



INTENTIONAL RADIATOR REPORT

for

Keycafe Inc.

409 – 55 Water St.
Vancouver, BC
V6B 1A1, Canada

Date: 03 November 2021
Report No.: 20.01.20647-1
Revision No.: 0
Project No.: 20647
Equipment: PN532 13.56 MHz NFC module installed in
SmartBox Console (rev 4)
Model No.: NFC_Card-Rev01
FCC ID: 2AELPNFC
IC ID.: 24333-NFC



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Unit 205 – 8291 92 ST., Delta, BC
V4G 0A4, Canada
Phone: 604-247-0444
Fax: 604-247-0442
www.labtestcert.com

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Prepared by: LabTest Certification Inc.
 Date Issued: 03 November 2021
 Project No.: 20647

Client: Keycafe Inc.
 Report No.: 20.01.20647.1
 Revision No.:0

TEST REPORT_FCC 15.225 & ISED RSS-210 Issue 10 Annex B.6		
Operation within the band 13.110-14.010 MHz		
Report Reference No.....:	20.01.20647-1	
Report Revision History.....:	✓ Rev. 0: 1 October 2021	
Conclusion.....:	Labtest certifies the submitted sample(s) and variant(s) listed COMPLY with the standards listed.	
Compiled by (+ signature).....	Bruce Balston	
Approved by (+ signature).....	David Johanson	 2021
Date of issue	03 November 2021	
Total number of pages	23	
FCC Site Registration No.:	721268	
IC Site Registration No.:	5970A	
ANAB Accreditation Number	AT-2033	
Testing Laboratory.....:	LabTest Certification Inc.	
Address	Unit 3128-20800 Westminster Hwy, Richmond, B.C. V6V 2W3 Canada	
Applicant's name.....:	Keycafe Inc.	
Address	409 – 55 Water St., Vancouver, BC, V6B 1A1, Canada	
Test specification:		
Standards.....:	➤ FCC Part 15.225, 15.207, 15.209, 15.205, 15.203 ➤ ISED RSS-210 Issue 10 ➤ ISED RSS-Gen Issue 5	
Test procedure	➤ ANSI C63.10(2013) ➤ FCC Part 2.1055	
Non-standard test method.....:	N/A	

Test item description :	
Model/Type reference	NFC_Card-Rev01
Serial Number	QR code
FCC ID	2AELPNFC
IC ID	24333-NFC
Possible test case verdicts:	
- Test case does not apply to the test object	N/A
- Test object does meet the requirement	Complies
- Test object does not meet the requirement	F (FAIL)
Testing:	
Date(s) of tests	7 July, 25-26 August & 10 September 2021

Device Under Test Description

Application for	Limited single modular approval
Operating Transmit Frequency	13.56 MHz
Operating Receive Frequency	27.21 MHz
Number of Channels	1 channel
Measured RF Output (field reading at 3meters)	52.7 dBµV/m
Modulation Type	ASK
Data Rate	Transfer speeds up to 424 kbit/s
Antenna Type/Gain	PCB Trace
Equipment mobility	Fixed
Operating condition	-20 to + 50 °C
Nominal Voltages for:	The auxiliary equipment (AE) supplies DC voltage to the module. Modular Approval: 5 VDC Host (AE): 120 V

If DC Power:	<input type="checkbox"/> Internal Power Supply <input checked="" type="checkbox"/> DC power supply by host <input type="checkbox"/> External Power Supply or AC/DC adapter <input type="checkbox"/> Battery <ul style="list-style-type: none"> <input type="checkbox"/> Nickel Cadmium <input type="checkbox"/> Alkaline, 4 X AA <input type="checkbox"/> Nickel-Metal Hydride <input type="checkbox"/> Lithium-Ion <input type="checkbox"/> Other
--------------	--

Testing location

<input checked="" type="checkbox"/>	Testing Laboratory:	LabTest Certification Inc.
Testing location/ address		
Richmond Lab		3128-20800 Westminster Hwy, Richmond, B.C.
Delta Lab		Unit 204-8291 92 St. Delta, B.C.

