FCC/ISED DTS RF TEST REPORT

Test Report Number……	**SUB-19042301-LC-15C-MOD**
Applicant……..	**Subeca, Inc.**
Applicant Address……..	**6769 Hollister Ave, Goleta, CA 93117**
Product Name……..	LoRA module
Model Number……	MOD01
Family Product/Model……..	N/A
FCC ID……	2AS4H-MOD01
ISED ID……	25019-MOD01
Host Product ……	HydraLink
Host Product Model……..	HL-01
Date of EUT received……..	06/13/2019
Date of Test……	06/13/2019
Report Issue Date……	06/21/2019
Test Standards……..	**47CFR Part 15.247** **RSS-247 Issue 2.0: Feb 2017** **RSS-Gen Issue 5: Apr 2018**
Test Result……..	Pass

Issued By:

Vista Laboratories

1261 Puerta Del Sol, San Clemente, CA 92673 USA

www.vista-compliance.com

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Tested by:	**Approved By:**
David Zhang/Test Engineer	**Sherwin Lee/Engineering Reviewer**

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For the Accreditation Council
Certificate Number 4848.01
Valid to July 31, 2020

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San Clemente, CA

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Presented this 1st day of October 2018.

President and CEO
For the Accreditation Council
Certificate Number 4848.02
Valid to July 31, 2020

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

17065 Product Certification Accreditation Certificate

TABLE OF CONTENTS

1 GENERAL INFORMATION 5

1.1 Applicant 5

1.2 Product information 5

1.3 Test standard and method 6

1.4 Test Purpose and statement 6

2 TEST SITE INFORMATION 7

3 MODIFICATION OF EUT 7

4 TEST CONFIGURATION AND OPERATION 7

4.1 EUT test configuration 7

4.2 EUT test mode 7

4.3 Supporting Equipment 8

4.4 EUT setup diagram 8

4.5 EUT operation 8

4.6 Test software 8

5 EUT AND TEST SETUP PICTURES 9

5.1 EUT pictures 9

5.2 EUT test setup pictures 11

6 TEST SUMMARY 14

7 UNCERTAINTY OF MEASUREMENT 15

8 TEST SUMMARY AND RESULT 16

8.1 Antenna Requirement 16

8.2 Radiated Band-Edge & Spurious Emissions into Restricted Frequency Bands 17

9 TEST INSTRUMENT LIST 28

REVISION HISTORY

Revision	Issue Date	Description	Note
Original	06/21/2019	Original release	N/A

1 General Information

1.1 Applicant

Applicant:	Subeca, Inc.
Applicant address:	4514 Cole Avenue, Suite 600 Dallas, TX 75205 USA
Manufacturer:	Subeca, Inc.
Manufacturer Address:	4514 Cole Avenue, Suite 600 Dallas, TX 75205 USA

1.2 Product information

Product Name	LoRA module
Model Number	MOD01
Family Model Number	N/A
Serial Number	N/A
Frequency Band	125KHz Channel: 902.3 – 914.9 MHz 500KHz Channel: 903 – 914.2 MHz
Type of modulation	LoRA
Equipment Class/ Category	DTS
Maximum output power	18.73 dBm (125KHz), 18.09 dBm (500KHz)
Antenna Information	PCB antenna: 1.9 dBi
Clock Frequencies	N/A
Port/Connectors	N/A
Input Power	DC 3.3 V
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	N/A
Additional Info	No. of channels - 125KHz channel: 64 channels - 500KHz channel: 8 channels Channel spacing - 125KHz channel: 200KHz - 500KHz channel: 1.6MHz The host product, HydraLink contains a BT single module (FCC ID: S9NSPBTLERF, IC ID: 8976C-SPBTLERF), but LoRA module and BT module cannot transmit simultaneously.

1.3 Test standard and method

Test standard	47CFR Part 15.247 RSS-247 Issue 2.0: Feb 2017 RSS-Gen Issue 5: Apr 2018
Test method	RSS-Gen Issue 5: Apr 2018 ANSI C63.10: 2013 558074 D01 15.247 Meas Guidance v05r02

1.4 Test Purpose and statement

The purpose of this test report is intended to demonstrate the compliance of product listed in section 1.2, received from company listed in section 1.1, to the requirements of standard and method listed in section 1.3. Based on our test results, we conclude that the product tested complies with the requirements of the standards indicated.

2 Test site information

Lab performing tests	**Vista Laboratories**
Lab Address	1261 Puerta Del Sol, San Clemente, CA 92673 USA
Phone Number	+1 (949) 393-1123
Website	www. Vista-compliance.com

Test condition	Test Engineer	Test Environment	Test Date
Radiated	David Zhang	23.0°C / 58.2%/1006 mbar	06/13/2019

3 Modification of EUT

The EUT is an engineering test sample loaded with RF test firmware specifically designed to support the RF TX/RX measurement in different aspects. No modification on the hardware.

4 Test configuration and operation

4.1 EUT test configuration

EUT is mounted onto a development board to support testing. A laptop with test software is used to send commend to EUT. The test command is used to set EUT to different transmission mode in terms of radio mode bandwidth, power level, test channel, etc.

4.2 EUT test mode

Radio	Channel	Frequency (MHz)	Bandwidth (KHz)
LoRA	Low	902.3	125
LoRA	Mid	908.5	125
LoRA	High	914.9	125
LoRA	Low	903.0	500
LoRA	Mid	907.8	500
LoRA	High	914.2	500

4.3 Supporting Equipment

Index	Description	Model	S/N	Brand	Remark
1	Laptop	G752V	F9N0CY758592398	ASUS	Sending command

4.4 EUT setup diagram

4.5 EUT operation

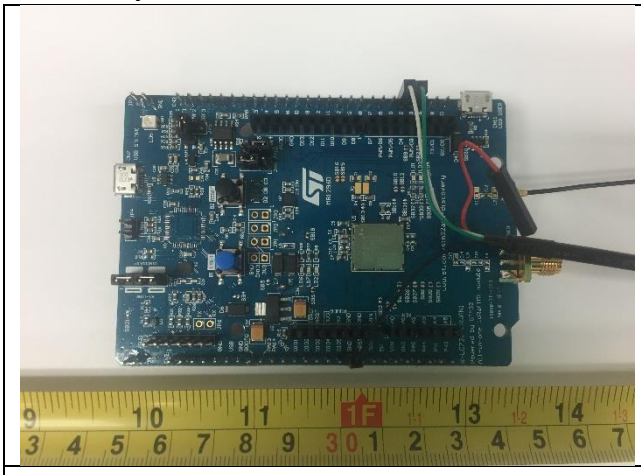
The control of EUT is test software on test laptop.

4.6 Test software

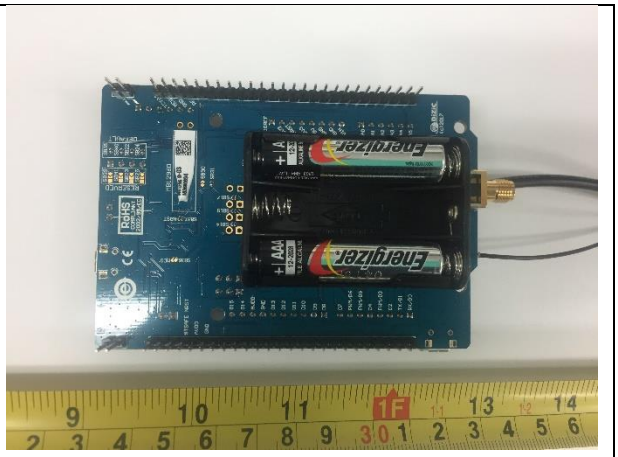
Index	Description	Remark
1	FSK-LoRA Module Test Tool V1.1.2	Sending command to EUT
2	EMISoft Vasona 6.0049	EMC/Spurious emission test software used during testing

