



BNetzA-CAB-21/21-21

# Test Report

Test report no.: 21065815-24571-0

Date of issue: 2022-03-01

**Test result:** The test item - **passed** - and **complies** with below listed standards.

## Applicant

rd electronic GmbH

## Manufacturer

rd electronic GmbH

## Test Item

SKX2WDE.RDE

## RF-Spectrum Testing according to:

**FCC 47 CFR Part 15**

Radio Frequency Devices (Subpart C)

Tested by *B.Sc. Piotr Sardyko*  
(name, function, signature) *Deputy Test Lab Manager Radio*

signature

Approved by *Andreas Bender*  
(name, function, signature) *Deputy Managing Director*

signature

**Applicant and Test item details**

|                              |                                                                   |
|------------------------------|-------------------------------------------------------------------|
| <b>Applicant</b>             | rd electronic GmbH<br>Keltenring 9<br>82041, Oberhaching, Germany |
| <b>Manufacturer</b>          | Adolf Tedsen GmbH & Co. KG; Otto-Hahn-Str. 13-14; D-22946 Trittau |
| <b>Test item description</b> | One-channel (halb duplexx) radio remote control                   |
| <b>Model/Type reference</b>  | SKX2WDE.RDE                                                       |
|                              |                                                                   |
| <b>FCC ID</b>                | 2A3UHRD02                                                         |
| <b>Frequency</b>             | 433.9 MHz                                                         |
| <b>Antenna</b>               | Integrated PCB antenna (magnetic loop)                            |
| <b>Power supply</b>          | 12 V DC                                                           |
| <b>Temperature range</b>     | -10 °C – +55 °C                                                   |

**Disclaimer and Notes**

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Within this test report, a ☒ point / ☐ comma is used as a decimal separator.  
If otherwise, a detailed note is added adjoined to its use.

IBL-Lab GmbH does not take test samples. The samples used for testing are provided by the applicant.

Decision rule:

Decision rule based on simple acceptance without guard bands, binary statement, based on mutually agreed uncertainty tolerances with expansion factor k=2 according to ILAC-G8:09/2019

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## 2 GENERAL INFORMATION

### 2.1 Administrative details

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Testing laboratory              | <b>IBL-Lab GmbH</b><br>Heinrich-Hertz-Allee 7<br>66386 Sankt Ingbert / Germany<br>Fon: +49 6894 38938-0<br>Fax: +49 6894 38938-99<br>URL: <a href="http://www.ib-lenhardt.de">www.ib-lenhardt.de</a><br>E-Mail: <a href="mailto:info@ib-lenhardt.de">info@ib-lenhardt.de</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Accreditation                   | <p>The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkKS) in compliance with DIN EN ISO/IEC 17025:2018.</p> <p>Scope of testing and registration number:</p> <ul style="list-style-type: none"> <li>Electronics <a href="#">D-PL-21375-01-01</a></li> <li>Electromagnetic Compatibility <a href="#">D-PL-21375-01-02</a></li> <li>Electromagnetic Compatibility and Telecommunication (FCC requirements) <a href="#">D-PL-21375-01-03</a></li> <li>Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards <a href="#">D-PL-21375-01-04</a></li> <li>ISED Company Number 27156</li> <li>Testing Laboratory CAB Identifier DE0020</li> <li>Telecommunication (TC) <a href="#">D-PL-21375-01-05</a></li> </ul> <p>Website DAkKS: <a href="https://www.dakks.de/">https://www.dakks.de/</a></p> <p>The Deutsche Akkreditierungsstelle GmbH (DAkKS) is also a signatory to the <a href="#">ILAC Mutual Recognition Arrangement</a></p> |
| Testing location                | <b>IBL-Lab GmbH</b><br>Heinrich-Hertz-Allee 7<br>66386 St. Ingbert / Germany                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Date of receipt of test samples | 2021-11-16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Start – End of tests            | 2022-01-21 – 2022-02-08                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

### 2.2 Possible test case verdicts

|                                             |                      |
|---------------------------------------------|----------------------|
| Test sample meets the requirements          | P (PASS)             |
| Test sample does not meet the requirements  | F (FAIL)             |
| Test case does not apply to the test sample | N/A (Not applicable) |
| Test case not performed                     | N/P (Not performed)  |

### 2.3 Observations

No additional observations other than the reported observations within this test report have been made.

### 2.4 Opinions and interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

### 2.5 Revision history

-0 Initial Version

Utilisation, publication and control of previous report editions is under responsibility of the applicant.

### 2.6 Further documents

List of further applicable documents belonging to the present test report:

– no additional documents –

### 3 ENVIRONMENTAL & TEST CONDITIONS

#### 3.1 Environmental conditions

|                     |               |
|---------------------|---------------|
| Temperature         | 20°C ± 5°C    |
| Relative humidity   | 25-75 % r.H.  |
| Barometric Pressure | 860-1060 mbar |
| Power supply        | 230 V / 50 Hz |

#### 3.2 Normal and extreme test conditions

|                   |           |
|-------------------|-----------|
|                   | normal    |
| Temperature       | 20 °C     |
| Relative humidity | 45 % r.h. |
| Power supply      | 12 V DC   |

### 4 TEST STANDARDS AND REFERENCES

| Test standard (accredited) | Description                         |
|----------------------------|-------------------------------------|
| FCC 47 CFR Part 15         | Radio Frequency Devices (Subpart C) |

| Reference        | Description                                                                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANSI C63.4-2014  | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.10-2013 | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices                                                                      |

## 5 EQUIPMENT UNDER TEST (EUT)

### 5.1 Product description

One-channel (halb duplexx) radio remote control

### 5.2 Description of test item

|                  |                 |
|------------------|-----------------|
| Model name*      | SKX2WDE.RDE     |
| Serial number*   | N/A             |
| PCB identifier*  | +2+SKX2WDRD     |
| Hardware status* | 431 00 00 00 00 |
| Software status* | SKXWRD2-1V0     |

\*: as declared by applicant

### 5.3 Technical data of test item

|                             |                                        |
|-----------------------------|----------------------------------------|
| Operational frequency*      | 433.9 MHz                              |
| Operational frequency band* | -                                      |
| Type of radio transmission* | Modulated carrier                      |
| Modulation type*            | ASK                                    |
| Number of channels*         | 1                                      |
| Channel bandwidth*          | -/-                                    |
| Channel spacing*            | -/-                                    |
| Antenna*                    | Integrated PCB antenna (magnetic loop) |
| Power supply*               | 12 Vdc                                 |
| Temperature range*          | -10°C to +55°C                         |

