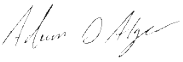
Test Report C-3600A

Equipment Under Test:	DCE042
Requirement(s):	FCC 15.247, RSS-247
Test Date(s):	8/8/2022-8/10/2022
Prepared for:	Stanley Black & Decker Attn: Kirwan Magdamo 701 East Joppa Road Towson, MD 21286

Report Issued by: Anthony Smith, EMC Engineering Specialist

Signature:  Date: 01/04/2023

Report Reviewed by: Adam Alger, Laboratory Manager

Signature:  Date: 01/04/2023

Report Constructed by: Anthony Smith, EMC Engineering Specialist

Signature:  Date: 01/04/2023

CONTENTS

Laird Connectivity Test Services in Review

The Laird Connectivity LLC laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:

Certificate #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025:2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein unless otherwise noted

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Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers

Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

1 Test Report Summary

During **8/8/2022-8/10/2022** the Equipment Under Test (EUT), **DCE042**, as provided by **Stanley Black & Decker** was tested to the following requirements:

FCC 15.247 / RSS-247, DTS

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) IC: RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Pass
FCC: 2.1049 IC: RSS-GEN 6.7	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (e) IC: RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Pass

Notice:

The results relate only to the item tested as configured and described in this report. Any additional configurations, modes of operation, or modifications made to the equipment under test after the specified test date(s) are at the decision of the client and may not apply to the data seen in this test report.

The decision rule for Pass / Fail assessment to the specification or standard listed in this test report has been agreed upon by the client and laboratory to be as follows:

Measurement Type	Rule
Emissions – Amplitude	1 dB below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Stanley Black & Decker
Contact Person	Kirwan Magdamo
Address	701 East Joppa Road Towson, MD 21286

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	DCE042
Model Number	DCE042
Serial Number	Engineering Sample
Additional Information	FCC ID: YJ7DCE042 IC ID: 9082A-DCE042

2.2 Product Description

The DCE042 Bluetooth Audit Chip is designed to be inserted into the foot of a DEWALT tool and retained by two screws fitted into the housing.

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

Device is powered via 3VDC coin cell battery. Device is programmed via a FTDI-USB cable, with the USB end connected to a programming laptop. Programming software used is nRF Connect for Desktop v3.11.1. Within the nRF Connect software the Direct Test Mode v.2.0.2 utility is used. Channels tested were 37 (2402 MHz), 17 (2440 MHz), and 39 (2480 MHz) with a 1M Data Rate. Transmit Power Settings used in the device are +4 dBm and -40 dBm.

3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
FCC eCFR	-	2022	-	-
RSS-247	2	2017	-	-
RSS-GEN	5	2018	2019	2021
ANSI C63.10	-	2013	-	-

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References
CISPR 16-4-1
CISPR 16-4-2
CISPR 32
ANSI C63.23
A2LA P103
A2LA P103c
ETSI TR 100-028

Measurement Type	Configuration	Uncertainty ±
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	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	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

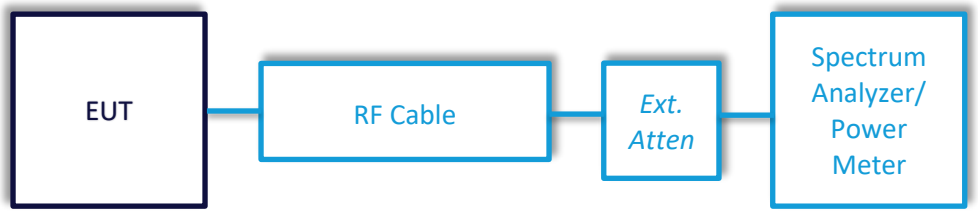
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %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

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960143	Cable	Gore	EKD01D01048.0	5546519	3/22/2022	3/22/2023	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2022	4/12/2023	Active Calibration

5.1.1 DTS Bandwidth

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	22.3°C	**R.H. %**	48.4%
Test Date	8/8/2022	**Location**	Conducted RF Bench
Requirement	FCC: 15.247 (a)(2) IC: RSS-247 5.2(a)	**Method**	ANSI C63.10 §11.8

Limits: BW Greater than 500 kHz

Test Parameters

Frequency	2402, 2440, 2480 MHz	**Setup**	Conducted
RBW	100 kHz	**VBW**	300 kHz
Detector(s)	Max Peak Hold	**Sweep Time**	Auto

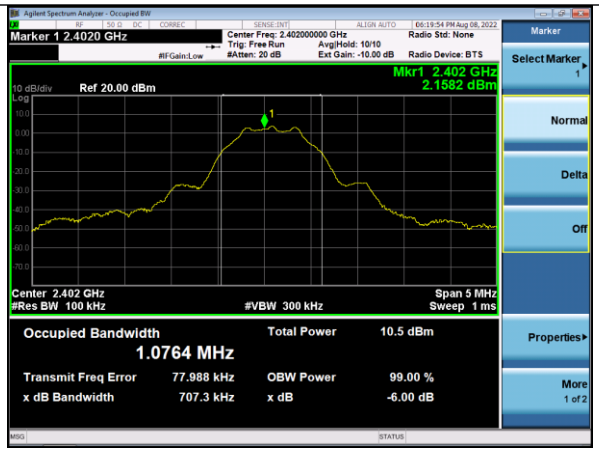
EUT Parameters

Input Power	3VDC Battery	**Mode**	BLE Transmit
Frequency	2402, 2440, 2480 MHz	**Channel**	37, 17, 39
Data Rate/Modulation	BLE 1 Mbps		

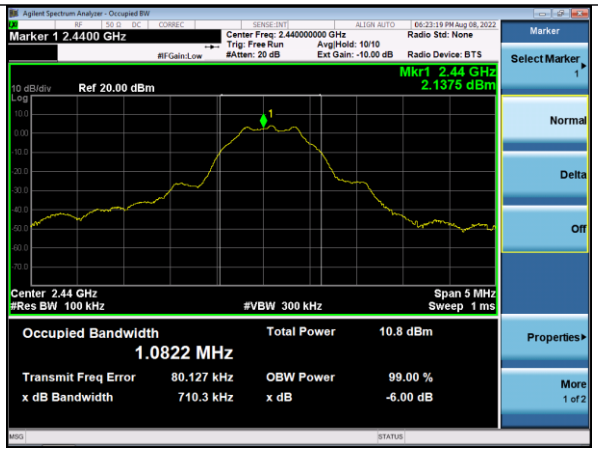
Data Table

Channel	Data Rate	DTS BW (kHz)	Limit (kHz)	Margin (kHz)
37	BLE 1Mbps	707.3	500	207.3
17	BLE 1Mbps	710.3	500	210.3
39	BLE 1Mbps	713.1	500	213.1

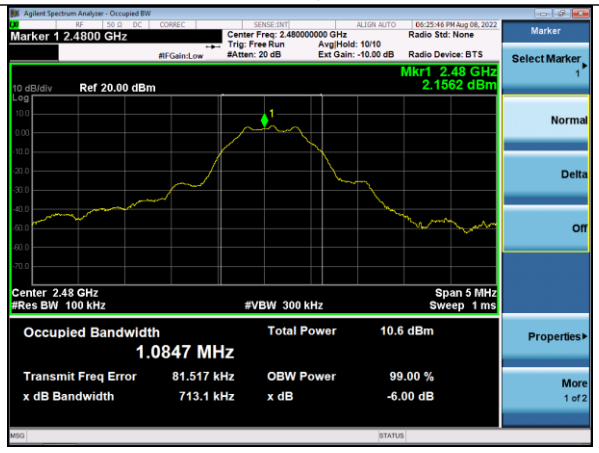
Plots



DTS Bandwidth, Channel 37



DTS Bandwidth, Channel 17



DTS Bandwidth, Channel 39

5.1.2 99% Occupied Bandwidth

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	22.3°C	**R.H. %**	48.4%
Test Date	8/8/2022	**Location**	Conducted RF Bench
Requirement	FCC: 2.1049 IC: RSS-GEN 6.7	**Method**	ANSI C63.10 §6.9

