

|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                            |                                                                                     |                       |                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------|-------------------------------------------|
| <b>Prüfbericht-Nr.:</b><br>Test Report No.:                                                                                                                                                                                                                                                                                                                                                                                                 | <b>60321881-001</b>                                                        | <b>Auftrags-Nr.:</b><br>Order No.:                                                  | <b>3309944_30</b>     | Seite 1 von 44<br>Page 1 of 44            |
| <b>Kunden-Referenz-Nr.:</b><br>Client Reference No.:                                                                                                                                                                                                                                                                                                                                                                                        | N/A                                                                        | <b>Auftragsdatum:</b><br>Order date:                                                | 20.11.2019            |                                           |
| <b>Auftraggeber:</b><br>Client:                                                                                                                                                                                                                                                                                                                                                                                                             | ALPS Electric Europe GmbH<br>Schießsstr. 43, D-40549 DÜSSELDORF            |                                                                                     |                       |                                           |
| <b>Prüfgegenstand:</b><br>Test item:                                                                                                                                                                                                                                                                                                                                                                                                        | Lykaner V (RC2)                                                            |                                                                                     |                       |                                           |
| <b>Bezeichnung / Typ-Nr.:</b><br>Identification / Type No.:                                                                                                                                                                                                                                                                                                                                                                                 | LYK194A                                                                    |                                                                                     |                       |                                           |
| <b>Auftrags-Inhalt:</b><br>Order content:                                                                                                                                                                                                                                                                                                                                                                                                   | Prüfung der Funkparameter nach FCC<br>Test of radio parameters acc. to FCC |                                                                                     |                       |                                           |
| <b>Prüfgrundlage:</b><br>Test specification:                                                                                                                                                                                                                                                                                                                                                                                                | Vollprüfung / Complete test<br>FCC CFR 47 Part 15 Subpart C - §15.247      |                                                                                     |                       |                                           |
| <b>Wareneingangsdatum:</b><br>Date of receipt:                                                                                                                                                                                                                                                                                                                                                                                              | 15.10.2019                                                                 |  |                       |                                           |
| <b>Prüfmuster-Nr.:</b><br>Test sample No.:                                                                                                                                                                                                                                                                                                                                                                                                  | A000245489-001<br>A000250657-001                                           |                                                                                     |                       |                                           |
| <b>Prüfzeitraum:</b><br>Testing period:                                                                                                                                                                                                                                                                                                                                                                                                     | 03.12.2019 – 05.12.2019                                                    |                                                                                     |                       |                                           |
| <b>Ort der Prüfung:</b><br>Place of testing:                                                                                                                                                                                                                                                                                                                                                                                                | Nürnberg<br>Nuremberg                                                      |                                                                                     |                       |                                           |
| <b>Prüflaboratorium:</b><br>Testing laboratory:                                                                                                                                                                                                                                                                                                                                                                                             | Wireless Test Center                                                       |                                                                                     |                       |                                           |
| <b>Prüfergebnis*:</b><br>Test result*:                                                                                                                                                                                                                                                                                                                                                                                                      | Pass                                                                       |                                                                                     |                       |                                           |
| <b>geprüft von / tested by:</b>                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                            | <b>kontrolliert von / reviewed by:</b>                                              |                       |                                           |
| 13.12.2019 M.Sc. Alaa Bustati, SV                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                            | 13.12.2019 Dipl. -Ing. Melanie Bense, TL                                            |                       |                                           |
| <b>Datum</b><br>Date                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Name / Stellung</b><br>Name / Position                                  | <b>Unterschrift</b><br>Signature                                                    | <b>Datum</b><br>Date  | <b>Name / Stellung</b><br>Name / Position |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                            |                                                                                     |                       |                                           |
| <b>Sonstiges / Other:</b>                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                            |                                                                                     |                       |                                           |
| <b>Zustand des Prüfgegenstandes bei Anlieferung:</b><br>Condition of the test item at delivery:                                                                                                                                                                                                                                                                                                                                             |                                                                            | Prüfmuster vollständig und unbeschädigt<br>Test item complete and undamaged         |                       |                                           |
| * Legende:                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 = sehr gut                                                               | 2 = gut                                                                             | 3 = befriedigend      | 4 = ausreichend                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             | P(ass) = entspricht o.g. Prüfgrundlage(n)                                  | F(ail) = entspricht nicht o.g. Prüfgrundlage(n)                                     | N/A = nicht anwendbar | 5 = mangelhaft                            |
| Legend:                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1 = very good                                                              | 2 = good                                                                            | 3 = satisfactory      | 4 = sufficient                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             | P(ass) = passed a.m. test specification(s)                                 | F(ail) = failed a.m. test specification(s)                                          | N/A = not applicable  | 5 = poor                                  |
| Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.<br>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark |                                                                            |                                                                                     |                       |                                           |

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**LISTE DER VERWENDETEN PRÜFMITTEL**  
**LIST OF USED TEST EQUIPMENT**

| Prüfmittel<br><i>Test equipment</i>                                                                                                            |                            | Prüfmittel-Nr. /<br>ID-Nr.<br><i>Equipment No. /<br/>ID-No.</i> | Letzte<br>Kalibrierung<br><i>Last calibration</i> | Nächste<br>Kalibrierung<br><i>Next calibration</i> |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------|---------------------------------------------------|----------------------------------------------------|
| Test System TS8997:<br>Power Meter: OSP-B157<br>Spectrum Analyzer: FSV-30<br>Signal Generator: SMB100A<br>Vector Signal Generator:<br>SMBV100A | Rohde & Schwarz            | 2728871                                                         | 07.2019                                           | 07.2021                                            |
| Fully Anechoic Room                                                                                                                            | Albatross Projects<br>GmbH | 2959749                                                         | 10.2018                                           | 10.2021                                            |
| Antenna HF907                                                                                                                                  | Rohde & Schwarz            | 2856263                                                         | 08.2018                                           | 08.2021                                            |
| Pre-Amplifier BBV 9718                                                                                                                         | Schwarzbeck                | 2731378                                                         | 10.2018                                           | 10.2020                                            |
| Spectrum Analyser FSU26                                                                                                                        | Rohde & Schwarz            | 2819976                                                         | 05.2019                                           | 05.2020                                            |
| Antenna VULB 9168                                                                                                                              | Schwarzbeck                | 2728787                                                         | 09.2019                                           | 09.2022                                            |
| Receiver ESU 8                                                                                                                                 | Rohde & Schwarz            | 2728844                                                         | 12.2018                                           | 12.2019                                            |
| Antenna HFH 2                                                                                                                                  | Rohde & Schwarz            | 2728893                                                         | 06.2018                                           | 06.2021                                            |
| Semi-Anechoic Chamber<br>30-1000 MHz                                                                                                           | Siemens                    | 2729645                                                         | 08.2018                                           | 07.2020                                            |

**LISTE DER VERWENDETEN PRÜFSOFTWARE**  
**LIST OF USED TESTING SOFTWARE**

| Software | Manufacturer    | Version   |
|----------|-----------------|-----------|
| EMC 32   | Rohde & Schwarz | 10.50.00  |
| BAT-EMC  | NEXIO           | 3.19.1.10 |

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**PRODUKTBESCHREIBUNG**  
**PRODUCT DESCRIPTION**

|           |                                  |                                                                                                                            |
|-----------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <b>1</b>  | <b>Test item</b>                 | Lykaner V                                                                                                                  |
| <b>2</b>  | <b>Typ-No.</b>                   | LYK194A                                                                                                                    |
| <b>3</b>  | <b>Description of DUT</b>        | The Lykaner devices are location trackers for assets in the logistic sector, using Sigfox as their main communication path |
| <b>4</b>  | <b>FCC-ID</b>                    | 2AT4V-LYKANER-V                                                                                                            |
| <b>5</b>  | <b>Operating Frequency (MHz)</b> | 902.1375 – 904.3625 MHz, 920.1375 - 920.2625 MHz (Sigfox)                                                                  |
| <b>6</b>  | <b>Channel Bandwidth</b>         | 25 kHz                                                                                                                     |
| <b>7</b>  | <b>Number of Channels</b>        | 54                                                                                                                         |
| <b>8</b>  | <b>Rated Voltage / Frequency</b> | Battery 3.6 V / DC                                                                                                         |
| <b>9</b>  | <b>Modulation</b>                | D-BPSK                                                                                                                     |
| <b>10</b> | <b>Transmit Operating Modes</b>  | Mode 1: TX unmodulated CW mode<br>Mode 2: TX modulated continuous streaming mode<br>Mode 3: TX Frequency hopping mode      |
| <b>11</b> | <b>Antenna Type, Gain</b>        | Integrated 0 dBi                                                                                                           |
| <b>12</b> | <b>Used Samples</b>              | A000245489-001 → Radiated<br>A000250657-001 → Conducted                                                                    |
| <b>13</b> | <b>Environment</b>               | Indoor/ Outdoor                                                                                                            |
| <b>14</b> | <b>Pictures of the DUT</b>       |                                                                                                                            |

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**PRODUKTBESCHREIBUNG**  
**PRODUCT DESCRIPTION**



**Figure1: Front View**

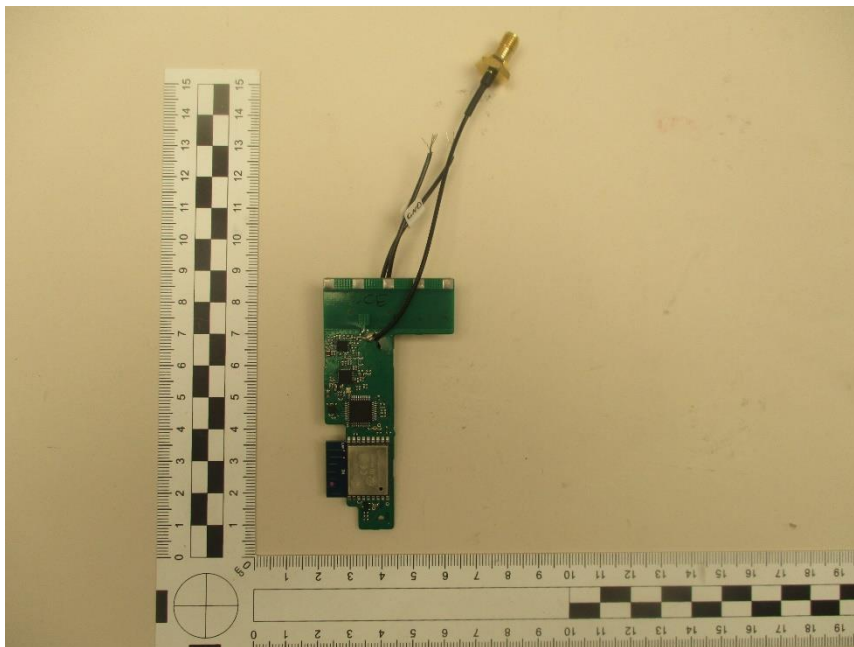


**Figure 2: Back View**

**PRODUKTBESCHREIBUNG  
PRODUCT DESCRIPTION**



**Figure 3: Inside View**



**Figure 4: Conducted Sample**

**MESSDOKUMENTATION**  
**TEST DOCUMENTATION**

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## 1 Overview of Test cases and Applicability

| Applied Standards: FCC CFR 47 Part 15 Subpart C - §15.247 |                                                   |        |
|-----------------------------------------------------------|---------------------------------------------------|--------|
| Section                                                   | Test Item                                         | Result |
| 15.247 (a)                                                | 20 dB Bandwidth and Number of Hopping Frequencies | Pass   |
| 15.247 (a)                                                | Time of Occupancy                                 | Pass   |
| 15.247 (a)                                                | Carrier Frequency Separation                      | Pass   |
| 15.247 (b)                                                | Maximum Output Power                              | Pass   |
| 15.247 (d)                                                | Band Edge Measurement                             | Pass   |
| 15.247 (d)                                                | Conducted Spurious Emission                       | Pass   |
| 15.205, 15.209                                            | Radiated Spurious Emission                        | Pass   |
| 15.207                                                    | AC Power Conducted Emissions                      | N/A    |

N/A: Not Applicable

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## 2 General

### 2.1 Registration

The measurement facilities for conducted and radiated disturbance measurements of the TRLP have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules. Measurement data will be accepted in conjunction with applications for Certification under Parts 15 and 18 of the Commission's Rules.

FCC Registration Number: 939976

Bundesnetzagentur Registrierungsnummer: BNetzA-CAB-17/21-16

### 2.2 Applied standards

FCC CFR 47 Part 15 Subpart C - §15.247

#### Test Methods and Guidance Documents:

- ANSI C63.10:2013
- KDB 558074 D01 DTS Measurement Guidance v05
- KDB 662911 D01 Multiple Transmitter Output v02r01

## 3 Additional Information of EUT

### 3.1.1 Type of EUT

Stand-Alone Equipment

### 3.2 Special Accessories

A test jig was provided for DUT configurations.

### 3.3 Equipment Modifications

None

### 3.4 Software/Firmware of EUT

Used Software to configure the DUT with the required testing mode: STM32 ST-LINK Utility

Used Firmware: Lykaner5\_SFXReady\_release\_3\_07

### 3.5 System description

|                         |                                                                           |
|-------------------------|---------------------------------------------------------------------------|
| <b>System:</b>          | Sigfox RC2                                                                |
| <b>Frequency Range:</b> | 902 MHz to 928 MHz                                                        |
| <b>Application:</b>     | Generic Use                                                               |
| <b>Channel:</b>         | Hopping on 54 channels (902.1375 – 904.3625 MHz, 920.1375 - 920.2625 MHz) |
| <b>Antenna:</b>         | Integrated                                                                |
| <b>Modulation:</b>      | D-BPSK                                                                    |
| <b>System Type:</b>     | Frequency hopping system                                                  |

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### 3.6 Test Modes

| TX mode                           | Frequency | Configurations provided by the manufacturer |
|-----------------------------------|-----------|---------------------------------------------|
| TX unmodulated CW                 | Lowest    | RC4, Lowest Band, unmodulated               |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A100000101000703              |
|                                   |           | 0x080800F00001000000000                     |
| TX unmodulated CW                 | Middle    | RC2, 54 Channels, Middle Band, unmodulated  |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A100000101000703              |
|                                   |           | 0x080800F000000000000000010                 |
| TX unmodulated CW                 | Highest   | RC4, 54 Channels, Highest Band, unmodulated |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A9AA0004000703                |
|                                   |           | 0x080800F00002000000000000010               |
| TX modulated continuous streaming | Lowest    | RC2, Lowest Band, modulated                 |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A100000101020703              |
|                                   |           | 0x080800F00001000000000                     |
| TX modulated continuous streaming | Middle    | RC2, 54 Channels, Middle Band, modulated    |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A100000101020703              |
|                                   |           | 0x080800F00000000000000000010               |
| TX modulated continuous streaming | Highest   | RC2, 54 Channels, Highest Band, modulated   |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A9AA0004020703                |
|                                   |           | 0x080800F0000100000005EB010                 |
| TX Frequency hopping              | -         | Frequency Hopping , 54 Channels             |
|                                   |           | Address048C                                 |
|                                   |           | 0x080800E0AA55A8AA0001000703                |
|                                   |           | 0x080800F0000000000000EB020                 |

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### 4 Test conditions

#### 4.1 General

The DUT was tested standalone on the transmit test mode in normal test conditions.

