

FCC IC Test Report

Report No.: FCC_IC_RF_SL20061501-CRE-008_BLE_2M_Rev 1.0

FCC ID: EROZUMLINK-KP

IC: 5683C-ZUMLINKKP

Test Model: M201937001

Received Date: 12/07/2020

Test Date: 12/16/2020 - 09/03/2021

Issued Date: 09/03/2021

Applicant: Crestron Electronics, Inc.

Address: 15 Volvo DrRockleigh, NJ 07647, USA

Manufacturer: Crestron Electronics, Inc.

Address: 15 Volvo DrRockleigh, NJ 07647, USA

Issued By: Bureau Veritas Consumer Products Services, Inc.

Lab Address: 775 Montague Expressway, Milpitas, CA 95035

Test Location (1): 775 Montague Expressway, Milpitas, CA 95035



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Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_SL20061501-CRE-008_BLE_2M	Original Release	07/01/2021
FCC_IC_RF_SL20061501-CRE-008_BLE_1M_Rev 1.0	Update all test item	09/03/2021

1 Certificate of Conformity

Product: ZUM Keypad

Brand: Crestron Electronics

Test Model: M201937001


Sample Status: Engineering sample

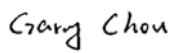
Applicant: Crestron Electronics, Inc.

Test Date: 12/16/2020 - 09/03/2021

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)
RSS-247 Issue 2, February 2017
ANSI C63.10: 2013
RSS-Gen Issue 5, March 2019
558074 D01 15.247 Meas Guidance v05r02

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 :  _____, **Date:** 07/01/2021
Ellen Chu / Test Engineer


Approved by : _____, **Date:** 09/03/2021
Gary Chou / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247)			
FCC / IC Clause	Test Item	Result	Remarks
15.207 RSS Gen 8.8	AC Power Conducted Emission	NA	EUT is DC powered.
15.205 &15.209 & 15.247(d) RSS 247 5.5C	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit.
15.247(a)(2) RSS 247 5.2.1	6dB bandwidth & 99% bandwidth	PASS	Meet the requirement of limit.
15.247(b) RSS 247 5.4.4	Conducted power	PASS	Meet the requirement of limit.
15.247(e) RSS 247 5.2.2	Power Spectral Density	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	The EUT has an internal antenna which is not user accessible

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) (\pm)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	ZUM Keypad
Brand	Crestron Electronics
PMN	ZUMLINK-KP
Test Model	M201937001
Identification No. of EUT	X141726 (Radiated), 651187 (Conducted)
Status of EUT	Engineering sample
Power Supply Rating	24Vdc
Modulation Type	GFSK
Modulation Technology	DTS
Transfer Rate	Up to 2Mbps
Operating Frequency	2.402 ~ 2.480GHz
Number of Channel	40
Output Power	BT LE 2M: 1.20 mW
Antenna Type	Low Profile Mini Chip Antenna, -2dBi Gain
Antenna Connector	Permanently attached

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.
2. The device support BT_LE 1M and BT_LE 2M, only 2M test result show in this report, for 1Mbps data rate test result, please refer to report: FCC_IC_RF_SL20061501-CRE-008_BLE_1M.

3.2 Description of Test Modes

40 channels are provided to this EUT:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

Test Tool and Power setting

Test Tool	STM32CubeMonitor-RF		
Modulation Mode	Test Frequency		
	2402	2440	2480
GFSK/2Mbps	25(0dBm)	25(0dBm)	25(0dBm)

3.2.1 Test Mode Applicability and Tested Channel Detail

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

Where RE \geq 1G: Radiated Emission above 1GHz & Bandedge Measurement
 RE<1G: Radiated Emission below 1GHz
 PLC: Power Line Conducted Emission
 APCM: Antenna Port Conducted Measurement

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **X-plane**.
NOTE: "-" 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.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	37,17,39	GFSK	2

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.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	17	GFSK	2

Antenna Port Conducted Measurement:

- 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.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	37,17,39	GFSK	2

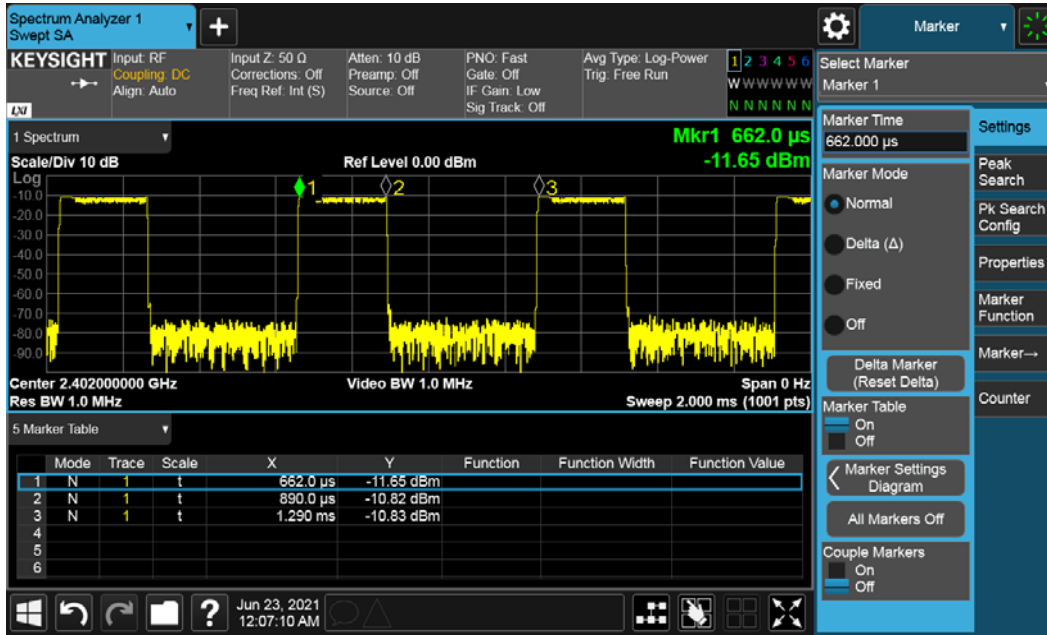
Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	24Vdc	Ellen Chu
RE<1G	25deg. C, 65%RH	24Vdc	Ellen Chu
PLC	25deg. C, 68%RH	24Vdc	Ellen Chu
APCM	21deg. C, 60%RH	24Vdc	Ellen Chu

3.3 Duty Cycle of Test Signal

Duty cycle of test signal is 36.31% for BLE_2M

BLE_2M



3.4 Description of Support Units

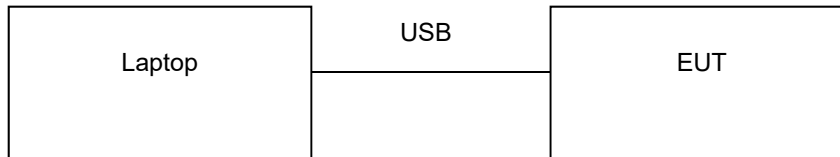
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Dell	Latitude E5410	GZFZPP1	N/A	Provided by Lab

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB to DB9 (RS232) adapter cable	1	1	N	0	Connect from EUT to Laptop

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

3.4.1 Configuration of System under Test



3.5 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:

- 47 CFR FCC Part 15, Subpart C (Section 15.247)**
- RSS 247 Issue2, February 2017**
- ANSI C63.10: 2013**
- RSS Gen Issue5, March 2019**
- 558074 D01 15.247 Meas Guidance v05r02**

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	MY57140100	07/22/2020	07/22/2022
Biconilog Antenna Sunol	JB1	A030702	03/09/2021	03/09/2022
Horn Antenna ETS-Lindgren	3117	218553	04/21/2021	04/21/2022
Pre-Amplifier (RF-Lambda)	RAMP00M50GA	18040300055	10/1/2020	10/1/2021
10m Semi-Anechoic Chambe (ETS-Lindgren)	S2010BL8X8	1462	07/21/2020	07/21/2022
Notch Filters MICRO-TRONICS	BRM50702	G242	07/21/2020	07/21/2022
Loop Antenna	N/A	00049120	11/25/2019	11/25/2021
EMI Receiver (Rohde and Schwarz)	ESW44	1328.4100K- 101662-MH	10/23/2020	10/23/2021
FSB Antenna Cable, 0.5m (Microwave Town)	FSB360PK-KMKM- 00.50M	201906110002	10/1/2020	10/1/2021
FSB Antenna Cable, 4m (Microwave Town)	FSB360PK-KMKM- 400M	21030447-002	10/1/2020	10/1/2021

4.1.3 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. 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 detects 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:

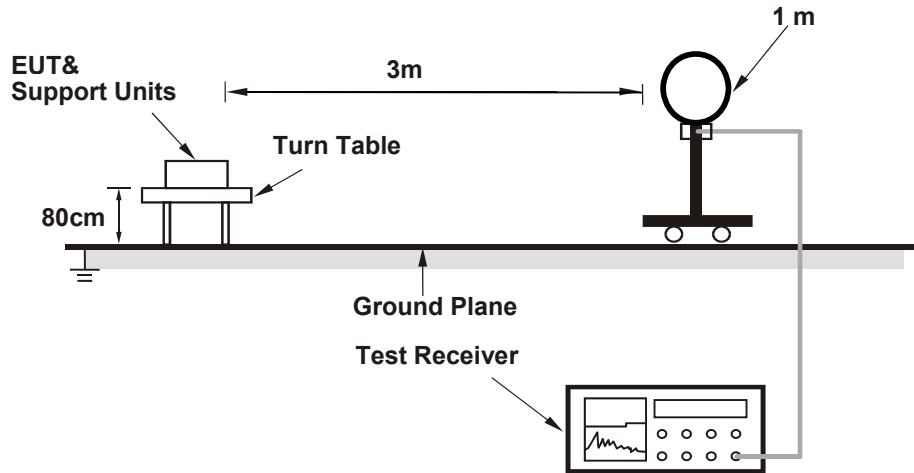
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.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

4.1.4 Deviation from Test Standard

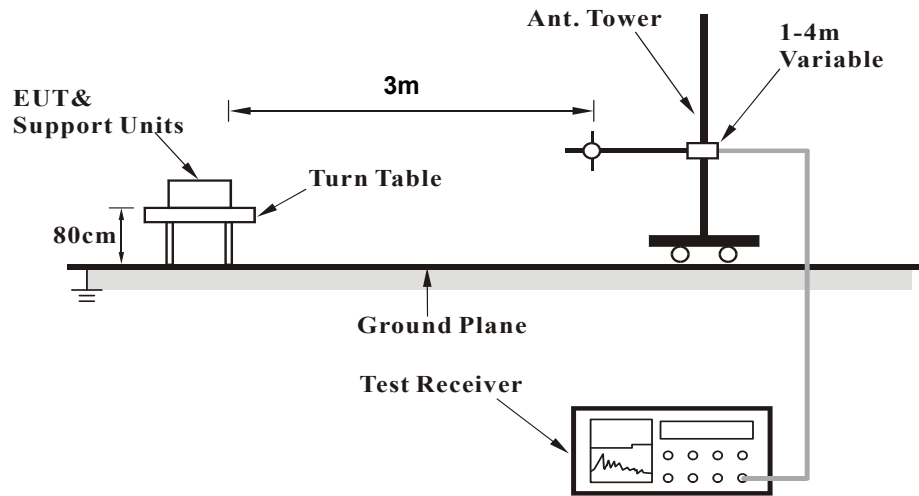
No deviation.

4.1.5 Test Setup

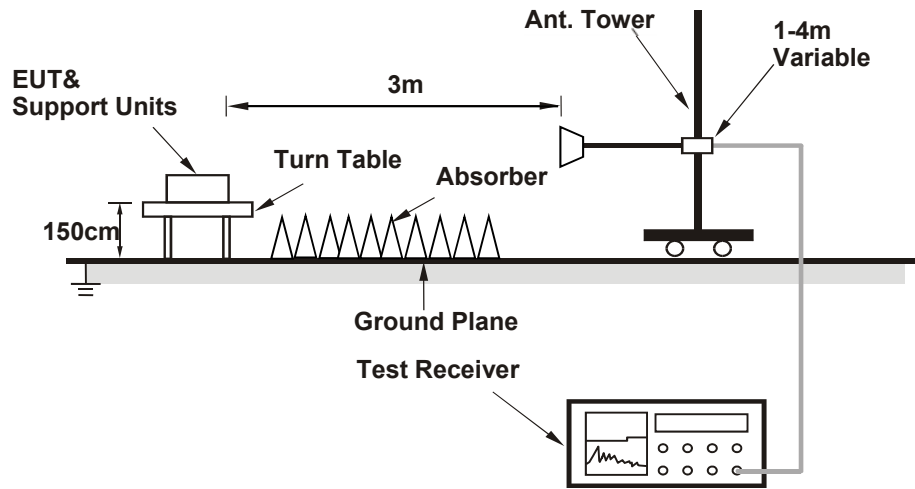
For Radiated emission below 30MHz



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).

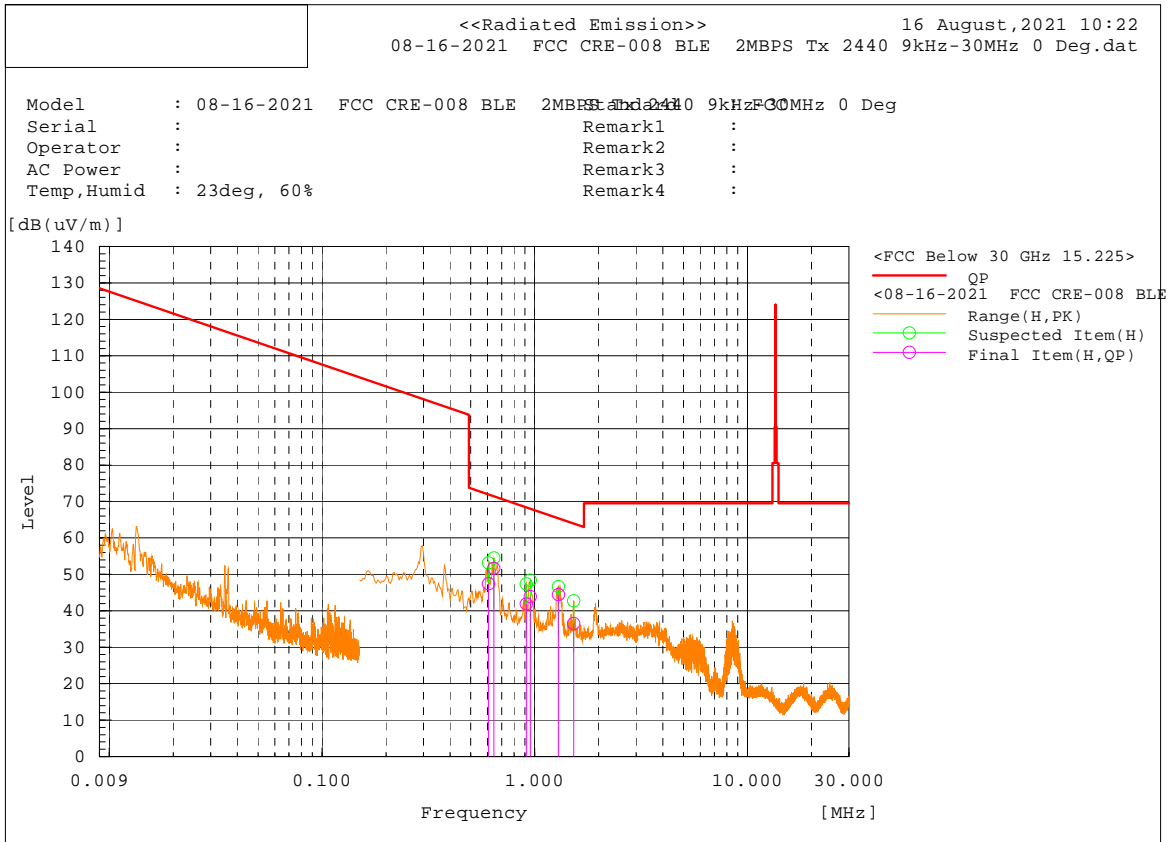
4.1.6 EUT Operating Conditions

- 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.

4.1.7 Test Results

Test result of Radiated emissions (9 KHz~30 MHz):

CHANNEL	TX Channel 17	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	9KHz – 30MHz		



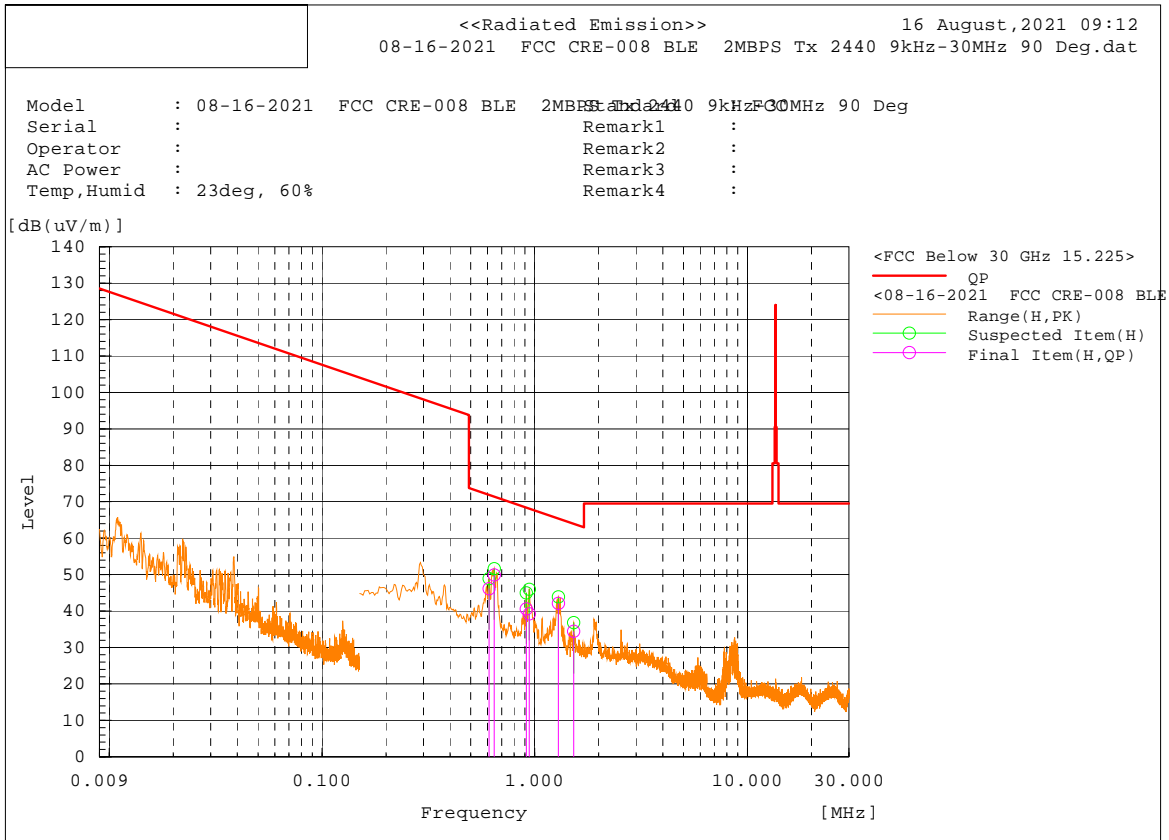
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Degree (0/90)	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	0.607	0	30.7	16.8	47.5	71.9	24.4	100	136.5	Pass
2	0.643	0	35.3	16.4	51.7	71.4	19.7	100	137.9	Pass
3	0.914	0	28.3	13.6	41.9	68.4	26.5	100	96.9	Pass
4	0.953	0	30.6	13.3	43.9	68	24.1	100	124.9	Pass
5	1.293	0	33.5	11	44.5	65.4	20.9	100	121.8	Pass
6	1.526	0	26.7	9.8	36.5	63.9	27.4	100	112.6	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 = Limit value (dBuV/m) - Level (dBuV/m)