Limits: Reported

Test Parameters

Frequency	2402, 2440, 2480 MHz	**Setup**	Conducted
RBW	10 kHz	**VBW**	30 kHz
Detector(s)	Max Peak Hold	**Sweep Time**	Auto

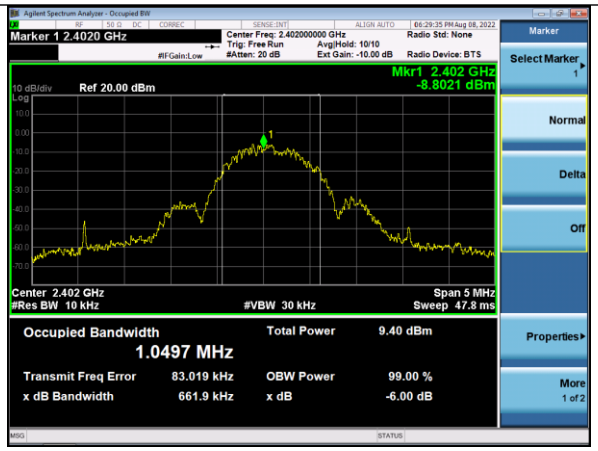
EUT Parameters

Input Power	3VDC	**Mode**	BLE Transmit
Frequency	2402, 2440, 2480 MHz	**Channel**	37, 17, 39
Data Rate/Modulation	BLE 1 Mbps		

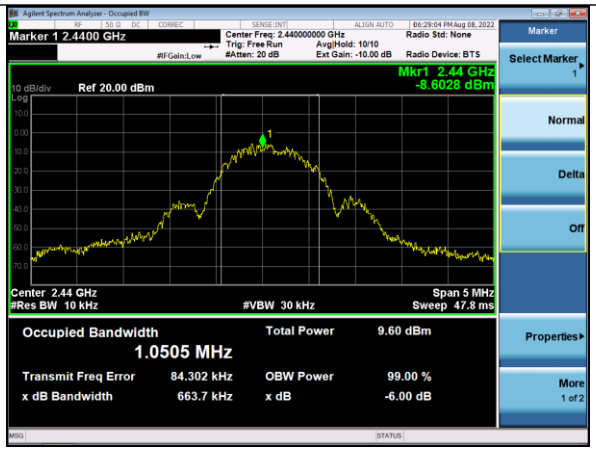
Data Table

Channel	Data Rate	99% OBW (MHz)
37	BLE 1Mbps	1.05
17	BLE 1Mbps	1.05
39	BLE 1Mbps	1.05

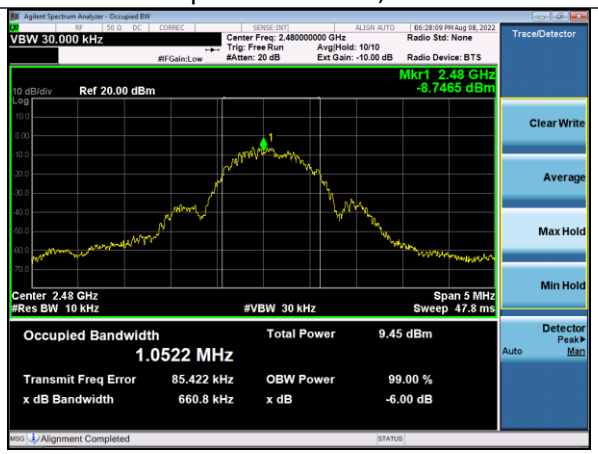
Plots



99% Occupied Bandwidth, Channel 37



99% Occupied Bandwidth, Channel 17



99% Occupied Bandwidth, Channel 39

5.1.3 Peak Output Power

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	22.3°C	**R.H. %**	48.4%
Test Date	8/8/2022	**Location**	Conducted RF Bench
Requirement	FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	**Method**	ANSI C63.10 §11.9

Limits: 30 dBm

Test Parameters

Frequency	2402, 2440, 2480 MHz	**Setup**	Conducted
RBW	3 MHz	**VBW**	50 MHz
Detector(s)	Max Peak Hold	**Sweep Time**	Auto

EUT Parameters

Input Power	3VDC Battery	**Mode**	BLE Transmit
Frequency	2402, 2440, 2480 MHz	**Channel**	37, 17, 39
Data Rate/Modulation	BLE 1Mbps		

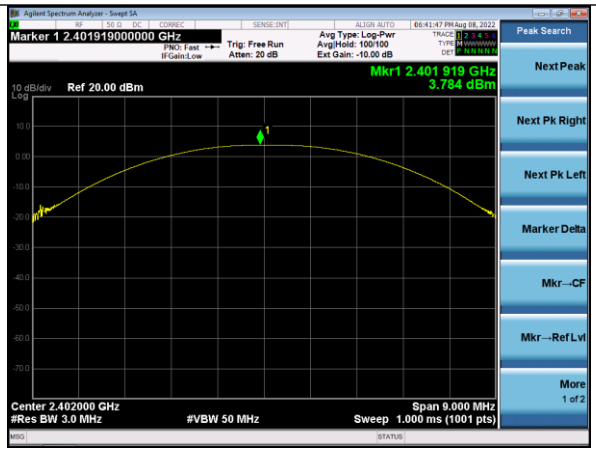
Data Table

Channel	Data Rate	Transmit Power Setting	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
37	BLE 1Mbps	4	3.8	30	26.2
17	BLE 1Mbps	4	4.1	30	25.9
39	BLE 1Mbps	4	3.8	30	26.2

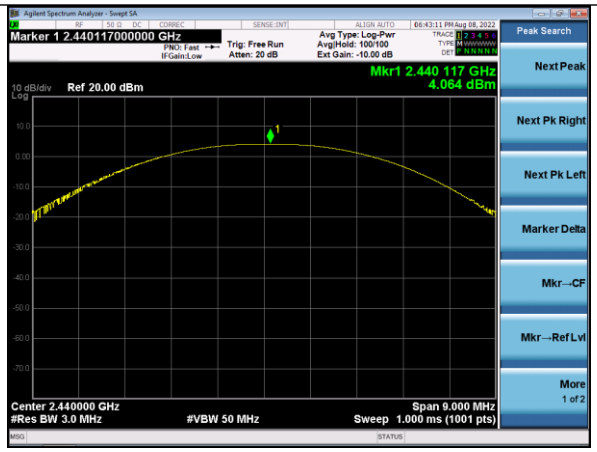
Channel	Data Rate	Transmit Power Setting	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
37	BLE 1Mbps	-40	-34.9	30	64.9
17	BLE 1Mbps	-40	-36.4	30	66.4
39	BLE 1Mbps	-40	-36.5	30	66.5

