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TESTING CERT #1255.01
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TEST REPORT # 316161
LSR Job #: C-2635

Compliance Testing of:
DeWalt Bluetooth Tag

Test Date(s):
1/16/17 – 1/26/17

Prepared For:
Attn: Kirwan Magdamo
Sr Project Engineer
Stanley Black & Decker, Inc.
701 East Joppa Rd.
Towson, MD 21286
410-716-3563
Kirwan.Magdamo@sbdinc.com
www.stanleyblackanddecker.com

This Test Report is issued under the Authority of:
Shane Dock, EMC Engineer

Signature: Shane Dock Date: 3-23-17

Test Report Reviewed by:	**Project Engineer:**
Adam Alger, Quality Systems Engineer	Shane Dock, EMC Engineer
Signature: Adam D Alger Date: 3-23-17	Signature: Shane Dock Date: 3-23-17

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 RSS 247
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	FCC KDB 558074 D01 DTS Measurement Guidance v03r05 ANSI C63.10 RSS 247 RSS GEN
Environmental Classification:	Residential

1.2 – Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2016	Code of Federal Regulations – Telecommunications
ANSI C63.4	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.
RSS-247 Issue 2	2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Measurement Guidance v03r05	2016	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

1.3 -Laird Technologies, Inc. Test Lab in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01

Federal Communications Commission (FCC) – USA

Listing of two 3 Meter Semi-Anechoic Chambers based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756

Industrie Canada Industry Canada

Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4
File Number: IC 3088A-2
On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4
File Number: IC 3088A-3

1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

Laird Technologies Inc.
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at Laird Technologies, Inc.:

Semi-Anechoic Chamber

1.5 – Test Equipment Utilized

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Stanley Black and Decker
Address:	701 East Joppa Rd., Towson, MD 21286 410-716-3563
Contact Name:	Kirwan Magdamo

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	DeWalt Bluetooth Tag
Model Number:	Engineering FCC Test Sample
Serial Number:	Engineering FCC Test Sample

2.3 - Associated Antenna Description

The antenna is a PCB-printed PIFA antenna. This antenna has a peak gain of 0 dBi.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2402 – 2480 MHz
Type of Modulation	Gaussian Shift Frequency
Transmitter Spurious (worst case) at 3 meters	62.2 dBuV/m (Peak) at 7320 MHz (42.2 dBuV/m with relaxation for duty cycle (Average))
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	-
Antenna Information	
Detachable/non-detachable	Non-Detachable
Type	PIFA
Gain	0 dBi
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.247
Modular Filing	☐ Yes ☒ No

Radio Characteristics

	BLE
Maximum Conducted Output Power (dBm)	3.67
Maximum Conducted Output Power (mW)	2.33
Minimum Conducted Output Power (dBm)	3.28
Minimum Conducted Output Power (mW)	2.12
99% Bandwidth (MHz)	1.06
6 dB Bandwidth (kHz)	735.90

2.5 - Product Description

The Bluetooth DeWalt Tag is designed for tracking and locating professional power tools, equipment, and machines using the DeWalt Tool Connect app which is capable of connecting with mobile devices that support Bluetooth Smart technology. The features of the Tag include a sealed enclosure with an IP68 rating, an over molded push button to initiate pairing to a mobile device, a blue LED to locate which Tag is currently connected to the mobile device, and various mounting options. The Tag is powered by a 3.0V CR2450 coin cell with an expected battery life of 3 years.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -74° F
Humidity:	30-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.247(b)(3) & 1.1310 IC : RSS 247 5.4 (d)	Maximum Output Power	Yes
FCC :15.247(d) IC : RSS 247 5.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(2) IC: RSS 247 5.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC:15.247 (e) IC: RSS 247 5.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(d), 15.209 & 15.205 IC : RSS-GEN 6.13	Transmitter Radiated Emissions	Yes

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☒ None ☐ Yes (explain below)

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

EXHIBIT 4. CONFORMANCE SUMMARY

When tested between September 2nd and October 26 of 2016, it was determined that the EUT, the Dewalt Bluetooth Tag, were compliant with the requirements of:

FCC Title 47 CFR Part 15.247
RSS 247 Issue 2

Using the methods of ANSI C63.10-2013 and RSS GEN

Any modifications made to the EUT after the specified test date(s) will invalidate the data herein.

If some emissions measurements are seen to be within the uncertainty value, as listed in Appendix C there is a possibility that this unit may not meet the required limit specification if subsequently tested.

EXHIBIT 5. UNWANTED EMISSIONS INTO THE RESTRICTED FREQUENCY BANDS.

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.10-2013. The EUT was placed on a 150 cm high non-conductive pedestal (80 cm for measurements under 1 GHz), centered on a flush mounted turntable inside a 3 meter Semi-Anechoic Chamber. The EUT was operated in continuous transmit mode for final testing. The unit has the capability to operate on 3 channels, controllable via proprietary software provided by the manufacturer.

The applicable limits apply at a 3 meter distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels to comply with FCC Part 15.31(m).

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 200 MHz, and a Log Periodic Antenna was used to measure emissions from 200 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz while a standard gain horn antenna was used in the 18 GHz to 25 GHz range. The maximum radiated RF emissions between 30MHz to 25 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. A tilt gear was utilized to keep the EUT within the cone of radiation for measurements above 1 GHz.

The EUT was positioned in 3 orthogonal orientations.

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at a calibration laboratory accredited to ISO 17025, and are traceable to the SI standard. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of at least 300 kHz), and a resolution bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of at least 3 MHz). For some plots, a reduced video bandwidth was used in order to identify spurious emissions (The relevant plots are labeled as such). In these cases, the standard video bandwidth was used with the appropriate detectors for measurement.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and RSS 247 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 - Calculation of Radiated Emissions Limits and reported data.

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBµV/m).

As specified in 15.247 (d), radiated emissions that fall within the restricted band described in 15.205(c) for FCC must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

Frequency (MHz)	3 m Limit µV/m	3 m Limit (dBµV/m)	1 m Limit (dBµV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-40,000	500	54.0	63.5

Sample conversion of field strength (µV/m to dBµV/m):
dBµV/m = 20 log $_{10}$ (100) = 40 dBµV/m (from 30-88 MHz)

For this unit, a Duty Cycle relaxation was used. The duty cycle (x) of the unit is 10%
Relaxation amount = 20 Log (x) = 20 Log (.10) = 20 dB.

For a sample peak measurement of 60 dBuV/m at 7300 MHz, the relaxation value is subtracted from the peak value and is compared to the average limit.
Peak Value with Relaxation (dBuV/m) = Peak Value (dBuV/m) – Relaxation Value (dB) = 60 – 20 = 40 dBuV/m

Since 40 dBuV/m < 54 dBuV/m, the sample measurement would be passing.

5.6 - Data

Manufacturer:	Stanley Black and Decker						
Date(s) of Test:	1/16/17 – 1/19/17						
Project Engineer(s):	Shane Dock						
Test Engineer(s):	Shane Dock						
Voltage:	3 VDC (Provided by 2x AA Batteries)						
Operation Mode:	Continuous transmit, modulated						
Environmental Conditions in the Lab:	Temperature: 70-74° F Relative Humidity: 30-42%						
EUT Power:		Single Phase 120VAC		3 Phase ___VAC			
	X	3VDC (2 AA Batteries)		Other: 3V			
EUT Placement:	X	150 cm non-conductive pedestal (80 cm for <1 GHz)		10cm Spacers			
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS			
Measurements:		Pre-Compliance		Preliminary	X	Final	
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average	

Measurements above 1 GHz:

Note: Emissions below were maximized between the three orientations. The worst-case emissions are reported

Frequency (MHz)	Orientation	Polarization	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading with Relaxation (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Margin (dB)	Average Margin (dB)
7206	V	H	208	15.6	53.7	33.7	74.0	54.0	20.3	20.3
	V	V	106	41.5	59.2	39.2	74.0	54.0	14.8	14.8
	H	H	144	7.6	58.2	38.2	74.0	54.0	15.8	15.8
	H	V	247	88.3	63.0	43.0	74.0	54.0	11.0	11.0
	F	H	180	58.8	61.5	41.5	74.0	54.0	12.5	12.5
	F	V	182	210.9	52.9	32.9	74.0	54.0	21.1	21.1

