

# Test report

**333777-1TRFWL**

Date of issue: July 27, 2017

Applicant:

**ÉLECTRONIQUE BLUEWAVE INC.**

Product:

**GET**

Model:

**BWG01**

FCC ID:

**2AL8WBWG01**

IC Registration number:

**22763-BWG01**

Specifications:

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

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

◆ **RSS-247, Issue 2, Feb 2017, Section 5**

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

5) Standard specifications for frequency hopping systems and digital transmission systems operating in the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz

#### Test location

|              |                                                      |
|--------------|------------------------------------------------------|
| Company name | Nemko Canada Inc.                                    |
| Address      | 292 Labrosse Avenue                                  |
| City         | Pointe-Claire                                        |
| Province     | QC                                                   |
| Postal code  | H9R 5L8                                              |
| Country      | Canada                                               |
| Telephone    | +1 514 694 2684                                      |
| Facsimile    | +1 514 694 3528                                      |
| Toll free    | +1 800 563 6336                                      |
| Website      | www.nemko.com                                        |
| Site number  | FCC: CA2041; IC: 2040G-5 (3 m semi anechoic chamber) |

|                    |                                                                                     |
|--------------------|-------------------------------------------------------------------------------------|
| Tested by          | Yong Huang, Wireless/EMC Specialist                                                 |
| Reviewed by        | Kevin Rose, Wireless/EMC Specialist                                                 |
| Review date        | July 27, 2017                                                                       |
| 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

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### 1.1 Applicant and manufacturer

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|                 |                            |
|-----------------|----------------------------|
| Company name    | ÉLECTRONIQUE BLUEWAVE INC. |
| Address         | 5292 rue Marquette         |
| City            | Montréal                   |
| Province/State  | Quebec                     |
| Postal/Zip code | H2J 3Z3                    |
| Country         | Canada                     |

### 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 5725–585 MHz                                                              |
| RSS-247, Issue 2, Feb 2017, Section 5        | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |

### 1.3 Test methods

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|                                      |                                                                                                                      |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| DA 00-705, Released March 30, 2000   | Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems                                      |
| KDB 558074 D01 DTS Meas Guidance v04 | GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247 |
| ANSI C63.10 v2013                    | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices                       |

### 1.4 Statement of compliance

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In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard or as per detailed in the section 1.5 Exclusions below. 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

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None

### 1.6 Test report revision history

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

## Section 2. Summary of test results

### 2.1 FCC Part 15 Subpart C, general requirements 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> As per customer, EUT was battery powered, tests were performed when battery fully charged.

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

### 2.2 FCC Part 15 Subpart C, intentional radiators 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                                   | Pass           |
| \$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                                                                                       | Pass           |

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

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

Notes: None

## 2.4 ISED RSS-247, Issue 2, test results

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

Notes: None

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

### 3.1 Sample information

|                        |              |
|------------------------|--------------|
| Receipt date           | July 4, 2017 |
| Nemko sample ID number | Item 1       |

### 3.2 EUT information

|               |       |
|---------------|-------|
| Product name  | GET   |
| Model         | BWG01 |
| Model variant | None  |
| Serial number | None  |

### 3.3 Technical information

|                                         |                                                                    |
|-----------------------------------------|--------------------------------------------------------------------|
| Applicant IC company number             | 22763                                                              |
| IC UPN number                           | BWG01                                                              |
| All used IC test site(s) Reg. number    | 2040G-5                                                            |
| RSS number and Issue number             | RSS-247 Issue 2, Feb 2017                                          |
| Frequency band                          | 2400–2483.5 MHz                                                    |
| Frequency Min (MHz)                     | 2402                                                               |
| Frequency Max (MHz)                     | 2480                                                               |
| RF power Min (W), Conducted/ERP/EIRP    | N/A                                                                |
| RF power Max (W), EIRP                  | 0.0022 (3.4 dBm), FHSS mode<br>0.0020 (3.0 dBm), DTS mode          |
| Field strength, Units @ distance        | 98.6 dBμV/m, @ 3 m, FHSS mode<br>98.2 dBμV/m, @ 3 m, DTS mode      |
| Measured BW (kHz)                       | 1058 (20 dB, FHSS mode)<br>718 (6 dB, DTS mode)                    |
| Calculated BW (kHz), as per TRC-43      | N/A                                                                |
| Type of modulation                      | FM $\pi/4$ -DQPSK and 8DPSK                                        |
| Emission classification (F1D, G1D, D1D) | G1D                                                                |
| Transmitter spurious, Units @ distance  | 53.4 dBμV/m, @ 3 m                                                 |
| Power requirements                      | 3.7 V <sub>dc</sub> battery                                        |
| Antenna information                     | The EUT uses a non-detachable antenna to the intentional radiator. |

### 3.4 Product description and theory of operation

---

Get is a Bluetooth receiver which main usage is to be a audio Sink. You can pair it with any bluetooth source and is used to receive audio wirelessly trough the A2DP Bluetooth profile. It then converts the bluetooth signal to analog amplify it and feed a 3.5 mm stereo audio output. It also has remote control features for music, a volume control an indicator LED and a microphone to receive phone calls.

### 3.5 EUT exercise details

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EUT was configured and operated by customer on site. During transmitter testing, EUT was set to transmit continuously.

3.6 EUT setup diagram

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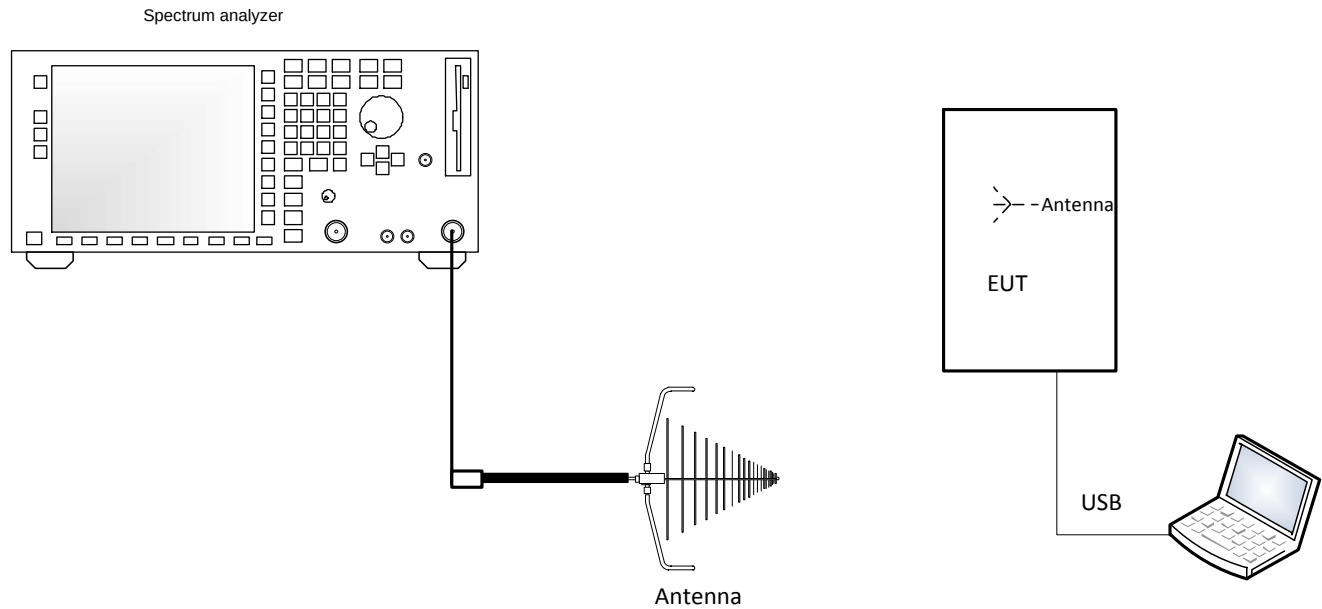


Figure 3.6-1: Setup diagram

## Section 4. Engineering considerations

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### 4.1 Modifications incorporated in the EUT

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

### 4.2 Technical judgment

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As per customer, EUT is able to employ two mutually exclusive operational modes. One mode is as a FHSS system and the other is as a DTS. Both FHSS and DTS modes were tested to show compliance.

### 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

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|                   |               |
|-------------------|---------------|
| 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

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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

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## 6.1 Uncertainty of measurement

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UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

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.  |
|-----------------------------|------------------------|--------------|-----------|-----------|------------|
| Flush mount turntable       | Sunol                  | FM2022       | FA002550  | —         | NCR        |
| Controller                  | Sunol                  | SC104V       | FA002551  | —         | NCR        |
| Antenna mast                | Sunol                  | TLT2         | FA002552  | —         | NCR        |
| Receiver/spectrum analyzer  | Rohde & Schwarz        | ESU 40       | FA002071  | 1 year    | May 3/18   |
| 50 Ω coax cable             | C.C.A.                 | None         | FA002603  | —         | VOU        |
| 50 Ω coax cable             | C.C.A.                 | None         | FA002605  | —         | VOU        |
| 50 Ω coax cable             | C.C.A.                 | None         | FA002607  | —         | VOU        |
| Bilog antenna (20–2000 MHz) | Sunol                  | JB1          | FA002517  | 1 year    | Oct. 5/17  |
| Horn antenna (1–18 GHz)     | EMCO                   | 3115         | FA001452  | 1 year    | Oct. 26/17 |
| Horn antenna (18–40 GHz)    | EMCO                   | 3116         | FA002487  | 2 year    | Aug. 16/17 |
| Pre-amplifier (0.5–18 GHz)  | COM-POWER              | PAM-118A     | FA002561  | 1 year    | May 8/18   |
| Pre-amplifier (18–40 GHz)   | COM-POWER              | PAM-840      | FA002508  | 1 year    | May 8/18   |
| 2.4 GHz band Notch Filter   | Microwave Circuits     | N0324413     | FA002693  | —         | VOU        |
| 50 Ω coax cable             | HUBER+SUHNER           | SUCOFLEX 100 | FA002564  | —         | VOU        |
| Power source                | California Instruments | 5001ix       | FA001770  | 1 year    | Feb 1/18   |

Note: NCR - no calibration required, VOU - verify on use

## Section 8. Testing data

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

#### 8.1.1 Definitions and limits

**FCC:**

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

**ISED:**

- a) 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 system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. 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.
- b) 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. Alternatively, FHSs operating in the band 2400–2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.
- d) 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.

