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# Test report

## FCC-15.247 and RSS-247 BLE 2015_291261

Date of issue: March 21, 2016

Applicant: Companion Medical

Product: BLE Module for Medical Injection Device

Model: InPen Model variant: N/A

FCC ID: 2AGUHINPEN IC Registration number: N/A

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

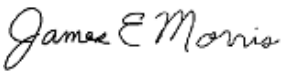
  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

- RSS-247, Issue 1, May 2015

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

Test location

| | |
|---|---|
| Company name | Nemko USA, Inc. |
| Address | 2210 Faraday Ave, Suite 150 |
| City | Carlsbad |
| Province | California |
| Postal code | 92008 |
| Country | USA |
| Telephone | +1 760 444 3500 |
| Website | www.nemko.com |
| Site number | FCC: US5058; IC: 2040B |

| | |
|---|---|
| Tested by | Feng You, Sr. Wireless Engineer |
| Reviewed by | James Morris |
| Review date | March 21, 2016 |
| Reviewer signature |  |

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

# Table of contents

# **Section 1.** Report summary

## 1.1 Applicant and manufacturer

| | |
|---|---|
| Company name | Companion Medical |
| Address | 13014 Texana Street |
| City | San Diego |
| Province/State | CA |
| Postal/Zip code | 92129 |
| Country | U.S.A. |

## 1.2 Test specifications

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

## 1.3 Test methods

| | |
|---|---|
| ANSI C64.3-2014 | American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.10-2013 | 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. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

## 1.5 Exclusions

None

## 1.6 Test report revision history

| Revision # | Details of changes made to test report |
|---|---|
| 1 | Original report issued |
| 2 | Updated according to checklist |
| 3 | Setup diagram updated |

# **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 | Pass[2] |
| §15.205 | Restricted bands of operation | Pass |

Notes: [1] Test performed with new batteries.

[2] The Antennas are located within the protective cover of EUT on PCB.

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

| Part | Test description | Verdict |
|---|---|---|
| §15.247(a)(1) | 20 dB bandwidth of the hopping channel | Not applicable |
| §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 | 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 | 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 | Pass |
| §15.247(f) | Time of occupancy for hybrid systems | Not applicable |

## 2.3 IC 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 |
| 8.10 | Restricted Frequency Bands | Pass |

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.

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

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

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

## 3.1 Sample information

| | |
|---|---|
| Receipt date | November 24, 2015 |
| Nemko sample ID number | 291261-1, 291261-2 |

## 3.2 EUT information

| | |
|---|---|
| Product name | BLE Module for Medical Injection Device |
| Model | InPen |
| Model variant | N/A |
| Serial number | N/A |

## 3.3 Technical information

| | |
|---|---|
| Applicant IC company number | N/A |
| IC UPN number | N/A |
| All used IC test site(s) Reg. number | 2040B |
| RSS number and Issue number | RSS-247, Issue 1, May 2015 |
| Frequency band | 2400–2483.5 MHz |
| Frequency Min (MHz) | 2402 |
| Frequency Max (MHz) | 2480 |
| RF power Min (W), Conducted/ERP/EIRP | N/A |
| RF power Max (W), Conducted/ERP/EIRP | 0.00037 (Conducted) |
| Field strength, Units @ distance | N/A |
| Measured BW (kHz) (6 dB) | 652.5 |
| Calculated BW (kHz), as per TRC-43 | N/A |
| Type of modulation | GFSK |
| Emission classification (F1D, G1D, D1D) | W7D |
| Transmitter spurious, Units @ distance | 49.7 dBµV/m @ 3m AVG, 50.1 dBµV/m @ 3m Peak |
| Power requirements | 3V DC battery |
| Antenna information | 0 dBi gain antenna on PCB. Johanson Technology Ceramic Chip 2.45 GHz Antenna P/N 2450AT42A100.<br>The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. |

## 3.4 Product description and theory of operation

EUT is BLE Module for Medical Injection Device with BT Low Energy radio interface.

A production flex PCBA was used as basis for test. It was mounted to a bare FR4 sheet for mechanical support and had power leads attached at the battery connection pads.

## 3.5 EUT exercise details

A test version of firmware was implemented that allows the different RF modes/channels to be sequenced through. EUT is set to fixed channel test mode with external buttons to toggle through channels and modes.

All 3 orthogonal positions are searched for worst case.

