

RADIO TEST REPORT – 445943-1R2TRFWL

Type of assessment:

Final product testing

Applicant:

ORBCOMM Inc.

Product:

Fleet Tracking Device

Model:

FM5000

FCC ID:

XGS-FM5

IC Registration number:

11881A-FM5

Specifications:

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

Date of issue: December 8, 2021

Alvin Liu, EMC/RF Specialist

Tested by



Signature

Tarek Elkholy, Wireless/EMC Specialist

Reviewed by



Signature

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada.
The tests included in this report are within the scope of this accreditation

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	292 Labrosse Avenue	1-130 Saltsman Drive	1500 Peter Robinson Road
	Ottawa, Ontario	Pointe-Claire, Québec	Cambridge, Ontario	West Carleton, Ontario
	Canada	Canada	Canada	Canada
	K1V 1H2	H9R 5L8	N3E 0B2	K0A 1L0
	Tel: +1 613 737 9680	Tel: +1 514 694 2684	Tel: +1 519 650 4811	Tel: +1 613 256-9117
	Fax: +1 613 737 9691	Fax: +1 514 694 3528		
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	License-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

Revision #	Date of issue	Details of changes made to test report
TRF	August 17, 2021	Original report issued
R1TRF	November 17, 2021	Added FCC id and IC Registration number, revised transmitter spurious data in section 5.4
R2TRF	December 8, 2021	Removed model variant FM5100

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 Model variant declaration

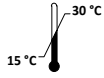
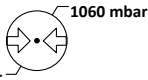
There were no model variants declared by the applicant.

2.4 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	 15 °C – 35 °C
Relative humidity	 20 % – 75 %
Air pressure	 86 kPa (860 mbar) – 106 kPa (1060 mbar)

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

3.2 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 Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B 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 budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of $K = 2$ with 95% certainty.

Table 4.1-1: Measurement uncertainty calculations

Test name	Measurement uncertainty, $\pm$ dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 5 Information provided by the applicant

5.1 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.

5.2 Applicant/Manufacturer

Applicant name	ORBCOMM Inc.
Applicant address	395 W, Passaic Street, Suite 325, Rochelle Park, NJ 07662, USA.
Manufacturer name	Sanmina SCI de Mexico SA de CV
Manufacturer address	Avenida Industrial Rio San Juan SN, Parque Industrial del Norte, Reynosa, Tamaulipas, 88736, Mexico.

5.3 EUT information

Product	Fleet Tracking Device
Model	FM5000
Serial number	JXHA821120076
Part number	FM5000-2X01-BETA
Power supply requirements	DC: 12 V
Product description and theory of operation	The device consists of a cellular radio, a WiFi/Bluetooth Radio and a RFID/NFC radio. The device is designed for the application of industrial assets tracking, monitoring and management of cabs/transportation vehicles etc. RFID/NFC radio is operated in 13.56MHz band to assist the Vehicles tracking and transportation management.

5.4 Radio technical information

Frequency band	13.553–13.567 MHz
Frequency Min (MHz)	13.56
Frequency Max (MHz)	13.56
RF power Max (W), Conducted	N/A
Field strength, dB μ V/m @ 3 m	64.0
Measured BW (kHz), 99% OBW	0.123
Type of modulation	ASK
Emission classification	A1D
Transmitter spurious, dB μ V/m @ 3 m	48.4 at 496.26 kHz
Antenna information	Internal, non-detachable antenna

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	The EUT was connected with a laptop via com interface , and was controlled to transmit RFID/NFC signal at 13.56 MHz by Tera Term.
Transmitter state	Transmitter was set into continuous mode.

5.5.2 EUT setup configuration

Table 5.5-1: EUT interface ports

Description	Qty.
Power/data port	1

Table 5.5-2: Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	Dell	SN: FA003070, MN: Latitude E6440

Table 5.5-3: Inter-connection cables

Cable description	From	To	Length (m)
Power/data cable harness	EUT	DC power source / Laptop	3

