

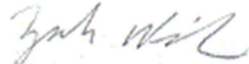
Test Report # 319379 B (BLE)

Equipment Under Test: SmartCraft Connect

Test Date(s): August 10th – November 3rd, 2020

Prepared for: Brunswick Corporation
Attn: Andrew Sember
W6250 Pioneer Road
Fond du Lac, WI 54936

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

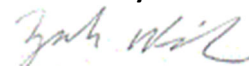
Date: 1/12/2021

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 11/18/2020

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 10/29/2020

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Laird Connectivity Test Services in Review

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



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



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

Company: Brunswick Corporation	Page 3 of 29	Name: SmartCraft Connect
Report: TR319379 B		Model: SCC-1
Job: C-3380		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **August 10th – November 3rd, 2020** the Equipment Under Test (EUT), **SmartCraft Connect**, as provided by **Brunswick Corporation** was tested to the following requirements of the **Federal Communications Commission and Innovation, Science and Economic Development Canada**:

FCC 15.247 and 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	Compliant
FCC: 2.1049 IC: RSS-GEN 6.7	Occupied Bandwidth	Reported	ANSI C63.10	Reported
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Compliant
FCC: 15.247 (e) IC: RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Compliant
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Compliant
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	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 specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Brunswick Corporation
Contact Person	Andrew Sember
Address	W6250 Pioneer Road Fond du Lac, WI 54936

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	SmartCraft Connect
Model Number	SCC-1
Serial Number	Engineering Sample
FCC ID	2APYL-GH19392020
IC ID	26775-HG19392020

2.2 Product Description

The EUT is a multimedia device for a motorboat. It is powered by 12VDC. The EUT contains the SILabs WFM200S022XNN WLAN 2.4 GHz Module with a Johanson Chip Antenna. The EUT also contains the SILabs EFR32BG21A010F1024IM32-BR BLE module with a Johanson Chip Antenna. The radios are not capable of simultaneous transmission.

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 Channels and Orientations

The channels 0 (2402MHz), 19 (2440MHz), and 39 (2480MHz) were tested. Side and vertical orientations were tested.

2.6 Radio Programming

The radio is programmed via the customer created program; Mercury RF Tester, v1.0.4. The program was installed on a provided PC.

Company: Brunswick Corporation	Page 6 of 29	Name: SmartCraft Connect
Report: TR319379 B		Model: SCC-1
Job: C-3380		Serial: Engineering Sample

3 REFERENCES

Publication	Edition	Date	AMD 1
CFR 47 Part 15	-	2020	-
RSS-GEN	5	2014	2019
RSS-247	2	2017	-
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	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 $\pm$
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

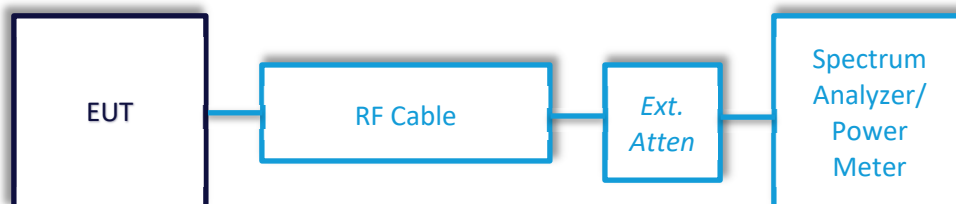
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
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



Date: 6-Nov-2020 Test: Conducted Radio Job: C-3380
 PE: Zach Wilson Customer: Mercury Marine Quote: 319379

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2019	7/14/2021	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	12/9/2019	12/9/2020	Active Verification

5.1.1 DTS and 99% Bandwidth

Operator	Anthony Smith	QA	Shane Dock
Temperature	21.9°C	R.H. %	27.60%
Test Date	11/3/2020	Location	Conducted Radio
Requirement	FCC 15.247 §a.2	Method	ANSI C63.10 §11.8.2 ANSI C63.10 §6.9.3

Limits:

DTS BW: > 500 kHz

99%: Reported

Test Parameters

Frequency	2402MHz, 2440MHz, 2480MHz	Setup	Conducted
RBW	DTS: 100kHz 99%: 30kHz	VBW	DTS: 300kHz 99%: 91kHz
Detector(s)	Max hold with peak detector	Span	MHz

EUT Parameters

Input Power	12VDC	Mode	WLAN TX
Channels	0,19,39	Data Rates	BLE

Data Tables

Channel	6 dB BW (MHz)	Limit (MHz)	Margin (MHz)
0	0.728	0.500	0.228
19	0.758	0.500	0.258
39	0.735	0.500	0.235

Channel	99% BW (kHz)
0	1072.3
19	1070.7
39	1071.8

Plots



Company: Brunswick Corporation

Report: TR319379 B

Job: C-3380

Name: SmartCraft Connect

Model: SCC-1

Serial: Engineering Sample

5.1.2 Output Power

Operator	Anthony Smith	QA	Shane Dock
Temperature	21.9°C	R.H. %	27.60%
Test Date	11/3/2020	Location	Conducted Radio
Requirement	FCC 15.247 §b.3	Method	ANSI C63.10 §11.9.1.1.1

Limits:

1W = 30dBm

Test Parameters

Frequency	2402MHz, 2440MHz, 2480MHz	Setup	Conducted
RBW	3 MHz	VBW	50 MHz
Detector(s)	Peak detector and max hold.	Span	10 MHz

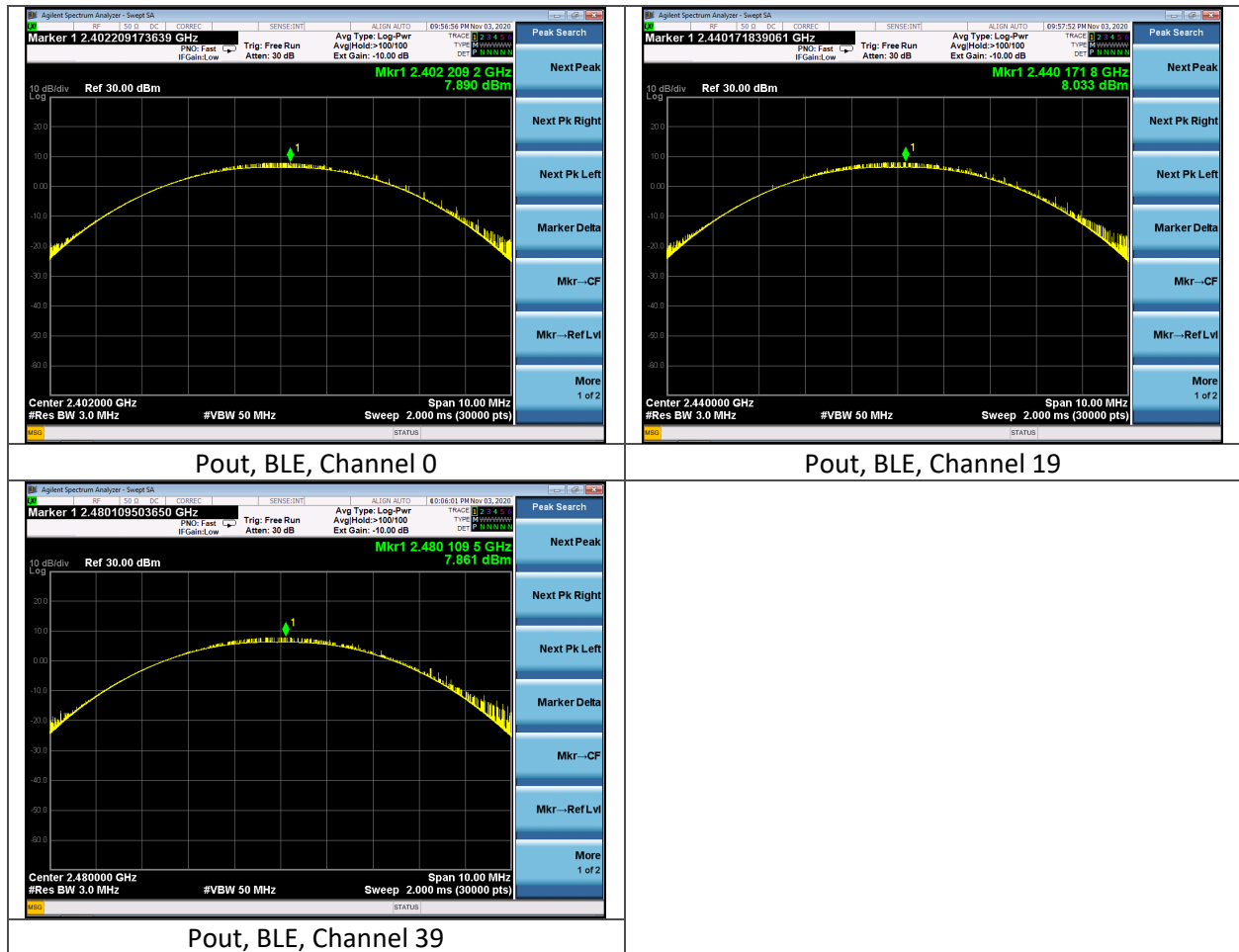
EUT Parameters

Input Power	12VDC	Mode	BLE TX
Channels	0, 19, 39	Data Rates	BLE TX

Data Table

Channel	Conducted Output Power (dBm)	Output Power Limit (dBm)	Margin (dB)
0	7.9	30.0	22.1
19	8.0	30.0	22.0
39	7.9	30.0	22.1

Plots



5.1.3 Power Spectral Density

Operator	Anthony Smith	QA	Shane Dock
Temperature	21.9°C	R.H. %	27.60%
Test Date	11/3/2020	Location	Conducted Radio
Requirement	FCC 15.247 §e	Method	ANSI C63.10 §11.10.2

Limits:

8dBm/3kHz

Test Parameters

Frequency	2402MHz, 2440MHz, 2480MHz	Setup	Conducted
RBW	30 kHz	VBW	91 kHz
Detector(s)	Peak detector with max hold	Span	1.2 MHz

