

FCC/ISED Test Report

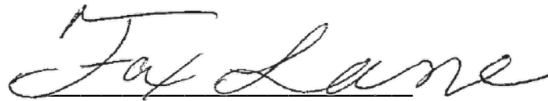
Prepared for: Garmin International, Inc.

Address: 1200 E. 151st Street
Olathe, Kansas, 66062, USA

Product: A04452

Test Report No: R20220901-21-E3A

Approved by:



Fox Lane,
EMC Test Engineer

DATE: December 6, 2022

Total Pages: 51

The Nebraska Center for Excellence in Electronics (NCEE) authorizes the above named company to reproduce this report provided it is reproduced in its entirety for use by the company's employees only. Any use that a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. NCEE accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report applies only to the items tested.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

REVISION PAGE

Rev. No.	Date	Description
0	18 November 2022	Issued by FLane Reviewed by KVepuri Prepared by FLane, GLarsen
A	6 December 2022	Removed Antenna Gain - FL



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

CONTENTS

Revision Page 2

1.0 Summary of test results..... 4

2.0 EUT Description 5

2.1 Equipment under test 5

2.2 Description of test modes 5

2.3 Description of support units..... 5

3.0 Laboratory and General Test Description 6

3.1 Laboratory description..... 6

3.2 Test personnel..... 6

3.3 Test equipment..... 7

3.4 General Test Procedure and Setup for Radio Measurements..... 8

4.0 Results 9

4.1 Output Power 11

4.2 Bandwidth..... 12

4.3 Duty Cycle 13

4.4 Radiated emissions..... 14

4.5 Conducted Spurious Emissions 20

4.6 Band edges 24

4.7 Power Spectral Density..... 26

4.8 Conducted AC Mains Emissions 27

4.9 Antenna Gain 30

Appendix A: Sample Calculation 32

Appendix B – Measurement Uncertainty 34

Appendix C – Graphs and Tables 35

REPORT END..... 51



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section (Please see the checked box below for the rule part used):

FCC Part 15.247

The EUT has been tested according to the following specifications:

- (1) US Code of Federal Regulations, Title 47, Part 15
- (2) ISED RSS-Gen, Issue 5
- (3) ISED RSS-247, Issue 2

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 5.5	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	A04452
IC	1792A-04452
FCC ID	IPH-04452
EUT Received	3 October 2022
EUT Tested	3 October 2022- 7 November 2022
Serial No.	3426283485 (Radiated Measurements) 3426283465 (Conducted Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	<input type="checkbox"/> GMSK <input type="checkbox"/> GFSK <input type="checkbox"/> BT BR <input checked="" type="checkbox"/> BT EDR 2MB <input checked="" type="checkbox"/> BT EDR 3MB <input type="checkbox"/> 802.11x
Power Supply / Voltage	Internal Battery / 5VDC Charger: Garmin (Phi Hong) Model: AQ27A-59CFA GPN: 362-00118-00 (Representative Power Supply)

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:


For Bluetooth Transmissions:

Channel	Frequency
Low	2402 MHz
Mid	2440 MHz
High	2480 MHz

These are the only representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

2.3 DESCRIPTION OF SUPPORT UNITS

None

	Report Number:	R20220901-21-E3A	Rev	A
	Prepared for:	Garmin International, Inc.		

3.0 LABORATORY AND GENERAL TEST DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
 4740 Discovery Drive
 Lincoln, NE 68521
 A2LA Certificate Number: 1953.01
 FCC Accredited Test Site Designation No: US1060
 Industry Canada Test Site Registration No: 4294A-1
 NCC CAB Identification No: US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of $35 \pm 4\%$
 Temperature of $22 \pm 3^\circ$ Celsius



3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Karthik Vepuri	Test Engineer	Review
2	Fox Lane	Test Engineer	Testing and Report
3	Blake Winter	Test Engineer	Testing
4	Grace Larsen	Test Engineer	Testing and Report
5	Ethan Schmidt	Test Technician	Testing

Notes:

All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (44GHz)**	N9038A	MY59050109	July 19, 2022	July 19, 2024
Keysight MXE Signal Analyzer (26.5GHz)**	N9038A	MY56400083	July 19, 2022	July 19, 2024
Keysight EXA Signal Analyzer**	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A082918-1	July 26, 2022	July 26, 2023
EMCO Horn Antenna	3115	6416	July 28, 2021	July 28, 2022
EMCO Horn Antenna***	3116	2576	March 9, 2020	March 9, 2023
Com-Power LISN, Single Phase**	LI-220C	20070017	July 18, 2022	July 18, 2024
8447F POT H64 Preampfier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preampfier**	TS-PR18	3545700803	August 22, 2022	August 22, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber***	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preampfier to antenna)*	MFR-57500	90-195-040	August 22, 2022	August 22, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

**2 Year Cal Cycle

Notes:

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

Measurement type presented in this report (Please see the checked box below):

Conducted

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

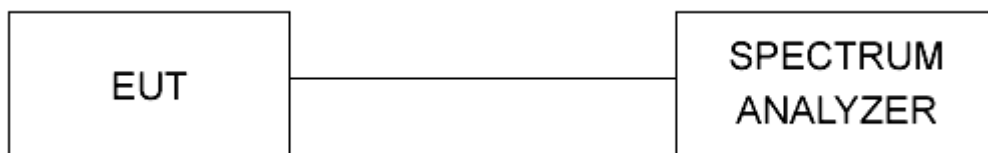


Figure 1 - Bandwidth Measurements Test Setup

Radiated

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

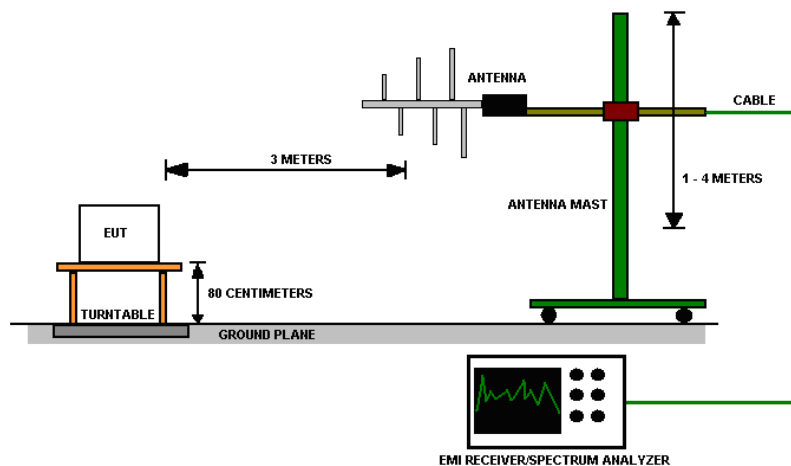


Figure 2 - Radiated Emissions Test Setup



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.0 RESULTS

DTS Radio Measurements							
CH.	Mode	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)	AVG Output Power	AVG Output Power (mW)	PSD (dBm)	RESULT
Low	2EDR	1200.50	1066.00	8.920	7.798	-3.349	PASS
Mid	2EDR	1200.80	1066.00	8.460	7.015	-5.485	PASS
High	2EDR	1197.90	1065.00	9.290	8.492	-4.279	PASS
Low	3EDR	1238.80	970.40	8.450	6.998	-3.416	PASS
Mid	3EDR	1236.00	966.20	9.090	8.110	-4.106	PASS
High	3EDR	1239.20	970.00	8.840	7.656	-4.194	PASS
Occupied Bandwidth = N/A; 6 dB Bandwidth Limit > 500 kHz				Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

Unrestricted Band-Edge							
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBuV)	Delta (dB)	Min Delta (dB)	Result
Low	2EDR	2400.00	73.77	114.66	40.89	30.00	PASS
Low	3EDR	2400.00	72.34	114.16	41.82	30.00	PASS
High	2EDR	2483.50	54.89	114.26	59.38	30.00	PASS
High	3EDR	2483.50	56.17	114.32	58.15	30.00	PASS
Peak Restricted Band-Edge							
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	2EDR	2390.00	53.42	Peak	73.98	20.56	PASS
Low	3EDR	2390.00	53.82	Peak	73.98	20.16	PASS
High	2EDR	2483.50	57.11	Peak	73.98	16.87	PASS
High	3EDR	2483.50	57.89	Peak	73.98	16.09	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

Average Restricted Band-Edge							
CH.	Mode	Band edge /Measurement Frequency (MHz)	Corrected Highest out of band level (dBuV/m @ 3m)**	Meas. Type	Limit (dBuV/m @ 3m)*	Margin	Result
Low	2EDR	2390	42.013	Average	53.98	11.967	PASS
Low	3EDR	2390	42.401	Average	53.98	11.579	PASS
High	2EDR	2483.5	46.855	Average	53.98	7.125	PASS
High	3EDR	2483.5	46.441	Average	53.98	7.539	PASS

*Limit shown is the average limit taken from FCC Part 15.209



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.1 OUTPUT POWER

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, Sec. 11.9.2.2.4

Limits of power measurements:

For FCC Part 15.247 Device:

The maximum allowed output power is 30 dBm.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the output power plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are listed in the tables below.
4. Compiled values can be found in the Results section, 4.0.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.2 BANDWIDTH

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of bandwidth measurements:

For FCC Part 15.247 Device:

The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the bandwidth plots can be found in the Appendix C.
2. All the measurements were found to be compliant.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.3 DUTY CYCLE

All modulation(s)/Transmitter(s) shown in this report have a duty cycle of >98%

Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.4 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.5, 6.6

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH ($\mu\text{V/m}$)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

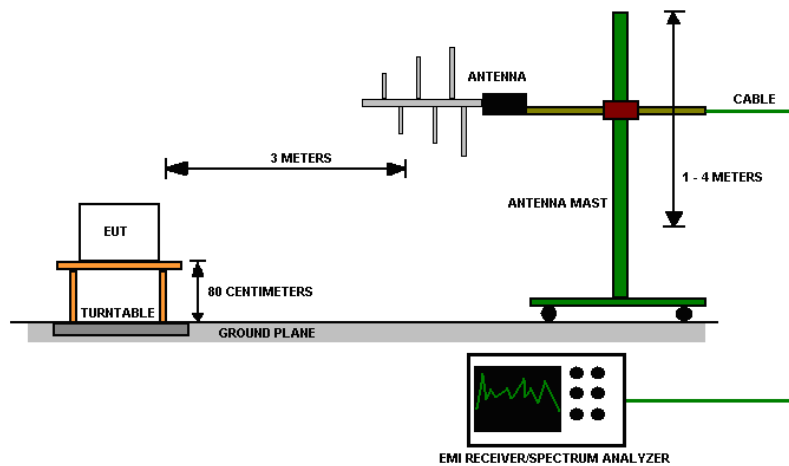
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = $20 * \log * \text{Emission level } (\mu\text{V/m})$.
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

Test procedures:

- a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.
- d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.
- e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

Test setup:

Figure 3 - Radiated Emissions Test Setup
NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.
2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

EUT operating conditions

Details can be found in section 2.1 of this report.

Test results:

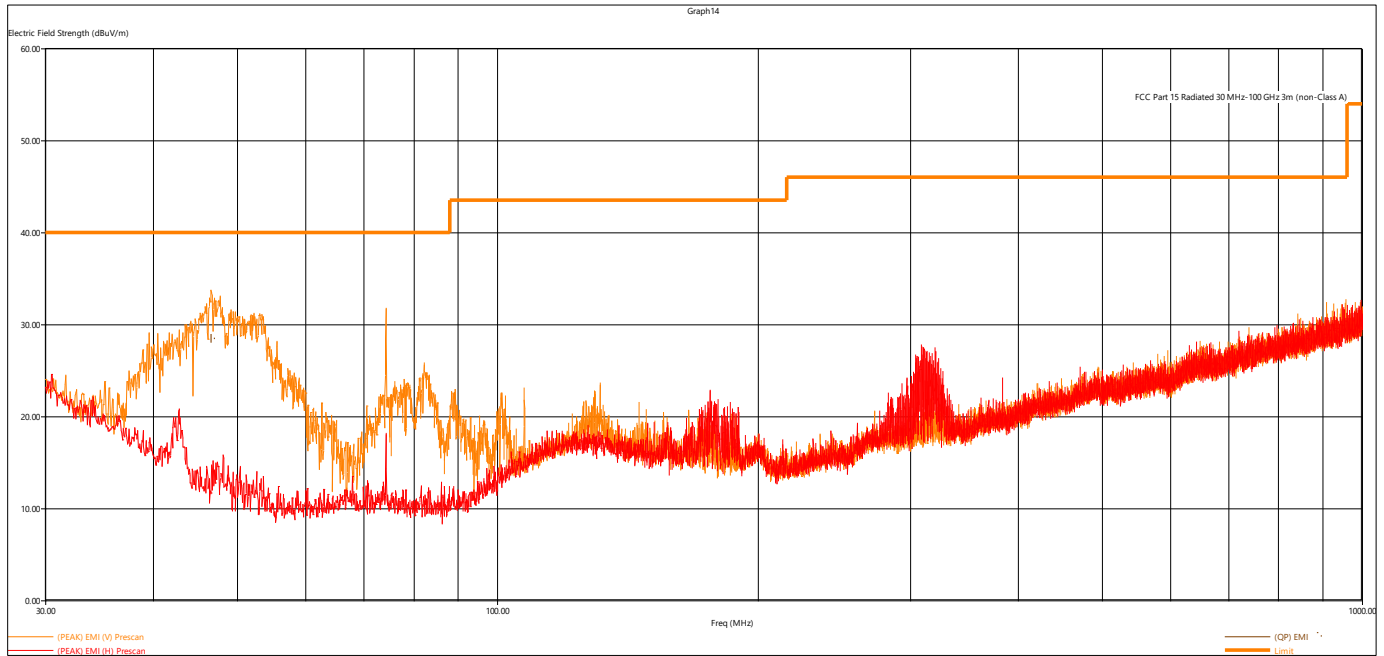


Figure 4 - Radiated Emissions Plot, Receive

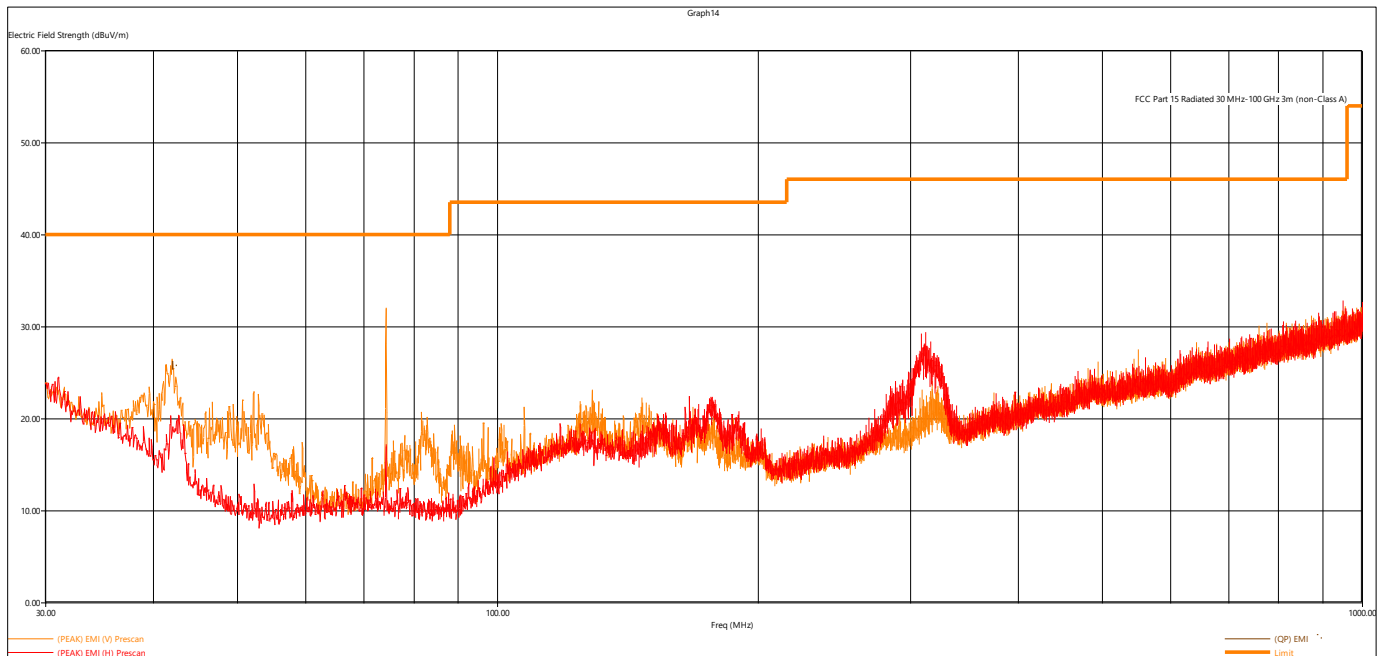


Figure 5 - Radiated Emissions Plot, BT EDR 2MB

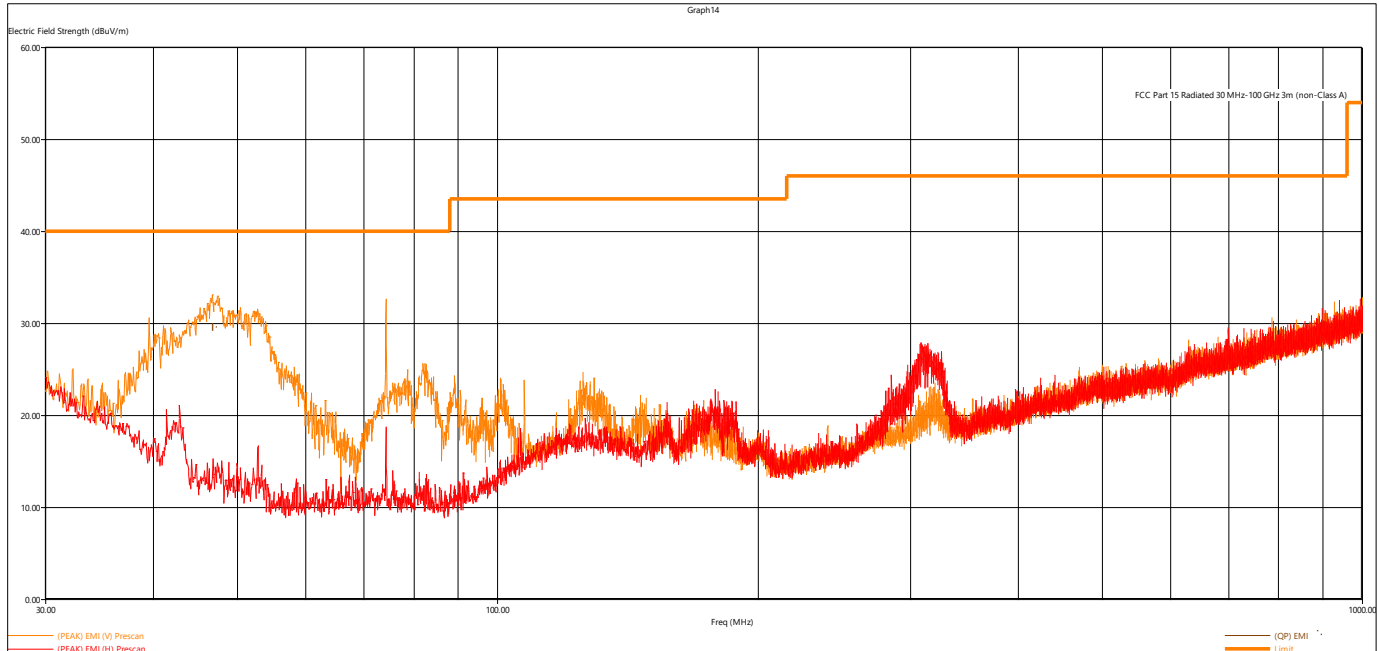


Figure 6 - Radiated Emissions Plot, BT EDR 3MB

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value

Quasi-Peak Measurements								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.			
41.875200	25.72	40.00	14.28	257.00	11.00	V	Low	2EDR
46.561200	29.56	40.00	10.44	105.00	176.00	V	Low	3EDR
46.431840	28.41	40.00	11.59	106.00	235.00	V	Rx	

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the table above.
All other emissions found to be at least 6dB below limit line



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

Peak Measurements								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.			
2402.140000	104.72	NA	NA	161.00	6.00	V	Low	BT EDR 2MB
2440.134000	105.77	NA	NA	187.00	358.00	V	Mid	BT EDR 2MB
2480.160000	106.17	NA	NA	175.00	5.00	V	High	BT EDR 2MB
2402.096000	104.64	NA	NA	162.00	6.00	V	Low	BT EDR 3MB
2439.830000	105.68	NA	NA	187.00	359.00	V	Mid	BT EDR 3MB
2479.810000	105.90	NA	NA	173.00	7.00	V	High	BT EDR 3MB

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the table above.
All other emissions found to be at least 6dB below limit line

Average Measurements								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.			
2402.140000	103.32	NA	NA	161.00	6.00	V	Low	BT EDR 2MB
2440.134000	104.43	NA	NA	187.00	358.00	V	Mid	BT EDR 2MB
2480.160000	104.65	NA	NA	175.00	5.00	V	High	BT EDR 2MB
2402.096000	103.55	NA	NA	162.00	6.00	V	Low	BT EDR 3MB
2439.830000	104.23	NA	NA	187.00	359.00	V	Mid	BT EDR 3MB
2479.810000	104.32	NA	NA	173.00	7.00	V	High	BT EDR 3MB

All other emissions found to be at least 6dB below limit line

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the table above.
All other emissions found to be at least 6dB below limit line



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.5 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.7

Limits of spurious emissions:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Test procedures:

The highest emissions level was measured and recorded. All spurious measurements were evaluated to 20dB below the fundamental. More details can be found in section 3.4 of this report.

Deviations from test standard:

None.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Please note; the line shown in the plot is merely a reference line, not a limit line

