TEST REPORT
On behalf of

Shanghai Teraoka Electronic Co., Ltd.

Product Name: SMART CARD TERMINAL

Model No.: WB-20

FCC ID: 2ARYWWB-20

Prepared For: Shanghai Teraoka Electronic Co., Ltd.
Tinglin Industry Development Zone, Jinshan District,
Shanghai, China

Prepared By: Audix Technology (Shanghai) Co., Ltd.
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TESTING
NVLAP LAB CODE 200371-0

File No. : C1D2011005
Report No. : ACI-F21108
Date of Test : 2020.11.11-2021.04.20
Date of Report : 2021.05.26

The statement is based on a single evaluation of one sample of the above-mentioned products. It does not imply an assessment of the whole production and does not permit the use of the test lab logo.
The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

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TEST REPORT

Applicant	:	Shanghai Teraoka Electronic Co., Ltd.
EUT Description	:	SMART CARD TERMINAL
	(A) Model No.	: Refer to Sec.2.1
	(B) Power Supply	: DC5V
	(C) Test Voltage	: DC5V (Via Adaptor)

Test Procedure Used:

FCC RULES AND REGULATIONS PART 15 SUBPART C
AND ANSI C63.10-2013

The device described above is tested by Audix Technology (Shanghai) Co., Ltd. to determine the maximum emission levels emanating from the device. The maximum emission levels are compared to the FCC Part 15 Subpart C limits.

The test results are contained in this test report and Audix Technology (Shanghai) Co., Ltd. is assumed full responsibility for the accuracy and completeness of these measurements. This report also shows that the EUT (M/N: Refer to Sec2.1), which was tested is technically compliance with the FCC limits.

This report applies to above tested Sample only. This report shall not be reproduced in part without written approval of Audix Technology (Shanghai) Co., Ltd.

The test results for EUT's WIFI (2.4G) /DFS/BT/ WIFI (5G) function are contained in No.ACI-F21109, ACI-F21123, ACI-F21121, ACI-F21122 report.

Date of Test : 2020.11.11-2021.04.20 Date of Report : 2021.05.26

Producer : Huimin Yan
HUIMIN YAN / Assistant

Review : Byron Wu
BYRON WU/ Deputy Assistant Manager

AUDIX® For and on behalf of
Audix Technology (Shanghai) Co., Ltd.

Signatory :
BYRON KWO/Assistant General Manager

Authorized Signature(s)

1 SUMMARY OF STANDARDS AND RESULTS

1.1 Description of Standards and Results

The EUT have been tested according to the applicable standards as referenced below:

Description / Test Item	Test Standard	Results	Meets Limit
EMISSION			
Conducted Emission	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.207
Radiated Emission	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.209(a) 15.205(a)(c)
6 dB Bandwidth Measurement	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.247(a)(2)
Maximum Peak Output Power Measurement	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.247(b)(3)
Emission Limitations Measurement	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.247(d)
Band Edge Measurement	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.247(d)
Power Spectral Density Measurement	FCC RULES AND REGULATIONS PART 15 SUBPART C AND ANSI C63.10:2013	Pass	15.247(e)
N/A is an abbreviation for Not Applicable.			

2 GENERAL INFORMATION

2.1 Description of Equipment Under Test

Description : SMART CARD TERMINAL

Type of EUT : ☑ Production ☐ Pre-product ☐ Pro-type

Model Number : WB-20

Radio Tech : Bluetooth 4.2;
IEEE 802.11 a/b/g/n/ac.

Channel Freq. : BLE: 2402MHz-2480MHz;
BT: 2402MHz-2480MHz
IEEE 802.11a:
5180MHz—5240MHz; 5260MHz—5320MHz
5500MHz—5700MHz; 5745MHz—5825MHz
IEEE 802.11ac VHT20:
5180MHz—5240MHz; 5260MHz—5320MHz
5500MHz—5700MHz; 5745MHz—5825MHz
IEEE 802.11ac VHT40:
5190MHz—5230MHz; 5270MHz—5310MHz
5510MHz—5670MHz; 5755MHz—5795MHz
IEEE 802.11ac VHT80:
5210MHz, 5290MHz; 5530MHz—5610MHz; 5775MHz
IEEE 802.11b: 2412MHz—2462MHz
IEEE 802.11g: 2412MHz—2462MHz
IEEE802.11nHT20:
2412MHz—2462MHz;
5180MHz—5240MHz; 5260MHz—5320MHz
5500MHz—5700MHz; 5745MHz—5825MHz
IEEE802.11nHT40:
5190MHz—5230MHz; 5270MHz—5310MHz
5510MHz—5670MHz; 5755MHz—5795MHz

Modulation : BLE: GFSK;
BT: FHSS, GFSK, DPSK, DQPSK;
802.11b: DSSS (CCK, DQPSK, DBPSK);
802.11a/g/n: OFDM (64QAM, 16QAM, QPSK, BPSK);
802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK).

Antenna Info. : Antenna Type: SMA Antenna
Antenna Gain: 5 dBi
The Antenna was an antenna that uses a unique coupling to the intentional radiator that is comply with 15.203 requirement.

Applicant : Shanghai Teraoka Electronic Co., Ltd.
Tinglin Industry Development Zone, Jinshan District, Shanghai, China

Manufacturer : same as Applicant

Factory : same as Applicant

2.2 EUT Specifications Assessed in Current Report

Mode	Modulation	Data Rate(Mbps)
BLE	GFSK	1

Channel List			
Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
00	2402	20	2442
01	2404	21	2444
02	2406	22	2446
…	…	…	…
…	…	…	…
…	…	…	…
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

2.3 Test Information

The test software " RFTestTool.apk" was used to control EUT work in TX mode, Power Setting and select test channel.

Modulation	data rate (Mbps)	Power Setting	Test Channel		Frequency (MHz)
BLE	1	Default	Low:	00	2402
		Default	Middle:	20	2442
		Default	High:	39	2480

2.4 Sample Description

Test Item	Model Number	Sample Number	Date of receipted
Conducted Emission	WB-20	E20111479-01/02	2020.11.02
Radiated Emission	WB-20	E20111479-02/02	2020.11.02
Conducted RF Test	WB-20	E20111479-01/02	2020.11.02

2.5 Supported equipment

Brand	:	HUAWEI
Product Name:	:	Adaptor
Model Name	:	HW-050200C01

2.6 Description of Test Facility

Name of Firm	:	Audix Technology (Shanghai) Co., Ltd.
Site Location	:	3F and 4F, 34Bldg, 680 Guiping Rd., Caohejing Hi-Tech Park, Shanghai 200233, China.
Accredited by NVLAP, Lab Code	:	200371-0
FCC Designation Number	:	CN5027
Test Firm Registration Number	:	954668

3 CONDUCTED EMISSION TEST

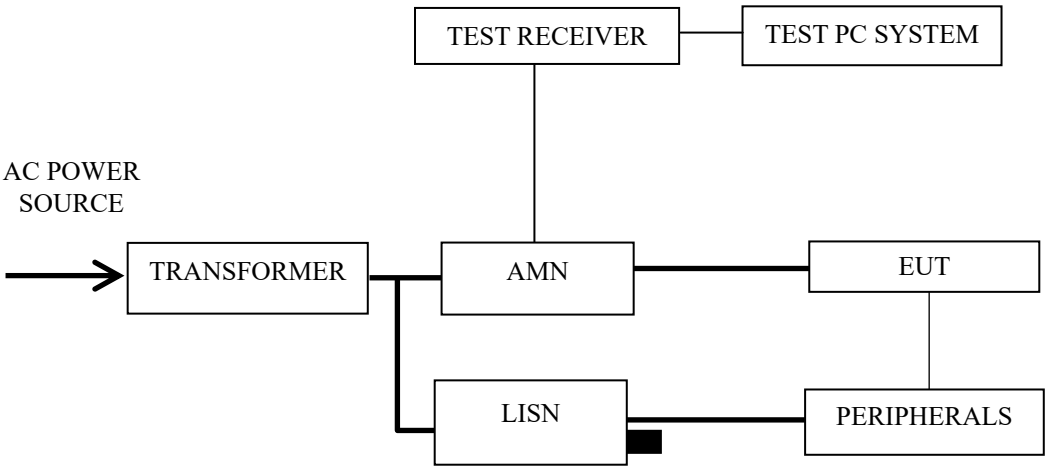
3.1 Test Equipment

The following test equipments are used during the conducted emission test in a shielded room:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Test Receiver	R&S	ESCI	100841	2020.02.11	1 Year
2.	Artificial Mains Network (AMN)	R&S	ESH2-Z5	843890/011	2020.01.06	1 Year
3.	Software	Audix	e3	6.2009-1-15	--	--

3.2 Block Diagram of Test Setup

3.2.1 Conducted Disturbance Test Setup



—— : Signal Line
▬ : Power Line
■ : 50 ohm Terminator

3.3 Conducted Emission Limits (§15.207)

Frequency Range (MHz)	Limits dB(μV)	
	Quasi-peak	Average
0.15 ~ 0.5	66~56	56~46
0.5 ~ 5	56	46
5 ~ 30	60	50

NOTE 1 – The lower limit shall apply at the transition frequencies.

NOTE 2 – The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz~0.50 MHz

3.4 Test Configuration

The EUT (listed in Sec.2.1) was installed as shown on Sec.3.2 to meet FCC requirement and operating in a manner which tends to maximize its emission level in a normal application.

3.5 Operating Condition of EUT

3.5.1 Setup the EUT as shown in Sec. 3.2.

3.5.2 Turn on the power of all equipment.

3.5.3 Turn the EUT on the test mode, and then test.

3.6 Test Procedures

The EUT was placed upon a non-metallic table, which is 0.8 m above the horizontal conducting ground plane and 0.4 m from a vertical reference plane. The EUT was connected to the power mains through an Artificial Mains Network (AMN) to provide a 50 Ω coupling impedance for the measuring equipment. Both sides of AC line (Line & Neutral) were checked to find out the maximum conducted emission according to FCC Part 15 Subpart C and ANSI C63.10: 2013 requirements during conducted disturbance test.

The I.F. bandwidth of Test Receiver ESCI was set at 9 kHz.

The frequency range from 150 kHz to 30 MHz was checked.

Test with a dummy load in lieu of the antenna to determine compliance with Section 15.207 limits within the transmitter's fundamental emission band. (According to KDB 174176 D01 Line Conducted FAQ)

The test modes were done on conducted disturbance test and all the test results are listed in Sec. 3.7

3.7 Test Results

< PASS >

The frequency and amplitude of the highest conducted emission relative the limit is reported. All the emissions not reported below are too low against the FCC limit.

Worst case emission:

No.	Operation	Modulation	Channel	Frequency (MHz)	Data Page
1.	Transmitting	--	--	--	P12

NOTE 1 – Level = Read Level + AMN Factor + Cable Loss
NOTE 2 – "QP" means "Quasi-Peak" values
NOTE 3 – The emission levels which not reported are too low against the official limit.

