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# **TEST REPORT**

Prepared for: Garmin International, Inc.

Address:

1200 E. 151<sup>st</sup> Street Olathe, Kansas, 66062, USA

Product:

A03626

**Test Report No:** 

R20210524-20-01B

Approved By:

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

DATE:

20 July 2021

Total Pages:

36

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# **REVISION PAGE**

Rev. No.	Date	Description
0	11 June 2021	Original – NJohnson
		Prepared by KVepuri/Flane/GLarsen
А	15 June 2021	1. Section 4.1 was updated to show the right limits
		2. Section 4.2 was updated to show the right output power
		values corresponding to the frequenciesKV/NJ
В	20 July 2021	3. Added note about intermodulation testing to Section
		4.1, test procedure, note g on page 10.
		<ol><li>Updated test results on pg 11 -NJ</li></ol>



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# 1.0 SUMMARY OF TEST RESULTS

The intention is to see if class II permissive change is possible on the EUT (FCC ID: IPH-03626). The worstcase 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 2.1046 FCC Part 95.2767	Output Power	PASS		
FCC Part 2.1053 FCC Part 95.2779	Radiated Spurious Emissions	PASS		
FCC Part 2.1049 FCC Part 95.2773, 95.2779	Emissions Masks/ Occupied Bandwidth	PASS		
FCC Part 2.1055 (a)(1), (b) FCC Part 95.2765	Frequency Stability Under Voltage and Temp Variation	PASS		
FCC Part 15.2765	Receiver Spurious Emissions	PASS		

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

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# 2.0 EUT DESCRIPTION

# 2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a portable transceiver from Garmin.

Model	A03626	
EUT Received	7 June 2021	
EUT Tested	7 June 2021- 9 June 2021	
	NCEE SN: 00182; used sections 4.2	
Serial No.	NCEE SN: 00181; used for sections 4.1 and 4.4	
	NCEE SN: 00179; used for sections 4.5	
Operating Band	151.820 MHz – 154.600 MHz	
Device Type	VHF	
Power Supply	Internal Battery/ Charger: Garmin (Phi Hong) MN: PSAI05R-050QL6	

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



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# 2.2 DESCRIPTION OF TEST MODES

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

Channel	Frequency (MHz)
Channel 1	151.820
Channel 2	151.880
Channel 3	151.940
Channel 4	154.570
Channel 5	154.600

These channels are described in FCC Part 95.2763 "MURS Channels"

This EUT was set to transmit in a worse-case scenario with modulation on.

# 2.3 DESCRIPTION OF SUPPORT UNITS

NA



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## 3.0 LABORATORY 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

All testing was performed by Karthik Vepuri, and Fox Lane of NCEE Labs. The results were reviewed by Nic Johnson.



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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	05 Dec 2019	05 Dec 2021
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2022
SunAR RF Motion	JB1	A082918-1	17 Aug 2020	17 Aug 2021
EMCO Horn Antenna	3115	6415	10 Mar 2020	10 Mar 2022
EMCO Horn Antenna	3116	2576	09 Mar 2020	09 Mar 2022
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	14 April 2020	14 April 2022
Trilithic High Pass Filter	6HC330	23042	14 April 2020*	14 April 2022*
Rohde & Schwarz LISN	ESH3-Z5	836679010	13 Aug 2020	13 Aug 2021
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)	MFR-57500	01-07-002	14 April 2020*	14 April 2022*
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	14 April 2020*	14 April 2022*
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	14 April 2020*	14 April 2022*
RF Cable (RF switch to test receiver)	FSCM 64639	01F1206	14 April 2020*	14 April 2022*
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	14 April 2020*	14 April 2022*
N connector bulkhead (control room)	PE9128	NCEEBH2	14 April 2020*	14 April 2022*

\*Internal Characterization



Garmin Prepared for:

#### 4.0 DETAILED RESULTS

#### 4.1 **RADIATED SPURIOUS EMISSIONS**

Test Method: ANSI C63.26:2015:

1. Section 5.5, "Radiated Emissions Testing"

#### Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 95.2779 as followed:

Transmitting Frequency (MHz)	Frequency Band	Limit (dB)
151.820 151.880 151.940	≥12.5kHz removed from center frequency	50 + 10log(P)
154.570 154.600	≥50kHz removed from center frequency	43 + 10log(P)

Where P is equal to the output power of the transmitter in Watts.

