

# Test report

## 313399-1TRFWL

Date of issue: September 28, 2016

Applicant:

**Mitel Networks Corporation**

Product:

**Bluetooth Handset**

Model:

**68XX/69XX Bluetooth Handset**

Part number:

**5601013301RA**

FCC ID:

**EHTAQUA1**

IC Registration number:

**173A-AQUA1**

Specifications:

◆ **FCC 47 CFR Part 15 Subpart C, §15.247**

Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

◆ **RSS-247, Issue 1, May 2015, Section 5**

Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs)  
and Licence-Exempt Local Area Network (LE-LAN) Devices

#### Test location

|              |                                                      |
|--------------|------------------------------------------------------|
| Company name | Nemko Canada Inc.                                    |
| Address      | 303 River Road                                       |
| City         | Ottawa                                               |
| Province     | Ontario                                              |
| Postal code  | K1V 1H2                                              |
| Country      | Canada                                               |
| Telephone    | +1 613 737 9680                                      |
| Facsimile    | +1 613 737 9691                                      |
| Toll free    | +1 800 563 6336                                      |
| Website      | www.nemko.com                                        |
| Site number  | FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber) |

|                    |                                                                                     |
|--------------------|-------------------------------------------------------------------------------------|
| Tested by          | Andrey Adelberg, Senior Wireless/EMC Specialist                                     |
| Reviewed by        | Kevin Rose, Wireless/EMC Specialist                                                 |
| Review date        | November 7, 2016                                                                    |
| Reviewer signature |  |

#### Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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## Section 1. Report summary

### 1.1 Applicant and manufacturer

|              |                                               |
|--------------|-----------------------------------------------|
| Company name | Mitel Networks Corporation                    |
| Address      | 350 Legget Drive, Kanata, ON, Canada, K2K 2W7 |

### 1.2 Test specifications

|                                              |                                                                                                                              |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| FCC 47 CFR Part 15, Subpart C, Clause 15.247 | Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.                                                            |
| RSS-247, Issue 1, May 2015, Section 5        | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |

### 1.3 Test methods

|                                                      |                                                                                                               |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| 558074 D01 DTS Meas Guidance v03 r05 (April 8, 2016) | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 |
| ANSI C63.10 v2013                                    | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices                |
| DA 00-705 Released March 30, 2000                    | Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems                               |

### 1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

### 1.5 Exclusions

None

### 1.6 Test report revision history

**Table 1.6-1:** Test report revision history

| Revision # | Details of changes made to test report |
|------------|----------------------------------------|
| TRF        | Original report issued                 |

Notes: None

## Section 2. Summary of test results

### 2.1 FCC Part 15 Subpart C, general requirements test results

**Table 2.1-1: FCC part 15 Subpart C test results**

| Part       | Test description          | Verdict           |
|------------|---------------------------|-------------------|
| §15.207(a) | Conducted limits          | Not applicable    |
| §15.31(e)  | Variation of power source | Pass <sup>1</sup> |
| §15.203    | Antenna requirement       | Pass <sup>2</sup> |

Notes: <sup>1</sup> The testing was performed with the fully charged battery.

<sup>2</sup> The antenna is located within the enclosure of EUT and not user accessible.

### 2.2 FCC Part 15 Subpart C, intentional radiators test results

**Table 2.2-1: FCC part 15 Subpart C, §15.247 test results**

| Part               | Test description                                                                                                           | Verdict        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------|----------------|
| §15.247(a)(1)(i)   | Frequency hopping systems operating in the 902–928 MHz band                                                                | Not applicable |
| §15.247(a)(1)(ii)  | Frequency hopping systems operating in the 5725–5850 MHz band                                                              | Not applicable |
| §15.247(a)(1)(iii) | Frequency hopping systems operating in the 2400–2483.5 MHz band                                                            | Pass           |
| §15.247(a)(2)      | Minimum 6 dB bandwidth for systems using digital modulation techniques                                                     | Pass           |
| §15.247(b)(1)      | Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band        | Pass           |
| §15.247(b)(2)      | Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band                                   | Not applicable |
| §15.247(b)(3)      | Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands | Pass           |
| §15.247(c)(1)      | Fixed point-to-point operation with directional antenna gains greater than 6 dBi                                           | Not applicable |
| §15.247(c)(2)      | Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams                                    | Not applicable |
| §15.247(d)         | Spurious emissions                                                                                                         | Pass           |
| §15.247(e)         | Power spectral density for digitally modulated devices                                                                     | Pass           |
| §15.247(f)         | Time of occupancy for hybrid systems                                                                                       | Not applicable |

Notes: EUT operates in two modes: frequency hopping device (BT) and digitally modulated device (BLE)

### 2.3 IC RSS-GEN, Issue 4, test results

**Table 2.3-1: RSS GEN test results**

| Part  | Test description                                                         | Verdict                     |
|-------|--------------------------------------------------------------------------|-----------------------------|
| 7.1.2 | Receiver radiated emission limits                                        | Not applicable <sup>1</sup> |
| 7.1.3 | Receiver conducted emission limits                                       | Not applicable <sup>1</sup> |
| 8.8   | Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus | Not applicable              |

Notes: <sup>1</sup> According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

## 2.4 IC RSS-247, Issue 1, test results

**Table 2.4-1:** RSS 247 test results

| Part    | Test description                                                                       | Verdict        |
|---------|----------------------------------------------------------------------------------------|----------------|
| 5.1     | Frequency Hopping Systems (FHSs)                                                       |                |
| 5.1 (1) | Bandwidth of a frequency hopping channel                                               | Pass           |
| 5.1 (2) | Minimum channel spacing for frequency hopping systems                                  | Pass           |
| 5.1 (3) | Frequency hopping systems operating in the 902–928 MHz band                            | Not applicable |
| 5.1 (4) | Frequency hopping systems operating in the 2400–2483.5 MHz band                        | Pass           |
| 5.1 (5) | Frequency hopping systems operating in the 5725–5850 MHz band                          | Not applicable |
| 5.2     | Digital Transmission Systems (DTSs)                                                    |                |
| 5.2 (1) | Minimum 6 dB bandwidth                                                                 | Pass           |
| 5.2 (2) | Maximum power spectral density                                                         | Pass           |
| 5.3     | Hybrid Systems                                                                         |                |
| 5.3 (1) | Digital modulation turned off                                                          | Not applicable |
| 5.3 (2) | Frequency hopping turned off                                                           | Not applicable |
| 5.4     | Transmitter output power and e.i.r.p. requirements                                     |                |
| 5.4 (1) | Frequency hopping systems operating in the 902–928 MHz band                            | Not applicable |
| 5.4 (2) | Frequency hopping systems operating in the 2400–2483.5 MHz band                        | Pass           |
| 5.4 (3) | Frequency hopping systems operating in the 5725–5850 MHz                               | Not applicable |
| 5.4 (4) | Systems employing digital modulation techniques                                        | Pass           |
| 5.4 (5) | Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band                       | Not applicable |
| 5.4 (6) | Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams | Not applicable |
| 5.5     | Out-of-band emissions                                                                  | Pass           |

Notes: EUT operates in two modes: frequency hopping device (BT) and digitally modulated device (BLE)

## Section 3. Equipment under test (EUT) details

### 3.1 Sample information

|                        |                                                             |
|------------------------|-------------------------------------------------------------|
| Receipt date           | July 18, 2016                                               |
| Nemko sample ID number | 133-002560 (conducted sample), 133-002586 (radiated sample) |

### 3.2 EUT information

|               |                                                        |
|---------------|--------------------------------------------------------|
| Product name  | Bluetooth Handset                                      |
| Model         | 68XX/69XX Bluetooth Handset                            |
| Part number   | 5601013301RA                                           |
| Serial number | 0800FA84523 (conducted sample); none (radiated sample) |

### 3.3 Technical information

|                                         |                                                                                                                                                                                      |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicant IC company number             | 173A                                                                                                                                                                                 |
| IC UPN number                           | AQUA1                                                                                                                                                                                |
| All used IC test site(s) Reg. number    | 2040A-4                                                                                                                                                                              |
| RSS number and Issue number             | RSS-247 Issue 1, May 2015                                                                                                                                                            |
| Frequency band                          | 2400–2483.5 MHz                                                                                                                                                                      |
| Frequency Min (MHz)                     | 2402                                                                                                                                                                                 |
| Frequency Max (MHz)                     | 2480                                                                                                                                                                                 |
| RF power BT (W), Conducted              | 0.0081 (9.07 dBm)                                                                                                                                                                    |
| RF power BLE (W), Conducted             | 0.0061 (7.84 dBm)                                                                                                                                                                    |
| Field strength, Units @ distance        | N/A                                                                                                                                                                                  |
| Measured BW (kHz) (20 dB for BT)        | 878                                                                                                                                                                                  |
| Measured BW (kHz) (6 dB for BLE)        | 699                                                                                                                                                                                  |
| Calculated BW (kHz), as per TRC-43      | N/A                                                                                                                                                                                  |
| Type of modulation                      | (BLE) GFSK; (BT) ACL Basic and EDR, SCO Basic, and eSCO Basic and EDR                                                                                                                |
| Emission classification (F1D, G1D, D1D) | F1E                                                                                                                                                                                  |
| Transmitter spurious, Units @ distance  | 53.73 dBμV/m average at 2483.5 MHz @ 3 m                                                                                                                                             |
| Power requirements                      | Internal 3.7 V <sub>DC</sub> battery powered                                                                                                                                         |
| Antenna information                     | SMD Antenna, EIA 1210, Detuning resilient, Edge Mount P/N 2450AT18D0100 1.5 dBi gain.<br>The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. |

### 3.4 Product description and theory of operation

EUT is a Bluetooth Handset with Bluetooth and BLE connectivity.

### 3.5 EUT exercise details

EUT was connected to a laptop running BlueTech software via USB programming kit that was used to control RF parameters.

3.6 EUT setup diagram

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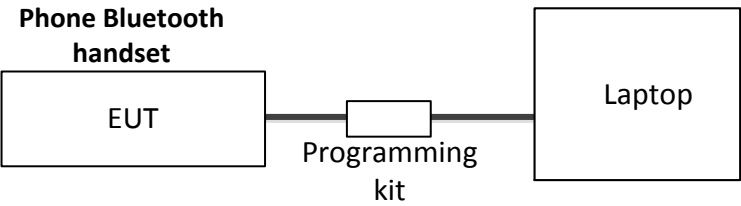


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

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Table 3.7-1: EUT sub assemblies

| Description | Brand name | Model/Part number | Serial number        |
|-------------|------------|-------------------|----------------------|
| Laptop      | Dell       | Latitude D600     | G8RZ461 (166-002584) |

**Section 4.**   Engineering considerations

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**4.1**   Modifications incorporated in the EUT

---

There were no modifications performed to the EUT during this assessment.

**4.2**   Technical judgment

---

None

**4.3**   Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.

# Section 5. Test conditions

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## 5.1 Atmospheric conditions

---

|                   |               |
|-------------------|---------------|
| Temperature       | 15–30 °C      |
| Relative humidity | 20–75 %       |
| Air pressure      | 860–1060 mbar |

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

## 5.2 Power supply range

---

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages  $\pm 5\%$ , for which the equipment was designed.



# Section 6. Measurement uncertainty

## 6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of  $K = 2$  with 95% certainty.

| Test name                         | Measurement uncertainty, dB |
|-----------------------------------|-----------------------------|
| All antenna port measurements     | 0.55                        |
| Conducted spurious emissions      | 1.13                        |
| Radiated spurious emissions       | 3.78                        |
| AC power line conducted emissions | 3.55                        |

## Section 7. Test equipment

### 7.1 Test equipment list

**Table 7.1-1: Equipment list**

| Equipment                   | Manufacturer       | Model no.     | Asset no. | Cal cycle | Next cal.   |
|-----------------------------|--------------------|---------------|-----------|-----------|-------------|
| 3 m EMI test chamber        | TDK                | SAC-3         | FA002047  | 1 year    | Dec. 01/16  |
| Receiver/spectrum analyzer  | Rohde & Schwarz    | ESU 26        | FA002043  | 1 year    | Jan. 07/17  |
| Spectrum analyzer           | Rohde & Schwarz    | FSU           | FA001877  | 1 year    | Apr. 15/17  |
| Bilog antenna (20–3000 MHz) | Sunol              | JB3           | FA002108  | 1 year    | Apr. 28/17  |
| Horn antenna (1–18 GHz)     | EMCO               | 3115          | FA000825  | 1 year    | Apr. 26/17  |
| Horn antenna 18–40 GHz      | EMCO               | 3116          | FA001847  | 1 year    | Apr. 15/17  |
| Pre-amplifier (1–18 GHz)    | JCA                | JCA118-503    | FA002091  | 1 year    | April 26/17 |
| Pre-amplifier (18–26 GHz)   | Narda              | BBS-1826N612  | FA001550  | —         | VOU         |
| Notch filter 2400–2483 MHz  | Microwave Circuits | 2400–2483 MHz | FA001940  | —         | VOU         |

Notes: VOU - verify on use

**Table 7.1-2: test software**

| Test description            | Manufacturer of Software | Details                                               |
|-----------------------------|--------------------------|-------------------------------------------------------|
| Radiated emissions – Ottawa | Rhode & Schwarz          | EMC32, Software for EMC Measurements, Version 9.26.01 |

Notes: None

## Section 8. Testing data

### 8.1 FCC 15.247(a)(2) and RSS-247 5.2(1): 6 dB bandwidth (DTS-BLE)

#### 8.1.1 Definitions and limits

**FCC §15.247 (a)(2):**

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
  - (2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

**RSS-247, Clause 5.2 (1):**

The minimum 6 dB bandwidth shall be 500 kHz.

#### 8.1.2 Test summary

|             |               |                   |                 |              |           |
|-------------|---------------|-------------------|-----------------|--------------|-----------|
| Verdict     | Pass          |                   |                 |              |           |
| Test date   | July 22, 2016 | Test engineer     | Andrey Adelberg |              |           |
| Temperature | 22 °C         | Relative humidity | 49 %            | Air pressure | 1006 mbar |

#### 8.1.3 Notes

- The EUT was set to transmit in BLE mode.
- Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05 (The test was performed using method described in Section 8.1)

#### 8.1.4 Setup details

Spectrum analyser settings: for 6 dB bandwidth test:

|                      |          |
|----------------------|----------|
| Resolution bandwidth | 100 kHz  |
| Video bandwidth      | ≥3 × RBW |
| Frequency span       | 2 MHz    |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

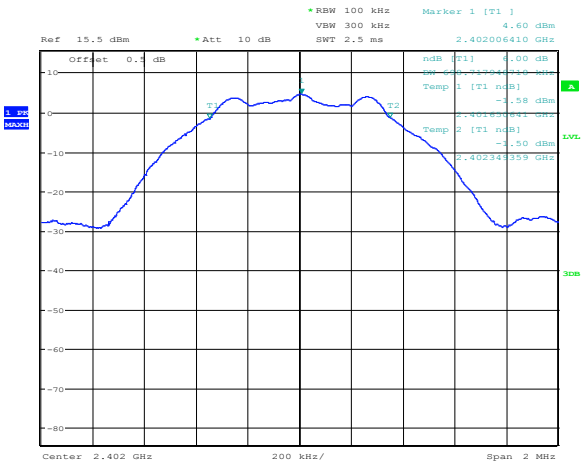
#### 8.1.5 Test data

**Table 8.1-1: 6 dB bandwidth results**

| Frequency, MHz | 6 dB bandwidth, kHz | Minimum limit, kHz | Margin, kHz |
|----------------|---------------------|--------------------|-------------|
| 2402           | 699                 | 500                | 199         |
| 2442           | 696                 | 500                | 196         |
| 2480           | 696                 | 500                | 196         |

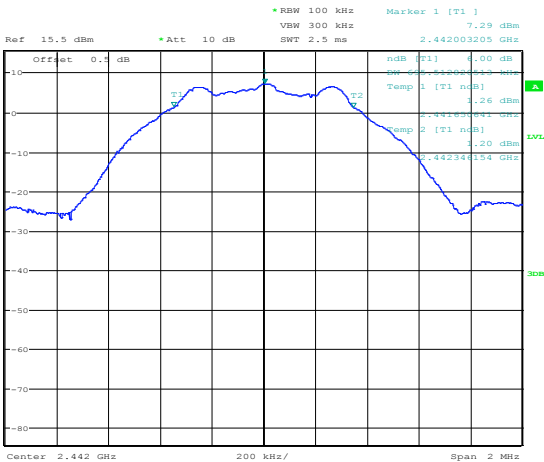
Notes:        None

8.1.6 Test data, continued



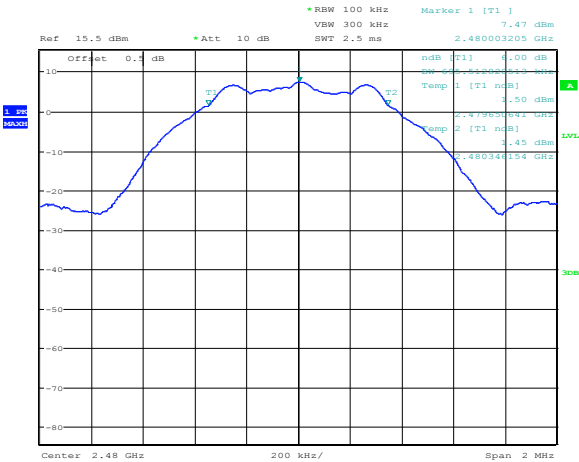
Date: 22.JUL.2016 11:08:10

Figure 8.1-1: 6 dB bandwidth on low channel



Date: 22.JUL.2016 11:07:12

Figure 8.1-2: 6 dB bandwidth on mid channel



Date: 22.JUL.2016 11:06:14

Figure 8.1-3: 6 dB bandwidth on high channel

## 8.2 FCC 15.247(a)(1) and RSS-247 5.1(1) Frequency Hopping Systems requirements

### 8.2.1 Definitions and limits

#### FCC §15.247 (a)(1) (iii):

- (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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
- (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.

