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# Test report

## 334725-5TRFWL

Date of issue: December 20, 2017

Applicant:

Tait Ltd.

Product:

UnifyVehicle

Model:

TMB UnifyVehicle 1.1

Model variant:

T02-00079-ABAA

FCC ID:

CASTMBM1A

IC Registration number:

737A-TMBM1A

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 | 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: 2040CA; IC: 2040A-4 (3 m semi anechoic chamber) |

| | |
|---|---|
| Tested by | Kevin Rose, Wireless/EMC Specialist |
| Reviewed by | Andrey Adelberg, Senior Wireless/EMC Specialist |
| Review date | December 20, 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.

Copyright notification

# Table of contents

# **Section 1.** Report summary

## 1.1 Applicant and manufacturer

| | |
|---|---|
| Company name | Tait Ltd |
| Address | 245 Wooldridge Road |
| City | Christchurch |
| Province/State | – |
| Postal/Zip code | 8053 |
| Country | New Zealand |

## 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

| | |
|---|---|
| 558074 D01 DTS Meas Guidance v04 (April 5, 2017) | 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 |

## 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 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

Partial testing Per quote 102118088

## 1.6 Test report revision history

| 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 | Not applicable[1] |
| §15.203 | Antenna requirement | Not applicable[2] |

Notes: [1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2] The Antennas use a unique adapter.

## 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 | Not applicable |
| §15.247(a)(2) | Minimum 6 dB bandwidth for systems using digital modulation techniques | Not tested |
| §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 | Not applicable |
| §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 | Not tested |
| §15.247(f) | Time of occupancy for hybrid systems | Not applicable |

Note: Not tested Per Quote Q102118088R3

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

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

Notes: [1] 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.

Note: Not tested Per Quote Q102118088R3

## 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 | Not applicable |
| 5.1 (b) | Minimum channel spacing for frequency hopping systems | Not applicable |
| 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 | Not applicable |
| 5.1 (e) | Frequency hopping systems operating in the 5725–5850 MHz band | Not applicable |
| 5.2 | Digital Transmission Systems (DTSs) | |
| 5.2 (a) | Minimum 6 dB bandwidth | Not tested |
| 5.2 (b) | Maximum power spectral density | Not tested |
| 5.3 | Hybrid Systems | |
| 5.3 (a) | Digital modulation turned off | Not applicable |
| 5.3 (b) | Frequency hopping turned off | Not applicable |
| 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) | Non Frequency hopping systems operating in the 2400–2483.5 MHz band | Pass |
| 5.5 | Unwanted emissions | Pass |

Note: Not tested Per Quote Q102118088R3

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

## 3.1 Sample information

| | |
|---|---|
| Receipt date | July 31, 2017 |
| Nemko sample ID number | 1, 2 |

## 3.2 EUT information

| | |
|---|---|
| Product name | UnifyVehicle |
| Model | TMB UnifyVehicle 1.1 |
| Model variant | T02-00079-ABAA |
| Serial number | 7330580 |

## 3.3 Technical information

| | |
|---|---|
| All used IC test site(s) Reg. number | 2040A-4 |
| RSS number and Issue number | RSS-247 Issue 2, Feb 2017 |
| Frequency band | 2402–2480 MHz |
| Type of modulation | BT4.1 BR, BT4.1 EDR2, BT4.1 EDR3, BLE 4.0 |
| Emission classification (F1D, G1D, D1D) | F1D |
| Power requirements | 13.8 Vdc |
| Antenna information | The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. |

**Table 3.3-1:** Antenna Assemblies

| Referenced to WL1837 o/p | Assembly items | Net Gain of Assembly, dBi |
|---|---|---|
| **Antenna assembly (GPSD)** | UFL_SMA cable (-0.5 dB) + 3 Meter vehicle cable (-2 dB) + GPSD Antenna (+4 dB) | 1.5 |
| **Antenna assembly (WLP2458NGP-T)** | UFL_SMA cable (-0.5 dB) + 3 Meter vehicle cable (-2 dB) + WL2458NGP Antenna (+3.9 dB) | 1.4 |

## 3.4 Product description and theory of operation

Legacy interface between the TMB LMR transceiver and the control head plus ARM based Linux application platform supporting Ethernet and WiFi/BT interfaces.

## 3.5 EUT exercise details

The EUT was programmed to transmit on Low. Mid, and High channels

## 3.6 EUT setup diagram

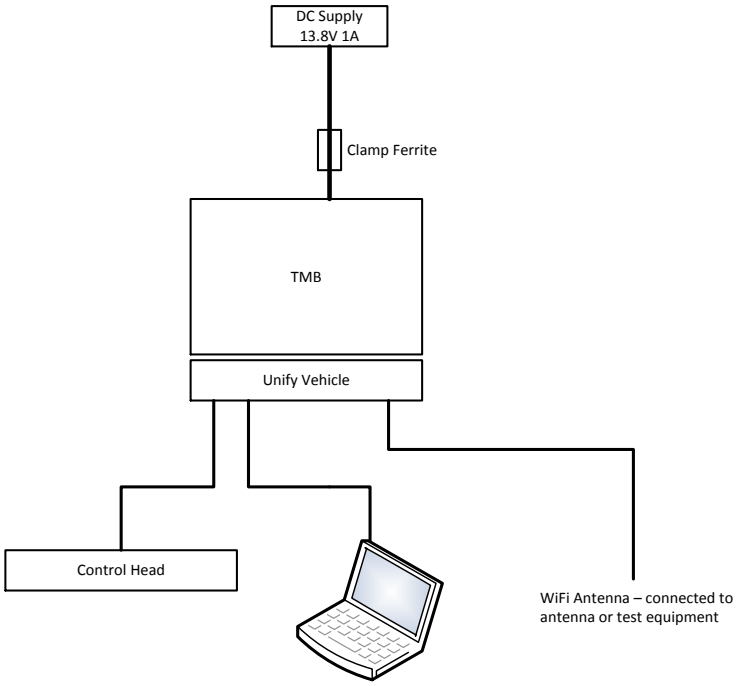



***Figure 3.6-1:*** *Setup diagram*

## 3.7 EUT sub assemblies

***Table 3.7-1:*** *EUT sub assemblies*

| Description | Brand name | Model/Part number | Serial number |
|---|---|---|---|
| TMB UnifyVehicle External Antenna WiFi BT | Tait Unify Vehicle | PN: T02-00079-ABAA Rev. IP005 | SN: 7330580 |
| Multi-Element GPSD Antenna | Tait Unify Vehicle | PN: T02-00024-0103 | 417744 |
| WLP2458NGP-T Antenna | Tait Unify Vehicle | PN: T02-00024-0104 | 26062017 |

# **Section 4.** Engineering considerations

## 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

No deviations were made from laboratory procedures.