Rated output power of transmitter is 1.5 W thus making the worst-case emissions attenuation 51.76 dB for 151.82 MHz and 44.76 dB for 154.6 MHz.

#### 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 form 30MHz-1Ghz and 1.5m for measurements from 1GHz to 2 GHz

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.



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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. During the preview scan, the other 2.4 GHz radios were also operated simultaneously with the VHF radio to investigate for any intermodulation products. If any were detected, they would be shown and noted as such in the data from this section.

#### 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 1 - Radiated Emissions Test Setup

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### **EUT operating conditions**

EUT was powered by micro-USB connected to 5V power supply. Device was set to transmit in the lowest and highest frequencies in its operating range. Both antennas were tested and the worse-case of the 2 is shown in the plots.

#### **Test results:**

Radiated Emissions Data					
Frequency Level		Limit	Margin	Operating Channel	
MHz	dBµV/m	dBµV/m	dB		
561.5962	45.63	82.23	36.60	154.6 MHz	
52.74456	21.13	82.23	61.10	154.6 MHz	
216.0226	36.23	82.23	46.00	154.6 MHz	
230.2783	26.76	82.23	55.47	154.6 MHz	
1956.166	45.31	75.23	29.92	151.82MHz*	

\*Worst-case spurious emissions frequency range from the original grant were investigated and compared to the limit.

**Note:** The EUT contained other radios like WIFI, BT, BLE, Iridium, which were investigated and the worst case radiated spurious were found to be within the permissible tolerance.

#### 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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4.2 **OUTPUT POWER** 

Test Method: ANSI C63.26:

Section(s) 5.2.3.3 "Measurement of peak power in a narrowband signal with a spectrum/signal analyzer or EMI receiver"

## FCC Part 95.2767 MURS transmitting power limit:

Prepared for:

Each MURS transmitter type must be designed such that the transmitter power output does not exceed 2 Watts under normal operating conditions.

# Test procedures:

a) Set the RBW  $\geq$  OBW.

- b) Set VBW  $\geq$  3 × RBW.
- c) Set span  $\geq 2 \times OBW$ .

d) Sweep time  $\geq$  10 × (number of points in sweep) × (transmission symbol period).

e) Detector = peak.

f) Trace mode = max hold.

g) Allow trace to fully stabilize.

h) Use the peak marker function to determine the peak amplitude level.

#### **Deviations from test standard:**

No deviation.

Test setup:



Figure 2 – Peak Output Power Measurements Test Setup

#### EUT operating conditions:

EUT was connected to a laptop via micro-USB cable. Device was set to transmit in each of its five allocated frequencies.



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#### Test results:

Limit = 33 dBm (2 W)

#### Output Power Rated power = 1.5 W = 31.76 dBm

CHANNEL FREQUENCY (MHz)	OUTPUT POWER (dBm)	OUTPUT POWER (W)	Method	RESULT
151.820	30.875	1.22	Conducted	PASS
151.880	30.998	1.26	Conducted	PASS
151.940	30.896	1.23	Conducted	PASS
154.570	31.520	1.42	Conducted	PASS
154.600	31.523	1.42	Conducted	PASS



#### Figure 3 –Output Power, 151.820 MHz

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Keysight Spectrum Analyzer - Swe	pt SA			
Center Freq 151.880	DC 000 MHz PNO: Close IFGain:Low	Trig: Free Run #Atten: 30 dB	ALIGN AUTO Avg Type: Log-Pwr Avg Hold:>100/100	10:57:40 AM Jun 07, 2021 TRACE <b>1 2 3 4 5 6</b> TYPE MWWW DET P S NNNN
Ref Offset 183 10 dB/div Ref 38.87 d	87 dB Bm		Mki	r1 151.877 24 MHz 30.998 dBm
		<b>∲</b> <sup>1</sup>		
28.9				
18.9				
8.87				
-1.13				
-11.1				
-21.1				
-31.1				
-41.1				
51.1				
-01.1				
Center 151.88000 MHz #Res BW 10 kHz		30 kHz	Swee	Span 30.00 kHz p 1.000 ms (1001 pts)
MSG			STATUS	