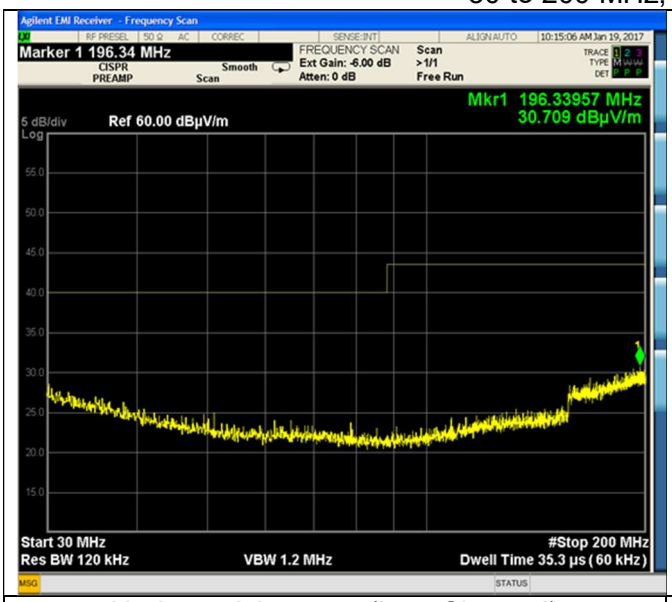
Frequency (MHz)	Orientation	Polarization	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading with Relaxation (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Margin (dB)	Average Margin (dB)
4804	V	H	250	117.8	53.7	33.7	74.0	54.0	20.3	20.3
	V	V	186	24.4	56.0	36.0	74.0	54.0	18.0	18.0
	H	H	128	135.9	58.1	38.1	74.0	54.0	15.9	15.9
	H	V	215	88.4	59.4	39.4	74.0	54.0	14.6	14.6
	F	H	146	166.1	59.9	39.9	74.0	54.0	14.1	14.1
	F	V	102	105.5	50.9	30.9	74.0	54.0	23.1	23.1

Frequency (MHz)	Orientation	Polarization	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading with Relaxation (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Margin (dB)	Average Margin (dB)
7320	H	V	245	90.0	62.2	42.2	74.0	54.0	11.8	11.8
7440	H	V	250	90.9	64.7	44.7	74.0	54.0	9.3	9.3
4880	F	H	193	160.0	61.1	41.1	74.0	54.0	12.9	12.9
4960	F	H	158	161.7	62.6	42.6	74.0	54.0	11.4	11.4

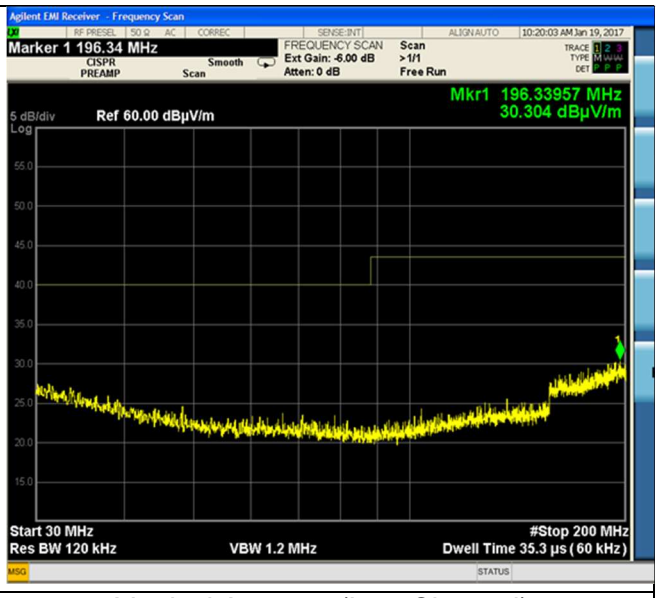
5.7 – Screen Captures.

The screen captures below are those using the Peak detector of the analyzer.

30 to 200 MHz, 3m distance

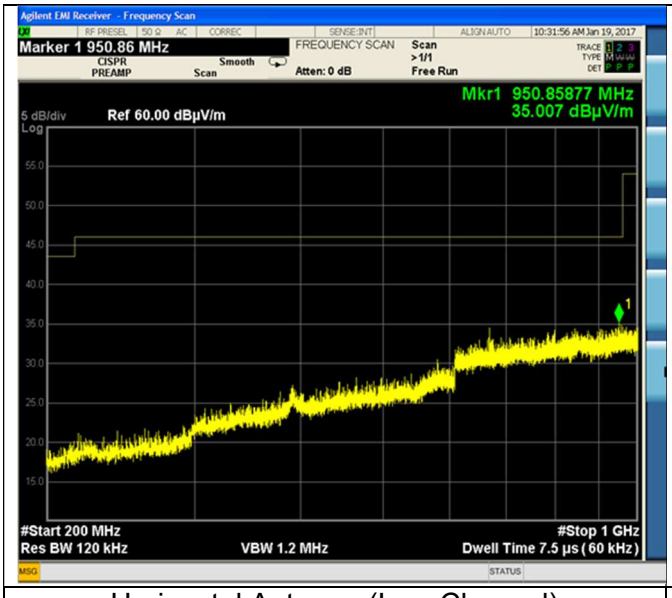


Horizontal Antenna (Low Channel)

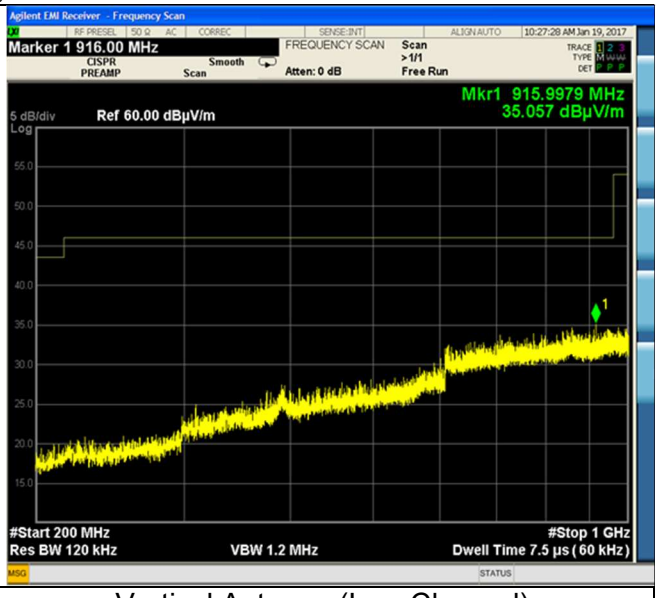


Vertical Antenna (Low Channel)

200 to 1000 MHz, 3m distance.

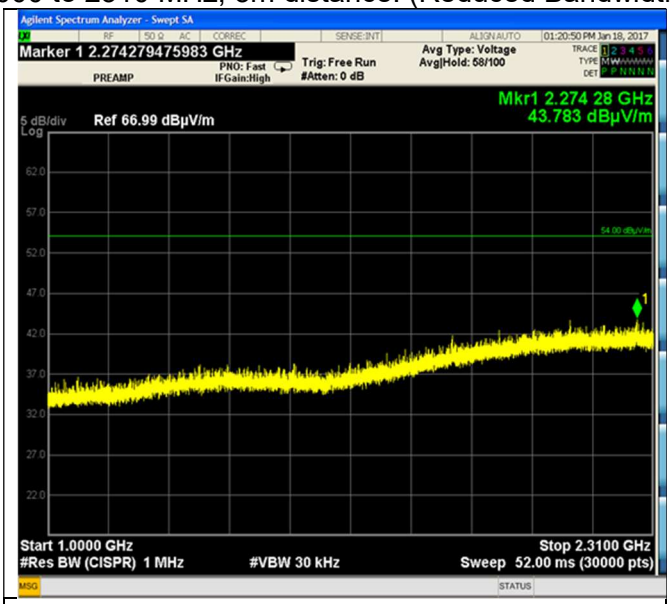


Horizontal Antenna (Low Channel)



Vertical Antenna (Low Channel)

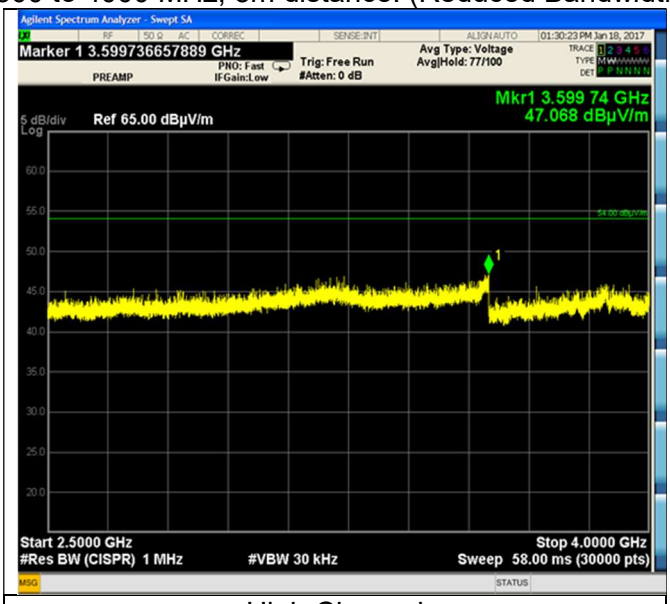
1000 to 2310 MHz, 3m distance. (Reduced Bandwidth)