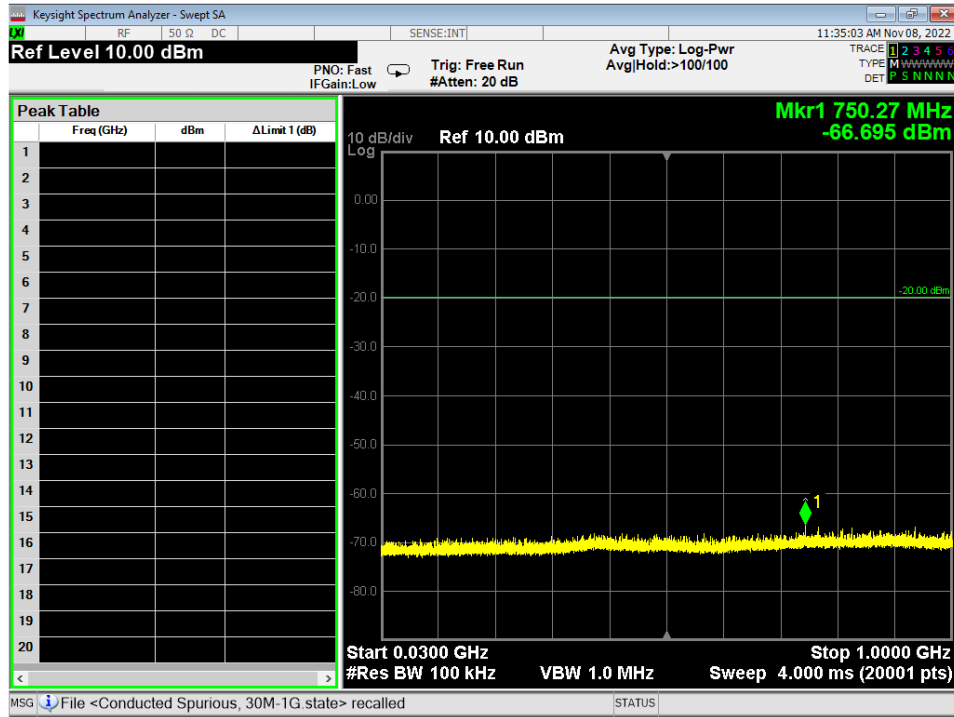


Figure 7 - Radiated Emissions Plot, 2EDR, 30M – 1G

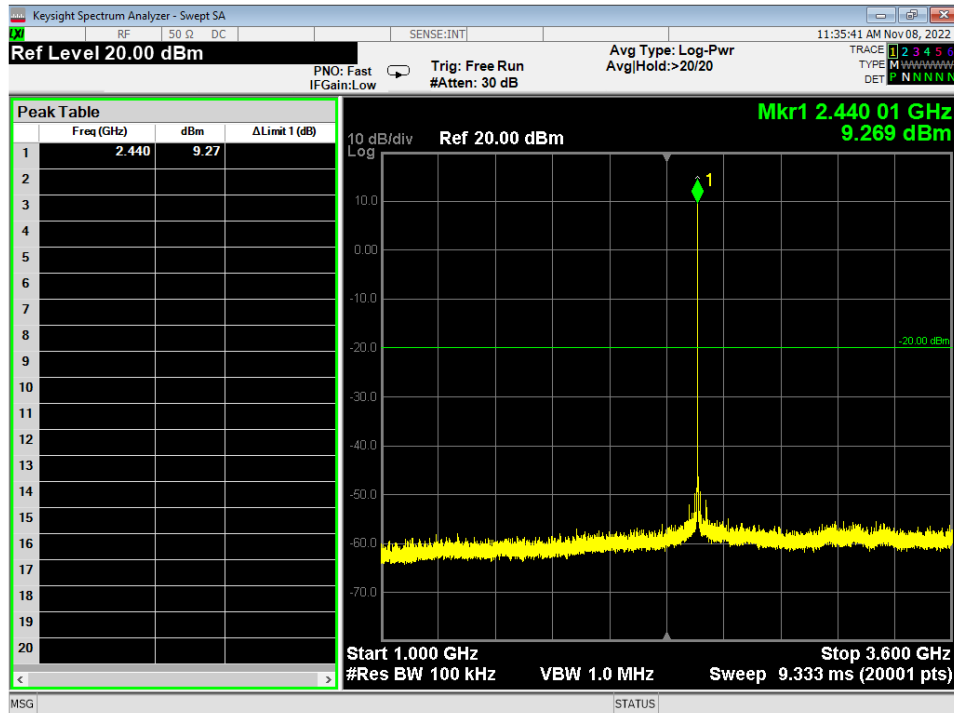


Figure 8 - Radiated Emissions Plot, 2EDR, 1G – 3.6G

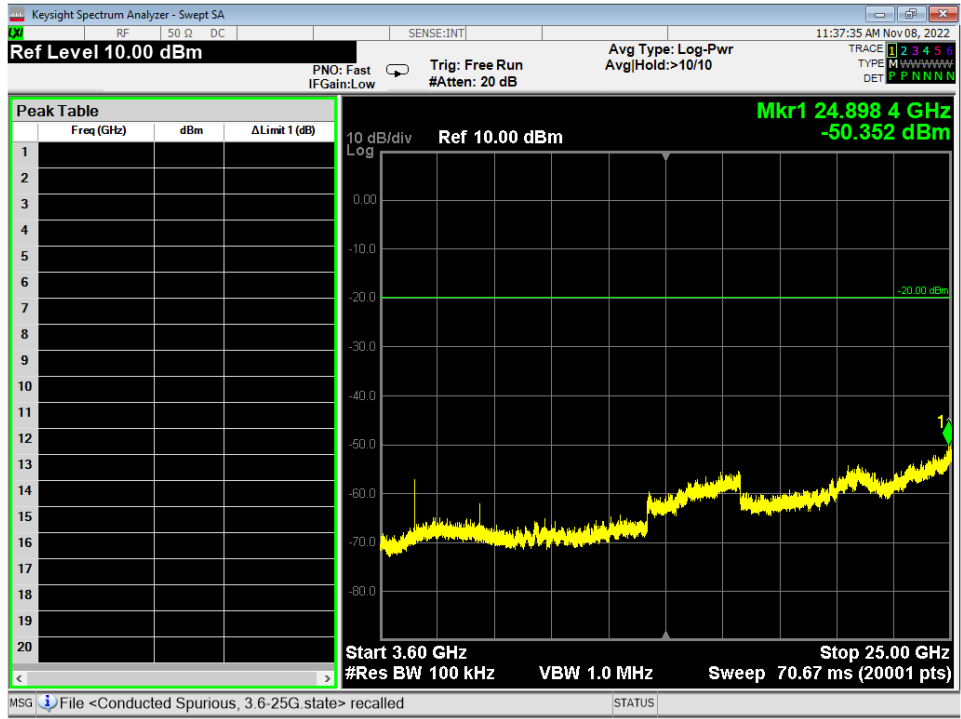


Figure 9 - Radiated Emissions Plot, 2EDR, 3.6G – 25G

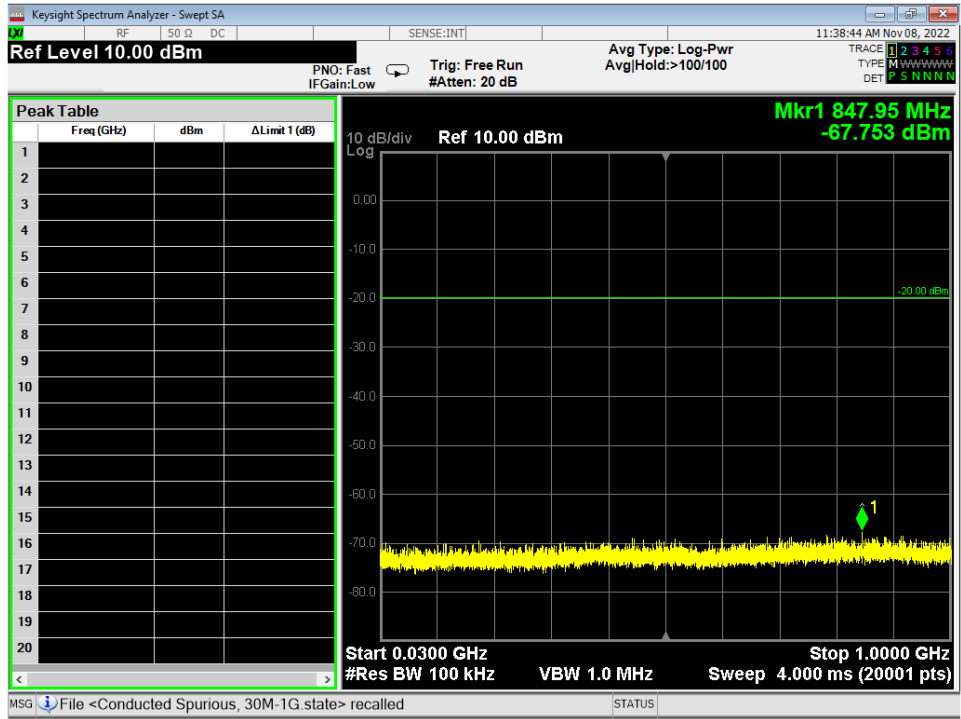


Figure 10 - Radiated Emissions Plot, 3EDR, 30M – 1G

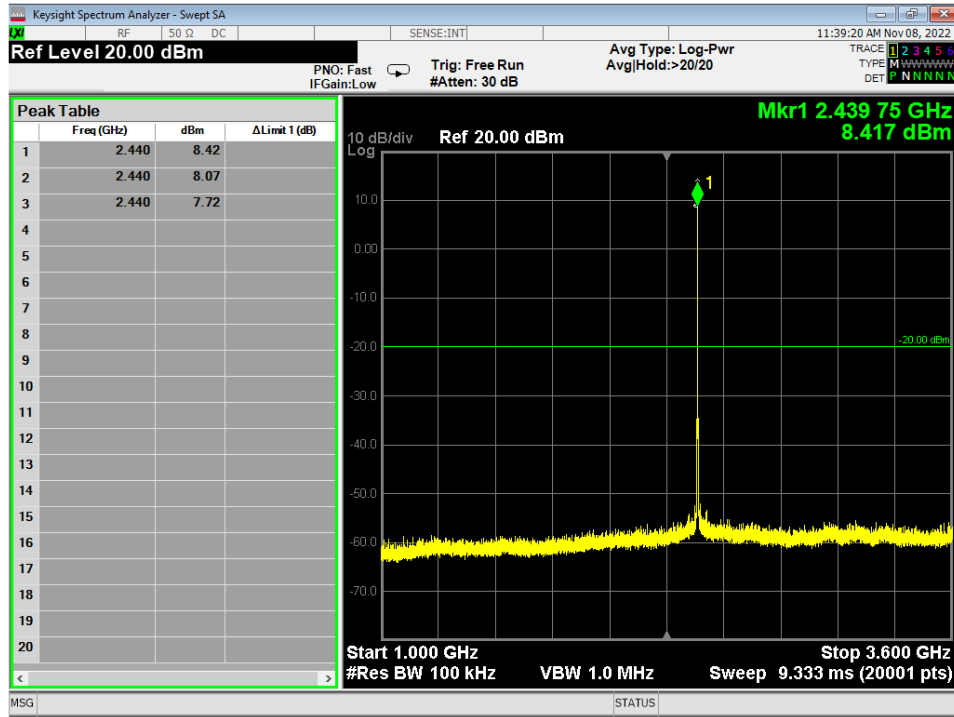


Figure 11 - Radiated Emissions Plot, 3EDR, 1G – 3.6G

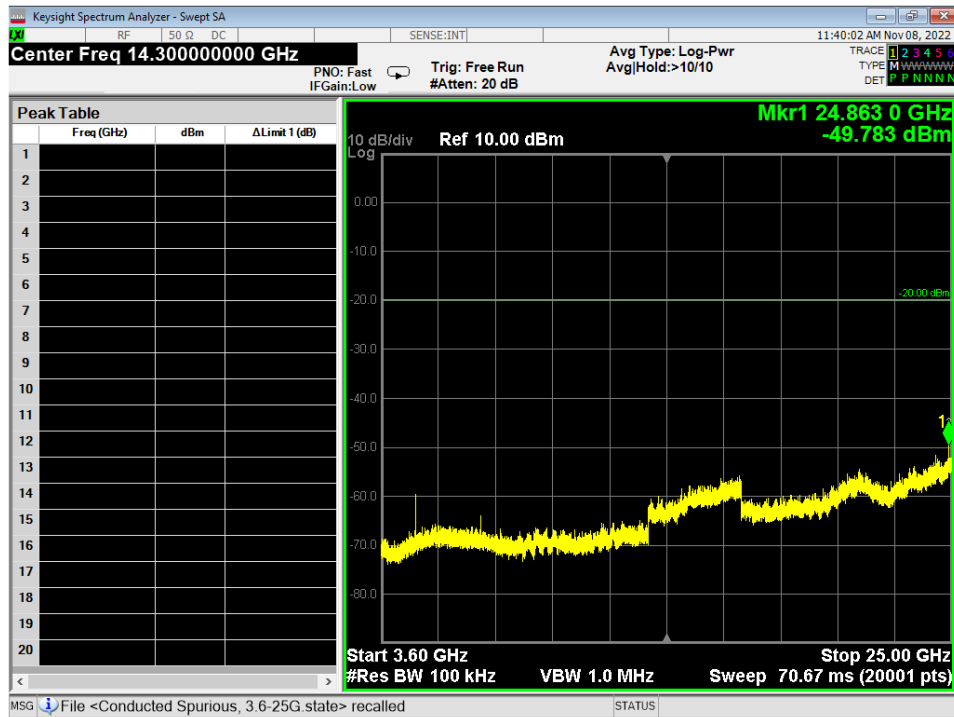


Figure 12 - Radiated Emissions Plot, 3EDR, 3.6G – 25G



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.6 BAND EDGES

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of band-edge measurements:

For FCC Part 15.247 Device:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

Test procedures:

The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209. More details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
3. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.7 POWER SPECTRAL DENSITY

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:

For FCC Part 15.247 Device:

The maximum PSD allowed is 8 dBm.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.8 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

Test Procedures:

- a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
- c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
- d. Results were compared to the 15.207 limits.

Deviation from the test standard:

No deviation

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test Results:

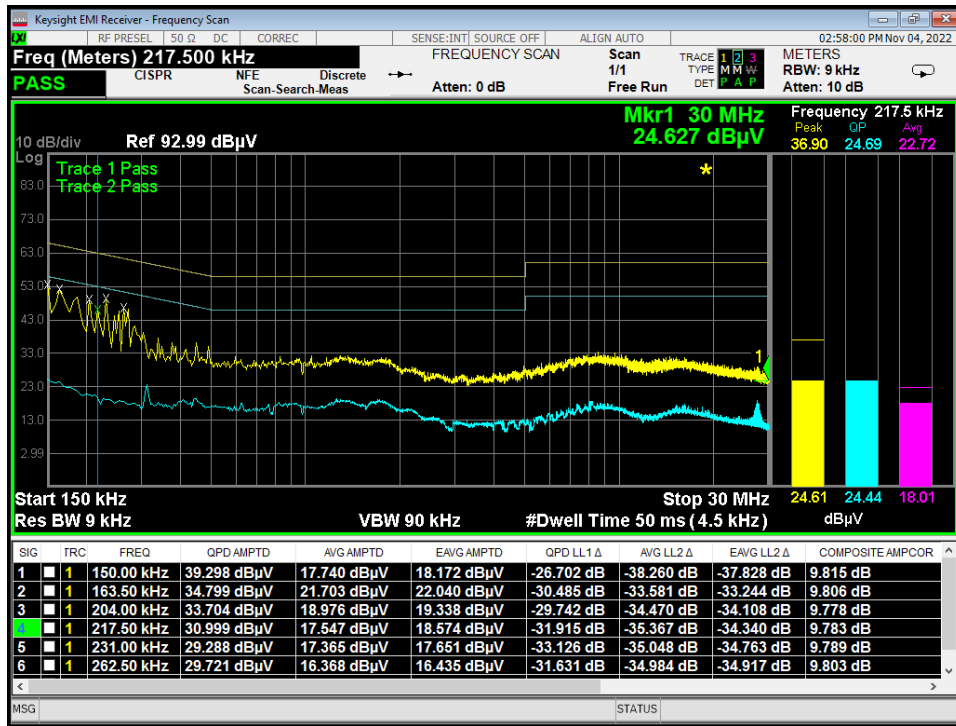


Figure 13 - Conducted Emissions Plot, Line, TX

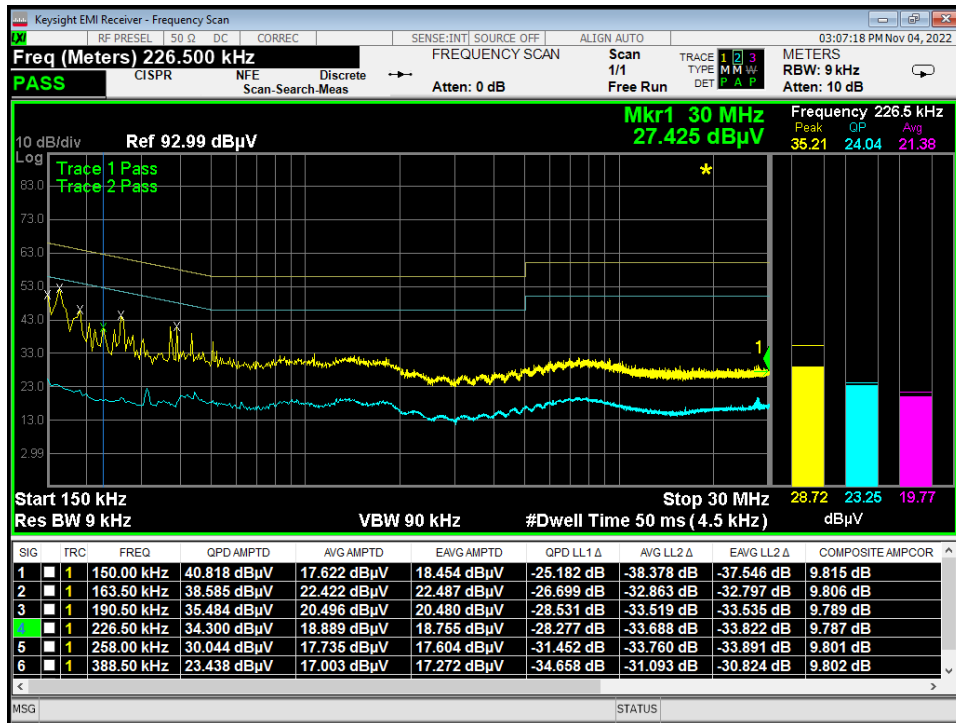


Figure 14 - Conducted Emissions Plot, Neutral, TX

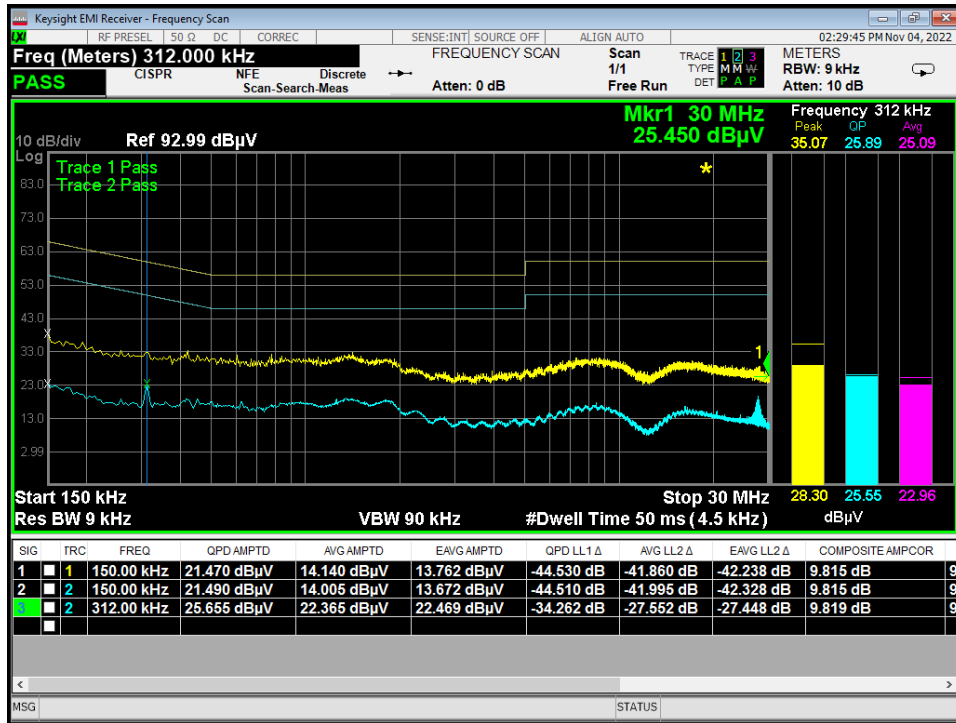


Figure 15 - Conducted Emissions Plot, Line, IDLE

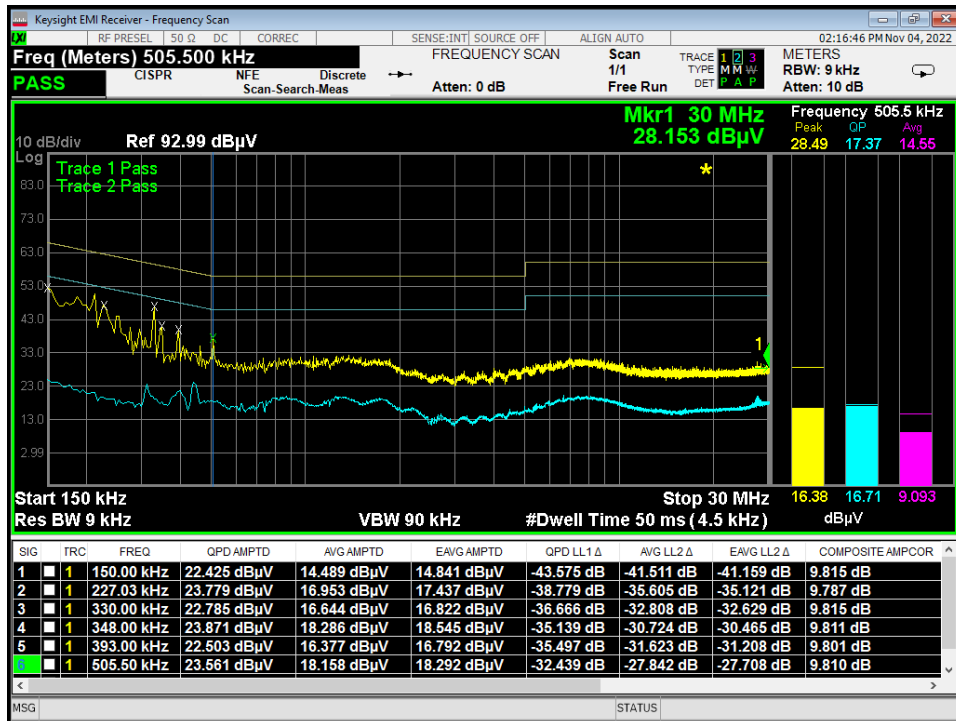


Figure 16 - Conducted Emissions Plot, Neutral, IDLE



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

4.9 ANTENNA GAIN

Test procedures:

Device's conducted power was measured then the same measurement was repeated on a radiated sample at 3m test distance and converted to E.I.R.P.

Test setup:

Details can be found in section 2.1 of this report.

EUT operating conditions:

Details can be found in section 2.1 and 2.2 of this report.

