**FCC ID: KR5FBD4** **IC: 7812D-FBD4**

# EMI – TEST REPORT

**- FCC Part 15.231 -**

| **Test Report No. :** **T39156-05-00HS** | 01. June 2015<br>Date of issue |
|---|---|

**Type / Model Name** : BMW FBD4 TRX

**Product Description** : Keyless entry system

**Applicant** : Continental Automotive GmbH

Address : Osterhofener Str. 14

93055 REGENSBURG, GERMANY

**Manufacturer** : Continental Automotive GmbH

Address : Osterhofener Str. 14

93055 REGENSBURG, GERMANY

**Licence holder** : Continental Automotive GmbH

Address : Osterhofener Str. 14

93055 REGENSBURG, GERMANY

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

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12030-01-00

# Contents

# 1 TEST STANDARDS

The tests were performed according to following standards:

**FCC Rules and Regulations Part 15, Subpart A - General (September, 2014)**

| | |
|---|---|
| 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 (September, 2014)**

| | |
|---|---|
| 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 15.231 | Periodic operation in the band 40.66-40.70 MHz and above 70 MHz |
| ANSI C63.4: 2009 | Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| CISPR 16-4-2: 2013 | Uncertainty in EMC measurement |

# 2 EQUIPMENT UNDER TEST

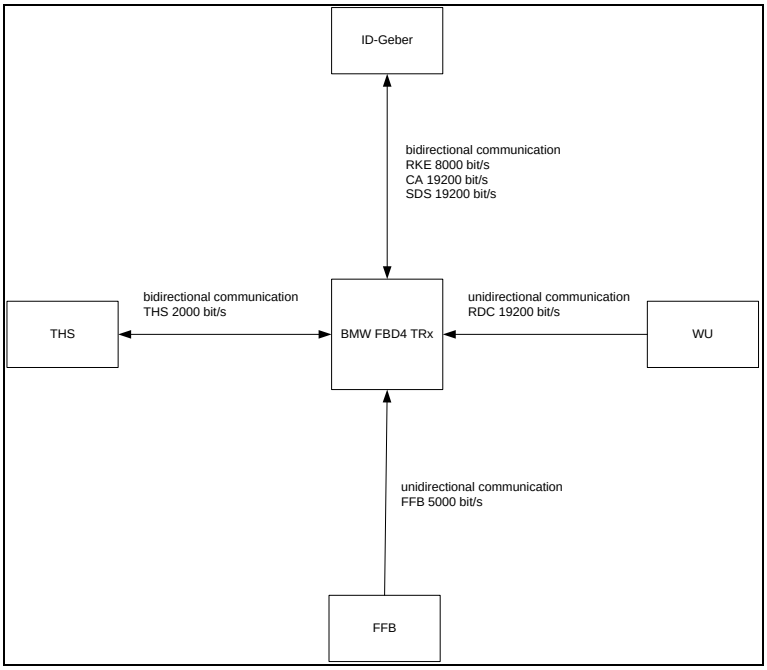
## 2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

## 2.2 Equipment type

Keyless entry system

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

The EUT is a remote keyless entry system fix installed in the car. The EUT supports 2 channels. The EUT is manually operated. Additionally the EUT is a receiver for wire pressure surveillance and get the information from all four (WU) “wire units”. A font remote control uses also the receiver of the unit to address the appropriate function unit. The (THS) “Telestarthandsender” use a bidirectional communication with the EUT.
System overview:




| | |
|---|---|
| Number of tested samples: | 1 unmodulated radiated sample, 1 modulated conducted sample, 1 sample in normal mode, radiated; |
| Serial number: | 161214, pre-production sample, 161227; |
| Firmware version: | 4.90 |

## 2.4 Variants of the EUT

There are no variants.

## 2.5 Operation frequency and channel plan

The operating frequency is 433 MHz.

Channel plan:

| Channel | Frequency (MHz) |
|---|---|
| 1 | 433.20 |
| 2 | 434.64 |

## 2.6 Antenna

The following integrated antenna is used with the EUT:

| Number | Characteristic | Model number | Plug | Frequency range (MHz) |
|---|---|---|---|---|
| 1 | Wire-antenna | - | no | 433 |

## 2.7 Transmit operating modes

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

- TX continuous mode

- TX normal mode

## 2.8 Power supply system utilised

Power supply voltage, $V_{nom}$ : 12 VDC (car-battery)

## 2.9 Extreme test conditions

The extreme temperature range for the EUT is:
Defined by the manufacturer: -40 °C to +85 °C, $T_{nom}$ = 20 °C;

## 2.10 Peripheral devices and interface cables

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

- - Model : -
- Model :
- Model :

## 2.11 Determination of worst case conditions for final measurement

Measurements have been made in two orthogonal axes to locate at which position of the EUT produce the maximum of the emissions. For the further measurement the EUT is mounted on metal plate to simulate the real environmental conditions and set in Y position with the following power setting: P97.

Decision for the worst case mode of the EUT:
- For final measurement the communication with the “ID-Geber” is selected because of the highest output power. Transmission ID-Geber → FBD4 TRX (DC correction factor 19.1.dB).
- The communication with THS has a duty cycle correction factor of 9.3 dB. This kind of transmission is identified by the EUT and therefore output power reduced. The acknowledge on this THS-request is only extreme short range transmission where very low power is sufficient. In this mode, the transmit power is reduced by more than 10 dB; therefore this mode provides a lower average power, despite the increased duty cycle. This is the reason why this case was not tested.

### 2.11.1 Test Jig

The conducted measurements are performed under support of a temporary connector.
Radiated measurements are performed under simulated environmental conditions (metal plate) and using the original antenna.

### 2.11.2 Test software

No test software for the EUT is needed. The test-samples are appropriate prepared for the measurements to operate by connect to supply voltage.

# 3 TEST RESULT SUMMARY

| FCC Rule Part | RSS Rule Part | Description | Result |
|---|---|---|---|
| 15.207(a) | RSS Gen, 8.8 | AC power line conducted emissions | not applicable |
| 15.231(b) | RSS210, A1.1.2 | Field strength of the fundamental wave | passed |
| 15.231(b) | RSS-Gen, 6.4 | Spurious emissions (magnetic field) 9 kHz – 30 MHz | passed |
| 15.231(b) | RSS-Gen, 6.5 | Spurious emissions radiated (electric field) | passed |
| 15.231(c) | RSS-Gen, 6.10 | Correction for pulse operation (duty cycle) | passed |
| 15.215(c) | RSS-Gen, 6.11 | Frequency stability | passed |
| 15.231(a1) | RSS210, A1.1.1 | Signal deactivation | passed |
| - | RSS210, A1.1.3 | Emission bandwidth and OBW99 | passed |

The mentioned RSS Rule Parts in the above table are related to:
RSS Gen, Issue 4, November 2014
RSS 210, Issue 8, December 2010

## 3.1 Final assessment:

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

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

Testing commenced on : 26 February 2015

Testing concluded on : 25 March 2015

Checked by:

Eduard Stangl
I confirm the correctness and integrity of this document
2015.06.02 14:36:04 +02'00'

Eduard Stangl
Technical Director

Tested by:

Hermann Smetana
I am the author of this document
2015.06.01 09:35:45 +02'00'

Hermann Smetana
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 acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

## 4.4 Measurement Protocol for FCC and IC

### 4.4.1 GENERAL INFORMATION

4.4.1.1 Test methodology

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

**IC 3009A**

In compliance with RSS 210 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.1.3 General Standard information

The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

### 4.4.2 Conducted emission

Description of measurement

The final level in dBµV is taken directly from the EMI receiver. This level is compared to the FCC limit or to the CISPR limit.

To convert dBµV to µV, the following conversions apply:

dBµV = 20*log (µV);
µV = 10^ (dBµV/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 50Ω/50 µH (CISPR 16) characteristics. 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 of a peak mode measurement appears to be less than 20 dB, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

### 4.4.3 Radiated emission (electrical field 30 MHz - 1 GHz)

Description of measurement

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. The setup of the equipment under test is established in accordance with ANSI C63.4.The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. 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 add the correction factors and cable loss factor (dB) to the reading from the EMI receiver (Level dBµV). The FCC or CISPR 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 (MHz) | Level (dBµV) | + | Factor (dB) | = | Level (dBµV/m) | - | CISPR Limit (dBµV/m) | = | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 719.0 | 75.0 | + | 32.6 | = | 107.6 | - | 110.0 | = | -2.4 |

### 4.4.4 Radiated emission (electrical field 1 GHz - 40 GHz)

Description of measurement

Radiated emissions from the EUT are measured in the frequency range 1 GHz up to the maximum frequency 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 1.0 X 1.5 metre non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.4. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyser set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak and 10 Hz for average measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface of the four equipment sides. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty and are calculated at the specified test distance.

