ncee labs
Product Compliance Solutions

4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

FCC/ISED DXX Part 15.225
Test Report

Prepared for: Garmin International Inc.

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

Product: C04112

Test Report No: R20220122-21-E2B

Approved By:

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

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ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
0	6 June 2022	Original – KVepuri Prepared by FLane, GLarsen
A	23 June 2022	Corrected conflicting test data Corrected limits tested - FL
B	24 June 2022	Updated Table on pg 8. - NJ

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1 Summary of Test Results

The intention of this report is to determine, if the EUT can be qualified as Class II permissive change (FCC ID: IPH-A04112). The manufacturer made modifications to the EUT that qualify for a C2PC. Manufacturer has declared that the changes would not change conducted measurements. So, only the measurements that would be affected due to these changes are investigated in this report. The measurements that can be done in conducted manner are ignored as they won't be affected due to these changes. The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section(s):

1.1 Emissions Test Results

The EUT was tested for compliance to:

US CFR Title 47 FCC Part 15.225
RSS-210 Issue 10

Table 1 – Emissions Test Results

Emissions Tests	Test Method and Limits	Result
Radiated Emissions	FCC Part 15.225 (a), (b), (c), (d) RSS-Gen, Issue 5, 6.5, 6.13 RSS-210 Issue 10 B.6	Complies
Bandedge	FCC Part 15.225 (b) (c) RSS-210 Issue 10 B.6	Complies

2 EUT Description

2.1 Equipment under Test (EUT)

Table 2 – Equipment under Test (EUT)

Model	C04112
EUT Tested	2 June 2022
Serial No.	3400415111 (Conducted Unit) 3412218493 (Radiated Unit)
Operating Band	13.56 MHz
Device Type	NFC
Antenna	Trace Antenna
Power Supply	Internal Battery/ 5VDC Charger: Garmin (Phi Hong) MN: PSAI10R-050Q (Representative Power Supply)

2.2 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 28 ± 4%
Temperature of 22 ± 3° C

2.3 EUT Setup

The EUT was powered by 120 VAC / 60Hz (5 VDC Output) for all tests. Emissions were compared between EUT charging and non-charging; worst case was reported.

EUT was paired with an NFC card reader (MN: ACR122U, SN: RR545-026162) for all testing.

3 Test Results

3.1 Radiated Emissions, Band Width, Field Strength and Band edge

Test:	FCC Part 15.225 (a), (b), (c), (d)
Test Specifications:	Class A
Test Result:	Complies

3.1.1 Test Description

Radiated emissions measurements were made from 30MHz to 1GHz at a distance of 3m (Radiated Emissions) and 3m (Bandwidth, Field Strength and Band edges) inside a semi-anechoic chamber. The EUT was rotated 360°, the antenna height varied from 1-4 meters and both the vertical and horizontal antenna polarizations examined. For measurements below 30 MHz, the loop antenna was used to measure in all 3 axis. The results were compared against the limits. Measurements were made by first using a spectrum analyzer to acquire the signal spectrum; individual frequencies were then measured using a CISPR 16.1 compliant receiver with the following bandwidth setting:

30MHz – 1GHz: 120kHz IF bandwidth, 60kHz steps
150kHz – 30MHz: 9kHz RBW, 4.5 kHz steps

Intermodulation products were investigated by measuring spurious emissions with each of the two 2.4 GHz radios running in parallel with the NFC radio. No intermodulation products were found above the labs system sensitivity.

3.1.2 Test Results

No radiated emissions measurements were found in excess of the limits. Test result data can be seen below.

3.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%
Temperature of 23 ±2° C

3.1.4 Test Setup

See Section 2.3 for further details.

3.1.5 Test Equipment Used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (26.5GHz)***	N9038A	MY56400083	May 5, 2020	May 5, 2023
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
ComPower Active Loop Antenna	AL-130R	10160084	April 12, 2022	April 12, 2023
Agilent Preamp*	87405A	3950M00669	March 21, 2022	March 21, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	December 1, 2021	December 1, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	December 1, 2021	December 1, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	December 1, 2021	December 1, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	December 1, 2021	December 1, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	December 1, 2021	December 1, 2023
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization
**Two Year Calibration Cycle
***3 Year calibration cycle

