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RADIO TEST REPORT – 405809-1TRFWL

Type of assessment:

Final product testing

Applicant:

Thales DIS USA, Inc

Product:

QS2000 Document Reader

Model:

PV55-02-00-01-00

Model variant(s):

PV55-00-00-00-00, PV55-01-00-00-00, PV55-02-00-00-00, PV55-03-00-00-00

FCC ID:

2AQL3PR01615

IC Registration number:

22832-PR01615

Specifications:

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

Date of issue: April 9, 2021

Andrey Adelberg, Senior Wireless/EMC Specialist
Tested by


Signature

David Duchesne, EMC/RF Lab Manager
Reviewed by


Signature

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.

Copyright notification

Table of Contents

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	April 9, 2021	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

The following modifications were installed by client:

- Ferrite on LED cable (no turns) is 28B0500-100, Mfr: Laird-Signal Integrity
- Ferrite on RF cable (no turns) is 28B0625-000, Mfr: Laird-Signal Integrity

2.2 Technical judgment

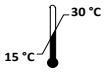
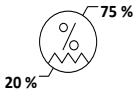
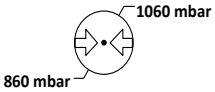
- There are two document reader models part of the QS2000 family: PV55 (Desktop) and PV59 (Kiosk). The difference between these two readers is the mechanical housing. The electronics and the interconnection cables are the same for both readers.
- The representative model provided for test was (PV55-02-00-01-00) the most complex Desktop model, including RFID. Different configurations (SKUs) are available, but one or both of these options are missing.

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
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	Thales DIS USA, Inc
Applicant address	Arboretum Plaza II, 9442 N. Capital of Texas Hwy, Suite 400, Austin, TX, 78759, USA
Manufacture name	Thales DIS (Shenzhen) Inc.
Manufacture address	Room 901, Building 3, Tingwei Industrial Park, 6 Liufang Road, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen, PRC, 518101
Manufacture name	Thales DIS (Tianjin) CO LTD
Manufacture address	4TH Floor, Building 8, Saifei Shiji Medical Equipment Park, Medical Equipment Industrial Park, Tianjin, Beichen Economic-Technological Development Area, Beichen District, Tianjin, China
Manufacture name	Benchmark Electronics Huntsville Inc.
Manufacture address	4807 Bradford Dr NW, Huntsville, AL 35805-1948, USA

5.3 EUT information

Product	QS2000 Document Reader
Model	PV55-02-00-01-00
Serial number	55E20390002
Part number	XSPV5502000100
Model variants	PV55-00-00-00-00, PV55-01-00-00-00, PV55-02-00-00-00, PV55-03-00-00-00
Power supply requirements	USB: 5 V(DC) from Laptop connected via 100–240 V_{AC} 50/60 Hz
Product description and theory of operation	The Thales Gemalto Document Reader QS2000 is designed to capture data from driving licences, electronic travel and identity documents quickly and reliably in a wide variety of commercial applications.

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	77.44
Measured BW (kHz), 99% OBW	3.301
Type of modulation	ASK
Emission classification	A1D
Transmitter spurious, dBµV/m @ 3 m	37.6 (Quasi-peak) at 81.4 MHz
Antenna information	Printed antenna with 1.0 dBi gain

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	Application firmware FW00289_0_9 PC Software SW-00355_3.12.01 (Autocal)
Transmitter state	Transmitter sets automatically to continuous mode once powered.

Table 5.5-1: *EUT sub assemblies*

Description	Brand name	Model, Part number, Serial number, Revision level
QS2000 Document Reader	THALES	SN: 55E20390002, PN: XSPV5502000100, MN: PV55-02-01-00, Rev. A

Table 5.5-2: *EUT interface ports*

Description	Qty.
USB 3.0	1

Table 5.5-3: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	Dell	SN: H7PZPQ2, MN: Latitude 5590
AC Adapter	Dell	SN: None, MN: LA90PM130

Table 5.5-4: *Inter-connection cables*

Cable description	From	To	Length (m)
USB cable	Reader	Laptop	1.2*
3-wire power cable	AC mains	AC adapter	1.2
2-wire power cable	AC adapter	Laptop	1.8

Notes: *Customer claimed that the maximum length of the USB cable was less than 3 meters.

EUT setup configuration, continued

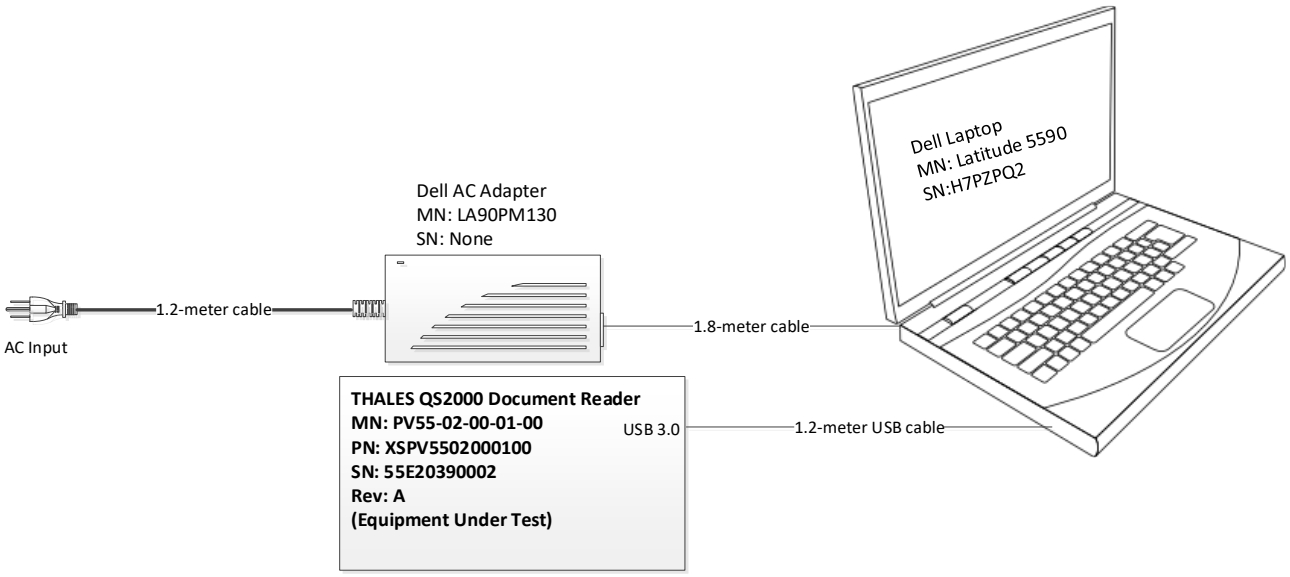


Figure 5.5-1: *Setup block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Ottawa

6.2 Testing period

Test start date	October 16, 2020	Test end date	October 26, 2020

6.3 Sample information

Receipt date	October 14, 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
61505 AC source	Chroma	61509	FA003036	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 8, 2020
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	April 31, 2021
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	January 14, 2021
Temperature chamber	Espec	EPX-4H	FA002735	1 year	October 8, 2021
LISN	Rohde & Schwarz	ENV216	FA002515	1 year	January 18, 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	October 21, 2020

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 is powered from USB port, input voltage was varied from a support power supply, no noticeable output power and functionality variations were observed.

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	October 21, 2020

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	October 21, 2020

8.3.3 Observations, settings and special notes

None

8.3.4 Test data

EUT is not professionally installed and does not contain a detachable antenna.

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	October 21, 2020

8.4.3 Observations, settings and special notes

Port under test – Coupling device	AC input of Laptop's Power supply – Artificial Mains Network (AMN)
EUT power input during test	5 V_{DC} USB Powered from laptop (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

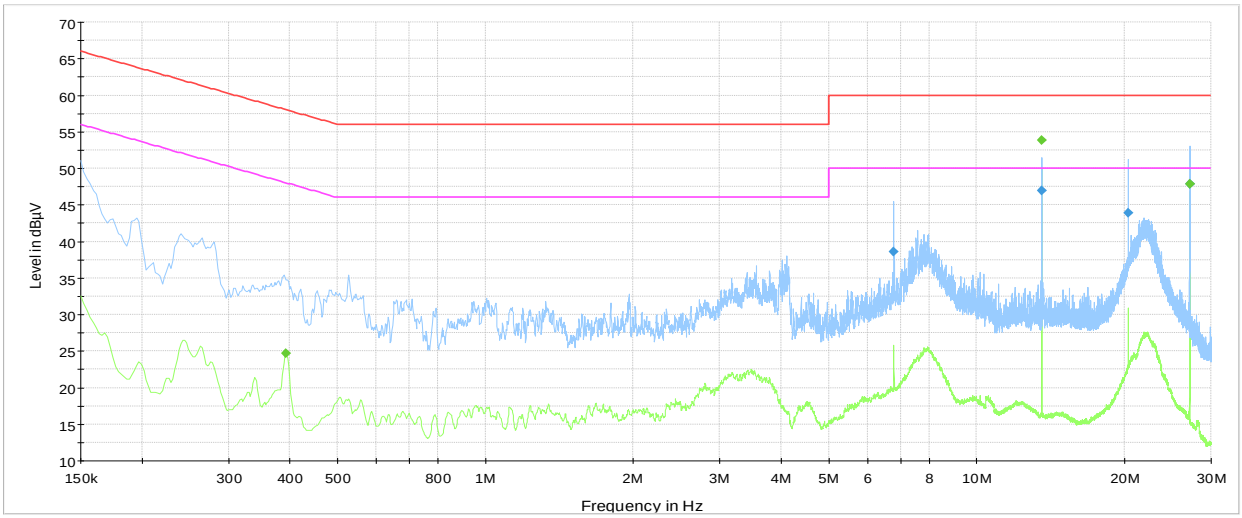
Table 8.4-2: *Conducted emissions results on phase line*

Frequency, MHz	Quasi-Peak result, dBµV	Quasi-Peak limit, dBµV	Quasi-Peak margin, dB	Correction factor, dB
6.780750	38.56	60.00	21.44	10.0
13.559500	46.91	60.00	13.09	10.1
20.341000	43.85	60.00	16.15	10.3
27.120250	47.86	60.00	12.14	10.2
Frequency, MHz	**CAverage result, dBµV**	**CAverage limit, dBµV**	**CAverage margin, dB**	**Correction factor, dB**
0.393000	24.73	48.00	23.27	10.2
27.120250	47.87	50.00	2.13	10.2

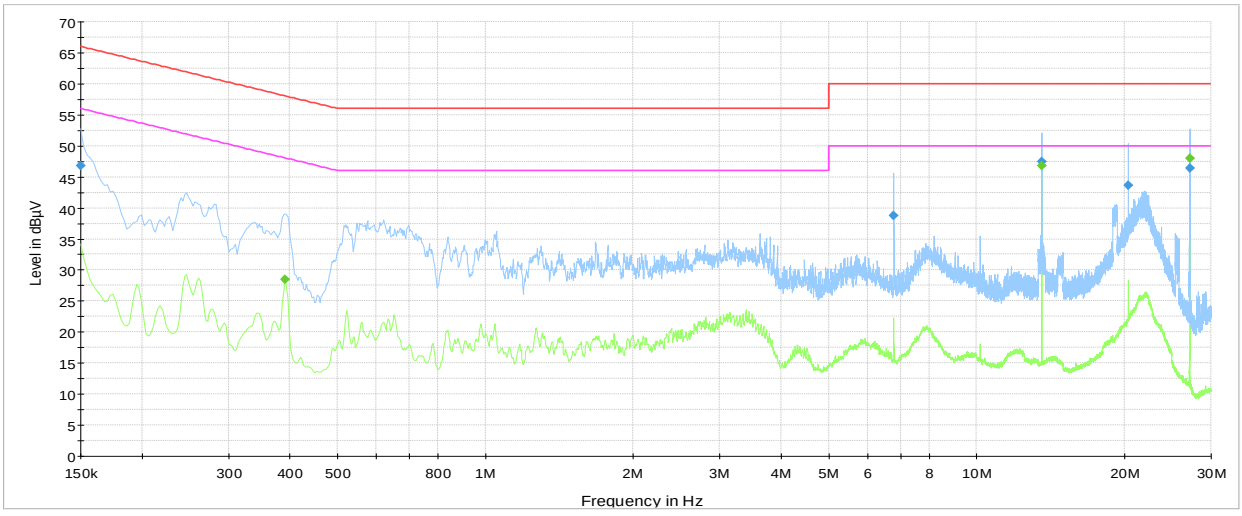
Table 8.4-3: *Conducted emissions results on neutral line*

Frequency, MHz	Quasi-Peak result, dBµV	Quasi-Peak limit, dBµV	Quasi-Peak margin, dB	Correction factor, dB
0.150000	46.83	66.00	19.17	10.1
6.780750	38.77	60.00	21.23	10.0
13.559500	47.43	60.00	12.57	10.1
20.341000	43.70	60.00	16.30	10.2
27.120250	46.38	60.00	13.62	10.3
Frequency, MHz	**CAverage result, dBµV**	**CAverage limit, dBµV**	**CAverage margin, dB**	**Correction factor, dB**
0.390750	28.48	48.05	19.57	10.2
27.120250	47.93	50.00	2.07	10.3

Test data, continued



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



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

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	October 16, 2020

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	3.301

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

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.55916	13.553	

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

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.56054	13.567	

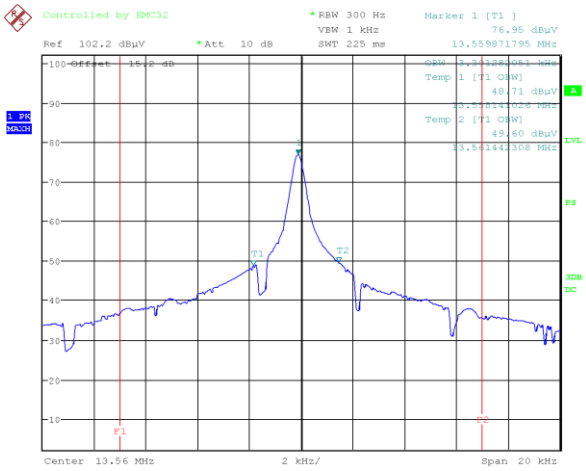


Figure 8.5-1: *99% bandwidth*

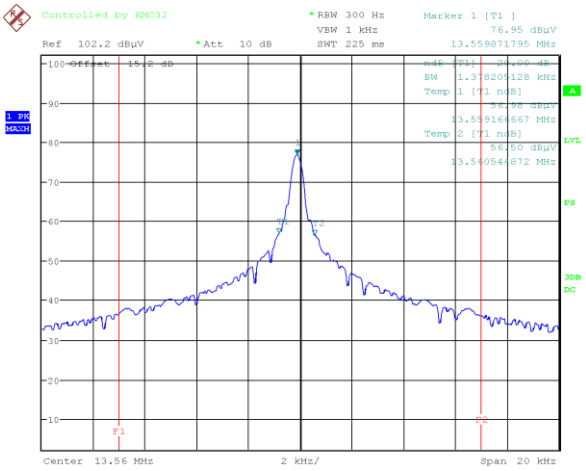


Figure 8.5-2: *20 dB bandwidth*

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

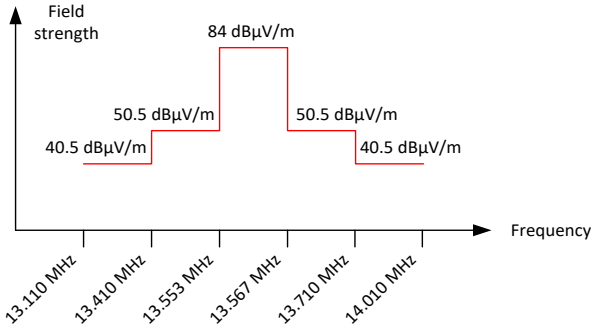


Figure 8.6-1: *In-band spurious emissions limit at 30 m*

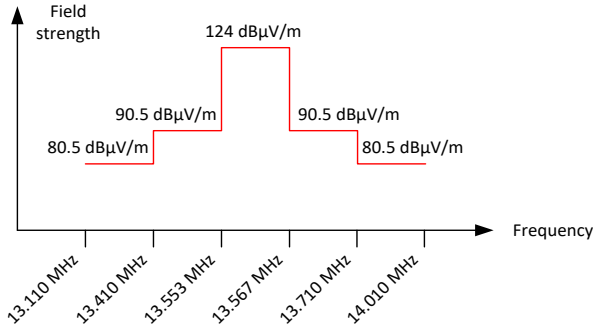


Figure 8.6-2: *In-band spurious emissions limit at 3 m*

8.6.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	October 27, 2020

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
13.110–13.410	13.158	42.76	2.76	40.50	37.74
13.410–13.553	13.448	53.32	13.32	50.50	37.18
13.553–13.567	13.559	77.44	37.44	84.00	46.56
13.567–13.710	13.701	55.70	15.70	50.50	34.80
13.710–14.010	13.985	42.36	2.36	40.50	38.14

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

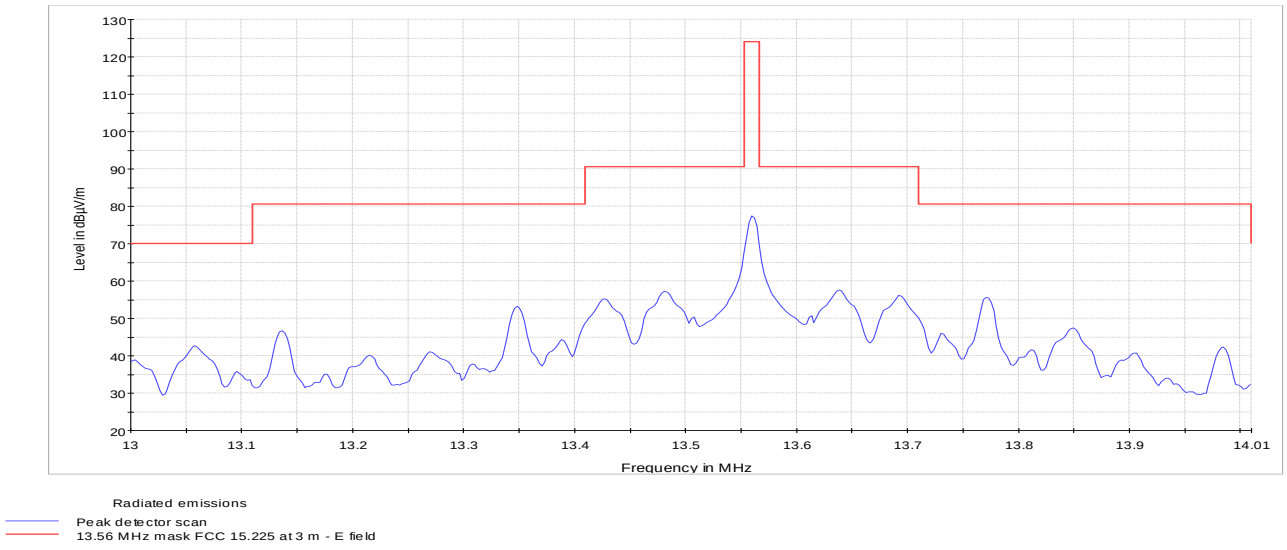


Figure 8.6-3: *Field strength within 13.110–14.010 MHz band*

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.

8.7.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	October 27, 2020

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

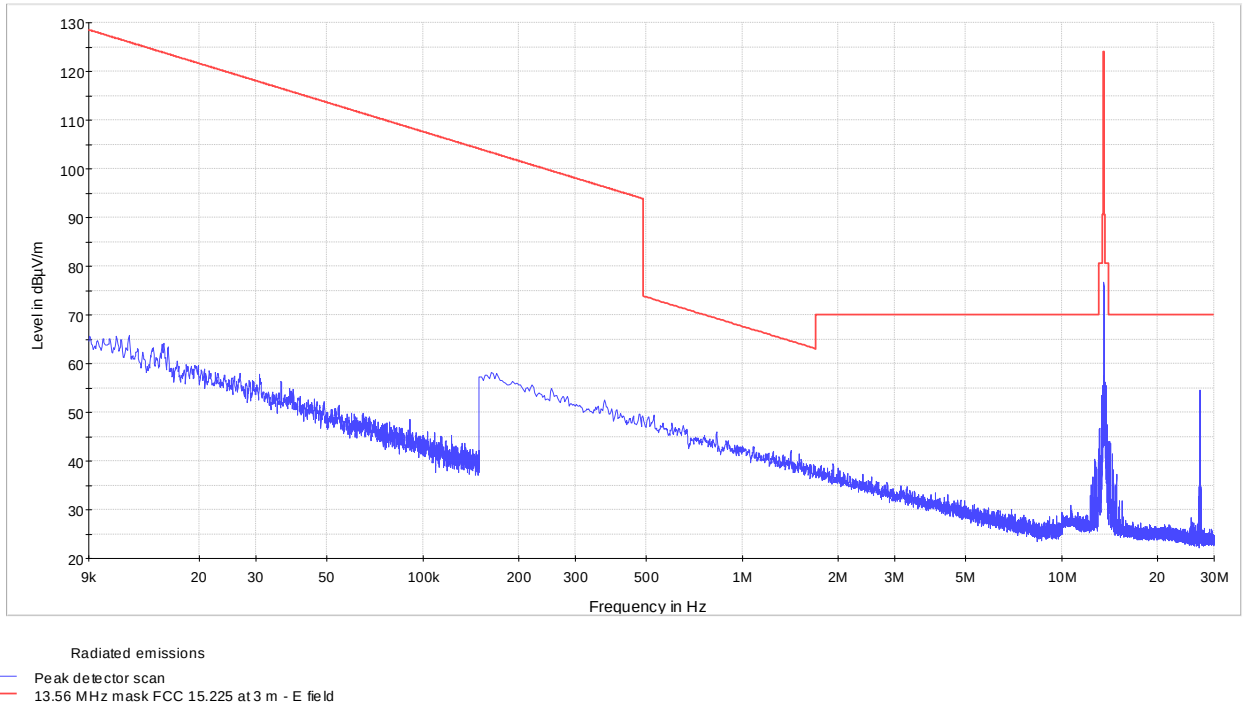


Figure 8.7-1: *Field strength of spurious emissions below 30 MHz*

Test data, continued

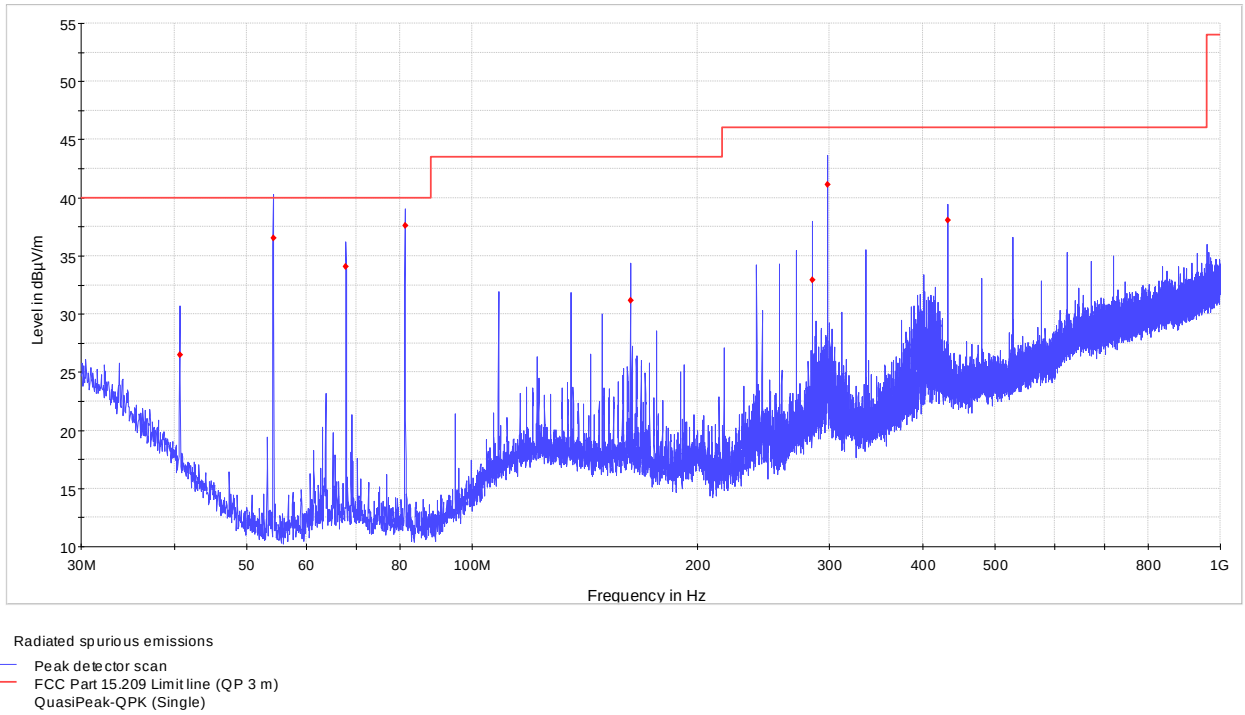


Figure 8.7-2: *Field strength of spurious emissions above 30 MHz*

Table 8.7-2: *Field strength measurements results*

Frequency, MHz	Q-Peak Field strength at 3 m, dBµV/m	Q-Peak 3 m limit, dBµV/m	Margin, dB
27.120	54.5	70.0	15.5
40.670	26.5	40.0	13.5
54.202	36.5	40.0	3.5
67.782	34.1	40.0	5.9
81.362	37.6	40.0	2.4
162.696	31.1	43.5	12.4
284.722	32.9	46.0	13.1
298.302	41.1	46.0	4.9
431.968	38.0	46.0	8.0

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	October 26, 2020

8.8.3 Observations, settings and special notes

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

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

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

Resolution bandwidth:	10 Hz
Video bandwidth:	30 Hz
Detector mode:	Peak

8.8.4 Test data

Table 8.8-1: *Frequency drift measurement*

Test conditions	Frequency, Hz	Drift, ppm	Limit, ppm	Margin, dB
+50 °C, Nominal	13559906	2.5	100	16.01
+40 °C, Nominal	13559899	2.0	100	17.01
+30 °C, Nominal	13559869	-0.2	100	26.55
+20 °C, +15 %	13559835	-2.7	100	15.64
+20 °C, Nominal	13559872		*Reference*	
+20 °C, −15 %	13559827	-3.3	100	14.79
+10 °C, Nominal	13559898	1.9	100	17.17
0 °C, Nominal	13559831	-3.0	100	15.19
−10 °C, Nominal	13559885	1.0	100	20.18
−20 °C, Nominal	13559859	-1.0	100	20.18

Section 9 EUT photos

9.1 External photos

Figure 9.1-1: *Front view photo*

Figure 9.1-2: *Rear view photo*

Figure 9.1-3: *Side view photo*

Figure 9.1-4: *Side view photo*

End of the test report