FCC Test Report (BT-LE)

Report No.:	FCC_RF_SL19040201-SEV-801R1_BLE_Rev1.0
FCC ID:	2ATJP-T410
Test Model:	T410
Received Date:	06/01/2019
Test Date:	06/05/2019
Issued Date:	07/02/2019
Applicant:	Vendwatch Telematics LLC
Address:	111 W. Anderson Lane, Suite E300, Austin, Texas 78753, USA
Manufacturer:	East West Manufacturing Enterprises
Address:	11100 Metric Blvd, Suite 200C, Austin, Texas 78758, 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
FCC Registration / Designation Number:	540430

ACCREDITED
TESTING CERT # 2742-01

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Release Control Record

Issue No.	Description	Date Issued
FCC_RF_SL19040201-SEV-801R1_BLE	Orignal Release	06/21/2019
FCC_RF_SL19040201-SEV-801R1_BLE_Rev1.0	Addressed TCB Questions	07/02/2019

1 Certificate of Conformity

Product:	Vending Machine Modem
Brand:	Vendwatch Telematics LLC
Test Model:	T410
Sample Status:	Engineering sample
Applicant:	Vendwatch Telematics LLC
Test Date:	06/05/2019
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) 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 : _____ , **Date:** 07/02/2019

Shuo Zhang / Test Engineer

Approved by : _____ , **Date:** 07/02/2019

Chen Ge / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	PASS	Meet the requirement of limit. Minimum passing margin is -7.4 dB at 0.473 MHz.
15.205 &15.209 & 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing margin is -11.35 dB at 935.97 MHz.
15.247(d)	Antenna Port Emission	PASS	Meet the requirement of limit.
15.247(a)(2)	6dB bandwidth	PASS	Meet the requirement of limit.
15.247(b)	Conducted power	PASS	Meet the requirement of limit.
15.247(e)	Power Spectral Density	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	Antenna is permanently attached.

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	3.51dB
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	Vending Machine Modem
Brand	Vendwatch Telematics LLC
Test Model	T410
Identification No. of EUT	T410000001
Status of EUT	Engineering sample
Power Supply Rating	24V, 3.75A
Modulation Type	GFSK
Modulation Technology	DTS
Transfer Rate	Up to 1Mbps
Operating Frequency	2.402 ~ 2.480GHz
Number of Channel	40
Output Power	1.52 mW
Antenna Type	SMT, 0.5dBi Gain
Antenna Connector	N/A

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

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 & 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 **Y-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	0,19,39	GFSK	1

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	0,19,39	GFSK	1

Power Line Conducted Emission Test:

☒ 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	19	GFSK	1

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.

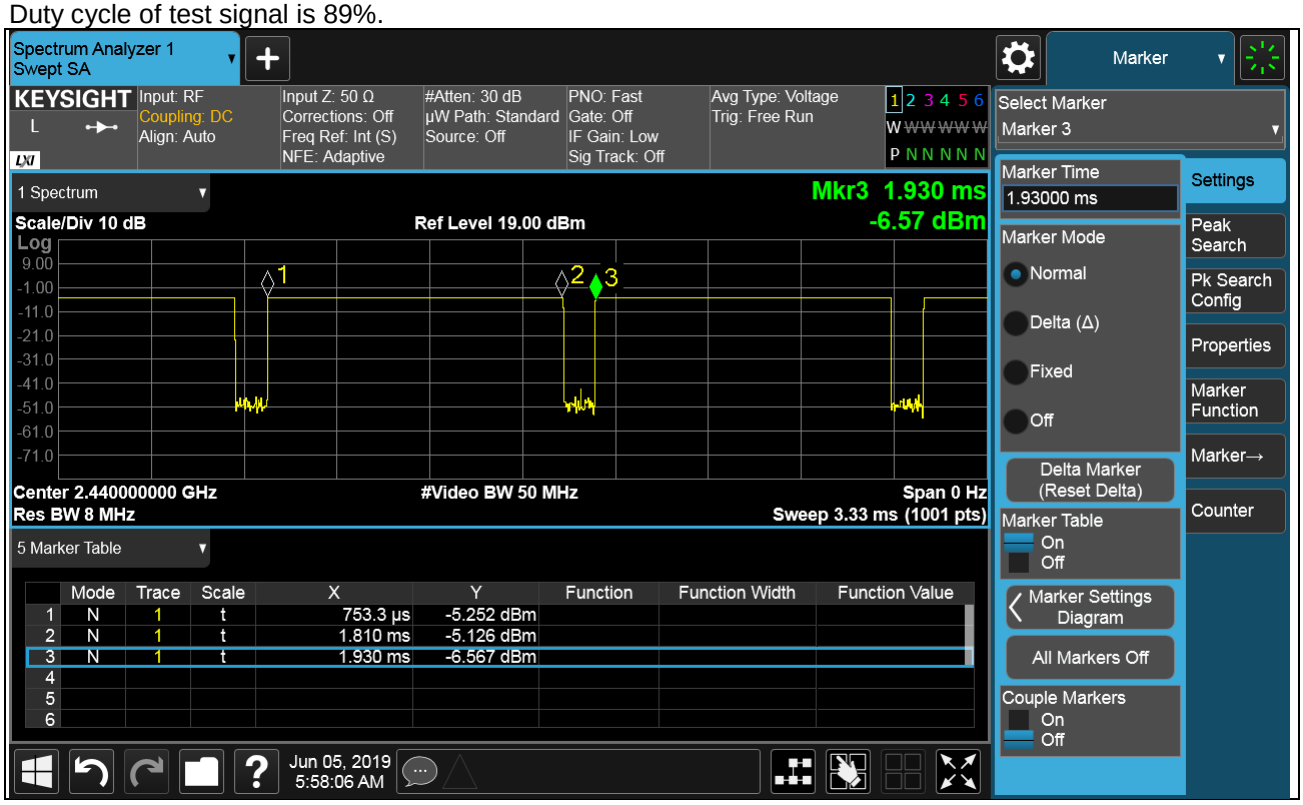
AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	19	GFSK	1

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	120Vac, 60Hz	Shuo Zhang
RE<1G	25deg. C, 65%RH	120Vac, 60Hz	Shuo Zhang
PLC	25deg. C, 68%RH	120Vac, 60Hz	Shuo Zhang
APCM	21deg. C, 60%RH	120Vac, 60Hz	Shuo Zhang

3.3 Duty Cycle of Test Signal

Duty cycle of test signal is 89%.



