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RADIO TEST REPORT

Report ID
REP004253

Project ID
PRJ0025795

Type of assessment:
Final product testing / New product certification

Applicant:
Bosch Security Systems, Inc.

Product:
Professional Series Detectors Curtain

Model numbers (USA):
ISC-PDL1-WAC30G
ISC-PDL1-WC30G

HVIN (Canada):
ISC-PDL1-WC30G

FCC ID:
T3X-WAC30GK

ISED certification number:
1249A-WAC30GK

Specifications:

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

Date of issue: January 17, 2023

Alvin Liu, EMC/RF Specialist

Signature

Fahar Abdul Sukkoor, EMC/RF Specialist
Reviewed by

Signature

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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.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Test specifications

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

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

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.
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

Table 1.5-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
REP004253	January 17, 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 Model variant declaration

As declared by the applicant, the EUT model ISC-PDL1-WAC30G has been chosen to be representative for other models in the model family. The model family includes ISC-PDL1-WAC30G and ISC-PDL1-WC30G, and the description of the variations are as follows:

ISC-PDL1-WC30G is a 30m PIR/microwave curtain detector, ISC-PDL1-WAC30G is a 30m PIR/microwave curtain detector with Anti-Mask feature.
Both detectors, AM and non-AM, PCBs are identical as is the main PCB however the AM detector unit will have components populated on the main PCB for the AM function.
SW version numbers for ISC-PDL1-WC30G and ISC-PDL1-WAC30G are tracked differently. Current version of ISC-PDL1-WC30G is v6.00 and ISC-PDL1-WAC30G has v2.00.
The transmitter is identical between the two models.

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 ±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, ±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	Bosch Security Systems
Applicant address	130 Perinton Parkway, Fairport, NY, USA 14450
Manufacturer name	Same as applicant
Manufacturer address	Same as applicant

5.3 EUT information

Product description	Professional Series Detectors Curtain
Model(s) / HVIN(s)	ISC-PDL1-WAC30G
Model variant(s)	ISC-PDL1-WC30G
Serial number	042167323706100007, 042167323706100003, 042167323706100004
Power supply requirements	9 – 15 V_{DC} (via a Panel with battery backup and direct plug-in AC transformer)
Product description and theory of operation	The device is a 30m PIR/microwave curtain detector with Anti-Mask feature, microwave is in 10.5 – 10.55 GHz range.

5.4 Radio technical information

Allocated frequency band	10.500 – 10.550 GHz
Operating frequency range	10.500 – 10.525 GHz
Field strength, dBµV/m @ 3 m	111.66 (peak)
Measured BW (kHz), 99% OBW	2078.96
Type of modulation	Pulse modulated
Emission classification	P0N
Transmitter spurious, dBµV/m @ 3 m	85.9 (peak) at 31.528 GHz
Antenna information	Integral PCB patch antenna made by Bosch, gain 8.5 dBi

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	EUT operated in standard transceiver mode as for the customer use. Firmware is v2.0
Transmitter state	The transmitter set into continuous Tx mode with regular duty cycle.

5.5.2 EUT test configuration

Table 5.5-1: *EUT interface ports*

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

Table 5.5-2: *Support equipment*

Description	Brand name	Serial number, Part number, Model, Revision level
Panel with battery backup	BOSCH	SN: 092064603952341411, MN: B6512,
AC Transformer INPUT: 120VAC 60Hz 30VA OUTPUT: 18VAC 1.22A 22VA	TDCpower	MN: DA-22-18

Table 5.5-3: *Inter-connection cables*

Cable description	From	To	Length (m)
Multi wires cable (including DC power and signal wires)	EUT	Panel	< 3
AC cable	Panel	AC Transformer	< 3

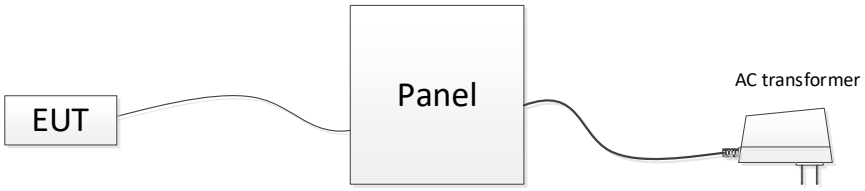


Figure 5.5-1: *Block diagram*

Section 6. Summary of test results

6.1 Testing location

Test location (s)	Cambridge

6.2 Testing period

Test start date	May 9, 2022	Test end date	June 17, 2022
Test start date	December 12, 2022	Test end date	December 16, 2022

6.3 Sample information

Receipt date	May 6, 2022	Nemko sample ID number(s)	4639160001 (SN 042167323706100004)
Receipt date	December 9, 2022	Nemko sample ID number(s)	3 (SN 042167323706100007), 4 (SN 042167323706100003)

6.4 FCC test results

Table 6.4-1: *FCC requirements results*

Part	Test description	Verdict
Generic requirements		
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass
§15.207(a)	Conducted limits	Pass
§15.215(c)	Emission bandwidth	Pass
§15.215(c)	Frequency stability	Pass
Specific requirements		
§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

6.5 ISED test results

Table 6.5-1: *ISED requirements results*

Part	Test description	Verdict
Generic requirements		
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
Specific requirements		
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: 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	February 7, 2023
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	December 31, 2023
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003009	1 year	January 31, 2023
Horn antenna (1–18 GHz)	EMCO	3115	FA000649	1 year	January 26, 2023
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	March 30, 2023
Horn antenna (18–40 GHz)	EMCO	3116B	FA002948	1 year	January 23, 2023
Preamp (18–40 GHz)	None	None	FA003323	1 year	March 30, 2023
Signal and Spectrum Analyzer	Rhode & Schwarz	FSW43	FA002971	1 year	December 31, 2023
Spectrum analyzer	Rohde & Schwarz	FSP	FA001920	1 year	December 31, 2023
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
Temperature humidity test chamber	LIK	LKPTH-100E	00185	—	VOU
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
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	July 13, 2023
50 Ω coax cable	Huber + Suhner	None	FA003043	1 year	July 13, 2023

Note: NCR - no calibration required, VOU - verify on use

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	December 13, 2022

8.1.3 Observations, settings and special notes

None

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	December 13, 2022

8.2.3 Observations, settings and special notes

None

8.2.4 Test data

Table 8.2-2: *Test frequency selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low Frequency, MHz	Mid Frequency, MHz	High Frequency, MHz
10500	10525	25	10508.06	10515.00	10521.20

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	December 13, 2022

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

Table 8.3-1: *Antenna information*

Antenna type	Manufacturer	Model number	Maximum gain	Connector type
Integral PCB patch	Bosch	NA	8.5 dBi	None

8.4 AC power line conducted emissions limits

8.4.1 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 µH/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 8.4-1: *Conducted emissions limit*

	Conducted limit, dBµV	
Frequency of emission, MHz	**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.