Test results:

Antenna Gain:

Radiated Average power – Conducted Average Power = Antenna gain

15.266 dBm – 17.78 dBm = **-2.514dBi**

Comments:

1. Data was used from a different transmitter (WIFI) that utilizes the same antenna and same frequency band
2. Since antenna gain found to be negative, conducted values are compared to limit where applicable

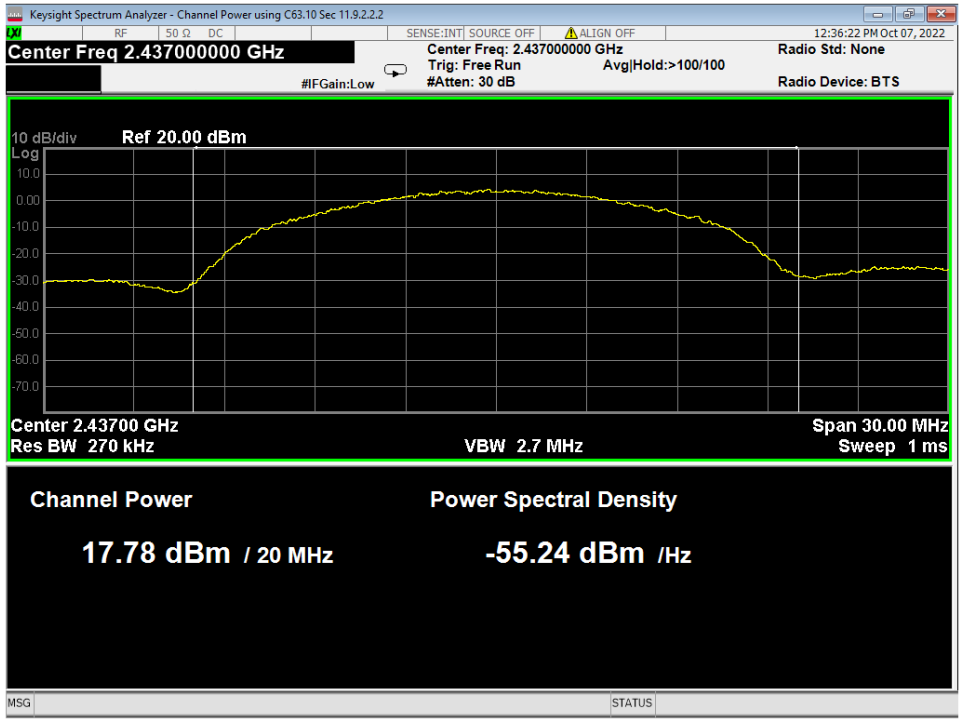


Figure 17 – Conducted Average Power Measurement, 802.11b 11MB

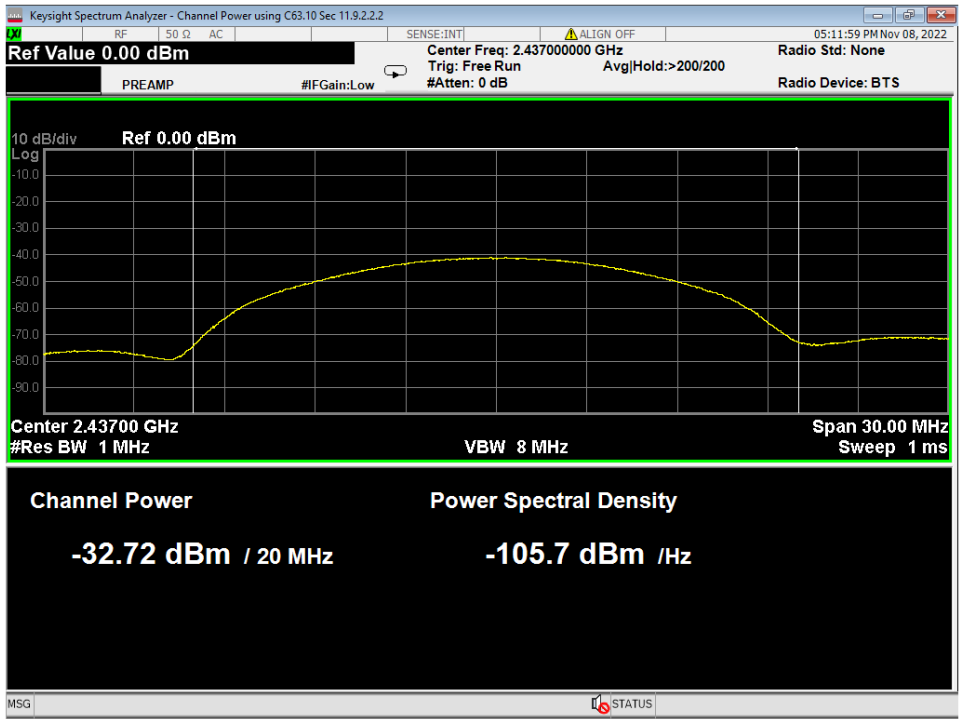


Figure 18 – Radiated Average Power Measurement, 802.11b 11MB

Value is uncorrected, see below for calculation
 Radiated EIRP = Raw Field strength + 3m EIRP Conversion + Transducer + Cable Loss
 $15.226 \text{ dBm} = -32.72 + 11.77 + 27.616 + 8.56$



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB μ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by the taking the $20 \cdot \log(T_{on}/100)$ where T_{on} is the maximum transmission time in any 100ms window.



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

$$EIRP (Watts) = [Field Strength (V/m) \times antenna distance (m)]^2 / 30$$

$$Power (watts) = 10^{[Power (dBm)/10]} / 1000$$

$$Voltage (dB\mu V) = Power (dBm) + 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$Field Strength (V/m) = 10^{[Field Strength (dB\mu V/m) / 20]} / 10^6$$

$$Gain = 1 \text{ (numeric gain for isotropic radiator)}$$

Conversion from 3m field strength to EIRP (d=3):

$$EIRP = [FS(V/m) \times d^2]/30 = FS [0.3] \quad \text{for } d = 3$$

$$EIRP(dBm) = FS(dB\mu V/m) - 10(\log 10^9) + 10\log[0.3] = FS(dB\mu V/m) - 95.23$$

10log(10^9) is the conversion from micro to milli



Report Number:	R20220901-21-E3A	Rev	A
Prepared for:	Garmin International, Inc.		

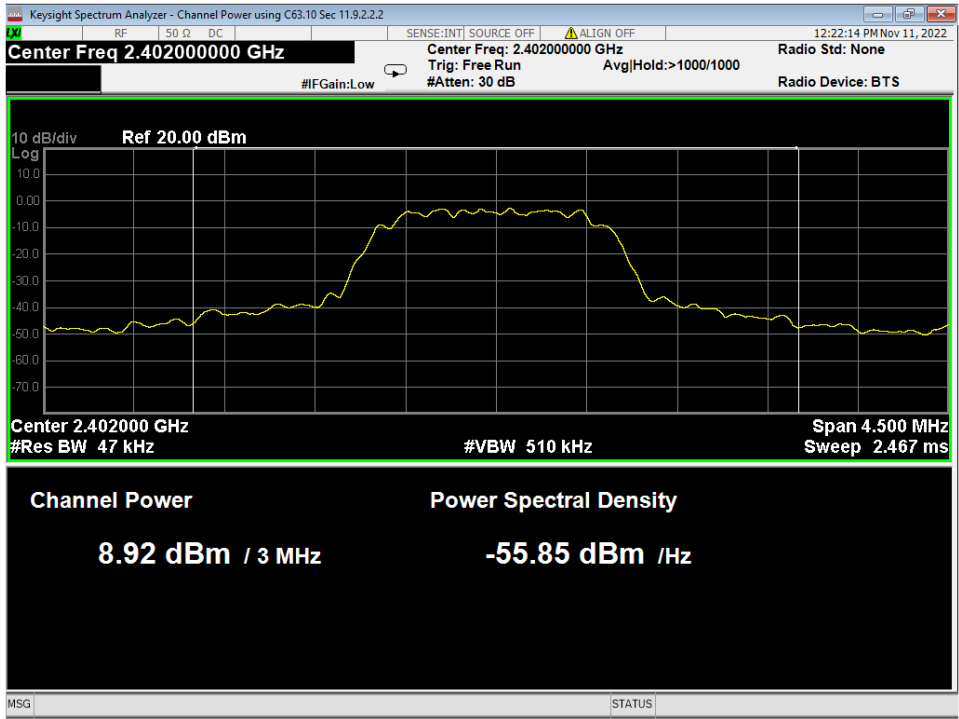
APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

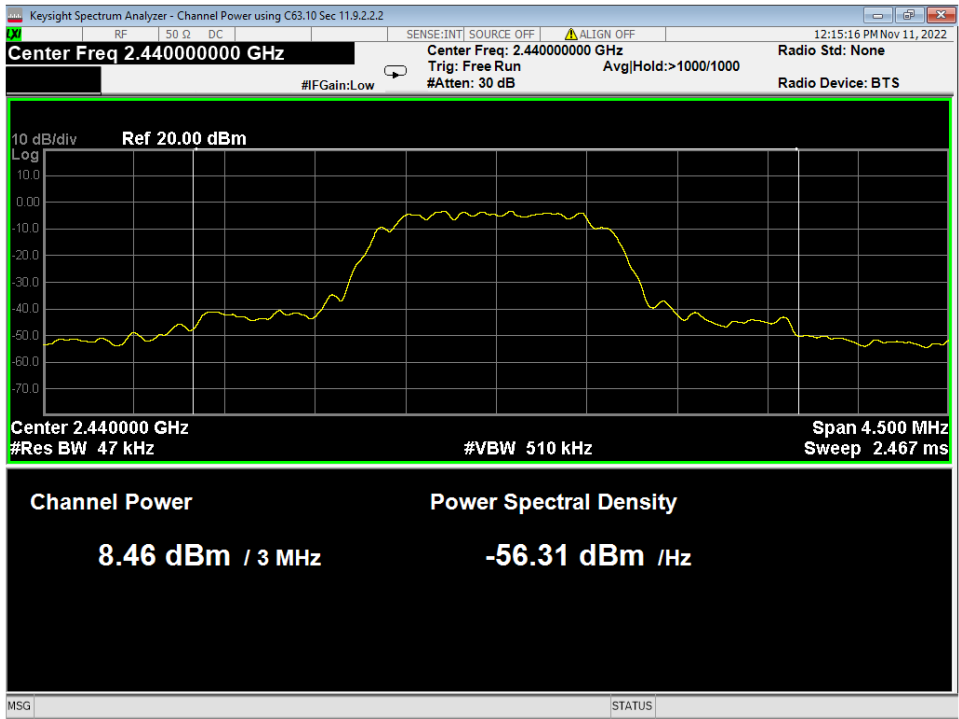
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

Expanded uncertainty values are calculated to a confidence level of 95%.

