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Test Report

Report Number:

F201483E2

Equipment under Test (EUT):

**“Bluetooth V 2.1 + EDR module” WT41U
inside dedicated host
“NT03 RMI”**

Applicant:

Topcon Electronics GmbH & Co. KG

Manufacturer:

Topcon Electronics GmbH & Co. KG



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **RSS-247 Issue 2 (March 2017)**, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- [4] **RSS-Gen Issue 5 (March 2019)**, General Requirements for Compliance of Radio Apparatus

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.

The complete test results are presented in the following.

| | | | |
|----------------------|---------------|--------------------------|------------|
| Test engineer: | Paul NEUFELD | <i>o.b.o. B. Neufeld</i> | 25.03.2021 |
| | Name | Signature | Date |
| Authorized reviewer: | Bernd STEINER | <i>B. Steiner</i> | 25.03.2021 |
| | Name | Signature | Date |

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1 Identification

1.1 Applicant

| | |
|--|--------------------------------------|
| Name: | Topcon Electronics GmbH & Co.KG. |
| Address: | Industriestrasse 7, 65366 Geisenheim |
| Country: | Germany |
| Name for contact purposes: | Mr. Thomas BERENZ |
| Phone: | +49 6722 4026 585 |
| eMail Address: | tberenz@topcon.com |
| Applicant represented during the test by the following person: | none |

1.2 Manufacturer

| | |
|--|--------------------------------------|
| Name: | Topcon Electronics GmbH & Co.KG. |
| Address: | Industriestrasse 7, 65366 Geisenheim |
| Country: | Germany |
| Name for contact purposes: | Mr. Thomas BERENZ |
| Phone: | +49 6722 4026 585 |
| eMail Address: | tberenz@topcon.com |
| Applicant represented during the test by the following person: | none |

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkKS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-05 and D-PL-17186-01-06, FCC Test Firm Accreditation designation number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment Under Test) inside dedicated host “Operator Panel NT03 RMI”

| | |
|--|--------------------------------------|
| Test object: * | class 1, Bluetooth® 2.1 + EDR module |
| Type / PMN: * | WT41U |
| FCC ID: * | WR4-WT41UN |
| IC: * | 6050B-WT41UN |
| Serial number: * | 1927AHEDBV7 |
| HVIN (Hardware Version Identification Number): * | WT41U |
| FVIN (Firmware Version Identification Number): * | - |
| Hardware version: * | WT41u-N |
| Software version: * | iWRAP 5.6 |

1.5 Dedicated Host (Equipment Under Test)

| | |
|--|---|
| Test object: * | Operator Panel NT03 RMI |
| HMN: * | NT03 RMI |
| FCC ID: * | - |
| IC certification number: * | - |
| Serial number: * | 2041041AC |
| EUT marking: * | OPNT03MF2CAN000 |
| PCB identifier: * | APNT03MBF01_AC |
| HVIN (Hardware Version Identification Number): * | - |
| FVIN (Firmware Version Identification Number): * | - |
| Hardware version: * | AC |
| Software version (Test FW): * | 4.1.15-nt03-2.1.1-1 / NT03 Test App (Build Oct 22 2020) |
| Software version (Final EUT): * | Will be provided by OEM integrator |
| Lowest / highest Internal clock frequency: * | 32.768 kHz / 2480 MHz |

*as declared by the applicant

Note: Phoenix Testlab GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

Classic Bluetooth radio channels:

| | | | | |
|------------|-----|----------|-----|----------|
| Channel 0 | RX: | 2402 MHz | TX: | 2402 MHz |
| Channel 39 | RX: | 2441 MHz | TX: | 2441 MHz |
| Channel 78 | RX: | 2480 MHz | TX: | 2480 MHz |

1.6 Technical Data of Equipment

| | | | | | | |
|-----------------------------|---|-----------|--------------------|----------|--------------------|-----------|
| Fulfills specifications: * | Bluetooth® 2.1 + EDR | | | | | |
| Antenna type: * | 2.4GHz Flex PCB Antenna with 105mm 1.37 coaxial cable | | | | | |
| Antenna name: * | FXP76B.07.0105C.et | | | | | |
| Antenna gain (peak): * | 3.8 dBi | | | | | |
| Antenna connector: * | IPEX MHFI (U.FL) on Main PCB | | | | | |
| Supply voltage EUT: * | U _{nom} = | 12.0 V DC | U _{min} = | 5.5 V DC | U _{max} = | 16.0 V DC |
| Type of modulation: * | 1 Mbps: GFSK 2 Mbps: $\pi/4$ -DQPSK 3 Mbps: 8DPSK | | | | | |
| Operating frequency range:* | 2402 – 2480 MHz | | | | | |
| Number of channels: * | 79 | | | | | |
| Temperature range: * | -20 °C to +70 °C | | | | | |

