



Test Report No.: (8822)312-0040

TEST REPORT

Applicant	Crossrope LLC
Address	1639 Green St Ste D Raleigh, NC, 27603 USA

Manufacturer or Supplier	Crossrope LLC
Address	1639 Green St Ste D Raleigh, NC, 27603 USA
Product	AMP HANDLE
Brand Name	N/A
Model	1.0 AMP HANDLE
Additional Model & Model Difference	N/A
Date of tests	Oct. 25, 2022 ~ Nov. 07, 2022

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

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

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

BUREAU VERITAS SHENZHEN CO.,LTD
DONGGUAN BRANCH

Tom Chen
Project Manager
Date: Nov. 07, 2022

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TABLE OF CONTENTS

RELEASE CONTROL RECORD	4
1 SUMMARY OF TEST RESULTS.....	5
2 MEASUREMENT UNCERTAINTY	5
3 GENERAL INFORMATION	6
3.1 GENERAL DESCRIPTION OF EUT.....	6
3.2 DESCRIPTION OF TEST MODES.....	7
3.2.1. CONFIGURATION OF SYSTEM UNDER TEST.....	8
3.2.2. TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL	8
3.3 GENERAL DESCRIPTION OF APPLIED STANDARDS.....	10
3.4 DESCRIPTION OF SUPPORT UNITS.....	10
4 TEST TYPES AND RESULTS.....	11
4.1. RADIATED EMISSION AND BANDEDGE MEASUREMENT	11
4.1.1 LIMITS OF RADIATED EMISSION AND BANDEDGE MEASUREMENT	11
4.1.2 TEST INSTRUMENTS	12
4.1.3 TEST PROCEDURES.....	13
4.1.4 DEVIATION FROM TEST STANDARD	14
4.1.5 TEST SETUP	14
4.1.6 EUT OPERATING CONDITIONS.....	15
4.1.7 TEST RESULTS	16
4.2 NUMBER OF HOPPING FREQUENCY USED.....	24
4.2.1 LIMIT OF HOPPING FREQUENCY USED	24
4.2.2 TEST SETUP	24
4.2.3 TEST INSTRUMENTS	24
4.2.4 TEST PROCEDURES.....	25
4.2.5 DEVIATION FROM TEST STANDARD	25
4.2.6 TEST RESULTS	25
4.3 DWELL TIME ON EACH CHANNEL	27
4.3.1 LIMIT OF DWELL TIME USED	27
4.3.2 TEST SETUP	27
4.3.3 TEST INSTRUMENTS	27
4.3.4 TEST PROCEDURES.....	27
4.3.5 DEVIATION FROM TEST STANDARD	28
4.3.6 TEST RESULTS	28
4.4 CHANNEL BANDWIDTH.....	31
4.4.1 LIMITS OF CHANNEL BANDWIDTH.....	31

4.4.2	TEST SETUP	31
4.4.3	TEST INSTRUMENTS	31
4.4.4	TEST PROCEDURE	31
4.4.5	DEVIATION FROM TEST STANDARD	31
4.4.6	EUT OPERATING CONDITION	31
4.4.7	TEST RESULTS	32
4.5	HOPPING CHANNEL SEPARATION	36
4.5.1	LIMIT OF HOPPING CHANNEL SEPARATION	36
4.5.2	TEST SETUP	36
4.5.3	TEST INSTRUMENTS	36
4.5.4	TEST PROCEDURES	36
4.5.5	DEVIATION FROM TEST STANDARD	36
4.5.6	TEST RESULTS	37
4.6	CONDUCTED OUTPUT POWER	41
4.6.1	LIMITS OF CONDUCTED OUTPUT POWER MEASUREMENT	41
4.6.2	TEST SETUP	41
4.6.3	TEST INSTRUMENTS	41
4.6.4	TEST PROCEDURES	41
4.6.5	DEVIATION FROM TEST STANDARD	41
4.6.6	EUT OPERATING CONDITION	42
4.6.7	TEST RESULTS	42
4.7	OUT OF BAND EMISSION MEASUREMENT	44
4.7.1	LIMITS OF out of band eMISSION MEASUREMENT	44
4.7.2	TEST INSTRUMENTS	44
4.7.3	TEST PROCEDURE	44
4.7.4	DEVIATION FROM TEST STANDARD	44
4.7.5	EUT OPERATING CONDITION	44
4.7.6	TEST RESULTS	44
5	PHOTOGRAPHS OF THE TEST CONFIGURATION	48
6	APPENDIX A - MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB	49



Test Report No.: (8822)312-0040

RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
(8822)312-0040	Original release	Nov. 07, 2022

1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part 15, Subpart C			
STANDARD SECTION	TEST TYPE AND LIMIT	RESULT	REMARK
15.207	AC Power Conducted Emission	N/A	Power by Battery
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)	Conducted Output Power	PASS	Meet the requirement of limit.
15.247(d)&15.209	Transmitter Radiated Emission	PASS	Meet the requirement of limit.
15.247(d)	Out of band Emission Measurement	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	No antenna connector is used.

2 MEASUREMENT UNCERTAINTY

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

MEASUREMENT	FREQUENCY	UNCERTAINTY
Radiated emissions	9KHz ~ 30MHz	5.04dB
	30MHz ~ 1GMHz	5.04dB
	1GHz ~ 18GHz	5.23dB
	18GHz ~ 40GHz	5.23dB

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

3 GENERAL INFORMATION

3.1 GENERAL DESCRIPTION OF EUT

PRODUCT	AMP HANDLE
MODEL NO.	1.0 AMP HANDLE
ADDITIONAL MODEL	N/A
FCC ID	2A89Z-AMP-HANDLE
POWER SUPPLY	3.7VDC From Li-ion battery
MODULATION TECHNOLOGY	FHSS
MODULATION TYPE	GFSK, $\pi/4$ DQPSK
OPERATING FREQUENCY	2402MHz~2480MHz
NUMBER OF CHANNEL	79
PEAK OUTPUT POWER	0.611 mW (Max. Measured)
ANTENNA TYPE	PCB Antenna, -0.58dBi Gain
I/O PORTS	Refer to user's manual
CABLE SUPPLIED	N/A

NOTE:

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
2. For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.
3. Please refer to the EUT photo document (Reference No.: (8822)312-0040) for detailed product photo.
4. When the EUT in the charging mode that RF function no working.

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. CONFIGURATION OF SYSTEM UNDER TEST

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

3.2.2. TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis, power supply voltage range and antenna ports. The worst case was found when positioned on X axis for radiated emission. Following channel(s) was (were) selected for the final test as listed below:

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE<1G	RE 1G	PLC	APCM	
A	√	√	-	√	Powered By Fully Battery

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

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

NOTE: No need to concern of Conducted Emission due to the EUT is powered by battery.

RADIATED EMISSION TEST (BELOW 1 GHz):

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

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
0 to 78	39	FHSS	GFSK	DH5

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

RADIATED EMISSION TEST (ABOVE 1 GHz):

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

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	$\pi/4$ DQPSK	2DH5

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, antenna ports (if EUT with antenna diversity architecture), and packet types.
- ☒ Following channel(s) was (were) selected for the final test as listed below.

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	$\pi/4$ DQPSK	2DH5

TEST CONDITION:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	TEST VOLTAGE (SYSTEM)	TESTED BY
RE<1G	25deg. C, 55%RH	Powered by Full Battery	Sean Yuan
RE 1G	25deg. C, 55%RH	Powered by Full Battery	Sean Yuan
PLC	-	-	-
APCM	25deg. C, 57%RH	Powered by Full Battery	Sean Yuan



Test Report No.: (8822)312-0040

3.3 GENERAL DESCRIPTION OF APPLIED STANDARDS

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

FCC Part 15, Subpart C, Section 15.247
KDB 558074 D01 15.247 Meas Guidance v05r02
ANSI C63.10-2013

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

3.4 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit without any other necessary accessory or support units.

