FCC Test Report

FCC ID	:	**IPH-03408**
Equipment	:	**Marine Stereo**
Model No.	:	**MS-RA770**
Brand Name	:	**FUSION**
Applicant	:	**Garmin International, Inc.**
Address	:	**1200 E. 151st Street Olathe, KS 66062 United States**
Standard	:	**47 CFR FCC Part 15.247**
Received Date	:	**Nov. 30, 2017**
Tested Date	:	**Dec. 11 ~ Dec. 28, 2017**

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.

Reviewed by: **Approved by:**

Along Chen / Assistant Manager **Gary Chang / Manager**

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
FR7N3001AD	Rev. 01	Initial issue	Mar. 27, 2018
FR7N3001AD	Rev. 02	Modify typo of test mode (Page11)	Apr. 10, 2018

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	Note[1]	N/A
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 33.88MHz 38.88 (Margin -1.12dB) - QP	Pass
15.247(d)	Band Edge	Meet the requirement of limit	Pass
15.247(b)(1)	Conducted Output Power	Power [dBm]: 10.89	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	2402-2480	0-78 [79]	1 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	2 Mbps
2400-2483.5	EDR	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	5.13	N/A	---

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	12Vdc

1.1.4 Accessories

N/A

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 EUT mode and Duty Cycle

EUT mode	BT Test, CBT

1.1.7 Power Setting

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

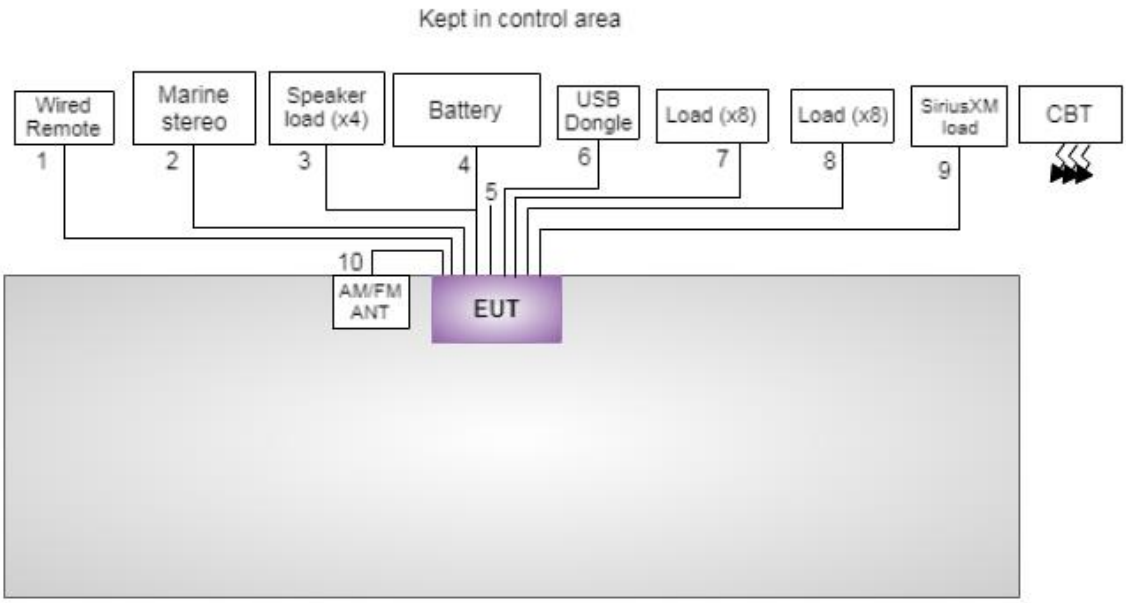
1.2 Local Support Equipment List

Support Equipment List						
No.	**Equipment**	**Brand**	**Model**	**S/N**	**FCC ID**	**Signal cable / Length (m)**
1	Battery	YUASA	36B20R(S)	---	---	Power cable, 5m non-shielded.
2	SiriusXM	---	---	---	---	SiriusXM cable, 1.2m shielded.
3	Load (x16)	---	---	---	---	Audio cable, 1.8m(x8) shielded. Audio cable, 1.8m(x8) shielded.
4	USB Dongle	Strontium	Pollex 4 G	---	---	USB cable, 2m shielded.
5	AM/FM ANT	---	---	---	---	AM/FM Ant., 4.2m shielded.
6	Speaker load (x4)	---	---	---	---	Speaker cable (8pin), 5m(x4) non-shielded.
7	Wired Remote	Fusion	MS-NRX300	---	---	NRX remote cable, 7.5m shielded.
8	Marine stereo	FUSION	MS-RA770	---	---	RJ45 cable, 10m shielded.

Note: No. 2 ~ No. 8 were supplied by applicant.

