FCC / ISED RF Test Report

Report No.:	FCC_IC_RF_SL20062601-PCE-001
FCC ID:	2ANUY-CEECPLUS
IC ID:	23265-CEECPLUS
Model:	CEECOACH PLUS
Received Date:	08/10/2020
Test Date:	08/17/2020 - 09/07/2020
Issued Date:	09/08/2020
Applicant:	Peiker Consumer Electronics Evolution GmbH
Address:	Gartenstraße 25, 61352 Bad Homburg vor der Höhe, Germany
Manufacturer:	Peiker Consumer Electronics Evolution GmbH
Address:	Gartenstraße 25, 61352 Bad Homburg vor der Höhe, Germany
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Lab Address:	775 Montague Expressway, Milpitas, CA 95035
FCC Registration / Designation Number:	540430
ISED# / CAB identifier:	4842D

TESTING CERT # 2742-01

Table of Contents

Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_ SL20062601-PCE-001	Original Report	09/07/2020

1 Certificate of Conformity

Product:	CEECOACH PLUS
Brand:	Peiker
Model:	CEECOACH PLUS
Sample Status:	Engineering Sample
Applicant:	Peiker Consumer Electronics Evolution GmbH
Test Date:	08/17/2020 – 09/07/2020
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) RSS-247 Issue 2, February 2017 ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Gary Chou **Date:** 09/08/2020

Gary Chou / Compliance Engineer

Approved by : Deon **Date:** 09/09/2020

Deon Dai / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.247) / ISED RSS-247 RSS 247 Issue2, RSS Gen Issue5				
FCC Clause	RSS Section(s)	Test Item	Result	Remarks
15.207	RSS-Gen [8.8]	AC Power Conducted Emission	PASS	Meet the requirement of limit.
15.247(a)(1)(iii)	RSS-Gen [8.9] RSS-247 [5.5]	Number of Hopping Frequency Used	PASS	Meet the requirement of limit.
15.247(a)(1)(iii)	RSS-247 [5.5]	Dwell Time	PASS	Meet the requirement of limit.
15.247(a)(1)	RSS-247[5.2]	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	PASS	Meet the requirement of limit.
15.247(b)	RSS-247 [5.4(4)]	Maximum Peak Output Power	PASS	Meet the requirement of limit.
15.205 & 15.209 & 15.247(d)	RSS-247 [5.2)]	Radiated Emissions & Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing QP margin.
15.247(d)	RSS-Gen [8.8]	Antenna Port Emission	PASS	Meet the requirement of limit.
15.203		Antenna Requirement	PASS	Inverted F Antenna without connector

1. If The Frequency Hopping System operating in 2400-2483.5MHz band and the output power less than 125mW. The hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of hopping channel whichever is greater.
2. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.856 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	4.638 dB
Radiated Emissions above 1 GHz	Above 1GHz	4.580dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product Name	CEECOACH PLUS
Brand	Peiker
Test Model	CEECOACH PLUS
Status of EUT	Engineering Sample
Power Input	5Vdc
Modulation Type	OQPSK
Modulation Technology	FHSS
Transfer Rate	250KHz
Operating Frequency	2405~2479MHz
Number of Channel	38
Output Power	76.612mW (18.843 dBm)
Antenna Type	2.4 GHz Inverted F Antenna
Antenna Gain	-1.1 dBi
Antenna Connector	N/A

3.2 Description of Test Modes

39 channels are provided for mode (15 Hopping Channel use Only):

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2405	20	2445				
1	2407	21	2447				
2	2409	22	2449				
3	2411	23	2451				
4	2413	24	2453				
5	2415	25	2455				
6	2417	26	2457				
7	2419	27	2459				
8	2421	28	2461				
9	2423	29	2463				
10	2425	30	2465				
11	2427	31	2467				
12	2429	32	2469				
13	2431	33	2471				
14	2433	34	2473				
15	2435	35	2475				
16	2437	36	2477				
17	2439	37	2479				
18	2441						
19	2443						

Power Setting:

Channel	Freq. (MHz)	Power Setting
0	2405	200
19	2443	200
37	2479	200

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	√	√	-

Where **RE≥1G:** Radiated Emission above 1GHz **RE<1G:** Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

NOTE:
1. The EUT had been pre-tested on the positions of each 3 axis. The worst case was found when positioned on **X-plane**.
2. "-" means no effect.

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 38	0, 19, 38	FHSS	OQPSK	-

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 38	19	FHSS	OQPSK	-

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 38	0, 19, 38	FHSS	OQPSK	-

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	5 Vac	Gary Chou
RE<1G	25deg. C, 65%RH	5 Vac	Gary Chou
APCM	21deg. C, 60%RH	5 Vac	Gary Chou

3.3 Description of Support Units

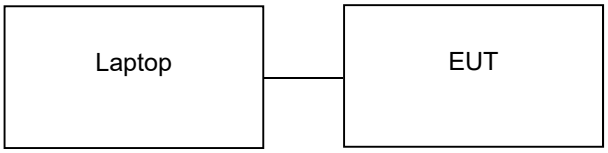
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Lenovo	4174-BB4	R9-NP0D4 12/04	QDS-BRCM1046	For control EUT

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB Cable	1	1	No	0	Connect from EUT to Laptop

Note: The core(s) is (are) originally attached to the cable(s).

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247)
KDB 558074 D01 15.247 Meas Guidance v05r02
ISED RSS-247
ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

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 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.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
PXA Signal Analyzer KEYSIGHT	N9030B	MY55330108	07/07/2020	07/07/2021
Horn Antenna ETS-Lindgren	3117	218554	11/06/2019	11/06/2020
Biconilog Antenna Sunol	JB6	A111717	08/27/2019	08/27/2020
Pre-Amplifier RF-Lambda	RAMP00M50GA	17032300048	06/18/2019	09/18/2020*

*Calibration extended by three months.

NOTE:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The horn antenna and preamplifier (model: 3117) are used only for the measurement of emission frequency above 1GHz if tested.

