



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:

Thornwave Labs
4831 Shallowbrook Trail
Raleigh, NC 27616

Attention of:

Razvan Turiac
Ph: (408)887-8423
E-mail: razvan.turiac@thornwave.com

Prepared By
Compliance Testing, LLC
1724 S. Nevada Way
Mesa, AZ 85204
(480) 926-3100 phone / (480) 926-3598 fax
www.compliancetesting.com
Project No: p1770019



Poona Saber
Project Test Engineer

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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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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 (°C)	Humidity (%)	Pressure (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 (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite 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 x RBW

Peak Detector

Trace mode = max hold

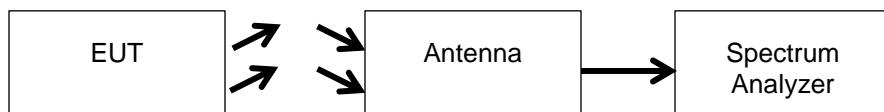
Sweep = auto

Span \geq 3 x 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.

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

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.

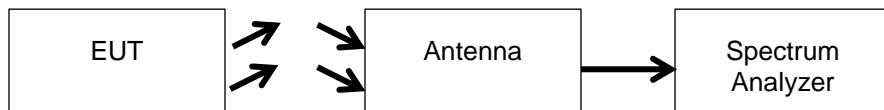
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