8.4.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	December 12, 2022

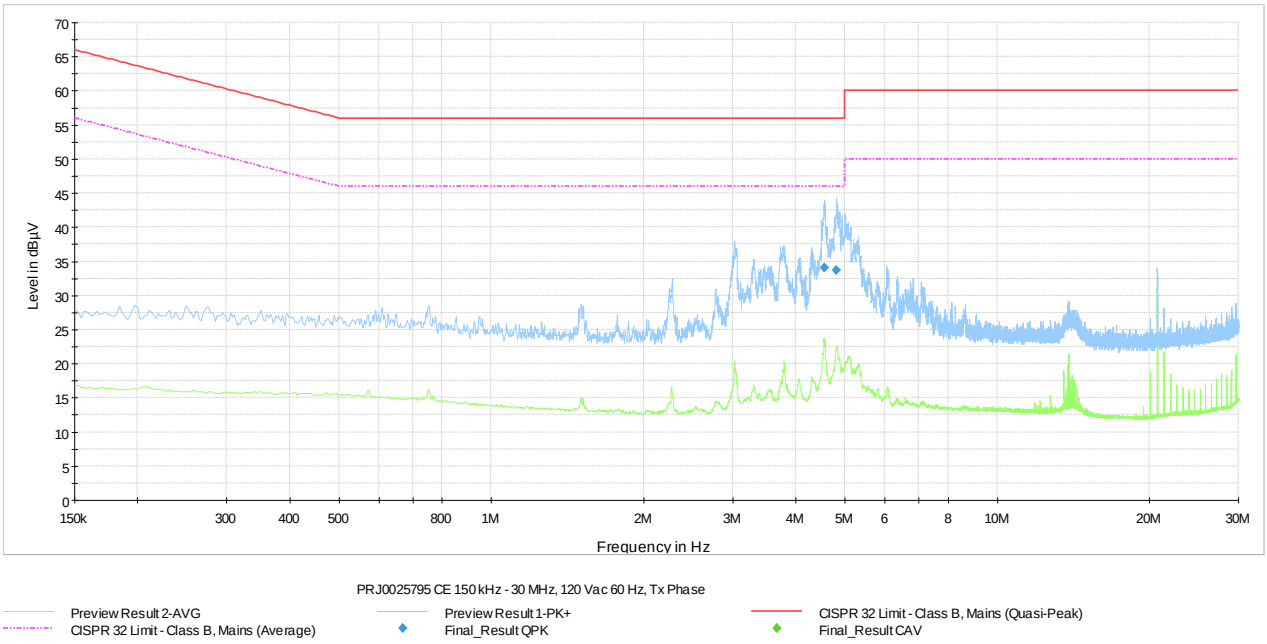
8.4.3 Observations, settings and special notes

Port under test – Coupling device	AC mains input of panel – 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:	– 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.

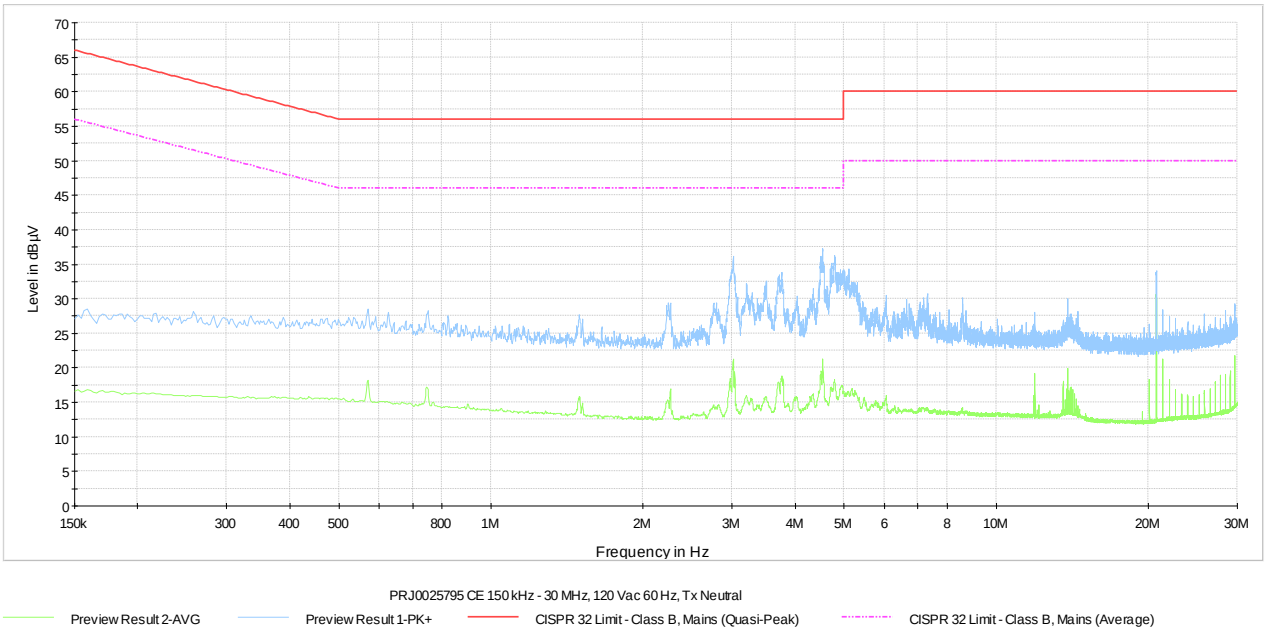
Receiver settings:

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)

8.4.4 Test data



Plot 8.4-1: *Conducted emissions on phase line*



Plot 8.4-2: *Conducted emissions on neutral line*

8.5 Field strength of emissions

8.5.1 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.

(b)(1) Regardless of the limits shown in the above 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:

(b)(1)(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.

(iii) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075-24175 MHz band, fully comply with the limits given in §15.209. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as forklifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

(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.

ANSI C63.10, Clause 6.3

Radiated emissions testing—common requirements

6.3.3 Radiated total peak emission level

Some wireless devices are subject to a peak limit based on the total peak emission level (i.e., rather than being based on a peak level over a specified bandwidth). Unless otherwise specified, radiated measurements of the fundamental-signal peak field strength shall be made using instrumentation with a bandwidth equal to or greater than the 6 dB bandwidth of the emission. For unlicensed wireless devices with fundamental signals subject to quasi-peak (QP) limits, when the QP detector bandwidth is less than the 6 dB bandwidth of the emission, a peak detector with a bandwidth equal to or greater than the 6 dB bandwidth of the emission shall be used.