# **Section 5.** Test conditions

## 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 ±5 %, for which the equipment was designed.

# **Section 6.** Measurement uncertainty

## 6.1 Uncertainty of measurement

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. |
|---|---|---|---|---|---|
| 3 m EMI test chamber | TDK | SAC-3 | FA002047 | 1 year | Dec. 1/17 |
| Flush mount turntable | Sunol | FM2022 | FA002082 | — | NCR |
| Controller | Sunol | SC104V | FA002060 | — | NCR |
| Antenna mast | Sunol | TLT2 | FA002061 | — | NCR |
| Bilog antenna (20–3000 MHz) | Sunol | JB3 | FA002108 | 1 year | June 27/18 |
| Biconical antenna (30–300 MHz) | Sunol | BC2 | FA002078 | 1 year | May. 8/18 |
| Horn with Preamp | ETS-Lindgren | 3117-PA | FA002840 | 1 year | Nov. 11/17 |
| Receiver/spectrum analyzer | Rohde & Schwarz | ESU 26 | FA002043 | 1 year | Jan. 31/18 |
| Spectrum analyzer | Rohde & Schwarz | FSP | FA001920 | 1 year | Aug. 08/18 |
| 18–26 GHz pre-amplifier | Narda | BBS-1826N612 | FA001550 | — | VOU |
| Horn antenna 18–40 GHz | EMCO | 3116 | FA001847 | 1 year | June 27/18 |
| 50 Ω coax cable | Huber + Suhner | None | FA002074 | 1 year | May 12/18 |
| 50 Ω coax cable | Huber + Suhner | None | FA002830 | 1 year | May 12/18 |

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

# Section 8. Testing data

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

### 8.1.1 Definitions and limits

**FCC:**

(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.

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(c) Operation with directional antenna gains greater than 6 dBi.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

**ISED:**

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).
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.
e. 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.

**ISED:**
f. Transmitters operating in the band 2400–2483.5 MHz, may employ antenna systems that emit multiple directional beams simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers, provided that the emissions comply with the following:

Different information must be transmitted to each receiver.

If the transmitter employs an antenna system that emits multiple directional beams, but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device (i.e. the sum of the power supplied to all antennas, antenna elements, staves, etc., and summed across all carriers or frequency channels) shall not exceed the applicable output power limit specified in sections 5.4(b) and 5.4(d). However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the applicable power limit specified in sections 5.4(b) and 5.4(d). If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the applicable limit specified in sections 5.4(b) and 5.4(d). In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the applicable limit specified in sections 5.4(b) and 5.4(d) by more than 8 dB.

Transmitters that transmit a single directional beam shall operate under the provisions of sections 5.4(b), 5.4(d) and 5.4(e).

### 8.1.2 Test summary

| | | | |
|---|---|---|---|
| Test date | October 19, 2017 | Temperature | 23 °C |
| Test engineer | Kevin Rose | Air pressure | 1008 mbar |
| Verdict | Pass | Relative humidity | 42 % |

### 8.1.3 Observations, settings and special notes

The test was performed according to DTS guidelines section 9.2.2.1: Measurement using a spectrum analyzer (SA) Method AVGSA-1 averaging with the EUT transmitting at full power throughout each sweep.

### 8.1.4 Test data

***Table 8.1-1:*** *Output power measurements results GPSD*

| Modulation | Frequency, MHz | Conducted output power, dBm | | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|---|---|---|---|---|---|---|---|---|
| | | dBm | Limit | | | | | |
| BT4.1 BR | 2480 | 8.16 | 30 | 21.84 | 1.5 | 9.66 | 36 | 26.34 |
| | 2440 | 7.99 | 30 | 22.01 | 1.5 | 9.49 | 36 | 26.51 |
| | 2402 | 8.07 | 30 | 21.93 | 1.5 | 9.57 | 36 | 26.43 |
| BT4.1 EDR2 | 2480 | 8.36 | 30 | 21.64 | 1.5 | 9.86 | 36 | 26.14 |
| | 2440 | 8.20 | 30 | 21.80 | 1.5 | 9.70 | 36 | 26.30 |
| | 2402 | 8.39 | 30 | 21.61 | 1.5 | 9.89 | 36 | 26.11 |
| BT4.1 EDR3 | 2480 | 8.77 | 30 | 21.23 | 1.5 | 10.27 | 36 | 25.73 |
| | 2440 | 8.62 | 30 | 21.38 | 1.5 | 10.12 | 36 | 25.88 |
| | 2402 | 8.95 | 30 | 21.05 | 1.5 | 10.45 | 36 | 25.55 |
| BLE 4.0 | 2480 | 8.46 | 30 | 21.54 | 1.5 | 9.96 | 36 | 26.04 |
| | 2440 | 8.32 | 30 | 21.68 | 1.5 | 9.82 | 36 | 26.18 |
| | 2402 | 8.52 | 30 | 21.48 | 1.5 | 10.02 | 36 | 25.98 |

