



RF TEST REPORT

Applicant	Ademco Inc.
FCC ID	CFSRTF0B4T1
Product	100-07866
Brand	resideo
Model	RTF0B4T1AL59UB
Marketing	rtf module
Report No.	R1908A0486-R1
Issue Date	October 30, 2019

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2018)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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Summary of measurement results

Number	Test Case	Clause in FCC rules	Verdict
1	Maximum conducted output power	15.247(b)(3)	PASS
2	6 dB bandwidth	15.247(a)(2)	PASS
3	Power spectral density	15.247(e)	PASS
4	Band Edge	15.247(d)	PASS
5	Spurious RF Conducted Emissions	15.247(d)	PASS
6	Unwanted Emissions	15.247(d),15.205,15.209	PASS
7	Conducted Emissions	15.207	PASS
Date of Testing: August 27, 2019 ~October 18, 2019			



1. Test Laboratory

1.1. Notes of the test report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Testing Location

Company: TA Technology (Shanghai) Co., Ltd.
Address: No.145, Jintang Rd, Tangzhen Industry Park, Pudong
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2. General Description of Equipment under Test

Client Information

Applicant	Ademco Inc.
Applicant address	2 Corporate Center Drive Suite 100 , Melville, United States
Manufacturer	UNIVERSAL SCIENTIFIC INDUSTRIES CO., LTD,
Manufacturer address	No.497, Huangpujiang Road, Qiandeng, Kunshan, Jiangsu Province, China

General information

EUT Description	
Model	RTF0B4T1AL59UB
SN	/
Hardware Version	100-07866 A version
Software Version	SMARTRFTM-STUDIO 2.14.0
Power Supply	External Power Supply
Antenna Type	External Antenna
Antenna Connector	connect spec
Antenna Gain	2.15dBi
Test Mode	Bluetooth V5.0 LE
Modulation Type	BLE :GFSK
Max. Conducted Power	BLE : 20.60dBm
Operating Frequency Range(s)	BLE: 2402 ~2480 MHz
Note: The information of the EUT is declared by the manufacturer.	

3. Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standards

- FCC CFR47 Part 15C (2018) Radio Frequency Devices
- ANSI C63.10 (2013)
- KDB 558074 D01 15.247 Meas Guidance v05r02

4. Test Configuration

Test Mode

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The radiated emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis). The worst emission was found in lie-down position (X axis) and the loop antenna is vertical, the others are vertical and horizontal. and the worst case was recorded.

In order to find the worst case condition, Pre-tests are needed at the presence of different data rate. Preliminary tests have been done on all the configuration for confirming worst case. Data rate below means worst-case rate of each test item.

Worst-case data rates are shown as following table.

Band	Data Rate
Bluetooth(Low Energy) V5.0	2Mbps
Bluetooth(Low Energy) V5.0	1Mbps
Bluetooth(Low Energy) V5.0	125Kbps
Bluetooth(Low Energy) V5.0	500Kbps

5. Test Case Results

5.1. Maximum output power

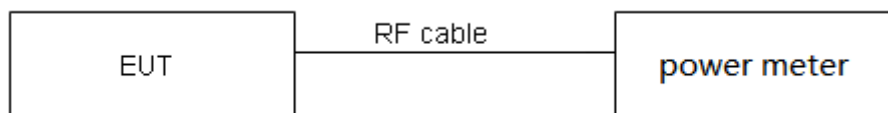
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Methods of Measurement

During the process of the testing, The EUT was connected to Average Power meter with a known loss. The EUT is max power transmission with proper modulation. The signal transmission is continuous.

Test Setup



Limits

Rule Part 15.247 (b) (3) specifies that " For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz: 1 Watt."

Average Output Power	$\leq 1W$ (30dBm)
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Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U = 0.44$ dB.

Test Results

Antenna 1

(BLE V5.0-1M FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.34	1.55	0.216	6.653
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	12.32	18.97	30	PASS
	2440	12.86	19.51	30	PASS
	2480	12.70	19.35	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-1M FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.34	1.55	0.216	6.646
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	12.77	19.42	30	PASS
	2440	13.60	20.25	30	PASS
	2480	12.61	19.26	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-2M FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.18	1.39	0.132	8.806
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	9.98	18.79	30	PASS
	2440	10.55	19.36	30	PASS
	2480	10.30	19.11	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-2M FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.18	1.39	0.129	8.877
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	10.89	19.77	30	PASS
	2440	11.55	20.43	30	PASS
	2480	10.87	19.75	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-125K FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	2.66	3.86	0.688	1.622
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	13.38	15.00	30	PASS
	2440	14.05	15.67	30	PASS
	2480	14.00	15.62	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-125K FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	2.66	3.89	0.683	1.653
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	12.90	14.55	30	PASS
	2440	14.31	15.96	30	PASS
	2480	13.75	15.40	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-500K FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.95	2.16	0.442	3.550
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	16.37	19.92	30	PASS
	2440	17.05	20.60	30	PASS
	2480	16.52	20.07	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-500K FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.95	2.18	0.436	3.606
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	16.63	20.24	30	PASS
	2440	16.57	20.18	30	PASS
	2480	16.80	20.41	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

Antenna 2

(BLE V5.0-1M FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.33	1.58	0.209	6.801
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	12.51	19.31	30	PASS
	2440	12.93	19.73	30	PASS
	2480	12.78	19.58	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-1M FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.34	1.55	0.216	6.653
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	13.16	19.81	30	PASS
	2440	13.64	20.29	30	PASS
	2480	13.68	20.33	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-2M FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.18	1.39	0.129	8.877
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	10.01	18.89	30	PASS
	2440	10.43	19.31	30	PASS
	2480	10.05	18.93	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-2M FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.18	1.39	0.129	8.877
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	11.46	20.34	30	PASS
	2440	11.41	20.29	30	PASS
	2480	11.22	20.10	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-125K FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	2.63	3.86	0.681	1.668
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	13.42	15.09	30	PASS
	2440	14.27	15.94	30	PASS
	2480	14.48	16.15	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-125K FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	2.66	3.86	0.688	1.622
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	13.17	14.79	30	PASS
	2440	14.00	15.62	30	PASS
	2480	13.90	15.52	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-500K FEM LINEAR MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.95	2.16	0.442	3.550
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	16.65	20.20	30	PASS
	2440	16.86	20.41	30	PASS
	2480	16.97	20.52	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

(BLE V5.0-500K FEM HIGH EFFICIENCY MODE)

Band	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
BLE	0.95	2.17	0.439	3.578
Note: when Duty cycle>0.98, Duty cycle correction Factor not required.				

Network Standards	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy)	2402	16.50	20.08	30	PASS
	2440	16.85	20.43	30	PASS
	2480	16.61	20.19	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

5.2. 6dB Bandwidth

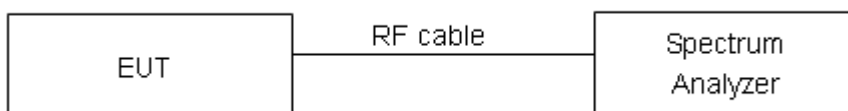
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable. RBW is set to 100 kHz; VBW is set to 300 kHz on spectrum analyzer. Dector=Peak, Trace mode=max hold.

Test Setup



Limits

Rule Part 15.247 (a) (2) specifies that “Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.”

minimum 6 dB bandwidth	≥ 500 kHz
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Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U = 936$ Hz.

Test Results:
Antenna 1
(BLE V5.0-1M FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.0608	0.6837	500	PASS
	2440	1.0622	0.6949	500	PASS
	2480	1.0841	0.7062	500	PASS

(BLE V5.0-1M FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.0651	0.6717	500	PASS
	2440	1.0565	0.6837	500	PASS
	2480	1.0794	0.7031	500	PASS

(BLE V5.0-2M FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	2.0734	1.245	500	PASS
	2440	2.0822	1.208	500	PASS
	2480	2.0754	1.265	500	PASS

(BLE V5.0-2M FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	2.0894	1.049	500	PASS
	2440	2.0814	1.113	500	PASS
	2480	2.0961	1.192	500	PASS

**(BLE V5.0-125K FEM LINEAR MODE)**

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1056	0.6039	500	PASS
	2440	1.1024	0.6038	500	PASS
	2480	1.1297	0.6063	500	PASS

(BLE V5.0-125K FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1136	0.6069	500	PASS
	2440	1.0983	0.6054	500	PASS
	2480	1.1329	0.6087	500	PASS

(BLE V5.0-500K FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1635	0.6633	500	PASS
	2440	1.1330	0.6481	500	PASS
	2480	1.1475	0.6504	500	PASS

(BLE V5.0-500K FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1701	0.6556	500	PASS
	2440	1.1337	0.6505	500	PASS
	2480	1.1670	0.6541	500	PASS

**Antenna 2****(BLE V5.0-1M FEM LINEAR MODE)**

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.0594	0.6804	500	PASS
	2440	1.0614	0.7005	500	PASS
	2480	1.0799	0.6915	500	PASS

(BLE V5.0-1M FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.0627	0.6643	500	PASS
	2440	1.0562	0.6823	500	PASS
	2480	1.0752	0.6853	500	PASS

(BLE V5.0-2M FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	2.0860	1.291	500	PASS
	2440	2.0941	1.189	500	PASS
	2480	2.0751	1.141	500	PASS

(BLE V5.0-2M FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	2.0873	1.169	500	PASS
	2440	2.0784	1.087	500	PASS
	2480	2.0824	1.186	500	PASS

(BLE V5.0-125K FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.0998	0.6038	500	PASS
	2440	1.1001	0.6035	500	PASS
	2480	1.1203	0.6076	500	PASS

(BLE V5.0-125K FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1021	0.6035	500	PASS
	2440	1.1009	0.6048	500	PASS
	2480	1.1281	0.6079	500	PASS

(BLE V5.0-500K FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1603	0.6667	500	PASS
	2440	1.1304	0.6479	500	PASS
	2480	1.1375	0.6545	500	PASS

(BLE V5.0-500K FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy)	2402	1.1499	0.6681	500	PASS
	2440	1.1282	0.6603	500	PASS
	2480	1.1714	0.6621	500	PASS



Antenna 1

(BLE V5.0-FEM LINEAR MODE)

99% bandwidth

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480





BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480



Minimum 6 dB bandwidth

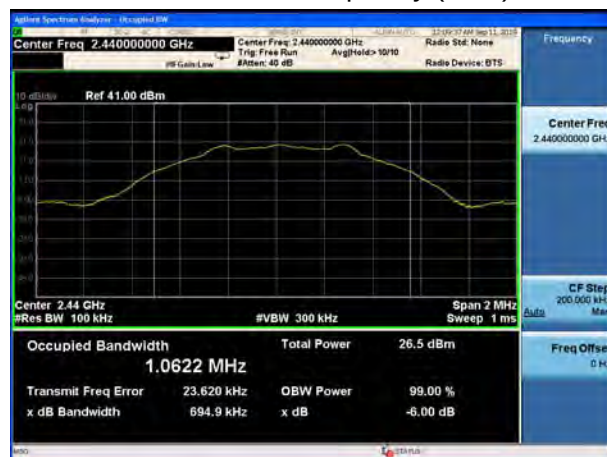
BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480



BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480



**(BLE V5.0- FEM HIGH EFFICIENCY MODE)****99% bandwidth**

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480



BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480





Minimum 6 dB bandwidth

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480



BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480





Antenna 2

(BLE V5.0-FEM LINEAR MODE)

99% bandwidth

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480



BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480





Minimum 6 dB bandwidth

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480



BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480



**(BLE V5.0- FEM HIGH EFFICIENCY MODE)****99% bandwidth**

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480



BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480





Minimum 6 dB bandwidth

BLE V5.0-1M Carrier frequency (MHz): 2402



BLE V5.0-2M Carrier frequency (MHz): 2402



BLE V5.0-1M Carrier frequency (MHz): 2440



BLE V5.0-2M Carrier frequency (MHz): 2440



BLE V5.0-1M Carrier frequency (MHz): 2480



BLE V5.0-2M Carrier frequency (MHz): 2480





BLE V5.0-125K Carrier frequency (MHz): 2402



BLE V5.0-500K Carrier frequency (MHz): 2402



BLE V5.0-125K Carrier frequency (MHz): 2440



BLE V5.0-500K Carrier frequency (MHz): 2440



BLE V5.0-125K Carrier frequency (MHz): 2480



BLE V5.0-500K Carrier frequency (MHz): 2480



5.3. Band Edge

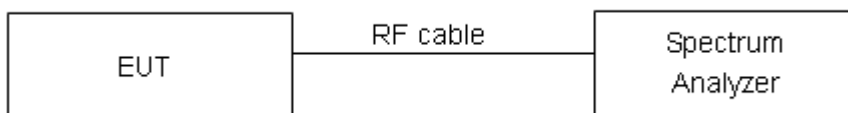
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable the band edge of the lowest and highest channels were measured. The peak detector is used and RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

Rule Part 15.247(d) specifies that “In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.” If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.”

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

Frequency	Uncertainty
2GHz-3GHz	1.407 dB



Test Results: PASS

Antenna 1

(BLE V5.0-FEM LINEAR MODE)

BLE V5.0-1M, Channel No.: 0



BLE V5.0-1M, Channel No.: 39



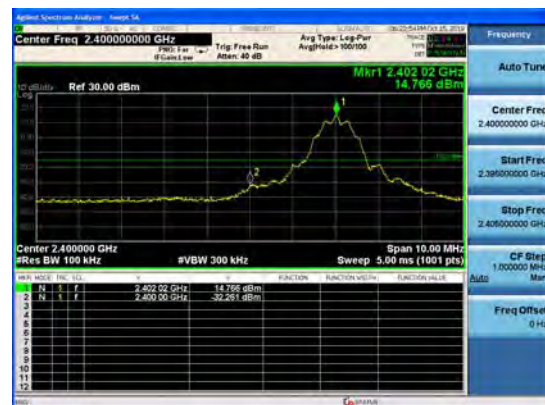
BLE V5.0-2M, Channel No.: 0



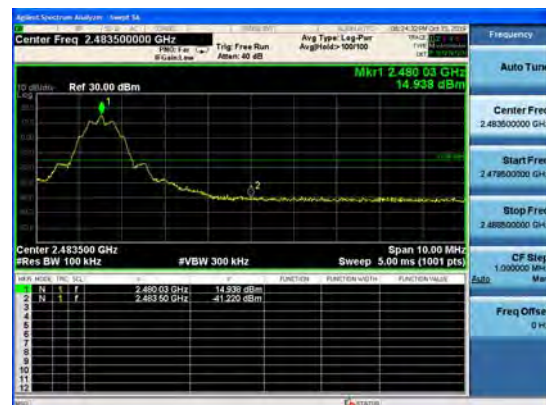
BLE V5.0-2M, Channel No.: 39



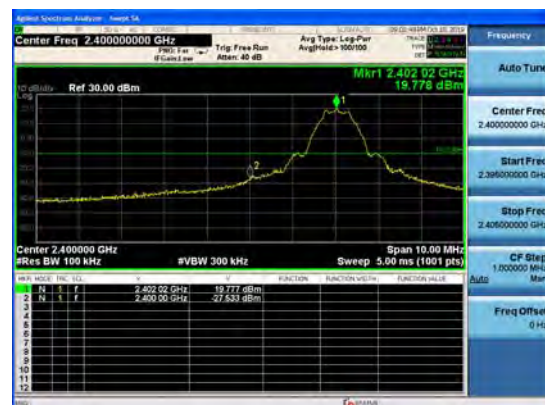
BLE V5.0-125K, Channel No.: 0



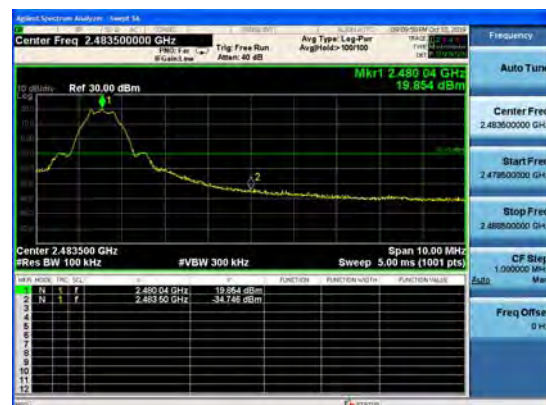
BLE V5.0-125K, Channel No.: 39

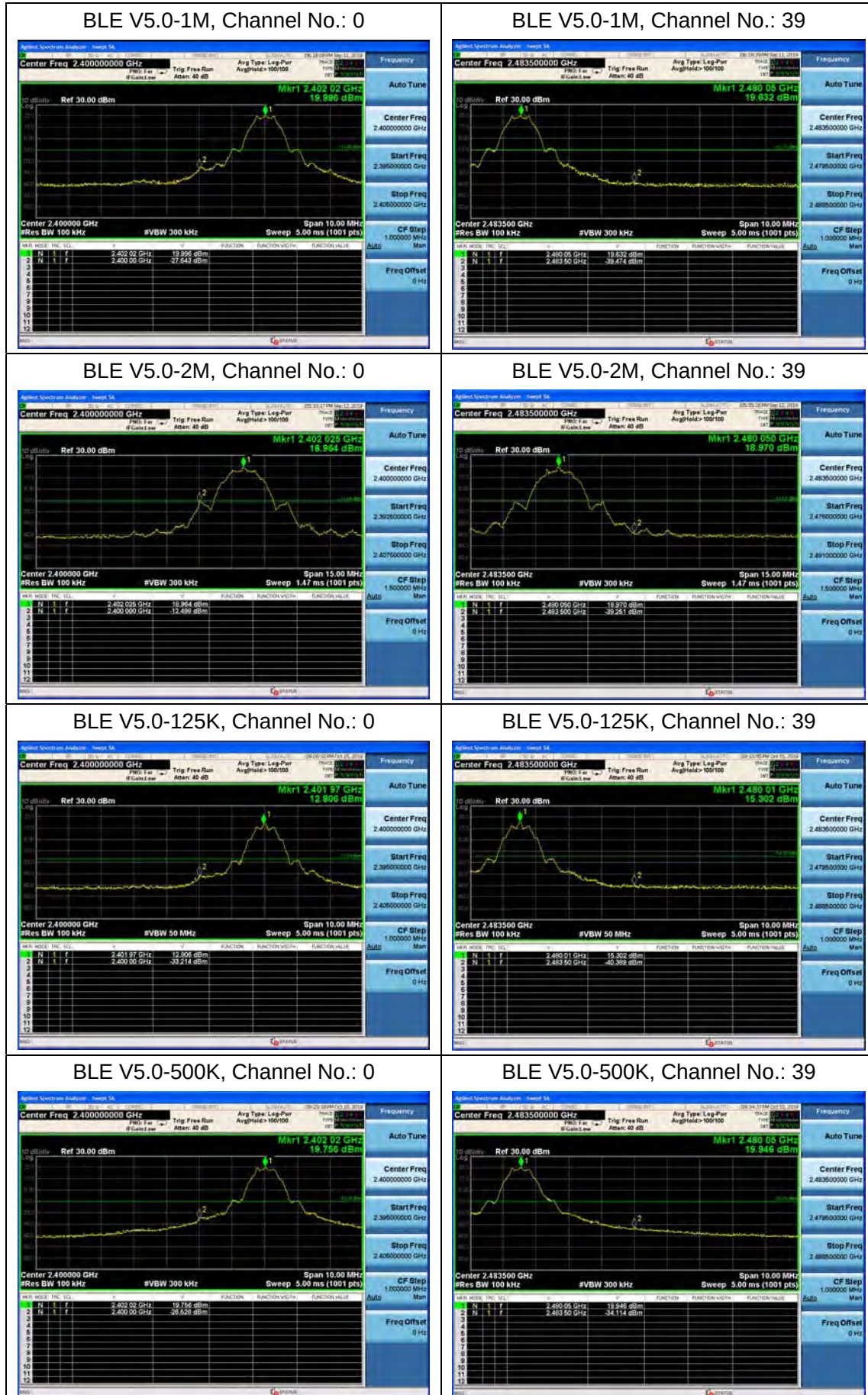


BLE V5.0-500K, Channel No.: 0



BLE V5.0-500K, Channel No.: 39



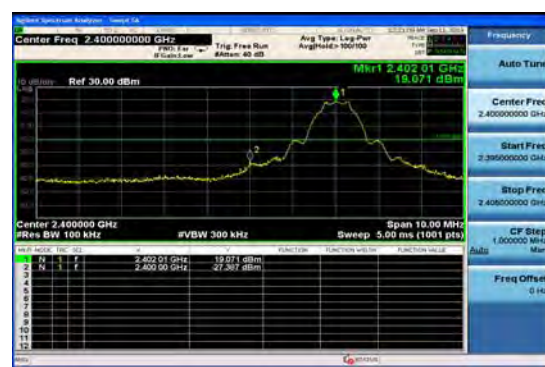
(BLE V5.0- FEM HIGH EFFICIENCY MODE)