CHANNEL	TX Channel 17	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	9KHz – 30MHz		



Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Degree (0/90)	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	0.61	H	29.3	16.8	46.1	71.9	25.8	100	207.9	Pass
2	0.646	H	33.5	16.4	49.9	71.4	21.5	100	198.8	Pass
3	0.914	H	27	13.6	40.6	68.4	27.8	100	204.5	Pass
4	0.944	H	25.9	13.3	39.2	68.1	28.9	100	205.1	Pass
5	1.293	H	31.1	11	42.1	65.4	23.3	100	183.7	Pass
6	1.526	H	24.6	9.8	34.4	63.9	29.5	100	186.9	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 = Limit value (dBuV/m) - Level (dBuV/m)

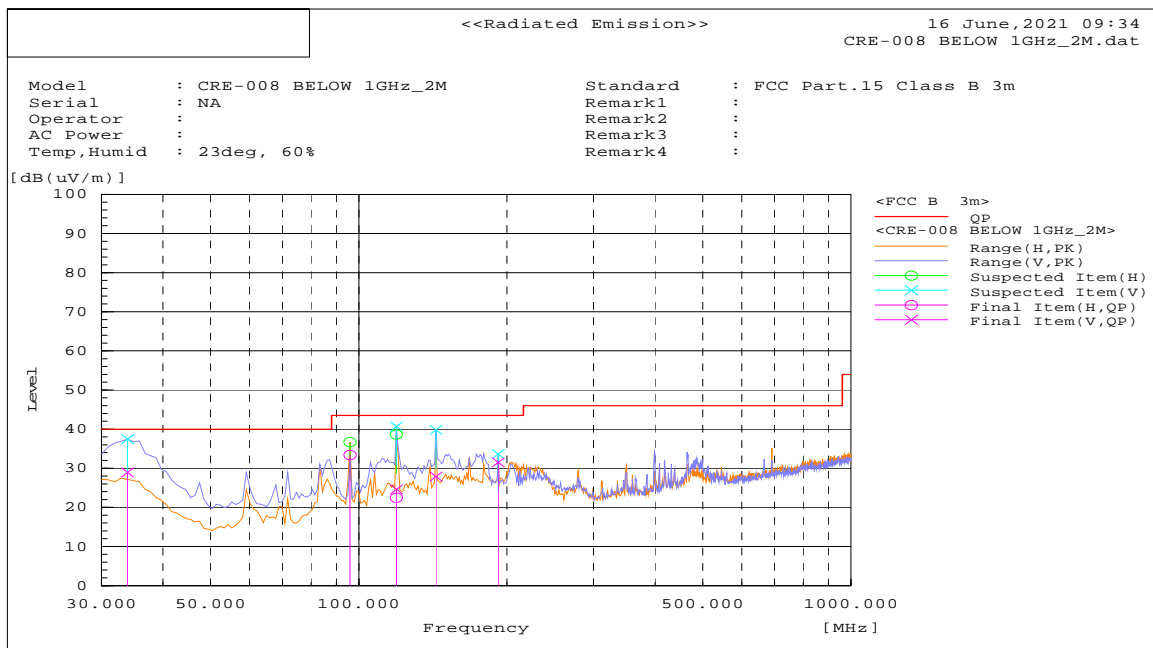
BELOW 1GHz WORST-CASE DATA:
BT-LE_2M

CHANNEL	TX Channel 17	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)]	LimitQP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	33.88	V	6.1	22.8	28.9	-	-	101	247	-
2	95.96	H	18.6	14.8	33.4	-	-	195	206	-
3	119.24	V	5.4	19.3	24.7	43.5	-18.8	112	146	Pass
4	119.24	H	3.3	19.2	22.5	43.5	-21	137	202	Pass
5	143.49	V	8.6	19.3	27.9	-	-	101	188	-
6	191.99	V	13.8	17.7	31.5	-	-	103	7.1	-

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."-": Emissions that do not fall within the restricted frequency bands where the attenuation below the general field strength limits specified in RSS-Gen is not required.



ABOVE 1GHz TEST DATA:

