



DELTA Test Report



TEST Reg. no. 19

Radio parameter test of CSN Bluetooth Low Energy 4.2 Sensor Node according to FCC specifications

Performed for **Pirelli Tyre S.p.A**

DANAK-19/18416 Revision A

Project no.: 117-28082-3

Page 1 of 37

25 October 2017

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| | |
|-----------------------|--|
| Title | Radio parameter test of CSN Bluetooth Low Energy 4.2 Sensor Node according to FCC specifications |
| Test object | CSN Bluetooth Low Energy 4.2 Sensor Node according to FCC specifications |
| Report no. | DANAK-19/18416 Revision A |
| Project no. | 117-28082-3 |
| Test period | 11 September to 19 September 2017 |
| Client | Pirelli Tyre LLC 100 Pirelli Drive Rome Georgia 30161-7000, USA Tel.: 1-800-PIRELLI (800-747-3554) |
| Contact person | Stephanie Dattilo E-mail: Stephanie.dattilo@pirelli.com |
| Manufacturer | Pirelli Tyre S.p.A |
| Specifications | 47 CFR Part 15, Subpart C (Specific rule part §15.249) |
| Results | The test object was found to be in compliance with the specifications |
| Test personnel | Peter Wolf Frandsen |
| Test site | DELTA – a part of FORCE Technology, Venlighedsvej 4, 2970 Hørsholm, Denmark |

Date 25 October 2017

Project Manager 

Peter Wolf Frandsen
Specialist, EMC
DELTA – a part of FORCE Technology

Responsible 

Peter Wolf Frandsen
Specialist, EMC
DELTA – a part of FORCE Technology

This test report replaces previously issued test report 117-28082-3 dated 18 October 2017.
The changes in this report are:

On the pages 1, 2, 6, 7, and 9, TSN has been changed to CSN.
In all the tables in Section 4 - the name of the 'Test object' has been changed from TSN to CSN

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1. Summary of tests

| Tests | Test methods | Rule Section | Results |
|--|---------------------|-----------------------|----------------|
| Measurement of radiated emission / field strength of harmonics | ANSI C63.10:2013 | 47 CFR Part 15.249 | Passed |
| Measurement of field strength of fundamental | ANSI C63.10:2013 | 47 CFR Part 15.249 | Passed |
| Measurement of band edge compliance | ANSI C63.10:2013 | 47 CFR Part 15.249 | Passed |
| Measurement of 20 dB bandwidth | ANSI C63.10:2013 | 47 CFR Part 15.215(c) | Passed |

The given result is based on a shared risk principle with respect to the measurement uncertainty.

Conclusion

The test objects mentioned in this report meet the requirements of the standard stated below, with respect to the tests listed above.

- 47 CFR Part 15, Subpart C (Specific rule part §15.249)

The test results relate only to the objects tested.

2. Test objects and auxiliary equipment

2.1 Test objects

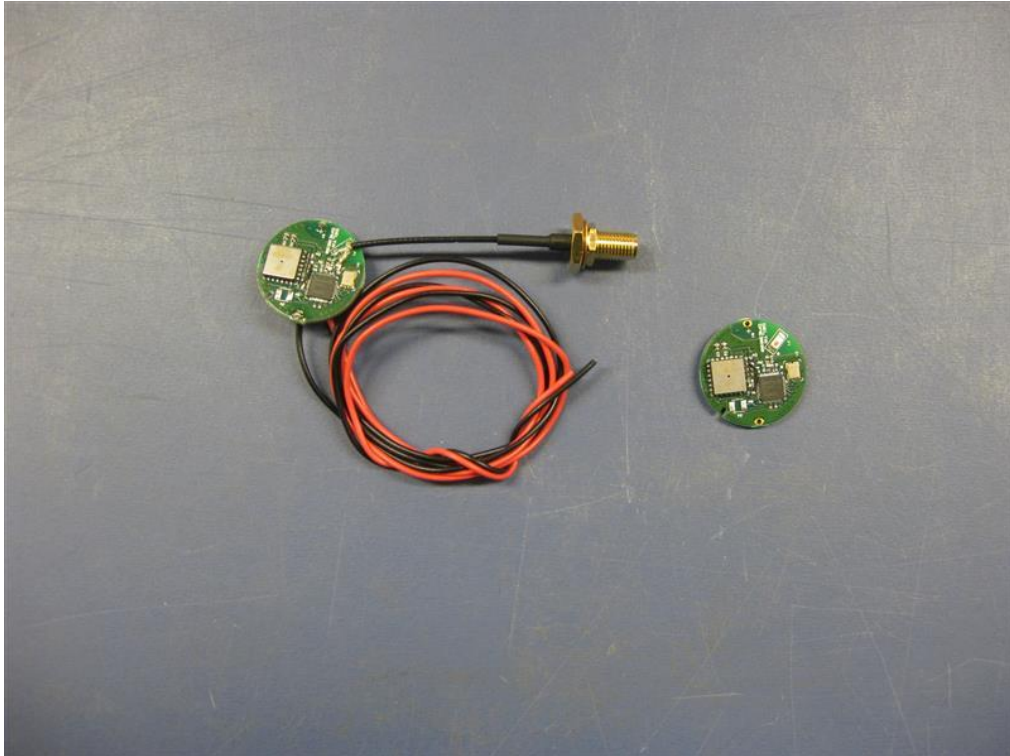


Photo 2.1.1 Test objects.

Test object 2.1.1

| | |
|-------------------------------------|--|
| Name of test object | CSN |
| Model / type | Bluetooth Low Energy 4.2 Sensor Node |
| Part no. | - |
| Serial no. | TX_LOW (10), TX_MID (14) and TX_HIGH (17) |
| FCC ID | 2ANX7CCSN1 |
| Manufacturer | Pirelli Tyre S.p.A. |
| Supply voltage | 3 VDC |
| Software version | 5.x |
| Hardware version | Special SRD version |
| Cycle time | < 1 ms |
| Highest frequency generated or used | 2483,5 MHz |
| Comment | 3 different test objects hardwired for low, mid, and high Tx frequency |
| Received | Date: 01 September 2017. Status: Test object sampled and provided by customer. |

Test object 2.1.2

| | |
|-------------------------------------|---|
| Name of test object | CSN |
| Model / type | Bluetooth Low Energy 4.2 Sensor Node |
| Part no. | - |
| Serial no. | TX_LOW (12), TX_MID (15) and TX_HIGH (20) |
| FCC ID | 2ANX7CCSN1 |
| Manufacturer | Pirelli Tyre S.p.A. |
| Supply voltage | 3 VDC |
| Software version | 5.x |
| Hardware version | Special SRD version |
| Cycle time | < 1 ms |
| Highest frequency generated or used | 2483,5 MHz |
| Comment | Antenna replaced by SMA connector. Battery replaced by external PSU. 3 different test objects hardwired for low, mid, and high Tx frequency |
| Received | Date: 01 August 2017. Status: Test object sampled and provided by customer. |

3. General test conditions

3.1 Test setup during test

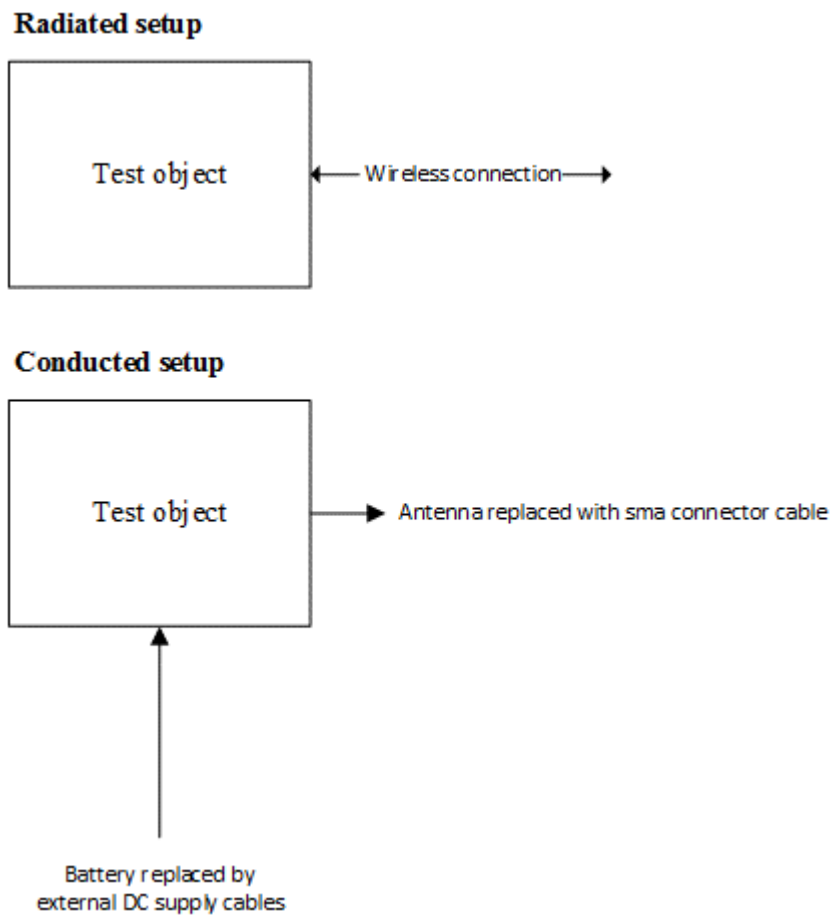


Figure 3.1.1 Block diagram of test objects with cables and auxiliary equipment.