1.3 Test Setup Chart

Test Setup Diagram



1. NRX remote cable, 7.5m shielded.
2. RJ45 cable, 10m shielded.
3. Speaker cable (8pin), 5m(x4) non-shielded with load.
4. Power cable, 5m non-shielded.
5. SPDIF optical cable, 1m non-shielded.
6. USB cable, 2m shielded.
7. Audio cable, 1.8m(x8) shielded with load.
8. Audio cable, 1.8m(x8) shielded with load.
9. SiriusXM cable, 1.2m shielded with load.
10. AM/FM Ant., 4.2m shielded.

1.4 The Equipment List

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Dec. 11, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101499	Dec. 16, 2016	Dec. 15, 2017
Receiver	R&S	ESR3	101658	Nov. 20, 2017	Nov. 19, 2018
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 25, 2017	Jul. 24, 2018
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 21, 2016	Dec. 20, 2017
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 23, 2017	Nov. 22, 2018
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2017	Nov. 12, 2018
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 07, 2017	Dec. 06, 2018
Preamplifier	EMC	EMC02325	980225	Jul. 28, 2017	Jul. 27, 2018
Preamplifier	Agilent	83017A	MY39501308	Oct. 06, 2017	Oct. 05, 2018
Preamplifier	EMC	EMC184045B	980192	Aug. 22, 2017	Aug. 21, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Dec. 07, 2017	Dec. 06, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 07, 2017	Dec. 06, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 07, 2017	Dec. 06, 2018
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	16052	Dec. 07, 2017	Dec. 06, 2018
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 07, 2017	Dec. 06, 2018
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 07, 2017	Dec. 06, 2018
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Bluetooth Tester	ROHDE&SCHWARZ	CBT	100959	Sep. 28, 2017	Sep. 27, 2018
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Dec. 28, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101063	Mar. 15, 2017	Mar. 14, 2018
Power Meter	Anritsu	ML2495A	1241002	Oct. 16, 2017	Oct. 15, 2018
Power Sensor	Anritsu	MA2411B	1207366	Oct. 16, 2017	Oct. 15, 2018
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 26, 2017	Oct. 25, 2018
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Bluetooth Tester	ROHDE&SCHWARZ	CBT	100959	Sep. 28, 2017	Sep. 27, 2018
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
ANSI C63.10-2013

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
Power density	±0.463 dB
Conducted emission	±2.670 dB
Radiated emission ≤ 1GHz	±3.66 dB
Radiated emission > 1GHz	±5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
Radiated Emissions	03CH01-WS	23°C / 64%	Roger Lu Akun Chung
RF Conducted	TH01-WS	20°C / 63%	Brad Wu

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- IC site registration No.: 10807A-1

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate (Mbps)	Test Configuration
Radiated Emissions ≤ 1GHz	GFSK	2480	1Mbps	---
Radiated Emissions > 1GHz	GFSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480	1Mbps 3Mbps	---
Conducted Output Power	GFSK Л/4 DQPSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480 2402, 2441, 2480	1Mbps 2Mbps 3Mbps	---
Number of Hopping Channels	GFSK 8DPSK	2402~2480 2402~2480	1Mbps 3Mbps	---
Hopping Channel Separation 20dB and Occupied bandwidth	GFSK 8DPSK	2402, 2441, 2480 2402, 2441, 2480	1Mbps 3Mbps	---
Dwell Time	GFSK 8DPSK	2441 2441	1Mbps 3Mbps	---

3 Transmitter Test Results

3.1 Unwanted Emissions into Restricted Frequency Bands

3.1.1 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.

3.1.2 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 test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
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:

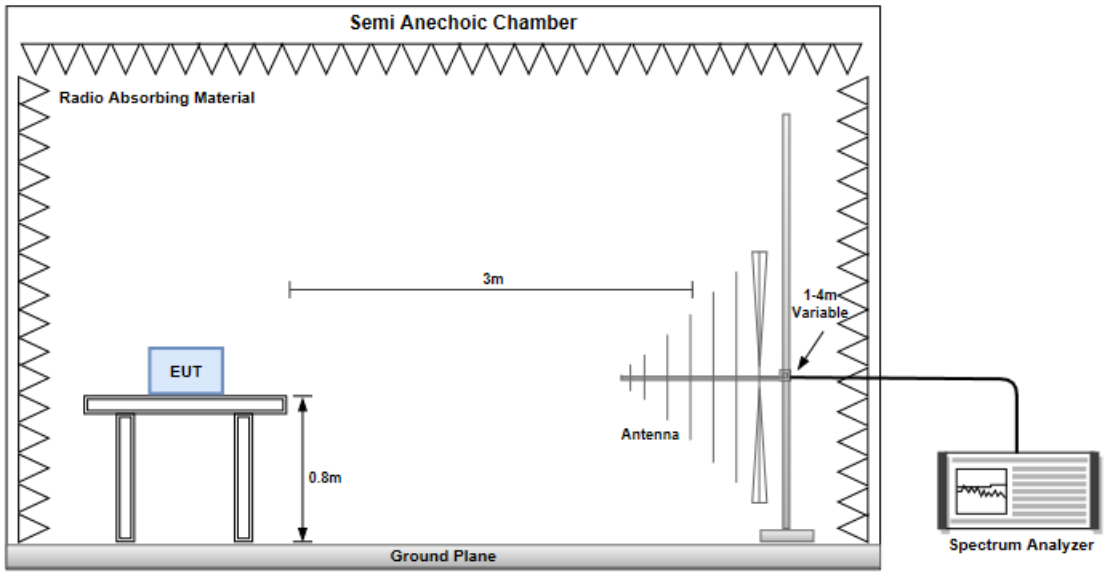
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. Radiated emission above 1GHz / Peak value
   RBW=1MHz, VBW=3MHz and Peak detector
3. Radiated emission above 1GHz / Average value for harmonics
   The average value is: Average = Peak value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

