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RADIO TEST REPORT – 407621-1R1TRFWL

Type of assessment:

Final product testing

Applicant:

EXFO Inc.

Product:

Fiber Inspection Scope

Model:

FIP-500

FCC ID:

2AYQHFIP500

IC Registration number:

26882-FIP500

Specifications:

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

Date of issue:

March 26, 2021

Andrey Adelberg, Senior Wireless/EMC Specialist

Tested by

Signature

Mark Libbrecht, Deputy EMC/RF Lab Manager

Reviewed by

Signature

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SCC File Number: 15064 (Ottawa/Almonte); 151100 (Montreal); 151097 (Cambridge)

Lab locations

Company name	Nemko Canada Inc.			
Facilities	*Ottawa site:* 303 River Road Ottawa, Ontario Canada K1V 1H2 Tel: +1 613 737 9680 Fax: +1 613 737 9691	*Montréal site:* 292 Labrosse Avenue Pointe-Claire, Québec Canada H9R 5L8 Tel: +1 514 694 2684 Fax: +1 514 694 3528	*Cambridge site:* 1-130 Saltsman Drive Cambridge, Ontario Canada N3E 0B2 Tel: +1 519 650 4811	*Almonte site:* 1500 Peter Robinson Road West Carleton, Ontario Canada K0A 1L0 Tel: +1 613 256-9117

Test site identifier	**Organization**	**Ottawa/Almonte**	**Montreal**	**Cambridge**
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Table of Contents

Table of Contents **3**
Section 1 Report summary **4**
1.1 Test specifications 4
1.2 Test methods 4
1.3 Exclusions 4
1.4 Statement of compliance 4
1.5 Test report revision history 4
Section 2 Engineering considerations **5**
2.1 Modifications incorporated in the EUT for compliance 5
2.2 Technical judgment 5
2.3 Deviations from laboratory tests procedures 5
Section 3 Test conditions **6**
3.1 Atmospheric conditions 6
3.2 Power supply range 6
Section 4 Measurement uncertainty **7**
4.1 Uncertainty of measurement 7
Section 5 Information provided by the applicant **8**
5.1 Disclaimer 8
5.2 Applicant/Manufacture 8
5.3 EUT information 8
5.4 Radio technical information 8
5.5 EUT setup details 9
Section 6 Summary of test results **10**
6.1 Testing location 10
6.2 Testing period 10
6.3 Sample information 10
6.4 FCC Part 15 Subpart A and C, general requirements test results 10
6.5 FCC Part §15.225 test results 10
6.6 ISED RSS-Gen, Issue 5, test results 11
6.7 ISED RSS-210, Issue 10, test results 11
Section 7 Test equipment **12**
7.1 Test equipment list 12
Section 8 Testing data **13**
8.1 Variation of power source 13
8.2 Number of frequencies 14
8.3 Antenna requirement 16
8.4 AC power line conducted emissions limits 17
8.5 Occupied bandwidth 22
8.6 Field strength within 13.110–14.010 MHz band 24
8.7 Field strength outside 13.110–14.010 MHz band 26
8.8 Frequency stability 30
Section 9 EUT photos **31**
9.1 External photos 31

Section 1 Report summary

1.1 Test specifications

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

1.2 Test methods

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

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	March 1, 2021	Original report issued
R1TRF	March 26, 2021	Revised for only one HVIN. Available model options were removed.

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

The following modifications were performed by client: for Conducted emissions on AC line test, the assessment was performed twice: with NFC antenna connected and with antenna replaced with dummy load of 50-ohm resistor. Client provided modified sample for this test.

2.2 Technical judgment

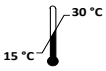
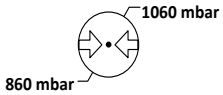
None

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 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/Manufacture

Applicant name	EXFO Inc.
Applicant address	400 Godin Avenue, Quebec, QC, CANADA, G1M 2K2
Manufacture name	Same as applicant
Manufacture address	Same as applicant

5.3 EUT information

Product	Fiber Inspection Scope
Model	FIP-500
Serial number	1404370
Version	ZD
Power supply requirements	Internal rechargeable battery or 5 V_{DC} USB Powered [via external 100–240 V_{AC};50/60 Hz USB power adapter]
Product description and theory of operation	The FIP-500 Fiber Inspection Scope is a portable video microscope equipped with a built-in 2.4-inch LCD capacitive touchscreen. The FIP-500 is used to inspect fiber ends, patchcord connectors, hard-to-reach optical connectors on the back of patch panels, and bulkhead adapters. The FIP-500 can be connected via Bluetooth® to a smartphone for sharing results. Wi-Fi connectivity for easy software updates without the need to connect to any external device. 13.56 MHz RFID capability.

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)	N/A
Field strength, dBµV/m @ 3 m	53.45
Measured BW (kHz), 99% OBW	118.6
Type of modulation	ASK
Emission classification	A1D
Transmitter spurious, dBµV/m @ 3 m	46.8 at 962 MHz
Antenna information	Internal, non-detachable antenna

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	SW: fip500-antenna-certification-pkg-israel-pcb191-0.0.0.20342.1
Transmitter state	Transmitter was set into continuous mode.

Table 5.5-1: *EUT interface ports*

Description	Qty.
USB port	1
Fiber port	1

Table 5.5-2: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
USB Hub	Anker	MN: A8352, SN: AELS2C0A24101134
Keyboard	Adesso	MN: AKB-510HB, SN: K1704000512
AC power adapter	Edacpower Elec.	MN: EA1012AVRU-050

Table 5.5-3: *Inter-connection cables*

Cable description	From	To	Length (m)
USB (Type C)	EUT	USB Hub	0.3
USB	Keyboard	USB Hub	1.0
USB	USB Hub	AC adapter	1.5

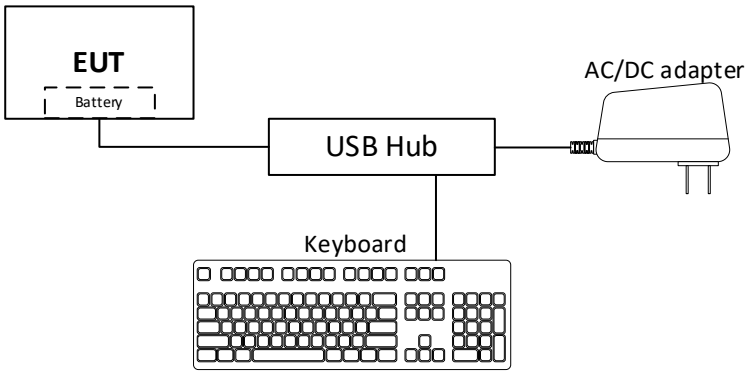


Figure 5.5-1: *Radiated testing block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Ottawa

6.2 Testing period

Test start date	January 13, 2021	Test end date	January 15, 2021

6.3 Sample information

Receipt date	December 16, 2020	Nemko sample ID number(s)	1

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	Pass
§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 AC 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
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass

Notes: [1]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.
EUT is an AC 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	FA002047	1 year	January 24, 2021
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 6, 2021
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	January 14, 2021
61505 AC source	Chroma	61509	FA003036	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002515	1 year	January 18, 2021
50 Ω coax cable	C.C.A.	None	FA002556	1 year	April 9, 2021
Signal and Spectrum Analyzer	Rhode&Schwarz	FSW50	FA003267	1 year	December 7, 2021
Temperature chamber	Espec	EPX-4H	FA002735	1 year	October 8, 2021
Active loop antenna (0.01–30 MHz)	Com-Power	AL-130	FA002674	1 year	September 23, 2021

Notes: 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	Andrey Adelberg	Test date	January 13, 2021

8.1.3 Observations, settings and special notes

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

a) 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.
b) For devices, where operating at a supply voltage deviating ±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.
c) 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.
d) 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	Andrey Adelberg	Test date	January 13, 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:

a) 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.
b) 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.
c) 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:

a) 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).
b) 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).
c) 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, kHz	Tx channel, MHz
13.553	13.567	14	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	Andrey Adelberg	Test date	January 13, 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 AC power line conducted emissions limits

8.4.1 References, definitions and limits

FCC §15.407(b):

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

FCC §15.207:

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 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 emissions 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	Andrey Adelberg	Test date	January 13, 2021

8.4.3 Observations, settings and special notes

Port under test – Coupling device	AC input of AC power adapter – Artificial Mains Network (AMN)
EUT power input during test	5 V_{DC} (via external 100–240 V_{AC}, 50/60 Hz power adapter)
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.

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

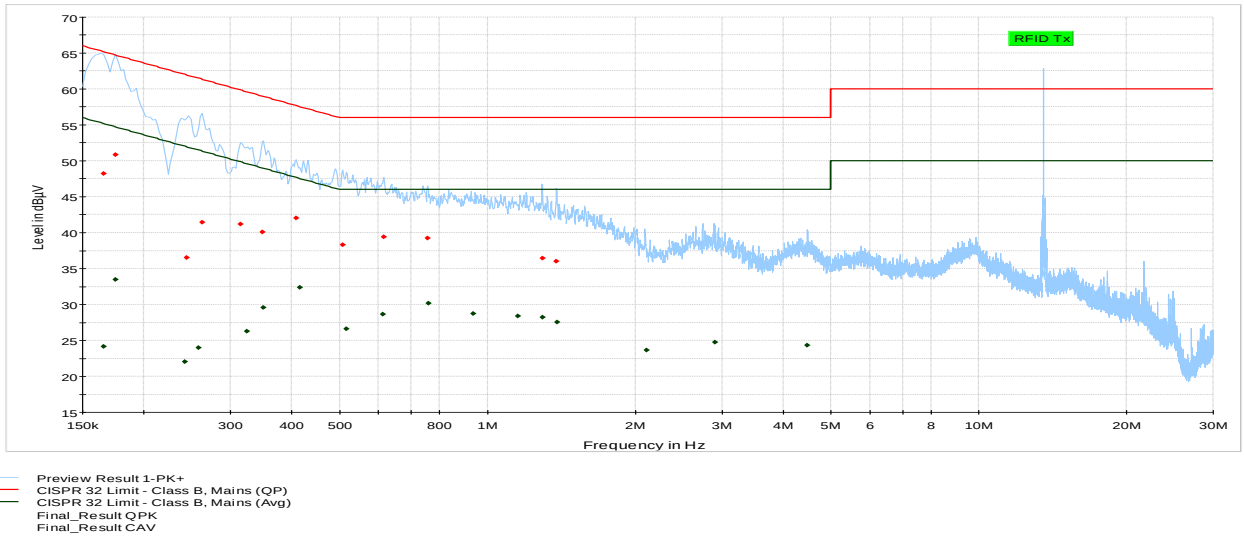
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average (Preview), Quasi-peak and CAverage (Final)
Trace mode	Max Hold
Measurement time	100 ms (Preview), 160 ms (Final)

8.4.4 Test data

Table 8.4-2: *Conducted emissions results on phase line*

Frequency, MHz	Quasi-Peak result, dBµV	Quasi-Peak limit, dBµV	Quasi-Peak margin, dB	Correction factor, dB
0.165750	48.25	65.17	16.92	10.32
0.174750	50.86	64.73	13.87	10.36
0.244500	36.52	61.94	25.42	9.98
0.262500	41.42	61.35	19.93	9.99
0.314250	41.19	59.86	18.67	10.10
0.348000	40.11	59.01	18.90	10.17
0.408750	42.02	57.67	15.65	10.23
0.507750	38.34	56.00	17.66	10.24
0.615750	39.43	56.00	16.57	10.21
0.755250	39.26	56.00	16.74	10.16
1.293000	36.40	56.00	19.60	10.06
1.383000	36.01	56.00	19.99	10.06

Frequency, MHz	CAverage result, dBµV	CAverage limit, dBµV	CAverage margin, dB	Correction factor, dB
0.165750	24.18	55.17	30.99	10.32
0.174750	33.45	54.73	21.28	10.36
0.242250	22.01	52.02	30.01	9.99
0.258000	23.99	51.50	27.51	9.98
0.323250	26.28	49.62	23.34	10.12
0.350250	29.56	48.96	19.40	10.17
0.415500	32.39	47.54	15.15	10.24
0.516750	26.58	46.00	19.42	10.24
0.611250	28.61	46.00	17.39	10.21
0.757500	30.16	46.00	15.84	10.16
0.935250	28.71	46.00	17.29	10.11
1.155750	28.35	46.00	17.65	10.08
1.295250	28.20	46.00	17.80	10.06
1.385250	27.58	46.00	18.42	10.06
2.105250	23.67	46.00	22.33	10.02
2.908500	24.73	46.00	21.27	10.01
4.481250	24.32	46.00	21.68	10.02



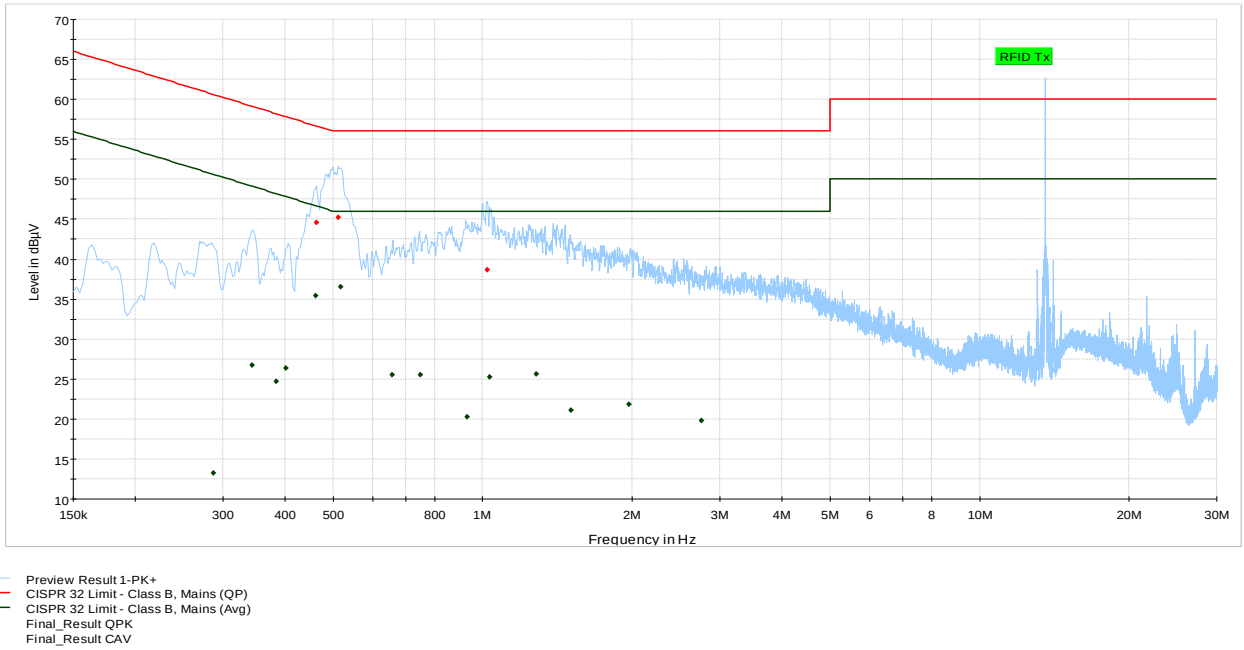
Plot 8.4-1: *Conducted emissions on phase line*

Test data, continued

Table 8.4-3: *Conducted emissions results on neutral line*

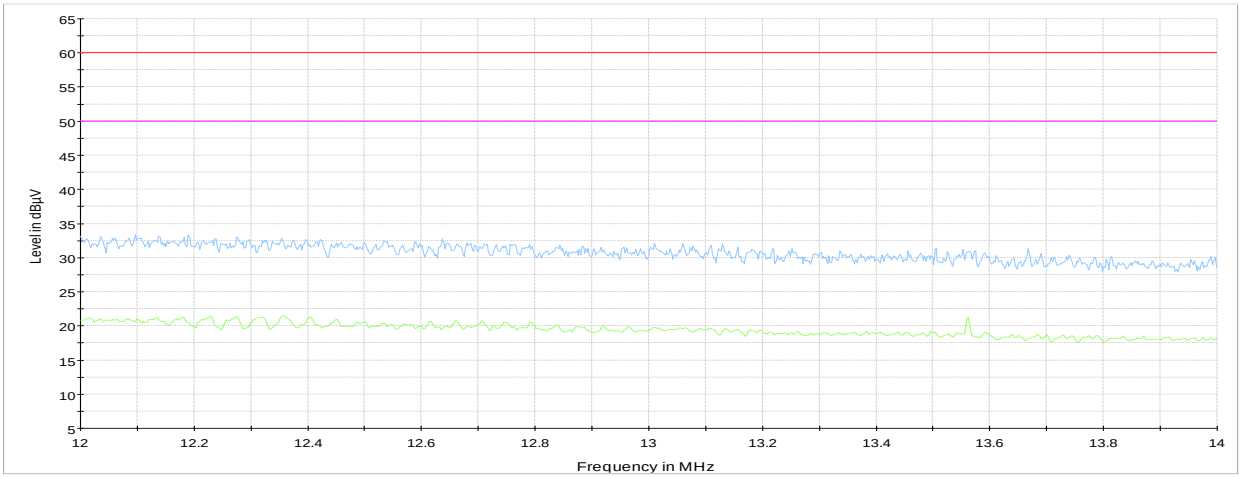
Frequency, MHz	Quasi-Peak result, dBµV	Quasi-Peak limit, dBµV	Quasi-Peak margin, dB	Correction factor, dB
0.469500	42.46	56.52	14.06	10.2
0.498750	49.18	56.02	6.84	10.2
0.525750	41.11	56.00	14.89	10.2
0.579750	40.36	56.00	15.64	10.2
0.640500	38.85	56.00	17.15	10.2
0.836250	33.78	56.00	22.22	10.1
1.009500	42.14	56.00	13.86	10.1
1.070250	37.39	56.00	18.61	10.1
1.115250	42.97	56.00	13.03	10.1
1.304250	38.33	56.00	17.67	10.1