Low Channel

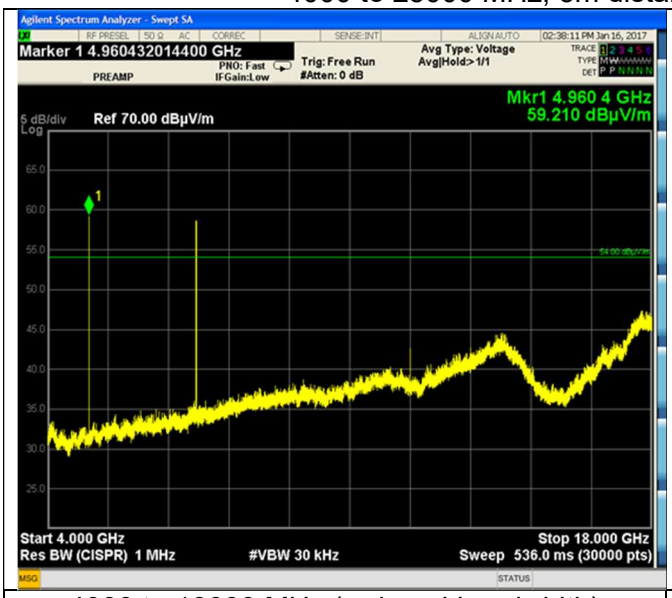
Note: The ranges 2310 to 2390 and 2483.5 to 2500 MHz are in section 8 of this report (Band-edges).

2500 to 4000 MHz, 3m distance. (Reduced Bandwidth)

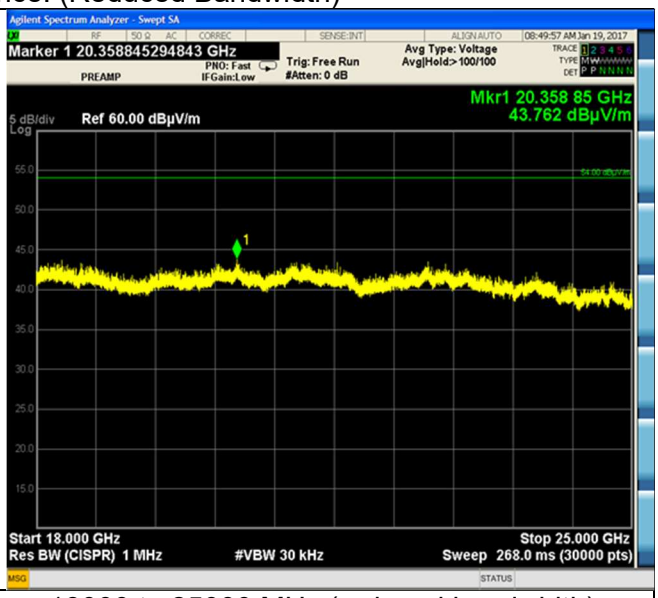


High Channel

4000 to 25000 MHz, 3m distance. (Reduced Bandwidth)



4000 to 18000 MHz (reduced bandwidth)



18000 to 25000 MHz (reduced bandwidth)

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

AC-Mains Conducted Emissions Testing is not applicable to the unit, as the unit is powered by a battery.

EXHIBIT 7. OCCUPIED BANDWIDTH

Test Engineer(s): Shane Dock

7.1 - Limits

For a DTS system operating in the 2400 to 2483.5 MHz band, the minimum 6dB emission bandwidth limit is 500 kHz.

7.2 - Method of Measurements

For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings thereby allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. A bandwidth measurement function that is built into the spectrum analyzer was used to measure the 20dB/emission bandwidth while the 6dB bandwidth was measured in accordance **FCC OET KDB 558074 section 8.**

7.3 - Test Data

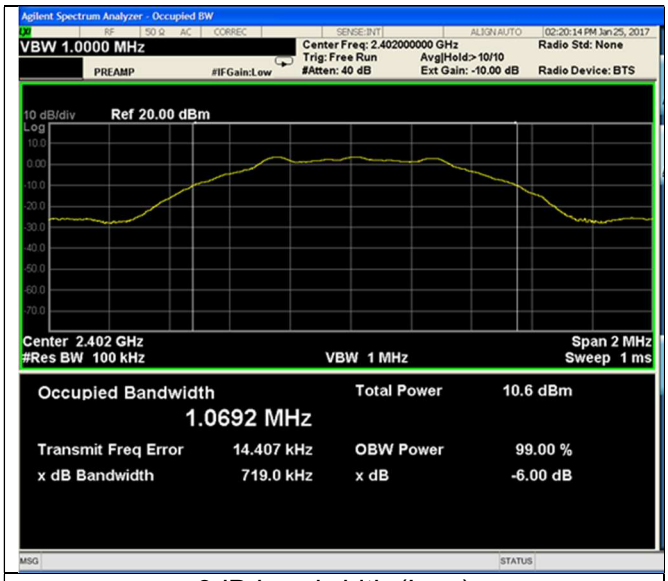
Frequency (MHz)	2402	2440	2480
6dB Bandwidth (kHz)	719.00	735.90	729.20

Frequency (MHz)	2402	2440	2480
99% Bandwidth (MHz)	1.06	1.06	1.06

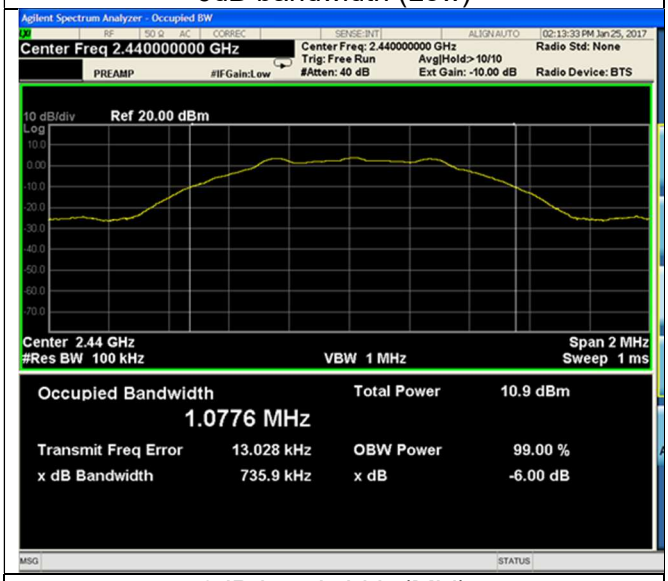
7.4 – Screen Captures

Examples of bandwidth measurements:

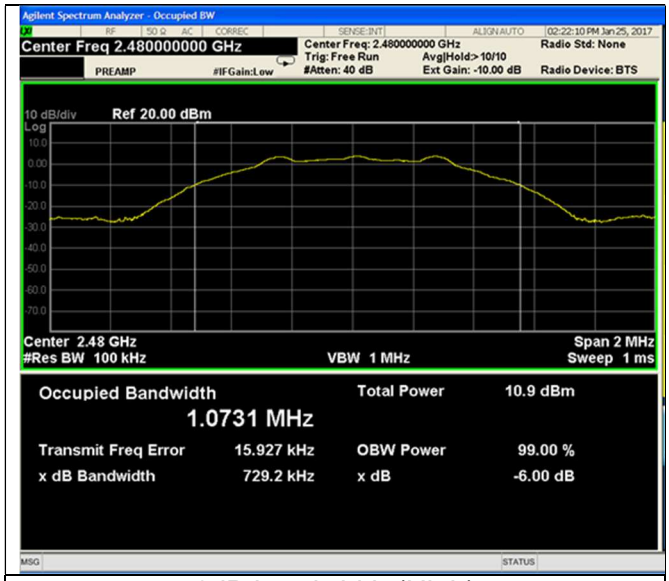
6 dB Bandwidth



6dB bandwidth (Low)