* Declared by the applicant

| Equipment used for testing | |
|---|--|
| Cables (attached to EUT but not connected during the test): | <ul style="list-style-type: none"> - 4 x CAN - RS232 - Automotive Ethernet - 2 x digital output - 1 x frequency input - 1 x analog input |
| Cable (DC power supply): | <ul style="list-style-type: none"> - DC power supply buffered by 12 V car battery inside the anechoic chamber |

*1 Provided by the laboratory

*2 Provided by the applicant

1.7 Dates

| | |
|---------------------------------|------------|
| Date of receipt of test sample: | 27.10.2020 |
| Start of test: | 11.11.2020 |
| End of test: | 11.11.2020 |

2 Operational States

The EUT is a Bluetooth classic + EDR module inside an operator panel "NT03 RMI", which is intended solely for agricultural automotive machinery with multiple digital and analogue interfaces.

The EUT is a full modular approved Bluetooth classic + EDR module. The module is integrated into the dedicated host using a trace design leading from the Bluetooth module to an U.FL connector on the back of the PCB. Connected to the U.FL connector is a FXP76B.07.0105C.et antenna, which also is clipped to the PCB. See the photographs of the trace design and the antenna below:

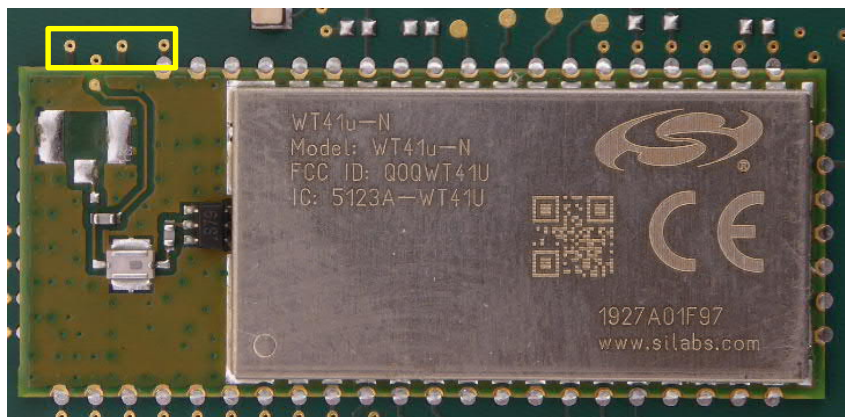


Figure 1: Bluetooth module on the back of the PCB with antenna trace (see yellow square – trace to U.FL connector on the other side of the PCB)

The photograph above shows the module during the test. The finale module will be labelled as shown below:



Figure 2: Bluetooth module with final label (as declared by the applicant)

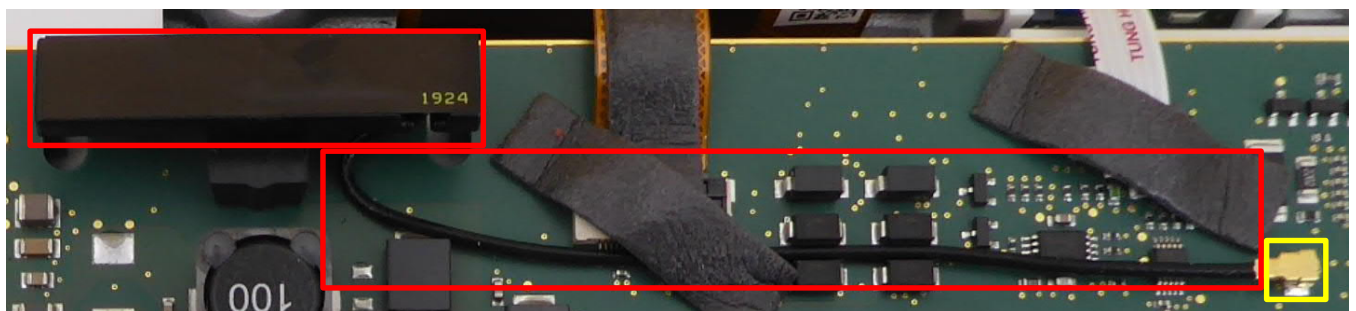


Figure 3: Antenna with U.FL cable (red squares) + trace design on the top of the PCB (U.FL connector + trace from the module on the other side of the PCB [yellow square])

During the test a special test firmware was installed on the dedicated host. The test mode was started using a Bluetooth test menu, that was located on the start screen of the dedicated host and could be accessed via touchpad commands.

During the tests the dedicated host was supplied with 5 V DC via the AC/DC power supply provided by the applicant.