Worst case emission

EUT	:	SMART CARD TERMINAL	Temperature :	22℃
Model No.	:	WB-20	Humidity :	51%RH
Test Mode	:	Transmitting	Date of Test :	2020.11.11

Polarization	Frequency (MHz)	Meter Reading dB (μV)	AMN Factor (dB)	Cable Loss (dB)	Emission Level dB (μV)	Limits dB (μV)	Margin (dB)	Remark
Line	0.1565	39.79	0.08	0.08	39.95	65.65	25.7	QP
	0.1565	27.78	0.08	0.08	27.94	55.65	27.71	Average
	0.3712	45.5	0.09	0.18	45.77	58.47	12.7	QP
	0.3712	**43.2**	**0.09**	**0.18**	**43.47**	**48.47**	**5**	**Average**
	0.743	40.44	0.11	0.16	40.71	56	15.29	QP
	0.743	32.23	0.11	0.16	32.5	46	13.5	Average
	1.065	35.9	0.11	0.14	36.15	56	19.85	QP
	1.065	27.92	0.11	0.14	28.17	46	17.83	Average
	2.707	30.37	0.15	0.17	30.69	56	25.31	QP
	2.707	24.34	0.15	0.17	24.66	46	21.34	Average
	13.989	26	0.18	0.13	26.31	60	33.69	QP
	13.989	16.7	0.18	0.13	17.01	50	32.99	Average
Neutral	0.1549	41.04	0.09	0.08	41.21	65.74	24.53	QP
	0.1549	26.99	0.09	0.08	27.16	55.74	28.58	Average
	0.3465	41.19	0.1	0.17	41.46	59.05	17.59	QP
	0.3465	27.16	0.1	0.17	27.43	49.05	21.62	Average
	0.7274	37.46	0.12	0.16	37.74	56	18.26	QP
	0.7274	27.13	0.12	0.16	27.41	46	18.59	Average
	1.032	35.78	0.13	0.14	36.05	56	19.95	QP
	1.032	23.57	0.13	0.14	23.84	46	22.16	Average
	3.436	27.79	0.19	0.18	28.16	56	27.84	QP
	3.436	20.4	0.19	0.18	20.77	46	25.23	Average
	13.551	34.32	0.41	0.13	34.86	60	25.14	QP
	13.551	23.93	0.41	0.13	24.47	50	25.53	Average

TEST ENGINEER: Jarey

4 RADIATED EMISSION TEST

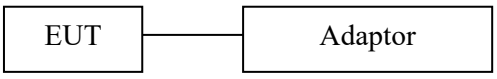
4.1 Test Equipment

The following test equipment are used during the radiated emission test in a semi-anechoic chamber:

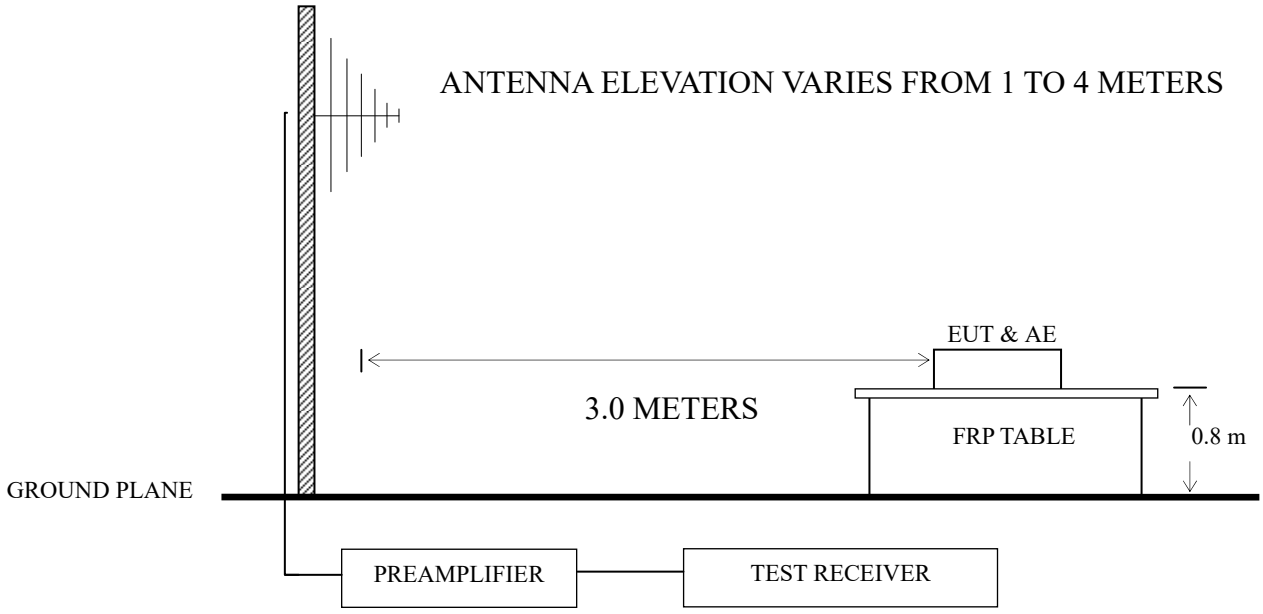
Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Preamplifier	Agilent	8447D	2944A10548	2020.04.26	1 Year
2.	Preamplifier	HP	8449B	3008A00864	2021.01.05	1 Year
3.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
4.	Test Receiver	R&S	ESCI	101303	2020.04.26	1 Year
5.	Bilog Antenna+6dB Attenuator	Schwarz beck	VULB 9168+EMCI-N-6-06	708+AT-N0638	2020.07.06	1 Year
6.	Horn Antenna	EMCO	3115	9607-4878	2020.07.13	1 Year
7.	Horn Antenna	EMCO	3116	00062643	2020.09.08	1 Year
8.	Cavity Band Rejection Filter	Microwave	WT-A3882-R10	WT200312-1-1	2020.07.07	1 Year
9.	Software	Audix	e3	SET00200 9912M295-2	--	--

4.2 Block Diagram of Test Setup

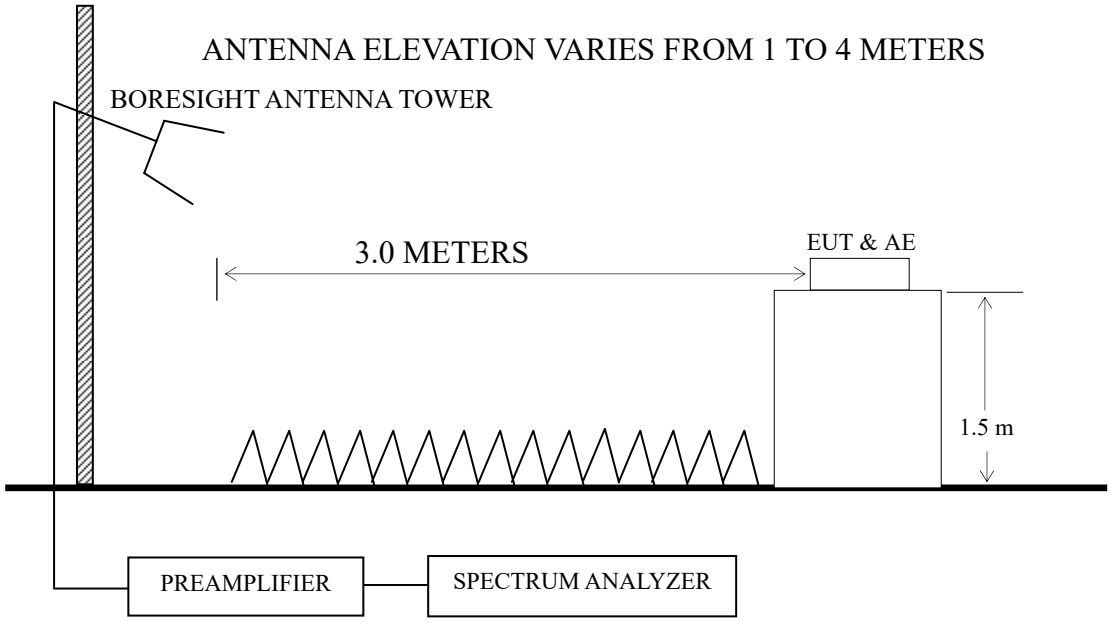
4.2.1 EUT & Peripherals



4.2.2 Below 1GHz



4.2.3 Above 1GHz



4.3 Radiated Emission Limit (§15.209)

Frequency (MHz)	Distance (m)	Field strength limits (μV/m)	
		(μV/m)	dB(μV/m)
30 ~ 88	3	100	40.0
88 ~ 216	3	150	43.5
216 ~ 960	3	200	46.0
Above 960	3	500	54.0

NOTE 1 - Emission Level dB (μV/m) = 20 log Emission Level (μV/m)
NOTE 2 - The tighter limit applies at the band edges.
NOTE 3 - Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.
NOTE 4 - The limits shown are based on Quasi-peak value detector below or equal to 1GHz and Average value detector above 1GHz.
NOTE 5 - Above 1 GHz, the limit on peak emission is 20 dB above the maximum permitted average emission limit applicable to the EUT

4.4 Test Configuration

The EUT (listed in Sec.2.1) and the simulators (listed in Sec.2.2) were installed as shown on Sec.4.2 to meet FCC requirements and operating in a manner that tends to maximize its emission level in a normal application.

4.5 Operating Condition of EUT

4.5.1 Setup the EUT as shown in Sec. 4.2.

4.5.2 Turn on the power of all equipment.

4.5.3 Turn the EUT on the test mode, and then test.

4.6 Test Procedures

Radiated emission test applies to harmonics/spurs that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. A pre-amp is necessary for this measurement. For measurement above 1 GHz, set RBW = 1MHz, VBW = 10 Hz, Sweep: Auto. If the emission is pulsed, modify the unit for continuous operation; use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation.

The EUT was placed on a turntable. Below 1 GHz, the table height is 80 cm above the reference ground plane. Above 1 GHz, the table height is 1.5 m. The turntable rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna, which was mounted on an antenna tower. The antenna moved up and down between 1 meter and 4 meters to find out the maximum emission level. Broadband antenna (Calibrated Bilog Antenna) or Horn antenna was used as receiving antenna. Both horizontal and vertical polarizations of the antenna were set on measurement. In order to find the maximum emission, all of the interference cables were manipulated according to ANSI C63.10: 2013 requirements during radiated emission test.

The bandwidth of Test Receiver R&S ESCI was set at 120 kHz from 30MHz to 1000MHz.

The bandwidth of Agilent N9010A was set at 1MHz for above 1GHz.

The frequency range from 30 MHz to 25 GHz (Up to 10^{th} harmonics from fundamental frequency) was checked.

All the test results are listed in Sec.4.7.

4.7 Test Results

<PASS>

The frequency and amplitude of the highest radiated emission relative the limit is reported. All the emissions not reported below are too low against the FCC limit.

Frequency range: below 1GHz (Worst case emission)

No.	Operation	Modulation	Channel	Frequency	Data Page
1.	Transmitting	BLE	39	2480 MHz	P17

Frequency range: above 1GHz

No.	Operation	Modulation	Channel	Frequency	Data Page
1.	Transmitting	BLE	00	2402 MHz	P18
2.			20	2442 MHz	P18
3.			39	2480 MHz	P19

Restricted bands:

No.	Operation	Modulation	Channel	Frequency	Data Page
1.	Transmitting	BLE	Cabinet Emission		P20

NOTE 1 – Level = Read Level + Antenna Factor + Cable Loss - Preamp Factor
NOTE 2 – "QP" means "Quasi-Peak" values
NOTE 3 – 0°was the table front facing the antenna. Degree is calculated from 0°clockwise facing the antenna.
NOTE 4 – The emission levels which not reported are too low against the official limit.
NOTE 5 – The emission levels recorded below is data of EUT configured in Standing direction, for Standing direction was the maximum emission direction during the test. The data of Side & Lying direction are too low against the official limit to be reported.
NOTE 6 – All reading are Quasi-Peak values below or equal to 1GHz, Peak and Average values above 1GHz.
For above 1GHz test, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
NOTE 7 – The frequency range 2310-2390MHz & 2483.5-2500MHz were tested for Restricted bands.

Worst case emission < 1GHz

EUT	:	SMART CARD TERMINAL	Temperature :	22℃	
Model No.	:	WB-20	Humidity	:	51%RH
Test Mode	:	Transmitting	Date of Test	:	2021.04.20

Polarization	Frequency (MHz)	Meter Reading dB (μV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission Level dB (μV/m)	Limits dB (μV/m)	Margin (dB)	Remark
Horizontal	52.76	28.02	19.63	0.45	28.35	19.75	40	20.25	QP
	150.02	37.2	19.1	0.59	27.74	29.15	43.5	14.35	QP
	254.73	37.79	17.77	0.76	27.41	28.91	46	17.09	QP
	300	40.4	19	0.88	27.35	32.93	46	13.07	QP
	450	46.8	22.8	1.17	27.2	43.57	46	2.43	QP
	750	40.9	27.5	1.83	27.44	42.79	46	3.21	QP
Vertical	51.843	41.06	19.69	0.45	28.35	32.85	40	7.15	QP
	66.266	40.11	18.11	0.5	28.25	30.47	40	9.53	QP
	150.01	39.86	19.1	0.59	27.74	31.81	43.5	11.69	QP
	450	42.7	22.8	1.17	27.2	39.47	46	6.53	QP
	600	41.5	25.3	1.51	27.28	41.03	46	4.97	QP
	750	41.9	27.5	1.83	27.44	43.79	46	2.21	QP

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Radiated Emission > 1GHz

EUT	:	SMART CARD TERMINAL	Temperature :	22℃
Model No.	:	WB-20	Humidity :	51%RH
Test Mode	:	Transmitting	Date of Test :	2021.04.20

BLE CH2402MHz

Polarization	Frequency (MHz)	Meter Reading dB (μV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission Level dB (μV/m)	Limits dB (μV/m)	Margin (dB)	Remark
Horizontal	1702	44.54	26.34	3.25	37.37	36.76	74	37.24	Peak
	4087	37.77	32.56	4.9	37.07	38.16	74	35.84	Peak
	5626	35.71	34.2	5.85	37.04	38.72	74	35.28	Peak
	7120	34.66	35.78	6.24	37.01	39.67	74	34.33	Peak
	8551	33.89	38.48	6.69	36.98	42.08	74	31.92	Peak
	9829	34.44	38.4	7.26	36.96	43.14	74	30.86	Peak
Vertical	1657	43.92	26.16	3.19	37.4	35.87	74	38.13	Peak
	3574	38.84	31.44	4.57	37.08	37.77	74	36.23	Peak
	5527	34.7	34.2	5.83	37.05	37.68	74	36.32	Peak
	7381	33.46	36.59	6.29	37	39.34	74	34.66	Peak
	8812	34.57	38.37	6.81	36.98	42.77	74	31.23	Peak
	9721	34.82	38.4	7.26	36.96	43.52	74	30.48	Peak

BLE CH2442MHz

Polarization	Frequency (MHz)	Meter Reading dB (μV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission Level dB (μV/m)	Limits dB (μV/m)	Margin (dB)	Remark
Horizontal	1567	44.74	25.78	3.08	37.49	36.11	74	37.89	Peak
	3709	38.71	31.8	4.65	37.08	38.08	74	35.92	Peak
	5140	35.96	33.55	5.71	37.06	38.16	74	35.84	Peak
	7156	34.77	35.9	6.24	37.01	39.9	74	34.1	Peak
	8380	35.65	38.26	6.62	36.99	43.54	74	30.46	Peak
	9757	34.71	38.4	7.26	36.96	43.41	74	30.59	Peak
Vertical	1324	46.13	24.95	2.77	37.74	36.11	74	37.89	Peak
	3763	39.05	31.94	4.67	37.08	38.58	74	35.42	Peak
	5500	34.66	34.2	5.8	37.05	37.61	74	36.39	Peak
	7480	33.71	36.84	6.31	37	39.86	74	34.14	Peak
	8560	35.18	38.47	6.69	36.98	43.36	74	30.64	Peak
	9973	34.82	38.4	7.33	36.96	43.59	74	30.41	Peak

BLE CH2480MHz

Polarization	Frequency (MHz)	Meter Reading dB (μV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission Level dB (μV/m)	Limits dB (μV/m)	Margin (dB)	Remark
Horizontal	1711	43.78	26.37	3.25	37.36	36.04	74	37.96	Peak
	3421	41.07	31.05	4.51	37.08	39.55	74	34.45	Peak
	4996	36.2	33.3	5.66	37.06	38.1	74	35.9	Peak
	6931	34.27	35.29	6.19	37.01	38.74	74	35.26	Peak
	8461	34.64	38.45	6.62	36.98	42.73	74	31.27	Peak
	9802	35.19	38.4	7.26	36.96	43.89	74	30.11	Peak
Vertical	1801	44.16	26.72	3.33	37.28	36.93	74	37.07	Peak
	3538	39.62	31.32	4.57	37.08	38.43	74	35.57	Peak
	5509	35.28	34.2	5.83	37.05	38.26	74	35.74	Peak
	7183	34.78	35.96	6.24	37.01	39.97	74	34.03	Peak
	8488	34.25	38.5	6.69	36.98	42.46	74	31.54	Peak
	9793	34.79	38.4	7.26	36.96	43.49	74	30.51	Peak

TEST ENGINEER: Jarey

Emissions in restricted frequency bands:

EUT	:	SMART CARD TERMINAL	Temperature :	22℃
Model No.	:	WB-20	Humidity :	51%RH
Test Mode	:	Transmitting	Date of Test :	2021.04.20

BLE

Polarization	Frequency (MHz)	Meter Reading dB (μV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission Level dB (μV/m)	Limits dB (μV/m)	Margin (dB)	Remark
Horizontal	2319.5	44.83	28.13	3.8	37.11	39.65	74	34.35	Peak
	2319.5	32.88	28.13	3.8	37.11	27.7	54	26.3	Average
	2352.2	46.27	28.2	3.83	37.11	41.19	74	32.81	Peak
	2352.2	33.62	28.2	3.83	37.11	28.54	54	25.46	Average
	2389.5	55.91	28.27	3.85	37.11	50.92	74	23.08	Peak
	2389.5	37.4	28.27	3.85	37.11	32.41	54	21.59	Average
	2483.7	47.51	28.47	3.93	37.11	42.8	74	31.2	Peak
	2483.7	36.36	28.47	3.93	37.11	31.65	54	22.35	Average
	2490.6	43.99	28.49	3.93	37.11	39.3	74	34.7	Peak
	2490.6	32.77	28.49	3.93	37.11	28.08	54	25.92	Average
	2496.6	45.61	28.5	3.93	37.11	40.93	74	33.07	Peak
	2496.6	33.35	28.5	3.93	37.11	28.67	54	25.33	Average
Vertical	2331.2	46.28	28.16	3.83	37.11	41.16	74	32.84	Peak
	2331.2	32.42	28.16	3.83	37.11	27.3	54	26.7	Average
	2359.9	47.35	28.21	3.85	37.11	42.3	74	31.7	Peak
	2359.9	34.74	28.21	3.85	37.11	29.69	54	24.31	Average
	2390	59.36	28.27	3.85	37.11	54.37	74	19.63	Peak
	2390	**41.2**	**28.27**	**3.85**	**37.11**	**36.21**	**54**	**17.79**	**Average**
	2483.5	43.49	28.47	3.93	37.11	38.78	74	35.22	Peak
	2483.5	36.66	28.47	3.93	37.11	31.95	54	22.05	Average
	2491	45.2	28.49	3.93	37.11	40.51	74	33.49	Peak
	2491	35.12	28.49	3.93	37.11	30.43	54	23.57	Average
	2498.2	46.52	28.5	3.93	37.11	41.84	74	32.16	Peak
	2498.2	35.76	28.5	3.93	37.11	31.08	54	22.92	Average

TEST ENGINEER: Jarey

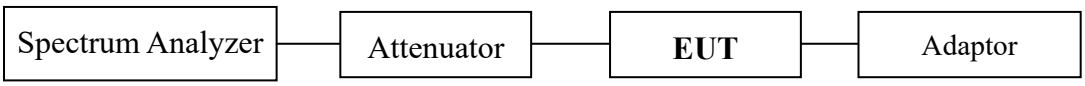
5 6 dB BANDWIDTH MEASUREMENT

5.1 Test Equipment

The following test equipment was used during the Emission Bandwidth measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2020.03.08	1 Year
3.	10 dB Attenuator	Mini-Circuits	VAT-10W2+	001	2020.08.06	1 Year

5.2 Block Diagram of Test Setup



5.3 Specification Limits (§15.247(a)(2))

The minimum 6 dB bandwidth shall be at least 500 kHz.

5.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

5.5 Test Procedure

The transmitter output was connected to the spectrum analyzer. The bandwidth of the fundamental frequency was measure by spectrum analyzer with settings: RBW = 100kHz, VBW ≥ 3 × RBW.

The 6 dB bandwidth is defined as the total spectrum the power of which is lower than peak power minus 6 dB .

The test procedure is defined in ANSI C63.10-2013 (the 11.8.2 Measurement Procedure “Option 2” was used).

5.6 Test Results

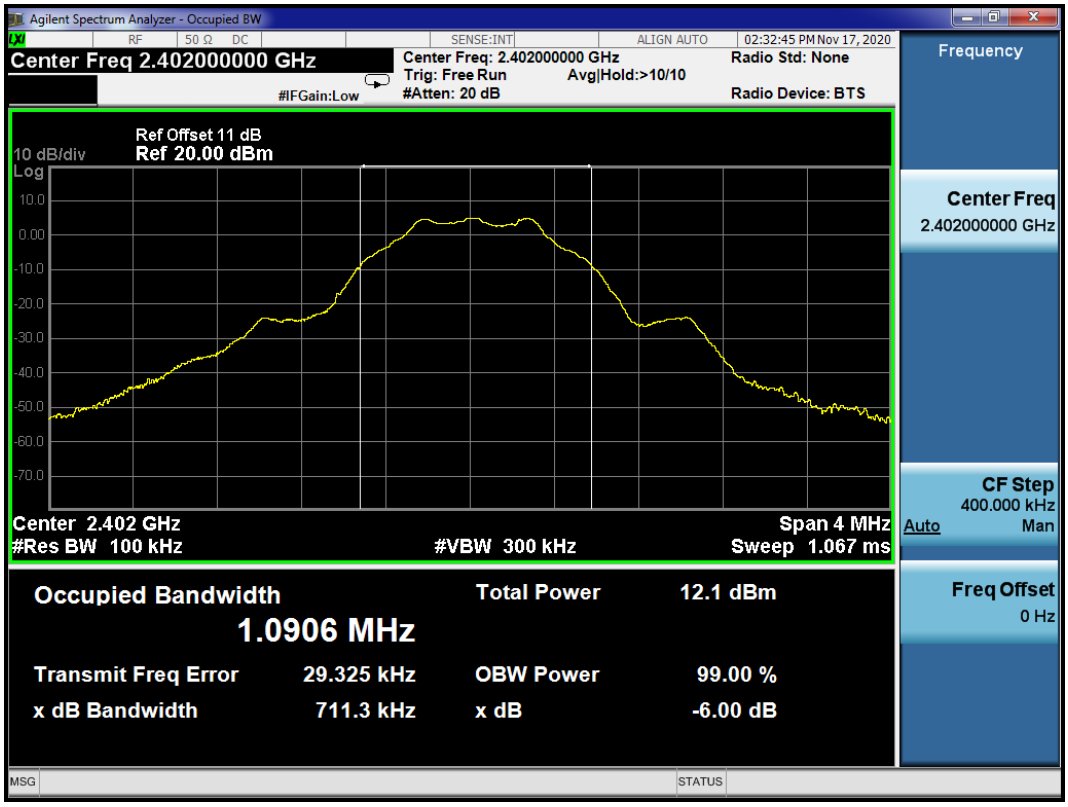
PASSED.