Description of Equipment Under Test and Variant Models

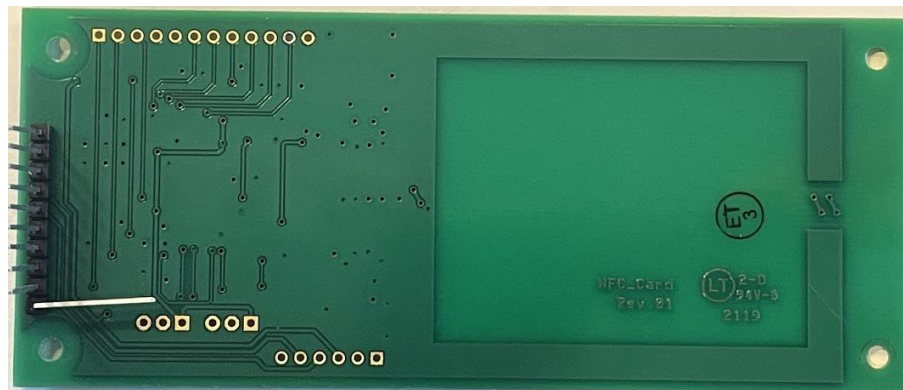
<p>Description:</p> <p>The NFC reader assembly is used in multiple Keycafe products for the purpose of reading NFC key tags. It is based on the NXP PN532 transceiver IC. The PN532 is a highly integrated transceiver module for contactless communication at 13.56 MHz based on the 80C51 microcontroller core. The on-board trace antenna has been tuned to match the output characteristics of the chip for maximum performance.</p>

EUT - Internal/External Photos

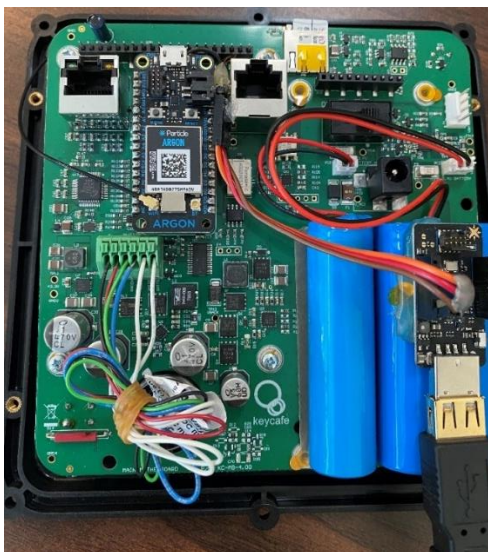
Top side



Bottom side



AE – Host Device 1



AE – Main Host Device 2



Abbreviations:

EUT - Equipment Under Test,
 AE - Auxiliary/Associated Equipment, or
 SIM - Simulator (Not Subjected to Test)

The following variant model were examined during the exploratory phase to determine worst-case. The manufacturer considers these models as being electrically identical, depopulated, or variants reasonably similar and to be included within this certification. Labtest does not make any claims of compliance for samples or variants which were not tested.

Tested Variant Models: None

Client Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
AE	PN532 13.56 MHz NFC module installed in SmartBox Console (rev 4)	Keycafe	NFC_Card-Rev01	Host device 1
AE	MS300Series Wi-Fi Console	Keycafe	MS300-BS26A	Host device 2
AE	MS300Series expansion module	Keycafe	MS300-EX30A	Host device 2

Software and Firmware

Use*	Description	Version
Test	firmware version specifically to update the LCD and to prevent a timeout that was prematurely terminating the test	EMC_TEST_NFC

Input/Output Ports

Port #	Name	Type*			Comments
1	INPUT	DC			EUT is supplied DC power.
2	SIG	IO			Control and I/O from the host device.
*Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical I/O = Signal Input or Output Port (Not Involved in Process Control) TP = Telecommunication Ports					

Power Interface

Mode	Voltage	Current	Power	Frequency	Phases	Comments
-	5 VDC	-	-	DC	-	DC voltage supplied by host device
-	120 VAC	-	-	60 Hz	1	Host

EUT Configuration Modes

Mode #	Description
1	The EUT was configured in transmit mode at a duty cycle exceeding one read/write cycle per second.

Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests:

Parameter	Uncertainty
Radio Frequency	± 0.2 ppm
Total RF Power: Conducted	± 1 dB
RF Power Density: Conducted	± 2.75 dB
Spurious Emissions: Conducted	± 3.0 dB
Temperature	± 1.0 °C
Humidity	± 5.0 %
DC and Low Frequency Voltages	± 3.0 %
Radiated Emission 30 to 250MHz	± 4.37 dB
Radiated Emission 250 to 1000MHz	± 4.29 dB
Radiated Emission, 1 to 6GHz	± 5.02 dB
Conducted Measurements 0.15 to 30MHz	± 3.52 dB
Notes: 1 - Uncertainty figures are valid to a confidence level of 95%.	