3.4 Description of Support Units

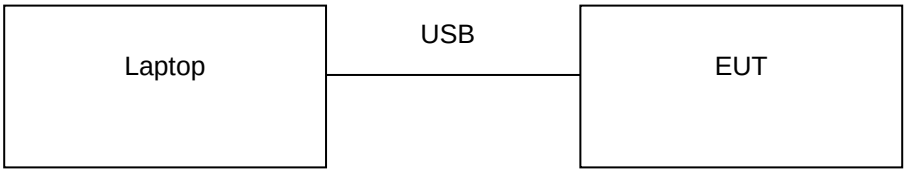
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Acer	N17Q1	NXGNPAA0167300AAAE7600	N/A	Provided by Lab

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB console cable	1	2	N	0	Provided by Customer

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:

FCC Part 15, Subpart C (15.247)
KDB 558074 D01 15.247 Meas Guidance v05r02
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
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2018	08/28/2019
Spectrum Analyzer KEYSIGHT	N9030B	MY57140374	07/22/2018	07/22/2019
Hybrid Antenna SUNAR	JB6	A111717	03/09/2019	03/09/2020
Double-Ridged Guide Antenna ETS LINDGREN	3117	214309	11/22/2018	11/22/2019
DRG Horn Antenna A.H SYSTEM	SAS-574	579	07/27/2018	07/27/2020
Preamplifier RF-LAMBDA	RAMP00M50GA	17032300047	09/19/2018	09/19/2019
Preamplifier RF-BAY	LPA-6-30	11170602	05/06/2019	05/06/2020

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:

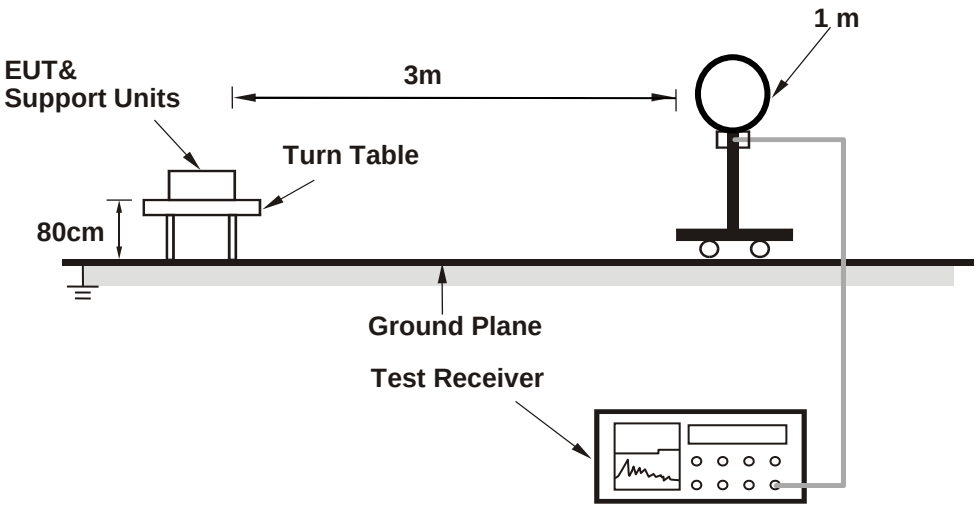
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 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.

4.1.4 Deviation from Test Standard

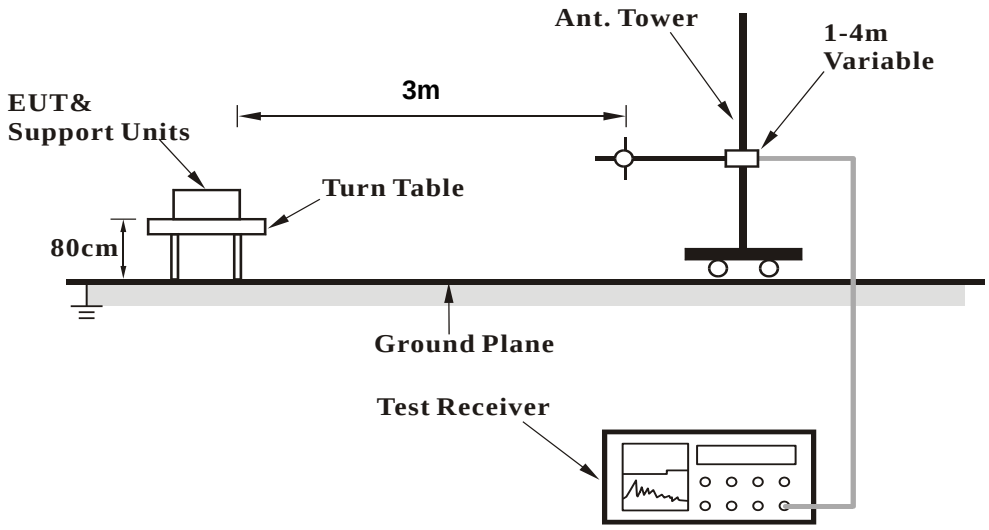
No deviation.

4.1.5 Test Setup

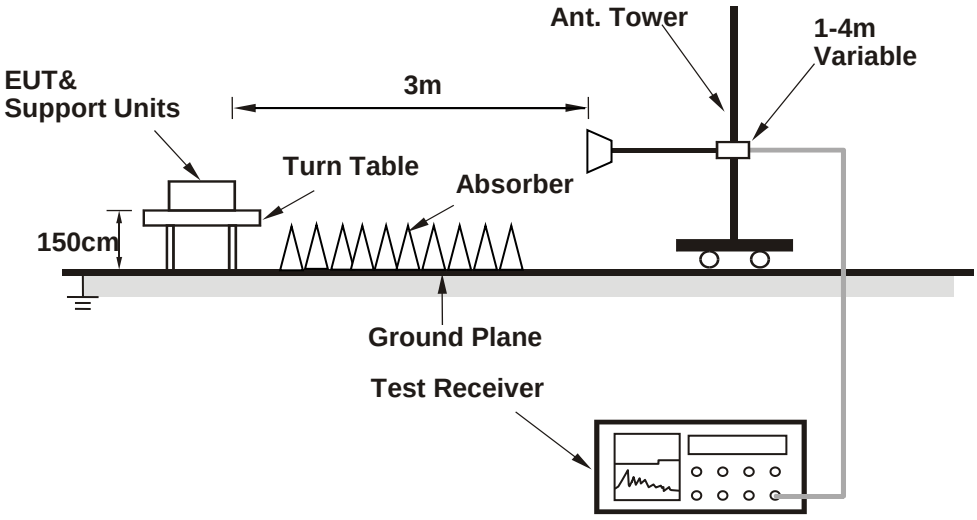
For Radiated emission below 30MHz



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

BELOW 1GHz WORST-CASE DATA:

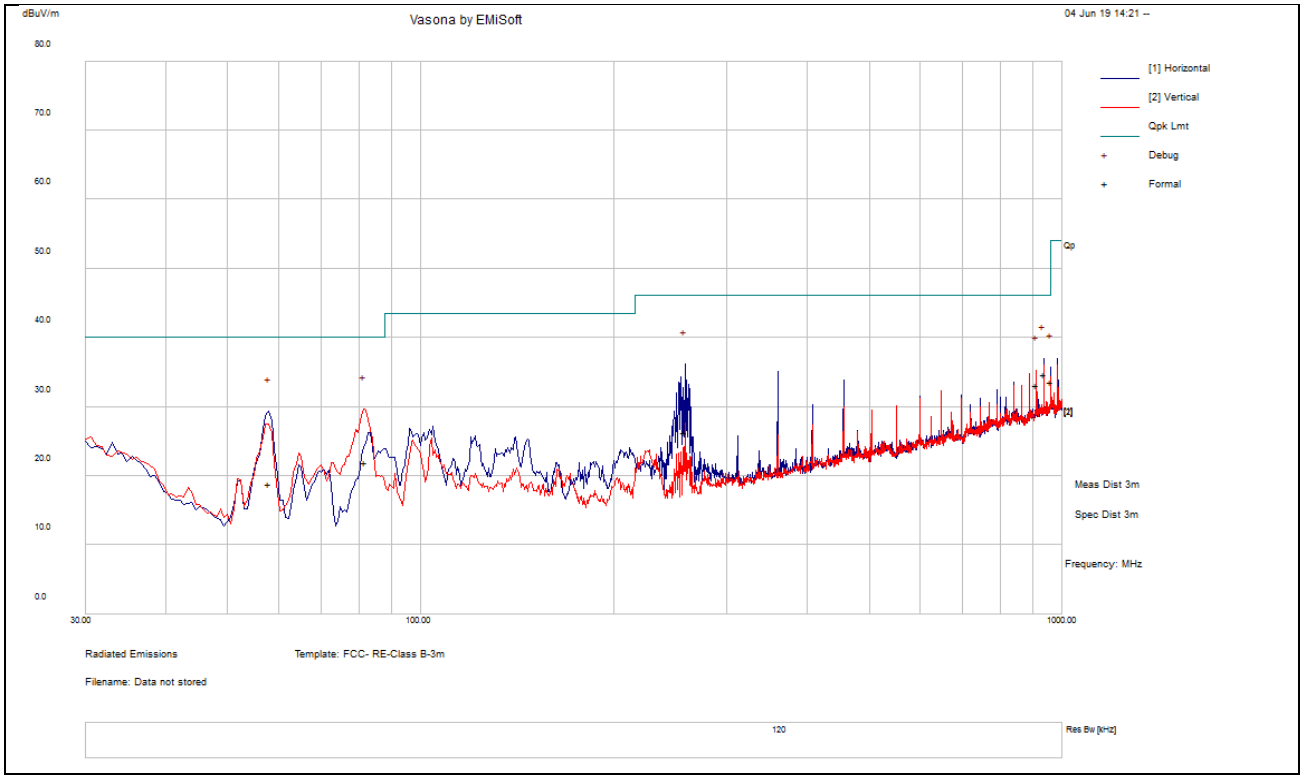
BT-LE (GFSK)

CHANNEL	TX Channel 19	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dB)	(dB)	(dB)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	935.97	31.52	15.93	-12.8	34.65	Quasi Max	H	101	332	46	-11.35	Pass
2	257.89	37.52	12.99	-24.22	26.29	Quasi Max	H	106	128	46	-19.71	Pass
3	81.75	38.37	11.69	-28.13	21.93	Quasi Max	V	167	121	40	-18.07	Pass
4	959.99	29.83	16.08	-12.23	33.68	Quasi Max	H	199	147	46	-12.32	Pass
5	912.00	30.48	15.91	-13.18	33.2	Quasi Max	V	102	225	46	-12.8	Pass
6	57.98	34.58	11.49	-27.2	18.87	Quasi Max	H	346	179	40	-21.13	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss(dB) + AF (dB)
2. AF (dB) = Antenna Factor (dB) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



ABOVE 1GHz TEST DATA:

BT-LE (GFSK)

CHANNEL	TX Channel 0	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dB)	(dB)	(dB)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	16798.3	37.7	8.06	1.92	47.68	Peak Max	H	164	341	74	-26.32	Pass
2	12507.61	39.22	6.55	-1.37	44.39	Peak Max	V	104	153	74	-29.61	Pass
3	4879.628	51.98	4.18	-10.98	45.17	Peak Max	H	164	325	74	-28.83	Pass
4	16798.3	22.38	8.06	1.92	32.36	Average Max	H	164	341	54	-21.64	Pass
5	12507.61	25.56	6.55	-1.37	30.73	Average Max	V	104	153	54	-23.27	Pass
6	4879.628	43.28	4.18	-10.98	36.47	Average Max	H	164	325	54	-17.53	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss(dB) + AF (dB)
2. AF (dB) = Antenna Factor (dB) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

CHANNEL	TX Channel 19	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dB)	(dB)	(dB)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	16543.6	39.84	8.09	1.49	49.43	Peak Max	H	134	246	74	-24.57	Pass
2	4802.8	48.74	4.1	-10.96	41.88	Peak Max	V	121	200	74	-32.12	Pass
3	1796.747	51.13	2.61	-16.09	37.66	Peak Max	V	190	206	74	-36.35	Pass
4	16543.6	25.41	8.09	1.49	35	Average Max	H	134	246	54	-19	Pass
5	4802.8	37.03	4.1	-10.96	30.17	Average Max	V	121	200	54	-23.83	Pass
6	1796.747	39.14	2.61	-16.09	25.67	Average Max	V	190	206	54	-28.33	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss(dB) + AF (dB)
2. AF (dB) = Antenna Factor (dB) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