#### 8.1.2 Test summary

|               |                              |                   |           |
|---------------|------------------------------|-------------------|-----------|
| Test date     | July 4, 2017 to July 6, 2017 | Temperature       | 25 °C     |
| Test engineer | Yong Huang                   | Air pressure      | 1009 mbar |
| Verdict       | Pass                         | Relative humidity | 40 %      |

#### 8.1.3 Observations, settings and special notes

Spectrum analyser settings for carrier frequency separation:

|                      |                                                           |
|----------------------|-----------------------------------------------------------|
| Resolution bandwidth | ≥ 1 % of the span                                         |
| 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 | ≥ 1 % of the span               |
| 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 | ≥ 1% of the 20 dB bandwidth                                                   |
| Video bandwidth      | ≥ RBW                                                                         |
| Frequency span       | approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel |
| Detector mode        | Peak                                                                          |
| Trace mode           | Max Hold                                                                      |

#### 8.1.4 Test data

**Table 8.1-1: 20 dB bandwidth results**

| Frequency, MHz | 20 dB bandwidth, kHz |
|----------------|----------------------|
| 2402           | 1048                 |
| 2441           | 1058                 |
| 2480           | 1048                 |

**Table 8.1-2: Carrier frequency separation results**

| Carrier frequency separation, kHz | Minimum limit, kHz | Margin, kHz |
|-----------------------------------|--------------------|-------------|
| 996.8                             | 705.3              | 291.5       |

Note: Limit is two-thirds of the 20 dB bandwidth

**Table 8.1-3: Number of hopping frequencies results**

| Number of hopping frequencies | Minimum limit | Margin |
|-------------------------------|---------------|--------|
| 79                            | 15            | 64     |

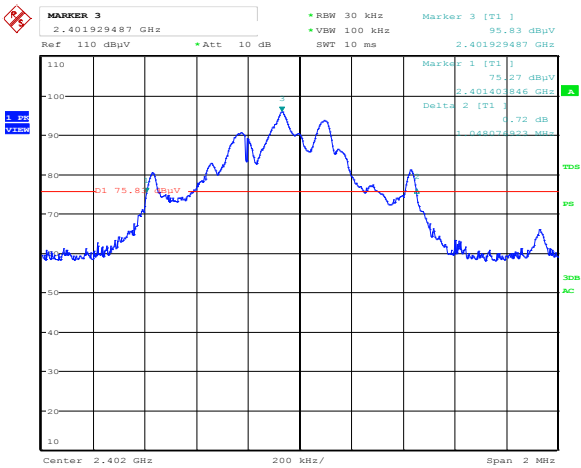
**Table 8.1-4: Average time of occupancy results**

| Dwell time of each pulse, ms | Number of pulses within period | Total dwell time within period, ms | Limit, ms | Margin, ms |
|------------------------------|--------------------------------|------------------------------------|-----------|------------|
| 2.9                          | 107                            | 310.3                              | 400       | 89.7       |

Measurement Period is 31.6 s, which equal to 0.4 s multiplied by the number of hopping channels 79

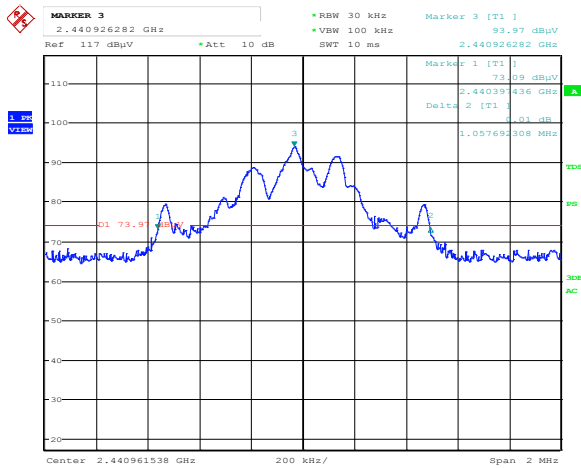
Section 8  
Test name  
Specification

Testing data  
FCC 15.247(a)(1) and RSS-247 5.1 Frequency Hopping Systems requirements  
FCC Part 15 Subpart C and RSS-247, Issue 2



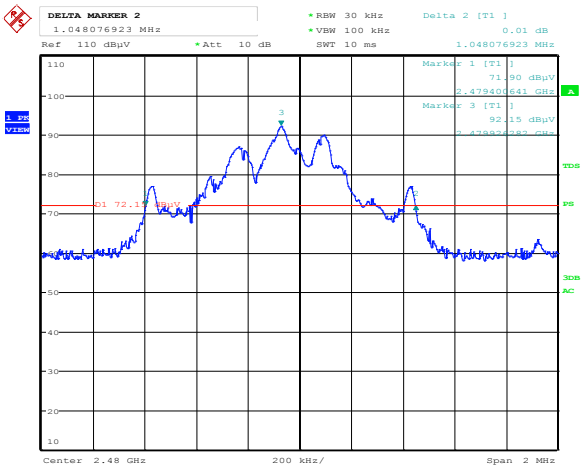
Date: 4.JUL.2017 19:49:05

Figure 8.1-1: 20 dB bandwidth on low channel



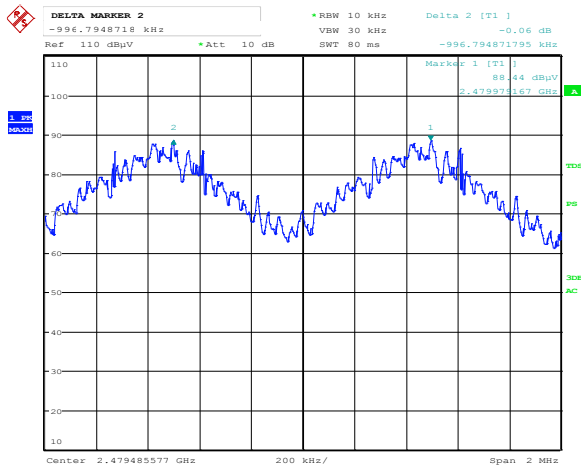
Date: 4.JUL.2017 19:42:23

Figure 8.1-2: 20 dB bandwidth on mid channel



Date: 4.JUL.2017 19:51:10

Figure 8.1-3: 20 dB bandwidth on high channel

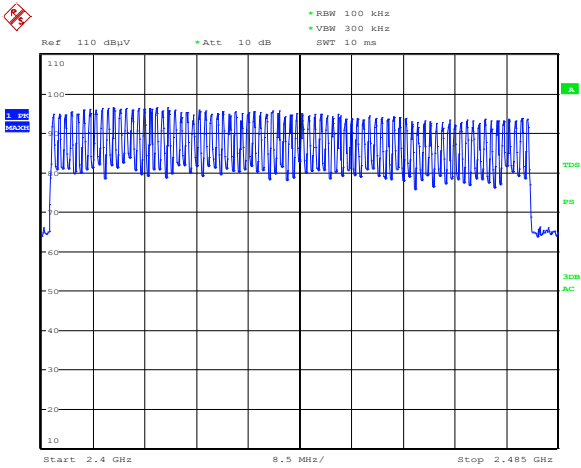


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Figure 8.1-4: Carrier frequency separation

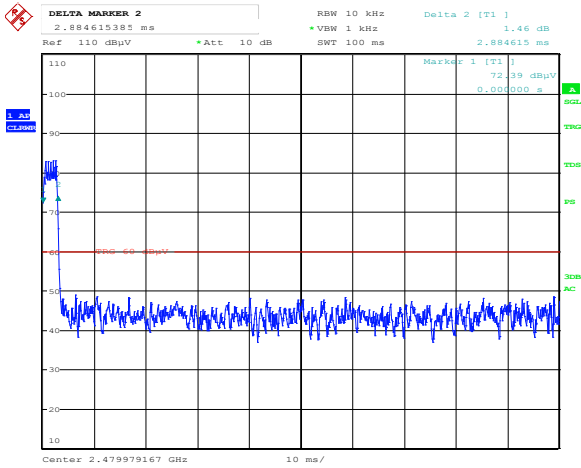
Section 8  
Test name  
Specification

Testing data  
FCC 15.247(a)(1) and RSS-247 5.1 Frequency Hopping Systems requirements  
FCC Part 15 Subpart C and RSS-247, Issue 2



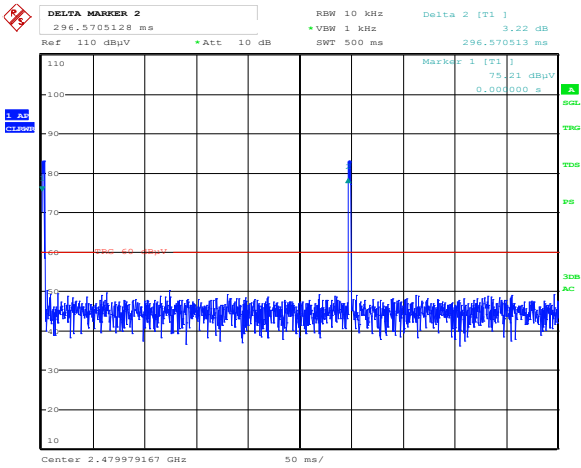
Date: 4.JUL.2017 20:04:33

Figure 8.1-5: Number of hopping channels



Date: 4.JUL.2017 20:16:41

Figure 8.1-6: Dwell time- sweep time 100ms



Date: 4.JUL.2017 20:15:31

Figure 8.1-7: Dwell time, sweep time 500 ms

## 8.2 FCC 15.247(b) and RSS-247 5.4 (b) and (d) Transmitter output power and e.i.r.p. requirements

### 8.2.1 Definitions and limits

**FCC:**

- (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).
  - (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.

