

FCC/ISED Test Report

Prepared for: Garmin International, Inc.

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

Product: A04952

Test Report No: R20240815-00-E3 **Rev:** 0

Approved by: 
Fox Lane,
EMC Test Engineer

DATE: November 18, 2024

Total Pages: 22

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REVISION PAGE

Rev. No.	Date	Description
0	18 November 2024	Issued by FLane Reviewed by KVepuri Prepared by ESchmidt



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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:

The EUT has been tested according to the following specifications:

- (1) US Code of Federal Regulations, Title 47, Part 15.249
- (2) ISED RSS-Gen, Issue 5
- (3) ISED RSS-210, Issue 11

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
Informational purposes only	Bandwidth	NA
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 FCC 15.249(a) RSS-210 Issue 11, Annex B.10(a)(b) RSS-Gen Issue 5, Section 6.13	Transmitter Radiated Emissions	Pass
FCC Part 15.209, 15.249(d) RSS-210 Issue 11 Annex B.10(b) RSS-Gen Issue 5, Section 6.13	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass



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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	A04952
FCC ID	IPH-04952
IC	1792A-04952
EUT Received	10 September 2024
EUT Tested	19 September 2024- 5 November 2024
Serial No.	3485373849 (Radiated Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	<input type="checkbox"/> GMSK <input type="checkbox"/> GFSK <input type="checkbox"/> BT BR <input type="checkbox"/> BT EDR 2MB <input type="checkbox"/> BT EDR 3MB <input type="checkbox"/> 802.11x <input checked="" type="checkbox"/> NFC
Power Supply / Voltage	Internal Battery / 5VDC Charger: Garmin (Phi Hong) Model: AQ27A-59CFA GPN: 362-00118-00 (Representative Power Supply)

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

2.2 DESCRIPTION OF TEST MODES

The EUT was tested in the following NFC operation mode(s): Card Emulator (CE).

2.3 DESCRIPTION OF SUPPORT UNITS

EUT was paired with an NFC card reader (MN: ACR122U) for all testing.

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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
 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	Fox Lane	Test Engineer	Testing and Report
2	Blake Winter	Test Engineer	Testing
3	Ethan Schmidt	Test Engineer	Testing and Report
4	Karthik Vepuri	Technical Manager	Review

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 (44GHz)	N9038A	MY59050109	July 17, 2024	July 18, 2026
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	July 17, 2024	July 18, 2026
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 18, 2023	July 17, 2025
SunAR RF Motion	JB1	A082918-1	July 17, 2024	July 17, 2025
EMCO Horn Antenna	3117	29616	June 12, 2024	June 12, 2025
Com-Power LISN, Single Phase	LI-220C	20070017	July 17, 2023	July 17, 2025
Agilent Preamp*	87405A	3207A01475	May 2, 2024	May 2, 2026
ETS Red Pre-amplifier (Orange)*	3115-PA	00218576	January 22, 2024	January 22, 2026
Trilithic High Pass Filter*	6HC330	23042	June 5, 2023	June 5, 2025
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	May 15, 2024	May 15, 2027
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 22, 2024	May 22, 2026
RF Cables (3m Ant. to Control room Bulkhead)	MFR-57500	1E3874	June 5, 2023	June 5, 2025
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	June 5, 2023	June 5, 2025
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	June 5, 2023	June 5, 2025
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	June 5, 2023	June 5, 2025
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	June 5, 2023	June 5, 2025
N connector bulkhead (control room)*	PE9128	NCEEBH2	June 5, 2023	June 5, 2025
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization

Notes:

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

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3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

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

Conducted

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in 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.