***Table 8.1-2:*** *Output power measurements results WLP2458NGP-T*

| Modulation | Frequency, MHz | Conducted output power, dBm | | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|---|---|---|---|---|---|---|---|---|
| | | dBm | Limit | | | | | |
| BT4.1 BR | 2480 | 8.16 | 30 | 21.84 | 1.4 | 9.56 | 36 | 26.44 |
| | 2440 | 7.99 | 30 | 22.01 | 1.4 | 9.39 | 36 | 26.61 |
| | 2402 | 8.07 | 30 | 21.93 | 1.4 | 9.47 | 36 | 26.53 |
| BT4.1 EDR2 | 2480 | 8.36 | 30 | 21.64 | 1.4 | 9.76 | 36 | 26.24 |
| | 2440 | 8.20 | 30 | 21.80 | 1.4 | 9.60 | 36 | 26.40 |
| | 2402 | 8.39 | 30 | 21.61 | 1.4 | 9.79 | 36 | 26.21 |
| BT4.1 EDR3 | 2480 | 8.77 | 30 | 21.23 | 1.4 | 10.17 | 36 | 25.83 |
| | 2440 | 8.62 | 30 | 21.38 | 1.4 | 10.02 | 36 | 25.98 |
| | 2402 | 8.95 | 30 | 21.05 | 1.4 | 10.35 | 36 | 25.65 |
| BLE 4.0 | 2480 | 8.46 | 30 | 21.54 | 1.4 | 9.86 | 36 | 26.14 |
| | 2440 | 8.32 | 30 | 21.68 | 1.4 | 9.72 | 36 | 26.28 |
| | 2402 | 8.52 | 30 | 21.48 | 1.4 | 9.92 | 36 | 26.08 |

**Table 8.1-3:** Antenna Assemblies

| Referenced to WL1837 o/p | Assembly items | Net Gain of Assembly, dBi |
|---|---|---|
| **Antenna assembly (GPSD)** | UFL_SMA cable (-0.5 dB) + 3 Meter vehicle cable (-2 dB) + GPSD Antenna (+4 dBi) | 1.5 |
| **Antenna assembly (WLP2458NGP-T)** | UFL_SMA cable (-0.5 dB) + 3 Meter vehicle cable (-2 dB) + WL2458NGP Antenna (+3.9 dBi) | 1.4 |

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

### 8.2.1 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 8.2-1:*** *FCC §15.209 and RSS-Gen – Radiated emission limits*

| Frequency, 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 8.2-2:*** *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 8.2-2 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 8.2-3:*** *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 | | | |

## 8.2.2 Test summary

| | | | |
|---|---|---|---|
| Test date | October 19, 2017 | Temperature | 23 °C |
| Test engineer | Kevin Rose | Air pressure | 1008 mbar |
| Verdict | Pass | Relative humidity | 42 % |

## 8.2.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit with 100 % duty cycle.

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 |

Spectrum analyser settings for conducted spurious emissions measurements:

