



# RF - TEST REPORT

- FCC Part 15.249, RSS210 -

**Type / Model Name** : SE 660

**Product Description** : Transceiver unit, 2.4 GHz

**Applicant** : Dr. Johannes Heidenhain GmbH

**Address** : Dr.-Johannes-Heidenhain-Str. 5

83301 Traunreut, Germany

**Manufacturer** : Dr. Johannes Heidenhain GmbH

**Address** : Dr.-Johannes-Heidenhain-Str. 5

83301 Traunreut, Germany

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

**POSITIVE**

**Test Report No. :** 80146498-04 Rev\_2

23. August 2023

Date of issue



Deutsche  
Akkreditierungsstelle  
D-PL-12030-01-03  
D-PL-12030-01-04

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ATTACHMENT A as separate supplement

# **1 TEST STANDARDS**

The tests were performed according to following standards:

## **FCC Rules and Regulations Part 15, Subpart A - General (December 2021)**

|                                   |                                               |
|-----------------------------------|-----------------------------------------------|
| Part 15, Subpart A, Section 15.31 | Measurement standards                         |
| Part 15, Subpart A, Section 15.33 | Frequency range of radiated measurements      |
| Part 15, Subpart A, Section 15.35 | Measurement detector functions and bandwidths |

## **FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (December 2021)**

|                                    |                                                                                                    |
|------------------------------------|----------------------------------------------------------------------------------------------------|
| Part 15, Subpart C, Section 15.203 | Antenna requirement                                                                                |
| Part 15, Subpart C, Section 15.204 | External radio frequency power amplifiers and antenna modifications                                |
| Part 15, Subpart C, Section 15.205 | Restricted bands of operation                                                                      |
| Part 15, Subpart C, Section 15.207 | Conducted limits                                                                                   |
| Part 15, Subpart C, Section 15.209 | Radiated emission limits, general requirements                                                     |
| Part 15, Subpart C, Section 15.215 | Additional provisions to the general radiated emission limitations                                 |
| Part 15, Subpart C, Section 15.249 | Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz, and 24.0 - 24.25 GHz |
| ANSI C63.10: 2013                  | Testing Unlicensed Wireless Devices                                                                |

## 2 EQUIPMENT UNDER TEST

### 2.1 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.

### 2.2 Sampling

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

### 2.3 Photo documentation of the EUT – Detailed photos see attachment A

### 2.4 Equipment category

EUT is a short-range device.

### 2.5 Short description of the equipment under test (EUT)

The EUT is a 2.4 GHz transceiver system for low power data transmission in 16 channels of the operating band. The system consists of a touch probe and a transceiver unit SE 660. The transceiver unit uses for diversity four parallel transceiver trees with RF part, 2 PCB antennas and 2 dedicated antennas. The EUT is tested as a system near a real application.

Number of tested samples: 1  
Serial number: SE 640 088 308

### 2.6 Variants of the EUT

There are no variants.

### 2.7 Operation frequency and channel plan

The operating frequency band is 2400 MHz to 2483.5 MHz.

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0       | 2405            | 8       | 2445            |
| 1       | 2410            | 9       | 2450            |
| 2       | 2415            | 10      | 2455            |
| 3       | 2420            | 11      | 2460            |
| 4       | 2425            | 12      | 2465            |
| 5       | 2430            | 13      | 2470            |
| 6       | 2435            | 14      | 2475            |
| 7       | 2440            | 15      | 2480            |

## 2.8 Transmit operating modes

The EUT allows free selection of channel and antenna in any combination.

TX continuous, modulated

TX continuous, unmodulated

## 2.9 Antenna

The following antennas shall be used with the EUT:

The EUT has only integrated antennas with no user access.

| Antenna | Type     |
|---------|----------|
| 0       | PCB      |
| 1       | PCB      |
| 2       | Flagpole |
| 3       | Flagpole |

## 2.10 Power supply system utilised

Power supply voltage,  $V_{nom}$  : 15 V to 30 V DC

## 2.11 Peripheral devices and interface cables

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

- Interface Cable Model : Cable 663631-03
- Touch probe Model : TT460
- AC/DC Adapter Model : FW75550/12

## 2.12 Determination of worst-case conditions for final measurement

Preliminary tests were performed to find the worst-case mode where the maximum emissions occur. The maximum output power is set while testing.

For the final test, the following channels and test modes are selected:

|                   | Test antennas | Test channels | Power setting | Modulation | Modulation type | Data rate |
|-------------------|---------------|---------------|---------------|------------|-----------------|-----------|
| proprietary radio | 1, 3          | 0, 7, 15      | default       | O-QPSK     | digital         | 250 kbps  |

### 2.12.1 Test jig

No test jig is used.

### 2.12.2 Test software

EUT is provided with special software to set test modes with buttons at the device.

### 3 TEST RESULT SUMMARY

| FCC Rule Part | RSS Rule Part   | Description                       | Result         |
|---------------|-----------------|-----------------------------------|----------------|
| 15.205(a)     | RSS-Gen, 8.10   | Emissions in restricted bands     | passed         |
| 15.207(a)     | RSS-Gen, 8.8    | AC power line conducted emissions | passed         |
| 15.215(c)     | -               | EBW                               | Not tested     |
| -             | RSS-Gen, 6.6    | OBW                               | Not tested     |
| 15.249(a)     | RSS-210, B10(a) | Field strength of fundamental     | passed         |
| 15.249(d)     | RSS-210, B10(b) | Out-of-band emission, radiated    | passed         |
| 15.215        | RSS-Gen, 8.11   | Transmitter frequency stability   | not applicable |

The mentioned RSS Rule Parts in the above table are related to:  
 RSS-Gen, Issue 5 + Amendment 1 + Amendment 2, March 2019  
 RSS-210, Issue 10 + Amendment (April 2020), December 2019

#### 3.1 Revision history of test report

| Test report No | Rev. | Issue Date      | Changes                                                               |
|----------------|------|-----------------|-----------------------------------------------------------------------|
| 80146498-04    | 0    | 20 January 2023 | Initial test report                                                   |
| 80146498-04    | 1    | 23 May 2023     | Remeasured second harmonic at 4.87972 GHz and clarified plot in 5.3.7 |
| 80146498-04    | 2    | 23 August 2023  | Updated 5.3.7 to show only SE 660 Data                                |

The test report with the highest revision number replaces the previous test reports.