Plots

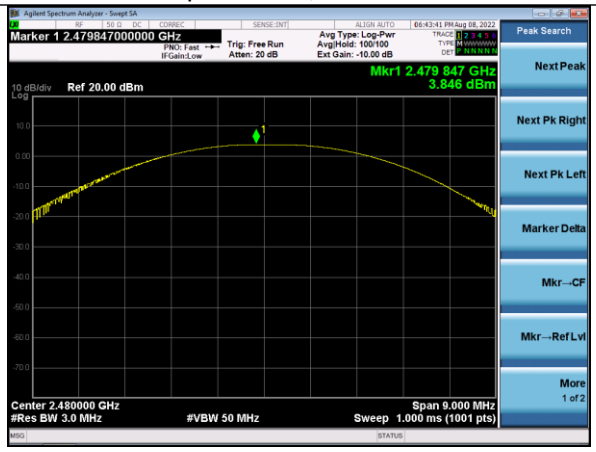
Transmit Power Setting: +4



Output Power, Channel 37

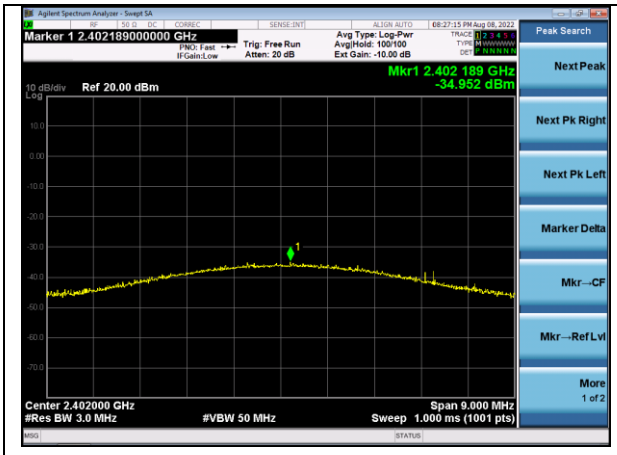


Output Power, Channel 17

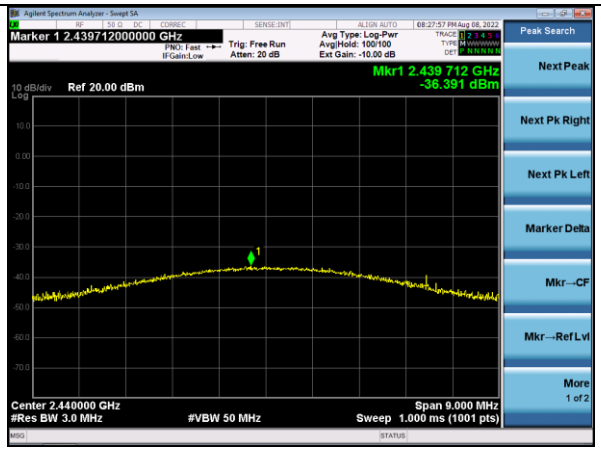


Output Power, Channel 39

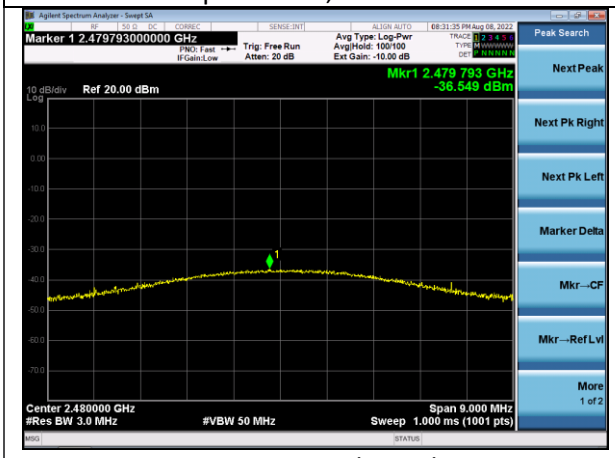
Transmit Power Setting: -40



Output Power, Channel 37



Output Power, Channel 17



Output Power, Channel 39

5.1.4 Peak Power Spectral Density

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	22.3°C	**R.H. %**	48.4%
Test Date	8/8/2022	**Location**	Conducted RF Bench
Requirement	FCC: 15.247 (e) IC: RSS-247 5.2 (b)	**Method**	ANSI C63.10 §11.10

Limits: 8dBm/3kHz

Test Parameters

Frequency	2402, 2440, 2480 MHz	**Setup**	Conducted
RBW	100 kHz	**VBW**	300 kHz
Detector(s)	Max Peak Hold	**Sweep Time**	Auto

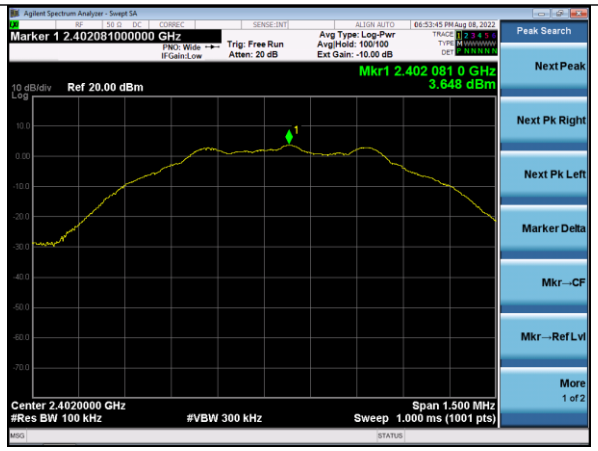
EUT Parameters

Input Power	3VDC Battery	**Mode**	BLE Transmit
Frequency	2402, 2440, 2480 MHz	**Channel**	37, 17, 39
Data Rate/Modulation	BLE 1Mbps		

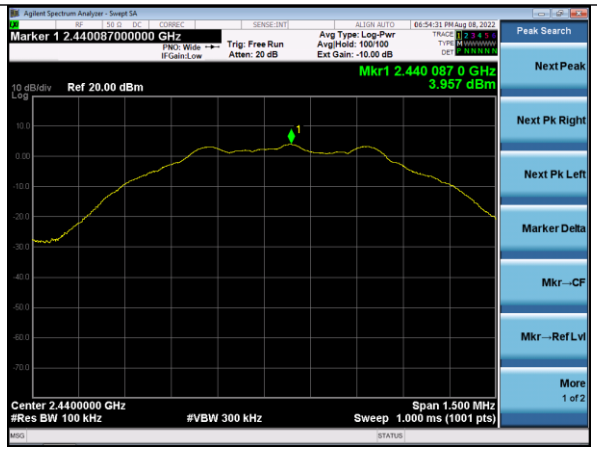
Data Table

Channel	Data Rate	PSD Reading (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)
37	BLE 1Mbps	3.6	8.0	4.4
17	BLE 1Mbps	4.0	8.0	4.0
39	BLE 1Mbps	3.7	8.0	4.3

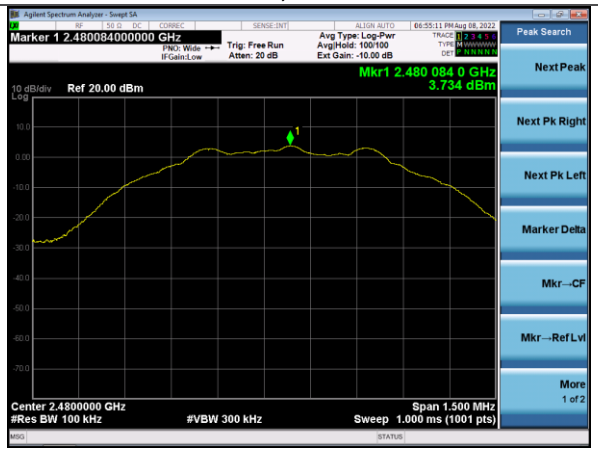
Plots



Peak PSD, Channel 37



Peak PSD, Channel 17



Peak PSD, Channel 39

5.1.5 Conducted Spurious Emissions

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	22.3°C	**R.H. %**	48.4%
Test Date	8/8/2022	**Location**	Conducted RF Bench
Requirement	FCC: 15.247 (d) IC: RSS-247 5.5	**Method**	ANSI C63.10 §11.11

Limits: 20 dBc

Reference Level = 4 dBm

Limit = -16 dBm

Test Parameters

Frequency	30 MHz – 25 GHz	**Setup**	Conducted
RBW	100 kHz	**VBW**	300 kHz
Detector(s)	Max Peak Hold	**Sweep Time**	Auto
Limit Calculation	Reference Level (dBm) – 20 dB = Limit (dBm)		

