



Shenzhen Global Test Service Co.,Ltd.

No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No......: **GTS20210827007-1-2**

FCC ID..... : **2APN5L2-C**

Compiled by

(position+printed name+signature)...: File administrators Jimmy Wang

Supervised by

(position+printed name+signature)...: Test Engineer Aaron Tan



Approved by

(position+printed name+signature)...: Manager Jason Hu

Date of issue.....: Aug. 28, 2021

Representative Laboratory Name .: Shenzhen Global Test Service Co., Ltd.

Address.....: No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

Applicant's name: **Shenzhen Sonoff Technologies Co.,Ltd.**

Address: 1001, BLDG8, Lianhua Industrial Park, Shenzhen, GD, China

Test specification

Standard: **FCC Part 15.247**

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Test item description: **Wi-Fi Smart controller**

Trade Mark: SONOFF

Manufacturer: Shenzhen Sonoff Technologies Co.,Ltd.

Model/Type reference.....: L2-C

Listed Models: N/A

Modulation: GFSK

Frequency..... From 2402MHz to 2480MHz

Ratings: DC 12.0V From External circuit

Result.....: **PASS**

TEST REPORT

Equipment under Test : Wi-Fi Smart controller

Model /Type : L2-C

Listed Models : N/A

Applicant : Shenzhen Sonoff Technologies Co.,Ltd.

Address : 1001, BLDG8, Lianhua Industrial Park, Shenzhen, GD, China

Manufacturer : Shenzhen Sonoff Technologies Co.,Ltd.

Address : 1001, BLDG8, Lianhua Industrial Park, Shenzhen, GD, China

Test Result:	PASS
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The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Contents

<u>1</u>	<u>TEST STANDARDS</u>	<u>4</u>
<u>2</u>	<u>SUMMARY</u>	<u>5</u>
2.1	General Remarks	5
2.2	Product Description	5
2.3	Equipment Under Test	5
2.4	Short description of the Equipment under Test (EUT)	5
2.5	EUT operation mode	6
2.6	Block Diagram of Test Setup	6
2.7	Related Submittal(s) / Grant (s)	6
2.8	Modifications	6
<u>3</u>	<u>TEST ENVIRONMENT</u>	<u>7</u>
3.1	Address of the test laboratory	7
3.2	Test Facility	7
3.3	Environmental conditions	7
3.4	Summary of measurement results	8
3.5	Statement of the measurement uncertainty	8
3.6	Equipments Used during the Test	9
<u>4</u>	<u>TEST CONDITIONS AND RESULTS.....</u>	<u>10</u>
4.1	AC Power Conducted Emission	10
4.2	Radiated Emissions and Band Edge	13
4.3	Maximum Peak Output Power	19
4.4	Power Spectral Density	20
4.5	6dB Bandwidth	22
4.6	Out-of-band Emissions	24
4.7	Antenna Requirement	29
<u>5</u>	<u>TEST SETUP PHOTOS OF THE EUT</u>	<u>30</u>
<u>6</u>	<u>PHOTOS OF THE EUT</u>	<u>31</u>

1 TEST STANDARDS

The tests were performed according to following standards:

[FCC Rules Part 15.247](#): Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

[ANSI C63.10-2013](#): American National Standard for Testing Unlicensed Wireless Devices

[KDB558074 D01 V05r02](#): Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

2 SUMMARY

2.1 General Remarks

Date of receipt of test sample	:	Jul. 01, 2021
Testing commenced on	:	Jul. 01, 2021
Testing concluded on	:	Aug. 28, 2021

2.2 Product Description

Product Description:	Wi-Fi Smart controller
Model/Type reference:	L2-C
Power supply:	DC 12.0V From External circuit
Adapter 1 information:	Model:GA-1202000 Input:AC100-240V-50/60Hz, 0.6A Output:DC 12.0V,2A
Adapter 2 information:	Model:KZ1202000S Input:AC100-240V-50/60Hz, 1.0A Output:DC 12.0V,2A
Testing sample ID:	GTS20210827007-1-2-1#(Engineer sample), GTS20210827007-1-2-2#(Normal sample)
Software version:	V1.0
Hardware version:	V1.0
Bluetooth BLE	
Supported type:	Bluetooth low Energy
Modulation:	GFSK
Operation frequency:	2402MHz to 2480MHz
Channel number:	40
Channel separation:	2 MHz
Antenna type:	PCB antenna
Antenna gain:	0.50 dBi

2.3 Equipment Under Test

Power supply system utilised

Power supply voltage	:	☐ 230V / 50 Hz	☐ 120V / 60Hz
		☒ 12 V DC	☐ 24 V DC
		☐ Other (specified in blank below)	

DC 12.0V From External circuit

2.4 Short description of the Equipment under Test (EUT)

This is a Wi-Fi Smart controller
For more details, refer to the user's manual of the EUT.

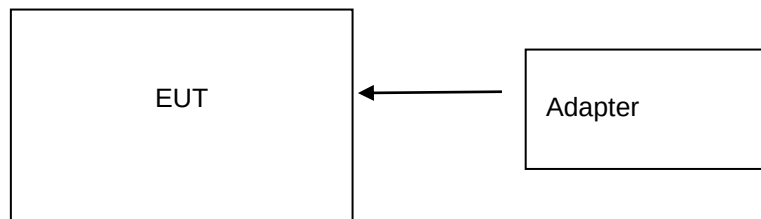
2.5 EUT operation mode

The Applicant provides communication tools software(Engineer mode) to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 40 channels provided to the EUT and Channel 00/19/39 were selected to test.

Operation Frequency:

Channel	Frequency (MHz)
00	2402
01	2404
02	2406
⋮	⋮
19	2440
⋮	⋮
37	2476
38	2478
39	2480

2.6 Block Diagram of Test Setup



2.7 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for the device filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.8 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

Shenzhen Global Test Service Co.,Ltd.

No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

3.2 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

FCC-Registration No.: 165725**FCC Designation Number is CN1234.**

Shenzhen Global Test Service Co.,Ltd EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.

A2LA-Lab Cert. No.: 4758.01

Shenzhen Global Test Service Co.,Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

CNAS-Lab Code: L8169

Shenzhen Global Test Service Co.,Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories. Date of Registration: Dec. 11, 2015. Valid time is until Dec. 10, 2024.

3.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Radiated Emission:

Temperature:	23 ° C
Humidity:	48 %
Atmospheric pressure:	950-1050mbar

AC Main Conducted testing:

Temperature:	24 ° C
Humidity:	45 %
Atmospheric pressure:	950-1050mbar

Conducted testing:

Temperature:	24 ° C
Humidity:	45 %

Atmospheric pressure:	950-1050mbar
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3.4 Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Test result
§15.247(e)	Power spectral density	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(a)(2)	Spectrum bandwidth – 6 dB bandwidth	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(b)(3)	Maximum Peak output power	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(d)	Band edge compliance conducted	BLE 1Mbps	☒ Lowest ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Highest	complies
§15.205	Band edge compliance radiated	BLE 1Mbps	☒ Lowest ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Highest	complies
§15.247(d)	TX spurious emissions conducted	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(d)	TX spurious emissions radiated	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mbps	☒ Lowest ☒ Middle ☒ Highest	complies
§15.209(a)	TX spurious Emissions radiated Below 1GHz	BLE 1Mbps	-/-	BLE 1Mbps	-/-	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	BLE 1Mbps	-/-	BLE 1Mbps	-/-	complies

Remark:

1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report

3.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 „Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen Global Test Service Co.,Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen GTS laboratory is reported:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.10 dB	(1)
Radiated Emission	1~18GHz	4.32 dB	(1)
Radiated Emission	18-40GHz	5.54 dB	(1)
Conducted Disturbance	0.15~30MHz	3.12 dB	(1)

- (1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3.6 Equipments Used during the Test