#### 3.2 Final assessment

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

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

Testing commenced on : 14 December 2022

Testing concluded on : 13 January 2023

Checked by:

Tested by:

\_\_\_\_\_  
 Klaus Gegenfurtner  
 Teamleader Radio

\_\_\_\_\_  
 Lukas Scheuermann  
 Radio Team

## 4 TEST ENVIRONMENT

### 4.1 Address of the test laboratory

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

### 4.2 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

### 4.3 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 on basis of the ETSI Technical Report TR 100 028 Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1 and Part 2. The results are documented in the quality system acc. to DIN EN ISO/IEC 17025. 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.

| Measurement Type                  | Range                  | Confidence Level | Calculated Uncertainty   |
|-----------------------------------|------------------------|------------------|--------------------------|
| AC power line conducted emissions | 0.15 MHz to 30 MHz     | 95%              | $\pm 3.29$ dB            |
| EBW and OBW                       | 2400 MHz to 30000 MHz  | 95%              | $\pm 2.5 \times 10^{-7}$ |
| Output power ERP, radiated        | 1000 MHz to 7000 MHz   | 95%              | $\pm 2.71$ dB            |
| Field strength of the fundamental | 1000 MHz to 7000 MHz   | 95%              | $\pm 2.71$ dB            |
| Power spectral density            | 2400 MHz to 3000 MHz   | 95%              | $\pm 0.62$ dB            |
| Spurious Emissions, conducted     | 9 kHz to 10000 MHz     | 95%              | $\pm 2.15$ dB            |
| Spurious Emissions, conducted     | 10000 MHz to 40000 MHz | 95%              | $\pm 3.47$ dB            |
| Spurious Emissions, radiated      | 9 kHz to 30 MHz        | 95%              | $\pm 3.53$ dB            |
| Spurious Emissions, radiated      | 30 MHz to 1000 MHz     | 95%              | $\pm 4.44$ dB            |
| Spurious Emissions, radiated      | 1000 MHz to 30000 MHz  | 95%              | $\pm 2.34$ dB            |
| Spurious Emissions, radiated      | 30000 MHz to 40000 MHz | 95%              | $\pm 5.13$ dB            |

## 4.4 Conformity Decision Rule

The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule ( $w = 0$ ).

Details can be found in the procedure CSA\_B\_V50\_29.

## 4.5 Measurement protocol for FCC and ISCED

### 4.5.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

**FCC: DE 0011**  
**ISED: DE0009**

### 4.5.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

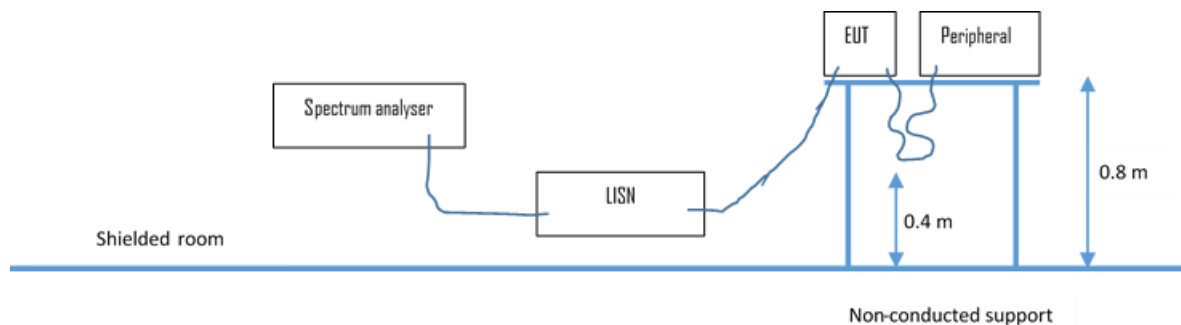
#### 4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

### 4.5.3 Details of test procedures

#### 4.5.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in dB $\mu$ V, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

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

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

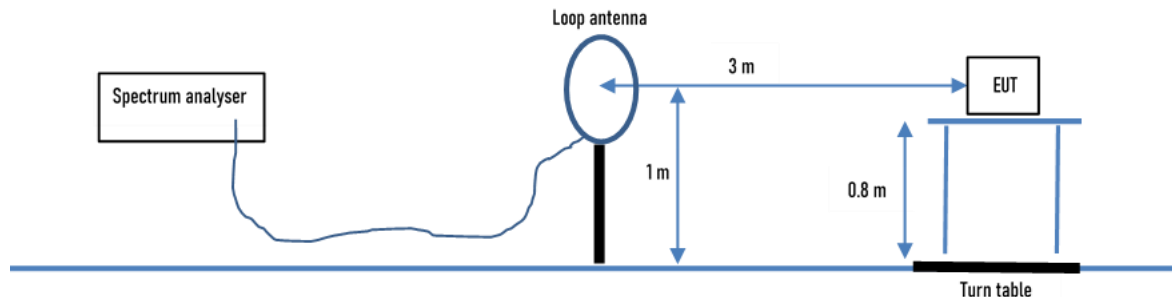
$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

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

#### 4.5.3.2 Radiated emission

##### 4.5.3.2.1 OATS1 test site (9 kHz - 30 MHz):

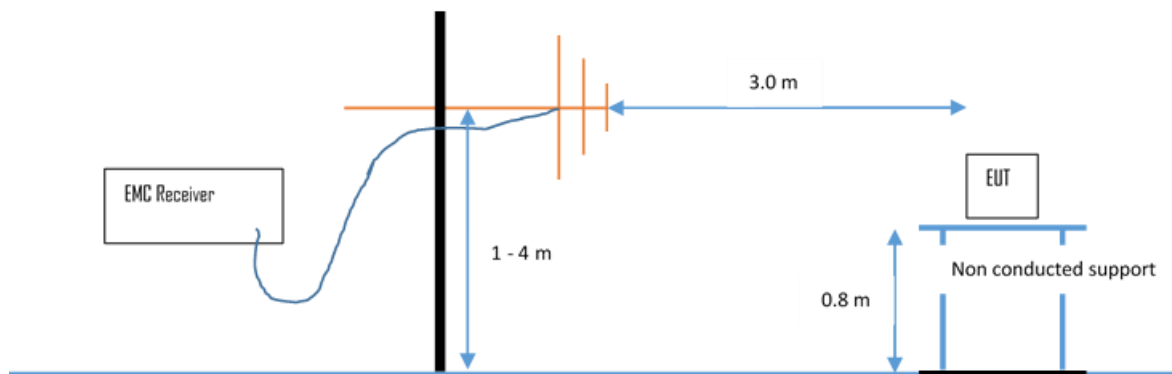
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above 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, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

