



# Compliance Testing, LLC

Previously Flom Test Lab

EMI, EMC, RF Testing Experts Since 1963

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## Test Report

Prepared for: Thornwave Labs

Model: BT-DCPM

Description: Bluetooth Smart DC Power Meter

Serial Number: N/A

FCC ID: 2AM22-BTDCPM

IC: 23015-BTDCPM

To

FCC Part 15.247 DTS

And

IC RSS 247

Date of Issue: August 22, 2017

On the behalf of the applicant:

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Project No: p1770019

Poona Saber  
Project Test Engineer

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All results contained herein relate only to the sample tested.



## Test Report Revision History

| Revision | Date            | Revised By  | Reason for Revision   |
|----------|-----------------|-------------|---|
| 1.0      | July 26, 2017   | Poona Saber | Original Document   |
| 2.0      | August 22, 2017 | Poona Saber | Added note on page 9 and changed test procedure for radiated measurement on page 15 |
|          |                 |             |   |
|          |                 |             |   |



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**ILAC / A2LA**

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.

Testing Certificate Number: **2152.01**



**FCC Site Reg. #349717**

**IC Site Reg. #2044A-2**

**Non-accredited tests contained in this report:**

**N/A**

**The applicant has been cautioned as to the following**

**15.21 - Information to User**

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**15.27(a) - Special Accessories**

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.



## Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

| Environmental Conditions |                 |                    |
|--------------------------|-----------------|--------------------|
| Temperature<br>(°C)      | Humidity<br>(%) | Pressure<br>(mbar) |
| 23.3                     | 28.9            | 967                |

### EUT Description

**Model:** BT-DCPM

**Description:** Bluetooth Smart DC Power Meter

**Firmware:** N/A

**Software:** N/A

**Serial Number:** N/A

**Additional Information:** Device is incorporating a Nordic Bluetooth version 4.0 chip with frequency range of 2402-2480

### EUT Operation during Tests

EUT is controlled from computer through a FTDI USB cable which provides 5V power to the unit and The BLE features of the nordic module are controlled through hex commands from Realterm serial communication terminal. Device is put on both modulated and unmodulated signals for Low, mid and high channels.



**Cables:**

| Qty | Description         | Length<br>(M) | Shielding<br>Y/N | Shielded Hood<br>Y/N | Ferrite<br>Y/N |
|-----|---------------------|---------------|------------------|----------------------|----------------|
| 1   | USB to Serial Cable | <1            | N                | N                    | N              |

**Accessories:** None

**Modifications:** None

**15.203: Antenna Requirement:**

- ☒ The antenna is permanently attached to the EUT
- ☐ The antenna uses a unique coupling
- ☐ The EUT must be professionally installed
- ☐ The antenna requirement does not apply



## Test Results Summary

| Specification                | Test Name                          | Pass, Fail, N/A | Comments                             |
|------------------------------|------------------------------------|-----------------|--------------------------------------|
| 15.247(b)                    | Peak Output Power                  | Pass            |                                      |
| 15.247(b)                    | Conducted Spurious Emissions       | N/A             | EUT doesn't have conducted connector |
| 15.247(d), 15.209(a), 15.205 | Radiated Spurious Emissions        | Pass            |                                      |
| 15.247(d), 15.209(a), 15.205 | Emissions At Band Edges            | Pass            |                                      |
| 15.247(a)(2)                 | Occupied Bandwidth                 | Pass            |                                      |
| 15.247(e)                    | Transmitter Power Spectral Density | Pass            |                                      |
| 15.207                       | A/C Powerline Conducted Emissions  | N/A             | EUT is battery powered               |
| RSS-Gen §7                   | Receiver Spurious Emission Limits  | Pass            |                                      |





## Peak Output Power

**Engineer:** Poona Saber

**Test Date:** 7/26/17

### Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. A spectrum analyzer was used to verify that the EUT met the requirements for Output Power. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

The Spectrum Analyzer was set to the following:

RBW =  $\geq$  DTS bandwidth

VBW  $\geq 3 \times$  RBW

Peak Detector

Trace mode = max hold

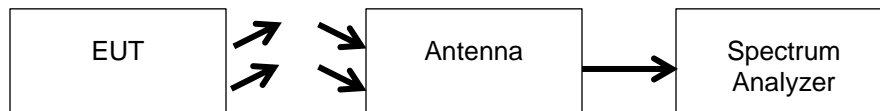
Sweep = auto

Span  $\geq 3 \times$  RBW

The EUT was set to continuous transmit on the lowest, middle and highest frequencies at the maximum power level. The RF output power was measured using the spectrum analyzer's channel power function. The measured field strength from EUT in dBuV/m at 3 meters distance was then converted to dBm with below formula to be compared with the power dBm limit.

$$\text{EIRP(dBm)} = \text{E(dBuV/m)} + 20\log(D) - 104.77$$

### Test Setup



### Transmitter Peak Output Power

| Tuned Frequency (MHz) | Measured Value (dBm) | Specification Limit | Result |
|-----------------------|----------------------|---------------------|--------|
| 2402                  | 2.86                 | 1 W (30 dBm)        | Pass   |
| 2440                  | 2.17                 | 1 W (30 dBm)        | Pass   |
| 2480                  | 1.37                 | 1 W (30 dBm)        | Pass   |



## Radiated Spurious Emissions

**Engineer:** Poona Saber

**Test Date:** 7/25/2017

### Test Procedure Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

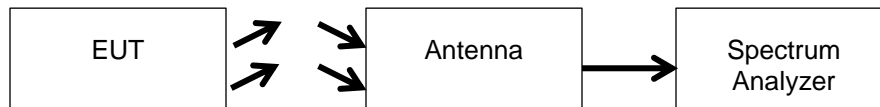
Correction factors were input into the spectrum analyzer before recording “Measured Level”.

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

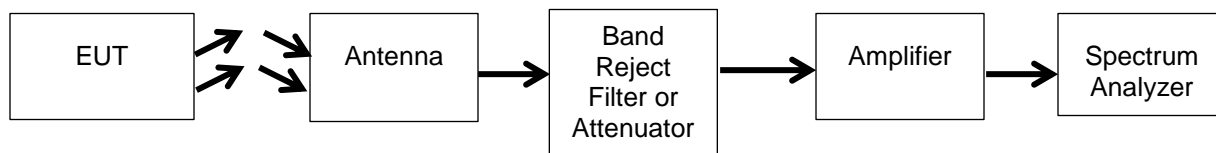
#### Test Setup



### Test Procedure for Radiated Spurious Emissions above 1 GHz

The EUT was tested in a semi anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. The antenna, band reject filter, amplifier and cable correction factors were input into the spectrum analyzer before recording the Measured Level to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic.

#### Test Setup



No other emissions were detectable. All emissions were more than -20 dBc.

**See Annex A for test data**



## Emissions at Band Edges

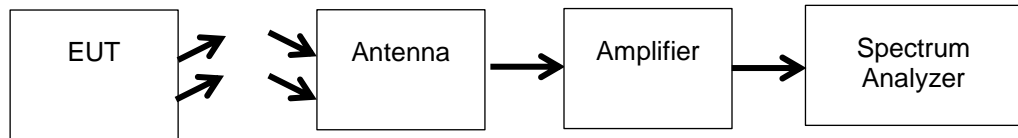
**Engineer:** Poona Saber

**Test Date:** 7/25/2017

### Test Procedure

The EUT was tested in a semi-anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for band edge and restricted band for both peak and average measurements. The cable and antenna correction factors were input into the analyzer as a reference level offset to ensure accurate readings. For the restricted band the amplifier and band reject filter correction factors were also input to the spectrum analyzer.

### Band Edge Test Setup



**See Annex B for test data**



## Occupied Bandwidth

Engineer: Poona Saber

Test Date: 7/26/2017

### Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. A spectrum analyzer was used to verify that the EUT met the requirements for DTS Bandwidth. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

The Spectrum Analyzer was set to the following:

RBW = 100 kHz

VBW  $\geq 3 \times$  RBW

Peak Detector

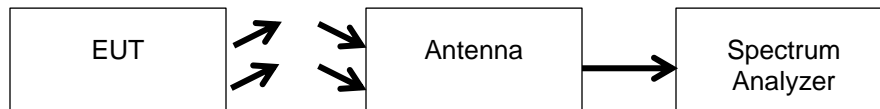
Trace mode = max hold

Sweep = auto couple

Span = 1.5 x EBW

The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. The maximum width of the emission that was determined by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that were attenuated by 6db and this value was used to determine the width of the carrier. Alternatively, the spectrum analyzer's automatic bandwidth capability was used.

