FCC RADIO TEST REPORT

The device described below is tested by Dongguan Nore Testing Center Co., Ltd. to determine the maximum emission levels emanating from the device, the severe levels which the device can endure and E.U.T.'s performance criterion. The test results, data evaluation, test procedures, and equipment of configurations shown in this report were made in accordance with the procedures in ANSI C63.10(2013).

Applicant	:	Paul C. Buff, Inc.
Address	:	2725 Bransford Ave. Nashville TN 37204, United States
Manufacturer/ Factory	:	Paul C. Buff, Inc.
Address	:	2725 Bransford Ave. Nashville TN 37204, United States
E.U.T.	:	LINK800WS
Brand Name	:	N/A
Model No.	:	LINK800WS
FCC ID	:	OUELINK800
Measurement Standard	:	FCC PART 15.249
Date of Receiver	:	April 08, 2020
Date of Test	:	April 08, 2020 to September 04, 2020
Date of Report	:	November 20, 2020

This Test Report is Issued Under the Authority of :

Prepared by

Sundiy Jiang/ Engineer

Approved & Authorized Signer

Iori Fan / Authorized Signatory

This test report is for the customer shown above and their specific product only. This report applies to above tested sample only and shall not be reproduced in part without written approval of Dongguan Nore Testing Center Co., Ltd.

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Revision History of This Test Report

Report Number	Description	Issued Date
NTC2004096FV00	Initial Issue	2020-11-20

1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test

Product Name	:	LINK800WS
Main model number	:	LINK800WS
Additional Model number	:	N/A
Brand Name	:	N/A
Power Supply	:	100-240V ~ 50/60Hz
Test voltage	:	AC 120V 60Hz, AC 240V 50Hz (Only the worst case was recorded in this report)
Model Difference Description	:	N/A
Cable	:	AC mains 4.3m unshielded with a core
Hardware version	:	V1.0
Software version	:	V1.0
S/N	:	LK80000027
Note	:	N/A

Technical Specification:

2.4G Function:

Frequency Range	:	2427-2457MHz
Modulation Type	:	GFSK
Number of Channel	:	16
Antenna Type	:	PCB Antenna
Antenna Gain	:	-1 dBi (Declaration by manufacturer)

Channel List:

Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz
1	2427	7	2439	13	2451
2	2429	8	2441	14	2453
3	2431	9	2443	15	2455
4	2433	10	2445	16	2457
5	2435	11	2447	-	-
6	2437	12	2449	-	-
Note: The Lowest, middle, and the Highest frequency of channel were selected to perform the test. The frequency selected see below:					
The Lowest frequency: 2427MHz The middle frequency: 2441MHz The Highest frequency: 2457MHz					

1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: OUELINK800** filing to comply with Section 15.249 of the FCC Part 15, Subpart C Rule.

1.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters.

1.4 Equipment Modifications

Not available for this EUT intended for grant.

1.5 Support Device

N/A

1.6 Test Facility and Location

Site Description

EMC Lab : Listed by CNAS, August 13, 2018
The certificate is valid until August 13, 2024
The Laboratory has been assessed and proved to be in compliance with CNAS/CL01
The Certificate Registration Number is L5795.

Listed by A2LA, November 01, 2017
The certificate is valid until December 31, 2019
The Laboratory has been assessed and proved to be in compliance with ISO17025
The Certificate Registration Number is 4429.01

Listed by FCC, November 06, 2017
The Designation Number is CN1214
Test Firm Registration Number: 907417

Listed by Industry Canada, June 08, 2017
The Certificate Registration Number is 46405-9743A

Name of Firm : Dongguan Nore Testing Center Co., Ltd.
(Dongguan NTC Co., Ltd.)

Site Location : Building D, Gaosheng Science and Technology park, Hongtu road, Nancheng district, Dongguan city, Guangdong province, China

1.7 Summary of Test Results

FCC Rules	Description Of Test	Uncertainty	Result
§15.207(a)	AC Power Conducted Emission	±1.06dB	Compliant
§15.249(a)/ 15.209	Radiated Emissions	±3.70dB	Compliant
§15.249(d)/ 15.205	Band Edge	±1.70dB	Compliant
§15.215(c)	20dB Bandwidth	±1.42 x10^{-4}%	Compliant
§15.203	Antenna Requirement	---	Compliant

2. System Test Configuration

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 Description of test modes

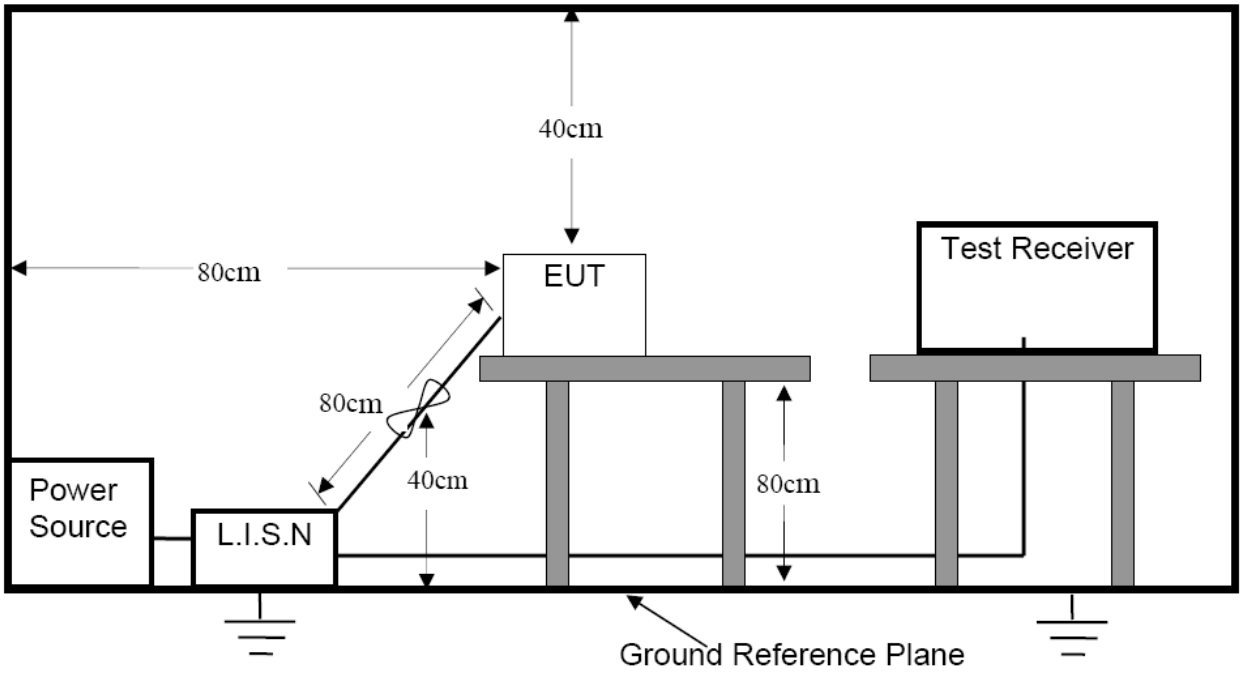
The EUT has been tested under operating condition. The Lowest, middle and highest frequencies were chosen for testing.