3.1.1 Description of test setup

Two different test setups were used:

- Radiated setup: Wireless connection with continuous transmission (low, mid or high channel).
- Conducted setup: Antenna replaced with a SMA connector and continuous transmission (low, mid or high channel).

3.1.2 Description and intended use of test object

The product is:

- Tyre Pressure Monitoring System Sensor (TPMS sensor)
- Located on a vehicle tyre, permanently attached to the inner lining
- A radio transceiver, operating on the 2.4 GHz Bluetooth low energy band

The real software, CSN 4.0, operates in a discontinuous state, only transmitting periodically depending on the mode/state (e.g. 30 seconds, 6 seconds). When a connection is made with a control unit, the transmission rates is up to 0.5 seconds.

3.1.3 Test modes during emission tests

Test software was implemented to operate at worst case (continuous transmission cycle), conditions for the low, mid and high bands.

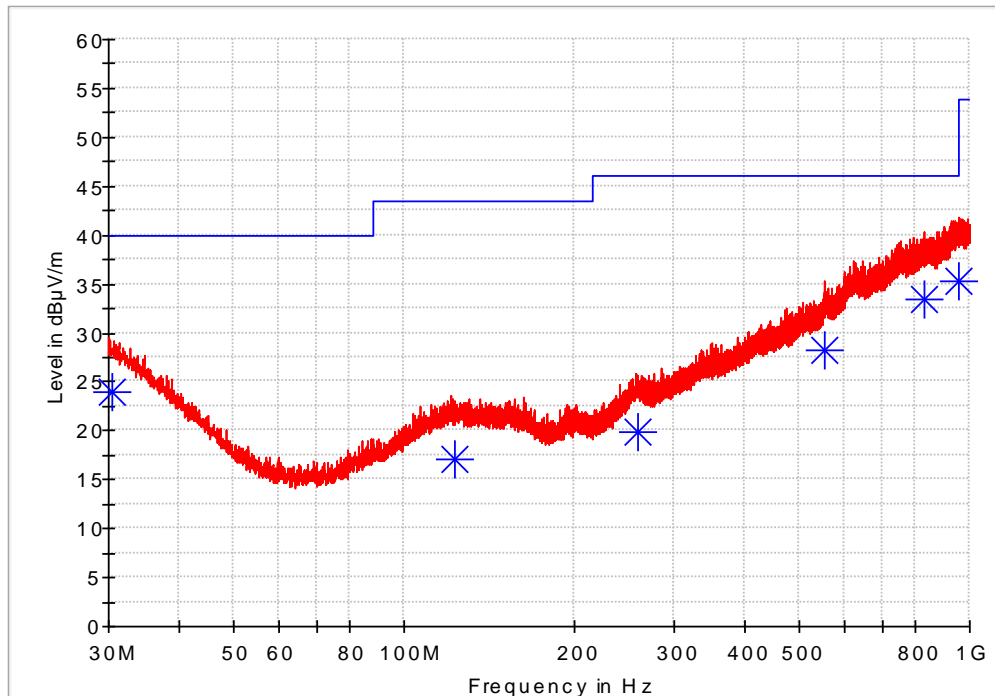
4. Test results

4.1 Measurement of radiated emission (below 1 GHz)

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-1 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10), TX_MID (14) and TX_HIGH (17) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 30-1000 MHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m | Humidity | 53 % RH |
| Detector | Peak and quasi peak | Bandwidth | 120 kHz |
| Test equipm. | EMI room Hørsholm 49704 49590 49817 49999 49807 49154 49600 | Uncertainty | 5.0 dB |

Full Spectrum



— Preview Result 1-PK — FCC Part 15C QP 3 m * Final_Result QPK

Comments

Continuous Tx - normal modulation - hopping off.
 Bundle test of 2402 MHz, 2442 MHz, and 2480 MHz.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-2 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10), TX_MID (14) and TX_HIGH (17) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 30-1000 MHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m | Humidity | 53 % RH |
| Detector | Quasi peak | Bandwidth | 120 kHz |
| Test equipm. | EMI room Hørsholm 49704 49590 49817 49999 49807 49154 49600 | Uncertainty | 5.0 dB |

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 30.51 | 23.89 | 40.00 | 16.11 | 15000.0 | 120.000 | 285.0 | V | 129 | 26.5 |
| 123.09 | 17.18 | 43.50 | 26.32 | 15000.0 | 120.000 | 100.0 | V | -24 | 20.2 |
| 259.71 | 19.81 | 46.00 | 26.19 | 15000.0 | 120.000 | 202.0 | H | 1 | 22.4 |
| 555.21 | 28.19 | 46.00 | 17.81 | 15000.0 | 120.000 | 200.0 | H | 151 | 29.8 |
| 831.51 | 33.45 | 46.00 | 12.55 | 15000.0 | 120.000 | 185.0 | H | 273 | 33.9 |
| 954.12 | 35.31 | 46.00 | 10.69 | 15000.0 | 120.000 | 352.0 | V | 117 | 35.5 |

| | |
|----------------|--|
| Test result | The measured field strengths are below the limit |
| Test Port | Enclosure |
| Test frequency | 2402, 2440, and 2480 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height, and antenna polarisation. Test voltage: Internal battery 3 VDC. |

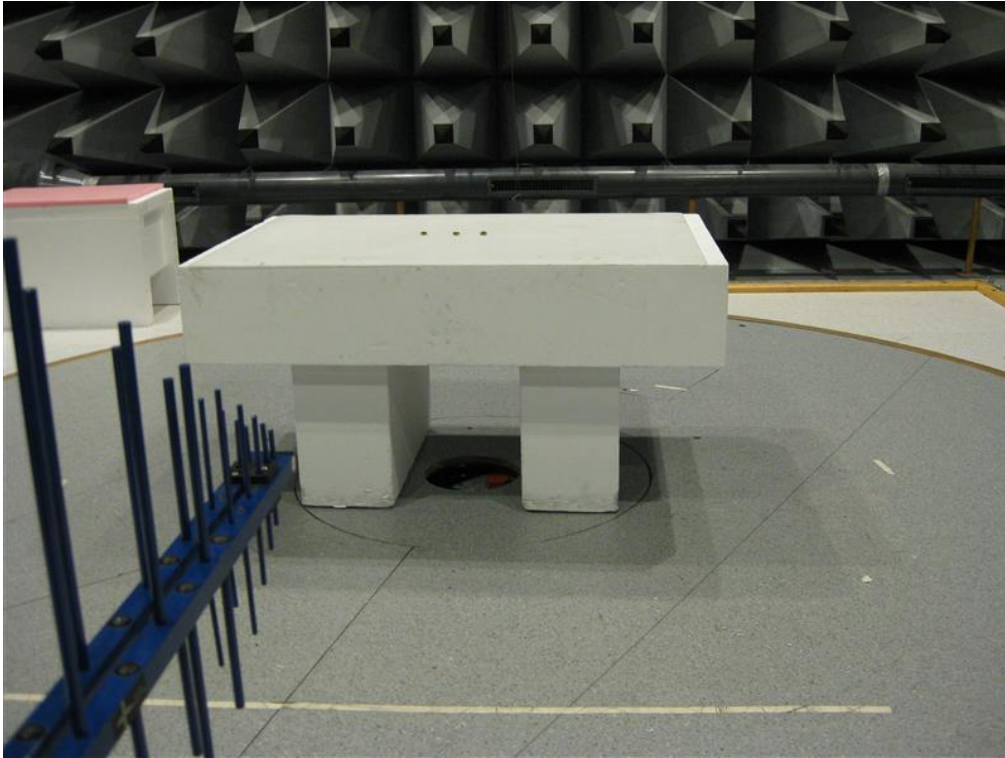


Photo 4.1.1 Test setup regarding measurement of radiated emission (below 1 GHz).