3.1.6 Test Pictures and/or Figures

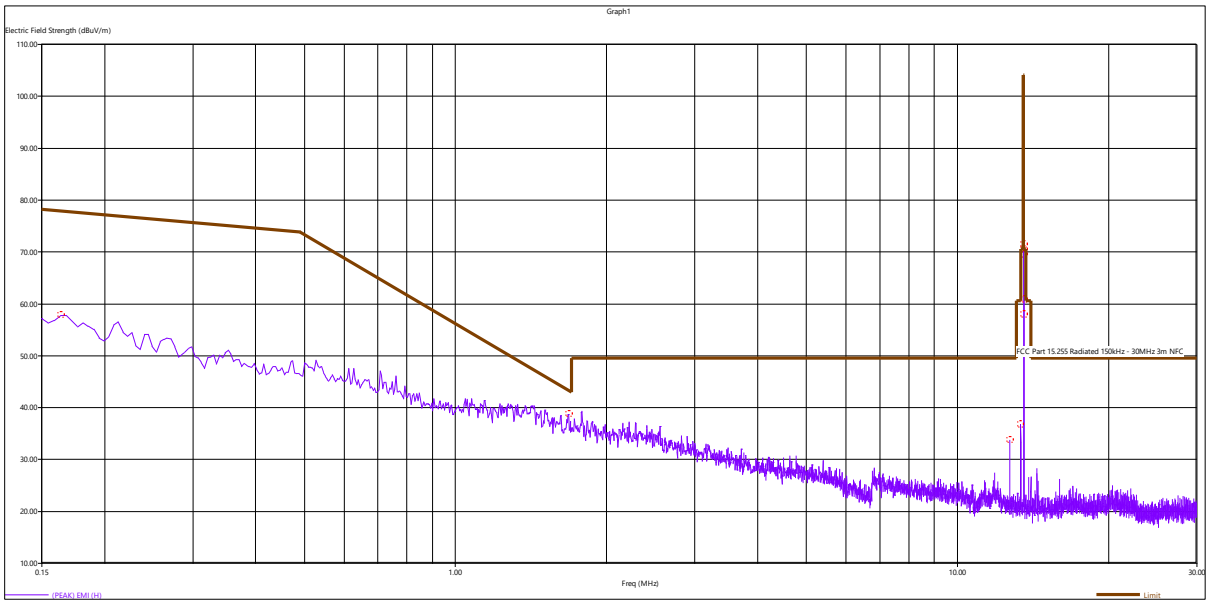

Figure 1 – NFC Radiated Emissions Plot, 150kHz – 30MHz

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

Peak Measurements, 150kHz – 30MHz			
Freq (MHz)	**(PEAK) EMI (H) (dBuV/m)**	**Limit (dBuV/m)**	**(PEAK) Margin (H) (dB)**
1.680000	38.66	43.33	4.67
12.714000	33.71	49.54	15.83
13.371000	36.70	60.51	23.81
13.551000	57.88	70.47	12.59
13.555500	69.45	104.00	34.55
13.560000	71.33	104.00	32.67
13.564500	70.43	104.00	33.57
13.569000	60.80	70.47	9.67

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

NFC Field Strength			
Field Strength (dBµV/m)	**Limit (dBµV/m)***	**Margin**	**Result**
71.33	104.00	33.67	PASS

*Limit extrapolated to 3m test distance.
See Figure 1 for plot

Band Edge Measurements				
Band edge /Measurement Frequency (MHz)	**Corrected band level dBµV/m @ 3m**	**Limit* dBµV**	**Margin**	**Result**
13.551	57.88	70.47	12.59	PASS
13.569	60.80	70.47	9.67	PASS