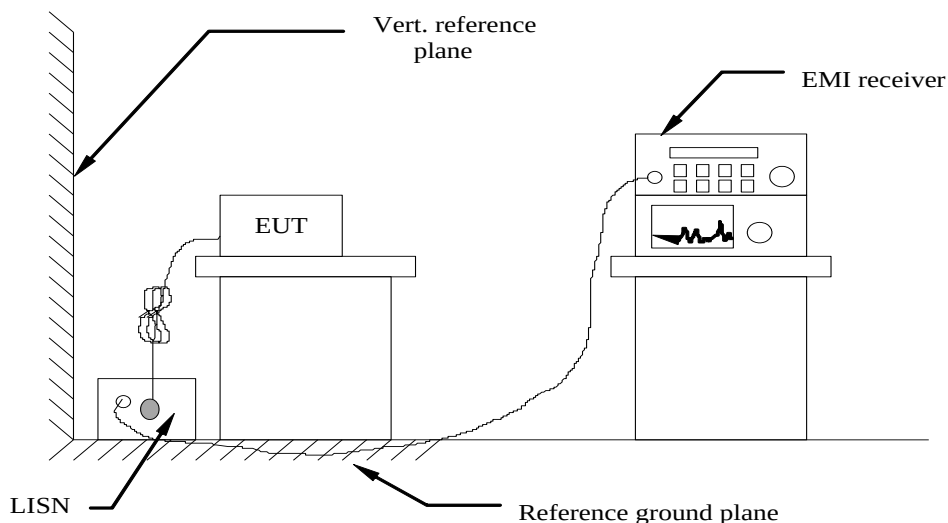
Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	3560.6550.08	2020/09/19	2021/09/18
LISN	R&S	ESH2-Z5	893606/008	2020/09/19	2021/09/18
EMI Test Receiver	R&S	ESPI3	101841-cd	2020/09/19	2021/09/18
EMI Test Receiver	R&S	ESCI7	101102	2020/09/19	2021/09/18
Spectrum Analyzer	Agilent	N9020A	MY48010425	2020/09/19	2021/09/18
Spectrum Analyzer	R&S	FSV40	100019	2020/09/19	2021/09/18
Vector Signal generator	Agilent	N5181A	MY49060502	2020/09/19	2021/09/18
Signal generator	Agilent	E4421B	3610AO1069	2020/09/19	2021/09/18
Climate Chamber	ESPEC	EL-10KA	A20120523	2020/09/19	2021/09/18
Control	EM Electronics	control EM 1000	N/A	N/A	N/A
Horn Antenna	Schwarzbeck	BBHA 9120D	01622	2020/09/19	2021/09/18
Active Loop Antenna	Beijing Da Ze Technology Co.,Ltd.	ZN30900C	15006	2020/10/11	2021/10/10
Bilog Antenna	Schwarzbeck	VULB9163	000976	2021/05/25	2022/05/24
Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	791	2020/09/19	2021/09/18
Amplifier	Schwarzbeck	BBV 9743	#202	2020/09/19	2021/09/18
Amplifier	Schwarzbeck	BBV9179	9719-025	2020/09/19	2021/09/18
Amplifier	EMCI	EMC051845B	980355	2020/09/19	2021/09/18
Temperature/Humidity Meter	Gangxing	CTH-608	02	2020/09/19	2021/09/18
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	KL142031	2020/09/19	2021/09/18
High-Pass Filter	K&L	41H10-1375/U12750-O/O	KL142032	2020/09/19	2021/09/18
RF Cable(below 1GHz)	HUBER+SUHNER	RG214	RE01	2020/09/19	2021/09/18
RF Cable(above 1GHz)	HUBER+SUHNER	RG214	RE02	2020/09/19	2021/09/18
Data acquisition card	Agilent	U2531A	TW53323507	2020/09/19	2021/09/18
Power Sensor	Agilent	U2021XA	MY5365004	2020/09/19	2021/09/18
Test Control Unit	Tonscend	JS0806-1	178060067	2021/06/19	2022/06/18
Automated filter bank	Tonscend	JS0806-F	19F8060177	2021/06/19	2022/06/18
EMI Test Software	Tonscend	JS1120-1	Ver 2.6.8.0518	/	/
EMI Test Software	Tonscend	JS1120-3	Ver 2.5.77.0418	/	/
EMI Test Software	Tonscend	JS32-CE	Ver 2.5	/	/
EMI Test Software	Tonscend	JS32-RE	Ver 2.5.1.8	/	/

Note: The Cal.Interval was one year.

4 TEST CONDITIONS AND RESULTS

4.1 AC Power Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

- 1 The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
- 2 Support equipment, if needed, was placed as per ANSI C63.10-2013
- 3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
- 4 The EUT received DC 12V power from adapter, the adapter received AC120V/60Hz and AC 240V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
- 5 All support equipments received AC power from a second LISN, if any.
- 6 The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
- 7 Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
- 8 During the above scans, the emissions were maximized by cable manipulation.

AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following :

Frequency range (MHz)	Limit (dBuV)	
	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.

TEST RESULTS

Remark:

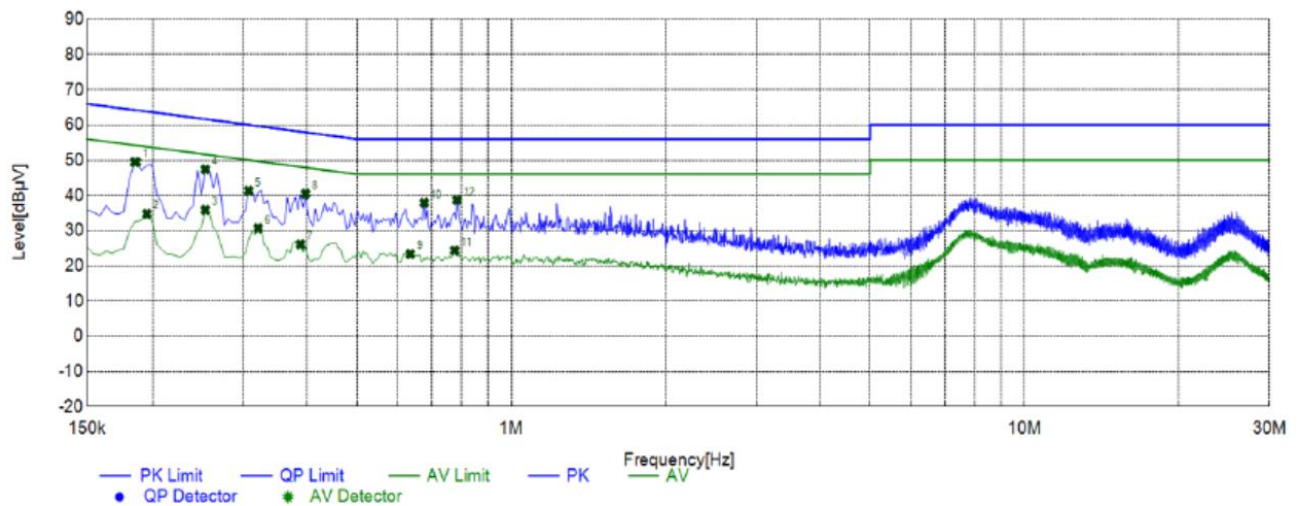
1. All modes of GFSK were test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:
2. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz at the Model GA-1202000 was reported as below:
3. Remark: Result=Reading value+Factor, and Margin=Limit- Result

Power supply:

DC 12.0V from Adapter AC
120V/60Hz

Polarization

L

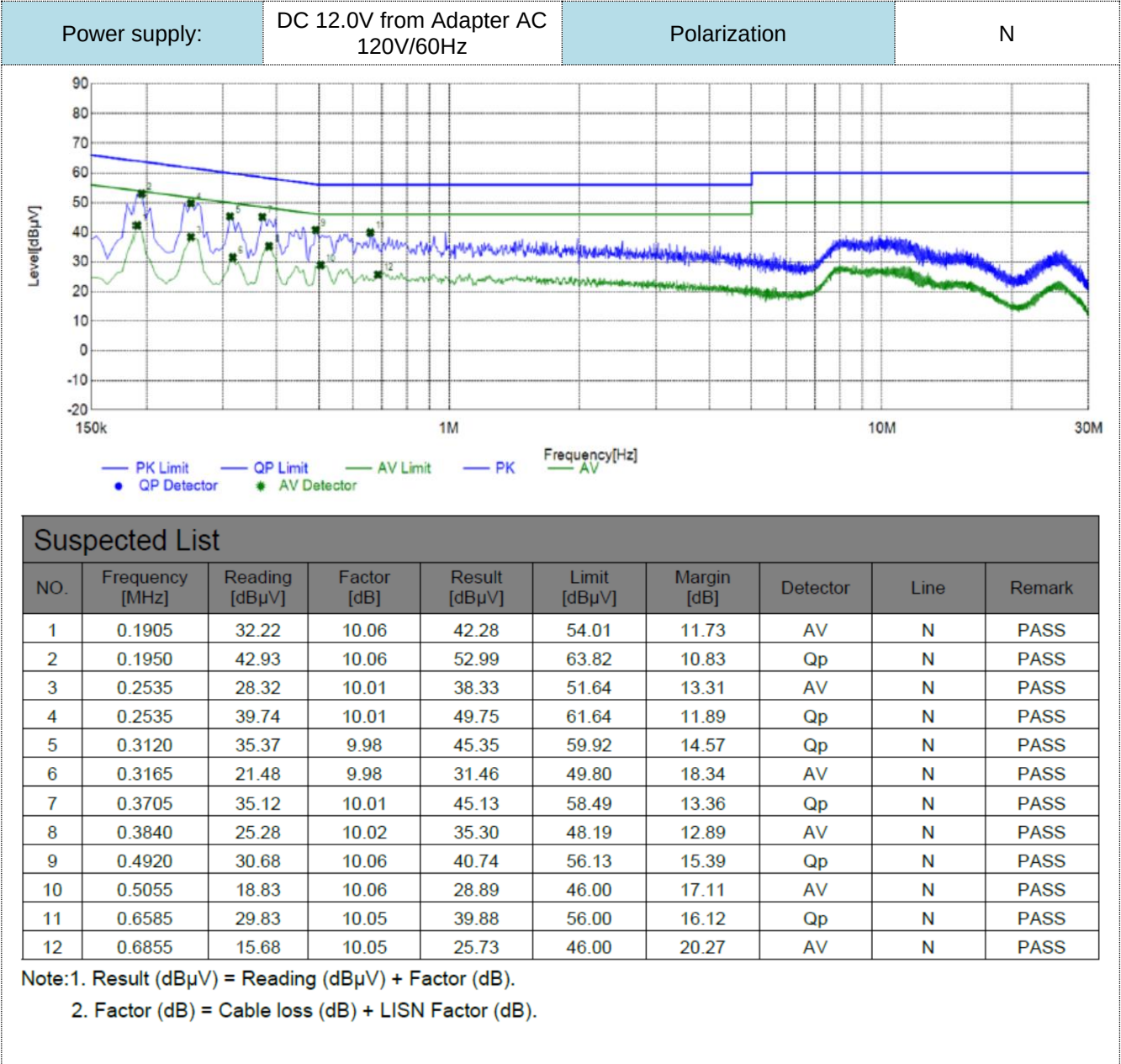


Suspected List

NO.	Frequency [MHz]	Reading [dBμV]	Factor [dB]	Result [dBμV]	Limit [dBμV]	Margin [dB]	Detector	Line	Remark
1	0.1860	39.38	10.06	49.44	64.21	14.77	Qp	L1	PASS
2	0.1950	24.69	10.06	34.75	53.82	19.07	AV	L1	PASS
3	0.2535	25.85	10.01	35.86	51.64	15.78	AV	L1	PASS
4	0.2535	37.38	10.01	47.39	61.64	14.25	Qp	L1	PASS
5	0.3075	31.38	9.98	41.36	60.04	18.68	Qp	L1	PASS
6	0.3210	20.71	9.98	30.69	49.68	18.99	AV	L1	PASS
7	0.3885	16.10	10.02	26.12	48.10	21.98	AV	L1	PASS
8	0.3975	30.41	10.03	40.44	57.91	17.47	Qp	L1	PASS
9	0.6360	13.30	10.06	23.36	46.00	22.64	AV	L1	PASS
10	0.6765	27.84	10.05	37.89	56.00	18.11	Qp	L1	PASS
11	0.7755	14.28	10.07	24.35	46.00	21.65	AV	L1	PASS
12	0.7845	28.63	10.07	38.70	56.00	17.30	Qp	L1	PASS

Note:1. Result (dBμV) = Reading (dBμV) + Factor (dB).

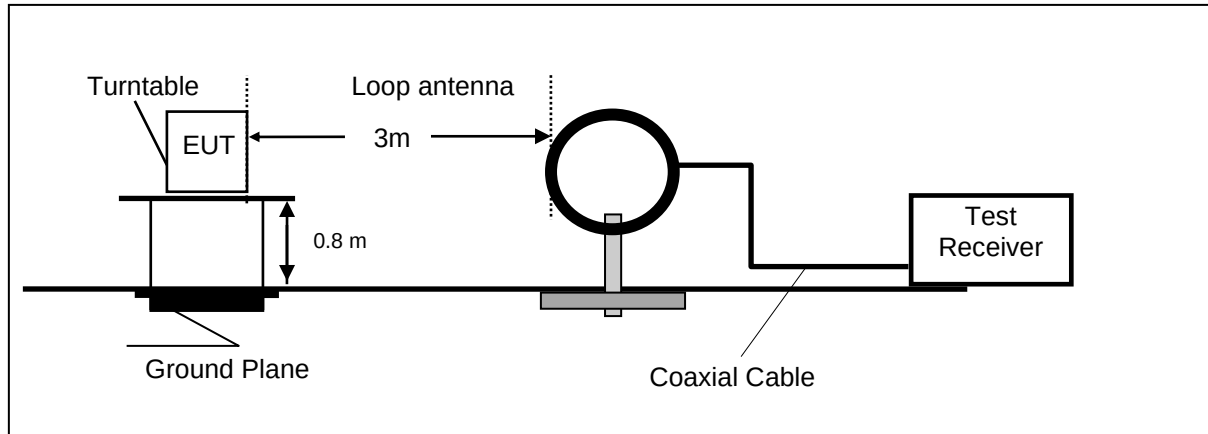
2. Factor (dB) = Cable loss (dB) + LISN Factor (dB).



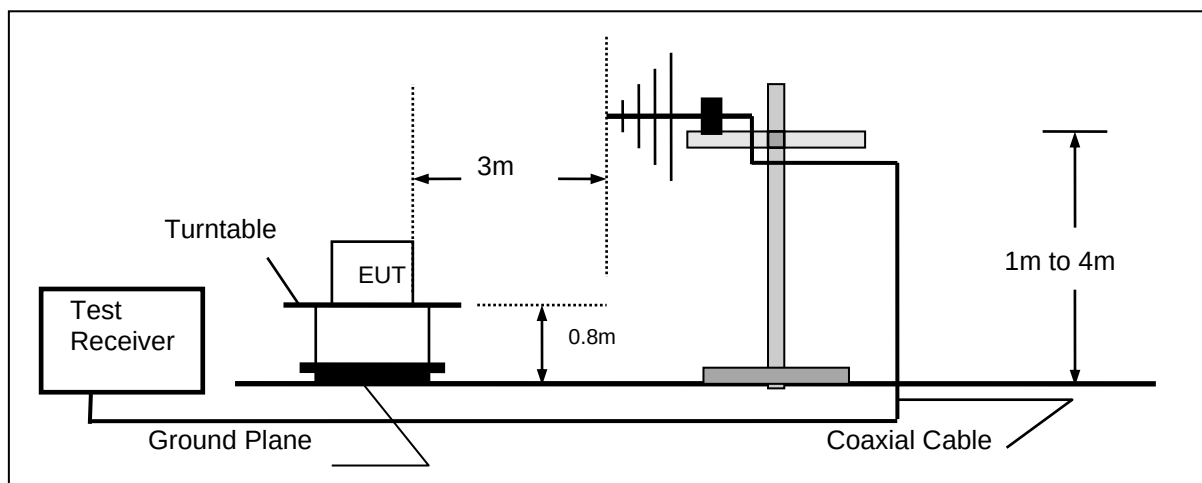
4.2 Radiated Emissions and Band Edge

TEST CONFIGURATION

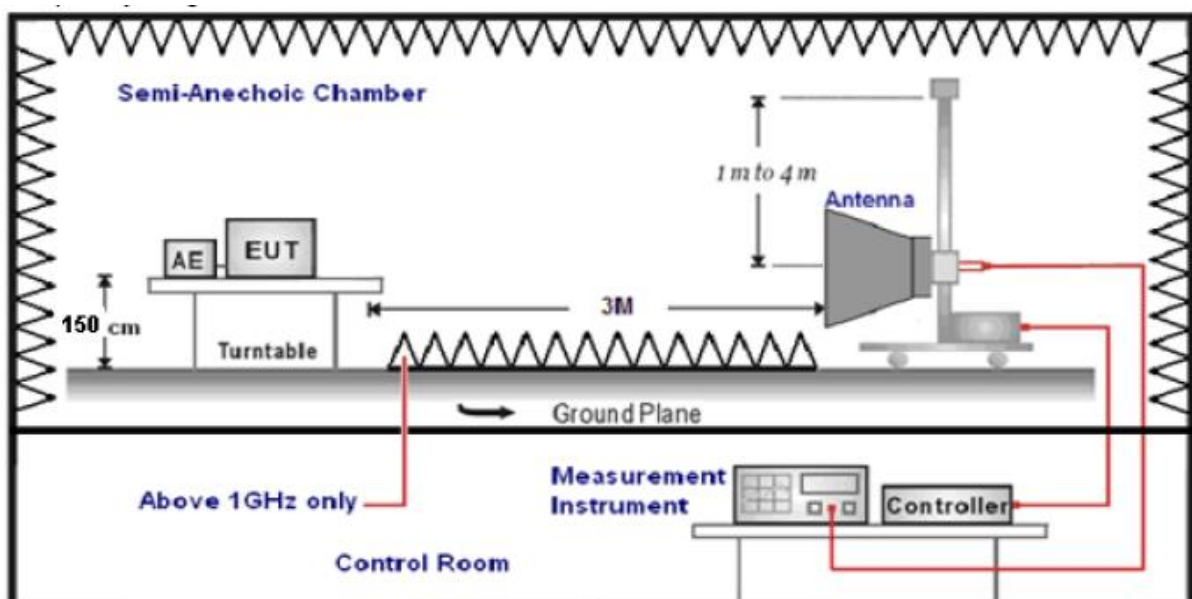
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0°C to 360°C to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-25GHz	Horn Antenna	1

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

$$\text{Transd}=AF +CL-AG$$

RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the100kHz bandwidth within the band that contains the highest level of desired power.