Power Settings for all measurements:

| Modulation | Power setting ch. 0 - 78 |
|--------------|--------------------------|
| GFSK, 1 Mbps | 127* |

* binary power setting at the EUT. Setting of this power settings produced output power slightly lower than the conducted power values listed in the original report for the module (report 286025-2 by Silicon Laboratories Finland Oy). Taking into consideration the trace design, it can be assumed that this maximum power setting is implemented by the module manufacturer to prevent the exceeding of the maximum tested power setting for all integrators of the module. Setting the settings as documented in the test report (46), lead to much lower power output than in the original report (~ 7 dB lower than in the original report).

| Operation mode | Description of the operation mode | mode | channel | Modulation | Data rate / Mbps |
|----------------|-------------------------------------|-------------------|---------|------------|------------------|
| 1 | Continuous transmitting on 2402 MHz | Classic Bluetooth | 0 | GFSK | 1 Mbps |
| 2 | Continuous transmitting on 2441 MHz | Classic Bluetooth | 39 | GFSK | 1 Mbps |
| 3 | Continuous transmitting on 2480 MHz | Classic Bluetooth | 78 | GFSK | 1 Mbps |

3 Additional Information

All tests were performed using an unmodified EUT.

4 Overview

| Application | Frequency range [MHz] | FCC 47 CFR Part 15 section [2] | RSS-247 [3] or RSS-Gen [4] | Status | Refer page |
|------------------------------------|-----------------------|--|---------------------------------|------------------------------|------------|
| Maximum conducted output power | 2400.0 - 2483.5 | 15.247 (b) (3), (4) | 5.4 (d) [3] | Passed | 10 et seq. |
| DTS Bandwidth / 99% Bandwidth | 2400.0 - 2483.5 | 15.247 (a) (2) | 5.2 (a) [3] | Not tested* ² | |
| Maximum Power Spectral Density | 2400.0 - 2483.5 | 15.247 (e) | 5.2 (b) [3] | Not tested* ² | |
| Band edge compliance | 2400.0 - 2483.5 | 15.247 (d) 15.205 (a) 15.209 (a) | 5.5 [3] | Passed* | |
| Maximum unwanted emissions | 0.009 – 26,500 | 15.247 (d) 15.205 (a) 15.209 (a) | 5.5 [3] 8.9 [4], 8.10 [4] | Passed* | 13 et seq. |
| Conducted emissions on supply line | 0.15 - 30 | 15.207 (a) | 8.8 [4] | Not applicable* ³ | |

* Only the worst case from the original test report for the C2PC of the Bluetooth module was tested. The original test report has the test report number 53513RRF.001A1 by DEKRA Testing and Certification, S.A.U.

*² Not tested, because not ordered by the applicant.

*³ Not applicable, because the EUT is integrated in dedicated host device exclusively used in agricultural automotive machineries.

5 Results

5.1 Duty cycle

Since the EUT was transmitting with 100 % duty cycle without gaps, not duty cycle measurement was necessary.

5.2 Maximum peak conducted output power

5.2.1 Method of measurement

The test was performed conducted at the U.FL antenna connector of the dedicated host.

Acceptable measurement configurations

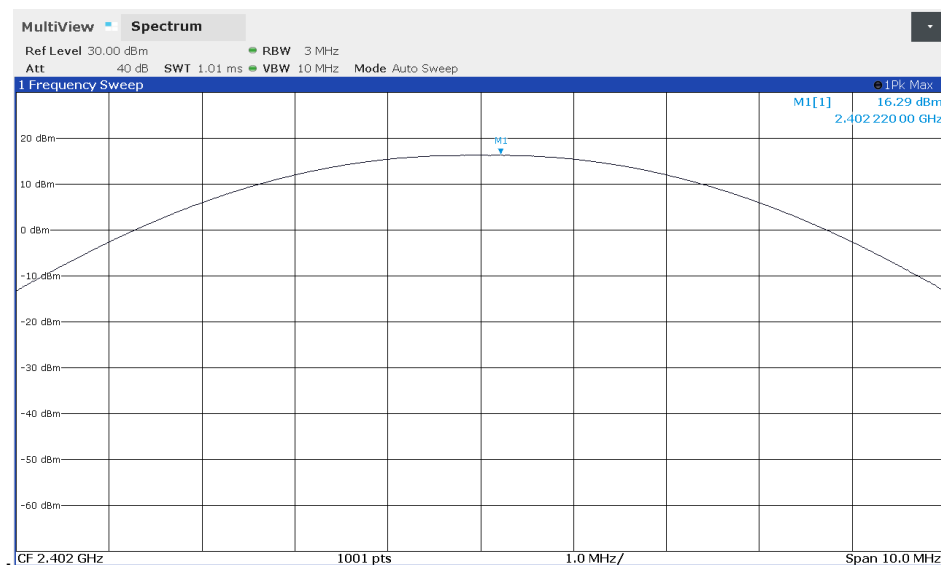
Procedure 11.9.1.1 in [1] was used for the following test.