#### 4.2 Normal test conditions

| Environmental condition | Parameter | Range    |
|-------------------------|-----------|----------|
| Temperature             | °C        | 24       |
| Relative humidity       | %         | 45       |
| Supply voltage          | Volts/DC  | 3.6 V/DC |

#### 4.3 Antenna assemblies

Antenna connector is prepared so tests were done in conducted and radiated mode.

#### 4.4 Measurement Uncertainty

Measurement uncertainties are calculated according to ETSI TR 100 028-1/-2 V.1.4.1 with a confidence level of 95% and with an expansion factor of k=2.

| Measurement Uncertainty                        |         |
|------------------------------------------------|---------|
| Frequency Error                                | 0,748 % |
| Temperature                                    | 1 °C    |
| Humidity                                       | 10 %    |
| E.R.P.                                         | 4,05 dB |
| Carrier Power                                  | 1,46 dB |
| Conducted Spurious Emissions Test              | 4,00 dB |
| Radiated Spurious Emissions Test < 30MHz       | 1,6 dB  |
| Radiated Spurious Emissions Test 30MHz – 1 GHz | 4,5 dB  |
| Radiated Spurious Emissions Test >1 GHz        | 5 dB    |
| Adjacent Channel Power                         | 1,43 dB |

**MESSDOKUMENTATION  
TEST DOCUMENTATION**

## 5 Test Results in Detail

### 5.1 20 dB bandwidth and Number of hopping frequencies

#### 5.1.1 Requirements / Limits

*FCC Part 15, Subpart C, §15.247 (a) (1)*

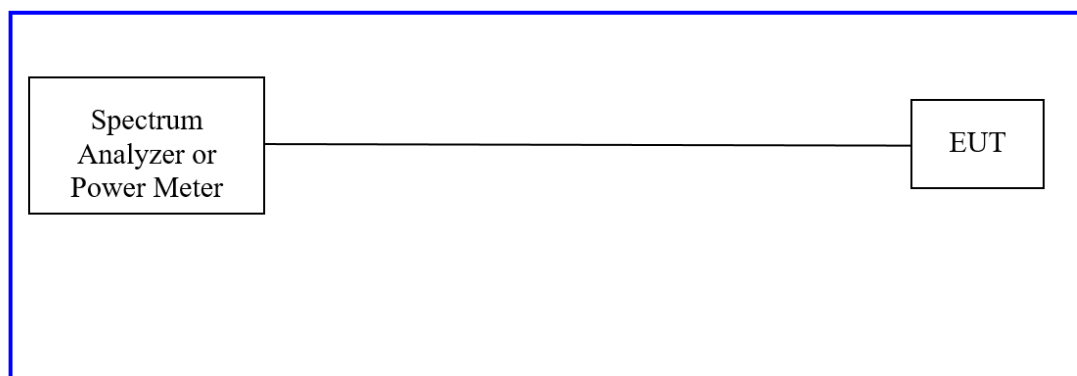
(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

#### 5.1.2 Test Method

Conducted method was used to measure the 20 dB bandwidth and number of hopping frequencies. The EUT was connected to the spectrum analyzer via a coax cable with a known loss.



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## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.1.3 Test Setup

#### 5.1.3.1 20 dB Bandwidth

|                   |                                                                                                              |
|-------------------|--------------------------------------------------------------------------------------------------------------|
| Operating mode    | TX modulated continuous streaming mode                                                                       |
| Test Condition    | Normal conditions                                                                                            |
| EUT Configuration | The EUT was configured to transmit continuous modulated signal on the lowest, middle and highest frequencies |

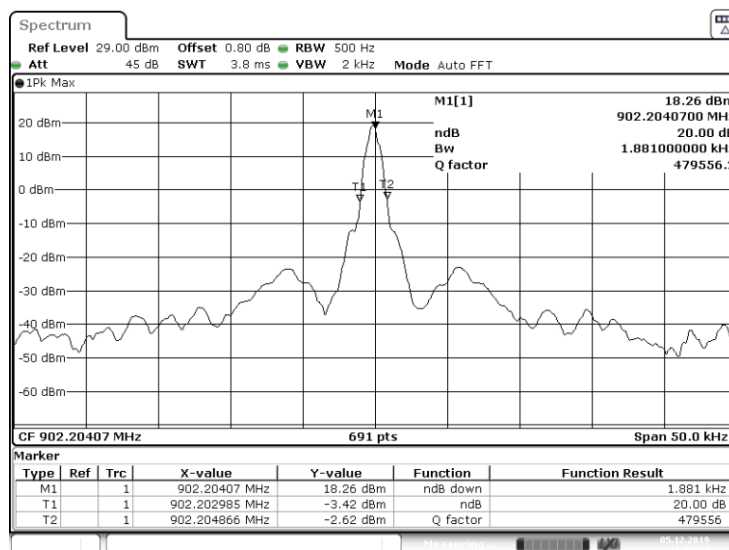
#### 5.1.3.2 Number of hopping frequencies

|                   |                                                    |
|-------------------|----------------------------------------------------|
| Operating mode    | TX Frequency hopping mode                          |
| Test Condition    | Normal conditions                                  |
| EUT Configuration | The EUT was configured to transmit in hopping mode |

### 5.1.4 Test Results

#### 5.1.4.1 20 dB Bandwidth

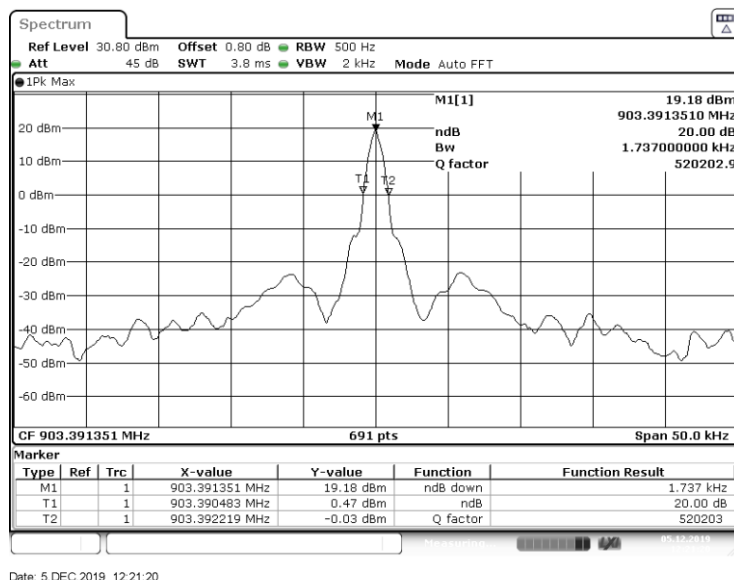
##### - Lowest Channel



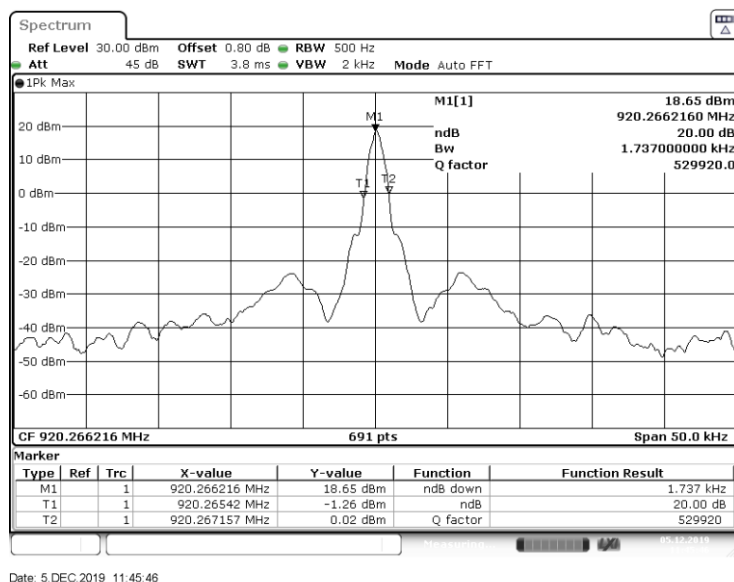
Date: 5 DEC 2019 11:52:43

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### - Middle Channel



### - Highest Channel



| Frequency | 20 dB Bandwidth (kHz) | Limit (kHz) | Test Result |
|-----------|-----------------------|-------------|-------------|
| Lowest    | 1.881                 | 250         | Pass        |
| Middle    | 1.737                 |             |             |
| Highest   | 1.737                 |             |             |

|                   |      |
|-------------------|------|
| Final Test Result | Pass |
|-------------------|------|

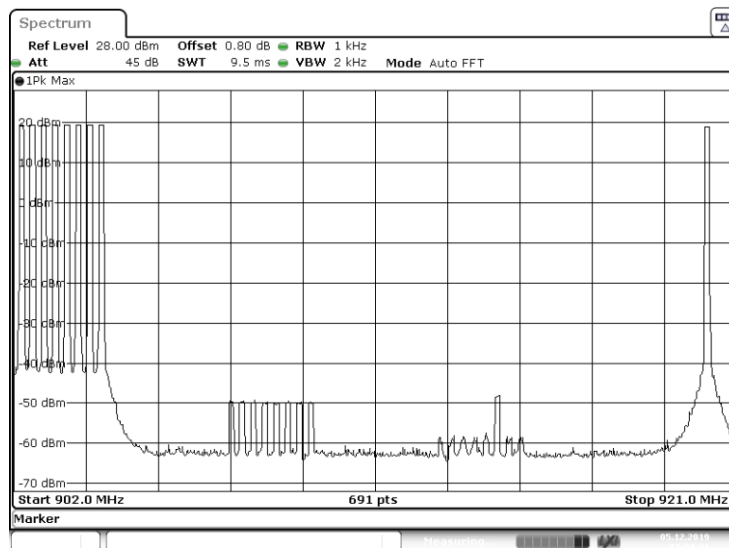
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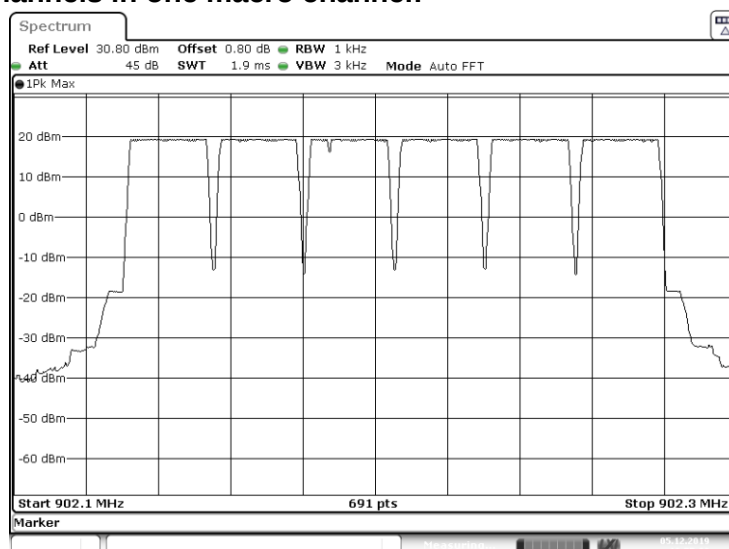
### 5.1.4.2 Number of hopping frequencies

Number of macro channels:



Date: 5.DEC.2019 12:34:21

Number of micro channels in one macro channel:



Date: 5.DEC.2019 13:55:28

| Number of macro channels | Number of micro channels in one macro channel | Total number of hopping frequencies | Minimum requirement    | Test Result |
|--------------------------|-----------------------------------------------|-------------------------------------|------------------------|-------------|
| 9                        | 6                                             | 54                                  | 50 hopping frequencies | pass        |

|                   |      |
|-------------------|------|
| Final Test Result | Pass |
|-------------------|------|

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### 5.2 Time of occupancy

#### 5.2.1 Requirements / Limits

The requirements of the average time of occupancy on any frequency are specified in 4.1.1.

#### 5.2.2 Test Method

Conducted method was used to measure the average time of occupancy. The EUT was connected to the spectrum analyzer via a coax cable with a known loss.

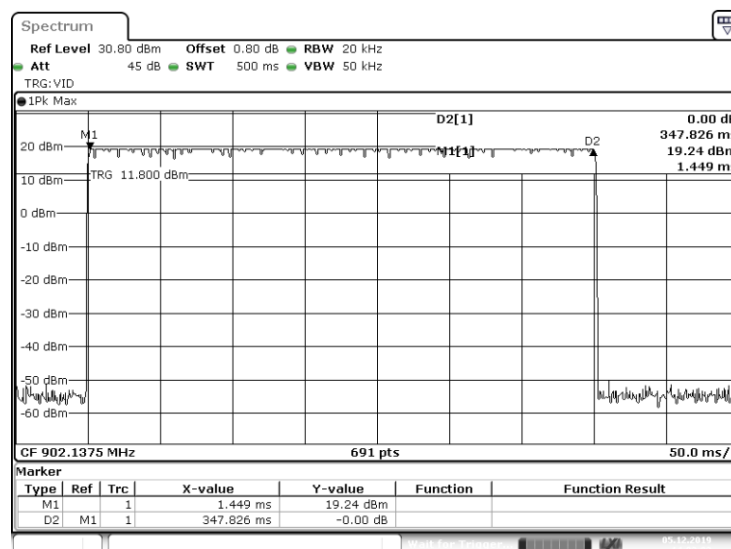
The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements (20 seconds).