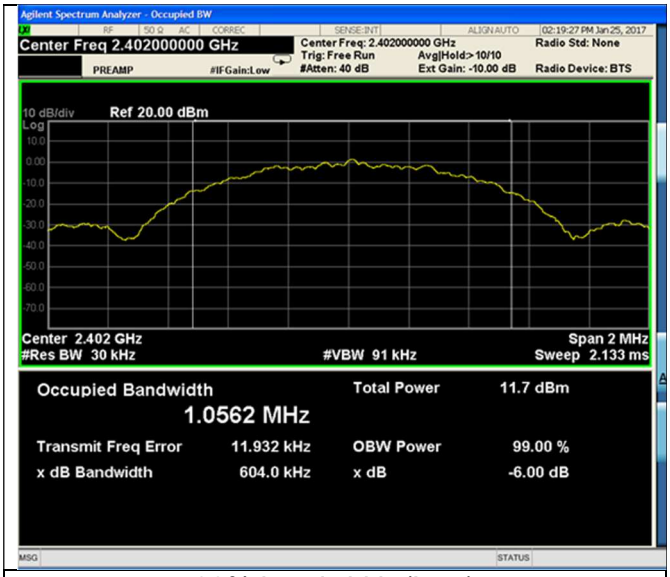


6dB bandwidth (Mid)

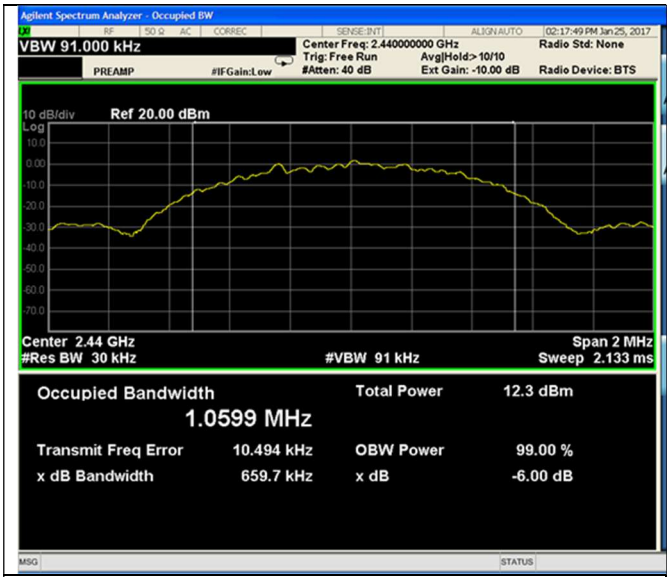


6dB bandwidth (High)

99% Bandwidth



99% bandwidth (Low)



99% bandwidth (Mid)

99% bandwidth (High)

EXHIBIT 8. BAND EDGE MEASUREMENTS

Test Engineer(s): Shane Dock

8.1 - Method of Measurements

FCC 15.247 requires a measurement of spurious emission levels at the restricted band to be compliant to the general emissions limit, in particular at the Band-Edges where the intentional radiator operates. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source.

The Band-edge measurements were performed conducted (100 kHz bandwidth) and radiated. The measurement of band-edge was performed to satisfy FCC 15.247(d).

Per FCC KDB 558074 D01 Measurement Guidance v03r05 (section 11), conducted measurements were performed with 100 kHz bandwidth for all emissions outside of the band of operation. For measuring radiated emissions in the restricted band, a bandwidth of 120 kHz (below 1000MHz) or 1MHz (above 1000MHz) was used in accordance with C63.4.

For both conducted and radiated measurements, correction factors and the cable loss factors were entered into the EMI Receiver database. **As a result, the plots taken from the EMI Receiver accounts for all applicable correction factor as well as cable loss, and can therefore be entered into the database as a corrected meter reading.**

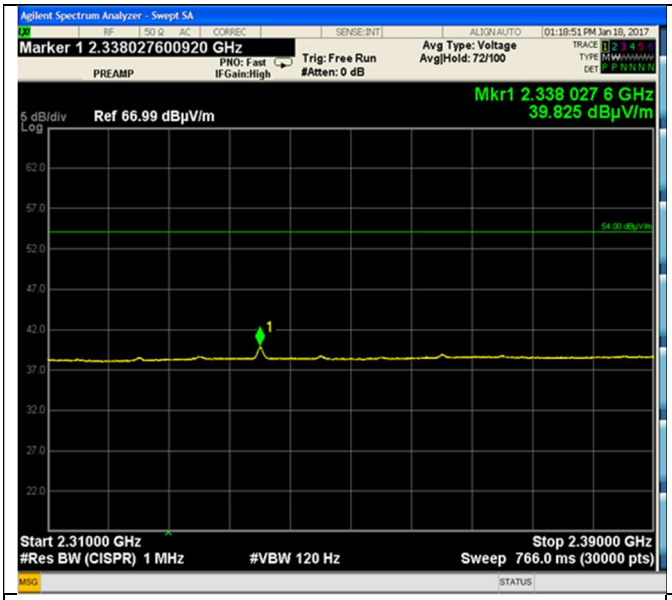
8.2. Band Edge Screen Captures

The data presented below are samples selected from the various data rates and channels tested.

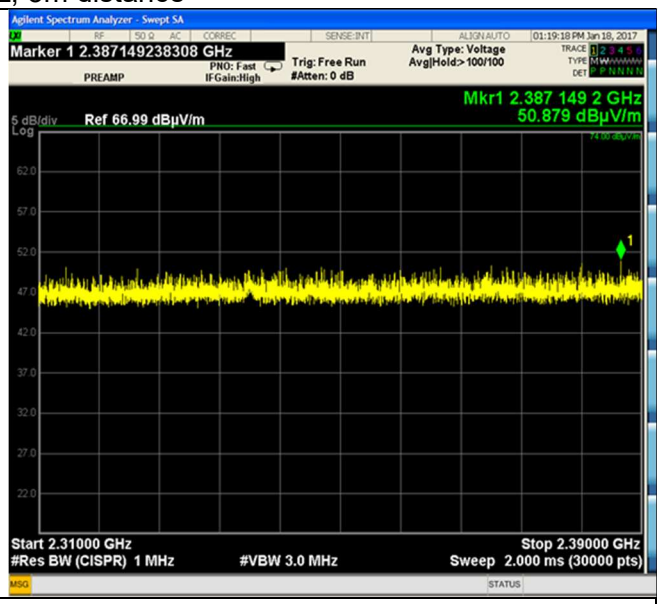
Band-edge in Restricted Band

Radiated Band-edge in Restricted Band:

2310 to 2390 MHz, 3m distance



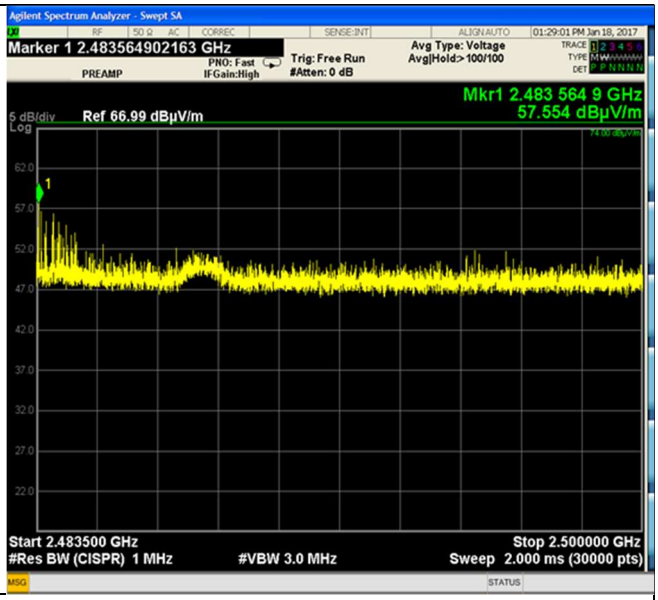
Low Channel Average



Low Channel Peak

2483.5 to 2500 MHz Restricted band

High Channel Average

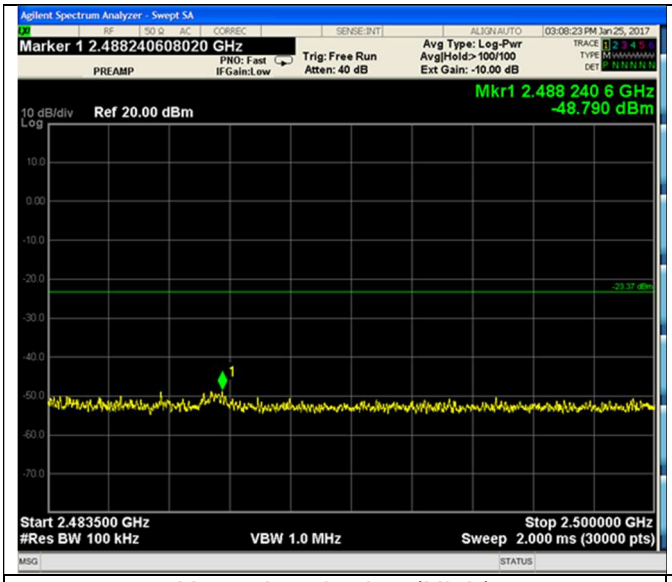


High Channel Peak

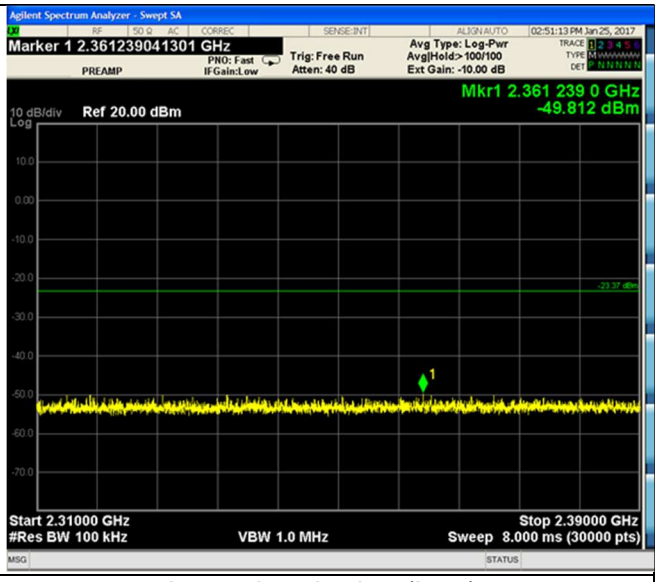
Conducted Band Edge Reference Pictures

Refer to Section 10 for reference levels.

Band-edge in 100 kHz bandwidth (Conducted Band Edge)



Upper band-edge (High)



Lower band-edge (Low)

EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

Test Engineer(s): Shane Dock

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings thereby allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

Measurement procedure used was FCC OET KDB 558074 D01 Measurement Guidance v03r05 section 9.1.1.

Peak Conducted Output Power Limit = 1 Watt (30 dBm).

9.2 - Test Data

Frequency (MHz)	2402	2440	2480
Conducted Pout (dBm)	3.28	3.67	3.54

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

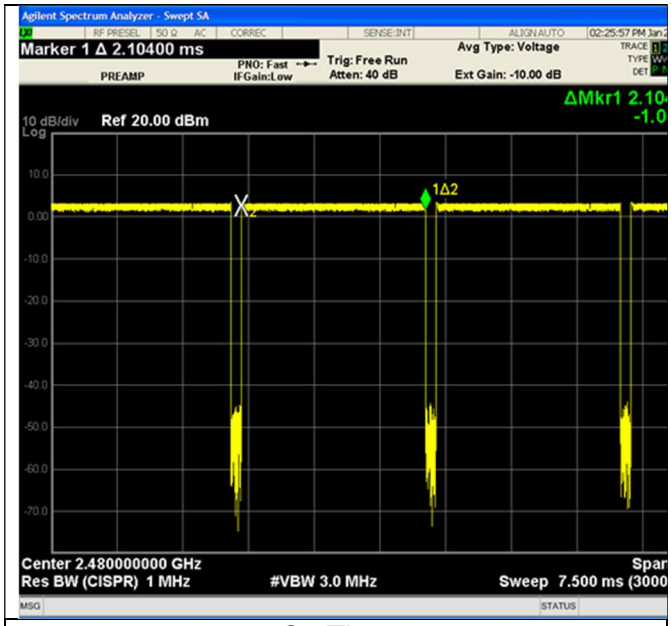
Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

9.2.1. Maximum conducted peak power:

9.2.1.1 Duty cycle:

Measurement procedure: **FCC OET KDB 558074 D01 Measurement Guidance v03r05.**

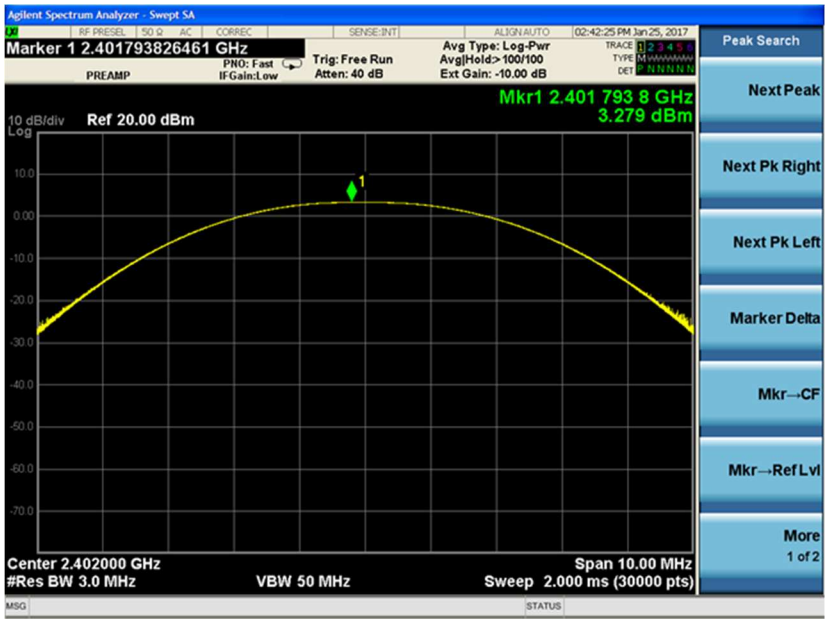
Screen captures:



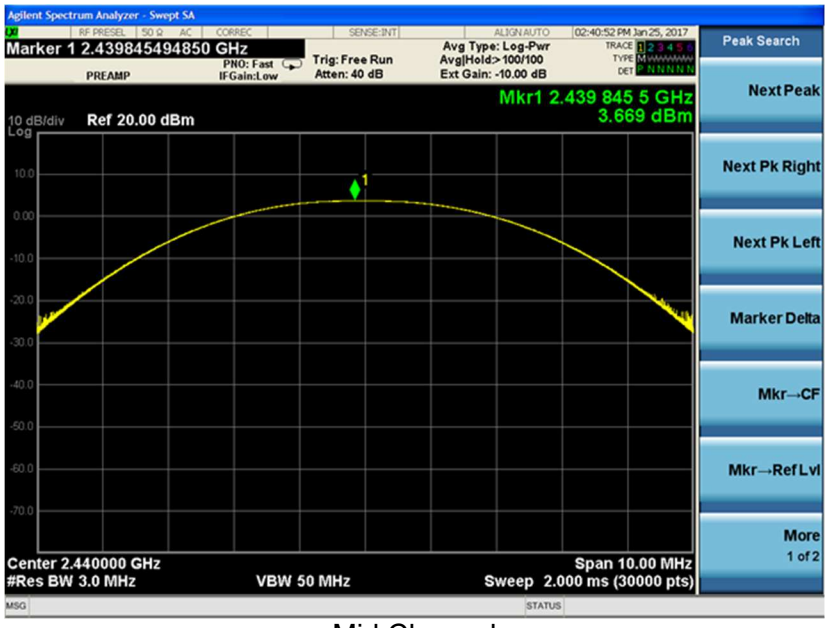
On Time

Duty cycle is 94.6%

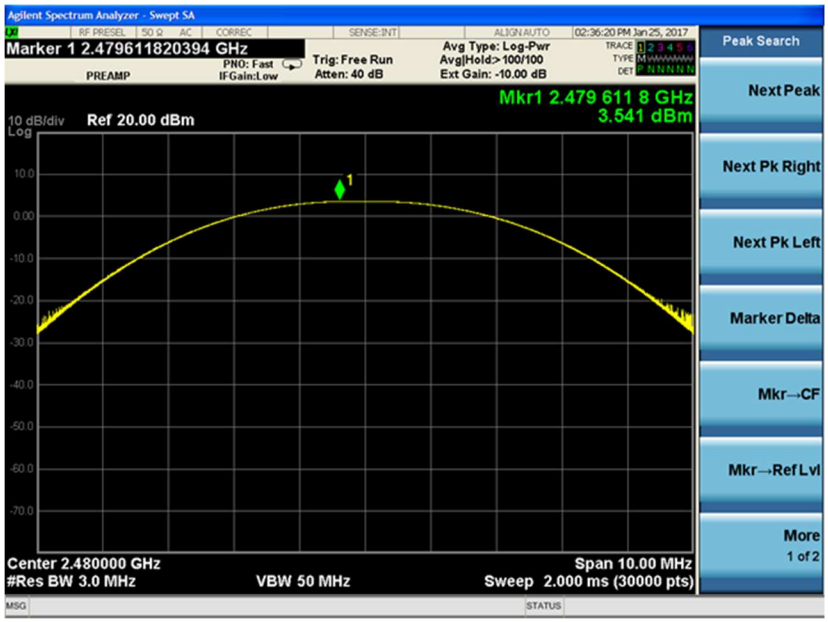
9.2.1.2 Maximum conducted (peak) output power:



Low Channel



Mid Channel



High Channel

EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

Test Engineer(s): Shane Dock

10.1 - Limits

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.

