FCC Test Report

Report No.:	RFBDTL-WTW-P21060470-2 R1
FCC ID:	VUI-CFWM
Test Model:	84911790C
Received Date:	Feb. 15, 2022
Test Date:	Mar. 10 ~ Mar. 27, 2022
Issued Date:	Nov. 22, 2022
Applicant:	PEGATRON CORPORATION
Address:	5F, NO. 76, LIGONG ST., BEITOU DISTRICT, TAIPEI CITY 112, TAIWAN
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:	No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, TAIWAN
FCC Registration / Designation Number:	788550 / TW0003

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Release Control Record

Issue No.	Description	Date Issued
RFBDTL-WTW-P21060470-2	Original release.	May 18, 2022
RFBDTL-WTW-P21060470-2 R1	Revised antenna gain	Nov. 22, 2022

1 Certificate of Conformity

Product:	Customer Facing Wi-Fi Module (CFWM)
Brand:	
Test Model:	84911790C
Sample Status:	DV
Applicant:	PEGATRON CORPORATION
Test Date:	Mar. 10 ~ Mar. 27, 2022
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 : Polly Chien , **Date:** Nov. 22, 2022

Polly Chien / Specialist

Approved by : Jeremy Lin , **Date:** Nov. 22, 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	NA	EUT is powered from DC
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(b)	Maximum Peak Output Power	Pass	Meet the requirement of limit.
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	Pass	Meet the requirement of limit. Minimum passing margin is -2.2dB at 187.14MHz.
15.247(d)	Antenna Port Emission	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	Antenna connector is I-pex not a standard connector.

Note:
1. If The Frequency Hopping System operating in 2400-2483.5MHz band and the output power less than 125mW. The hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB 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) (±)
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.04 dB
	30MHz ~ 200MHz	3.63 dB
	200MHz ~1000MHz	3.64 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	2.29 dB
	18GHz ~ 40GHz	2.29 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Customer Facing Wi-Fi Module (CFWM)
Brand	
Test Model	84911790C
Sample Status	DV
Power Supply Rating	12Vdc
Modulation Type	GFSK, π/4-DQPSK, 8DPSK
Modulation Technology	FHSS
Transfer Rate	1/2/3Mbps
Operating Frequency	2402~2480MHz
Number of Channel	79
Output Power	5.383mW
Antenna Type	PCB antenna with 4.07 dBi gain
Antenna Connector	I-pex
Accessory Device	NA
Cable Supplied	NA

Note:

1. Detail antenna specification please refer to antenna photos/or drawings, including antenna dimensions.
2. The EUT contains certified LTE module (Brand: Quectel, Model: AG521R-NA (FCC ID: VUI-DAV001)).

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	
-	√	√	Note 2	√	-

Where RE≥1G: Radiated Emission above 1GHz & Bandedge Measurement RE<1G: Radiated Emission below 1GHz

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

Note:

1. The EUT was positioned on the X-plane (antenna) during testing.
2. No need to concern of PLC due to the EUT is powered from DC.
3. For radiated emission (below 1GHz) test items chosen the worst maximum fundamental emission level channel.

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 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	Pakcet Type
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5
-	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

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 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	Pakcet Type
-	0 to 78	39	FHSS	GFSK	DH5

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.

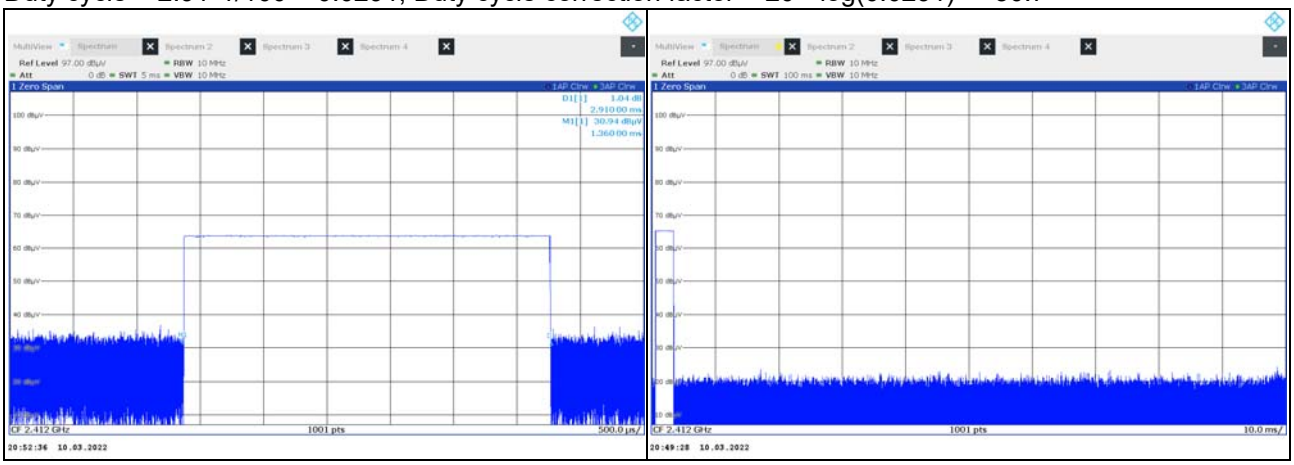
EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Pakcet Type
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5
-	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

Test Condition:

Applicable to	Environmental Conditions	Input Power (System)	Tested by
RE≥1G	23 deg. C, 66% RH	12Vdc	Luis Lee
RE<1G	23 deg. C, 66% RH	12Vdc	Titan Hsu
APCM	25 deg. C, 60% RH	12Vdc	Chris Lin

3.3 Duty Cycle of Test Signal

Duty cycle = 2.91*1/100 = 0.0291, Duty cycle correction factor = 20 * log(0.0291) = -30.7



3.4 Description of Support Units

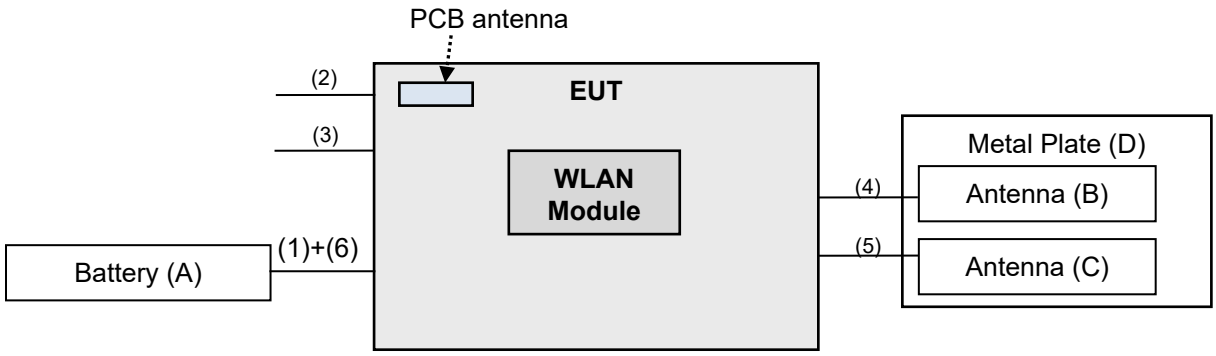
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Battery	YUASA	75D23R-CMF II	NA	NA	-
B.	Antenna	TE	84623918	NA	NA	Provided by client
C.	Antenna	Continental	85004261	NA	NA	Provided by client
D.	Metal Plate	NA	NA	NA	NA	Provided by client

Note: All power cords of the above support units are non-shielded (1.8m).

ID	Cable Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	Power cable	1	2	N	0	Provided by client 2M (With Power Supply 0.85M Cable, 0.3M Cable, 1.8M Cable)
2.	Combo B cable	1	5.2	N	0	Provided by client
3.	Combo A cable	1	5.2	N	0	Provided by client
4.	Rosenberger Harness_CFWM WiFi	1	0.15	N	0	Provided by client
5.	Rosenberger Harness_CFWM LTE	1	2.35	N	0	Provided by client
6.	Power cable	1	2	N	0	-

3.4.1 Configuration of System under Test



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 20dB 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:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. 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.

