Electromagnetic Compatibility Test Report

Tests Performed on an RF IDeas, Inc. Wave ID Mobile SP RFID Reader

Models RDR-300H1CKU-MXS and RDR-30MH1CKU-MXS

Radiometrics Document RP-9350

ACCREDITED
TESTING CERT #1495.01

Product Detail:	
FCC ID: M9MHP30100 IC: 6571A-HP30100 Equipment type: Multi Frequency Card Reader	
Test Standards:	
US CFR Title 47, Chapter I, FCC Part 15 Subpart C FCC Part 15 CFR Title 47: 2020 Canada ISED; RSS-210, Issue 10: 2019 as required for Category I Equipment FCC Part 15.209 & 15.225	
Tests Performed For:	Test Facility:
RF IDeas, Inc. 4020 Winnetka Av. Rolling Meadows, IL 60008	Radiometrics Midwest Corporation 12 Devonwood Avenue Romeoville, IL 60446
Test completion Date(s):	
October 2, 2020	

Document RP-9350 Revisions:

Rev.	Issue Date	Affected Sections	Revised By
0	October 7, 2020		
1	October 8, 2020	Cover, 11.3.1	Joseph Strzelecki
2	October 13, 2020	11.3.1	Joseph Strzelecki

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1.0 ADMINISTRATIVE DATA

Equipment Under Test:	
An RF IDeas, Inc., Wave ID Mobile SP, RFID Reader Models: RDR-300H1CKU-MXS and RDR-30MH1CKU-MXS Serial Numbers BH01C00011, BH01MC00011 These will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics:	*Test Date(s):*
September 30, 2020	September 30 to October 2, 2020
Test Report Written and Authorized by:	*Radiometrics' Personnel Responsible for Test:*
Joseph Strzelecki 10/07/2020 Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	Joseph Strzelecki Senior EMC Engineer Richard L. Tichgelaar EMC Technician Chris E. D'Alessio EMC Technician Dave Jarvis EMC Technician
Test Witnessed By:	
The tests were partially witnessed by Shiung Lo of RF IDeas, Inc.	

2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Wave ID Mobile SP RFID Reader, 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 per RSS-210 & FCC Part 15

Environmental Phenomena	Frequency Range	Test Result
RF Radiated Emissions	30-1000 MHz	Pass
Conducted Emissions, AC Mains	0.15 - 30 MHz	Pass
RF Radiated Emissions H-Field	0.009 – 30 MHz	Pass
Occupied Bandwidth	125, 132 kHz & 13.56 MHz	Pass
Frequency Stability vs Temp & Voltage	None	Pass

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 Wave ID Mobile SP Multi Frequency RFID Reader, Models RDR-30MH1CKU-MXS and RDR-300H1CKU-MXS, 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 products will not be sold to the general public. RF IDeas or the OEM will be responsible to ensure the proper installation in accordance with RF IDeas requirements.

These two antennas have a unique interface connector to ensure no other OEM antennas can be used. The antenna is internal to the EUT and it is not readily available to be modified by the end user.

3.1.2 Product Family

The following table is the product family list of the readers that use the same electronics and PCB as the ones tested in this report. The only changes are in firmware that would not affect the EMC characteristics of the readers.

The Main PCBA listed on the table below was fully tested and the results of which are featured in herein. The other untested model numbers listed below are electrically identical with the same electromagnetic emissions and electromagnetic compatibility characteristics as those tested, therefore the tests on the model numbers below are representative for the tested models.

Model Number	Description
RDR-300H1CKU-MXS	WAVE ID Mobile SP Keystroke HID Mobile Access Black USB Reader
RDR-300H3CKU-MXS-HP	WAVE ID Mobile SP MFP24 HP HID Mobile Access Black USB Reader (Private label with MPF24 Firmware)
RDR-30MH1CKU-MXS	WAVE ID Mobile SP Keystroke HID Mobile Access MIFARE Secure Black USB Reader
RDR-30MH3CKU-MXS-HP	WAVE ID Mobile SP MFP24 HP HID Mobile Access MIFARE Secure Black USB Reader (Private label with MPF24 Firmware)
RDR-300H1CKU-MXS-HP	WAVE ID Mobile SP Keystroke HP HID Mobile Access Black USB Reader
RDR-30MH1CKU-MXS-HP	WAVE ID Mobile SP Keystroke HP HID Mobile Access MIFARE Secure Black USB Reader

All these mentioned model numbers use the same frequency determining circuitry and use a USB interface. The 125 kHz and 13.56 MHz transmitter circuits are identical on all models.

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	RFID Reader	E	RF IDeas	RDR-30MH1CKU-MXS	BH0MC00011
2	RFID Reader	E	RF IDeas	RDR-300H1CKU-MXS	BH01C00011
3	Latitude Laptop PC	H	HP	Elite x2	5CG545482P
4	Laptop AC-DC power supply	P	HP	854055-002	None

* 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 from Reader to Host computer	Yes
1	1.2	AC Cord to AC-DC power supply to host computer	No
1	1.5	DC Cord to Computer	No

4.2 Special Accessories

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

4.3 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	2020	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
IC RSS-210 Issue 10	2019	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 5	2019	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: 2017 "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 3124A with a CAB ID US0224..

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-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	24 Mo.	12/13/19
ANT-07	RMC	Log-Periodic Ant.	LP1000	1001	200-1000MHz	24 Mo.	11/19/18
ANT-53	EMCO	Loop Antenna	6507	1453	1 kHz-30 MHz	24 Mo	02/04/20
ANT-66	ETS-Lindgren	Horn Antenna	3115	62580	1.0-18GHz	24 Mo.	03/05/19
ANT-80	AH Systems	Bicon Antenna	SAS-540	294	20-330MHz	24 Mo.	12/19/18
CAB-106A	Teledyne	Coaxial Cable	N/A	1090	DC-2 GHz	24 Mo.	01/29/20
CAB-1090	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	02/06/20
CAB-160B	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	02/05/20
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	03/02/20

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	08/12/19
REC-11	Agilent	Spectrum Analyzer	E7405A	US39110103	9kHz-3GHz	24 Mo.	04/16/20
REC-20	HP / Agilent	Spectrum Analyzer	85460A/84562A	33330A00135 3410A00178	30Hz-6GHz	24 Mo.	08/14/19
REC-43	Adventest	Spectrum Analyzer	U3772	150800305	9kHz-43GHz	24 Mo.	06/24/19
TC-01	GS Blue M Electric	Temperature Chamber	ETC-04S-E	0003-ETC-201	-40 to 100 C	12 Mo.	11/08/19
THM-03	Fluke	Temp/Humid Meter	971	95850465	N/A	12 Mo.	06/03/20

Note: All calibrated equipment is subject to periodic checks.

Software Company	Test Software Name	Version	Applicable Tests
Radiometrics	EN550XX0	07.16.19	RF Conducted Emissions (FCC Part 15 & EN 55032)
Radiometrics	REREC11D	07.16.19	RF Radiated Emissions (FCC Part 15 & EN 55032)
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 computer recorded the data and then plotted it on a semi-log graph. 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.		