Test Equipment Used

Test Equipment	Manufacturer	Model	Identifie	Calibration	Calibration
Spectrum Analyzer	Keysight	N9038A	702	04-Jun-2021	04-Jun-2022
EMC Shielded Enclosure	USC	USC-26	374	18 July, 2019	18 July, 2022
AC Power Source	California Instrument	5001i	059	calibration not required	calibration not required
LISN	Com-Power	LIN-120C	920	11-Dec-2020	11-Dec-2021
Active Loop Antenna 10KHz – 30 MHz	Com-Power Co	AL-130	241	18 Nov 2019	18 Nov 2021
LPDA Antenna	Schwarzbeck Mess	VUSLP9111B	996	05-Apr-2021	05-Apr-2023
BiCon Antenna	A.H Systems	SAS-540	1115	06-May-2021	06-May-2023
EMC Analyzer	Agilent	E7405A	272	29-July- 2021	29-July-2022
Temperature chamber	Haida international equipment Co., LTD	HD-E702- 100-7	1068	calibration not required	calibration not required
Software	Tile! 7	-	-	-	-

Compliance Summary

Compliance status is determined based on direct measurements and calculated values compared to the appropriate standards' limits. Measurement uncertainty values listed were not used in determining compliance status.

Tests indicated in summary were performed on the product constructed as described above. Deviations from the standard(s) are specifically noted. The results obtained in this test report pertain only to the specific item(s) tested or models listed as variants. LabTest declares compliance only for samples and variants listed.

LabTest has concluded the EUT **complies** with the requirements of the following standard(s)

FCC Part 15C and ISED RSS-210			
Test Type	Regulation	Measurement Method	Result
Spurious Radiated Emission	FCC 15.225(d),15.209,15.205 ISED RSS-210 Annex B.6	ANSI C63.10:2013 5.9, 6.4, 6.5	Complies
Conducted Emission	FCC 15. 207 ISED RSS-Gen 8.8	ANSI C63.10 2013 6.2	Complies
Emission Mask	FCC 15.225(a), (b), (c) ISED RSS-210 Annex B.6(a) i, ii, iii	ANSI C63.10. 2013 6.9	Complies
Frequency Stability Temperature & Voltage Variation	FCC 15.225(e) ISED RSS-210 2.6(iv)	FCC Part 2.1055(d)	Complies
Antenna Requirement	FCC 15.203	-	Complies

1- Radiated Spurious Emissions

Regulation	FCC 15.225(d), 15.209, 15.205 ISED RSS-210 Annex B.6	Ambient Temperature (°C)	24
Measurement Method	ANSI C63.10: 2013 5.9, 6.4, 6.5	Relative Humidity (%)	47.3
Test Location	Richmond	Barometric Pressure (kPa)	101.2
Test Engineer	Bruce Balston	Date	25 August 2021
EUT Voltage	<input checked="" type="checkbox"/> DC <input type="checkbox"/> 120VAC @ 60Hz		
Detector:	<input type="checkbox"/> Peak <input checked="" type="checkbox"/> Quasi-Peak/AVG		
RBW/VBW:	<input checked="" type="checkbox"/> 120/300kHz <input type="checkbox"/> 1/3MHz		
Frequency Range:	<input checked="" type="checkbox"/> 30-1000MHz <input checked="" type="checkbox"/> 150kHz-30MHz		
Type of Facility:	<input checked="" type="checkbox"/> SAC <input type="checkbox"/> FSOATS <input type="checkbox"/> <i>in-situ</i>		
Distance:	<input checked="" type="checkbox"/> 3meter <input type="checkbox"/> 10meter <input type="checkbox"/> 1meter		
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only <input type="checkbox"/> Floor-standing only <input type="checkbox"/> Rack Mounted		
Classification:	<input checked="" type="checkbox"/> Class B <input type="checkbox"/> Class A		
	Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>		

Test Method

Radiated spurious emissions evaluates the potential for the EUT to cause radio frequency interference to other electronic devices. Testing was performed in accordance with the test standard(s) referenced in the test summary section of this report. The EUT was configured based upon the requirements of the applicable test standard.