## 3.6 EUT setup diagram

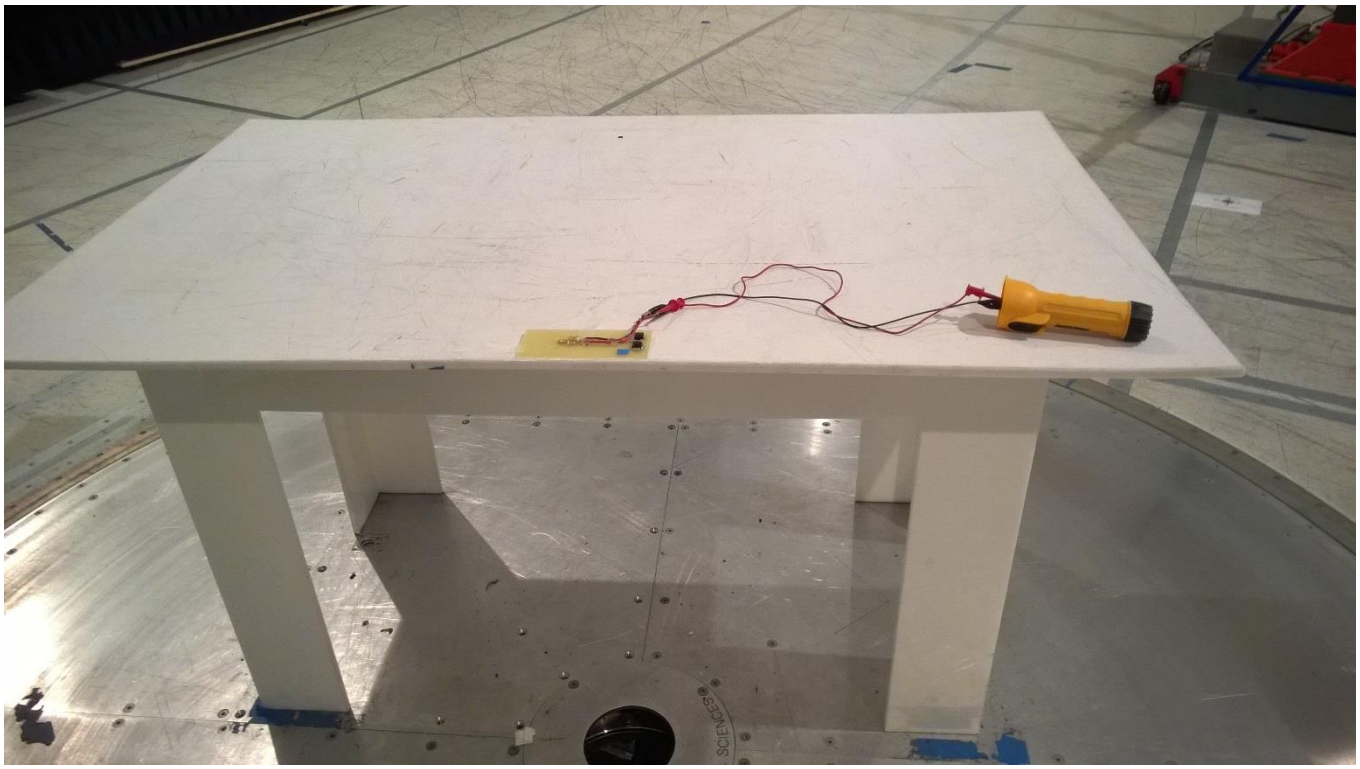


***Figure 3.6-1:*** *Radiated Emissions Test Setup – below 1GHz*

***Figure 3.6-2:*** *Radiated Emissions Test Setup – above 1GHz*

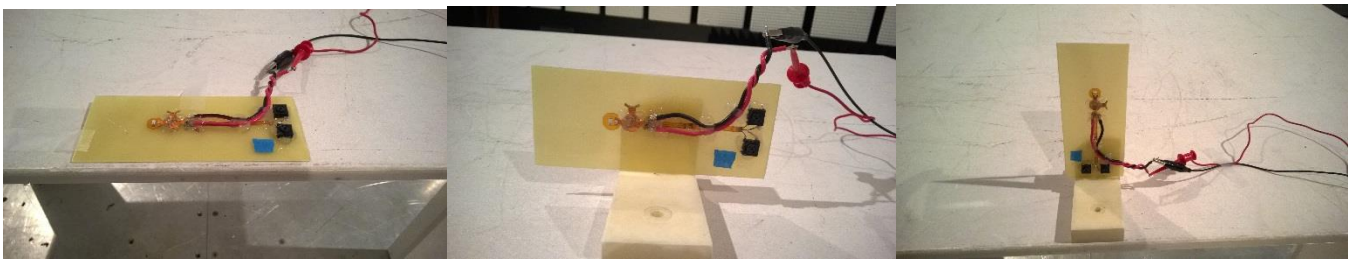


***Figure 3.6-3:*** *Radiated Emissions Test Setup – 3 Orthogonal Positions*

## 3.7 EUT sub assemblies

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

| Description | Brand name | Model/Part number | Serial number |
|---|---|---|---|
| Module with antenna | Companion Medical | InPen | N/A |
| Module with temporary RF connector | Companion Medical | InPen | N/A |

# **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

Due to the small size (and small energy rating) of button battery used in product, an external battery pack (2 Type C Battery) was used to simulate the 3V button battery during radiated emissions test. In RF conducted test, a power supply was used to provide the 3V DC supply.

1. Button battery will not last through normal test period, as test mode is set to constant transmission, but in real use this device has very low duty cycle;
2. The added battery pack and battery leads will not improve the EMC performance (may increase spurious emissions – represent worst case).

## 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.

3V DC battery.

# **Section 6.** Measurement uncertainty

## 6.1 Uncertainty of measurement

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

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

# **Section 7.** Test equipment

## 7.1 Test equipment list

***Table 7.1-1:*** *Equipment list*

| Asset Tag | Description | Manufacturer | Model | Serial # | Next Cal |
|---|---|---|---|---|---|
| 529 | Antenna, DRWG | EMCO | 3115 | 2505 | 08-Dec-2016 |
| 835 | Spectrum Analyzer | Rohde & Schwarz | FSEK30 | 829058/0005 | 04-Aug-2017 |
| E1017 | 9kHz to 7GHz Spectrum Analyzer | Rohde & Schwarz | FSP7 | 839337/0022 | 01-Jan-2016 |
| E1035 | Variac (Variable Transformer) 3KVA | Shanghai China | TDGC | N/A | Verify |
| 1480 | Antenna, Bilog | Schaffner-Chase | CBL6111C | 2572 | 18-May-2016 |
| 1767 | Receiver, EMI Test 20Hz - 26.5 GHz - 150 - +30 dBm LCD | Rohde & Schwartz | ESIB26 | 837491/0002 | 04-Dec-2015 |
| 4043 | True RMS Multimeter | Fluke | 115 | 22620350 | 20-Jan-2016 |

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

# Section 8. Test Data

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

### 8.1.1 Definitions and limits

**FCC 15.247:**

(a) (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.

**IC RSS-247**

5.2 (1) The minimum 6 dB bandwidth shall be 500 kHz.

### 8.1.2 Test summary

| | | | |
|---|---|---|---|
| Test date | November 30, 2015 | Temperature | 16 °C |
| Test engineer | Feng You | Air pressure | 1011 mbar |
| Verdict | Pass | Relative humidity | 30 % |

### 8.1.3 Observations, settings and special notes

Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth | 1–5 % of Channel BW (no wider than 100 kHz) |
| Video bandwidth | ≥3 × RBW |
| Frequency span | 1.5 MHz |
| Detector mode | Peak |
| Trace mode | Max Hold |

### 8.1.4 Test data

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

| Modulation | Frequency, MHz | 6dB bandwidth, kHz | Limit, kHz | Margin, kHz |
|---|---|---|---|---|
| GFSK | 2402 | 652.5 | 500 | 152.5 |
| | 2440 | 648.75 | 500 | 148.75 |
| | 2480 | 651.375 | 500 | 151.375 |