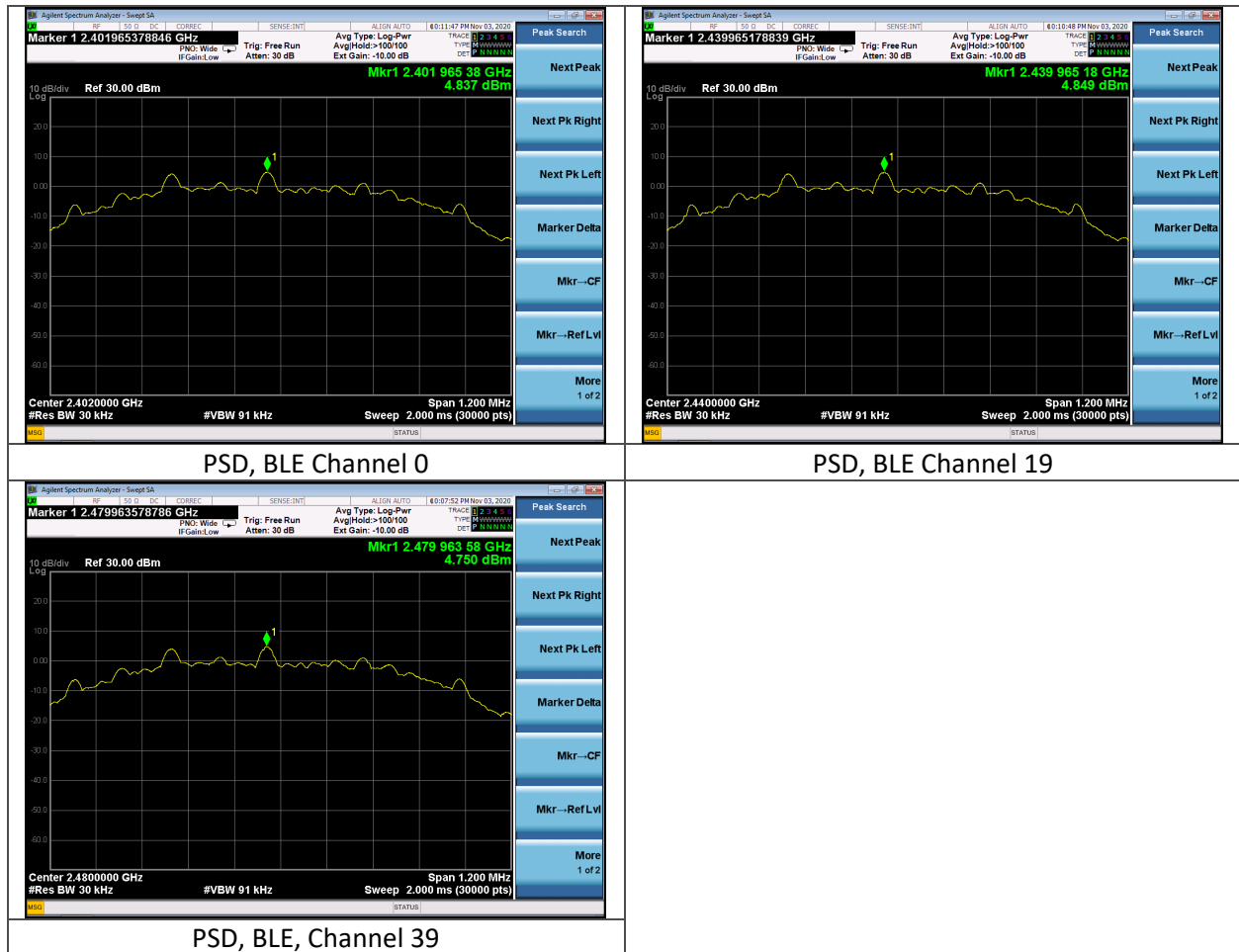
EUT Parameters

Input Power	12VDC	Mode	BLE TX
Channels	0, 19, 39	Data Rates	BLE

Data Table

Channel	Conducted PSD (dBm)	PSD Limit (dBm)	Margin (dB)
0	4.8	8.0	3.2
19	4.8	8.0	3.2
39	4.8	8.0	3.3

Plots



5.1.4 Conducted Transmitter Spurious

Operator	Anthony Smith	QA	Shane Dock
Temperature	21.9°C	R.H. %	27.60%
Test Date	11/3/2020	Location	Conducted Radio
Requirement	FCC 15.247 §d	Method	ANSI C63.10 §11.11

Limits:

-20 dBc

Reference Level = 6.2

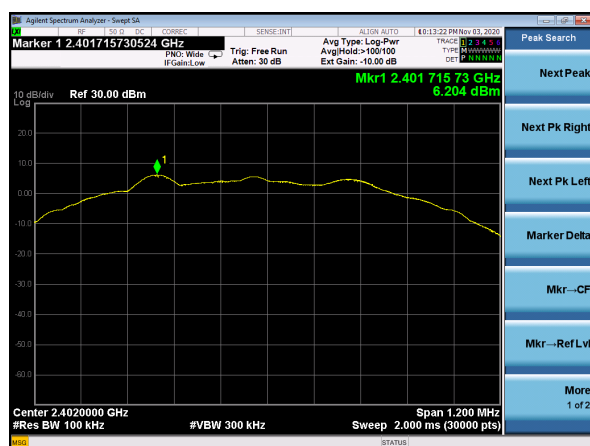
Limit = -13.8 dBm

Test Parameters

Frequency	2402MHz, 2440MHz, 2480MHz	Setup	Conducted
RBW	100kHz	VBW	300kHz
Detector(s)	Max hold with peak detector for plots.		