### Test Setup



### 6 dB Occupied Bandwidth Summary

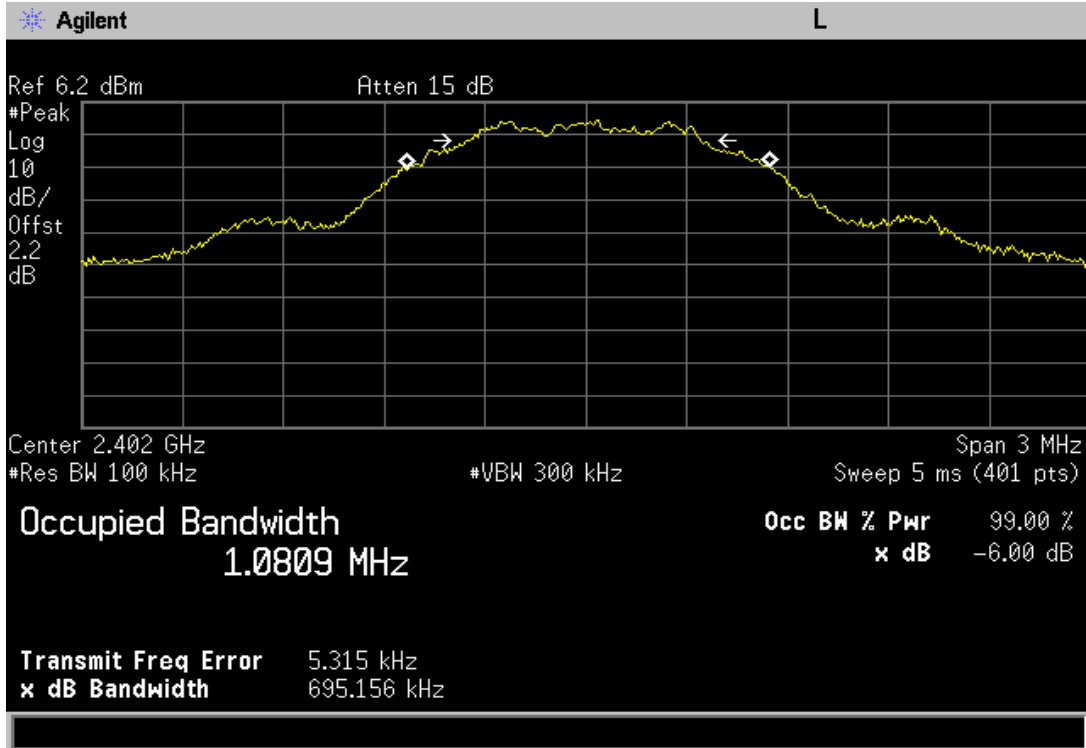
| Frequency (MHz) | Measured Bandwidth (MHz) | Specification Limit (kHz) | Result |
|-----------------|--------------------------|---------------------------|--------|
| 2402            | 695.15                   | $\geq 500$                | Pass   |
| 2440            | 676.79                   | $\geq 500$                | Pass   |
| 2480            | 704.38                   | $\geq 500$                | Pass   |

