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FCC/ISED Test Report

Prepared for:

Garmin International Inc.

Address:

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

Product:

A03626

Test Report No:

Approved by:

R20191022-26-01B

Nic S. Johnson, NCE Technical Manager iNARTE Certified EMC Engineer #EMC-003337-NE

DATE:

26 May 2020

Total Pages:

42

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ncee labs	Report Number:	R20191022-26-01 R		В
	Prepared for:	Garmin		

REVISION PAGE

Rev. No.	Date	Description
0	27 March 2020	Original – NJohnson
		Prepared by KVepuri/CFarrington
A	17 April 2020	Updated calibration table.
		Subtracted antenna gain from PSD measurements
		Includes NCEE Labs report R20191022-26-01 and its amendment in fullNJ
В	26 May 2020	Subtracted antenna gain from power measurements
		Includes NCEE Labs report R20191022-26-01A and its amendment in fullNJ

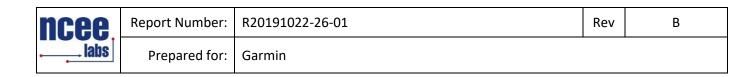


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Garmin

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1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. The EUT has been tested according to the following specifications:

APPLIED STANDARDS AND REGULATIONS						
Standard Section	Test Type	Result				
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	NA				
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				

See Section 4 for details on the test methods used for each test.



2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

EUT	A03626
EUT Received	25 November 2019
EUT Tested	25 November 2019 - 2 March 2020
Serial No.	3322745536
Operating Band	2400 – 2483.5 MHz
Device Type	GMSK
Power Supply	Internal Battery/ Charger: Garmin (Phi Hong) MN: LAC046

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



2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency				
Low	2402 MHz				
Mid	2440 MHz				
High	2480 MHz				

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These are the only three 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.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, middle and highest frequency channels.

The EUT was tested for spurious emissions while running off of battery power.

2.3 DESCRIPTION OF SUPPORT UNITS

None



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	Nic Johnson	Technical Manager	Review/editing
2	Karthik Vepuri	Test Engineer	Testing and report
3	Caleb Farrington	Test Engineer	Testing and report
4	Fox Lane	Test Technician	Testing and report
5	April Inamura	Test Technician	Testing and report

Notes:

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

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3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer	N9038A	MY59050109	23 Apr 2019	23 Apr 2021
Keysight EXA Signal Analyzer	N9010A	MY56070862	14 Dec 2018	14 Dec 2020
Rohde & Schwarz Test Receiver	ES126	100037	30 Jan 2018	30 Jan 2021
SunAR RF Motion	JB1	A082918-1	15 Oct 2018	15 Oct 2020
EMCO Horn Antenna	3115	6416	10 Mar 2020	10 Mar 2022
EMCO Horn Antenna	3116	2576	09 Mar 2020	09 Mar 2022
EMCO Horn Antenna	3115	6416	26 Jan 2018	26 Jan 2021
EMCO Horn Antenna	3116	2576	26 Jan 2018	26 Jan 2021
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	09 Mar 2018*	09 Mar 2021*
Trilithic High Pass Filter	6HC330	23042	09 Mar 2018*	09 Mar 2021*
Rohde & Schwarz LISN	ESH3-Z5	836679/010	26 Jul 2018	26 Jul 2019
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)	MFR-57500	01-07-002	09 Mar 2018*	09 Mar 2021*
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	09 Mar 2018*	09 Mar 2021*
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	09 Mar 2018*	09 Mar 2021*
RF Cable (Control room bulkhead to RF switch)	FSCM 64639	01E3871	09 Mar 2018*	09 Mar 2021*
RF Cable (RF switch to test receiver)	FSCM 64639	01F1206	09 Mar 2018*	09 Mar 2021*
RF switch – Rohde and Schwarz	TS-RSP	1113.5503.14	09 Mar 2018*	09 Mar 2021*
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	09 Mar 2018*	09 Mar 2021*
N connector bulkhead (control room)	PE9128	NCEEBH2	09 Mar 2018*	09 Mar 2021*

*Internal Characterization

Notes:

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

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Test Method: NA



4.2 OUTPUT POWER

Test Method: ANSI C63.10:

1. Section(s) 11.9.1.1 "RBW ≥ DTS Bandwidth"

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Limits of power measurements:

The maximum allowed peak output power is 30 dBm.

Test procedures:

The EUT was measured at 3m with 8 MHz RBW and 50 MHz VBW.

Deviations from test standard:

No deviation.