#### 5.2.3 Test Setup

|                   |                                                    |
|-------------------|----------------------------------------------------|
| Operating mode    | TX Frequency hopping mode                          |
| Test Condition    | Normal conditions                                  |
| EUT Configuration | The EUT was configured to transmit in hopping mode |

#### 5.2.4 Test Results

Transmit time per hop:



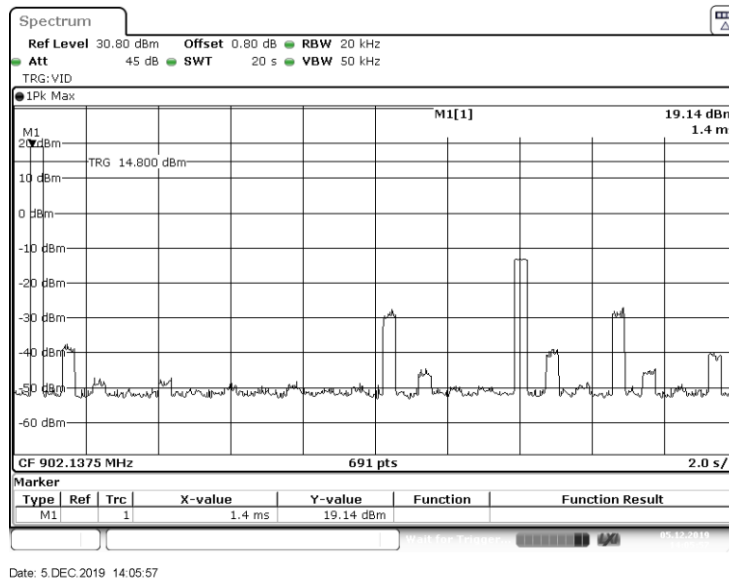
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Number of hops in 20 seconds:



| Transmit time per hop | Number of hops in 20 seconds | Average time of occupancy | Limit  | Test Result |
|-----------------------|------------------------------|---------------------------|--------|-------------|
| 348.551 ms            | 1                            | 347.826 ms                | 400 ms | pass        |

|                   |      |
|-------------------|------|
| Final Test Result | Pass |
|-------------------|------|

## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.3 Carrier Frequency Separation

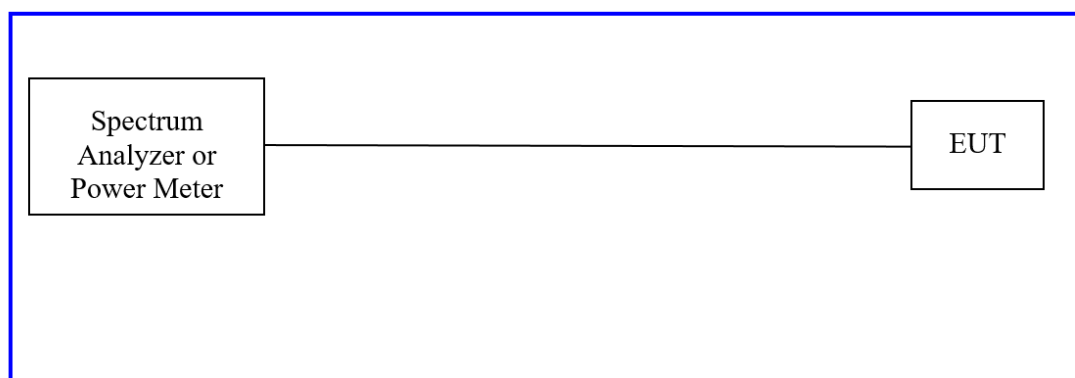
#### 5.3.1 4.2.1 Requirements / Limits

*FCC Part 15, Subpart C, §15.247 (a) (1)*

Frequency hopping systems shall have hopping channel carrier frequencies separated by a **minimum** of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

#### 5.3.2 Test Method

Conducted method was used to measure the minimum frequency separation. The EUT was connected to the spectrum analyzer via a coax cable with a known loss



#### 5.3.3 Test Setup

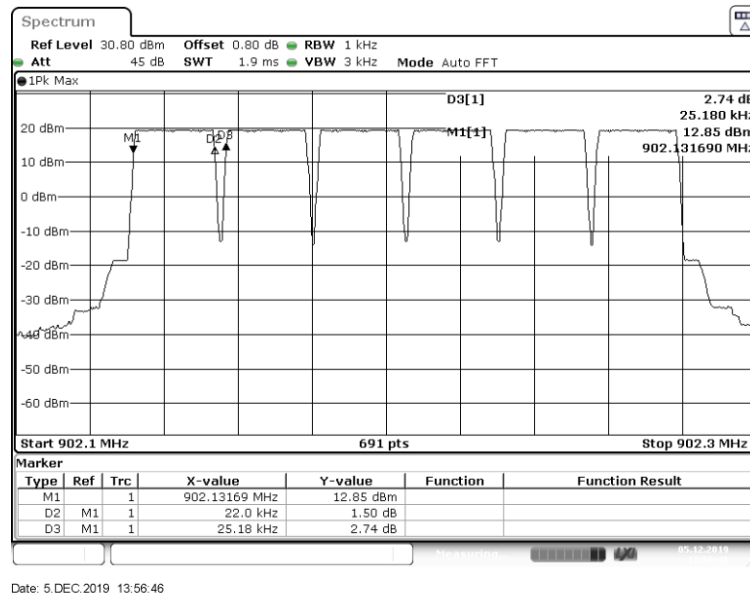
|                   |                                                    |
|-------------------|----------------------------------------------------|
| Operating mode    | TX Frequency hopping mode                          |
| Test Condition    | Normal conditions                                  |
| EUT Configuration | The EUT was configured to transmit in hopping mode |

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## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.3.4 Test Results



| Channel Separation (kHz) | Minimum requirement (kHz) | Test Result |
|--------------------------|---------------------------|-------------|
| 25.18                    | 25                        | Pass        |

|                   |      |
|-------------------|------|
| Final Test Result | Pass |
|-------------------|------|

**MESSDOKUMENTATION**  
**TEST DOCUMENTATION**

## **5.4 Maximum Output Power**

### **5.4.1 Requirements / Limits**

The maximum output power limit is expressed in terms of either maximum peak conducted output power or maximum conducted output power.

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the full signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

#### **DTS devices:**

*FCC Part 15, Subpart C, §15.247 (b) (3)*

For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt. Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

#### **Frequency Hopping Systems:**

*FCC Part 15, Subpart C, §15.247 (b) (1)*

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

*FCC Part 15, Subpart C, §15.247 (b) (2)*

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

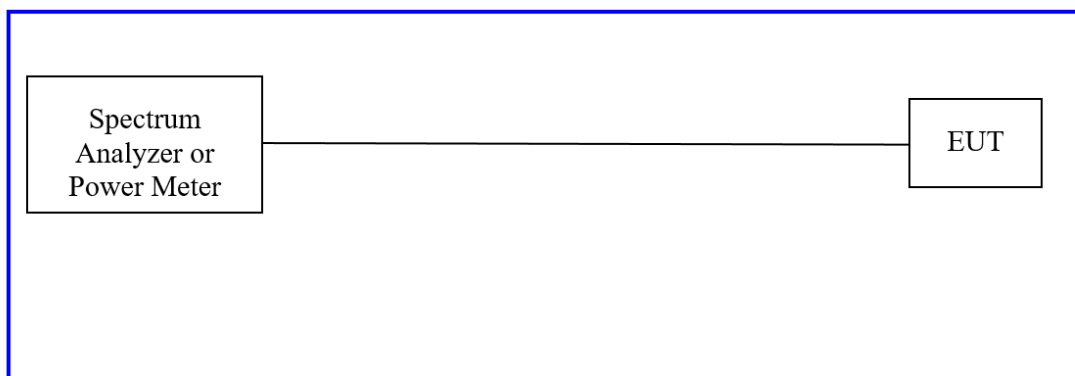
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## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.4.2 Test Method

Conducted method was used to measure the maximum output power. The EUT was connected to the spectrum analyzer via a coax cable with a known loss.



### 5.4.3 Test Setup

|                   |                                                                                                              |
|-------------------|--------------------------------------------------------------------------------------------------------------|
| Operating mode    | TX modulated continuous streaming mode                                                                       |
| Test Condition    | Normal conditions                                                                                            |
| EUT Configuration | The EUT was configured to transmit continuous modulated signal on the lowest, middle and highest frequencies |

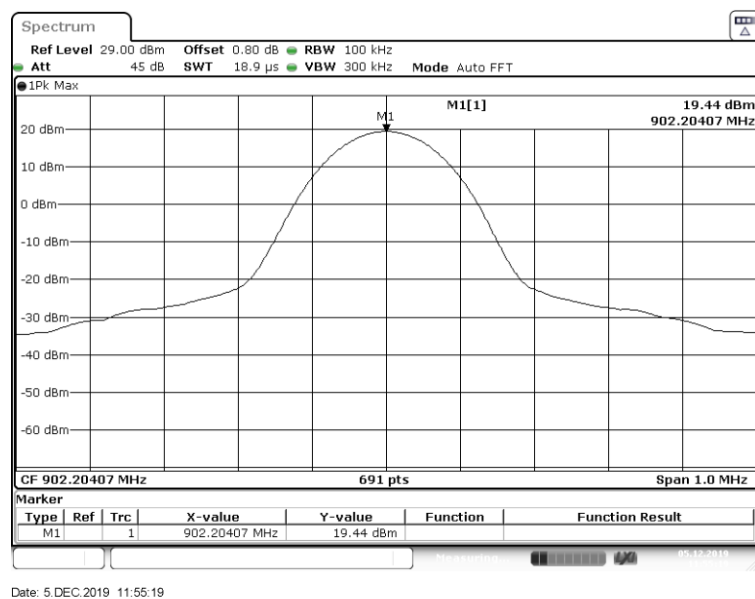
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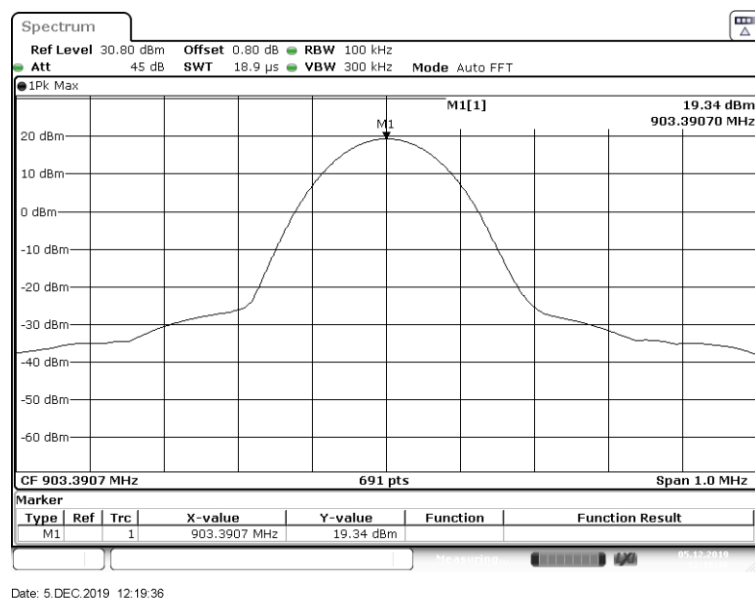
## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.4.4 Test Results

#### - Lowest Channel



#### - Middle Channel

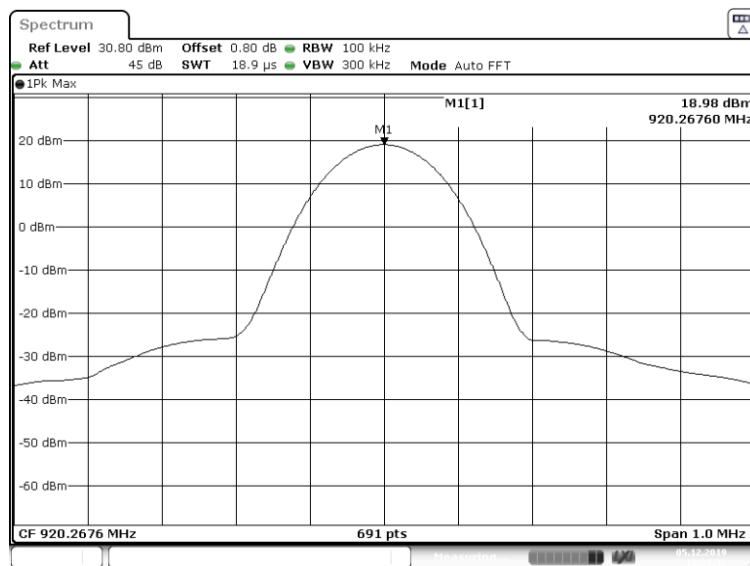


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### - Highest Channel



Date: 5.DEC.2019 11:31:32

| Frequency | Peak conducted output power (dBm) | Limit (dBm) | Margin (dB) | Test Result |
|-----------|-----------------------------------|-------------|-------------|-------------|
| Lowest    | 19.44                             | 30          | 10.56       | Pass        |
| Middle    | 19.34                             |             | 10.66       |             |
| Highest   | 18.98                             |             | 11.02       |             |

|                   |      |
|-------------------|------|
| Final Test Result | Pass |
|-------------------|------|

## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.5 Conducted Spurious Emissions

#### 5.5.1 Requirements / Limits

FCC Part 15, Subpart C, §15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provide the transmitter demonstrates compliance with the peak conducted power limits.

#### 5.5.2 Test Method

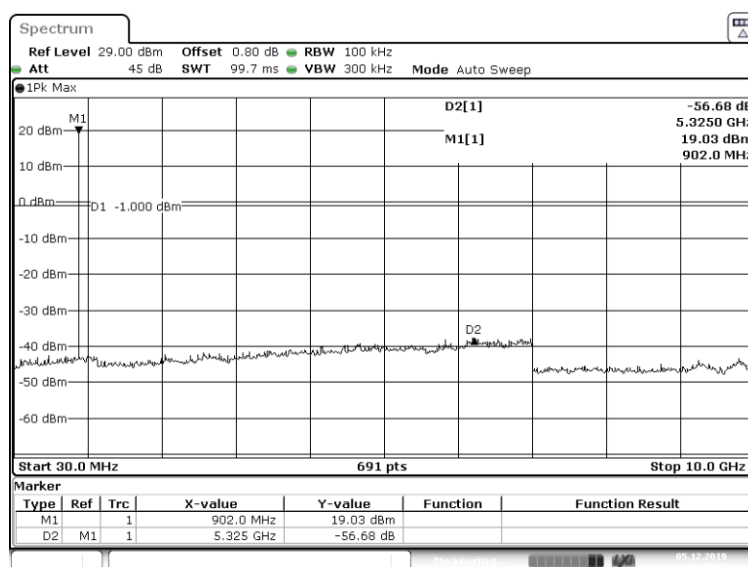
Conducted method was used to measure the conducted spurious emissions in frequency range (30 MHz to 10 GHz). The EUT was connected to the spectrum analyzer via a coax cable with a known loss.