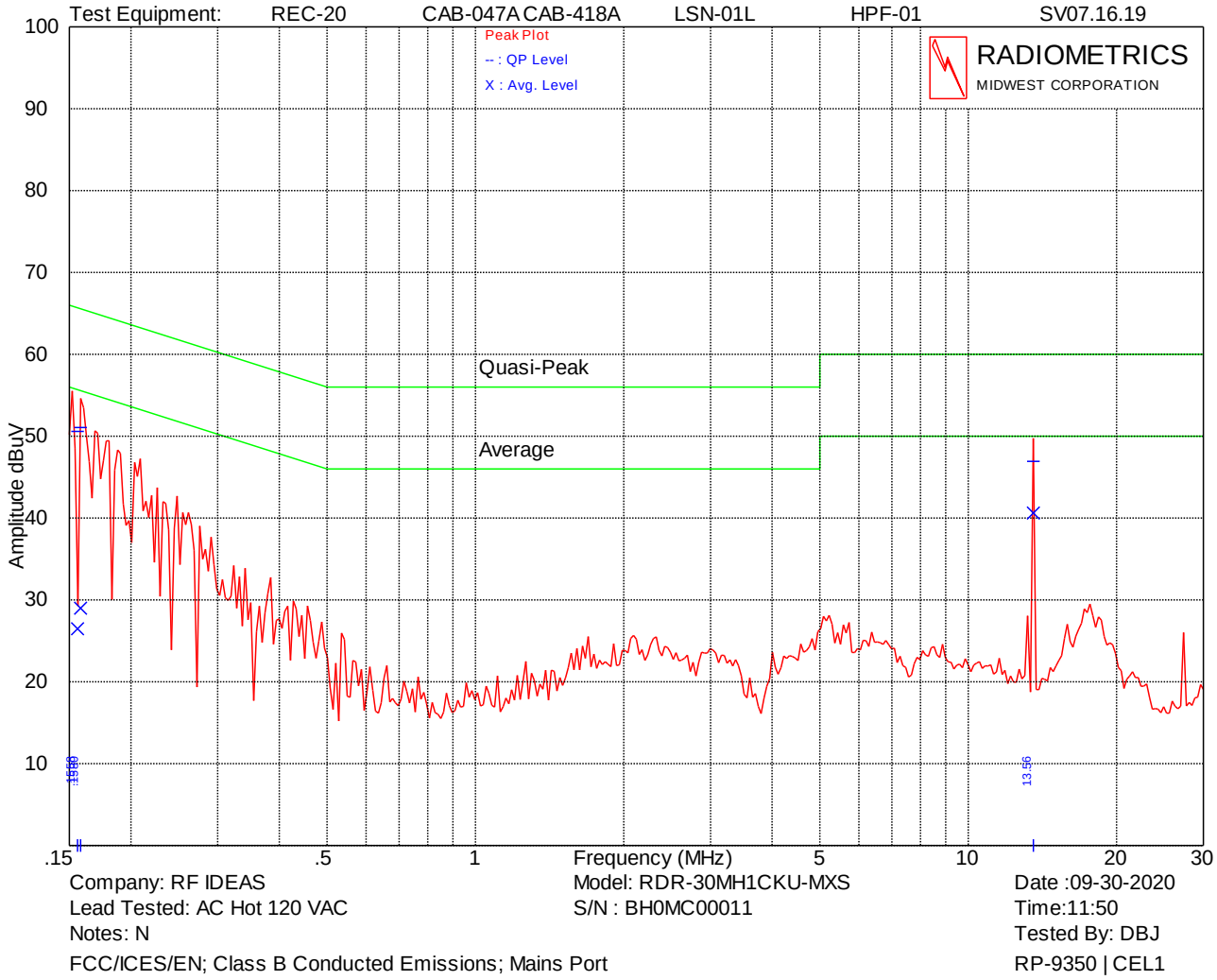
The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from 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.

The transmitter was tested with a dummy load under the following conditions:
1) First, the AC line conducted tests with the antenna attached were performed to determine if the EUT complies with the 15.207 limits outside the transmitter's fundamental emission band.

2) The AC line conducted emissions were retested with a dummy load to make sure the device complies with the 15.207 limits inside the transmitter's fundamental emission band. Only the fundamental TX emission band needs to be retested. The load was 50 Ohm. This is the characteristic impedance of the antenna.

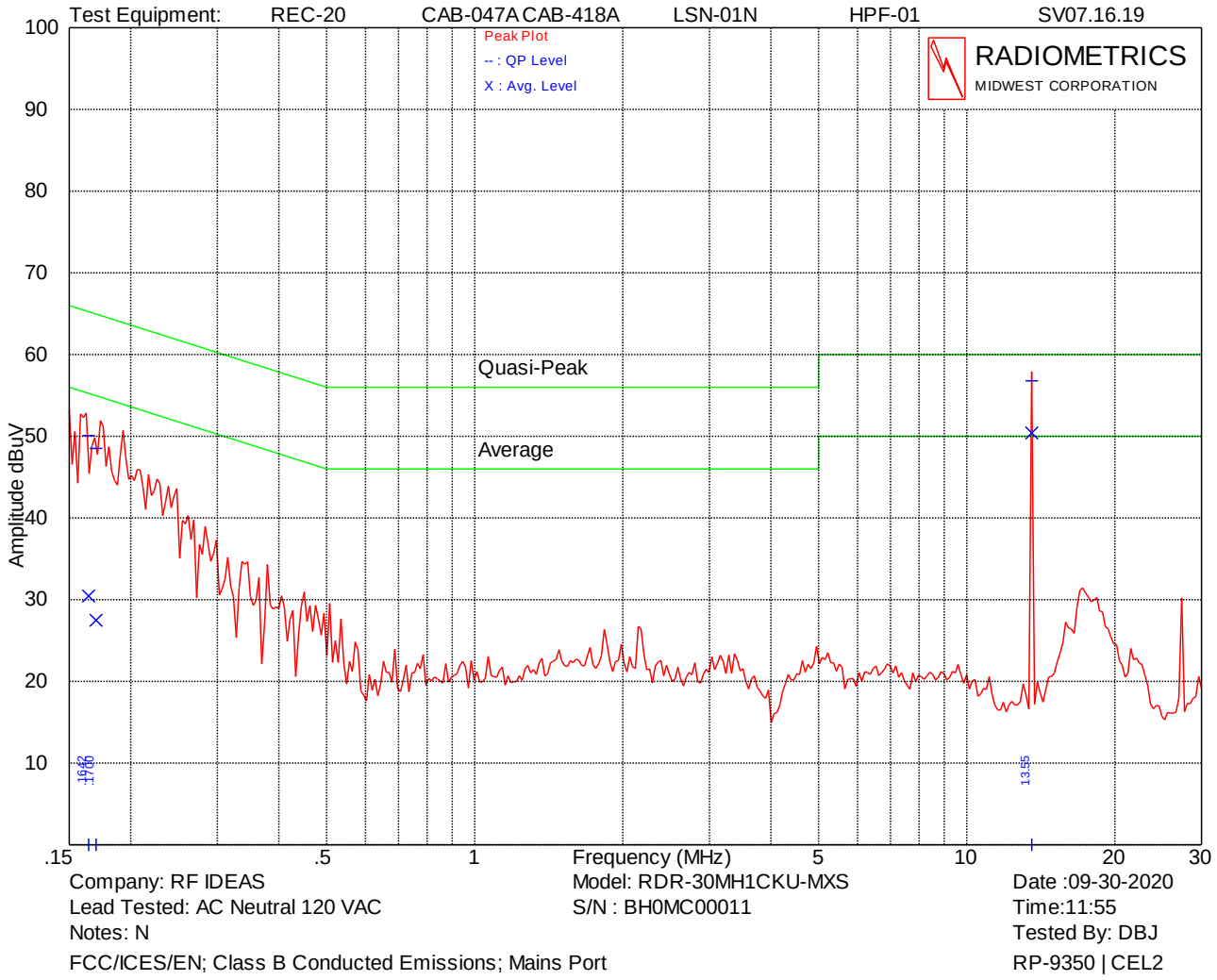
Tested by	Dave Jarvis
Test Dates	09/30/2020

The following shows the worst case from 125, 132 kHz and 13.56 MHz transmitters.
The Limit shown in the graphs are the FCC 15.107 and RSS-GEN Table 3.