References, definitions and limits, continued

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
ii. 7.5 mV/m for all other devices
d. Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation, unless their emissions in the restricted frequency bands as listed in RSS-Gen, other than the second and third harmonic emissions from devices operating in the band 24075–24175 MHz, comply with the general field strength limits specified in RSS-Gen.
Continuous operation of field disturbance sensors designed to be used in farm equipment (i.e. forklifts that are intended primarily for use indoors or for very specialized operations), or railroad locomotives, railroad cars, and other equipment that travel on fixed tracks, is permitted. A field disturbance sensor is considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g. putting a vehicle into reverse gear, activating a turn signal).
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 8.5-1: *Field strength limits*

Fundamental frequency, MHz	Average Field strength of fundamental		Average Field strength of harmonic 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

Table 8.5-2: *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			

References, definitions and limits, continued

Table 8.5-3: *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 8.5-4: *15.209 and RSS-Gen emissions field strength limits*

Frequency	Field strength of emissions		Measurement distance
MHz	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. *F* is in kHz. 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

8.5.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu and Moustapha	Test date	May 9, 2022 and May 18, 2022
Tested by	Alvin Liu	Test date	December 13, 2022

8.5.3 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 5th harmonic.
- Radiated measurements were performed at a distance of 3 m below 18 GHz, from 18 GHz to 40 GHz at 1 m, and from 40 GHz to 60 GHz at 0.3 m
- Above 26 GHz, spurious emissions and harmonics were either not detected or were more than 20 dB below the applicable limit, so they were not reported as per ANSI C63.10 Section 6.6.4.3
- Average was calculated from peak results using duty cycle correction factor (DCCF),
  Pulse width = 0.018 ms, Pulse repetition = 85 pulses within 100 ms, DCCF = 20 × Log10 ((0.018 × 85) / 100) = −36.3 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
Detector mode	Peak
Trace mode	Max Hold

8.5.4 Test data

Table 8.5-5: *Radiated field strength measurement results – Low Fundamental Frequency*

Frequency, GHz	Peak field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Duty cycle factor, dB	Average field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
10.509	111.7	148.0	36.3	−36.3	75.4	128	52.6
21.019	72.8	108.0	35.2	−36.3	36.5	88	51.5
31.528	85.9	108.0	22.1	−36.3	49.6	88	38.4
10.500	70.6	74.0	3.4	−36.3	34.3	54	19.7

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

Table 8.5-6: *Radiated field strength measurement results – Mid Fundamental Frequency*

Frequency, GHz	Peak field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Duty cycle factor, dB	Average field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
10.515	111.2	148.0	36.8	−36.3	74.9	128	53.1
21.029	70.7	108.0	37.3	−36.3	34.4	88	53.6
31.543	76.8	108.0	31.2	−36.3	40.5	88	47.5

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

Table 8.5-7: *Radiated field strength measurement results – High Fundamental Frequency*

Frequency, GHz	Peak field strength, dBµV/m	Peak limit, dBµV/m	Margin, dB	Duty cycle factor, dB	Average field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
10.522	111.5	148.0	36.5	−36.3	75.2	128	52.8
21.045	69.3	108.0	38.7	−36.3	33.0	88	55.0
31.567	82.4	108.0	25.6	−36.3	46.1	88	41.9
10.550	71.6	74.0	2.4	−36.3	35.3	54	18.7

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

Test data, continued

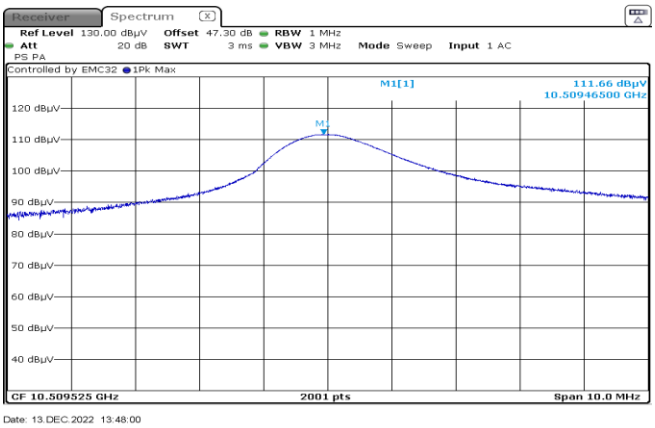


Figure 8.5-1: *Field strength of fundamental emission – Low Fundamental Frequency*

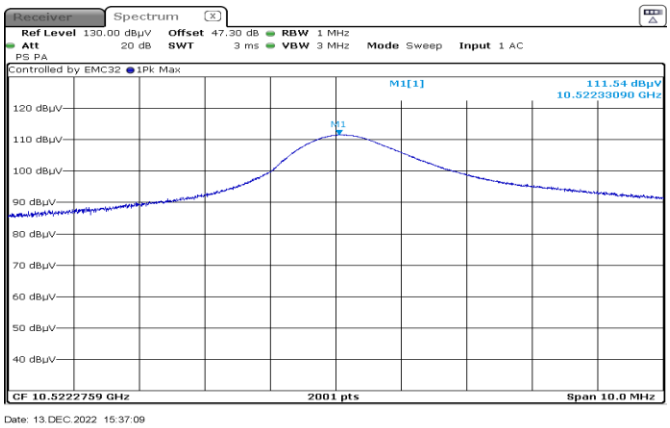


Figure 8.5-2: *Field strength of fundamental emission – High Fundamental Frequency*

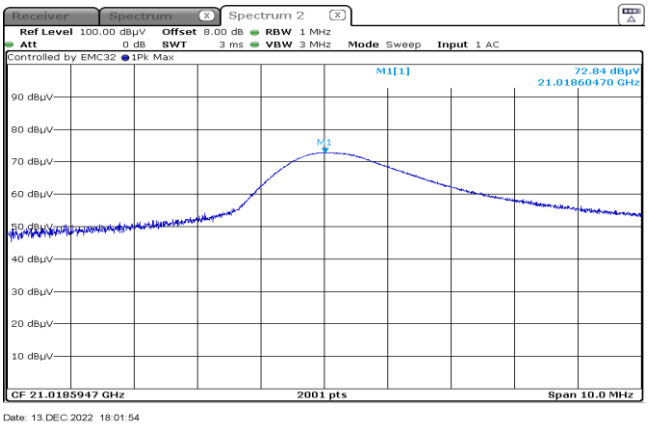


Figure 8.5-3: *Field strength of 2nd harmonic emission – Low Fundamental Frequency*