\*: as declared by applicant

### 5.4 Additional information

|                                       |      |
|---------------------------------------|------|
| Model differences                     | none |
| Ancillaries tested with               | none |
| Additional equipment used for testing | none |

## 6 SUMMARY OF TEST RESULTS

### Test specification

FCC 47 CFR Part 15

| Clause                     | Requirement / Test case               | Test Conditions | Result / Remark            | Verdict |
|----------------------------|---------------------------------------|-----------------|----------------------------|---------|
| §15.231(b)                 | Fundamental field strength            | Normal          | 85.362 dB $\mu$ V/m<br>@3m | Pass    |
| §15.231(b) /<br>§15.209(a) | Field strength of spurious emissions  | Normal          | < limit                    | Pass    |
| §15.231 (a) (1)            | Transmit time                         | Normal          | 240 ms                     | Pass    |
| §15.231(c)                 | 20 dB bandwidth<br>Occupied bandwidth | Normal          | 63.90 kHz<br>330.306 kHz   | Pass    |

### Notes

– none –

### Comments and observations

– none –

## 7 TEST RESULTS

### 7.1 Field strength of fundamental

#### Description / Limits

§15.231 (b)

In addition to the provisions of § 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

| Frequency<br>[MHz] | Field strength of fundamental @3m |                 |
|--------------------|-----------------------------------|-----------------|
|                    | [µV/m]                            | [dBuV/m]        |
| 40.66-40.70        | 2250                              | 67.04           |
| 70-130             | 1250                              | 61.93           |
| 130-174            | 1250 to 3750*                     | 61.93 to 71.48* |
| 174-260            | 3750                              | 71.48           |
| 260-470            | 3750 to 12500*                    | 71.48 to 81.93* |
| Above 470          | 12500                             | 81.93           |

\*Linear interpolations

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges. (2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in § 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of § 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in § 15.209, whichever limit permits a higher field strength.

#### Test procedure

§15.31 (m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

| Frequency range      | Number of frequencies | Location                     |
|----------------------|-----------------------|------------------------------|
| < 1MHz bandwidth     | 1                     | middle                       |
| 1 – 10 MHz bandwidth | 2                     | 1 near bottom and 1 near top |
| > 10 MHz bandwidth   | 3                     | 1 near bottom / middle / top |

§15.35 (a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long as the same bandwidth as indicated for CISPR quasi-peak measurements are employed.

**Test setup:** see 8.1

**Test results Peak detector**

Limit(uV/m@433.9MHz):

 $X_{11}=260, Y_{11}=3750, X_{12}=470, Y_{12}=12500$ 
 $f(x)=mx+b, m=(12500-3750)/(470-260)=8750/210=41.66, b=f(x)-mx=12500-41.66*470=-7080.2$ 
 $\Rightarrow f(x)=41.66*x-7080.2 \Rightarrow f(433.9)=41.66*433.9-7080.2=10996.074$ 

Limit dBuV/m RMS/Peak:

Average/RMS Limit =  $20\text{LOG}(10996.074) = 80.82 \text{ dB}\mu\text{V/m}$ . Peak Limit = RMS Limit + 20 dB=100.82 dB $\mu\text{V/m}$ .

| Channel frequency [MHz] | Frequency [MHz] | Detector | Field strength [dB $\mu\text{V/m}$ ] | Limit [dB $\mu\text{V/m}$ ] | Margin [dB] | Verdict |
|-------------------------|-----------------|----------|--------------------------------------|-----------------------------|-------------|---------|
| 433.9                   | 433.899         | Peak     | 85.362                               | 100.82                      | 15.458      | Pass    |

**Test results RMS detector. Calculation.**

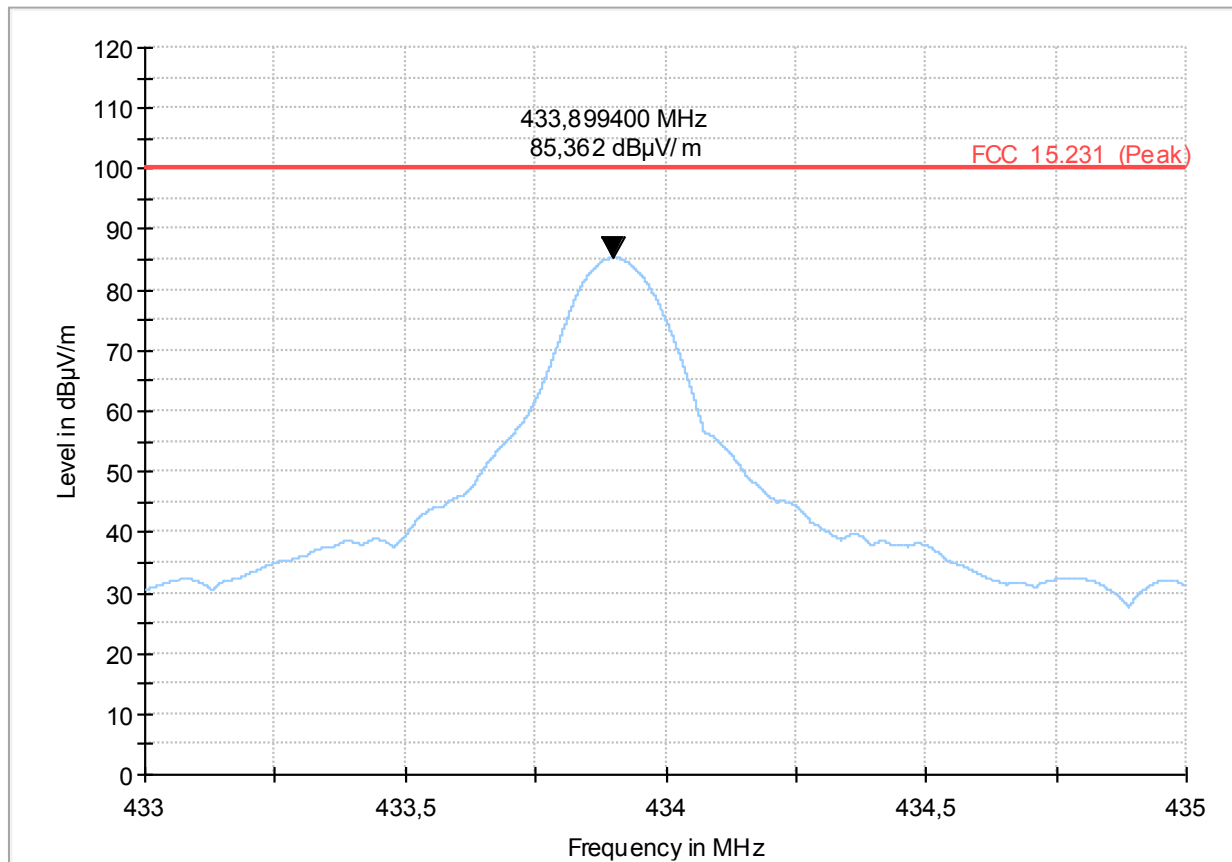
Duty cycle= 0.4026 (please see chapter 7.3)