With Antenna installed

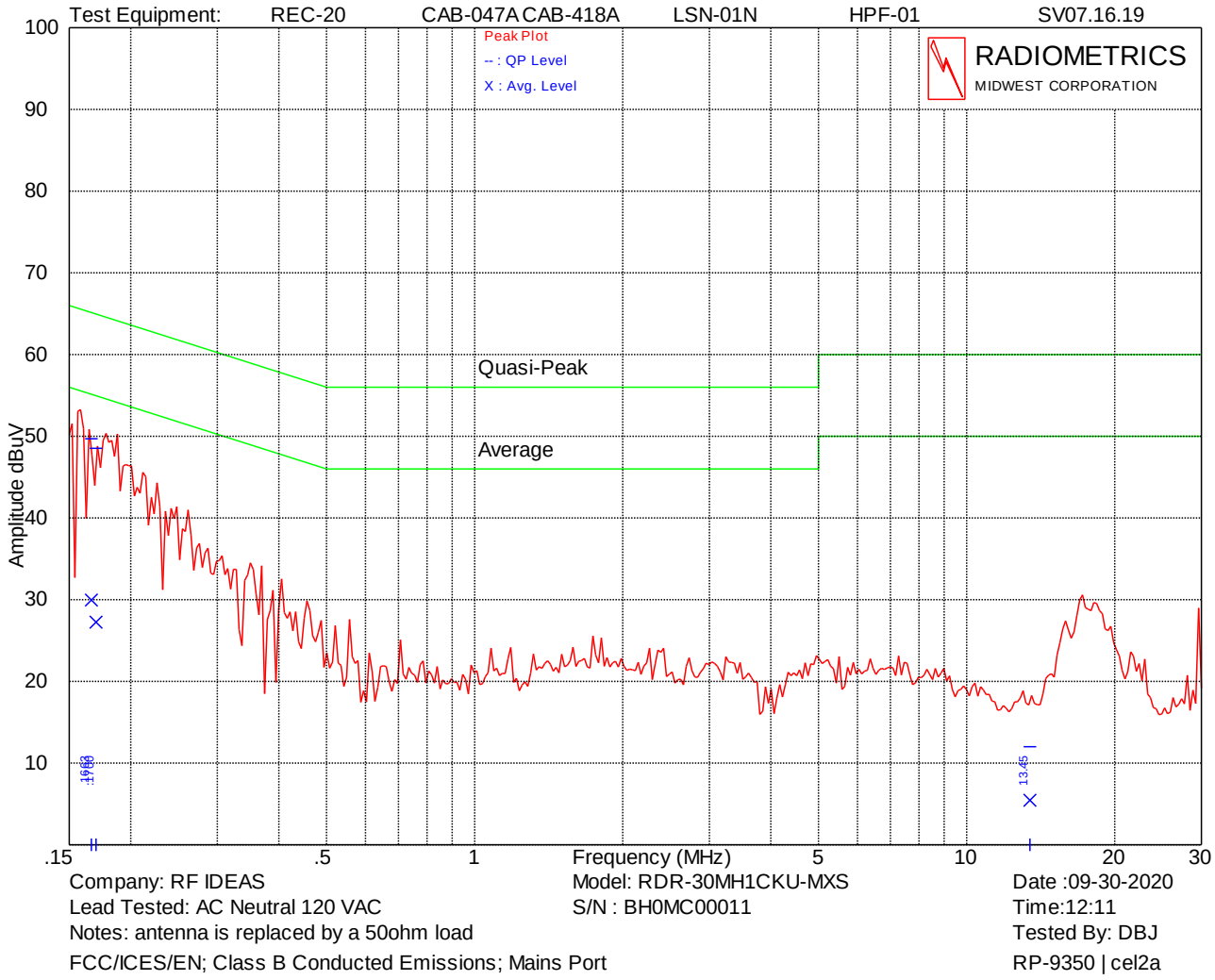
Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.158	51.1	65.6	29.0	55.6	14.5
0.156	50.6	65.7	26.5	55.7	15.1
13.562	46.9	60.0	40.6	50.0	9.4



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)
0.164	50.1	65.2	30.4	55.2	15.2
0.170	48.5	65.0	27.5	55.0	16.4
13.560	56.8	60.0	50.4	50.0	-0.4

Note: Above measurements were done with the 13.56Mhz antenna on-board

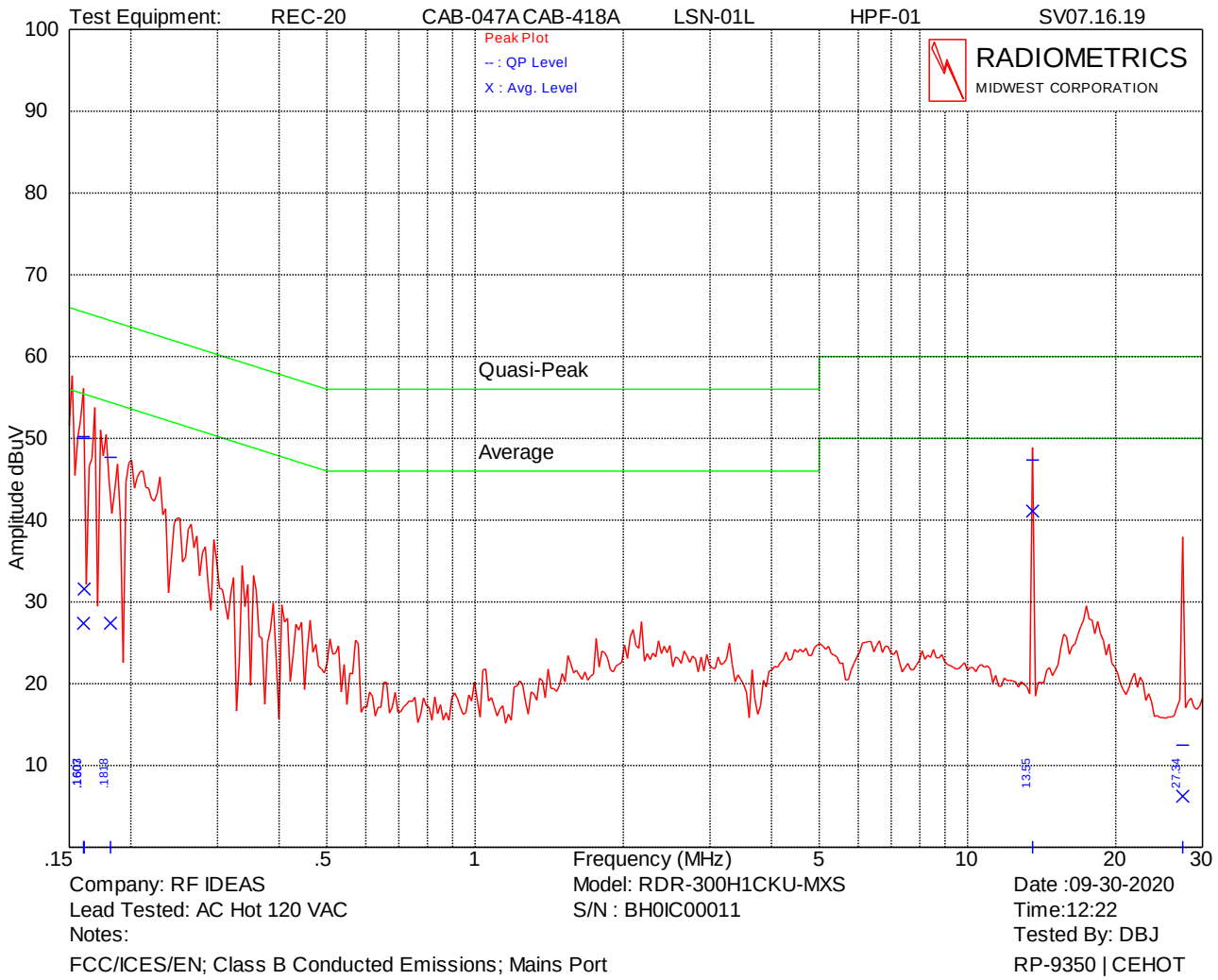


With 50 Ohms in place of Antenna

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.166	49.7	65.1	30.0	55.1	15.5
0.170	48.5	65.0	27.2	55.0	16.4
13.451	12.0	60.0	5.5	50.0	44.5