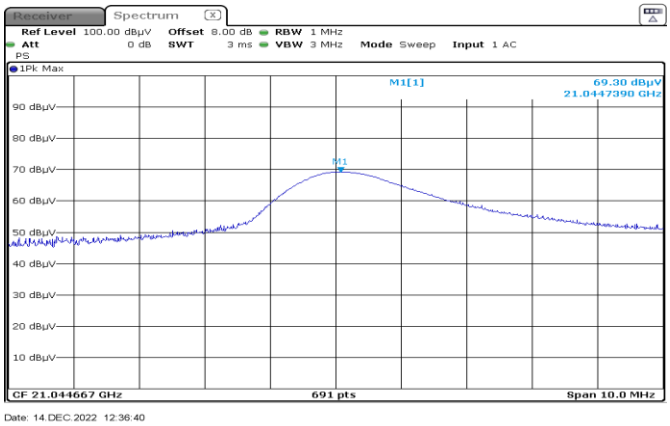


Figure 8.5-4: *Field strength of 2nd harmonic emission – High Fundamental Frequency*

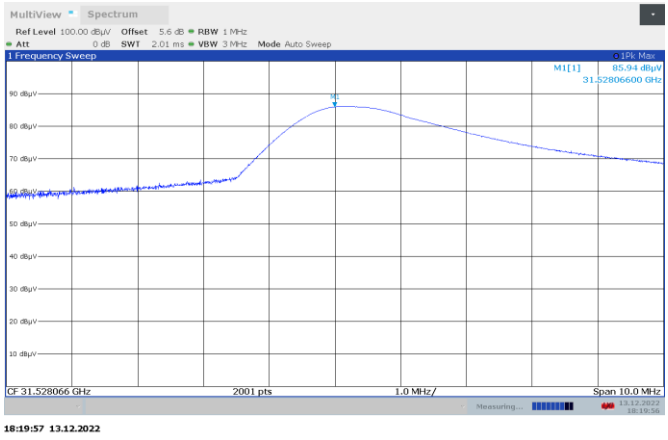


Figure 8.5-5: *Field strength of 3rd harmonic emission – Low Fundamental Frequency*

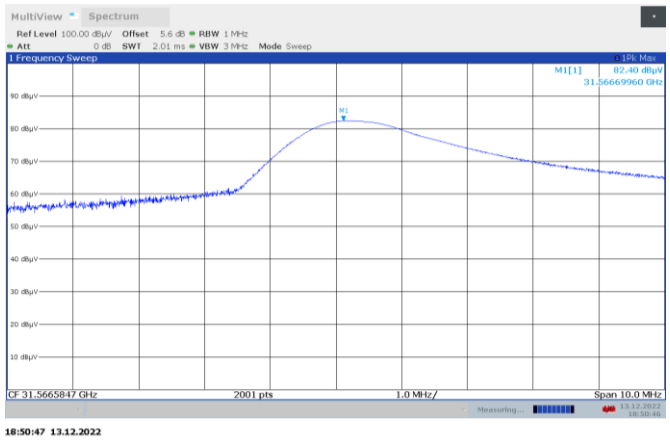


Figure 8.5-6: *Field strength of 3rd harmonic emission – High Fundamental Frequency*

Test data, continued

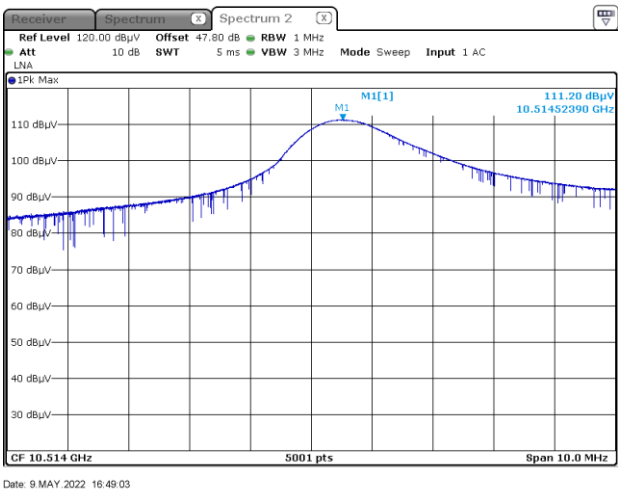


Figure 8.5-7: *Field strength of fundamental emission – Mid Fundamental Frequency*

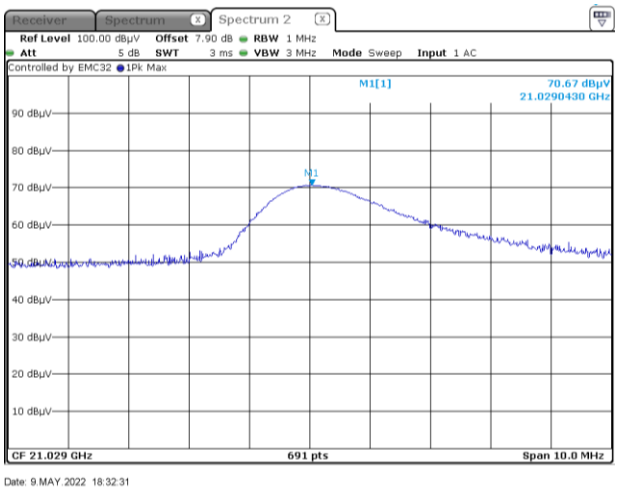


Figure 8.5-8: *Field strength of 2nd harmonic emission – Mid Fundamental Frequency*

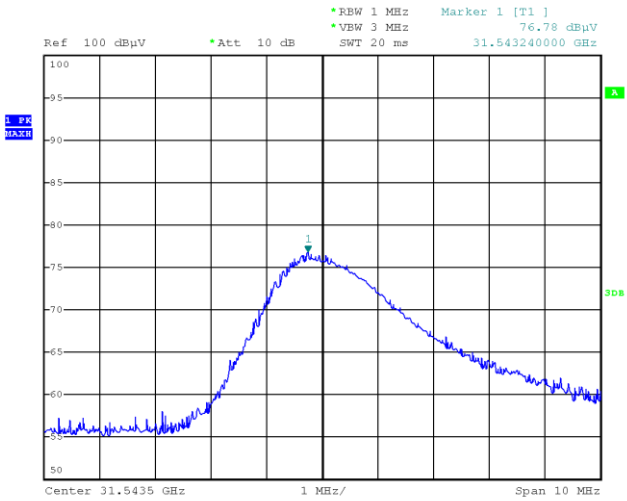


Figure 8.5-9: *Field strength of 3rd harmonic emission – Mid Fundamental Frequency*