2.3 EUT Exercise

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements.

3. Conducted Emissions Test

3.1 Test SET-UP (Block Diagram of Configuration)



3.2 Test Condition

Test Requirement: FCC Part 15.207

Frequency Range: 150KHz ~ 30MHz

Detector: RBW 9KHz, VBW 30KHz

Operation Mode: TX

3.3 Measurement Results

Pass
Please refer to following the test plots of the worst case: Low channel.

Dongguan NTC Co., Ltd.
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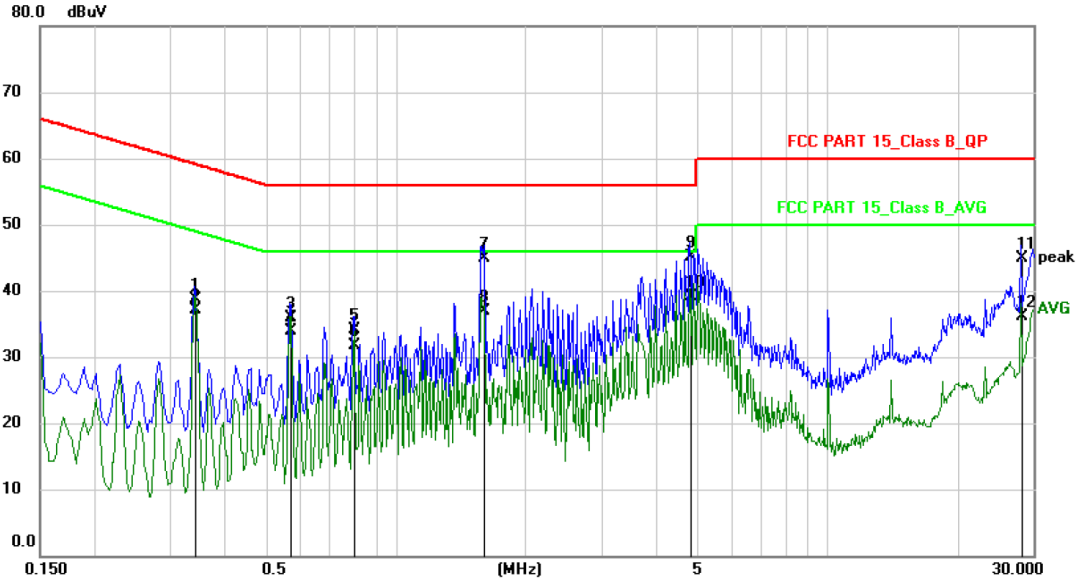
Web: Http://www.ntc-c.com

Conducted Emission Measurement

File :LINK800WS Data :#42 Date: 2020/8/17 Time: 10:35:43



Site
Limit: FCC PART 15_Class B_QP
EUT: LINK800WS
M/N: LINK800WS
Mode: TX
Note:

Phase: *L1*
Power: AC120V/60Hz

Temperature: 26
Humidity: 50 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.3420	28.09	10.61	38.70	59.15	-20.45	QP	
2		0.3420	26.59	10.61	37.20	49.15	-11.95	AVG	
3		0.5697	25.36	10.64	36.00	56.00	-20.00	QP	
4		0.5697	23.36	10.64	34.00	46.00	-12.00	AVG	
5		0.7980	23.53	10.67	34.20	56.00	-21.80	QP	
6		0.7980	21.13	10.67	31.80	46.00	-14.20	AVG	
7		1.6019	34.20	10.70	44.90	56.00	-11.10	QP	
8		1.6019	26.20	10.70	36.90	46.00	-9.10	AVG	
9		4.8018	34.49	10.71	45.20	56.00	-10.80	QP	
10	*	4.8018	28.39	10.71	39.10	46.00	-6.90	AVG	
11		28.1060	34.11	10.79	44.90	60.00	-15.10	QP	
12		28.1060	25.31	10.79	36.10	50.00	-13.90	AVG	

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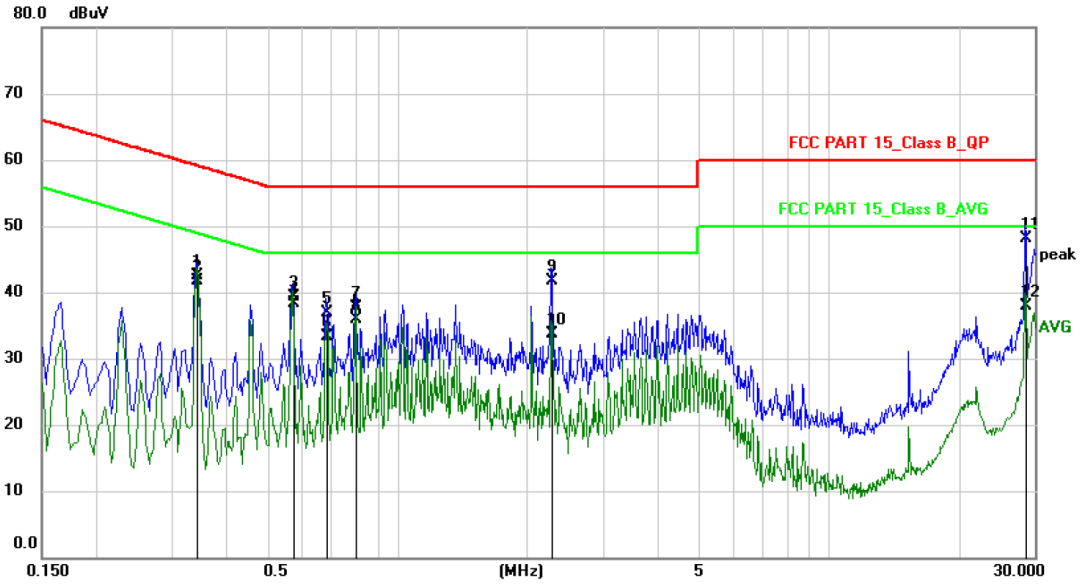
Conducted Emission Measurement

