FCC Test Report

FCC ID	:	**NKR-SP69**
Equipment	:	**11abgn/ac WLAN/Bluetooth Combo Module**
Model No.	:	**DHUB-SP69**
Brand Name	:	**SHARP Corporation**
Applicant	:	**Wistron NeWeb Corp.**
Address	:	**20 Park Avenue II, Hsinchu Science Park, Hsinchu 308, Taiwan, R.O.C.**
Standard	:	**47 CFR FCC Part 15.247**
Received Date	:	**Oct. 13, 2014**
Tested Date	:	**Oct. 29 ~ Nov. 12 , 2014**

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Approved & Reviewed by:

Gary Chang / Manager

Testing Laboratory
2732

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Release Record

Report No.	Version	Description	Issued Date
FR4O1301AD	Rev. 01	Initial issue	Dec. 04, 2014

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.491MHz 33.33 (Margin -12.81dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]:719.67MHz 44.74 (Margin -1.26dB) - QP	Pass
15.247(d)	Band Edge	Meet the requirement of limit	Pass
15.247(b)(1)	Conducted Output Power	Power [dBm]: 11.85	Pass
15.247(a)(1)(iii)	Number of Hopping Channels	Meet the requirement of limit	Pass
15.247(a)(1)	Hopping Channel Separation	Meet the requirement of limit	Pass
15.247(a)(1)(iii)	Dwell Time	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	**Bluetooth Mode**	**Ch. Frequency (MHz)**	**Channel Number**	**Data Rate**
2400-2483.5	BR V4.0	2402-2480	0-78 [79]	1 Mbps
2400-2483.5	EDR V4.0	2402-2480	0-78 [79]	2 Mbps
2400-2483.5	EDR V4.0	2402-2480	0-78 [79]	3 Mbps
Note 1: RF output power specifies that Maximum Peak Conducted Output Power. Note 2: Bluetooth BR uses a GFSK. Note 3: Bluetooth EDR uses a combination of π/4-DQPSK and 8DPSK.				

1.1.2 Antenna Details

Ant. No.	Type	Gain (dBi)	Connector	Remark
1	PIFA	4.2	U.FL	---

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	5Vdc from host

1.1.4 Accessories

NA

1.1.5 Channel List

Frequency band (MHz)				2400~2483.5			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (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	---	---

1.1.6 Test Tool and Duty Cycle

Test Tool	Blue Tool, Version: 1.8.8.6

1.1.7 Power Setting

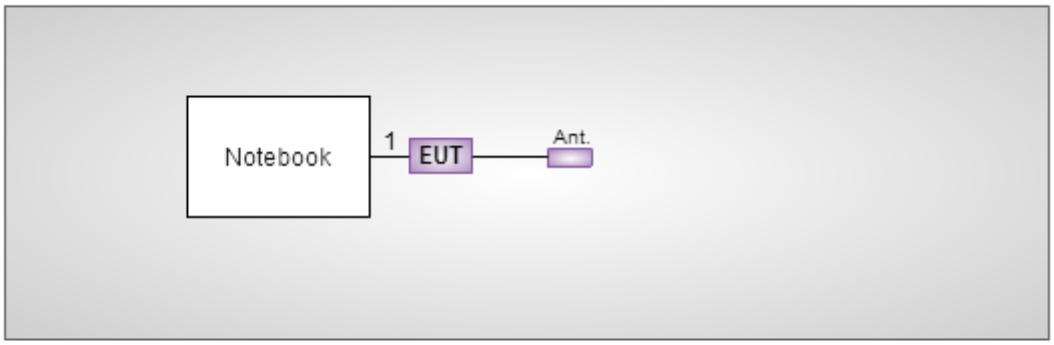
Modulation Mode	Test Frequency (MHz)		
	2402	2441	2480
GFSK/1Mbps	index0	index0	index0
π/4 QDPSK/2Mbps	index0	index0	index0
8DPSK/3Mbps	index0	index0	index0

1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**FCC ID**	**Signal cable / Length (m)**
1	Notebook	DELL	E6430	DoC	Fixture cable 0.12m non-shielded cable w/o core

1.3 Test Setup Chart

Test Setup Diagram



1. Fixture cable 0.12m non-shielded cable w/o core

1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
EMC Receiver	R&S	ESCS 30	100174	Apr. 14. 2014	Apr. 13. 2015
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 23, 2013	Nov. 22, 2014
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Dec. 04, 2013	Dec. 03, 2014
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Apr. 23, 2014	Apr. 22, 2015
50 ohm terminal (Support Unit)	NA	50	04	Apr. 18, 2014	Apr. 17, 2015
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber 3 / (03CH03-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	Agilent	N9010A	MY53400091	Sep. 16, 2014	Sep. 15, 2015
Receiver	R&S	ESR3	101657	Jan. 18, 2014	Jan. 17, 2015
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-562	Feb. 07, 2014	Feb. 06, 2015
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Feb. 20, 2014	Feb. 19, 2015
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA9170154	Jan. 10, 2014	Jan. 09, 2015
Preamplifier	EMC	EMC02325	980187	Nov. 22, 2013	Nov. 21, 2014
Preamplifier	Agilent	83017A	MY53270014	Sep. 17, 2014	Sep. 16, 2015
Preamplifier	EMC	EMC184045B	980192	Aug. 26, 2014	Aug. 25, 2015
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Feb. 19, 2014	Feb. 18, 2015
RF cable-8M	HUBER+SUHNER	SUCOFLEX104	MY22601/4	Feb. 19, 2014	Feb. 18, 2015
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22624/4	Feb. 19, 2014	Feb. 18, 2015
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-001	Feb. 17, 2014	Feb. 16, 2015
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Feb. 17, 2014	Feb. 16, 2015
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Feb. 17, 2014	Feb. 16, 2015
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Loop Antenna	R&S	HFH2-Z2	100330	Nov. 15, 2012	Nov. 14, 2014
Note: Calibration Interval of instruments listed above is two year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101063	Feb. 17, 2014	Feb. 16, 2015
Spectrum Analyzer	Agilent	N9010A	MY53400091	Sep. 16, 2014	Sep. 15, 2015
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Dec. 11, 2013	Dec. 10, 2014
Power Meter	Anritsu	ML2495A	1241002	Sep. 29, 2014	Sep. 28, 2015
Power Sensor	Anritsu	MA2411B	1207366	Sep. 29, 2014	Sep. 28, 2015
Signal Generator	R&S	SMB100A	175727	Jan. 07, 2014	Jan. 06, 2015
Radio Communication Analyzer	Anritsu	MT8820C	6201240341	Mar. 18, 2014	Mar. 17, 2015
MXG-B RF Vector Signal Generator	Agilent	N5182B	MY53050081	Apr. 08, 2014	Apr. 07, 2015
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

47 CFR FCC Part 15.247
FCC Public notice DA 00-705
ANSI C63.10-2009

1.6 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	**Uncertainty**
Bandwidth	±34.134 Hz
Conducted power	±0.808 dB
Frequency error	±34.134 Hz
Temperature	±0.6 ^{o}C
Conducted emission	±2.670 dB
AC conducted emission	±2.92 dB
Radiated emission ≤ 1GHz	±3.26 dB
Radiated emission > 1GHz	±4.94 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	22°C / 69%	Peter Lin
Radiated Emissions	03CH03-WS	21-22°C / 61-63%	Aska Huang
RF Conducted	TH01-WS	23°C / 62%	Brad Wu

- FCC site registration No.: 390588
- IC site registration No.: 10807C-1

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate (Mbps)	Test Configuration
Conducted Emissions	GFSK	2441	1Mbps	1
Radiated Emissions ≤ 1GHz	GFSK	2441	1Mbps	1,2
Radiated Emissions > 1GHz	GFSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480	1Mbps 3Mbps	1
Conducted Output Power	GFSK π/4 QDPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	1
Number of Hopping Channels	GFSK 8DPSK	2402~2480 2402~2480	1Mbps 3Mbps	1
Hopping Channel Separation	GFSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480	1Mbps 3Mbps	1
Dwell Time	GFSK 8DPSK	2480 2480	1Mbps 3Mbps	1

NOTE:

1. The EUT and its antenna were pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** results were found as the worst case for EUT, and the **X-plane** results were found as the worst case for antenna and shown in this report.
2. 4 different length of BT antenna cable were provided for this device: 400mm / 500mm / 550mm / 600mm.

   400mm and 600mm were selected for final testing as below test configurations.

   1) Configuration 1: 400mm
   2) Configuration 2: 600mm

3 Transmitter Test Results

3.1 Conducted Emissions

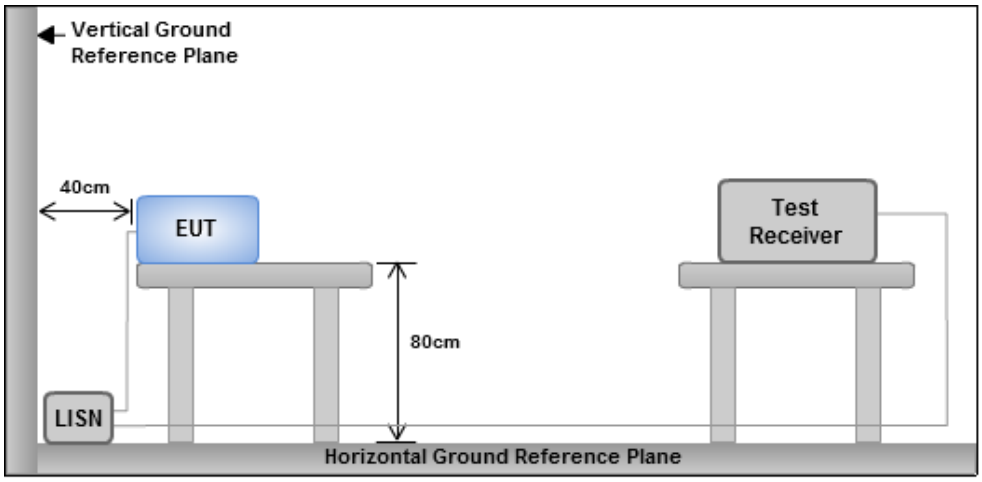
3.1.1 Limit of Conducted Emissions

Conducted Emissions Limit		
Frequency Emission (MHz)	**Quasi-Peak**	**Average**
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50
Note 1: * Decreases with the logarithm of the frequency.		

