

RADIO TEST REPORT

Report ID:

REP010643

Project number:

PRJ0027115

Type of assessment:

Final product testing

Applicant:

Mosaic Manufacturing Ltd.

Description of the product:

Active plastic filament enclosure with RFID

Model (HVIN):

MP-V1

Product marketing name (PMN):

Material Pod

FCC identifier:

FCC ID: 2BA8T-MP01

ISED certification number:

IC: 30572-MP01

Specifications:

- ◆ FCC 47 CFR Part 15 Subpart C, §15.225
- ◆ RSS-210, Issue 10, December 2019, Annex B.6

Date of issue: June 19, 2023

Tarek Elkholy, Wireless/EMC Specialist

Tested by



Signature

Hossein Zamani, EMC/RF Specialist

Reviewed by



Signature

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ANAB File Number: AT-3195 (Ottawa/Almonte); AT-3193 (Pointe-Claire); AT-3194 (Cambridge)



Lab locations

Company name	Nemko Canada Inc.			
Facilities	<i>Ottawa site:</i>	<i>Montréal site:</i>	<i>Cambridge site:</i>	<i>Almonte site:</i>
	303 River Road Ottawa, Ontario Canada K1V 1H2	292 Labrosse Avenue Pointe-Claire, Québec Canada H9R 5L8	1-130 Saltsman Drive Cambridge, Ontario Canada N3E 0B2	1500 Peter Robinson Road West Carleton, Ontario Canada K0A 1L0
	Tel: +1 613 737 9680 Fax: +1 613 737 9691	Tel: +1 514 694 2684 Fax: +1 514 694 3528	Tel: +1 519 650 4811	Tel: +1 613 256-9117
Test site identifier	Organization	Ottawa/Almonte	Montreal	Cambridge
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.225	Operation within the band 13.110–14.010 MHz.
RSS-210, Issue 10, Dec 2019, Annex B.6	Licence-Exempt Radio Apparatus: Category I Equipment. Devices operating in frequency bands for any application Band 13.110–14.010 MHz

1.2 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
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1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.5 Test report revision history

Table 1.5-1: Test report revision history

Report ID	Date of issue	Details of changes made to test report
REP010643	June 19, 2023	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

2.2 Technical judgment

None.

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 4 Information provided by the applicant

4.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

4.2 Applicant/Manufacture

Applicant name	Mosaic Manufacturing Ltd.
Applicant address	111 Peter St, Toronto, ON M5V 2H1, Canada
Manufacture name	Microart Services, Inc.
Manufacture address	4412 14th Avenue, Markham, ON L3R 0J3, Canada

4.3 EUT information

Product	Active plastic filament enclosure with RFID
Model	MP-V1
Serial number	QQ1H-MP
Power supply requirements	DC: 24 V
Product description and theory of operation	Active plastic filament enclosure with RFID

4.4 Radio technical information

Frequency band	13.110–14.010 MHz
Frequency Min (MHz)	13.56
Frequency Max (MHz)	13.56
Field strength, dB μ V/m @ 3 m	77.4 dB μ V/m @ 3 m
Measured BW (kHz), 99% OBW	21 kHz
Type of modulation	OOK
Emission classification	H1D
Transmitter spurious, dB μ V/m @ 3 m	30.3 dB μ V/m at 27.1 MHz
Antenna information	Type: Coil PCB antenna, manufacturer: Mosaic Manufacturing, model: EMPEL105RA.1

4.5 EUT setup details

Radio exercise details

Operating conditions	The EUT was powered up using a 24 V _{DC} power supply, the EUT is loaded with a firmware that forces the RFID into continuous transmission once powered up.
Transmitter state	Transmitter set into continuous mode.

Table 4.5-1: EUT interface ports

Description	Qty.
DC power port	1

Table 4.5-2: Support equipment

Description	Brand name	Model
DC power supply	SKY TOPPOWER	MN: STP6005,
Custom made interface to supply DC power to the EUT	Moasic	MN: None