Correction Factor @ RMS detector =  $20*\text{LOG}(\text{Duty Cycle}) = -7.9 \text{ dB}$ 
 $\Rightarrow \text{Field strength RMS detector} = 85.362 \text{ dB}\mu\text{V/m} - 7.9 \text{ dB} = 77.462 \text{ dB}\mu\text{V/m} < \text{RMS Limit} \Rightarrow \text{Pass}$

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Plot no. 1: Fundamental field strength



— Preview Result 1-PK+      \* Critical\_Freqs PK+  
— FCC\_15.231\_(Peak)      ◆ Final\_Result QPK

## 7.2 Field strength of spurious emissions

### Description / Limits

§15.231 (b)

In addition to the provisions of § 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

| Frequency<br>[MHz] | Field strength of spurious emissions @3m |                 |
|--------------------|------------------------------------------|-----------------|
|                    | [µV/m]                                   | [dBµV/m]        |
| 40.66-40.70        | 225                                      | 47.04           |
| 70-130             | 125                                      | 41.94           |
| 130-174            | 125 to 375*                              | 41.94 to 51.48* |
| 174-260            | 375                                      | 51.48           |
| 260-470            | 375 to 1250*                             | 51.48 to 61.94* |
| Above 470          | 1250                                     | 61.94           |

\*Linear interpolations

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges. (2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in § 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of § 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in § 15.209, whichever limit permits a higher field strength.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency         | Field Strength          | Measurement distance |
|-------------------|-------------------------|----------------------|
| 0.009 – 0.490 MHz | 2400/F[kHz] µV/m        | 300 m                |
| 0.490 – 1.705 MHz | 24000/F[kHz] µV/m       | 30 m                 |
| 1.705 – 30.0 MHz  | 30.0 µV/m / 29.5 dBµV/m | 30 m                 |
| 30 – 88 MHz       | 100 µV/m / 40.0 dBµV/m  | 3 m                  |
| 88 – 216 MHz      | 150 µV/m / 43.5 dBµV/m  | 3 m                  |
| 216 – 960 MHz     | 200 µV/m / 46.0 dBµV/m  | 3 m                  |
| 960 – 100 000 MHz | 500 µV/m / 54.0 dBµV/m  | 3 m                  |

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

§15.209 (c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

§15.209 (d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector

#### Test procedure

§15.31 (m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

| Frequency range      | Number of frequencies | Location                     |
|----------------------|-----------------------|------------------------------|
| < 1MHz bandwidth     | 1                     | middle                       |
| 1 – 10 MHz bandwidth | 2                     | 1 near bottom and 1 near top |
| > 10 MHz bandwidth   | 3                     | 1 near bottom / middle / top |

§15.35 (a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long as the same bandwidth as indicated for CISPR quasi-peak measurements are employed.

**Test setup:** see 8.1

#### Test results

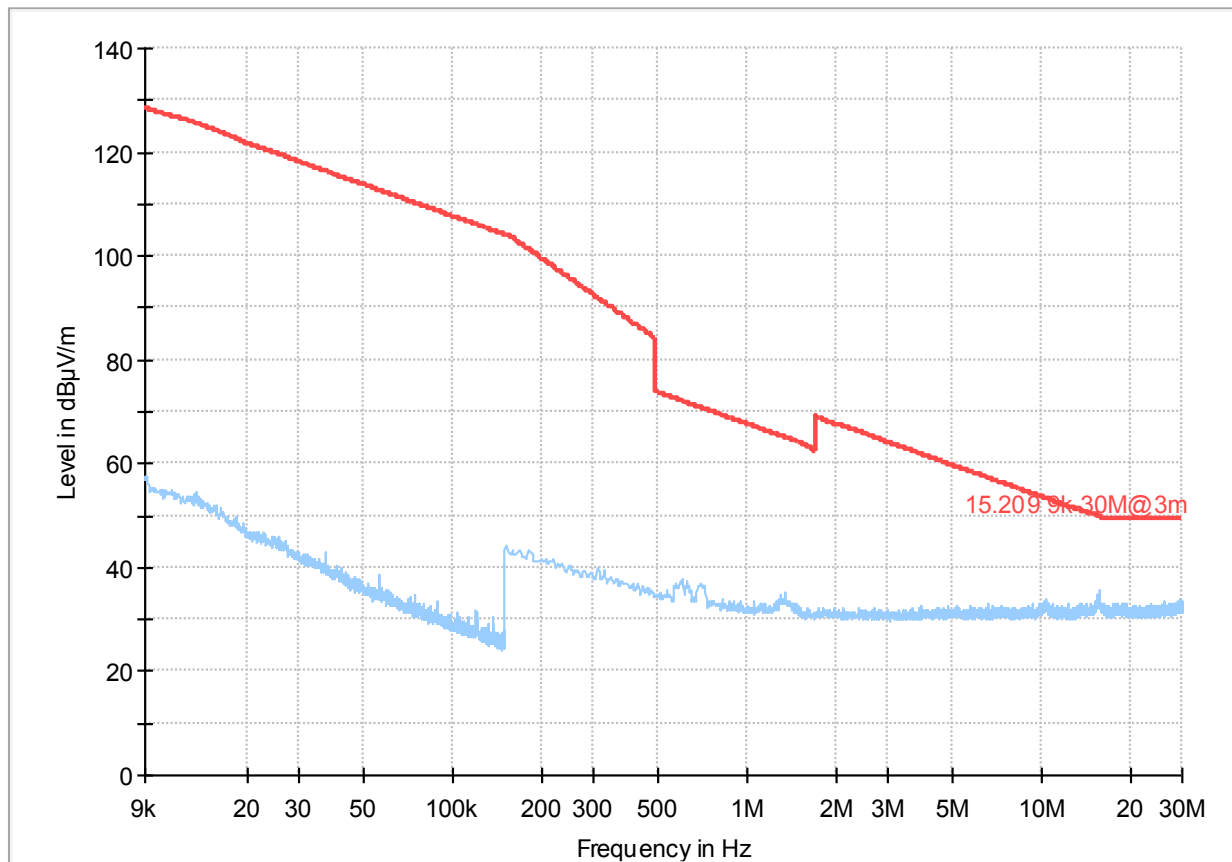
| Channel frequency [MHz] | Frequency [MHz] | Detector  | Test distance [m] | Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|-------------------------|-----------------|-----------|-------------------|----------------|----------------|-------------|
| 433.9 MHz               | see plots       | see plots | 3                 | see plots      | see plots      | see plots   |