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

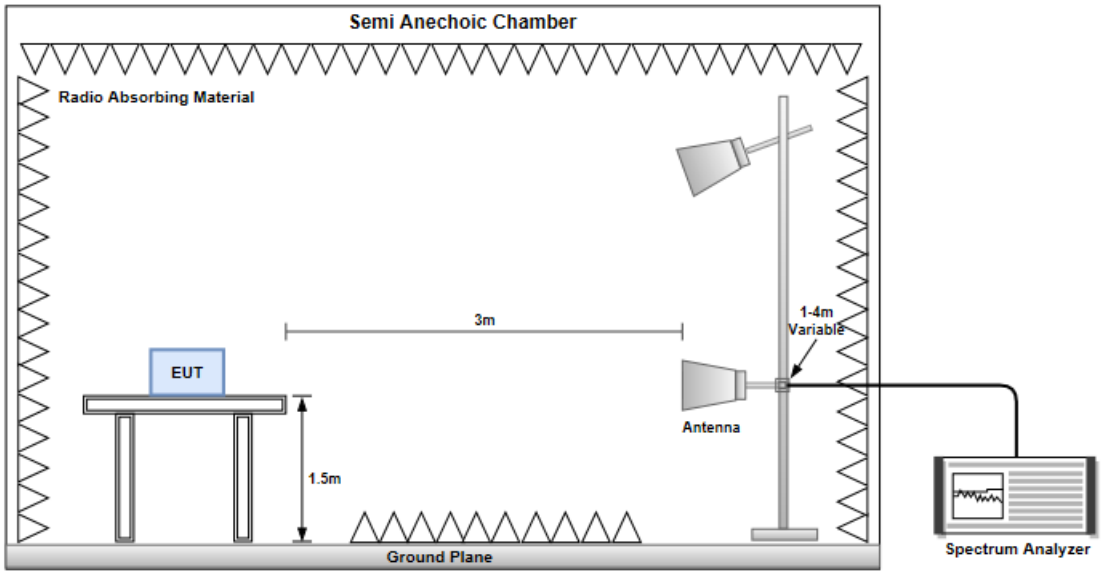
4. Radiated emission above 1GHz / Average value for other emissions
   RBW=1MHz, VBW=1/T and Peak detector