# 5 TEST RESULTS

## 5.1 Conducted emissions

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

### 5.1.1 Description of the test location

Test location: NONE

**Remarks:** Not applicable the EUT is power supplied by car battery.

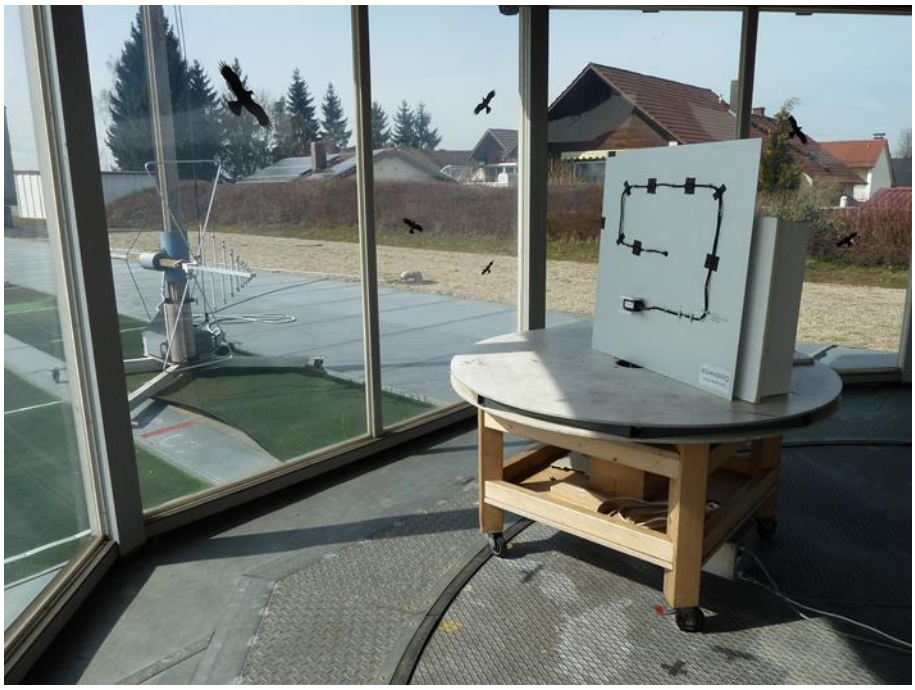
## 5.2 Field strength of the fundamental wave

For test instruments and accessories used see section 6 Part **CPR 2**.

### 5.2.1 Description of the test location

Test location: OATS 1
Test distance: 3 m

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



### 5.2.1 Applicable standard

According to FCC Part 15C, Section 15.231(b):
The field strength of emissions from intentional radiators shall not exceed the effective field strength limits.

### 5.2.2 Description of Measurement

The radiated field strength of the fundamental wave from the EUT is measured using a tuned EMI-receiver. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.4, Item 8.3. The EUT is measured in TX continuous mode, unmodulated, under normal conditions.

EMI test receiver settings:
30 MHz – 1000 MHz: RBW: 120 kHz

### 5.2.3 Test result

| Frequency | Level Pk | Limit Pk | DC corr. | Level AV | AV Limit 433.2 MHz | Delta |
|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | dB(µV/m) | (dB) | dB(µV/m) | dB(µV/m) | (dB) |
| 433.20 | 97.8 | 100.8 | 19.1 | 78.7 | 80.8 | -2.1 |
| 434.64 | 98.4 | 100.8 | 19.1 | 79.3 | 80.8 | -1.5 |

Limit according to FCC Section 15.231(b):

| Frequency | Field strength at 3 m | | Effective limit for 433.2 MHz | |
|---|---|---|---|---|
| (MHz) | (µV/m) | dB(µV/m) | (µV/m) | dB(µV/m) |
| 40.66 – 40.70 | 2250 | 67 | | |
| 70 - 130 | 1250 | 62 | | |
| 130 - 174 | 1250 to 3750* | 62 to 71.4* | | |
| 174 - 260 | 3750 | 71,4 | | |
| **260 - 470** | **3750 to 12500*** | **71.4 to 81.9*** | **10967** | **80.8** |
| Above 470 | 1250 | 61.9 | | |

*Linear interpolation

The requirements are **FULFILLED.**

**Remarks:** _____

_____

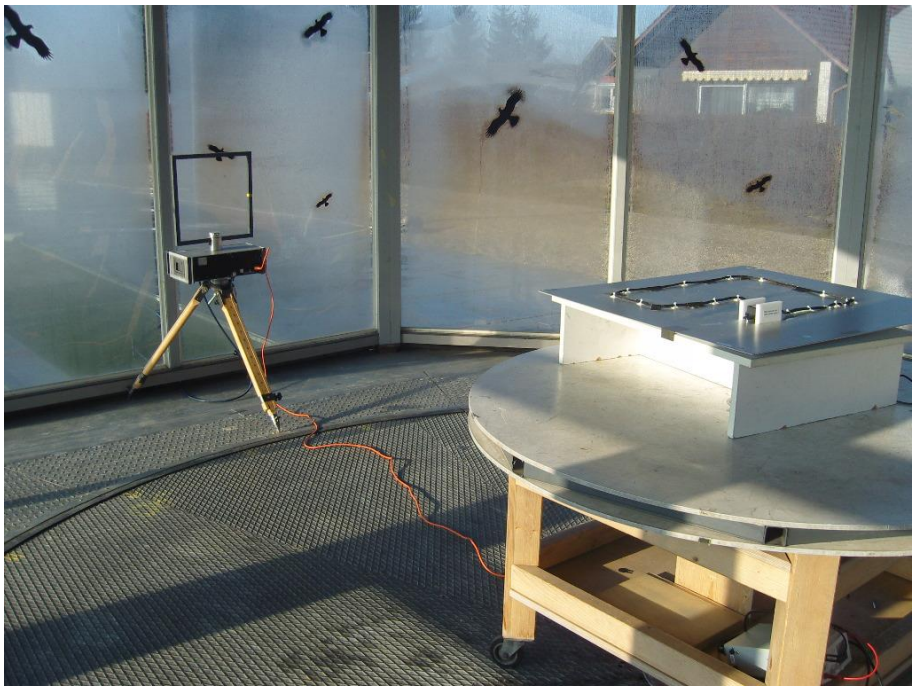
## 5.3 Spurious emissions (magnetic field) 9 kHz – 30 MHz

For test instruments and accessories used see section 6 Part **SER 1**.

### 5.3.1 Description of the test location

Test location: OATS 1
Test distance: 3 m

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



### 5.3.3 Applicable standard

According to FCC Part 15C, Section 15.209:
The emissions from intentional radiators shall not exceed the field strength limits for spurious emissions in the table.

### 5.3.4 Description of Measurement

The magnetic field strength of spurious emission from the EUT is measured in an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.4, Item 8.3. The EUT is measured in TX continuous mode, unmodulated, under normal conditions.
According to Section 15.31 (f) (2): The measurement below 30 MHz is performed at a distance of 3 m. The results are extrapolated to the specified distance by using the square of an inverse linear distance extrapolation factor of 40 dB/decade.

The resolution bandwidth during the measurement is as follows:
9 kHz – 150 kHz: RBW: 200 Hz
150 kHz – 30 MHz: RBW: 9 kHz

### 5.3.5 Test result

| Frequency | Level QP | Bandwidth | Correct. factor | Corrected level | Effective limit | Delta |
|---|---|---|---|---|---|---|
| (MHz) | (dBµV) | (kHz) | (dB) | dB(µV/m) | dB(µV/m) | (dB) |
| 7.9 | 3.4 | 9 | 60 | -56.6 | 29.5 | -86.1 |
| 27.6 | 1.8 | 9 | 60 | -58.2 | 29.5 | -87.7 |

Note: The level above means the noise level in the band. No emission could be detected.

Limit according to FCC Part 15C Section 15.209(a):

| Frequency | Field strength of spurious emissions | | Measurement distance |
|---|---|---|---|
| (MHz) | (µV/m) | dB(µV/m) | (metres) |
| 0.009-0.490 | 2400/F(kHz) | -- | 300 |
| 0.490-1.705 | 24000/F (kHz) | -- | 30 |
| 1.705-30.0 | 30 | 29.5 | 30 |

The requirements are **FULFILLED.**

**Remarks:** _____

_____

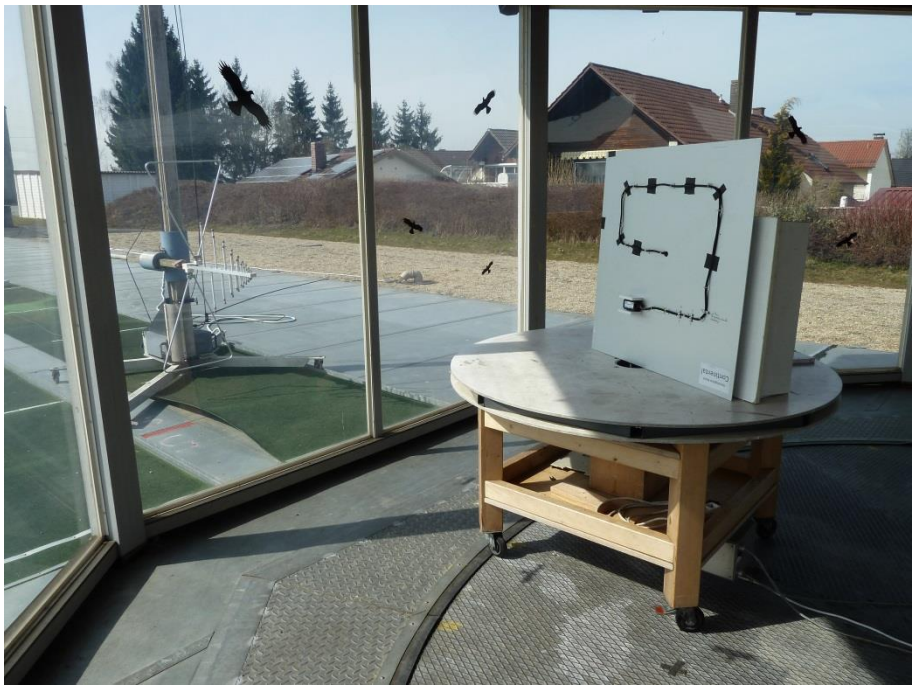
## 5.4 Spurious emissions radiated (electric field)

