

Wireless test report – 359008-2TRFWL

Applicant:

Dormakaba Canada Inc.

Product name: Model: 79 Series RT Plus

FCC ID: IC Registration number: Q8SRTPLUS 4652A-RTPLUS

Specifications:

FCC 47 CFR Part 15 Subpart C, §15.247

FCC 47 CFR Part 15 Subpart C, §15.225

RSS-247, Issue 2, Feb 2017, Section 5

• RSS-210, Issue 10, Dec 2019, Annex B.6

Date of issue: June 16, 2022

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Test location(s)

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Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	dormakaba Canada Inc.
Address	7301 Decarie Blvd, Montreal, QC, Canada, H4P 2G7

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz
FCC 47 CFR Part 15, Subpart C, Clause 15.225	Operation within the band 13.110–14.010 MHz.
RSS-247, Issue 2, Feb 2017, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
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

1.3 Test methods

558074 D01 DTS Meas Guidance v05	Guidance for Compliance Measurements on Digital Transmission Systerm, Frequency Hopping Spread
(Aug. 24, 2018)	Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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 1.5 below. 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 Exclusions

None

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report	
TRF	June 16, 2022	Original report issued	



Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Table 2.1-1: FCC general requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is a battery-operated device, the testing was performed using fresh batteries.

2.2 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS)

Table 2.2-1: FCC §15.247 results for DTS

Part	Test description	Verdict
§15.247(a)(2)	Minimum 6 dB bandwidth	Pass
§15.247(b)(3)	Maximum peak output power in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

2.3 FCC Part §15.225 test results

Table 2.3-1: 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	



2.4 ISED RSS-Gen, Issue 5, test results

Table 2.4-1: RSS-Gen results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Number of frequencies	Pass
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Not applicable

Notes: ¹ According to section 5 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements. EUT is a battery-operated device, the testing was performed using fresh batteries.

2.5 ISED RSS-247, Issue 2, test results for digital transmission systems (DTS)

Table 2.5-1: RSS-247 results for DTS

Part	Test description	Verdict
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.3	Hybrid Systems	
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (d)	Systems employing digital modulation techniques	Pass
5.4 (e)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (f)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Unwanted emissions	Pass

Notes: None

2.6 ISED RSS-210, Issue 10, test results

Table 2.6-1: ISED RSS-210 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 3. Equipment under test (EUT) details

Sample information 3.1

Receipt date	May 1, 2018
Nemko sample ID number	Item#1 and #2

EUT information 3.2

Product name	79 Series
Model	RT Plus
Product description	Wireless door lock
Serial numbers	J1621.1005944
	J1621.1005779
	J122B1.006129
	79ZO1011EL32
Part number	124-212135-002

Technical information 3.3

Frequency band	2400 to 2483.5 MHz	13.553-13.567 MHz	
Frequency Min (MHz)	2402 MHz	13.56	
Frequency Max (MHz)	2480 MHz	13.56	
RF power Max (W), Conducted	0.0011 (0.4 dBm)	-	
Field strength (dBµV/m) @ 30 m	-	11.9	
Measured BW (kHz) (99%)	1031.0	2.199	
Calculated BW (kHz), as per TRC-43	1031.0	2.199	
Type of modulation	GFSK	ООК	
Emission classification (F1D, G1D, D1D)	F1D	A1D	
Transmitter spurious, Units @ distance	49.5, Average, at 4960 MHz @ 3 m	32.2, Quasi-peak, at 30.24 MHz @ 3 m	
Power requirements	4.5 V _{DC}		
Antenna information	The EUT uses a non-detachable antenna to t	he intentional radiator.	
	2.4 GHz Antenna type: Low profile Compact Ceramic Chip Antenna		
	Model: ACAG0201-2450-T		
	Brand: Abracon, max peak gain is 2.7 dBi.		

Product description and theory of operation 3.4

Battery operated door lock using an RFID card reader and BLE radio.

3.5 **EUT** exercise details

EUT was set with test firmware up by client on site, continuous transmit mode was configured during transmitter tests.



3.6 EUT setup diagram

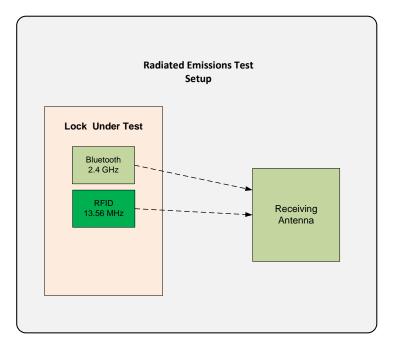


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
RFID Antenna + BLE Circuit PCB	Saflok	124-515135-002	J1621.1005944 or J1621.1005779
Main Controller PCB	Saflok	124-512999-407	J122B1.006129



Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.



Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 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.

5.2 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 6. Measurement uncertainty

6.1 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 6.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB		
All antenna port measurements	0.55		
Conducted spurious emissions	1.13		
Radiated spurious emissions	3.78		



Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list – conducted measurement

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Conducted measurement					
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Sept. 18/18
50 Ω coax cable	Sucoflex	None	FA002563	_	VOU
Radiated measurement					
3 m EMI test chamber (Emissions)	TDK	SAC-3	FA002532e	2 year	February 25, 2022
Bilog antenna (20–2000 MHz)	Sun AR	JB1	FA003009	1 year	February 2, 2022
Active loop antenna (9 kHz-30 MHz)	COM-POWER	AL-130	FA002674	1 year	June 21, 2018
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	June 1, 2021
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	February 16, 2022
Pre-amplifier (0.5–18 GHz)	Com-Power	PAM-118A	FA002561	1 year	September 22, 2021
Pre-amplifier (18–40 GHz)	Com-Power	PAM-840	FA002508	1 year	September 24, 2021
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	March 11, 2021
2300-2583.5 MHz Notch Filter	Microwave Circuits	N0324413	FA002693	_	VOU
50 Ω coax cable	C.C.A.	None	FA002603	_	VOU
50 Ω coax cable	C.C.A.	None	FA002831	_	VOU

Notes:

VOU - verify on use

Section 8 Test name Specification Testing data

FCC 15.31(e) Number of frequencies

FCC Part 15 Subpart A



Section 8. Testing data

8.1 FCC 15.31(e) Variation of power source

8.1.1 Definitions and limits

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 date

Start date

September 4, 2018

8.1.3 Observations, settings and special notes

None

8.1.4 Test data

EUT is battery powered, testing performed with new batteries

FCC Part 15 Subpart A and RSS-Gen, Issue 5



8.2 FCC 15.31(m) and RSS-Gen 6.9 Number of frequencies

8.2.1 Definitions and limits

FCC:

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.

ISED

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 Measurement Frequencies Required	Location of Measurement Frequency in Band of Operation
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

8.2.2 Test date

Start date

8.2.3 Observations, settings and special notes

None

8.2.4 Test data

Table 8.2-2: Test channels selection for BLE

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
2400	2483.5	83.5	2402	2440	2480

Table 8.2-3: Test channels selection for RFID

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, kHz	Tx channel, MHz
13.553	13.567	14	13.560

Section 8 Test name Specification Testing data

FCC 15.203 Antenna requirement

FCC Part 15 Subpart C



8.3 FCC 15.203 Antenna requirement

8.3.1 Definitions and limits

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.

8.3.2 Test date

Start date May 22, 2018

8.3.3 Observations, settings and special notes

None

8.3.4 Test data

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

Section 8

Specification

Testing data

Test name FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems

FCC Part 15 Subpart C and RSS-247, Issue 2



8.4 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems

8.4.1 Definitions and limits

FCC:

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

ISED

The minimum 6 dB bandwidth shall be 500 kHz.

8.4.1 Test date

Start date August 31, 2018

8.4.2 Observations, settings and special notes

Spectrum analyzer settings for 6 dB bandwidth:

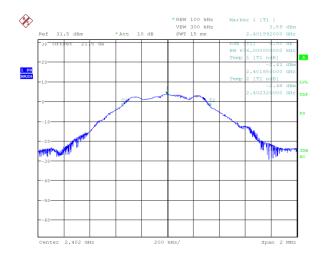
Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	2 MHz
Detector mode	Peak
Trace mode	Max Hold



8.4.3 Test data

Table 8.4-1: 6 dB bandwidth results

Frequency, MHz	6 dB bandwidth, kHz	Minimum Limit, kHz	Margin, kHz
2402	676	500	176
2440	666	500	166
2480	692	500	192



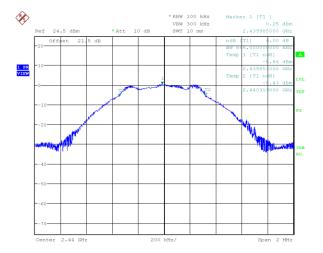


Figure 8.4-1: 6 dB bandwidth on low channel

Figure 8.4-2: 6 dB bandwidth on mid channel

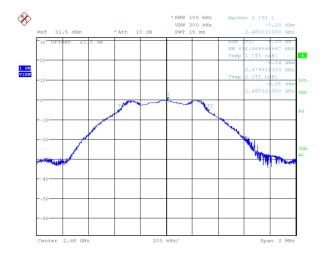


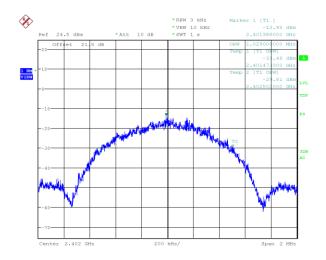
Figure 8.4-3: 6 dB bandwidth on high channel





Table 8.4-2: 99% bandwidth results

Frequency, MHz	99% bandwidth, kHz
2402	1029
2440	1027
2480	1031



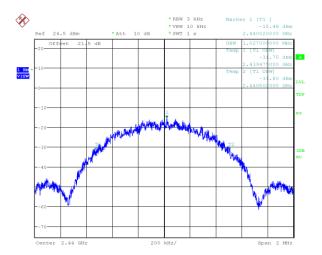


Figure 8.4-4: 99% bandwidth on low channel

Figure 8.4-5: 99% bandwidth on mid channel

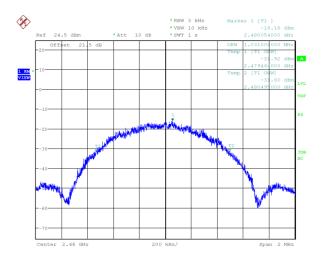


Figure 8.4-6: 99% bandwidth on high channel

Specification

FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements

FCC Part 15 Subpart C and RSS-247, Issue 2



8.5 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements for DTS in 2 GHz

8.5.1 Definitions and limits

FCC:

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
 - (3) For systems using digital modulation in the 2400–2483.5 MHz band: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
 - (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
- (c) Operation with directional antenna gains greater than 6 dBi.
- (1) Fixed point-to-point operation:
- (i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.
- (iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.
- (2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:
- (i) Different information must be transmitted to each receiver.
- (ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:
- (A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.
- (B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.
- (iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.
- (iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

Section 8 Testing data

FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements Test name Specification

FCC Part 15 Subpart C and RSS-247, Issue 2



ISED:

d. For DTSs employing digital modulation techniques operating in the 2400-2483.5 MHz band, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

e. Fixed point-to-point systems in the 2400-2483.5 MHz band are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

f. Transmitters operating in the band 2400–2483.5 MHz, may employ antenna systems that emit multiple directional beams simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers, provided that the emissions comply with the following:

i Different information must be transmitted to each receiver.

ii If the transmitter employs an antenna system that emits multiple directional beams, but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device (i.e. the sum of the power supplied to all antennas, antenna elements, staves, etc., and summed across all carriers or frequency channels) shall not exceed the applicable output power limit specified in sections 5.4(b) and 5.4(d). However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

iii If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the applicable power limit specified in sections 5.4(b) and 5.4(d). If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the applicable limit specified in sections 5.4(b) and 5.4(d). In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the applicable limit specified in sections 5.4(b) and 5.4(d) by more than 8 dB. iv Transmitters that transmit a single directional beam shall operate under the provisions of sections 5.4(b), 5.4(d) and 5.4(e).

8.5.1 Test date

|--|--|--|--|

8.5.2 Observations, settings and special notes

The test was performed using spectrum analyzer setting as below:

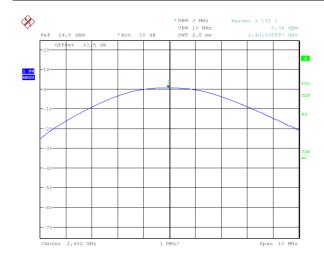
Resolution bandwidth	3 MHz
Video bandwidth	≥3 × RBW
Frequency span	10 MHz
Detector mode	Peak
Trace mode	Max Hold



8.5.3 Test data

Table 8.5-1: Output power measurements results

Frequency,	Conducted out	put power, dBm	Maurin dD	Antenna gain,	EIRP,	EIRP limit,	FIDD measure all
MHz	Measured	Limit	Margin, dB	dBi	dBm	dBm	EIRP margin, dB
2402	0.36	30	29.64	2.7	3.06	36	32.94
2440	0.40	30	29.60	2.7	3.10	36	32.90
2480	-0.01	30	30.01	2.7	2.69	36	33.31



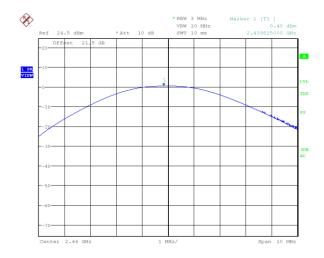


Figure 8.5-1: Output power on low channel

Figure 8.5-2: Output power on mid channel



Figure 8.5-3: Output power on high channel



8.6 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions for DTS

8.6.1 Definitions and limits

FCC:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

ISED:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.6-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency,	Field strength of emissions		Measurement distance, m
MHz	μV/m	dBμV/m	
0.009-0.490	2400/F	67.6 – 20 × 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

Table 8.6-2: 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

Note: Certain frequency bands listed in Table 8.6-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

Section 8 Test name Specification Testing data

FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions

FCC Part 15 Subpart C and RSS-247, Issue 2



Table 8.6-3: FCC restricted frequency bands

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

8.6.2 Test date

Start date August 31, 2018 and March 9, 2021

Section 8 Specification Testing data

Test name

FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions FCC Part 15 Subpart C and RSS-247, Issue 2

8.6.3 Observations, settings and special notes

- Spectrum was investigated from 30 MHz to 25 GHz. Above 18 GHz, no emission related to RF portion were detected within 6 dB below the limit.
- EUT was set to transmit with 100 % duty cycle.
- Radiated measurements were performed at a distance of 3 m. The level of spurious emissions were measured as their effective radiated power when radiated by cabinet and antenna in case of integral antenna equipment with no antenna connectors.
- Since fundamental power was tested using the maximum peak conducted output power procedure to demonstrate compliance, the spurious emissions limit is -20 dBc/100 kHz.
- Spurious emissions of transmitter colocation have been investigated, no inter-modulation product emissions were observed.

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

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

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for average radiated measurements within restricted bands above 1 GHz:

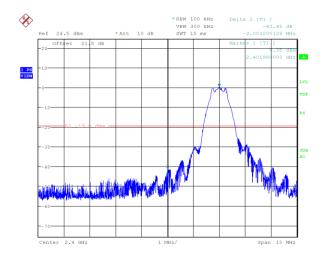
Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements:

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



8.6.4 Test data



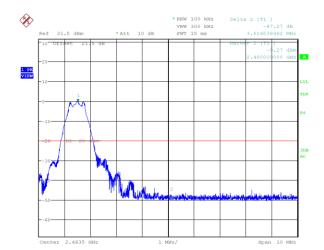
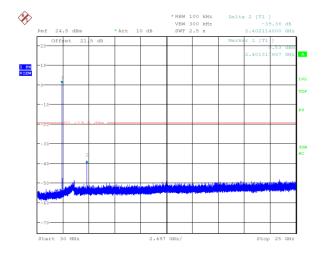


Figure 8.6-1: Conducted spurious emission at band edge outside restricted band, low channel

Figure 8.6-2: Conducted spurious emissions at band edge outside restricted band, High channel





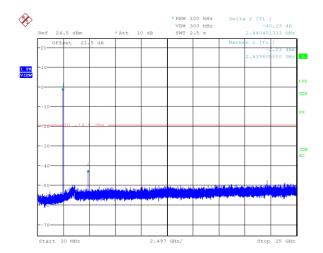


Figure 8.6-3: Conducted spurious emissions outside restricted band, Low channel

Figure 8.6-4: Conducted spurious emissions outside restricted band, Mid channel

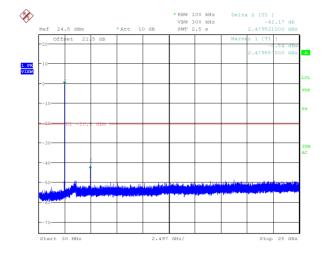


Figure 8.6-5: Conducted spurious emissions outside restricted band, High channel



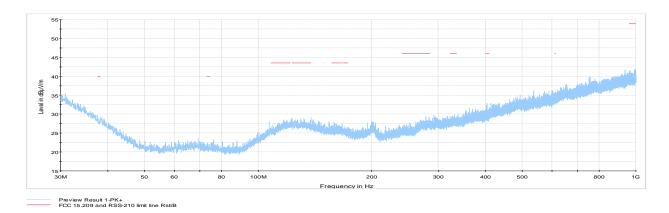


Figure 8.6-6: Radiated spurious emissions 30 MHz to 1 GHz, Low channel

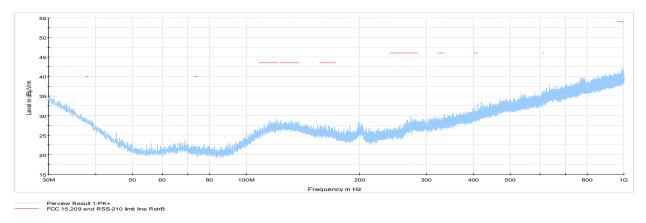


Figure 8.6-7: Radiated spurious emissions 30 MHz to 1 GHz, mid channel

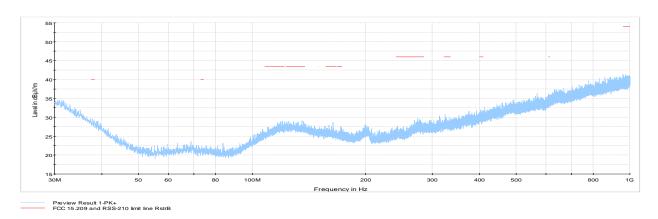


Figure 8.6-8: Radiated spurious emissions 30 MHz to 1 GHz, High channel



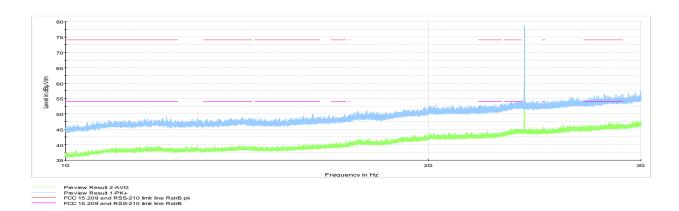


Figure 8.6-9: Radiated spurious emissions 1 to 3 GHz, Low channel

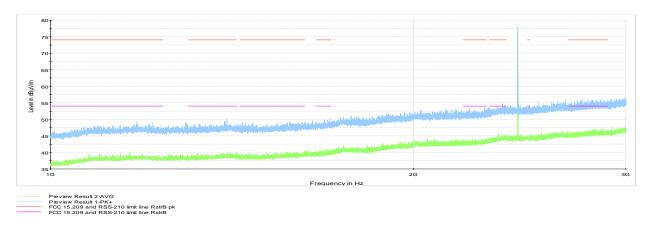


Figure 8.6-10: Radiated spurious emissions 1 to 3 GHz, mid channel

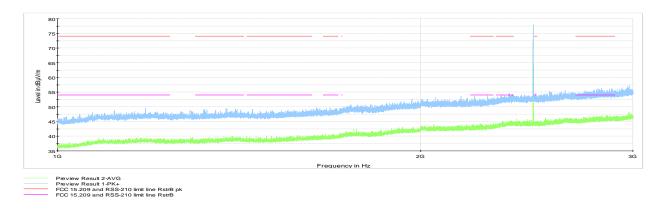


Figure 8.6-11: Radiated spurious emissions 1 to 3 GHz, High channel



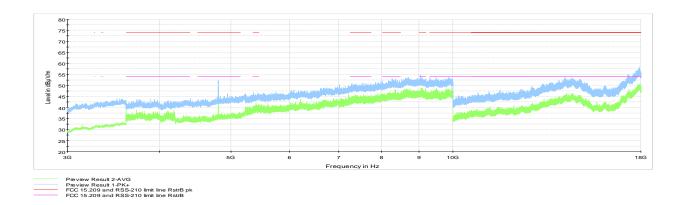


Figure 8.6-12: Radiated spurious emissions 3 to 18 GHz, Low channel

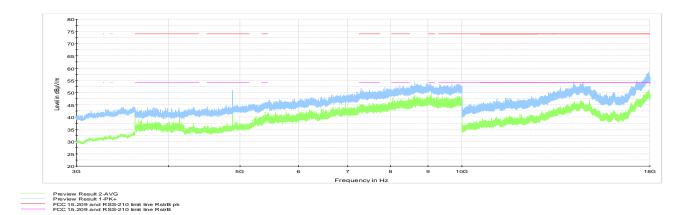


Figure 8.6-13: Radiated spurious emissions 3 to 18 GHz, mid channel

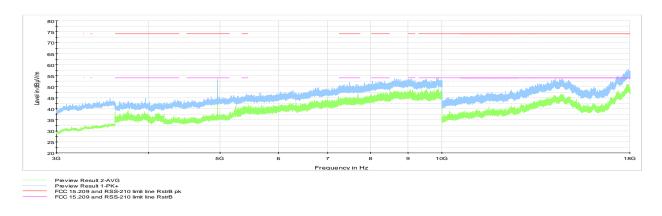


Figure 8.6-14: Radiated spurious emissions 3 to 18 GHz, High channel

Section 8 Testing data

Test name FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions

Specification FCC Part 15 Subpart C and RSS-247, Issue 2



 Table 8.6-4: Radiated field strength measurement results above 1 GHz

Channel	Frequency,	Peak Field strer	ngth, dBμV/m	Margin,	Average Field str	ength, dBμV/m	Margin,
Cilatillei	MHz	Measured	Limit	dB	Measured	Limit	dB
Low	2390	54.6	74.0	19.4	44.9	54.0	9.1
Low	4804	52.4	74.0	21.6	49.1	54.0	4.9
Mid	4879	51.0	74.0	23.0	45.8	54.0	8.2
High	2483.5	54.7	74.0	19.3	44.7	54.0	9.3
High	4960	53.7	74.0	20.3	49.5	54.0	4.5

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

Testing data

Test name Specification FCC Clause 15.247(e) and RSS-247 5.2(b) Power spectral density for digitally modulated devices FCC Part 15 Subpart C and RSS-247, Issue 2



8.7 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density for digitally modulated devices

8.7.1 Definitions and limits

FCC:

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

ISED:

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.7.2 Test date

8.7.3 Observations, settings and special notes

The test was performed using method PKPSD (peak PSD).

Spectrum analyser settings:

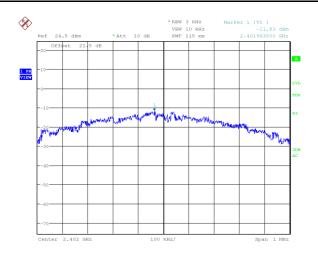
Resolution bandwidth:	3 kHz ≤ RBW ≤ 100 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	1.5 times the OBW
Detector mode:	Peak
Trace mode:	Maxhold



8.7.4 Test data

Table 8.7-1: PSD measurements results

Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
2402	-11.83	8.00	19.83
2440	-11.54	8.00	19.54
2480	-11.60	8.00	19.60



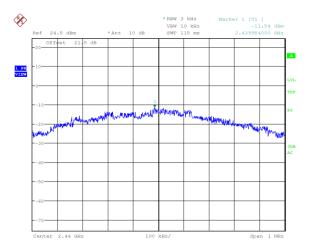


Figure 8.7-1: PSD plot on Low channel

Figure 8.7-2: PSD plot on Mid channel

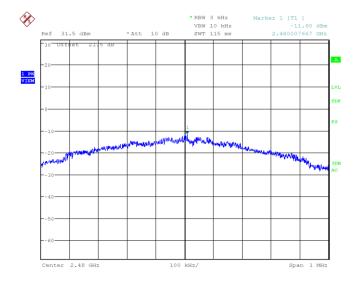


Figure 8.7-3: PSD plot on High channel



Section 8
Test name

Testing data
Occupied bandwidth

Specification FCC Part 15 Subpart C, ANSI C63.10-2013 and RSS-Gen, Issue 5

8.8 Occupied bandwidth - RFID

8.8.1 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).

8.8.2 Test date

|--|

8.8.3 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

8.8.4 Test data

Table 8.8-1: 99% bandwidth results

Frequency, MHz	99% bandwidth, kHz
13.56	2.199

Table 8.8-2: Lower 20 dBc frequency cross result

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.5600	13.5588	13.553	5.8

Table 8.8-3: Upper 20 dBc frequency cross result

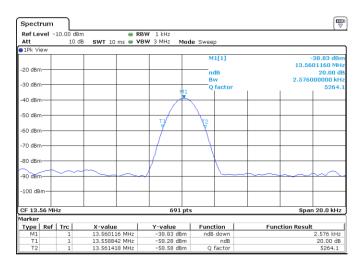
Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.5600	13.5614	13.567	5.6



Section 8
Test name

Testing data
Occupied bandwidth

Specification FCC Part 15 Subpart C, ANSI C63.10-2013 and RSS-Gen, Issue 5



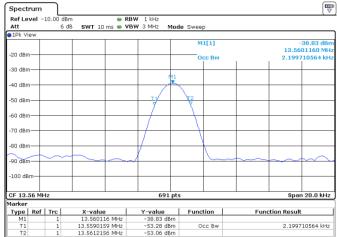


Figure 8.8-1: 20 dB bandwidth

Figure 8.8-2: 99% dB bandwidth



8.9 Field strength within 13.110-14.010 MHz band

8.9.1 References, definitions and limits

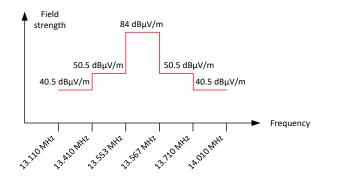
FCC §15.225:

- (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:

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



Field strength 124 dBμV/m

90.5 dBμV/m

90.5 dBμV/m

80.5 dBμV/m

80.5 dBμV/m

Frequency

23.10 mHt

13.53 mHt

13.53 mHt

13.71 mHt

13.71 mHt

13.71 mHt

Figure 8.9-1: In-band spurious emissions limit at 30 m

Figure 8.9-2: In-band spurious emissions limit at 3 m

8.9.2 Test date

Start date

August 31, 2018

8.9.3 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.

st 30 m to 3 m distance correction factor calculation (for 13 MHz band):

$$40 \times Log_{10}$$
 (3 m/30 m) = $40 \times Log_{10}$ (0.1) = -40 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	n bandwidth:	10 kHz
Video ban	dwidth:	30 kHz
Detector r	node:	Peak
Trace mod	de:	Max Hol

8.9.4 Test data

Table 8.9-1: Field strength measurements results at 30 m

Frequency, MHz	Measured field strength at 3 m, dBμV/m	Calculated field strength at 30 m, dBμV/m	Limit, dBμV/m	Margin, dB
13.56	51.9	11.9	83.9	72.0

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

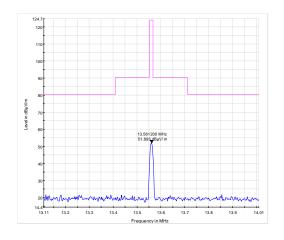


Figure 8.9-3: Field strength within 13.56 MHz mask



Section 8
Test name
Specification

Testing data

Field strength outside 13.110–14.010 MHz band FCC Part 15 Subpart C and RSS-210, Issue 10

8.10 Field strength outside 13.110-14.010 MHz band

8.10.1 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 8.10-1: 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 × 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

8.10.2 Test date

Start date August 31, 2018

8.10.3 Observations, settings and special notes

- The spectrum was searched from 9 kHz to 1 GHz.
- $-\hspace{0.4cm}$ 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 30 MHz:

Resolution bandwidth:	300 Hz (9–150 kHz)	9 kHz (above 150 kHz)		
Video bandwidth:	9 kHz (9–150 kHz)	30 kHz (above 150 kHz)		
Detector mode:	Quasi-Peak	Quasi-Peak		
Trace mode:	Max Hold	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

8.10.4 Test data

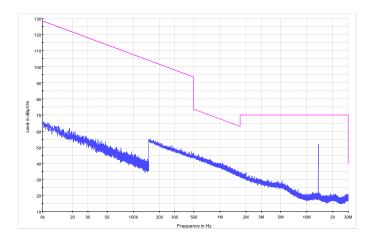


Figure 8.10-1: Field strength of spurious emissions below 30 MHz

Table 8.10-2: Radiated emissions (Quasi-Peak) results above 30 MHz

Frequency (MHz)	Quasi-Peak field strength¹ (dBμV/m)	3 m Quasi- Peak limit ³ (dBµV/m)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Antenna height (cm)	Pol. (V/H)	Turn table position (°)	Correction factor ² (dB)
30.240	32.2	40.0	7.8	100	120	121	Н	19	23.2
32.550	30.9	40.0	9.1	100	120	146	V	186	21.5
32.760	29.2	40.0	10.8	100	120	234	V	28	21.3

Notes:

- 1 Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)
- ² Correction factor = antenna factor ACF (dB) + cable loss (dB)
- ³ 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.

Sample calculation: 32.2 dB μ V/m (field strength) = 9.0 dB μ V (receiver reading) + 23.2 dB (Correction factor)



Section 8
Test name

Testing data
Frequency stability

Specification FCC Part 15 Subpart C and RSS-210, Issue 10

8.11 Frequency stability - RFID

8.11.1 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

8.11.2 Test data

Start date

8.11.3 Observations, settings and special notes

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

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

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

8.11.4 Test data

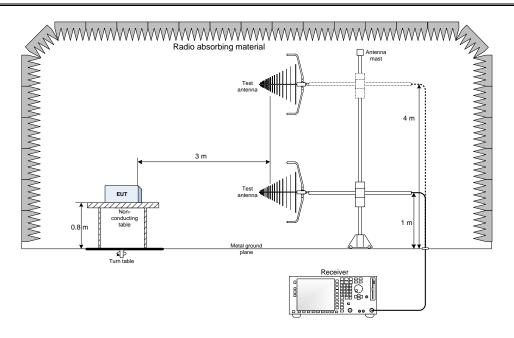
Table 8.11-1: Frequency drift measurements results

Test conditions	Frequency, MHz	Frequency drift, ±ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	13.560140	0	100	100
+20 °C, +15 %	13.560140	0	100	100
+20 °C, Nominal	13.560140	Reference	Reference	Reference
+20 °C, −15 %	13.560140	0	100	100
−20 °C, Nominal	13.560000	10.3	100	89.7

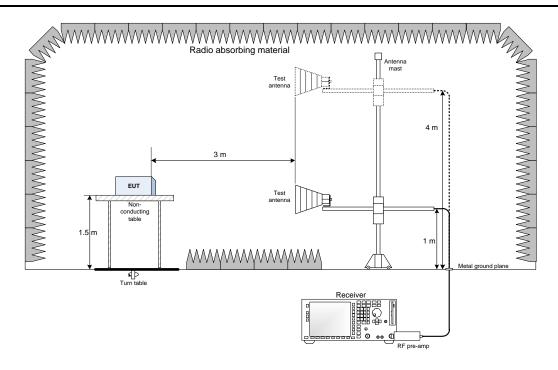


Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz

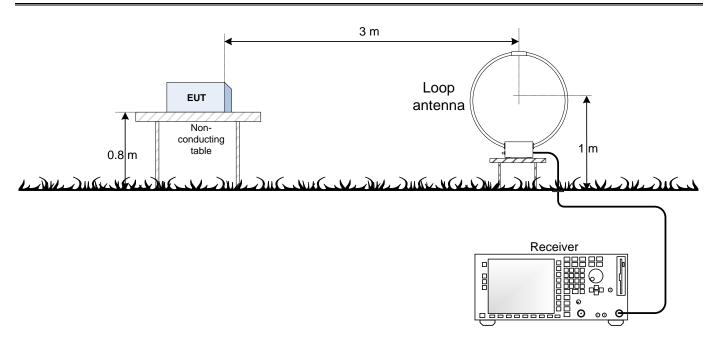


9.2 Radiated emissions set-up for frequencies above 1 GHz





9.3 Radiated emissions set-up below 30 MHz



9.4 Antenna port set-up