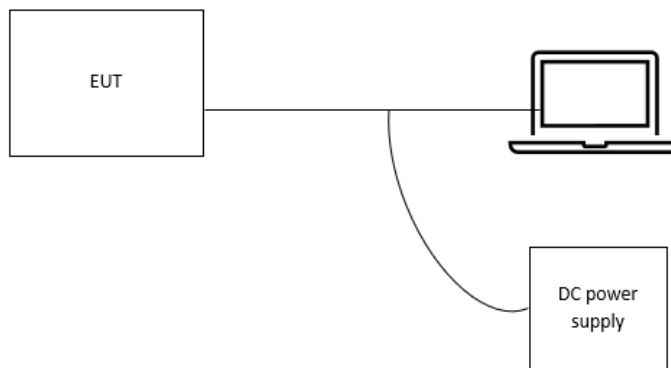


Figure 5.5-1: Block diagram

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Cambridge
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6.2 Testing period

Test start date	August 3, 2021	Test end date	August 4, 2021
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6.3 Sample information

Receipt date	August 3, 2021	Nemko sample ID number(s)	1
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6.4 FCC Part 15 Subpart A and C, general requirements test results

Table 6.4-1: FCC general requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass
Notes: EUT is an DC powered device.		

6.5 FCC Part §15.225 test results

Table 6.5-1: 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		

6.6 ISED RSS-Gen, Issue 5, test results

Table 6.6-1: RSS-Gen requirements results

Clause	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable ¹
7.4	Receiver conducted emission limits	Not applicable ¹
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Not applicable ²

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.

²EUT is an DC powered device.

6.7 ISED RSS-210, Issue 10, test results

Table 6.7-1: ISED RSS-247 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 7 Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA003012	1 year	April 12, 2022
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	November 12, 2021
Spectrum analyzer	Rohde & Schwarz	FSP	FA001920	1 year	November 12, 2021
Active loop antenna (0.01–30 MHz)	Com-Power	AL-130R	FA003002	1 year	March 24, 2022
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003010	1 year	April 28, 2022
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	December 17, 2021
50 Ω coax cable	Huber + Suhner	None	FA003043	1 year	December 17, 2021

Note: NCR - no calibration required

Section 8 Testing data

8.1 Variation of power source

8.1.1 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.

8.1.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 3, 2021

8.1.3 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.

8.1.4 Test data

EUT Power requirements:

	☐ AC	☒ DC	☐ Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	☐ YES	☒ NO	☐ N/A
If EUT is battery operated, was the testing performed using fresh batteries?	☐ YES	☐ NO	☒ N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	☐ YES	☐ NO	☒ N/A

8.2 Number of frequencies

8.2.1 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 8.2-1: 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.

8.2.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 3, 2021

8.2.3 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.

8.2.4 Test data

Table 8.2-2: *Test channels selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Tx channel, MHz
13.553	13.567	0.014	13.560

8.3 Antenna requirement

8.3.1 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.

8.3.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 3, 2021

8.3.3 Observations, settings and special notes

None

8.3.4 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

8.4 Occupied bandwidth

8.4.1 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).

8.4.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 3, 2021

8.4.3 Observations, settings and special notes

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

Resolution bandwidth:	≥ 1 % of span
Video bandwidth:	≥ 3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data

Table 8.4-1: 99% bandwidth results

Frequency, MHz	99% bandwidth, Hz
13.560	123.010

Table 8.4-2: Lower 20 dBc frequency cross result

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.559952	13.559886	13.553000	6.886

Table 8.4-3: Upper 20 dBc frequency cross result

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.559952	13.560014	13.567000	6.986