Test setup:

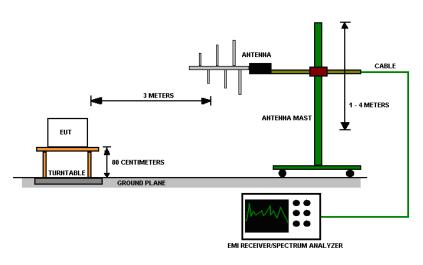


Figure 1 – Peak Output Power Measurements Test Setup

EUT operating conditions:

The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.



The uncertainty for radiated peak power measurements is $\pm 4.4 \text{ dB}$

Peak Output Power									
CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK OUTPUT POWER (dBm)	EIRP PEAK OUTPUT POWER (mW)	CONDUCTED PEAK OUTPUT POWER (dBm)	RESULT	TRANSMITTER			
Low	2402	4.61	2.89	2.11	PASS	GMSK			
Mid	2440	5.79	3.79	3.29	PASS	GMSK			
High	2480	9.84	9.63	7.34	PASS	GMSK			

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*Peak conducted power = Peak EIRP power – antenna gain. Antenna gain = 2.5 dBi

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	pectrum Analyzer - Swe							
w Marker 1	RF 50 Ω 1 2.40160000	AC 0000 GHz		SENSE:INT Trig: Free Run #Atten: 0 dB	Avg Type: Avg Hold:>	Log-Pwr 100/100	T	2 AM Nov 25, 2019 RACE 1 2 3 4 5 6 TYPE M WWWW DET P N N N N N
10 dB/div Log	Ref -20.00 c	IBm					Mkr1 2.40 -44	1 60 GHz 900 dBm
-30.0								
-40.0				1				
-50.0				¥				
-60.0								
-70.0 -80.0	had a fail of a							
-90.0								
-100								
-110								
Center 2. #Res BW	.40200 GHz / 8 MHz	I	#VB	W 50 MHz		Sw	Span eep 1.000 ms	20.00 MHz s (1001 pts)
MSG					STATUS			

Figure 2 – Output Power, Low Channel, GMSK

EIRP Peak Output Power = -44.900 + 107 - 95.23 + AF + CL = 4.61

Output power = -44.900 dBm

AF = Antenna Factor = 28.36

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🔤 Keysight Sp	pectrum Analyzer - Swept SA				
U I	RF 50 Ω AC		ENSE:INT		11:34:16 AM Nov 25, 201
/larker 1	1 2.439980000000 GH	-Iz PNO: Fast ♀ IFGain:High	Trig: Free Run #Atten: 0 dB	Avg Type: Log-Pwr Avg Hold:>100/100	
0 dB/div	Ref -20.00 dBm				Mkr1 2.439 98 GH -41.975 dBn
30.0					
40.0			1		
50.0					
50.0					
70.0 st. grow y	which we wanted the				Un houts married
30.0					
90.0					
100					
110					
enter 2. Res BW	.44000 GHz / 8 MHz	#VBV	V 50 MHz	S	Span 20.00 MH weep 1.000 ms (1001 pts
SG				STATUS	

Figure 3 – Output Power, Mid Channel, GMSK

EIRP Peak Output Power = -41.975 + 107 - 95.23 + AF + CL = 5.795

Output power = -41.975dBm

AF = Antenna Factor = 28.3

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Keysight Spectrum Analyzer - Swept SA			
A RF 50 Ω AC Marker 1 2.479920000000	SENSE:INT PNO: Fast IFGain:High #Atten: 0 dB		11:37:50 AM Nov 25, 201 TRACE 2 3 4 5 TYPE M WWWW DET P N N N N
0 dB/div Ref -20.00 dBm		N	lkr1 2.479 92 GH -37.930 dBn
30.0	1		
10.0			
50.0			
60.0			
70.0 Internet and the second se			Mr. Jakary
30.0			
90.0			
100			
110			
-110			
Center 2.48000 GHz Res BW 8 MHz	#VBW 50 MHz	Sweep	Span 20.00 MH 0 1.000 ms (1001 pts
ISG		STATUS	

Figure 4 – Output Power, High Channel, GMSK

EIRP Peak Output Power = -37.930 + 107 - 95.23 + AF + CL = 9.84

Output power = -37.930 dBm

AF = Antenna Factor = 28.3

Test Method: ANSI C63.10,

- 1. Section(s) 11.8.2 "DTS Bandwidth, Option 2"
- 2. 6.9.2 "Occupied bandwidth-relative measurement procedure"
- 3. 6.9.3 "Occupied bandwidth—power bandwidth (99%) measurement procedure"

Limits of bandwidth measurements:

The 99% occupied bandwidth is displayed.

