TEST REPORT

FCC PART 15 SUBPART C 15.247

Test report

On Behalf of

The Tintometer Ltd

For

Portable Spectrophotometer

Model No.: TR500

FCC ID: 2AWMG-TR500

Prepared for : **The Tintometer Ltd**

Lovibond House, Sunrise Way, Amesbury, SP4 7GR, United Kingdom

Prepared By : **Shenzhen HUAK Testing Technology Co., Ltd.**

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Date of Test: **Jun. 05, 2020 ~ Jun.18, 2020**

Date of Report: **Jun. 18, 2020**

Report Number: **HK2006121350-E**

TEST RESULT CERTIFICATION

Applicant's name .....: The Tintometer Ltd

Address .....: Lovibond House, Sunrise Way, Amesbury, SP4 7GR, United Kingdom

Manufacture's Name.....: The Tintometer Ltd

Address .....: Lovibond House, Sunrise Way, Amesbury, SP4 7GR, United Kingdom

Product description

Trade Mark .....: Lovibond

Product name .....: Portable Spectrophotometer

Model and/or type reference ...: TR500, TR520, TR515

Standards .....: **47 CFR FCC Part 15 Subpart C 15.247**

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Date of Test..... :

Date (s) of performance of tests ..... : Jun. 05, 2020 ~ Jun.18, 2020

Date of Issue ..... : Jun. 18, 2020

Test Result ..... : **Pass**

Prepared by: Gary Qian

Project Engineer

Reviewed by: Edan Hu

Project Supervisor

Approved by: Jason Zhou

Technical Director

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1 Test Summary

1.1 Test Description

Test Item	Test Requirement	Result
Antenna Requirement	FCC 15.203/ FCC 15.247 (c)	PASS
Conducted Emission	FCC Part 15.207	PASS
Radiated Emissions	FCC Part 15.205/15.209	PASS
Maximum Peak Output Power	FCC Part 15.247(b)	PASS
Power Spectral Density	FCC Part 15.247 (e)	PASS
6dB Bandwidth & 99% Bandwidth	FCC Part 15.247(a)(2)	PASS
Spurious RF Conducted Emission	FCC Part 15.247(d)	PASS
Band Edge	FCC Part 15.247(d)	PASS

1.2 Test Facility

1.2.1 Address of the test laboratory

Shenzhen HUAK Testing Technology Co., Ltd.
Add.:1F, B2 Building, Junfeng Zhongcheng Zhizao Innovation Park,Heping Community, Fuhai Street, Bao'an District, Shenzhen, China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents CISPR 32/EN 55032 requirements.

1.2.2 Laboratory accreditation

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

IC Registration No.: 21210

The 3m alternate test site of Shenzhen HUAK Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 21210 on May 24, 2016.

1.3 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 HUAK Testing Technology 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 HUAK laboratory is reported:

No.	Item	MU
1	Conducted Emission	±2.56dB
2	RF power, conducted	±0.12dB
3	Spurious emissions, conducted	±0.11dB
4	All emissions, radiated(<1G)	±3.92dB
5	All emissions, radiated(>1G)	±4.28dB
6	Temperature	±0.1°C
7	Humidity	±1.0%

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

2 General Information

2.1 Environmental conditions

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

Normal Temperature:	25°C
Relative Humidity:	55 %
Air Pressure:	101 kPa

2.2 General Description of EUT

Product Name	Portable Spectrophotometer
Model/Type reference	TR500
Serial Model	TR520, TR515
Model Difference	All models have the same functionality, software and electronics, only the color, front frame shape and model names may differ. Test sample model: TR500
Trade Mark	Lovibond
FCC ID	2AWMG-TR500
Hardware Version	2.002.40.0108
Software Version	V1.0.1.2
Operation frequency	2402MHz ~ 2480MHz
Channel separation	2MHz
Channel number	40
Modulation Technology	GFSK
Antenna Type	Chip Antenna
Antenna Gain	2dBi
Power Supply	DC 3.7V from battery & Adapter
Adapter Information	MODEL: DSA-12PFU-05 FUS 050200 INPUT: 100V-240V~50/60Hz 0.5A OUTPUT: 5V⎓2A

Note: 1. For more details, refer to the user's manual of the EUT.

2.3 Description of Test Modes and Test Frequency

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing.
There are 40 channels provided to the EUT and Channel 00/19/39 was selected for testing.

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

Test channel：

Channel	Frequency (MHz)	/
0	2402	Low channel
19	2440	Middle channel
39	2480	High channel

Preliminary tests were performed in each mode and packet length of BT, and found worst case as bellow, finally test were conducted at those mode and recorded in this report.

Test Items	Worst case
Conducted Emissions	Low/Middle/High channel
Radiated Emissions and Band Edge	Low/Middle/High channel
Maximum Conducted Output Power	Low/Middle/High channel
Power Spectral Density	Low/Middle/High channel
6dB Bandwidth&99% Bandwidth	Low/Middle/High channel
Out-of-band Emissions	Low/Middle/High channel

2.4 Equipments Used during the Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	L.I.S.N. Artificial Mains Network	R&S	ENV216	HKE-002	Dec. 26, 2019	1 Year
2.	Receiver	R&S	ESCI 7	HKE-010	Dec. 26, 2019	1 Year
3.	RF automatic control unit	Tonscend	JS0806-2	HKE-060	Dec. 26, 2019	1 Year
4.	Spectrum analyzer	R&S	FSP40	HKE-025	Dec. 26, 2019	1 Year
5.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 26, 2019	1 Year
6.	Preamplifier	Schwarzbeck	BBV 9743	HKE-006	Dec. 26, 2019	1 Year
7.	EMI Test Receiver	Rohde & Schwarz	ESCI 7	HKE-010	Dec. 26, 2019	1 Year
8.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	HKE-012	Dec. 26, 2019	1 Year
9.	Loop Antenna	Schwarzbeck	FMZB 1519 B	HKE-014	Dec. 26, 2019	1 Year
10.	Horn Antenna	Schewarzbeck	9120D	HKE-013	Dec. 26, 2019	1 Year
11.	Pre-amplifier	EMCI	EMC051845 SE	HKE-015	Dec. 26, 2019	1 Year
12.	Pre-amplifier	Agilent	83051A	HKE-016	Dec. 26, 2019	1 Year
13.	EMI Test Software EZ-EMC	Tonscend	JS1120-B Version	HKE-083	Dec. 27, 2018	N/A
14.	Power Sensor	Agilent	E9300A	HKE-086	Dec. 26, 2019	1 Year
15.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 26, 2019	1 Year
16.	Signal generator	Agilent	N5182A	HKE-029	Dec. 26, 2019	1 Year
17.	Signal Generator	Agilent	83630A	HKE-028	Dec. 26, 2019	1 Year
18.	Shielded room	Shiel Hong	4*3*3	HKE-039	Dec. 27, 2017	3 Year
19.	Power Meter	R&S	NRVD	SEL0069	Dec. 26, 2019	1 Year
20	High Gain Antenna	Schewarzbeck	LB-180400K F	HKE-054	Dec. 26, 2019	1 Year

Note: The calibration interval was one year

2.5 Description of Test conditions

(1) E.U.T. test conditions:
For intentional radiators, measurements of the variation of the input power or the adiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

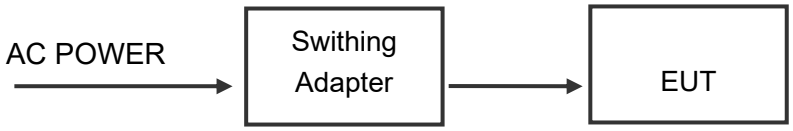
(2) Frequency range of radiated measurements:
The test range will be up to the tenth harmonic of the highest fundamental frequency.

(3) Pre-test the EUT in all transmitting mode at the lowest (2402 MHz), middle (2440 MHz) and highest (2480 MHz) channel with different data packet and conducted to determine the worst-case mode, only the worst-case results are recorded in this report.

(4) The EUT was programmed to be in continuously transmitting mode and the transmit duty cycle is not less than 98%.

2.6 DESCRIPTION OF TEST SETUP

Operation of EUT during conducted testing:



Operation of EUT during Radiation and Above1GHz Radiation testing:

2.7 Description of Support Units

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

Description	Information	Manufacturer	Remark	Certificate
/	/	/	/	/
/	/	/	/	/

3 TEST CONDITIONS AND RESULTS

3.1 Antenna Requirement

Standard requirement

Standard Applicable

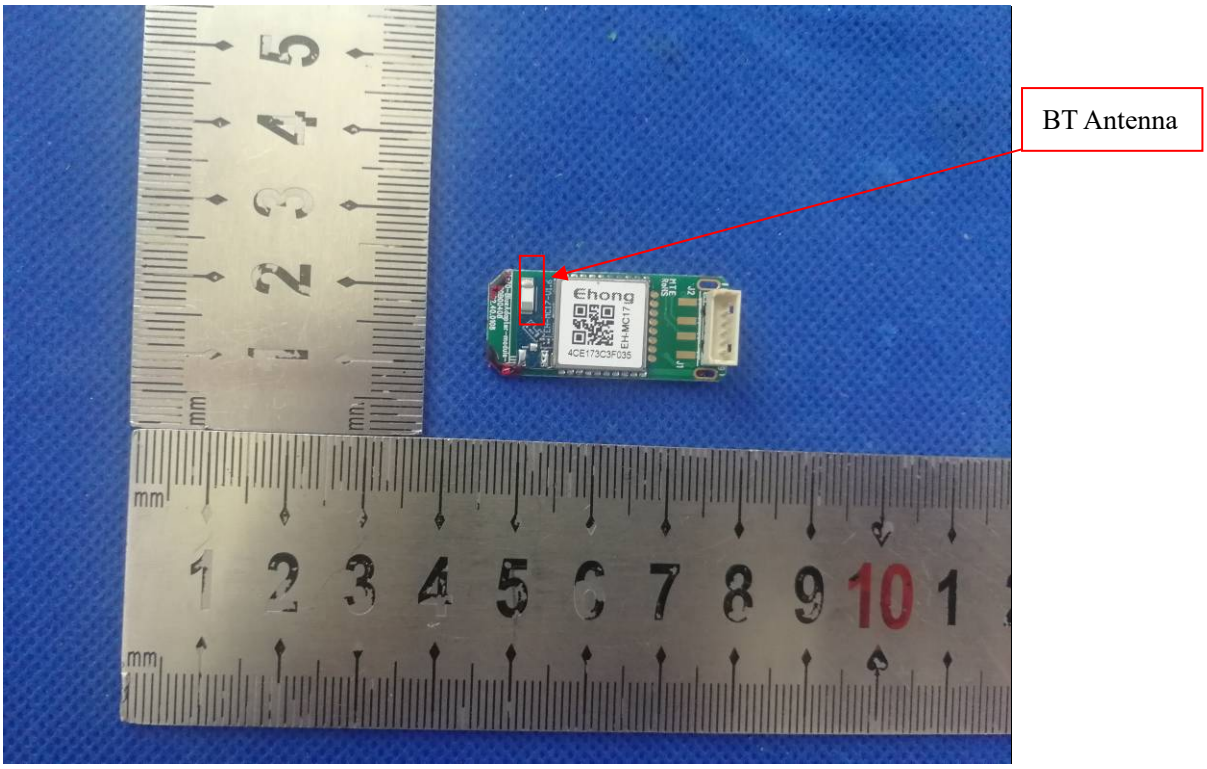
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247, if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Refer to statement below for compliance.

The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

Antenna Connected Construction

The Chip antenna used in the product is a permanently connected antenna that complies with the provisions of part 15.203 requirement in this section. The antenna used in this product is a Chip Antenna, The directional gains of antenna used for transmitting is 2 dBi.