3.1.3 Test Setup

Radiated Emissions below 1 GHz

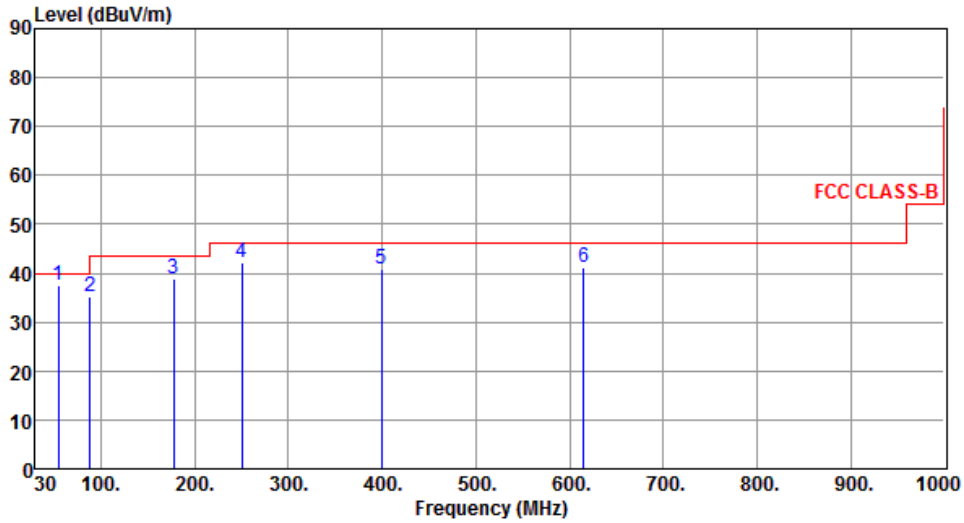


Radiated Emissions above 1 GHz



3.1.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

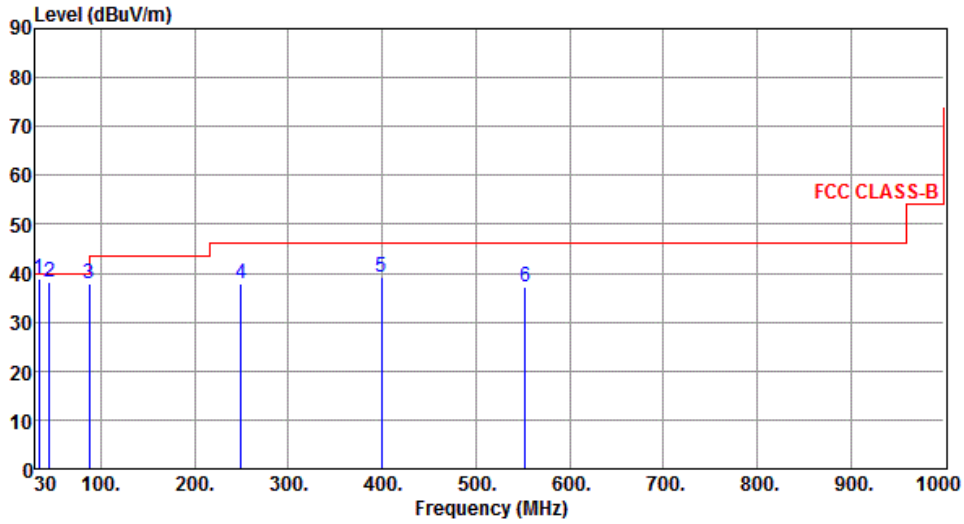
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	54.39	37.67	40.00	-2.33	45.68	-8.01	Peak	---	---
2	88.51	35.16	43.50	-8.34	49.41	-14.25	QP	178	100
3	177.38	38.70	43.50	-4.80	48.13	-9.43	Peak	---	---
4	250.27	42.01	46.00	-3.99	51.34	-9.33	QP	100	243
5	399.42	40.89	46.00	-5.11	45.85	-4.96	Peak	---	---
6	614.87	41.15	46.00	-4.85	41.66	-0.51	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)**	2480
Polarization	Vertical		

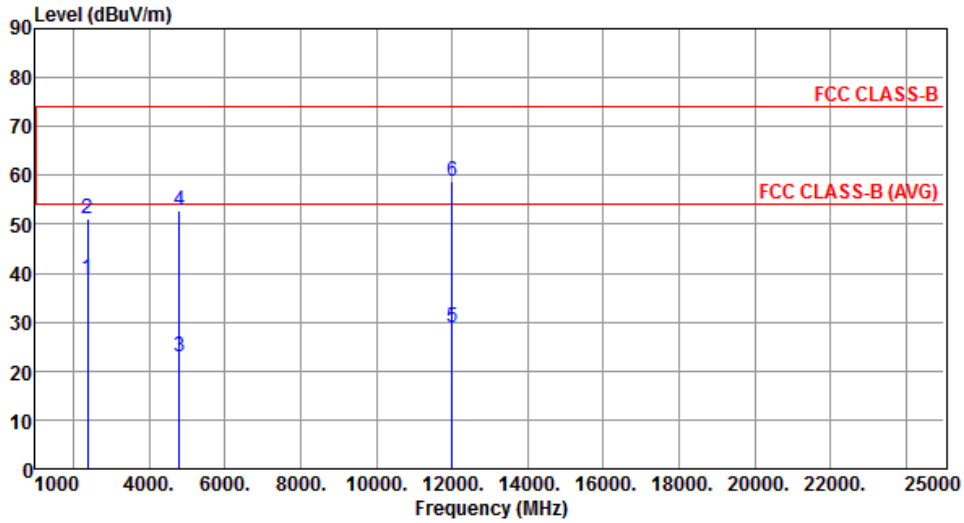


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	33.88	38.88	40.00	-1.12	47.40	-8.52	QP	100	209
2	44.77	38.17	40.00	-1.83	45.95	-7.78	QP	100	274
3	87.34	37.79	40.00	-2.21	51.84	-14.05	Peak	---	---
4	249.31	37.87	46.00	-8.13	47.22	-9.35	Peak	---	---
5	399.58	39.27	46.00	-6.73	44.22	-4.95	Peak	---	---
6	552.68	37.27	46.00	-8.73	38.94	-1.67	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.