Figure 4 –Output Power, 151.880 MHz

ncee.	Report Number:	R20210524-20-01	Rev	В
labs	Prepared for:	Garmin		

Keysight Spectrum Analyzer - Swept SA			
Center Freq 151.940000 MHz	PNO: Close IFGain:Low Trig: Free Ru #Atten: 30 dB	ALIGN AUTO Avg Type: Log-Pwr n Avg Hold:>100/100	10:55:49 AM Jun 07, 2021 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P S NNNN
Ref Offset 18.87 dB 10 dB/div Ref 38.87 dBm		Mk	r1 151.939 70 MHz 30.896 dBm
28.9	Ŷ		
18.9			
8.87			
-1.13			
-11.1			
-21.1			
-31.1			
-41.1			
-61.1			
Center 151.94000 MHz #Res BW 10 kHz	#VBW 30 kHz		Span 30.00 kHz
MSG		STATUS	

Figure 5 –Output Power, 151.940 MHz

ncee.	Report Number:	R20210524-20-01	Rev	В
labs	Prepared for:	Garmin		

Keysight Spectrum Analyzer - Swept SA			
Center Freq 154.570000 MHz	PNO: Close Trig: Free R IFGain:Low #Atten: 30 of	Aug Type: Log-Pwr Run Avg Hold:>100/100 IB	10:55:00 AM Jun 07, 2021 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P S N N N N
Ref Offset 18.87 dB 10 dB/div Ref 38.87 dBm			lkr1 154.571 08 MHz 31.520 dBm
28 g		<b>1</b>	
19.0			
0.9			
1.12			
-1.13			
-11.1			
-21.1			
-31.1			
51.1			
-01.1			
Center 154.57000 MHz #Res BW 10 kHz	#VBW 30 kHz	Sw	Span 30.00 kHz eep 1.000 ms (1001 pts)
MSG		STATUS	

Figure 6 –Output Power, 154.570 MHz

ncee.	Report Number:	R20210524-20-01	Rev	В
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Keysight Spectrum Analyzer - Swept SA			
Ref Offset 18.87 dB	PNO: Close Trig: Fre IFGain:Low #Atten: 3	ALIGN AUTO Avg Type: L e Run Avg Hold:>1 0 dB	00/100 TYPE M
Ref Offset 18.87 dB 10 dB/div Ref 38.87 dBm			Mkr1 154.600 24 MHz 31.523 dBm
		<b>1</b>	
28.9			
18.9			
8.87			
-1.13			
-11.1			
-21.1			
-31.1			
-41.1			
-51.1			
#Res BW 10 kHz	#VBW 30 kHz		Span 30.00 KHZ Sweep 1.000 ms (1001 pts)
MSG		<b>I</b> STATUS	

Figure 7 –Output Power, 154.600 MHz



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#### 4.3 BANDWIDTH AND EMISSIONS MASK

Test Method: ANSI C63.26,

1. Section(s) 5.4.3, 5.4.4

Limits:

FCC Part 95.2773 MURS authorized bandwidths:

Each MURS transmitter type must be designed to meet the emission bandwidth limitations in this section.

(a) The occupied bandwidth of emissions transmitted on the center frequencies 151.820 MHz, 151.880 MHz, and 151.940 MHz must not exceed 11.25 kHz.

(b) The occupied bandwidth of emissions transmitted on the center frequencies 154.570 MHz and 154.600 MHz must not exceed 20.0 kHz.

