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INTENTIONAL RADIATOR

TEST REPORT

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Laboratory Accreditations (per ISO/IEC 17025:2017)

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Manufacturer:	**Cooper Industries (Electrical) Inc.**
Address:	74 – 1833 Coast Meridian Rd. Port Coquitlam BC V3E 6G5, Canada
Equipment Tested:	**Wireless Remote**
Model Number(s):	TD110
FCC ID:	IA9TD1109
ISED ID:	IC:1338B-TD1109
ISED PMN:	TD110

Powering Business Worldwide

REVISION HISTORY

Date	Title	Details	Author's Initials
May 19, 2020	E10788-2004_TD110_FCC-ISED_**Rev-1.0**	Final	MK
April 2, 2020	E10788-2004_TD110_FCC-ISED_**Rev-0.0**	Initial draft	MK
All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.			

REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by the manufacturer. The tests were conducted on the sample equipment as requested by the manufacturer for the purpose of demonstrating compliance with the standards outlined in Section I of this report as agreed upon by the Manufacturer under the quote 20SH02052R1.

The Manufacturer is responsible for the tested product configurations, continued product compliance, and for the appropriate auditing of subsequent products as required.

This report may comprise a partial list of tests that are required for FCC and ISED Declaration of Conformity can only be produced by the manufacturer. This is to certify that the following report is true and correct to the best of our knowledge.

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QAI EMC ACCREDITATION

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EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
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EMC Facility Burnaby BC, Canada

TABLE OF CONTENTS

Section I: Executive Summary of Standards and Limits

1.1 Applicable Standards and Results

No.	Test	Report Section	Applicable Standard	Result
1	Antenna Requirement	3.1	FCC 47 CFR Part 15.203 RSS-Gen Issue 5 Section 7.1.2	Complies
2	20-dB Bandwidth	3.2	FCC 47 CFR Part 15.247(a)(1)(i) RSS-247 Issue 2 (5.1) (c)	Complies
3	Number of Channels	3.3	FCC 47 CFR Part 15.247(a)(1)(i) RSS-247 Issue 2 (5.1) (c)	Complies
4	Channel Separation	3.4	FCC 47 CFR Part 15.247(a)(1) RSS-247 Issue 2 (5.1) (b)	Complies
5	Time of Occupancy	3.5	FCC 47 CFR Part 15.247(a)(1)(i) RSS-247 Issue 2 (5.1) (c)	Complies
6	Hopping Requirements	3.6	FCC 47 CFR Part 15.247(a)(1) RSS-247 Issue 2 (5.1) (a)	Complies
7	Max. Peak Conducted Output Power	3.7	FCC 47 CFR Part 15.247(a)(1) RSS-247 Issue 2 (5.1) (b)	Complies
8	Out-of-Band Emissions (Bandedge)	3.8	FCC 47 CFR Part 15.247(d)	Complies
9	Radiated Spurious Emissions	3.9	FCC Subpart C §15.205(a), §15.209 (a) & §15.247 (d) FCC Title 47 CFR Part 15: Subpart B - §15.109 RSS-Gen Issue 5 (8.9), (8.10) ICES-003 Issue 6	Complies
10	Spurious Emissions – Receiver Mode	3.10	FCC Title 47 CFR Part 15: Subpart B - §15.109 ICES-003 Issue 6	Complies
11	RF Exposure Evaluation	3.11	FCC 47 CFR §2.1093 (e) & 1.1310 (d) KDB 447498 D01 v06 (4.2.3) RSS-102 (2.5.1)	Complies

The tests documented in this report were performed in accordance with ANSI C63.4-2014, ANSI C63.10-2013, and KDB 447498 D01 General RF Exposure Guidance v06

1.2 Product Description

The information provided in this section is for the Equipment Under Test (EUT) and the corresponding Auxiliary Equipment needed to perform the tests as a complete system.

EUT - Conducted (L) and Radiated Unit (R)

Equipment Under Test (EUT)

Equipment	Description	Manufacturer	Model No.	Serial No.
2-Way Handheld Wireless Remote	With Rechargeable battery	Cooper Industries (Electrical) Inc.	TD110	1396908
Clock frequencies tuned upon within the EUT:	1.625MHz, 2.4MHz, 13MHz			
Highest frequency generated within the EUT:	927.7MHz			

Equipment Under Test (EUT) - RF Information

RF device type	Transceiver
Operating frequency	902.2MHz – 927.7MHz
Number of available channels/Transmitter	256 (1/4 used at a time)
Channel separation	400 kHz
Channel bandwidth	25 kHz
Output Power/Transmitter	11.52 dBm (conducted) – non-adjustable
Modulation type	2-level FSK
Test Channels (L, M, H)	920.2, 914.9, 927.7MHz
Data Rate2	10416 BAUD
Adaptive	No
Geo-location-capable	No
Number of antennas	1
Antenna type	Chip (non-detachable)
Antenna gain	0.3 dBi

Equipment Under Test (EUT) - General Information

Tested as	Table-top
Dimensions	13.5 x 7.1 x 3.3 (cm)
Declared operating temperature range:	-200 to +70C
Input power	Internal battery
Grounded	No
Device use	Portable (within 20 cm of human body)

Note: EUT has not I/O cables.

Test Modes

Test	Transmitter state	Power
Pre-scans	1) Modulated fixed-frequency transmission 2) Hopping 3) Receiver mode	1) Battery-operated 2) Charging

EUT Input Power

Type	Count	Description	Output	Manufacturer	Model #
Cylindrical LiFePO4 Battery	1	220mAH lithium polymer	1200mAh 3.2V	Howell	14500-2P

Auxiliary Equipment Information

Equipment	Count	Specification	Manufacturer	Model No.	Serial No.
Wireless battery charger pad	1	TD110 Charge Cradle	Cooper Industries (Electrical) Inc.	TD1000 Charge Cradle	--
Car Battery	1	Output: 12VDC	Nautilus	Marine/RV	N/A

1.3 Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

Parameter	Conditions
Location	Indoors
Temperature	21ºC
Relative Humidity	59.4%
Atmospheric Pressure	101kPa

1.4 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Radio Frequency	±1.5 x 10-5 MHz
Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1ºC
Humidity	±5 %
DC and low frequency voltages	±3 %

1.5 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohdes & Schwarz. Transducer factors like Antenna factors, Cable Losses and Amplifier gains were stored in the test templates which are used to perform the emissions measurements. After test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

Frequency (MHz)	Q-Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable Position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

Quasi-Peak reading shown in the table above is already corrected by the software using correction factor shown in column "Corr." The correction factor listed under "Corr." table calculated as:

Corr.(dB) = Antenna factor + Cable loss

Or

Corr.(dB) = Antenna factor + Cable Loss - Amp gain (if pre-amplifier was used)

The final Quasi peak reading shown in the data is calculated by the software using following equation:

Corrected Quasi-Peak (dBµV/m) = Raw Quasi-Peak Reading + Antenna factor + Cable loss

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

Frequency (MHz)	Q-Peak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	44.3	1000.000	9.000	GND	0.6	21.7	66.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	27.2	1000.000	9.000	GND	0.6	28.8	56.0

Quasi Peak or Average reading shown in above table is already corrected by the software using the correction factor shown in column "Corr." The correction factor listed under "Corr." table calculated as:

Corr.(dB) = Antenna factor + Cable loss

The final Quasi-peak or Average reading shown in the data is calculated by the software using following equation:

Corr. Quasi-Peak/Average Reading (dBµV) = Raw Quasi-Peak/Average Reading + Antenna factor + Cable loss

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

Margin(dB) = Limit – Quasi-Peak or Average reading

1.6 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories in conducting all tests on the Equipment Under Test (EUT) as per Section 1.