The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:

The EUT was measured at 3 meters. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 27 kHz RBW and 270 kHz VBW.

The measurement was recorded using the occupied bandwidth measurement mode on a spectrum analyzer. The 6 dB bandwidth was recorded using this function as well.

Deviations from test standard:

No deviation

Test setup:

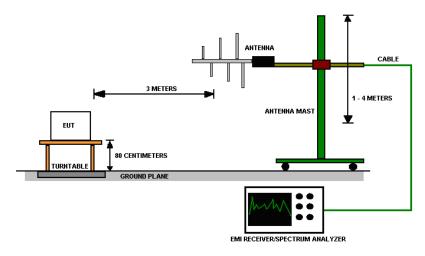


Figure 5 – Peak Output Power Measurements Test Setup

EUT operating conditions:

The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

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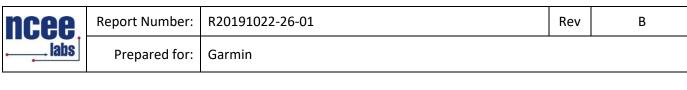


Test results:

Occupied Bandwidth							
CHANNEL	Mode	CHANNEL FREQUENCY (MHz)	OBW (KHz)				
Low	GMSK	2402	1039.7				
Mid	GMSK	2440	1034.7				
High	GMSK	2480	1033.3				

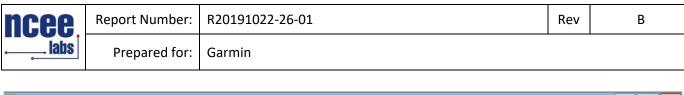
		6dB Bandwidt	h	
CHANNEL	Mode	CHANNEL FREQUENCY (MHz)	OBW (KHz)	RESULT
Low	GMSK	2402	667.7	PASS
Mid	GMSK	2440	665.8	PASS
High	GMSK	2480	666.6	PASS

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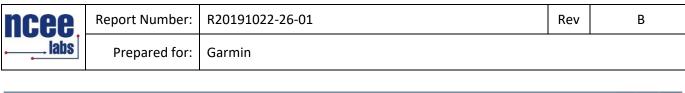
Keysight Spectrum Anal	· · ·				
RF	50 Ω AC		SENSE:INT		11:26:47 AM Nov 25, 20
enter Freq 2.4	402000000 G		Center Freq: 2.4020000 Trig: Free Run	00 GHz Avg Hold:>10/10	Radio Std: None
		ے #IFGain:Low	#Atten: 0 dB		Radio Device: BTS
dB/div Re i	f -30.00 dBm				
g Rel					
0					
0					
0					
0					
0	June	\checkmark			
0 mmmmm		-			- march - marc
0					
0					
20					
enter 2.402 Gl					Span 3 Mi
s BW 27 kHz			VBW 270 kH	2	Sweep 3.8 n
Occupied E	Bandwidth		Total Power	-39.2 dBm	
	1.03	397 MHz			
Transmit Fre	q Error	9.138 kHz	% of OBW Powe	er 99.00 %	
x dB Bandwi	dth	667.7 kHz	x dB	-6.00 dB	
1				STATUS	

Figure 6 - Bandwidth, Low Channel, GMSK



Keysight Spectrum Analyzer - Occupied BW			1	- 6 -
RF 50 Ω AC Center Freq 2.440000000 Center Freq 2.440000000 Center Freq 2.4400000000	GHz	SENSE:INT Center Freq: 2.44000000		11:33:10 AM Nov 25, 201 Radio Std: None
	#IFGain:Low	Trig: Free Run #Atten: 0 dB	Avg Hold:>10/10	Radio Device: BTS
5 dB/div Ref -30.00 dBn				
.og	•			
5.0	~~~~		~~	
5.0				
05				
20				
35				
50				
65				
enter 2.44 GHz				Span 3 MF
es BW 27 kHz		VBW 270 kHz		Sweep 3.8 m
Occupied Bandwidth	ı	Total Power	-36.1 dBm	
)347 MHz			
Transmit Freq Error	9.530 kHz	% of OBW Power	99.00 %	
x dB Bandwidth	665.8 kHz	x dB	-6.00 dB	
3			STATUS	