#### 5.5.3 Test Setup

|                   |                                                                                                              |
|-------------------|--------------------------------------------------------------------------------------------------------------|
| Operating mode    | TX modulated continuous streaming mode                                                                       |
| Test Condition    | Normal conditions                                                                                            |
| EUT Configuration | The EUT was configured to transmit continuous modulated signal on the lowest, middle and highest frequencies |

#### 5.5.4 Test results

##### - Lowest Channel

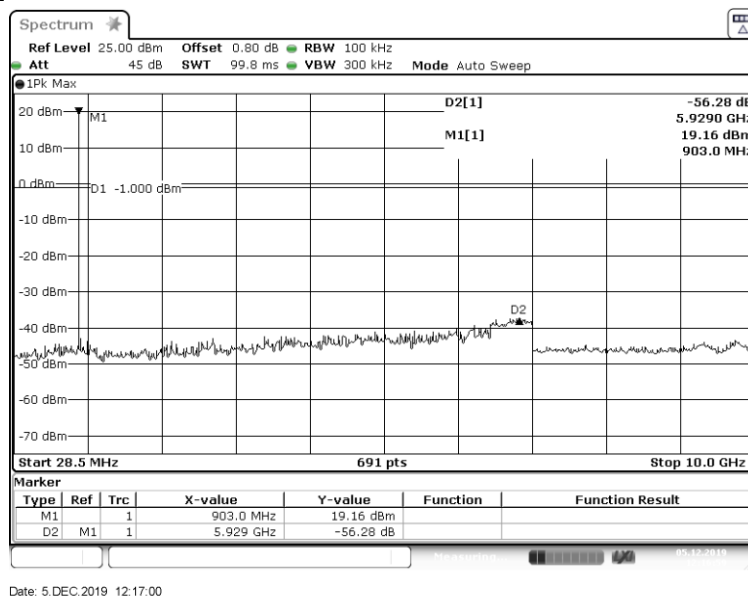


Prüfbericht-Nr.: 60321881-001  
Test Report No.:

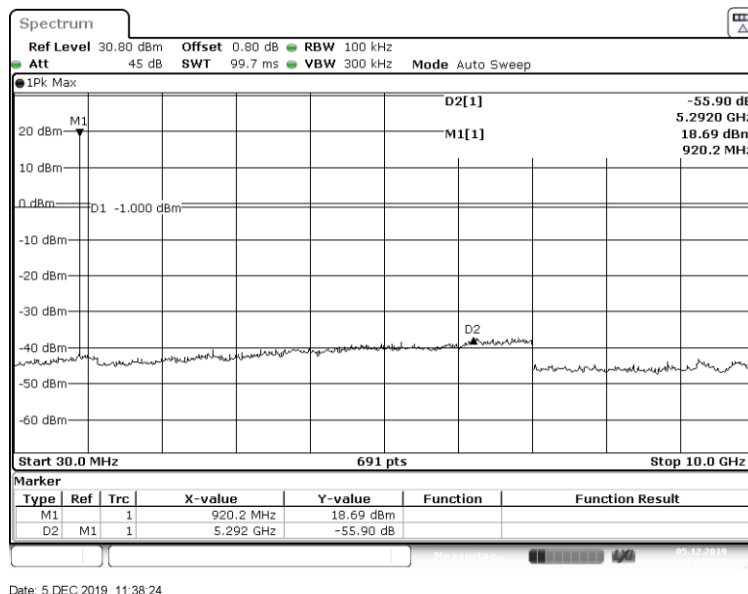
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## MESSDOKUMENTATION TEST DOCUMENTATION

### - Middle Channel



### - Highest Channel



Final Test Result

Pass

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**TEST DOCUMENTATION**

## 5.6 Band Edge Measurement

### 5.6.1 Requirements / Limits

*FCC Part 15, Subpart C, §15.247 (d)*

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provide the transmitter demonstrates compliance with the peak conducted power limits.

### 5.6.2 Test Method

Conducted method was used to perform the band edge measurements. The EUT was connected to the spectrum analyzer via a coax cable with a known loss. The measurements are done when DUT is configured to the lowest and highest channels, and in hopping mode as given by the manufacturer.

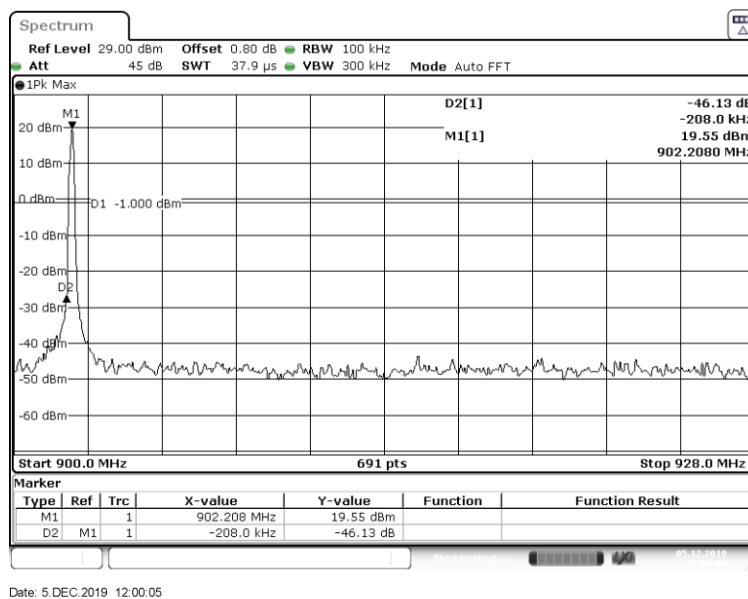
### 5.6.3 Test Setup

|                   |                                                                                                                                   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Operating mode    | TX modulated continuous streaming mode                                                                                            |
| Test Condition    | Normal conditions                                                                                                                 |
| EUT Configuration | The EUT was configured to transmit continuous modulated signal on the lowest and highest channels and to transmit in hopping mode |

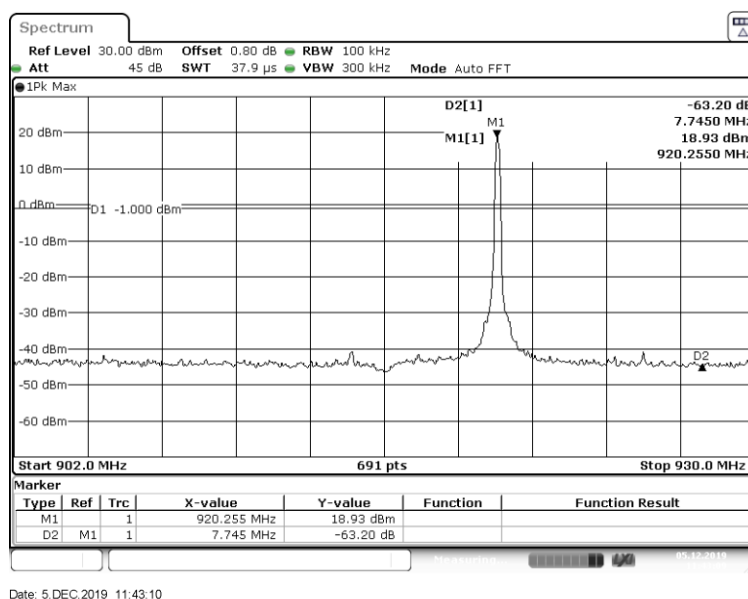
## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.6.4 Test results

#### - Lowest Channel



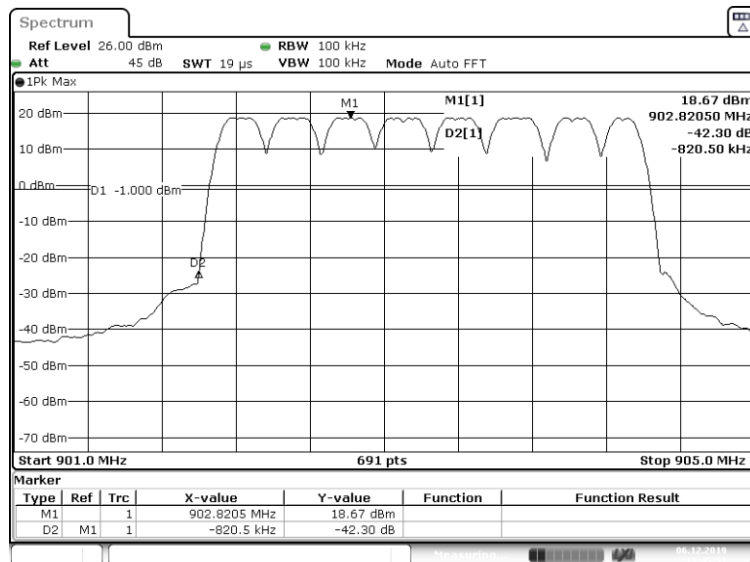
#### - Highest Channel



## MESSDOKUMENTATION TEST DOCUMENTATION

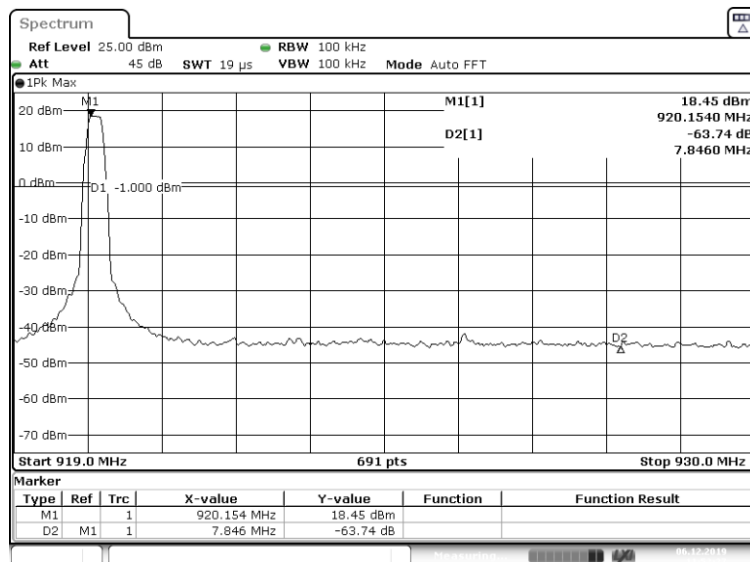
### - Hopping Mode

#### Lower Edge:



Date: 6 DEC.2019 11:45:51

#### Higher Edge:



Date: 6 DEC.2019 11:52:28

Final Test Result

Pass

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### 5.7 Radiated Spurious Emissions

#### 5.7.1 Requirements / Limits

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode. The emissions shall not exceed the values in FCC Part 15, Subpart C §15.205, §15.209, §15.247(d).

FCC Part 15, Subpart C, §15.247 (d)

... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

#### FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

| Frequency [MHz] | Limit [ $\mu\text{V/m}$ ] | Measurement distance [m] | Limits [ $\text{dB}\mu\text{V/m}$ ] |
|-----------------|---------------------------|--------------------------|-------------------------------------|
| 0.009 – 0.49    | 2400/F(kHz)@300m          | 3                        | (48.5 – 13.8)@300m                  |
| 0.49 – 1.705    | 24000/F(kHz)@30m          | 3                        | (33.8 – 23.0)@30m                   |
| 1.705 – 30      | 30@30m                    | 3                        | 29.5@30m                            |

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (f)(2).

| Frequency [MHz] | Limit [ $\mu\text{V/m}$ ] | Measurement distance [m] | Limits [ $\text{dB}\mu\text{V/m}$ ] |
|-----------------|---------------------------|--------------------------|-------------------------------------|
| 30 – 88         | 100@3m                    | 3                        | 40.0@3m                             |
| 88 – 216        | 150@3m                    | 3                        | 43.5@3m                             |
| 216 – 960       | 200@3m                    | 3                        | 46.0@3m                             |
| 960 - 40000     | 500@3m                    | 3                        | 54.0@3m                             |

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

Used conversion factor:

$$\text{Limit } [\text{dB}\mu\text{V/m}] = 20 \log (\text{Limit } [\mu\text{V/m}] / 1\mu\text{V/m})$$

## MESSDOKUMENTATION TEST DOCUMENTATION

### 5.7.2 Test Method

#### 5.7.2.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. Preliminary emission profile testing was performed inside the anechoic chamber. The receiving antenna was placed at a distance of 3m for all measurements. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT. The different measurement setup for each frequency range are shown below.

#### 9 kHz - 30 MHz

Following Measurement Setup is used:

|                                |                                                       |
|--------------------------------|-------------------------------------------------------|
| Test Site                      | Semi-anechoic chamber                                 |
| Receiving Antenna              | Loop antenna (HFH 2)                                  |
| Receiving Antenna Height       | 1 m                                                   |
| Receiving Antenna Polarisation | Parallel – Perpendicular                              |
| EUT Table                      | 1.0m x 1.5m non-conductive table 80cm above the floor |
| EUT Turn Table Step Size       | 22.5°                                                 |
| Receiver Configurations        | Average and peak detectors                            |
|                                | RBW: 200Hz (9 - 150 kHz) and 9 kHz (150 kHz – 30 MHz) |
|                                | Step Size: 50Hz (9-150kHz) and 2.25kHz (150k-30MHz)   |
|                                | Sweep Time: 100ms (FFT)                               |

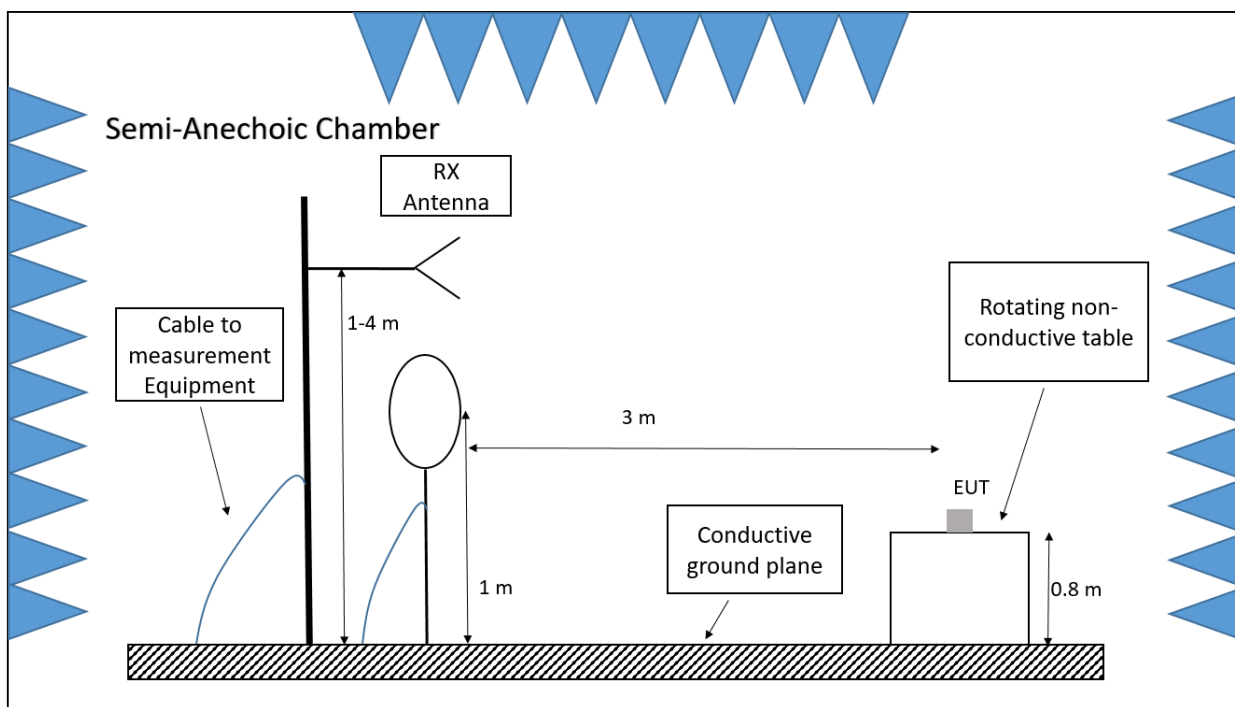
#### 30 MHz - 1 GHz

Following Measurement Setup is used:

|                                |                                                       |
|--------------------------------|-------------------------------------------------------|
| Test Site                      | Semi-anechoic chamber                                 |
| Receiving Antenna              | Hybrid Antenna VULB 9168                              |
| Receiving Antenna height       | Varied (1m to 4 m, step size 1m)                      |
| Receiving Antenna Polarisation | Horizontal– Vertical                                  |
| EUT Table                      | 1.0m x 1.5m non-conductive table 80cm above the floor |
| EUT Turn Table Step Size       | 45°                                                   |
| Receiver Configurations        | Peak detector                                         |
|                                | RBW :120 kHz                                          |
|                                | Step Size: 30kHz (30-1000MHz)                         |
|                                | Sweep Time : 100 ms (FFT)                             |