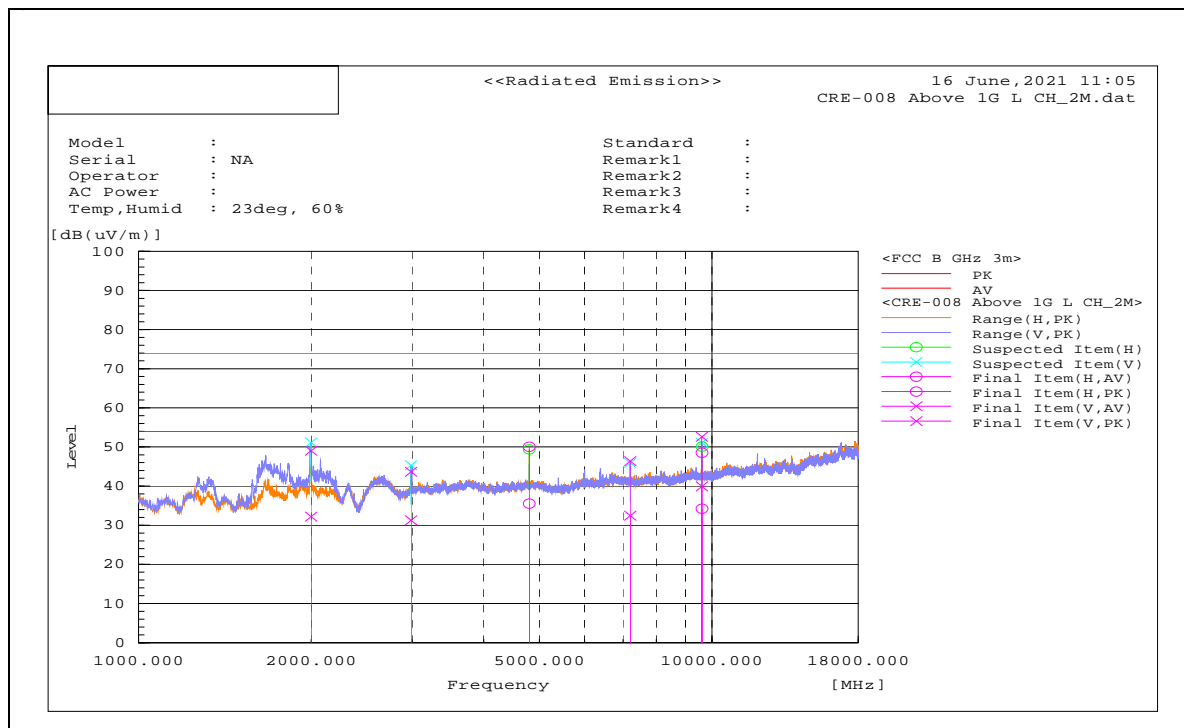
BT-LE_2M

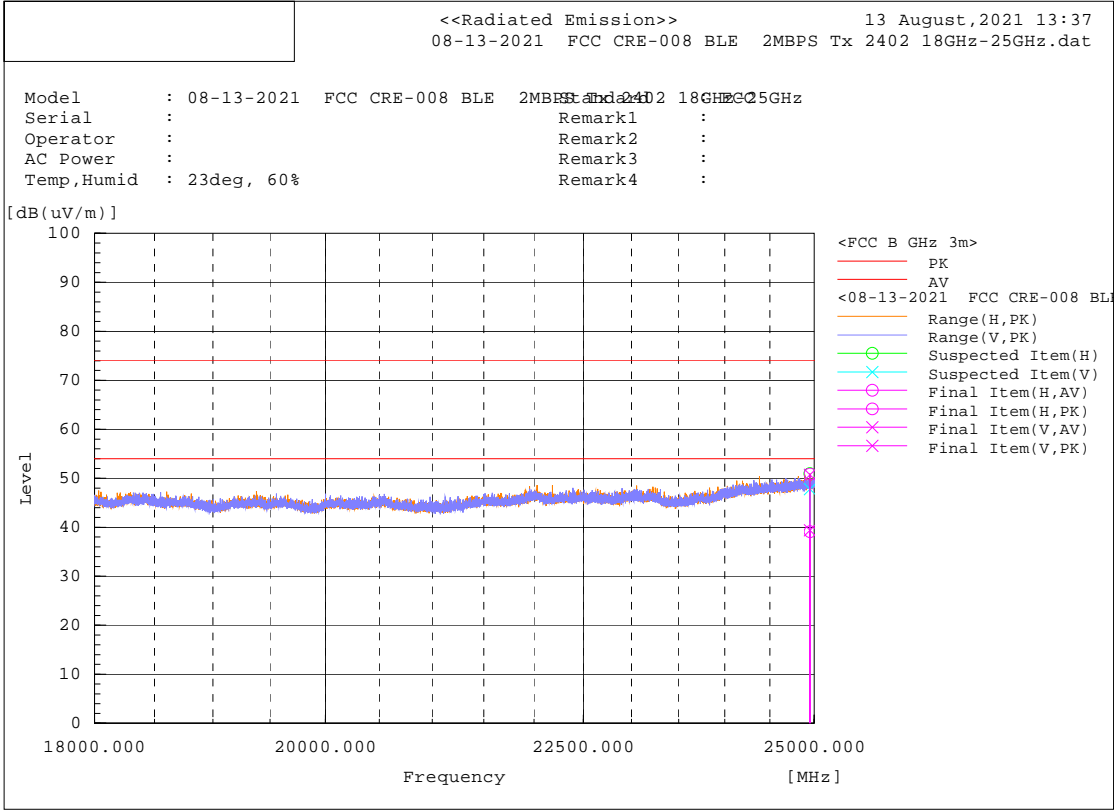
CHANNEL	TX Channel 37	DETECTOR FUNCTION	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

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	1998.369	V	44.4	61.2	-12.2	32.2	49	-	-	-	-	104.5	304.3	-
2	2987.592	V	41.6	54	-10.3	31.3	43.7	-	-	-	-	128.5	24.9	-
3	4803.032	H	41.5	56.1	-6	35.5	50.1	54	74	-18.5	-23.9	104.3	2.7	Pass
4	7206.204	V	33.3	47.2	-0.8	32.5	46.4	-	-	-	-	195.9	210.6	-
5	9606.213	V	35.8	48.5	4.1	39.9	52.6	-	-	-	-	104.1	294.8	-
6	9608.136	H	30.2	44.4	4.1	34.3	48.5	-	-	-	-	174	64	-
7	24951.194	H	21.3	33.1	17.8	39.1	50.9	-	-	-	-	207	353.7	-
8	24949.642	V	21.6	32.9	17.8	39.4	50.7	-	-	-	-	322	234.3	-

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. Margin value = Emission level – Limit value.
4. "-": Emissions that do not fall within the restricted frequency bands where the attenuation below the general field strength limits specified in RSS-Gen is not required.



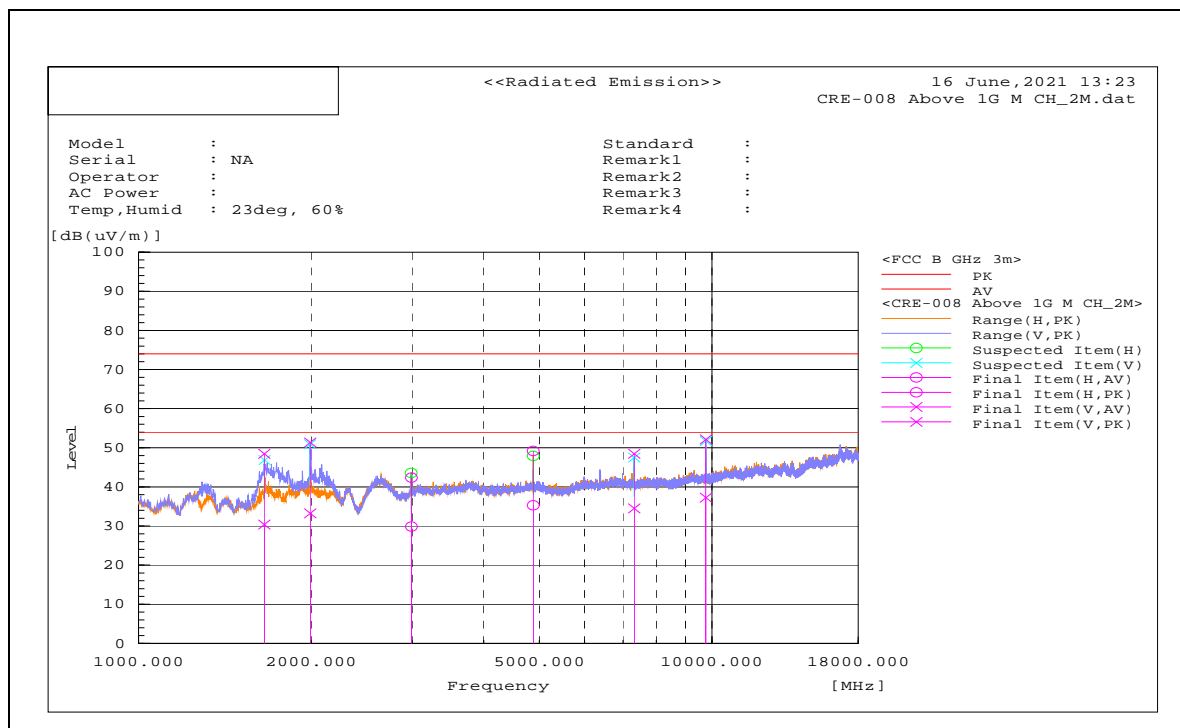


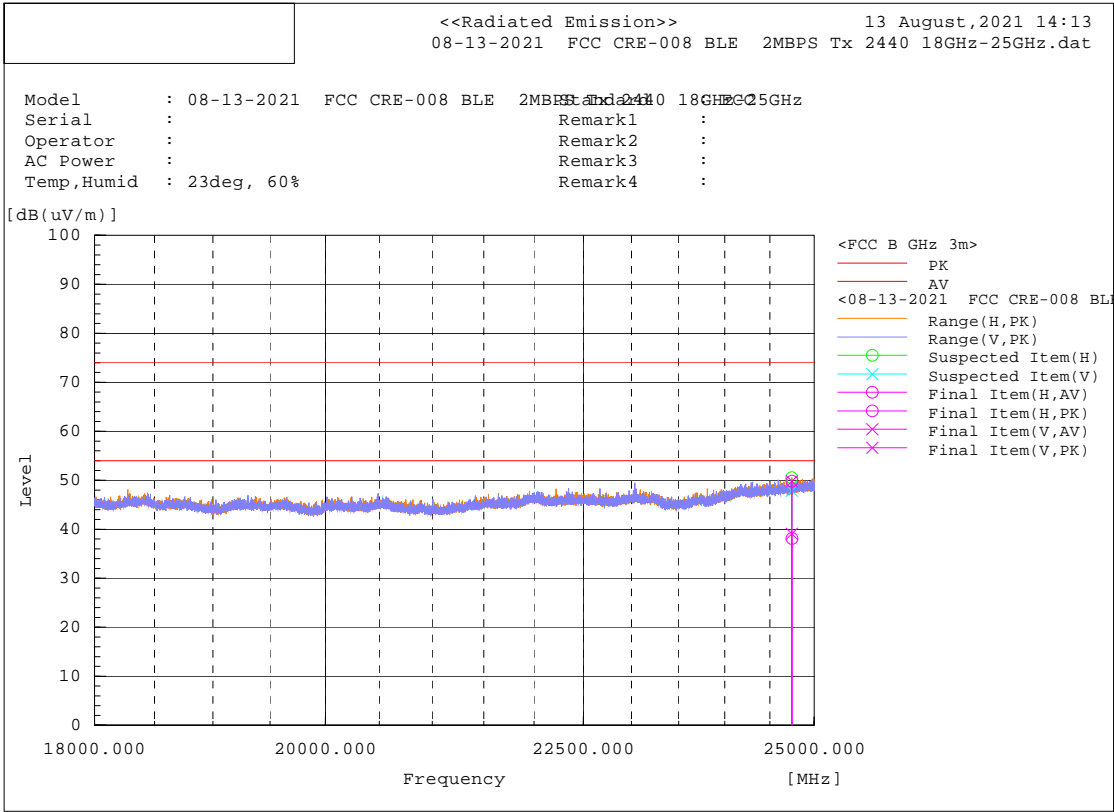
CHANNEL	TX Channel 17	DETECTOR FUNCTION	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

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	1657.727	V	46	64.1	-15.6	30.4	-	-	-	-	-	144.7	9.4	-
2	1991.758	V	45.5	63.6	-12.2	33.3	-	-	-	-	-	100	11.9	-
3	2990.881	H	40.1	52.7	-10.3	29.8	-	-	-	-	-	239.3	2.7	-
4	4879.046	H	41.3	55.2	-6	35.3	49.2	54	74	-18.7	-24.8	195.8	295.1	Pass
5	7320.014	V	35	49	-0.5	34.5	48.5	54	74	-19.5	-25.5	144	19.4	Pass
6	9760.495	V	32.8	47.7	4.5	37.3	-	-	-	-	-	143.3	311.1	-
7	24746.942	H	20.5	32.2	17.6	38.1	-	-	-	-	-	396	229	-
8	24746.078	V	21.5	32.2	17.6	39.1	-	-	-	-	-	283	134.4	-

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Pre-amplifier Gain (dB).
3. Margin value = Emission level – Limit value.
4. "-": Emissions that do not fall within the restricted frequency bands where the attenuation below the general field strength limits specified in RSS-Gen is not required.



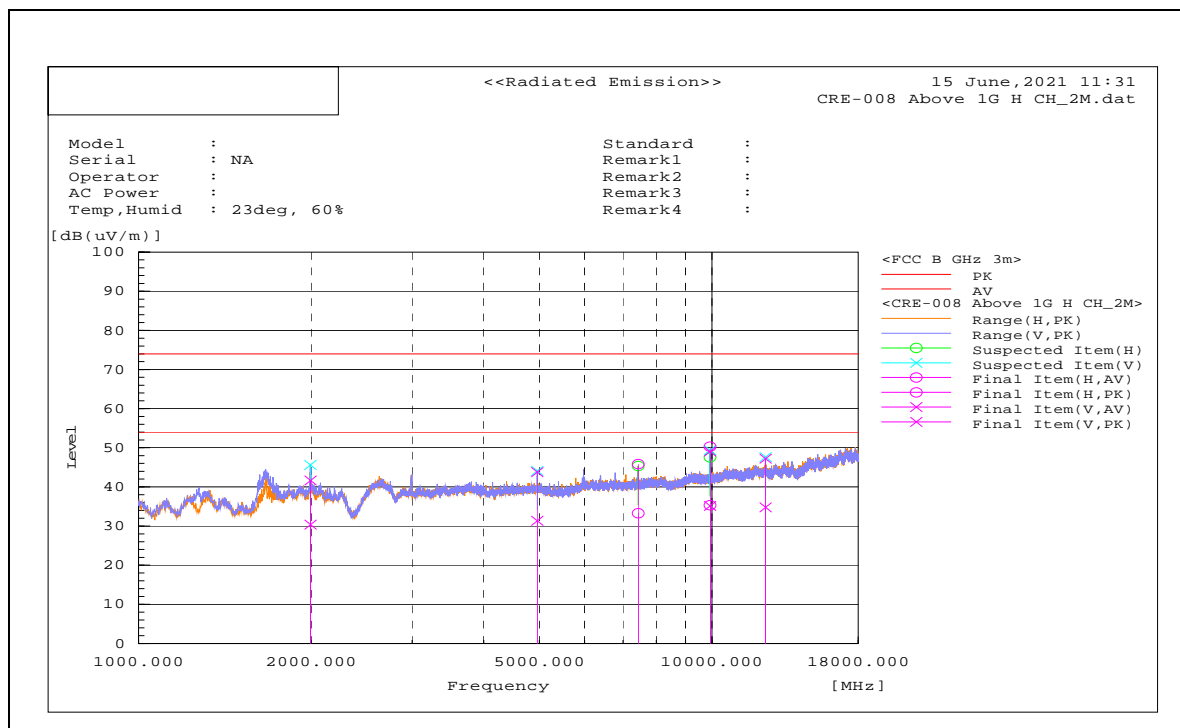


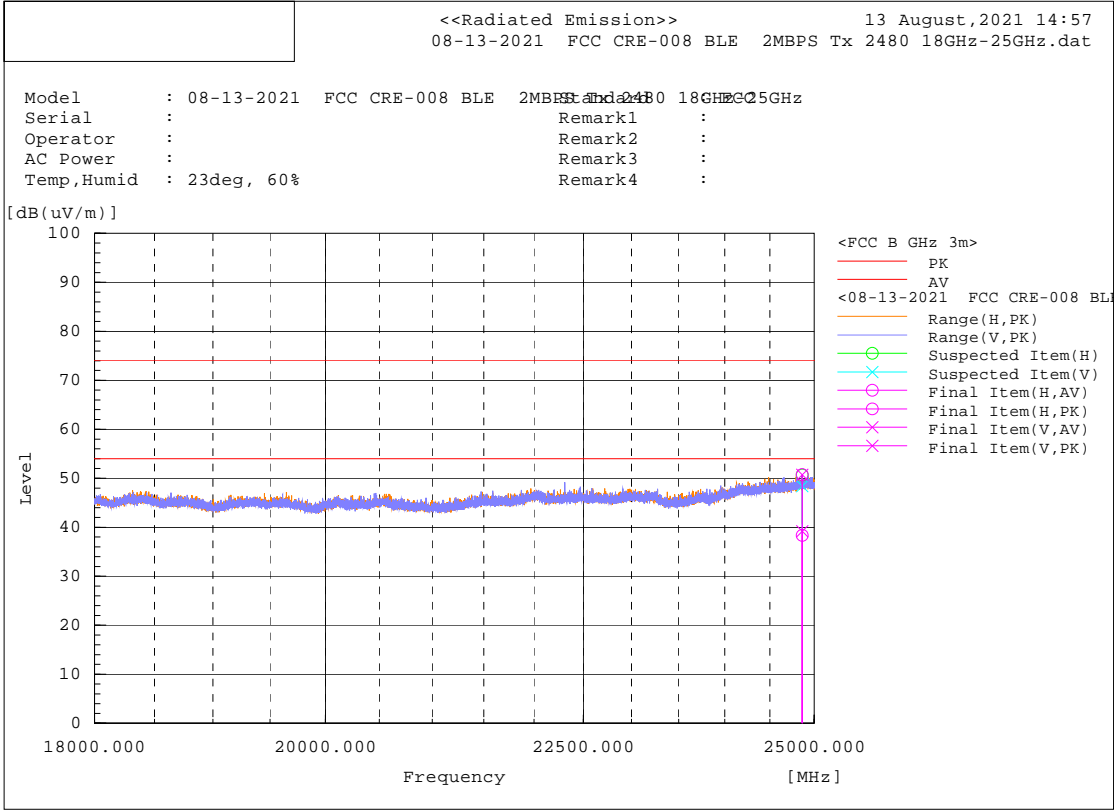
CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

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	1994.951	V	42.6	53.9	-12.2	30.4	41.7	-	-	-	-	107.4	40.3	-
2	4959.055	V	37.3	49.7	-5.9	31.4	43.8	54	74	-22.6	-30.2	195.7	0	Pass
3	7439.055	H	33.4	45.9	-0.1	33.3	45.8	54	74	-20.7	-28.2	111.6	271.8	Pass
4	9922.004	V	30.5	44.3	4.7	35.2	49	-	-	-	-	400	189.2	-
5	9922.09	H	30.6	45.6	4.7	35.3	50.3	-	-	-	-	128.9	2.8	-
6	12402.48	V	28.4	40.8	6.4	34.8	47.2	54	74	-19.2	-26.8	104.5	216.9	Pass
7	24864.456	H	20.7	33.1	17.7	38.4	50.8	-	-	-	-	400	189.7	-
8	24864.13	V	21.5	33	17.7	39.2	50.7	-	-	-	-	400	25.6	-

REMARKS:

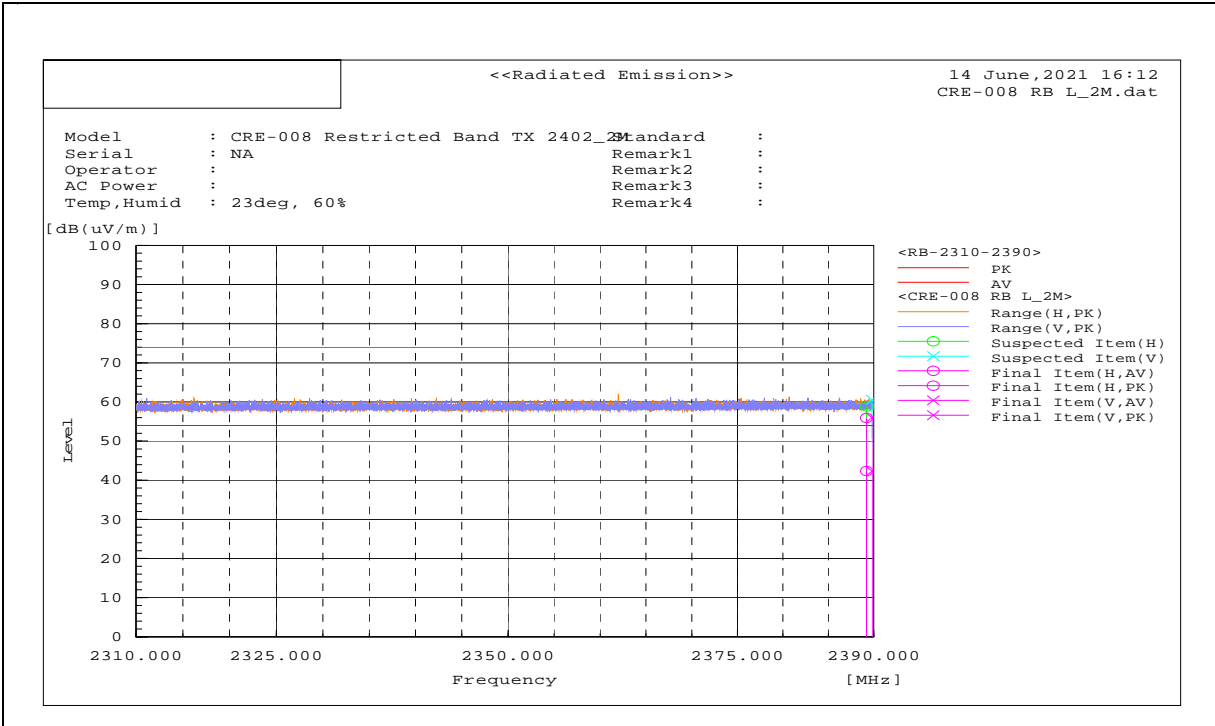
1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Pre-amplifier Gain (dB).
3. Margin value = Emission level – Limit value.
4. "-": Emissions that do not fall within the restricted frequency bands where the attenuation below the general field strength limits specified in RSS-Gen is not required.





BT_LE_2M

RESTRICTED BAND (LOW CHANNEL)

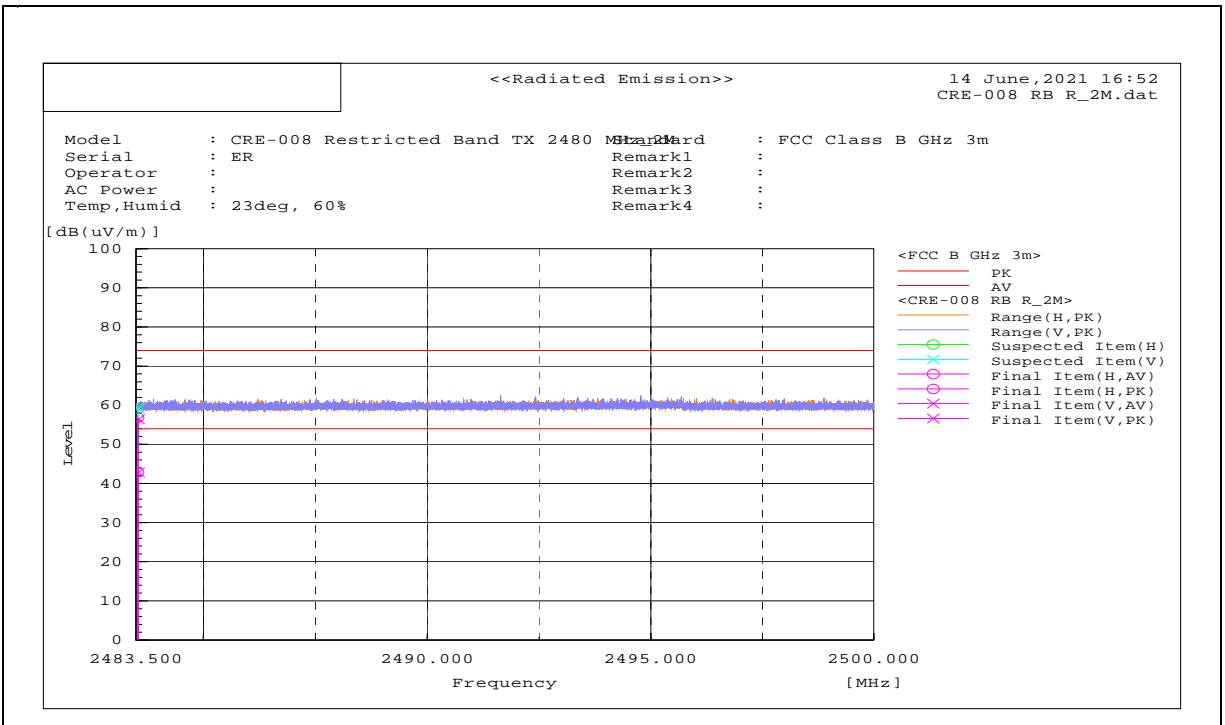


Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2389.2	H	7.3	20.9	35	42.3	55.9	54	74	-11.7	-18.1	301	294	Pass
2	2389.816	V	7.3	21	35	42.3	56	54	74	-11.7	-18	151	181	Pass

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. Margin value = Emission level – Limit value.

RESTRICTED BAND (HIGH CHANNEL)



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	2483.54	H	7.5	21.4	35.4	42.9	56.8	54	74	-11.1	-17.2	329	0	Pass
2	2483.556	V	7.5	21	35.4	42.9	56.4	54	74	-11.1	-17.6	360	32.1	Pass

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. Margin value = Emission level – Limit value.

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 Procedures

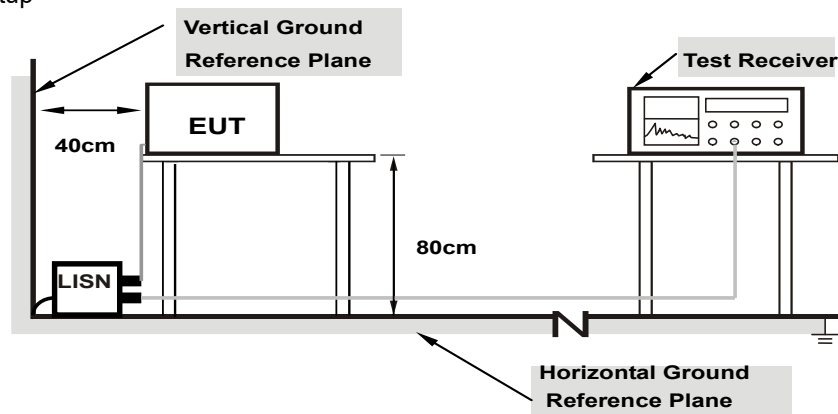
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance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

4.2.3 Deviation from Test Standard

No deviation.

4.2.4 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).

4.2.5 EUT Operating Conditions

Same as 4.1.6.

4.2.6 Test Results

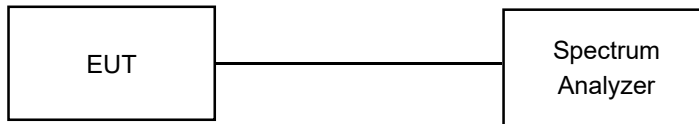
N/A (Work with battery).

4.3 6dB Bandwidth Measurement & 99% Bandwidth Measurement

4.3.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

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. Set resolution bandwidth (RBW) = 100kHz
- b. Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- c. Trace mode = max hold.
- d. Sweep = auto couple.
- e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

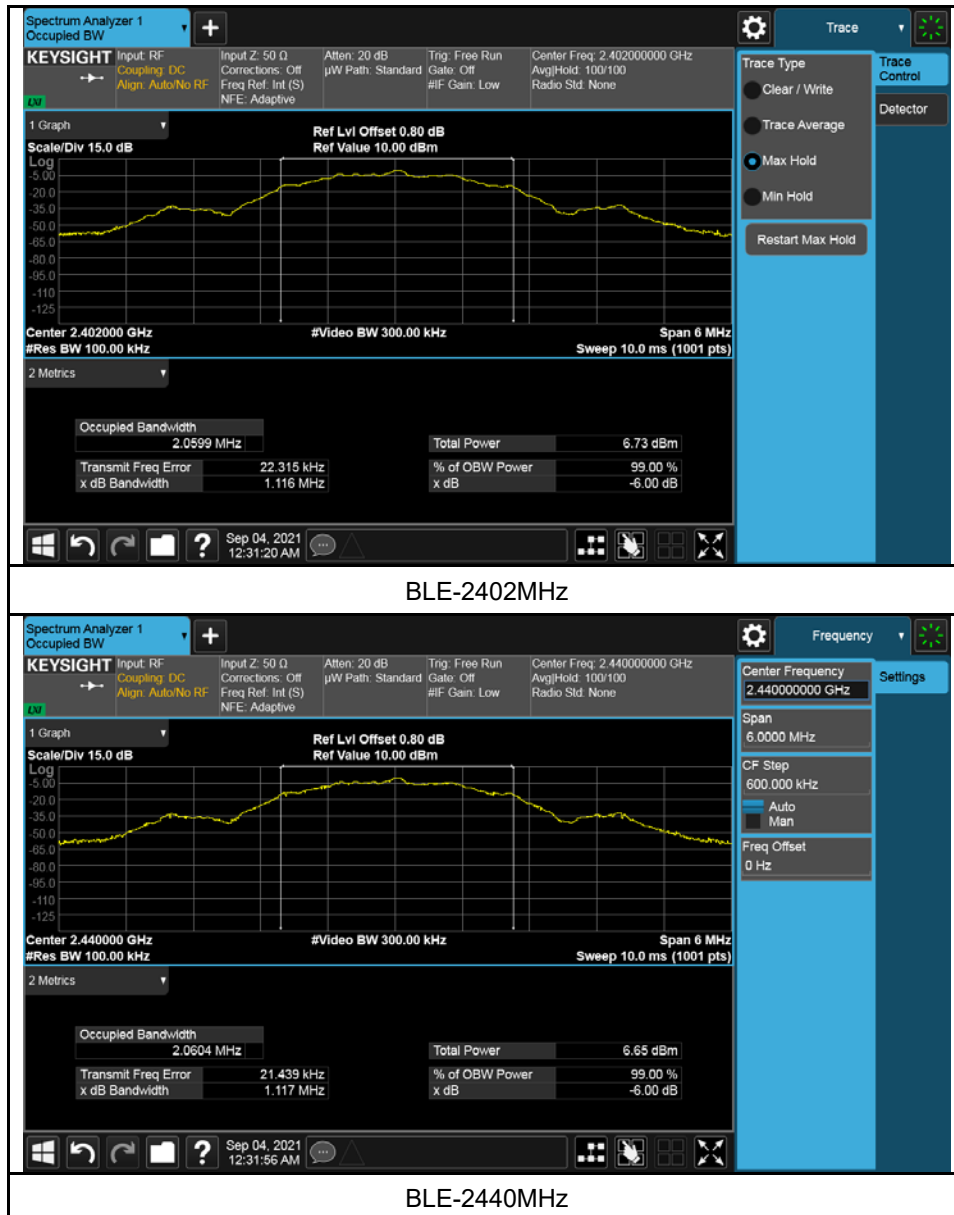
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Result
BT_LE_2M