Test data, continued

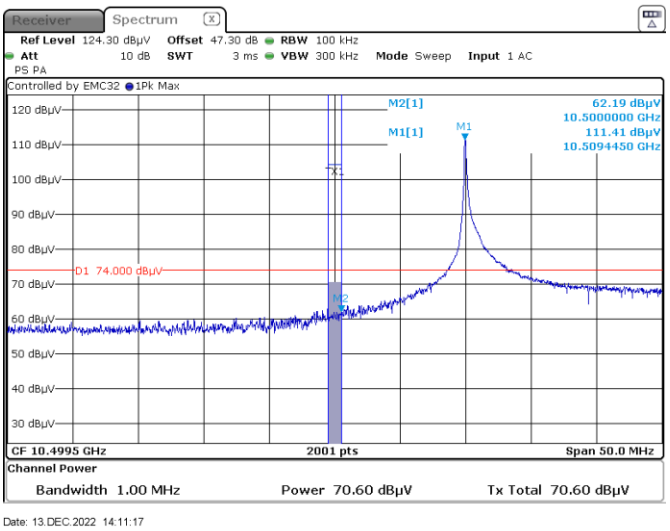


Figure 8.5-10: *Field strength of lower bandedge emission*

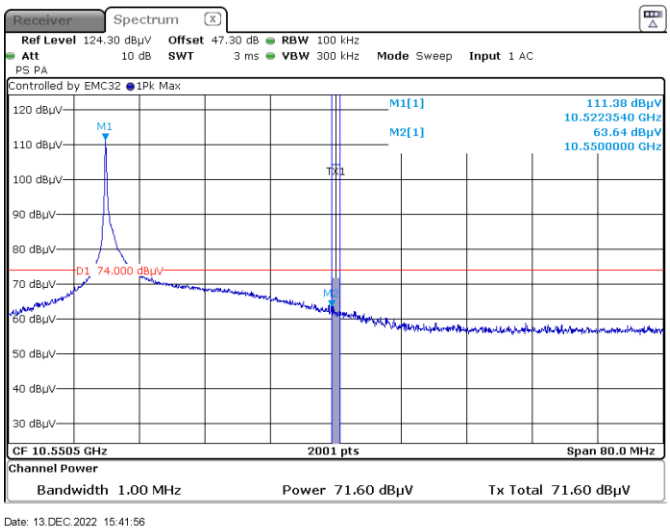


Figure 8.5-11: *Field strength of upper bandedge emission*

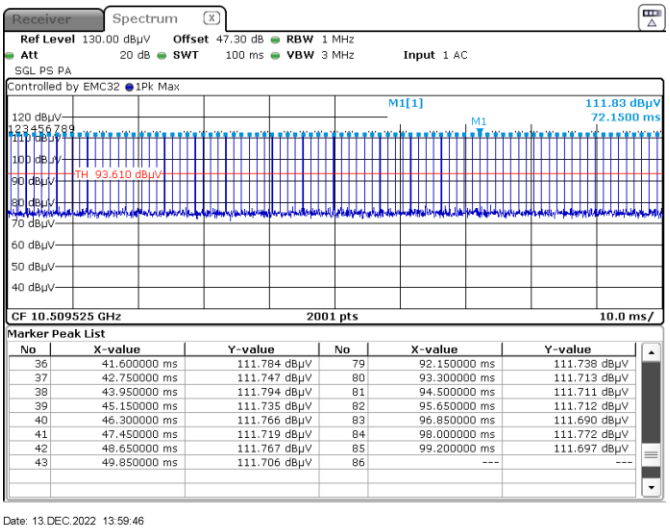


Figure 8.5-12: *Pulse numbers per 100 ms*

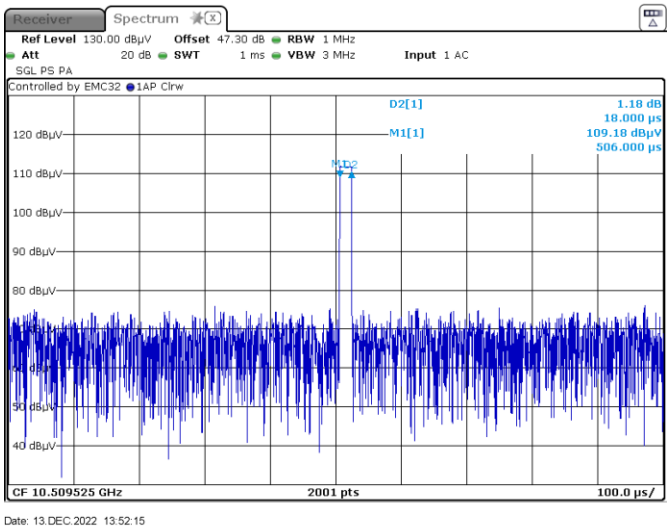


Figure 8.5-13: *Pulse width*

Test data, continued

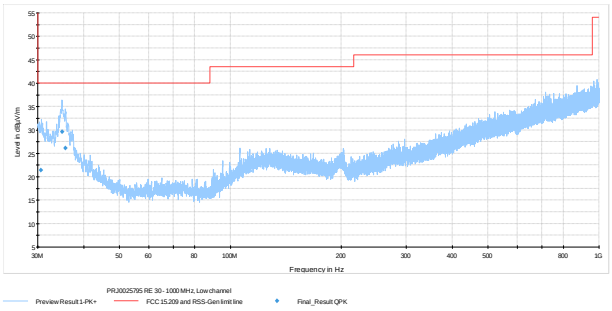


Figure 8.5-14: *Field strength of spurious emissions 30–1000 MHz – Low Fundamental Frequency*

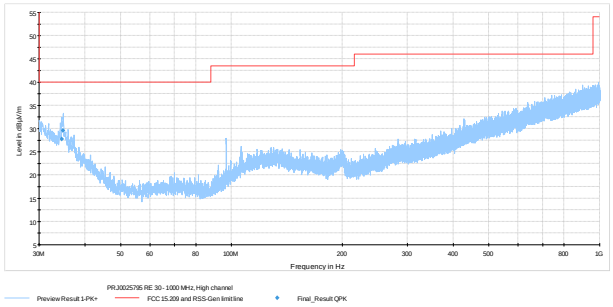


Figure 8.5-15: *Field strength of spurious emissions 30–1000 MHz – High Fundamental Frequency*

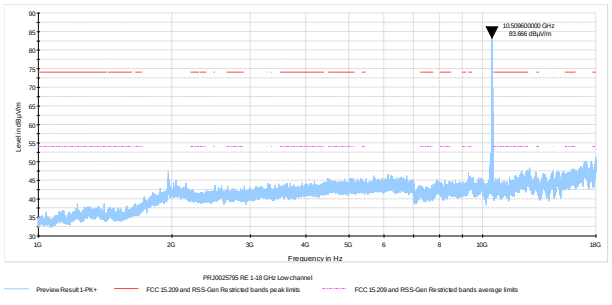


Figure 8.5-16: *Field strength of spurious emissions within 1–18 GHz – Low Fundamental Frequency*