#### RSS-247, Clause 5.1:

1. The bandwidth of a frequency hopping channel is the –20 dB emission bandwidth, measured with the hopping stopped. The system's radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, whereas the long-term distribution appears evenly distributed.
2. FHSS 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. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
4. FHSS operating in the band 2400–2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

### 8.2.2 Test summary

|             |               |                   |                 |              |           |
|-------------|---------------|-------------------|-----------------|--------------|-----------|
| Verdict     | Pass          |                   |                 |              |           |
| Test date   | July 22, 2016 | Test engineer     | Andrey Adelberg |              |           |
| Temperature | 22 °C         | Relative humidity | 49 %            | Air pressure | 1006 mbar |

### 8.2.3 Notes

The EUT was set to transmit in BT mode.

#### 8.2.4 Setup details

Spectrum analyser settings for carrier frequency separation:

|                      |                                                           |
|----------------------|-----------------------------------------------------------|
| Resolution bandwidth | 100 kHz                                                   |
| Video bandwidth      | ≥ RBW                                                     |
| Frequency span       | wide enough to capture the peaks of two adjacent channels |
| Detector mode        | Peak                                                      |
| Trace mode           | Max Hold                                                  |

Spectrum analyser settings for number of hopping frequencies:

|                      |                                 |
|----------------------|---------------------------------|
| Resolution bandwidth | 100 kHz                         |
| Video bandwidth      | ≥ RBW                           |
| Frequency span       | the frequency band of operation |
| Detector mode        | Peak                            |
| Trace mode           | Max Hold                        |

Spectrum analyser settings for time of occupancy (dwell time):

|                      |           |
|----------------------|-----------|
| Resolution bandwidth | 1 MHz     |
| Video bandwidth      | ≥ RBW     |
| Frequency span       | Zero span |
| Detector mode        | Peak      |
| Trace mode           | Max Hold  |

Spectrum analyser settings for 20 dB bandwidth:

|                      |          |
|----------------------|----------|
| Resolution bandwidth | 30 kHz   |
| Video bandwidth      | ≥ RBW    |
| Frequency span       | 3 MHz    |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

#### 8.2.5 Test data

**Table 8.2-1: 20 dB bandwidth results**

| Frequency, MHz | 20 dB bandwidth, MHz |
|----------------|----------------------|
| 2402           | 0.878                |
| 2441           | 0.849                |
| 2480           | 0.852                |

**Table 8.2-2: Carrier frequency separation results**

| Carrier frequency separation, MHz | Minimum limit, MHz | Margin, MHz |
|-----------------------------------|--------------------|-------------|
| 1.00                              | 0.849              | 0.151       |

**Table 8.2-3: Number of hopping frequencies and system RF BW results**

| Number of hopping frequencies | Minimum limit | Margin | System RF bandwidth, MHz |
|-------------------------------|---------------|--------|--------------------------|
| 79                            | 15            | 64     | 69.36                    |

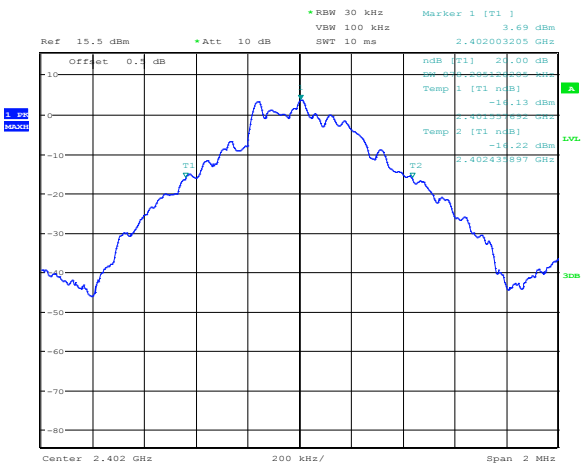
Note: System RF bandwidth = Number of hopping frequencies × 20 dB bandwidth

**Table 8.2-4: Average time of occupancy results**

| Dwell time of each pulse, ms | Number of pulses within period | Total dwell time within period, ms | Limit, ms | Margin, ms |
|------------------------------|--------------------------------|------------------------------------|-----------|------------|
| 0.379                        | 320                            | 121.28                             | 400.00    | 278.72     |

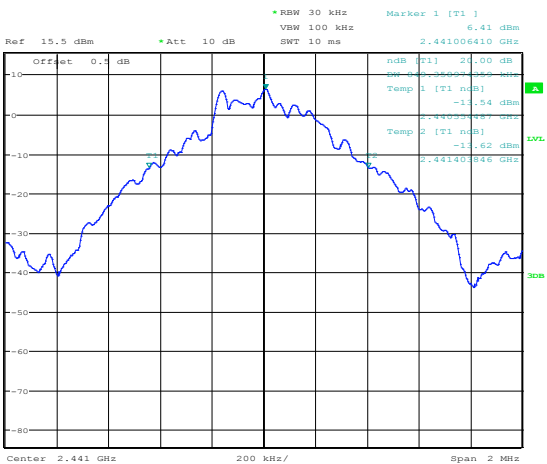
Notes: Measurement Period is 79 channels × 0.4 s = 31.6 s; Pulse repetition is 98.88 ms; Number of pulses within period = measurement period ÷ pulse repetition.

8.2.5 Test data, continued



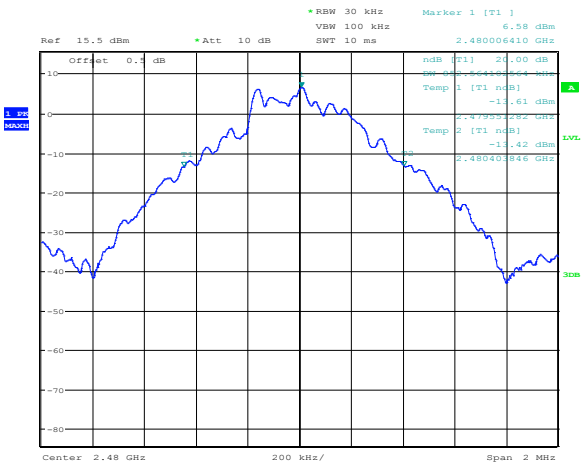
Date: 22.JUL.2016 11:10:06

Figure 8.2-1: 20 dB bandwidth on low channel



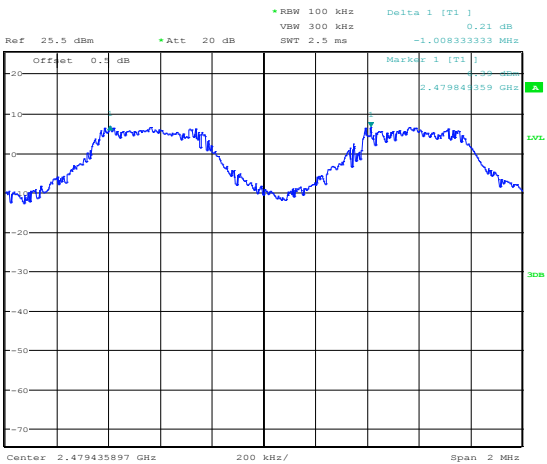
Date: 22.JUL.2016 11:11:17

Figure 8.2-2: 20 dB bandwidth on mid channel



Date: 22.JUL.2016 11:12:07

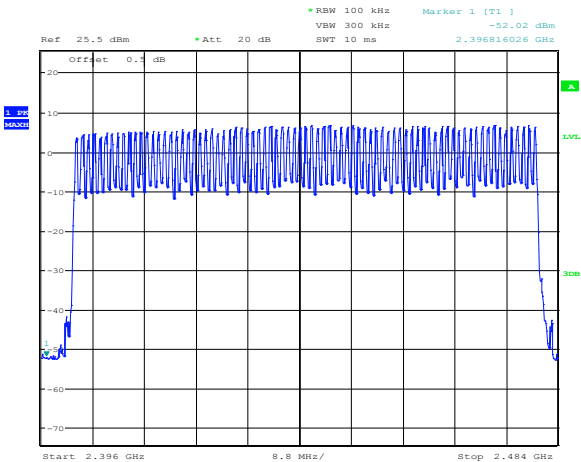
Figure 8.2-3: 20 dB bandwidth on high channel



Date: 22.JUL.2016 11:16:30

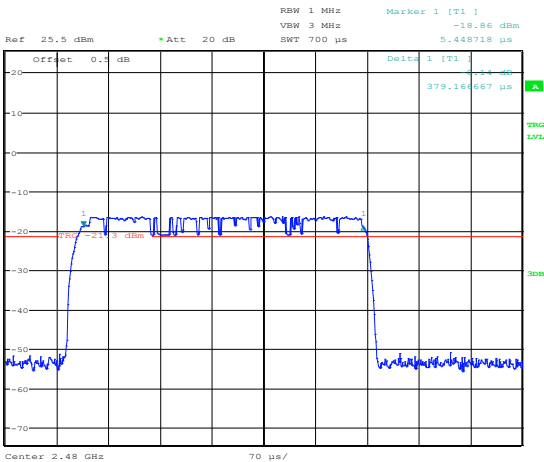
Figure 8.2-4: Carrier frequency separation

8.2.5 Test data, continued



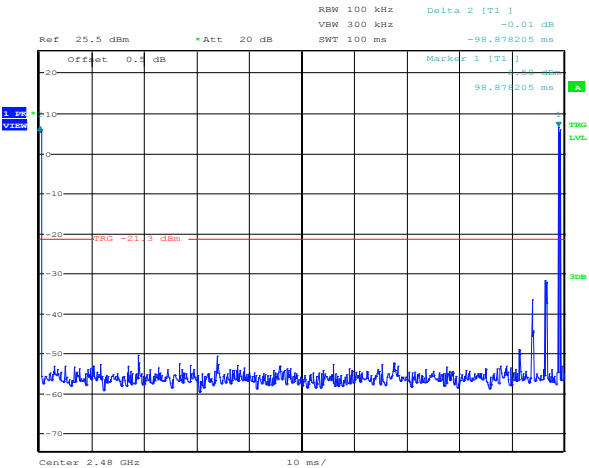
Date: 22.JUL.2016 11:19:37

Figure 8.2-5: Number of hopping channels



Date: 22.JUL.2016 11:23:24

Figure 8.2-6: Dwell time



Date: 22.JUL.2016 11:20:44

Figure 8.2-7: Pulse repetition

## 8.3 FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and e.i.r.p. requirements (DTS-BLE)

### 8.3.1 Definitions and limits

#### FCC §15.247 (b)(3,4):

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- (3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. 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. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
- (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### RSS-247, Clause 5.4 (4):

For DTSs employing digital modulation techniques operating in the bands 902–928 MHz and 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W. Fixed point-to-point systems in the bands 2400-2483.5 MHz and 5725-5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

### 8.3.2 Test summary

|             |               |                   |                 |              |           |
|-------------|---------------|-------------------|-----------------|--------------|-----------|
| Verdict     | Pass          |                   |                 |              |           |
| Test date   | July 22, 2016 | Test engineer     | Andrey Adelberg |              |           |
| Temperature | 21.7 °C       | Relative humidity | 49 %            | Air pressure | 1010 mbar |

### 8.3.3 Notes

- EUT was set to transmit in **BLE mode**.
- The test was performed according to 558074 D01 DTS Meas Guidance v03r05 (The test was performed using method described in Section 9.1.1: Maximum peak conducted output power.)

### 8.3.4 Setup details

Spectrum analyser settings:

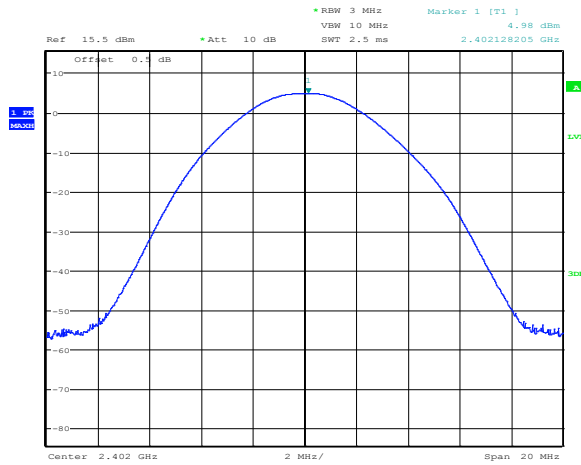
|                      |          |
|----------------------|----------|
| Resolution bandwidth | 3 MHz    |
| Video bandwidth      | ≥3 × RBW |
| Frequency span       | 20 MHz   |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

### 8.3.5 Test data

**Table 8.3-1: Output power measurements results**

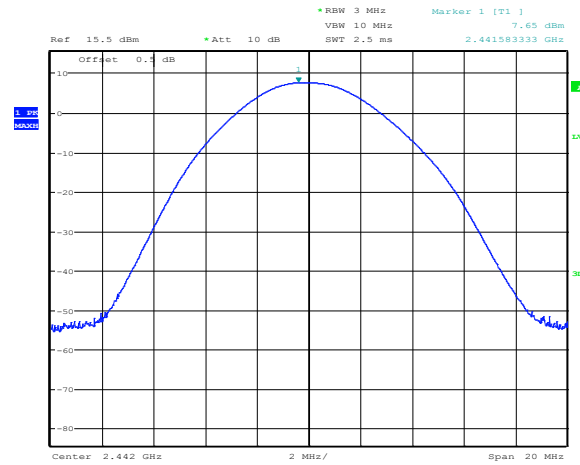
| Frequency,<br>MHz | Conducted output power, dBm |       | Margin, dB | Antenna gain,<br>dBi | EIRP,<br>dBm | EIRP limit,<br>dBm | EIRP margin,<br>dB |
|-------------------|-----------------------------|-------|------------|----------------------|--------------|--------------------|--------------------|
|                   | Measured                    | Limit |            |                      |              |                    |                    |
| 2402              | 4.98                        | 30.00 | 25.02      | 1.50                 | 6.48         | 36.00              | 29.52              |
| 2442              | 7.65                        | 30.00 | 22.35      | 1.50                 | 9.15         | 36.00              | 26.85              |
| 2480              | 7.84                        | 30.00 | 22.16      | 1.50                 | 9.34         | 36.00              | 26.66              |

Notes: EIRP = Output power + Antenna gain



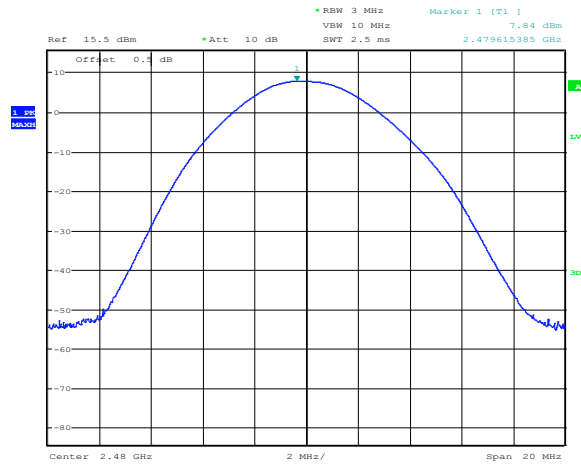
Date: 22.JUL.2016 11:01:43

**Figure 8.3-1: Output power on low channel**



Date: 22.JUL.2016 11:03:31

**Figure 8.3-2: Output power on mid channel**



Date: 22.JUL.2016 11:04:15

**Figure 8.3-3: Output power on high channel**

## 8.4 FCC 15.247(b) and RSS-247 5.4 (2) Transmitter output power and e.i.r.p. requirements (FHSS-BT)

### 8.4.1 Definitions and limits

#### FCC §15.247 (b)(1,4):

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
- (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 (30 dBm). For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts (21 dBm).
  - (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### RSS-247, Clause 5.4 (2):

For FHSS operating in the band 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W (30 dBm) and the e.i.r.p. shall not exceed 4 W (36 dBm) if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W (21 dBm) and the e.i.r.p. shall not exceed 0.5 W (27 dBm) if the hopset uses less than 75 hopping channels.