TEST PROCEDURES
For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Both Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. 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.

d. 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.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

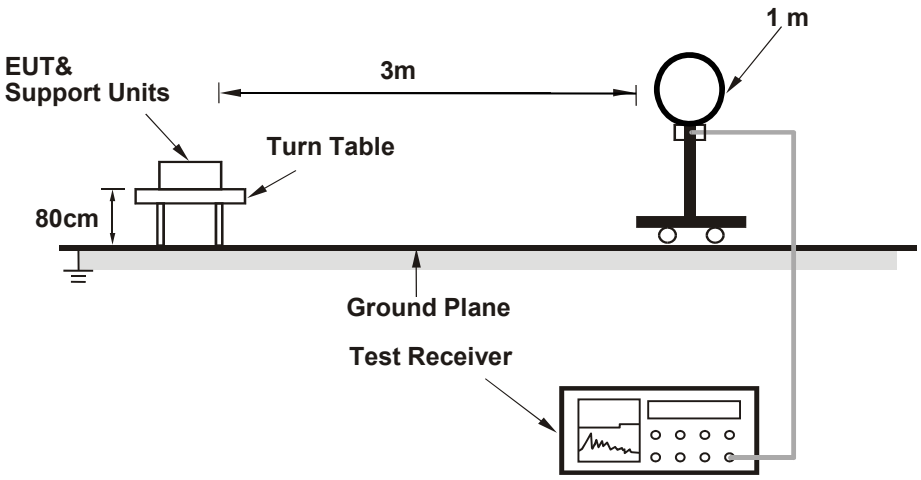
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.3 Deviation from Test Standard

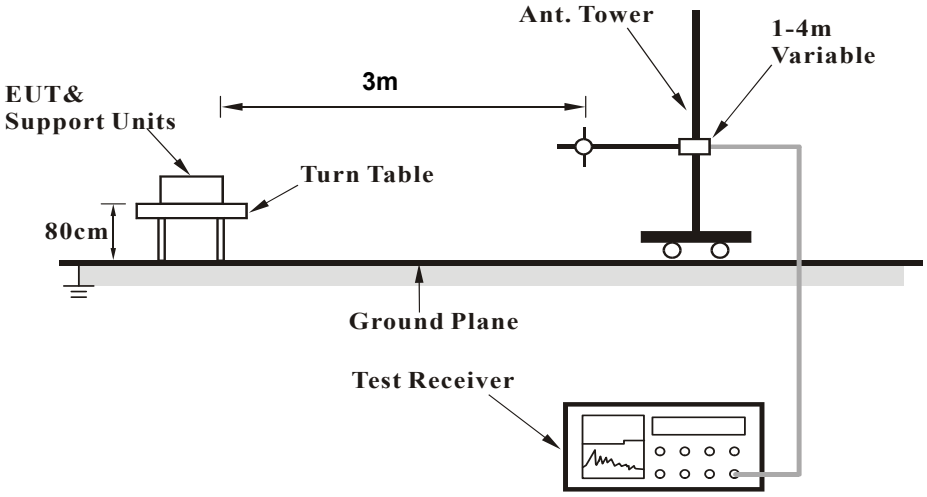
No deviation.

4.1.4 Test Setup

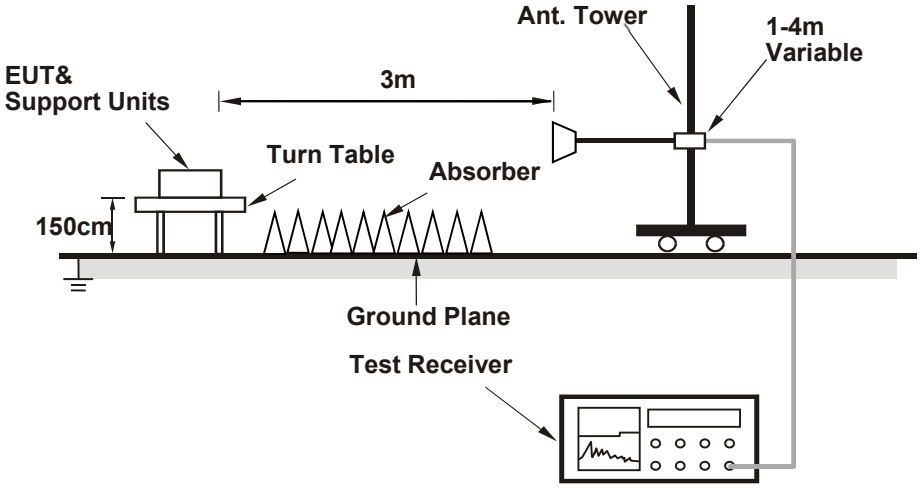
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.5 EUT Operating Conditions

a. Connected the EUT with the Notebook Computer which is placed on remote site.
b. Controlling software has been activated to set the EUT on specific status.

4.1.6 Test Results

Above 1GHz Data:

CHANNEL	TX MODE 2405 MHz	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	4809.280	V	38.2	50.3	-1.9	36.3	48.4	54	74	-17.7	-25.6	108	72.6	Pass
2	4808.935	H	37.2	49.6	-1.9	35.3	47.7	54	74	-18.7	-26.3	172	33.4	Pass
3	7214.283	V	28.3	41.4	2.9	31.2	44.3	54	74	-22.8	-29.7	201	22.6	Pass
4	7213.382	H	28.2	41.3	2.9	31.1	44.2	54	74	-22.9	-29.8	144	149.7	Pass
5	9618.981	V	27.3	40.7	6.1	33.4	46.8	54	74	-20.6	-27.2	108	63.1	Pass
6	9620.909	H	27.2	41.1	6.1	33.3	47.2	54	74	-20.7	-26.8	108	64.8	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

CHANNEL	TX MODE 2443 MHz	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	4886.3	V	39.2	50.3	-2.2	37	48.1	54	74	-17	-25.9	225	77.3	Pass
2	4886.2	H	38.6	49.7	-2.2	36.4	47.5	54	74	-17.6	-26.5	247	25.7	Pass
3	7329.5	V	29.5	42.6	2.6	32.1	45.2	54	74	-21.9	-28.8	106	24	Pass
4	7329.4	H	28.4	41.5	2.6	31	44.1	54	74	-23	-29.9	332	261.1	Pass
5	9772.4	V	26.3	39.4	6.4	32.7	45.8	54	74	-21.3	-28.2	302	359.1	Pass
6	9772.4	H	26.8	39.1	6.4	33.2	45.5	54	74	-20.8	-28.5	214	217.8	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

CHANNEL	TX MODE 2479 MHz	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	4962.969	V	39.8	50.4	-2	37.8	48.4	54	74	-16.2	-25.6	222	70.3	Pass
2	4962.937	H	38.7	49.9	-2	36.7	47.9	54	74	-17.3	-26.1	215	28.7	Pass
3	7443.18	V	29.8	42.9	3.1	32.9	46	54	74	-21.1	-28.0	102	0	Pass
4	7441.397	H	28.5	41.8	3.1	31.6	44.9	54	74	-22.4	-29.1	339	250.1	Pass
5	9924.624	V	26.1	39.6	6.8	32.9	46.4	54	74	-21.1	-27.6	308	359.1	Pass
6	9924.254	H	26.4	39.5	6.8	33.2	46.3	54	74	-20.8	-27.7	215	203.8	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

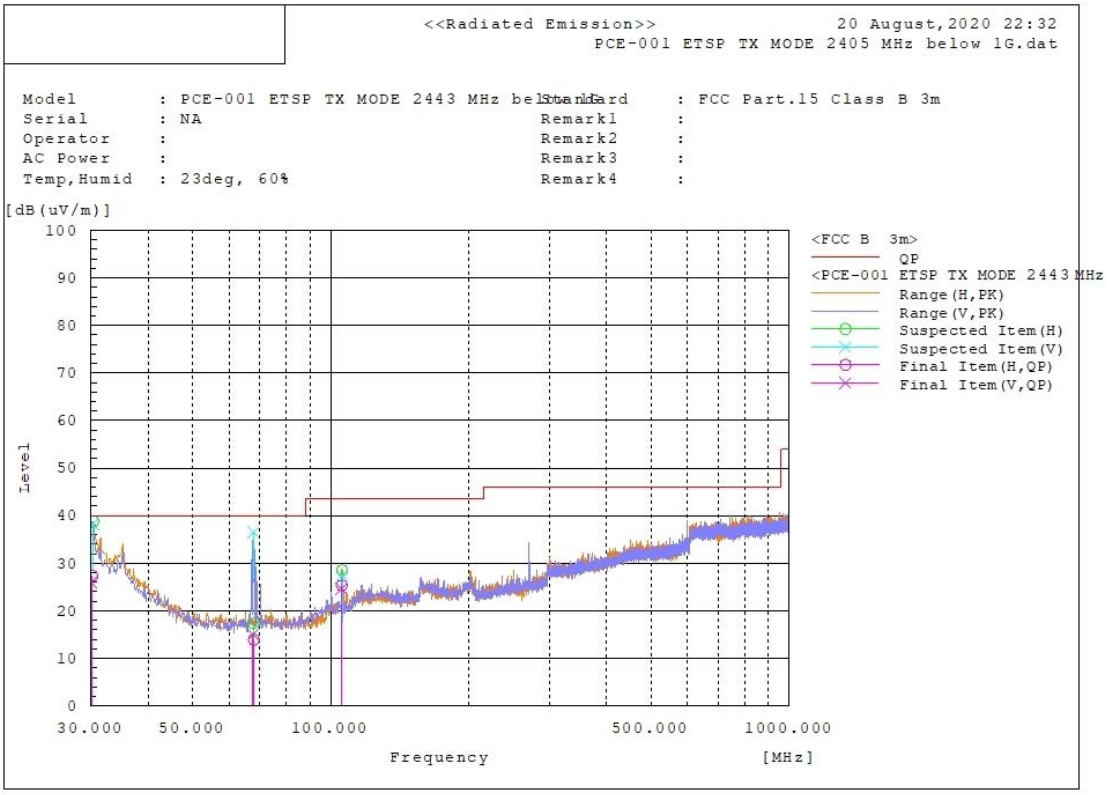
Below 1GHz Data:

CHANNEL	TX MODE 2443 MHz	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	30.182	H	0.5	26.8	27.3	40	12.7	Pass	197	Pass
2	30.069	V	0.5	25.5	26	40	14	Pass	255	Pass
3	67.588	V	2	13	15	40	25	Pass	100	Pass
4	67.956	H	0.6	13.4	14	40	26	Pass	185	Pass
5	105.71	V	7.7	16.9	24.6	43.5	18.9	Pass	100	Pass
6	105.697	H	7.7	17.7	25.4	43.5	18.1	Pass	303	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)



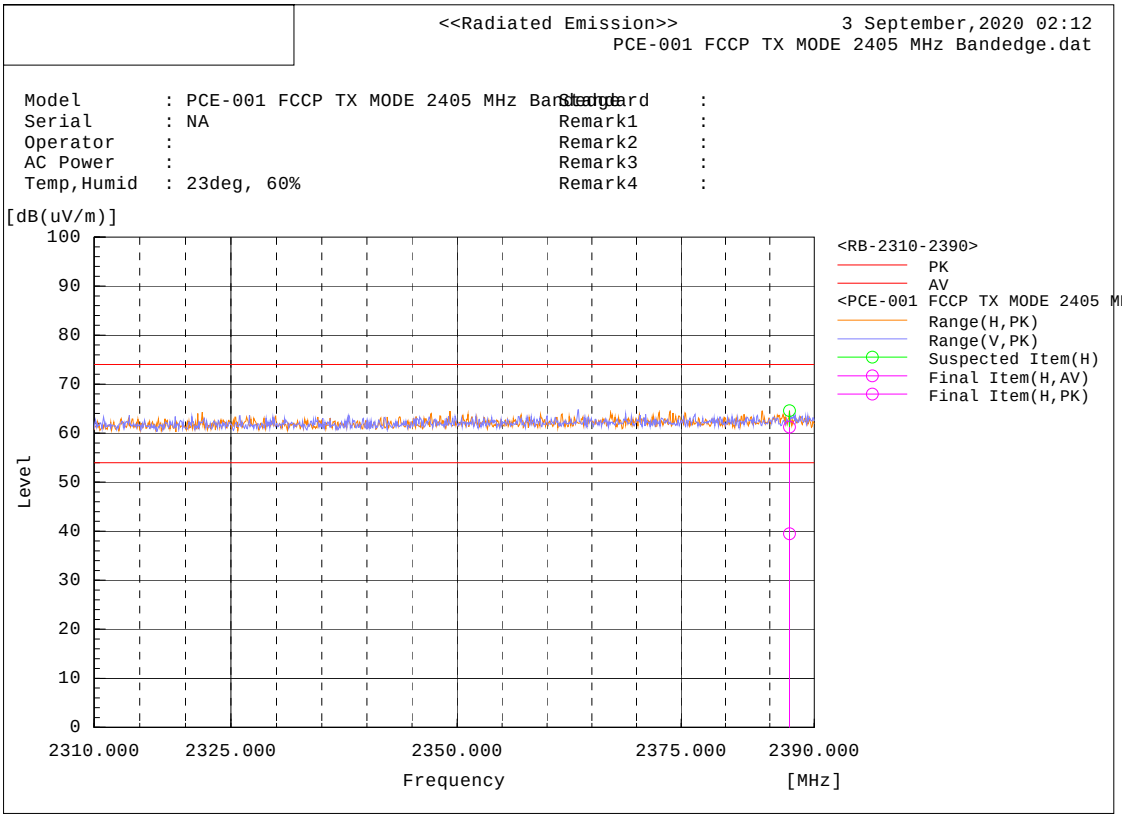
RESTRICTED BAND

CHANNEL	TX MODE 2405 MHz	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	2310MHz-2390MHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	2387.2	H	0.4	22.2	39.1	39.5	61.3	54	74	-14.5	-12.7	197	162.2	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)



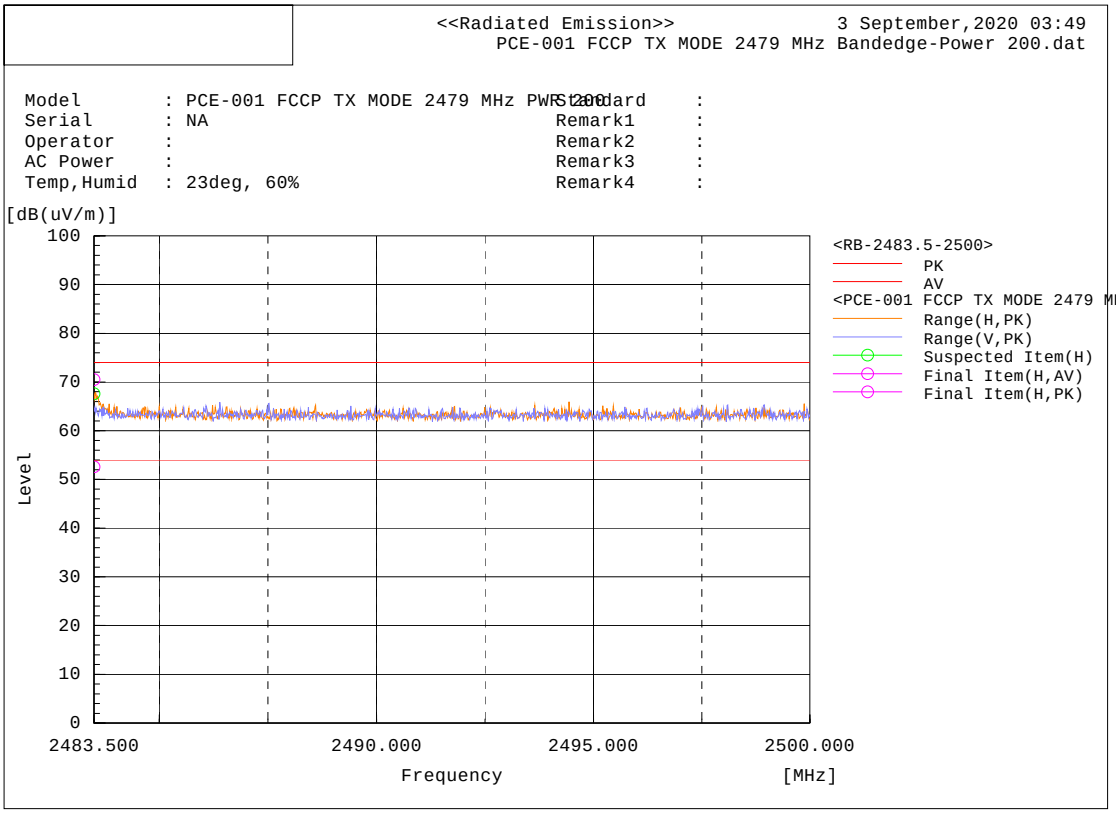
RESTRICTED BAND

CHANNEL	TX MODE 2479 MHz	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	2483.5MHz-2500MHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	2483.5	H	13	30.9	39.6	52.6	70.5	54	74	-1.4	-3.5	188	249.8	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)



4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

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

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
EMI Test Receiver Rohde & Schwarz	ESIB 40	100179	11/01/2019	11/01/2020
Transient Limiter Electro-Metrics	EM-7600-5	106	12/31/2019	12/31/2020
LISN ETS-Lindgren	3816/2NM	214372	1/14/2020	1/14/2021

NOTE: N/A

4.2.3 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

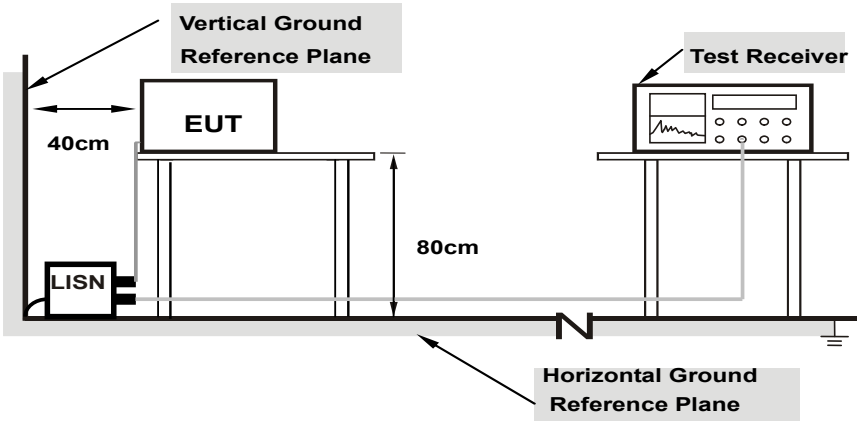
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation From Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Condition

Same as 4.1.6.

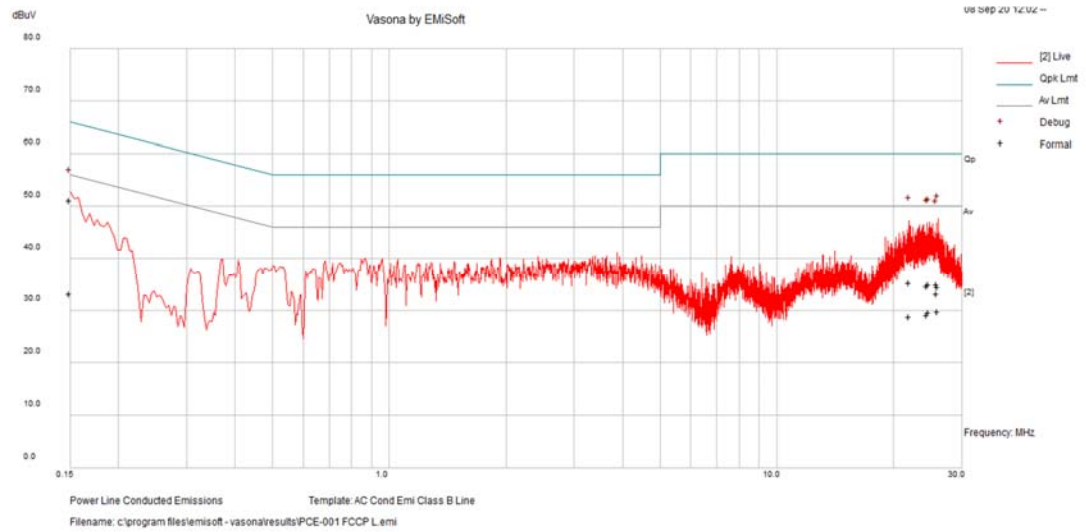
4.2.7 Test Results

Frequency Range	0.15-30 MHz	Phase	Line
Input Power	120 Vac, 60 Hz	Environmental Conditions	24 °C, 50% RH
Tested by	Gary Chou	Test Date	09/08/2020
Test Mode	Mode 1		

No	Frequency (MHz)	Reading Value (dBuV)	Cable Loss (dB)	Insertion Loss (dB)	Emission Level Corrected (dBuV)	Measurement Type	Line/ Neutral	Limit (dBuV)	Margin (dB)	Pass/ Fail
1	26.087545	23.97	9.87	0.6	34.45	Quasi Peak	Line	60	-25.55	Pass
2	21.970525	24.87	9.78	0.54	35.18	Quasi Peak	Line	60	-24.82	Pass
3	24.704226	24.53	9.82	0.58	34.94	Quasi Peak	Line	60	-25.06	Pass
4	24.412583	24.2	9.83	0.58	34.61	Quasi Peak	Line	60	-25.39	Pass
5	0.15	41.75	9.29	0.04	51.08	Quasi Peak	Line	66	-14.92	Pass
6	25.867794	24.43	9.86	0.6	34.89	Quasi Peak	Line	60	-25.11	Pass
7	26.087545	19.32	9.87	0.6	29.8	Average	Line	50	-20.2	Pass
8	21.970525	18.5	9.78	0.54	28.82	Average	Line	50	-21.18	Pass
9	24.704226	19.19	9.82	0.58	29.6	Average	Line	50	-20.4	Pass
10	24.412583	18.62	9.83	0.58	29.02	Average	Line	50	-20.98	Pass
11	0.15	23.86	9.29	0.04	33.19	Average	Line	56	-22.81	Pass
12	25.867794	22.66	9.86	0.6	33.12	Average	Line	50	-16.88	Pass

Remarks:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level – Limit value
3. Correction factor = Insertion loss + Cable loss
4. Emission Level = Correction Factor + Reading Value

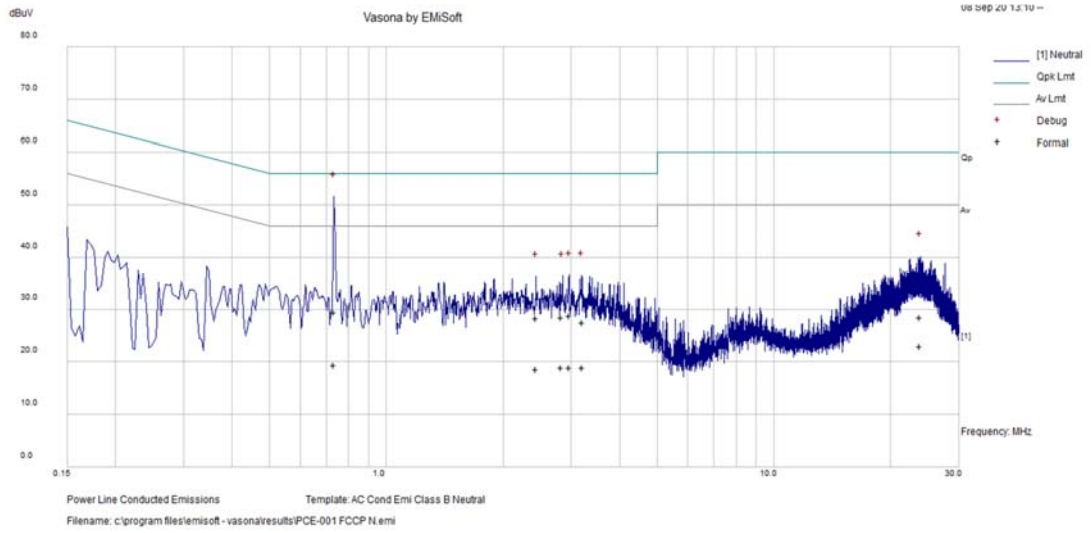


Frequency Range	0.15-30 MHz	Phase	Neutral
Input Power	120 Vac, 60 Hz	Environmental Conditions	24 °C, 50% RH
Tested by	Gary Chou	Test Date	09/08/2020
Test Mode	Mode 1		

No	Frequency (MHz)	Reading Value (dBuV)	Cable Loss (dB)	Insertion Loss (dB)	Emission Level Corrected (dBuV)	Measurement Type	Line/ Neutral	Limit (dBuV)	Margin (dB)	Pass/ Fail
1	0.731591	19.97	9.47	0.03	29.46	Quasi Peak	Neutral	56	-26.54	Pass
2	2.973349	19.22	9.52	0.05	28.79	Quasi Peak	Neutral	56	-27.21	Pass
3	3.20891	17.97	9.53	0.05	27.56	Quasi Peak	Neutral	56	-28.44	Pass
4	2.8329	18.95	9.51	0.05	28.51	Quasi Peak	Neutral	56	-27.49	Pass
5	2.442569	18.69	9.49	0.05	28.23	Quasi Peak	Neutral	56	-27.77	Pass
6	23.873152	18.09	9.83	0.61	28.53	Quasi Peak	Neutral	60	-31.47	Pass
7	0.731591	9.86	9.47	0.03	19.35	Average	Neutral	46	-26.65	Pass
8	2.973349	9.27	9.52	0.05	18.84	Average	Neutral	46	-27.16	Pass
9	3.20891	9.26	9.53	0.05	18.84	Average	Neutral	46	-27.16	Pass
10	2.8329	9.41	9.51	0.05	18.97	Average	Neutral	46	-27.03	Pass
11	2.442569	9.04	9.49	0.05	18.58	Average	Neutral	46	-27.42	Pass
12	23.873152	12.57	9.83	0.61	23.00	Average	Neutral	50	-27.00	Pass

Remarks:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level – Limit value
3. Correction factor = Insertion loss + Cable loss
4. Emission Level = Correction Factor + Reading Value

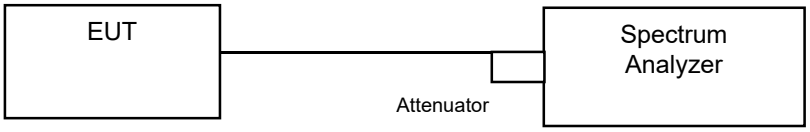


4.3 Number of Hopping Frequency Used

4.3.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.

c. Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.

d. Set the SA on View mode and then plot the result on SA screen.

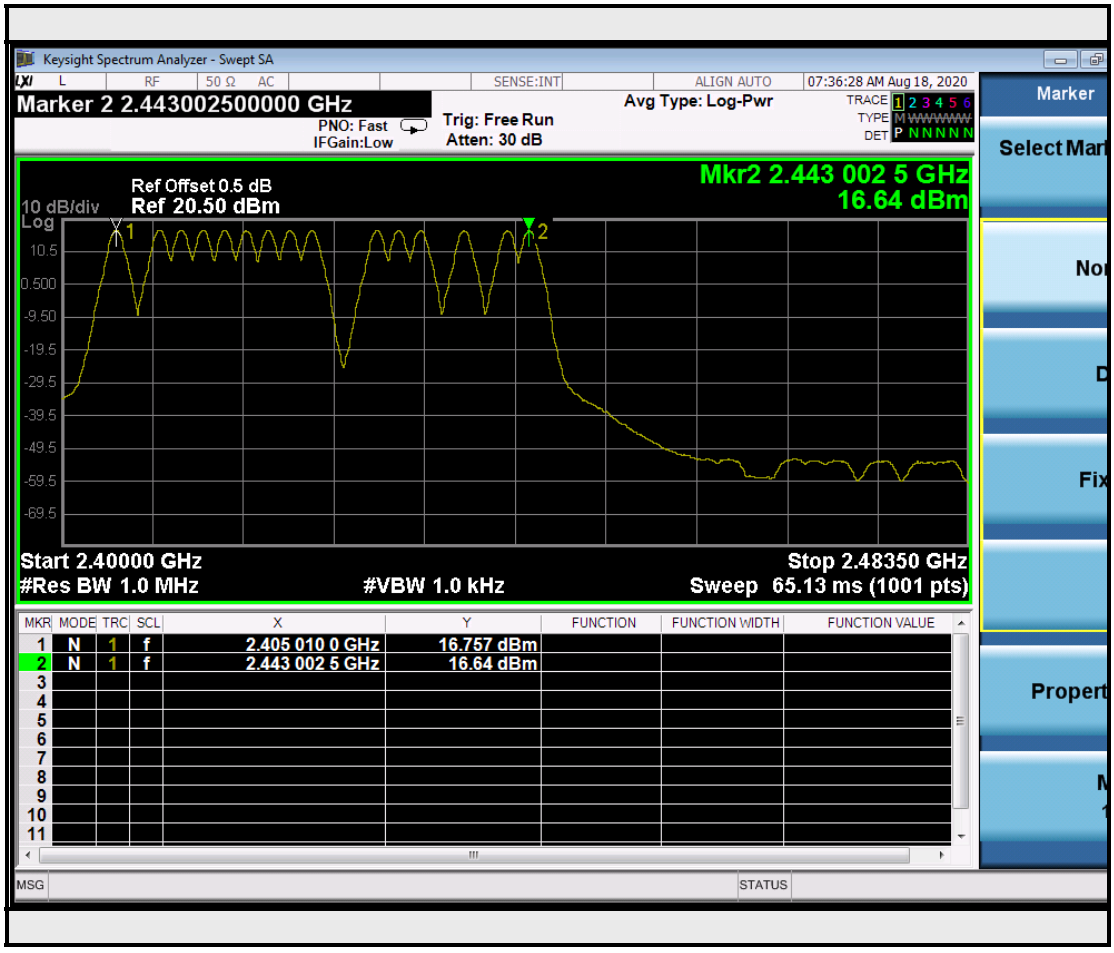
e. Repeat above procedures until all frequencies measured were complete.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 Test Results

There are 15 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.

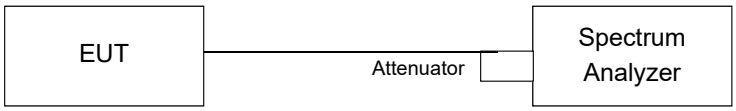

Keysight Spectrum Analyzer - Swept SA
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
07:36:28 AM Aug 18, 2020
Marker 2 2.443002500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P N N N N N
Ref Offset 0.5 dB
10 dB/div
Log
Ref 20.50 dBm
Mkr2 2.443 002 5 GHz
16.64 dBm
10.5
0.500
-9.50
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
Start 2.40000 GHz
#Res BW 1.0 MHz
#VBW 1.0 kHz
Stop 2.48350 GHz
Sweep 65.13 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.405 010 0 GHz 16.757 dBm
2 N 1 f 2.443 002 5 GHz 16.64 dBm
Marker
Select Mark
Norm
Delta
Fix
Propert
MSG
STATUS

4.4 Dwell Time on Each Channel

4.4.1 Limits of Dwell Time on Each Channel Measurement

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedures

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
d. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
e. Repeat above procedures until all different time-slot modes have been completed.

.

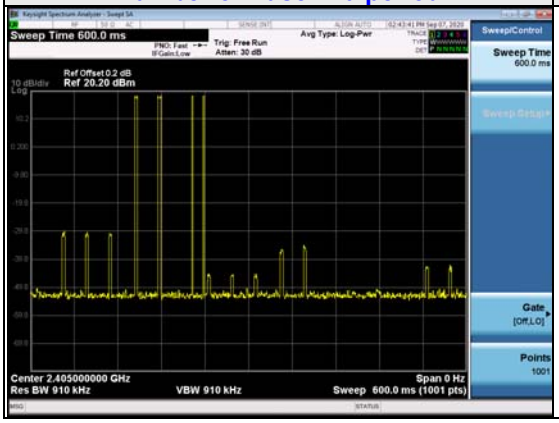
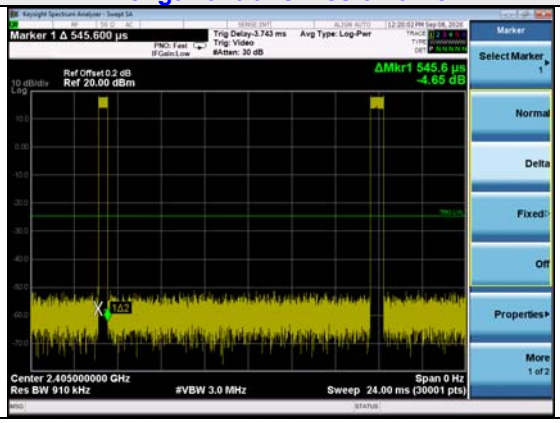
4.4.5 Deviation from Test Standard

No deviation.

4.4.6 Test Results

Number Of Hopping Channel	Number of Puse in a period	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Result
15	4	0.5450	0.0872	0.4000	Pass

Test Plot:

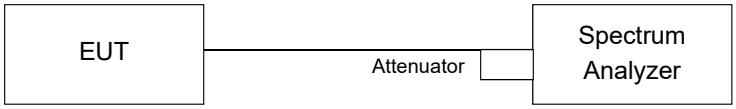
Number of Puse in a period	Length of transmission time
	

4.5 Channel Bandwidth

4.5.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5MHz, If the 20dB bandwidth of hopping channel is greater than 25kHz, two-thirds 20dBbandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
c. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

4.5.5 Deviation from Test Standard

No deviation.