Frequency, MHz	CAverage result, dBµV	CAverage limit, dBµV	CAverage margin, dB	Correction factor, dB
0.287250	13.24	50.60	37.36	10.00
0.343500	26.75	49.12	22.37	10.20
0.384000	24.69	48.19	23.50	10.20
0.402000	26.39	47.81	21.42	10.20
0.460500	35.46	46.68	11.22	10.20
0.516750	36.57	46.00	9.43	10.20
0.658500	25.49	46.00	20.51	10.20
0.748500	25.50	46.00	20.50	10.20
0.928500	20.25	46.00	25.75	10.10
1.032000	25.24	46.00	20.76	10.10
1.279500	25.59	46.00	20.41	10.10
1.504500	21.09	46.00	24.91	10.00
1.970250	21.86	46.00	24.14	10.00
2.755500	19.83	46.00	26.17	10.00



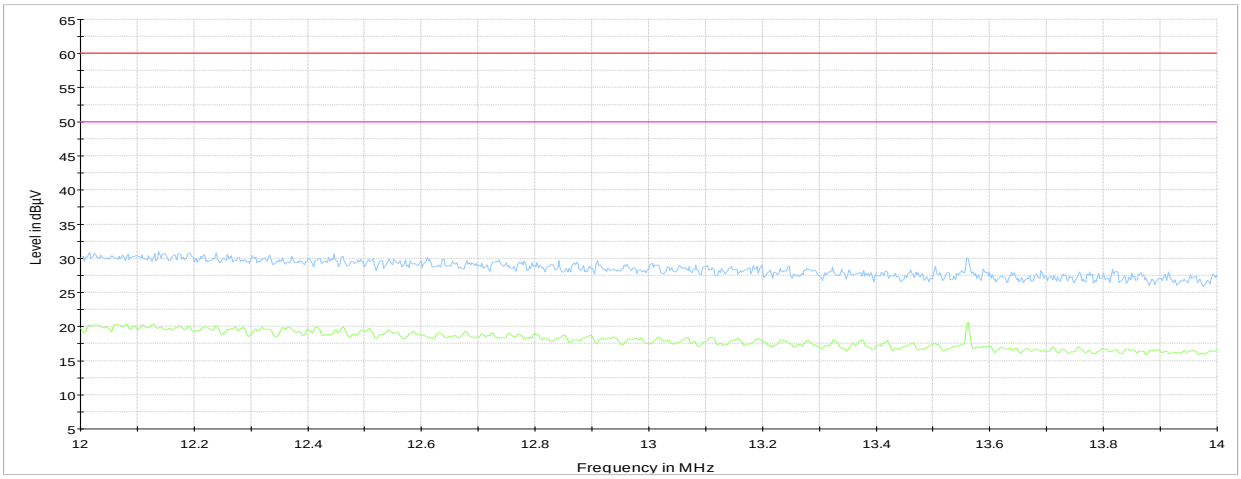
Plot 8.4-2: *Conducted emissions on neutral line*

Test data, continued



Conducted emissions on Phase line (around 13 MHz)
Preview Result 2-AVG
Preview Result 1-PK+
CISPR 32 Limit - Class B, Mains (QP)
CISPR 32 Limit - Class B, Mains (Avg)

Plot 8.4-3: *Conducted emissions on phase line around 13 MHz with terminated NFC antenna*



Conducted emissions on Neutral line (around 13 MHz)
Preview Result 2-AVG
Preview Result 1-PK+
CISPR 32 Limit - Class B, Mains (QP)
CISPR 32 Limit - Class B, Mains (Avg)

Plot 8.4-4: *Conducted emissions on neutral line around 13 MHz with terminated NFC antenna*

8.5 Occupied bandwidth

8.5.1 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).