Table 4.5-3: Inter-connection cables

Cable description	From	To	Length (m)
Power cable	DC power supply	EUT	1

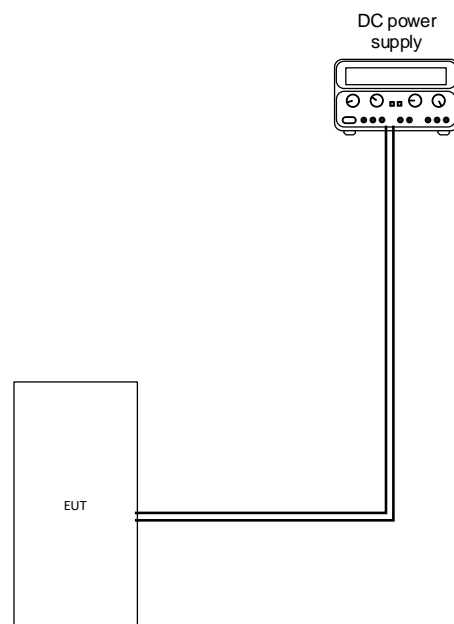


Figure 4.5-1: Radiated testing block diagram

Section 5 Summary of test results

5.1 Testing location

Test location (s) Cambridge

5.2 Testing period

Test start date May 25, 2023

Test end date May 29, 2023

5.3 Sample information

Receipt date May 18, 2023

Nemko sample ID number(s) PRJ00271150001, PRJ00271150002

5.4 FCC Part 15 Subpart A and C, general requirements test results

Table 5.4-1: FCC general requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass
§15.215	Occupied bandwidth	Pass

Notes: EUT is a part of a system which is AC powered system.

5.5 FCC Part §15.225 test results

Table 5.5-1: FCC §15.225 requirements results

Part	Test description	Verdict
§15.225(a)	Field strength within 13.553–13.567 MHz band	Pass
§15.225(b)	Field strength within 13.410–13.553 MHz and 13.567–13.710 MHz bands	Pass
§15.225(c)	Field strength within 13.110–13.410 MHz and 13.710–14.010 MHz bands	Pass
§15.225(d)	Field strength outside 13.110–14.010 MHz band	Pass
§15.225(e)	Frequency tolerance of carrier signal	Pass

Notes: None

5.6 ISED RSS-Gen, Issue 5, test results

Table 5.6-1: RSS-Gen requirements results

Clause	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass
6.7	Occupied bandwidth	Pass

Notes: ¹According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.
EUT is a part of a system which is AC powered system.

5.7 ISED RSS-210, Issue 10, test results

Table 5.7-1: ISED RSS-210 requirements results

Section	Test description	Verdict
Annex B.6 (a)(i)	The field strength within the band 13.553–13.567 MHz	Pass
Annex B.6 (a)(ii)	The field strength within the bands 13.410–13.553 MHz and 13.567–13.710 MHz	Pass
Annex B.6 (a)(iii)	The field strength within the bands 13.110–13.410 MHz and 13.710–14.010 MHz	Pass
Annex B.6 (a)(iv)	The field strength outside the band 13.110–14.010 MHz	Pass
Annex B.6 (b)	Carrier frequency stability	Pass

Notes: None

Section 6 Test equipment

6.1 Test equipment list

Table 6.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA003012	1 year	January 31, 2024
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	February 10, 2024
Spectrum analyzer	Rohde & Schwarz	FSW43	FA002971	1 year	December 31, 2023
Active loop antenna (0.01–30 MHz)	Com-Power	AL-130R	FA003002	1 year	Apr 25, 2024
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003009	1 year	March 21, 2024
Temperature chamber	Espec	EPX-4H	FA003033	1 year	March 8, 2024
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	January 18, 2024
50 Ω coax cable	Huber + Suhner	None	FA003046	1 year	January 18, 2024
50 Ω coax cable	Huber + Suhner	None	FA003402	1 year	January 18, 2024
Two-line v-network	Rohde & Schwarz	ENV216	FA002965	1 year	December 31, 2023
50 Ω coax cable	Rohde & Schwarz	None	FA003074	1 year	July 13, 2023
Two-line v-network	Rohde & Schwarz	ENV216	FA002964	1 year	December 31, 2023

Notes: NCR - no calibration required

Table 6.1-2: Automation software details

Test description	Manufacturer of Software	Details
Radio/EMC test software	Rohde & Schwarz	EMC32, Software for EMC Measurements, Version 10.60.00

Table 6.1-3: Measurement uncertainty calculations based on equipment list

Measurement	Measurement uncertainty, ±dB
AC power line conducted emissions	3.29
Radiated disturbances (using an active loop antenna) (9 kHz to 30 MHz)	3.74
Radiated spurious emissions (30 MHz to 1 GHz)	4.13
RF Output power measurement using Spectrum Analyzer	0.85
Other antenna port measurements	0.94

Notes: UKAS Lab 34, TIA-603 and ETSI TR 100 028-1&2 have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products. Measurement uncertainty calculations assume a coverage factor of $K = 2$ with 95% certainty.