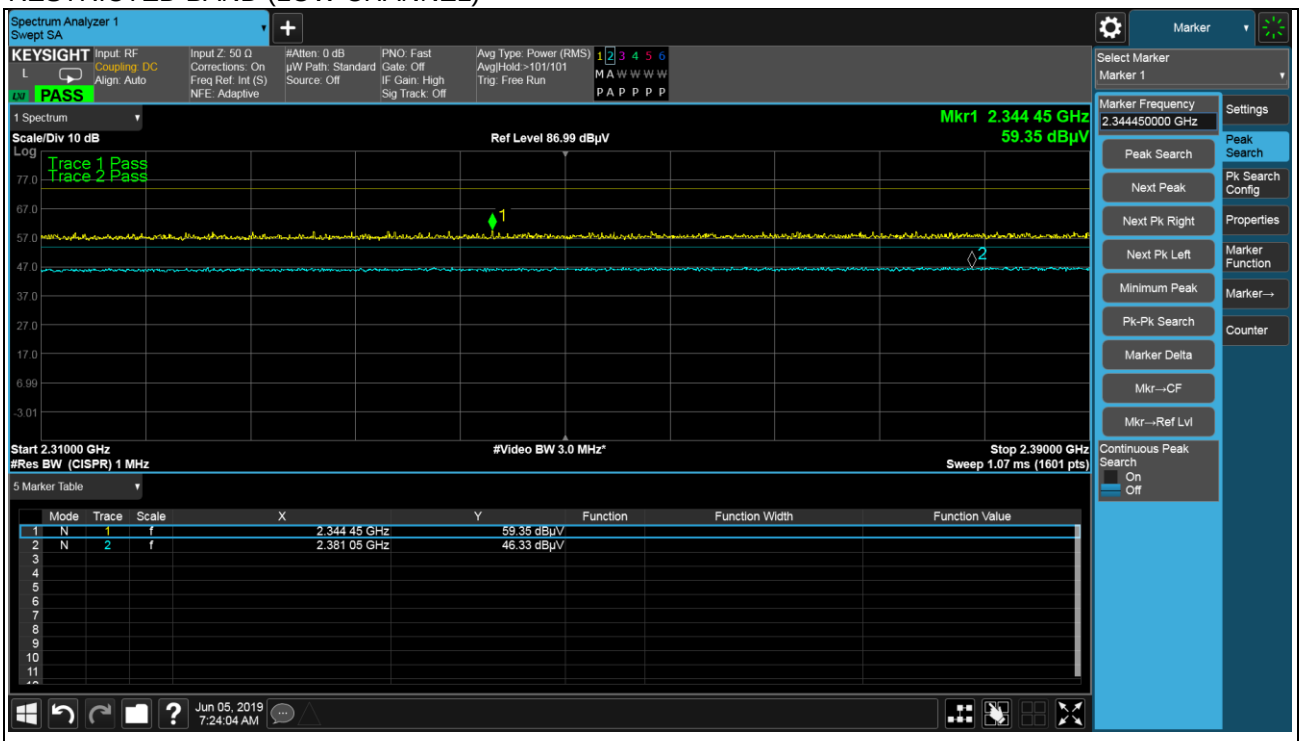
CHANNEL	TX Channel 39	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dB)	(dB)	(dB)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	17371.56	38.55	8.16	1.34	48.05	Peak Max	H	186	268	74	-25.95	Pass
2	4961.128	49.2	4.25	-11.01	42.45	Peak Max	H	163	307	74	-31.56	Pass
3	9647.693	41.52	5.56	-5.03	42.06	Peak Max	V	125	116	74	-31.94	Pass
4	17371.56	24.1	8.16	1.34	33.6	Average Max	H	186	268	54	-20.4	Pass
5	4961.128	38.09	4.25	-11.01	31.33	Average Max	H	163	307	54	-22.67	Pass
6	9647.693	27.93	5.56	-5.03	28.47	Average Max	V	125	116	54	-25.53	Pass

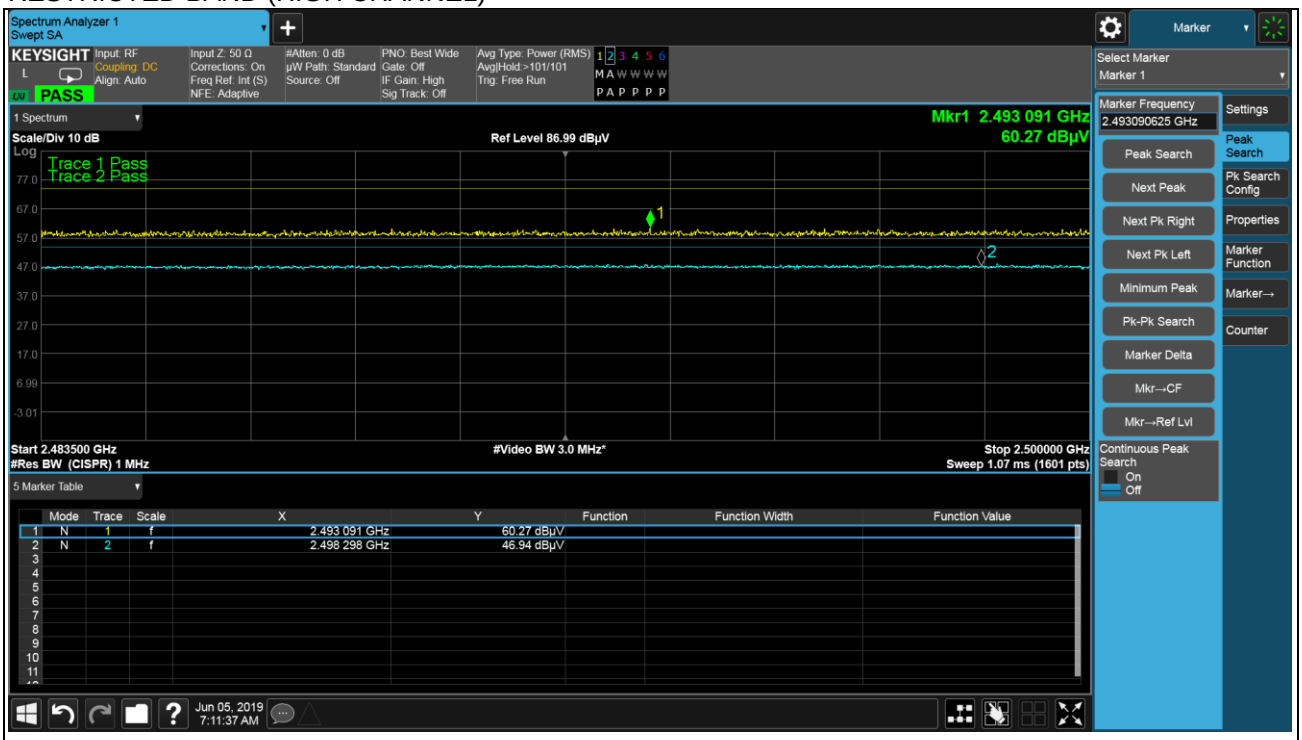
REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss(dB) + AF (dB)
2. AF (dB) = Antenna Factor (dB) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

RESTRICTED BAND (LOW CHANNEL)



RESTRICTED BAND (HIGH CHANNEL)



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.	Date Of Calibration	Due Date Of Calibration
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2018	08/28/2019
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2018	12/31/2019
LISN EMCO	3816/2NM	214372	01/10/2019	01/10/2020

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.