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
37	2402	1.116	2.0599	0.5	PASS
17	2440	1.117	2.0604	0.5	PASS
39	2480	1.113	2.0576	0.5	PASS

Test Plots:

99%/-6dB Occupied Bandwidth:



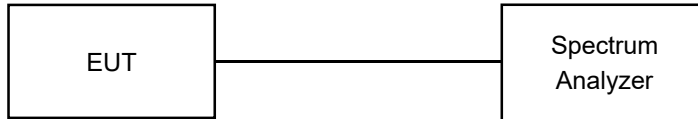


4.4 Conducted Output Power Measurement

4.4.1 Limits of Conducted Output Power Measurement

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

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. Set the RBW \geq DTS bandwidth.
- b. Set VBW $\geq 3 \times$ RBW.
- c. Set span $\geq 3 \times$ RBW
- d. Sweep time = auto couple.
- e. Detector = peak.
- f. Trace mode = max hold.
- g. Allow trace to fully stabilize.
- h. Use peak marker function to determine the peak amplitude level.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Conditions

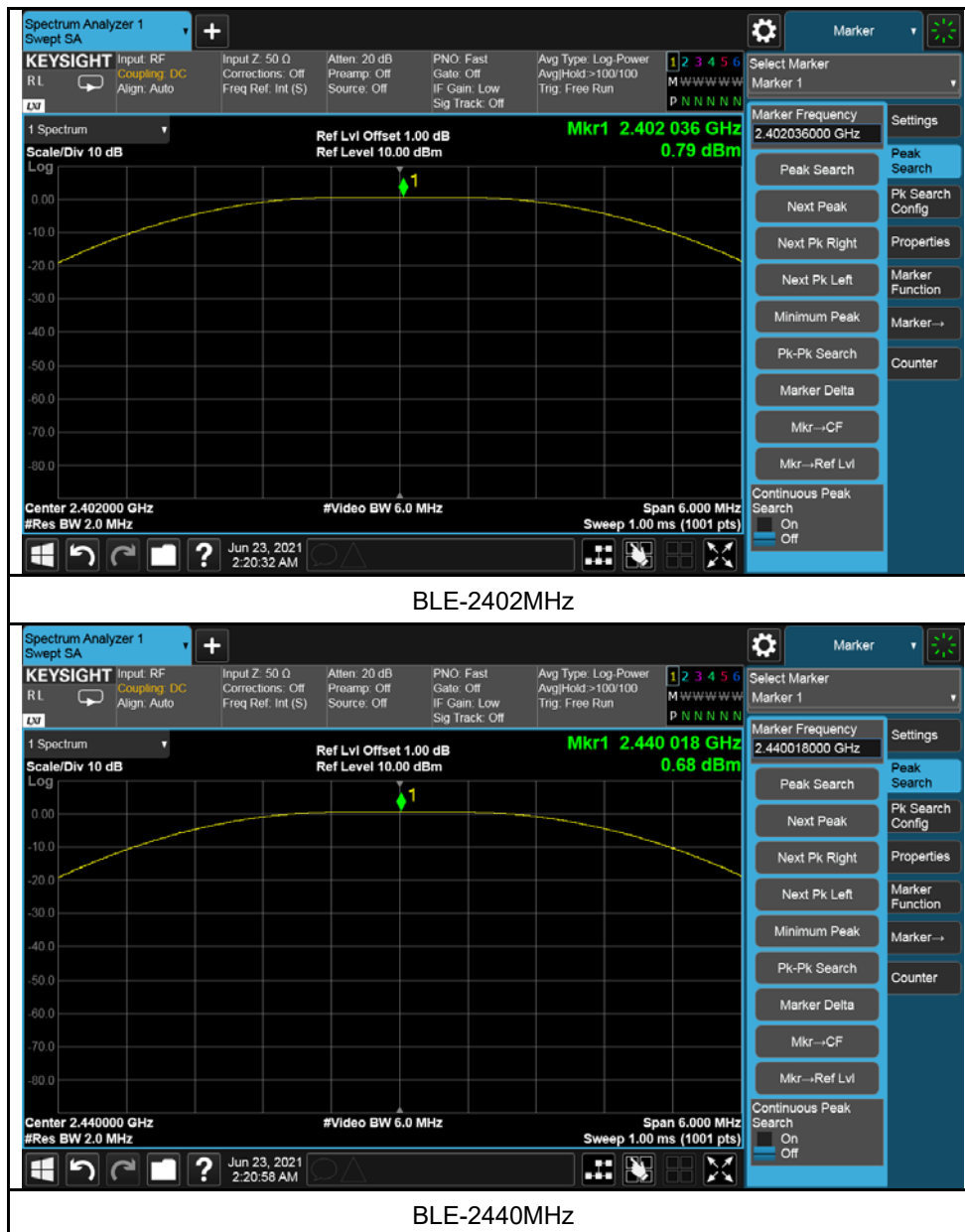
Same as Item 4.3.6.

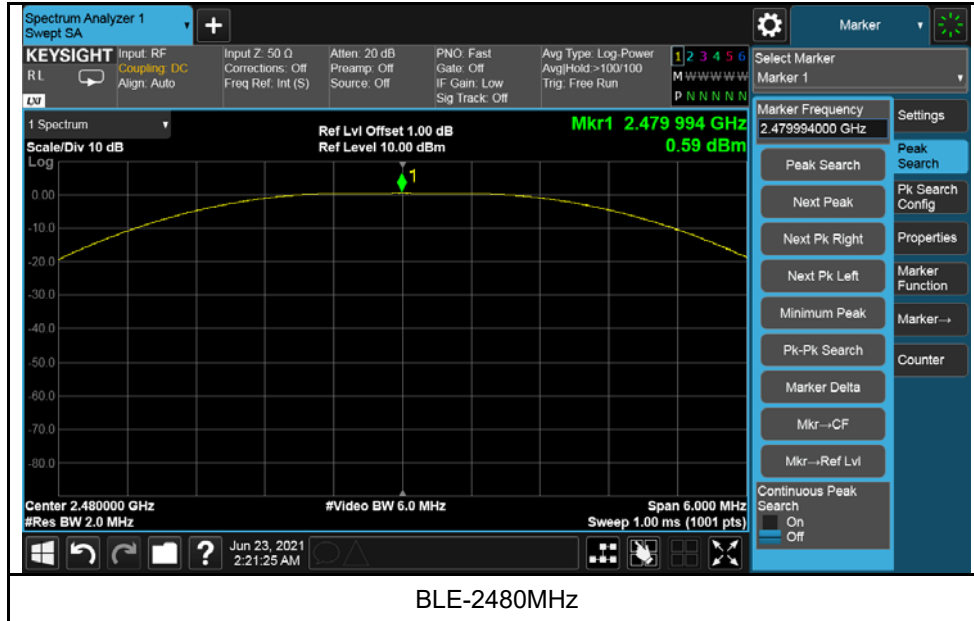
4.4.7 Test Results

BT_LE_2M

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
37	2402	0.79	30	Pass
17	2440	0.68	30	Pass
39	2480	0.59	30	Pass

Test Plots:



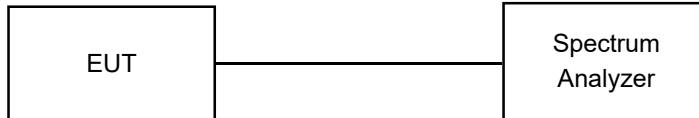


4.5 Power Spectral Density Measurement

4.5.1 Limits of Power Spectral Density Measurement

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

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. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- d. Set the VBW $\geq 3 \times \text{RBW}$.
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Condition