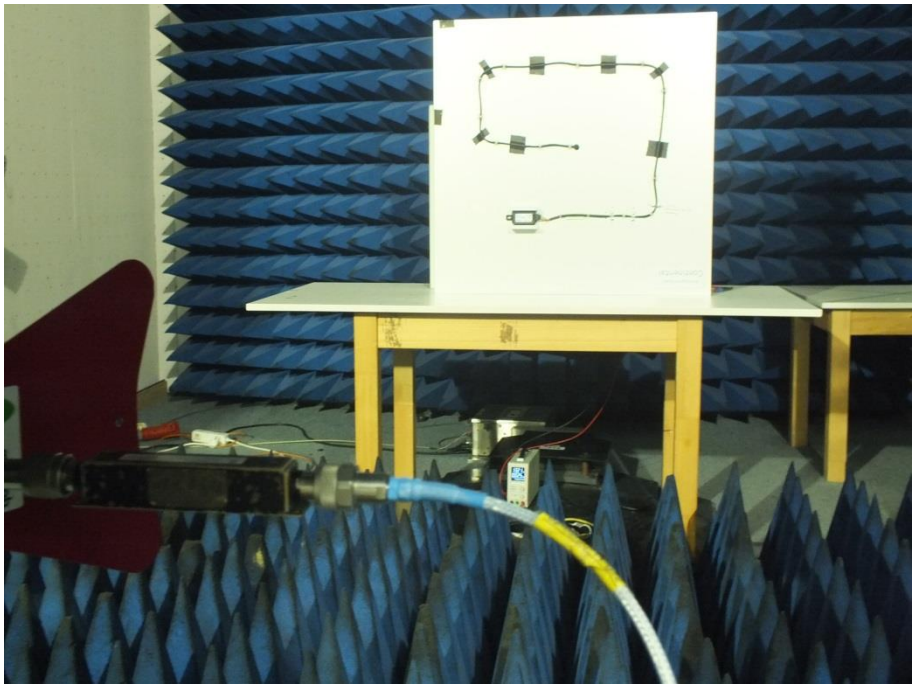
For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

### 5.4.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 2
Test distance: 3 m

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





### 5.4.3 Applicable standard

According to FCC Part 15C, Section 15.231(b), Section 15.209(a) and Section 15.205(a):
The emissions from intentional radiators shall not exceed the effective field strength limits.

### 5.4.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.4, Item 8.3. The highest emission level of the EUT in peak mode is reported. If they do not comply with the average limit, then the duty cycle correction factor will be subtracted and verified with the average limits.
Instrument settings:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 4500 MHz RBW: 1 MHz

### 5.4.5 Test result f < 1 GHz

| Frequency (MHz) | Level QP (dBµV) | Bandwidth (kHz) | Correct. factor (dB) | Corrected level dB(µV/m) | Effective limit dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|
| 866.4 | 16.4 | 120 | 32.9 | 49.3 | 60.8 | -11.5 |
| 869.3 | 17.3 | 120 | 33.0 | 50.3 | 60.8 | -10.5 |

Note: Correct. Factor includes antenna correction and the correction for distance.

### 5.4.6 Test result f > 1 GHz

**Channel1:**

| Frequency (MHz) | Bandwidth (kHz) | Level PK dB(µV/m) | Limit PK dB(µV/m) | Delta to PK Limit (dB) | DC Correction (dB) | Level AV dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 3034 | 1000 | 66.8 | 80.8 | -14.0 | 19.1 | 47.7 | 60.8 | -13.1 |
| 3466 | 1000 | 55.5 | 80.8 | -25.3 | 19.1 | 36.4 | 60.8 | -24.4 |
| 3904 | 1000 | 59.7 | 80.8 | -21.1 | 19.1 | 40.6 | 60.8 | -20.2 |
| 4332 | 1000 | 57.2 | 80.8 | -23.6 | 19.1 | 38.1 | 60.8 | -22.7 |

Note. DC correction means the duty cycle correction factor, calculated under item 5.5.,

**Channel2:**

| Frequency (MHz) | Bandwidth (kHz) | Level PK dB(µV/m) | Limit PK dB(µV/m) | Delta to PK Limit (dB) | DC Correction (dB) | Level AV dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 3046 | 1000 | 68.2 | 80.8 | -12.6 | 19.1 | 49.1 | 60.8 | -11.7 |
| 3478 | 1000 | 57.7 | 80.8 | -23.1 | 19.1 | 38.6 | 60.8 | -22.2 |
| 3916 | 1000 | 59.6 | 80.8 | -21.2 | 19.1 | 40.5 | 60.8 | -20.3 |
| 4347 | 1000 | 59.1 | 80.8 | -21.7 | 19.1 | 40.0 | 60.8 | -20.8 |

Limit according to FCC Section 15.231(b), Section 15.209(a) and Section 15.205(a):

| Frequency | Field strength of spurious emissions | | **Effective limit for 433.2 MHz** | |
|---|---|---|---|---|
| (MHz) | (µV/m) | dB(µV/m) | (µV/m) | dB(µV/m) |
| 40.66 – 40.70 | 225 | 47 | | |
| 70 - 130 | 125 | 42 | | |
| 130 - 174 | 125 to 375* | 42 to 51.4* | | |
| 174 - 260 | 375 | 51,4 | | |
| **260 - 470** | **375 to 1250*** | **51.4 to 61.9*** | **1097** | **60.8** |
| Above 470 | 1250 | 61.9 | | |

*Linear interpolation

Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in the table above or to the general limits shown in the table below according to § 15.209, whichever limit permits a higher field strength.

| Frequency (MHz) | 15.209 Limits (µV/m) | 15.209 Limits dB(µV/m) |
|---|---|---|
| 30 - 88 | 100 | 40 |
| 88 - 216 | 150 | 43,5 |
| 216 - 960 | 200 | 46 |
| Above 960 | 500 | 54 |

Additionally there is a limit according to §15.35(b) on the radio frequency emissions, as measured with a peak detector, corresponding to 20 dB above the maximum permitted average limits.

The requirements are **FULFILLED.**

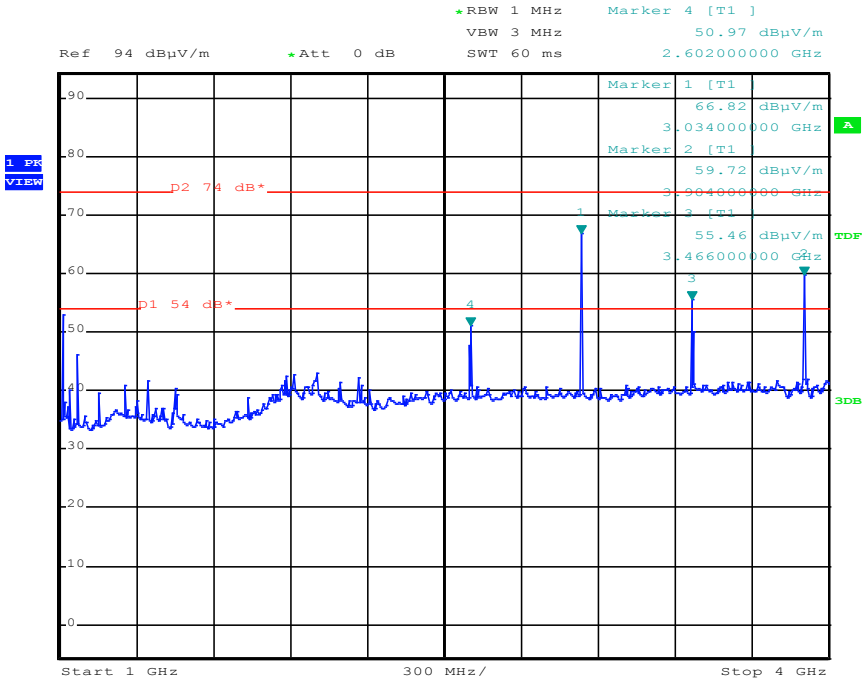
**Remarks:** The measurement was performed up to the 10th harmonic.