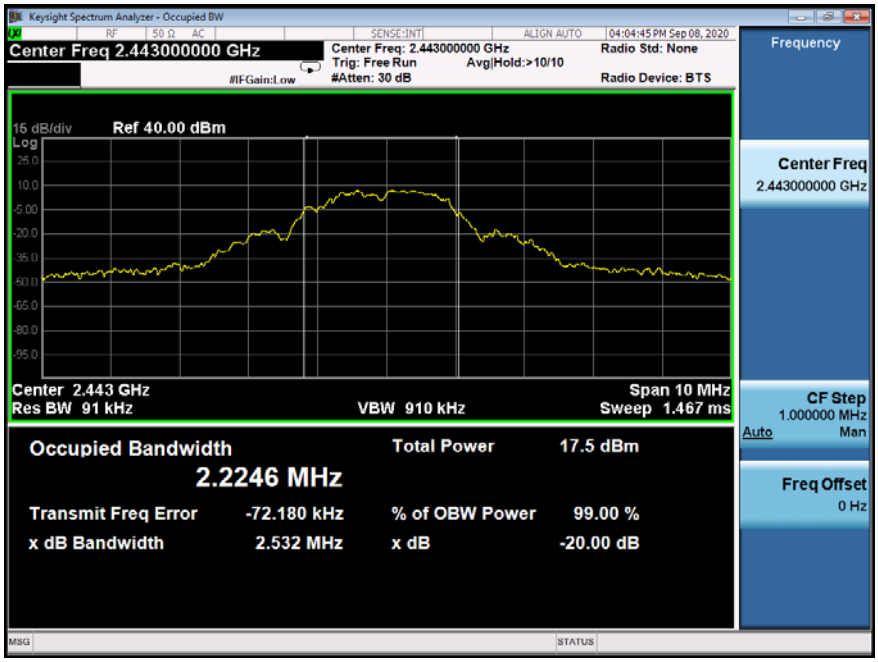
4.5.6 EUT Operating Condition

The software provided by client enabled the EUT to Test mode and transmit and receive data at lowest, middle and highest channel frequencies individually.

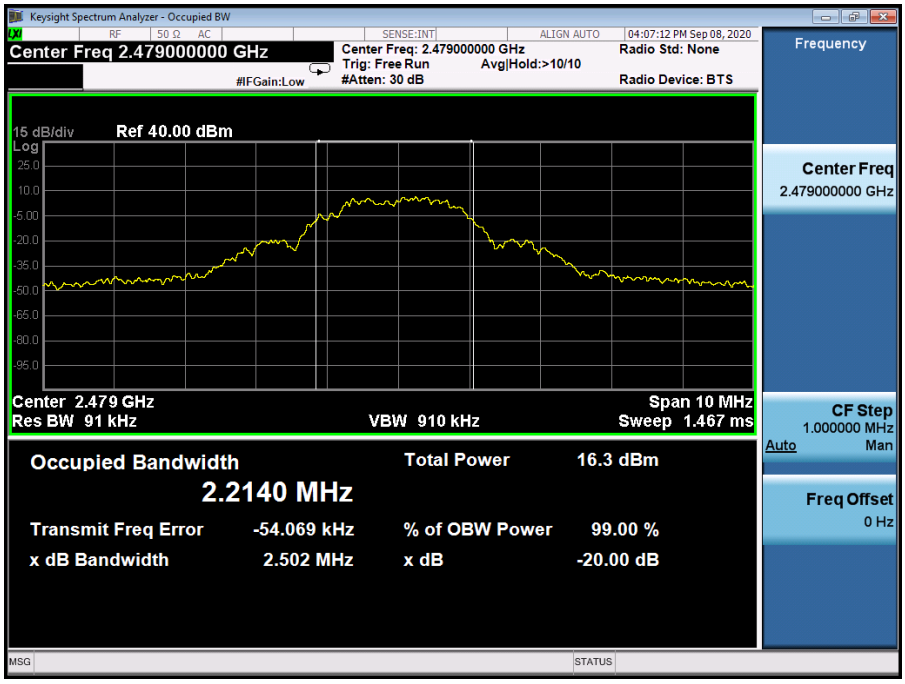
4.5.7 Test Results

Channel	Frequency (MHz)	-20dB Bandwidth (MHz)	Limit	Result
0	2405	2.485	-	Pass
19	2443	2.532	-	Pass
37	2479	2.502	-	Pass

2405MHz



2443MHz


Keysight Spectrum Analyzer - Occupied BW
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
04:07:12 PM Sep 08, 2020
Center Freq 2.479000000 GHz
Center Freq: 2.479000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#IFGain:Low
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Frequency
15 dB/div
Log
Ref 40.00 dBm
25.0
10.0
-5.00
-20.0
-35.0
-50.0
-65.0
-80.0
-95.0
Center Freq
2.479000000 GHz
Center 2.479 GHz
Res BW 91 kHz
VBW 910 kHz
Span 10 MHz
Sweep 1.467 ms
CF Step
1.000000 MHz
Auto
Man
Freq Offset
0 Hz
Occupied Bandwidth
2.2140 MHz
Total Power
16.3 dBm
Transmit Freq Error
-54.069 kHz
% of OBW Power
99.00 %
x dB Bandwidth
2.502 MHz
x dB
-20.00 dB
MSG
STATUS

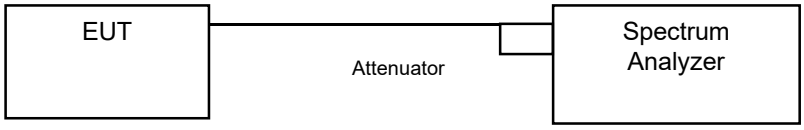
2479MHz

4.6 Hopping Channel Separation

4.6.1 Limits of Hopping Channel Separation Measurement

At least 25kHz or two-third of 20dB hopping channel bandwidth (whichever is greater).

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

Measurement Procedure REF

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.

c. By using the MaxHold function record the separation of two adjacent channels.

d. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.

e. Repeat above procedures until all frequencies measured were complete.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 Test Results

Adjacent Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
2.016	2.485	1.66	Pass

NOTE: The minimum limit is two-third 20dB bandwidth.

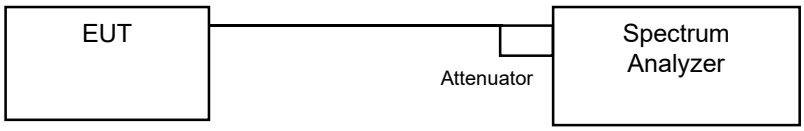
Spectrum Plots

4.7 Maximum Output Power

4.7.1 Limits of Maximum Output Power Measurement

The Maximum Output Power Measurement is 0.125W.

4.7.2 Test Setup



4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.4 Test Procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.

c. The center frequency of the spectrum analyzer is set to the fundamental frequency and using 1MHz RBW and 3 MHz VBW.

d. Measure the captured power within the band and recording the plot.

e. Repeat above procedures until all frequencies required were complete.

4.7.5 Deviation from Test Standard

No deviation.