### 8.4.2 Test summary

|             |               |                   |                 |              |           |
|-------------|---------------|-------------------|-----------------|--------------|-----------|
| Verdict     | Pass          |                   |                 |              |           |
| Test date   | July 22, 2016 | Test engineer     | Andrey Adelberg |              |           |
| Temperature | 21.7 °C       | Relative humidity | 49 %            | Air pressure | 1010 mbar |

### 8.4.3 Notes

- EUT was set to transmit in **BT mode**.
  - The test was performed according to DA 00-705.
- EUT has a hopset that uses more than 75 hopping channels, hence the output power limit is 1 W.

### 8.4.4 Setup details

#### Spectrum analyser settings

|                      |          |
|----------------------|----------|
| Resolution bandwidth | 3 MHz    |
| Video bandwidth      | ≥ RBW    |
| Frequency span       | 20 MHz   |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

## 8.4.5 Test data

**Table 8.4-1:** Output power and EIRP results for ACL link type with Basic data rate

| Packet type | Frequency, MHz | Output power, dBm | Output power limit, dBm | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|-------------|----------------|-------------------|-------------------------|------------|-------------------|-----------|-----------------|-----------------|
| DM1         | 2402           | 7.56              | 30.00                   | 22.44      | 1.50              | 9.06      | 36.00           | 26.94           |
| DM1         | 2440           | 8.01              | 30.00                   | 21.99      | 1.50              | 9.51      | 36.00           | 26.49           |
| DM1         | 2480           | 9.00              | 30.00                   | 21.00      | 1.50              | 10.50     | 36.00           | 25.50           |
| DM3         | 2402           | 7.56              | 30.00                   | 22.44      | 1.50              | 9.06      | 36.00           | 26.94           |
| DM3         | 2440           | 8.01              | 30.00                   | 21.99      | 1.50              | 9.51      | 36.00           | 26.49           |
| DM3         | 2480           | 9.01              | 30.00                   | 20.99      | 1.50              | 10.51     | 36.00           | 25.49           |
| DH3         | 2402           | 7.55              | 30.00                   | 22.45      | 1.50              | 9.05      | 36.00           | 26.95           |
| DH3         | 2440           | 7.99              | 30.00                   | 22.01      | 1.50              | 9.49      | 36.00           | 26.51           |
| DH3         | 2480           | 8.95              | 30.00                   | 21.05      | 1.50              | 10.45     | 36.00           | 25.55           |
| DM5         | 2402           | 7.57              | 30.00                   | 22.43      | 1.50              | 9.07      | 36.00           | 26.93           |
| DM5         | 2440           | 8.01              | 30.00                   | 21.99      | 1.50              | 9.51      | 36.00           | 26.49           |
| DM5         | 2480           | 9.03              | 30.00                   | 20.97      | 1.50              | 10.53     | 36.00           | 25.47           |
| DH5         | 2402           | 7.55              | 30.00                   | 22.45      | 1.50              | 9.05      | 36.00           | 26.95           |
| DH5         | 2440           | 8.02              | 30.00                   | 21.98      | 1.50              | 9.52      | 36.00           | 26.48           |
| DH5         | 2480           | 9.07              | 30.00                   | 20.93      | 1.50              | 10.57     | 36.00           | 25.43           |
| DH1         | 2402           | 7.56              | 30.00                   | 22.44      | 1.50              | 9.06      | 36.00           | 26.94           |
| DH1         | 2440           | 8.04              | 30.00                   | 21.96      | 1.50              | 9.54      | 36.00           | 26.46           |
| DH1         | 2480           | 9.06              | 30.00                   | 20.94      | 1.50              | 10.56     | 36.00           | 25.44           |
| 2-DH1       | 2402           | 6.77              | 30.00                   | 23.23      | 1.50              | 8.27      | 36.00           | 27.73           |
| 2-DH1       | 2440           | 8.49              | 30.00                   | 21.51      | 1.50              | 9.99      | 36.00           | 26.01           |
| 2-DH1       | 2480           | 8.27              | 30.00                   | 21.73      | 1.50              | 9.77      | 36.00           | 26.23           |
| 3-DH1       | 2402           | 6.96              | 30.00                   | 23.04      | 1.50              | 8.46      | 36.00           | 27.54           |
| 3-DH1       | 2440           | 8.59              | 30.00                   | 21.41      | 1.50              | 10.09     | 36.00           | 25.91           |
| 3-DH1       | 2480           | 8.38              | 30.00                   | 21.62      | 1.50              | 9.88      | 36.00           | 26.12           |

Notes: EIRP = Output power + Antenna gain

**Table 8.4-2:** Output power and EIRP results for ACL link type with EDR data rate

| Packet type | Frequency, MHz | Output power, dBm | Output power limit, dBm | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|-------------|----------------|-------------------|-------------------------|------------|-------------------|-----------|-----------------|-----------------|
| DM1         | 2402           | 6.13              | 30.00                   | 23.87      | 1.50              | 7.63      | 36.00           | 28.37           |
| DM1         | 2440           | 8.02              | 30.00                   | 21.98      | 1.50              | 9.52      | 36.00           | 26.48           |
| DM1         | 2480           | 7.77              | 30.00                   | 22.23      | 1.50              | 9.27      | 36.00           | 26.73           |
| 2-DH3       | 2402           | 6.73              | 30.00                   | 23.27      | 1.50              | 8.23      | 36.00           | 27.77           |
| 2-DH3       | 2440           | 8.43              | 30.00                   | 21.57      | 1.50              | 9.93      | 36.00           | 26.07           |
| 2-DH3       | 2480           | 8.28              | 30.00                   | 21.72      | 1.50              | 9.78      | 36.00           | 26.22           |
| 3-DH3       | 2402           | 6.93              | 30.00                   | 23.07      | 1.50              | 8.43      | 36.00           | 27.57           |
| 3-DH3       | 2440           | 8.61              | 30.00                   | 21.39      | 1.50              | 10.11     | 36.00           | 25.89           |
| 3-DH3       | 2480           | 8.47              | 30.00                   | 21.53      | 1.50              | 9.97      | 36.00           | 26.03           |
| 2-DH5       | 2402           | 6.74              | 30.00                   | 23.26      | 1.50              | 8.24      | 36.00           | 27.76           |
| 2-DH5       | 2440           | 8.43              | 30.00                   | 21.57      | 1.50              | 9.93      | 36.00           | 26.07           |
| 2-DH5       | 2480           | 8.31              | 30.00                   | 21.69      | 1.50              | 9.81      | 36.00           | 26.19           |
| 3-DH5       | 2402           | 6.93              | 30.00                   | 23.07      | 1.50              | 8.43      | 36.00           | 27.57           |
| 3-DH5       | 2440           | 8.62              | 30.00                   | 21.38      | 1.50              | 10.12     | 36.00           | 25.88           |
| 3-DH5       | 2480           | 8.50              | 30.00                   | 21.50      | 1.50              | 10.00     | 36.00           | 26.00           |

Notes: EIRP = Output power + Antenna gain

**Table 8.4-3:** Output power and EIRP results for SCO link type with Basic data rate

| Packet type | Frequency, MHz | Output power, dBm | Output power limit, dBm | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|-------------|----------------|-------------------|-------------------------|------------|-------------------|-----------|-----------------|-----------------|
| HV1         | 2402           | 6.10              | 30.00                   | 23.90      | 1.50              | 7.60      | 36.00           | 28.40           |
| HV1         | 2440           | 7.99              | 30.00                   | 22.01      | 1.50              | 9.49      | 36.00           | 26.51           |
| HV1         | 2480           | 7.74              | 30.00                   | 22.26      | 1.50              | 9.24      | 36.00           | 26.76           |
| HV2         | 2402           | 6.13              | 30.00                   | 23.87      | 1.50              | 7.63      | 36.00           | 28.37           |
| HV2         | 2440           | 7.99              | 30.00                   | 22.01      | 1.50              | 9.49      | 36.00           | 26.51           |
| HV2         | 2480           | 7.72              | 30.00                   | 22.28      | 1.50              | 9.22      | 36.00           | 26.78           |
| HV3         | 2402           | 6.16              | 30.00                   | 23.84      | 1.50              | 7.66      | 36.00           | 28.34           |
| HV3         | 2440           | 7.99              | 30.00                   | 22.01      | 1.50              | 9.49      | 36.00           | 26.51           |
| HV3         | 2480           | 7.72              | 30.00                   | 22.28      | 1.50              | 9.22      | 36.00           | 26.78           |
| DV          | 2402           | 6.13              | 30.00                   | 23.87      | 1.50              | 7.63      | 36.00           | 28.37           |
| DV          | 2440           | 7.98              | 30.00                   | 22.02      | 1.50              | 9.48      | 36.00           | 26.52           |
| DV          | 2480           | 7.75              | 30.00                   | 22.25      | 1.50              | 9.25      | 36.00           | 26.75           |

Notes: EIRP = Output power + Antenna gain

**Table 8.4-4:** Output power and EIRP results for eSCO link type with Basic data rate

| Packet type | Frequency, MHz | Output power, dBm | Output power limit, dBm | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|-------------|----------------|-------------------|-------------------------|------------|-------------------|-----------|-----------------|-----------------|
| EV3         | 2402           | 6.13              | 30.00                   | 23.87      | 1.50              | 7.63      | 36.00           | 28.37           |
| EV3         | 2440           | 7.98              | 30.00                   | 22.02      | 1.50              | 9.48      | 36.00           | 26.52           |
| EV3         | 2480           | 7.70              | 30.00                   | 22.30      | 1.50              | 9.20      | 36.00           | 26.80           |
| EV4         | 2402           | 6.13              | 30.00                   | 23.87      | 1.50              | 7.63      | 36.00           | 28.37           |
| EV4         | 2440           | 7.89              | 30.00                   | 22.11      | 1.50              | 9.39      | 36.00           | 26.61           |
| EV4         | 2480           | 7.67              | 30.00                   | 22.33      | 1.50              | 9.17      | 36.00           | 26.83           |
| EV5         | 2402           | 6.12              | 30.00                   | 23.88      | 1.50              | 7.62      | 36.00           | 28.38           |
| EV5         | 2440           | 8.01              | 30.00                   | 21.99      | 1.50              | 9.51      | 36.00           | 26.49           |
| EV5         | 2480           | 7.67              | 30.00                   | 22.33      | 1.50              | 9.17      | 36.00           | 26.83           |

Notes: EIRP = Output power + Antenna gain

**Table 8.4-5:** Output power and EIRP results for eSCO link type with EDR data rate

| Packet type | Frequency, MHz | Output power, dBm | Output power limit, dBm | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|-------------|----------------|-------------------|-------------------------|------------|-------------------|-----------|-----------------|-----------------|
| 2-EV3       | 2402           | 6.74              | 30.00                   | 23.26      | 1.50              | 8.24      | 36.00           | 27.76           |
| 2-EV3       | 2440           | 8.44              | 30.00                   | 21.56      | 1.50              | 9.94      | 36.00           | 26.06           |
| 2-EV3       | 2480           | 8.20              | 30.00                   | 21.80      | 1.50              | 9.70      | 36.00           | 26.30           |
| 3-EV3       | 2402           | 6.97              | 30.00                   | 23.03      | 1.50              | 8.47      | 36.00           | 27.53           |
| 3-EV3       | 2440           | 8.58              | 30.00                   | 21.42      | 1.50              | 10.08     | 36.00           | 25.92           |
| 3-EV3       | 2480           | 8.38              | 30.00                   | 21.62      | 1.50              | 9.88      | 36.00           | 26.12           |
| 2-EV5       | 2402           | 6.74              | 30.00                   | 23.26      | 1.50              | 8.24      | 36.00           | 27.76           |
| 2-EV5       | 2440           | 8.47              | 30.00                   | 21.53      | 1.50              | 9.97      | 36.00           | 26.03           |
| 2-EV5       | 2480           | 8.22              | 30.00                   | 21.78      | 1.50              | 9.72      | 36.00           | 26.28           |
| 3-EV5       | 2402           | 6.93              | 30.00                   | 23.07      | 1.50              | 8.43      | 36.00           | 27.57           |
| 3-EV5       | 2440           | 8.67              | 30.00                   | 21.33      | 1.50              | 10.17     | 36.00           | 25.83           |
| 3-EV5       | 2480           | 8.38              | 30.00                   | 21.62      | 1.50              | 9.88      | 36.00           | 26.12           |

Notes: EIRP = Output power + Antenna gain

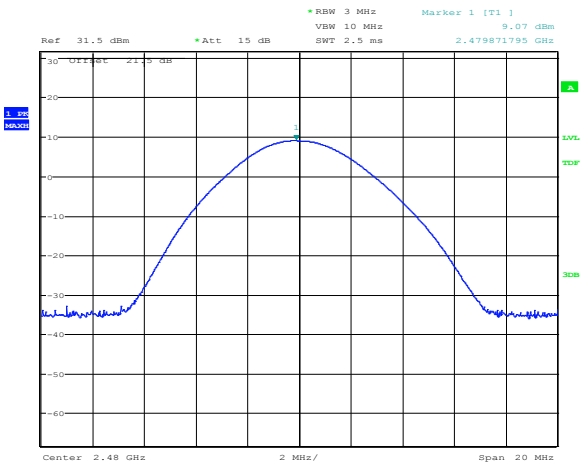


Figure 8.4-1: Output power sample plot

## 8.5 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions

### 8.5.1 Definitions and limits

#### FCC §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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

#### RSS-247, Clause 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

**Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits**

| Frequency,<br>MHz | Field strength of emissions |                                 | Measurement distance, m |
|-------------------|-----------------------------|---------------------------------|-------------------------|
|                   | µV/m                        | dBµV/m                          |                         |
| 0.009–0.490       | 2400/F                      | $67.6 - 20 \times \log_{10}(F)$ | 300                     |
| 0.490–1.705       | 24000/F                     | $87.6 - 20 \times \log_{10}(F)$ | 30                      |
| 1.705–30.0        | 30                          | 29.5                            | 30                      |
| 30–88             | 100                         | 40.0                            | 3                       |
| 88–216            | 150                         | 43.5                            | 3                       |
| 216–960           | 200                         | 46.0                            | 3                       |
| above 960         | 500                         | 54.0                            | 3                       |

Notes: In the emission table above, the tighter limit applies at the band edges.  
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

**Table 8.5-2: IC restricted frequency bands**

| MHz             | MHz                 | MHz           | GHz         |
|-----------------|---------------------|---------------|-------------|
| 0.090–0.110     | 12.51975–12.52025   | 399.9–410     | 5.35–5.46   |
| 2.1735–2.1905   | 12.57675–12.57725   | 608–614       | 7.25–7.75   |
| 3.020–3.026     | 13.36–13.41         | 960–1427      | 8.025–8.5   |
| 4.125–4.128     | 16.42–16.423        | 1435–1626.5   | 9.0–9.2     |
| 4.17725–4.17775 | 16.69475–16.69525   | 1645.5–1646.5 | 9.3–9.5     |
| 4.20725–4.20775 | 16.80425–16.80475   | 1660–1710     | 10.6–12.7   |
| 5.677–5.683     | 25.5–25.67          | 1718.8–1722.2 | 13.25–13.4  |
| 6.215–6.218     | 37.5–38.25          | 2200–2300     | 14.47–14.5  |
| 6.26775–6.26825 | 73–74.6             | 2310–2390     | 15.35–16.2  |
| 6.31175–6.31225 | 74.8–75.2           | 2655–2900     | 17.7–21.4   |
| 8.291–8.294     | 108–138             | 3260–3267     | 22.01–23.12 |
| 8.362–8.366     | 156.52475–156.52525 | 3332–3339     | 23.6–24.0   |
| 8.37625–8.38675 | 156.7–156.9         | 3345.8–3358   | 31.2–31.8   |
| 8.41425–8.41475 | 240–285             | 3500–4400     | 36.43–36.5  |
| 12.29–12.293    | 322–335.4           | 4500–5150     | Above 38.6  |

Notes: Certain frequency bands listed in this table and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

**Table 8.5-3: FCC restricted frequency bands**

| MHz               | MHz                 | MHz           | GHz         |
|-------------------|---------------------|---------------|-------------|
| 0.090–0.110       | 16.42–16.423        | 399.9–410     | 4.5–5.15    |
| 0.495–0.505       | 16.69475–16.69525   | 608–614       | 5.35–5.46   |
| 2.1735–2.1905     | 16.80425–16.80475   | 960–1240      | 7.25–7.75   |
| 4.125–4.128       | 25.5–25.67          | 1300–1427     | 8.025–8.5   |
| 4.17725–4.17775   | 37.5–38.25          | 1435–1626.5   | 9.0–9.2     |
| 4.20725–4.20775   | 73–74.6             | 1645.5–1646.5 | 9.3–9.5     |
| 6.215–6.218       | 74.8–75.2           | 1660–1710     | 10.6–12.7   |
| 6.26775–6.26825   | 108–121.94          | 1718.8–1722.2 | 13.25–13.4  |
| 6.31175–6.31225   | 123–138             | 2200–2300     | 14.47–14.5  |
| 8.291–8.294       | 149.9–150.05        | 2310–2390     | 15.35–16.2  |
| 8.362–8.366       | 156.52475–156.52525 | 2483.5–2500   | 17.7–21.4   |
| 8.37625–8.38675   | 156.7–156.9         | 2690–2900     | 22.01–23.12 |
| 8.41425–8.41475   | 162.0125–167.17     | 3260–3267     | 23.6–24.0   |
| 12.29–12.293      | 167.72–173.2        | 3332–3339     | 31.2–31.8   |
| 12.51975–12.52025 | 240–285             | 3345.8–3358   | 36.43–36.5  |
| 12.57675–12.57725 | 322–335.4           | 3600–4400     | Above 38.6  |
| 13.36–13.41       |                     |               |             |