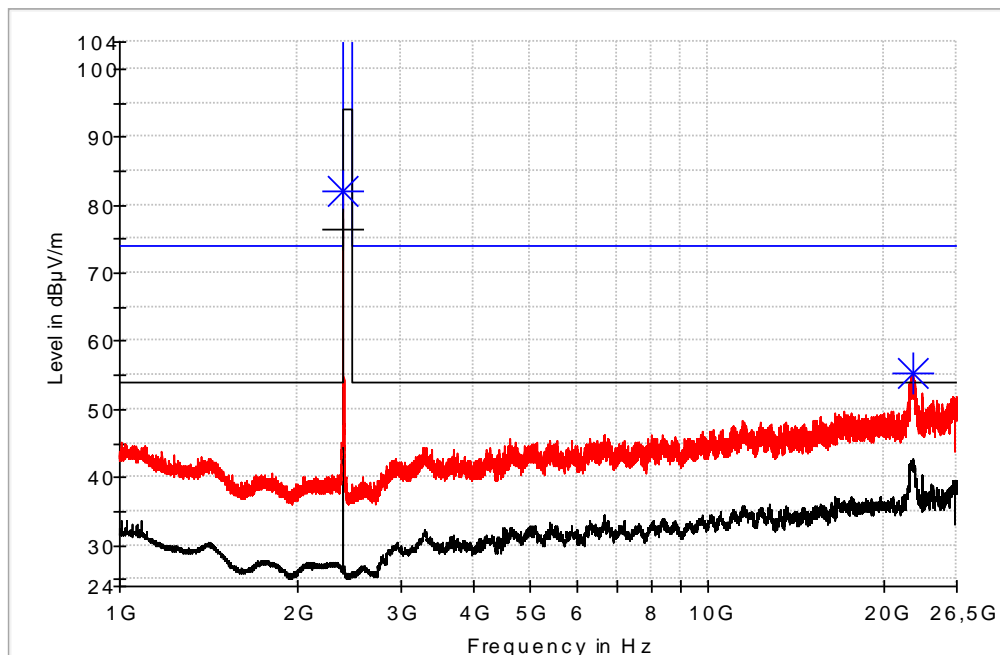
Photo 4.1.2 Test setup regarding measurement of radiated emission (below 1 GHz).

4.2 Measurement of radiated emission (above 1 GHz), LOW

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-3 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 53 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

Full Spectrum



— Preview Result 2-AVG — Preview Result 1-PK+
— FCC Part 15.249 2,4 GHz Pk 3-m — FCC Part 15.249 2,4 GHz Avg 3 m
* Fina_Result PK+ + Fina_Result CAV

Polarization Vertical and horizontal peak measurements

Comments Continuous Tx - normal modulation - hopping off.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-4 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 53 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Height (cm) | Pol | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-------------|-----|------------|---------------|
| 2402.00 | --- | 76.51 | 94.00 | 17.49 | 15000.0 | 173.0 | V | -15.3 | 206 |
| 2402.25 | 82.12 | --- | 114.00 | 31.88 | 15000.0 | 246.0 | V | -15.3 | 210 |
| 22386.50 | 55.37 | --- | 73.90 | 18.53 | 15000.0 | 102.0 | H | -3.2 | 328 |

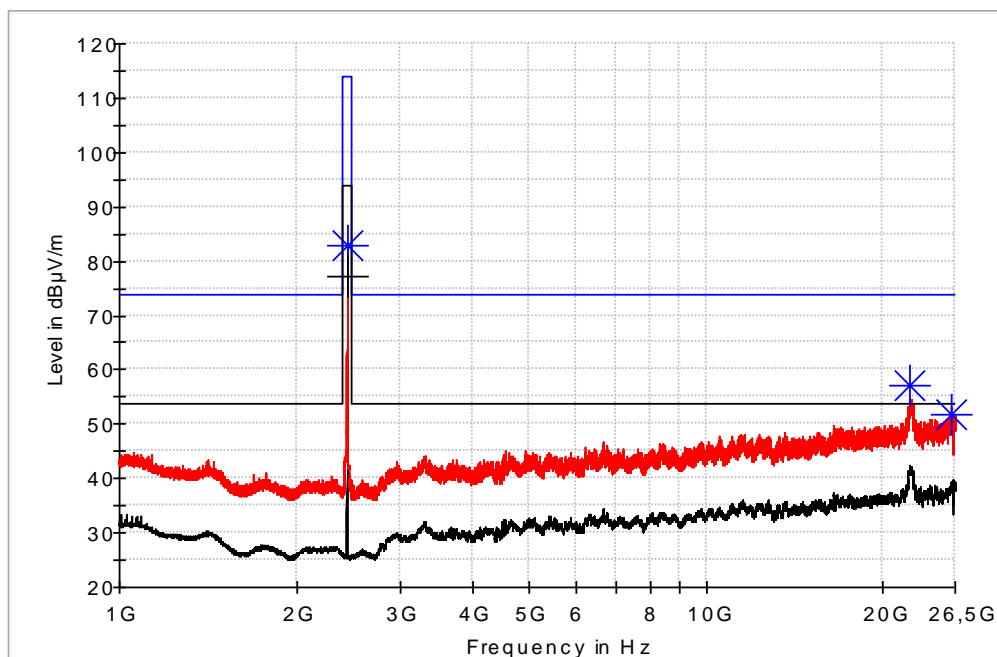
| | |
|----------------|---|
| Test result | The measured peak field strengths are below the peak and average limits |
| Test Port | Enclosure |
| Test frequency | 2402 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height and antenna polarization. Test voltage: Internal battery 3 VDC. |

4.3 Measurement of radiated emission (above 1 GHz), MID

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-5 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_MID (14) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

Full Spectrum



— Preview Result 2-AVG — Preview Result 1-PK+
— FCC Part 15.249 2,4 GHz Pk 3-m — FCC Part 15.249 2,4 GHz Avg 3 m
* Fina_Result PK+ + Fina_Result CAV

Polarization

Vertical and horizontal peak measurements

Comments

Continuous Tx - normal modulation - hopping off.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-6 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_MID (14) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Height (cm) | Pol | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-------------|-----|------------|---------------|
| 2442.00 | --- | 77.17 | 94.00 | 16.83 | 15000.0 | 169.0 | V | -15.5 | 27 |
| 2442.25 | 82.99 | --- | 114.00 | 31.01 | 15000.0 | 102.0 | V | -15.5 | 226 |
| 22208.50 | 56.97 | --- | 73.90 | 16.93 | 15000.0 | 385.0 | V | -2.7 | 140 |
| 26139.75 | 51.89 | --- | 73.90 | 22.01 | 15000.0 | 250.0 | V | 2.3 | 48 |

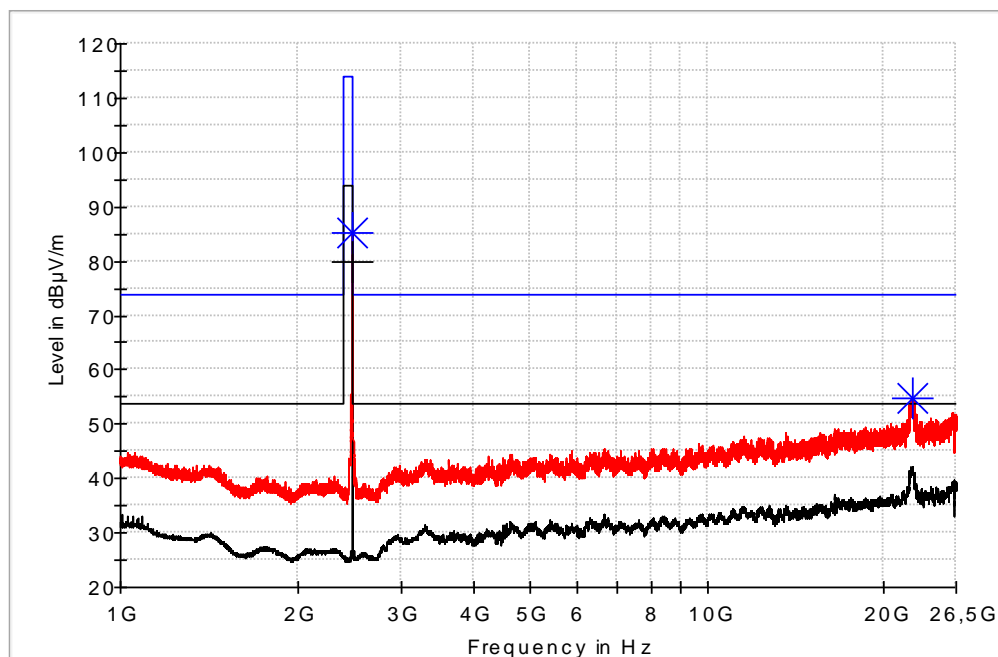
| | |
|----------------|---|
| Test result | The measured peak field strengths are below the peak and average limits |
| Test Port | Enclosure |
| Test frequency | 2442 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height and antenna polarization. Test voltage: Internal battery 3 VDC. |

4.4 Measurement of radiated emission (above 1 GHz), HIGH

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-7 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_HIGH (17) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|--|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 4962549622 49623 49999 | Uncertainty | 4.9 dB |

Full Spectrum



— Preview Result 2-AVG — Preview Result 1-PK+
 — FCC Part 15.249 2,4 GHz Pk 3-m — FCC Part 15.249 2,4 GHz Avg 3 m
 * Fina_Result PK+ + Fina_Result CAV