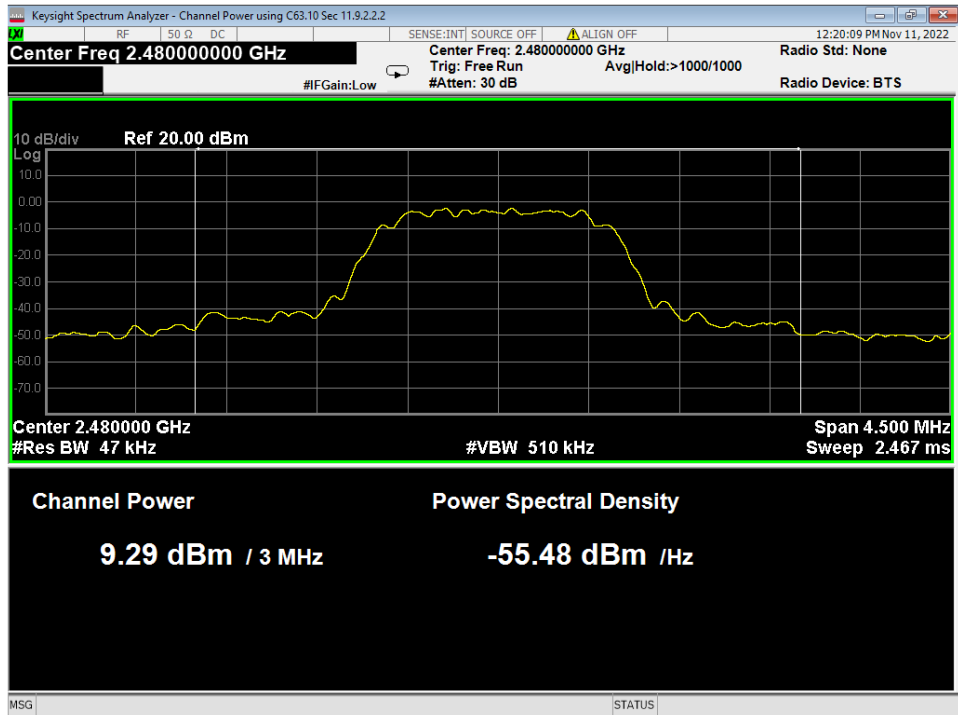
APPENDIX C – GRAPHS AND TABLES



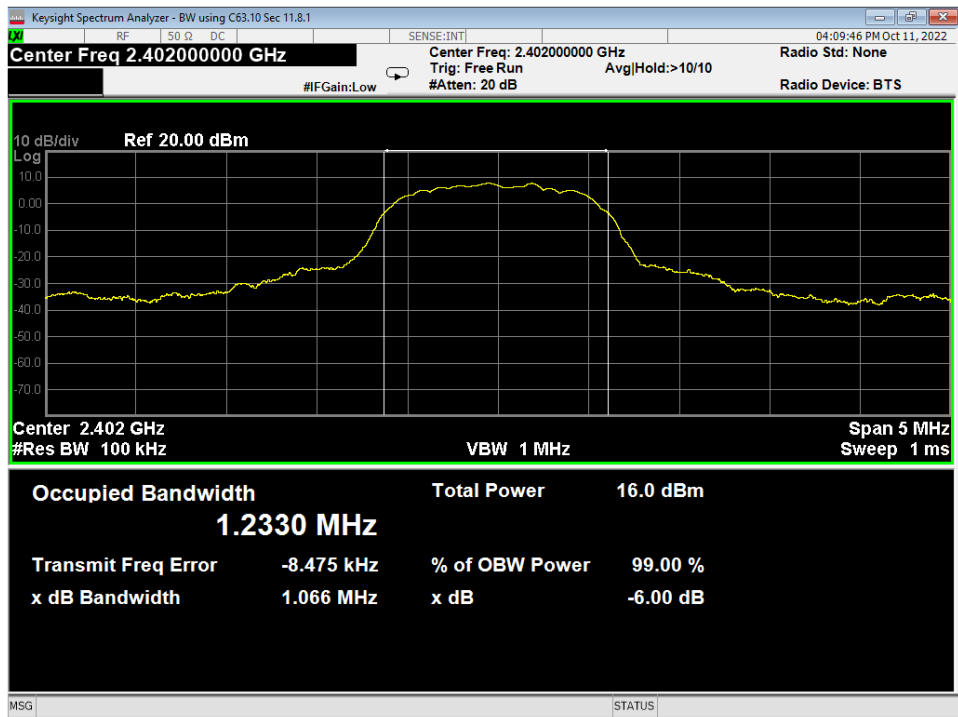
01 Power, Low Channel, 2EDR



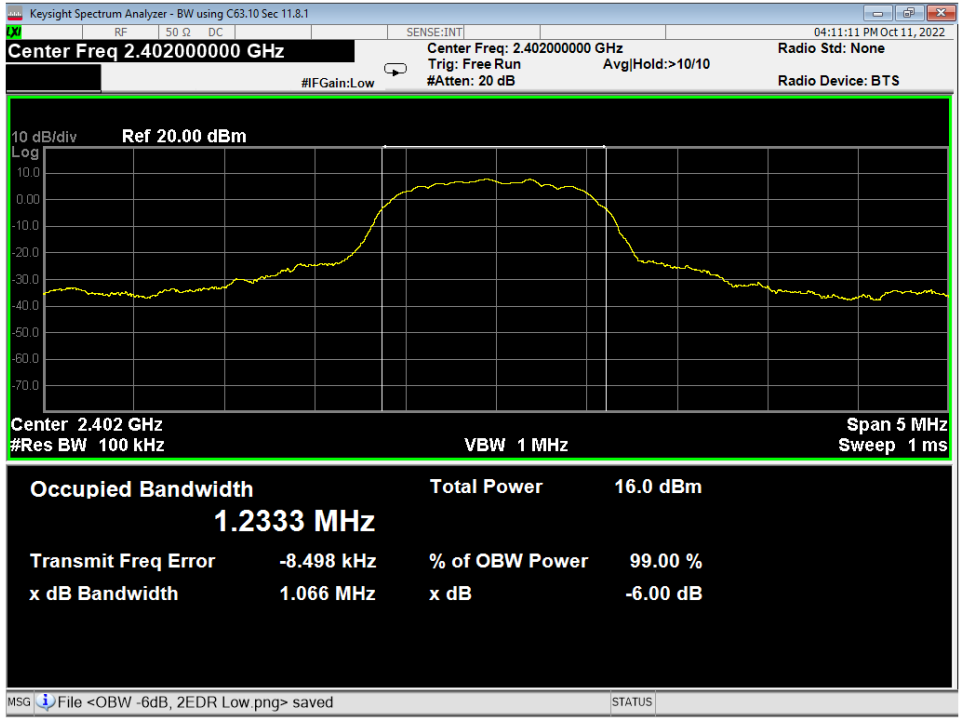
02 Power, Mid Channel, 2EDR



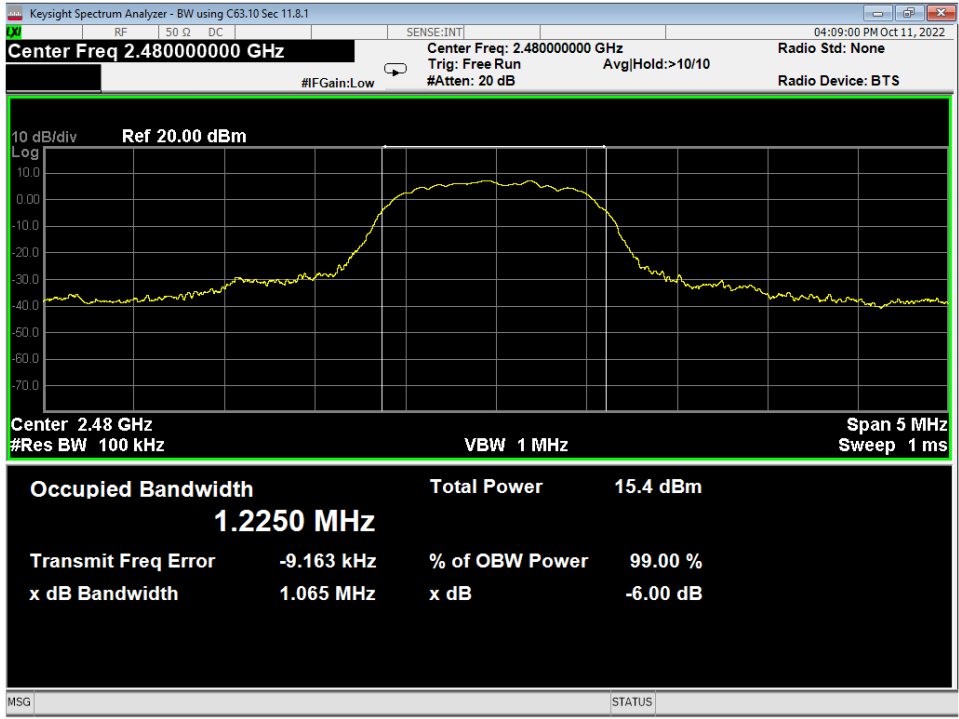
03 Power, High Channel, 2EDR



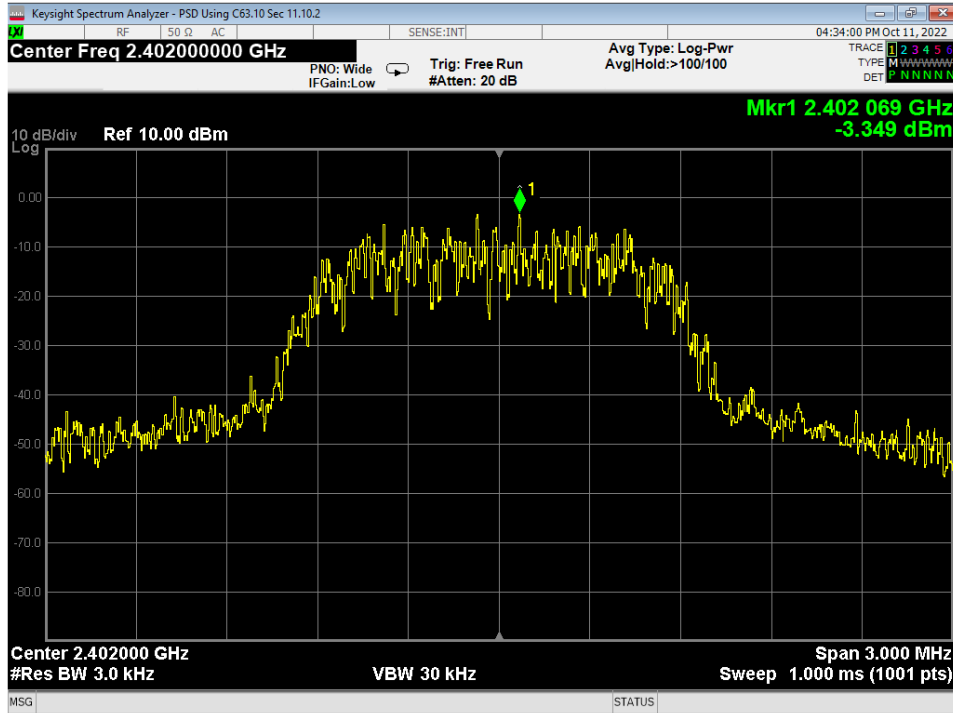
04 6dB Bandwidth, Low Channel, 2EDR



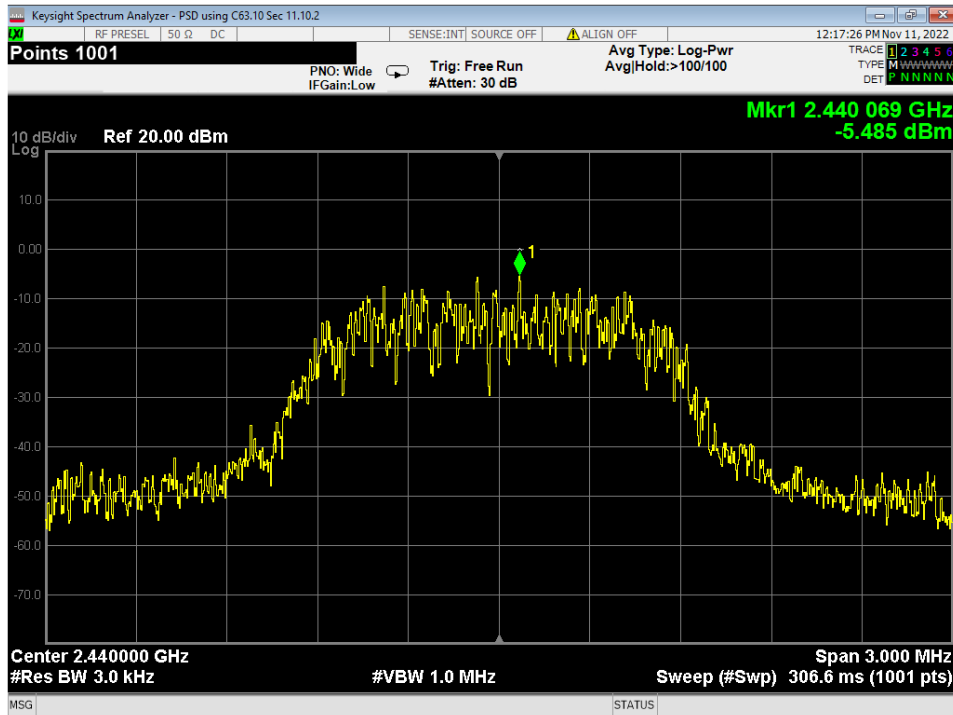
05 6dB Bandwidth, Mid Channel, 2EDR



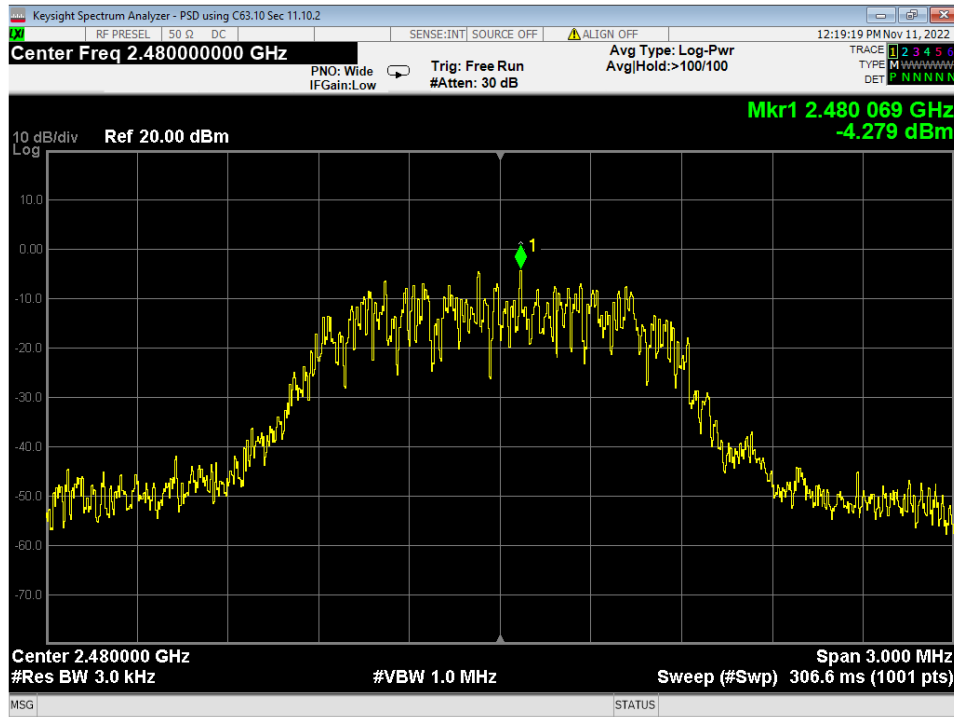
06 6dB Bandwidth, High Channel, 2EDR



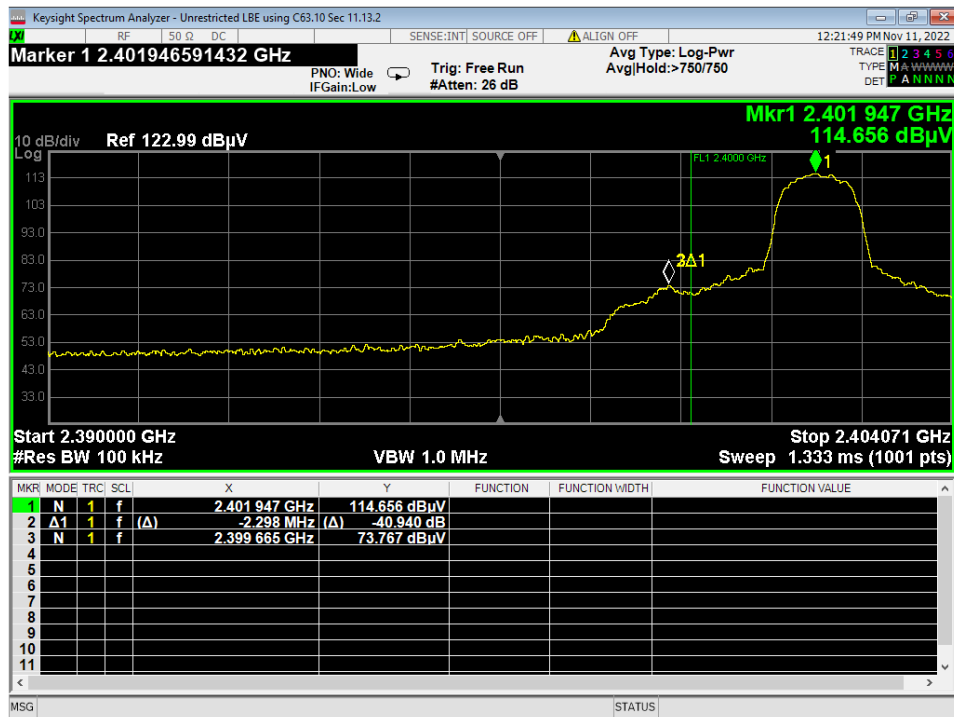
07 PSD, Low Channel, 2EDR



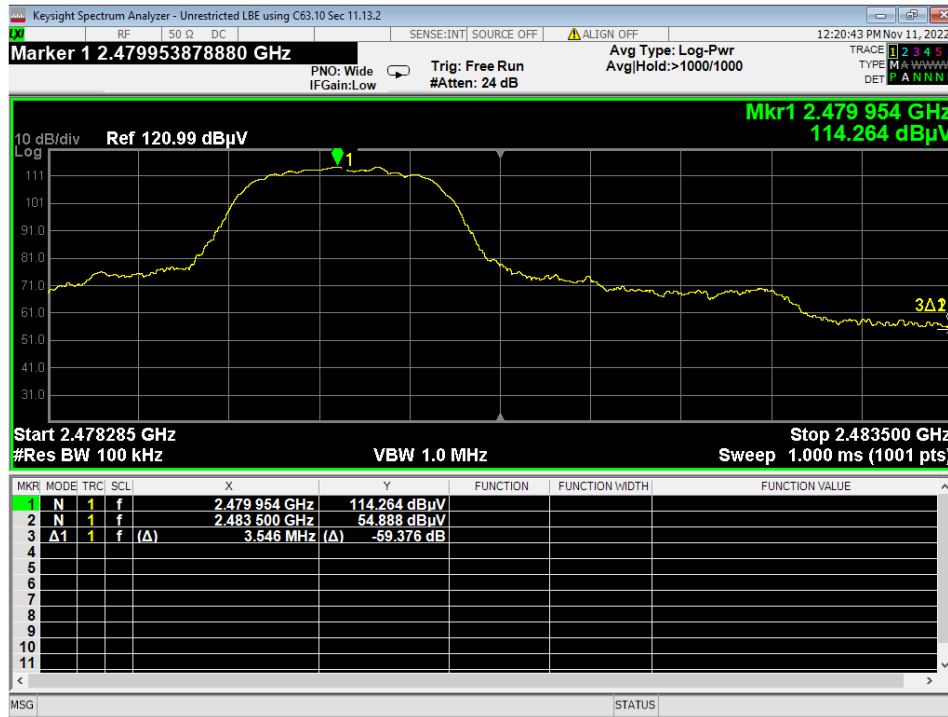