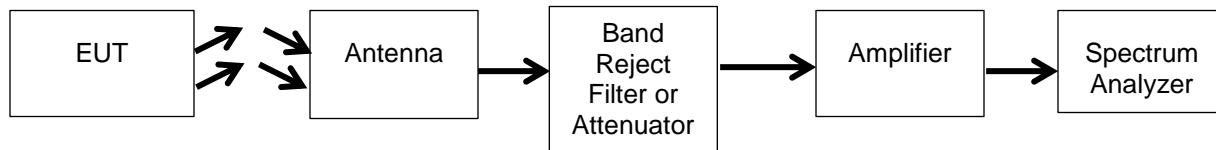
Test Setup



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

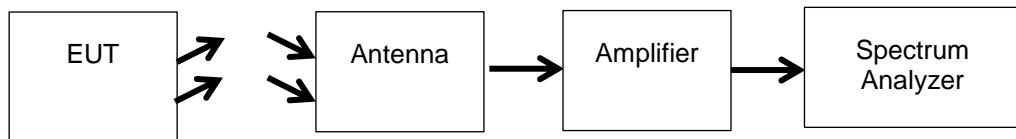
Engineer: Poona Saber

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 x RBW

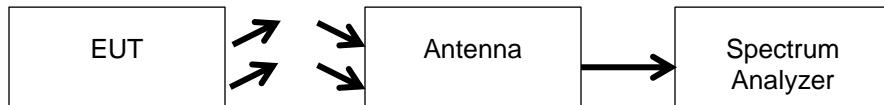
Peak Detector

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**

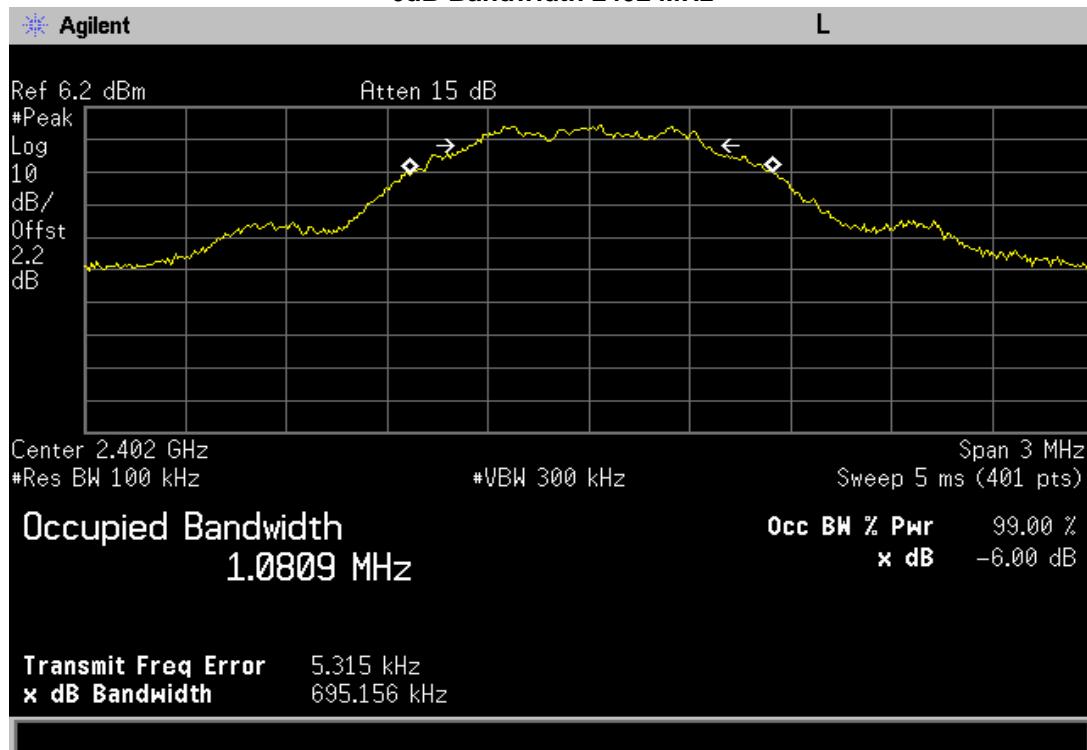
Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2402	695.15	\geq 500	Pass
2440	676.79	\geq 500	Pass
2480	704.38	\geq 500	Pass

99% Bandwidth Summary

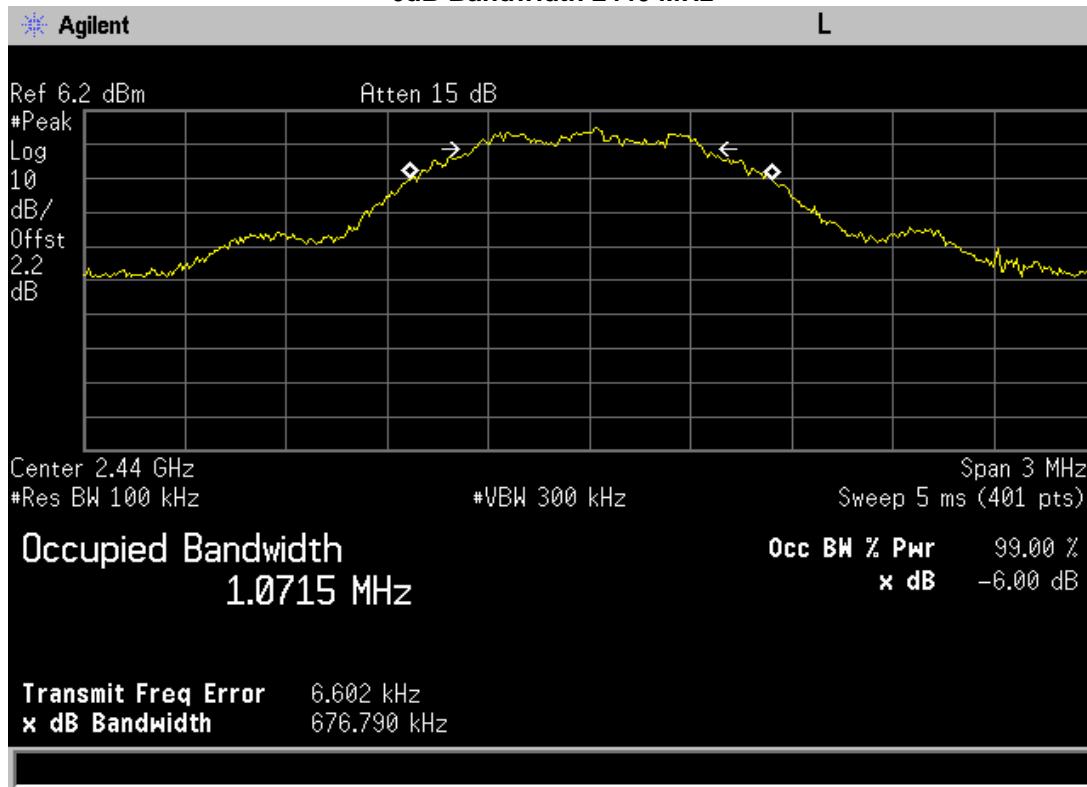
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2402	1.0809	Pass
2440	1.0715	Pass
2480	1.0813	Pass