EUT Parameters

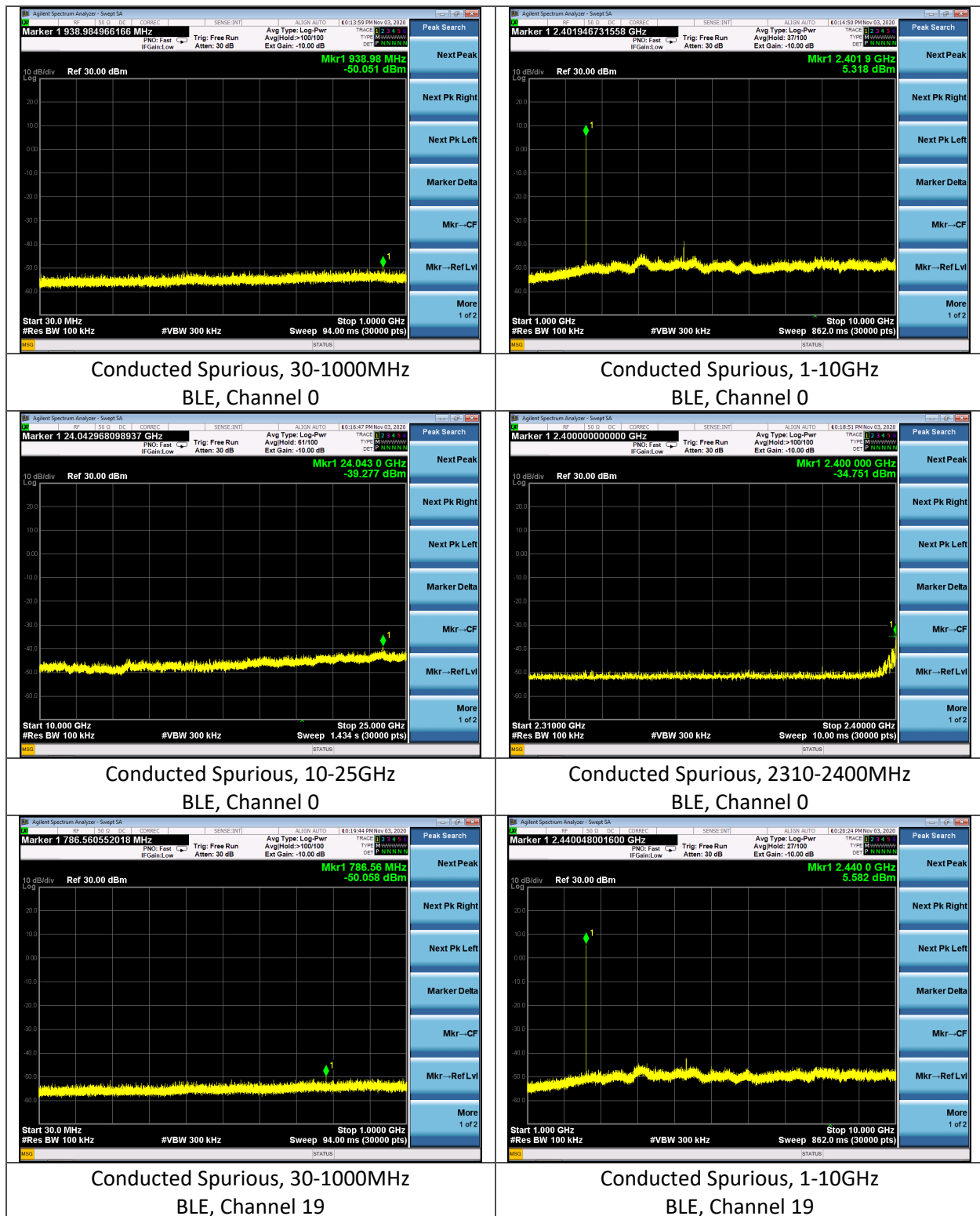
Input Power	12VDC	Mode	BLE TX
Channels	0, 19, 39	Data Rates	BLE

