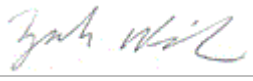
Test Report # 3560 A

Equipment Under Test:	OD1025-01
Requirement(s):	FCC 15.247 (DTS BLE), FCC 15.209, RSS-247, RSS-GEN
Test Date(s):	March 9th, 2022 to April 22nd, 2022
Prepared for:	Enovation Controls, LLC Attn: Jim Fox 5311 South 122nd East Avenue Tulsa, OK 74146

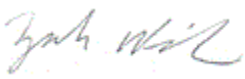
Report Issued by: Zach Wilson, EMC Engineer

Signature:  Date: 5/26/2022

Report Reviewed by: Adam Alger, Laboratory Manager

Signature:  Date: 4/28/2022

Report Constructed by: Zach Wilson, EMC Engineer II

Signature:  Date: 4/22/2022

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

Government of Canada

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 **March 9th, 2022, to April 22nd, 2022,** the Equipment Under Test (EUT), **OD1025-01**, as provided by **Enovation Controls, LLC** was tested to the following requirements of the **Federal Communications Commission and Innovation, Science** and **Economic Development Canada**:

FCC 15.247 DTS (BLE)

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) ISED: RSS-247: 5.2 a	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Compliant
FCC: 2.1049 ISED: RSS-GEN 6.7	Occupied Bandwidth	Reported	ANSI C63.10	Compliant
FCC: 15.247 (b)(3) ISED: RSS-247: 5.4 d	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Compliant
FCC: 15.247 (e) ISED: RSS-247: 5.2 b	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Compliant
FCC: 15.247 (d) ISED: RSS-247 5.5	RF Spurious Emissions	20 dBc	ANSI C63.10	Compliant
FCC: 15.247 (d) ISED: RSS-247 5.5	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.10	ANSI C63.10	Compliant
FCC: 2.1055 (d) ISED: RSS-GEN 8.11	Frequency Stability	Reported	ANSI C63.10	Compliant
FCC 15.247 (d) ISED: RSS-247 5.5	Simultaneous Transmission	KDB 996369 D v02 Section C	ANSI C63.10	Compliant

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 the specified limit
Emissions – Frequency	1% less than the specification

2 CLIENT INFORMATION

Company Name	Enovation Controls, LLC
Contact Person	Jim Fox
Address	5311 S. 122nd E. Avenue Tulsa, OK 74146

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	OD1025-01
Model Number	78350859
Serial Number	Engineering Sample
FCC ID	2A3FV-ECB01
ISED ID	28102-ECB01

2.2 Product Description

The EUT contains three Laird Connectivity BT850 BLE/BT modules. Each module contains a different trace layout. All modules use the chip antenna listed in section 2.5. Device powered at 14 VDC.

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 Antenna Information

Johanson Chip Antenna (3), P/N: 2450AT18D0100, with a peak gain of 1.5 dBi.

2.6 Programming Information

Programmed via CYbluetool v0.1.55.1. Radiated programming used host unit with selectable rates/channels/power via the front panel touch screen (code provided by client).

2.7 Data Rates/Modulations and Channels

BLE Data Rate/Modulations: GFSK 1Mbps

BLE Channels: 0 (2402 MHz), 19 (2440 MHz), 39 (2480 MHz)

3 REFERENCES

Publication	Edition	Date			Amd. 1	Amd. 2
FCC eCFR	-		2022		-	-
ANSI C63.10	-		2013		-	-
KDB 996369 D	02	2015	-	-		
RSS-247	2	2017	-	-		
RSS-GEN	5	2018	2019	2021		

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	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

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

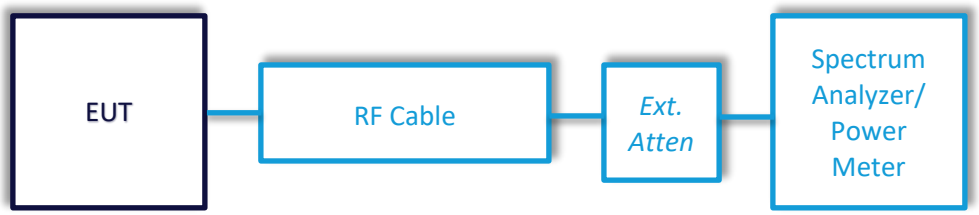
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %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



5.1.1 DTS Bandwidth (6dB)

Operator	Zach Wilson	**QA**	Anthony Smith
Temperature	20.5°C	**R.H. %**	25.4
Test Date	3/9/2022	**Location**	Bench
Requirement	FCC 15.247, RSS-247	**Method**	ANSI C63.10 §11.8.2

Limits: DTS BW greater than or equal to 500kHz

Test Parameters

Frequency	2402 MHz, 2440 MHz, 2480 MHz	**Setup**	Conducted
RBW	100kHz	**VBW**	300kHz
Detector(s)	Max peak hold	**Span**	3 MHz

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	3/22/2021	3/22/2022	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2021	4/12/2022	Active Calibration

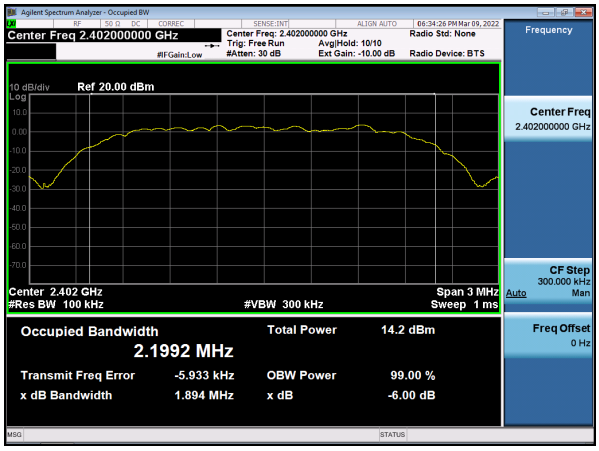
EUT Parameters

Input Power	14VDC via lab supply	**Mode**	BLE Modulated Transmit
Frequency	2402-2480 MHz	**Channel**	0, 19, 39

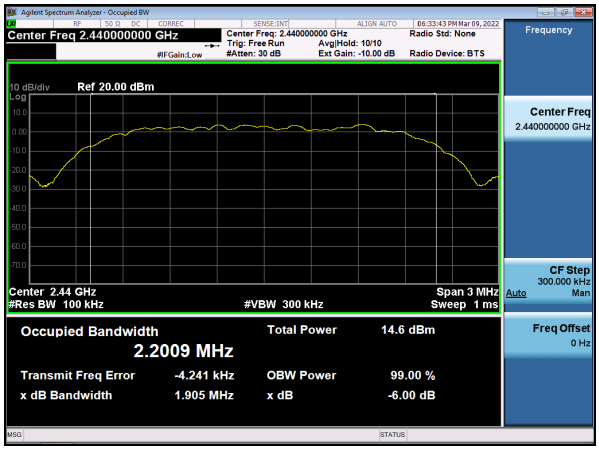
Data Table

Frequency (MHz)	6 dB/DTS BW (kHz)	Limit (kHz)	Margin (kHz)
2402.0	1894.0	500.0	1394.0
2440.0	1905.0	500.0	1405.0
2480.0	1899.0	500.0	1399.0

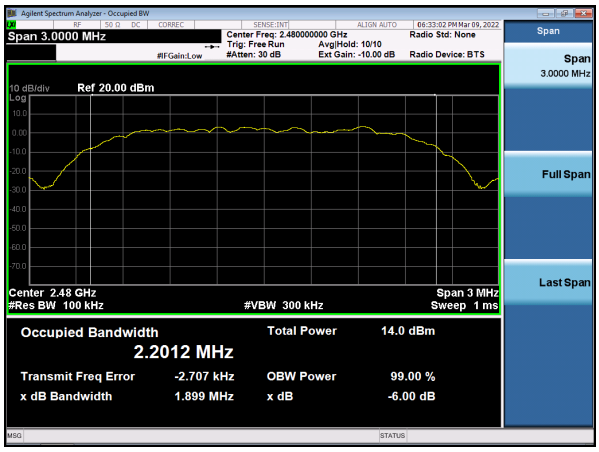
Plots



DTS BW, Channel 0



DTS BW, Channel 19



DTS BW, Channel 39

5.1.2 99% Occupied Bandwidth

Operator	Zach Wilson	**QA**	Anthony Smith
Temperature	20.5°C	**R.H. %**	25.4
Test Date	3/9/2022	**Location**	Bench
Requirement	FCC 15.247, RSS-247	**Method**	ANSI C63.10 §6.9.3

Limits: Reported

Test Parameters

Frequency	2402 MHz, 2440 MHz, 2480 MHz	**Setup**	Conducted
RBW	30 kHz	**VBW**	100 kHz
Detector(s)	Max peak hold	**Span**	3 MHz

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	3/22/2021	3/22/2022	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2021	4/12/2022	Active Calibration

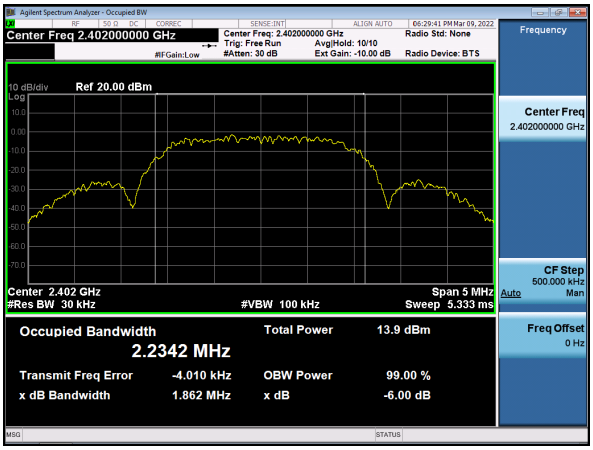
EUT Parameters

Input Power	14VDC via lab supply	**Mode**	BLE Modulated Transmit
Frequency	2402-2480 MHz	**Channel**	0, 19, 39

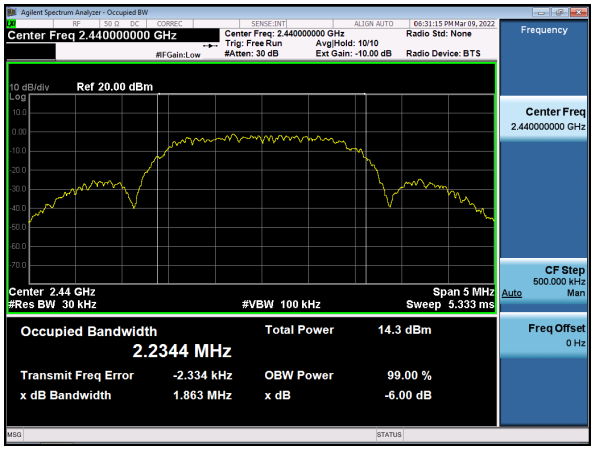
Data Table

Frequency (MHz)	99% OBW (kHz)
2402.0	2234.2
2440.0	2234.4
2480.0	2233.9

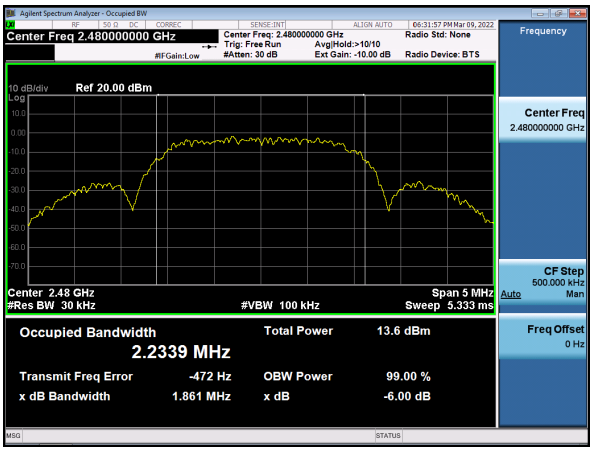
Plots



99% OBW, Channel 0



99% OBW, Channel 19



99% OBW, Channel 39

5.1.3 Peak Fundamental Emission Output Power

Operator	Zach Wilson	**QA**	Anthony Smith
Temperature	20.5°C	**R.H. %**	25.4
Test Date	3/9/2022	**Location**	Bench
Requirement	FCC 15.247, RSS-247	**Method**	ANSI C63.10 §11.9.1.1