## 8.5.2 Test summary

|             |               |                   |                |              |           |
|-------------|---------------|-------------------|----------------|--------------|-----------|
| Verdict     | Pass          |                   |                |              |           |
| Test date   | July 19, 2016 | Test engineer     | David Duchesne |              |           |
| Temperature | 22 °C         | Relative humidity | 49 %           | Air pressure | 1006 mbar |

## 8.5.3 Notes

- The spectrum was searched from 30 MHz to the 10<sup>th</sup> harmonic.
- Since fundamental power was tested using peak method, the spurious emissions limit is –20 dBc/100 kHz
- The radiated spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

#### 8.5.4      Setup details

---

Spectrum analyser settings for conducted measurements:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 100 kHz  |
| Video bandwidth:      | 300 kHz  |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 100 kHz  |
| Video bandwidth:      | 300 kHz  |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

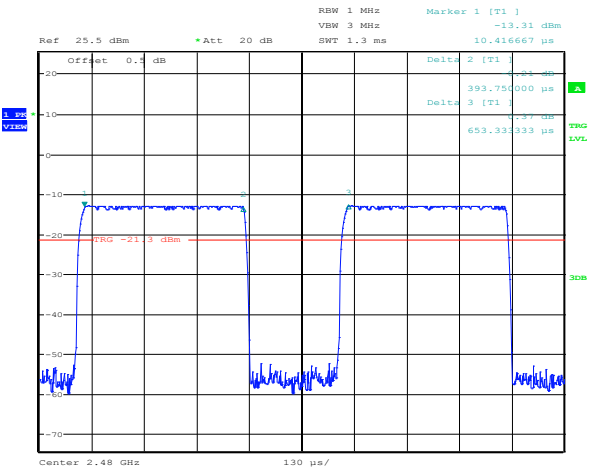
Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 1 MHz    |
| Video bandwidth:      | 3 MHz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

Spectrum analyser settings for average radiated measurements within restricted bands above 1 GHz:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 1 MHz    |
| Video bandwidth:      | 10 Hz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

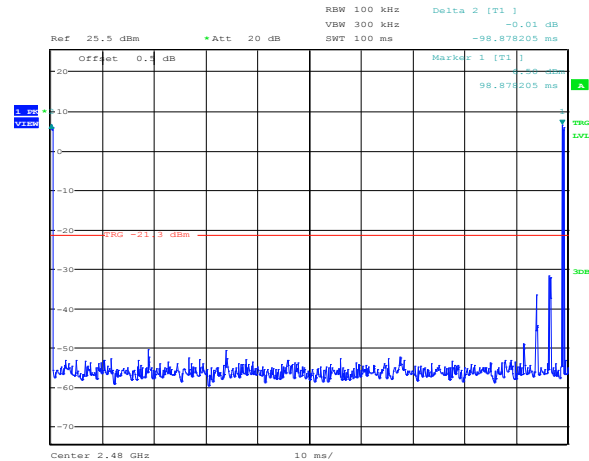
8.5.5 Test data



Date: 22.JUL.2016 11:31:35

Figure 8.5-1: Pulse width for BLE

BLE Duty Cycle Calculation:  
Tx on Time: 0.394 ms; T period = 0.653 ms; Tx off time = 0.259 ms (0.653 ms – 0.394 ms)  
Duty cycle correction factor:  $20 \times \log_{10}(0.394 / 0.653) = -4.4$  dB



Date: 22.JUL.2016 11:20:44

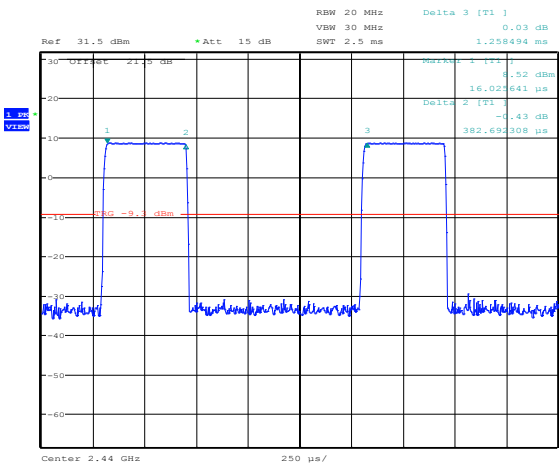
Figure 8.5-2: Number of pulses for BT (hopping on) within 100 ms time frame

**Section 8**  
**Test name**  
**Specification**

Testing data  
FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions  
FCC Part 15 Subpart C and RSS-247, Issue 1

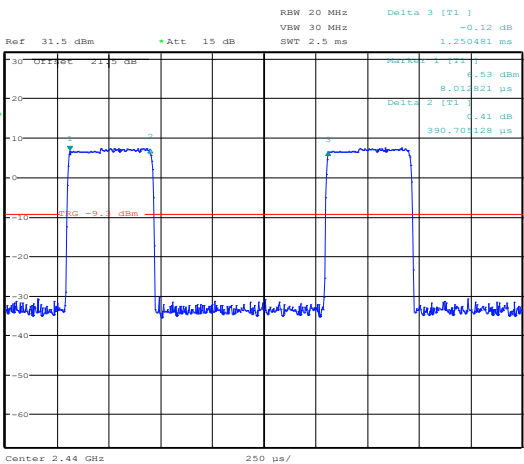


The following plots were taken with hopping sequence turned off.  
With the hopping sequence turned on there are two pulses within 100 ms time frame.



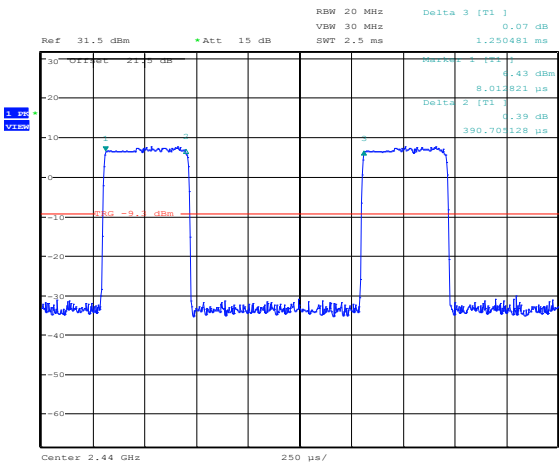
Date: 7.NOV.2016 17:21:45

**Figure 8.5-3: Pulse width for DH1**



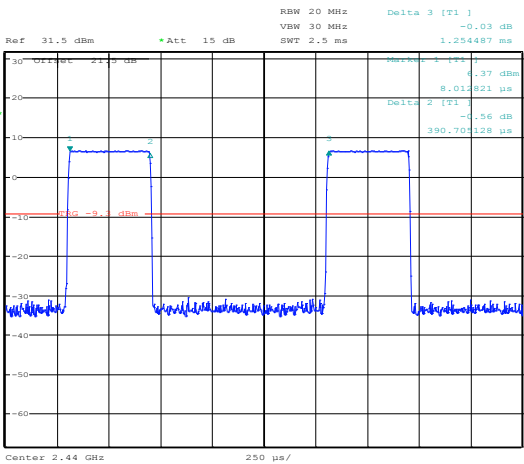
Date: 7.NOV.2016 17:22:47

**Figure 8.5-4: Pulse width for 2-DH1**



Date: 7.NOV.2016 17:23:14

**Figure 8.5-5: Pulse width for 3-DH1**

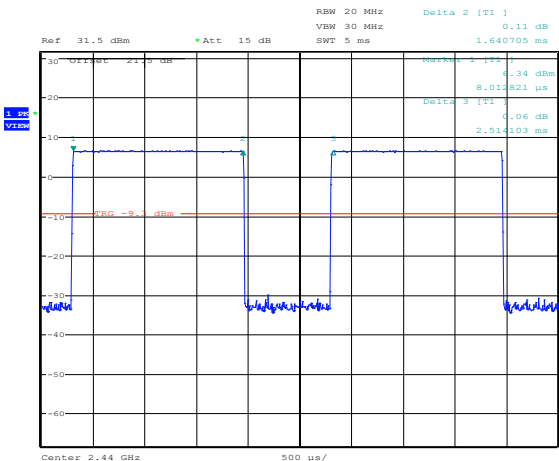


Date: 7.NOV.2016 17:23:43

**Figure 8.5-6: Pulse width for DM1 (Basic data rate)**

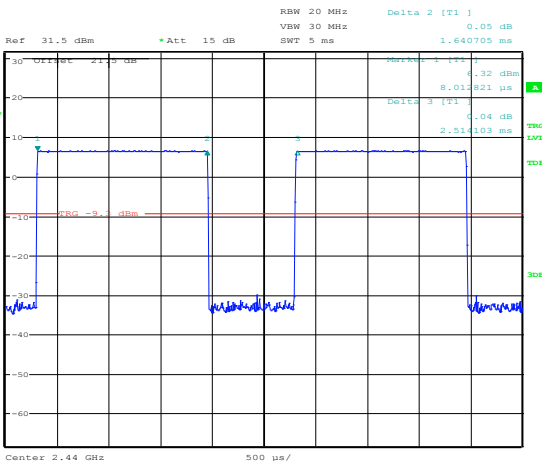
**Section 8**  
**Test name**  
**Specification**

Testing data  
FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions  
FCC Part 15 Subpart C and RSS-247, Issue 1



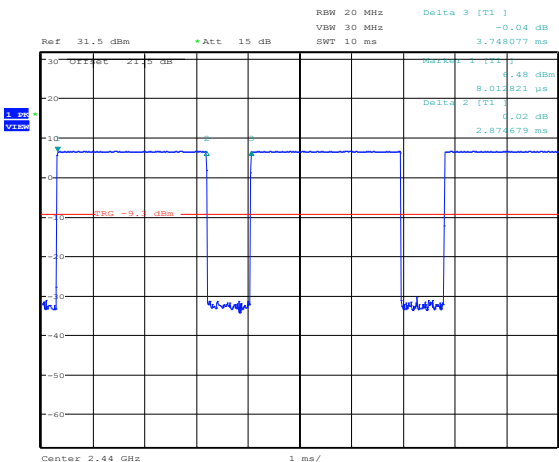
Date: 7.NOV.2016 17:24:22

Figure 8.5-7: Pulse width for DM3



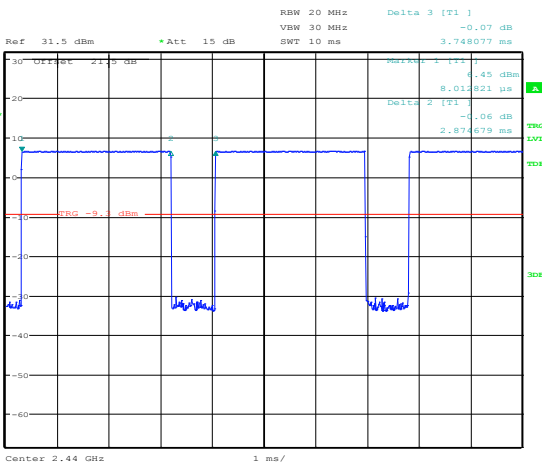
Date: 7.NOV.2016 17:24:48

Figure 8.5-8: Pulse width for DH3



Date: 7.NOV.2016 17:25:27

Figure 8.5-9: Pulse width for DM5

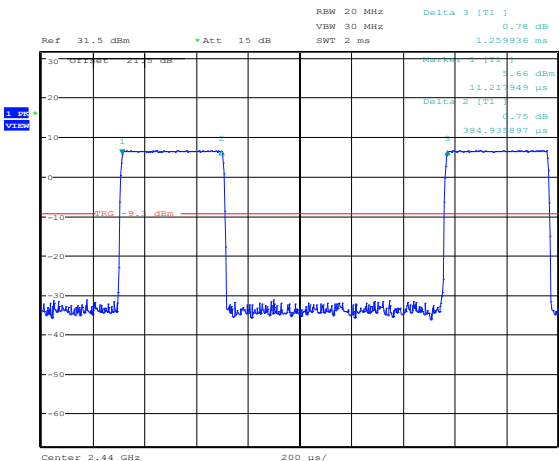


Date: 7.NOV.2016 17:25:58

Figure 8.5-10: Pulse width for DH5

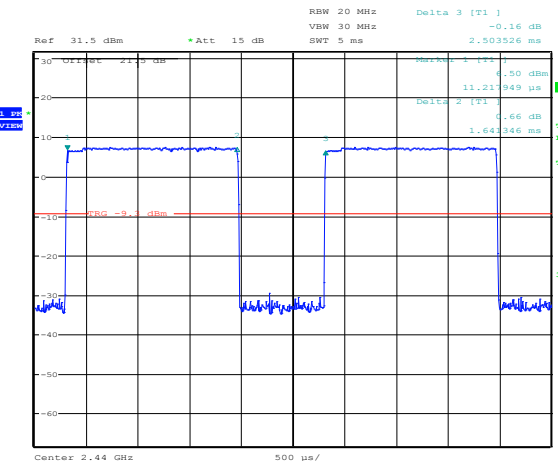
**Section 8**  
**Test name**  
**Specification**

Testing data  
FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions  
FCC Part 15 Subpart C and RSS-247, Issue 1



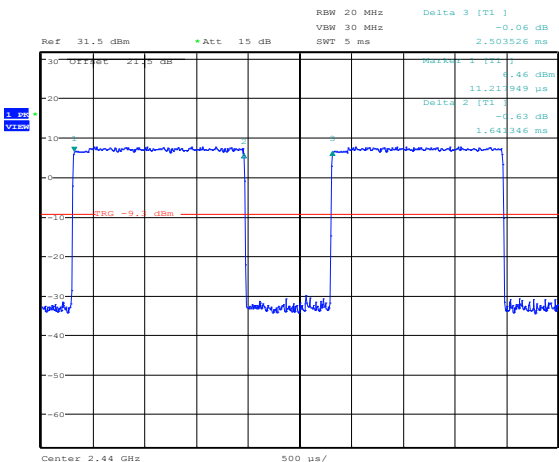
Date: 7.NOV.2016 17:27:08

Figure 8.5-11: Pulse width for DM1 (EDR data rate)



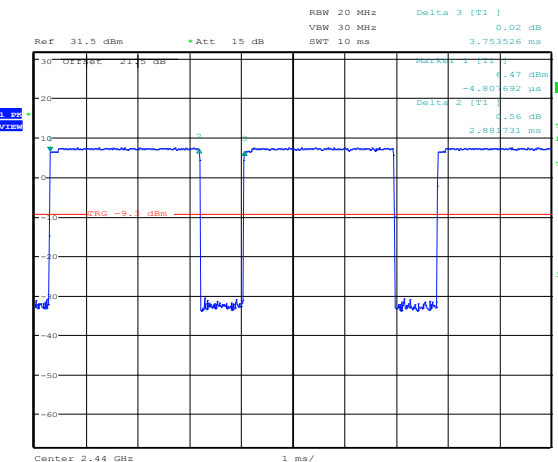
Date: 7.NOV.2016 17:28:09

Figure 8.5-12: Pulse width for 2-DH3



Date: 7.NOV.2016 17:28:40

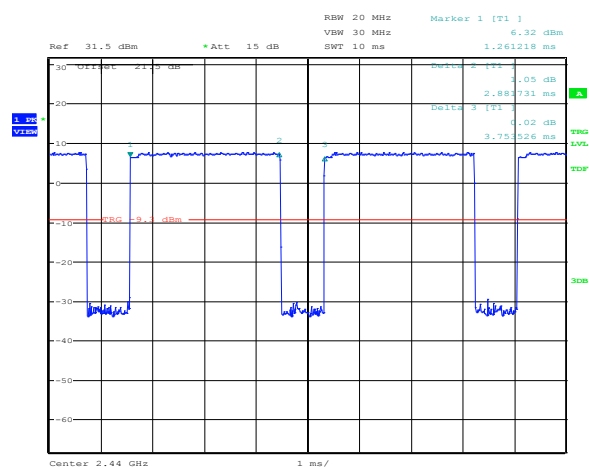
Figure 8.5-13: Pulse width for 3-DH3



Date: 7.NOV.2016 17:29:25

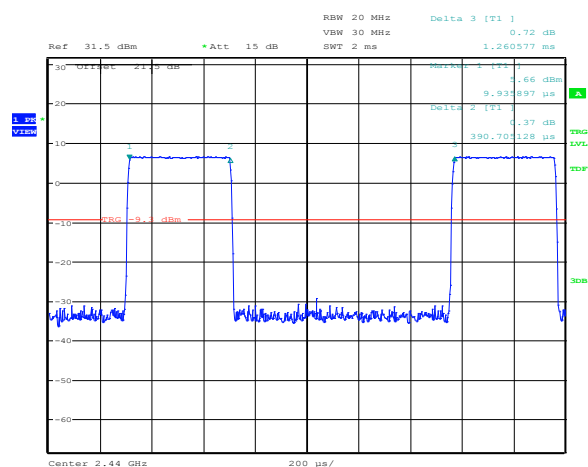
Figure 8.5-14: Pulse width for 2-DH3

Testing data  
FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions  
FCC Part 15 Subpart C and RSS-247, Issue 1