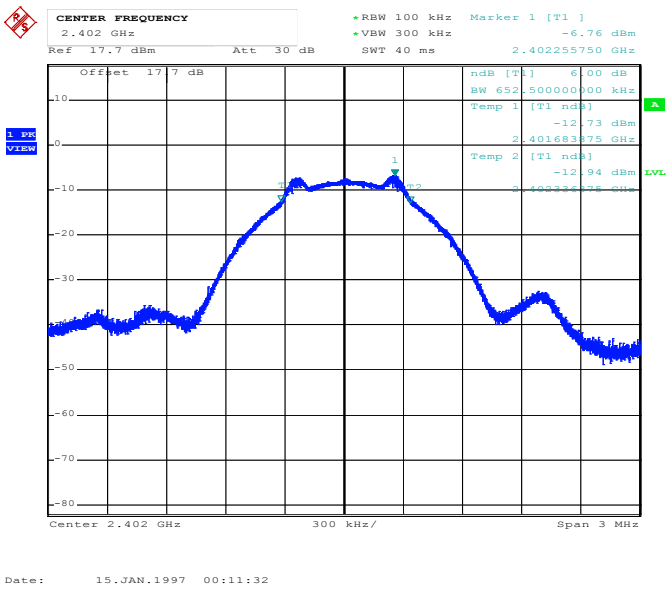



***Figure 8.1-1:*** *6 dB bandwidth, 2402MHz*

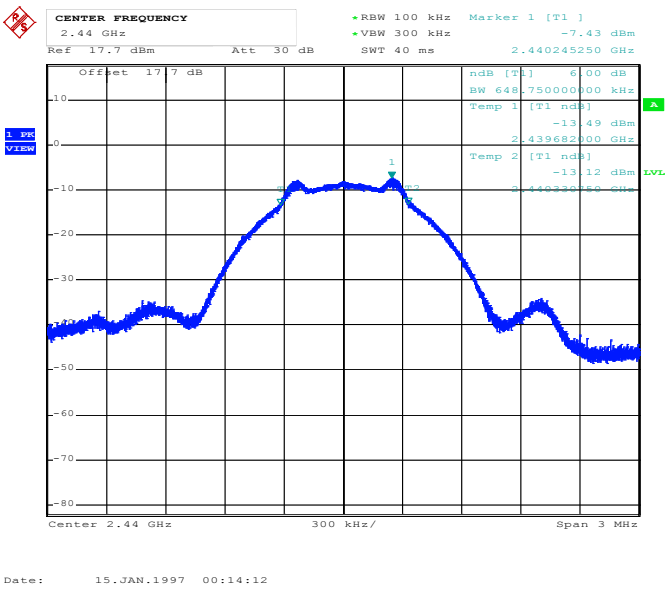



***Figure 8.1-2:*** *6 dB bandwidth, 2440MHz*

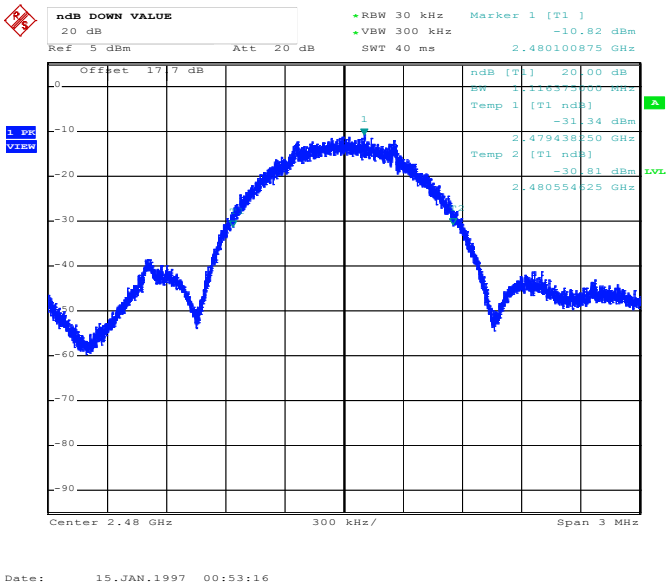



***Figure 8.1-3:*** *6 dB bandwidth, 2480MHz*

## 8.2 FCC 15.247(b) and RSS-247 5.4 (4) 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:

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. 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.

**IC:**

5.4 Transmitter Output Power and Equivalent Isotropically Radiated Power (E.I.R.P.) Requirements

(4) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W.

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.

### 8.2.2 Test summary

| | | | |
|---|---|---|---|
| Test date | November 30, 2015 | Temperature | 16 °C |
| Test engineer | Feng You | Air pressure | 1011 mbar |
| Verdict | Pass | Relative humidity | 30 % |

### 8.2.3 Observations, settings and special notes

Peak Conducted Power Measured
Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth | ≥ Channel BW (3MHz) |
| Video bandwidth | ≥ 3 × RBW (10MHz) |
| Frequency span | ≥ 3 x RBW (10MHz) |
| Detector mode | Peak |
| Trace mode | Max Hold |

### 8.2.4 Test data

***Table 8.2-1:*** *Output power measurements results*

| Power Source | Frequency, MHz | Conducted output power, dBm | | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|---|---|---|---|---|---|---|---|---|
| | | Measured | Limit | | | | | |
| Battery | 2402 | -4.3 | 30 | 34.3 | 0 | -4.3 | 36 | 40.3 |
| | 2440 | -4.96 | 30 | 34.96 | 0 | -4.96 | 36 | 40.96 |
| | 2480 | -5.52 | 30 | 35.52 | 0 | -5.52 | 36 | 41.52 |

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

## 8.3.1 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)).

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

(a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 8.4-1 except for apparatus complying under RSS-287;
(b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and
(c) Unwanted emissions that do not fall within the restricted frequency bands of Table 8.4-1 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

***Table 8.3-1:*** *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 8.3-2:*** *IC restricted frequency bands*

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

Note: Certain frequency bands listed in Table 8.3-2 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 8.3-3:*** *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 | | | |

## 8.3.2 Test summary

| | | | |
|---|---|---|---|
| Test date | November 25, 2015 | Temperature | 21 °C |
| Test engineer | Feng You | Air pressure | 1008 mbar |
| Verdict | Pass | Relative humidity | 34 % |

## 8.3.3 Observations, settings and special notes

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

Spectrum analyser settings for conducted spurious emissions measurements:

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

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

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

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

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

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

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

## 8.3.4 Test data

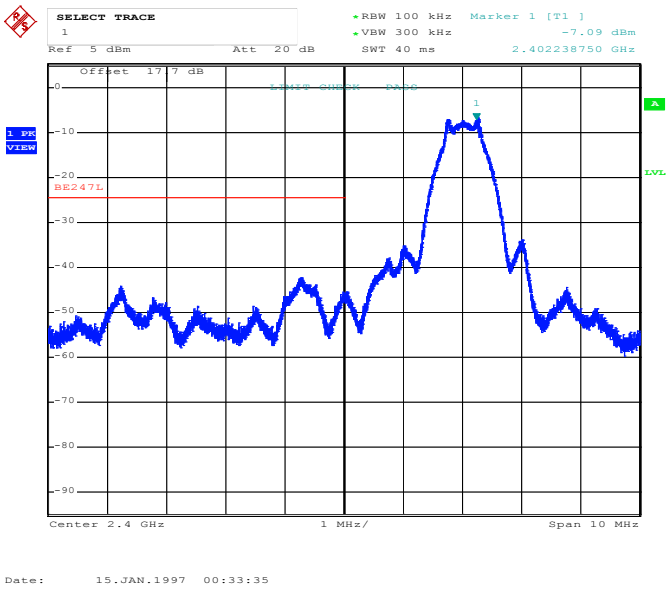



***Figure 8.3-1:*** *Bandedge Measurement, low channel*

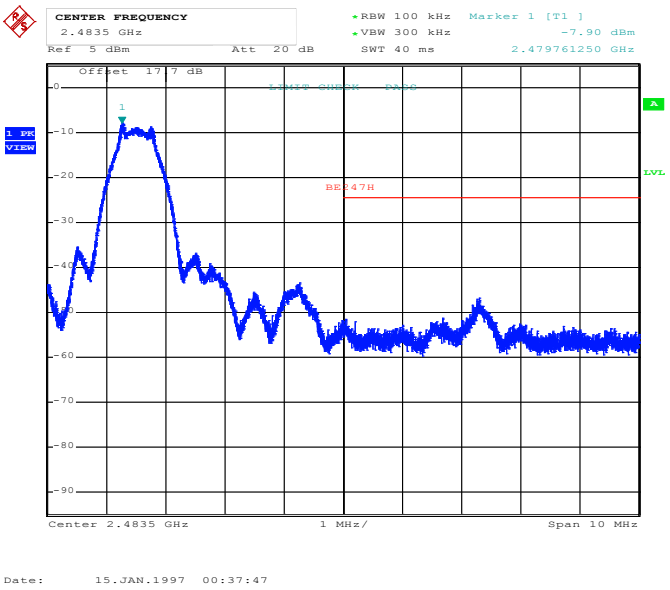



***Figure 8.3-2:*** *Bandedge Measurement, high channel*

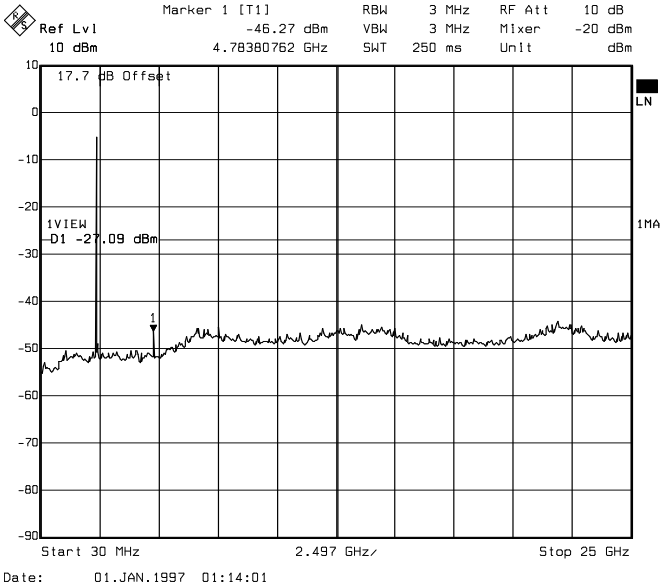



***Figure 8.3-3:*** *Conducted spurious emissions, low channel*

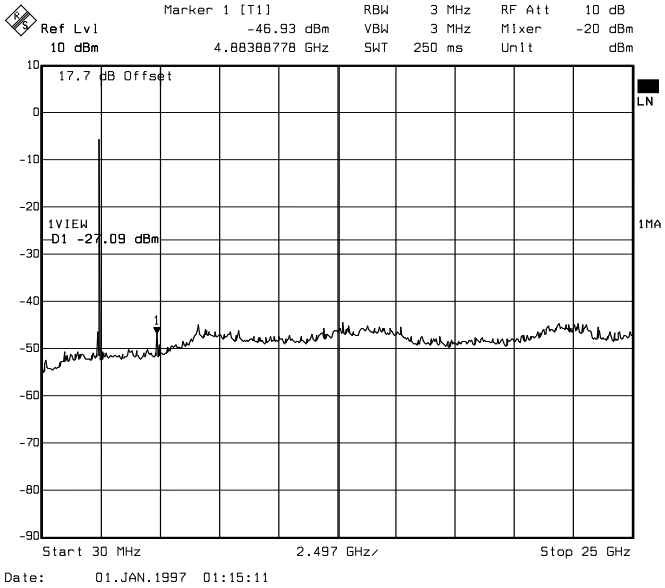



***Figure 8.3-4:*** *Conducted spurious emissions, high channel*

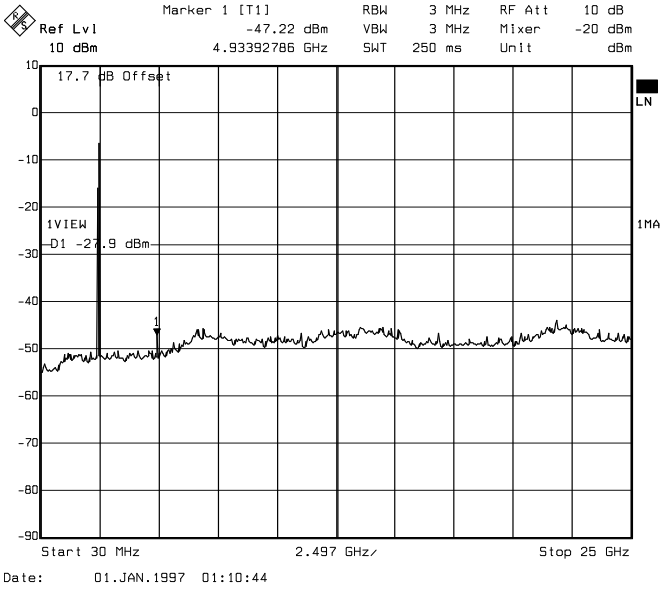



***Figure 8.3-5:*** *Conducted spurious emissions, mid channel*

Peaks within 2400-2483.5MHz are transmitter fundamentals.