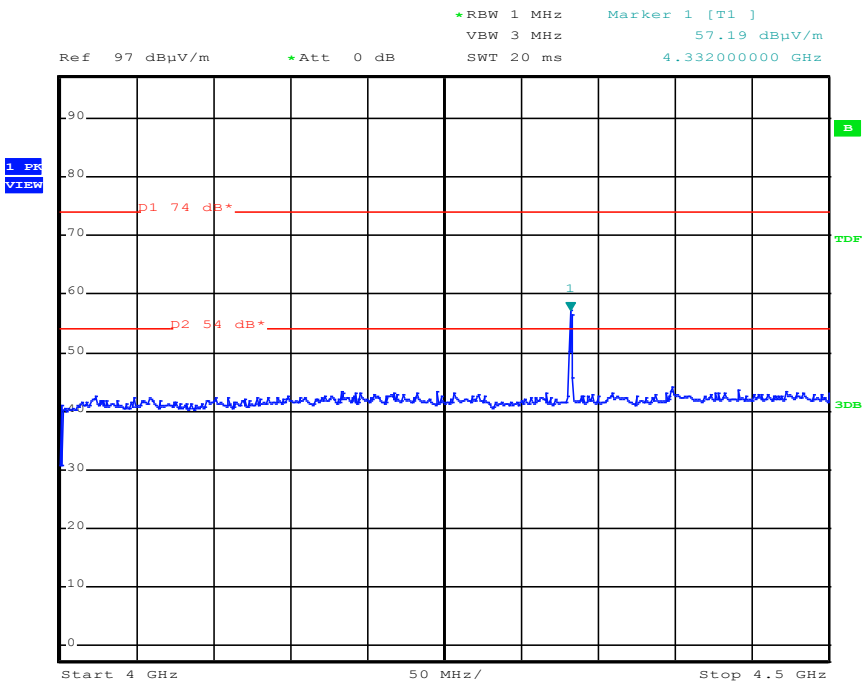
For detailed test results please see the following test protocols.

### 5.4.7 Test protocol spurious emissions

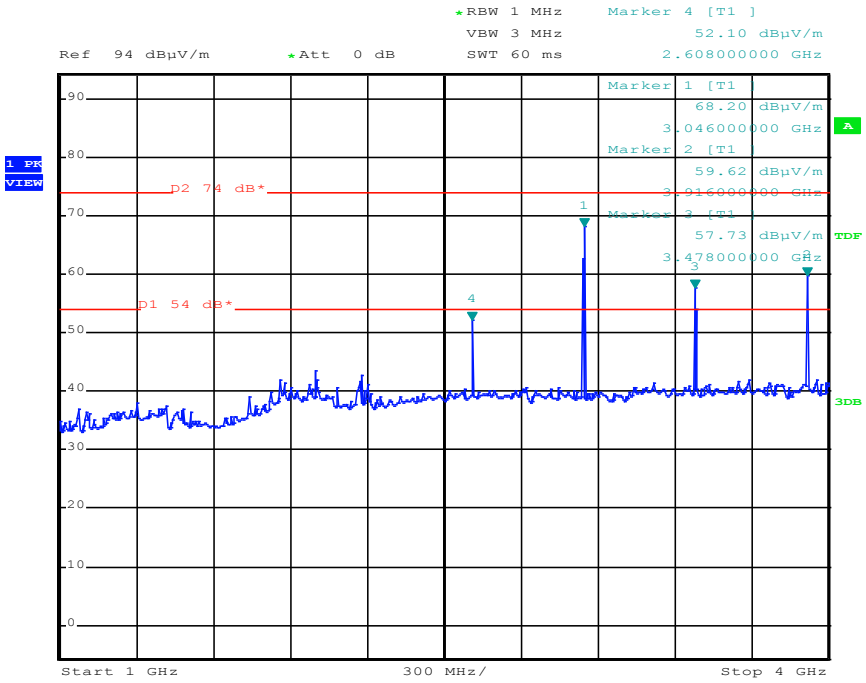
**f > 1 GHz:**

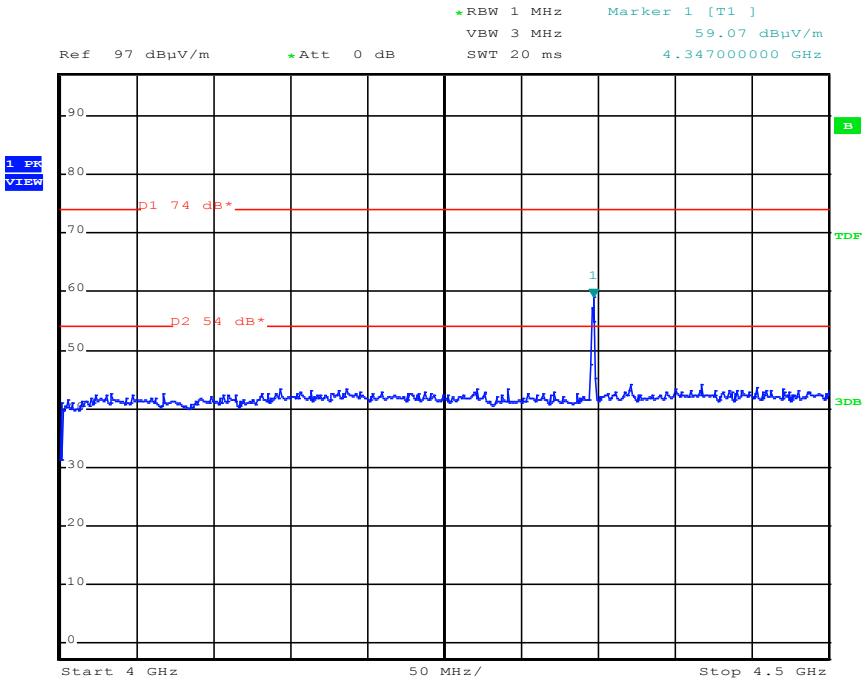
**Channel 1**



## Channel 2


RBW 1 MHz
VBW 3 MHz
SWT 60 ms
Marker 4 [T1 ]
52.10 dBµV/m
2.608000000 GHz
Ref 94 dBµV/m
Att 0 dB
Marker 1 [T1 ]
68.20 dBµV/m
3.046000000 GHz
Marker 2 [T1 ]
59.62 dBµV/m
3.916000000 GHz
Marker 3 [T1 ]
57.73 dBµV/m
3.478000000 GHz
p2 74 dB*
p1 54 dB*
Start 1 GHz
300 MHz/
Stop 4 GHz


RBW 1 MHz
VBW 3 MHz
SWT 20 ms
Marker 1 [T1 ]
59.07 dBµV/m
4.347000000 GHz
Ref 97 dBµV/m
Att 0 dB
p1 74 dB*
p2 54 dB*
Start 4 GHz
50 MHz/
Stop 4.5 GHz

## 5.5 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **DC**.

### 5.5.1 Description of the test location

Test location: NONE

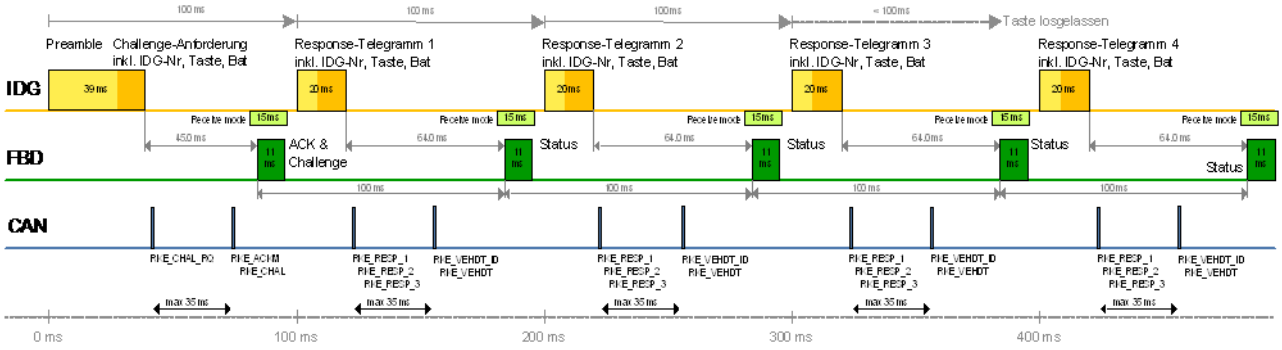
### 5.5.2 Applicable standard

According to FCC Part 15C, Section 15.35(c):
The emissions from intentional radiators shall not exceed the effective field strength limits.