All the test results are attached in next pages.

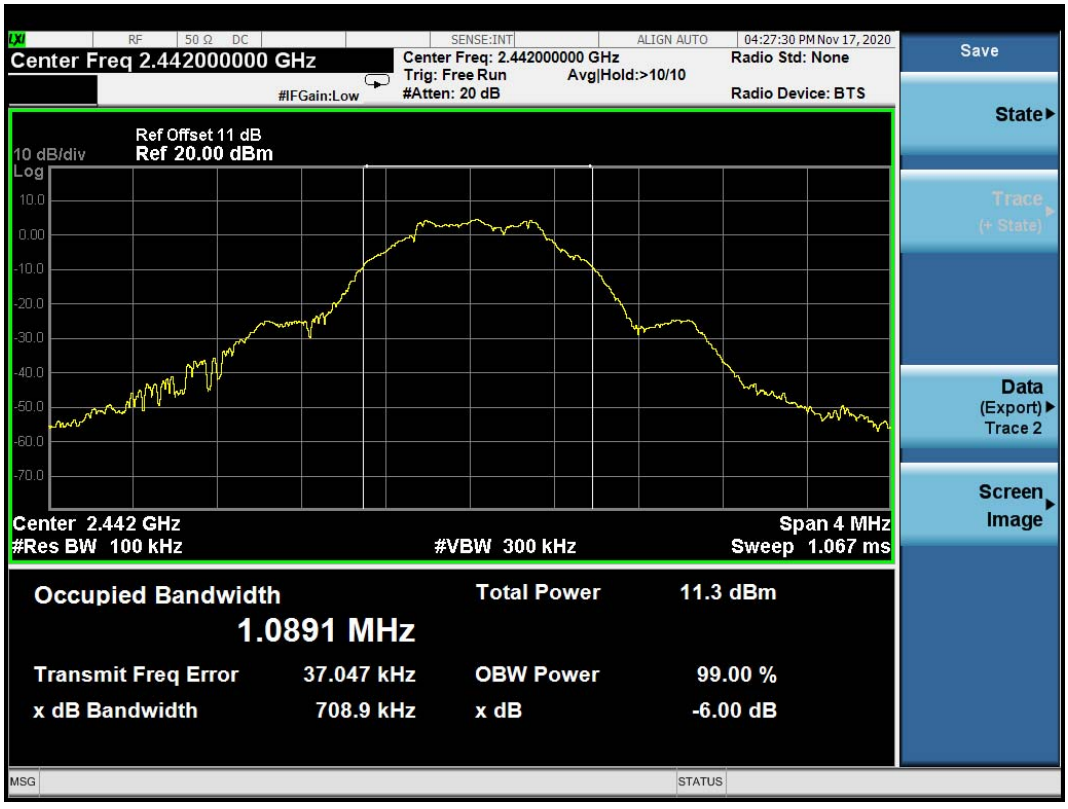
(Test Date: 2020.11.17 Temperature: 23℃ Humidity: 51 %)

Modulation	Channel	Frequency (MHz)	**6dB Bandwidth (kHz)**	Limit
BLE	00	2402	**711.3**	500 kHz
	20	2442	**708.9**	500 kHz
	39	2480	**710.6**	500 kHz

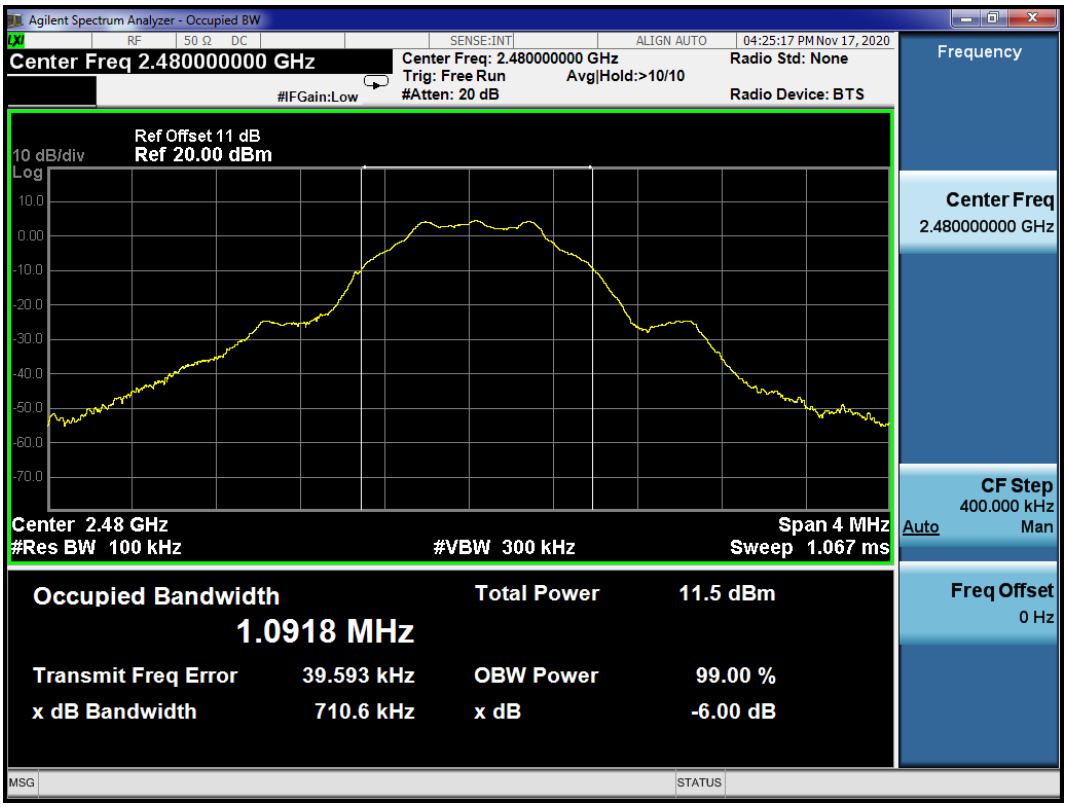
BLE CH2402MHz



BLE CH2442MHz



BLE CH2480MHz



6 MAXIMUM PEAK OUTPUT POWER MEASUREMENT

6.1 Test Equipment

The following test equipment was used during the maximum peak output power measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2020.03.08	1 Year
3.	10 dB Attenuator	Mini-Circuits	VAT-10W2+	001	2020.08.06	1 Year

6.2 Block Diagram of Test Setup

The Same as Section. 5.2.

6.3 Specification Limits ((§15.247(b)(3))

The Limits of maximum Peak Output Power for digital modulation in 2400-2483.5 MHz is: 1 Watt. (30 dBm)

6.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

6.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.

The following procedure can be used when the maximum available RBW of the instrument is less than the DTS bandwidth:
a) Set the RBW = 1 MHz.
b) Set the VBW ≥ [3 RBW].
c) Set the span ≥ [1.5 DTS bandwidth].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some instruments, this may require a manual override to select the peak detector). If the instrument does not have a band power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the DTS channel bandwidth

The test procedure is defined in ANSI C63.10-2013 (11.9.1.2 Measurement Procedure " Integrated band power method" was used).

6.6 Test Results

PASSED.

All the test results are listed below.

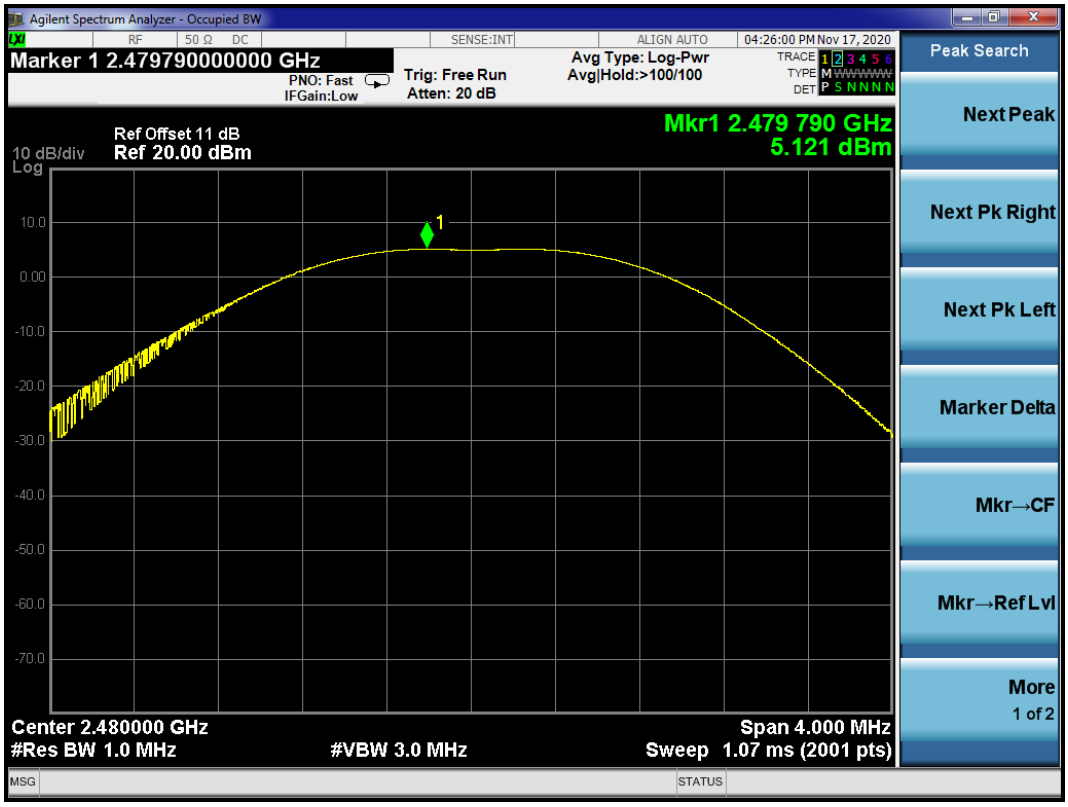
(Test Date: 2020.11.17 Temperature: 23℃ Humidity: 51 %)

Modulation	Channel	Frequency (MHz)	**Peak Output Power (dBm)**	Limit
BLE	00	2402	**5.559**	30 dBm
	20	2442	**5.419**	30 dBm
	39	2480	**5.121**	30 dBm

BLE CH2402MHz

BLE CH2442MHz

BLE CH2480MHz



7 EMISSION LIMITATIONS MEASUREMENT

7.1 Test Equipment

The following test equipment was used during the emission limitations test:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2020.03.08	1 Year
3.	10 dB Attenuator	Mini-Circuits	VAT-10W2+	001	2020.08.06	1 Year

7.2 Block Diagram of Test Setup

The Same as Section. 5.2.

7.3 Specification Limits (§15.247(d))

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. Attenuation below the general limits specified in §15.209(a) is not required.
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)). (※This test result attaching to Section. 3.7)

7.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

7.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.

Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the 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 PSD level.
Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Establish an emission level by using the following procedure:
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit.

Scan up through 10^{th} harmonic.