##### 4.5.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised 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 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/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. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBμV/m is calculated by taking the reading from the EMI receiver (Level dBμV) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

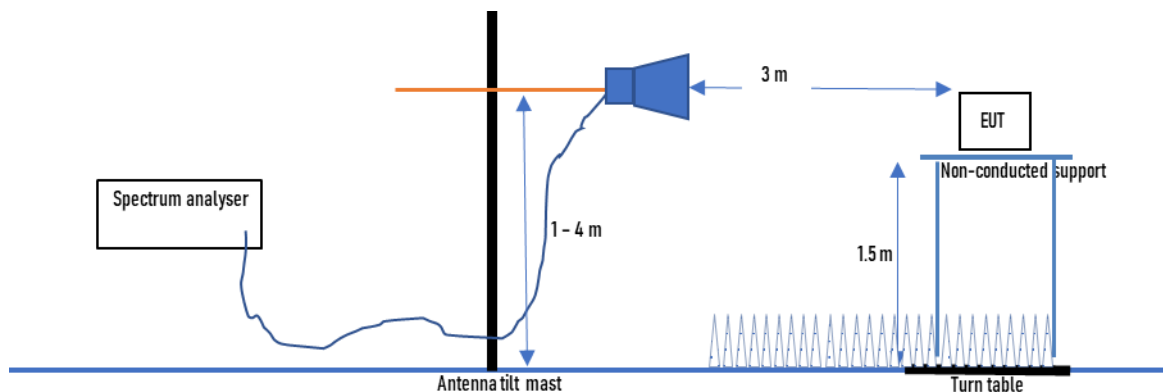
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

| Frequency<br>(MHz) | Level<br>(dBμV) | + | Factor<br>(dB) | = | Level<br>(dBμV/m) | - | Limit<br>(dBμV/m) | = | Delta<br>(dB) |
|--------------------|-----------------|---|----------------|---|-------------------|---|-------------------|---|---------------|
| 719.0              | 75.0            | + | 32.6           | = | 107.6             | - | 110.0             | = | -2.4          |

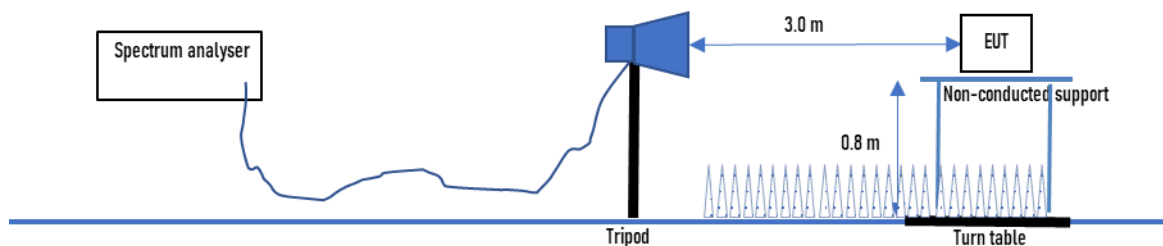
#### 4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

#### 4.5.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit is adopted.

## 5 TEST CONDITIONS AND RESULTS

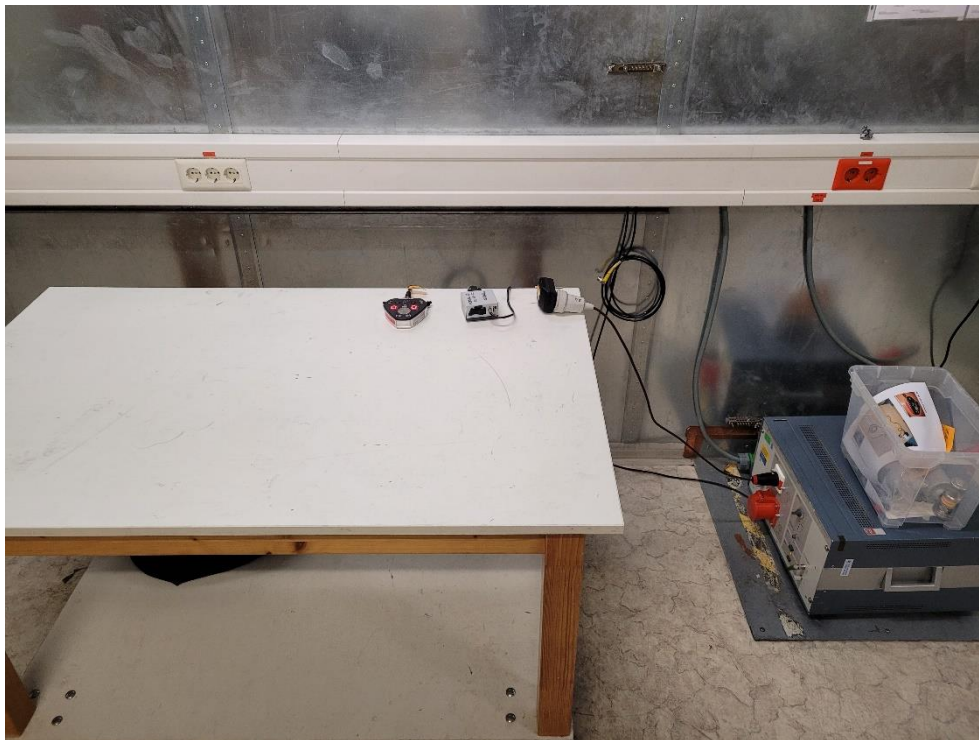
### 5.1 AC power line conducted emissions

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

#### 5.1.1 Description of the test location

Test location:                      Shielded Room S2

#### 5.1.2 Photo documentation of the test set-up



#### 5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):

Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

#### 5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

#### 5.1.5 Test result

Frequency range:                      0.15 MHz - 30 MHz

Min. limit margin                      -26.13 dB at 14.973 MHz

Limit according to FCC Part 15, Section 15.207(a):

| Frequency of Emission<br>(MHz) | Conducted Limit (dBμV) |            |
|--------------------------------|------------------------|------------|
|                                | Quasi-peak             | Average    |
| 0.15-0.5                       | 66 to 56 *             | 56 to 46 * |
| 0.5-5                          | 56                     | 46         |
| 5-30                           | 60                     | 50         |

\* Decreases with the logarithm of the frequency

The requirements are **FULFILLED**.