Limits: 1W or 30dBm

Test Parameters

Frequency	2402 MHz, 2440 MHz, 2480 MHz	**Setup**	Conducted
RBW	3 MHz	**VBW**	50 MHz
Detector(s)	Max peak hold	**Span**	3 MHz

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	3/22/2021	3/22/2022	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2021	4/12/2022	Active Calibration

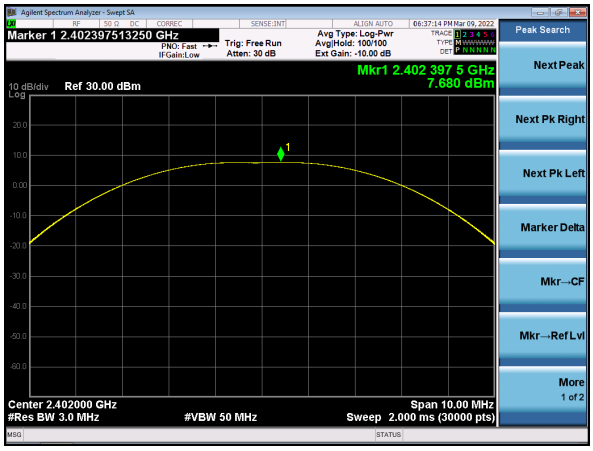
EUT Parameters

Input Power	14 VDC via lab supply	**Mode**	BLE Modulated Transmit
Frequency	2402-2480 MHz	**Channel**	0, 19, 39

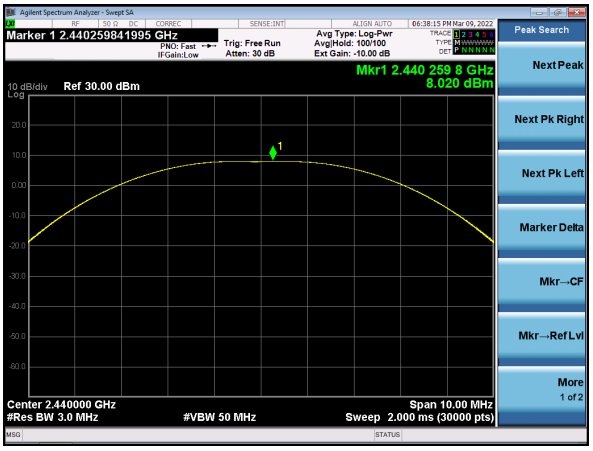
Data Table

Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
2402.0	7.7	30.0	22.3
2440.0	8.0	30.0	22.0
2480.0	7.4	30.0	22.6

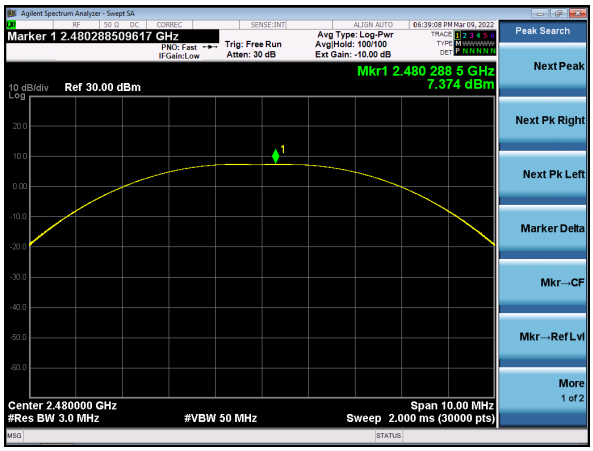
Plots



Output Power, Channel 0



Output Power, Channel 19



Output Power, Channel 39

5.1.4 Peak Power Spectral Density

Operator	Zach Wilson	**QA**	Anthony Smith
Temperature	20.5°C	**R.H. %**	25.4
Test Date	3/9/2022	**Location**	Bench
Requirement	FCC 15.247, RSS-247	**Method**	ANSI C63.10 §11.10.2

Limits: 8dBm/3kHz

Test Parameters

Frequency	2402 MHz, 2440 MHz, 2480 MHz	**Setup**	Conducted
RBW	3 kHz	**VBW**	10 kHz
Detector(s)	Max peak hold	**Span**	3 MHz

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	3/22/2021	3/22/2022	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2021	4/12/2022	Active Calibration

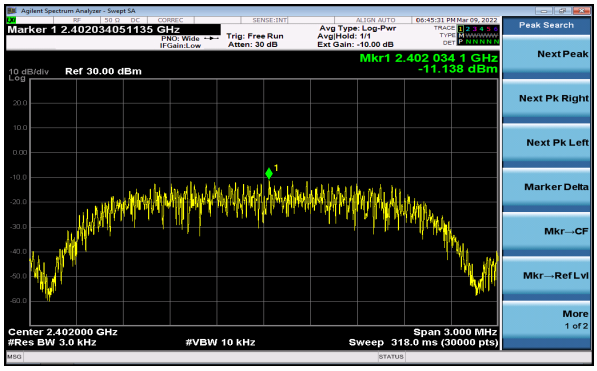
EUT Parameters

Input Power	14VDC via lab supply	**Mode**	BLE Modulated Transmit
Frequency	2402-2480 MHz	**Channel**	0, 19, 39

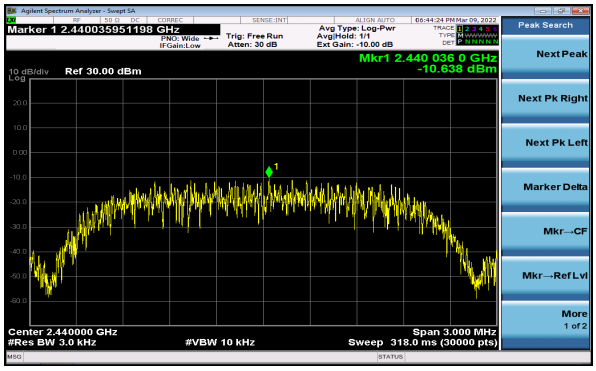
Data Table

Frequency (MHz)	Peak Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dBm/3kHz)
2402.0	-11.1	8.0	19.1
2440.0	-10.6	8.0	18.6
2480.0	-11.5	8.0	19.5

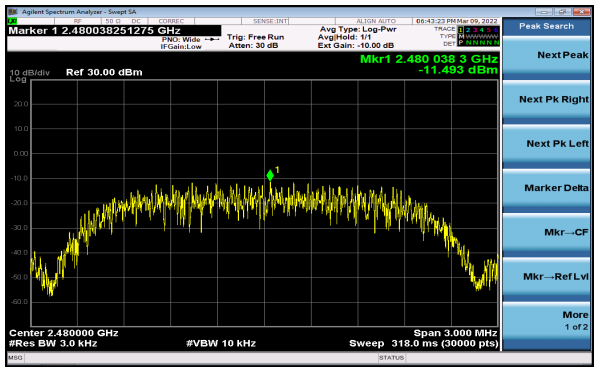
Plots



PSD, Channel 0



PSD, Channel 19



PSD, Channel 39

5.1.5 Conducted Spurious Emissions and Conducted Band Edge Measurements

Operator	Zach Wilson	**QA**	Anthony Smith
Temperature	20.5°C	**R.H. %**	25.4
Test Date	3/9/2022	**Location**	Bench
Requirement	FCC 15.247, RSS-247	**Method**	ANSI C63.10 §11.11, 11.12, 11.13

Limits: 20 dBc

Test Parameters

Frequency	30-25000 MHz	**Setup**	Conducted
RBW	100 kHz	**VBW**	300 kHz
Detector(s)	Max hold with peak detector for plots and data.		
Notes	Mid channel shown for spurious emissions		

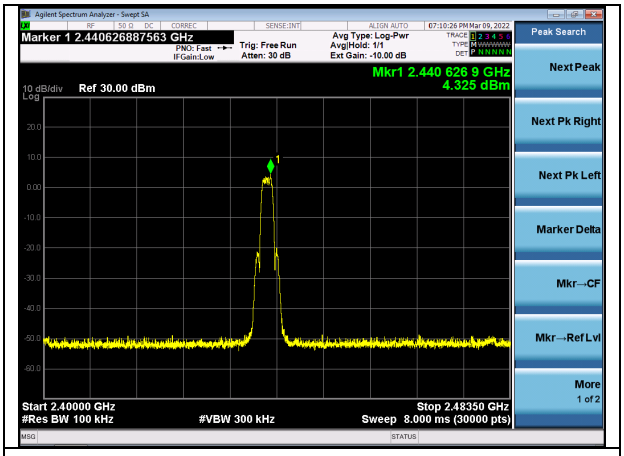
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	3/22/2021	3/22/2022	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2021	4/12/2022	Active Calibration

EUT Parameters

Input Power	14VDC via lab supply	**Mode**	BLE Transmit
Frequency	2402, 2440, 2480 MHz	**Channel**	0, 19, 39

Reference Level Plot



Level = 4.3 dBm
20 dBc Limit = -15.7 dBm

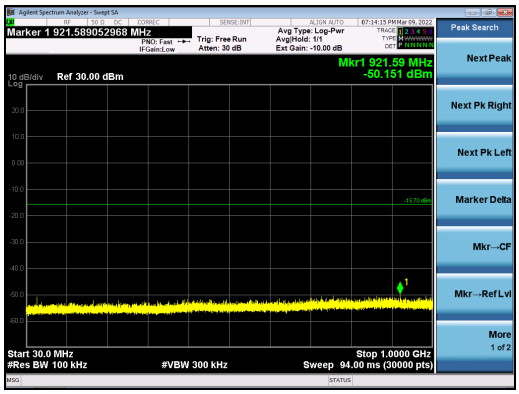
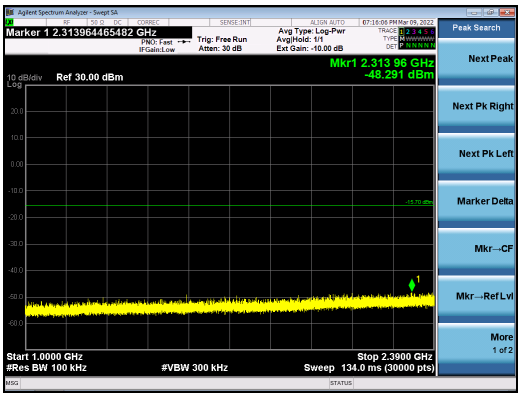
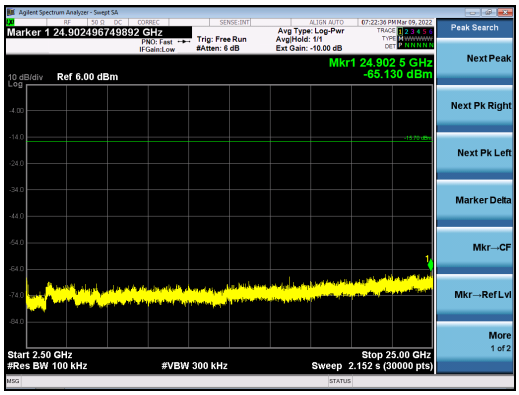
Data Tables