Emissions Test Equipment

Sl. NO.	Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
1	ETS Lindgren	2165	Turntable	00043677	N/A	N/A
2	ETS Lindgren	2125	Mast	00077487	N/A	N/A
3	EMCO	6502	Loop Antenna 9 kHz – 30 MHz	2016	N/A	2022-Feb-19
4	Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	N/A	2020-Nov-10
5	ETS-Lindgren	3117	Horn Antenna 1GHz-18GHz	75944	N/A	2020-Aug-29
7	Rohde & Schwarz	ESU40	EMI Receiver	100011	EMC32 v10.35.10/ FV 4.73 SP4	2019-Dec-01
8	Hewlett Packard	8449B OPT H02	Preamplifier (1-26.5GHz)	2933A00198	N/A	2022-Jun-22
9	Rohde & Schwarz	FSU	Spectrum Analyzer 20 Hz – 67 GHz	101388	N./A	2022-Jan-19
10	Rohde & Schwarz	NRP	Power Meter	101283	N/A	2021-Feb-18
11	ETS Lindgren	S201	5-meter Semi Anechoic Chamber	1030	N/A	N/A

Note: Equipment listed above have 3 years calibration interval.

Measurement Software List

Sl. No.	Manufacturer	Model	Version	Description
1	Rhode & Schwarz	EMC 32	6.20.0	Emissions Test Software

Section II: DATA & TEST RESULTS

2.1 Antenna Requirements

- **Test Standard:** FCC 47 CFR Part 15.203 and RSS-Gen Issue 5 (7.1.2)

- **Requirement:**

The purpose of this requirement is to make certain that no other antenna, except for that provided by the responsible party, shall be used with the Equipment-Under-Test (EUT) as defined in FCC CFR 47 Part 15.203 & RSS-Gen Issue 5:

"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 the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited." … "the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded."

- **Antenna Information:**

Manufacturer	Linx
Part number	ANT 916 uSP
Center frequency	916 MHz
Dimensions	0.5" x 0.36" x 0.10"
Connection	Surface-mount
Bandwidth	25 MHz
Wavelength	¼-wave
VSWR	=<0.2 typycal at center
Peak gain	0.3 dBi
Impedance	50 Ohms

Result:

An integrated antenna is used on this product and is not field-replaceable.
EUT Complies.

2.2 20-dB Bandwidth

- **Date Performed:** March 6, 2020

- **Requirement:**

  For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

- **Test Set-up:**

  Conducted measurement at antenna port using spectrum analyzer.

  Span = 70 kHz. RBW = 200 Hz, VBW = 100 kHz

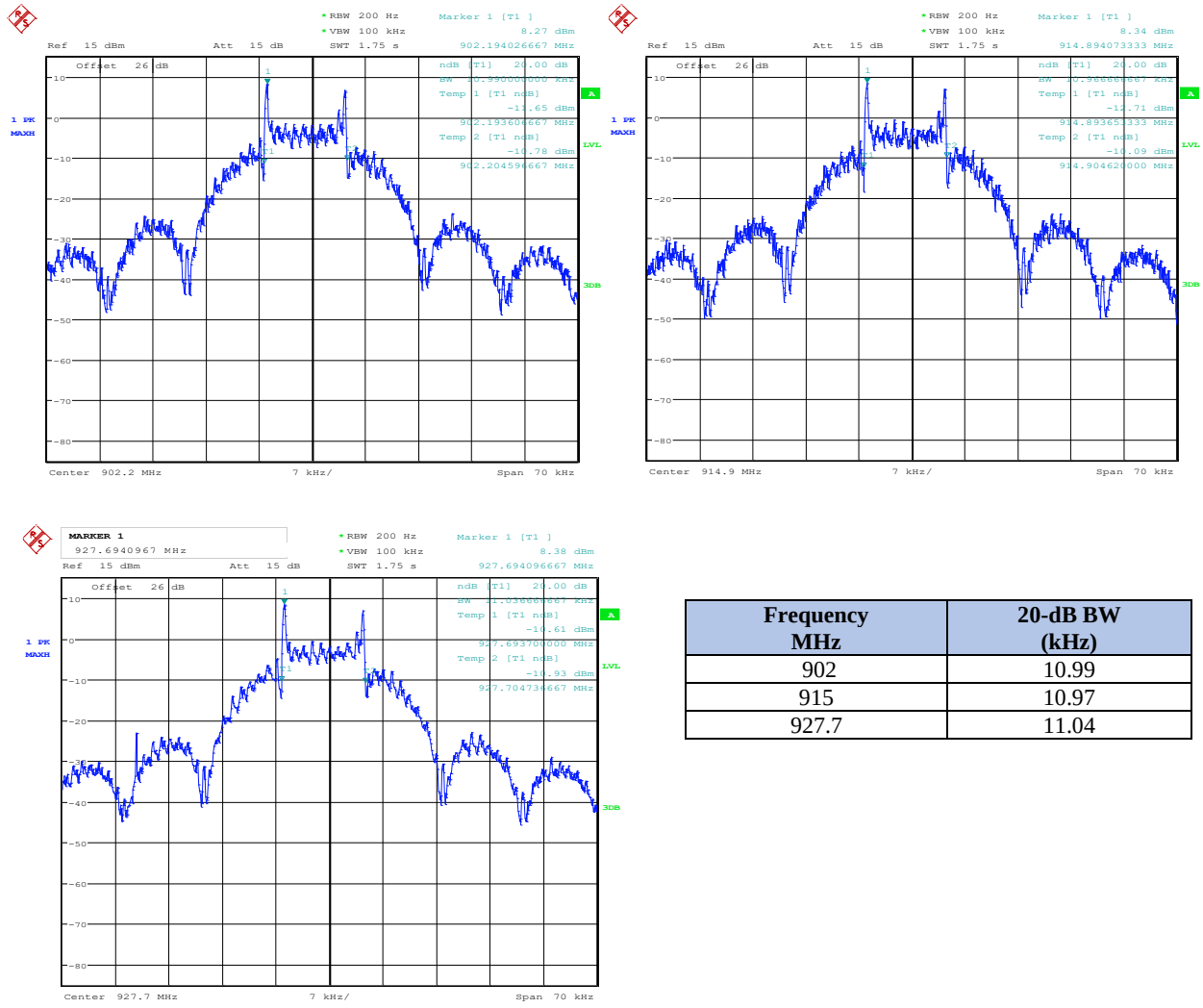
- **Modifications:**

  EUT configured to transmit at 100% duty cycle at fixed modulated frequency. Integrated antenna removed.

- **Result:**

  20-dB Bandwidth is less than 250 kHz.

- **Plot:**



Frequency MHz	20-dB BW (kHz)
902	10.99
915	10.97
927.7	11.04

Clockwise from top left: Channel L, M and H

2.3 Number of Channels

- **Date Performed:** March 6, 2020

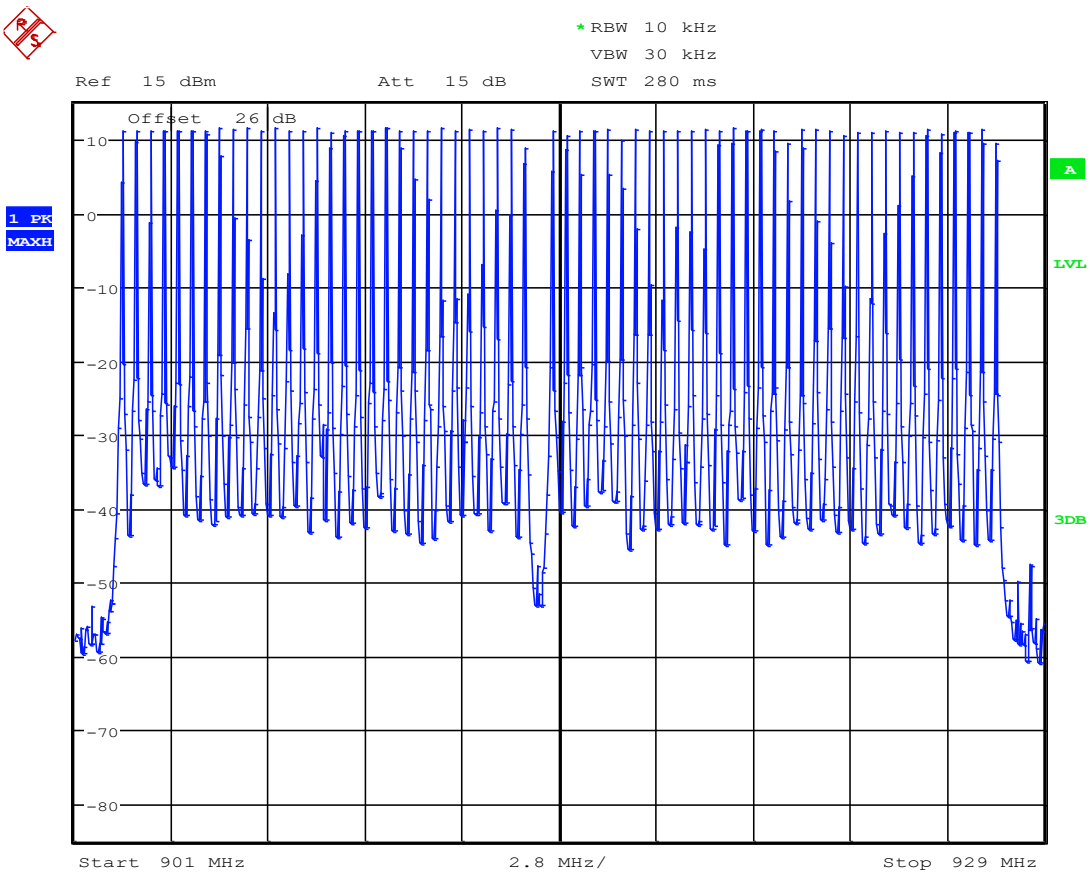
- **Requirement:**
  For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

- **Test Set-up:**
  Conducted measurement at antenna port using spectrum analyzer.
  Span = 28 MHz, RBW = 10kHz, VBW = 30 kHz
  Sweep time: 280 ms, trace stabilization time: 3.5 minutes.

- **Modifications:**
  EUT configured to transmit at 100% duty cycle in frequency hopping mode. Integrated antenna removed.

- **Result:**
  EUT uses 63 channels > 50. EUT complies.

- **Plot:**



Number of channels

2.4 Channel Separation

- **Date Performed:** March 6, 2020

- **Requirement:**

  Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

- **Test Set-up:**

  Conducted measurement at antenna port using spectrum analyzer.

  Span = 2 MHz.

  RBW = 10kHz, VBW = 30 kHz

  Sweep time: 20 ms.

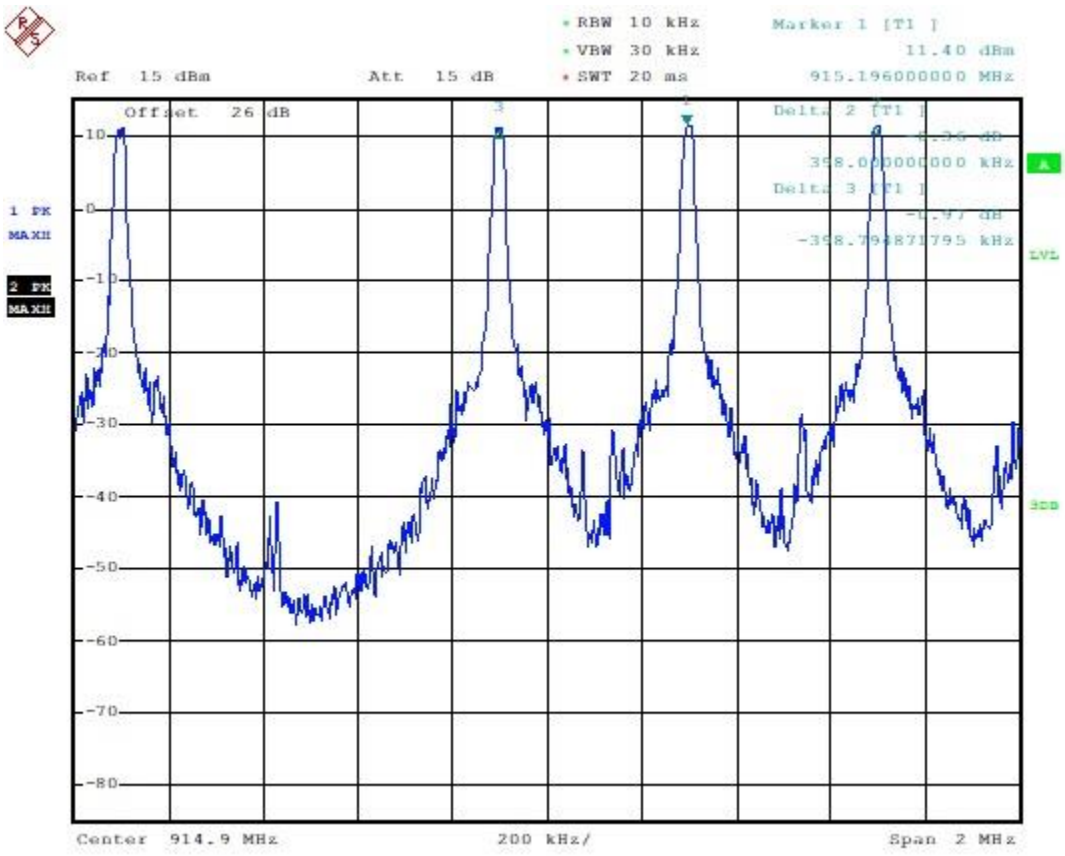
- **Modifications:**

  EUT configured to transmit at 100% duty cycle in frequency hopping mode. Integrated antenna removed.

- **Result:**

  Channel separation is 399 kHz > max. (25 kHz, 11 kHz). EUT complies.

- **Plot:**



Channel separation

2.5 Time of Occupancy

- **Date Performed:** March 6, 2020

- **Requirement:**

  For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

- **Test Set-up:**

  Conducted measurement at antenna port using spectrum analyzer.

  Span = 0 Hz.

  RBW = 10kHz, VBW = 30 kHz

  Sweep time: 20 s.

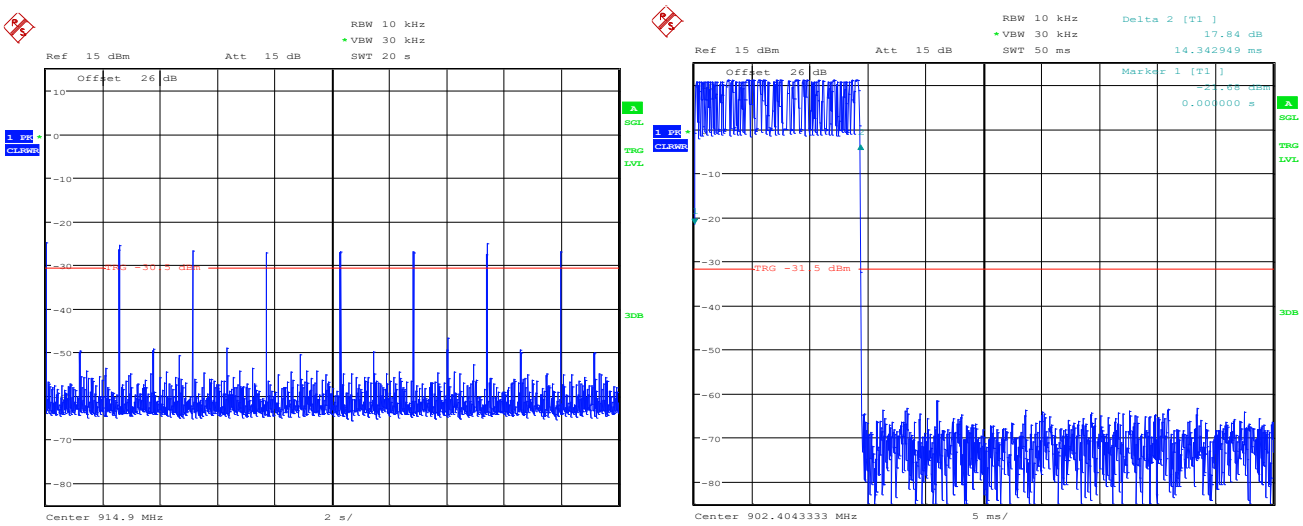
- **Modifications:**

  EUT configured to transmit at 100% duty cycle in frequency hopping mode. Integrated antenna removed.

- **Result:**

  Time of occupancy is 114.8 ms < 400 ms. EUT complies.

- **Plots and table:**



Bursts in 20 s (L) and duty cycle of each burst (R)

Test Channel (MHz)	Number of Bursts in 20 s	Burst Duty Cycle (ms)	Time of Occupancy (ms)
915	8	14.35	114.8

2.6 Hopping Requirements

- **Date Performed:** March 6, 2020

- **Requirement:**

  The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

- **Manufacturer's Description of Hopping:**

  The TD110 transceiver module can be set to operate on any of 256 frequency channels in the 902.2 – 927.7 MHz band. The frequencies are divided into four groups of 64 frequencies, each group using every fourth available frequency. These 64 frequencies in a group are then used equally by the spread spectrum transmitter in a pseudo random sequence.

  The hop sequence is a sequence of 63 numbers randomly generated with a Reed-Solomon algorithm. The unique serial number of the transmitter is used as a seed to the random number generator. The list of 63 numbers (channels) is used to lookup in the frequency table to determine the next transmit frequency.
  Here are the first five sequences:
  Seq(1): 0 59 54 35 44 7 6 45 24 28 13 50 11 42 26 56 47 34 55 27 25 43 36 9 21 15 20 10 51 33 48 61 30 18 4 23 46 57 53 60 49 14 22 5 8 37 17 31 41 12 29 62 39 3 19 16 38 63 2 40 32 52 58
  Seq(2): 59 0 60 55 36 45 8 7 46 25 29 14 51 12 43 27 57 48 35 56 28 26 44 37 10 22 16 21 11 52 34 49 62 31 19 5 24 47 58 54 61 50 15 23 6 9 38 18 32 42 13 30 63 40 4 20 17 39 1 3 41 33 53
  Seq(3): 54 60 0 61 56 37 46 9 8 47 26 30 15 52 13 44 28 58 49 36 57 29 27 45 38 11 23 17 22 12 53 35 50 63 32 20 6 25 48 59 55 62 51 16 24 7 10 39 19 33 43 14 31 1 41 5 21 18 40 2 4 42 34
  Seq(4): 35 55 61 0 62 57 38 47 10 9 48 27 31 16 53 14 45 29 59 50 37 58 30 28 46 39 12 24 18 23 13 54 36 51 1 33 21 7 26 49 60 56 63 52 17 25 8 11 40 20 34 44 15 32 2 42 6 22 19 41 3 5 43
  Seq(5): 44 36 56 62 0 63 58 39 48 11 10 49 28 32 17 54 15 46 30 60 51 38 59 31 29 47 40 13 25 19 24 14 55 37 52 2 34 22 8 27 50 61 57 1 53 18 26 9 12 41 21 35 45 16 33 3 43 7 23 20 42 4 6
  After the receiver reaches the last channel it starts again from the beginning.

- **Result:**

  EUT complies.

2.7 Max. Peak Conducted Output Power

- **Date Performed:** March 6, 2020

- **Requirement:**
  The maximum peak conducted output power of the intentional radiator shall not exceed the following:
  For frequency hopping systems operating in the 902-928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels.

- **Test Set-up:**
  Conducted measurement at antenna port using power meter.

- **Modifications:**
  EUT configured to transmit at 100% duty cycle at fixed modulated frequency. Integrated antenna removed.

- **Result:**
  Max. peak conducted output power is < 30 dBm. EUT complies.

- **Measurements:**

Frequency MHz	Output Power (dBm)
902	11.52
915	11.42
927.7	11.33

2.8 Out-of-Band Emissions (Band edge)

- **Date Performed:** March 6, 2020

- **Requirement:**
  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.

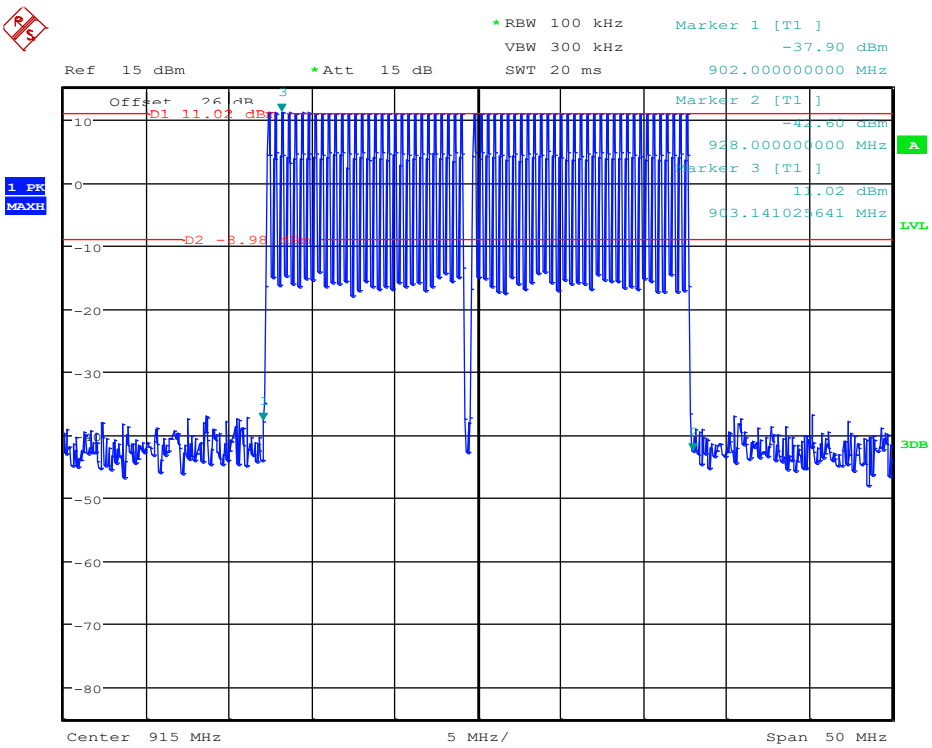
- **Test Set-up:**
  Conducted measurement at antenna port using spectrum analyzer.
  Span = 50 MHz, RBW = 100 kHz, VBW = 300 kHz
  Attenuation: 15 dB, trace stabilization time: 3.5 minutes.