Figure 7 - Bandwidth, Mid Channel, GMSK



Keysight Spectrum Analyzer - Occupied BW RF 50 Ω AC		SENSE:INT		11:40:27 AM Nov 25, 20
enter Freq 2.480000000		Center Freq: 2.48000000	GHz Avg Hold:>10/10	Radio Std: None
	#IFGain:Low #Atten: 0 dB			Radio Device: BTS
dB/div Ref -30.00 dBn	1		_	
9				
.0		m		
0			~~~	
.0				
0			\sim	
0				
20				
inter 2.40 CHz				Onen 2 Mil
enter 2.48 GHz es BW 27 kHz		VBW 270 kHz		Span 3 Mi Sweep 3.8 n
Occupied Bandwidth	ı	Total Power	-31.9 dBm	
1.0)333 MHz			
Transmit Freq Error	9.522 kHz	% of OBW Power	99.00 %	
x dB Bandwidth	666.6 kHz	x dB	-6.00 dB	
			STATUS	

Figure 8 - Bandwidth, High Channel, GMSK



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4.4 RADIATED EMISSIONS

Test Method: ANSI C63.10:2013:

- 1. Section 6.5, "Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz"
- Section 6.6, "Radiated emissions from unlicensed wireless devices above 1 GHz"
- 3. Section 11.11, "Measurement in nonrestricted frequency bands"
- 4. Section 11.12, "Emissions in restricted bands"

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 about requirement from FCC Part 15.247(d) and RSS-247, Section 5.5:

In addition to the limits shown above, all emissions were also required to be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. All measurements were performed with a 1 MHz bandwidth, but the bandwidth conversion from 1 MHz to 100 kHz would be equally applied to the highest emission and the spurious emissions, so it would not effect the delta measurement.

Since the fundamental emissions was at least 20 dB over the spurious emissions limits from 15.209 and all spurious emissions were below the 15.209 limit, this requirement was met.

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.



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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 form 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.



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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.

Test setup:

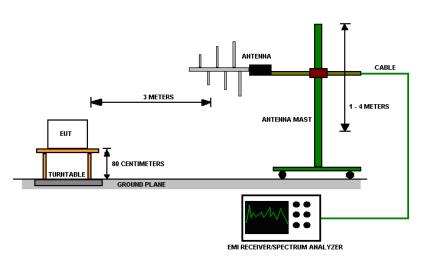


Figure 9 - Radiated Emissions Test Setup

EUT operating conditions

The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

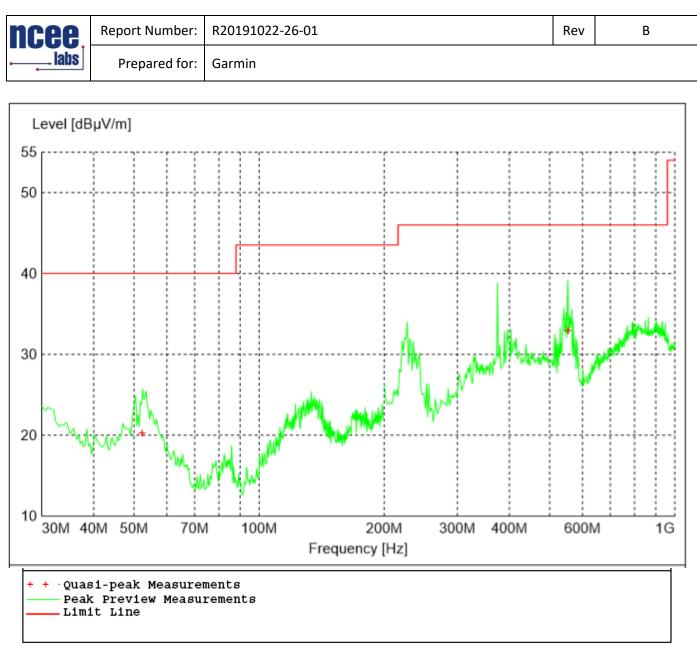


Figure 10 - Radiated Emissions Plot, GMSK

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
52.25000	20.24	40	19.8	111.0	9	VERT
553.92000	32.91	46	13.1	98.0	350	VERT

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

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Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2402.000000	88.32	N/A	N/A	150	223	н
2440.000000	91.74	N/A	N/A	150	223	Н
2480.000000	95.89	N/A	N/A	150	223	Н

Table 2 - Radiated Emissions Average Measurements, GMSK

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

Table 3 - Radiated Emissions Peak Measurements, GMSK

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2402.000000	93.68	N/A	N/A	150	223	н
2440.000000	96.98	N/A	N/A	150	223	н
2480.000000	101.06	N/A	N/A	150	223	Н

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



Test Method: ANSI C63.10,

1. Section 11.10.2 "Method PKPSD (peak PSD)"

Limits of power measurements:

The maximum PSD allowed is 8 dBm.

