

TEST REPORT

Applicant	Particle Industries, Inc
Address	325 9th Street, San Francisco, CA 94103 United States

Manufacturer or Supplier	Particle Industries, Inc
Address	325 9th Street, San Francisco, CA 94103 United States
Product	Wi-Fi Module
Brand Name	Particle
Model	P2
Additional Model & Model Difference	N/A
Date of tests	Feb. 21, 2021 ~ Apr. 11, 2022

The tests have been carried out according to the requirements of the following standard:

☒ **FCC Part 15, Subpart C, Section 15.247**

CONCLUSION: The submitted sample was found to COMPLY with the test requirement

Tested by Lucas Chen Project Engineer / EMC Department	Approved by Glyn He Assistant Manager / EMC Department
	 Date: May 19, 2022

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Test Report No.: RF2202WDG0092-1

RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
RF2202WDG0092-1	Original release	May 19, 2022

1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC PART 15, SUBPART C (SECTION 15.247)			
STANDARD SECTION	TEST TYPE AND LIMIT	RESULT	REMARK
15.207	AC Power Conducted Emission	PASS	Meet the requirement of limit.
15.205 15.209	Radiated Emission	PASS	Meet the requirement of limit.
15.247(d)	Out of band Emission Measurement	PASS	Meet the requirement of limit.
15.247(a)(2)	6dB bandwidth	PASS	Meet the requirement of limit.
15.247(b)	Conducted Output power	PASS	Meet the requirement of limit.
15.247(e)	Power Spectral Density	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	Meet the requirement of limit.

2 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

MEASUREMENT	FREQUENCY	UNCERTAINTY
Conducted emissions	0.15MHz ~ 30MHz	3.05dB
Radiated emissions	9KHz ~ 30MHz	2.16dB
	30MHz ~ 1GMHz	3.82dB
	1GHz ~ 18GHz	4.94dB
	18GHz ~ 40GHz	5.07dB

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

3 GENERAL INFORMATION

3.1 GENERAL DESCRIPTION OF EUT

PRODUCT	Wi-Fi Module
MODEL NO.	P2
ADDITIONAL MODEL	N/A
FCC ID	2AEMI-P2
NOMINAL VOLTAGE	DC 3.3V
MODULATION TECHNOLOGY	DTS
MODULATION TYPE	GFSK (1& 2Mbps)
OPERATING FREQUENCY	2402-2480MHz
PEAK OUTPUT POWER	9.354mW (Max. Measured)
ANTENNA TYPE	PCB Antenna, 2.41dBi Gain External PCB Antenna, 1.55dBi Gain
I/O PORTS	Refer to user's manual
CABLE SUPPLIED	N/A

NOTES:

- For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
- For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.
- Please refer to the EUT photo document (Reference No.: 2202WDG0092-1) for detailed product photo.
- The Wi-Fi Module uses two antennas, but couldn't transmit simultaneously, the antenna type and gain are different, and the antenna port is the same, so the RF conducted output power is the same. Radiated emission and conducted emission have been evaluated for both antennas respectively, but only the worst antenna data (PCB antenna) is shown in the test report.
- The EUT provides completed transmitters and receivers, the EUT uses only one antenna at any time.

MODULATION MODE	TX FUNCTION
BLE (1&2Mbps)	1TX/1RX

3.2 DESCRIPTION OF TEST MODES

40 channels are provided for BT-LE (1, 2 Mbps):

CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (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

3.2.1. CONFIGURATION OF SYSTEM UNDER TEST

Please see section 5 photographs of the test configuration for reference.

3.2.2. TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis, power supply voltage range and antenna ports. The worst case was found when positioned on X axis for radiated emission. Following test modes were selected for the final test, and the final worst case is marked in boldface and recorded in the report:

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE<1G	RE≥1G	PLC	APCM	
A	√	√	√	√	Powered by DC 3.3V from PCB base support with BT link

Where

RE<1G: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission

RE≥1G: Radiated Emission above 1GHz
APCM: Antenna Port Conducted Measurement

POWER LINE CONDUCTED EMISSION TEST:

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, antenna ports (if EUT with antenna diversity architecture), and packet types.
- ☒ Following channels were selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
0 to 39	BT Link	DTS	GFSK	1
0 to 39	BT Link	DTS	GFSK	2

For the test results, only the worst case was shown in test report.

RADIATED EMISSION TEST (BELOW 1GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channels were selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
BT-LE	0 to 39	39	DTS	GFSK	1
BT-LE	0 to 39	39	DTS	GFSK	2

For the test results, only the worst case was shown in test report.

RADIATED EMISSION TEST (ABOVE 1GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channels were selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
BT-LE	0 to 39	0,19, 39	DTS	GFSK	1
BT-LE	0 to 39	0,19, 39	DTS	GFSK	2

ANTENNA PORT CONDUCTED MEASUREMENT:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channels were selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
BT-LE	0 to 39	0, 19, 39	DTS	GFSK	1
BT-LE	0 to 39	0, 19, 39	DTS	GFSK	2

TEST CONDITION:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	TEST VOLTAGE	TESTED BY
RE<1G	25deg. C, 55%RH	DC 3.3V from PCB base support	Jelly
RE≥1G	25deg. C, 55%RH	DC 3.3V from PCB base support	Jelly
PLC	25deg. C, 58%RH	DC 3.3V from PCB base support	Summer
APCM	25deg. C, 58%RH	DC 3.3V from PCB base support	Vincent

3.3 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C, Section 15.247

558074 D01 15.247 Meas Guidance v05r02

ANSI C63.10-2013

Note: All test items have been performed and recorded as per the above standards.

3.4 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.

NO.	PRODUCT	BRAND	MODEL NO.	SERIAL NO.	FCC ID
1	Notebook	DELL	Inspiron 13-7378	GMSJZD2	N/A
2	PCB base support	N/A	N/A	N/A	N/A

NO.	SIGNAL CABLE DESCRIPTION OF THE ABOVE SUPPORT UNITS
1	AC Line: Unshielded, Detachable 0.8m; DC Line: Unshielded, Non-detachable 1.8m; USB Cable: Shielded, Detachable, 0.5m
2	N/A

4 TEST TYPES AND RESULTS

4.1 CONDUCTED EMISSION MEASUREMENT

4.1.1 LIMITS OF CONDUCTED EMISSION MEASUREMENT

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dB μ V)	
	Quasi-peak	Average
0.15 ~ 0.5	66 to 56	56 to 46
0.5 ~ 5	56	46
5 ~ 30	60	50

- NOTES:**
1. The lower limit shall apply at the transition frequencies.
 2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.
 3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.1.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESR7	101494	Jan. 18,23
Artificial Mains Network	Rohde&Schwarz	ENV216	101173	Jan. 23,23
Artificial Mains Network	Rohde&Schwarz	ESH3-Z5	100317	Jan. 18,23
Voltage probe	SCHWARZBECK	TK 9421	TK 9421-176	Aug. 05,22
Coaxial RF Cable	/	CE CABLE	C2310066DG	Jul. 27,22
Test software	ADT	ADT_Cond_V7.3.7	N/A	N/A

- NOTES:**
1. The test was performed in shielded room 553.
 2. The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.1.3 TEST PROCEDURES

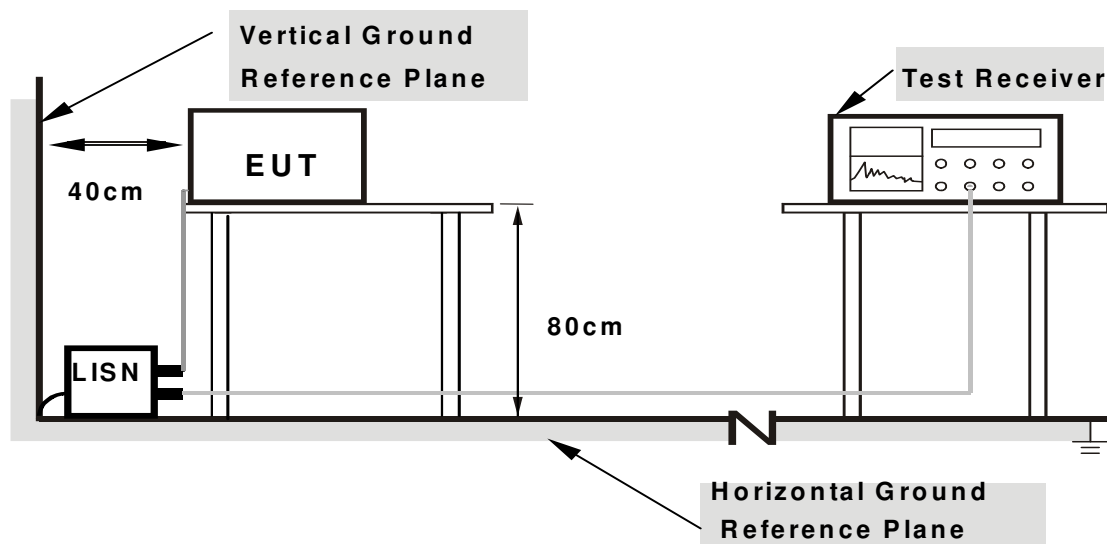
- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 DEVIATION FROM TEST STANDARD

No deviation.

4.1.5 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 cm from other units and other metal planes

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT OPERATING CONDITIONS

- a. Turned on the power and connected of all equipment.
- b. EUT was operated according to the type used was description in manufacturer's specifications or the User's Manual.