10.2 – Conducted Harmonic and Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 247 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

Measurement procedure used was FCC OET KDB 558074 D01 Measurement Guidance v03r05 section 11.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

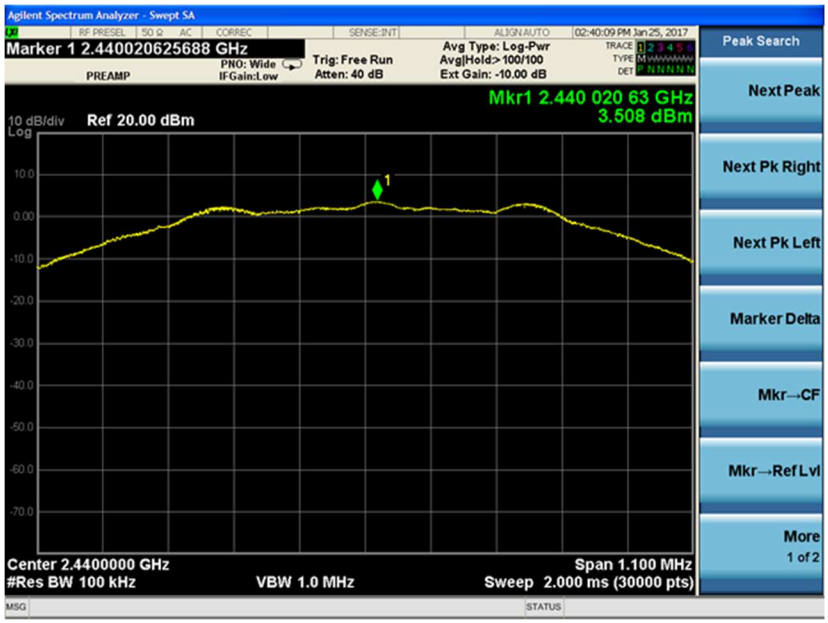
Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

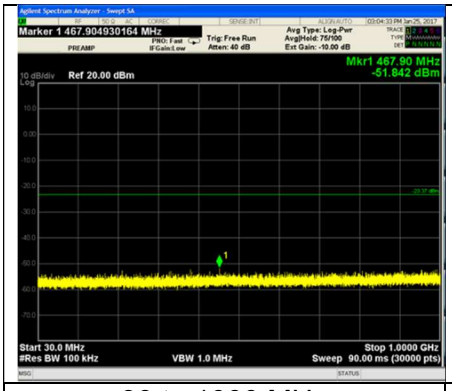
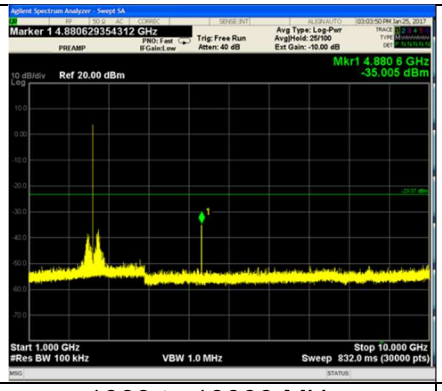
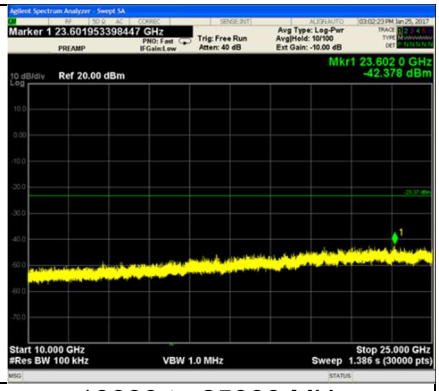
10.3 - Test Data

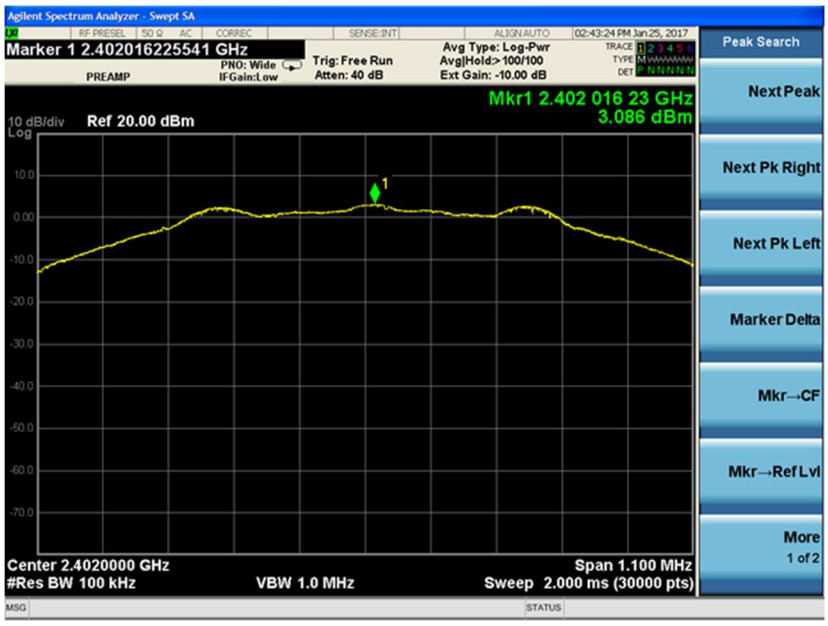
The data presented below are samples selected from the various data rates and channels tested. Display lines on captures do not represent limit lines, so refer to the fundamental picture for limits. Pictures below are samples. All emissions are more than 15 dB below the limit.

Note: Refer to PSD screenshots in Section 11.3 for limits

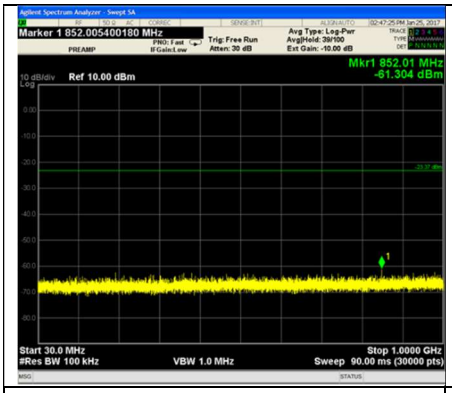


Example: Mid Channel. Reference Level = PSD – 20 dB = -16.49 dB

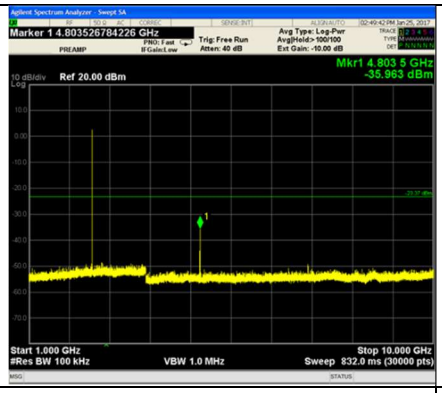
		
30 to 1000 MHz	1000 to 10000 MHz	10000 to 25000 MHz



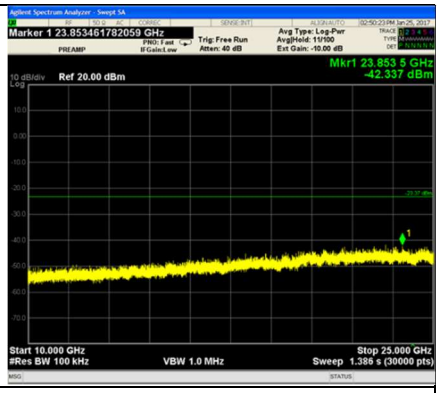
Low Channel. Reference Level = PSD – 20 dB = -16.91 dB