Frequency (MHz)	Channel	Data Rate	Peak Reading (dBm)	Limit (dBm)	Margin (dB)
2400.0	0	BLE	-24.1	-15.7	8.4
2483.5	39	BLE	-32.8	-15.7	17.1

Conducted Band Edge Plots

	
2390-2400 MHz, Channel 0, BR	2483.5-2500 MHz, Channel 78, BR

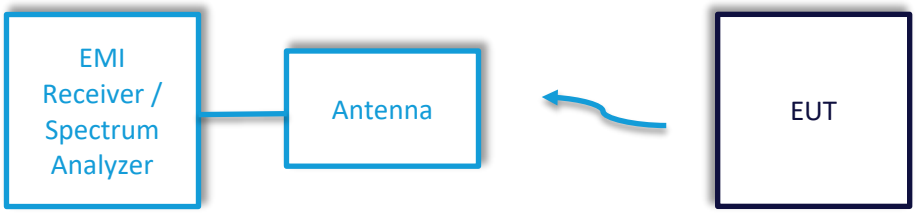
Conducted Spurious Plots

	
30-1000 MHz, BLE, Channel 19	1000-2390 MHz, BLE, Channel 19
	
2.5-25 GHz, BLE, Channel 19	

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 Frequency Stability

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	24.3°C	**R.H. %**	31.60%
Test Date	4/22/2022	**Location**	Chamber 3
Requirement	FCC 2.1055, RSS-GEN	**Method**	ANSI C63.10 §6.8.2

Limits: Reported

Test Parameters

Frequency	2402, 2440, 2480 MHz	**Setup**	Radiated

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	9/7/2021	9/7/2022	Active Calibration
EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	4/13/2022	4/13/2023	Active Calibration
LSC-300	Cable	Chamber 3 Emissions	-	-	4/15/2022	4/15/2023	Active Verification

EUT Parameters

Input Power	12.6, 14.0, 15.4 VDC via lab supply	**Mode**	BLE CW
Frequency	2402, 2440, 2480 MHz	**Channel**	0, 19, 39

Data Table

	Input Voltage		
	12.6 VDC	**14.0 VDC**	**15.4 VDC**
Channel	**Center Frequency (Hz)**	**Center Frequency (Hz)**	**Center Frequency (Hz)**
0	2401984605	2401984560	2401984477
19	2439986605	2439986575	2439986580
39	2479988725	2479988731	2479988787

5.2.2 Radiated Emissions

Operator	Jon Dilley; Braden Smith	**QA**	Anthony Smith; Alec Krabbe
Temperature	23.7°C	**R.H. %**	21.20%
Test Date	3/29/2022-4/1/2022	**Location**	Chamber 3
Requirement	FCC 15.209, FCC 15.247, RSS-247, RSS-GEN	**Method**	ANSI C63.10

Limits:

Frequency (MHz)	Quasi-Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Limit (dBµV/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 MHz – 25 GHz	**Distance**	3m
Detector(s)	Quasi-peak detector for measurements under 1 GHz. Average measurements were made with a reduced VBW of 10Hz as the signal is 100% duty cycle. Max peak hold for plots.	**Table height**	80cm (below 1 GHz) 150cm (above 1 GHz)
RBW	Below 1 GHz: 120 kHz Above 1 GHz: 1 MHz	**VBW**	Below 1 GHz: 1.2 MHz Above 1 GHz, Peak: 3 MHz Above 1 GHz, Avg.: 10 Hz **30 kHz for emission identification*
Plots	Worst case plots are shown.	**EUT Orientations**	Flat, Vertical, Horizontal
Notes	Significant host emissions not related to radio. Host emissions were found compliant with FCC 15.109 class A limits in host product report. Reference plots provided with radios disabled. Three BLE radios were tested.		

EUT Parameters

Input Power	14 VDC	**Mode**	BLE Transmit
Channel	0, 19, 39	**Data Rate/Modulation**	GFSK 1Mbps

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960005	Antenna - Biconical	EMCO	93110B	9601-2280	8/19/2021	8/19/2022	Active Calibration
AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/13/2022	4/13/2023	Active Calibration
AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	9/27/2021	9/27/2022	Active Calibration
AA 960176	Cable	A.H. Systems, Inc.	SAC-26G-6	395	3/22/2022	3/22/2023	Active Verification
AA 960195	Antenna - Log Periodic	A.H. Systems, Inc.	SAS-512-2	557	8/17/2021	8/17/2022	Active Calibration
EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/11/2022	4/11/2023	Active Calibration
EE 960196	Meter - Hygro-Thermometer	Control Company	90080-03	180045462	5/14/2021	5/14/2022	Active Calibration
LSC-300	Cable	Chamber 3 Emissions	-	-	4/15/2022	4/15/2023	Active Verification

Data Tables – Module 1

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)	Note
70.7	Horizontal	Vertical	100	0	30.5	40.0	9.5	Emissions not a function of radio
153.0	Horizontal	Vertical	100	80	31.9	43.5	11.6	Emissions not a function of radio
153.0	Horizontal	Horizontal	195	261	32.7	43.5	10.8	Emissions not a function of radio
396.4	Horizontal	Vertical	146	178	41.5	46.0	4.5	Emissions not a function of radio

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Channel
2362.0	Vertical	Vertical	176	119	40.0	54.0	14.0	0
2483.5	Vertical	Vertical	176	119	40.4	54.0	13.6	39

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Channel
2331.9	Vertical	Vertical	176	119	52.9	74.0	21.1	0
2484.7	Vertical	Vertical	176	119	53.9	74.0	20.1	39

Data Tables – Module 2

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)	Note
70.7	Horizontal	Vertical	100	0	30.1	40.0	9.9	Emissions not a function of radio
153.3	Horizontal	Vertical	100	117	32.1	43.5	11.4	Emissions not a function of radio
153.3	Horizontal	Horizontal	100	100	29.8	43.5	13.7	Emissions not a function of radio
395.5	Horizontal	Vertical	135	185	43.4	46.0	2.6	Emissions not a function of radio
800.0	Horizontal	Vertical	160	248	39.4	46.0	6.6	Emissions not a function of radio

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Channel
2362.1	Vertical	Vertical	183	100	40.0	54.0	14.0	0
2496.4	Vertical	Vertical	177	102	40.4	54.0	13.6	39

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Channel
2384.3	Vertical	Vertical	183	100	52.4	74.0	21.6	0
2487.2	Vertical	Vertical	177	102	53.3	74.0	20.7	39

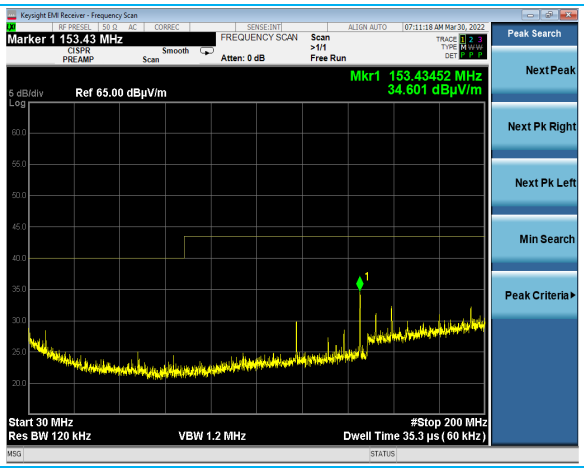
Data Tables – Module 3

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)	Note
129.8	Horizontal	Vertical	100	17	29.9	43.5	13.6	Emissions not a function of radio
153.3	Horizontal	Vertical	100	115	32.0	43.5	11.5	Emissions not a function of radio
153.4	Horizontal	Horizontal	223	111	30.7	43.5	12.8	Emissions not a function of radio
600.0	Horizontal	Horizontal	142	157	38.9	46.0	7.1	Emissions not a function of radio
383.3	Horizontal	Horizontal	110	319	38.4	46.0	7.6	Emissions not a function of radio
800.0	Horizontal	Vertical	200	94	41.8	46.0	4.2	Emissions not a function of radio

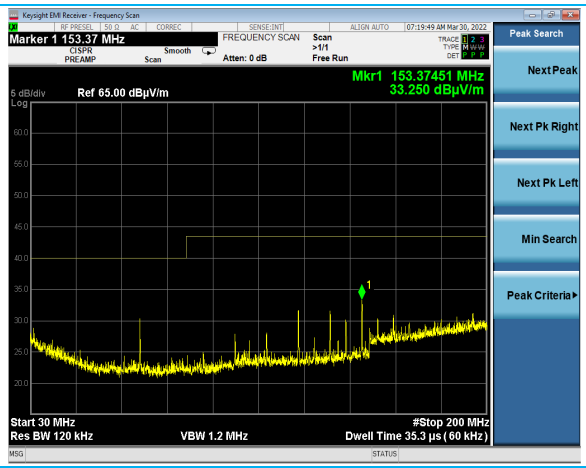
Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Channel
2362.1	Vertical	Vertical	153	94	39.9	54.0	14.1	0
2493.3	Vertical	Vertical	153	94	40.4	54.0	13.6	39

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Channel
2383.8	Vertical	Vertical	153	94	52.6	74.0	21.4	0
2495.1	Vertical	Vertical	153	94	52.9	74.0	21.1	39

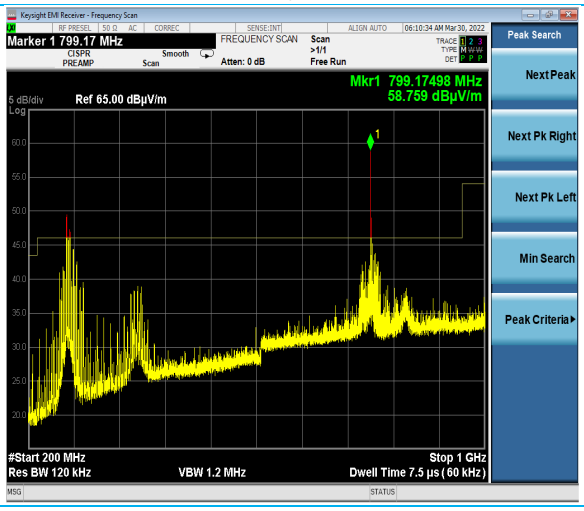
Plots – Reference, Radios Off



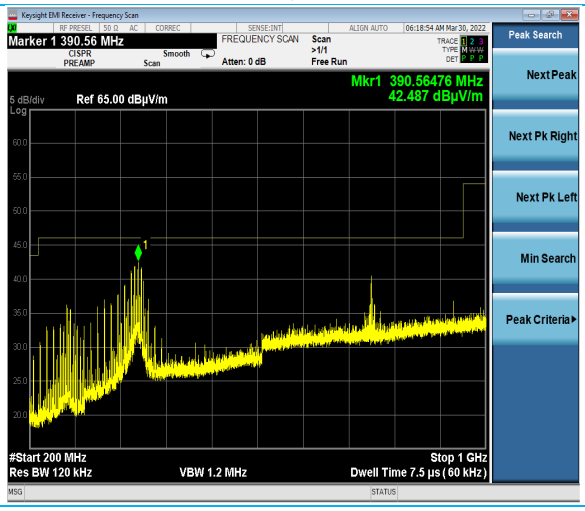
30-200 MHz, Horizontal Antenna
All radios disabled, REFERENCE ONLY