**ISED:**

b. For FHSs operating in the band 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W (30 dBm) if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W (21 dBm) if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W (36 dBm), except as provided in section 5.4(e).

d. 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 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

### 8.2.2 Test summary

|               |                              |                   |           |
|---------------|------------------------------|-------------------|-----------|
| Test date     | July 4, 2017 to July 6, 2017 | Temperature       | 25 °C     |
| Test engineer | Yong Huang                   | Air pressure      | 1009 mbar |
| Verdict       | Pass                         | Relative humidity | 40 %      |

### 8.2.3 Observations, settings and special notes

As per customer, EUT uses integral antenna, conducted antenna port is not available. Radiated measurements were performed to show compliance.

Spectrum analyser settings for output power:

|                      |                                                                          |
|----------------------|--------------------------------------------------------------------------|
| Resolution bandwidth | > the 20 dB bandwidth of the emission being measured                     |
| Video bandwidth      | ≥ RBW                                                                    |
| Frequency span       | approximately 5 times the 20 dB bandwidth, centered on a hopping channel |
| Detector mode        | Peak                                                                     |
| Trace mode           | Max Hold                                                                 |

8.2.4 Test data

Table 8.2-1: Output power and EIRP results for FHSS mode

| Frequency, MHz | Field Strength @ 3 m, dBμV/m | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|----------------|------------------------------|-----------|-----------------|-----------------|
| 2402           | 98.6                         | 3.4       | 27              | 23.6            |
| 2441           | 98.1                         | 2.9       | 27              | 24.1            |
| 2480           | 98.4                         | 3.2       | 27              | 23.8            |

EIRP(dBm) = Field Strength(dBμV/m, @ 3 m) -95.2

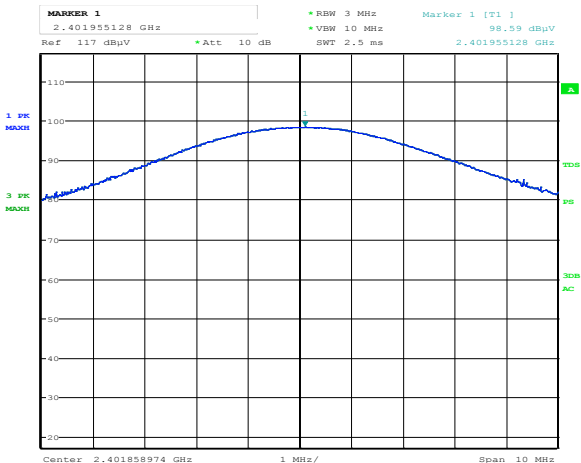


Figure 8.2-1: Output power on low channel, FHSS mode

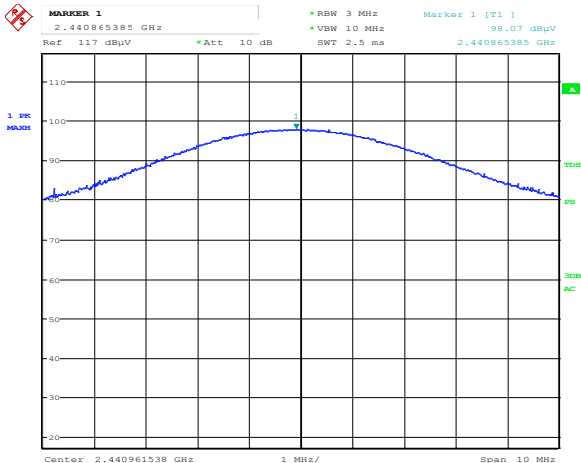


Figure 8.2-2: Output power on mid channel, FHSS mode

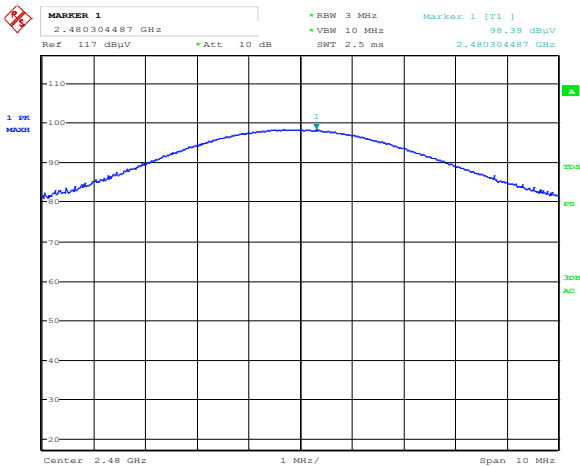
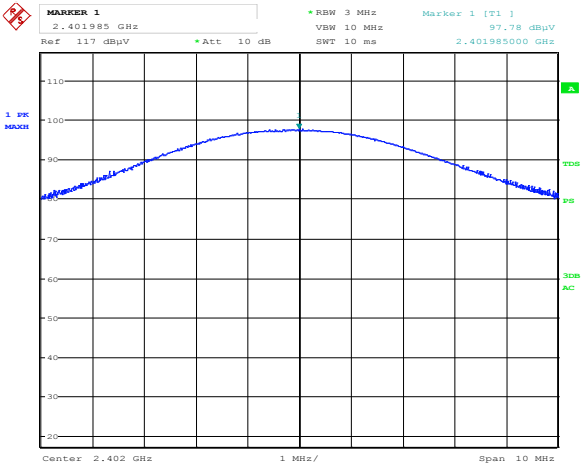


Figure 8.2-3: Output power on high channel, FHSS mode

Table 8.2-2: Output power and EIRP results for DTS mode

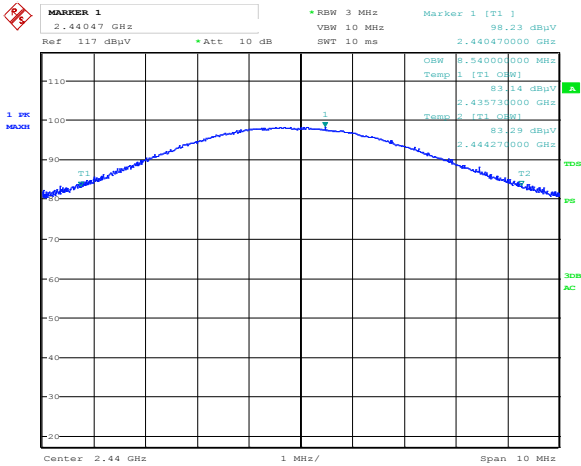
| Frequency, MHz | Field Strength @ 3 m, dBμV/m | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|----------------|------------------------------|-----------|-----------------|-----------------|
| 2402           | 97.8                         | 2.6       | 36              | 33.4            |
| 2440           | 98.2                         | 3.0       | 36              | 33.0            |
| 2480           | 97.9                         | 2.7       | 36              | 33.3            |

$$\text{EIRP(dBm)} = \text{Field Strength(dB}\mu\text{V/m, @ 3 m)} - 95.2$$



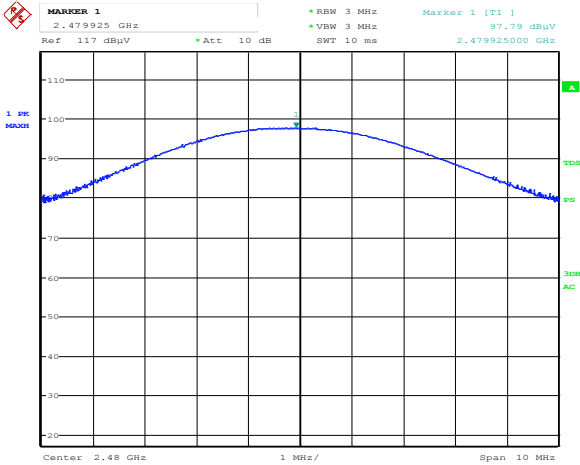
Date: 4.JUL.2017 20:59:15

Figure 8.2-4: Output power on low channel, DTS mode



Date: 4.JUL.2017 20:49:07

Figure 8.2-5: Output power on mid channel, DTS mode



Date: 4.JUL.2017 21:24:23

Figure 8.2-6: Output power on high channel, DTS mode

### 8.3 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for systems using digital modulation techniques

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#### 8.3.1 Definitions and limits

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**FCC and IC:**

- (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.

#### 8.3.2 Test summary

---

|               |                              |                   |           |
|---------------|------------------------------|-------------------|-----------|
| Test date     | July 4, 2017 to July 6, 2017 | Temperature       | 25 °C     |
| Test engineer | Yong Huang                   | Air pressure      | 1009 mbar |
| Verdict       | Pass                         | Relative humidity | 40 %      |

#### 8.3.3 Observations, settings and special notes

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Spectrum analyser settings:

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

Section 8

Test name

Specification

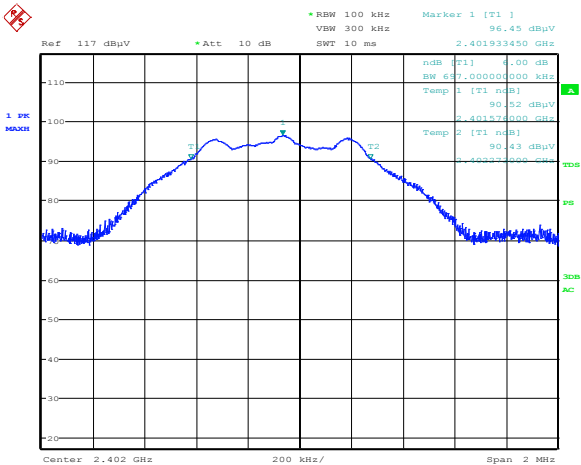
Testing data  
FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for systems using digital modulation techniques  
FCC Part 15 Subpart C and RSS-247, Issue 2