**Note:**

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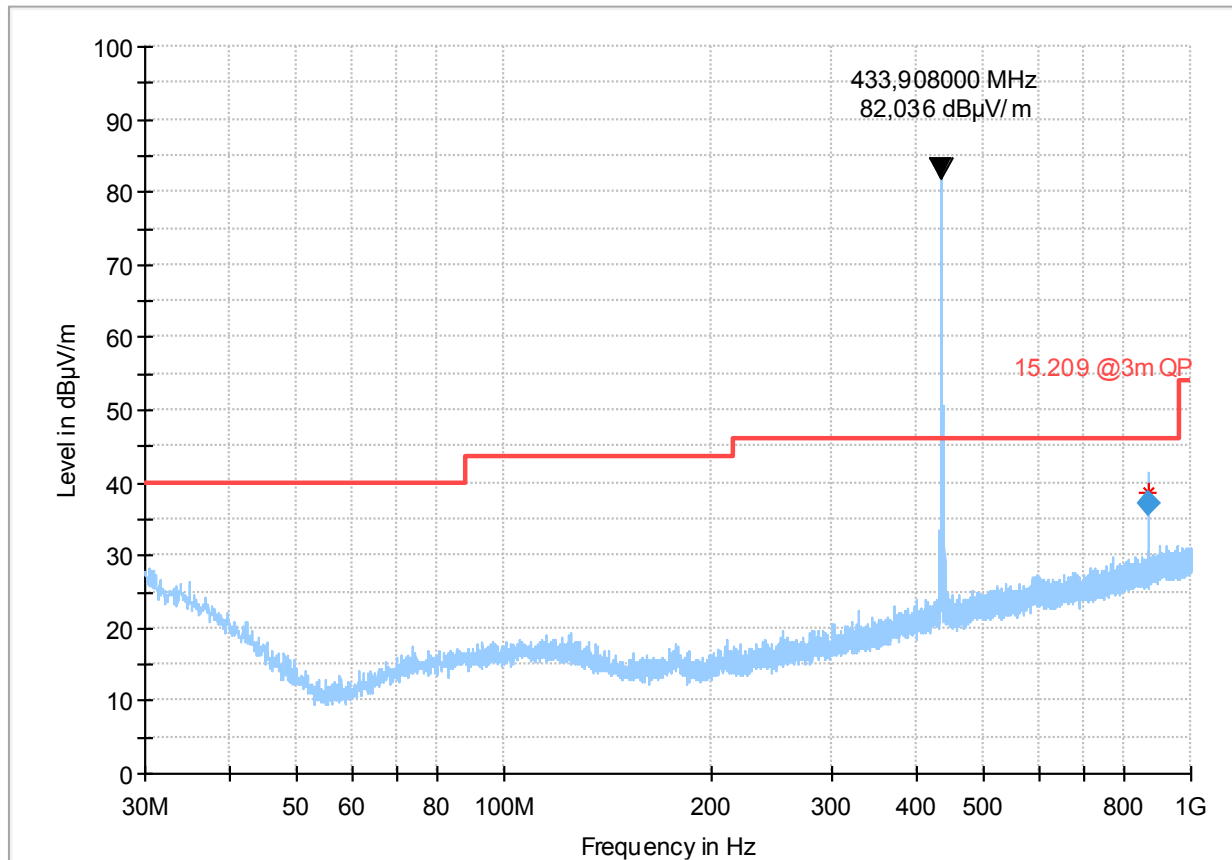
Plot no. 2: Field strength of spurious emissions 9 kHz – 30 MHz



— Preview Result 1-PK+  
— 15.209 9k-30M@3m

\* Critical\_Freqs PK+  
◆ Final\_Result QPK

Plot no. 3: Field strength of spurious emissions 30 MHz – 1 GHz, hor./vert. polarization