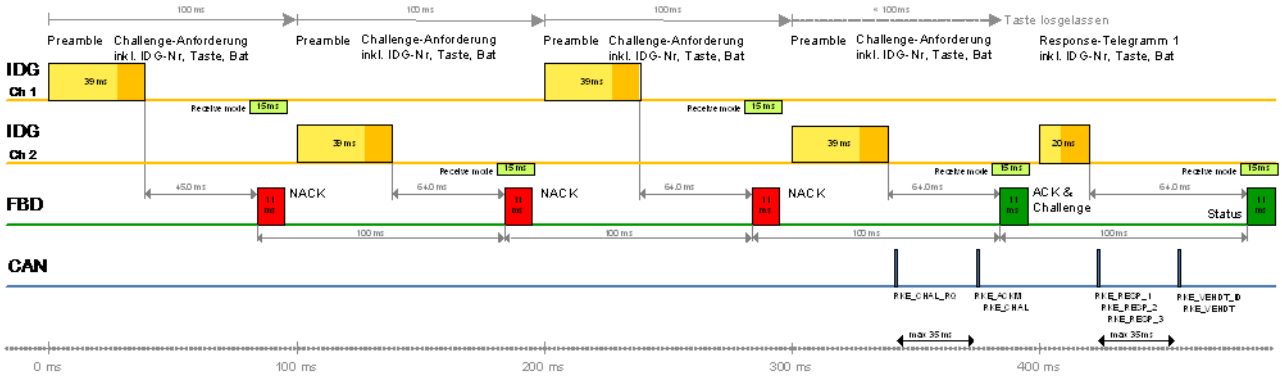
### 5.5.3 Test result

The EUT supports several services with different duty cycle. The worst case in communication with FDB4 TRX means the following telegrams (customer declared):

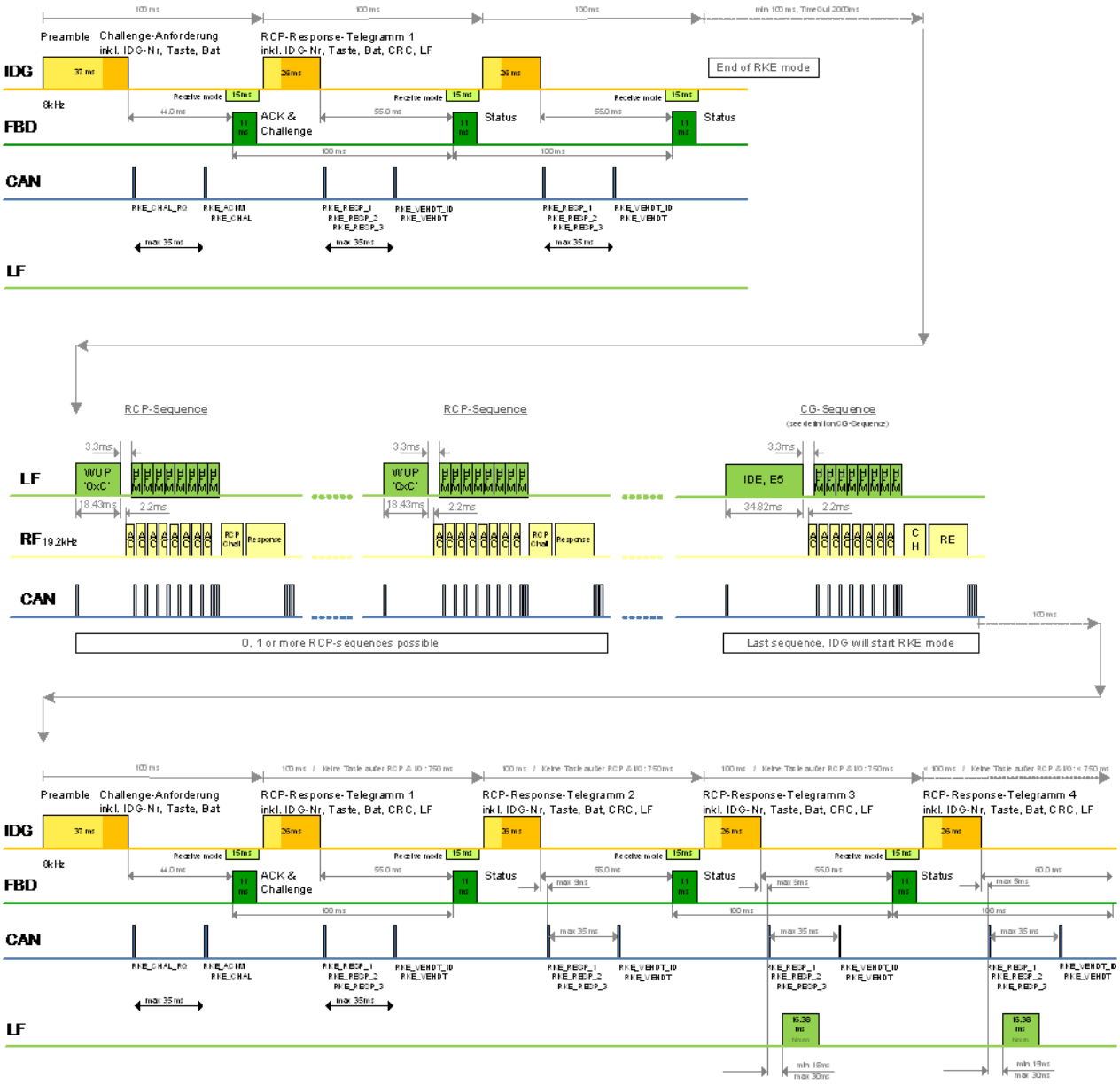
**"Challenge Response (8 kBit/s)"**




**"Challenge Response repeating strategy with channel switching"**



**“Remote Controlled Parking / with RKE Sequence”**



| Acknowledge with challenge | |
|---|---|
| **Preamble** | 16 bit |
| **Data** | 8.5 byte = 68 bit |
| **Code violation** | 2*2bit = 4 bit |
| **Sum** | 88 bit => 11ms (@ 8 kBit/s) |

**Averaging Factor:**
Considering the minimum possible period of acknowledge with challenge telegrams (regarding the sequence: Challenge Response; Challenge Response repeating strategy with channel switching; Remote Controlled Parking / with RKE Sequence), the FBD4 could send each 100 ms acknowledge with challenge telegram.

- Acknowledge with challenge = 11 ms
- 1 acknowledge with challenge telegram could be within the 100 ms window.
- Duty cycle correction factor is **19.1 dB**.

**Remarks:** The pulse train exceeds 100 ms, therefore the duty cycle has been calculated within 100 ms.

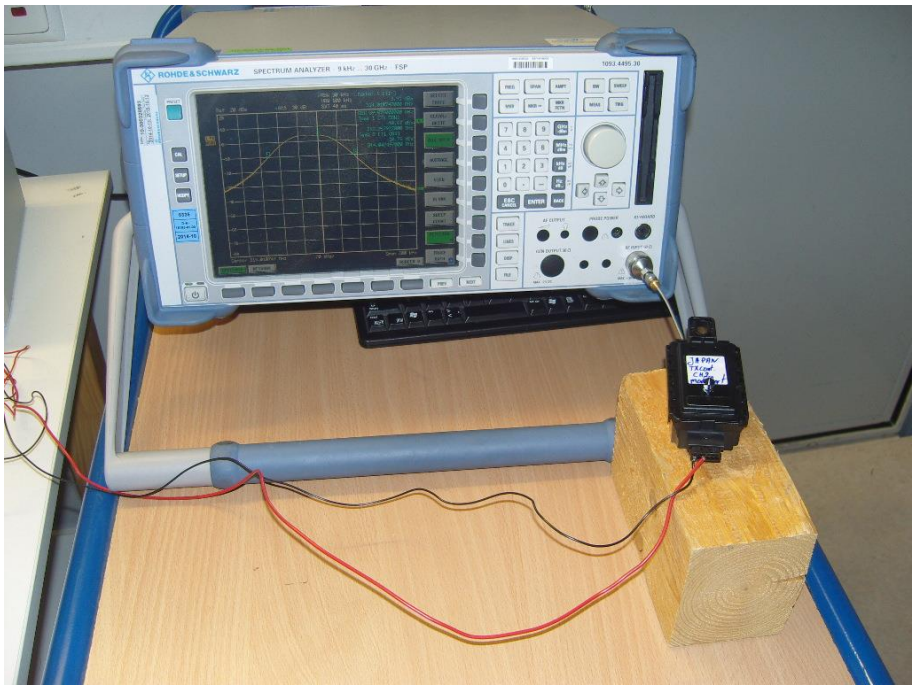
## 5.6 Emission bandwidth and OBW99

For test instruments and accessories used see section 6 Part **MB**.

### 5.6.1 Description of the test location

Test location: AREA4

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




### 5.6.3 Applicable standard

According to FCC Part 15C, Section 15.231(c):
The bandwidth of the emission shall not exceed the effective limits.

### 5.6.4 Description of Measurement

The measurement is performed conducted using a spectrum analyser. The analyser span is set wide enough to capture the most of the power envelope of the signal. The function “20-dB-down” (OBW 99% for RSS) is used to determine the BW.