08 PSD, Mid Channel, 2EDR



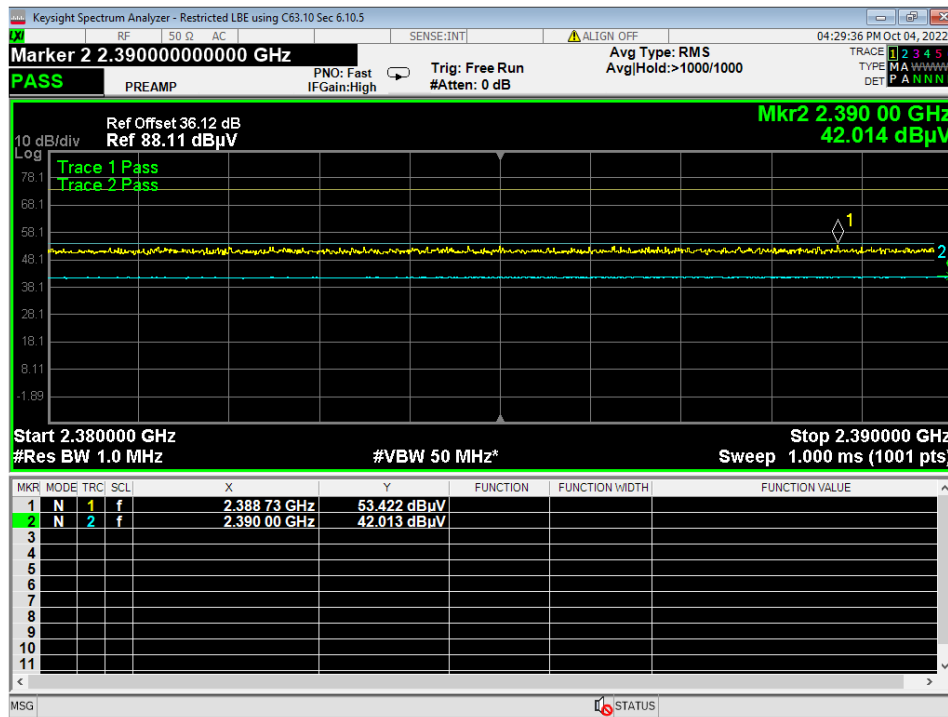
09 PSD, High Channel, 2EDR



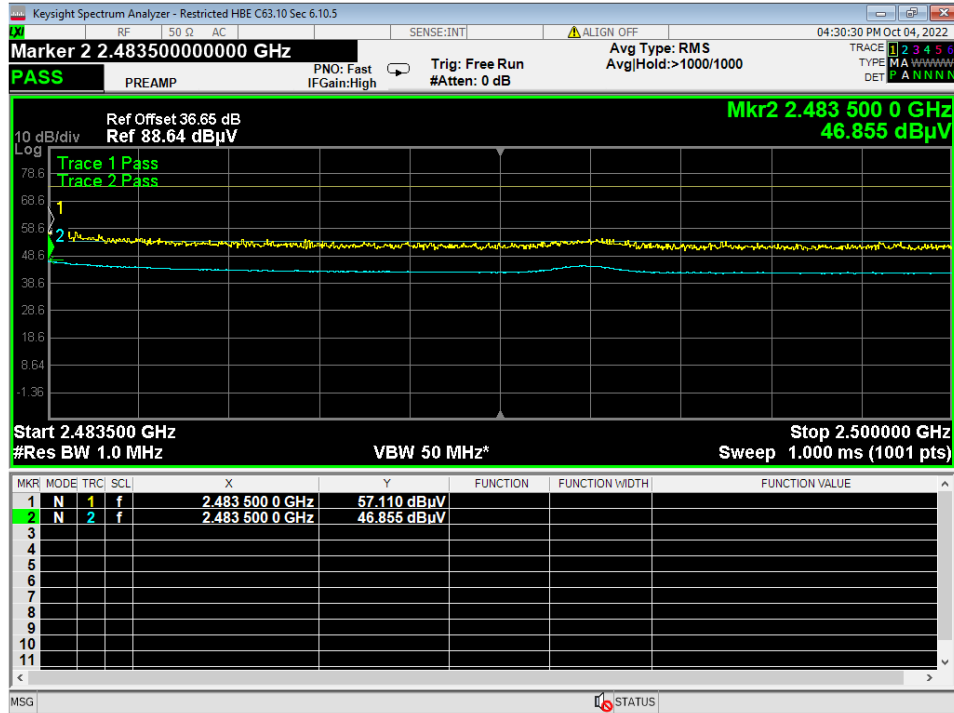
10 Lower Bandedge, Unrestricted, 2EDR



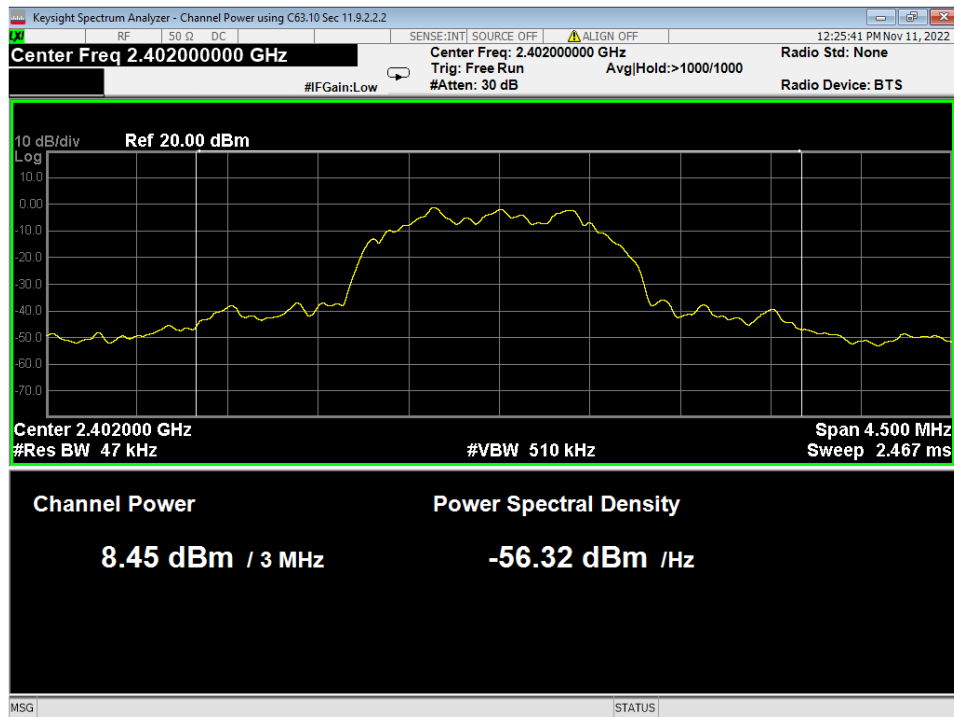
11 Higher Bandedge, Unrestricted, 2EDR



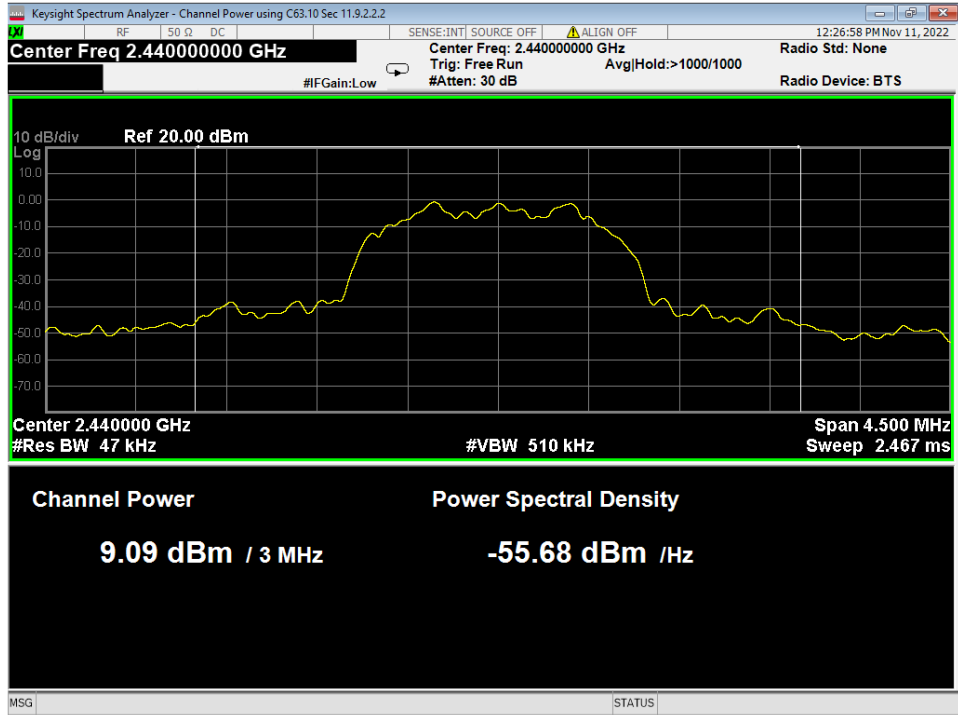
12 Lower Bandedge, Restricted, 2EDR



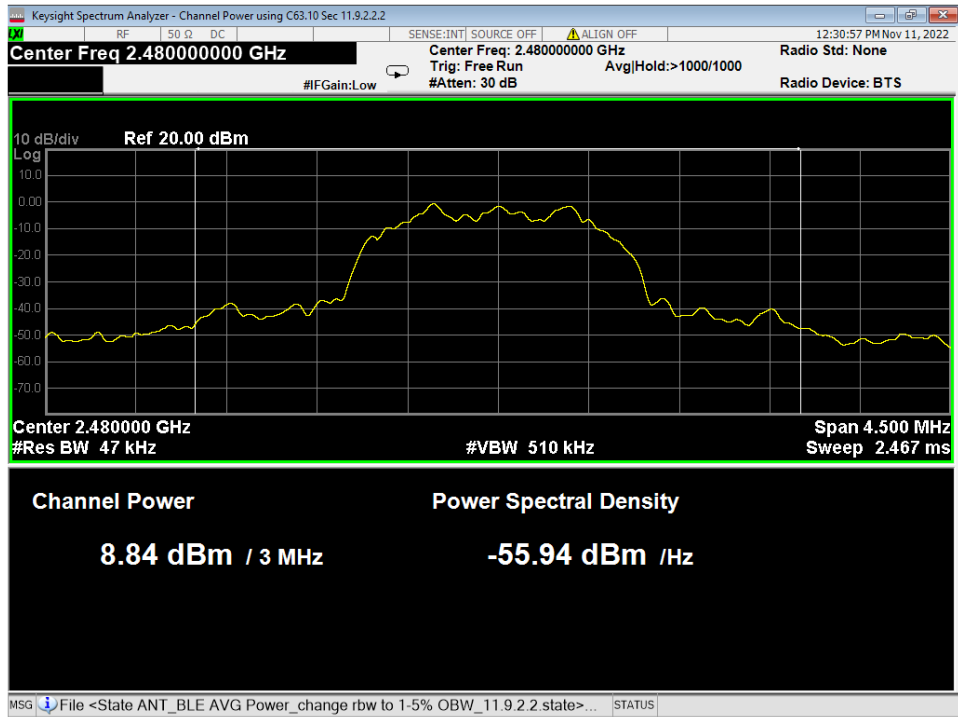
13 Higher Bandedge, Restricted, 2EDR



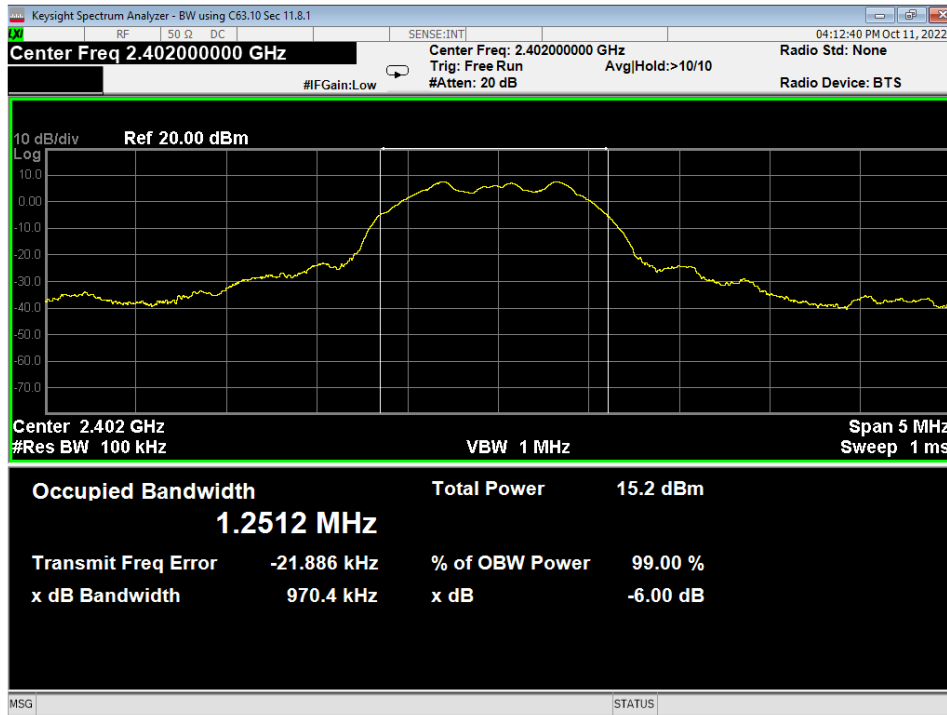
14 Average Power, Low Channel, 3EDR



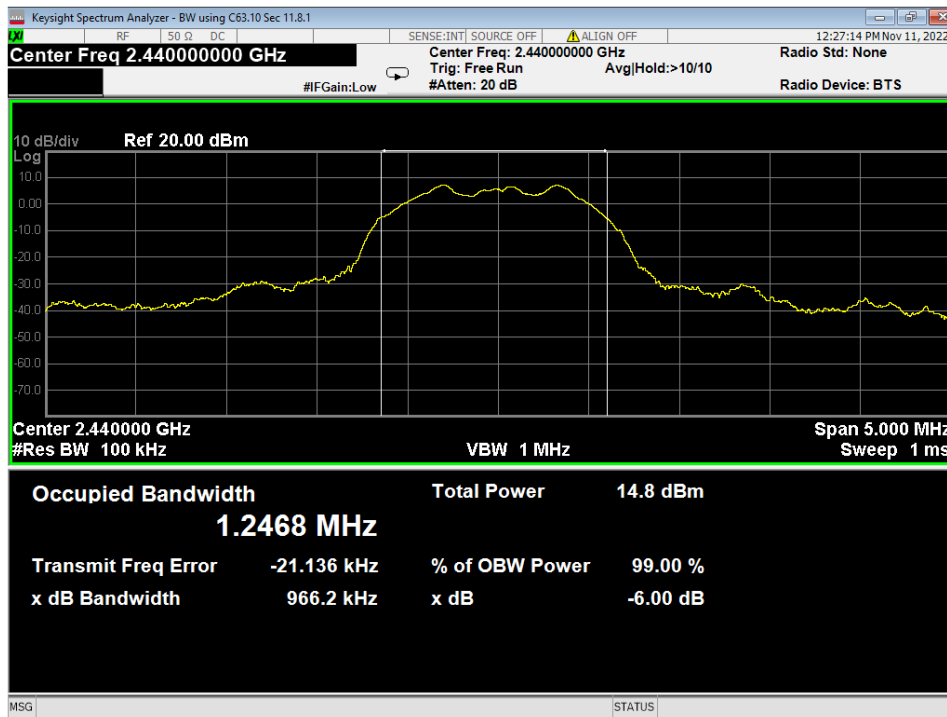
15 Average Power, Mid Channel, 3EDR



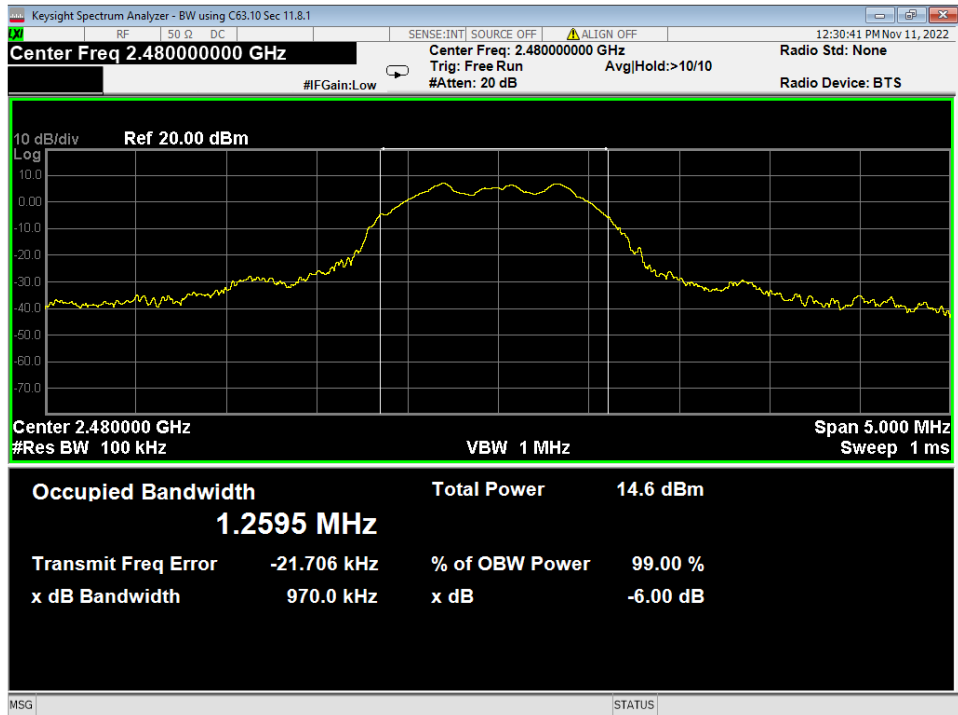