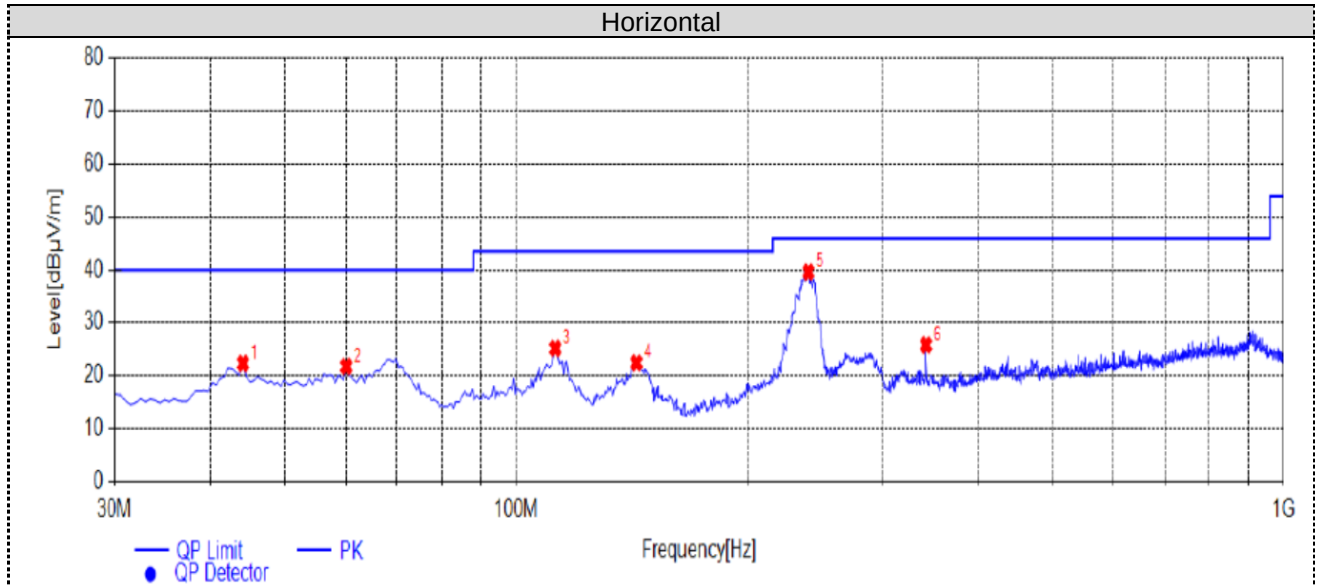
The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBµV/m)	Radiated (µV/m)
0.009-0.49	3	$20\log(2400/F(KHz))+40\log(300/3)$	$2400/F(KHz)$
0.49-1.705	3	$20\log(24000/F(KHz))+ 40\log(30/3)$	$24000/F(KHz)$
1.705-30	3	$20\log(30)+ 40\log(30/3)$	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

TEST RESULTS

Remark:

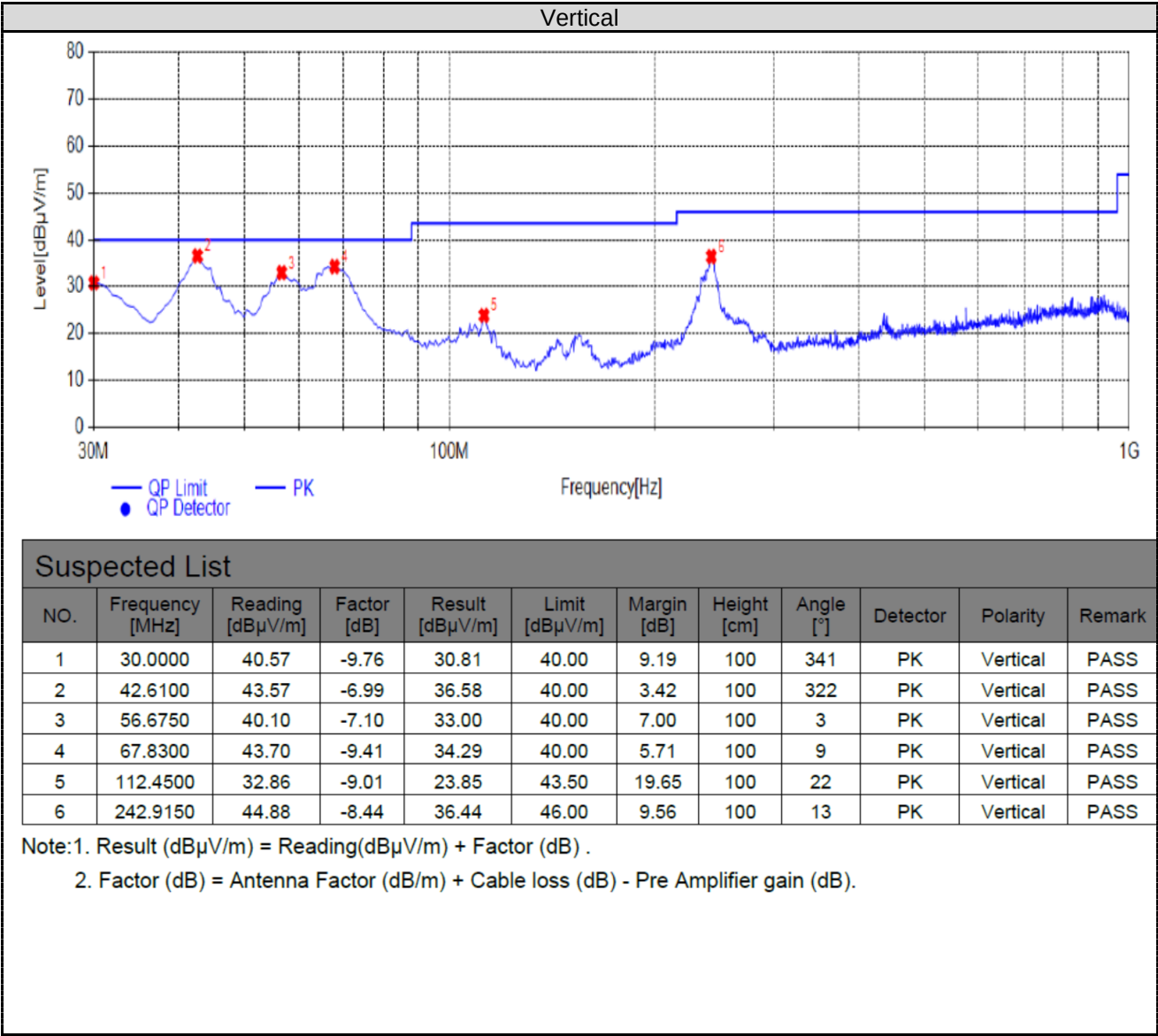
1. This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.
2. Both modes of BLE 1Mbps were tested at Low, Middle, and High channel and recorded worst mode at BLE 1Mbps(Supplied by Adapter Model GA-1202000).
3. Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.

For 30MHz-1GHz**Suspected List**

NO.	Frequency [MHz]	Reading [dBμV/m]	Factor [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity	Remark
1	44.0650	28.97	-6.63	22.34	40.00	17.66	100	268	PK	Horizontal	PASS
2	60.0700	30.14	-8.38	21.76	40.00	18.24	100	284	PK	Horizontal	PASS
3	112.4500	34.19	-9.01	25.18	43.50	18.32	100	0	PK	Horizontal	PASS
4	143.4900	34.52	-12.08	22.44	43.50	21.06	100	179	PK	Horizontal	PASS
5	240.4900	48.22	-8.59	39.63	46.00	6.37	100	265	PK	Horizontal	PASS
6	342.3400	32.11	-6.28	25.83	46.00	20.17	100	258	PK	Horizontal	PASS

Note:1. Result (dBμV/m) = Reading(dBμV/m) + Factor (dB) .