8.3.4 Test data

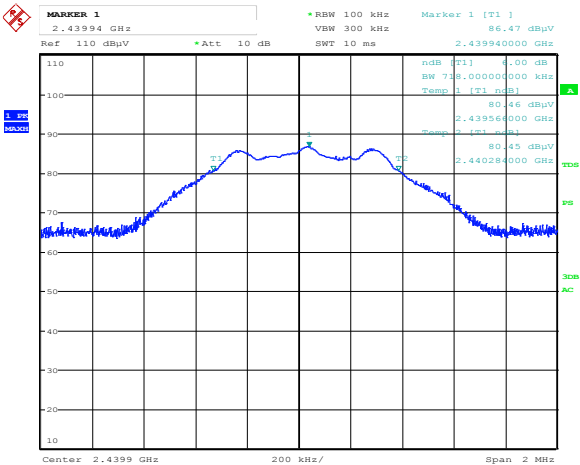
Table 8.3-1: 6 dB bandwidth results

| Frequency, MHz | 6 dB bandwidth, kHz | Minimum Limit, kHz | Margin, kHz |
|----------------|---------------------|--------------------|-------------|
| 2402           | 697                 | 500                | 197         |
| 2440           | 718                 | 500                | 218         |
| 2480           | 696                 | 500                | 196         |



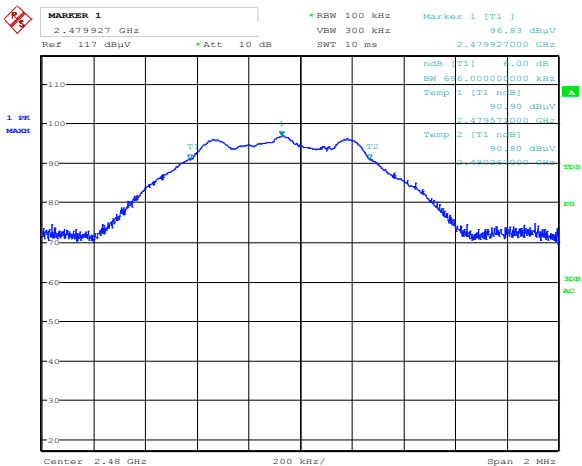
Date: 4.JUL.2017 21:01:24

Figure 8.3-1: 6 dB bandwidth on low channel



Date: 4.JUL.2017 20:43:12

Figure 8.3-2: 6 dB bandwidth on mid channel



Date: 4.JUL.2017 21:27:45

Figure 8.3-3: 6 dB bandwidth on high channel

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

### 8.4.1 Definitions and limits

#### FCC:

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)).

#### ISED:

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(d), 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 8.4-1: 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 8.4-2: ISED 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  |

Note: Certain frequency bands listed in Table 8.4-2 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 8.4-3: 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       |                     |               |             |

#### 8.4.2 Test summary

|               |                              |                   |           |
|---------------|------------------------------|-------------------|-----------|
| Test date     | July 4, 2017 to July 6, 2017 | Temperature       | 25 °C     |
| Test engineer | Yong Huang                   | Air pressure      | 1009 mbar |
| Verdict       | Pass                         | Relative humidity | 40 %      |

#### 8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10<sup>th</sup> harmonic.

EUT was set to transmit continuously.

As per customer, EUT uses integral antenna, conducted antenna port is not available. Radiated measurements at 3 m were performed to show compliance.

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:

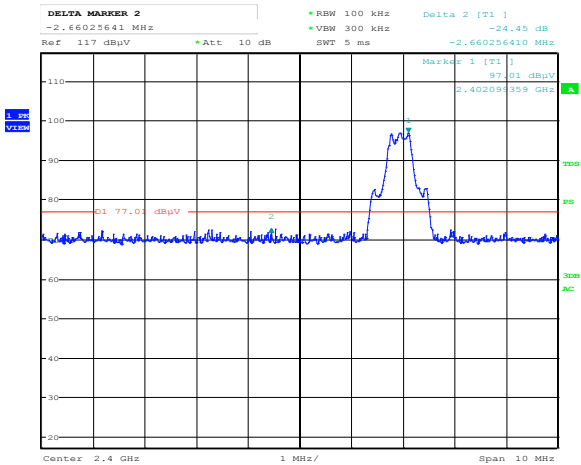
|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 1 MHz    |
| Video bandwidth:      | 3 MHz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

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

|                       |         |
|-----------------------|---------|
| Resolution bandwidth: | 1 MHz   |
| Video bandwidth:      | 3 MHz   |
| Detector mode:        | RMS     |
| Trace mode:           | Average |

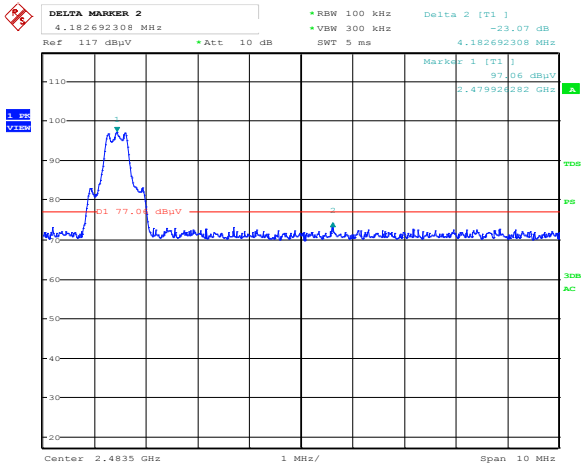
For FHSS mode, average radiated measurements within restricted bands above 1 GHz were calculated with duty cycle correction factors.

8.4.4 Test data



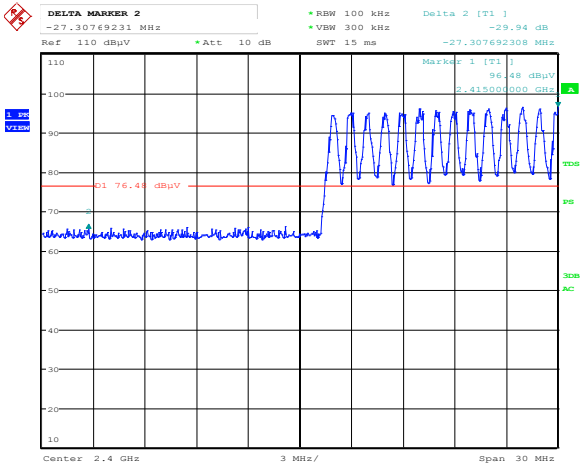
Date: 4.JUL.2017 15:31:11

Figure 8.4-1: Lower band edge emission, tx on low ch, FHSS mode



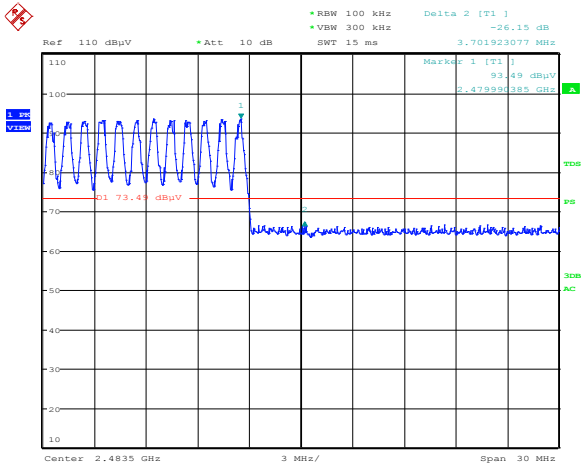
Date: 4.JUL.2017 19:22:49

Figure 8.4-2: Upper band edge emission, tx on high channel, FHSS mode



Date: 4.JUL.2017 20:06:15

Figure 8.4-3: Lower band edge emission, tx hopping on, FHSS mode



Date: 4.JUL.2017 20:07:56

Figure 8.4-4: Upper band edge emission, tx hopping on, FHSS mode

8.4.5 Test data, continued

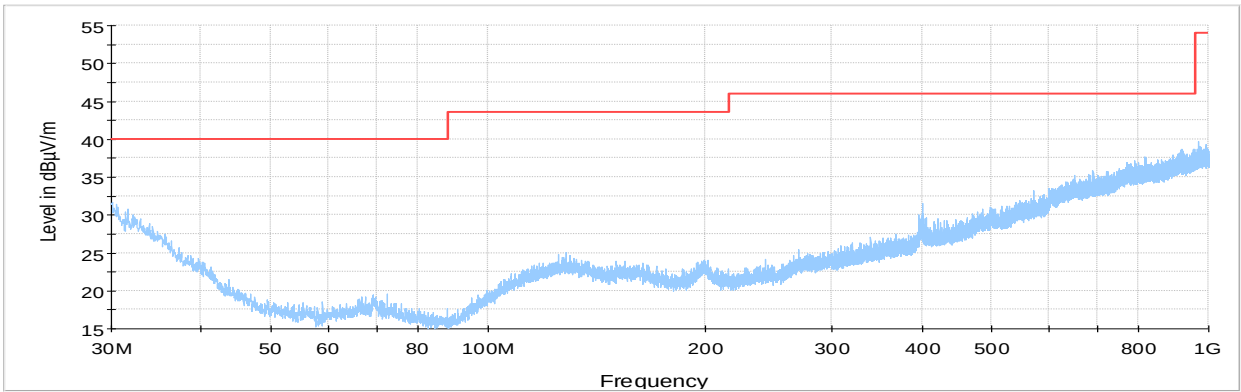


Figure 8.4-5: Radiated spurious emissions for low channel below 1 GHz for restricted band emissions, FHSS mode

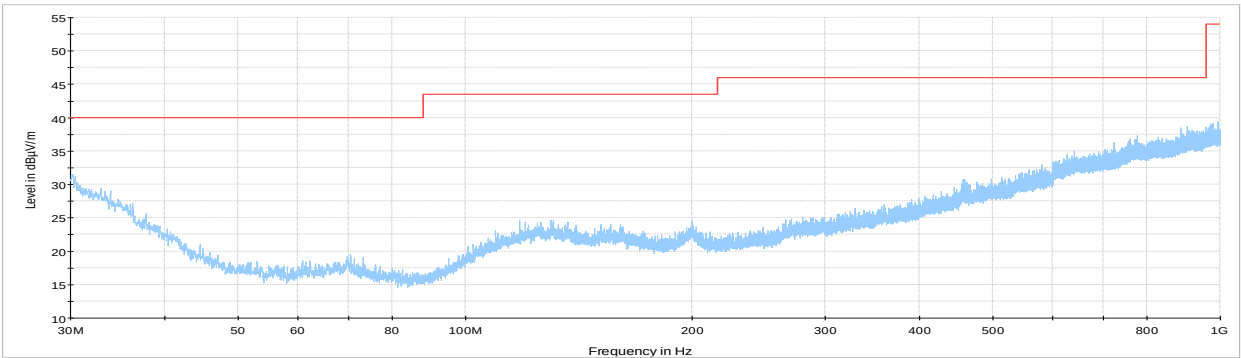


Figure 8.4-6: Radiated spurious emissions for mid channel below 1 GHz for restricted band emissions, FHSS mode

