

Partial FCC Test Report

Report No.: RFBBGM-WTW-P22110832-4

FCC ID: WIYSLM500QA

Test Model: SLM500

Received Date: Nov. 30, 2022

Test Date: Dec. 26, 2022 ~ Feb. 20, 2023

Issued Date: Mar. 13, 2023

Applicant: CASTLES TECHNOLOGY CO., LTD.

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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
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**FCC Registration /
Designation Number:** 788550 / TW0003



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Release Control Record

Issue No.	Description	Date Issued
RFBBGM-WTW-P22110832-4	Original Release	Mar. 13, 2023

1 Certificate of Conformity

Product: Smart module

Brand:  **CASTLES**
TECHNOLOGY

Test Model: SLM500

Sample Status: Identical Prototype

Applicant: CASTLES TECHNOLOGY CO., LTD.

Test Date: Dec. 26, 2022 ~ Feb. 20, 2023

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. 13, 2023
Lena Wang / Specialist

Approved by : Jeremy Lin, **Date:** Mar. 13, 2023
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 -7.98 dB at 0.68595 MHz.
15.247(a)(1)(iii)	Number of Hopping Frequency Used	N/A	Refer to note
15.247(a)(1)(iii)	Dwell Time on Each Channel	N/A	Refer to note
15.247(a)(1)	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	N/A	Refer to note
15.247(b) (1)	Maximum Peak Output Power	Pass	Meet the requirement of limit.
---	Occupied Bandwidth Measurement	N/A	Refer to note
15.205 & 209	Radiated Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -9.2 dB at 2390.00 MHz.
15.247(d)	Band Edge Measurement	N/A	Refer to note
15.247(d)	Antenna Port Emission	N/A	Refer to note
15.203	Antenna Requirement	N/A	Refer to note

Note:

1. This report is a partial report, and only test items of AC Power Conducted Emission, Maximum Peak Output Power and Radiated Emissions tests were verified and recorded in this report. Other testing data please refer to SGS report no.: SZCR210300003001.
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	9 kHz ~ 30 MHz	2.44 dB
	30 MHz ~ 200 MHz	2.95 dB
	200 MHz ~ 1000 MHz	2.95 dB
Radiated Emissions above 1 GHz	1 GHz ~ 18 GHz	2.26 dB
	18 GHz ~ 40 GHz	1.94 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Smart module
Brand	 CASTLES TECHNOLOGY
Test Model	SLM500
Status of EUT	Identical Prototype
Power Supply Rating	5.0 Vdc (Adapter) 3.7 Vdc (Li-ion battery)
Modulation Type	GFSK, $\pi/4$ -DQPSK, 8DPSK
Transfer Rate	1/2/3 Mbps
Operating Frequency	2402 ~ 2480 MHz
Number of Channel	79
Output Power	15.311 mW
Antenna Type	PIFA antenna with 2.13 dBi gain
Antenna Connector	N/A
Accessory Device	N/A
Data Cable Supplied	N/A

Note:

1. This report is prepared for FCC class II permissive change. This report is issued as a supplementary report of SGS report no.: SZCR210300003001. The differences from the original report are adding an End-product (POS Terminal (Brand:  Model: SATURN1000MINI)) and changing antenna type. Only AC Power Conducted Emission, Maximum Peak Output Power and radiated emissions were verified and recorded in this report. Other testing data please refer to the original SGS report no.: SZCR210300003001.
2. The EUT was installed in POS Terminal (Brand:  Model: SATURN1000MINI).
3. The POS Terminal contains following accessory devices.

Product	Brand	Model	Description
Adapter	 CASTLES TECHNOLOGY	1A52-UB52A	I/P: 100-240 Vac, 50/60 Hz, 0.3 A O/P: 5 Vdc, 2 A
Battery	 CASTLES TECHNOLOGY	S1Mini	3.7V 1600mAh / 5.92Wh
USB Cable	CHANG YANG ELECTRON CO.,LTD	CY-AS-HK0059	0.95 m shielded cable w/o core

4. Detail antenna specification please refer to antenna datasheet and/or antenna measurement report.
5. 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.
6. BT & WWAN & NFC (FCC ID: WIYS1MINI001) technology can transmit at same time.
7. WLAN 2.4G & WWAN & NFC (FCC ID: WIYS1MINI001) technology can transmit at same time.
8. WLAN 5G & WWAN & NFC (FCC ID: WIYS1MINI001) technology can transmit at same time.