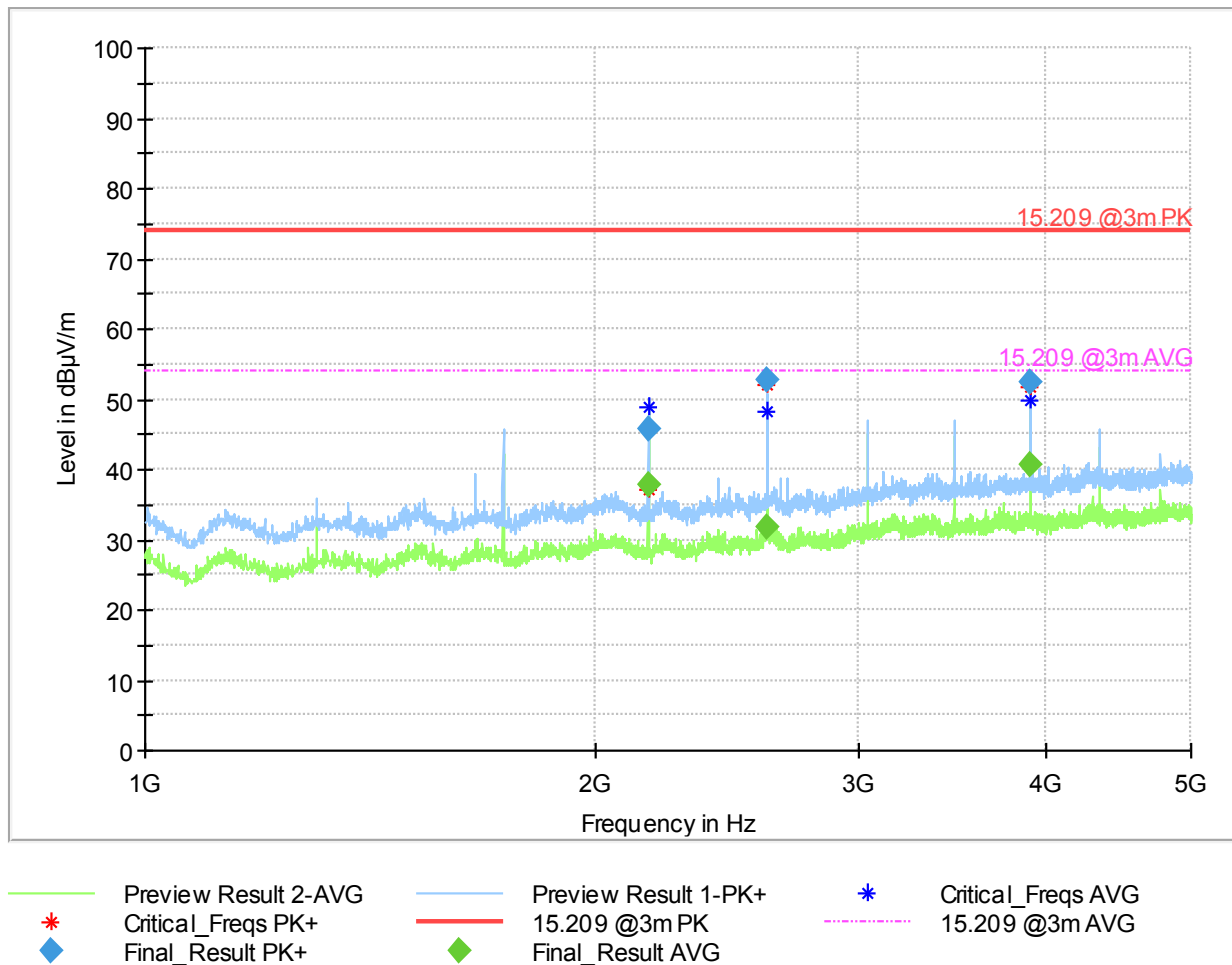
— Preview Result 1-PK+  
— 15.209 @3m QP

\* Critical\_Freqs PK+  
◆ Final\_Result QPK

## Final\_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|
| 867.812500      | 37.24              | 46.00          | 8.76        | 100.0           | 120.000         | 100.0       | H   | 18.0          |

Plot no. 4: Field strength of spurious emissions 30 MHz – 1 GHz, hor./vert. polarization



## Final\_Result

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol |
|-----------------|------------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|
| 2169.222222     | ---              | 37.88            | 54.00          | 16.12       | 100.0           | 1000.000        | 150.0       | V   |
| 2170.047222     | 45.75            | ---              | 74.00          | 28.25       | 100.0           | 1000.000        | 150.0       | V   |
| 2602.722222     | ---              | 31.66            | 54.00          | 22.34       | 100.0           | 1000.000        | 150.0       | V   |
| 2603.366667     | 52.70            | ---              | 74.00          | 21.30       | 100.0           | 1000.000        | 150.0       | V   |
| 3905.111111     | 52.27            | ---              | 74.00          | 21.73       | 100.0           | 1000.000        | 150.0       | H   |
| 3905.111111     | ---              | 40.61            | 54.00          | 13.39       | 100.0           | 1000.000        | 150.0       | H   |

### 7.3 Transmission time

#### Description / Limits

§15.231

(a) The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in [paragraph \(e\)](#) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in [paragraphs \(a\)\(1\)](#) and [\(a\)\(2\)](#) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

**Test setup:** see 8.1

#### Test results

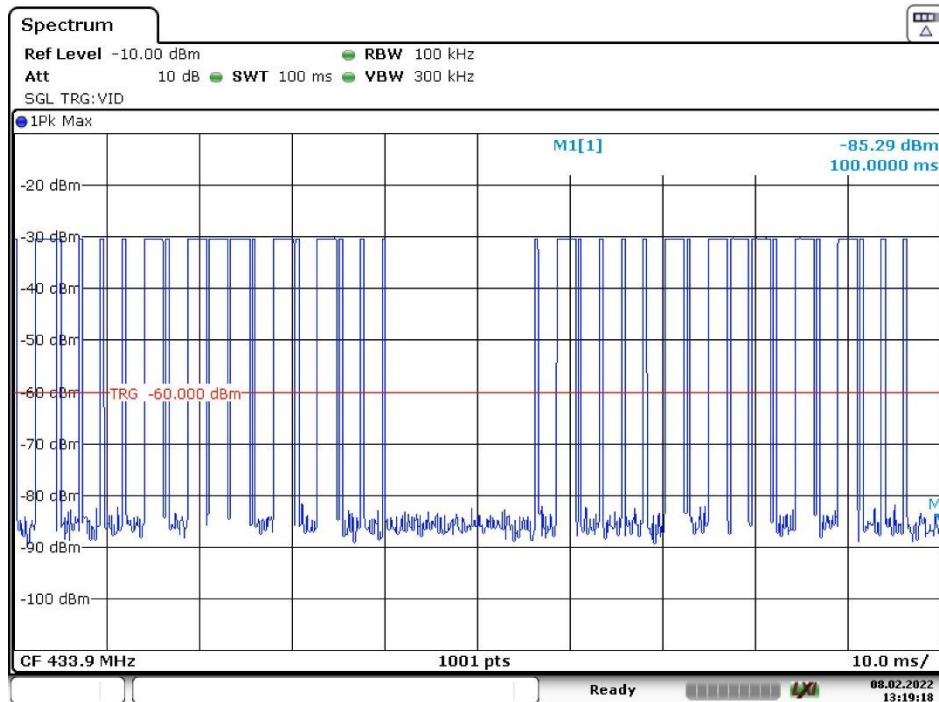
| EUT mode | Test conditions | Declared frequency [MHz] | Measured time [ms] | Limit [s] | Result |
|----------|-----------------|--------------------------|--------------------|-----------|--------|
| Normal   | Normal          | 433.9                    | 240                | 5         | Pass   |