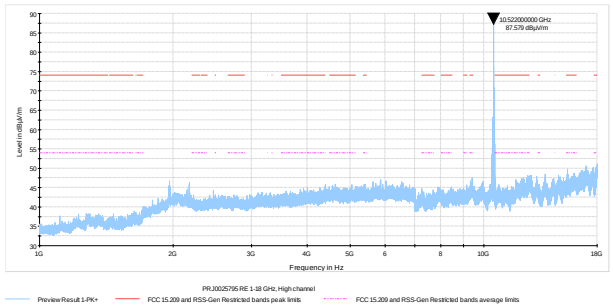


Figure 8.5-17: *Field strength of spurious emissions within 1–18 GHz – High Fundamental Frequency*

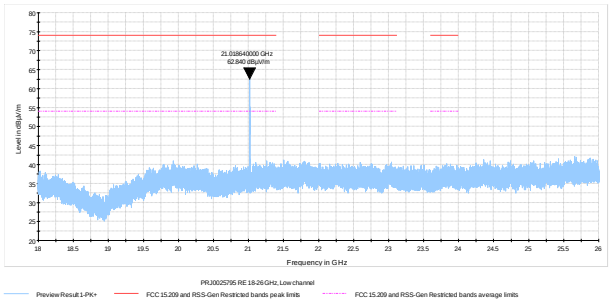


Figure 8.5-18: *Field strength of spurious emissions within 18–26 GHz – Low Fundamental Frequency*

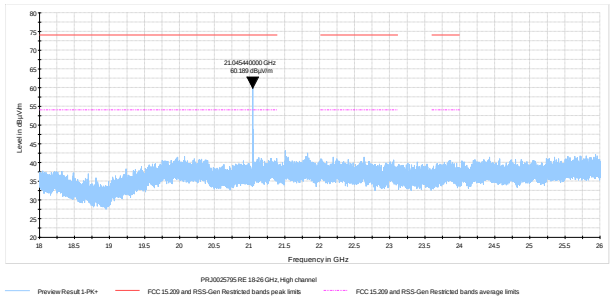


Figure 8.5-19: *Field strength of spurious emissions within 18–26 GHz – High Fundamental Frequency*

Test data, continued

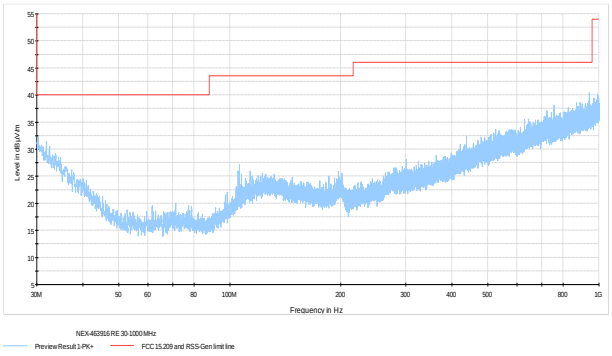


Figure 8.5-20: *Field strength of spurious emissions 30–1000 MHz – Mid Fundamental Frequency*

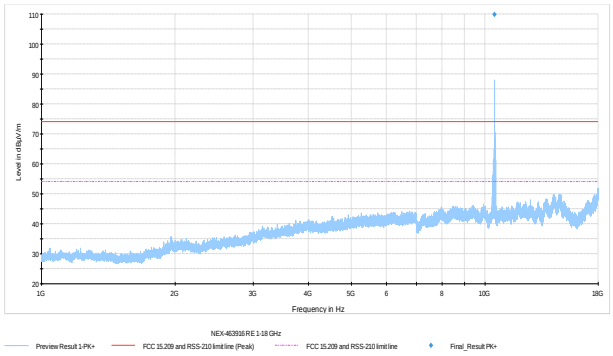


Figure 8.5-21: *Field strength of spurious emissions within 1–18 GHz – Mid Fundamental Frequency*

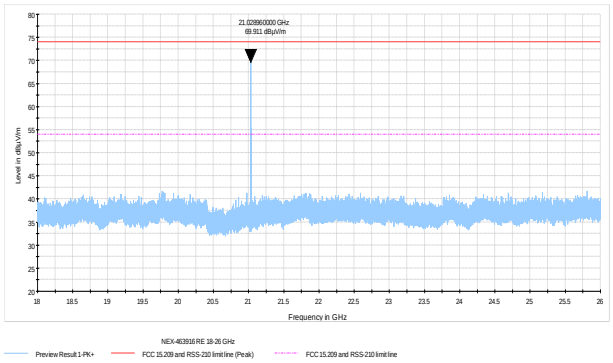


Figure 8.5-22: *Field strength of spurious emissions within 18–26 GHz – Mid Fundamental Frequency*

8.6 Emission bandwidth and Frequency stability

8.6.1 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 8.6-1: *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

8.6.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	December 16, 2022

8.6.3 Observations, settings and special notes

The frequency stability is not specified in the regulations, as requested by the applicant, the fundamental emission shall be kept within the permitted band.

Spectrum analyser settings:

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

8.6.4 Test data

Table 8.6-2: *Frequency drift measurement*

Test conditions	Frequency, MHz	Drift, MHz
+55 °C, Nominal	10515.473	0.310
+50 °C, Nominal	10515.243	0.080
+40 °C, Nominal	10515.510	**0.347**
+30 °C, Nominal	10515.337	0.174
+20 °C, +15 %	10515.130	−0.033
+20 °C, Nominal	**10515.163**	***Reference***
+20 °C, −15 %	10515.167	0.004
+10 °C, Nominal	10514.880	−0.283
0 °C, Nominal	10514.644	−0.519
−10 °C, Nominal	10514.544	**−0.619**
−20 °C, Nominal	10514.700	−0.463
−30 °C, Nominal	10514.963	−0.200

Table 8.6-3: *Occupied bandwidth measurement result*

Frequency, GHz	20 dB BW, MHz	99% BW, MHz
10.509	0.575	2.069
10.515	0.580	2.079
10.522	0.565	1.994

Table 8.6-4: *Frequency band stability (lower band edge) per FCC*

20 dBc lower, MHz	Maximum negative drift, MHz	Adjusted 20 dBc (lower), MHz	Limit, MHz	Margin, MHz
10509.069	−0.619	10508.450	10500	8.450

Table 8.6-5: *Frequency band stability (upper band edge) per FCC*

20 dBc upper, MHz	Maximum positive drift, MHz	Adjusted 20 dBc (upper), MHz	Limit, MHz	Margin, MHz
10522.520	0.347	10522.867	10550	27.133