#### FCC Part 95.2773 MURS authorized bandwidths:

Channel Center Frequencies	Paragraphs
151.820, 151.880 and 151.940	(1), (2)
154.570 & 154.600, without audio filter	(5), (6), (7)

(1) 7.27(fd-2.88 kHz) dB on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 5.625 kHz, but not more than 12.5 kHz. RBW = 300 Hz

(2)  $50 + 10 \log (P) dB$  or 70 dB, whichever is the lesser attenuation, on any frequency removed from the channel center frequency by more than 12.5 kHz. RBW = 1 kHz

(3) 25 dB on any frequency removed from the channel center frequency by more than 10 kHz, but not more than 20 kHz. RBW = 300 Hz

(4) 35 dB on any frequency removed from the channel center frequency by more than 20 kHz, but not more than 50 kHz. RBW = 300 Hz

(5) 83 log (fd  $\div$  5) dB on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) that is more than 5 kHz, but not more than 10 kHz. RBW = 300 Hz

(6) 29 log (fd2  $\div$  11) dB or 50 dB, whichever is the lesser attenuation on any frequency removed from the channel center frequency by a displacement frequency (fd in kHz) that is more than 10 kHz, but not more than 50 kHz. RBW = 300 Hz

(7)  $43 + 10 \log(P) dB$  on any frequency removed from the channel center frequency by more than 50 kHz. RBW = 1 kHz



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#### Test procedures:

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 300 Hz RBW and 910 Hz VBW. The bandwidth measurements were done using the automatic bandwidth measurement.

(c) Measurement bandwidths. The power of unwanted emissions in the frequency bands specified in paragraphs (b)(1) and (3) through (6) of this section is measured with a reference bandwidth of 300 Hz. The power of unwanted emissions in the frequency ranges specified in paragraphs (b)(2) and (7) of this section is measured with a reference bandwidth of at least 30 kHz.

Start Freq	Stop Freq	Integ BW
5.625 kHz	12.50 kHz	300.0 Hz
12.50 kHz	100.0 kHz	300.0 Hz
24.14 kHz	50.00 kHz	300.0 Hz
50.00 kHz	100.0 kHz	30.00 kHz
8.000 MHz	12.50 MHz	1.000 MHz
12.50 MHz	15.00 MHz	1.000 MHz
12.50 MHz	15.00 MHz	1.000 MHz

#### **Deviations from test standard:** No deviation

Test setup:



Figure 8 – Measurements Test Setup

#### EUT operating conditions:

EUT was connected to a laptop via micro-USB cable. Device was set to transmit in each of its five allocated frequencies.

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Test	results:	
99%	Occupied	Bandwidth

CHANNEL FREQUENCY (MHz)	99% Occupied BW (kHz)
151.820	6.870
151.880	6.866
151.940	6.860
154.570	6.866
154.600	6.871

6dB Bandwidth						
CHANNEL FREQUENCY (MHz)	6dB Occupied BW (kHz)					
151.820	6.465					
151.880	6.471					
151.940	6.475					
154.570	6.450					
154.600	6.489					

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Figure 9 - Bandwidth, 151.820 MHz

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Figure 10 - Bandwidth, 151.880 MHz

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www. Keysight Spectrum Analyzer - Occupied	BW			
RF 50 Ω DC   Contor Frog 151 04000 Contor Frog 151 0400 Contor Frog 151 0400<		SENSE:INT SOURCE OFF AL Center Freq: 151 940000	IGN AUTO	03:12:03 PM Jun 07, 2021 Radio Std: None
Center Freq 151.94000	<u>G MINZ</u>	□ Trig: Free Run	Avg Hold:>10/10	Rudo Sta. Hone
	#IFGain:Low	#Atten: 30 dB		Radio Device: BTS
10 dB/div Ref 20.00 dl	Bm		_	
10.0		A		
		$\square$		
10.0				
20.0				
-20.0				
-30.0				
-40.0				
-50.0	ma mar no		have a	
-60.0 -1 V \n/\ // // // // // /////				and a share and a share a shar
-70.0				
Center 151 94000 MHz				Span 30.00 kHz
#Res BW 300 Hz		#VBW 910 Hz		Sweep 411 ms
Occupied Bandwi	dth	Total Power	18.0 dBm	
	6 860 kHz			
	0.000 KHZ			
Transmit Freq Error	-3 Hz	% of OBW Power	99.00 %	
x dB Bandwidth	6 475 kHz	x dB	-6 00 dB	
NSC			C STATUS	
MSG			STATUS	