4.1.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Test Receiver ROHDE & SCHWARZ	ESCI	100424	Dec. 30, 2021	Dec. 29, 2022
Spectrum Analyzer ROHDE & SCHWARZ	FSP40	100040	Sep. 15, 2021	Sep. 14, 2022
BILOG Antenna SCHWARZBECK	VULB9168	9168-155	Nov. 01, 2021	Oct. 31, 2022
HORN Antenna SCHWARZBECK	BBHA 9120D	9120D-1170	Nov. 14, 2021	Nov. 13, 2022
HORN Antenna SCHWARZBECK	BBHA 9170	BBHA9170241	Oct. 26, 2021	Oct. 35, 2022
Loop Antenna TESEQ	HLA 6121	45745	Jul. 21, 2021	Jul. 20, 2022
Preamplifier Agilent (Below 1GHz)	8447D	2944A10631	Jun. 05, 2021	Jun. 04, 2022
Preamplifier KEYSIGHT (Above 1GHz)	83017A	MY53270295	Jun. 05, 2021	Jun. 04, 2022
RF Coaxial Cable WOKEN With 5dB PAD	8D-FB	Cable-CH4-01	Jul. 24, 2021	Jul. 23, 2022
RF Coaxial Cable EMCI	EMC102-KM-KM-3000	150929	Jul. 24, 2021	Jul. 23, 2022
RF Coaxial Cable EMCI	EMC102-KM-KM-600	150928	Jul. 24, 2021	Jul. 23, 2022
RF signal cable HUBER+SUHNER	SUCOFLEX 104	MY 13380+295012/04	Jun. 05, 2021	Jun. 04, 2022
RF signal cable HUBER+SUHNER	SUCOFLEX 104	Cable-CH4-03 (250724)	Jun. 05, 2021	Jun. 04, 2022
Software BV ADT	ADT_Radiated_ V7.6.15.9.5	NA	NA	NA
Antenna Tower inn-co GmbH	MA 4000	010303	NA	NA
Turn Table Controller BV ADT	SC100	SC93021702	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP01	NA	NA
Peak Power Analyzer KEYSIGHT	8990B	MY51000485	Jan. 18, 2022	Jan. 17, 2023
Wideband Power Sensor KEYSIGHT	N1923A	MY58020002	Jan. 17, 2022	Jan. 16, 2023

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 Chamber 4.

4.1.3 Test Procedures

For Radiated emission below 30MHz

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 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) 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 detect 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:

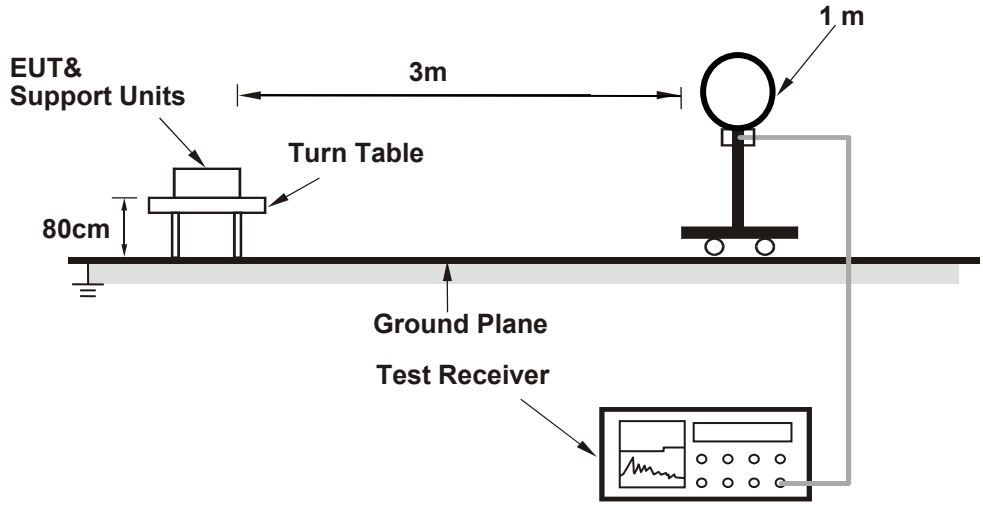
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) and Average detection (AV) at frequency above 1GHz. 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

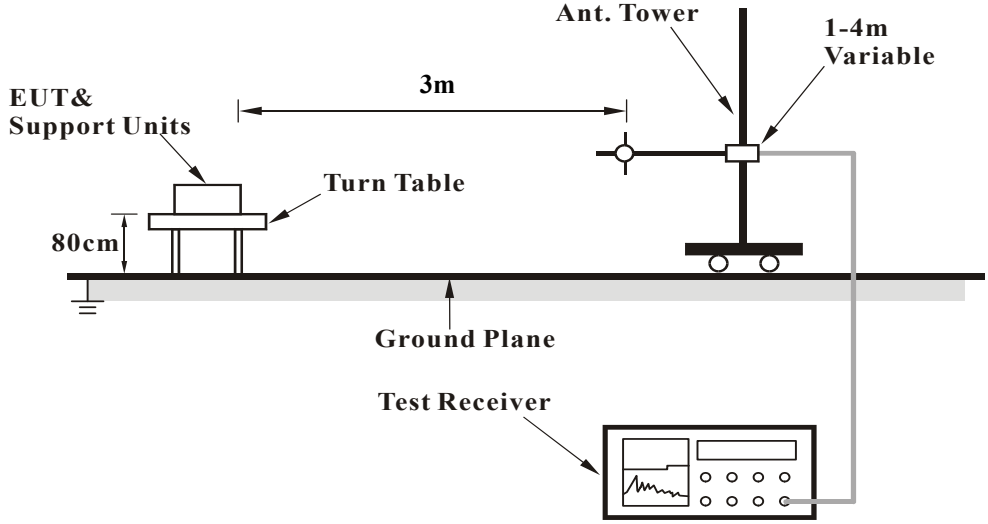
No deviation.

4.1.5 Test Setup

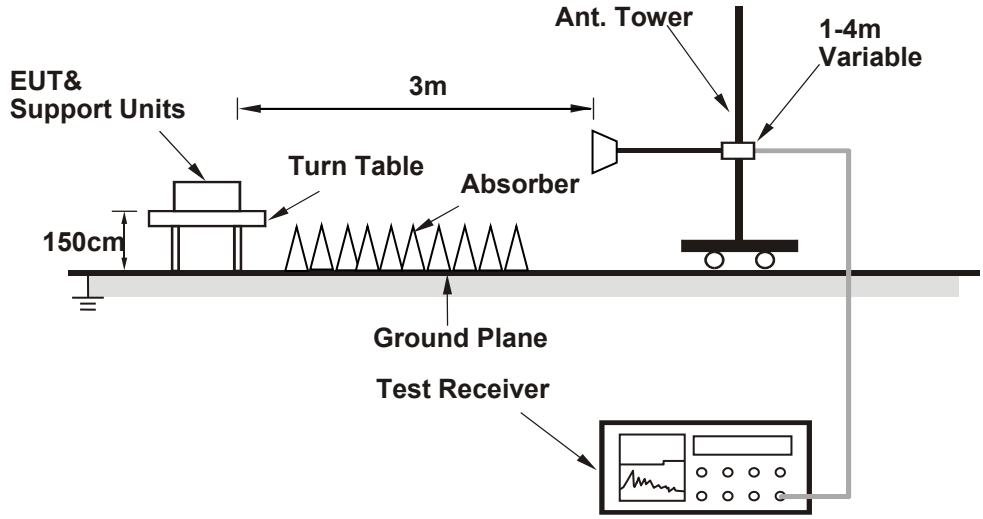
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



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

4.1.6 EUT Operating Conditions

a. The EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1GHz data:

GFSK

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

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	58.6 PK	74.0	-15.4	1.06 H	143	24.5	34.1
2	2390.00	45.4 AV	54.0	-8.6	1.06 H	143	11.3	34.1
3	*2402.00	102.6 PK			1.06 H	143	68.5	34.1
4	*2402.00	71.9 AV			1.06 H	143	37.8	34.1
5	4804.00	52.2 PK	74.0	-21.8	2.35 H	196	38.6	13.6
6	4804.00	21.5 AV	54.0	-32.5	2.35 H	196	7.9	13.6
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	58.9 PK	74.0	-15.1	1.99 V	255	24.8	34.1
2	2390.00	45.7 AV	54.0	-8.3	1.99 V	255	11.6	34.1
3	*2402.00	104.0 PK			1.99 V	255	69.9	34.1
4	*2402.00	73.3 AV			1.99 V	255	39.2	34.1
5	4804.00	53.3 PK	74.0	-20.7	1.57 V	236	39.7	13.6
6	4804.00	22.6 AV	54.0	-31.4	1.57 V	236	9.0	13.6

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. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:
   The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)
   where the duty factor is calculated from following formula:
   20Log(Duty cycle) = 20 log (2.91ms*1/100) = -30.7dB please refer to the plotted duty (see section 3.3)

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

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	103.9 PK			1.12 H	148	69.6	34.3
2	*2441.00	73.2 AV			1.12 H	148	38.9	34.3
3	4882.00	52.3 PK	74.0	-21.7	2.36 H	189	38.7	13.6
4	4882.00	21.6 AV	54.0	-32.4	2.36 H	189	8.0	13.6
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	105.3 PK			1.90 V	255	71.0	34.3
2	*2441.00	74.6 AV			1.90 V	255	40.3	34.3
3	4882.00	53.5 PK	74.0	-20.5	1.64 V	233	39.9	13.6
4	4882.00	22.8 AV	54.0	-31.2	1.64 V	233	9.2	13.6