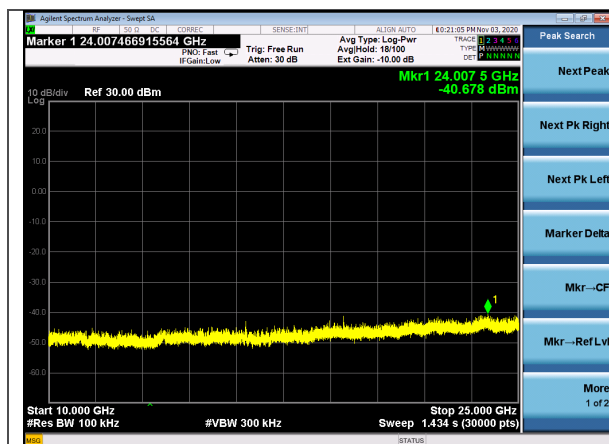


Reference Level Plot

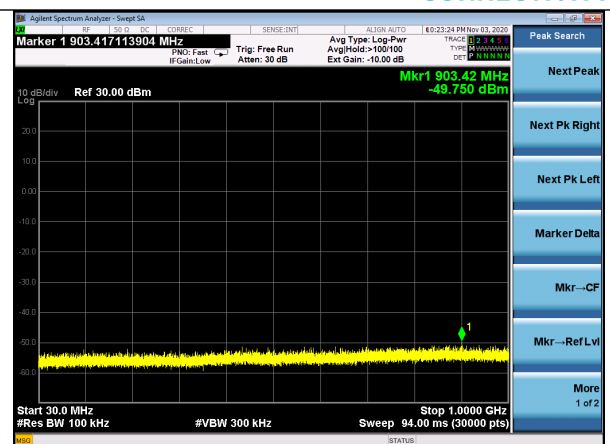
Company: Brunswick Corporation	Page 18 of 29	Name: SmartCraft Connect
Report: TR319379 B		Model: SCC-1
Job: C-3380		Serial: Engineering Sample

Plots

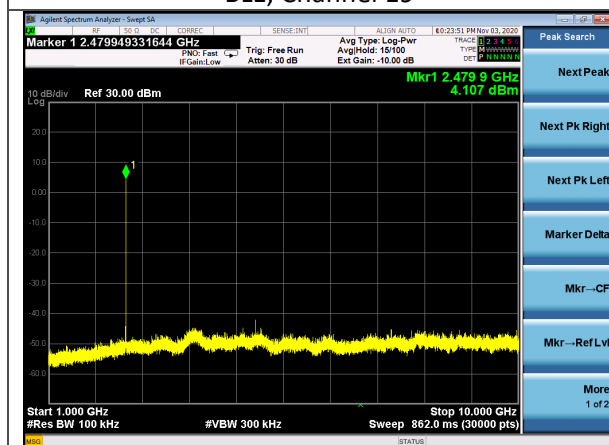




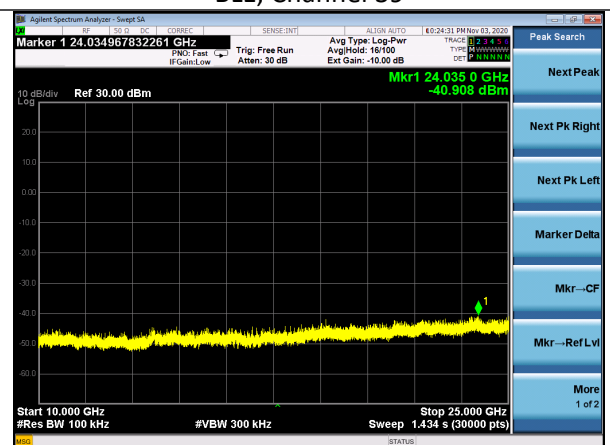
Conducted Spurious, 10-25GHz
BLE, Channel 19



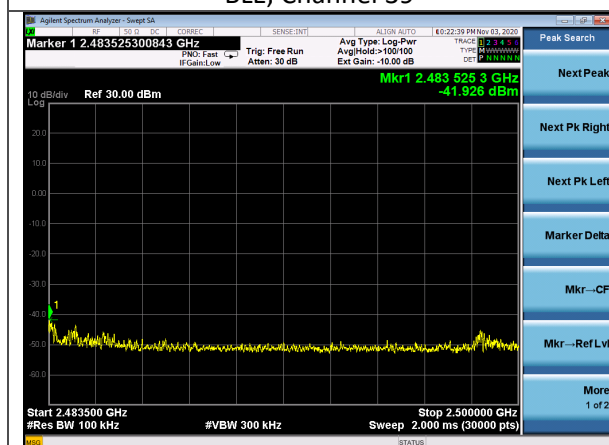
Conducted Spurious, 30-1000MHz
BLE, Channel 39



Conducted Spurious, 1-10GHz
BLE, Channel 39



Conducted Spurious, 10-25GHz
BLE, Channel 39



Conducted Spurious, 2483.5-2500MHz
BLE, Channel 39

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 30-1000 MHz

Operator	Jon Dille	QA	Anthony Smith
Temperature	24.0°C	R.H. %	46.00%
Test Date	8/6/2020	Location	Chamber 3
Requirement	FCC 15.209, RSS-GEN	Method	ANSI C63.10

Limits: FCC 15.209, RSS-GEN @ 3m

Frequency (MHz)	Quasi Peak Limit (dBμV/m)
30-88	40.0
88-216	43.5
216-960	46.0
960-1000	54.0

Test Parameters

Frequency	30-1000MHz	Distance	3 m
Detector(s)	Max hold with peak detector for plots. Quasi peak detector for final measurement.	Table height	80 cm
RBW	120kHz	VBW	1.2MHz

Instrumentation



Date : 29-Oct-2020

Test : Radiated Emissions 209

Job : C-3380

PE : Zach Wilson

Customer : Mercury Marine

Quote : 319379

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/14/2020	7/14/2021	Active Calibration
2	AA 960194	Antenna - Biconical	A.H. Systems, Inc	SAS-540	780	9/21/2019	9/22/2021	Active Calibration
3	LSC-300	Cable	Chamber 3 Emiss -	-	-	8/9/2019	8/9/2021	Active Verification
4	AA 960195	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	557	7/24/2020	7/24/2021	Active Calibration

