Electromagnetic Compatibility Test Report

Tests Performed on an RF IDeas, Inc.

Multi-Protocol Card Reader

Models RDR-30081AKU and RDR-30581AKU

Radiometrics Document RP-8935A

ACCREDITED
TESTING CERT #1495.01

Product Detail:	
FCC ID: M9MLC3XX8U IC: 6571A-LC3XX8U Equipment type: Multi-Protocol Card Reader	
Test Standards:	
US CFR Title 47, Chapter I, FCC Part 15 Subpart C FCC Part 15 CFR Title 47: 2017 Canada ISED; RSS-210, Issue 9: 2016 as required for Category I Equipment FCC Part 15.225	
Tests Performed For:	*Test Facility:*
RF IDeas, Inc. 4020 Winnetka Av. Rolling Meadows, IL 60008	**Radiometrics Midwest Corporation** 12 East Devonwood Avenue Romeoville, IL 60446
Test Date(s): (Month-Day-Year)	
August 17 thru October 11, 2018	

Document RP-8935A Revisions:

Rev.	Issue Date	Affected Sections	Revised By
0	October 23, 2018		

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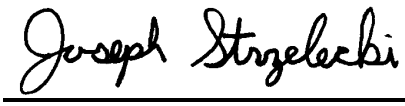
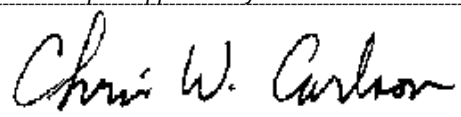
1.0 ADMINISTRATIVE DATA

Equipment Under Test:	
A RF IDeas, Inc., Multi-Protocol Card Reader Model: RDR-30081AKU, RDR-30581AKU Serial Numbers: LOIC000778, L05A058444 This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year)	*Test Date(s): (Month-Day-Year)*
August 17, 2018	August 17 thru October 11, 2018
Test Report Written and authorized by:	*Test Witnessed By:*
Joseph Strzelecki Senior EMC Engineer	The tests were partially witnessed by Shiung Lo of RF IDeas, Inc.
Radiometrics' Personnel Responsible for Test:	*Test Report Approved By*
 Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	 Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Multi-Protocol Card Reader, Models RDR-30081AKU and RDR-30581AKU, manufactured by RF IDeas, Inc. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
RF Radiated Emissions	30-1000 MHz	RSS-210 & FCC Part 15	Pass
Conducted Emissions, AC Mains	0.15 - 30 MHz	RSS-210 & FCC Part 15	Pass
RF Radiated Emissions H-Field	0.009 – 30 MHz	RSS-210 & FCC Part 15	Pass
Occupied Bandwidth	125 kHz and 13.56 MHz	RSS-210 & FCC Part 15	Pass

Note: The RSS-210 specification is not currently covered in Radiometrics' Scope of Accreditation. This is technically very similar to FCC, CFR 47 Part 15 which is on Radiometrics scope.

2.1 RF Exposure Compliance Requirements

Since the effective power output is less than 1 mW, the EUT meets the FCC requirement for RF exposure and is exempt from RSS-102. There are no power level adjustments and the antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Multi-Protocol card reader, Models RDR-30081AKU and RDR-30581AKU, manufactured by RF IDeas, Inc. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The antenna is permanently attached to the PCB. The antenna is internal to the EUT and it is not readily available to be modified by the end user.

3.2 Related Submittals

RF IDeas, Inc. is not submitting any other products simultaneously for equipment authorization related to the EUT.

4.0 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. Power was supplied at 115 VAC, 60 Hz single-phase to the host computer. The EUT was powered from the USB. The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Multi-Protocol Reader	E	RF IDeas	RDR-30081AKU	BT0IA00123
2	Multi-Protocol Reader	E	RF IDeas	RDR-30581AKU	BT05A00213
3	Laptop PC	H	Dell	DCNE	53FMFC1
4	Router	P	Dynex	DX-GB8PRT	10K22B16124

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

List of Cables

QTY	Length (m)	Cable Description	Shielded?
1	1.8	USB Cable to Card Reader	Yes
1	1.8	AC Cord to Computer	No
1	2.2	Ethernet cable from Computer to Router	No

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Description of Permissive Change

The only difference is that the ownership and supply chain for one of the IC's, U8, has changed from Austria Microsystems (AMS) to ST Microelectronics. The part number and marking has changed from AS3911B to ST25R3911B. The form, fit, and function of the IC remained identical.

4.4 Equipment Modifications

No modifications were made at Radiometrics in order to meet the requirements listed in this report.

5.0 TEST SPECIFICATIONS

Document	Date	Title
FCC CFR Title 47	2017	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
IC RSS-210 Issue 9	2016	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 4	2014	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)

6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

Document	Date	Title
ANSI C63.4-2014	2014	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	2013	American National Standard for Testing Unlicensed Wireless Devices

7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom-made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6-inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC8727A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

10.0 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
ANT-03	Tensor	Biconical Antenna	4104	2231	20-250MHz	24 Mo.	12/06/17
ANT-68	EMCO	Log-Periodic Ant.	93146	9604-4456	200-1000MHz	24 Mo.	12/05/17
ANT-53	EMCO	Loop Antenna	6507	1453	1 kHz-30 MHz	24 Mo	12/28/17
CAB-106A	Teledyne	Coaxial Cable	N/A	1090	DC-2 GHz	24 Mo.	05/07/18
CAB-1090	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	05/16/18
CAB-160B	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	05/09/18
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	06/30/17
LSN-17	EMCO	LISN	3810/2NM	9602-1356	0.15 - 30MHz	24 Mo.	02/22/17
REC-21	Agilent	Spectrum Analyzer	E7405A	MY45118341	9kHz-26.5 GHz	24 Mo.	01/06/18
REC-43	Adventest	Spectrum Analyzer	U3772	150800305	9kHz-43GHz	24 Mo.	04/19/17

Note: All calibrated equipment is subject to periodic checks.

Software Company	Test Software Name	Version	Applicable Tests
Radiometrics	EN550XX0	02.28.17	RF Conducted Emissions (FCC Part 15 & EN 55011/22)
Radiometrics	REREC11D	04.19.17	RF Radiated Emissions (FCC Part 15 & EN 55011/22)
Agilent	PSA/ESA-E/L/EMC	2.4.0.42	Bandwidth and screen shots

11.0 TEST SECTIONS

11.1 AC Conducted Emissions

The tests and limits are in accordance with FCC section 15.207 and RSS Gen section 8.8.

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on a semi-log graph generated by the computer. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

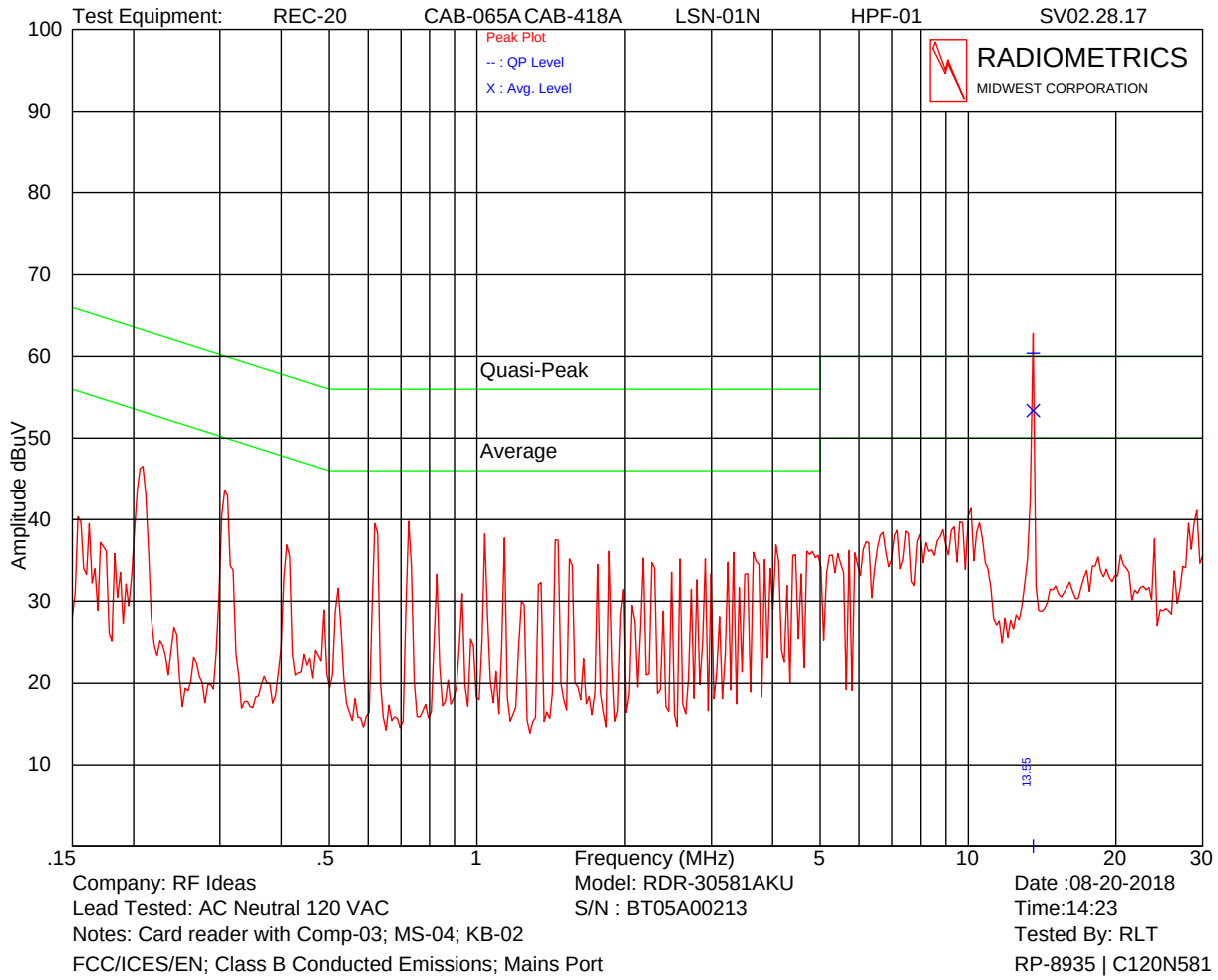
Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

FCC/IC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBuV)	
	Quasi-Peak	Average
0.150 - 0.50*	66 - 56	56 - 46
0.5 – 5.0	56	46
5.0 - 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from the host computer (with the EUT connected) power cord, after testing all modes of operation. QP readings are quasi-peak with a 9 kHz bandwidth and no video filter.

Test Date : 08/21/2018
The 125 kHz and the 13.56 MHz transmitters were both on during the following tests.
The Limit shown in the graphs are the FCC 15.107 and RSS-GEN Table 3.