Analyser settings:
Span: 100 kHz, RBW: 1 kHz VBW: 3 kHz Detector: peak;

**For RSS:**
Span: 100 kHz, RBW: 1 kHz VBW: 3 kHz Detector: peak;

### 5.6.5 Test result

| Centre *f* (MHz) | 20dB bandwidth $f_1$ | 20dB bandwidth $f_2$ | Measured EBW (MHz) | Limit (*f**0.0025)(MHz) |
|---|---|---|---|---|
| 433.203800 | 433.186800 | 433.220800 | 0.034000 | 1.083010 |
| 434.643375 | 434.626375 | 434.660375 | 0.034000 | 1.086608 |

| Centre *f* (MHz) | 99% bandwidth $f_1$ | 99% bandwidth $f_2$ | Measured OBW (MHz) | Limit (*f**0.0025)(MHz) |
|---|---|---|---|---|
| 433.203850 | 433.187100 | 433.220600 | 0.033500 | 1.083010 |
| 434.643200 | 434.626512 | 434.659887 | 0.033375 | 1.086608 |

Limit according to FCC Part 15C Section 15.231(c):

| Frequency (MHz) | 20 dB BW limit dependent of the carrier (%) |
|---|---|
| **70 – 900** | **0.25** |
| above 900 | 0.50 |

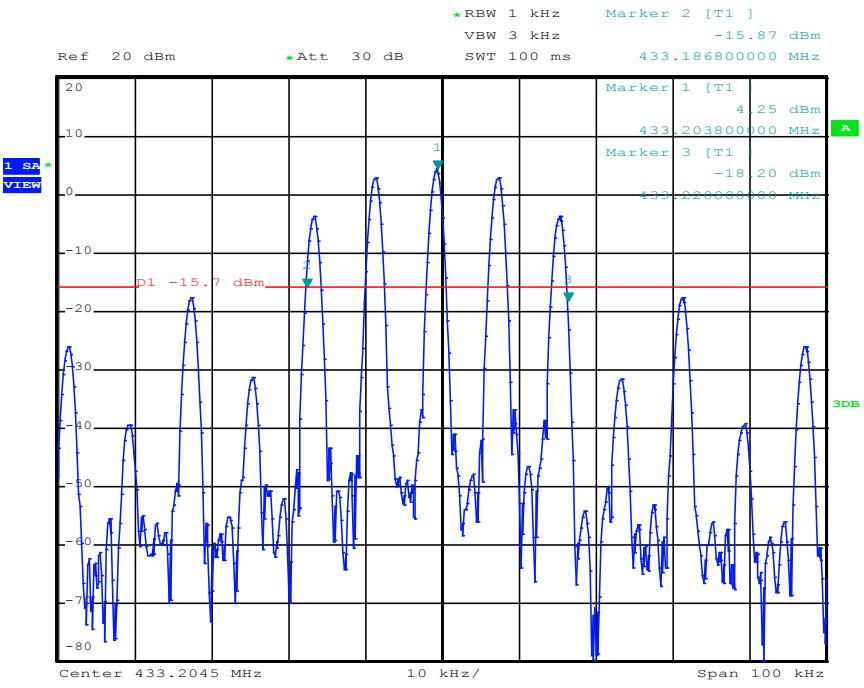
The bandwidth of the emission shall be no wider than 0.25% of the centre frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

The requirements are **FULFILLED.**

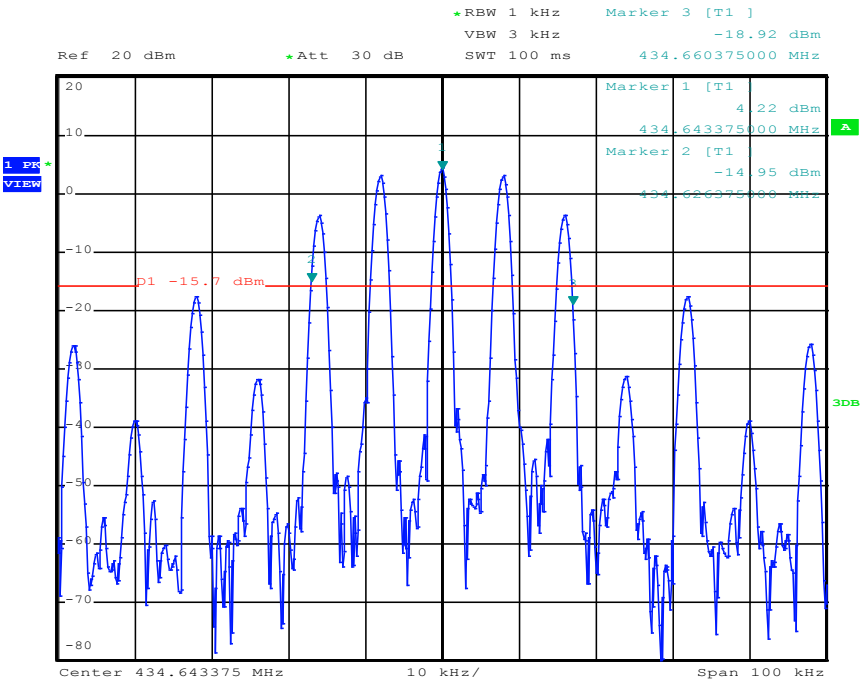
**Remarks:** For detailed test results please see the following test protocols.