Antenna 2

(BLE V5.0-FEM LINEAR MODE)

BLE V5.0-1M, Channel No.: 0



BLE V5.0-1M, Channel No.: 39



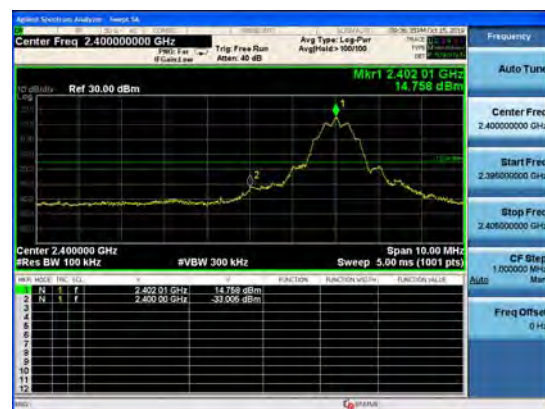
BLE V5.0-2M, Channel No.: 0



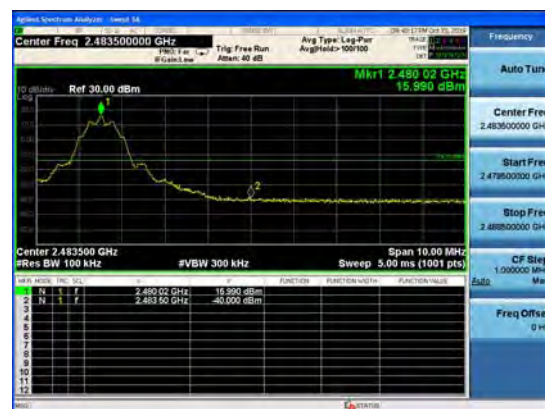
BLE V5.0-2M, Channel No.: 39



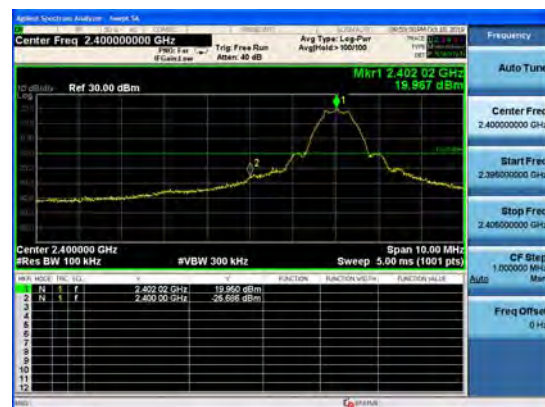
BLE V5.0-125K, Channel No.: 0



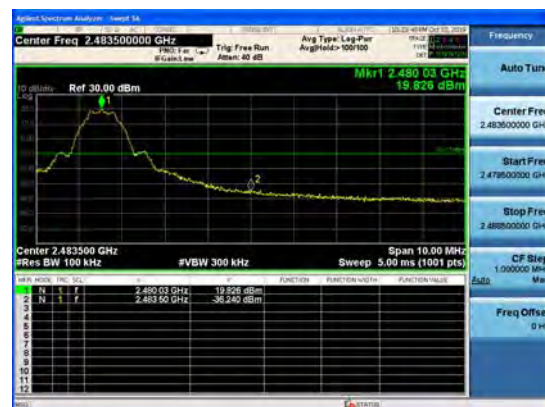
BLE V5.0-125K, Channel No.: 39



BLE V5.0-500K, Channel No.: 0



BLE V5.0-500K, Channel No.: 39



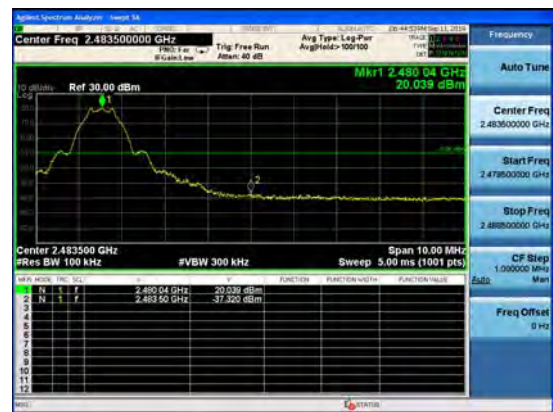


(BLE V5.0- FEM HIGH EFFICIENCY MODE)

BLE V5.0-1M, Channel No.: 0



BLE V5.0-1M, Channel No.: 39



BLE V5.0-2M, Channel No.: 0



BLE V5.0-2M, Channel No.: 39



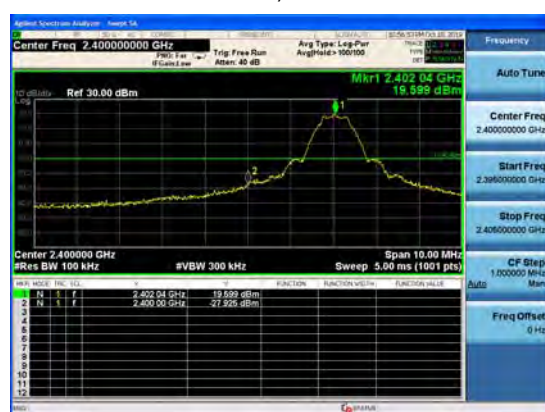
BLE V5.0-125K, Channel No.: 0



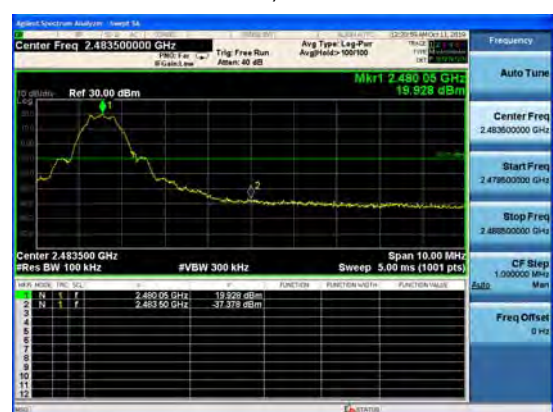
BLE V5.0-125K, Channel No.: 39



BLE V5.0-500K, Channel No.: 0



BLE V5.0-500K, Channel No.: 39



5.4. Power Spectral Density

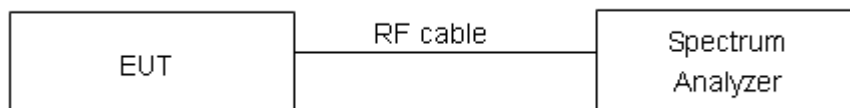
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

During the process of the testing, The EUT was connected to Spectrum Analyzer with a known loss. The EUT is max power transmission with proper modulation. Method AVGPS-2 in KDB558074 D01 was used for this test.

Test setup



Limits

Rule Part 15.247(e) specifies that" For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. "

Limits	$\leq 8 \text{ dBm} / 3\text{kHz}$
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Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U = 0.75\text{dB}$.

Test Results:
Antenna 1
(BLE V5.0-1M FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-4.04	2.61	8	PASS
	19	-3.58	3.07	8	PASS
	39	-6.60	0.05	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-1M FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-3.97	2.67	8	PASS
	19	-3.45	3.20	8	PASS
	39	-2.87	3.78	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-2M FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-9.40	-0.59	8	PASS
	19	-8.30	0.51	8	PASS
	39	-8.63	0.17	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-2M FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-8.78	0.09	8	PASS
	19	-9.07	-0.19	8	PASS
	39	-9.45	-0.57	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-125K FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	6.10	7.72	8	PASS
	19	6.23	7.85	8	PASS
	39	6.25	7.87	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-125K FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	5.95	7.60	8	PASS
	19	6.29	7.94	8	PASS
	39	6.32	7.98	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-500K FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	4.15	7.70	8	PASS
	19	4.43	7.98	8	PASS
	39	4.13	7.68	8	PASS

Note: Power Spectral Density =Read Value+Duty cycle correction factor

(BLE V5.0-500K FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	4.11	7.72	8	PASS
	19	4.30	7.91	8	PASS
	39	4.25	7.86	8	PASS

Note: Power Spectral Density =Read Value+Duty cycle correction factor

Antenna 2

(BLE V5.0-1M FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-4.02	2.79	8	PASS
	19	-3.15	3.65	8	PASS
	39	-6.30	0.50	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-1M FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-4.75	1.90	8	PASS
	19	-3.00	3.65	8	PASS
	39	-3.40	3.25	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-2M FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-9.16	-0.29	8	PASS
	19	-7.91	0.97	8	PASS
	39	-8.71	0.17	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-2M FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	-8.70	0.18	8	PASS
	19	-8.46	0.42	8	PASS
	39	-9.82	-0.94	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-125K FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	6.12	7.79	8	PASS
	19	6.22	7.89	8	PASS
	39	6.22	7.89	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-125K FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	5.88	7.50	8	PASS
	19	6.30	7.92	8	PASS
	39	6.26	7.89	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

(BLE V5.0-500K FEM LINEAR MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	4.16	7.71	8	PASS
	19	4.21	7.76	8	PASS
	39	4.00	7.55	8	PASS

Note: Power Spectral Density =Read Value+Duty cycle correction factor

(BLE V5.0-500K FEM HIGH EFFICIENCY MODE)

Network Standards	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy)	0	4.03	7.61	8	PASS
	19	4.00	7.58	8	PASS
	39	4.16	7.74	8	PASS

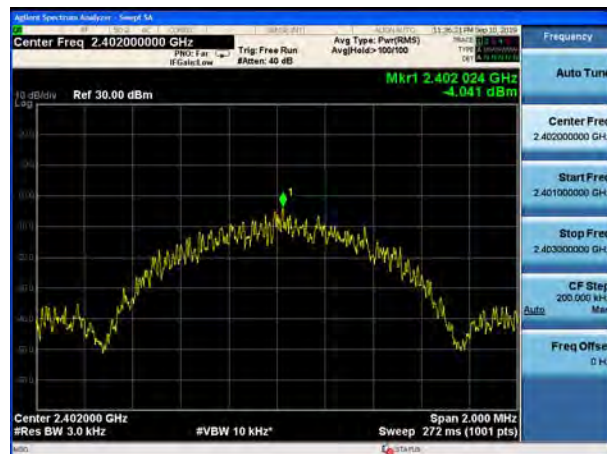
Note: Power Spectral Density =Read Value+Duty cycle correction factor



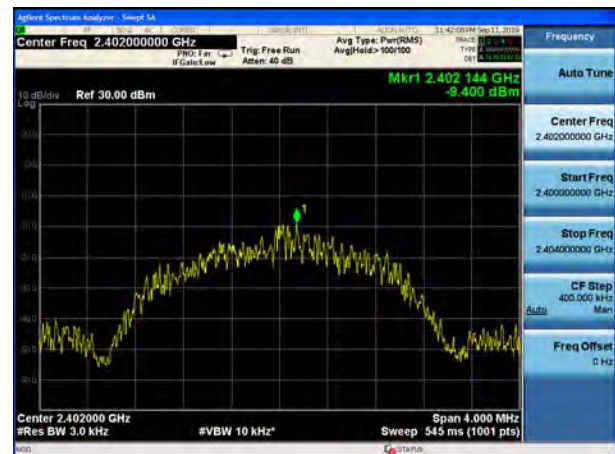
Antenna 1

(BLE V5.0-FEM LINEAR MODE)

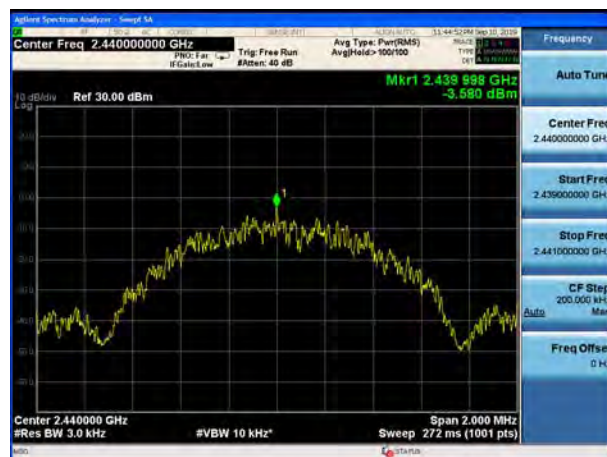
BLE V5.0-1M, Channel No.: 0



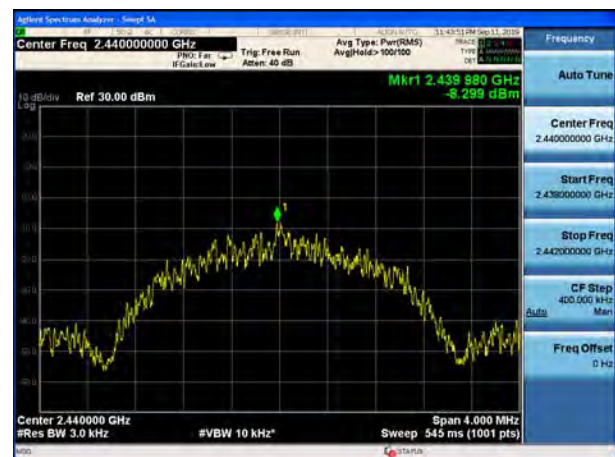
BLE V5.0-2M, Channel No.: 0



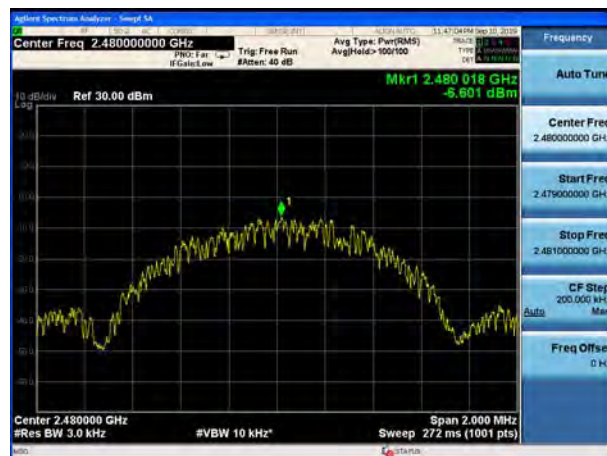
BLE V5.0-1M, Channel No.: 19



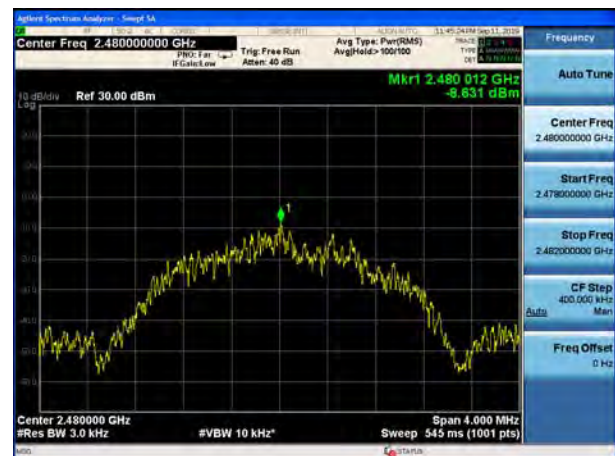
BLE V5.0-2M, Channel No.: 19



BLE V5.0-1M, Channel No.: 39

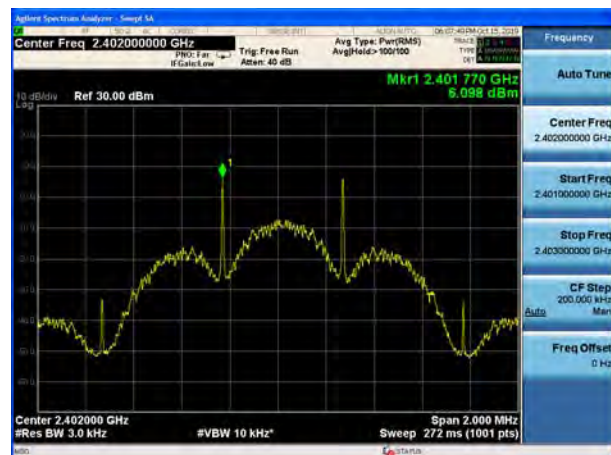


BLE V5.0-2M, Channel No.: 39





BLE V5.0-125K, Channel No.: 0



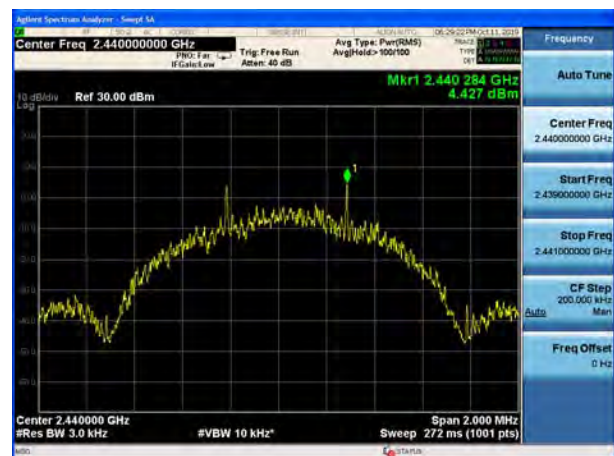
BLE V5.0-500K, Channel No.: 0



BLE V5.0-125K, Channel No.: 19



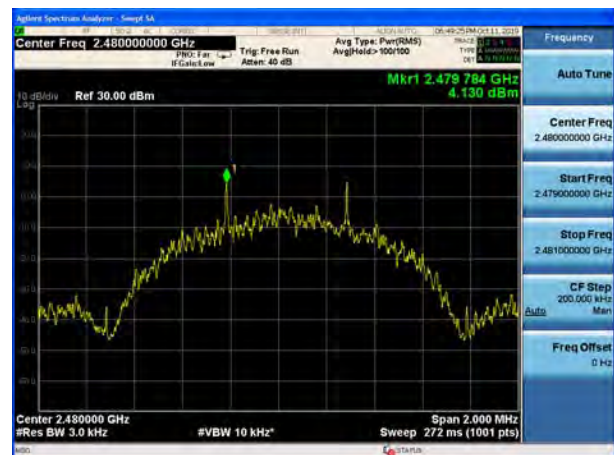
BLE V5.0-500K, Channel No.: 19



BLE V5.0-125K, Channel No.: 39



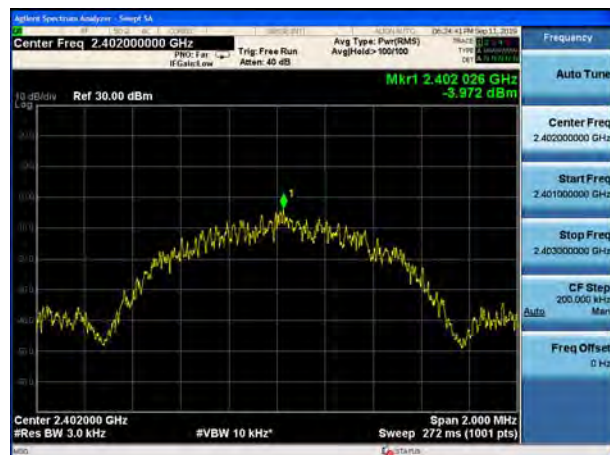
BLE V5.0-500K, Channel No.: 39



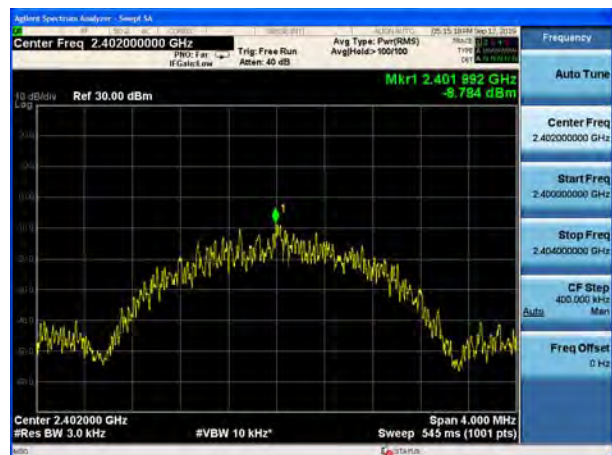


(BLE V5.0- FEM HIGH EFFICIENCY MODE)

