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FCC/ISED Test Report

Prepared for: Garmin International, Inc.

Address:

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

Product:

A04252

Test Report No:

R20210128-20-E28

Approved by:

Mahendra Karthik Vepuri, NCE **EMC** Test Engineer, iNARTE Certified EMC Engineer #EMC-041453-E

DATE:

December 8, 2021

Total Pages:

77

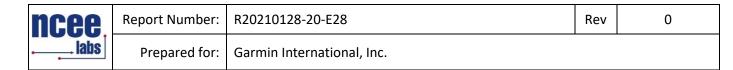
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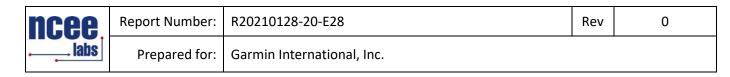
REVISION PAGE

Rev. No.	Date	Description
0	8 December 2021	Original – KVepuri
		Prepared by FLane



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1.0 SUMMARY OF TEST RESULTS

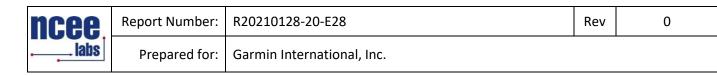
The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section:

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(a)(1) RSS-247 Issue 2 Section 5.2	Peak output power	Pass		
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass		
FCC Part 15.209 RSS-Gen Issue 4, Section 7.1	Receiver Radiated Emissions	Pass		
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 4, Section 8.9	Transmitter Radiated Emissions	Pass		
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass		
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 11.13	Band Edge Measurement	Pass		
FCC Part 15.207 RSS-Gen Issue 4, Section 7.1	Conducted Emissions	Pass		



2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	A04252
EUT Received	9 March 2021
EUT Tested	9 March 2021- 3 December 2021
Serial No.	3388435202 (Conducted Unit) 3388435284 (Radiated Unit)
Operating Band	2400 – 2483.5 MHz
Device Type	□ GMSK □ GFSK □ BT BR □ BT EDR 2MB □ BT EDR 3MB ⊠ 802.11x
Power Supply / Voltage	Internal Battery/ 5VDC Charger: Garmin (Phi Hong) MN: PSAI10R-050Q (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	2440/2441 MHz		
High	2480 MHz		

For 802.11x Transmissions:			
Channel	Frequency		
Low	2412 MHz		
Mid	2437 MHz		
High	2462 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.

	Powe	er Settings used:	
Modulation	Low	Mid	High
802.11b	42	42	42
802.11g	42	42	42
802.11n	35	42	31

2.3 DESCRIPTION OF SUPPORT UNITS

None



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/editing
2	Fox Lane	Test Engineer	Testing and report
3	Grace Larsen	Test Technician	Testing
4	Samuel Probst	Test Technician	Testing
5	Matthew Emory	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.



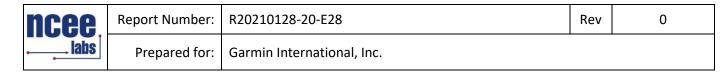
3.3 TEST EQUIPMENT

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 21, 2021	July 21, 2023
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2022
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2022
EMCO Horn Antenna	3116	2576	March 9, 2020	March 9, 2022
Com-Power LISN 50μH / 250μH - 50Ω	LI-220C	20070017	September 22, 2020	September 22, 2022
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	February 1, 2021	February 1, 2022
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	April 14, 2020	April 14, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
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	October 25, 2019	October 25, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
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

Notes:

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



3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

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

Conducted \boxtimes

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.

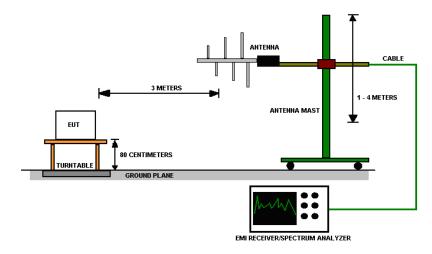


Figure 2 - Radiated Emissions Test Setup

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4.0 RESULTS

		DT	S Radio Meas	surements			
CHANNEL	Transmitter	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)	OUTPUT POWER (dBm)	OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	802.11 b	14.63	9.04	23.010	199.986	-5.953	PASS
Mid	802.11 b	14.64	9.03	23.050	201.837	-6.331	PASS
High	802.11 b	14.60	9.50	22.640	183.654	-6.624	PASS
Low	802.11 g	16.53	16.52	23.650	231.739	-7.838	PASS
Mid	802.11 g	16.51	16.49	22.800	190.546	-8.701	PASS
High	802.11 g	16.50	16.51	22.700	186.209	-9.289	PASS
Low	802.11 n	17.50	17.59	21.660	146.555	-11.343	PASS
Mid	802.11 n	17.51	17.60	23.930	247.172	-9.01	PASS
High	802.11 n	17.49	17.58	19.570	90.573	-13.565	PASS
Occupied Ba kHz	andwidth = N/A;	6 dB Bandwidth I	_imit =500	Output Power Li	mit = 30 dBm;	PSD Limit	= 8 dBm
		U	nrestricted Ba	and-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	802.11 b	2400.00	82.06	115.45	33.39	20.00	PASS
Low	802.11 g	2400.00	73.03	109.37	36.34	20.00	PASS
Low	802.11 n	2400.00	70.48	106.72	36.24	20.00	PASS
High	802.11 b	2483.50	61.69	114.61	52.92	20.00	PASS
High	802.11 g	2483.50	73.11	108.34	35.23	20.00	PASS
High	802.11 n	2483.50	63.32	105.55	42.23	20.00	PASS
<u> </u>		Radiate		ted Band-Edge			<u>.</u>
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	55.43	Peak	73.98	18.55	PASS
Low	802.11 g	2390.00	63.40	Peak	73.98	10.58	PASS
Low	802.11 n	2390.00	63.86	Peak	73.98	10.12	PASS
High	802.11 b	2483.50	57.23	Peak	73.98	16.75	PASS
High	802.11 g	2483.50	68.34	Peak	73.98	5.64	PASS
High	802.11 n	2483.50	65.81	Peak	73.98	8.17	PASS
		it taken from FCC					

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		Radiated	Average Rest	ricted 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	802.11 b	2390.00	43.83	Average	53.98	10.16	PASS
Low	802.11 g	2390.00	49.08	Average	53.98	4.90	PASS
Low	802.11 n	2390.00	50.36	Average	53.98	3.62	PASS
High	802.11 b	2483.50	46.79	Average	53.98	7.19	PASS
High	802.11 g	2483.50	52.65	Average	53.98	1.33	PASS
High	802.11 n	2483.50	53.84	Average	53.98	0.14	PASS
*Limit shown	is the average	limit taken from F	CC Part 15.20	9			



4.1 OUTPUT POWER

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 allowed peak 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.



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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:

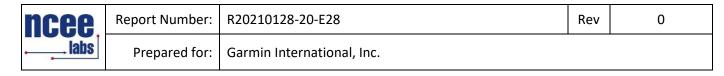
Details can be found in section 2.1 of this report.

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.



4.3 DUTY CYCLE

Test Method:

All Modulations/Transmitters in this report had a duty cycle of >98%



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 (μV/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 * Emission level (μ 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.



Test procedures:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semianechoic 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.

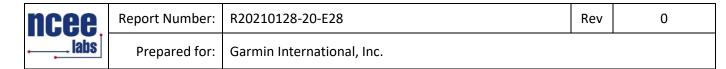
c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

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:

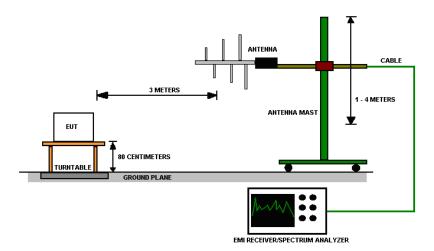


Figure 3 - Radiated Emissions Test Setup

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.