EUT Parameters

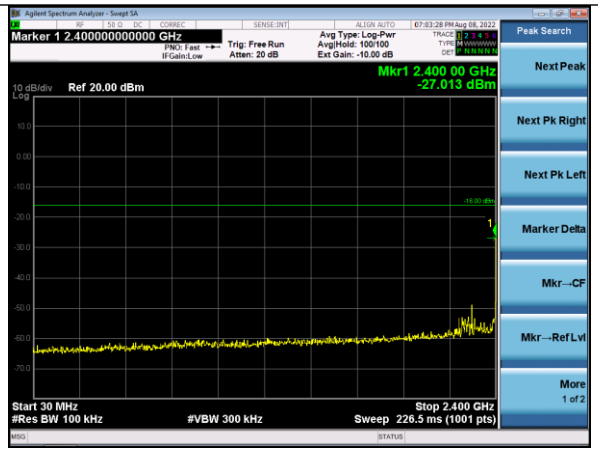
Input Power	3VDC Battery	**Mode**	BLE Transmit
Frequency	2402, 2440, 2480 MHz	**Channel**	37, 17, 39
Data Rate/Modulation	BLE 1Mbps		

Reference Level Plot

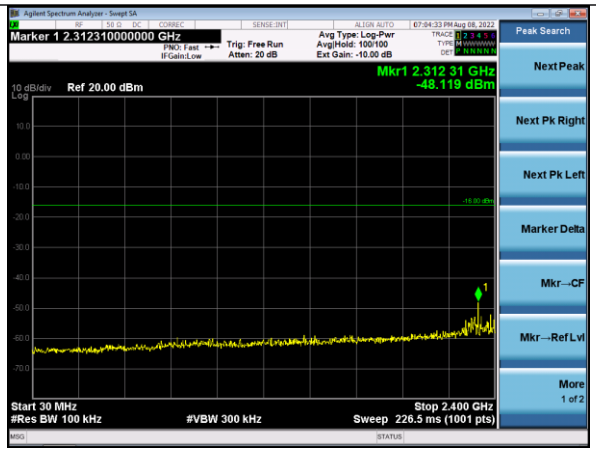
Data Table

Frequency (MHz)	Emission Measurement (dBm)	Limit (dBm)	Margin (dB)	Channel	Data Rate
2400.0	-27.0	-16.0	11.0	37	1M
2312.3	-48.1	-16.0	32.1	17	1M
2352.6	-48.1	-16.0	32.1	39	1M
2522.5	-48.4	-16.0	32.4	37	1M
2567.5	-48.2	-16.0	32.2	17	1M
2612.5	-47.6	-16.0	31.6	39	1M
2497.9	-52.1	-16.0	36.0	37	1M
2488.1	-53.1	-16.0	37.1	17	1M
2483.9	-43.7	-16.0	27.7	39	1M