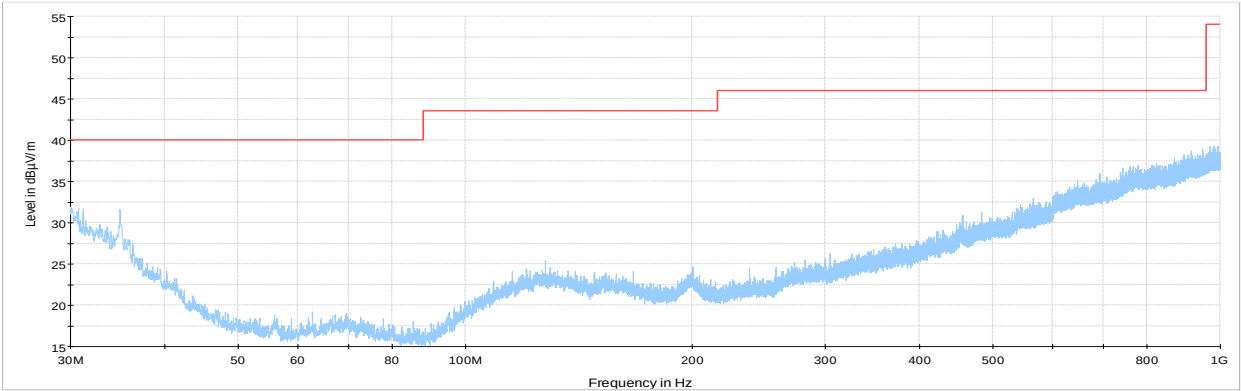
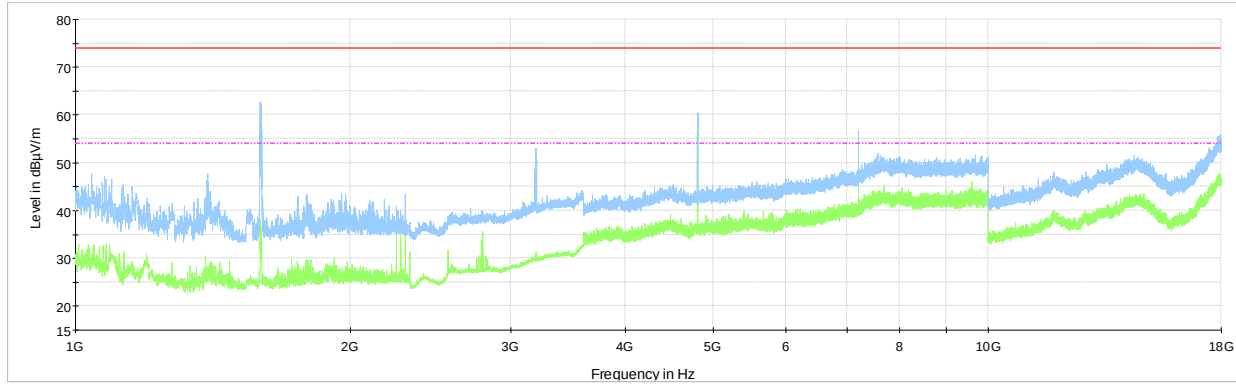
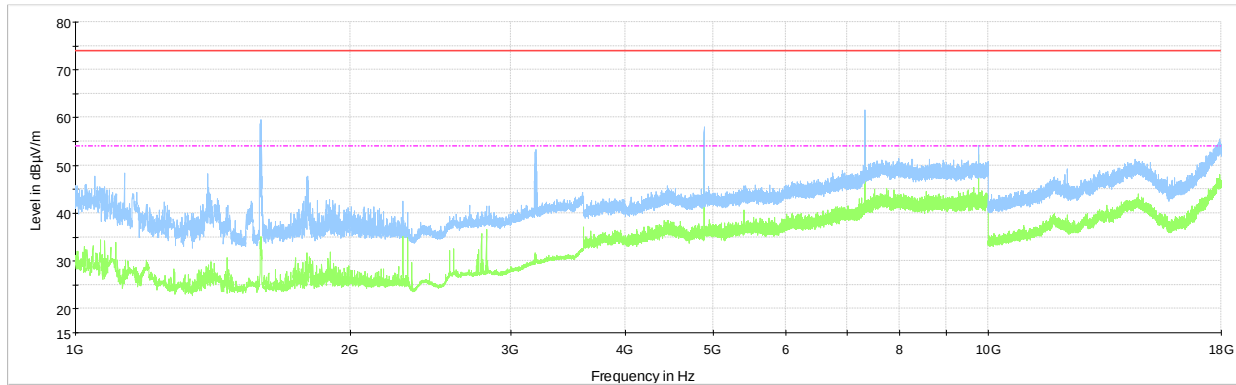


Figure 8.4-7: Radiated spurious emissions for high channel below 1 GHz for restricted band emissions, FHSS mode

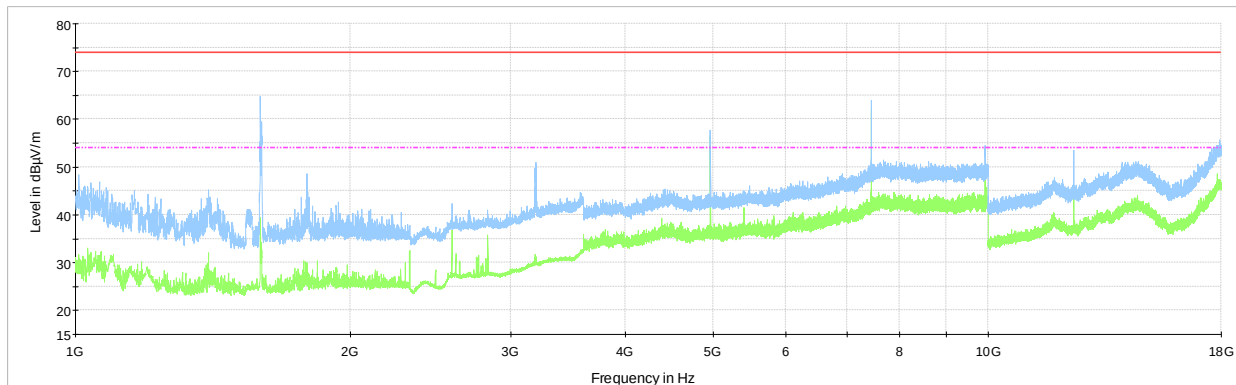
#### 8.4.6 Test data, continued



**Figure 8.4-8:** Radiated spurious emissions for low channel above 1 GHz for restricted band emissions, FHSS mode



**Figure 8.4-9:** Radiated spurious emissions for mid channel above 1 GHz for restricted band emissions, FHSS mode



**Figure 8.4-10:** Radiated spurious emissions for high channel above 1 GHz for restricted band emissions, FHSS mode

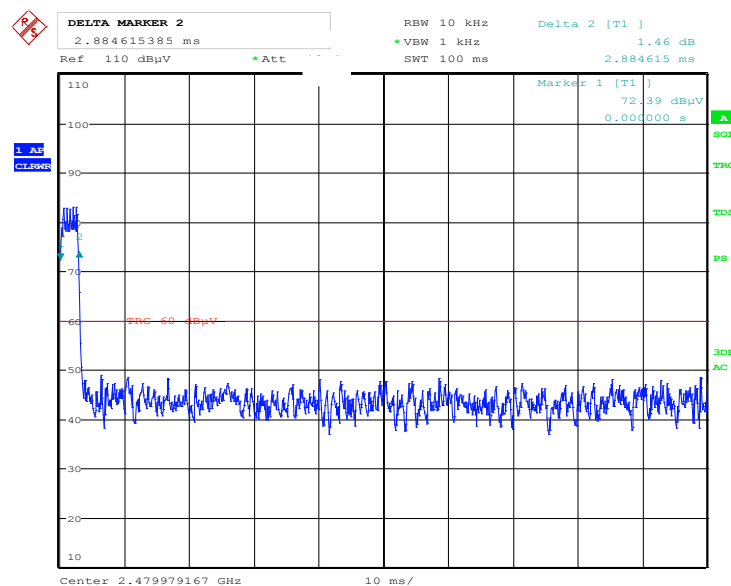
Note: Spectrum was investigated up to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz

#### 8.4.4 Test data, continued

**Table 8.4-4:** Radiated field strength measurement results, FHSS mode

| Channel | Frequency, MHz | Peak Field strength, dBμV/m |       | Margin, dB | Average Field strength, dBμV/m |       | Margin, dB |
|---------|----------------|-----------------------------|-------|------------|--------------------------------|-------|------------|
|         |                | Measured                    | Limit |            | Calculated                     | Limit |            |
| Low     | 2390.0         | 51.0                        | 74    | 23.0       | 20.3                           | 54    | 33.7       |
| Low     | 4804.0         | 59.8                        | 74    | 14.2       | 29.1                           | 54    | 24.9       |
| Low     | 7206.0         | 56.7                        | 74    | 17.3       | 26.0                           | 54    | 28.0       |
| Mid     | 4882.5         | 58.0                        | 74    | 16.0       | 27.3                           | 54    | 26.7       |
| Mid     | 7322.8         | 61.6                        | 74    | 12.4       | 30.9                           | 54    | 23.1       |
| Mid     | 9763.6         | 54.0                        | 74    | 20.0       | 23.3                           | 54    | 30.7       |
| High    | 2483.5         | 53.0                        | 74    | 21.0       | 22.3                           | 54    | 31.7       |
| High    | 4960.5         | 57.7                        | 74    | 16.3       | 27.0                           | 54    | 27.0       |
| High    | 7439.2         | 64.0                        | 74    | 10.0       | 33.3                           | 54    | 20.7       |
| High    | 9920.8         | 54.5                        | 74    | 19.5       | 23.8                           | 54    | 30.2       |
| High    | 12399.2        | 53.5                        | 74    | 20.5       | 22.8                           | 54    | 31.2       |

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.  
 Average radiated measurements within restricted bands above 1 GHz were calculated with duty cycle correction factors (DCCF) as below:.  
 Average Field strength = Peak Field strength + DCCF  
 $DCCF = 20 \cdot \log(2.9 \text{ ms} / 100 \text{ ms}) = -30.7 \text{ dB}$



Date: 4.JUL.2017 20:16:41

**Figure 8.4-11:** Duty cycle in 100ms

8.4.4 Test data, continued

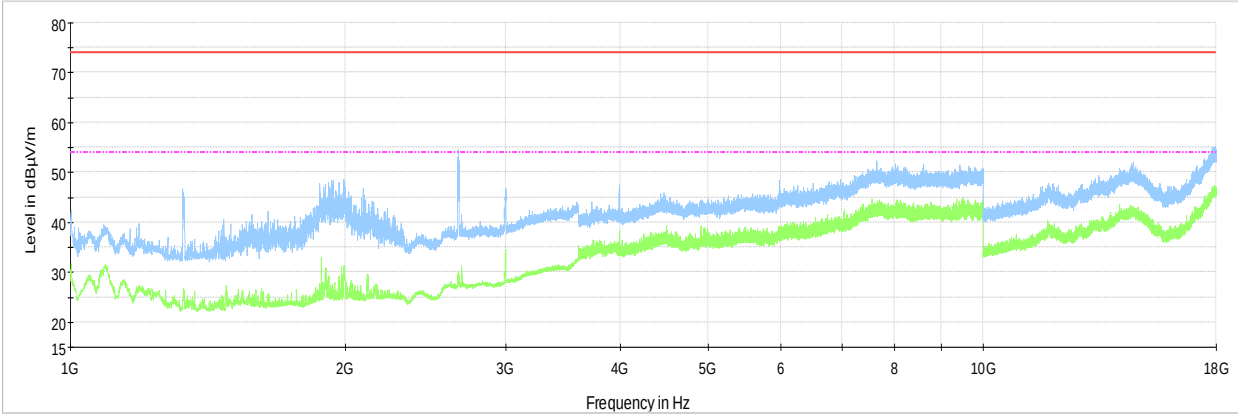
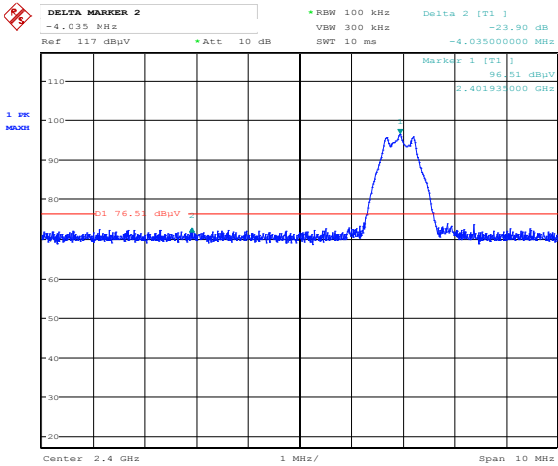


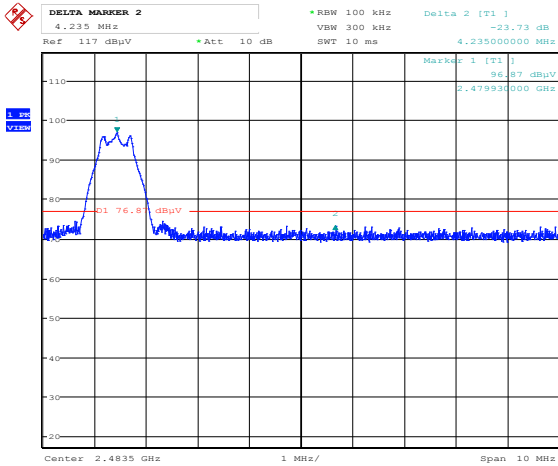
Figure 8.4-12: Radiated spurious emissions 1 GHz to 18 GHz, FHSS Receiver mode

Note: Spectrum was investigated from 30 MHz to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz and below 1 GHz.



Date: 4.JUL.2017 21:04:01

Figure 8.4-13: Lower band edge emission, tx on low ch, DTS mode



Date: 4.JUL.2017 21:30:46

Figure 8.4-14: Upper band edge emission, tx on high channel, DTS mode

8.4.4 Test data, continued

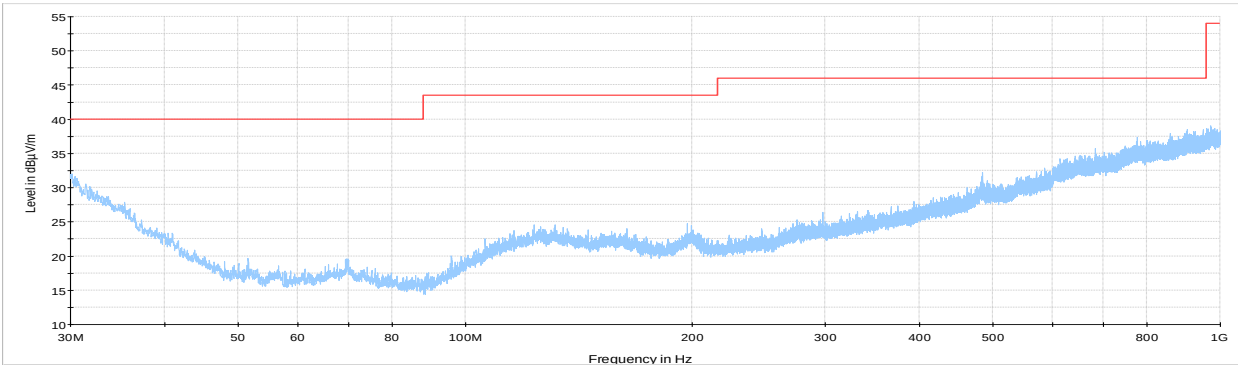


Figure 8.4-15: Radiated spurious emissions for low channel below 1 GHz for restricted band emissions, DTS mode

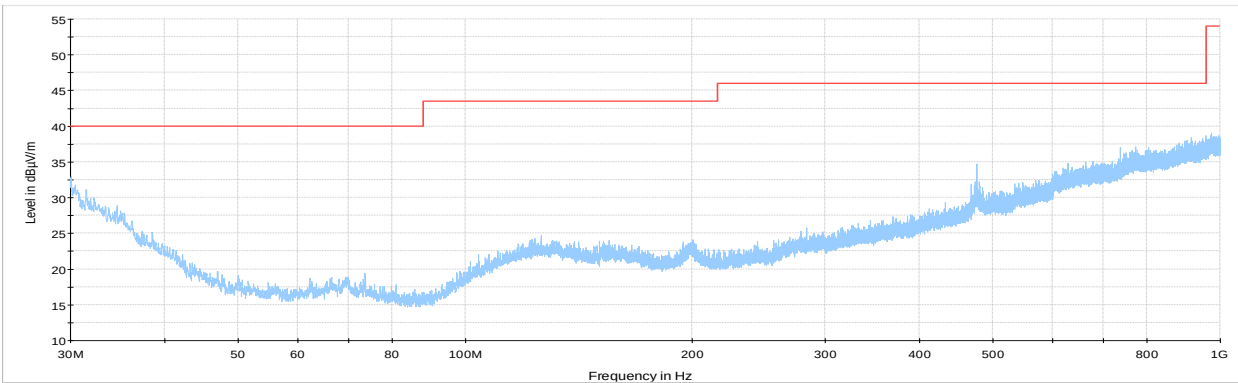


Figure 8.4-16: Radiated spurious emissions for mid channel below 1 GHz for restricted band emissions, DTS mode