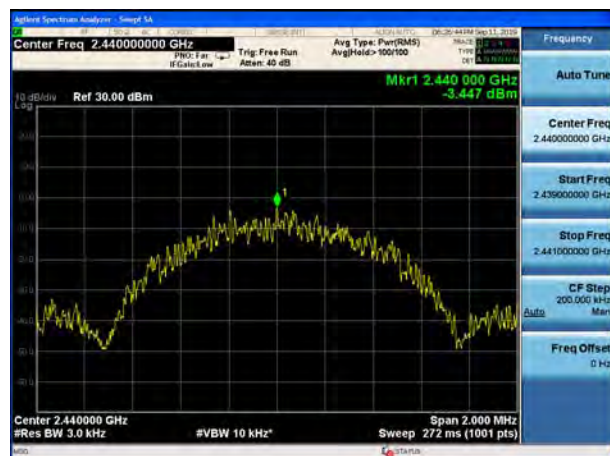
BLE V5.0-1M, Channel No.: 0



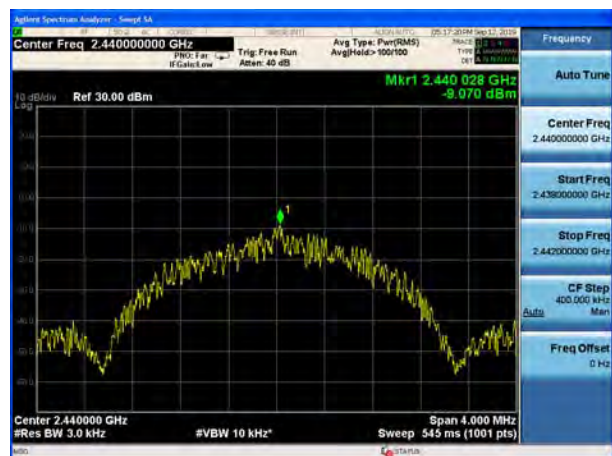
BLE V5.0-2M, Channel No.: 0



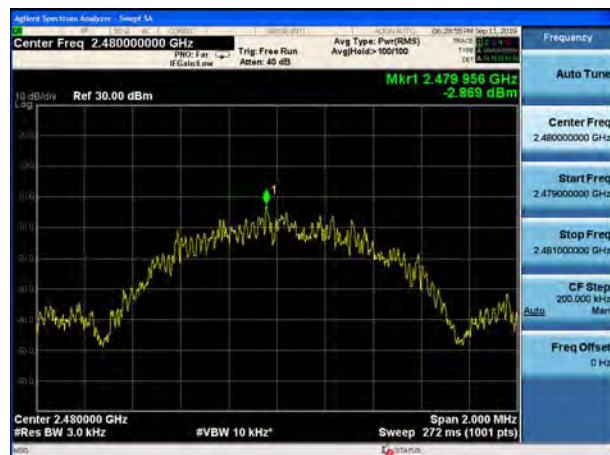
BLE V5.0-1M, Channel No.: 19



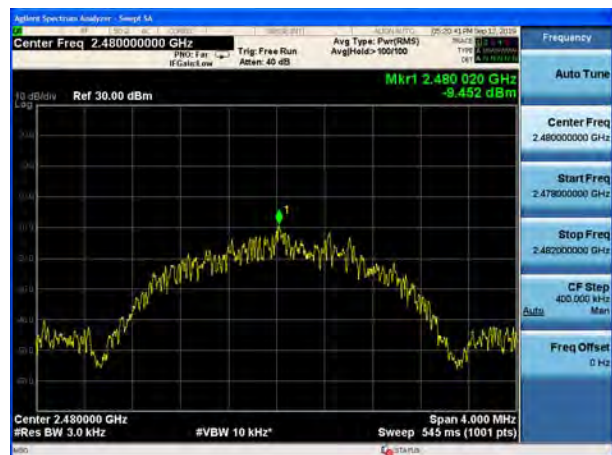
BLE V5.0-2M, Channel No.: 19



BLE V5.0-1M, Channel No.: 39



BLE V5.0-2M, Channel No.: 39





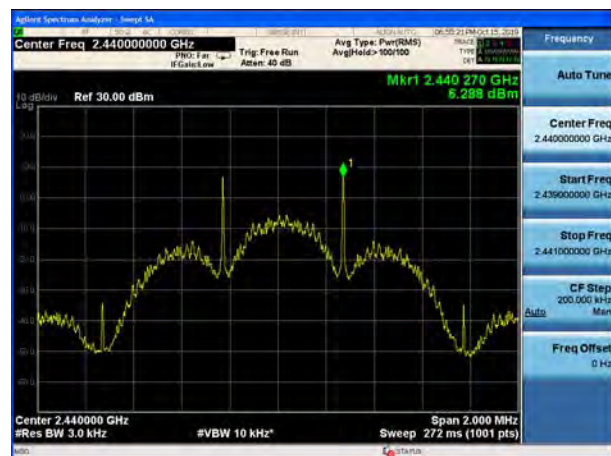
BLE V5.0-125K, Channel No.: 0



BLE V5.0-500K, Channel No.: 0



BLE V5.0-125K, Channel No.: 19



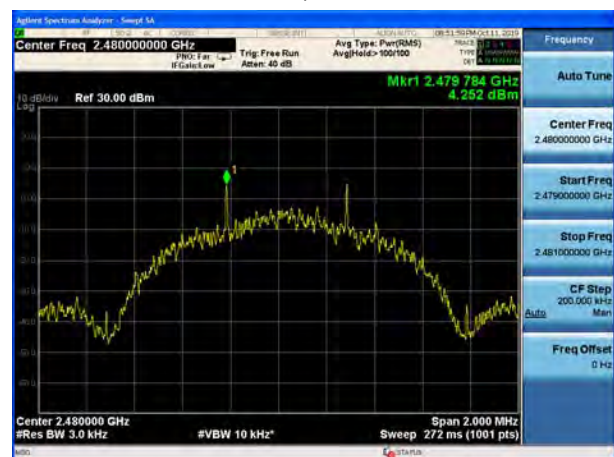
BLE V5.0-500K, Channel No.: 19



BLE V5.0-125K, Channel No.: 39



BLE V5.0-500K, Channel No.: 39

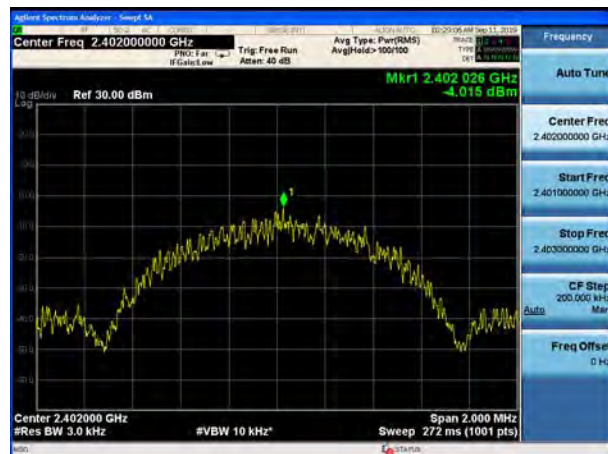




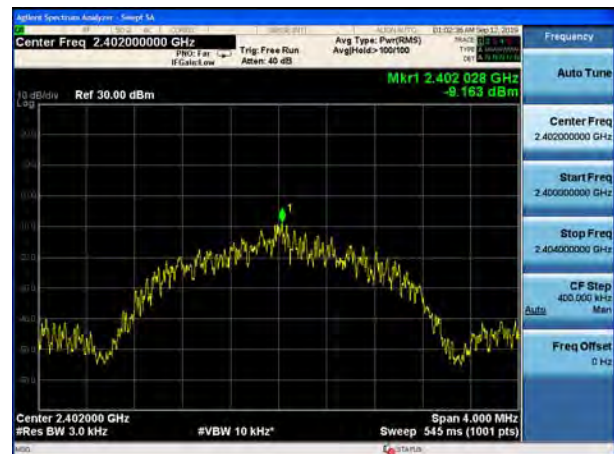
Antenna 2

(BLE V5.0-FEM LINEAR MODE)

BLE V5.0-1M, Channel No.: 0



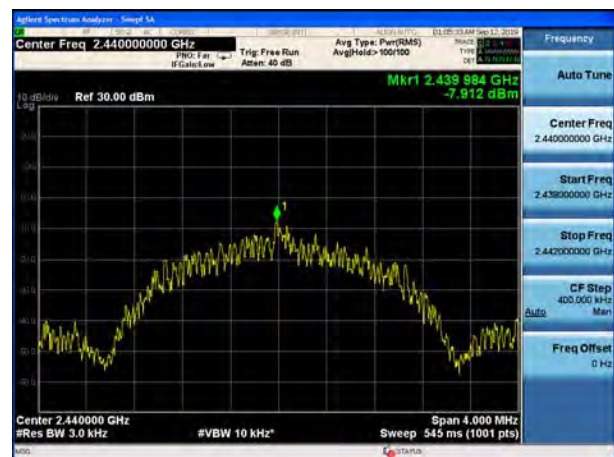
BLE V5.0-2M, Channel No.: 0



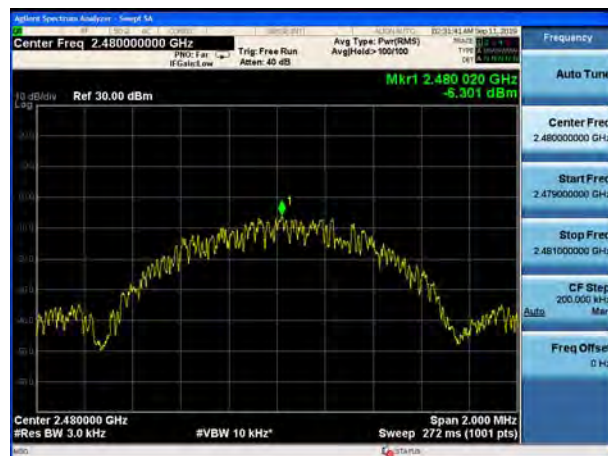
BLE V5.0-1M, Channel No.: 19



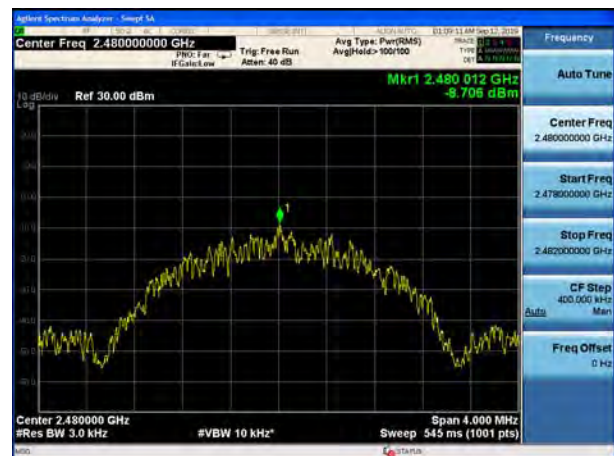
BLE V5.0-2M, Channel No.: 19



BLE V5.0-1M, Channel No.: 39

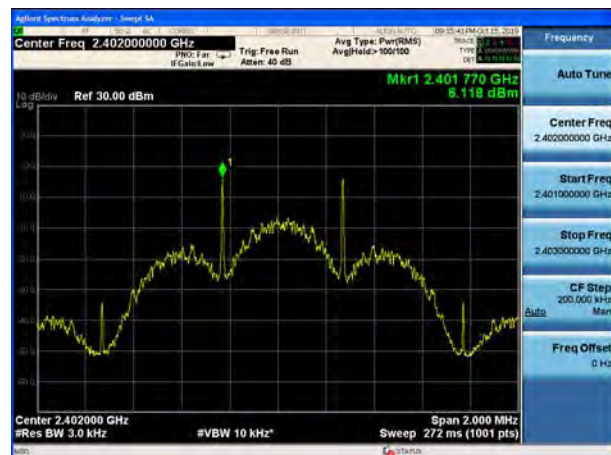


BLE V5.0-2M, Channel No.: 39

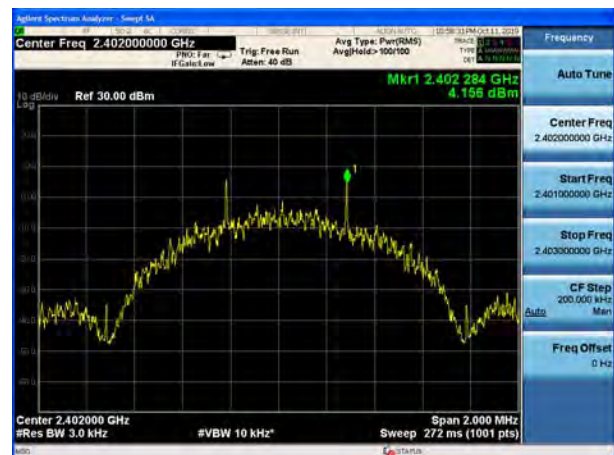




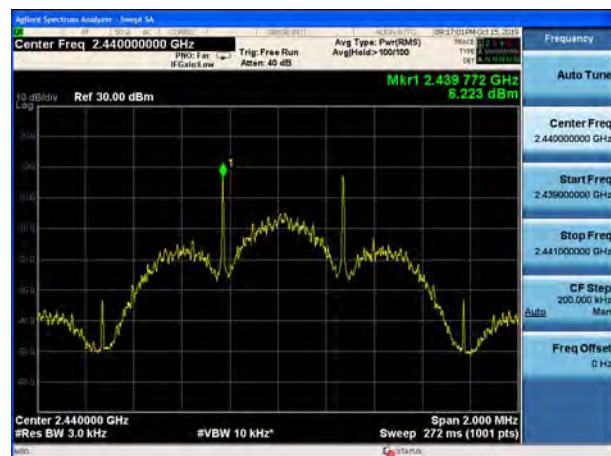
BLE V5.0-125K, Channel No.: 0



BLE V5.0-500K, Channel No.: 0



BLE V5.0-125K, Channel No.: 19



BLE V5.0-500K, Channel No.: 19



BLE V5.0-125K, Channel No.: 39



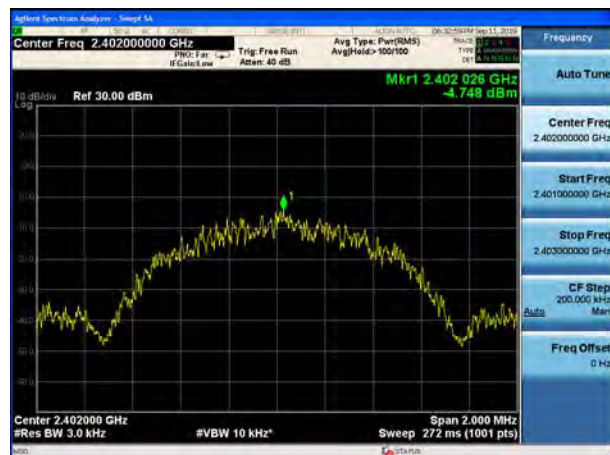
BLE V5.0-500K, Channel No.: 39



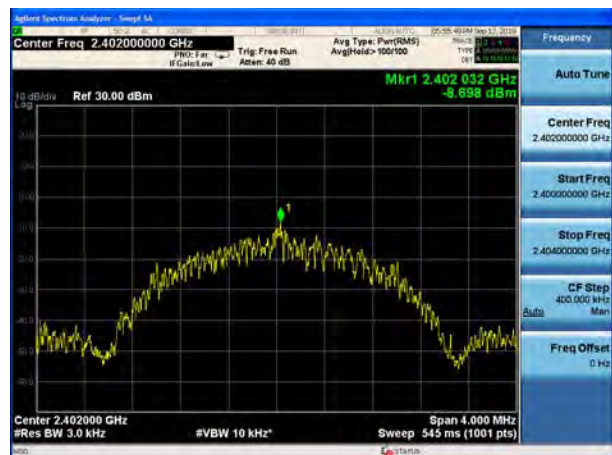


(BLE V5.0- FEM HIGH EFFICIENCY MODE)