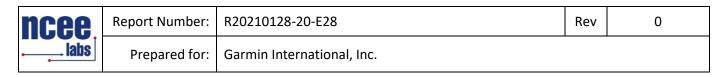
2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

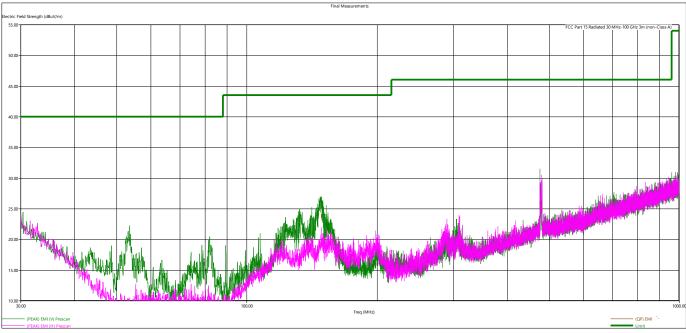
No deviation.

EUT operating conditions

Details can be found in section 2.1 of this report.



Test results:





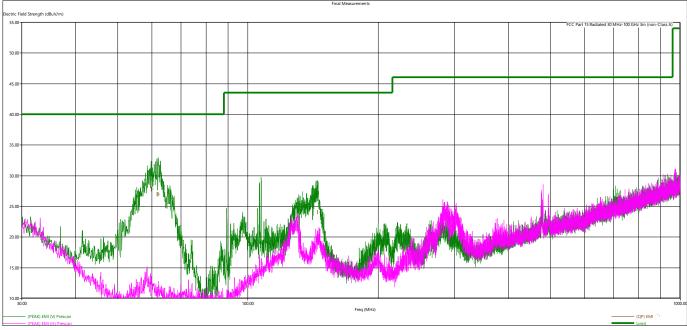
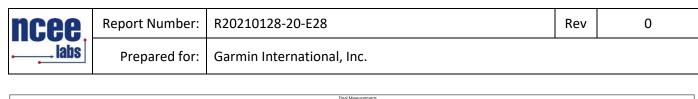
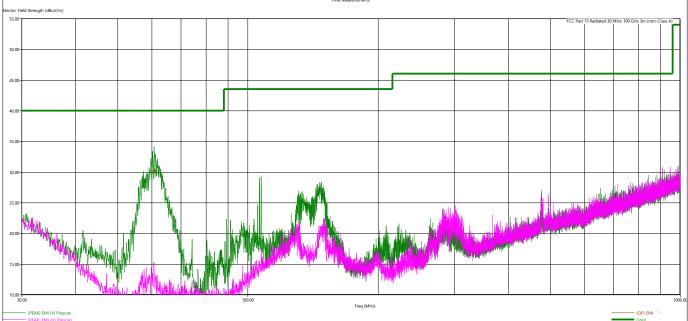


Figure 5 - Radiated Emissions Plot, 802.11b







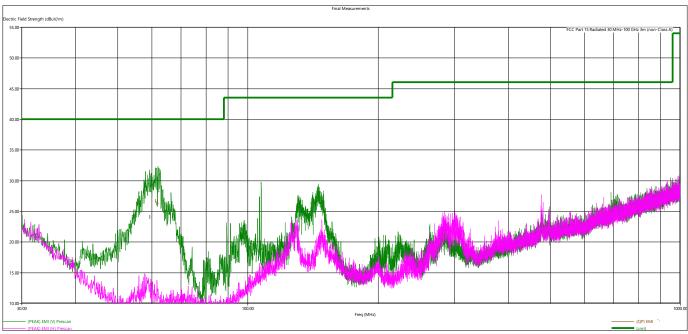


Figure 7 - Radiated Emissions Plot, 802.11n

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

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	Quasi-Peak Measurements, 802.11											
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation				
MHz	dBµV/m	dBµV/m	dB	cm.	deg.							
59.717040	27.73	40.00	12.27	105	2	V	Low	802.11b				
61.398480	26.92	40.00	13.08	136	280	V	Low	802.11b				
62.129040	26.94	40.00	13.06	132	354	V	Low	802.11b				
144.709200	24.02	43.52	19.50	119	57	V	Low	802.11b				
60.192000	29.87	40.00	10.13	105	301	V	Low	802.11g				
60.730320	30.15	40.00	9.85	106	300	V	Low	802.11g				
61.122480	29.93	40.00	10.07	109	315	V	Low	802.11g				
59.460480	24.01	40.00	15.99	142	270	V	Low	802.11n				
61.309680	26.66	40.00	13.34	112	347	V	Low	802.11n				
61.429680	26.25	40.00	13.75	121	289	V	Low	802.11n				
148.543920	23.78	43.52	19.74	115	103	V	Re	eceive				
476.324400	25.89	46.02	20.13	107	64	V	Receive					

All other measurements were found to be at least 6 dB Below the limit. Worst case emissions are reported.

	Peak Measurements, 802.11x										
Frequency	Level	Limit	Limit Margin He		ht Angle		Channel	Modulation			
MHz	dBµV/m	dBµV/m	dB	cm.	deg.						
2413.810000	102.45	NA	NA	221	144	Н	Low	802.11b			
2436.372000	101.5	NA	NA	140	145	Н	Mid	802.11b			
2463.222000	100.35	NA	NA	134	142	Н	High	802.11b			
2410.836000	97.09	NA	NA	128	160	Н	Low	802.11g			
2434.884000	96.97	NA	NA	239	201	V	Mid	802.11g			
2460.964000	94.27	NA	NA	112	164	Н	High	802.11g			
2407.572000	96.42	NA	NA	263	206	V	Low	802.11n			
2437.798000	95.94	NA	NA	230	203	V	Mid	802.11n			
2459.664000	94.94	NA	NA	281	198	V	High	802.11n			

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. All other measurements were found to be at least 6 dB Below the limit.

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	lahs
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Average Measurements, 802.11x										
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation		
MHz	dBµV/m	dBµV/m	dB	cm.	deg.					
2413.810000	95.03	NA	NA	221	144	Н	Low	802.11b		
2436.372000	93.72	NA	NA	140	145	Н	Mid	802.11b		
2463.222000	91.94	NA	NA	134	142	Н	High	802.11b		
2410.836000	86.84	NA	NA	128	160	н	Low	802.11g		
2434.884000	86.8	NA	NA	239	201	V	Mid	802.11g		
2460.964000	84.25	NA	NA	112	164	н	High	802.11g		
2407.572000	85.68	NA	NA	263	206	V	Low	802.11n		
2437.798000	86.21	NA	NA	230	203	V	Mid	802.11n		
2459.664000	84.98	NA	NA	281	198	V	High	802.11n		

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.

All other measurements were found to be at least 6 dB Below the limit.



Test Method: ANSI C63.10-2013, Section 7.8.8

Limits of spurious emissions:

From FCC Part 15.247:

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 § 15.205(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:

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:

The highest value measured was 7.631 dBm at the fundamental emissions. All other values were at least 20 dB below the fundamental. All 3 channels were investigated and worst case was reported.