Section 7 Testing data

7.1 Variation of power source

References, definitions and limits

FCC §15.31 (e):

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test summary

Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

The testing was performed as per ANSI C63.10 Section 5.13.

- Where the device is intended to be powered from an external power adapter, the voltage variations shall be applied to the input of the adapter provided with the device at the time of sale. If the device is not marketed or sold with a specific adapter, then a typical power adapter shall be used.
- For devices, where operating at a supply voltage deviating $\pm 15\%$ from the nominal rated value may cause damages or loss of intended function, test to minimum and maximum allowable voltage per manufacturer's specification and document in the report.
- For devices with wide range of rated supply voltage, test at 15% below the lowest and 15% above the highest declared nominal rated supply voltage.
- For devices obtaining power from an input/output (I/O) port (USB, firewire, etc.), a test jig is necessary to apply voltage variation to the device from a support power supply, while maintaining the functionalities of the device.

For battery-operated equipment, the equipment tests shall be performed using a variable power supply.

Test data

EUT Power requirements:

	<input type="checkbox"/> AC	<input checked="" type="checkbox"/> DC	<input type="checkbox"/> Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO	<input type="checkbox"/> N/A
If EUT is battery operated, was the testing performed using fresh batteries?	<input type="checkbox"/> YES	<input type="checkbox"/> NO	<input checked="" type="checkbox"/> N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	<input type="checkbox"/> YES	<input type="checkbox"/> NO	<input checked="" type="checkbox"/> N/A

7.2 Number of frequencies

References, definitions and limits

FCC §15.31:

- (m) Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

RSS-Gen, Clause 6.9:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 7.2-1: Frequency Range of Operation

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Notes: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

Test summary

Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

ANSI C63.10, Clause 5.6.2.1:

The number of channels tested can be reduced by measuring the center channel bandwidth first and then applying the following relaxations as appropriate:

- For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.
- For multiple-input multiple-output (MIMO) systems, if the measured channel bandwidth on testing the middle channel exceeds the minimum permitted bandwidth by more than 50% on one transmit chain, then it is not necessary to repeat testing on the other chains.
- If the measured channel bandwidth on the middle channel is less than 50% of the maximum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

ANSI C63.10, Clause 5.6.2.2:

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

- Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

Test data

Table 7.2-2: *Test channels selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Tx channel, MHz
13.110	14.010	0.9	13.56

Note: EUT utilizes only one operational channel.

7.3 Antenna requirement

References, definitions and limits

FCC §15.203:

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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

RSS-Gen, Clause 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

Test summary

Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

None

Test data

Must the EUT be professionally installed? ☐ YES ☒ NO
 Does the EUT have detachable antenna(s)? ☐ YES ☒ NO
 If detachable, is the antenna connector(s) non-standard? ☐ YES ☐ NO ☒ N/A

Table 7.3-1: Antenna information

Antenna type	Manufacturer	Model number	Connector type
Coil PCB antenna	Mosaic Manufacturing	EMPEL105RA.1	PCB antenna

7.4 AC power line conducted emissions limits

References, definitions and limits

FCC §15.407(b):

- (8) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in § 15.207.

FCC §15.207:

- (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

ANSI C63.10, Clause 6.2:

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an “off-the-shelf” unmodified ac power adapter shall be used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host.

RSS-Gen, Clause 8.8:

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 7.4-1: Conducted emissions limit

Frequency of emission, MHz	Conducted emissions 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: * - The level decreases linearly with the logarithm of the frequency.