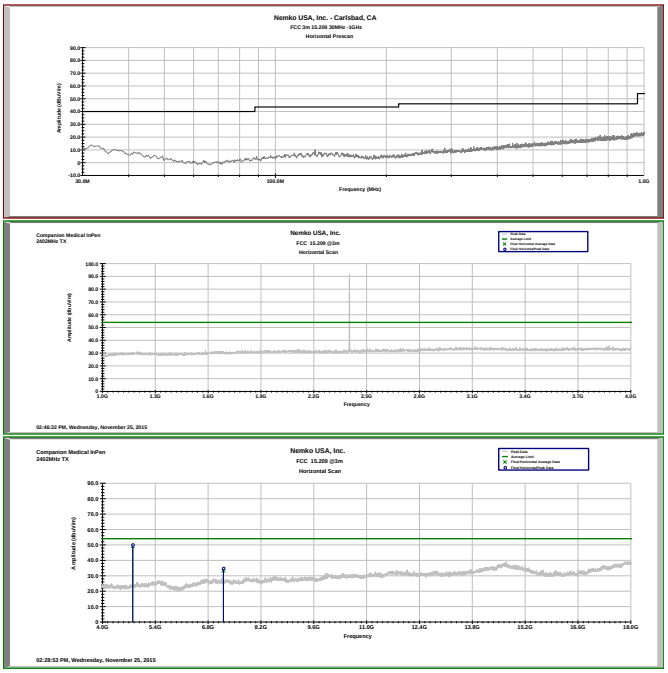



***Figure 8.3-6:*** *Radiated spurious emissions, low channel, Horizontal*

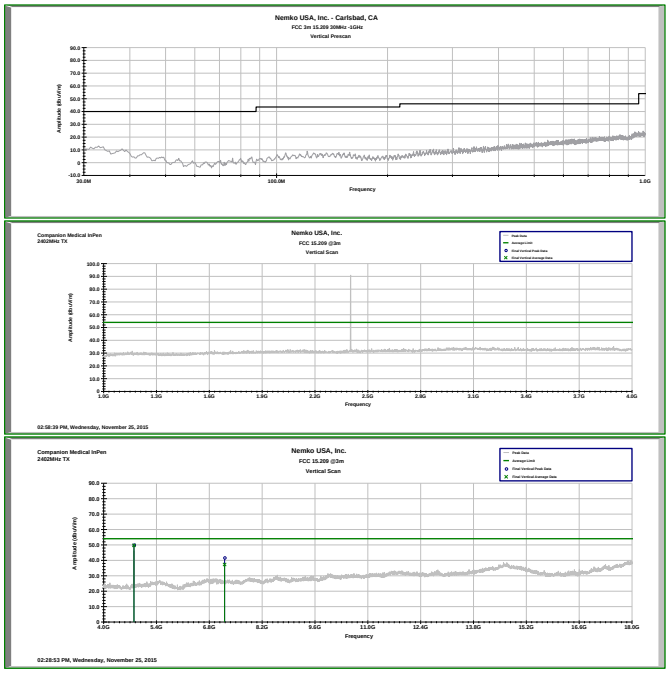



***Figure 8.3-7:*** *Radiated spurious emissions, low channel, Vertical*

***Table 8.3-4:*** *Radiated field strength measurement results for low channel 2402MHz*

| Frequency | AVG Field strength | Peak Field strength | AVG Limit | Peak Limit | AVG Margin | Peak Margin | Polarity |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dBµV/m | dBµV/m | dB | dB | H/V |
| 4803.82 | 49.1 | 50.1 | 54 | 74 | 4.9 | 23.9 | H |
| 7205.79 | 33.2 | 34.9 | 54 | 74 | 20.8 | 39.1 | H |
| 4803.95 | 49.7 | 50 | 54 | 74 | 4.3 | 24 | V |
| 7205.89 | 37.3 | 41.7 | 54 | 74 | 16.7 | 32.3 | V |