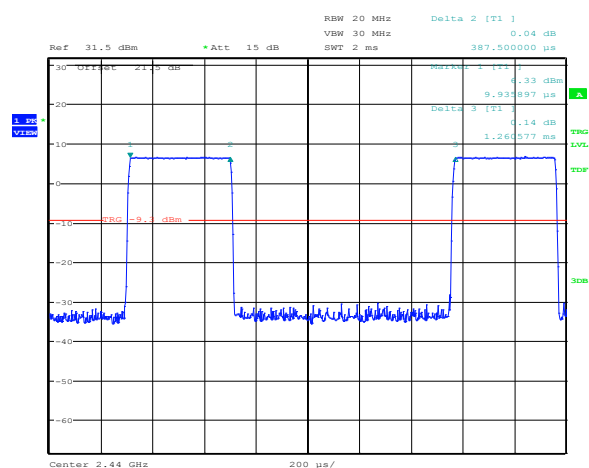
Date: 7.NOV.2016 17:30:10

**Figure 8.5-15: Pulse width for 3-DH5**



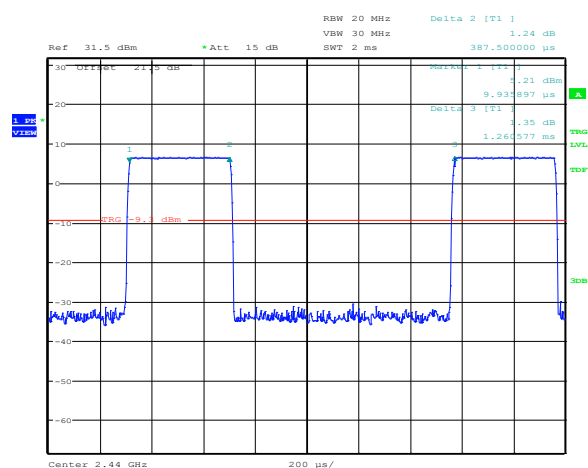
Date: 7.NOV.2016 17:30:55

**Figure 8.5-16: Pulse width for HV1**



Date: 7.NOV.2016 17:31:25

**Figure 8.5-17: Pulse width for HV2**

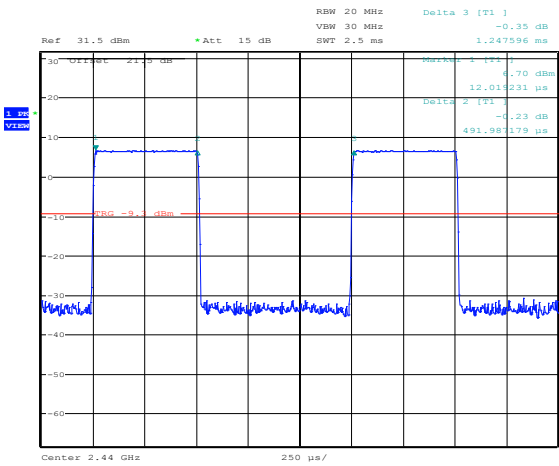


Date: 7.NOV.2016 17:31:48

**Figure 8.5-18: Pulse width for HV3**

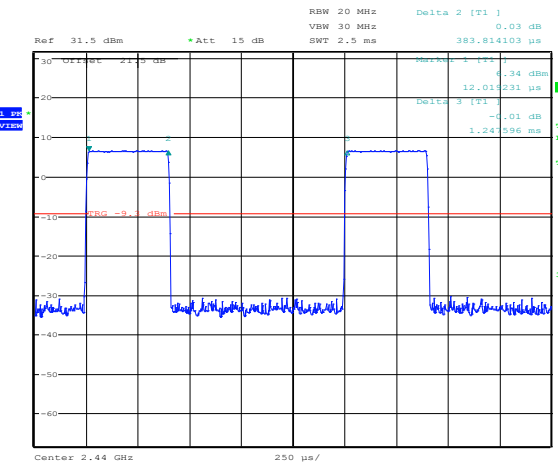
**Section 8**  
**Test name**  
**Specification**

Testing data  
FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions  
FCC Part 15 Subpart C and RSS-247, Issue 1



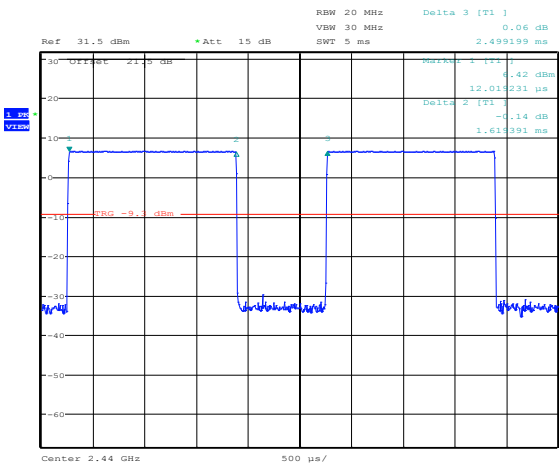
Date: 7.NOV.2016 17:32:54

Figure 8.5-19: Pulse width for DV



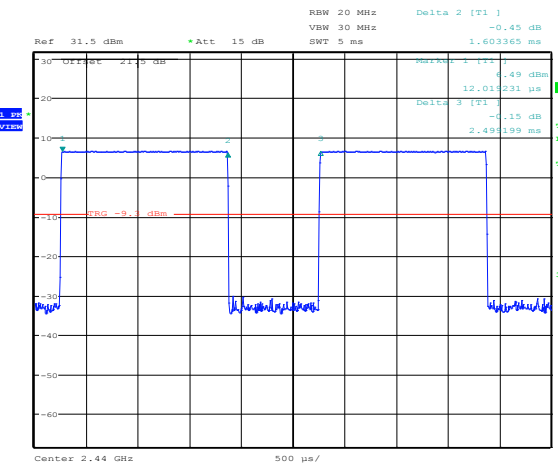
Date: 7.NOV.2016 17:33:24

Figure 8.5-20: Pulse width for EV3



Date: 7.NOV.2016 17:34:02

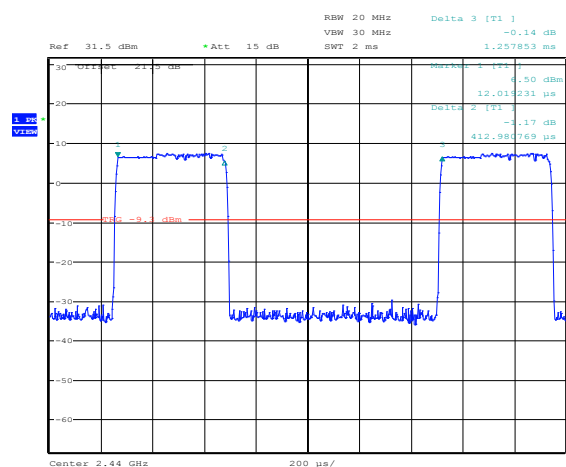
Figure 8.5-21: Pulse width for EV4



Date: 7.NOV.2016 17:34:28

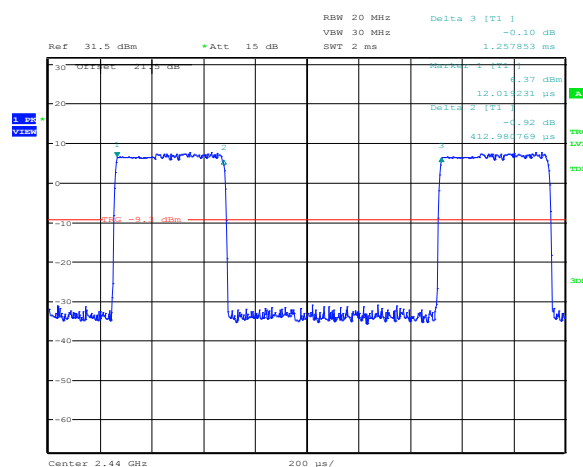
Figure 8.5-22: Pulse width for EV5

Testing data  
FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions  
FCC Part 15 Subpart C and RSS-247, Issue 1



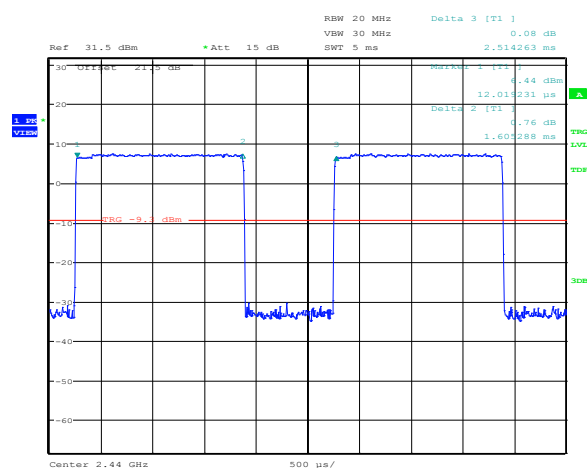
Date: 7.NOV.2016 17:35:05

**Figure 8.5-23: Pulse width for 2-EV3**



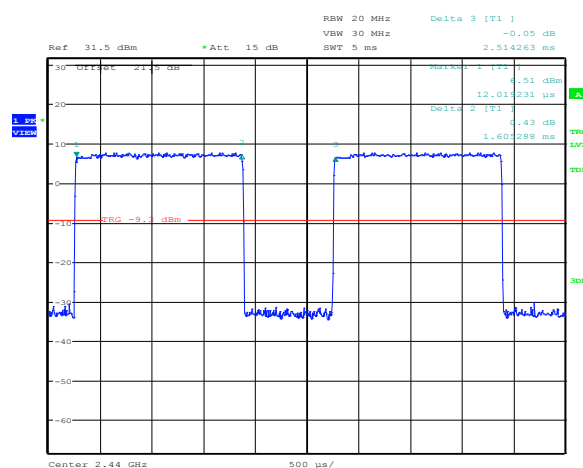
Date: 7.NOV.2016 17:35:29

**Figure 8.5-24: Pulse width for 3-EV3**



Date: 7.NOV.2016 17:36:03

**Figure 8.5-25: Pulse width for 2-EV5**



Date: 7.NOV.2016 17:36:25

**Figure 8.5-26: Pulse width for 3-EV5**

Duty cycle correction factor was calculated as follows:

$$20 \times \log_{10} [(Pulse\ width\ (ms) \times number\ of\ pulses\ within\ 100\ ms) / 100\ (ms)]$$

**Table 8.5-4:** Output power and EIRP results for ACL link type with Basic data rate

| Packet type | Pulse width, ms | Number of pulses within 100 ms | Duty cycle correction factor, dB |
|-------------|-----------------|--------------------------------|----------------------------------|
| DM1         | 0.391           | 2                              | -42.14                           |
| DM3         | 1.641           | 2                              | -29.68                           |
| DH3         | 1.641           | 2                              | -29.68                           |
| DM5         | 2.875           | 2                              | -24.81                           |
| DH5         | 2.875           | 2                              | -24.81                           |
| DH1         | 0.383           | 2                              | -42.32                           |
| 2-DH1       | 0.391           | 2                              | -42.14                           |
| 3-DH1       | 0.391           | 2                              | -42.14                           |

**Table 8.5-5:** Output power and EIRP results for ACL link type with EDR data rate

| Packet type | Pulse width, ms | Number of pulses within 100 ms | Duty cycle correction factor, dB |
|-------------|-----------------|--------------------------------|----------------------------------|
| DM1         | 0.385           | 2                              | -42.27                           |
| 2-DH3       | 1.641           | 2                              | -29.68                           |
| 3-DH3       | 1.641           | 2                              | -29.68                           |
| 2-DH5       | 2.882           | 2                              | -24.79                           |
| 3-DH5       | 2.882           | 2                              | -24.79                           |

**Table 8.5-6:** Output power and EIRP results for SCO link type with Basic data rate

| Packet type | Pulse width, ms | Number of pulses within 100 ms | Duty cycle correction factor, dB |
|-------------|-----------------|--------------------------------|----------------------------------|
| HV1         | 0.391           | 2                              | -42.14                           |
| HV2         | 0.388           | 2                              | -42.20                           |
| HV3         | 0.388           | 2                              | -42.20                           |
| DV          | 0.492           | 2                              | -40.14                           |

**Table 8.5-7:** Output power and EIRP results for eSCO link type with Basic data rate

| Packet type | Pulse width, ms | Number of pulses within 100 ms | Duty cycle correction factor, dB |
|-------------|-----------------|--------------------------------|----------------------------------|
| EV3         | 0.384           | 2                              | -42.29                           |
| EV4         | 1.619           | 2                              | -29.79                           |
| EV5         | 1.603           | 2                              | -29.88                           |

**Table 8.5-8:** Output power and EIRP results for eSCO link type with EDR data rate

| Packet type | Pulse width, ms | Number of pulses within 100 ms | Duty cycle correction factor, dB |
|-------------|-----------------|--------------------------------|----------------------------------|
| 2-EV3       | 0.413           | 2                              | -41.66                           |
| 3-EV3       | 0.413           | 2                              | -41.66                           |
| 2-EV5       | 1.605           | 2                              | -29.87                           |
| 3-EV5       | 1.605           | 2                              | -29.87                           |

## 8.5.5 Test data, continued

**Table 8.5-9: Radiated field strength measurement results for BT**

| Channel | Frequency, MHz | Peak Field strength, dBμV/m |       | Margin, dB | Average Field strength, dBμV/m |       | Margin, dB |
|---------|----------------|-----------------------------|-------|------------|--------------------------------|-------|------------|
|         |                | Measured                    | Limit |            | Calculated                     | Limit |            |
| Low     | 2390           | 51.72                       | 74.00 | 22.28      | 26.93                          | 54.00 | 27.07      |
| Low     | 4804           | 45.20                       | 74.00 | 28.80      | 20.41                          | 54.00 | 33.59      |
| Low     | 7206           | 52.47                       | 74.00 | 21.53      | 27.68                          | 54.00 | 26.32      |
| Mid     | 4882           | 41.93                       | 74.00 | 32.07      | 17.14                          | 54.00 | 36.86      |
| Mid     | 7323           | 54.93                       | 74.00 | 19.07      | 30.14                          | 54.00 | 23.86      |
| High    | 2483.5         | 58.78                       | 74.00 | 15.22      | 33.99                          | 54.00 | 20.01      |
| High    | 4960           | 44.35                       | 74.00 | 29.65      | 19.56                          | 54.00 | 34.44      |
| High    | 7440           | 55.24                       | 74.00 | 18.76      | 30.45                          | 54.00 | 23.55      |

Notes: Field strength (dBμV/m) = Spectrum analyzer value (dBμV) + transducer factors (dB)

Transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Average field strength calculation was performed using the following formula: Average Field strength = Peak Field strength + Duty cycle correction factor (DCCF) for BT

The lowest DCCF (see tables above) was -24.79 dB

All other emissions were greater than 20 dB below the limit.