Emission frequencies (signals) are identified by positioning a receive antenna three meters from the EUT. The test was performed with a spectrum analyzer and software listed. The emission at each frequency of interest was maximized by varying the receive antenna from 1-4 meters in height and rotating the turntable 360 degrees.

Horizontal and vertical polarizations were examined for devices with a defined orientation; devices without a defined orientation were tested in 3 axes. All models, configurations and operational modes listed in this report were examined to determine the worst-case reported.

The measurements were made using CISPR 16-1 compliant detectors and bandwidths. A quasi-peak detector used for frequencies 30 M - 1GHz with a measurement (resolution) bandwidth of 120 kHz. The frequency range examined is at least 10% below the lowest frequency; and 10x the highest frequency used or generated.

Sample Calculations

Measurement Correction (Cm)

Radiated Emissions (dBμV/m) = Analyzer Reading (dBμV) + Correction Total (dB/m)

Correction Total (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB)

Measurement Distance Correction (Cd)

Cd (dB) = 20 log (Measurement Distance/Specified Distance) > 30 MHz

Cd (dB) = 40 log (Measurement Distance/Specified Distance) < 30 MHz

Bandwidth Correction (Cbw)

Cbw (dB) = 10 log (Measurement Bandwidth/Specified Bandwidth)

Compliance Margin

(Compliance) Margin (dB) = Limit (dBμV/m) - Field Strength Level (dBμV/m)

Test setup

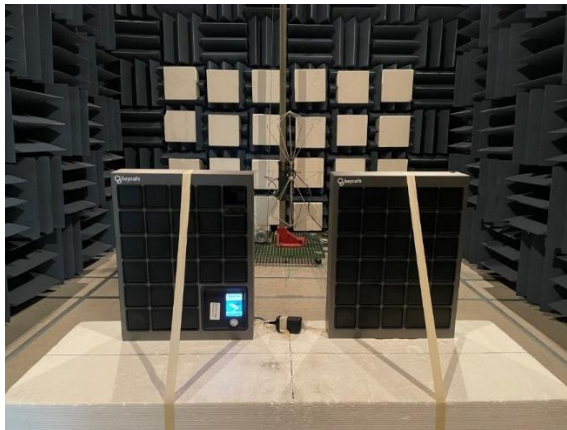
Description of test set-up:

The EUT was placed at 0.8 m above ground reference plane (GRP) on a non-conducting table for measurements less than 1 GHz. The EUT was set to **Operation Mode 1**.