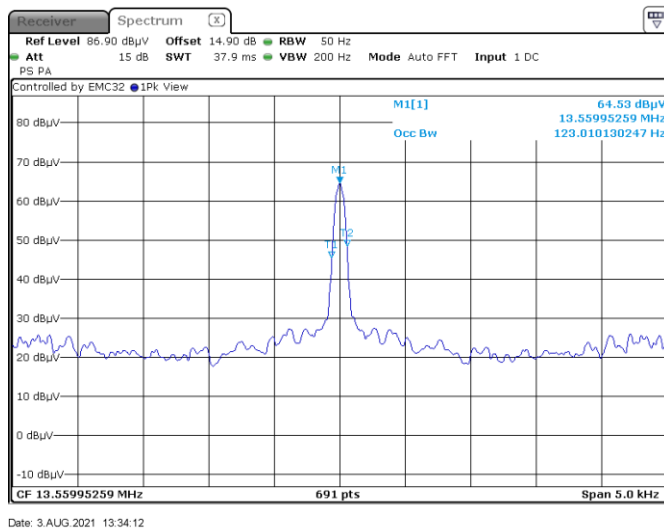


Figure 8.4-1: 99% bandwidth

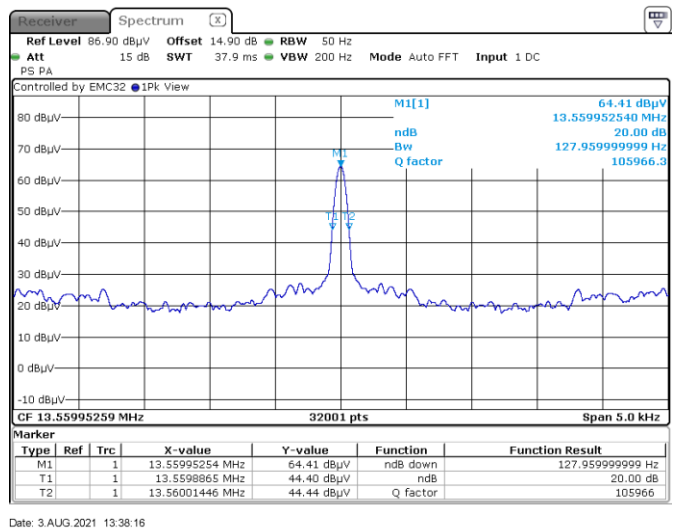


Figure 8.4-2: 20 dB bandwidth

8.5 Field strength within 13.110–14.010 MHz band

8.5.1 References, definitions and limits

FCC §15.225:

- The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 $\mu\text{V/m}$ (84 dB $\mu\text{V/m}$) at 30 meters.
- 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 dB $\mu\text{V/m}$) at 30 meters.
- 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 dB $\mu\text{V/m}$) at 30 meters.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

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

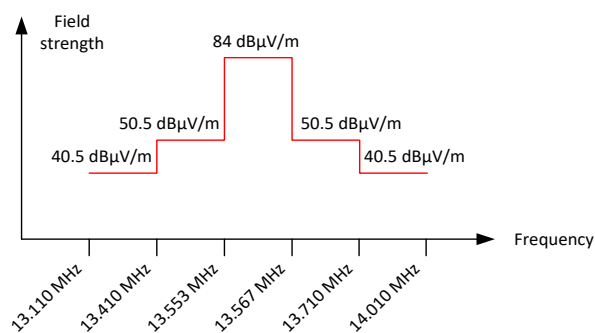


Figure 8.5-1: In-band spurious emissions limit at 30 m

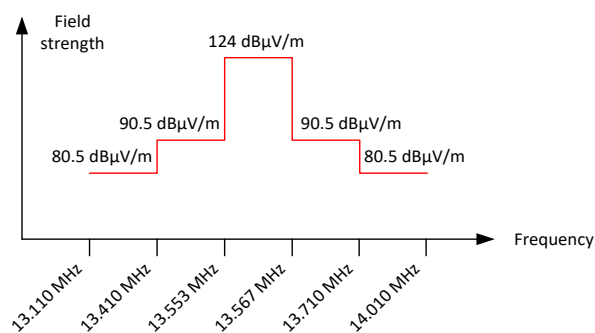


Figure 8.5-2: In-band spurious emissions limit at 3 m

8.5.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 3, 2021

8.5.3 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):

$$40 \times \log_{10} (3 \text{ m}/30 \text{ m}) = 40 \times \log_{10} (0.1) = -40 \text{ dB}$$

- 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

8.5.4 Test data

Table 8.5-1: Field strength measurements results

Frequency range, MHz	Frequency, MHz	Measured field strength at 3 m, dBμV/m	Calculated field strength at 30 m, dBμV/m	Limit, dBμV/m	Margin, dB
13.553–13.567	13.560	64.0	24.0	84.0	60.0