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

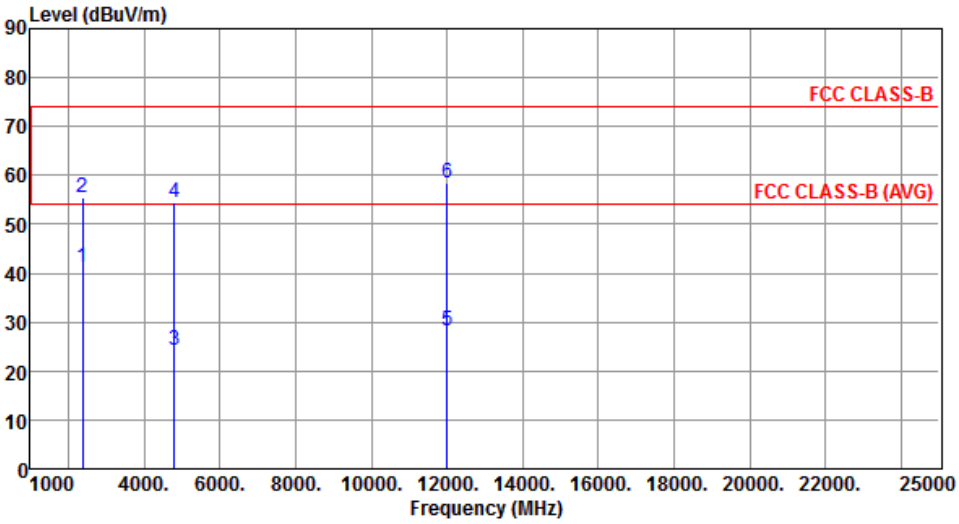
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	39.02	54.00	-14.98	42.60	-3.58	Average	204	45
2	2390.00	51.20	74.00	-22.80	54.78	-3.58	Peak	204	45
3	4804.00	22.85	54.00	-31.15	19.23	3.62	Average	284	355
4	4804.00	52.95	74.00	-21.05	49.33	3.62	Peak	284	355
5	12010.00	28.83	54.00	-25.17	15.47	13.36	Average	100	138
6	12010.00	58.93	74.00	-15.07	45.57	13.36	Peak	100	138

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).

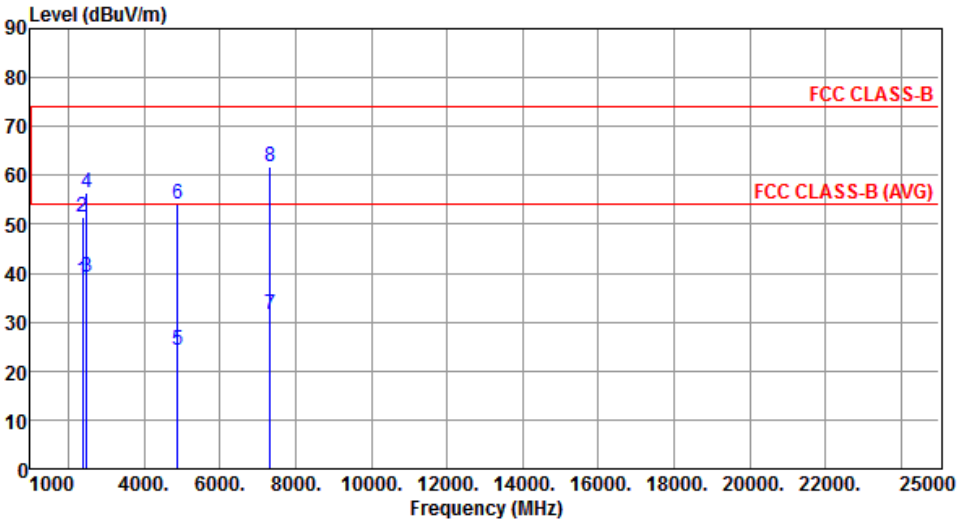
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	41.31	54.00	-12.69	44.89	-3.58	Average	100	120
2	2390.00	55.59	74.00	-18.41	59.17	-3.58	Peak	100	120
3	4804.00	24.23	54.00	-29.77	20.61	3.62	Average	105	133
4	4804.00	54.33	74.00	-19.67	50.71	3.62	Peak	105	133
5	12010.00	28.36	54.00	-25.64	15.00	13.36	Average	100	150
6	12010.00	58.46	74.00	-15.54	45.10	13.36	Peak	100	150

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).