Pass by at least 10 dB at 13.56 MHz with Load in place of antenna

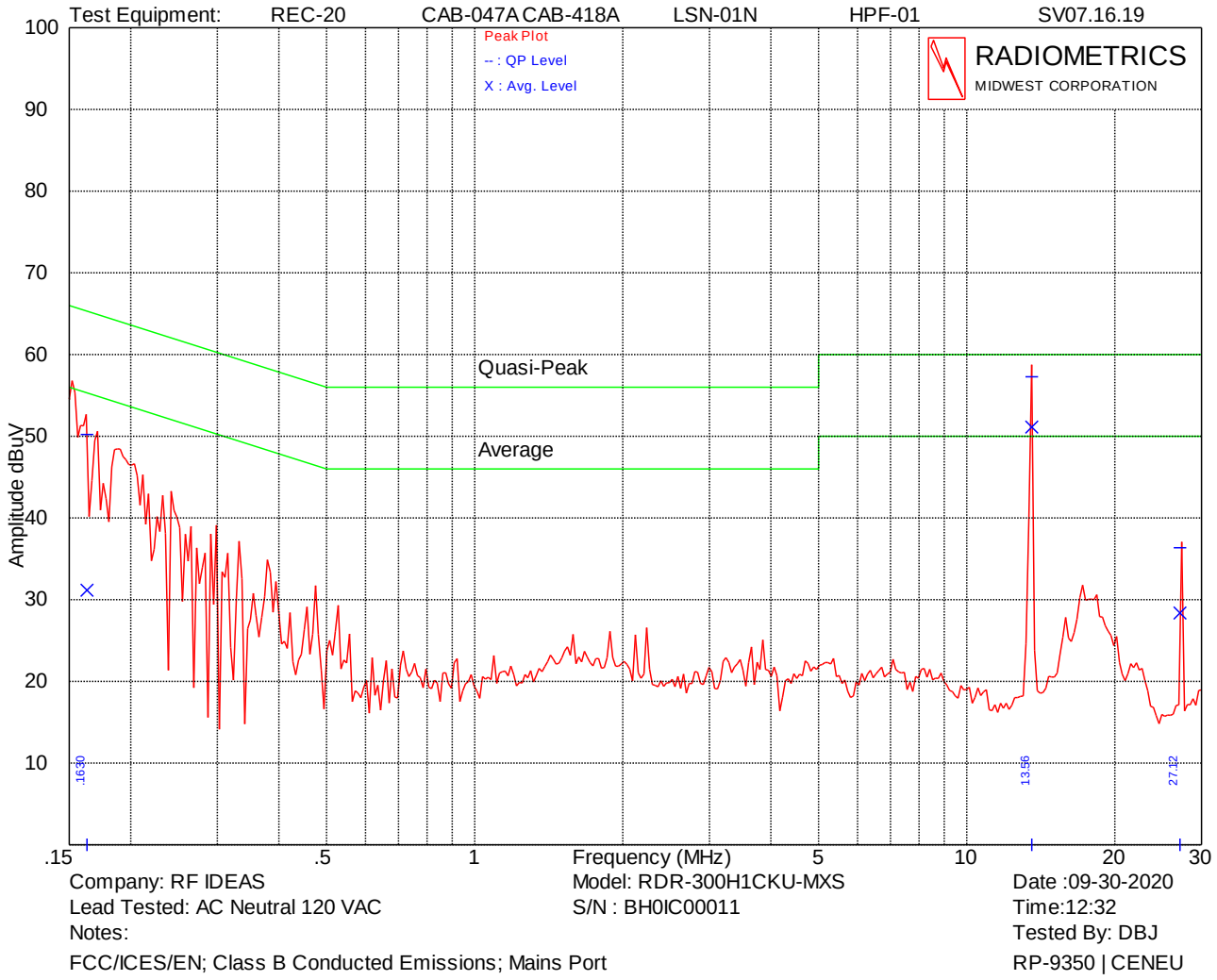
Model: RDR-300H1CKU-MXS



With Antenna installed

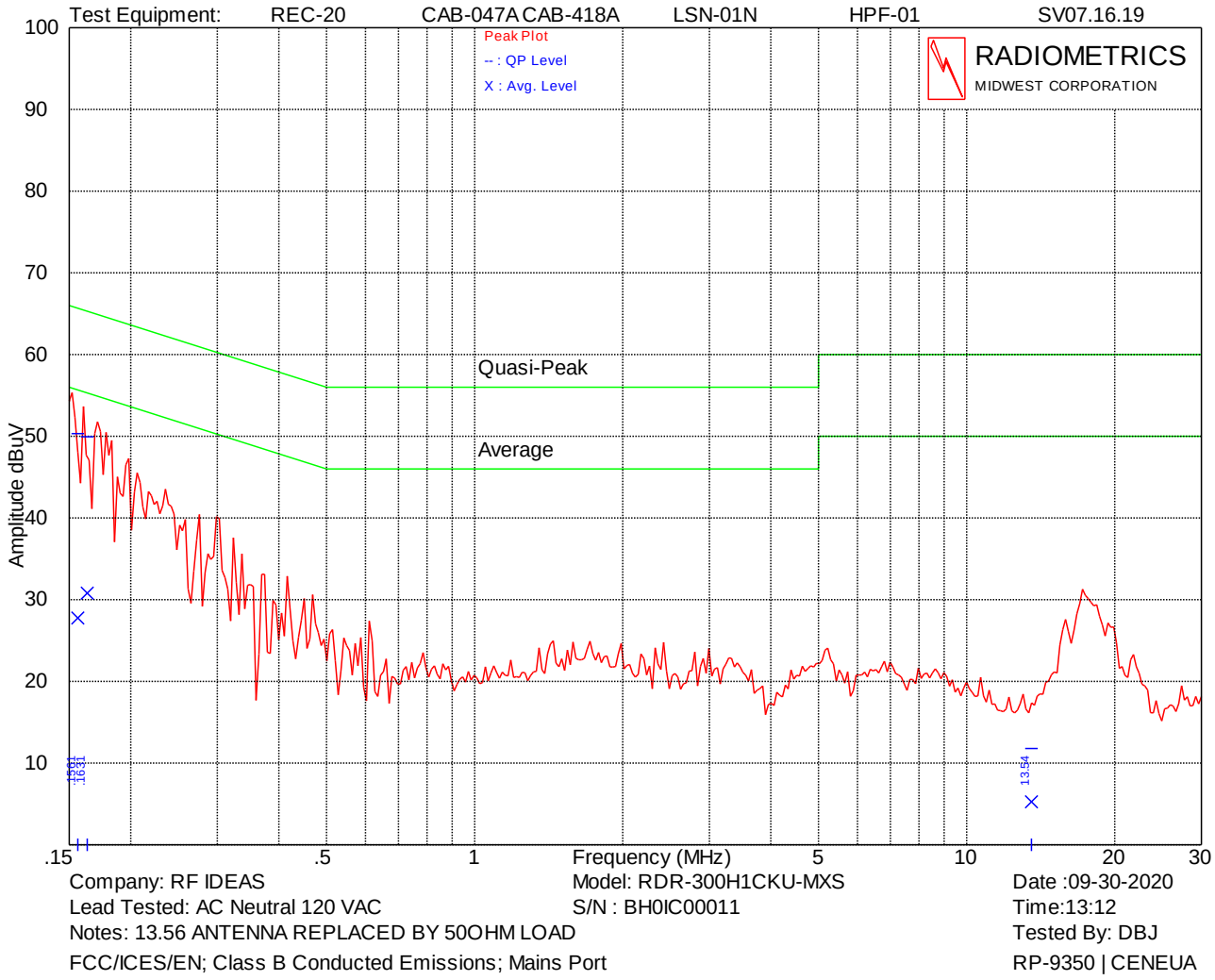
Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.160	50.2	65.4	27.4	55.4	15.2
0.161	50.0	65.4	31.6	55.4	15.4
0.182	47.7	64.4	27.4	54.4	16.7
13.560	47.3	60.0	41.1	50.0	8.9
27.350	12.5	60.0	6.2	50.0	43.8

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 dB at all frequencies, except 13.56 MHz, with standard Loop antenna installed.



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)
0.163	50.2	65.3	31.1	55.3	15.1
13.561	57.3	60.0	51.1	50.0	-1.1
27.121	36.3	60.0	28.4	50.0	21.6