8.5.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	January 13, 2021

8.5.3 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

8.5.4 Test data

Table 8.5-1: *99% bandwidth results*

Frequency, MHz	99% bandwidth, kHz
13.56	118.589

Table 8.5-2: *Lower 20 dBc frequency cross result*

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.56130	13.56124	13.55300	8.24

Table 8.5-3: *Upper 20 dBc frequency cross result*

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.56130	13.56137	13.56700	5.63

Test data, continued

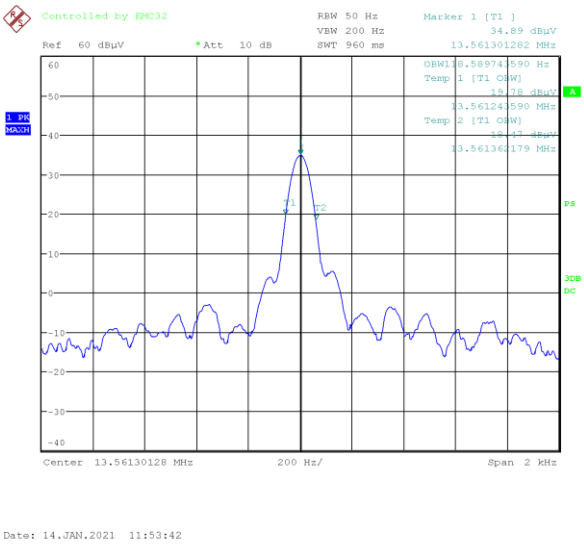


Figure 8.5-1: *99% bandwidth*

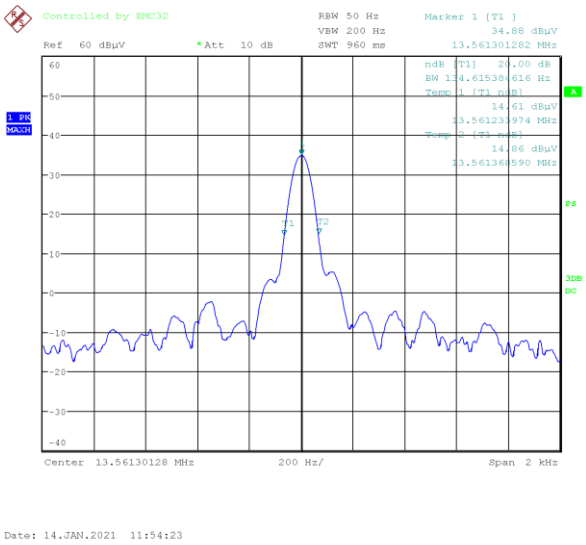


Figure 8.5-2: *20 dB bandwidth*

8.6 Field strength within 13.110–14.010 MHz band

8.6.1 References, definitions and limits

FCC §15.225:

(a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 µV/m (84 dBµV/m) at 30 meters.

(b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m (50.5 dBµV/m) at 30 meters.

(c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 µV/m (40.5 dBµV/m) at 30 meters.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

a. the field strength of any emission shall not exceed the following limits:

i. 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553–13.567 MHz

ii. 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410–13.553 MHz and 13.567–13.710 MHz

iii. 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110–13.410 MHz and 13.710–14.010 MHz

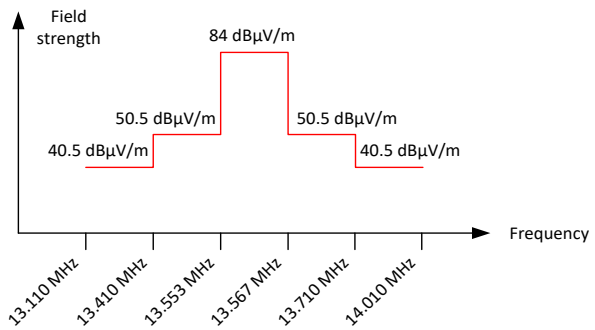


Figure 8.6-1: *In-band spurious emissions limit at 30 m*

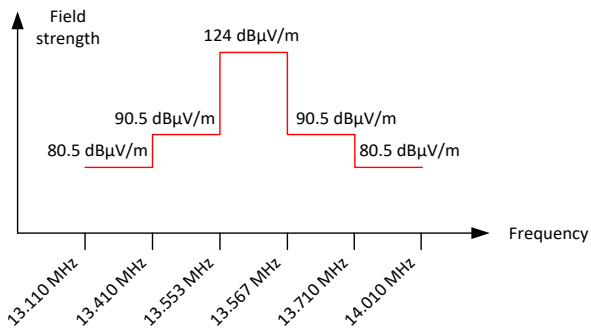


Figure 8.6-2: *In-band spurious emissions limit at 3 m*

8.6.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	January 13, 2021

8.6.3 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):

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

- 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

8.6.4 Test data

Table 8.6-1: *Field strength measurements results*

Frequency range, MHz	Frequency, MHz	Field strength at 3 m, dBµV/m	Calculated field strength at 30 m, dBµV/m	Limit, dBµV/m	Margin, dB
13.553–13.567	13.561	53.45	13.45	84.00	70.55

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

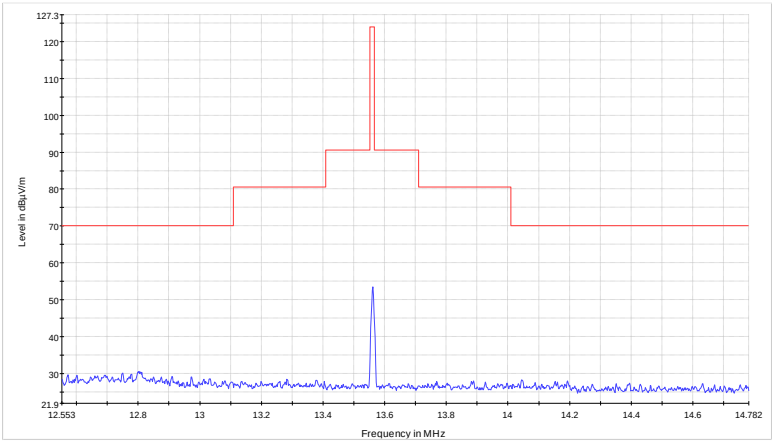


Figure 8.6-3: *Field strength within 13.110–14.010 MHz band*

8.7 Field strength outside 13.110–14.010 MHz band

8.7.1 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 8.7-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

	Field strength of emissions		
Frequency, MHz	**µV/m**	**dBµV/m**	**Measurement distance, 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 8.7-2: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
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 8.7-3: *FCC restricted frequency bands*

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

8.7.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	January 13, 2021

8.7.3 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:	300 Hz
Video bandwidth:	9 kHz
Detector mode:	Quasi-Peak
Trace mode:	Max Hold

Spectrum analyser settings for measurements below 30 MHz:

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

Spectrum analyser settings for measurements below 1 GHz:

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

8.7.4 Test data

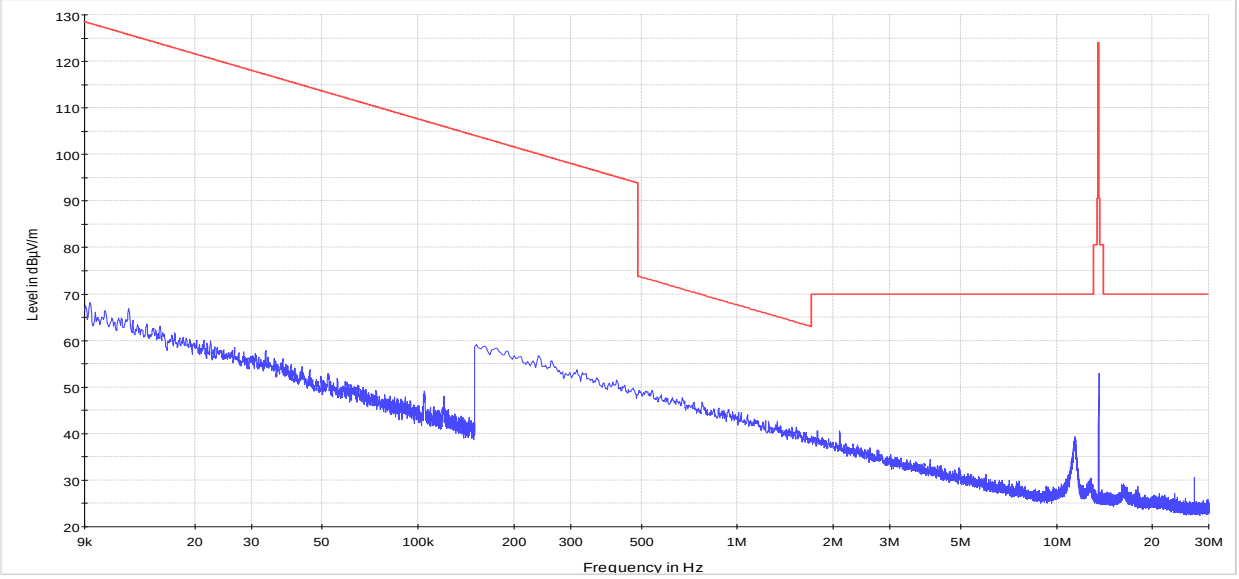


Figure 8.7-1: *Field strength of spurious emissions below 30 MHz*

Test data, continued

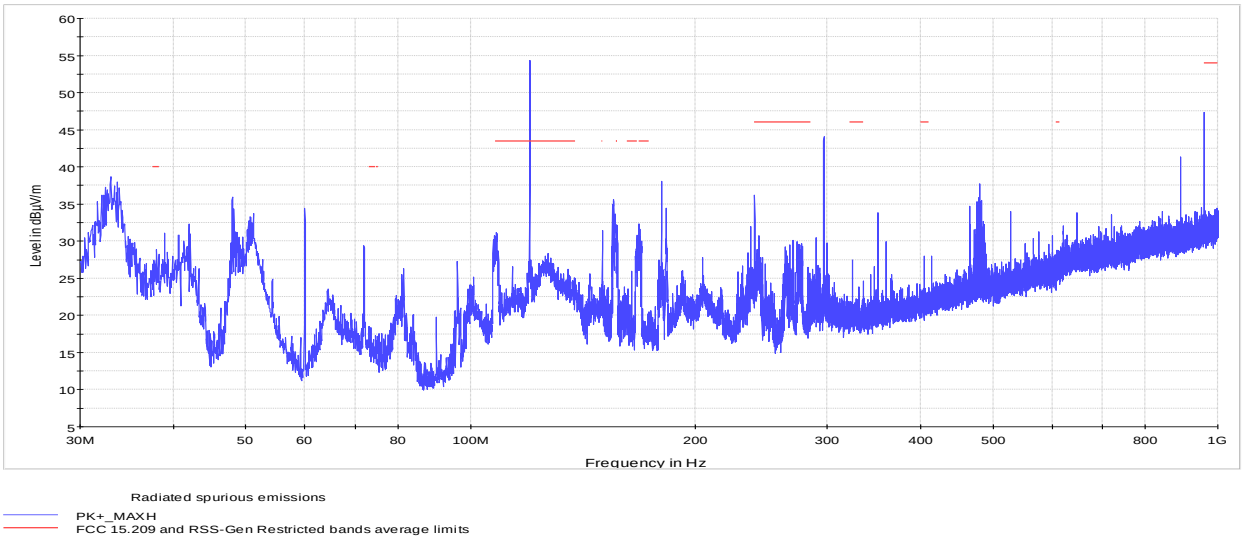


Figure 8.7-2: *Field strength of spurious emissions above 30 MHz*

Notes: It was verified that the emission on the above plot that exceeds the limit at about 120 MHz frequency range originates from the auxiliary (support) equipment and therefore is exempt from the scope of this test report.
Worst case emission was measured at 962 MHz with 46.8 dBµV/m (peak)

8.8 Frequency stability

8.8.1 References, definitions and limits

FCC §15.225:

(e) The frequency tolerance of the carrier signal shall be maintained within ±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

8.8.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	January 15, 2021

8.8.3 Observations, settings and special notes

Frequency $drift_{[ppm]} = ((F_{measured} - F_{reference}) \div F_{reference}) \times 1\times10^6$

$Margin[dB] = 10\times Log_{10}(Limit_{[ppm]} \div Draft_{[ppm]})$

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

8.8.4 Test data

Table 8.8-1: *Frequency drift measurement*

Test conditions	Frequency, MHz	Drift, Hz	Drift, ppm	Drift limit, ±ppm	Margin, dB
+50 °C, Nominal	13.56128882	12.19	-0.90	100.00	20.46
+40 °C, Nominal	13.56127544	25.57	-1.89	100.00	17.25
+30 °C, Nominal	13.56128483	16.18	-1.19	100.00	19.23
+20 °C, +15 %	13.56130201	-1.00	0.07	100.00	31.32
+20 °C, Nominal	13.56130101		*Reference*		
+20 °C, −15 %	13.56130281	-1.80	0.13	100.00	28.77
+10 °C, Nominal	13.56132299	-21.98	1.62	100.00	17.90
0 °C, Nominal	13.56135915	-58.14	4.29	100.00	13.68
−10 °C, Nominal	13.56137395	-72.94	5.38	100.00	12.69
−20 °C, Nominal	13.56137695	-75.94	5.60	100.00	12.52
−30 °C, Nominal	13.56137595	-74.94	5.53	100.00	12.58

Section 9 EUT photos

9.1 External photos

Figure 9.1-1: *Side view photo*

Figure 9.1-2: *Side view photo*

Figure 9.1-3: *Front view photo*

Figure 9.1-4: *Top view photo*

Figure 9.1-5: *Rear view photo*

Figure 9.1-6: *Bottom view photo*

End of the test report