FCC TEST REPORT

Product Name:	LP-M0 Series Industrial IoT module
Trade Mark:	LP SENSOR TECHNOLOGY
Model No.:	LP-M01
Add. Model No.:	N/A
Report Number:	2210132087RFC-1
Test Standards:	FCC 47 CFR Part 15 Subpart C
FCC ID:	2A8PY-MIOW001
Test Result:	PASS
Date of Issue:	February 8, 2023

Prepared for:

LP SENSOR TECHNOLOGY LLC
149 Silverado, Irvine, CA, 92618

Prepared by:

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UnionTrust Laboratories UnionTrust *Certified*

Version

Version No.	Date	Description
V1.0	February 8, 2023	Original

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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	LP SENSOR TECHNOLOGY LLC
Address of Applicant:	149 Silverado, Irvine, CA, 92618
Manufacturer:	LP SENSOR TECHNOLOGY LLC
Address of Manufacturer:	149 Silverado, Irvine, CA, 92618

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	LP-M0 Series Industrial IoT module	
Model No.:	LP-M01	
Add. Model No.:	N/A	
Trade Mark:	LP SENSOR TECHNOLOGY	
DUT Stage:	Production Unit	
EUT Supports Function: (Provided by the customer)	General 915MHz Technique	902.5 MHz to 914.9 MHz 903.0 MHz to 914.2 MHz
Power Supply:	Input: DC 10-30V	
	Input: DC 12V from External Battery Supply	
Software Version:	2.0.7 (Provided by the customer)	
Hardware Version:	V1.0 (Provided by the customer)	
Sample Received Date:	October 9, 2022	
Sample Tested Date:	November 4, 2022 to November 15, 2022	
Remark: The above EUT's information was provided by customer. Please refer to the specifications or user's manual for more detailed description.		

1.2.2 Description of Accessories

None.

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Band:	902 MHz to 915 MHz
Frequency Range:	902 MHz to 915 MHz
Modulation Technique:	General 915MHz Technique
Type of Modulation:	LoRa
Number of Channels:	63 channels for 125kHz Bandwidth 8 channels for 500kHz Bandwidth
Channel Separation:	200kHz for 125kHz Bandwidth 1.6MHz for 500kHz Bandwidth
Antenna Type:	Rod Antenna
Antenna Gain: (Provided by the customer)	4 dBi
Maximum Field Strength:	93.78 dBμV/m @3m
Normal Test Voltage:	30 VDC

1.4 OTHER INFORMATION

Channel List for 125kHz Bandwidth

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	902.5	**17**	905.7	**33**	908.9	**49**	912.1
2	902.7	**18**	905.9	**34**	909.1	**50**	912.3
3	902.9	**19**	906.1	**35**	909.3	**51**	912.5
4	903.1	**20**	906.3	**36**	909.5	**52**	912.7
5	903.3	**21**	906.5	**37**	909.7	**53**	912.9
6	903.5	**22**	906.7	**38**	909.9	**54**	913.1
7	903.7	**23**	906.9	**39**	910.1	**55**	913.3
8	903.9	**24**	907.1	**40**	910.3	**56**	913.5
9	904.1	**25**	907.3	**41**	910.5	**57**	913.7
10	904.3	**26**	907.5	**42**	910.7	**58**	913.9
11	904.5	**27**	907.7	**43**	910.9	**59**	914.1
12	904.7	**28**	907.9	**44**	911.1	**60**	914.3
13	904.9	**29**	908.1	**45**	911.3	**61**	914.5
14	905.1	**30**	908.3	**46**	911.5	**62**	914.7
15	905.3	**31**	908.5	**47**	911.7	**63**	914.9
16	905.5	**32**	908.7	**48**	911.9	**--**	---

Channel List for 500kHz Bandwidth

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	903.0	**3**	906.2	**5**	909.4	**7**	912.6
2	904.6	**4**	907.8	**6**	911.0	**8**	914.2

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	DELL	Latitude 3400	16238087894	UnionTrust
Mouse	DELL	MS111	CN-011D3V-738	UnionTrust
DC Source	Agilent	66319B	MY43000795	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.30 Meter	UnionTrust
2	DC Power Cable	Detachable	1.5 Meter	UnionTrust

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: Unit D/E of 9/F and 16/F, Block A, Building 6, Baoneng science and technology park, Longhua district, Shenzhen, China, China 518109
Telephone: +86 (0) 755 2823 0888
Fax: +86 (0) 755 2823 0886

1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L9069
The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

A2LA-Lab Certificate No.: 4312.01
Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

ISED Wireless Device Testing Laboratories
CAB identifier: CN0032

FCC Accredited Lab.
Designation Number: CN1194
Test Firm Registration Number: 259480

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-150KHz	±3.8 dB
2	Conducted emission 150KHz-30MHz	±3.4 dB
3	Radiated emission 9KHz-30MHz	±4.9 dB
4	Radiated emission 30MHz-1GHz	±4.7 dB
5	Radiated emission 1GHz-18GHz	±5.1 dB
6	Radiated emission 18GHz-26GHz	±5.2 dB
7	Radiated emission 26GHz-40GHz	±5.2 dB

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203	ANSI C63.10-2013	PASS
Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	N/A(Note2)
Radiated Emission	FCC 47 CFR Part 15 Subpart C Section 15.249 (a)/15.209/15.205	ANSI C63.10-2013	PASS
20dB Occupied Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.215 (c)	ANSI C63.10-2013	PASS

Note:

1) N/A: In this whole report not applicable.
2) This EUT is powered by DC power from systems or DC 12V from External Battery Supply.

Disclaimer and Explanations:
The declared of product specification and data (e.g., antenna gain, RF specification, etc) for EUT presented in the report are provided by the customer, and the customer takes all the responsibilities for the accuracy of product specification.

3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☒	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	Euroshiedpn-CT001270-1317	22-Jan-2021	21-Jan-2024
☒	Receiver	R&S	ESIB26	100114	3-Nov-2022	2-Nov-2023
☐	Loop Antenna	ETS-LINDGREN	6502	00202525	11-Nov-2021	10-Nov-2023
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	11-Nov-2021	10-Nov-2023
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	11-Nov-2021	10-Nov-2023
☒	Preamplifier	HP	8447F	2805A02960	1-Nov-2022	31-Oct-2023
☐	Horn Antenna	ETS-LINDGREN	3117	00164202	11-Nov-2021	10-Nov-2023
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	17-Apr-2022	16-Apr-2024
☒	Pre-amplifier	ETS-LINDGREN	00118385	00201874	1-Nov-2022	31-Oct-2023
☐	Horn Antenna	ETS-LINDGREN	3116C	00200180	17-Apr-2022	16-Apr-2024
☐	Pre-amplifier	ETS-LINDGREN	00118384	00202652	17-Nov-2020	16-Nov-2022
☐	Band Rejection Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	2-Nov-2022	1-Nov-2023
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☒	Test Software	Audix	e3	Software Version: 9.160323		

RF Conducted Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☒	Spectrum analyzer	R&S	FSV40-N	101653	15-Apr-2022	14-Apr-2023

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage (VDC)	Relative Humidity (%)
NT/NV	+15 to +35	30	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment and Test Sample

Test Item	Temp. (°C)	Relative Humidity (%)	Pressure (kPa)	Sample No.	Tested by
Conducted Emission	N/A	N/A	N/A	N/A	N/A
Radiated Emission	25.2	50.0	100.2	S20221009613-ZJA03/3	Yana Zeng
20dB Occupied Bandwidth	24.4	48.9	99.9	S20221009613-ZJA02/3	Rain Wang

4.2 TEST CHANNELS

Type of Modulation	Tx/Rx Frequency	Test RF Channel Lists		
LoRa (Bandwidth=125kHz)	902.5 MHz to 914.9 MHz	Lowest(L)	Middle(M)	Highest(H)
		Channel 1	Channel 31	Channel 63
		902.5 MHz	908.5 MHz	914.9 MHz

Type of Modulation	Tx/Rx Frequency	Test RF Channel Lists		
LoRa (Bandwidth=500kHz)	903.0 MHz to 914.2 MHz	Lowest(L)	Middle(M)	Highest(H)
		Channel 1	Channel 5	Channel 8
		903.0 MHz	909.4 MHz	914.2 MHz

4.3 EUT TEST STATUS

Modulation Mode	Tx Function	Description
LoRa	1Tx	Keep the EUT in continuously transmitting with modulation test single.

Power Setting (Provided by the customer)		
Channel	125kHz Bandwidth	500kHz Bandwidth
L	-1	-1
M	-1	-1
H	-1	-1

Test Software (Provided by the customer)
Test software name: lpm01SettingTool_V2.02.exe

4.4 TEST SETUP

4.4.1 For Radiated Emissions test setup

Figure 1. Below 30MHz

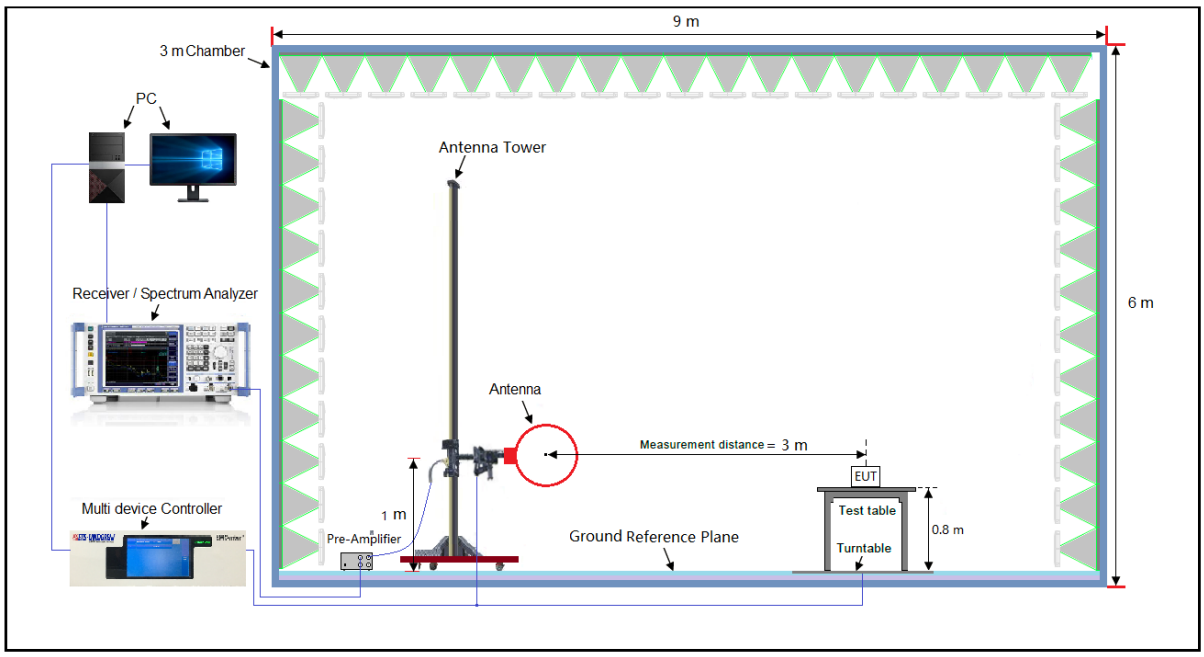


Figure 2. 30MHz to 1GHz

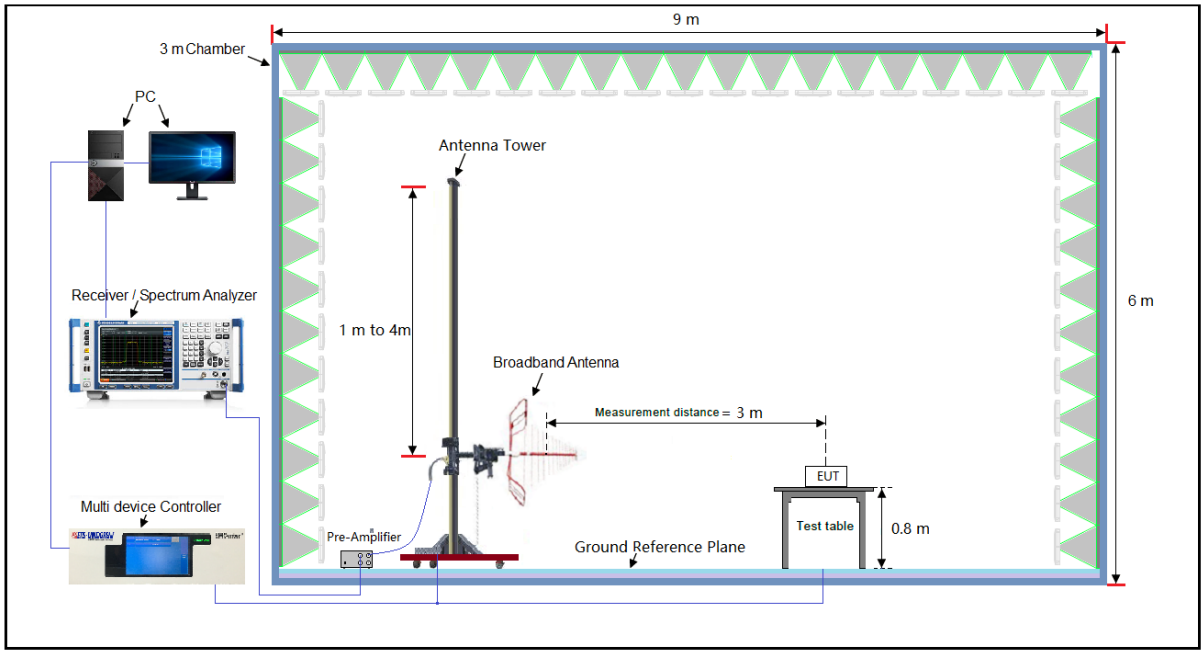
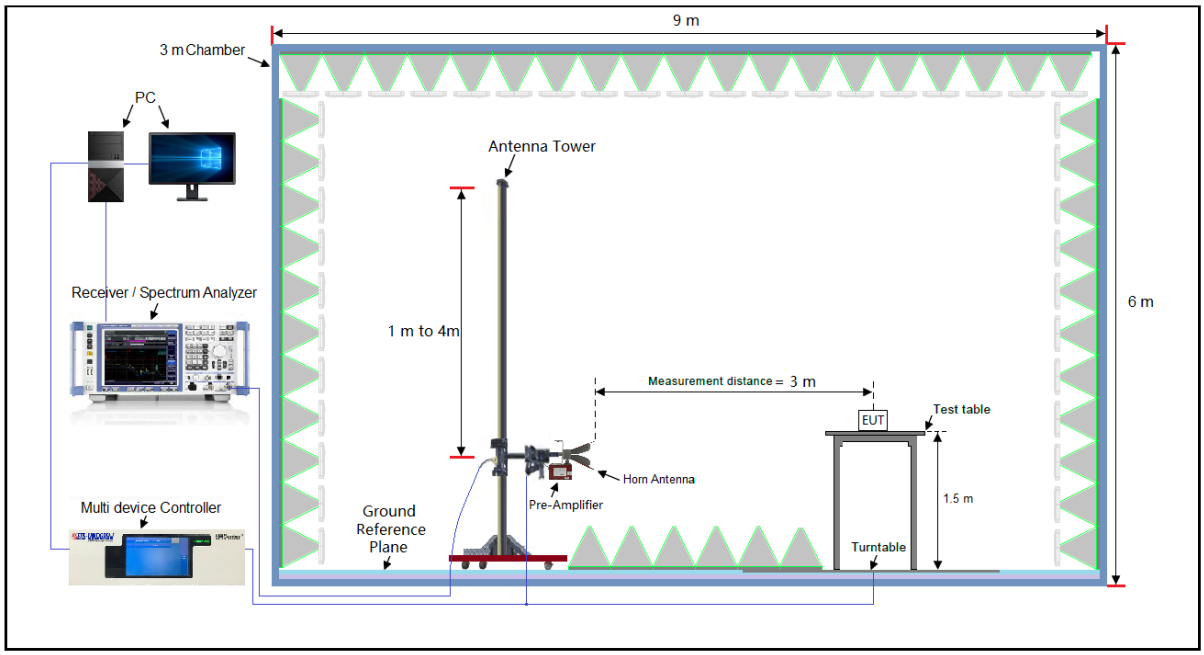
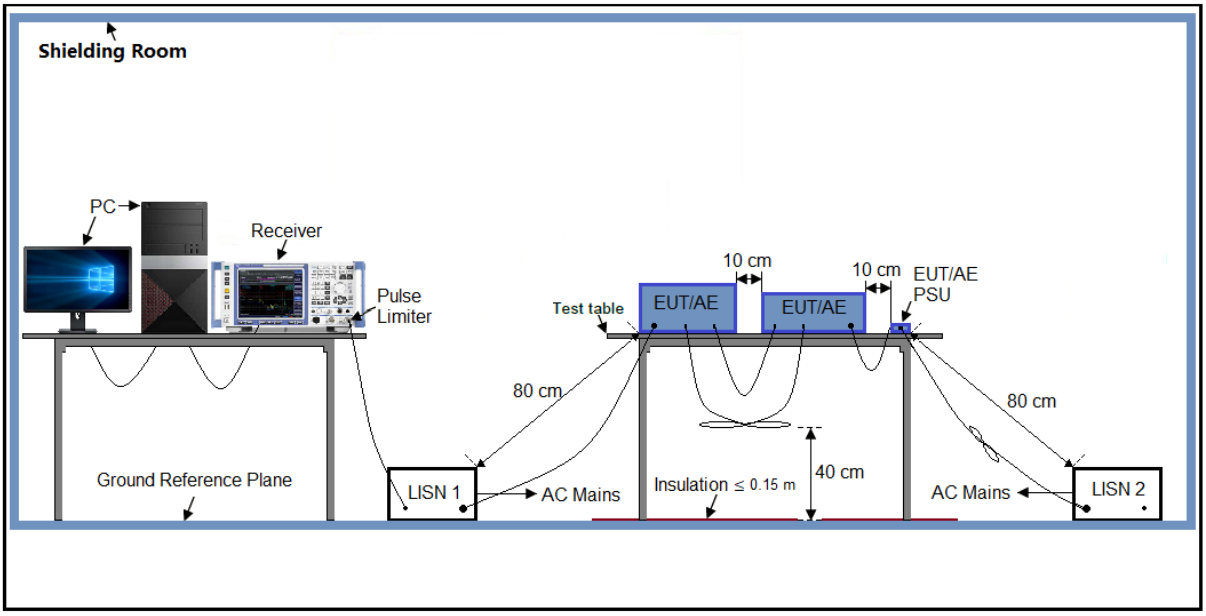


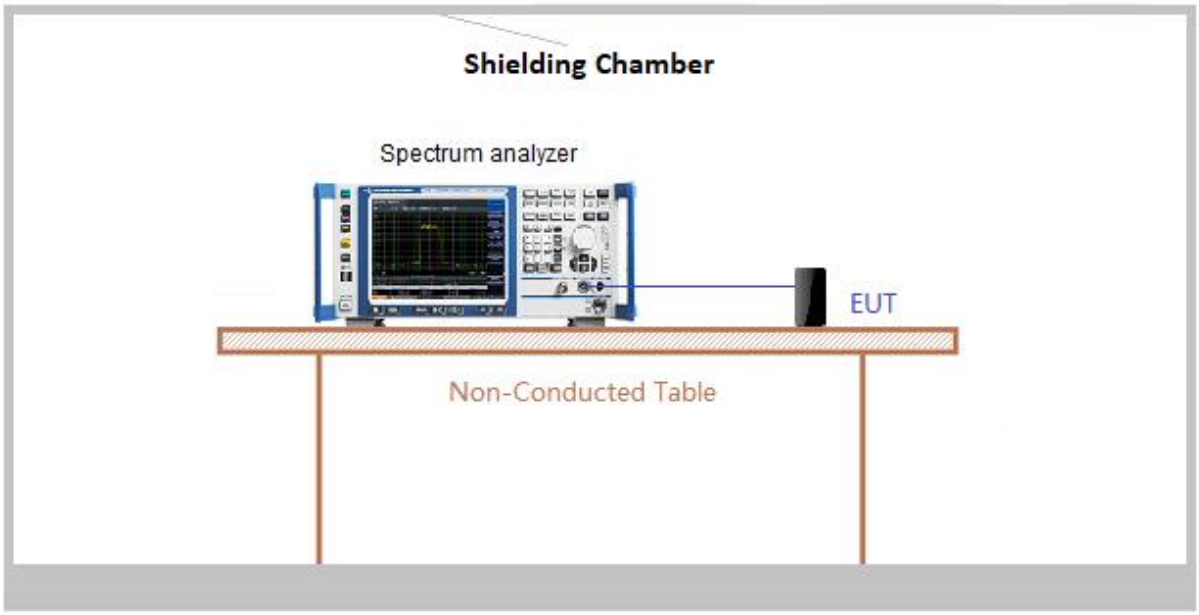
Figure 3. Above 1GHz



4.4.2 For Conducted Emissions test setup



4.4.3 For Conducted Emissions test setup



4.5 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by a 30Vdc DC Power. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in orientation.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

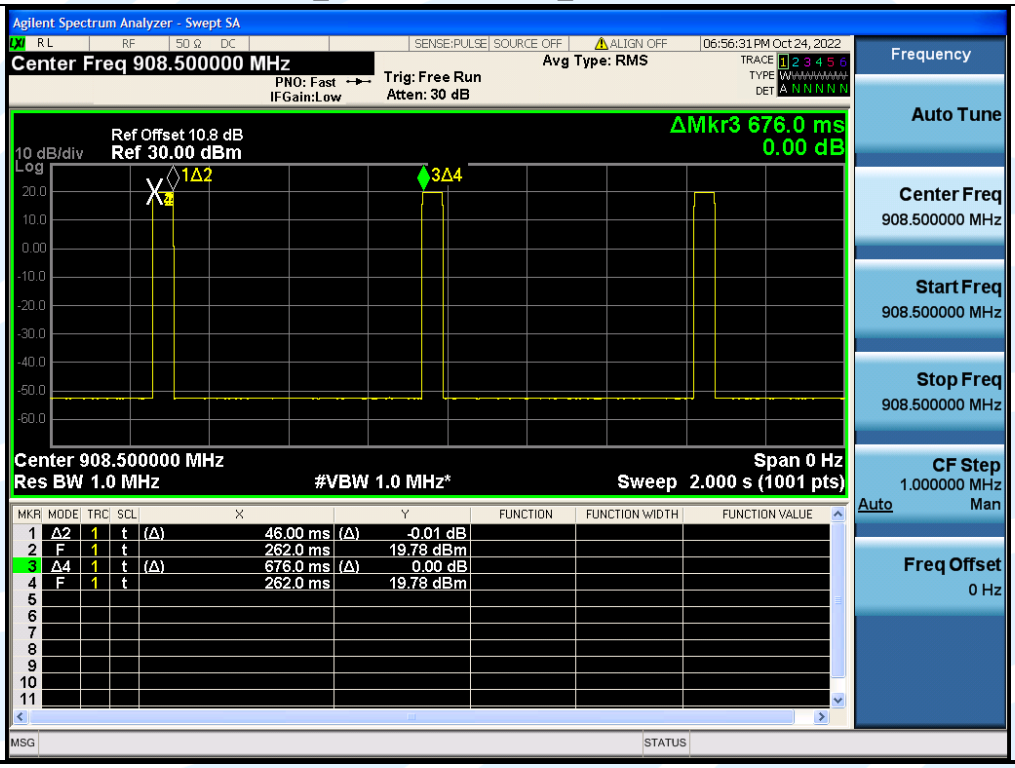
4.6 DUTY CYCLE

Type of Modulation	Bandwidth (kHz)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Average Factor (dB)
LoRa	125	46	676	0.068	6.80	-23.34
	500	10.5	564	0.019	1.86	-34.60

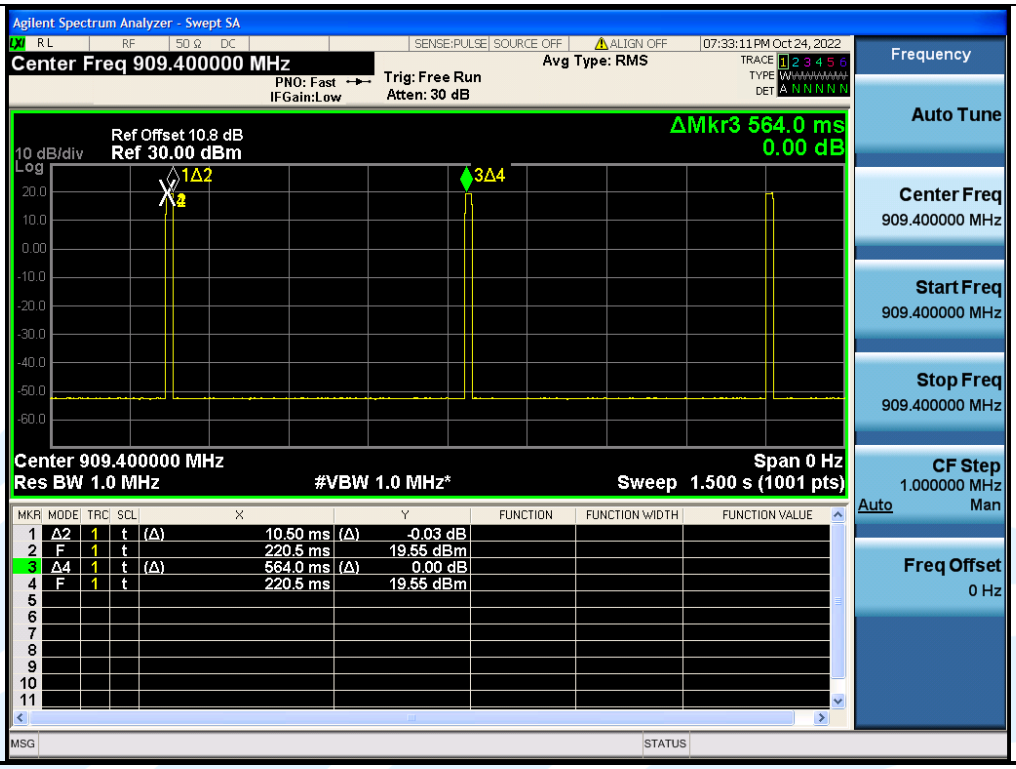
Remark:
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log (1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plot as follows

LoRa_125kHz Bandwidth _ Middle Channel



LoRa_500kHz Bandwidth _ Middle Channel



5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 15	Radio Frequency Devices
2	ANSI C63.10-2013	American National Standard for Testing Unlicesed Wireless Devices

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, 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.
EUT Antenna:
The EUT has a permanently and irreplaceable attached antenna. The gain of the antenna is 4 dBi.

5.3 RADIATED EMISSION

Test Requirement: FCC 47 CFR Part 15.205,15.209 and 15.249

Test Method: ANSI C63.10-2013 Section 6.6.4.3

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009 MHz-0.090 MHz	Peak	10 kHz	30 KHz	Peak
0.009 MHz-0.090 MHz	Average	10 kHz	30 KHz	Average
0.090 MHz-0.110 MHz	Quasi-peak	10 kHz	30 KHz	Quasi-peak
0.110 MHz-0.490 MHz	Peak	10 kHz	30 KHz	Peak
0.110 MHz-0.490 MHz	Average	10 kHz	30 KHz	Average
0.490 MHz -30 MHz	Quasi-peak	10 kHz	30 kHz	Quasi-peak
30 MHz-1 GHz	Quasi-peak	100 kHz	300 KHz	Quasi-peak
Above 1 GHz	Peak	1 MHz	3 MHz	Peak
	Peak	1 MHz	10 Hz	Average

Limits:

Field strength of the fundamental signal

As per 47 CFR Part 15.249(a), except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

As per 47 CFR Part 15.249(c), Field strength limits are specified at a distance of 3 meters.

Spurious Emissions

47 CFR Part 15.249(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009 MHz-0.490 MHz	2400/F(kHz)	--	--	300
0.490 MHz-1.705 MHz	24000/F(kHz)	--	--	30
1.705 MHz-30 MHz	30	--	--	30
30 MHz-88 MHz	100	40.0	Quasi-peak	3
88 MHz-216 MHz	150	43.5	Quasi-peak	3
216 MHz-960 MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1 GHz	500	54.0	Average	3

Remark:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

Test Setup: Refer to section 4.4.1 for details.

Test Procedures:

1. From 30 MHz to 1GHz test procedure as below:

1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
5) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

2. Above 1GHz test procedure as below:

1) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter (Above 18GHz the distance is 1 meter and table is 1.5 meter).
2) Test the EUT in the lowest channel, middle channel, the Highest channel
3) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the Y axis positioning which it is worse case.
4) Repeat above procedures until all frequencies measured was complete.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

The measurement data as follows:

For 125kHz Bandwidth:

Field Strength of the Fundamental Signal and Bandedge

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
Lowest Channel_902.5MHz								
1	902.50	84.02	4.31	88.33	94.00	-5.67	QP	Horizontal
2	902.00	25.89	4.31	30.20	46.00	-15.80	QP	Horizontal
3	902.50	89.39	4.31	93.70	94.00	-0.30	QP	Vertical
4	902.00	27.99	4.31	32.30	46.00	-13.70	QP	Vertical
Middle Channel_908.5MHz								
1	908.50	83.37	4.35	87.72	94.00	-6.28	QP	Horizontal
2	908.50	88.89	4.35	93.24	94.00	-0.76	QP	Vertical
Highest Channel_914.9MHz								
1	914.90	82.89	4.39	87.28	94.00	-6.72	QP	Horizontal
2	928.00	23.41	4.39	27.80	46.00	-18.20	QP	Horizontal
3	914.90	89.39	4.39	93.78	94.00	-0.22	QP	Vertical
4	928.00	24.00	4.39	28.39	46.00	-17.61	QP	Vertical

For 500kHz Bandwidth:

Field Strength of the Fundamental Signal and Bandedge

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
Lowest Channel_903.0MHz								
1	903.00	82.86	4.31	87.17	94.00	-6.83	QP	Horizontal
2	902.00	30.12	4.31	34.43	46.00	-11.57	QP	Horizontal
3	903.00	88.93	4.31	93.24	94.00	-0.76	QP	Vertical
4	902.00	32.09	4.31	36.40	46.00	-9.60	QP	Vertical
Middle Channel_909.4MHz								
1	909.40	83.76	4.36	88.12	94.00	-5.88	QP	Horizontal
2	909.40	88.69	4.36	93.05	94.00	-0.95	QP	Vertical
Highest Channel_914.2MHz								
1	914.20	78.44	4.39	82.83	94.00	-11.17	QP	Horizontal
2	928.00	26.05	4.39	30.44	46.00	-15.56	QP	Horizontal
3	914.20	87.98	4.39	92.37	94.00	-1.63	QP	Vertical
4	928.00	25.37	4.39	29.76	46.00	-16.24	QP	Vertical

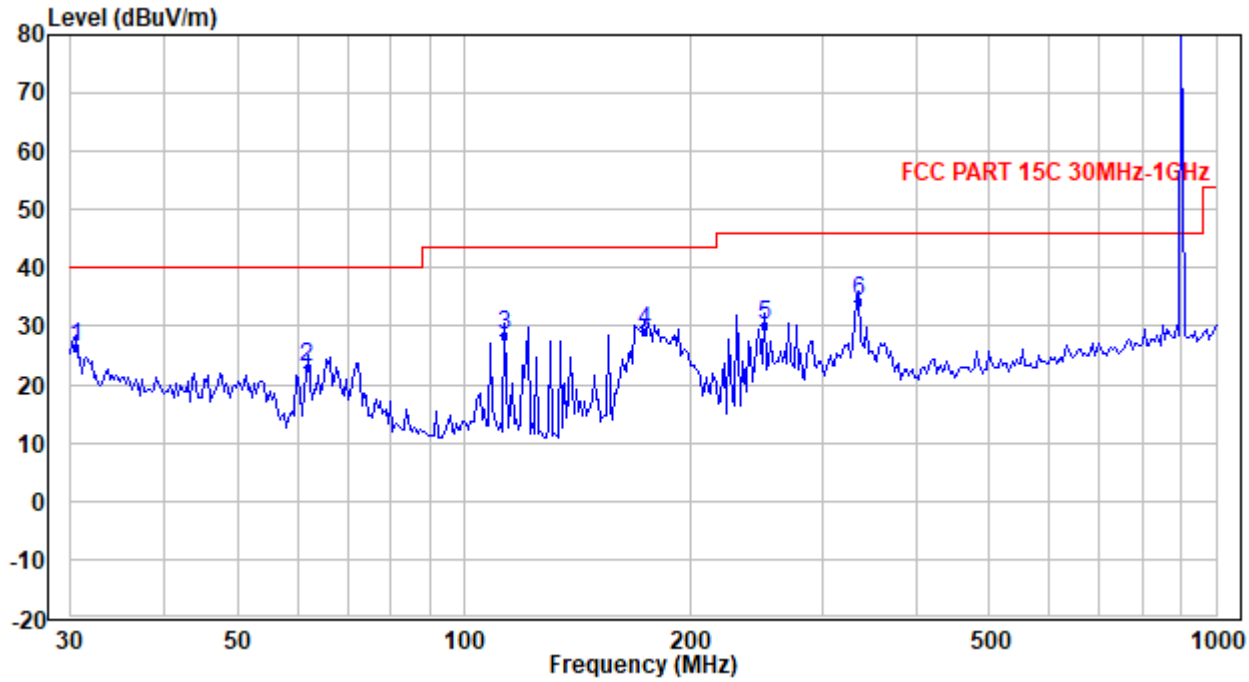
Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Radiated Emission Test Data (9 kHz ~ 30 MHz):
The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

Radiated Emission Test Data (30 MHz ~ 1 GHz):
Lowest Channel for 125kHz Bandwidth

Horizontal

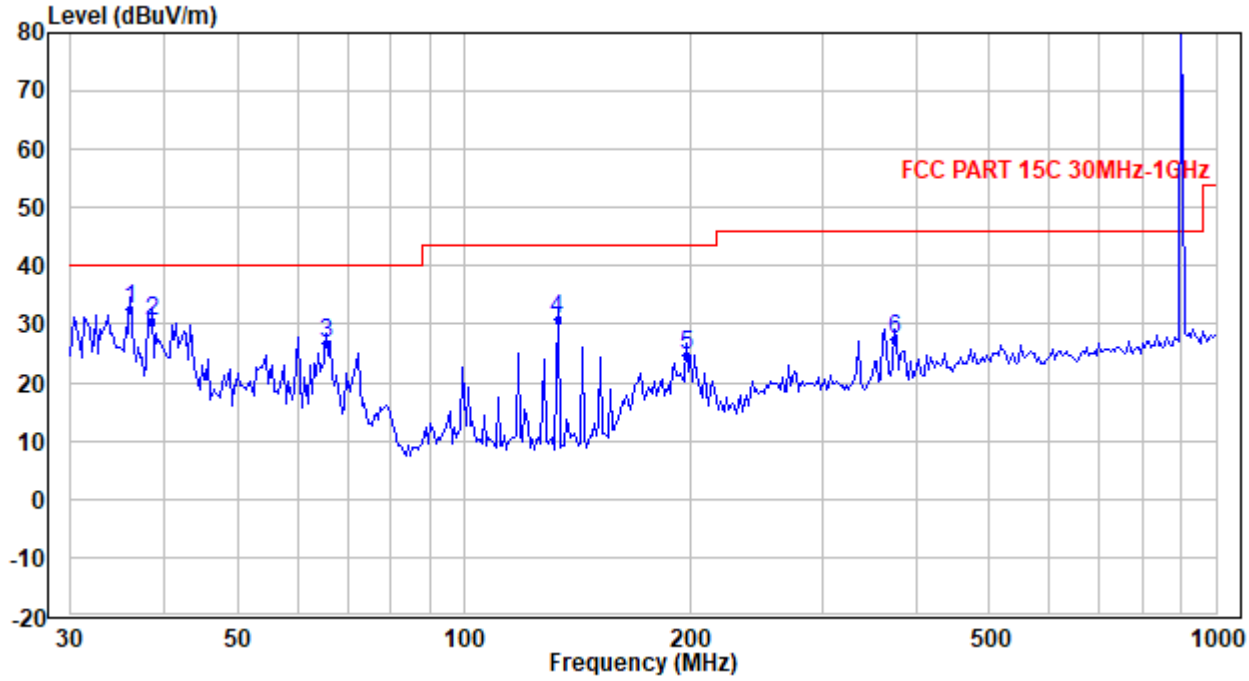


No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	30.425	30.75	-4.46	26.29	40.00	-13.71	QP
2	61.868	40.49	-17.51	22.98	40.00	-17.02	QP
3	113.220	44.26	-15.92	28.34	43.50	-15.16	QP
4	173.815	40.48	-11.41	29.07	43.50	-14.43	QP
5	250.486	39.15	-8.82	30.33	46.00	-15.67	QP
6	334.126	39.86	-5.69	34.17	46.00	-11.83	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Vertical



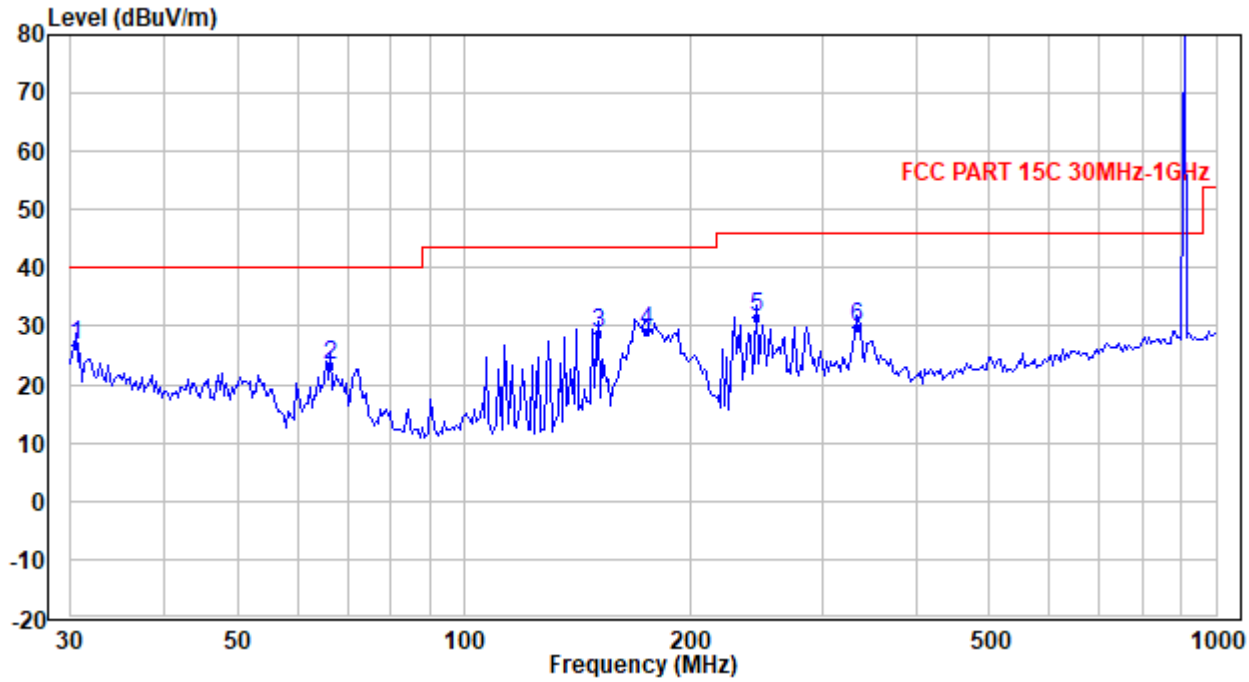
No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	36.014	38.14	-5.43	32.71	40.00	-7.29	QP
2	38.365	37.54	-6.93	30.61	40.00	-9.39	QP
3	65.445	43.64	-17.06	26.58	40.00	-13.42	QP
4	133.081	46.50	-15.73	30.77	43.50	-12.73	QP
5	197.251	35.24	-10.61	24.63	43.50	-18.87	QP
6	373.886	32.67	-5.38	27.29	46.00	-18.71	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Middle Channel for 125kHz Bandwidth

Horizontal

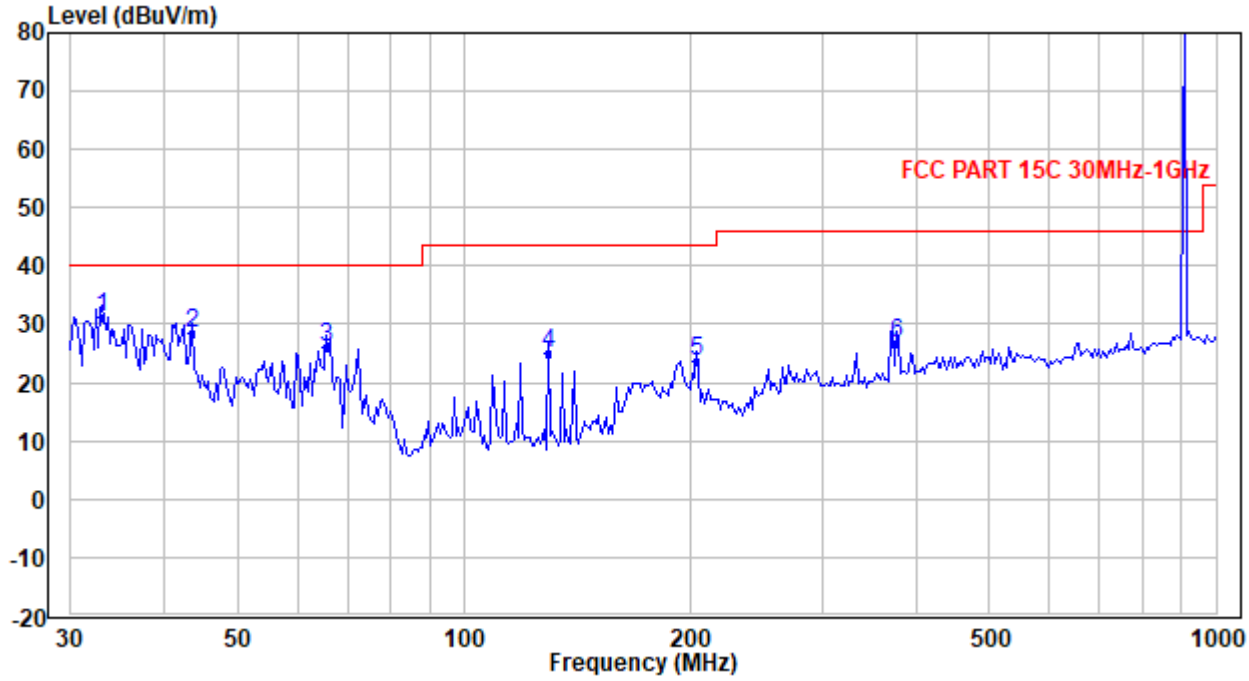


No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	30.425	31.31	-4.46	26.85	40.00	-13.15	QP
2	66.371	40.67	-17.20	23.47	40.00	-16.53	QP
3	151.025	43.74	-15.01	28.73	43.50	-14.77	QP
4	175.040	39.96	-10.68	29.28	43.50	-14.22	QP
5	245.261	40.48	-8.79	31.69	46.00	-14.31	QP
6	331.786	35.52	-5.72	29.80	46.00	-16.20	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Vertical



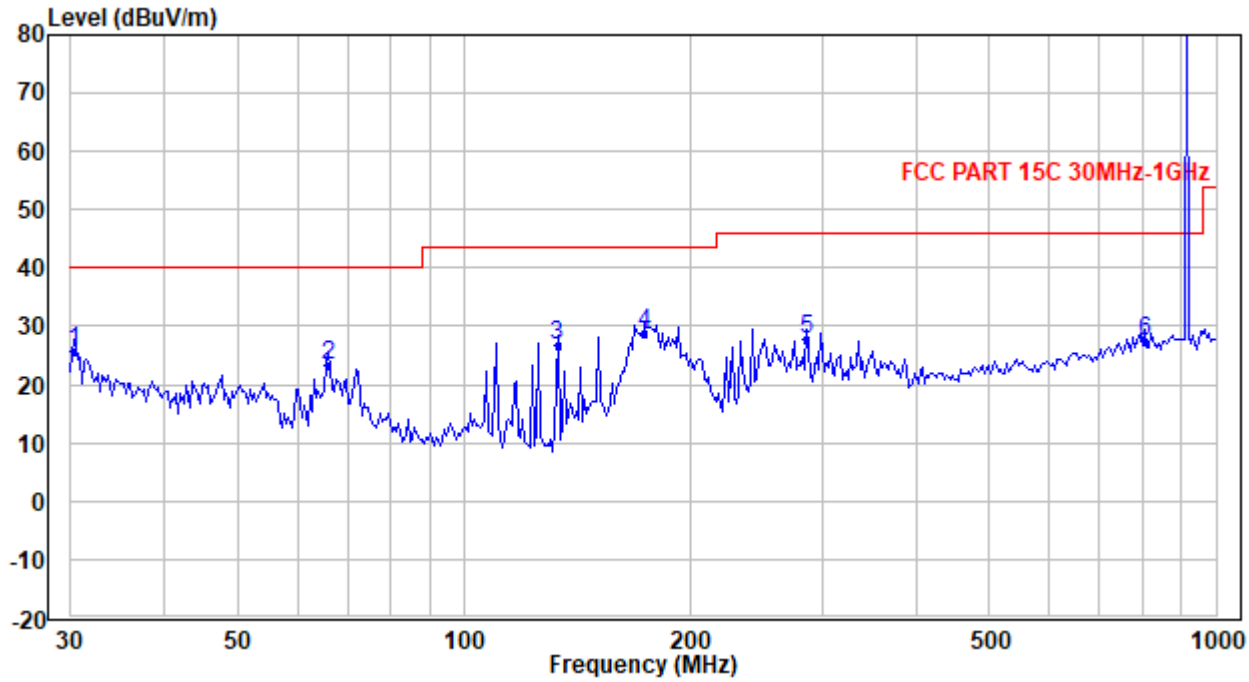
No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	33.101	36.06	-4.83	31.23	40.00	-8.77	QP
2	43.538	38.45	-10.12	28.33	40.00	-11.67	QP
3	65.445	43.14	-17.06	26.08	40.00	-13.92	QP
4	129.392	40.73	-15.69	25.04	43.50	-18.46	QP
5	204.305	34.29	-10.76	23.53	43.50	-19.97	QP
6	376.523	32.10	-5.26	26.84	46.00	-19.16	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Highest Channel for 125kHz Bandwidth

Horizontal

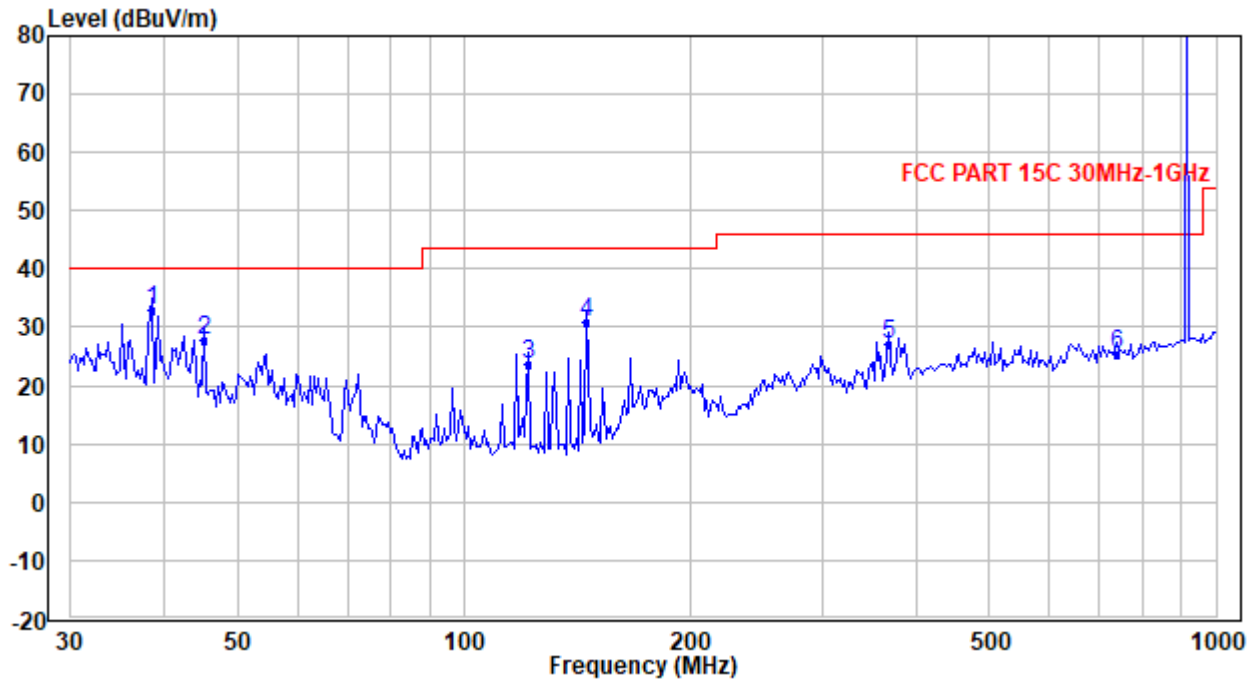


No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	30.212	30.02	-4.42	25.60	40.00	-14.40	QP
2	65.907	40.59	-17.15	23.44	40.00	-16.56	QP
3	133.081	42.33	-15.73	26.60	43.50	-16.90	QP
4	173.815	40.06	-11.41	28.65	43.50	-14.85	QP
5	286.265	34.72	-7.09	27.63	46.00	-18.37	QP
6	804.252	24.77	2.60	27.37	46.00	-18.63	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Vertical



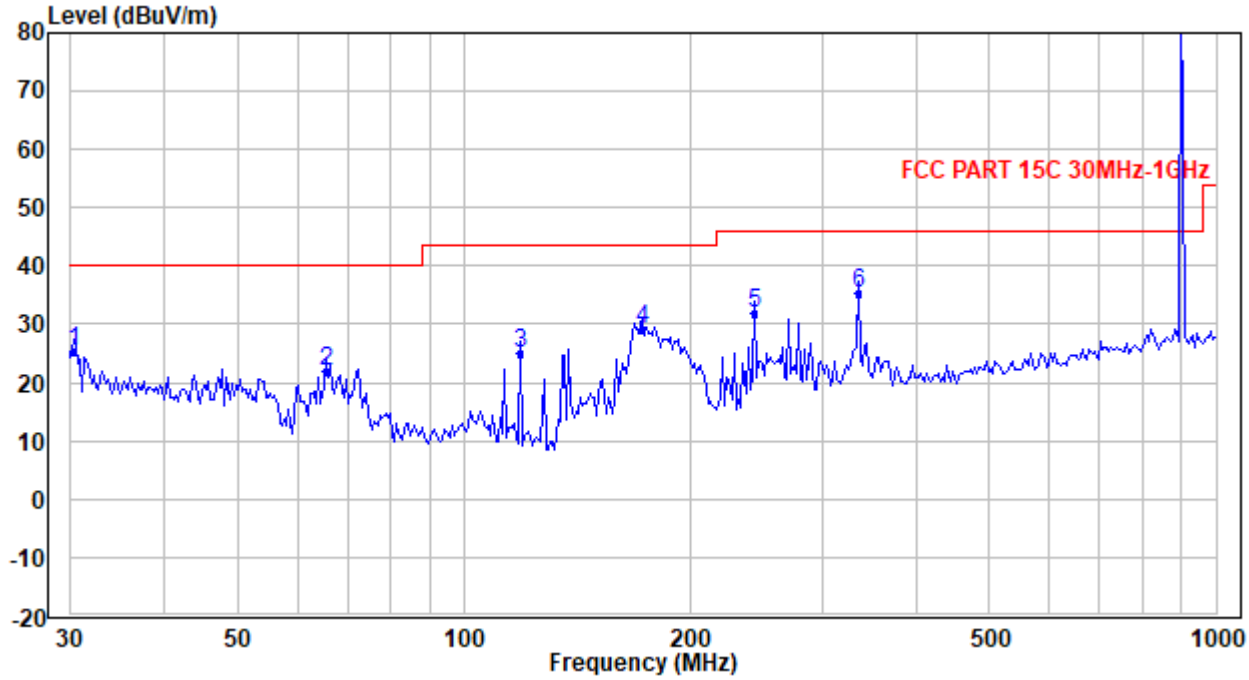
No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	38.365	40.01	-6.93	33.08	40.00	-6.92	QP
2	45.095	39.22	-11.32	27.90	40.00	-12.10	QP
3	121.462	39.43	-15.89	23.54	43.50	-19.96	QP
4	145.811	46.52	-15.62	30.90	43.50	-12.60	QP
5	366.087	32.09	-5.11	26.98	46.00	-19.02	QP
6	739.214	23.38	2.00	25.38	46.00	-20.62	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Radiated Emission Test Data (30 MHz ~ 1 GHz):
Lowest Channel for 500kHz Bandwidth

Horizontal

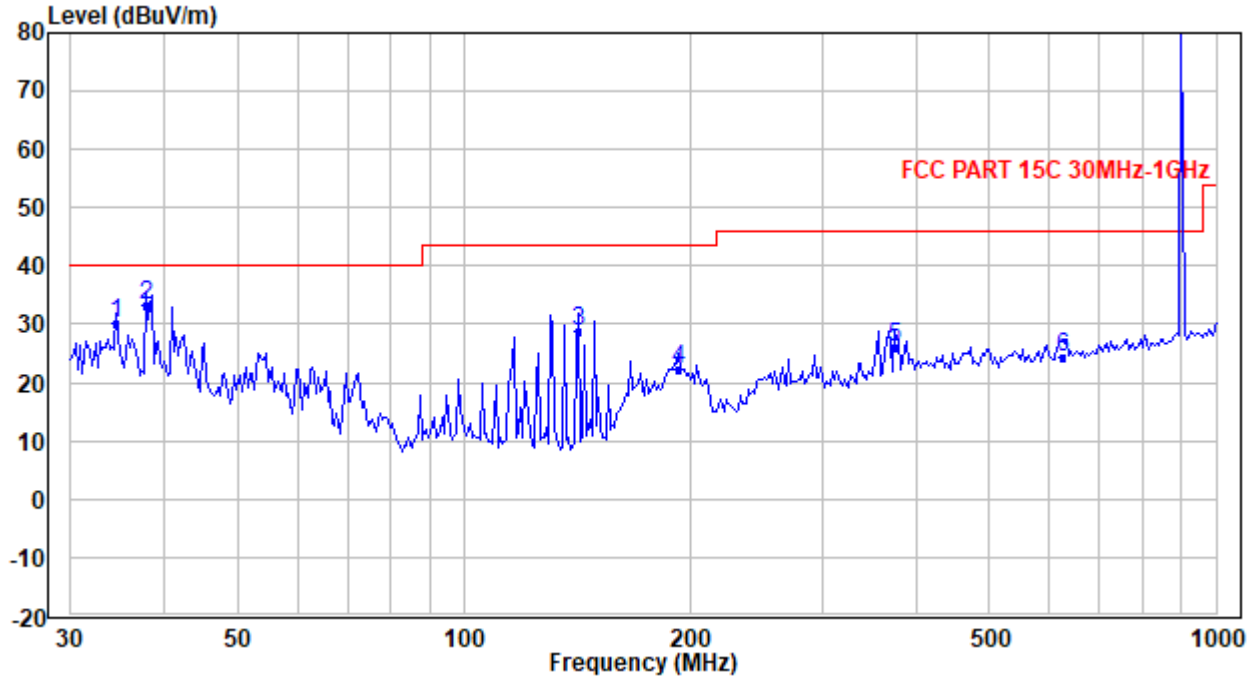


No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	30.212	29.87	-4.42	25.45	40.00	-14.55	QP
2	65.445	38.98	-17.06	21.92	40.00	-18.08	QP
3	118.929	40.74	-15.67	25.07	43.50	-18.43	QP
4	172.598	40.37	-11.33	29.04	43.50	-14.46	QP
5	243.543	40.87	-8.88	31.99	46.00	-14.01	QP
6	334.126	41.05	-5.69	35.36	46.00	-10.64	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Vertical