The measurement was performed at the upper and lower end and the middle of the assigned frequency band.

5.2.2 Test results

| | |
|---------------------|-------|
| Ambient temperature | 22 °C |
|---------------------|-------|

| | |
|-------------------|------|
| Relative humidity | 62 % |
|-------------------|------|



| Operation mode | Reading [dBm] | Corr. Fact. [dB] | Peak output power [dBm] | Limit [dBm] | Result |
|----------------|---------------|------------------|-------------------------|-------------|--------|
| 1 | 16.29 | 0.3 | 16.59 | 30 | passed |
| 2 | 16.14 | 0.3 | 16.44 | 30 | passed |
| 3 | 14.76 | 0.3 | 15.06 | 30 | passed |

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

1

5.3 Band-edge compliance

5.3.1 Method of measurement (band edges next to restricted bands (radiated))

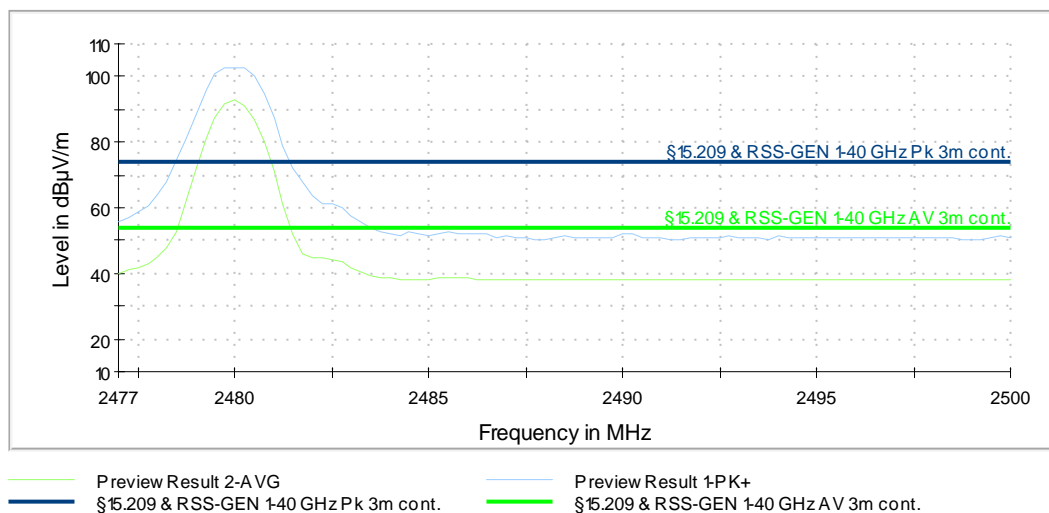
The EUT was measured radiated in the anechoic chamber using the procedures described in 5.4.1.

Acceptable measurement configurations

The same measurement configurations as described in 5.4.1. were used for the preview and final measurement.

5.3.2 Test result (band edges next to restricted bands (radiated))

15C 2,39-2,5G ch78 DH5: radiated band-edge compliance at a restricted band-edge (operation mode 3):



Transmitter operates at the upper end of the assigned frequency band (operation mode 3 GFSK)

| Frequency [MHz] | MaxPeak [dBµV/m] | Coverage [dBµV/m] | Limit [dBµV/m] | Margin (dB) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-------------------------|------------------|-------------------|----------------|-------------|-----|---------------|-----------------|------------|
| 2483.500000 | 53.91 | --- | 74.00 | 20.09 | H | 135.0 | 90.0 | 34.6 |
| 2483.500000 | --- | 37.68 | 54.00 | 16.32 | H | 135.0 | 90.0 | 34.6 |
| Measurement uncertainty | | | | +/- 5.12 dB | | | | |

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

2 – 9

5.4 Maximum unwanted emissions

5.4.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five stages.

- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range above 1 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range above 1 GHz.