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 $\geq$ 1G	RE<1G	PLC	Power	
-	√	√	√	√	-

Where **RE $\geq$ 1G:** Radiated Emission above 1 GHz **RE<1G:** Radiated Emission below 1 GHz
PLC: Power Line Conducted Emission **Power:** Maximum Output Power

Note:

1. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Y-plane**.
2. "-" 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
-	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
-	0 to 78	0	FHSS	GFSK	DH5

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
-	0 to 78	0	FHSS	GFSK	DH5

Maximum Output Power:

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

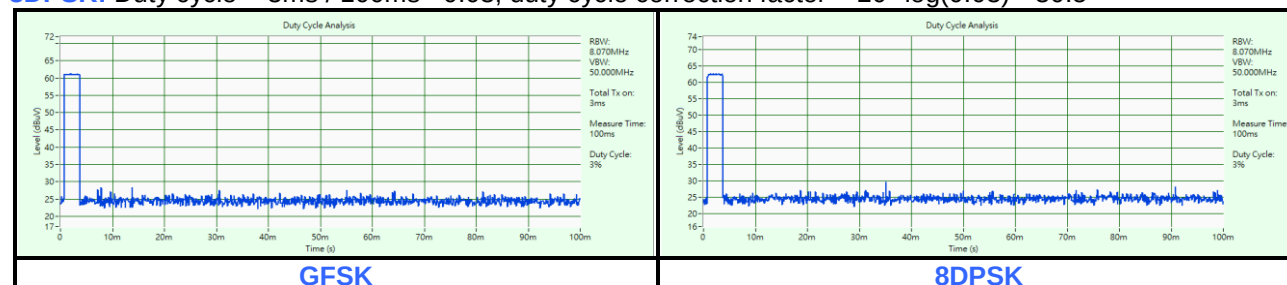
Test Condition:

Applicable To	Environmental Conditions	Input Power	Tested by
RE $\geq$ 1G	21.6 deg. C, 72.8 % RH	120 Vac, 60 Hz	Vincent Chen
RE<1G	24 deg. C, 78 % RH	120 Vac, 60 Hz	Thomas Cheng
PLC	18.1 deg. C, 64.7 % RH	120 Vac, 60 Hz	Thomas Cheng
Power	25 deg. C, 60 % RH	120 Vac, 60 Hz	Ted Chang

3.3 Duty Cycle of Test Signal

GFSK: Duty cycle = 3ms / 100ms = 0.03, duty cycle correction factor = $20 \cdot \log(0.03) = -30.5$

8DPSK: Duty cycle = 3ms / 100ms = 0.03, duty cycle correction factor = $20 \cdot \log(0.03) = -30.5$



3.4 Description of Support Units

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

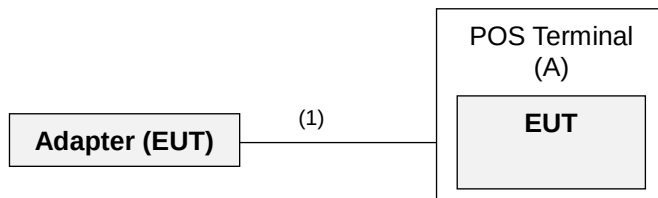
No.	Product	Brand	Model No.	Serial No.	FCC ID
A	POS Terminal	 CASTLES TECHNOLOGY	SATURN1000MINI	N/A	N/A

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB cable	1	0.95	Y	0	Provided by client

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Items A acted as communication partners to transfer data.

3.4.1 Configuration of System under Test



Remote site

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:

- The lower limit shall apply at the transition frequencies.
- Emission level (dBuV/m) = 20 log Emission level (uV/m).
- 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
Software BV ADT	ADT_Radiated_ V7.6.15.9.5	NA	NA	NA
Antenna Tower & Turn Max-Full	MFA-440H	AT93021705	NA	NA
Turn Table Max-Full	MFT-201SS	NA	NA	NA
Turn Table Controller Max-Full	MG-7802	NA	NA	NA
Test Receiver KEYSIGHT	N9038A	MY55420137	Apr. 27, 2022	Apr. 26, 2023
Signal Analyzer Agilent	N9010A	MY52220207	Jan. 06, 2022	Jan. 05, 2023
			Jan. 03, 2023	Jan. 02, 2024
Loop Antenna TESEQ	HLA 6121	45745	Jul. 27, 2022	Jul. 26, 2023
Loop Antenna EMCI	EM-6879	269	Sep. 19, 2022	Sep. 18, 2023
Pre-amplifier EMCI	EMC001340	980201	Sep. 23, 2022	Sep. 22, 2023
RF Coaxial Cable EMCI	5D-NM-BM	140903+140902	Jan. 15, 2022	Jan. 14, 2023
			Jan. 07, 2023	Jan. 06, 2024
Pre-Amplifier EMCI	EMC 330H	980112	Oct. 01, 2022	Sep. 30, 2023
Bi_Log Antenna Schwarzbeck	VULB9168	9168-472	Oct. 21, 2022	Oct. 20, 2023
RF Coaxial Cable WORKEN	8D-FB	Cable-Ch10-01	Oct. 01, 2022	Sep. 30, 2023
Horn Antenna Schwarzbeck	BBHA 9120D	9120D-969	Nov. 13, 2022	Nov. 12, 2023
Pre-Amplifier EMCI	EMC 012645	980115	Oct. 01, 2022	Sep. 30, 2023
RF Coaxial Cable EMCI	EMC104-SM-SM- 8000+3000	171005	Oct. 01, 2022	Sep. 30, 2023
RF Coaxial Cable HUBER SUHNER	SUCOFLEX 104	EMC104-SM-SM- 1000(140807)	Oct. 01, 2022	Sep. 30, 2023
RF FLITER MICRO-TRONICS	BRM50716	060	Jan. 10, 2022	Jan. 09, 2023
			Jan. 11, 2023	Jan. 10, 2024
RF FLITER MICRO-TRONICS	BRM17690	004	Jan. 10, 2022	Jan. 09, 2023
			Jan. 11, 2023	Jan. 10, 2024
Boresight antenna tower fixture BV	BAF-02	7	NA	NA
Radio Communication Analyzer Anritsu	MT8821C	6201462755	Mar. 03, 2022	Mar. 02, 2023
Pre-Amplifier EMCI	EMC 184045	980116	Oct. 01, 2022	Sep. 30, 2023
Horn Antenna Schwarzbeck	BBHA 9170	148	Nov. 13, 2022	Nov. 12, 2023
RF Coaxial Cable EMCI	EMC102-KM-KM-600	150928	Jul. 09, 2022	Jul. 08, 2023
RF Coaxial Cable EMCI	EMC102-KM-KM-3000	150929	Jul. 09, 2022	Jul. 08, 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 HY - 966 chamber 5.

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:

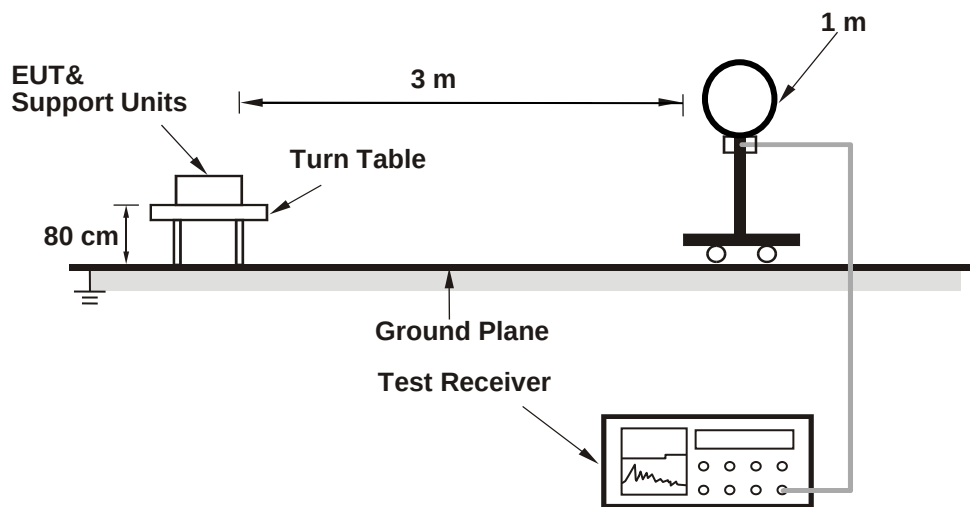
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) and at frequency above 1 GHz.
3. For Fundamental frequency and band edge & harmonic:
The average value of fundamental frequency is :average value = peak value + 20*log(Duty cycle) where the duty cycle correction factor is calculated from following formula:
 $20 \cdot \log(\text{Duty cycle}) = 20 \cdot \log(3\text{ms}/100\text{ms}) = -30.5 \text{ dB}$, please refer to the plotted duty (see section 3.3)
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

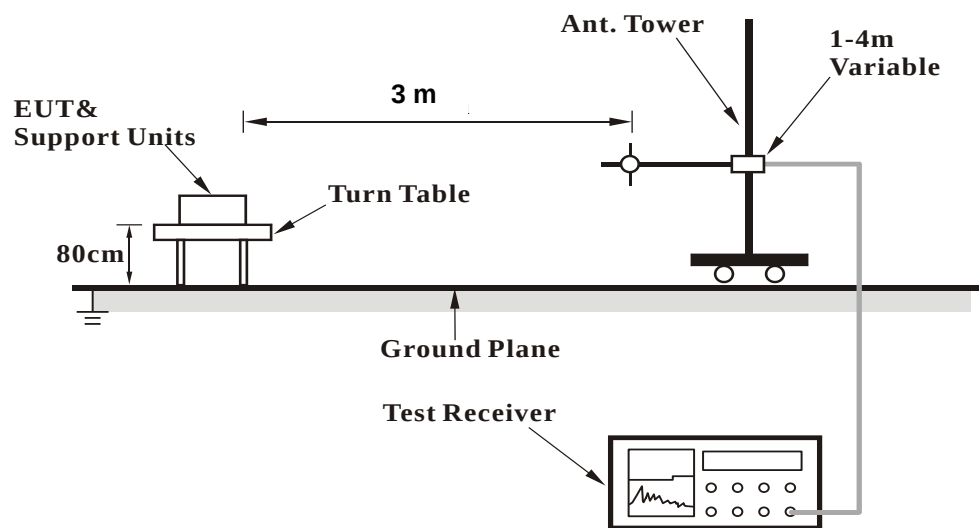
No deviation.

4.1.5 Test Set Up

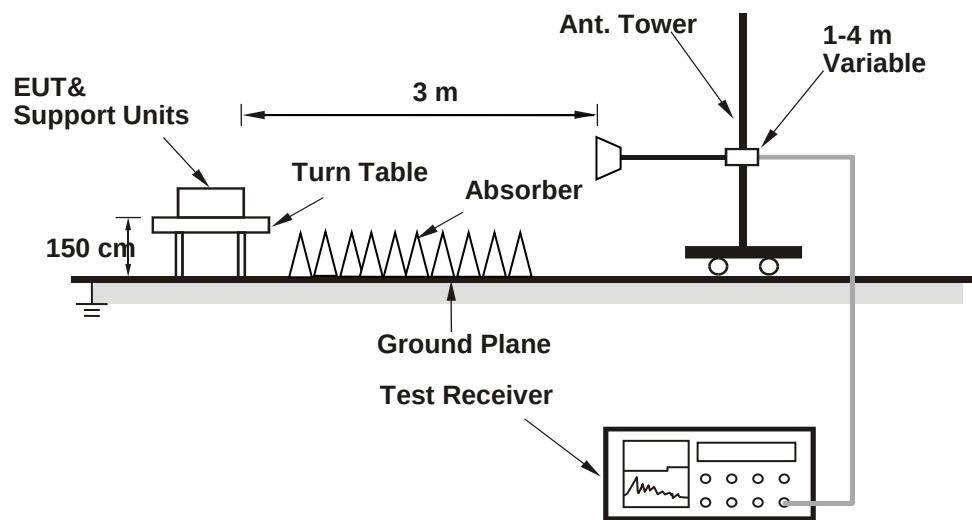
<Radiated Emission below 30 MHz>



<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:

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

Antenna Polarity & Test Distance : Horizontal at								
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	53.2 PK	74.0	-20.8	1.33 H	220	55.7	-2.5
2	2390.00	44.2 AV	54.0	-9.8	1.33 H	220	46.7	-2.5
3	*2402.00	103.4 PK			1.13 H	220	69.3	34.1
4	*2402.00	72.9 AV			1.13 H	220	38.8	34.1
5	4804.00	49.8 PK	74.0	-24.2	1.62 H	310	53.8	-4.0
6	4804.00	19.3 AV	54.0	-34.7	1.62 H	310	23.3	-4.0
Antenna Polarity & Test Distance : Vertical at								
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	53.2 PK	74.0	-20.8	2.65 V	103	55.7	-2.5
2	2390.00	44.8 AV	54.0	-9.2	2.65 V	103	47.3	-2.5
3	*2402.00	104.0 PK			2.65 V	103	69.9	34.1
4	*2402.00	73.5 AV			2.65 V	103	39.4	34.1
5	4804.00	50.9 PK	74.0	-23.1	1.23 V	265	54.9	-4.0
6	4804.00	20.4 AV	54.0	-33.6	1.23 V	265	24.4	-4.0

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, the limit was restricted at the RF Output Power.
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 (3ms*1/100) = -30.5dB please refer to the plotted duty (see section 3.3)

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

Antenna Polarity & Test Distance : Horizontal at								
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	103.4 PK			1.33 H	221	69.1	34.3
2	*2441.00	72.9 AV			1.33 H	221	38.6	34.3
3	4882.00	49.3 PK	74.0	-24.7	2.32 H	301	53.5	-4.2
4	4882.00	18.8 AV	54.0	-35.2	2.32 H	301	23.0	-4.2
Antenna Polarity & Test Distance : Vertical at								
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	103.6 PK			2.04 V	144	69.3	34.3
2	*2441.00	73.1 AV			2.04 V	144	38.8	34.3
3	4882.00	50.4 PK	74.0	-23.6	1.23 V	254	54.6	-4.2
4	4882.00	19.9 AV	54.0	-34.1	1.23 V	254	24.1	-4.2

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, the limit was restricted at the RF Output Power.
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 (3ms*1/100) = -30.5dB please refer to the plotted duty (see section 3.3)

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

Antenna Polarity & Test Distance : Horizontal at								
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	103.5 PK			1.25 H	222	69.1	34.4
2	*2480.00	73.0 AV			1.25 H	222	38.6	34.4
3	2483.50	54.2 PK	74.0	-19.8	1.25 H	222	56.1	-1.9
4	2483.50	23.7 AV	54.0	-30.3	1.25 H	222	25.6	-1.9
5	4960.00	49.1 PK	74.0	-24.9	2.32 H	154	53.4	-4.3
6	4960.00	18.6 AV	54.0	-35.4	2.32 H	154	22.9	-4.3
Antenna Polarity & Test Distance : Vertical at								
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	104.9 PK			1.82 V	156	70.5	34.4
2	*2480.00	74.4 AV			1.82 V	156	40.0	34.4
3	2483.50	54.7 PK	74.0	-19.3	1.82 V	156	56.6	-1.9
4	2483.50	24.2 AV	54.0	-29.8	1.82 V	156	26.1	-1.9
5	4960.00	50.5 PK	74.0	-23.5	2.06 V	225	54.8	-4.3
6	4960.00	20.0 AV	54.0	-34.0	2.06 V	225	24.3	-4.3

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, the limit was restricted at the RF Output Power.
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 (3ms*1/100) = -30.5dB please refer to the plotted duty (see section 3.3)

RF Mode	BT 8DPSK	Channel	CH 0 : 2402 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at								
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	52.9 PK	74.0	-21.1	1.33 H	223	55.4	-2.5
2	2390.00	44.1 AV	54.0	-9.9	1.33 H	223	46.6	-2.5
3	*2402.00	103.4 PK			1.33 H	223	69.3	34.1
4	*2402.00	72.9 AV			1.33 H	223	38.8	34.1
5	4804.00	49.2 PK	74.0	-24.8	2.03 H	311	53.2	-4.0
6	4804.00	18.7 AV	54.0	-35.3	2.03 H	311	22.7	-4.0
Antenna Polarity & Test Distance : Vertical at								
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	52.7 PK	74.0	-21.3	2.08 V	155	55.2	-2.5
2	2390.00	43.9 AV	54.0	-10.1	2.08 V	155	46.4	-2.5
3	*2402.00	104.6 PK			2.08 V	155	70.5	34.1
4	*2402.00	74.1 AV			2.08 V	155	40.0	34.1
5	4804.00	50.5 PK	74.0	-23.5	1.65 V	204	54.5	-4.0
6	4804.00	20.0 AV	54.0	-34.0	1.65 V	204	24.0	-4.0

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, the limit was restricted at the RF Output Power.
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 (3ms*1/100) = -30.5dB please refer to the plotted duty (see section 3.3)

RF Mode	BT 8DPSK	Channel	CH 39 : 2441 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at								
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	102.7 PK			1.36 H	222	68.4	34.3
2	*2441.00	72.2 AV			1.36 H	222	37.9	34.3
3	4882.00	49.3 PK	74.0	-24.7	2.65 H	152	53.5	-4.2
4	4882.00	18.8 AV	54.0	-35.2	2.65 H	152	23.0	-4.2
Antenna Polarity & Test Distance : Vertical at								
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	104.1 PK			1.87 V	158	69.8	34.3
2	*2441.00	73.6 AV			1.87 V	158	39.3	34.3
3	4882.00	50.1 PK	74.0	-23.9	2.03 V	141	54.3	-4.2
4	4882.00	19.6 AV	54.0	-34.4	2.03 V	141	23.8	-4.2

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, the limit was restricted at the RF Output Power.
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 (3ms*1/100) = -30.5dB please refer to the plotted duty (see section 3.3)

RF Mode	BT 8DPSK	Channel	CH 78 : 2480 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at								
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	102.8 PK			1.03 H	222	68.4	34.4
2	*2480.00	72.3 AV			1.03 H	222	37.9	34.4
3	2483.50	53.4 PK	74.0	-20.6	1.03 H	222	55.3	-1.9
4	2483.50	22.9 AV	54.0	-31.1	1.03 H	222	24.8	-1.9
5	4960.00	48.9 PK	74.0	-25.1	2.06 H	152	53.2	-4.3
6	4960.00	18.4 AV	54.0	-35.6	2.06 H	152	22.7	-4.3
Antenna Polarity & Test Distance : Vertical at								
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	104.4 PK			1.81 V	157	70.0	34.4
2	*2480.00	73.9 AV			1.81 V	157	39.5	34.4
3	2483.50	56.1 PK	74.0	-17.9	1.81 V	157	58.0	-1.9
4	2483.50	25.6 AV	54.0	-28.4	1.81 V	157	27.5	-1.9
5	4960.00	50.1 PK	74.0	-23.9	2.53 V	206	54.4	-4.3
6	4960.00	19.6 AV	54.0	-34.4	2.53 V	206	23.9	-4.3

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, the limit was restricted at the RF Output Power.
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 (3ms*1/100) = -30.5dB please refer to the plotted duty (see section 3.3)

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.

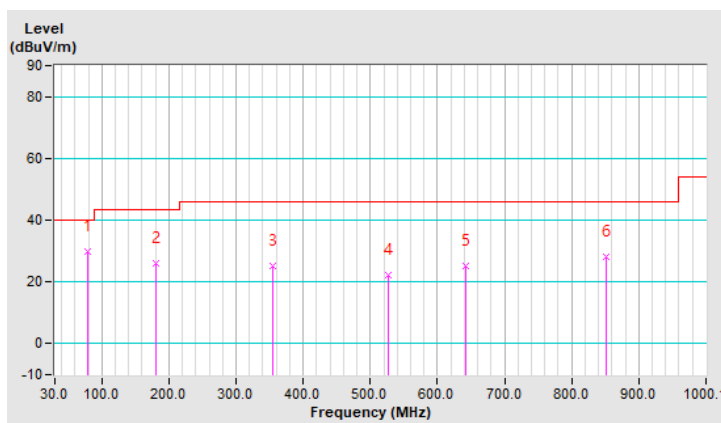
30 MHz ~ 1 GHz Worst-Case Data:

RF Mode	BT GFSK	Channel	CH 0 : 2402 MHz
Frequency Range	30 MHz ~ 1 GHz	Detector Function & Bandwidth	(QP) RB = 120kHz

Antenna Polarity & Test Distance : Horizontal at								
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	78.50	29.8 QP	40.0	-10.2	1.36 H	146	46.2	-16.4
2	181.34	26.2 QP	43.5	-17.3	1.72 H	82	40.4	-14.2
3	354.01	25.3 QP	46.0	-20.7	3.60 H	310	35.9	-10.6
4	526.69	22.4 QP	46.0	-23.6	3.15 H	210	28.8	-6.4
5	642.13	25.3 QP	46.0	-20.7	2.94 H	215	29.7	-4.4
6	850.70	28.1 QP	46.0	-17.9	2.44 H	70	29.7	-1.6

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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.

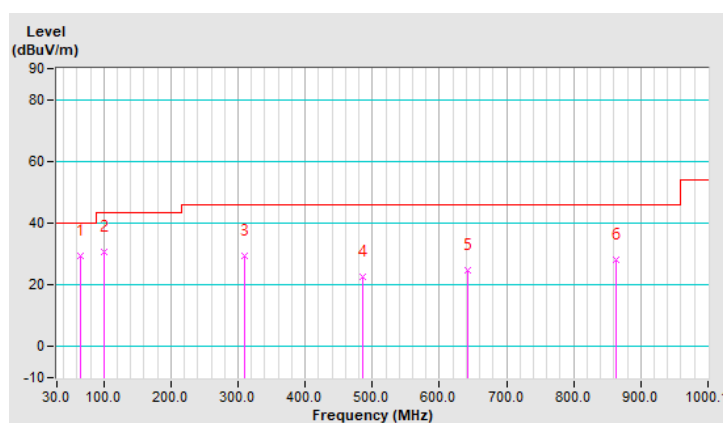


RF Mode	BT GFSK	Channel	CH 0 : 2402 MHz
Frequency Range	30 MHz ~ 1 GHz	Detector Function & Bandwidth	(QP) RB = 120kHz

Antenna Polarity & Test Distance : Vertical at								
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	65.89	29.3 QP	40.0	-10.7	1.78 V	317	43.1	-13.8
2	99.85	30.7 QP	43.5	-12.8	2.55 V	310	47.5	-16.8
3	309.39	29.5 QP	46.0	-16.5	1.09 V	92	41.0	-11.5
4	485.95	22.7 QP	46.0	-23.3	3.03 V	75	29.9	-7.2
5	642.13	24.8 QP	46.0	-21.2	2.59 V	249	29.2	-4.4
6	862.35	28.3 QP	46.0	-17.7	1.19 V	190	29.8	-1.5

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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.



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	ESR3	102783	Dec. 21, 2022	Dec. 20, 2023
RF signal cable (with 10dB PAD) Woken	5D-FB	Cable-cond2-01	Sep. 03, 2022	Sep. 02, 2023
LISN/AMN ROHDE & SCHWARZ (EUT)	ESH2-Z5	100100	Feb. 17, 2022	Feb. 16, 2023
LISN/AMN ROHDE & SCHWARZ (Peripheral)	ENV216	101196	May 24, 2022	May 23, 2023
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 2 (Conduction 2).
 3. The VCCI Site Registration No. is C-12047.
 4. Test Date: 2022/12/26

4.2.3 Test Procedures

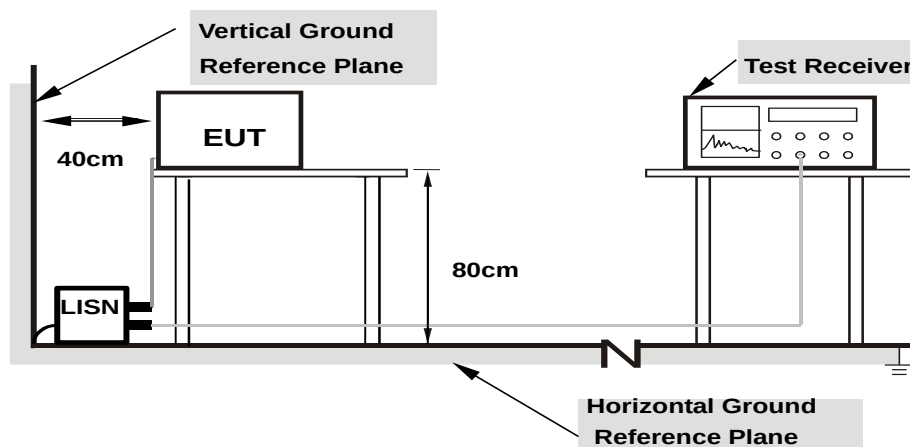
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50 uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- 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 cm 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.

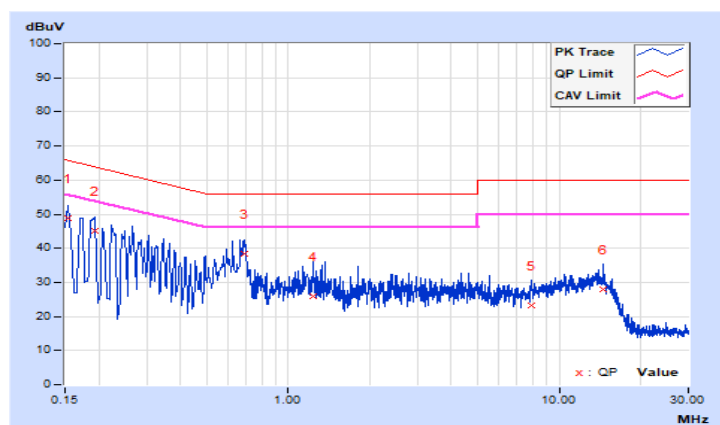
4.2.7 Test Results

RF Mode	BT GFSK	Channel	CH 0 : 2402 MHz
Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz

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	0.15400	10.12	38.72	23.62	48.84	33.74	65.78	55.78	-16.94	-22.04
2	0.19316	10.14	34.86	18.53	45.00	28.67	63.90	53.90	-18.90	-25.23
3	0.68595	10.17	28.05	17.33	38.22	27.50	56.00	46.00	-17.78	-18.50
4	1.23400	10.19	15.71	6.33	25.90	16.52	56.00	46.00	-30.10	-29.48
5	7.87800	10.28	13.11	2.88	23.39	13.16	60.00	50.00	-36.61	-36.84
6	14.53400	10.35	17.67	7.24	28.02	17.59	60.00	50.00	-31.98	-32.41

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

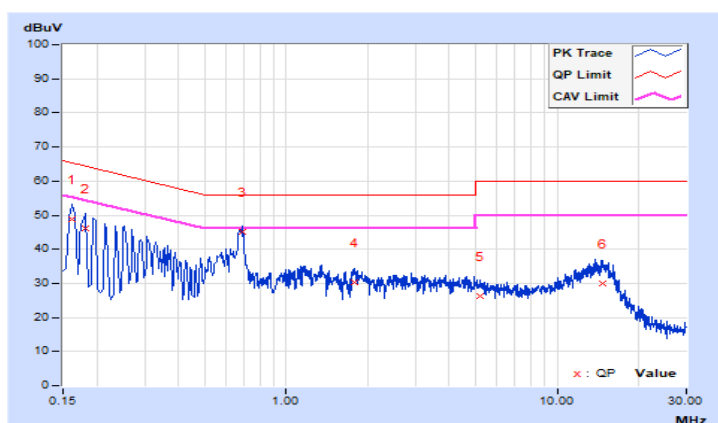


RF Mode	BT GFSK	Channel	CH 0 : 2402 MHz
Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz

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	0.16200	10.13	38.68	20.76	48.81	30.89	65.36	55.36	-16.55	-24.47
2	0.18180	10.14	35.97	21.13	46.11	31.27	64.40	54.40	-18.29	-23.13
3	0.68595	10.18	34.87	27.84	45.05	38.02	56.00	46.00	-10.95	-7.98
4	1.78600	10.22	19.96	11.75	30.18	21.97	56.00	46.00	-25.82	-24.03
5	5.17800	10.29	16.13	8.24	26.42	18.53	60.00	50.00	-33.58	-31.47
6	14.65000	10.46	19.36	7.21	29.82	17.67	60.00	50.00	-30.18	-32.33

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



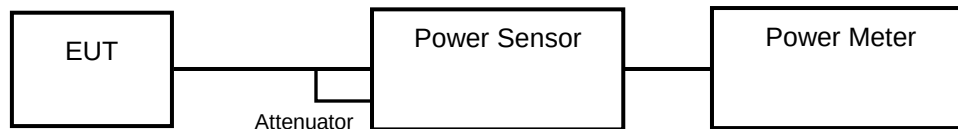
4.3 Maximum Output Power

4.3.1 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.

4.3.2 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 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.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Condition

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

4.3.7 Test Results

<GFSK>

Channel	Freq. (MHz)	Peak Power		Average Power		Power Limit (mW)	Pass / Fail
		(mW)	(dBm)	(mW)	(dBm)		
0	2402	15.311	11.85	14.655	11.66	125 / 1000 ^{Note}	Pass
39	2441	14.223	11.53	13.583	11.33	125 / 1000 ^{Note}	Pass
78	2480	13.305	11.24	12.706	11.04	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	14.825	11.71	9.226	9.65	125 / 1000 ^{Note}	Pass
39	2441	14.093	11.49	8.71	9.40	125 / 1000 ^{Note}	Pass
78	2480	12.912	11.11	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.

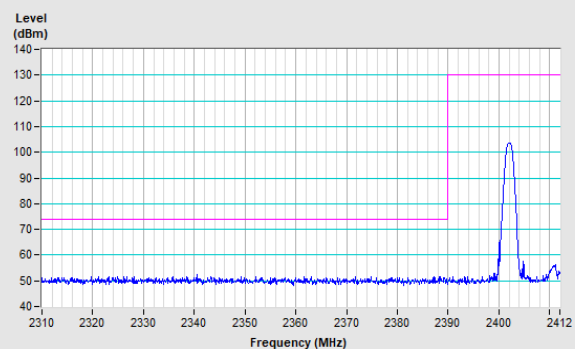
5 Pictures of Test Arrangements

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

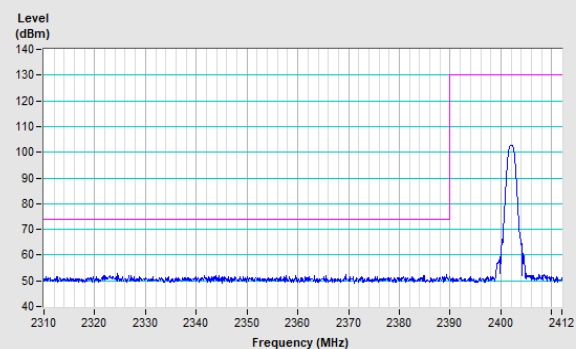
Annex A- Band Edge Measurement

BT GFSK Channel 0

Horizontal (Peak)

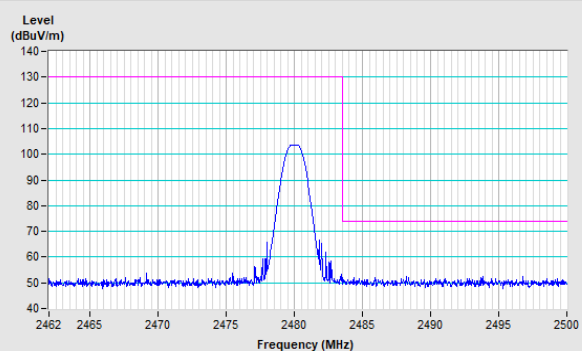


Vertical (Peak)

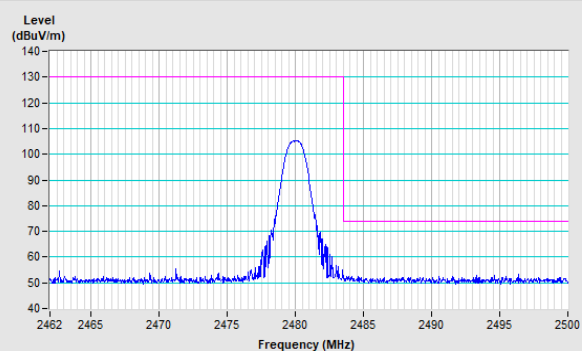


BT GFSK Channel 78

Horizontal (Peak)

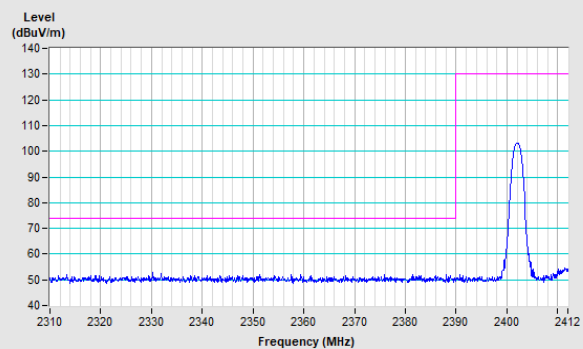


Vertical (Peak)

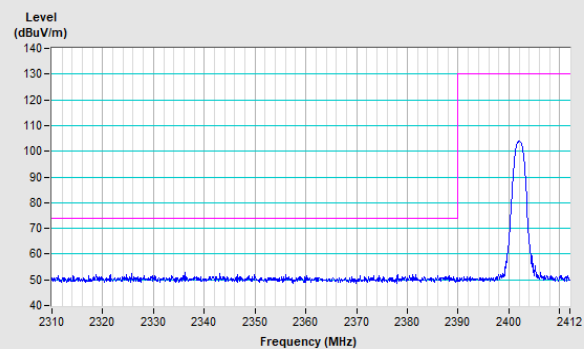


BT 8DPSK Channel 0

Horizontal (Peak)

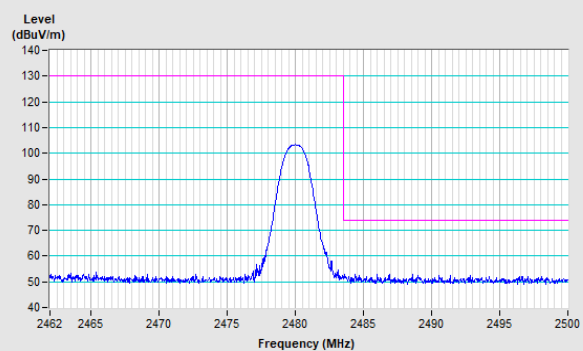


Vertical (Peak)

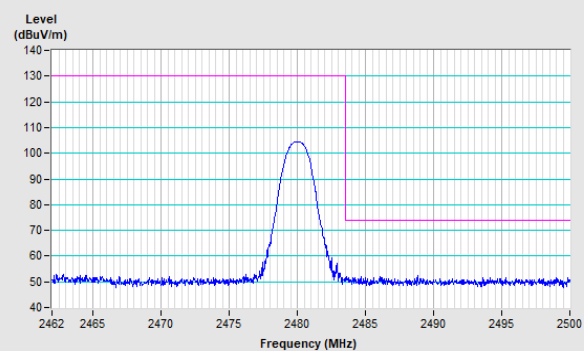


BT 8DPSK Channel 78

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

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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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