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

### 8.2.4 Test data

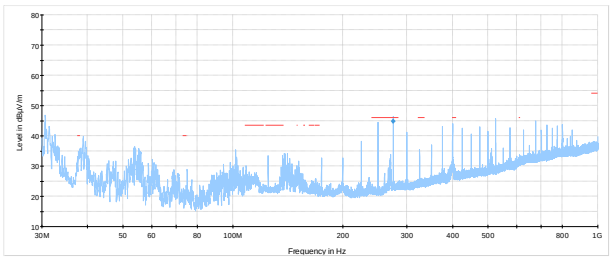



***Figure 8.2-1:*** *Spurious emissions below 1 GHz, low channel*

*BT4.1 BR* ***WLP2458NGP***

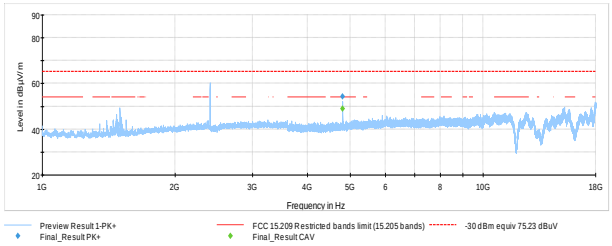



***Figure 8.2-2:*** *Spurious emissions above 1 GHz, low channel*

*BT4.1 BR* ***WLP2458NGP***

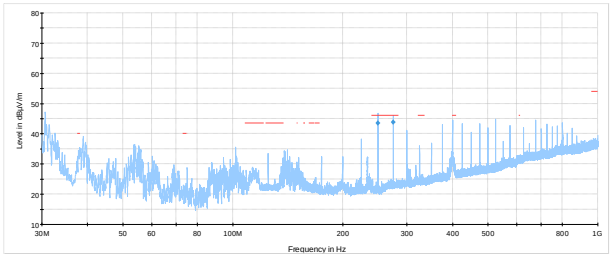



***Figure 8.2-3:*** *Spurious emissions below 1 GHz, mid channel*

*BT4.1 BR* ***WLP2458NGP***

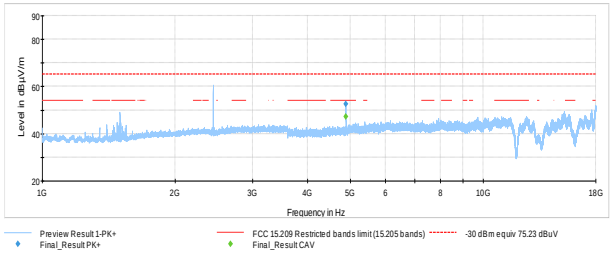



***Figure 8.2-4:*** *Spurious emissions above 1 GHz, mid channel*

*BT4.1 BR* ***WLP2458NGP***

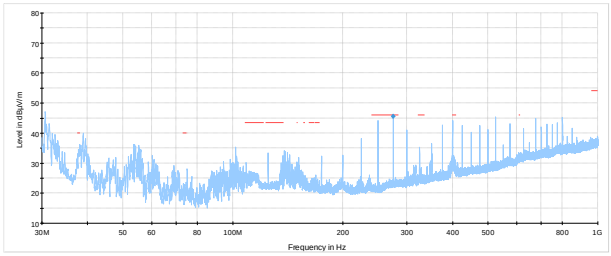



***Figure 8.2-5:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 BR* ***WLP2458NGP***

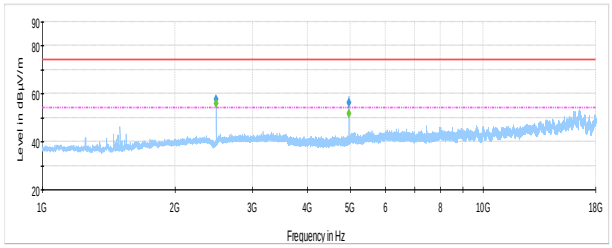



***Figure 8.2-6:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 BR* ***WLP2458NGP***

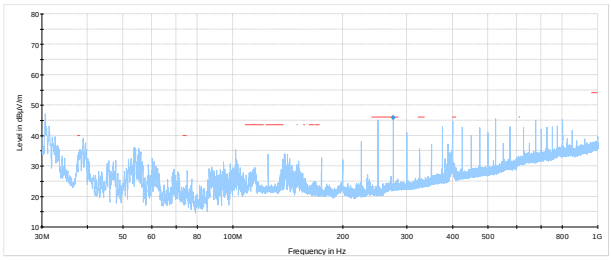



***Figure 8.2-7:*** *Spurious emissions below 1 GHz, low channel*

*BT4.1 EDR2* ***WLP2458NGP***

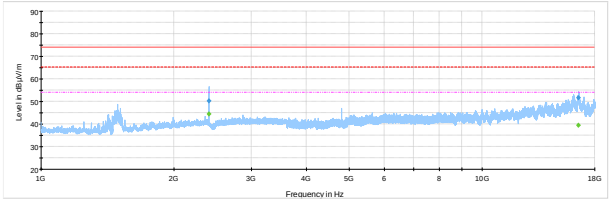



***Figure 8.2-8:*** *Spurious emissions above 1 GHz, low channel*

*BT4.1 EDR2* ***WLP2458NGP***

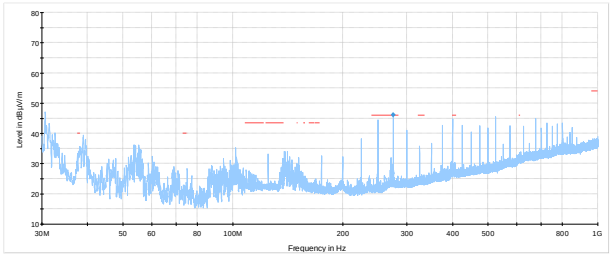



***Figure 8.2-9:*** *Spurious emissions below 1 GHz, mid channel*

*BT4.1 EDR2* ***WLP2458NGP***

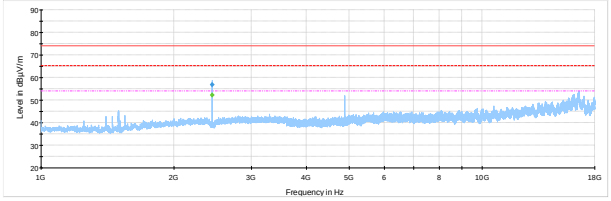