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V/60Hz

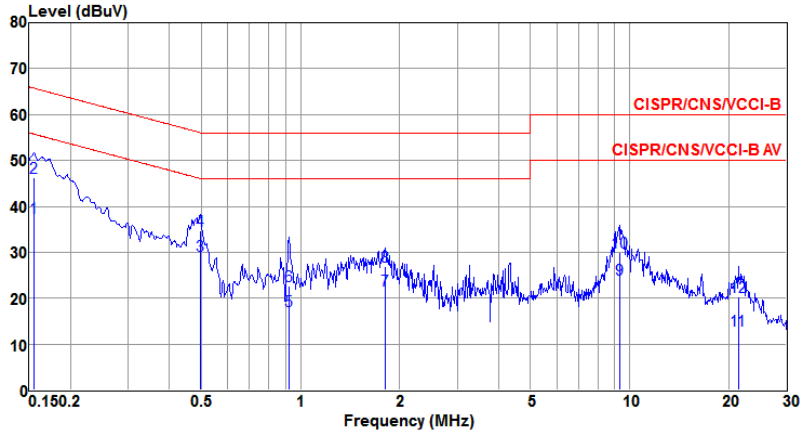
3.1.3 Test Setup



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

3.1.4 Test Result of Conducted Emissions

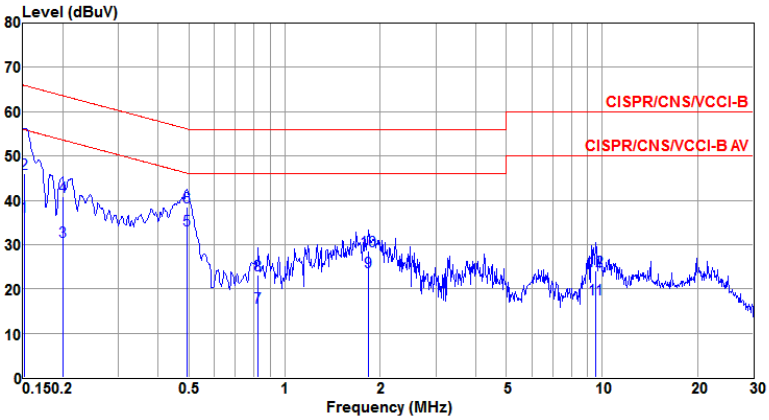
Modulation Mode	GFSK	Test Freq. (MHz)	2441
Power Phase	Line		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.155	37.55	55.74	-18.19	37.13	0.40	0.02	Average
2	0.155	46.35	65.74	-19.39	45.93	0.40	0.02	QP
3*	0.497	29.30	46.05	-16.75	28.89	0.39	0.02	Average
4	0.497	34.67	56.05	-21.38	34.26	0.39	0.02	QP
5	0.923	17.29	46.00	-28.71	16.86	0.41	0.02	Average
6	0.923	22.59	56.00	-33.41	22.16	0.41	0.02	QP
7	1.810	21.75	46.00	-24.25	21.30	0.43	0.02	Average
8	1.810	26.82	56.00	-29.18	26.37	0.43	0.02	QP
9	9.302	24.07	50.00	-25.93	23.30	0.53	0.24	Average
10	9.302	29.90	60.00	-30.10	29.13	0.53	0.24	QP
11	21.373	12.90	50.00	-37.10	11.94	0.55	0.41	Average
12	21.373	20.24	60.00	-39.76	19.28	0.55	0.41	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation Mode	GFSK	Test Freq. (MHz)	2441
Power Phase	Neutral		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.152	36.45	55.91	-19.46	35.95	0.48	0.02	Average
2	0.152	45.91	65.91	-20.00	45.41	0.48	0.02	QP
3	0.200	30.80	53.62	-22.82	30.31	0.48	0.01	Average
4	0.200	40.85	63.62	-22.77	40.36	0.48	0.01	QP
5*	0.491	33.33	46.14	-12.81	32.84	0.47	0.02	Average
6	0.491	38.50	56.14	-17.64	38.01	0.47	0.02	QP
7	0.826	15.92	46.00	-30.08	15.42	0.48	0.02	Average
8	0.826	23.04	56.00	-32.96	22.54	0.48	0.02	QP
9	1.839	23.76	46.00	-22.24	23.24	0.50	0.02	Average
10	1.839	28.57	56.00	-27.43	28.05	0.50	0.02	QP
11	9.552	17.75	50.00	-32.25	16.95	0.56	0.24	Average
12	9.552	24.07	60.00	-35.93	23.27	0.56	0.24	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 Unwanted Emissions into Restricted Frequency Bands

3.2.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	**Field Strength (uV/m)**	**Field Strength (dBuV/m)**	**Measure Distance (m)**
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit
Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.2.2 Test Procedures

1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at a height of 0.8 m test table above the ground plane.
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

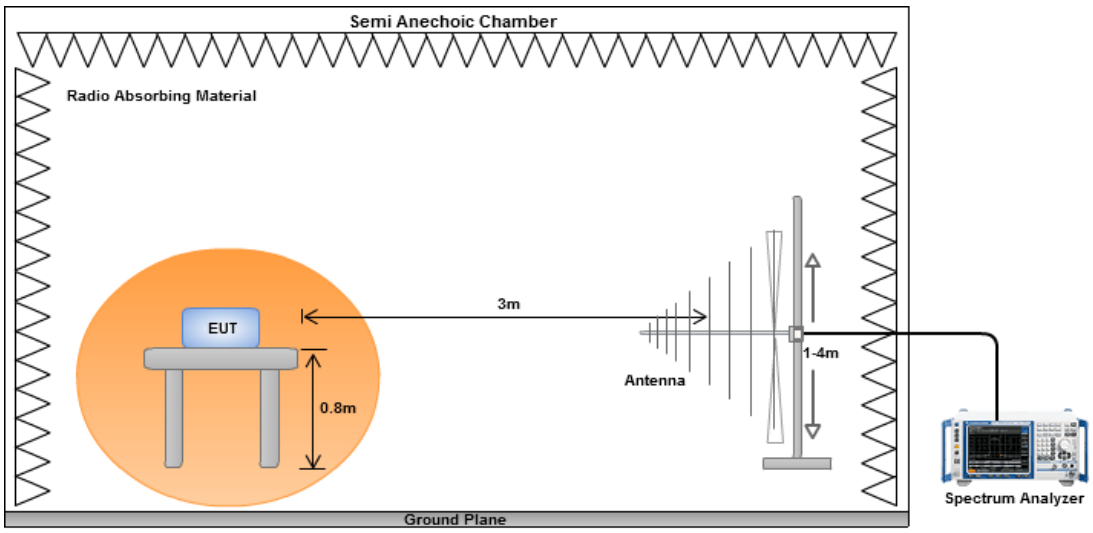
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. Radiated emission above 1GHz / Peak value
   RBW=1MHz, VBW=3MHz and Peak detector
3. Radiated emission above 1GHz / Average value for harmonics
   The average value is: Average = Peak value + 20log(Duty cycle) Where the duty factor is calculated from following formula for DH5 packet type which has worst duty factor:

$$20\log(\text{Duty cycle}) = 20\log\frac{1s / 1600 * 5}{100\ ms} = -30.1dB$$

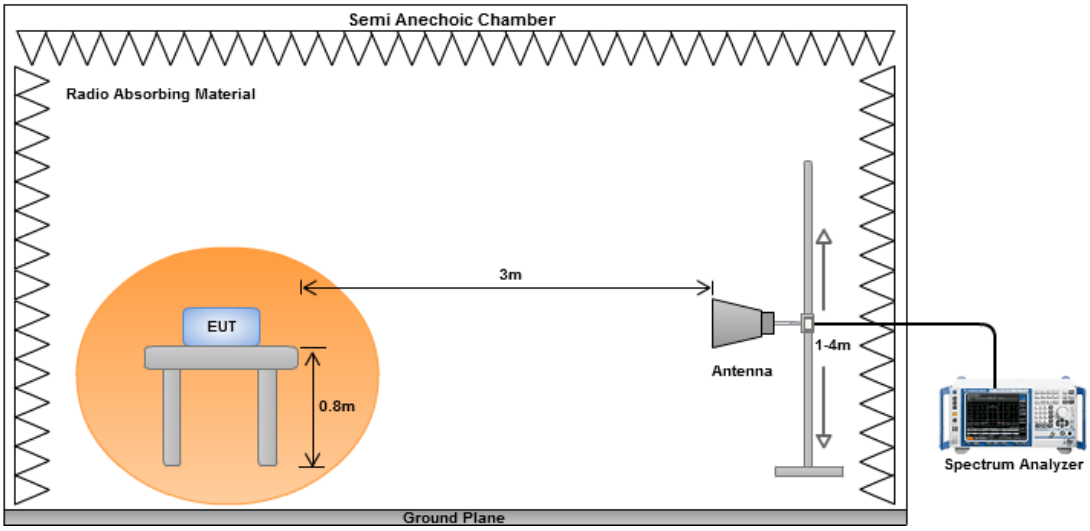
4. Radiated emission above 1GHz / Average value for other emissions
   RBW=1MHz, VBW=1/T and Peak detector

3.2.3 Test Setup

Radiated Emissions below 1 GHz

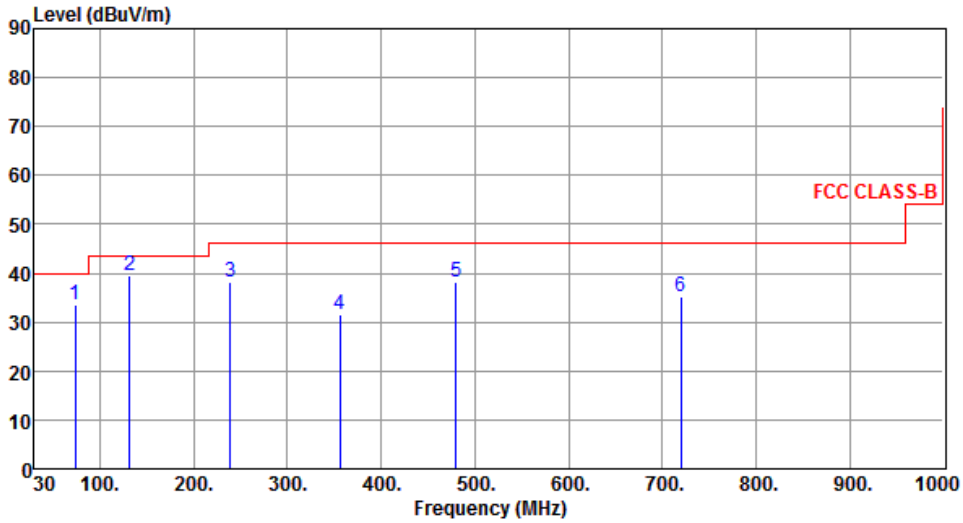


Radiated Emissions above 1 GHz



3.2.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

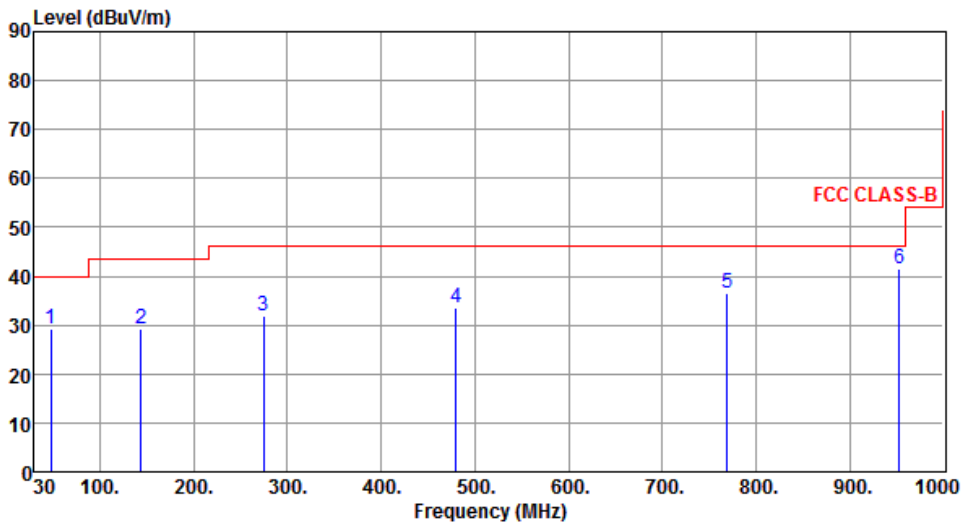
Modulation	GFSK	**Test Freq. (MHz)**	2441
Polarization	Horizontal	**Test Configuration**	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	73.65	33.70	40.00	-6.30	49.91	-16.21	Peak	---	---
2	131.85	39.67	43.50	-3.83	54.10	-14.43	Peak	---	---
3	239.52	38.07	46.00	-7.93	52.80	-14.73	Peak	---	---
4	355.92	31.47	46.00	-14.53	42.68	-11.21	Peak	---	---
5	480.08	38.22	46.00	-7.78	46.46	-8.24	Peak	---	---
6	719.67	35.22	46.00	-10.78	38.96	-3.74	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

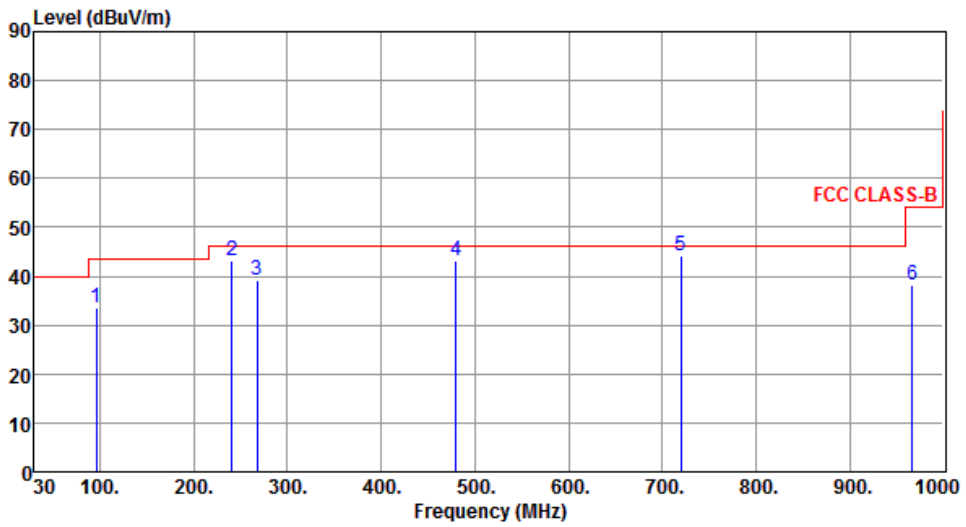
Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	47.46	29.16	40.00	-10.84	42.24	-13.08	Peak	---	---
2	143.49	29.36	43.50	-14.14	42.86	-13.50	Peak	---	---
3	274.44	31.80	46.00	-14.20	45.18	-13.38	Peak	---	---
4	480.08	33.62	46.00	-12.38	41.86	-8.24	Peak	---	---
5	769.14	36.65	46.00	-9.35	39.52	-2.87	Peak	---	---
6	952.47	41.59	46.00	-4.41	41.34	0.25	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

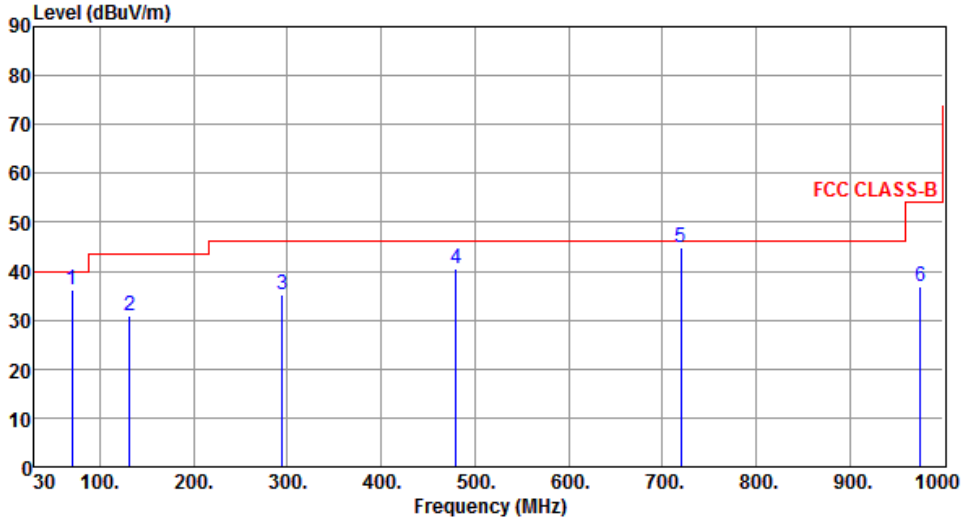
Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Horizontal	Test Configuration	2



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	95.96	33.52	43.50	-9.98	52.07	-18.55	Peak	---	---
2	240.49	43.21	46.00	-2.79	57.90	-14.69	Peak	---	---
3	267.65	39.34	46.00	-6.66	53.05	-13.71	Peak	---	---
4	480.08	43.04	46.00	-2.96	51.28	-8.24	Peak	---	---
5	719.67	44.17	46.00	-1.83	47.91	-3.74	QP	---	---
6	967.02	38.20	54.00	-15.80	37.79	0.41	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical	Test Configuration	2

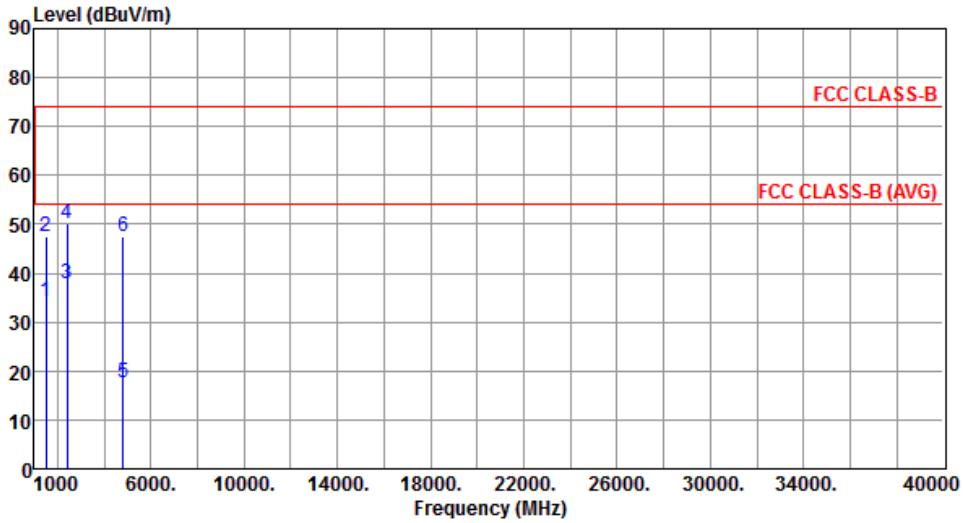


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	69.77	36.21	40.00	-3.79	51.54	-15.33	Peak	---	---
2	131.85	30.91	43.50	-12.59	45.34	-14.43	Peak	---	---
3	294.81	35.14	46.00	-10.86	47.87	-12.73	Peak	---	---
4	480.08	40.60	46.00	-5.40	48.84	-8.24	Peak	---	---
5	719.67	44.74	46.00	-1.26	48.48	-3.74	QP	---	---
6	975.75	37.01	54.00	-16.99	36.51	0.50	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

3.2.5 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

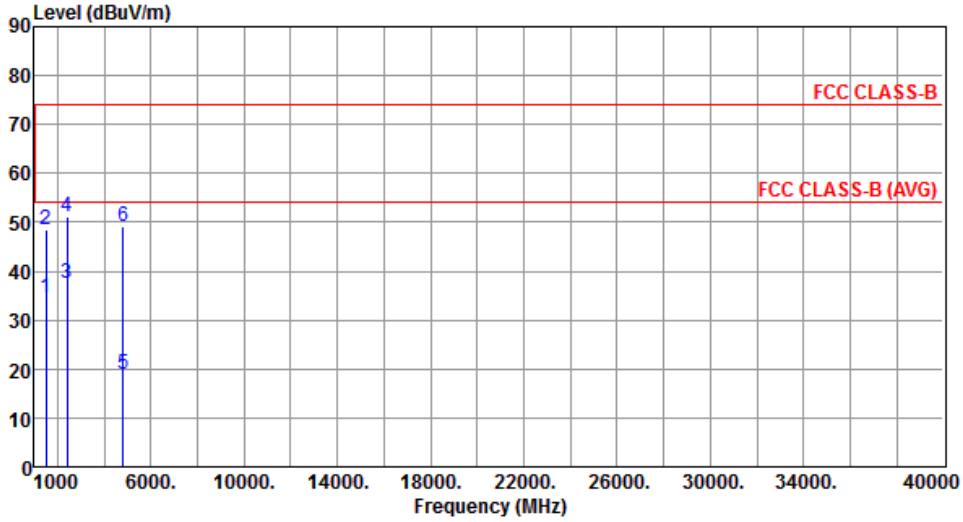
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal	**Test Configuration**	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.35	54.00	-19.65	39.34	-4.99	Average	---	---
2	1500.00	47.44	74.00	-26.56	52.43	-4.99	Peak	---	---
3	2390.00	37.94	54.00	-16.06	39.62	-1.68	Average	---	---
4	2390.00	50.19	74.00	-23.81	51.87	-1.68	Peak	---	---
5	4804.00	17.49	54.00	-36.51	12.15	5.34	Average	---	---
6	4804.00	47.59	74.00	-26.41	42.25	5.34	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

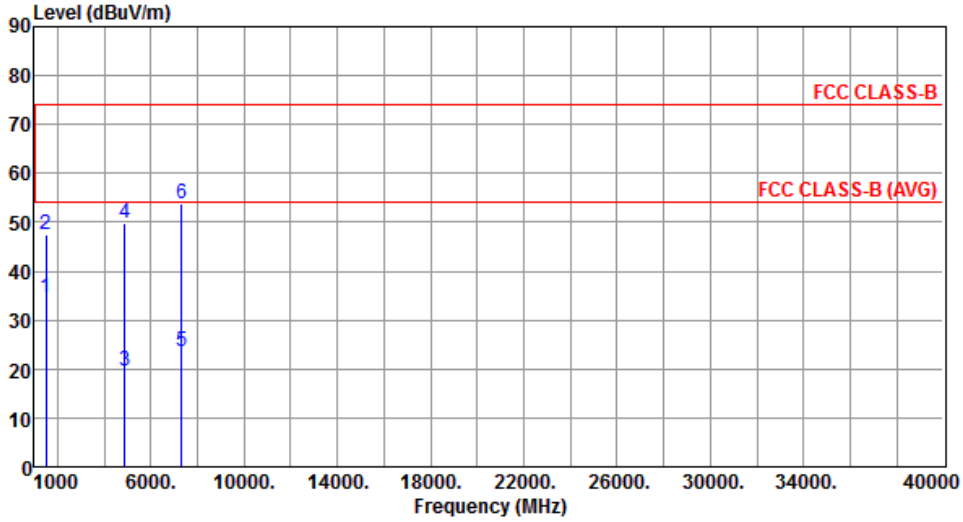
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.44	54.00	-19.56	39.43	-4.99	Average	---	---
2	1500.00	48.35	74.00	-25.65	53.34	-4.99	Peak	---	---
3	2390.00	37.63	54.00	-16.37	39.31	-1.68	Average	---	---
4	2390.00	50.99	74.00	-23.01	52.67	-1.68	Peak	---	---
5	4804.00	19.07	54.00	-34.93	13.73	5.34	Average	---	---
6	4804.00	49.17	74.00	-24.83	43.83	5.34	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

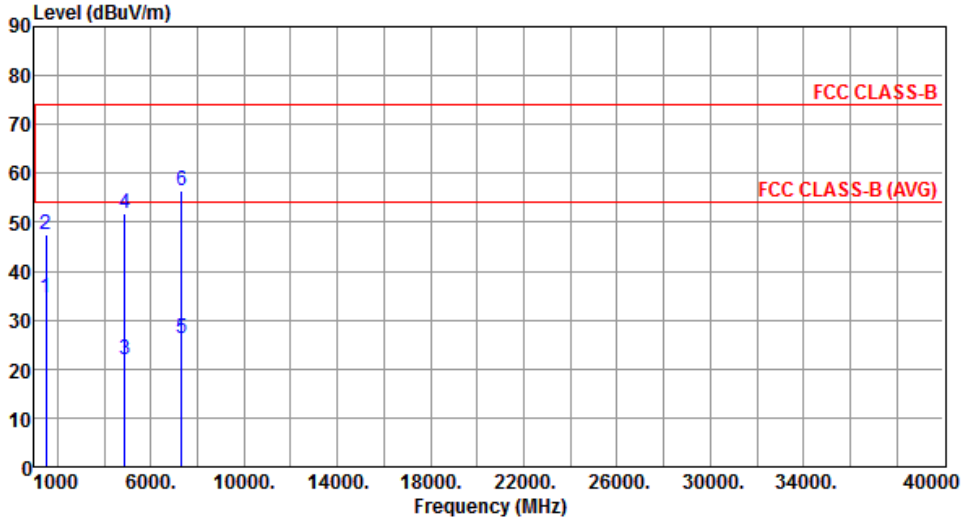
Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Horizontal	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.39	54.00	-19.61	39.38	-4.99	Average	---	---
2	1500.00	47.49	74.00	-26.51	52.48	-4.99	Peak	---	---
3	4882.00	19.70	54.00	-34.30	14.16	5.54	Average	---	---
4	4882.00	49.80	74.00	-24.20	44.26	5.54	Peak	---	---
5	7323.00	23.54	54.00	-30.46	12.25	11.29	Average	---	---
6	7323.00	53.64	74.00	-20.36	42.35	11.29	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

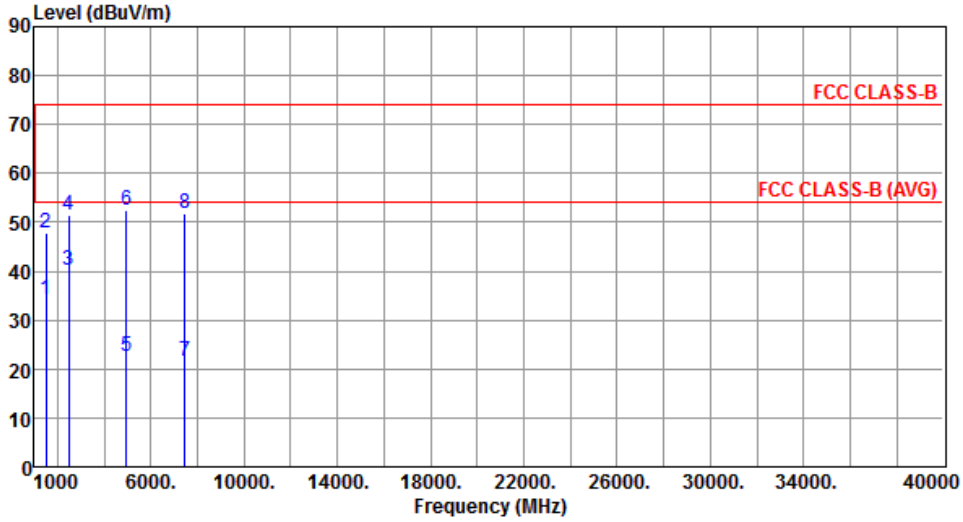
Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.40	54.00	-19.60	39.39	-4.99	Average	---	---
2	1500.00	47.38	74.00	-26.62	52.37	-4.99	Peak	---	---
3	4882.00	21.80	54.00	-32.20	16.26	5.54	Average	---	---
4	4882.00	51.90	74.00	-22.10	46.36	5.54	Peak	---	---
5	7323.00	26.37	54.00	-27.63	15.08	11.29	Average	---	---
6	7323.00	56.47	74.00	-17.53	45.18	11.29	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

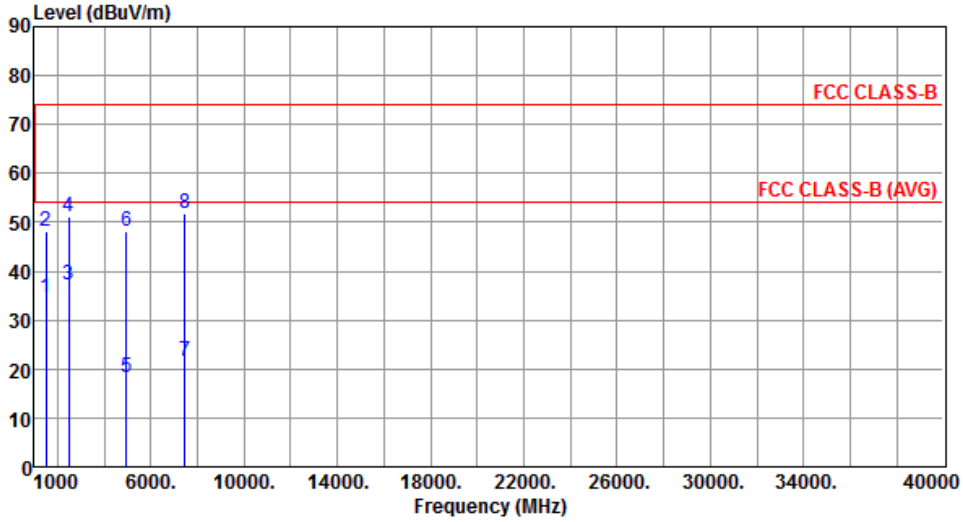
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.33	54.00	-19.67	39.32	-4.99	Average	---	---
2	1500.00	47.72	74.00	-26.28	52.71	-4.99	Peak	---	---
3	2483.50	40.12	54.00	-13.88	41.46	-1.34	Average	---	---
4	2483.50	51.54	74.00	-22.46	52.88	-1.34	Peak	---	---
5	4960.00	22.51	54.00	-31.49	16.77	5.74	Average	---	---
6	4960.00	52.61	74.00	-21.39	46.87	5.74	Peak	---	---
7	7440.00	21.57	54.00	-32.43	10.31	11.26	Average	---	---
8	7440.00	51.67	74.00	-22.33	40.41	11.26	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical	Test Configuration	1

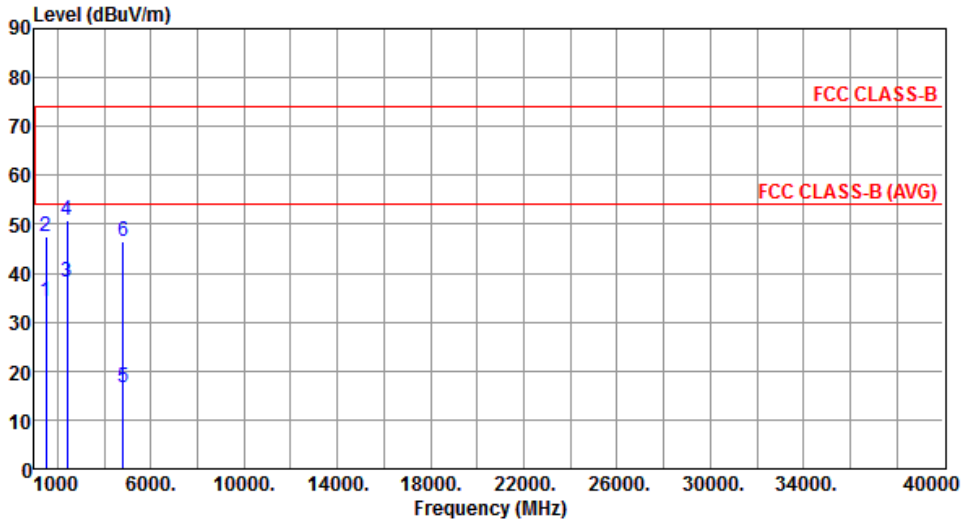


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.62	54.00	-19.38	39.61	-4.99	Average	---	---
2	1500.00	48.26	74.00	-25.74	53.25	-4.99	Peak	---	---
3	2483.50	37.20	54.00	-16.80	38.54	-1.34	Average	---	---
4	2483.50	51.14	74.00	-22.86	52.48	-1.34	Peak	---	---
5	4960.00	18.18	54.00	-35.82	12.44	5.74	Average	---	---
6	4960.00	48.28	74.00	-25.72	42.54	5.74	Peak	---	---
7	7440.00	21.59	54.00	-32.41	10.33	11.26	Average	---	---
8	7440.00	51.69	74.00	-22.31	40.43	11.26	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.2.6 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 8DPSK

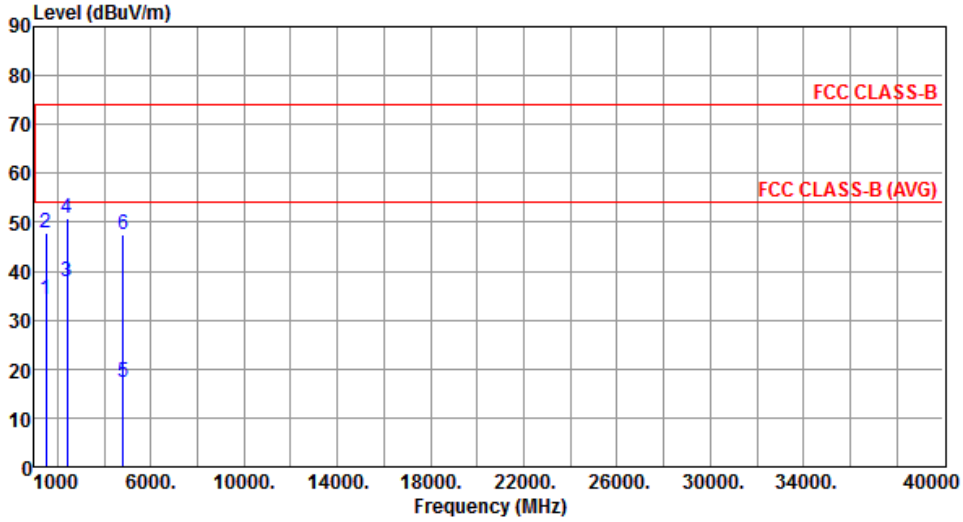
Modulation	8DPSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal	**Test Configuration**	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.28	54.00	-19.72	39.27	-4.99	Average	---	---
2	1500.00	47.62	74.00	-26.38	52.61	-4.99	Peak	---	---
3	2390.00	38.12	54.00	-15.88	39.80	-1.68	Average	---	---
4	2390.00	50.74	74.00	-23.26	52.42	-1.68	Peak	---	---
5	4804.00	16.56	54.00	-37.44	11.22	5.34	Average	---	---
6	4804.00	46.66	74.00	-27.34	41.32	5.34	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

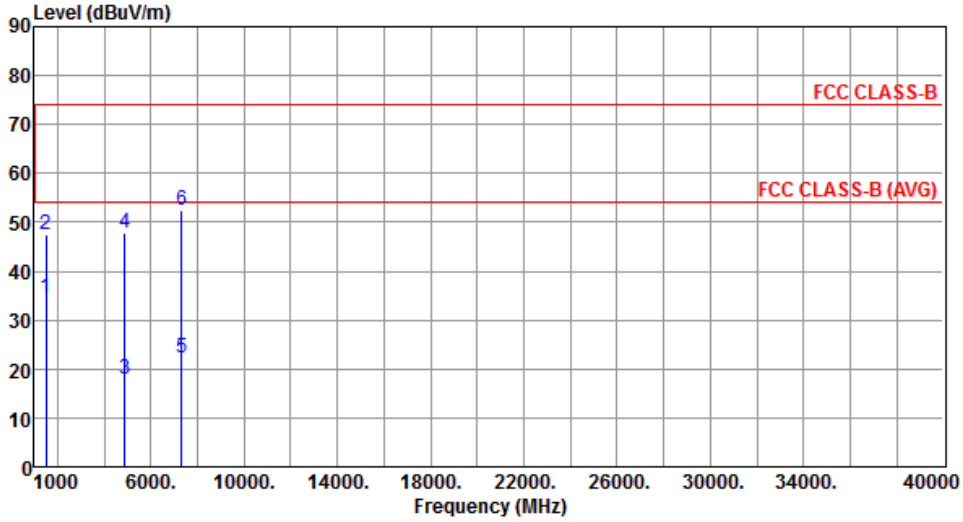
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.33	54.00	-19.67	39.32	-4.99	Average	---	---
2	1500.00	47.80	74.00	-26.20	52.79	-4.99	Peak	---	---
3	2390.00	37.74	54.00	-16.26	39.42	-1.68	Average	---	---
4	2390.00	50.85	74.00	-23.15	52.53	-1.68	Peak	---	---
5	4804.00	17.26	54.00	-36.74	11.92	5.34	Average	---	---
6	4804.00	47.36	74.00	-26.64	42.02	5.34	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

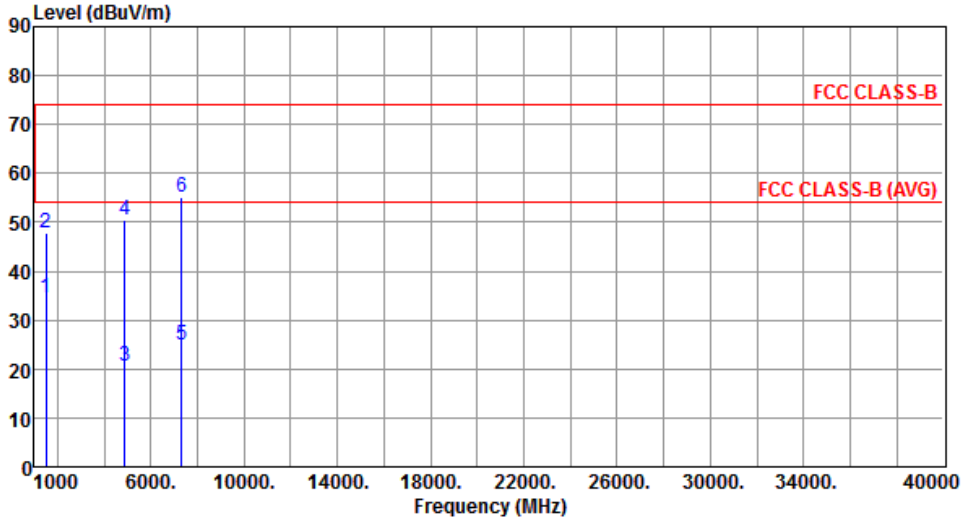
Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Horizontal	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.44	54.00	-19.56	39.43	-4.99	Average	---	---
2	1500.00	47.55	74.00	-26.45	52.54	-4.99	Peak	---	---
3	4882.00	17.87	54.00	-36.13	12.33	5.54	Average	---	---
4	4882.00	47.97	74.00	-26.03	42.43	5.54	Peak	---	---
5	7323.00	22.21	54.00	-31.79	10.92	11.29	Average	---	---
6	7323.00	52.31	74.00	-21.69	41.02	11.29	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

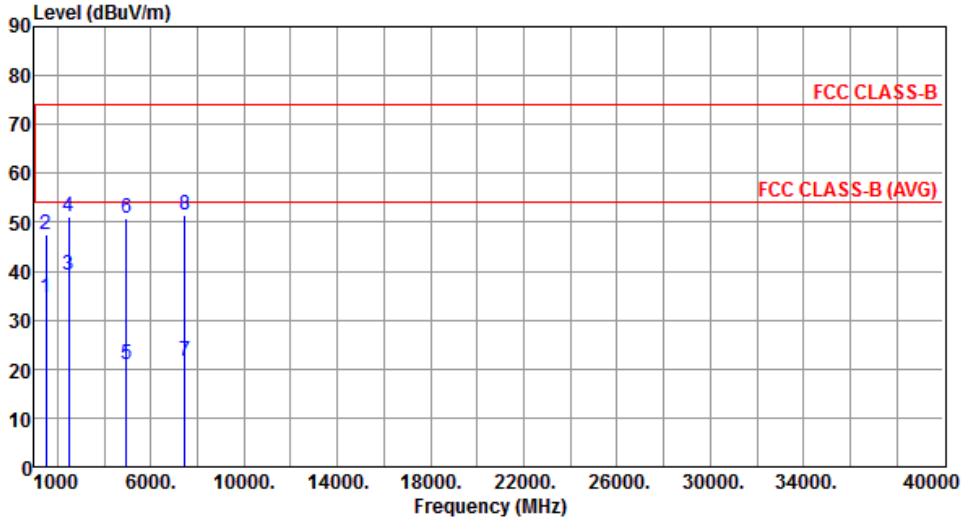
Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Vertical	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.56	54.00	-19.44	39.55	-4.99	Average	---	---
2	1500.00	47.69	74.00	-26.31	52.68	-4.99	Peak	---	---
3	4882.00	20.46	54.00	-33.54	14.92	5.54	Average	---	---
4	4882.00	50.56	74.00	-23.44	45.02	5.54	Peak	---	---
5	7323.00	25.05	54.00	-28.95	13.76	11.29	Average	---	---
6	7323.00	55.15	74.00	-18.85	43.86	11.29	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

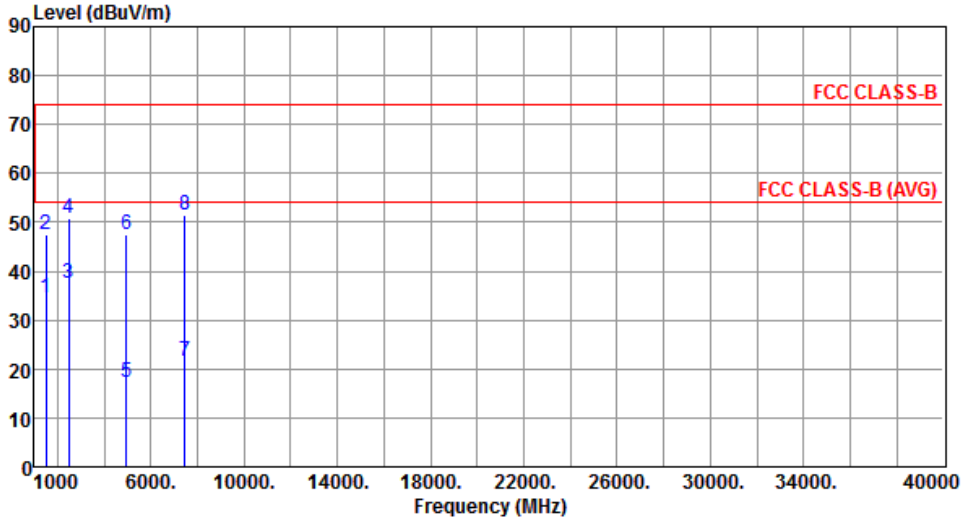
Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.40	54.00	-19.60	39.39	-4.99	Average	---	---
2	1500.00	47.55	74.00	-26.45	52.54	-4.99	Peak	---	---
3	2483.50	39.35	54.00	-14.65	40.69	-1.34	Average	---	---
4	2483.50	51.11	74.00	-22.89	52.45	-1.34	Peak	---	---
5	4960.00	20.78	54.00	-33.22	15.04	5.74	Average	---	---
6	4960.00	50.88	74.00	-23.12	45.14	5.74	Peak	---	---
7	7440.00	21.47	54.00	-32.53	10.21	11.26	Average	---	---
8	7440.00	51.57	74.00	-22.43	40.31	11.26	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical	Test Configuration	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1500.00	34.48	54.00	-19.52	39.47	-4.99	Average	---	---
2	1500.00	47.40	74.00	-26.60	52.39	-4.99	Peak	---	---
3	2483.50	37.53	54.00	-16.47	38.87	-1.34	Average	---	---
4	2483.50	50.90	74.00	-23.10	52.24	-1.34	Peak	---	---
5	4960.00	17.33	54.00	-36.67	11.59	5.74	Average	---	---
6	4960.00	47.43	74.00	-26.57	41.69	5.74	Peak	---	---
7	7440.00	21.53	54.00	-32.47	10.27	11.26	Average	---	---
8	7440.00	51.63	74.00	-22.37	40.37	11.26	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.3 Unwanted Emissions into Non-Restricted Frequency Bands

3.3.1 Limit of Unwanted Emissions into Non-Restricted Frequency Bands

The peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.3.2 Test Procedures

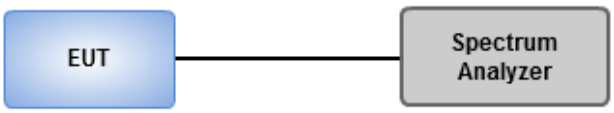
Reference Level Measurement

1. Set the RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Set Sweep time = auto couple, Trace mode = max hold.
3. Allow trace to fully stabilize.
4. Use the peak marker function to determine the maximum amplitude level.

Unwanted Emissions Level Measurement

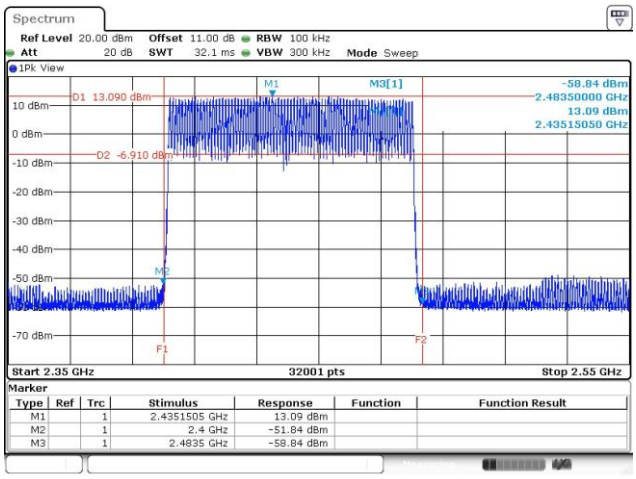
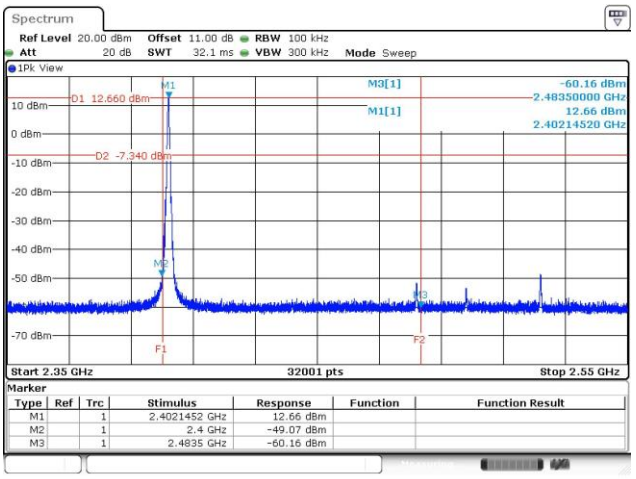
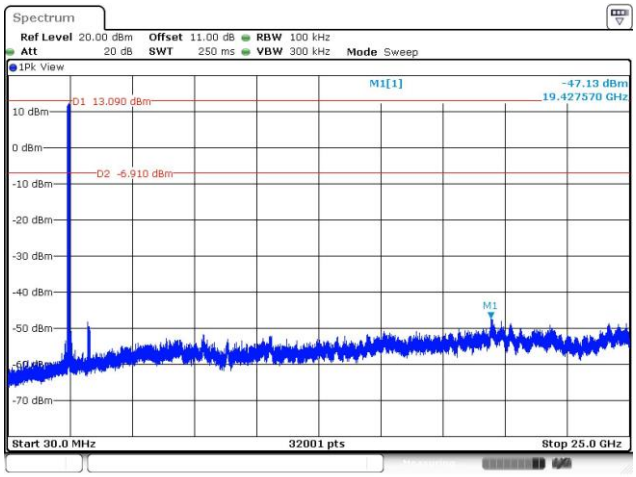
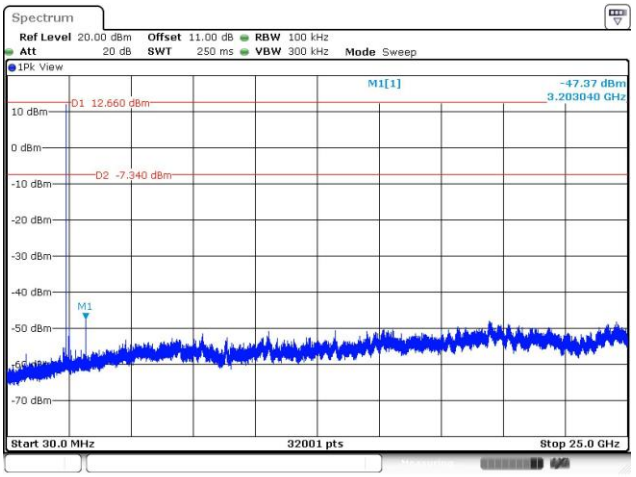
1. Set RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Trace Mode = max hold, Sweep = auto couple.
3. Allow the trace to stabilize.
4. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

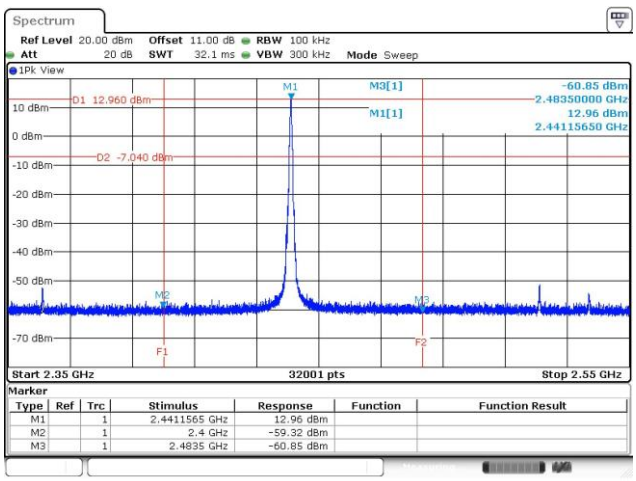
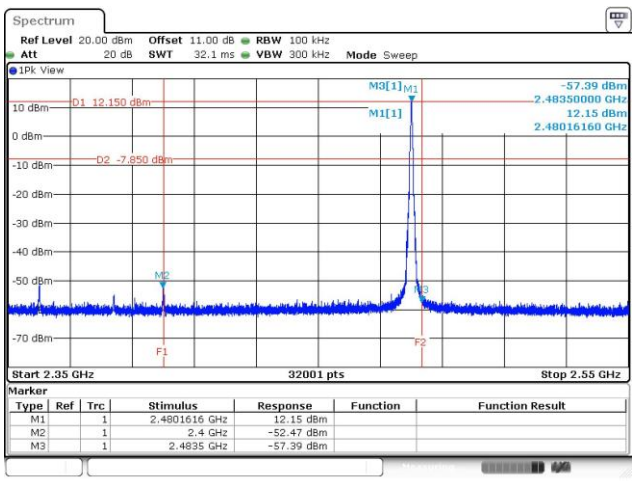
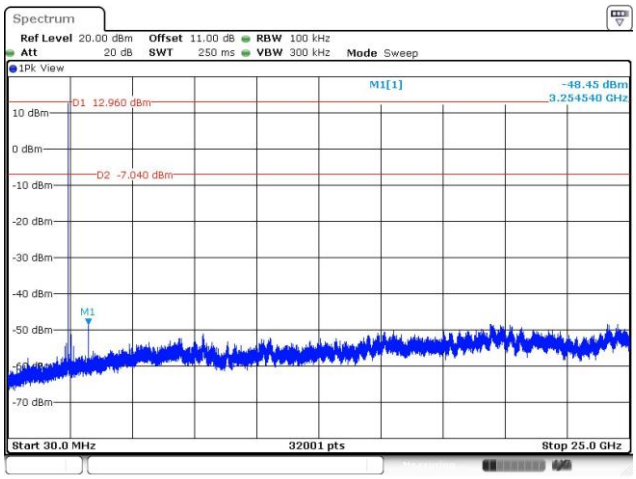
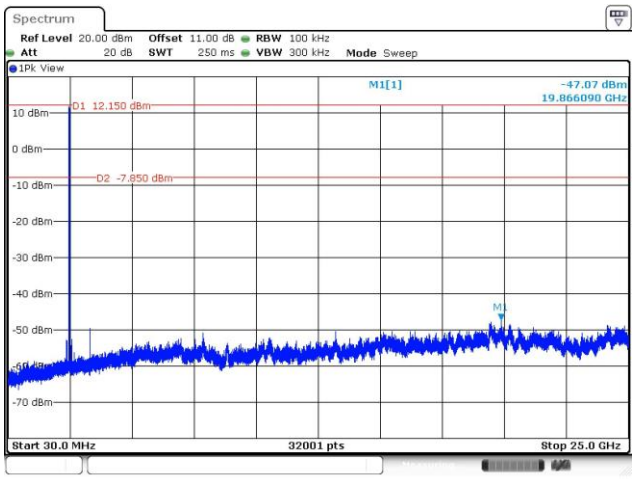
3.3.3 Test Setup



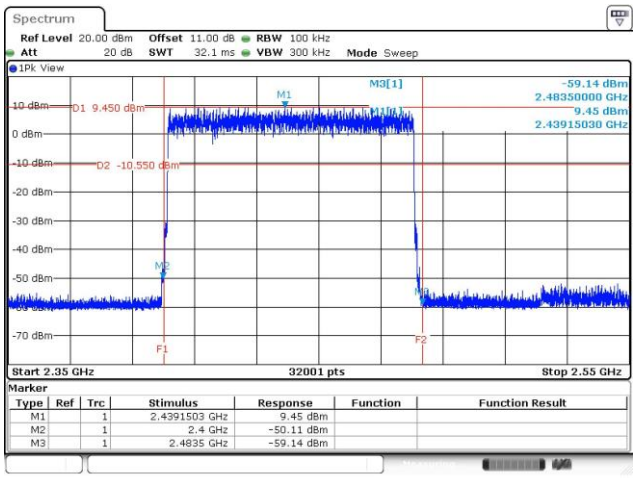
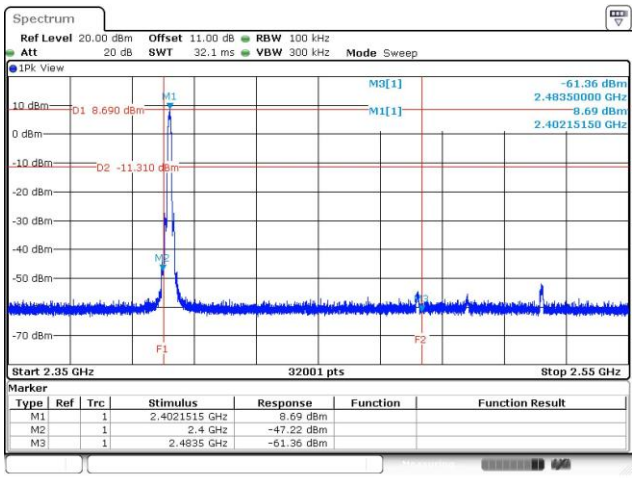
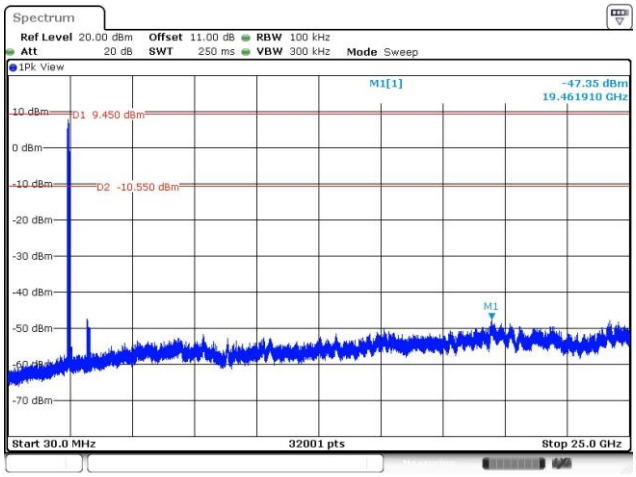
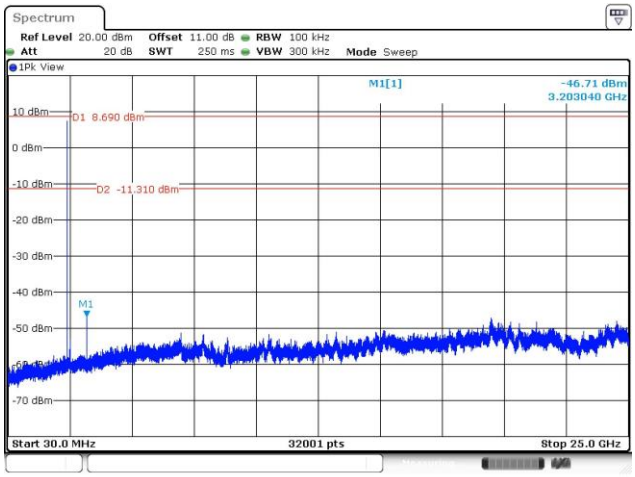
3.3.4 Unwanted Emissions into Non-Restricted Frequency Bands

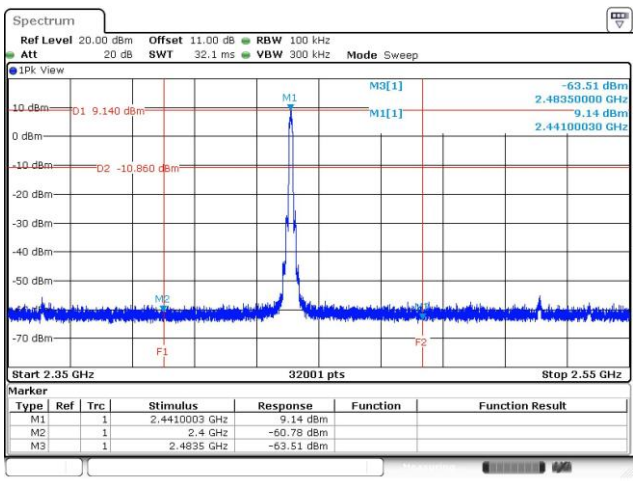
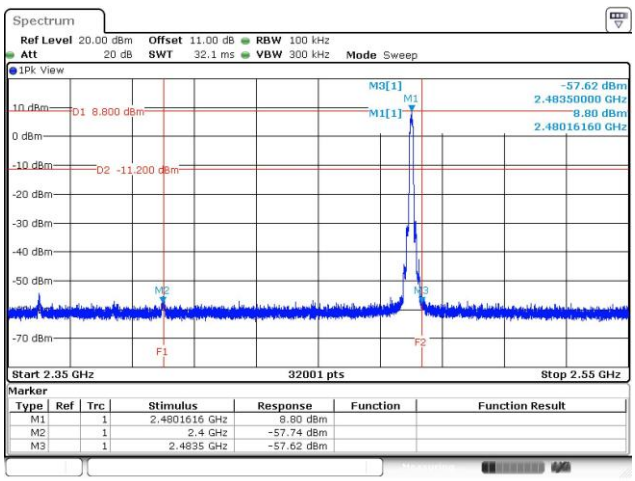
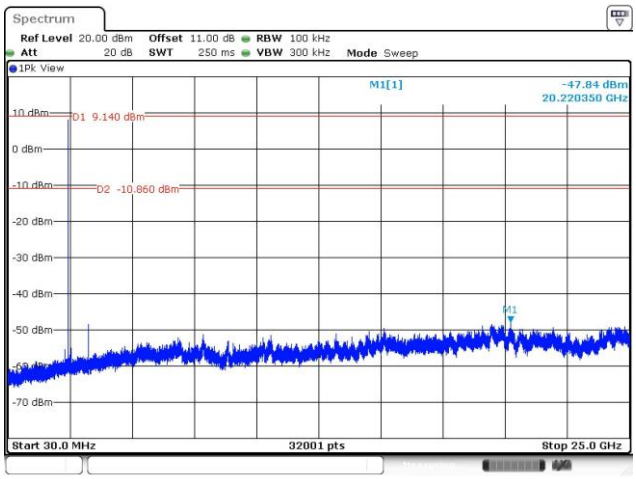
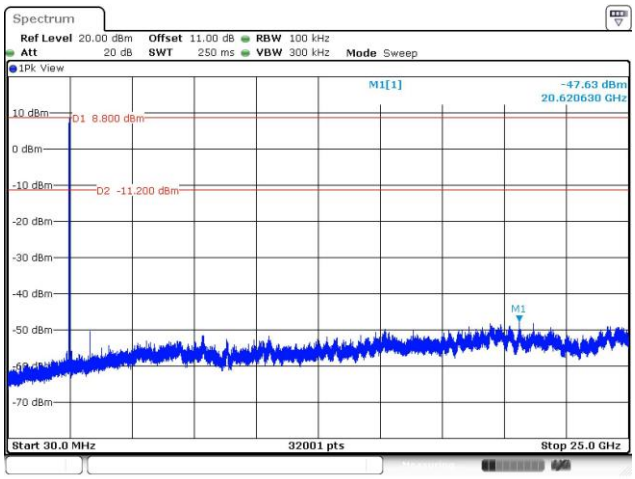
GFSK

Hopping on	Hopping off
30MHz~25GHz (down 20dBc)	**TX Freq 2402MHz / 30MHz~25GHz (down 20dBc)**
	
	

Hopping off	Hopping off
TX Freq 2441MHz / 30MHz~25GHz (down 20dBc)	**TX Freq 2480MHz / 30MHz~25GHz (down 20dBc)**
	
	

8DPSK

Hopping on	Hopping off
30MHz~25GHz (down 20dBc)	**TX Freq 2402MHz / 30MHz~25GHz (down 20dBc)**
	
	

Hopping off	Hopping off
TX Freq 2441MHz / 30MHz~25GHz (down 20dBc)	**TX Freq 2480MHz / 30MHz~25GHz (down 20dBc)**
	
	

3.4 Conducted Output Power

3.4.1 Limit of Unwanted Emissions into Non-Restricted Frequency Bands

☐ 1 Watt
For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band.

☒ 0.125 Watt
For all other frequency hopping systems in the 2400–2483.5 MHz band.

☐ 0.125 Watt
For Frequency hopping systems operating in the 2400–2483.5 MHz band have hopping channel carrier frequencies that are separated by two-thirds of the 20 dB bandwidth of the hopping channel.

3.4.2 Test Procedures

1. A wideband power meter is used for power measurement. Bandwidth of power senor and meter is 50MHz
2 If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power

3.4.3 Test Setup

3.4.4 Test Result of Conducted Output Power

Modulation Mode	Freq. (MHz)	Output Power (mW)	Output Power (dBm)	Limit (mW)
GFSK	2402	13.68	11.36	125
GFSK	2441	15.31	**11.85**	125
GFSK	2480	12.74	11.05	125
π/4 DQPSK	2402	10.69	10.29	125
π/4 DQPSK	2441	12.05	10.81	125
π/4 DQPSK	2480	10.67	10.28	125
8DPSK	2402	11.09	10.45	125
8DPSK	2441	12.53	10.98	125
8DPSK	2480	11.22	10.50	125

Modulation Mode	Freq. (MHz)	AV Output Power (mW)	AV Output Power (dBm)
GFSK	2402	13.12	11.18
GFSK	2441	14.76	**11.69**
GFSK	2480	12.19	10.86
π/4 DQPSK	2402	6.00	7.78
π/4 DQPSK	2441	6.92	8.40
π/4 DQPSK	2480	6.04	7.81
8DPSK	2402	6.04	7.81
8DPSK	2441	6.93	8.41
8DPSK	2480	5.97	7.76

Note: Average power is for reference only.

3.5 Number of Hopping Frequency

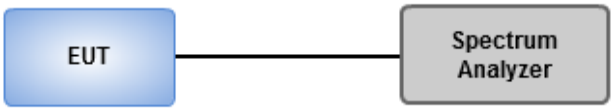
3.5.1 Limit of Number of Hopping Frequency

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

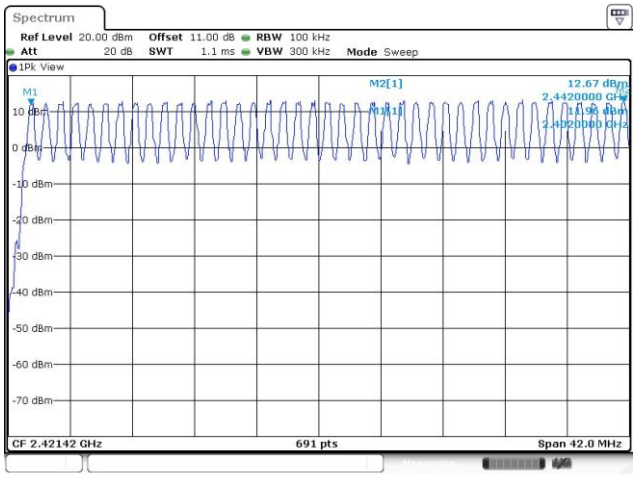
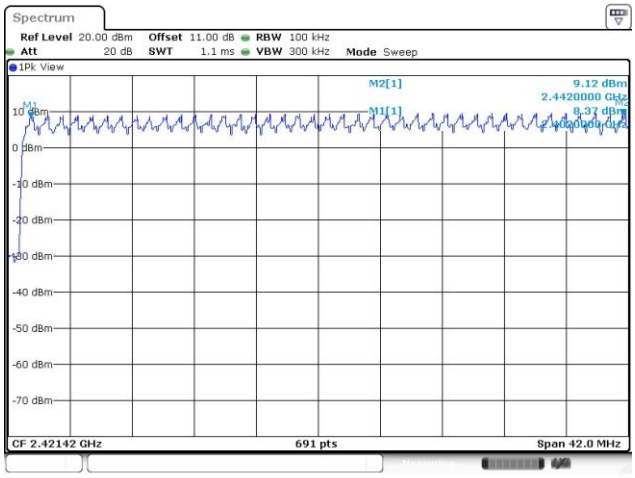
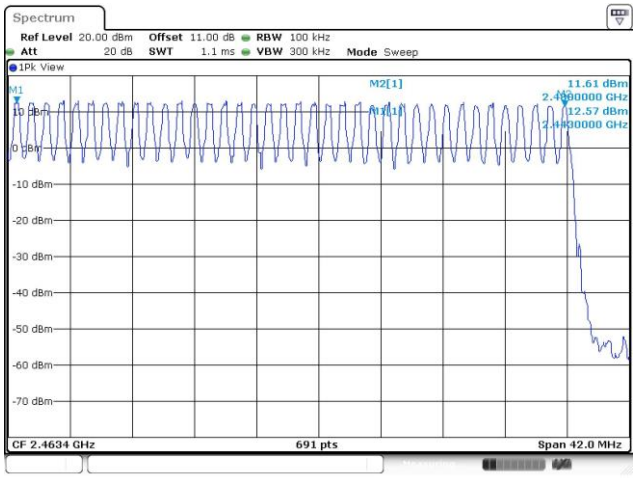
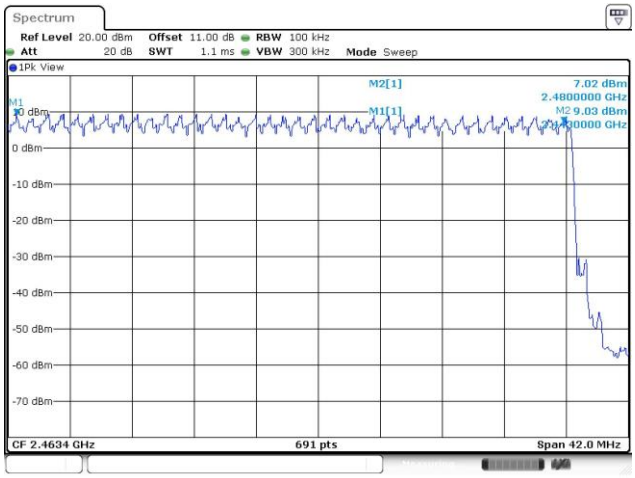
3.5.2 Test Procedures

1. Set RBW = 100kHz, VBW = 300kHz, Sweep time = Auto, Detector = Peak Trace max hold.
2 Allow trace to stabilize.

3.5.3 Test Setup



3.5.4 Test Result of Number of Hopping Frequency

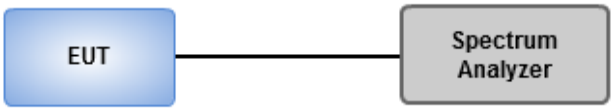
GFSK	8DPSK
	
	

3.6 20dB and Occupied Bandwidth

3.6.1 Test Procedures

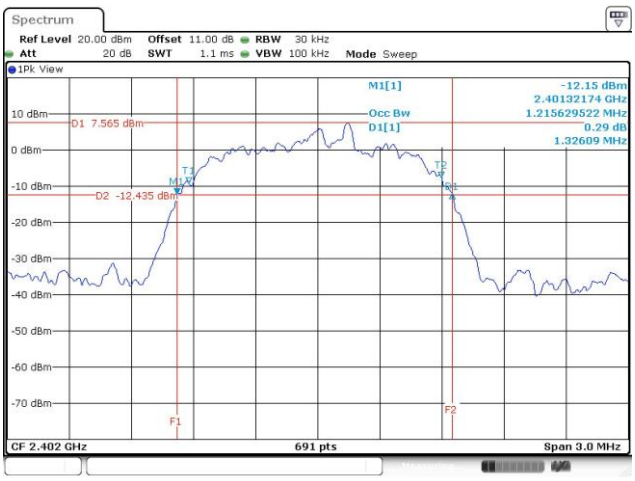
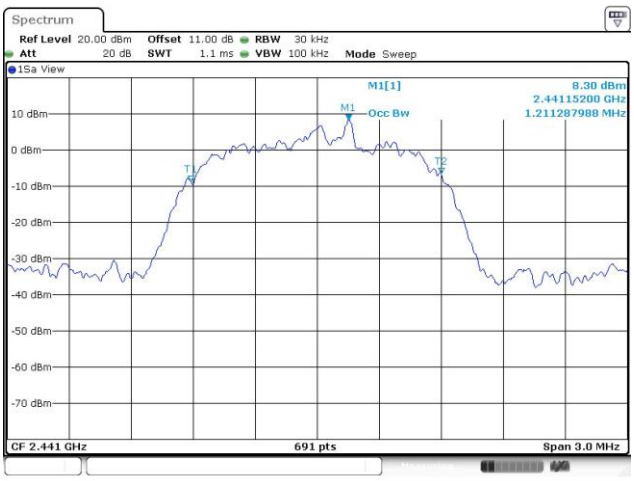
1. Set RBW=30kHz, VBW=100kHz,Sweep time = Auto, Detector=Peak Trace max hold
2 Allow trace to stabilize
3 Use N dB function of spectrum analyzer to measuring 20 dB bandwidth
4. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth

3.6.2 Test Setup



3.6.3 Test result of 20dB and Occupied Bandwidth

Modulation Mode	Freq. (MHz)	20dB Bandwidth (MHz)	Occupied Bandwidth (MHz)
GFSK	2402	0.952	0.907
GFSK	2441	0.952	0.907
GFSK	2480	0.948	0.903
8DPSK	2402	**1.326**	1.211
8DPSK	2441	1.326	**1.211**
8DPSK	2480	1.326	1.211

Worst Plots of 20dB Bandwidth	Worst Plots of Occupied Bandwidth
	

3.7 Channel Separation

3.7.1 Limit of Channel Separation

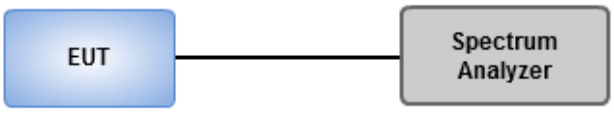
☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

3.7.2 Test Procedures

1. Set RBW=100kHz, VBW=300kHz,Sweep time = Auto, Detector=Peak Trace max hold
2 Allow trace to stabilize
3 Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The EUT shall show compliance with the appropriate regulatory limit

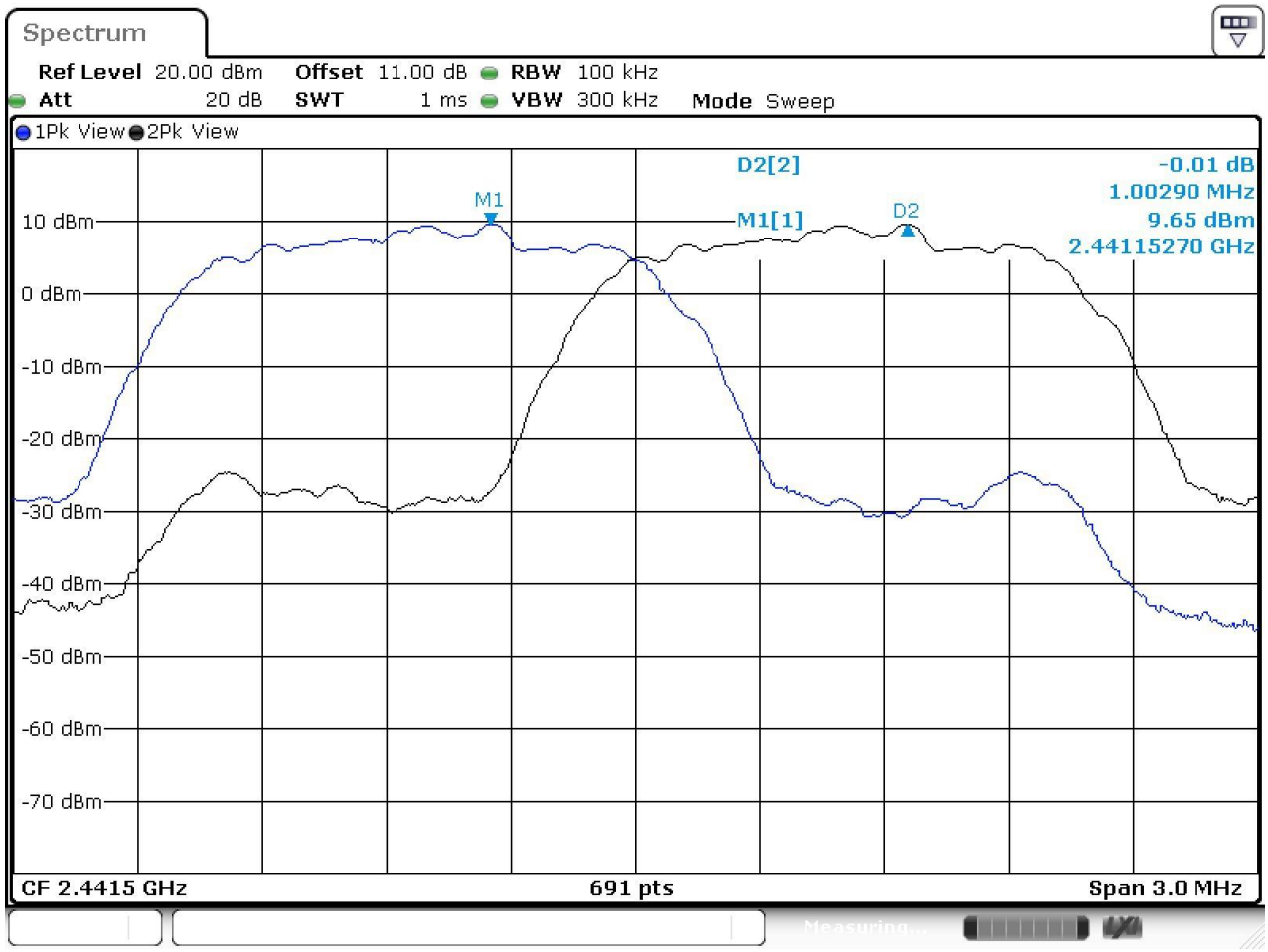
3.7.3 Test Setup



3.7.4 Test result of Channel Separation

Modulation Mode	Freq. (MHz)	Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)
GFSK	2402	**1.003**	0.952	0.635
GFSK	2441	1.003	0.952	0.635
GFSK	2480	1.003	0.948	0.632
8DPSK	2402	1.003	1.326	0.884
8DPSK	2441	1.003	1.326	0.884
8DPSK	2480	1.003	1.326	0.884

Worst Plots



3.8 Number of Dwell Time

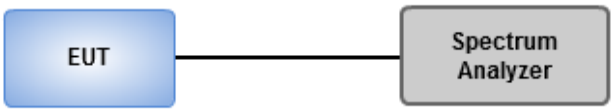
3.8.1 Limit of Dwell time

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.

3.8.2 Test Procedures

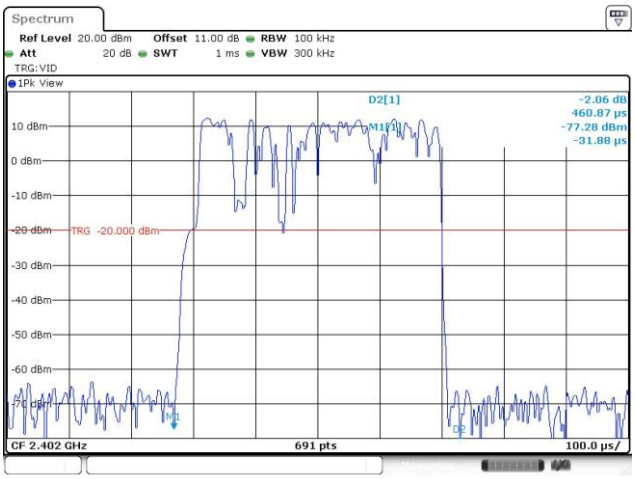
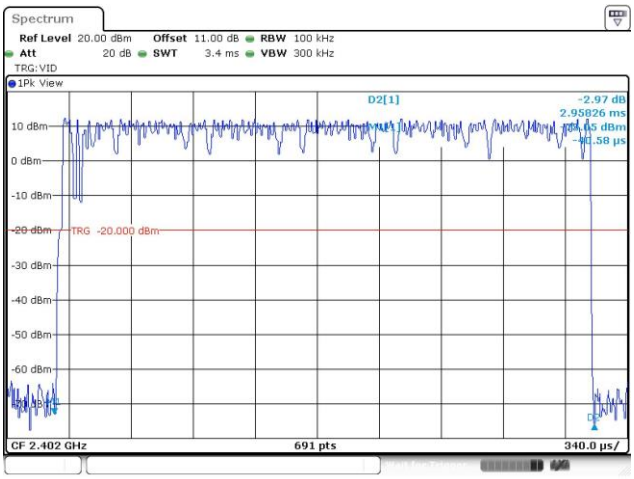
1. Set RBW=100kHz,VBW=300kHz,Sweep time = 500us(DH1),2ms(DH3),4ms(DH5), Detector=Peak, Span=0Hz,Trace max hold
2 Enable gating and trigger function of spectrum analyzer to measure burst on time.
3. The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 1/1600 seconds, or 0.625ms. DH1 Packet permit maximum 1600 / 79 /2 = 10.12 hops per second in each channel (1 time slot TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times 10.12 x 31.6 = 320 within 31.6 seconds.
4. The DH3 packet can cover up to 3 time slots. A maximum length packet has duration of 3 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 3/1600 seconds, or 1.875ms. DH3 Packet permit maximum 1600 / 79 / 4 = 5.06 hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times 5.06 x 31.6 = 160 within 31.6 seconds.
5 The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and maximum duty cycle. A maximum length packet has duration of 5 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 5/1600 seconds, or 3.125ms. DH5 Packet permit maximum 1600/ 79 / 6 = 3.37 hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times 3.37 x 31.6 = 106.6 within 31.6 seconds

3.8.3 Test Setup



3.8.4 Test Result of Dwell Time

Modulation Mode	Freq. (MHz)	Length of Transmission Time (msec)	Number of Transmission in a 31.6 (79 Hopping*0.4)	Result (s)	Limit (s)
GFSK-DH1	2402	0.46087	320	0.147	0.4
GFSK-DH3	2402	1.70464	160	0.273	0.4
GFSK-DH5	2402	2.95826	106.6	0.315	0.4
8DPSK-DH1	2402	0.46522	320	0.149	0.4
8DPSK-DH3	2402	1.70232	160	0.272	0.4
8DPSK-DH5	2402	3.00812	106.6	0.321	0.4

GFSK	
DH1	**DH5**
	
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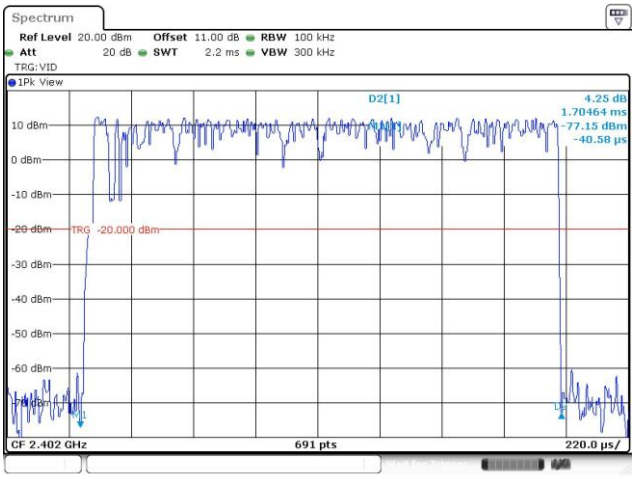
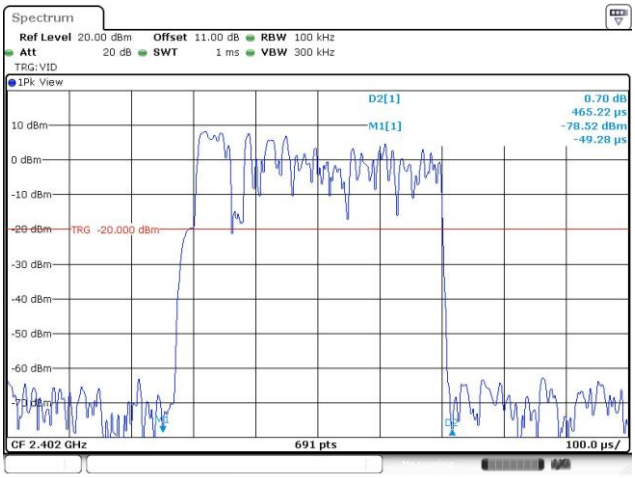
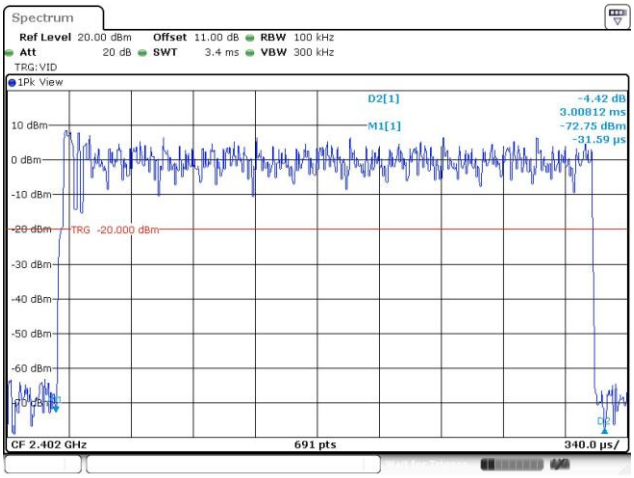
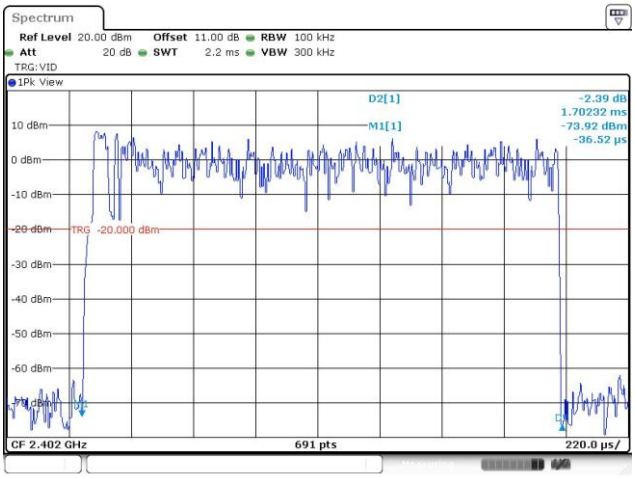
	--

8DPSK	
3DH1	**3DH5**
	
3DH3	**--**
	--

4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp, it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan Hsiang. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan Hsiang, Tao Yuan Hsien 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan Hsiang, Tao Yuan Hsien 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

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