FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No.....:	**GTS20201020012-1-1**
FCC ID..... :	**2ATNE-L1P**
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Date of issue.....:	Oct. 20, 2020
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Applicant's name.....:	**Shenzhen Hingin Technology Co., Ltd.**
Address .....:	B9-B11,2/F, Building A1, Red Box Creative Park, No. 3Huancheng South Road, Bantian Str, Longgang Dis, Shenzhen,China
Test specification .....:	
Standard .....:	**FCC Part 15.247**
TRF Originator.....:	Shenzhen Global Test Service Co.,Ltd.
Master TRF.....:	Dated 2014-12

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Test item description .....:	LaserPecker
Trade Mark .....:	LaserPecker
Manufacturer .....:	**Shenzhen Hingin Technology Co., Ltd.**
Model/Type reference.....:	L1P_V2.0
Listed Models .....:	L1P_V2.0_2003
Modulation Type .....:	GFSK
Operation Frequency.....:	From 2402-2480MHz
Rating .....:	5V⎓2A
Result.....:	**PASS**

TEST REPORT

Test Report No. :	GTS20201020012-1-1	Oct. 20, 2020 Date of issue

Equipment under Test	:	LaserPecker
Model /Type	:	L1P_V2.0
Listed Models	:	L1P_V2.0_2003
Applicant	:	**Shenzhen Hingin Technology Co., Ltd.**
Address	:	B9-B11,2/F, Building A1, Red Box Creative Park, No. 3Huancheng South Road, Bantian Str, Longgang Dis, Shenzhen,China
Manufacturer	:	**Shenzhen Hingin Technology Co., Ltd.**
Address	:	B9-B11,2/F, Building A1, Red Box Creative Park, No. 3Huancheng South Road, Bantian Str, Longgang Dis, Shenzhen,China

Test Result:	**PASS**

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.

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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 V03r05: 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	:	Oct. 03, 2020
Testing commenced on	:	Oct. 04, 2020
Testing concluded on	:	Oct. 15, 2020

2.2 Product Description

Product Name:	LaserPecker
Model/Type reference:	L1P_V2.0
Power supply:	DC5V from adapter
Hardware version:	V1.2
Software version:	V1.0
Sample ID:	GTS20201020012-1-1#/GTS20201020012-1-2#
Adapter(Auxiliary testProvided by the laborator)	Mode:EP-TA20CBC Input:AC100-240V-50/60Hz，0.5A Output:DC 5V,2A
Bluetooth LE	
Supported type:	Bluetooth low Energy
Modulation:	GFSK
Operation frequency:	2402MHz to 2480MHz
Channel number:	40
Channel separation:	2 MHz
Antenna type:	Ceramic antenna
Antenna gain:	2.0dBi

2.3 Test Sample

The application provides 2 samples to meet requirement.

Sample Number	Description
GTS20201020012-1-1#	Engineer sample – continuous transmit
GTS20201020012-1-2#	Normal sample – Intermittent transmit

2.4 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)		

DC5.0V from adapter

2.5 Short description of the Equipment under Test (EUT)

This is a TWS Bluetooth earbuds.

For more details, refer to the user's manual of the EUT.

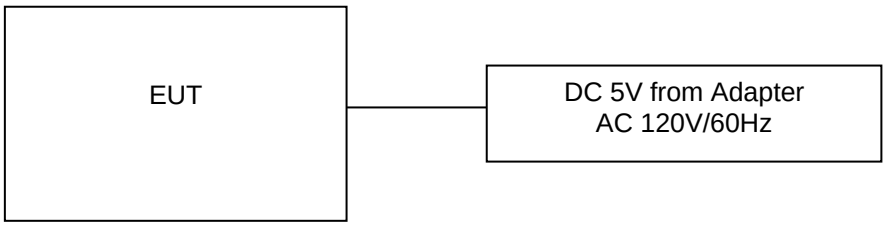
2.6 EUT operation mode

The Applicant provides communication tools software(SmartRF_Studio_7) 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**

2.7 Block Diagram of Test Setup



2.8 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.

2.9 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

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:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	950-1050mbar

3.4 Summary of measurement results

Test Specification clause	Test case	Test Sample	Test Mode	Test Channel	Recorded In Report		Test result
§15.247(e)	Power spectral density	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(a)(2)	Spectrum bandwidth – 6 dB bandwidth	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(b)(1)	Maximum output power	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(d)	Band edge compliance conducted	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Highest	GFSK	☒ Lowest ☒ Highest	complies
§15.205	Band edge compliance radiated	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Highest	GFSK	☒ Lowest ☒ Highest	complies
§15.247(d)	TX spurious emissions conducted	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(d)	TX spurious emissions radiated	GTS202010200 12-1-1#	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	complies
§15.209(a)	TX spurious Emissions radiated Below 1GHz	GTS202010200 12-1-2#	GFSK	-/-	GFSK	-/-	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	GTS202010200 12-1-2#	GFSK	-/-	GFSK	-/-	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

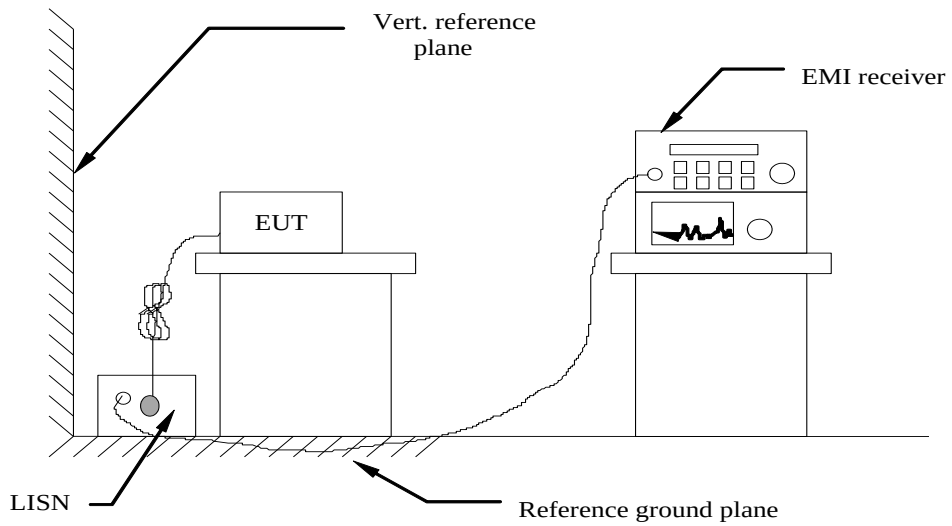
Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	3560.6550.08	2020/09/20	2021/09/19
LISN	R&S	ESH2-Z5	893606/008	2020/09/20	2021/09/19
EMI Test Receiver	R&S	ESPI3	101841-cd	2020/09/20	2021/09/19
EMI Test Receiver	R&S	ESCI7	101102	2020/09/20	2021/09/19
Spectrum Analyzer	Agilent	N9020A	MY48010425	2020/09/20	2021/09/19
Spectrum Analyzer	R&S	FSV40	100019	2020/09/20	2021/09/19
Spectrum Analyzer	Agilent	E4407B	MY45132751	2020/09/20	2021/09/19
Vector Signal generator	Agilent	N5181A	MY49060502	2020/09/20	2021/09/19
Signal generator	Agilent	E4421B	3610AO1069	2020/09/20	2021/09/19
Climate Chamber	ESPEC	EL-10KA	A20120523	2020/09/20	2021/09/19
Controller	EM Electronics	Controller EM 1000	N/A	N/A	N/A
Horn Antenna	Schwarzbeck	BBHA 9120D	01622	2020/09/23	2021/09/22
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	2021/05/24
Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	791	2020/09/20	2021/09/19
Amplifier	Schwarzbeck	BBV 9743	#202	2020/09/20	2021/09/19
Amplifier	Schwarzbeck	BBV9179	9719-025	2020/09/20	2021/09/19
Amplifier	EMCI	EMC051845B	980355	2020/09/20	2021/09/19
Temperature/Humidity Meter	Gangxing	CTH-608	02	2020/09/20	2021/09/19
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	KL142031	2020/09/20	2021/09/19
High-Pass Filter	K&L	41H10-1375/U12750-O/O	KL142032	2020/09/20	2021/09/19
RF Cable(below 1GHz)	HUBER+SUHNER	RG214	RE01	2020/09/20	2021/09/19
RF Cable(above 1GHz)	HUBER+SUHNER	RG214	RE02	2020/09/20	2021/09/19
Data acquisition card	Agilent	U2531A	TW53323507	2020/09/20	2021/09/19
Power Sensor	Agilent	U2021XA	MY5365004	2020/09/20	2021/09/19
Test Control Unit	Tonscend	JS0806-1	178060067	2020/06/19	2021/06/18
Automated filter bank	Tonscend	JS0806-F	19F8060177	2020/06/19	2021/06/18
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