30-200 MHz, Vertical Antenna
All radios disabled, REFERENCE ONLY

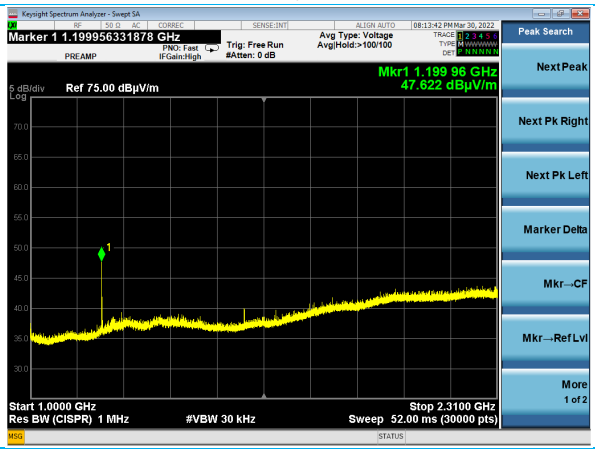


200-1000 MHz, Horizontal Antenna
All radios disabled, REFERENCE ONLY



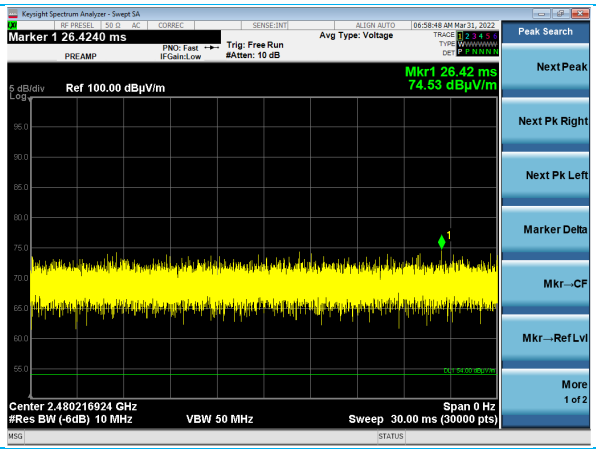
200-1000 MHz, Vertical Antenna
All radios disabled, REFERENCE ONLY

1000-2310 MHz, Horizontal Antenna
All radios disabled, REFERENCE ONLY



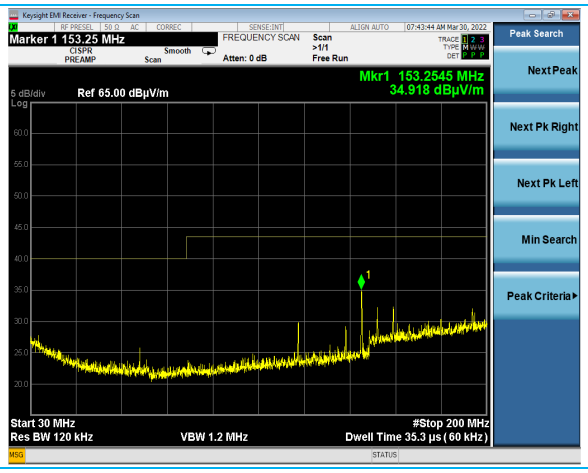
1000-2310 MHz, Vertical Antenna
All radios disabled, REFERENCE ONLY

Plots – Duty Cycle

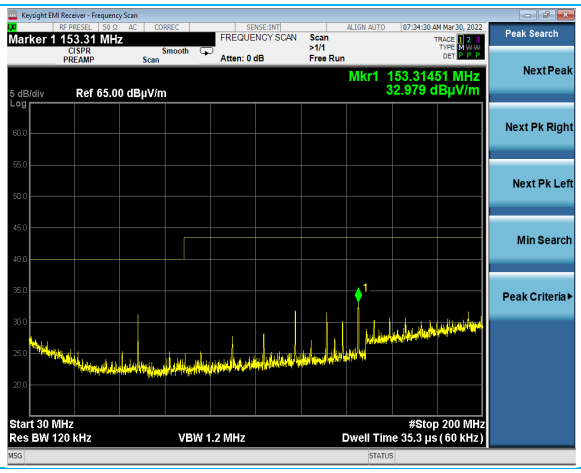


Duty Cycle, BLE, 100%

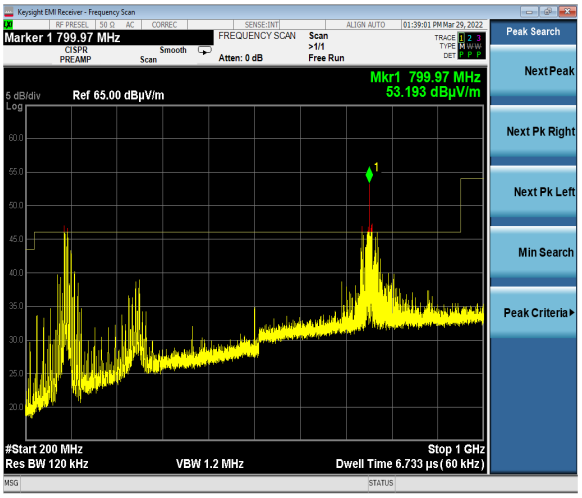
Plots – Module 1



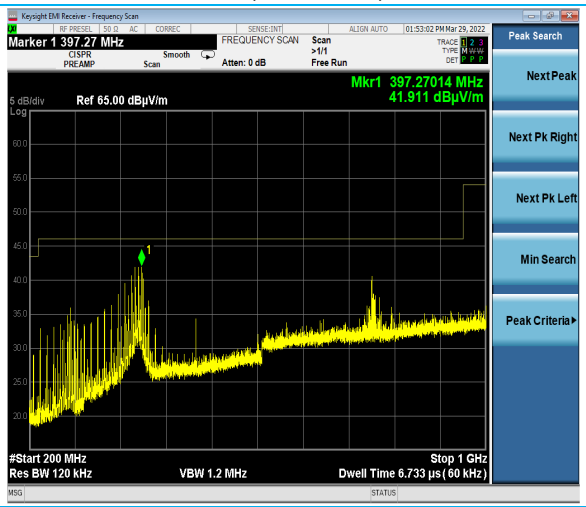
30-200 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 1



30-200 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 1



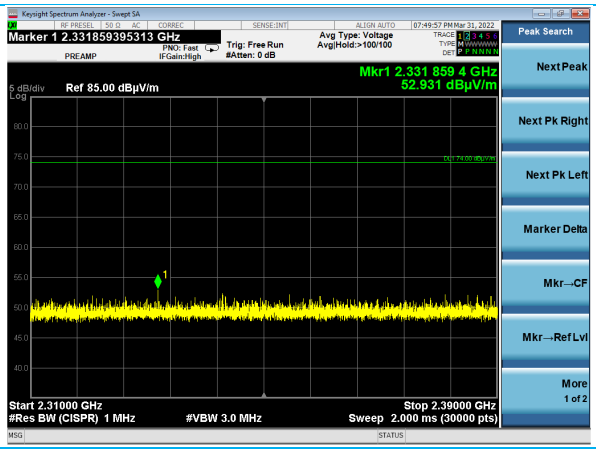
200-1000 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 1



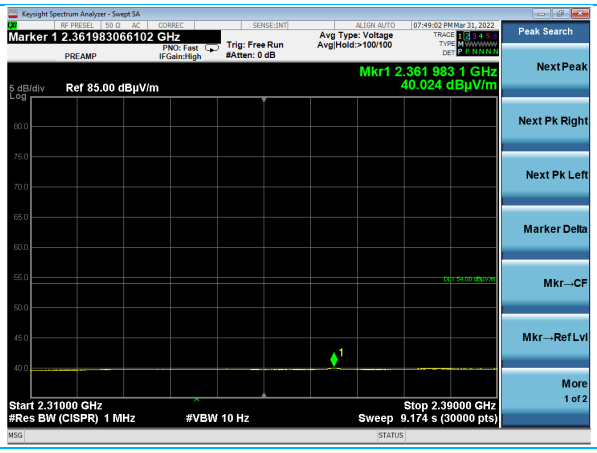
200-1000 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 1

1000-2310 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 1

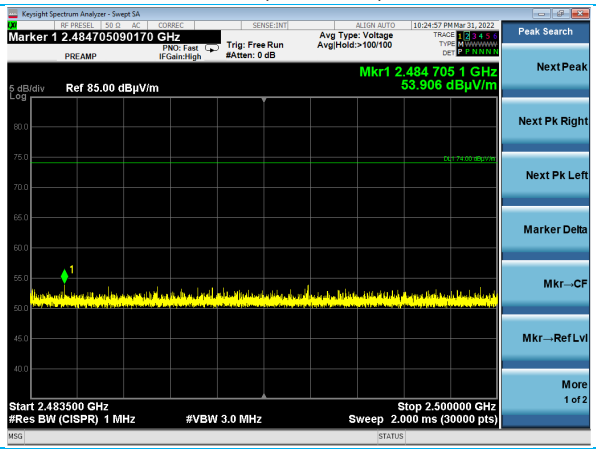
1000-2310 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 1



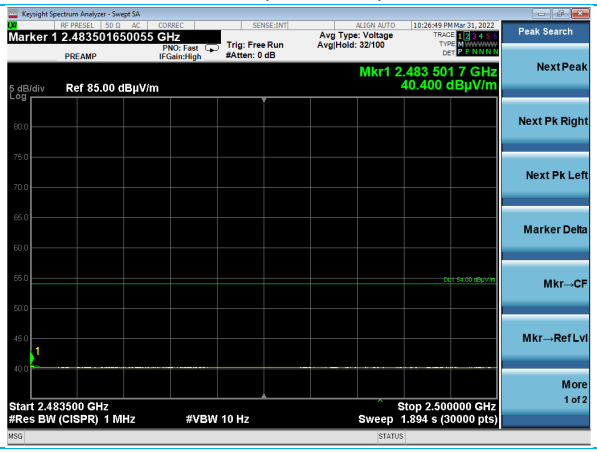
2310-2390 MHz, Peak
Horizontal EUT, BLE Ch. 1, Module 1



2310-2390 MHz, Average
Horizontal EUT, BLE Ch. 1, Module 1



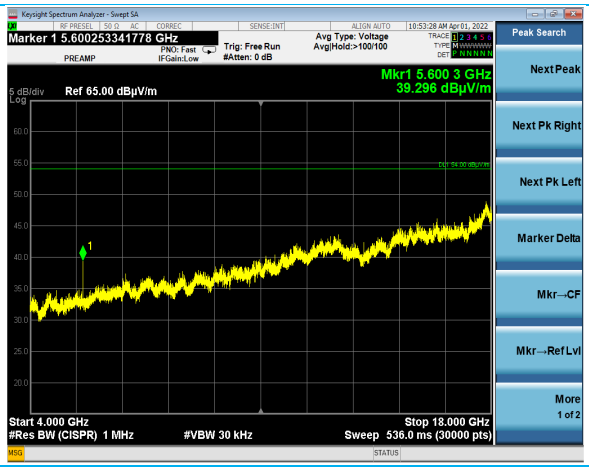
2483.5-2500 MHz, Peak
Horizontal EUT, BLE Ch. 39, Module 1