2. Factor (dB) = Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB).



For 1GHz to 25GHz

GFSK (above 1GHz)

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	59.13	PK	74	14.87	57.23	31.42	6.98	36.5	1.9
4804.00	42.97	AV	54	11.03	41.07	31.42	6.98	36.5	1.9
7206.00	54.79	PK	74	19.21	44.19	37.03	8.87	35.3	10.6
7206.00	41.86	AV	54	12.14	31.26	37.03	8.87	35.3	10.6

Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	59.38	PK	74	14.62	57.48	31.42	6.98	36.5	1.9
4804.00	43.59	AV	54	10.41	41.69	31.42	6.98	36.5	1.9
7206.00	55.42	PK	74	18.58	44.82	37.03	8.87	35.3	10.6
7206.00	42.52	AV	54	11.48	31.92	37.03	8.87	35.3	10.6

Frequency(MHz):			2440		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4880.00	59.34	PK	74	14.66	57.28	30.98	7.58	36.5	2.06
4880.00	42.28	AV	54	11.72	40.22	30.98	7.58	36.5	2.06
7320.00	55.51	PK	74	18.49	44.59	37.66	8.56	35.3	10.92
7320.00	41.77	AV	54	12.23	30.85	37.66	8.56	35.3	10.92

Frequency(MHz):			2440		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4880.00	59.98	PK	74	14.02	57.92	30.98	7.58	36.5	2.06
4880.00	42.92	AV	54	11.08	40.86	30.98	7.58	36.5	2.06
7320.00	55.69	PK	74	18.31	44.77	37.66	8.56	35.3	10.92
7320.00	42.21	AV	54	11.79	31.29	37.66	8.56	35.3	10.92

Frequency(MHz):			2480		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	59.92	PK	74	14.08	56.85	31.47	7.8	36.2	3.07
4960.00	41.99	AV	54	12.01	38.92	31.47	7.8	36.2	3.07
7440.00	54.86	PK	74	19.14	43.12	38.32	8.72	35.3	11.74
7440.00	41.33	PK	54	12.67	29.59	38.32	8.72	35.3	11.74

Frequency(MHz):			2480		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	60.34	PK	74	13.66	57.27	31.47	7.8	36.2	3.07
4960.00	43.01	AV	54	10.99	39.94	31.47	7.8	36.2	3.07
7440.00	55.72	PK	74	18.28	43.98	38.32	8.72	35.3	11.74
7440.00	42.35	PK	54	11.65	30.61	38.32	8.72	35.3	11.74

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

Results of Band Edges Test (Radiated)**GFSK**

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	57.61	PK	74	16.39	63.02	27.49	3.32	36.22	-5.41
2390.00	39.48	AV	54	14.52	44.89	27.49	3.32	36.22	-5.41
Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	57.55	PK	74	16.45	62.96	27.49	3.32	36.22	-5.41
2390.00	40.31	AV	54	13.69	45.72	27.49	3.32	36.22	-5.41
Frequency(MHz):			2480		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	57.42	PK	74	16.58	62.93	27.45	3.38	36.34	-5.51
2483.50	38.64	AV	54	15.36	44.15	27.45	3.38	36.34	-5.51
Frequency(MHz):			2480		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	56.94	PK	74	17.06	62.45	27.45	3.38	36.34	-5.51
2483.50	38.82	AV	54	15.18	44.33	27.45	3.38	36.34	-5.51

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.

4.3 Maximum Peak Output Power

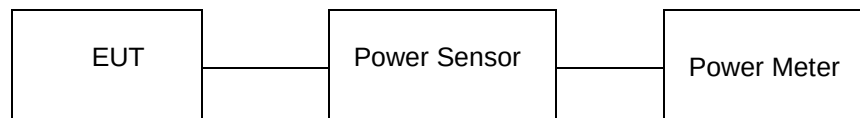
Limit

The Maximum Peak Output Power Measurement is 30dBm.

Test Procedure

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power sensor.

Test Configuration



Test Results

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK 1Mbps	00	8.806	30.00	Pass
	19	8.718		
	39	8.337		

Note: 1.The test results including the cable lose.

4.4 Power Spectral Density

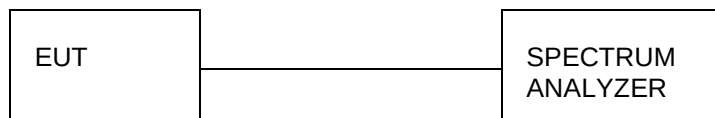
Limit

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.

Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW ≥ 3 kHz.
3. Set the VBW $\geq 3 \times$ RBW.
4. Set the span to 1.5 times the DTS channel bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
11. The resulting peak PSD level must be 8dBm.

Test Configuration

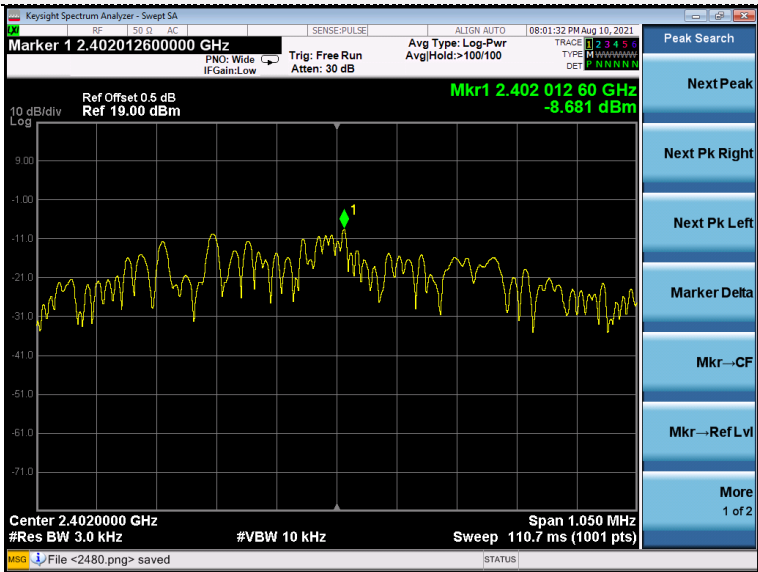


Test Results

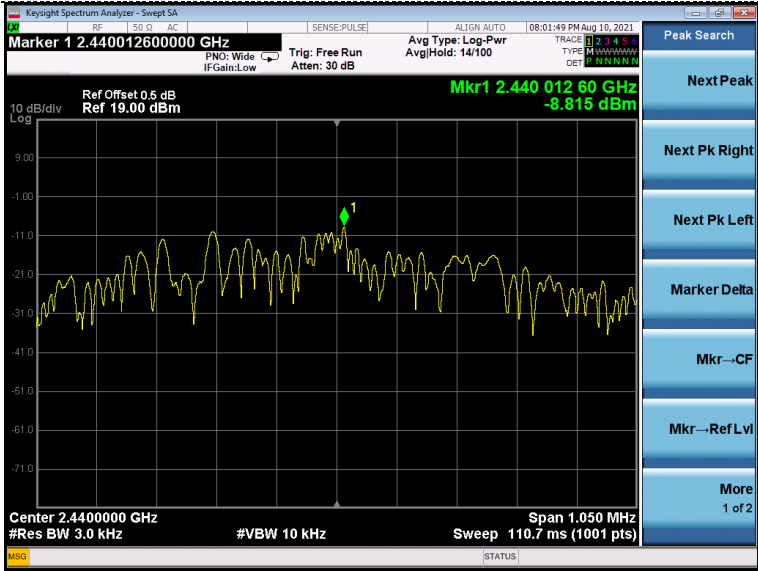
Type	Channel	Power Spectral Density (dBm/3KHz)	Limit (dBm/3KHz)	Result
GFSK 1Mbps	00	-8.681	8.00	Pass
	19	-8.815		
	39	-9.374		

Test plot as follows:

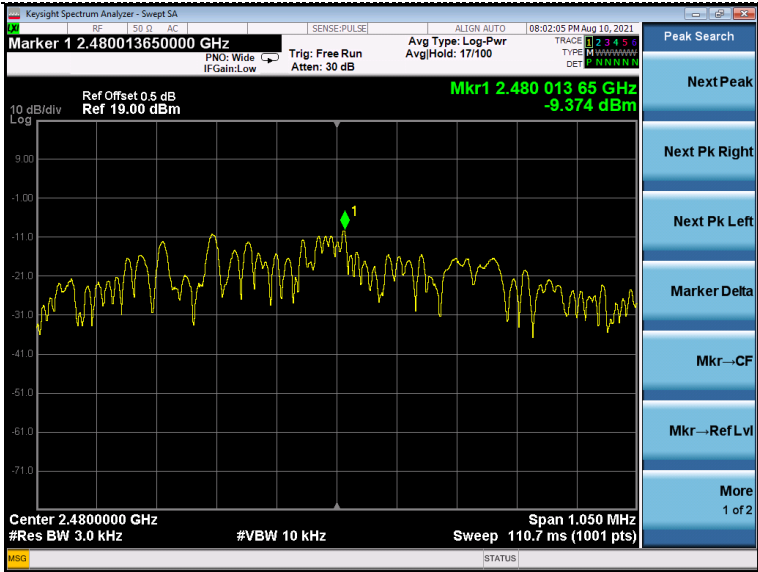
BLE GFSK 1Mbps



CH00



CH19



CH39

4.5 6dB Bandwidth

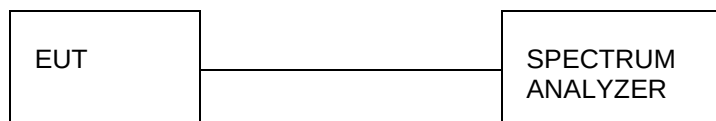
Limit

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW. The 6dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6dB.

Test Configuration



Test Results

Type	Channel	6dB Bandwidth (MHz)	Limit (KHz)	Result
GFSK 1Mbps	00	0.6856	≥500	Pass
	19	0.6895		
	39	0.6895		

Test plot as follows:



4.6 Out-of-band Emissions

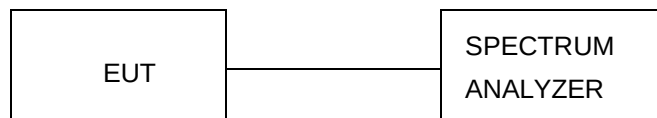
Limit

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.