16 Average Power, High Channel, 3EDR



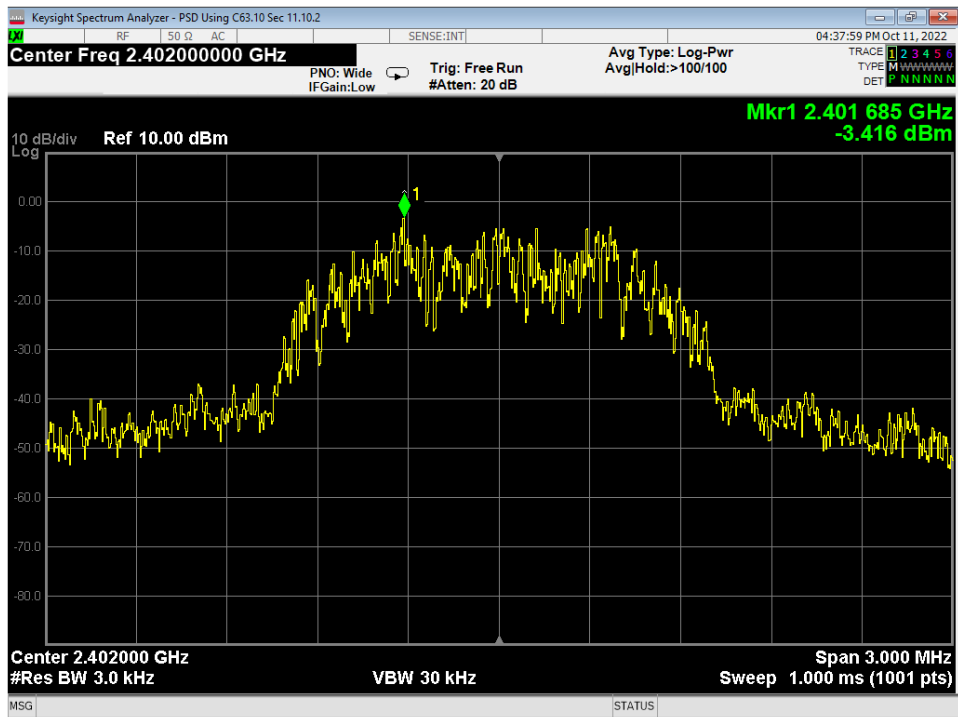
17 6dB Bandwidth, Low Channel, 3EDR



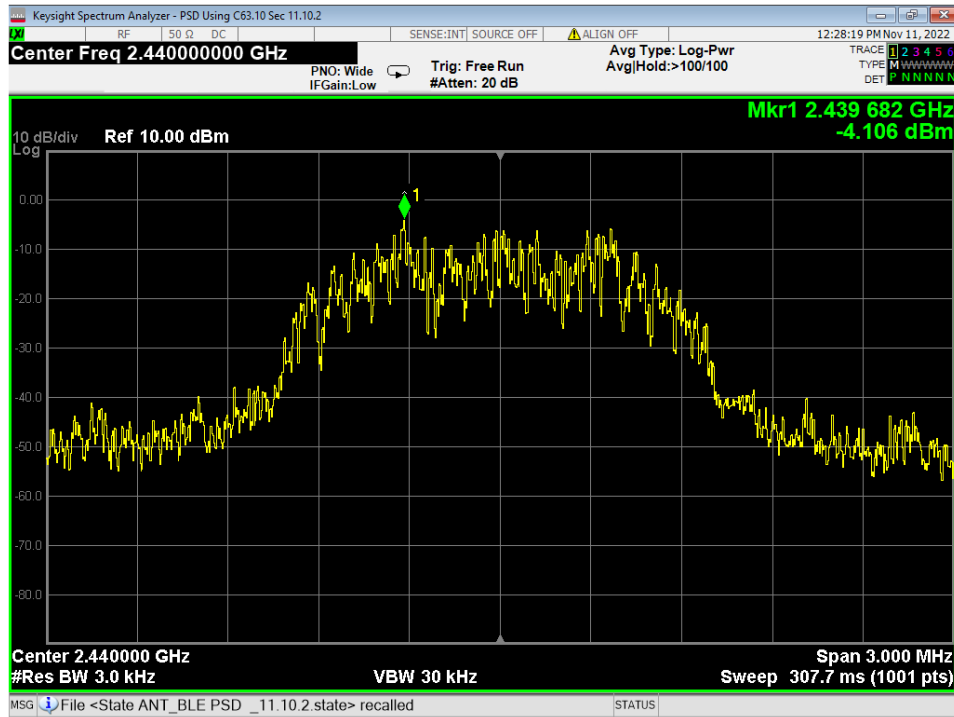
18 6dB Bandwidth, Mid Channel, 3EDR



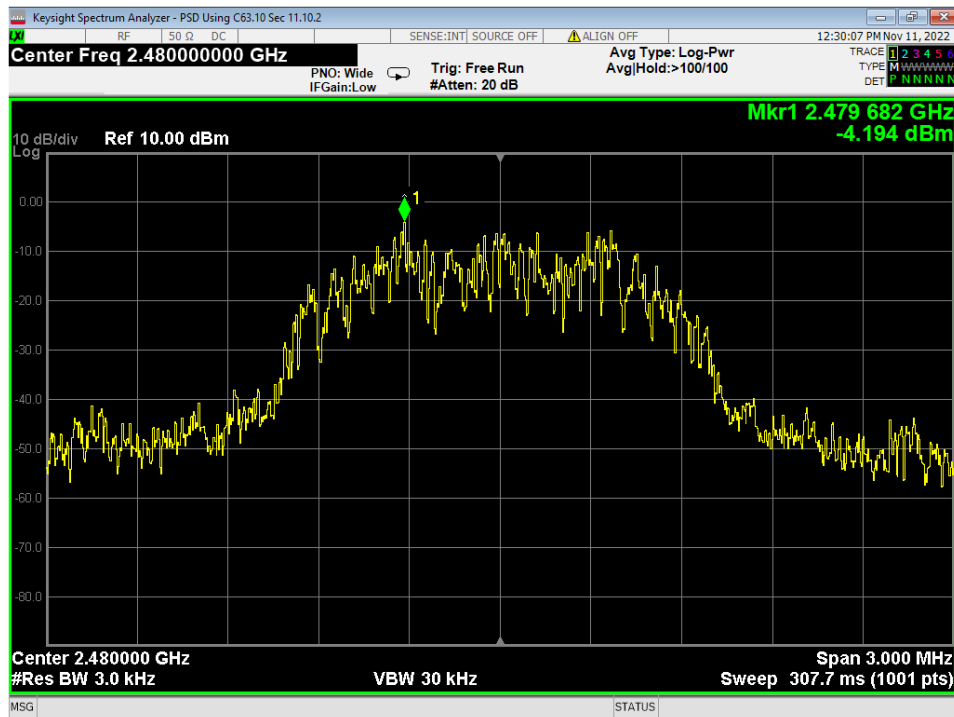
19 6dB Bandwidth, High Channel, 3EDR



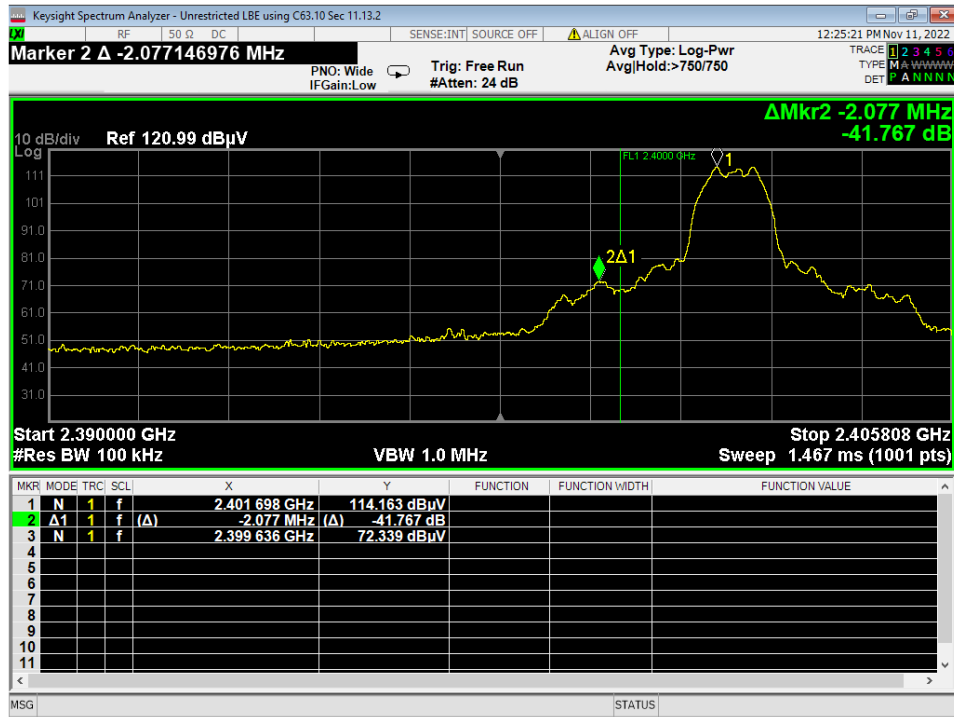
20 PSD, Low Channel, 3EDR



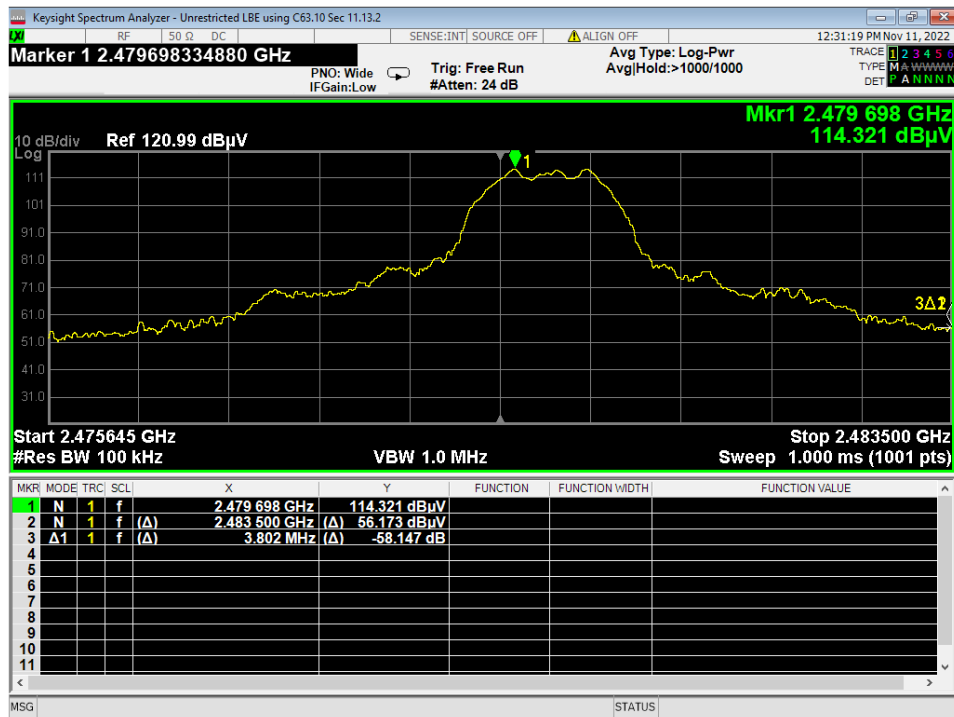
21 PSD, Mid Channel, 3EDR



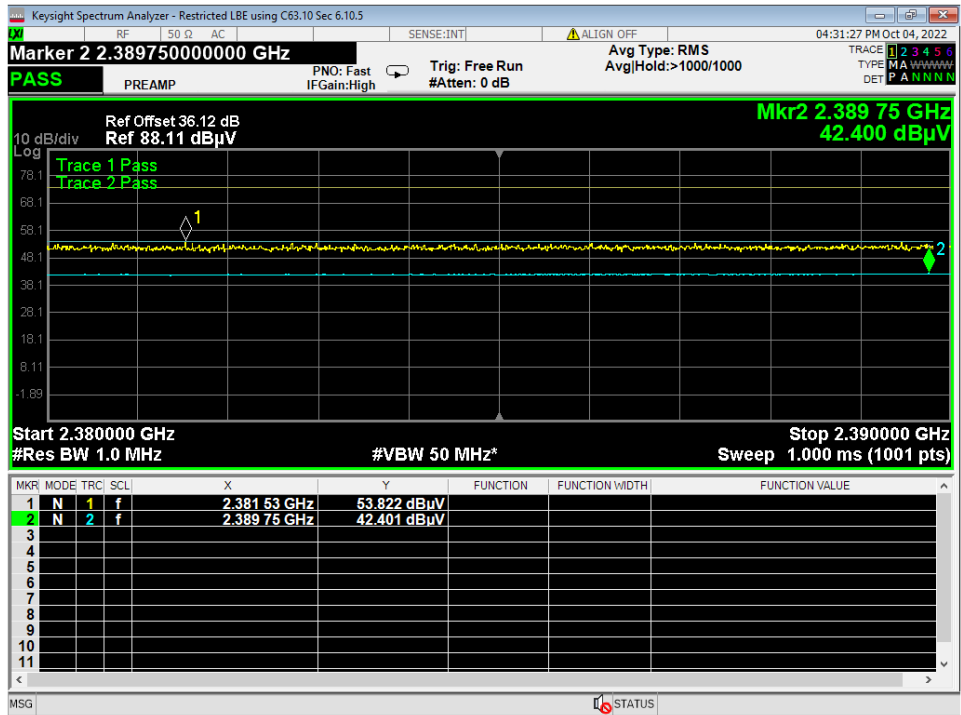
22 PSD, High Channel, 3EDR



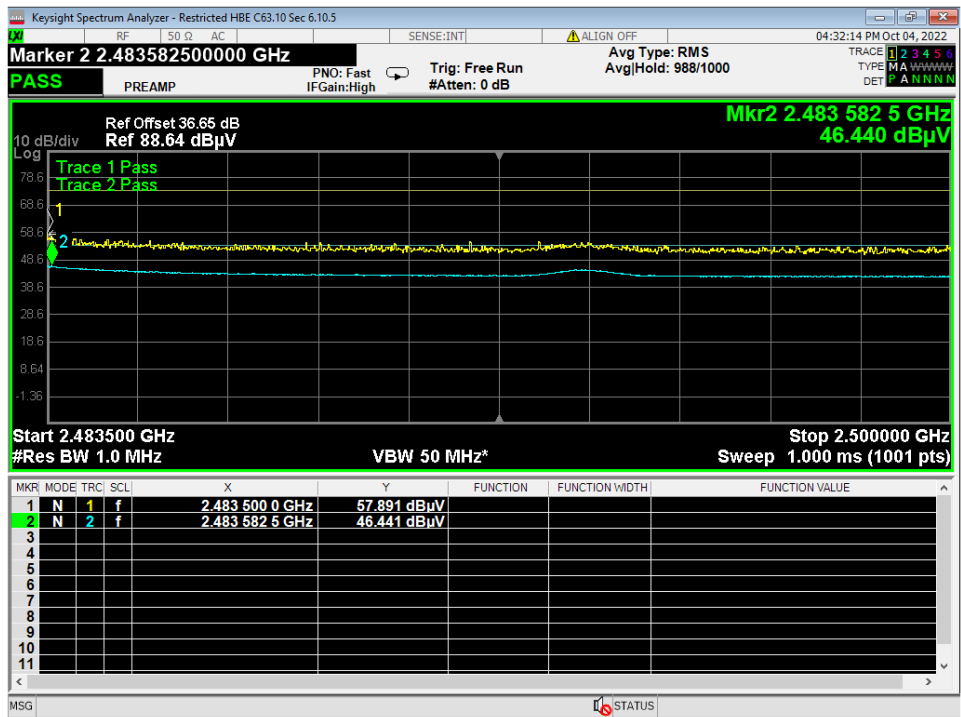
23 Lower Bandedge, Unrestricted, 3EDR



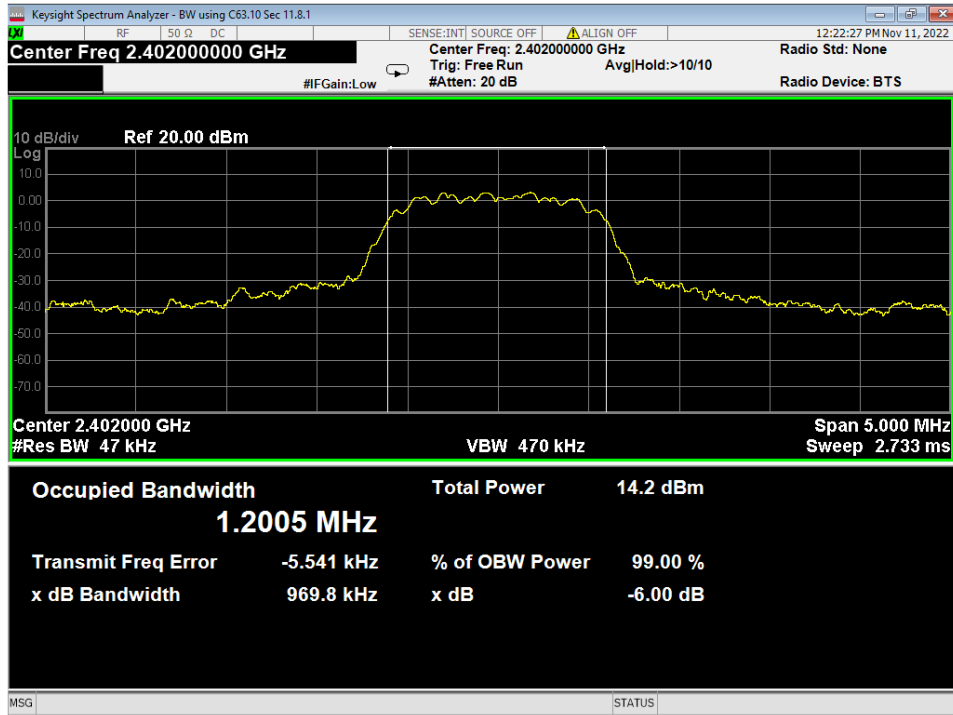
24 Higher Bandedge, Unrestricted, 3EDR