Polarization

Vertical and horizontal peak measurements

Comments

Continuous Tx - normal modulation - hopping off.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-8 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_HIGH (17) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Height (cm) | PoI | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-------------|-----|------------|---------------|
| 2480.00 | --- | 79.98 | 94.00 | 14.02 | 15000.0 | 125.0 | V | -15.3 | 289 |
| 2480.25 | 85.22 | --- | 114.00 | 28.78 | 15000.0 | 125.0 | V | -15.3 | 290 |
| 22297.25 | 54.94 | --- | 73.90 | 18.96 | 15000.0 | 126.0 | H | -2.6 | 159 |

| | |
|----------------|---|
| Test result | The measured peak field strengths are below the peak and average limits |
| Test Port | Enclosure |
| Test frequency | 2480 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height and antenna polarization. Test voltage: Internal battery 3 VDC. |

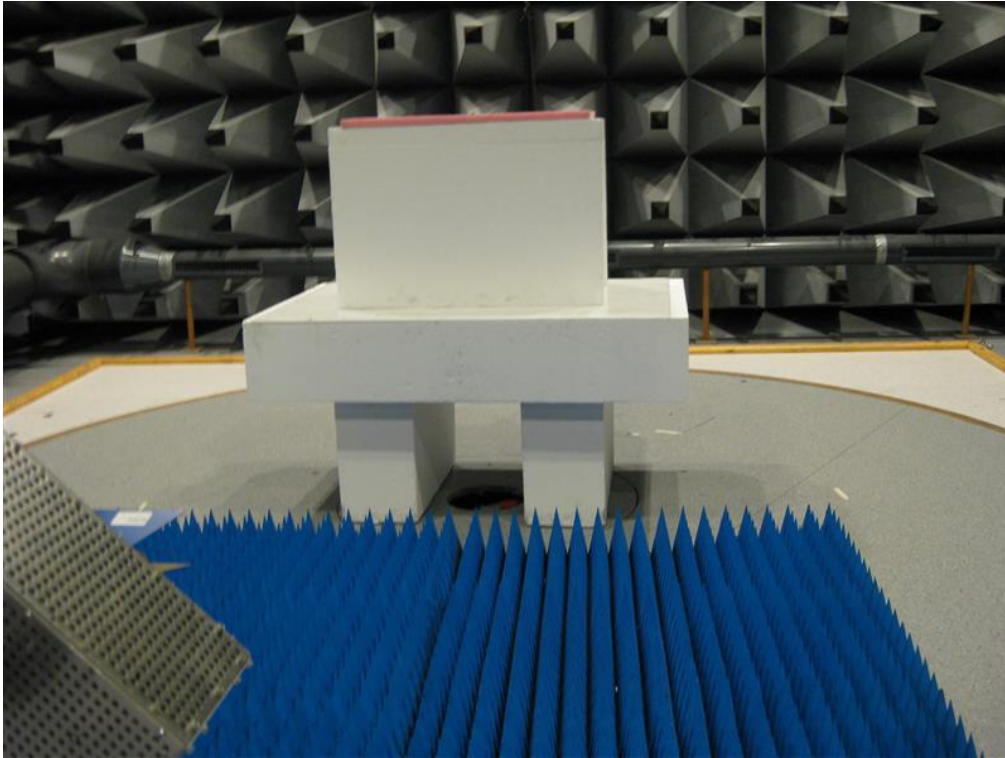


Photo 4.4.1 Test setup regarding measurement of radiated emission (above 1 GHz)



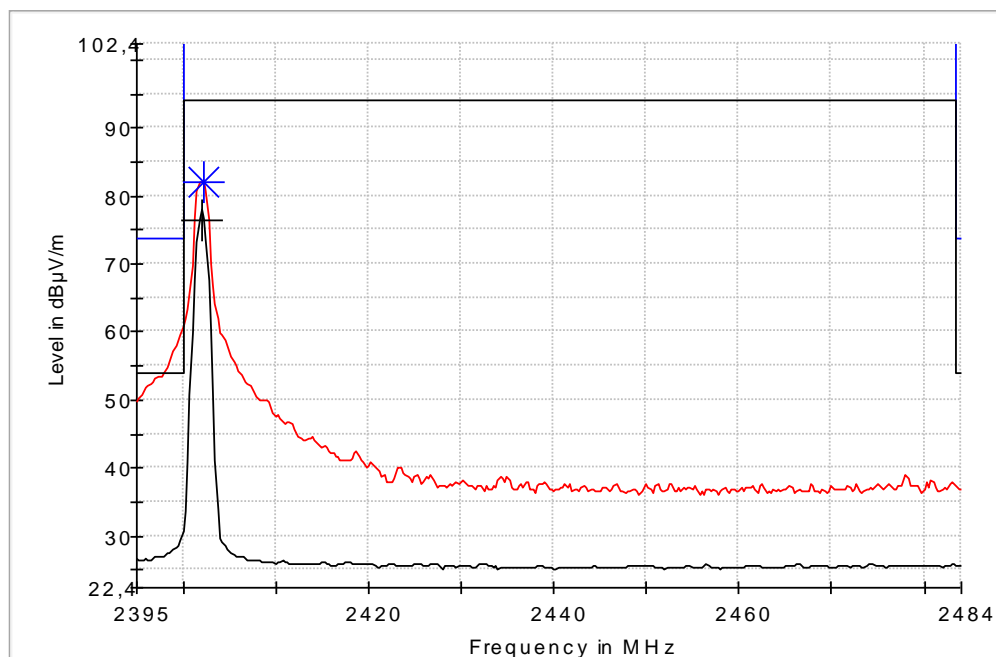
Photo 4.4.2 Test setup regarding measurement of radiated emission (above 1 GHz)

4.5 Measurement of field strength of fundamental, LOW

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-9 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 53 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

Full Spectrum



— Preview Result 2-AVG — Preview Result 1-PK+
 — FCC Part 15.249 2,4 GHz Pk 3-m — FCC Part 15.249 2,4 GHz Avg 3 m
 * Fina_Result PK+ + Fina_Result CAV

Polarization

Vertical and horizontal peak measurements

Comments

Continuous Tx - normal modulation - hopping off.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-10 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m | Humidity | 53 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Height (cm) | Pol | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-------------|-----|------------|---------------|
| 2402.00 | --- | 76.51 | 94.00 | 17.49 | 15000.0 | 173.0 | V | -15.3 | 206 |
| 2402.25 | 82.12 | --- | 114.00 | 31.88 | 15000.0 | 246.0 | V | -15.3 | 210 |

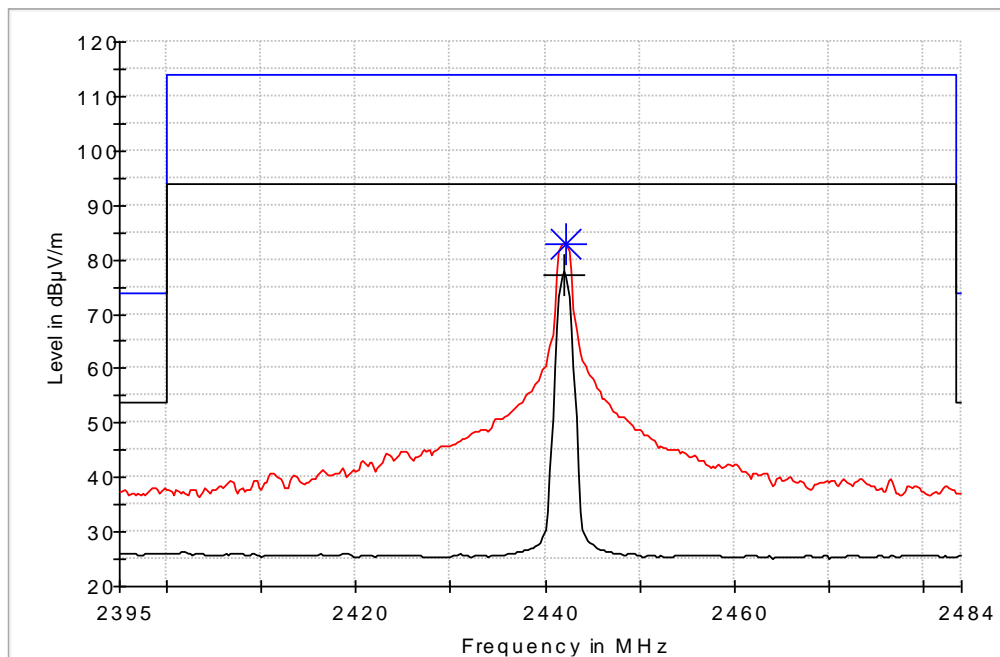
| | |
|----------------|---|
| Test result | The measured peak field strengths are below the peak and average limits |
| Test Port | Enclosure |
| Test frequency | 2402 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height and antenna polarization. Test voltage: Internal battery 3 VDC. |

4.6 Measurement of field strength of fundamental, MID

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-11 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_MID (14) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