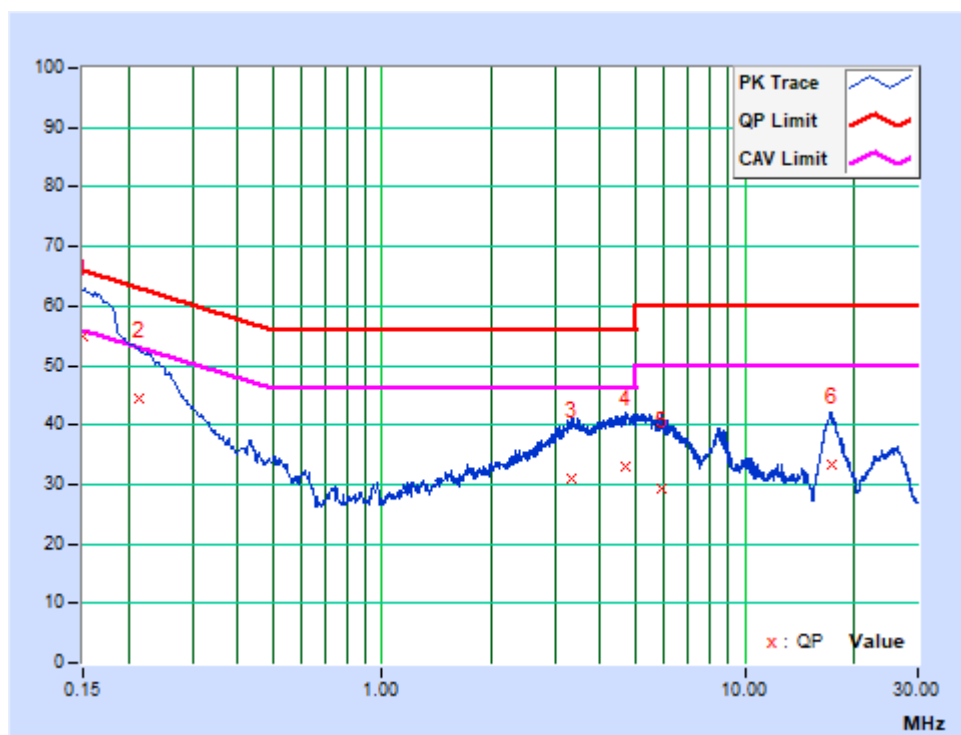
4.1.7 TEST RESULTS

CONDUCTED DATA: BT Link (Worst-case PCB Antenna)

PHASE	Line	6dB BANDWIDTH	9kHz
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No.	Freq.	Corr.	Reading Value		Emission Level		Limit		Margin	
	[MHz]	Factor	[dB (uV)]		[dB (uV)]		[dB (uV)]		(dB)	
		(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.90	44.85	10.65	54.75	20.55	66.00	56.00	-11.25	-35.45
2	0.21300	9.92	34.37	13.73	44.29	23.65	63.09	53.09	-18.79	-29.43
3	3.31800	10.14	20.99	14.55	31.13	24.69	56.00	46.00	-24.87	-21.31
4	4.70400	10.17	22.76	16.75	32.93	26.92	56.00	46.00	-23.07	-19.08
5	5.88750	10.21	19.13	14.28	29.34	24.49	60.00	50.00	-30.66	-25.51
6	17.27470	10.45	22.88	13.60	33.33	24.05	60.00	50.00	-26.67	-25.95

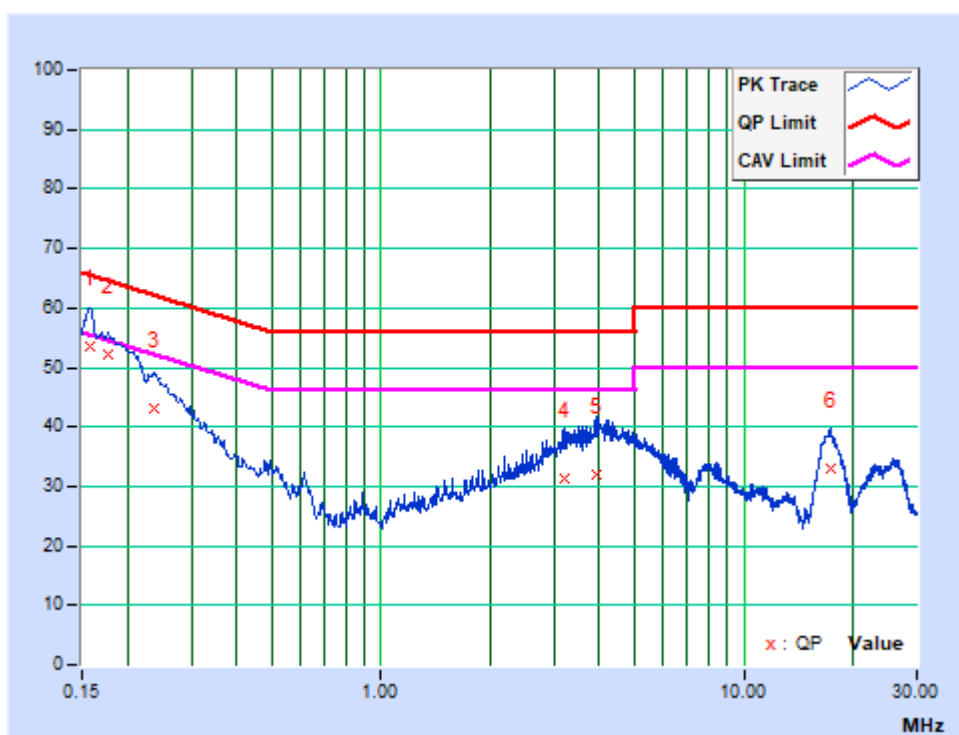
REMARKS: The emission levels of other frequencies were very low against the limit.



PHASE	Neutral	6dB BANDWIDTH	9kHz
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No.	Freq.	Corr.	Reading Value		Emission Level		Limit		Margin	
	[MHz]	Factor	[dB (uV)]		[dB (uV)]		[dB (uV)]		(dB)	
		(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15715	9.84	43.58	11.85	53.42	21.69	65.61	55.61	-12.19	-33.92
2	0.17698	9.85	42.32	22.91	52.17	32.76	64.63	54.63	-12.46	-21.87
3	0.23662	9.85	33.38	13.58	43.23	23.43	62.21	52.21	-18.98	-28.78
4	3.21450	9.93	21.29	14.44	31.22	24.37	56.00	46.00	-24.78	-21.63
5	3.93675	9.95	22.11	15.64	32.06	25.59	56.00	46.00	-23.94	-20.41
6	17.33100	10.29	22.76	13.70	33.05	23.99	60.00	50.00	-26.95	-26.01

REMARKS: The emission levels of other frequencies were very low against the limit.





4.2 RADIATED EMISSION MEASUREMENT

4.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

FREQUENCIES (MHz)	FIELD STRENGTH (microvolts/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

NOTES:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.2.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESU40	100449	Mar. 07, 23
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV7	102331	May 09, 22
Active Loop Antenna (9KHz -30MHz)	SCHWARZBECK	FMZB 1519B	1519B-045	May 20, 22
Amplifier (9KHz -1GHz)	Burgeon	BPA-530	100210	Mar. 13, 23
Bilog Antenna (20MHz -2GHz)	Teseq	CBL 6111D	30643	May 21, 22
Horn Antenna (1GHz -18GHz)	ETS -Lindgren	3117	00062558	May 21, 22
Horn Antenna (18GHz -40GHz)	SCHWARZBECK	BBHA 9170	BBHA9170147	May 14, 22
3m Semi-anechoic Chamber	ETS-LINDGREN	9m*6m*6m	NSEMC003	May 22, 22
Test Software	ADT	ADT_Radiated_V 7.6.15.9.2	N/A	N/A
Broadband Preamplifier (1GHz~18GHz)	SCHWARZBECK	BBV9718	305	May 12, 22
Pre-Amplifier (18GHz-40GHz)	EMCI	EMC 184045	980102	Jan. 10, 23
Test Software	ADT	ADT_Radiated_V 7.6.15.9.2	N/A	N/A
BLUETOOTH TESTER	Rohde&Schwarz	CBT32	100811	N/A

NOTES:

1. The test was performed in 966 Chamber.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GREGT/CHINA and NIM/CHINA.
3. The horn antenna is used only for the measurement of emission frequency above 1GHz if tested.
4. The FCC Site Registration No. is 749762.

4.2.3 TEST PROCEDURES

- a. The EUT was placed on the top of a rotating table 1.5 meters (above 1GHz) and 0.8 meters (below 1GHz) above the ground at a 3 meters semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna is a broadband antenna, and its 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.
- d. 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 and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. For below 30MHz, a loop antenna with its vertical plane is place 3m from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. And the centre of the loop shall be 1m above the ground.
- g. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, For battery operated equipment, the equipment tests shall be perform using fresh batteries. The turntable was rotated to maximize the emission level.

NOTES:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and video bandwidth is 3MHz for Peak detection at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or 10Hz(Duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.
5. The testing of the EUT was performed on all 3 orthogonal axes; the worst-case test configuration was reported on the file test setup photo.

4.2.4 DEVIATION FROM TEST STANDARD

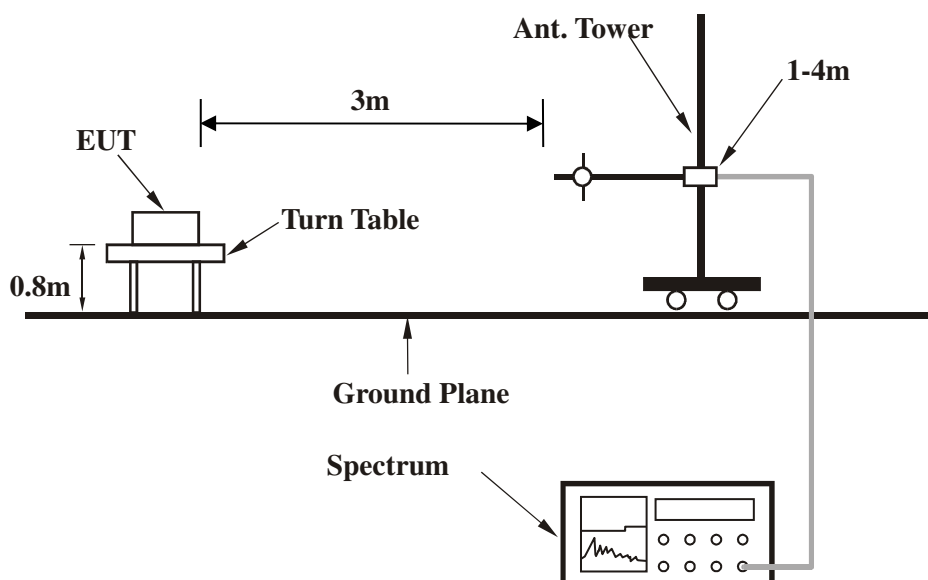
No deviation.

4.2.5 TEST SETUP

Below 30MHz test setup



Below 1GHz test setup



Note: For the actual test configuration, please refer to the attached file (Test Setup Photo).

