Test Report

Report No.:	MTi211215005-06E2
Date of issue:	Apr. 22, 2022
Applicant:	RYDER ELECTRONICS(SHENZHEN)LTD
Product name:	Bluetooth 5.0 module
Model(s):	BTM-2801, BTM2853
IC:	20439-BTM2801

Shenzhen Microtest Co., Ltd.
http://www.mtitest.com

Address: 101, No. 7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao' an District, Shenzhen, Guangdong, China.
Tel: (86-755)88850135 Fax: (86-755) 88850136 Web:www.mtitest.com E-mail: mti@51mti.com

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TEST RESULT CERTIFICATION	
Applicant's name.....:	RYDER ELECTRONICS(SHENZHEN)LTD
Address.....:	139 Da Bao Road, District 33, Bao'an, ShenZhen, China
Manufacturer's Name.....:	RYDER ELECTRONICS(SHENZHEN)LTD
Address.....:	139 Da Bao Road, District 33, Bao'an, ShenZhen, China
Factory's Name.....:	Ryder Electronics(Xinfeng)Ltd.
Address.....:	Xinfeng Industrial Park, Xinfeng Town, 341600, GanZhou City, Jiangxi Province China
Product description	
Product name.....:	Bluetooth 5.0 module
Trademark .....:	N/A
Model Name .....:	BTM-2801
Serial Model.....	BTM2853
Standards.....:	RSS-247 Issue 2 Feb 2017 RSS-Gen Issue 5, Amendment 2, February, 2021
Test procedure .....:	ANSI C63.10-2013
Date of Test	
Date (s) of performance of tests .....:	2022-01-04 ~ 2022-04-21
Test Result.....:	Pass
This device described above has been tested by Shenzhen Microtest Co., Ltd. and the test results show that the equipment under test (EUT) is in compliance with the IC requirements. And it is applicable only to the tested sample identified in the report.	

Testing Engineer : Yanice Xie

(Yanice Xie)

Technical Manager : Leon Chen

(Leon Chen)

Authorized Signatory : Tom Xue

(Tom Xue)

1 General information

1.1 Description of EUT

Product name:	Bluetooth 5.0 module
Model name:	BTM-2801
Series model:	BTM2853
Difference in series models:	All the models are the same circuit and RF module, except the model name.
Operation Frequency:	2402-2480MHz
Modulation type:	GFSK
Bit Rate of transmitter:	1 Mbps, 2Mbps
Antenna type:	PCB Antenna
Antenna gain:	0dBi
Max. output power:	6.447dBm
Bluetooth version:	V5.3
Hardware version:	1.0
Software version:	1.0
Power source:	Input: DC 5V 50mA
Adapter information:	N/A
Battery:	N/A
S/N:	MTi211215005-06S1001

1.2 Operation channel list

Channel List for BLE

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

1.3 Test channel list

Channel	Channel	Frequency (MHz)
Low	00	2402
Middle	19	2440
High	39	2480

1.4 EUT operation mode

During testing, RF test program provided by the manufacture to control the Tx operation followed the test requirement.

Test Software Version	Test Program: FCC_V2.24		
Frequency	2402MHz	2440MHz	2480MHz
Parameters	DEF	DEF	DEF

1.5 Ancillary equipment list

Equipment	Model	S/N	Manufacturer
XiaoXin	AIR 12	/	Lenovo

1.6 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.

Item	Equipment	Brand	Model/Type No.	Series No.	Note

Note:

(1) The support equipment was authorized by Declaration of Confirmation.

(2))FOR DETACHABLE TYPE I/O CABLE SHOULD BE SPECIFIED THE LENGTH IN CM IN 『Length』column.

2 Summary of test results

Test procedures according to the technical standards:

IC Standard Section	Description of Test	Judgment	Remark
RSS-Gen §8.8	AC power line conducted emission	PASS	
RSS-247 §5.4.b	Maximum peak output power	PASS	
RSS-247.5.4(4)	Equivalent Isotropically Radiated Power	PASS	
RSS-247 §5.2.a RSS-Gen § 6.7	6dB emission bandwidth & 99% occupied bandwidth	PASS	
RSS-247 §5.2.b	Power spectral density (PSD)	PASS	
RSS-247 §5.5	Band edge spurious emission, conducted spurious emission	PASS	
RSS-Gen §8.9 §8.10	Radiated emission	PASS	
RSS-247 5.4(4)	Duty Cycle	PASS	
RSS-Gen §6.8	Antenna Requirement	PASS	

3 Test Facilities and Accreditations

3.1 Test laboratory

Test Laboratory	Shenzhen Microtest Co., Ltd.
Location	101, No. 7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao' an District, Shenzhen, Guangdong, China.
FCC Registration No.	448573
IC Registration No:	21760
CAB identifier	CN0093

3.2 Environmental conditions

Temperature:	-10ºC~70ºC
Humidity	20%~75%
Atmospheric pressure	98kPa~101kPa

3.3 Measurement uncertainty

The reported uncertainty of measurement y ± U · where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2 · providing a level of confidence of approximately 95 %

RF frequency	1 x 10-7
RF power, conducted	± 1 dB
Conducted emission(150kHz~30MHz)	± 2.5 dB
Radiated emission (9 kHz ~ 30 MHz)	±4.0 dB
Radiated emission(30MHz~1GHz)	± 4.2 dB
Radiated emission (above 1GHz)	± 4.3 dB
Temperature	±1 degree
Humidity	± 5 %

3.4 Test software

Software Name	Manufacturer	Model	Version
Bluetooth and WiFi Test System	Shenzhen JS tonscend co., ltd	JS1120-3	2.5.77.0418

4 Equipment list for all test items

Equipment No.	Equipment Name	Manufacturer	Model	Serial No.	Calibration date	Due date
MTI-E043	EMI Test Receiver	Rohde&schwarz	ESCI7	101166	2021/06/02	2022/06/01
MTI-E044	TRILOG Broadband Antenna	schwarabeck	VULB 9163	9163-1338	2021/05/30	2023/05/29
MTI-E047	Amplifier	Hewlett-Packard	8447F	3113A06150	2021/06/02	2022/06/01
MTI-E089	ESG Vector Signal Generator	Agilent	N5182A	MY49060455	2021/06/02	2022/06/01
MTI-E058	ESG Series Analog Ssignal Generator	Agilent	E4421B	GB40051240	2021/06/02	2022/06/01
MTI-E062	PXA Signal Analyzer	Agilent	N9030A	MY51350296	2021/06/02	2022/06/01
MTI-E066	MXA Signal Analyzer	Agilent	N9020A	MY50143483	2021/06/02	2022/06/01
MTI-E078	Synthesized Sweeper	Agilent	83752A	3610A01957	2021/06/02	2022/06/01
MTI-E079	DC Power Supply	Agilent	E3632A	MY40027695	2021/06/02	2022/06/01
MTI-E045	Double Ridged Broadband Horn Antenna	schwarabeck	BBHA 9120 D	9120D-2278	2021/05/30	2023/05/29
MTI-E021	EMI Test Receiver	Rohde&schwarz	ESCS30	100210	2021/06/02	2022/06/01
MTI-E022	Pulse Limiter	Schwarzbeck	VSTD 9561-F	00679	2021/06/02	2022/06/01
MTI-E023	Artificial mains network	Schwarzbeck	NSLK 8127	NSLK 8127 #841	2021/06/02	2022/06/01
MTI-E046	Active Loop Antenna	Schwarzbeck	FMZB 1519 B	00044	2021/05/30	2023/05/29
MTI-E048	Amplifier	Agilent	8449B	3008A02400	2021/06/02	2022/06/01
MTI-E072	Thermometer Clock Humidity Monitor	-	HTC-1	/	2021/06/02	2022/06/01
Note: the calibration interval of the above test instruments is 12 or 24 months and the calibrations are traceable to international system unit (SI).						

5 EMC EMISSION TEST

5.1 Conducted emission measurement

5.1.1 Power line conducted emission limits

Frequency(MHz)	Conducted Emission Limit	
	Quasi-peak	Average
0.15-0.5	66-56*	56-46*
0.5-5.0	56	46
5.0-30.0	60	50
Note: 1. *Decreases with the logarithm of the frequency 2. The lower limit shall apply at the transition frequencies 3. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.		

The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

5.1.2 Test procedure

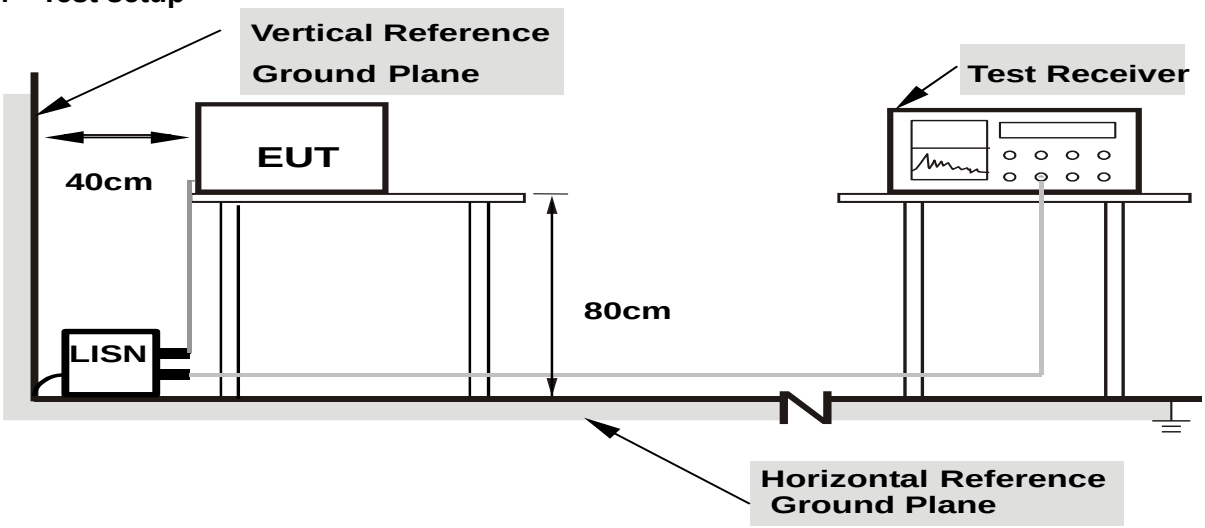
According to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 Conducted emissions the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and average detector mode.

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room.
2. The EUT was placed on a table which is 0.8m above ground plane.
3. Connect EUT to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
4. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40cm long.
5. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
6. LISN at least 80 cm from nearest part of EUT chassis.
7. The frequency range from 150KHz to 30MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF bandwidth=9KHz) with Maximum Hold Mode
9. For the actual test configuration, please refer to the related Item –EUT Test Photos.

5.1.3 Deviation from test standard

No deviation

5.1.4 Test setup



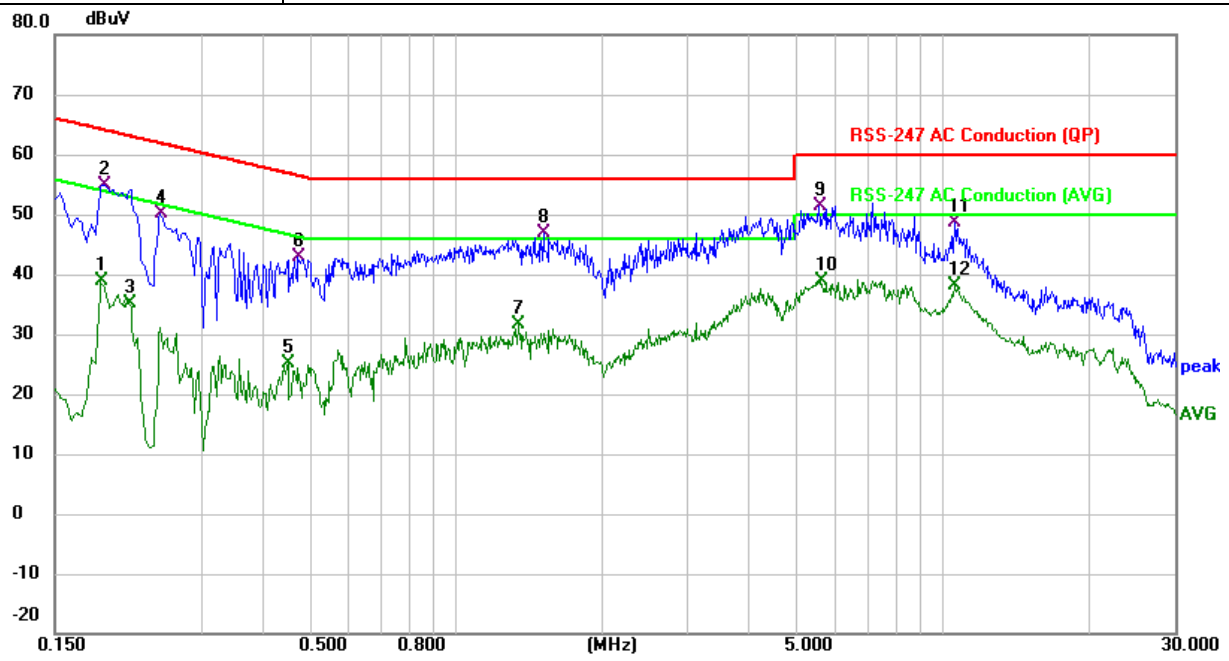
Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

5.1.5 EUT operating conditions

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

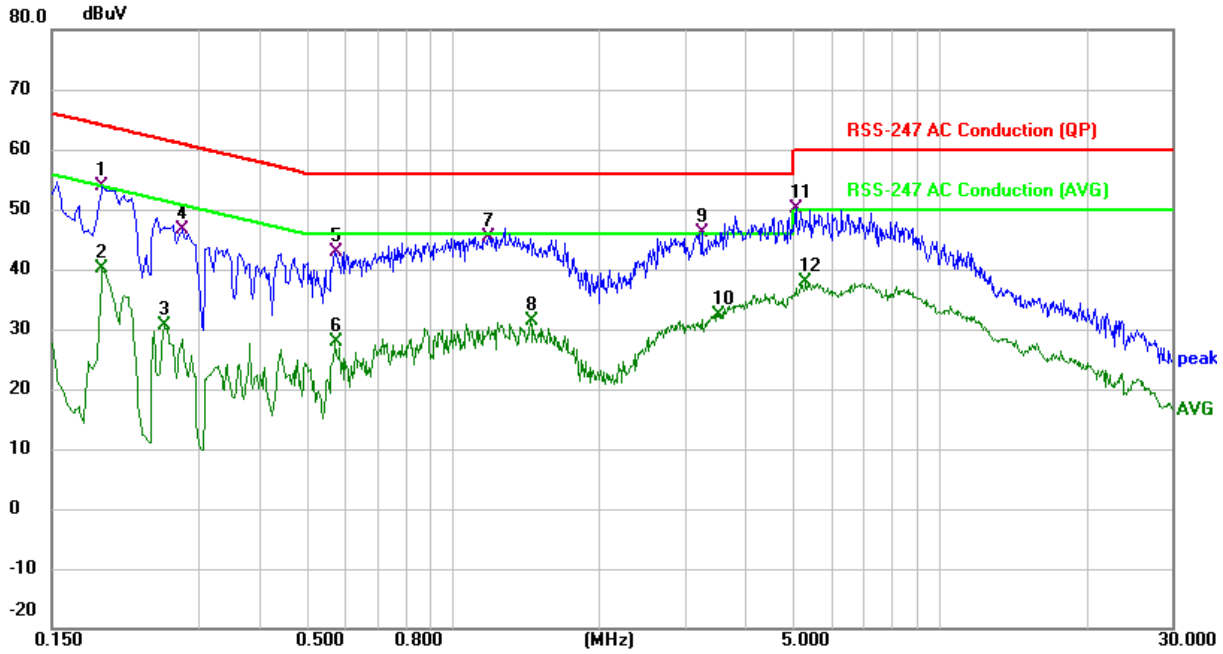
5.1.6 Test results

EUT:	Bluetooth 5.0 module	Model Name:	BTM-2801
Pressure:	1010hPa	Phase:	L
Test Voltage:	AC 120V/60Hz		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1860	27.80	10.98	38.78	54.21	-15.43	QP
2		0.1900	43.83	10.98	54.81	64.04	-9.23	AVG
3		0.2128	24.13	10.98	35.11	53.10	-17.99	QP
4		0.2460	39.12	10.99	50.11	61.89	-11.78	AVG
5		0.4500	14.02	11.02	25.04	46.88	-21.84	QP
6		0.4740	31.86	11.04	42.90	56.44	-13.54	AVG
7		1.3460	17.54	14.03	31.57	46.00	-14.43	QP
8		1.5180	32.43	14.39	46.82	56.00	-9.18	AVG
9	*	5.5780	39.79	11.52	51.31	60.00	-8.69	QP
10		5.5939	27.29	11.52	38.81	50.00	-11.19	AVG
11		10.5700	37.04	11.59	48.63	60.00	-11.37	QP
12		10.5700	26.45	11.59	38.04	50.00	-11.96	AVG