5 EUT and test setup pictures

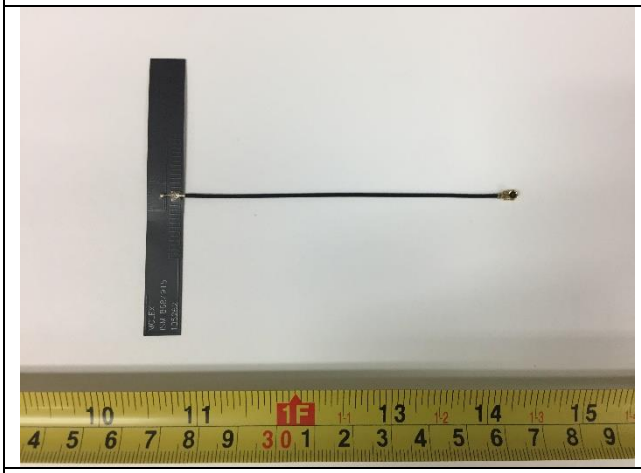
5.1 EUT pictures



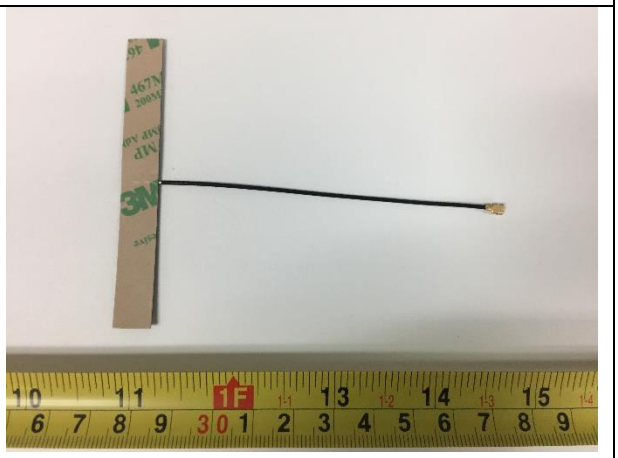
EUT Top View



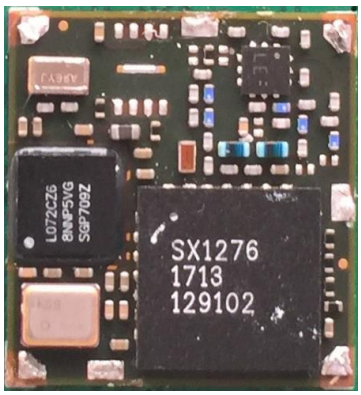
EUT Bottom View



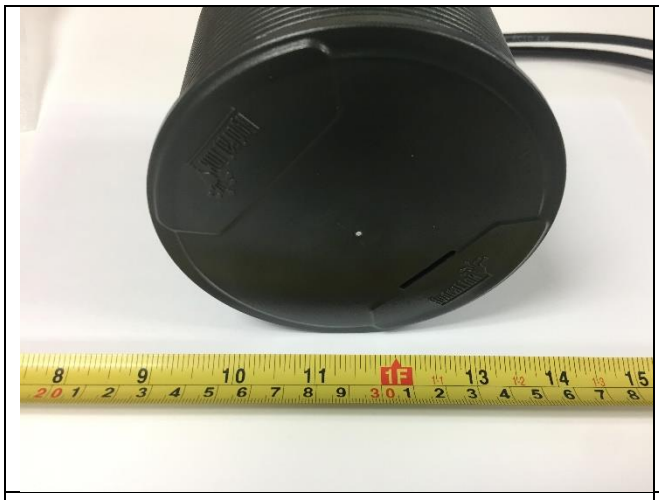
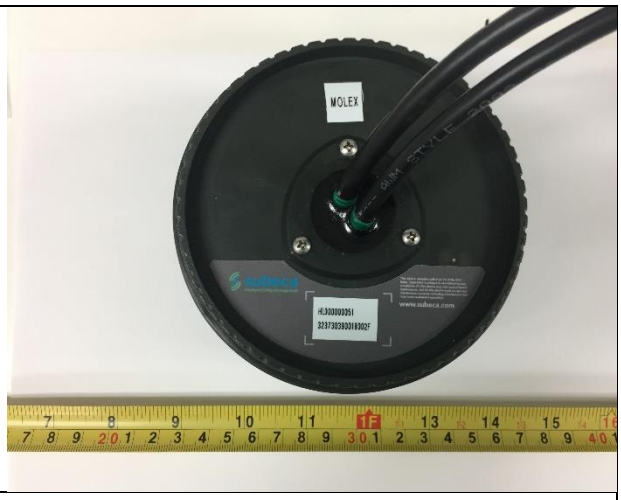
Antenna Top View



Antenna Bottom View

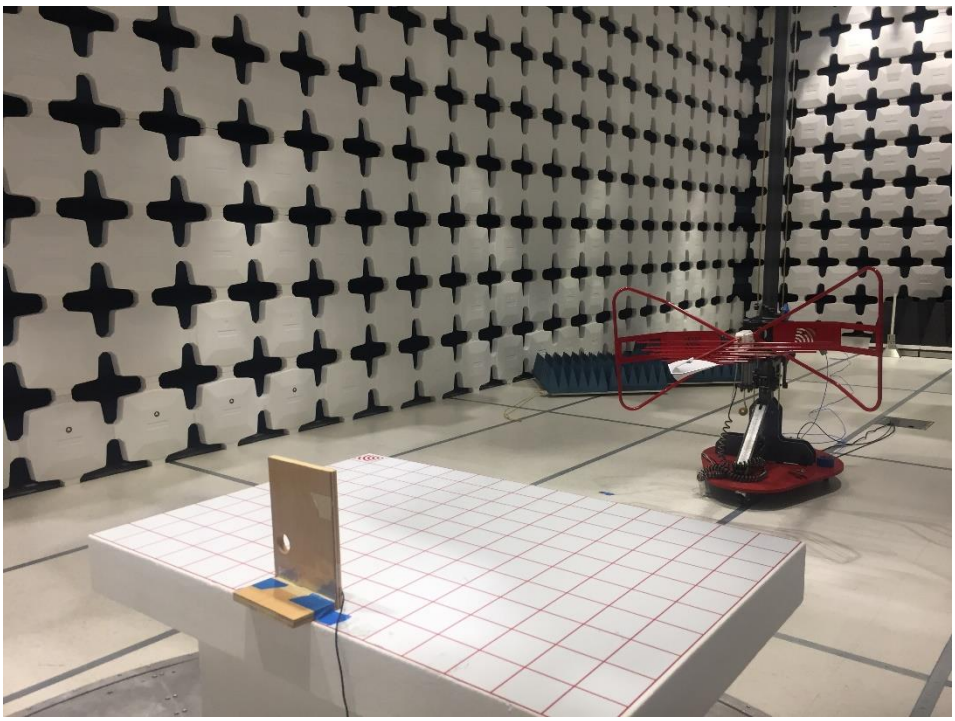


EUT Shielding Off View

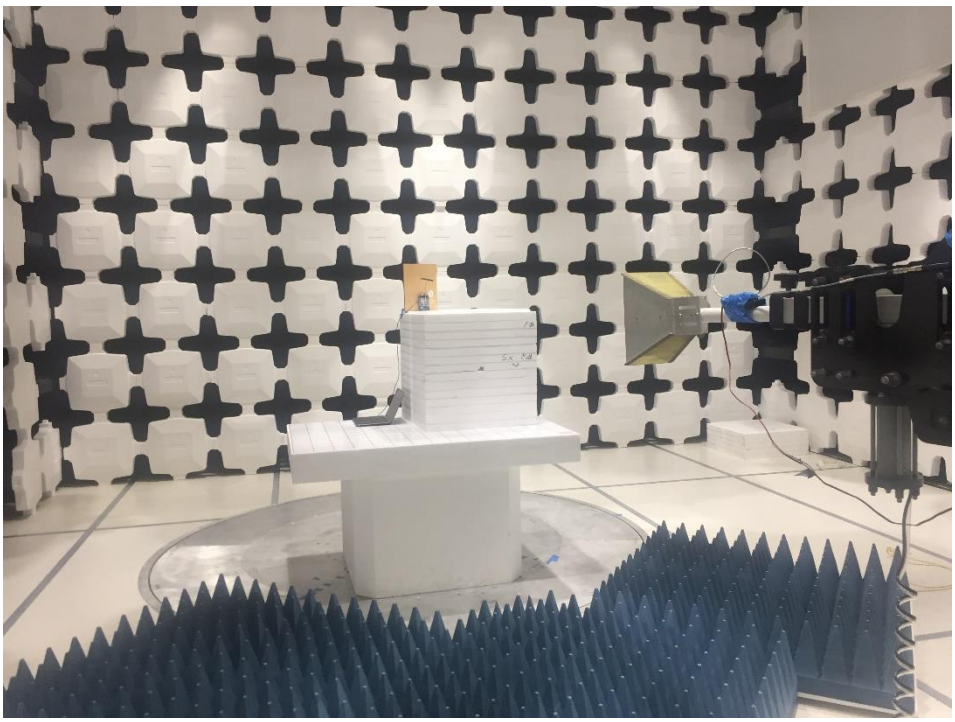
	
Host Product Front View	**Host Product Rear View**
Host Product Side View	

5.2 EUT test setup pictures

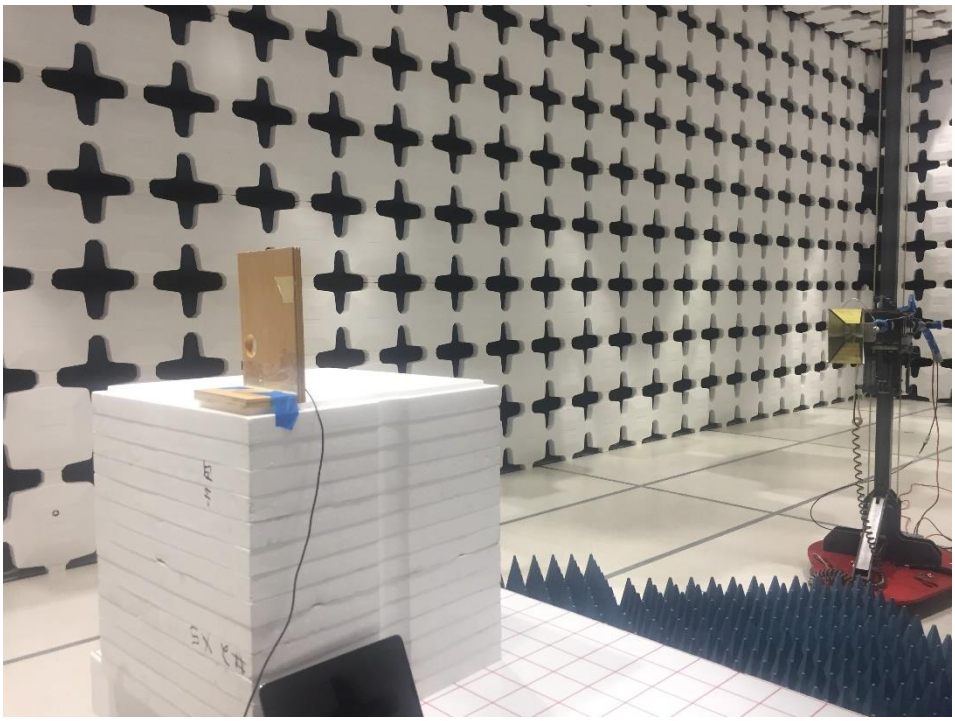
Radiated Emissions Below 1GHz setup – Front



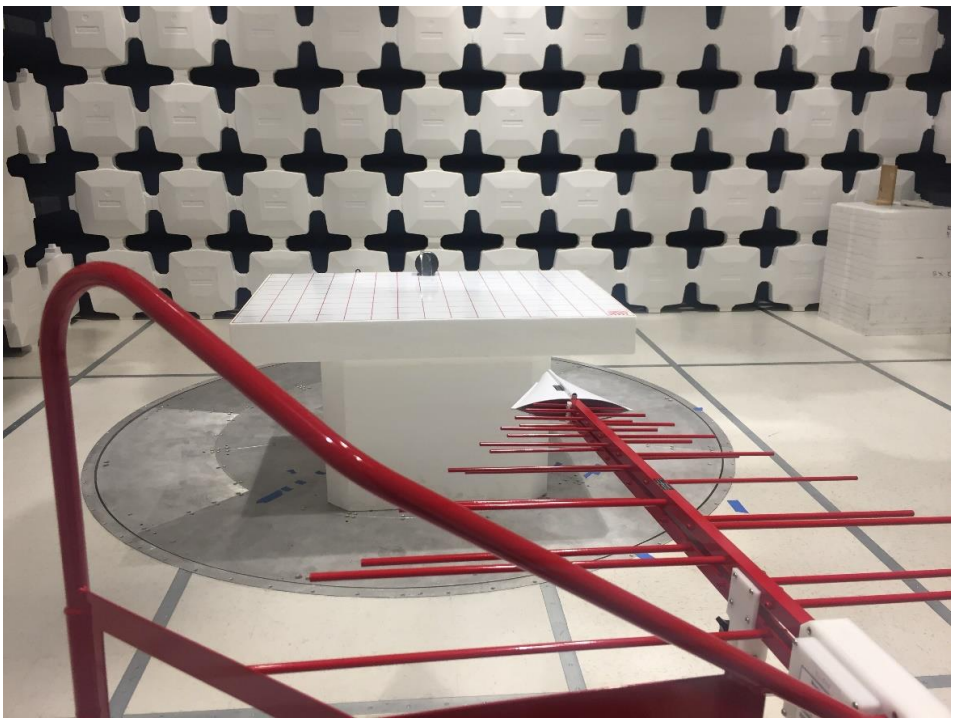
Radiated Emissions Below 1GHz setup – Rear



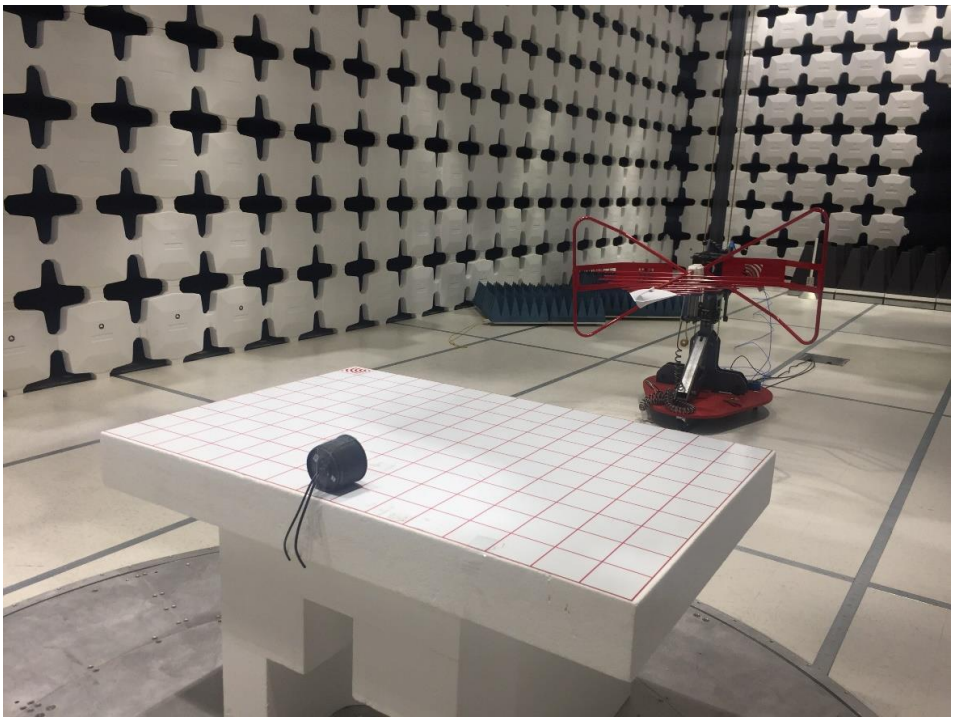
Radiated Emissions Above 1GHz setup – Front



Radiated Emissions Above 1GHz setup – Rear



Test setup with Host – Front



Test setup with Host – Rear

6 Test Summary

ISED Rules	ISED Rules	Test Item	Section	Verdict
§15.203	-	Antenna Requirement	8.1	Pass
§15.205, §15.209, §15.247(d)	RSS-247 §5.5	Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands	8.2	Pass

7 Uncertainty of Measurement

Test item	Measurement Uncertainty (dB)
RF Output Power (Conducted)	±1.2 dB
Power Spectral Density	±0.9 dB
Unwanted Emission (conducted)	±2.6 dB
Occupied Channel Bandwidth	±5 %
Radiated Emission (9KHz-30MHz)	±3.5 dB
Radiated Emission (30MHz-1GHz)	±4.6 dB
Radiated Emission (1-18GHz)	±4.9 dB
Radiated Emission (18-40GHz)	±3.5 dB

8 Test summary and result

8.1 Antenna Requirement

8.1.1 Requirement

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

8.1.2 Result

Analysis:

- EUT has one removable PCB trace antennas which connect to the main board through unique U.FL RF connectors.
- Both main board and antenna are equipped with U.FL connector. No standard RF connector is used.

