FCC Test Report

Report No.: RFBCEE-WTW-P21116046-2

FCC ID: 2A3ULMTW3R

Model No.: MTW3 R

Received Date: Nov. 29, 2021

Test Date: Nov. 30 ~ Dec. 15, 2021

Issued Date: Mar. 17, 2022

Applicant: Sennheiser Consumer Audio GmbH

Address: Am Labor 1, 30900 Wedemark, Germany

Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
Lin Kou Laboratories

Lab Address: No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan

Test Location (1): No.19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, Taiwan

Test Location (2): No. 70, Wenming Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)

FCC Registration / Designation Number: 788550 / TW0003
281270 / TW0032

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Release Control Record

Issue No.	Description	Date Issued
RFBCEE-WTW-P21116046-2	Original Release	Mar. 17, 2022

1 Certificate of Conformity

Product Name: MOMENTUM True Wireless 3 (MTW3)

Brand Name: SENNHEISER

Model No.: MTW3 R

Sample Status: Engineering Sample

Applicant: Sennheiser Consumer Audio GmbH

Test Date: Nov. 30 ~ Dec. 15, 2021

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)
ANSI C63.10:2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Lena Wang , **Date:** Mar. 17, 2022

Lena Wang / Specialist

Approved by : Jeremy Lin , **Date:** Mar. 17, 2022

Jeremy Lin / Project Engineer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247)			
FCC Clause	**Test Item**	**Result**	**Remarks**
15.207	AC Power Conducted Emission	Pass	Meet the requirement of limit. Minimum passing margin is -8.68 dB at 0.47800 MHz.
15.247(a)(1)(iii)	Number of Hopping Frequency Used	Pass	Meet the requirement of limit.
15.247(a)(1)(iii)	Dwell Time on Each Channel	Pass	Meet the requirement of limit.
15.247(a)(1)	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	Pass	Meet the requirement of limit.
15.247(a)(1)	Maximum Peak Output Power	Pass	Meet the requirement of limit.
---	Occupied Bandwidth Measurement	Pass	Reference only
15.205 & 209	Radiated Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -7.26 dB at 2390.00 MHz.
15.247(d)	Band Edge Measurement	Pass	Meet the requirement of limit.
15.247(d)	Antenna Port Emission	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	No antenna connector is used.

Note:

1. If the Frequency Hopping System operating in 2400-2483.5 MHz band and the output power less than 125 mW. The hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of hopping channel whichever is greater.
2. For 2.4G band compliance with rule 15.247(d) of the band-edge items, the test plots were recorded in Annex A. Test Procedures refer to report 4.1.3.
3. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 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	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150 kHz ~ 30 MHz	2.79 dB
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.00 dB
	30MHz ~ 200MHz	2.91 dB
	200MHz ~1000MHz	2.93 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	1.76 dB
	18GHz ~ 40GHz	1.77 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Test Item Description	True Wireless Earphones
Product Name	MOMENTUM True Wireless 3 (MTW3)
Brand Name	SENNHEISER
Model No.	MTW3 R (refer to note for more details)
Status of EUT	Engineering Sample
Power Ratings	3.7Vdc, 70mAh (from battery) Charging Case: 5Vdc,1000 mA (from Type-C USB interface) 3.6Vdc, 820mAh (from battery)
Power Supply (Nominal & Testing)	5Vdc, 1000 mA (from Type-C USB interface)
Operating Temperature range	0°C ~ +40°C
Modulation Type	GFSK, π/4 DQPSK, 8DPSK
Transmission Technology	FHSS
Technology	Bluetooth
Operating Frequency	2402 - 2480MHz (for Frequency Band: 2400-2483.5MHz)
Number of Channel	79
Channel Spacing	BDR & EDR: 1MHz
Channel Bandwidth	BDR & EDR: 79MHz
Data Transfer Rate	1Mbps (BDR), 2Mbps/3Mbps (EDR)
Maximum Output Power	16.749 mW
Antenna Type	Monopole antenna
Antenna Gain	Max -3.8 dBi
HW Version	Earbuds: 5D Charging case: 8B
SW Version	Earbuds: V1.11.24 Charging Case: V19
Antenna Connector	N/A
Cable Supplied	0.4 m Shielded USB cable without core

Note:

1. The EUT system MOMENTUM True Wireless 3 (MTW3) contain the following devices:

Item	Brand	Device Model No.
Right Earbud	SENNHEISER	MTW3 R
Left Earbud	SENNHEISER	MTW3 L
Charging Case	SENNHEISER	MTW3 C

   * MTW3 R and MTW3 L with BT & BT LE TX/RX function
   * Charging case is solely used for charging MTW3 R and MTW3 L only
2. The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.
3. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or User's Manual.

3.2 Description of Test Modes

79 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable To				Description
	RE≥1G	RE<1G	PLC	APCM	
A	√	√	-	√	EUT (Right Earbud)
B	-	√	√	-	EUT (Left Earbud + Right Earbud + Charging case)
C	-	√	√	-	EUT (Left Earbud + Right Earbud + Charging case + Wireless charger)

Where **RE≥1G:** Radiated Emission above 1 GHz **RE<1G:** Radiated Emission below 1 GHz

PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

Note:

1. For Radiated emission test, pre-tested GFSK, π/4-DQPSK, 8DPSK modulation type and found 8DPSK was the worse, therefore chosen for the final test and presented in the test report.
2. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Z-plane**.
3. "-" means no effect.

Radiated Emission Test (Above 1 GHz):

☒ 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 channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
A	0 to 78	0, 39, 78	FHSS	GFSK	DH5
	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

Radiated Emission Test (Below 1 GHz):

☒ 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 channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
A, B, C	0 to 78	0	FHSS	8DPSK	3DH5

Power Line Conducted Emission Test:

☒ 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 channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
B, C	0 to 78	0	FHSS	8DPSK	3DH5

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 channel(s) was (were) selected for the final test as listed below.

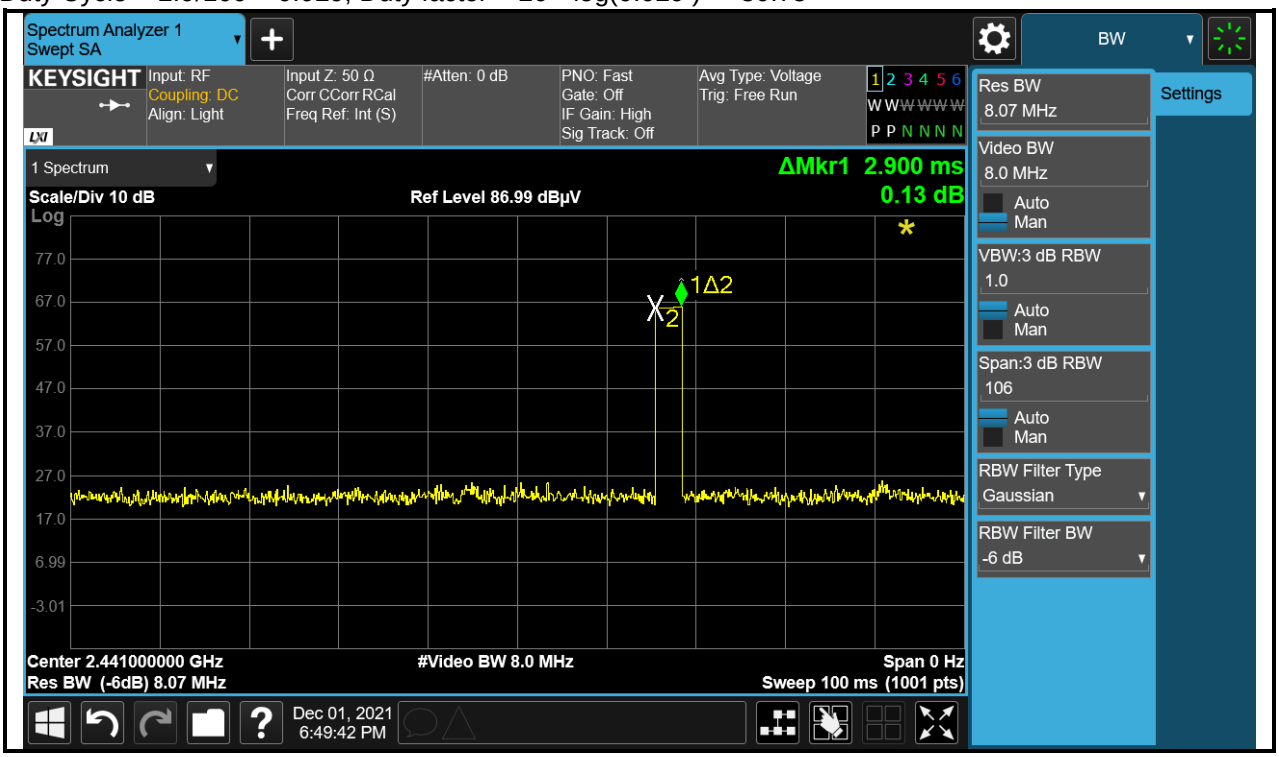
EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
A	0 to 78	0, 39, 78	FHSS	GFSK	DH5
	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

Test Condition:

Applicable To	Environmental Conditions	Input Power	Tested by
RE≥1G	25 deg. C, 65 % RH	3.7 Vdc	Greg Lin
RE<1G	25 deg. C, 65 % RH	3.7 Vdc, 120 Vac, 60Hz	Greg Lin
PLC	25 deg. C, 65 % RH	120 Vac, 60 Hz	Greg Lin
APCM	25 deg. C, 65 % RH	3.7 Vdc	Ivan Tseng

3.3 Duty Cycle of Test Signal

Duty Cycle = 2.9/100 = 0.029, Duty factor = 20 * log(0.029) = -30.75



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.

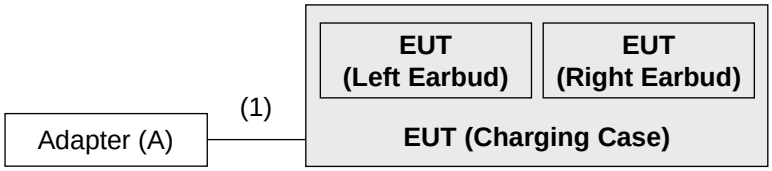
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Adapter	Liteon	PA-1050-39	NA	NA	-
B.	Adapter	MI	MDY-10-EJ	NA	NA	-
C.	Wireless Charger	MI	MDY-10-EP	NA	NA	-

No.	Cable Descriptions	Qty.	Length (m)	Shielded (Yes/ No)	Cores (Qty.)	Remark
1.	USB Cable	1	0.4	Y	0	Provided by client
2.	USB Cable	1	1	Y	0	--

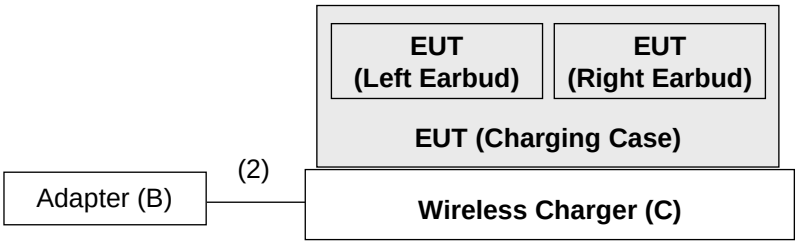
3.4.1 Configuration of System under Test

Test Mode A

Test Mode B



Test Mode C



3.5 General Description of Applied Standards and References

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

Test Standard:

FCC Part 15, Subpart C (15.247)
ANSI C63.10-2013

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

References Test Guidance:

KDB 558074 D01 15.247 Meas Guidance v05r02

All test items have been performed as a reference to the above KDB test guidance.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20 dB below the highest level of the desired power:

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

Note:

a. The lower limit shall apply at the transition frequencies.

b. Emission level (dBuV/m) = 20 log Emission level (uV/m).

c. For frequencies above 1000 MHz, 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 20 dB under any condition of modulation.