File :LINK800WS Data :#43 Date: 2020/8/17 Time: 10:42:35



Site
Limit: FCC PART 15_Class B_QP
EUT: LINK800WS
M/N: LINK800WS
Mode: TX
Note:

Phase: N
Power: AC120V/60Hz

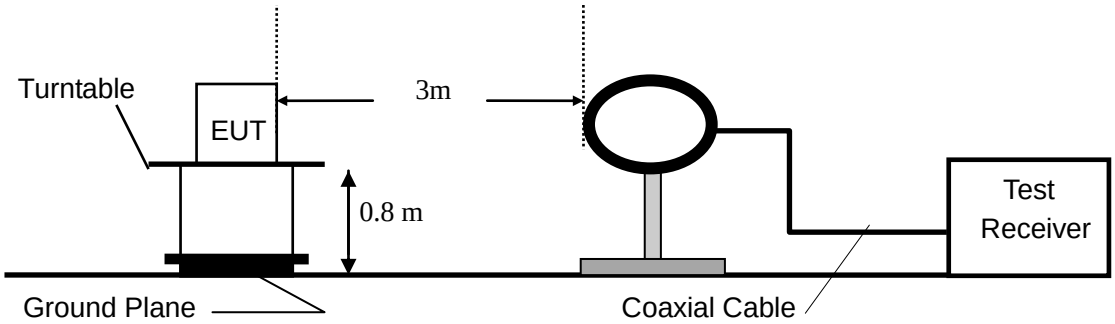
Temperature: 26
Humidity: 50 %

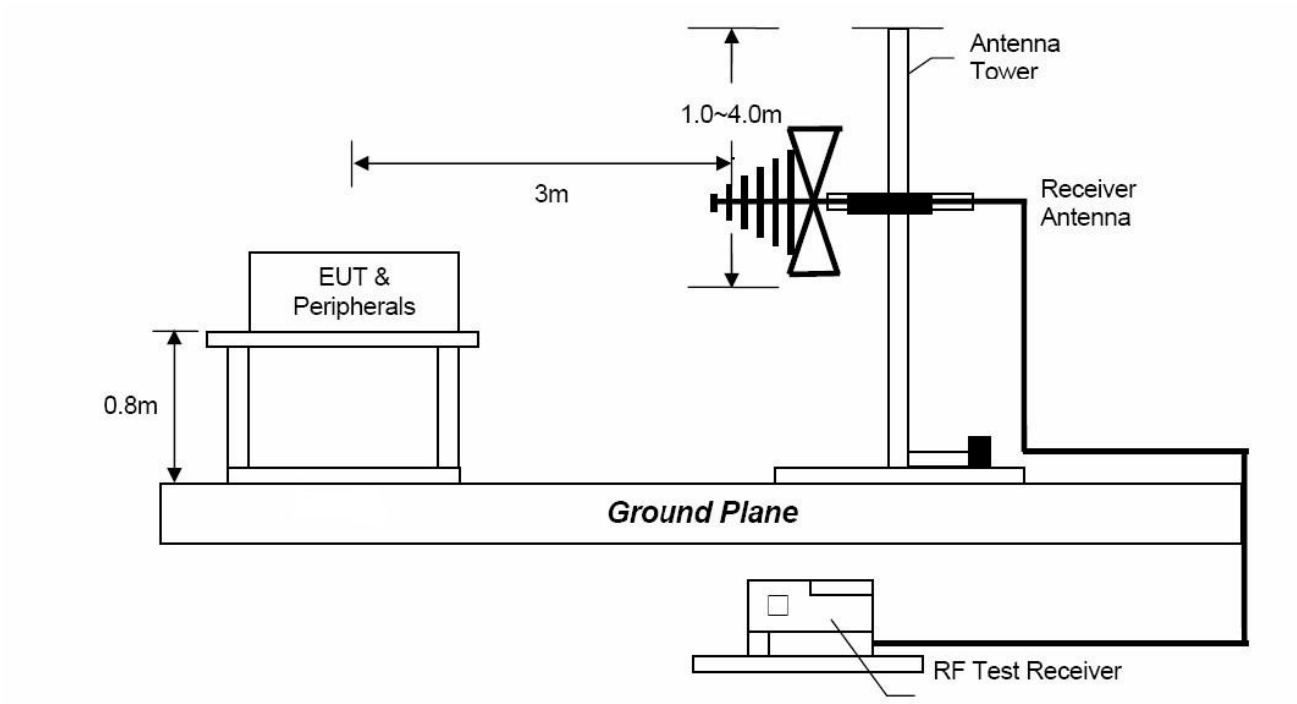
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.3420	31.99	10.61	42.60	59.15	-16.55	QP	
2	*	0.3420	31.09	10.61	41.70	49.15	-7.45	AVG	
3		0.5738	28.76	10.64	39.40	56.00	-16.60	QP	
4		0.5738	27.66	10.64	38.30	46.00	-7.70	AVG	
5		0.6860	26.35	10.65	37.00	56.00	-19.00	QP	
6		0.6860	22.75	10.65	33.40	46.00	-12.60	AVG	
7		0.8020	27.03	10.67	37.70	56.00	-18.30	QP	
8		0.8020	25.23	10.67	35.90	46.00	-10.10	AVG	
9		2.2780	31.00	10.70	41.70	56.00	-14.30	QP	
10		2.2780	23.10	10.70	33.80	46.00	-12.20	AVG	
11		28.5858	37.30	10.80	48.10	60.00	-11.90	QP	
12		28.5858	27.10	10.80	37.90	50.00	-12.10	AVG	

4. Radiated Emission Test

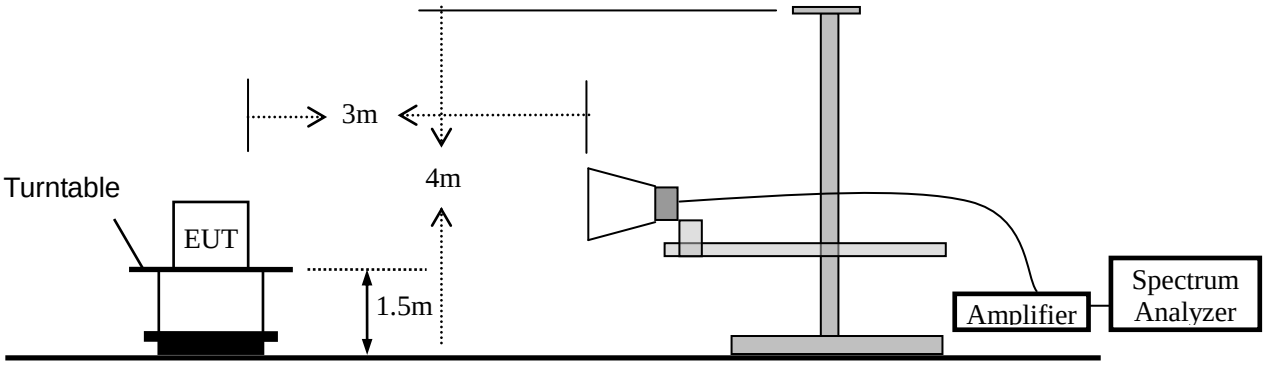
4.1 Test SET-UP (Block Diagram of Configuration)

4.1.1 Radiated Emission Test Set-Up, Frequency Below 30MHz and 30-1000MHz.





4.1.2 Radiated Emission Test Set-Up, Frequency above 1GHz



4.2 Measurement Procedure

a. Blow 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi- anechoic chamber room.
b. For the radiated emission test above 1GHz:
   The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
d. The height of antenna 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.
e. 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 and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to peak detect function and specified bandwidth with maximum hold mode.
f. A Quasi-peak measurement was then made for that frequency point for below 1GHz test. PK and AV for above 1GHz emission test.
   During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Band (MHz)	Level	Resolution Bandwidth	Video Bandwidth
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	3 MHz
	Average	1 MHz	10 Hz

4.3 Limit

Frequency range MHz	Distance Meters	Field Strengths Limit (15.209)	
		μV/m	
0.009 ~ 0.490	300	2400/F(kHz)	
0.490 ~ 1.705	30	24000/F(kHz)	
1.705 ~ 30	30	30	
30 ~ 88	3	100	
88 ~ 216	3	150	
216 ~ 960	3	200	
Above 960	3	500	
Frequency range MHz	Distance Meters	Field Strengths Limit (15.249)	
		mV/m (Field strength of fundamental)	μV/m (Field strength of Harmonics)
902 ~ 928	3	50	500
2400 ~ 2483.5	3	50	500
5725 ~ 5875	3	50	500
24000 ~ 2425000	3	250	2500

Remark : (1) Emission level (dB)μV = 20 log Emission level μV/m

(2) The smaller limit shall apply at the cross point between two frequency bands.

(3) As shown in 15.35(b), for frequencies above 1000MHz, 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 20dB under any condition of modulation.

(4) The frequency range scanned is 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 40 GHz, whichever is lower.

(5) Sample of data calculate:

Level=Reading + Factor; Margin= Level-Limit

Factor=CF+AF+AG

Where CF=Cable attenuation factor in dB

AF= Antenna factor in dB

AG=Amplifier Gain in dB

4.4 Measurement Results

Pass

Please refer to following the test plots of the worst case: Low channel.

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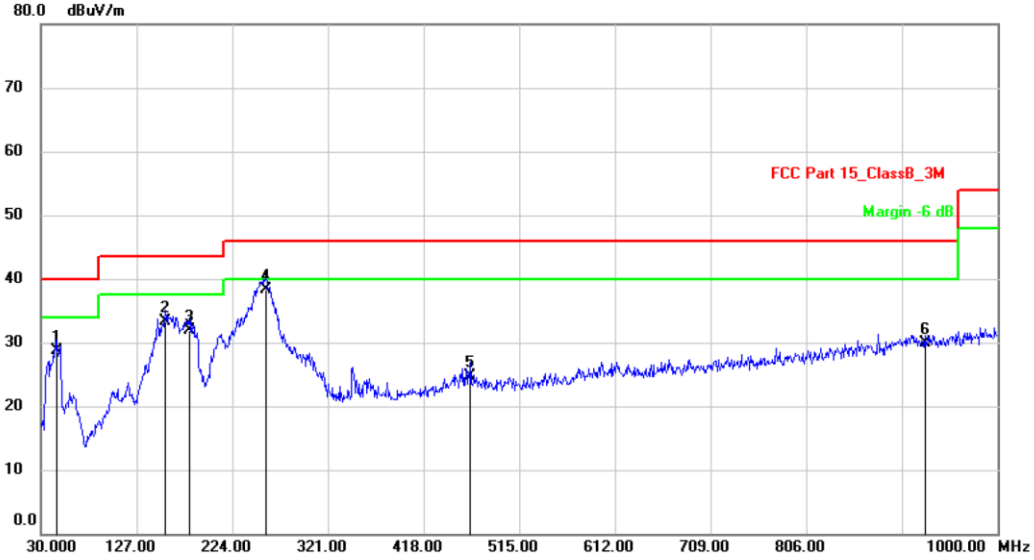
Radiated Emission Measurement

File :LINK800WS Data :#143 Date: 2020/8/28 Time: 19:19:46



Site
Limit: FCC Part 15_ClassB_3M
EUT: LINK800WS
M/N: LINK800WS
Mode: TX
Note:

Polarization: *Horizontal*
Power: AC120V/60Hz
Distance: 3m

Temperature: 26
Humidity: 47 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		45.5200	36.24	-7.56	28.68	40.00	-11.32	QP			
2		156.1000	43.87	-10.62	33.25	43.50	-10.25	QP			
3		180.3500	41.14	-9.21	31.93	43.50	-11.57	QP			
4	*	257.9500	44.45	-6.20	38.25	46.00	-7.75	QP			
5		465.5300	26.98	-2.30	24.68	46.00	-21.32	QP			
6		926.2800	23.58	6.23	29.81	46.00	-16.19	QP			

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.

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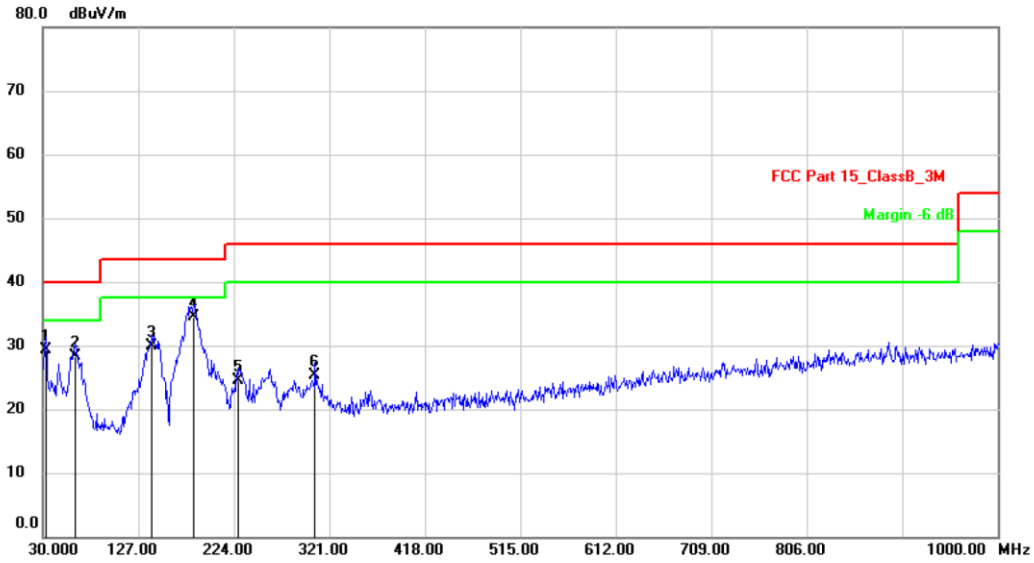
Web: Http://www.ntc-c.com

Radiated Emission Measurement

File :LINK800WS Data :#144 Date: 2020/8/28 Time: 19:26:44



Site
Limit: FCC Part 15_ClassB_3M
EUT: LINK800WS
M/N: LINK800WS
Mode: TX
Note:

Polarization: *Vertical*
Power: AC120V/60Hz
Distance: 3m

Temperature: 26
Humidity: 47 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		32.9100	38.87	-9.49	29.38	40.00	-10.62	QP			
2		62.9800	37.07	-8.68	28.39	40.00	-11.61	QP			
3		140.5800	41.35	-11.50	29.85	43.50	-13.65	QP			
4	*	183.2600	43.83	-9.30	34.53	43.50	-8.97	QP			
5		228.8500	32.58	-8.02	24.56	46.00	-21.44	QP			
6		306.4500	31.66	-6.34	25.32	46.00	-20.68	QP			

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.

Frequency Range:	1-25GHz	Test Date :	August 28, 2020
Test Result:	PASS	Temperature :	21 ℃
Measured Distance:	3m	Humidity :	55 %
Test By:	Sance		

Freq. (MHz)	Ant.Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV)		Limit 3m (dBuV/m)		Margin (dB)	
		PK	AV		PK	AV	PK	AV	PK	AV
Operation Mode: TX Mode (Low)										
2427	V	67.50	57.36	0.20	67.70	57.56	114.00	94.00	-46.30	-36.44
4854	V	52.20	42.37	6.49	58.69	48.86	74.00	54.00	-15.31	-5.14
7281	V	48.85	39.20	10.52	59.37	49.72	74.00	54.00	-14.63	-4.28

2427	H	70.68	60.38	0.20	70.88	60.58	114.00	94.00	-43.12	-33.42
4854	H	54.06	44.19	6.49	60.55	50.68	74.00	54.00	-13.45	-3.32
7281	H	50.20	39.97	10.52	60.72	50.49	74.00	54.00	-13.28	-3.51

Operation Mode: TX Mode (Mid)										
2441	V	67.05	57.04	0.24	67.29	57.28	114.00	94.00	-46.71	-36.72
4882	V	52.07	42.11	6.32	58.69	48.73	74.00	54.00	-15.31	-5.27
7323	V	47.71	31.80	10.55	58.26	48.35	74.00	54.00	-15.74	-5.65

2441	H	73.05	63.13	0.24	73.29	63.37	114.00	94.00	-40.71	-30.63
4882	H	53.96	43.85	6.62	60.58	50.47	74.00	54.00	-13.42	-3.53
7323	H	49.71	39.84	10.55	60.26	50.39	74.00	54.00	-13.74	-3.61

Operation Mode: TX Mode (High)										
2457	V	66.70	56.56	0.29	66.99	56.85	114.00	94.00	-47.01	-37.15
4914	V	52.23	41.89	6.72	58.95	48.61	74.00	54.00	-15.05	-5.39
7371	V	48.80	39.15	10.57	59.37	49.72	74.00	54.00	-14.63	-4.28

2457	H	72.80	62.98	0.29	73.09	63.27	114.00	94.00	-40.91	-30.73
4914	H	53.86	44.04	6.72	60.58	50.76	74.00	54.00	-13.42	-3.24
7371	H	50.15	39.92	10.57	60.72	50.49	74.00	54.00	-13.28	-3.51

Note: (1) All Readings are Peak Value and AV.
(2) Emission Level= Reading Level + Factor
(3) Factor= Antenna Gain + Cable Loss – Amplifier Gain
(4) Data of measurement within this frequency range shown " ---" in the table above means the reading of emissions are attenuated more than 10dB below the permissible limits.
(5) Measurement uncertainty : ±3.7dB.
(6) Horn antenna used for the emission over 1000MHz.

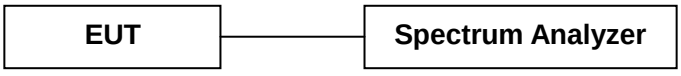
5. 20dB Bandwidth

5.1 Measurement Procedure

The 20dB bandwidth of the emission was contained within the frequency band designated which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over excepted variations in temperature and supply voltage were considered, FCC Rule 15.215(c):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

5.2 Test SET-UP (Block Diagram of Configuration)



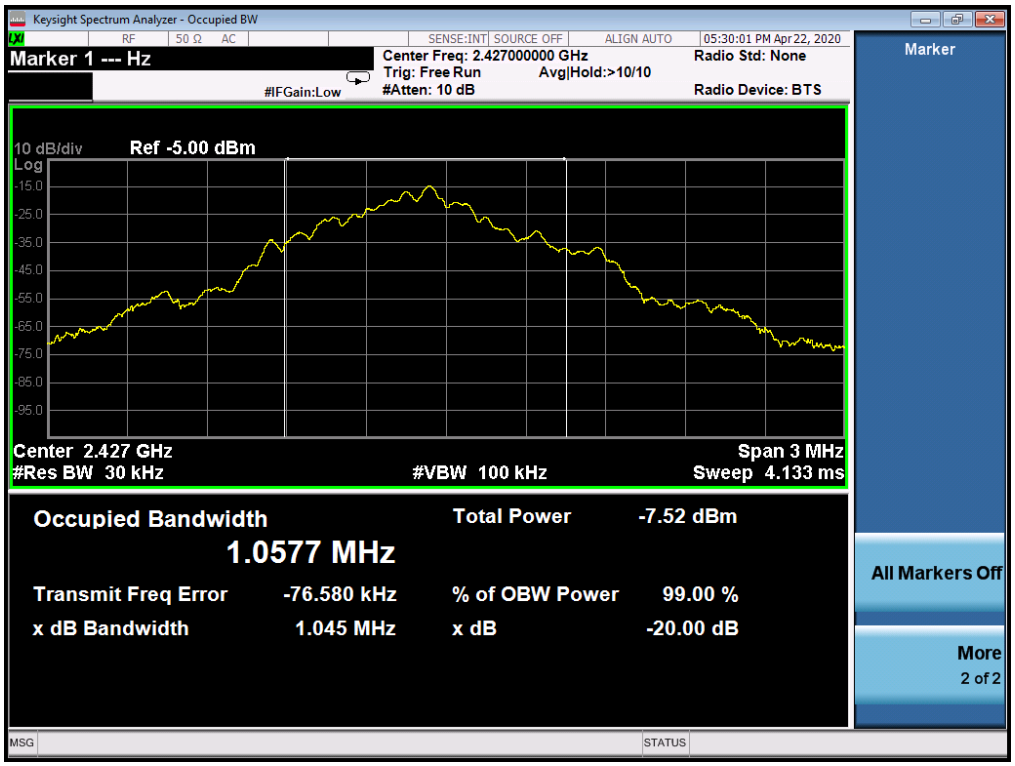
5.3 Measurement Results

Refer to attached data chart.

RBW:	30KHz	VBW:	100KHz
Spectrum Detector:	PK	Temperature :	22 ℃
Test By:	Sance	Humidity :	54 %
Test Result:	PASS	Test Date :	April 22, 2020

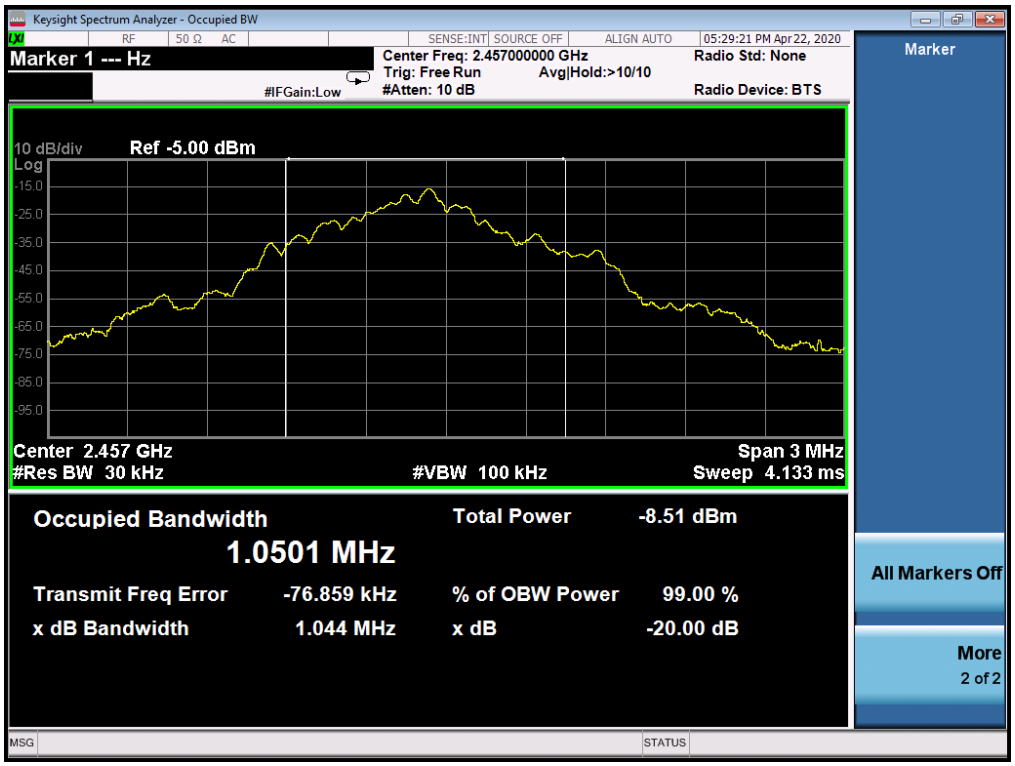
Channel frequency (MHz)	20dB Down BW(kHz)
2427	1045.0
2441	950.8
2457	1044.0

Lowest Channel



Middle Channel

Highest Channel



6. Band Edge

6.1 Measurement Procedure

Same as Radiated Emission Test.

6.2 Limit

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.

6.3 Measurement Results

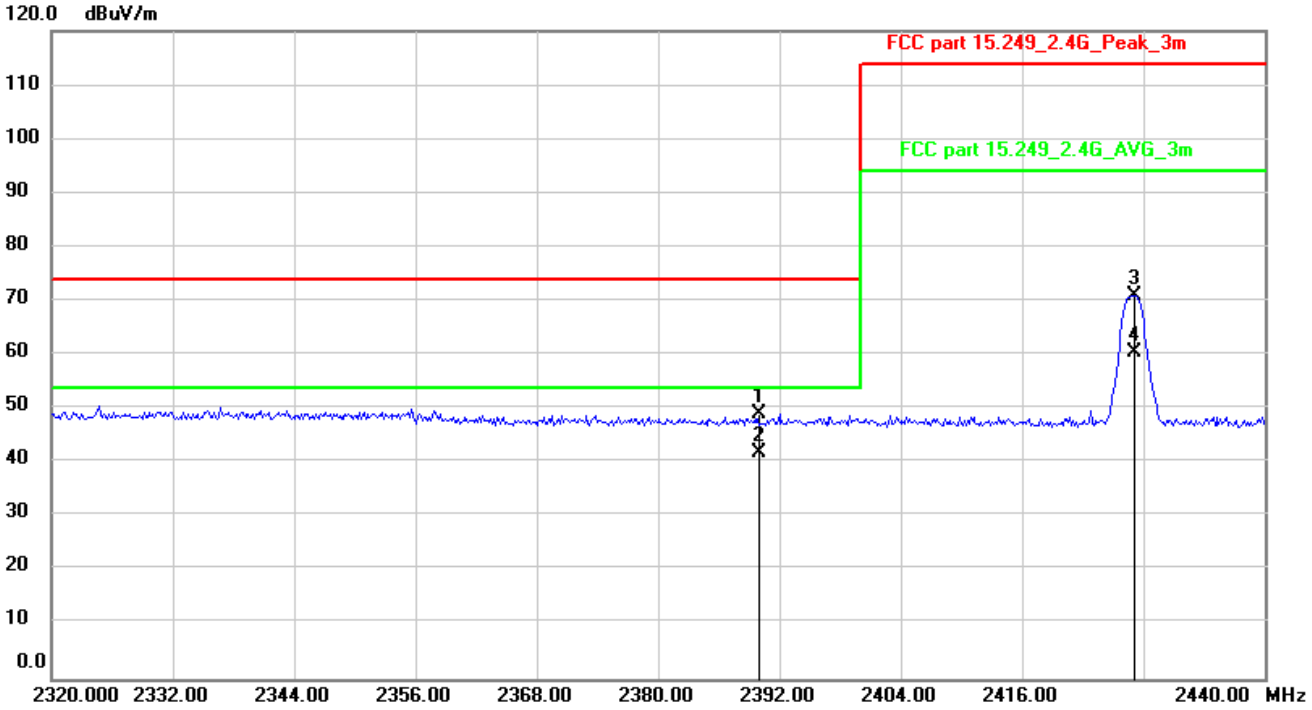
Operation Mode:	TX Mode	Test Date :	August 28, 2020
Temperature :	21 ℃	Humidity :	55 %
Test Result:	PASS	Test By:	Sance
Measured Distance:	3m		

Freq. (MHz)	Ant.Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV)		Limit 3m (dBuV/m)		Margin (dB)	
		PK	AV		PK	AV	PK	AV	PK	AV
2390.000	H	49.01	41.64	0.09	49.10	41.73	74.00	54.00	-24.90	-12.27
2390.000	V	49.70	41.43	0.09	49.79	41.52	74.00	54.00	-24.21	-12.48
2483.500	H	48.04	39.89	0.34	48.38	40.23	74.00	54.00	25.62	13.77
2483.500	V	48.23	39.82	0.34	48.57	40.16	74.00	54.00	-25.43	-13.84

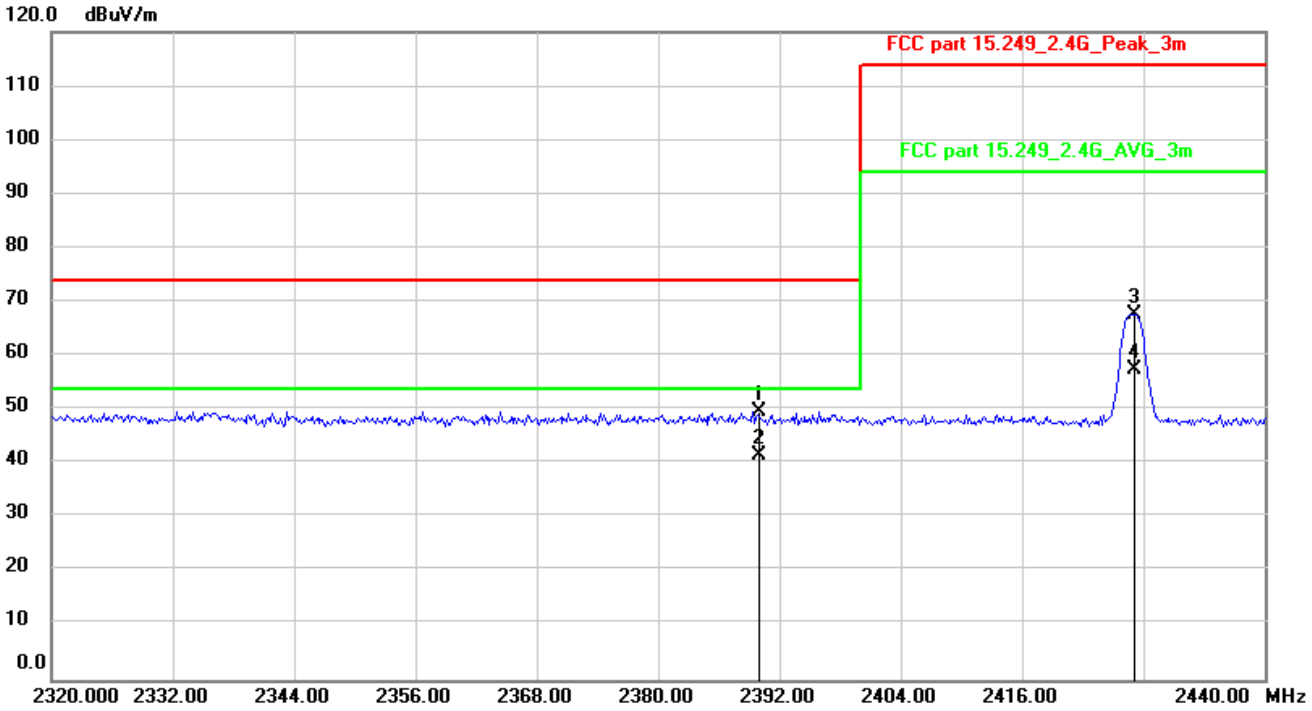
Note: (1) Emission Level= Reading Level + Factor
(2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
(3) Horn antenna used for the emission over 1000MHz.