**Table 8.5-10: Radiated field strength measurement results for BLE**

| Channel | Frequency, MHz | Peak Field strength, dBμV/m |       | Margin, dB | Average Field strength, dBμV/m |       | Margin, dB |
|---------|----------------|-----------------------------|-------|------------|--------------------------------|-------|------------|
|         |                | Measured                    | Limit |            | Calculated                     | Limit |            |
| Low     | 2390           | 51.63                       | 74.00 | 22.37      | 47.13                          | 54.00 | 6.87       |
| Low     | 4804           | 43.00                       | 74.00 | 31.00      | 38.50                          | 54.00 | 15.50      |
| Low     | 7206           | 51.39                       | 74.00 | 22.61      | 46.89                          | 54.00 | 7.11       |
| Mid     | 4880           | 43.31                       | 74.00 | 30.69      | 38.81                          | 54.00 | 15.19      |
| Mid     | 7320           | 55.84                       | 74.00 | 18.16      | 51.34                          | 54.00 | 2.66       |
| High    | 2483.5         | 58.23                       | 74.00 | 15.77      | 53.73                          | 54.00 | 0.27       |
| High    | 4960           | 44.61                       | 74.00 | 29.39      | 40.11                          | 54.00 | 13.89      |
| High    | 7440           | 54.80                       | 74.00 | 19.20      | 50.30                          | 54.00 | 3.70       |

Notes: Field strength (dBμV/m) = Spectrum analyzer value (dBμV) + transducer factors (dB)

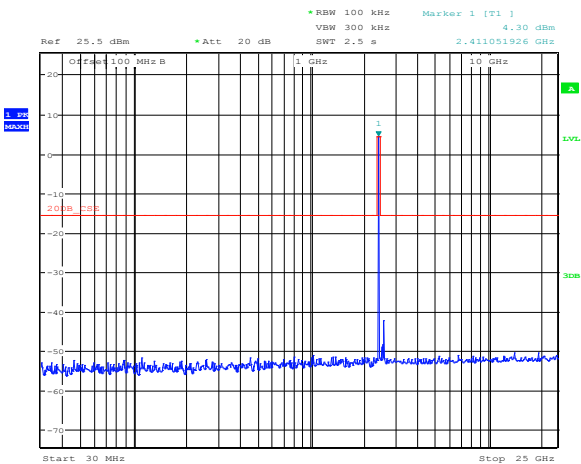
Transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Average field strength calculation was performed using the following formula: Average Field strength = Peak Field strength + Duty cycle correction factor for BLE

DCCF = -4.4 dB

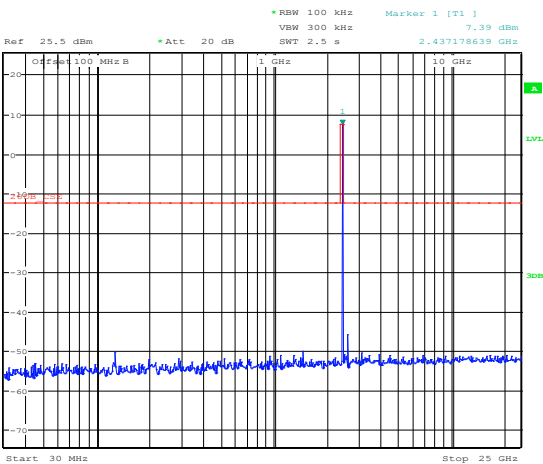
All other emissions were greater than 20 dB from limit.

8.5.5 Test data, continued



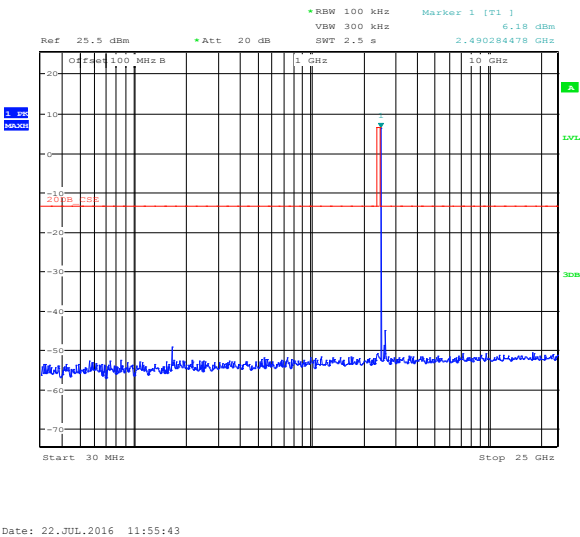
Date: 22.JUL.2016 11:54:54

Figure 8.5-27: Conducted spurious emissions for BT, low channel



Date: 22.JUL.2016 11:56:29

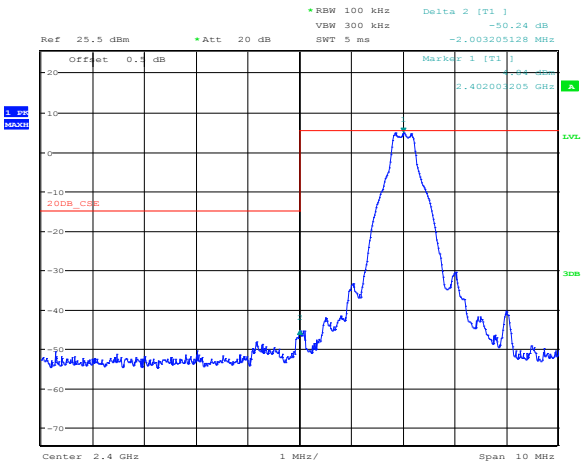
Figure 8.5-28: Conducted spurious emissions for BT, mid channel



Date: 22.JUL.2016 11:55:43

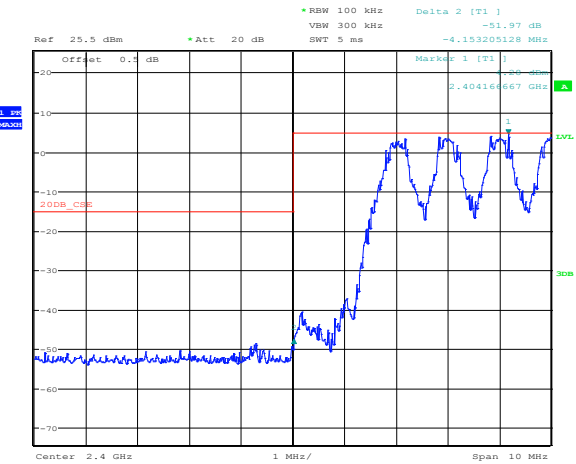
Figure 8.5-29: Conducted spurious emissions for BT, high channel

8.5.5 Test data, continued



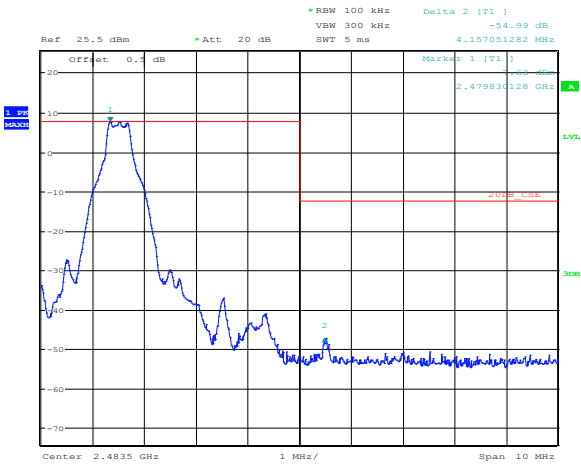
Date: 22.JUL.2016 11:53:54

Figure 8.5-30: Conducted spurious emissions lower band edge for BT, low channel (hopping sequence is off)



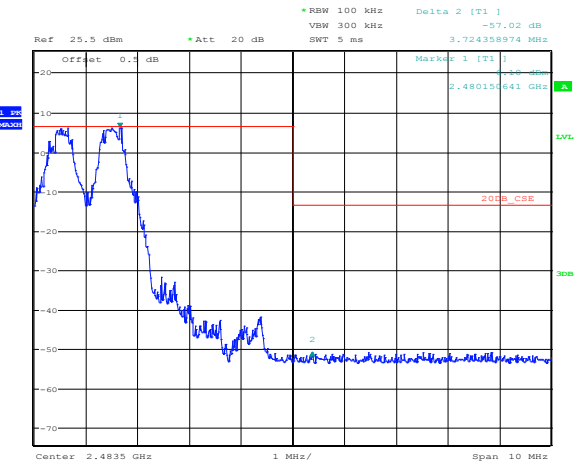
Date: 22.JUL.2016 11:50:56

Figure 8.5-31: Conducted spurious emissions lower band edge for BT, hopping sequence is on



Date: 22.JUL.2016 11:53:07

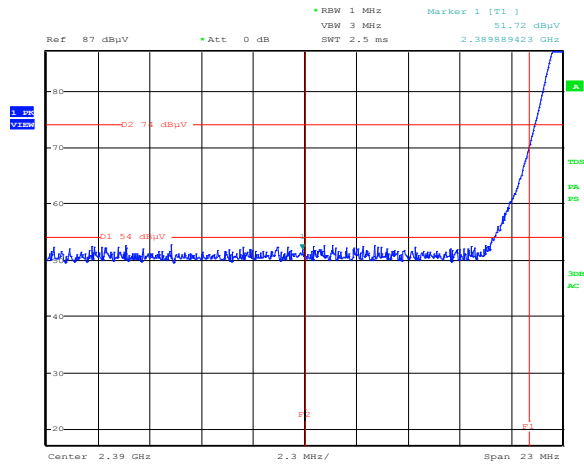
Figure 8.5-32: Conducted spurious emissions upper band edge for BT, high channel (hopping sequence is off)



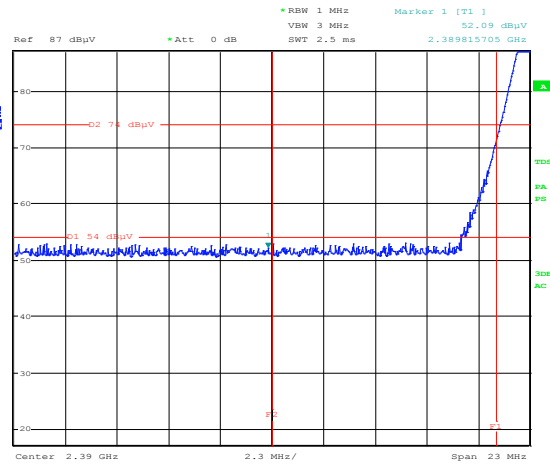
Date: 22.JUL.2016 11:52:15

Figure 8.5-33: Conducted spurious emissions upper band edge for BT, hopping sequence is on

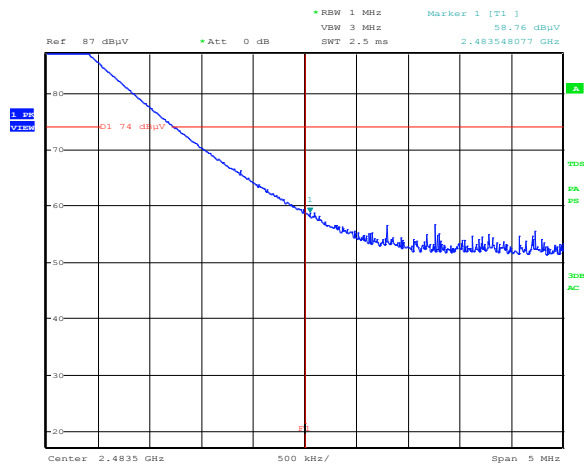
## 8.5.5 Test data, continued



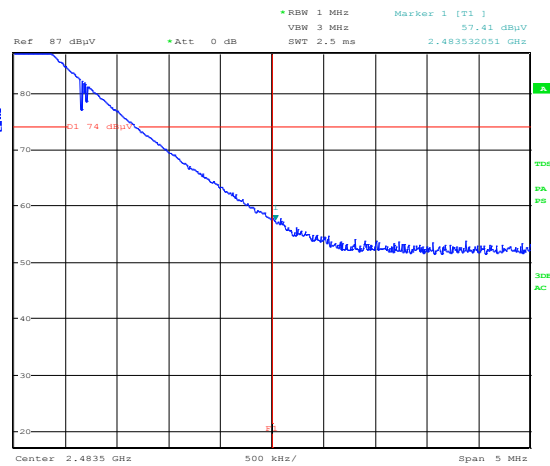
**Figure 8.5-34:** Radiated spurious emissions Lower band edge emission for BT, hopping is turned off – Low channel. F2 = 2.39 GHz (end of restricted band), F1 = 2.4 GHz



**Figure 8.5-35:** Radiated spurious emissions Lower band edge emission for BT, hopping is turned on. F2 = 2.39 GHz (end of restricted band), F1 = 2.4 GHz



**Figure 8.5-36:** Radiated spurious emissions Upper band edge emission for BT, hopping is turned off – high channel. F1 = 2.4835 GHz (beginning of restricted band)



**Figure 8.5-37:** Radiated spurious emissions Upper band edge emission for BT, hopping is turned on. F1 = 2.4835 GHz (beginning of restricted band)