- **Modifications:**
  EUT configured to transmit at 100% duty cycle with integrated antenna removed 1) in hopping mode, and 2) at lowest and highest frequency – modulated.

- **Result:**
  EUT complies.

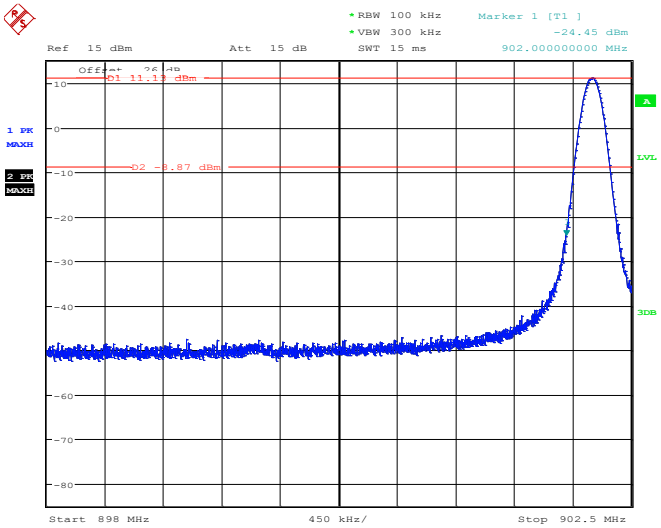
- **Plots:**

  1) <u>Hopping mode:</u>

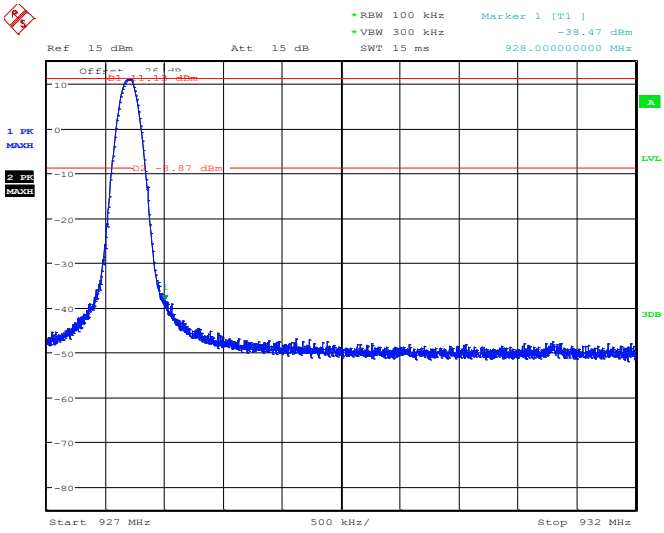


Band edge – hopping mode

2) Lowest and highest frequencies:



Band edge at lowest freq. 902 MHz



Band edge at highest freq. 927.7 MHz

2.9 Radiated Spurious Emissions

- **Test Standards:**

Test or Measurement	Applicable Standards	Investigated Spectrum
Radiated Emissions	ICES-003 Issue 6 CFR Title 47 FCC Part 15 Subpart B	The radiated emissions are measured in the 30-1000MHz range or **upto** the highest EUT frequency required by the standard.
	RSS-247-Issue 2, RSS-Gen Issue 5 (8.9) & (8.10) FCC Subpart C §15.205(a), 15.209(a) & 15.247(d) and 15.33(a)(1) & (4)	From the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

- **Required Limits:**

1) Radiated emission limits; general requirements – unintentional radiators:

The field strength of radiated emissions from a Class A digital device, as determined at a distance of 3 meters, shall not exceed the following as per §15.109:

Frequency, *f* (MHz)	Maximum Field strength Quasi-peak (dBµV/m at 3 m)
30 – 88	49.50
88 – 216	53.5
216 – 960	56.0
above 960	59.50
Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges. **Note 2:** The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.	

2) Radiated emission limits; general requirements – intentional radiators:

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table as per §15.209:

Frequency, *f* (MHz)	Maximum Field strength Quasi-peak (dBµV/m at 3 m)
0.009 – 0.490	2400/F(kHz)
0.490 – 1.705	24000/F(kHz)
1.705 – 30.0	49.5
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	54.0
Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges. **Note 2:** The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.	

Maximum Field Strength (dB mV/m at 3 m)		
Frequency (GHz)	**Peak**	**Average**
1-40	60	80
Note 1: The lower limit shall apply at the transition frequency **Note 2**: Additional provisions may be required for cases where interference occurs		

2) Restricted bands of operation:

Unwanted emissions that fall into the restricted bands specified on the table below shall comply with the limits specified on the table limits above as per §15.209 and Clause 8.9 of RSS-Gen.

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

* Certain frequency bands listed in table 7 and in bands 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.

Restricted Bands – RSS Gen Issue 5

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]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	([2])
13.36-13.41			

Restricted Bands – FCC Part

Measurement Method:

The EUT was positioned at the edge of the turntable in the 3m SAC with all cables draped down the side, 40 cm off the ground plate. EUT was rotated 360 deg at each antenna height to identify maximum emissions. Emissions were measured in the frequency range of 10 kHz – 12 GHz using the appropriate components and equipment.

Emissions in both horizontal and vertical polarizations were measured. EUT was placed 3 m from the antenna. 30 MHz – 12 GHz: antenna height was varied 1-4 m. 10 kHz – 30 MHz: antenna fixed at 150 cm height.

Permutations of test modes listed in table below was investigated. Only worst case reported.

Refer to Section 2.4 of this report for Sample Calculations of Emissions Data.

- **Test Configurations:**

Input power test modes	1) Battery-operated, 2) charging
Transmission test modes	1) Hopping 2) modulated fixed freq. (L, M, & H), 3) receiver
EUT orientation	xy, yz and xz planes

- **Modifications:**

EUT with integrated antenna configured using firmware to transmit at 100% RF duty cycle in transmission modes above.

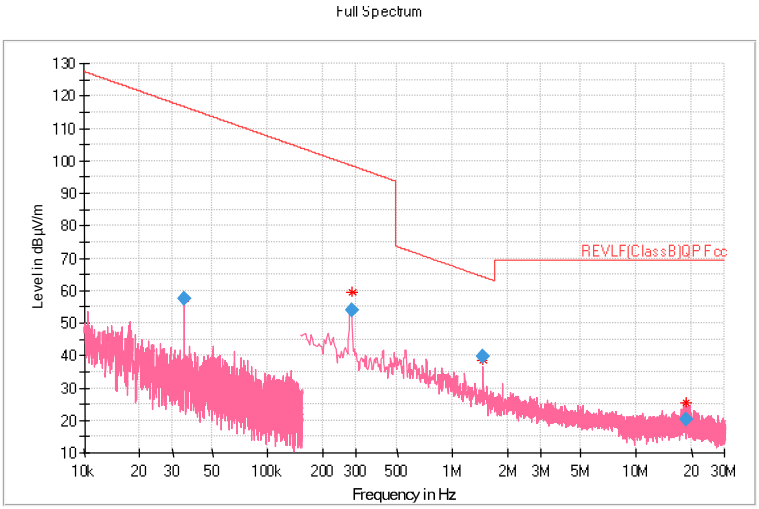
Result: The EUT complies with the applicable standards.

Measurement Data:

Only data for settings in Test Configurations yielding the worst case presented for each section.