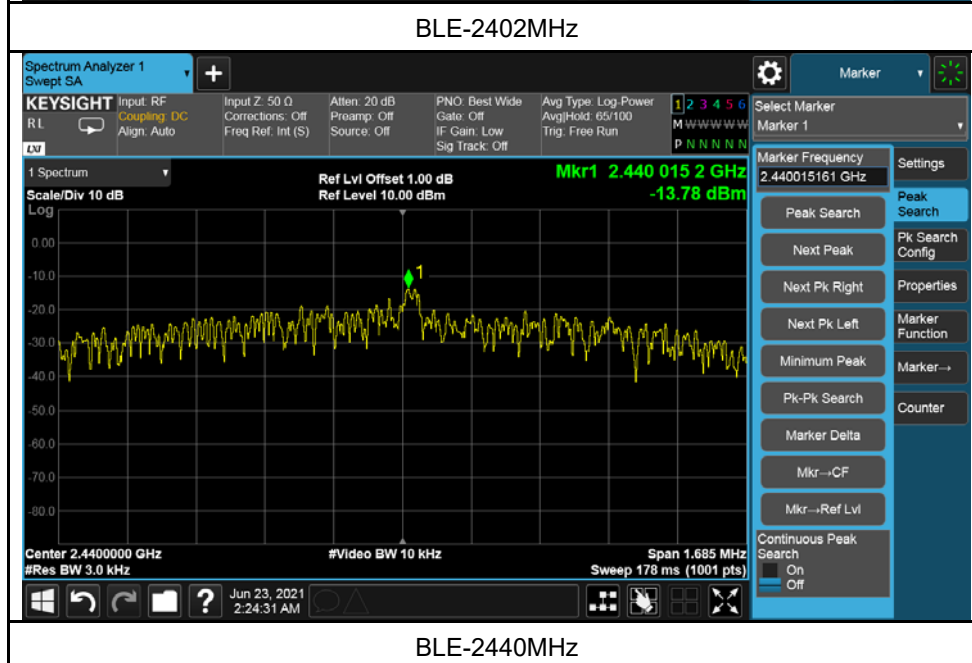
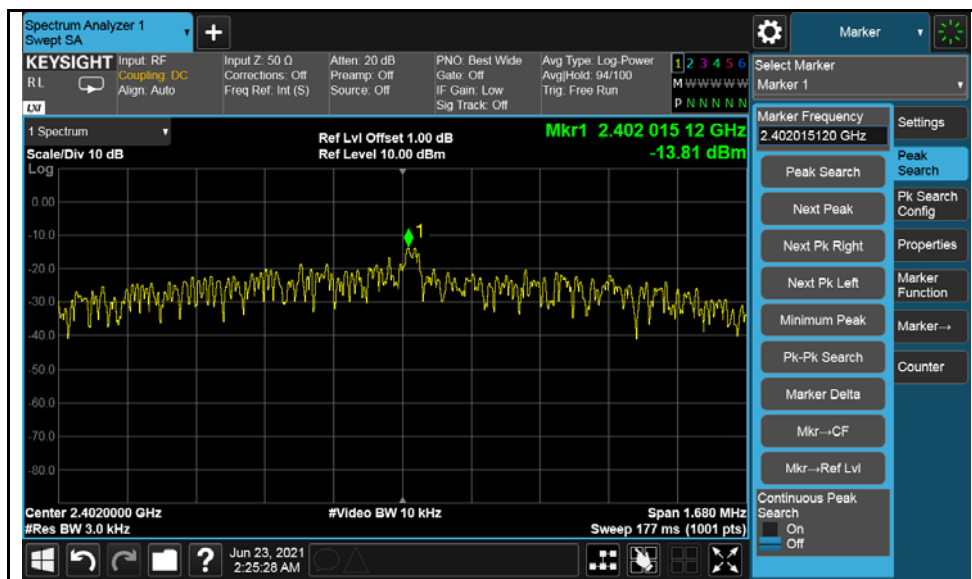
Same as Item 4.3.6

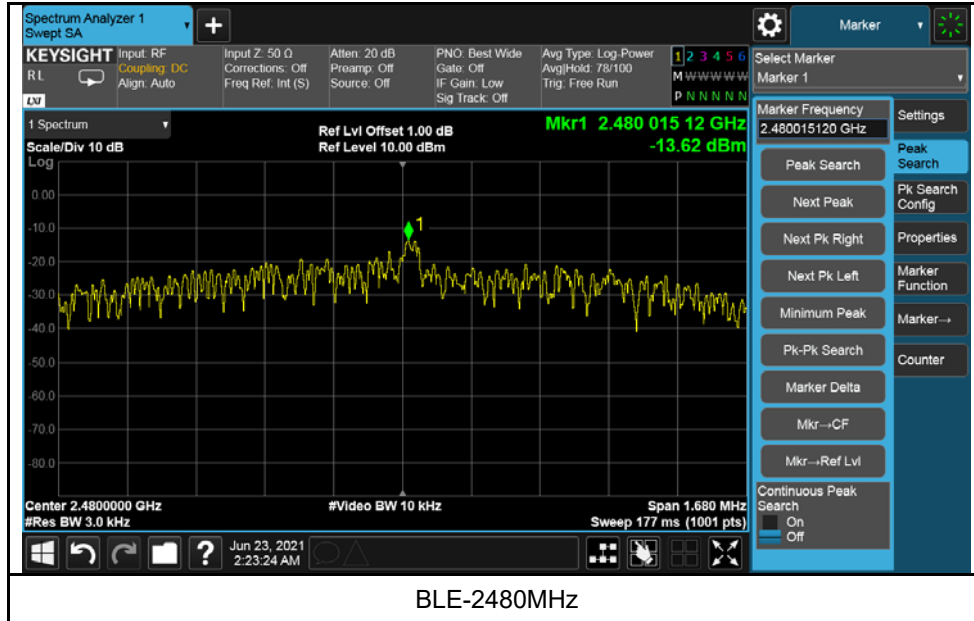
4.5.7 Test Results

BT_LE_2M

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
37	2402	-13.81	8	Pass
17	2440	-13.78	8	Pass
39	2480	-13.62	8	Pass

Test Plots:



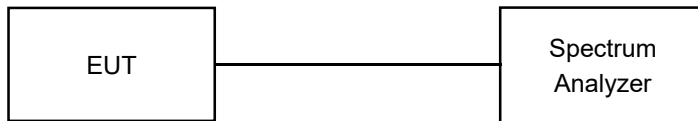


4.6 Conducted Out of Band Emission Measurement

4.6.1 Limits of Conducted Out of Band Emission Measurement

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

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

1. Set the RBW = 100 kHz.
2. Set the VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOB

1. Set RBW = 100 kHz.
2. Set VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

4.6.5 Deviation from Test Standard

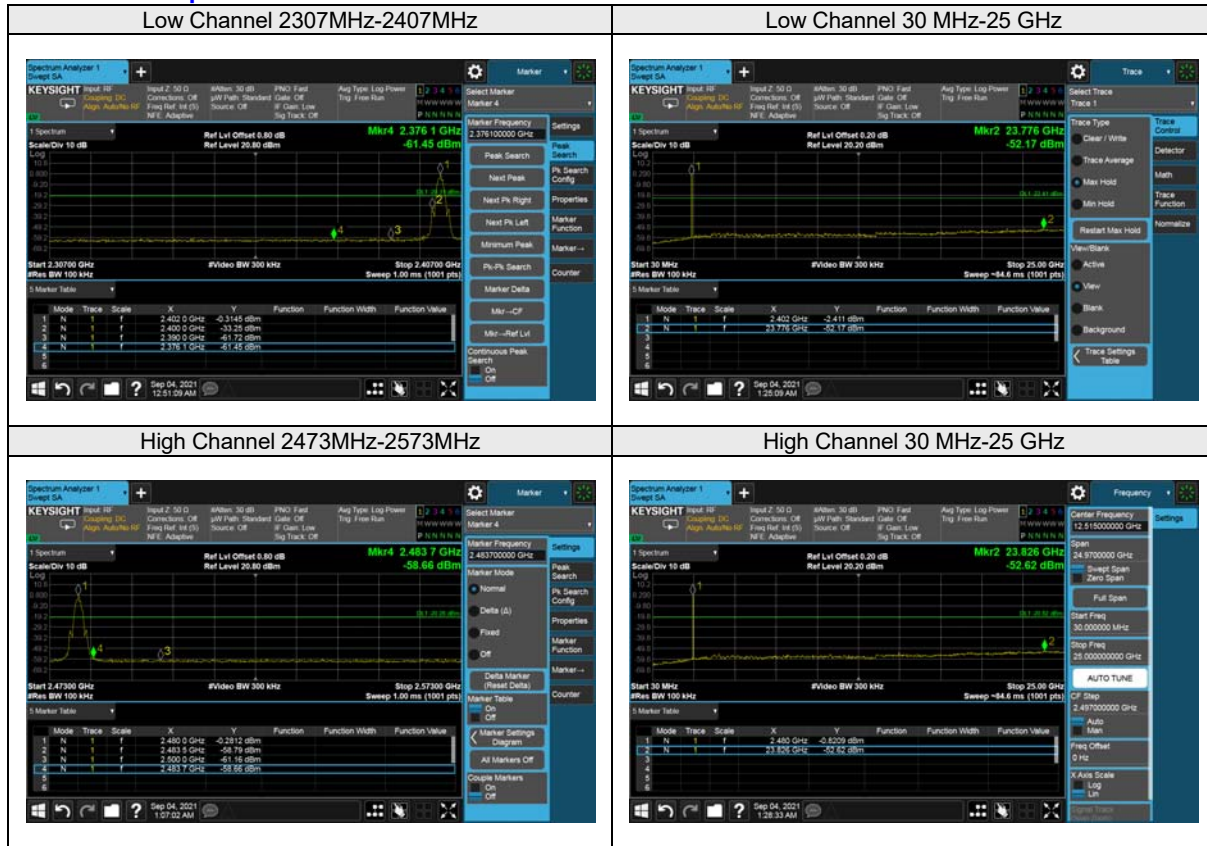
No deviation.

4.6.6 EUT Operating Condition

Same as Item 4.3.6

4.6.7 Test Results

Data Rate: 1Mbps



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:

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Web Site: www.cpsusa-bureauveritas.com

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

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