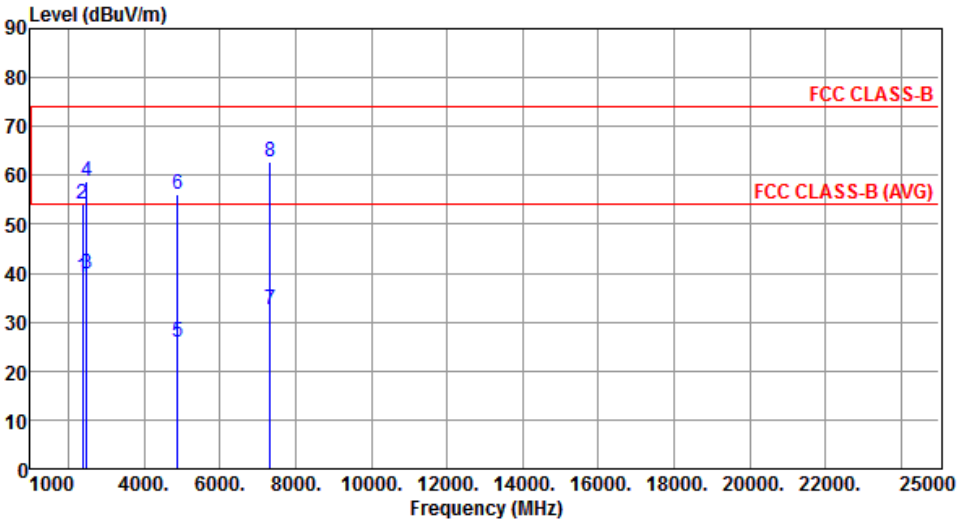
Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.67	54.00	-15.33	42.25	-3.58	Average	185	57
2	2390.00	51.62	74.00	-22.38	55.20	-3.58	Peak	185	57
3	2483.50	39.14	54.00	-14.86	42.32	-3.18	Average	185	57
4	2483.50	56.29	74.00	-17.71	59.47	-3.18	Peak	185	57
5	4882.00	24.15	54.00	-29.85	20.32	3.83	Average	290	0
6	4882.00	54.25	74.00	-19.75	50.42	3.83	Peak	290	0
7	7323.00	31.70	54.00	-22.30	23.58	8.12	Average	242	347
8	7323.00	61.80	74.00	-12.20	53.68	8.12	Peak	242	347

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).

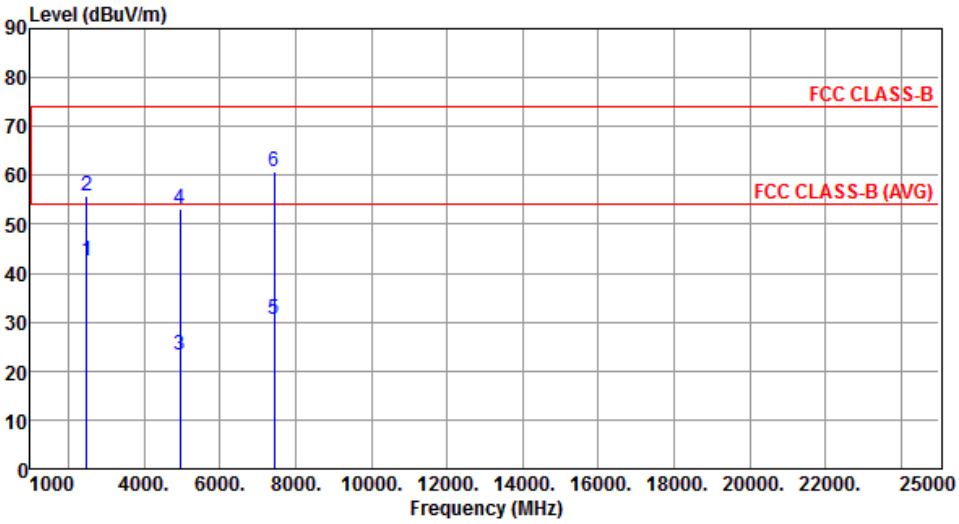
Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	39.25	54.00	-14.75	42.83	-3.58	Average	100	105
2	2390.00	54.12	74.00	-19.88	57.70	-3.58	Peak	100	105
3	2483.50	39.72	54.00	-14.28	42.90	-3.18	Average	100	105
4	2483.50	58.64	74.00	-15.36	61.82	-3.18	Peak	100	105
5	4882.00	25.90	54.00	-28.10	22.07	3.83	Average	102	132
6	4882.00	56.00	74.00	-18.00	52.17	3.83	Peak	102	132
7	7323.00	32.57	54.00	-21.43	24.45	8.12	Average	128	283
8	7323.00	62.67	74.00	-11.33	54.55	8.12	Peak	128	283

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).

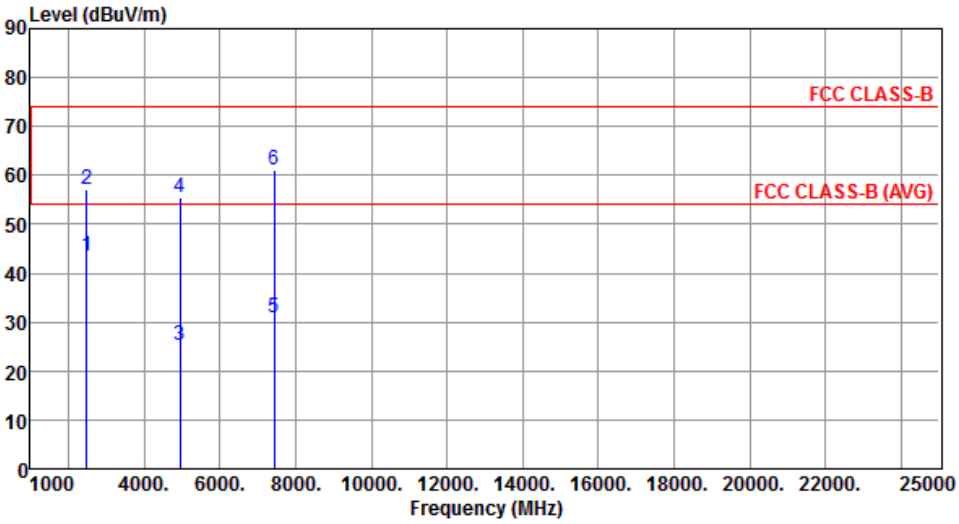
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	42.64	54.00	-11.36	45.82	-3.18	Average	177	48
2	2483.50	55.81	74.00	-18.19	58.99	-3.18	Peak	177	48
3	4960.00	23.12	54.00	-30.88	19.08	4.04	Average	175	2
4	4960.00	53.22	74.00	-20.78	49.18	4.04	Peak	175	2
5	7440.00	30.59	54.00	-23.41	22.29	8.30	Average	241	350
6	7440.00	60.69	74.00	-13.31	52.39	8.30	Peak	241	350