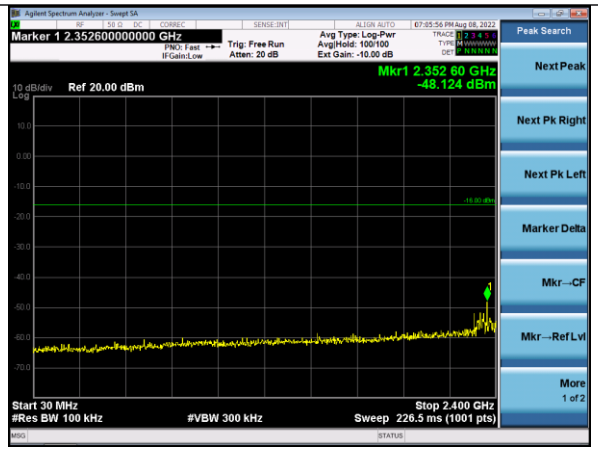
Plots



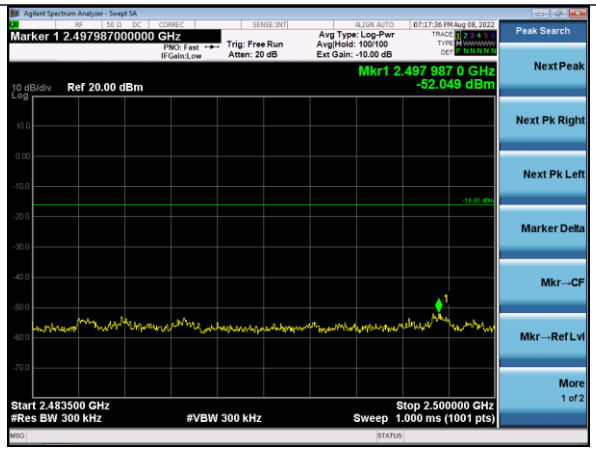
30-2400 MHz
Tx Ch 37



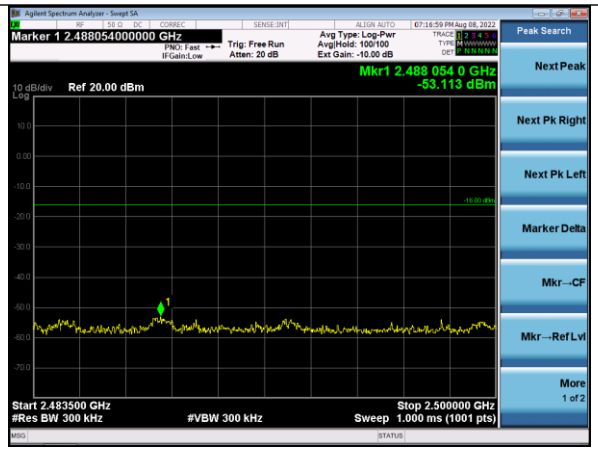
30-2400 MHz
Tx Ch 17



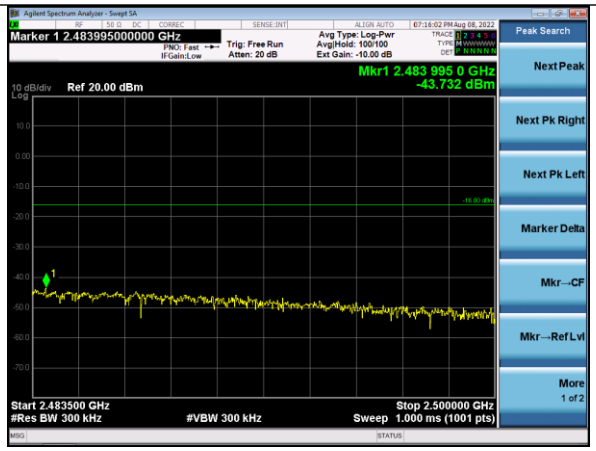
30-2400 MHz
Tx Ch 39



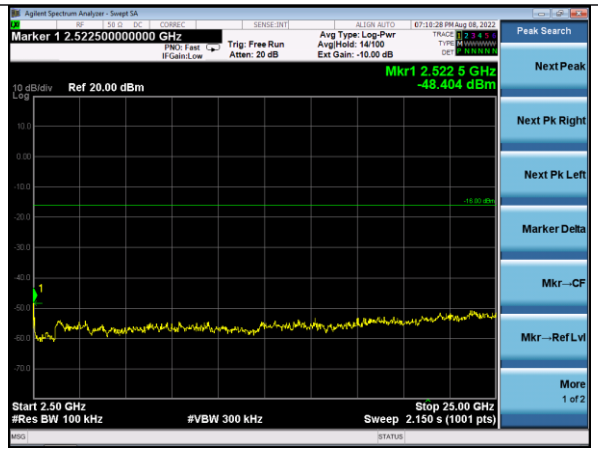
2483.5-2500 MHz
Tx Ch 37



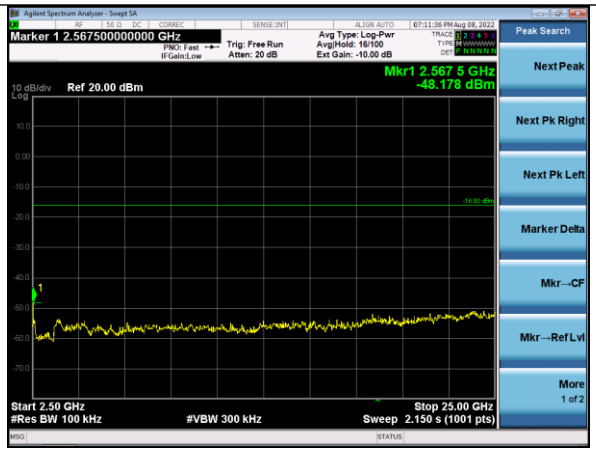
2483.5-2500 MHz
Tx Ch 17



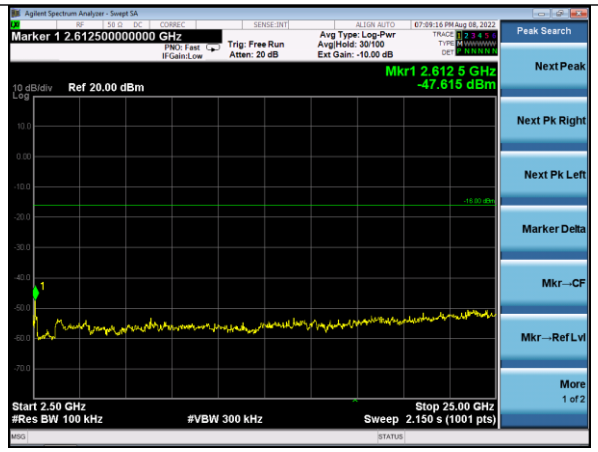
2483.5-2500 MHz
Tx Ch 39



2500-25000 MHz
Tx Ch 37



2500-25000 MHz
Tx Ch 17



2500-25000 MHz
Tx Ch 39

5.1.6 Frequency Stability

Operator	Anthony Smith	QA	Adam Alger
Temperature	21.5°C	R.H. %	49.4%
Test Date	8/10/2022	Location	Conducted RF Bench
Requirement	FCC: 2.1055 (d) IC: RSS-GEN 6.11	Method	ANSI C63.10 §6.8

Limits: Reported

Test Parameters

Frequency	2402, 2440, 2480 MHz	Setup	Conducted
RBW	1 kHz	VBW	3 kHz

EUT Parameters

Input Power	2.55, 3 VDC via DC Lab Supply	Mode	BLE CW
Frequency	2402, 2440, 2480 MHz	Channel	37, 17, 39
Notes	Only 85% and 100% checked due to being a battery powered device		

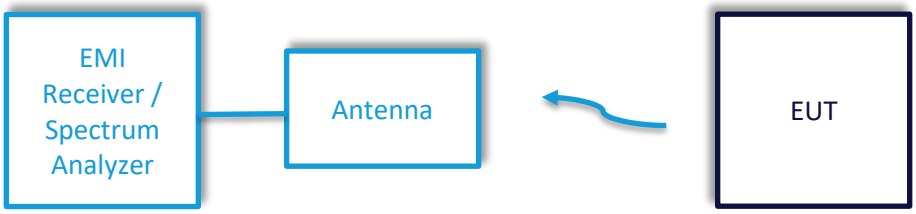
Data Table

Channel	Frequency (Hz) 2.55VDC	Frequency (Hz) 3VDC	Deviation (Hz)	Limit (Hz)	Margin (Hz)
37	2402072115	2402071839	276	120104	119828
17	2440073262	2440072938	324	122004	121680
39	2480074367	2480073942	425	124004	123579

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBµV/m) Margin (dB) = Limit (dBµV/m) - Corrected Reading (dBµV/m) Example at 4000 MHz: Reading = 40 dBµV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBµV/m Average Limit = 20 log (500) = 54 dBµV/m Margin = 54 dBµV/m - 50.8 dBµV/m = 3.2 dB

Block Diagram



5.2.1 Radiated Emissions – Intentional Radiators

Operator	Anthony Smith, Braden Smith	**QA**	Adam Alger, Jon Dilley
Temperature	22.4°C, 22.6°C, 21.5°C	**R.H. %**	47.1%, 44.1%, 48.4%
Test Date	8/8/2022, 8/9/2022	**Location**	Chamber 3, Chamber 5
Requirement	FCC: 15.247 (d) IC: RSS-GEN 8.10	**Method**	ANSI C63.10 §11.12

Limits:

Frequency (MHz)	Quasi Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Peak Limit (dBuV/m)
30-88	40.0	-	-
88-216	43.5	-	-
216-960	46.0	-	-
960-1000	54.0	-	-
1000-25000	-	54.0	74.0

Test Parameters

Frequency	30-25000 MHz	**Distance**	3m
Detector(s)	Peak, Quasi-Peak	**Table height**	80cm Below 1 GHz 150cm Above 1 GHz
RBW	120 kHz Below 1 GHz 1 MHz Above 1 GHz	**VBW**	1.2 MHz Below 1 GHz 3 MHz Above 1 GHz (Peak) 3 kHz Above 1 GHz (Average)
Notes	See Appendix A for Justification for Duty Cycle Relaxation		
Example Calculations	Peak Reading – Worst Case Duty Cycle = Calculated Average Duty Cycle Relaxation: 20*log(0.0233) = -32 dB Worst Case Duty Cycle: 2.33%		

EUT Parameters

Input Power	3VDC Battery	**Mode**	Transmit Modulated
Channels	37 (2402) 17 (2440) 39 (2480)	**Data Rate**	1 Mbps

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960163	Antenna - Log Periodic	A.H. Systems, Inc.	SAS-512-2	500	7/29/2021	7/29/2023	Active Calibration
AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	9/1/2021	9/1/2022	Active Calibration
AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	9/7/2021	9/7/2022	Active Calibration
AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	9/27/2021	9/27/2022	Active Calibration
AA 960211	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	977711030	9/27/2021	9/27/2022	Active Calibration
AA 960150	Antenna - Biconical	ETS Lindgren	3110B	0003-3346	10/7/2021	10/7/2022	Active Calibration
AA 960176	Cable	A.H. Systems, Inc.	SAC-26G-6	395	3/22/2022	3/22/2023	Active Verification
EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/11/2022	4/11/2023	Active Calibration
AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/13/2022	4/13/2023	Active Calibration
EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	4/13/2022	4/13/2023	Active Calibration
LSC-300	Cable	Chamber 3 Emissions	-	-	4/26/2022	4/26/2023	Active Verification

Band Edge Data Table

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading with Relaxation (dBµV/m)*	Average Limit (dBµV/m)	Average Margin (dB)	EUT Orientation	Note
2371.4	Vertical	150	260	18.9	54.0	35.1	Vertical	Low Channel
2484.6	Vertical	150	256	23.1	54.0	30.9	Vertical	High Channel

*Peak Reading – Worst Case Duty Cycle = Calculated Average
Duty Cycle Relaxation: 20*log(0.0233) = -32 dB

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	EUT Orientation	Note
2371.4	Vertical	150	260	50.9	74.0	23.1	Vertical	Low Channel
2484.6	Vertical	150	256	55.1	74.0	18.9	Vertical	High Channel