***Figure 8.2-10:*** *Spurious emissions above 1 GHz, mid channel*

*BT4.1 EDR2* ***WLP2458NGP***

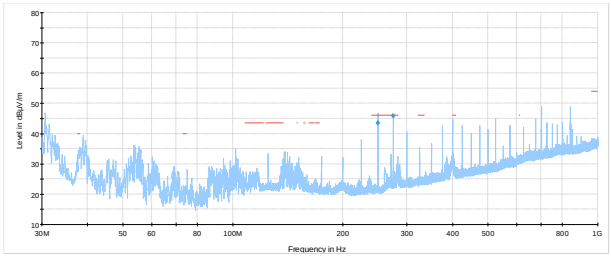



***Figure 8.2-11:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR2* ***WLP2458NGP***

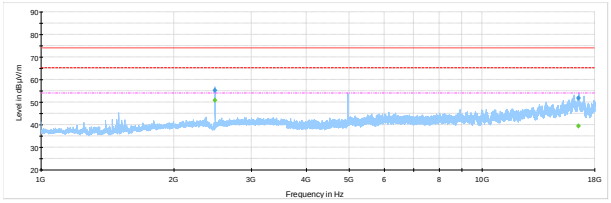



***Figure 8.2-12:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR2* ***WLP2458NGP***

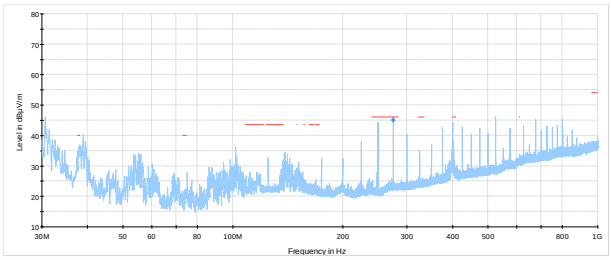



***Figure 8.2-13:*** *Spurious emissions below 1 GHz, low channel*

*BT4.1 EDR3* ***WLP2458NGP***

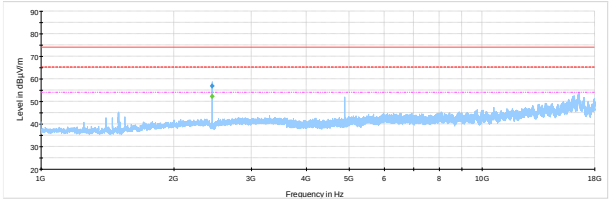



***Figure 8.2-14:*** *Spurious emissions above 1 GHz, low channel*

*BT4.1 EDR3* ***WLP2458NGP***

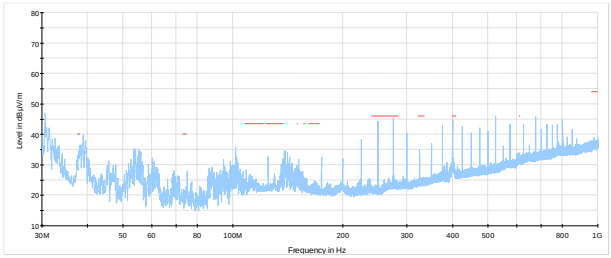



***Figure 8.2-15:*** *Spurious emissions below 1 GHz, mid channel*

*BT4.1 EDR3* ***WLP2458NGP***

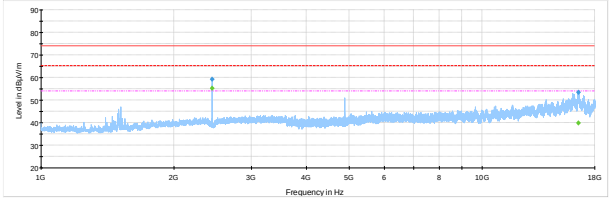



***Figure 8.2-16:*** *Spurious emissions above 1 GHz, mid channel*

*BT4.1 EDR3* ***WLP2458NGP***

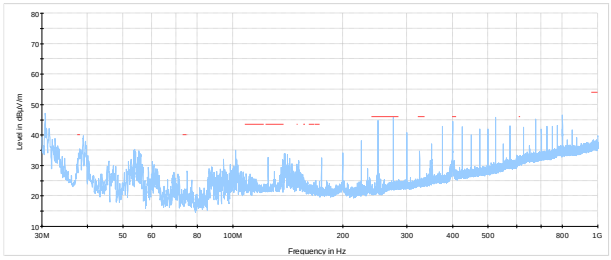



***Figure 8.2-17:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR3* ***WLP2458NGP***

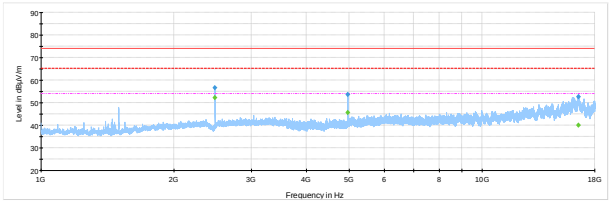



***Figure 8.2-18:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR3* ***WLP2458NGP***

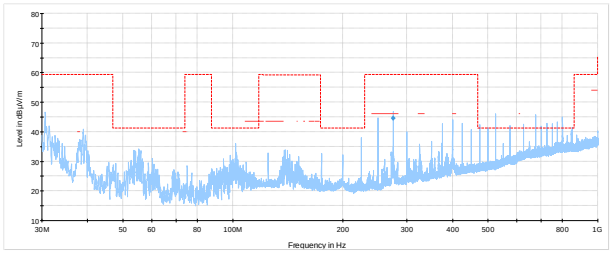



***Figure 8.2-19:*** *Spurious emissions below 1 GHz, low channel*

*BLE 4.0* ***WLP2458NGP***

