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# RADIO TEST REPORT

Report ID:

**REP010354**

Project number:

**PRJ0034847**

Type of assessment:

**Final product testing**

Applicant:

**Tyco Safety Products Canada Ltd.**

Description of product:

**Dual Tech Motion Detector**

Product marketing name (PMN):

**Dual Tech Motion Detector**

Model(s)/HVIN(s):

**LC-203**

Model Variants:

**LC-204**

FCC identifier:

**FCC ID: F5323LC2034**

ISED certification number:

**IC: 160A-LC2034**

Specifications:

- ◆ FCC 47 CFR Part 15, Subpart C, §15.245
- ◆ RSS-210 Annex F.1, Issue 10, December 2019

Date of issue: May 5, 2023

**Alvin Liu, EMC/RF Specialist**

Tested by

Signature

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Signature

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



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	ISED:	2040A-4	2040G-5	24676
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#### 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

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### 1.1 Test specifications

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FCC 47 CFR Part 15, Subpart C, Clause 15.245	Operation within the bands 902–928 MHz, 2435–2465 MHz, 5785–5815 MHz, 10500–10550 MHz, and 24075–24175 MHz.
RSS-210 Annex F.1, Issue 10, December 2019	Licence-Exempt Radio Apparatus: Category I Equipment. Field disturbance sensors operating in the bands 902–928 MHz, 2435–2465 MHz, 5785–5815 MHz, 10.5–10.55 GHz, and 24.075–24.175 GHz.

### 1.2 Test methods

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ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 5, March 2019	General Requirements for Compliance of Radio Apparatus

### 1.3 Exclusions

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None

### 1.4 Statement of compliance

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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.

Determining compliance is based on the results of the compliance measurement, not taking into account measurement uncertainty, in accordance with section 1.3 of ANSI C63.10 v2013.

See “Summary of test results” for full details.

### 1.5 Test report revision history

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**Table 1.5-1:** Test report revision history

Revision #	Date of issue	Details of changes made to test report
REP010354	May 5, 2023	Original report issued

## Section 2. Engineering considerations

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### 2.1 Modifications incorporated in the EUT for compliance

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

### 2.2 Technical judgment

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None

### 2.3 Model variant declaration

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As declared by the applicant, the EUT model LC-203 has been chosen to be representative for all other models in the model family. The model family, and the description of the variations, are as follows:

Model LC-203 is the fully populated models, it includes also antimasking feature while variant model LC-204 does not. All HW/SW/Construction is the same for both models in this family.

### 2.4 Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.

## Section 3. Test conditions

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### 3.1 Atmospheric conditions

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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

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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/Manufacturer

Applicant name	Tyco Safety Products Canada Ltd.
Applicant address	3301 Langstaff Rd., Concord, ON L4K 4L2 Canada
Manufacturer name	Same as applicant
Manufacturer address	Same as applicant

### 4.3 EUT information

Product description	Dual Tech Motion Detector
Model(s) / HVIN(s)	LC-203
Serial number	None
Model variants	LC-204
Power supply requirements	DC: 9 – 15 V, powered from the alarm control panel
Product description and theory of operation	This product is a dual technology motion detector used for burglary alarm systems, it includes PIR and MW detection and Antimasking. The MW module operates at 10.525 GHz
Software information	HW Ver 5.0 and SW Ver 1.5

### 4.4 Radio technical information

Operating band	10500 – 10550 MHz
Operating frequency	10525 MHz $\pm$ 5 MHz
RF power Max (W), Conducted	N/A
Field strength, dB $\mu$ V/m @ 3 m	108.08
Measured BW (kHz), 99% OBW	1154
Type of modulation	PM
Emission classification	P0N
Transmitter spurious, dB $\mu$ V/m @ 3 m	63.8 (peak) at 10.500 GHz
Antenna information	Micro-strip path antenna is integral to module NJR4178 (New Japan Radio Co., Ltd), gain 0 dBi

## 4.5 EUT setup details

### 4.5.1 Radio exercise details

Operating conditions	EUT operated in transmitting mode.
Transmitter state	The transmitter set into continuous Tx mode.

### 4.5.2 EUT setup configuration

**Table 4.5-1: EUT interface ports**

Description	Qty.
Interface connected to panel (including DC power and signal)	1

**Table 4.5-2: Support equipment**

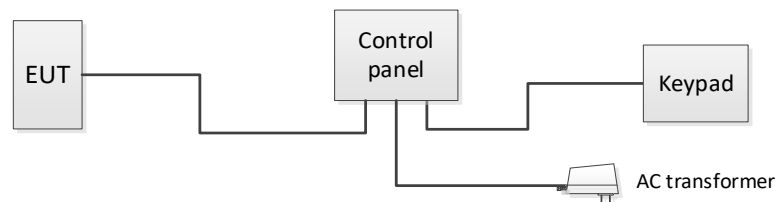
Description	Brand name	Serial number, Part number, Model, Revision level
AC Transformer 16.5VAC, 40VA	DSC	MN: PTD1640U
Control panel	DSC/Tyco	MN: HS2128, Rev. UA621 Rev 03
Keypad	DSC/Tyco	SN: 52115A28, MN: HS2LCD, Rev. UA628 Rev. 03

**Table 4.5-3: Inter-connection cables**

Cable description	From	To	Length (m)
Multi wires cable (including DC power and signal wires)	EUT	DC power / Control panel	> 3
Power cable	AC Transformer	Control panel	< 1
Multi wires cable	Keypad	Control panel	< 1



**Figure 4.5-1: Radiated testing block diagram**



**Figure 4.5-2: Conducted emissions testing block diagram**



## Section 5. Summary of test results

### 5.1 Testing period

Test start date	April 21, 2023	Test end date	April 24, 2023
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### 5.2 Sample information

Receipt date	April 19, 2023	Nemko sample ID number(s)	PRJ00348470001, PRJ00348470002
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### 5.3 FCC test results

**Table 5.3-1: FCC requirements results**

Part	Test description	Verdict
<b>Generic requirements</b>		
\$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(c)	Emission bandwidth	Pass
\$15.215(c)	Frequency stability	Pass
<b>Specific requirements</b>		
\$15.245(b)	Radiated emissions of fundamental and harmonics	Pass
\$15.245(b)(1)	Radiated emissions of harmonics that fall within restricted frequency bands	Pass
\$15.245(b)(3)	Radiated spurious emissions except for harmonics	Pass