Conclusion:

This requirement is FCC/ISED requirement.

8.2 Radiated Band-Edge & Spurious Emissions into Restricted Frequency Bands

8.2.1 Requirement

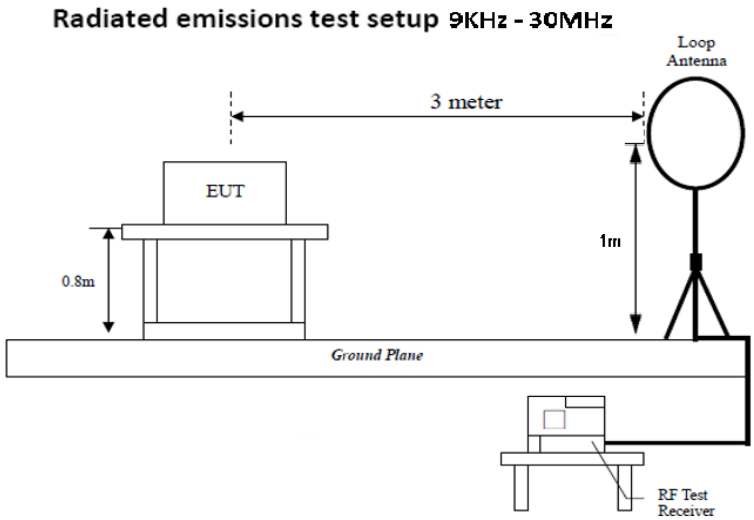
§ 15.247 (d), RSS-247 §5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

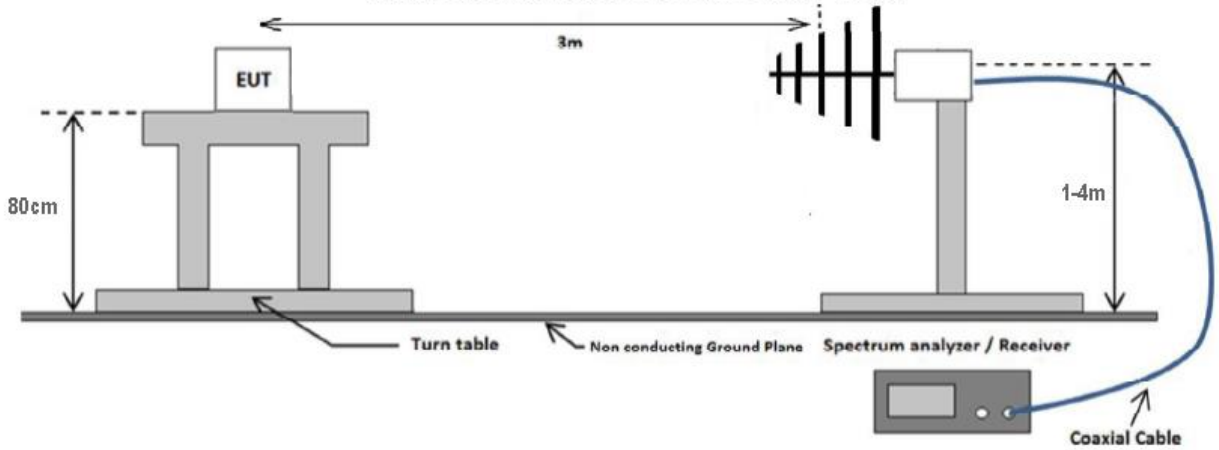
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency range (MHz)	Field Strength (µV/m)
0.009~0.490	2400/F(KHz)
0.490~1.705	24000/F(KHz)
1.705~30.0	30
30 – 88	100
88 – 216	150
216 960	200
Above 960	500

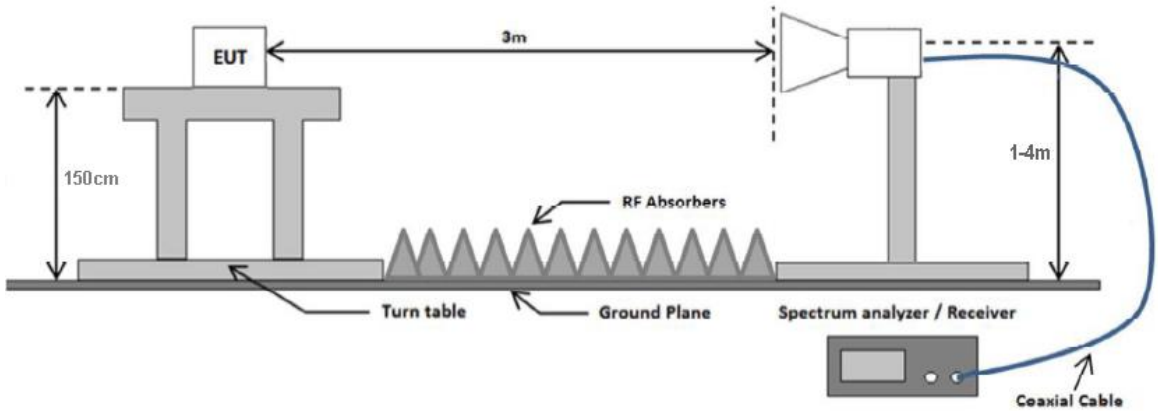
8.2.2 Test setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