**Note:**

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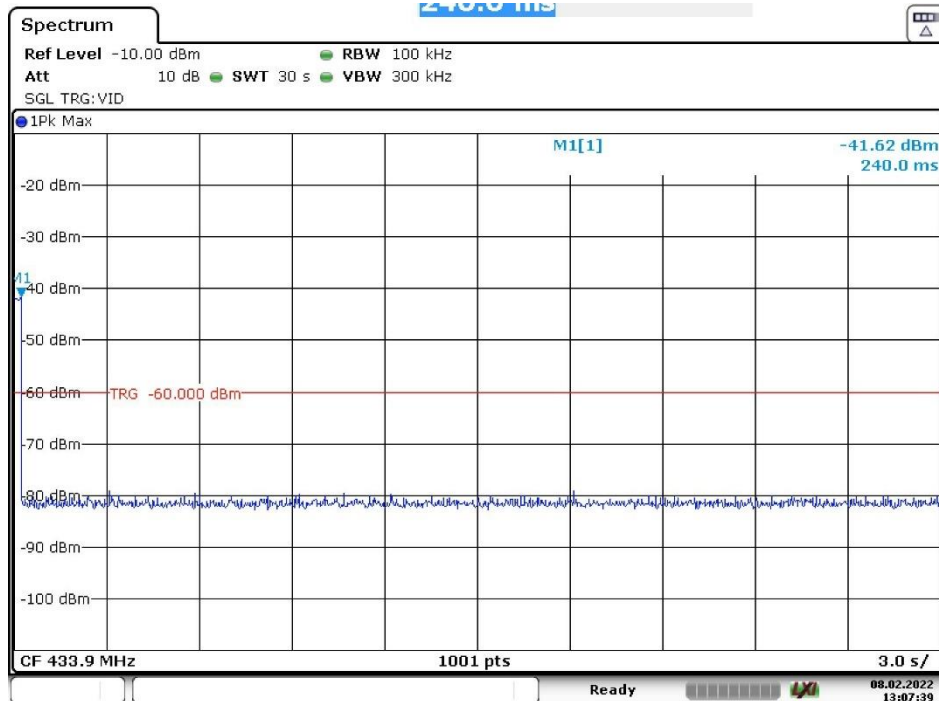
Plot no. 5: Transmission time, 100 ms



Date: 8.FEB.2022 13:19:18

Duty cycle=  $\text{pts}(P > \text{TRG}) / \text{pts\_all} = 403 / 1001 = 0.4026$

Plot no. 6: Transmission time, 30 s



Date: 8.FEB.2022 13:07:39

## 7.4 20 dB bandwidth / occupied bandwidth

### Description / limit

§15.231 (c)

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

**Note:** It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

### Test procedure

ANSI C63.10, 6.9.3

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

The following procedure shall be used for measuring 99% power bandwidth:

- a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
- g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency,

are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

#### Note

Measurements with the peak detector are also suitable to demonstrate compliance of an EUT, as long as the required resolution bandwidth is used, because peak detection will yield amplitudes equal to or greater than amplitudes measured with RMS detector. The measurement data from a spectrum analyser peak detector will represent the worst-case results (see ANSI C63.10).

#### Test Results:

| Channel | Min. Frequency $F_L$<br>[MHz] | Max. frequency $F_H$<br>[MHz] | Occupied bandwidth (99%)<br>[kHz] |
|---------|-------------------------------|-------------------------------|-----------------------------------|
| 1       | 433.767                       | 434.097                       | 330.306                           |

| Channel<br>frequency [MHz] | Min. Frequency<br>$F_L$<br>[MHz] | Max. frequency<br>$F_H$<br>[MHz] | 20 dB<br>bandwidth<br>[kHz] | Limit<br>[kHz] | Margin<br>[kHz] |
|----------------------------|----------------------------------|----------------------------------|-----------------------------|----------------|-----------------|
| 1                          | 433.866                          | 433.930                          | 63.90                       | 1084.5         | 1020.6          |

Where:  $F_L$  = is the lower edge of the OBW  
 $F_H$  = is the upper edge of the OBW

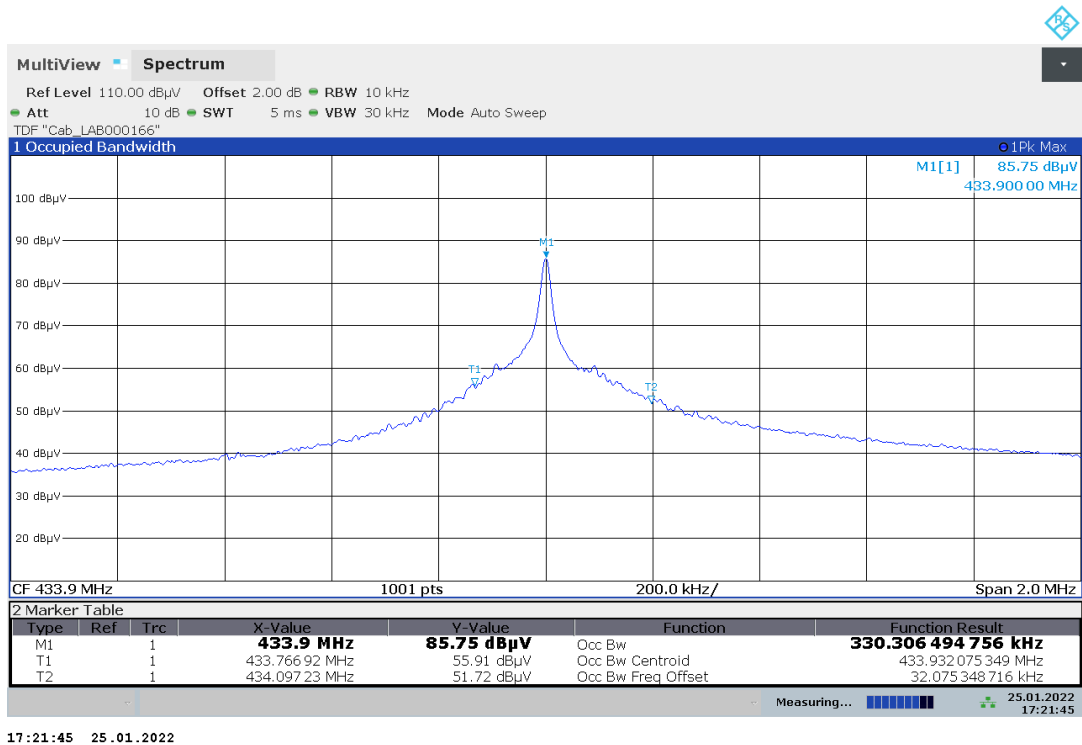
|                |                 |                                       |
|----------------|-----------------|---------------------------------------|
| <b>Verdict</b> | <b>- PASS -</b> | Measurement plot(s) see next page(s). |
|----------------|-----------------|---------------------------------------|