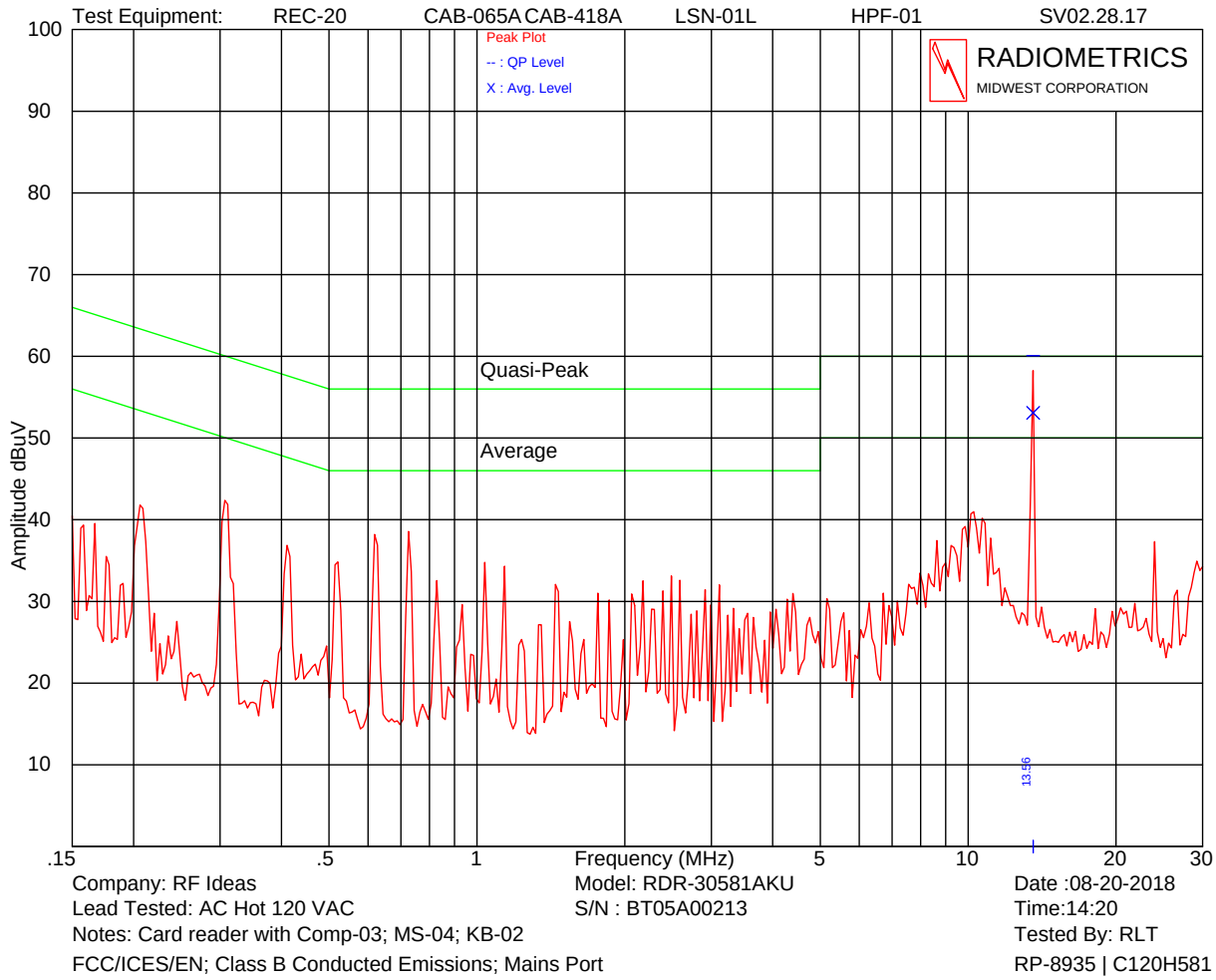


With Antenna installed
The emission at 13.56 MHz was re-measured with a resistive load in place of the antenna and was fully compliant.

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
13.559	60.5	60.0	53.4	50.0	-3.4

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Neutral 120 VAC	0.209	46.6	53.2	6.7
AC Neutral 120 VAC	0.307	43.6	50.1	6.5
AC Neutral 120 VAC	0.619	39.5	46.0	6.5
AC Neutral 120 VAC	0.726	39.8	46.0	6.2
AC Neutral 120 VAC	1.037	38.2	46.0	7.8
AC Neutral 120 VAC	1.138	37.8	46.0	8.3
AC Neutral 120 VAC	1.445	37.5	46.0	8.5
AC Neutral 120 VAC	4.060	36.9	46.0	9.1
AC Neutral 120 VAC	9.992	40.5	50.0	9.5
AC Neutral 120 VAC	10.125	41.4	50.0	8.6
AC Neutral 120 VAC	13.373	42.5	50.0	7.5
AC Neutral 120 VAC	29.216	41.1	50.0	8.9

The above are the highest readings relative to the limit. The peak readings met the average limit.

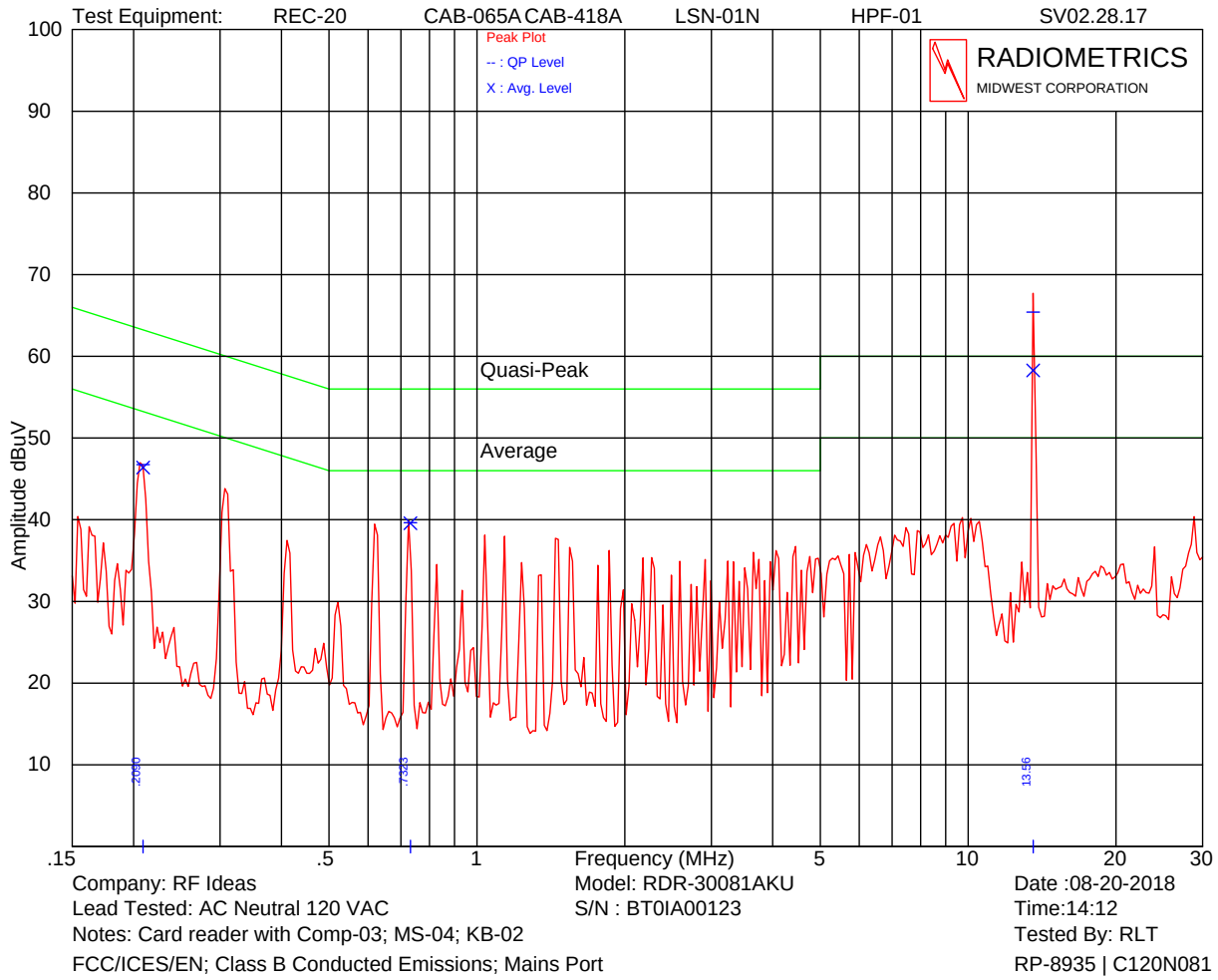


With Antenna installed
The emission at 13.56 MHz was re-measured with a resistive load in place of the antenna and was fully compliant.

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
13.561	60.1	60.0	53.1	50.0	-3.1

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Hot 120 VAC	0.307	42.4	50.1	7.7
AC Hot 120 VAC	0.311	41.9	49.9	8.1
AC Hot 120 VAC	0.619	38.2	46.0	7.8
AC Hot 120 VAC	0.726	38.6	46.0	7.4
AC Hot 120 VAC	10.125	40.7	50.0	9.3
AC Hot 120 VAC	10.260	41.0	50.0	9.0
AC Hot 120 VAC	10.676	40.2	50.0	9.8
AC Hot 120 VAC	13.373	41.3	50.0	8.7

The above are the highest readings relative to the limit. The peak readings met the average limit.

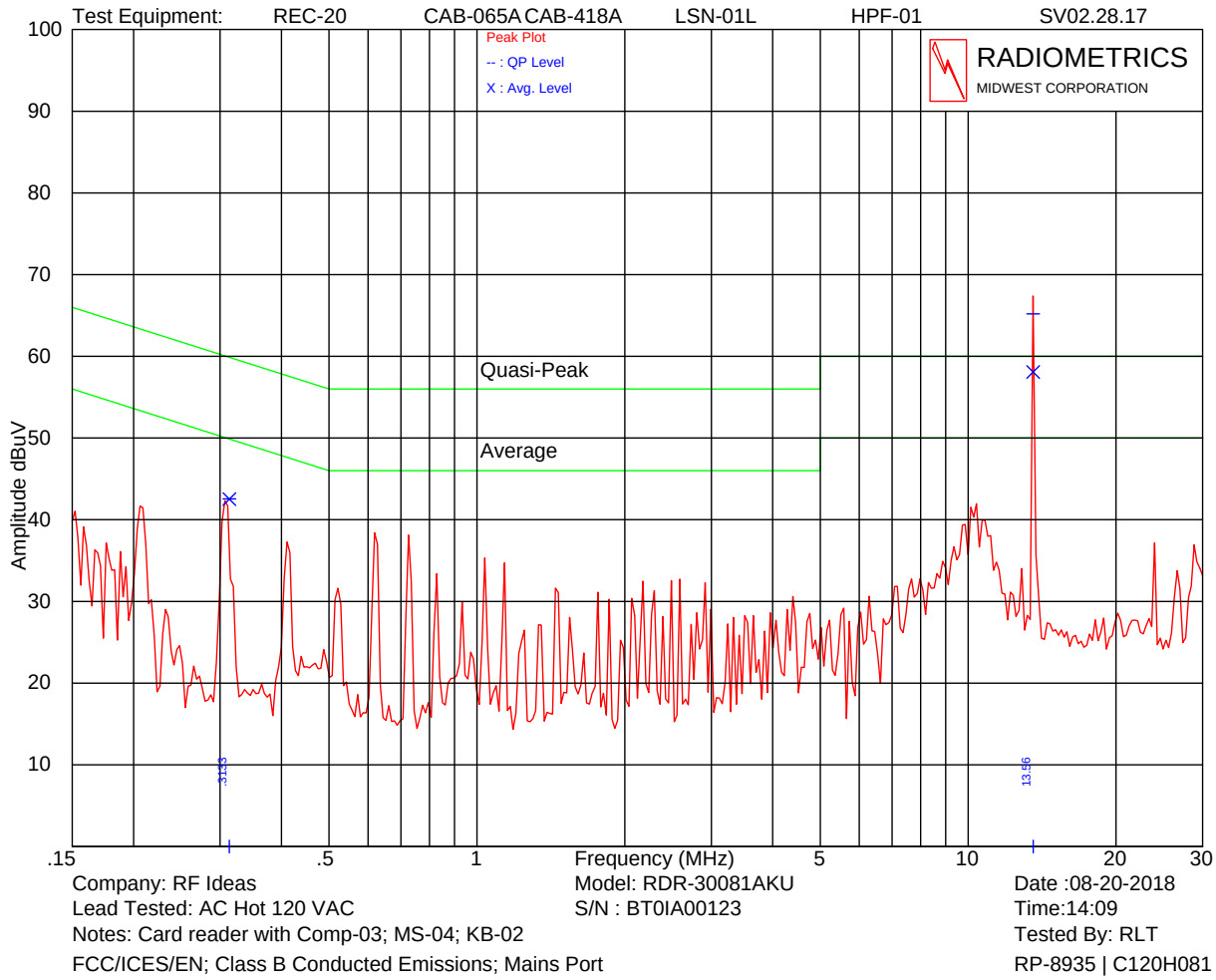


With Antenna installed
The emission at 13.56 MHz was re-measured with a resistive load in place of the antenna and was fully compliant.

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.209	46.7	63.2	46.4	53.2	6.9
0.732	39.7	56.0	39.6	46.0	6.4
13.561	65.4	60.0	58.3	50.0	-8.3

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Neutral 120 VAC	0.206	47.0	53.4	6.4
AC Neutral 120 VAC	0.307	43.8	50.1	6.2
AC Neutral 120 VAC	0.619	39.5	46.0	6.5
AC Neutral 120 VAC	0.726	39.9	46.0	6.1
AC Neutral 120 VAC	1.037	38.1	46.0	7.9
AC Neutral 120 VAC	1.138	38.0	46.0	8.0
AC Neutral 120 VAC	1.445	37.7	46.0	8.3
AC Neutral 120 VAC	4.060	36.2	46.0	9.8
AC Neutral 120 VAC	4.454	36.7	46.0	9.3
AC Neutral 120 VAC	9.731	40.3	50.0	9.7
AC Neutral 120 VAC	28.831	40.4	50.0	9.6

The above are the highest readings relative to the limit. The peak readings met the average limit.

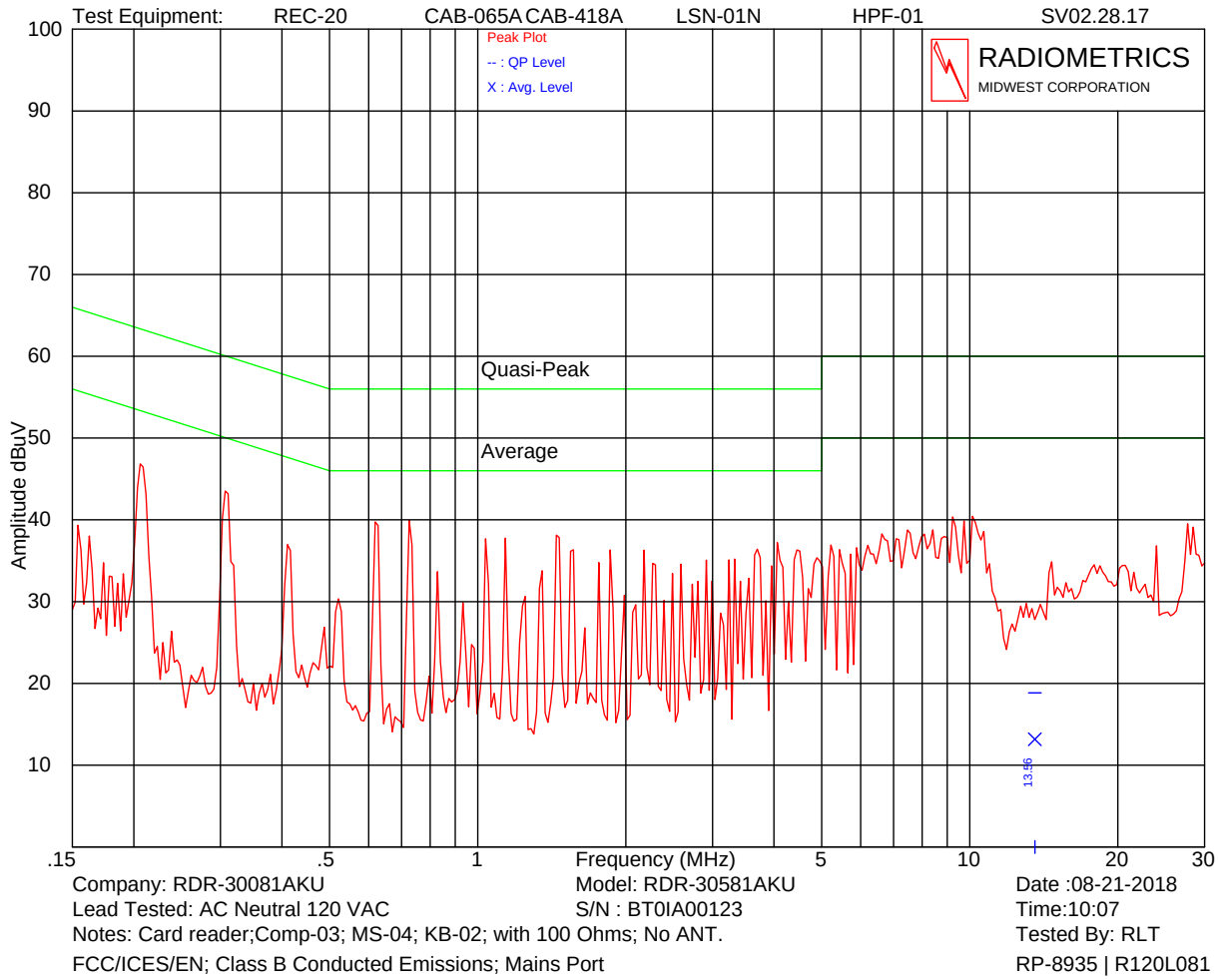


With Antenna installed
The emission at 13.56 MHz was re-measured with a resistive load in place of the antenna and was fully compliant.

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.313	42.5	59.9	42.5	49.9	7.4
13.561	65.2	60.0	58.1	50.0	-8.1

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Hot 120 VAC	0.206	41.7	53.4	11.7
AC Hot 120 VAC	0.307	42.3	50.1	7.7
AC Hot 120 VAC	0.311	41.7	49.9	8.3
AC Hot 120 VAC	0.410	37.3	47.6	10.4
AC Hot 120 VAC	0.619	38.4	46.0	7.6
AC Hot 120 VAC	0.726	38.1	46.0	7.9
AC Hot 120 VAC	1.037	35.3	46.0	10.7
AC Hot 120 VAC	9.861	39.4	50.0	10.6
AC Hot 120 VAC	10.125	41.5	50.0	8.5
AC Hot 120 VAC	10.260	40.3	50.0	9.7
AC Hot 120 VAC	10.397	42.0	50.0	8.0

The above are the highest readings relative to the limit. The peak readings met the average limit.

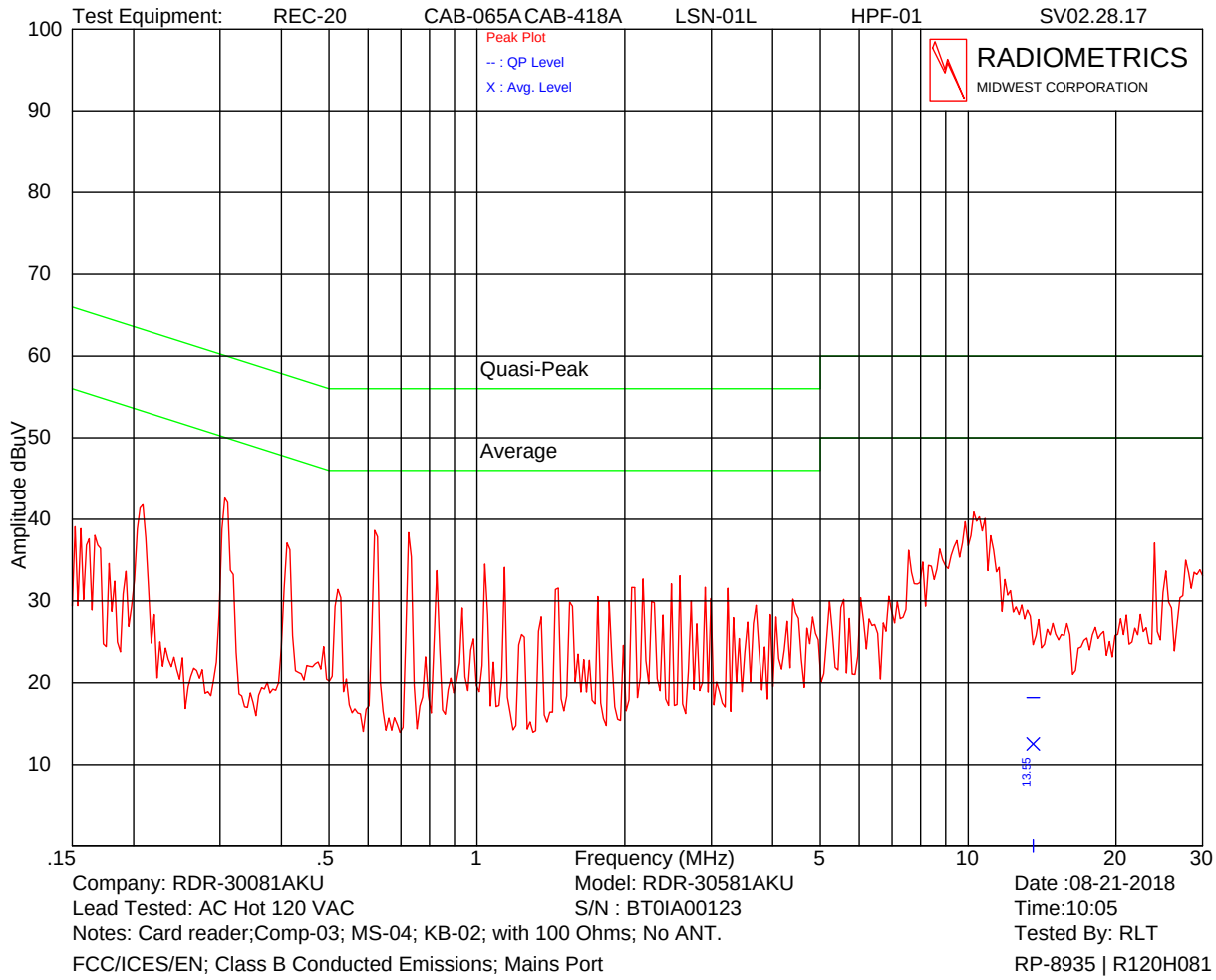


With Resistor in place of 13.56 MHz antenna

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
13.56	18.9	60.0	13.2	50.0	36.8

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Neutral 120 VAC	0.206	46.9	53.4	6.5
AC Neutral 120 VAC	0.307	43.5	50.1	6.5
AC Neutral 120 VAC	0.311	43.2	49.9	6.7
AC Neutral 120 VAC	0.619	39.8	46.0	6.3
AC Neutral 120 VAC	0.726	39.9	46.0	6.1
AC Neutral 120 VAC	1.037	37.7	46.0	8.3
AC Neutral 120 VAC	1.138	37.8	46.0	8.2
AC Neutral 120 VAC	1.445	38.1	46.0	7.9
AC Neutral 120 VAC	2.178	36.3	46.0	9.7
AC Neutral 120 VAC	3.700	36.4	46.0	9.6
AC Neutral 120 VAC	4.060	37.3	46.0	8.8
AC Neutral 120 VAC	4.454	36.3	46.0	9.7
AC Neutral 120 VAC	9.229	40.4	50.0	9.6
AC Neutral 120 VAC	10.125	40.4	50.0	9.6

The above are the highest readings relative to the limit. The peak readings met the average limit.

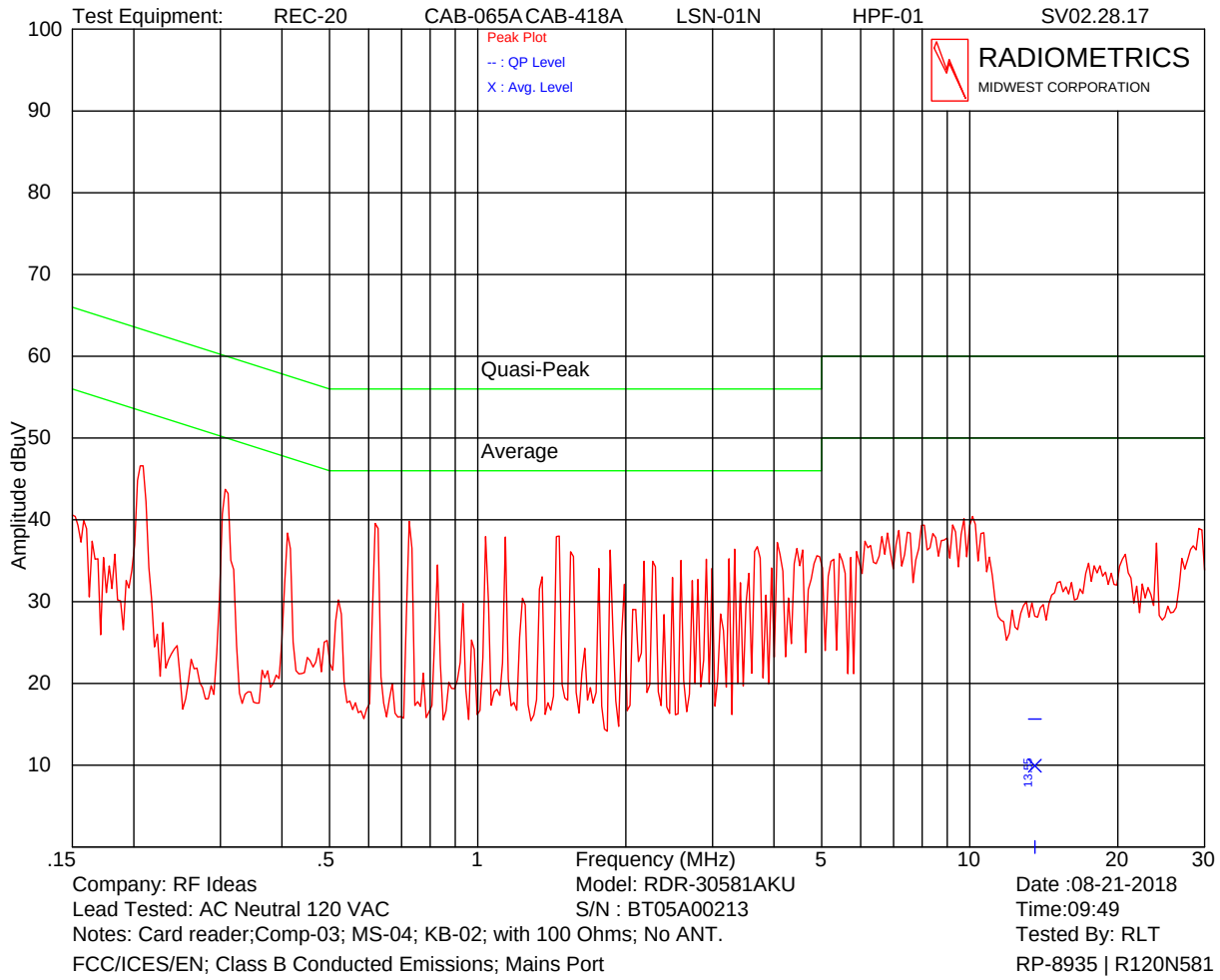


With Resistor in place of 13.56 MHz antenna

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
13.559	18.2	60.0	12.5	50.0	37.5

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Hot 120 VAC	0.307	42.6	50.1	7.4
AC Hot 120 VAC	0.311	42.0	49.9	7.9
AC Hot 120 VAC	0.410	37.1	47.6	10.5
AC Hot 120 VAC	0.619	38.7	46.0	7.4
AC Hot 120 VAC	0.726	38.4	46.0	7.6
AC Hot 120 VAC	9.861	39.7	50.0	10.3
AC Hot 120 VAC	10.260	40.9	50.0	9.1
AC Hot 120 VAC	10.536	40.3	50.0	9.7

The above are the highest readings relative to the limit. The peak readings met the average limit.

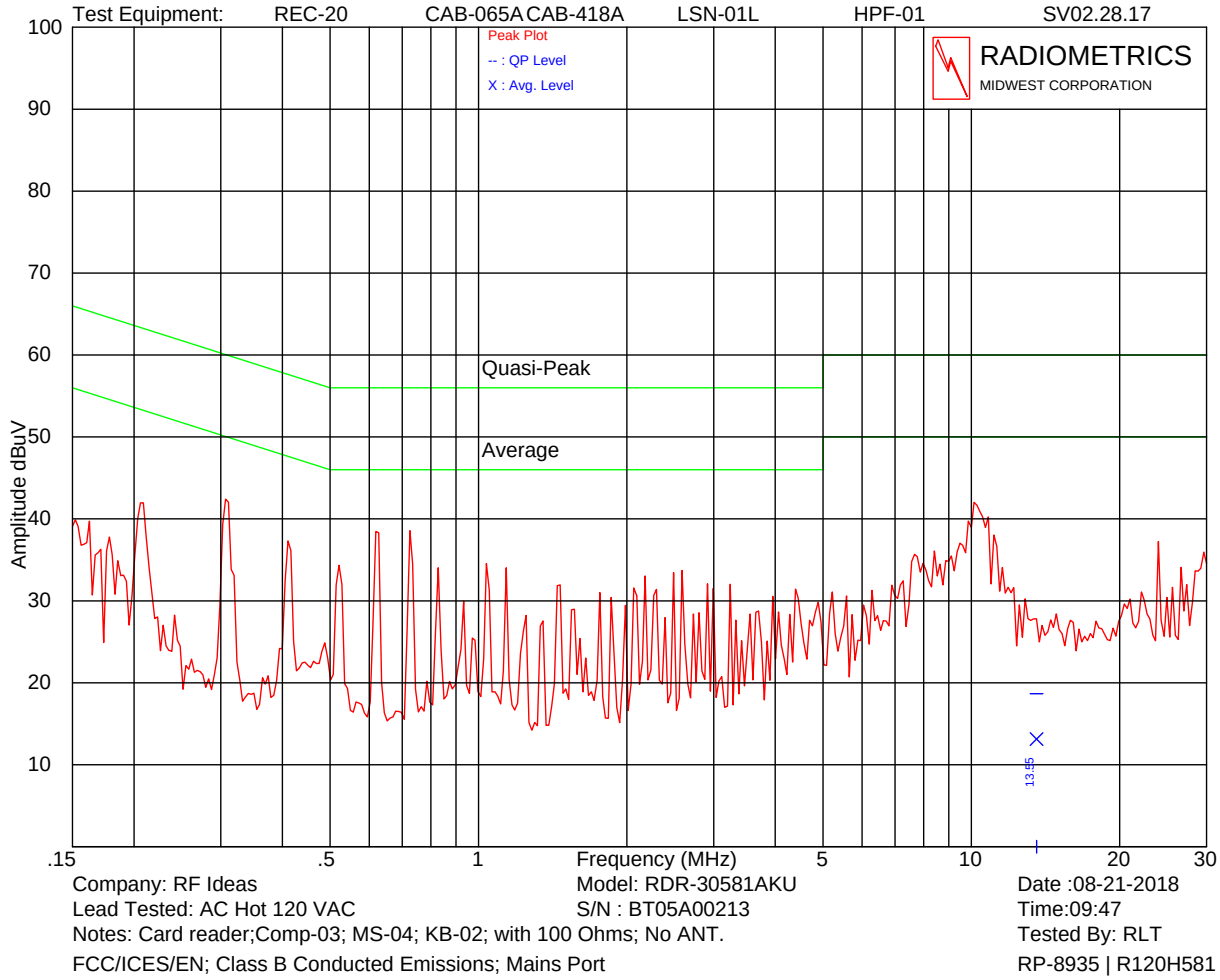


With Resistor in place of 13.56 MHz antenna

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
13.555	15.6	60.0	9.9	50.0	40.1

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Neutral 120 VAC	0.206	46.6	53.4	6.7
AC Neutral 120 VAC	0.209	46.6	53.2	6.6
AC Neutral 120 VAC	0.307	43.7	50.1	6.3
AC Neutral 120 VAC	0.311	43.2	49.9	6.7
AC Neutral 120 VAC	0.410	38.4	47.6	9.3
AC Neutral 120 VAC	0.619	39.6	46.0	6.4
AC Neutral 120 VAC	0.627	39.0	46.0	7.1
AC Neutral 120 VAC	0.726	39.8	46.0	6.2
AC Neutral 120 VAC	1.037	38.0	46.0	8.1
AC Neutral 120 VAC	1.138	37.9	46.0	8.1
AC Neutral 120 VAC	1.464	38.0	46.0	8.0
AC Neutral 120 VAC	4.060	37.3	46.0	8.8
AC Neutral 120 VAC	10.125	40.4	50.0	9.6

The above are the highest readings relative to the limit. The peak readings met the average limit.