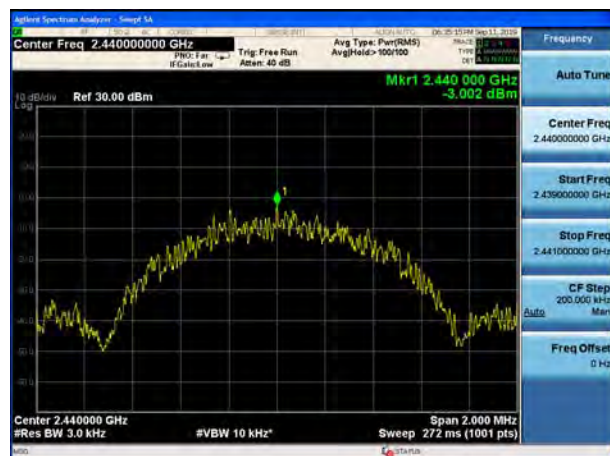
BLE V5.0-1M, Channel No.: 0



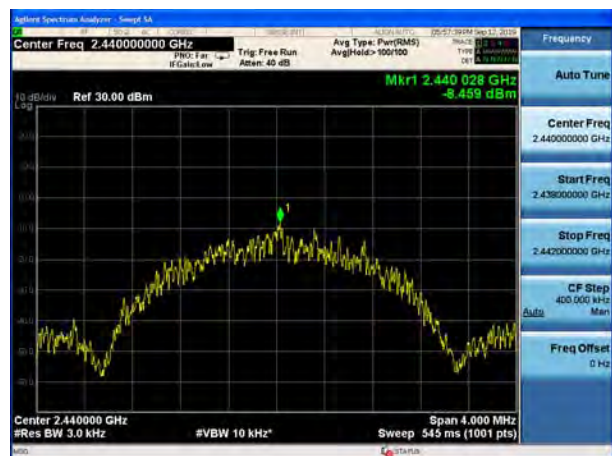
BLE V5.0-2M, Channel No.: 0



BLE V5.0-1M, Channel No.: 19



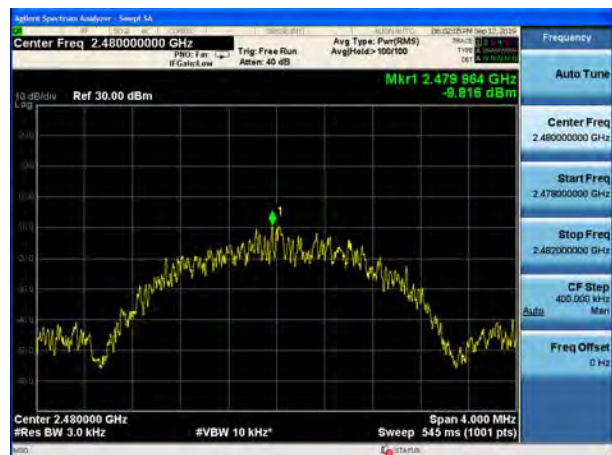
BLE V5.0-2M, Channel No.: 19



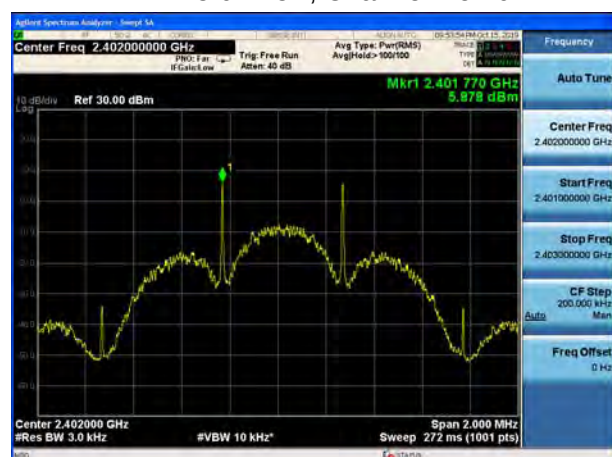
BLE V5.0-1M, Channel No.: 39



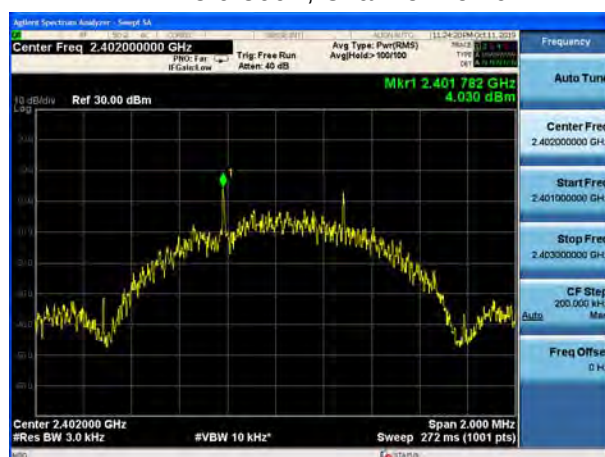
BLE V5.0-2M, Channel No.: 39



BLE V5.0-125K, Channel No.: 0



BLE V5.0-500K, Channel No.: 0



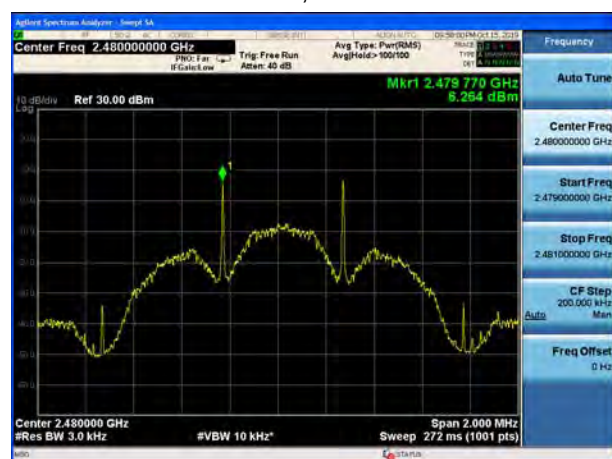
BLE V5.0-125K, Channel No.: 19



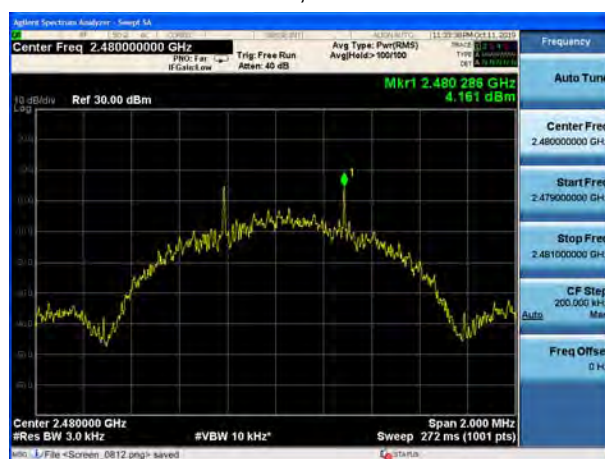
BLE V5.0-500K, Channel No.: 19



BLE V5.0-125K, Channel No.: 39



BLE V5.0-500K, Channel No.: 39



5.5. Spurious RF Conducted Emissions

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer with a known loss. The spectrum analyzer scans from 30MHz to the 10th harmonic of the carrier. The peak detector is used. Set RBW to 100 kHz and VBW to 300 kHz, Sweep is set to ATUO.

The test is in transmitting mode.

Test setup



Limits

Rule Part 15.247(d) pacifies that "In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. "

Antenna 1

(BLE V5.0-FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-1M (Low Energy)	2402	19.14	-10.86
	2440	19.70	-10.30
	2480	18.77	-11.23
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-2M (Low Energy)	2402	19.47	-10.54
	2440	18.92	-11.08
	2480	20.07	-9.93

Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-125K (Low Energy)	2402	12.28	-17.72
	2440	14.88	-15.12
	2480	12.35	-17.65
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-500K (Low Energy)	2402	19.28	-10.72
	2440	20.30	-9.70
	2480	19.80	-10.20

(BLE V5.0- FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-1M (Low Energy)	2402	20.36	-9.64
	2440	20.40	-9.60
	2480	20.73	-9.27
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-2M (Low Energy)	2402	20.44	-9.56
	2440	19.82	-10.18
	2480	20.93	-9.07
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-125K (Low Energy)	2402	15.06	-14.94
	2440	12.27	-17.73
	2480	15.02	-14.98
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-500K (Low Energy)	2402	19.13	-10.87
	2440	19.76	-10.24
	2480	20.33	-9.67

Antenna 2
(BLE V5.0-FEM LINEAR MODE)

Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-1M (Low Energy)	2402	19.81	-10.19
	2440	19.24	-10.76
	2480	20.10	-9.90

Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-2M (Low Energy)	2402	19.79	-10.21
	2440	19.89	-10.11
	2480	20.15	-9.85
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-125K (Low Energy)	2402	12.15	-17.85
	2440	14.52	-15.48
	2480	12.52	-17.48
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-500K (Low Energy)	2402	19.58	-10.42
	2440	19.79	-10.21
	2480	20.19	-9.81

(BLE V5.0- FEM HIGH EFFICIENCY MODE)

Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-1M (Low Energy)	2402	19.81	-10.19
	2440	20.15	-9.85
	2480	20.80	-9.20
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-2M (Low Energy)	2402	20.54	-9.46
	2440	19.53	-10.47
	2480	21.01	-8.99
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-125K (Low Energy)	2402	14.85	-15.15
	2440	15.07	-14.93
	2480	15.00	-15.00
Network Standards	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth V5.0-500K (Low Energy)	2402	19.11	-10.89
	2440	19.88	-10.12
	2480	19.78	-10.22

**Measurement Uncertainty**

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

Frequency	Uncertainty
100kHz-2GHz	0.684 dB
2GHz-26GHz	1.407 dB

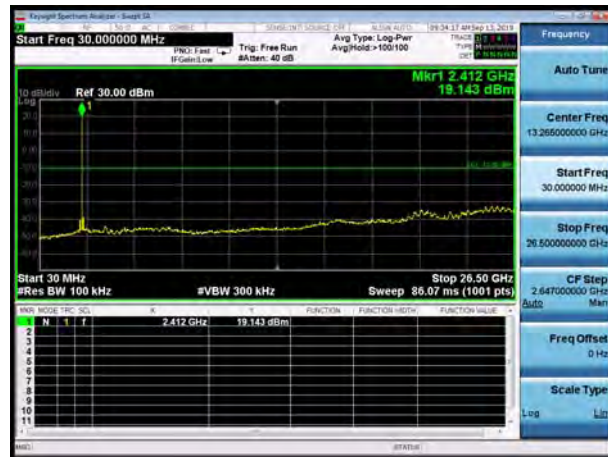


Test Results:

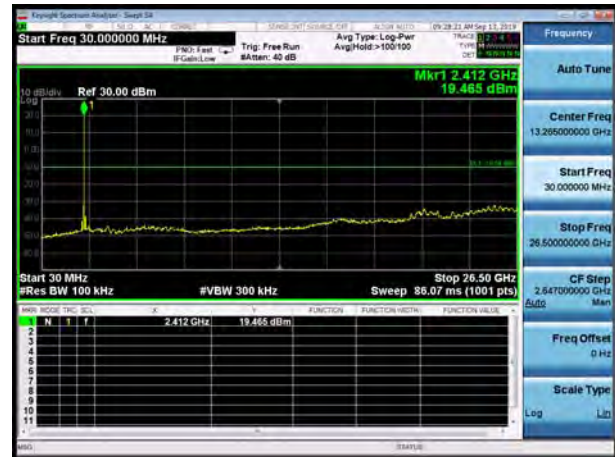
Antenna 1

(BLE V5.0-FEM LINEAR MODE)

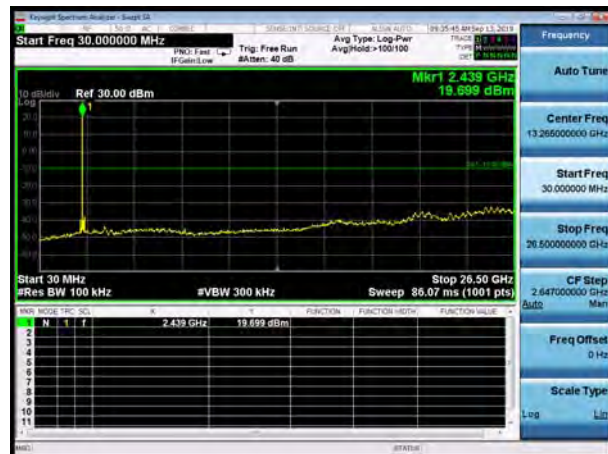
BLE V5.0-1M, Channel No.: 0



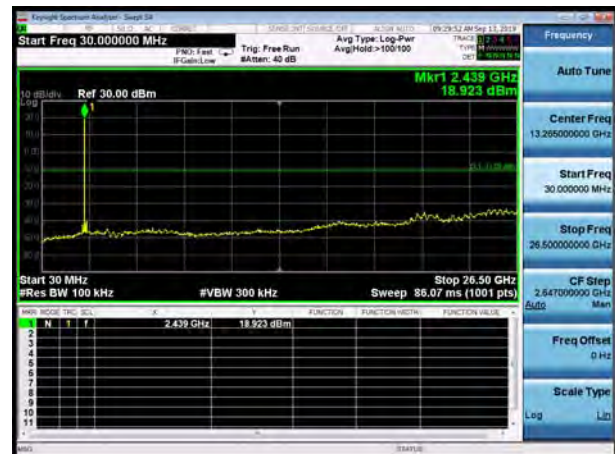
BLE V5.0-2M, Channel No.: 0



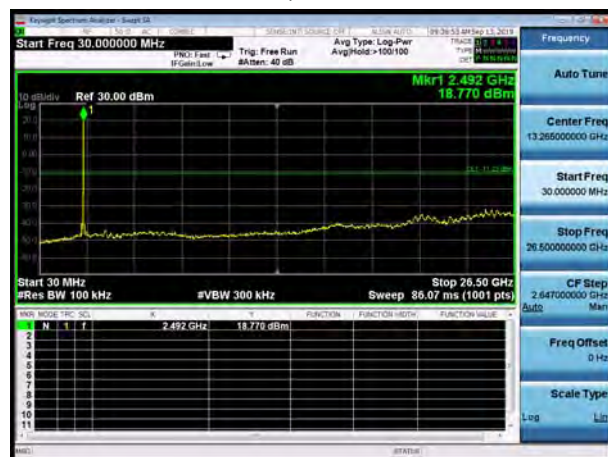
BLE V5.0-1M, Channel No.: 19



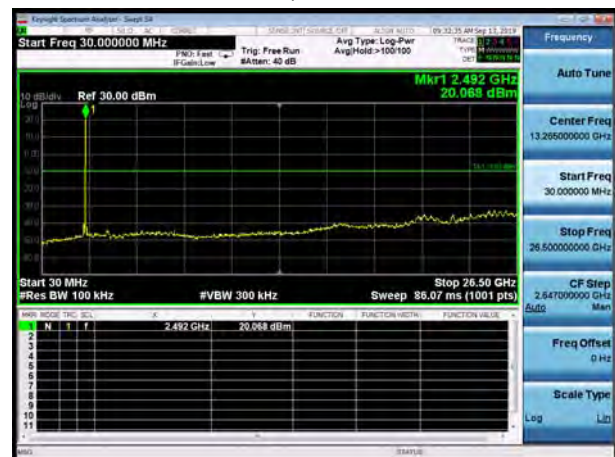
BLE V5.0-2M, Channel No.: 19



BLE V5.0-1M, Channel No.: 39

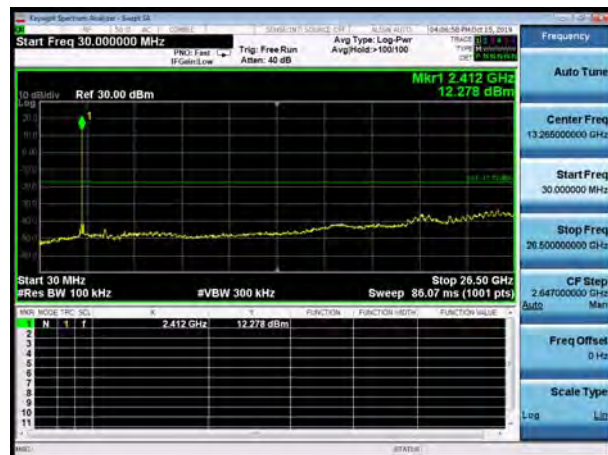


BLE V5.0-2M, Channel No.: 39

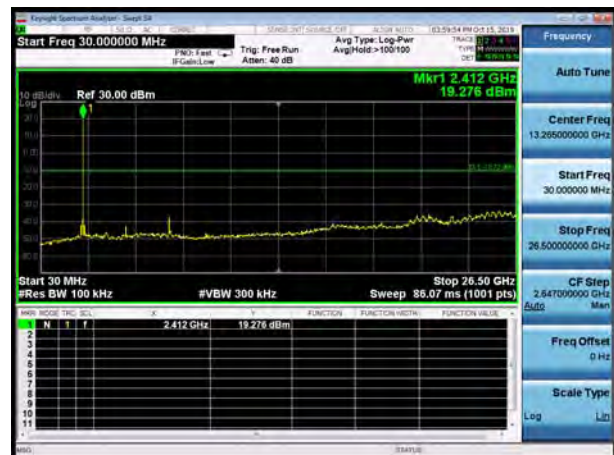




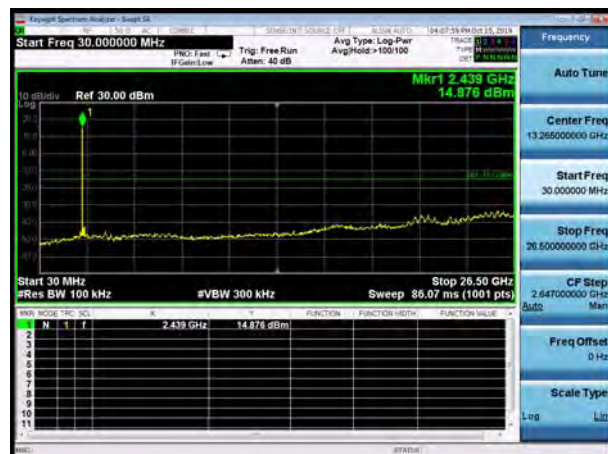
BLE V5.0-125K, Channel No.: 0



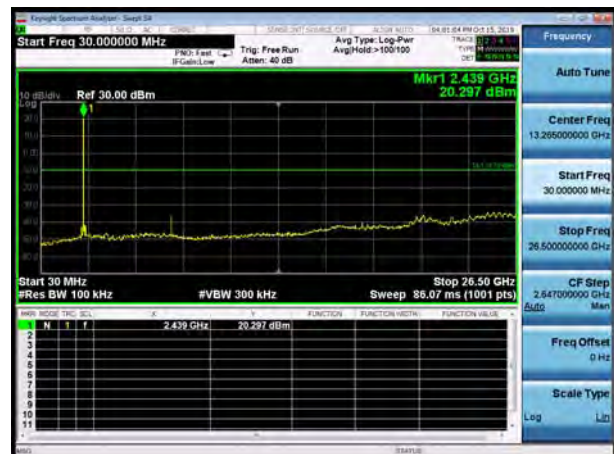
BLE V5.0-500K, Channel No.: 0



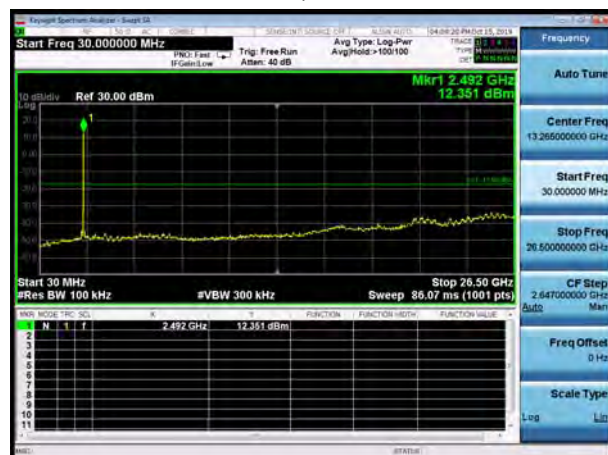
BLE V5.0-125K, Channel No.: 19



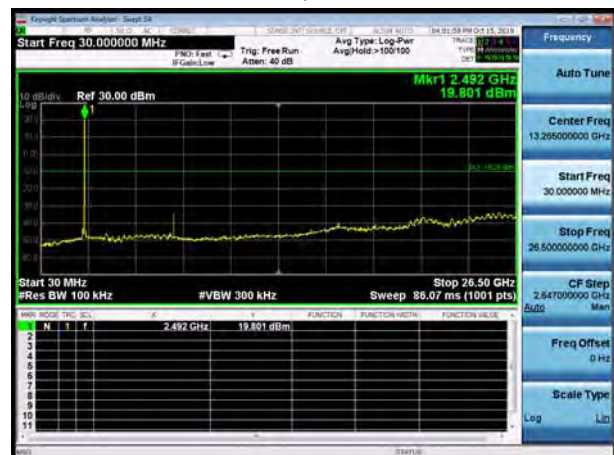
BLE V5.0-500K, Channel No.: 19



BLE V5.0-125K, Channel No.: 39



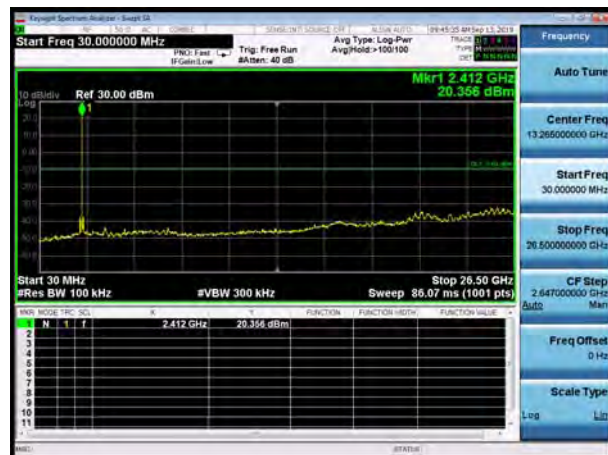
BLE V5.0-500K, Channel No.: 39



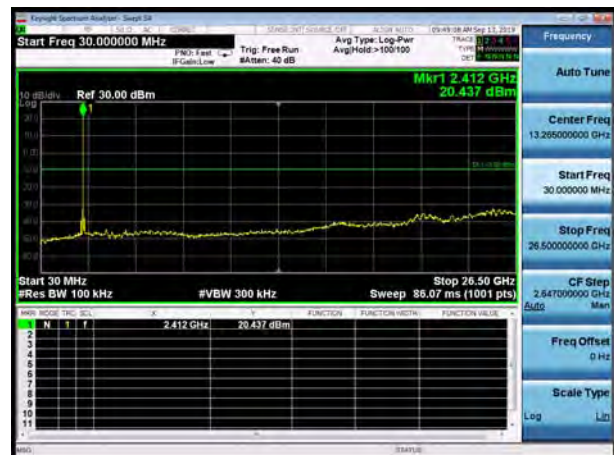


(BLE V5.0- FEM HIGH EFFICIENCY MODE)

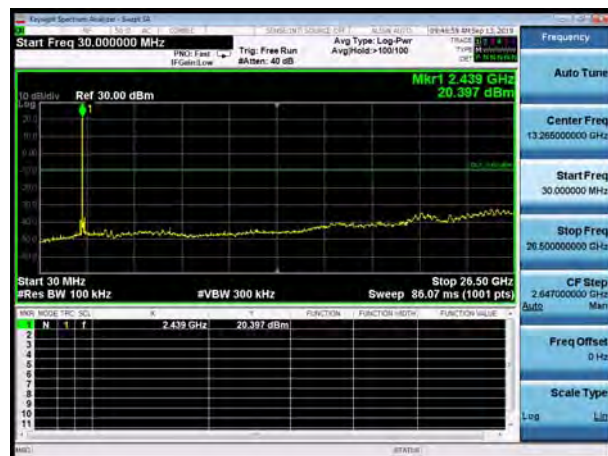
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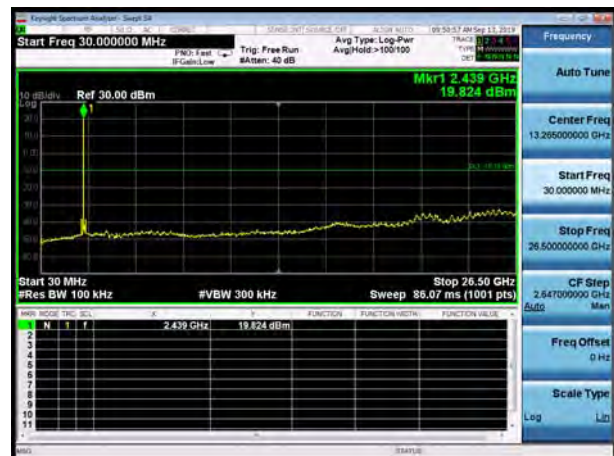
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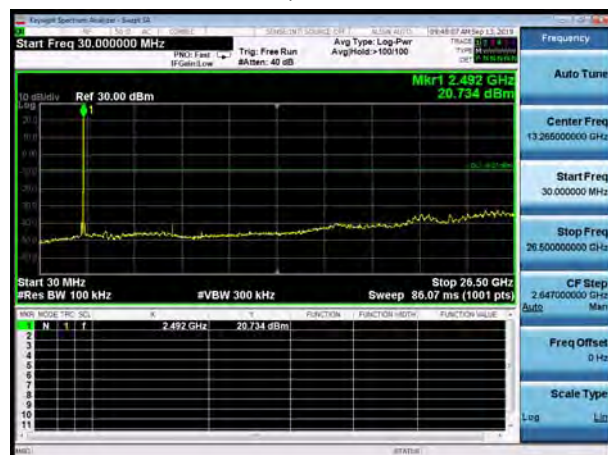
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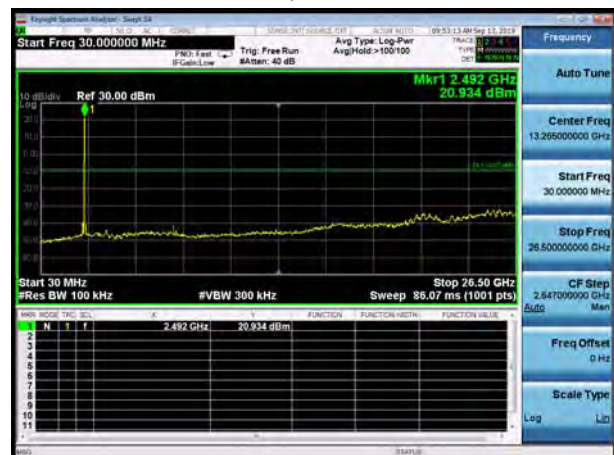
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BLE V5.0-1M, Channel No.: 39

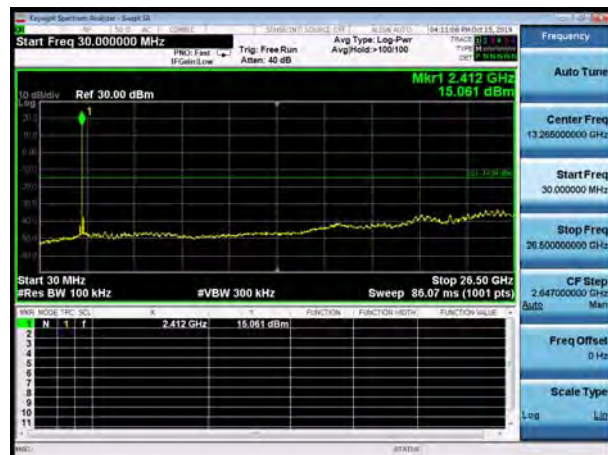


BLE V5.0-2M, Channel No.: 39

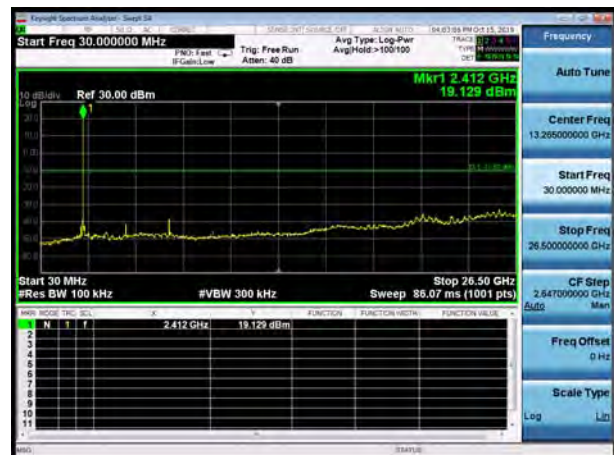




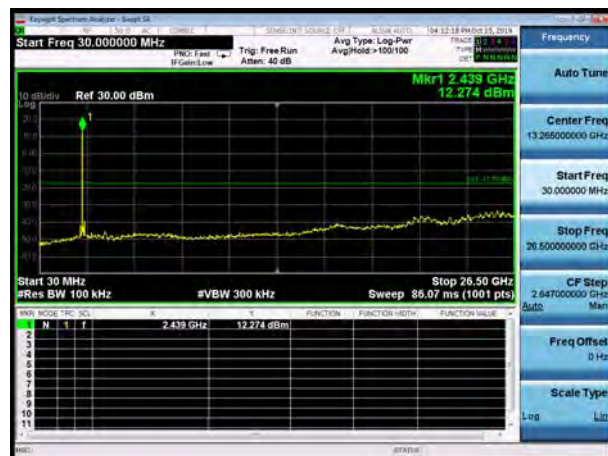
BLE V5.0-125K, Channel No.: 0



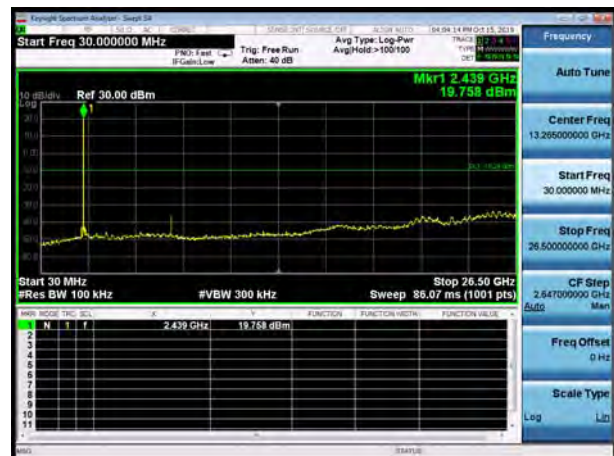
BLE V5.0-500K, Channel No.: 0



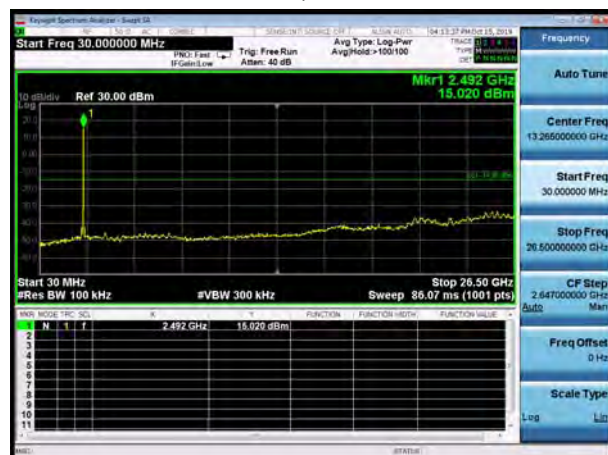
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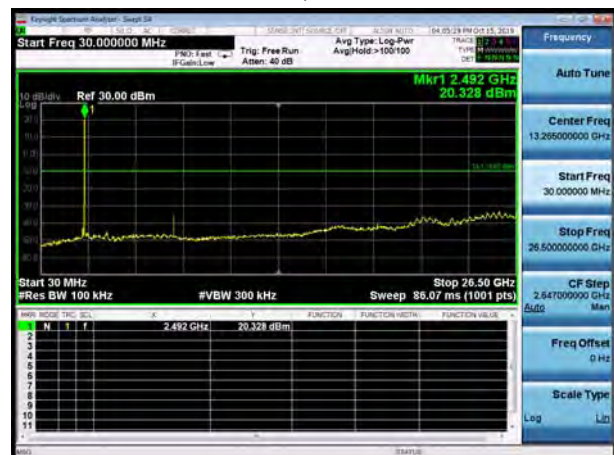
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BLE V5.0-125K, Channel No.: 39



BLE V5.0-500K, Channel No.: 39

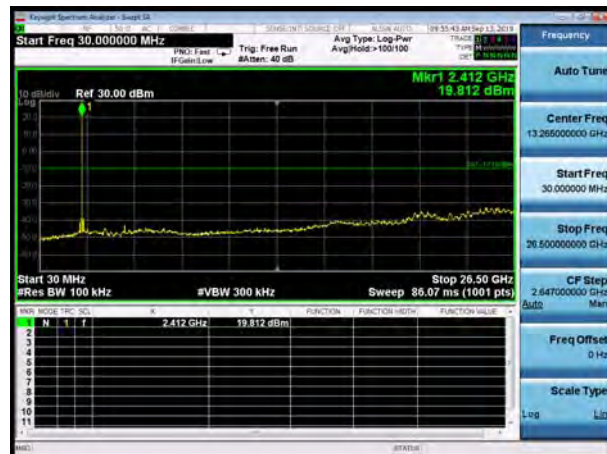




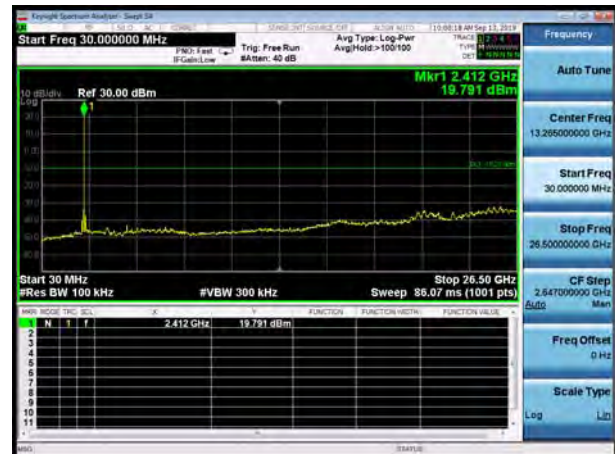
Antenna 2

(BLE V5.0-FEM LINEAR MODE)

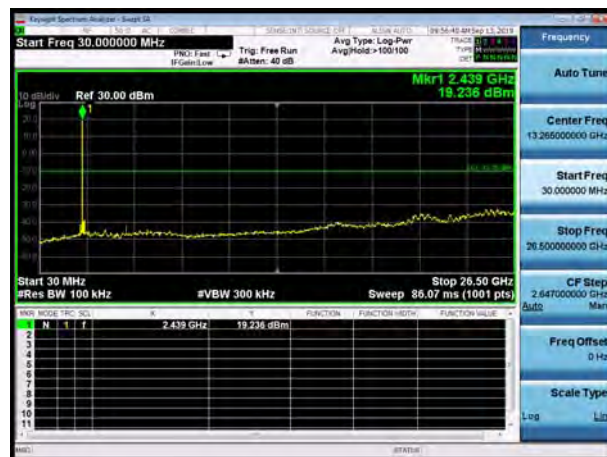
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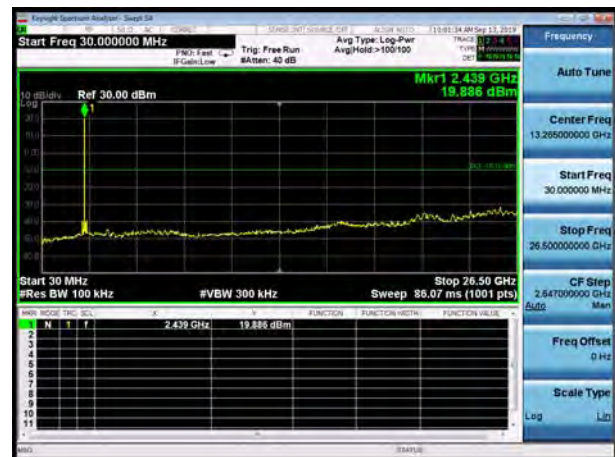
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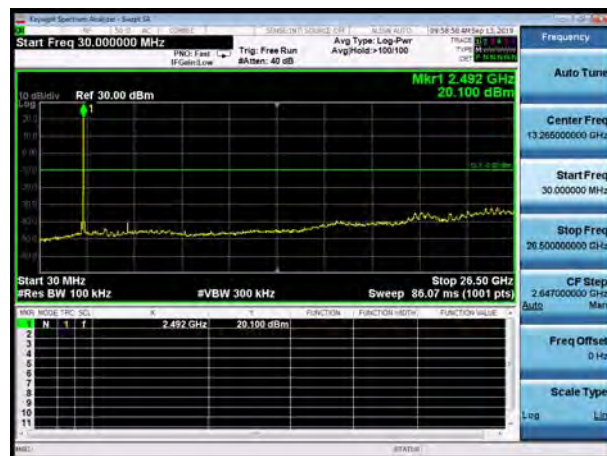
BLE V5.0-1M, Channel No.: 19



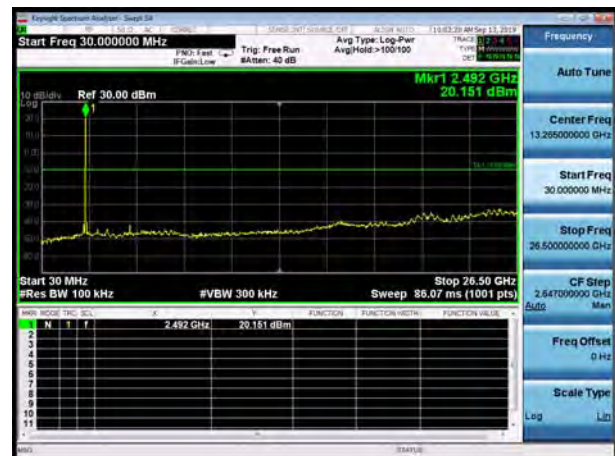
BLE V5.0-2M, Channel No.: 19



BLE V5.0-1M, Channel No.: 39

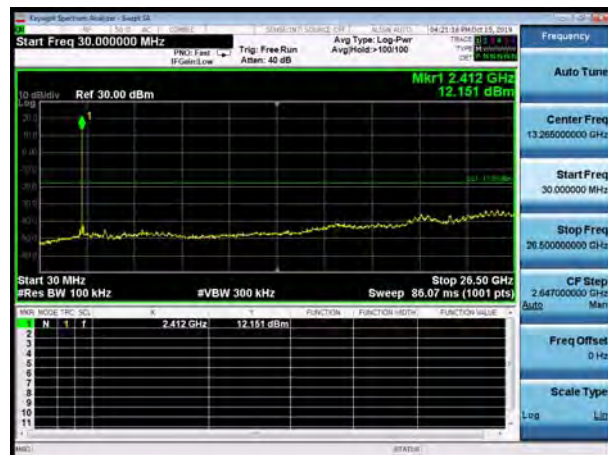


BLE V5.0-2M, Channel No.: 39

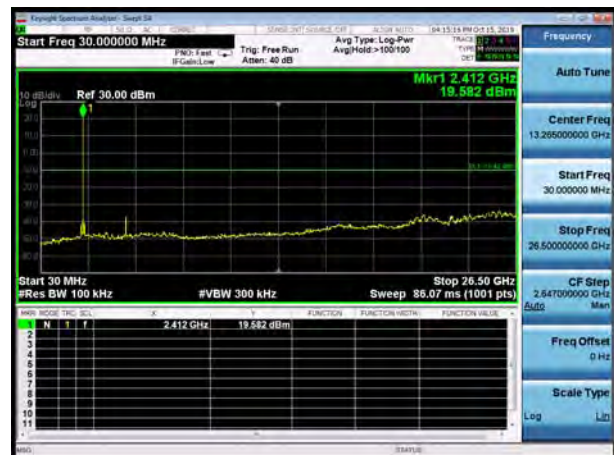




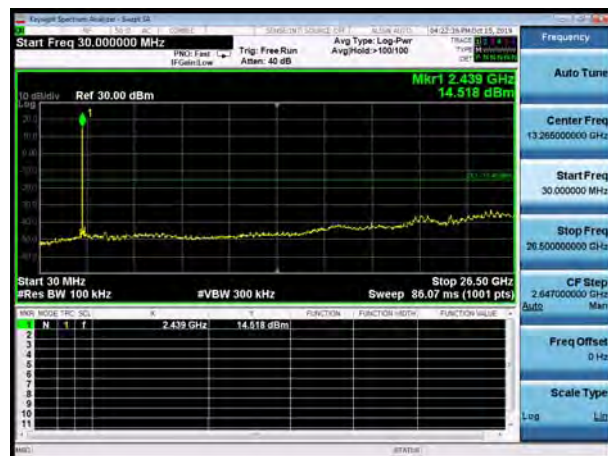
BLE V5.0-125K, Channel No.: 0



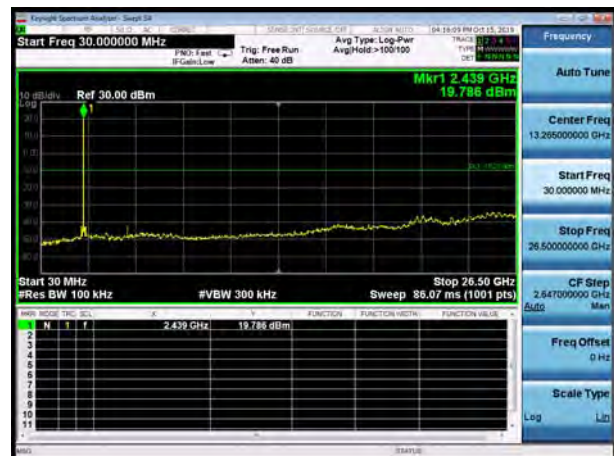
BLE V5.0-500K, Channel No.: 0



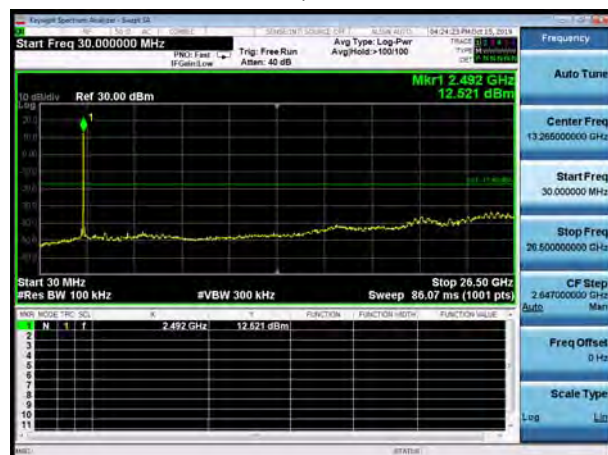
BLE V5.0-125K, Channel No.: 19



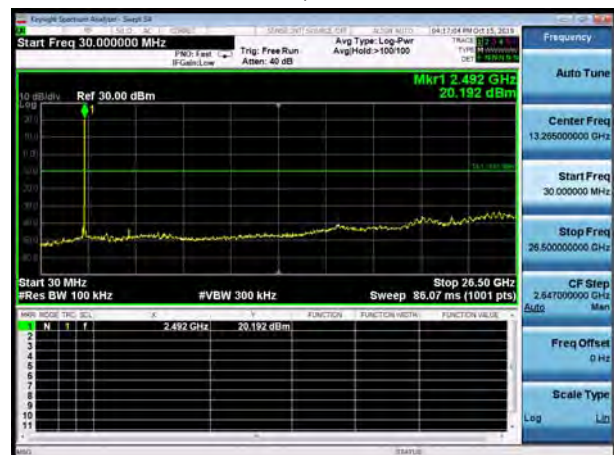
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BLE V5.0-125K, Channel No.: 39



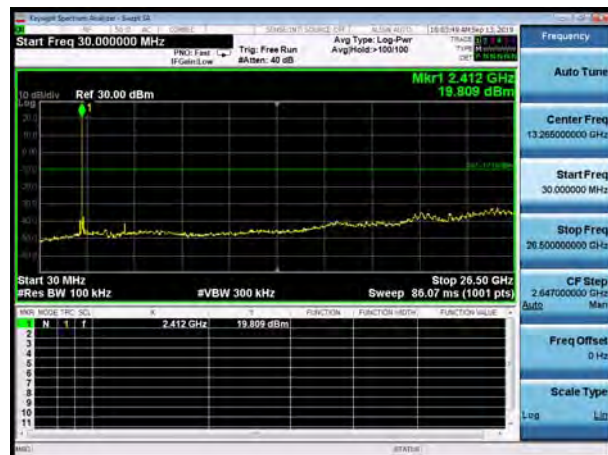
BLE V5.0-500K, Channel No.: 39



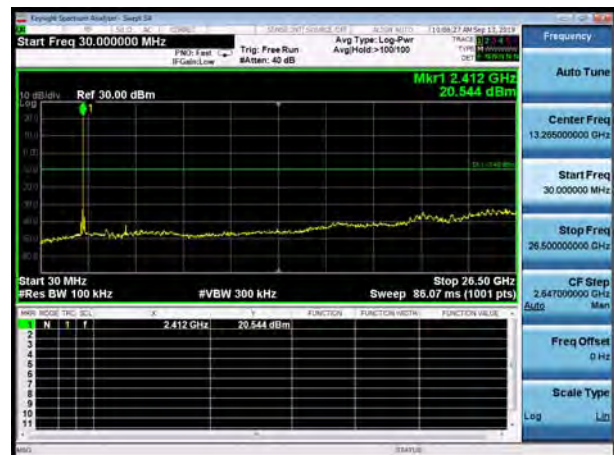


(BLE V5.0- FEM HIGH EFFICIENCY MODE)

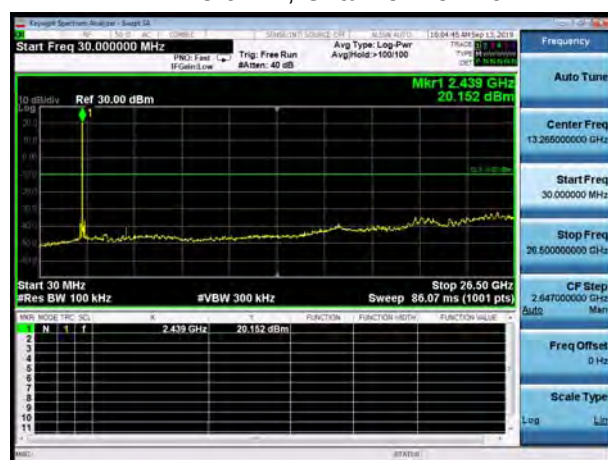
BLE V5.0-1M, Channel No.: 0



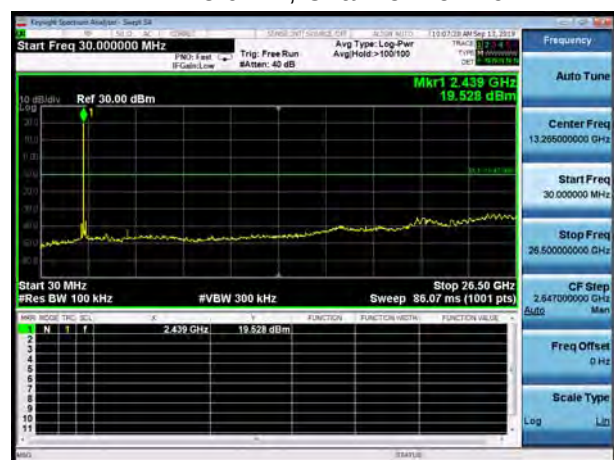
BLE V5.0-2M, Channel No.: 0



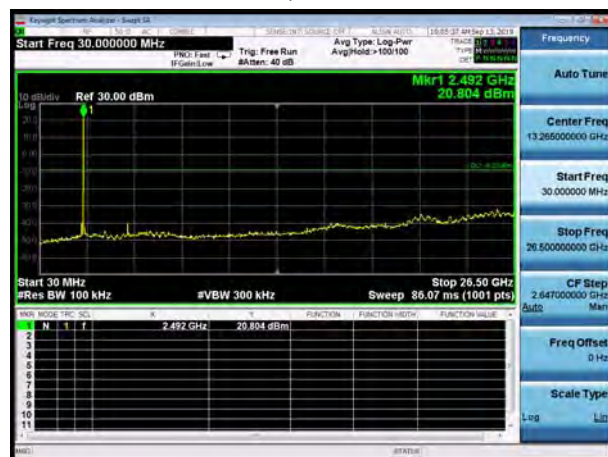
BLE V5.0-1M, Channel No.: 19



BLE V5.0-2M, Channel No.: 19



BLE V5.0-1M, Channel No.: 39

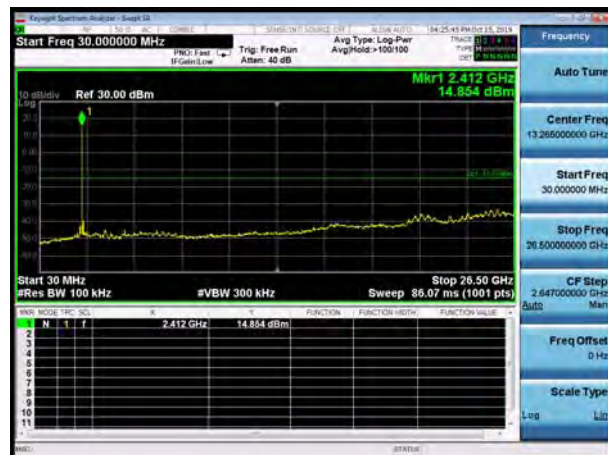


BLE V5.0-2M, Channel No.: 39

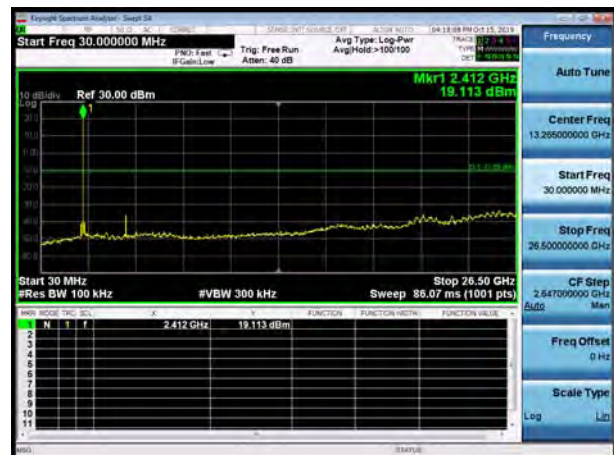




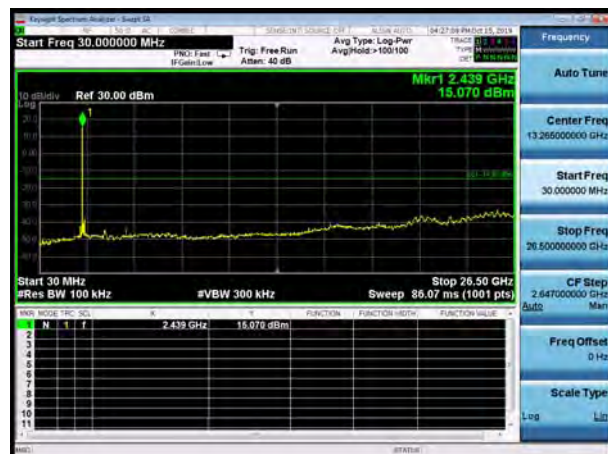
BLE V5.0-125K, Channel No.: 0



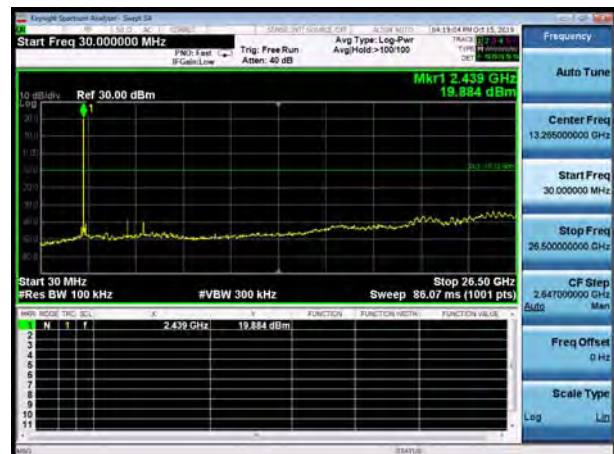
BLE V5.0-500K, Channel No.: 0



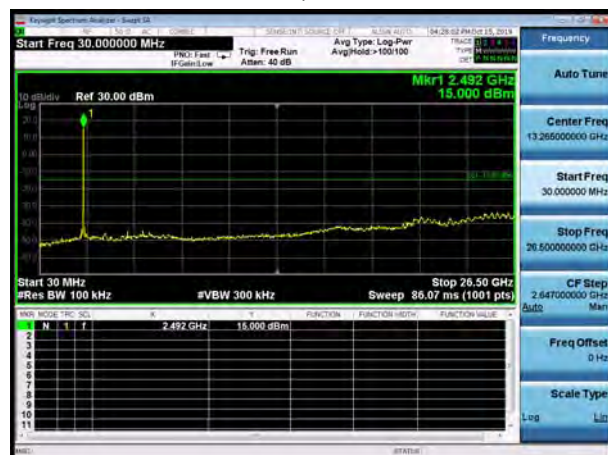
BLE V5.0-125K, Channel No.: 19



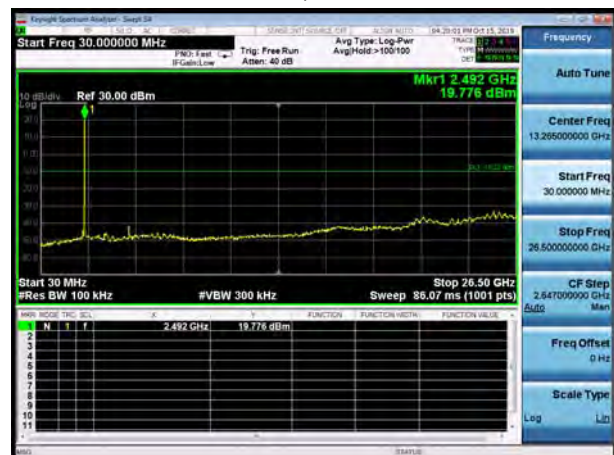
BLE V5.0-500K, Channel No.: 19



BLE V5.0-125K, Channel No.: 39



BLE V5.0-500K, Channel No.: 39



5.6. Unwanted Emission

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	102.5kPa

Method of Measurement

The test set-up was made in accordance to the general provisions of ANSI C63.10-2013.

The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna.

The turntable shall be rotated from 0 to 360 degrees for detecting the maximum of radiated spurious signal level. The measurements shall be repeated with orthogonal polarization of the test antenna. The data of cable loss and antenna factor has been calibrated in full testing frequency range before the testing. Sweep the Restricted Band and the emissions less than 20 dB below the permissible value are reported.

The radiated emissions measurements were made in a typical installation configuration.

Sweep the whole frequency band through the range from 9 kHz to the 10th harmonic of the carrier, and the emissions less than 20 dB below the permissible value are reported.

This method refer to ANSI C63.10-2013.

The procedure for peak unwanted emissions measurements above 1000 MHz is as follows:

I) Peak emission levels are measured by setting the instrument as follows:

- 1) RBW = 1 MHz.
- 2) VBW $\geq [3 \times \text{RBW}]$
- 3) Detector = peak.
- 4) Sweep time = auto.
- 5) Trace mode = max hold.
- 6) Allow sweeps to continue until the trace stabilizes. Note that if the transmission is not continuous, then the time required for the trace to stabilize will increase by a factor of approximately $1 / D$, where D is the duty cycle.

II) Average emission levels are measured by setting the instrument as follows:

- a) RBW = 1 MHz.
- b) VBW $\geq [3 \times \text{RBW}]$.
- c) Detector = RMS (power averaging), if $[\text{span} / (\# \text{ of points in sweep})] \leq \text{RBW} / 2$. Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
- d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage



averaging. Log or dB averaging shall not be used.)

e) Sweep time = auto.

f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of $1 / D$, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)

g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:

1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is $[10 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.