### 99% Bandwidth Summary

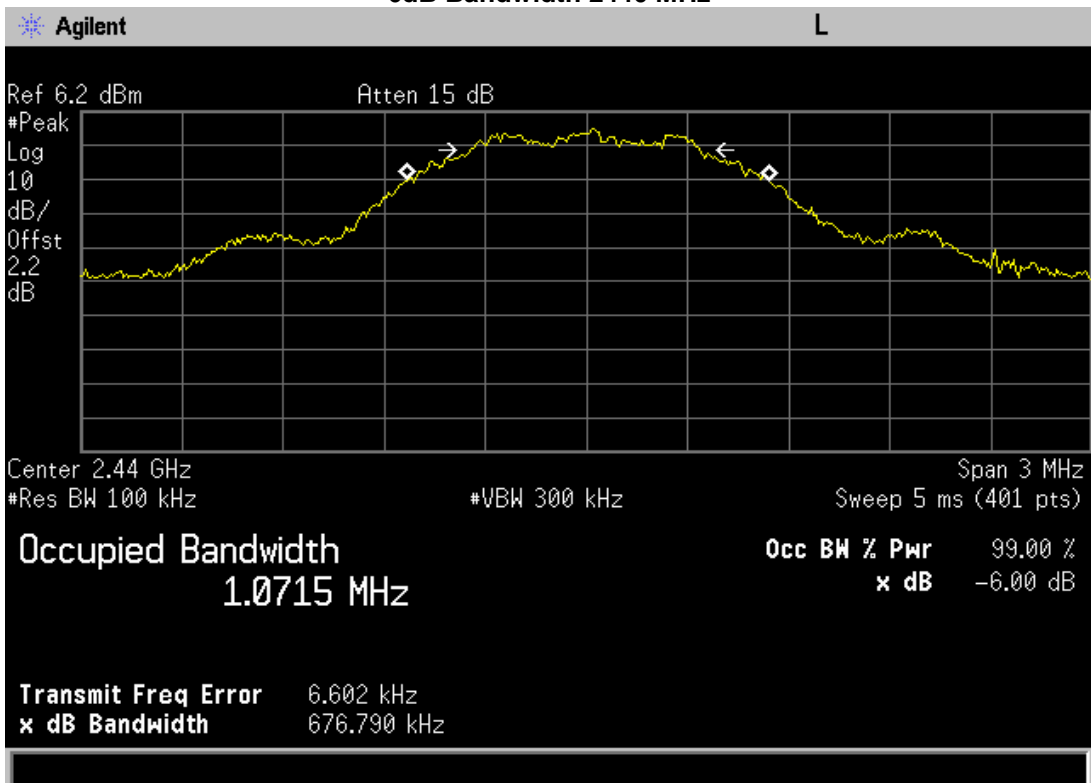
| Frequency (MHz) | Measured Bandwidth (MHz) | Result |
|-----------------|--------------------------|--------|
| 2402            | 1.0809                   | Pass   |
| 2440            | 1.0715                   | Pass   |
| 2480            | 1.0813                   | Pass   |