With Resistor in place of 13.56 MHz antenna

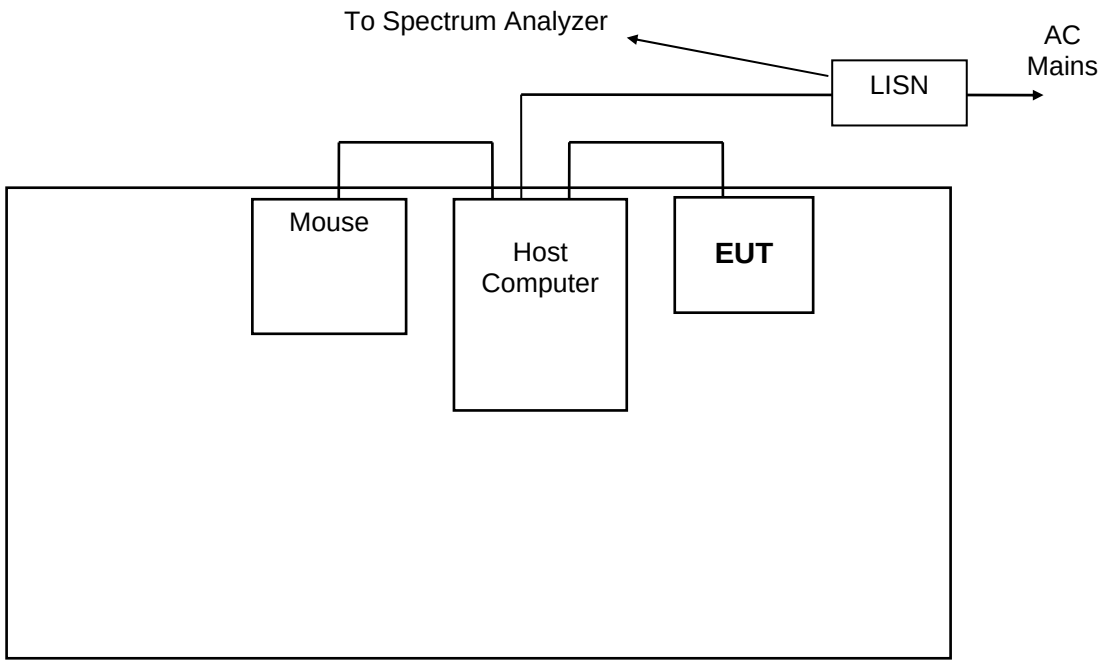
Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
13.56	18.7	60.0	13.1	50.0	36.9

Lead under test	Freq. MHz	Peak dBuV	Average Limit dBuV	Margin dB
AC Hot 120 VAC	0.307	42.4	50.1	7.6
AC Hot 120 VAC	0.311	42.0	49.9	7.9
AC Hot 120 VAC	0.619	38.5	46.0	7.5
AC Hot 120 VAC	0.726	38.6	46.0	7.4
AC Hot 120 VAC	10.125	42.0	50.0	8.0
AC Hot 120 VAC	10.260	41.7	50.0	8.3
AC Hot 120 VAC	10.397	41.0	50.0	9.1
AC Hot 120 VAC	10.536	40.3	50.0	9.7

The above are the highest readings relative to the limit. The peak readings met the average limit.

Judgment: Passed by at least 10 dB at 13.56 MHz with Resistive Load in place of standard Loop antenna. Passed by at least 6.0 dB at all frequencies, except 13.56 MHz, with standard Loop antenna installed.

Figure 1. Conducted Emissions Test Setup



Notes:
- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of table top
- EUT power cord bundled

11.2 Radiated RF Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4 and CISPR 16-1. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 1000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

Radiated Emissions Field Strength Limits

Frequency Range (MHz)	Test Distance (meters)	Class B Limits	
		uV/m	dB(uV/m)
0.009-0.490	300	2400/F(kHz)	20*LOG(2400/kHz)
0.490-1.705	30	24000/F(kHz)	20*LOG(24000/kHz)
1.705-30.0	30	30	29.5
30 - 88	3	100	40.0
88 - 216	3	150	43.5
216 - 960	3	200	46.0
Above 960	3	500	54.0

The emission limits shown in the above table are based on measurements using 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.

11.2.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + CF – AG

Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain (if any)

11.2.2 Radiated Emissions Test Results

Test Dates	08/17/2018
Test Distance	3 Meters
Specification	FCC Part 15 Subpart C & RSS-210
Abbreviations	P = peak; Q = QP Pol = Antenna Polarization; V = Vertical; H = Horizontal
EUT	Model RDR-80081AKU, Serial Number

The 125, 132 kHz and the 13.56 MHz transmitters were on during the following tests.
The following shows the highest emissions during the tests.

Model RDR-30081AKU; Serial Number BT01A00123

Freq. (MHz)	Meter Reading (dBuV)	Dect.	Ant. Pol.	Antenna Factor	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
54.1	14.7	P	H	12.5	0.6	0.0	27.8	40.0	12.2
63.5	20.0	P	H	10.7	0.6	0.0	31.3	40.0	8.7
72.1	15.5	P	H	8.1	0.7	0.0	24.3	40.0	15.7
79.0	22.6	P	H	8.4	0.7	0.0	31.7	40.0	8.3
80.7	23.2	P	H	8.7	0.7	0.0	32.6	40.0	7.4
96.2	14.3	P	H	11.5	0.8	0.0	26.6	43.5	16.9

Freq. (MHz)	Meter Reading (dBuV)	Dect.	Ant. Pol.	Antenna Factor	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
121.2	12.7	P	H	14.7	0.9	0.0	28.3	43.5	15.2
137.9	11.2	P	H	13.5	0.9	0.0	25.6	43.5	17.9
150.0	13.1	P	H	13.4	1.0	0.0	27.5	43.5	16.0
162.0	13.9	P	H	15.1	1.1	0.0	30.1	43.5	13.4
177.9	13.3	P	H	19.1	1.1	0.0	33.5	43.5	10.0
186.1	13.9	P	H	19.1	1.1	0.0	34.1	43.5	9.4
190.0	13.5	P	H	18.7	1.1	0.0	33.3	43.5	10.2
198.1	12.8	P	H	17.6	1.1	0.0	31.5	43.5	12.0
213.6	13.4	P	H	10.5	1.2	0.0	25.1	43.5	18.4
215.1	20.5	P	H	10.4	1.2	0.0	32.1	43.5	11.4
217.4	21.3	P	H	10.4	1.2	0.0	32.9	46.0	13.1
226.4	20.4	P	H	10.7	1.2	0.0	32.3	46.0	13.7
236.2	24.2	P	H	10.7	1.3	0.0	36.2	46.0	9.8
245.3	21.8	P	H	11.1	1.3	0.0	34.2	46.0	11.8
248.3	22.9	P	H	11.3	1.3	0.0	35.5	46.0	10.5
257.4	18.6	P	H	12.0	1.3	0.0	31.9	46.0	14.1
271.0	24.7	P	H	13.0	1.3	0.0	39.0	46.0	7.0
282.3	21.7	P	H	13.2	1.4	0.0	36.3	46.0	9.7
288.4	15.4	Q	H	13.1	1.4	0.0	29.9	46.0	16.1
295.1	24.7	P	H	13.2	1.4	0.0	39.3	46.0	6.7
338.2	17.0	P	H	14.6	1.5	0.0	33.1	46.0	12.9
352.5	13.8	P	H	14.4	1.6	0.0	29.8	46.0	16.2
379.7	16.6	P	H	14.8	1.6	0.0	33.0	46.0	13.0
406.9	16.2	P	H	14.8	1.7	0.0	32.7	46.0	13.3
461.2	15.0	P	H	16.2	1.8	0.0	33.0	46.0	13.0
488.4	17.1	P	H	17.3	1.9	0.0	36.3	46.0	9.7
516.3	17.7	P	H	17.7	1.9	0.0	37.3	46.0	8.7
528.8	15.5	P	H	16.8	1.9	0.0	34.2	46.0	11.8
542.5	17.0	P	H	17.7	1.9	0.0	36.6	46.0	9.4
651.3	15.0	P	H	20.2	2.1	0.0	37.3	46.0	8.7
990.0	11.1	P	H	23.1	2.7	0.0	36.9	54.0	17.1
36.5	16.5	P	V	11.7	0.5	0.0	28.7	40.0	11.3
37.7	18.8	P	V	11.9	0.5	0.0	31.2	40.0	8.8
39.0	18.5	P	V	12.1	0.5	0.0	31.1	40.0	8.9
51.1	20.4	P	V	12.6	0.6	0.0	33.6	40.0	6.4
54.1	18.8	P	V	12.5	0.6	0.0	31.9	40.0	8.1
60.1	15.0	P	V	11.6	0.6	0.0	27.2	40.0	12.8
69.6	14.1	P	V	8.7	0.6	0.0	23.4	40.0	16.6
76.0	15.0	P	V	7.9	0.7	0.0	23.6	40.0	16.4
96.2	15.2	P	V	11.5	0.8	0.0	27.5	43.5	16.0
122.4	12.5	P	V	14.7	0.9	0.0	28.1	43.5	15.4
150.0	12.7	P	V	13.4	1.0	0.0	27.1	43.5	16.4
162.0	12.2	P	V	15.1	1.1	0.0	28.4	43.5	15.1
174.1	12.2	P	V	18.4	1.1	0.0	31.7	43.5	11.8
192.1	12.1	P	V	18.4	1.1	0.0	31.6	43.5	11.9
209.8	12.6	P	V	10.6	1.2	0.0	24.4	43.5	19.1
243.8	12.7	P	V	11.0	1.3	0.0	25.0	46.0	21.0
257.4	11.4	P	V	12.0	1.3	0.0	24.7	46.0	21.3
271.0	20.0	P	V	13.0	1.3	0.0	34.3	46.0	11.7
284.6	16.1	P	V	13.0	1.4	0.0	30.5	46.0	15.5
298.9	12.0	P	V	13.5	1.4	0.0	26.9	46.0	19.1
338.2	20.5	P	V	14.6	1.5	0.0	36.6	46.0	9.4
379.7	16.5	P	V	14.8	1.6	0.0	32.9	46.0	13.1

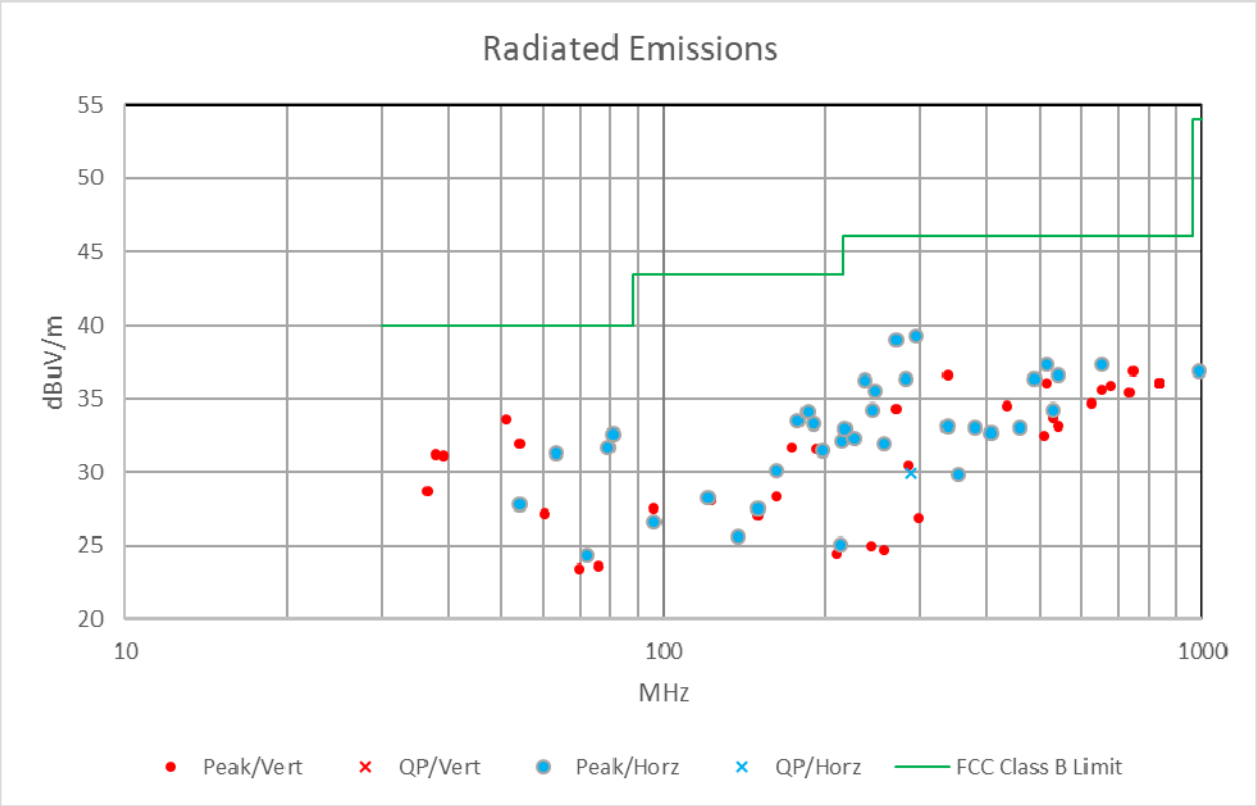
Freq. (MHz)	Meter Reading (dBuV)	Dect.	Ant. Pol.	Antenna Factor	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
434.0	17.0	P	V	15.8	1.7	0.0	34.5	46.0	11.5
510.0	12.6	P	V	18.0	1.9	0.0	32.5	46.0	13.5
516.3	16.5	P	V	17.7	1.9	0.0	36.1	46.0	9.9
528.8	15.0	P	V	16.8	1.9	0.0	33.7	46.0	12.3
542.5	13.5	P	V	17.7	1.9	0.0	33.1	46.0	12.9
623.8	13.7	P	V	18.9	2.1	0.0	34.7	46.0	11.3
651.3	13.3	P	V	20.2	2.1	0.0	35.6	46.0	10.4
678.8	12.5	P	V	21.2	2.2	0.0	35.9	46.0	10.1
732.5	12.5	P	V	20.6	2.3	0.0	35.4	46.0	10.6
746.3	14.5	P	V	20.1	2.3	0.0	36.9	46.0	9.1
833.8	12.2	P	V	21.4	2.5	0.0	36.1	46.0	9.9

Model RDR-30581AKU; Serial Number BT05A00213

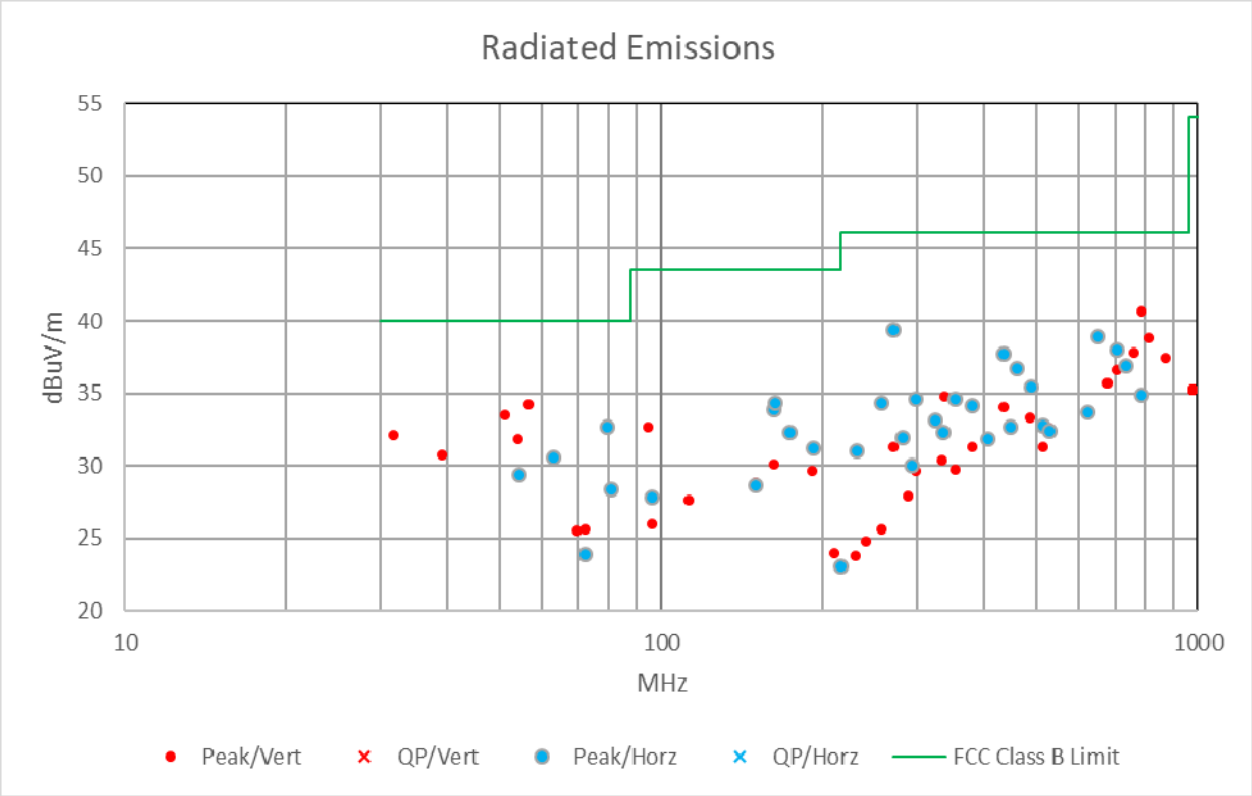
Freq. (MHz)	Meter Reading (dBuV)	Dect.	Ant. Pol.	Antenna Factor	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
54.5	16.4	P	H	12.4	0.6	0.0	29.4	40.0	10.6
63.1	19.1	P	H	10.9	0.6	0.0	30.6	40.0	9.4
72.1	15.1	P	H	8.1	0.7	0.0	23.9	40.0	16.1
79.4	23.5	P	H	8.5	0.7	0.0	32.7	40.0	7.3
80.7	19.0	P	H	8.7	0.7	0.0	28.4	40.0	11.6
96.2	15.5	P	H	11.5	0.8	0.0	27.8	43.5	15.7
150.0	14.2	P	H	13.4	1.0	0.0	28.6	43.5	14.9
162.0	17.7	P	H	15.1	1.1	0.0	33.9	43.5	9.6
162.9	17.9	P	H	15.3	1.1	0.0	34.3	43.5	9.2
174.1	12.8	P	H	18.4	1.1	0.0	32.3	43.5	11.2
192.1	11.7	P	H	18.4	1.1	0.0	31.2	43.5	12.3
215.9	11.4	P	H	10.4	1.2	0.0	23.0	43.5	20.5
231.7	19.0	P	H	10.8	1.2	0.0	31.0	46.0	15.0
257.4	21.0	P	H	12.0	1.3	0.0	34.3	46.0	11.7
271.0	25.1	P	H	13.0	1.3	0.0	39.4	46.0	6.6
282.3	17.3	P	H	13.2	1.4	0.0	31.9	46.0	14.1
293.6	15.4	P	H	13.2	1.4	0.0	30.0	46.0	16.0
298.1	19.7	P	H	13.5	1.4	0.0	34.6	46.0	11.4
325.3	17.5	P	H	14.1	1.5	0.0	33.1	46.0	12.9
335.9	16.3	P	H	14.5	1.5	0.0	32.3	46.0	13.7
352.5	18.6	P	H	14.4	1.6	0.0	34.6	46.0	11.4
379.7	17.7	P	H	14.8	1.6	0.0	34.1	46.0	11.9
406.9	15.3	P	H	14.8	1.7	0.0	31.8	46.0	14.2
434.0	20.2	P	H	15.8	1.7	0.0	37.7	46.0	8.3
447.6	15.2	P	H	15.7	1.8	0.0	32.7	46.0	13.3
461.2	18.7	P	H	16.2	1.8	0.0	36.7	46.0	9.3
488.4	16.2	P	H	17.3	1.9	0.0	35.4	46.0	10.6
516.3	13.2	P	H	17.7	1.9	0.0	32.8	46.0	13.2
528.8	13.7	P	H	16.8	1.9	0.0	32.4	46.0	13.6
625.0	12.6	P	H	19.0	2.1	0.0	33.7	46.0	12.3
651.3	16.6	P	H	20.2	2.1	0.0	38.9	46.0	7.1
706.3	15.2	P	H	20.6	2.2	0.0	38.0	46.0	8.0
732.5	14.0	P	H	20.6	2.3	0.0	36.9	46.0	9.1
787.5	11.6	P	H	20.9	2.4	0.0	34.9	46.0	11.1
31.7	21.0	P	V	10.7	0.4	0.0	32.1	40.0	7.9
39.0	18.1	P	V	12.1	0.5	0.0	30.7	40.0	9.3