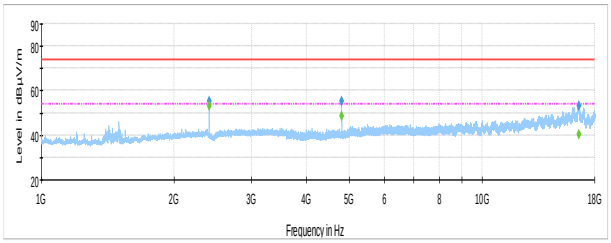



***Figure 8.2-20:*** *Spurious emissions above 1 GHz, low channel*

*BLE 4.0* ***WLP2458NGP***

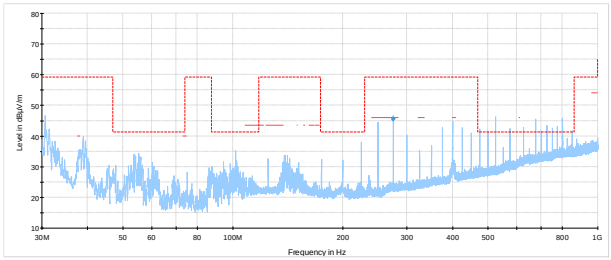



***Figure 8.2-21:*** *Spurious emissions below 1 GHz, mid channel*

*BLE 4.0* ***WLP2458NGP***

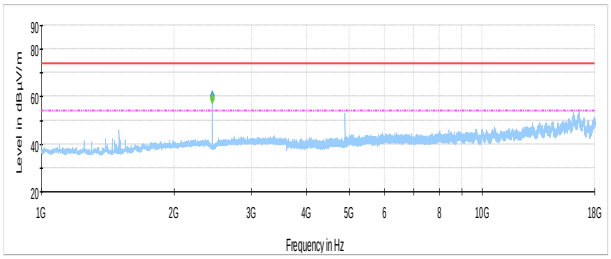



***Figure 8.2-22:*** *Spurious emissions above 1 GHz, mid channel*

*BLE 4.0* ***WLP2458NGP***

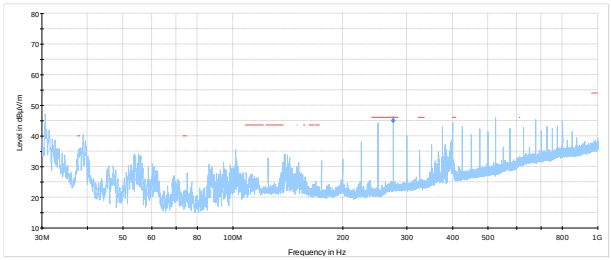



***Figure 8.2-23:*** *Spurious emissions below 1 GHz, high channel*

*BLE 4.0* ***WLP2458NGP***

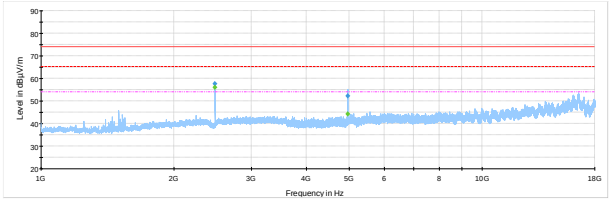



***Figure 8.2-24:*** *Spurious emissions below 1 GHz, high channel*

*BLE 4.0* ***WLP2458NGP***

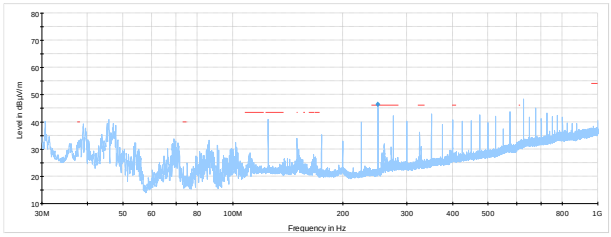



***Figure 8.2-25:*** *Spurious emissions below 1 GHz, low channel*

*BT4.1 BR* ***GPSD***

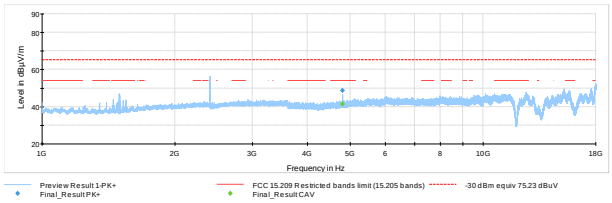



***Figure 8.2-26:*** *Spurious emissions above 1 GHz, low channel*

*BT4.1 BR* ***GPSD***

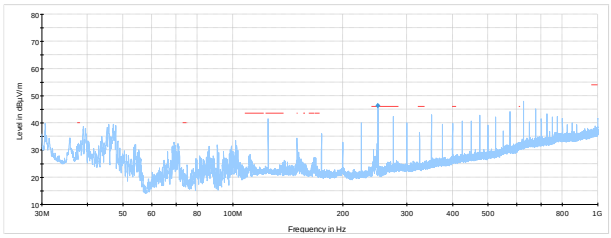



***Figure 8.2-27:*** *Spurious emissions below 1 GHz, mid channel*

*BT4.1 BR* ***GPSD***

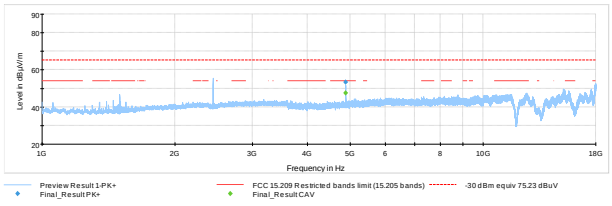



***Figure 8.2-28:*** *Spurious emissions above 1 GHz, mid channel*

*BT4.1 BR* ***GPSD***

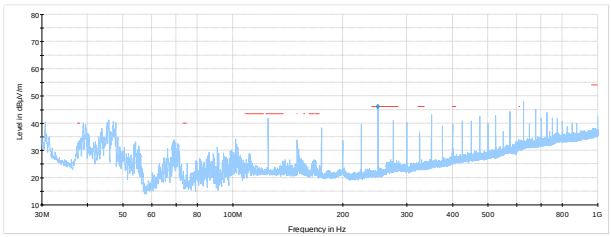



***Figure 8.2-29:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 BR* ***GPSD***

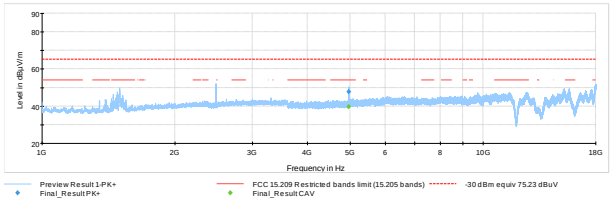