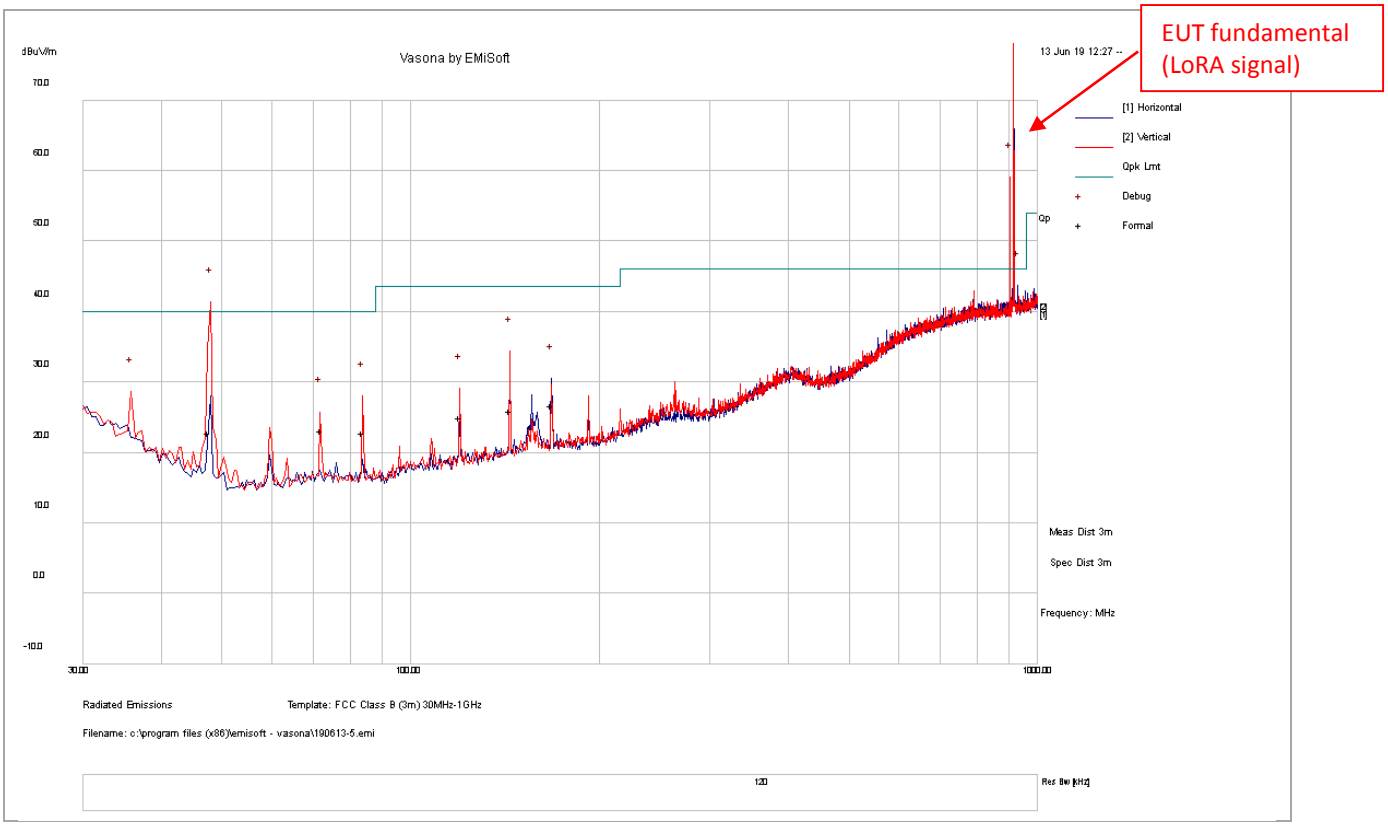
8.2.3 Test Procedure

According to section 8.6 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.12.2.7 Radiated spurious emission measurements in ANSI C62.10-2013 as well as the procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 was followed. Boresight antenna mast was used during the scanning to point to EUT to maximize the emission. The process will be repeated in 3 EUT orientations.

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300 Hz for frequency below 150KHz.
4. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for frequency between 150KHz – 30MHz.
5. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-Peak detection at frequency between 30MHz - 1GHz.
6. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak and average measurement at frequency above 1GHz.
7. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.

8.2.4 Test Result

Test Standard:	**47CFR 15.209, RSS-Gen, RSS-247**	**Mode:**	**LoRA, 125KHz, high CH**
Frequency Range:	**30-1000MHz**	**Test Date:**	**06/13/2019**
Antenna Type/Polarity:	**Bi-Log/Hor & Ver**	**Test Personnel:**	**David Zhang**
Remark:	**N/A**	**Test Result:**	**Pass**

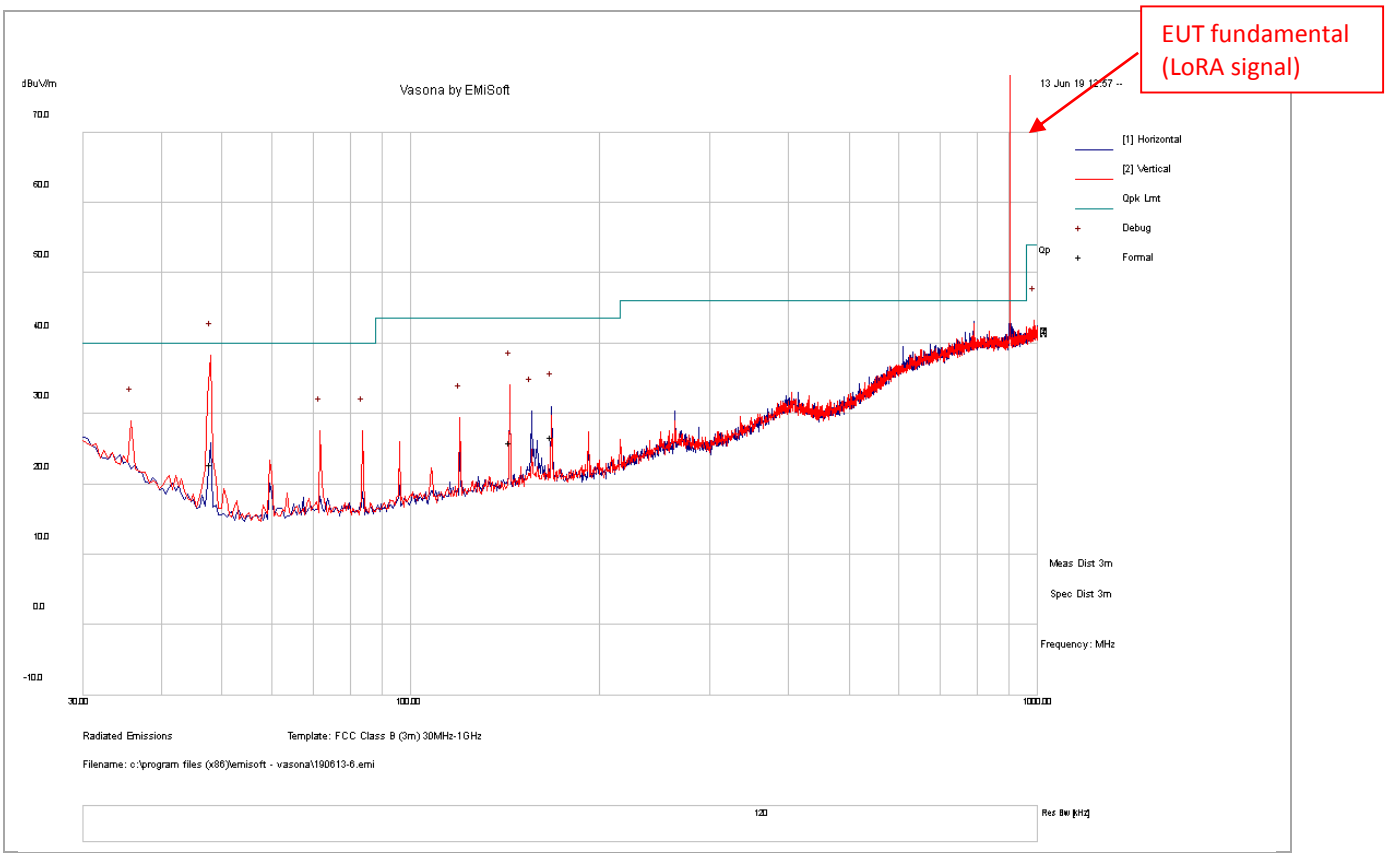


Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
199.99	41.14	4.73	-21.81	24.06	QP	V	377	60	40.00	-17.10
225.01	50.17	5.01	-20.46	34.72	QP	V	167	292	40.00	-16.91
299.91	42.09	5.68	-18.73	29.04	QP	V	176	21	40.00	-17.11
350.00	53.96	6.05	-16.13	43.88	QP	V	221	34	43.50	-18.44
400.00	47.03	6.37	-13.43	39.97	QP	V	101	22	43.50	-17.52
403.19	37.81	6.36	-13.47	30.70	QP	H	198	326	43.50	-16.78

Note:

1) For below 1GHz, all different channel and modes were verified but only the worst case result is shown here.

Test Standard:	**47CFR 15.209, RSS-Gen, RSS-247**	**Mode:**	**LoRA, 500KHz, low CH**
Frequency Range:	**30-1000MHz**	**Test Date:**	**06/13/2019**
Antenna Type/Polarity:	**Bi-Log/Hor & Ver**	**Test Personnel:**	**David Zhang**
Remark:	**N/A**	**Test Result:**	**Pass**