### 5.6.6 Test protocol

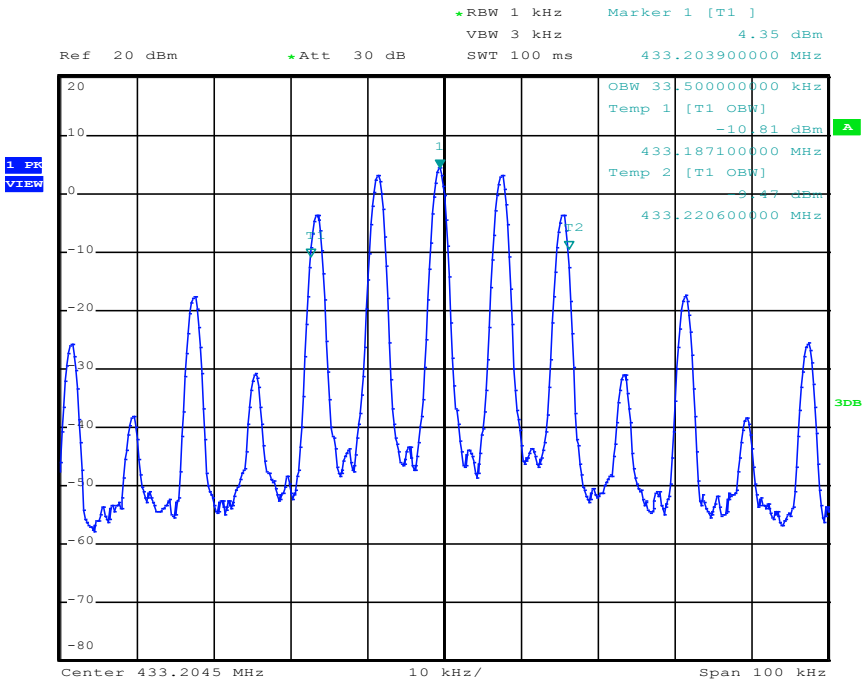
**EBW, CH1:**



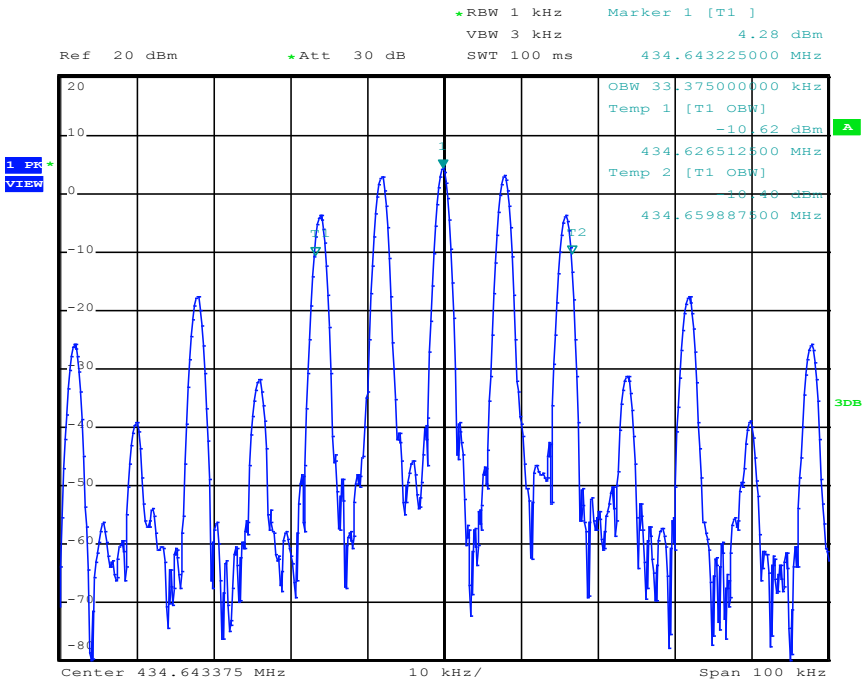

**EBW, CH2:**



**OBWCH1:**




**OBWCH2:**



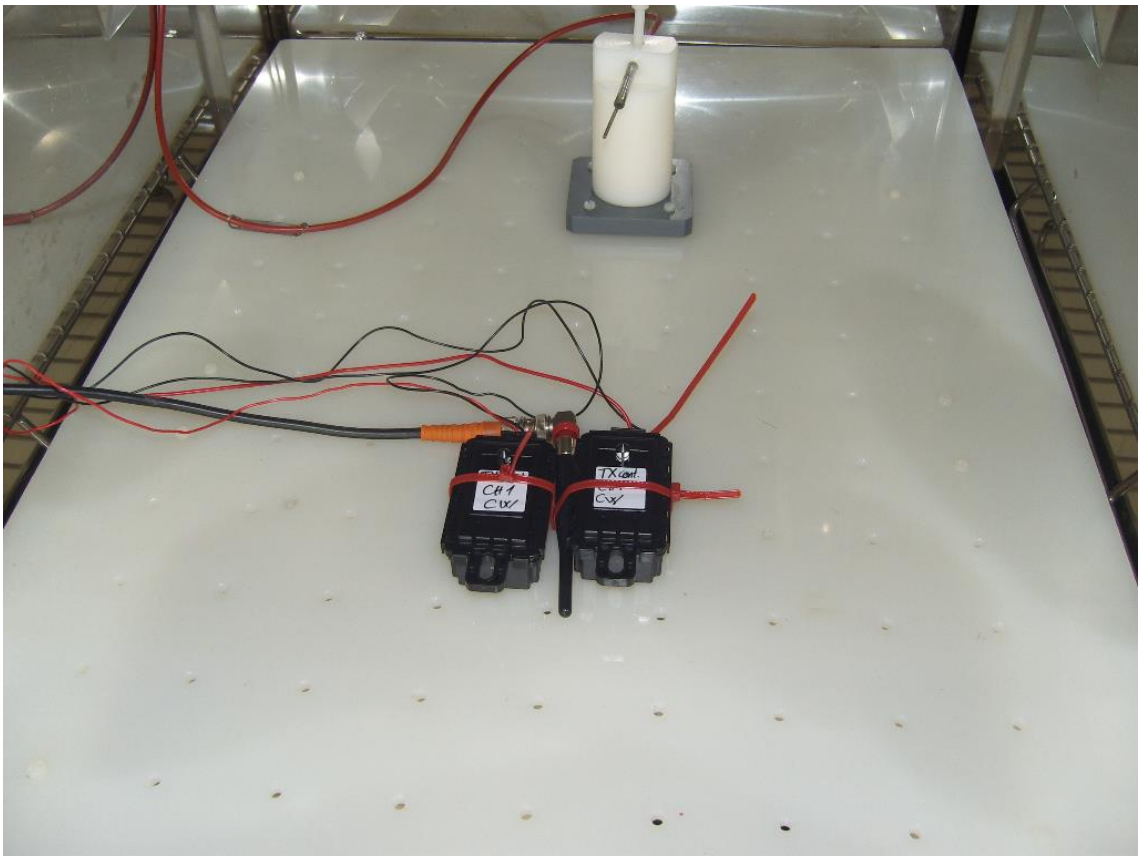
## 5.7 Frequency tolerance

For test instruments and accessories used see section 6 Part **FE**.

### 5.7.1 Description of the test location

Test location: AREA4

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



### 5.7.3 Applicable standard

According to FCC Part 15C, Section 15.215(c):
If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

### 5.7.4 Description of Measurement

The frequency tolerance is measured with the spectrum analyser. The sweep points are set to maximum for higher the frequency resolution or the function “frequency counter” is used. The signal is unmodulated; the marker of the analyser is set to maximum amplitude at normal temperature, the frequency was recorded. Than the maximum supply voltage is set and the marker of the analyser is set to maximum amplitude. This procedure is done again for the minimum supply voltage. The EUT was now driven at normal supply voltage but in the climatic chamber to range the temperature from -40 °C to +85 °C in steps of 10 degrees. The drifting carrier is measured by setting the marker at the analyser.

### 5.7.5 Test result

| Test conditions | | Test result |
|---|---|---|
| | | Frequency (MHz) |
| $T_{min}$ (-40)°C | $V_{nom}$ | 433.203426 |
| T (-30)°C | $V_{nom}$ | 433.203932 |
| T (-20)°C | $V_{nom}$ | 433.205219 |
| T (-10)°C | $V_{nom}$ | 433.206868 |
| T (0)°C | $V_{nom}$ | 433.206522 |
| T (10)°C | $V_{nom}$ | 433.205842 |
| $T_{nom}$ (20)°C | $V_{min}$ (10.2 V) | 433.202963 |
| $T_{nom}$ (20)°C | $V_{nom}$ (12 V) | 433.202963 |
| $T_{nom}$ (20)°C | $V_{max}$ (13.8 V) | 433.202963 |
| T (30)°C | $V_{nom}$ | 433.203691 |
| T (40)°C | $V_{nom}$ | 433.201773 |
| T (50)°C | $V_{nom}$ | 433.200655 |
| T (60)°C | $V_{nom}$ | 433.199675 |
| T (70)°C | $V_{nom}$ | 433.199366 |
| $T_{max}$ (85)°C | $V_{nom}$ | 433.199862 |
| Measurement uncertainty | | ± 10 Hz |

| | |
|---|---|
| Carrier frequency $f_c$ | 433.202963 MHz |
| Max tolerance | no limit |
| Highest frequency $f_h$ | 433.206868 MHz |
| Lowest frequency $f_l$ | 433.199366 MHz |
| Negative tolerance $f_l - f_c$ | -3.597 kHz |
| Positive tolerance $f_h - f_c$ | 3.905 kHz |

Limit according to FCC Part 15C, Section 15.215(c):

If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

The requirements are **FULFILLED.**

**Remarks:** _____

_____

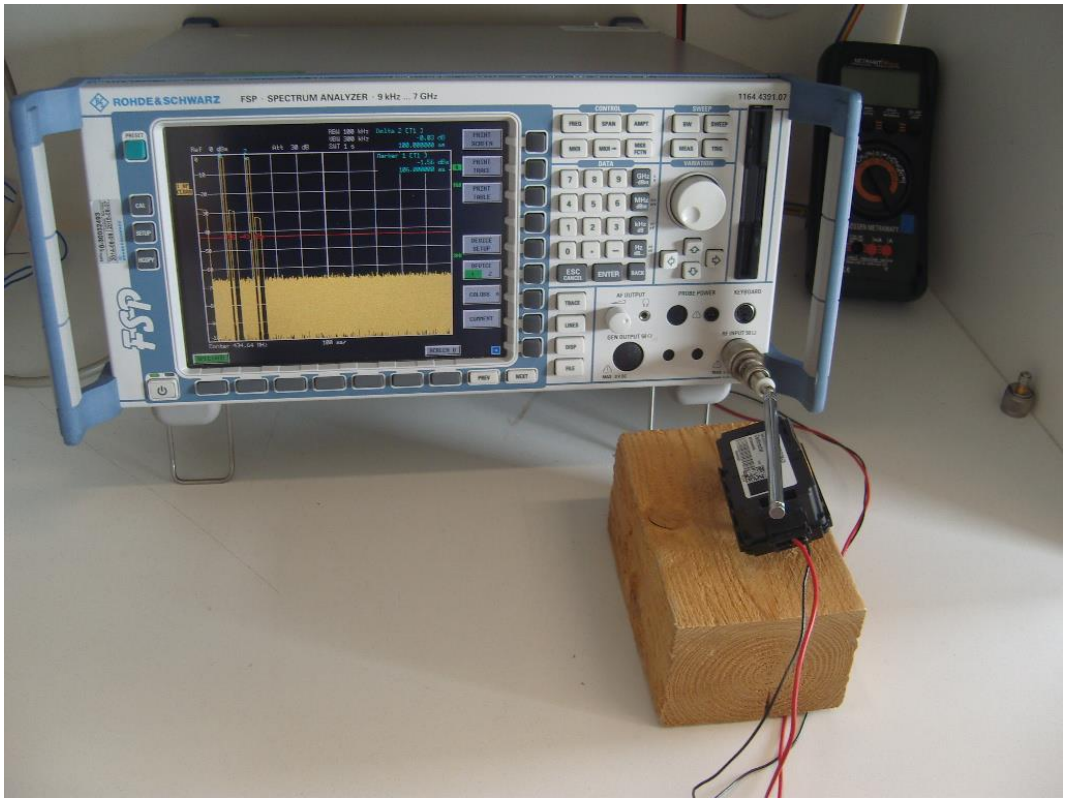
## 5.8 Signal deactivation

For test instruments and accessories used see section 6 Part **MB**.

### 5.8.1 Description of the test location

Test location: AREA4

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




### 5.8.3 Applicable standard

According to FCC Part 15C, Section 15.231(a) (1):
A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter not exceeding the defined on time limit.

### 5.8.4 Description of Measurement

The duration of transmission is measured with the spectrum analyser. The sweep points are set to maximum to increase the time resolution. The signal is modulated; the marker of the analyser is set to maximum amplitude at normal temperature and zero span. The analyser is set to single sweep and triggered by pressing the button; the marker is set to the edges in order to measure the duration time and then recorded.

### 5.8.5 Test result

There are two scenarios:
Scenario one is normal mode. The ID-Transmitter is pressed shortly. The request is called out, the EUT acknowledges the request, the ID-Transmitter asks for execution and the EUT confirm the execution.

| Duration of transmission (ms) | Duration after releasing the button (ms) |
|---|---|
| 22.0 | 22.0 |

Scenario two is unwanted fixing the ID-Transmitter. The ID-Transmitter transmits all the time the same request. The EUT react on this permanent requesting with only one acknowledge and gives the next acknowledge till request changes.

| Duration of transmission (ms) | Duration after releasing the button (ms) |
|---|---|
| 22.0 | - |

Limit according to FCC Part 15C, Section 15.231(a):
A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released and a transmitter activated automatically shall cease transmission within 5 seconds after activation.