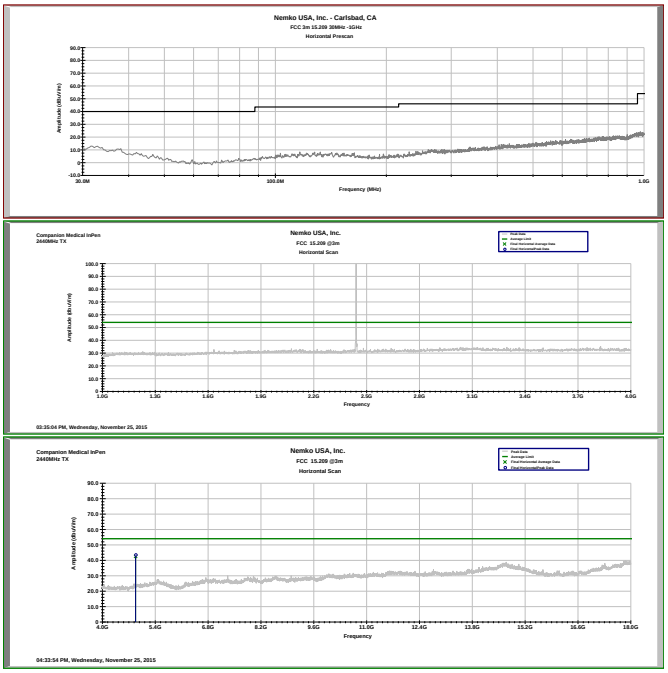



***Figure 8.3-8:*** *Radiated spurious emissions, mid channel, Horizontal*

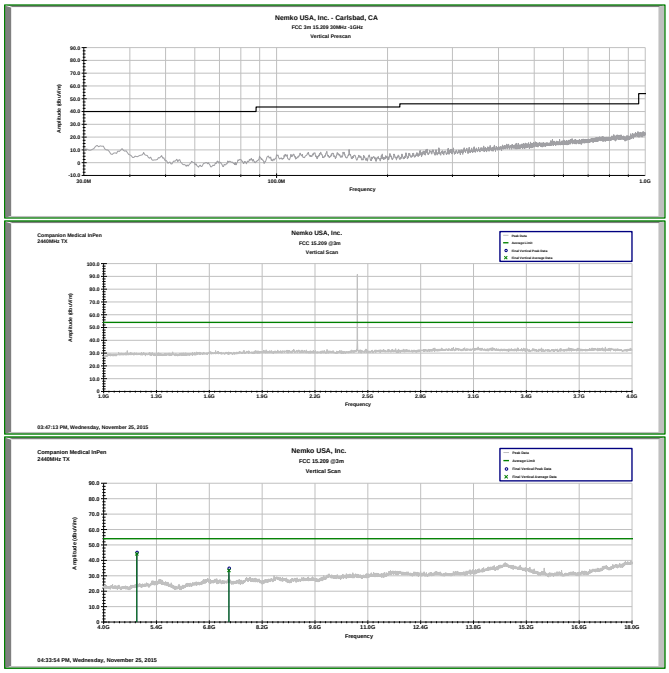



***Figure 8.3-8:*** *Radiated spurious emissions, mid channel, Vertical*

***Table 8.3-5:*** *Radiated field strength measurement results for mid channel 2440MHz*

| Frequency | AVG Field strength | Peak Field strength | AVG Limit | Peak Limit | AVG Margin | Peak Margin | Polarity |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dBµV/m | dBµV/m | dB | dB | H/V |
| 4879.91 | 42.6 | 43.7 | 54 | 74 | 11.4 | 30.3 | H |
| 4880.02 | 44.2 | 45.3 | 54 | 74 | 9.8 | 28.7 | V |
| 7319.74 | 33.4 | 35 | 54 | 74 | 20.6 | 39 | V |

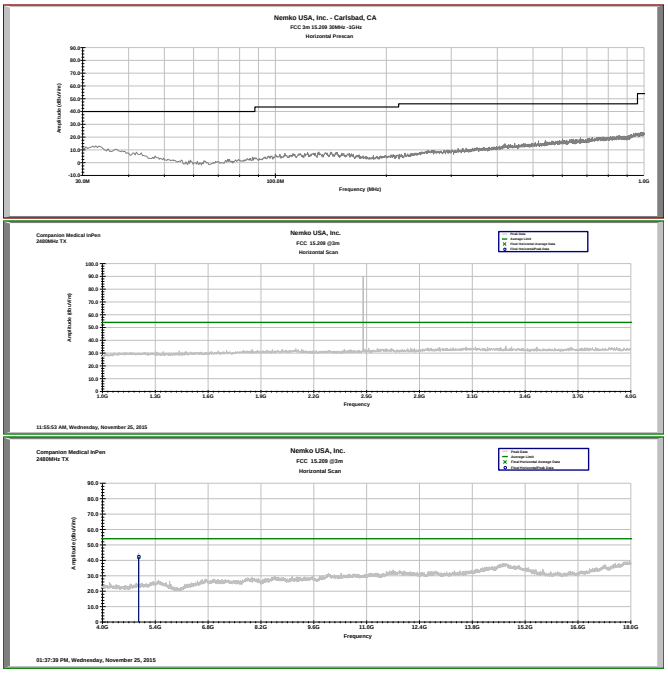



***Figure 8.3-10:*** *Radiated spurious emissions, high channel, Horizontal*

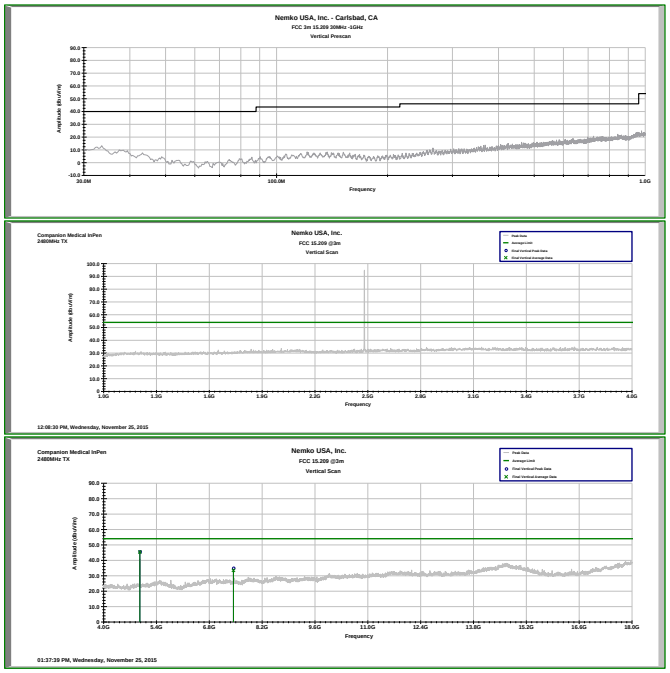



***Figure 8.3-11:*** *Radiated spurious emissions, high channel, Vertical*

***Table 8.3-5:*** *Radiated field strength measurement results for high channel 2480MHz*

| Frequency | AVG Field strength | Peak Field strength | AVG Limit | Peak Limit | AVG Margin | Peak Margin | Polarity |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dBµV/m | dBµV/m | dB | dB | H/V |
| 4960.01 | 42.1 | 42.5 | 54 | 74 | 11.9 | 31.5 | H |
| 4959.99 | 45.4 | 45.7 | 54 | 74 | 8.6 | 28.3 | V |
| 7439.47 | 33.5 | 35 | 54 | 74 | 20.5 | 39 | V |

## 8.4 FCC 15.247(e) and RSS-247 5.2(2) Power Spectrum Density

### 8.4.1 Definitions and limits

**FCC and IC:**
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.

### 8.4.2 Test summary

| | | | |
|---|---|---|---|
| Test date | November 25, 2015 | Temperature | 21 °C |
| Test engineer | Feng You | Air pressure | 1008 mbar |
| Verdict | Pass | Relative humidity | 34 % |