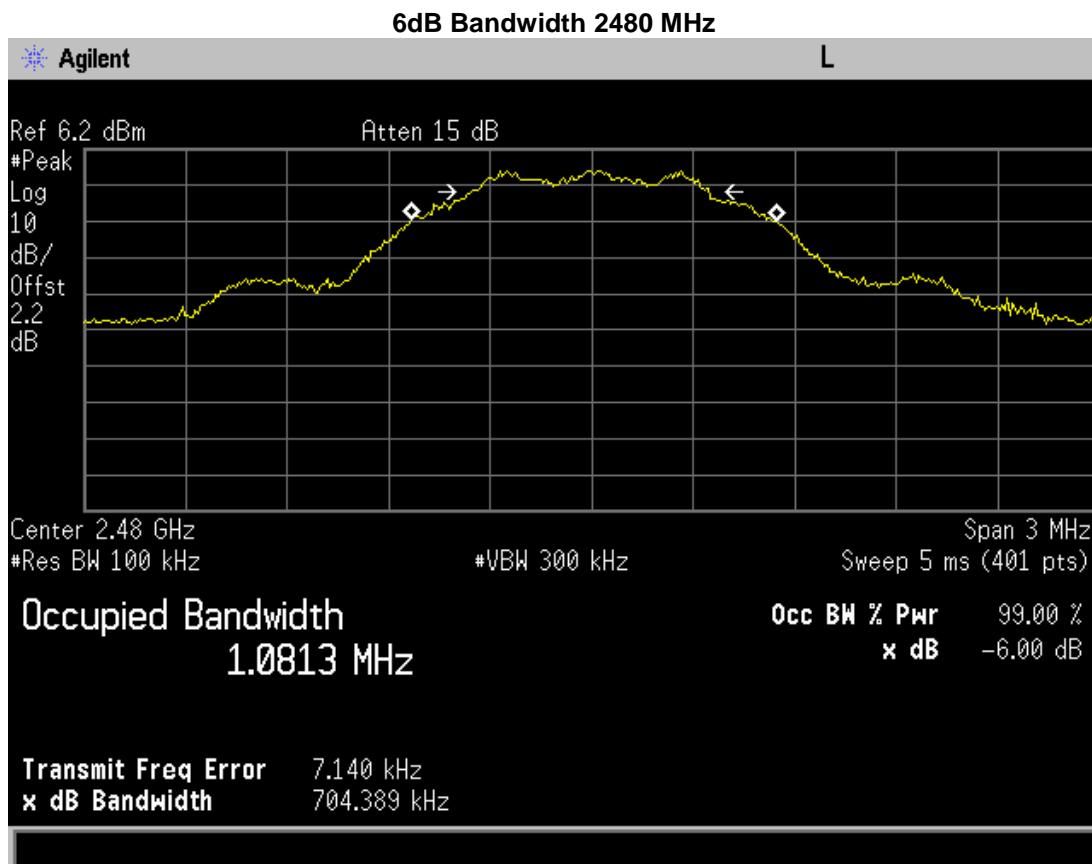


6dB Bandwidth 2402 MHz



6dB Bandwidth 2440 MHz







Transmitter Power Spectral Density (PSD)