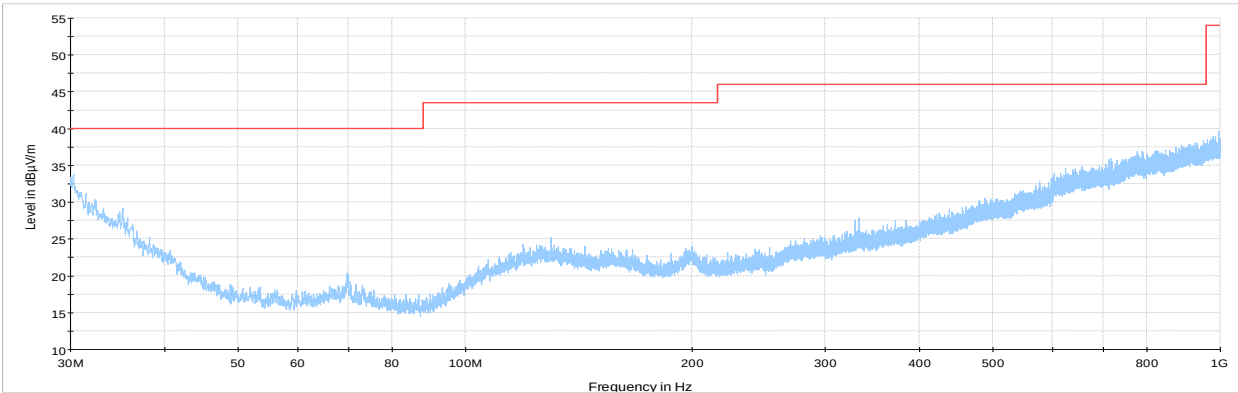
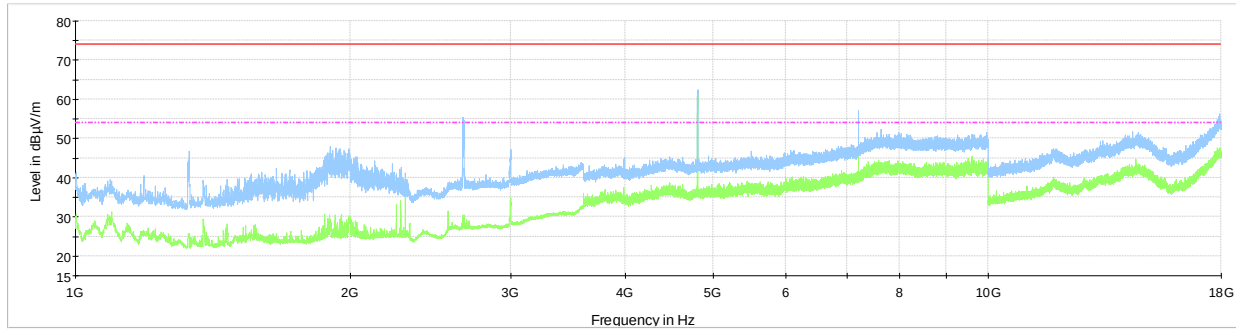
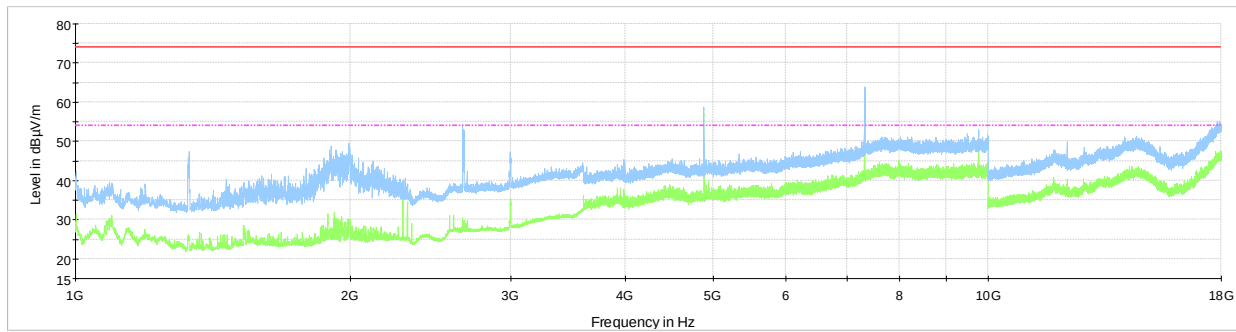


Figure 8.4-17: Radiated spurious emissions for high channel below 1 GHz for restricted band emissions, DTS mode

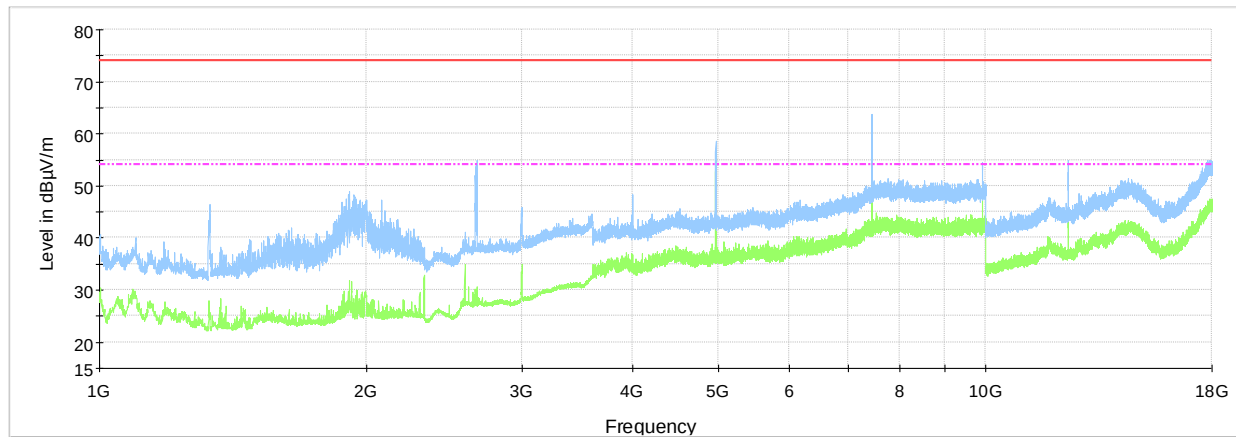
#### 8.4.5 Test data, continued



**Figure 8.4-18:** Radiated spurious emissions for low channel above 1 GHz for restricted band emissions, DTS mode



**Figure 8.4-19:** Radiated spurious emissions for mid channel above 1 GHz for restricted band emissions, DTS mode



**Figure 8.4-20:** Radiated spurious emissions for high channel above 1 GHz for restricted band emissions, DTS mode

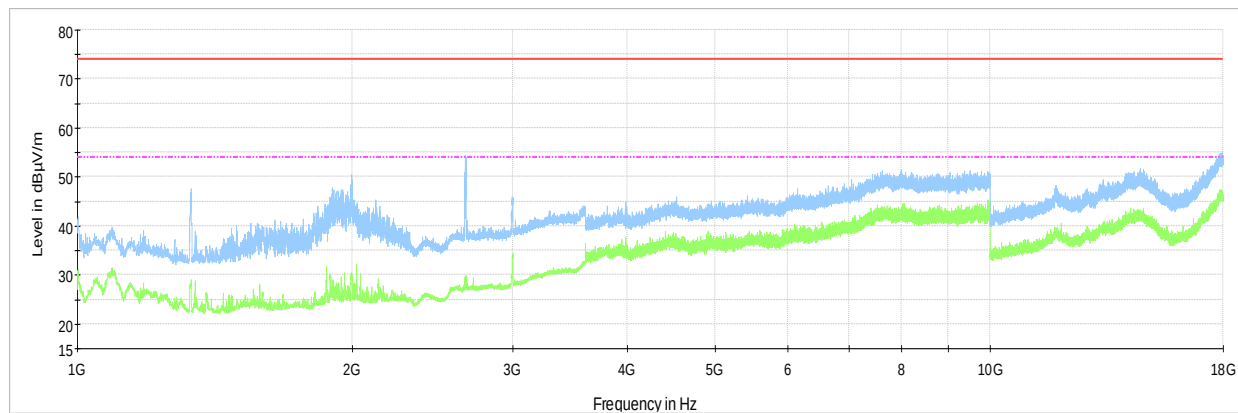
Note: Spectrum was investigated up to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz

#### 8.4.4 Test data, continued

**Table 8.4-5:** Radiated field strength measurement results for DTS mode

| Channel | Frequency, MHz | Peak Field strength, dB $\mu$ V/m |       | Margin, dB | Average Field strength, dB $\mu$ V/m |       | Margin, dB |
|---------|----------------|-----------------------------------|-------|------------|--------------------------------------|-------|------------|
|         |                | Measured                          | Limit |            | Measured                             | Limit |            |
| Low     | 2390           | 52.6                              | 74    | 21.4       | 40.7                                 | 54    | 13.3       |
| Low     | 4803.9         | 62.6                              | 74    | 11.4       | 52.9                                 | 54    | 1.1        |
| Low     | 7206.5         | 57.1                              | 74    | 16.9       | 46.2                                 | 54    | 7.8        |
| Mid     | 4879.5         | 58.8                              | 74    | 15.2       | 49.8                                 | 54    | 4.2        |
| Mid     | 7319.2         | 63.9                              | 74    | 10.1       | 53.4                                 | 54    | 0.6        |
| High    | 2483.5         | 56.0                              | 74    | 18.0       | 46.1                                 | 54    | 7.9        |
| High    | 4960.4         | 58.6                              | 74    | 15.4       | 49.3                                 | 54    | 4.7        |
| High    | 7439.8         | 63.7                              | 74    | 10.3       | 53.5                                 | 54    | 0.5        |

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.



**Figure 8.4-21:** Radiated spurious emissions 1 GHz to 18 GHz, DTS Receiver mode

Note: Spectrum was investigated from 30 MHz to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz and below 1 GHz.

## 8.5 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density for digitally modulated devices

### 8.5.1 Definitions and limits

**FCC:**

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.

**ISED:**

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(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

### 8.5.2 Test summary

|               |                              |                   |           |
|---------------|------------------------------|-------------------|-----------|
| Test date     | July 4, 2017 to July 6, 2017 | Temperature       | 25 °C     |
| Test engineer | Yong Huang                   | Air pressure      | 1009 mbar |
| Verdict       | Pass                         | Relative humidity | 40 %      |

### 8.5.3 Observations, settings and special notes

As per customer, EUT uses integral antenna, conducted antenna port is not available. Radiated measurements at 3 m were performed to show compliance.