Notes: None

### 5.4 ISSED test results

**Table 5.4-1: ISSED requirements results**

Part	Test description	Verdict
<b>Generic requirements</b>		
RSS-Gen, 7.3	Receiver radiated emission limits	Not applicable
RSS-Gen, 7.4	Receiver conducted emission limits	Not applicable
RSS-Gen, 6.9	Operating bands and selection of test frequencies	Pass
RSS-Gen, 8.8	AC powerline conducted emissions limits	Pass
RSS-Gen, 8.11	Frequency stability	Pass
<b>Specific requirements</b>		
Annex F.1(a)	Radiated emissions of fundamental and harmonics	Pass
Annex F.1(b, c)	Radiated emissions of harmonics that fall within restricted frequency bands	Pass
Annex F.1(e)	Radiated spurious emissions except for harmonics	Pass

Notes: <sup>1</sup>According 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.

## 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
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003010	1 year	June 21, 2023
Horn antenna (1–18 GHz)	EMCO	3117	FA002911	1 year	May 11, 2023
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	March 27, 2024
Signal and Spectrum Analyzer	Rhode & Schwarz	FSW43	FA002971	1 year	December 31, 2023
Horn antenna (18–40 GHz)	EMCO	3116B	FA002948	1 year	March 27, 2024
Preamp (18–40 GHz)	None	PA1840	FA003323	1 year	March 27, 2024
Signal and Spectrum Analyzer	Rhode & Schwarz	FSW50	FA003267	1 year	December 8, 2023
Standard gain horn (33–50 GHz)	Mi-Wave	261B-25/383	FA003274	—	NCR
Hamonic mixer (50–75 GHz)	Rohde & Schwarz	FS-Z75	FA003263	3 years	September 24, 2023
Standard gain horn (50–75 GHz)	Mi-Wave	261V-25/385	FA003270	—	NCR
Two-line v-network	Rohde & Schwarz	ENV216	FA002965	1 year	December 31, 2023
50 Ω coax cable	Huber + Suhner	None	FA003402	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	FA003047	1 year	January 18, 2024

Note: NCR - no calibration required

**Table 6.1-2: Automation software details**

Test description	Manufacturer of Software	Details
Radiated/conducted emissions	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 (150 kHz to 30 MHz)	2.96
Radiated disturbance (30 MHz to 1 GHz)	4.27
Radiated disturbance (1 GHz to 6 GHz)	4.74
Radiated disturbance (6 GHz to 18 GHz)	5.04
Radiated spurious emissions (18 GHz – 40 GHz)	4.78
Radiated disturbance (40 GHz to 220 GHz)	5.81

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

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### 7.1 Variation of power source

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#### 7.1.1 References, definitions and limits

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**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.

#### 7.1.2 Test summary

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Verdict	Pass		
Test date	April 21, 2023	Temperature	23 °C
Tested by	Alvin Liu	Air pressure	975 mbar
Test location	Cambridge	Relative humidity	48 %

#### 7.1.3 Observations, settings and special notes

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None

#### 7.1.4 Test data

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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

### 7.2.1 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 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.

### 7.2.2 Test summary

Verdict	Pass		
Test date	April 21, 2023	Temperature	23 °C
Tested by	Alvin Liu	Air pressure	975 mbar
Test location	Cambridge	Relative humidity	48 %

### 7.2.3 Observations, settings and special notes

None

### 7.2.4 Test data

**Table 7.2-2: Test channels selection**

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Operating frequency, MHz
10500	10550	50	10525

Note: EUT is a single frequency transmitter.

## 7.3 Antenna requirement

### 7.3.1 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.

### 7.3.2 Test summary

Verdict	Pass		
Test date	April 21, 2023	Temperature	23 °C
Tested by	Alvin Liu	Air pressure	975 mbar
Test location	Cambridge	Relative humidity	48 %

### 7.3.3 Observations, settings and special notes

None

### 7.3.4 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

**Table 7.3-1:** Antenna information

Antenna type	Manufacturer	Model number	Maximum gain	Connector type
PCB micro strip patch	New Japan Radio Co., Ltd	N/A (integral to module NJR4178)	0 dBi	None

## 7.4 AC power line conducted emissions limits

### 7.4.1 References, definitions and limits

#### 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  $\mu$ H/50  $\Omega$  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 limit, dB $\mu$ 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.

### 7.4.2 Test summary

Verdict	Pass		
Test date	April 24, 2023	Temperature	23 °C
Tested by	Alvin Liu	Air pressure	985 mbar
Test location	Cambridge	Relative humidity	49 %

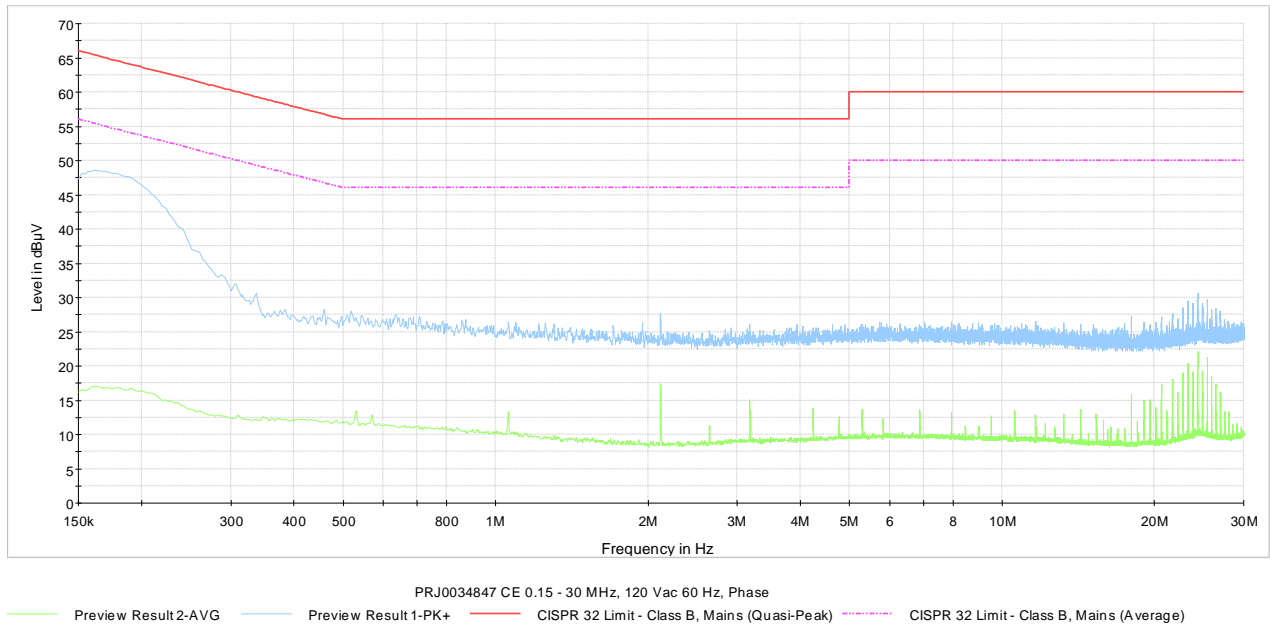
### 7.4.3 Observations, settings and special notes