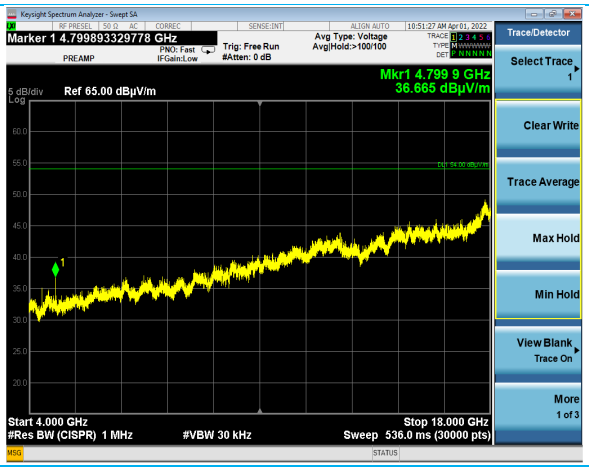
2483.5-2500 MHz, Average
Horizontal EUT, BLE Ch. 39, Module 1

2500-4000 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 1

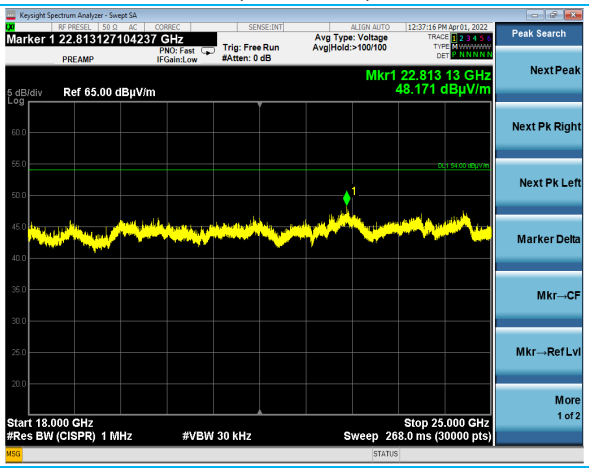
2500-4000 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 1



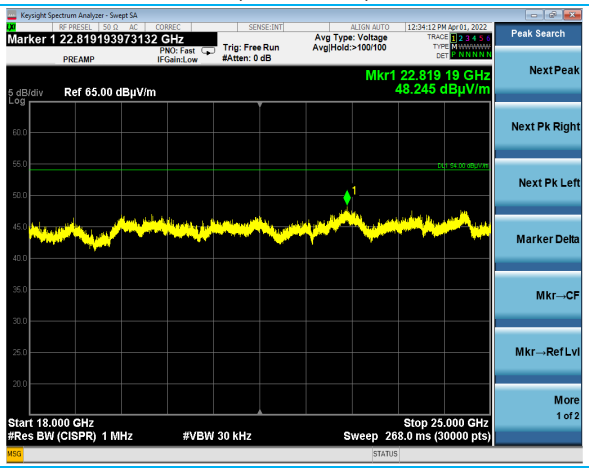
4-18 GHz, Horizontal Antenna
Vertical EUT, BLE Ch. 19, Module 1



4-18 GHz, Vertical Antenna
Vertical EUT, BLE Ch. 19, Module 1

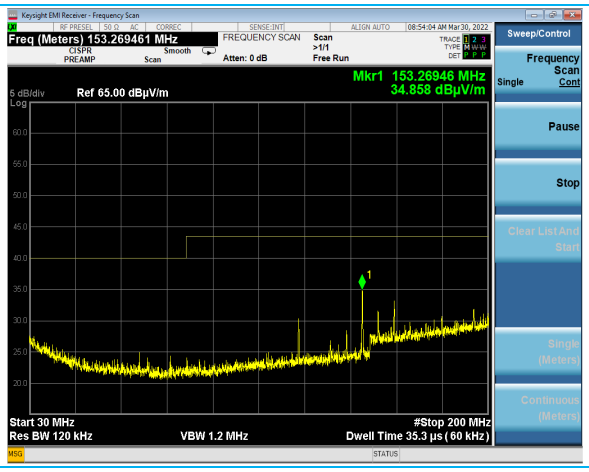


18-25 GHz, Horizontal Antenna
Vertical EUT, BLE Ch. 19, Module 1

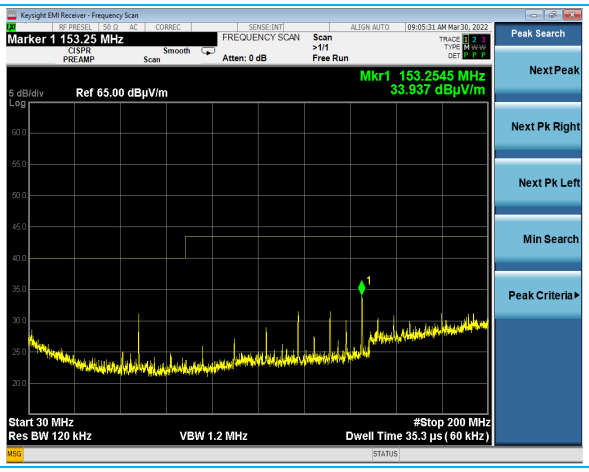


18-25 GHz, Vertical Antenna
Vertical EUT, BLE Ch. 19, Module 1

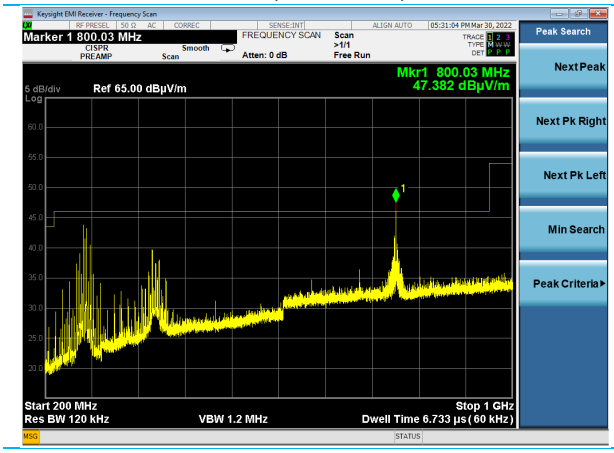
Plots – Module 2



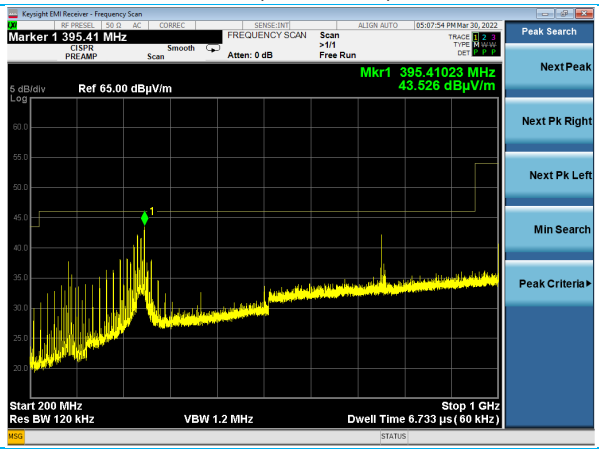
30-200 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 2



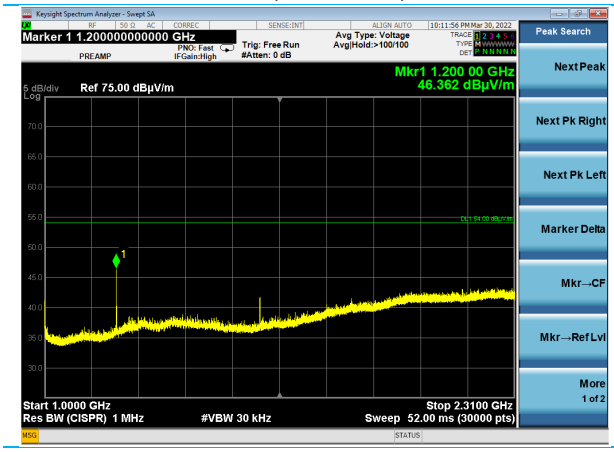
30-200 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 2



200-1000 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 2

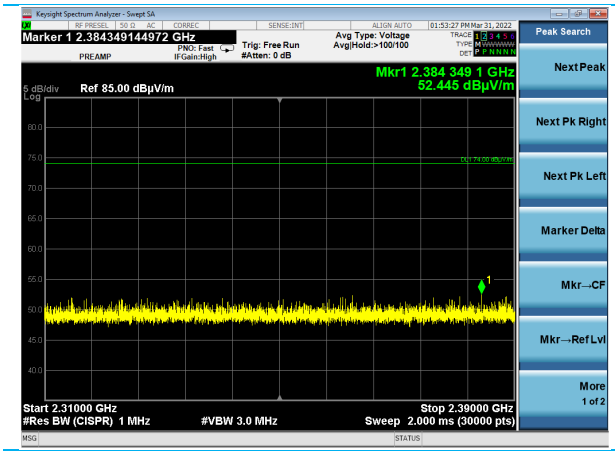


200-1000 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 2

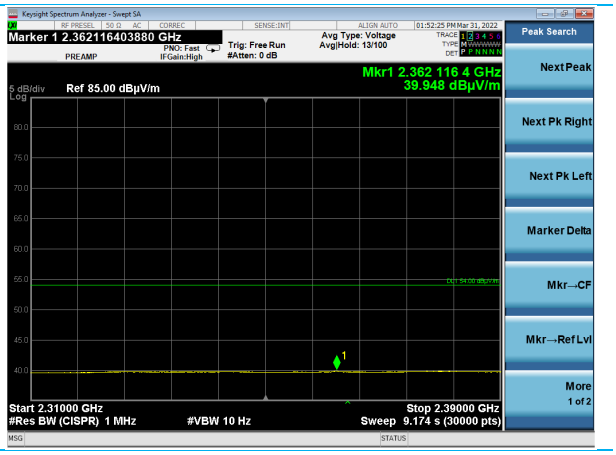


1000-2310 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 2

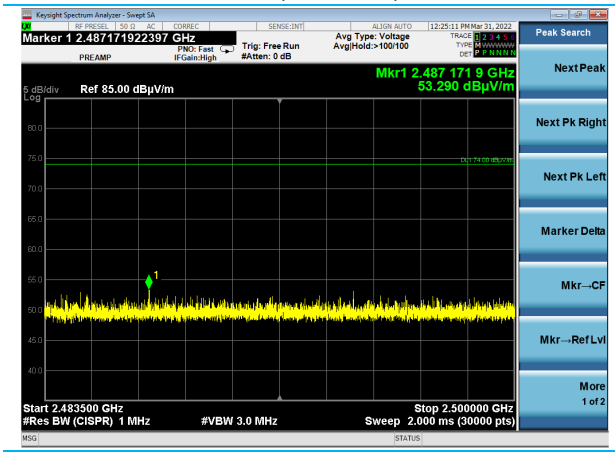
1000-2310 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 2