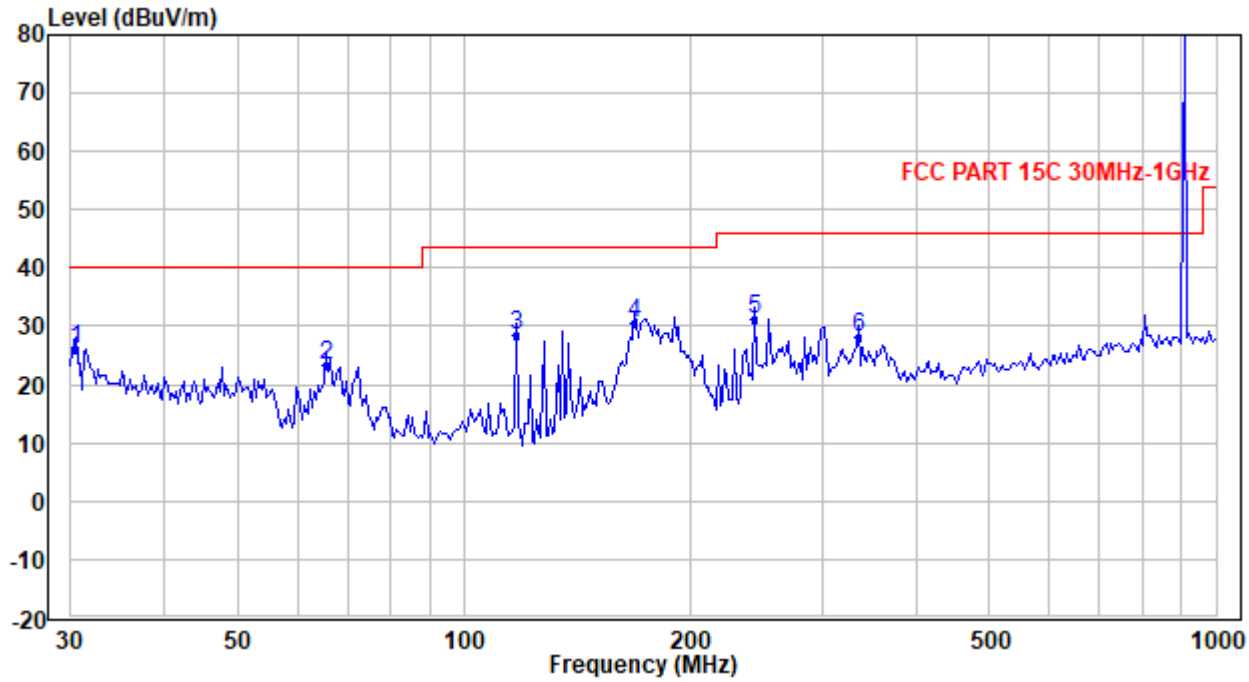
No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	34.527	34.61	-4.60	30.01	40.00	-9.99	QP
2	37.830	39.74	-6.53	33.21	40.00	-6.79	QP
3	141.769	44.51	-15.59	28.92	43.50	-14.58	QP
4	193.137	32.51	-10.36	22.15	43.50	-21.35	QP
5	373.886	31.54	-5.38	26.16	46.00	-19.84	QP
6	624.490	24.71	-0.26	24.45	46.00	-21.55	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Middle Channel for 500kHz Bandwidth

Horizontal

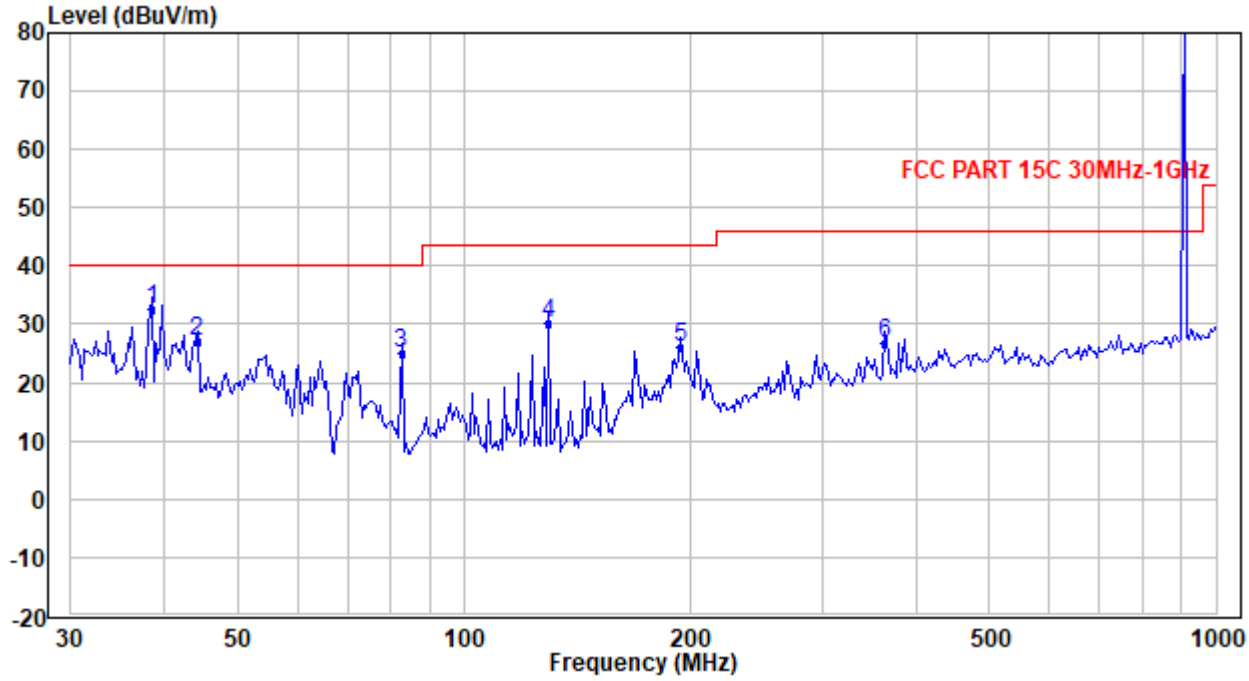


No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	30.425	30.42	-4.46	25.96	40.00	-14.04	QP
2	65.445	40.28	-17.06	23.22	40.00	-16.78	QP
3	117.269	44.37	-15.91	28.46	43.50	-15.04	QP
4	168.997	42.22	-11.75	30.47	43.50	-13.03	QP
5	243.543	40.18	-8.88	31.30	46.00	-14.70	QP
6	334.126	33.96	-5.69	28.27	46.00	-17.73	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Vertical



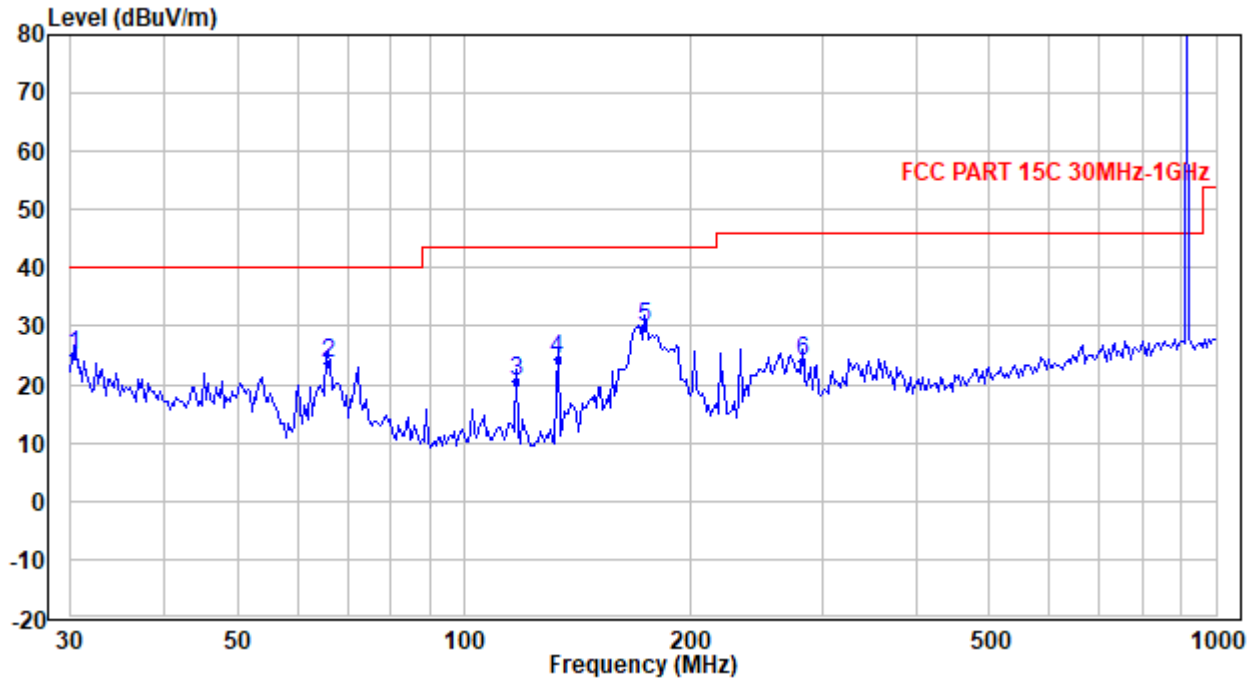
No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	38.365	39.57	-6.93	32.64	40.00	-7.36	QP
2	44.154	37.62	-10.66	26.96	40.00	-13.04	QP
3	82.526	42.18	-17.28	24.90	40.00	-15.10	QP
4	129.392	45.81	-15.69	30.12	43.50	-13.38	QP
5	194.499	36.40	-10.48	25.92	43.50	-17.58	QP
6	363.523	31.65	-5.02	26.63	46.00	-19.37	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Highest Channel for 500kHz Bandwidth