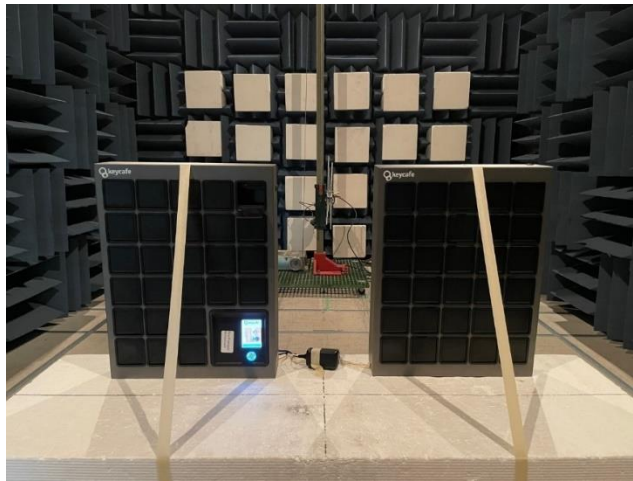
2M-30M Hz – AL-130



30M-250M Hz – SAS-540

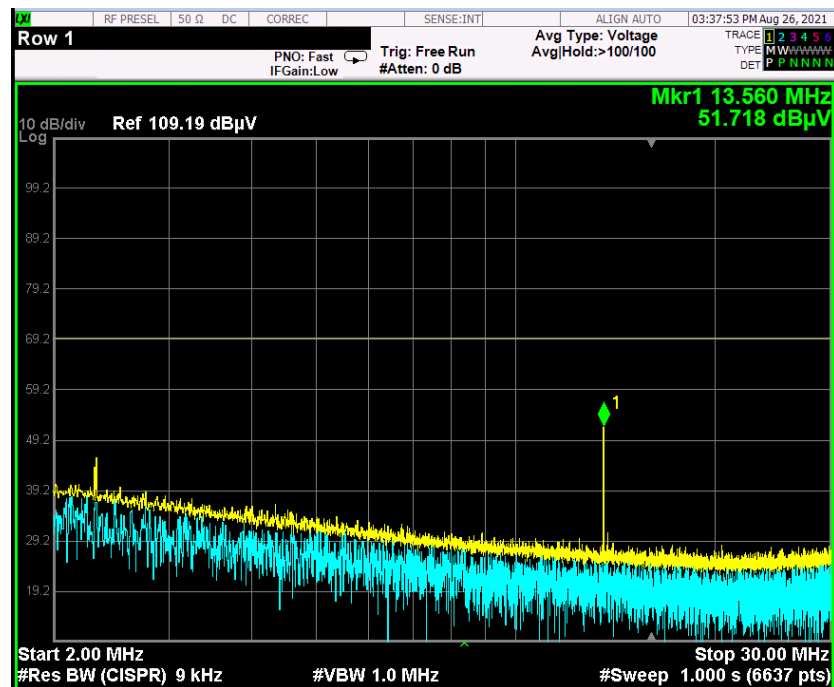


250M-1G Hz – VUSLP9111B



Radiated Spurious Emissions Results

Radiated Emissions Data – 2M-30M Hz



Notes: 1 - No emissions found within 20dB of limit.
2 – Fundamental emission at 13.56 MHz shown.

Radiated Emissions Data – 30-1G MHz

Vertical Polarization

Frequency (MHz)	Ant Fac (dB)	Cable loss (dB)	Preamplifier (dB)	AZ (Deg)	HGT (cm)	Peak (dBuV/m)	QP (dBuV/m)	Limit (dBuV/m)	Margin (dB)
58.0275	15.30	1.14	0.00	359	100	38.07	33.59	39.54	5.95
94.1415	15.91	1.48	0.00	59	104	40.72	34.95	43.98	9.03
177.0810	19.51	2.22	0.00	225	106	39.37	36.93	43.98	7.05
250.0000	21.40	2.68	0.00	214	100	42.10	39.70	46.90	7.20
300.0062	15.30	1.14	0.00	359	100	38.07	33.59	39.54	5.95
375.0062	15.91	1.48	0.00	59	104	40.72	34.95	43.98	9.03
624.9775	19.51	2.22	0.00	225	106	39.37	36.93	43.98	7.05

Horizontal Polarization

Frequency (MHz)	Ant Fac (dB)	Cable loss (dB)	Preamplifier (dB)	AZ (Deg)	HGT (cm)	Peak (dBuV/m)	QP (dBuV/m)	Limit (dBuV/m)	Margin (dB)
36.6145	17.92	0.86	0.00	176	256	31.28	26.87	39.54	12.67
184.1790	19.82	2.28	0.00	72	102	41.78	37.81	43.98	6.17
250.0000	21.40	2.68	0.00	325	139	46.54	44.65	46.90	2.25

Notes: 1 – Signal identified as host device

2- Conducted Emissions – AC Power Line

Governing Doc	FCC 15. 207 ISED RSS-Gen 8.8	Ambient Temperature (°C)	28.6
Basic Standard	ANSI C63.10 2013 6.2	Relative Humidity (%)	40.4
Test Location	Richmond	Barometric Pressure (kPa)	101.6
Test Engineer	Daniel Lee	Date	07 July 2021
EUT Voltage	<input checked="" type="checkbox"/> 120VAC @ 60Hz <input type="checkbox"/> 230VAC @ 50Hz		
Frequency Range:	<input checked="" type="checkbox"/> 150kHz-30MHz <input type="checkbox"/> 9-150kHz		
Detector:	<input type="checkbox"/> Peak <input checked="" type="checkbox"/> Quasi-Peak <input checked="" type="checkbox"/> Averaging		
RBW/VBW:	<input checked="" type="checkbox"/> 9/30kHz <input type="checkbox"/> 200/300Hz		
Coupling device:	<input checked="" type="checkbox"/> AMN <input type="checkbox"/> AAN <input type="checkbox"/> Current Probe <input type="checkbox"/> CVP		
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only <input type="checkbox"/> Floor-standing only <input type="checkbox"/> Rack Mounted		
Classification:	<input checked="" type="checkbox"/> Class B <input type="checkbox"/> Class A		
Compliant <input checked="" type="checkbox"/>	Non-Compliant <input type="checkbox"/>		

Test Method

Conducted emissions (AC) determines the potential for the EUT to cause radio frequency interference to other electronic devices conducted along the AC power line. The measurements were made using CISPR 16-1 compliant detectors and bandwidths. Quasi-peak and average detectors were used with a measurement (resolution) bandwidth of 9 kHz.