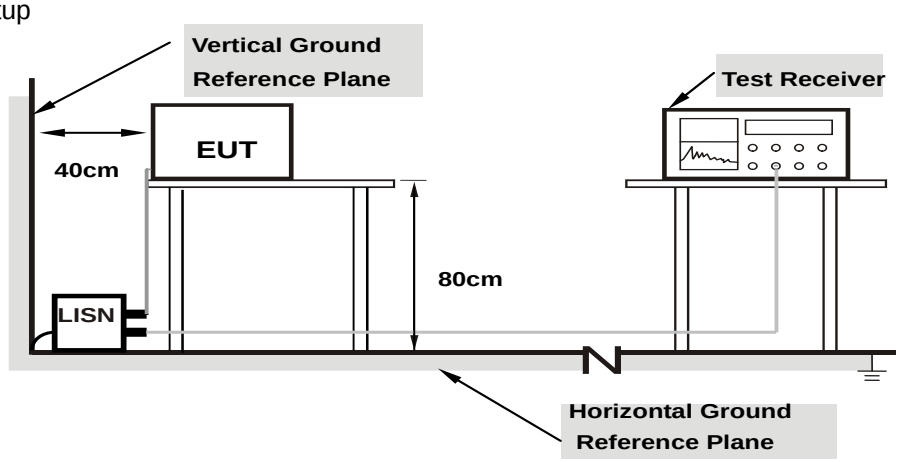
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

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 Conditions

Same as 4.1.6.

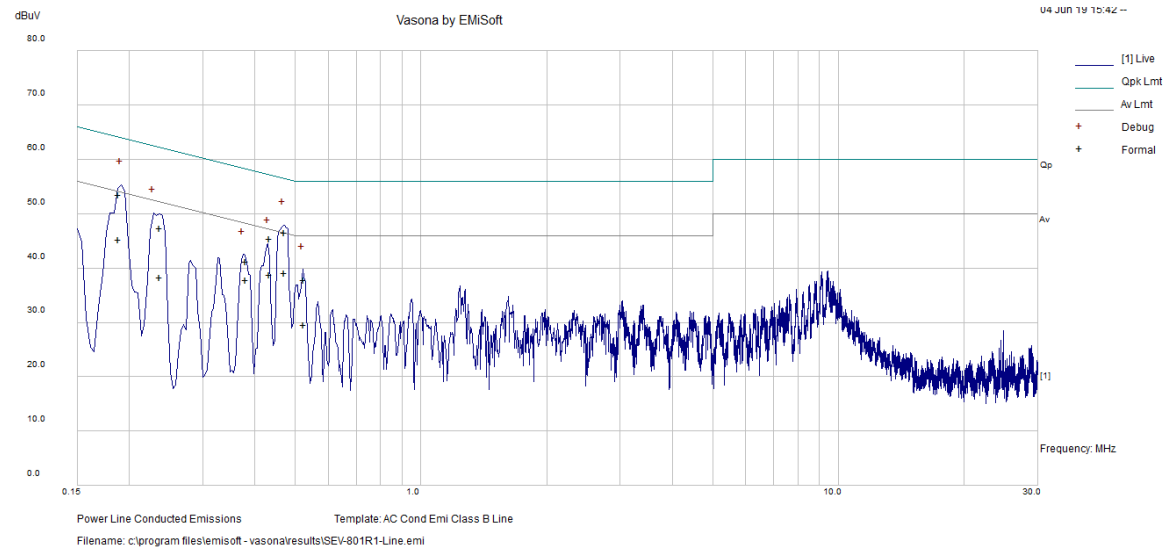
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak / Average

No	Freq.	Raw	Cale Loss	Factors	Level	Measurement Type	Line	Limit	Margin	Pass /Fail
	[MHz]	(dB)	(dB)	(dB)	(dBuV)			(dBuV)	(dB)	
1	0.189	46.4	7.16	0.04	53.61	Quasi Peak	Live	64.08	-10.48	Pass
2	0.473	39.19	7.34	0.04	46.57	Quasi Peak	Live	56.46	-9.89	Pass
3	0.237	40.1	7.2	0.04	47.35	Quasi Peak	Live	62.19	-14.85	Pass
4	0.435	38.14	7.32	0.04	45.5	Quasi Peak	Live	57.16	-11.66	Pass
5	0.382	33.97	7.3	0.04	41.31	Quasi Peak	Live	58.24	-16.93	Pass
6	0.525	30.5	7.37	0.04	37.92	Quasi Peak	Live	56	-18.08	Pass
7	0.189	38.15	7.16	0.04	45.35	Average	Live	54.08	-8.73	Pass
8	0.473	31.68	7.34	0.04	39.06	Average	Live	46.46	-7.4	Pass
9	0.237	31.01	7.2	0.04	38.25	Average	Live	52.19	-13.94	Pass
10	0.435	31.41	7.32	0.04	38.77	Average	Live	47.16	-8.39	Pass
11	0.382	30.51	7.3	0.04	37.84	Average	Live	48.24	-10.39	Pass
12	0.525	22.23	7.37	0.04	29.64	Average	Live	46	-16.36	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level - Limit value
3. Emission Level = Correction Factor + Raw Value + Factors Value.