|                |  |
|----------------|--|
| <b>Comment</b> |  |
|----------------|--|

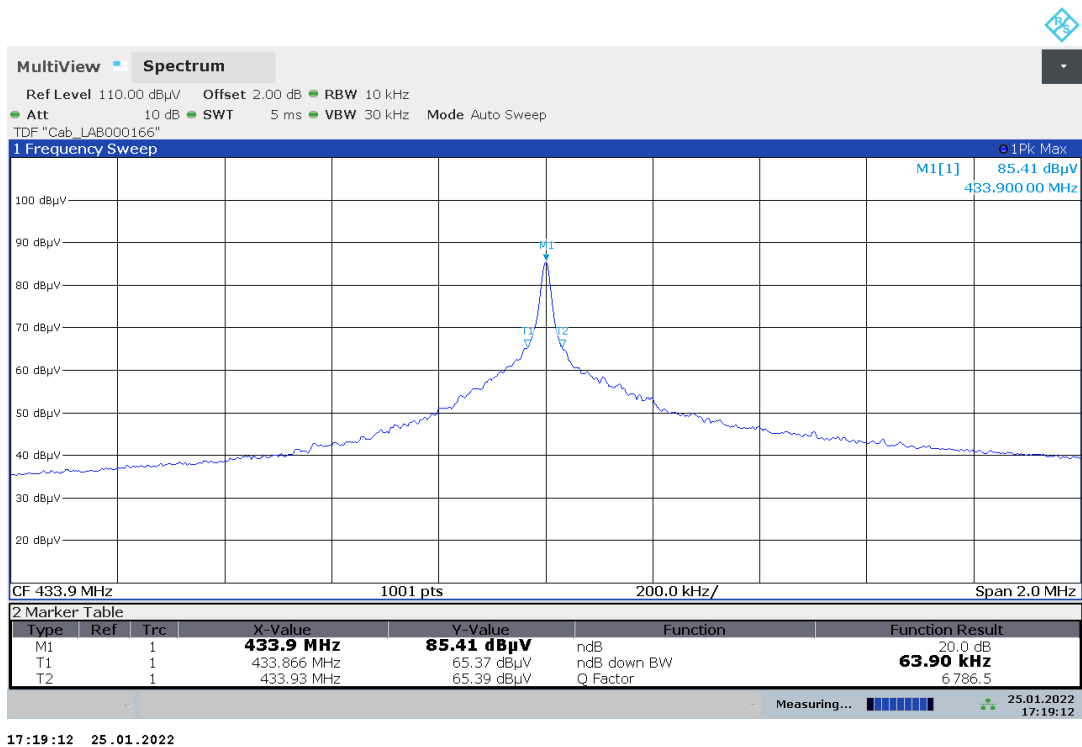
TR no.: **21065815-24571-0**

**2022-03-01**

Plot No. 7: 99 % Occupied Bandwidth



Plot No. 8: 20 dB Bandwidth



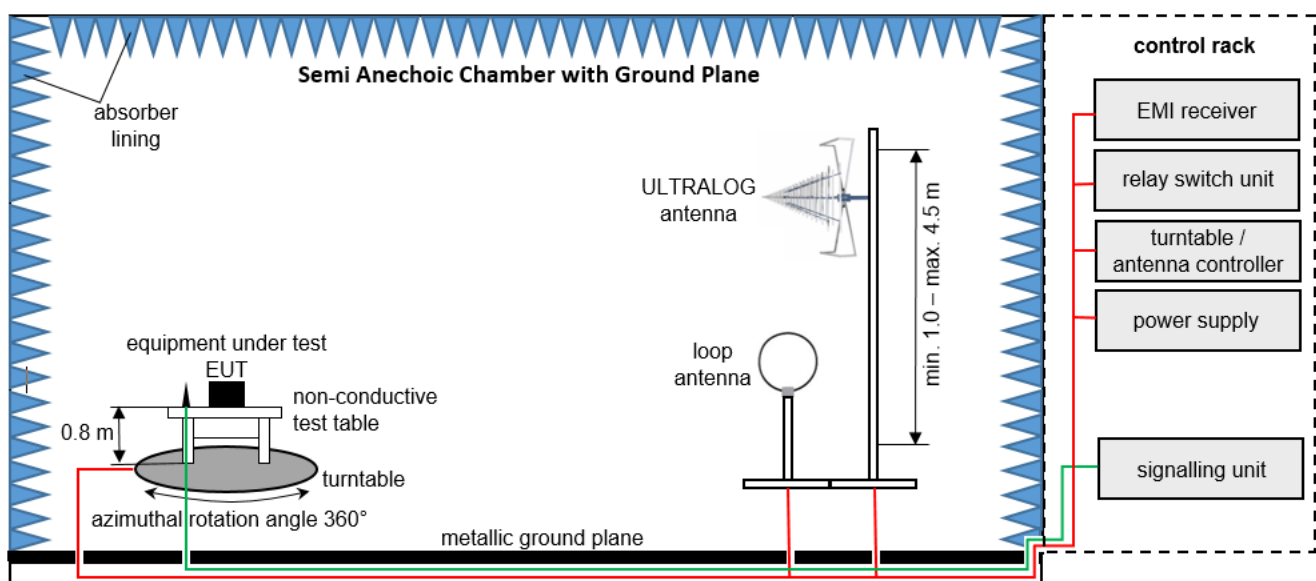
## 8 Test Setup Description

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Cyclically chamber inspections and range calibrations are performed. Where possible resp. necessary, RF generating and signalling equipment as well as measuring receivers and analysers are connected to an external high-precision 10 MHz reference (GPS-based frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