Rev



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):Fast 🕞 in:Low	#Atten:	ree Run : 20 dB		Avg Hold	.~100/10			DET	PPNN
eak Table										Mkr1		
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			-10.0									
			-20.0									-20.00
			-30.0									
			-40.0									
			-40.0									
			-50.0									
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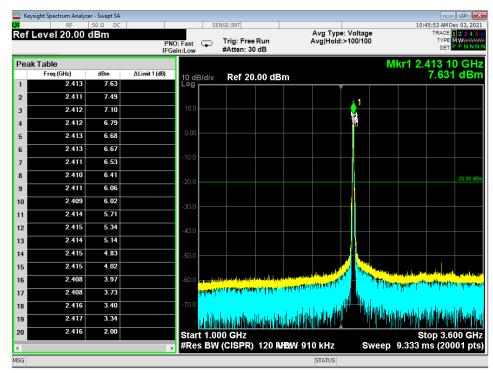


Figure 9 - Radiated Emissions Plot, WIFI 802.11b, 1G - 3.6G, Low



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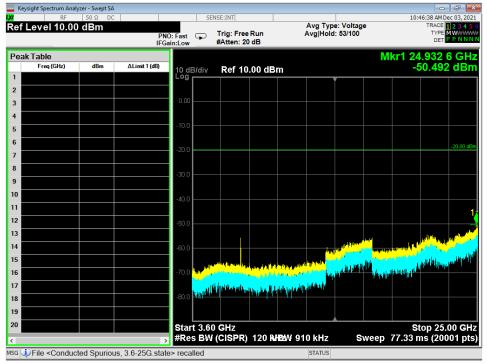
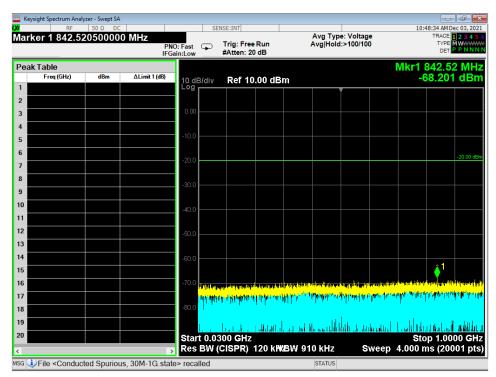


Figure 10 - Radiated Emissions Plot, WIFI 802.11b, 3.6G - 25G, Low







Keysight Spectrum Analyz	50 Ω DC	SENSE:INT		🗖 🗗 🗐 🖬
/larker 1 2.4098	50000000 GHz	PNO: Fast 😱 Trig: Free Run IFGain:Low #Atten: 20 dB	Avg Type: Voltage Avg Hold:>100/100	TRACE 2 3 4 TYPE MWWWW DET P P N N
Peak Table			M	r1 2.409 85 GH
Freq (GHz)	dBm ΔLimit1	TIU dB/dlV Ref 10.00 dBm		3.176 dBr
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2 2.413	2.79			
3 2.411	2.60	0.00		
4 2.413	2.52			
5 2.410	2.31	-10.0		
6 2.414	2.22			-20.00 dE
7 2.419	2.20	-20.0		
8 2.412	2.15	-30.0		
9 2.409	2.13	-30.0		
10 2.413	2.07	-40.0		
11 2.407	1.98	-40.0		
12 2.409	1.98	-50.0		
13 2.415	1.96			
14 2.414	1.96	-60.0		
15 2.408	1.83			
16 2.411	1.80	-70.0 dependentligetelentet bieren had de		ter in an and the second second second
17 2.411	1.77	-70.0 0000000000000000000000000000000000		الانتقار بالمتلا بالا
18 2.414	1.76	-80.0	ا برا الله المحمد ا	and the data data and
19 2.409	1.68	autal dation detail description of the		
20 2.415	1.66	Start 1.000 GHz		Stop 3.600 GH
		#Res BW (CISPR) 120 MH	W 910 kHz Sweep 9).333 ms (20001 pt
sg			STATUS	

Figure 12 - Radiated Emissions Plot, WIFI 802.11g, 1G – 3.6G, Low

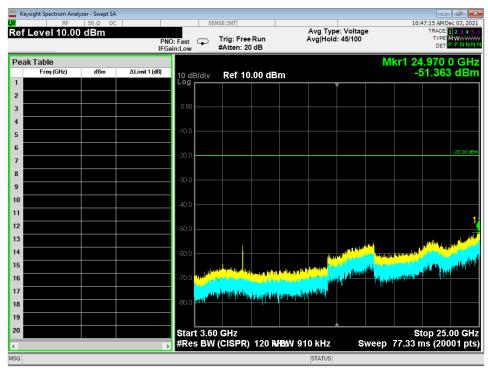


Figure 13 - Radiated Emissions Plot, WIFI 802.11g, 3.6G – 25G, Low



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arker 1 783.9	8100000	PNC	D:Fast 😱	Trig: Free Run	Avg Ty Avg Hol	pe: Voltage d:>100/100	T	ACE 1 2 3 4 YPE M WARA DET P P N N
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eak Table Freq (GHz)	dBm	∆Limit1(dB)			_		Mkr1 783	516 dB
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			-10.0					
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			-30.0					
0			-40.0					
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		>	Res BW	300 GHz (CISPR) 120 kF	₩2BW 910 kHz	Swee	Stop 1. p 4.000 ms (2	20001 pt



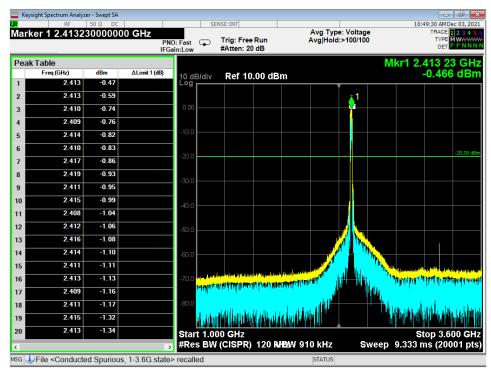


Figure 15 - Radiated Emissions Plot, WIFI 802.11n, 1G - 3.6G, Low



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Prepared for: Garmin International, Inc.

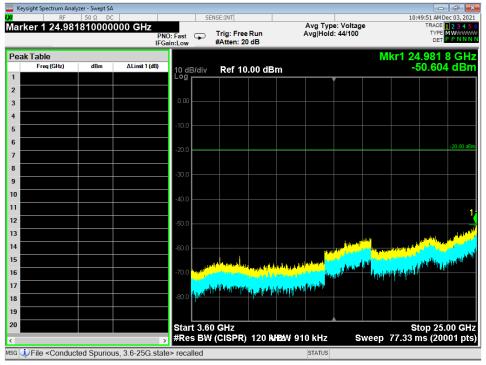


Figure 16 - Radiated Emissions Plot, WIFI 802.11n, 3.6G - 25G, Low



Prepared for: Garmin International, Inc.

4.5 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 §15.205(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.



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.



4.6 **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:

- 4. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
- 5. All the measurements were found to be compliant.
- 6. The measurements are reported on the graph.



4.7 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	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.

The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
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.

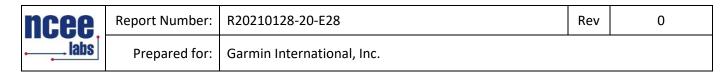
Deviation from the test standard:

No deviation

EUT operating conditions:

Details can be found in section 2.1 of this report.

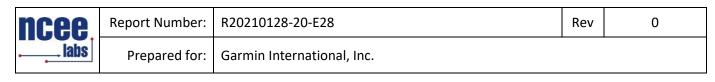
Rev



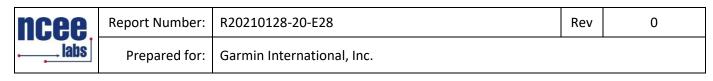
Test Results:

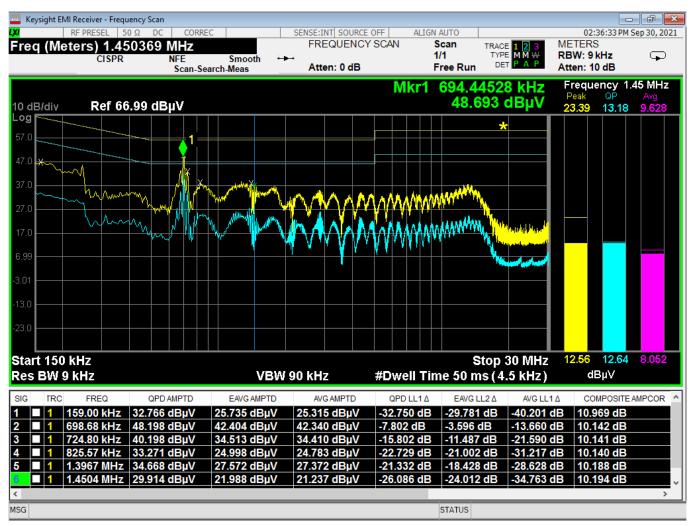


Figure 17 - Conducted Emissions Plot, Line, TX









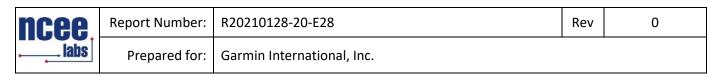




Figure 20 - Conducted Emissions Plot, Neutral, IDLE

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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.