*Limit extrapolated to 3m test distance
See Figure 1 for plot

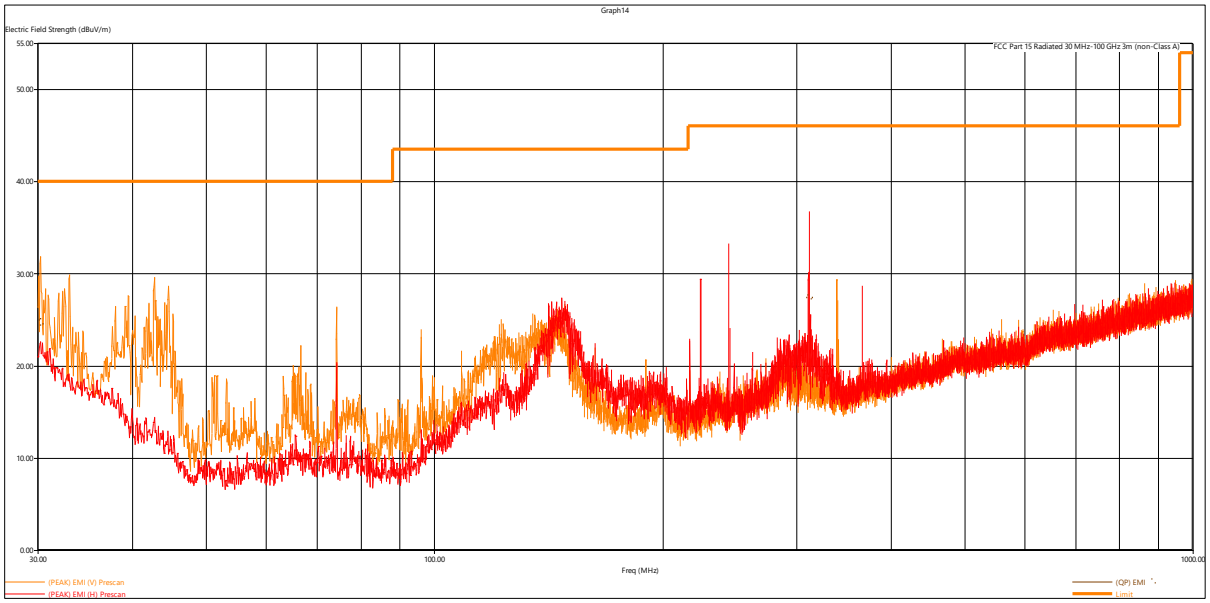

Figure 2 – NFC Radiated Emissions Plot, 30MHz – 1GHz

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

Quasi-Peak Measurements, 30MHz – 1GHz						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
311.830080	27.46	46.02	18.56	100.00	224.00	H
30.204240	24.66	40.00	15.34	110.00	70.00	V

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the plot and table above. All other emissions found to be at least 6dB below the limit line. System Noise floor was at least 6 dB below the limit line throughout the test range.

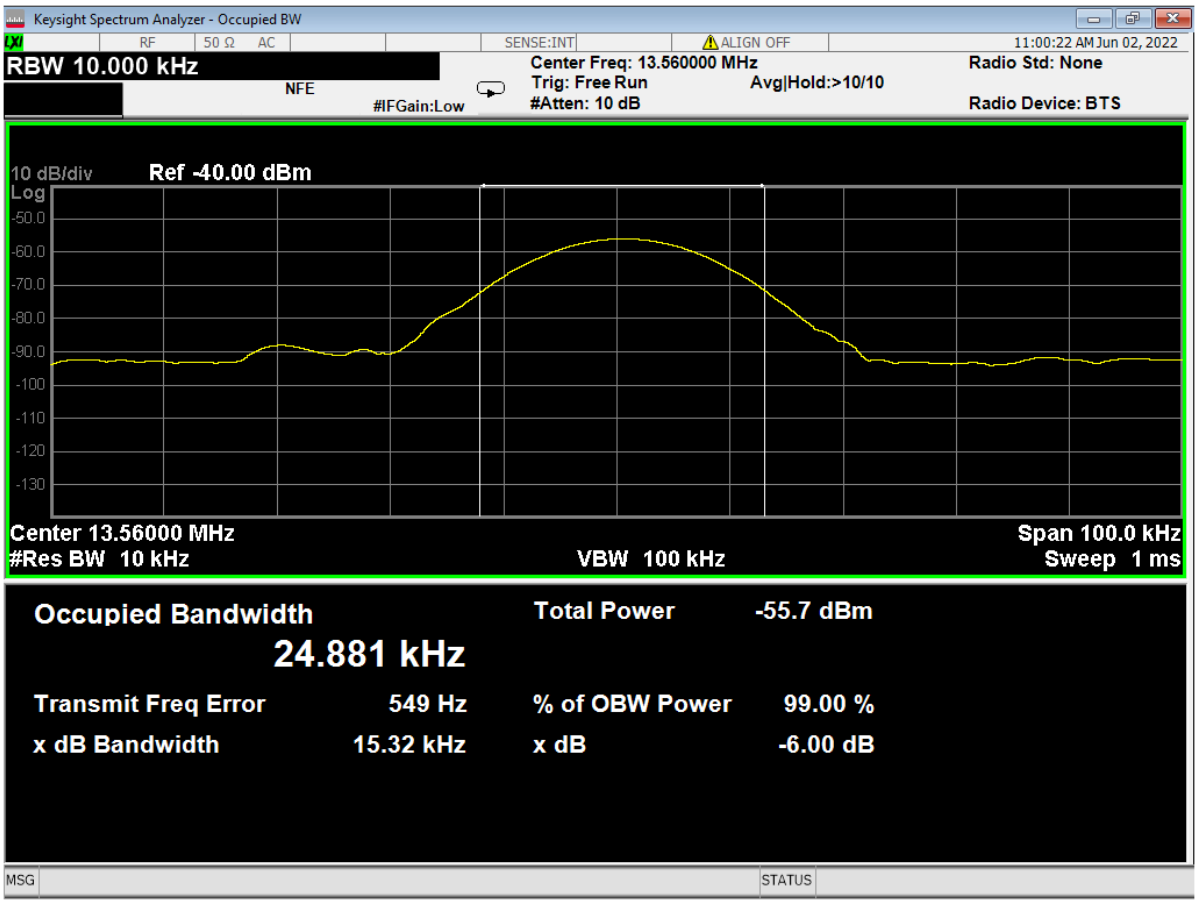

Figure 3 – NFC Occupied Bandwidth

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 dBμV 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 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/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.

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 (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)
Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6
Gain = 1 (numeric gain for isotropic radiator)
Conversion from 3m field strength to EIRP (d=3):

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

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/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	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

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

REPORT END