Table 8.6-6: *Frequency band stability (lower band edge) per ISED*

99% OBW lower, MHz	Maximum negative drift, MHz	Adjusted 99% OBW (lower), MHz	Limit, MHz	Margin, MHz
10508.914	−0.619	10508.295	10500	8.295

Table 8.6-7: *Frequency band stability (upper band edge) Per ISED*

99% OBW upper, MHz	Maximum positive drift, MHz	Adjusted 99% OBW (upper), MHz	Limit, MHz	Margin, MHz
10523.804	0.347	10524.151	10550	25.849

Test data, continued

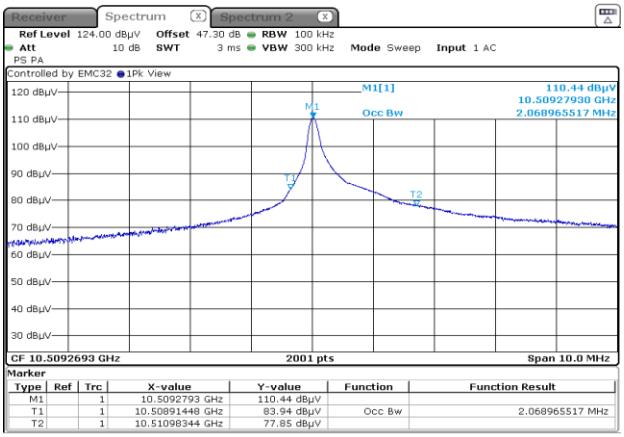


Figure 8.6-1: *99 % occupied bandwidth – Low Fundamental Frequency*

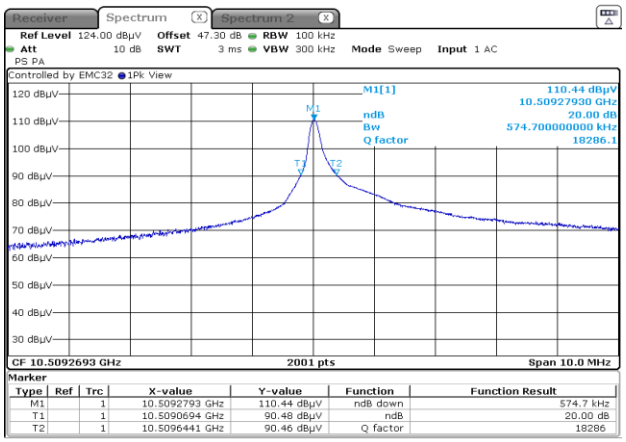


Figure 8.6-2: *20 dB occupied bandwidth – Low Fundamental Frequency*

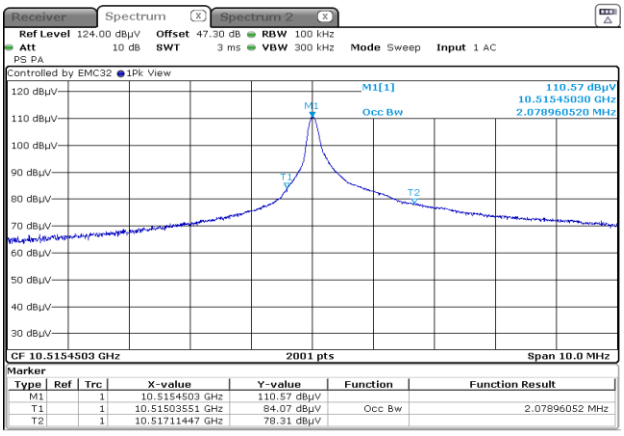


Figure 8.6-3: *99 % occupied bandwidth – Mid Fundamental Frequency*