Port under test – Coupling device	AC mains input of the control panel – Artificial Mains Network (AMN)
EUT power input during test	120 V <sub>AC</sub> , 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"> <li>– The EUT was set up as tabletop configuration per ANSI C63.10-2013 measurement procedure.</li> <li>– 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)</li> <li>– 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.</li> </ul>

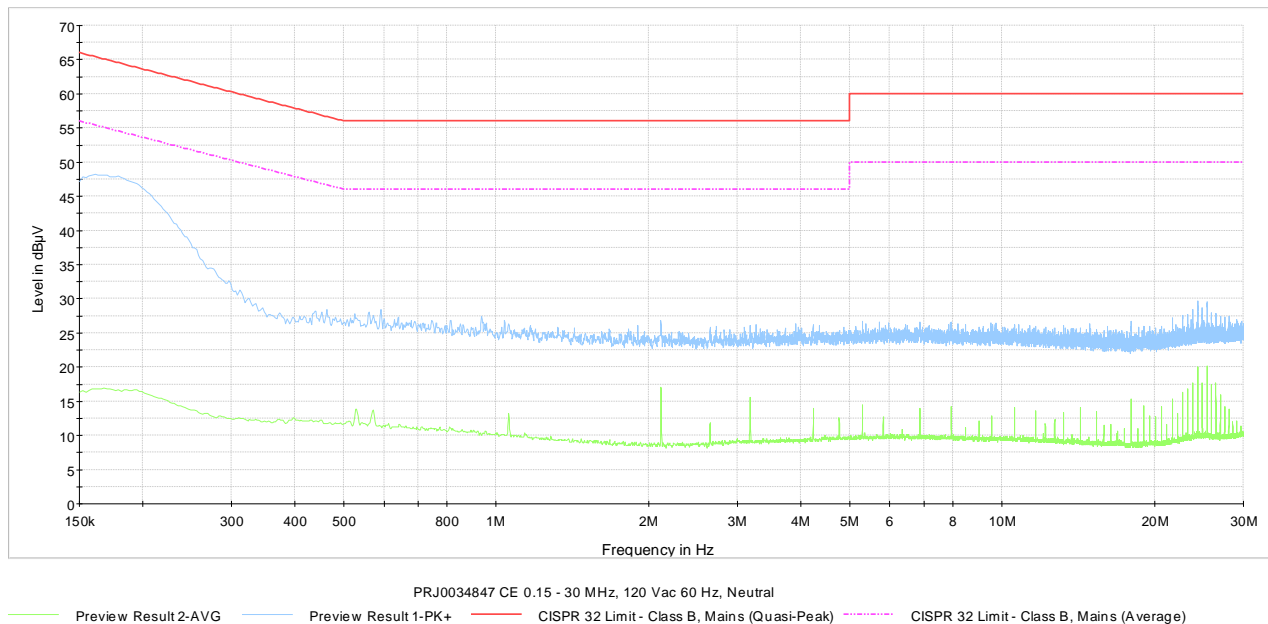
#### Receiver settings:

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)

#### 7.4.4 Test data



**Plot 7.4-1:** Conducted emissions on phase line



**Plot 7.4-2:** Conducted emissions on neutral line



## 7.5 Field strength of emissions

### 7.5.1 References, definitions and limits

#### FCC §15.245:

- (b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following table.
- (1) Regardless of the limits shown in the following table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:
  - (i) For the second and third harmonics of field disturbance sensors operating in the 24075–24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.
  - (ii) For all other field disturbance sensors, 7.5 mV/m.
- (2) Field strength limits are specified at a distance of 3 meters.
- (3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
- (4) The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply.

#### ANSI C63.10, Clause 4.1.4.2:

Specific detector functions and bandwidths for unlicensed wireless device measurements

##### 4.1.4.2.1 Frequencies less than or equal to 1000 MHz

At any frequency or frequencies less than or equal to 1000 MHz, measurements shall be made with the CISPR quasi-peak detector and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector are given in CISPR 16-1-1:2010. Where average limits are specified, an average detector shall be used. Where peak limits are also specified, the peak emission shall also be measured with instrumentation properly adjusted for factors, such as pulse desensitization. As an alternative to CISPR quasi-peak measurements or average measurements, a test laboratory may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long as the equivalent or greater bandwidths as indicated for CISPR quasi-peak measurements or average measurements, as applicable, are employed.

Pulse-modulated devices with a pulse repetition frequency of 20 Hz or less have additional requirements.

##### 4.1.4.2.2 Frequencies above 1000 MHz

Unless otherwise stated, on any frequency or frequencies above 1000 MHz, measurements shall be made with measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. Peak measurements can apply to the total peak emission level radiated by the device (i.e., the total peak power level) depending on the applicable regulatory requirement. Note that the use of a pulse desensitization correction factor might be needed to determine the total peak emission level.