Freq. (MHz)	Meter Reading (dBuV)	Dect.	Ant. Pol.	Antenna Factor	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
51.1	20.3	P	V	12.6	0.6	0.0	33.5	40.0	6.5
54.1	18.7	P	V	12.5	0.6	0.0	31.8	40.0	8.2
56.7	21.4	P	V	12.2	0.6	0.0	34.2	40.0	5.8
69.6	16.2	P	V	8.7	0.6	0.0	25.5	40.0	14.5
72.1	16.8	P	V	8.1	0.7	0.0	25.6	40.0	14.4
94.5	20.6	P	V	11.3	0.8	0.0	32.7	43.5	10.8
96.2	13.7	P	V	11.5	0.8	0.0	26.0	43.5	17.5
112.6	12.8	P	V	13.9	0.9	0.0	27.6	43.5	15.9
150.0	14.4	P	V	13.4	1.0	0.0	28.8	43.5	14.7
162.0	13.9	P	V	15.1	1.1	0.0	30.1	43.5	13.4
190.8	9.9	P	V	18.6	1.1	0.0	29.6	43.5	13.9
209.8	12.2	P	V	10.6	1.2	0.0	24.0	43.5	19.5
230.2	11.8	P	V	10.8	1.2	0.0	23.8	46.0	22.2
240.8	12.7	P	V	10.8	1.3	0.0	24.8	46.0	21.2
257.4	12.3	P	V	12.0	1.3	0.0	25.6	46.0	20.4
271.0	17.0	P	V	13.0	1.3	0.0	31.3	46.0	14.7
288.3	13.4	P	V	13.1	1.4	0.0	27.9	46.0	18.1
298.1	14.7	P	V	13.5	1.4	0.0	29.6	46.0	16.4
332.9	14.5	P	V	14.4	1.5	0.0	30.4	46.0	15.6
338.2	18.7	P	V	14.6	1.5	0.0	34.8	46.0	11.2
352.5	13.7	P	V	14.4	1.6	0.0	29.7	46.0	16.3
379.7	14.9	P	V	14.8	1.6	0.0	31.3	46.0	14.7
434.0	16.5	P	V	15.8	1.7	0.0	34.0	46.0	12.0
486.1	13.9	P	V	17.5	1.9	0.0	33.3	46.0	12.7
516.3	11.7	P	V	17.7	1.9	0.0	31.3	46.0	14.7
528.8	13.9	P	V	16.8	1.9	0.0	32.6	46.0	13.4
678.8	12.3	P	V	21.2	2.2	0.0	35.7	46.0	10.3
706.3	13.8	P	V	20.6	2.2	0.0	36.6	46.0	9.4
760.0	15.2	P	V	20.3	2.3	0.0	37.8	46.0	8.2
787.5	17.3	P	V	20.9	2.4	0.0	40.6	46.0	5.4
813.8	15.4	P	V	20.9	2.5	0.0	38.8	46.0	7.2
868.8	12.5	P	V	22.4	2.5	0.0	37.4	46.0	8.6
977.5	9.7	P	V	22.8	2.7	0.0	35.2	54.0	18.8

Judgment: Passed by 5.4 dB



Model RDR-30081AKU, Serial Number

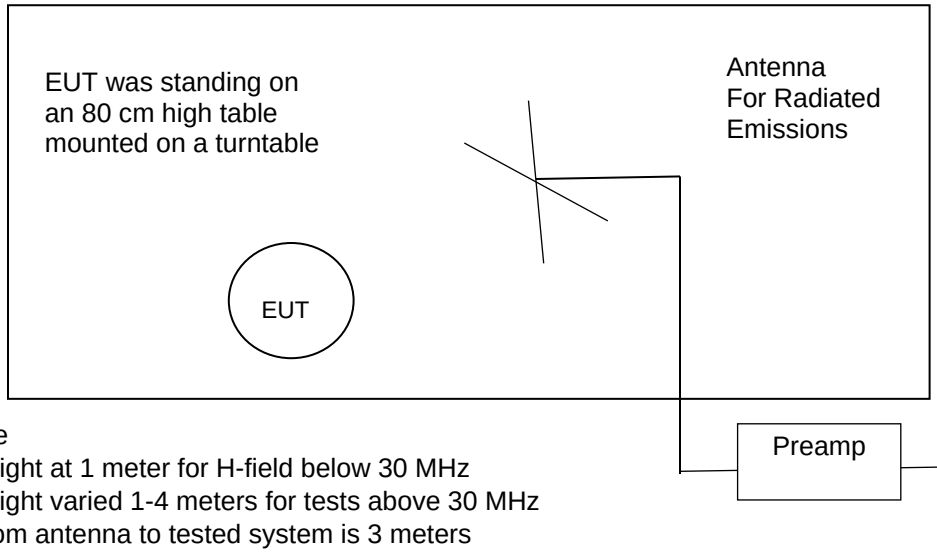


Model RDR-30581AKU; Serial Number

Radiated emissions in a graphical format. The above charts are the same data as the previous tables.

Figure 2. Drawing of Radiated Emissions Test Setup

Chamber E, anechoic



Notes:
- Not to Scale
- Antenna height at 1 meter for H-field below 30 MHz
- Antenna height varied 1-4 meters for tests above 30 MHz
- Distance from antenna to tested system is 3 meters
- AC cords not shown. They are connected to an AC outlet with low-pass filter on turntable

Frequency Range	Receive Antenna	Pre-Amplifier	Spectrum Analyzer
0.01 to 30 MHz	ANT-53	None	REC-21
30 to 200 MHz	ANT-03	Internal	REC-21
200 to 1000 MHz	ANT-68	Internal	REC-21

11.3 Magnetic Field Measurements and Decay Factor Calculations

Radiated emission measurements are performed with an EMCO shielded loop antenna. The antenna was rotated in order to find the maximize readings.

The distance correction factor is calculated as follows:
The distance factor in (dB) = DE*20*Log(TD/SD)
Where: DE = Decay Exponent (2.0 is used for this)
TD = Test distance in meters. This is 3 meters
SD = Specifciation Distance in meters

From 9 kHz to 490 kHz, the Specifcation Distance is 300m therefore the distance factor is 2*20*LOG(300/3) = 80 dB.
From 490 kHz to 30 MHz, the Specifcation Distance is 30m therefore the distance factor is 2*20*LOG(30/3) = 40 dB.

11.3.1 Magnetic Field Radiated Emissions Results (0.009 to 30 MHz)

Test Date	August 17, 2018
EUT	RDR-30081AKU; S/N LOIC000778 and RDR-30581AKU; SN: L05A058444
Test Distance	3 Meters
Specification	FCC 15 & RSS-GEN
Notes	A shielded Loop Antenna was used for this test.

125 & 132 kHz Frequencies

Freq (kHz)	meter reading (dBuV)	Loop Ant Factor	Dist. (m)	Decay exp	Cable Loss (dB)	FCC Distance factor (dB)	Field Strength dBuV/m	RSS-GEN & FCC 15.209 Limit dBuV/m	Margin under limit (dB)	EUT tested RDR-
125.0	65.0	19.1	3.0	2.0	0.1	-80.0	4.2	25.7	21.5	30581
250.0	40.0	18.9	3.0	2.0	0.1	-80.0	-21.0	19.6	40.6	30581
375.0	36.0	18.9	3.0	2.0	0.1	-80.0	-25.0	16.1	41.1	30581
500.0	34.0	18.8	3.0	2.0	0.1	-40.0	12.9	33.6	20.7	30581
132.0	67.3	19.1	3.0	2.0	0.1	-80.0	6.5	25.2	18.7	30581
264.0	43.6	18.9	3.0	2.0	0.1	-80.0	-17.4	19.2	36.6	30581
396.0	40.6	18.9	3.0	2.0	0.1	-80.0	-20.4	15.7	36.1	30581
125.0	64.2	19.1	3.0	2.0	0.1	-80.0	3.4	25.7	22.3	30081
250.0	40.0	18.9	3.0	2.0	0.1	-80.0	-21.0	19.6	40.6	30081
375.0	38.3	18.9	3.0	2.0	0.1	-80.0	-22.7	16.1	38.8	30081
500.0	34.0	18.8	3.0	2.0	0.1	-40.0	12.9	33.6	20.7	30081
132.0	65.7	19.1	3.0	2.0	0.1	-80.0	4.9	25.2	20.3	30081
264.0	42.9	18.9	3.0	2.0	0.1	-80.0	-18.1	19.2	37.3	30081
396.0	40.1	18.9	3.0	2.0	0.1	-80.0	-20.9	15.7	36.6	30081

13.56 MHz Frequencies

Freq (MHz)	meter reading (dBuV)	Loop Ant Factor	Dist. (m)	Decay exp	Cable Loss (dB)	FCC Distance factor (dB)	Field Strength (dBuV/m)	RSS & FCC Limit (dBuV/m)	Margin under limit (dB)	EUT tested RDR-
13.560	53.9	16.8	3.0	2.0	0.4	-40.0	31.1	40.5	9.4	30081
27.120	14.3	16.0	3.0	2.0	0.5	-40.0	-9.2	29.5	38.7	30081
13.560	54.1	16.8	3.0	2.0	0.4	-40.0	31.3	40.5	9.2	30581
27.120	14.1	16.0	3.0	2.0	0.5	-40.0	-9.4	29.5	38.9	30581

The limit shown at 13.56 MHz in the above table is the lowest limit from 15.225 sections (a), (b) and (c).

The limit from 13.553-13.567 MHz at 30 meters is 15,848 uV/m which = 84 dBuV/m in accordance with FCC 15.225 (c) and RSS-210 section B.6 (a).
The limit drops to 334uV/m from 13.410-13.553 MHz and 13.567-13.710 MHz, and 106uV/m = 40.5 dBuV/m from the bands 13.110-13.410 MHz and 13.710-14.010 MHz.

The lower limit (40.5 dBuV/m) was used for all frequencies from 13.110-14.010 MHz.

All other limits are general limits of FCC 15.209 or the RSS-Gen.

The emissions were scanned from 10 kHz to 30 MHz, including 13.11 and 14.01 MHz.
No other emissions were detected from 10 kHz to 30 MHz within 10 dB of the 15.209 or the RSS-GEN limits.
Judgement: Passed by 9.2 dB.

11.4 Occupied Bandwidth Data

The occupied bandwidth of the RF output was measured using a spectrum analyzer using a peak detector function and a narrow resolution bandwidth. A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. The plots of the occupied bandwidth for the EUT are supplied on the following page.

99% OBW		
125 kHz signal	132 kHz Signal	13.56 MHz Signal
1.32 kHz	1.695 kHz	2.225 kHz

Judgement: Pass

The bandwidth test was performed only on the RDR-30081AKU since the RF sections are the same in both versions.

The RBW of the analyzer that measured 99% OBW for 125 kHz cannot go lower than 100 Hz, so it was set to 100 Hz, even though it is more than 5% of the OBW. This produces a worst case measurement.

Figure 3. Occupied Bandwidth 125 kHz

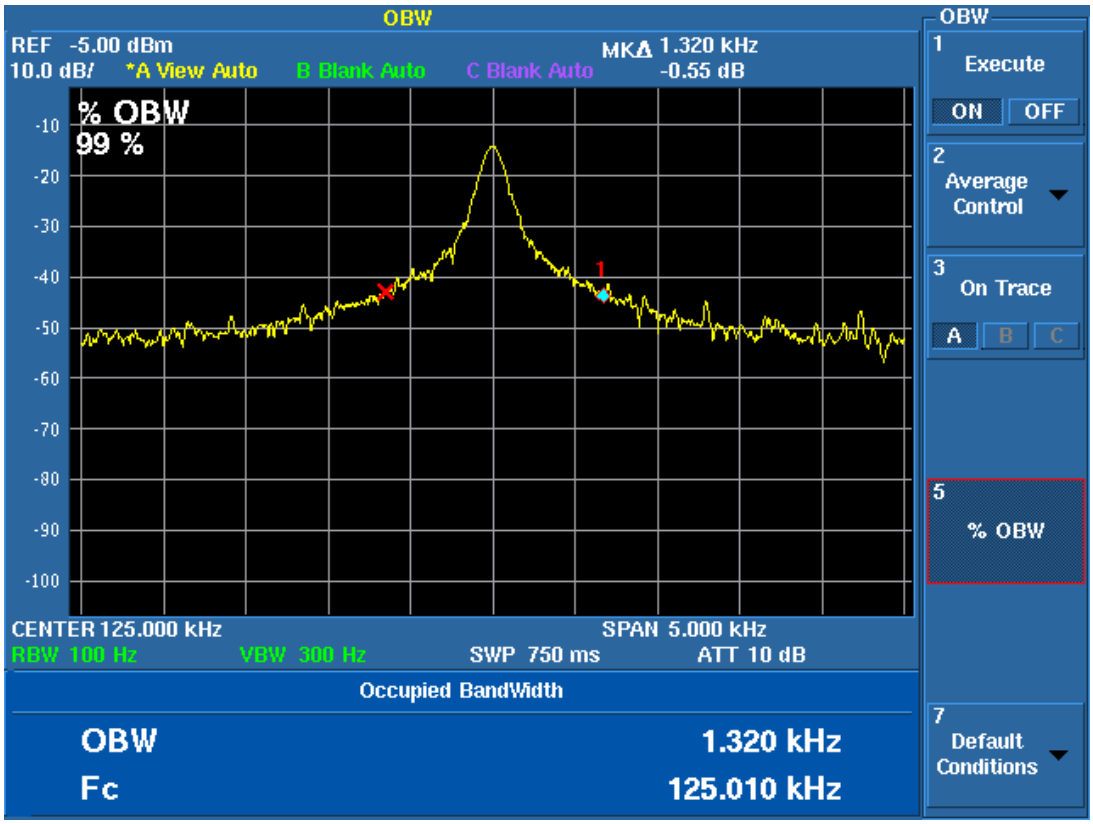


Figure 4. Occupied Bandwidth 132 kHz

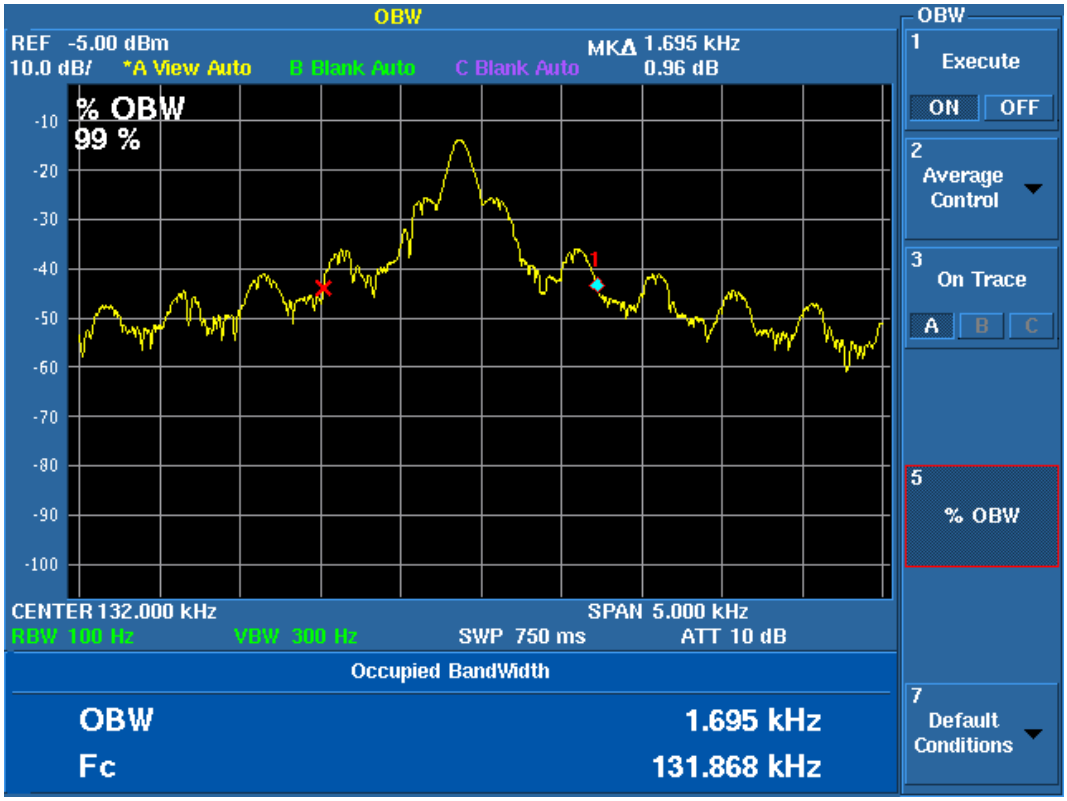
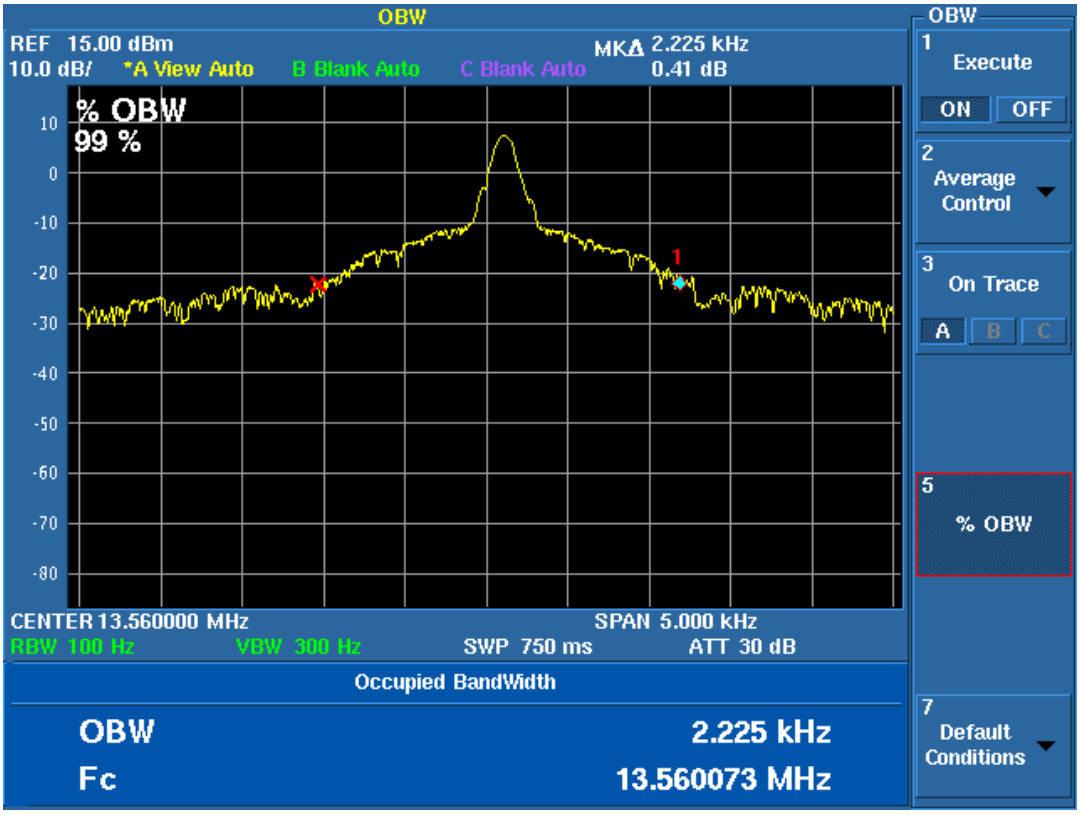


Figure 5. Occupied Bandwidth 13.56 MHz



11.5 Frequency Stability

The tests were in accordance to FCC 15.225 and RSS-210 Section A2.6. Since the product is USB powered, a desktop PC was used to power the device. The input power to the desktop PC was varied by 15%, using a variable AC supply.

11.5.1 Test Results for Frequency Stability

Model	RDR-30081AKU	Specification	FCC Part 15.225 RSS-210 Section A2.6
Serial Number	BT0IA00123	Test Date	10-11-2018
Test Personnel	Joseph Strzelecki	Test Location	Chamber B
Test Equipment	Spectrum Analyzer (REC-21); Temperature Chamber TC-01 Power Supply (PSA-02)		
Notes	10 minutes at each Temperature; 1 min at each voltage		
Nominal Frequency	13.560 MHz		

Volts VAC	Freq. (MHz)	Deviation %	PPM
102.0	13.560140	0.00103	10.32
120.0	13.560135	0.00100	9.96
138.0	13.560138	0.00102	10.18

Temp.	Freq. (@0min.)	Freq. (@2min.)	Freq. (@5min.)	Freq. (@10min.)	Change from Nominal			
Deg C	(MHz)	(MHz)	(MHz)	(MHz)	%	%	%	%
50	13.559985	13.560008	13.560015	13.560023	-0.00011	0.00006	0.00011	0.00017
40	13.560030	13.560015	13.560010	13.560060	0.00022	0.00011	0.00007	0.00044
30	13.560045	13.560098	13.560060	13.560015	0.00033	0.00072	0.00044	0.00011
20	13.560135	13.560075	13.560105	13.560075	0.00100	0.00055	0.00077	0.00055
10	13.560135	13.560068	13.560098	13.560083	0.00100	0.00050	0.00072	0.00061
0	13.560105	13.560090	13.560095	13.560105	0.00077	0.00066	0.00070	0.00077
-10	13.560083	13.560113	13.560143	13.560113	0.00061	0.00083	0.00105	0.00083
-20	13.560098	13.560135	13.560083	13.560060	0.00072	0.00100	0.00061	0.00044

Test Requirements: Limit is 100 ppm or 0.01% deviation.
Judgement: Pass

12.0 MEASUREMENT INSTRUMENTATION UNCERTAINTY

The uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2 in accordance with CISPR 16-4-2.

Measurement	Uncertainty
Conducted Emissions, LISN method, 150 kHz to 30 MHz	2.7 dB
Radiated Emissions, H-field, 3 meters, 9 kHz to 30 MHz	2.7 dB
Radiated Emissions, E-field, 3 meters, 30 to 200 MHz	3.3 dB
Radiated Emissions, E-field, 3 meters, 200 to 1000 MHz	4.9 dB
Frequency counter at 13.56 MHz; REC-21	136 Hz
99% Occupied Bandwidth using REC-43	1% of frequency span
Temperature THM-03	0.6 Deg C