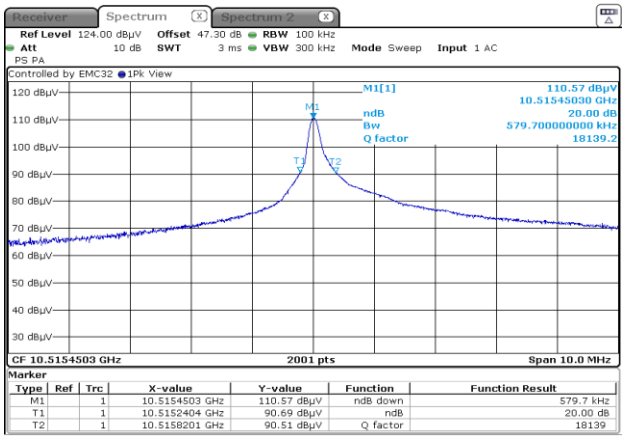


Figure 8.6-4: *20 dB occupied bandwidth – Mid Fundamental Frequency*

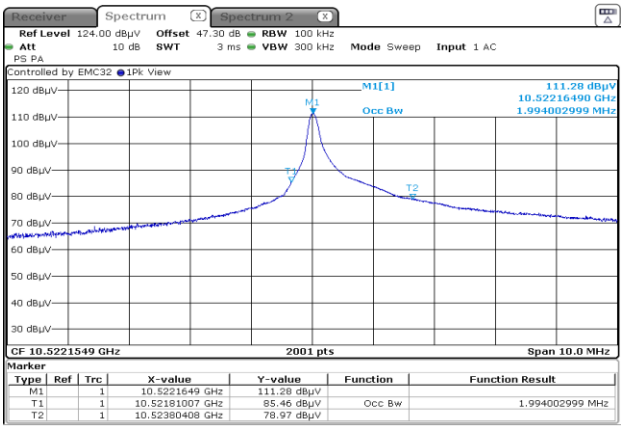


Figure 8.6-5: *99 % occupied bandwidth – High Fundamental Frequency*

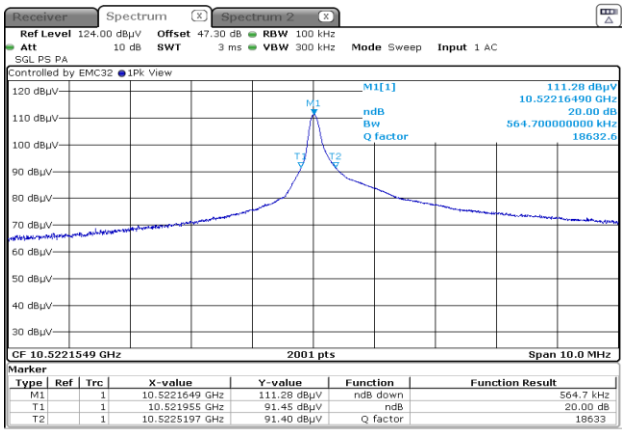
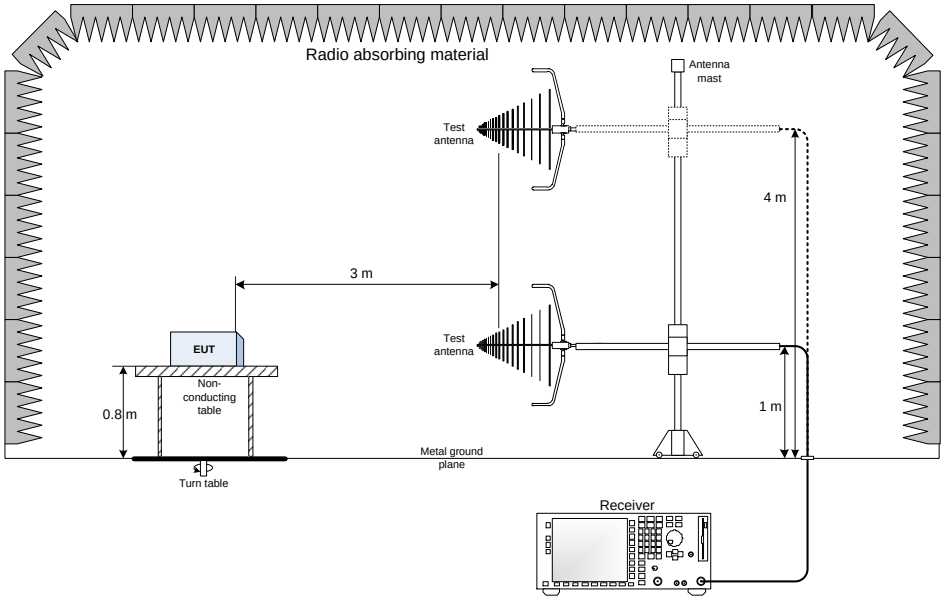


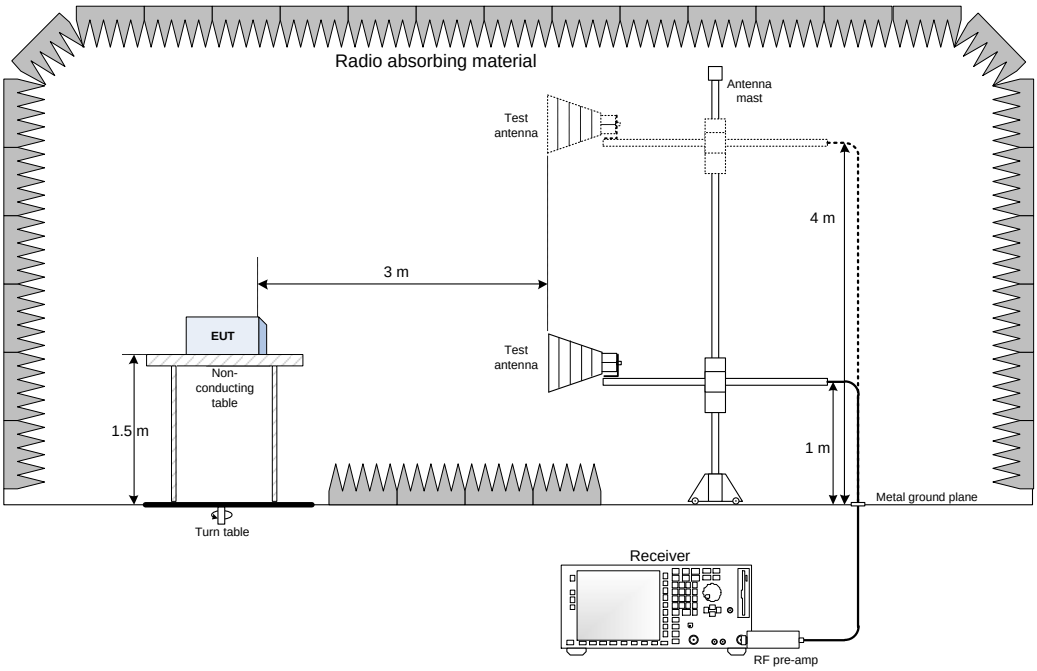
Figure 8.6-6: *20 dB occupied bandwidth – High Fundamental Frequency*

Section 9. Block diagrams of test set-ups

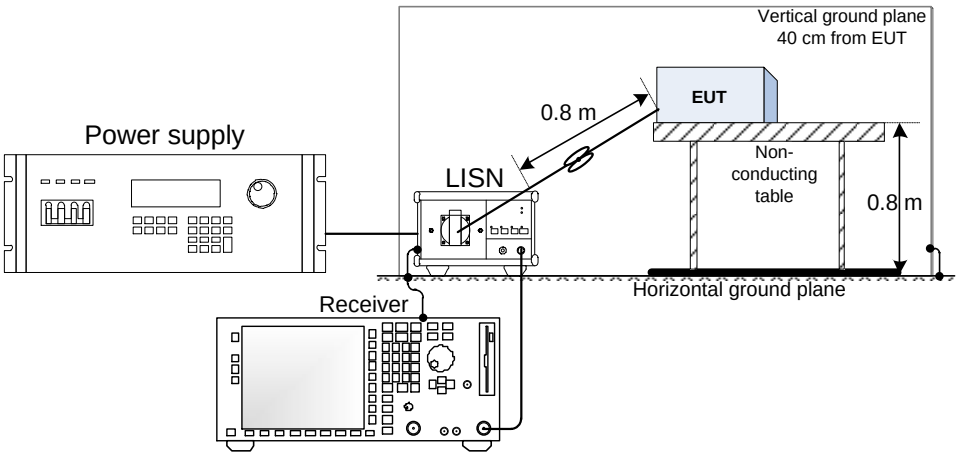
9.1 Radiated emissions set-up for frequencies below 1 GHz



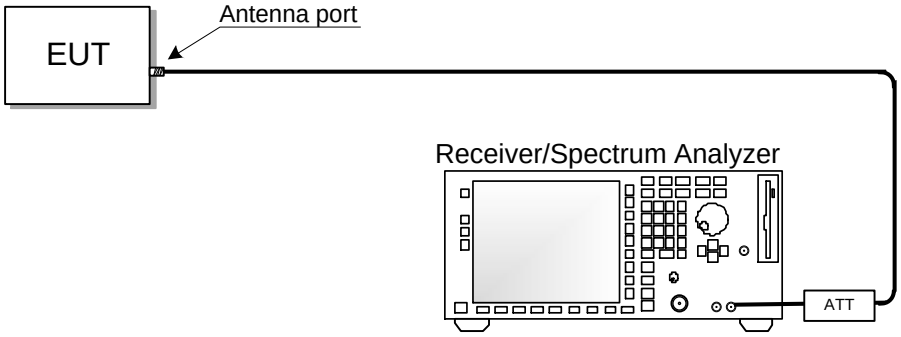
9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



9.4 Antenna port set-up



End of the test report