**Remarks:** For detailed test result please refer to following test protocols

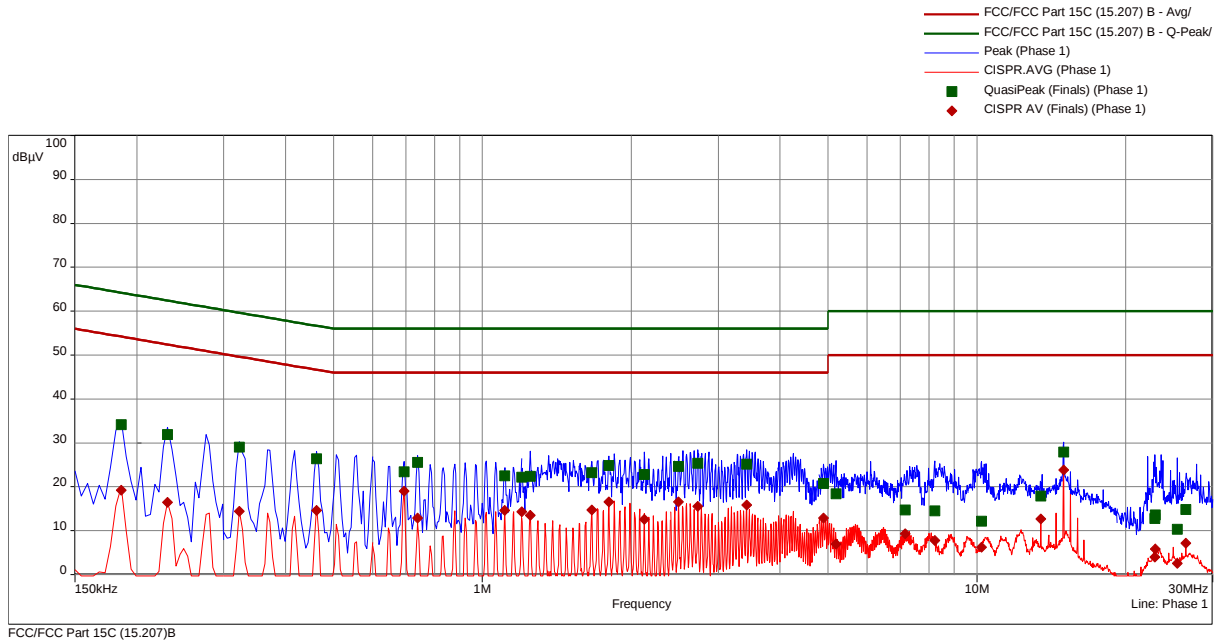
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The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