#### RSS-210 Annex F.1:

- a. The average field strength of fundamental and harmonic emissions measured at 3 m shall not exceed the limits shown in table
- b. Additionally, harmonic emissions falling into restricted frequency bands listed in RSS-Gen and that are below 17.7 GHz shall meet the general field strength limits specified in RSS-Gen, regardless of the limits given in table below.
- c. Harmonic emissions falling into restricted frequency bands listed in RSS-Gen and that are at or above 17.7 GHz shall not exceed the following field strength limits measured at a distance of 3 m:
  - c. i. 25 mV/m for the second and third harmonic emissions of field disturbance sensors operating in the band 24075–24175 MHz and for devices designed for use only within buildings or for intermittent use, such as to open building doors
  - c. ii. 7.5 mV/m for all other devices
- e. Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

**Table 7.5-1: Field strength limits**

Fundamental frequency, MHz	Average Field strength of fundamental,		Average Field strength of spurious emissions,	
	mV/m	dBμV/m	mV/m	dBμV/m
902–928	500	114	1.6	64
2435–2465	500	114	1.6	64
5785–5815	500	114	1.6	64
10500–10550	2500	128	25	88
24075–24175	2500	128	25	88

References, definitions and limits, continued

**Table 7.5-2: 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			

**Table 7.5-3: ISED restricted frequency bands**

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677–5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Notes: Certain frequency bands listed in this table and above 38.6 GHz are designated for low-power license-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this standard

**Table 7.5-4: 15.209 and RSS-Gen emissions field strength limits**

Frequency MHz	Field strength of emissions		Measurement distance
	μV/m	dBμV/m	m
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.

## 7.5.2 Test summary

Verdict	Pass		
Test date	April 21, 2023	Temperature	23 °C
Tested by	Alvin Liu	Air pressure	975 mbar
Test location	Cambridge	Relative humidity	48 %

## 7.5.3 Observations, settings and special notes

- The spectral plots within this section are a summation of vertical and horizontal scans. The spectral plots within this section have been corrected with all relevant transducer factors.
- The spectrum was searched from 30 MHz to the 5<sup>th</sup> harmonic.
- Radiated measurements were performed at a distance of 3 m below 18 GHz, from 18 GHz to 40 GHz at 0.3 m, and above 40 GHz at 0.1 m.
- Average was calculated from peak results using duty cycle correction factor (DCCF),  
Pulse width = 0.0122 ms, Pulse repetition = 100 pulses within 10 ms, DCCF =  $20 \times \text{Log}_{10} ((0.0122 \times 100) / 10) = -18.3 \text{ dB}$

Spectrum analyser settings for radiated measurements below 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak or Quasi-peak
Trace mode	Max Hold

Spectrum analyser settings for radiated measurements above 1 GHz:

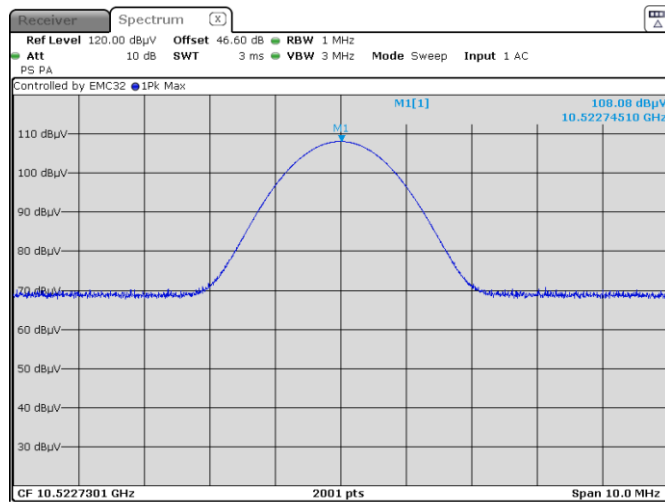
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz (for Peak); 10 Hz (for Average)
Detector mode	Peak
Trace mode	Max Hold

## 7.5.4 Test data

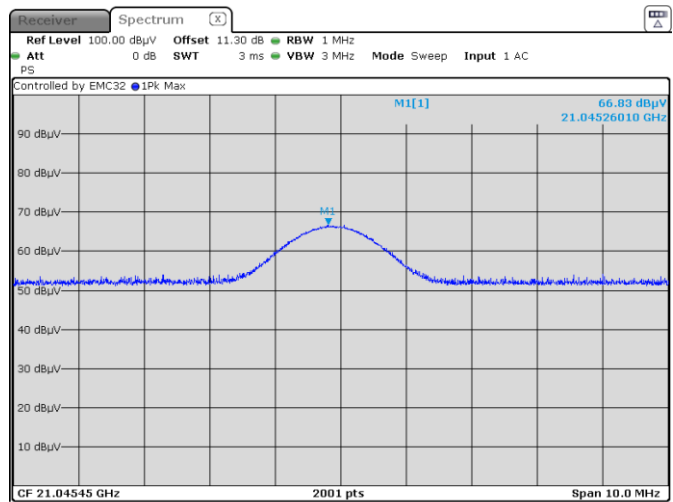
**Table 7.5-5: Radiated field strength measurement results**

Frequency, GHz	Peak field strength, dB $\mu$ V/m	Peak limit, dB $\mu$ V/m	Margin, dB	Duty cycle factor, dB	Average field strength, dB $\mu$ V/m	Average limit, dB $\mu$ V/m	Margin, dB
10.523	108.1	148.0	39.9	-18.3	89.8	128.0	38.2
21.045	66.8	108.0	41.2	-18.3	48.5	88.0	39.5
31.568	79.9	108.0	28.1	-18.3	61.6	88.0	26.4
10.500	63.8	74.0	10.2	-18.3	45.5	54.0	8.5
10.550	62.6	74.0	11.4	-18.3	44.3	54.0	9.7

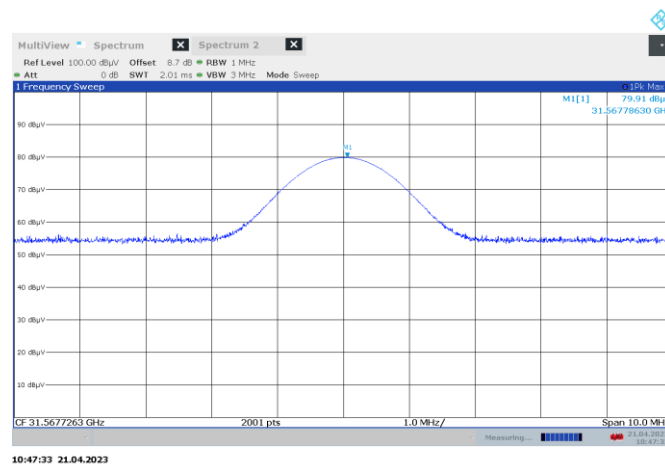
Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.