The test procedure is defined in ANSI C63.10-2013 (11.11.2 Reference level measurement and 11.11.3 Emission level measurement was used).

7.6 Test Results

PASSED.

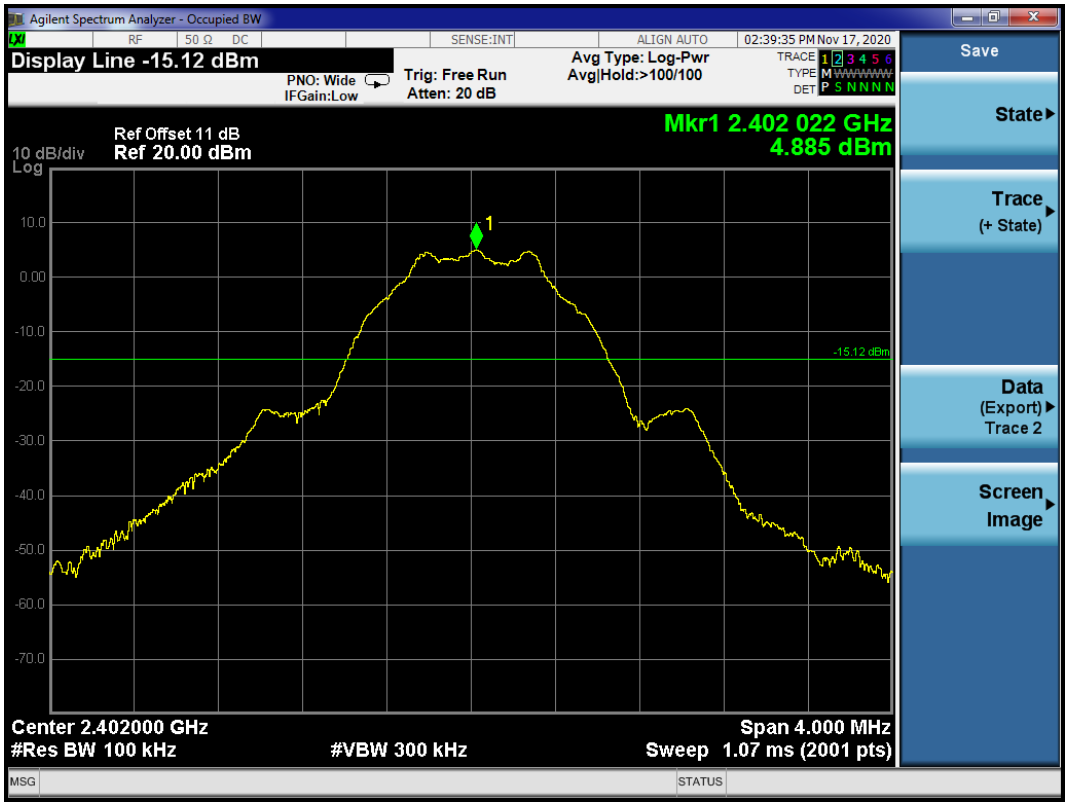
The test data was attached in the next pages.

(Test Date: 2020.11.17 Temperature: 23℃ Humidity: 51 %)

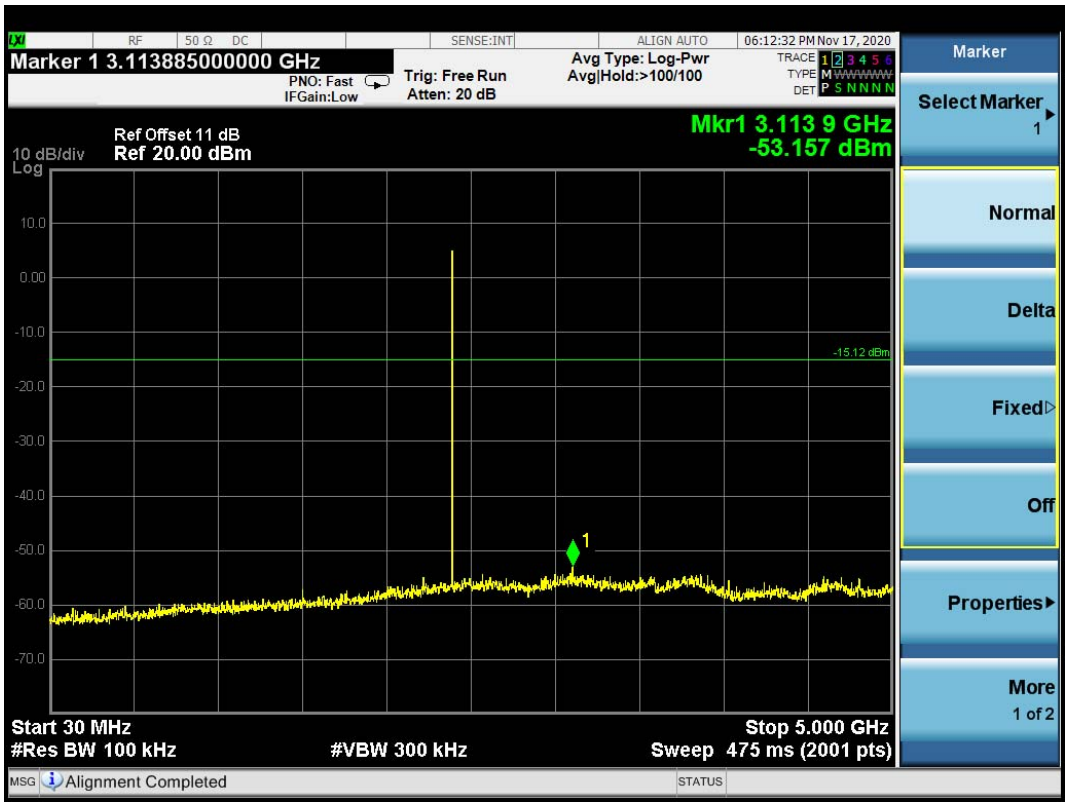
Modulation	Channel	Frequency (MHz)	Data Page
BLE	00	2402	P32-33
	20	2442	P34-35
	39	2480	P36-37

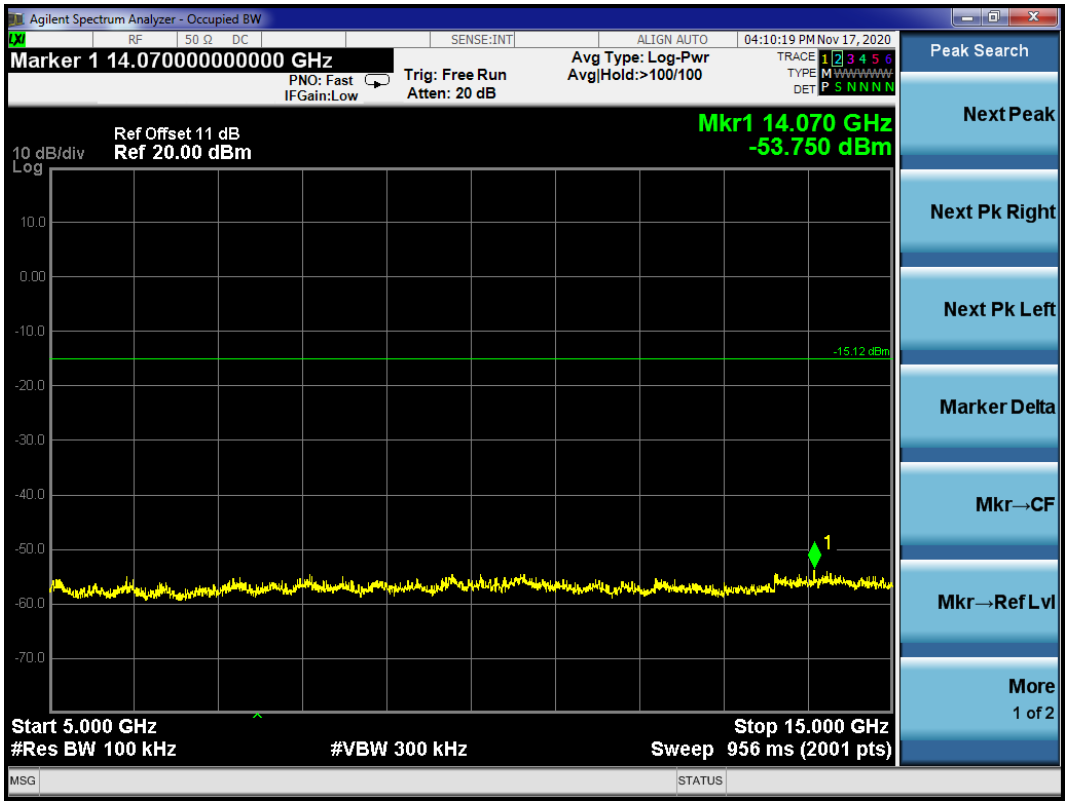
BLE CH2402MHz

Reference level



Emission level

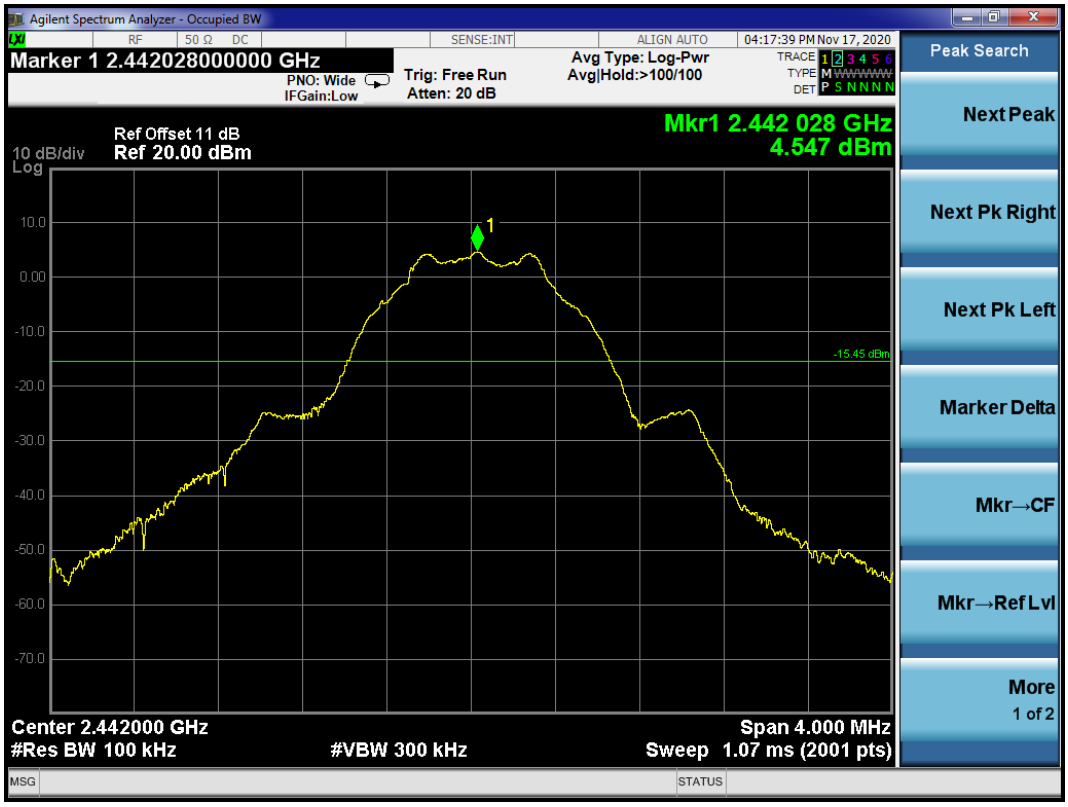



Agilent Spectrum Analyzer - Occupied BW
RF 50 Ω DC
SENSE:INT
ALIGN AUTO
04:10:19 PM Nov 17, 2020
Marker 1 14.070000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P S N N N N
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2
Ref Offset 11 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr1 14.070 GHz
-53.750 dBm
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-15.12 dBm
1
Start 5.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 15.000 GHz
Sweep 956 ms (2001 pts)
MSG
STATUS