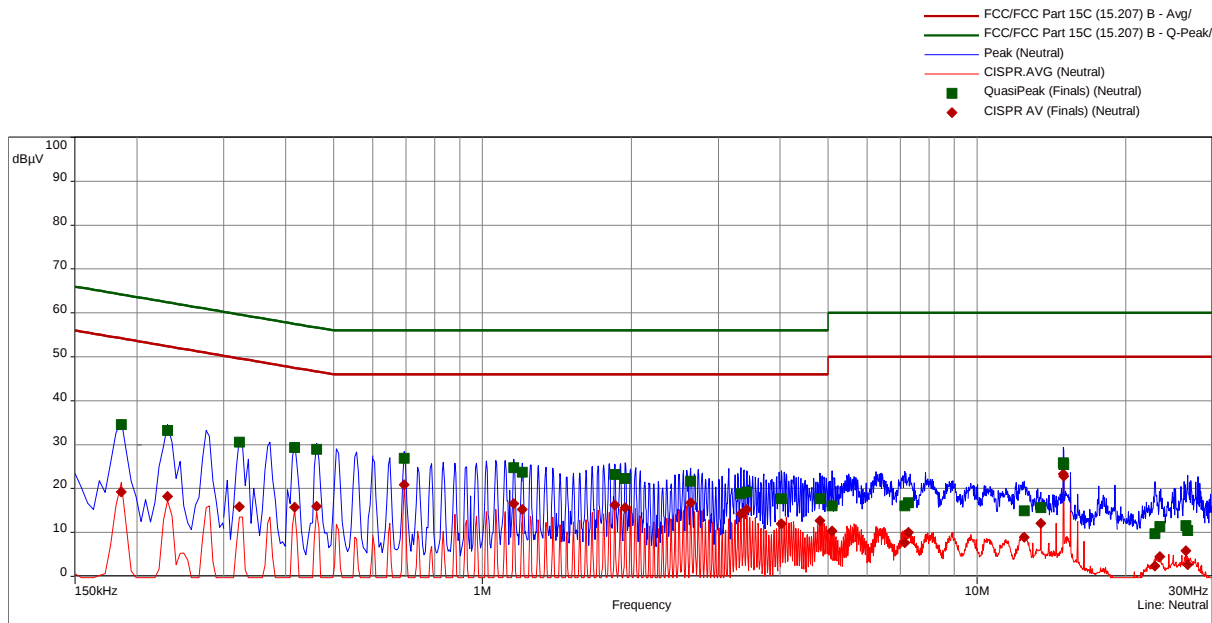
## 5.1.6 Test protocol



FCC/FCC Part 15C (15.207)B

| freq   | SR | QP     | margin | limit | AV     | margin | limit | line    | corr  |
|--------|----|--------|--------|-------|--------|--------|-------|---------|-------|
| MHz    |    | dB(μV) | dB     | dB    | dB(μV) | dB     | dB    |         | dB    |
| 0.186  | 1  | 34.17  | -30.04 | 64.2  | 19.28  | -34.93 | 54.2  | Phase 1 | 10.23 |
| 0.231  | 1  | 31.92  | -30.49 | 62.4  | 16.47  | -35.94 | 52.4  | Phase 1 | 10.17 |
| 0.3225 | 2  | 29.04  | -30.6  | 59.6  | 14.38  | -35.26 | 49.6  | Phase 1 | 10.16 |
| 0.462  | 2  | 26.37  | -30.28 | 56.7  | 14.59  | -32.07 | 46.7  | Phase 1 | 10.13 |
| 0.6945 | 3  | 23.38  | -32.62 | 56    | 19.01  | -26.99 | 46    | Phase 1 | 10.12 |
| 0.7395 | 3  | 25.57  | -30.43 | 56    | 12.85  | -33.15 | 46    | Phase 1 | 10.12 |
| 1.1085 | 3  | 22.47  | -33.53 | 56    | 14.68  | -31.32 | 46    | Phase 1 | 10.13 |
| 1.2    | 3  | 22.17  | -33.83 | 56    | 14.37  | -31.63 | 46    | Phase 1 | 10.14 |
| 1.2495 | 4  | 22.36  | -33.64 | 56    | 13.53  | -32.47 | 46    | Phase 1 | 10.14 |
| 1.6635 | 4  | 23.22  | -32.78 | 56    | 14.7   | -31.3  | 46    | Phase 1 | 10.17 |
| 1.803  | 4  | 24.84  | -31.16 | 56    | 16.62  | -29.38 | 46    | Phase 1 | 10.17 |
| 2.127  | 4  | 22.79  | -33.21 | 56    | 12.62  | -33.38 | 46    | Phase 1 | 10.18 |
| 2.4945 | 5  | 24.69  | -31.31 | 56    | 16.6   | -29.4  | 46    | Phase 1 | 10.22 |
| 2.7285 | 5  | 25.32  | -30.68 | 56    | 15.55  | -30.45 | 46    | Phase 1 | 10.22 |
| 3.4215 | 5  | 25.19  | -30.81 | 56    | 15.87  | -30.13 | 46    | Phase 1 | 10.19 |
| 4.899  | 6  | 20.74  | -35.26 | 56    | 12.94  | -33.06 | 46    | Phase 1 | 10.25 |
| 5.187  | 6  | 18.36  | -41.64 | 60    | 6.93   | -43.07 | 50    | Phase 1 | 10.26 |
| 7.167  | 6  | 14.73  | -45.27 | 60    | 9.34   | -40.66 | 50    | Phase 1 | 10.34 |
| 8.2245 | 6  | 14.48  | -45.52 | 60    | 7.82   | -42.18 | 50    | Phase 1 | 10.37 |
| 10.221 | 7  | 12.16  | -47.84 | 60    | 6.23   | -43.77 | 50    | Phase 1 | 10.40 |
| 13.475 | 7  | 17.94  | -42.06 | 60    | 12.68  | -37.32 | 50    | Phase 1 | 10.51 |
| 14.973 | 7  | 27.93  | -32.07 | 60    | 23.87  | -26.13 | 50    | Phase 1 | 10.55 |

|        |   |       |        |    |      |        |    |         |       |
|--------|---|-------|--------|----|------|--------|----|---------|-------|
| 22.913 | 8 | 12.76 | -47.24 | 60 | 4.01 | -45.99 | 50 | Phase 1 | 10.72 |
| 22.958 | 8 | 13.56 | -46.44 | 60 | 5.81 | -44.19 | 50 | Phase 1 | 10.72 |
| 25.41  | 8 | 10.36 | -49.64 | 60 | 2.56 | -47.44 | 50 | Phase 1 | 10.78 |
| 26.45  | 8 | 14.87 | -45.13 | 60 | 7.13 | -42.87 | 50 | Phase 1 | 10.80 |



FCC/FCC Part 15C (15.207)B

| freq   | SR | QP     | margin | limit | AV     | margin | limit | line    | corr  |
|--------|----|--------|--------|-------|--------|--------|-------|---------|-------|
| MHz    |    | dB(μV) | dB     | dB    | dB(μV) | dB     | dB    |         | dB    |
| 0.186  | 9  | 34.54  | -29.68 | 64.2  | 19.18  | -35.03 | 54.2  | Neutral | 10.23 |
| 0.231  | 9  | 33.29  | -29.12 | 62.4  | 18.24  | -34.17 | 52.4  | Neutral | 10.17 |
| 0.3225 | 10 | 30.57  | -29.07 | 59.6  | 15.9   | -33.74 | 49.6  | Neutral | 10.16 |
| 0.417  | 10 | 29.31  | -28.19 | 57.5  | 15.78  | -31.73 | 47.5  | Neutral | 10.14 |
| 0.462  | 10 | 28.89  | -27.76 | 56.7  | 15.96  | -30.7  | 46.7  | Neutral | 10.13 |
| 0.6945 | 11 | 26.95  | -29.05 | 56    | 20.85  | -25.15 | 46    | Neutral | 10.12 |
| 1.158  | 11 | 24.75  | -31.25 | 56    | 16.59  | -29.41 | 46    | Neutral | 10.13 |
| 1.2045 | 12 | 23.71  | -32.29 | 56    | 15.23  | -30.77 | 46    | Neutral | 10.14 |
| 1.8525 | 12 | 23.24  | -32.76 | 56    | 16.22  | -29.78 | 46    | Neutral | 10.17 |
| 1.9425 | 12 | 22.34  | -33.66 | 56    | 15.67  | -30.33 | 46    | Neutral | 10.16 |
| 2.6385 | 13 | 21.65  | -34.35 | 56    | 16.75  | -29.25 | 46    | Neutral | 10.22 |
| 3.3315 | 13 | 18.79  | -37.21 | 56    | 14.19  | -31.81 | 46    | Neutral | 10.20 |
| 3.426  | 13 | 19.2   | -36.8  | 56    | 15.27  | -30.73 | 46    | Neutral | 10.19 |
| 4.0245 | 13 | 17.66  | -38.34 | 56    | 11.93  | -34.07 | 46    | Neutral | 10.21 |
| 4.8135 | 14 | 17.72  | -38.28 | 56    | 12.73  | -33.27 | 46    | Neutral | 10.25 |
| 5.097  | 14 | 16.03  | -43.97 | 60    | 10.36  | -39.64 | 50    | Neutral | 10.25 |
| 7.1535 | 14 | 16.06  | -43.94 | 60    | 7.7    | -42.3  | 50    | Neutral | 10.34 |
| 7.266  | 14 | 16.82  | -43.18 | 60    | 10     | -40    | 50    | Neutral | 10.34 |

|        |    |       |        |    |       |        |    |         |       |
|--------|----|-------|--------|----|-------|--------|----|---------|-------|
| 12.467 | 15 | 14.96 | -45.04 | 60 | 8.86  | -41.14 | 50 | Neutral | 10.48 |
| 13.475 | 15 | 15.66 | -44.34 | 60 | 12.08 | -37.92 | 50 | Neutral | 10.51 |
| 14.969 | 15 | 25.89 | -34.11 | 60 | 23.37 | -26.63 | 50 | Neutral | 10.55 |
| 14.973 | 15 | 25.47 | -34.53 | 60 | 22.82 | -27.18 | 50 | Neutral | 10.55 |
| 22.886 | 16 | 9.74  | -50.26 | 60 | 2.32  | -47.68 | 50 | Neutral | 10.72 |
| 23.453 | 16 | 11.34 | -48.66 | 60 | 4.53  | -45.47 | 50 | Neutral | 10.73 |
| 26.45  | 16 | 11.53 | -48.47 | 60 | 5.83  | -44.17 | 50 | Neutral | 10.80 |
| 26.679 | 16 | 10.47 | -49.53 | 60 | 2.71  | -47.29 | 50 | Neutral | 10.80 |