 ** - A linear average detector is required.

Test summary

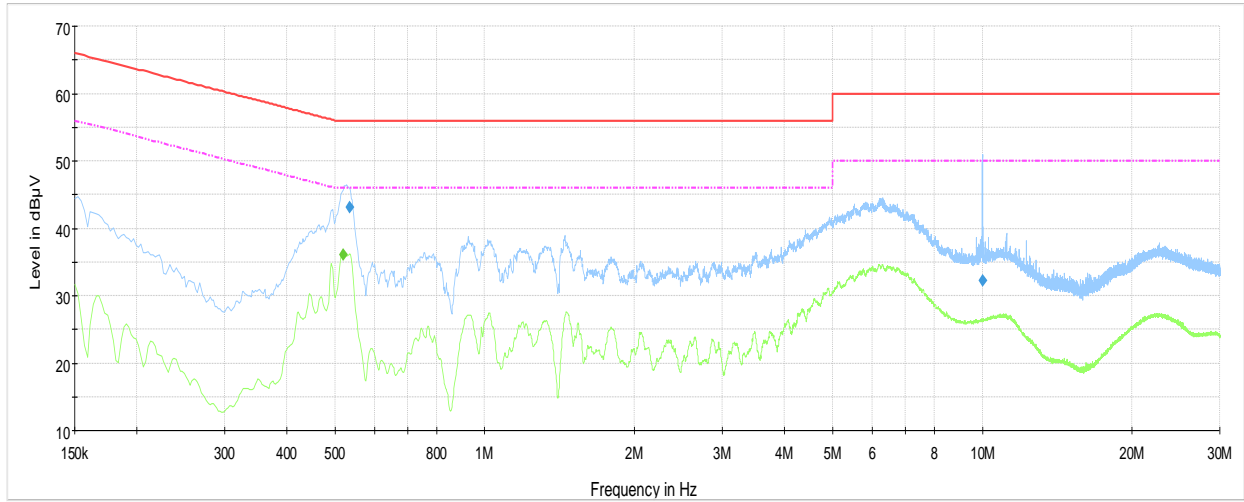
Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

Port under test – Coupling device	AC power input of the Element 3D Printer – Artificial Mains Network (AMN)
EUT power input during test	120 V _{AC} , 60 Hz
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 10 dB or above the limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.
Additional notes:	<ul style="list-style-type: none"> – The EUT was set up as tabletop configuration per ANSI C63.10-2013 measurement procedure. – The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance. Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB) – Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded. – In typical application the EUT is attached to Element 3D Printer, the EUT is 24 V_{DC} powered through 3D printer which is AC powered, the test is conducted at the AC power input of the Element 3D Printer which was in idle mode.

Conducted AC line emissions test was performed as per ANSI C63.10, Clause 6.2. Spectrum analyser settings:

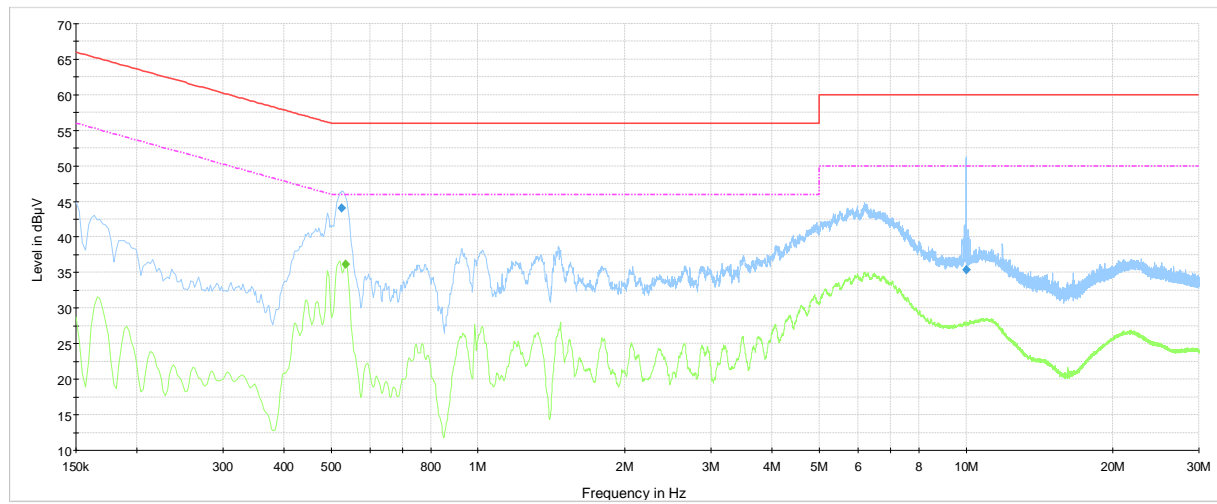
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average (Preview), Quasi-peak and CAverage (Final)
Trace mode	Max Hold
Measurement time	100 ms (Preview), 160 ms (Final)

Test data


PRJ0027115, CE, 150 kHz - 30 MHz, 120 V 60 Hz, Phase

Preview Result 2-AVG
 Preview Result 1-PK+
 CISPR 32 Limit - Class B, Mains (Quasi-Peak)
 CISPR 32 Limit - Class B, Mains (Average)
 Final_Result QPK
 Final_Result CAV