### 6dB Bandwidth 2402 MHz

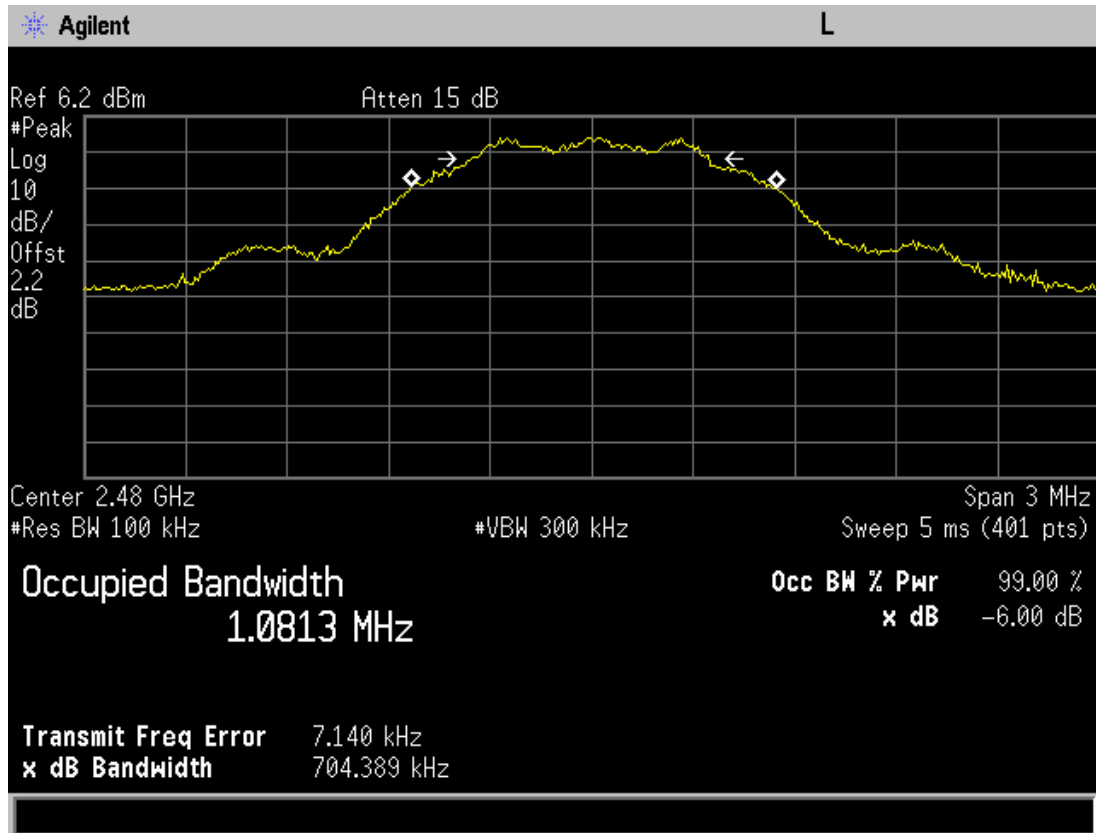


### 6dB Bandwidth 2440 MHz





6dB Bandwidth 2480 MHz





## Transmitter Power Spectral Density (PSD)

**Engineer:** Poona Saber

**Test Date:** 7/26/2017

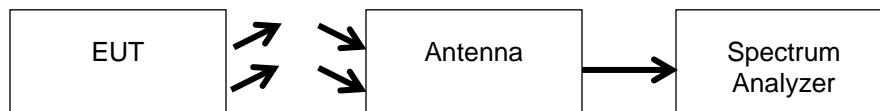
### Test Procedure

The EUT was placed on a turn table in a semi anechoic chamber and the PSD was measured Radiated by maximizing the emission from EUT. The correction factor for antenna, cables and any pre-amplifier used for measurement was put directly to a spectrum analyzer used for measurement out of the chamber. The test was performed per section 11.10 of C63.10:2013 "Procedure for determining PSD for DTS devices".

The measured field strength from EUT in dBuV/m at 3 meters distance was then converted to dBm with below formula to be compared with the PSD dBm limit.