Figure 11 - Bandwidth, 151.940 MHz

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Keysight Spectrum Analyzer - Occupied BW				- 6
₩ RF 50 Ω DC		SENSE:INT SOURCE OFF ALL Center Freq: 154.570000 M	GN AUTO	03:09:28 PM Jun 07, 2021 Radio Std: None
	#EColution	Trig: Free Run	Avg Hold:>10/10	Padio Device: BTS
	#IFGain:Low	#Atten: 30 dB		Radio Device. B 15
to JD/Jky Dof 20.00 dBm				
10.0				
0.00				
-10.0	/			
-20.0	$\longrightarrow$			
-30.0				
-40.0				
-50.0				Δ. Δ. Δ. Ο
-60.0	mann		- more and a second	many warden / hours
-70.0				
Center 154.57000 MHz #Res BW 300 Hz		#VBW 910 Hz		Span 30.00 KHZ Sweep 411 ms
				•
Occupied Bandwidth		Total Power	18.4 dBm	
6.8	866 kHz			
Transmit Freq Error	2 Hz	% of OBW Power	99.00 %	
x dB Bandwidth	6 450 kHz	x dB	-6 00 dB	

Figure 12 - Bandwidth, 154.570 MHz

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Keysight Spectrum Analyzer - Occupied I	BW			
$\mathbf{X}$ RF 50 $\Omega$ DC		SENSE:INT SOURCE OFF AL Center Freq: 154,600000	IGN AUTO	03:07:10 PM Jun 07, 2021 Radio Std: None
	C	Trig: Free Run	Avg Hold:>10/10	
	#IFGain:Low	#Atten: 30 dB		Radio Device: BTS
10 dB/div Ref 20.00 dB	m	4		
10.0				
		/ man		
10.0	/	Ĩ		
-10.0				
-20.0				
-30.0				
-40.0				
-50.0 mmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmm	moment		- way	mmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmm
-60.0				
-70.0				
Cepter 154 60000 MHz				Spap 30.00 kHz
#Res BW 300 Hz		#VBW 910 Hz		Sweep 411 ms
Occupied Bandwid	lth	Total Power	18.4 dBm	
	6.871 kHz			
Transmit Freq Error	7 Hz	% of OBW Power	99.00 %	
x dB Bandwidth	6 489 kHz	x dB	-6.00 dB	
	0.400 KHZ		0.00 ub	
			1	
MSG			STATUS	