Company: Brunswick Corporation	Page 22 of 29	Name: SmartCraft Connect
Report: TR319379 B		Model: SCC-1
Job: C-3380		Serial: Engineering Sample

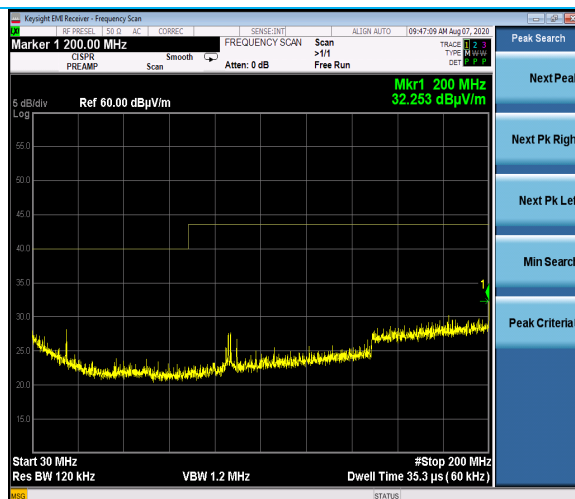
EUT Parameters

Input Power	12VDC via Bench Supply	Mode	BLE TX
EUT Orientations	Side, Vertical	Data Rates	BLE
Channels	0, 19, 39	Notes	Showing worst case plots only.

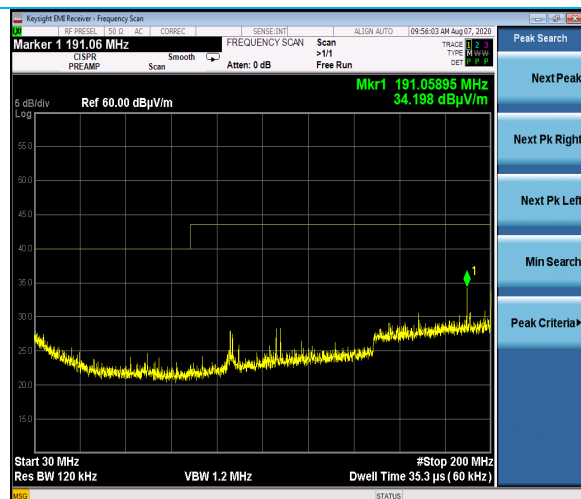
Data Table

Frequency (MHz)	Antenna Polarity	EUT Orientation	Channel	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dB μ V/m)	Quasi-Peak Limit (dB μ V/m)	Quasi-Peak Margin (dB)
200.0	Horizontal	Vertical	6	200	0	30.9	43.5	12.6
191.0	Vertical	Vertical	6	100	0	31.1	43.5	12.4
550.8	Horizontal	Vertical	6	100	0	35.6	46.0	10.4
915.3	Vertical	Vertical	6	100	0	33.5	46.0	12.5

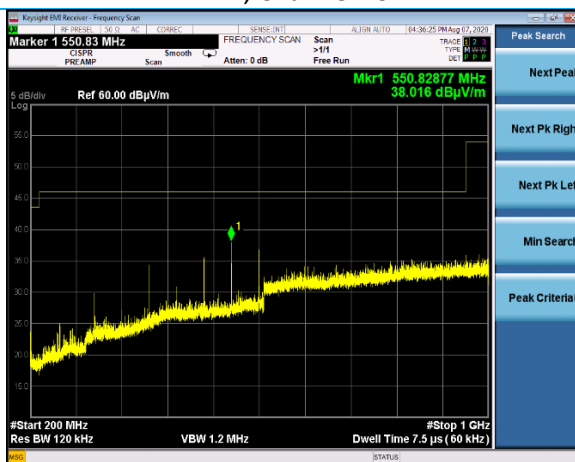
Plots



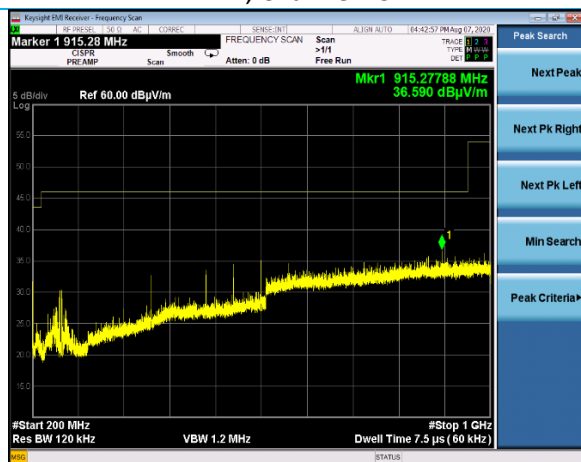
30-200 MHz, Horizontal Antenna, Vertical EUT BLE, Channel 19



30-200 MHz, Vertical Antenna, Vertical EUT BLE, Channel 19



200-1000 MHz, Horizontal Antenna, Vertical EUT BLE, Channel 19



200-1000 MHz, Vertical Antenna, Vertical EUT BLE, Channel 19

5.2.2 Radiated Emissions 1-25 GHz

Operator	Anthony Smith	QA	Braden Smith
Temperature	21.9°C, 22.2°C	R.H. %	62.3%, 65.0%
Test Date	8/10/2020, 8/13/2020	Location	Chamber 5, Chamber 3
Requirement	FCC 15.209, RSS-GEN	Method	ANSI C63.10