$$\text{EIRP(dBm)} = \text{E(dBuV/m)} + 20\log(D) - 104.77$$

### Test Setup

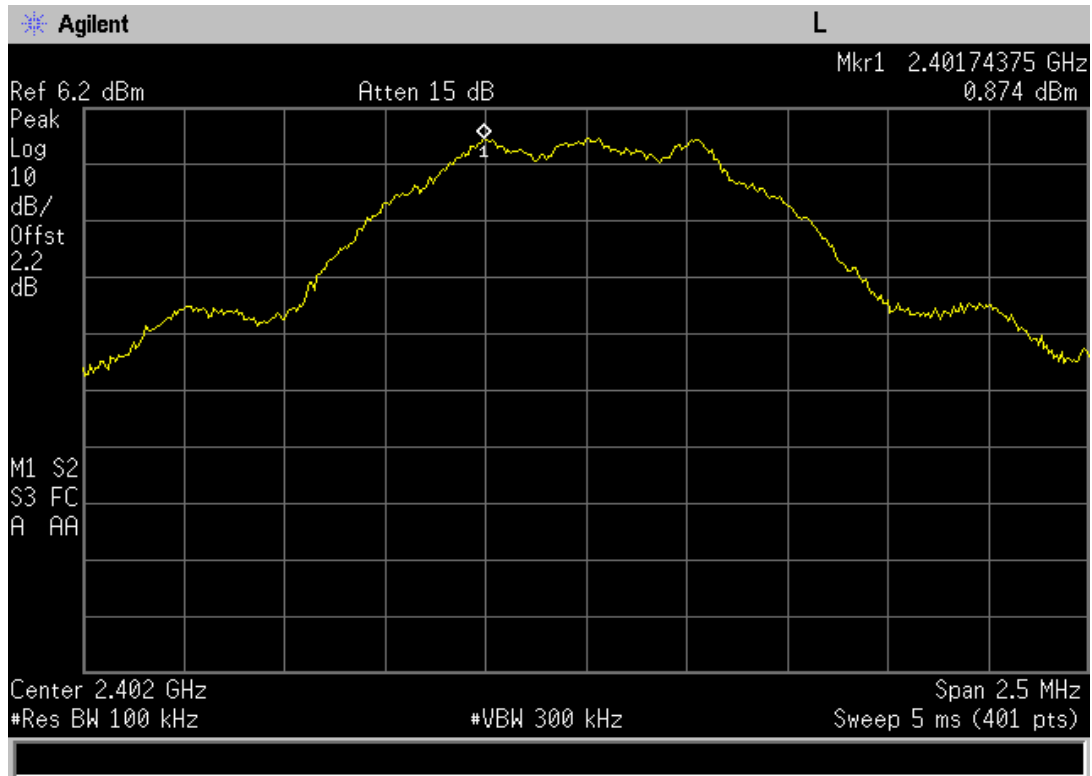


### PSD Summary

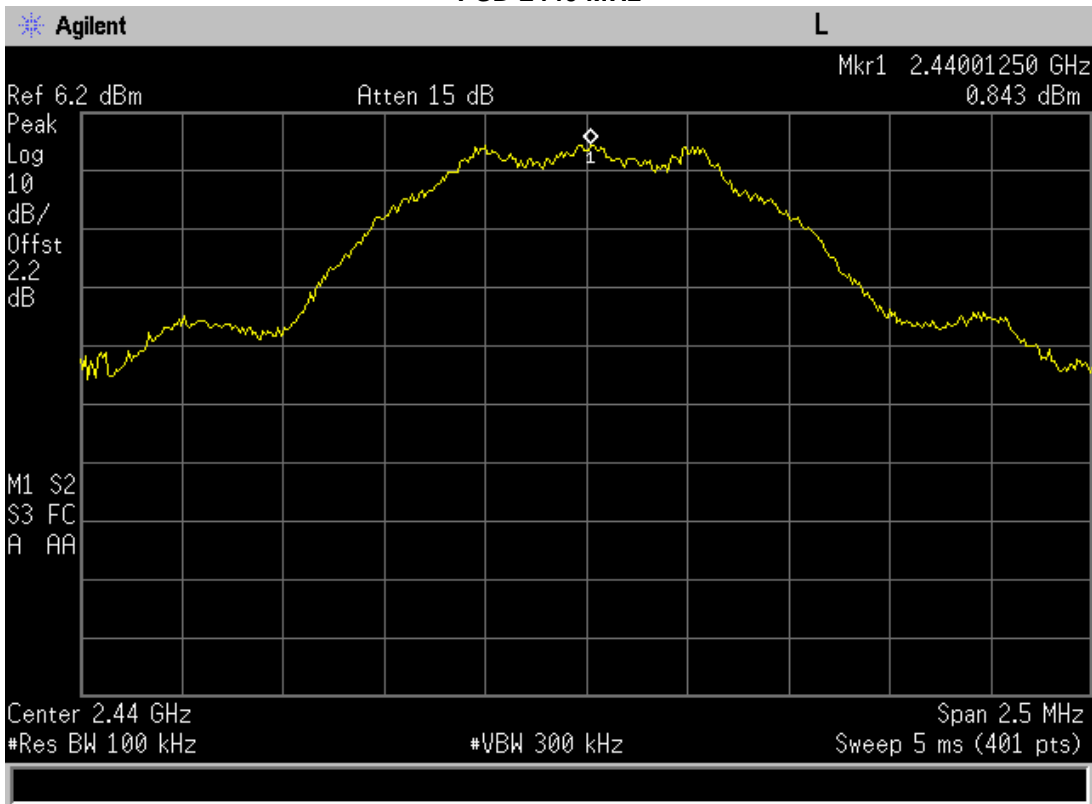
| Frequency (MHz) | Measured Data (dBm) | Specification Limit (dBm) | Result |
|-----------------|---------------------|---------------------------|--------|
| 2402            | 0.847               | 8                         | Pass   |
| 2440            | 0.843               | 8                         | Pass   |
| 2480            | 0.564               | 8                         | Pass   |