4.7.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.7.7 Test Results

Channel	Frequency (MHZ)	Output Power (W)	Output Power (dBm)	Power Limit (W)	Pass / Fail
0	2405	0.0766	18.843	0.125	Pass
19	2443	0.0753	18.771	0.125	Pass
37	2479	0.0759	18.805	0.125	Pass

Spectrum Plot of Worst Value

2405 MHz

2443 MHz

2479 MHz

4.8 Conducted Out of Band Emission Measurement

4.8.1 Limits of Conducted Out of Band Emission Measurement

Below –20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.8.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.8.3 Test Procedure

The transmitter output was connected to the spectrum analyzer via a low loss cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

4.8.4 Deviation from Test Standard

No deviation.

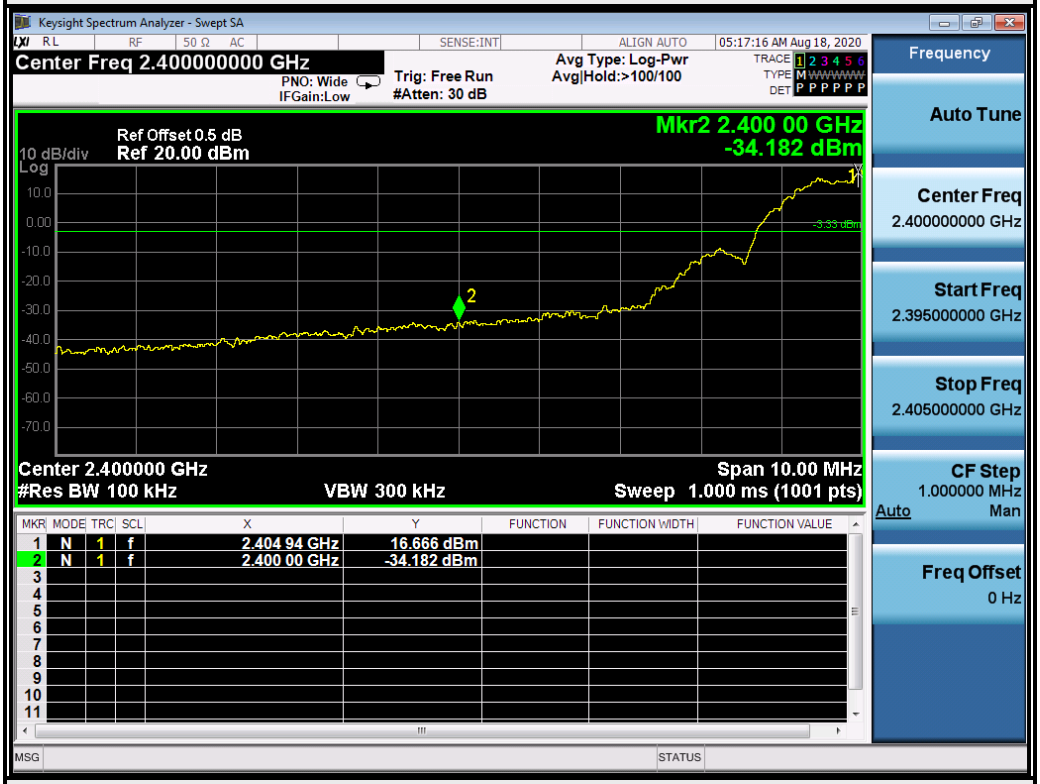
4.8.5 EUT Operating Condition

The software provided by client enabled the EUT to test mode and transmit and receive data at lowest, middle and highest channel frequencies individually.

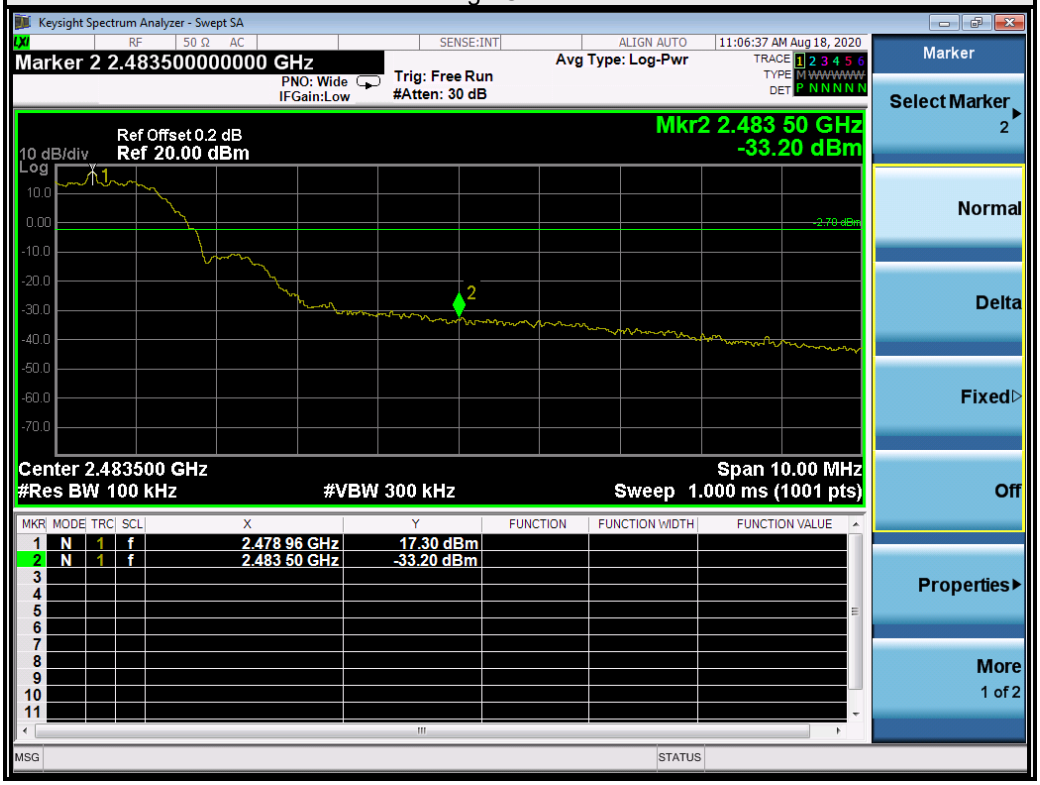
4.8.6 Test Results

The spectrum plots are attached on the following images. D1 line indicates the highest level, Mark 2 indicates the 20dB offset below D1. It shows compliance with the requirement.

Low Channel



High Channel



5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

Milpitas EMC/RF/Safety/Telecom Lab
775 Montague Expressway, Milpitas, CA 95035
Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab
1293 Anvilwood Avenue, Sunnyvale, CA 94089
Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab
1 Distribution Center Cir #1, Littleton, MA 01460
Tel: +1 978 486 8880

Email: sales.eaw@us.bureauveritas.com
Web Site: www.cpsusa-bureauveritas.com

The address and road map of all our labs can be found in our web site also.

--- END ---