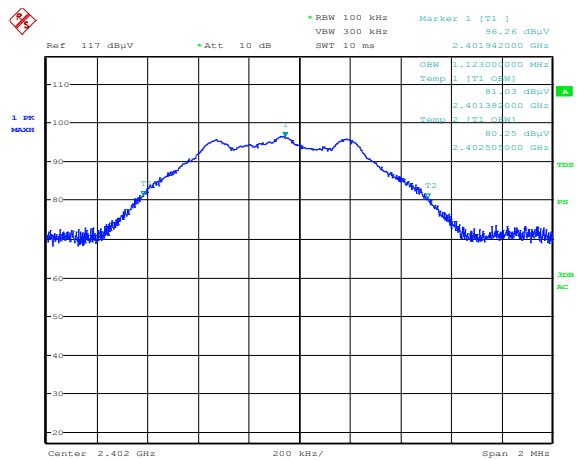
|                       |                                                      |
|-----------------------|------------------------------------------------------|
| Resolution bandwidth: | $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ |
| Video bandwidth:      | $\geq 3 \times \text{RBW}$                           |
| Frequency span:       | 1.5 times the OBW                                    |
| Detector mode:        | Peak                                                 |
| Trace mode:           | Max hold                                             |

8.5.4 Test data

Table 8.5-1: PSD measurements results, DTS mode

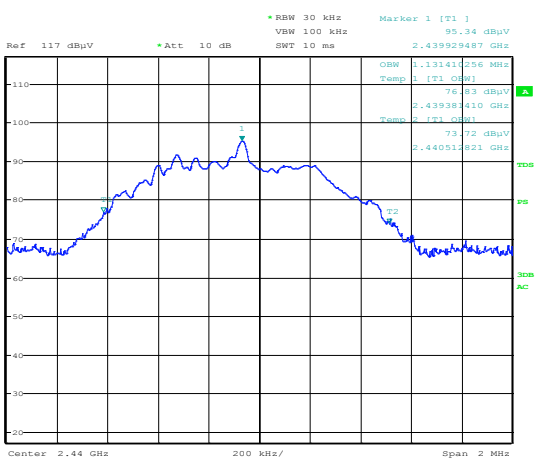
| Frequency, MHz | Field Strength@ 3m,<br>dBμV/m/100 kHz | PSD, dBm/100 kHz | PSD limit, dBm/3 kHz | Margin, dB |
|----------------|---------------------------------------|------------------|----------------------|------------|
| 2402           | 96.3                                  | 1.1              | 8                    | 6.9        |
| 2440           | 95.3                                  | 0.1              | 8                    | 7.9        |
| 2480           | 96.8                                  | 1.6              | 8                    | 6.4        |

EIRP(dBm) = Field Strength(dBμV/m, @ 3 m) -95.2



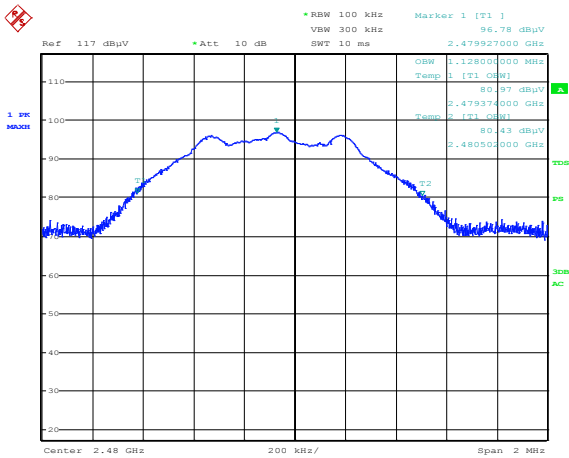
Date: 4.JUL.2017 21:02:02

Figure 8.5-1: PSD plot on Low channel



Date: 5.JUL.2017 20:21:14

Figure 8.5-2: PSD plot on mid channel

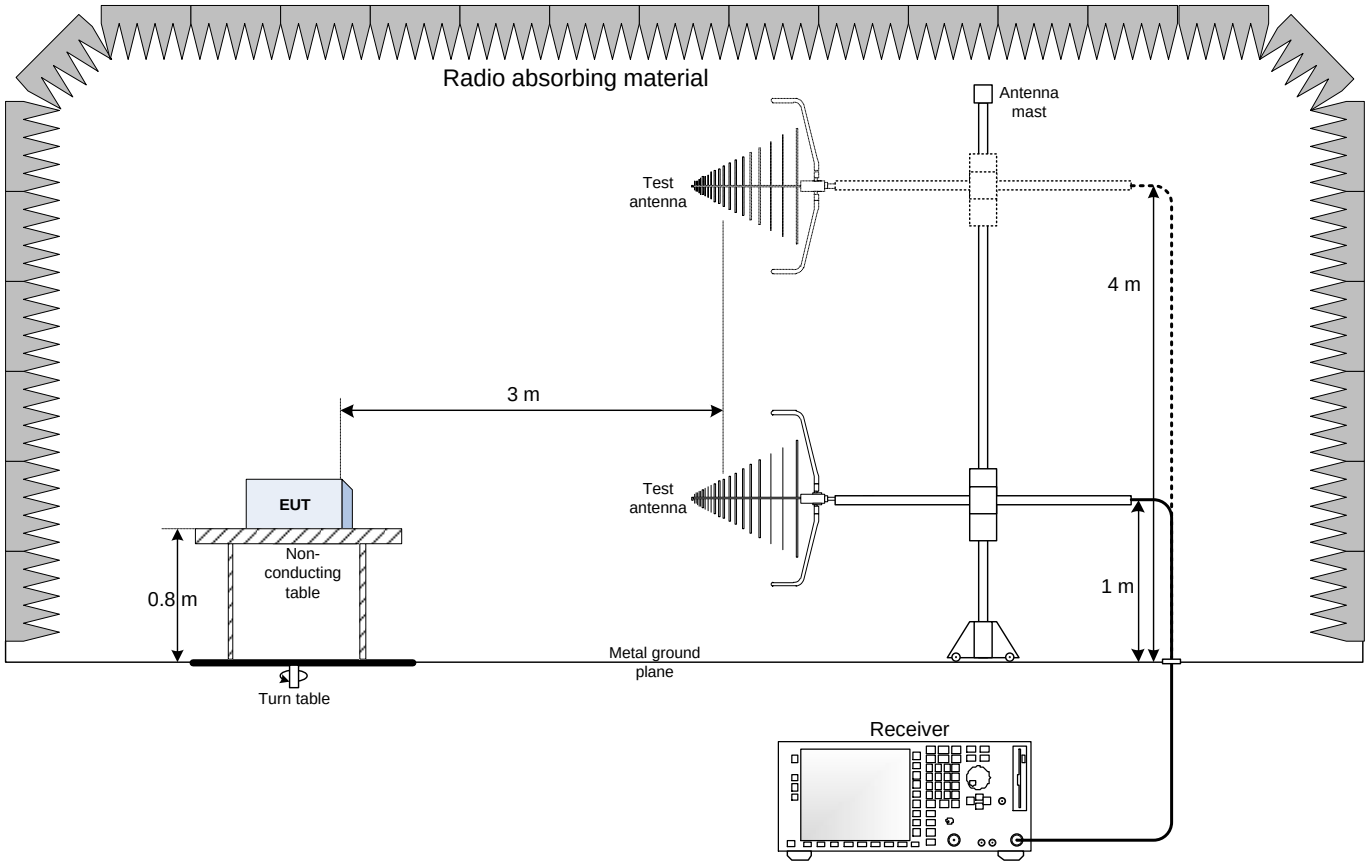


Date: 4.JUL.2017 21:27:02

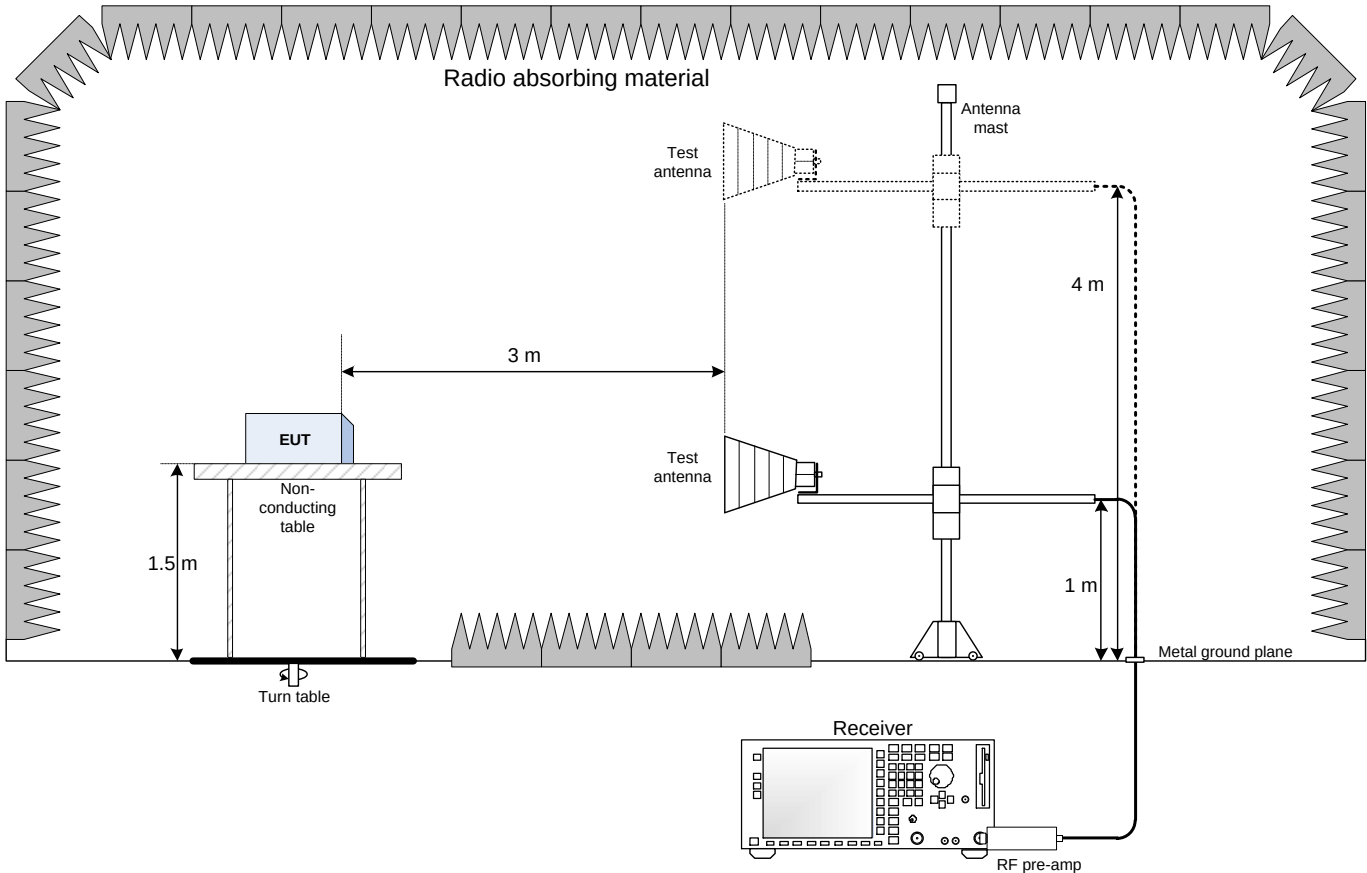
Figure 8.5-3: PSD plot on high channel

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



9.3 Conducted antenna port set-up