### PSD 2402 MHz



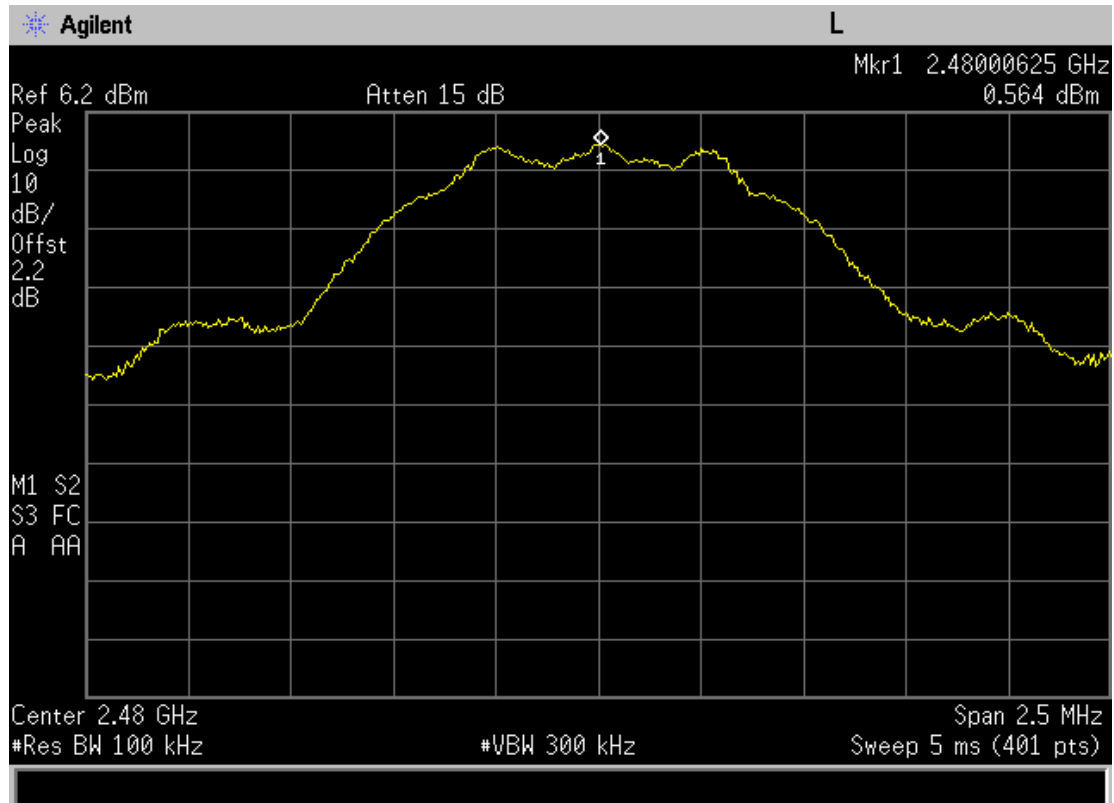
### PSD 2440 MHz







# PSD 2480 MHz





## Test Equipment Utilized

| Description                   | Manufacturer | Model #                       | CT Asset # | Last Cal Date | Cal Due Date |
|-------------------------------|--------------|-------------------------------|------------|---------------|--------------|
| Horn Antenna                  | ARA          | DRG-118/A                     | i00271     | 6/16/16       | 6/16/18      |
| Horn Antenna, Amplified       | ARA          | MWH-1826/B                    | i00273     | 4/22/15       | 4/22/18      |
| Humidity / Temp Meter         | Newport      | IBTHX-W-5                     | i00282     | 6/9/17        | 6/9/18       |
| Spectrum Analyzer             | Agilent      | E4407B                        | i00331     | 10/19/16      | 10/19/17     |
| Bi-Log Antenna                | Schaffner    | CBL 6111D                     | i00349     | 8/3/16        | 8/3/18       |
| EMI Analyzer                  | Agilent      | E7405A                        | i00379     | 2/22/17       | 2/22/18      |
| 3 Meter Semi-Anechoic Chamber | Panashield   | 3 Meter Semi-Anechoic Chamber | i00428     | 8/15/16       | 8/15/19      |
| PSA Spectrum Analyzer         | Agilent      | E4445A                        | i00471     | 8/30/16       | 8/30/17      |
| Preamplifier                  | Miteq        | AFS44 00101 400 23-10P-44     | i00509     | N/A           | N/A          |

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT