

COMPLIANCE WORLDWIDE INC. TEST REPORT 350-20R1

In Accordance with the Requirements of
Federal Communications Commission CFR Title 47 Part 15.225, Subpart C
Innovation, Science and Economic Development Canada
RSS 210, Issue 10
Low Power License-Exempt Radio Communication Devices
Intentional Radiators

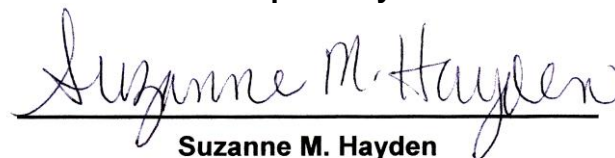
Issued to
Alert Innovation
101 Billerica Ave - Bldg 5
North Billerica, MA 01862

for the
AlphaBot
13.56 MHz RFID Reader Module

FCC ID: 2AYRD-ALPHABOT
IC: 26910-ALPHABOT

Report Issued on March 31, 2021
Revision R1 Issued on August 30, 2021

Prepared by



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1. Scope

This test report certifies that the AlphaBot 13.56 MHz RFID Reader, as tested, meets the FCC Part 15.225 Subpart C, and ISED Canada RSS 210 requirements. The scope of this test report is limited to the test samples provided by the client, only in as much as those samples represent other production units. If any significant changes are made to the units, the changes shall be evaluated, and a retest may be required. Revision R1 adds the firmware revision to this page in the report and updated the RF Exposure for simultaneous transmission of the RFID and WLAN radios within the host product.

2. Product Details

2.1. Manufacturer:	Alert Innovation
2.2. Model Number:	AlphaBot RFID Reader Module
2.3. Serial Numbers:	B01-000-021X
2.4. Description:	Robot cart for micro fulfillment.
2.5. Power Source:	208 VAC \pm 10%, 60 Hz External Power or 30-70V through maintenance port, typically super-capacitor powered
2.6. Hardware Revision:	N/A
2.7. Software/Firmware Revision:	0.18.5.1
2.8. Modulation Type:	Pulse Modulation
2.9. Operating Frequency:	13.56 MHz
2.10. EMC Modifications:	None

3. Product Configuration

3.1. Operational Characteristics & Software

The AlphaBot with Dual RFID Readers was configured to continuously transmit its 13.56 MHz RFID signal upon completion of its self-initialization routine.

3. Product Configuration (continued)

3.2. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Volts	Freq (Hz)	Description/Function
Alert Innovation	AlphaBot 1000995-01-01	B01-000-021X	208	60	Robot Cart for micro fulfillment

3.3. Host Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Voltage	Freq (Hz)	Description/Function
Siemens AG	WLAN Access Point				FCC ID: LYHMSN1V1 IC: 267AA-MSN1V1

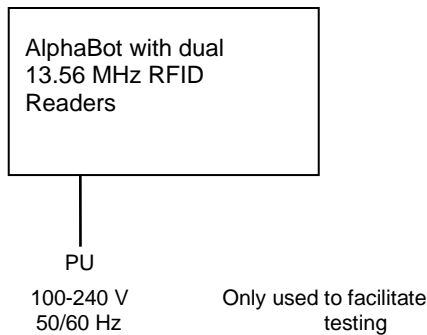
3.4. EUT Cables/Transducers

Cable Type	Length	Shield	From	To
Power	2 Meter + 1 Meter	Yes	EUT	120 VAC, 60 Hz

3.5. Support Equipment

Manufacturer	Model/Part # / Options	Serial Number	Input Voltage	Freq (Hz)	Description/Function
Meanwell	HEP-185		120	60	Power Supply to facilitate testing, not sold or used with the product

3.6. Block Diagram



4. Measurements Parameters

4.1. Measurement Equipment and Software Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Interval
EMI Test Receiver, 9kHz - 7GHz ¹	Rohde & Schwarz	ESR7	101156	10/16/2022	2 Years
EMI Test Receiver, 10 Hz - 7GHz ¹	Rohde & Schwarz	ESR7	101770	7/17/2022	2 Years
Spectrum Analyzer, 2 Hz to 26.5 GHz ²	Rohde & Schwarz	FSW26	102057	9/13/2021	3 Years
Spectrum Analyzer, 9 kHz to 40 GHz ³	Rohde & Schwarz	FSV40	100899	8/12/2022	2 Years
Spectrum Analyzer, 9 kHz to 40 GHz ⁴	Rohde & Schwarz	FSVR40	100909	9/18/2022	2 Years
Loop Antenna 9 kHz - 30 MHz	EMCO	6512	9309-1139	1/28/2022	3 Years
Biconilog Antenna, 30 MHz - 2 GHz	Sunol Sciences	JB1	A050913	6/5/2022	2 Years
Horn Antenna, 960 MHz to 18 GHz	Electro-Metrics	EM-6961	6337	10/3/2021	3 Years
Horn Antenna, 18 to 40 GHz	Com-Power	AH-840	101032	9/28/2021	3 Years
Preamplifier, 1 GHz to 26.5 GHz	Hewlett Packard	8449B	3008A01323	9/11/2021	3 Years
Digital Barometer	Control Company	4195	ID236	4/3/2021	3 Years
Temperature Chamber ⁵	Associated Environmental	SD-308	10782	CNR	

¹ ESR7 Firmware revision: V3.48 SP3, Date installed: 9/30/2020

Previous V3.48 SP2, installed 7/23/2020.

² FSW26 Firmware revision: V4.71 SP1, Date installed: 11/16/2020

Previous V4.61, installed 8/11/2020.

³ FSV40 Firmware revision: V2.30 SP4, Date installed: 05/04/2016

Previous V2.30 SP1, installed 10/22/2014.

⁴ FSVR40 Firmware revision: V2.23 SP1, Date installed: 08/19/2016

Previous V2.23 installed 10/20/2014.

⁵ Used with calibrated measurement equipment.

Manufacturer	Software Description	Title or Model #	Rev.	Report Sections
Compliance Worldwide	Test Report Generation Software	Test Report Generator	1.0	Used to process conducted emissions data

4.2. Measurement & Equipment Setup

Test Dates:	12/22/2020, 12/23/2020, 1/4/2021
Test Engineers:	Brian Breault, Sean Defelice
Normal Site Temperature (15 - 35°C):	19.5
Relative Humidity (20 -75%RH):	32%
Frequency Range:	.03 MHz to 1 GHz
Measurement Distance:	3 & 10 Meters
EMI Receiver IF Bandwidth:	200 Hz – 9 kHz to 30 MHz 9 kHz – 150 kHz to 30 MHz 120 kHz - 30 MHz to 1 GHz 1 MHz - Above 1 GHz
EMI Receiver Avg Bandwidth:	>= 3 * IF (BW) RBW
Detector Function:	Peak, QP - 30 MHz to 1 GHz Peak, Avg - Above 1 GHz Unless otherwise specified.

4. Measurements Parameters (continued)

4.3 Measurement Procedure

The test measurements contained in this report are based on the requirements detailed in FCC Part 15, Subpart C - Intentional Radiators, notably Section 15.225, Operation within the band 13.110 – 14.010 MHz. The test procedures for these measurements are detailed in ANSI C63.10-2013.

5. Choice of Equipment for Test Suits

5.1. Choice of Model

This test report is based on the test samples supplied by the manufacturer and are reported by the manufacturer to be equivalent to the production units.

5.2. Presentation

The test sample was tested complete with all required ancillary equipment. Refer to Section 3 of this report for the product equipment configuration.

5.3. Choice of Operating Frequencies

The transmitter in the unit under test utilizes a single operating frequency at approximately 13.56 MHz

6. Measurement Summary

Test Requirement	FCC Part 15 Reference	RSS Reference	Test Report Section	Result	Comment
Antenna Requirement	15.203	RSS-GEN Section 7.1.2	7.1	Compliant	
Operation within the Band 13.110 MHz – 14.010 MHz (Radiated Field Strength)	15.225 (a), (b), (c)	RSS-210 Section B6	7.2	Compliant	
Spurious Radiated Emissions	15.209		7.3	Compliant	
Operation within the Band 13.110 MHz – 14.010 MHz (Frequency Stability)	15.225 (e)	RSS-210 Section B6	7.4	Compliant	
Occupied Bandwidth/ Lower and Upper Band Edges	15.215(c) C63.10	N/A	7.5	Compliant	
99% Power Bandwidth	N/A	RSS-GEN Section 4.6.1	7.6	Compliant	
Power Line Conducted Emissions	15.207	RSS-GEN Section 7.2.4	7.7	Compliant	
Public Exposure to Radio Frequency Energy Levels.	1.1307 (b)(1)	RSS 102, Issue 5	7.8	Compliant	

7. Measurement Data

7.1. Antenna Requirement (Section 15.203, RSS-GEN 7.1.2)

Requirement: 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.

Result: Compliant - The RFID antenna utilized by the device under test is a PCB antenna contained inside a non-user accessible enclosure.

7. Measurement Data (continued)

7.2. Operation within the Band 13.110 MHz – 14.010 MHz (15.225 (a), (b) and (c))

Radiated Field Strength of Fundamental (15.225 (a), (b) and (c))

- Requirement: (a) The field strength of any emissions within the band 13.553 - 13.567 MHz shall not exceed 15,848 microvolts/meter (84 dB μ V/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 microvolts/meter (50.5 dB μ V/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 microvolts/meter (40.5 dB μ V/m) at 30 meters.

Test Note: Reference ANSI C63.10-2013 sections 5.3.2 and 6.4.4.2. The following formula was used to extrapolate the measurement distance to the limit distance:

$$\text{Equation 1 } FS_{\text{limit}} = FS_{\text{max}} - 20 \log \left(\frac{d_{\text{limit}}}{d_{\text{measure}}} \right)$$

FS _{limit} is the calculation of field strength at the limit distance (dB μ V/m)	64.08
FS _{max} is the measured field strength, expressed in (dB μ V/m QP @ 10M)	73.62
d _{near field} is the $\lambda / 2\pi$ distance (Meters)	10.00
d _{limit} is the reference limit distance (Meters)	30.00

The screen captures on the following pages display the value measured at a distance of 10 meters. This distance value was adjusted to the limit distance using the formula detailed in Equation 1.

Result: Compliant - The fundamental frequency radiated field strength of the device under test complies with the requirements detailed in FCC Part 15.225, Section (a).

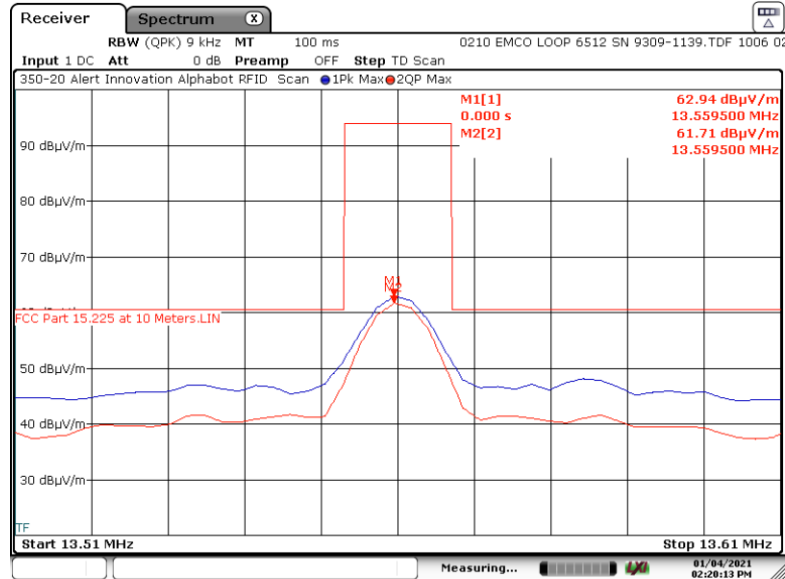
Freq. (MHz)	Ampl. ¹ (dB μ V/m) Peak	Corr. Ampl. ² (dB μ V/m) (10M) QP	Corr. Ampl. ² (dB μ V/m) (10M) QP	FCC 15.225 Limit (dB μ V/m) QP 30M	Margin (dB)	Ant Pos. Par/Per Gnd Par	Ant Height (cm)	Turntable Azimuth (Deg)	Result
13.56	74.66	73.62	73.62	84.00	-10.38	Per	100	184	Compliant

¹ Measurement has been extrapolated from 10 meters to 30 meters using Equation 1 on this page.

7. Measurement Data (continued)

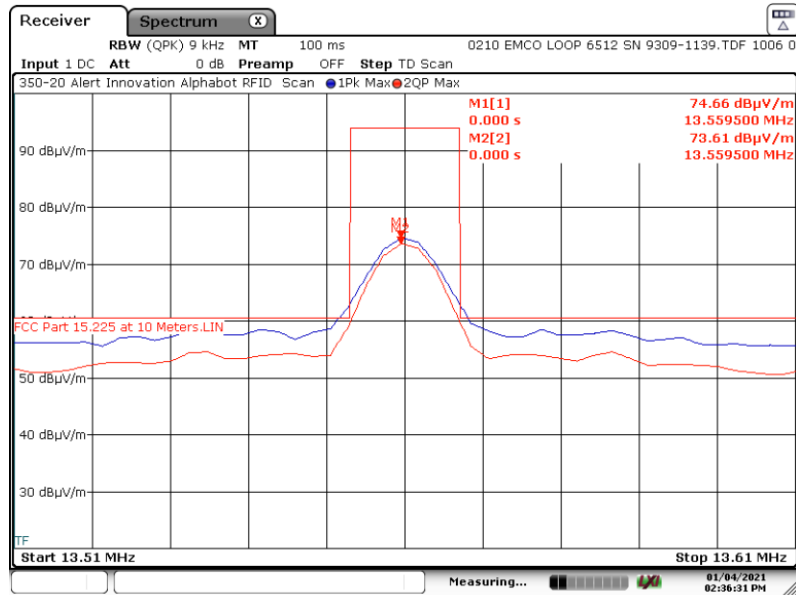
7.2. Operation within the Band 13.110 MHz – 14.010 MHz (15.225 (a), (b) and (c)) Radiated Field Strength of Fundamental (15.225 (a), (b) and (c)) (continued)

7.2.1. Worst Case Field Strength of the Fundamental – Parallel Antenna



Date: 4 JAN 2021 14:20:13

7.2.2. Worst Case Field Strength of the Fundamental – Perpendicular Antenna



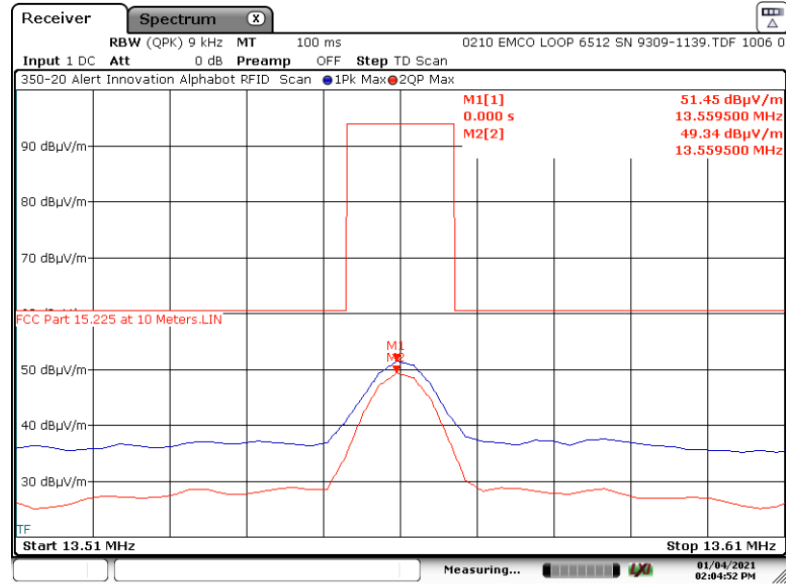
Date: 4 JAN 2021 14:36:31

7. Measurement Data (continued)

7.2. Operation within the Band 13.110 MHz – 14.010 MHz (15.225 (a), (b) and (c))

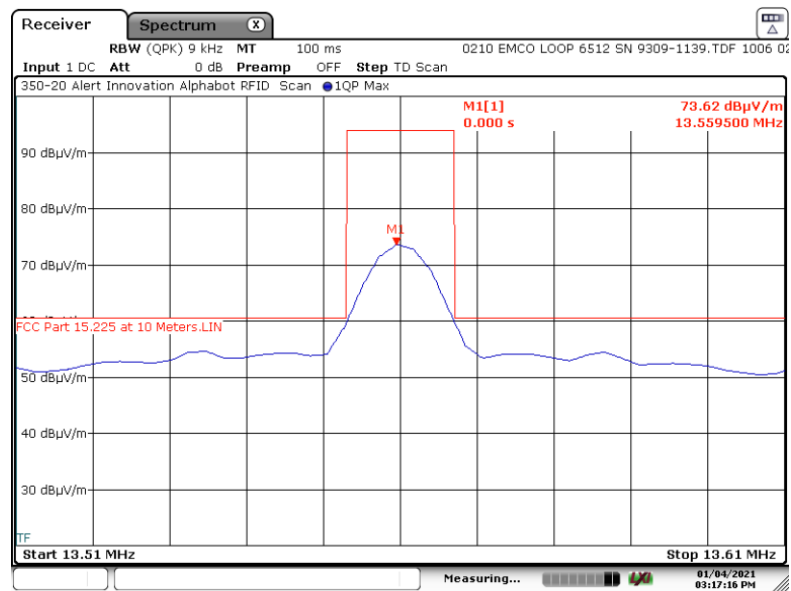
Radiated Field Strength of Fundamental (15.225 (a), (b) and (c)) (continued)

7.2.3. Worst Case Field Strength of the Fundamental – Ground Parallel Antenna



Date: 4 JAN 2021 14:04:53

7.2.4. Worst Case Field Strength of the Fundamental – Perpendicular Antenna QP



Date: 4 JAN 2021 15:17:16

7. Measurement Data (continued)

7.3. Transmitter Spurious Radiated Emissions (15.225 (d), 15.209)

Requirement: The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table (Reference FCC 15.209):

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$)	Meas. Dist. (meters)	Field Strength (dB $\mu\text{V}/\text{m}$)	Distance (Meters)
0.009–0.490	2400/F(kHz)	300	128.5 to 93.8	3
0.490–1.705	24000/F(kHz)	30	73.8 to 63.0	3
1.705–30.0	30	30	69.5	3
30-88	100	3	40	3
88-216	150	3	43.5	3
216-960	200	3	46	3
Above 960	500	3	54	3

¹ Measurements in the 9 to 90 kHz, 110 to 490 kHz and above 1000 MHz ranges employ an average detector. Otherwise a quasi-peak detector is used.

² Extrapolation below 30 MHz is calculated at 40 dB/decade.

Procedure: Test measurements were made in accordance with ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices, Section 6.5.

Test Notes: 1. The marked emissions cursors in scans 7.3.2.1, 7.3.2.2 and 7.3.3.3 are the fundamental frequency for the device under test.

Results: Compliant - The transmitter installed in the unit under test meet the FCC Part 15.209 emissions requirements.

Note: The fundamental at 13.56 MHz falls under the FCC P15.225 Limit.

Sample Calculation: Final Result (dB $\mu\text{V}/\text{m}$) = Measurement Value (dB μV) + Antenna Factor (dB/m) + Cable Loss (dB) – Pre-amplifier Gain (dB) Internal or External.

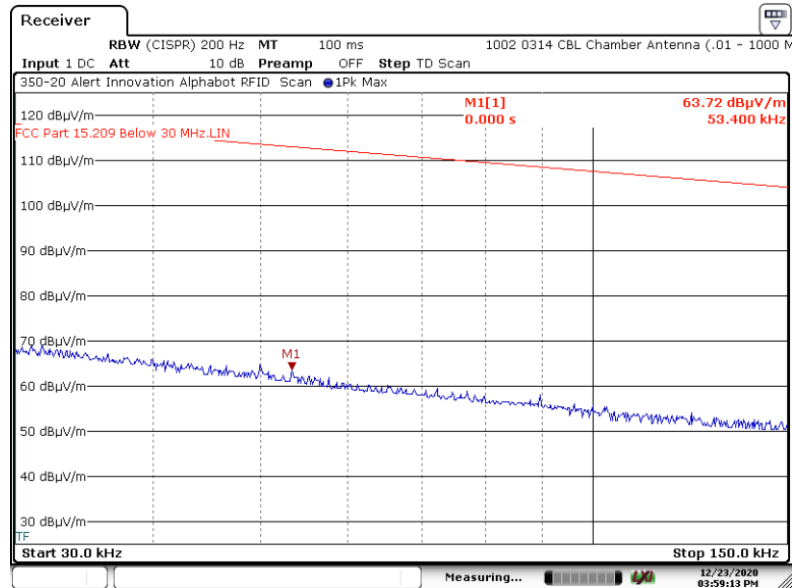
Note: All correction factors are loaded into the measurement instrument prior to testing to determine the final result.

7. Measurement Data (continued)

7.3. Spurious Radiated Emissions, 30 kHz to 1 GHz (15.225, § (d), 15.209) (cont'd)

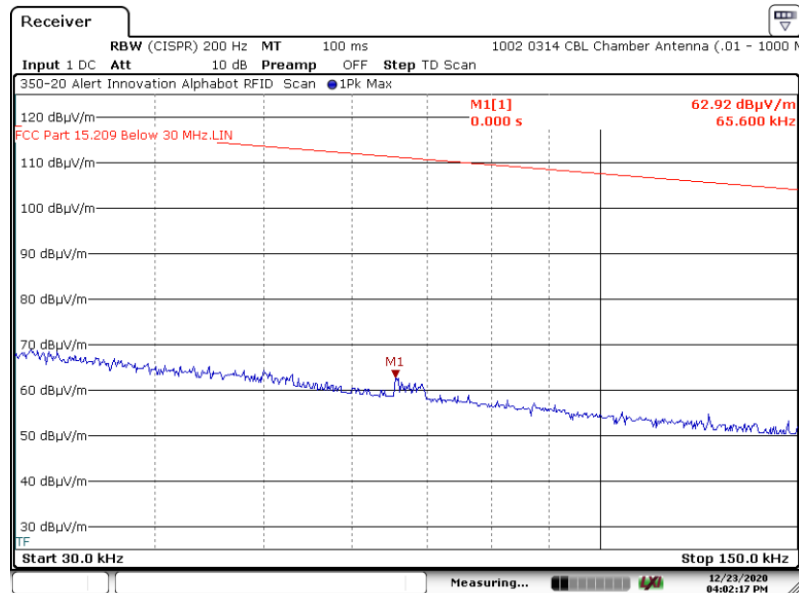
7.3.1. Spurious Radiated Emissions, 30 kHz to 150 kHz Test Results

7.3.1.1. Parallel Antenna



Date: 23.DEC.2020 15:59:14

7.3.1.2. Perpendicular Antenna



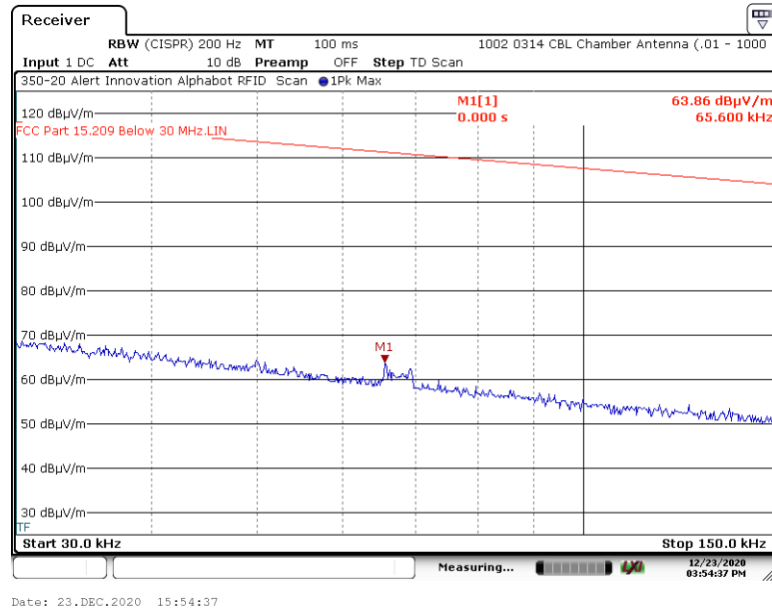
Date: 23.DEC.2020 16:02:17

7. Measurement Data (continued)

7.3. Spurious Radiated Emissions, 30 kHz to 1 GHz (15.225, § (d), 15.209) (cont'd)

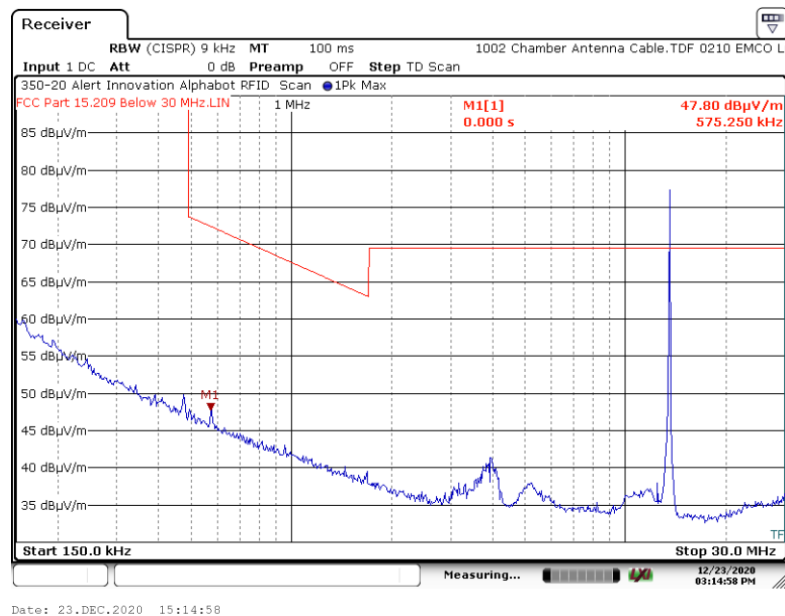
7.3.1. Spurious Radiated Emissions, 30 kHz to 150 kHz Test Results

7.3.1.3. Ground Parallel Antenna



7.3.2. Spurious Radiated Emissions, 150 kHz to 30 MHz Test Results

7.3.2.1. Parallel Antenna

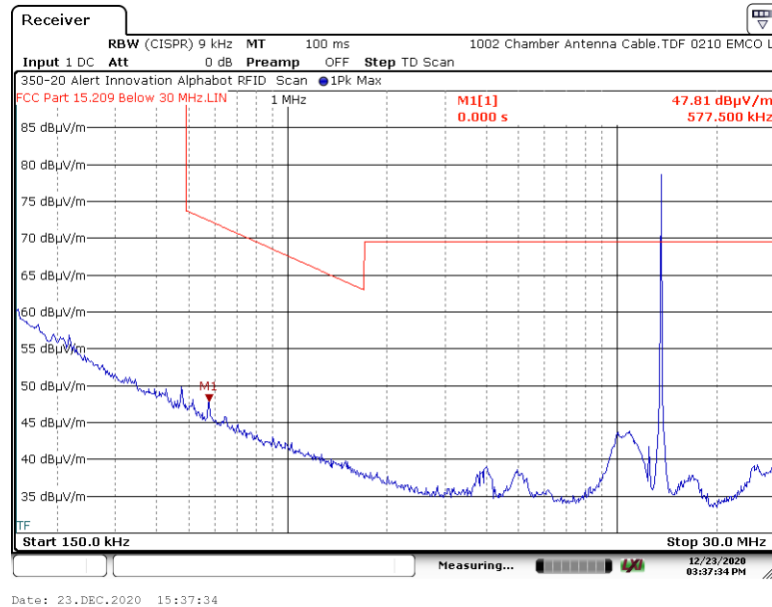


7. Measurement Data (continued)

7.3. Spurious Radiated Emissions, 30 kHz to 1 GHz (15.225, § (d), 15.209) (cont'd)

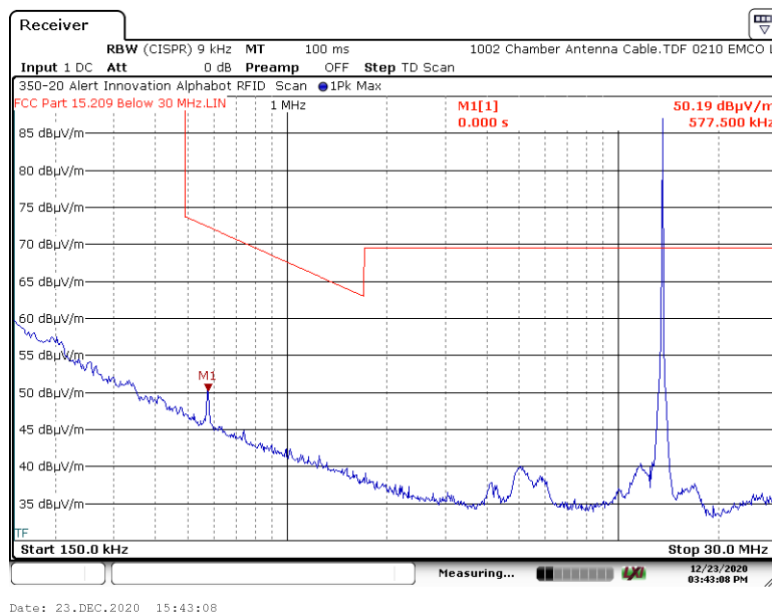
7.3.2. Spurious Radiated Emissions, 150 kHz to 30 MHz Test Results

7.3.2.2. Perpendicular Antenna



7.3.2. Spurious Radiated Emissions, 150 kHz to 30 MHz Test Results

7.3.2.3. Ground Parallel Antenna



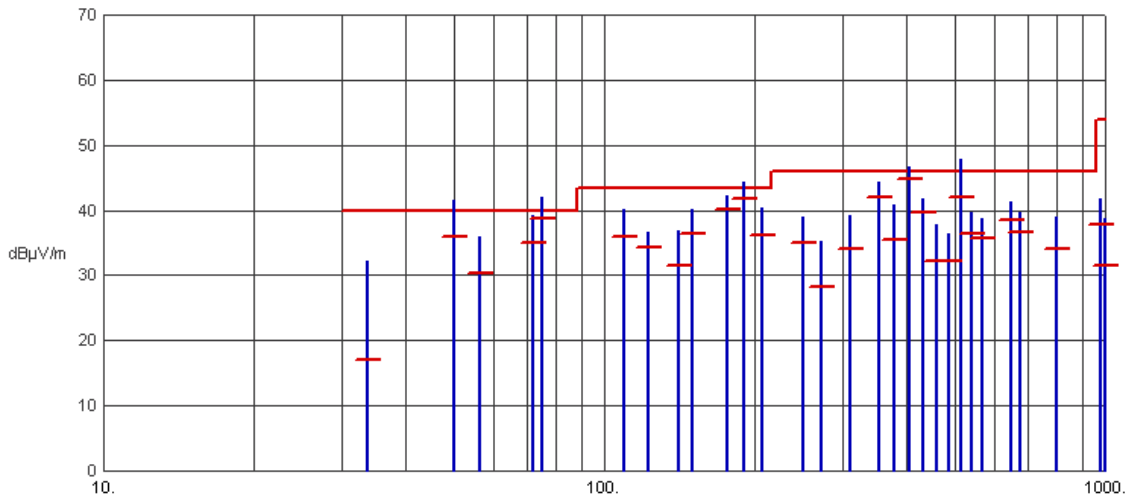
7. Measurement Data (continued)

7.3. Spurious Radiated Emissions, 30 kHz to 1 GHz (15.225, § (d), 15.209) (cont'd)

7.3.3. Horizontal Polarity

Test No.: 350-20, Radiated Emissions - Horizontal Polarity

FCC, Class B



Frequency (MHz)	Pk Amp (dBµV/m)	QP Amp (dBµV/m)	QP Limit (dBµV/m)	Margin (dB)	Ant Ht (cm)	Table (Deg)	Comments
33.6800	32.10	17.11	40.00	-22.89	N/A	N/A	
50.0000	41.56	36.05	40.00	-3.95	N/A	N/A	
56.2400	35.91	30.45	40.00	-9.55	N/A	N/A	
71.8700	39.13	34.95	40.00	-5.05	N/A	N/A	
75.0000	42.11	38.79	40.00	-1.21	N/A	N/A	
109.3700	40.25	35.93	43.50	-7.57	N/A	N/A	
122.0300	36.70	34.25	43.50	-9.25	N/A	N/A	
140.6300	36.92	31.41	43.50	-12.09	N/A	N/A	
150.0000	40.06	36.45	43.50	-7.05	N/A	N/A	
176.2700	42.26	40.19	43.50	-3.31	N/A	N/A	
189.8398	44.29	41.83	43.50	-1.67	N/A	N/A	
206.2400	40.31	36.07	43.50	-7.43	N/A	N/A	
250.0000	38.97	34.98	46.00	-11.02	N/A	N/A	
271.8800	35.34	28.29	46.00	-17.71	N/A	N/A	
310.7300	39.30	34.00	46.00	-12.00	N/A	N/A	
352.5500	44.42	41.96	46.00	-4.04	N/A	N/A	
379.6700	40.86	35.44	46.00	-10.56	N/A	N/A	
406.7900	46.60	44.75	46.00	-1.25	N/A	N/A	
433.9100	41.83	39.75	46.00	-6.25	N/A	N/A	
461.0300	37.88	32.21	46.00	-13.79	N/A	N/A	
488.1500	36.43	32.14	46.00	-13.86	N/A	N/A	
515.2700	47.72	42.03	46.00	-3.97	N/A	N/A	
542.3900	39.63	36.48	46.00	-9.52	N/A	N/A	
569.5100	38.80	35.59	46.00	-10.41	N/A	N/A	
650.8700	41.38	38.55	46.00	-7.45	N/A	N/A	
678.0000	39.62	36.52	46.00	-9.48	N/A	N/A	
800.0000	39.07	34.08	46.00	-11.92	N/A	N/A	
976.3100	41.80	37.69	54.00	-16.31	N/A	N/A	
1000.0000	38.63	31.44	54.00	-22.56	N/A	N/A	

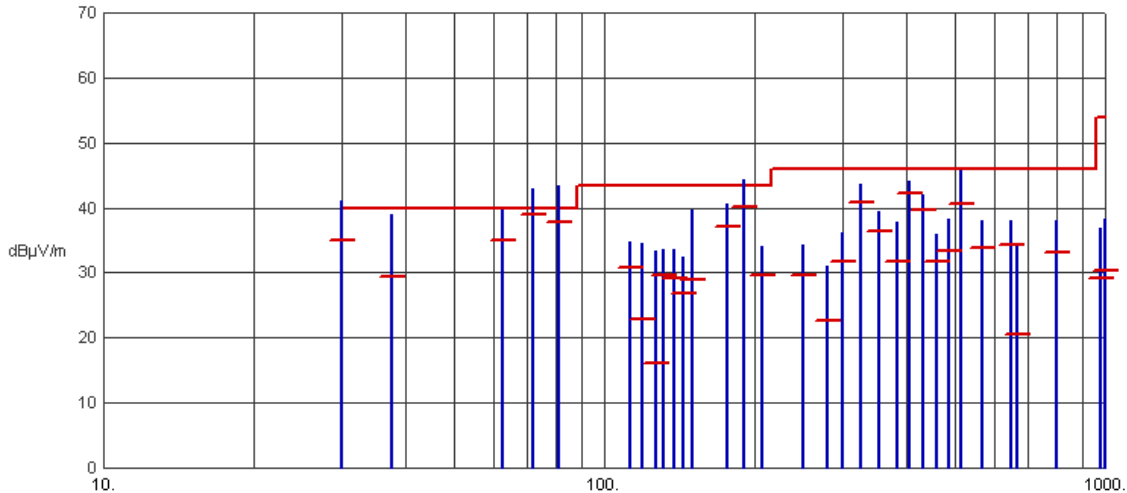
7. Measurement Data (continued)

7.3. Spurious Radiated Emissions, 30 kHz to 1 GHz (15.225, § (d), 15.209) (cont'd)

7.3.4. Vertical Polarity

Test No.: 350-20, Radiated Emissions - Vertical Polarity

FCC, Class B



Frequency (MHz)	Pk Amp (dBµV/m)	QP Amp (dBµV/m)	QP Limit (dBµV/m)	Margin (dB)	Ant Ht (cm)	Table (Deg)	Comments
30.0000	41.18	34.92	40.00	-5.08	N/A	N/A	
37.5400	38.97	29.46	40.00	-10.54	N/A	N/A	
62.5100	39.56	34.92	40.00	-5.08	N/A	N/A	
71.8700	43.03	39.01	40.00	-0.99	N/A	N/A	
81.2600	43.32	37.82	40.00	-2.18	N/A	N/A	
112.5000	34.77	30.80	43.50	-12.70	N/A	N/A	
118.7600	34.49	22.88	43.50	-20.62	N/A	N/A	
127.1900	33.40	16.15	43.50	-27.35	N/A	N/A	
131.2400	33.59	29.70	43.50	-13.80	N/A	N/A	
137.5100	33.56	29.15	43.50	-14.35	N/A	N/A	
143.7500	32.54	26.80	43.50	-16.70	N/A	N/A	
150.0000	39.77	29.04	43.50	-14.46	N/A	N/A	
176.2700	40.49	37.09	43.50	-6.41	N/A	N/A	
189.8300	44.30	40.17	43.50	-3.33	N/A	N/A	
206.2400	34.10	29.67	43.50	-13.83	N/A	N/A	
250.0000	34.21	29.68	46.00	-16.32	N/A	N/A	
278.1200	30.98	22.58	46.00	-23.42	N/A	N/A	
300.0000	36.18	31.74	46.00	-14.26	N/A	N/A	
325.4300	43.64	40.84	46.00	-5.16	N/A	N/A	
352.5500	39.37	36.29	46.00	-9.71	N/A	N/A	
384.0200	37.79	31.79	46.00	-14.21	N/A	N/A	
406.8000	44.06	42.24	46.00	-3.76	N/A	N/A	
433.9100	42.06	39.75	46.00	-6.25	N/A	N/A	
461.0300	35.99	31.65	46.00	-14.35	N/A	N/A	
488.1500	38.38	33.37	46.00	-12.63	N/A	N/A	
515.2700	45.68	40.55	46.00	-5.45	N/A	N/A	
569.5100	37.92	33.82	46.00	-12.18	N/A	N/A	
650.8700	38.08	34.19	46.00	-11.81	N/A	N/A	
667.3400	34.39	20.62	46.00	-25.38	N/A	N/A	
800.0000	38.12	33.06	46.00	-12.94	N/A	N/A	
976.3100	36.85	29.20	54.00	-24.80	N/A	N/A	
1000.0000	38.17	30.24	54.00	-23.76	N/A	N/A	

7. Measurement Data (continued)

7.4. Frequency Stability (§ 15.225 (e))

Requirement: The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ 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. The nominal power is 208 VAC, 60 Hz.

Test Notes: The size of the host device that houses the device under test exceeds the volume of the site environmental chamber. In order to test the RFID transmitter and antenna assembly, it was necessary to remove the assembly from the host device and test it in the environmental chamber. In order to do this, a custom cable capable of carrying all power and signal lines to the DUT was constructed. By doing so, the DUT was subjected to the required temperature variations while maintaining operational communications with the host device.

Result: Compliant - The unit under test complies with the requirements detailed in FCC Part 15.225 (e).

7.4.1. Temperature and Voltage Variation

Temp °C	Supply Voltage	Meas Freq.	Limit			Offset	Result
		(MHz)	F _{MIN} (MHz)	F _{MAX} (MHz)	%	(%)	
Ambient (20.1°C)	208 VAC	13.5599867	N/A			N/A	
-20		13.5600208	13.558631	13.561343	± 0.01	0.00025148	Compliant
-10		13.5600122	13.558631	13.561343	± 0.01	0.00018805	Compliant
0		13.5600043	13.558631	13.561343	± 0.01	0.00012979	Compliant
+10		13.5599947	13.558631	13.561343	± 0.01	0.00005863	Compliant
+20		13.5599885	13.558631	13.561343	± 0.01	0.00001327	Compliant
+30		13.5599854	13.558631	13.561343	± 0.01	0.00000996	Compliant
+40		13.5599754	13.558631	13.561343	± 0.01	0.00008370	Compliant
+50		13.5599766	13.558631	13.561343	± 0.01	0.00007485	Compliant
+20		177 VAC	13.5599703	13.558656	13.561368	± 0.01	0.00030900
	239 VAC	13.5599912	13.558656	13.561368	± 0.01	0.00015524	Compliant

7. Measurement Data (continued)

7.5. Occupied Bandwidth (Section 15.215 (c) and ANSI C63.10, Section 6.9)

Requirement: Intentional radiators operating under the alternative provisions to the general emission limits, as contained in Sections 15.217 through 15.255 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule. The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW

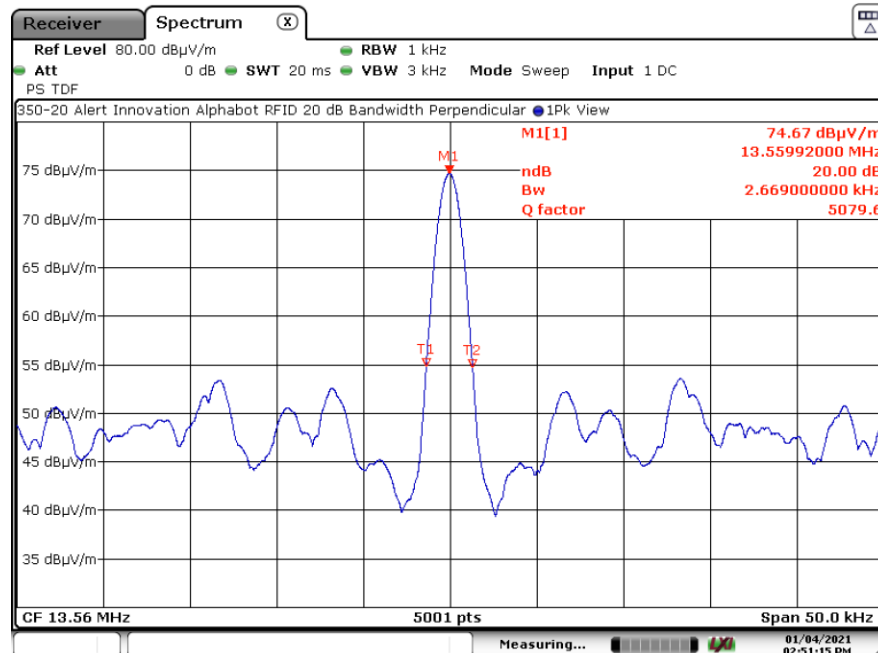
Frequency Band: $F_{MIN} = 13.110$ MHz

$F_{MAX} = 14.010$ MHz

Result: Compliant.

-20 dB Frequency Measured		Lower & Upper Band Edge		Result
(F _{LO} & F _{HI})		(F _{MIN} & F _{Max})		
MHz		MHz		
F _{LO}	13.5585	F _{MIN}	13.11	Compliant (F _{LO} > F _{MIN})
F _{HI}	13.5613	F _{MAX}	14.01	Compliant (F _{HI} < F _{Max})

7.5.1. Plot of 20 dB Bandwidth vs. Frequency Band



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7. Measurement Data (continued)

7.6. 99% Power Bandwidth (RSS-GEN Section 4.6.1)

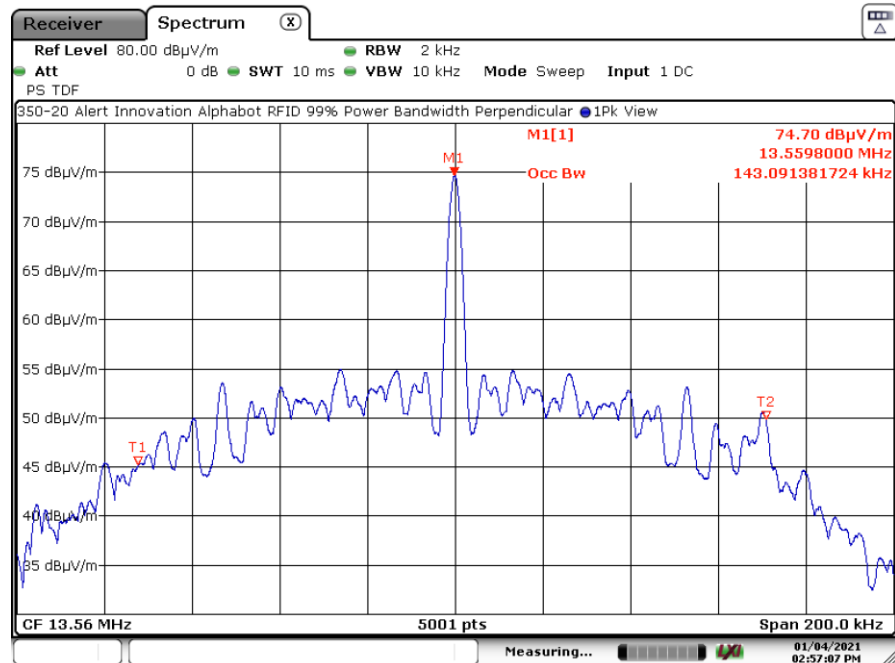
Requirement: When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

Procedure: This test was performed utilizing the automated 99% bandwidth function of the spectrum analyzer.

Frequency (MHz)	99% Power Bandwidth (kHz)
13.5598	143.09

7.6.1. Plot of 99% Power Bandwidth



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7. Measurement Data (continued)

7.7. Power Line Conducted Emissions (FCC Part 15.207)

Requirement: 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 μ H/50 ohms 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.

Frequency Range (MHz)	Limits (dB μ V)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50

* Decreases with the logarithm of the frequency.

Procedure: Test measurements were made in accordance with ANSI C63.10-2013, Section 6.2: Standard test method for ac power-line conducted emissions from unlicensed wireless devices.

Results: The product operates on super-capacitors during its typical operation and doesn't connect to conventional connection to mains power within a warehouse.

Sample Calculation: Final Result (dB μ V) = Measurement Value (dB μ V) + LISN Insertion Loss (dB) + Cable Loss (dB).

Note: All correction factors are loaded into the measurement instrument prior to testing to determine the final result.

7. Measurement Data (continued)

7.8. Public Exposure to Radio Frequency Energy Levels ((FCC KDB 447498 D01 v06, 1.1307 (b)(1), 2.1091(b)) RSS-GEN, RSS 102, Issue 5

RF Exposure for a Portable Device

7.8.1 SAR Test Exclusion (FCC KDB 447498 D01 v06, Clause 4.3.1.c)2)

Frequency (MHz)	MPE Distance (mm)	DUT Output Power (mW)	SAR Test Exclusion (mW)	Result
	(1)	(2)	(3)	
13.56	≤50	0.07674	442.9735	Compliant

- (1) FCC KDB 447498 D01 v06, Clause 4.3.1.(c)2)
- (2) Converted from 10M field strength measurement ($FS_{(dB\mu V/m)} - 84.77$)
Reference Section 7.2, Measured Field Strength
- (3) $\frac{1}{2} (1 + \log(100/f(\text{MHz})))$
Formula detailed in KDB 447498 D01 v06, Clause 4.3.1.(c)2)

7.8.2 Exemption Limits for Routine Evaluation – SAR Evaluation (RSS-102 Clause 2.5.1)

Frequency (MHz)	MPE Distance (mm)	DUT Output Power (mW)	SAR Test Exclusion (mW)	Result
	(1)	(2)	(3)	
13.56	≤5 mm	0.07674	71	Compliant

- (1) RSS-102, Clause 2.5.1
- (2) Converted from 10M field strength measurement ($FS_{(dB\mu V/m)} - 84.77$)
Reference Section 7.2, Measured Field Strength
- (3) RSS-102, Clause 2.5.1, Table 1 ≤ 300 MHz = 71 mW at ≤ 5 mm

7. Measurement Data (continued)

7.8. Public Exposure to Radio Frequency Energy Levels ((FCC KDB 447498 D01 v06, 1.1307 (b)(1), 2.1091(b)) RSS-GEN, RSS 102, Issue 5 (continued)

7.8.3. Reference CFR 2.1091: For purposes of this section, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

RF Exposure of simultaneously operated radios within the host which is considered a Mobile Device.

WLAN Radio highest reported output power is in 802.11b mode of operation is 87 mW

The RFID radios put out a power of 0.07674 mW

Frequency (MHz)	MPE Distance (cm)	DUT Field Strength at 10M (dB μ V/m)	DUT Output Power (dBm)	DUT Antenna Gain (dBi)	DUT Output Power (mW)	Power Density	Limit (mW/cm ²)	Result
						(mW/cm ²)		
	(1)		(2)	(3)		(4)	(5)	
13.56	20	73.62	-11.15		0.07674	0.00001527	0.9789334	Compliant
2412	20		13.40	6	87	0.01732727	1.0	Compliant
SUM						0.0173425		

Power Density Limit from 1.34 to 30 MHz is $180 / f^2$ where f is in MHz

Power Density Limit from 1500 to 100,000 MHz is 1.0

7.8.4. RSS-102 Issue 5 Requirements

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

below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1W (adjusted for tune-up tolerance)

at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} \times f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz.

Frequency (MHz)	Separation Distance	Maximum Power	Maximum Power	RSS-102 Exemption Limit ²	Result
(MHz)	(cm)	(mW)	(W)	(W)	
13.56	≥ 20	0.07674	0.00007674	1.00	Compliant
2412	≥ 20	87.00	0.087	2.68	Compliant
SUM			0.08707674		

8. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1**) and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 32, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

The radiated emissions test site for measurements above 1GHz is a 3 Meter open area test site (OATS) with a 3.6 by 3.6 meter anechoic absorber floor patch to achieve a quasi-free space measurement environment per ANSI C63.4/C63.10 and CISPR 16-1-4 standards.

The sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

9. Test Setup Photographs

9.1. Radiated Emissions Front View



9. Test Setup Photographs

9.2. Radiated Emissions Rear View – Fundamental & Spurious Emissions < 30 MHz



9. Test Setup Photographs

9.3. Radiated Emissions Rear View Emissions > 30 MHz



9. Test Setup Photographs

9.4. Frequency and Voltage Stability Setup



9. Test Setup Photographs

9.5. Frequency Stability – Device Under Test (RFID Reader removed from system)