Note: Calculated field strength at 30 m = Measured field strength at 3 m – 40 dB

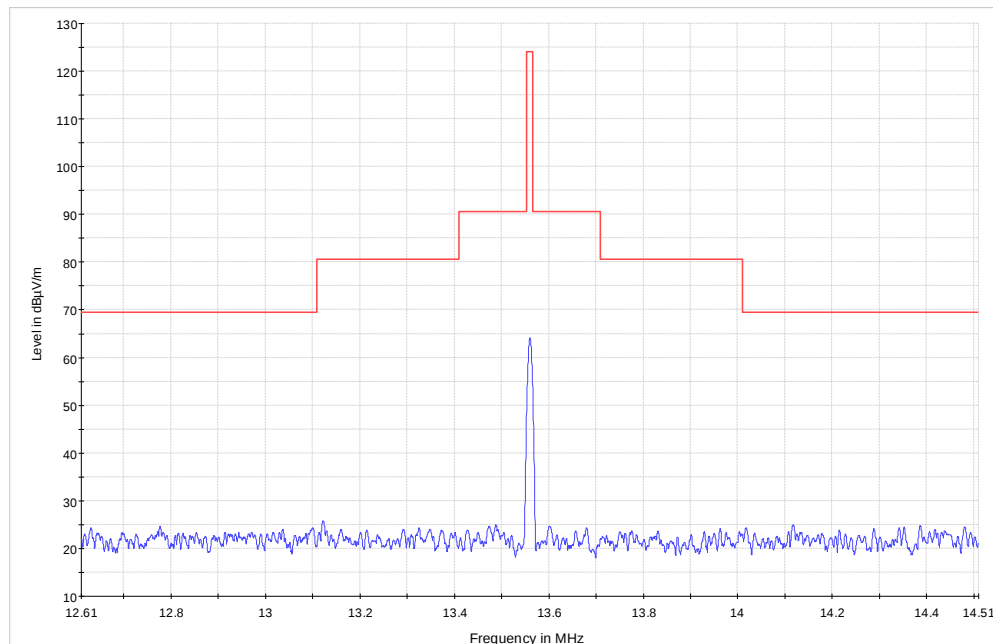


Figure 8.5-3: Field strength within 13.110–14.010 MHz band

8.6 Field strength outside 13.110–14.010 MHz band

8.6.1 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 8.6-1: 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 8.6-2: 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 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 8.6-3: 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			

8.6.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 3, 2021

8.6.3 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:	200 Hz
Video bandwidth:	1 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for measurements below 30 MHz:

Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	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