Engineer: Poona Saber

Test Date: 7/26/2017

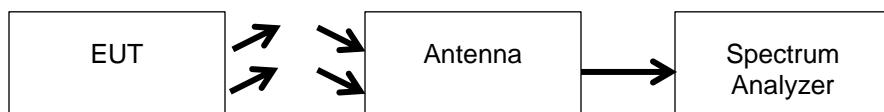
Test Procedure

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

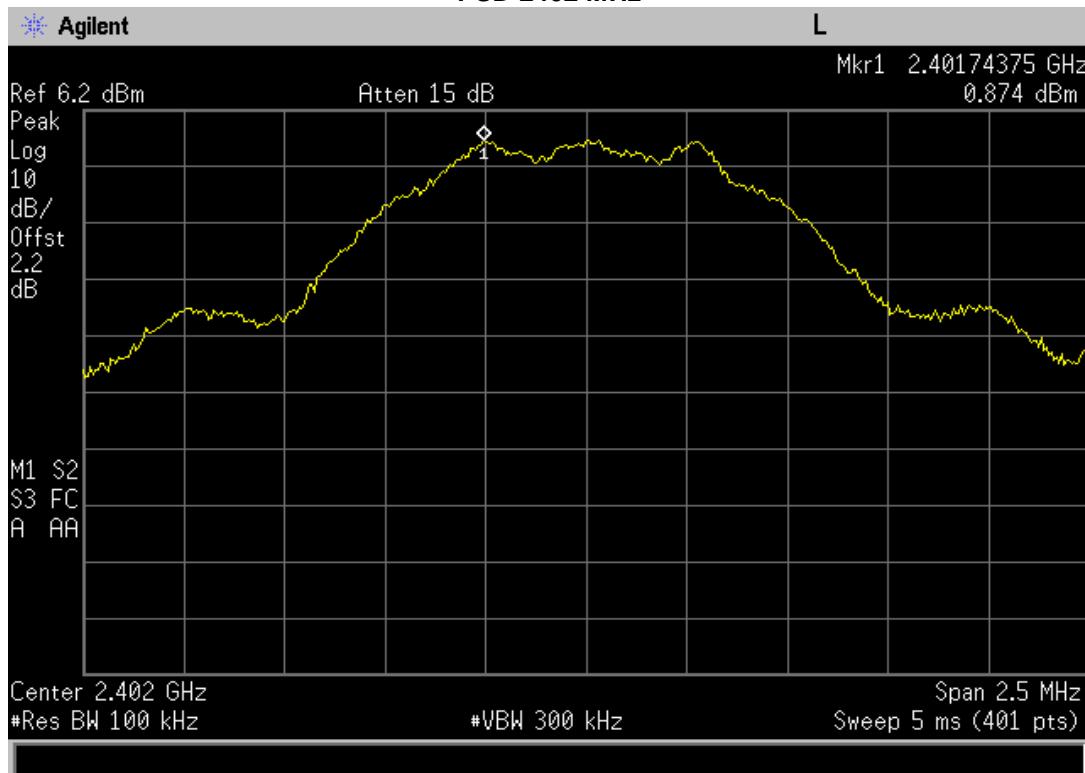


PSD Summary

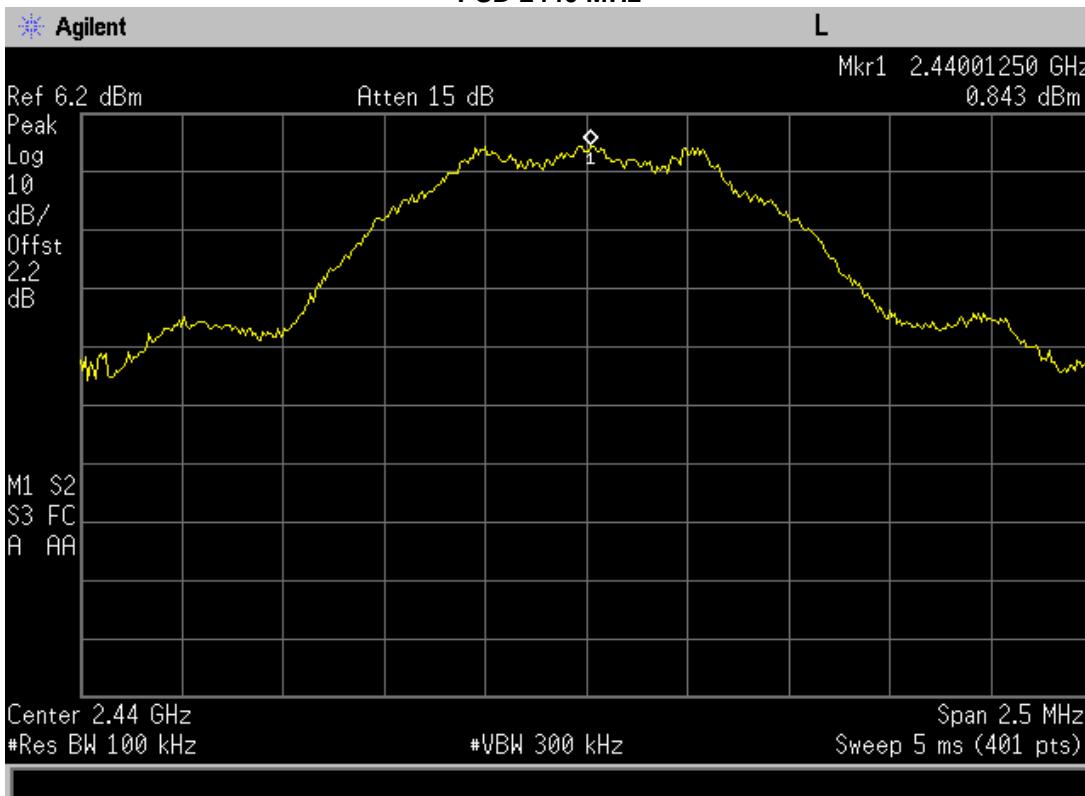
Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2402	0.847	8	Pass
2440	0.843	8	Pass
2480	0.564	8	Pass