## MESSDOKUMENTATION TEST DOCUMENTATION

For Measurements below 1 GHz, the EUT was positioned as shown in the setup photograph:



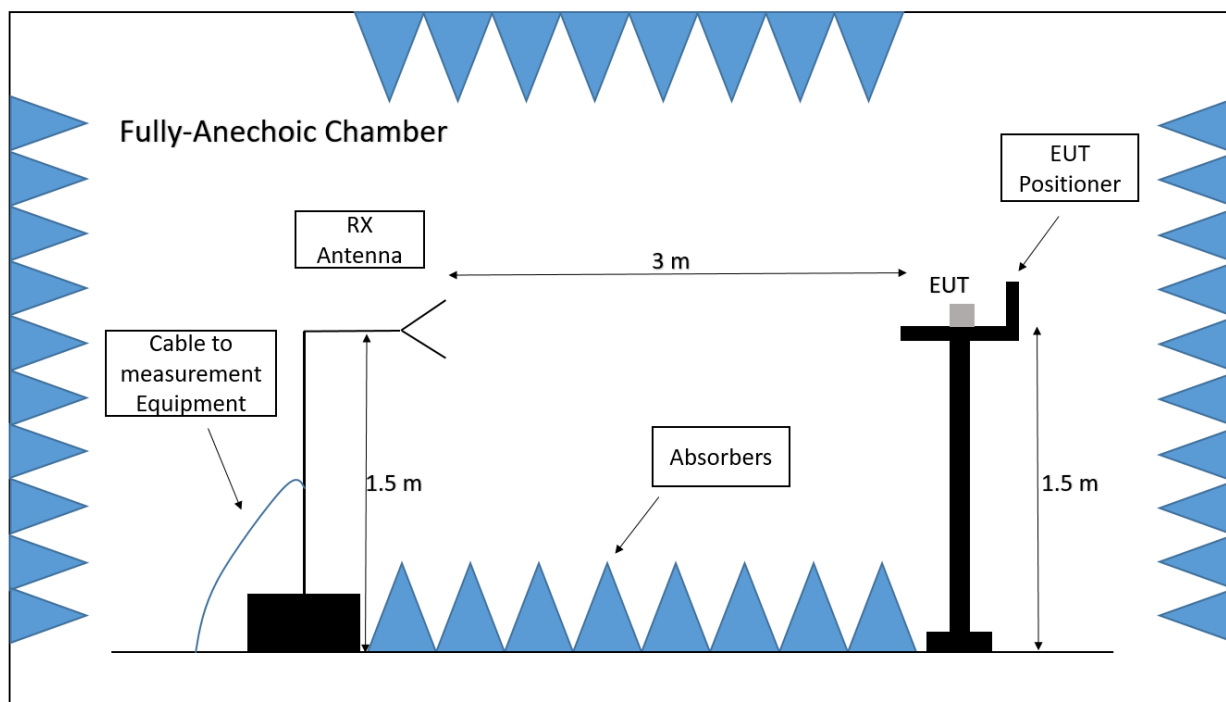
### 1 GHz - 10 GHz

Following Measurement Setup is used:

|                                |                                                                                               |
|--------------------------------|-----------------------------------------------------------------------------------------------|
| Test Site                      | Fully-anechoic chamber                                                                        |
| Receiving Antenna              | Horn Antenna HF907 (1-10 GHz)                                                                 |
| Receiving Antenna Height       | 1.5 m                                                                                         |
| Receiving Antenna Polarisation | Horizontal– Vertical                                                                          |
| EUT Positioner                 | 40 cm x 60 cm non-conductive positioner 1.5 m above the floor / Step size,elevation angle 45° |
| EUT Turn Table Step Size       | 45°                                                                                           |
| Spectrum Analyser              | Average and peak detectors                                                                    |
|                                | RBW: 1 MHz                                                                                    |
|                                | Sweep Time : 100 ms                                                                           |

## MESSDOKUMENTATION TEST DOCUMENTATION

For Measurements over 1 GHz, the EUT was positioned as shown in the setup photograph:



### 5.7.2.2 Final Test

The placement of EUT and cables were the same as for preliminary testing. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, then the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked. For the measurements in the frequency range 30 MHz to 1 GHz for each measured frequency the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. For measurement above 1 GHz the turntable and positioner step sizes were set to a range of 22° and the antenna height is fixed.

For the measurements in the frequency ranges (90-110kHz, 490 kHz-1 GHz) quasi-peak detector is used, while average and peak detectors are used in other ranges.

Final testing was performed on an SVSWR compliant test site.

The final average electric field value ( $E_{final}$ ) is calculated in the final measurement table using the following equation:

$$E_{final} = \text{RawRec} + \text{Corr.}$$

While

$$\text{Corr.} = \text{Trd. Corr.} + \text{Sig Path} + \text{Preamp}$$

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### 5.7.3 Test Setup

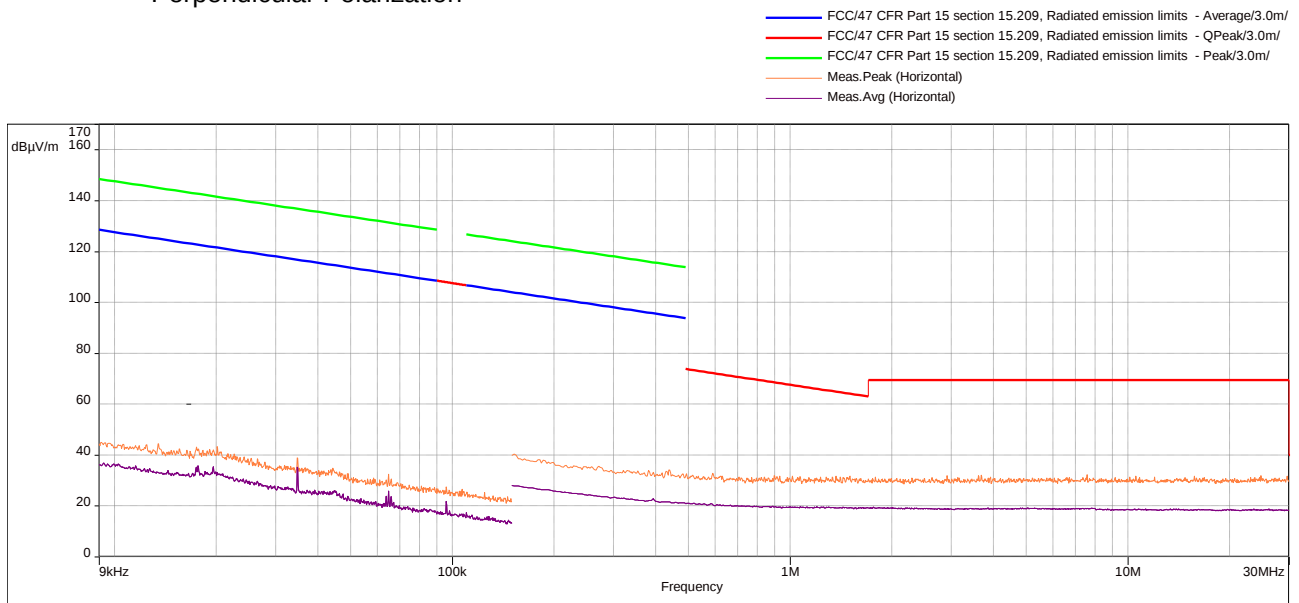
|                   |                                                                                                              |
|-------------------|--------------------------------------------------------------------------------------------------------------|
| Operating mode    | TX modulated continuous streaming mode                                                                       |
| Test Condition    | Normal conditions                                                                                            |
| EUT Configuration | The EUT was configured to transmit continuous modulated signal on the lowest, middle and highest frequencies |