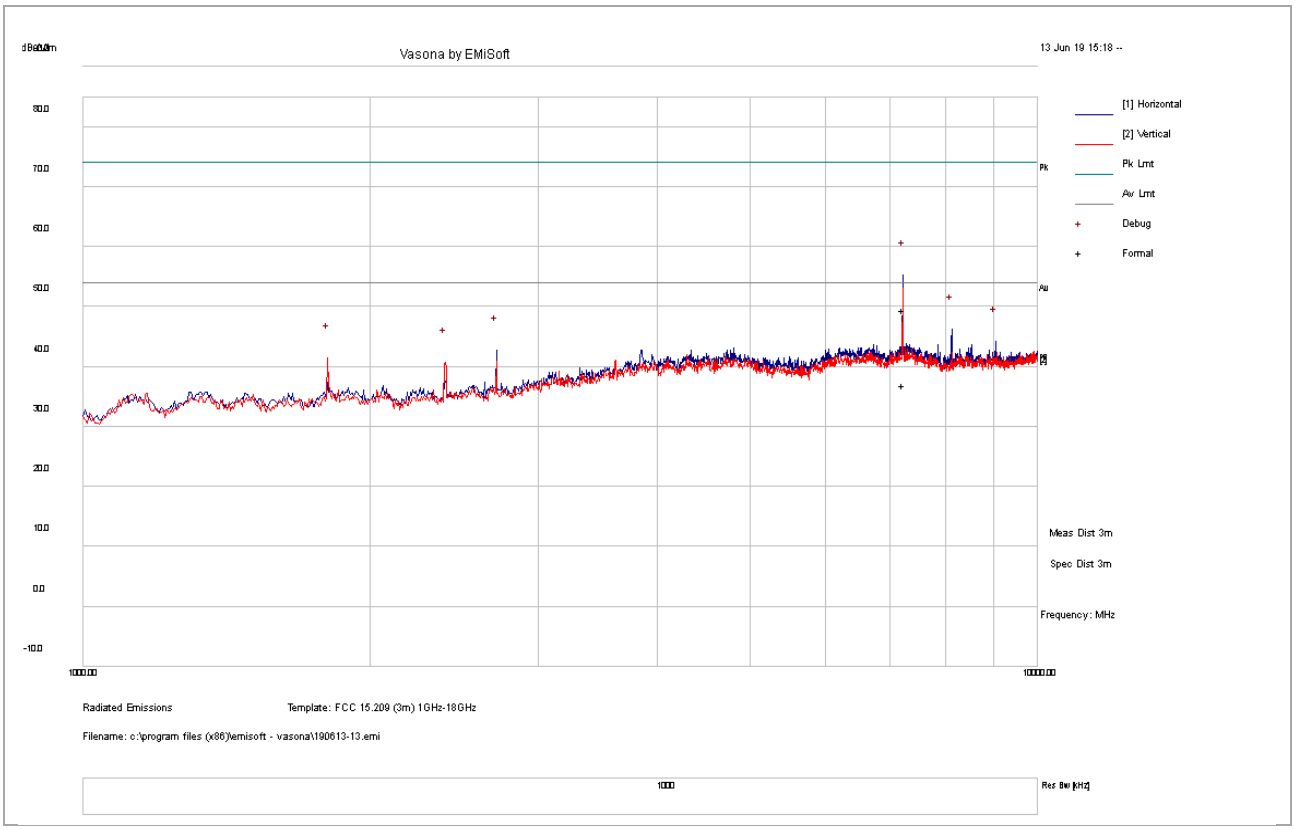
Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
48.01	13.14	2.75	7.04	22.92	QP	V	100	60	40.00	-17.08
144.18	12.76	4.18	9.07	26.01	QP	H	246	74	43.50	-17.49
167.76	12.76	4.43	9.51	26.70	QP	H	324	240	43.50	-16.80

Note:

1) For below 1GHz, all different channel and modes were verified but only the worst case result is shown here.

1GHz – 18GHz test result

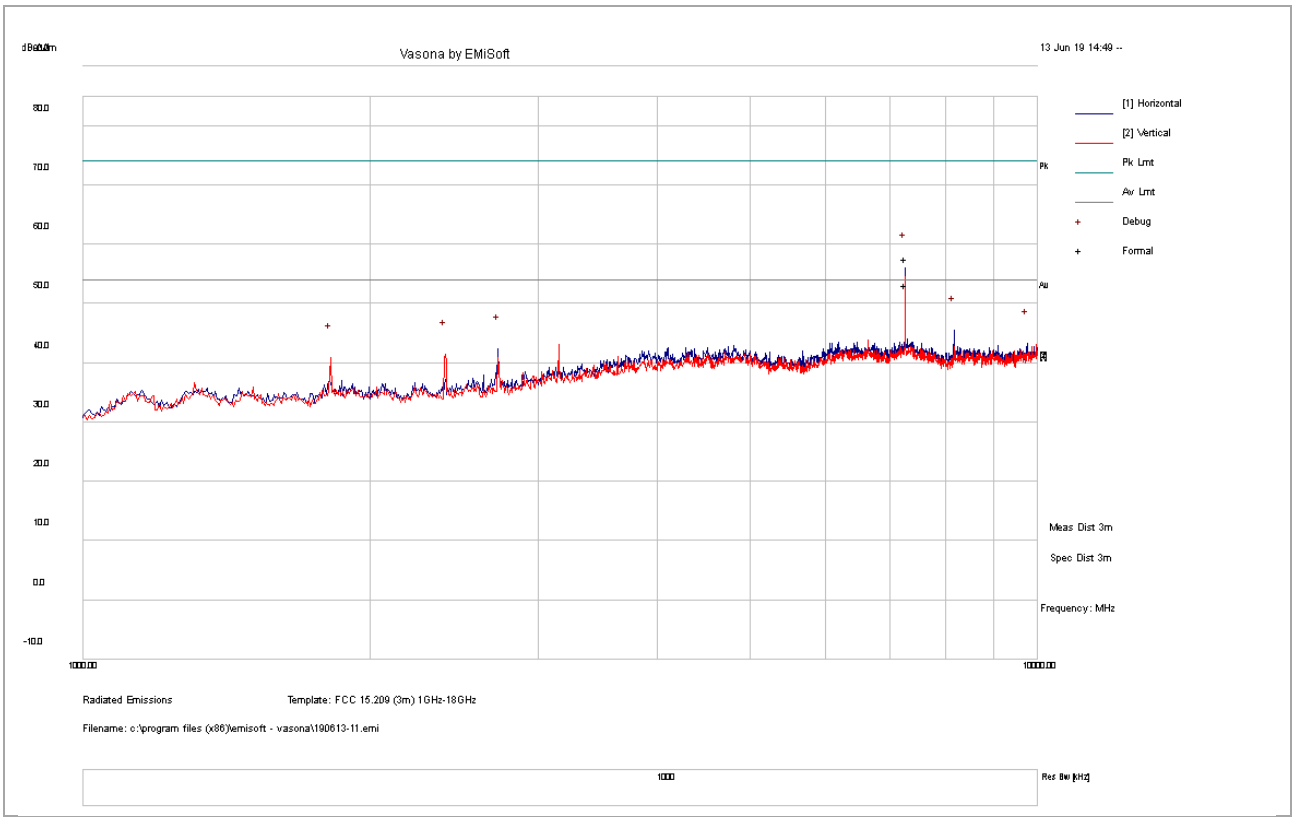
Test Standard:	**47CFR 15.209, RSS-Gen, RSS-247**	**Mode:**	**LoRA, 125KHz, Low CH**
Frequency Range:	**1GHz-18GHz**	**Test Date:**	**06/13/2019**
Antenna Type/Polarity:	**Horn/Hor & Ver**	**Test Personnel:**	**David Zhang**
Remark:	**N/A**	**Test Result:**	**Pass**



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
7219.33	24.82	16.48	11.68	52.99	PK	H	214	107	74	-21.01
7219.33	12.21	16.48	11.68	40.37	AV	H	214	107	54	-13.63