30 to 1000 MHz

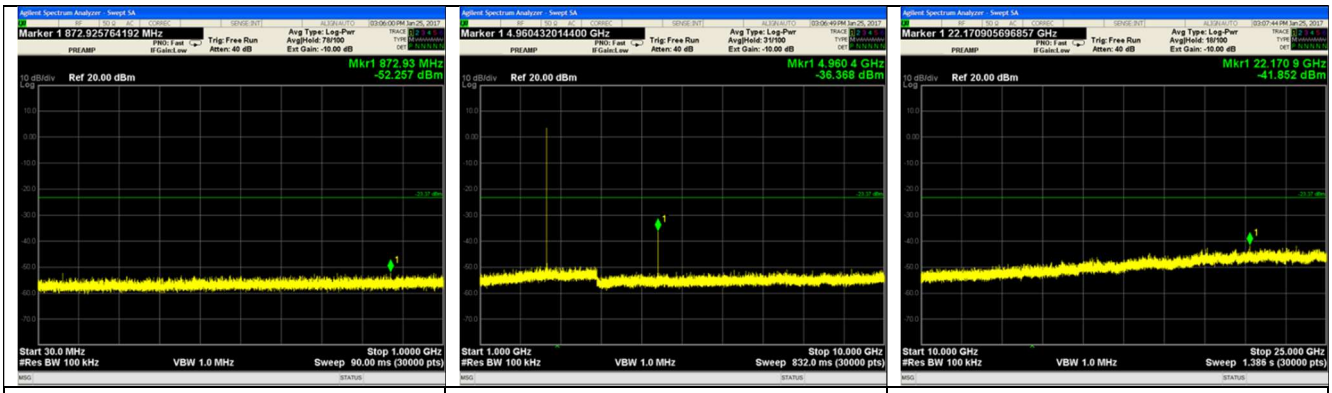


1000 to 10000 MHz



10000 to 25000 MHz

High Channel. Reference Level = PSD – 20 dB = -16.63 dB



30 to 1000 MHz	1000 to 10000 MHz	10000 to 25000 MHz

EXHIBIT 11. POWER SPECTRAL DENSITIES: 15.247(e)

11.1 Limits

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.

In accordance with FCC Part 15.247(e) and RSS 247, the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed.

Measurement procedure used was FCC OET KDB 558074 D01 Measurement Guidance v03r05 section 10.2.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

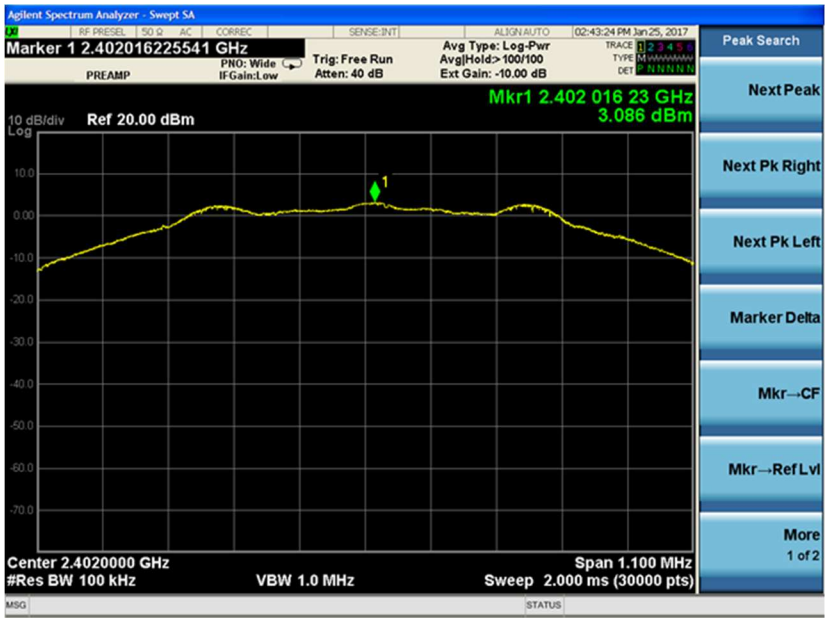
Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

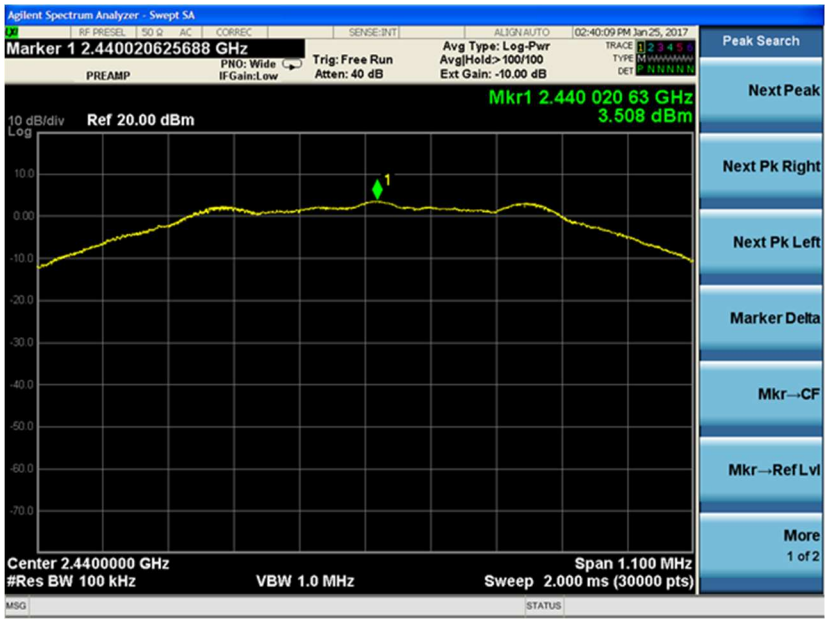
11.2 Test Data

Frequency (MHz)	2402	2440	2480
Conducted PSD (dBm)	3.09	3.51	3.37
Reference Level (dBm)	-16.91	-16.49	-16.63

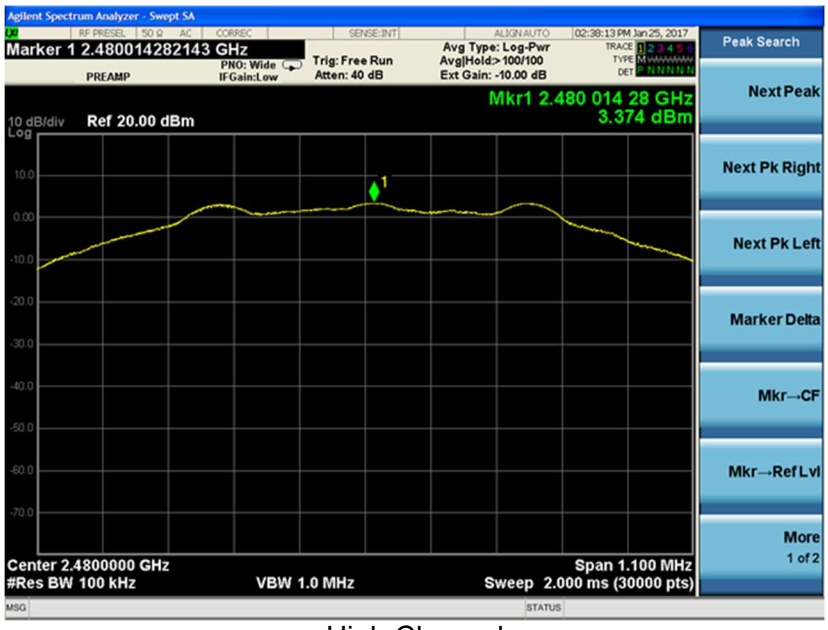
11.3 Screen Captures – Power Spectral Density



Low Channel



Mid Channel



High Channel

EXHIBIT 12. FREQUENCY STABILITY OVER VOLTAGE VARIATIONS

Test Engineer(s): Shane Dock

The frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply (To simulate battery power) and by a variable AC voltage supply (To simulate AC mains power). Each supply was tested separately and was varied ±15% from the nominal values. If the unit could not be changed by 15% it was instead changed to its minimum or maximum value.

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle. The stability was found to be approximately 6.99 ppm.

Nominal Frequency (MHz)	2.55 V	3.00 V	3.45 V	Deviation (Hz)
2402	2402016830	2402005700	2402007370	11130
2440	2440007700	2440024100	2440004770	19330
2480	2480007470	2480015570	2480018700	11230

APPENDIX A – Test Equipment List

Laird
Smart Technology. Delivered.

Date : 16-Jan-2017 Test : Radiated Emissions Job # : C-2635

PE Shane Dock Customer : Stanley Black and Decker Quote #: 316161

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	7/22/2016	7/22/2017	Active Calibration
2	EE 960160	0.8-21GHz LNA	Mini-Circuits	ZVA-213X-S+	977711030	7/22/2016	7/22/2017	Active Calibration
3	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/23/2017	Active Calibration
4	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration
5	AA 960150	Biconical Antenna	ETS	3110B	0003-3346	2/1/2016	1/31/2017	Active Calibration
6	AA 960163	Log Periodic Antenna	A.H. Systems, Inc	SAS-512-2	500	3/18/2016	3/18/2017	Active Calibration
7	AA 960174	Small Horn Antenna 18-40 GHz	ETS-Lindgren	3116C-PA	00206880	4/23/2016	4/23/2017	Active Calibration
8	AA 960171	Cable - low loss 6m	A.H. Systems, Inc	SAC-26G-6	386	3/31/2016	3/31/2017	Active Verification

Tested By: Shane Dock Quality Assurance:

Laird
Smart Technology. Delivered.