Preliminary and final measurement (1 GHz to 40 GHz)

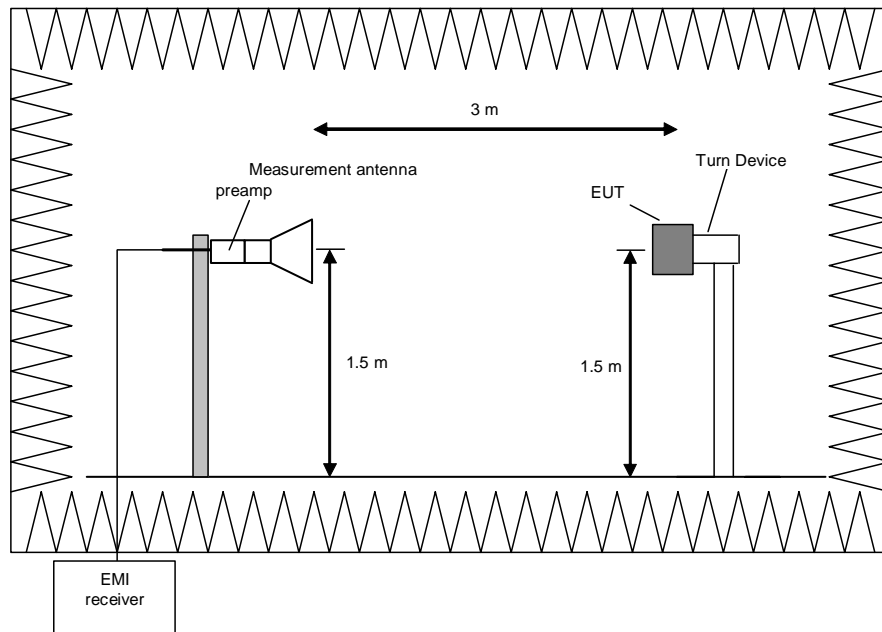
This measurement will be performed in a semi-anechoic chamber with floor absorbers. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

| Frequency range | Resolution bandwidth |
|-------------------------|----------------------|
| 1 GHz to 4 GHz | 1 MHz |
| 4 GHz to 12 GHz | 1 MHz |
| 12 GHz to 18 GHz | 1 MHz |
| 18 GHz to 25 / 26.5 GHz | 1 MHz |
| 26.5 GHz to 40 GHz | 1 MHz |



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

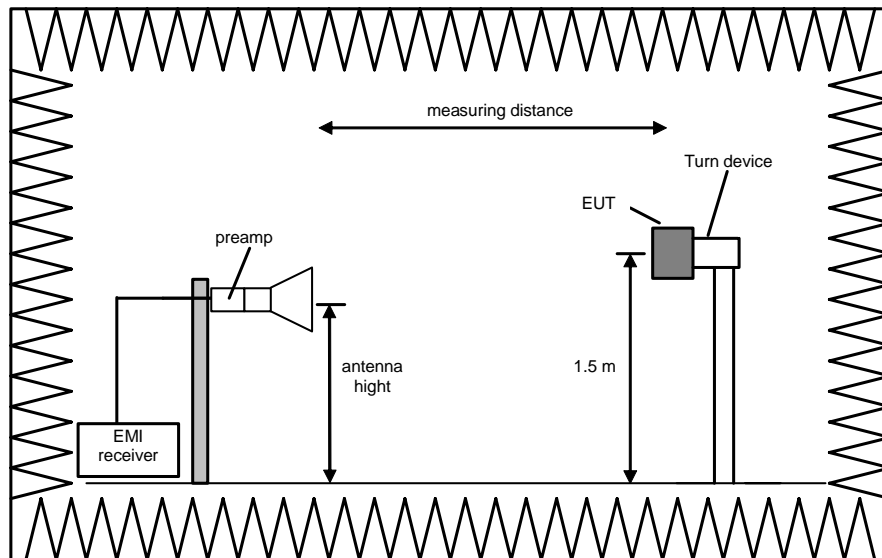
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0°.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. Measure the azimuth of the detected emissions with slower speed on the single to increase the accuracy and note the azimuth value.
8. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

The resolution bandwidth of the EMI Receiver will be set to the following values:

| Frequency range | Resolution bandwidth |
|-------------------------|----------------------|
| 1 GHz to 4 GHz | 1 MHz |
| 4 GHz to 12 GHz | 1 MHz |
| 12 GHz to 18 GHz | 1 MHz |
| 18 GHz to 25 / 26.5 GHz | 1 MHz |
| 26.5 GHz to 40 GHz | 1 MHz |



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 GHz.