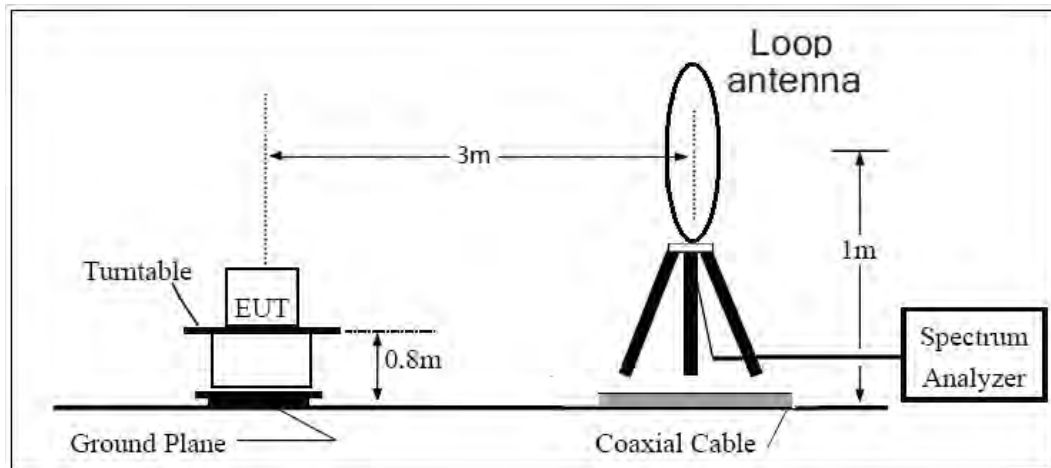
2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is $[20 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

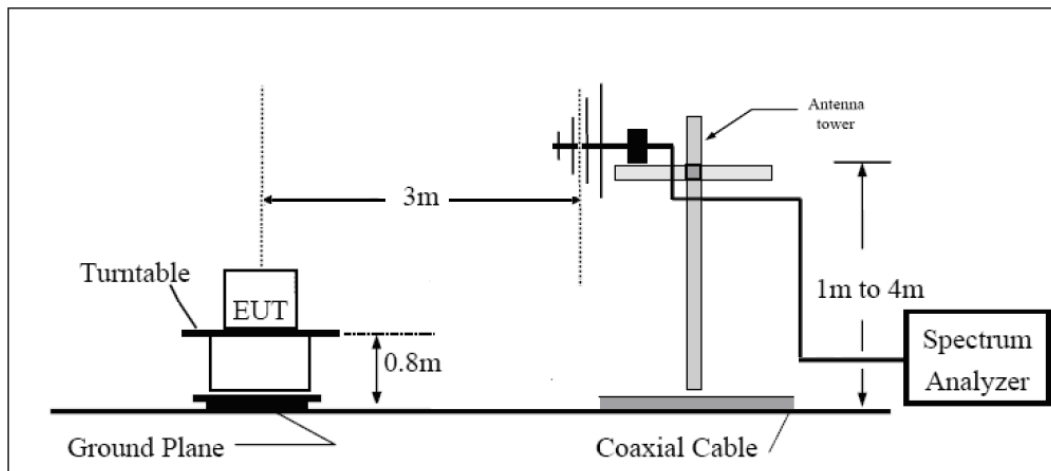
The test is in transmitting mode.

Test setup

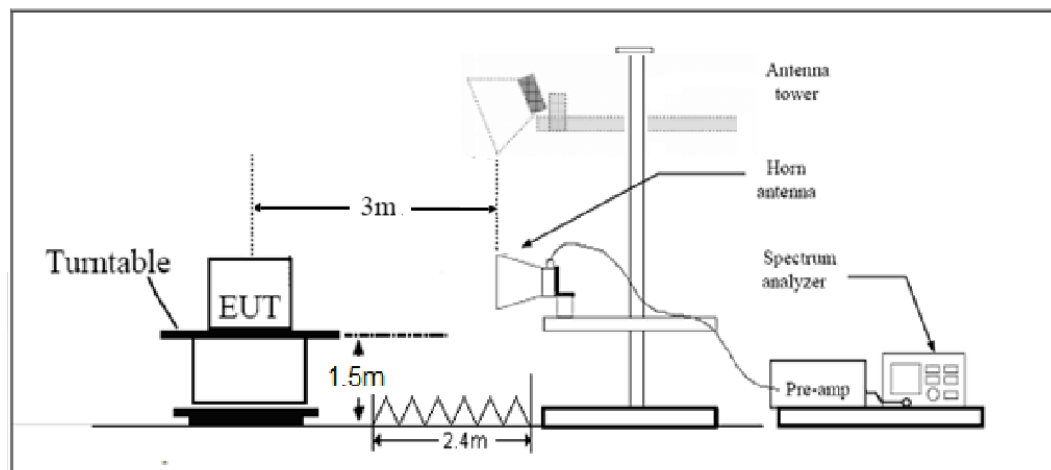
9KHz ~ 30MHz



30MHz ~ 1GHz



Above 1GHz



Note: Area side:2.4mX3.6m

Limits

Rule Part 15.247(d) specifies that “In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).”

Limit in restricted band

Frequency of emission (MHz)	Field strength(uV/m)	Field strength(dBuV/m)
0.009–0.490	2400/F(kHz)	/
0.490–1.705	24000/F(kHz)	/
1.705–30.0	30	/
30-88	100	40
88-216	150	43.5
216-960	200	46
Above960	500	54

§15.35(b)

There is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.

Peak Limit=74 dBuV/m

Average Limit=54 dBuV/m

Spurious Radiated Emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(²)
13.36 - 13.41			

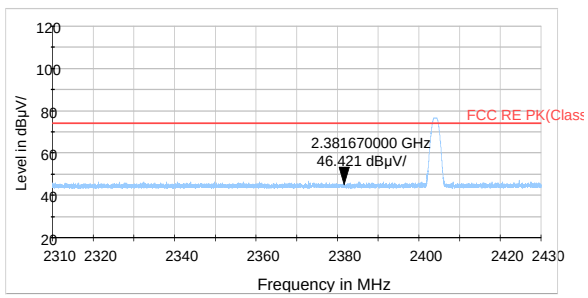
**Measurement Uncertainty**

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

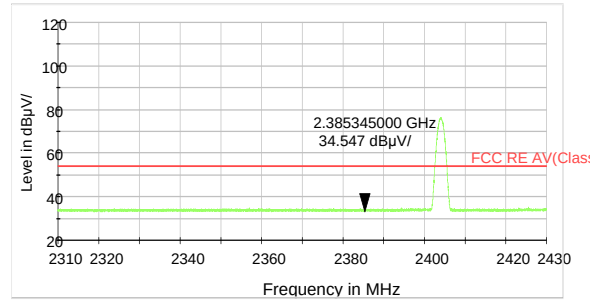
Frequency	Uncertainty
9KHz-30MHz	3.55 dB
30MHz-200MHz	4.02 dB
200MHz-1GHz	3.28 dB
1-18GHz	3.70 dB
18-26.5GHz	5.78 dB



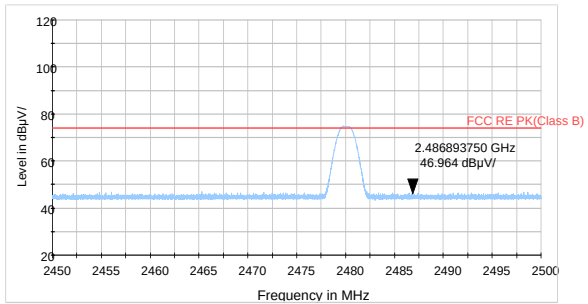
Test Results:



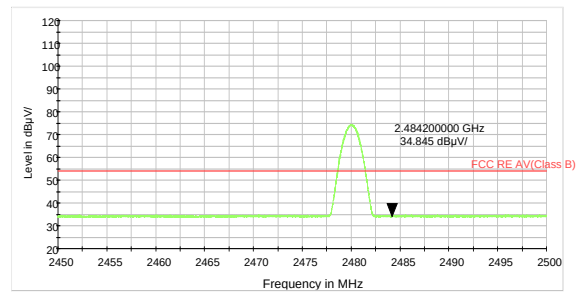
BLE Channel 0 Peak



BLE Channel 0 Average



BLE Channel 39 Peak



BLE Channel 39 Average

Result of RE

Test result

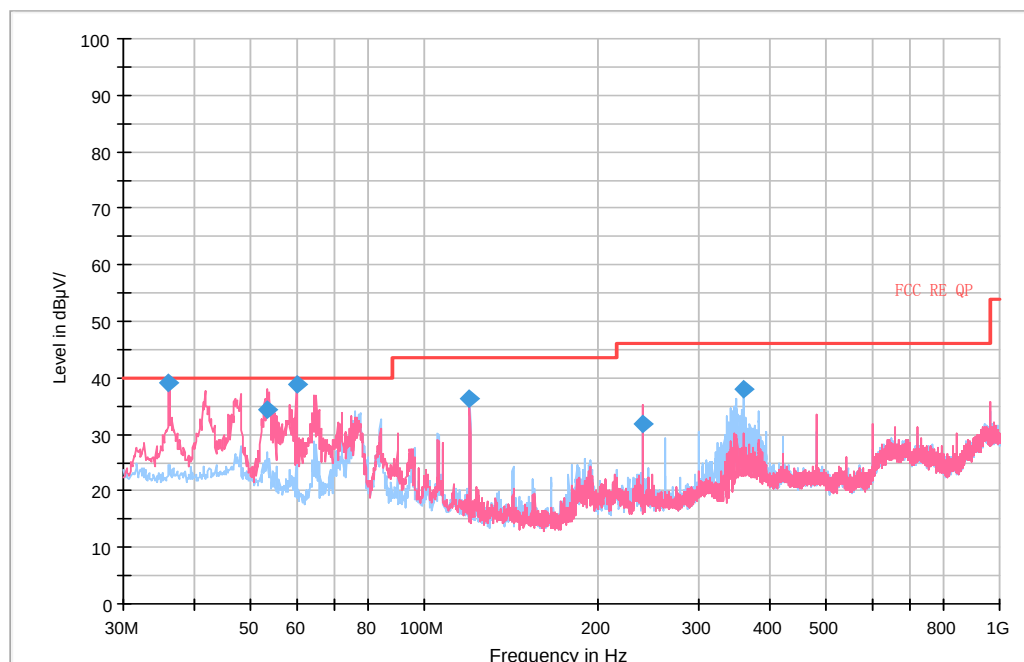
Sweep the whole frequency band through the range from 9kHz to the 10th harmonic of the carrier, the Emissions in the frequency band 9kHz-30MHz and 18GHz-26.5GHz are more than 20dB below the limit are not reported.

The following graphs display the maximum values of horizontal and vertical by software.
For above 1GHz, Blue trace uses the peak detection, Green trace uses the average detection.

After the pretest ,Antenna 1 was selected as the worst Antenna.

During the test, the Radiates Emission from 30MHz to 1GHz was performed in all modes with all channels, BLE-Channel 19 are selected as the worst condition. The test data of the worst-case condition was recorded in this report.

Continuous TX mode:



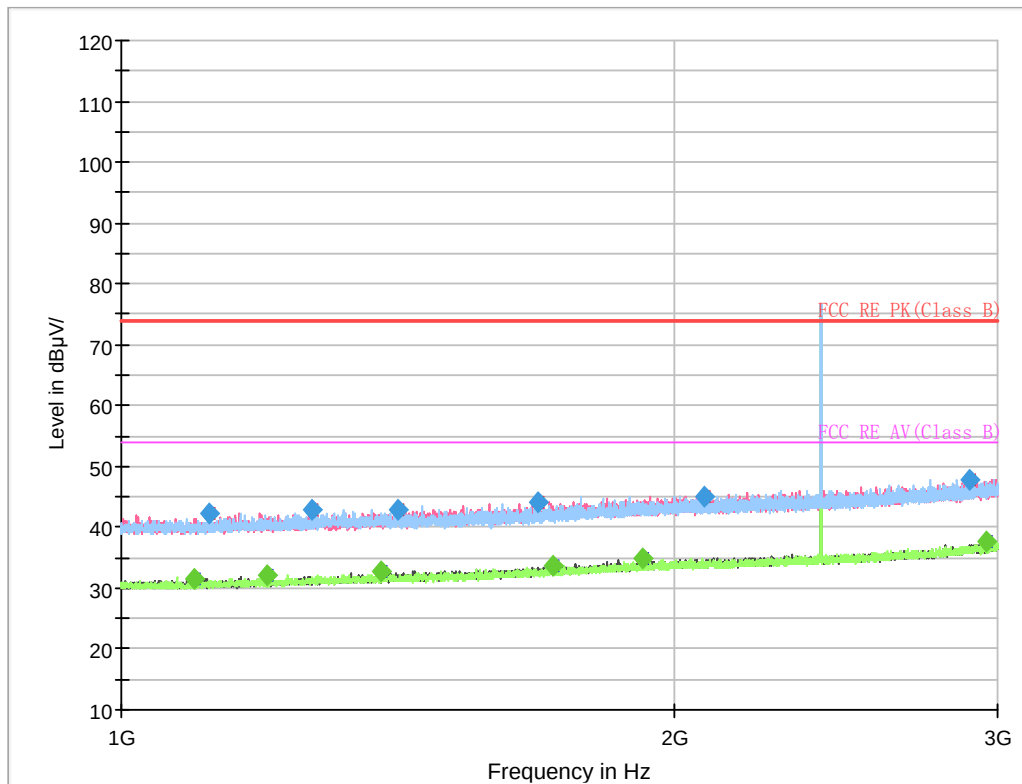
Radiates Emission from 30MHz to 1GHz

Frequency (MHz)	Quasi-Peak (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
36.011397	39.20	100.0	V	112.0	-4.0	0.8	40.00
53.346800	34.23	110.0	V	27.0	-6.7	5.77	40.00
59.998878	38.82	100.0	V	22.0	-8.8	1.18	40.00
120.027581	36.45	210.0	H	296.0	-13.3	7.05	43.50
240.005000	31.96	100.0	V	92.0	-11.7	14.04	46.00
360.022500	38.07	100.0	H	231.0	-5.5	7.93	46.00

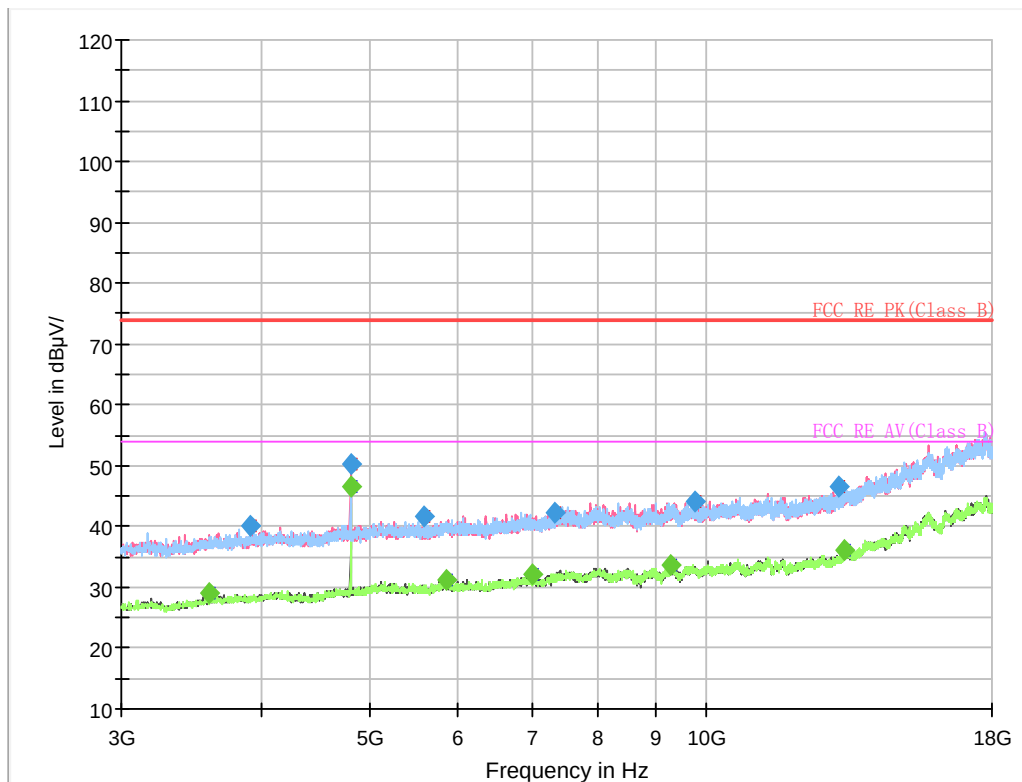
Remark: 1. Correction Factor = Antenna factor+ Insertion loss(cable loss+amplifier gain)

2. Margin = Limit – Quasi-Peak

BLE-Channel 0



Note: The signal beyond the limit is carrier.
Radiates Emission from 1GHz to 3GHz



Radiates Emission from 3GHz to 18GHz

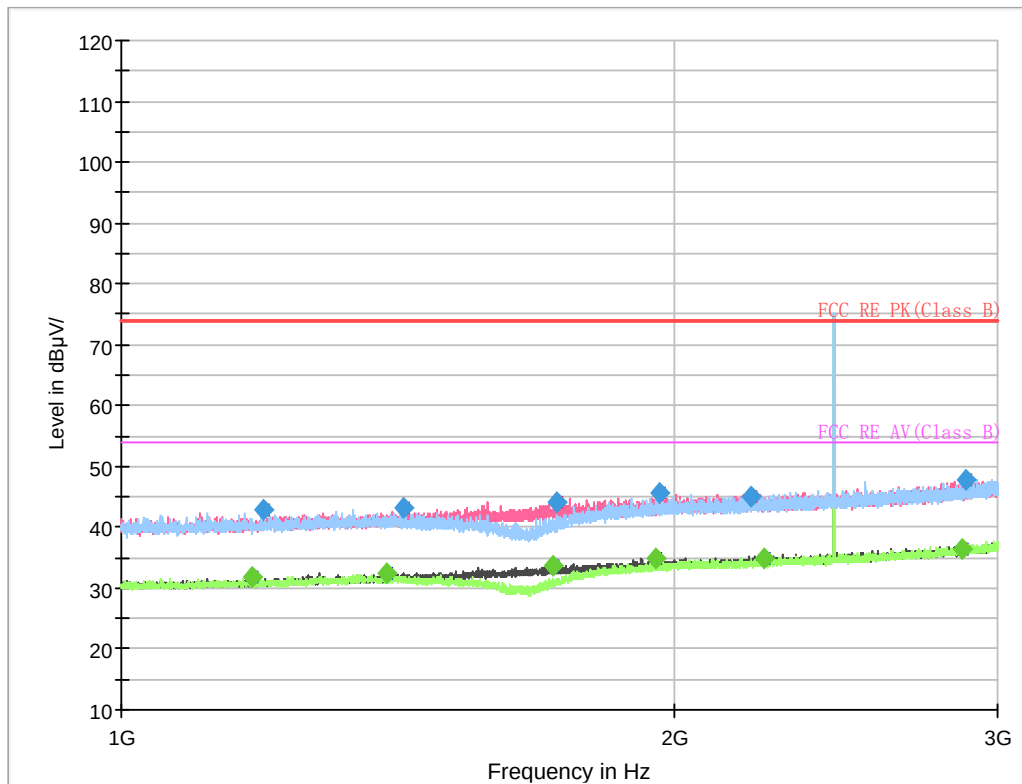
Frequency (MHz)	Peak (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
1115.750000	42.30	200.0	V	162.0	-8.1	31.70	74.00
1271.000000	42.90	100.0	V	341.0	-7.2	31.10	74.00
1413.250000	43.01	200.0	V	73.0	-6.4	30.99	74.00
1685.500000	44.19	200.0	V	200.0	-4.9	29.81	74.00
2076.500000	45.14	200.0	V	182.0	-2.9	28.86	74.00
2896.500000	47.91	100.0	V	0.0	0.8	26.09	74.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