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

## 5.2 Field strength of fundamental

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

### 5.2.1 Description of the test location

Test location: Anechoic chamber 1  
Test distance: 3 m

### 5.2.2 Photo documentation of the test set-up



### 5.2.3 Applicable standard

According to FCC Part 15C, Section 15.249(a):

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the effective limits.

### 5.2.4 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.5. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Analyser settings:

Peak measurement: RBW: 5 MHz

VBW: 20 MHz

Detector: Max peak

## 5.2.5 Test result

### SE 660: Antenna 3, CH7

| Frequency | Level PK | Limit PK | Margin PK | Level AV | Limit AV | Margin AV |
|-----------|----------|----------|-----------|----------|----------|-----------|
| MHz       | dB(μV/m) | dB(μV/m) | dB        | dB(μV/m) | dB(μV/m) | dB        |
| 2440      | 102.7    | 114      | -11.3     | 89.0     | 94       | -5.0      |

Note: The correction factor of 13.7 dB is used to calculate the AV from the PK level.

### SE 661: Antenna 3, CH7

| Frequency | Level PK | Limit PK | Margin PK | Level AV | Limit AV | Margin AV |
|-----------|----------|----------|-----------|----------|----------|-----------|
| MHz       | dB(μV/m) | dB(μV/m) | dB        | dB(μV/m) | dB(μV/m) | dB        |
| 2440      | 100.9    | 114      | -13.1     | 87.2     | 94       | -6.8      |

Note: The correction factor of 13.7 dB is used to calculate the AV from the PK level.

Limit according to FCC Part 15C, Section 15.249(a):

| Frequency<br>(MHz)   | Field strength of fundamental |                |
|----------------------|-------------------------------|----------------|
|                      | (mV/m)                        | dB( $\mu$ V/m) |
| 902 - 928            | 50                            | 94             |
| <b>2400 - 2483.5</b> | <b>50</b>                     | <b>94</b>      |
| 5725-5875            | 50                            | 94             |
| 24000 - 24250        | 250                           | 108            |

Peak-Limit according to FCC Part 15C, Section 15.249(e):

However, the peak fieldstrength shall not exceed the maximum permitted average limit by more than 20 dB.

The requirements are **FULFILLED**.

**Remarks:** None.

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

### 5.3 Out-of-band emission, radiated

For test instruments and accessories used see section 6 Part **SER1, SER 2, SER 3.**

#### 5.3.1 Description of the test location

Test location: OATS 1  
Test location: Anechoic chamber 1  
Test distance: 3 m

#### 5.3.2 Photo documentation of the test set-up

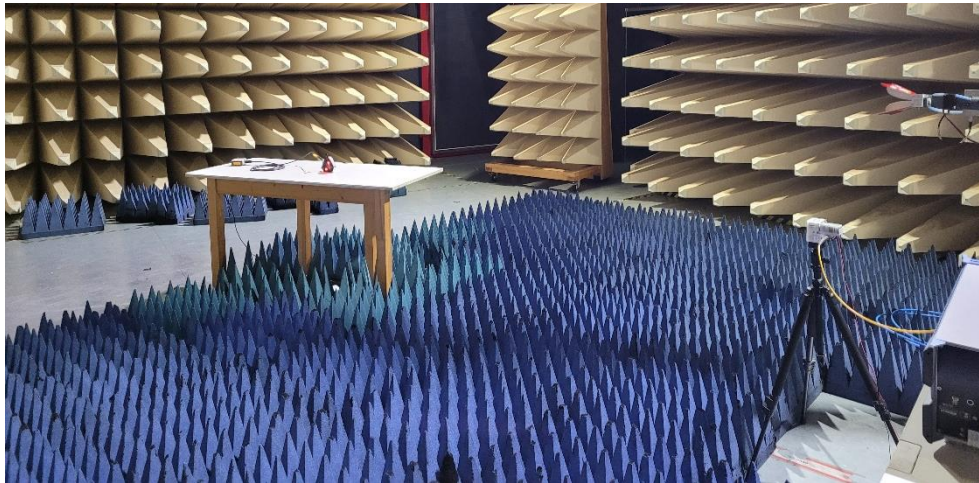
Test setup 30 MHz – 1000 MHz:



Test setup 1 GHz – 18 GHz:



Test setup 18 GHz – 25 GHz:



### 5.3.3 Applicable standard

According to FCC Part 15C, Section 15.249 (d):

Emission radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated limit in FCC Part 15C, Section 15.209, whichever is the lesser attenuation.

### 5.3.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.3. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Instrument settings:

|                    |      |         |
|--------------------|------|---------|
| 30 MHz – 1000 MHz: | RBW: | 120 kHz |
| 1000 MHz – 25 GHz  | RBW: | 1 MHz   |

### 5.3.5 Test result $f < 1$ GHz

| Frequency (MHz) | Reading Vert. (dB $\mu$ V) | Reading Hor. (dB $\mu$ V) | Correct. Vert. (dB) | Correct. Hor. (dB) | Level Vert. (dB $\mu$ V/m) | Level Hor. (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Dlimit (dB) |
|-----------------|----------------------------|---------------------------|---------------------|--------------------|----------------------------|---------------------------|----------------------|-------------|
| 39.00           | 7.5                        | 7.7                       | 16.7                | 17.8               | 24.2                       | 25.5                      | 40.0                 | -14.5       |
| 280.00          | 8.0                        | 9.3                       | 19.6                | 19.9               | 27.6                       | 29.2                      | 46.0                 | -16.8       |
| 600.00          | 7.0                        | 9.3                       | 28.0                | 28.4               | 35.0                       | 37.7                      | 46.0                 | -8.3        |
| 760.00          | 7.7                        | 6.4                       | 30.6                | 31.1               | 38.3                       | 37.5                      | 46.0                 | -7.7        |
| 600.00          | 7.0                        | 9.3                       | 28.0                | 28.4               | 35.0                       | 37.7                      | 46.0                 | -8.3        |
| 920.00          | 8.3                        | 8.2                       | 32.8                | 33.4               | 41.1                       | 41.6                      | 46.0                 | -4.4        |

Note: No Emission from the EUT was identified. Values show noise from the measurement site.