Full Spectrum



— Preview Result 2-AVG — Preview Result 1-PK+
 — FCC Part 15.249 2,4 GHz Pk 3-m — FCC Part 15.249 2,4 GHz Avg 3 m
 * Fina_Result PK+ + Fina_Result CAV

Polarization

Vertical and horizontal peak measurements

Comments

Continuous Tx - normal modulation - hopping off.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-12 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_MID (14) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Height (cm) | Pol | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-------------|-----|------------|---------------|
| 2442.00 | --- | 77.17 | 94.00 | 16.83 | 15000.0 | 169.0 | V | -15.5 | 27 |
| 2442.25 | 82.99 | --- | 114.00 | 31.01 | 15000.0 | 102.0 | V | -15.5 | 226 |

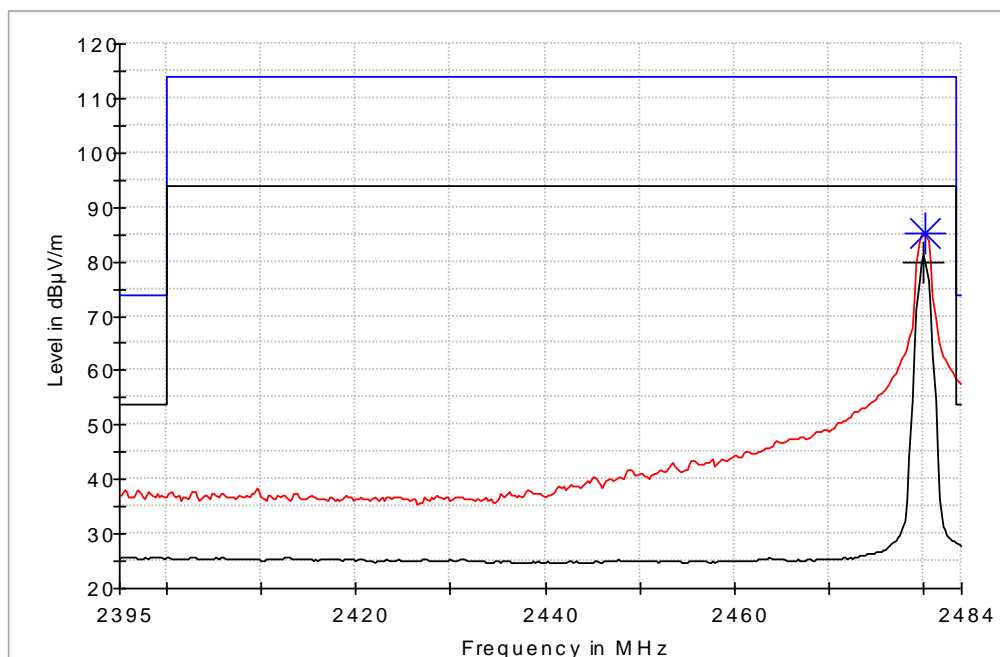
| | |
|----------------|---|
| Test result | The measured peak field strengths are below the peak and average limits |
| Test Port | Enclosure |
| Test frequency | 2442 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height and antenna polarization. Test voltage: Internal battery 3 VDC. |

4.7 Measurement of field strength of fundamental, HIGH

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-13 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_HIGH (17) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

Full Spectrum



— Preview Result 2-AVG — Preview Result 1-PK+
— FCC Part 15.249 2,4 GHz Pk 3-m — FCC Part 15.249 2,4 GHz Avg 3 m
* Fina_Result PK+ + Fina_Result CAV

Polarization Vertical and horizontal peak measurements

Comments Continuous Tx - normal modulation - hopping off.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | RE_Spur-14 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_HIGH (17) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | Frequency | 1-25 GHz |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m | Humidity | 54 % RH |
| Detector | Peak and average | Bandwidth | 1 MHz |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Height (cm) | Pol | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-------------|-----|------------|---------------|
| 2480.00 | --- | 79.98 | 94.00 | 14.02 | 15000.0 | 125.0 | V | -15.3 | 289 |
| 2480.25 | 85.22 | --- | 114.00 | 28.78 | 15000.0 | 125.0 | V | -15.3 | 290 |

| | |
|----------------|---|
| Test result | The measured peak field strengths are below the peak and average limits |
| Test Port | Enclosure |
| Test frequency | 2480 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Final maximal measurements by variation of turntable azimuth, antenna height and antenna polarization. Test voltage: Internal battery 3 VDC. |

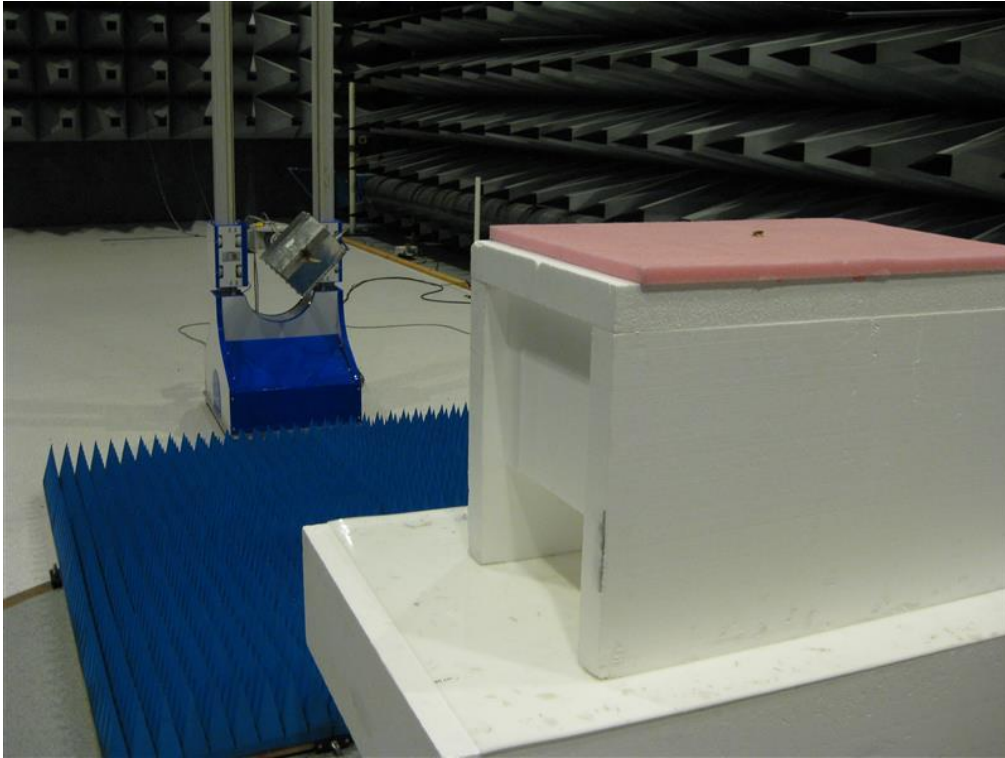


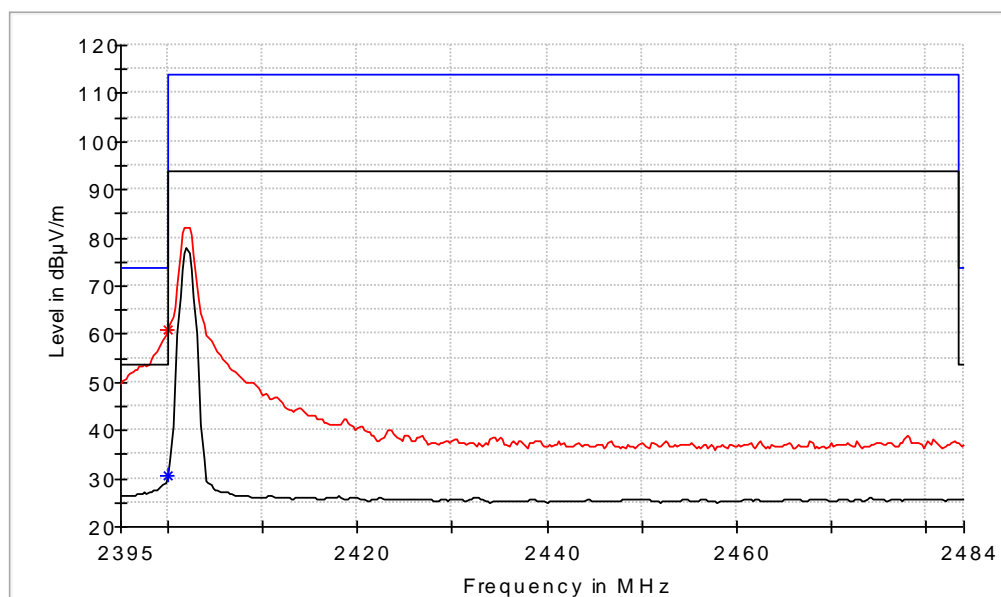
Photo 4.7.1 Test setup regarding measurement of field strength of fundamental.