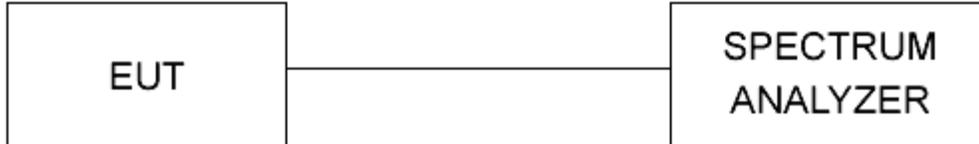


Figure 1 - Bandwidth Measurements Test Setup

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 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.

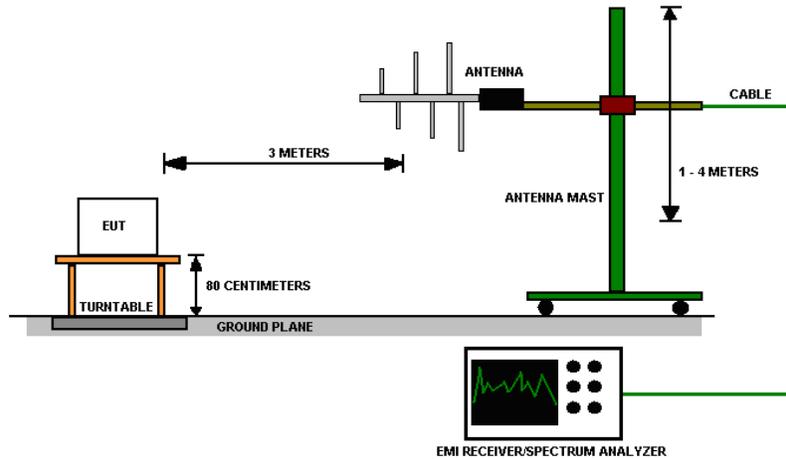


Figure 2 - Radiated Emissions Test Setup

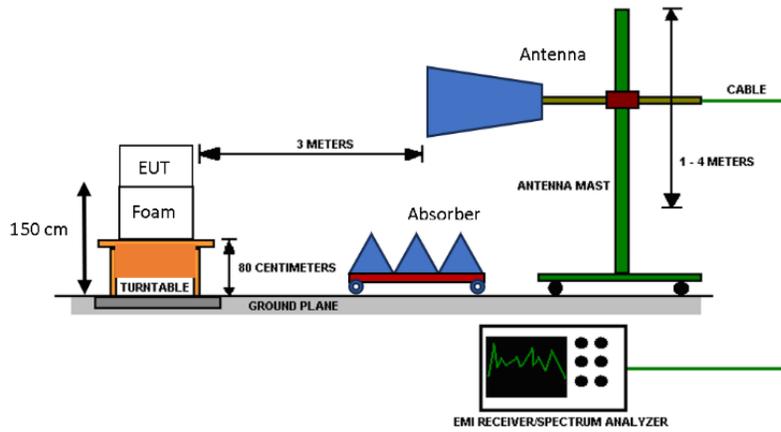


Figure 3 - Radiated Emissions Test Setup, >1GHz

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4.0 RESULTS

4.1 RADIATED EMISSIONS, BANDWIDTH, FIELD STRENGTH, AND BAND EDGES

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

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 axes. 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

Test Results

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

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 $30 \pm 5\%$

Temperature of $23 \pm 2^\circ \text{C}$

Test Setup

See Section 3.4 for further details.

Test Equipment Used

See section 3.3 for the equipment list.

Test Pictures and/or Figures:

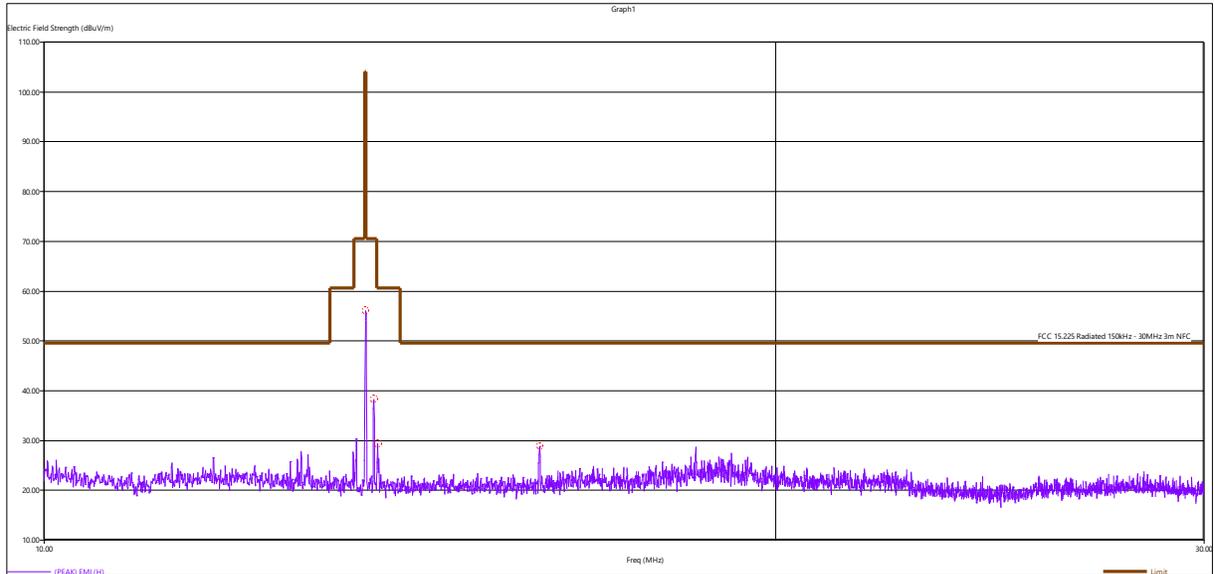


Figure 4 – NFC Radiated Emissions Plot, 10MHz – 30MHz, CE mode

Peak Measurements, 10MHz – 30MHz, CE mode			
Freq (MHz)	(PEAK) EMI (H) (dBuV/m)	Limit (dBuV/m)	(PEAK) Margin (H) (dB)
13.560000	56.01	104.00	47.99
13.663500	38.19	70.47	32.28
13.717500	29.37	60.51	31.14
15.985500	28.75	49.54	20.79