1GHz – 18GHz test result

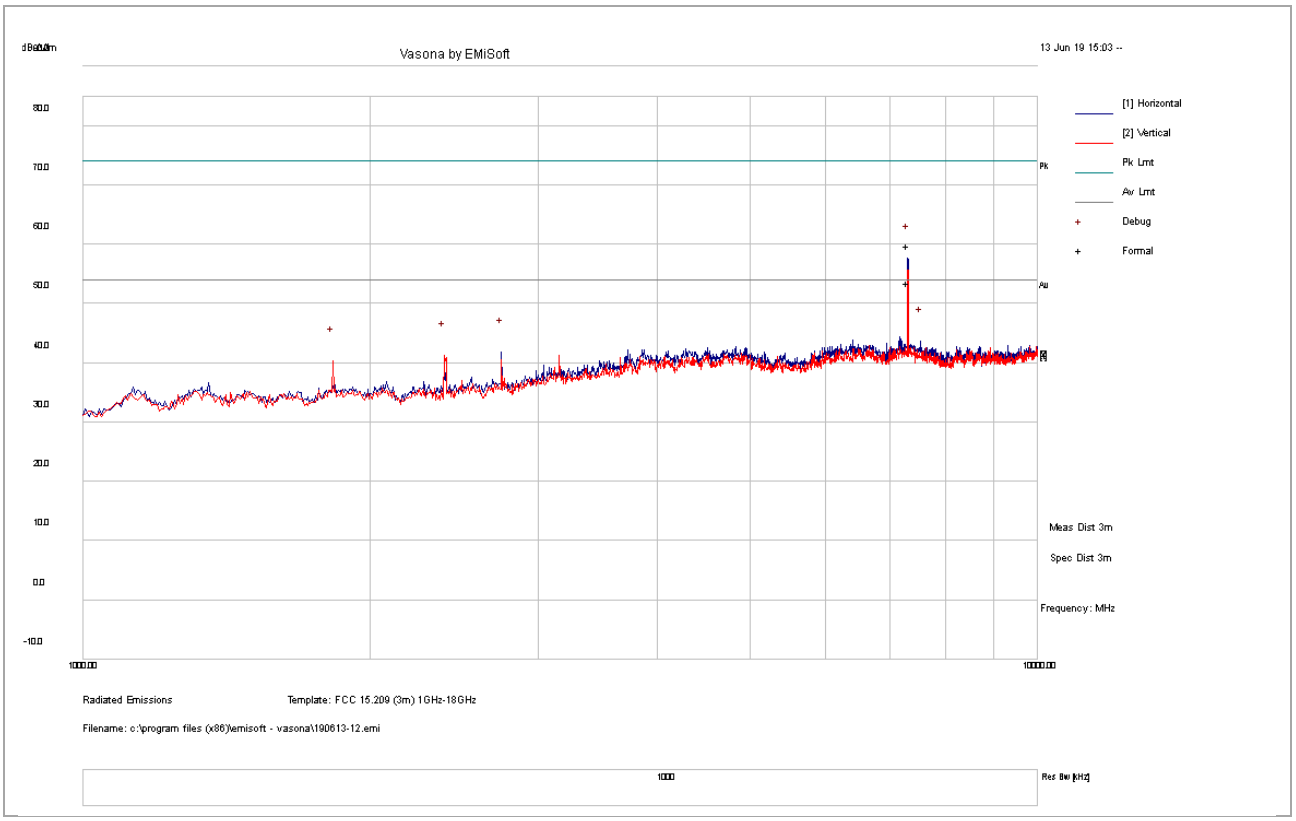
Test Standard:	47CFR 15.209, RSS-Gen, RSS-247	Mode:	LoRA, 125KHz, Mid CH
Frequency Range:	1GHz-18GHz	Test Date:	06/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	David Zhang
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
7262.41	29.31	16.56	11.70	57.58	PK	H	176	129	74	-16.43
7262.41	24.82	16.56	11.70	53.08	AV	H	176	129	54	-0.92

1GHz – 18GHz test result

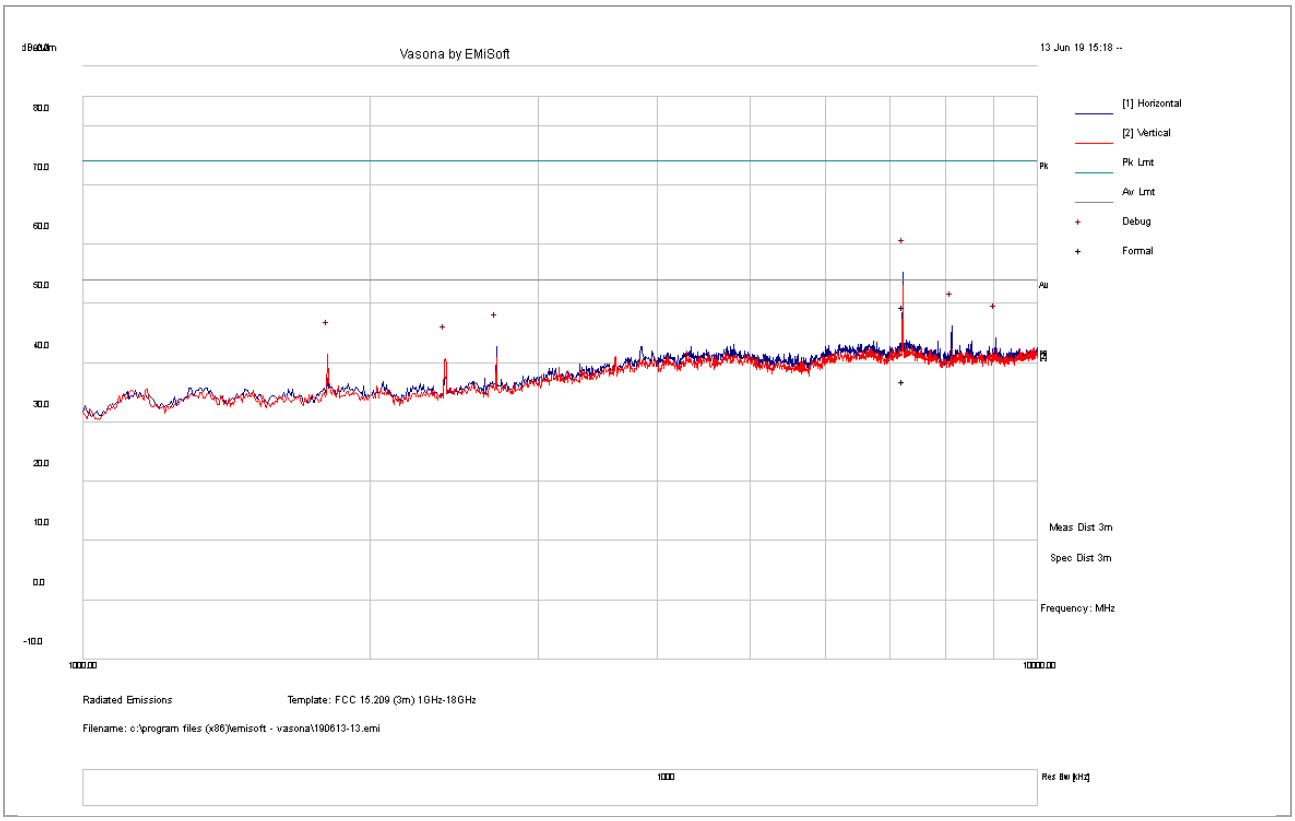
Test Standard:	**47CFR 15.209, RSS-Gen, RSS-247**	**Mode:**	**LoRA, 125KHz, High CH**
Frequency Range:	**1GHz-18GHz**	**Test Date:**	**06/13/2019**
Antenna Type/Polarity:	**Horn/Hor & Ver**	**Test Personnel:**	**David Zhang**
Remark:	**N/A**	**Test Result:**	**Pass**



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
7313.22	31.37	16.66	11.69	59.72	PK	H	174	114	74	-14.28
7313.22	25.10	16.66	11.69	53.45	AV	H	174	114	54	-0.55