8.6.4 Test data

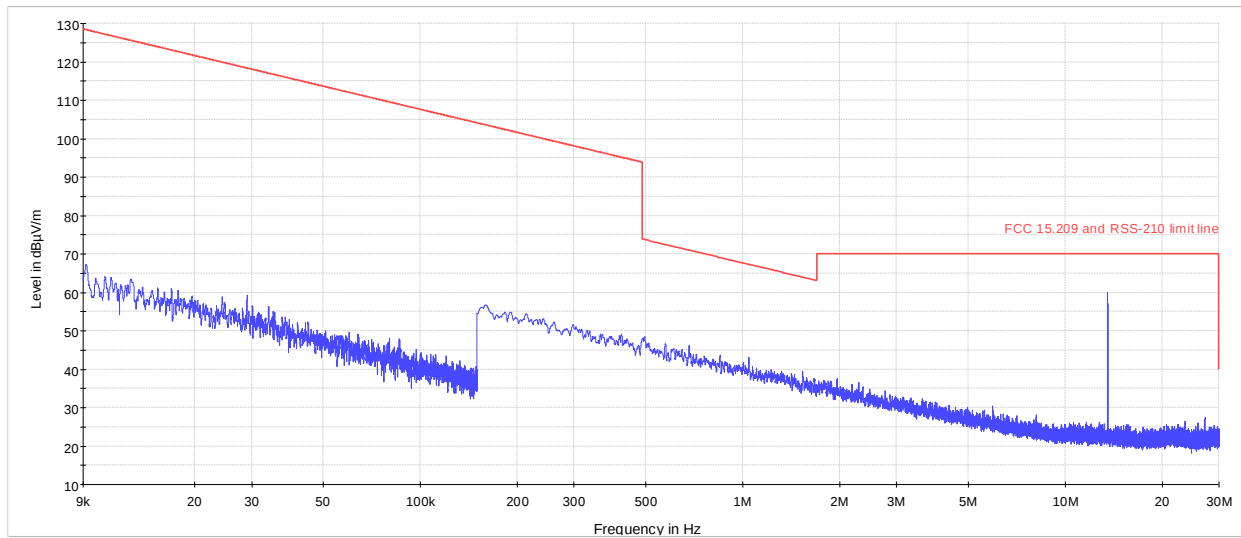


Figure 8.6-1: Field strength of spurious emissions below 30 MHz

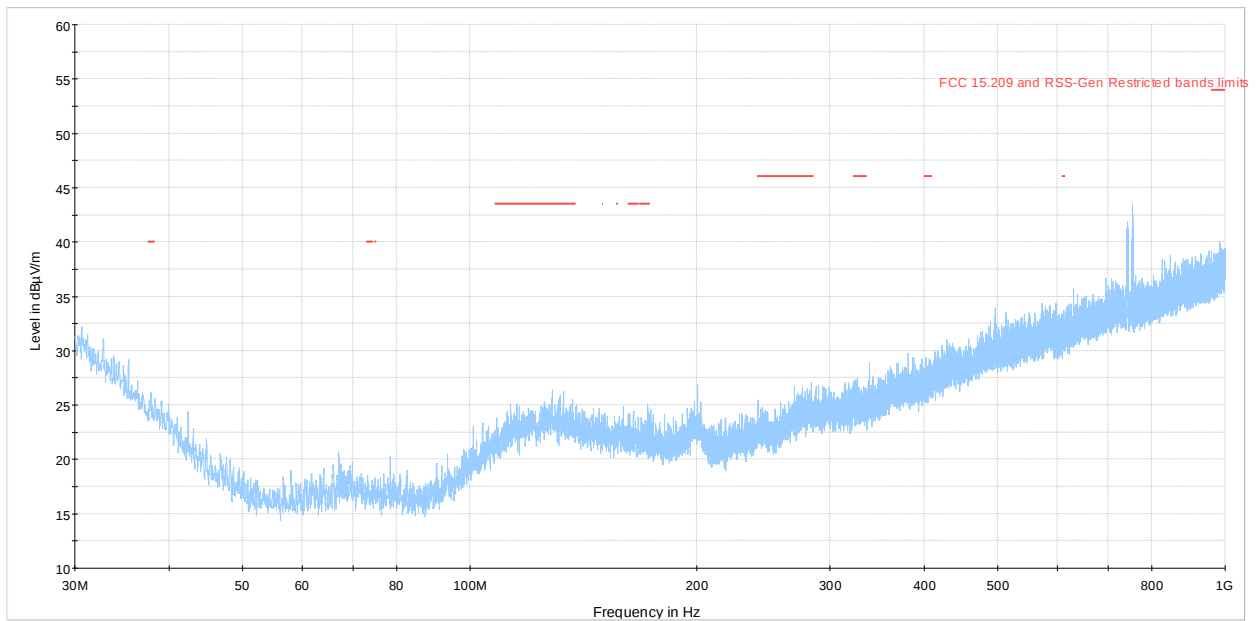


Figure 8.6-2: Field strength of spurious emissions above 30 MHz

8.7 Frequency stability

8.7.1 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

8.7.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	August 4, 2021

8.7.3 Observations, settings and special notes

Frequency drift (ppm) = $((F_{\text{measured}} - F_{\text{reference}}) \div F_{\text{reference}}) \times 1 \times 10^6$

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

8.7.4 Test data

Table 8.7-1: Frequency drift measurement

Test conditions	Frequency, MHz	Drift, Hz	Drift, ppm	Limit, $\pm$ ppm	Margin, ppm
+50 °C, Nominal	13.559910	-140	10.3	100.0	89.7
+40 °C, Nominal	13.559920	-130	9.6	100.0	90.4
+30 °C, Nominal	13.559960	-90	6.6	100.0	93.4
+20 °C, +15 %	13.560050	0	0	100.0	100.0
+20 °C, Nominal	13.560050	Reference			
+20 °C, -15 %	13.560050	0	0	100.0	100.0
+10 °C, Nominal	13.560100	+50	3.7	100.0	96.3
0 °C, Nominal	13.560160	+110	8.1	100.0	91.9
-10 °C, Nominal	13.560200	+150	11.1	100.0	88.9
-20 °C, Nominal	13.560200	+150	11.1	100.0	88.9

Section 9 EUT photos

9.1 External photos



Figure 9.1-1: Front view photo



Figure 9.1-2: Rear view photo



Figure 9.1-3: Side view photo



Figure 9.1-4: Side view photo



Figure 9.1-5: Top view photo



Figure 9.1-6: Bottom view photo



Figure 9.1-7: Cable harness photo

End of the test report