Test Procedure

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector, and max hold. Measurements utilizing these settings are made of the in-band reference level, band edge and out-of-band emissions.

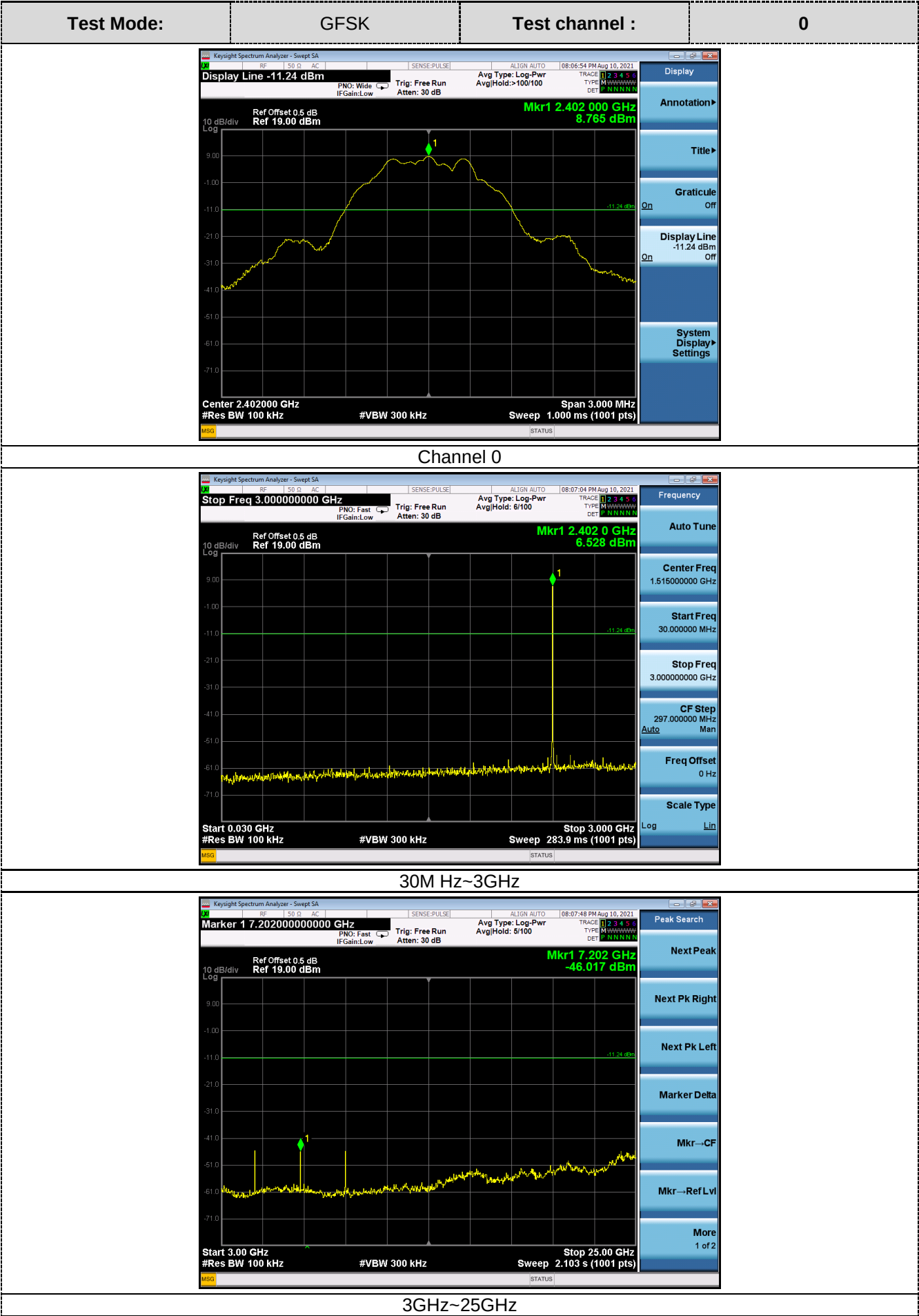
Test Configuration



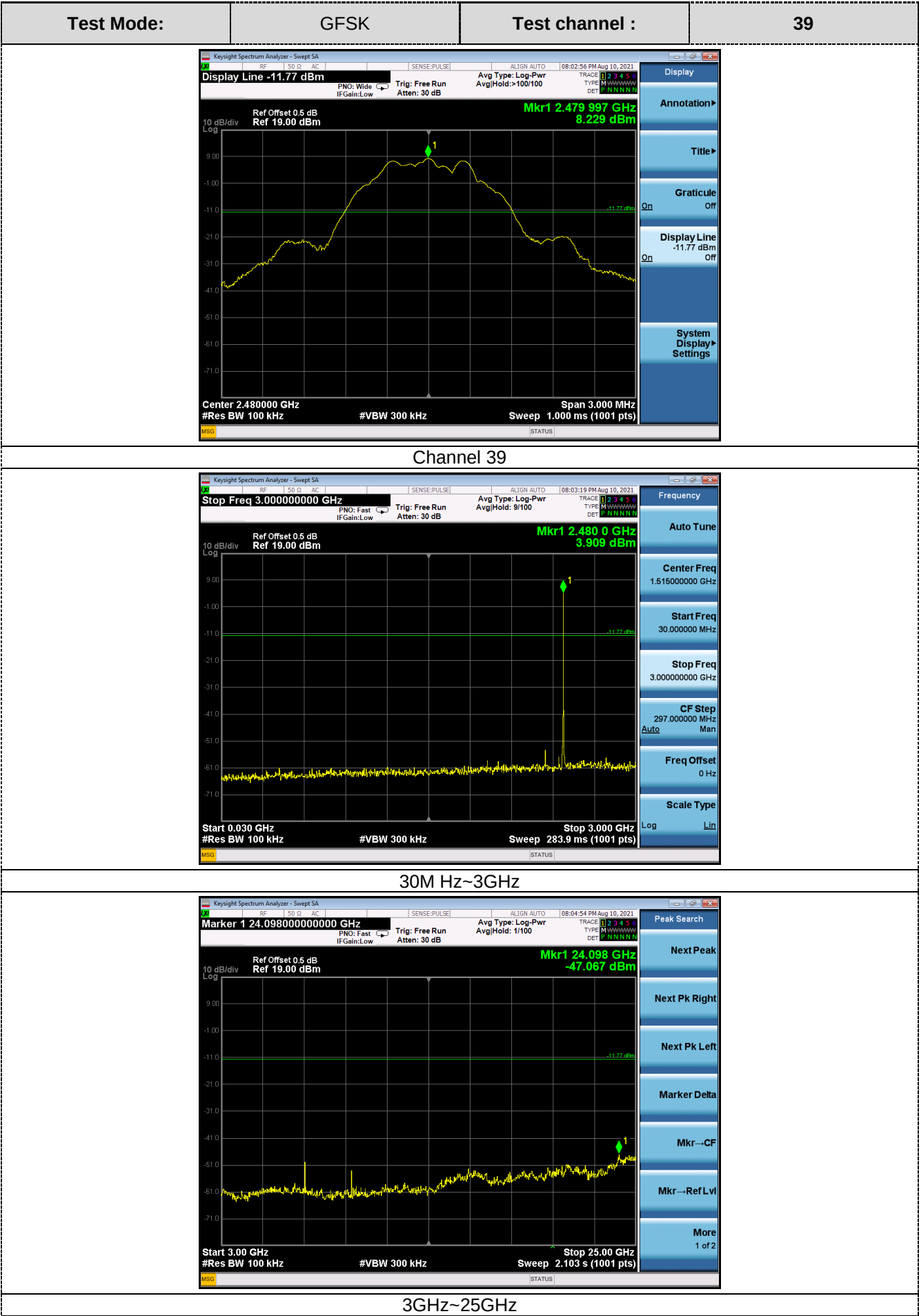
Test Results

Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and band edge measurement data.

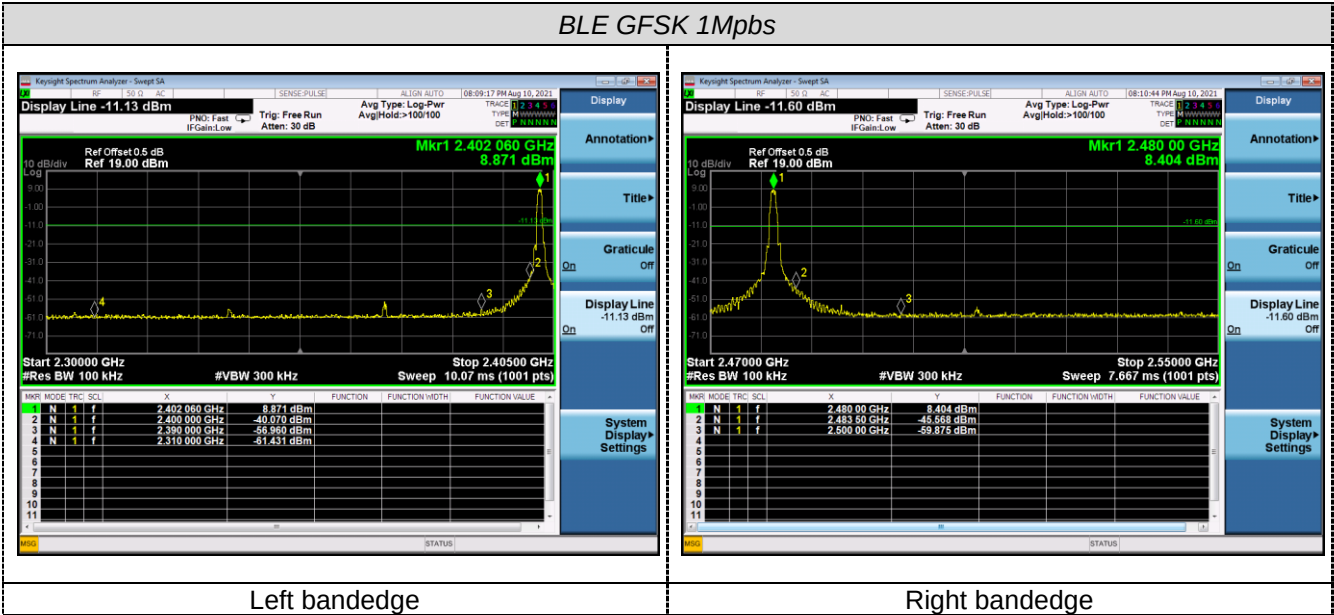
Test plot as follows:



Test Mode:	GFSK	Test channel :	19
Keysight Spectrum Analyzer - Swept SA Display Line -11.33 dBm RF 50.0 AC SENSE:PULSE ALIGN AUTO 08:05:41 PM Aug 10, 2021 Trig: Free Run Avg Type: Log-Pwr Avg/Hold: 100/100 Trace 1 2 3 4 5 6 TYPE M W W W W W W DET P N N N N N Ref Offset 0.5 dB Ref 19.00 dBm Mkr1 2.440 000 GHz 8.673 dBm 10 dB/div Log 9.00 -1.00 -11.0 -21.0 -31.0 -41.0 -51.0 -61.0 -71.0 Center 2.440000 GHz #Res BW 100 kHz #VBW 300 kHz Span 3.000 MHz Sweep 1.000 ms (1001 pts) MSG STATUS Display Annotation Title Graticule Off Display Line -11.33 dBm Off System Display Settings			
Channel 19			
Keysight Spectrum Analyzer - Swept SA Stop Freq 3.000000000 GHz RF 50.0 AC SENSE:PULSE ALIGN AUTO 08:05:58 PM Aug 10, 2021 Trig: Free Run Avg Type: Log-Pwr Avg/Hold: 10/100 Trace 1 2 3 4 5 6 TYPE M W W W W W W DET P N N N N N Ref Offset 0.5 dB Ref 19.00 dBm Mkr1 2.440 0 GHz 6.582 dBm 10 dB/div Log 9.00 -1.00 -11.0 -21.0 -31.0 -41.0 -51.0 -61.0 -71.0 Start 0.030 GHz #Res BW 100 kHz #VBW 300 kHz Stop 3.000 GHz Sweep 283.9 ms (1001 pts) MSG STATUS Frequency Auto Tune Center Freq 1.515000000 GHz Start Freq 30.0000000 MHz Stop Freq 3.000000000 GHz CF Step 297.000000 MHz Auto Man Freq Offset 0 Hz Scale Type Log Lin			
30M Hz~3GHz			
Keysight Spectrum Analyzer - Swept SA Marker 1 7.312000000000 GHz RF 50.0 AC SENSE:PULSE ALIGN AUTO 08:06:17 PM Aug 10, 2021 Trig: Free Run Avg Type: Log-Pwr Avg/Hold: 1/100 Trace 1 2 3 4 5 6 TYPE M W W W W W W DET P N N N N N Ref Offset 0.5 dB Ref 19.00 dBm Mkr1 7.312 GHz -41.987 dBm 10 dB/div Log 9.00 -1.00 -11.0 -21.0 -31.0 -41.0 -51.0 -61.0 -71.0 Start 3.00 GHz #Res BW 100 kHz #VBW 300 kHz Stop 25.00 GHz Sweep 2.103 s (1001 pts) MSG STATUS Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
3GHz~25GHz			



Band-edge Measurements for RF Conducted Emissions:



4.7 Antenna Requirement

Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited

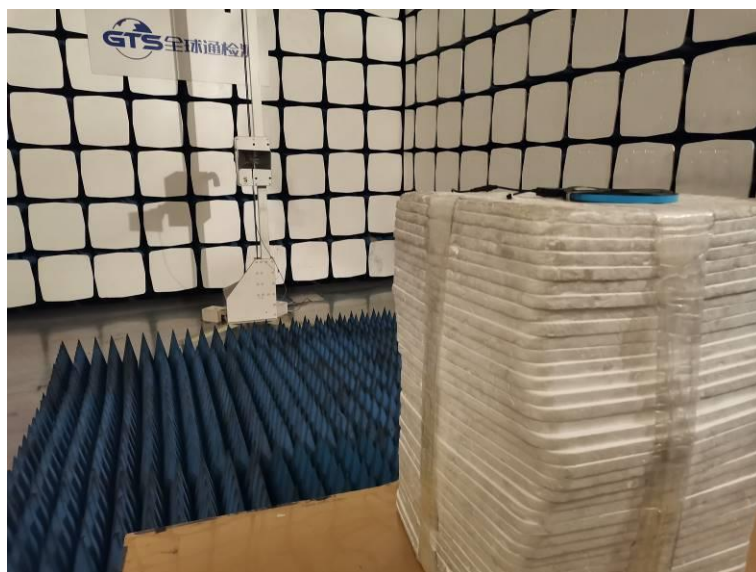
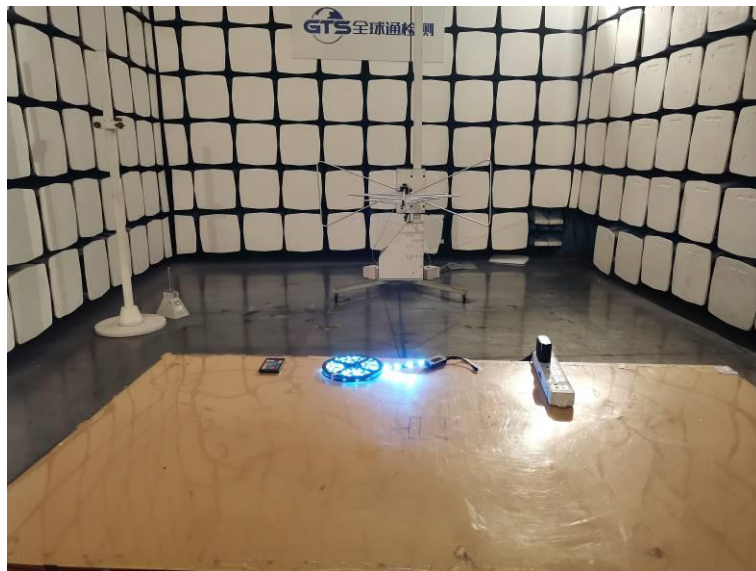
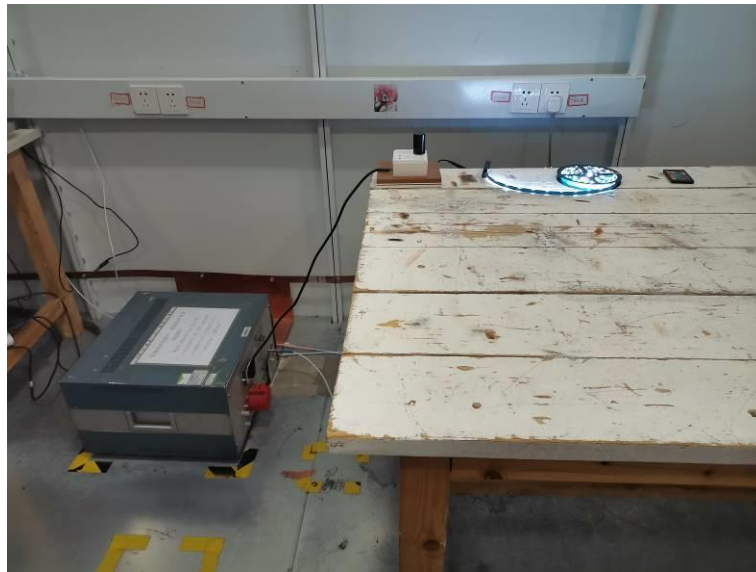
FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1) (I):

(i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

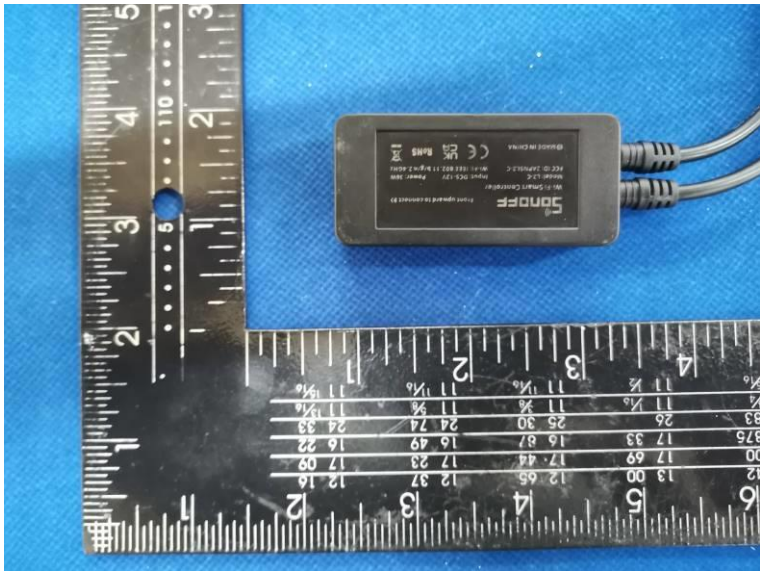
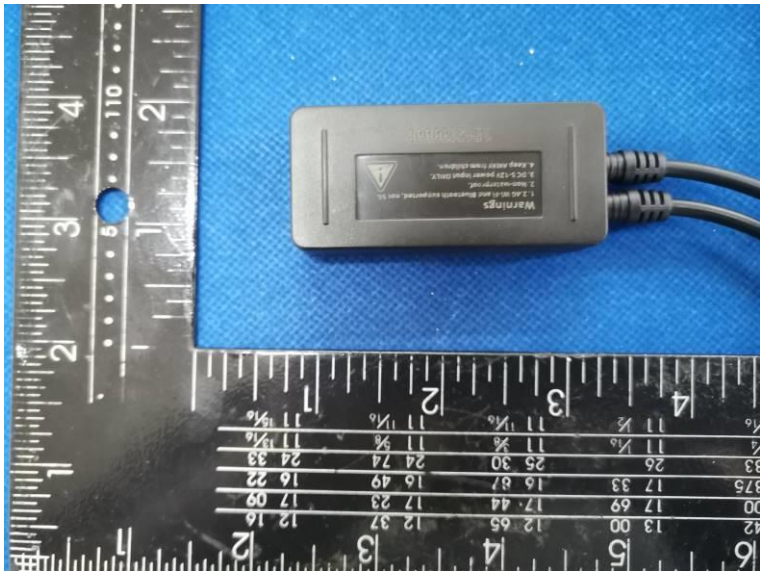
Antenna Connected Construction

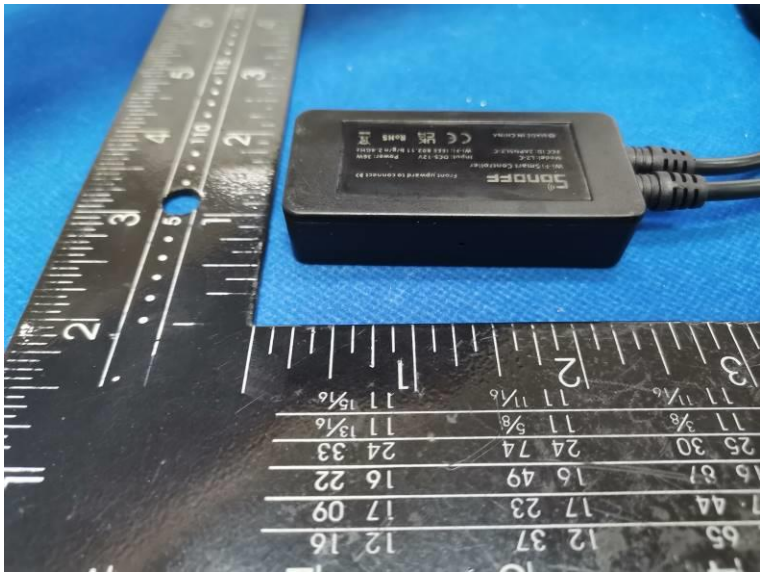
The maximum gain of antenna was 0.50dBi.

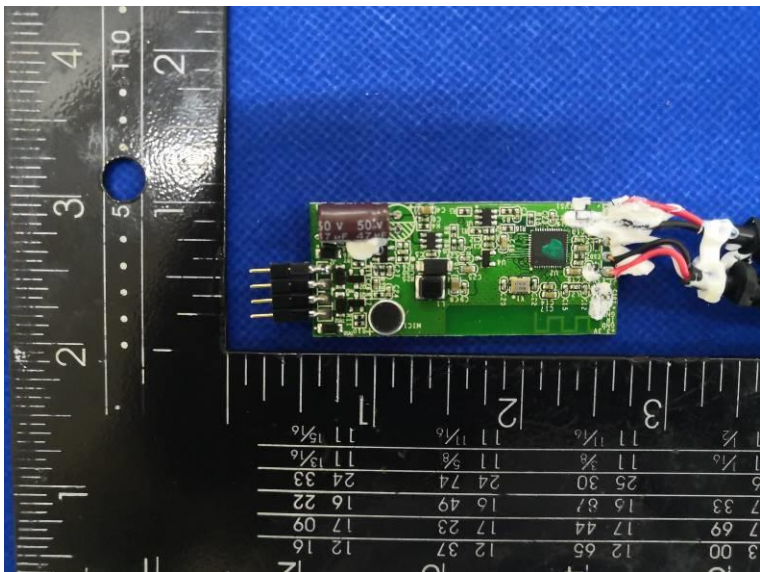
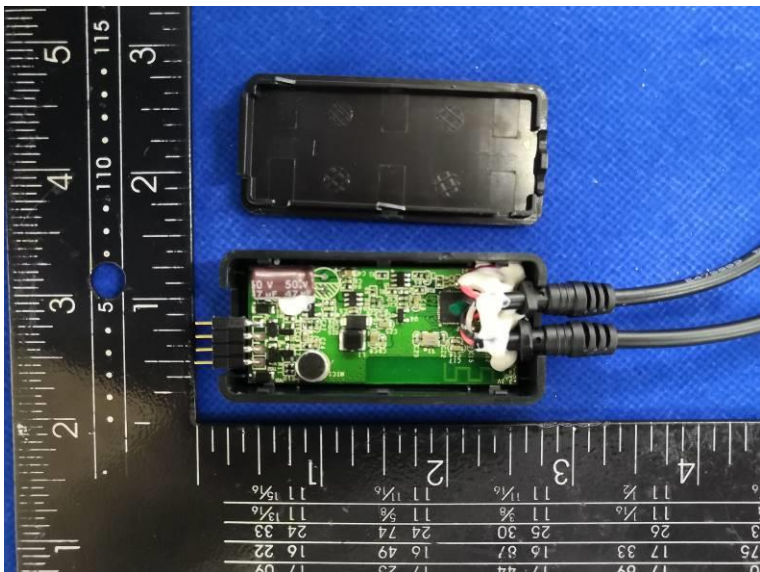
5 Test Setup Photos of the EUT

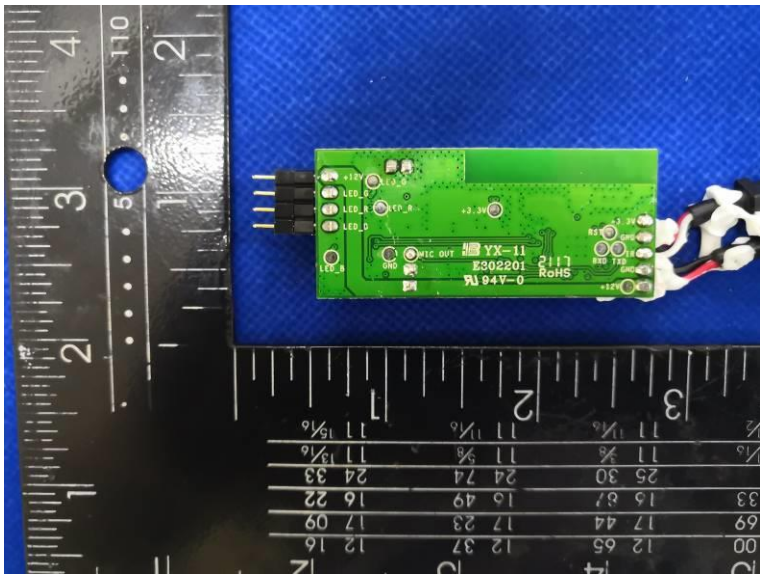


6 Photos of the EUT









***** End of Report *****