Plot 7.4-1: Conducted emissions on phase line



PRJ0027115, CE, 150 kHz - 30 MHz, 120 V 60 Hz, Neutral

Preview Result 2-AVG
 Preview Result 1-PK+
 CISPR 32 Limit - Class B, Mains (Quasi-Peak)
 CISPR 32 Limit - Class B, Mains (Average)
 Final_Result QPK
 Final_Result CAV

Plot 7.4-2: Conducted emissions on neutral line

7.5 Occupied bandwidth

References, definitions and limits

FCC Part §15.215:

Additional provisions to the general radiated emission limitations:

- (c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

ANSI C63.10-2013, Clause 6.9.3:

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

RSS-Gen, Clause 6.7:

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

Test summary

Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

The emission bandwidth was tested per ANSI C63.10, Clause 6.9.3. Spectrum analyser settings:

Resolution bandwidth:	10 kHz
Video bandwidth:	$\geq 3 \times \text{RBW}$
Detector mode:	Peak
Trace mode:	Max Hold

Test data

Table 7.5-1: 99% bandwidth results

Frequency, MHz	99% bandwidth, kHz
13.56	21.0

Table 7.5-2: Lower 20 dBc frequency cross result

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.55	13.11	440

Table 7.5-3: Upper 20 dBc frequency cross result

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.57	14.01	440

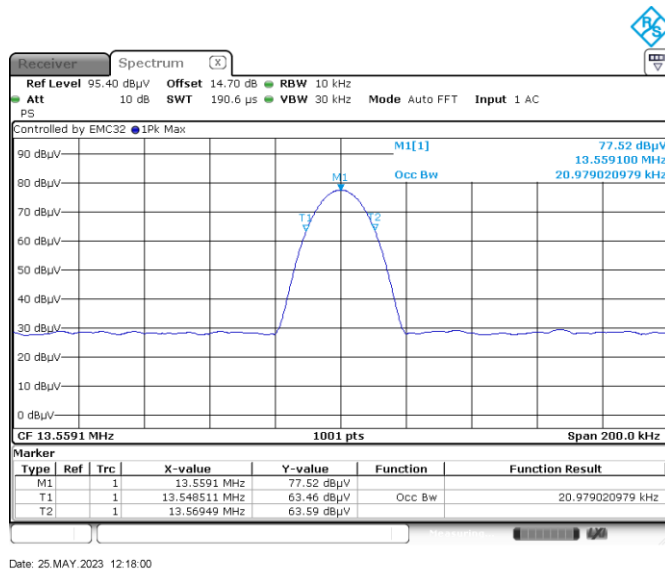


Figure 7.5-1: 99% bandwidth

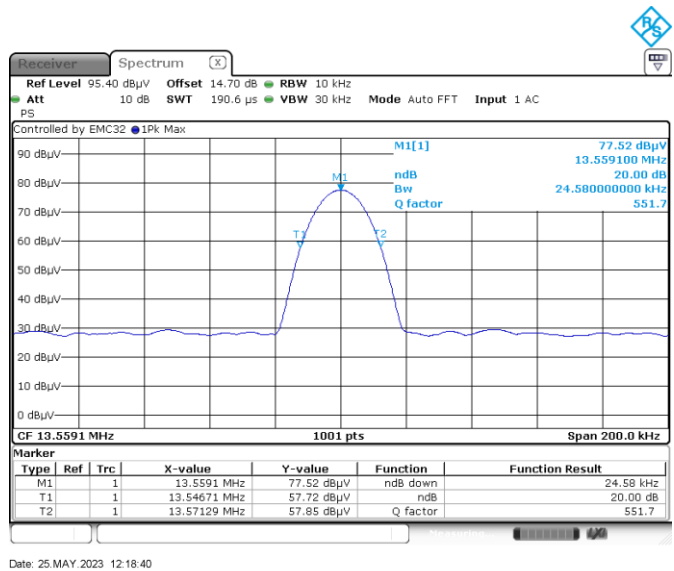


Figure 7.5-2: 20 dB bandwidth

7.6 Field strength within 13.110–14.010 MHz band

References, definitions and limits

FCC §15.225:

- (a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 $\mu\text{V/m}$ (84 $\text{dB}\mu\text{V/m}$) at 30 meters.
- (b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 $\mu\text{V/m}$ (50.5 $\text{dB}\mu\text{V/m}$) at 30 meters.
- (c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 $\mu\text{V/m}$ (40.5 $\text{dB}\mu\text{V/m}$) at 30 meters.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