Spurious Emissions Data Table

Peak Data

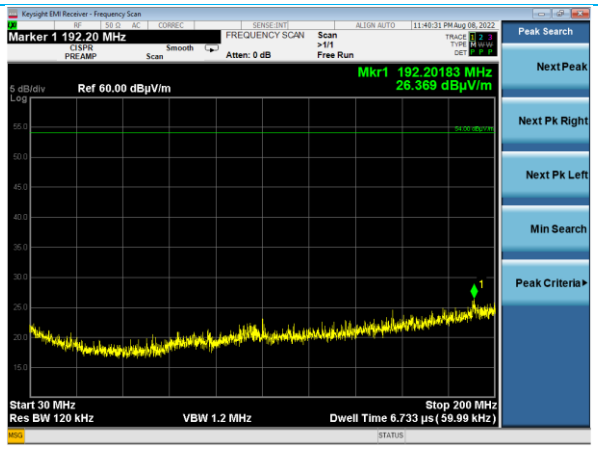
Channel	Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	EUT Orientation
17	7319.6	V	100	72	68.3	74.0	5.7	Vertical
17	7319.5	H	100	295	69.7	74.0	4.3	Vertical
17	7319.6	V	100	288	66.9	74.0	7.1	Horizontal
17	7319.5	H	100	160	66.1	74.0	7.9	Horizontal
17	7319.5	V	100	275	66.9	74.0	7.1	Flat
17	7319.6	H	100	194	68.5	74.0	5.5	Flat
37	7205.5	H	100	285	67.0	74.0	7.0	Vertical
39	7439.6	H	100	290	66.9	74.0	7.1	Vertical
17	4880.2	H	100	320	47.8	74.0	26.2	Vertical
17	4880.2	V	100	314	50.2	74.0	23.8	Vertical
17	4880.3	V	100	0	46.9	74.0	27.1	Horizontal
17	4879.7	H	274	353	47.2	74.0	26.8	Horizontal
17	4879.9	H	100	100	49.8	74.0	24.2	Flat
17	4880.2	V	100	318	45.7	74.0	28.3	Flat
37	4804.1	H	110	105	50.2	74.0	23.8	Flat
39	4959.9	H	112	83	48.4	74.0	25.6	Flat

Peak Reading with Relaxation against Average Limit

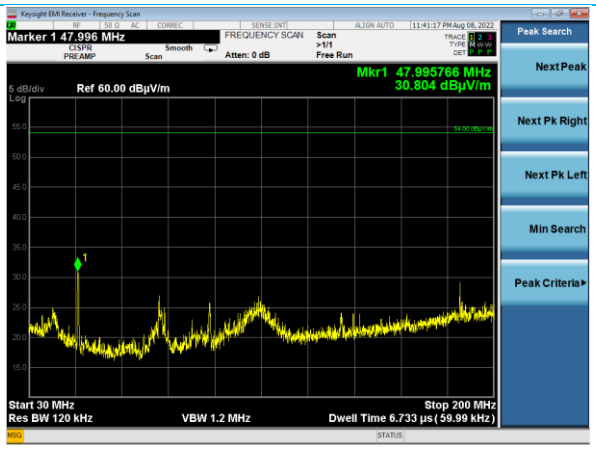
Channel	Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading with Relaxation (dBµV/m)*	Average Limit (dBµV/m)	Average Margin (dB)	EUT Orientation
17	7319.6	V	100	72	36.3	54.0	17.7	Vertical
17	7319.5	H	100	295	37.7	54.0	16.3	Vertical
17	7319.6	V	100	288	34.9	54.0	19.1	Horizontal
17	7319.5	H	100	160	34.1	54.0	19.9	Horizontal
17	7319.5	V	100	275	34.9	54.0	19.1	Flat
17	7319.6	H	100	194	36.5	54.0	17.5	Flat
37	7205.5	H	100	285	35.0	54.0	19.0	Vertical
39	7439.6	H	100	290	34.9	54.0	19.1	Vertical
17	4880.2	H	100	320	15.8	54.0	38.2	Vertical
17	4880.2	V	100	314	18.2	54.0	35.8	Vertical
17	4880.3	V	100	0	14.9	54.0	39.1	Horizontal
17	4879.7	H	274	353	15.2	54.0	38.8	Horizontal
17	4879.9	H	100	100	17.8	54.0	36.2	Flat
17	4880.2	V	100	318	13.7	54.0	40.3	Flat
37	4804.1	H	110	105	18.2	54.0	35.8	Flat
39	4959.9	H	112	83	16.4	54.0	37.6	Flat

*Peak Reading – Worst Case Duty Cycle = Calculated Average
Duty Cycle Relaxation: 20*log(0.0233) = -32 dB

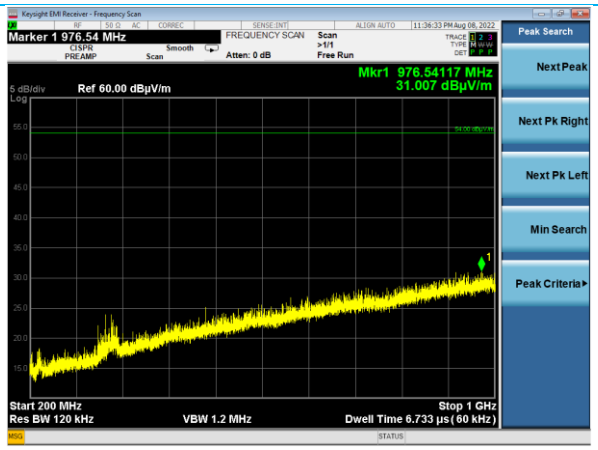
Plots



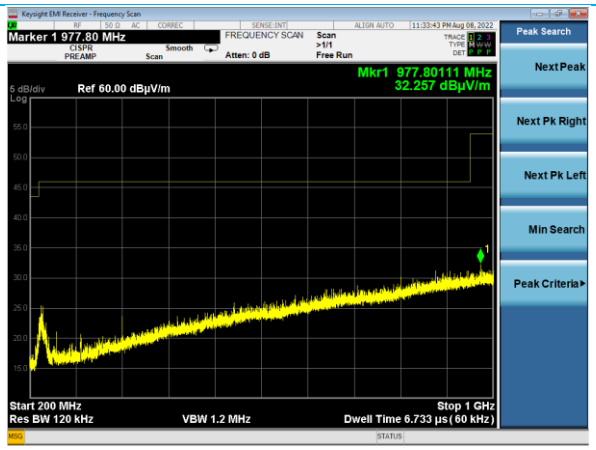
30-200 MHz Horizontal Polarity
EUT Vertical



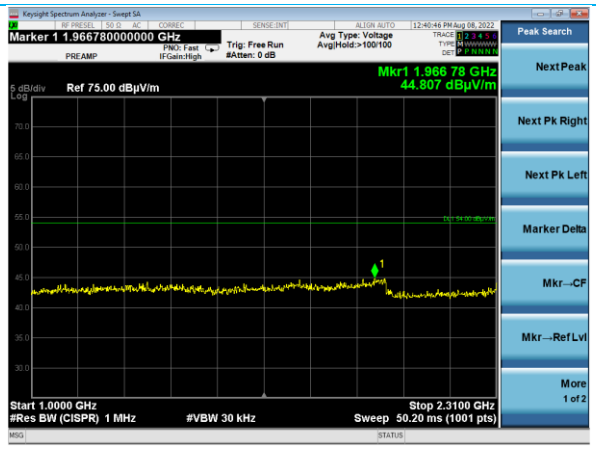
30-200 MHz Vertical Polarity
EUT Vertical