EUT:	Bluetooth 5.0 module	Model Name:	BTM-2801
Pressure:	1010hPa	Phase:	N
Test Voltage:	AC 120V/60Hz		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1900	42.99	10.93	53.92	64.04	-10.12	QP
2		0.1900	29.17	10.93	40.10	54.04	-13.94	AVG
3		0.2540	19.61	10.91	30.52	51.63	-21.11	QP
4		0.2779	35.70	10.89	46.59	60.88	-14.29	AVG
5		0.5740	31.95	10.96	42.91	56.00	-13.09	QP
6		0.5740	16.83	10.96	27.79	46.00	-18.21	AVG
7		1.1900	31.76	13.61	45.37	56.00	-10.63	QP
8		1.4420	17.34	14.16	31.50	46.00	-14.50	AVG
9		3.2580	34.74	11.37	46.11	56.00	-9.89	QP
10		3.5100	21.06	11.37	32.43	46.00	-13.57	AVG
11	*	5.0660	38.76	11.39	50.15	60.00	-9.85	QP
12		5.3100	26.42	11.39	37.81	50.00	-12.19	AVG

5.2 Radiated emission measurement

5.2.1 Radiated Emission Limits

According to IC RSS-Gen 6.13: radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits. According to IC RSS-Gen, Restricted bands

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

According to IC RSS-Gen 4.9, the level of any transmitter spurious emission in Restricted bands shall not exceed the level of the emission specified in the following table

Restricted Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance
0.009~0.490	2400/F(KHz)	20 log (uV/m)	300
0.490~1.705	2400/F(KHz)	20 log (uV/m)	30
1.705~30.0	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

Limits of Radiated Emission Measurement(Above 1000MHz)

Frequency(MHz)	Class B (dBuV/m) (at 3M)	
	PEAK	AVERAGE
Above 1000	74	54

Remark :1. Emission level in dBuV/m=20 log (uV/m)

2. Measurement was performed at an antenna to the closed point of EUT distance of meters.

3. Distance extrapolation factor =40log(Specific distance/ test distance)(dB);

Limit line=Specific limits(dBuV) + distance extrapolation factor.

5.2.2 Test procedure

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.10-2013. The test distance is 3m.The setup is according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 and CAN/CSA-CEI/IEC CISPR 22.

This test is required for any spurious emission that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT.

Use the following spectrum analyzer settings:

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (emission in restricted band)	1 MHz / 1 MHz for Peak, 1 MHz / 10Hz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 120kHz for QP

Measurements shall be taken, using the following steps, at a test site that has been validated using the procedures of ANSI C63.4 or the latest CISPR 16-1-4 for measurements above 1 GHz, so as to simulate a near free-space environment (see RSS-Gen for applicable versions of ANSI and CISPR standards).

(1) Line the ground plane with absorbers between the transmitter and the receive antenna to minimize reflections. The absorbers used should have a minimum-rated attenuation of 20 dB through the measurement frequency range of interest. The absorbers shall be positioned to replicate the layout used when compliance with the applicable acceptability criterion was achieved, as set forth in the aforementioned standards on site validation.

(2) Set the height of the receive antenna to 1.5 m. The receive antenna must be one that was designed and fabricated to operate over the entire frequency range of interest, for example, an appropriate standard gain horn.

(3) The distance between the receive antenna and the radiating source shall be sufficient in order to ensure far-field conditions.

(4) Mount the transmitter at a height of 1.5 m.

(5) Configure the device under test (DUT) to produce the maximum power spectral density as measured while assessing compliance with Section 6.2.2 (i.e. channel frequency, modulation type and data rate). If the DUT is equipped with a detachable antenna and the antenna is intended for remote installation (i.e. tower-mounted), the DUT may be substituted with a suitable signal generator. The

level and frequency settings on the generator shall be set so as to reproduce the maximum power spectral density, measured within a 1 MHz bandwidth, obtained while assessing compliance to Section 6.2.2.

(6) Position the transmitter or the radiating antenna so that elevation pattern measurements can be taken.

(7) Find the 0° reference point in the horizontal plane.

(8) Care should be taken when positioning the receive antenna to avoid cross-polarization. Antennas of known mounting polarization should be assessed with the receive antenna oriented in the same polarity. If the polarization of the transmit antenna is unknown or the transmit antenna can be mounted in either polarization, e.i.r.p. measurements should be performed to find which mounting polarity provides the highest e.i.r.p. value. Testing shall be carried out with the receive antenna and the DUT mounted in each polarity.

(9) The emission shall be centred on the display of the spectrum analyzer with the following settings:

i. If the power spectral density of the DUT was assessed with a peak detector and the antenna cannot be detached from the DUT, the spectrum analyzer shall be set to a peak detector with a resolution bandwidth and video bandwidth of 1 MHz.

ii. If the power spectral density of the DUT was assessed using a sample detector with power averaging and the antenna cannot be detached from the DUT, the spectrum analyzer shall be set to a sample detector, configured to produce 100 power averages and set with a resolution bandwidth, as well as a video bandwidth of 1 MHz.

iii. If the antenna can be detached from the DUT, a continuous wave (CW) signal equal to that of the power spectral density measurement may be used, the spectrum analyzer shall be set to peak detector with a resolution bandwidth and video bandwidth of 1 MHz.

(10) Rotate the turntable 360° recording the field strength at each step. Throughout the main beam of the antenna, the step size shall be kept to a maximum of 1°.

Once outside the main beam of the antenna, the maximum step size shall be as follows, when compared to the requirements of Section 6.2.2:

i. Between 0° and 8°, maximum step size of 2°;

ii. Between 8° and 40°, maximum step size of 4°;

iii. Between 40° and 45°, maximum step size of 1°;

iv. Between 45° and 90°, maximum step size of 5°.

Once the mask reaches 90°, the mask will be inverted and the step size will follow in the same manner as above.

For the purpose of this procedure, the main beam of the antenna is defined as the 3 dB beamwidth.

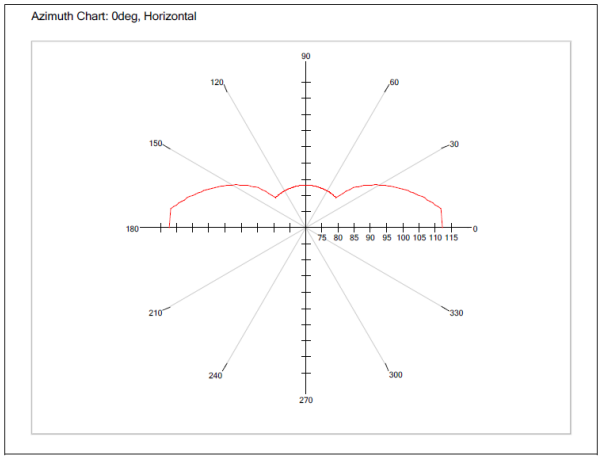
(11) Convert the measured field strength values in terms of e.i.r.p. density (dBW/1 MHz) using the following equation:

e.i.r.p density(dBW/MHz)=10log((E*r)2/30)

E = field strength in V/m

r = measurement distance in metres

(12) Plot the results against the emission mask with reference to the horizontal plane.
(13) Using the plot, the 0° can be rotated to determine the worst-case installation tilt angle.
(14) Testing shall be performed using the highest gain antenna for every antenna type, if applicable.
(15) Antenna type(s), antenna model number(s), and worst-case tilt angle(s) necessary to remain compliant with the elevation mask requirement set forth in Section 6.2.2(3) of RSS-247 shall be clearly indicated in the user manual.
The following figure is an exa7mple of a polar elevation mask measured using the Method 1 reference to dBμV/m at 3 m.



During the radiated emission test, the Spectrum Analyzer was set with the following configurations:

Frequency Band (MHz)	Function	Resolution bandwidth	Video Bandwidth
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	1 MHz
	Average	1 MHz	10 Hz

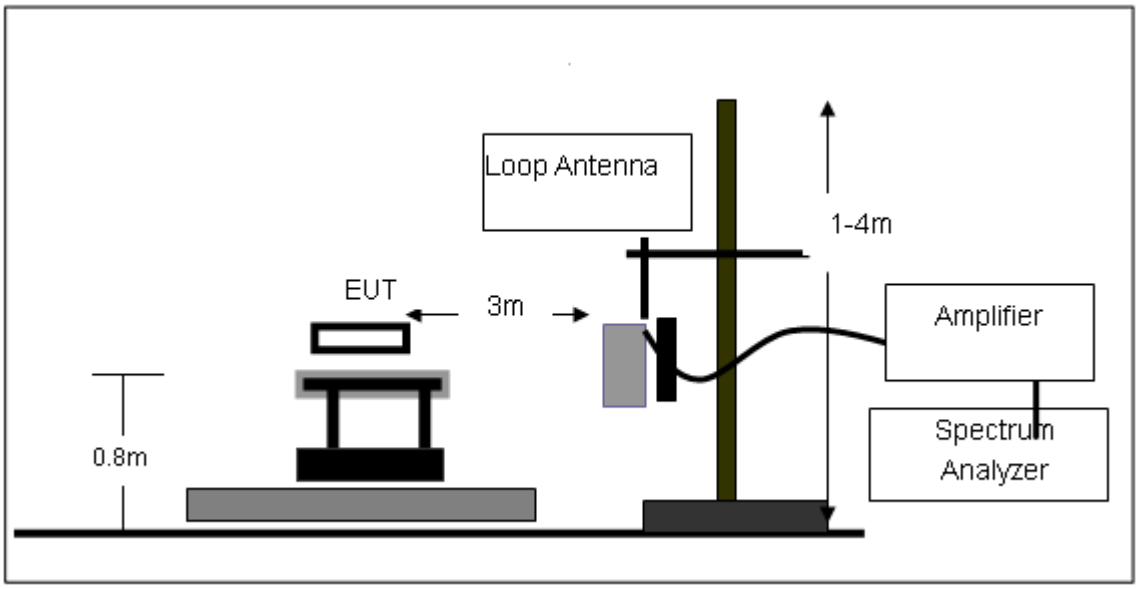
Note: for the frequency ranges below 30 MHz, a narrower RBW is used for these ranges but the measured value should add a RBW correction factor (RBWCF) where RBWCF [dB] =10*lg(100 [kHz]/narrower RBW [kHz]). , the narrower RBW is 1 kHz and RBWCF is 20 dB for the frequency 9 kHz to 150 kHz, and the narrower RBW is 10 kHz and RBWCF is 10 dB for the frequency 150 kHz to 30 MHz.

5.2.3 Deviation from test standard

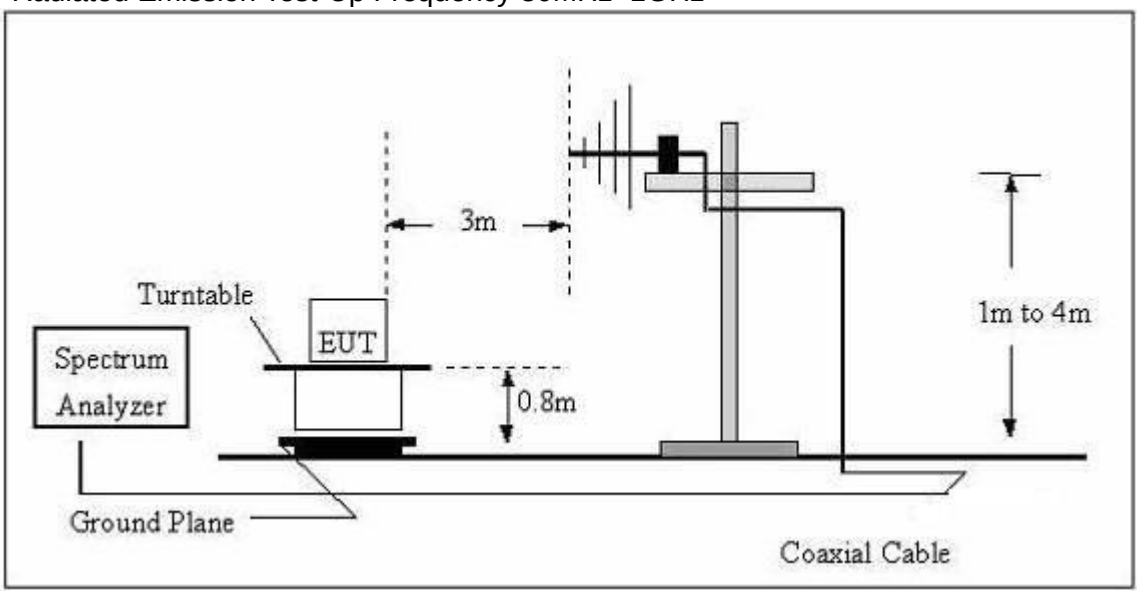
No deviation

5.2.4 Test setup

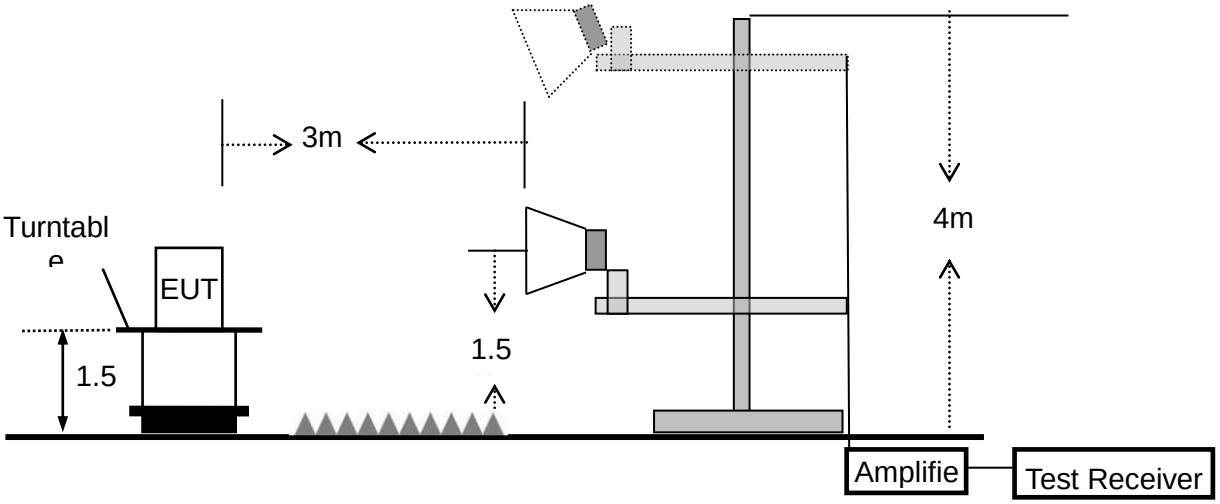
（A）Radiated Emission Test-Up Frequency Below 30MHz