The test was performed with a spectrum analyzer controlled by software listed with LISN inserted into the AC power line. All models, configurations and operational modes listed in this report were examined to determine the worst-case.

Sample Calculations

Conducted Emission (QP/AV) (dBμV) = Analyzer Level (dBμV) + Correction (dB)

Correction (dB) = Insertion Loss of LISN (dB) + Cable Loss (dB)

Margin (dB) = QP/AV Limit (dBμV) – QP/AV level (dBμV)

Test Setup

Description of test set-up:

The EUT was placed at 0.8 m above (horizontal) ground reference plane (GRP) on a non-conducting table and 0.4 m from vertical reference plane (VRP). The EUT was set to **Operation Mode 1**.



Conducted Emissions AC Data – 150k-30MHz

Conducted Emissions - Line 1 (Hot)

Frequency (dB)	LISN Loss (dB)	Path Loss (dB)	Peak (dBuV)	QP (dBuV)	QP Limit (dBuV)	Margin QP (dB)	AVG (dBuV)	AVG Limit (dBuV)	Margin AVG (dB)
165.75000 kHz	0.49	0.01	65.48	59.05	65.5	6.45	38.65	55.5	16.85
13.56405	0.18	0.08	51.80	43.81	60.00	16.19	31.87	50.00	18.13

Conducted Emissions - Line 2 (Neutral)

Frequency (MHz)	LISN Loss (dB)	Path Loss (dB)	Peak (dBuV)	QP (dBuV)	QP Limit (dBuV)	Margin QP (dB)	AVG (dBuV)	AVG Limit (dBuV)	Margin AVG (dB)
166.51500 kHz	0.51	0.01	64.90	59.18	65.5	6.32	39.01	55.5	16.49
220.47000 kHz	0.34	0.01	55.07	47.51	63.5	15.99	27.48	53.5	26.0
297.42000 kHz	0.22	0.01	50.78	45.41	60.00	14.59	30.38	50.00	19.62
13.55955 MHz	0.25	0.08	56.35	48.58	60.00	11.42	34.51	50.00	15.49

Notes 1 - Fundamental is considered a spurious emission on AC power line.