## MESSDOKUMENTATION TEST DOCUMENTATION

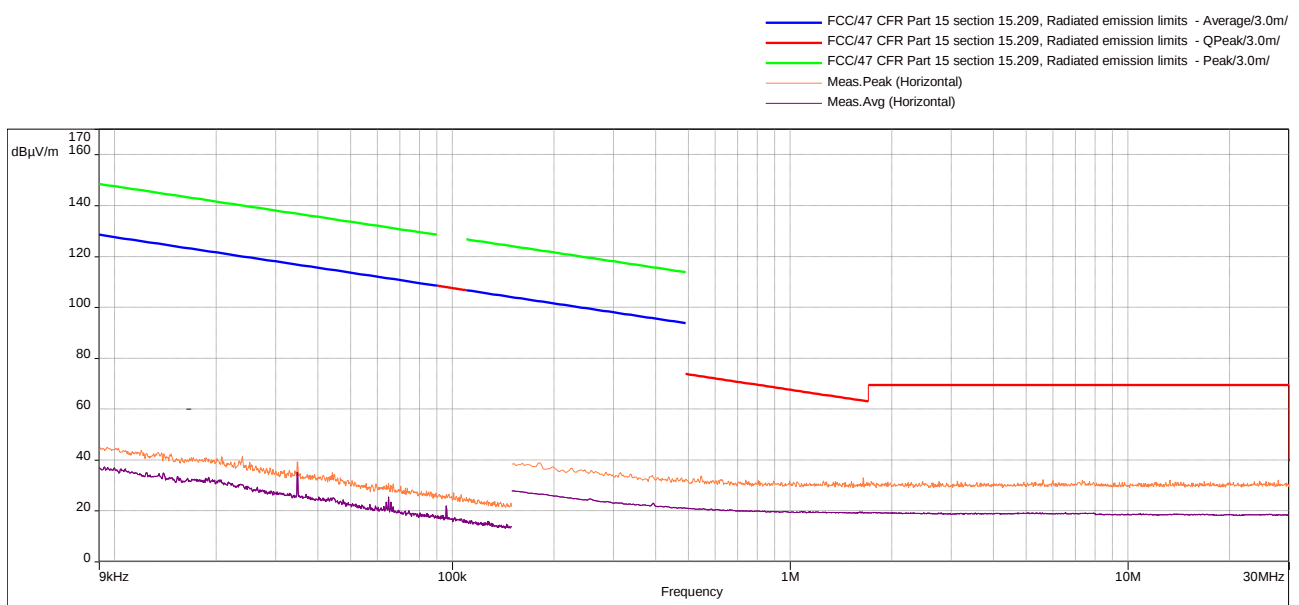
### 5.7.4 Test Results

#### – 9kHz to 30 MHz, lowest channel

##### • Perpendicular Polarization



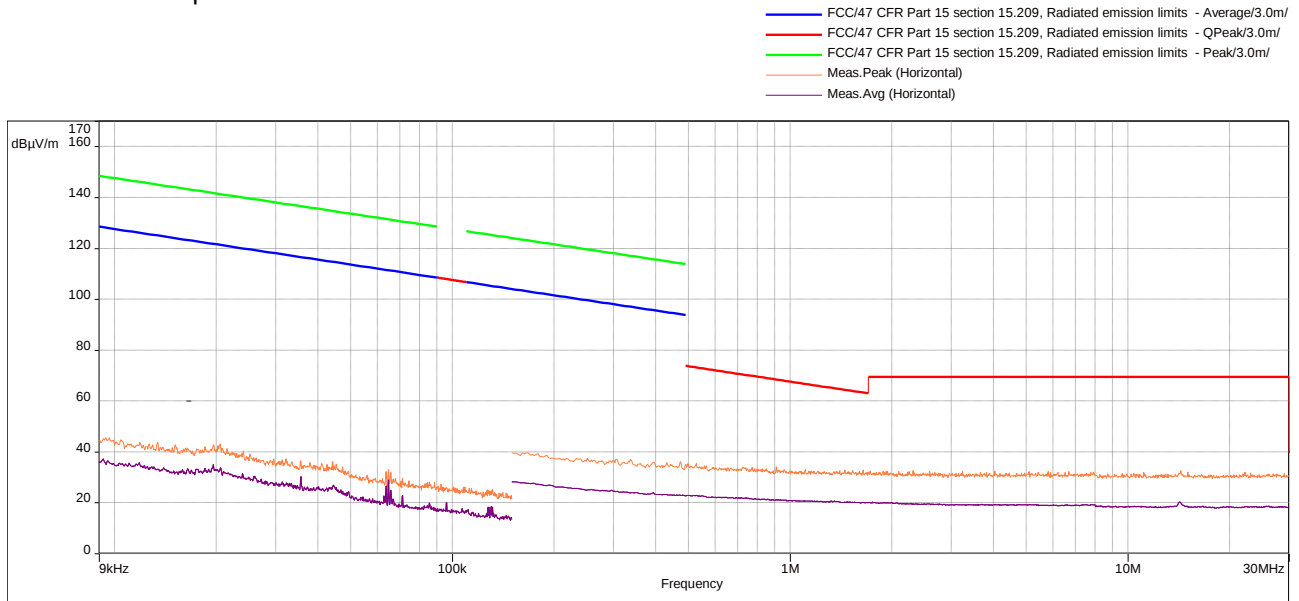
##### • Parallel Polarization



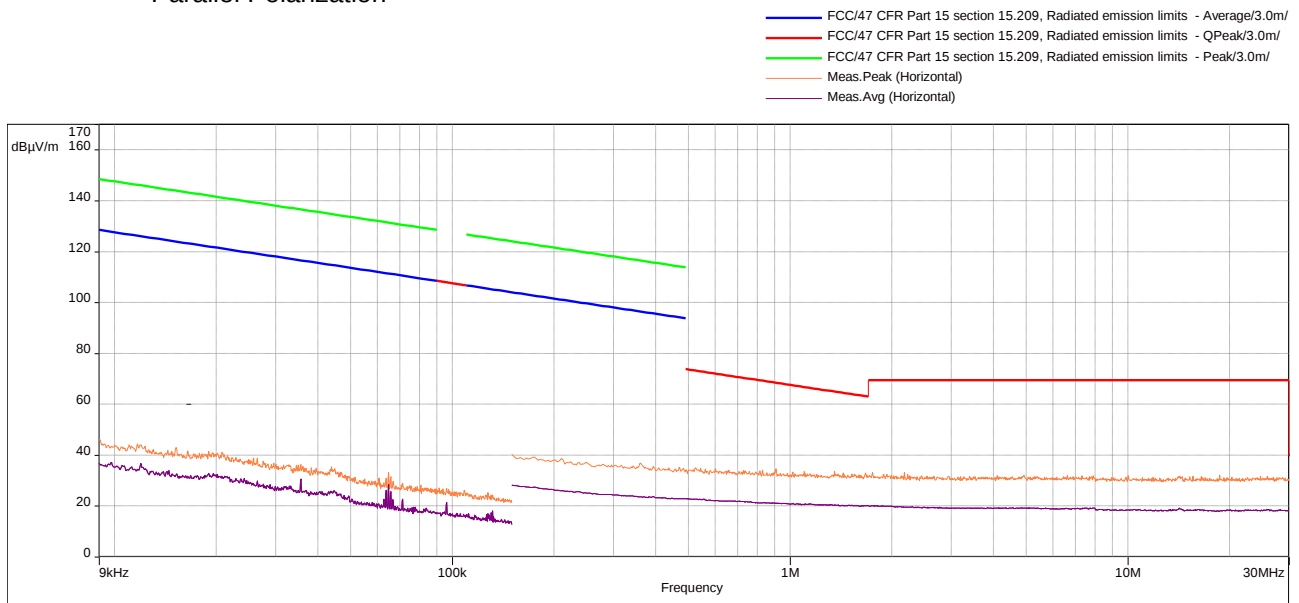
## MESSDOKUMENTATION TEST DOCUMENTATION

### – 9kHz to 30 MHz, middle channel

#### • Perpendicular Polarization



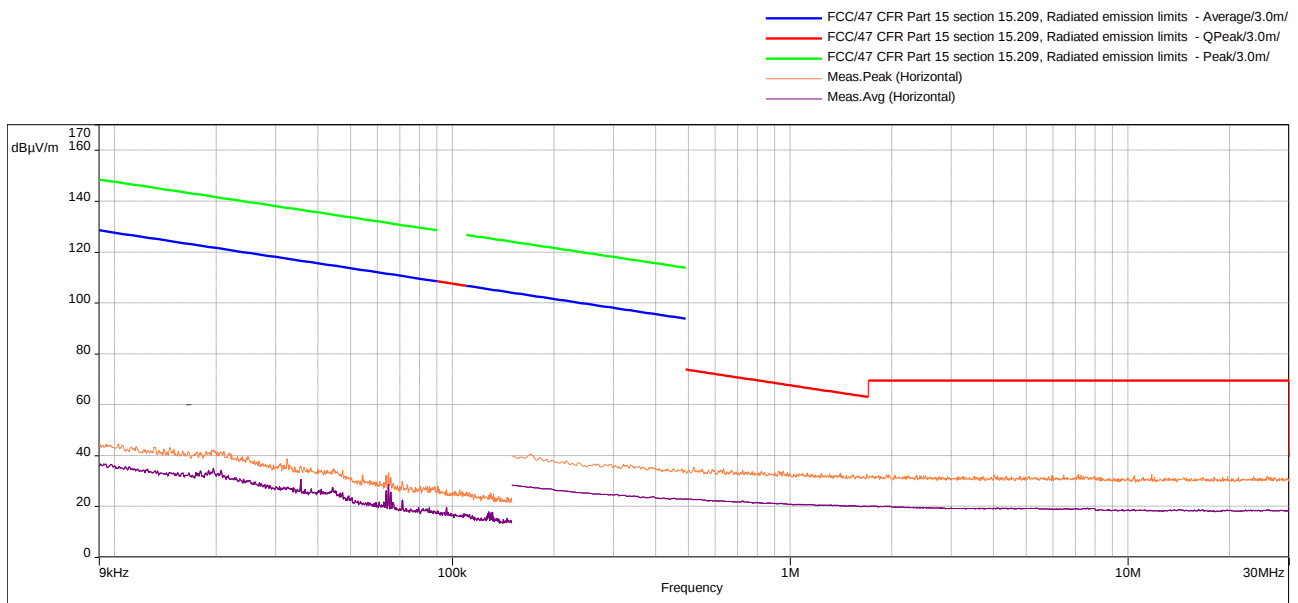
#### • Parallel Polarization



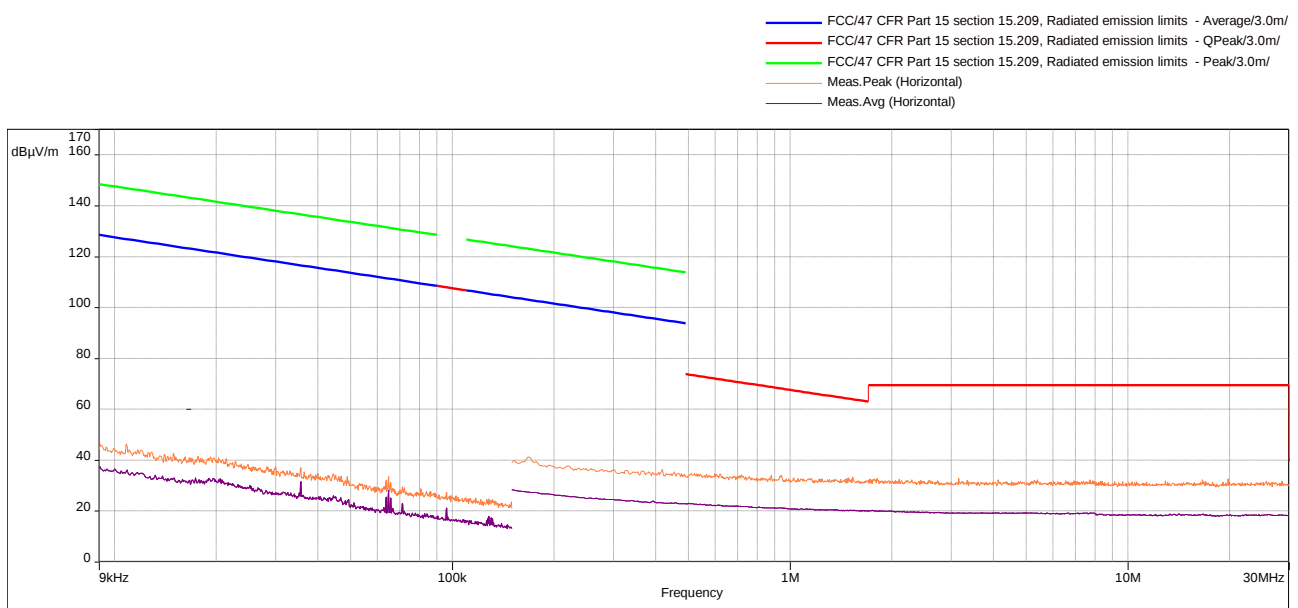
## MESSDOKUMENTATION TEST DOCUMENTATION

### – 9kHz to 30 MHz, highest channel

#### • Perpendicular Polarization



#### • Parallel Polarization



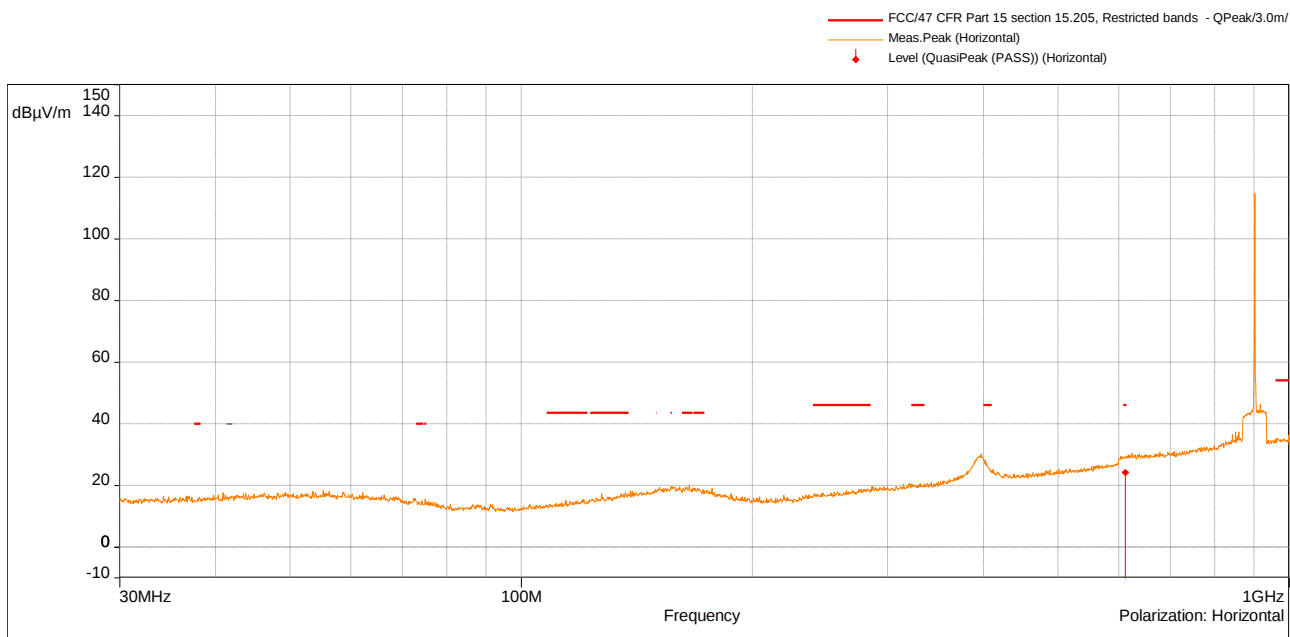
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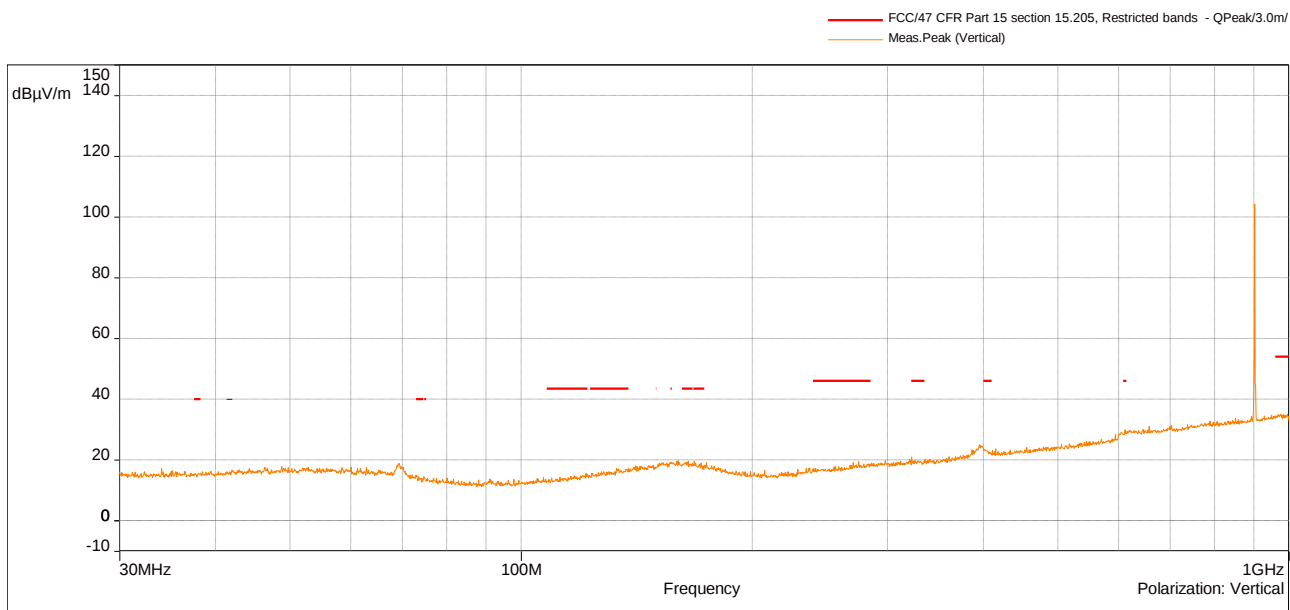
## MESSDOKUMENTATION TEST DOCUMENTATION

### – 30 MHz – 1 GHz , lowest channel

#### • Horizontal Polarization



#### • Vertical Polarization



| Frequency (MHz) | SR | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Azimuth (deg) | Height (m) | Pol.       | Meas. Time (s) | Correction (dB) |
|-----------------|----|----------------|----------------|-------------|---------------|------------|------------|----------------|-----------------|
| 611.67          | 1  | 24.22          | 46.00          | 21.78       | 259.9         | 4.00       | Horizontal | 1.00           | 23.83           |