4.1.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date of Calibration
Test Receiver KEYSIGHT	N9038B	MY60180018	Feb. 01, 2021	Jan. 31, 2022
Spectrum Analyzer KEYSIGHT	N9020B	MY60110513	Dec. 21, 2020	Dec. 20, 2021
BILOG Antenna SCHWARZBECK	VULB9168	9168-1214	Oct. 27, 2021	Oct. 26, 2022
HORN Antenna RF SPIN	DRH18-E	210101A18E	Nov. 14, 2021	Nov. 13, 2022
HORN Antenna SCHWARZBECK	BBHA 9170	9170-995	Nov. 14, 2021	Nov. 13, 2022
Loop Antenna EMCI	EM-6879	269	Sep. 16, 2021	Sep. 15, 2022
Loop Antenna TESEQ	HLA 6121	45745	Jul. 21, 2021	Jul. 20, 2022
Preamplifier EMCI	EMC330N	980798	Jan. 12, 2021	Jan. 11, 2022
Preamplifier EMCI	EMC118A45SE	980809	Jan. 12, 2021	Jan. 11, 2022
Preamplifier EMCI	EMC184045SE	980786	Jan. 12, 2021	Jan. 11, 2022
RF signal cable EMCI	EMC104-SM-SM-(9000+2000+1000)	201244+ 201232+ 210103	Jan. 12, 2021	Jan. 11, 2022
RF signal cable EMCI	EMCCFD400-NM-NM-(9000+300+500)	201251+ 201249+ 201248	Jan. 12, 2021	Jan. 11, 2022
RF signal cable EMCI	EMC101G-KM-KM-(5000+3000+2000)	201261+201258+201255	Jan. 18, 2021	Jan. 17, 2022
Software BV ADT	ADT_Radiated_V7.6.15.9.5	NA	NA	NA
Antenna Tower Max-Full	MFA-515BSN	NA	NA	NA
Turn Table Max-Full	MFT-201SS	NA	NA	NA
Turn Table Controller Max-Full	MF-7802BS	MF780208676	NA	NA
USB Wideband Power Sensor KEYSIGHT	U2021XA	MY55050005/MY55190004/MY55190007/MY55210005	Jul. 12, 2021	Jul. 11, 2022

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in WM Chamber 9.

4.1.3 Test Procedures

For Radiated Emission below 30 MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. 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. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case 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 Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30 MHz.

For Radiated Emission above 30 MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30 MHz ~ 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. 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 height of antenna 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 quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
f. The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

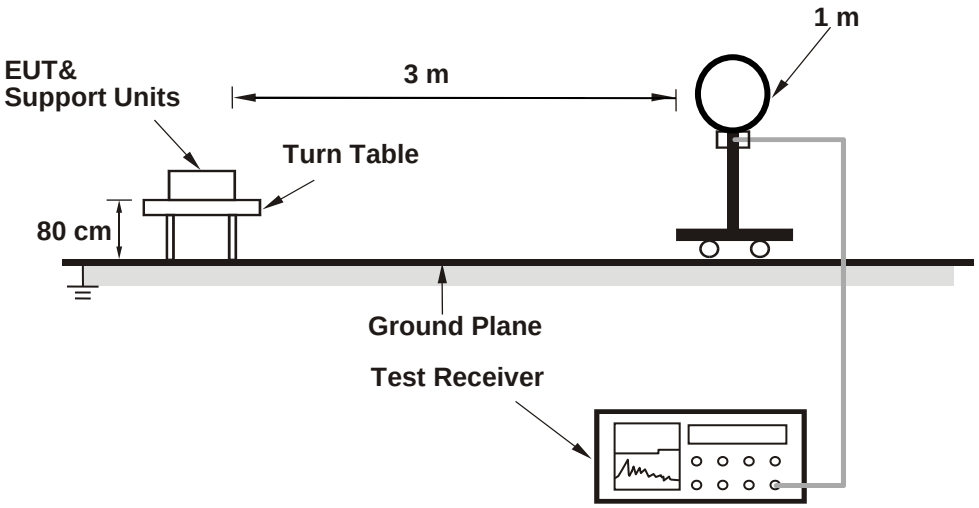
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) or Peak detection (PK) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) and Average detection (AV) at frequency above 1 GHz. For fundamental and harmonic signal measurement, according to ANSI C63.10 section 7.5, the average value = peak value + duty cycle correction factor. The duty cycle correction factor refer to Chapter 3.3 of this report.
3. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

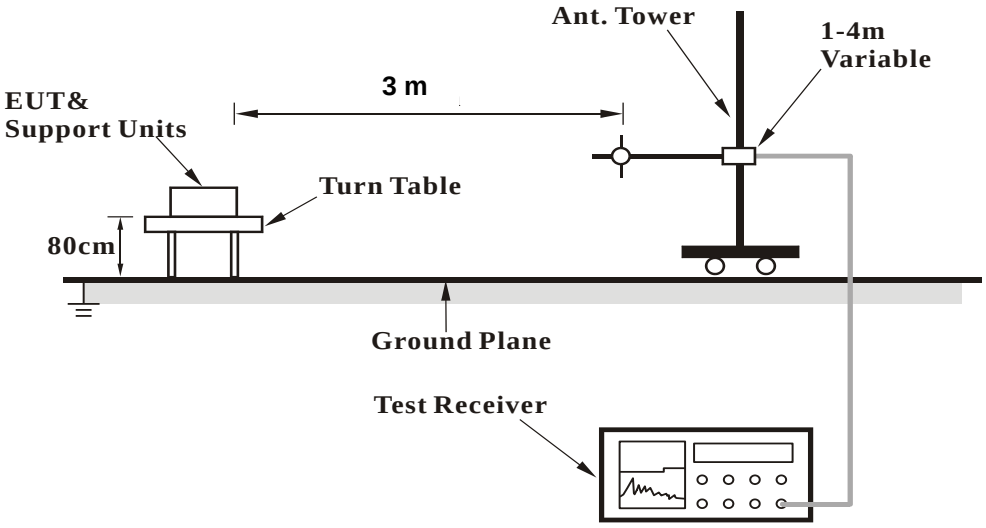
No deviation.

4.1.5 Test Set Up

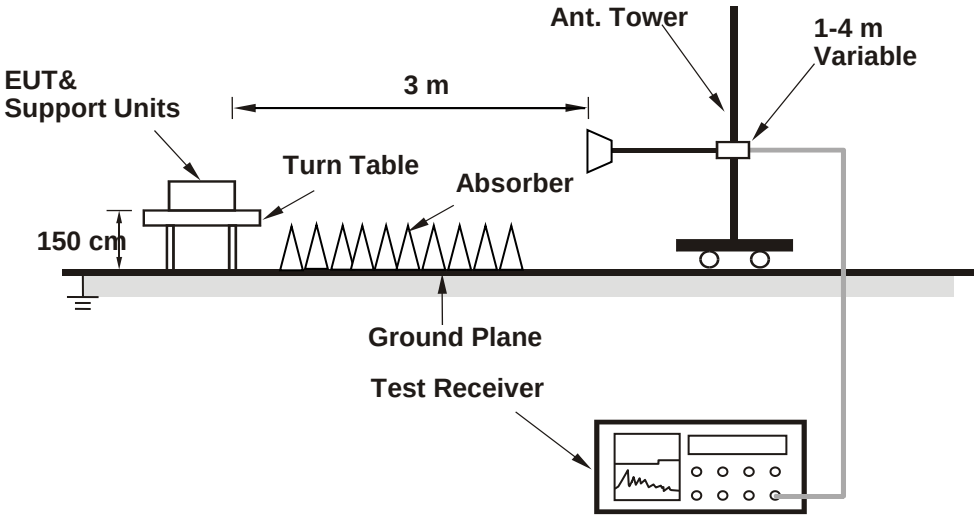
<Radiated Emission below 30 MHz>



<Radiated Emission 30 MHz to 1 GHz>



<Radiated Emission above 1 GHz>



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

4.1.6 EUT Operating Conditions

Set the EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1 GHz Data:

GFSK

RF Mode	TX BT_GFSK	**Channel**	CH 0：2402 MHz
Frequency Range	1GHz ~ 25GHz	**Detector Function**	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	**Frequency (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	58.22 PK	74.00	-15.78	1.23 H	93	26.46	31.76
2	2390.00	45.52 AV	54.00	-8.48	1.23 H	93	13.76	31.76
3	*2402.00	94.60 PK			1.23 H	93	62.86	31.74
4	*2402.00	63.85 AV			1.23 H	93	32.11	31.74
5	4804.00	50.73 PK	74.00	-23.27	1.35 H	57	46.76	3.97
6	4804.00	19.98 AV	54.00	-34.02	1.35 H	57	16.01	3.97
Antenna Polarity & Test Distance : Vertical at 3 m								
No	**Frequency (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	59.29 PK	74.00	-14.71	1.27 V	172	27.53	31.76
2	2390.00	45.93 AV	54.00	-8.07	1.27 V	172	14.17	31.76
3	*2402.00	96.72 PK			1.27 V	172	64.98	31.74
4	*2402.00	65.97 AV			1.27 V	172	34.23	31.74
5	4804.00	51.59 PK	74.00	-22.41	1.08 V	83	47.62	3.97
6	4804.00	20.84 AV	54.00	-33.16	1.08 V	83	16.87	3.97

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.029) = -30.75 dB for plotted duty.

RF Mode	TX BT_GFSK	Channel	CH 39：2441 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2441.00	98.56 PK			1.16 H	93	66.89	31.67
2	*2441.00	67.81 AV			1.16 H	93	36.14	31.67
3	4882.00	51.00 PK	74.00	-23.00	1.28 H	43	46.81	4.19
4	4882.00	20.25 AV	54.00	-33.75	1.28 H	43	16.06	4.19
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2441.00	100.64 PK			1.08 V	156	68.97	31.67
2	*2441.00	69.89 AV			1.08 V	156	38.22	31.67
3	4882.00	52.15 PK	74.00	-21.85	1.04 V	76	47.96	4.19
4	4882.00	21.40 AV	54.00	-32.60	1.04 V	76	17.21	4.19

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.029) = -30.75 dB for plotted duty.

RF Mode	TX BT_GFSK	Channel	CH 78：2480 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (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	97.69 PK			1.14 H	91	65.97	31.72
2	*2480.00	66.94 AV			1.14 H	91	35.22	31.72
3	2483.50	57.26 PK	74.00	-16.74	1.14 H	91	60.77	-3.51
4	2483.50	26.51 AV	54.00	-27.49	1.14 H	91	30.02	-3.51
5	4960.00	51.21 PK	74.00	-22.79	1.31 H	52	46.85	4.36
6	4960.00	20.46 AV	54.00	-33.54	1.31 H	52	16.10	4.36
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (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	100.00 PK			1.00 V	177	68.28	31.72
2	*2480.00	69.25 AV			1.00 V	177	37.53	31.72
3	2483.50	58.36 PK	74.00	-15.64	1.00 V	177	61.87	-3.51
4	2483.50	27.61 AV	54.00	-26.39	1.00 V	177	31.12	-3.51
5	4960.00	52.14 PK	74.00	-21.86	1.12 V	93	47.78	4.36
6	4960.00	21.39 AV	54.00	-32.61	1.12 V	93	17.03	4.36

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.029) = -30.75 dB for plotted duty.

8DPSK

RF Mode	TX BT_8DPSK	Channel	CH 0：2402 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (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	58.71 PK	74.00	-15.29	1.06 H	28	26.95	31.76
2	2390.00	46.73 AV	54.00	-7.27	1.06 H	28	14.97	31.76
3	*2402.00	94.98 PK			1.06 H	28	63.24	31.74
4	*2402.00	64.23 AV			1.06 H	28	32.49	31.74
5	4804.00	50.68 PK	74.00	-23.32	1.38 H	62	46.71	3.97
6	4804.00	19.93 AV	54.00	-34.07	1.38 H	62	15.96	3.97
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (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	58.51 PK	74.00	-15.49	1.10 V	62	26.75	31.76
2	**2390.00**	**46.74 AV**	**54.00**	**-7.26**	**1.10 V**	**62**	**14.98**	**31.76**
3	*2402.00	96.94 PK			1.10 V	62	65.20	31.74
4	*2402.00	66.19 AV			1.10 V	62	34.45	31.74
5	4804.00	51.75 PK	74.00	-22.25	1.02 V	85	47.78	3.97
6	4804.00	21.00 AV	54.00	-33.00	1.02 V	85	17.03	3.97

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.029) = -30.75 dB for plotted duty.