PSD 2402 MHz



PSD 2440 MHz

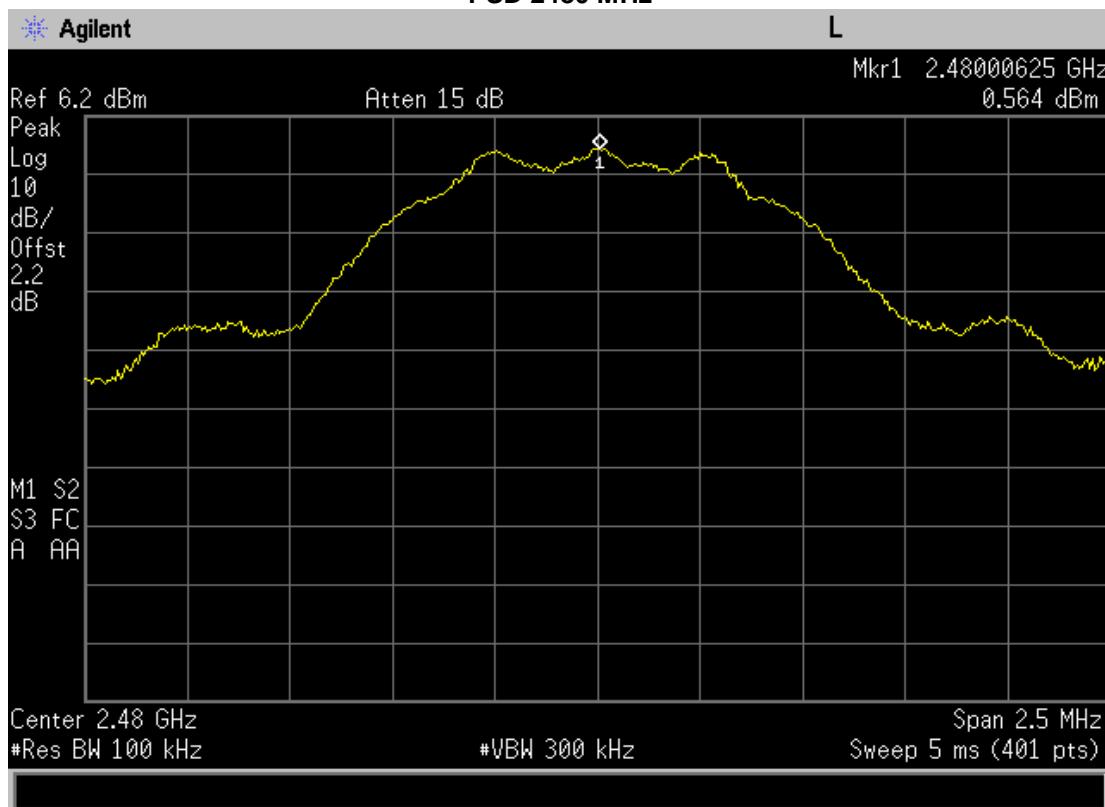




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Testing since 1963

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