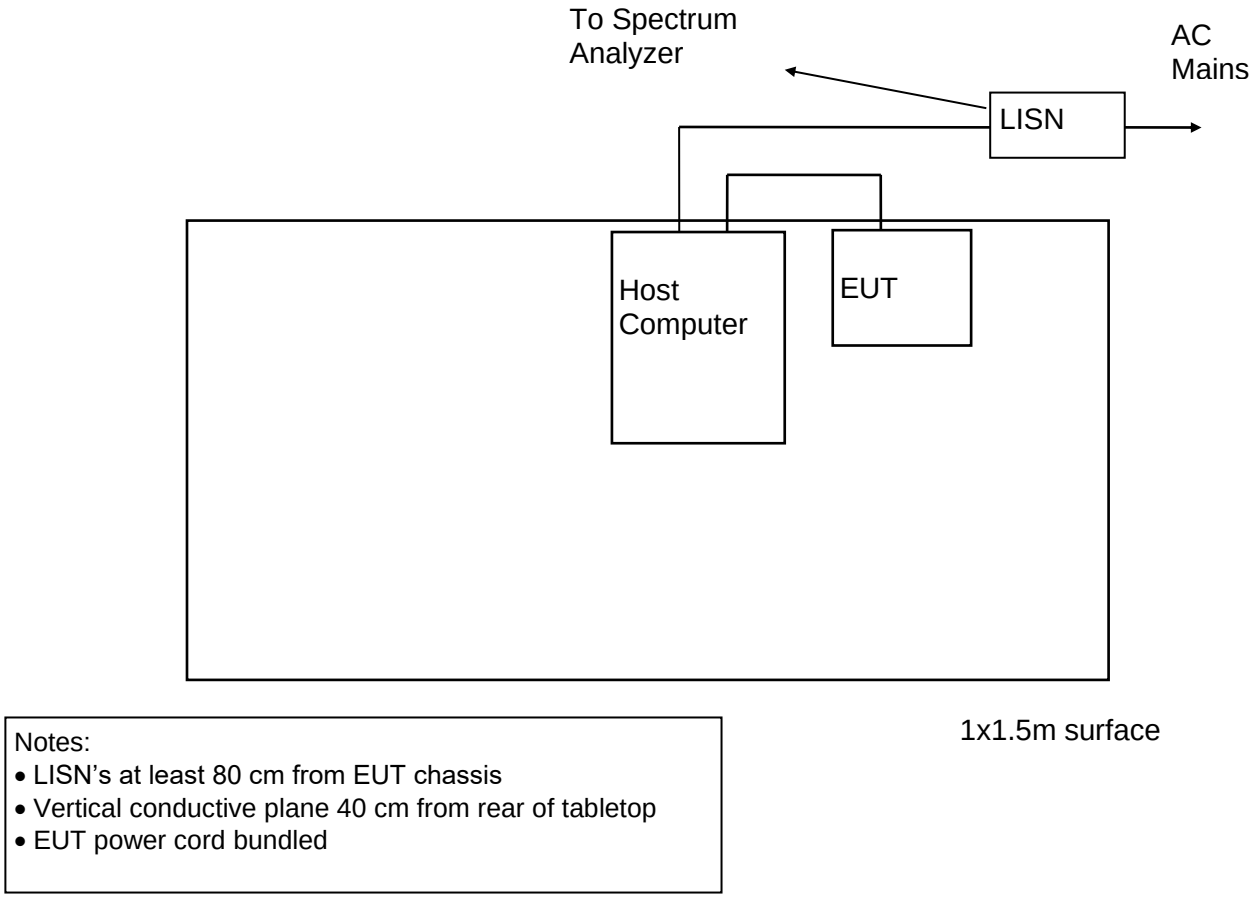


With 50 Ohms in place of Antenna

Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.156	50.3	65.7	27.8	55.7	15.3
0.163	49.9	65.3	30.8	55.3	15.4
13.544	11.8	60.0	5.3	50.0	44.7

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 dB at all frequencies, except 13.56 MHz, with standard Loop antenna installed.

Figure 1. Conducted Emissions Test Setup



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 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. The EUT was rotated through three orthogonal axes as per 5.10.1 of ANSI C63.10 during the radiated tests.

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 in dBuv
AF = Antenna Factor in dB/m
CF = Cable Attenuation Factor in dB
AG = Amplifier Gain in dB

11.2.2 Radiated Emissions Test Results

Test Dates	09/30/2020
Test Distance	3 Meters
Specification	FCC Part 15 Subpart C & RSS-210
Abbreviations	P = peak; Q = QP Pol = Antenna Polarization; V = Vertical; H = Horizontal
Tested by	Chris D'Alessio
Note	The following shows the worst case emissions from all transmitters and digital devices.

EUT		RDR-30MH1CKU-MXS, Serial Number BH0MC00012							
Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Antenna Factor (dB/m)	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
54.3	17.3	P	H	9.3	0.8	0.0	27.4	40.0	12.6
96.9	16.0	P	H	10.1	1.1	0.0	27.2	43.5	16.3
108.5	12.2	P	H	10.8	1.1	0.0	24.1	43.5	19.4
157.6	16.6	P	H	12.9	1.4	0.0	30.9	43.5	12.6
189.7	20.8	Q	H	13.8	1.5	0.0	36.1	43.5	7.4
189.7	21.3	P	H	13.8	1.5	0.0	36.6	43.5	6.9
198.0	17.5	P	H	14.2	1.5	0.0	33.2	43.5	10.3
248.8	15.2	P	H	15.4	1.7	0.0	32.3	46.0	13.7
279.1	16.3	P	H	13.0	1.8	0.0	31.1	46.0	14.9

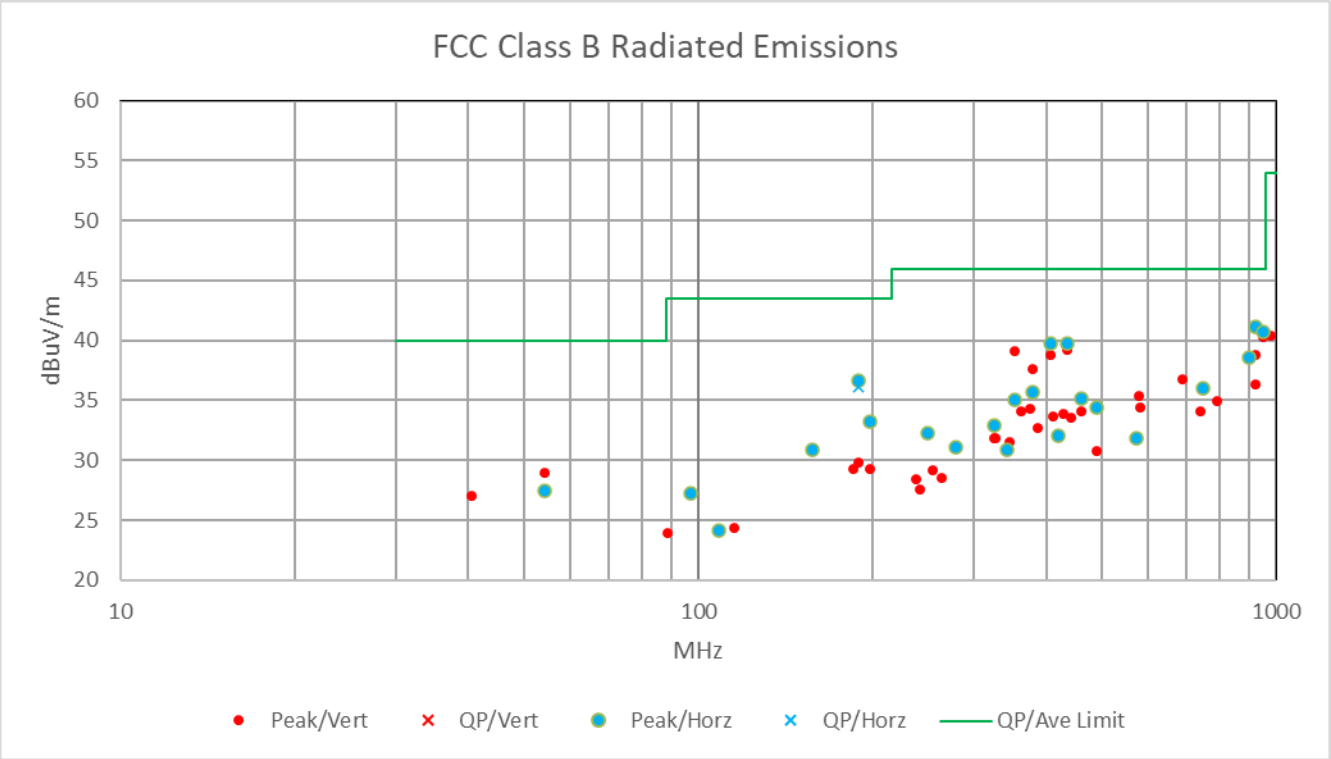
EUT	RDR-30MH1CKU-MXS, Serial Number BH0MC00012								
Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Antenna Factor (dB/m)	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
325.7	17.0	P	H	14.0	1.9	0.0	32.9	46.0	13.1
341.5	14.6	P	H	14.3	2.0	0.0	30.9	46.0	15.1
352.8	18.7	P	H	14.3	2.0	0.0	35.0	46.0	11.0
379.9	18.9	P	H	14.7	2.1	0.0	35.7	46.0	10.3
407.0	22.2	P	H	15.4	2.2	0.0	39.8	46.0	6.2
419.6	14.2	P	H	15.6	2.2	0.0	32.0	46.0	14.0
434.1	21.5	P	H	16.0	2.3	0.0	39.8	46.0	6.2
461.2	16.0	P	H	16.8	2.3	0.0	35.1	46.0	10.9
488.3	14.7	P	H	17.3	2.4	0.0	34.4	46.0	11.6
573.8	10.8	P	H	18.4	2.6	0.0	31.8	46.0	14.2
747.5	12.1	P	H	20.9	3.0	0.0	36.0	46.0	10.0
898.8	12.5	P	H	22.8	3.3	0.0	38.6	46.0	7.4
922.5	14.8	P	H	22.9	3.4	0.0	41.1	46.0	4.9
950.0	14.1	P	H	23.2	3.4	0.0	40.7	46.0	5.3
40.5	15.2	P	V	11.1	0.7	0.0	27.0	40.0	13.0
54.3	18.8	P	V	9.3	0.8	0.0	28.9	40.0	11.1
88.6	13.2	P	V	9.7	1.0	0.0	23.9	43.5	19.6
115.6	11.8	P	V	11.3	1.2	0.0	24.3	43.5	19.2
185.8	14.1	P	V	13.7	1.5	0.0	29.3	43.5	14.2
189.7	14.5	P	V	13.8	1.5	0.0	29.8	43.5	13.7
198.0	13.6	P	V	14.2	1.5	0.0	29.3	43.5	14.2
241.6	10.7	P	V	15.2	1.7	0.0	27.6	46.0	18.4
264.0	14.6	P	V	12.2	1.7	0.0	28.5	46.0	17.5
325.7	15.9	P	V	14.0	1.9	0.0	31.8	46.0	14.2
352.8	22.8	P	V	14.3	2.0	0.0	39.1	46.0	6.9
379.9	20.8	P	V	14.7	2.1	0.0	37.6	46.0	8.4
407.0	21.2	P	V	15.4	2.2	0.0	38.8	46.0	7.2
434.1	20.9	P	V	16.0	2.3	0.0	39.2	46.0	6.8
461.2	15.0	P	V	16.8	2.3	0.0	34.1	46.0	11.9
581.3	13.3	P	V	18.5	2.6	0.0	34.4	46.0	11.6
738.8	10.2	P	V	20.9	3.0	0.0	34.1	46.0	11.9
922.5	12.5	P	V	22.9	3.4	0.0	38.8	46.0	7.2
950.0	13.7	P	V	23.2	3.4	0.0	40.3	46.0	5.7
977.5	13.4	P	V	23.5	3.5	0.0	40.4	54.0	13.6