**Figure 7.5-1: Field strength of fundamental emission**



**Figure 7.5-2: Field strength of 2<sup>nd</sup> harmonic emission**



**Figure 7.5-3: Field strength of 3<sup>rd</sup> harmonic emission**

## Test data, continued

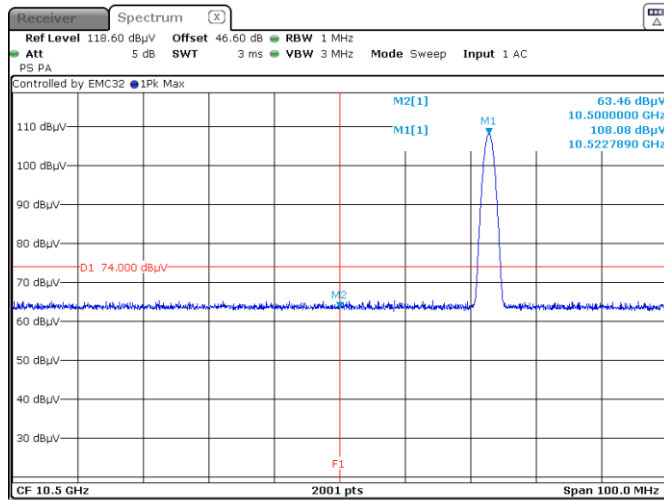


Figure 7.5-4: Field strength of emission at lower bandedge

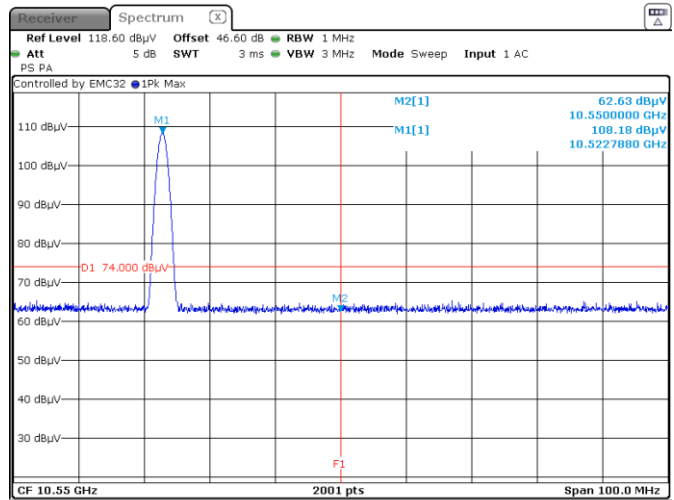


Figure 7.5-5: Field strength of emission at upper bandedge

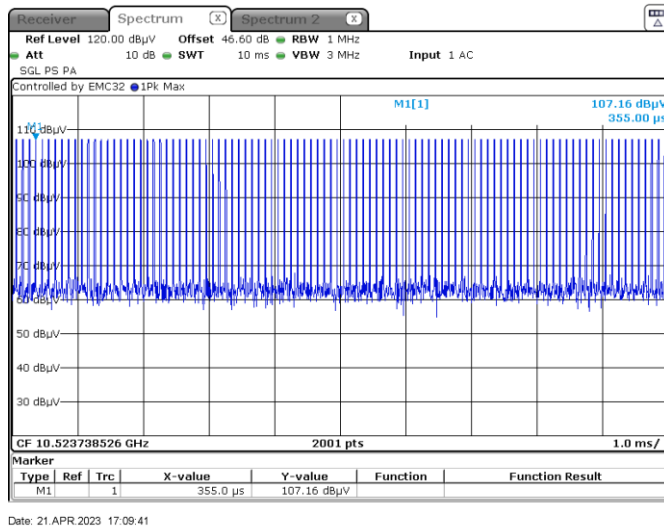


Figure 7.5-6: Pulse numbers per 10 ms

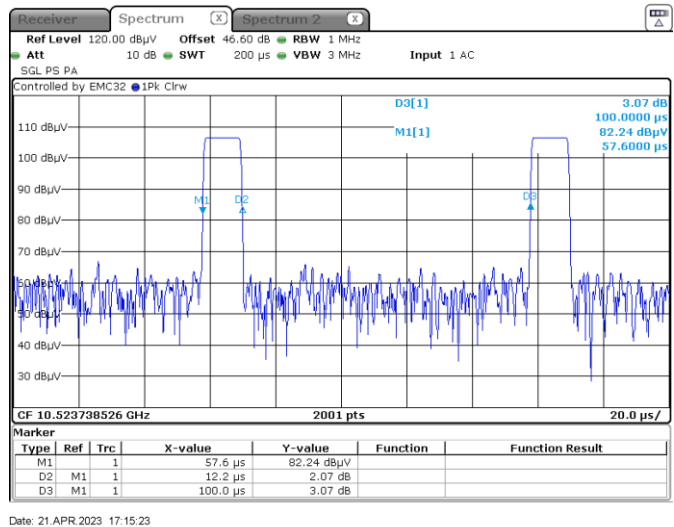
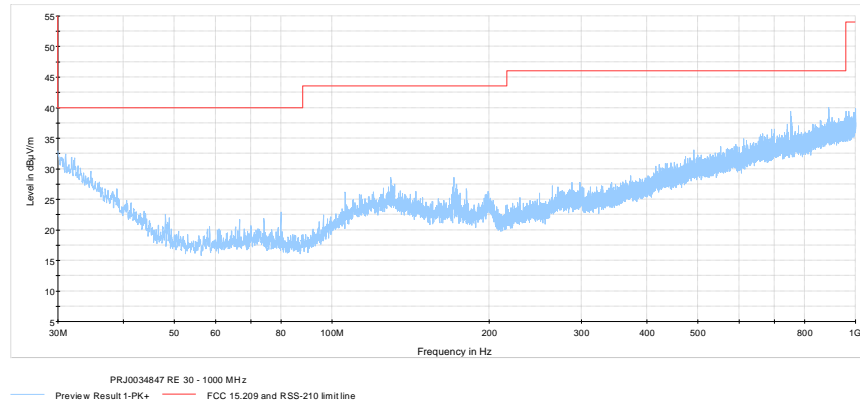
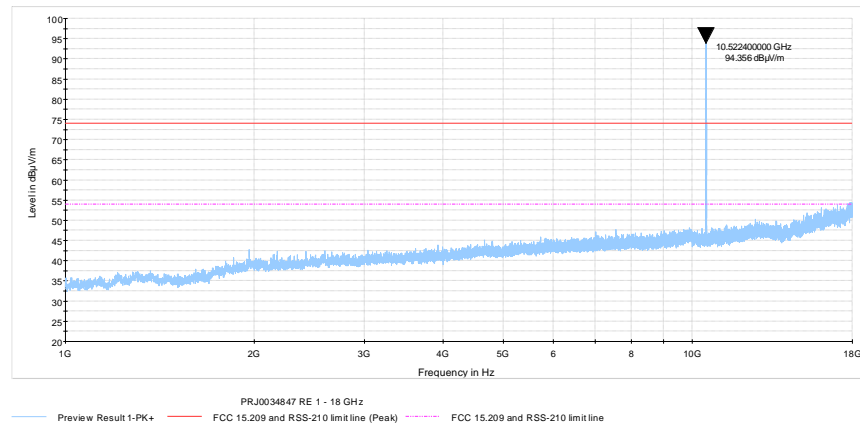