Low channel

Horizontal

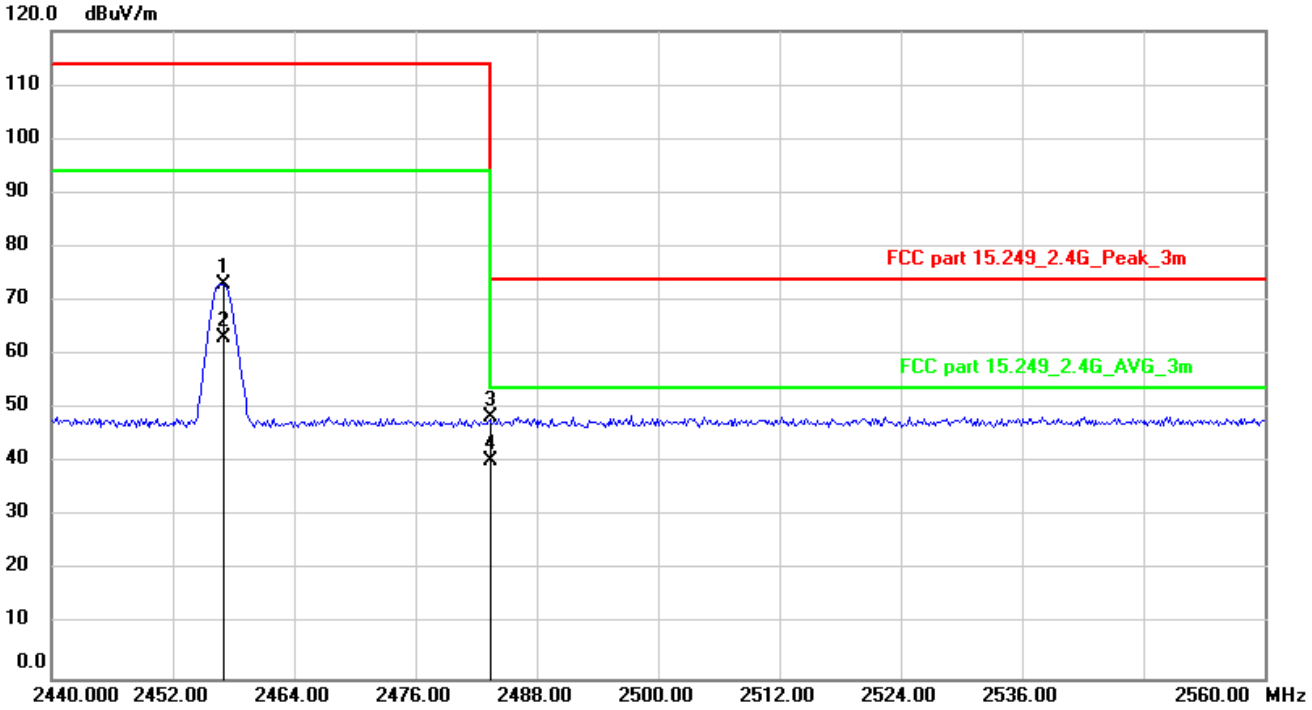


Vertical

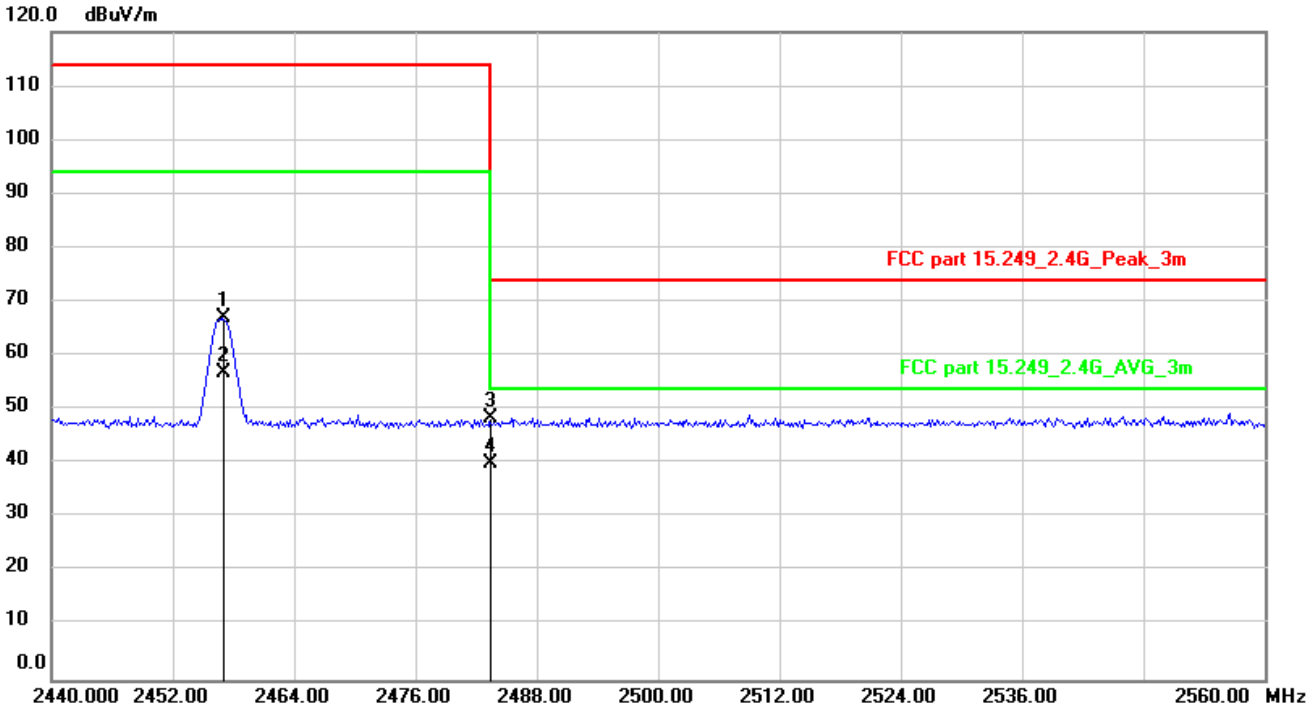


High channel

Horizontal



Vertical



7. Antenna requirement

7.1 Measurement Procedure

According to of FCC part 15C section 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, 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.

Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

7.2 Measurement Results

The antenna is PCB antenna and no consideration of replacement, and the best case gain of the antenna is -1 dBi. Therefore, the antenna is consider meet the requirement.

8. Test Equipment List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Test Receiver	Rohde & Schwarz	ESCI7	100837	Mar. 13, 2020	1 Year
2.	Antenna	Schwarzbeck	VULB9162	9162-010	Mar. 23, 2020	1 Year
3.	Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	Mar. 13, 2020	1 Year
4.	Spectrum Analyzer	Keysight	N9020A	MY54200831	Mar. 13, 2020	1 Year
5.	Spectrum Analyzer	Rohde & Schwarz	FSV40	101094	Mar. 13, 2020	1 Year
6.	Horn Antenna	Schwarzbeck	BBHA9170	9170-172	Mar. 22, 2019	2 Year
7.	Power Sensor	DARE	RPR3006W	15I00041SNO64	Mar. 13, 2020	1 Year
8.	Communication Tester	Rohde & Schwarz	CMW500	149004	Mar. 13, 2020	1 Year
9.	Horn Antenna	COM-Power	AH-118	071078	Mar. 23, 2020	1 Year
10.	Pre-Amplifier	HP	HP 8449B	3008A00964	Mar. 13, 2020	1 Year
11.	Pre-Amplifier	HP	HP 8447D	1145A00203	Mar. 13, 2020	1 Year
12.	Loop Antenna	Schwarzbeck	FMZB 1513	1513-272	Mar. 23, 2020	1 Year
13.	Test Receiver	Rohde & Schwarz	ESCI	101152	Mar. 14, 2020	1 Year
14	L.I.S.N	Rohde & Schwarz	ENV 216	101317	Mar. 13, 2020	1 Year
15	L.I.S.N	Rohde & Schwarz	ESH2-Z5	893606/014	Mar. 13, 2020	1 Year
16.	RF Switching Unit	Compliance Direction Systems Inc.	RSU-M2	38311	Mar.13, 2020	1 Year
17	Temperature & Humidity Chamber	REMAFEE	SYHR225L	N/A	Mar. 13, 2020	1 Year
18.	DC Source	Maynuo	MY8811	N/A	Mar. 13, 2020	1 Year
19.	Temporary antenna connector	TESCOM	SS402	N/A	N/A	N/A
20.	Chamber	SAEMC	9*7*7m	N/A	Jun. 20, 2019	2 Year
21.	Test Software	EZ	EZ_EMC	N/A	N/A	N/A

Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

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