Date : 16-Jan-2017 Test : Conducted Radio Job # : C-2635

PE Customer : Stanley Black and Decker Quote #: 316161

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/26/2015	6/25/2017	Active Calibration
2	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration

Tested By: Shane Dock Quality Assurance:

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2014		
ANSI C63.10	2013		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2016		
RSS GEN	2014		
RSS 247	2017		

APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

Measurement Type	*Configuration*	*Uncertainty Values*
Radiated Emissions	*Biconical Antenna*	*5.0 dB*
Radiated Emissions	*Log Periodic Antenna*	*5.3 dB*
Radiated Emissions	*Horn Antenna*	*4.7 dB*
AC Line Conducted Emissions	*AMN*	*3.4 dB*
Telecom Conducted Emissions	*AAN*	*4.9 dB*
Disturbance Power (Emissions)	*Absorbing Clamp*	*4.1 dB*
Radiated Immunity	*3 Volts/Meter*	*2.2 dB*
Conducted Immunity	*CDN/EM/BCI*	*2.4/3.5/3.4 dB*
EFT Burst / Surge	*Peak pulse voltage*	*164 volts*
ESD Immunity	*15 kV level*	*1377 Volts*

Parameter	**ETSI U.C.+/-**	**U.C.+/-**
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (PM)	1.5 dB	1.2 dB
RF conducted emissions (SA)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

APPENDIX D – Justification for Duty Cycle Relaxation

General Device Description:
The DUT is a BLE (Bluetooth Low Energy or Bluetooth Smart) asset tag. This device is disposable and operates off a CR2450 coin sell battery.
The PCBA within the device is 1.25”x 1.0” in size.

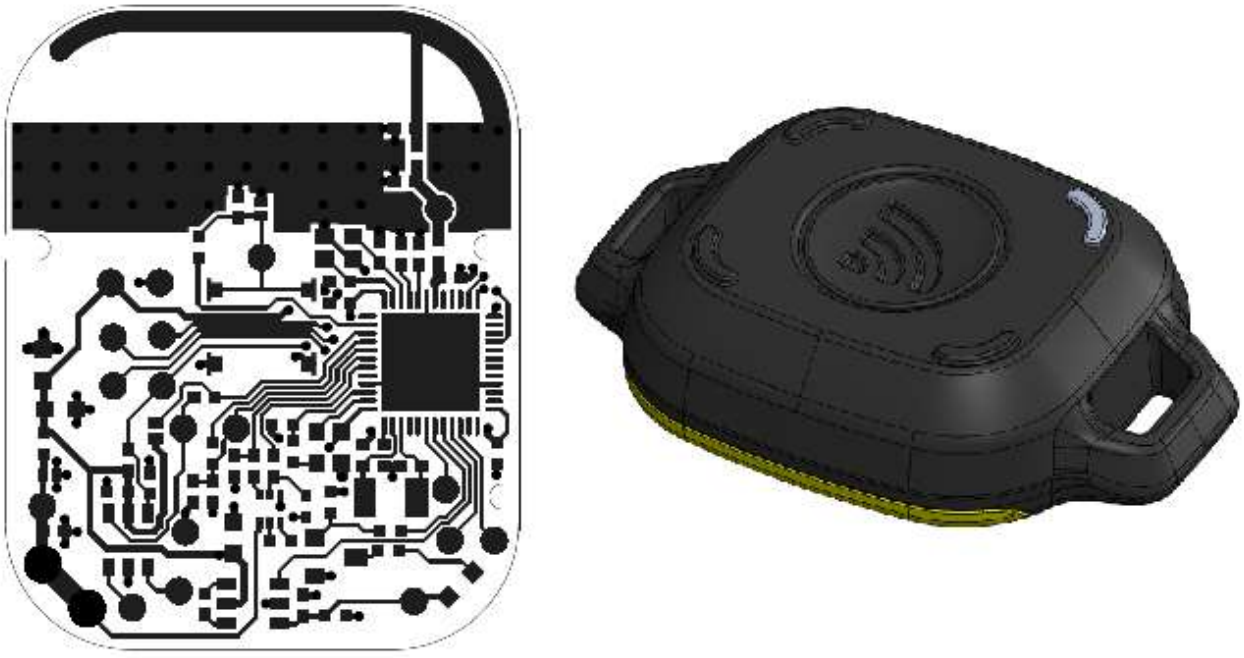


Figure 1: DUT

Theory of Operation:
The device spends the vast majority of its life sending out advertisement “beacons” at a two second interval never connecting to other devices such as smartphones. The total advertising beacon packet is 47bytes (376 bits) and the BLE data-rate is 1Mb/s. Each advertising beacon is 376uS long and at a 2-second rate is confined within a 100mS window. This is a duty cycle of .376%.
A BLE advertisement is generally used to solicit connectivity with another complaint device. In this use case, the connectivity is inhibited. The beacon packet (ex: transmission information) is limited to:

1) A unique device ID used for asset tracking or identification
2) An indicator of battery condition
3) The current device temperature

While the above description comprises the main operation and use case, the device can be reimaged over-the-air (OTA). This functionality comprises a rare occurrence across the device’s 3 year life span. A device would likely not be updated more than twice in its lifetime. **Even so, this OTA event with a worst-case TX rate within any window of time has a duty cycle of 10%.**

BLE Characteristics:
OAD Duration: 135 Seconds (Soft Device and Application v0.5 to v0.5 using BL v7) = >100mS
Connection Interval: 30ms

Transmit Duration with any interval: 300us
Maximum Transmissions per Connection Interval: 10

Duty Cycle Calculation:

Window of observation: 100mS
Number of connection intervals: 3.33r
TX time per connection interval (max): 300uS x 10 = 3mS
Total TX time within a 100mS window: 3.33r x 3mS = 10mS
Duty Cycle: 10mS/100mS = **10%**
Duty Cycle Relaxation: 20Log (.10) = 20dB

Conclusions or Summary

The device spends its three year life with a TX duty cycle under 1% (.376%). The worst case TX duration within any time window is an over-the-air reimage which takes 135 seconds to complete. The TX duty cycle within this duration in any 100mS window is 10%.

Exhibits:

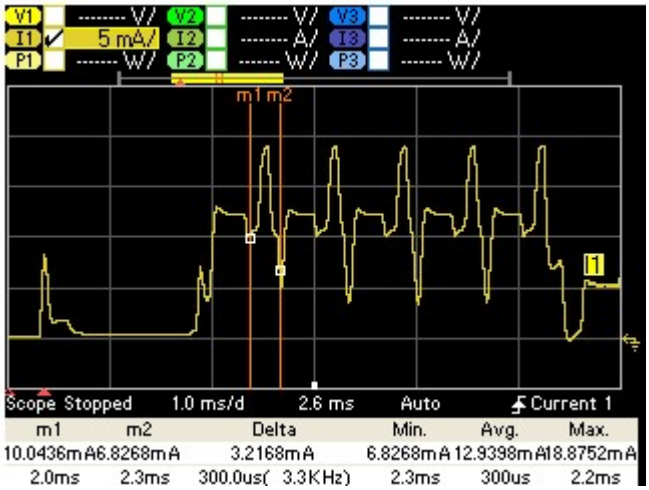


Figure 2: Single TX Event (300uS), 5 Events in the Connection Interval

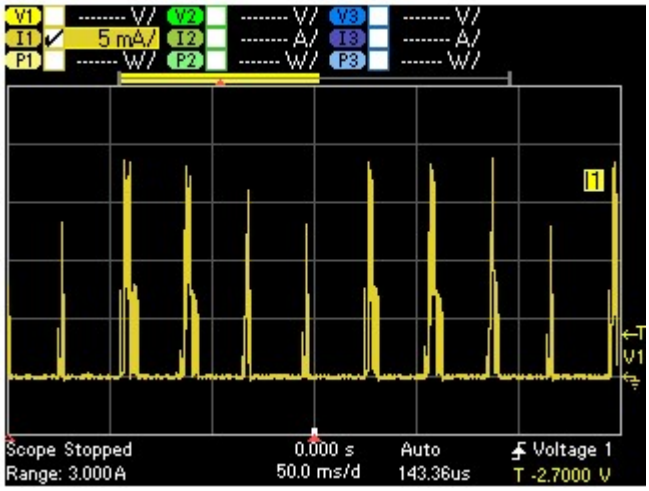


Figure 3: OTA Event in Progress