Figure 7.5-7: Pulse width

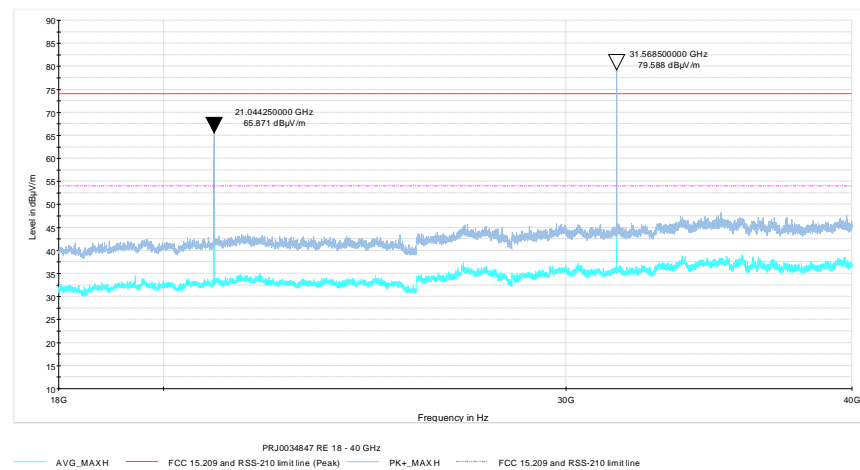
Test data, continued



**Figure 7-5-8:** Field strength of spurious emissions 30–1000 MHz

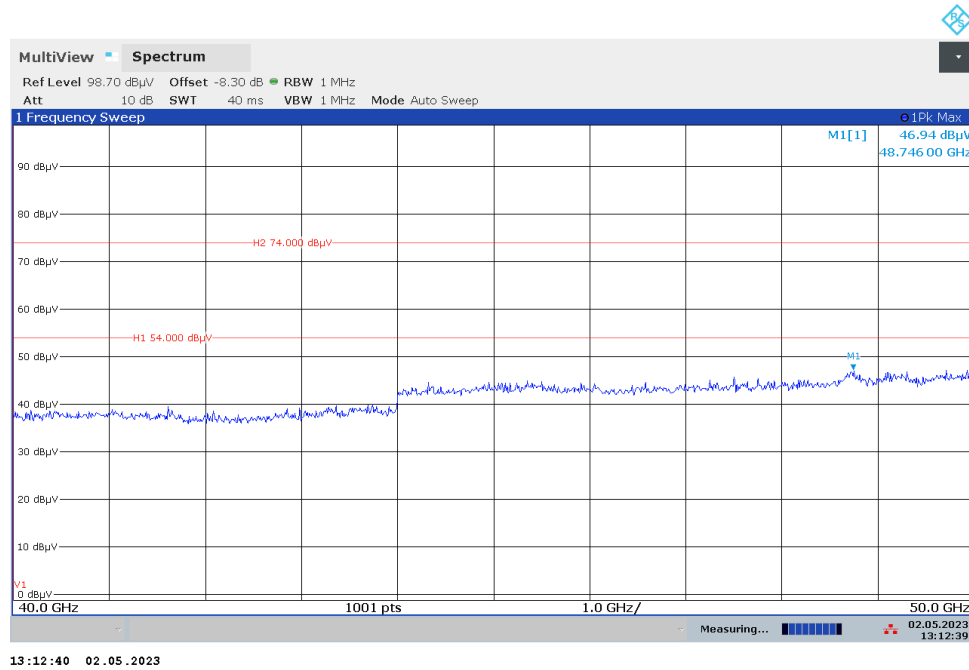


**Figure 7-5-9:** Field strength of spurious emissions within 1–18 GHz

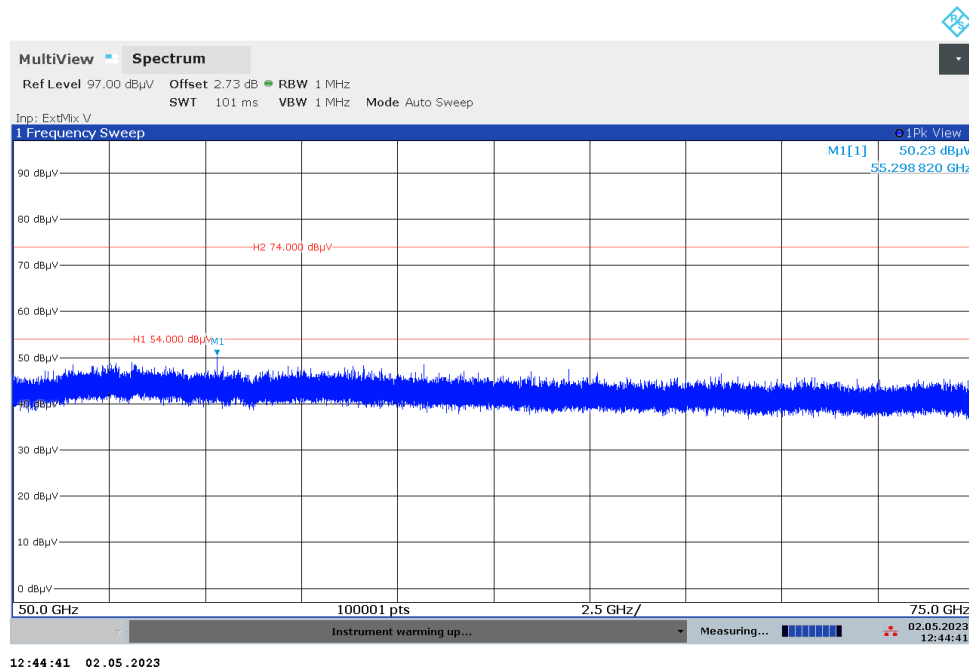


**Figure 7-5-10:** Field strength of spurious emissions within 18–40 GHz

Test data, continued



**Figure 7.5-11:** Field strength of spurious emissions within 40-50 GHz



**Figure 7.5-12:** Field strength of spurious emissions within 50-75 GHz

## 7.6 Emission bandwidth and frequency stability

### 7.6.1 References, definitions and limits

#### FCC §15.215:

- (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.
- If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

#### RSS-Gen, Clause 6.7:

Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

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).

#### RSS-Gen, Clause 8.11:

Frequency stability

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation.

**Table 7.6-1: Frequency stability limit**

Fundamental frequency band, MHz	Central 80% of permitted operating frequency band, MHz
902–928	904.6–925.4