4.8 Measurement of band edge compliance

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | PROF-1 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10) | Date | 11 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 53 % RH |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |
| Detector | Peak and average | Bandwidth | 1 MHz |

Full Spectrum



| | | | |
|---|--------------------------------|---|---------------------------------|
| — | Preview Result 2-AVG | — | Preview Result 1-PK+ |
| * | MaxPeak-PK+ | * | Average-AVG |
| — | FCC Part 15.249 2,4 GHz Pk 3-m | — | FCC Part 15.249 2,4 GHz Avg 3 m |
| * | Final Result PK+ | + | Final Result CAV |
| × | MaxPeak-PK+ (Single) | + | Average-AVG (Single) |
| × | CAverage-CAV (Single) | | |

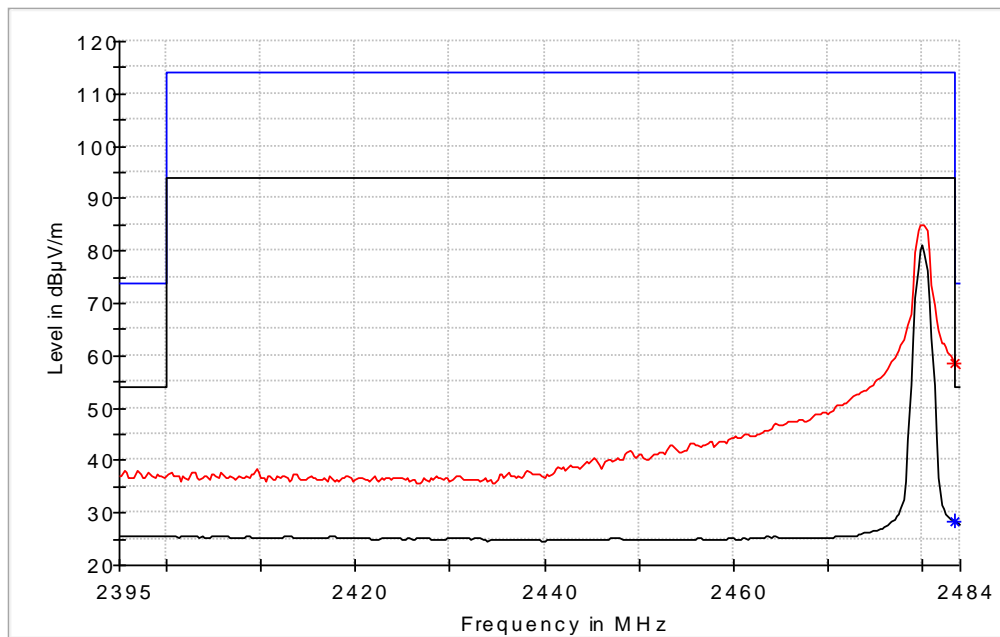
Comments

Operating frequency: 2402 MHz

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | PROF-2 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_HIGH (17) | Date | 12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 54 % RH |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |
| Detector | Peak and average | Bandwidth | 1 MHz |

Full Spectrum



- Preview Result 2-AVG
- * MaxPeak-PK+
- FCC Part 15.249 2,4 GHz Pk 3-m
- * Final_Result PK+
- Preview Result 1-PK+
- * Average-AVG
- FCC Part 15.249 2,4 GHz Avg 3 m
- + Final_Result CAV

Comments

Operating frequency: 2480 MHz

| | | | |
|---------------|--|-------------|--------------------|
| Test object | CSN | Sheet | PROF-3 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (10) and TX_HIGH (17) | Date | 11-12 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|-------------|------------|
| Test method | ANSI C63.10:2013 | Temperature | 24 °C |
| Characteristics | Complete search, antenna distance 3 m. | Humidity | 53-54 % RH |
| Test equipm. | EMI room Hørsholm 49600 49624 49625 49622 49623 49999 | Uncertainty | 4.9 dB |
| Detector | Peak and average | Bandwidth | 1 MHz |

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Corr. (dB) | Azimuth (deg) |
|-----------------|------------------|------------------|----------------|-------------|-------------|-----|------------|---------------|
| 2400.00 | --- | 30.58 | 94.00 | 63.42 | 200.0 | V | -15.3 | 225 |
| 2400.00 | 60.88 | --- | 114.00 | 53.12 | 200.0 | V | -15.3 | 225 |
| 2483.50 | --- | 28.28 | 53.90 | 25.62 | 100.0 | V | -15.3 | 270 |
| 2483.50 | 58.49 | --- | 73.90 | 15.41 | 100.0 | V | -15.3 | 270 |

| | |
|--------------------|---|
| Band edge criteria | The measured field strengths were within the limit of the band edge |
| Test port | Enclosure |
| Test frequency | 2402 and 2480 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Test voltage: Internal battery 3 VDC |

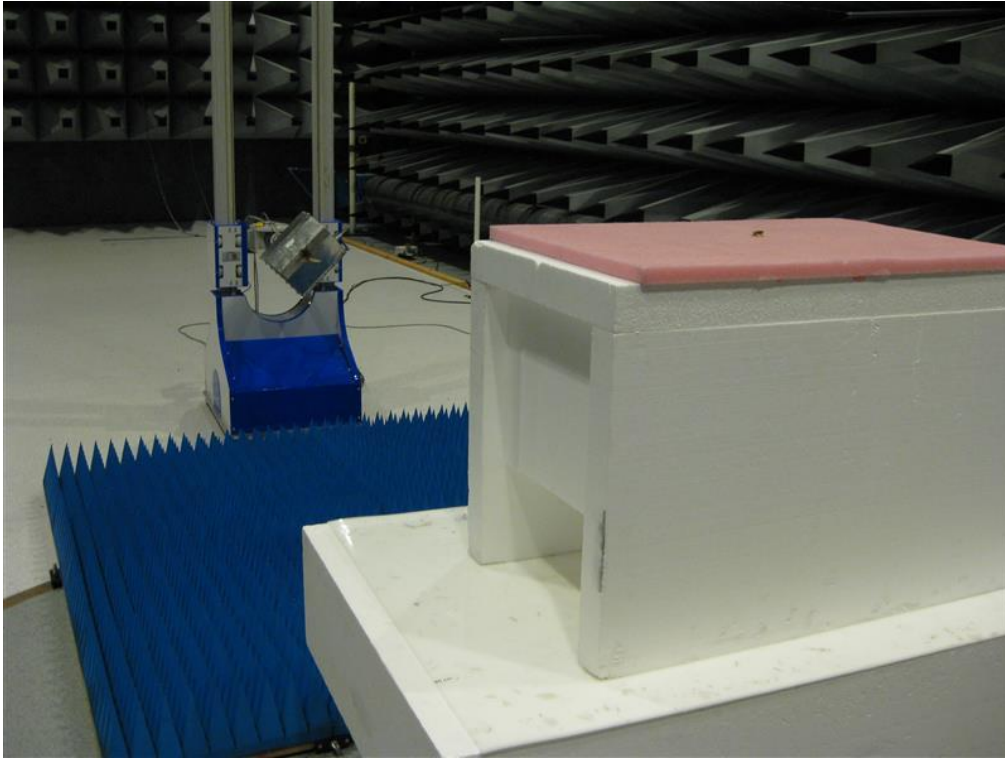
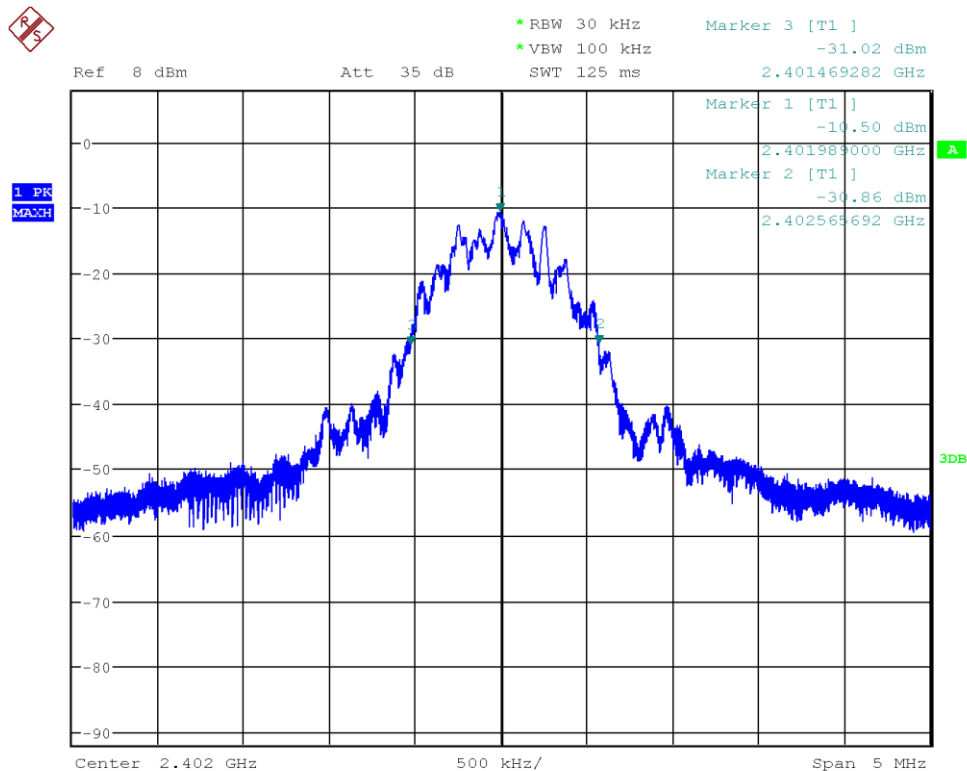


Photo 4.8.1 Test setup regarding measurement of band edge compliance.