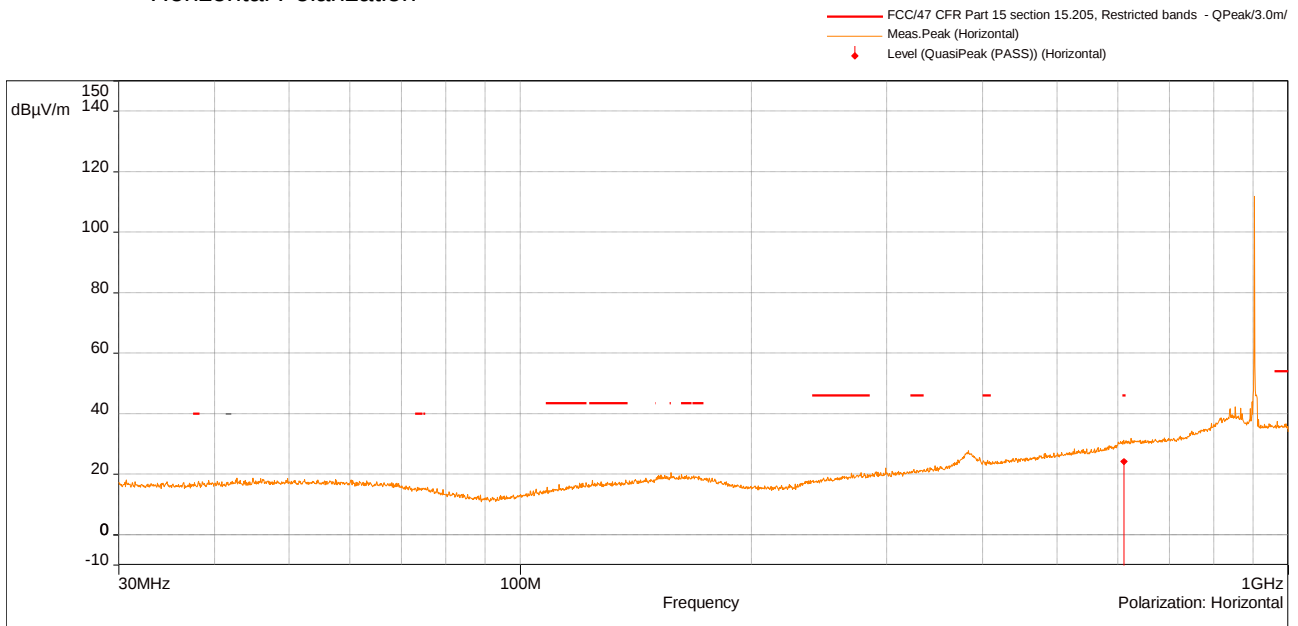
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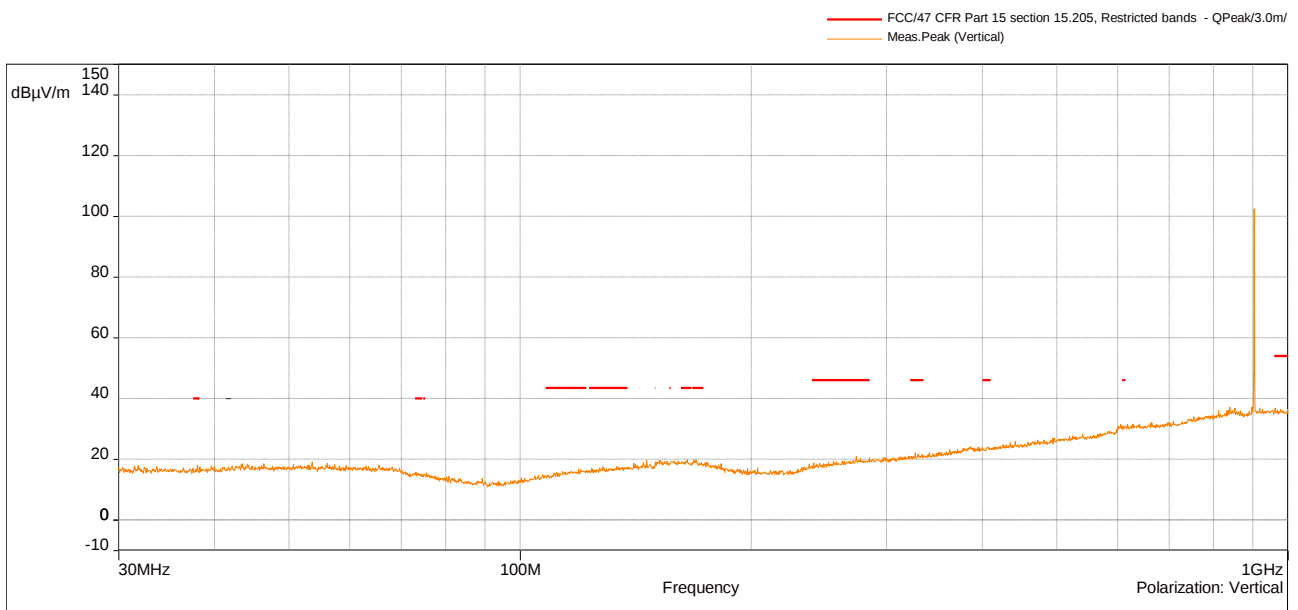
## MESSDOKUMENTATION TEST DOCUMENTATION

### – 30 MHz – 1 GHz , middle channel

#### • Horizontal Polarization



#### • Vertical Polarization



| Frequency (MHz) | SR | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Azimuth (deg) | Height (m) | Pol.       | Meas. Time (s) | Correction (dB) |
|-----------------|----|----------------|----------------|-------------|---------------|------------|------------|----------------|-----------------|
| 610.86          | 1  | 24.23          | 46.00          | 21.77       | 213.70        | 1.58       | Horizontal | 1.00           | 23.83           |

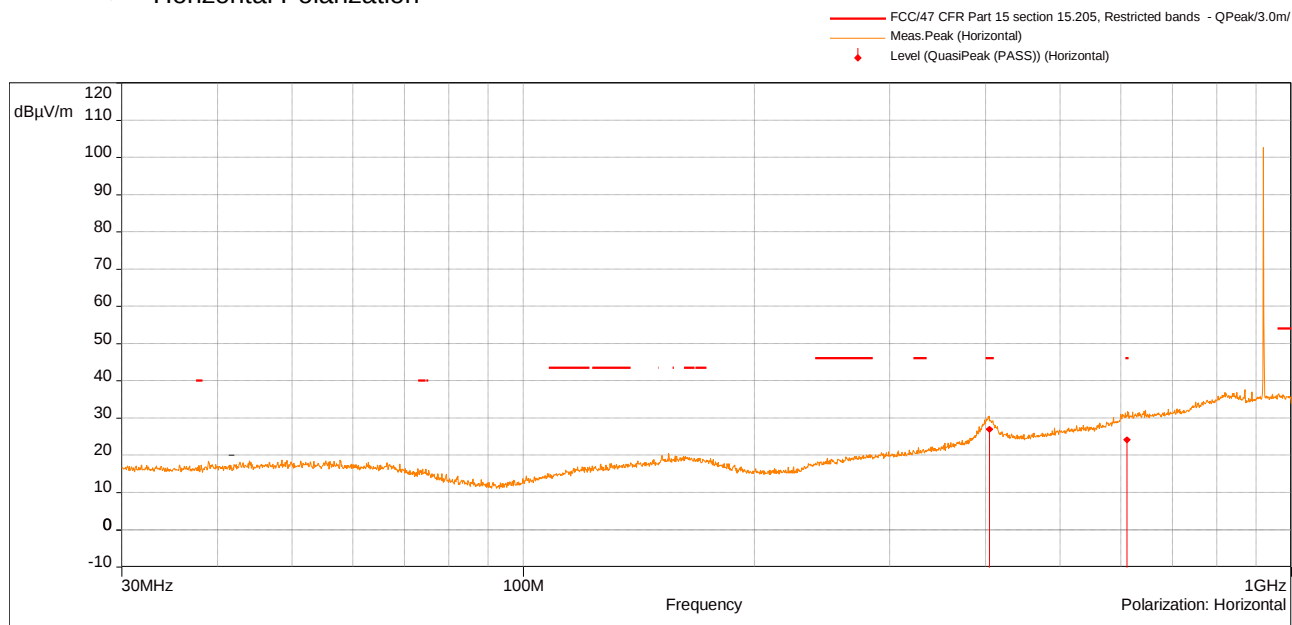
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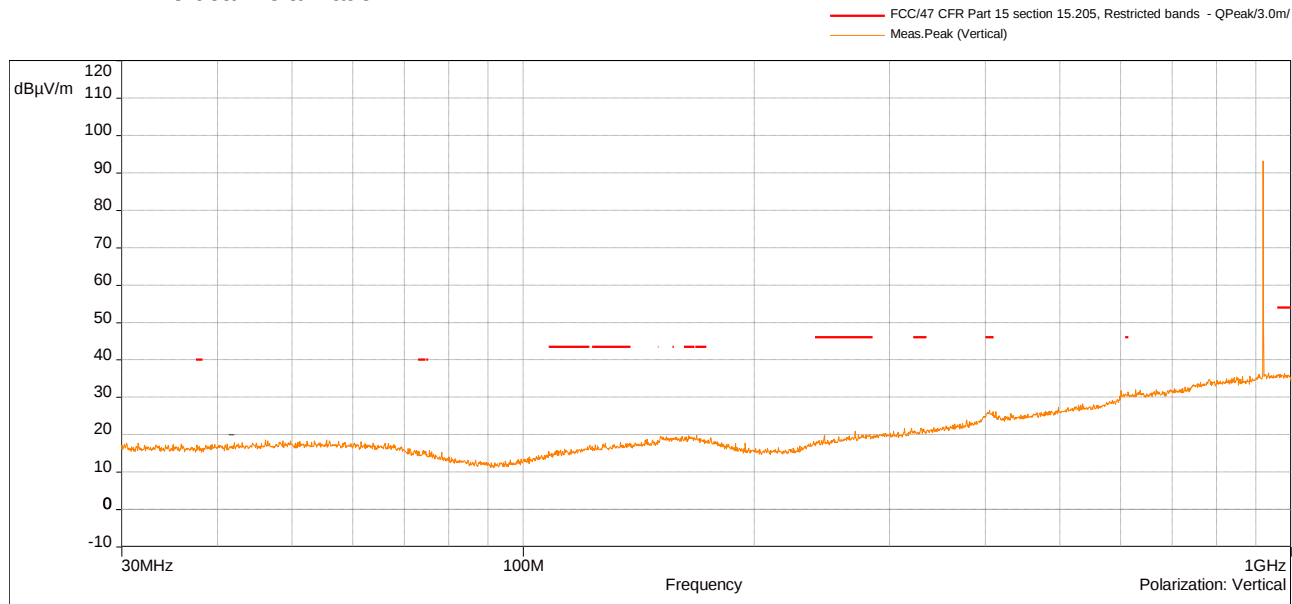
## MESSDOKUMENTATION TEST DOCUMENTATION

### – 30 MHz – 1 GHz , highest channel

#### • Horizontal Polarization



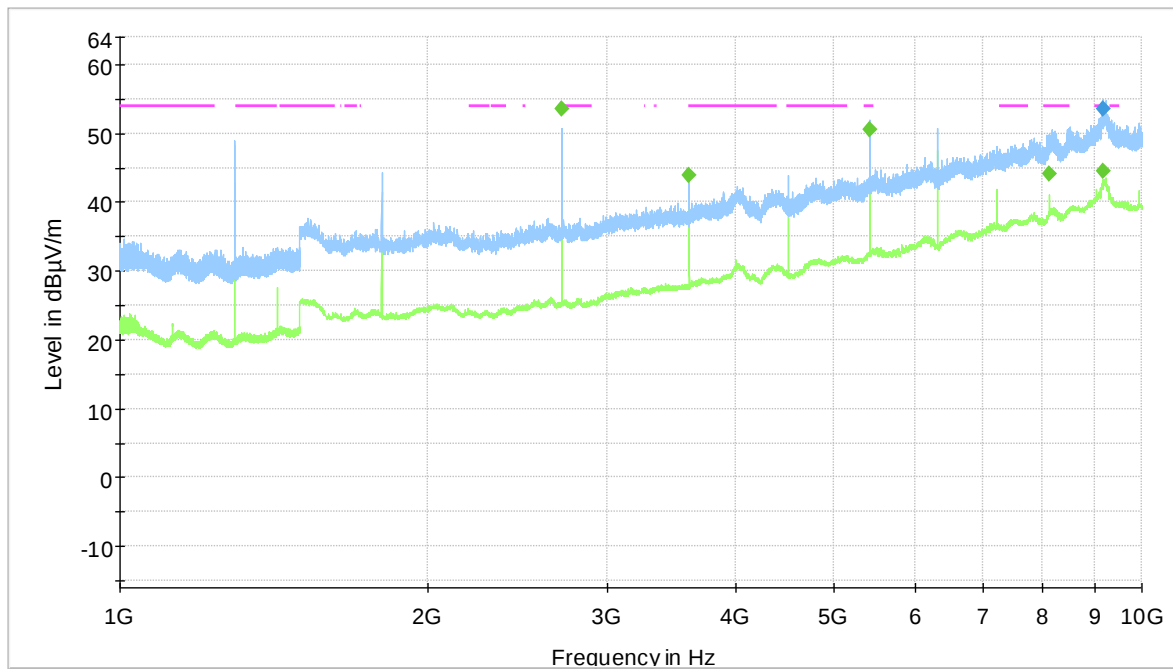
#### • Vertical Polarization



| Frequency (MHz) | SR | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Azimuth (deg) | Height (m) | Pol.       | Meas. Time (s) | Correction (dB) |
|-----------------|----|----------------|----------------|-------------|---------------|------------|------------|----------------|-----------------|
| 404.34          | 1  | 27.06          | 46.00          | 18.94       | 137.70        | 1.00       | Horizontal | 1.00           | 18.61           |
| 610.89          | 1  | 24.18          | 46.00          | 21.82       | 14.40         | 1.57       | Horizontal | 1.00           | 23.83           |

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### – 1-10 GHz , lowest channel

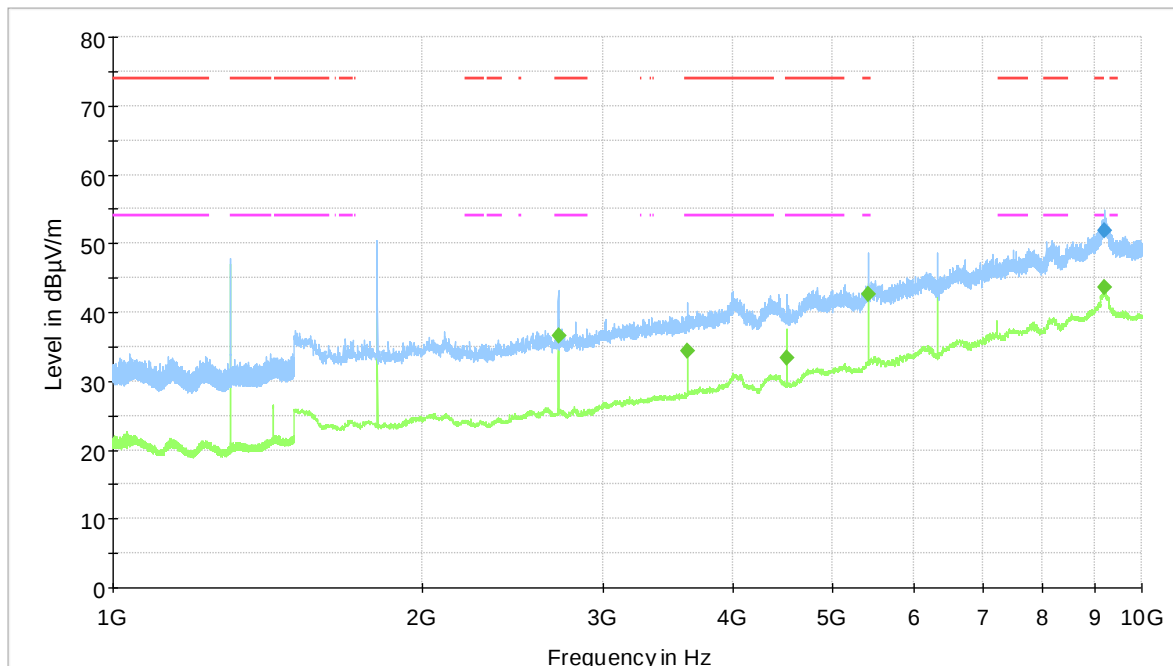


— Preview Result 2-AVG  
— FCC\_15C\_15.209\_Radiated\_Emissions\_Peak  
◆ Final\_Result PK+
 — Preview Result 1-PK+  
- - - FCC\_15C\_15.209\_Radiated\_Emissions\_Avg  
◆ Final\_Result AVG

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB/m) | Sig Path (dB) | Preamp (dB) | Trd Corr. (dB/m) | Raw Rec (dBµV) |
|-----------------|------------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|--------------|---------------|-------------|------------------|----------------|
| 2706.291667     | ---              | 53.55            | 54.00          | 0.45        | 10.0            | 1000.000        | 150.0       | H   | 259.0         | 113.0           | -2.4         | -32.1         | 0.0         | 29.7             | 56.0           |
| 3608.354167     | ---              | 43.88            | 54.00          | 10.12       | 10.0            | 1000.000        | 150.0       | V   | 156.0         | 344.0           | 0.8          | -31.2         | 0.0         | 32.0             | 43.1           |
| 5412.479167     | ---              | 50.59            | 54.00          | 3.41        | 10.0            | 1000.000        | 150.0       | V   | 143.0         | 49.0            | 6.6          | -28.0         | 0.0         | 34.6             | 44.0           |
| 8119.020833     | ---              | 44.12            | 54.00          | 9.88        | 10.0            | 1000.000        | 150.0       | H   | 219.0         | 51.0            | 13.0         | -23.4         | 0.0         | 36.4             | 31.1           |
| 9173.375000     | 53.52            | ---              | 74.00          | 20.48       | 10.0            | 1000.000        | 150.0       | V   | 338.0         | 113.0           | 17.9         | -18.9         | 0.0         | 36.7             | 35.7           |
| 9176.562500     | ---              | 44.48            | 54.00          | 9.52        | 10.0            | 1000.000        | 150.0       | V   | 338.0         | 109.0           | 17.9         | -18.8         | 0.0         | 36.7             | 26.6           |

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### – 1-10 GHz , middle channel

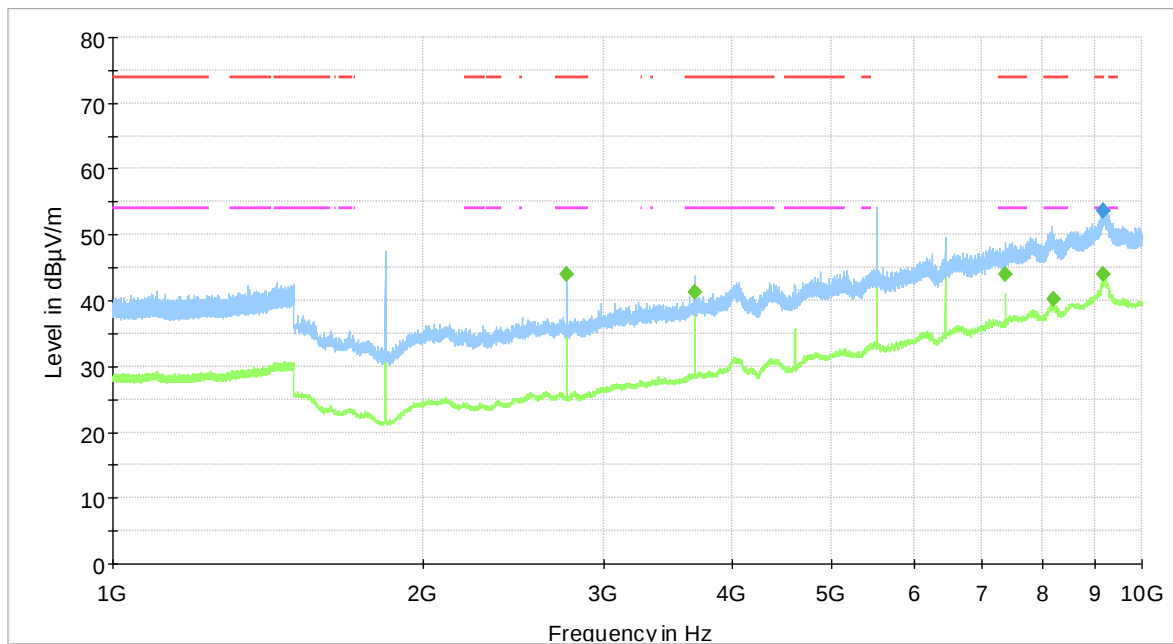


— Preview Result 2-AVG  
— FCC\_15C\_15.209\_Radiated\_Emissions\_Peak  
◆ Final\_Result PK+
 — Preview Result 1-PK+  
— FCC\_15C\_15.209\_Radiated\_Emissions\_Avg  
◆ Final\_Result AVG

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB/m) | Sig Path (dB) | Preamp (dB) | Trd Corr. (dB/m) | Raw Rec (dBµV) |
|-----------------|------------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|--------------|---------------|-------------|------------------|----------------|
| 2710.00000      | ---              | 36.65            | 54.00          | 17.35       | 10.0            | 1000.000        | 150.0       | V   | 195.0         | 330.0           | -2.4         | -32.1         | 0.0         | 29.6             | 39.1           |
| 3613.37500      | ---              | 34.33            | 54.00          | 19.67       | 10.0            | 1000.000        | 150.0       | H   | 22.0          | 314.0           | 0.9          | -31.2         | 0.0         | 32.1             | 33.4           |
| 4516.75000      | ---              | 33.39            | 54.00          | 20.61       | 10.0            | 1000.000        | 150.0       | V   | 308.0         | 34.0            | 3.4          | -30.1         | 0.0         | 33.5             | 30.0           |
| 5420.12500      | ---              | 42.57            | 54.00          | 11.43       | 10.0            | 1000.000        | 150.0       | V   | 255.0         | 45.0            | 6.4          | -28.2         | 0.0         | 34.6             | 36.2           |
| 9193.12500      | 51.95            | ---              | 74.00          | 22.05       | 10.0            | 1000.000        | 150.0       | H   | 112.0         | 67.0            | 17.4         | -19.3         | 0.0         | 36.8             | 34.5           |
| 9193.81250      | ---              | 43.71            | 54.00          | 10.29       | 10.0            | 1000.000        | 150.0       | V   | 157.0         | 276.0           | 17.4         | -19.3         | 0.0         | 36.8             | 26.3           |

## MESSDOKUMENTATION TEST DOCUMENTATION

### – 1-10 GHz , highest channel



— Preview Result 2-AVG  
\* MaxPeak-PK+  
— FCC\_15C\_15.209\_Radiated\_Emissions\_Peak  
◆ Final\_Result PK+

— Preview Result 1-PK+ Average-AVG  
\* Average-AVG  
— FCC\_15C\_15.209\_Radiated\_Emissions\_Avg  
◆ Final\_Result AVG

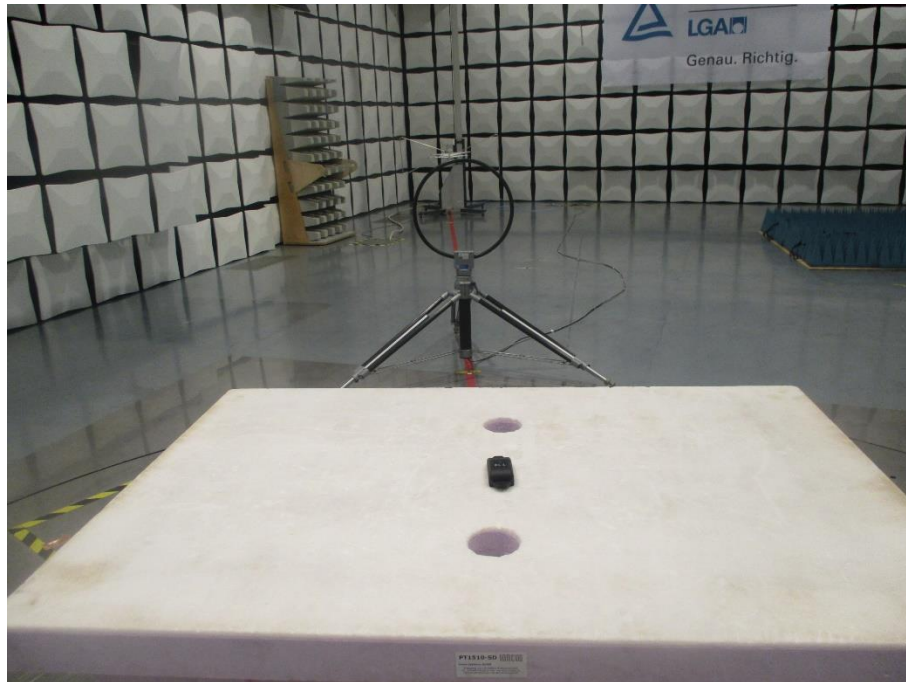
| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB/m) | Sig Path (dB) | Preamp (dB) | Trd Corr. (dB/m) | Raw Rec (dBµV) |
|-----------------|------------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|--------------|---------------|-------------|------------------|----------------|
| 2760.833333     | ---              | 44.06            | 54.00          | 9.94        | 10.0            | 1000.000        | 150.0       | H   | 241.0         | 104.0           | -2.7         | -32.1         | 0.0         | 29.5             | 46.7           |
| 3680.958333     | ---              | 41.16            | 54.00          | 12.84       | 10.0            | 1000.000        | 150.0       | V   | 84.0          | 76.0            | 1.4          | -31.0         | 0.0         | 32.4             | 39.8           |
| 7362.166667     | ---              | 43.94            | 54.00          | 10.06       | 10.0            | 1000.000        | 150.0       | V   | 112.0         | 87.0            | 11.0         | -24.6         | 0.0         | 35.6             | 32.9           |
| 8197.645833     | ---              | 40.21            | 54.00          | 13.79       | 10.0            | 1000.000        | 150.0       | H   | 222.0         | 87.0            | 13.2         | -23.3         | 0.0         | 36.6             | 27.0           |
| 9171.958333     | 53.53            | ---              | 74.00          | 20.47       | 10.0            | 1000.000        | 150.0       | H   | 112.0         | 113.0           | 17.8         | -18.9         | 0.0         | 36.7             | 35.7           |
| 9174.083333     | ---              | 43.94            | 54.00          | 10.06       | 10.0            | 1000.000        | 150.0       | H   | 49.0          | 30.0            | 17.9         | -18.9         | 0.0         | 36.7             | 26.1           |

Final Test Result

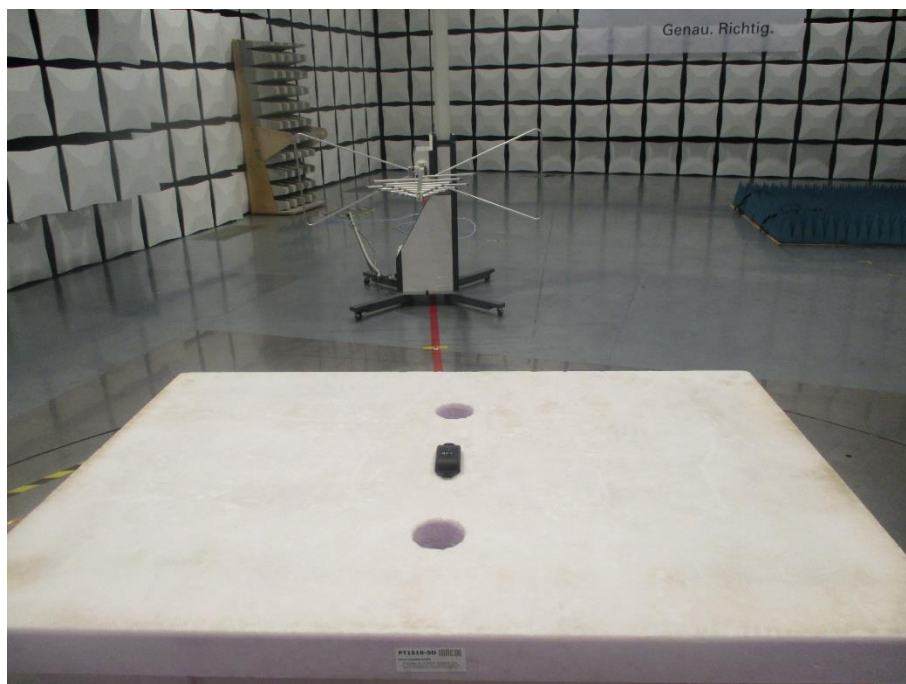
Pass

**FOTODOKUMENTATION**  
**PHOTO DOCUMENTATION**

**6 Test Setup Photos**



Test Setup: Radiated Measurements (9 kHz - 30 MHz)

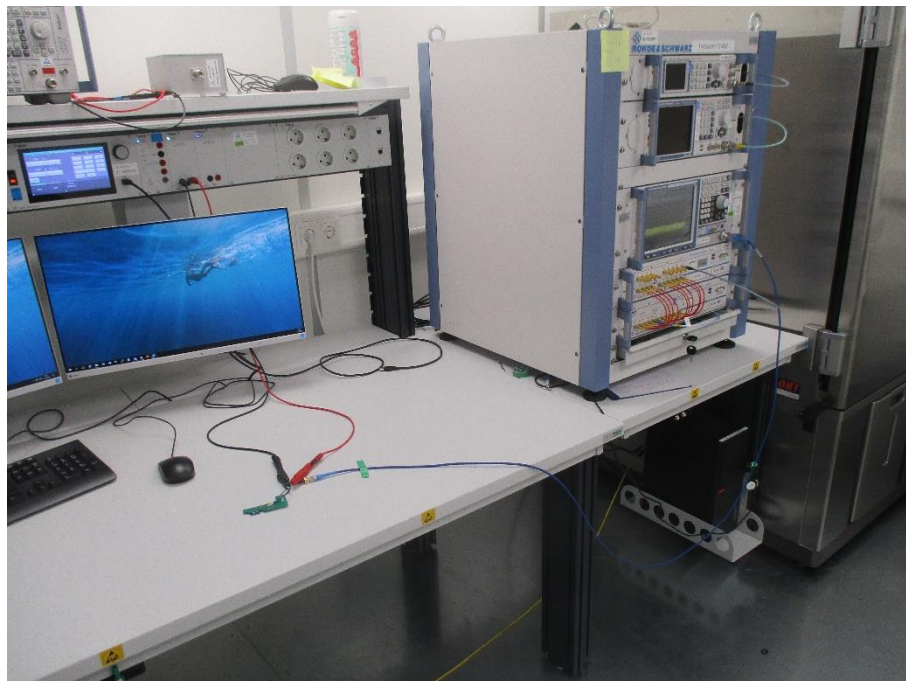


Test Setup: Radiated Measurements (30 MHz - 1 GHz)

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Test Setup: Radiated Measurements (1 GHz to 10 GHz)



Test Setup: Conducted Measurements

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Ende des Prüfberichts  
*End of Test Report*