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, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a). 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. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Test Receiver	Rohde & Schwarz	ESCI7	100837	Mar. 13, 2022	Mar. 13, 2023
Antenna	Schwarzbeck	VULB9162	9162-010	Mar. 23, 2022	Mar. 23, 2024
Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	Mar. 13, 2022	Mar. 13, 2023
Spectrum Analyzer	Keysight	N9020A	MY54200831	Mar. 13, 2022	Mar. 13, 2023
Spectrum Analyzer	Rohde & Schwarz	FSV40	101094	Mar. 13, 2022	Mar. 13, 2023
Horn Antenna	Schwarzbeck	BBHA9170	9170-172	Mar. 23, 2022	Mar. 23, 2024
Horn Antenna	COM-Power	AH-118	071078	Mar. 23, 2022	Mar. 23, 2024
Pre-Amplifier	HP	HP 8449B	3008A00964	Mar. 13, 2022	Mar. 13, 2023
Pre-Amplifier	HP	HP 8447D	1145A00203	Mar. 13, 2022	Mar. 13, 2023
Loop Antenna	Schwarzbeck	FMZB 1513	1513-272	Mar. 23, 2022	Mar. 23, 2023
Test Receiver	Rohde & Schwarz	ESCI	101152	Mar. 13, 2022	Mar. 13, 2023
L.I.S.N	Rohde & Schwarz	ENV 216	101317	Mar. 13, 2022	Mar. 13, 2023
Test Software	EZ	EZ EMC	N/A	N/A	N/A

NOTE:

1. The test was performed at Dongguan NTC Co., Ltd.
2. The calibration interval of the above test instruments is 12 or 24 months and the calibrations are traceable to LISAI/CHINA.
3. The horn antenna is used only for the measurement of emission frequency above 1GHz if tested.
4. The FCC Site Registration No. is 749762.

4.1.3 TEST PROCEDURES

- a. The EUT was placed on the top of a rotating table 1.5 meters(above 1GHz) and 0.8 meters(below 1GHz) above the ground at a 3 meters semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. For below 1GHz was used bilog antenna, and above 1GHz was used horn antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. For below 30MHz, a loop antenna with its vertical plane is place 3m from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. And the centre of the loop shall be 1m above the ground.
- g. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, For battery operated equipment, the equipment tests shall be perform using fresh batteries. The turntable was rotated to maximize the emission level.

NOTE:

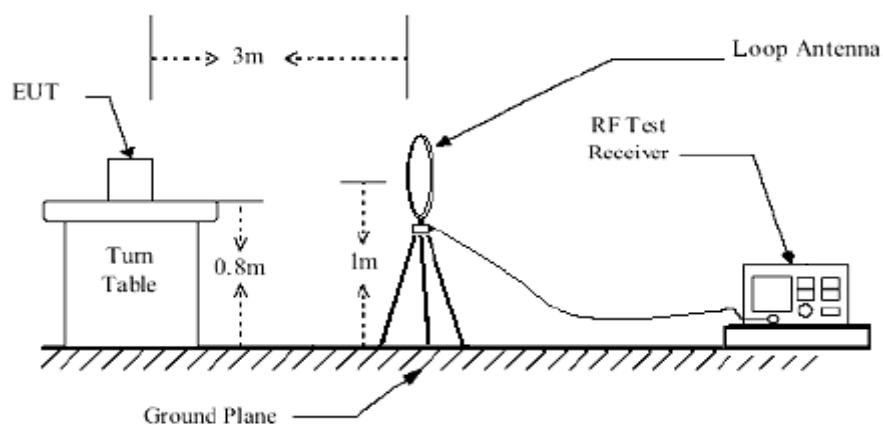
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and video bandwidth is 3MHz for Peak detection at frequency above 1GHz.
3. The resolution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

4.1.4 DEVIATION FROM TEST STANDARD

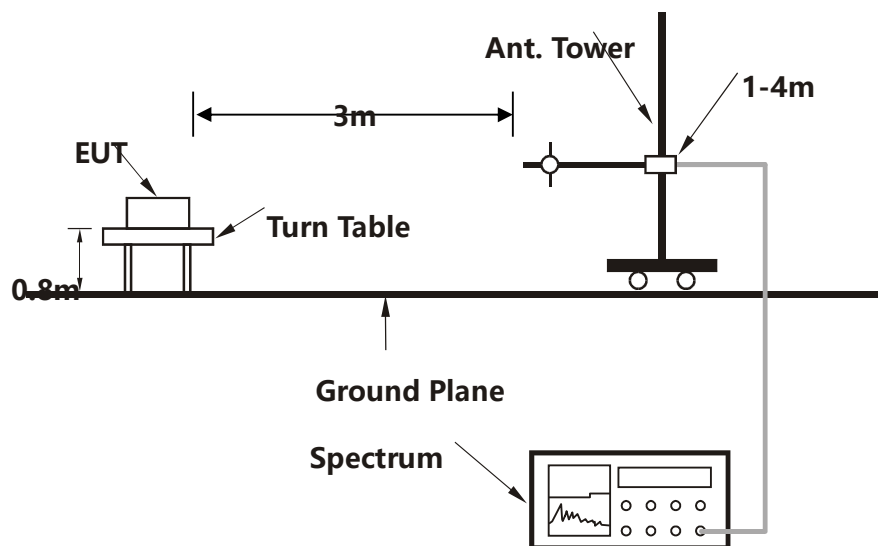
No deviation.

4.1.5 TEST SETUP

Below 30MHz test setup

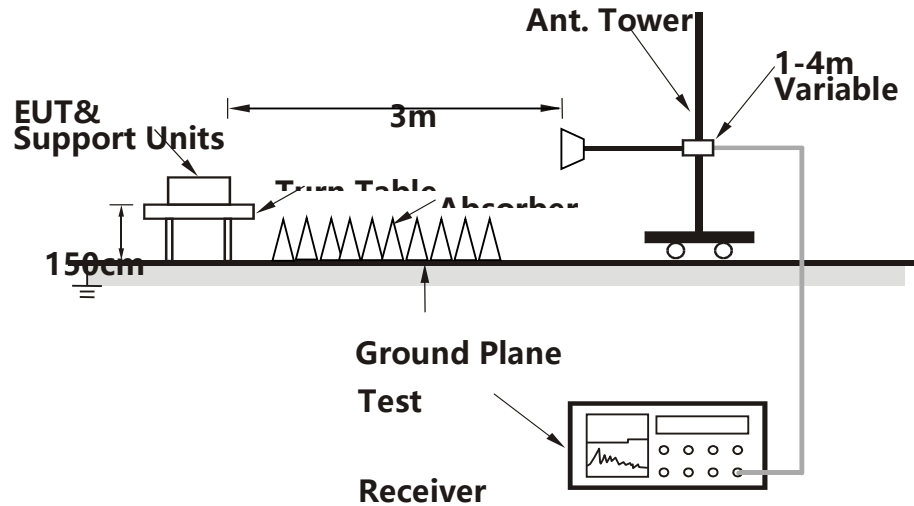


Below 1GHz test setup



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

Above 1GHz test setup



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

4.1.6 EUT OPERATING CONDITIONS

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

4.1.7 TEST RESULTS

BELOW 1GHz WORST-CASE DATA:

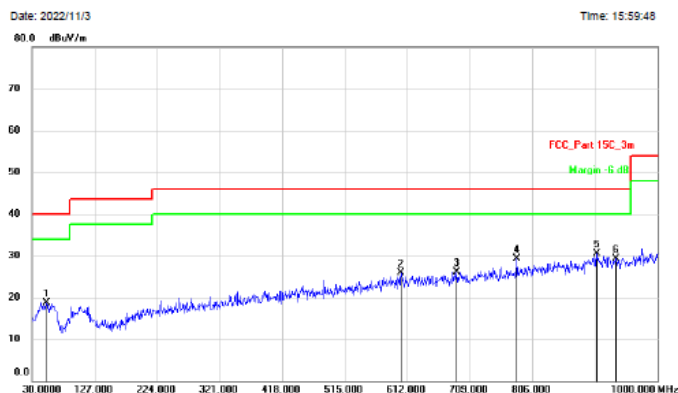
GFSK DH5

CHANNEL	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)	CORRECTIO N FACTOR (dB/m)
1	52.3100	18.66 QP	40.00	-21.34	1.00 H	212	25.83	-7.17
2	602.3000	25.84 QP	46.00	-20.16	1.00 H	148	25.13	0.71
3	688.6300	26.16 QP	46.00	-19.84	1.00 H	25	24.19	1.97
4	781.7500	29.26 QP	46.00	-16.74	1.00 H	125	25.63	3.63
5	905.9100	30.42 QP	46.00	-15.58	1.00 H	225	24.22	6.20
6	935.9800	29.35 QP	46.00	-16.65	1.00 H	328	23.10	6.25

REMARKS:

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

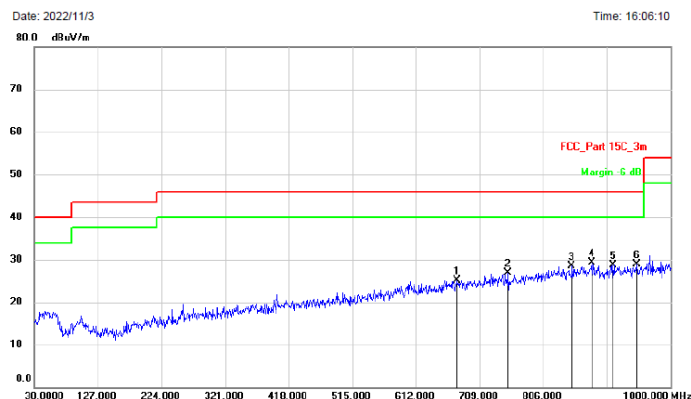


CHANNEL	Channel 39	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9KHz ~ 1GHz		

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)	CORRECTIO N FACTOR (dB/m)
1	675.0500	25.18 QP	46.00	-20.82	1.00 V	251	23.44	1.74
2	752.6500	26.83 QP	46.00	-19.17	1.00 V	156	23.75	3.08
3	849.6500	28.45 QP	46.00	-17.55	1.00 V	145	23.66	4.79
4	879.7200	29.21 QP	46.00	-16.79	1.00 V	148	24.27	4.94
5	912.7000	28.70 QP	46.00	-17.30	1.00 V	126	23.73	4.97
6	948.5900	28.98 QP	46.00	-17.02	1.00 V	214	23.91	5.07

REMARKS:

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



ABOVE 1GHz DATA

BT_GFSK

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

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	47.50 PK	74.00	-26.50	2.27 H	254	50.70	-3.20
2	2390.00	31.05 AV	54.00	-22.95	2.27 H	254	34.25	-3.20
3	*2402.00	92.49 PK			1.98 H	131	95.66	-3.17
4	*2402.00	53.26 AV			1.98 H	131	56.43	-3.17
5	4804.00	48.23 PK	74.00	-25.77	1.30 H	169	44.67	3.56
6	4804.00	37.65 AV	54.00	-16.35	1.30 H	169	34.09	3.56
7	#7206.00	51.22PK	74.00	-22.78	1.28 H	37	40.78	10.44
8	#7206.00	40.55 AV	54.00	-13.45	1.28 H	37	30.11	10.44
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	47.53 PK	74.00	-26.47	2.00 V	264	50.73	-3.20
2	2390.00	32.05 AV	54.00	-21.95	2.00 V	264	35.25	-3.20
3	*2402.00	90.36 PK			1.50 V	125	93.53	-3.17
4	*2402.00	52.40 AV			1.50 V	125	55.57	-3.17
5	4804.00	48.36 PK	74.00	-25.64	1.35 V	187	44.80	3.56
6	4804.00	38.12 AV	54.00	-15.88	1.35 V	187	34.56	3.56
7	#7206.00	51.22 PK	74.00	-22.78	1.38 V	133	40.78	10.44
8	#7206.00	41.52 AV	54.00	-12.48	1.38 V	133	31.08	10.44

REMARKS:

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

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

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2441.00	93.45 PK			2.32 H	98	96.53	-3.08
2	*2441.00	54.11 AV			2.32 H	98	57.19	-3.08
3	4882.00	47.36 PK	74.00	-26.64	1.50 H	62	43.36	4.00
4	4882.00	37.66 AV	54.00	-16.34	1.50 H	62	33.66	4.00
5	7323.00	53.21 PK	74.00	-20.79	1.89 H	285	42.66	10.55
6	7323.00	42.59 AV	54.00	-11.41	1.89 H	285	32.04	10.55
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	*2441.00	91.26 PK			2.31 V	306	94.34	-3.08
2	*2441.00	53.76 AV			2.31 V	306	56.84	-3.08
3	4882.00	48.17 PK	74.00	-25.83	1.30 V	166	44.17	4.00
4	4882.00	38.14 AV	54.00	-15.86	1.30 V	166	34.14	4.00
5	7323.00	53.36 PK	74.00	-20.64	1.28 V	237	42.81	10.55
6	7323.00	44.25 AV	54.00	-9.75	1.28 V	237	33.70	10.55

REMARKS:

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

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

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	89.74 PK			3.00 H	126	92.76	-3.02
2	*2480.00	51.26 AV			3.00 H	126	54.28	-3.02
3	2483.50	53.86 PK	74.00	-20.14	2.30 H	43	56.88	-3.02
4	2483.50	36.57 AV	54.00	-17.43	2.30 H	43	39.59	-3.02
5	4960.00	48.37 PK	74.00	-25.63	1.00 H	90	44.36	4.01
6	4960.00	38.12 AV	54.00	-15.88	1.00 H	90	34.11	4.01
7	7440.00	53.33 PK	74.00	-20.67	1.37 H	312	42.73	10.60
8	7440.00	42.03 AV	54.00	-11.97	1.37 H	312	31.43	10.60
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	93.41 PK			2.38 V	223	96.43	-3.02
2	*2480.00	53.48 AV			2.38 V	223	56.50	-3.02
3	2483.50	54.34 PK	74.00	-19.66	1.82 V	287	57.36	-3.02
4	2483.50	37.26 AV	54.00	-16.74	1.82 V	287	40.28	-3.02
5	4960.00	48.66 PK	74.00	-25.34	1.35 V	181	44.65	4.01
6	4960.00	38.67 AV	54.00	-15.33	1.35 V	181	34.66	4.01
7	7440.00	54.21 PK	74.00	-19.79	1.70 V	115	43.61	10.60
8	7440.00	43.55 AV	54.00	-10.45	1.70 V	115	32.95	10.60

REMARKS:

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

BT_π/4 DQPSK

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

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	47.83 PK	74.00	-26.17	2.54 H	227	51.03	-3.20
2	2390.00	31.93 AV	54.00	-22.07	2.54 H	227	35.13	-3.20
3	*2402.00	90.53 PK			1.91 H	133	93.70	-3.17
4	*2402.00	53.16 AV			1.91 H	133	56.33	-3.17
5	4804.00	48.30 PK	74.00	-25.70	1.32 H	163	44.76	3.56
6	4804.00	37.12 AV	54.00	-16.88	1.32 H	163	33.69	3.56
7	#7206.00	52.90 PK	74.00	-21.10	1.24 H	32	42.46	10.44
8	#7206.00	41.63 AV	54.00	-12.37	1.24 H	32	31.19	10.44
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	51.02 PK	74.00	-51.02	2.10 V	261	54.22	-3.20
2	2390.00	34.33 AV	54.00	-34.33	2.10 V	261	37.53	-3.20
3	*2402.00	92.46 PK			1.60 V	122	95.63	-3.17
4	*2402.00	55.14 AV			1.60 V	122	58.31	-3.17
5	4804.00	53.23 PK	74.00	-49.10	1.33 V	157	49.67	3.56
6	4804.00	39.35 AV	54.00	-41.61	1.33 V	157	35.79	3.56
7	#7206.00	53.56 PK	74.00	-53.56	1.35 V	125	43.12	10.44
8	#7206.00	41.55 AV	54.00	-41.55	1.35 V	125	31.11	10.44

REMARKS:

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

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

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2441.00	91.25 PK			2.38 H	92	94.33	-3.08
2	*2441.00	52.45 AV			2.38 H	92	55.53	-3.08
3	4882.00	48.17 PK	74.00	-25.83	1.52 H	63	44.17	4.00
4	4882.00	37.80 AV	54.00	-16.20	1.52 H	63	33.80	4.00
5	7323.00	54.25 PK	74.00	-19.75	1.83 H	285	43.70	10.55
6	7323.00	42.10 AV	54.00	-11.90	1.83 H	285	31.55	10.55
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	*2441.00	91.56 PK			2.31 V	302	94.64	-3.08
2	*2441.00	52.33 AV			2.31 V	302	55.41	-3.08
3	4882.00	48.63 PK	74.00	-25.37	1.30 V	167	44.63	4.00
4	4882.00	37.29 AV	54.00	-16.71	1.30 V	167	33.29	4.00
5	7323.00	53.26 PK	74.00	-20.74	1.28 V	233	42.71	10.55
6	7323.00	42.11 AV	54.00	-11.89	1.28 V	233	31.56	10.55

REMARKS:

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

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

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	89.25 PK			3.02 H	129	92.27	-3.02
2	*2480.00	53.22 AV			3.02 H	129	56.24	-3.02
3	2483.50	54.37 PK	74.00	-19.63	2.31 H	48	57.39	-3.02
4	2483.50	37.90 AV	54.00	-16.10	2.31 H	48	40.92	-3.02
5	4960.00	48.87 PK	74.00	-25.13	1.32 H	91	44.86	4.01
6	4960.00	38.56 AV	54.00	-15.44	1.32 H	91	34.55	4.01
7	7440.00	53.76 PK	74.00	-20.24	1.43 H	312	43.16	10.60
8	7440.00	42.10 AV	54.00	-11.90	1.43 H	312	31.50	10.60
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2480.00	90.47 PK			2.32 V	229	93.49	-3.02
2	*2480.00	51.67 AV			2.32 V	229	54.69	-3.02
3	2483.50	48.11 PK	74.00	-25.89	1.81 V	284	51.13	-3.02
4	2483.50	33.34 AV	54.00	-20.66	1.81 V	284	36.36	-3.02
5	4960.00	48.19 PK	74.00	-25.81	1.33 V	187	44.18	4.01
6	4960.00	37.35 AV	54.00	-16.65	1.33 V	187	33.34	4.01
7	7440.00	53.60 PK	74.00	-20.40	1.77 V	113	43.00	10.60
8	7440.00	42.11 AV	54.00	-11.89	1.77 V	113	31.51	10.60

REMARKS:

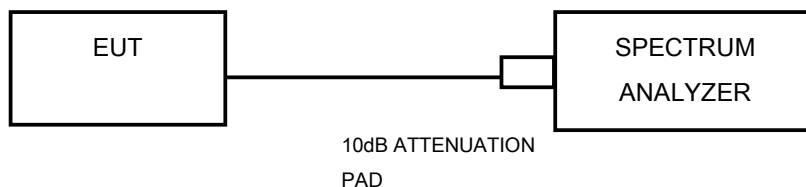
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.

4.2 NUMBER OF HOPPING FREQUENCY USED

4.2.1 LIMIT OF HOPPING FREQUENCY USED

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

4.2.2 TEST SETUP



4.2.3 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Test Receiver	Rohde & Schwarz	ESCI7	100837	Mar. 13, 2022	Mar. 13, 2023
Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	Mar. 13, 2022	Mar. 13, 2023
Spectrum Analyzer	Keysight	N9020A	MY54200831	Mar. 13, 2022	Mar. 13, 2023
Spectrum Analyzer	Rohde & Schwarz	FSV40	101094	Mar. 13, 2022	Mar. 13, 2023
Power Sensor	DARE	RPR3006W	15I00041SNO64	Mar. 13, 2022	Mar. 13, 2023
Power Meter	Agilent	E4419B	GB40201469	Mar. 13, 2022	Mar. 13, 2023
Test Receiver	Rohde & Schwarz	ESCI	101152	Mar. 13, 2022	Mar. 13, 2023
RF Switching Unit	Compliance Direction Systems Inc.	RSU-M2	38311	Mar.13, 2022	Mar.13, 2023
Temporary antenna connector	TESCOM	SS402	N/A	N/A	N/A
Test Software	EZ	EZ_EMC	N/A	N/A	N/A

NOTE:

1. The test was performed at Dongguan NTC Co., Ltd.
2. The calibration interval of the above test instruments is 12 or 24 months and the calibrations are traceable to LISAI/CHINA.

4.2.4 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. 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 completed.

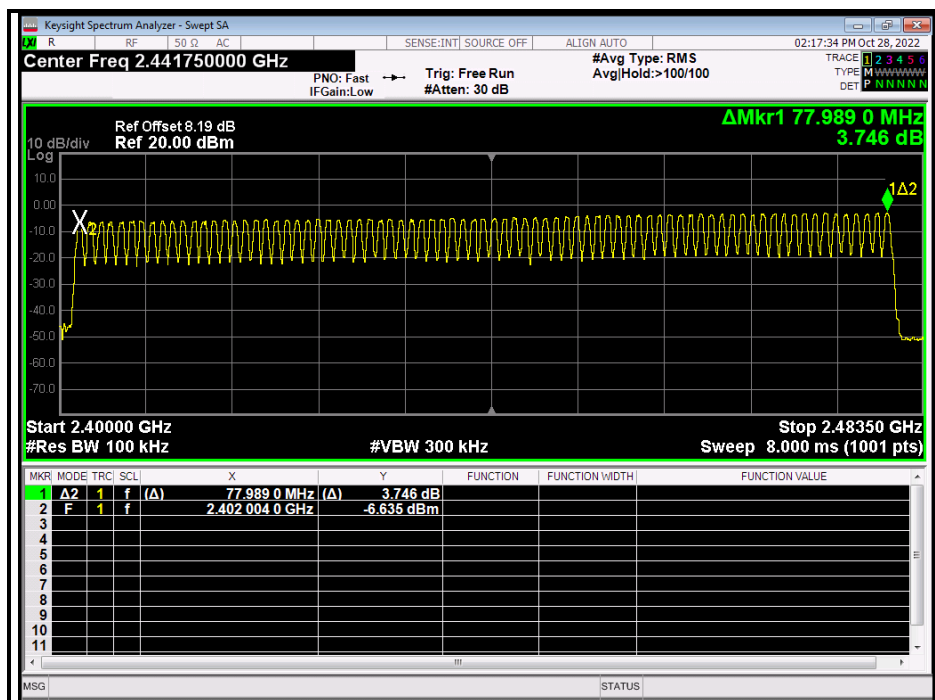
4.2.5 DEVIATION FROM TEST STANDARD

No deviation.

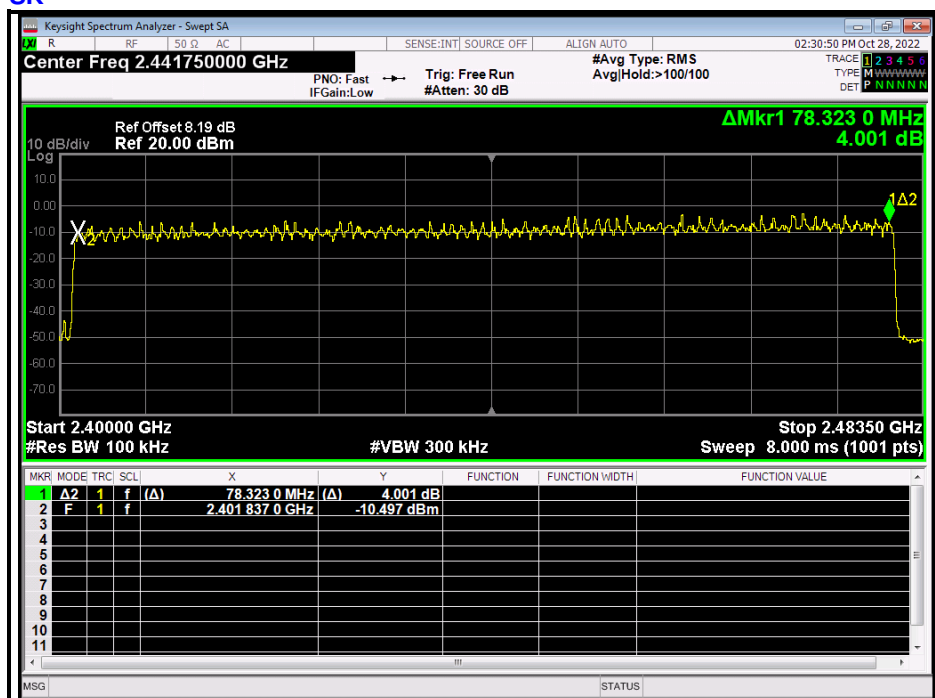
4.2.6 TEST RESULTS

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

GFSK



$\pi/4$ DQPSK

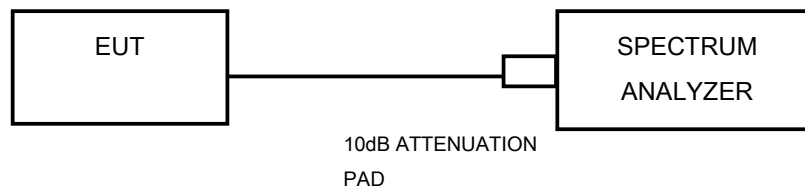


4.3 DWELL TIME ON EACH CHANNEL

4.3.1 LIMIT OF DWELL TIME USED

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 4.2.3 to get information of above instrument.

4.3.4 TEST PROCEDURES

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- 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.
- 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.
- Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
- 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 Hopping Channel	Observation period (Number of hopping channel*0.4 sec)	Total Hops	Length of transmission time (msec)	Result (msec)	Limit (msec)	Test Result
DH1	79	31.6	320	0.372	119.04	400	PASS
DH3	79	31.6	160	1.630	260.80	400	PASS
DH5	79	31.6	106.67	2.878	307.00	400	PASS

$\pi/4$ DQPSK

Mode	Number of Hopping Channel	Observation period (Number of hopping channel*0.4 sec)	Total Hops	Length of transmission time (msec)	Result (msec)	Limit (msec)	Test Result
2DH1	79	31.6	320	0.380	121.60	400	PASS
2DH3	79	31.6	160	1.635	261.60	400	PASS
2DH5	79	31.6	106.67	2.878	307.00	400	PASS

NOTE:

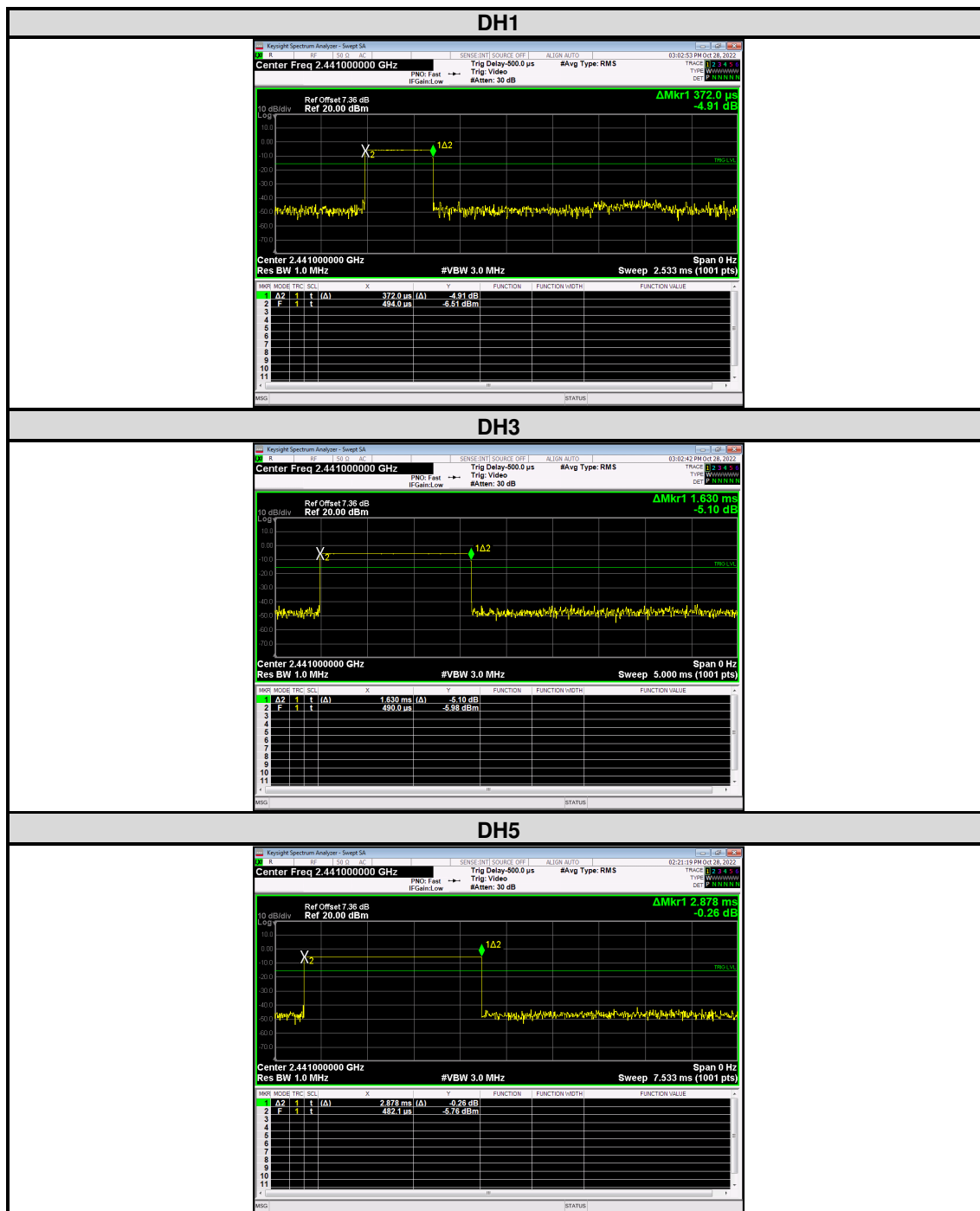
Total Hops in 31.6s for DH1=1600 / 2 / 79 *31.6=320

Total Hops in 31.6s for DH3=1600 / 4 / 79 *31.6=160

Total Hops in 31.6s for DH5=1600 / 6 / 79 *31.6=106.67

Test plots of the transmitting time slot are shown on next page.

GFSK



$\pi/4$ DQPSK

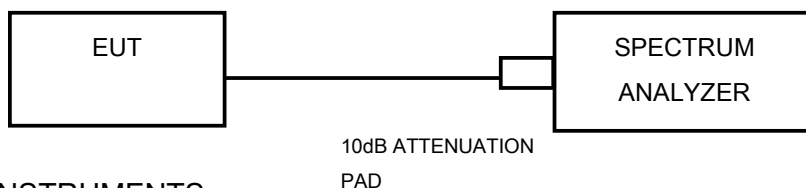


4.4 CHANNEL BANDWIDTH

4.4.1 LIMITS OF CHANNEL BANDWIDTH

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

4.4.2 TEST SETUP



4.4.3 TEST INSTRUMENTS

Refer to section 4.2.3 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

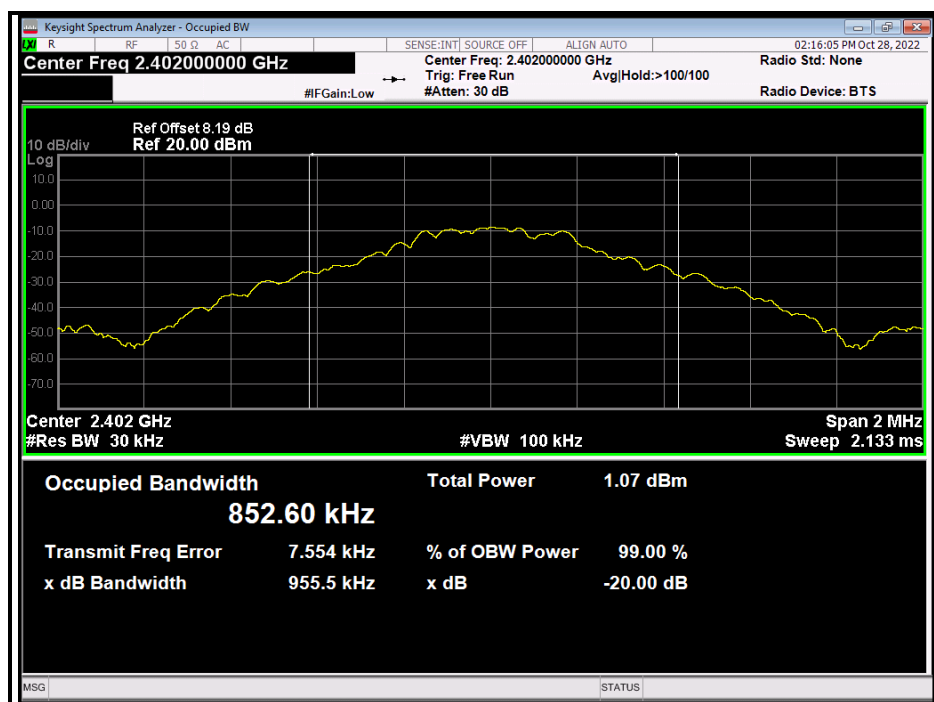
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.4.7 TEST RESULTS

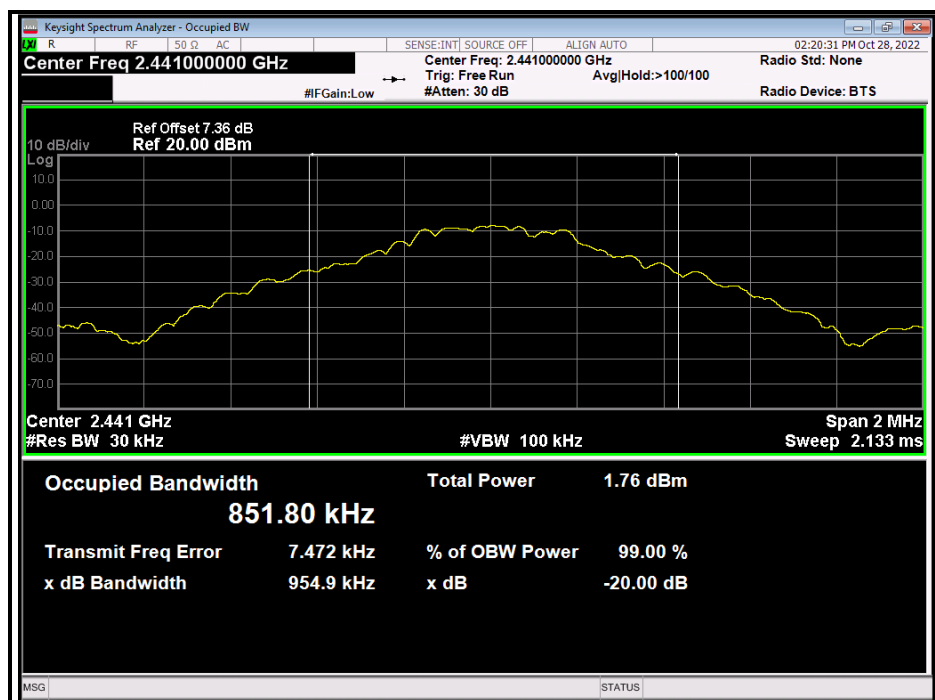
GFSK

CHANNEL	CHANNEL FREQUENCY (MHz)	20dB BANDWIDTH (MHz)
0	2402	0.9555
39	2441	0.9549
78	2480	0.9560

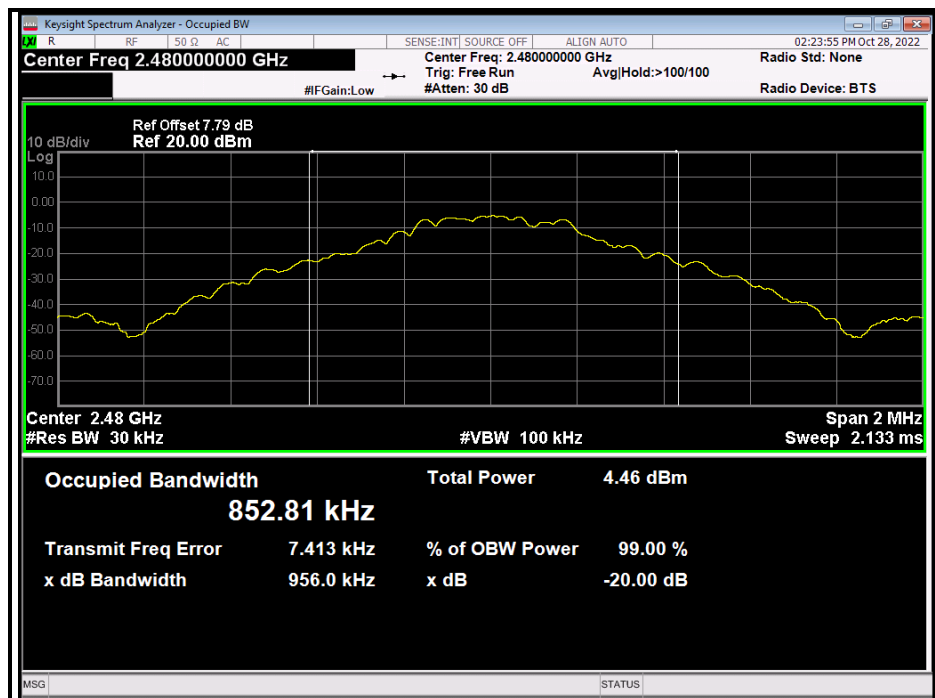
CH 0



CH 39



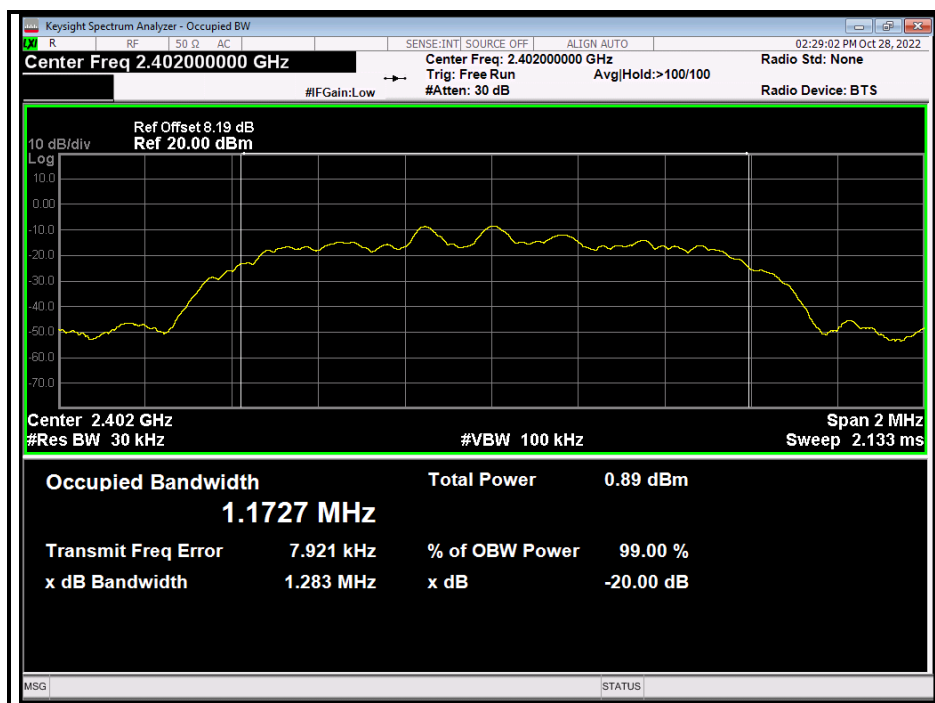
CH 78



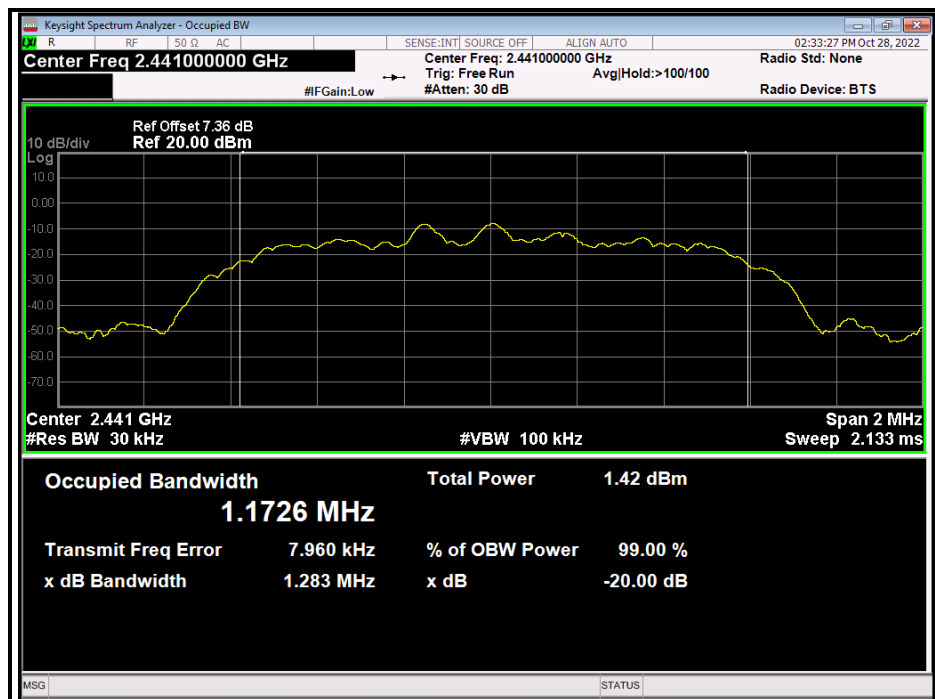
$\pi/4$ DQPSK

CHANNEL	CHANNEL FREQUENCY (MHz)	20dB BANDWIDTH (MHz)
0	2402	1.283
39	2441	1.283
78	2480	1.283

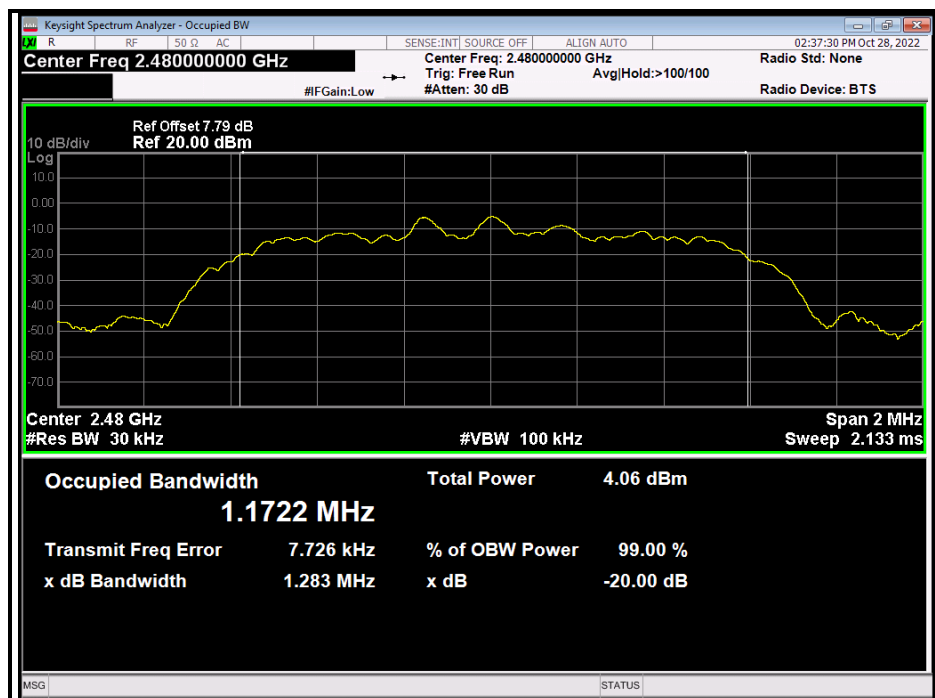
CH 0



CH 39



CH 78

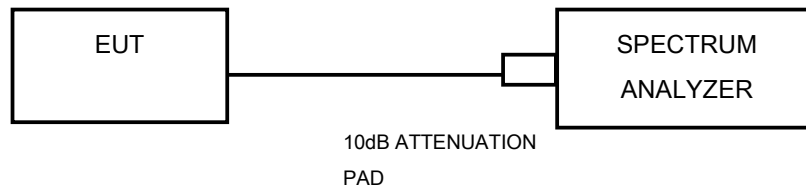


4.5 HOPPING CHANNEL SEPARATION

4.5.1 LIMIT OF HOPPING CHANNEL SEPARATION

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 4.2.3 to get information of above instrument.

4.5.4 TEST PROCEDURES

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

4.5.5 DEVIATION FROM TEST STANDARD

No deviation.

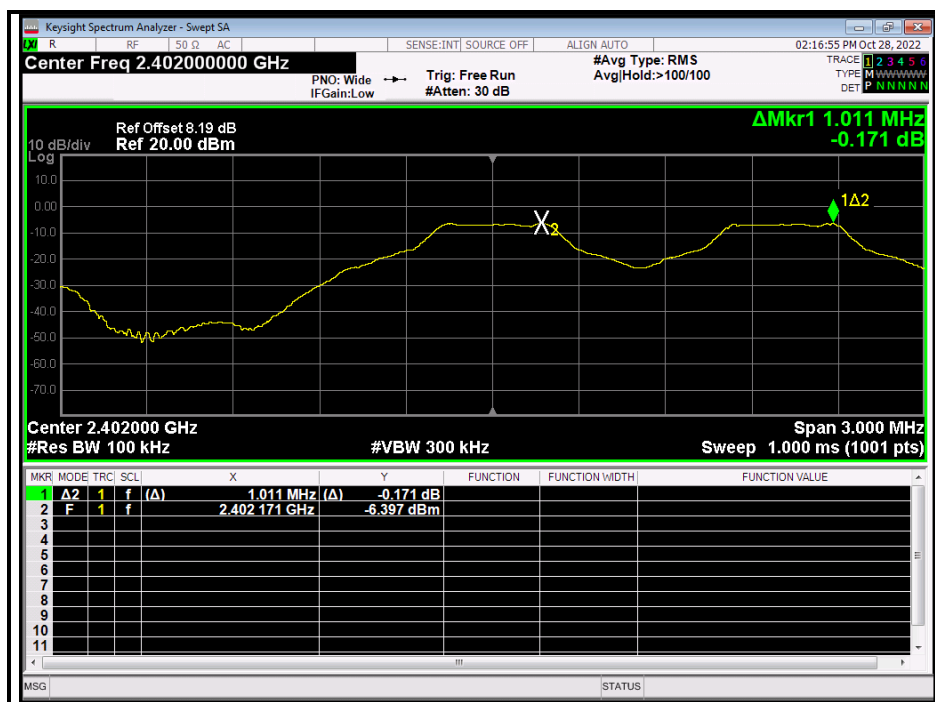
4.5.6 TEST RESULTS

GFSK

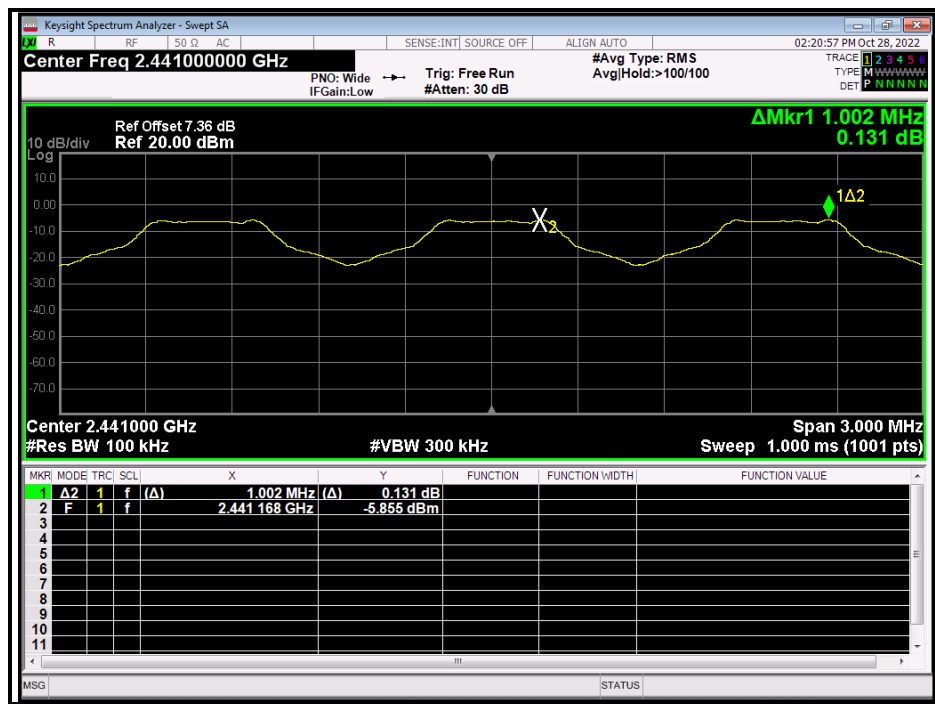
CHANNEL	FREQUENCY (MHz)	ADJACENT CHANNEL SEPARATION (MHz)	20dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS / FAIL
0	2402	1.011	0.9555	0.637	PASS
39	2441	1.002	0.9549	0.637	PASS
78	2480	0.999	0.9560	0.637	PASS

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

CH 0

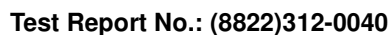


CH 39



CH 78





CHANNEL	FREQUENCY (MHz)	ADJACENT CHANNEL SEPARATION (MHz)	20dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS / FAIL
0	2402	1.002	1.283	0.855	PASS
39	2441	1.002	1.283	0.855	PASS
78	2480	1.002	1.283	0.855	PASS

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

Keysight Spectrum Analyzer - Swept SA

02:30:12 PM Oct 28, 2022

Center Freq 2.40200000 GHz

PNO: Wide IFGain: Low

Trig: Free Run #Atten: 30 dB

#Avg Type: RMS Avg/Hold: >100/100

Ref Offset 8.19 dB Ref 20.00 dBm

Δ Mkr1 1.002 MHz 0.063 dB

Center 2.402000 GHz #Res BW 100 kHz #VBW 300 kHz Span 3.000 MHz Sweep 1.000 ms (1001 pts)

MKR	MODE	TRG	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ2	1	f	(Δ)	1.002 MHz (Δ)	0.063 dB		
2	F	1	f		2.401850 GHz	-6.317 dBm		
3								
4								
5								
6								
7								
8								
9								
10								
11								

MSG

STATUS

CH 39



CH 78

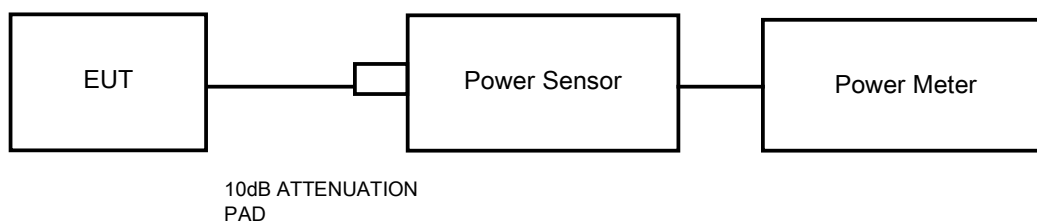


4.6 CONDUCTED OUTPUT POWER

4.6.1 LIMITS OF CONDUCTED OUTPUT POWER MEASUREMENT

The Maximum Output Power Measurement is 0.125W.

4.6.2 TEST SETUP



4.6.3 TEST INSTRUMENTS

Refer to section 4.2.3 to get information of above instrument.

4.6.4 TEST PROCEDURES

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

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

4.6.5 DEVIATION FROM TEST STANDARD

No deviation.

4.6.6 EUT OPERATING CONDITION

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

4.6.7 TEST RESULTS

MAXIMUM PEAK OUTPUT POWER

GFSK

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER (dBm)	PEAK POWER (mW)	PEAK POWER LIMIT (W)	PASS/FAIL
0	2402	-4.20	0.380	0.125	PASS
39	2441	-3.08	0.492	0.125	PASS
78	2480	-2.14	0.611	0.125	PASS

$\pi/4$ DQPSK

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER (dBm)	PEAK POWER (mW)	PEAK POWER LIMIT (W)	PASS/FAIL
0	2402	-5.15	0.305	0.125	PASS
39	2441	-4.05	0.394	0.125	PASS
78	2480	-3.12	0.488	0.125	PASS

AVERAGE OUTPUT POWER(FOR REFERENCE)

GFSK

CHANNEL	CHANNEL FREQUENCY (MHz)	AVERAGE POWER (dBm)	AVERAGE POWER (mW)
0	2402	-10.70	0.085
39	2441	-9.60	0.110
78	2480	-8.70	0.135

$\pi/4$ DQPSK

CHANNEL	CHANNEL FREQUENCY (MHz)	AVERAGE POWER (dBm)	AVERAGE POWER (mW)
0	2402	-11.90	0.065
39	2441	-10.80	0.083
78	2480	-9.90	0.102

4.7 OUT OF BAND EMISSION MEASUREMENT

4.7.1 LIMITS OF 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 4.2.3 to get information of above instrument.

4.7.3 TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer via a low loss cable. of Spectrum Analyzer was set RBW to 100 kHz and VBW to 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. Detector = PEAK and Trace mode = Max Hold. 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 to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

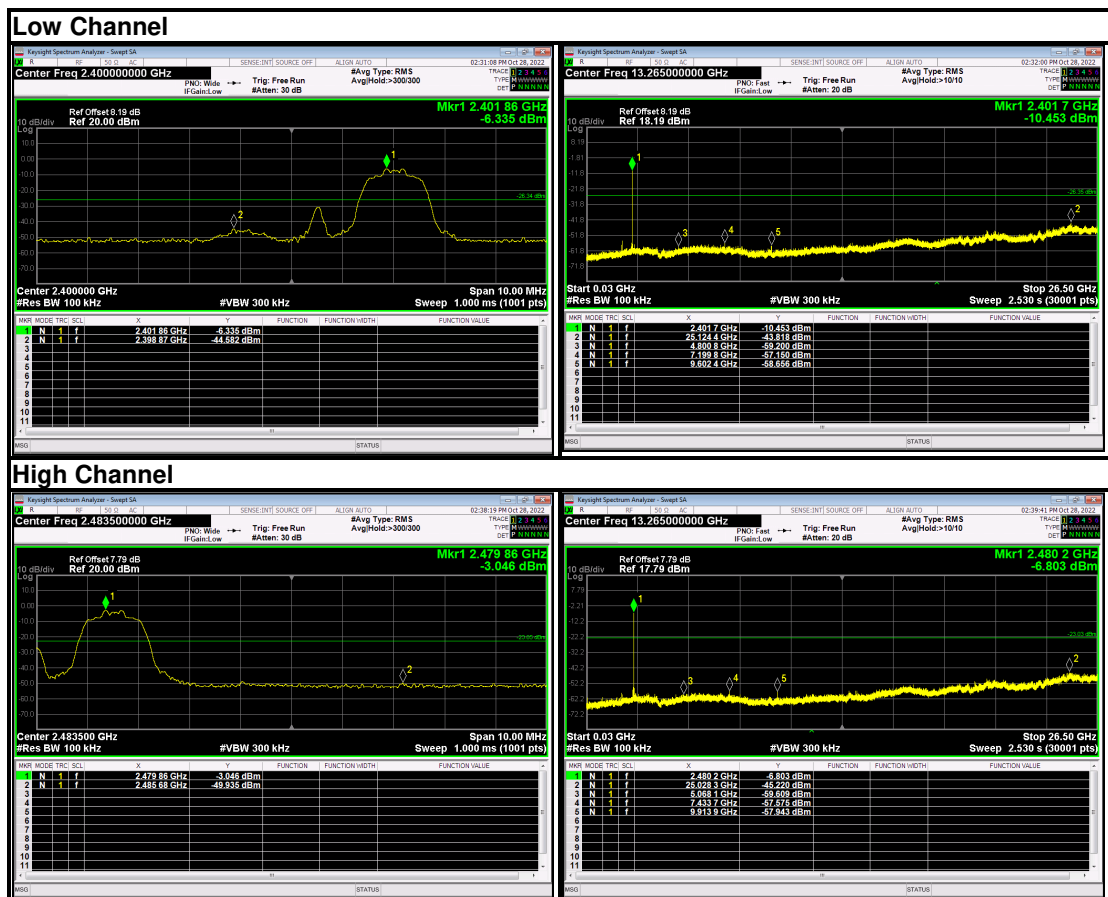
4.7.6 TEST RESULTS

The spectrum plots are attached on the following images. Mark1 indicates the highest level. Green line indicates the 20dB offset below Mark1. It shows compliance to the requirement.

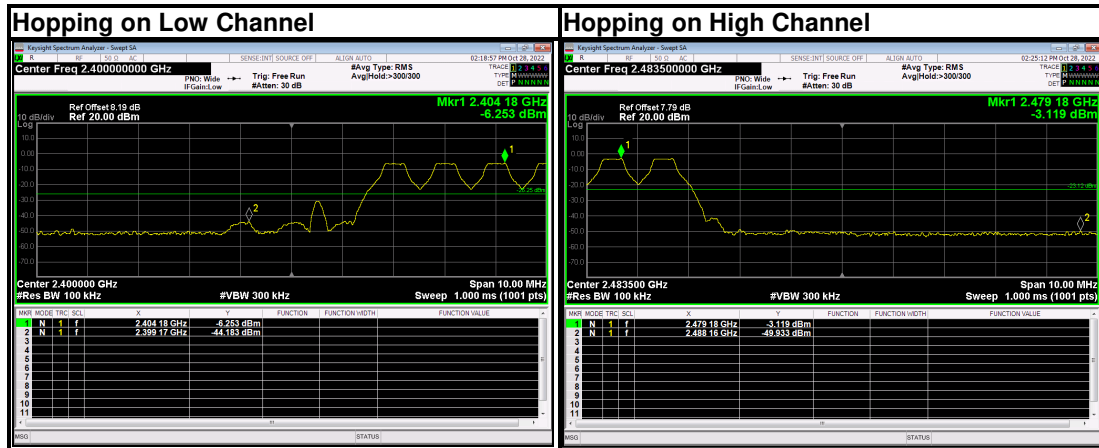
GFSK



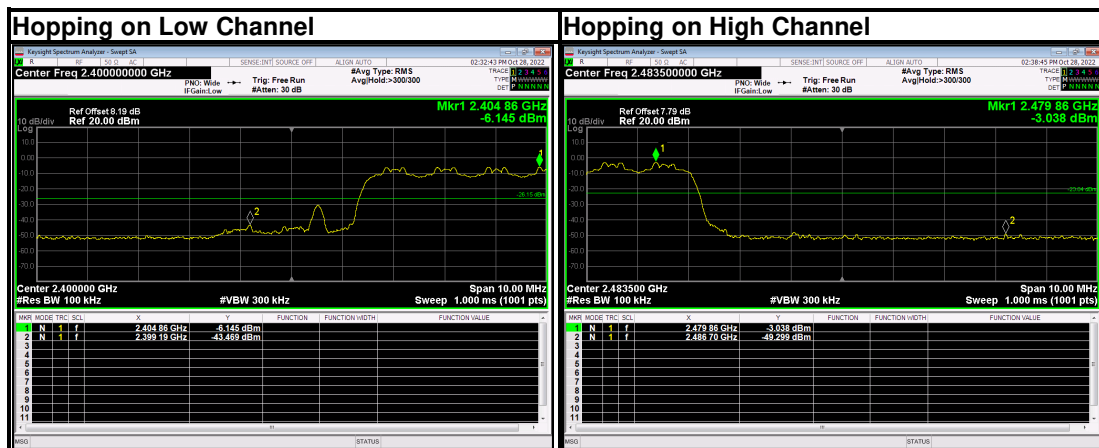
$\pi/4$ DQPSK



GFSK



$\pi/4$ DQPSK





Test Report No.: (8822)312-0040

5 PHOTOGRAPHS OF THE TEST CONFIGURATION

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



Test Report No.: (8822)312-0040

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

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

---END---