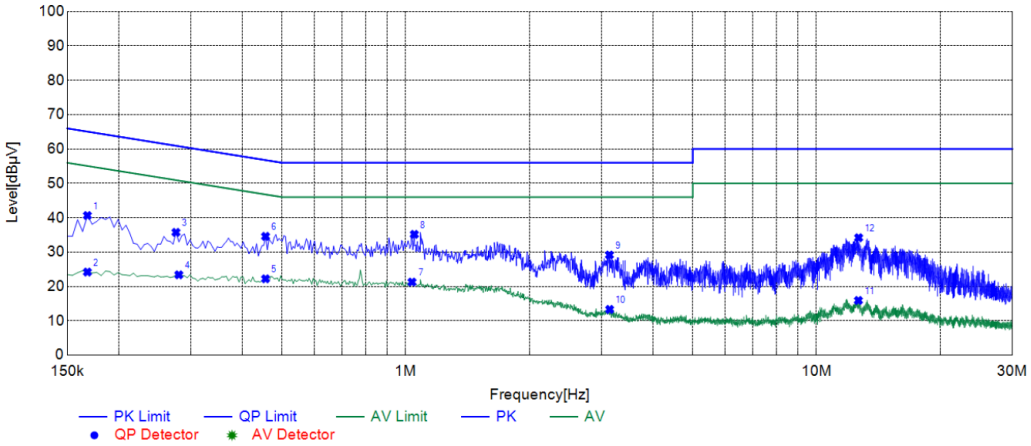
Temperature	22.8℃	Humidity	56%
Test Engineer	Moon Tan	Configurations	BLE

Remark:

1. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply(charge from adapter)have been tested, only the worst result of 120 VAC, 60 Hz with BLE middle channel was reported as below:

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	L

Test Graph



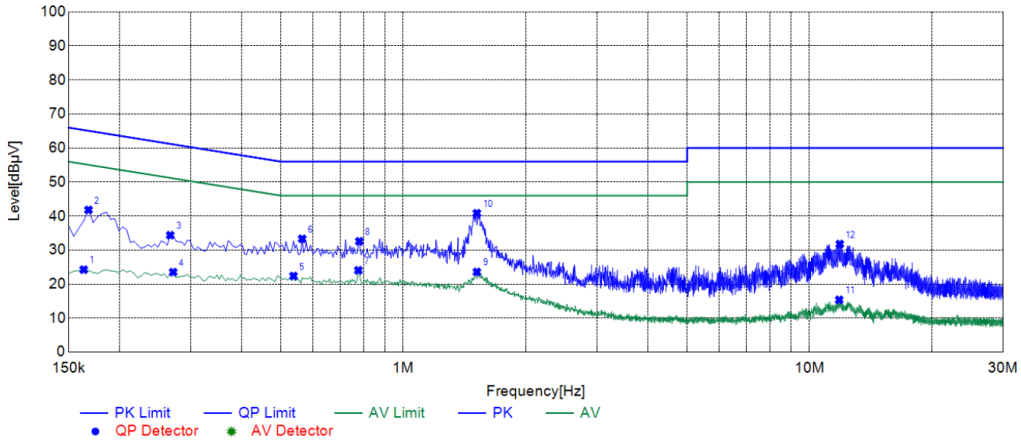
Suspected List									
NO.	Frequency [MHz]	Reading [dBµV]	Factor [dB]	Result [dBµV]	Limit [dBµV]	Margin [dB]	Detector	Line	Remark
1	0.1680	30.59	10.05	40.64	65.06	24.42	PK	L1	PASS
2	0.1680	14.13	10.05	24.18	55.06	30.88	AV	L1	PASS
3	0.2760	25.75	9.99	35.74	60.94	25.20	PK	L1	PASS
4	0.2805	13.39	9.99	23.38	50.80	27.42	AV	L1	PASS
5	0.4560	12.16	10.05	22.21	46.77	24.56	AV	L1	PASS
6	0.4560	24.52	10.05	34.57	56.77	22.20	PK	L1	PASS
7	1.0365	11.20	10.07	21.27	46.00	24.73	AV	L1	PASS
8	1.0500	25.08	10.08	35.16	56.00	20.84	PK	L1	PASS
9	3.1335	18.85	10.30	29.15	56.00	26.85	PK	L1	PASS
10	3.1380	3.00	10.30	13.30	46.00	32.70	AV	L1	PASS
11	12.6510	5.03	10.89	15.92	50.00	34.08	AV	L1	PASS
12	12.6690	23.29	10.89	34.18	60.00	25.82	PK	L1	PASS

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

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

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	N

Test Graph



Suspected List									
NO.	Frequency [MHz]	Reading [dBμV]	Factor [dB]	Result [dBμV]	Limit [dBμV]	Margin [dB]	Detector	Line	Remark
1	0.1635	14.18	10.05	24.23	55.28	31.05	AV	N	PASS
2	0.1680	31.75	10.05	41.80	65.06	23.26	PK	N	PASS
3	0.2670	24.36	10.00	34.36	61.21	26.85	PK	N	PASS
4	0.2715	13.50	10.00	23.50	51.07	27.57	AV	N	PASS
5	0.5370	12.30	10.06	22.36	46.00	23.64	AV	N	PASS
6	0.5640	23.25	10.06	33.31	56.00	22.69	PK	N	PASS
7	0.7755	13.97	10.07	24.04	46.00	21.96	AV	N	PASS
8	0.7800	22.50	10.07	32.57	56.00	23.43	PK	N	PASS
9	1.5180	13.44	10.11	23.55	46.00	22.45	AV	N	PASS
10	1.5180	30.72	10.11	40.83	56.00	15.17	PK	N	PASS
11	11.8365	4.55	10.82	15.37	50.00	34.63	AV	N	PASS
12	11.8770	20.94	10.82	31.76	60.00	28.24	PK	N	PASS

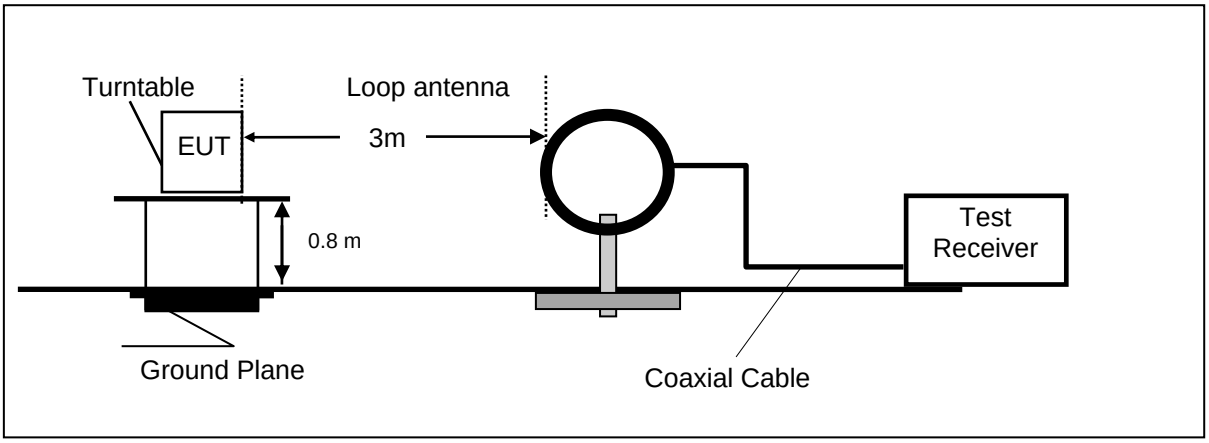
Note:1. Result (dBμV) = Reading (dBμV) + Factor (dB).

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

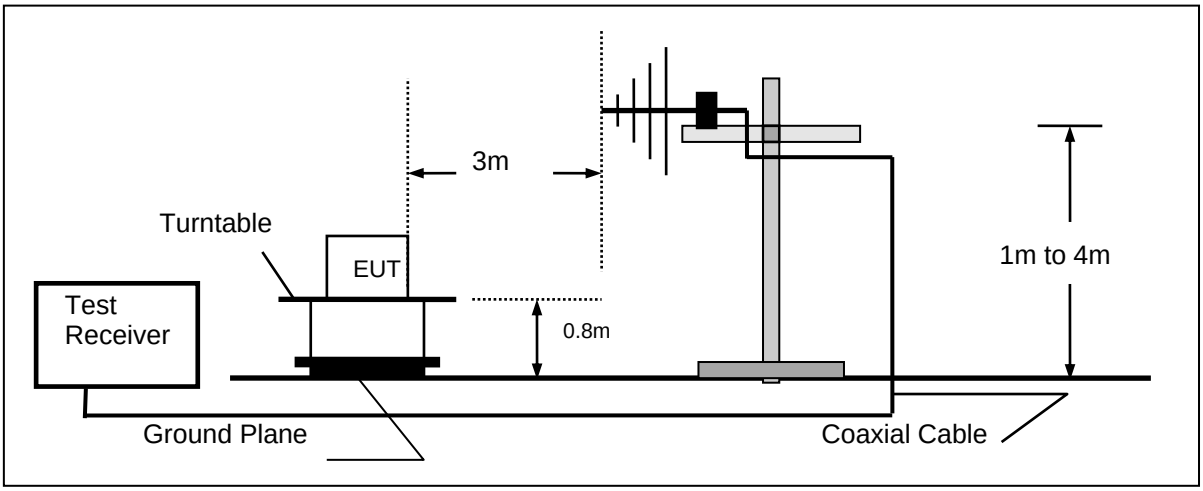
4.2 Radiated Emissions and Band Edge

TEST CONFIGURATION

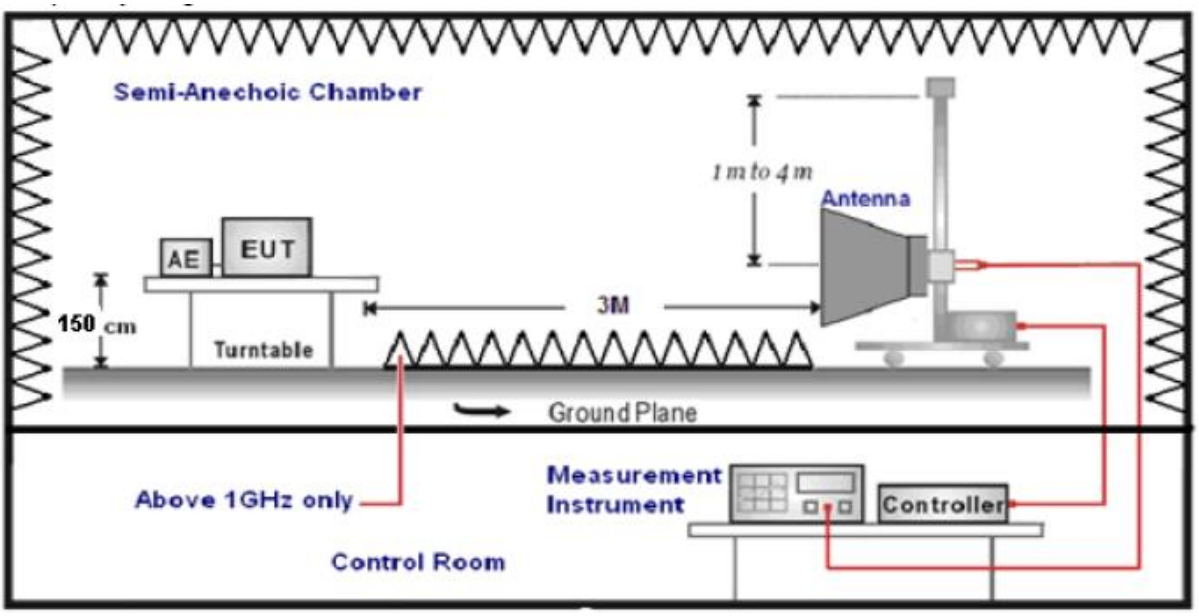
Frequency range 9 KHz – 30MHz



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℃ to 360℃ 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 Anternna	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	

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	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(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

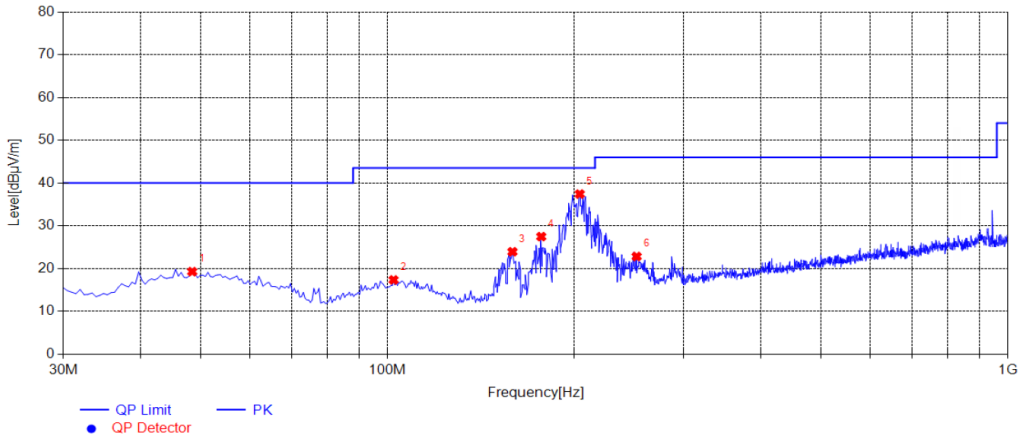
Temperature	22.8℃	Humidity	56%
Test Engineer	Moon Tan	Configurations	BLE

Remark:
1. For below 1GHz testing recorded worst mode at BLE low channel.
2. 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

Horizontal

Test Graph



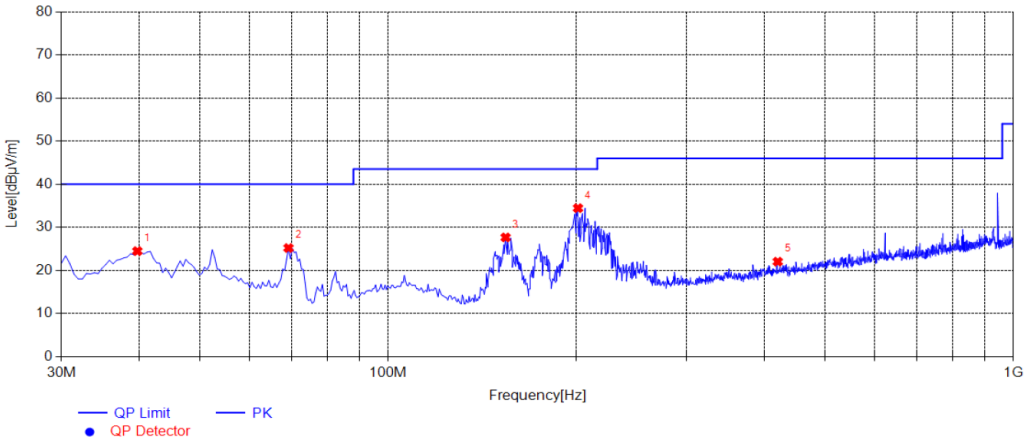
Suspected List											
NO.	Frequency [MHz]	Reading [dBµV/m]	Factor [dB]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity	Remark
1	48.4300	26.02	-6.72	19.30	40.00	20.70	100	99	PK	Horizonta	PASS
2	102.2650	25.81	-8.45	17.36	43.50	26.14	100	139	PK	Horizonta	PASS
3	159.0100	35.78	-11.84	23.94	43.50	19.56	100	104	PK	Horizonta	PASS
4	176.9550	38.46	-10.98	27.48	43.50	16.02	100	90	PK	Horizonta	PASS
5	204.1150	46.64	-9.21	37.43	43.50	6.07	100	118	PK	Horizonta	PASS
6	252.1300	30.94	-8.10	22.84	46.00	23.16	100	73	PK	Horizonta	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).