### 5.3.6 Test result $f > 1$ GHz

Average value determined by Duty Cycle Correction (5.4) applied to Peak Level.

| Frequency | Level PK       | Limit PK       | Margin PK | Level AV       | Limit AV       | Margin AV |
|-----------|----------------|----------------|-----------|----------------|----------------|-----------|
| GHz       | dB( $\mu$ V/m) | dB( $\mu$ V/m) | dB        | dB( $\mu$ V/m) | dB( $\mu$ V/m) | dB        |
| 4.87972   | 63.3           | 74             | -10.7     | 49.6           | 54             | -4.4      |

Limit according to FCC Part 15C, Section 15.209:

| Frequency (MHz) | 15.209 Limits ( $\mu$ V/m) | Measurement distance (m) |
|-----------------|----------------------------|--------------------------|
| 0.009 - 0.49    | $2400/f(\text{kHz})$       | 300                      |
| 0.49 - 1.705    | $24000/f(\text{kHz})$      | 30                       |
| 1.705 - 30.0    | 30                         | 30                       |
| 30 - 88         | 100                        | 3                        |
| 88 - 216        | 150                        | 3                        |
| 216 - 960       | 200                        | 3                        |
| Above 960       | 500                        | 3                        |

Average limit according to FCC Part 15C, Section 15.249(a):

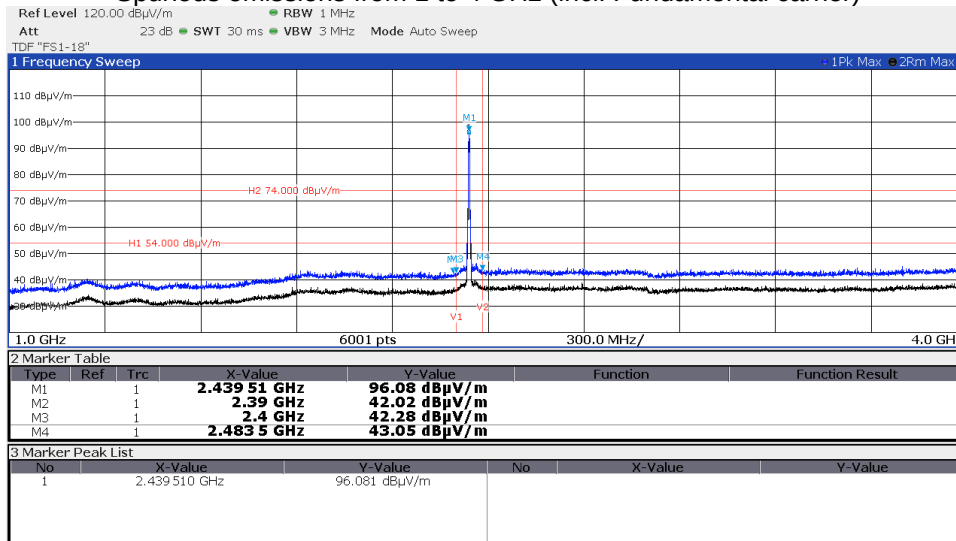
| Fundamental frequency (MHz) | Field strength of harmonics |                |
|-----------------------------|-----------------------------|----------------|
|                             | ( $\mu$ V/m)                | dB( $\mu$ V/m) |
| 902 - 928                   | 500                         | 54             |
| <b>2400 - 2483.5</b>        | 500                         | 54             |
| 5725 - 5875                 | 500                         | 54             |
| 24000 - 24250               | 2500                        | 68             |

The requirements are **FULFILLED**.

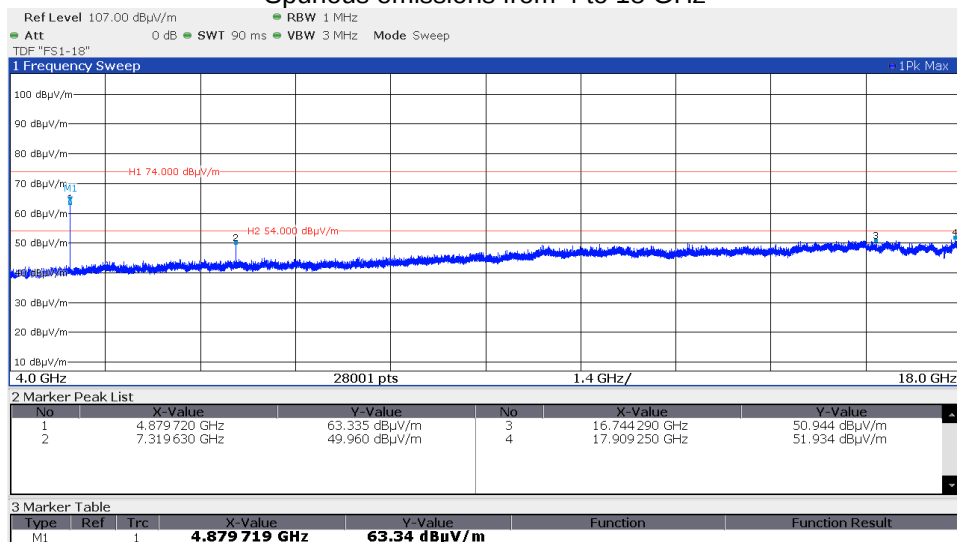
**Remarks:** The measurement was performed up to the 10<sup>th</sup> harmonic (25000 MHz). For detailed test result please refer to following test protocols. As of the small dimensions of the EUT no measurement was carried out below 30 MHz.