## 8.1 Semi Anechoic Chamber with Ground Plane

Radiated measurements are performed in vertical and horizontal plane in the frequency range 30 MHz to 1 GHz in a Semi Anechoic Chamber with a metallic ground plane. The EUT is positioned on a non-conductive test table with a height of 0.80 m above the metallic ground plane that covers the whole chamber. The receiving antennas conform to specification ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices. These antennas can be moved over the height range between 1.0 m and 4.5 m in order to search for maximum field strength emitted from the EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by a spectrum analyzer where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: ULTRALOG antenna 3 m; loop antenna 3 m  
EMC32 software version: 11.10.00

$FS = UR + CL + AF$

(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:

$FS [dB\mu V/m] = 12.35 [dB\mu V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB\mu V/m] (35.69 \mu V/m)$

### List of test equipment used:

| No. | Equipment                        | Manufacturer                    | Type                           | Serial No.   | IBL No.   | Kind of Calibration | Calibration                   |
|-----|----------------------------------|---------------------------------|--------------------------------|--------------|-----------|---------------------|-------------------------------|
| 1   | Power Supply                     | Elektro-Automatik GmbH & Co. KG | EA-PSI 9080-40 T               | 2000230001   | LAB000313 | NE                  | –                             |
| 2   | Test table                       | innco systems GmbH              | PT1208-080-RH                  | -            | LAB000306 | NE                  | –                             |
| 3   | Power Supply                     | Chroma                          | 61604                          | 616040005416 | LAB000285 | NE                  | –                             |
| 4   | Positioner                       | matur GmbH                      | TD 1.5-10KG                    |              | LAB000258 | NE                  | –                             |
| 5   | Compressed Air                   | Implotex                        | 1-850-30                       | -            | LAB000256 | NE                  | –                             |
| 6   | EMI Test Receiver                | Rohde & Schwarz                 | ESW26                          | 101481       | LAB000236 | K                   | 2021-07-01 → 12M → 2022-07-01 |
| 78  | Semi-Anechoic Chamber (SAC)      | Albatross Projects GmbH         | Babylon 5 (SAC 5)              | 20168.PR.B   | LAB000235 | NE                  | –                             |
| 9   | Measurement Software             | Rohde & Schwarz                 | EMC32 V11.20                   |              | LAB000226 | NE                  | –                             |
| 10  | Turntable                        | matur GmbH                      | TT2.0-2t                       | TT2.0-2t/921 | LAB000225 | NE                  | –                             |
| 11  | Antenna Mast                     | matur GmbH                      | CAM4.0-P                       | CAM4.0-P/316 | LAB000224 | NE                  | –                             |
| 12  | Antenna Mast                     | matur GmbH                      | BAM4.5-P                       | BAM4.5-P/272 | LAB000223 | NE                  | –                             |
| 132 | Controller                       | matur GmbH                      | FCU 3.0                        | 10082        | LAB000222 | NE                  | –                             |
| 14  | Power Supply                     | Elektro-Automatik GmbH & Co. KG | EA-PS 2042-10 B                | 2878350292   | LAB000191 | NE                  | –                             |
| 14  | Pre-Amplifier                    | Schwarzbeck Mess-Elektronik OHG | BBV 9718 C                     | 84           | LAB000169 | NE                  | –                             |
| 15  | Antenna                          | Rohde & Schwarz                 | HF907                          | 102899       | LAB000151 | K                   | 2020-04-23 → 36M → 2023-04-23 |
| 16  | Antenna                          | Rohde & Schwarz                 | HL562E                         | 102005       | LAB000150 | K                   | 2020-07-05 → 36M → 2023-07-05 |
| 17  | Open Switch and Control Platform | Rohde & Schwarz                 | OSP200 Base Unit 2HU           | 101748       | LAB000149 | NE                  | –                             |
| 18  | Antenna                          | Rohde & Schwarz                 | HF907                          | 102898       | LAB000124 | K                   | 2020-04-23 → 36M → 2023-04-23 |
| 19  | Antenna                          | Rohde & Schwarz                 | HL562E                         | 102001       | LAB000123 | K                   | 2020-07-05 → 36M → 2023-07-05 |
| 20  | Antenna                          | Rohde & Schwarz                 | HFH2-Z2E - Active Loop Antenna | 100954       | LAB000108 | K                   | 2020-03-25 → 36M → 2023-03-25 |

## 9 Measurement procedures

### 9.1 Radiated spurious emissions from 9 kHz to 30 MHz

#### Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.  
In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, ... necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, ... are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

#### Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- For each turntable step the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

#### Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated with special 3D adapter set to find maximum level of emissions.
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position and settings of measuring equipment is recorded.

#### Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade of distance in the region closer than  $\lambda$  in m divided by  $2\pi$  (i.e.,  $\lambda/2\pi$ ), and at 20 dB/decade of distance beyond that, using the measurement of a single point at the radial angle that produces the maximum emission.  
This correction is already included in the limit line of corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

## 9.2 Radiated spurious emissions from 30 MHz to 1 GHz

### Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.  
In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, ... necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, ... are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

### Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable step / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

### Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

### Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region  $\lambda$  in m divided by  $2\pi$  (i.e.,  $\lambda/2\pi$ ), using the measurement of a single point at the radial angle that produces the maximum emission.  
This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

### 9.3 Radiated spurious emissions from 1 GHz to 18 GHz

#### Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.  
In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, ... necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, ... are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

#### Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable step / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

#### Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

#### Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region  $\lambda$  in m divided by  $2\pi$  (i.e.,  $\lambda/2\pi$ ), using the measurement of a single point at the radial angle that produces the maximum emission.  
This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

## 10 MEASUREMENT UNCERTAINTIES

|                               |                   |
|-------------------------------|-------------------|
| Radio frequency               | $\leq \pm 10$ ppm |
| Radiated emission             | $\leq \pm 6$ dB   |
| Temperature                   | $\leq \pm 1$ °C   |
| Humidity                      | $\leq \pm 5$ %    |
| DC and low frequency voltages | $\leq \pm 3$ %    |

The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor  $k = 2$ . It was determined in accordance with EA-4/01 m:2013. The true value is located in the corresponding interval with a probability of 95 %.