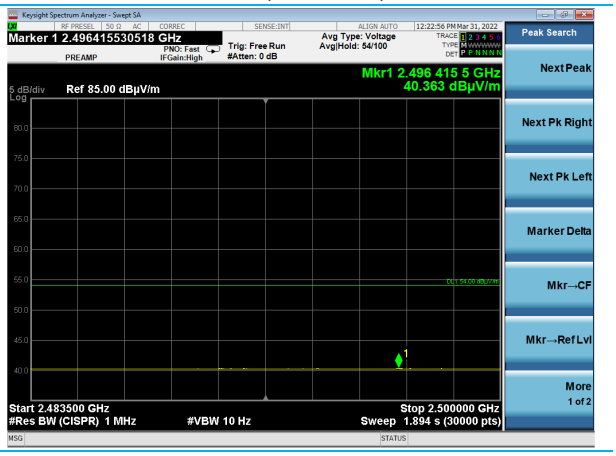
2310-2390 MHz, Peak
Horizontal EUT, BLE Ch. 1, Module 2



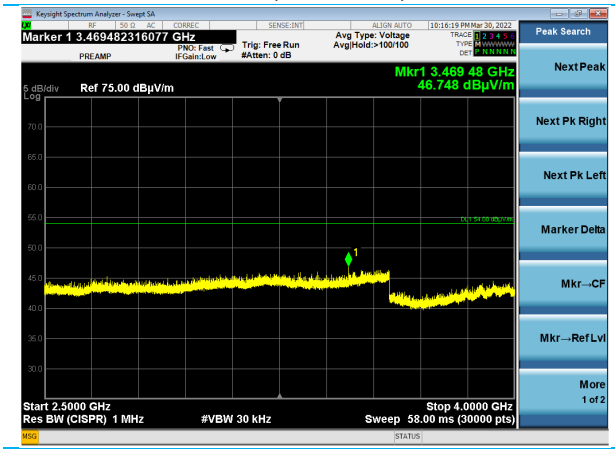
2310-2390 MHz, Average
Horizontal EUT, BLE Ch. 1, Module 2



2483.5-2500 MHz, Peak
Horizontal EUT, BLE Ch. 39, Module 2

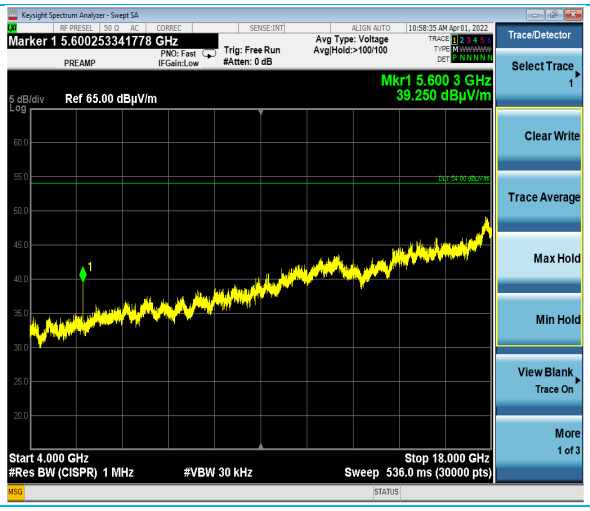


2483.5-2500 MHz, Average
Horizontal EUT, BLE Ch. 39, Module 2

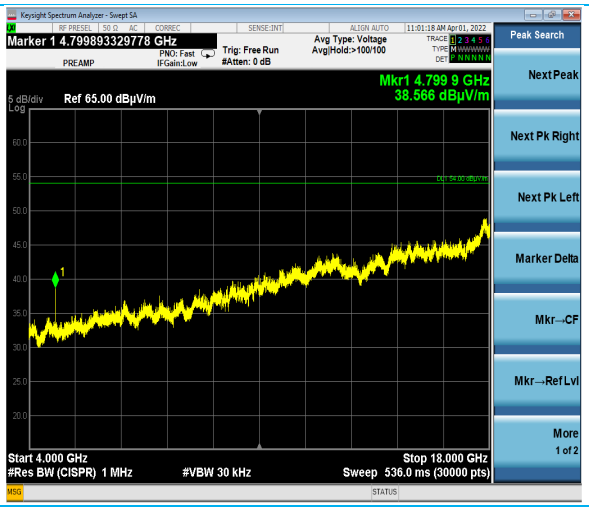


2500-4000 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 2

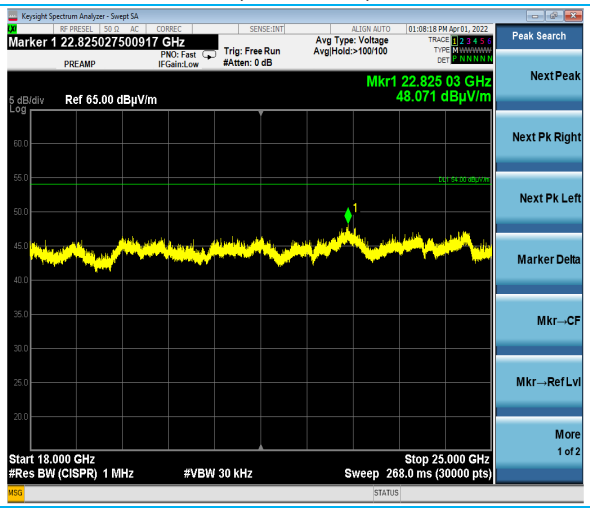
2500-4000 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 2



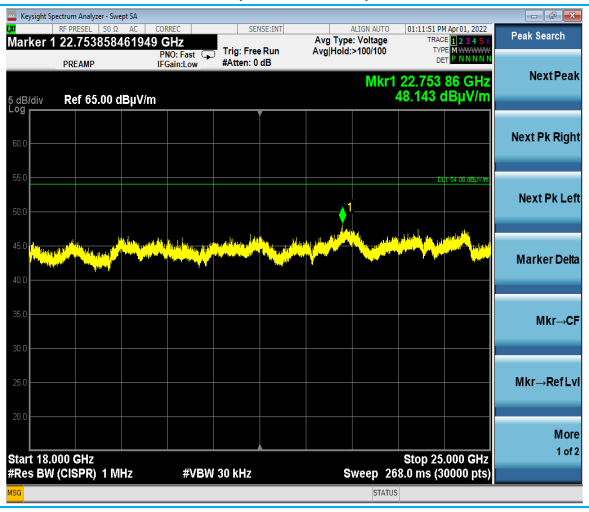
4-18 GHz, Horizontal Antenna
Vertical EUT, BLE Ch. 19, Module 2



4-18 GHz, Vertical Antenna
Vertical EUT, BLE Ch. 19, Module 2

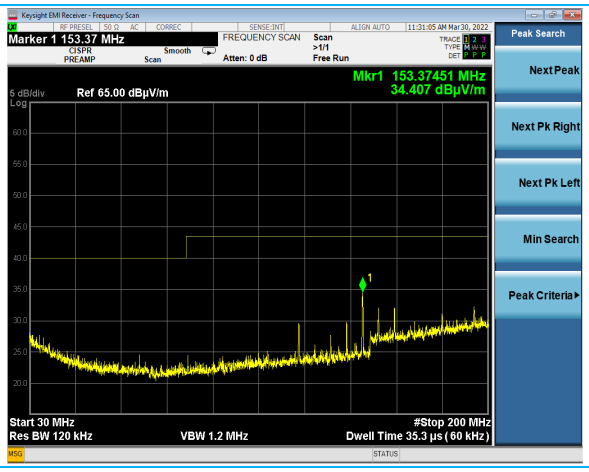


18-25 GHz, Horizontal Antenna
Vertical EUT, BLE Ch. 19, Module 2

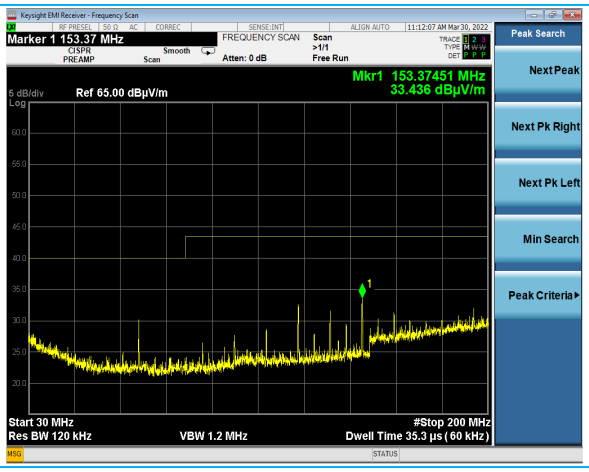


18-25 GHz, Vertical Antenna
Vertical EUT, BLE Ch. 19, Module 2

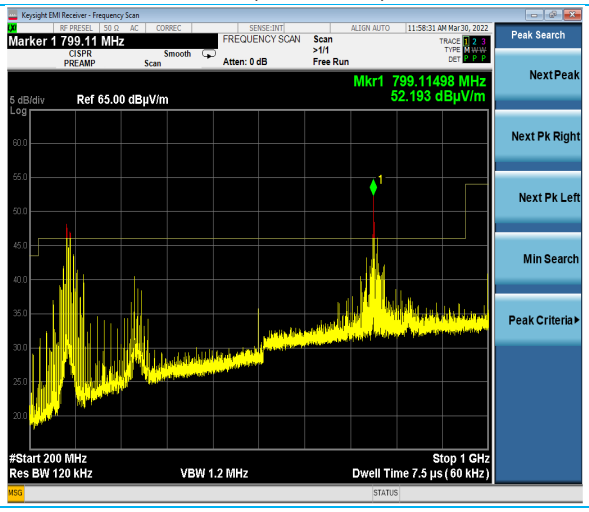
Plots – Module 3



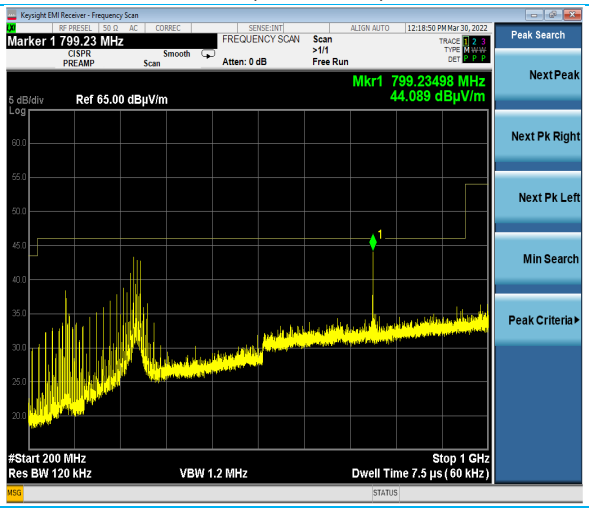
30-200 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 3