Above 1GHz test setup



Note: For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT OPERATING CONDITIONS

- Set the EUT under full load condition and placed them on a testing table.
- Set the transmitter part of EUT under transmission condition continuously at specific channel frequency.
- The necessary accessories enable the EUT in full functions.



4.2.7 TEST RESULTS

BELOW 1GHz WORST-CASE DATA:

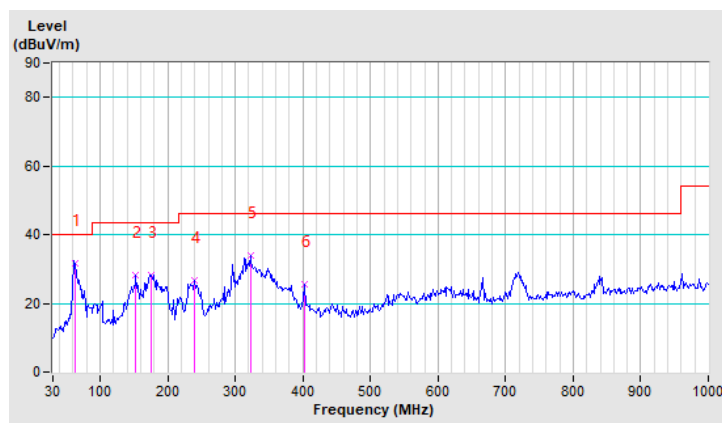
BT-LE GFSK (1Mbps)

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9KHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	62.64	31.69 QP	40.00	-8.31	1.00 H	215	50.17	-18.48
2	152.80	28.36 QP	43.50	-15.14	1.00 H	157	45.03	-16.67
3	176.12	28.13 QP	43.50	-15.37	1.00 H	36	46.01	-17.88
4	239.86	26.81 QP	46.00	-19.19	1.00 H	206	44.39	-17.58
5	322.24	33.93 QP	46.00	-12.07	1.00 H	87	48.97	-15.04
6	401.52	25.45 QP	46.00	-20.55	1.00 H	45	38.40	-12.95

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. 9KHz~30MHz have been test and test data more than 20dB margin.
5. Margin value = Emission level – Limit value

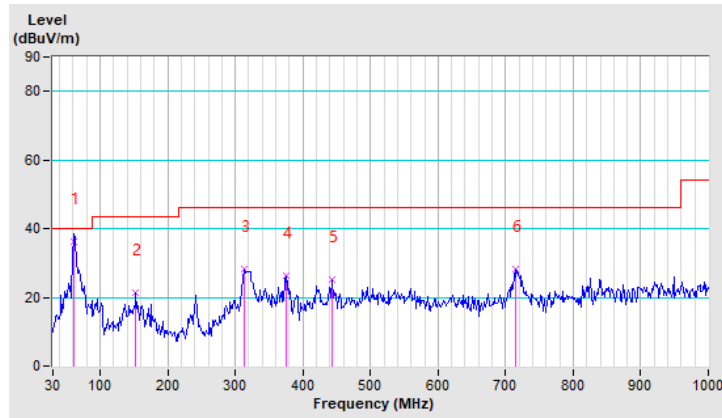


CHANNEL	TX Channel 39	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9KHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	61.09	36.25 QP	40.00	-3.75	1.00 V	69	54.62	-18.37
2	152.80	21.31 QP	43.50	-22.19	1.00 V	45	37.98	-16.67
3	312.92	28.35 QP	46.00	-17.65	1.00 V	128	43.62	-15.27
4	375.10	26.36 QP	46.00	-19.64	1.00 V	324	40.03	-13.67
5	443.49	25.25 QP	46.00	-20.75	1.00 V	88	37.18	-11.93
6	713.97	28.07 QP	46.00	-17.93	1.00 V	241	34.55	-6.48

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. 9KHz~30MHz have been test and test data more than 20dB margin.
5. Margin value = Emission level – Limit value



ABOVE 1GHz TEST DATA:

BT-LF GFSK (1Mbps)

CHANNEL	TX Channel 0	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE : HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	51.30 PK	74.00	-22.70	1.00 H	56	50.76	0.54
2	2390.00	35.84 AV	54.00	-18.16	1.00 H	56	35.30	0.54
3	*2402.00	106.36 PK			1.00 H	56	105.78	0.58
4	*2402.00	104.75 AV			1.00 H	56	104.17	0.58
5	4804.00	50.21 PK	74.00	-23.79	1.00 H	301	44.90	5.31
6	4804.00	37.51 AV	54.00	-16.49	1.00 H	301	32.20	5.31
7	#7206.00	51.03 PK	74.00	-22.97	1.05 H	207	41.33	9.70
8	#7206.00	39.10 AV	54.00	-14.90	1.05 H	207	29.40	9.70
ANTENNA POLARITY & TEST DISTANCE : VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	Peak (PK) Average (AV)
1	2390.00	50.36 PK	74.00	-23.64	1.00 V	125	49.82	0.54
2	2390.00	35.10 AV	54.00	-18.90	1.00 V	125	34.56	0.54
3	*2402.00	104.36 PK			1.00 V	125	103.78	0.58
4	*2402.00	103.20 AV			1.00 V	125	102.62	0.58
5	4804.00	48.63 PK	74.00	-25.37	1.00 V	129	43.32	5.31
6	4804.00	36.51 AV	54.00	-17.49	1.00 V	129	31.20	5.31
7	#7206.00	50.12 PK	74.00	-23.88	1.05 V	71	40.42	9.70
8	#7206.00	38.57 AV	54.00	-15.43	1.05 V	71	28.87	9.70

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 19	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE : HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2440.00	103.21 PK			1.00 H	204	102.49	0.72
2	*2440.00	102.70 AV			1.00 H	204	101.98	0.72
3	4880.00	48.26 PK	74.00	-25.74	1.00 H	69	42.87	5.39
4	4880.00	36.24 AV	54.00	-17.76	1.00 H	69	30.85	5.39
5	7320.00	49.26 PK	74.00	-24.74	1.00 H	70	39.48	9.78
6	7320.00	36.84 AV	54.00	-17.16	1.00 H	70	27.06	9.78
ANTENNA POLARITY & TEST DISTANCE : VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2440.00	105.32 PK			1.06 V	36	104.60	0.72
2	*2440.00	104.10 AV			1.06 V	36	103.38	0.72
3	4880.00	48.63 PK	74.00	-25.37	1.00 V	105	43.24	5.39
4	4880.00	35.62 AV	54.00	-18.38	1.00 V	105	30.23	5.39
5	7320.00	50.36 PK	74.00	-23.64	1.00 V	119	40.58	9.78
6	7320.00	37.48 AV	54.00	-16.52	1.00 V	119	27.70	9.78

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE : HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	105.36 PK			1.05 H	14	104.49	0.87
2	*2480.00	104.68 AV			1.05 H	14	103.81	0.87
3	2483.50	55.36 PK	74.00	-18.64	1.05 H	14	54.47	0.89
4	2483.50	42.36 AV	54.00	-11.64	1.05 H	14	41.47	0.89
5	4960.00	48.36 PK	74.00	-25.64	1.00 H	58	42.87	5.49
6	4960.00	36.51 AV	54.00	-17.49	1.00 H	58	31.02	5.49
7	7440.00	49.36 PK	74.00	-24.64	1.20 H	69	39.50	9.86
8	7440.00	38.15 AV	54.00	-15.85	1.20 H	69	28.29	9.86
ANTENNA POLARITY & TEST DISTANCE : VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	103.10 PK			1.00 V	158	102.23	0.87
2	*2480.00	102.36 AV			1.00 V	158	101.49	0.87
3	2483.50	54.10 PK	74.00	-19.90	1.00 V	158	53.21	0.89
4	2483.50	40.39 AV	54.00	-13.61	1.00 V	158	39.50	0.89
5	4960.00	47.40 PK	74.00	-26.60	1.00 V	70	41.91	5.49
6	4960.00	36.01 AV	54.00	-17.99	1.00 V	70	30.52	5.49
7	7440.00	48.61 PK	74.00	-25.39	1.03 V	107	38.75	9.86
8	7440.00	37.99 AV	54.00	-16.01	1.03 V	107	28.13	9.86

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.

BT-LE GFSK (2Mbps)

CHANNEL	TX Channel 0	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE : HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	50.36 PK	74.00	-23.64	1.00 H	159	49.82	0.54
2	2390.00	36.48 AV	54.00	-17.52	1.00 H	159	35.94	0.54
3	*2402.00	105.32 PK			1.00 H	159	104.74	0.58
4	*2402.00	104.36 AV			1.00 H	159	103.78	0.58
5	4804.00	49.59 PK	74.00	-24.41	1.00 H	114	44.28	5.31
6	4804.00	37.10 AV	54.00	-16.90	1.00 H	114	31.79	5.31
7	#7206.00	50.36 PK	74.00	-23.64	1.51 H	28	40.66	9.70
8	#7206.00	40.36 AV	54.00	-13.64	1.51 H	28	30.66	9.70
ANTENNA POLARITY & TEST DISTANCE : VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	49.36 PK	74.00	-24.64	1.00 V	206	48.82	0.54
2	2390.00	35.71 AV	54.00	-18.29	1.00 V	206	35.17	0.54
3	*2402.00	103.21 PK			1.00 V	206	102.63	0.58
4	*2402.00	102.51 AV			1.00 V	206	101.93	0.58
5	4804.00	49.20 PK	74.00	-24.80	1.00 V	158	43.89	5.31
6	4804.00	36.69 AV	54.00	-17.31	1.00 V	158	31.38	5.31
7	#7206.00	49.81 PK	74.00	-24.19	1.03 V	70	40.11	9.70
8	#7206.00	40.02 AV	54.00	-13.98	1.03 V	70	30.32	9.70

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 19	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE : HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2440.00	104.62 PK			1.01 H	91	103.90	0.72
2	*2440.00	102.71 AV			1.01 H	91	101.99	0.72
3	4880.00	50.15 PK	74.00	-23.85	1.00 H	76	44.76	5.39
4	4880.00	38.51 AV	54.00	-15.49	1.00 H	76	33.12	5.39
5	7320.00	51.84 PK	74.00	-22.16	1.00 H	207	42.06	9.78
6	7320.00	41.36 AV	54.00	-12.64	1.00 H	207	31.58	9.78
ANTENNA POLARITY & TEST DISTANCE : VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2440.00	102.36 PK			1.21 V	309	101.64	0.72
2	*2440.00	101.39 AV			1.21 V	309	100.67	0.72
3	4880.00	49.62 PK	74.00	-24.38	1.00 V	201	44.23	5.39
4	4880.00	37.48 AV	54.00	-16.52	1.00 V	201	32.09	5.39
5	7320.00	51.36 PK	74.00	-22.64	1.00 V	84	41.58	9.78
6	7320.00	40.15 AV	54.00	-13.85	1.00 V	84	30.37	9.78

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.



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VERITAS**

Test Report No.: RF2202WDG0092-1

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE : HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	102.36 PK			1.00 H	269	101.49	0.87
2	*2480.00	100.71 AV			1.00 H	269	99.84	0.87
3	2483.50	56.36 PK	74.00	-17.64	1.00 H	269	55.47	0.89
4	2483.50	43.15 AV	54.00	-10.85	1.00 H	269	42.26	0.89
5	4960.00	48.63 PK	74.00	-25.37	1.00 H	108	43.14	5.49
6	4960.00	36.95 AV	54.00	-17.05	1.00 H	108	31.46	5.49
7	7440.00	49.81 PK	74.00	-24.19	1.55 H	304	39.95	9.86
8	7440.00	38.16 AV	54.00	-15.84	1.55 H	304	28.30	9.86
ANTENNA POLARITY & TEST DISTANCE : VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	100.84 PK			1.00 V	46	99.97	0.87
2	*2480.00	99.02 AV			1.00 V	46	98.15	0.87
3	2483.50	55.41 PK	74.00	-18.59	1.00 V	46	54.52	0.89
4	2483.50	42.19 AV	54.00	-11.81	1.00 V	46	41.30	0.89
5	4960.00	47.51 PK	74.00	-26.49	1.00 V	204	42.02	5.49
6	4960.00	35.48 AV	54.00	-18.52	1.00 V	204	29.99	5.49
7	7440.00	48.69 PK	74.00	-25.31	1.07 V	205	38.83	9.86
8	7440.00	37.61 AV	54.00	-16.39	1.07 V	205	27.75	9.86

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.

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4.3 6dB BANDWIDTH MEASUREMENT

4.3.1 LIMITS OF 6dB BANDWIDTH MEASUREMENT

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

4.3.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
Power Sensor	Keysight	U2021XA	MY57320002	Feb.23.23
Power Sensor	Keysight	U2021XA	MY55060018	May 09, 22
Power Meter	Anritsu	ML2495A	1139001	Feb. 24, 22
Power Sensor	Anritsu	MA2411B	1531155	Feb. 24, 22
Digital Multimeter	FLUKE	15B	A1220010DG	N/A
Humid & Temp Programmable Tester	Haida	HD-225T	110807201	Nov. 03, 22
Oscilloscope	Agilent	DSO9254A	MY51260160	Aug. 11, 22
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV40	101094	Jan. 16, 23
Signal Generator	Agilent	N5183A	MY50140980	Mar 23, 23
MXG-B RF Vector Signal Generator	Keysight	N5182B	MY56200288	Sep. 14, 22
BLUETOOTH TESTER	Rohde&Schwarz	CBT32	100811	N/A
Attenuator	MINI	BW-S10W2+	S130129FGE2	N/A
DC Source	Keysight	E3642A	MY56146098	N/A
Test software	ADT	ADT_RF Test Software V6.6.5.3	N/A	N/A

NOTES:

1. The test was performed in RF Oven room.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

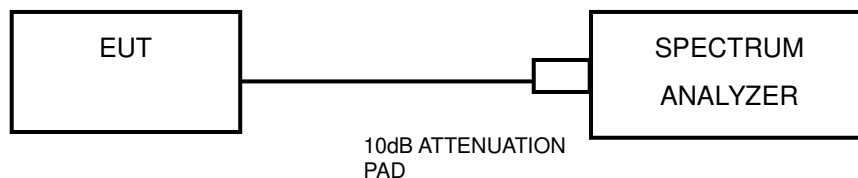
4.3.3 TEST PROCEDURE

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.

4.3.4 DEVIATION FROM TEST STANDARD

No deviation.

4.3.5 TEST SETUP



4.3.6 EUT OPERATING CONDITIONS

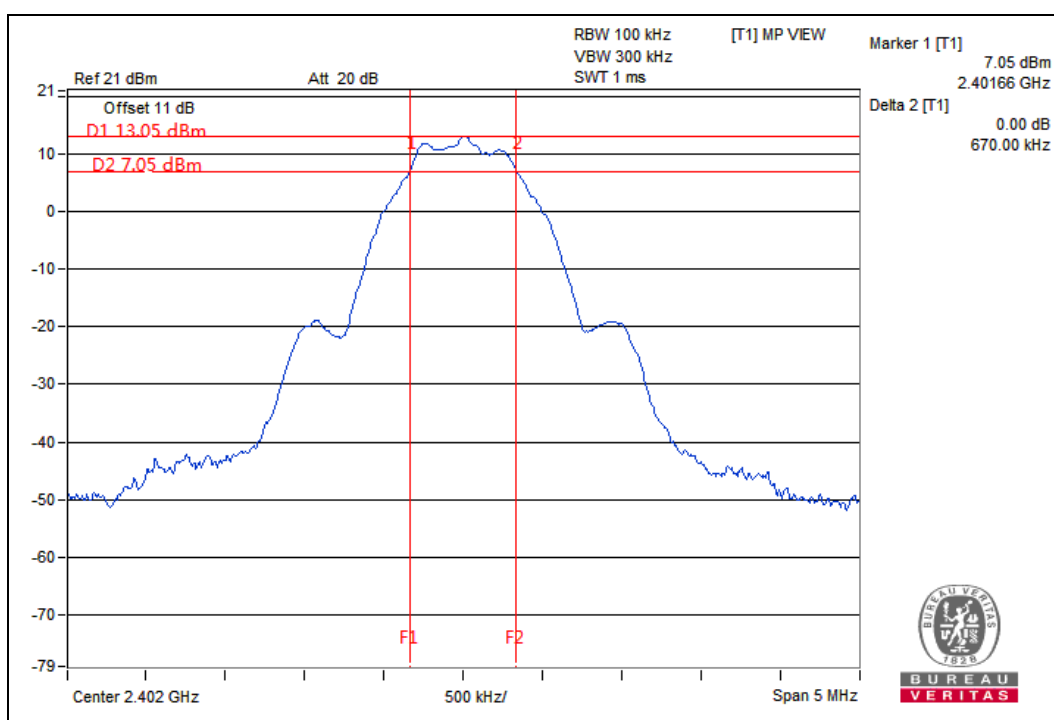
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 TEST RESULTS

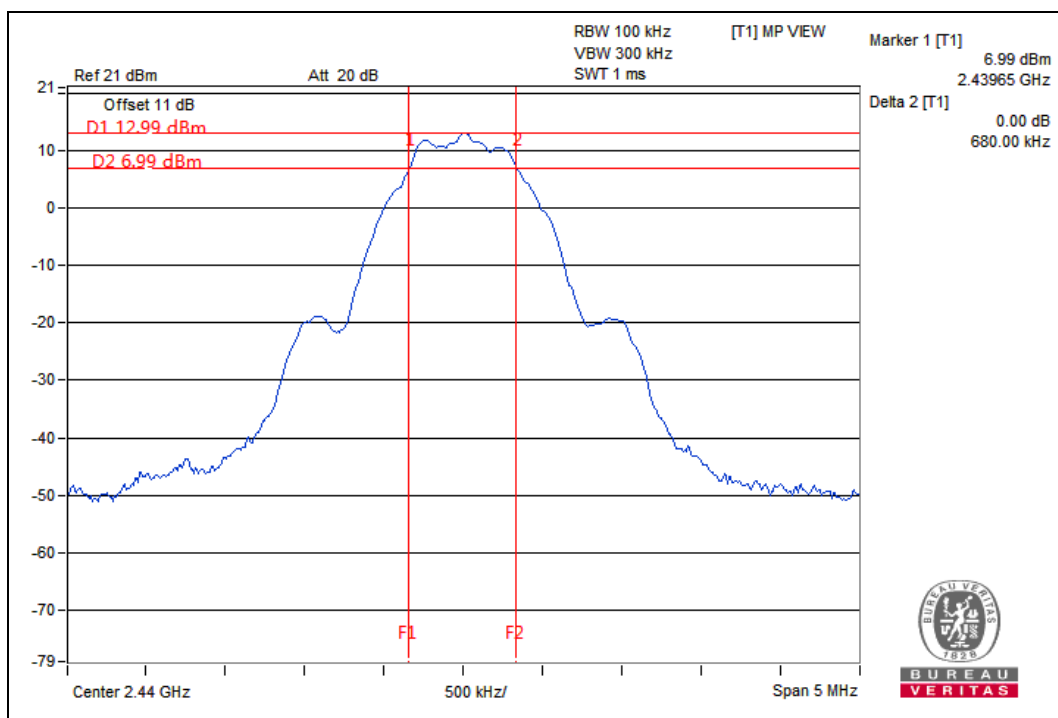
BT-LE GFSK (1Mbps)

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS / FAIL
0	2402	0.67	0.5	PASS
19	2440	0.68	0.5	PASS
39	2480	0.68	0.5	PASS

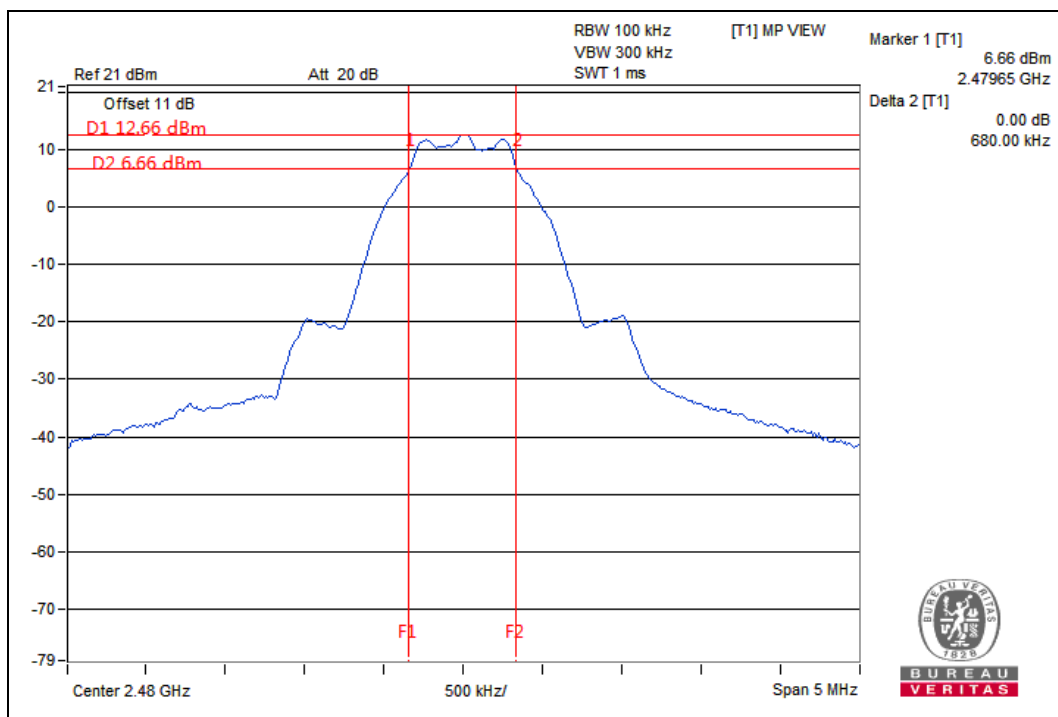
CH0



CH19



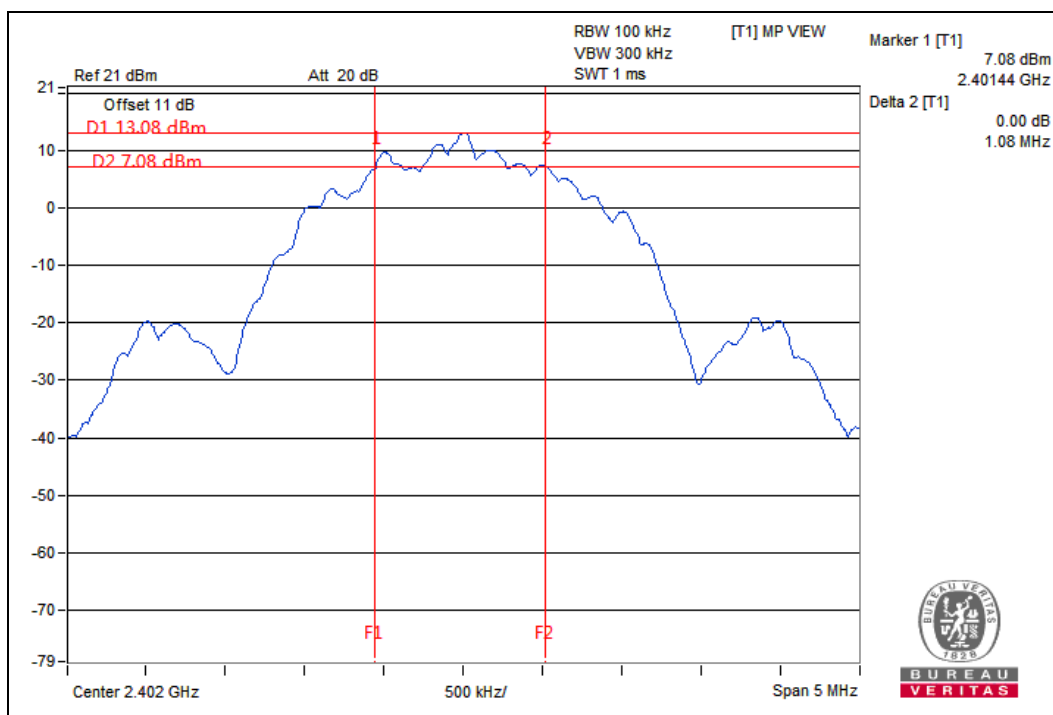
CH40



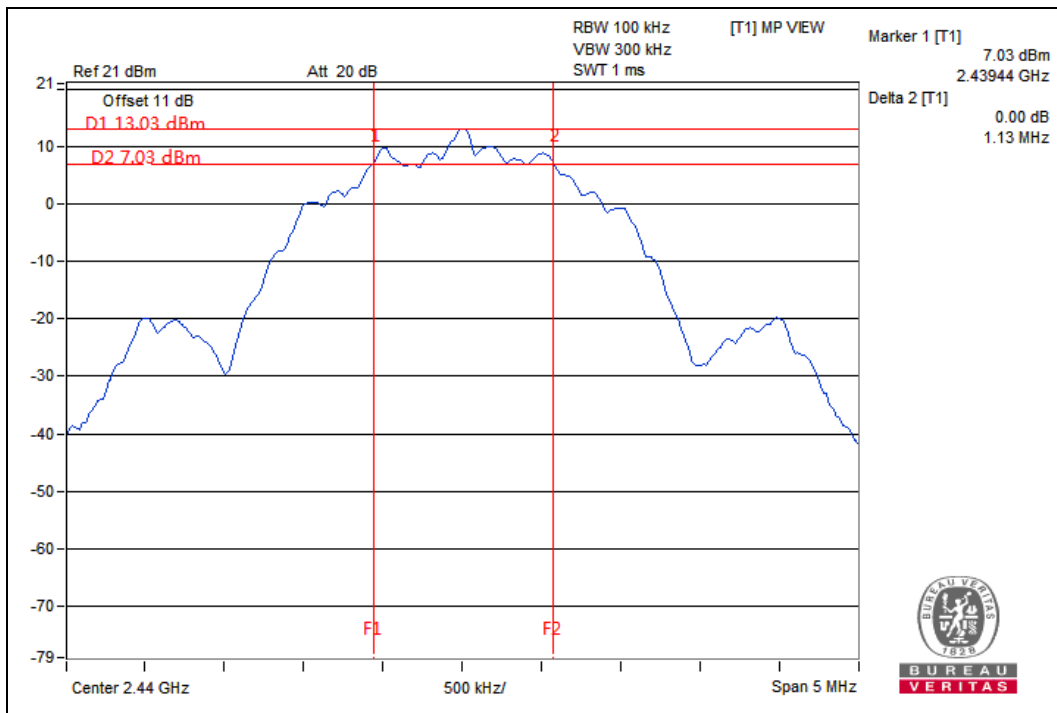
BT-LE GFSK (2Mbps)

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS / FAIL
0	2402	1.08	0.5	PASS
19	2440	1.13	0.5	PASS
39	2480	1.12	0.5	PASS

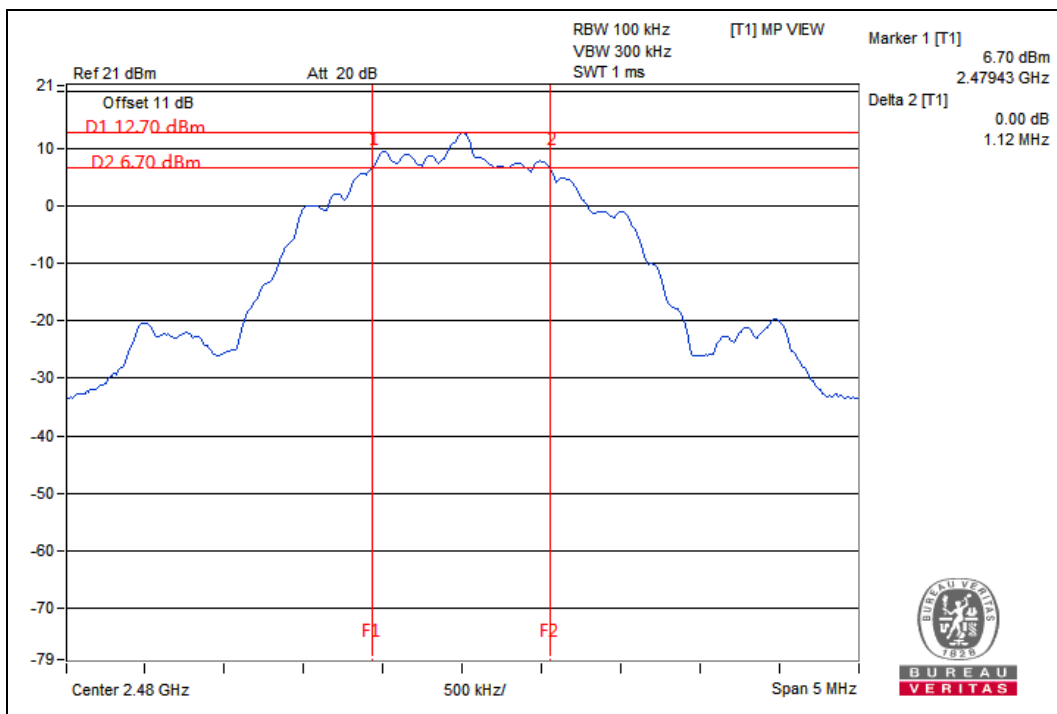
CH0



CH19



CH40

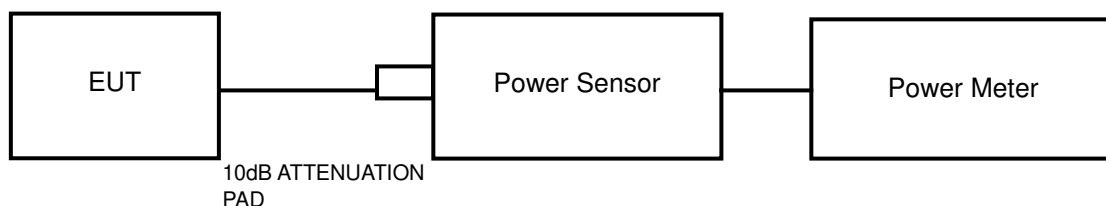


4.4 CONDUCTED OUTPUT POWER

4.4.1 LIMITS OF CONDUCTED OUTPUT POWER MEASUREMENT

For systems using digital modulation in the 2400–2483.5 MHz band: 1 Watt (30dBm)

4.4.2 TEST SETUP



4.4.3 TEST INSTRUMENTS

Refer to section 4.3.2 to get information of above instrument.

4.4.4 TEST PROCEDURES

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor and set the detector to PEAK. Record the power level.

An average power sensor was used on the output port of the EUT. A power meter was used to read the response of the average power sensor and set the detector to AVERAGE. Record the power level.

4.4.5 DEVIATION FROM TEST STANDARD

No deviation.

4.4.6 EUT OPERATING CONDITIONS

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.4.7 TEST RESULTS

4.4.7.1 MAXIMUM PEAK OUTPUT POWER

BT-LE GFSK (1Mbps)

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER (dBm)	PEAK POWER (mW)	PEAK POWER LIMIT (W)	PASS/FAIL
0	2402	9.71	9.354	1	PASS
19	2440	9.57	9.057	1	PASS
39	2480	9.21	8.337	1	PASS

BT-LE GFSK (2Mbps)

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER (dBm)	PEAK POWER (mW)	PEAK POWER LIMIT (W)	PASS/FAIL
0	2402	9.38	8.670	1	PASS
19	2440	9.28	8.472	1	PASS
39	2480	9.08	8.091	1	PASS

4.4.7.2 AVERAGE OUTPUT POWER (FOR REFERENCE)

The average power sensor was used on the output port of the EUT. A power meter was used to read the response of the power sensor. Record the power level.

BT-LE GFSK (1Mbps)

CHANNEL	CHANNEL FREQUENCY (MHz)	AVERAGE POWER (dBm)
0	2402	7.81
19	2440	7.82
39	2480	7.29

BT-LE GFSK (2Mbps)

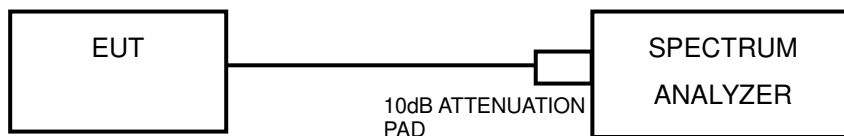
CHANNEL	CHANNEL FREQUENCY (MHz)	AVERAGE POWER (dBm)
0	2402	6.53
19	2440	6.38
39	2480	6.03

4.5 POWER SPECTRAL DENSITY MEASUREMENT

4.5.1 LIMITS OF POWER SPECTRAL DENSITY MEASUREMENT

The Maximum of Power Spectral Density Measurement is 8dBm/3KHz.

4.5.2 TEST SETUP



4.5.3 TEST INSTRUMENTS

Refer to section 4.3.2 to get information of above instrument.

4.5.4 TEST PROCEDURE

1. Set the span to 1.5 times the DTS bandwidth
2. Set the RBW = 3 kHz, VBW $\geq 3 \times$ RBW, Detector = peak.
3. Sweep time = auto couple, Trace mode = max hold, allow trace to fully stabilize.
4. Use the peak marker function to determine the maximum amplitude level.

4.5.5 DEVIATION FROM TEST STANDARD

No deviation.

4.5.6 EUT OPERATING CONDITION

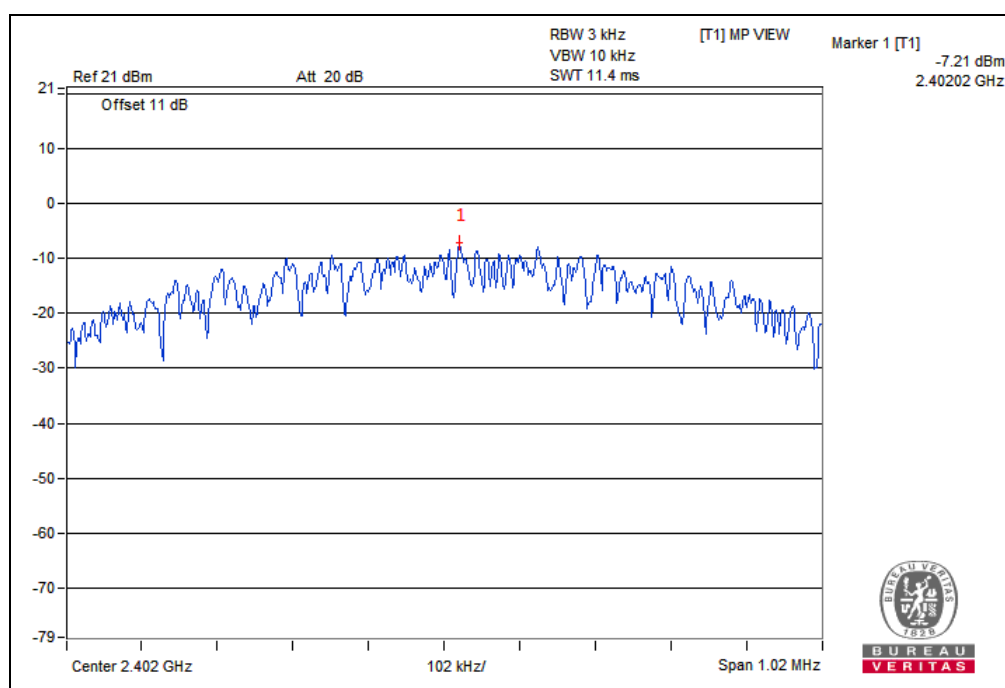
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.5.7 TEST RESULTS

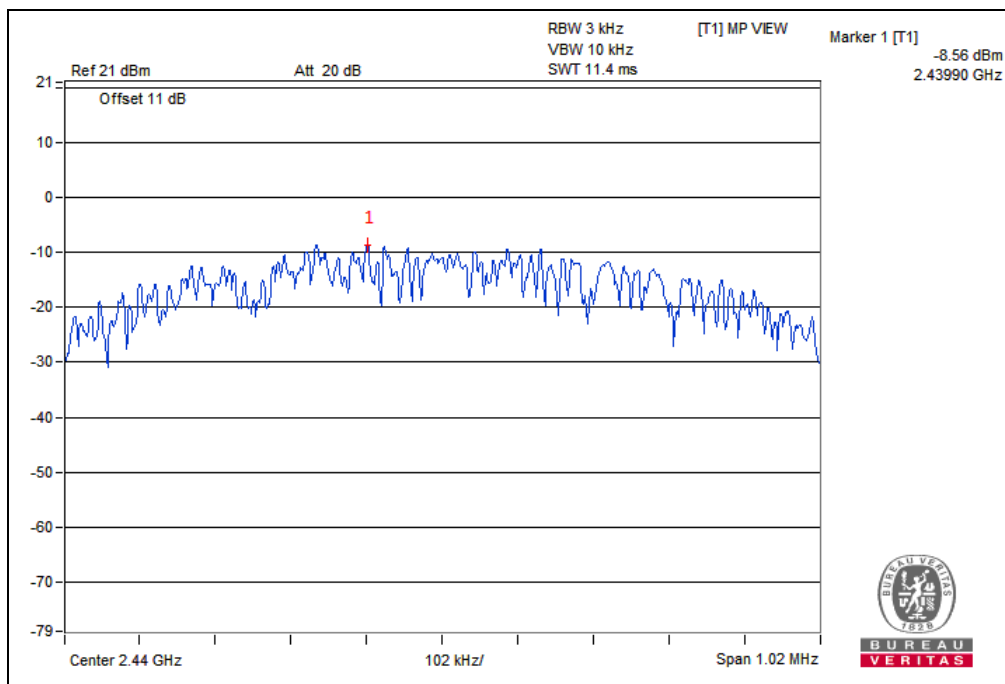
BT-LE GFSK (1Mbps)

Channel	FREQ. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	PASS /FAIL
0	2402	-7.21	8	PASS
19	2440	-8.56	8	PASS
39	2480	-8.65	8	PASS

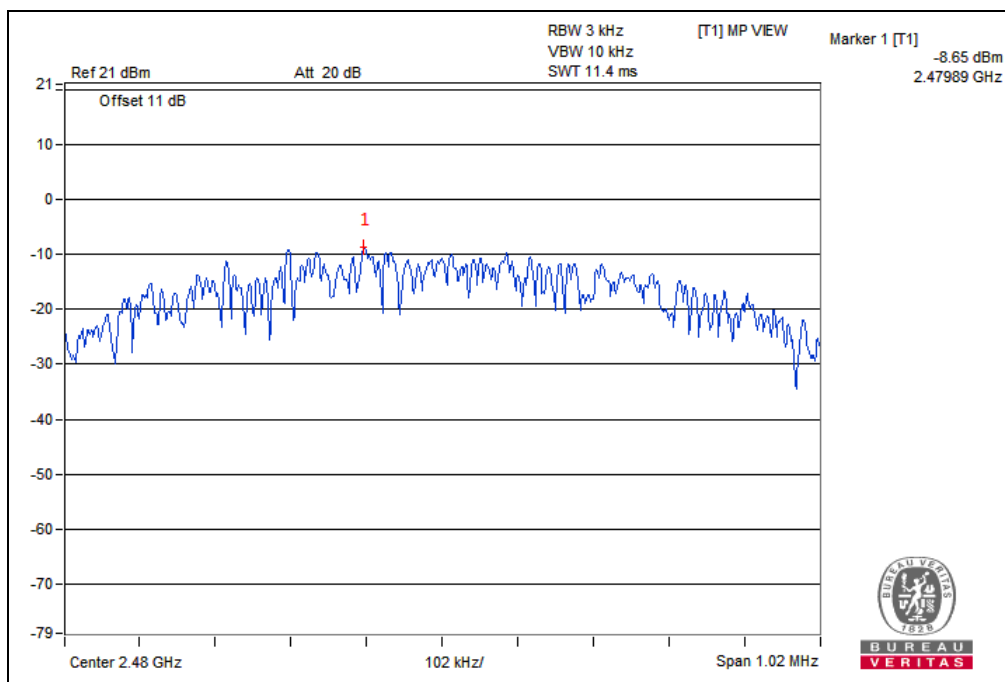
CH0



CH19



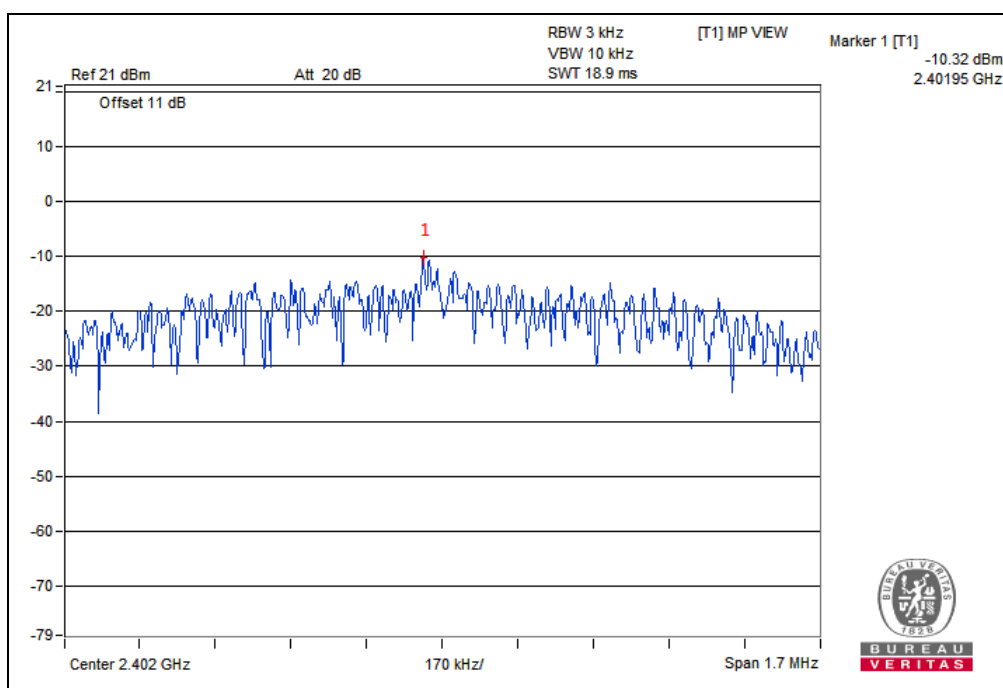
CH39



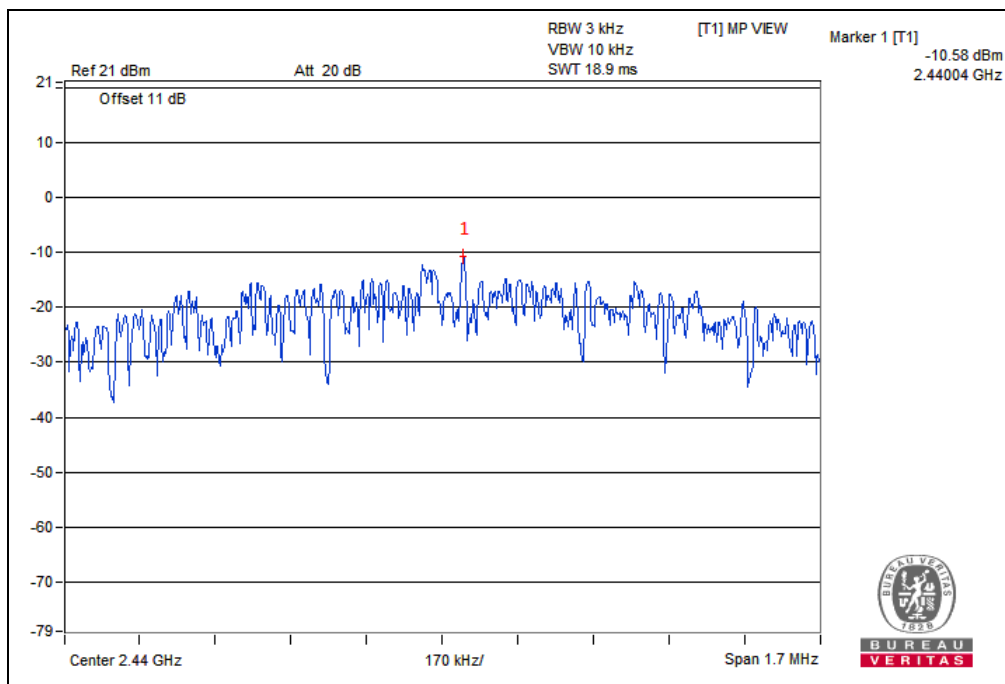
BT-LE GFSK (2Mbps)

Channel	FREQ. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	PASS /FAIL
0	2402	-10.32	8	PASS
19	2440	-10.58	8	PASS
39	2480	-11.21	8	PASS

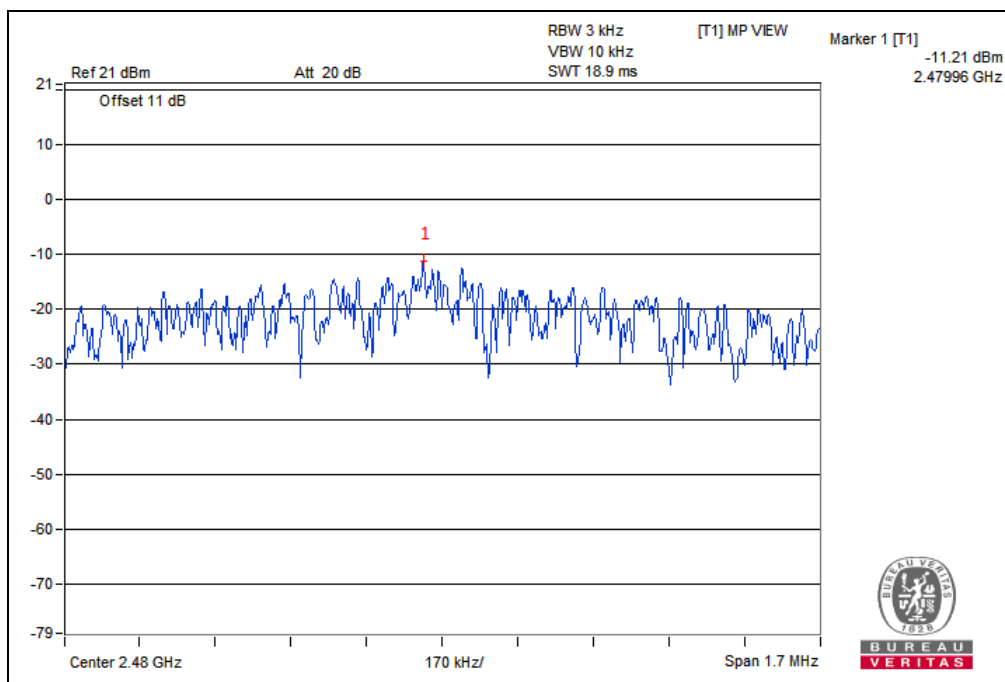
CH0



CH19



CH39

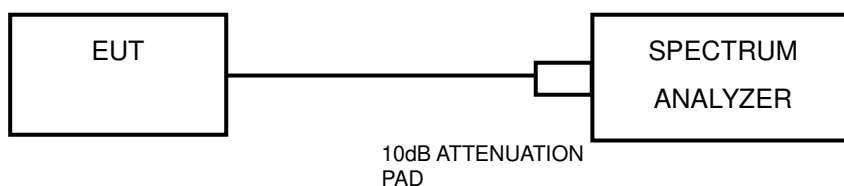


4.6 OUT OF BAND EMISSION MEASUREMENT

4.6.1 LIMITS OF OUT OF BAND EMISSION MEASUREMENT

Below -20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.6.2 TEST SETUP



4.6.3 TEST INSTRUMENTS

Refer to section 4.3.2 to get information of above instrument.

4.6.4 TEST PROCEDURE

MEASUREMENT PROCEDURE REF

1. Set the RBW = 100 kHz.
2. Set the VBW $\geq$ 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOB

1. Set RBW = 100 kHz.
2. Set VBW $\geq$ 300 kHz.
3. Set span to encompass the spectrum to be examined
4. Detector = peak.
5. Trace Mode = max hold.
6. Sweep = auto couple.

4.6.5 DEVIATION FROM TEST STANDARD

No deviation.

4.6.6 EUT OPERATING CONDITION

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.



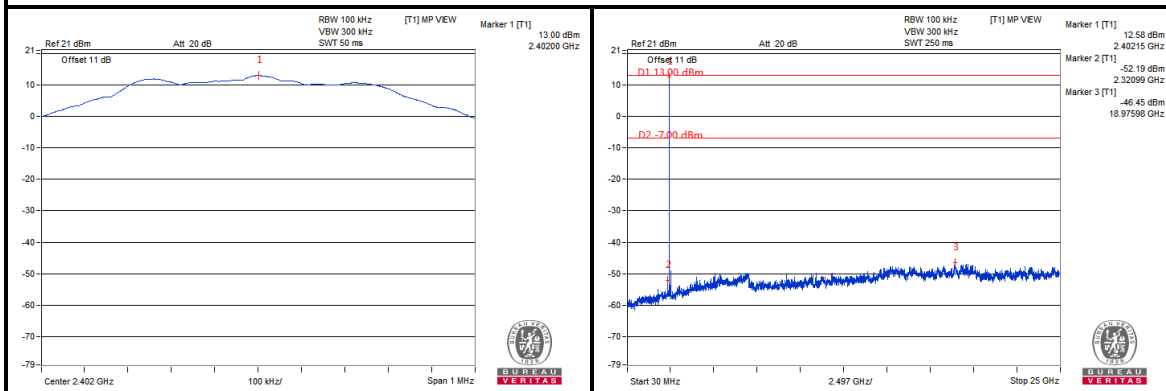
BUREAU
VERITAS

Test Report No.: RF2202WDG0092-1

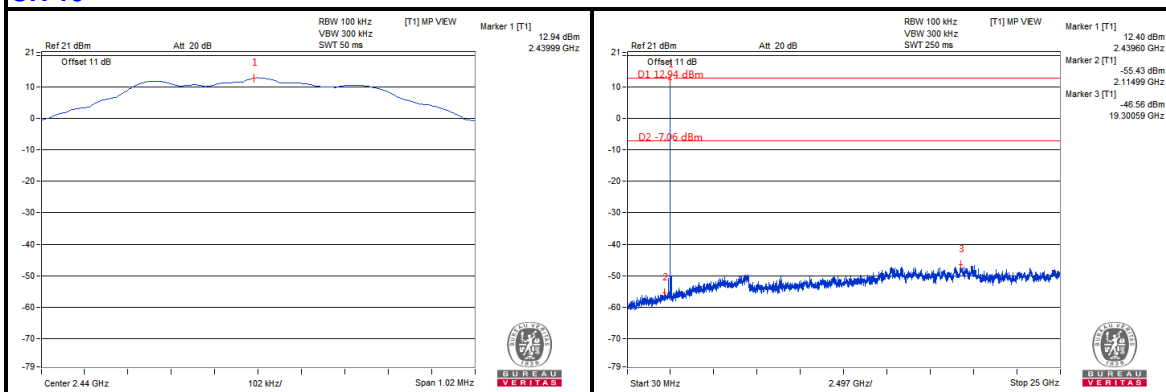
4.6.7 TEST RESULTS

BT-LE GFSK (1Mbps)

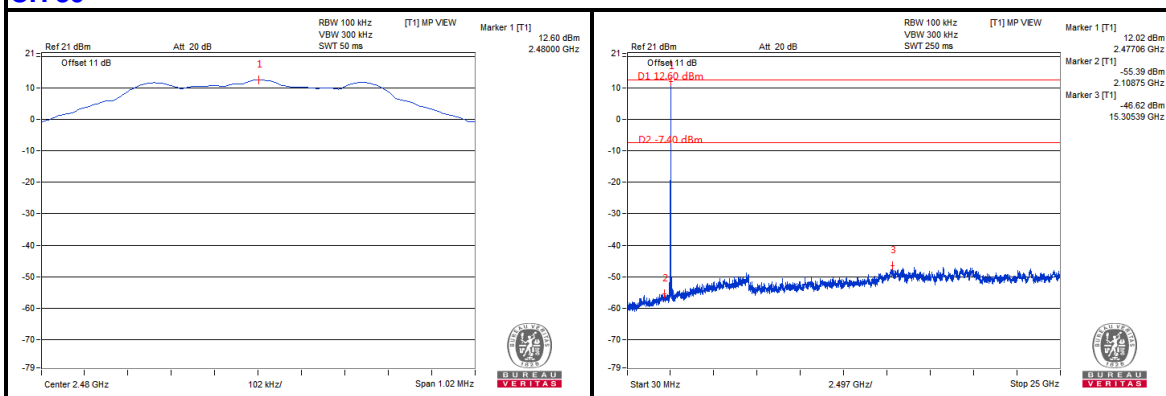
CH 0



CH 19



CH 39

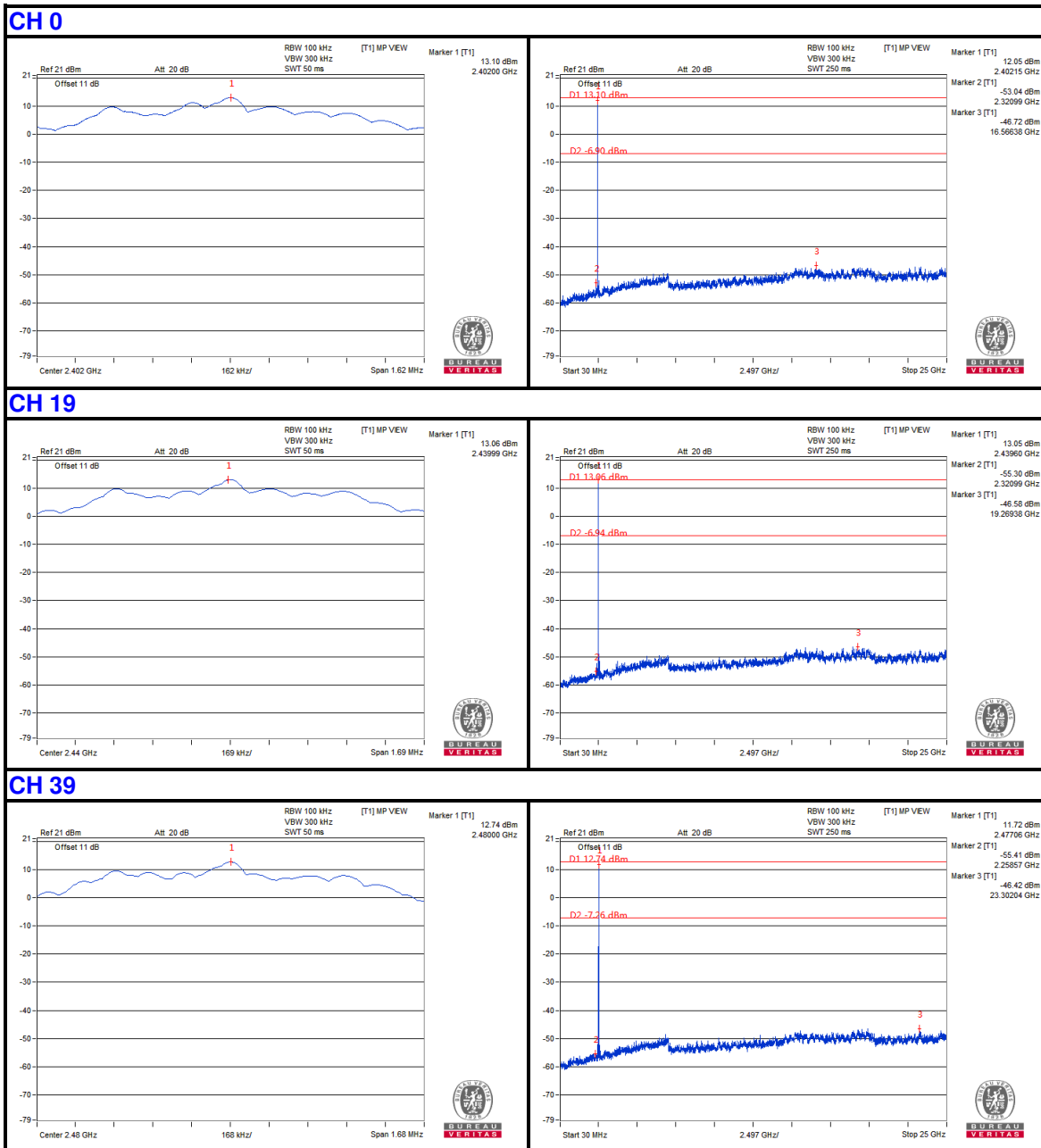


Bureau Veritas Shenzhen Co., Ltd.
Dongguan Branch

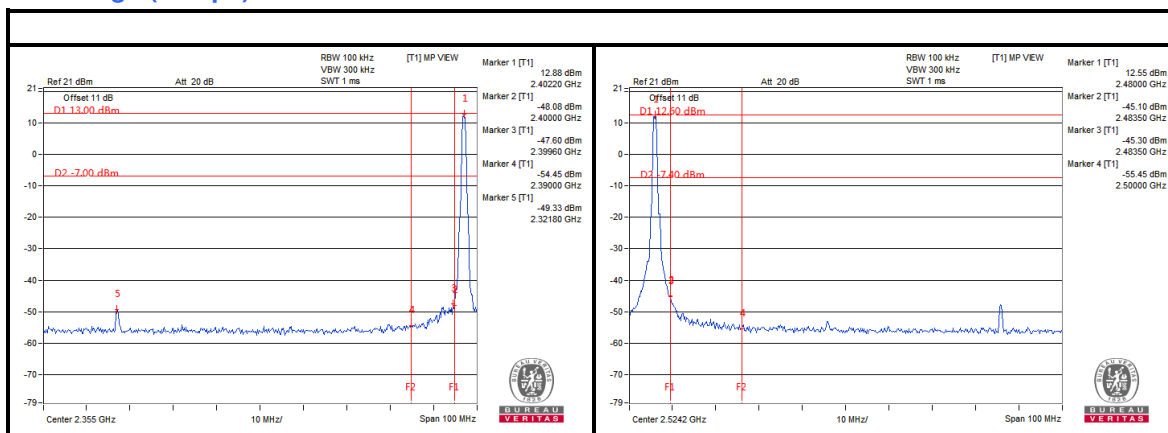
No. 96, Guantai Road (Houjie Section), Houjie
Town, Dongguan City, Guangdong Province.
523942. People's Republic of China.

Tel: +86 769 8998 2098
Fax: +86 769 8593 1080
Email: customerservice.dg@bureauveritas.com

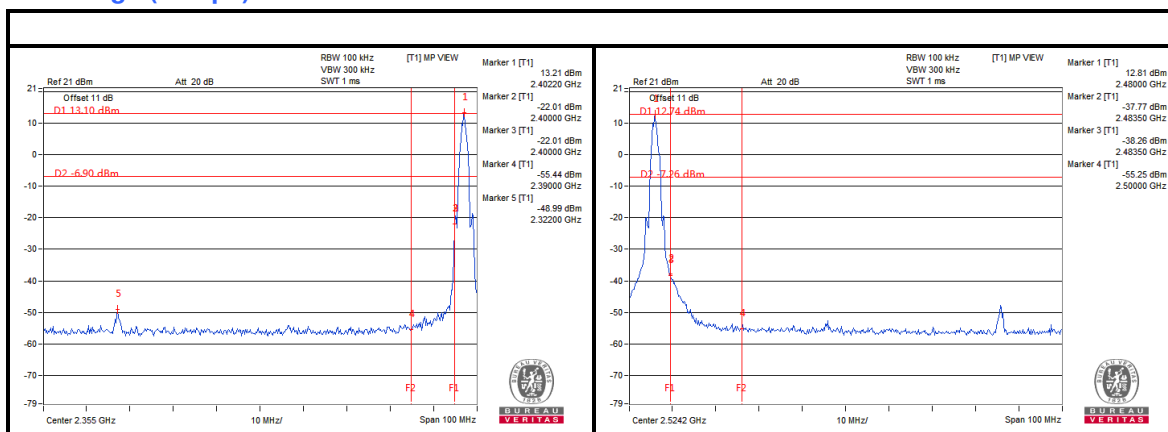
BT-LE GFSK (2Mbps)



Band Edge (1Mbps):



Band Edge (2Mbps):





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5 PHOTOGRAPHS OF THE TEST CONFIGURATION

Please refer to the attached file (Test Setup Photo).



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6 APPENDIX A - MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No any modifications are made to the EUT by the lab during the test.

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