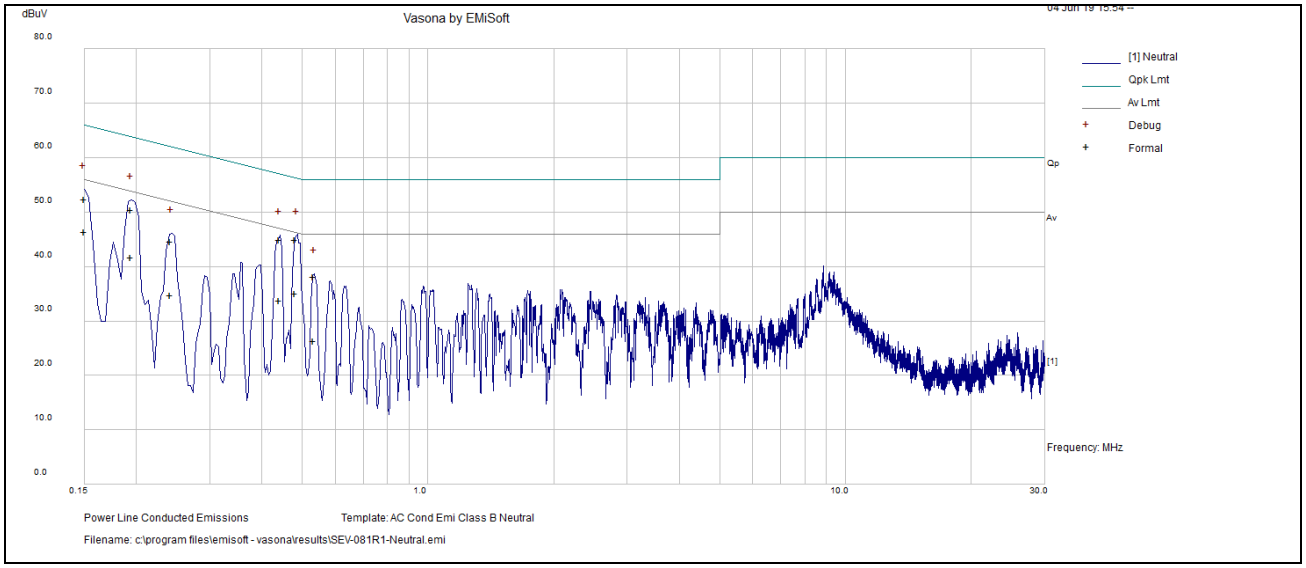


Phase	Neutral (N)	Detector Function	Quasi-Peak / Average

No	Freq.	Raw	Cale Loss	Factors	Level	Measurement Type	Line	Limit	Margin	Pass /Fail
	[MHz]	(dB)	(dB)	(dB)	(dBuV)			(dBuV)	(dB)	
1	0.482	37.67	7.34	0.03	45.04	Quasi Peak	Neutral	56.31	-11.27	Pass
2	0.442	37.57	7.32	0.03	44.93	Quasi Peak	Neutral	57.03	-12.1	Pass
3	0.194	43.19	7.16	0.04	50.39	Quasi Peak	Neutral	63.86	-13.47	Pass
4	0.150	45.29	7.11	0.04	52.44	Quasi Peak	Neutral	65.99	-13.54	Pass
5	0.242	37.47	7.21	0.03	44.71	Quasi Peak	Neutral	62.01	-17.3	Pass
6	0.533	30.8	7.38	0.03	38.21	Quasi Peak	Neutral	56	-17.79	Pass
7	0.482	27.66	7.34	0.03	35.03	Average	Neutral	46.31	-11.27	Pass
8	0.442	26.5	7.32	0.03	33.86	Average	Neutral	47.03	-13.17	Pass
9	0.194	34.5	7.16	0.04	41.7	Average	Neutral	53.86	-12.15	Pass
10	0.150	39.23	7.11	0.04	46.38	Average	Neutral	55.99	-9.61	Pass
11	0.242	27.59	7.21	0.03	34.83	Average	Neutral	52.01	-17.18	Pass
12	0.533	18.91	7.38	0.03	26.32	Average	Neutral	46	-19.68	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level - Limit value
3. Emission Level = Correction Factor + Raw Value + Factors Value.

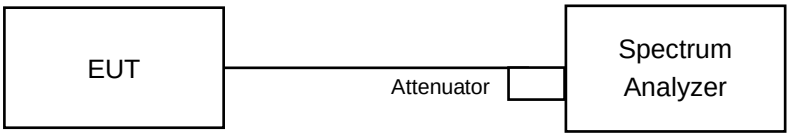


4.3 6dB Bandwidth Measurement

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) ≥ 3 x 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 fromTest 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

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
0	2402	0.718	0.5	PASS
19	2440	0.752	0.5	PASS
39	2480	0.769	0.5	PASS

Test Plots:

BLE-2402MHz

BLE-2440MHz


Spectrum Analyzer 1
Occupied BW
KEYSIGHT
RL
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.480000000 GHz
Avg|Hold:>10/10
Radio Std: None
Frequency
Center Frequency
2.480000000 GHz
Settings
Span
3.0000 MHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 1.50 dB
Ref Value 20.00 dBm
Scale/Div 10.0 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.480000 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 3 MHz
Sweep 5.00 ms (1001 pts)
2 Metrics
Occupied Bandwidth
1.8745 MHz
Total Power
7.63 dBm
Transmit Freq Error
-10.287 kHz
% of OBW Power
99.00 %
x dB Bandwidth
769.2 kHz
x dB
-6.00 dB
Jun 05, 2019
4:16:48 AM

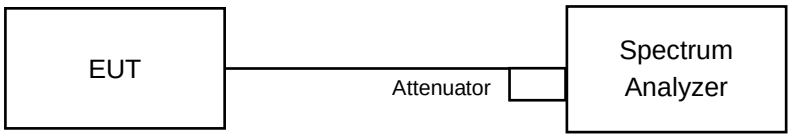
BLE-2480MHz

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 ≥ DTS bandwidth.
b. Set VBW ≥ 3 × RBW.
c. Set span ≥ 3 x 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.

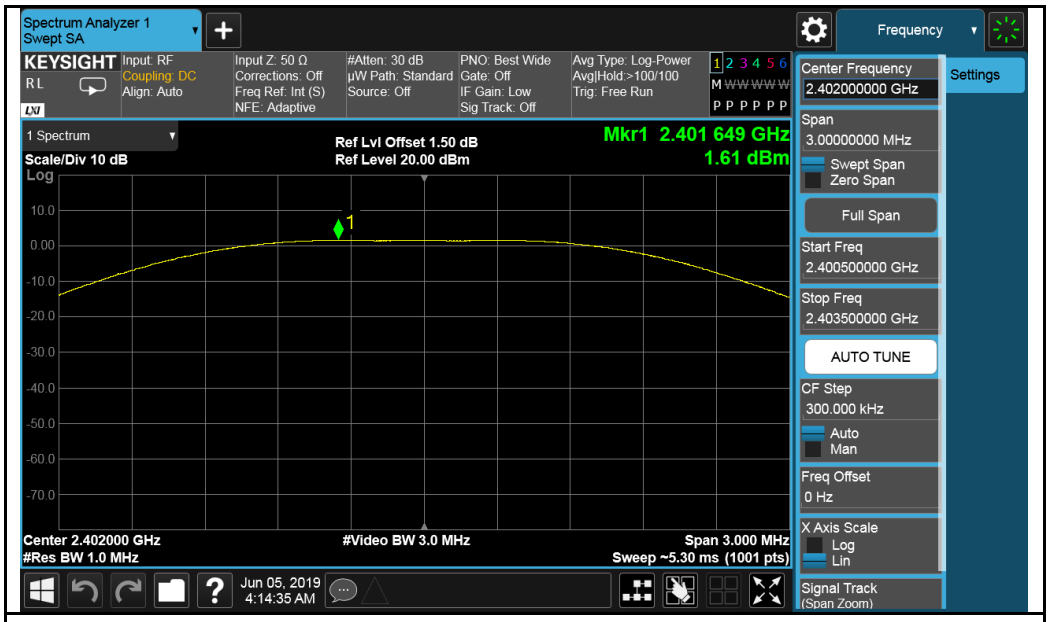
4.4.6 EUT Operating Conditions

Same as Item 4.3.6.