Test procedures:

1. The EUT was measured at a distance of 3 meters.

2. The resolution bandwidth was set to 3 kHz and the video bandwidth was set to 10 kHz to capture the signal. The analyzer used a peak detector in max hold mode.

Test setup:

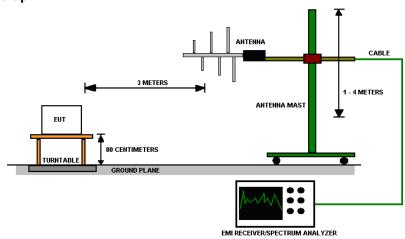


Figure 11 – Power Spectral Density Measurements Test Setup

EUT operating conditions:

The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

Test results:

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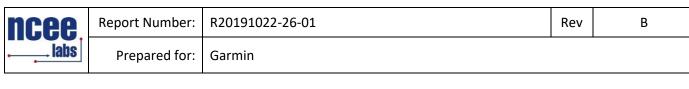
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Power Spectral Den	sity
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CHANNEL	MODE	CHANNEL FREQUENCY (MHz)	PEAK EIRP PSD(dBm)	PEAK Conducted PSD(dBm)*	Limit (dBm)	RESULT
Low	GMSK	2402	-13.153	-15.65	8.00	PASS
Mid	GMSK	2441	-9.989	-12.489	8.00	PASS
High	GMSK	2480	-5.951	-8.45	8.00	PASS

*Peak Conducted = Peak EIRP – antenna gain

Antenna gain = 2.5 dBi



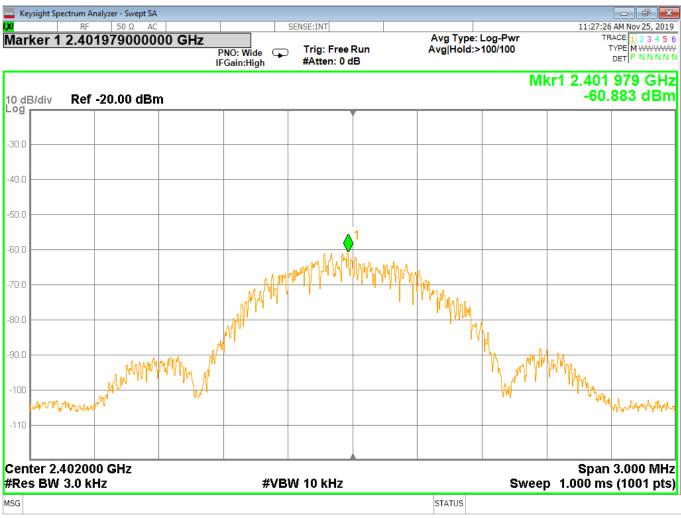
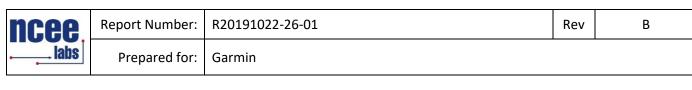


Figure 12 - Power Spectral Density, Low Channel, GMSK

Corrected Peak PSD = -60.883 + 107 - 95.23 + AF + CL = -13.153

Peak PSD = -60.883 dBm

AF = Antenna Factor = 28.36



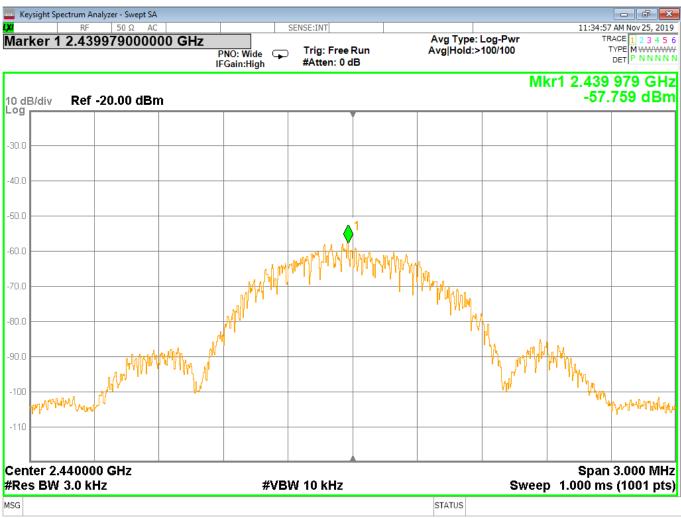
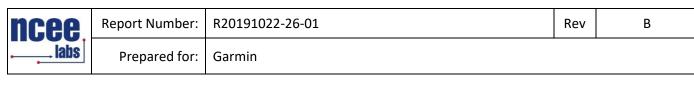


Figure 13 - Power Spectral Density, Mid Channel, GMSK

Corrected Peak PSD = -57.759 +107 - 95.23 + AF + CL = -9.989

Peak PSD = -57.759 dBm

AF = Antenna Factor = 28.3



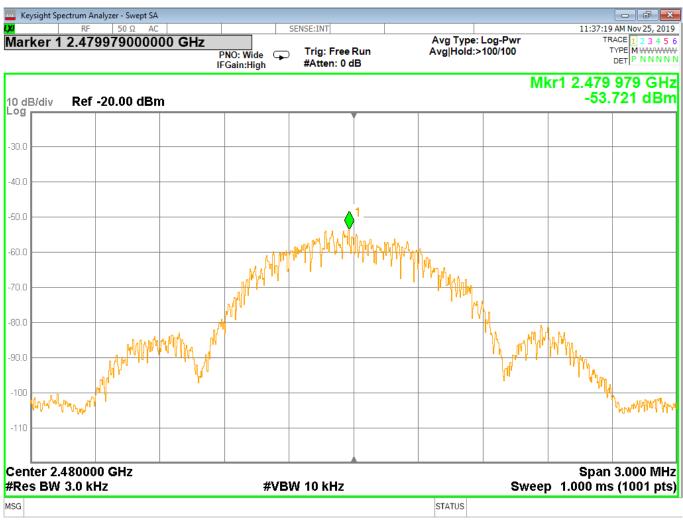


Figure 14 - Power Spectral Density, High Channel, GMSK

Corrected Peak PSD = -53.721 + 107 - 95.23 + AF + CL = -5.951

Peak PSD = -53.721 dBm

- AF = Antenna Factor = 28.3
- CL = Cable Loss = 7.7



Test Method: ANSI C63.10-2013, Section(s) 11.13.2, 6.10.6

Limits of band-edge measurements:

For emissions outside of the allowed band of operation, the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:

Measurements were performed at a distance of 3 meters. The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band-edge to the fundamental frequency with a peak detector. 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.

To calculate the level at the band-edge frequencies, the difference between the peak and the band edge level was subtracted from the peak radiated value at the fundamental. This value was compared to the 15.209 radiated limits for compliance.

Deviations from test standard:

No deviation.

Test setup:

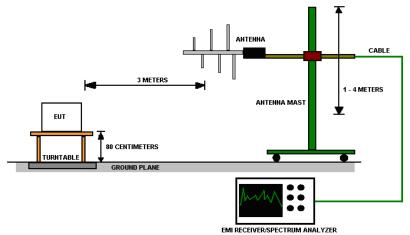


Figure 15 – Band-Edge Measurement Test Setup

EUT operating conditions:

The EUT was powered by internal battery power unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range on each indicated modulation.

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Test results: Band edge Relative Relative Min /Measurement Highest out Fundamental Delta Mode CHANNEL Delta Result Frequency of band dBm (dB) (dB) (MHz) level dBm GMSK Low, Continuous 2390 -88.515 -46.202 42.313 39.68 PASS (restricted) GMSK High, Continuous 2483.5 -88.515 -38.993 49.522 47.06 PASS (restricted) GMSK Low, Continuous 2400 -88 -46.202 41.798 20 PASS (unrestricted) GMSK High, Continuous -88 20 PASS 2483.5 -38.993 49.007 (unrestricted)

*Minimum delta = [highest fundamental peak field strength from Section 4.2] – [Part 15.209 radiated emissions limit.]

From Section 4.2

Fundamental frequency reference values:

CHANNEL	Mode	Peak Field Strength (dBuV/m)	Field Strength Limit (dBuV/m)	Min Delta (dBc)	Result
Low	GMSK	93.68	54.00	39.68	PASS
High	GSMK	101.06	54.00	47.06	PASS

*Min Delta = Peak Field Strength - Field Strength Limit

FCC Part 15.249 requires the attenuation of all emissions outside of the specified band to be at least 50 dB or below the 15.209 limits, whichever is the lesser. In this case, the 15.209 limits were the lesser and used to show compliance.

ncee	Report Number:	R20191022-26-01		Rev	В
labs	Prepared for:	Garmin		I	<u> </u>
Keysight Spectrum	Analyzer - Swept SA				
IXI F		SENSE:INT		11	:30:36 AM Nov 25, 2019
Marker 1 2.3	83100000000 GH		Avg Type: Log-Pwr		TRACE 1 2 3 4 5 6

dB/div Ref -20	.00 dBm					.383 10 G 88.515 dE
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	are a factor and a contraction of the second s					
rt 2.380000 GH es BW 100 kHz	Z	#VBW 300 k	Hz		Stop Sweep 1.00) 2.390000 G 0 ms (1001 p
MODE TRC SCL	Х		FUNCTION FUNCTION	ON WIDTH	FUNCTION V	ALUE
N 1 f	2.383 10 GHz	-88.515 dBm				

Figure 16 - Band-edge Measurement, Low Channel, Restricted Frequency, Peak, GMSK

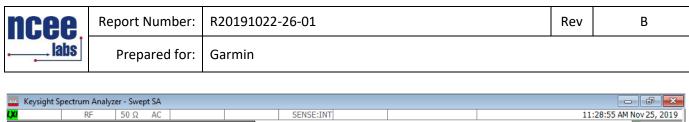


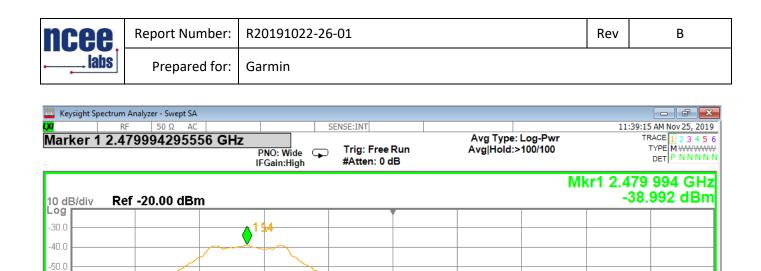


Figure 17 - Band-edge Measurement, Low Channel, Fundamental, Peak, GMSK

ncee.	Report Number:	R20191022-26-01		Rev	В
labs	Prepared for:	Garmin			
IXI R	Analyzer - Swept SA F 50 Ω AC 98597500000 GH	SENSE:INT	Avg Type: Log-Pwr	11	:39:55 AM Nov 25, 2019 TRACE 1 2 3 4 5 6
		PNO: Fast Trig: Free Run IFGain:High #Atten: 0 dB	Avg Hold:>100/100		DET P NNNN
10 dB/div Re	ef -20.00 dBm		Mkr		8 597 5 GHz 88.515 dBm

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tart 2.483500 GH	Z	#VBW 30	00 kHz		Swee	Stop 2.5 ep 1.000 m	i00000 GI s (1001 pt
art 2.483500 GH Res BW 100 kHz R MODE TRC SCL	X	Y	FUNCTION	FUNCTION WIDTH		Stop 2.5 ep 1.000 ms	600000 GI s (1001 pt
tart 2.483500 GH Res BW 100 kHz R MODE TRC SCL 1 N 1 f		#VBW 30 Y -88.515 dBm	FUNCTION	FUNCTION WIDTH		ep 1.000 m	00000 GI s (1001 p1
tart 2.483500 GH Res BW 100 kHz R MODE TRE SCI 1 N 1 f 2	X	Y	FUNCTION	FUNCTION WIDTH		ep 1.000 m	00000 GH s (1001 pt
tart 2.483500 GH Res BW 100 kHz R MODE TRC SCL 1 N 1 f 2 3 4	X	Y	FUNCTION	FUNCTION WIDTH		ep 1.000 m	500000 Gł s (1001 pt
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tart 2.483500 GH Res BW 100 kHz MODE TRC SCL 1 N 1 f 2 3 4 5 6 6 7 7	X	Y	FUNCTION	FUNCTION WIDTH		ep 1.000 m	500000 GH 5 (1001 pt
tart 2.483500 GH Res BW 100 kHz XR MODE TRG SCL 1 N 1 f 2 3 4 5 6 7 8 9	X	Y	FUNCTION			ep 1.000 m	500000 GH 5 (1001 pt
tart 2.483500 GH: Res BW 100 kHz MODE TRC SCL 1 N 1 f 2 3 4 5 6 7 8 9 0	X	Y	FUNCTION			ep 1.000 m	500000 GH 5 (1001 pt
tart 2.483500 GH Res BW 100 kHz XR MODE TRG SCL 1 N 1 f 2 3 4 5 6 7 8 9	X	Y	FUNCTION			ep 1.000 m	00000 GH 5 (1001 pt
tart 2.483500 GH: Res BW 100 kHz MODE TRC SCL 1 N 1 f 2 3 4 5 6 7 8 9 0 1	X	Y	FUNCTION	FUNCTION WIDTH		ep 1.000 m	s (1001 pt