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		

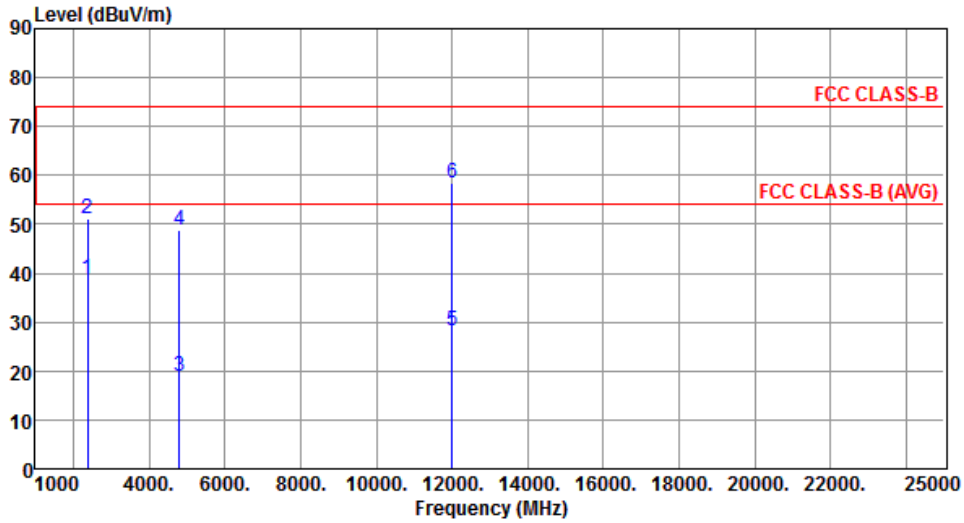


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	43.38	54.00	-10.62	46.56	-3.18	Average	100	134
2	2483.50	57.17	74.00	-16.83	60.35	-3.18	Peak	100	134
3	4960.00	25.36	54.00	-28.64	21.32	4.04	Average	100	132
4	4960.00	55.46	74.00	-18.54	51.42	4.04	Peak	100	132
5	7440.00	30.84	54.00	-23.16	22.54	8.30	Average	124	286
6	7440.00	60.94	74.00	-13.06	52.64	8.30	Peak	124	286

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).

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

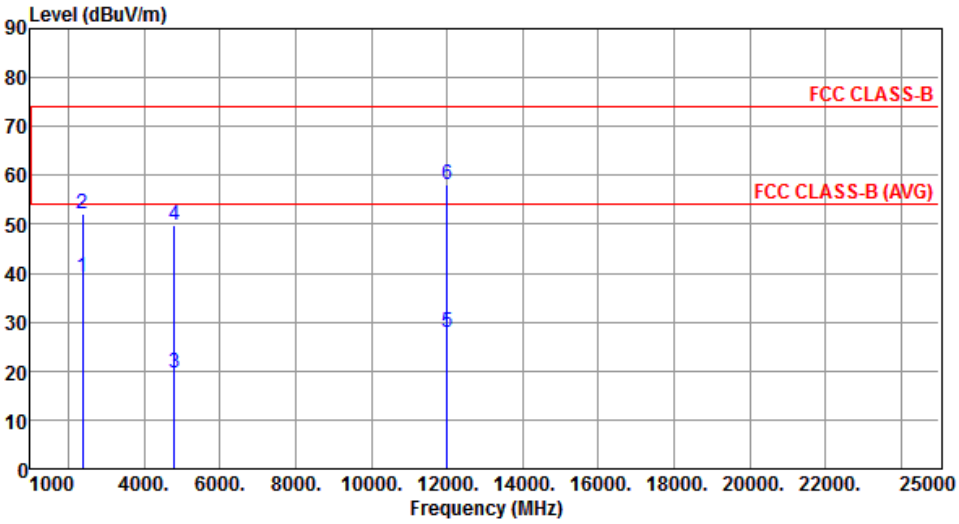
Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.94	54.00	-15.06	42.52	-3.58	Average	201	50
2	2390.00	51.12	74.00	-22.88	54.70	-3.58	Peak	201	50
3	4804.00	18.86	54.00	-35.14	15.24	3.62	Average	200	352
4	4804.00	48.96	74.00	-25.04	45.34	3.62	Peak	200	352
5	12010.00	28.31	54.00	-25.69	14.95	13.36	Average	100	135
6	12010.00	58.41	74.00	-15.59	45.05	13.36	Peak	100	135

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).