EUT	RDR-300H1CKU-MXS; S/N BH01C00011								
Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Antenna Factor (dB/m)	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
33.9	16.2	P	H	12.6	0.6	0.0	29.4	40.0	10.6
54.3	18.3	P	H	9.3	0.8	0.0	28.4	40.0	11.6
95.2	17.5	P	H	10.0	1.0	0.0	28.5	43.5	15.0
108.5	16.2	P	H	10.8	1.1	0.0	28.1	43.5	15.4
159.8	19.1	P	H	12.9	1.4	0.0	33.4	43.5	10.1
166.5	19.8	P	H	13.0	1.4	0.0	34.2	43.5	9.3
189.7	20.1	Q	H	13.8	1.5	0.0	35.4	43.5	8.1
189.7	21.3	P	H	13.8	1.5	0.0	36.6	43.5	6.9
195.2	14.5	P	H	14.1	1.5	0.0	30.1	43.5	13.4
198.0	14.4	P	H	14.2	1.5	0.0	30.1	43.5	13.4
236.1	10.6	P	H	15.1	1.7	0.0	27.4	46.0	18.6
237.2	13.7	P	H	15.1	1.7	0.0	30.5	46.0	15.5
262.1	14.4	P	H	12.1	1.7	0.0	28.2	46.0	17.8

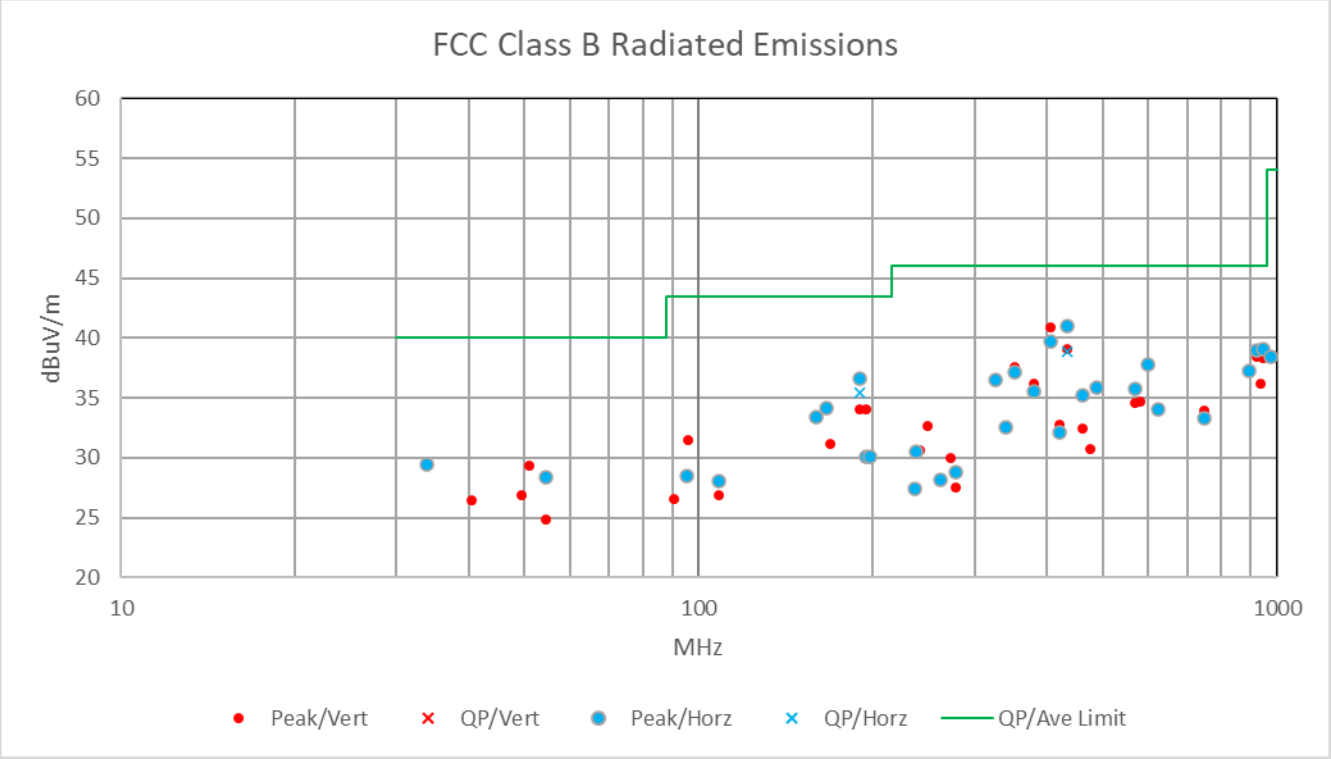
EUT	RDR-300H1CKU-MXS; S/N BH01C00011								
Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Antenna Factor (dB/m)	Cable Loss (dB)	Distance Factor (dB)	EUT (dBuV/m)	Limit (dBuV/m)	Margin Under Limit (dB)
279.1	14.0	P	H	13.0	1.8	0.0	28.8	46.0	17.2
325.7	20.6	P	H	14.0	1.9	0.0	36.5	46.0	9.5
339.0	16.3	P	H	14.3	2.0	0.0	32.6	46.0	13.4
352.8	20.9	P	H	14.3	2.0	0.0	37.2	46.0	8.8
379.9	18.7	P	H	14.7	2.1	0.0	35.5	46.0	10.5
407.0	22.1	P	H	15.4	2.2	0.0	39.7	46.0	6.3
420.2	14.3	P	H	15.6	2.2	0.0	32.1	46.0	13.9
434.1	20.6	Q	H	16.0	2.3	0.0	38.9	46.0	7.1
434.1	22.7	P	H	16.0	2.3	0.0	41.0	46.0	5.0
461.2	16.1	P	H	16.8	2.3	0.0	35.2	46.0	10.8
488.3	16.2	P	H	17.3	2.4	0.0	35.9	46.0	10.1
570.0	14.9	P	H	18.3	2.6	0.0	35.8	46.0	10.2
597.5	16.4	P	H	18.7	2.7	0.0	37.8	46.0	8.2
625.0	12.3	P	H	19.0	2.7	0.0	34.0	46.0	12.0
751.3	9.4	P	H	20.9	3.0	0.0	33.3	46.0	12.7
895.0	11.3	P	H	22.7	3.3	0.0	37.3	46.0	8.7
922.5	12.7	P	H	22.9	3.4	0.0	39.0	46.0	7.0
950.0	12.5	P	H	23.2	3.4	0.0	39.1	46.0	6.9
977.5	11.4	P	H	23.5	3.5	0.0	38.4	54.0	15.6
40.5	14.7	P	V	11.1	0.7	0.0	26.5	40.0	13.5
49.3	16.5	P	V	9.6	0.8	0.0	26.9	40.0	13.1
51.0	19.1	P	V	9.4	0.8	0.0	29.3	40.0	10.7
54.3	14.8	P	V	9.3	0.8	0.0	24.9	40.0	15.1
90.8	15.8	P	V	9.8	1.0	0.0	26.6	43.5	16.9
95.7	20.4	P	V	10.0	1.1	0.0	31.5	43.5	12.0
108.5	15.0	P	V	10.8	1.1	0.0	26.9	43.5	16.6
169.2	16.7	P	V	13.1	1.4	0.0	31.2	43.5	12.3
189.7	18.7	P	V	13.8	1.5	0.0	34.0	43.5	9.5
195.2	18.4	P	V	14.1	1.5	0.0	34.0	43.5	9.5
241.1	13.7	P	V	15.2	1.7	0.0	30.6	46.0	15.4
248.8	15.6	P	V	15.4	1.7	0.0	32.7	46.0	13.3
272.2	15.7	P	V	12.5	1.8	0.0	30.0	46.0	16.0
279.1	12.7	P	V	13.0	1.8	0.0	27.5	46.0	18.5
352.8	21.3	P	V	14.3	2.0	0.0	37.6	46.0	8.4
379.9	19.4	P	V	14.7	2.1	0.0	36.2	46.0	9.8
407.0	23.3	P	V	15.4	2.2	0.0	40.9	46.0	5.1
420.2	15.0	P	V	15.6	2.2	0.0	32.8	46.0	13.2
434.1	20.8	P	V	16.0	2.3	0.0	39.1	46.0	6.9
461.2	13.3	P	V	16.8	2.3	0.0	32.4	46.0	13.6
476.3	11.2	P	V	17.1	2.4	0.0	30.7	46.0	15.3
570.0	13.7	P	V	18.3	2.6	0.0	34.6	46.0	11.4
581.3	13.6	P	V	18.5	2.6	0.0	34.7	46.0	11.3
750.0	10.0	P	V	20.9	3.0	0.0	33.9	46.0	12.1
922.5	12.1	P	V	22.9	3.4	0.0	38.4	46.0	7.6
937.5	9.8	P	V	23.0	3.4	0.0	36.2	46.0	9.8
950.0	11.7	P	V	23.2	3.4	0.0	38.3	46.0	7.7