Figure 13 - Bandwidth, 154.600 MHz

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🔤 Kej	ysight Spectr	um Analyzer - Spectrur	n Emission Mask								
L <mark>XI</mark>		RF 50 Ω D	C		SENSE:INT	SOURCE OFF	ALIG	N AUTO		02:34:06	PM Jun 07, 2021
Ref	Offset	18.87 dB			Cente Trig: I	r Freq: 151 Free Run	.820000 M	HZ Ava: 100.00%	of 100	adio Std: N	lone
PAS	S			FGain:Low	#Atter	n: 26 dB			Ra	adio Device	e: BTS
10 dl	B/div	Ref Offset 18. Ref 33.9 dB	37 dB Sm								
Log						6 A					Absolute Limit
23.9						- MAN-					
13.9											
3.87											
6 12											
-0.13											Deletine Line
-16.1											Relative Limit
-26.1			_ ըիշել						Res a		Spectrum
-36.1	๛๛๛๛	<sup>ՠ</sup> ՟ֈֈֈՠֈՠֈՠֈՠֈՠֈՠֈՠֈՠ	man the for	ᡅᢇ᠊ᡆᢇᠧᢧ <sup>ᠠᠧ</sup> ᠬ			սողեսութո	ᠳ᠁᠕ᡁᠬ᠕᠁	~ഡ <sup>്- ്</sup> പംഹുപിംഹുപ്പം	ᠬᡙᡗ᠋ᢑᡙᠺᡆ	$\mathcal{L}_{\mathcal{A}}$
-46.1							<b>W</b>				
<b>EC 4</b>											
-36.1											
Cen	ter 151.	8200 MHz								Span	200.0 kHz
Tota		r Dof 21.7	d Rm / 0.001	MH-							
100		<b>I KEI</b> 51.70	0 UDII17 0.00 I	INILIZ							
					Lower		<- Peak ->	Upper			
Sta	art Freq	Stop Freq	Integ BW	dBm	∆Lim(dB)	Freq (Hz)	dBn	n ∆Lim(dB)	Freq (Hz)		
5.	625 kHz	12.50 kHz	300.0 Hz	-38.74	(-1.32)	-12.40	k -40.6	69 (-2.51)	12.50 k	^	
12	2.50 kHz	100.0 kHz	1.000 kHz	-28.96	(-10.72)	-48.81	k -29.3	33 (-11.09)	46.63 k		
24	4.14 kHz	50.00 kHz	300.0 Hz		()			()			
50	).00 kHz	100.0 kHz	30.00 kHz		()	-		()			
8.	000 MHz	12.50 MHz	1.000 MHz		()			()			
12	2.50 MHz	15.00 MHz	1.000 MHz		()			()			

Figure 14 – Emissions Mask, 151.820 MHz

**I**STATUS

12.50 MHz

MSG

15.00 MHz

1.000 MHz

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Keysight Spect	rum Analyzer - Spectrum	Emission Mask							- 6 <mark>- x</mark>
L <mark>XI</mark>	RF 50 Ω DC			SENSE:INT	SOURCE OFF	ALIGN A	UTO		02:39:43 PM Jun 07, 2021
Center Fre	a 151.88000	) MHz		Cente	r Freq: 151.88	0000 MHz	:	Rad	lio Std: None
DACC				🛶 Trig:	Free Run	A	vg: 100.00% c	of 100 _	
FA55			Gain:Low	#Atte	n: 26 dB			Rad	lio Device: BTS
	Ref Offset 18.8	7 dB							
10 dB/div	Ref 33.9 dB	m							Absolute Limit
					A. A				Absolute Limit
23.9					1				
13.9					┼┟┼┼┼┼				
2 07					$/ \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow$				
3.07				1					
-6.13				/	+				
-16.1				/					Relative Limit
-10.1									
-26.1		he	_	<u> </u>			Π	_	Spectrum
-36.1 <mark>~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~</mark>	᠕ᠵᠬᢦᡙᡗᠳ᠕ᡀᠬ᠕᠁	ᢄᢣᡄᡊᡟᠮᡐ᠂ᢅᠧᢧ	Նմեր-լիսեվ՝՝՝՝			᠕᠕ᡁ᠘᠁	<sup>ᢦᠺ</sup> ᡐᠧ᠕ᢧ᠕ᡁ᠕	ware the form	᠁᠋ᡗ᠋᠋ᢔᡅ᠆ᡀᡢᡃᢧ᠘ <sub>ᡆᡗ</sub> ᡅᡅᠰᠬᡧᡁ
10.1					Y yes				
-46.1									
-56.1									
Center 151	.8800 MHz								Span 200.0 kHz
Total Powe	er Ref 31.76	dBm / 0.001	MHz						
				Lower		Peak ->	Upper		
Start Freq	Stop Freq	Integ BW	dBm	$\Delta Lim(dB)$	Freq (Hz)	dBm	∆Lim(dB)	Freq (Hz)	
5.625 kHz	12.50 kHz	300.0 Hz	-38.85	(-0.92)	-12.47 k	-38.15	(-0.47)	12.43 k 🛆	