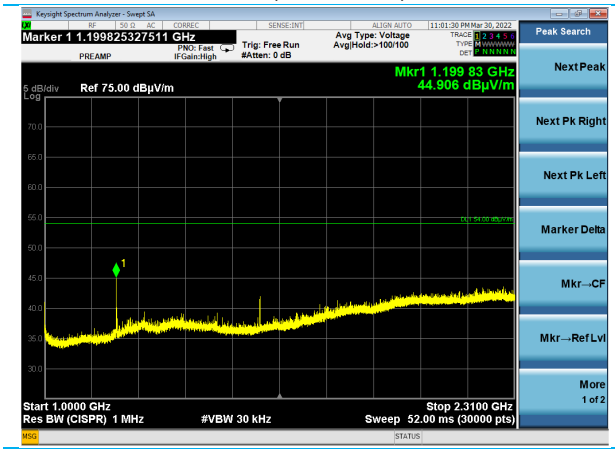
30-200 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 3



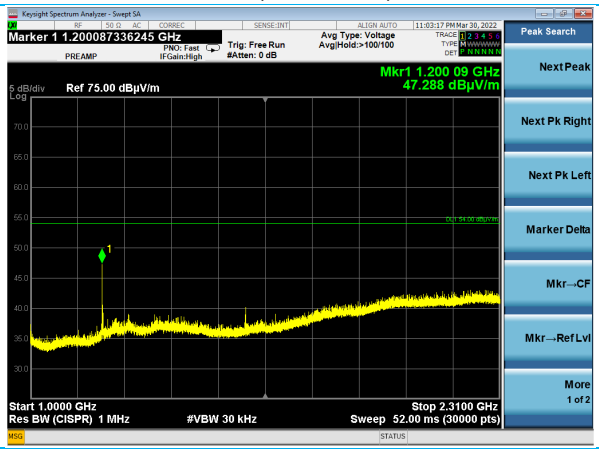
200-1000 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 3



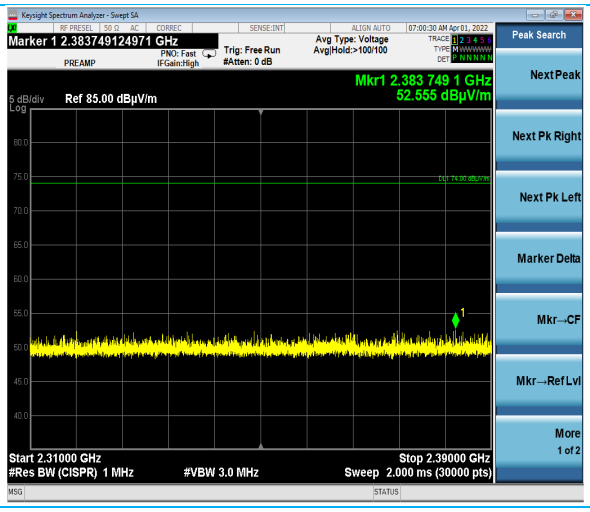
200-1000 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 3



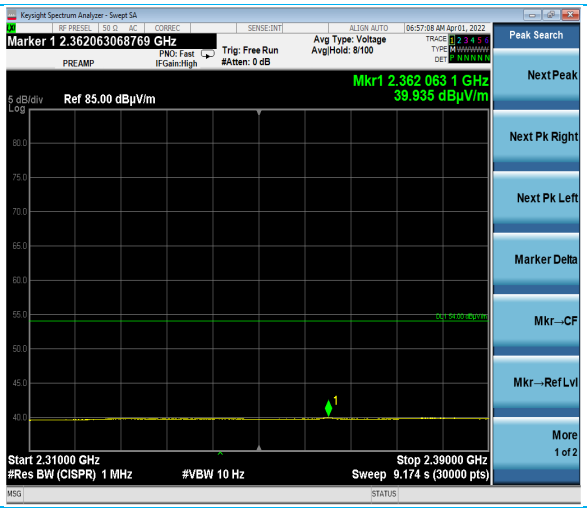
1000-2310 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 3



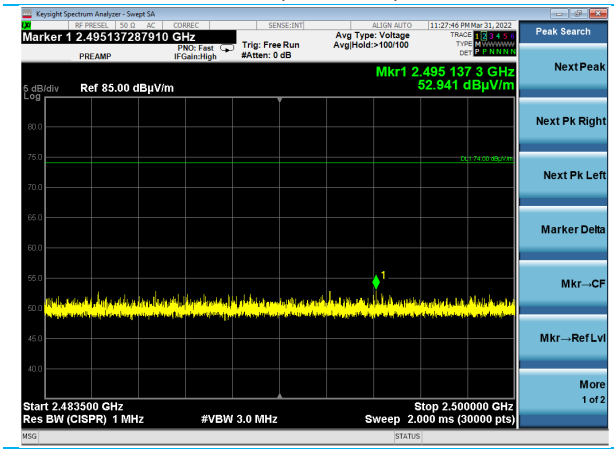
1000-2310 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 3



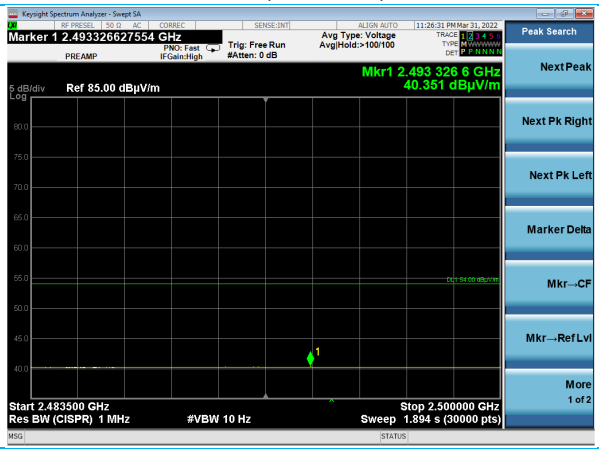
2310-2390 MHz, Peak
Horizontal EUT, BLE Ch. 1, Module 3



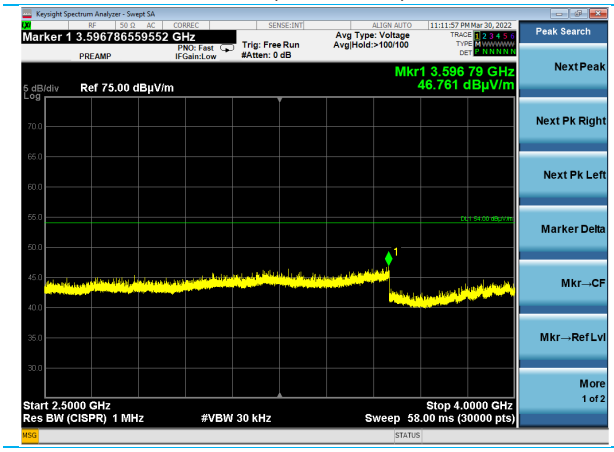
2310-2390 MHz, Average
Horizontal EUT, BLE Ch. 1, Module 3



2483.5-2500 MHz, Peak
Horizontal EUT, BLE Ch. 39, Module 3

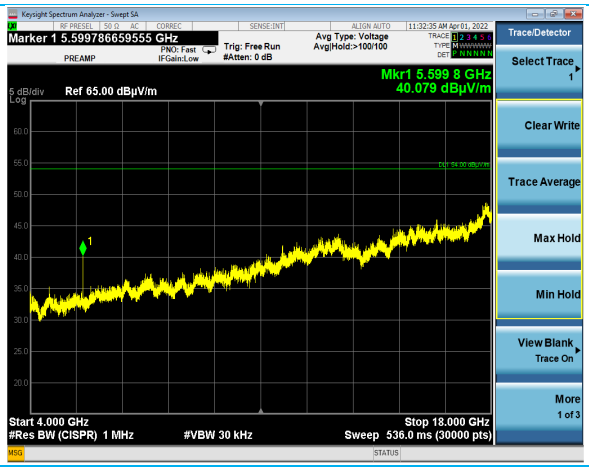


2483.5-2500 MHz, Average
Horizontal EUT, BLE Ch. 39, Module 3

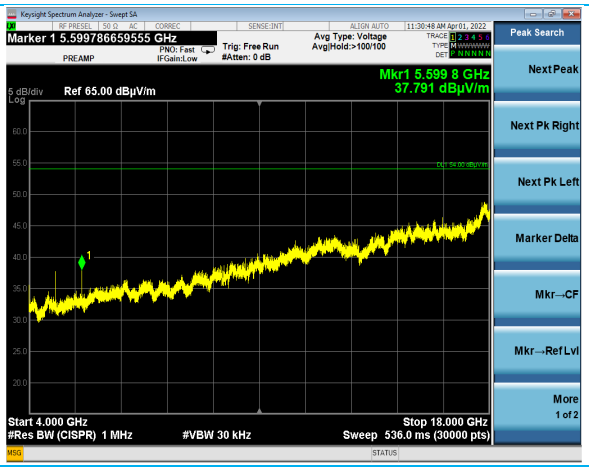


2500-4000 MHz, Horizontal Antenna
Horizontal EUT, BLE Ch. 19, Module 3

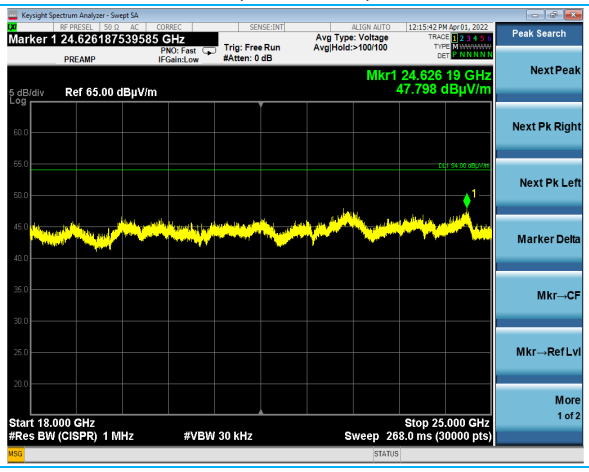
2500-4000 MHz, Vertical Antenna
Horizontal EUT, BLE Ch. 19, Module 3



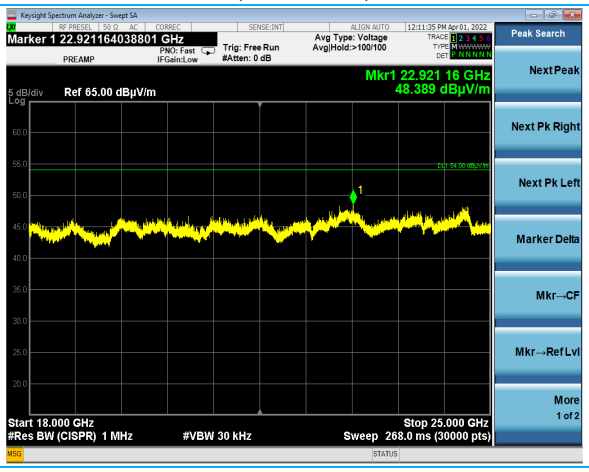
4-18 GHz, Horizontal Antenna
Vertical EUT, BLE Ch. 19, Module 3



4-18 GHz, Vertical Antenna
Vertical EUT, BLE Ch. 19, Module 3



18-25 GHz, Horizontal Antenna
Vertical EUT, BLE Ch. 19, Module 3



18-25 GHz, Vertical Antenna
Vertical EUT, BLE Ch. 19, Module 3

5.2.3 Simultaneous Transmit

Operator	Jon Dilley; Braden Smith	**QA**	Anthony Smith; Ivan Alvarez
Temperature	23.1°C	**R.H. %**	36.60%
Test Date	4/6/2022	**Location**	Chamber 3
Requirement	FCC 15.209, FCC 15.247	**Method**	ANSI C63.10

Limits:

Frequency (MHz)	Average Limit (dBµV/m)	Peak Limit (dBµV/m)
1000-18000	54.0	74.0

Test Parameters

Frequency	2310-2390 MHz 2483.5-2500 MHz 4-18 GHz	**Distance**	3m
Detector(s)	Average measurements were made with a reduced VBW of 10Hz as the signal is 100% duty cycle. Max peak hold for plots.	**Table height**	150cm (above 1 GHz)
RBW	1 MHz	**VBW**	Peak: 3 MHz Average: 10 Hz **30 kHz for emission identification*
Plots	Worst case plots are shown.	**EUT Orientations**	Vertical shown as worst case
Notes	No intermodulation effects were observed. No constructive interference was observed. No harmonics were observed in the 4-18 GHz range.		