Judgment: Passed by 4.9 dB

Tabulated data from above represented graphically.



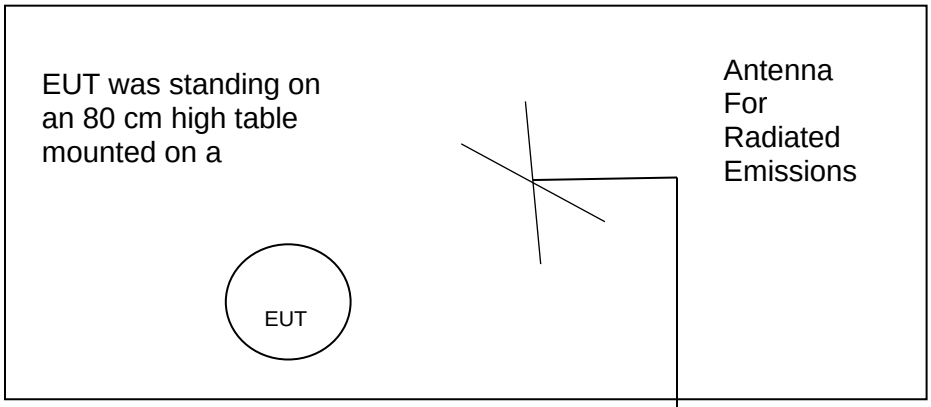
RDR-30MH1CKU-MXS



RDR-300H1CKU-MXS

Figure 2. Drawing of Radiated Emissions Test Setup

Chamber E, anechoic



Spectrum Analyzer

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	Spectrum Analyzer
0.01 to 30 MHz	ANT-53	REC-11
30 to 200 MHz	ANT-80	REC-11
200 to 1000 MHz	ANT-68	REC-11

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	September 30, and October 5, 2020
EUT	#1: Model RDR-30MH1CKU-MXS; Serial Number BH0MC00012 #2: Model RDR-300H1CKU-MXS; Serial Number BH01C00011
Test Distance	3 Meters
Specification	FCC 15 & RSS-GEN
Notes	A shielded Loop Antenna was used for this test. Test were performed with a 0.8 meter table
Tested by	Chris D'Alessio; Richard Tichgelaar

Freq (kHz)	Peak reading dBuV	Loop Ant Factor dB/m	Test Dist. (m)	Decay exp	Cable Loss dB	FCC Distance factor dB	Field Strength dBuV/m	RSS & FCC Limit dBuV/m	Margin under limit	Notes
125.0	64.1	19.1	3.0	2.0	0.1	-80.0	3.3	25.7	22.4	#1
250.0	36.5	18.9	3.0	2.0	0.1	-80.0	-24.5	19.6	44.1	#1
375.0	36.7	18.9	3.0	2.0	0.1	-80.0	-24.3	16.1	40.4	#1
500.0	35.1	18.8	3.0	2.0	0.1	-40.0	14.0	33.6	19.6	#1
132.0	63.4	19.1	3.0	2.0	0.1	-80.0	2.6	25.2	22.6	#1
264.0	35.8	18.9	3.0	2.0	0.1	-80.0	-25.2	19.2	44.4	#1
396.0	34.0	18.8	3.0	2.0	0.2	-80.0	-27.0	15.7	42.7	#1
13560	54.1	16.8	3.0	2.0	0.4	-40.0	31.3	40.5	9.2	#1
27120	29.6	16.0	3.0	2.0	0.5	-40.0	6.1	29.5	23.4	#1
125.0	64.0	19.1	3.0	2.0	0.1	-80.0	3.2	25.7	22.5	#2
250.0	36.7	18.9	3.0	2.0	0.1	-80.0	-24.3	19.6	43.9	#2
375.0	35.1	18.9	3.0	2.0	0.1	-80.0	-25.9	16.1	42.0	#2
132.0	63.8	19.1	3.0	2.0	0.1	-80.0	3.0	25.2	22.2	#2
264.0	37.3	18.9	3.0	2.0	0.1	-80.0	-23.7	19.2	42.9	#2
396.0	35.0	18.8	3.0	2.0	0.2	-80.0	-26.0	15.7	41.7	#2
13560	54.6	16.8	3.0	2.0	0.4	-40.0	31.8	40.5	8.7	#2
27120	28.0	16.0	3.0	2.0	0.5	-40.0	4.5	29.5	25.0	#2

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. Therefore it also met 15.225 (a) (b) since the (a) & (b) limits are less stringent than (c).

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 8.7 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.