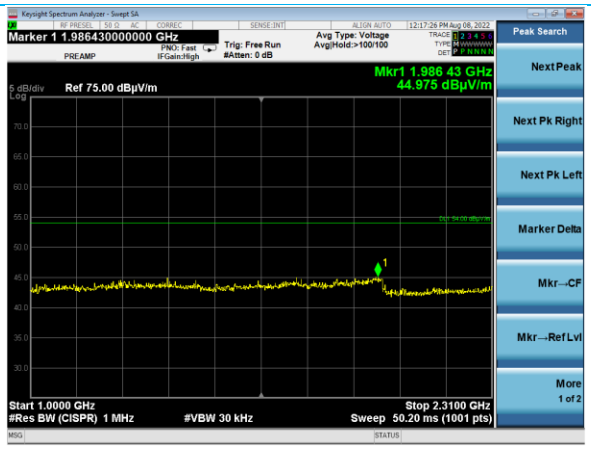
200-1000 MHz Horizontal Polarity
EUT Vertical



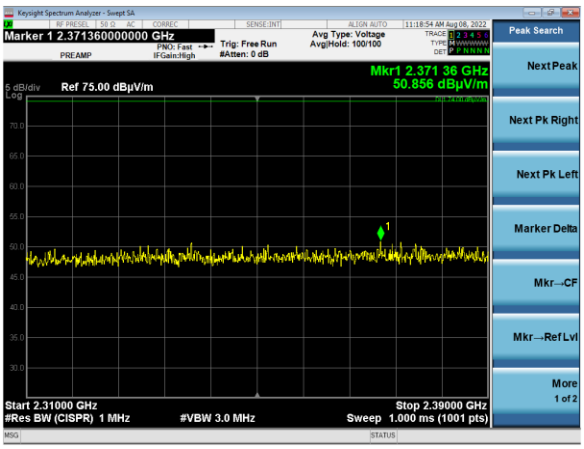
200-1000 MHz Vertical Polarity
EUT Vertical



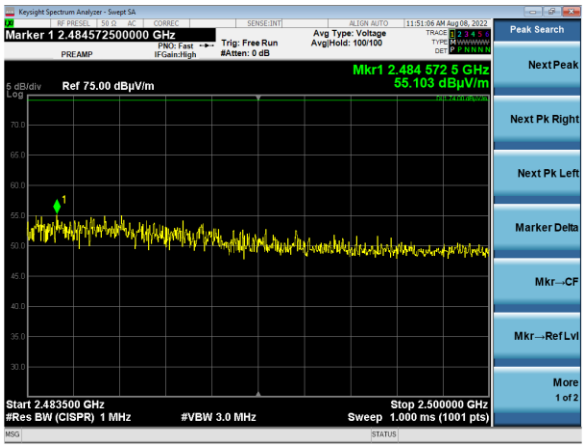
1000-2310 MHz Horizontal Polarity
EUT Vertical Tx High



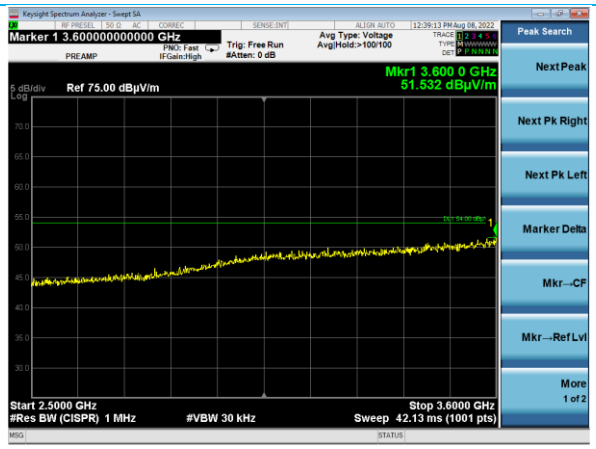
1000-2310 MHz Vertical Polarity
EUT Vertical Tx High



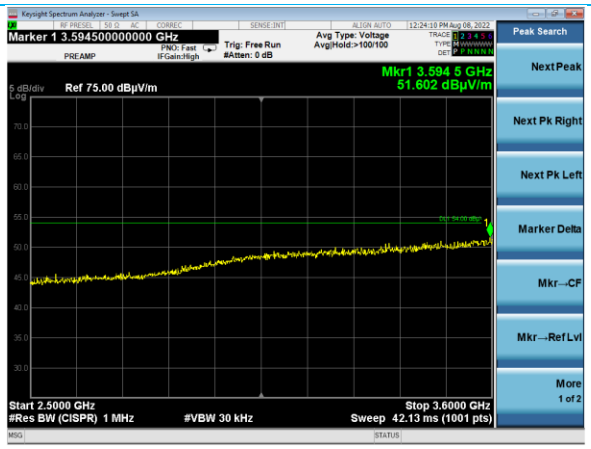
2310-2390 MHz Vertical Polarity
EUT Vertical Tx Low
Peak Measurement



2483.5-2500 MHz Vertical Polarity
EUT Vertical Tx High
Peak Measurement



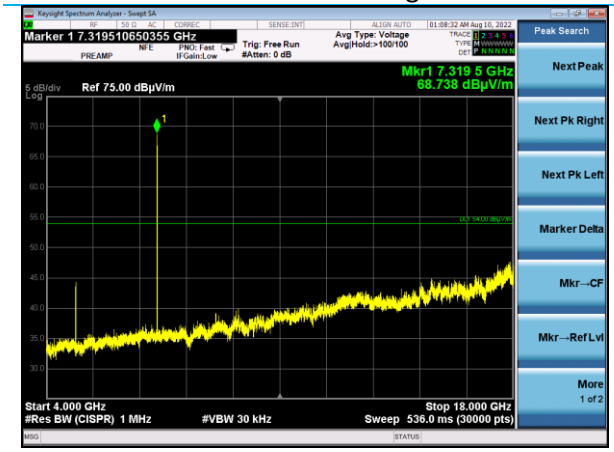
2500-3600 MHz Horizontal Polarity
EUT Vertical Tx High



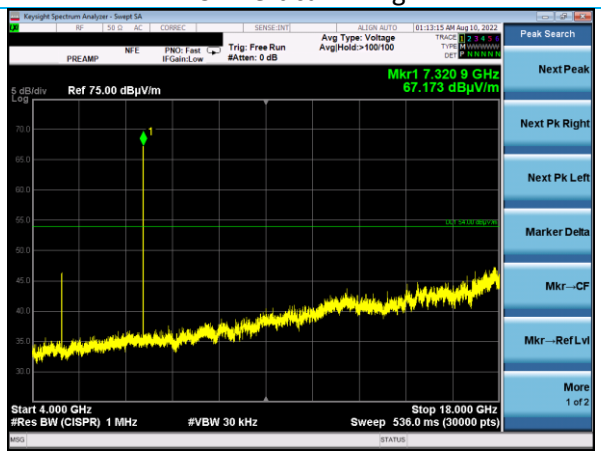
2500-3600 MHz Vertical Polarity
EUT Vertical Tx High

3600-4000 MHz Horizontal Polarity
EUT Vertical Tx High

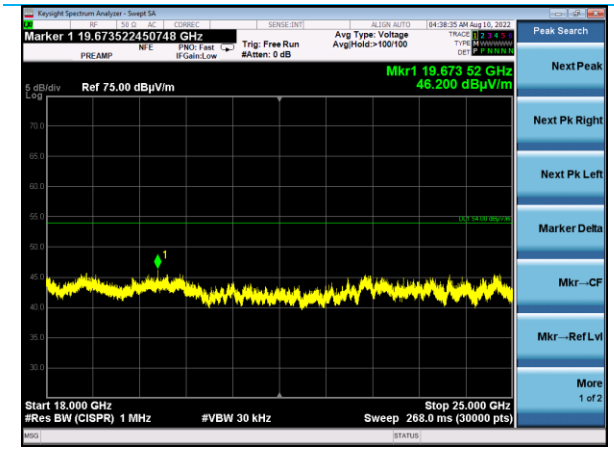
3600-4000 MHz Vertical Polarity
EUT Vertical Tx High