### 5.3.7 Test protocols

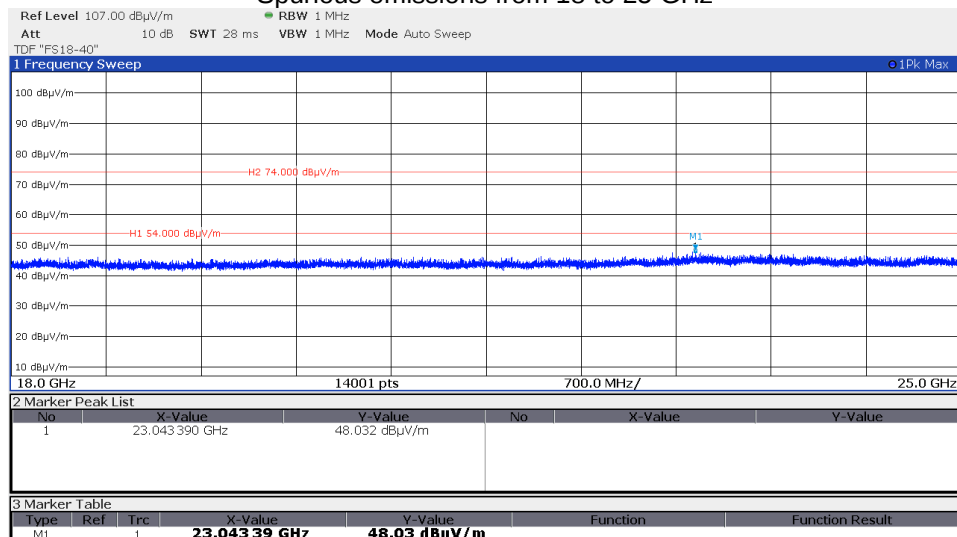
#### Spurious emissions from 1 to 4 GHz (incl. Fundamental carrier)



#### Spurious emissions from 4 to 18 GHz



#### Spurious emissions from 18 to 25 GHz



## 5.4 Correction for pulse operation (duty cycle)

### 5.4.1 Applicable standard

According to FCC Part 15A, Section 15.35(c):

When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete puls train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the puls train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted.

### 5.4.2 Description of Measurement

The duty cycle factor (dB) is calculated applying the following formula:

$$KE = 20 \log ((t_{iw}/T_w) * (t_{iB}/T_B))$$

*KE*: pulse operation correction factor  
*t<sub>iw</sub>* pulse duration for one complete pulse track  
*t<sub>iB</sub>* pulse duration for one pulse  
*T<sub>w</sub>* a period of the pulse track  
*T<sub>B</sub>* a period of one pulse

### 5.4.3 Test result

|                        |          |
|------------------------|----------|
| Total length of period | 3.038 ms |
| Max. On time Port4     | 0.627 ms |
| DC                     | 0.21     |
| Correction factor      | -13.7 dB |

**Remarks:** Manufacturer stated Duty Cycle Correction has not changed since  
measurement of Test Report T36611-00. Therefore, data of named Report is used.

## 5.5 Antenna application

### 5.5.1 Applicable standard

According to FCC Part 15C, Section 15.203(a):

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section.

### 5.5.2 Result

User has no access to the antennas.

The antenna of the EUT meets the requirement of FCC Part 15C, Section 15.203 and 15.204.

The requirements are **FULFILLED**.

Remarks: None.

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## 6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

| Test ID | Model Type             | Equipment No.   | Next Calib. | Last Calib. | Next Verif. | Last Verif. |
|---------|------------------------|-----------------|-------------|-------------|-------------|-------------|
| A 4     | BAT-EMC 2022.0.21.0    | 01-02/68-13-001 |             |             |             |             |
|         | ESCI                   | 02-02/03-15-001 | 17/06/2023  | 17/06/2022  |             |             |
|         | ESH 2 - Z 5            | 02-02/20-05-004 | 13/10/2025  | 13/10/2022  | 13/04/2023  | 13/10/2022  |
|         | N-4000-BNC             | 02-02/50-05-138 |             |             |             |             |
|         | ESH 3 - Z 2            | 02-02/50-05-155 | 09/11/2025  | 09/11/2022  | 09/05/2023  | 09/11/2022  |
|         | SP 103 /3.5-60         | 02-02/50-05-182 |             |             |             |             |
| CPR 3   | FSW43                  | 02-02/11-15-001 | 22/04/2023  | 22/04/2022  |             |             |
|         | AMF-6D-01002000-22-10P | 02-02/17-15-004 |             |             |             |             |
|         | 3117                   | 02-02/24-05-009 | 23/06/2023  | 23/06/2022  |             |             |
|         | BAM 4.5-P              | 02-02/50-17-024 |             |             |             |             |
|         | NCD                    | 02-02/50-17-025 |             |             |             |             |
|         | KK-SF106-2X11N-6,5M    | 02-02/50-18-016 |             |             |             |             |
| SER 2   | BAT-EMC 2022.0.21.0    | 02-02/68-13-001 |             |             |             |             |
|         | ESVS 30                | 02-02/03-05-006 | 27/07/2023  | 27/07/2022  |             |             |
|         | VULB 9168              | 02-02/24-05-005 | 20/12/2022  | 20/12/2021  | 03/07/2023  | 03/07/2022  |
|         | NW-2000-NB             | 02-02/50-05-113 |             |             |             |             |
|         | KK-EF393/U-16N-21N20 m | 02-02/50-12-018 |             |             |             |             |
|         | KK-SD_7/8-2X21N-33,0M  | 02-02/50-15-028 |             |             |             |             |
| SER 3   | 50F-003 N 3 dB         | 02-02/50-21-010 |             |             |             |             |
|         | FSW43                  | 02-02/11-15-001 | 22/04/2023  | 22/04/2022  |             |             |
|         | AMF-6D-01002000-22-10P | 02-02/17-15-004 |             |             |             |             |
|         | LNA-40-18004000-33-5P  | 02-02/17-20-002 |             |             |             |             |
|         | 3117                   | 02-02/24-05-009 | 23/06/2023  | 23/06/2022  |             |             |
|         | BBHA 9170              | 02-02/24-05-013 | 19/05/2023  | 19/05/2020  | 10/03/2023  | 10/03/2022  |
|         | BAM 4.5-P              | 02-02/50-17-024 |             |             |             |             |
|         | NCD                    | 02-02/50-17-025 |             |             |             |             |
|         | KK-SF106-2X11N-6,5M    | 02-02/50-18-016 |             |             |             |             |
|         | KMS116-GL140SE-KMS116- | 02-02/50-20-026 |             |             |             |             |
|         | BAT-EMC 2022.0.21.0    | 02-02/68-13-001 |             |             |             |             |

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