Part 1 10kHz – 30 MHz

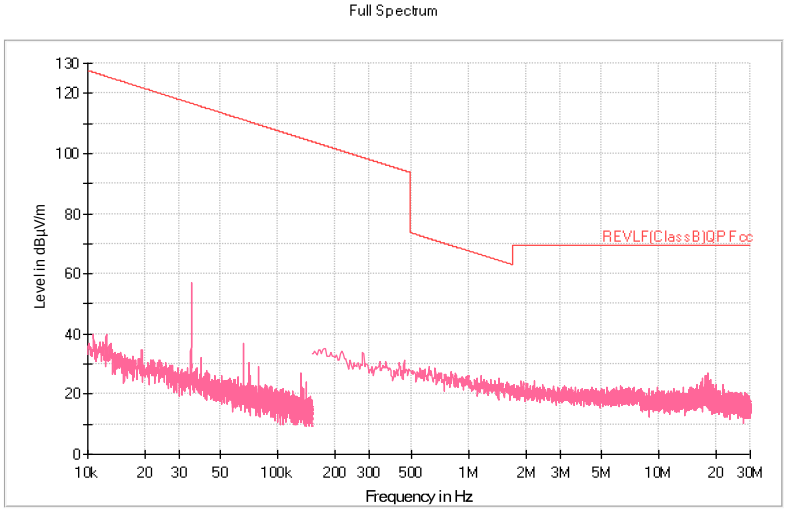
- **Date performed:** February 28, 2020
- **Worst case:** hopping, charging.



Polarization: perpendicular, vertical:

Table 1: Quasi-Peak Data of Radiated Emissions measured at 3m–FCC /ISED Class B Limit – for reference only

Frequency (MHz)	Quasi Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB)
0.035032	57.66	116.70	59.04	1000.0	0.200	202.0	23.1
0.283284	54.15	98.56	44.41	1000.0	9.000	64.0	20.2
1.471008	39.86	64.28	24.42	1000.0	9.000	0.0	20.9
18.657822	20.26	69.50	49.24	1000.0	9.000	63.0	21.1



Polarization: perpendicular, horizontal

Note: No significant emissions observed within 20 dB of the limit.

Part 2 30 MHz – 1 GHz

- **Date performed:** February 28, 2020
- **Worst case:** hopping, charging.

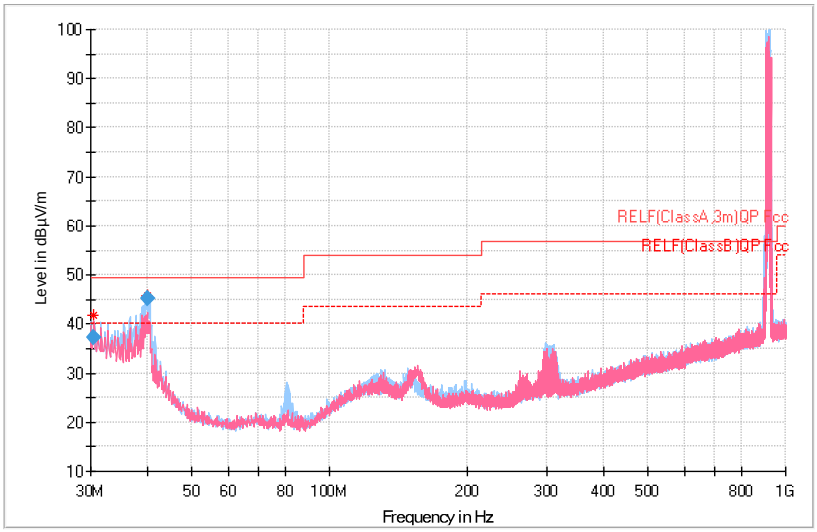


Table 2: Quasi-Peak Data of Radiated Emissions measured at 3m–FCC /ISED Class A Limit

Frequency (MHz)	Quasi Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.496220	37.34	49.50	12.16	390.0	H	332.0	27.4
39.932880	45.28	49.50	4.22	148.0	H	248.0	21.1

Part 3 1 – 12 GHz

- **Date performed:** February 28, 2020
- **Worst case:** hopping, charging.

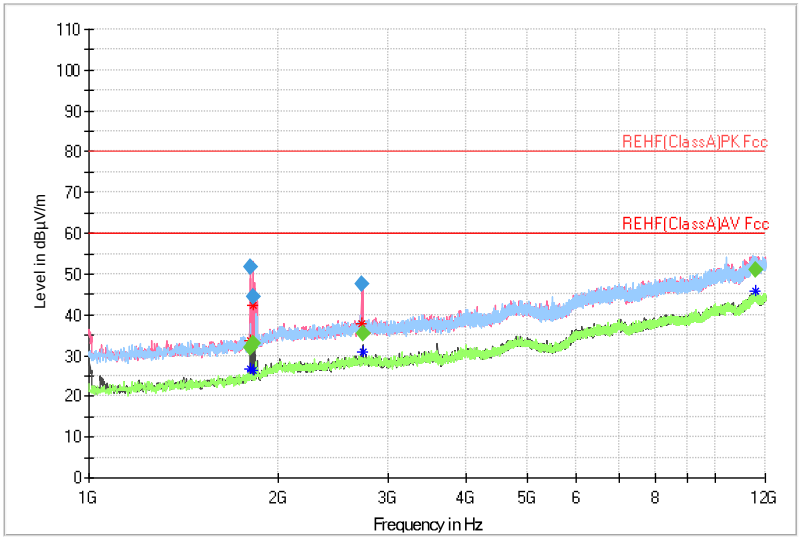


Table 3: Max-peak and Average Data of Radiated Emissions measured at 3m–FCC /ISED Class A Limit

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Corr. (dB)
1806.830400	---	31.99	60.00	28.01	1000.0	1000.000	161.0	-2.8
1807.608000	51.65	---	80.00	28.35	1000.0	1000.000	152.0	-2.8
1824.708000	44.54	---	80.00	35.46	1000.0	1000.000	161.0	-2.6
1825.331600	---	33.04	60.00	26.96	1000.0	1000.000	161.0	-2.6
2723.339600	47.62	---	80.00	32.38	1000.0	1000.000	233.0	1.4
2737.635200	---	35.35	60.00	24.65	1000.0	1000.000	161.0	1.5
11564.276000	---	50.99	60.00	9.01	1000.0	1000.000	161.0	18.4

Part 4 30 MHz – 1 GHz - OATS

- **Date performed:** March 12, 2020
- **Worst case:** Receiver mode, charging.
- **Test engineer:** Rick Hiebert
- **Result:** No emissions observed above the noise floor.

2.10 Spurious Emissions – Receiver Mode

- **Date Performed:**
- N/A

- **Test Standard:**
- FCC Title 47 CFR Part 15: Subpart B - §15.109
- ICES-003 Issue 6

- **Test Method:**
- ANSI C63.4-2014

- **Required Limit:**
- The field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

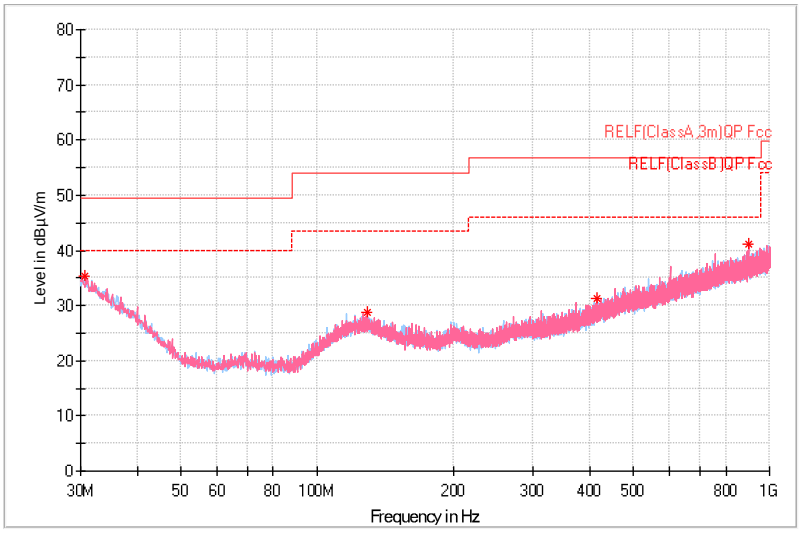
Frequency, *f* (MHz)	Maximum Field strength Quasi-peak (dBµV/m at 3 m)
30 – 88	49.50
88 – 216	53.5
216 – 960	56.0
above 960	59.50

Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.
Note 2: The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

- **Modifications:**
- EUT with integrated antenna was set in receive mode.