1GHz – 18GHz test result

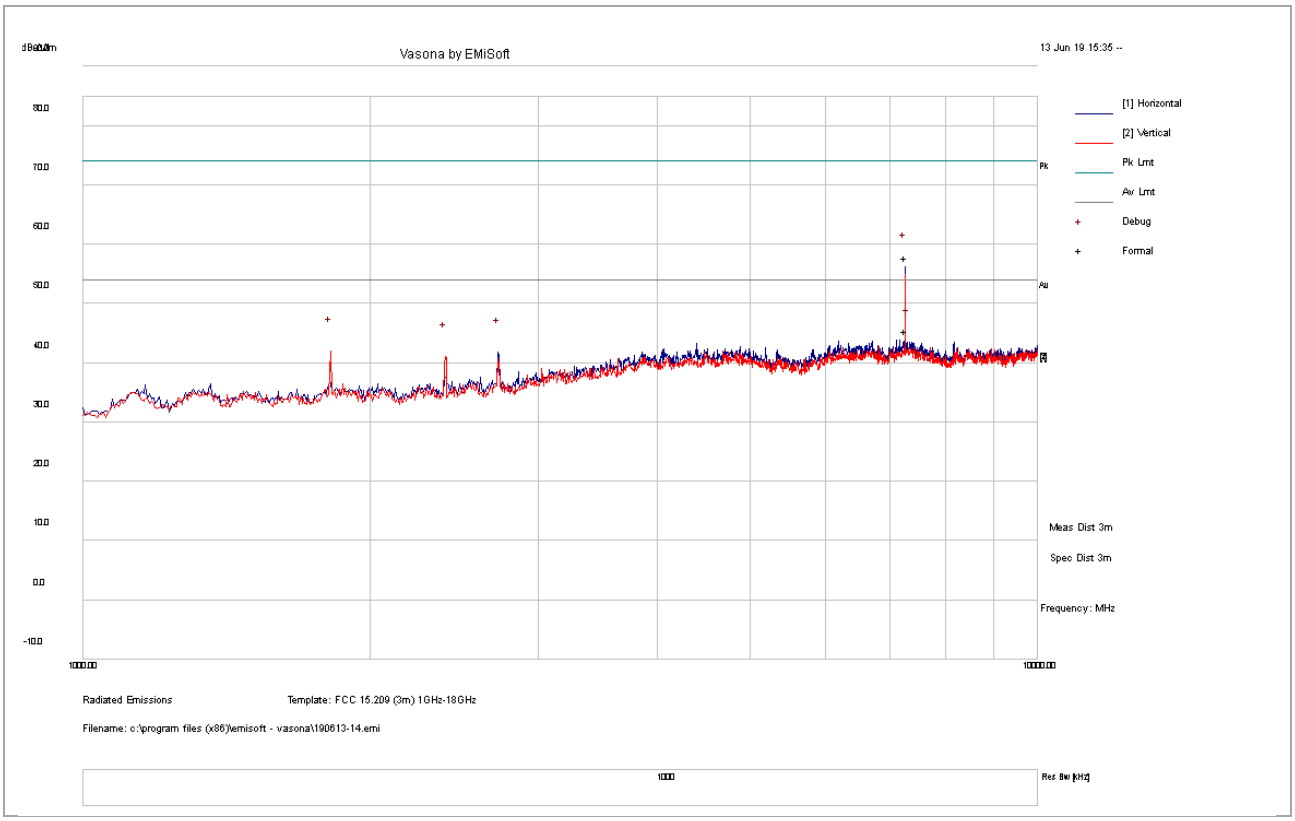
Test Standard:	**47CFR 15.209, RSS-Gen, RSS-247**	**Mode:**	**LoRA, 500KHz, Low CH**
Frequency Range:	**1GHz-18GHz**	**Test Date:**	**06/13/2019**
Antenna Type/Polarity:	**Horn/Hor & Ver**	**Test Personnel:**	**David Zhang**
Remark:	**N/A**	**Test Result:**	**Pass**



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
7225.71	21.33	16.49	11.69	49.50	PK	H	100	113	74	-24.50
7225.71	8.68	16.49	11.69	36.86	AV	H	100	113	54	-17.14

1GHz – 18GHz test result

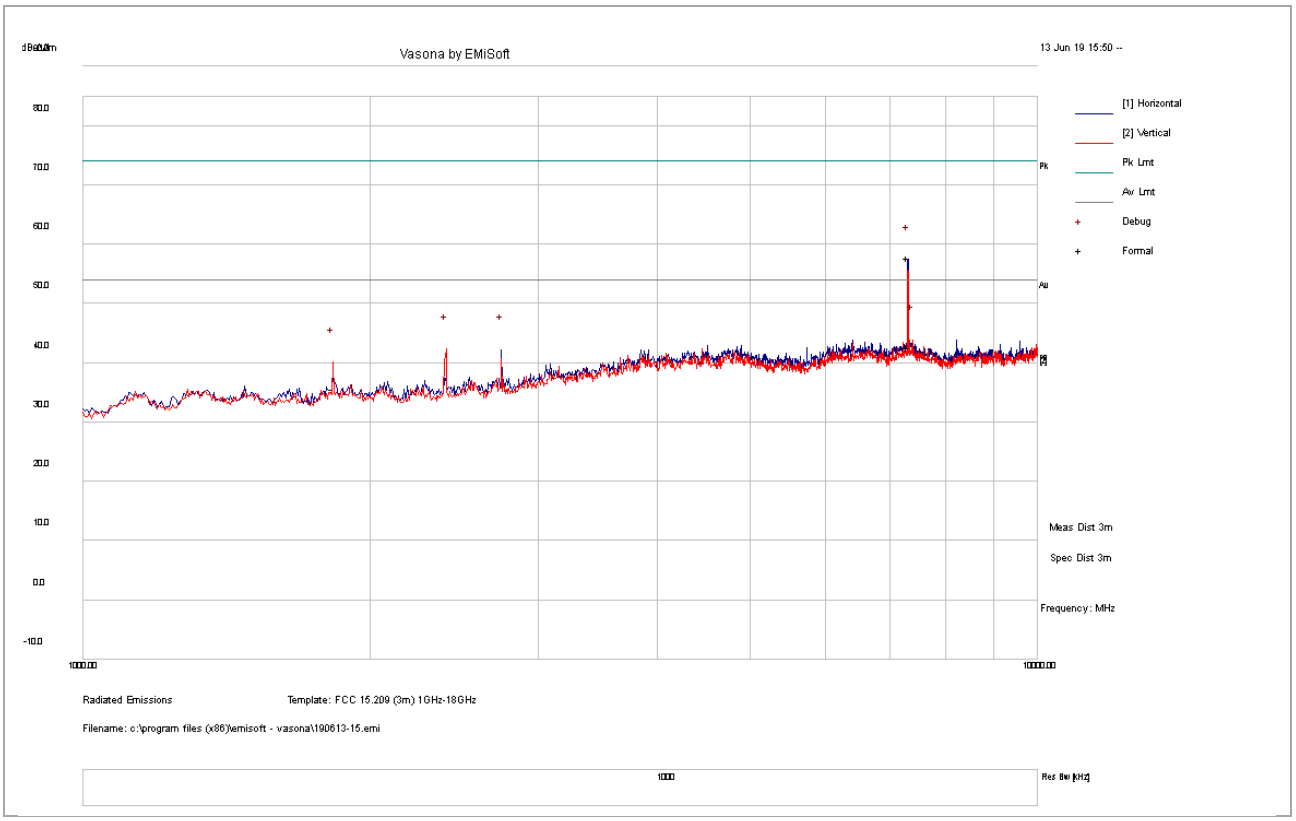
Test Standard:	47CFR 15.209, RSS-Gen, RSS-247	Mode:	LoRA, 500KHz, Mid CH
Frequency Range:	1GHz-18GHz	Test Date:	06/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	David Zhang
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
7262.02	29.46	16.56	11.70	57.72	PK	H	182	111	74	-16.28
7262.02	17.18	16.56	11.70	45.44	AV	H	182	111	54	-8.56

1GHz – 18GHz test result

Test Standard:	47CFR 15.209, RSS-Gen, RSS-247	Mode:	LoRA, 500KHz, High CH
Frequency Range:	1GHz-18GHz	Test Date:	06/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	David Zhang
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
7311.80	29.48	16.66	11.69	57.83	PK	H	152	104	74	-16.17
7311.80	14.38	16.66	11.69	42.74	AV	H	152	104	54	-11.27

9 Test instrument list

Equipment	Manufacturer	Model	Serial Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	5/11/2019	5/11/2020
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	5/4/2019	5/4/2020
EMC Test Receiver	R&S	ESL6	100230	5/7/2019	5/7/2020
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	5/4/2019	5/4/2020
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2018	11/15/2019
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	5/2/2019	5/2/2020
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	5/2/2019	5/2/2020
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	5/10/2019	5/10/2020
True RMS Multi-meter	UNI-T	UT181A	C173014829	5/10/2019	5/10/2020
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	5/9/2019	5/9/2020
RF Attenuator	Pasternack	PE7005-3	VL061	5/10/2019	5/10/2020
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	5/10/2019	5/10/2020
EM Center Control	ETS-Lindgren	7006-001	160136	N/A	N/A
Turn Table	ETS-Lindgren	2181-3.03	VL002	N/A	N/A
Boresight Antenna Tower	ETS-Lindgren	2171B	VL003	N/A	N/A
Loop Antenna (9k-30MHz)	Com-Power	AL-130	121012	5/9/2019	5/9/2020
RE test cable(below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	5/10/2019	5/10/2020
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	5/10/2019	5/10/2020
RE test cable (>18GHz)	Sucoflex	104	344903/4	5/10/2019	5/10/2020
Pulse limiter	Com-Power	LIT-930A	531727	5/15/2019	5/15/2020
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	5/10/2019	5/10/2020
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	5/9/2019	5/9/2020