Level in μ V/m = Common Antilogarithm [(48.1 dB μ V/m)/20]= 254.1 μ V/m

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

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	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) x antenna distance (m)]² / 30

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

Voltage ($dB\mu V$) = Power (dBm) + 107 (for 50 Ω measurement systems)

Field Strength (V/m) = 10^{Field} Strength (dB μ V/m) / 20] / 10^{6}

Gain = 1 (numeric gain for isotropic radiator)

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

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

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

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



APPENDIX B - MEASUREMENT UNCERTAINTY

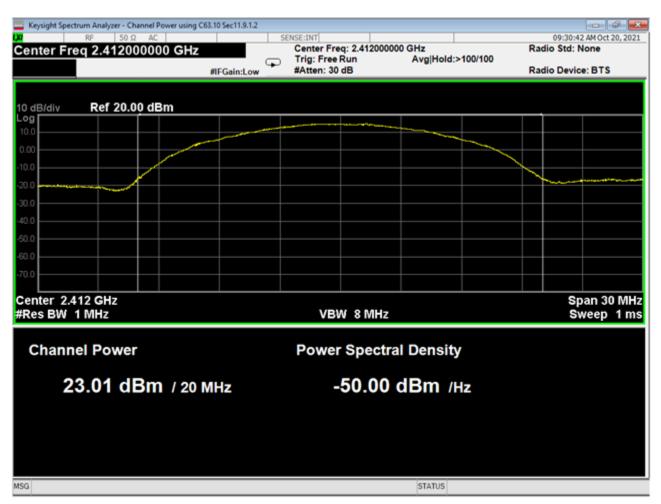
Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

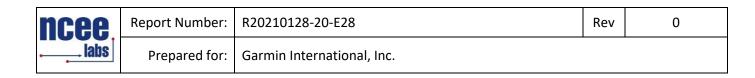
Expanded uncertainty values are calculated to a confidence level of 95%.

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

APPENDIX C – GRAPHS AND TABLES

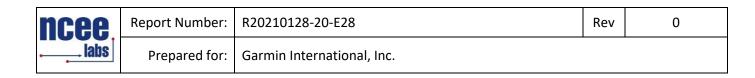


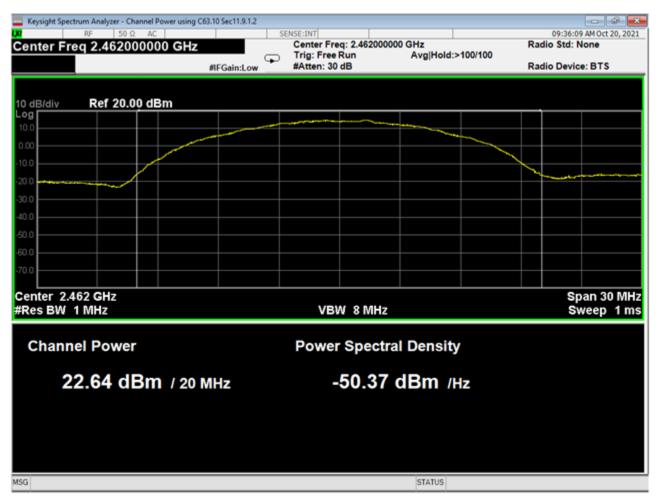
01 Power, Low, Wifi B





02 Power, Mid, Wifi B





03 Power, High, Wifi B

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	Prepared for:	Garmin International, Inc.		



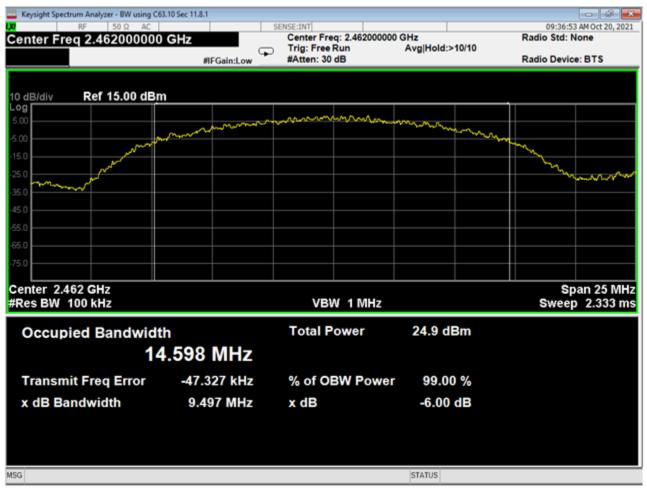
04 OBW-6dB, Low, Wifi B

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		



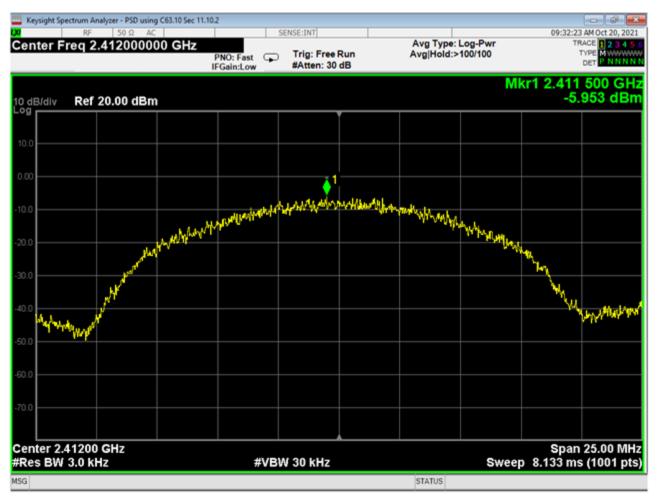
05 OBW-6dB, Mid, Wifi B

ncee labs	Report Number:	R20210128-20-E28	Rev	0
		Garmin International, Inc.		



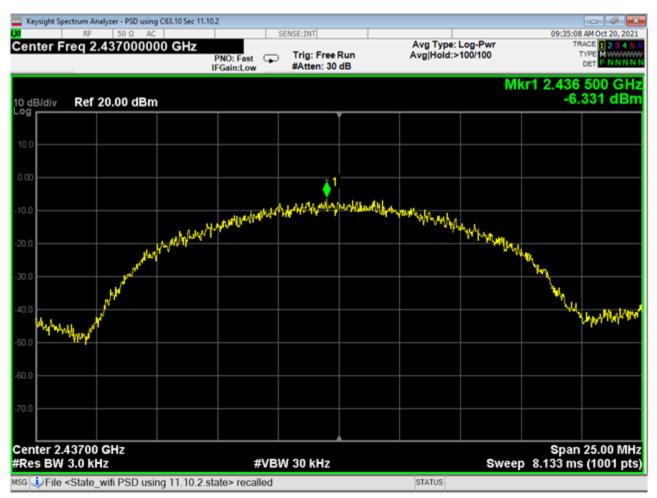
06 OBW-6dB, High, Wifi B

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

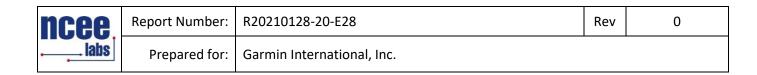


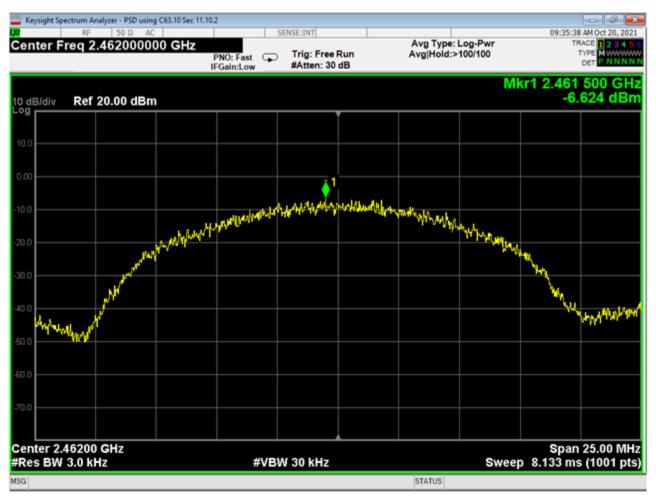
07 PSD, Low, Wifi B

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		



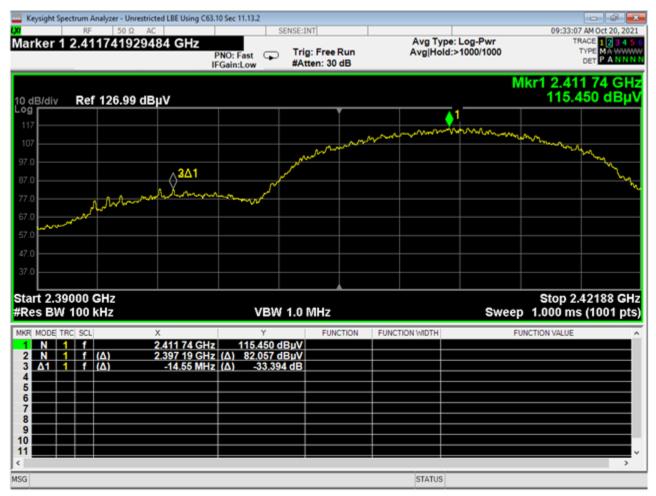
08 PSD, Mid, Wifi B





09 PSD, High, Wifi B

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labs	Prepared for:	Garmin International, Inc.		



10 Lower Bandedge, Unrestricted, Wifi B

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		



11 Higher Bandedge, Unrestricted, Wifi B

Incee labs	Report Number:	R20210128-20-E28	Rev	0
	Prepared for:	Garmin International, Inc.		

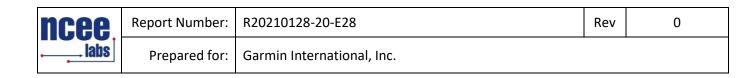
Keysight Spectrum Ar	halyzer - Restricted LBE using (C63.10 Sec 6.10.5				- 0
RF	50 Ω AC		NSE:INT	ALIGN OFF		07:13:40 AM Oct 19, 20
0.0	9970000000 GH2 REAMP	PNO: Fast 😱	Trig: Free Run #Atten: 0 dB	Avg Type: R Avg Hold:>10		TRACE 1 2 3 4 TYPE MAWW DET PANN
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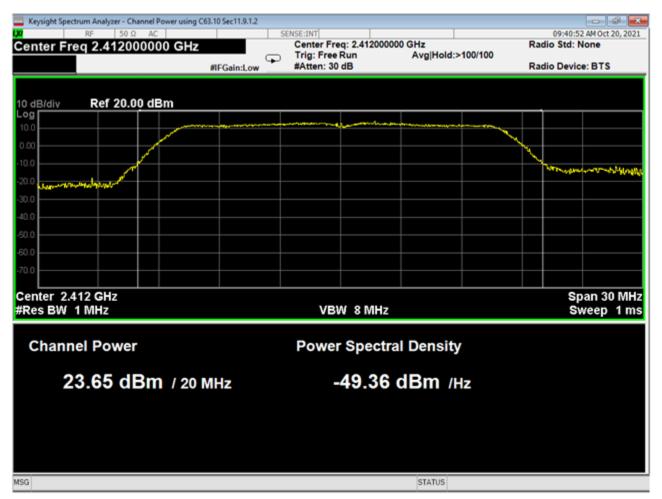
12	Lower	Bandedge,	Restricted,	Wifi B
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ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

	ectrum Analyzer - Restricted HBE C63.	10 Sec 6.10.5				- 6
	RF 50 Ω AC	SENSE:	INT	ALIGN OFF		07:12:26 AM Oct 19, 20
rker 2 SS	2.485760500000 GH	PNO: Fast 😱 Tri	ig: Free Run tten: 0 dB	Avg Type: Avg Hold:>		TRACE 2 3 4 TYPE MA WW DET P A N N
	Ref Offset 34.77 dB				Mkr2	2.485 760 5 GI 46.789 dB
dB/div g	Ref 86.76 dBµV		•			40.100 0.00
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			FUNCTION	FUNCTION WIDTH	ELIA	CTION VALUE
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N 1 N 2	f 2.485 117 0) GHz 57.226 dBµV		PONCTION WIDTH	POP	
N 1 N 2	f 2.485 117 0) GHz 57.226 dBµV		PONCTION WIDTH	Por	
N 1 N 2	f 2.485 117 0) GHz 57.226 dBµV			Por	
N 1 N 2	f 2.485 117 0) GHz 57.226 dBµV			FUN	
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N 1 N 2	f 2.485 117 0) GHz 57.226 dBµV)

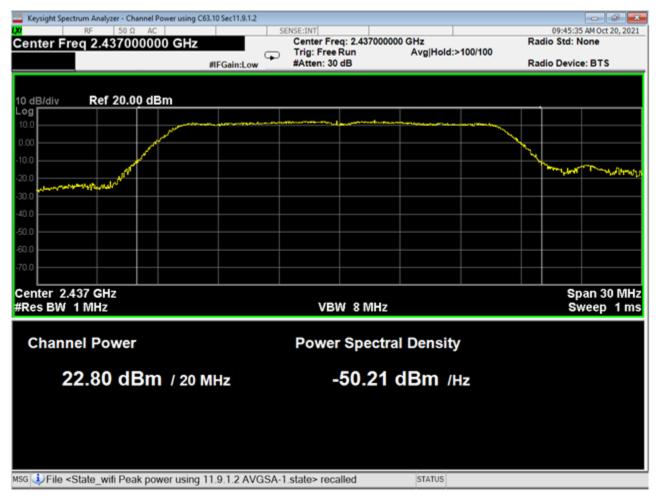
13 Higher Bandedge, Restricted, Wifi B



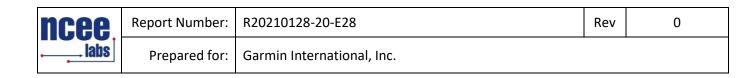


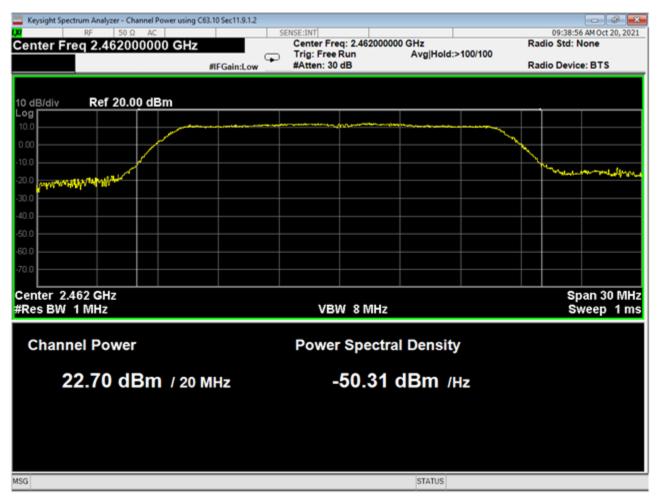
14 Power, Low, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		



15 Power, Mid, Wifi G





16 Power, High, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

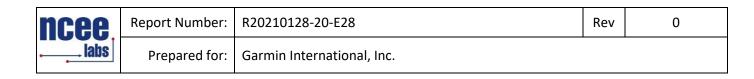


17 OBW-6dB, Low, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

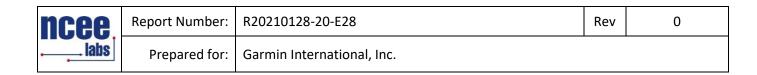


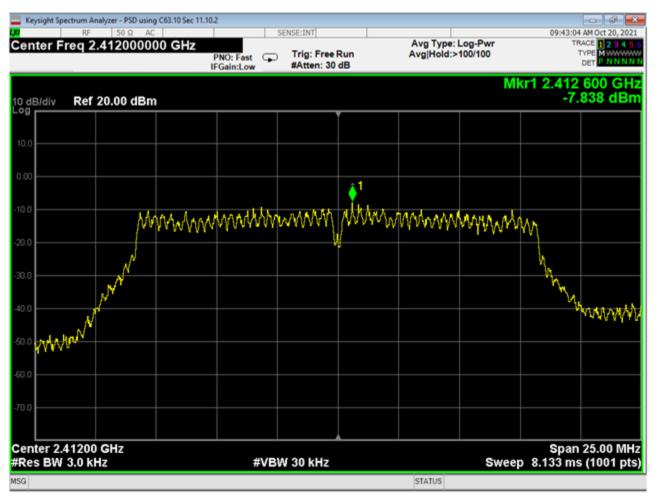
18 OBW-6dB, Mid, Wifi G



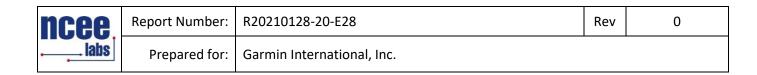


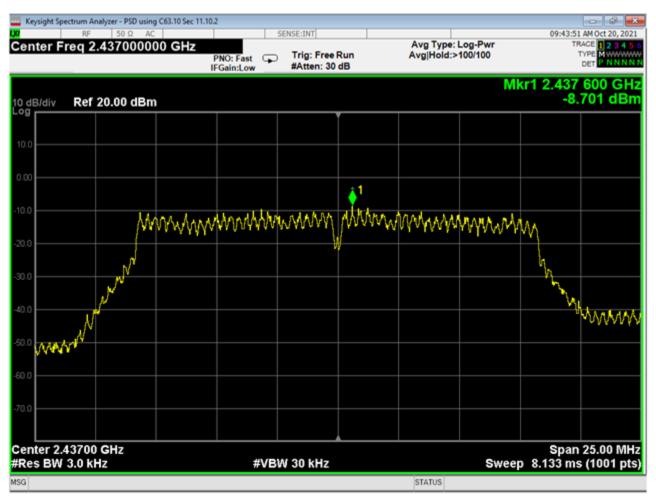
19 OBW-6dB, High, Wifi G



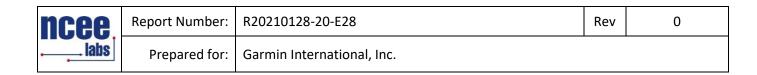


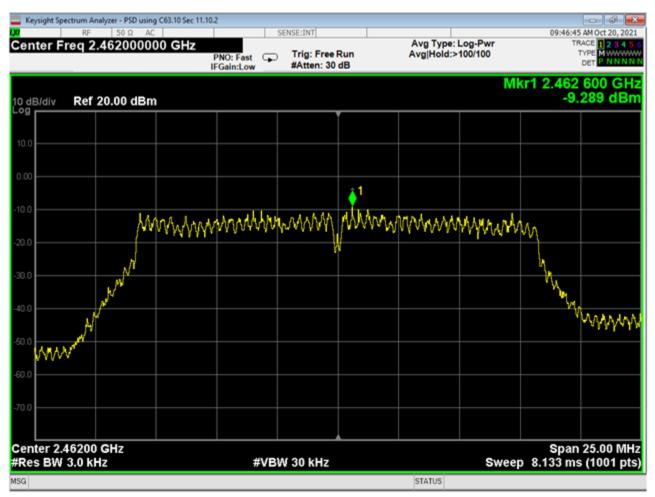
20 PSD, Low, Wifi G





21 PSD, Mid, Wifi G





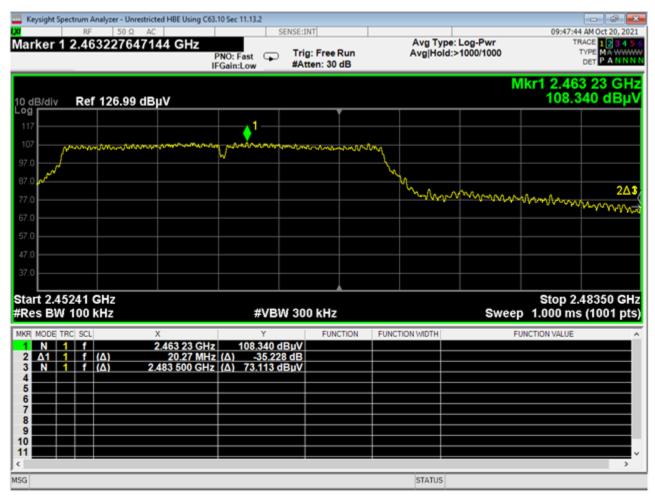
22 PSD, High, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

Keysight Spect	trum Analyzer - Unr	estricted LBE Using (C63.10 Sec 11.13.2						
arker 1 2	RF 50 Ω 2.40909591		PNO: Fast	SENSE:INT			be: Log-Pwr d:>1000/1000		6 AM Oct 20, 20 RACE 1234 TYPE MAWW DET PANN
			IFGain:Low	#Atten:	30 dB			Mkr1 2.40	9 10 GI
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									)

23 Lower Bandedge, Unrestricted, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		



24 Higher Bandedge, Unrestricted, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

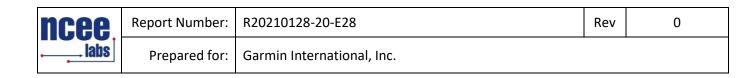
Keysight Spectrum Analyzer - R		c 6.10.5					- 6
arker 2 2.3898600	Ω AC 000000 GHz	SENS		ALIGN OFF Avg Type:		TRA	
ASS			rig: Free Run Atten: 0 dB	Avg Hold:	1000/1000		PE MA WWA ET PANN
Ref Offset 3					M	kr2 2.389	
dB/div Ref 86.60	dBµV		Y			49.07	′5 dBµ
6.6 Trace 1 Pass Trace 2 Pass							
5.6			montestanes	والمحمد والمحمد والمحامد		a sa a sa a sa ana da	Herm
5.5 here the second	and and a feature of a second s	hand and the state of the state	mmpaga,pagaagada	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
.6							
i.6							
.6							
60							
40							
art 2.380000 GHz Res BW 1.0 MHz		#VBW 5	0 MHz*		Sweep	Stop 2.39 1.000 ms (	0000 GI 1001 pt
R MODE TRC SCL	Х	Y	FUNCTION	FUNCTION WIDTH	FUI	NCTION VALUE	
N 1 1 N 2 f	2.389 82 GHz 2.389 86 GHz	63.396 dBµ 49.075 dBµ					
							>
				STATUS			

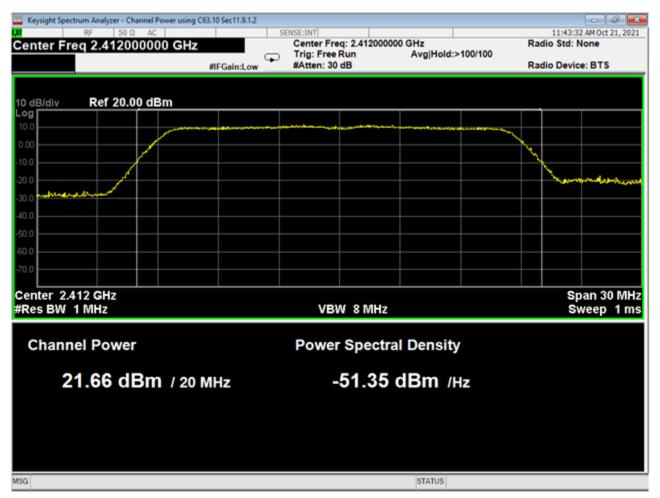
25 Lower Bandedge, Restricted, Wifi G

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

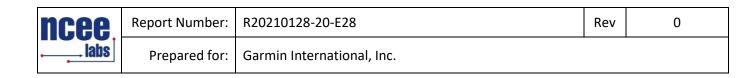
Keysight Spectrum Analyz	er - Restricted HBE C63.10 Sec	6.10.5				
	50 Ω AC	SEN	SE:INT	ALIGN OFF		08:17:05 AM Oct 20, 20
rker 2 2.48363	32000000 GHz		Trig: Free Run #Atten: 0 dB	Avg Type Avg Hold:	: RMS >1000/1000	TRACE 2 3 4 TYPE MAWW DET PANN
Ref Offs dB/div Ref 86	et 34.77 dB .76 dВµV				Mkr2	2.483 632 0 GI 52.648 dB
Trace 1 Pass			Ĭ			
a trace 2 Pass						
a 2 martine of the state	mannamentalement	warden				
8			Contraction of the second	www.enerthoughdigen	and the second	W.W. Somewalking Sameward
8					• • • • • • • • • • • • • • • • • • • •	· · · · · · · · · · · · · · · · · · ·
8						
8						
6						
4						
art 2.483500 GH es BW 1.0 MHz		VBW 5	0 MHz*		Sweep	Stop 2.500000 G 1.000 ms (1001 p
MODE TRC SCL	х	Y	FUNCTION	FUNCTION WIDTH	FUI	NCTION VALUE
N 1 f N 2 f	2.483 764 0 GH 2.483 632 0 GH	z 68.343 dB z 52.645 dB				
						>

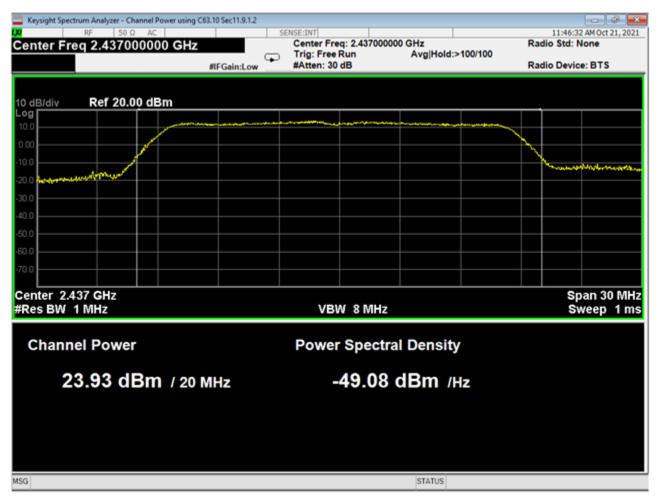
26 Higher Bandedge, Restricted, Wifi G



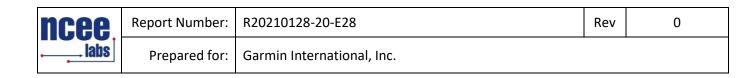


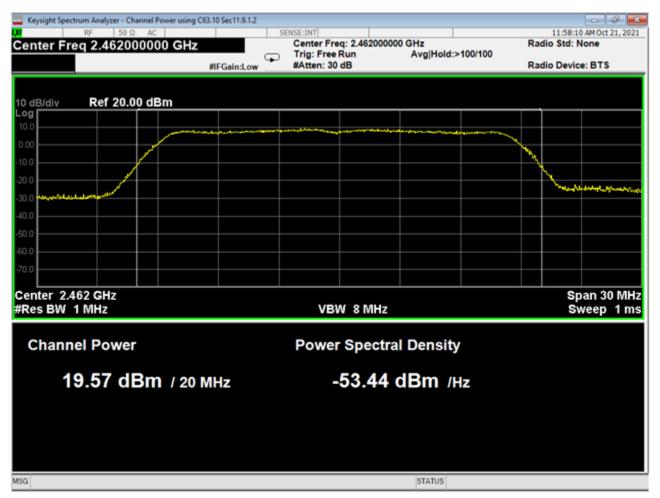
27 Power, Low, Wifi N





28 Power, Mid, Wifi N





29 Power, High, Wifi N

ncee,	Report Number:	R20210128-20-E28	Rev O	
labs	Prepared for:	Garmin International, Inc.		

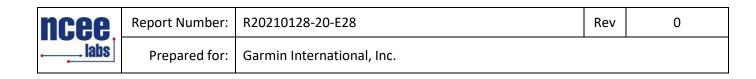


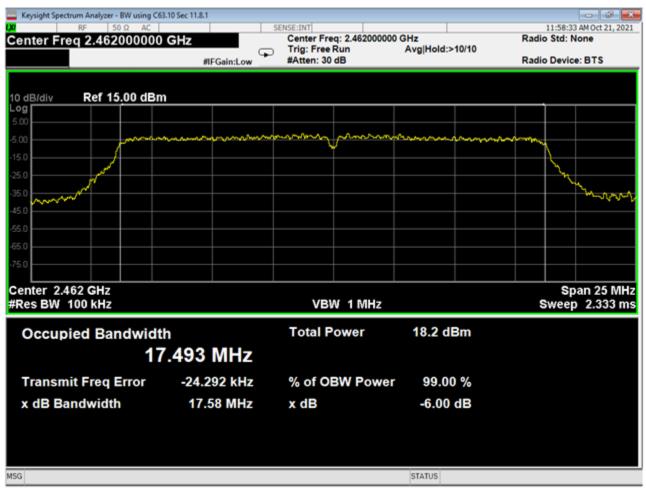
30 OBW-6dB, Low, Wifi N

ncee.	Report Number:R20210128-20-E28Rev0Prepared for:Garmin International, Inc.	0		
labs	Prepared for:	Garmin International, Inc.		

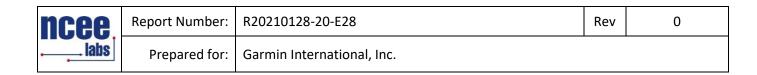
Keysight Spectrum Analyzer - BW using C63.	10 Sec 11.8.1			
enter Freq 2.437000000	GHz #FGain:Low	SENSE:INT Center Freq: 2.4370000 Trig: Free Run #Atten: 30 dB	00 GHz Avg Hold:>10/10	11:46:52 AM Oct 21,20 Radio Std: None Radio Device: BTS
dB/div Ref 15.00 dBm				
20	ann ann	mm	mmmmm	m
				man
0				
0				
0				
enter 2.437 GHz les BW 100 kHz		VBW 1 MHz		Span 25 Mi Sweep 2.333 n
Occupied Bandwidth		Total Power	22.3 dBm	
17	.513 MHz			
Transmit Freq Error	-15.470 kHz	% of OBW Powe	er 99.00 %	
x dB Bandwidth	17.60 MHz	x dB	-6.00 dB	
File <state bandwi<="" dts="" p="" wifi=""></state>	dth 11.8.1.state> recal	led	STATUS	

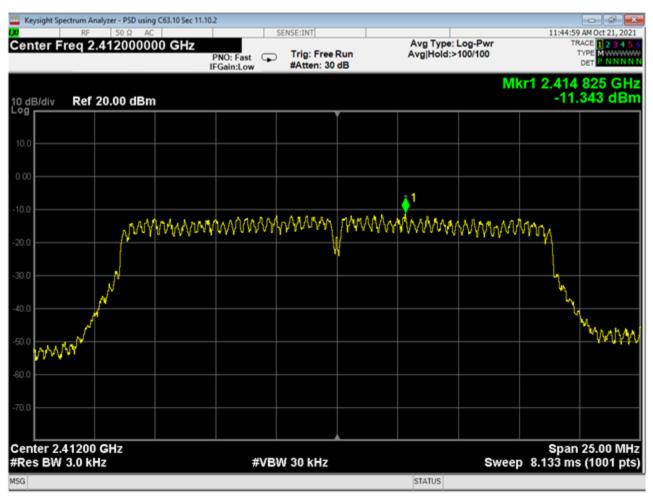
31 OBW-6dB, Mid, Wifi N





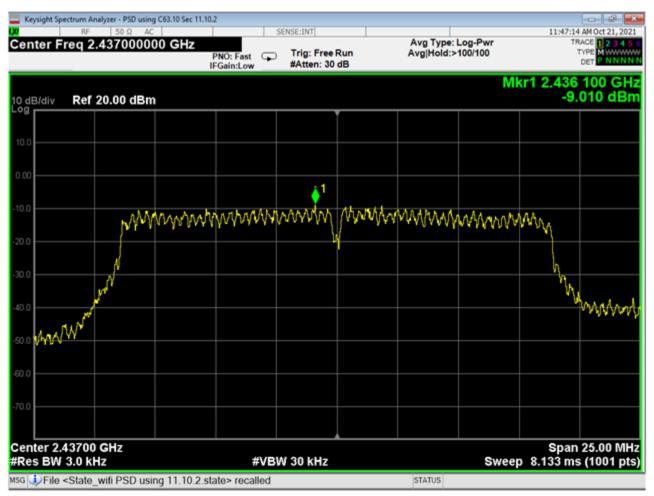
32 OBW-6dB, High, Wifi N



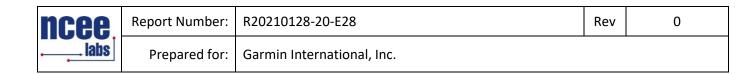


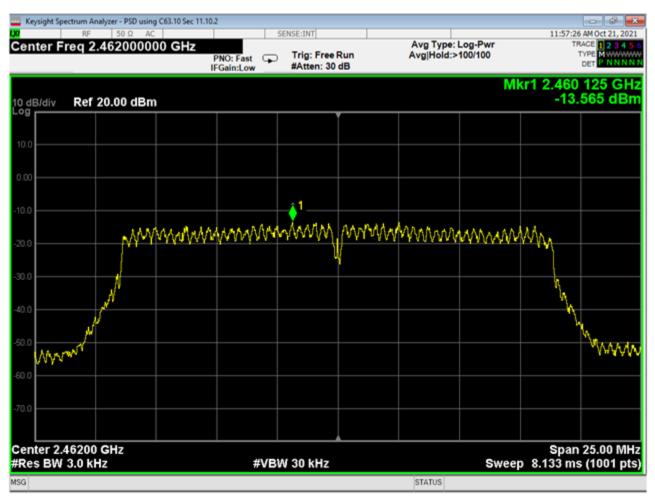
33 PSD, Low, Wifi N

ncee,	Report Number:	umber: R20210128-20-E28 Rev 0 red for: Garmin International, Inc.	0	
labs	Prepared for:	Garmin International, Inc.		



34 PSD, Mid, Wifi N





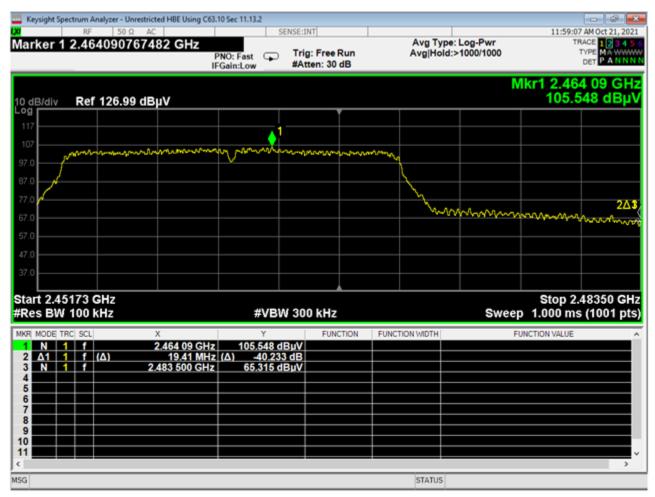
35 PSD, High, Wifi N

ncee.		0		
labs	Prepared for:	Garmin International, Inc.		

Keysight Spectrum Ana	lyzer - Unrestricted LBE Usin 50 Ω AC		c.awr			12:00:36 PM Oct 21, 202
	359373540 GH	Z PNO: Fast	E:INT rig: Free Run Atten: 30 dB	Avg Type: L Avg Hold:>1		TRACE 1234 9 TYPE MANNE DET PANN
dB/div Ref 1	I26.99 dBµV				Mkr1	2.411 36 GH 106.718 dBµ
17				1-		
07		ſ	mannene	anna ann ann an an an an an an an an an	and the second second	mound
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.0 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	mmm	man				
0						
.0						
art 2.39000 G es BW 100 kl		VBW 1.	0 MHz		Sweep 1.0	top 2.42188 GH 00 ms (1001 pt
N 1 1 N 1 F	× 2.411 36 2.399 81		FUNCTION	FUNCTION WIDTH	FUNCTION	IVALUE
<u>Δ1 1 f (</u>	A) -11.52	MHz (Δ) -36.382 d	B			

36 Lower Bandedge, Unrestricted, Wifi N

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		



37	Higher	Bandedge,	Unrestricted,	Wifi N
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Report Number:R20210128-20-E28Rev0Image: Prepared for:Garmin International, Inc.	0			
	Prepared for:	Garmin International, Inc.		

Keysight Spe	ctrum Analyzer - Restricted LBE using C				
larker 2 <mark>ASS</mark>	RF 50 Ω AC 2.390000000000 GHz PREAMP	PNO: Fast Tric	g: Free Run ten: 0 dB	ALIGN AUTO Avg Type: RMS Avg Hold:>1000	
0 dB/div	Ref Offset 34.61 dB Ref 86.60 dBµV				Mkr2 2.390 00 GH 50.362 dBµ
	e 1 Pass e 2 Pass				
	~~~~		Ngalonag por time that	and and a second stand of the second	have the second and t
6.6					
5.6 5.6					
60 40					
	0000 GHz 1.0 MHz	#VBW 50	MHz*		Stop 2.390000 GF Sweep 1.000 ms (1001 pt
R MODE TR	1 2.389 45 0	Υ GHz 63.861 dBµV GHz (Δ) 50.361 dBµV	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
i				STATUS	>

38 Lower Bandedge, Restricted, Wifi N

ncee.	Report Number:	R20210128-20-E28	Rev	0
labs	Prepared for:	Garmin International, Inc.		

Keysight Spectrum Analyzer	- Restricted HBE C63.10 Sec 6.	10.5				- 6
	50 Ω AC	SE	NSE:INT	ALIGN OFF Avg Typ	DMS	02:57:18 PM Oct 18, 20 TRACE 2 3 4
ASS PREAM		PNO: Fast 😱	Trig: Free Run #Atten: 0 dB		:>1000/1000	
	t 34.77 dB 76 dBµV				Mkr2	2.483 533 0 GH 53.839 dBµ
Trace 1 Pass			Ť			
^{5.8} Trace 2 Pass						
6.8 2 mart rate of the	what when a second					
5.8	and the second s	were and a second s	موتيه المهار والمداد فاستأن أحط	A. Martin Martin	and a state of the	Print Miner Marching
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.8						
76						
24						
24						
art 2.483500 GHz Res BW 1.0 MHz	2	VBW	50 MHz*		Sweep	Stop 2.500000 GH 1.000 ms (1001 pt
R MODE TRC SCL	х	Y	FUNCTION	FUNCTION WIDTH	FUI	ICTION VALUE
N 1 f	2.483 566 0 GHz 2.483 533 0 GHz	65.813 dE 53.836 dE				
	2.465 555 0 6112	55.650 dt	sh t			
				\vdash		
						>

39 Higher Bandedge, Restricted, Wifi N

ncee labs	Report Number:	R20210128-20-E28	Rev	0
	Prepared for:	Garmin International, Inc.		

REPORT END