Limits: FCC 15.209, RSS-GEN @ 3m

Frequency (MHz)	Average Limit (dBμV/m)	Peak Limit (dBμV/m)
1-25 GHz	54	74

Test Parameters

Frequency	1-25 GHz	Distance	3 m
Detector(s)	Max hold with peak detector for plots. Reduced VBW method in relation to duty cycle for average measurements.	Table height	150 cm
RBW	1MHz	VBW	Peak: 3MHz Average: 470Hz

Instrumentation



Date : 29-Oct-2020 Test : Radiated Emissions 209 Job : C-3380
PE : Zach Wilson Customer : Mercury Marine Quote : 319379

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/14/2020	7/14/2021	Active Calibration
2	AA 960171	Cable	A.H. Systems, Inc	SAC-26G-6	386	9/21/2019	12/9/2020	Active Verification
3	AA 960153	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-04	8/9/2019	7/16/2021	Active Calibration
4	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	10/18/2019	10/18/2020	Active Calibration
5	EE 960096	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	40201429	10/18/2019	10/18/2020	Active Calibration

EUT Parameters

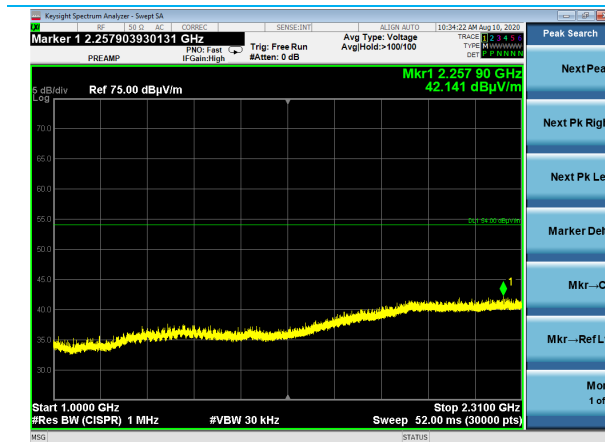
Input Power	12VDC via Bench Supply	Mode	BLE TX
EUT Orientations	Side, Vertical	Data Rates	BLE
Channels	0, 19, 39	Notes	Showing worst case plots only.

Data Tables

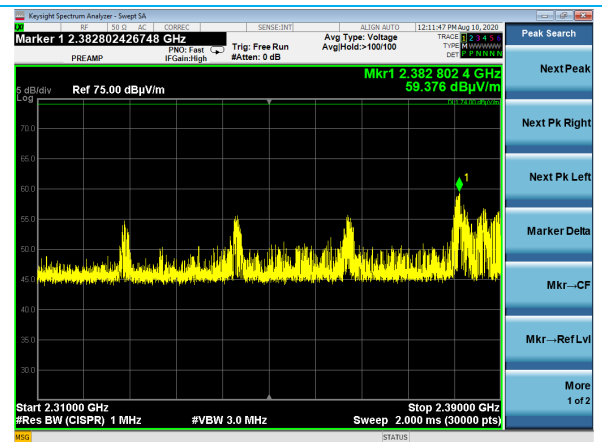
Frequency (MHz)	Antenna Polarity	Channel	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)
2363.7	Vertical	0	292	270	38.9	54.0	15.1	38.9	74.0	35.1
2382.8	Vertical	0	292	270	44.8	54.0	9.2	59.4	74.0	14.6
2483.5	Vertical	39	272	245	43.7	54.0	10.3	70.7	74.0	3.3

Frequency (MHz)	Antenna Polarity	Channel	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)
4959.8	Vertical	39	Side	156	30	43.7	54.0	10.3	48.9	74.0	25.1
4959.9	Horizontal	39	Side	145	91	35.8	54.0	18.2	43.8	74.0	30.2
4959.9	Horizontal	39	Vertical	110	340	42.3	54.0	11.7	48.0	74.0	26.0
4960.0	Vertical	39	Vertical	165	224	34.7	54.0	19.3	43.5	74.0	30.5
4804.0	Vertical	0	Side	205	33	47.4	54.0	6.6	52.5	74.0	21.5
4879.9	Vertical	19	Side	172	26	44.3	54.0	9.7	49.7	74.0	24.3
7440.5	Vertical	39	Side	115	70	42.5	54.0	11.5	50.6	74.0	23.4
7439.3	Horizontal	39	Side	160	19	44.4	54.0	9.6	52.2	74.0	21.8
7440.5	Horizontal	39	Vertical	140	297	44.4	54.0	9.6	52.3	74.0	21.7
7440.6	Vertical	39	Vertical	165	44	42.9	54.0	11.1	51.3	74.0	22.7
7320.6	Horizontal	19	Vertical	150	289	45.6	54.0	8.4	54.3	74.0	19.7