The following procedure will be used:

- 1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with peak and average detector activated.
- 4) Note the highest displayed peak and average values
- 5) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.4.2 Test results (radiated emissions) with internal antenna from 1 GHz – 26.5 GHz

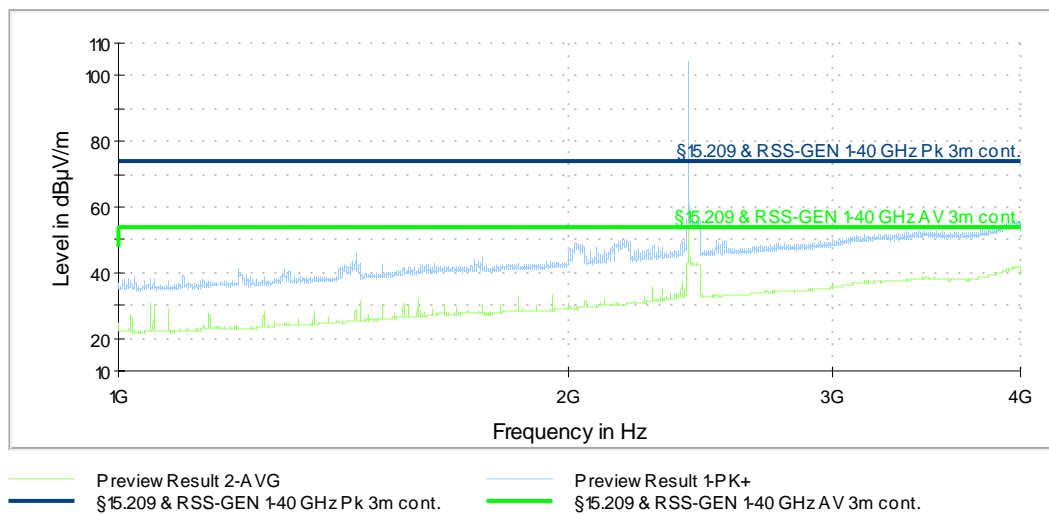
5.4.2.1 Preliminary radiated emission measurement 1 GHz – 26.5 GHz

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 22 °C | Relative humidity | 59 % |
|---------------------|-------|-------------------|------|

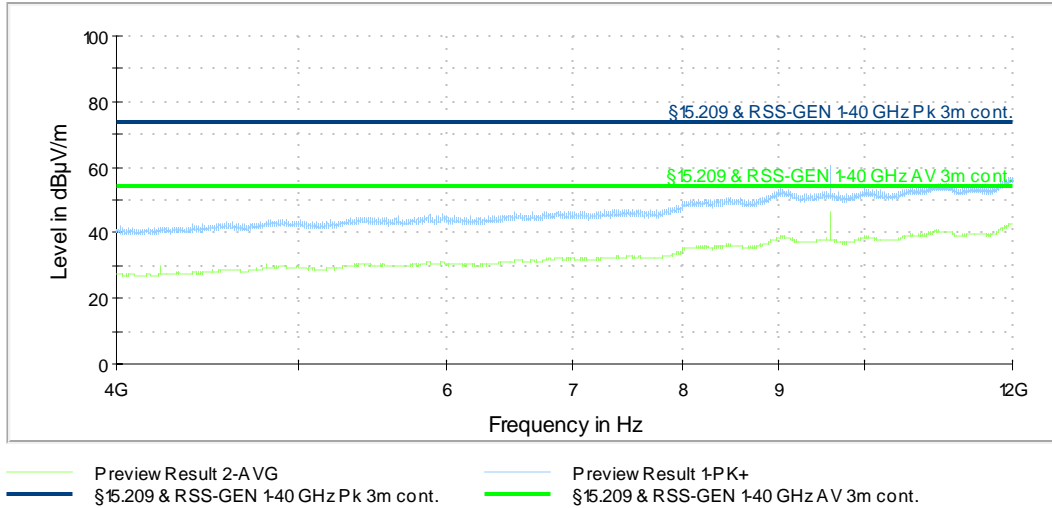
- Position of EUT: The EUT was set-up on an EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.
- Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.
- Test record: All plots and results are submitted below.
- Remark: Since no significant emissions were found in the original report below 1 GHz, only emission above 1 GHz were tested in the following.

Plots of the worst case transmitter spurious emissions

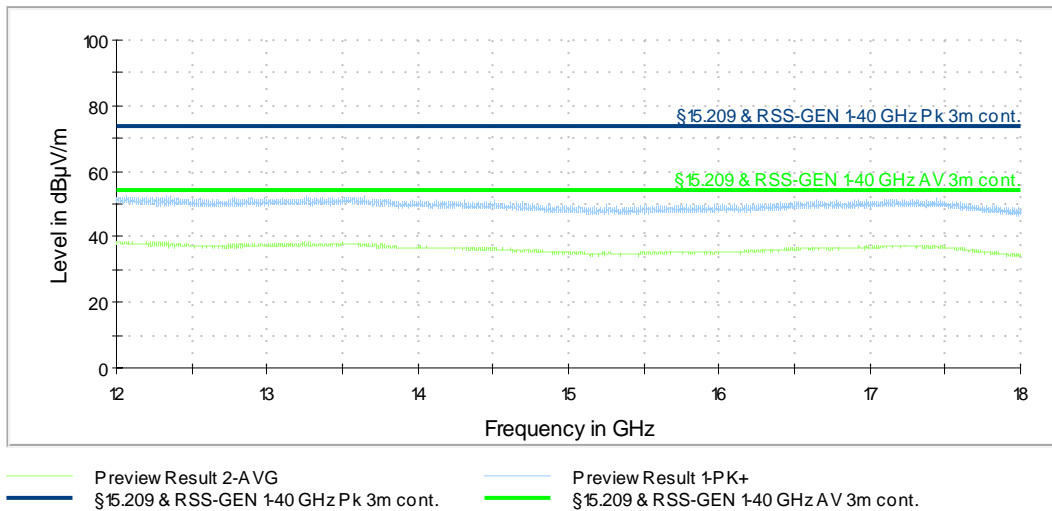
15C 1-4G ch0 DH5: Spurious emissions from 1 GHz to 4 GHz (operation mode 1)