EUT Parameters

Input Power	14 VDC	**Mode**	BLE (single channel) Bluetooth Classic (Hopping)
Channel	BLE: 0, 19, 39 BTC: Hopping 0-78	**Data Rate/Modulation**	GFSK 1Mbps (BLE) BR, EDR2, EDR3 (BTC)

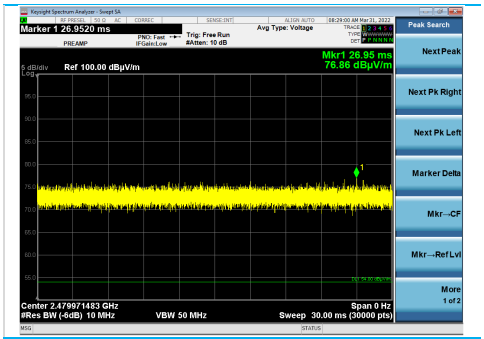
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/13/2022	4/13/2023	Active Calibration
AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	9/27/2021	9/27/2022	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
EE 960196	Meter - Hygro-Thermometer	Control Company	90080-03	180045462	5/14/2021	5/14/2022	Active Calibration
LSC-300	Cable	Chamber 3 Emissions	-	-	4/15/2022	4/15/2023	Active Verification

Data Tables

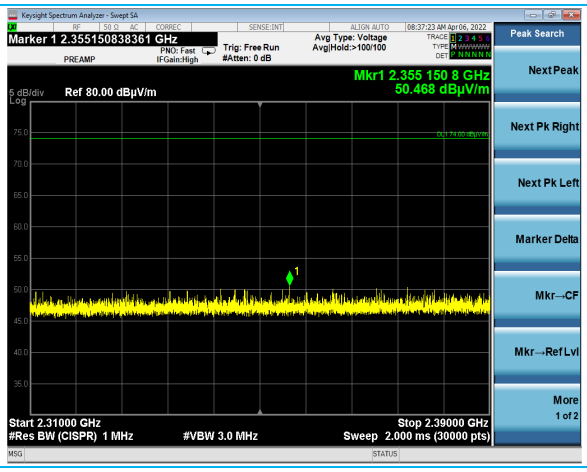
Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Module/Channel
2389.2	Vertical	Vertical	150	0	37.6	54.0	16.4	All BLE Ch. 0
2500.0	Vertical	Vertical	150	0	38.3	54.0	15.7	All BLE Ch. 39
2498.4	Vertical	Vertical	150	0	38.2	54.0	15.8	All BTC Hopping
2380.2	Vertical	Vertical	150	0	37.6	54.0	16.4	All BTC Hopping

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Module/Channel
2355.2	Vertical	Vertical	150	0	50.5	74.0	23.5	All BLE Ch. 0
2497.5	Vertical	Vertical	150	0	51.4	74.0	22.6	All BLE Ch. 39
2499.8	Vertical	Vertical	150	0	50.6	74.0	23.4	All BTC Hopping
2384.4	Vertical	Vertical	150	0	50.1	74.0	23.9	All BTC Hopping

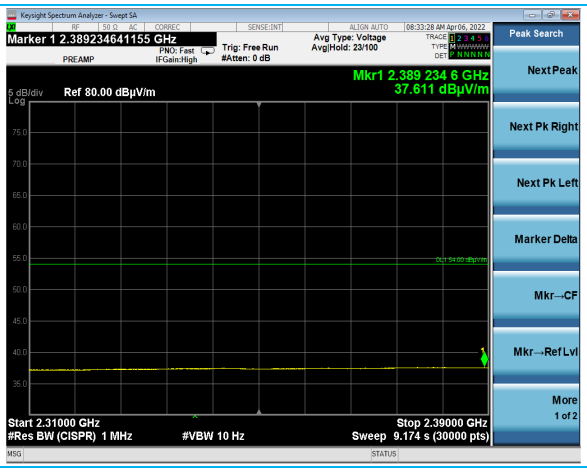


Duty Cycle, BT Hopping, 100%

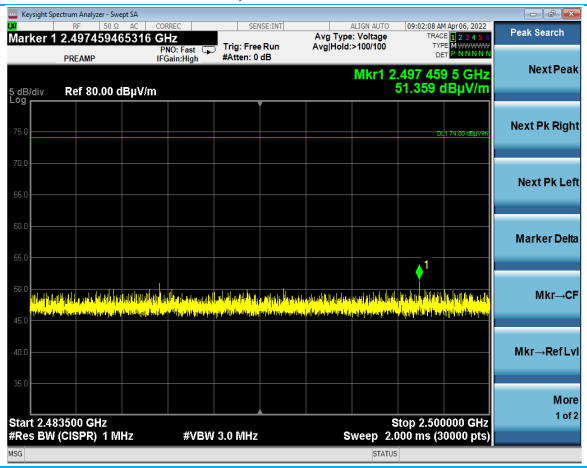
Plots



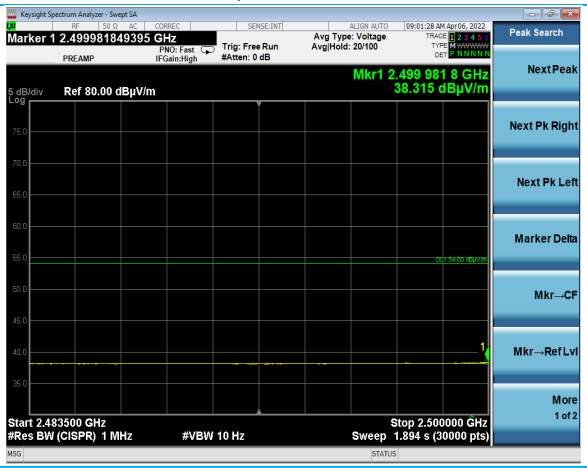
2310-2390 MHz, Peak
Vertical EUT, All modules BLE Ch. 0



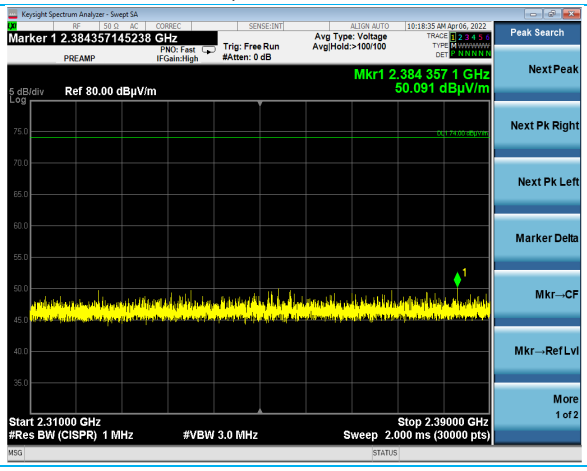
2310-2390 MHz, Average
Vertical EUT, All modules BLE Ch. 0



2483.5-2500 MHz, Peak
Vertical EUT, All modules BLE Ch. 38

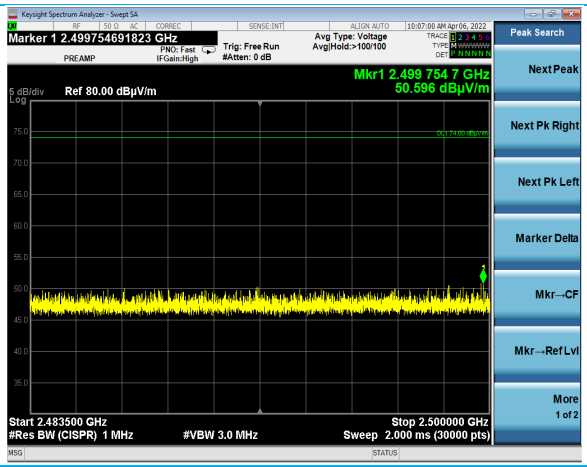


2483.5-2500 MHz, Average
Vertical EUT, All modules BLE Ch. 38



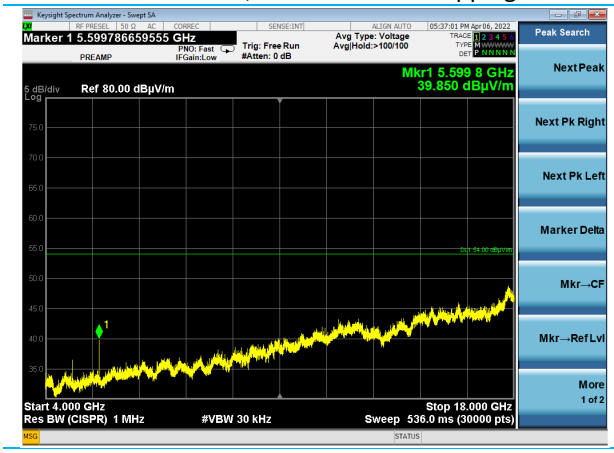
2310-2390 MHz, Peak
Vertical EUT, All modules BT Hopping

2310-2390 MHz, Average
Vertical EUT, All modules BT Hopping

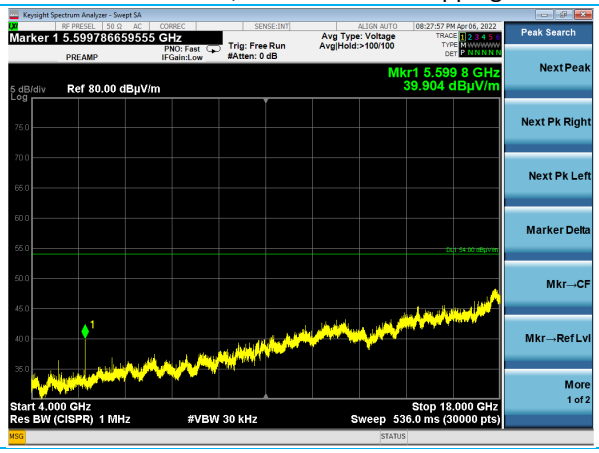


2483.5-2500 MHz, Peak
Vertical EUT, All modules BT Hopping

2483.5-2500 MHz, Average
Vertical EUT, All modules BT Hopping



4-18 GHz, Horizontal Antenna, Vertical EUT
Module 1: BLE Ch. 0, Module 2: BLE Ch. 19
Module 3: BLE Ch. 39



4-18 GHz, Horizontal Antenna, Vertical EUT
Module 1: BT Hopping, Module 2: BLE Ch. 0
Module 3: BT Hopping

6 REVISION HISTORY

Version	Date	Notes	Person
0	4/22/2022	Initial Draft	Zach Wilson
1	4/27/2022	Revised per internal review	Zach Wilson

END OF REPORT