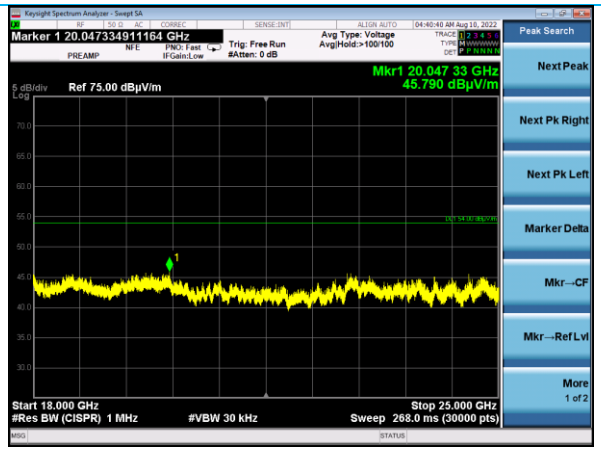
4000-18000 MHz Horizontal Polarity
EUT Vertical Tx Mid



4000-18000 MHz Vertical Polarity
EUT Vertical Tx Mid



18000-25000 MHz Horizontal Polarity
EUT Vertical Tx Mid



18000-25000 MHz Vertical Polarity
EUT Vertical Tx Mid

Appendix A – Justification for Duty Cycle Relaxation

General Device Description:

The DUT is a BLE (Bluetooth Low Energy or Bluetooth Smart) asset tag. The device is disposable and operates off a CR2032 coin cell battery. The PCBA within the device is 26 mm x 19.83 mm in size.

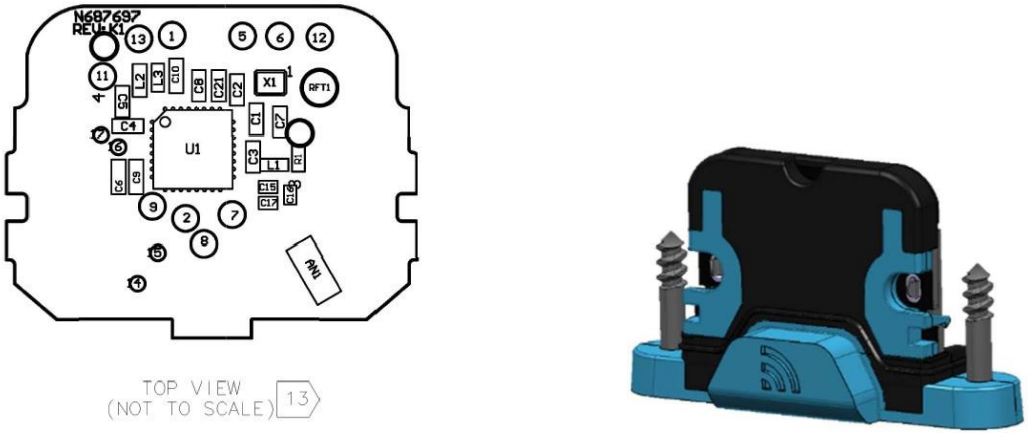


Figure 1: DCE042 DUT

Theory of Operation:

The device spends most 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 44 bytes (352 bits) and the BLE data-rate is 1Mb/s. Removing the pull-tab activates the device and puts it into an advertising mode at an initial 500 ms beacon rate for a duration of 30 seconds, after which it will revert to a 2 second advertisement rate. This beacon is 352 µs long and at its minimum advertisement period of 500 ms is confined within a 100 ms window. This is a duty cycle of 0.352%.

A BLE advertisement is generally used to solicit connectivity with another compliant device. The beacon packet (ex: transmission information) is generally limited to:

1) A unique device ID and information used for asset tracking or identification

2) An indicator of battery condition

While the above description comprises the main operation and use case, the device can be connected to for allocating purposes. This functionality compromises a rare occurrence across the device’s 1 year life span. A device would likely not be allocated more than once in its lifetime. **Even so, during this connection event, with a worse case TX rate within any window has a duty cycle of 2.3%.**

BLE Characteristics:

Connection Duration: 5 s

Connection Interval: 7.5 ms

Transmit Duration with any interval: 175 µs

Maximum Transmissions per Advertisement Interval: 1

Worst Case Duty Cycle Calculation:

Window of observation: 100 ms

Number of advertisement intervals: 13.33r

TX time per connection interval (max): 175 µs x 1 = 175 µs

Total TX time within a 100mS window: 13.33r x 175 µs = 2.33 ms

Duty Cycle: 2.33 ms / 100 ms = 2.33%

Duty Cycle Relaxation: 20*log(0.0233) = -32 dB

Conclusions or Summary:

The device spends the majority of its one-year life with a TX duty cycle under 1% (0.352%). The worst-case TX duration within any time window is a connection during which the device is allocated, which takes 5 seconds to complete. The TX duty cycle within this duration in any 100 ms window is 2.33%.

Exhibits:

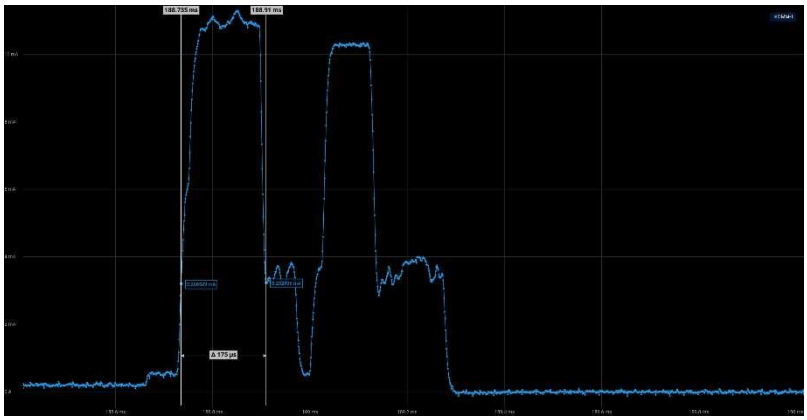


Figure 2: Single TX event (175 µs), 1 TX in the connection interval

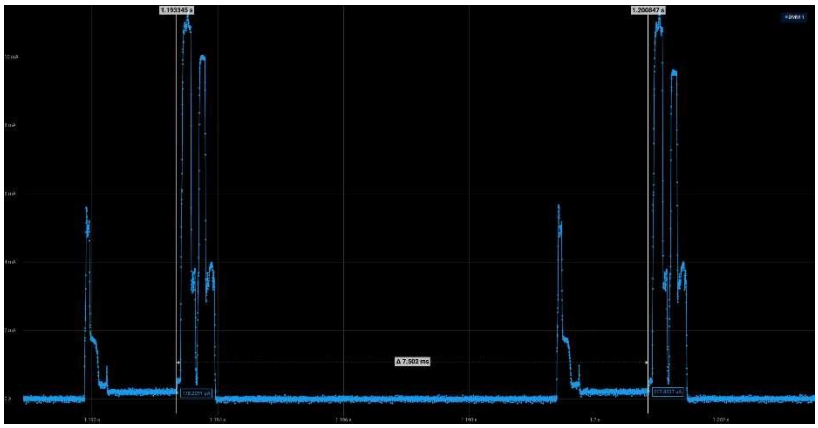


Figure 3: Connection in Progress

6 REVISION HISTORY

Version	Date	Notes	Person
0.0	10/10/2022	Initial Draft	Anthony Smith
1.0	10/18/2022	Details added to Initial Draft	Anthony Smith
2.0	10/21/2022	Final Draft	Anthony Smith
3.0	11/18/2022	Revised Draft	Anthony Smith
4.0	12/7/2022	Revised Final Draft	Anthony Smith
5.0	01/04/2023	Appendix A Revised	Anthony Smith

END OF REPORT