（B）Radiated Emission Test-Up Frequency 30MHz~1GHz



（C）Radiated Emission Test-Up Frequency Above 1GHz



5.2.5 Test results (between 9kHz – 30 MHz)

EUT：	Bluetooth 5.0 module	Model Name. ：	BTM-2801
Pressure：	1010 hPa	Test Voltage ：	AC 120V/60Hz
Test Mode ：	Charging+TX		

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	PASS
--	--	--	--	PASS

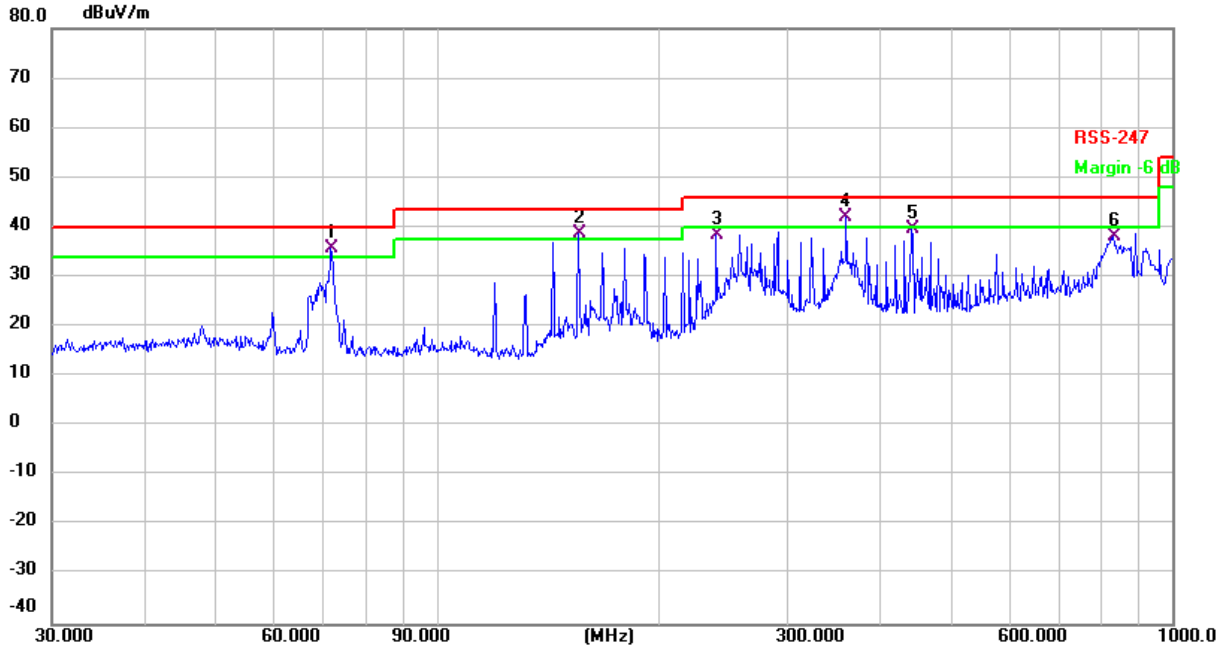
NOTE:

For 9kHz-30MHz, the amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits(dBuv) + distance extrapolation factor.

5.2.6 Test results (between 30MHz – 1GHz)

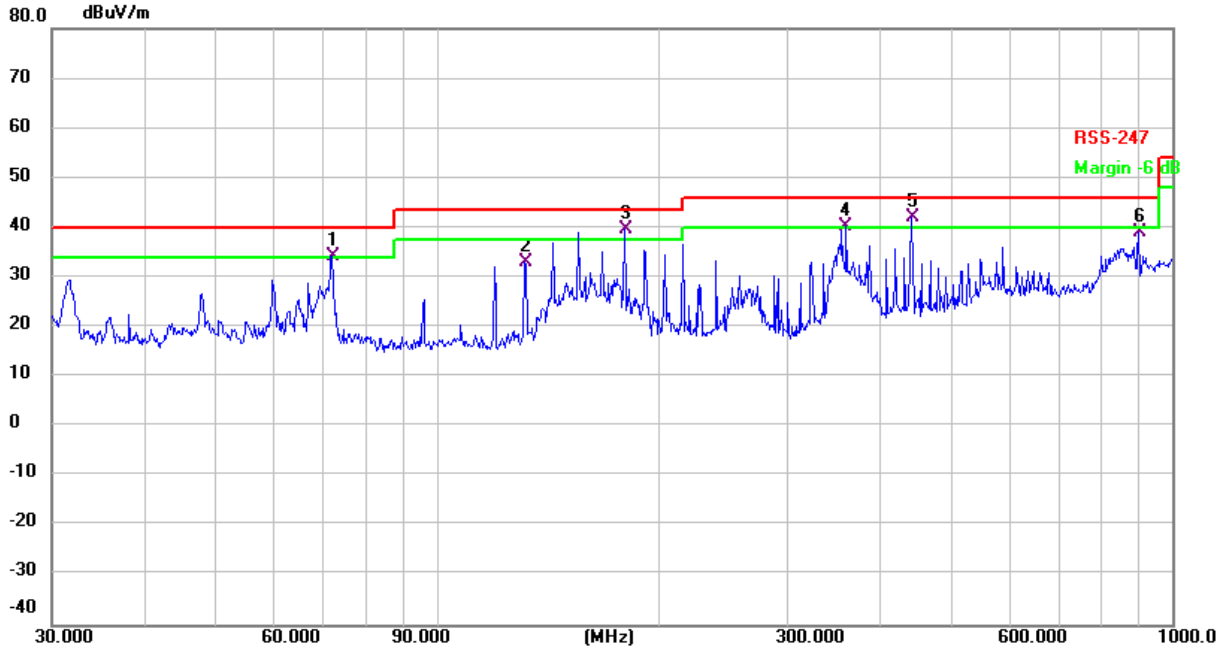
All the modulation modes have been tested, and the worst result was report as below:

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1010 hPa	Phase:	H
Test Mode ：	Charging+TX	Test Voltage ：	AC 120V/60Hz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1	!	71.8320	45.88	-10.03	35.85	40.00	-4.15	QP
2	!	155.9101	48.68	-10.05	38.63	43.50	-4.87	QP
3		239.9874	44.81	-6.30	38.51	46.00	-7.49	QP
4	*	360.4476	46.63	-4.58	42.05	46.00	-3.95	QP
5		441.7426	42.96	-3.41	39.55	46.00	-6.45	QP
6		830.4002	35.88	2.22	38.10	46.00	-7.90	QP

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1010 hPa	Phase:	V
Test Mode ：	Charging+TX	Test Voltage ：	AC 120V/60Hz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1	!	72.0843	44.33	-10.04	34.29	40.00	-5.71	QP
2		131.7577	43.76	-10.81	32.95	43.50	-10.55	QP
3	*	180.0165	48.58	-8.87	39.71	43.50	-3.79	QP
4	!	360.4476	44.78	-4.58	40.20	46.00	-5.80	QP
5	!	441.7426	45.56	-3.41	42.15	46.00	-3.85	QP
6		900.1474	35.42	3.60	39.02	46.00	-6.98	QP

5.2.7 Test results (1-25GHz)

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
BLE 1Mbps - 2402 MHz TX mode							
4804	43.89	1.52	45.41	74	-28.59	Peak	V
4804	38.84	1.52	40.36	54	-13.64	AVG	V
7206	40.15	5.46	45.61	74	-28.39	Peak	V
7206	34.86	5.46	40.32	54	-13.68	AVG	V
9608	42.41	6.33	48.74	74	-25.26	Peak	V
9608	37.35	6.33	43.68	54	-10.32	AVG	V
4804	42.93	1.52	44.45	74	-29.55	Peak	H
4804	38.16	1.52	39.68	54	-14.32	AVG	H
7206	39.48	5.46	44.94	74	-29.06	Peak	H
7206	34.12	5.46	39.58	54	-14.42	AVG	H
9608	41.63	6.33	47.96	74	-26.04	Peak	H
9608	36.35	6.33	42.68	54	-11.32	AVG	H
BLE 1Mbps - 2440 MHz TX mode							
4880	41.18	1.68	42.86	74	-31.14	Peak	V
4880	36.01	1.68	37.69	54	-16.31	AVG	V
7320	39.94	5.45	45.39	74	-28.61	Peak	V
7320	34.87	5.45	40.32	54	-13.68	AVG	V
9760	42.59	6.37	48.96	74	-25.04	Peak	V
9760	37.3	6.37	43.67	54	-10.33	AVG	V
4880	41.49	1.68	43.17	74	-30.83	Peak	H
4880	36.97	1.68	38.65	54	-15.35	AVG	H
7320	39.96	5.45	45.41	74	-28.59	Peak	H
7320	34.93	5.45	40.38	54	-13.62	AVG	H
9760	41.99	6.37	48.36	74	-25.64	Peak	H
9760	37.21	6.37	43.58	54	-10.42	AVG	H

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
BLE 1Mbps - 2480 MHz TX mode							
4960	42.22	1.83	44.05	74	-29.95	Peak	V
4960	37.85	1.83	39.68	54	-14.32	AVG	V
7440	40.67	5.43	46.1	74	-27.9	Peak	V
7440	34.82	5.43	40.25	54	-13.75	AVG	V
9920	44.61	6.41	51.02	74	-22.98	Peak	V
9920	39.57	6.41	45.98	54	-8.02	AVG	V
4960	41.1	1.83	42.93	74	-31.07	Peak	H
4960	35.86	1.83	37.69	54	-16.31	AVG	H
7440	40.58	5.43	46.01	74	-27.99	Peak	H
7440	36.26	5.43	41.69	54	-12.31	AVG	H
9920	45.45	6.41	51.86	74	-22.14	Peak	H
9920	40.17	6.41	46.58	54	-7.42	AVG	H

5.2.8 Band edge - radiated

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
BLE 1Mbps – Low band-edge							
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
2310	47.48	-6.60	40.88	74	-33.12	Peak	V
2310	38.77	-6.60	32.17	54	-21.83	AVG	V
2390	48.49	-6.23	42.26	74	-31.74	Peak	V
2390	39.09	-6.23	32.86	54	-21.14	AVG	V
2310	49.08	-6.60	42.48	74	-31.52	Peak	H
2310	38.87	-6.60	32.27	54	-21.73	AVG	H
2390	48.70	-6.23	42.47	74	-31.53	Peak	H
2390	39.45	-6.23	33.22	54	-20.78	AVG	H
BLE 1Mbps – High band-edge							
2483.5	48.78	-5.79	42.99	74	-31.01	Peak	V
2483.5	39.22	-5.79	33.43	54	-20.57	AVG	V
2500	48.13	-5.72	42.41	74	-31.59	Peak	V
2500	39.04	-5.72	33.32	54	-20.68	AVG	V
2483.5	49.47	-5.79	43.68	74	-30.32	Peak	H
2483.5	39	-5.79	33.21	54	-20.79	AVG	H
2500	49.10	-5.72	43.38	74	-30.62	Peak	H
2500	39.10	-5.72	33.38	54	-20.62	AVG	H

5.3 Power spectral density

5.3.1 Applied procedures / limit

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

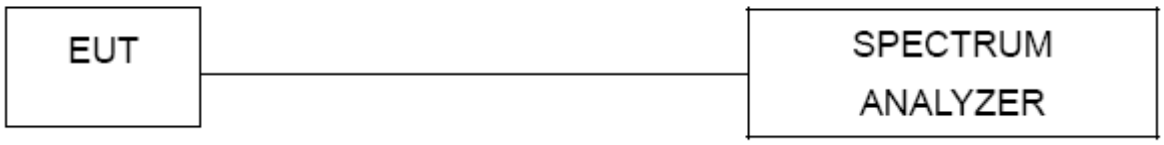
5.3.2 Test procedure

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW ≥ 3 kHz.
4. Set the VBW ≥ 3 x RBW.
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 amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

5.3.3 Deviation from standard

No deviation.

5.3.4 Test setup



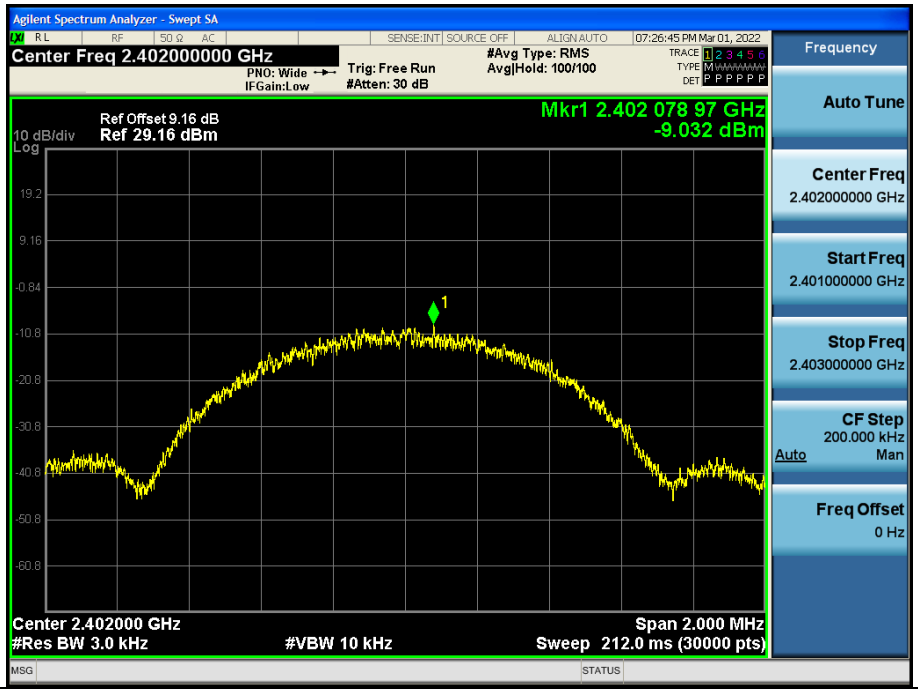
5.3.5 Test results

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1015 hPa	Test Voltage ：	DC 5V
Test Mode ：	TX GFSK Mode /CH00, CH19, CH39		

1M:

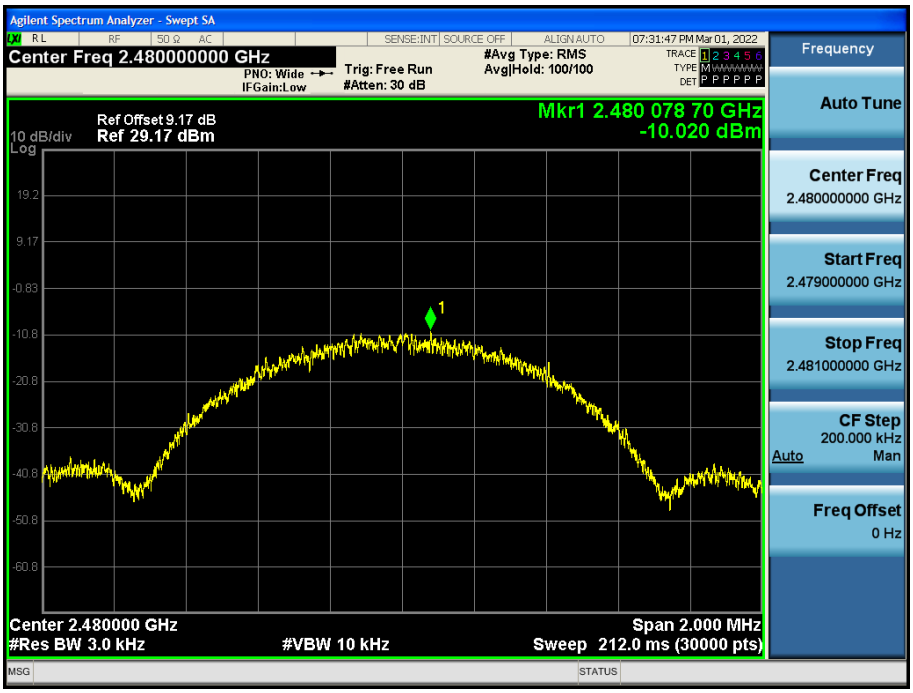
Frequency	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402 MHz	-9.032	8	PASS
2440 MHz	-9.399	8	PASS
2480 MHz	-10.020	8	PASS

TX CH00



TX CH19

TX CH39



2M:

Frequency	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402 MHz	-5.140	8	PASS
2440 MHz	-4.734	8	PASS
2480 MHz	-4.444	8	PASS

TX CH00

TX CH19

TX CH39

5.4 6dB emission bandwidth

5.4.1 Applied procedures / limit

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

5.4.2 Test procedure

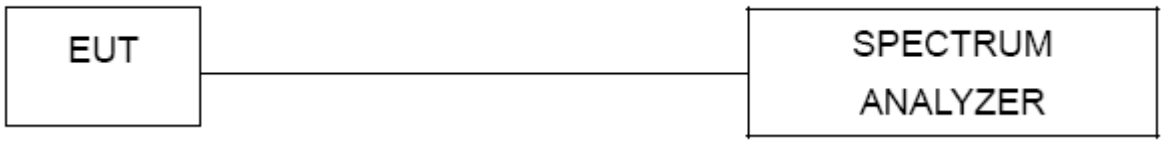
Span = set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions
RBW ≥1% to 5% of the actual occupied / x dB bandwidth
VBW ≥3RBW
Sweep = auto
Detector function = peak
Trace = max hold

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.4.3 Deviation from standard

No deviation.

5.4.4 Test setup



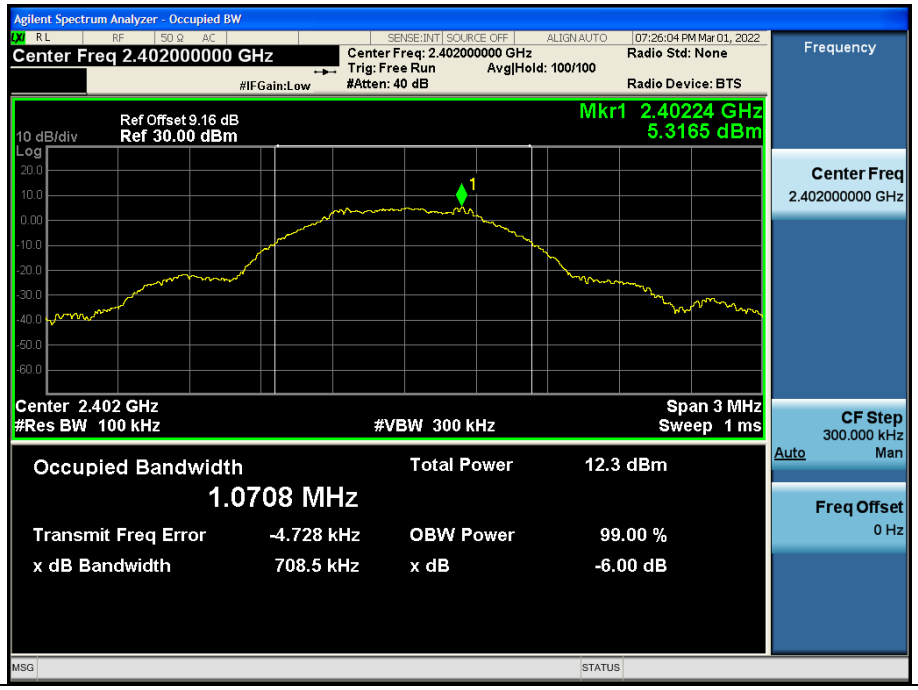
5.4.5 Test results

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1012 hPa	Test Voltage ：	DC 5V
Test Mode ：	TX Mode /CH00, CH19, CH39		

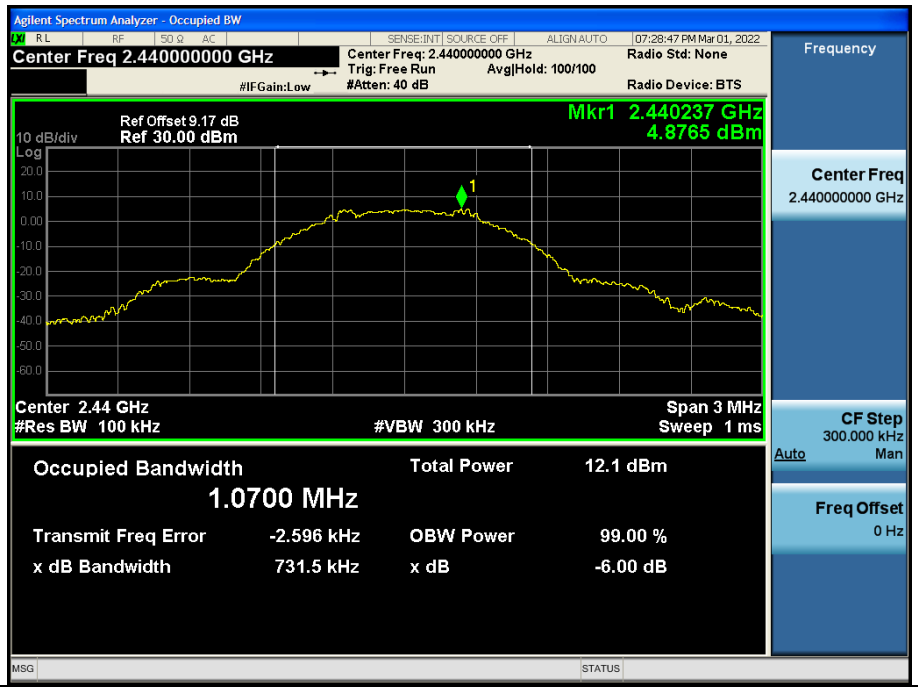
1M:

Channel	Frequency (MHz)	6dB bandwidth (MHz)	Limit (kHz)	Result
Low	2402	0.7085	500	Pass
Middle	2440	0.7315	500	Pass
High	2480	0.7058	500	Pass

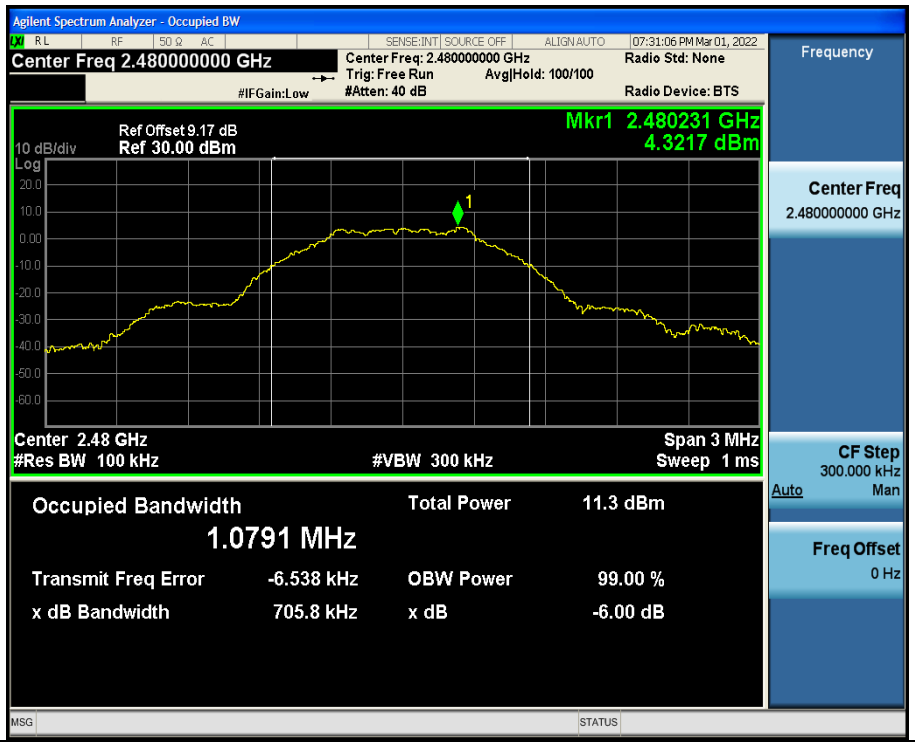
TX CH 00



TX CH 19



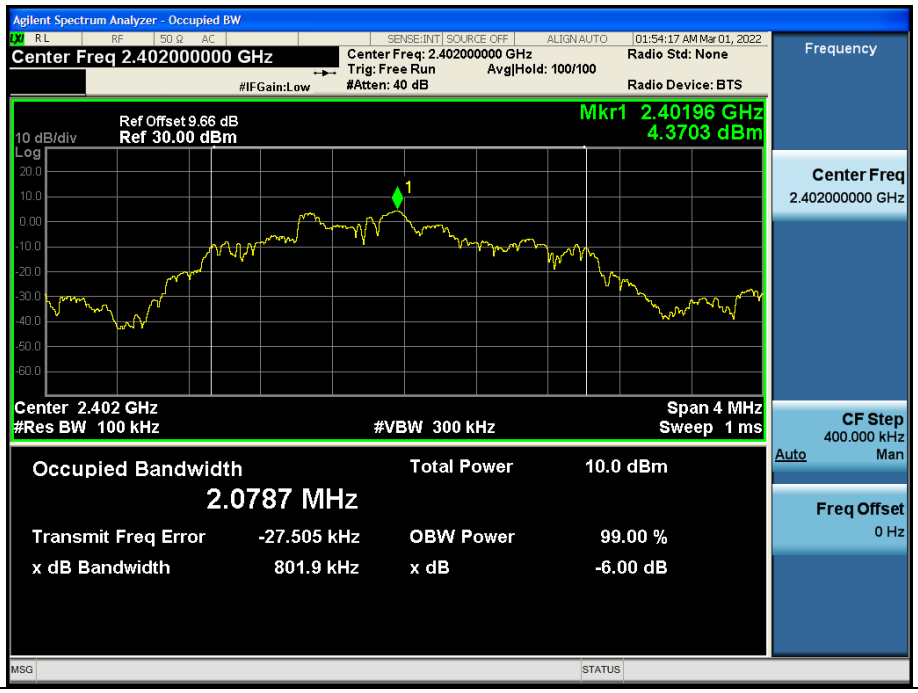
TX CH 39



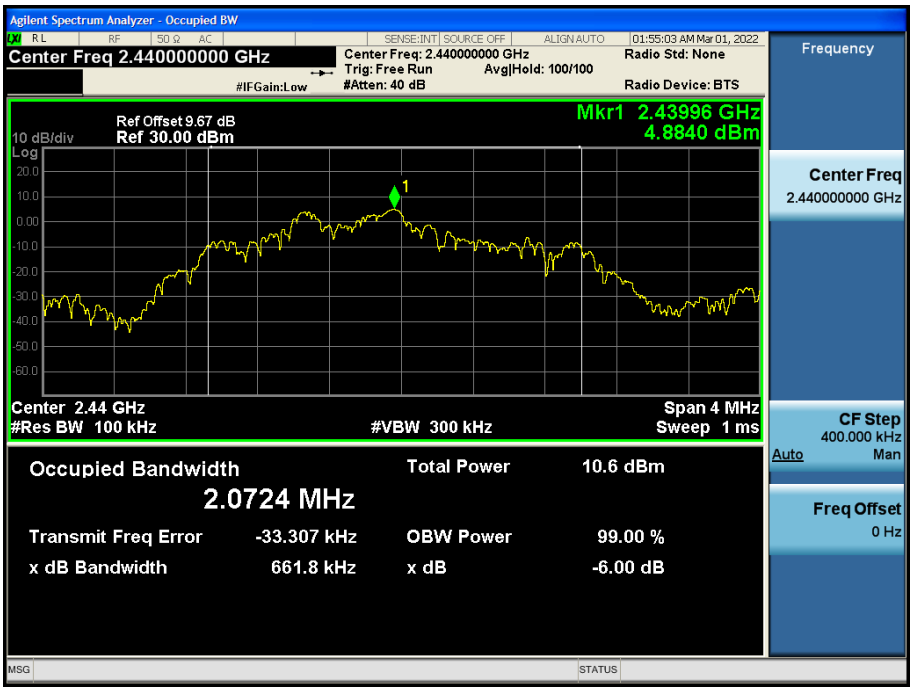
2M:

Channel	Frequency (MHz)	6dB bandwidth (MHz)	Limit (kHz)	Result
Low	2402	0.8019	500	Pass
Middle	2440	0.6618	500	Pass
High	2480	0.8345	500	Pass

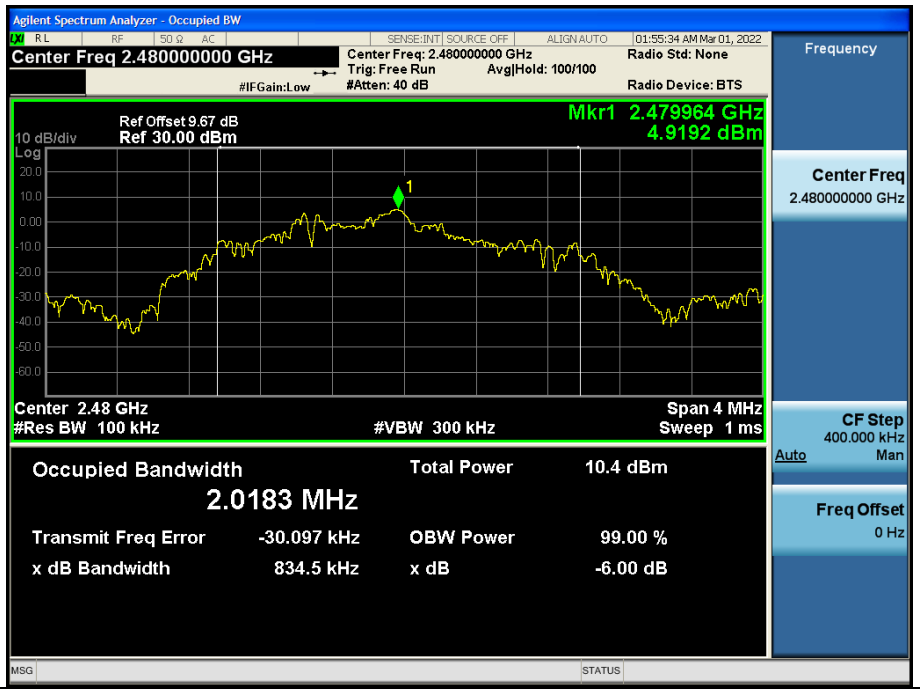
TX CH 00



TX CH 19



TX CH 39



5.5 99% occupied bandwidth

5.5.1 Applied procedures / limit

According to RSS-Gen 6.7.
No limit requirement.

5.5.2 Test procedure

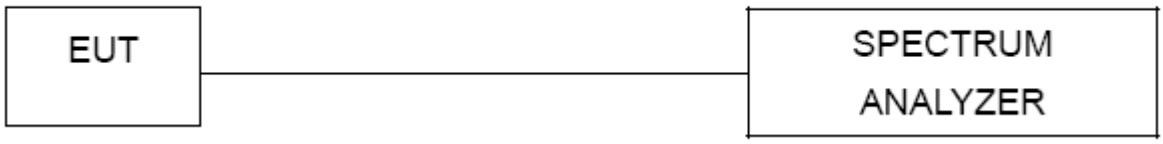
Span = set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions
RBW ≥1% to 5% of the actual occupied / x dB bandwidth
VBW ≥3RBW
Sweep = auto
Detector function = peak
Trace = max hold

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.5.3 Deviation from standard

No deviation.

5.5.4 Test setup



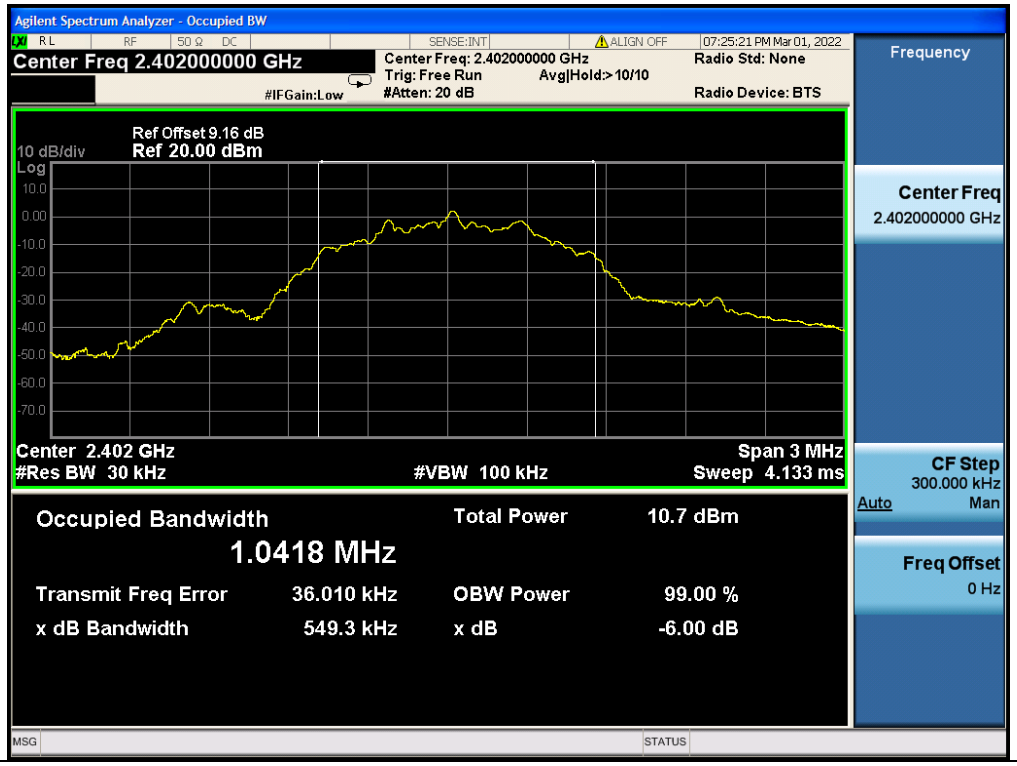
5.5.5 Test results

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1012 hPa	Test Voltage ：	DC 5V
Test Mode ：	TX Mode /CH00, CH19, CH39		

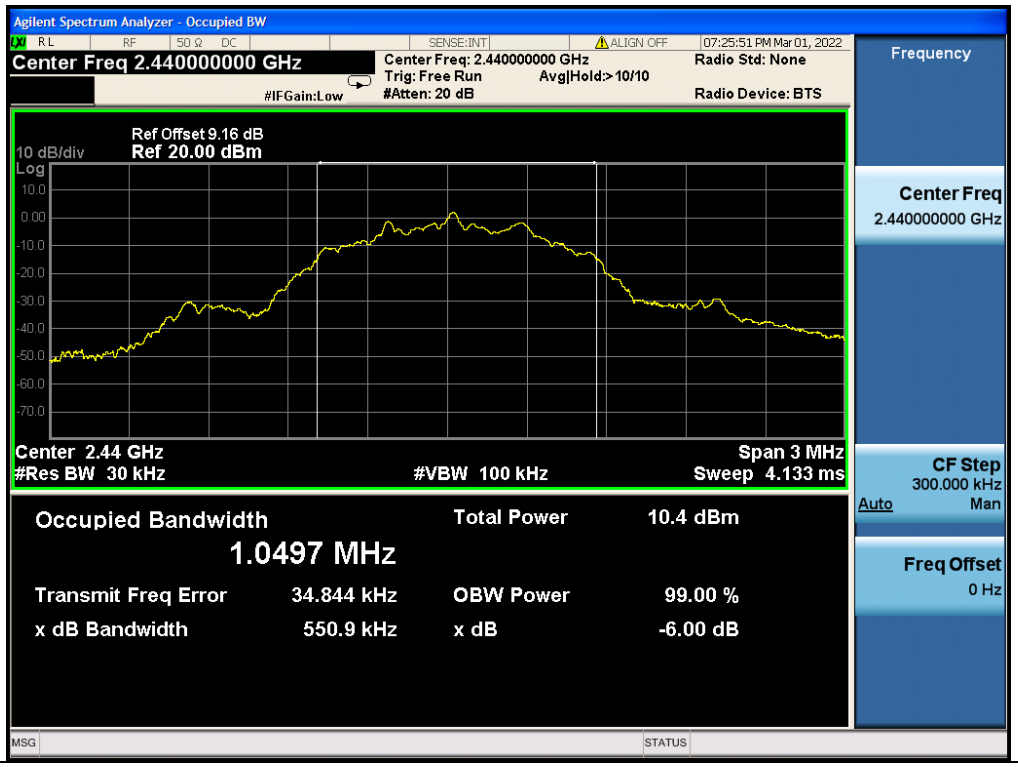
1M:

Channel	Frequency (MHz)	99% bandwidth (MHz)	Limit (kHz)	Result
Low	2402	1.0418	N/A	Pass
Middle	2440	1.0497	N/A	Pass
High	2480	1.0500	N/A	Pass

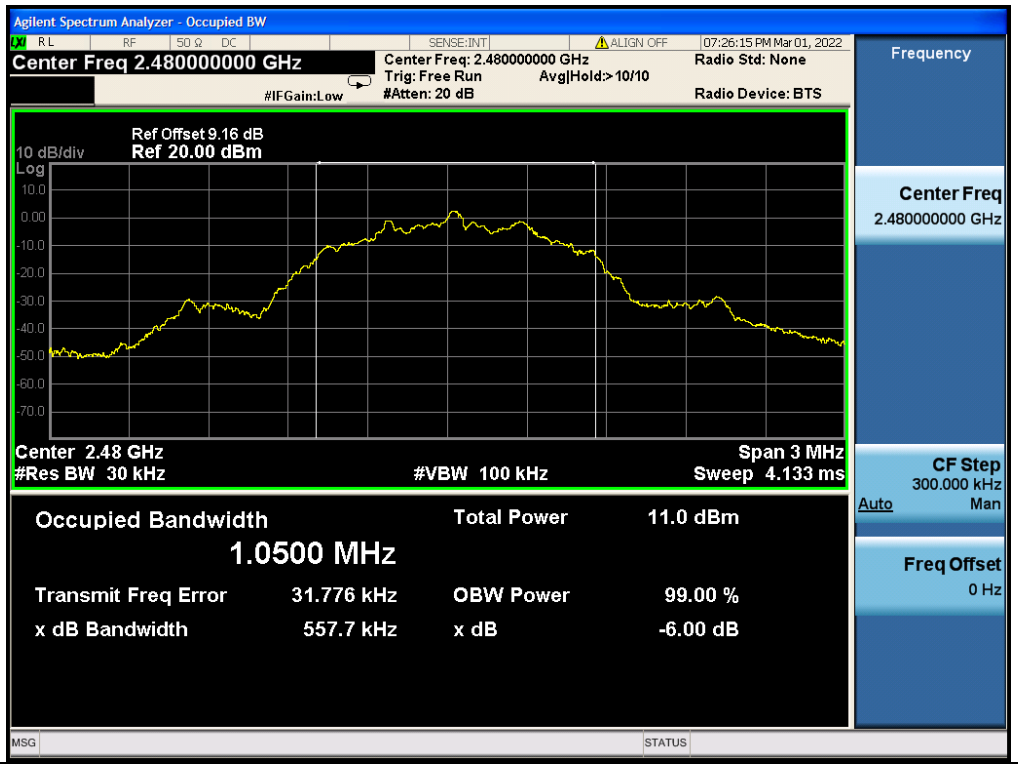
TX CH 00



TX CH 19



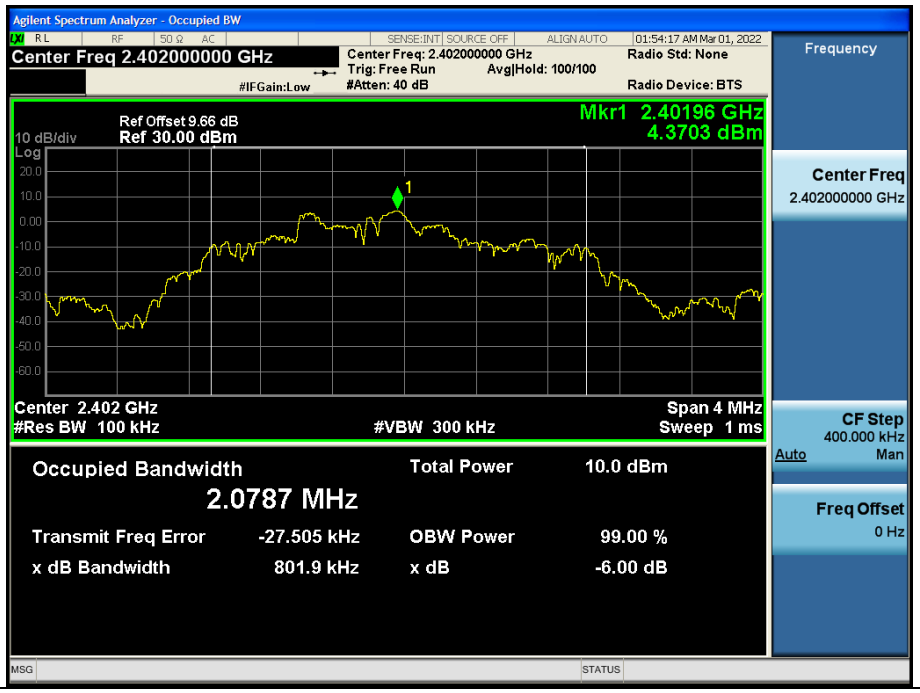
TX CH 39



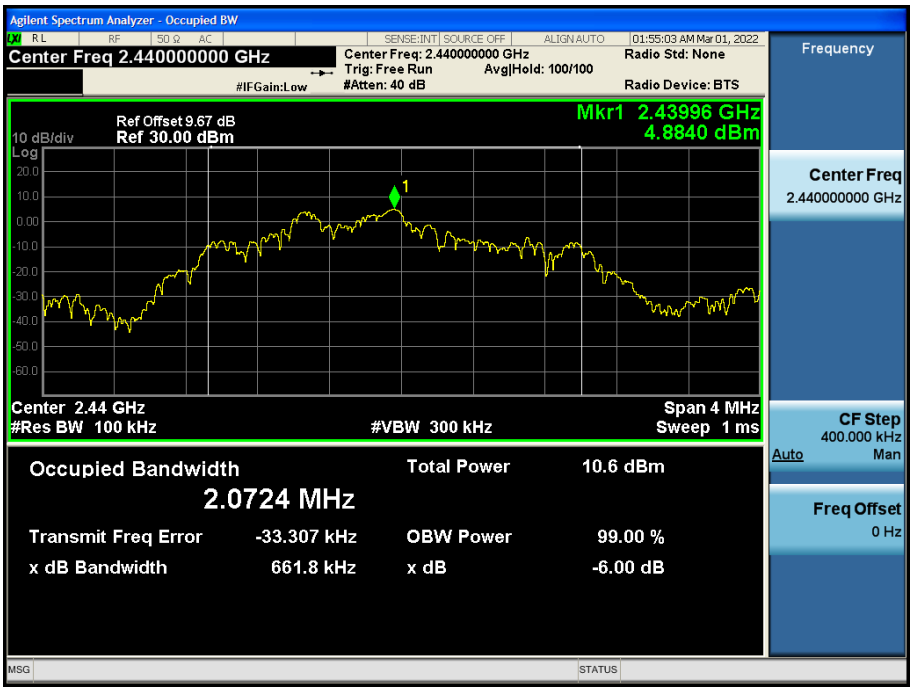
2M:

Channel	Frequency (MHz)	99% bandwidth (MHz)	Limit (kHz)	Result
Low	2402	2.0787	N/A	Pass
Middle	2440	2.0724	N/A	Pass
High	2480	2.0183	N/A	Pass

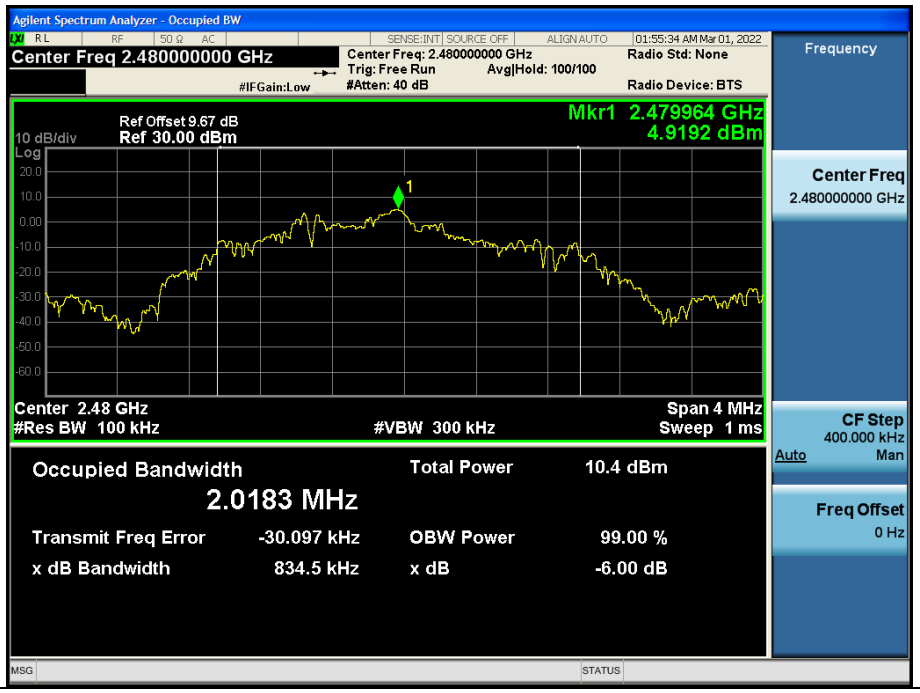
TX CH 00



TX CH 19



TX CH 39



5.6 Peak output power

5.6.1 Applied procedures / limit

Conducted peak output power limit is 1W (30dBm).

5.6.2 Test procedure

(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

(2) Spectrum Setting:

RBW=1MHz, VBW=3MHz, Detector=Peak (If 20dB BW ≤1 MHz)

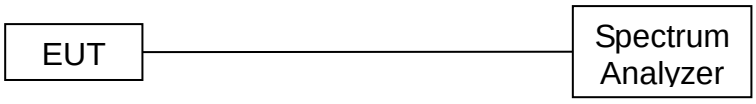
RBW=3MHz, VBW=8MHz, Detector=Peak (If 20dB BW > 1 MHz)

(3) The EUT was set to continuously transmitting in the max power during the test.

5.6.3 Deviation from standard

No deviation.

5.6.4 Test setup



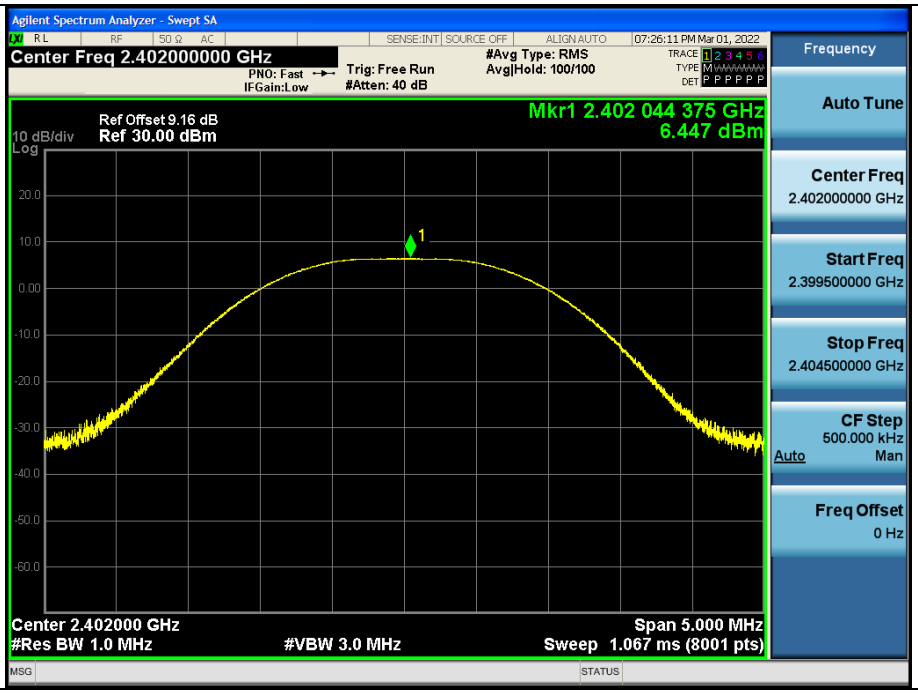
5.6.5 Test results

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1012 hPa	Test Voltage ：	DC 5V
Test Mode ：	TX Mode /CH00, CH19, CH39		

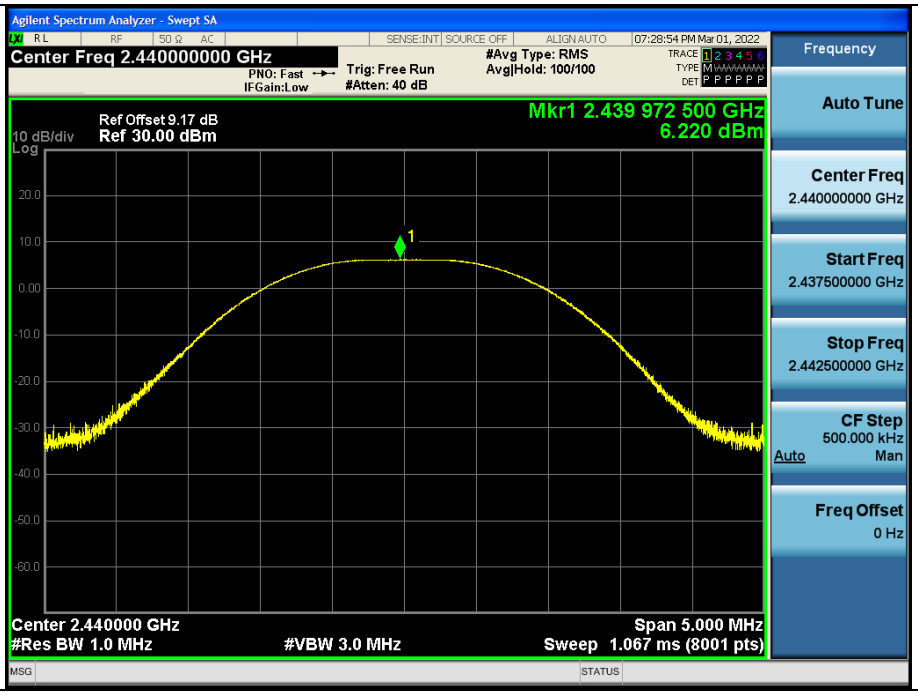
1M:

TX GFSK Mode			
Test Channe	Frequency	Maximum Conducted Output Power(PK)	Limit
	(MHz)	(dBm)	dBm
CH00	2402	6.447	30
CH19	2442	6.220	30
CH39	2480	5.432	30

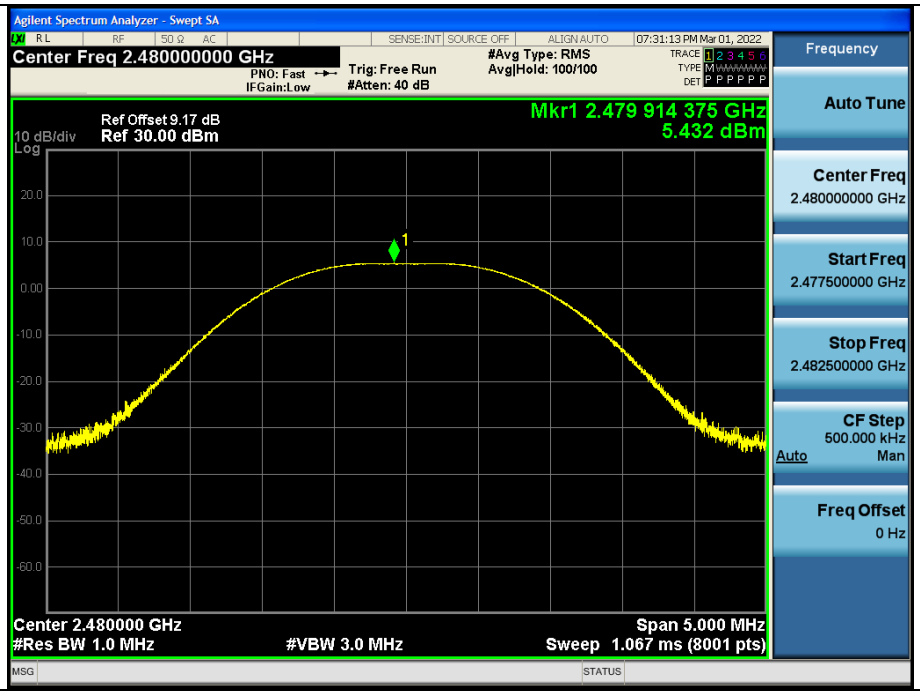
2402MHz



2440MHz



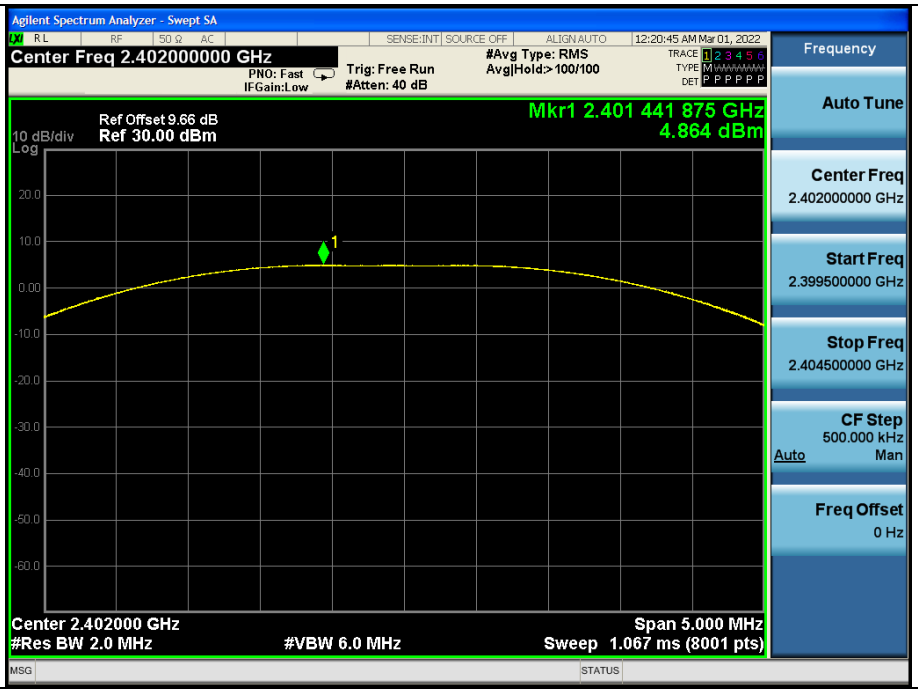
2480MHz


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
Avg|Hold: 100/100
07:31:13 PM Mar 01, 2022
Ref Offset 9.17 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 2.479 914 375 GHz
5.432 dBm
Center 2.480000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Span 5.000 MHz
Sweep 1.067 ms (8001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.477500000 GHz
Stop Freq
2.482500000 GHz
CF Step
500.000 kHz
Auto
Man
Freq Offset
0 Hz

2M:

TX GFSK Mode			
Test Channe	Frequency	Maximum Conducted Output Power(PK)	Limit
	(MHz)	(dBm)	dBm
CH00	2402	4.864	30
CH19	2442	5.420	30
CH39	2480	5.438	30

2402MHz



2440MHz

2480MHz


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
Avg|Hold:>100/100
12:24:07 AM Mar 01, 2022
Ref Offset 9.67 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 2.480 383 25 GHz
5.438 dBm
Center 2.480000 GHz
#Res BW 2.0 MHz
#VBW 6.0 MHz
Span 6.000 MHz
Sweep 1.067 ms (8001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.477000000 GHz
Stop Freq
2.483000000 GHz
CF Step
600.000 kHz
Auto
Man
Freq Offset
0 Hz
MSG
STATUS

5.7 Equivalent isotropically radiated power

5.7.1 Applied procedures / limit

According to RSS-247 5.4(4)

For employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the e.i.r.p. shall not exceed 4 W.

5.7.2 Test procedure

The testing follows RSS-247 5.4(4)

The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator.

The path loss was compensated to the results for each measurement.

Set to the maximum power setting and enable the EUT transmit continuously.

The EUT was operating in controlled its channel.

a) Set instrument center frequency to DTS channel center frequency.

b) Set span to at least 1.5 times the OBW.

c) Set RBW = 1-5% of the OBW, not to exceed 1MHz.

d) Set VBW ≥3 x RBW.

e) Number of points in sweep ≥ 2x span / RBW.

(This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)

f) Sweep time = auto.

g) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.

h) If transmit duty cycle < 98 %, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 %, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run”.

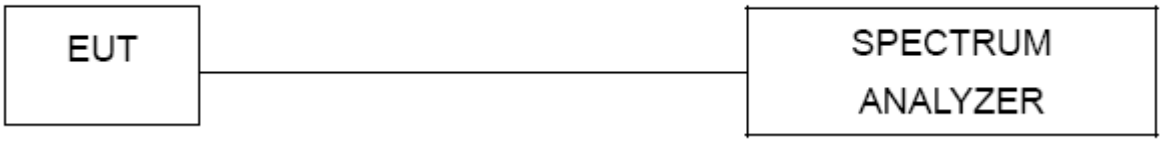
i) Trace average at least 100 traces in power averaging (i.e., RMS) mode.

j) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

5.7.3 Deviation from standard

No deviation.

5.7.4 Test setup



5.7.5 Test results

EUT：	Bluetooth 5.0 module	Model Name ：	BTM-2801
Pressure：	1012 hPa	Test Voltage ：	DC 5V
Test Mode ：	TX Mode /CH00, CH19, CH39		

1M:

Mode	Channel	Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBi)	E.I.R.P Measurement (dBm)	Limit (dBm)	Result
GFSK	Low	2402	6.447	0	6.447	36.02	Pass
	Middle	2440	6.220	0	6.220	36.02	Pass
	High	2480	5.432	0	5.432	36.02	Pass

2M:

Mode	Channel	Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBi)	E.I.R.P Measurement (dBm)	Limit (dBm)	Result
GFSK	Low	2402	4.864	0	4.864	36.02	Pass
	Middle	2440	5.420	0	5.420	36.02	Pass
	High	2480	5.438	0	5.438	36.02	Pass

Note: EIRP= Output Power+ ANT Gain

5.8 100 kHz bandwidth of frequency band edge

5.8.1 Applied procedures / 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.

5.8.2 Test procedure

a) Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

b) Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.

c) Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.

d) Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.

e) Repeat above procedures until all measured frequencies were complete.

5.8.3 Deviation from standard

No deviation.

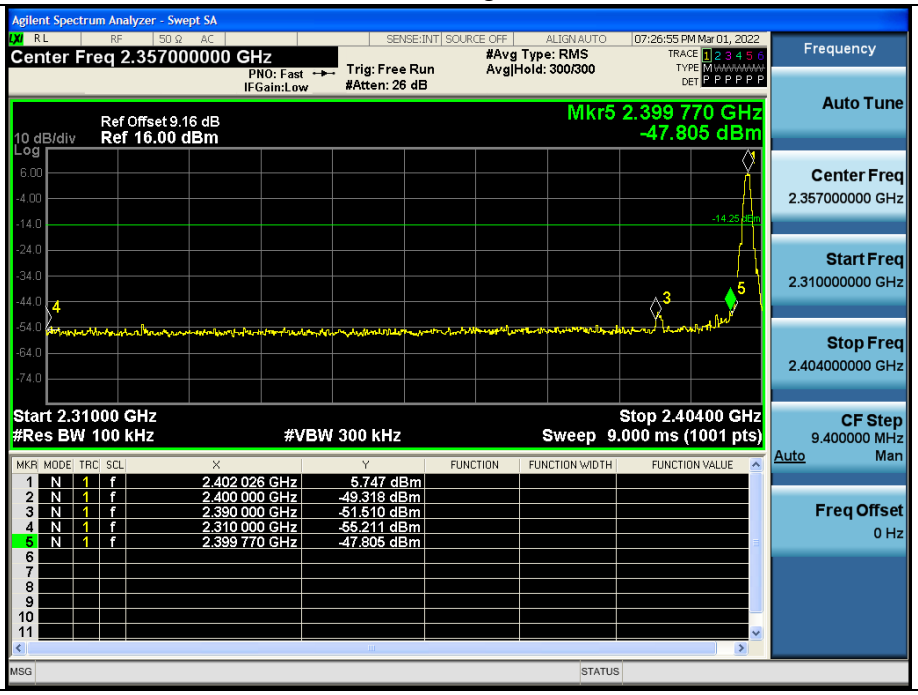
5.8.4 Test setup

5.8.5 Test results

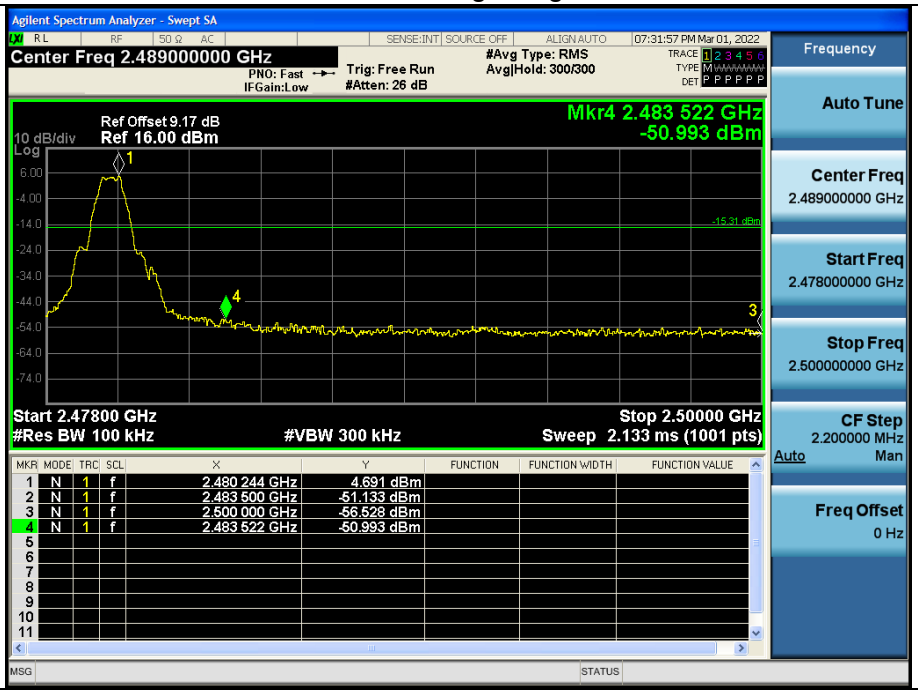
Test plots:

1M:

GFSK: Band Edge, Left Side

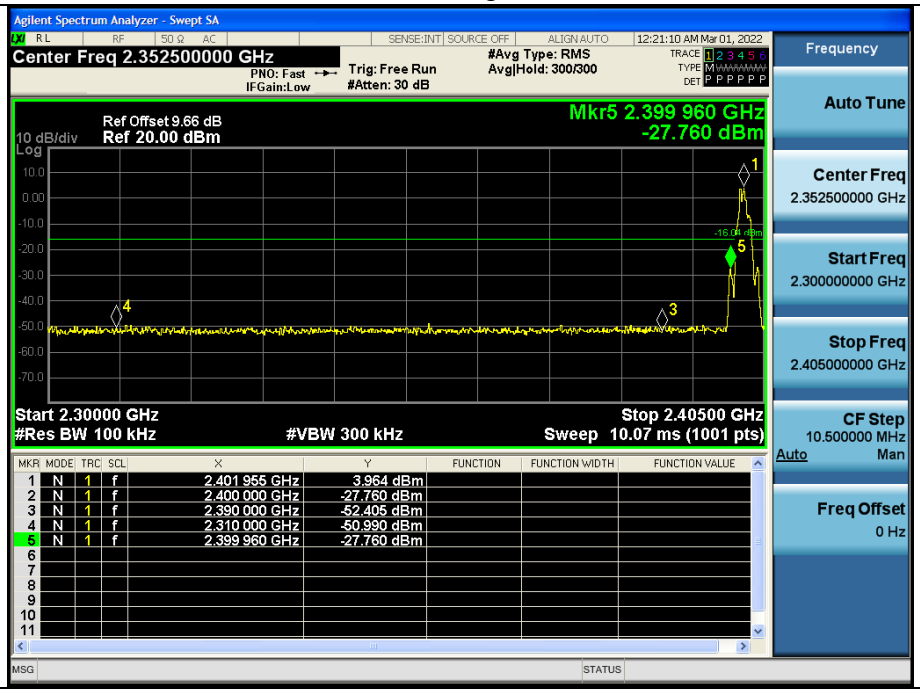


GFSK: Band Edge, Right Side

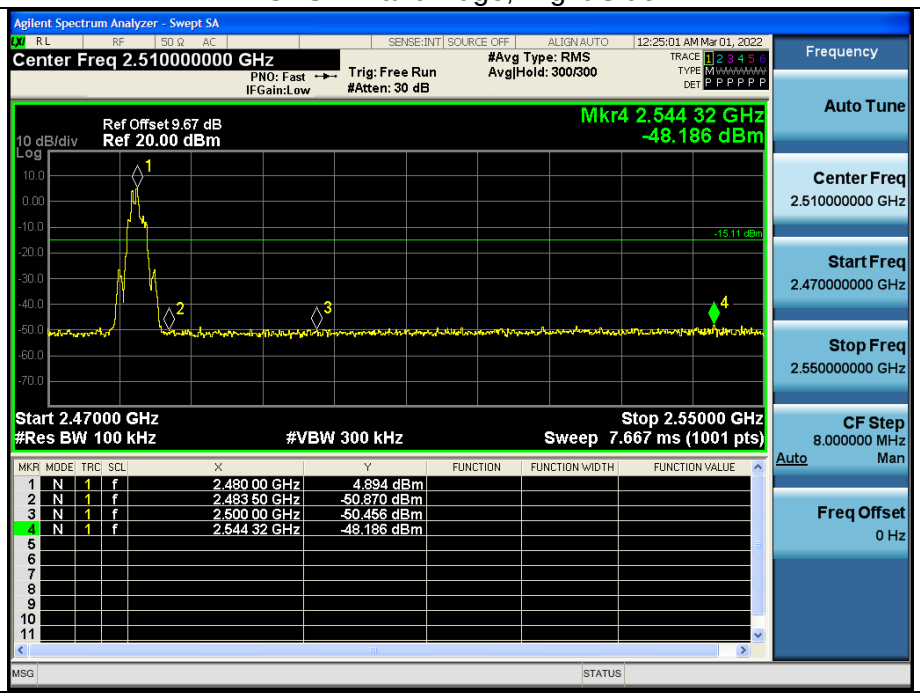


2M:

GFSK: Band Edge, Left Side



GFSK: Band Edge, Right Side



5.9 Duty cycle

5.9.1 Applied procedures / limit

According to RSS-247 5.4(4)

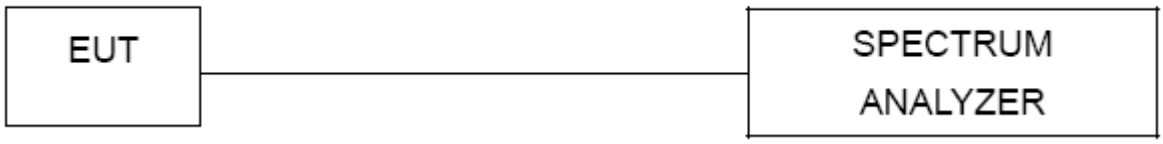
5.9.2 Conformance limit

No limit requirement.

5.9.3 Measuring instruments

The Measuring equipment is listed in the section 4 of this test report.

5.9.4 Test setup



5.9.5 Test procedure

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

The transmitter output is connected to the Spectrum Analyzer. We tested accroding to the zero-span measurement method, 6.0)b) in RSS-247 5.4(4)

The largest availble value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/T.

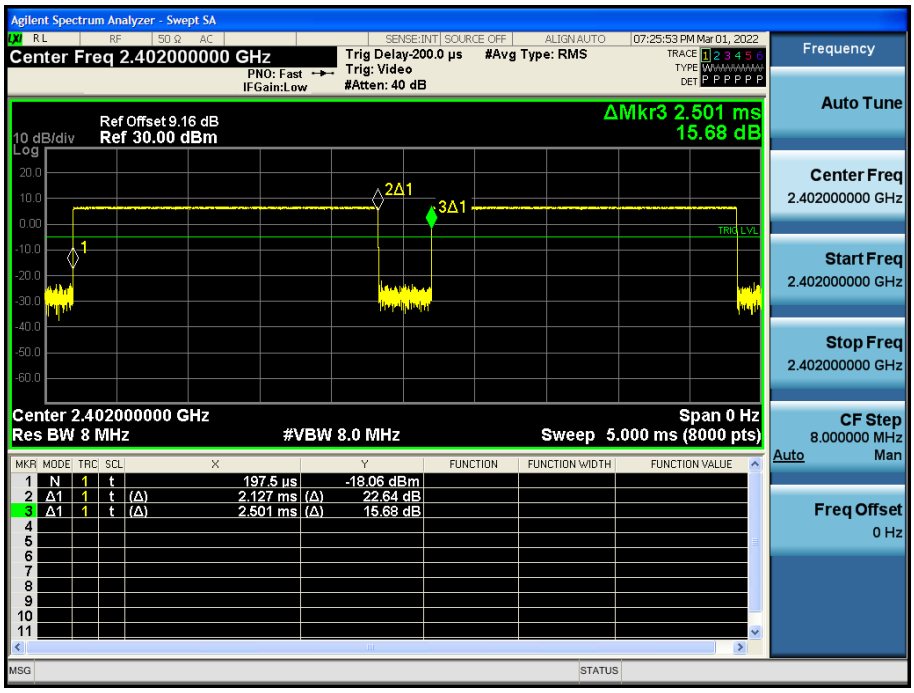
The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator.
The path loss was compensated to the results for each measurement.
Set to the maximum power setting and enable the EUT transmit continuously.
The EUT was operating in controlled its channel.
Use the following spectrum analyzer settings:
Span = Zero Span
RBW = 8MHz(the largest available value)
VBW = 8MHz (≥ RBW)
Number of points in Sweep >100
Detector function = peak
Trace = Clear write
Measure Ttotal and Ton

Calculate Duty Cycle = Ton / Ttotal and Duty Cycle Factor=10*log(1/Duty Cycle)

5.9.6 Test setup

EUT :	Bluetooth 5.0 module	Model Name :	BTM-2801
Pressure :	1012 hPa	Test Voltage :	DC 5V
Test Mode :	TX / CH00		

1M:



2M:

5.10 Spurious rf conducted emissions

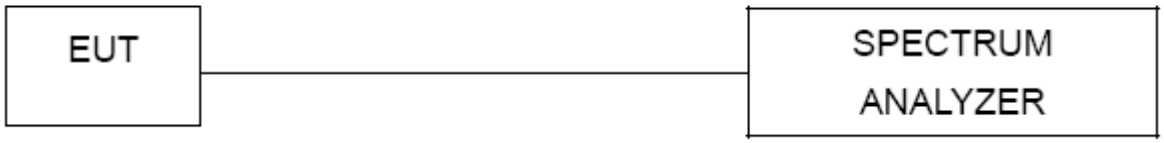
5.10.1 Conformance limit

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in RSS-gen-i5 8.10. The maximum permitted average field strength is listed in RSS-gen-i5 8.9.

5.10.2 Measuring instruments

The Measuring equipment is listed in the section 4 of this test report.

5.10.3 Test setup



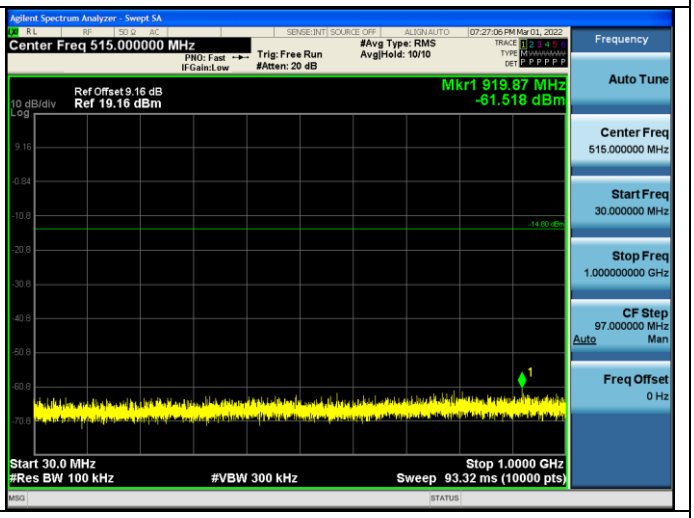
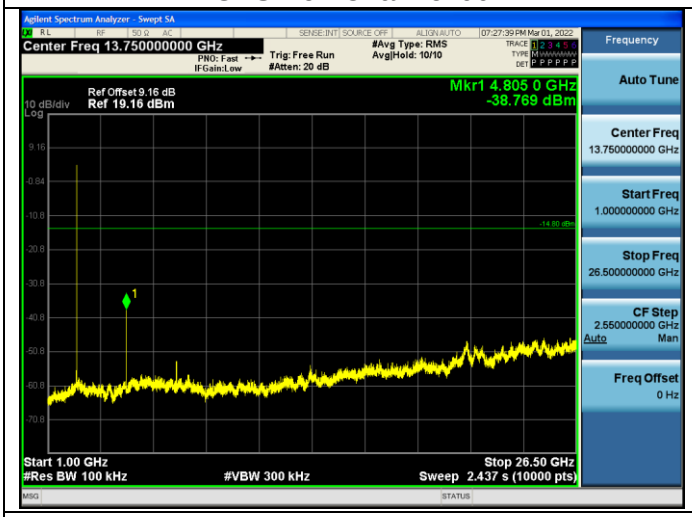
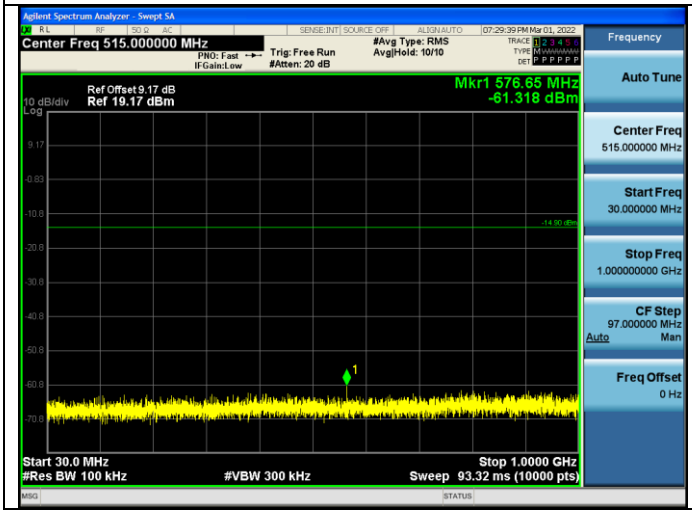
5.10.4 Test procedure

The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=100kHz and VBW= 300KHz to measure the peak field strength , and mwasure frequeny range from 9KHz to 26.5GHz.

5.10.5 Test results

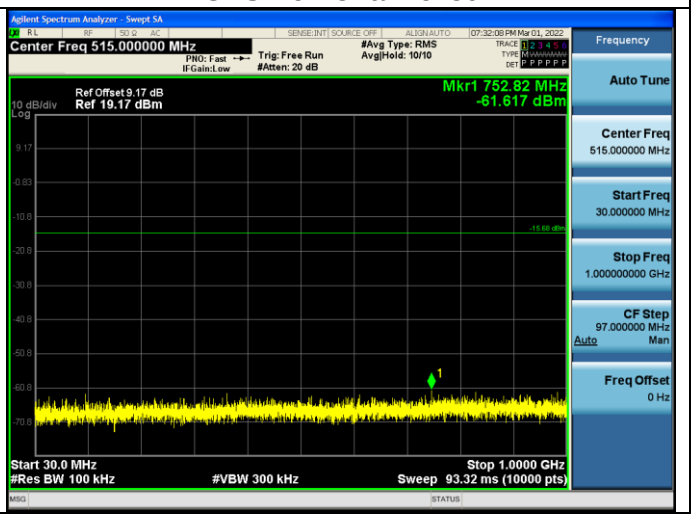
Remark: The measurement frequency range is from 9KHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandege measurement data. The worst mode is GFSK CH00/19/39.

1M:

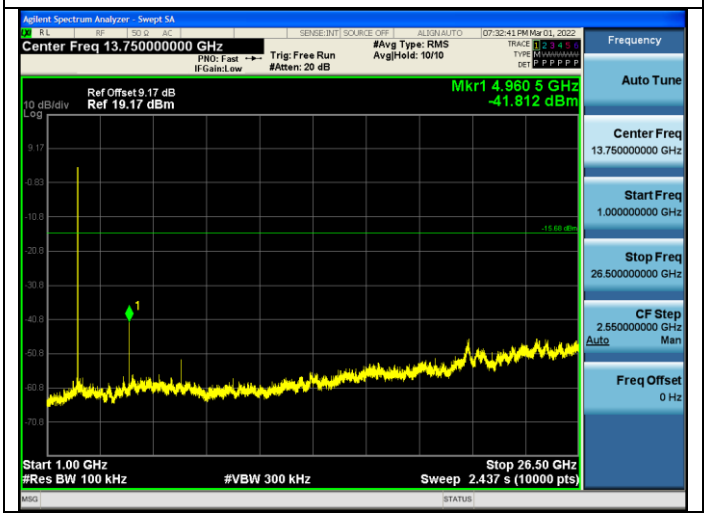
GFSK on Channel 00	GFSK on Channel 00
	
GFSK on Channel 00	**GFSK on Channel 19**
	
GFSK on Channel 19	**GFSK on Channel 19**
	

GFSK on Channel 39

GFSK on Channel 39



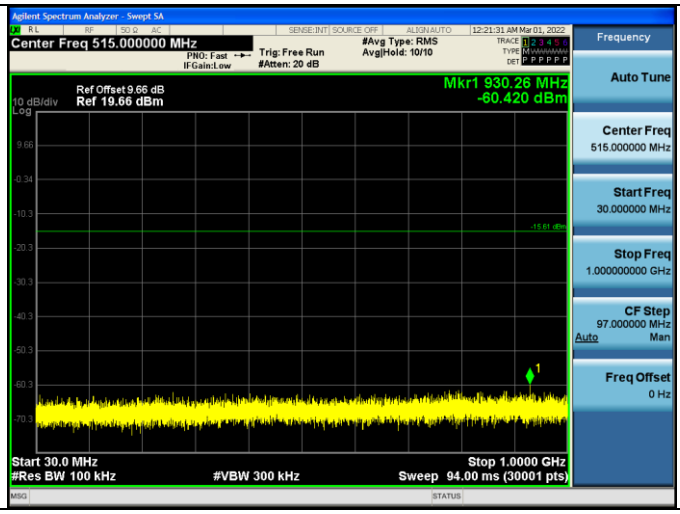
GFSK on Channel 39



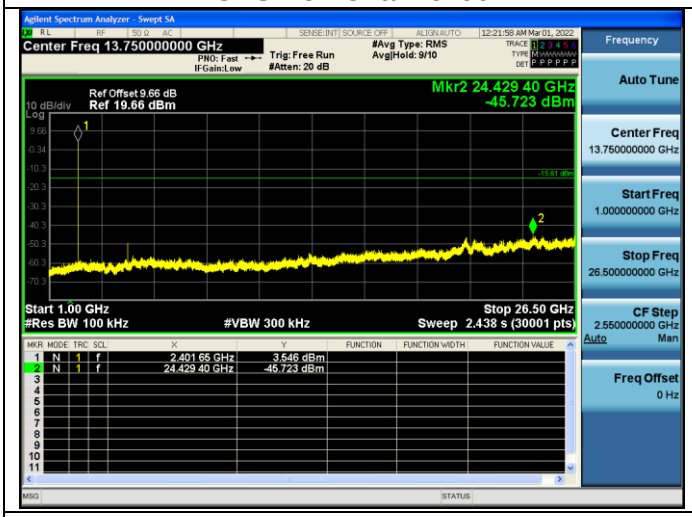
2M:

GFSK on Channel 00

GFSK on Channel 00

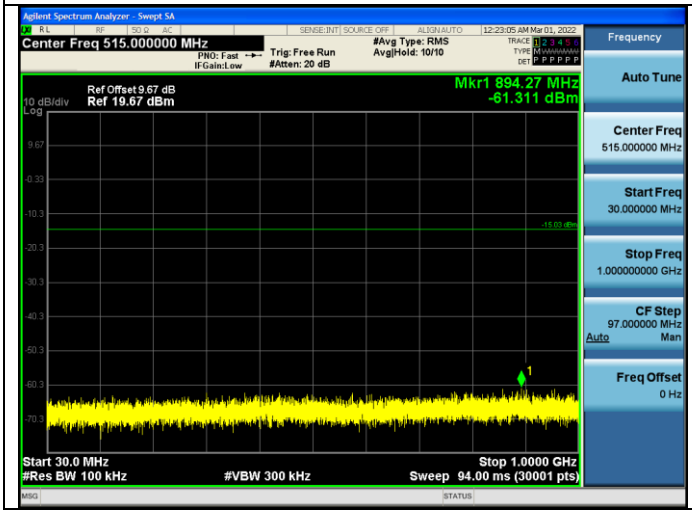


GFSK on Channel 00

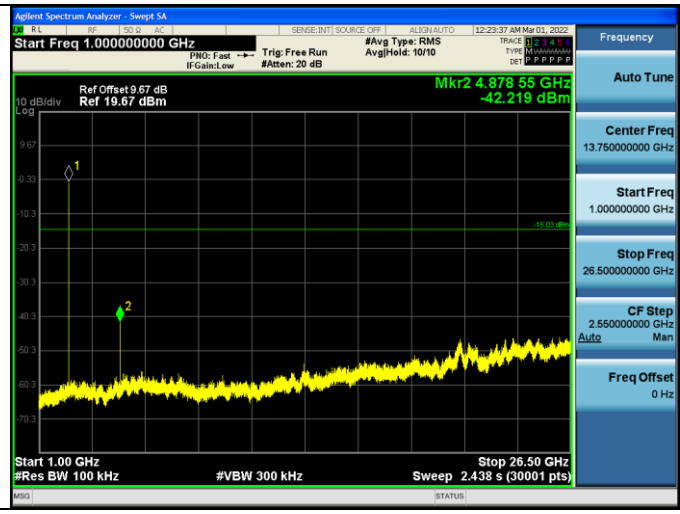


GFSK on Channel 19

GFSK on Channel 19

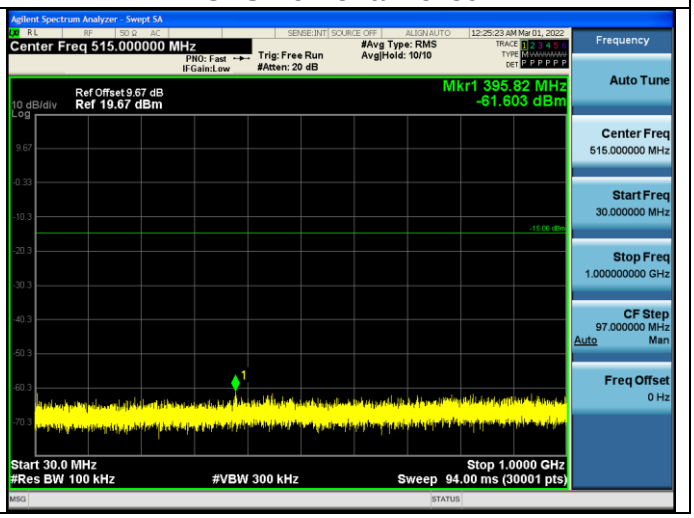


GFSK on Channel 19

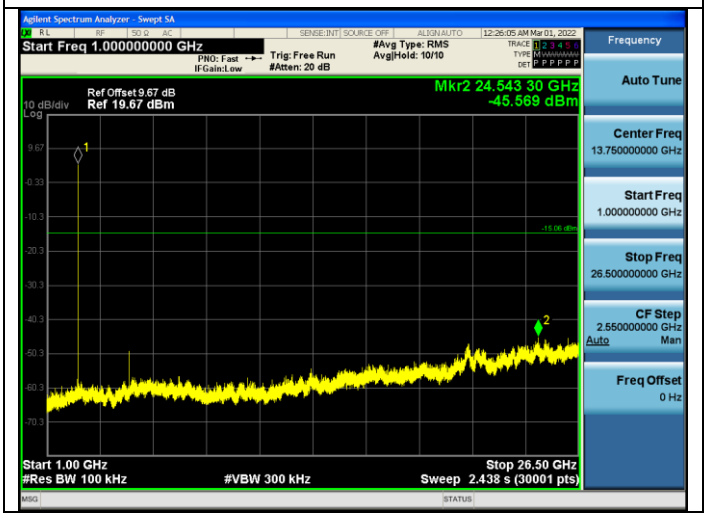


GFSK on Channel 39

GFSK on Channel 39



GFSK on Channel 39



5.11 Antenna application

5.11.1 Standard Requirement

As per RSP-100, each applicant for equipment certification must provide a list of all antenna types that may be used with the transmitter, indicating the maximum permissible antenna gain (in dBi).
When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer. The test report shall state the RF power, output power setting and spurious emission measurements, including the antenna type used.
In addition, applicants shall perform RF power and spurious emission measurements with each antenna type supplied or specified by the manufacturer for use with the transmitter.

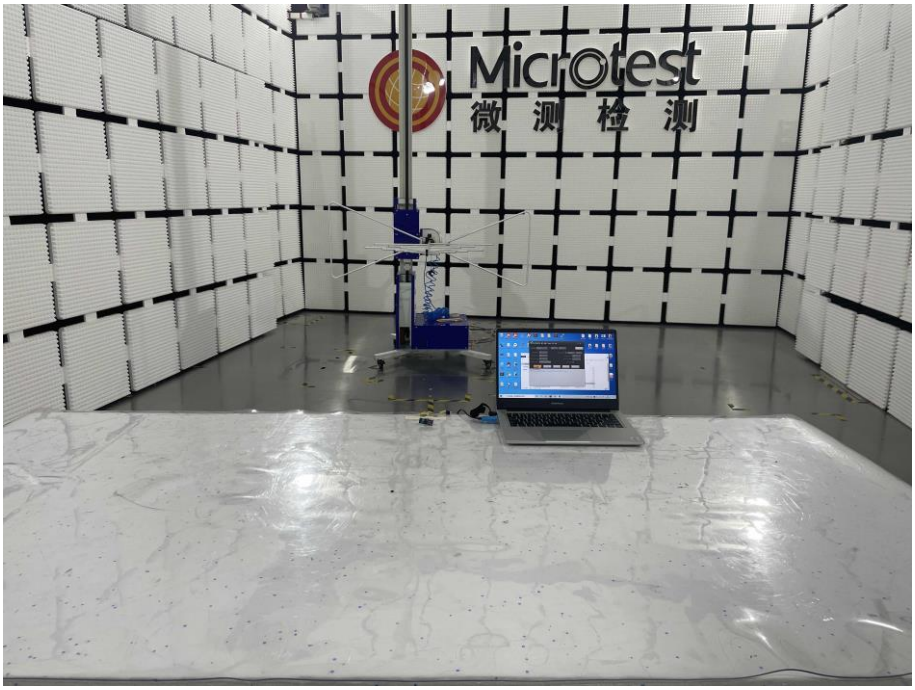
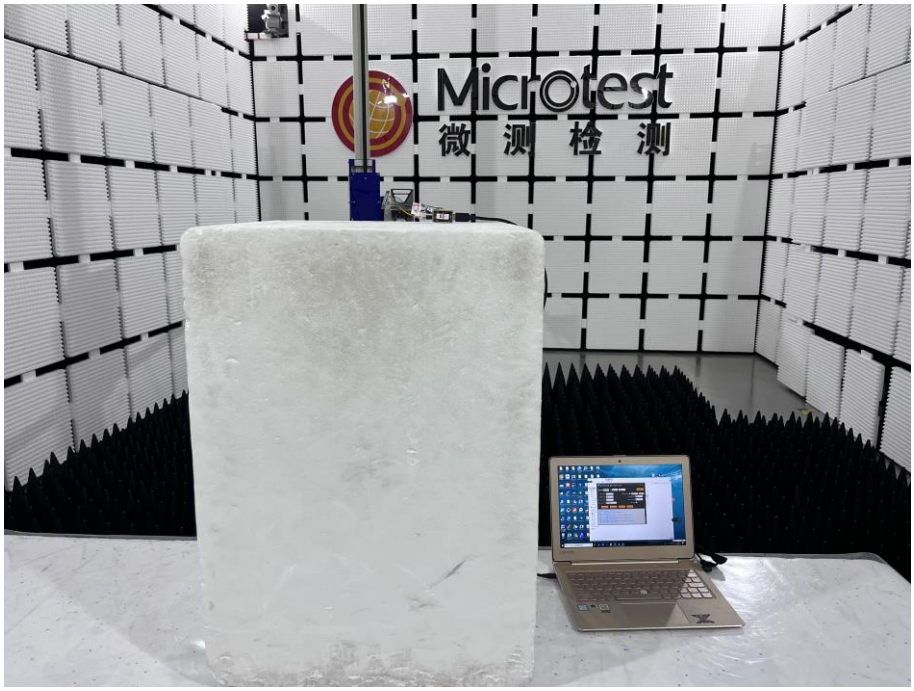
5.11.2 Antenna Anti-Replacement Construction

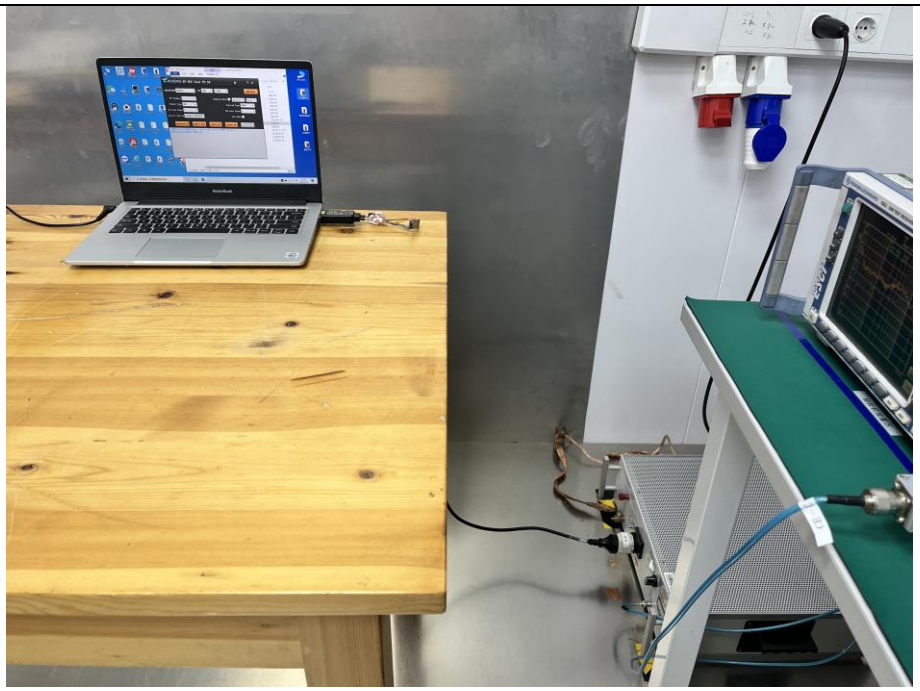
An embedded-in antenna design is used.

5.11.3 Antenna Gain

The antenna is a PCB antenna, peak gain of EUT is (0 dBi),Therefore, it is not necessary to reduce maximum peak output power limit.

Photographs of the Test Setup

Radiated emission



Conducted emission


Photographs of the EUT

See the APPENDIX 1: EUT PHOTO in the report NO.: MTi20062814-9E1-1

----END OF REPORT----