	5.625 kHz	12.50 kHz	300.0 Hz	-38.85	(-0.92)	-12.47 k	-38.15	(-0.47)	12.43 k 🔺
	12.50 kHz	100.0 kHz	1.000 kHz	-27.33	(-9.09)	-48.81 k	-28.72	(-10.48)	27.81 k
	24.14 kHz	50.00 kHz	300.0 Hz		()			()	
	50.00 kHz	100.0 kHz	30.00 kHz		()			()	
	8.000 MHz	12.50 MHz	1.000 MHz		()			()	
	12.50 MHz	15.00 MHz	1.000 MHz		()			()	
	12.50 MHz	15.00 MHz	1.000 MHz		()			()	
SG							I 🔥 ST	ATUS	



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. labs	Prepared for:	Garmin		

	Keysight Spect	rum Analyzer - Spectrum	Emission Mask								×
LXI		RF 50 Ω DC			SENSE:INT	SOURCE OFF	ALIGN A	UTO		02:43:56 PM Jun 07, 202	21
Ce	nter Fre	q 151.94000	0 MHz		Cente	r Freq: 151.	940000 MHz		Rad	lio Std: None	
PΔ	88				Trig:	Free Run	Av	/g: 100.00% d	of 100		
				FGain:Low	#Atte	n: 20 ab			Rat	IIO Device: B 1 5	_
10	d <u>B/div</u>	Ref Offset 18.8 <b>Ref 33.9 dB</b>	37 dB m								
L0;	g					A. A				Absolute L	mi
23.	.9					V. VY					
13.	.9										
3.8					,	╱╱╴┝					
-6.1	3					+++					
-16.	1					+ + +				Relative Li	nit
-26.	1				/_					Spectr	um
-36	1 <b>ԻսՐԿՆՆՆԵ</b>	ഄ൜൨ൄ഻ഀ൮൜൜൜൜	<sup>[</sup> www.jul.w <sup>h</sup> ww	᠂ᠰᡁᠬᢦᡁᠥᠵᢪ <sup>ᠺ</sup> ᠋		$\square$	Ju gang	<sup>P</sup> WWWWWW	March March Labor	᠕᠕᠕᠕᠕᠕᠕	<b>6</b>
46	1				- Aller	·   *	n.				
-40.											
-56.											
Ce	nter 151	.9400 MHz				I				Span 200.0 kH	7
To	tal Bowe	r Dof 04.76	dDm /0.001								2
		<b>I KEI</b> 31.70	0.001	MIL							
					Lower		<- Peak ->	Unner			
5	Start Freq	Stop Freq	Integ BW	dBm	∆Lim(dB)	Freq (Hz)	dBm	∆Lim(dB)	Freq (Hz)		
	5.625 kHz	12.50 kHz	300.0 Hz	-39.28	(-1.36)	-12.47 k	-39.16	(-1.24)	12.47 k 🛆		
	12.50 kHz	100.0 kHz	1.000 kHz	-27.71	(-9.47)	-48.38 k	-29.67	(-11.43)	47.94 k		
	24.14 kHz	50.00 kHz	300.0 Hz		()			()			
	50.00 kHz	100.0 kHz	30.00 kHz		()			()			

8.000 MHz 12.50 MHz 1.000 MHz 12.50 MHz 15.00 MHz 1.000 MHz 12.50 MHz 15.00 MHz 1.000 MHz **I**STATUS MSG

Figure 16 - Emissions Mask, 151.940 MHz

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Figure 17 - Emissions Mask, 154.570 MHz