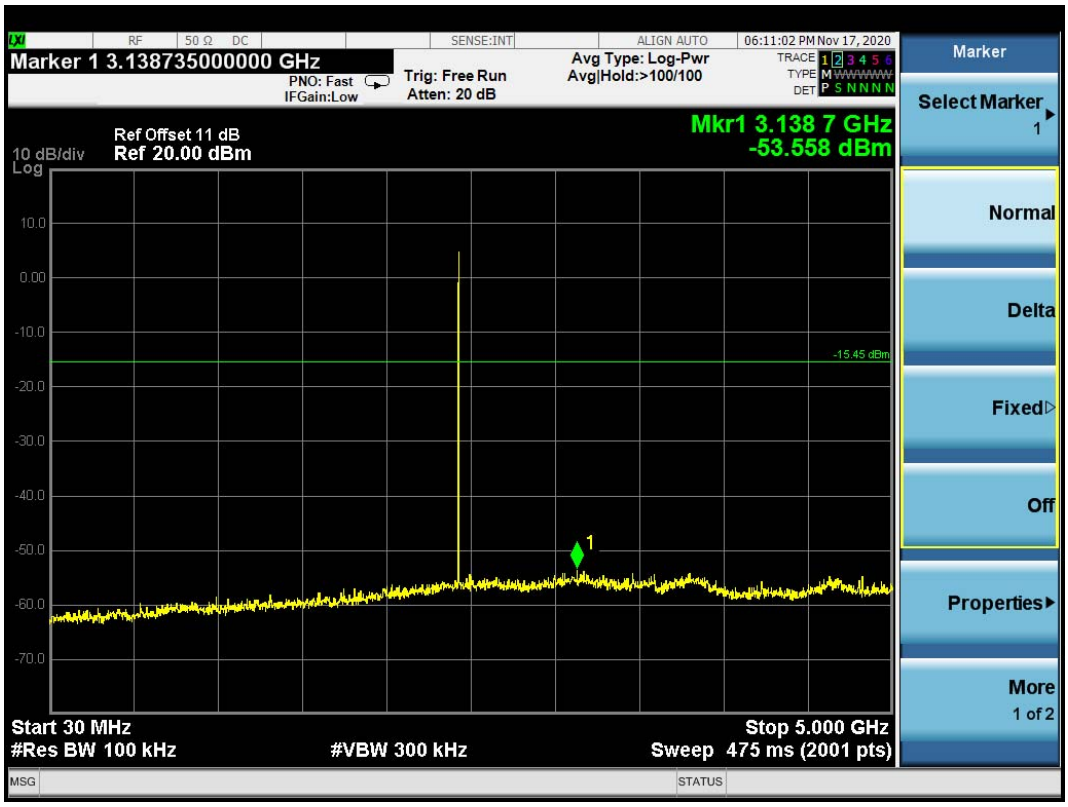

Agilent Spectrum Analyzer - Occupied BW
RF 50 Ω DC
SENSE:INT
ALIGN AUTO
04:13:08 PM Nov 17, 2020
Marker 1 23.630000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P S N N N N
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2
Ref Offset 11 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr1 23.630 GHz
-50.375 dBm
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-15.12 dBm
1
Start 15.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.000 GHz
Sweep 956 ms (2001 pts)
MSG
STATUS

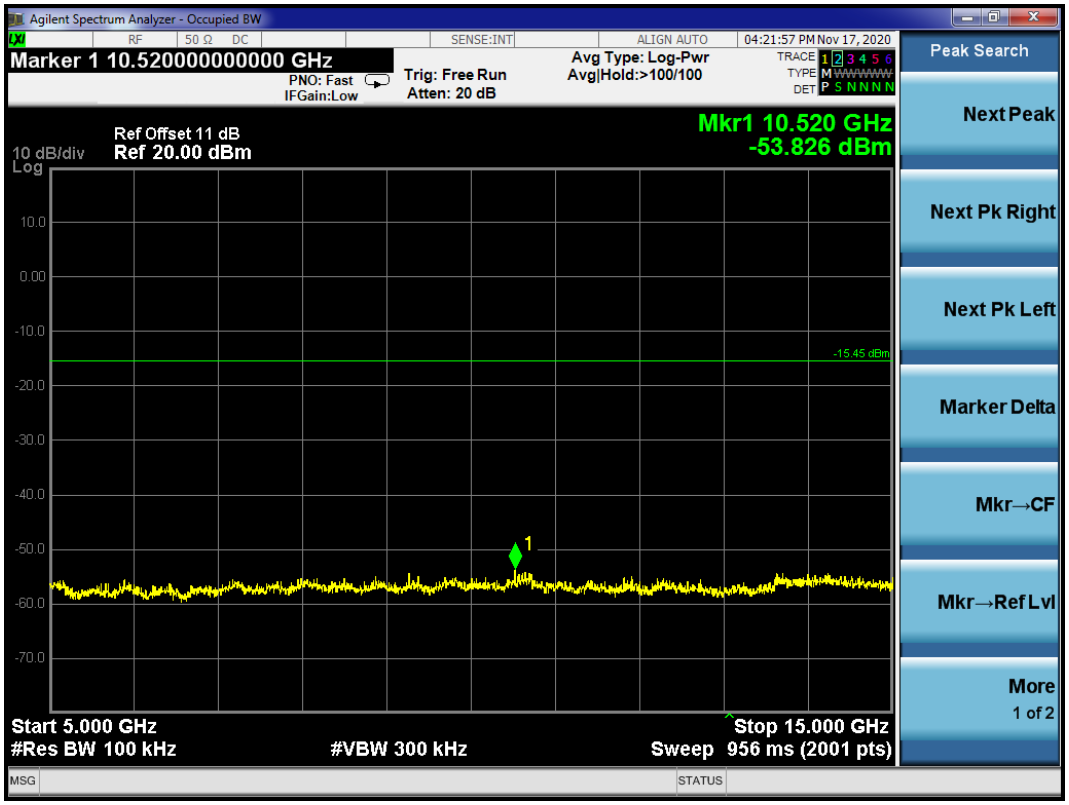
BLE CH2442MHz

Reference level



Emission level

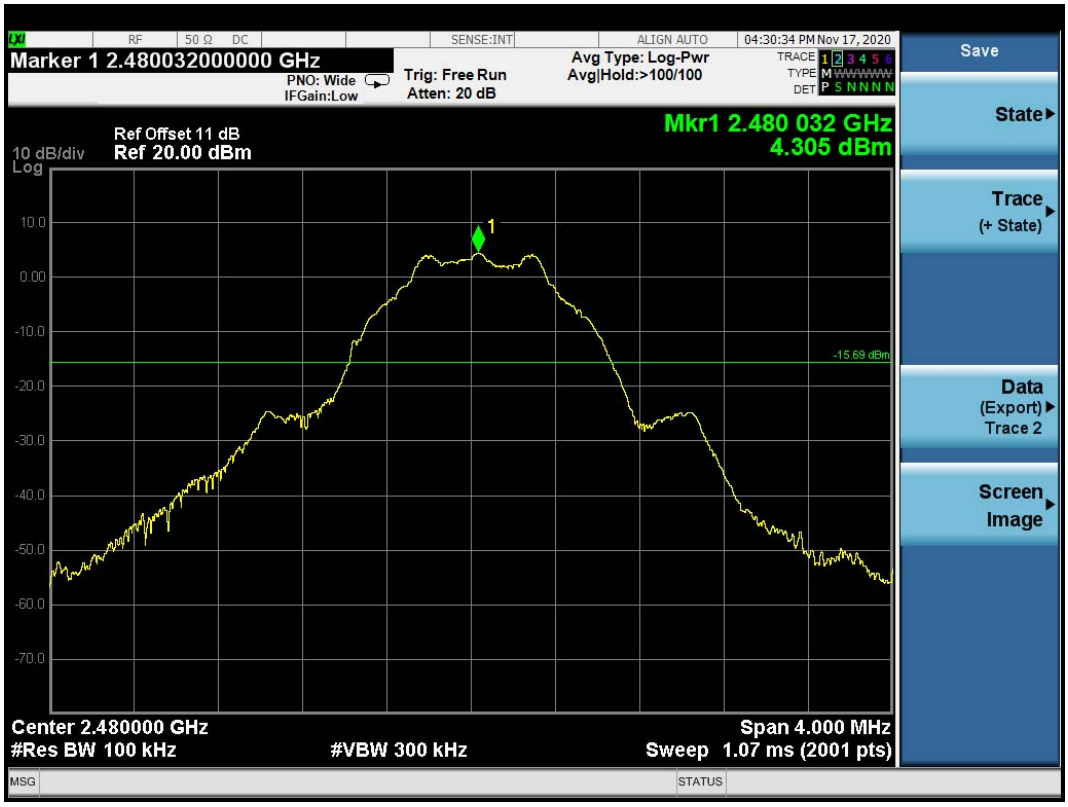



Agilent Spectrum Analyzer - Occupied BW
RF 50 Ω DC
SENSE:INT
ALIGN AUTO
04:21:57 PM Nov 17, 2020
Marker 1 10.520000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P S N N N N
Ref Offset 11 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr1 10.520 GHz
-53.826 dBm
10.0
0.00
-10.0
-15.45 dBm
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Start 5.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 15.000 GHz
Sweep 956 ms (2001 pts)
MSG
STATUS
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

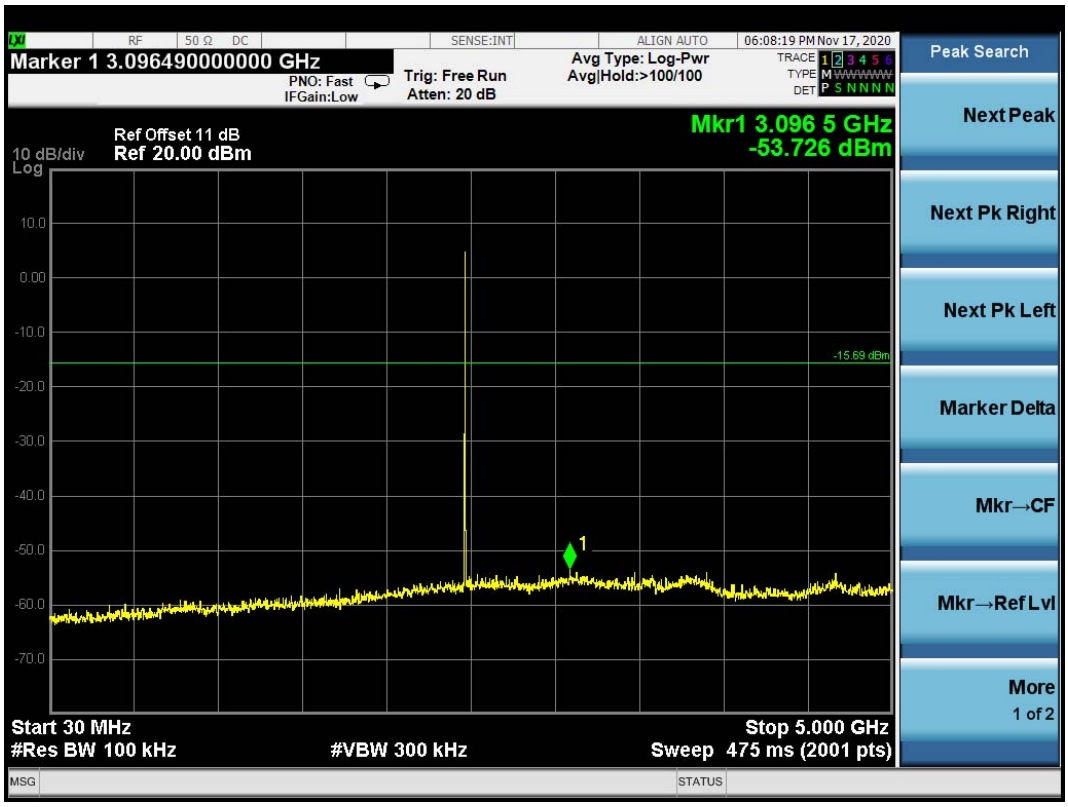

Agilent Spectrum Analyzer - Occupied BW
RF 50 Ω DC
SENSE:INT
ALIGN AUTO
04:24:48 PM Nov 17, 2020
Marker 1 23.670000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P S N N N N
Ref Offset 11 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr1 23.670 GHz
-50.181 dBm
10.0
0.00
-10.0
-15.45 dBm
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Start 15.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.000 GHz
Sweep 956 ms (2001 pts)
MSG
STATUS
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