Figure 18 - Band-edge Measurement, High Channel, Restricted Frequency, Peak, GMSK



				1 GHz kHz		#VE	300 kH	z			Sweep	Stop 2.43 1.000 ms	83500 GHz (1001 pts)
MKR	MODE	TRC	SCL		X	Y	FU	INCTION	FUNCTIO	N WIDTH	FU	NCTION VALUE	~
1	N	1	f		2.479 994 GHz	-38.99	2 dBm						
2	N	1	f		2.483 500 GHz	-90.61	7 dBm						
3	Δ4	1	f	(Δ)	-3.506 MHz	(Δ) 51.6	25 dB						
4	F	1	f		2.483 500 GHz	-90.61	7 dBm						
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ISG										STATUS			

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Figure 19 - Band-edge Measurement, High Channel, Fundamental, Peak, GMSK

-60.0 -70.0 -80.0 -90.0

-100 -110



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.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz3. 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.

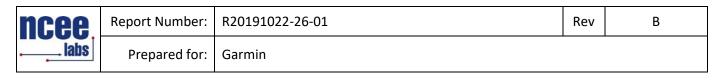
Deviation from the test standard:

No deviation

EUT operating conditions:

The EUT was powered by 5 VDC unless specified and set to transmit continuously on the middle channel.

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Test Results:

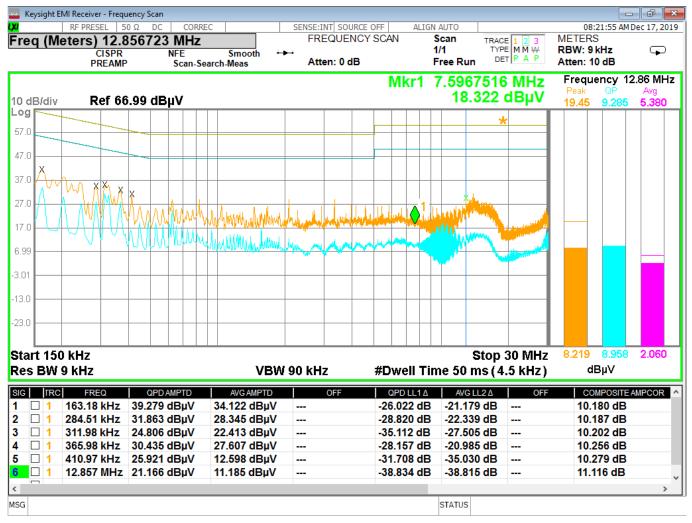
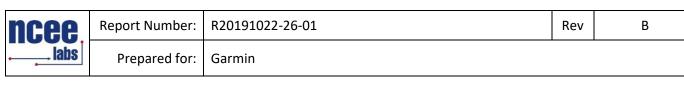


Figure 20 - Conducted Emissions Plot, Line

All Measurements were found to be at least 10 dB below the limits.



eysight EM	II Receiver - Fre																		- F
RF PRESEL 50 Ω CORREC reg (Meters) 325.482 kHz KHz						S	SENSE:INT SOURCE OFF ALIG									08:14:24 AM Dec 17, 20 METERS			
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	PREAM	IP	3	can-	Sear	cn-weas		A.											
											M	kr1	- 7	.5967	7516	6 MHz			825.5 kH
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s BW 9	kHz					VE	3W 90	N 90 kHz #Dwell T					īm	ime 50 ms (4.5 kHz)			dBµV		
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	FREQ 163.50 kHz	_	PD AMP			AVG AMPT			OFF			00 d		AVG L		OFF			AMPCOR
				•		33.530 dBµ					-25.7							180 dB	
	203.99 kHz					28.995 dBµ					-27.3			-24.452				180 dB	
	244.49 kHz			•		25.072 dBµ					-28.0			-26.870				180 dB	
	284.58 kHz					25.937 dBµ					-28.0		_	-24.744				187 dB	
	325.48 kHz			•		29.059 dBµ					-26.0		_	-20.507				215 dB	
	17.217 MH	z 27.38	57 dE	BμV		18.830 dBµ	IV -				-32.6	43 d	В	-31.170) dB		11.	314 dB	
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Figure 21 - Conducted Emissions Plot, Neutral

All Measurements were found to be at least 10 dB below the limits.

The plot shows the composite maximum value of both the line and neutral conductors. It shows the worse-case at each frequency.



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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

Prepared for:

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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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%.

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REPORT END