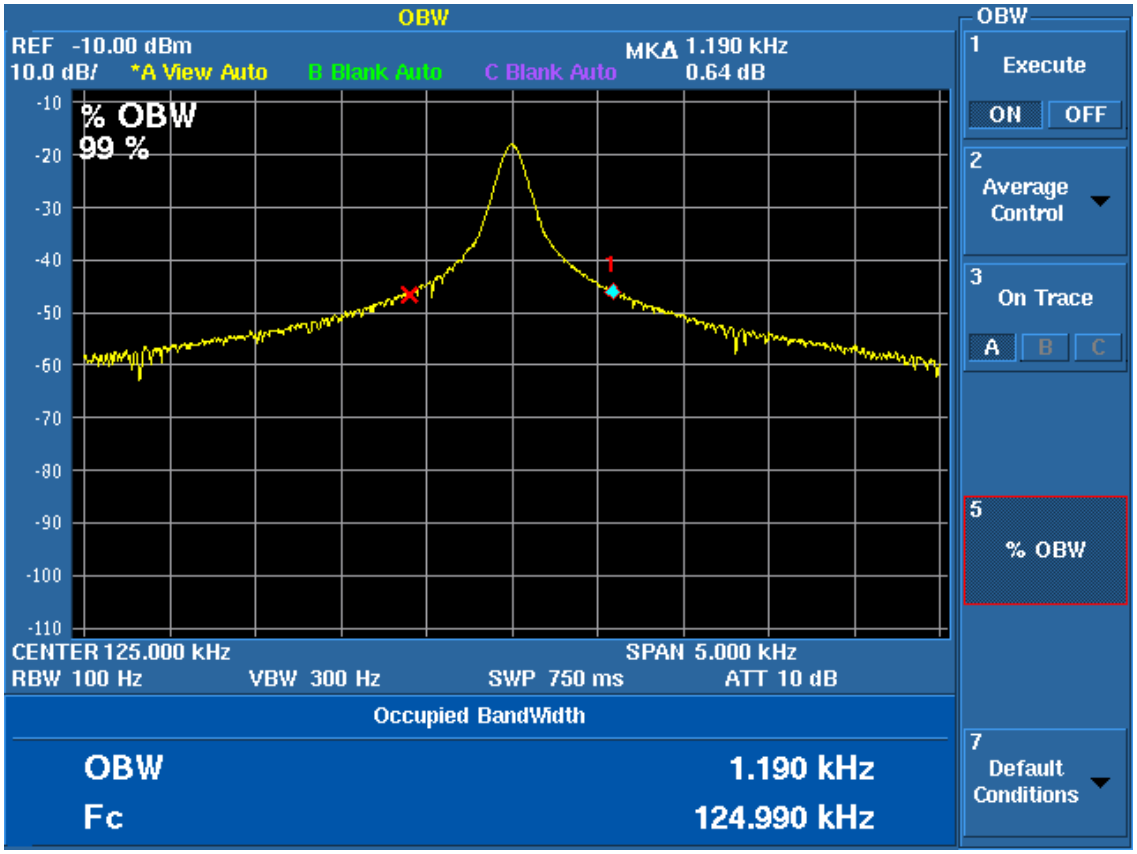
Model	RDR-30MH1CKU-MXS	Specification	FCC Part 15.225 RSS-210
Serial Number	BH01C00011	Test Date	October 2, 2020
Test Personnel	Richard Tichgelaar	Equipment	REC-43

99% OBW = 1.190 kHz at 125 kHz
99% OBW = 1.690 kHz at 132 kHz
99% OBW = 2.355 kHz at 13.56 MHz

Judgement: Pass

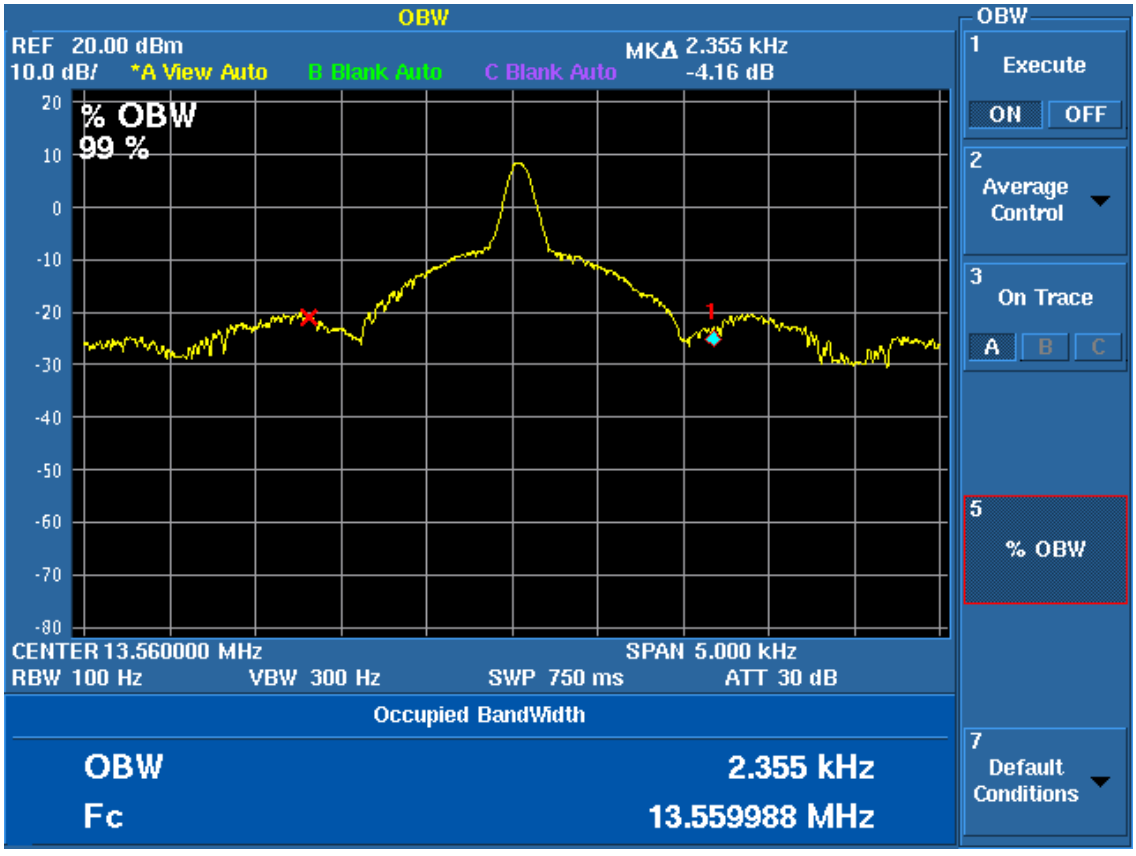
Figure 3. Occupied Bandwidth Plot

125 kHz:



132 kHz:

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-30MH1CKU-MXS	Specification	FCC Part 15.225 RSS-210 Section A2.6
Serial Number	BH01C00011	Test Date	October 2, 2020
Test Personnel	Richard Tichgelaar 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	13.560090 MHz		

Volts VAC	Freq. (MHz)	Deviation %	PPM
102.0	13.560025	-0.00048	-4.79
120.0	13.560100	0.00007	0.74
138.0	13.560065	-0.00018	-1.84

Only one sample was tested since all models use the same frequency determining circuitry.

Temp.	Freq. (@0min.)	Freq. (@2min.)	Freq. (@5min.)	Freq. (@10min.)	Change from Nominal			
Deg C	(MHz)	(MHz)	(MHz)	(MHz)	% 0 min.	% 2 min.	% 5 min	% 10 min.
50	13.559998	13.559993	13.559998	13.560018	-0.00068	-0.00072	-0.00068	-0.00053
40	13.560013	13.560005	13.560010	13.559999	-0.00057	-0.00063	-0.00059	-0.00067
30	13.560030	13.560015	13.560033	13.559968	-0.00044	-0.00055	-0.00042	-0.00090
20	13.560090	13.560075	13.560065	13.560048	0.00000	-0.00011	-0.00018	-0.00031
10	13.560055	13.560075	13.560093	13.560058	-0.00026	-0.00011	0.00002	-0.00024
0	13.560103	13.560095	13.560080	13.560088	0.00010	0.00004	-0.00007	-0.00001
-10	13.560068	13.560210	13.560150	13.560098	-0.00016	0.00088	0.00044	0.00006
-20	13.560063	13.560088	13.560065	13.560048	-0.00020	-0.00001	-0.00018	-0.00031

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 with REC-11	136 Hz
99% Occupied Bandwidth using REC-43	1% of frequency span
Temperature THM-03	0.6 Deg C