Vertical

Test Graph



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	39.7000	33.10	-8.60	24.50	40.00	15.50	100	53	PK	Vertical	PASS
2	69.2850	35.20	-9.98	25.22	40.00	14.78	100	318	PK	Vertical	PASS
3	154.1600	40.21	-12.54	27.67	43.50	15.83	100	360	PK	Vertical	PASS
4	201.2050	43.51	-9.05	34.46	43.50	9.04	100	116	PK	Vertical	PASS
5	419.9400	26.31	-4.26	22.05	46.00	23.95	100	278	PK	Vertical	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	56.04	PK	74	17.96	54.14	31.42	6.98	36.50	1.90
4804.00	47.21	AV	54	6.79	45.31	31.42	6.98	36.50	1.90
7206.00	46.57	PK	74	27.43	35.97	37.03	8.87	35.30	10.60
7206.00	--	AV	54	--	--	--	--	--	--

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	57.44	PK	74	16.56	55.54	31.42	6.98	36.50	1.90
4804.00	47.91	AV	54	6.09	46.01	31.42	6.98	36.50	1.90
7206.00	47.37	PK	74	26.63	36.77	37.03	8.87	35.30	10.60
7206.00	--	AV	54	--	--	--	--	--	--

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	56.37	PK	74	17.63	54.31	30.98	7.58	36.50	2.06
4880.00	46.85	AV	54	7.15	44.79	30.98	7.58	36.50	2.06
7320.00	45.98	PK	74	28.02	35.06	37.66	8.56	35.30	10.92
7320.00	--	AV	54	--	--	--	--	--	--

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	56.97	PK	74	17.03	54.91	30.98	7.58	36.50	2.06
4880.00	47.75	AV	54	6.25	45.69	30.98	7.58	36.50	2.06
7320.00	46.58	PK	74	27.42	35.66	37.66	8.56	35.30	10.92
7320.00	--	AV	54	--	--	--	--	--	--

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	57.21	PK	74	16.79	54.14	31.47	7.80	36.20	3.07
4960.00	48.40	AV	54	5.60	45.33	31.47	7.80	36.20	3.07
7440.00	46.82	PK	74	27.18	35.08	38.32	8.72	35.30	11.74
7440.00	--	AV	54	--	--	--	--	--	--

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	58.41	PK	74	15.59	55.34	31.47	7.80	36.20	3.07
4960.00	49.10	AV	54	4.90	46.03	31.47	7.80	36.20	3.07
7440.00	48.22	PK	74	25.78	36.48	38.32	8.72	35.30	11.74
7440.00	--	AV	54	--	--	--	--	--	--

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	49.11	PK	74.00	24.89	54.52	27.49	3.32	36.22	-5.41
2390.00	--	AV	54.00	--	--	--	--	--	--
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	50.21	PK	74.00	23.79	55.62	27.49	3.32	36.22	-5.41
2390.00	--	AV	54.00	--	--	--	--	--	--
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	47.95	PK	74.00	26.05	53.46	27.45	3.38	36.34	-5.51
2483.50	--	AV	54.00	--	--	--	--	--	--
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	49.35	PK	74.00	24.65	54.86	27.45	3.38	36.34	-5.51
2483.50	--	AV	54.00	--	--	--	--	--	--

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

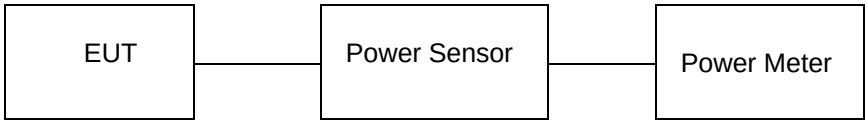
Limit

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

Temperature	22.8℃	Humidity	56%
Test Engineer	Moon Tan	Configurations	BLE

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	00	-0.192	30.00	Pass
	19	-0.940		
	39	-1.468		

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

4.4 Power Spectral Density

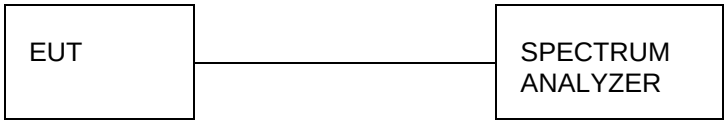
Limit

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 ≥ 3× 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



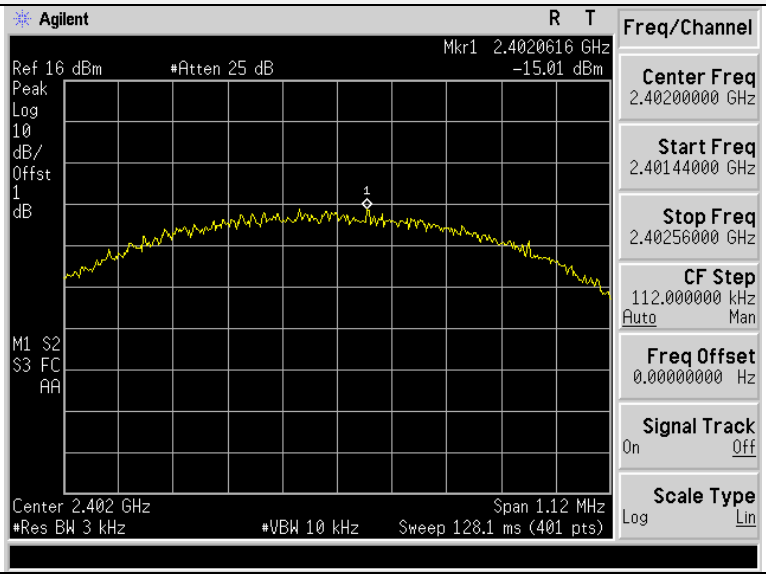
Test Results

Temperature	22.8℃	Humidity	56%
Test Engineer	Moon Tan	Configurations	BLE

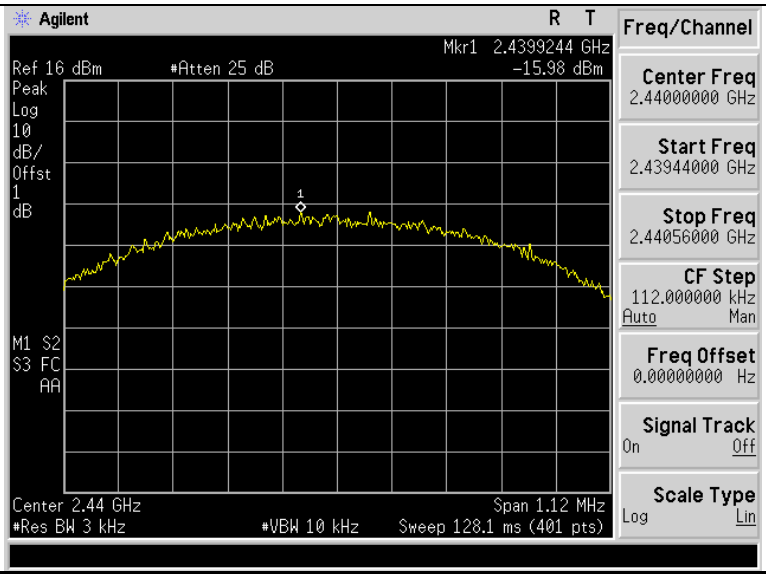
Type	Channel	Power Spectral Density (dBm/3KHz)	Limit (dBm/3KHz)	Result
GFSK	00	-15.01	8.00	Pass
	19	-15.98		
	39	-16.50		

Test plot as follows:

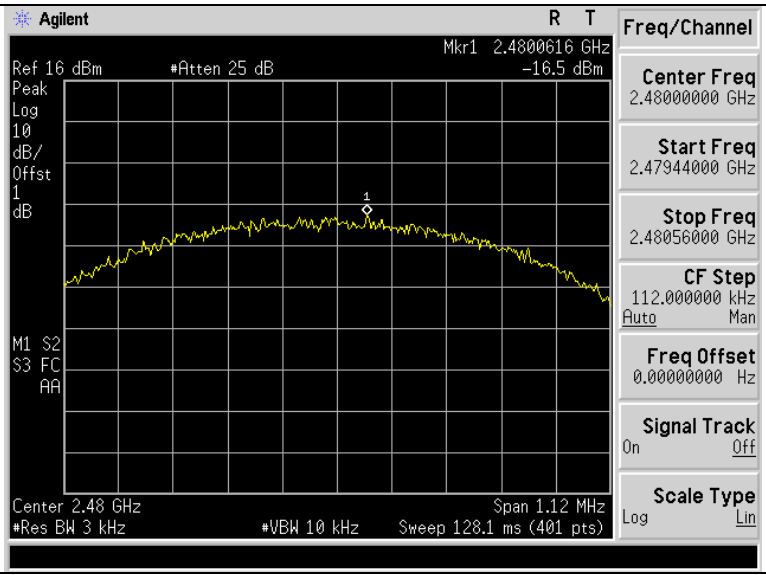
BLE GFSK



CH00



CH19



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4.5 6dB Bandwidth

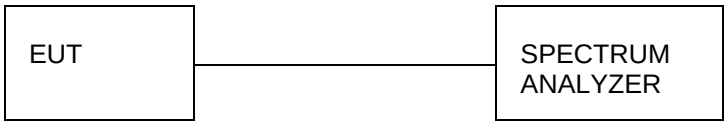
Limit

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



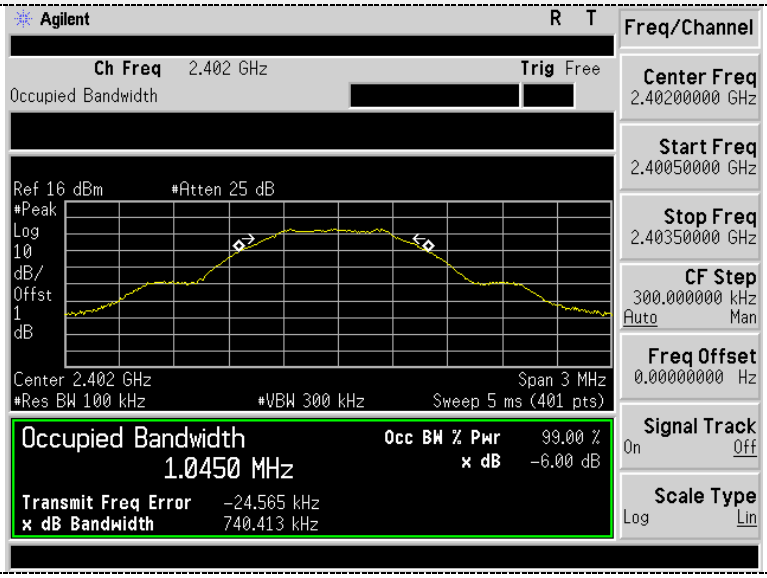
Test Results

Temperature	22.8℃	Humidity	56%
Test Engineer	Moon Tan	Configurations	BLE

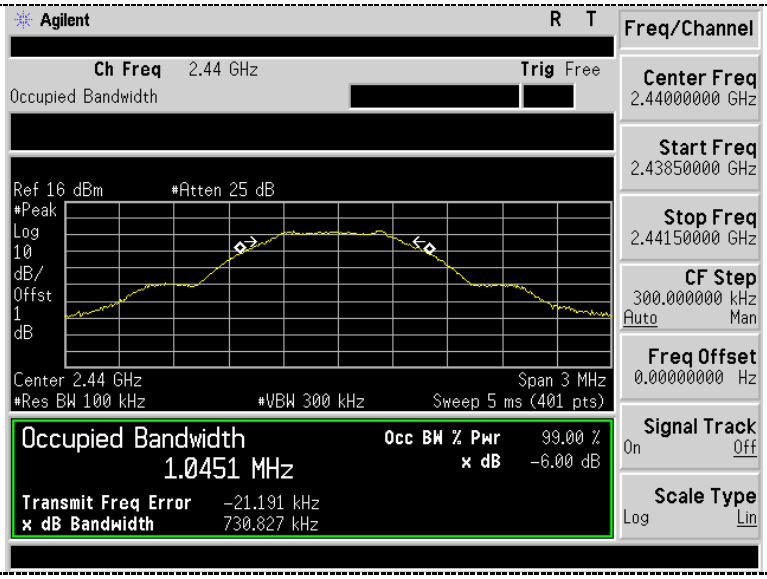
Type	Channel	6dB Bandwidth (MHz)	99% OBW (MHz)	Limit (KHz)	Result
GFSK	00	0.7404	1.0450	≥500	Pass
	19	0.7308	1.0451		
	39	0.7230	1.0448		

Test plot as follows:

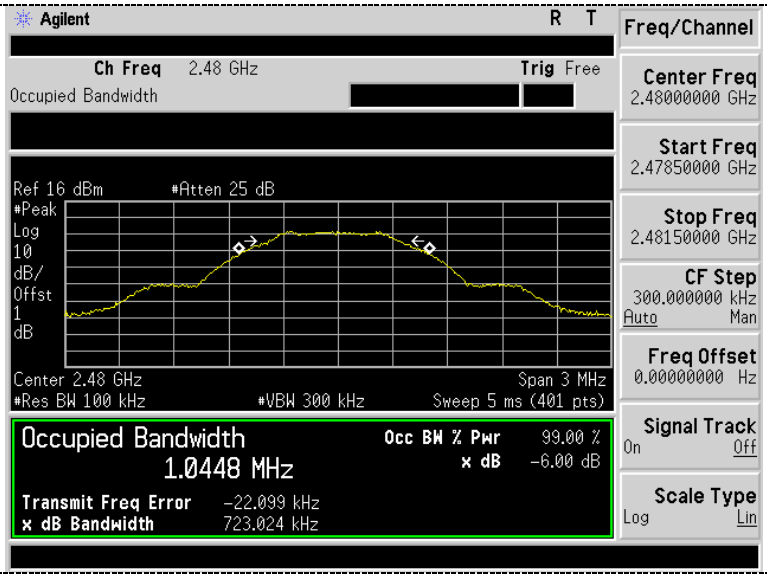
BLE GFSK



CH00



CH19



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4.6 Out-of-band Emissions

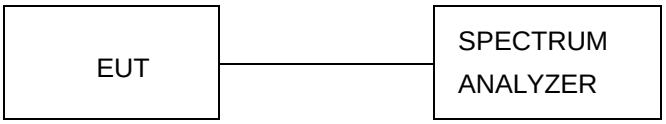
Limit

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 con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies 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 setting are made of the in-band reference level, bandedge and out-of-band emissions.

Test Configuration



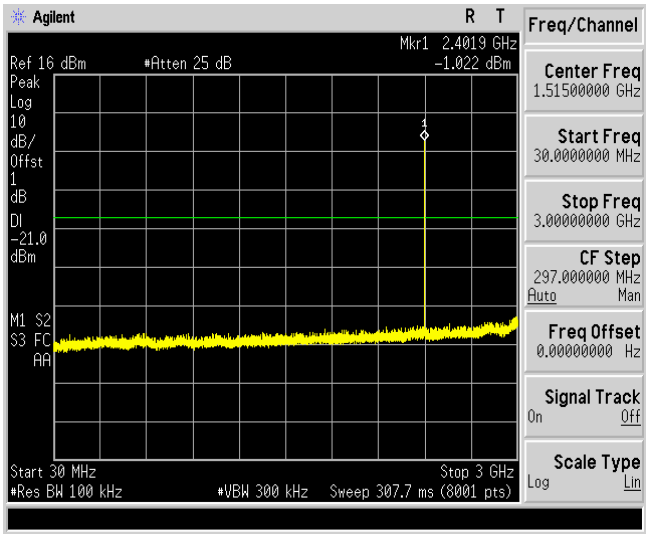
Test Results

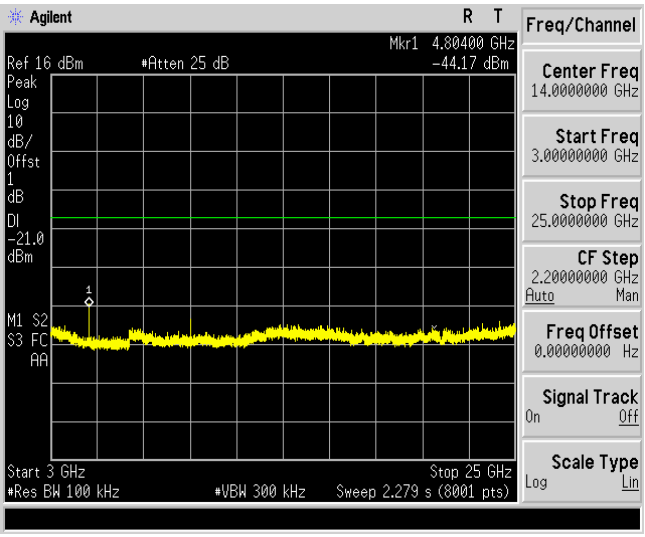
Temperature	22.8℃	Humidity	56%
Test Engineer	Moon Tan	Configurations	BLE

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 bandage measurement data.

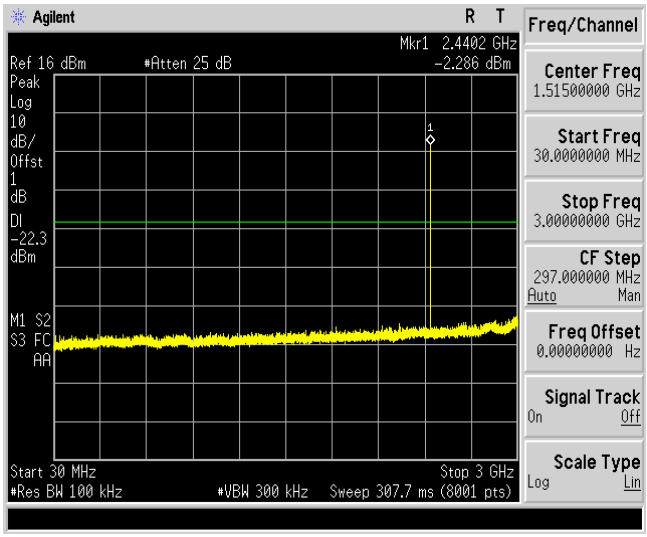
Test plot as follows:

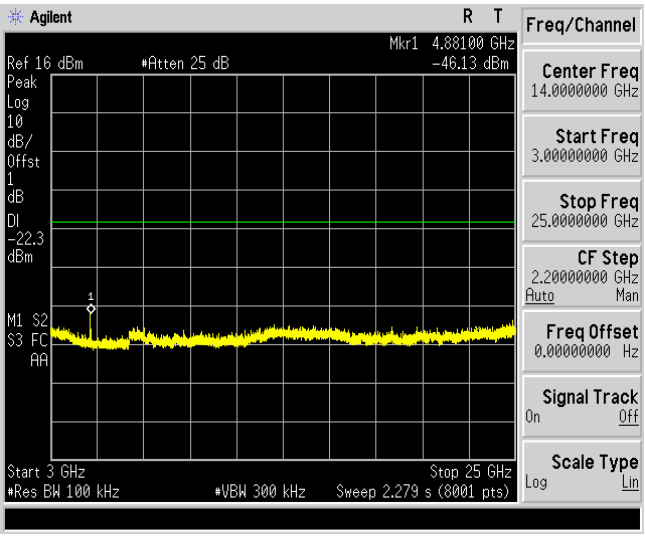
GFSK



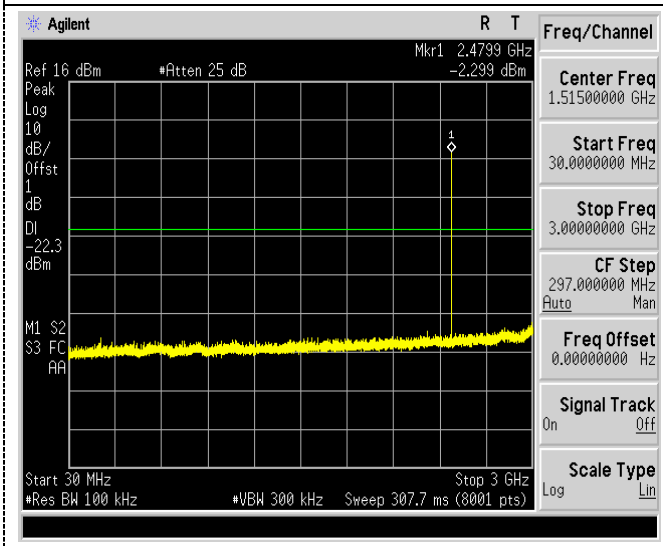


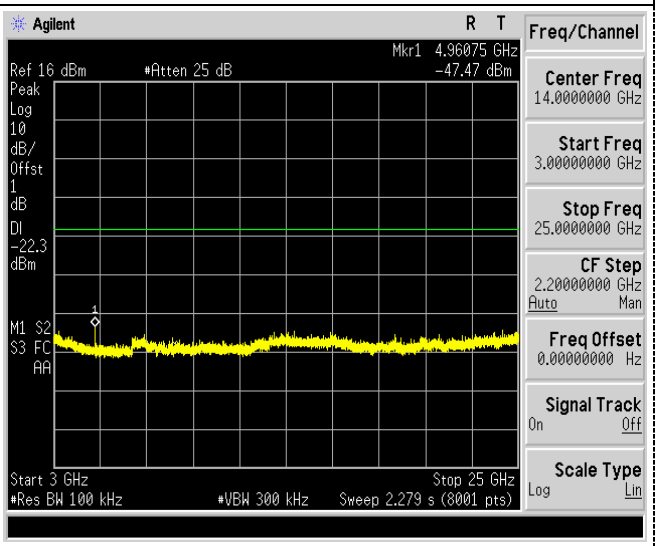
CH00





CH19





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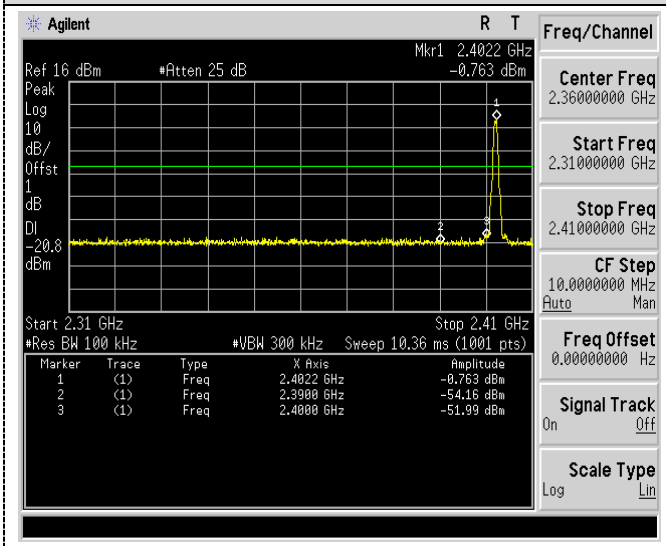
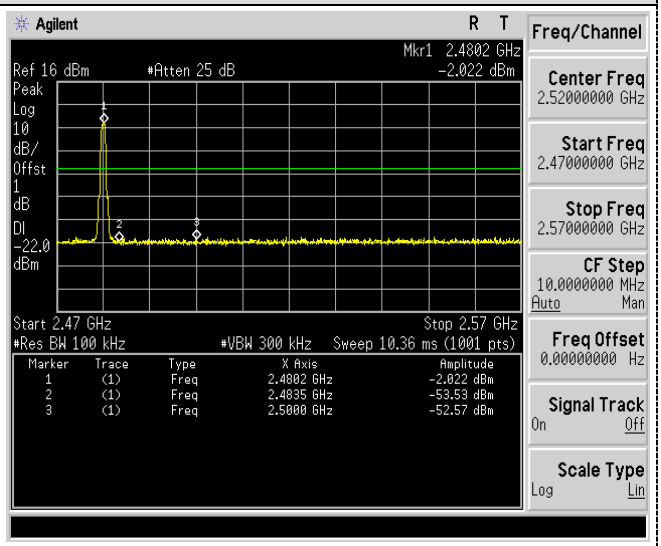
Band-edge Measurements for RF Conducted Emissions:

BLE GFSK



Left bandedge



Right bandedge

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

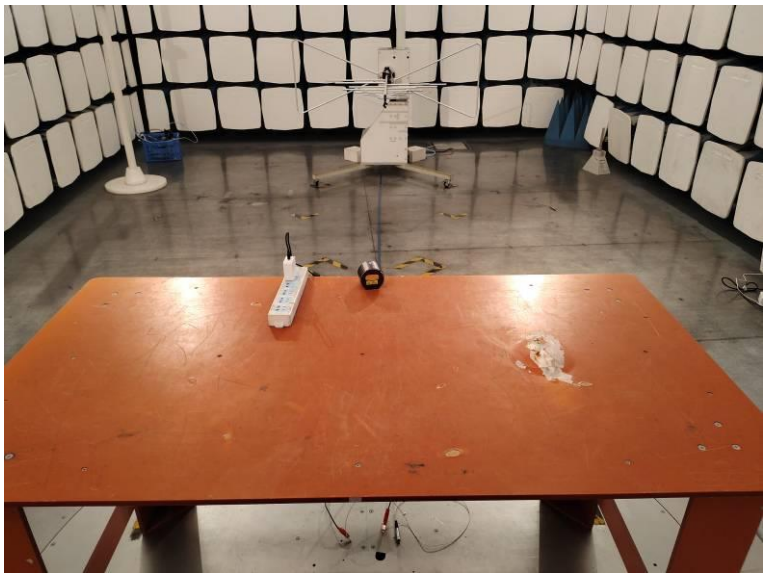
FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1) (I):

(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

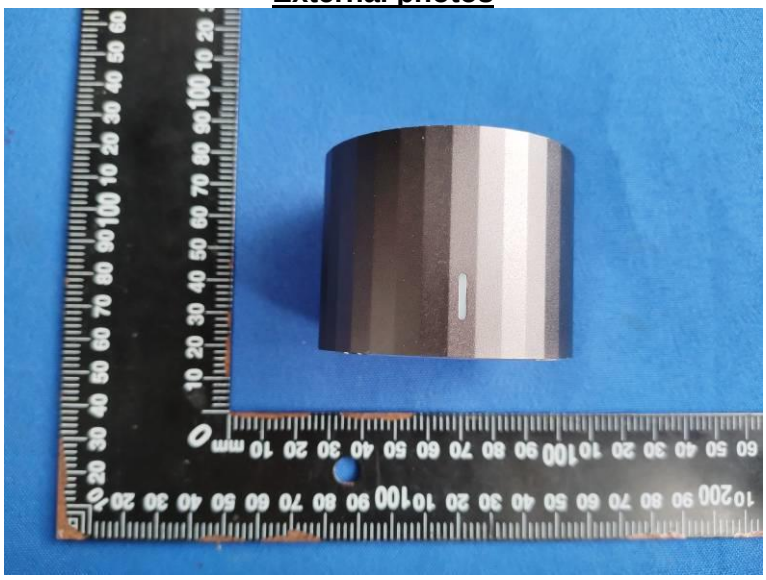
The maximum gain of antenna was 2.00dBi.

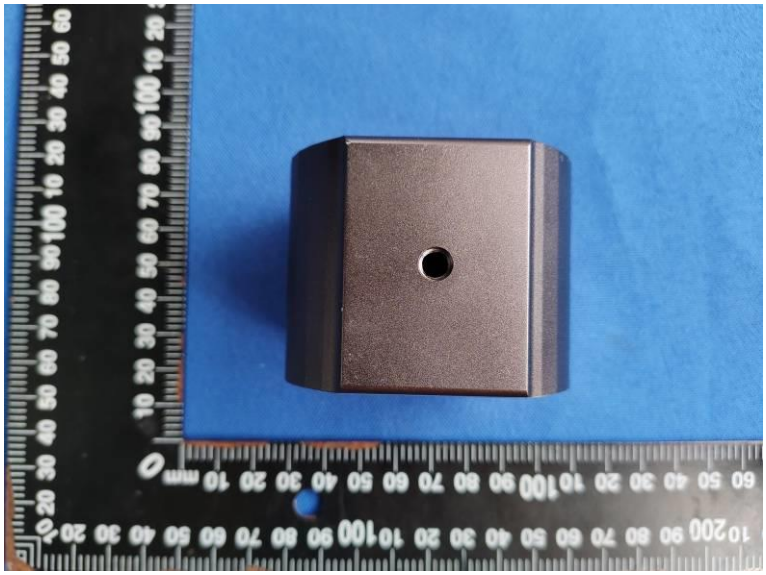
5 Test Setup Photos of the EUT

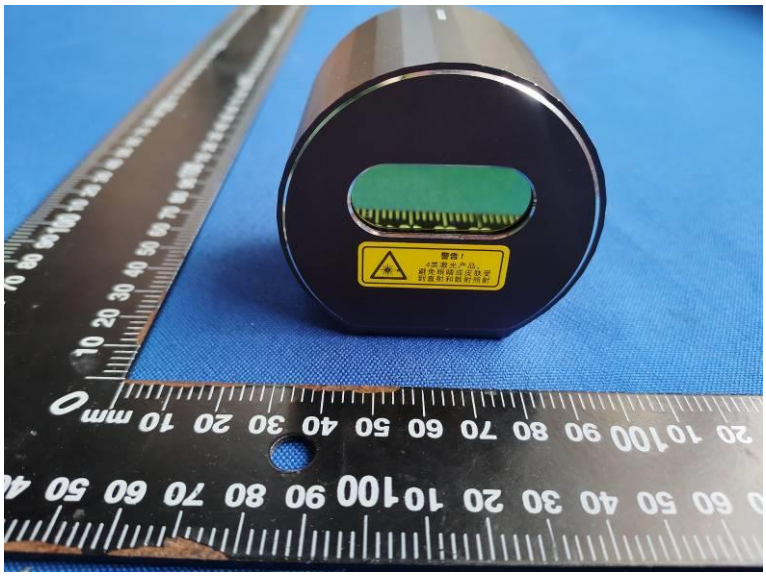


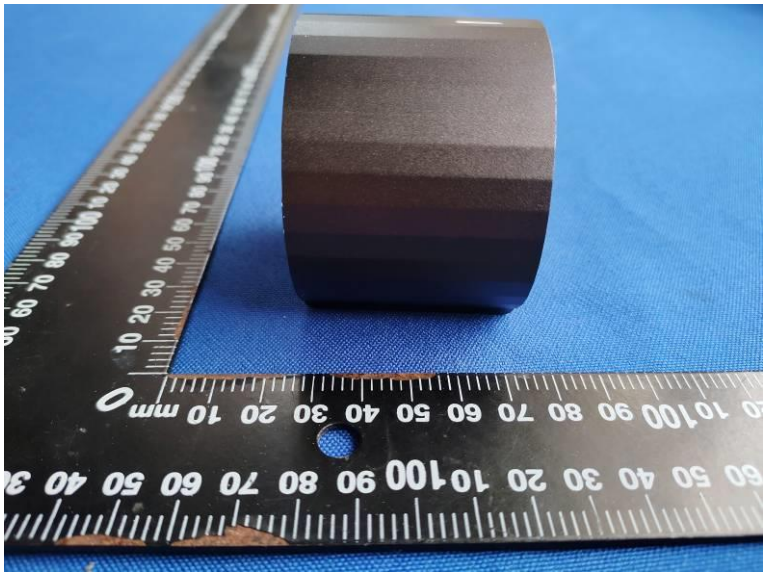
6 Photos of the EUT

External photos

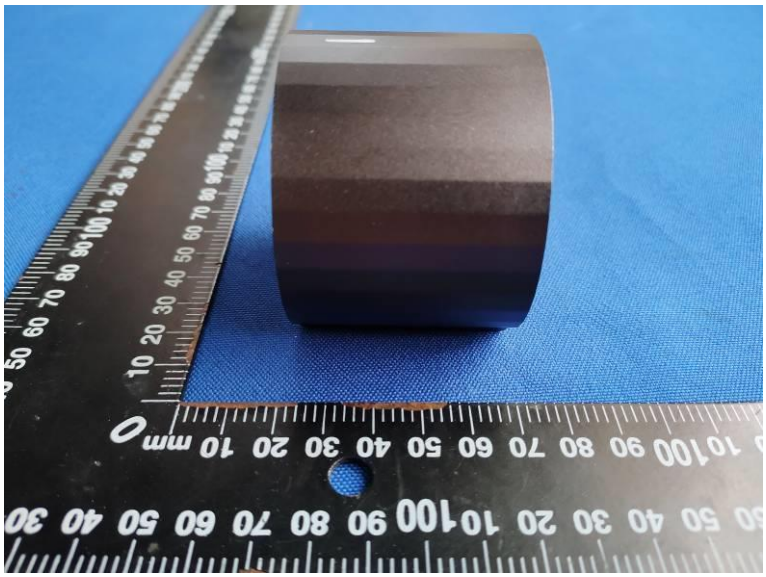




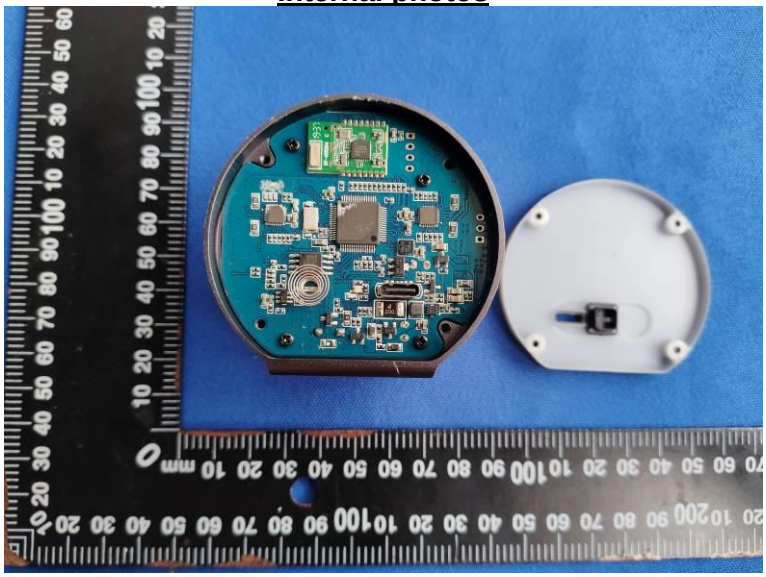


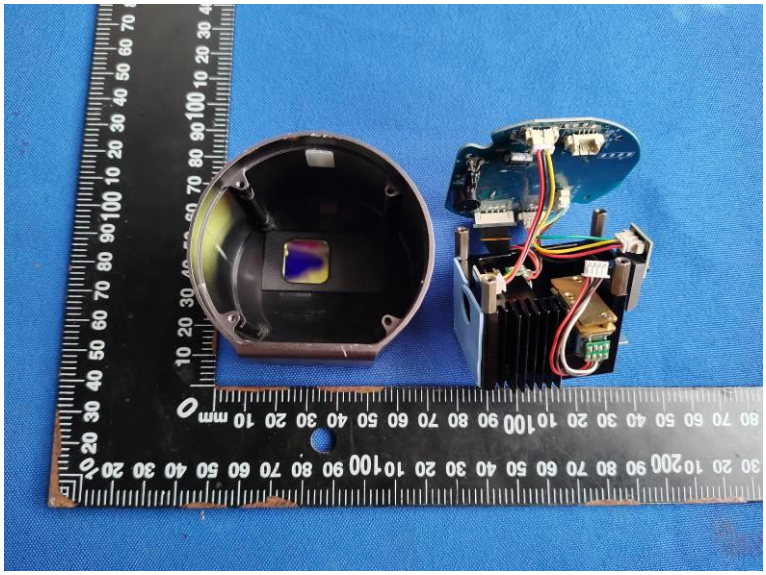


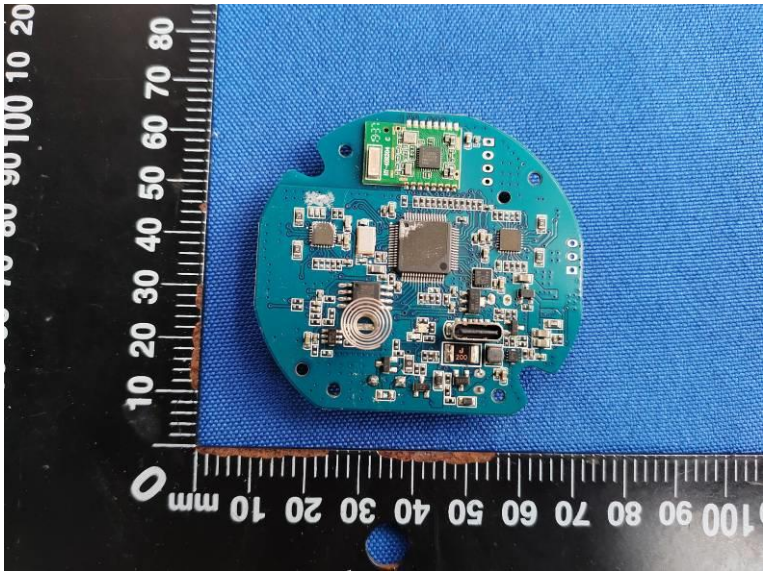
LASERPECKER

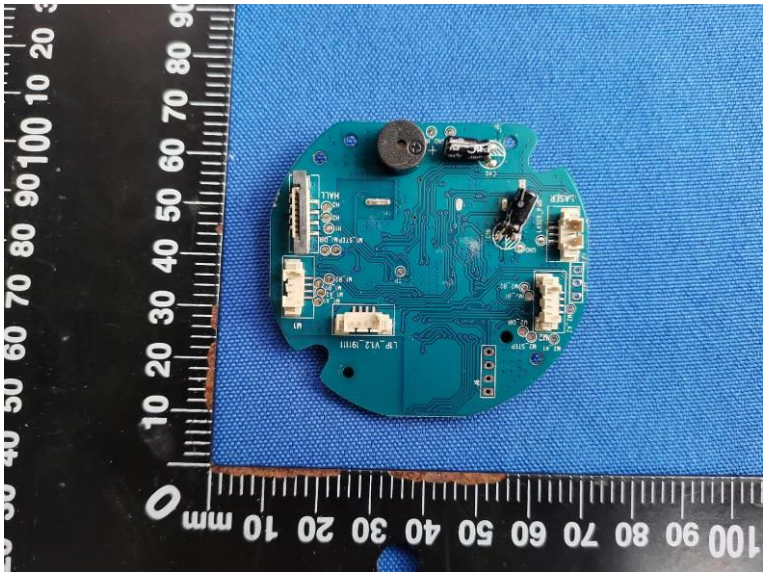


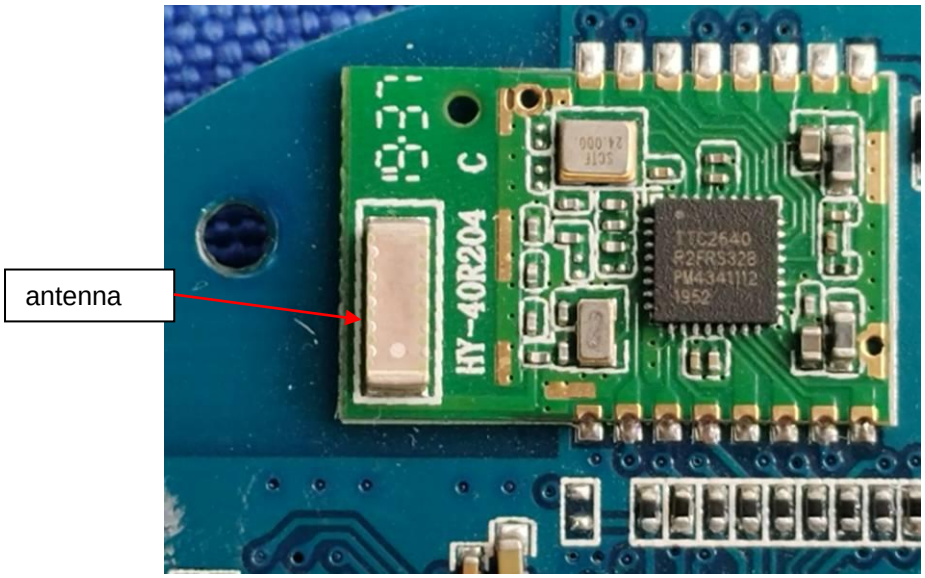
Internal photos











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