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. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:
   The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)
   where the duty factor is calculated from following formula:
   20Log(Duty cycle) = 20 log (2.91ms*1/100) = -30.7dB please refer to the plotted duty (see section 3.3)

CHANNEL	TX Channel 78	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

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	100.5 PK			1.15 H	156	66.2	34.3
2	*2480.00	69.8 AV			1.15 H	156	35.5	34.3
3	2483.50	52.4 PK	74.0	-21.6	1.15 H	156	49.0	3.4
4	2483.50	21.7 AV	54.0	-32.3	1.15 H	156	18.3	3.4
5	4960.00	52.9 PK	74.0	-21.1	2.38 H	197	39.4	13.5
6	4960.00	22.2 AV	54.0	-31.8	2.38 H	197	8.7	13.5
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	102.1 PK			1.98 V	257	67.8	34.3
2	*2480.00	71.4 AV			1.98 V	257	37.1	34.3
3	2483.50	52.7 PK	74.0	-21.3	1.98 V	257	49.3	3.4
4	2483.50	22.0 AV	54.0	-32.0	1.98 V	257	18.6	3.4
5	4960.00	53.0 PK	74.0	-21.0	1.49 V	234	39.5	13.5
6	4960.00	22.3 AV	54.0	-31.7	1.49 V	234	8.8	13.5

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. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:
   The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)
   where the duty factor is calculated from following formula:
   20Log(Duty cycle) = 20 log (2.91ms*1/100) = -30.7dB please refer to the plotted duty (see section 3.3)

8DPSK

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

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	58.4 PK	74.0	-15.6	1.09 H	138	24.3	34.1
2	2390.00	45.5 AV	54.0	-8.5	1.09 H	138	11.4	34.1
3	*2402.00	97.6 PK			1.09 H	138	63.5	34.1
4	*2402.00	66.9 AV			1.09 H	138	32.8	34.1
5	4804.00	52.5 PK	74.0	-21.5	2.30 H	195	38.9	13.6
6	4804.00	21.8 AV	54.0	-32.2	2.30 H	195	8.2	13.6
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	59.1 PK	74.0	-14.9	1.97 V	256	25.0	34.1
2	2390.00	45.7 AV	54.0	-8.3	1.97 V	256	11.6	34.1
3	*2402.00	98.8 PK			1.97 V	256	64.7	34.1
4	*2402.00	68.1 AV			1.97 V	256	34.0	34.1
5	4804.00	53.4 PK	74.0	-20.6	1.48 V	227	39.8	13.6
6	4804.00	22.7 AV	54.0	-31.3	1.48 V	227	9.1	13.6

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. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:
   The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)
   where the duty factor is calculated from following formula:
   20Log(Duty cycle) = 20 log (2.91ms*1/100) = -30.7dB please refer to the plotted duty (see section 3.3)

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

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	98.5 PK			1.04 H	134	64.2	34.3
2	*2441.00	67.8 AV			1.04 H	134	33.5	34.3
3	4882.00	52.3 PK	74.0	-21.7	2.14 H	188	38.7	13.6
4	4882.00	21.6 AV	54.0	-32.4	2.14 H	188	8.0	13.6
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	100.1 PK			1.95 V	258	65.8	34.3
2	*2441.00	69.4 AV			1.95 V	258	35.1	34.3
3	4882.00	53.5 PK	74.0	-20.5	1.59 V	237	39.9	13.6
4	4882.00	22.8 AV	54.0	-31.2	1.59 V	237	9.2	13.6

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. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:
   The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)
   where the duty factor is calculated from following formula:
   20Log(Duty cycle) = 20 log (2.91ms*1/100) = -30.7dB please refer to the plotted duty (see section 3.3)

CHANNEL	TX Channel 78	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

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	96.5 PK			1.08 H	136	62.2	34.3
2	*2480.00	65.8 AV			1.08 H	136	31.5	34.3
3	2483.50	52.9 PK	74.0	-21.1	1.08 H	136	49.5	3.4
4	2483.50	22.2 AV	54.0	-31.8	1.08 H	136	18.8	3.4
5	4960.00	52.3 PK	74.0	-21.7	2.29 H	187	38.8	13.5
6	4960.00	21.6 AV	54.0	-32.4	2.29 H	187	8.1	13.5
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	97.7 PK			1.96 V	258	63.4	34.3
2	*2480.00	67.0 AV			1.96 V	258	32.7	34.3
3	2483.50	53.1 PK	74.0	-20.9	1.96 V	258	49.7	3.4
4	2483.50	22.4 AV	54.0	-31.6	1.96 V	258	19.0	3.4
5	4960.00	53.3 PK	74.0	-20.7	1.46 V	229	39.8	13.5
6	4960.00	22.6 AV	54.0	-31.4	1.46 V	229	9.1	13.5

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. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:
   The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)
   where the duty factor is calculated from following formula:
   20Log(Duty cycle) = 20 log (2.91ms*1/100) = -30.7dB please refer to the plotted duty (see section 3.3)

Below 1GHz worst-case data:

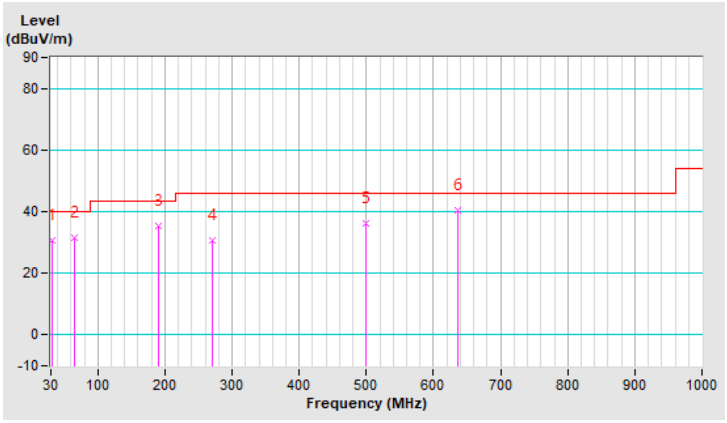
GFSK

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	31.94	30.6 QP	40.0	-9.4	1.01 H	103	40.9	-10.3
2	64.92	31.4 QP	40.0	-8.6	1.50 H	19	41.4	-10.0
3	191.02	35.5 QP	43.5	-8.0	1.01 H	111	46.8	-11.3
4	270.56	30.8 QP	46.0	-15.2	1.01 H	206	39.2	-8.4
5	499.48	36.2 QP	46.0	-9.8	1.50 H	74	40.1	-3.9
6	637.22	40.4 QP	46.0	-5.6	1.01 H	118	41.3	-0.9

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. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
4. Margin value = Emission Level – Limit value
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20dB below the permissible value to be report.

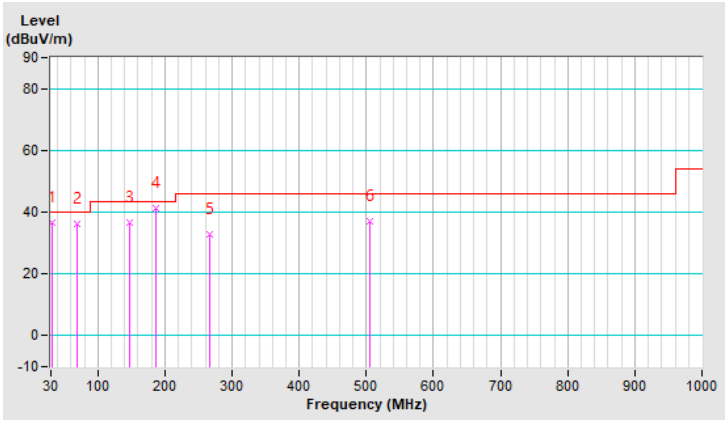


CHANNEL	TX Channel 39	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

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	31.94	36.6 QP	40.0	-3.4	1.00 V	161	46.9	-10.3
2	68.80	36.2 QP	40.0	-3.8	1.50 V	102	46.8	-10.6
3	146.40	36.5 QP	43.5	-7.0	1.00 V	91	45.3	-8.8
4	**187.14**	**41.3 QP**	**43.5**	**-2.2**	**1.00 V**	**236**	**52.3**	**-11.0**
5	266.68	33.0 QP	46.0	-13.0	1.50 V	102	41.6	-8.6
6	505.30	37.0 QP	46.0	-9.0	1.00 V	102	40.8	-3.8

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. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
4. Margin value = Emission Level – Limit value
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20dB below the permissible value to be report.



4.2 Number of Hopping Frequency Used

4.2.1 Limits of Hopping Frequency Used Measurement

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

4.2.2 Test Setup

4.2.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.2.4 Test Procedure

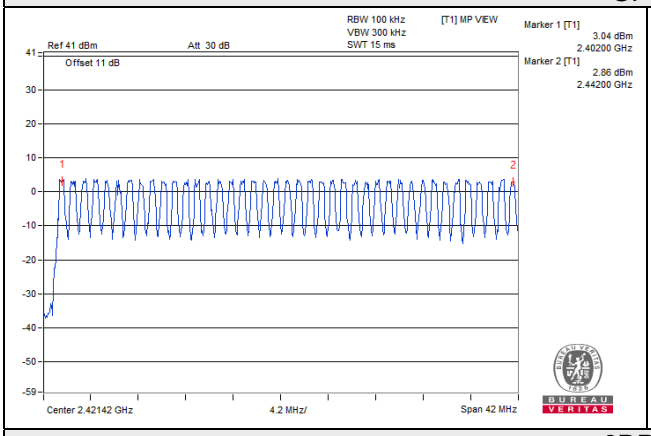
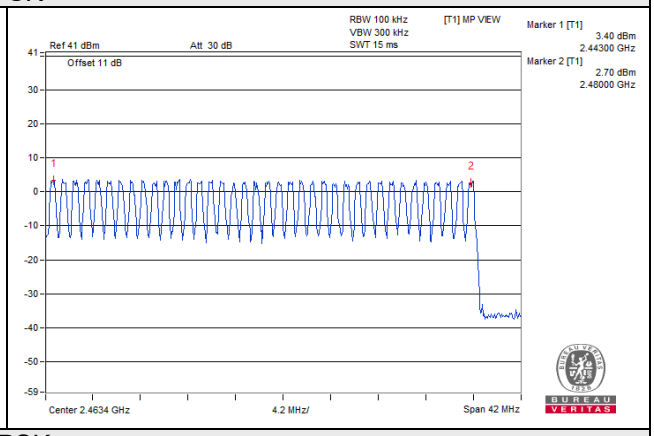
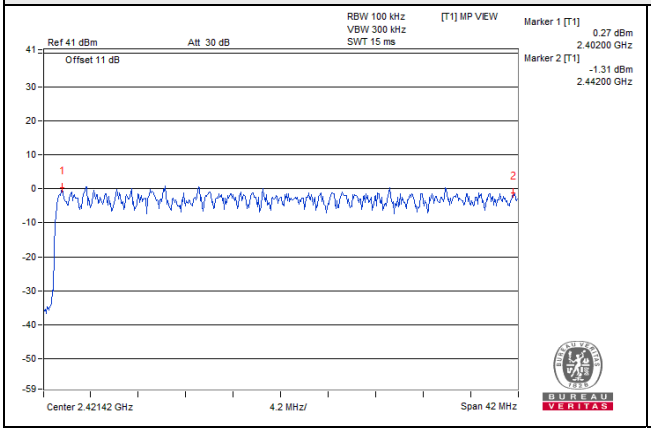
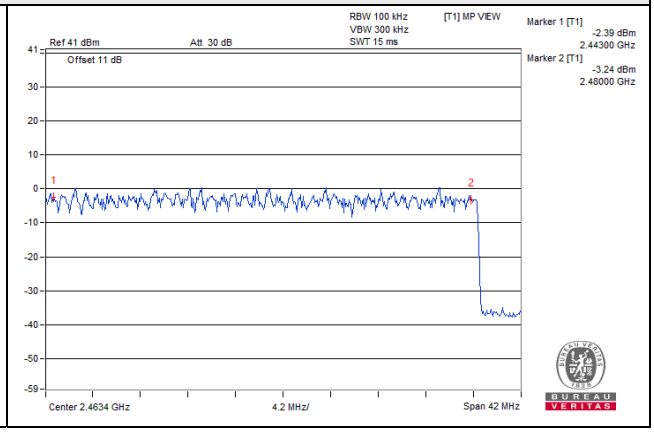
a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and 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.

4.2.5 Deviation fromTest Standard

No deviation.

4.2.6 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	
	

4.3 Dwell Time on Each Channel

4.3.1 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.

4.3.2 Test Setup

4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test 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.

4.3.5 Deviation from Test Standard

No deviation.

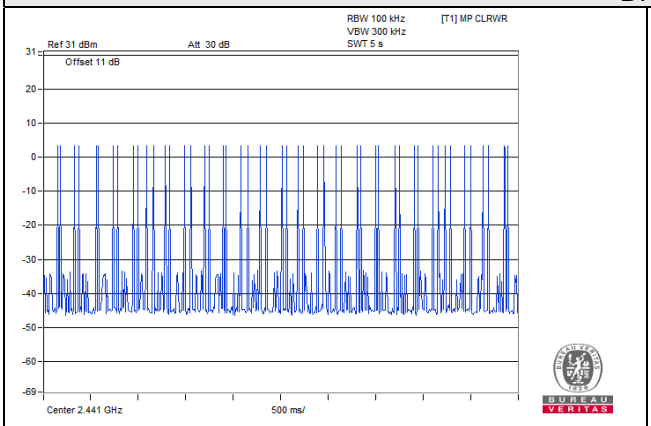
4.3.6 Test Results

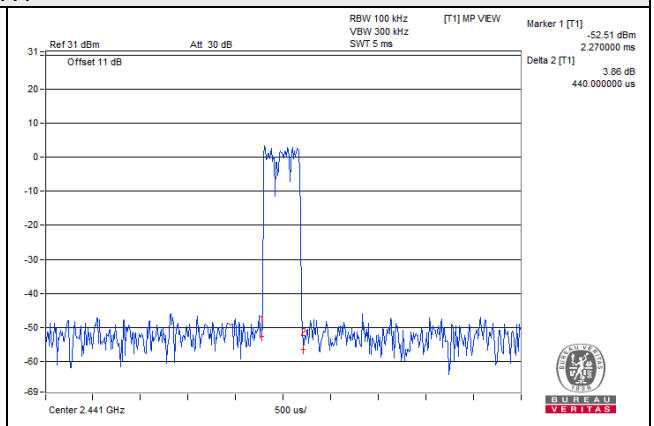
GFSK

Mode	Number of transmission in a 31.6 (79Hopping*0.4)	Length of transmission time (msec)	Result (msec)	Limit (msec)
DH1	50 (times / 5 sec) * 6.32 = 316 times	0.440	139.040	400
DH3	26 (times / 5 sec) * 6.32 = 165 times	1.740	287.100	400
DH5	18 (times / 5 sec) * 6.32 = 114 times	2.970	338.580	400

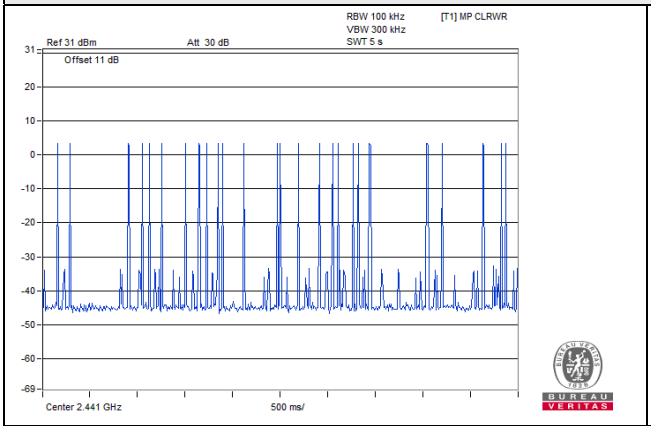
Note: Test plots of the transmitting time slot are shown as below.

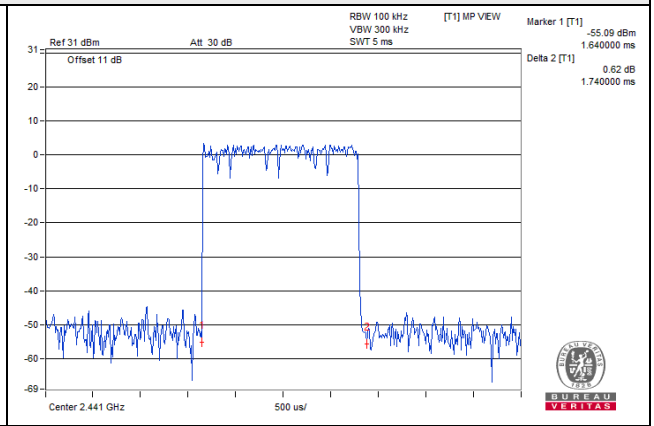
DH1



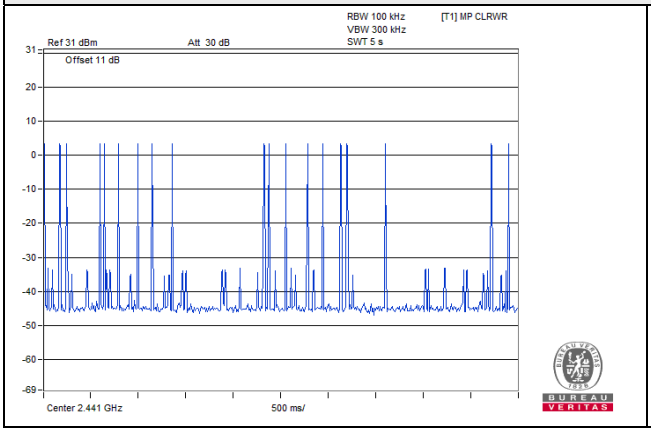


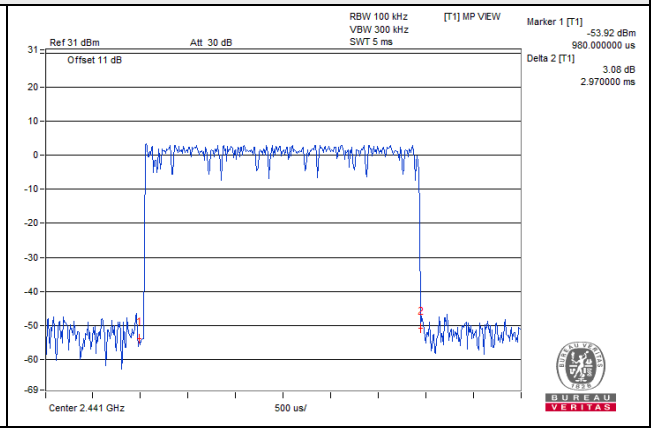
DH3





DH5



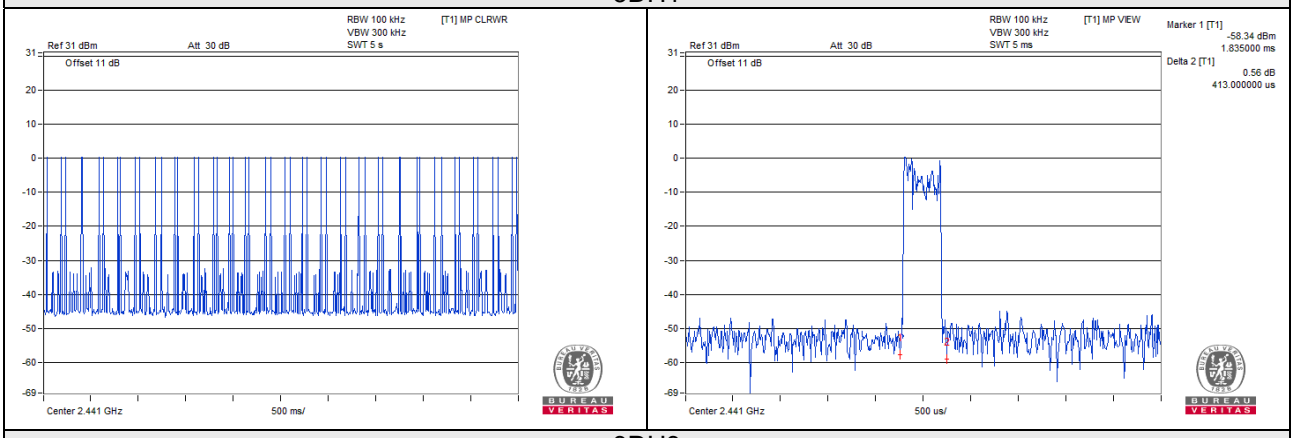


8DPSK

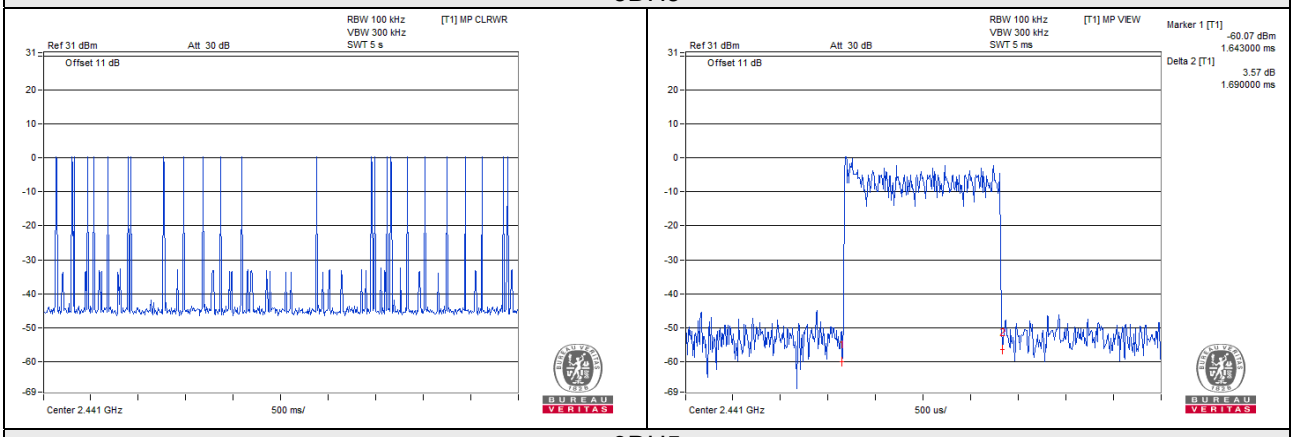
Mode	Number of transmission in a 31.6 (79Hopping*0.4)	Length of transmission time (msec)	Result (msec)	Limit (msec)
3DH1	50 (times / 5 sec) * 6.32 = 316 times	0.413	130.508	400
3DH3	25 (times / 5 sec) * 6.32 = 158 times	1.690	267.020	400
3DH5	17 (times / 5 sec) * 6.32 = 108 times	2.916	314.928	400

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

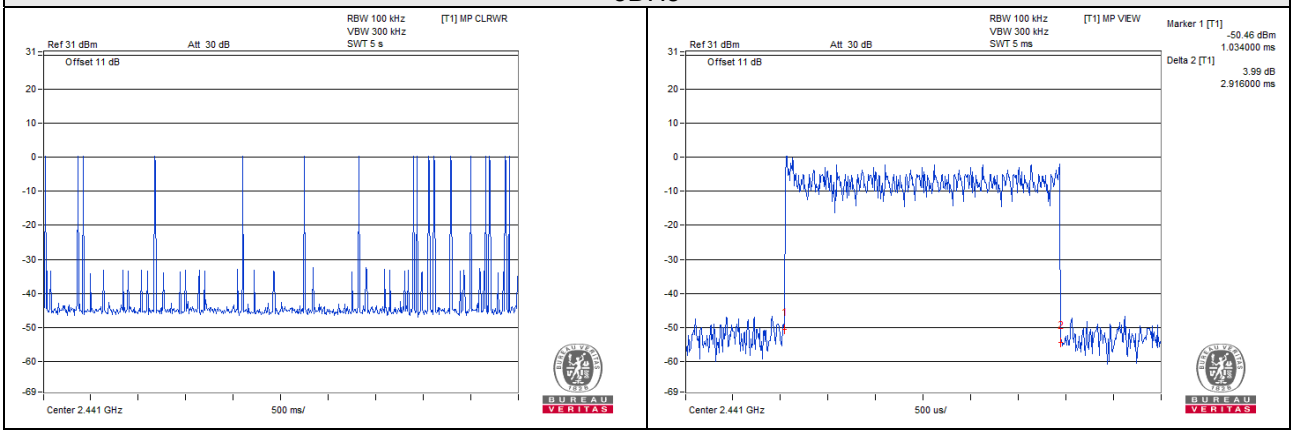
3DH1



3DH3



3DH5



4.4 Channel Bandwidth

4.4.1 Limits of Channel Bandwidth Measurement

Maximum bandwidth is not specified.

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 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 20dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

4.4.5 Deviation from Test Standard

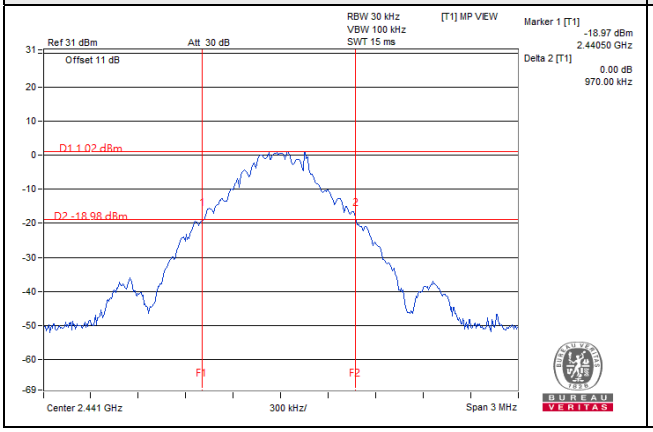
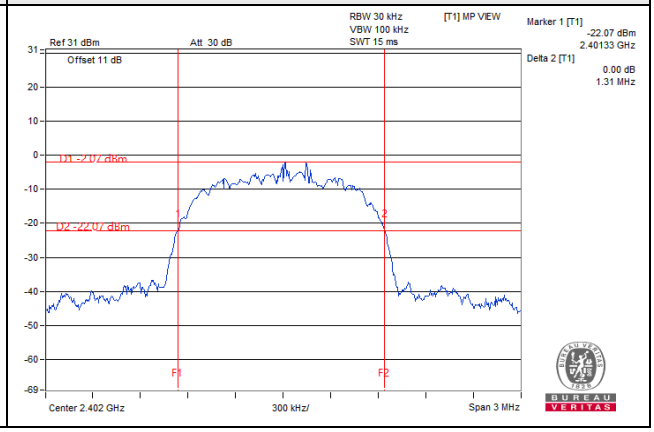
No deviation.

4.4.6 EUT Operating Condition

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

4.4.7 Test Results

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.96	1.31
39	2441	0.97	1.30
78	2480	0.96	1.30

Spectrum Plot of Worst Value	
GFSK	8DPSK
	

4.5 Hopping Channel Separation

4.5.1 Limits of Hopping Channel Separation Measurement

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

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

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.

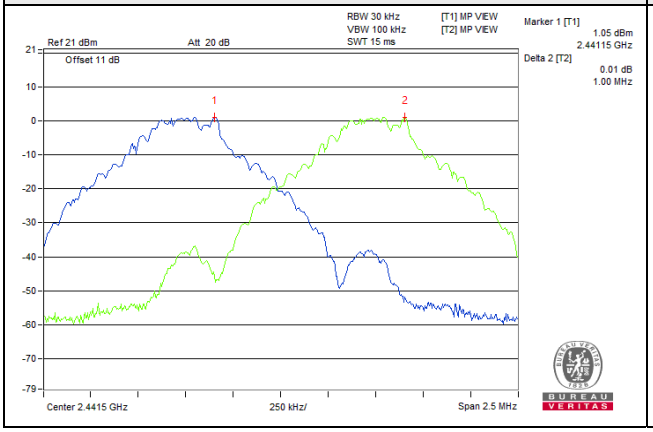
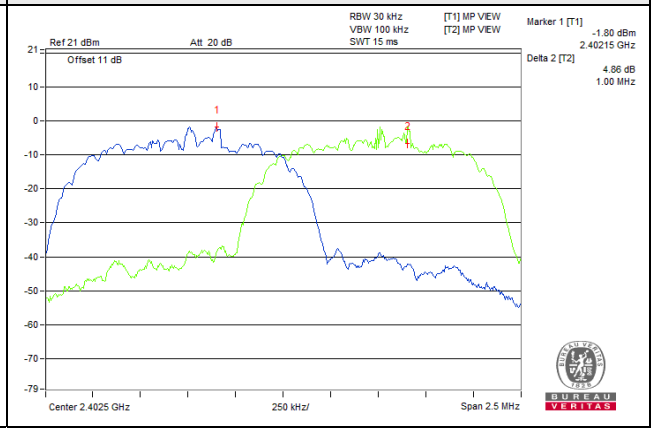
4.5.5 Deviation from Test Standard

No deviation.

4.5.6 Test Results

Channel	Frequency (MHz)	Adjacent Channel Separation (MHz)		20dB Bandwidth (MHz)		Minimum Limit (MHz)		Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK	GFSK	8DPSK	
0	2402	1.00	1.00	0.96	1.31	0.64	0.88	Pass
39	2441	1.00	1.00	0.97	1.30	0.65	0.87	Pass
78	2480	1.00	1.00	0.96	1.30	0.64	0.87	Pass

Note: The minimum limit is two-third 20dB bandwidth.

Spectrum Plot of Worst Value	
GFSK	8DPSK
	

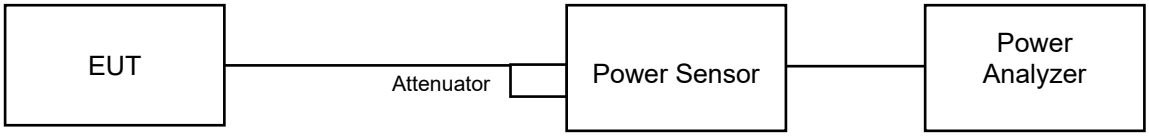
4.6 Maximum Output Power

4.6.1 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.

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

For Peak Power
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.

For Average Power
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.

4.6.5 Deviation fromTest Standard

No deviation.

4.6.6 EUT Operating Condition

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

4.6.7 Test Results

For Peak Power

Channel	Frequency (MHz)	Peak Power (mW)		Peak Power (dBm)		Power Limit (mW)	Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK		
0	2402	**5.383**	4.808	7.31	6.82	125 / 1000 Note	Pass
39	2441	5.236	4.498	7.19	6.53	125 / 1000 Note	Pass
78	2480	4.519	3.882	6.55	5.89	125 / 1000 Note	Pass

Note: RF Output Power limit depends on the operating channel numbers, please refer to section 3.2 of the results.

For Average Power

Channel	Frequency (MHz)	Average Power (mW)		Average Power (dBm)	
		GFSK	8DPSK	GFSK	8DPSK
0	2402	5.272	2.679	7.22	4.28
39	2441	5.140	2.618	7.11	4.18
78	2480	4.385	2.244	6.42	3.51

4.7 Conducted Out of Band Emission Measurement

4.7.1 Limits Of Conducted Out Of Band Emission Measurement

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

4.7.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.3 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.

4.7.4 Deviation from Test Standard

No deviation.

4.7.5 EUT Operating Condition

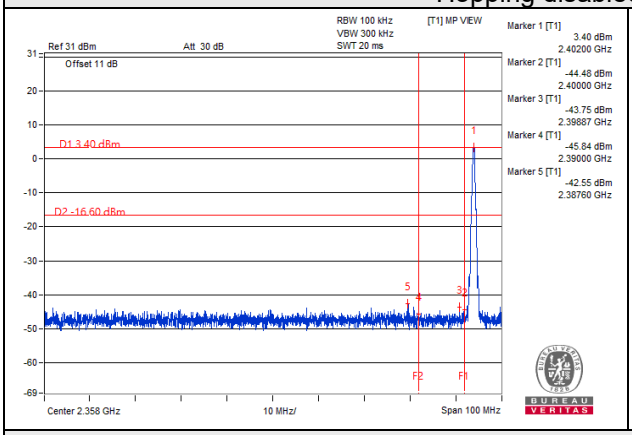
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

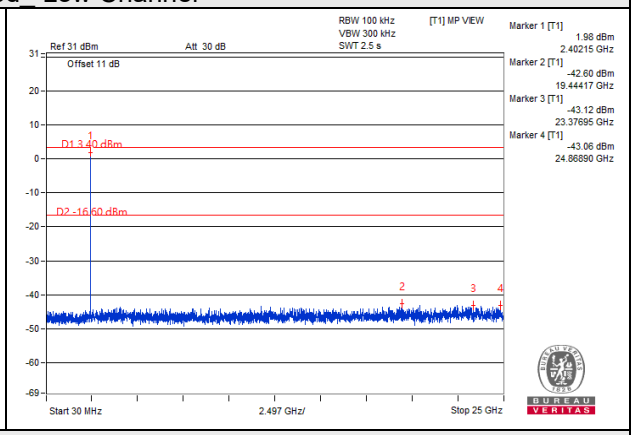
4.7.6 Test Results

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

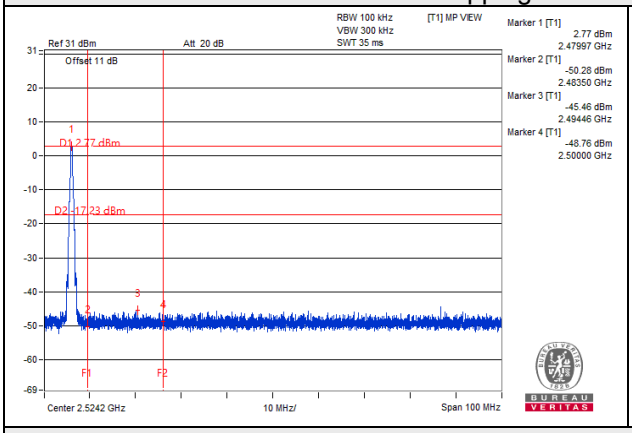
GFSK

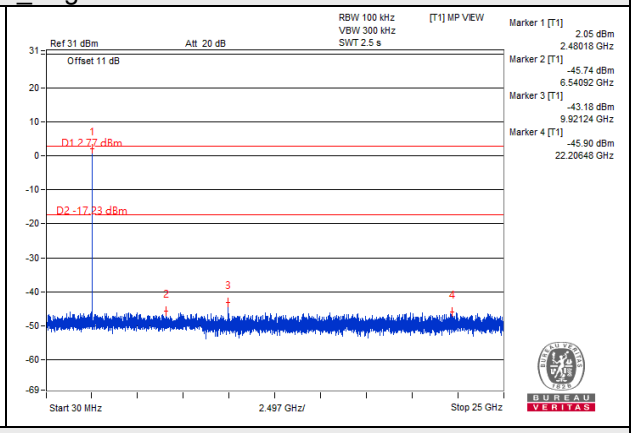
Hopping disabled_ Low Channel



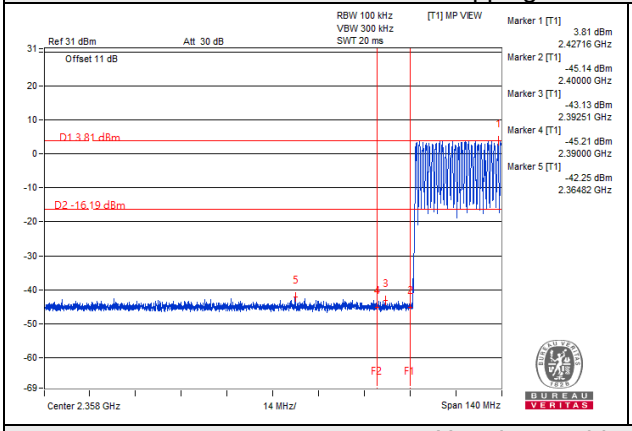


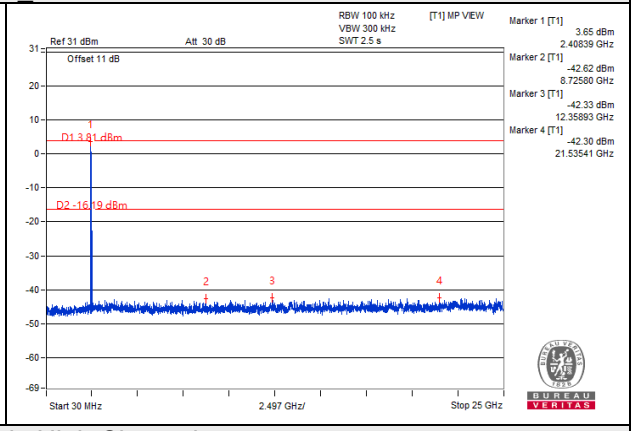
Hopping disabled_ High Channel



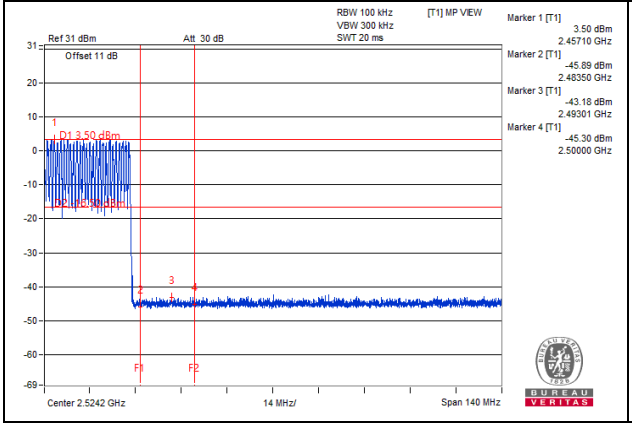


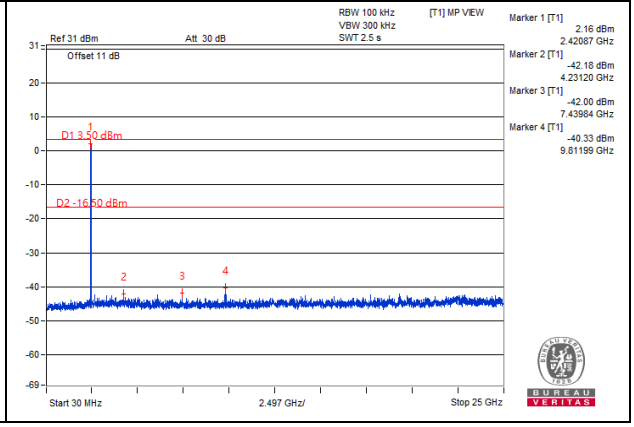
Hopping enabled_ Low Channel





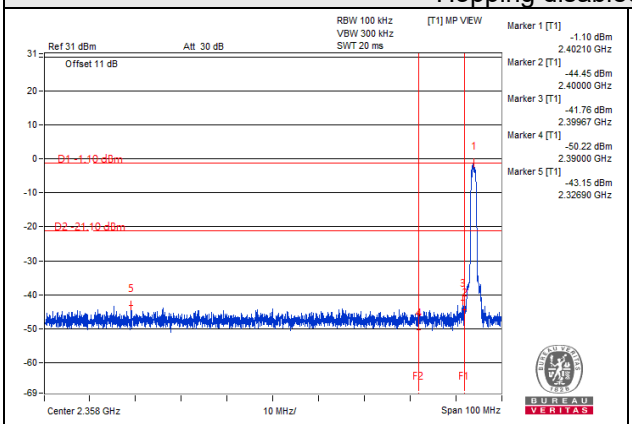
Hopping enabled_ High Channel

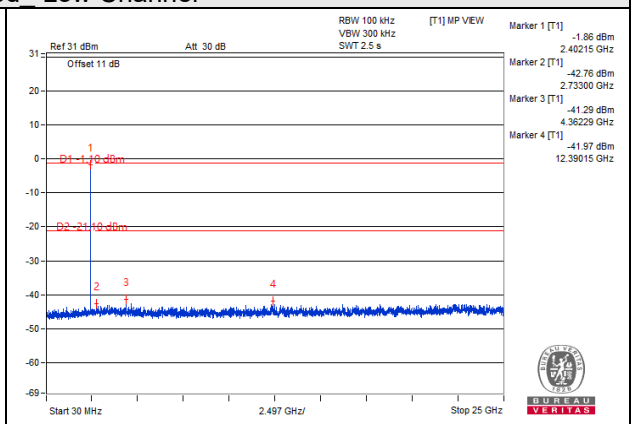




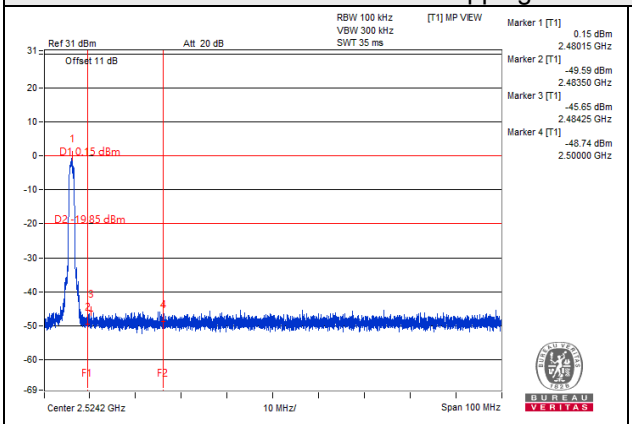
8DPSK

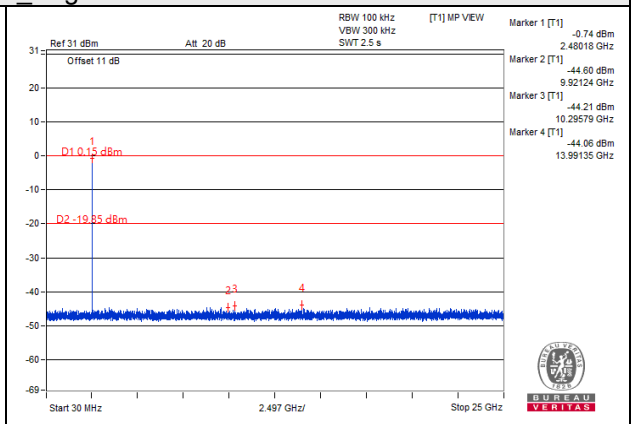
Hopping disabled_ Low Channel



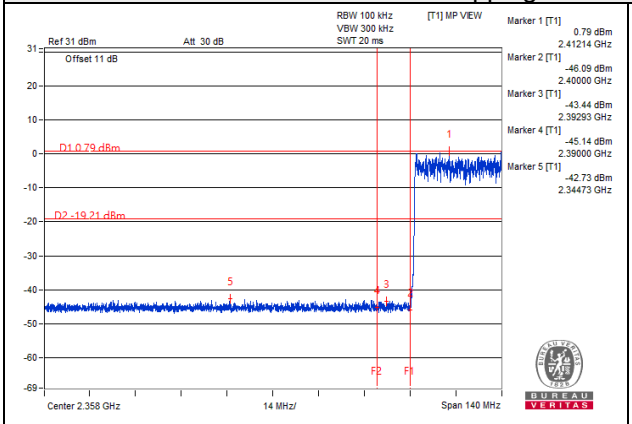


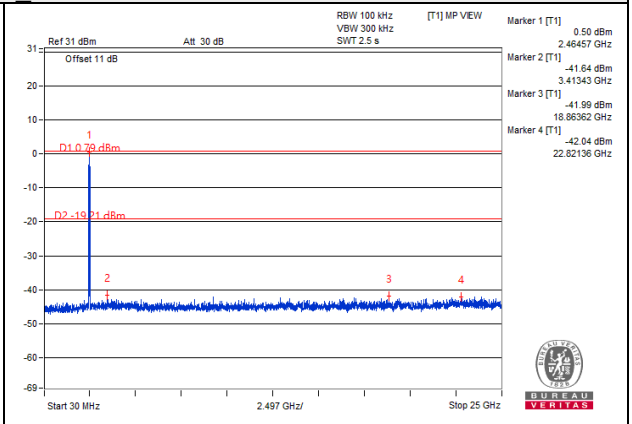
Hopping disabled_ High Channel



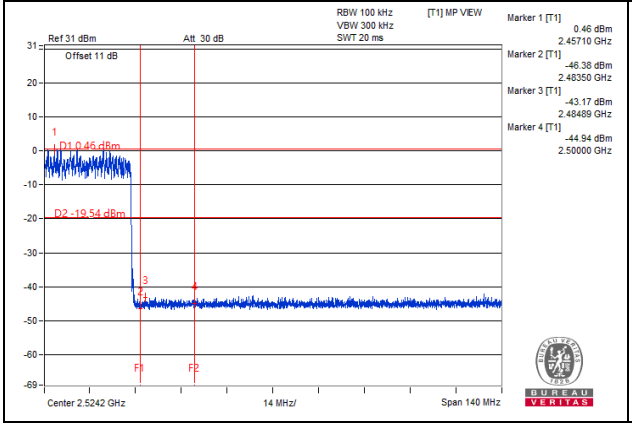


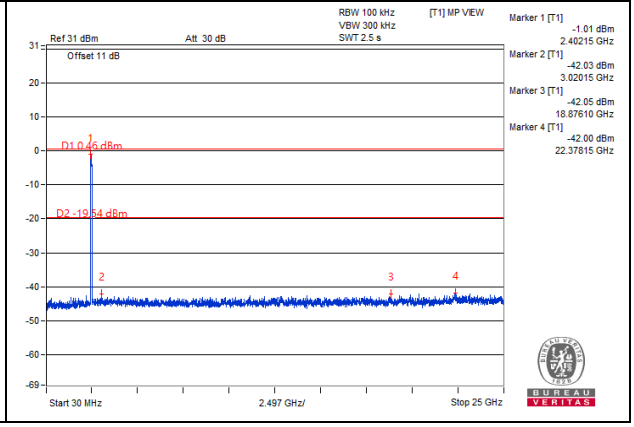
Hopping enabled_ Low Channel



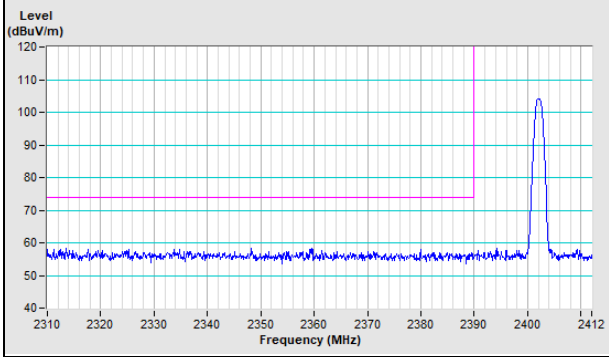
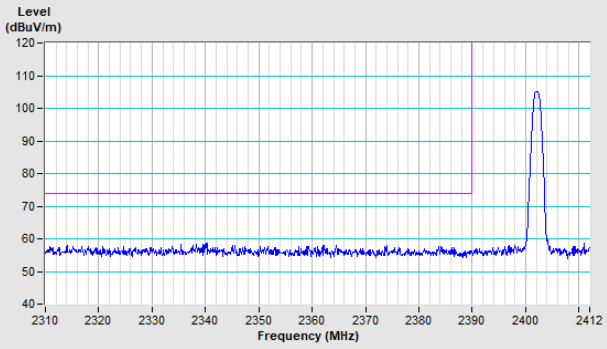
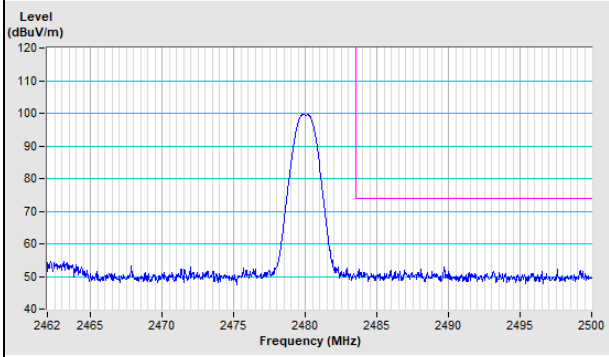
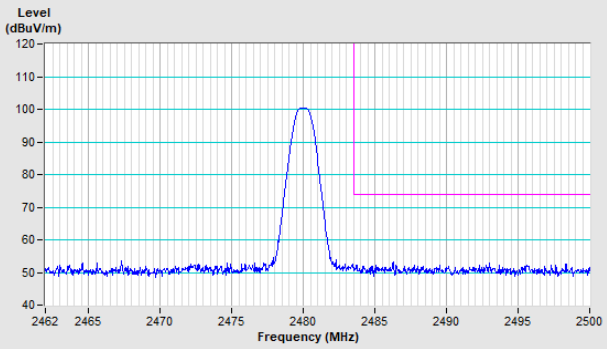
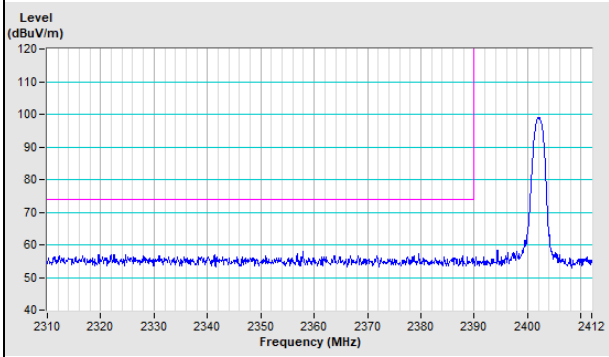
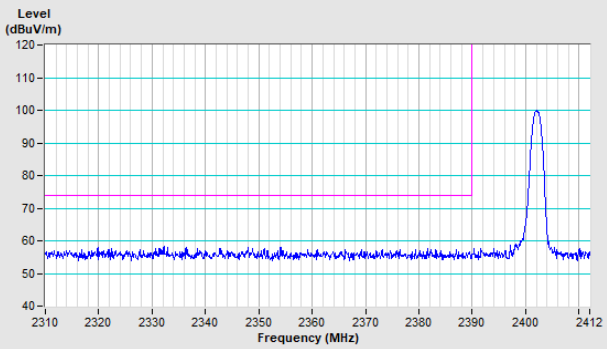
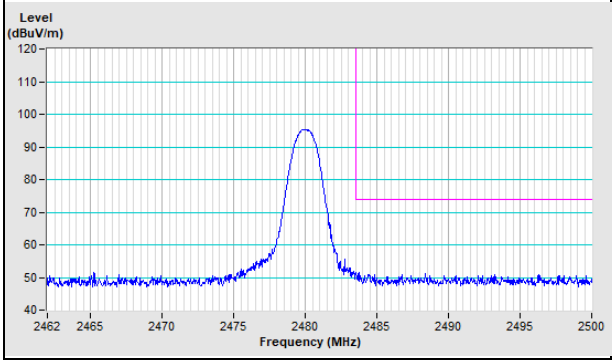
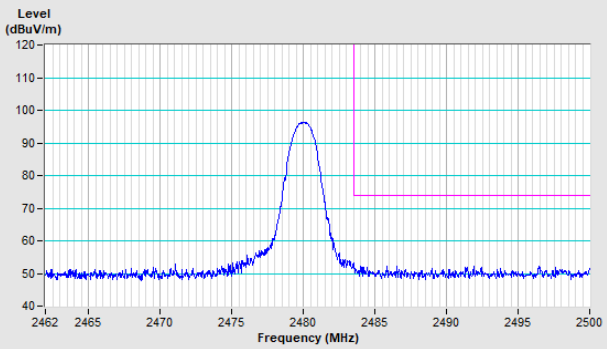


Hopping enabled_ High Channel





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)
	

5 Pictures of Test Arrangements

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

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 and approved according to ISO/IEC 17025.

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

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

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