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ten Key	/sight Spectrun	n Analyzer - Spectrun	n Emission Mask										
L <mark>XI</mark>	F	RF 50 Ω DC			SENSE:IN	IT SOUR	CE OFF	AL	IGN AU	JTO		02:47:3	80 PM Jun 08, 2021
Cen	ter Freq	154.60000	0 MHz		Cen Trig	ter Fre • Free I	q: 154. Run	600000	MHZ	a: 100.00%	6 of 100	Radio Std:	None
PAS	S			FGain:Low	#Att	en: 20	dB		~	g. 100.007		Radio Devi	ce: BTS
		Ref Offset 29 3	35 dB										
10 dl	3/div	Ref 44.4 dB	m										
Log													Absolute Limit
34.4						ß	4						
24.4						]h,	A						
14.4													
1 75													
4.33						ľ	1						
-5.65													Relative Limit
-15.7													
-25.7						_							Spectrum
-35.7	All the war and	han way have a second	Worker Allower	Mar	h. h. h.				ماريد	-	mound	ull al wood book of	Low remand the
45.7			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A ALL AND A A A A A A A A A A A A A A A A A A	in diverti			*******					
-45.7													
Cen	ter 15/1 6	000 MHz						1				Sna	n 200 0 kHz
Gen		000 141112										opu	1 200.0 KHZ
		<b>B</b> -6 0170											
Tota	al Power	Ref 31.76	6 dBm / 0.001	MHz									
								C Deele					
Sta	art Freg	Stop Freg	Integ BW	dBm	ΔLim(dB)	Fre	a (Hz)	dE	3m	ΔLim(dB	) Freg (Hz	<u>z)</u>	
10	00 kHz	20 00 kHz	300 0 Hz	-32 79	(-39 55)		15 70 k	-34	21	(-40 97)	) 199(	) k ^	
20	00 kHz	50 00 kHz	300 0 Hz	-30 49	(-27 25)	_4	48 00 k	-31	72	(-28 48)	) 47.20	) k	
50	.00 kHz	100.0 kHz	1.000 kHz	-27.63	(-14.63)	-5	50.25 k	-26	6.56	(-13.56)	) 60.50	) k	
50	.00 kHz	100.0 kHz	30.00 kHz		()					(	)		
8.	000 MHz	12.50 MHz	1.000 MHz		()					(	)		
12	2.50 MHz	15.00 MHz	1.000 MHz		()					(	)		
12	2.50 MHz	15.00 MHz	1.000 MHz		()					(			
MSG									IL ST	TATUS			

Figure 18 - Emissions Mask, 154.600 MHz

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# 4.4 FREQUENCY STABILITY MEASUREMENTS

Test Method: ANSI C63.26,

1. Section(s) 5.6.3 "Procedure for frequency stability testing"

Limits:

#### FCC Part 95.2765 MURS frequency accuracy:

Each MURS transmitter type must be designed to meet the applicable frequency tolerance and stability requirements of this section.

(a) MURS transmitters that operate with an emission bandwidth of 6.25 kHz or less must be designed such that the carrier frequencies remain within  $\pm 2.0$  parts-per-million (ppm) of the channel center frequencies specified in §95.2763 during normal operating conditions.

#### Test procedures:

Radiated power was measured on a spectrum analyzer with resolution bandwidth and video bandwidth set to 300 Hz and 1 kHz respectively. The frequency error functionality on the receiver was used. The temperature was varied from -30°C to -50°C.

#### Deviations from test standard:

No deviation

#### Test setup:



Figure 19 – Measurements Test Setup

#### EUT operating conditions:

EUT was connected to a laptop via micro USB cable. Device was set to transmit in each of its five allocated frequencies.

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### **Test results:**

# Frequency Stability, Temperature Variation

Temp in												
C°	-30	-20	-10	0	10	20	30	40	<b>50</b>			
Freq (MHz)			D	eviatio	on (Hz)	)				limit (Hz)	limit (ppm)	Result
454 0300	26	25	25	20	25	26	22	10	47	202.640	_	D
151.8200	26	25	25	28	35	26	23	18	1/	303.640	5	Pass
151 9400	26	29	22	35	38	27	20	16	16	303 880	5	Pass
131.3400	20	25	55	55	50	21	20	10	10	303.000		1 0 3 3
154.6000	26	30	36	33	37	29	16	14	16	309.200	5	Pass



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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 $\mu$ 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 $\mu$ V/m.

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

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

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

AV is calculated by the taking the  $20*\log(T_{on}/100)$  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)]<sup>2</sup> / 30

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

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

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



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# 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 dB
Radiated Emissions, 3m	1GHz - 18GHz	±4.44 dB
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB
Antenna port conducted	9 kHz – 25 GHz	±0.50 dB

Values were calculated per CISPR 16-4-2:2011

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

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# REPORT END

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