Horizontal

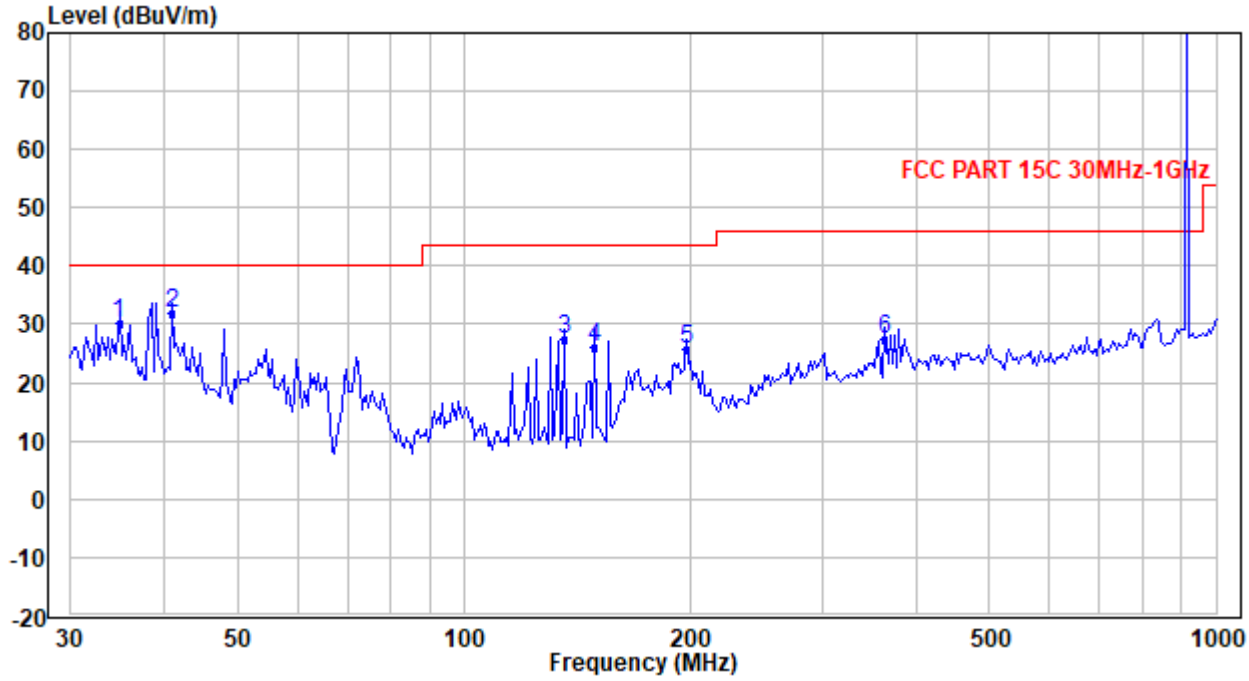


No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	30.212	29.28	-4.42	24.86	40.00	-15.14	QP
2	65.907	40.81	-17.15	23.66	40.00	-16.34	QP
3	117.269	36.50	-15.91	20.59	43.50	-22.91	QP
4	133.081	40.18	-15.73	24.45	43.50	-19.05	QP
5	173.815	41.18	-11.41	29.77	43.50	-13.73	QP
6	282.270	31.22	-7.26	23.96	46.00	-22.04	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	34.770	34.50	-4.43	30.07	40.00	-9.93	QP
2	40.870	40.03	-8.29	31.74	40.00	-8.26	QP
3	135.916	42.92	-15.61	27.31	43.50	-16.19	QP
4	148.917	41.40	-15.30	26.10	43.50	-17.40	QP
5	197.251	36.19	-10.61	25.58	43.50	-17.92	QP
6	363.523	32.56	-5.02	27.54	46.00	-18.46	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

Radiated Emission Test Data (Above 1GHz):

Lowest Channel for 125kHz Bandwidth:

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
1	1328.205	56.92	-13.10	43.82	74.00	-30.18	Peak	Horizontal
2	1664.628	51.61	-11.53	40.08	74.00	-33.92	Peak	Horizontal
3	2396.630	52.63	-8.28	44.35	74.00	-29.65	Peak	Horizontal
4	1804.412	50.92	-10.62	40.30	74.00	-33.70	Peak	Vertical
5	2388.912	54.73	-8.32	46.41	74.00	-27.59	Peak	Vertical
6	2709.125	54.95	-7.52	47.43	74.00	-26.57	Peak	Vertical
7	3598.275	47.63	-4.36	43.27	74.00	-30.73	Peak	Vertical

Middle Channel for 125kHz Bandwidth:

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
1	2388.912	59.85	-8.32	51.53	74.00	-22.47	Peak	Horizontal
2	3152.564	54.36	-6.13	48.23	74.00	-25.77	Peak	Horizontal
3	4080.593	50.17	-3.10	47.07	74.00	-26.93	Peak	Horizontal
4	1197.958	57.16	-13.49	43.67	74.00	-30.33	Peak	Vertical
5	1816.089	52.52	-10.55	41.97	74.00	-32.03	Peak	Vertical
6	2396.630	56.01	-8.28	47.73	74.00	-26.27	Peak	Vertical

Highest Channel for 125kHz Bandwidth:

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
1	1323.928	56.51	-13.11	43.40	74.00	-30.60	Peak	Horizontal
2	1659.268	53.17	-11.57	41.60	74.00	-32.40	Peak	Horizontal
3	2396.630	59.17	-8.28	50.89	74.00	-23.11	Peak	Horizontal
4	1197.958	57.10	-13.49	43.61	74.00	-30.39	Peak	Vertical
5	1827.842	54.83	-10.48	44.35	74.00	-29.65	Peak	Vertical
6	2396.630	59.30	-8.28	51.02	74.00	-22.98	Peak	Vertical

Lowest Channel for 500kHz Bandwidth:

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
1	1323.928	57.26	-13.11	44.15	74.00	-29.85	Peak	Horizontal
2	2396.630	58.01	-8.28	49.73	74.00	-24.27	Peak	Horizontal
3	2427.750	60.00	-8.16	51.84	74.00	-22.16	Peak	Horizontal
4	1159.936	56.94	-13.58	43.36	74.00	-30.64	Peak	Vertical
5	1804.412	54.03	-10.62	43.41	74.00	-30.59	Peak	Vertical
6	2396.630	58.65	-8.28	50.37	74.00	-23.63	Peak	Vertical

Middle Channel for 500kHz Bandwidth:

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
1	1328.205	56.49	-13.10	43.39	74.00	-30.61	Peak	Horizontal
2	1664.628	52.59	-11.53	41.06	74.00	-32.94	Peak	Horizontal
3	2388.912	56.18	-8.32	47.86	74.00	-26.14	Peak	Horizontal
4	1197.958	56.71	-13.49	43.22	74.00	-30.78	Peak	Vertical
5	1816.089	55.24	-10.55	44.69	74.00	-29.31	Peak	Vertical
6	2396.630	55.78	-8.28	47.50	74.00	-26.50	Peak	Vertical

Highest Channel for 500kHz Bandwidth:

No.	Frequency (MHz)	Reading (dBμV/m)	Correction factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
1	1328.205	57.48	-13.10	44.38	74.00	-29.62	Peak	Horizontal
2	1664.628	55.23	-11.53	43.70	74.00	-30.30	Peak	Horizontal
3	2396.630	56.37	-8.28	48.09	74.00	-25.91	Peak	Horizontal
4	1194.100	56.88	-13.50	43.38	74.00	-30.62	Peak	Vertical
5	1659.268	54.76	-11.57	43.19	74.00	-30.81	Peak	Vertical
6	2388.912	55.96	-8.32	47.64	74.00	-26.36	Peak	Vertical

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit
4. As shown in this section, for frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. So, only the peak measurements were shown in the report.

5.4 20DB OCCUPIED BANDWIDTH

Test Requirement: FCC 47 CFR Part 15.215
Test Method: ANSI C63.10-2013
Test Setup: Refer to section 4.4.3 for details.
Limits: N/A
Equipment Used: Refer to section 3 for details.
Test Result: Pass
The measurement procedure shall be as follows:

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
b) RBW ≥ 1% of the 20 dB bandwidth
c) VBW ≥ RBW
d) Sweep = auto;
e) Detector function = peak
f) Trace = max hold
g) All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down bandwidth of the emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Result: Pass
The measurement data as follows:

Bandwidth	Test Channel	Test Frequency (MHz)	20 dB Bandwidth (kHz)
125kHz	Lowest	902.5	140.38
	Middle	908.5	140.38
	Highest	914.9	140.38
500kHz	Lowest	903.0	558.60
	Middle	909.4	558.60
	Highest	914.2	564.40

The test plot as follows:

125kHz Bandwidth	500kHz Bandwidth
Lowest Channel	
Middle Channel	
Highest Channel	

5.5 CONDUCTED EMISSION

Test Requirement: FCC 47 CFR Part 15.207

Test Method: ANSI C63.10-2013 Section 6.2

Limits:

Frequency range (MHz)	Limits (dB(μV)	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50

Remark:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 to 0.50 MHz.

Test Setup: Refer to section 4.4.2 for details.

Test Procedures:

1) The Product was placed on a nonconductive table 0.8 m above the horizontal ground reference plane, and 0.4 m from the vertical ground reference plane, and connected to the main through Line Impedance Stability Network (L.I.S.N).
2) The RBW of the receiver was set at 9 kHz in 150 kHz ~ 30MHz with Peak and AVG detector in Max Hold mode. Run the receiver's pre-scan to record the maximum disturbance generated from Product in all power lines in the full band.
3) For each frequency whose maximum record was higher or close to limit, measure its QP and AVG values and record.

Equipment Used: Refer to section 3 for details.

Test Result: N/A.

The product is powered by a DC Power from systems or external battery, not applicable for this test item.

APPENDIX 1 PHOTOS OF TEST SETUP

See test photos attached in Appendix 1 for the actual connections between Product and support equipment.

APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photos.

*** End of Report ***

The test report is effective only with both signature and specialized stamp. The result(s) shown in this report refer only to the sample(s) tested. Without written approval of UnionTrust, this report can't be reproduced except in full.