RF Mode	TX BT_8DPSK	Channel	CH 39：2441 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2441.00	98.45 PK			1.49 H	9	66.78	31.67
2	*2441.00	67.70 AV			1.49 H	9	36.03	31.67
3	4882.00	50.72 PK	74.00	-23.28	1.42 H	68	46.53	4.19
4	4882.00	19.97 AV	54.00	-34.03	1.42 H	68	15.78	4.19
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2441.00	100.24 PK			1.08 V	112	68.57	31.67
2	*2441.00	69.49 AV			1.08 V	112	37.82	31.67
3	4882.00	50.86 PK	74.00	-23.14	1.06 V	89	46.67	4.19
4	4882.00	20.11 AV	54.00	-33.89	1.06 V	89	15.92	4.19

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.029) = -30.75 dB for plotted duty.

RF Mode	TX BT_8DPSK	Channel	CH 78：2480 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (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	100.44 PK			1.00 H	14	68.72	31.72
2	*2480.00	69.69 AV			1.00 H	14	37.97	31.72
3	2483.50	58.40 PK	74.00	-15.60	1.00 H	14	61.91	-3.51
4	2483.50	27.65 AV	54.00	-26.35	1.00 H	14	31.16	-3.51
5	4960.00	49.90 PK	74.00	-24.10	1.33 H	69	45.54	4.36
6	4960.00	19.15 AV	54.00	-34.85	1.33 H	69	14.79	4.36
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (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	103.54 PK			1.07 V	115	71.82	31.72
2	*2480.00	72.79 AV			1.07 V	115	41.07	31.72
3	2483.50	64.01 PK	74.00	-9.99	1.07 V	115	67.52	-3.51
4	2483.50	33.26 AV	54.00	-20.74	1.07 V	115	36.77	-3.51
5	4960.00	50.05 PK	74.00	-23.95	1.09 V	80	45.69	4.36
6	4960.00	19.30 AV	54.00	-34.70	1.09 V	80	14.94	4.36

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.029) = -30.75 dB for plotted duty.

9 kHz ~ 30 MHz Data:

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

30 MHz ~ 1 GHz Worst-Case Data:

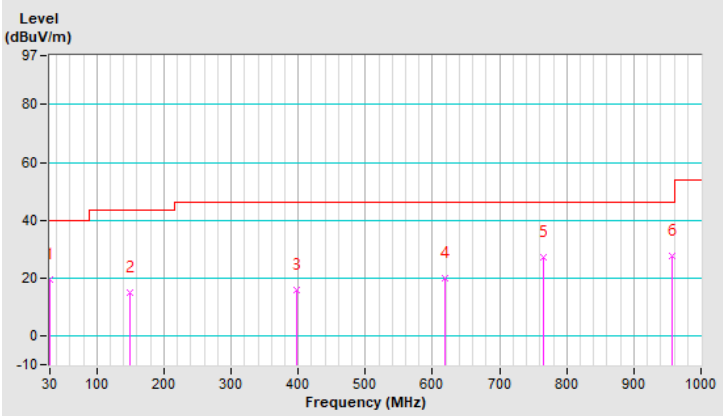
Mode A

RF Mode	TX BT_8DPSK	**Channel**	CH 0：2402 MHz
Frequency Range	30MHz ~ 1GHz	**Detector Function**	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	**Frequency (MHz)**	**Emission Level (dBuV/m)**	**Limit (dBuV/m)**	**Margin (dB)**	**Antenna Height (m)**	**Table Angle (Degree)**	**Raw Value (dBuV)**	**Correction Factor (dB/m)**
1	30.00	19.64 QP	40.00	-20.36	1.25 H	203	38.93	-19.29
2	148.34	15.13 QP	43.50	-28.37	1.25 H	288	33.37	-18.24
3	398.60	15.76 QP	46.00	-30.24	1.00 H	240	31.09	-15.33
4	617.82	20.07 QP	46.00	-25.93	1.50 H	208	30.35	-10.28
5	766.23	27.26 QP	46.00	-18.74	1.00 H	351	35.34	-8.08
6	956.35	27.66 QP	46.00	-18.34	1.25 H	345	33.39	-5.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

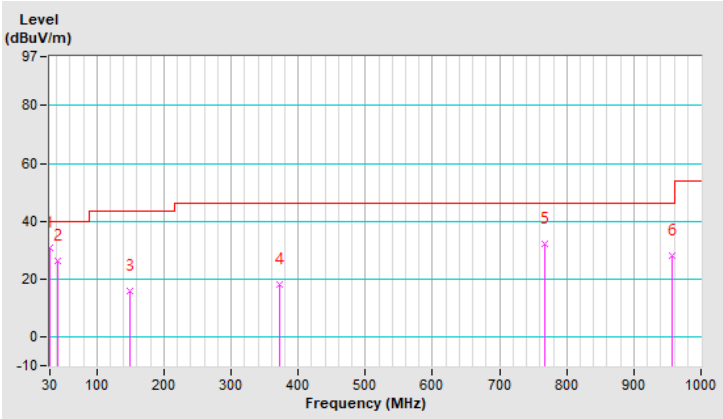


RF Mode	TX BT_8DPSK	Channel	CH 0：2402 MHz
Frequency Range	30MHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	30.97	30.73 QP	40.00	-9.27	1.25 V	252	50.40	-19.67
2	42.61	26.16 QP	40.00	-13.84	1.50 V	65	44.47	-18.31
3	148.34	15.99 QP	43.50	-27.51	1.00 V	45	34.23	-18.24
4	371.44	18.01 QP	46.00	-27.99	1.25 V	242	33.93	-15.92
5	767.20	32.15 QP	46.00	-13.85	1.00 V	223	40.24	-8.09
6	956.35	27.89 QP	46.00	-18.11	1.25 V	2	33.62	-5.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



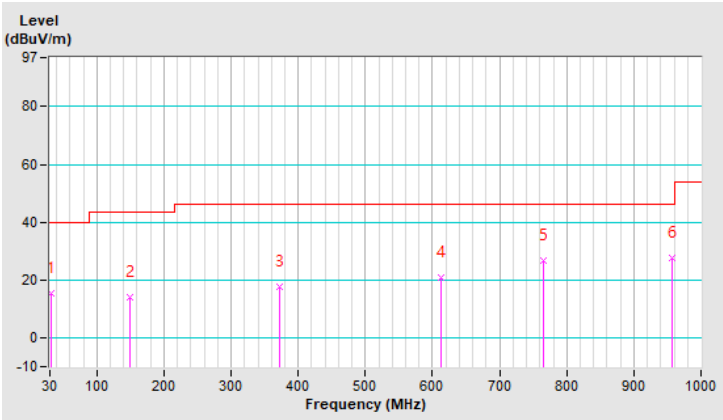
Mode B

RF Mode	TX BT_8DPSK	Channel	CH 0：2402 MHz
Frequency Range	30MHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	31.94	15.44 QP	40.00	-24.56	1.00 H	180	34.82	-19.38
2	148.34	14.23 QP	43.50	-29.27	1.00 H	291	32.47	-18.24
3	371.44	17.60 QP	46.00	-28.40	1.25 H	130	33.52	-15.92
4	612.00	20.82 QP	46.00	-25.18	1.50 H	18	31.04	-10.22
5	766.23	26.64 QP	46.00	-19.36	1.25 H	2	34.72	-8.08
6	956.35	27.52 QP	46.00	-18.48	1.00 H	11	33.25	-5.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

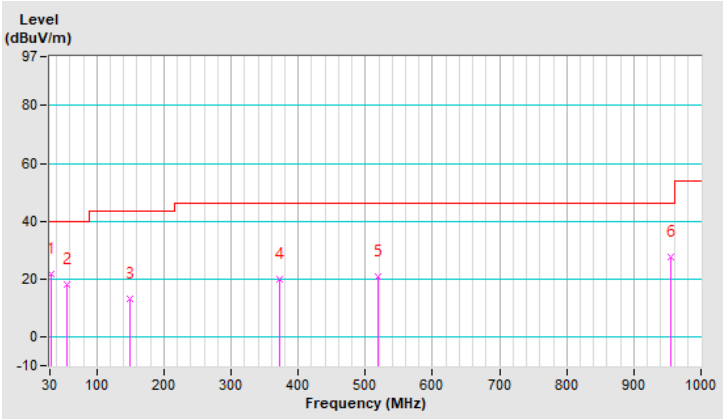


RF Mode	TX BT_8DPSK	Channel	CH 0：2402 MHz
Frequency Range	30MHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	31.94	21.95 QP	40.00	-18.05	1.25 V	315	41.33	-19.38
2	55.22	18.08 QP	40.00	-21.92	1.00 V	354	36.44	-18.36
3	148.34	13.15 QP	43.50	-30.35	1.50 V	2	31.39	-18.24
4	371.44	20.05 QP	46.00	-25.95	1.00 V	37	35.97	-15.92
5	519.85	20.79 QP	46.00	-25.21	1.25 V	88	33.31	-12.52
6	954.41	27.81 QP	46.00	-18.19	1.00 V	209	33.60	-5.79

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



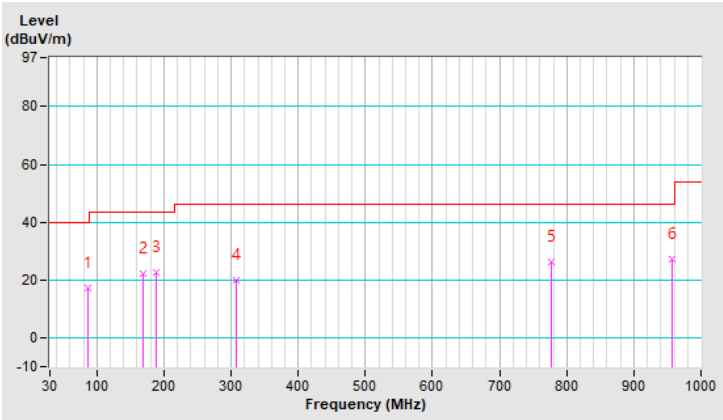
Mode C

RF Mode	TX BT_8DPSK	Channel	CH 0：2402 MHz
Frequency Range	30MHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	86.26	17.27 QP	40.00	-22.73	1.25 H	221	41.22	-23.95
2	168.71	22.14 QP	43.50	-21.36	1.00 H	117	40.66	-18.52
3	189.08	22.64 QP	43.50	-20.86	1.50 H	106	43.50	-20.86
4	308.39	19.95 QP	46.00	-26.05	1.00 H	105	37.41	-17.46
5	777.87	26.14 QP	46.00	-19.86	1.50 H	3	34.11	-7.97
6	956.35	27.12 QP	46.00	-18.88	1.25 H	85	32.85	-5.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

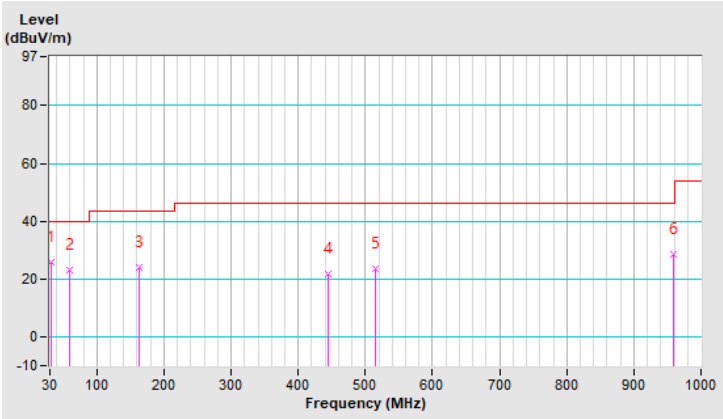


RF Mode	TX BT_8DPSK	Channel	CH 0：2402 MHz
Frequency Range	30MHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	31.94	25.75 QP	40.00	-14.25	1.25 V	310	45.13	-19.38
2	60.07	22.91 QP	40.00	-17.09	1.00 V	2	41.82	-18.91
3	162.89	23.88 QP	43.50	-19.62	1.50 V	106	42.06	-18.18
4	444.19	21.72 QP	46.00	-24.28	1.00 V	253	35.62	-13.90
5	515.00	23.43 QP	46.00	-22.57	1.00 V	258	36.11	-12.68
6	959.26	28.32 QP	46.00	-17.68	1.25 V	270	33.95	-5.63

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 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 0.50 MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date of Calibration
Test Receiver ROHDE & SCHWARZ	ESCI	100613	Dec. 04, 2020	Dec. 03, 2021
			Dec. 03, 2021	Dec. 02, 2022
RF signal cable Woken	5D-FB	Cable-cond1-01	Jan. 16, 2021	Jan. 15, 2022
LISN ROHDE & SCHWARZ (EUT)	ENV216	101826	Feb. 25, 2021	Feb. 24, 2022
LISN ROHDE & SCHWARZ (Peripheral)	ESH3-Z5	100311	Sep. 07, 2021	Sep. 06, 2022
Software ADT	BV ADT_Cond_ V7.3.7.4	NA	NA	NA

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in HwaYa Shielded Room 1 (Conduction 1).
3. The VCCI Site Registration No. is C-12040.

4.2.3 Test Procedures

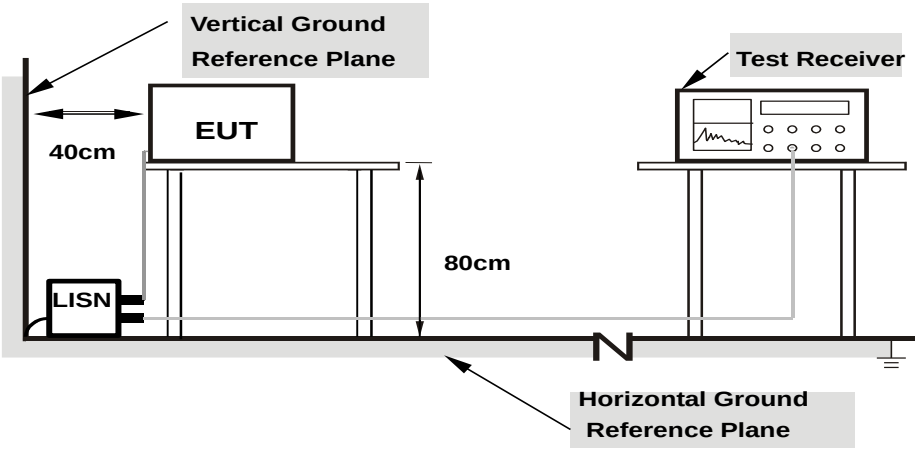
a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50 uH of coupling 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 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20 dB) was not recorded.

Note: The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15 MHz - 30 MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 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 from other units and other metal planes

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

4.2.6 EUT Operating Condition

Set the EUT under transmission condition continuously at specific channel frequency.

4.2.7 Test Results

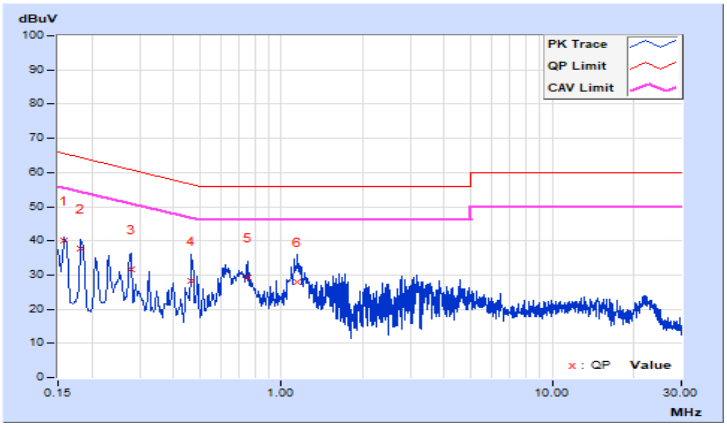
Mode B

Frequency Range	150kHz ~ 30MHz	**Detector Function & Resolution Bandwidth**	Quasi-Peak (QP) / Average (AV), 9kHz
Input Power	120Vac, 60Hz	**Environmental Conditions**	25 °C, 75% RH
Tested by	Greg Lin	**Test Date**	2021/11/30

Phase Of Power : Line (L)										
No	**Frequency (MHz)**	**Correction Factor (dB)**	**Reading Value (dBuV)**		**Emission Level (dBuV)**		**Limit (dBuV)**		**Margin (dB)**	
			Q.P.	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**
1	0.15800	9.76	30.29	16.82	40.05	26.58	65.57	55.57	-25.52	-28.99
2	0.18200	9.76	28.01	13.22	37.77	22.98	64.39	54.39	-26.62	-31.41
3	0.27786	9.79	21.70	14.87	31.49	24.66	60.88	50.88	-29.39	-26.22
4	0.46600	9.84	18.28	11.46	28.12	21.30	56.58	46.58	-28.46	-25.28
5	0.75000	9.88	19.56	13.44	29.44	23.32	56.00	46.00	-26.56	-22.68
6	1.14200	9.91	17.94	11.44	27.85	21.35	56.00	46.00	-28.15	-24.65

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

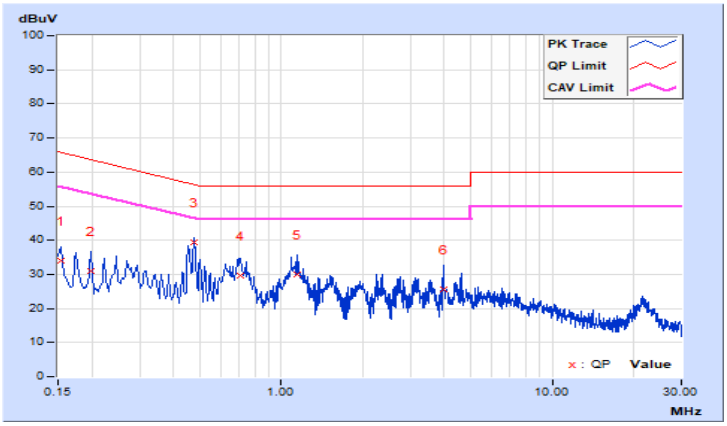


Frequency Range	150kHz ~ 30MHz	**Detector Function & Resolution Bandwidth**	Quasi-Peak (QP) / Average (AV), 9kHz
Input Power	120Vac, 60Hz	**Environmental Conditions**	25 °C, 75% RH
Tested by	Greg Lin	**Test Date**	2021/11/30

Phase Of Power : Neutral (N)										
No	**Frequency (MHz)**	**Correction Factor (dB)**	**Reading Value (dBuV)**		**Emission Level (dBuV)**		**Limit (dBuV)**		**Margin (dB)**	
			Q.P.	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**
1	0.15400	9.81	24.30	15.85	34.11	25.66	65.78	55.78	-31.67	-30.12
2	0.19800	9.83	21.29	11.81	31.12	21.64	63.69	53.69	-32.57	-32.05
3	**0.47800**	**9.91**	**29.35**	**27.78**	**39.26**	**37.69**	**56.37**	**46.37**	**-17.11**	**-8.68**
4	0.70982	9.93	19.86	14.79	29.79	24.72	56.00	46.00	-26.21	-21.28
5	1.15000	9.96	20.05	13.14	30.01	23.10	56.00	46.00	-25.99	-22.90
6	3.95400	10.04	15.54	3.29	25.58	13.33	56.00	46.00	-30.42	-32.67

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value



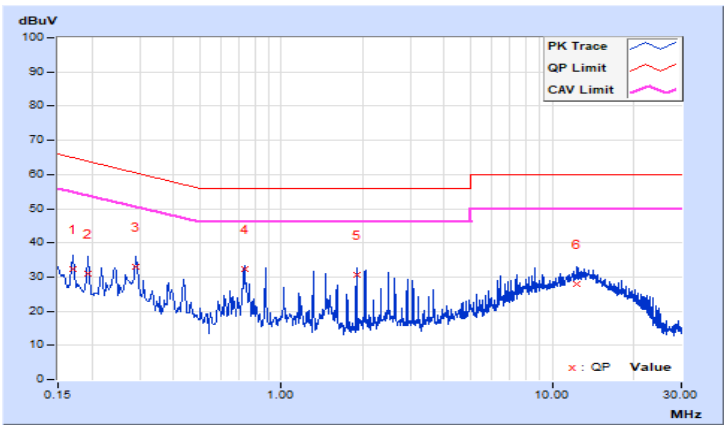
Mode C

Frequency Range	150kHz ~ 30MHz	**Detector Function & Resolution Bandwidth**	Quasi-Peak (QP) / Average (AV), 9kHz
Input Power	120Vac, 60Hz	**Environmental Conditions**	25 °C, 75% RH
Tested by	Greg Lin	**Test Date**	2021/12/9

Phase Of Power : Line (L)										
No	**Frequency (MHz)**	**Correction Factor (dB)**	**Reading Value (dBuV)**		**Emission Level (dBuV)**		**Limit (dBuV)**		**Margin (dB)**	
			Q.P.	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**
1	0.17000	9.76	22.48	12.28	32.24	22.04	64.96	54.96	-32.72	-32.92
2	0.19400	9.77	21.24	11.79	31.01	21.56	63.86	53.86	-32.85	-32.30
3	0.29000	9.80	23.18	20.85	32.98	30.65	60.52	50.52	-27.54	-19.87
4	0.73000	9.87	22.48	20.14	32.35	30.01	56.00	46.00	-23.65	-15.99
5	1.89800	9.94	20.58	20.05	30.52	29.99	56.00	46.00	-25.48	-16.01
6	12.40200	10.06	17.80	13.59	27.86	23.65	60.00	50.00	-32.14	-26.35

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

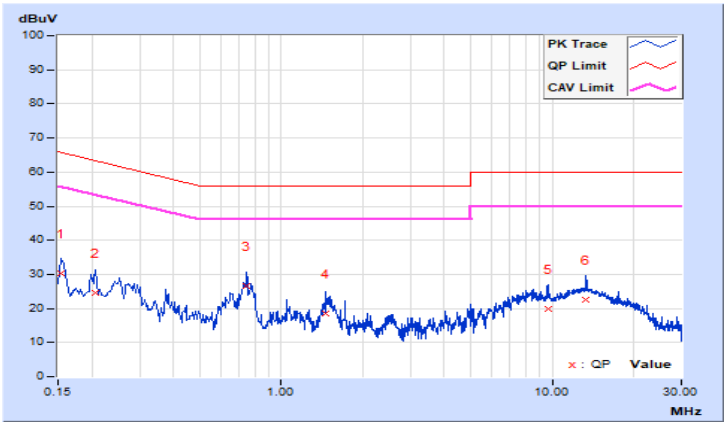


Frequency Range	150kHz ~ 30MHz	**Detector Function & Resolution Bandwidth**	Quasi-Peak (QP) / Average (AV), 9kHz
Input Power	120Vac, 60Hz	**Environmental Conditions**	25 °C, 75% RH
Tested by	Greg Lin	**Test Date**	2021/12/9

Phase Of Power : Neutral (N)										
No	**Frequency (MHz)**	**Correction Factor (dB)**	**Reading Value (dBuV)**		**Emission Level (dBuV)**		**Limit (dBuV)**		**Margin (dB)**	
			Q.P.	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**
1	0.15400	9.81	20.57	14.25	30.38	24.06	65.78	55.78	-35.40	-31.72
2	0.20600	9.83	14.80	6.53	24.63	16.36	63.37	53.37	-38.74	-37.01
3	0.74200	9.93	16.67	9.96	26.60	19.89	56.00	46.00	-29.40	-26.11
4	1.46200	9.97	8.61	2.76	18.58	12.73	56.00	46.00	-37.42	-33.27
5	9.64200	10.13	9.72	4.04	19.85	14.17	60.00	50.00	-40.15	-35.83
6	13.34200	10.18	12.34	6.75	22.52	16.93	60.00	50.00	-37.48	-33.07

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

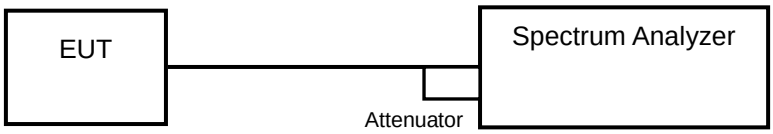


4.3 Number of Hopping Frequency Used

4.3.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement 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 the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
d. Set the SA on View mode and then plot the result on SA screen.
e. Repeat above procedures until all frequencies measured were complete.

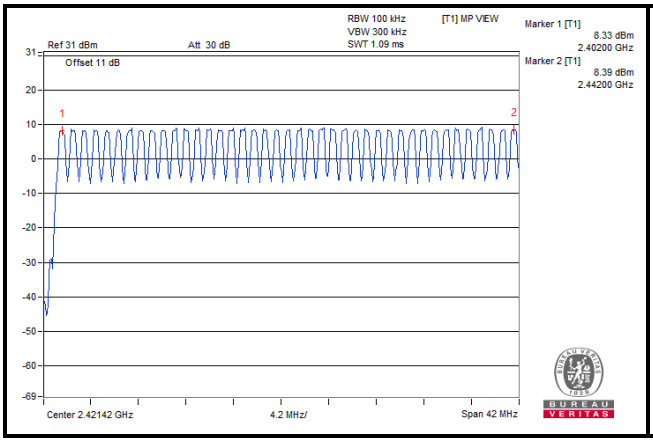
4.3.5 Deviation from Test Standard

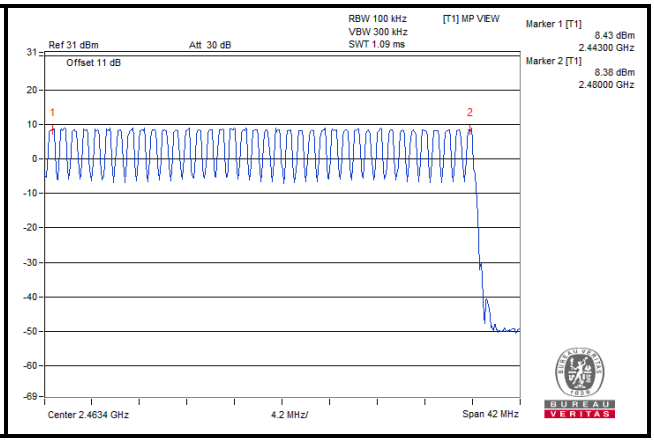
No deviation.

4.3.6 Test Results

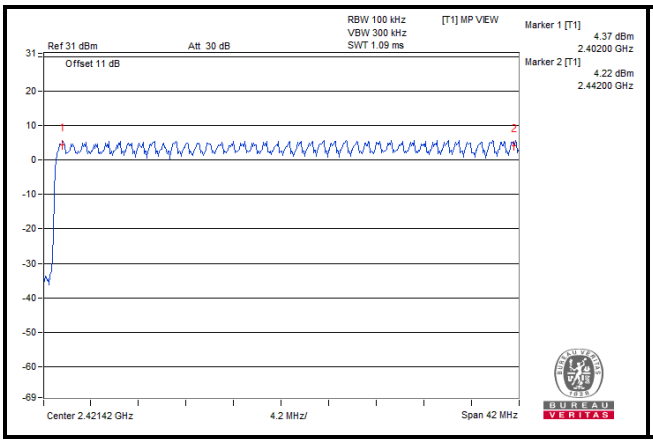
There are 79 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.

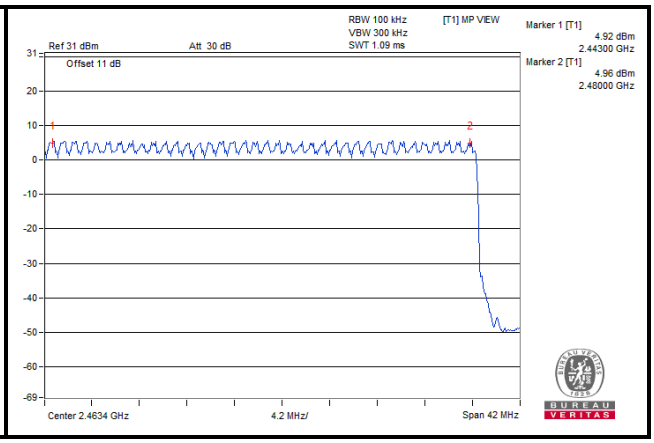
<GFSK>





<8DPSK>



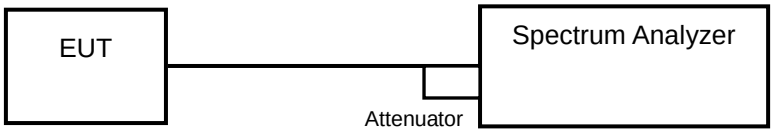


4.4 Dwell Time on Each Channel

4.4.1 Limits of Dwell Time on Each Channel Measurement

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedures

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement 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. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
d. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
e. Repeat above procedures until all different time-slot modes have been completed.

.

4.4.5 Deviation from Test Standard

No deviation.

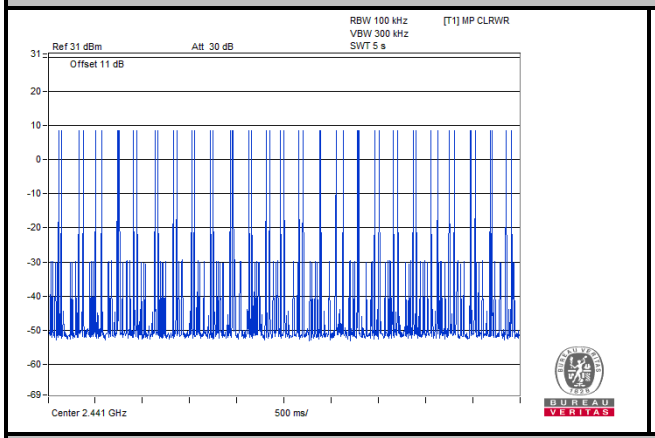
4.4.6 Test Results

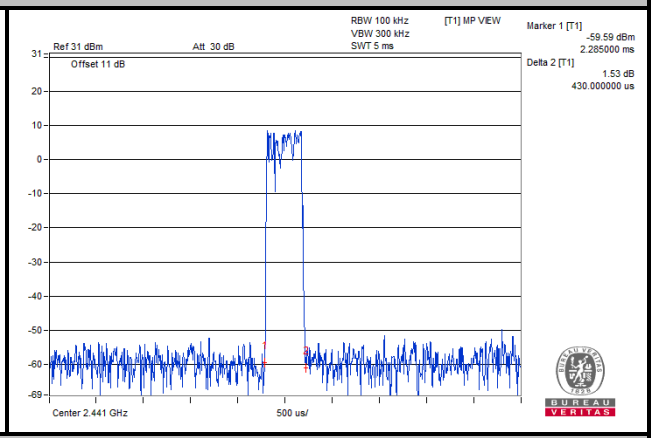
GFSK

Mode	Number of Transmission in a 31.6 (79 Hopping*0.4)	Length of Transmission Time (msec)	Result (msec)	Limit (msec)
DH1	50 (times / 5 sec) * 6.32 = 316 times	0.43	135.88	400
DH3	27 (times / 5 sec) * 6.32 = 171 times	1.705	291.56	400
DH5	18 (times / 5 sec) * 6.32 = 114 times	2.925	333.45	400

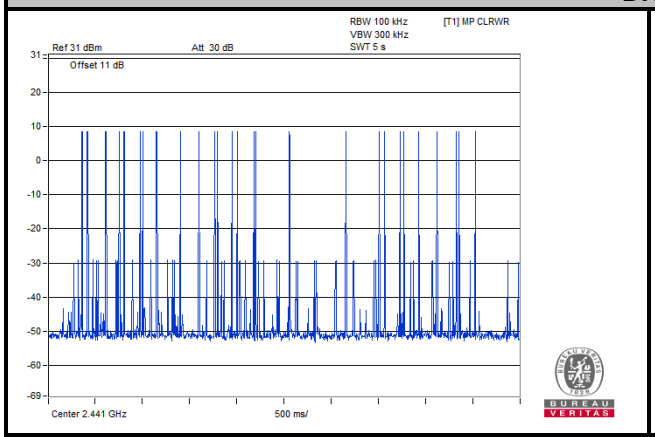
Note: Test plots of the transmitting time slot are shown as below.

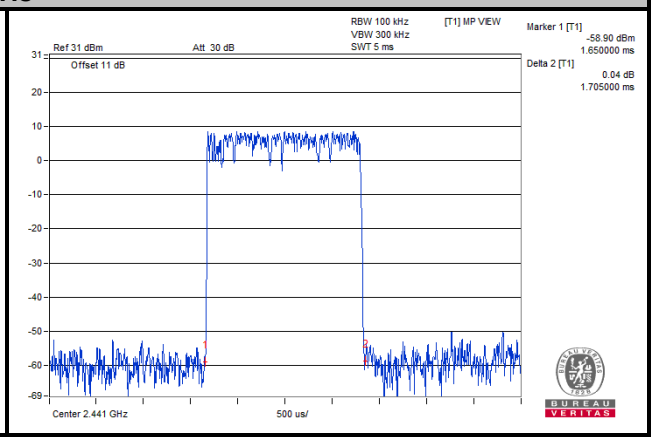
DH1



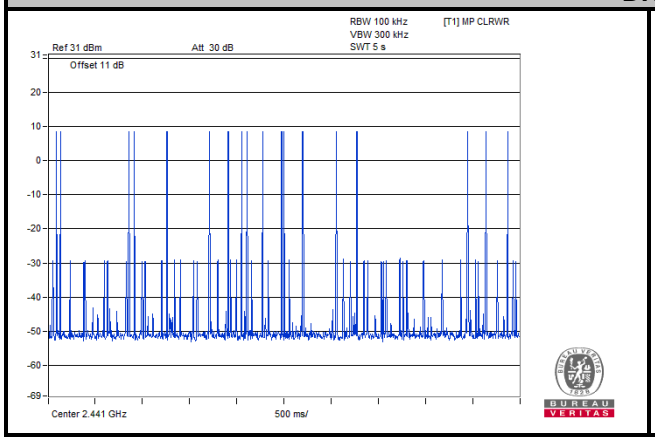


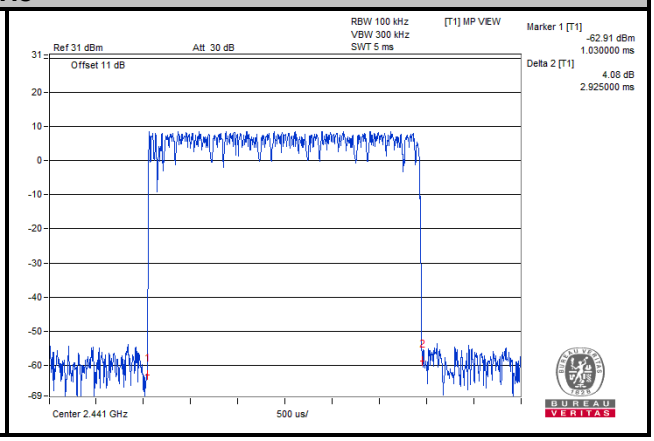
DH3





DH5



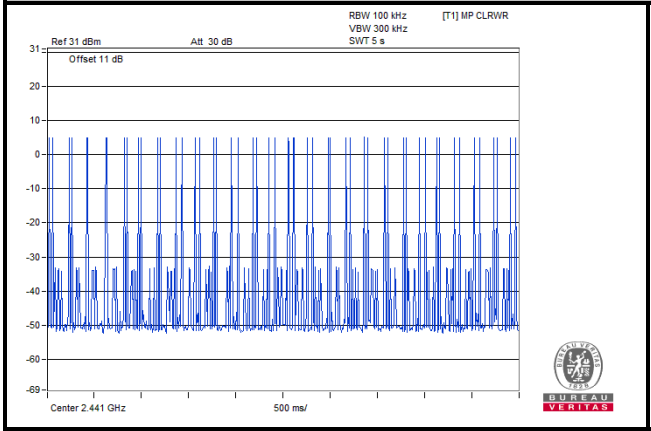


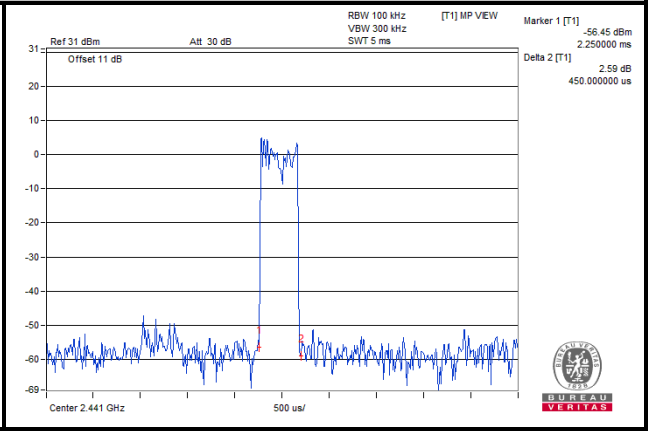
8DPSK

Mode	Number of Transmission in a 31.6 (79 Hopping*0.4)	Length of Transmission Time (msec)	Result (msec)	Limit (msec)
3DH1	50 (times / 5 sec) * 6.32 = 316 times	0.45	142.2	400
3DH3	26 (times / 5 sec) * 6.32 = 165 times	1.72	283.8	400
3DH5	17 (times / 5 sec) * 6.32 = 108 times	2.97	320.76	400

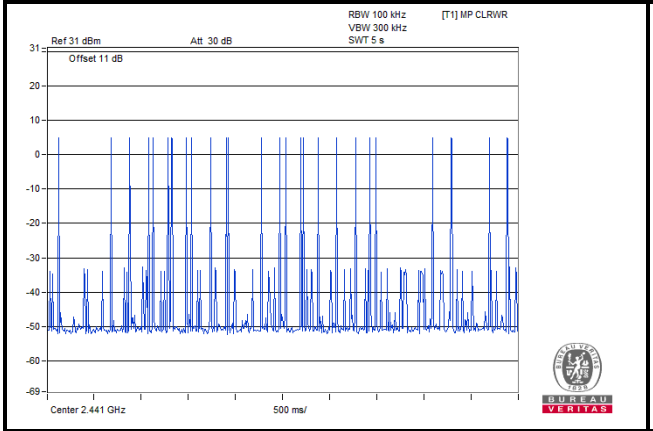
Note: Test plots of the transmitting time slot are shown as below.

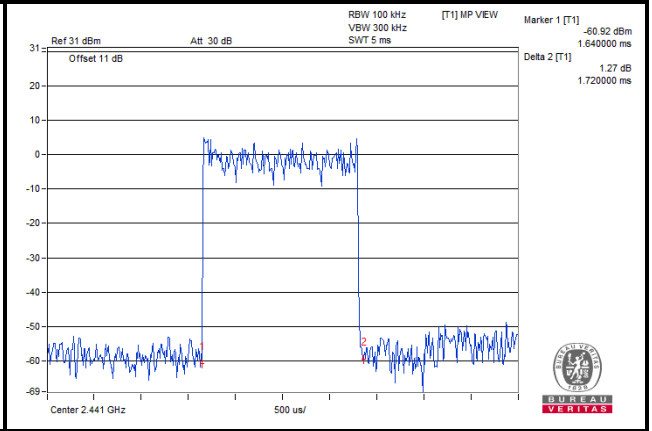
3DH1



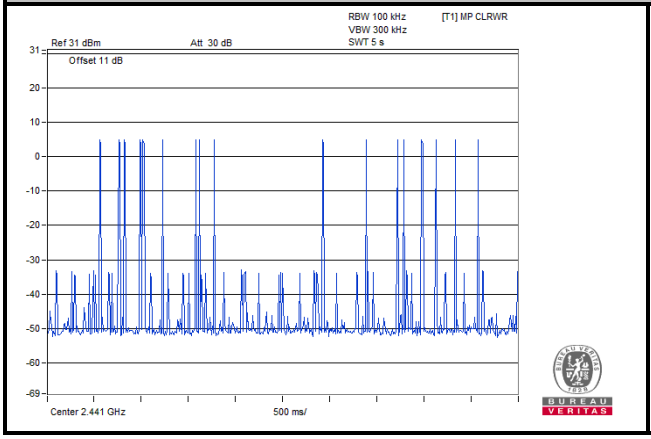


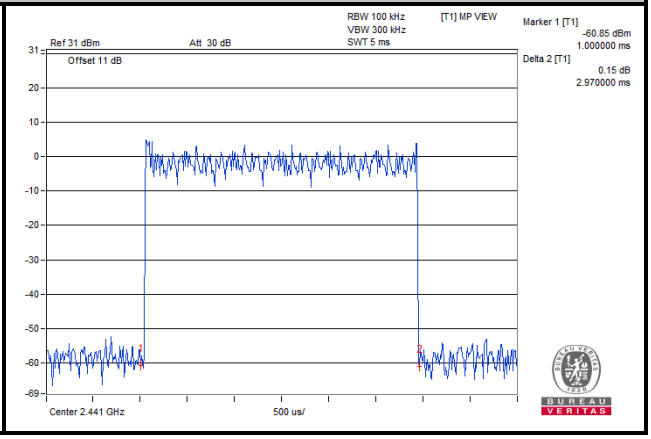
3DH3





3DH5



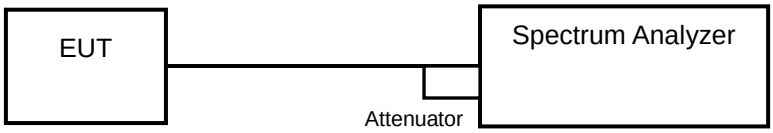


4.5 Channel Bandwidth

4.5.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5 MHz, if the 20 dB bandwidth of hopping channel is greater than 25 kHz, two-thirds 20 dB bandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
c. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

4.5.5 Deviation from Test Standard

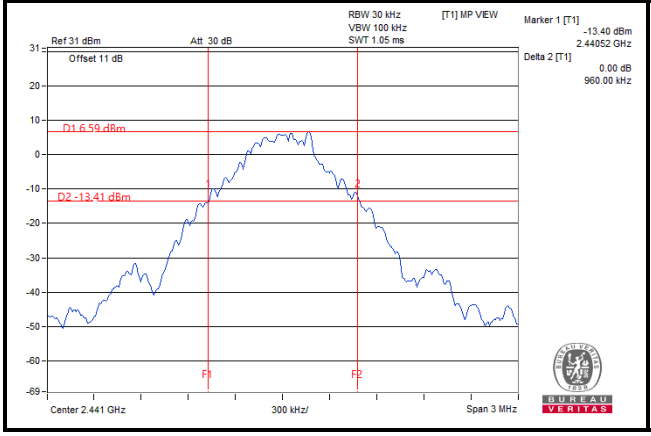
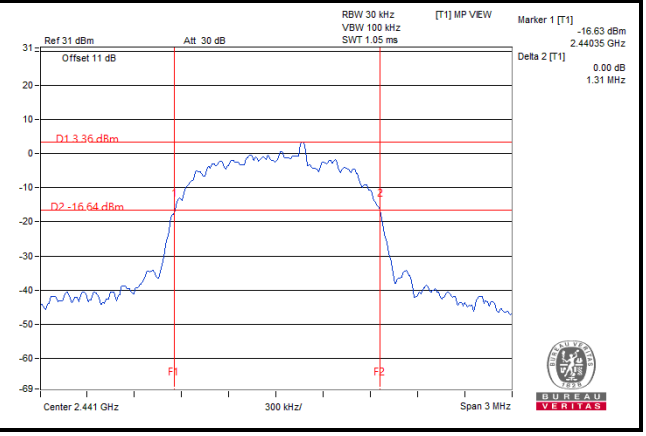
No deviation.

4.5.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

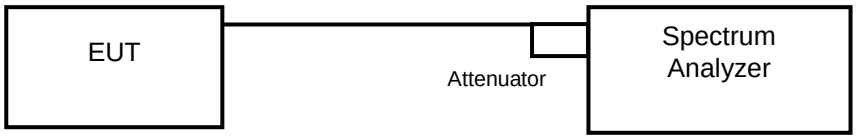
4.5.7 Test Results

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.95	1.30
39	2441	0.96	1.31
78	2480	0.96	1.31

Spectrum Plot of Worst Value	
GFSK	8DPSK
	

4.6 Occupied Bandwidth Measurement

4.6.1 Test Setup



4.6.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument

4.6.3 Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1 % to 5 % of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to sampling. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 % of the total mean power of a given emission.

4.6.4 Deviation from Test Standard

No deviation.

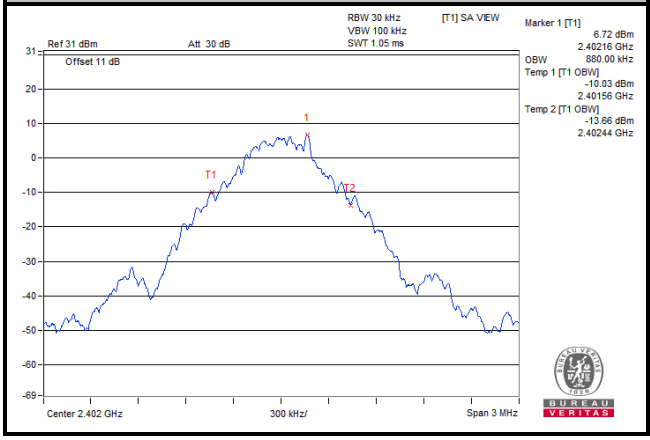
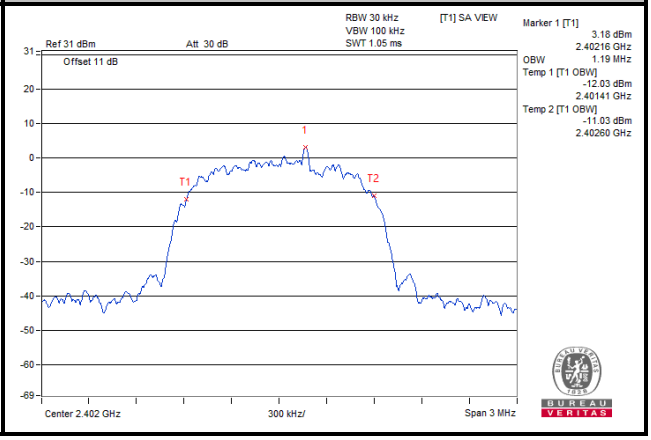
4.6.5 EUT Operating Conditions

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

4.6.6 Test Results

Channel	Frequency (MHz)	Occupied Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.88	1.19
39	2441	0.88	1.18
78	2480	0.87	1.18

Spectrum Plot of Worst Value

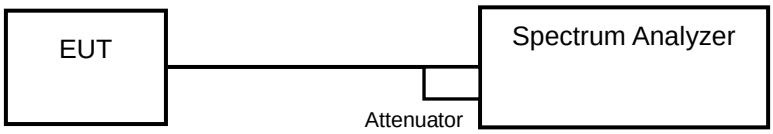
GFSK	8DPSK
	

4.7 Hopping Channel Separation

4.7.1 Limits of Hopping Channel Separation Measurement

At least 25 kHz or two-third of 20 dB hopping channel bandwidth (whichever is greater).

4.7.2 Test Setup



4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.4 Test Procedure

Measurement Procedure REF

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
c. By using the MaxHold function record the separation of two adjacent channels.
d. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
e. Repeat above procedures until all frequencies measured were complete.

4.7.5 Deviation from Test Standard

No deviation.

4.7.6 Test Results

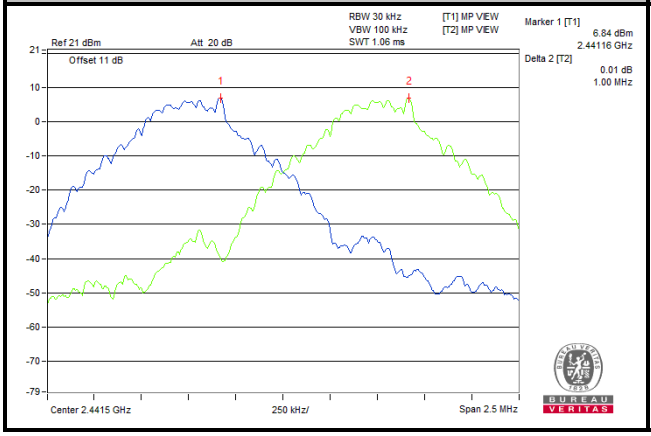
Channel	Freq. (MHz)	Adjacent Channel Separation (MHz)		20 dB Bandwidth (MHz)		Minimum Limit (MHz)		Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK	GFSK	8DPSK	
0	2402	1.00	1.00	0.95	1.30	0.64	0.87	Pass
39	2441	1.00	1.00	0.96	1.31	0.64	0.88	Pass
78	2480	1.00	1.00	0.96	1.31	0.64	0.88	Pass

Note:

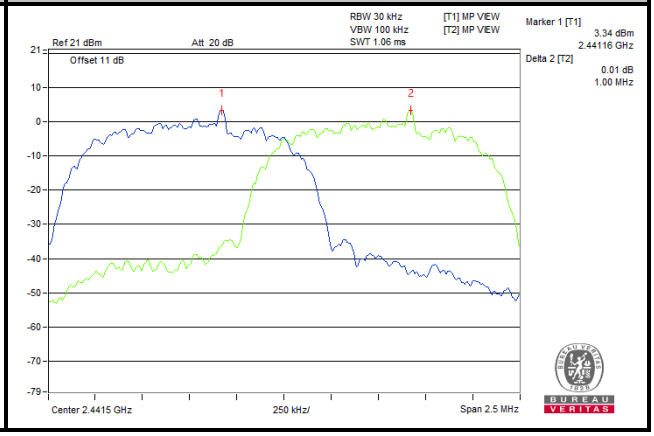
1. The minimum limit is two-third 20 dB bandwidth.

Spectrum Plot of Worst Value

GFSK



8DPSK



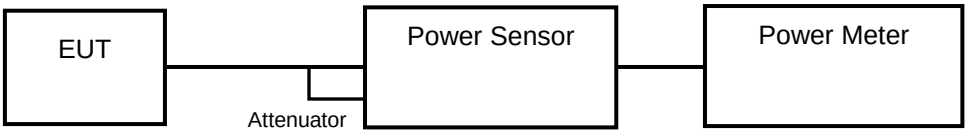
4.8 Maximum Output Power

4.8.1 Limits of Maximum Output Power Measurement

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt.

For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

4.8.2 Test Setup



4.8.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.8.4 Test Procedure

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. Record the power level.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

4.8.5 Deviation from Test Standard

No deviation.

4.8.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.8.7 Test Results

<GFSK>

Channel	Freq. (MHz)	Peak Power		Average Power		Power Limit (mW)	Pass / Fail
		(mW)	(dBm)	(mW)	(dBm)		
0	2402	6.934	8.41	6.887	8.38	125 / 1000 Note	Pass
39	2441	6.902	8.39	6.855	8.36	125 / 1000 Note	Pass
78	2480	6.761	8.30	6.73	8.28	125 / 1000 Note	Pass

Note: RF Output Power limit depends on the operating channel numbers, please refer to section 4.3 of the results.

<8DPSK>

Channel	Freq. (MHz)	Peak Power		Average Power		Power Limit (mW)	Pass / Fail
		(mW)	(dBm)	(mW)	(dBm)		
0	2402	16.482	12.17	8.035	9.05	125 / 1000 Note	Pass
39	2441	16.749	12.24	8.188	9.13	125 / 1000 Note	Pass
78	2480	15.417	11.88	8.091	9.08	125 / 1000 Note	Pass

Note: RF Output Power limit depends on the operating channel numbers, please refer to section 4.3 of the results.

4.9 Conducted Out of Band Emission Measurement

4.9.1 Limits Of Conducted Out of Band Emission Measurement

Below –20 dB of the highest emission level of operating band (in 100 kHz RBW).

4.9.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.9.3 Test Procedure

The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

4.9.4 Deviation from Test Standard

No deviation.

4.9.5 EUT Operating Condition

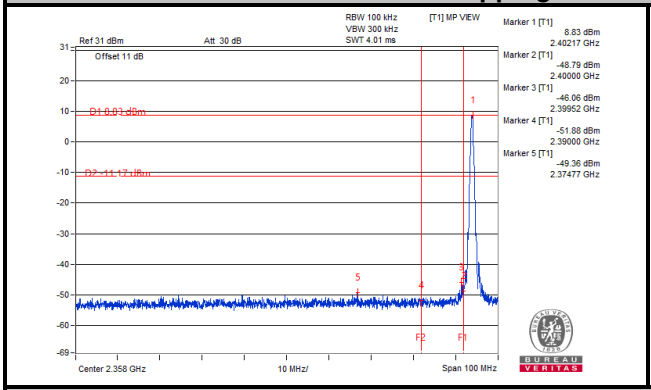
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

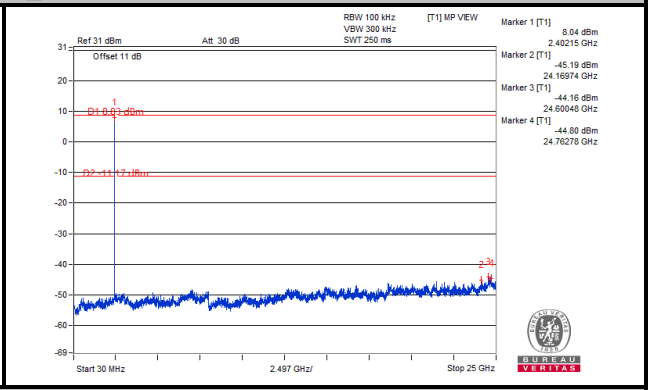
4.9.6 Test Results

The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20 dB offset below D1. It shows compliance with the requirement.

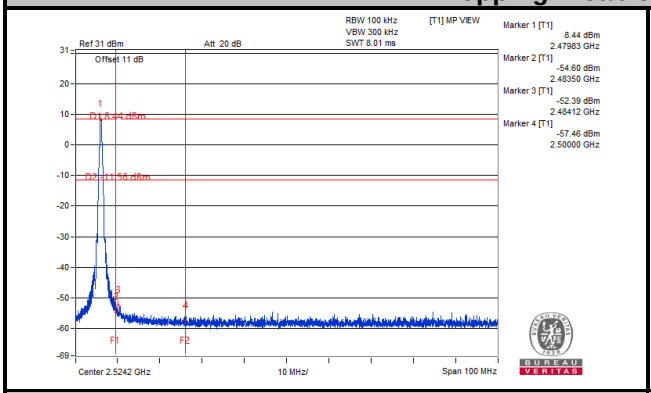
GFSK

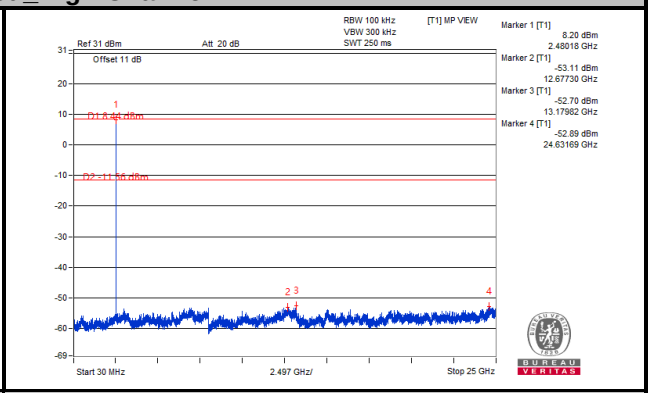
Hopping Disabled_Low Channel



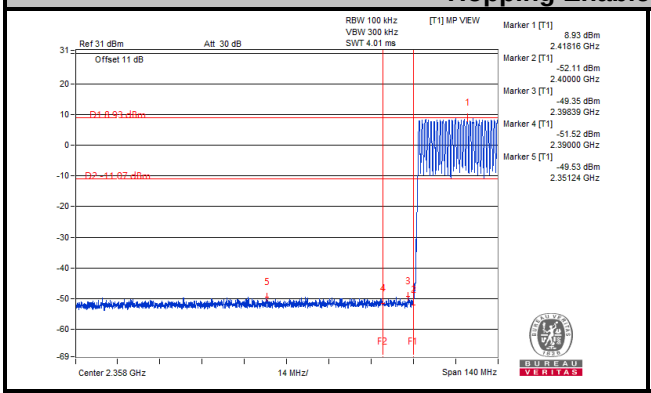


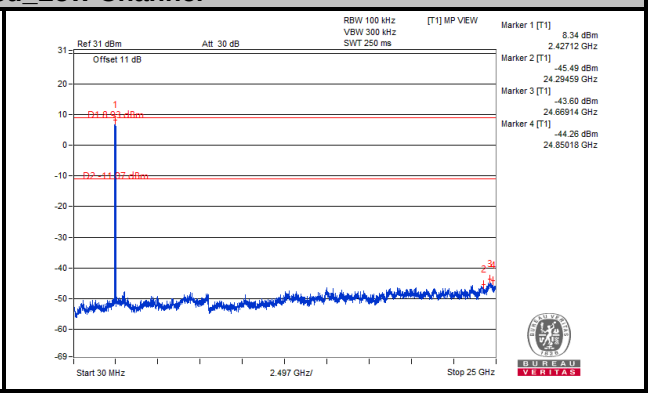
Hopping Disabled_High Channel



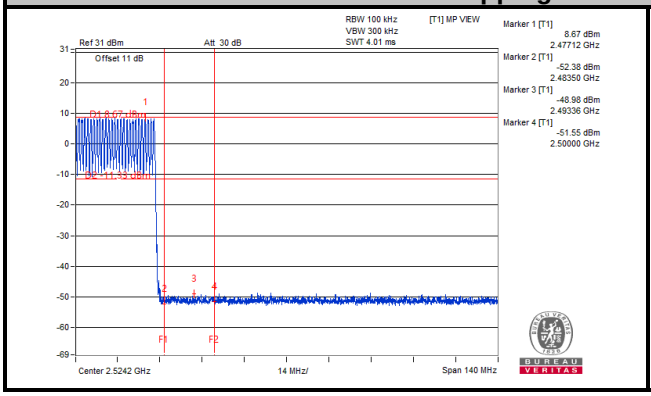


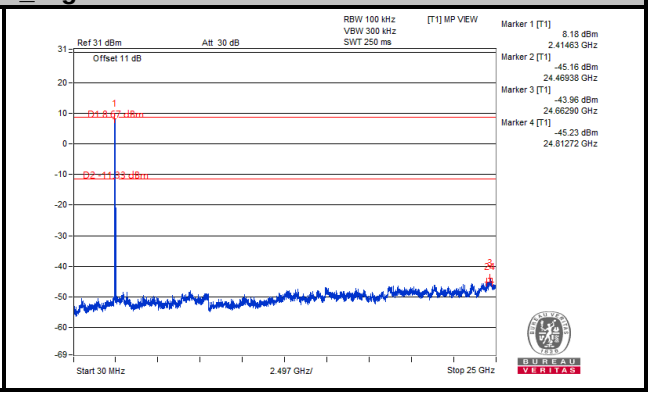
Hopping Enabled_Low Channel





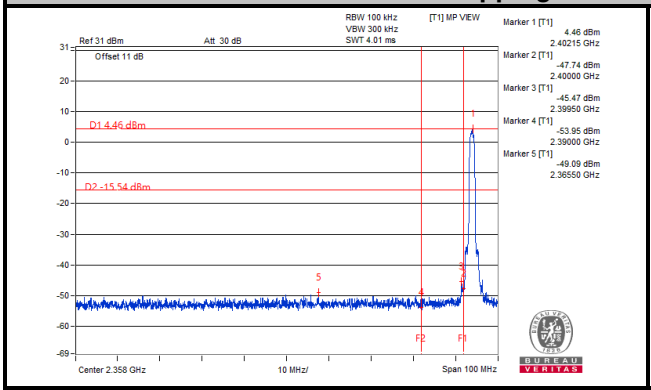
Hopping Enabled_High Channel

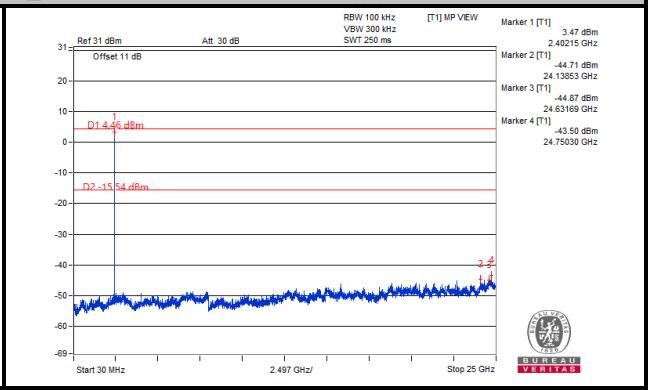




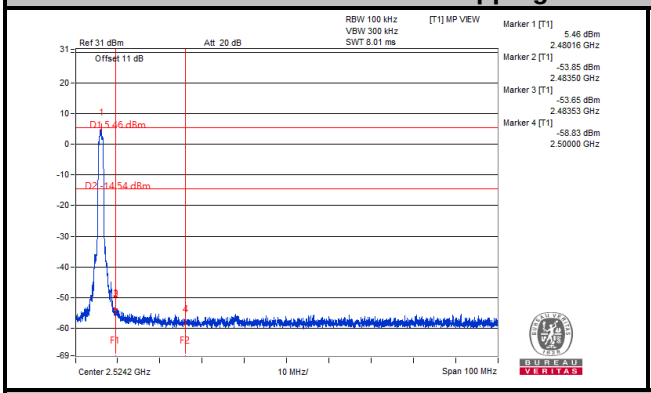
8DPSK

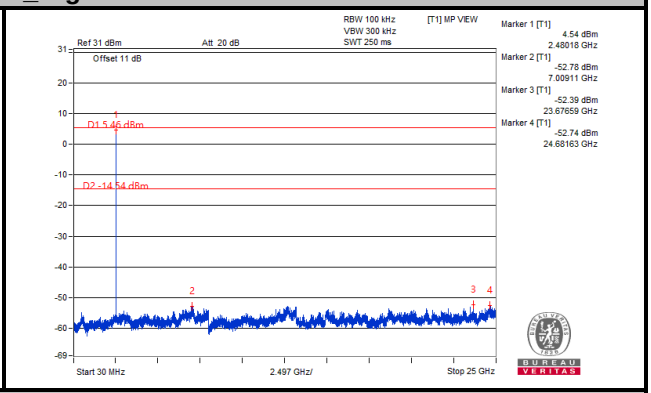
Hopping Disabled_Low Channel



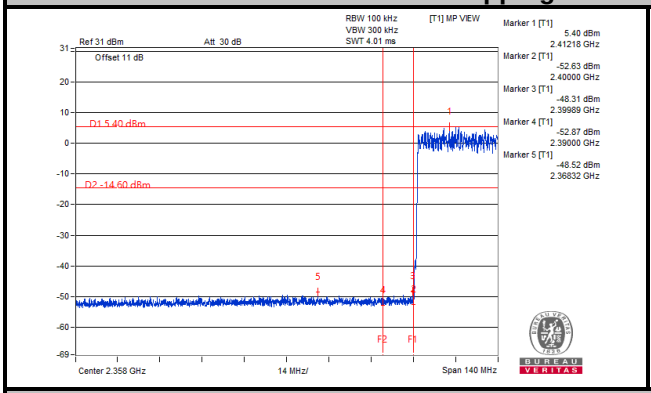


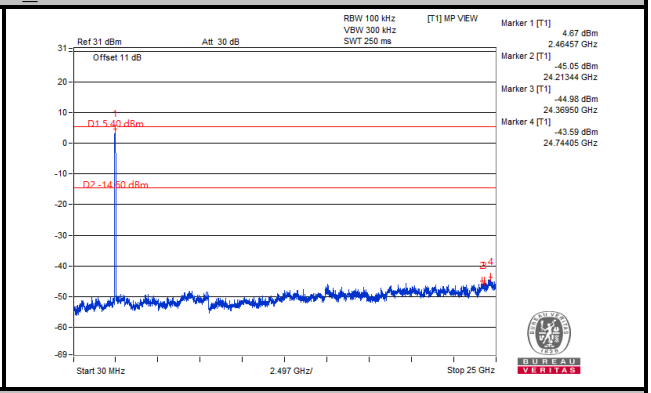
Hopping Disabled_High Channel



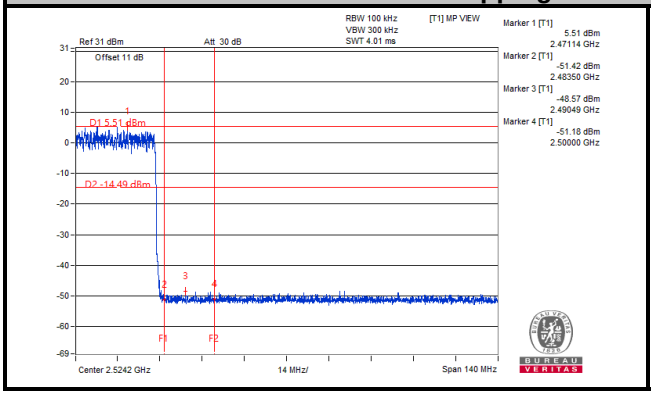


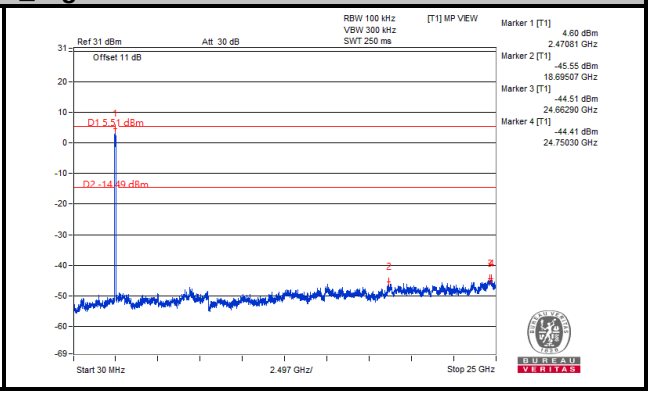
Hopping Enabled_Low Channel





Hopping Enabled_High Channel





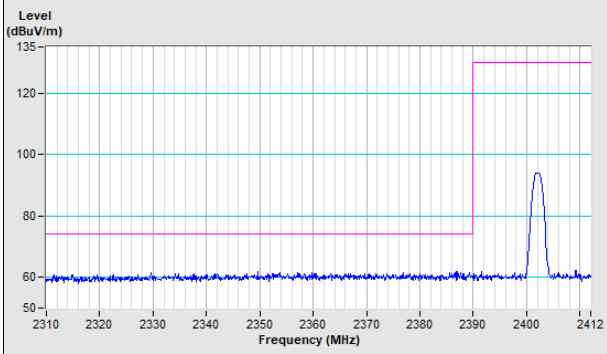
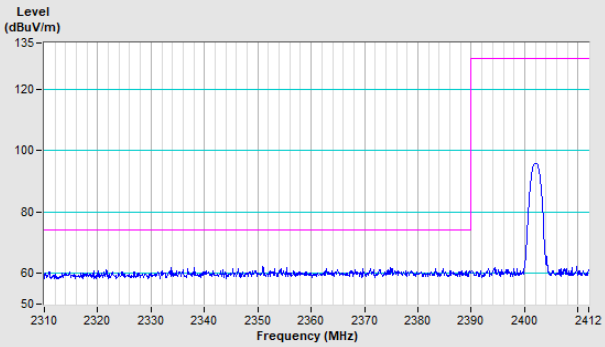
5 Photographs of the Test Configuration

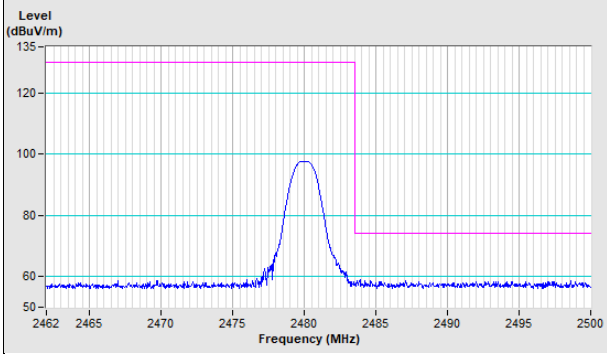
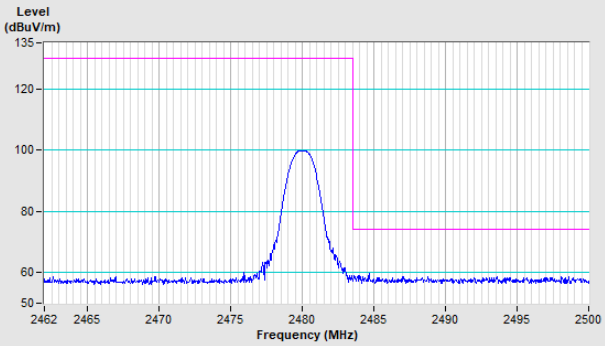
Please refer to the attached file (Reference no.: RFBCEE-WTW-P21116046-1 (TSup photo_right earbud)).

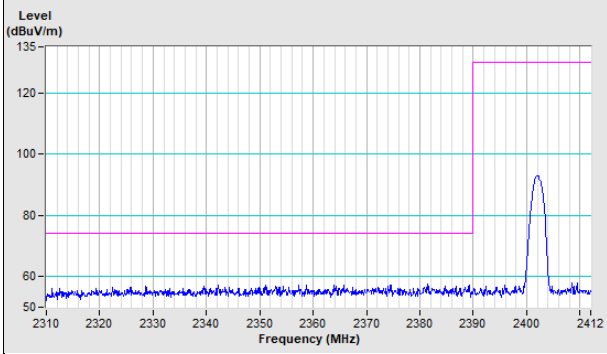
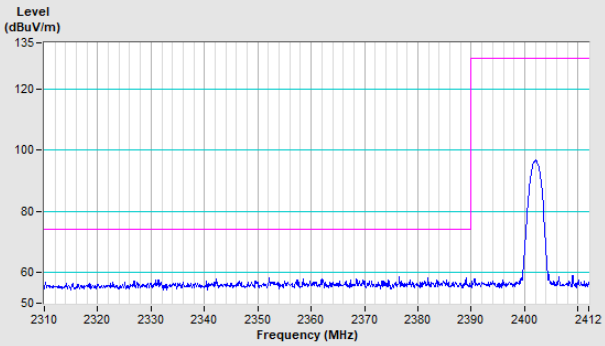
6 Construction Photos of EUT

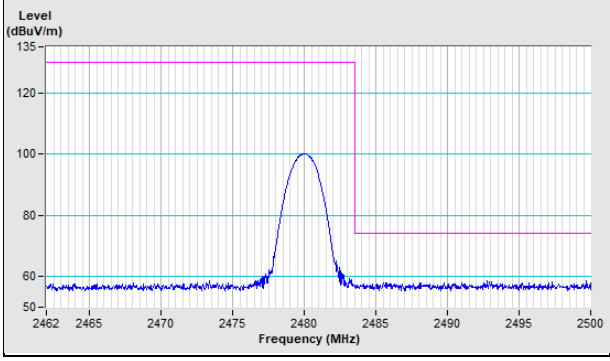
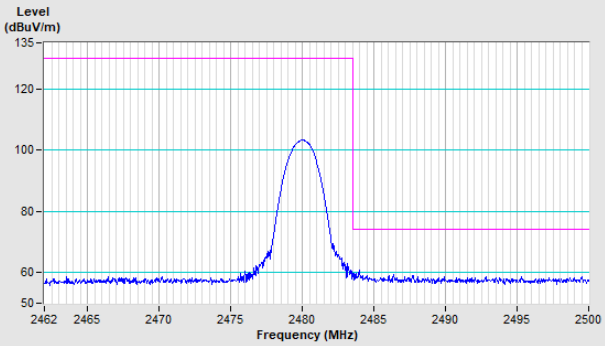
Please refer to the attached file (BCEE-WTW-P21116046 (EUT photo)).

Annex A- Band Edge Measurement

BT_GFSK Channel 0	
Horizontal (Peak)	Vertical (Peak)
	

BT_GFSK Channel 78	
Horizontal (Peak)	Vertical (Peak)
	

BT_8DPSK Channel 0	
Horizontal (Peak)	Vertical (Peak)
	

BT_8DPSK Channel 78	
Horizontal (Peak)	Vertical (Peak)
	

Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Lin Kou EMC/RF Lab
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab
Tel: 886-3-6668565
Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab
Tel: 886-3-3183232
Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com
Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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