4.9 Measurement of 20 dB bandwidth

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | PROF-4 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (12) | Date | 19 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 23 °C |
| Characteristics | Test voltage: External power supply at 3 VDC | Humidity | 44 % RH |
| Test equipm. | SRD lab Hørsholm 49550 | Uncertainty | 1.6 dB |
| SA Settings | RBW: 30 kHz VBW: 100 kHz SPAN: 5 MHz DET: Peak CF: Operating freq. Trace: Max. hold | | |



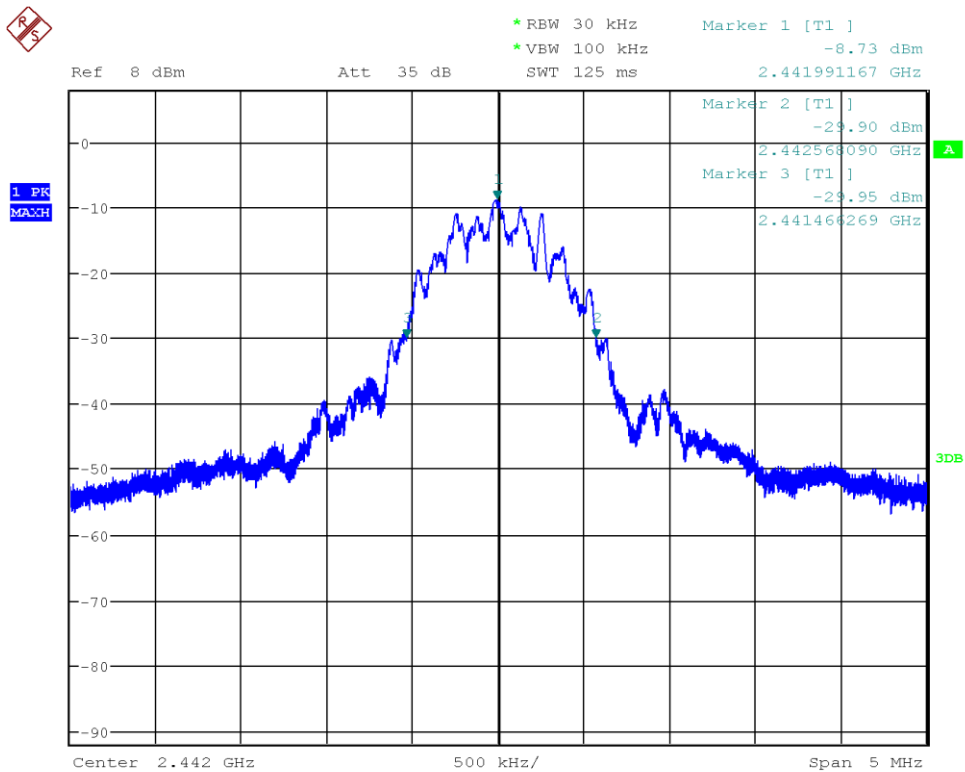
Date: 19.SEP.2017 14:51:43

Comments

Operating frequency: 2402 MHz.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | PROF-5 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_MID (15) | Date | 19 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 23 °C |
| Characteristics | Test voltage: External power supply at 3 VDC | Humidity | 44 % RH |
| Test equipm. | SRD lab Hørsholm 49550 | Uncertainty | 1.6 dB |
| SA Settings | RBW: 30 kHz VBW: 100 kHz SPAN: 5 MHz DET: Peak CF: Operating freq. Trace: Max. hold | | |



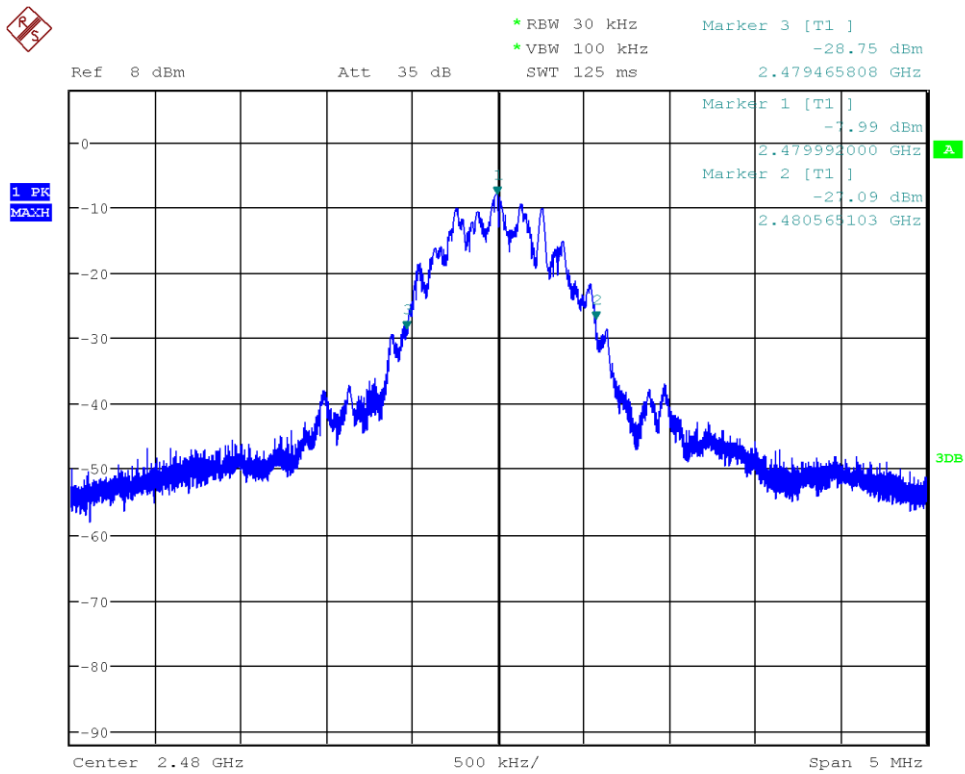
Date: 19.SEP.2017 15:12:55

Comments

Operating frequency: 2442 MHz

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | PROF-1 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_HIGH (20) | Date | 19 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|-------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 23 °C |
| Characteristics | Test voltage: External power supply at 3 VDC | Humidity | 44 % RH |
| Test equipm. | SRD lab Hørsholm 49550 | Uncertainty | 1.6 dB |
| SA Settings | RBW: 30 kHz VBW: 100 kHz SPAN: 5 MHz DET: Peak CF: Operating freq. Trace: Max. hold | | |



Date: 19.SEP.2017 14:46:28

Comments

Operating frequency: 2480 MHz.

| | | | |
|---------------|--|-------------|--------------|
| Test object | CSN | Sheet | PROF-6 |
| Type | Bluetooth Low Energy 4.2 Sensor Node | Project no. | 117-28082-3 |
| Serial no. | TX_LOW (12), TX_MID (15) and TX_HIGH (20) | Date | 19 Sep. 2017 |
| Client | Pirelli Tyre S.p.A | Initials | PWF |
| Specification | 47 CFR Part 15, Subpart C (Specific rule part §15.249) | | |

| | | | |
|-----------------|---|--------------|---------|
| Test method | ANSI C63.10:2013 | Temperature | 23 °C |
| Characteristics | Test voltage: External power supply at 3 VDC | Humidity | 44 % RH |
| Test equipm. | SRD lab Hørsholm 49550 | Uncertainty: | 1.6 dB |
| SA Settings | RBW: 30 kHz VBW: 100 kHz SPAN: 5 MHz DET: Peak CF: Operating freq. Trace: Max. hold | | |

| Operating frequency [MHz] | Low frequency [MHz] | High frequency [MHz] | Remarks |
|---------------------------|---------------------|----------------------|---------|
| 2402 | 2401.47 | 2402.57 | - |
| 2442 | 2442.47 | 2442.57 | - |
| 2480 | 2479.47 | 2480.57 | - |

Note 1:

| Operating frequency [MHz] | Measured [MHz] | Limit [MHz] | Remarks |
|---------------------------|----------------|-------------|---------|
| Lowest frequency | 2401.47 | 2400.00 | Passed |
| Highest frequency | 2480.57 | 2483.50 | Passed |

| | |
|--------------------|---|
| Band edge criteria | 20 dB bandwidth (-20 dBc) |
| Test result | The measured 20 dB bandwidth was within the limit designated in 15.215(c) |
| Test port | Antenna replaced by SMA connector |
| Test frequency | 2402, 2442, and 2480 MHz |
| Test mode | Continuous Tx - normal modulation - hopping off |
| Condition | Normal |
| Compliant | Yes |
| Comments | Test voltage: External power supply at 3 VDC. |