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

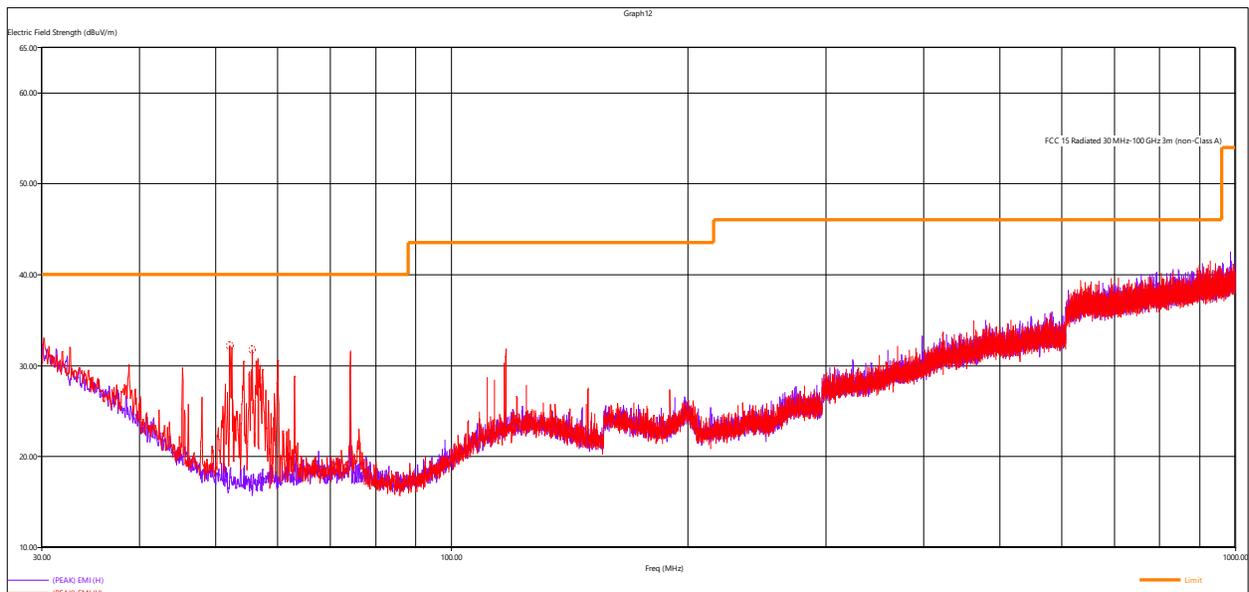


Figure 5 – NFC Radiated Emissions Plot, 30MHz-1GHz, CE mode

Peak Measurements, 10MHz – 30MHz, CE mode						
Freq (Max)	(QP) EMI	Limit	(QP) Margin	Twr Ht	Ttbl Ang	Pol
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(cm)	(deg)	
52.236720	22.60	40.00	17.40	108.82	124.75	V
55.522080	24.46	40.00	15.54	104.76	195.25	V