### 8.4.3 Observations, settings and special notes

3kHz RBW

### 8.4.4 Test data

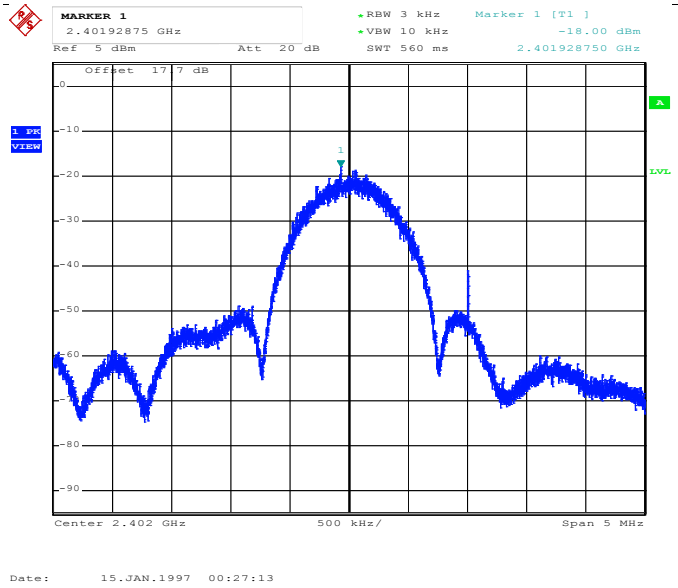



***Diagram 8.4-1:*** *Power Spectrum Density,, 2402MHz*

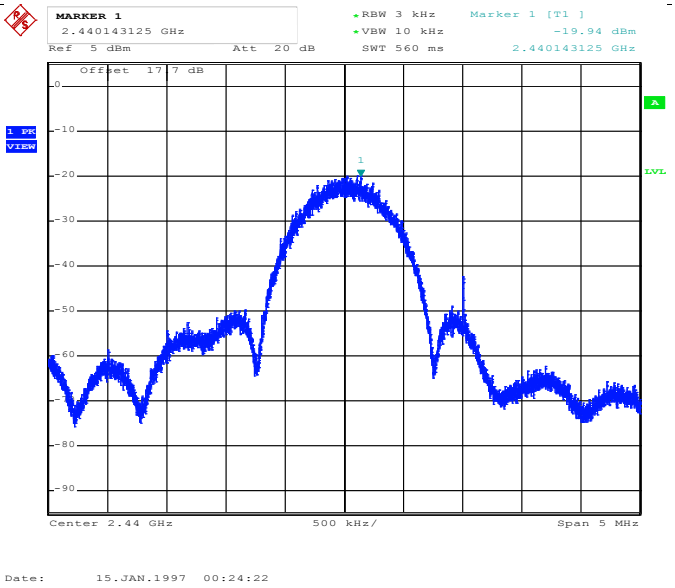



***Diagram 8.4-2:*** *Power Spectrum Density,, 2440MHz*

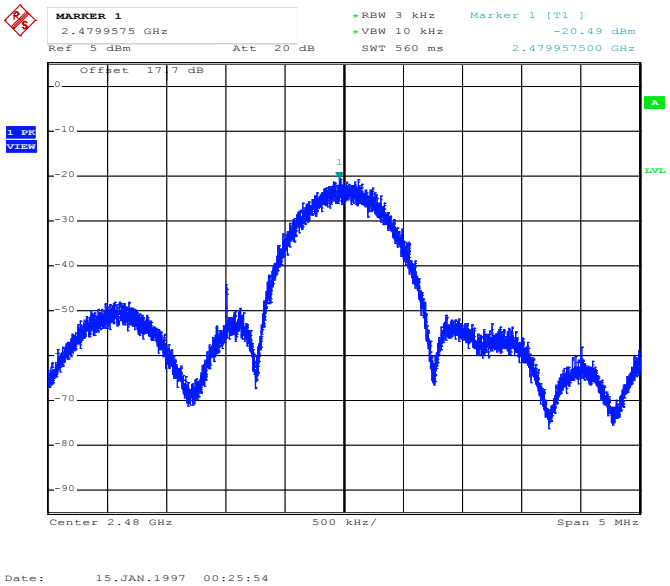


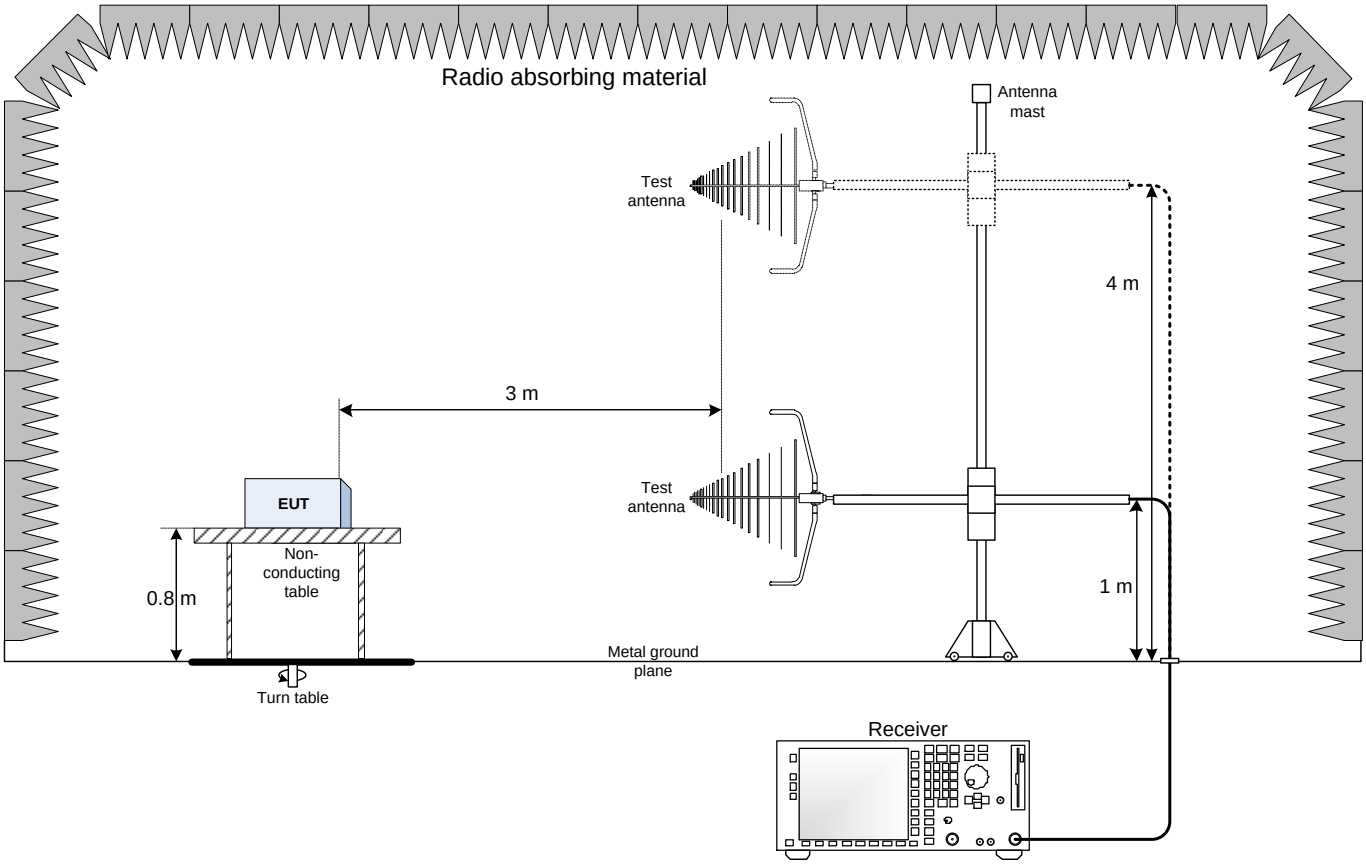

***Diagram 8.4-3:*** *Power Spectrum Density,, 2480MHz*

***Table 8.4-1:*** *Power Spectrum Density*

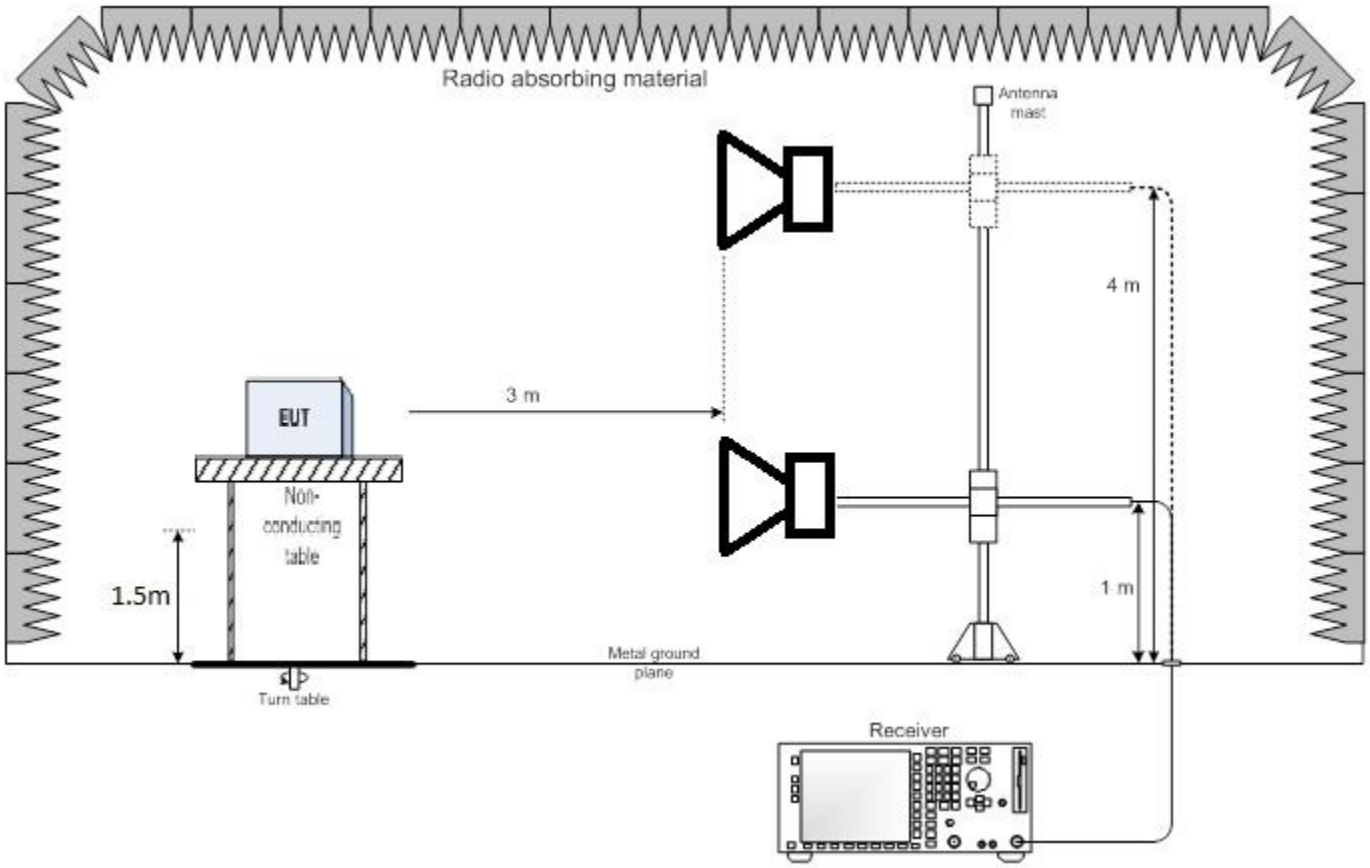
| Power Source | Frequency, MHz | Conducted PSD@3kHz, dBm | | Margin, dB | Antenna gain, dBi | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB |
|---|---|---|---|---|---|---|---|---|
| | | Measured | Limit | | | | | |
| Battery | 2402 | -18 | 8 | 26 | 0 | -18 | 14 | 32 |
| | 2440 | -19.94 | 8 | 27.94 | 0 | -19.94 | 14 | 33.94 |
| | 2480 | -20.49 | 8 | 28.49 | 0 | -20.49 | 14 | 34.49 |

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

## 9.1 Radiated emissions set-up – Below 1GHz



## 9.2 Radiated emissions set-up – Above 1GHz




## 9.3 Conducted emissions set-up