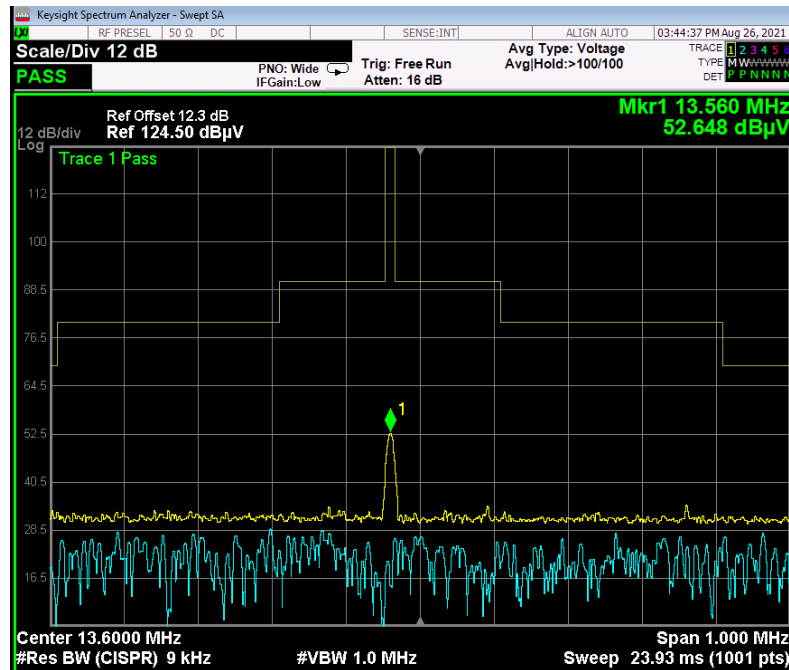
3- Emission Mask

Governing Doc	FCC 15.225(a), (b), (c) ISED RSS-210 Annex B.6(a) i, ii, iii	Ambient Temperature (°C)	24
Basic Standard	ANSI C63.10 6.9	Relative Humidity (%)	47.1
Test Location	Richmond	Barometric Pressure (kPa)	103.5
Test Engineer	Bruce Balston	Date	26 August 2021
EUT Voltage	<input checked="" type="checkbox"/> DC <input type="checkbox"/> 120VAC @ 60Hz		
Frequency Range:	<input type="checkbox"/> 30-1000 MHz <input checked="" type="checkbox"/> 150 kHz-30 MHz		
Detector:	<input checked="" type="checkbox"/> Peak <input type="checkbox"/> Quasi-Peak		
RBW/VBW:	<input type="checkbox"/> 120/300 kHz <input checked="" type="checkbox"/> 9/30 kHz		
Type of Facility:	<input type="checkbox"/> Testbench <input checked="" type="checkbox"/> SAC		
Distance:	<input type="checkbox"/> Direct <input checked="" type="checkbox"/> 3 meter		
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only <input type="checkbox"/> Floor-standing only <input type="checkbox"/> Rack Mounted		
Channel Bandwidth: N/A			
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>			

Test Method

The emission mask was measured by field reading as the transmit antenna is integral to the device. A resolution bandwidth (RBW) of 9kHz was used. See radiated spurious emissions for test setup. The EUT was configured for maximum output power by the manufacturer. The EUT was examined in 3-axes.

Results



Frequency (MHz)	Peak (dBuV)	Corr (dB)	Limit (dBuV)	Margin QP (dB)
13.560 MHz	52.7	12.3	124	71.3

Notes: 1 - The trace was completely within the specified emission mask.

4- Frequency Stability (Temperature & Voltage Variation)

Governing Doc	FCC 15.225 (e) ISED RSS-210 2.6 iv	Ambient Temperature (°C)	20
Basic Standard	FCC Part 2.1055 (d)	Relative Humidity (%)	40.2
Test Location	Delta	Barometric Pressure (kPa)	101.1
Test Engineer	Bruce Balston	Date	10 September 2021
EUT Voltage	<input type="checkbox"/> DC <input checked="" type="checkbox"/> 120VAC @ 60Hz		
Frequency Range:	<input type="checkbox"/> 30-1000MHz <input checked="" type="checkbox"/> 150kHz-30MHz		
Detector:	<input checked="" type="checkbox"/> Peak		
RBW/VBW:	<input checked="" type="checkbox"/> 10/30kHz		
Type of Facility:	<input checked="" type="checkbox"/> Tabletop		
Distance:	<input checked="" type="checkbox"/> Direct		
Limit: $\pm 0.01\%$ or 100 PPM at 13.56 MHz = 1356 Hz			
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>			