- a. the field strength of any emission shall not exceed the following limits:
 - i. 15.848 mV/m (84 $\text{dB}\mu\text{V/m}$) at 30 m, within the band 13.553–13.567 MHz
 - ii. 334 $\mu\text{V/m}$ (50.5 $\text{dB}\mu\text{V/m}$) at 30 m, within the bands 13.410–13.553 MHz and 13.567–13.710 MHz
 - iii. 106 $\mu\text{V/m}$ (40.5 $\text{dB}\mu\text{V/m}$) at 30 m, within the bands 13.110–13.410 MHz and 13.710–14.010 MHz

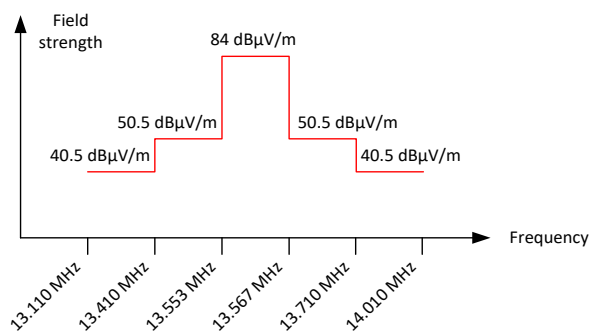


Figure 7.6-1: In-band spurious emissions limit at 30 m

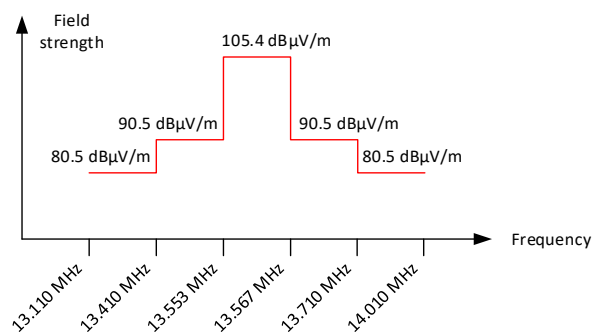


Figure 7.6-2: In-band spurious emissions limit at 3 m

Test summary

Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

The measurements were performed at the distance of 3 m. 40 dB distance correction factor* was applied to the measurement result in order to comply with 30 m limits.

* 30 m to 3 m distance correction factor calculation (for 13 MHz band):

$$\text{Limit} = 84 \text{ (dB}\mu\text{V/m)} + 40 \times \text{Log}_{10} (3.5 \text{ m}/3 \text{ m}) + 20 \text{ Log}_{10} (30 \text{ m}/3.5 \text{ m}) = 105.4 \text{ dB}\mu\text{V/m}$$

Extrapolation method is used. (ANSI C63.10 Clause 6.4.4.2)

- EUT was set to transmit with 100 % duty cycle.
- Radiated measurements were performed at a distance of 3 m.
- The spurious emission was tested per ANSI C63.10, Clause 6.4.

Spectrum analyser settings:

Resolution bandwidth:	10 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Test data