***Figure 8.2-30:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 BR* ***GPSD***

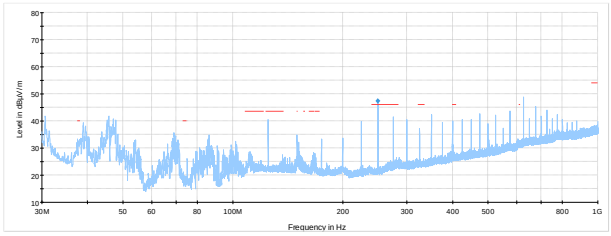



***Figure 8.2-31:*** *Spurious emissions below 1 GHz, low channel*

*BT4.1 EDR2* ***GPSD***

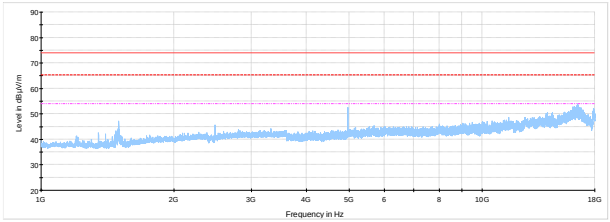



***Figure 8.2-32:*** *Spurious emissions above 1 GHz, low channel*

*BT4.1 EDR2* ***GPSD***

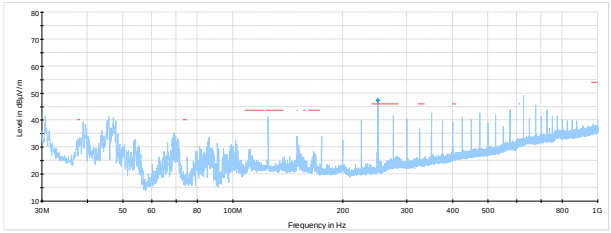



***Figure 8.2-33:*** *Spurious emissions below 1 GHz, mid channel*

*BT4.1 EDR2* ***GPSD***

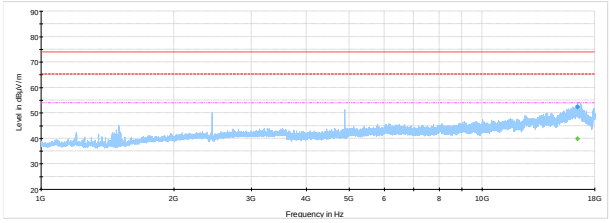



***Figure 8.2-34:*** *Spurious emissions above 1 GHz, mid channel*

*BT4.1 EDR2* ***GPSD***

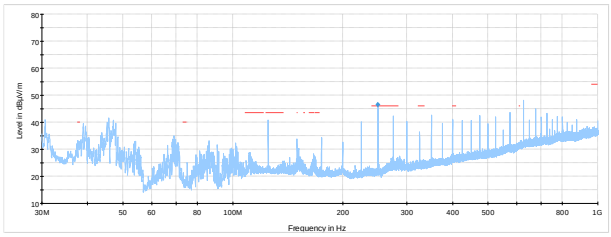



***Figure 8.2-35:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR2* ***GPSD***

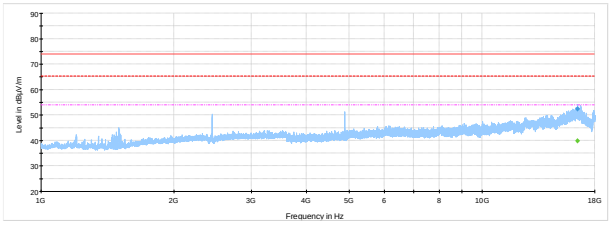



***Figure 8.2-36:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR2* ***GPSD***

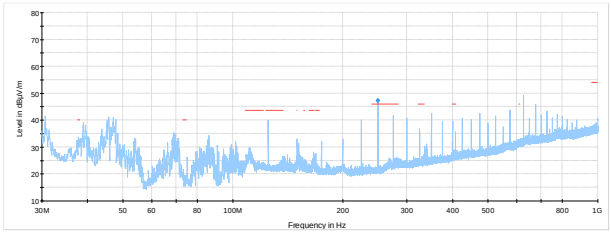



***Figure 8.2-37:*** *Spurious emissions below 1 GHz, low channel*

*BT4.1 EDR3* ***GPSD***

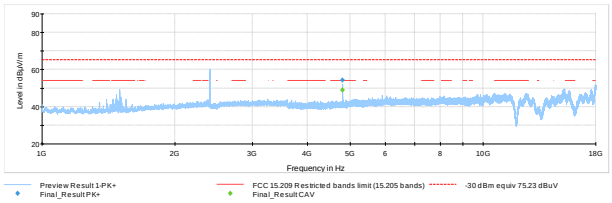



***Figure 8.2-38:*** *Spurious emissions above 1 GHz, low channel*

*BT4.1 EDR3* ***GPSD***

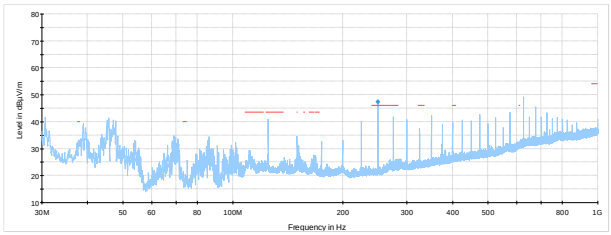



***Figure 8.2-39:*** *Spurious emissions below 1 GHz, mid channel*

*BT4.1 EDR3* ***GPSD***

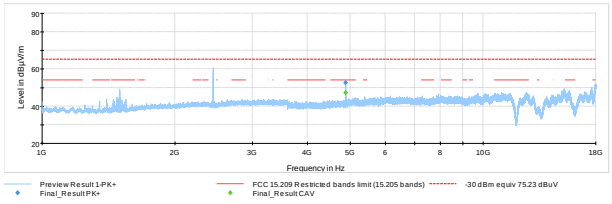