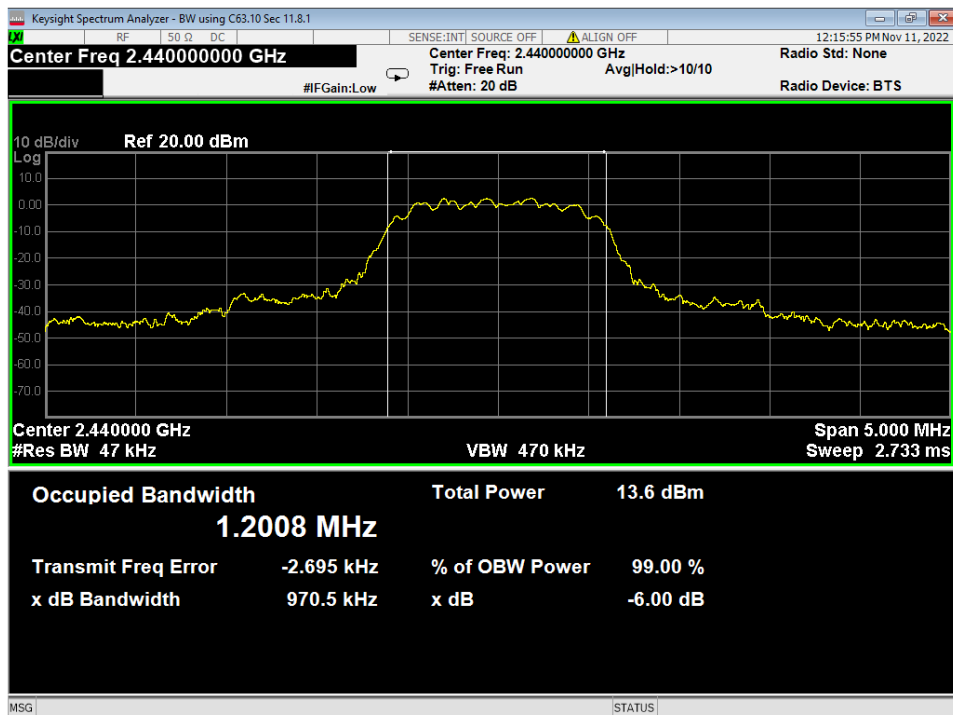
25 Lower Bandedge, Restricted, 3EDR



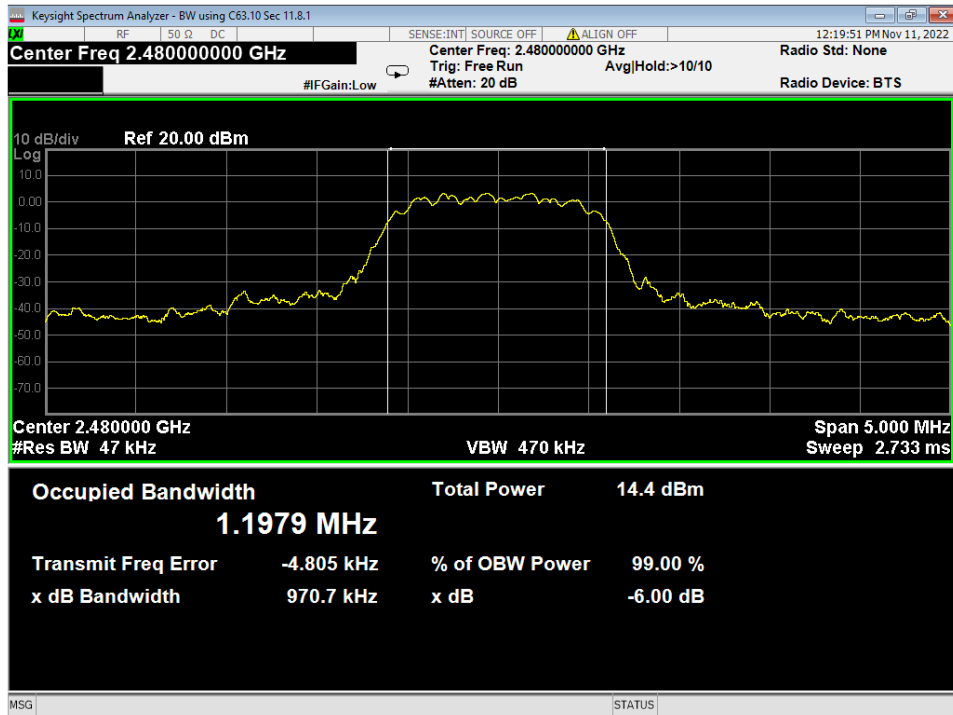
26 Higher Bandedge, Restricted, 3EDR



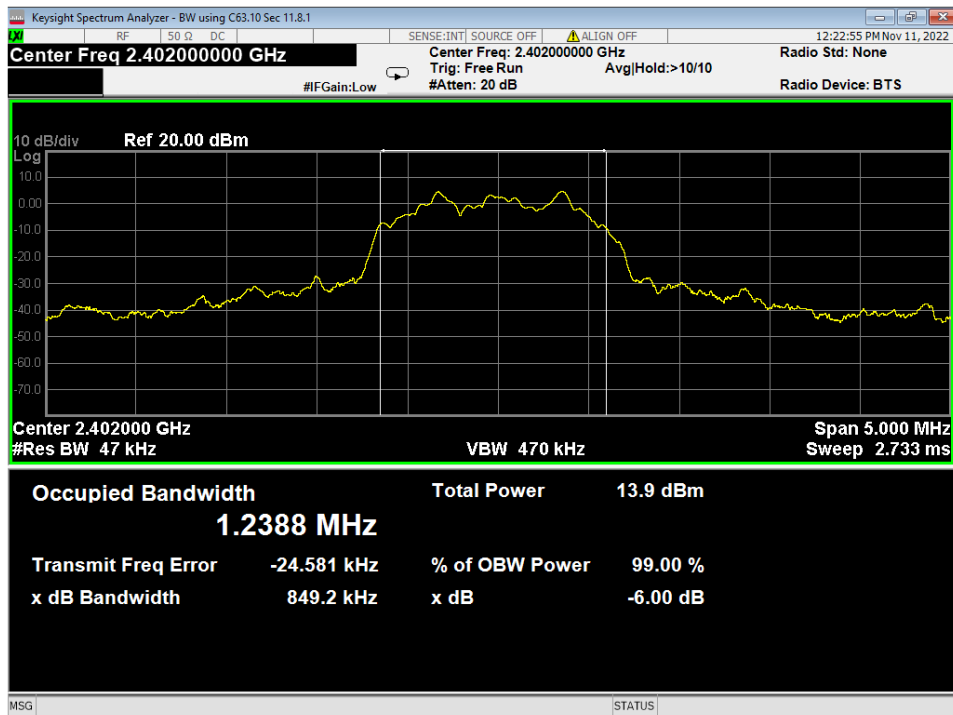
27 Occupied Bandwidth, Low Channel, 2EDR



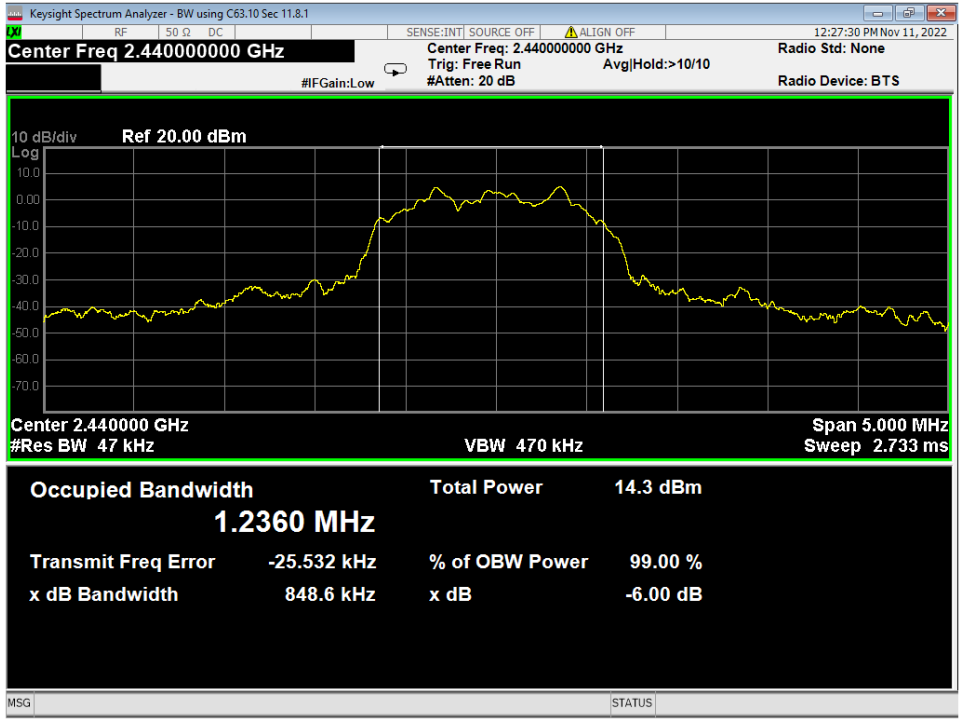
28 Occupied Bandwidth, Mid Channel, 2EDR



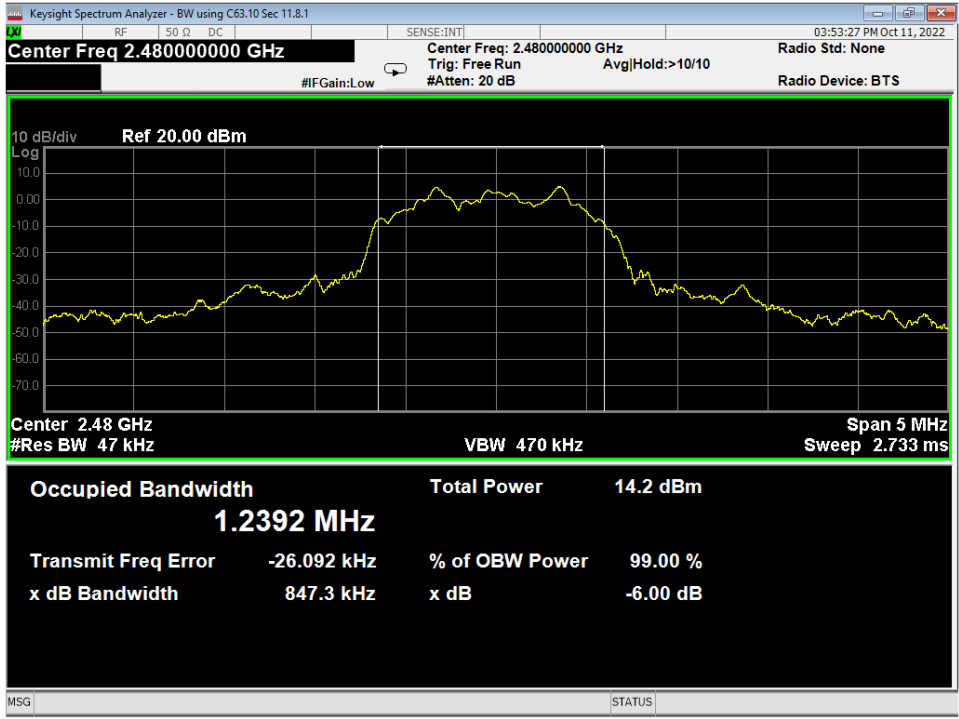
29 Occupied Bandwidth, High Channel, 2EDR



30 Occupied Bandwidth, Low Channel, 3EDR



31 Occupied Bandwidth, Mid Channel, 3EDR



32 Occupied Bandwidth, High Channel, 3EDR



Report Number:

R20220901-21-E3A

Rev

A

Prepared for:

Garmin International, Inc.

REPORT END