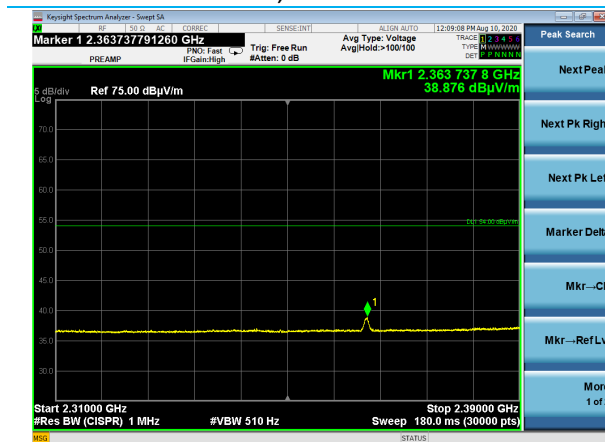
Plots



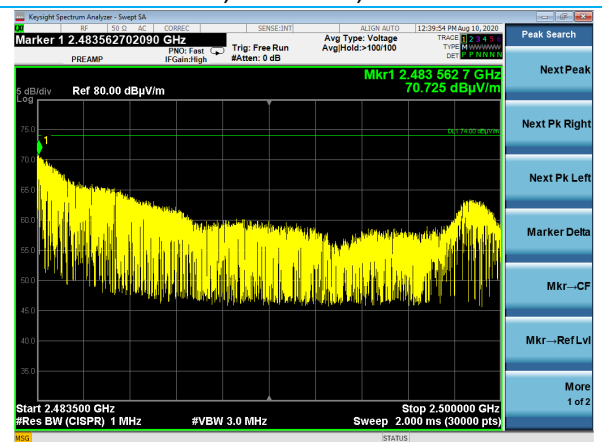
1000-2310 MHz, Vertical Antenna, Vertical EUT BLE, Channel 0



2310-2390 MHz, Vertical Antenna, Vertical EUT BLE, Channel 0, Peak



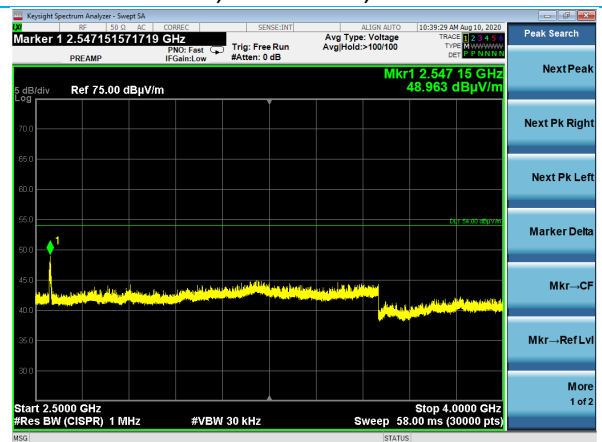
2390 MHz, Vertical Antenna, Vertical EUT BLE, Channel 0, Average



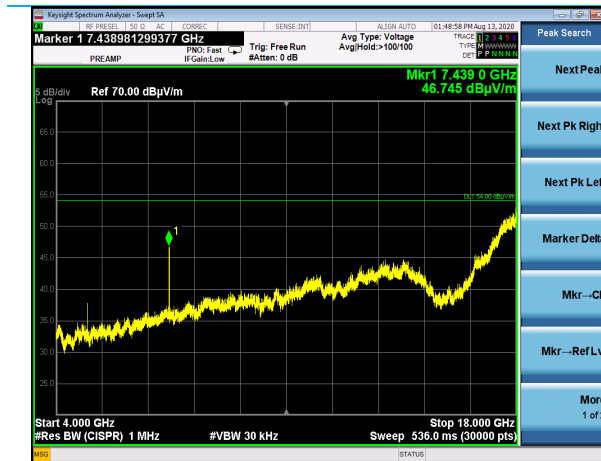
2483.5-2500 MHz, Vertical Antenna, Side EUT BLE, Channel 39, Peak



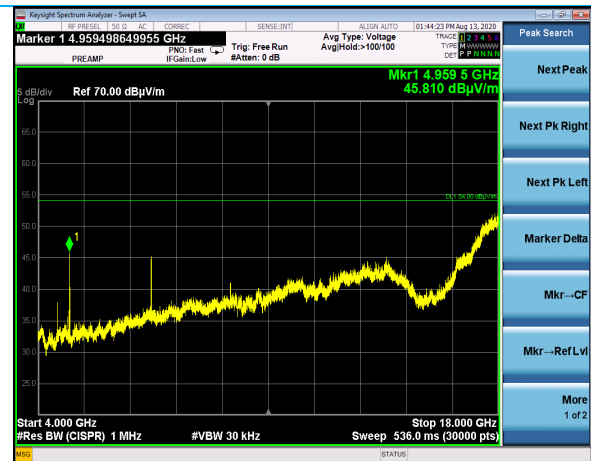
2483.5-2500 MHz, Vertical Antenna, Side EUT BLE, Channel 39, Average



2.5-4 GHz, Vertical Antenna, Vertical EUT BLE, Channel 0



4-18 GHz, Horizontal Antenna, Side EUT
BLE, Channel 39



4-18 GHz, Vertical Antenna, Side EUT
BLE Channel 39



18-25 GHz, Vertical Antenna, Vertical EUT
BLE, Channel 39

6 REVISION HISTORY

Version	Date	Notes	Person
v1	10-30-2020	Initial Draft	Zach Wilson

END OF REPORT