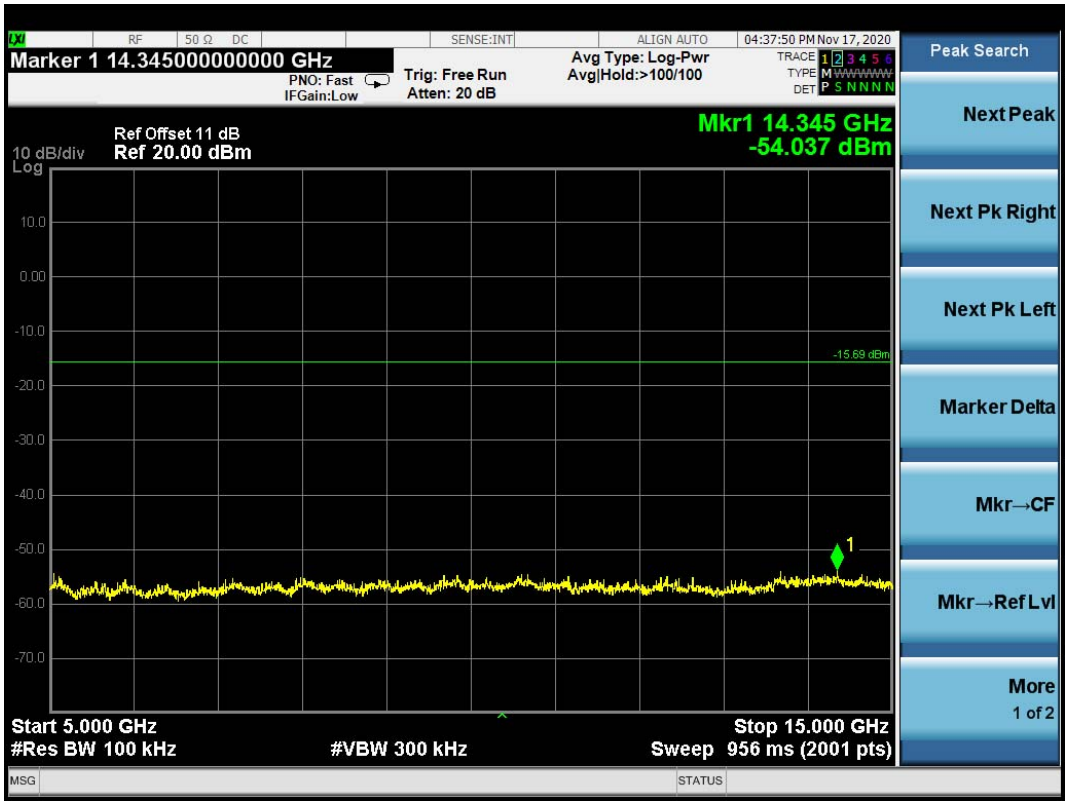
BLE CH2480MHz

Reference level



Emission level




RF 50 Ω DC
SENSE:INT
ALIGN AUTO
04:37:50 PM Nov 17, 2020
Marker 1 14.345000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P S N N N N
Ref Offset 11 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr1 14.345 GHz
-54.037 dBm
10.0
0.00
-10.0
-15.69 dBm
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Start 5.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 15.000 GHz
Sweep 956 ms (2001 pts)
MSG
STATUS
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2


RF 50 Ω DC
SENSE:INT
ALIGN AUTO
04:40:12 PM Nov 17, 2020
Marker 1 23.595000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P S N N N N
Ref Offset 11 dB
10 dB/div
Log
Ref 20.00 dBm
Mkr1 23.595 GHz
-49.662 dBm
10.0
0.00
-10.0
-15.69 dBm
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Start 15.000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.000 GHz
Sweep 956 ms (2001 pts)
MSG
STATUS
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

8 BAND EDGES MEASUREMENT

8.1 Test Equipment

The following test equipment was used during the band edges measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105FLEX	F02-150819-045	2020.03.08	1 Year
3.	10 dB Attenuator	Mini-Circuits	VAT-10W2+	001	2020.08.06	1 Year

8.2 Block Diagram of Test Setup

The Same as section. 5.2.

8.3 Specification Limits (§15.247(d))

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. Attenuation below the general limits specified in §15.209(a) is not required.

8.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

8.5 Test Procedure

The transmitter output was connected to the spectrum analyzer. Set RBW of Test Receiver to 100kHz and VBW to 300kHz with suitable frequency span including 100kHz bandwidth from band edge.
The test procedure is defined in ANSI C63.10-2013 (11.11.3 Emission level measurement was used).

8.6 Test Results

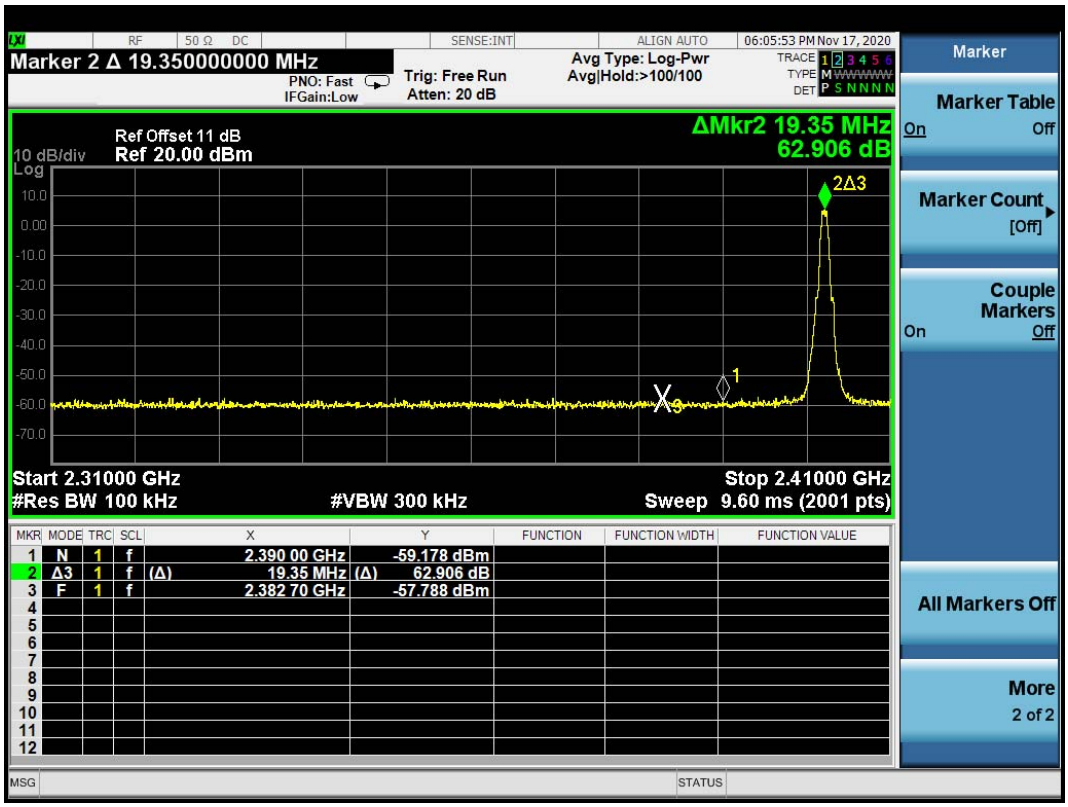
PASSED.

All the test results are attached in next pages.

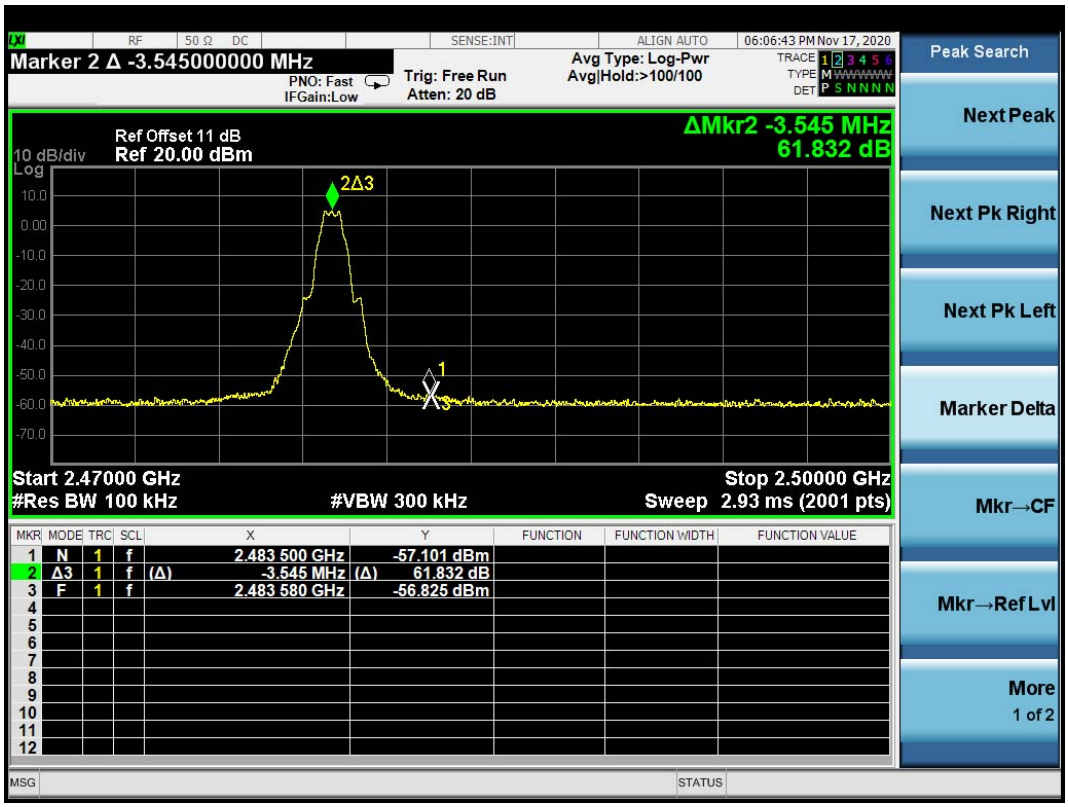
(Test Date: 2020.11.17 Temperature: 23℃ Humidity: 51 %)

Modulation	Location	Channel	Frequency (MHz)	**Delta Marker (dB)**	Result
BLE	Below Band Edge	00	2402	**62.906**	More than **20 dB** below the highest level of the desired power
	Upper Band Edge	39	2480	**61.832**	

BLE CH2402MHz (Below Edge 2390 MHz)



BLE CH2480MHz (Upper Edge 2483.5 MHz)



9 POWER SPECTRAL DENSITY MEASUREMENT

9.1 Test Equipment

The following test equipment was used during the power spectral density measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2020.03.08	1 Year
3.	10 dB Attenuator	Mini-Circuits	VAT-10W2+	001	2020.08.06	1 Year

9.2 Block Diagram of Test Setup

The Same as section 5.2.

9.3 Specification Limits (§15.247(e))

The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band.

9.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

9.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.

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.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

The test procedure is defined in ANSI C63.10-2013 (11.10.2 Measurement Procedure “Method PKPSD (peak PSD)” was used).

9.6 Test Results

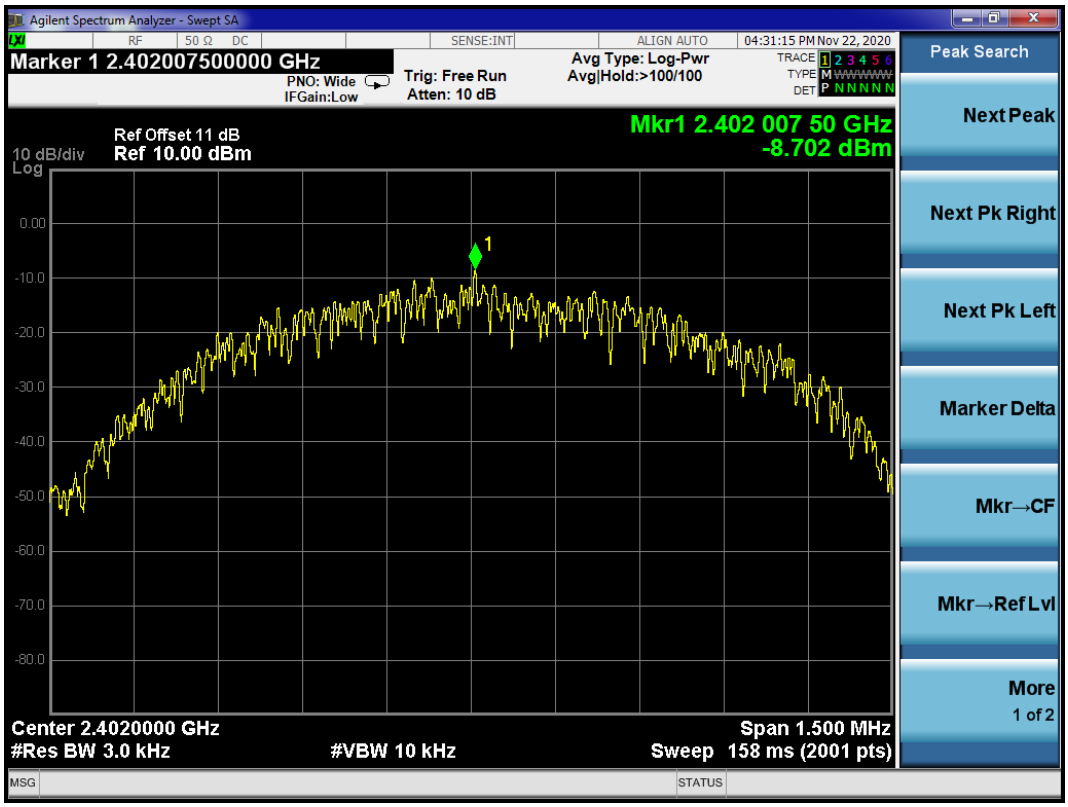
PASSED.

All the test results are attached in next pages.

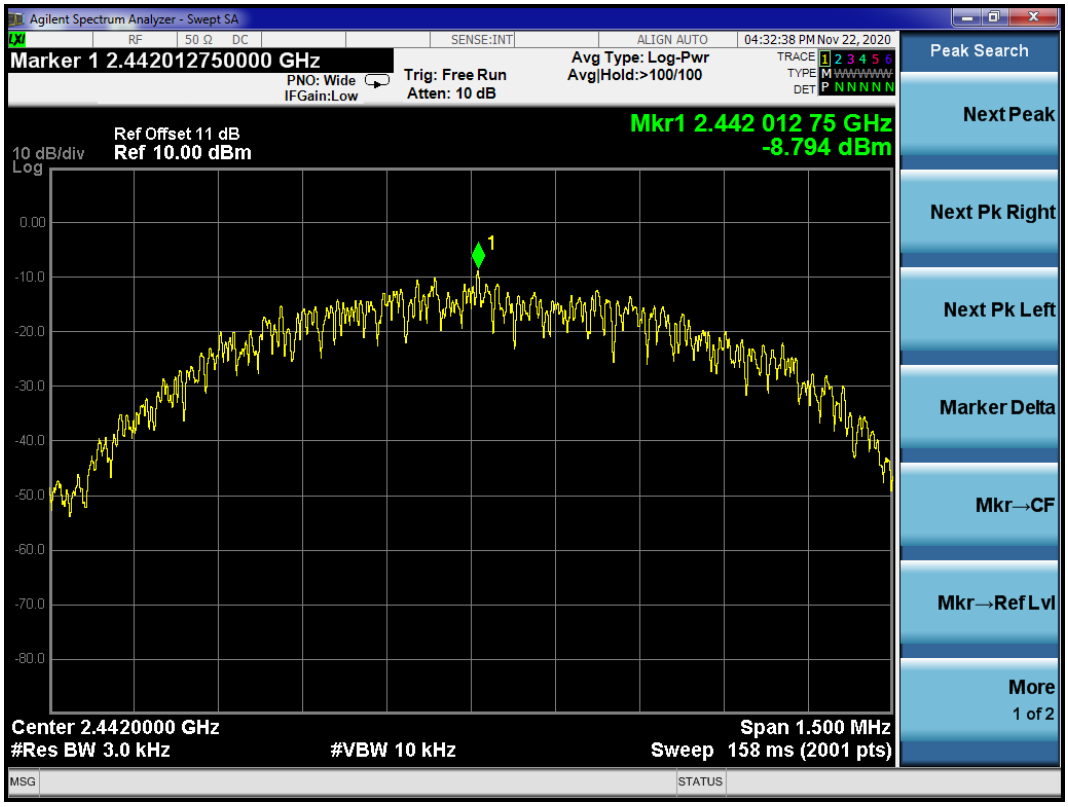
(Test Date: 2020.11.22 Temperature: 23℃ Humidity: 51 %)

Modulation	Channel	Frequency (MHz)	**Power Spectral Density (dBm)**	Limit
BLE	00	2402	**-8.702**	8 dBm
	20	2442	**-8.794**	8 dBm
	39	2480	**-8.915**	8 dBm

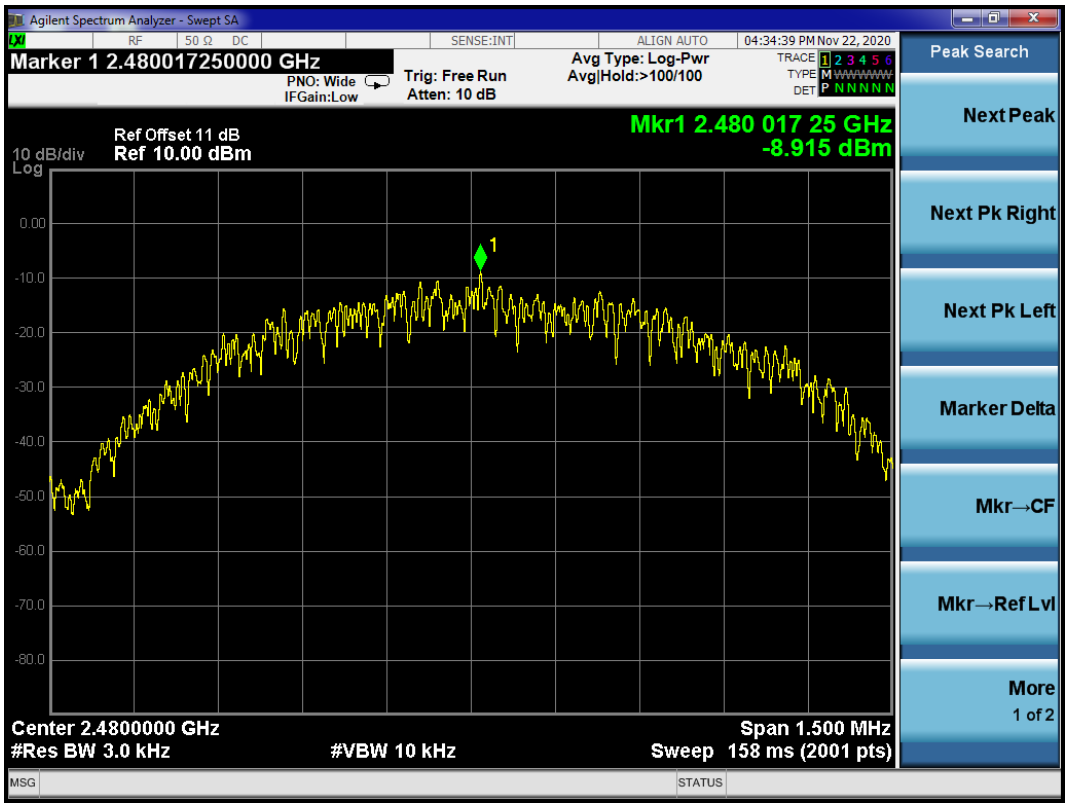
BLE CH2402 MHz



BLE CH2442 MHz



BLE CH2480 MHz



10 DEVIATION TO TEST SPECIFICATIONS

None.

11 MEASUREMENT UNCERTAINTY LIST

The measurement uncertainty was estimated for test on the EUT according to CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage of K=2.
The uncertainties value is not used in determining the PASS/FAIL results.

Test Items/Facilities	**Frequency/Equipment/Unit**	**Uncertainty**
Conducted Emission No.1 Shielded Room	9kHz~150kHz	±3.2 dB
	150kHz~30MHz	±3.1 dB
Conducted Emission No.3 Shielded Room	150kHz~30MHz	±3.1 dB
Radiated Emission	30MHz~200MHz, Horizontal	±3.4 dB
	30MHz~200MHz, Vertical	±4.0 dB
	200MHz~1000MHz, Horizontal	±3.7 dB
	200MHz~1000MHz, Vertical	±5.1 dB
	1GHz~6GHz	±5.7 dB
	6GHz~18GHz	±4.7 dB
Output Power Test	50MHz~18GHz	0.77 dB
Power Density Test	9kHz~6GHz	1.08 dB
RF Frequency Test	9kHz~40GHz	$6*10^{-4}$
Bandwidth Test	9kHz~6GHz	$1.5*10^{-3}$
RF Radiated Power Test	30MHz~1000MHz	3.06 dB
Conducted Output Power Test	50MHz~18GHz	0.83 dB
AC Voltage(<10kHz) Test	120V~230V	0.04 %
DC Power Test	0V~30V	0.4 %
Temperature	-40℃~+100℃	0.52 ℃
Humidity	30%~95%	2.6 %