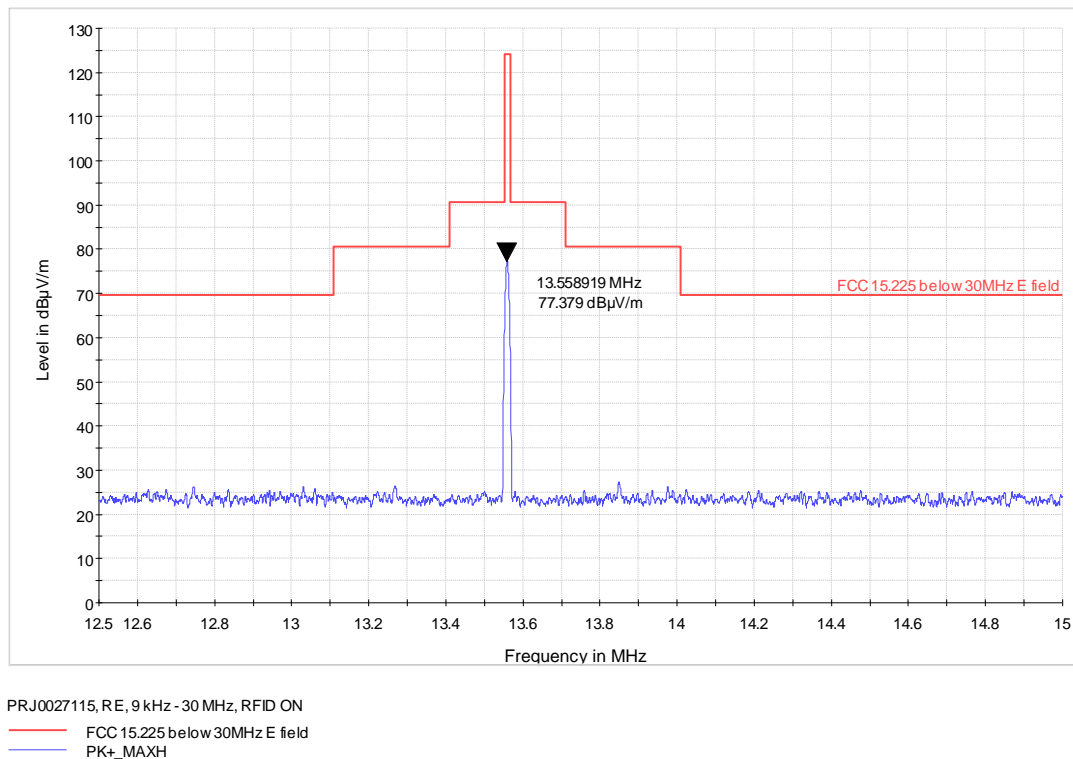


Figure 7.6-3: Field strength within 13.553–13.567 MHz band

Note: Fundamental signal limit is 105.4 dBμV/m

7.7 Field strength outside 13.110–14.010 MHz band

References, definitions and limits

FCC §15.225:

- (d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

- a. the field strength of any emission shall not exceed the following limits:
- iv. RSS-Gen general field strength limits for frequencies outside the band 13.110–14.010 MHz

Table 7.7-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	μV/m	dBμV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

References, definitions and limits, continued

Table 7.7-2: ISED restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	
8.41425–8.41475	167.72–173.2	3500–4400	Above 38.6
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in this table **Error! Reference source not found.** and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 7.7-3: FCC restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

Test summary

Verdict	Pass		
Test date	May 25, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	995 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

- The spectrum was searched from 9 kHz to 1 GHz.
- EUT was set to transmit with 100 % duty cycle.
- Radiated measurements were performed at a distance of 3 m.
- The spurious emission was tested per ANSI C63.10, Clause 6.4 and 6.5.

Spectrum analyser settings for measurements below 150 kHz:

Resolution bandwidth:	300 Hz
Video bandwidth:	9 kHz
Detector mode:	Quasi-Peak
Trace mode:	Max Hold

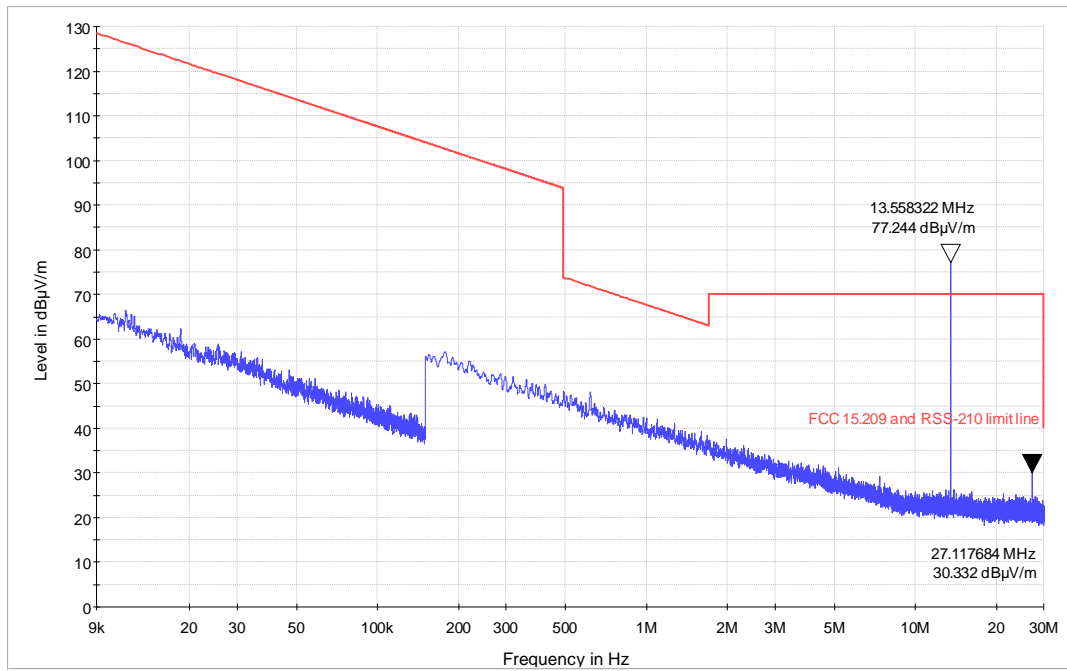
Spectrum analyser settings for measurements below 30 MHz:

Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Quasi-Peak
Trace mode:	Max Hold

Spectrum analyser settings for measurements below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Test data



PRJ0027115, RE, 9 kHz - 30 MHz, RFID ON

— PK+_MAXH
 — FCC 15.209 and RSS-210 limit line

Figure 7.7-1: Field strength of spurious emissions below 30 MHz

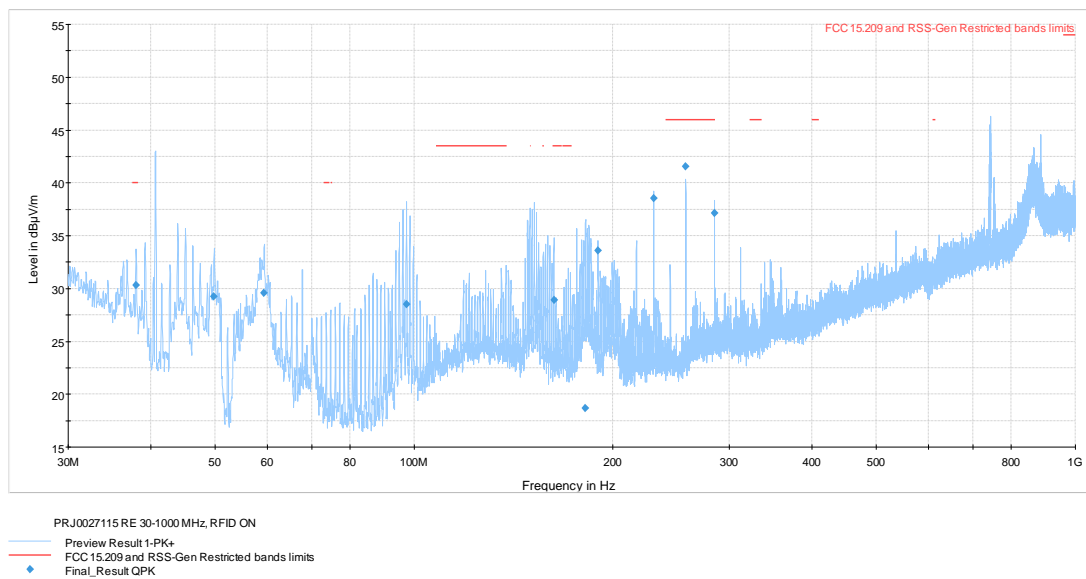


Figure 7.7-2: Field strength of spurious emissions above 30 MHz

Note: emissions at 700 MHz are not relevant to the EUT.

7.8 Frequency stability

References, definitions and limits

FCC §15.225:

- (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

- b. the carrier frequency stability shall not exceed ± 100 ppm

Test summary

Verdict	Pass		
Test date	May 29, 2023	Temperature	22 °C
Tested by	Tarek Elkholy	Air pressure	993 mbar
Test location	Cambridge	Relative humidity	33 %

Observations, settings and special notes

$\pm 0.01\%$ of the operating frequency = ± 1.356 kHz

Frequency stability test was performed as per ANSI C63.10, Clause 6.8. Spectrum analyser settings:

Resolution bandwidth:	100 Hz
Video bandwidth:	300 Hz
Detector mode:	Peak
Trace mode:	Max Hold

Test data

Table 7.8-1: Frequency drift measurement

Test conditions	Frequency, MHz	Drift, kHz	Limit, kHz	Margin, kHz
+50 °C, Nominal	13.55899015	0.042	1.356	1.31
+40 °C, Nominal	13.55899029	0.041	1.356	1.31
+30 °C, Nominal	13.55900082	0.031	1.356	1.33
+20 °C, +15 %	13.55907101	0.039	1.356	1.32
+20 °C, Nominal	13.55903173		Reference	
+20 °C, -15 %	13.55906302	0.031	1.356	1.32
+10 °C, Nominal	13.55904806	0.016	1.356	1.34
0 °C, Nominal	13.55907055	0.039	1.356	1.32
-10 °C, Nominal	13.55907882	0.047	1.356	1.31
-20 °C, Nominal	13.55907150	0.040	1.356	1.32
-30 °C, Nominal	13.55904220	0.010	1.356	1.35

End of the test report