2435–2465	2438–2462
5785–5815	5788–5812
10500–10550	10505–10545
24075–24175	24085–24165

### 7.6.2 Test summary

Verdict	Pass		
Test date	April 21, 2023	Temperature	23 °C
Tested by	Alvin Liu	Air pressure	975 mbar
Test location	Cambridge	Relative humidity	48 %

### 7.6.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission bandwidth
Video bandwidth	≥ 3 × RBW
Frequency span	Wider than emission bandwidth
Detector mode	Peak



## 7.6.4 Test data

**Table 7.6-2: Occupied bandwidth measurement result**

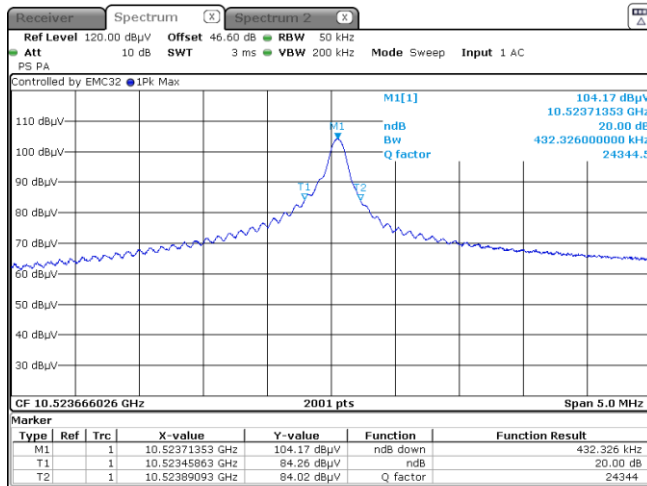
Frequency, GHz	20 dB BW, MHz	99% BW, MHz
10.524	0.432	1.154

**Table 7.6-3: FCC occupied bandwidth limitations**

Fundamental frequency, MHz	Lower -20 dBc frequency cross, MHz	Lower limit, MHz	Margin, MHz	Upper -20 dBc frequency cross, MHz	Upper limit, MHz	Margin, MHz
10523.714	10523.459	10505.000	18.459	10523.891	10545.000	21.109

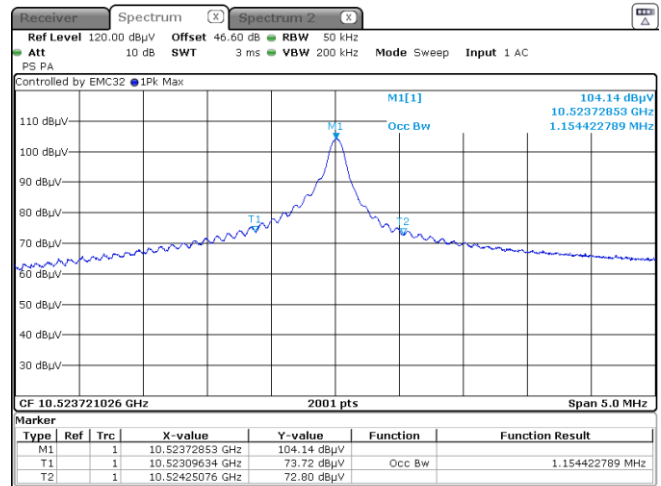
**Table 7.6-4: ISED occupied bandwidth limitations**

Fundamental frequency, MHz	Lower 99% BW frequency cross, MHz	Lower limit, MHz	Margin, MHz	Upper 99% BW frequency cross, MHz	Upper limit, MHz	Margin, MHz
10523.729	10523.096	10505.000	18.096	10524.251	10545.000	20.749