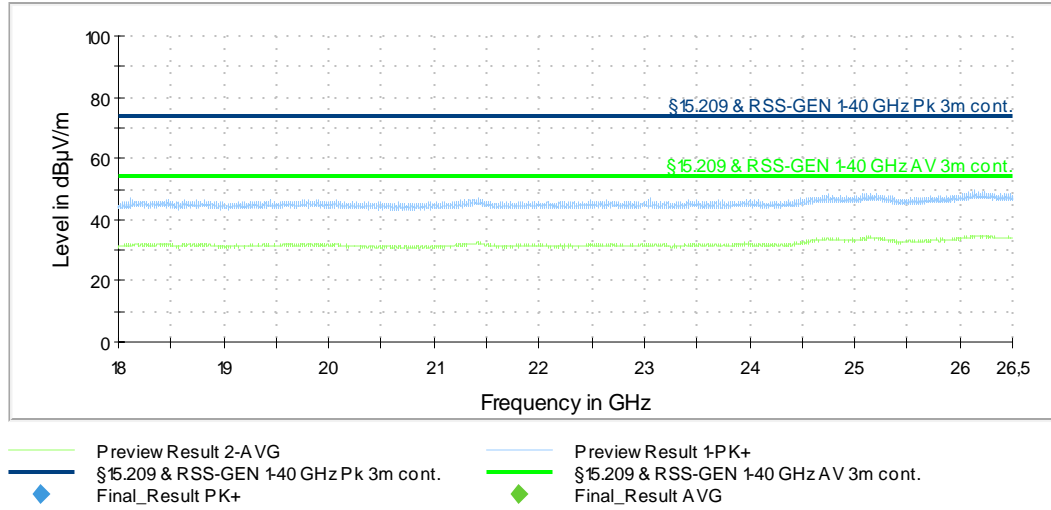
15C 4-12G ch0 DH5: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



15C 12-18G ch0 DH5: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



15C 18-26.5G ch0 DH5: Spurious emissions from 18 GHz to 26.5 GHz (operation mode 1):



5.4.2.2 Final radiated measurements

Transmitter operates at the lower end of the assigned frequency band (operation mode 1, GFSK)

| Frequency [MHz] | MaxPeak [dB μ V/m] | Coverage [dB μ V/m] | Limit [dB μ V/m] | Margin (dB) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-------------------------|------------------------|-------------------------|----------------------|-------------|-----|---------------|-----------------|------------|
| 1050.000 | --- | 25.36 | 54.00 | 28.65 | H | 191.0 | 30.0 | 25.5 |
| 1050.000 | 36.94 | --- | 74.00 | 37.06 | H | 191.0 | 30.0 | 25.5 |
| 1949.550 | 43.41 | --- | 74.00 | 30.59 | V | 60.0 | 150.0 | 31.9 |
| 1949.550 | --- | 31.66 | 54.00 | 22.34 | V | 60.0 | 150.0 | 31.9 |
| 2375.900 | --- | 37.55 | 54.00 | 16.45 | H | 196.0 | 60.0 | 34.3 |
| 2375.900 | 50.82 | --- | 74.00 | 23.18 | H | 196.0 | 60.0 | 34.3 |
| 2386.350 | --- | 35.67 | 54.00 | 18.33 | H | 202.0 | 60.0 | 34.3 |
| 2386.350 | 50.47 | --- | 74.00 | 23.53 | H | 202.0 | 60.0 | 34.3 |
| 2401.800 | --- | 94.40 | Fund. | - | H | 197.0 | 60.0 | 34.4 |
| 2401.800 | 104.86 | --- | Fund. | - | H | 197.0 | 60.0 | 34.4 |
| 3994.150 | 54.80 | --- | 74.00 | 19.20 | H | 237.0 | 30.0 | 40.3 |
| 3994.150 | --- | 42.75 | 54.00 | 11.25 | H | 237.0 | 30.0 | 40.3 |
| 4224.050 | --- | 28.57 | 54.00 | 25.43 | H | 333.0 | 60.0 | 6.1 |
| 4224.050 | 40.28 | --- | 74.00 | 33.72 | H | 333.0 | 60.0 | 6.1 |
| 4751.750 | 41.74 | --- | 74.00 | 32.26 | H | 94.0 | 60.0 | 8.1 |
| 4751.750 | --- | 28.99 | 54.00 | 25.01 | H | 94.0 | 60.0 | 8.1 |
| 4804.150 | 42.48 | --- | 74.00 | 31.52 | H | 96.0 | 60.0 | 8.7 |
| 4804.150 | --- | 30.17 | 54.00 | 23.83 | H | 96.0 | 60.0 | 8.7 |
| 9607.250 | --- | 45.45 | 54.00 | 8.55 | V | 236.0 | 120.0 | 17.7 |
| 9607.250 | 60.77 | --- | 74.00 | 13.23 | V | 236.0 | 120.0 | 17.7 |
| Measurement uncertainty | | | | +/- 5.12 dB | | | | |