3.2 Conduction Emissions Measurement

Limit

According to FCC CFR Title 47 Part 15 Subpart C Section 15.207, AC Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus as below:

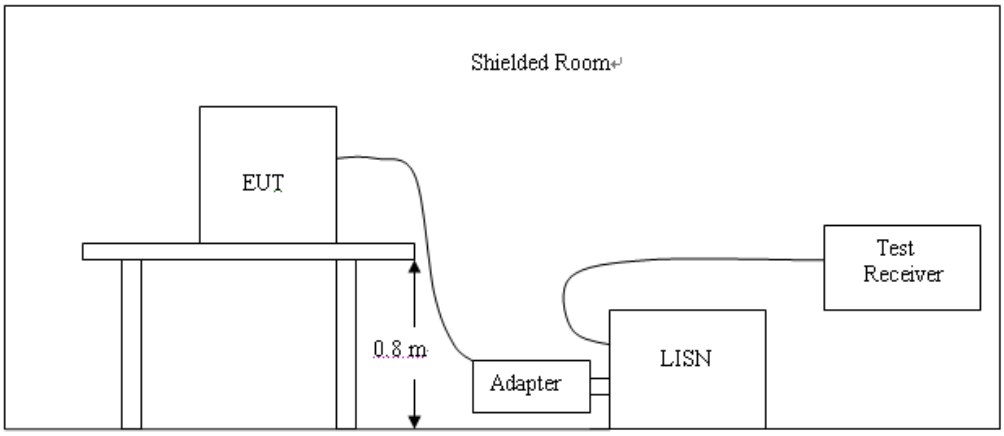
Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Test procedure

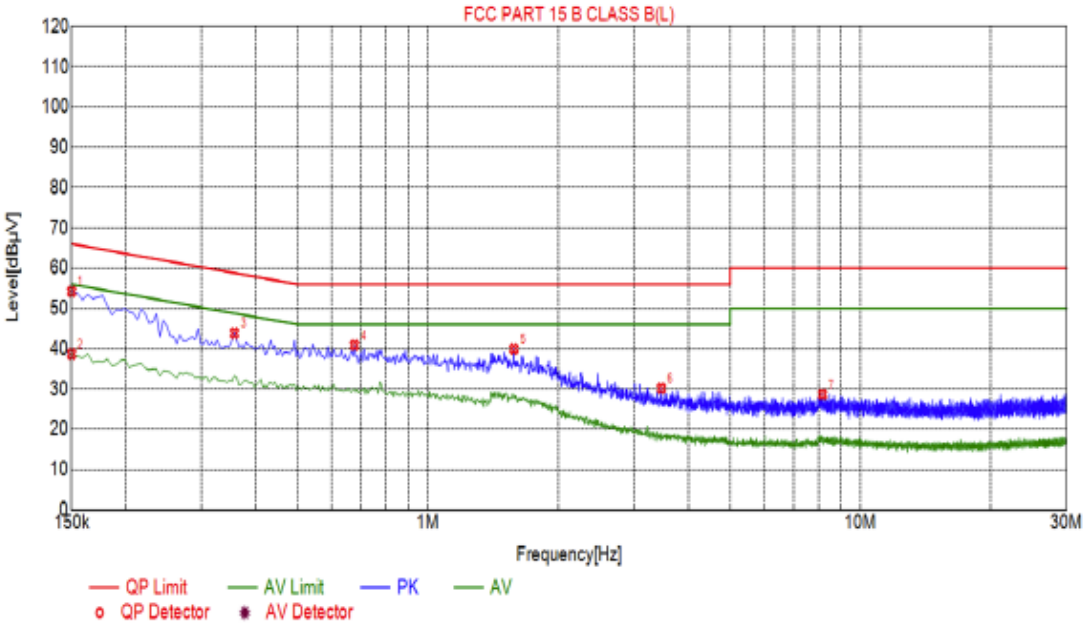
1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10:2013.
2. Support equipment, if needed, was placed as 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 adapter received AC120V/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.

Test setup



Test results

Test Specification: Line



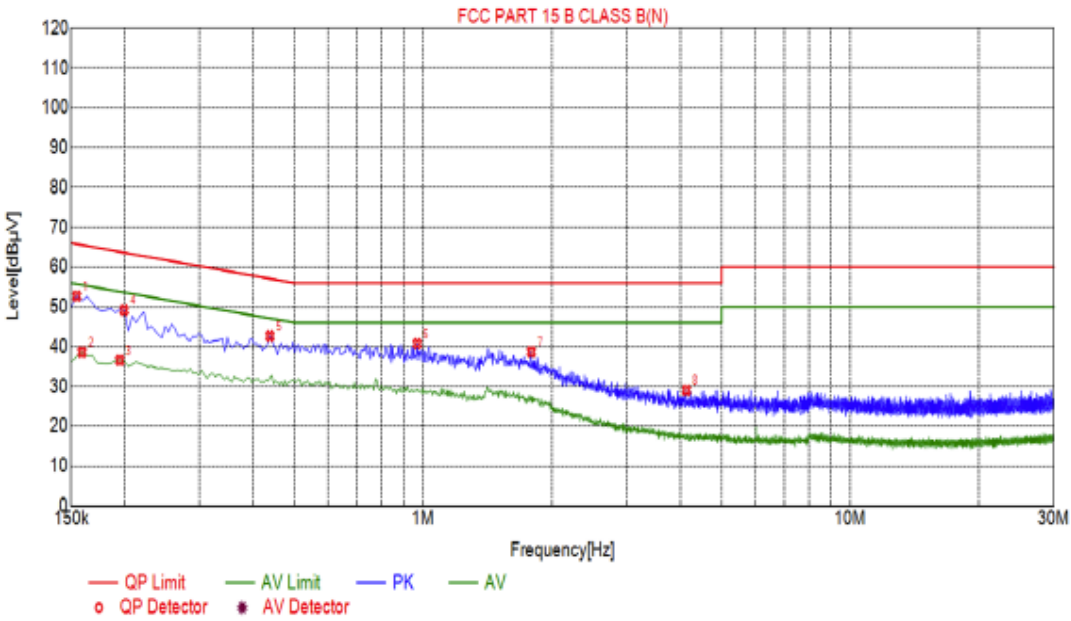
Suspected List								
NO.	Freq. [MHz]	Level [dBµV]	Factor [dB]	Limit [dBµV]	Margin [dB]	Reading [dBµV]	Detector	Type
1	0.1500	54.21	10.03	66.00	11.79	44.18	PK	L
2	0.1500	38.68	10.03	56.00	17.32	28.65	AV	L
3	0.3570	43.88	10.03	58.80	14.92	33.85	PK	L
4	0.6765	40.87	10.05	56.00	15.13	30.82	PK	L
5	1.5810	39.96	10.11	56.00	16.04	29.85	PK	L
6	3.4665	30.16	10.25	56.00	25.84	19.91	PK	L
7	8.1735	28.71	10.14	60.00	31.29	18.57	PK	L

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss

Level=Test receiver reading + correction factor

Test Specification: Neutral



Suspected List								
NO.	Freq. [MHz]	Level [dBµV]	Factor [dB]	Limit [dBµV]	Margin [dB]	Reading [dBµV]	Detector	Type
1	0.1545	52.70	10.03	65.75	13.05	42.67	PK	N
2	0.1590	38.62	10.01	55.52	16.90	28.61	AV	N
3	0.1950	36.58	10.03	53.82	17.24	26.55	AV	N
4	0.1995	49.19	10.03	63.63	14.44	39.16	PK	N
5	0.4380	42.69	10.05	57.10	14.41	32.64	PK	N
6	0.9690	40.73	10.06	56.00	15.27	30.67	PK	N
7	1.7925	38.69	10.14	56.00	17.31	28.55	PK	N
8	4.1370	29.08	10.25	56.00	26.92	18.83	PK	N

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss

Level=Test receiver reading + correction factor

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.

2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.

3. Final Level =Receiver Read level + LISN Factor + Cable Loss.

If the average limit is met when using a quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

3.3 Radiated Emissions Measurement

Limit

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

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)

Except when the requirements applicable to a given device state otherwise, emissions from licence□exempt transmitters shall comply with the field strength limits shown in table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

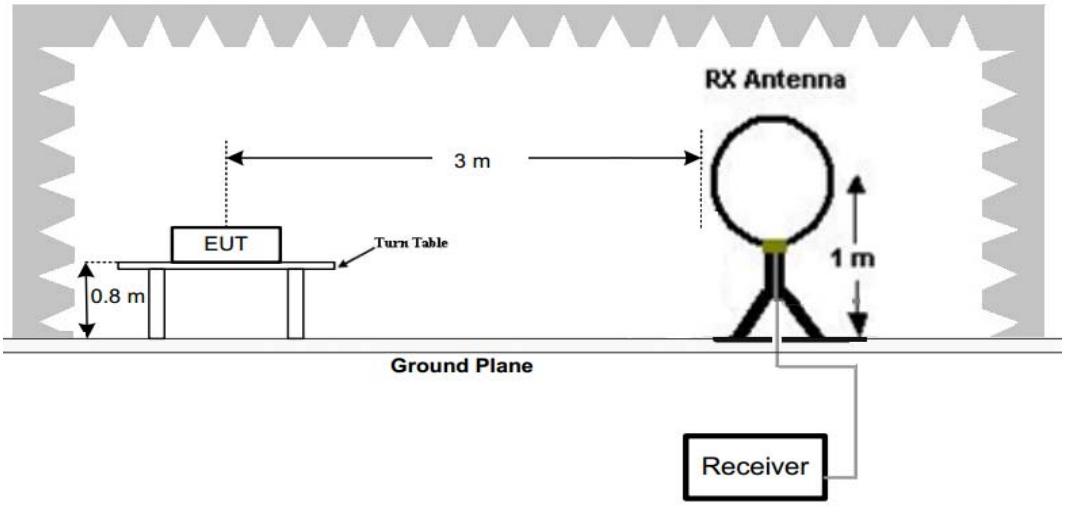
Radiated emission limits

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

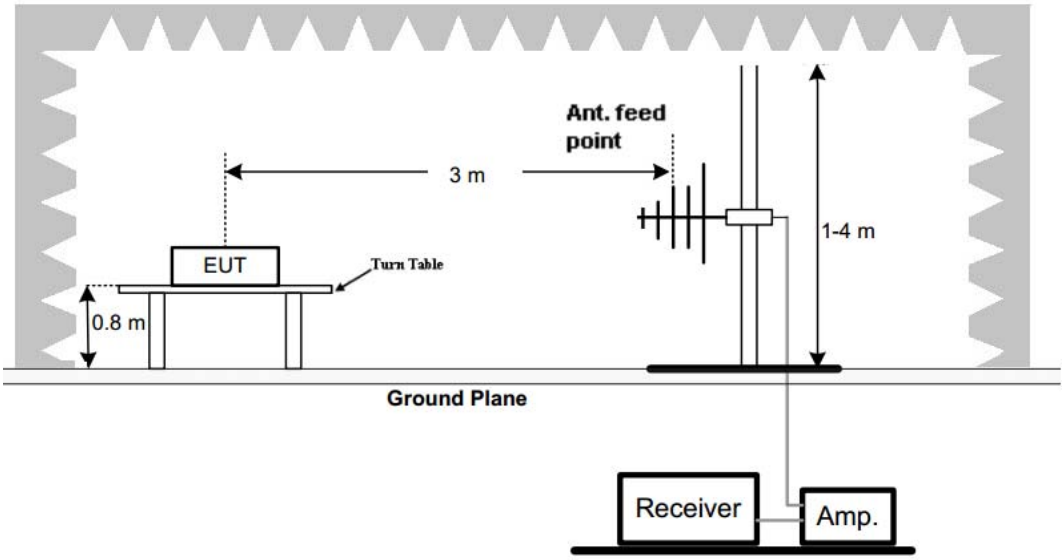
Test setup

Test Configuration:

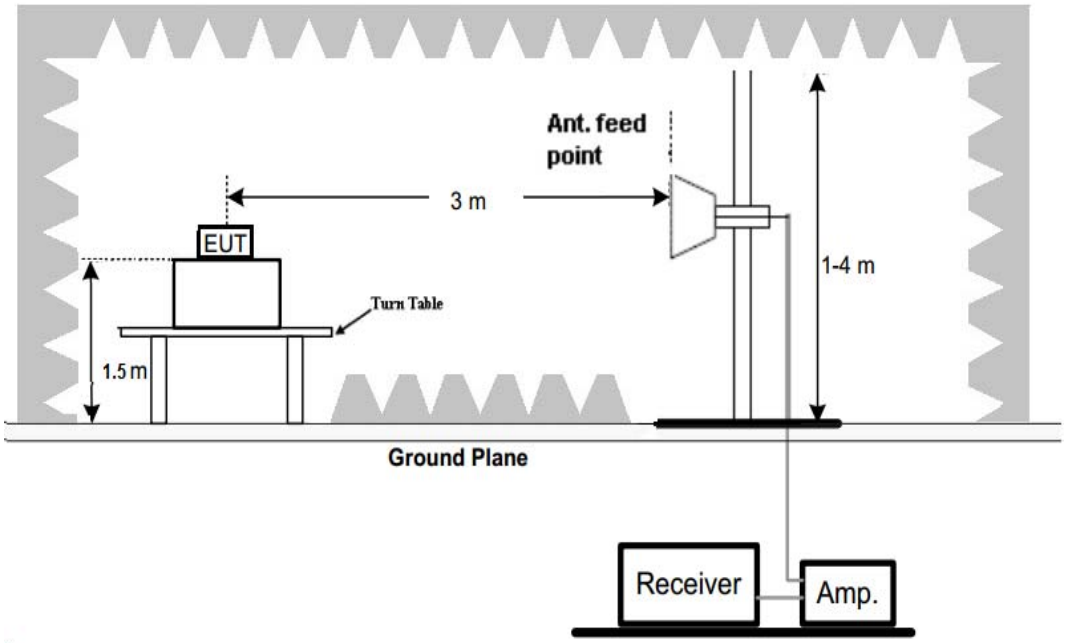
1) 9 kHz to 30 MHz emissions:



2) 30 MHz to 1 GHz emissions:



3) 1 GHz to 25 GHz emissions:



Test Procedure

1) Below 1G: The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2) Above 1G: The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

Note: For the radiated emission test above 1GHz:Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

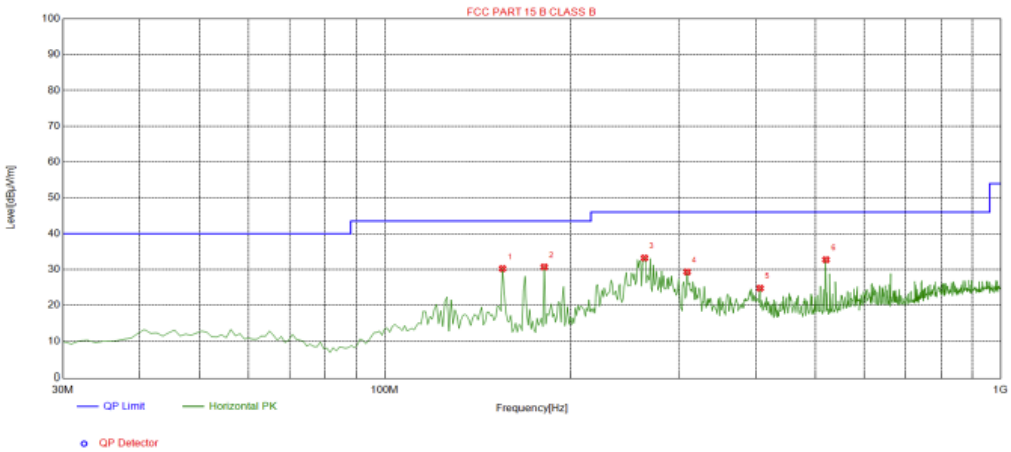
Test the EUT in the lowest channel,the middle channel,the Highest channel
The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.Repeat above procedures until all frequencies measured was complete.

Test Result

Remark:
1. Radiated Emission measured at GFSK low/mid/high channel from 9 KHz to 10th harmonic of fundamental and recorded worst case at low channel.
2. Radiated emission test from 9KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor (more than 20dB below the limit) in 9KHz to 30MHz and not recorded in this report.
3. For below 1GHz testing recorded worst at Low channel.

Below 1GHz Test Results:

Antenna polarity: H



Suspected List

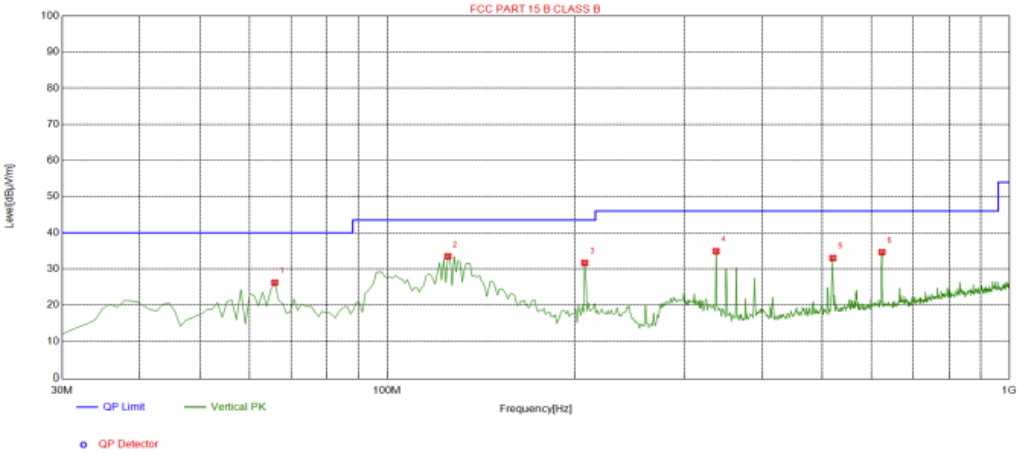
Suspected List									
NO.	Freq. [MHz]	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	155.2553	-18.56	48.82	30.26	43.50	13.24	100	345	Horizontal
2	181.4715	-16.73	47.44	30.71	43.50	12.79	100	348	Horizontal
3	264.0040	-13.58	46.81	33.23	46.00	12.77	100	348	Horizontal
4	309.6396	-12.61	41.92	29.31	46.00	16.69	100	164	Horizontal
5	406.7367	-10.28	35.06	24.78	46.00	21.22	100	186	Horizontal
6	520.3403	-7.72	40.45	32.73	46.00	13.27	100	345	Horizontal

Remark: Margin = Limit – Level

Correction Factor= Antenna Factor + Cable loss – Pre-amplifier

Level=Test receiver reading + correction factor

Antenna polarity: V



Suspected List

Suspected List									
NO.	Freq. [MHz]	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	65.9259	-16.65	42.84	26.19	40.00	13.81	100	120	Vertical
2	125.1552	-17.86	51.35	33.49	43.50	10.01	100	358	Vertical
3	207.6877	-14.86	46.52	31.66	43.50	11.84	100	47	Vertical
4	337.7978	-11.63	46.53	34.90	46.00	11.10	100	248	Vertical
5	520.3403	-7.72	40.73	33.01	46.00	12.99	100	235	Vertical
6	624.2342	-5.50	40.15	34.65	46.00	11.35	100	146	Vertical

Remark: Margin = Limit – Level
Correction Factor= Antenna Factor + Cable loss – Pre-amplifier
Level=Test receiver reading + correction factor

Remark：

(1) Measuring frequencies from 9 KHz to the 1 GHz, Radiated emission test from 9KHz to 30MHz was verified, and no any emission was found except system noise floor(emission in 9kHz to 30MHz is more than 20dB below the limit), so not recorded in the report.
(2) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.
(3) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz.

For 1GHz to 25GHz

CH Low (2402MHz)
Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.00	58.21	-3.65	54.56	74.00	-19.44	Peak
4804.00	45.45	-3.65	41.80	54.00	-12.20	AVG
7206.00	56.19	-0.95	55.24	74.00	-18.76	Peak
7206.00	44.27	-0.95	43.32	54.00	-10.68	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.00	57.89	-3.65	54.24	74.00	-19.76	Peak
4804.00	45.12	-3.65	41.47	54.00	-12.53	AVG
7206.00	55.94	-0.95	54.99	74.00	-19.01	Peak
7206.00	43.92	-0.95	42.97	54.00	-11.03	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

CH Middle (2440MHz)

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4880.00	58.34	-3.54	54.80	74.00	-19.20	Peak
4880.00	45.61	-3.54	42.07	54.00	-11.93	AVG
7320.00	56.24	-0.81	55.43	74.00	-18.57	Peak
7320.00	44.76	-0.81	43.95	54.00	-10.05	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4880.00	57.88	-3.54	54.34	74.00	-19.66	Peak
4880.00	45.23	-3.54	41.69	54.00	-12.31	AVG
7320.00	55.89	-0.81	55.08	74.00	-18.92	Peak
7320.00	43.85	-0.81	43.04	54.00	-10.96	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

CH High (2480MHz)

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.00	58.51	-3.43	55.08	74.00	-18.92	Peak
4960.00	45.72	-3.43	42.29	54.00	-11.71	AVG
7440.00	56.33	-0.77	55.56	74.00	-18.44	Peak
7440.00	44.80	-0.77	44.03	54.00	-9.97	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.00	57.92	-3.43	54.49	74.00	-19.51	Peak
4960.00	45.41	-3.43	41.98	54.00	-12.02	AVG
7440.00	55.91	-0.77	55.14	74.00	-18.86	Peak
7440.00	43.79	-0.77	43.02	54.00	-10.98	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Remark：
(1) Measuring frequencies from 1 GHz to the 25 GHz。
(2) “F” denotes fundamental frequency; “H” denotes spurious frequency. “E” denotes band edge frequency.
(3) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.
(4) Data of measurement within this frequency range shown “--- ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
(5) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for peak measurement with peak detector at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 10Hz for Average measurement with peak detection at frequency above 1GHz.
(6) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed. For example: Top Channel at Fundamental 73.16dBuV/m(PK Value) <93.98(AV Limit), at harmonic 53.20 dBuV/m(PK Value) <54 dBuV/m(AV Limit), the Average Detected not need to completed.
(7)All modes of operation were investigated and the worst-case emissions are reported.

Radiated Band Edge Test:

Operation Mode: TX CH Low (2402MHz)

Horizontal (Worst case):

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2310	59.22	-5.81	53.41	74.00	-20.59	Peak
2310	46.24	-5.81	40.43	54.00	-13.57	AVG
2390	60.15	-5.84	54.31	74.00	-19.69	Peak
2390	47.02	-5.84	41.18	54.00	-12.82	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2310	60.46	-5.81	54.65	74.00	-19.35	Peak
2310	47.29	-5.81	41.48	54.00	-12.52	AVG
2390	60.14	-5.84	54.30	74.00	-19.70	Peak
2390	46.94	-5.84	41.10	54.00	-12.90	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Operation Mode: TX CH High (2480MHz)

Horizontal (Worst case)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2483.5	59.73	-6.04	53.69	74.00	-20.31	Peak
2483.5	47.38	-6.04	41.34	54.00	-12.66	AVG
2500	60.44	-6.06	54.38	74.00	-19.62	Peak
2500	47.22	-6.06	41.16	54.00	-12.84	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
2483.5	60.37	-6.04	54.33	74.00	-19.67	Peak
2483.5	47.29	-6.04	41.25	54.00	-12.75	AVG
2500	61.34	-6.06	55.28	74.00	-18.72	Peak
2500	47.55	-6.06	41.49	54.00	-12.51	AVG
Remark :Factor= Antenna Factor + Cable Loss - Pre-amplifier						

3.4 Maximum Output Power Measurement

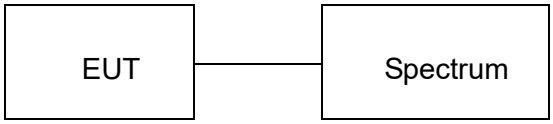
Limit

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

Test procedure

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

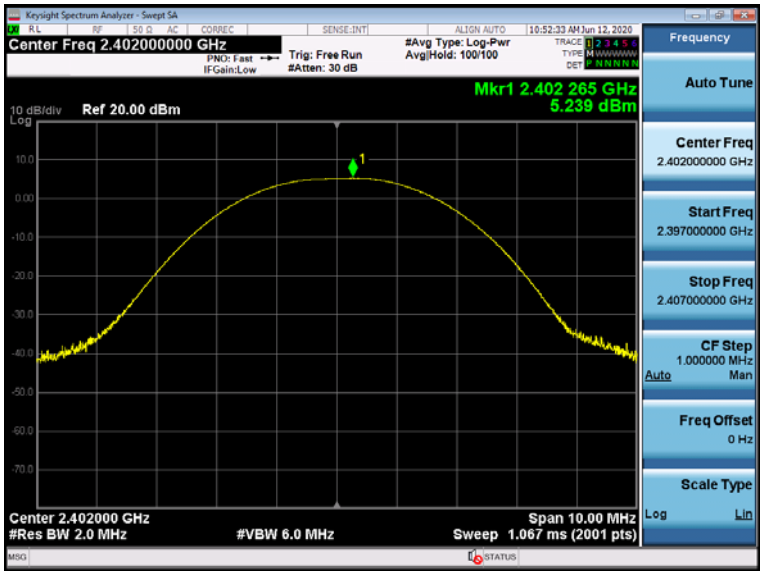
Test setup



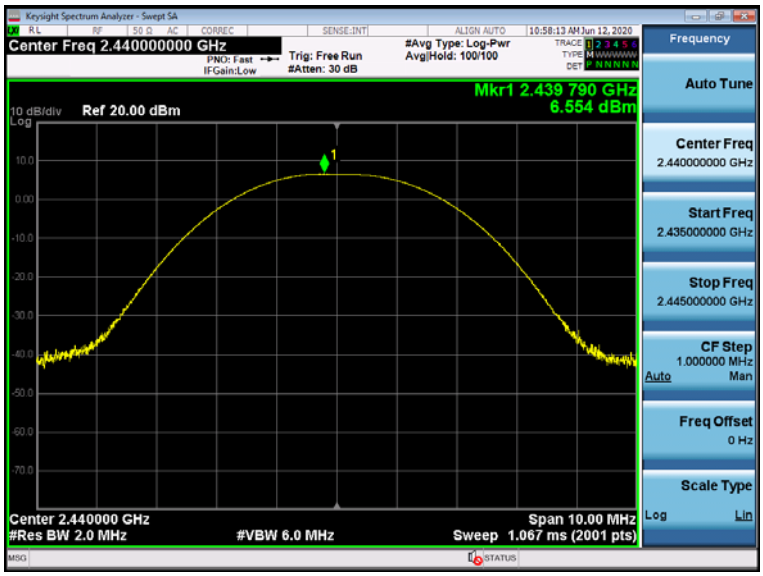
Test results

Channel	Channel frequency (MHz)	Output power (dBm)	Limit (dBm)	Result
Low	2402	5.239	30	Pass
Middle	2440	6.554		Pass
High	2480	6.938		Pass

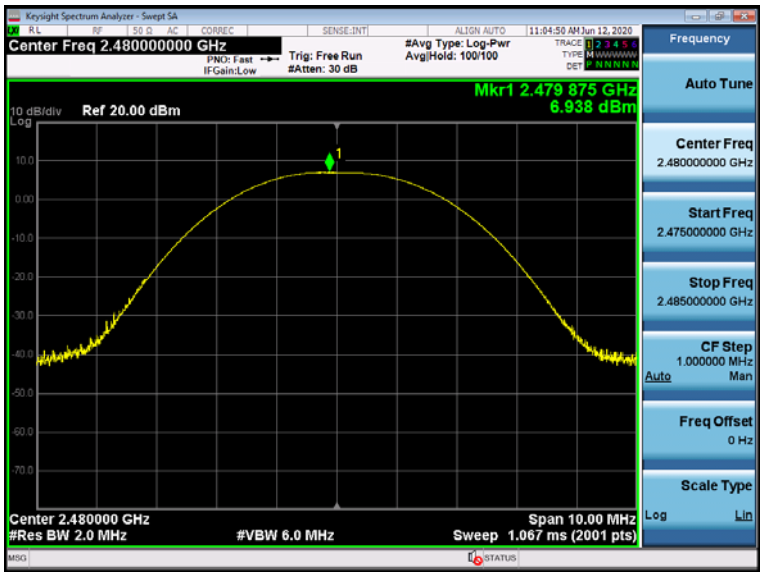
Low



Middle



High



3.5 Power Spectral Density

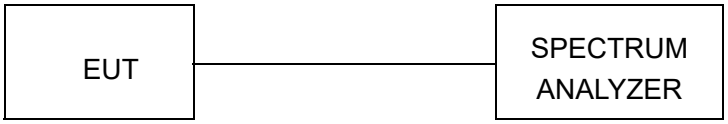
Limit

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

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

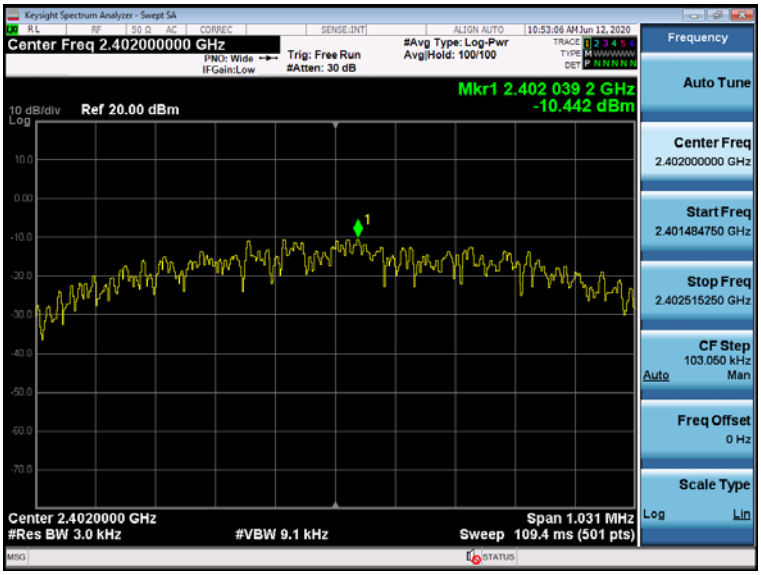
Test setup



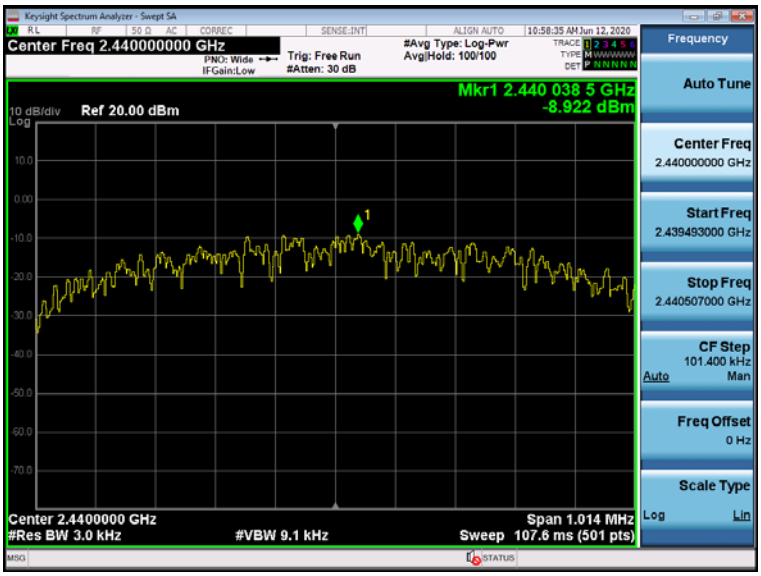
Test results

Channel	Channel frequency (MHz)	Power Spectral Density (dBm/3KHz)	Limit (dBm/3KHz)	Result
Low	2402	-10.442	8	Pass
Middle	2440	-8.922		Pass
High	2480	-8.407		Pass

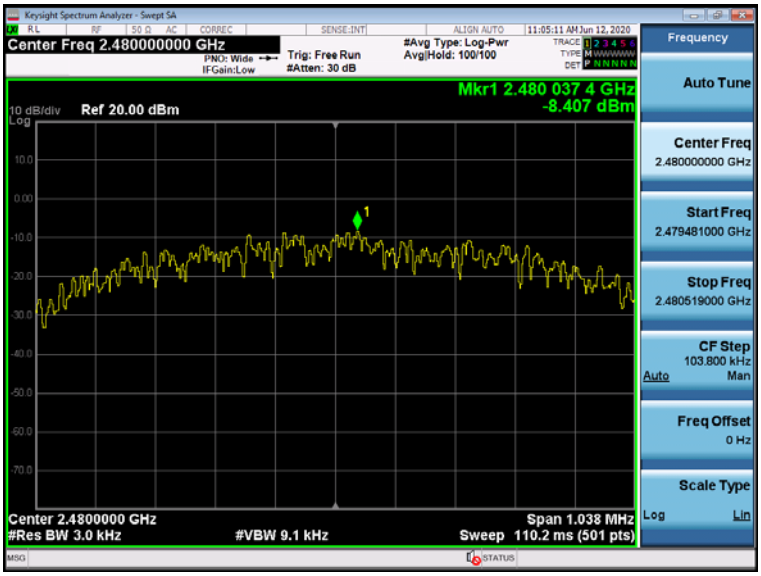
CH 00



CH 19



CH 39



3.6 6dB Bandwidth

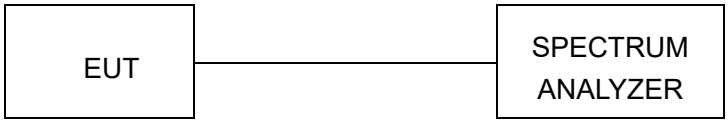
Limit

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 RBW=100 KHz and VBW=300KHz.
The 6dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6dB.
1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

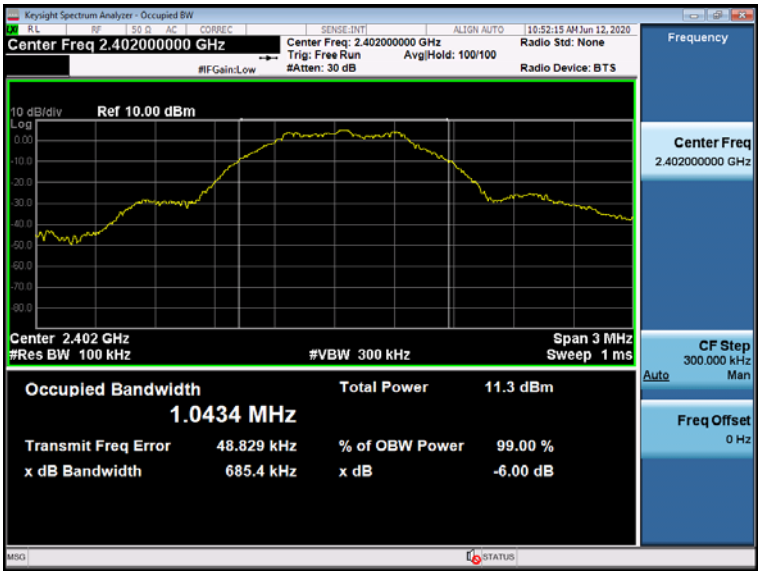
Test setup



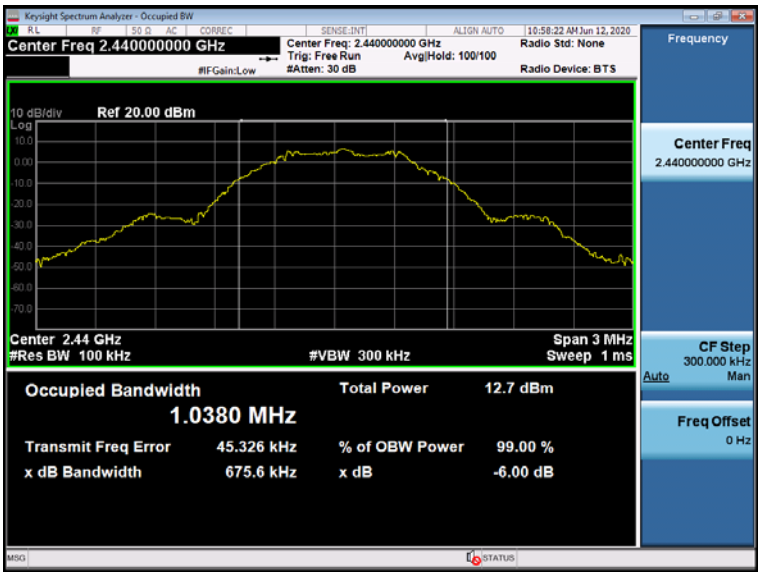
Test result

Channel	Channel frequency (MHz)	6dB Bandwidth (MHz)	Limit (KHz)	Result
Low	2402	0.685	≥500	Pass
Middle	2440	0.676		Pass
High	2480	0.692		Pass

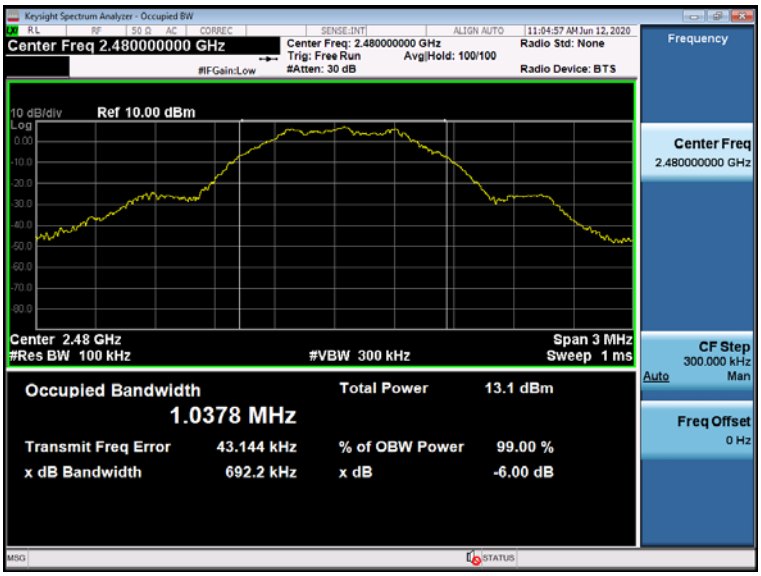
CH 00



CH 19



CH 39

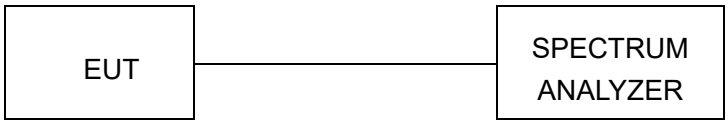


3.7 Occupied Bandwidth

Test procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:
RBW=1% to 5% of the OBW
VBW=approximately 3 X RBW
Detector=Peak
Trace Mode: Max Hold
Use the 99% power bandwidth function of the instrument to measure the Occupied Bandwidth and recorded.

Test setup



Test result

N/A

3.8 Band edge

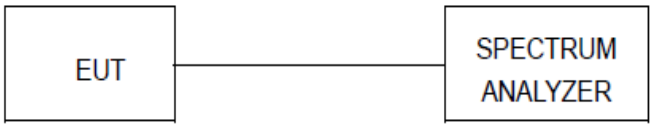
Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section (b)(3) of RSS 5.4(4), the attenuation required shall be 30 dB instead of 20 dB.

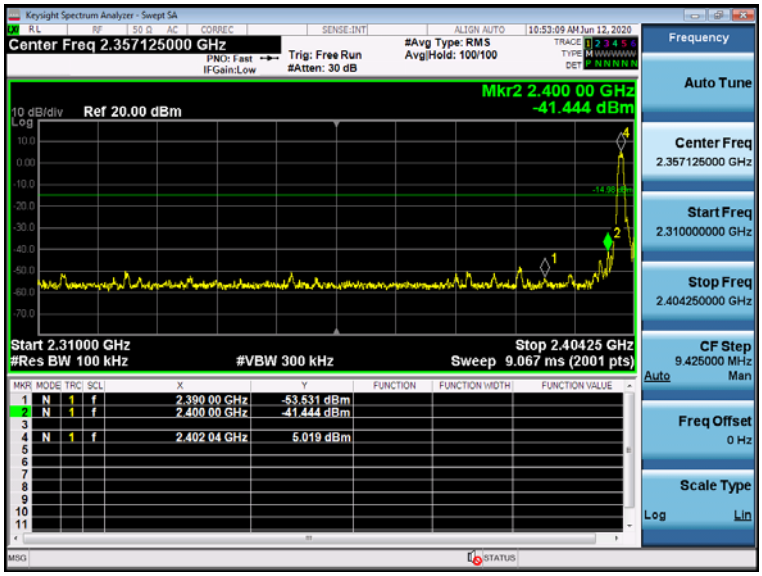
Test procedure

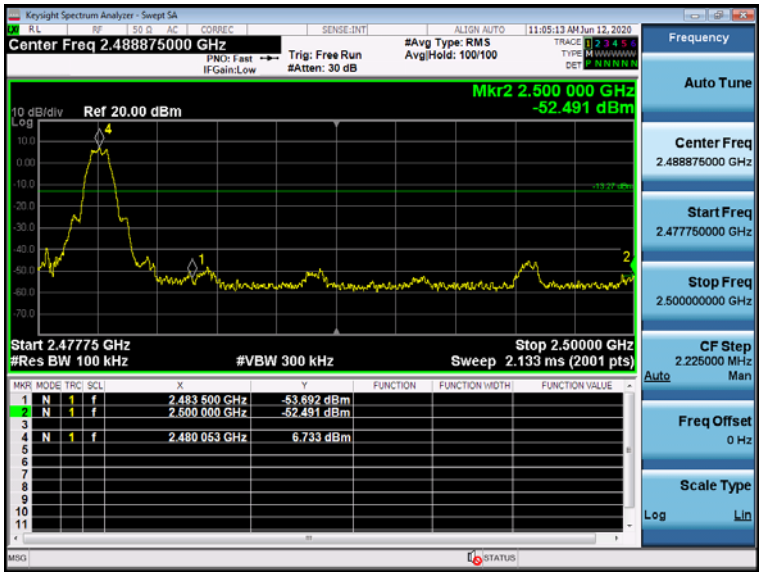
The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation,
RBW ≥ 1% of the span,
VBW ≥ RBW, Sweep = auto,
Detector function = peak,
Trace = max hold

Test setup



Test Results





3.9 Conducted Spurious Emissions

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section (b)(3) of RSS 5.4(4), the attenuation required shall be 30 dB instead of 20 dB.

For below 30MHz,For 9KHz-150kHz,150K-10MHz,We use the RBW 1KHz,10KHz, So the limit need to calculated by “10lg(BW1/BW2)“. for example For9KHz-150kHz,RBW 1KHz, The Limit= the highest emission level-20-10log(100/1)= the highest emission level-40.

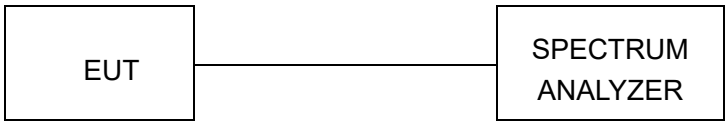
Test procedure

a.The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.

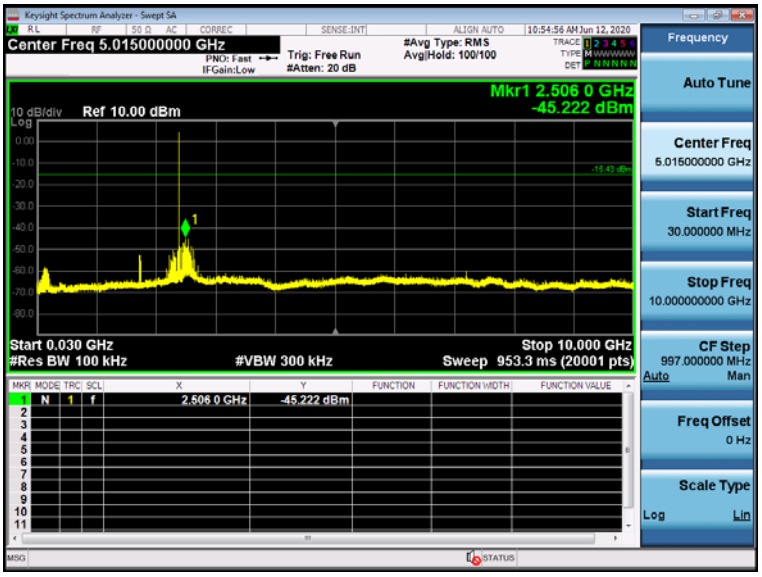
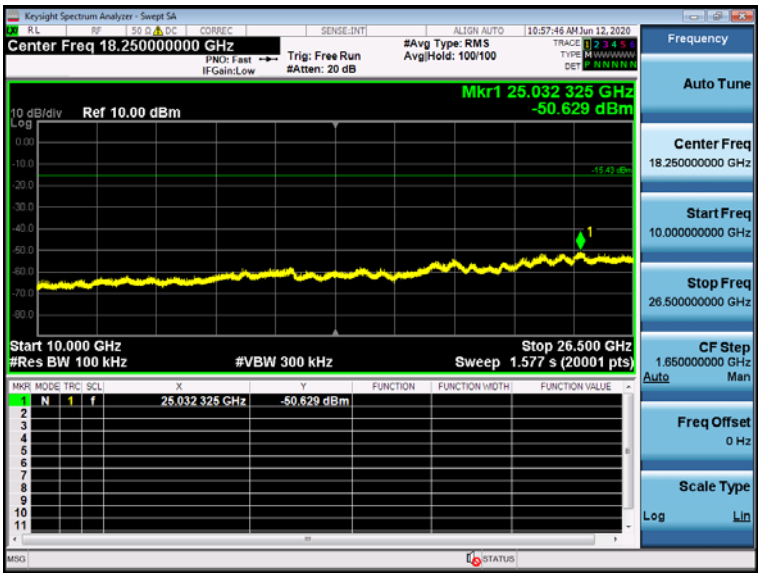
b.Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation, RBW ≥ 1% of the span, VBW ≥ RBW, Sweep = auto,

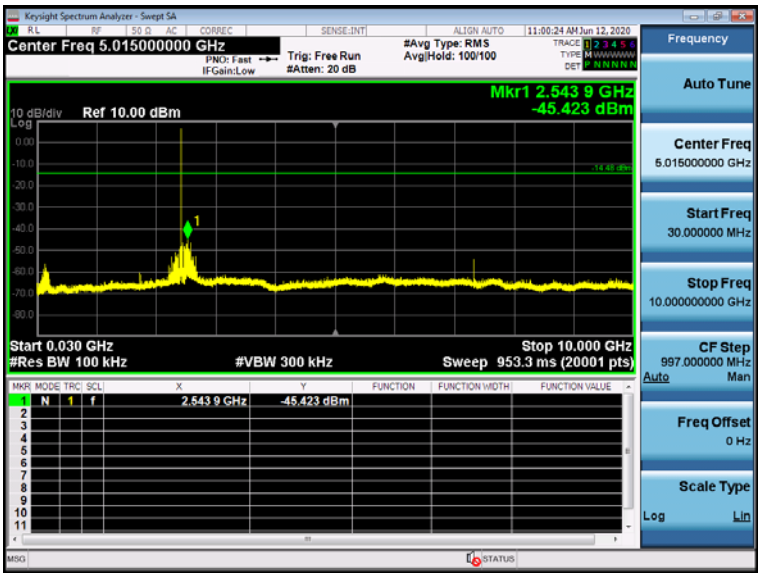
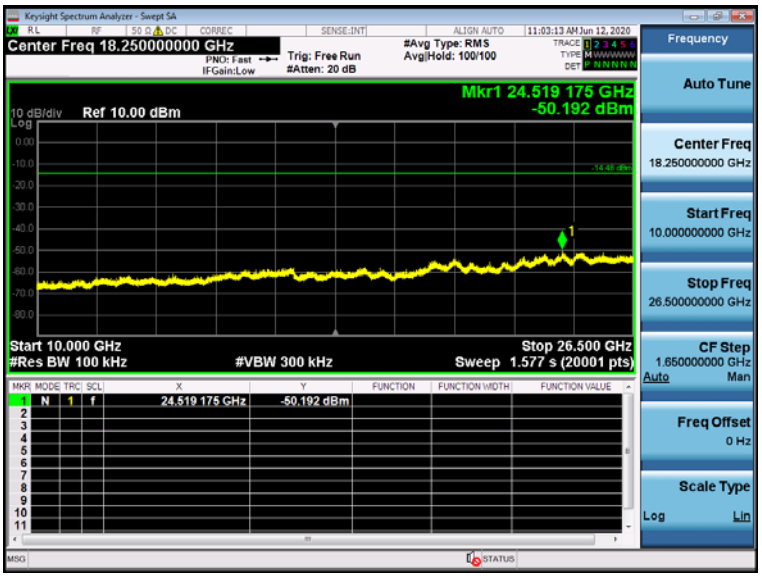
Detector function = peak, Trace = max hold

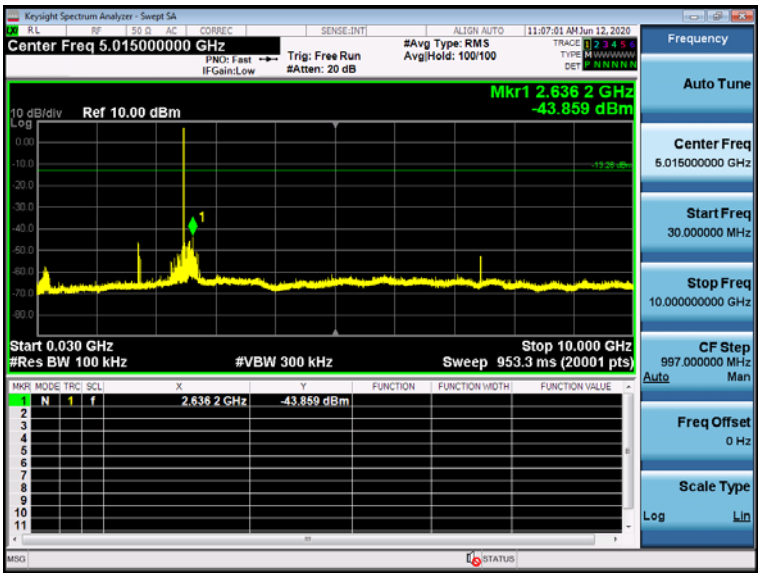
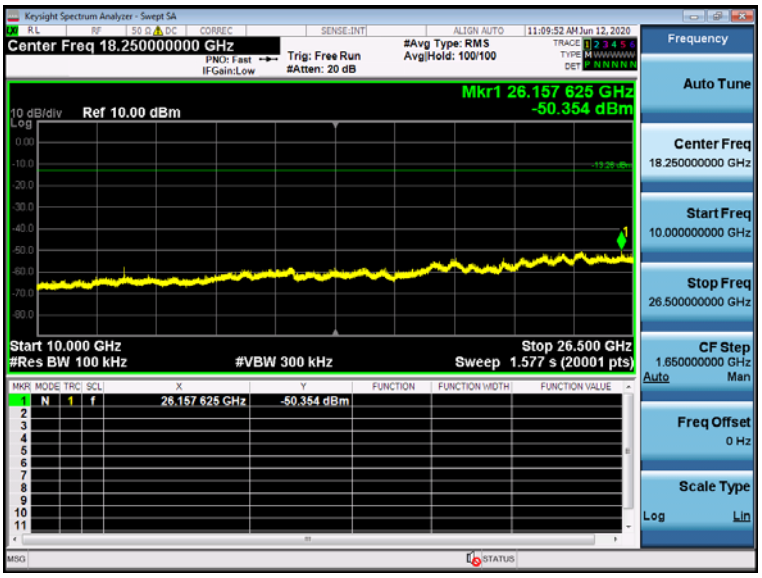
Test setup



Test results

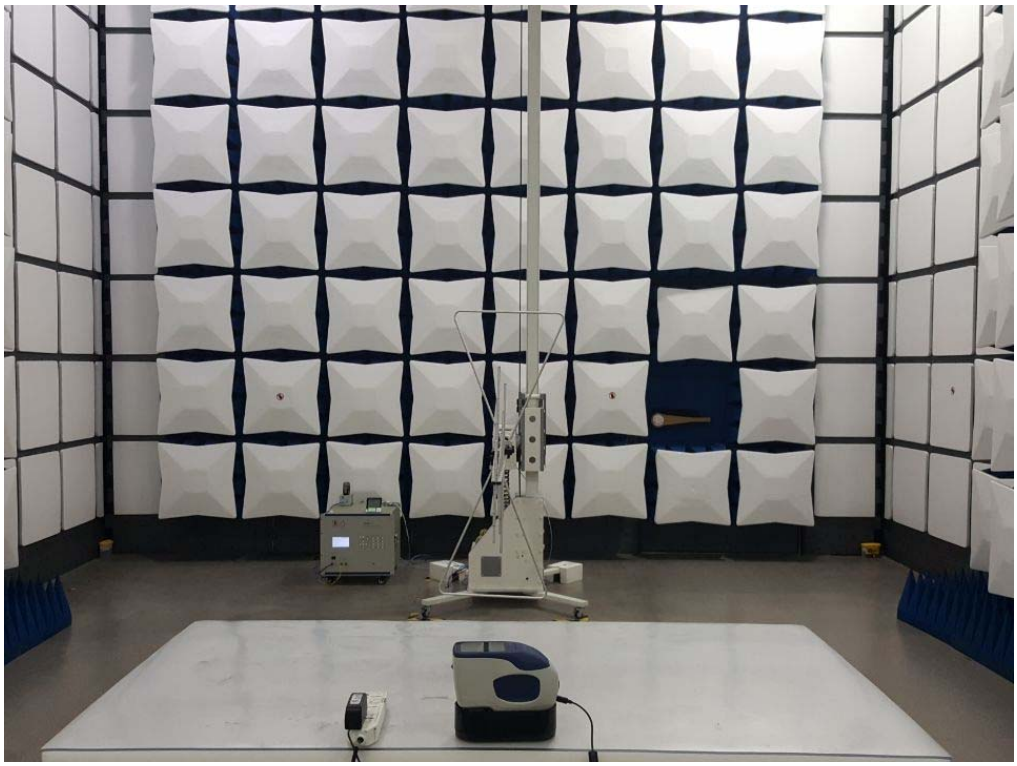
	Reference
	30MHz-10GHz
CH00	
	10GHz-26.5GHz
	

	Reference
	30MHz-10GHz
CH19	
	10GHz-26.5GHz
	

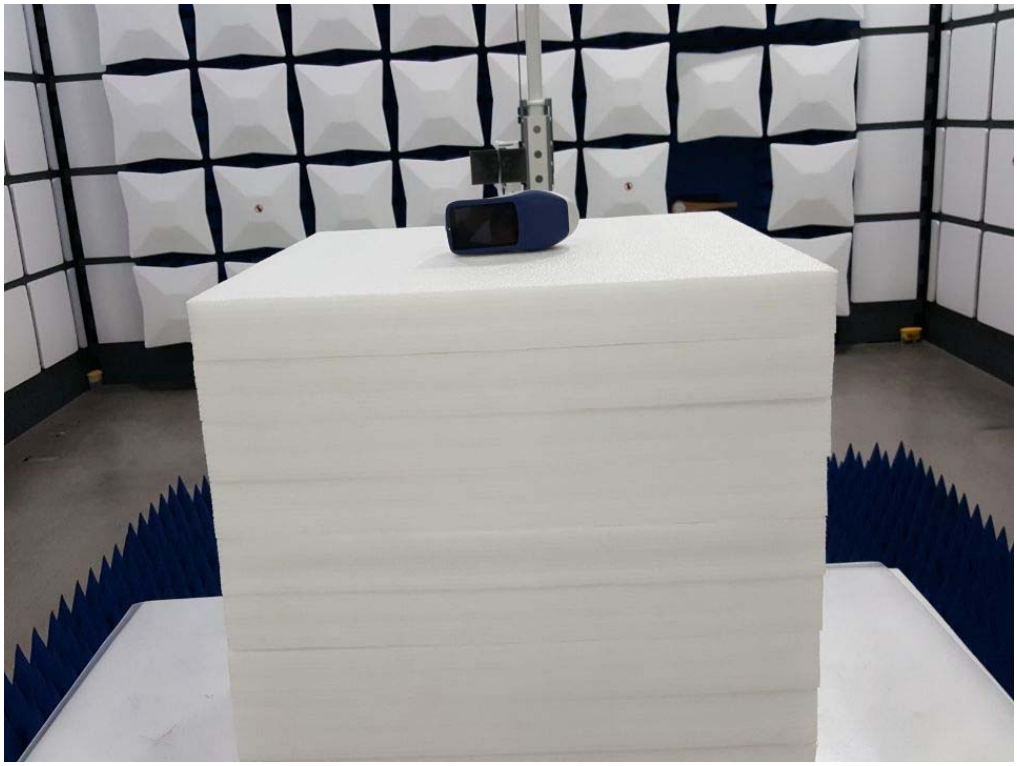
	Reference
	30MHz-10GHz
CH39	
	10GHz-26.5GHz
	

4 Test Setup Photos of the EUT

Radiated Emissions: 30MHz-1000MHz



Radiated Emissions: Above 1000MHz

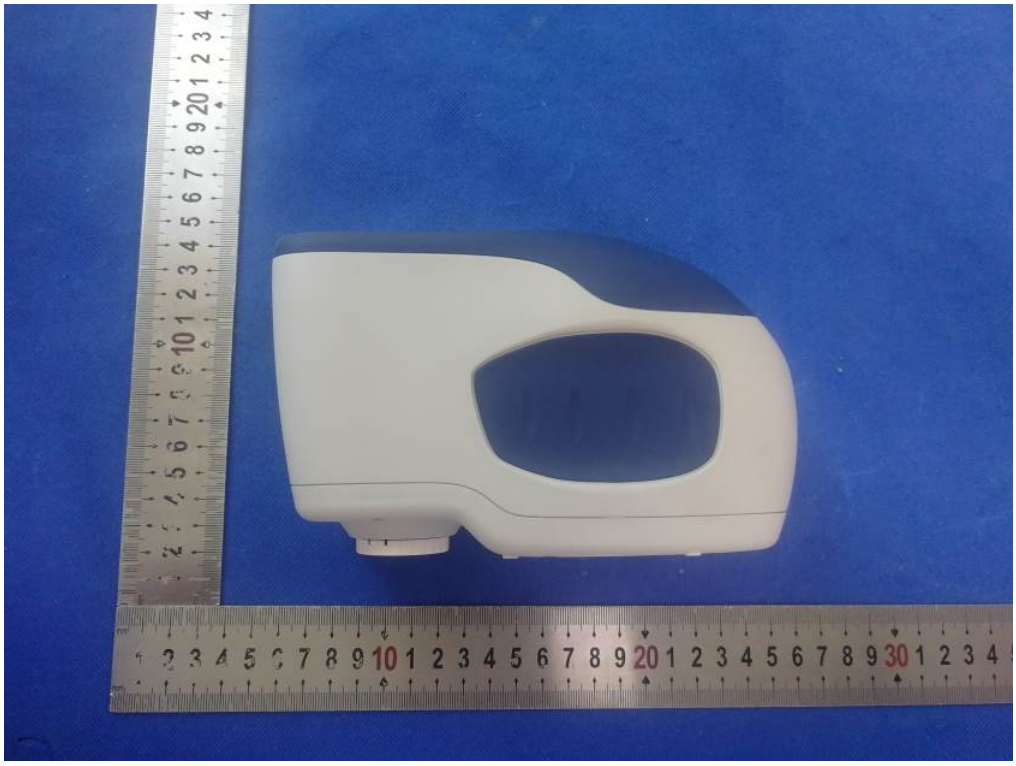


Conducted Emission

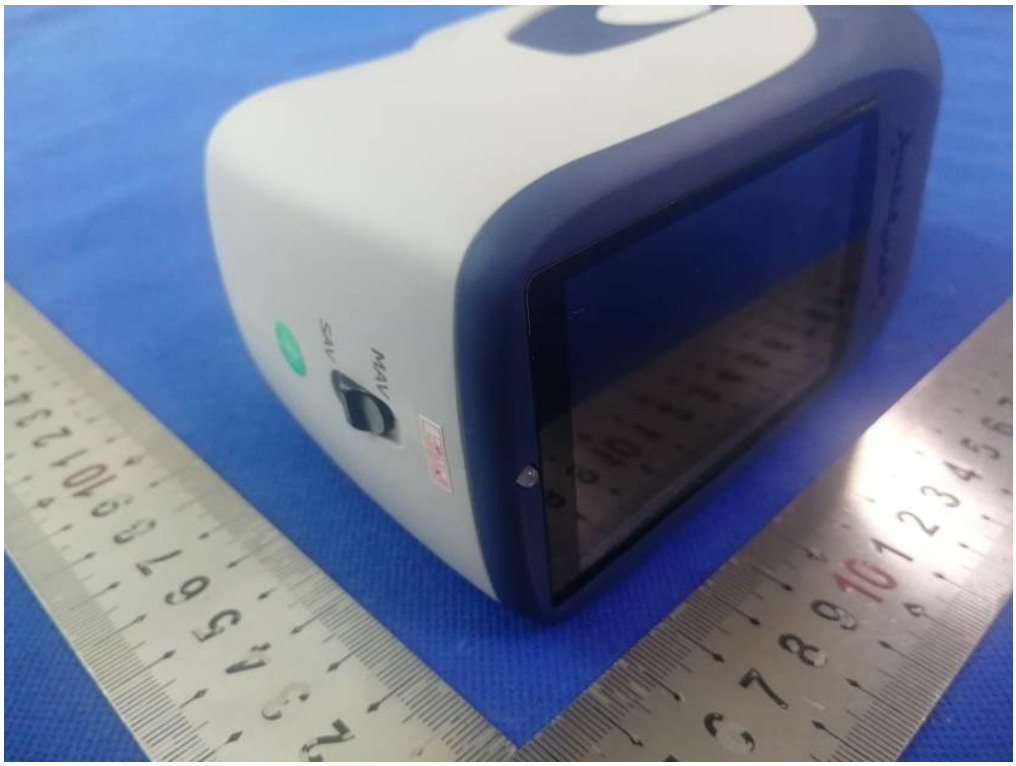
5 PHOTOS OF THE EUT

External Photos of EUT

SPECTROPHOTOMETER
TR520
AC ADAPTER:5V 2A
BATTERY: Li-ion 3.7V 3200mAh

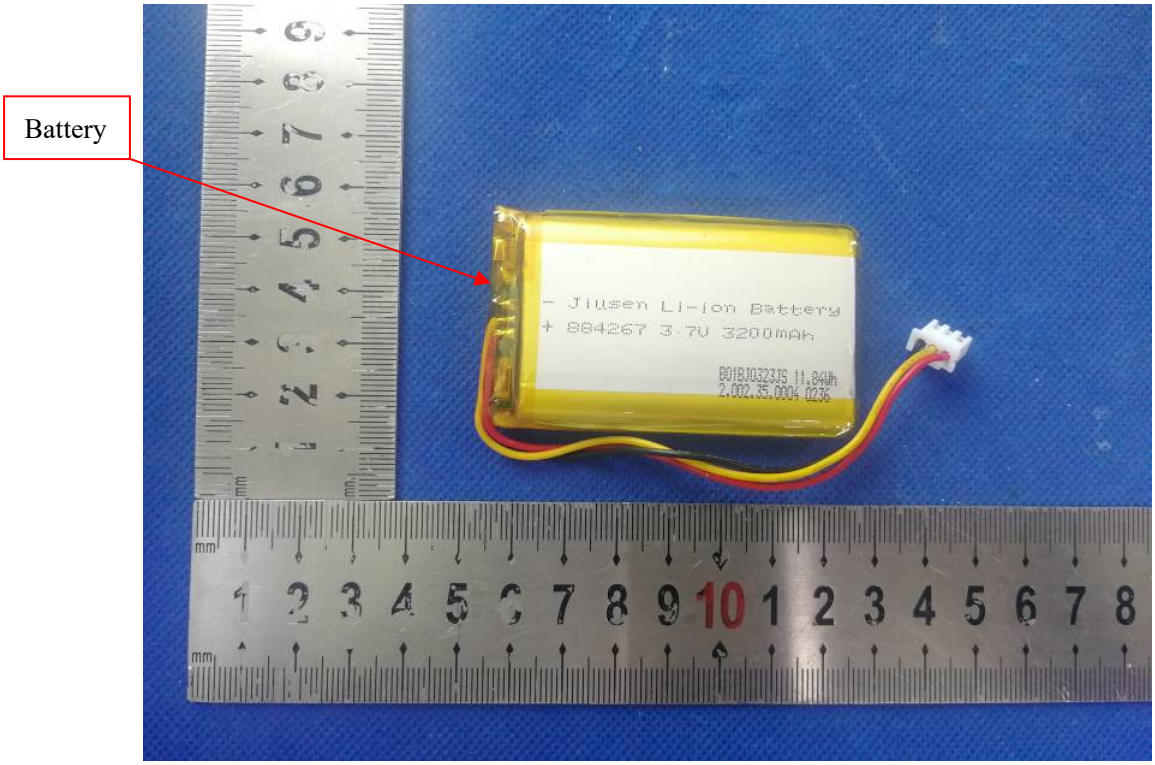


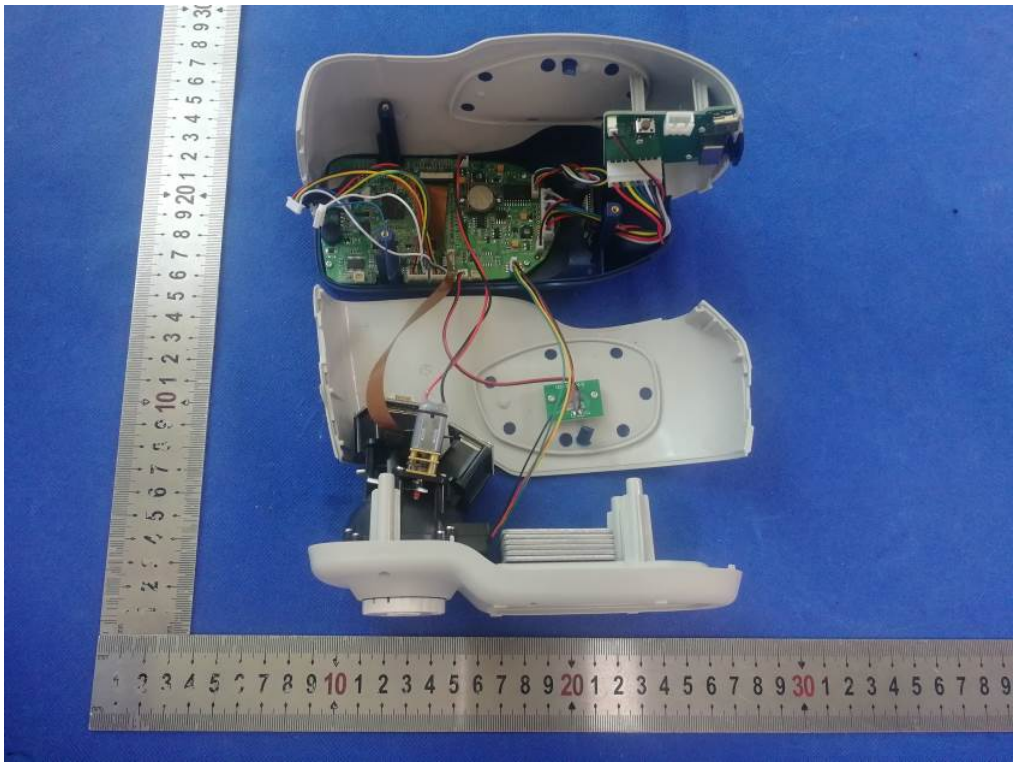
MAV
SAV

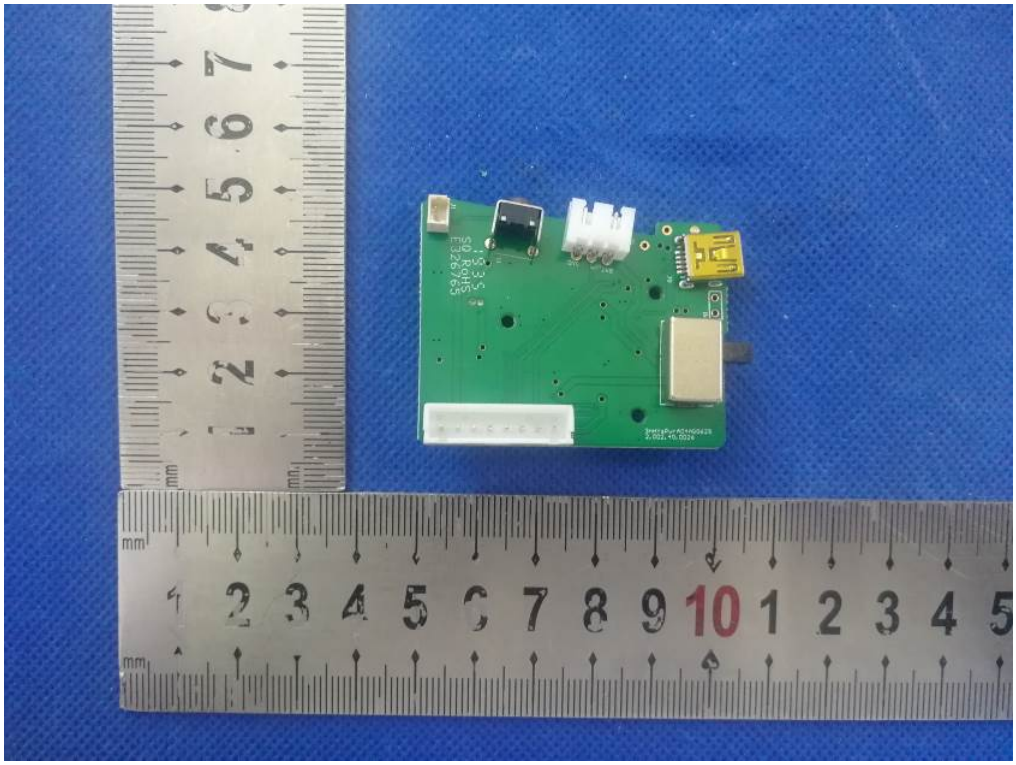


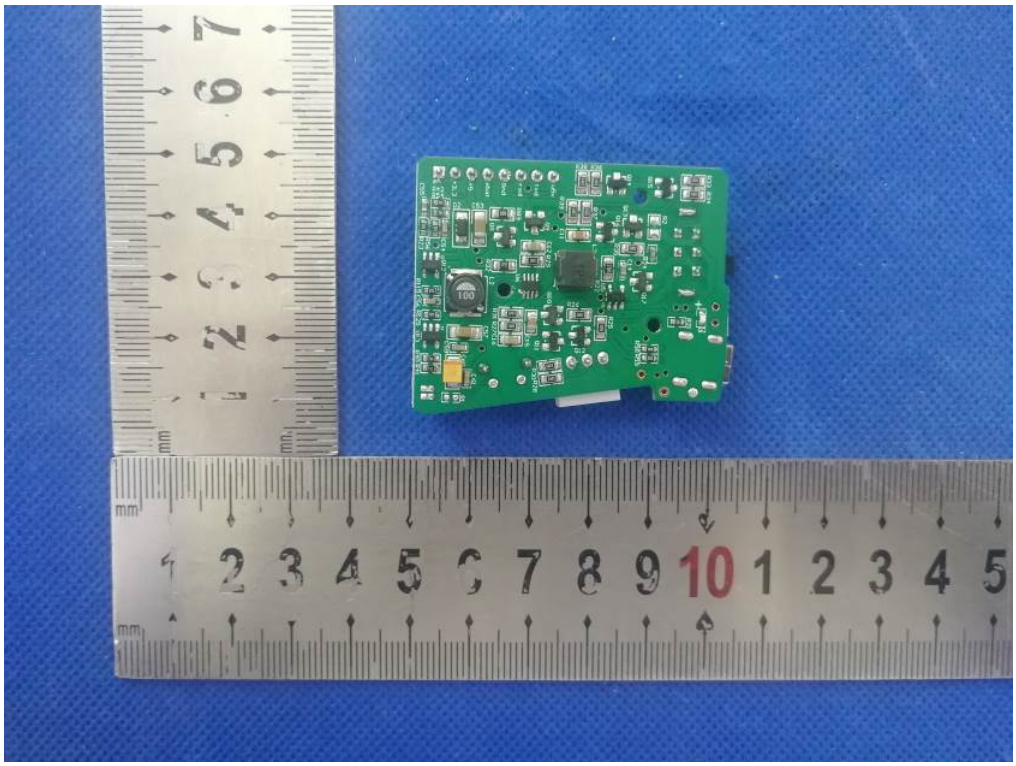
DVE® Switching Adapter
MODEL: DSA-12PFU-05 FUS 050200
INPUT: 100-240V ~ 50/60Hz 0.5A
OUTPUT: +5V ⎓ 2A
EFFICIENCY LEVEL: VI
I.T.E L.P.S
81GJ
E135856
PIN1"+"
PIN5"-"
LISTED
Made In China

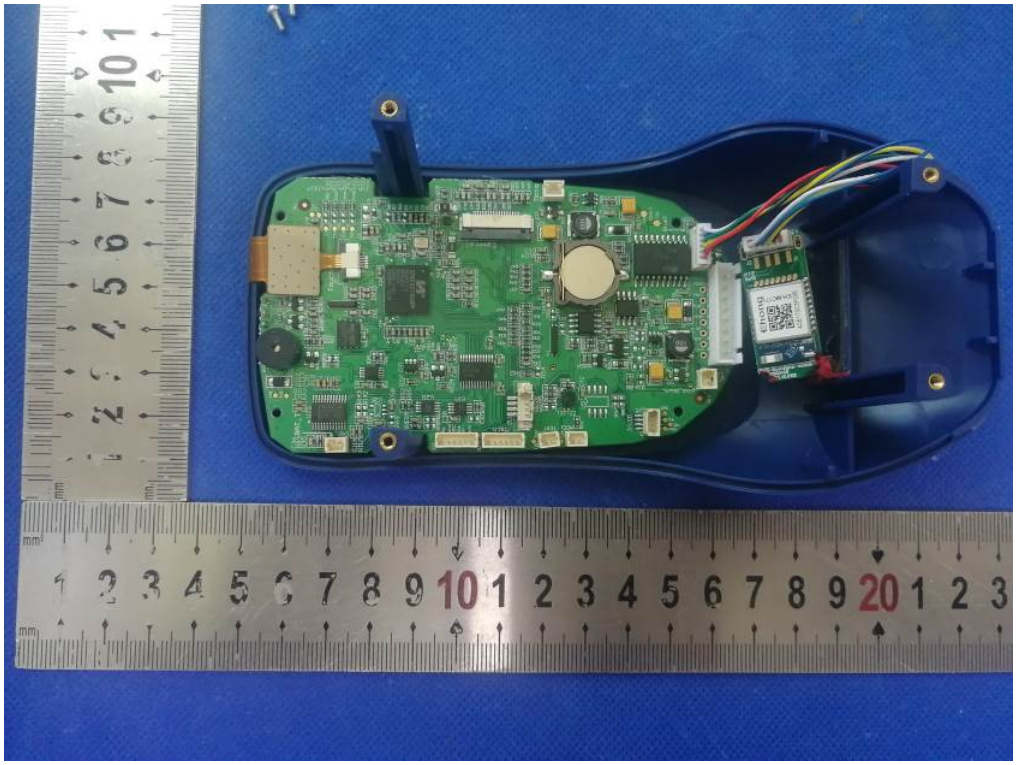
Internal Photos of EUT

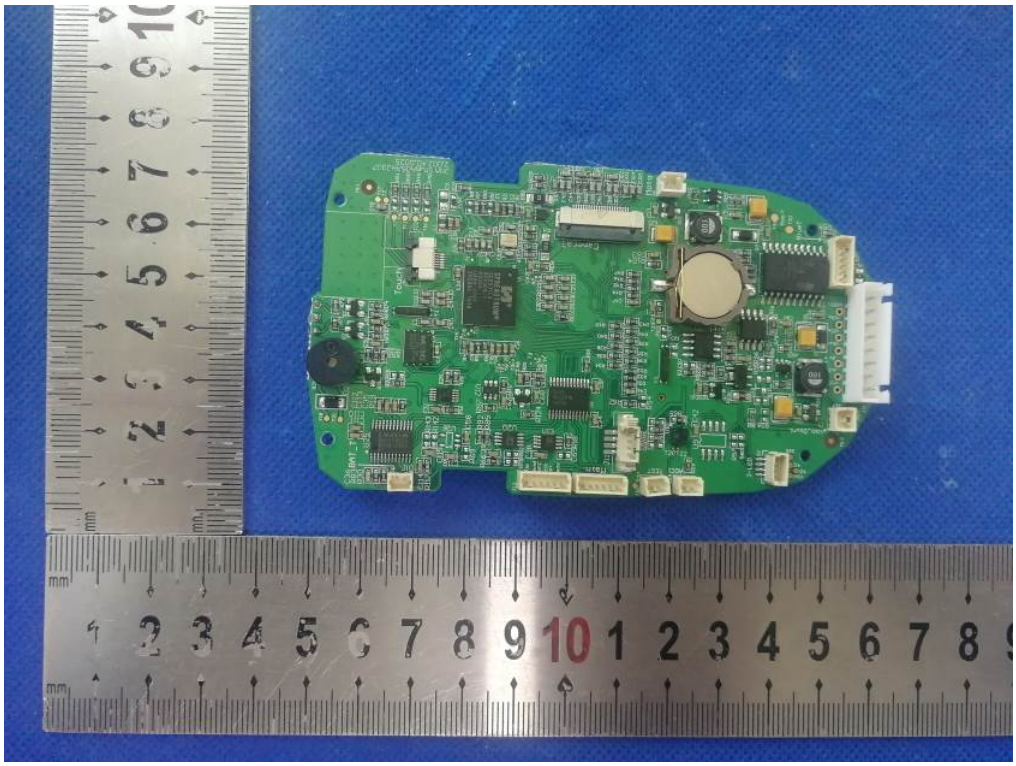


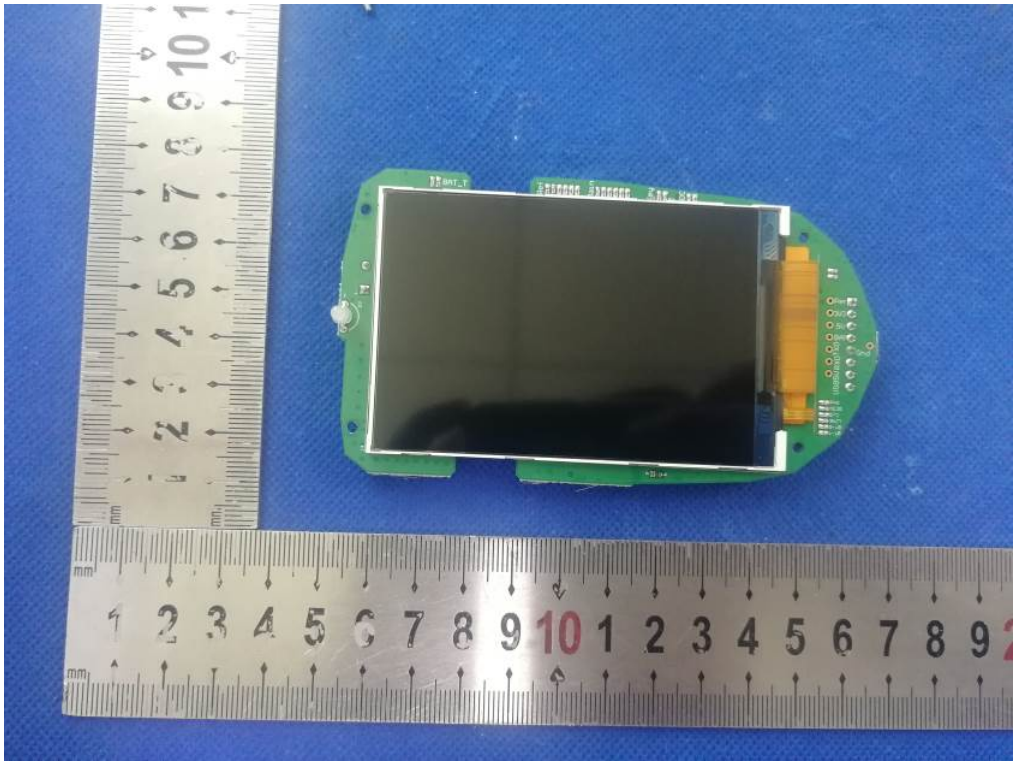


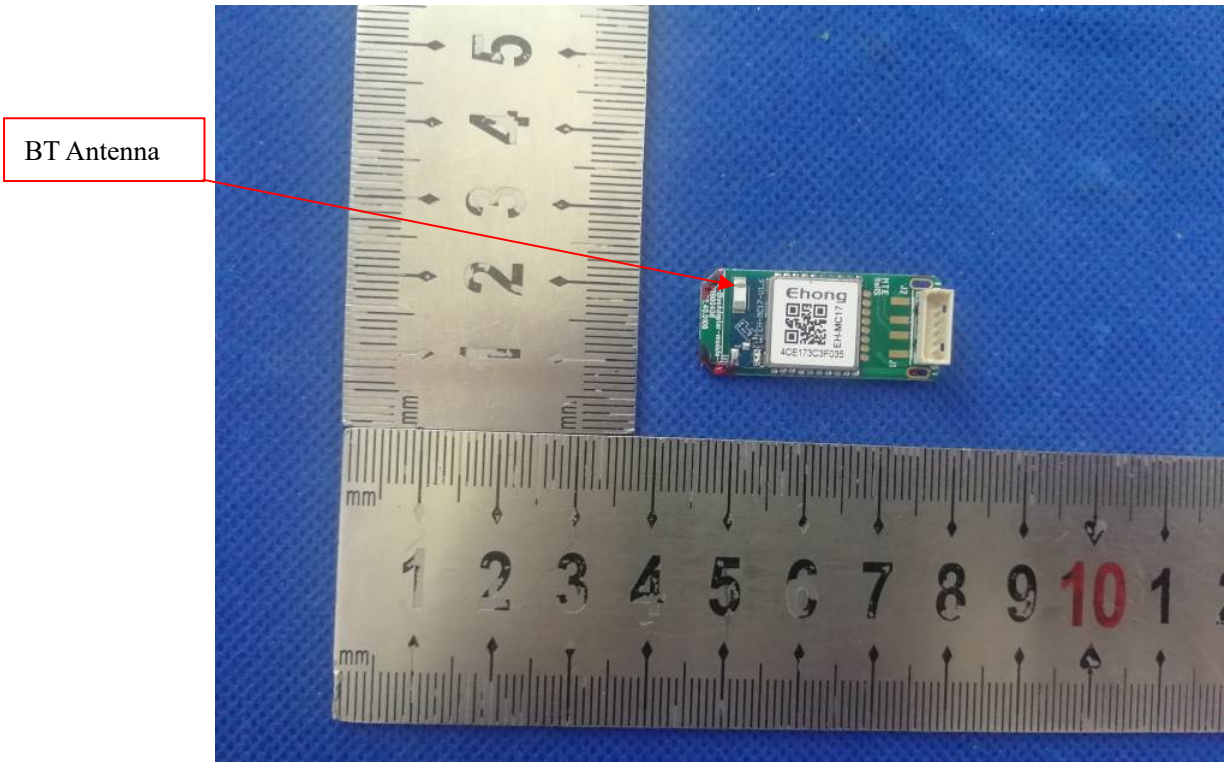








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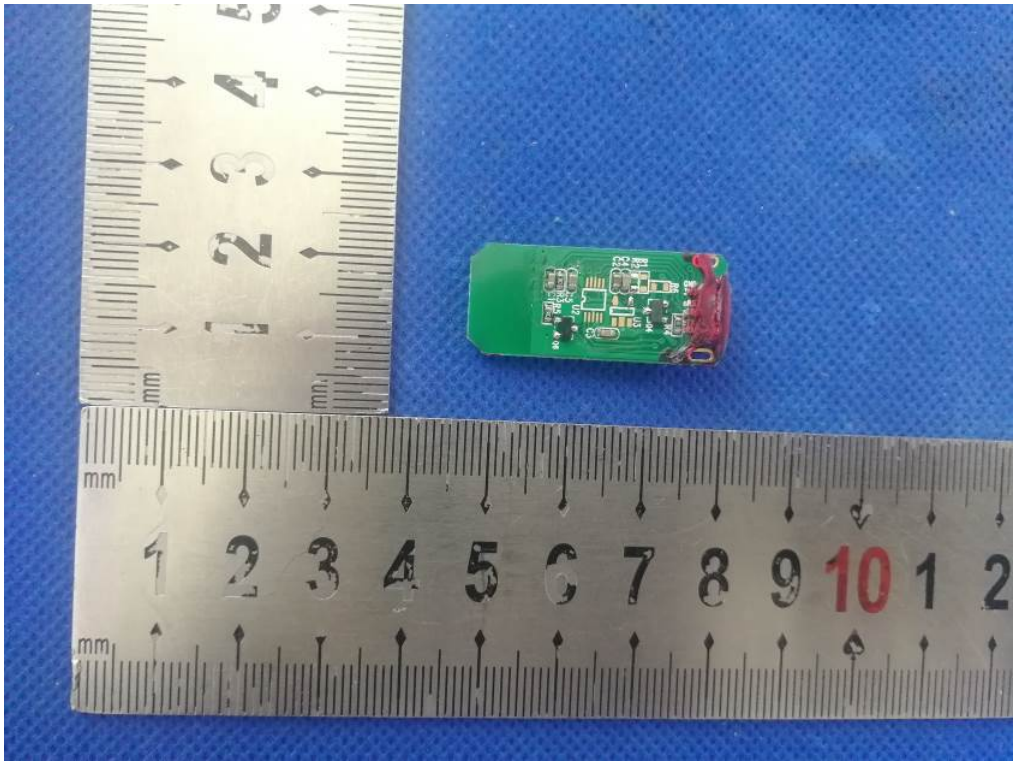

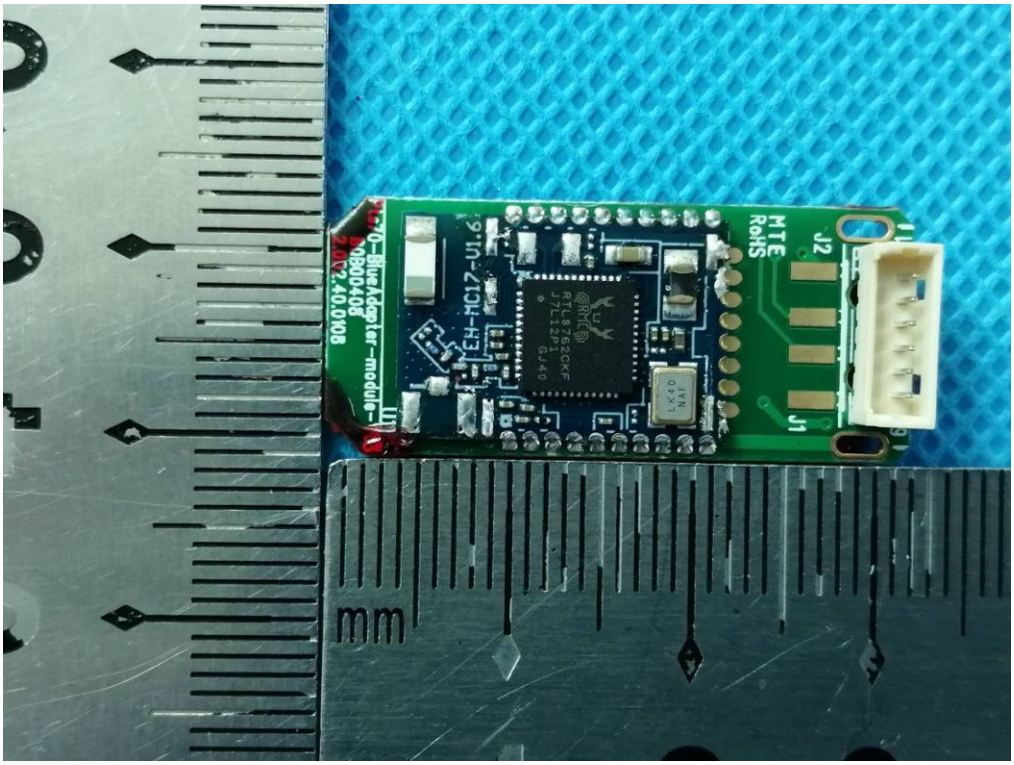

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