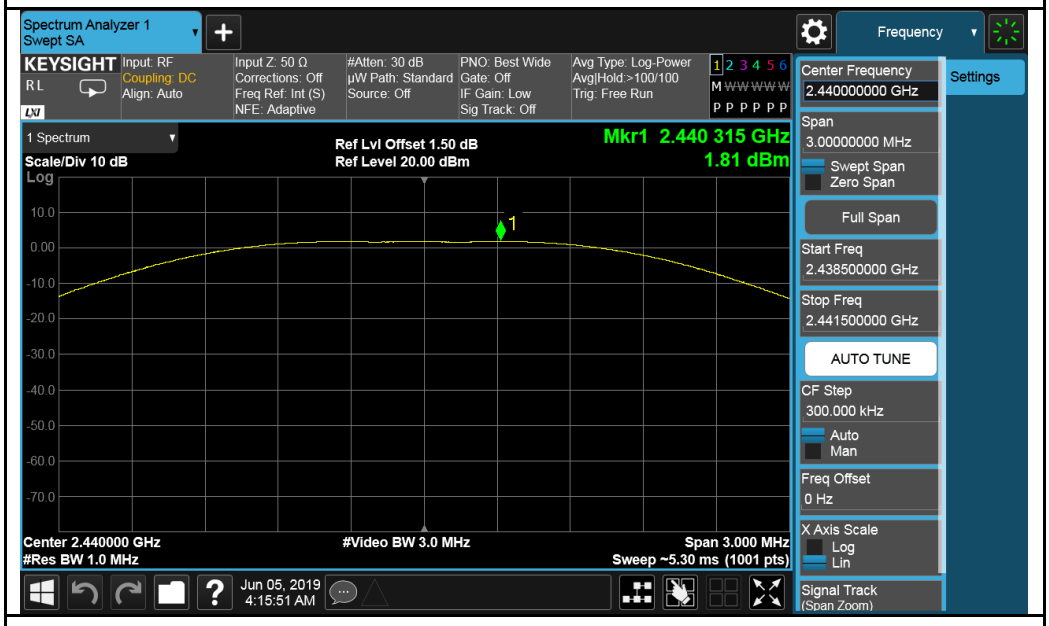
4.4.7 Test Results

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	1.61	30	Pass
19	2440	1.81	30	Pass
39	2480	1.83	30	Pass

Test Plots:



BLE-2402MHz



BLE-2440MHz


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
1 Spectrum
Ref Lvl Offset 1.50 dB
Ref Level 20.00 dBm
Mkr1 2.479 652 GHz
1.83 dBm
Scale/Div 10 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.480000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Span 3.000 MHz
Sweep ~5.30 ms (1001 pts)
Jun 05, 2019
4:16:45 AM
Frequency
Settings
Center Frequency
2.480000000 GHz
Span
3.00000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.478500000 GHz
Stop Freq
2.481500000 GHz
AUTO TUNE
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)

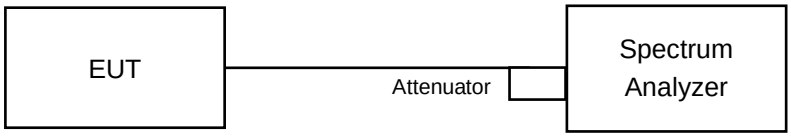
BLE-2480MHz

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 kHz ≤ RBW ≤ 100 kHz.
d. Set the VBW ≥ 3 × 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.

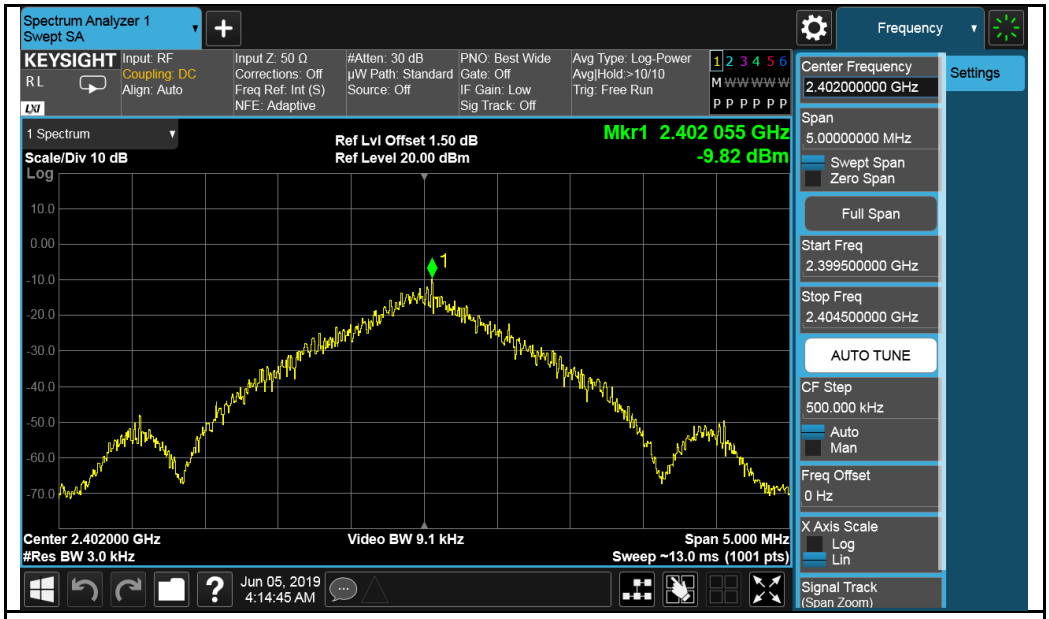
4.5.6 EUT Operating Condition

Same as Item 4.3.6

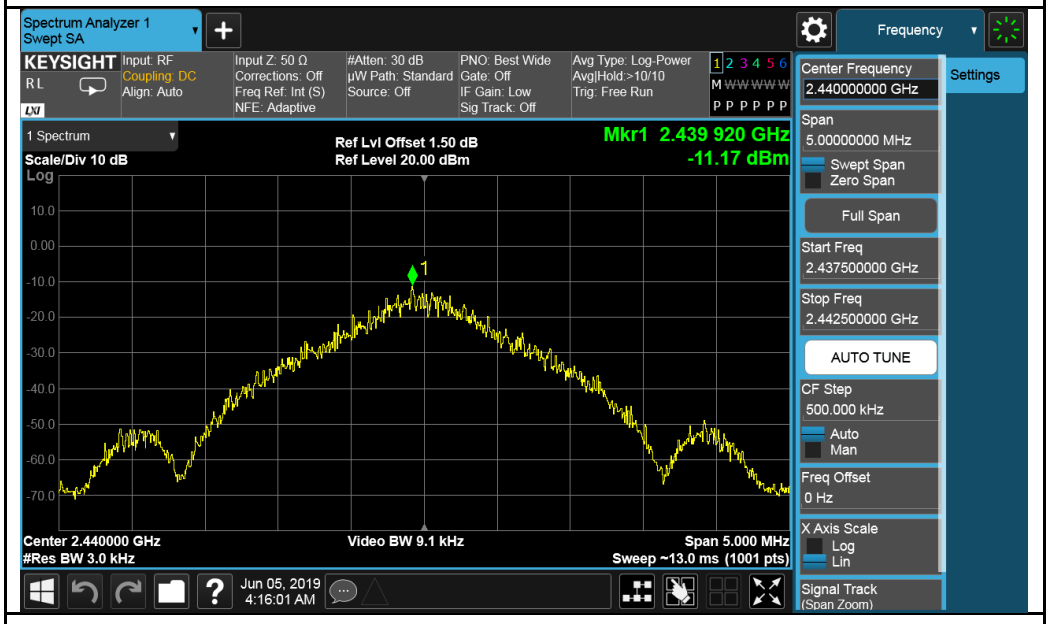
4.5.7 Test Results

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
0	2402	-9.82	8	Pass
19	2440	-11.17	8	Pass
39	2480	-10.99	8	Pass