***Figure 8.2-40:*** *Spurious emissions above 1 GHz, mid channel*

*BT4.1 EDR3* ***GPSD***

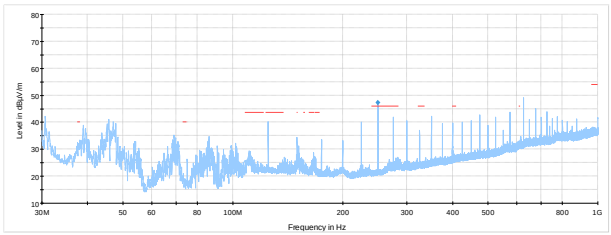



***Figure 8.2-41:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR3* ***GPSD***

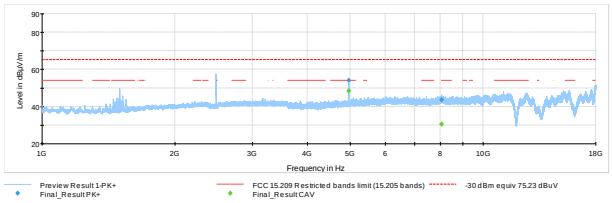



***Figure 8.2-42:*** *Spurious emissions below 1 GHz, high channel*

*BT4.1 EDR3* ***GPSD***

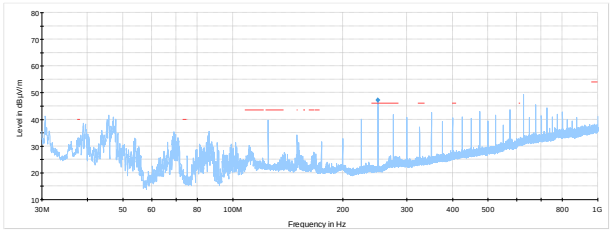



***Figure 8.2-43:*** *Spurious emissions below 1 GHz, low channel*

*BLE 4.0* ***GPSD***

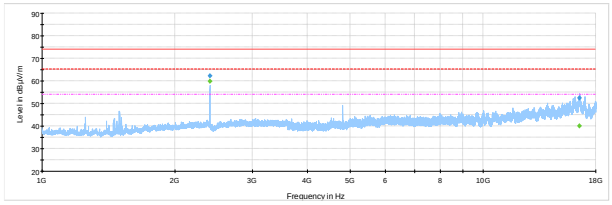



***Figure 8.2-44:*** *Spurious emissions above 1 GHz, low channel*

*BLE 4.0* ***GPSD***

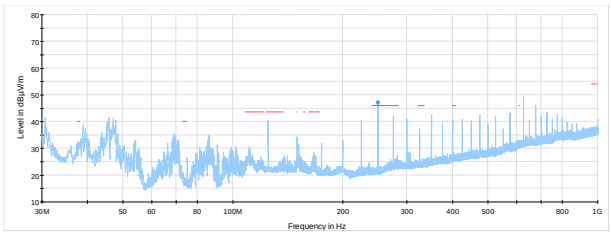



***Figure 8.2-45:*** *Spurious emissions below 1 GHz, mid channel*

*BLE 4.0* ***GPSD***

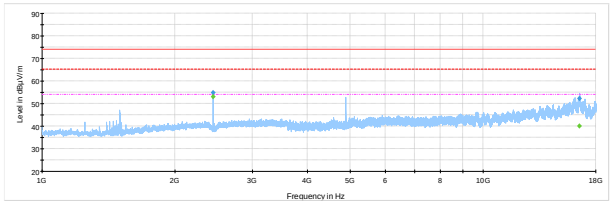



***Figure 8.2-46:*** *Spurious emissions above 1 GHz, mid channel*

*BLE 4.0* ***GPSD***

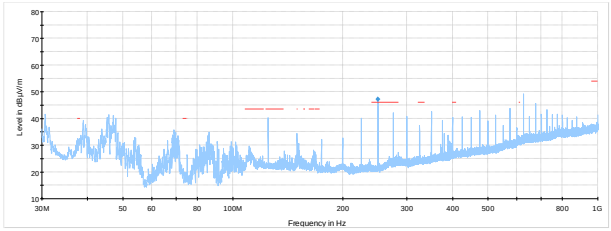



***Figure 8.2-47:*** *Spurious emissions below 1 GHz, high channel*

*BLE 4.0* ***GPSD***

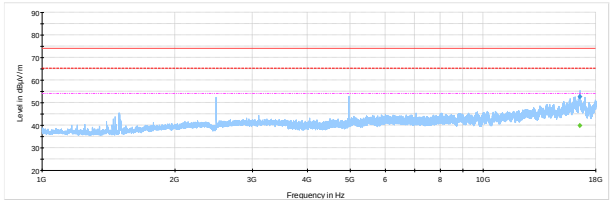


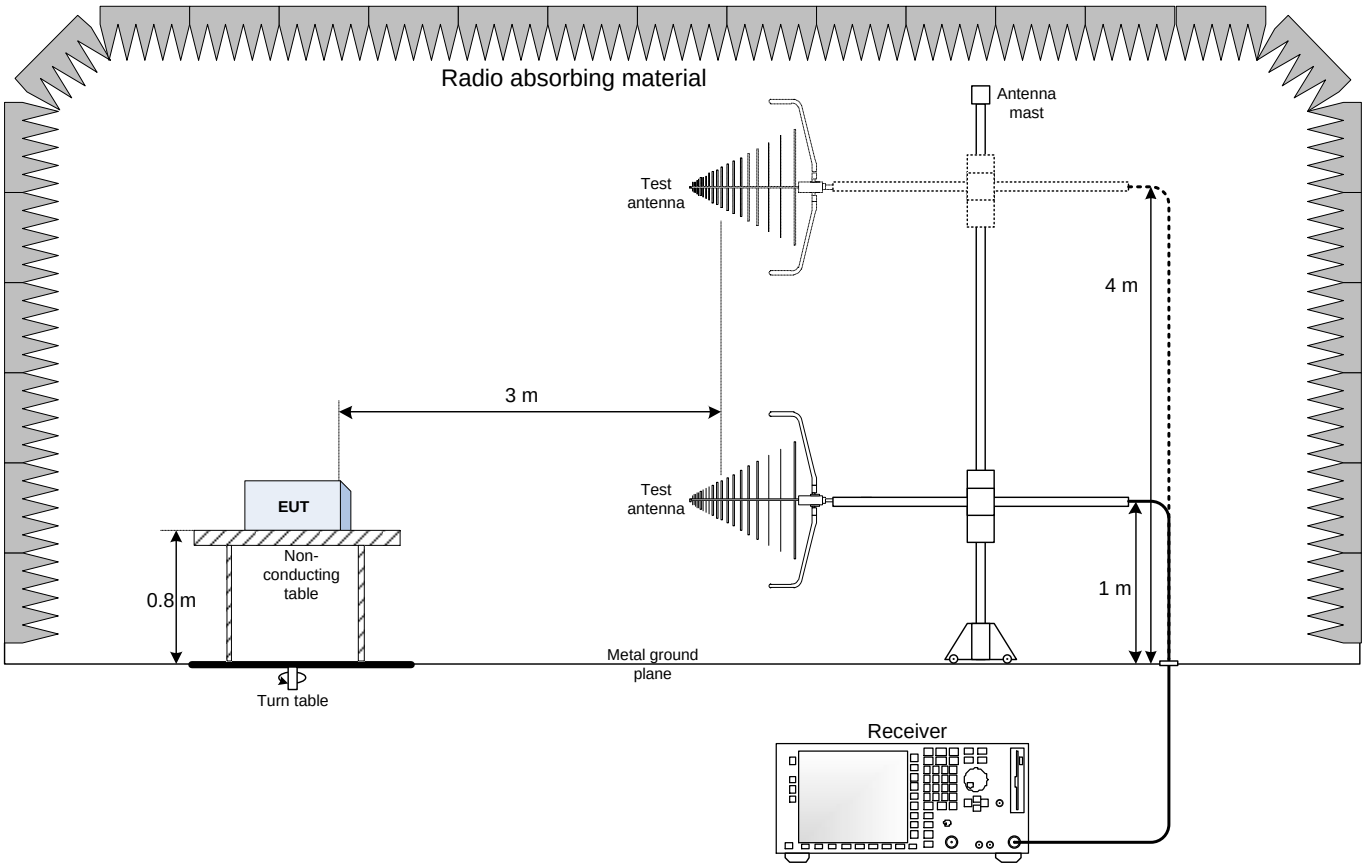

***Figure 8.2-48:*** *Spurious emissions below 1 GHz, high channel*

*BLE 4.0* ***GPSD***

Note: Digital emission are not subject to 15.247. The EUT is a Class A digital device.

# **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