8.5.5 Test data, continued

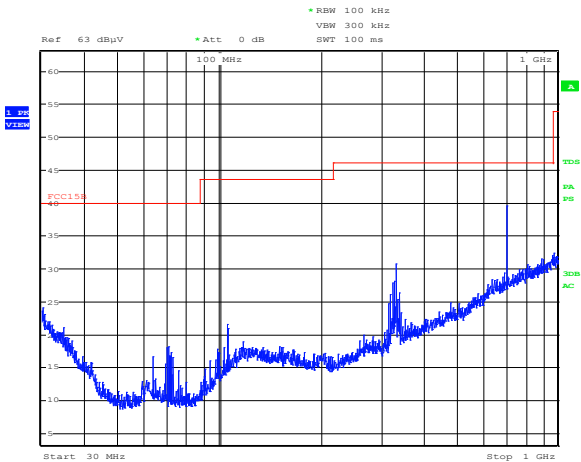


Figure 8.5-38: Radiated spurious emissions for BT, low channel, 30 to 1000 MHz

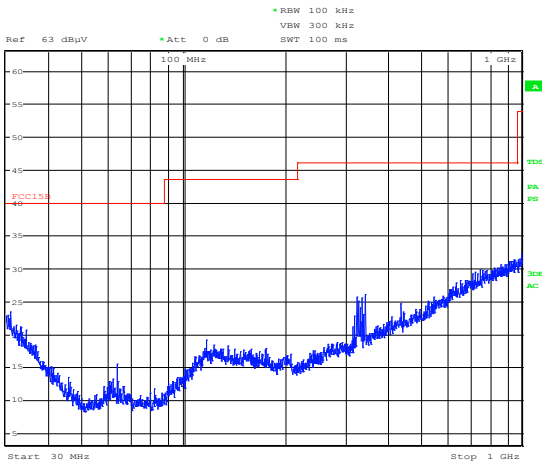


Figure 8.5-39: Radiated spurious emissions for BT, mid channel, 30 to 1000 MHz

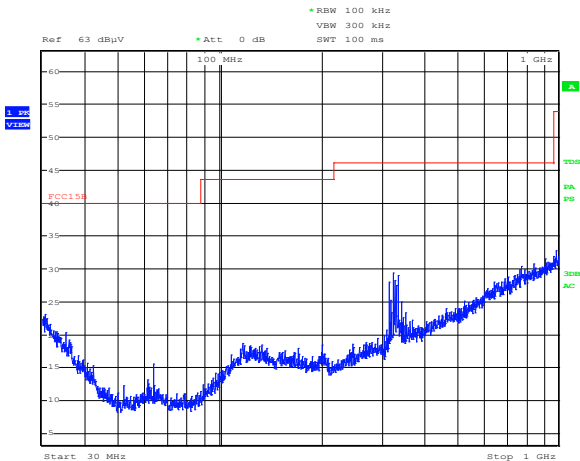


Figure 8.5-40: Radiated spurious emissions for BT, high channel, 30 to 1000 MHz

8.5.5 Test data, continued

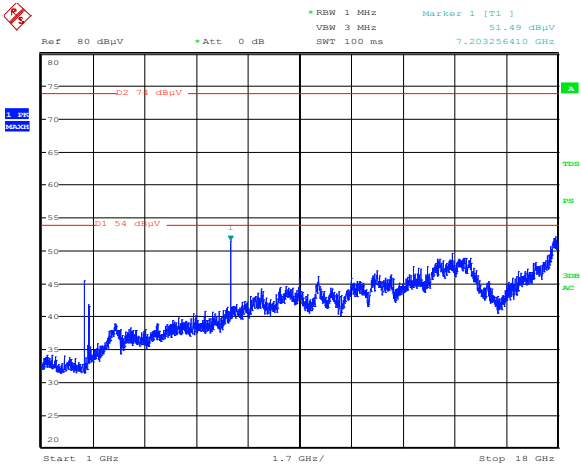


Figure 8.5-41: Radiated spurious emissions for BT, low channel, 1 to 18 GHz

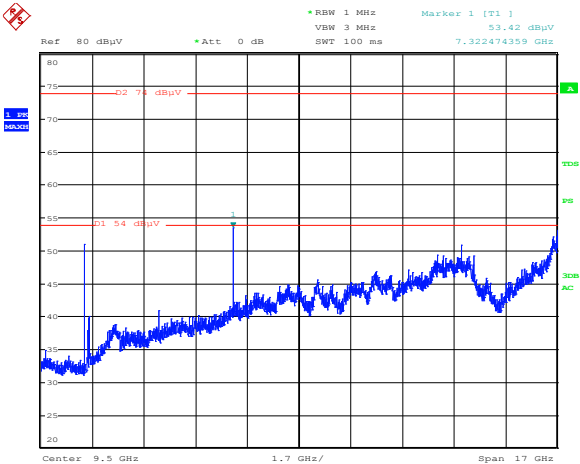


Figure 8.5-42: Radiated spurious emissions for BT, mid channel, 1 to 18 GHz

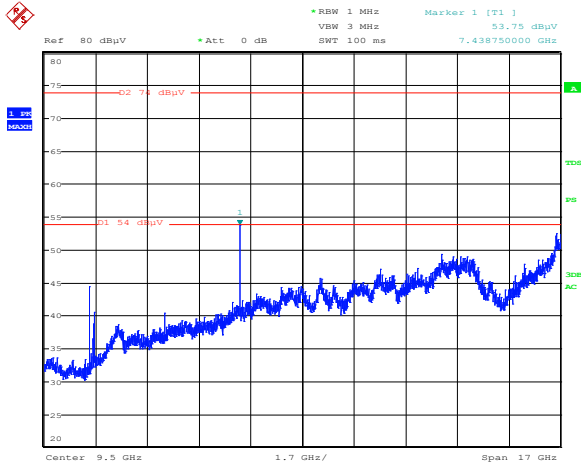


Figure 8.5-43: Radiated spurious emissions for BT, high channel, 1 to 18 GHz

8.5.5 Test data, continued

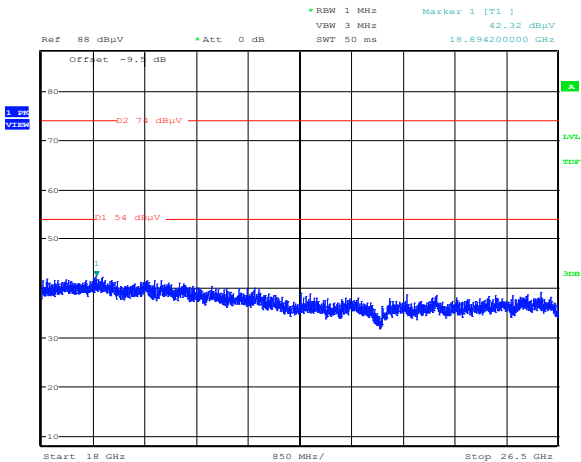


Figure 8.5-44: Radiated spurious emissions for BT, low channel, 18 to 26.5 GHz

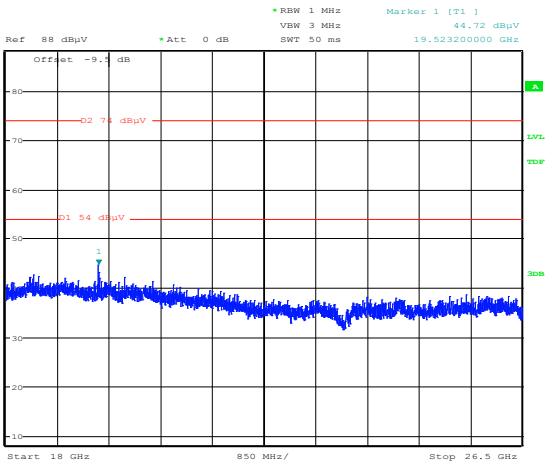


Figure 8.5-45: Radiated spurious emissions for BT, mid channel, 18 to 26.5 GHz

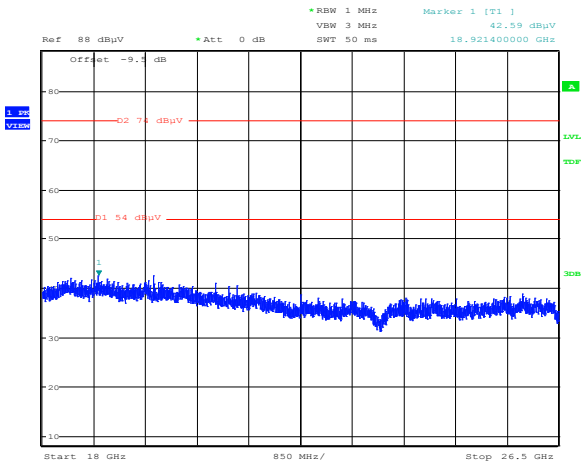


Figure 8.5-46: Radiated spurious emissions for BT, high channel, 18 to 26.5 GHz

8.5.5 Test data, continued

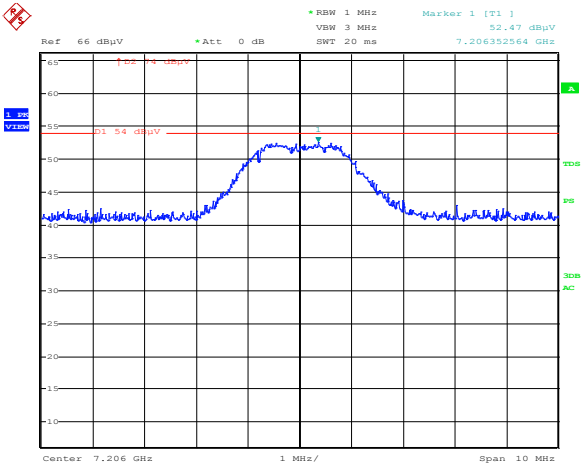


Figure 8.5-47: Radiated spurious emissions 2<sup>nd</sup> harmonic peak level for BT, low channel

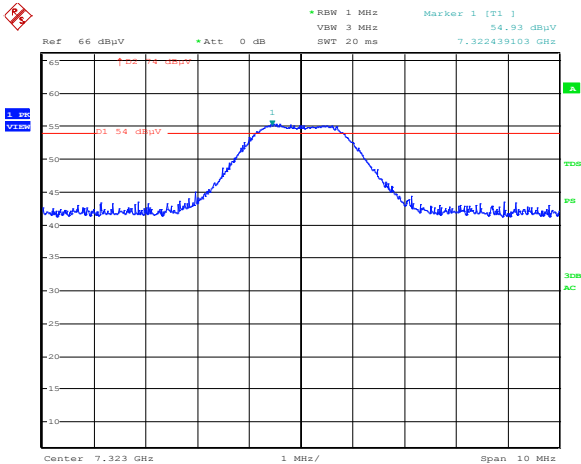


Figure 8.5-48: Radiated spurious emissions 2<sup>nd</sup> harmonic peak level for BT, mid channel

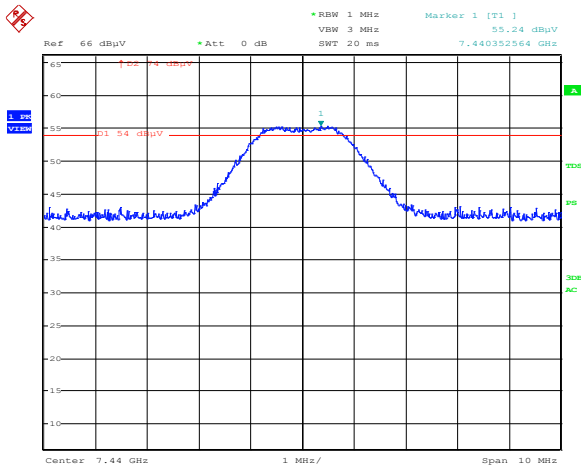
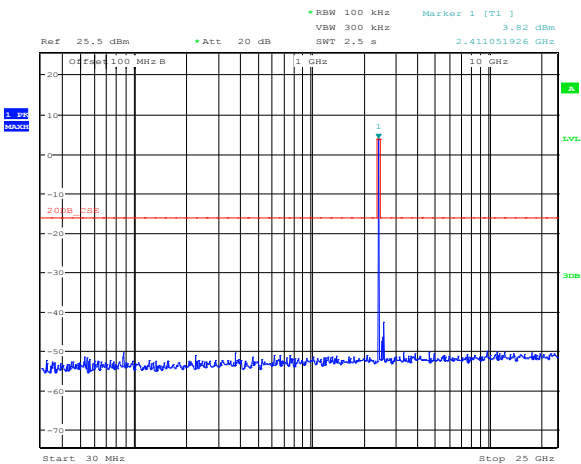


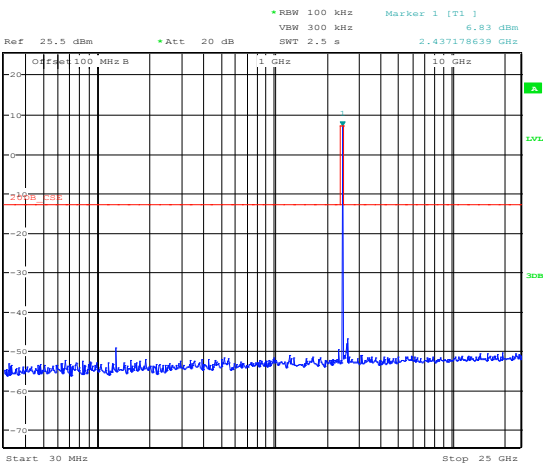
Figure 8.5-49: Radiated spurious emissions 2<sup>nd</sup> harmonic peak level for BT, high channel

8.5.5 Test data, continued



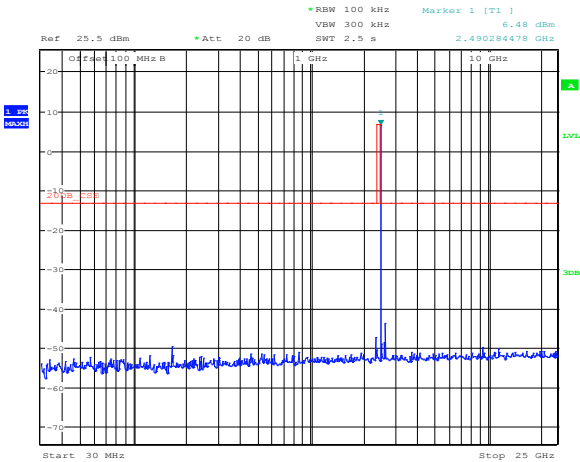
Date: 22.JUL.2016 11:44:14

Figure 8.5-50: Conducted spurious emissions for BLE, low channel



Date: 22.JUL.2016 11:46:09

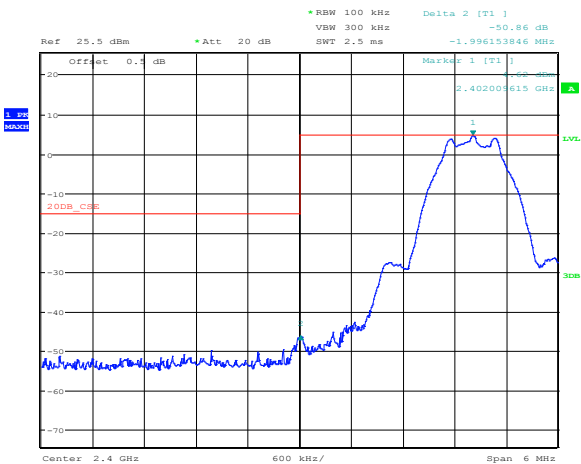
Figure 8.5-51: Conducted spurious emissions for BLE, mid channel



Date: 22.JUL.2016 11:45:15

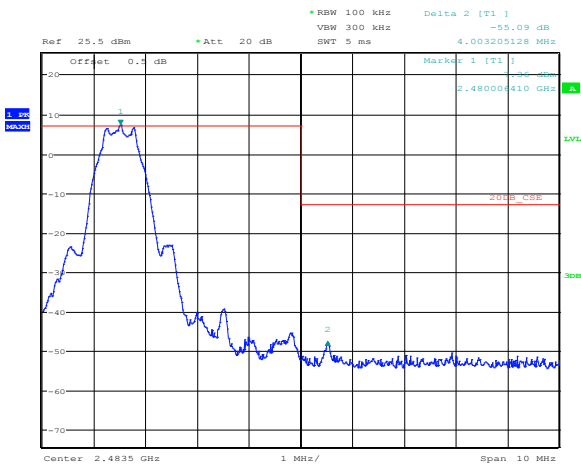
Figure 8.5-52: Conducted spurious emissions for BLE, high channel

8.5.5 Test data, continued



Date: 22.JUL.2016 11:48:42

Figure 8.5-53: Conducted spurious emissions Lower band for BLE, low channel



Date: 22.JUL.2016 11:47:44

Figure 8.5-54: Conducted spurious emissions upper band edge for BLE, high channel

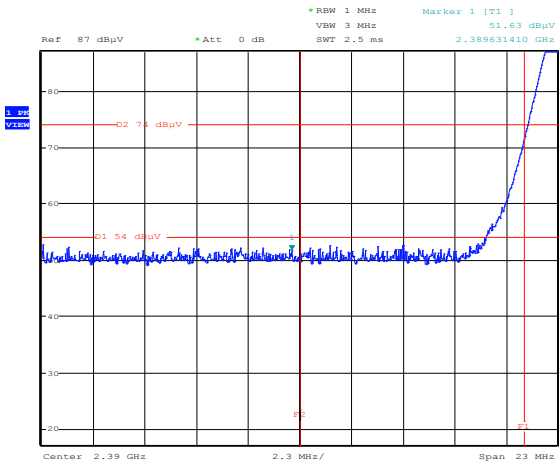


Figure 8.5-55: Radiated spurious emissions Lower band edge emission for BLE, low channel. F2 = 2.39 GHz (end of restricted band), F1 = 2.4 GHz

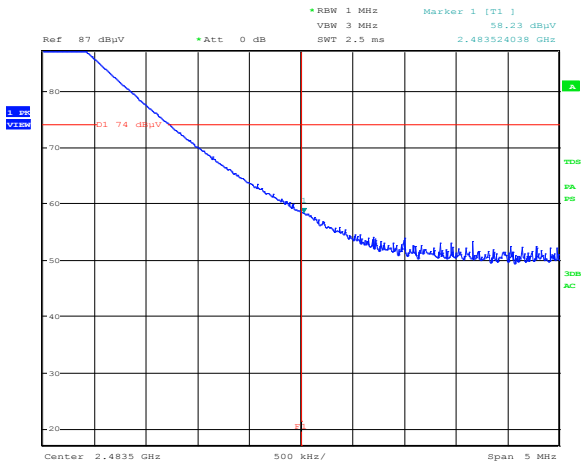


Figure 8.5-56: Radiated spurious emissions Upper band edge emission for BLE, High channel. F1 = 2.4835 GHz (beginning of restricted band)

