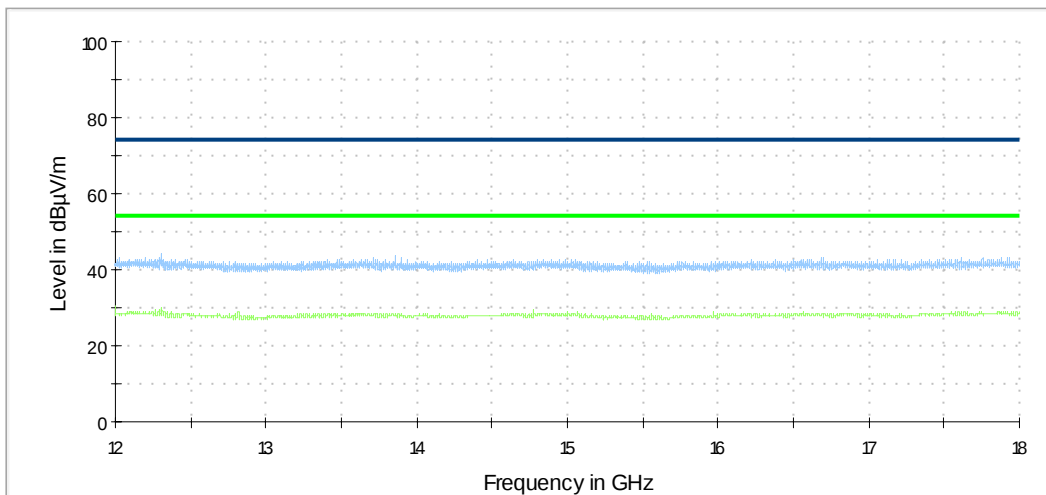
The emissions in the 2.4 GHz-band are wanted radio links, so they were excluded from evaluation.

Final Plot 4 -12 GHz



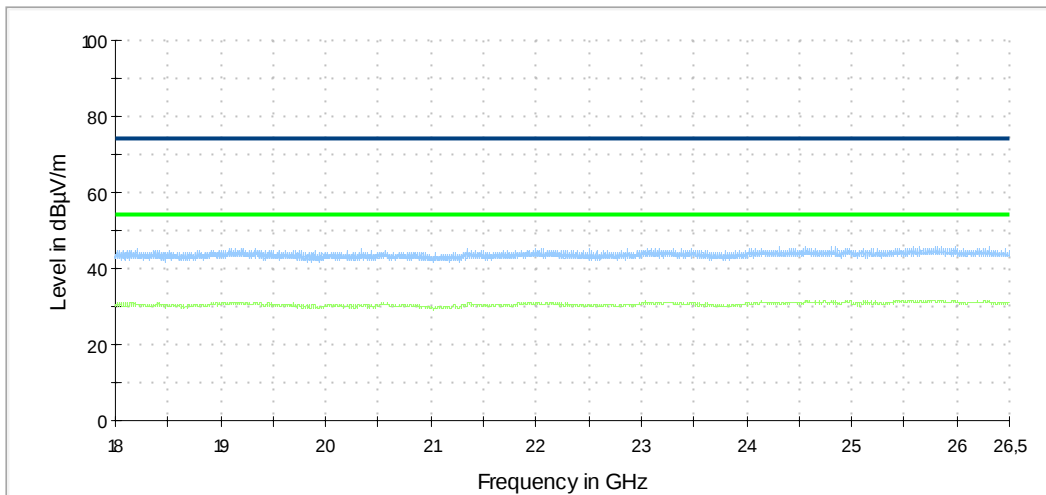
The emissions around 4 GHz are wanted radio links, so they were excluded from evaluation.

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<br>[MHz]      | Result<br>(Pk)<br>[dBμV/m] | Result<br>(Av)<br>[dBμV/m] | Limit<br>[dBμV/m] | Margin<br>[dB] | Reading<br>[dBμV] | Correction<br>[dB/m] | Height<br>[cm] | Azimuth<br>[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