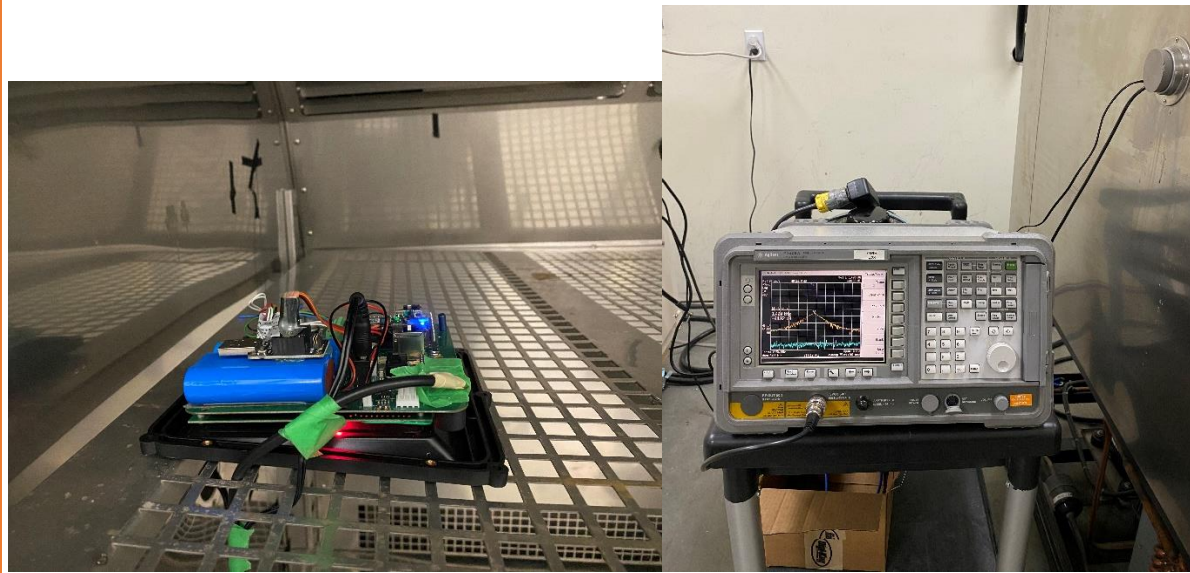
Test Method

Measurement in accordance with FCC Part 2.1055. The EUT was placed in temperature chamber and allowed to reach desired temperature and stabilize and the spectrum analyzer was used to measure frequency. The EUT was set to transmit, and the EUT was investigated over the range -20C - 50 °C.

Test setup

For temperature variation, the host device which supplies DC voltage to the EUT was powered by an external AC power supply and the RF output was measured with the use of a receive antenna while the EUT was placed inside the temperature chamber.

For voltage variation, at ambient temperature ($25 \pm 5^{\circ}\text{C}$), the host device which supplies DC voltage to the EUT was powered by an external AC power supply. The frequency of the transmitter was measured while the AC input voltage was varied from 85% to 115%.



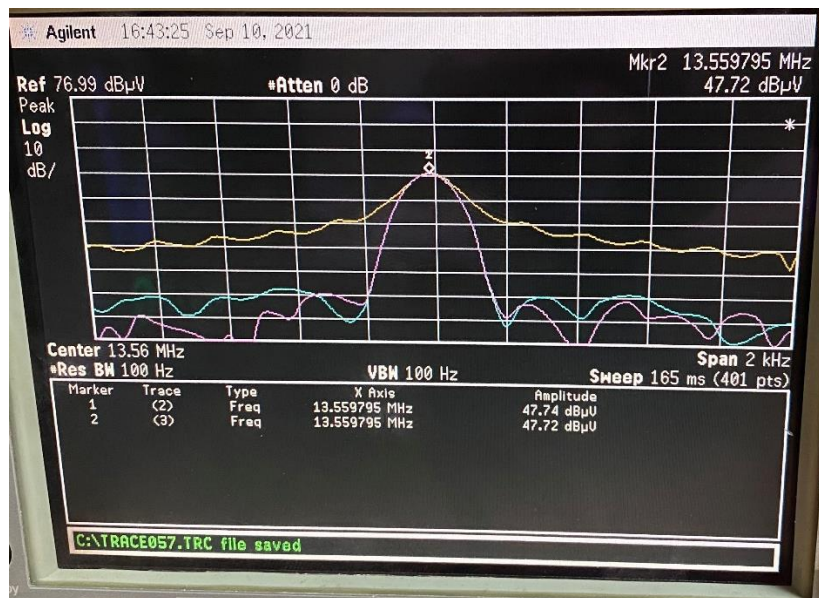
Results

Temperature Variation Data

Temp (Deg C)	Measured frequency (Hz)	Frequency Error (Hz)	Limit (Hz)
50	13559925	-75	±1356
40	13559875	-125	±1356
30	13559800	-200	±1356
20	13559300	-700	±1356
10	13559950	-50	±1356
0	13559925	-75	±1356
-10	13560075	75	±1356
-20	13559975	-25	±1356

Voltage Variation Data

Nominal Voltage	Temp (C)	Measured Frequency (MHz)	Frequency Error (Hz)	Limit (Hz)
115%	20	13.559795	1	±1356
85%	20	13.559795	1	±1356



Note 1 -Temperature related frequency variation: -700 to +75 = 775 Hz

Note 2 -Voltage related frequency variation: 1 Hz

5- Antenna Requirement

Governing Doc	FCC 15. 203	Ambient Temperature (°C)	24
Basic Standard	-	Relative Humidity (%)	47.3
Test Location	Richmond	Barometric Pressure (kPa)	101.2
Test Engineer	Bruce Balston	Date	25 August 2021
EUT Voltage	<input checked="" type="checkbox"/> DC <input type="checkbox"/> 120 VAC @ 60Hz		
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>			

Limit

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Result

The EUT has an integral (trace) antenna and complies.