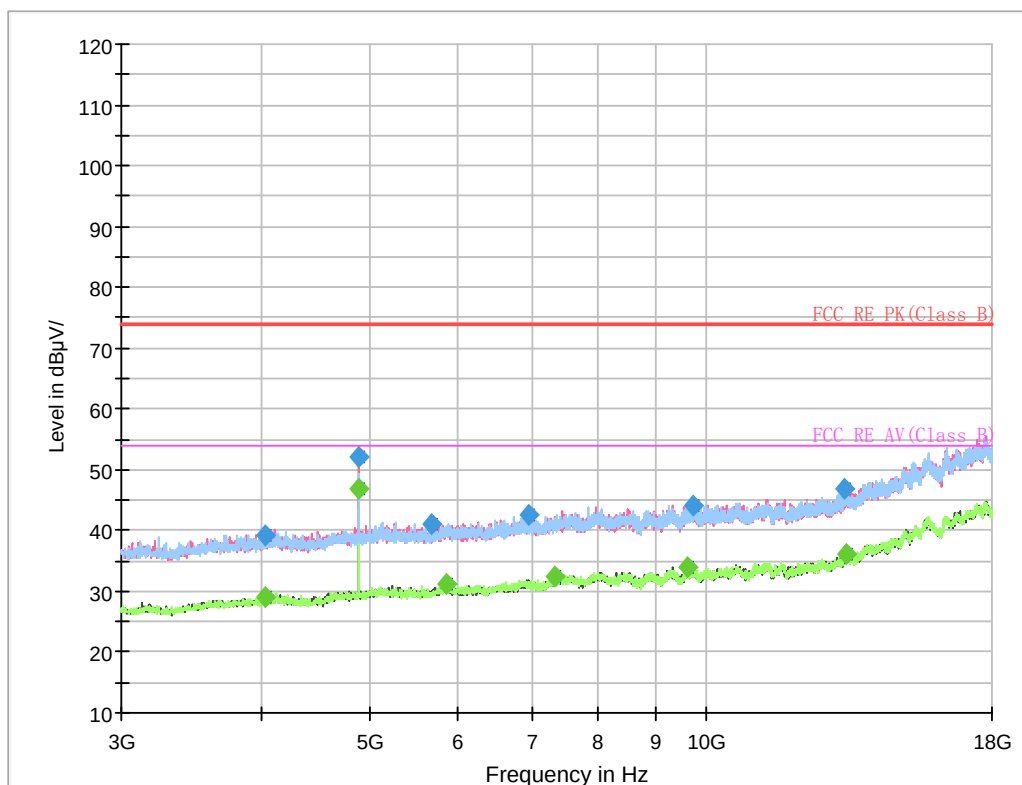
Frequency (MHz)	Average (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
1095.000000	31.46	200.0	V	11.0	-8.2	22.54	54.00
1200.000000	32.21	100.0	V	110.0	-7.6	21.79	54.00
1385.750000	32.65	100.0	V	168.0	-6.5	21.35	54.00
1718.250000	33.76	200.0	V	1.0	-4.7	20.24	54.00
1920.250000	34.88	200.0	V	7.0	-3.6	19.12	54.00
2957.750000	37.65	100.0	H	0.0	1.1	16.35	54.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

BLE-Channel 19



Note: The signal beyond the limit is carrier.
Radiates Emission from 1GHz to 3GHz



Radiates Emission from 3GHz to 18GHz

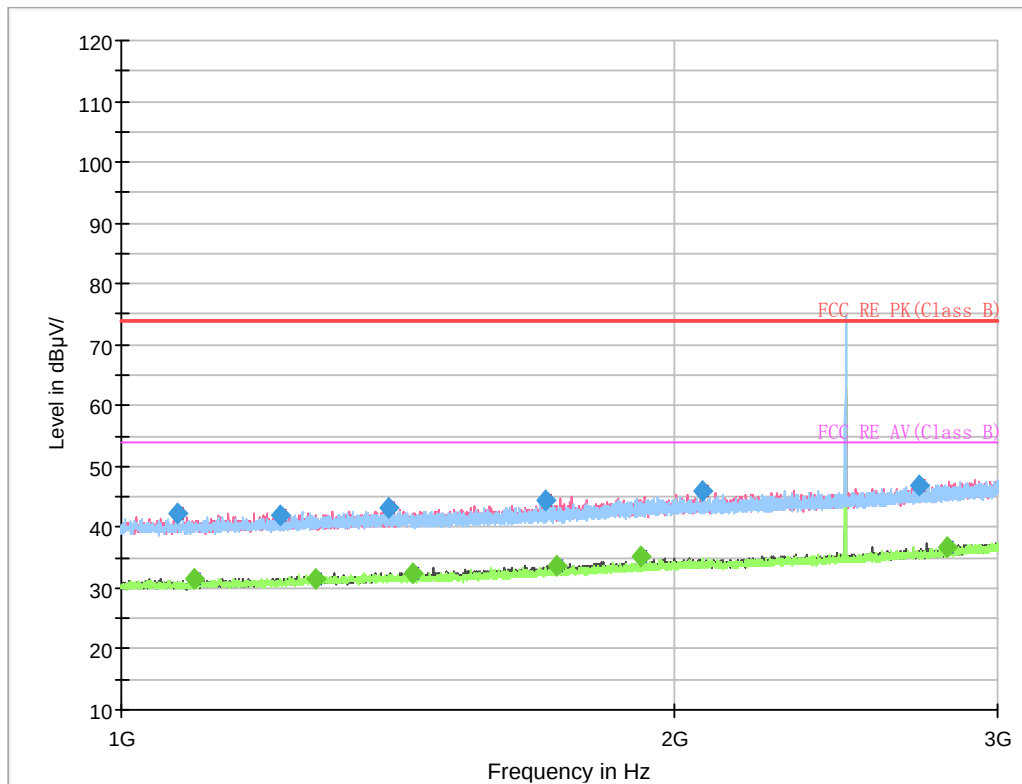
Frequency (MHz)	Peak (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
1195.750000	42.79	100.0	V	233.0	-7.6	31.21	74.00
1425.250000	43.07	200.0	V	10.0	-6.4	30.93	74.00
1724.000000	44.03	200.0	V	176.0	-4.7	29.97	74.00
1963.750000	45.52	100.0	V	283.0	-3.4	28.48	74.00
2201.000000	44.93	200.0	H	313.0	-2.4	29.07	74.00
2885.500000	47.93	100.0	H	188.0	0.7	26.07	74.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

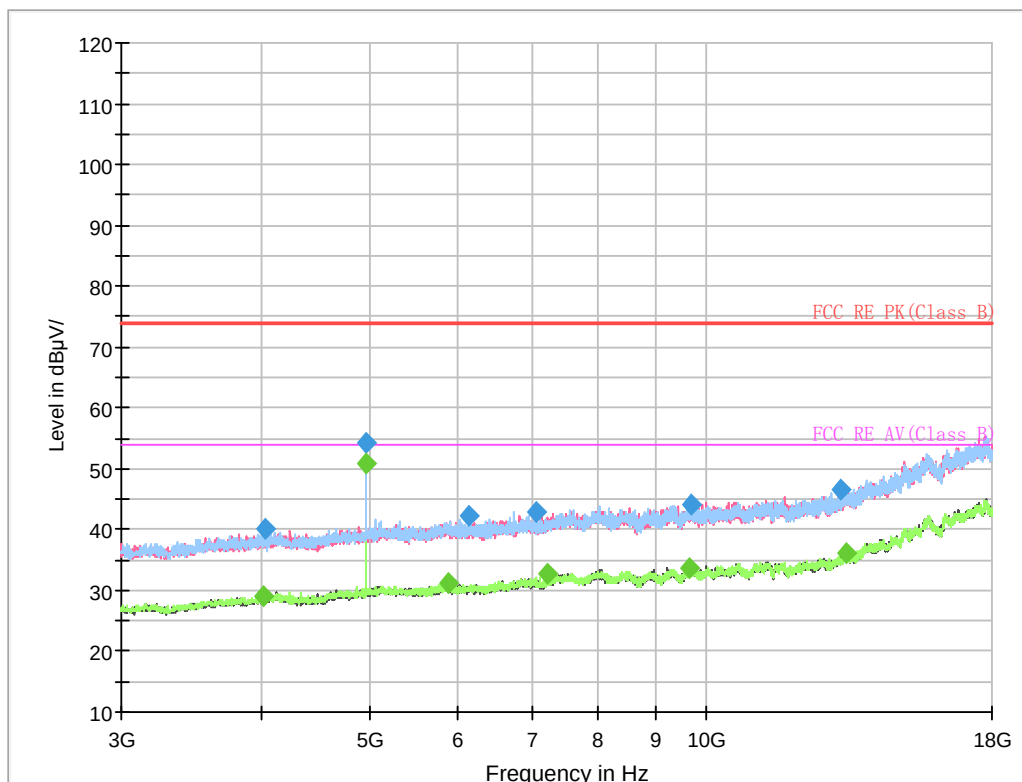
Frequency (MHz)	Average (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
1178.750000	31.80	100.0	V	23.0	-7.7	22.20	54.00
1396.000000	32.47	200.0	V	226.0	-6.5	21.53	54.00
1719.250000	33.58	100.0	V	97.0	-4.7	20.42	54.00
1956.250000	34.95	200.0	V	239.0	-3.4	19.05	54.00
2236.250000	34.92	100.0	H	302.0	-2.3	19.08	54.00
2870.750000	36.43	100.0	V	352.0	0.6	17.57	54.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

BLE-Channel 39



Note: The signal beyond the limit is carrier.
Radiates Emission from 1GHz to 3GHz



Radiates Emission from 3GHz to 18GHz

Frequency (MHz)	Peak (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
1074.000000	42.21	200.0	H	357.0	-8.3	31.79	74.00
1221.000000	42.00	200.0	V	26.0	-7.5	32.00	74.00
1397.750000	43.08	200.0	H	190.0	-6.5	30.92	74.00
1702.000000	44.27	200.0	H	150.0	-4.8	29.73	74.00
2073.500000	45.86	200.0	H	328.0	-2.9	28.14	74.00
2721.750000	47.00	200.0	V	163.0	-0.3	27.00	74.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

Frequency (MHz)	Average (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
1096.250000	31.63	200.0	V	40.0	-8.2	22.37	54.00
1275.500000	31.48	100.0	V	307.0	-7.2	22.52	54.00
1441.500000	32.38	200.0	H	210.0	-6.3	21.62	54.00
1726.500000	33.73	200.0	V	308.0	-4.6	20.27	54.00
1920.000000	35.15	200.0	V	104.0	-3.6	18.85	54.00
2816.500000	36.78	100.0	H	60.0	0.2	17.22	54.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

5.7. Conducted Emission

Ambient condition

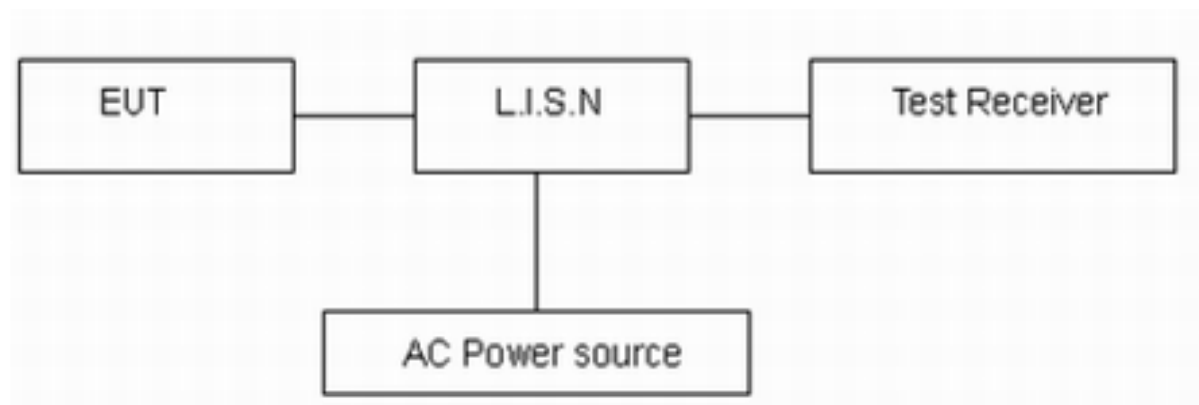
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Methods of Measurement

The EUT is placed on a non-metallic table of 80cm height above the horizontal metal reference ground plane. During the test, the EUT was operating in its typical mode. The test method is according to ANSI C63.10-2013. Connect the AC power line of the EUT to the L.I.S.N. Use EMI receiver to detect the average and Quasi-peak value. RBW is set to 9 kHz, VBW is set to 30kHz. The measurement result should include both L line and N line.

The test is in transmitting mode.

Test Setup



Note: AC Power source is used to change the voltage 110V/60Hz.

Limits

Frequency (MHz)	Conducted Limits(dBμV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46*
0.5 - 5	56	46
5 - 30	60	50

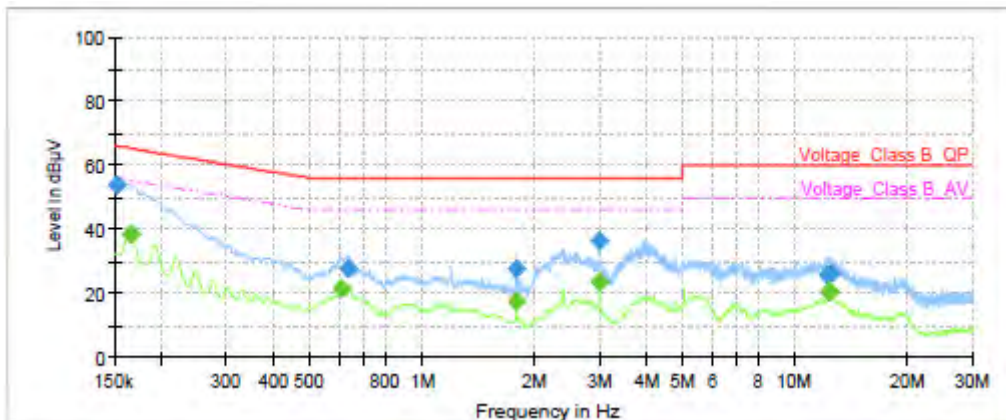
*: Decreases with the logarithm of the frequency.

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$, $U = 2.69$ dB.

Test Results:

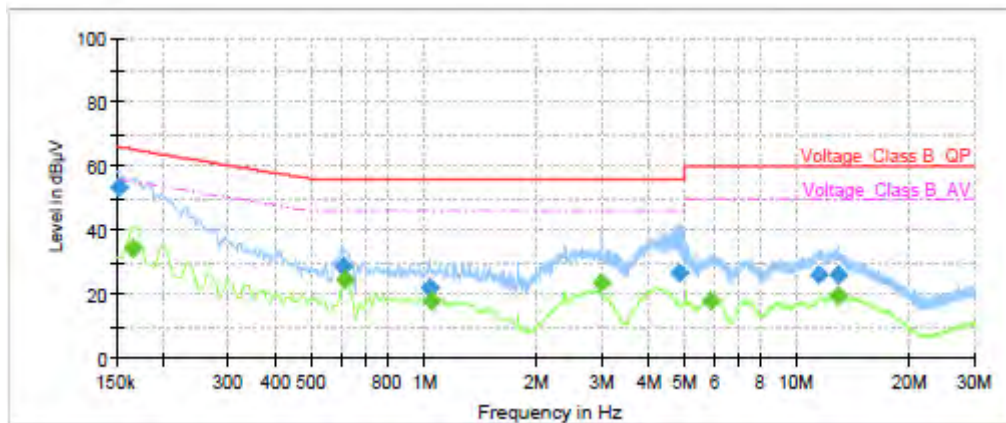
Following plots, Blue trace uses the peak detection and Green trace uses the average detection. During the test, the Conducted Emission was performed in all modes (BLE) with all channels, BLE-Channel 19 are selected as the worst condition. The test data of the worst-case condition was recorded in this report.



Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.15	53.90	---	65.88	11.98	1000.0	9.000	L1	ON	19.05
0.17	---	38.26	55.17	16.91	1000.0	9.000	L1	ON	19.14
0.61	---	21.70	46.00	24.30	1000.0	9.000	L1	ON	19.27
0.63	27.67	---	56.00	28.33	1000.0	9.000	L1	ON	19.27
1.79	---	17.64	46.00	28.36	1000.0	9.000	L1	ON	19.17
1.79	27.65	---	56.00	28.35	1000.0	9.000	L1	ON	19.17
2.99	36.60	---	56.00	19.40	1000.0	9.000	L1	ON	19.11
2.99	---	23.81	46.00	22.19	1000.0	9.000	L1	ON	19.11
12.31	25.78	---	60.00	34.22	1000.0	9.000	L1	ON	19.41
12.33	---	20.30	50.00	29.70	1000.0	9.000	L1	ON	19.42
12.42	---	20.41	50.00	29.59	1000.0	9.000	L1	ON	19.43
12.51	26.09	---	60.00	33.91	1000.0	9.000	L1	ON	19.44

Remark: Correct factor=cable loss + LISN factor

L line Conducted Emission from 150 KHz to 30 MHz



Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.15	53.09	---	65.88	12.79	1000.0	9.000	N	ON	19.07
0.17	---	34.13	55.17	21.04	1000.0	9.000	N	ON	19.15
0.61	28.51	---	56.00	27.49	1000.0	9.000	N	ON	19.27
0.61	---	24.68	46.00	21.32	1000.0	9.000	N	ON	19.27
1.03	21.80	---	56.00	34.20	1000.0	9.000	N	ON	19.24
1.05	---	17.91	46.00	28.09	1000.0	9.000	N	ON	19.24
2.99	---	23.78	46.00	22.22	1000.0	9.000	N	ON	19.11
4.84	26.62	---	56.00	29.38	1000.0	9.000	N	ON	19.07
5.87	---	17.82	50.00	32.18	1000.0	9.000	N	ON	19.10
11.51	25.90	---	60.00	34.10	1000.0	9.000	N	ON	19.37
12.91	---	19.69	50.00	30.31	1000.0	9.000	N	ON	19.48
12.94	25.91	---	60.00	34.09	1000.0	9.000	N	ON	19.48

Remark: Correct factor=cable loss + LISN factor

N line Conducted Emission from 150 KHz to 30 MHz



6. Main Test Instruments

Name	Manufacturer	Type	Serial Number	Calibration Date	Expiration Date
Spectrum Analyzer	R&S	FSV30	100815	2018-12-16	2019-12-15
EMI Test Receiver	R&S	ESCI	100948	2019-05-19	2020-05-18
Loop Antenna	SCHWARZBECK	FMZB1519	1519-047	2017-09-26	2020-09-25
TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	9163-201	2017-11-18	2019-11-17
Double Ridged Waveguide Horn Antenna	R&S	HF907	100126	2018-07-07	2020-07-06
Standard Gain Horn	ETS-Lindgren	3160-09	00102643	2018-06-20	2020-06-19
EMI Test Receiver	R&S	ESR	101667	2019-05-19	2020-05-18
LISN	R&S	ENV216	101171	2016-12-16	2019-12-15
Spectrum Analyzer	Agilent	N9010A	MY47191109	2019-05-19	2020-05-18
Power Meter	R&S	NRP	104306	2019-05-19	2020-05-18
Power Sensor	R&S	NRP-Z21	104799	2019-05-19	2020-05-18
20dB Attenuator	Star River Highlight	UCL-TS2S-20	18013001	2018-12-16	2019-12-15
RF Cable	Agilent	SMA 15cm	0001	2019-09-14	2019-12-13
Software	R&S	EMC32	9.26.0	/	/

*****END OF REPORT *****