Test Plots:



BLE-2402MHz



BLE-2440MHz


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>10/10
Trig: Free Run
1 Spectrum
Ref Lvl Offset 1.50 dB
Ref Level 20.00 dBm
Mkr1 2.479 930 GHz
-10.99 dBm
Scale/Div 10 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.480000 GHz
#Res BW 3.0 kHz
Video BW 9.1 kHz
Span 5.000 MHz
Sweep ~13.0 ms (1001 pts)
Jun 05, 2019
4:16:55 AM
Frequency
Settings
Center Frequency
2.480000000 GHz
Span
5.00000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.477500000 GHz
Stop Freq
2.482500000 GHz
AUTO TUNE
CF Step
500.000 kHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)

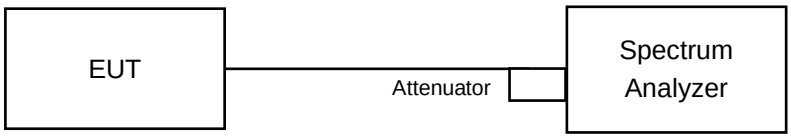
BLE-2480MHz

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 ≥ 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 OOBE

1. Set RBW = 100 kHz.
2. Set VBW ≥ 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.

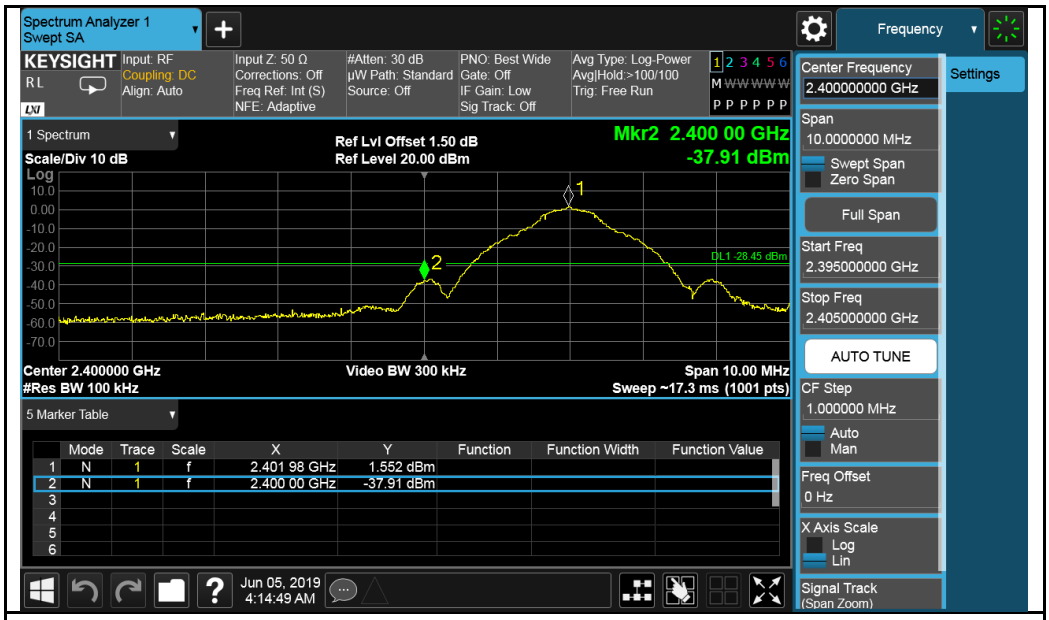
4.6.5 Deviation from Test Standard

No deviation.

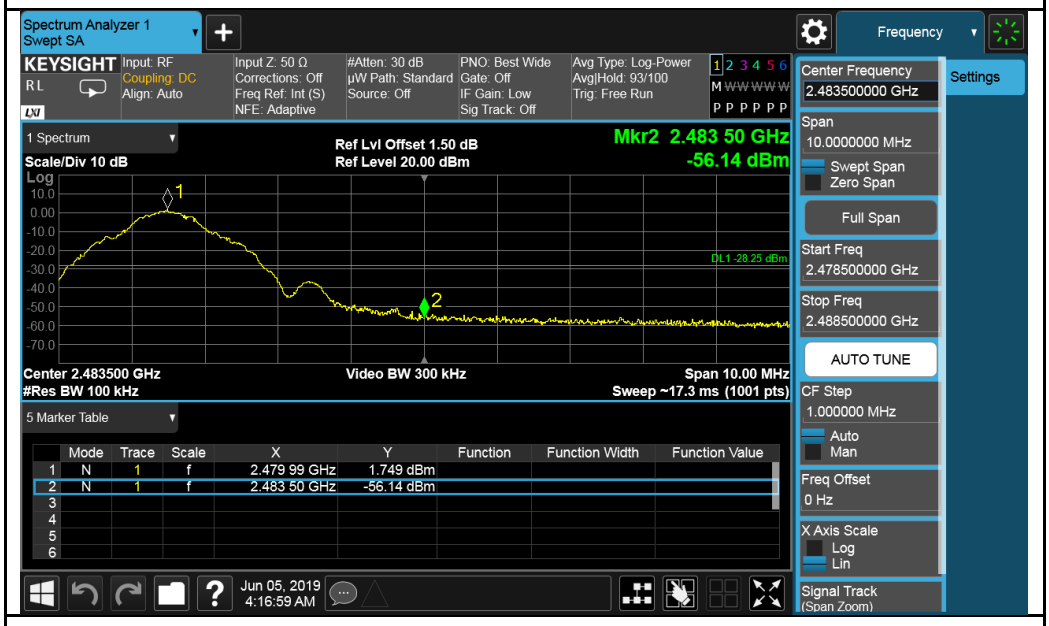
4.6.6 EUT Operating Condition

Same as Item 4.3.6

4.6.7 Test Results



BLE-2402MHz



BLE-2480MHz

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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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

Irvine OTA/PTCRB/Bluetooth/V2X Lab
15 Musick, Irvine, CA 92618
Tel: +1 949 716 6512

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.

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