TEST EQUIPMENT USED FOR THE TEST:

2 - 15

6 Test equipment and ancillaries used for tests

| No. | Test equipment | Type | Manufacturer | Serial No. | PM. No. | Cal. Date | Cal. Due |
|-----|---|------------------------|------------------------|----------------------------|---------|---------------------------|----------|
| 1 | Signal & Spektrum Analysator | FSW43 | Rohde & Schwarz | 100586 & 100926 | 481720 | 17.03.2020 | 03.2022 |
| 2 | Positioner | TG1.5-10kg | Maturo | 110/2648.01 | 483042 | Calibration not necessary | |
| 3 | Semi anechoic chamber | M276 | Albatross Projects | C62128-A540-A138-10-0006 | 483227 | Calibration not necessary | |
| 4 | Antenna mast | BAM4.5-P-10kg | maturo | 222/2612.01 | 483225 | Calibration not necessary | |
| 5 | Turntable | | Deisel | 412/316 | 480087 | Calibration not necessary | |
| 6 | Controller | HD100 | Deisel | 100/349 | 480139 | Calibration not necessary | |
| 7 | Software | EMC32 | Rohde & Schwarz | ID: 1300.7010.12-100970-Be | 482972 | Calibration not necessary | |
| 8 | Log Per Antenne | HL050 | Rohde & Schwarz | - | 482977 | 13.08.2019 | 08.2022 |
| 9 | EMI Testreceiver | ESW | Rohde & Schwarz | 101828 | 482979 | 12.04.2019 | 04.2021 |
| 10 | Low Noise Amplifier | LNA-30-00101800-25-10P | Narda-Miteq | 2110917 | 482967 | 18.02.2020 | 02.2022 |
| 11 | High-pass filter | WHKX4.0/18G-8SS | Wainwright Instruments | 1 | 480587 | Calibration not necessary | |
| 12 | Standard Gain Horn 11.9 GHz – 18 GHz | 18240-20 | Flann Microwave | 483 | 480294 | Calibration not necessary | |
| 13 | Standard Gain Horn 17.9 GHz – 26.7 GHz | 20240-20 | Flann Microwave | 411 | 480297 | Calibration not necessary | |
| 14 | Preamplifier | JS3-12001800-16-5A | Miteq | 571667 | 480343 | 13.02.2020 | 02.2022 |
| 15 | Preamplifier | JS3-18002600-20-5A | Miteq | 658697 | 480342 | 13.02.2020 | 02.2022 |

7 Test site Validation

| Test equipment | PM. No. | Frequency range | Type of validation | According to | Val. Date | Val Due |
|-------------------------------|---------|-----------------|--------------------|---|------------|------------|
| Semi anechoic chamber M276 | 483227 | 30 – 1000 MHz | NSA | ANSI C63.4-2017 | 19.09.2019 | 18.09.2021 |
| Semi anechoic chamber M276 | 483227 | 1 -18 GHz | SVSWR ¹ | CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017 | 19.09.2019 | 18.09.2021 |

8 Report History

| Report Number | Date | Comment |
|---------------|------------|---------------------|
| F201483E2 | 17.03.2021 | Initial Test Report |
| - | - | - |
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9 List of Annexes

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|---------|-------------------|---------|
| ANNEX A | TEST SETUP PHOTOS | 5 pages |
| ANNEX B | EXTERNAL PHOTOS | 7 pages |
| ANNEX C | INTERNAL PHOTOS | 7 pages |