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

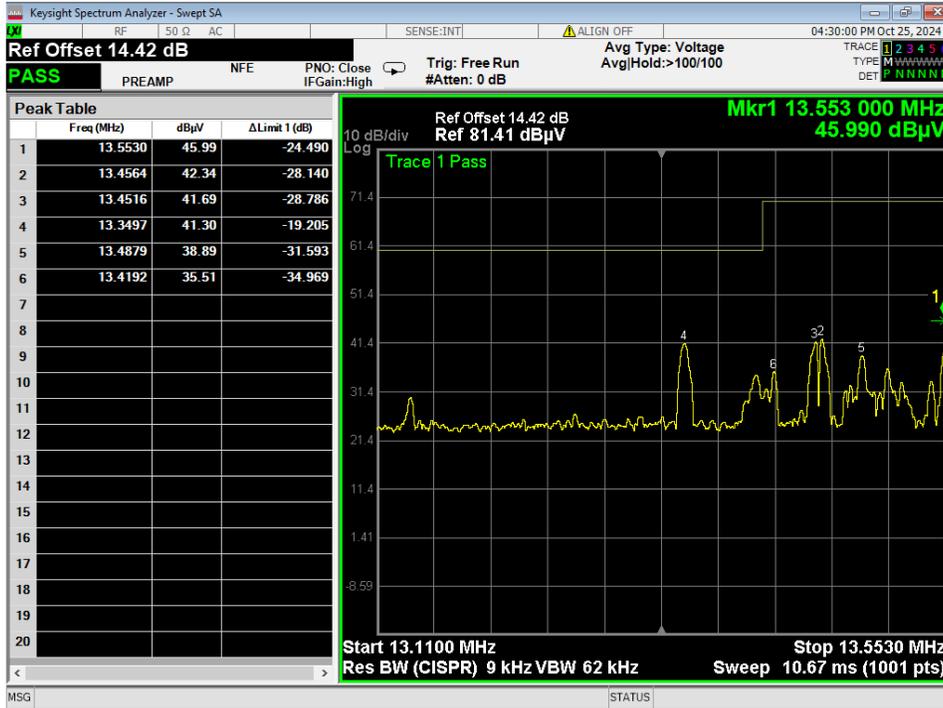


Figure 6 – Lower Bandedge, CE mode

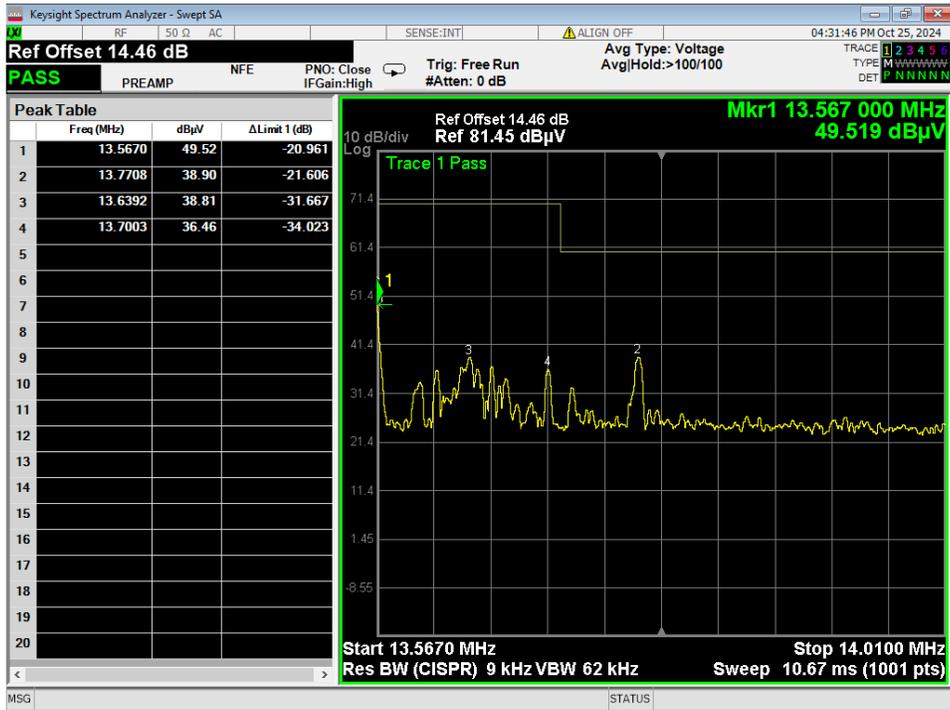


Figure 7 – Higher Bandedge, CE mode

Band Edge Measurements, CE mode				
Band edge /Measurement Frequency (MHz)	Corrected band level dBμV/m @ 3m	Limit* dBμV	Margin	Result
13.3497	41.30	60.505	19.205	PASS
13.5670	49.519	70.48	20.961	PASS