- **Result:**
- EUT complies with the applicable standard.

- **Plot:**



Receiver mode – no significant emissions observed above the noise floor.

2.11 RF Exposure Evaluation

- **Date Performed:**

  March 13, 2020

- **Requirements:**

A) KDB 447498

4.2.3. Extremity exposure conditions: Devices that are designed or intended for use on extremities, or mainly operated in extremity only exposure conditions, i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation.26 When the device also operates in close proximity to the user's body, SAR compliance for the body is also required. The 1-g body and 10-g extremity SAR Test Exclusion Thresholds in 4.3 should be applied to determine SAR test requirements.

4.3. General SAR test exclusion guidance: (a) For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR,30 where f(GHz) is the RF channel transmit frequency in GHz.

When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

B) RSS-102 Section:

2.5.1 RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is less than or equal to 20 cm, **except** when the device operates as follows:

- from 3 kHz up to 1 GHz inclusively, and with output power (i.e. the higher of the conducted or equivalent isotropic ally radiated power (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 200 mW for general public use and 1000 mW for controlled use;

- **Result:**

EUT complies with required standards.

- **EIRP Calculations:**

Carrier Frequency	RF Peak Output Power Conducted	Peak Antenna Gain	EIRP	
MHz	dBm	dBi	dBm	mW
902.2	11.52	0.3	11.82	15.21
914.9	11.42	0.3	11.72	14.86
927.7	11.33	0.3	11.63	14.56

EIRP (dBm) = RF Peak Output Power (from Report section 3.7)(dBm) + Antenna Gain (dBi)

- **RF Exposure Evaluation:**

A) KDB 447498

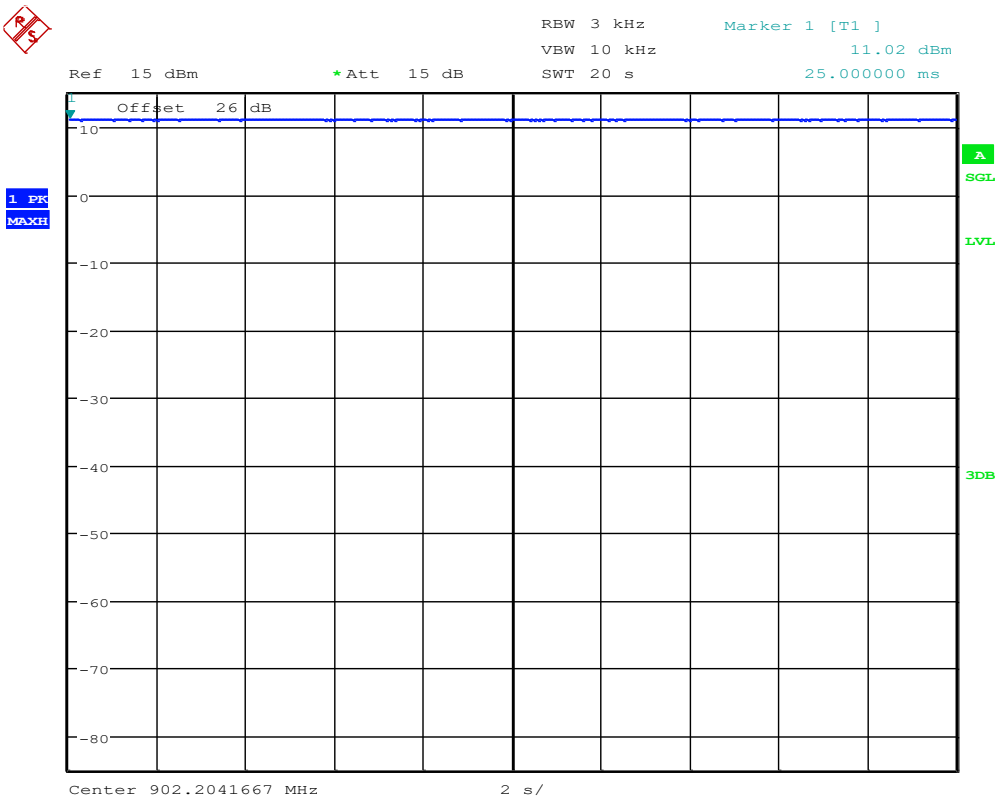
Frequency (MHz)	Min. separation (mm)	Exclusion Thresholds	Limit 1-g SAR	Limit 10-g SAR	Result
902.2	5	2.86	3.0	7.5	Exempt
914.9	5	2.82	3.0	7.5	Exempt
927.7	5	2.73	3.0	7.5	Exempt

B) RSS-102:

Frequency (MHz)	Peak EIRP (mW)*	Limit General Public (mW)	Limit Controlled Use (mW)	Result
902.2	15.21	200	1000	Exempt
914.9	14.86	200	1000	Exempt
927.7	14.56	200	1000	Exempt

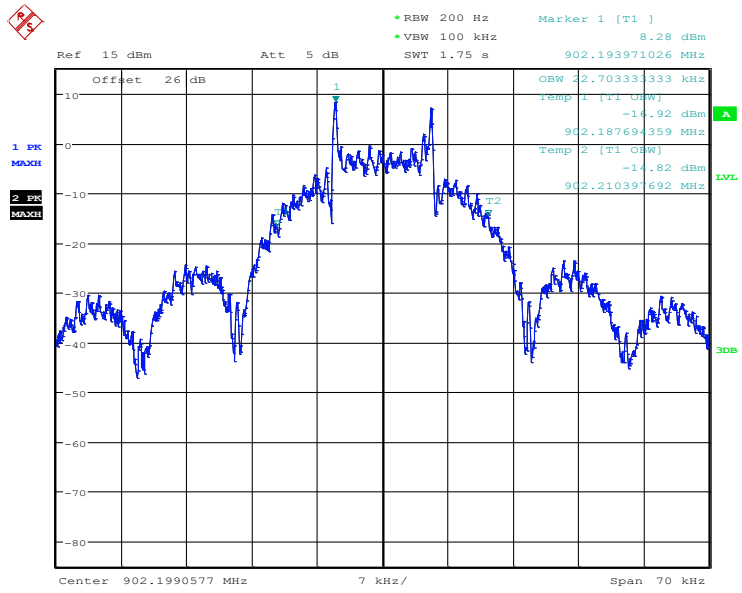
*Time-averaged EIRP < Peak EIRP

Appendix A: Test Duty Cycle Plot – for reference only

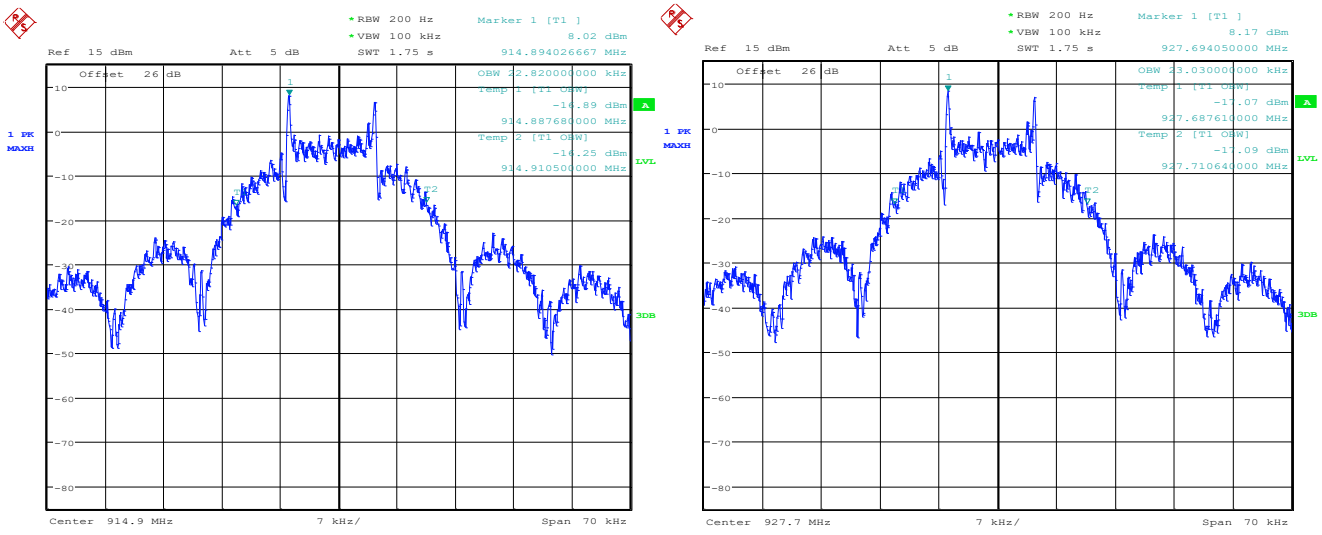


Low, Mid and High Channels

Appendix B: Occupied Bandwidth Plots – for reference only



Low Channel



Mid (L) and High (R) channels

Appendix C: Test Set-up Photos

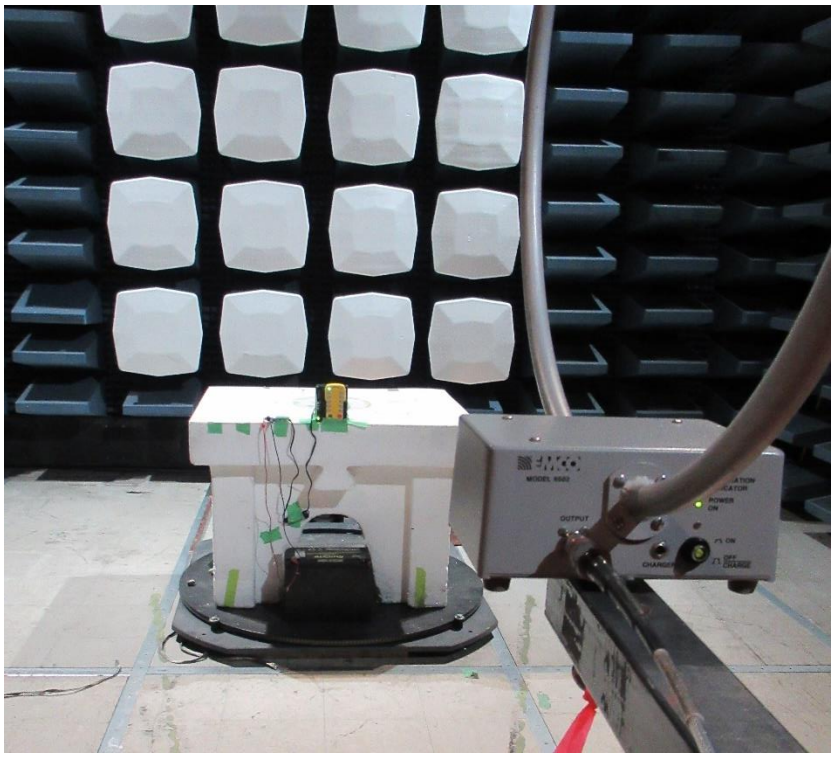


Figure 1: Radiated Emissions 10 kHz – 30 MHz

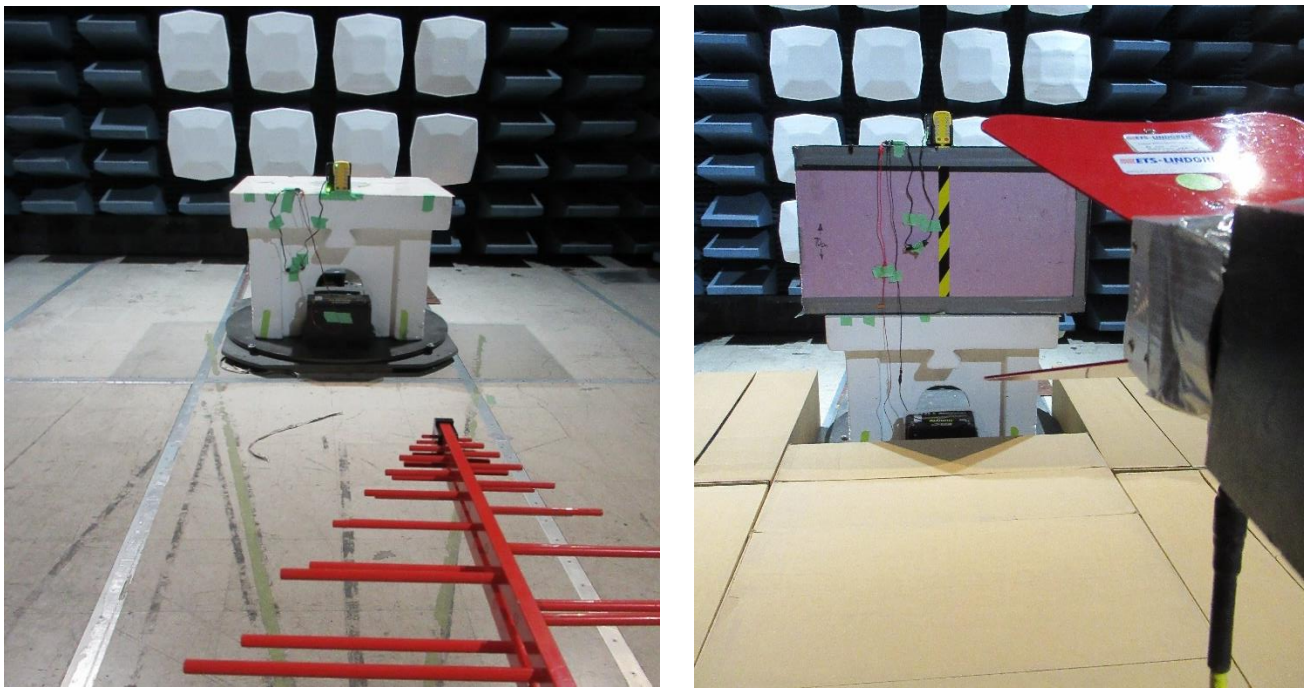


Figure 1: Radiated Emissions 30 MHz – 1 GHz (L) and 1-12 GHz (R)

Figure 3: Radiated Emissions 30 MHz – 1 GHZ - OATS

Figure 4: Max Peak Conducted Output Power Measurements

Appendix D: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
CE	European Conformity
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
DC	Direct Current
EFT	Electrical Fast Transient
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
IC	Industry Canada
ICES	Interference Causing Equipment Standard
IEC	International Electrotechnical Commission
LISN	Line Impedance Stabilizing Network
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root-Mean-Square
SAC	Semi-Anechoic Chamber

END OF REPORT