8.5.5 Test data, continued

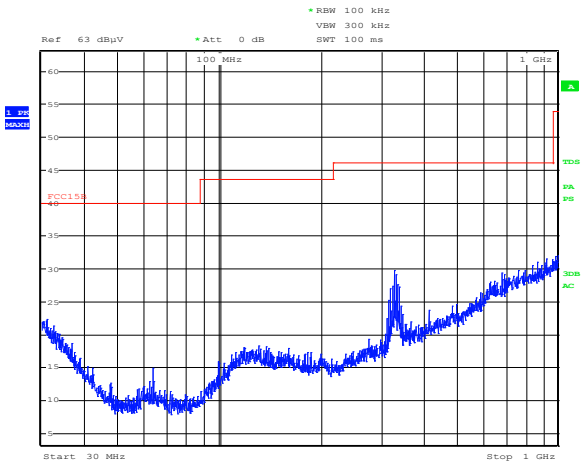


Figure 8.5-57: Radiated spurious emissions for BLE, low channel, 30 to 1000 MHz

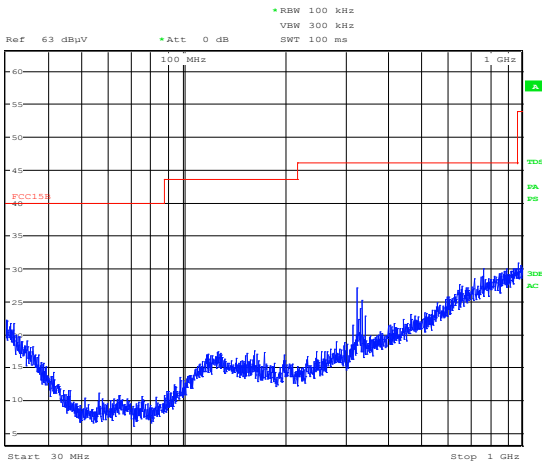


Figure 8.5-58: Radiated spurious emissions for BLE, mid channel, 30 to 1000 MHz

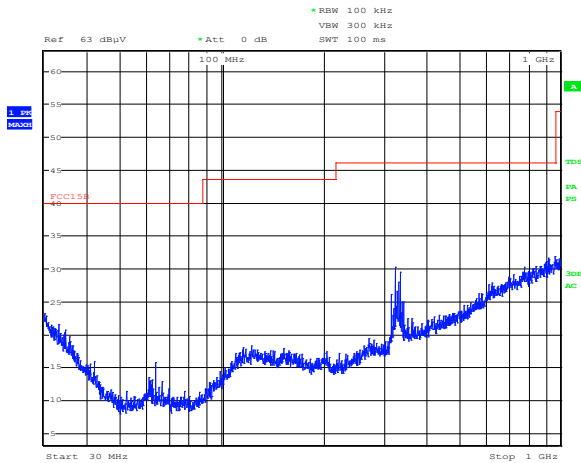


Figure 8.5-59: Radiated spurious emissions for BLE, high channel, 30 to 1000 MHz

8.5.5 Test data, continued

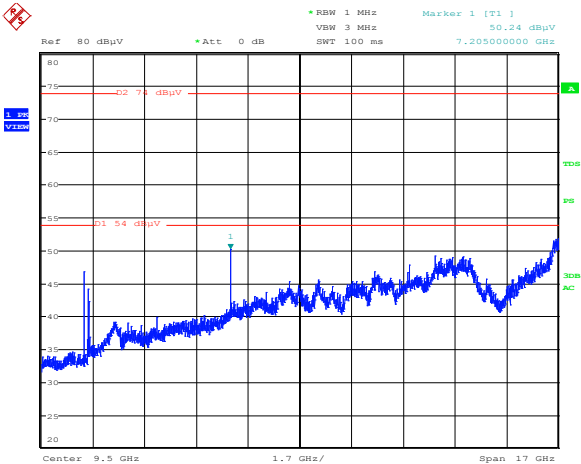


Figure 8.5-60: Radiated spurious emissions for BLE, low channel, 1 to 18 GHz

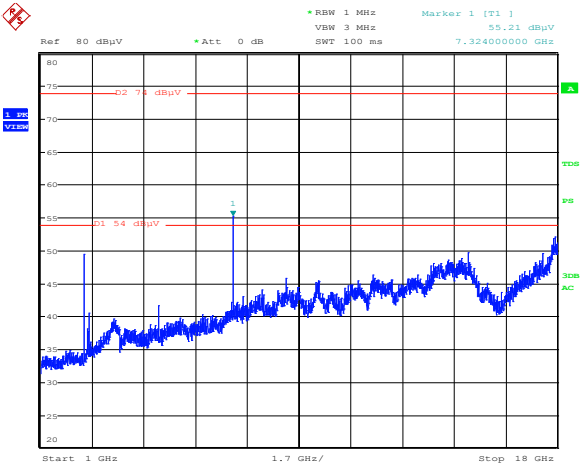


Figure 8.5-61: Radiated spurious emissions for BLE, mid channel, 1 to 18 GHz

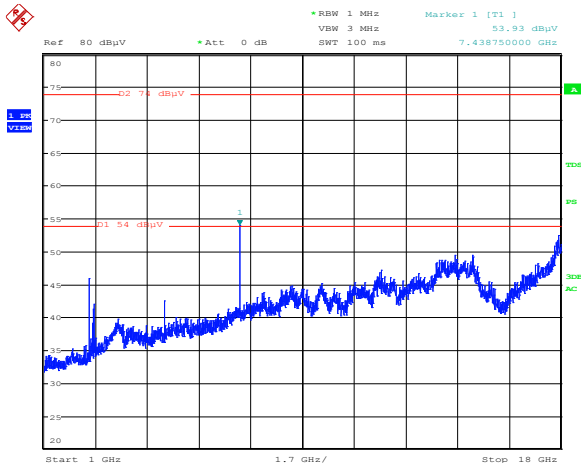


Figure 8.5-62: Radiated spurious emissions for BLE, high channel, 1 to 18 GHz

8.5.5 Test data, continued

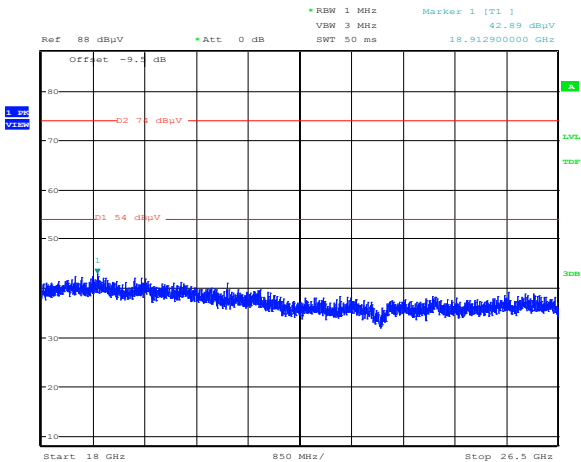


Figure 8.5-63: Radiated spurious emissions for BLE, low channel, 18 to 26.5 GHz

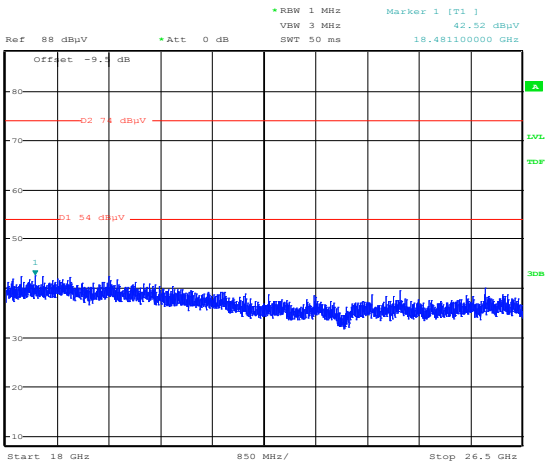


Figure 8.5-64: Radiated spurious emissions for BLE, mid channel, 18 to 26.5 GHz

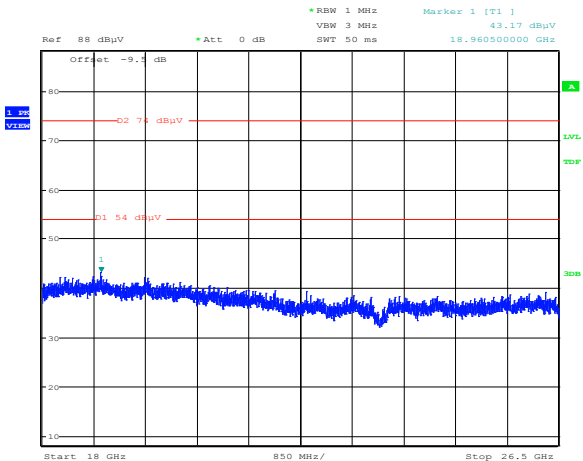


Figure 8.5-65: Radiated spurious emissions for BLE, high channel, 18 to 26.5 GHz

8.5.5 Test data, continued

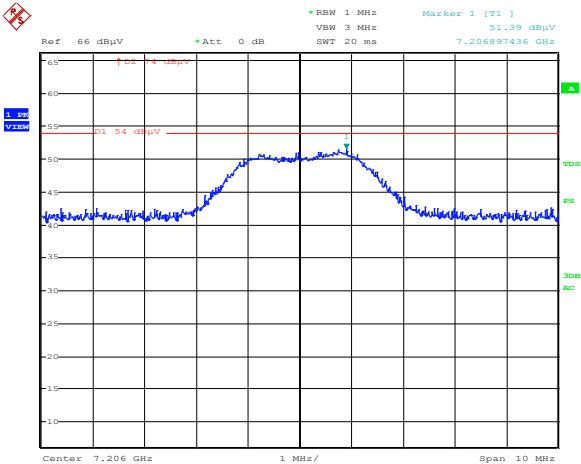


Figure 8.5-66: 2<sup>nd</sup> harmonic peak level for BLE, low channel

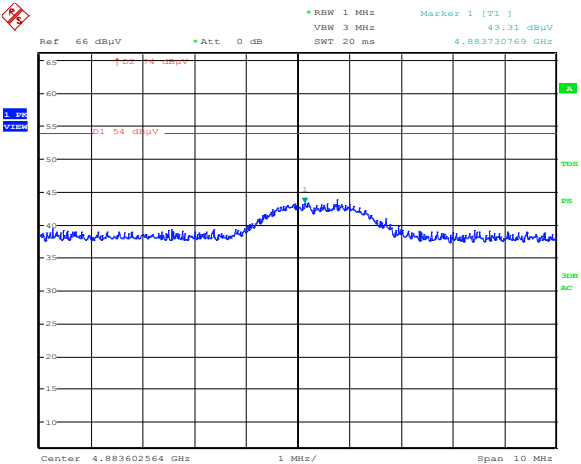


Figure 8.5-67: 2<sup>nd</sup> harmonic peak level for BLE, mid channel

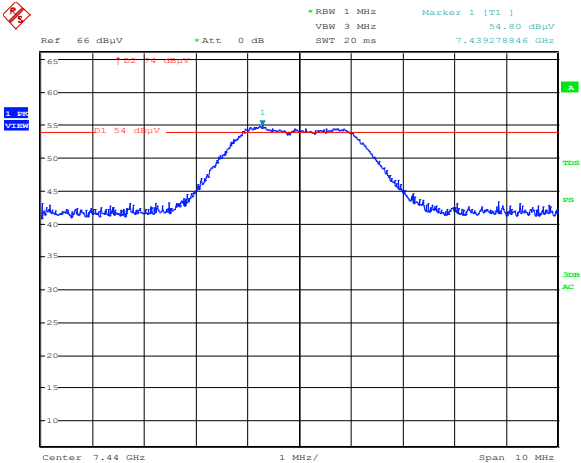


Figure 8.5-68: 2<sup>nd</sup> harmonic peak level for BLE, high channel

8.5.6 Setup photos



**Figure 8.5-69:** Radiated spurious (out-of-band) emissions setup photo – 30 to 1000 MHz

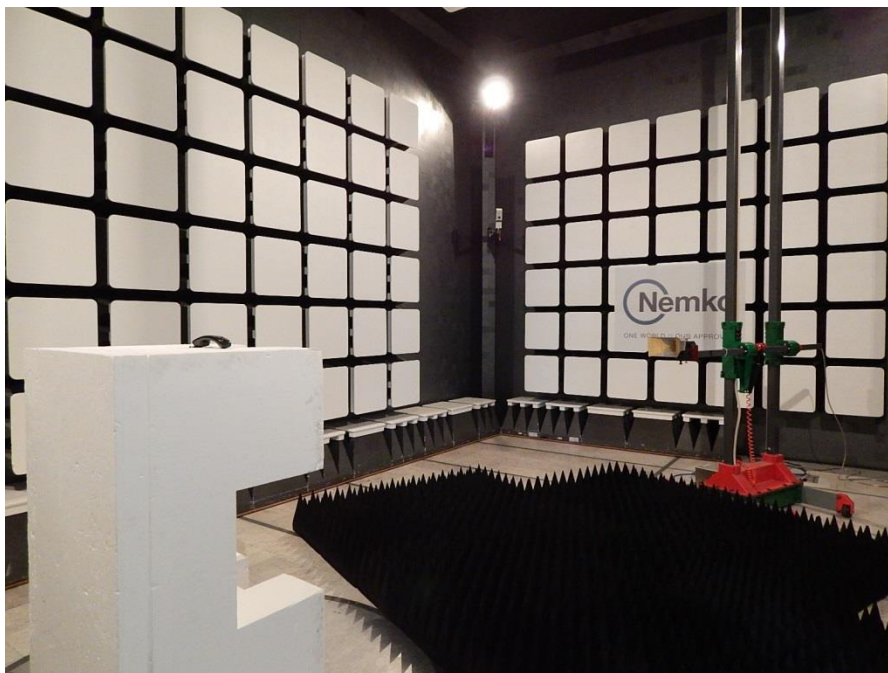


**Figure 8.5-70:** Radiated spurious (out-of-band) emissions setup photo – 30 to 1000 MHz

8.5.6 Setup photos, continued



*Figure 8.5-71: Radiated spurious (out-of-band) emissions setup photo – above 1 GHz*



*Figure 8.5-72: Radiated spurious (out-of-band) emissions setup photo – above 1 GHz*

## 8.6 FCC 15.247(e) and RSS-247 5.2(2) Power spectral density for digitally modulated devices (DTS-BLE)

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### 8.6.1 Definitions and limits

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#### FCC §15.247 (e):

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

#### RSS-247, Clause 5.2 (2):

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

### 8.6.2 Test summary

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|             |               |                   |                 |              |           |
|-------------|---------------|-------------------|-----------------|--------------|-----------|
| Verdict     | Pass          |                   |                 |              |           |
| Test date   | July 22, 2016 | Test engineer     | Andrey Adelberg |              |           |
| Temperature | 21.7 °C       | Relative humidity | 49 %            | Air pressure | 1010 mbar |

### 8.6.3 Notes

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- EUT was set to transmit in **BLE mode**.
- Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05. (The test was performed using method described in section 10.2 Method PKPSD (peak PSD).

### 8.6.4 Setup details

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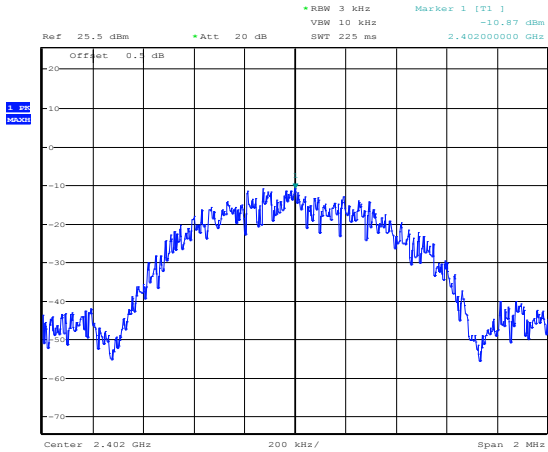
Spectrum analyser settings:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 3 kHz    |
| Video bandwidth:      | 10 kHz   |
| Frequency span:       | 2 MHz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

8.6.5 Test data

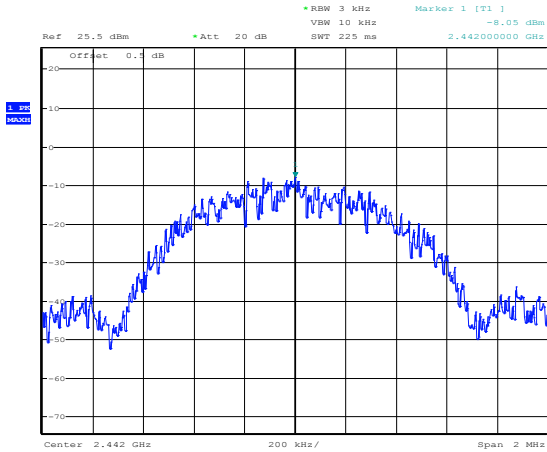
Table 8.6-1: PSD measurements results for BLE

| Frequency, MHz | PSD, dBm/3 kHz | PSD limit, dBm/3 kHz | Margin, dB |
|----------------|----------------|----------------------|------------|
| 2402           | -10.87         | 8.00                 | 18.87      |
| 2442           | -8.05          | 8.00                 | 16.05      |
| 2480           | -7.94          | 8.00                 | 15.94      |



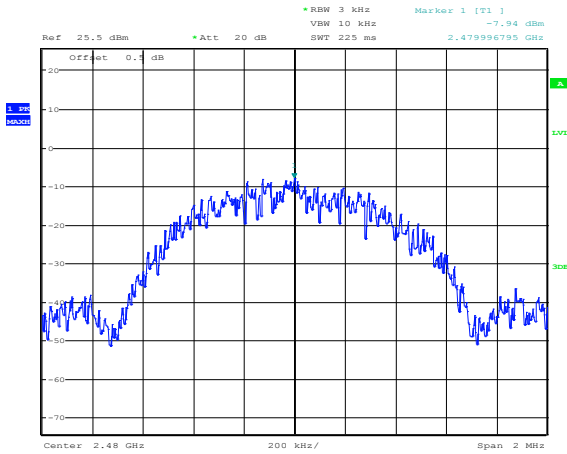
Date: 22.JUL.2016 11:41:37

Figure 8.6-1: PSD sample plot on low channel



Date: 22.JUL.2016 11:40:45

Figure 8.6-2: PSD sample plot on mid channel

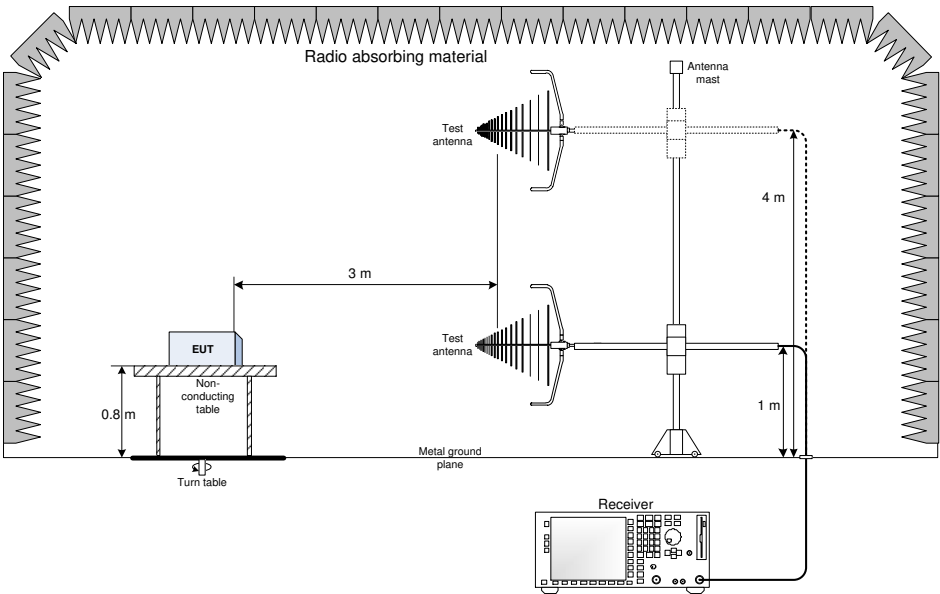


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Figure 8.6-3: PSD sample plot on high channel

## Section 9. Block diagrams of test set-ups

### 9.1 Radiated emissions set-up for frequencies below 1 GHz



### 9.2 Radiated emissions set-up for frequencies above 1 GHz