*Limit extrapolated to 3m test distance

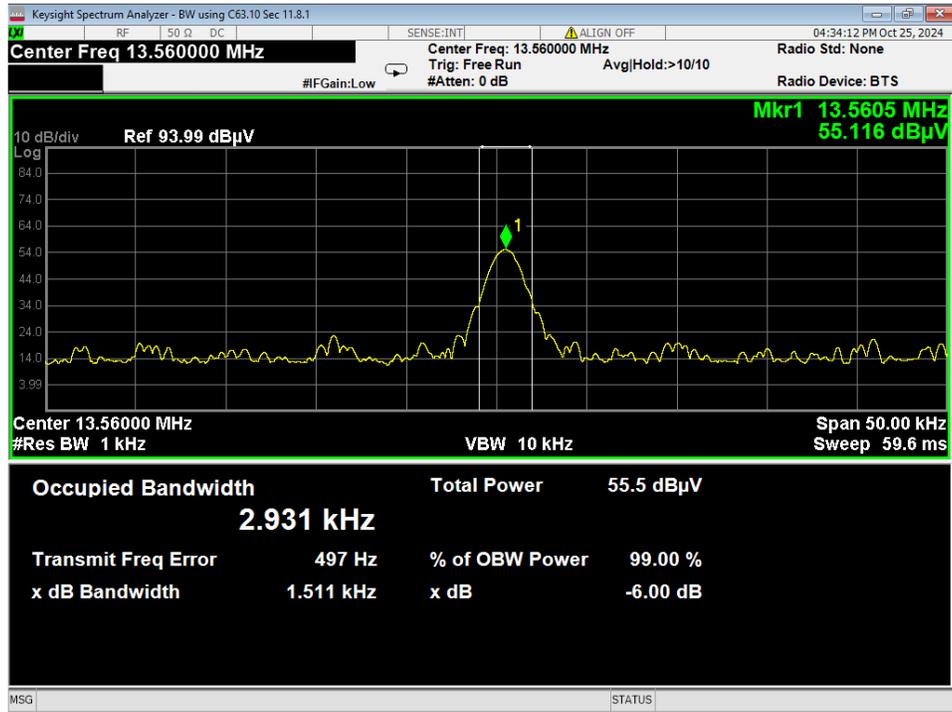


Figure 8 – NFC Occupied Bandwidth, CE mode



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4.1 FREQUENCY ERROR

Test:	FCC Part 15.225 (e)
Test Result:	Complies

Test Description

Frequency error was determined using the built-in frequency error function of the spectrum analyzer. The analyzer finds the occupied bandwidth, calculates the center of the given band then returns the deviation with respect to the given transmit frequency. The temperature was varied from -20°C to 55°C. The voltage was not variable, but the battery was let to drain, voltage of drained battery was reported.

Limit: 100 PPM

Test Results

No results were found to be in excess of the limits. A table of the results can be seen below.

Test Environment

Testing was performed at the NCEE Labs Lincoln facility.

Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $30 \pm 5\%$

Temperature of $23 \pm 2^\circ \text{C}$

Test Setup

Device was tested at 100% battery and 1% battery for worst case voltage for frequency error.

See Section 2.3 for further details.

Test Equipment Used

See section 3.3 for the equipment list.



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Test Results:

A04952, CE mode	
Temperature (°C)	Channel (Hz)
	13.56000 Nom.
-20°C	555
-10°C	491
0°C	506
10°C	493
20°C	489
30°C	499
40°C	455
55°C	415

A04952, CE mode		Nominal Battery Voltage: 3.87V
Voltage (V)	Temperature	Frequency Error (Hz)
3.22*	20°C	462
4.49*	20°C	478

*Tested voltage was the Lowest/Highest we could get battery powered EUT to achieve

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4.4 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 (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:

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

Test Procedures:

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

Deviation from the test standard:

No deviation

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test Results:

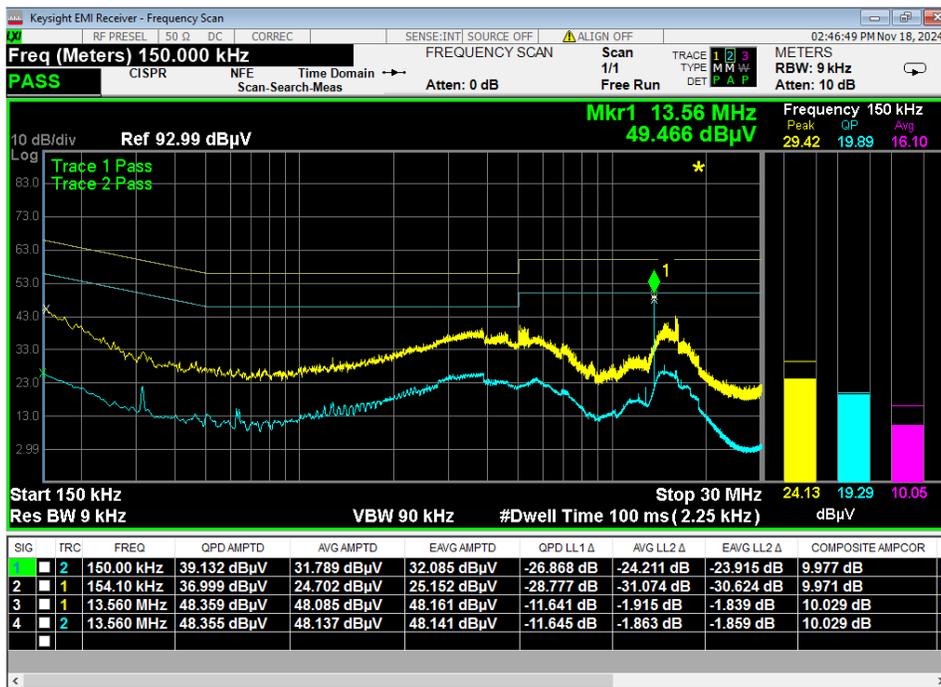


Figure 9 - Conducted Emissions Plot, Line, CE mode

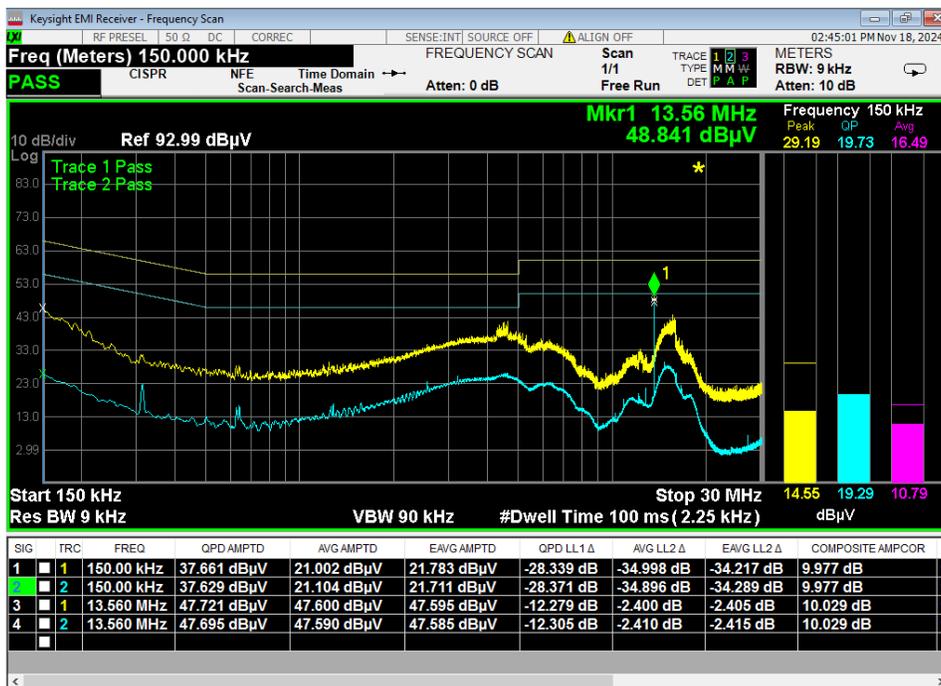


Figure 10 - Conducted Emissions Plot, Neutral, CE mode

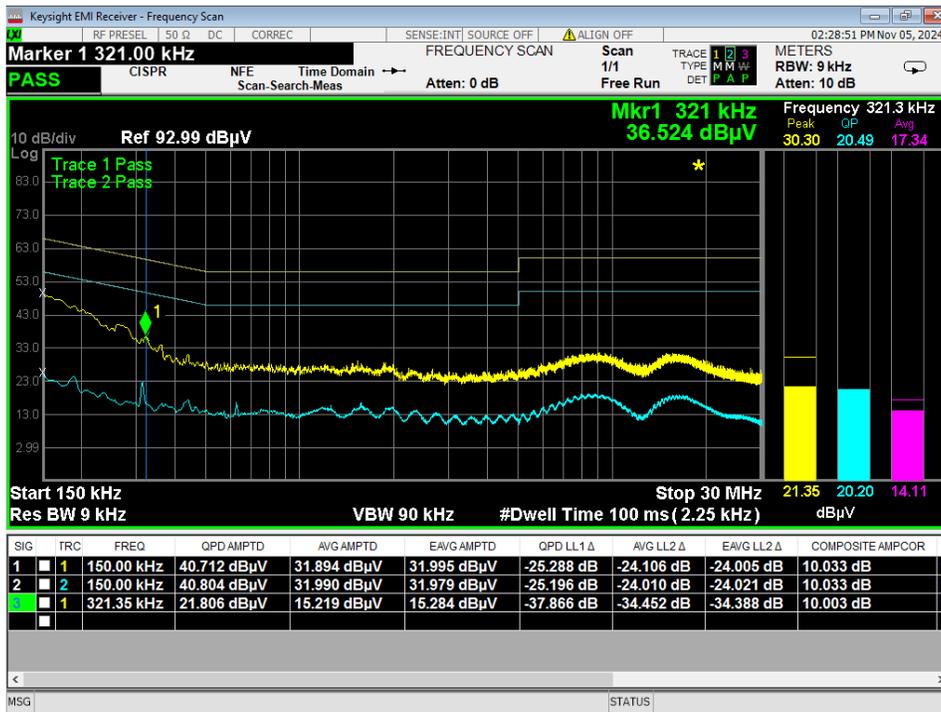


Figure 11 - Conducted Emissions Plot, Line, Idle

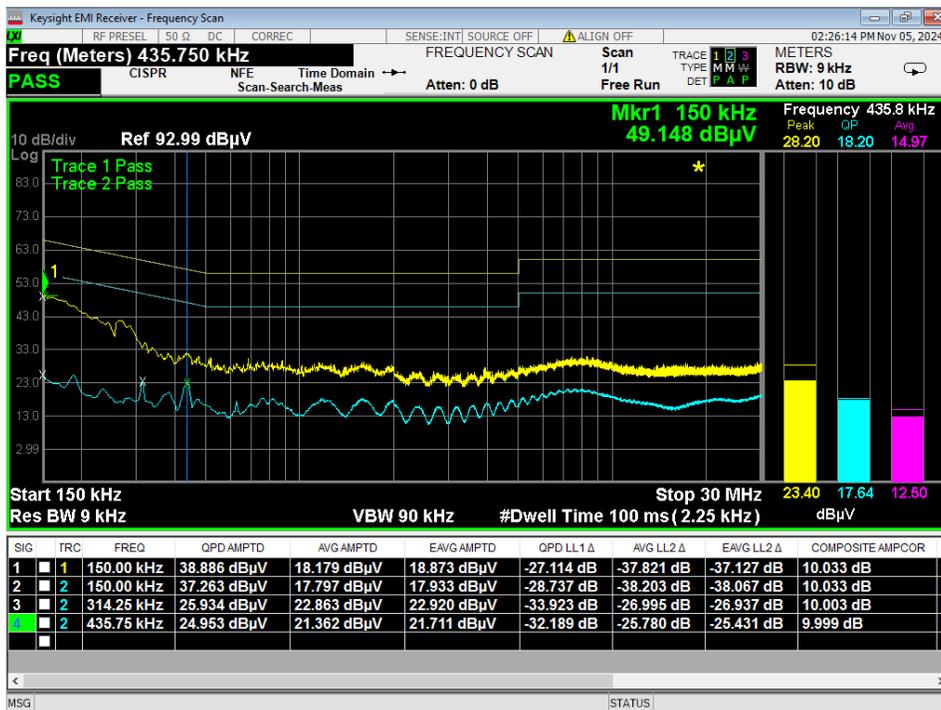


Figure 12 - Conducted Emissions Plot, Neutral, Idle



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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.

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

AV is calculated by taking the $20 \cdot \log(T_{on}/100)$ 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;

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

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

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

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

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

$$\text{Conversion from 3m field strength to EIRP (d=3):}$$

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

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

$$10\log(10^9) \text{ is the conversion from micro to milli}$$



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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	±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%.



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