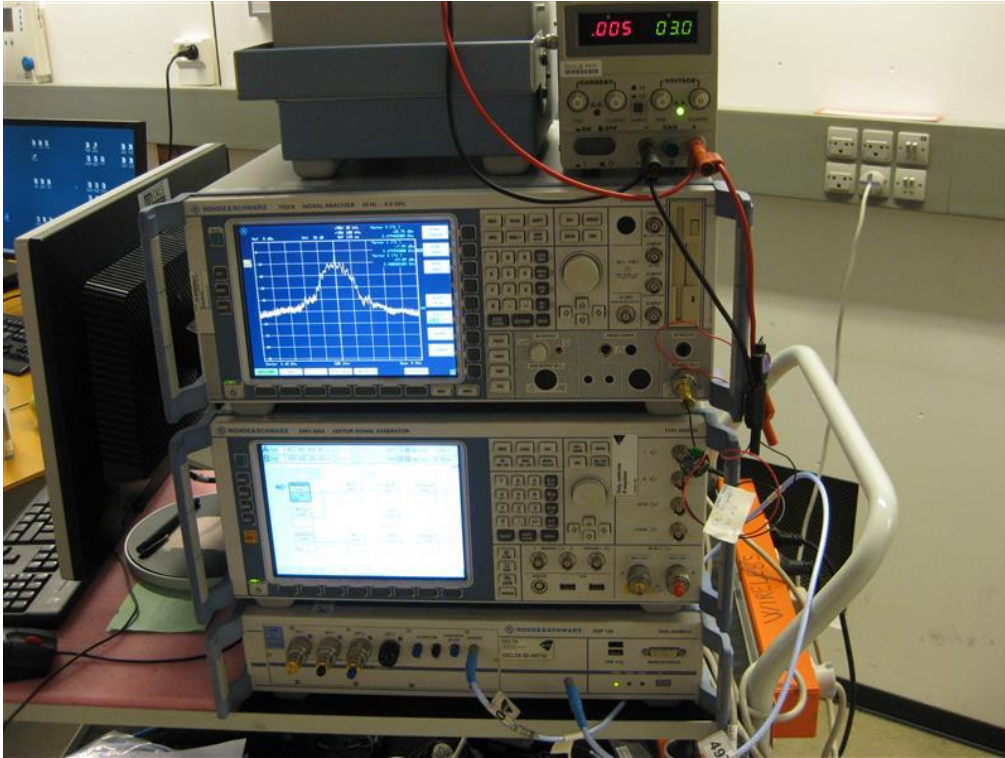


Photo 4.9.1 Test setup regarding measurement of 20 dB bandwidth.

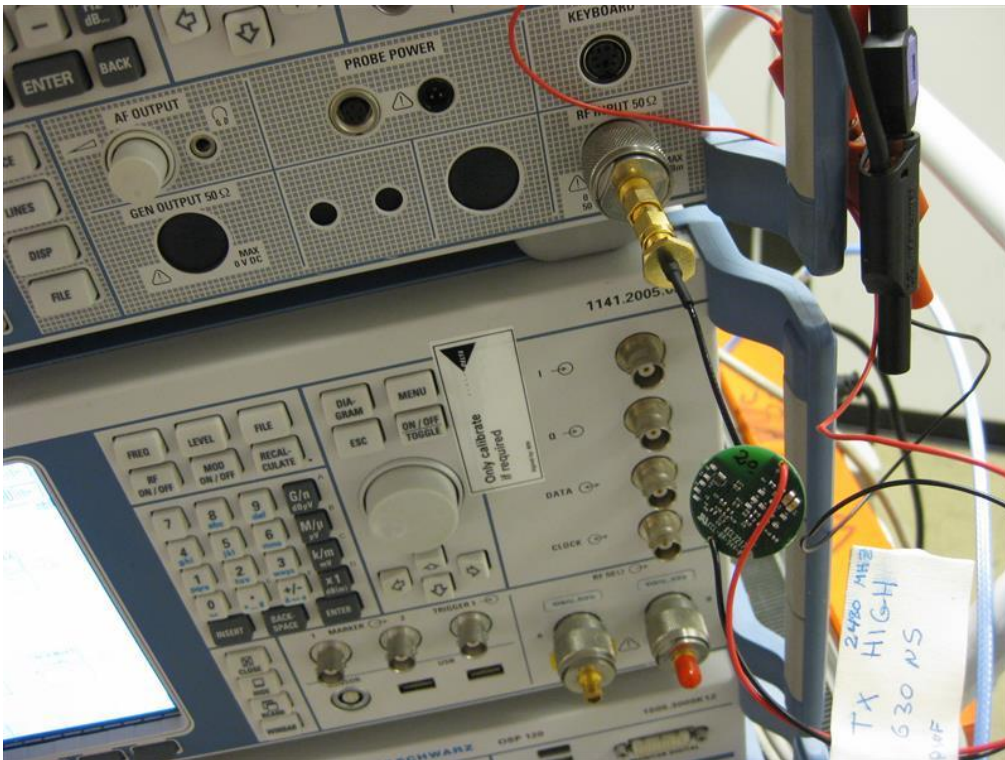


Photo 4.9.2 Test setup regarding measurement of 20 dB bandwidth.

5. National registrations and accreditations

5.1 DANAK Accreditation

Organization: Danish Accreditation and Metrology Fund - DANAK, see www.danak.dk and www.ilac.org

Registration Number: 19

Area Number: C

DANAK is part of ILAC (International Laboratory Accreditation Cooperation) including its MRA (Mutual Recognition Arrangement). The MRA includes the Australian NATA and Canadian SCC.

5.2 FCC Registrations

Organization: Federal Communications Commission, USA

Registration Number: 913950

Facilities: EMC room 2 Hørsholm (EMC-2)
EMC room 3 Hørsholm (EMC-3)
EMC room 4 Hørsholm (EMC-4)
EMI room Hørsholm (EMC-5)

5.3 VCCI Registrations

Organization: Voluntary Control Council for Interference by Information Technology, Japan

Member Number: 910

Facilities: EMC room 3 Hørsholm (EMC-3): C-2532 and T-1548
EMC room 4 Hørsholm (EMC-4): C-2533 and T-1549
EMI room Hørsholm (EMC-5): R-1180, C-706, T-1550 and G-470

5.4 IC Registrations

Organization: Industry Canada, Certification and Engineering Bureau

Registration Number: IC4187A-5

Facilities: EMI room Hørsholm (EMC-5)

6. List of instruments

| No | Category/Action | Manufacturer | Type no | Cal. date | Cal. exp. |
|-------|---|-----------------|-----------------------|------------|------------|
| 49154 | Bilog Antenne | CHASE | CBL6111A | 23-06-2016 | 23-06-2018 |
| 49550 | SIGNAL ANALYZER | ROHDE & SCHWARZ | FSQ8 | 25-10-2016 | 25-10-2017 |
| 49590 | CABLE, LOW-LOSS uWAVE CABLE, N-N, 8.0 m "EMI" | SUHNER | SUCOFLEX 104 PB | 04-11-2016 | 04-11-2017 |
| 49600 | SPECTRUM ANALYZER / MEASUREMENT RECEIVER | ROHDE & SCHWARZ | ESU40 | 21-07-2017 | 21-07-2018 |
| 49622 | CABLE 3.25 M PC3.5 MALE- FEMALE SUCOFLEX 104 | HUBER+SUHNER | | 24-10-2016 | 24-10-2017 |
| 49623 | CABLE 16 M PC3.5 MALE- MALE SUCOFLEX 104PB | HUBER+SUHNER | | 24-10-2016 | 24-10-2017 |
| 49624 | DUAL RIDGE HORN ANTENNA – 1GHZ-26GHZ (2GHZ-32GHZ) | SATIMO | SH2000 | 04-11-2014 | 04-11-2017 |
| 49625 | SRD COAX SWITCH MATRIX USED IN 1GHZ TO 26GHZ SRD ANTENNASYSTEM | DELTA | COAX SWITCH MATRIX | 24-10-2016 | 24-10-2017 |
| 49704 | CABLE 3 m SMA-N | SUHNER | SUCOFLEX104 | 04-11-2016 | 04-11-2017 |
| 49807 | ATTENUATOR, DC- 12.4GHz, 6 dB | HUBER-SUHNER | 6806.17A | 15-02-2017 | 15-02-2018 |
| 49817 | CABLE, LOW-LOSS uWAVE CABLE, N-N, 8.0 m "EMI" | SUHNER | SUCOFLEX 104 PB | 04-11-2016 | 04-11-2017 |
| 49999 | EMC32-SOFTWARE | ROHDE & SCHWARZ | Ver. 9.28 | - | - |