Date: 21 APR 2023 17:02:22

**Figure 7.6-1: 20 dB occupied bandwidth**

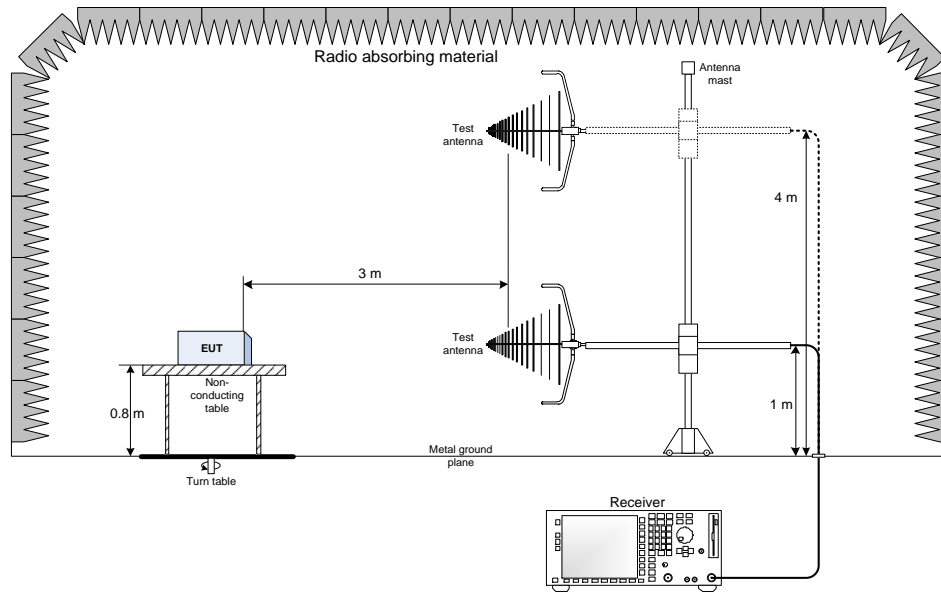


Date: 21 APR 2023 17:06:07

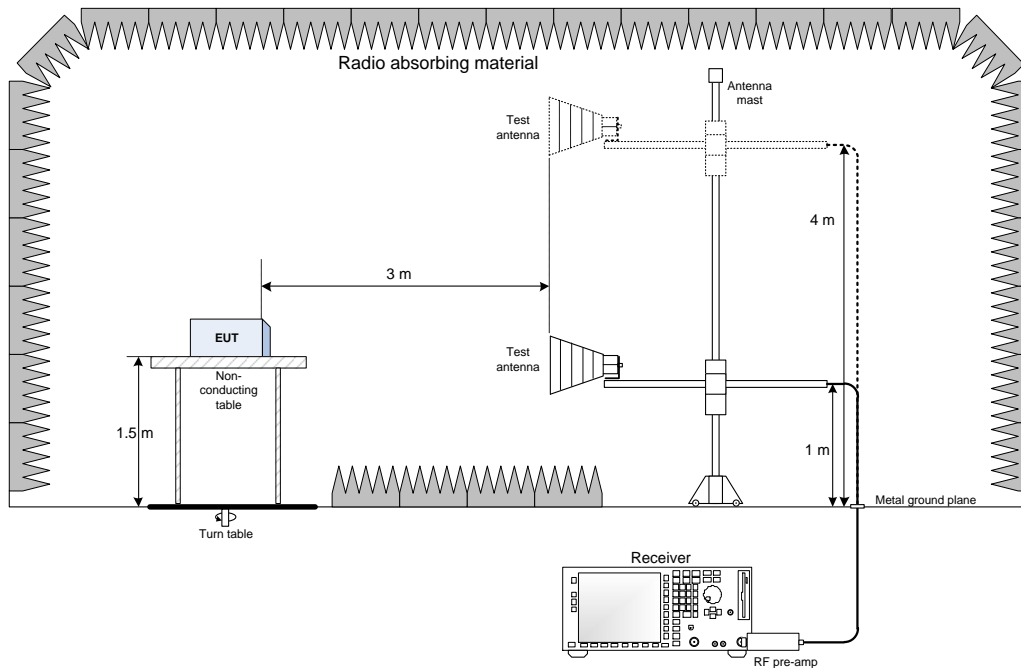
**Figure 7.6-2: 99 % occupied bandwidth**

## Section 8. Block diagrams of test set-ups

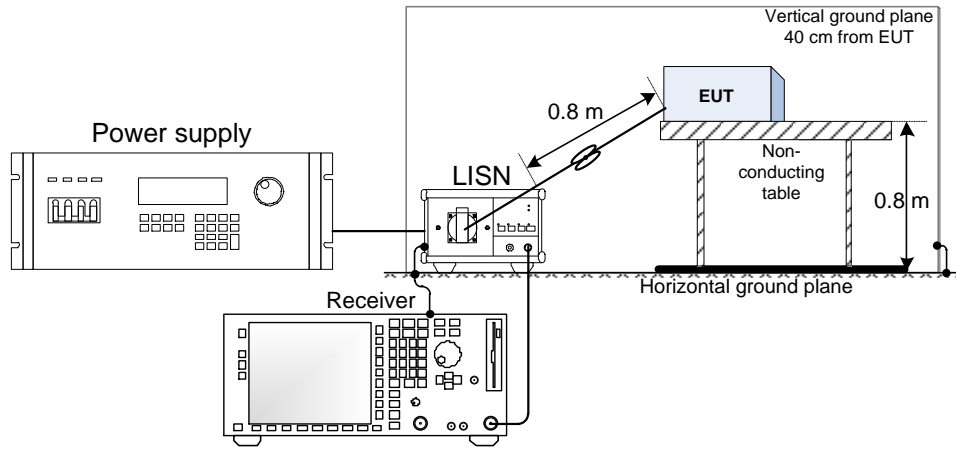
### 8.1 Radiated emissions set-up for frequencies below 1 GHz



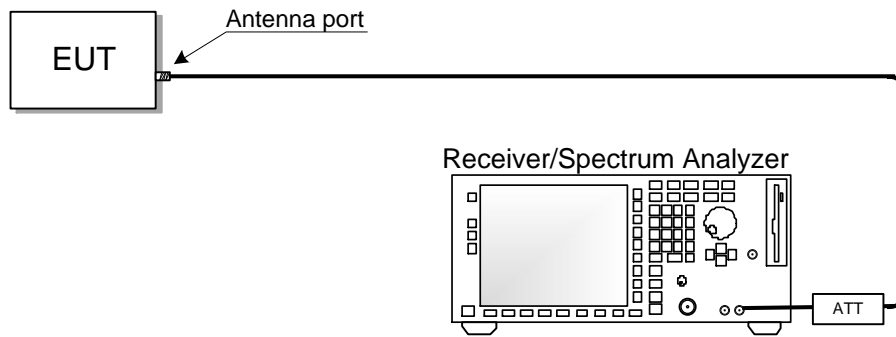
### 8.2 Radiated emissions set-up for frequencies above 1 GHz



### 8.3 Conducted emissions set-up



### 8.4 Antenna port set-up



End of the test report