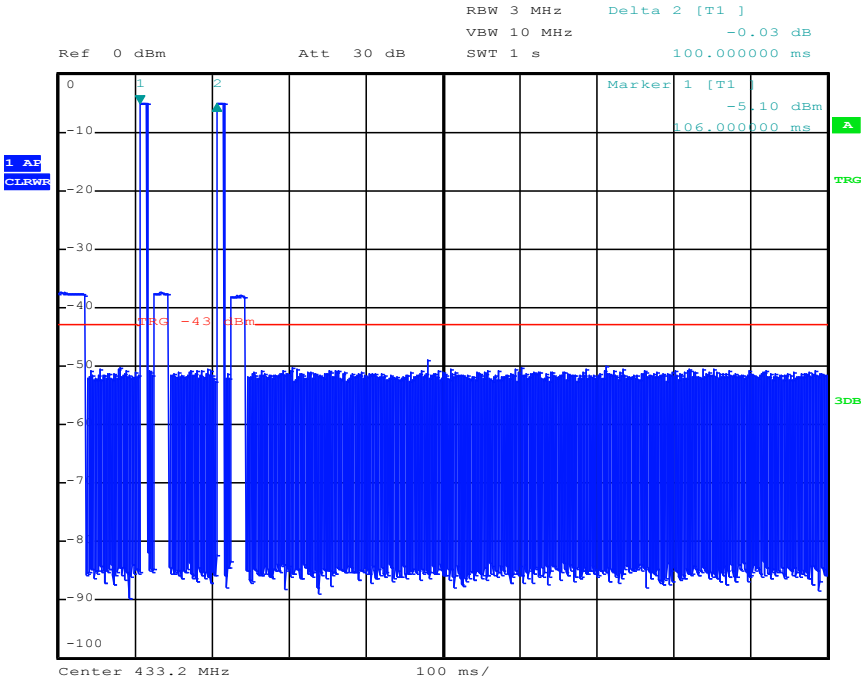
The requirements are **FULFILLED.**

**Remarks:** For detailed test results please see the following test protocols.

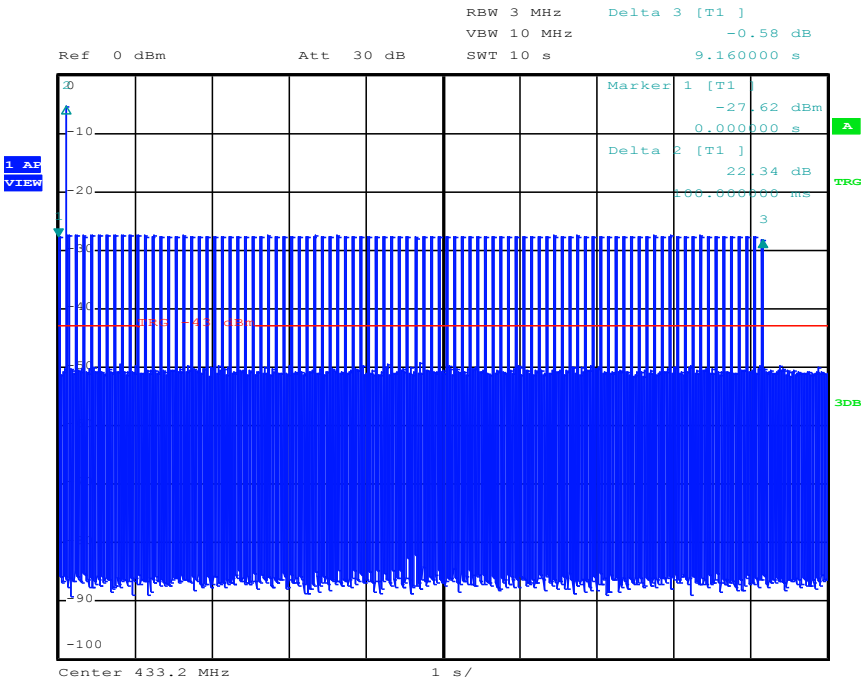
### 5.8.6 Test protocol

**Signal deactivation**

Normal mode:




ID-Transmitter fixed for continuous requesting for 9.16 s.



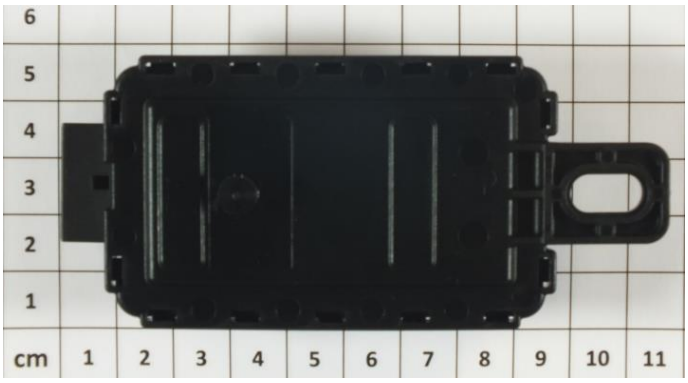
# 6 USED TEST EQUIPMENT AND ACCESSORIES

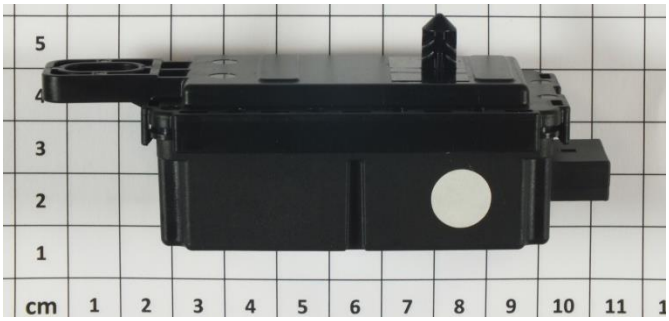
All test instruments used are calibrated and verified regularly. The calibration history is available on request.

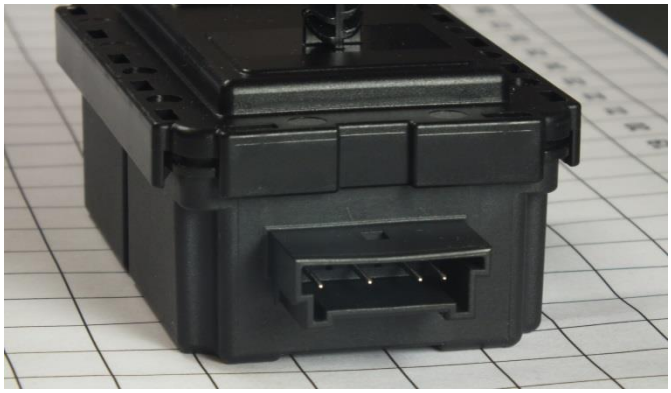
| Test ID | Model Type | Equipment No. | Next Calib. | Last Calib. | Next Verif. | Last Verif. |
|---|---|---|---|---|---|---|
| CPR 2 | ESVS 30 | 02-02/03-05-006 | 03/07/2015 | 03/07/2014 | | |
| | VULB 9168 | 02-02/24-05-005 | 08/04/2015 | 08/04/2014 | 12/09/2015 | 12/03/2015 |
| | S10162-B | 02-02/50-05-032 | | | | |
| | NW-2000-NB | 02-02/50-05-113 | | | | |
| | KK-EF393/U-16N-21N20 m | 02-02/50-12-018 | | | | |
| | NSP 3630 | 02-02/50-14-015 | | | | |
| FE | FSP 30 | 02-02/11-05-001 | 20/10/2015 | 20/10/2014 | | |
| | WK-340/40 | 02-02/45-05-001 | 24/06/2017 | 24/06/2014 | 24/12/2014 | 24/06/2014 |
| | 6543A | 02-02/50-05-157 | | | | |
| MB | FSP 30 | 02-02/11-05-001 | 20/10/2015 | 20/10/2014 | | |
| | 6543A | 02-02/50-05-157 | | | | |
| SER 1 | ESCI | 02-02/03-05-005 | 09/12/2015 | 09/12/2014 | | |
| | S10162-B | 02-02/50-05-031 | | | | |
| | KK-EF393-21N-16 | 02-02/50-05-033 | | | | |
| | NW-2000-NB | 02-02/50-05-113 | | | | |
| | NSP 3630 | 02-02/50-14-015 | | | | |
| SER 2 | ESVS 30 | 02-02/03-05-006 | 03/07/2015 | 03/07/2014 | | |
| | VULB 9168 | 02-02/24-05-005 | 08/04/2015 | 08/04/2014 | 12/09/2015 | 12/03/2015 |
| | S10162-B | 02-02/50-05-032 | | | | |
| | NW-2000-NB | 02-02/50-05-113 | | | | |
| | KK-EF393/U-16N-21N20 m | 02-02/50-12-018 | | | | |
| | NSP 3630 | 02-02/50-14-015 | | | | |
| SER 3 | AFS5-12001800-18-10P-6 | 02-02/17-06-002 | | | | |
| | AFS4-01000400-10-10P-4 | 02-02/17-13-002 | | | | |
| | AMF-4F-04001200-15-10P | 02-02/17-13-003 | | | | |
| | 3117 | 02-02/24-05-009 | 07/05/2015 | 07/05/2014 | | |
| | Sucoflex N-2000-SMA | 02-02/50-05-075 | | | | |
| | SF104/11N/11N/1500MM | 02-02/50-13-015 | | | | |
| | NSP 3630 | 02-02/50-14-015 | | | | |

# ATTACHMENT A

## A1 Photo documentation of the EUT





Internal view: