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RFRain LLC
FRN 0025997503

1905-032E-1

EMI Test Report 1905-032E-1 Rev. E

Test Standards: FCC Part 15, Subpart B & ICES-003 & ANSI C63.4-2014

For

RFRain LLC

FRN 0025997503
2063 Main St
Sarasota, FL 34237

On

RFID Reader

Model Number: RFR-RAIN-4-SMART; UPC Code: 850008280009; Serial Number: 85000828000; FCC ID: 2AJ7RRFRAIN4SMART

Performed By: **Keystone Compliance, LLC.**
131 Columbus Inner Belt
New Castle, PA 16101

Keystone Compliance, LLC. does hereby certify that all inspections and tests have been performed in accordance with the documents referenced herein with exceptions as noted in this report. The results in this report pertain to the specified equipment tested. This report shall not be reproduced, except in full, without the written authorization of Keystone Compliance, LLC.

Prepared By: _____ **Date:** 11/18/2019
Coy Price, Technical Writer

Approved By: _____ **Date:** 11/18/2019
Tony Masone Jr., EMC Lab Manager

Approved By: _____ **Date:** 11/18/2019
Joey Sullivan, Quality Manager

Document History

Revision	Issue Date	Description of Modifications	Revised By	Approved By
N/C	6/20/2019	Initial release	N/A	T.M.
A	6/26/2019	Updated EUT Information	CP	TM
B	7/9/2019	Added FRN Number	CP	TM
C	8/8/2019	Added FCC ID Number	MR	TM
D	9/17/2019	Added an appendix for photos, added an additional spec, added calibration dates.	MR	TM
E	11/18/2019	Data added from job number 1910-027E	MR	TM

Client Information

Purchase Order	ACH Wire Payment
Quote Number	1905-032E-1
EUT Arrival Date	6/5/2019 and 10/24/19 -- Received in good condition
Company Name	RFRain LLC
FRN Number	0025997503
Address	2063 Main St
City, State Zip	Sarasota, FL 34237
Contact Name	Luv Sachdeva
Phone	(833) 273-7246
Email	luv.sachdeva@rfrain.com

Test Facility Information

Test Laboratory	Keystone Compliance, LLC.
Address	131 Columbus Inner Belt
City, State, Zip Code	New Castle, PA 16101
Phone	(724) 657-9940
Fax	(724) 657-9920
Web Site	www.keystonecompliance.com
Contact Name	Tony Masone Jr.
Title	Lab Manager
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Test Program Information

Test Personnel	Doug Brown – EMC Test Technician
Test Title & Test Dates	Radiated Emissions – June 13, 2019

Test Program Information

Test Personnel	Doug Brown – EMC Test Technician
Test Title & Test Dates	Conducted Emissions – November 11, 2019

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LIST OF TABLES

Introduction

This report documents the results of the EMC tests performed on the RFID Reader, Model Number: RFR-RAIN-4-SMART; UPC Code: 850008280009; Serial Number: 85000828000, submitted by RFRain LLC

The EMC test programs described herein were performed in accordance with the applicable requirements of FCC Part 15, Subpart B & ICES-003 & ANSI C63.4-2014.

All test data is included in Section 3 of this document.

All tests performed at Keystone Compliance New Castle, PA EMC test facility. All tests were performed using the test set-ups of the relevant standard for tests performed in laboratory conditions.

Acronyms and Abbreviations

EMC – Electromagnetic Compatibility

EMI – Electromagnetic Interference

EUT – Equipment Under Test

M/N – Model Number

P/N – Part Number

S/N – Serial Number

Vac – Voltage Alternating Current

DC – Direct Current

AM – Amplitude Modulation

dB – Decibel

deg – Degree

H/V – Horizontal or Vertical Polarity

m – Meters

cm – Centimeter

V/m – Volts per meter

dBuV/m – Decibel microvolts per meter

kV – Kilovolt

Hz – Hertz

kHz – Kilohertz

MHz – Megahertz

GHz – Gigahertz

pF – Pico farad

Ω – Ohm

QP – Quasi-Peak

N/A – Not Applicable

Configuration

Testing performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations, and settings used to complete the evaluation. The actual test parameters specified in the test data; this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation, indicated in the test data.

EUT		
Description		Manufacturer
RFID Reader		**RFRain LLC**
Model Number	UPC Code	Serial Number
RFR-RAIN-4-SMART	**850008280009**	**85000828000**
FCC ID: 2AJ7RRFRAIN4SMART		

Summary of Tests Performed & Results

Table 1 Tests Performed & Results

Report Paragraph	Test Description	Specification	Notes	Results
FCC Part 15, Subpart B & ICES-003				
3.1	Radiated Emissions	FCC Part 15.109, Subpart B / ICES-003/ANSI C63.4-2014	Class B 30MHz – 6GHz	Compliant
3.2	Conducted Emissions	FCC Part 15.107	Class B Frequency Range: 150kHz-30MHz Testing to be performed at 120VAC/60Hz with customer provided AC adapter.	Compliant

Section 1 – Test Conditions and Equipment

1.1 Instrumentation and Equipment

Measuring and test equipment, utilized in the performance of these tests, was calibrated in accordance with ANSI/NCSL Z540-3-2006, by Keystone Compliance, LLC or a commercial facility, utilizing reference standards (or interim standards) whose calibrations have been certified as being traceable to the National Institute of Standards & Technology (NIST). All reference standards utilized in the above calibration system are supported by certificates, reports, or data sheets attesting to the date, accuracy, and conditions under which the results furnished were obtained. All subordinate standards, measuring and test equipment are supported by like data when such information is essential to achieve the accuracy control required by the procedure.

Keystone Compliance, LLC attests that the commercial sources providing calibration services on the above-referenced equipment, other than the NIST Standards are in fact capable of performing the required services to the satisfaction of Keystone Compliance, LLC Quality Assurance. Certifications of all calibrations performed are retained on file in the Keystone Compliance, LLC Quality Assurance Department, and are available for inspection upon request by customer representatives.

The test equipment utilized during this test program is listed on individual Test Equipment Logs located in Section 3 of this document.

1.2 Tolerances

All test conditions were maintained within all applicable specified tolerances.

Section 2 – References

2.1 Applicable Specifications

Reference Specification Title	**FCC Part 15, Subpart B** **Part 15 – Radio Frequency Devices; Subpart B – Unintentional Radiators**
Reference Specification Title	**ICES-003** **Digital Apparatus**
Calibration Information	**ANSI C63.4-2014** **American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz**
Calibration Information	**ANSI/NCSL Z540-3-2006** **Calibration Laboratories and Measuring Test Equipment - General Requirements**

Section 3 – Test Description, Test Equipment, Test Data, & Test Photographs

3.1 Radiated Emissions Test

a) The Radiated Emissions requirement for the RFID Reader is specified in FCC Part 15, Subpart B / ICES-003/ANSI C63.4-2014.

b) The Radiated Emissions Test Description for the RFID Reader is located in Paragraph 3.1.1 of this document.

c) The Radiated Emissions test equipment used to test the RFID Reader is located in Paragraph 3.1.2 of this document.

d) All recorded test data for the Radiated Emissions test on the RFID Reader is located in Paragraph 3.1.3 of this document.

3.1.1 Radiated Emissions Test Description

Test Description
Using the mode of operation and configuration noted within this report, a Radiated Emissions test was performed to FCC Part 15, Subpart B / ICES-003/ANSI C63.4-2014. The frequency range investigated (scanned) is also noted in this report. During the performance of the Radiated Emissions test, the RFID Reader unit was in the Normal mode and powered with 5VDC.

Frequency Range Investigated			
Start Frequency:	30MHz	Stop Frequency:	6GHz

Sample Calculation
Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor – Amplifier Gain + Distance Adjustment Factor

Measurement Bandwidths			
Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01-0.15	0.2	0.2	0.2
0.15-30.0	9.0	9.0	9.0
30.0-1000	120.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

3.1.2 Radiated Emissions Test Equipment Log

Equipment Log	
Customer:	**RFRain LLC**
Date:	**6/13/19**
Test Engineer:	**D. Brown**

	Test Equipment					
Asset No.	Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
EB049	Spectrum Analyzer	HP	8593E	3624A02438	02/20/19	2/20/2020
EI000	Positioning Controller	EMCO	1050	None	UWCE	UWCE
EI009	Positioning Controller	EMCO	1061-2.013	9401-1717	UWCE	UWCE
EG053	Pre-Amplifier	Hewlett Packard	8447D	None	6/6/18	6/6/2020
EE005	Bilog Antenna	Chase	CBL-6111	1167	6/26/18	6/26/2020
EG024	Pre-Amplifier	Keystone Compliance	KCM106	8-30-2010	3/19/19	3/19/2021
EE009	DRG Horn Antenna	A.H. Systems, Inc.	SAS-200/571	175	1/23/18	1/23/2020
EU001	Software, Tile (Version 3.4.k.6)	Quantum Change	None	None	UWCE	UWCE
None	Computer System	Assorted	Assorted	Assorted	UWCE	UWCE

UWCE: Used with Calibrated Equipment

3.1.3 Radiated Emissions Test Data

Radiated Emissions Data Sheet					
Customer:	**RFRain LLC**			Date:	**6/13/19**
Attendees:	**None**			Test Engineer:	**D. Brown**
Temp.:	**73.8°F**	Humidity:	**42%**	Barometric Pres.:	**30.05 in**
Config. #:	**1**	Power:	**5VDC**	Job Site:	**Keystone Compliance**
Test Specifications					
Test Spec:	**FCC Part 15, Subpart B / ICES-003/ANSI C63.4-2014**			Test Limit:	**Class B Part 15.109**

Test Data

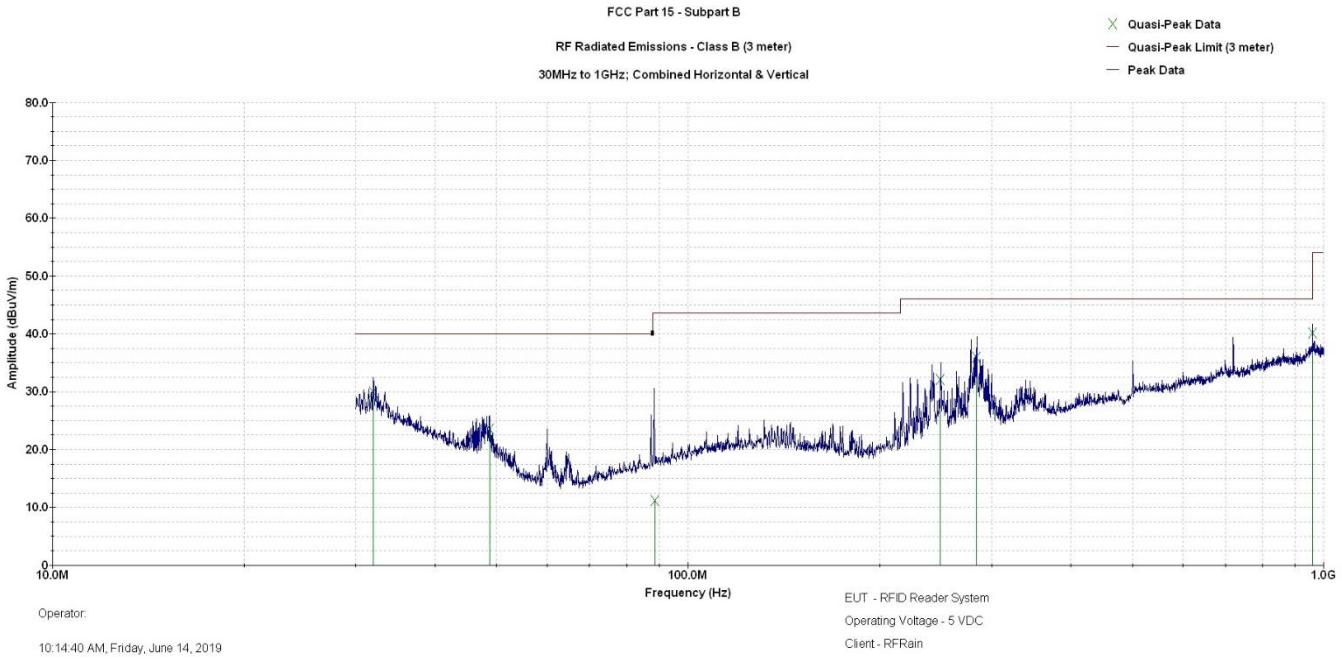
Test Parameters			
Antenna Height(s) (m):	**1-4**	Test Distance:	**3 m**
EUT Operating Modes			
Normal			
Comments			
Frequency Range: 30MHz-6GHz (FCC Class B Limit)			
Deviations from Test Standard			
None			
Results			
Compliant			

Radiated Emissions – 30Mhz to 1GHz

FCC Part 15 - Subpart B
RF Radiated Emissions - Class B (3 meter)
30MHz to 1GHz; Quasi-Peak Frequencies

	1	2	3	4	5	6	
Frequency	QP Limit	QP Data	QP Delta	Azimuth	Height	Polarity	
MHz	(dBuV/m)	(dBuV/m)	(dB)	(deg)	(cm)	(H/V)	
31.960	40.000	29.852	-10.148	2.000	0.000	V	
48.709	40.000	23.523	-16.477	42.000	100.000	V	
88.721	43.522	11.110	-32.412	132.000	100.000	V	
249.413	46.030	32.114	-13.916	310.000	100.000	H	
284.407	46.030	35.975	-10.055	138.000	99.000	H	
959.994	46.030	40.092	-5.938	48.000	99.000	H	
EUT - RFID Reader System							
Operating Voltage - 5 VDC							
Client - RFRain							

Radiated Emissions – 30Mhz to 1GHz

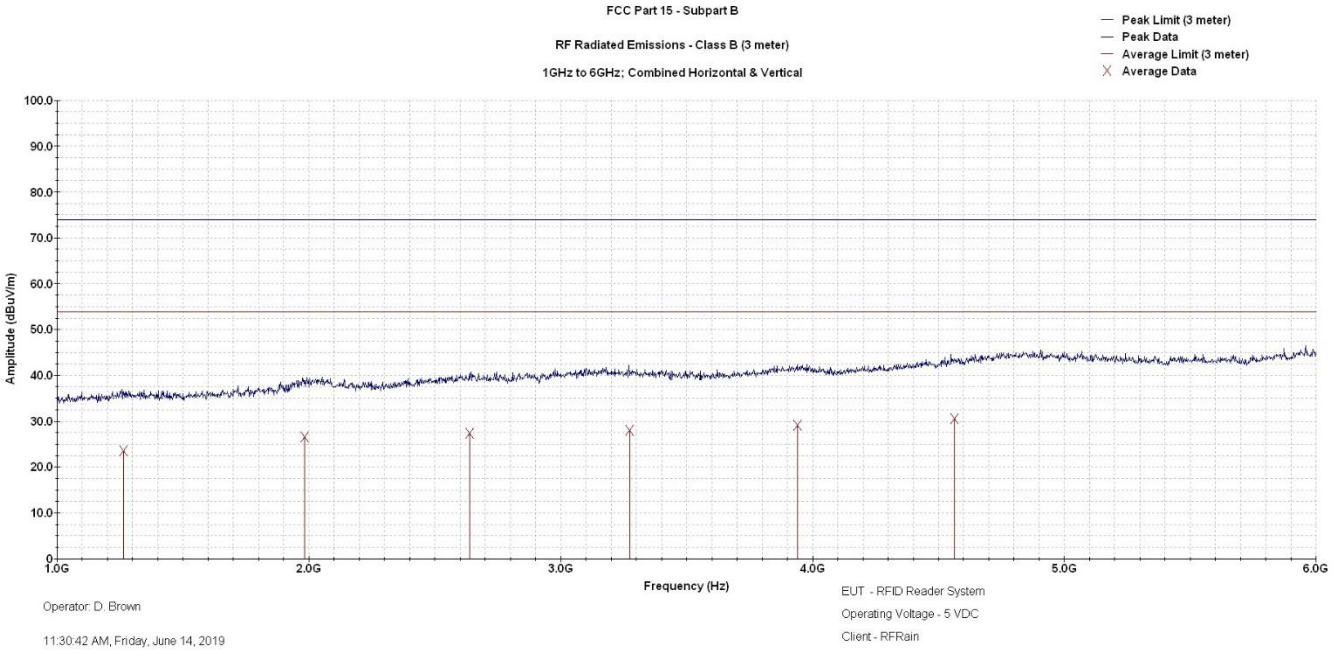


Radiated Emissions – 1GHz to 8GHz

FCC Part 15 - Subpart B
RF Radiated Emissions - Class B (3 meter)
Average Data

	1	2	3	4	5	6	
Frequency	AVG Limit	AVG Data	AVG Delta	Azimuth	Height	Polarity	
GHz	(dBuV/m)	(dBuV/m)	(dB)	(deg)	(cm)	(H/V)	
1.265 GHz	53.900	23.564	-30.336	40.000	0.000	H	
1.984 GHz	53.900	26.586	-27.314	264.000	99.000	H	
2.639 GHz	53.900	27.377	-26.523	181.000	99.000	H	
3.275 GHz	53.900	27.916	-25.984	267.000	99.000	H	
3.940 GHz	53.900	29.034	-24.866	267.000	99.000	H	
4.564 GHz	53.900	30.521	-23.379	309.000	99.000	H	
EUT - RFID Reader System							
Operating Voltage - 5 VDC							
Client - RFRain							

Radiated Emissions – 1GHz to 8GHz



3.2 Conducted Emissions Test

a) The Conducted Emissions test requirements for the RFID Reader are specified in FCC Part 15, Subpart B/ICES-003.

b) The Conducted Emissions Test Description for the RFID Reader is located in Paragraph 3.2.1 of this document.

c) The Conducted Emissions test equipment used to test the RFID Reader is located in Paragraph 3.2.2 of this document.

d) All recorded test data for the Conducted Emissions test on the RFID Reader is located in Paragraph 3.2.3 of this document.

3.2.1 Conducted Emissions Test Description

Test Description
Using the mode of operation and configuration noted within this report Conducted Emissions test was performed to FCC Part 15, Subpart B/ICES-003. The frequency range investigated (scanned) is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150kHz-30MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via a separate transformer or power supplies) connected to a public power network. Equipment is tested with power cords that are normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically, those measurements are made using a LISN (Line Impedance Stabilization Network), the 50Ω measuring port is terminated by a 50Ω EMI meter or a 50Ω resistive load. All 50 Ω measuring ports of the LISN are terminated by 50 Ω. During the performance of the Conducted Emissions test, the RFID Reader unit was in the Normal mode and powered with 5VDC.

Sample Calculation
Conducted Emissions: Adjusted Level = Measured Level + Transducer Factor + Cable Attenuation Factor + External Attenuator

Measurement Bandwidths			
Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01-0.15	0.2	0.2	0.2
0.15-30.0	9.0	9.0	9.0
30.0-1000	120.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

3.2.2 Conducted Emissions Test Equipment Log

Equipment Log	
Customer:	**RFRain LLC**
Date:	**11/11/19**
Test Engineer:	**D. Brown**

Asset No.	Description	Manufacturer	Model Number	Serial No.	Cal. Recall Date
EB049	Spectrum Analyzer	HP	8593E	3624A02438	2/20/2020
EK032	LISN (50uH)	EMCO	3825/2	9508-2455	4/30/2020
EN012	Attenuator, 10dB, 10W	Texscan	HFP50/10	None	2/20/2021
EU001	Software, Tile (Version 3.4.k.6)	Quantum Change	None	None	UWCE
None	Computer System	Assorted	Assorted	Assorted	UWCE

UWCE: Used with Calibrated Equipment

3.2.3 Conducted Emissions Test Data

Conducted Emissions Data Sheet					
Customer:	**RFRain LLC**			Date:	**11/11/19**
Attendees:	**None**			Test Engineer:	**D. Brown**
Temp.:	**70°F**	Humidity:	**41%**	Barometric Pres.:	**30.03 in**
Config. #:	**1**	Power:	**5VDC**	Job Site:	**Keystone Compliance**
Test Specifications					
Test Spec:	**FCC Part 15, Subpart B/ICES-003**			Test Limit:	**Class B**
				Method:	**LISN**

Test Data

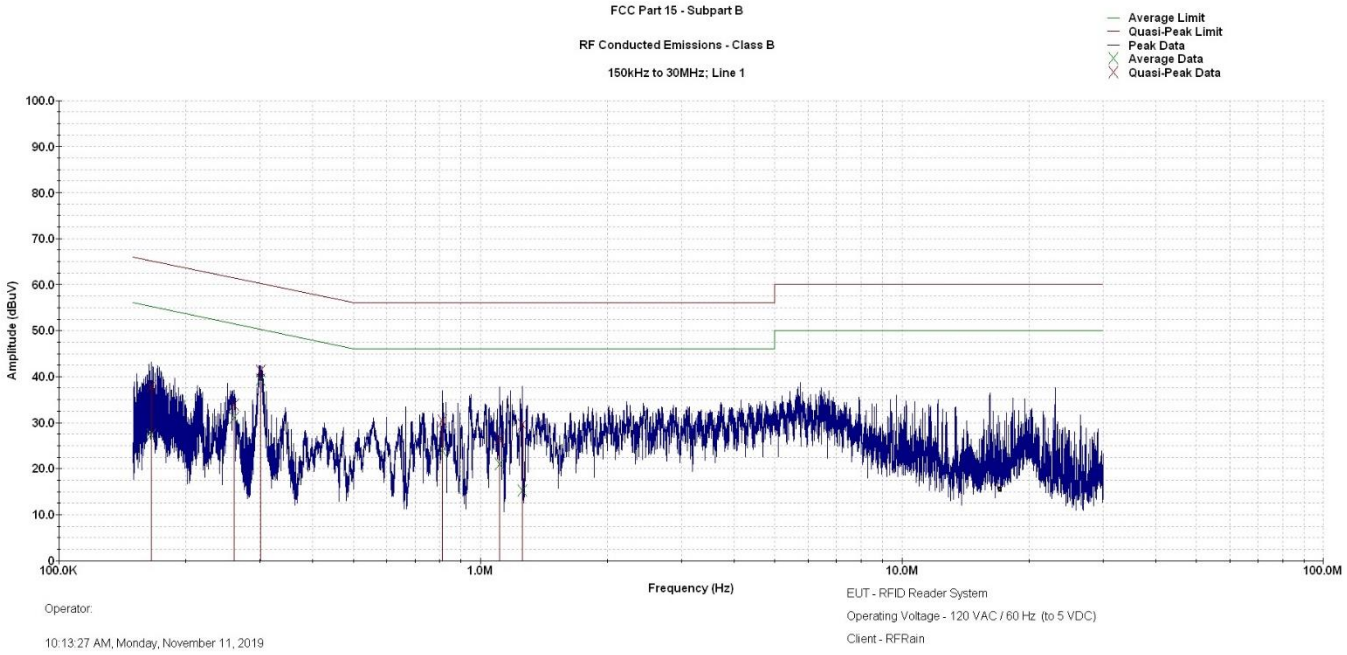
Test Parameters						
Run#:	**1**	Line:	**High**	Ext. Attn:	**10 dB**	
EUT Operating Modes						
Normal						
Comments						
Voltage: 120 VAC / 60 Hz *(to 5 VDC)*						
Deviations From Test Standard						
None						
Results						
Compliant						

Test Parameters						
Run#:	**2**	Line:	**Neutral**	Ext. Attn:	**10 dB**	
EUT Operating Modes						
Normal						
Comments						
Voltage: 120 VAC / 60 Hz *(to 5 VDC)*						
Deviations From Test Standard						
None						
Results						
Compliant						

Line 1

FCC Part 15 - Subpart B
RF Conducted Emissions - Class B
150kHz to 30MHz; Line 1 Peak Data

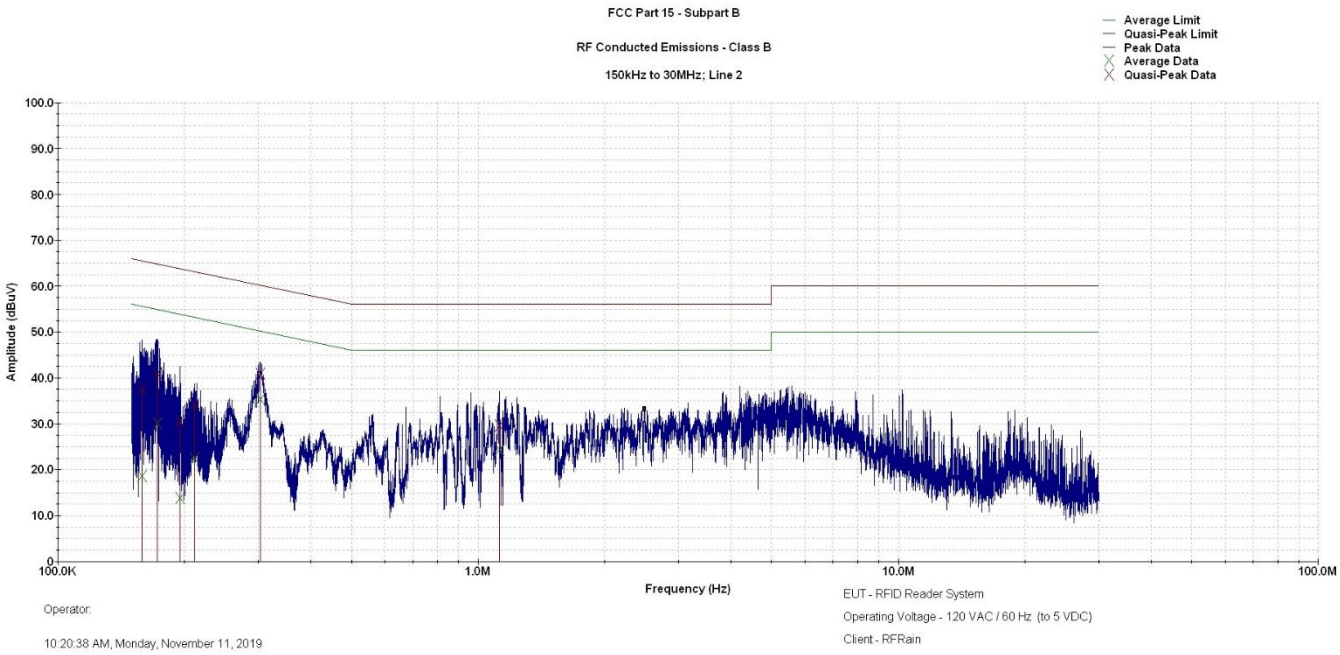
	1	2	3	4	5	6	
Frequency	QP Limit	QP Data	QP Delta	AVG Limit	AVG Data	AVG Delta	
(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)	
0.166	65.55	37.94	-27.60	55.55	27.41	-28.14	
0.260	62.84	33.88	-28.97	52.84	31.03	-21.81	
0.301	61.69	41.17	-20.52	51.69	39.30	-12.39	
0.814	56.00	30.34	-25.66	46.00	23.80	-22.20	
1.110	56.00	26.50	-29.50	46.00	21.01	-24.99	
1.260	56.00	29.53	-26.47	46.00	15.18	-30.82	
RFID Reader System							
120 VAC / 60 Hz (to 5 VDC)							
RFRain							


FCC Part 15 - Subpart B
RF Conducted Emissions - Class B
150kHz to 30MHz; Line 1
Average Limit
Quasi-Peak Limit
Peak Data
Average Data
Quasi-Peak Data
Amplitude (dBuV)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
100.0K
1.0M
10.0M
100.0M
Frequency (Hz)
Operator:
10:13:27 AM, Monday, November 11, 2019
EUT - RFID Reader System
Operating Voltage - 120 VAC / 60 Hz (to 5 VDC)
Client - RFRain

Line 2

FCC Part 15 - Subpart B
RF Conducted Emissions - Class B
150kHz to 30MHz; Line 2 Peak Data

	1	2	3	4	5	6	
Frequency	QP Limit	QP Data	QP Delta	AVG Limit	AVG Data	AVG Delta	
(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)	
0.159 MHz	65.751	37.761	-27.989	55.751	18.599	-37.152	
0.173 MHz	65.356	40.979	-24.377	55.356	30.022	-25.335	
0.196 MHz	64.695	30.591	-34.104	54.695	13.766	-40.929	
0.212 MHz	64.237	34.248	-29.989	54.237	22.448	-31.789	
0.304 MHz	61.601	40.980	-20.621	51.601	35.370	-16.231	
1.123 MHz	56.000	29.560	-26.440	46.000	24.388	-21.612	
RFID Reader System							
120 VAC / 60 Hz (to 5 VDC)							
RFRain							


FCC Part 15 - Subpart B
RF Conducted Emissions - Class B
150kHz to 30MHz; Line 2
Average Limit
Quasi-Peak Limit
Peak Data
Average Data
Quasi-Peak Data
Amplitude (dBuV)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
100.0K
1.0M
10.0M
100.0M
Frequency (Hz)
Operator:
10:20:38 AM, Monday, November 11, 2019
EUT - RFID Reader System
Operating Voltage - 120 VAC / 60 Hz (to 5 VDC)
Client - RFRain

Section 4 – Conclusion

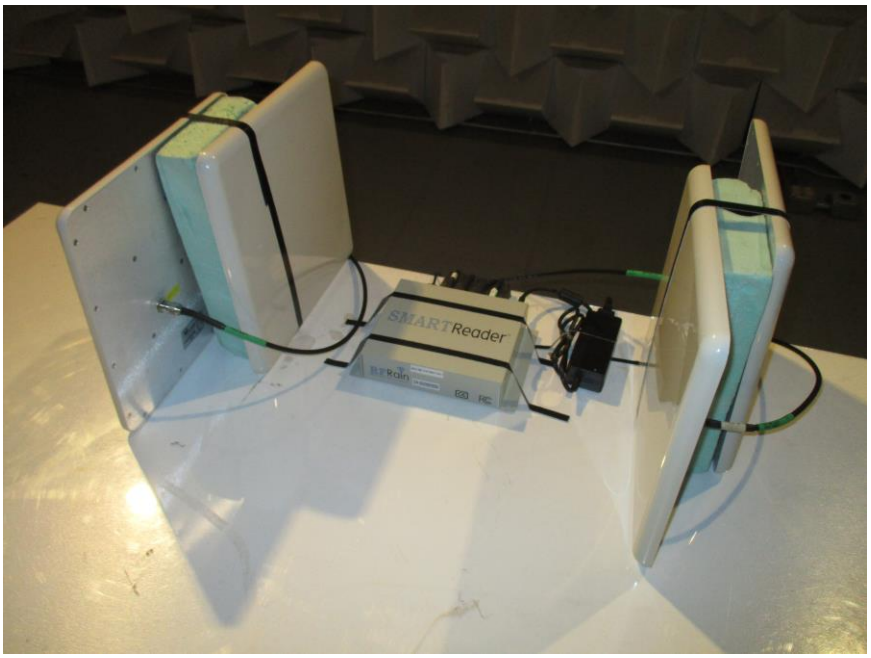
a) The RFID Reader, Model Number: RFR-RAIN-4-SMART; UPC Code: 850008280009; Serial Number: 85000828000 was subjected to the following EMC Tests in accordance with FCC Part 15, Subpart B & ICES-003 & ANSI C63.4-2014 and the specifications as shown in Table 2:

Table 2 Tests Performed & Results

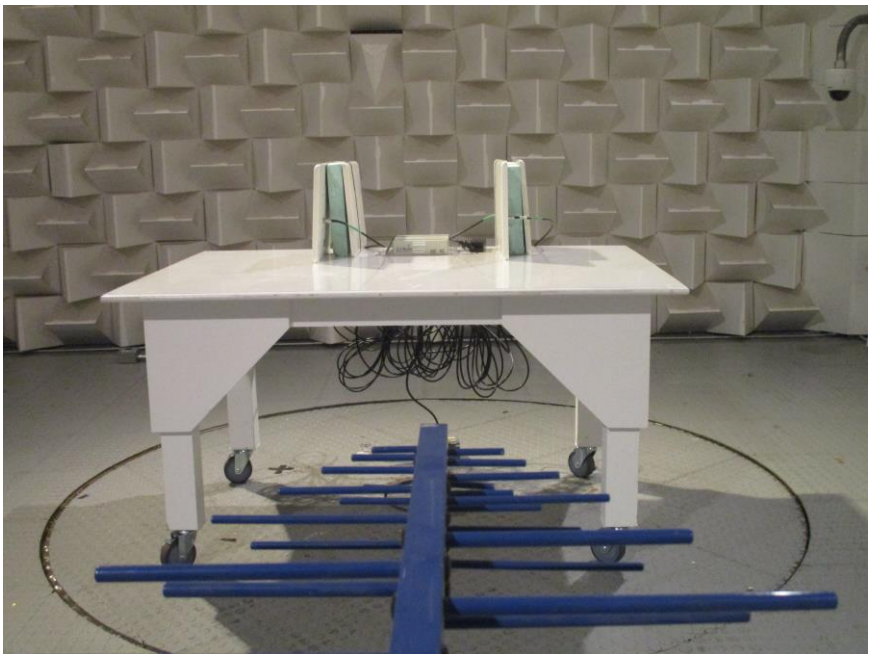
Test Description	Specification	Results
FCC Part 15, Subpart B & ICES-003		
Radiated Emissions	**FCC Part 15.109, Subpart B / ICES-003/ANSI C63.4-2014**	**Compliant**
Conducted Emissions	**FCC Part 15.107**	**Compliant**

b) The RFID Reader was returned to RFRain LLC after completion of the EMI Test.

APPENDIX A: TEST PHOTOGRAPHS



EUT
RFID Reader



Radiated Emissions
Test Setup 30MHz to 1GHz

Radiated Emissions
Test Setup 1GHz to 6GHz

Radiated Emissions
Test Setup Wiring Layout

Conducted Emissions
Test Setup