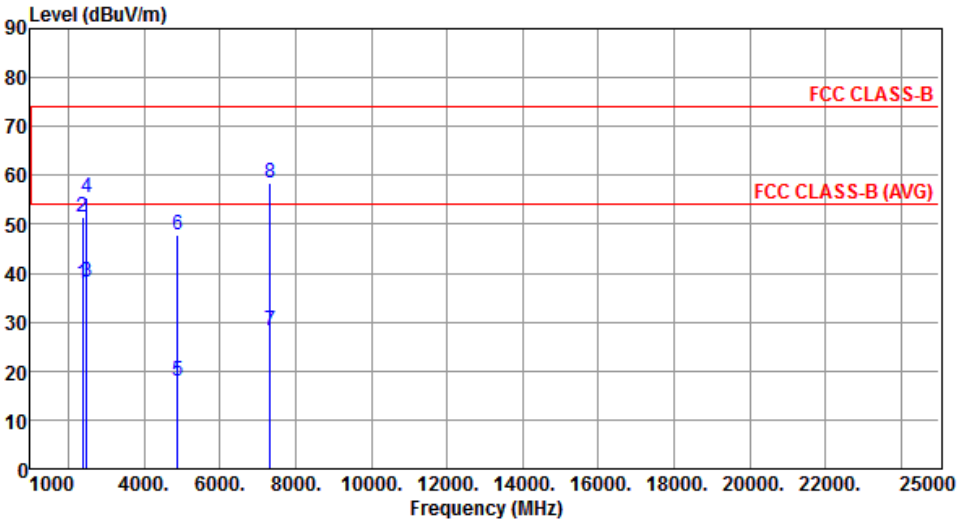
Modulation	8DPSK	**Test Freq. (MHz)**	2402
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	39.15	54.00	-14.85	42.73	-3.58	Average	100	118
2	2390.00	52.27	74.00	-21.73	55.85	-3.58	Peak	100	118
3	4804.00	19.57	54.00	-34.43	15.95	3.62	Average	100	136
4	4804.00	49.67	74.00	-24.33	46.05	3.62	Peak	100	136
5	12010.00	27.90	54.00	-26.10	14.54	13.36	Average	100	136
6	12010.00	58.00	74.00	-16.00	44.64	13.36	Peak	100	136

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).

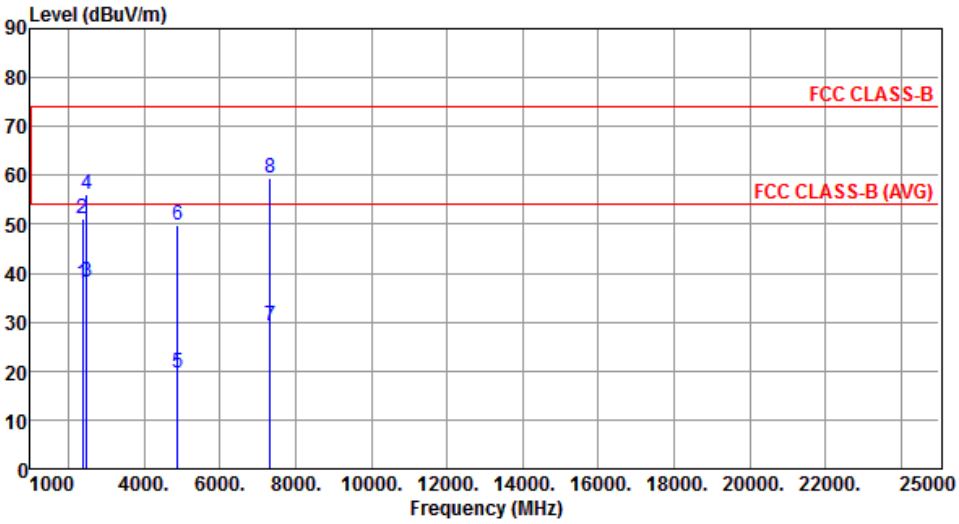
Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	37.87	54.00	-16.13	41.45	-3.58	Average	270	49
2	2390.00	51.31	74.00	-22.69	54.89	-3.58	Peak	270	49
3	2483.50	38.33	54.00	-15.67	41.51	-3.18	Average	270	49
4	2483.50	55.56	74.00	-18.44	58.74	-3.18	Peak	270	49
5	4882.00	17.81	54.00	-36.19	13.98	3.83	Average	100	96
6	4882.00	47.91	74.00	-26.09	44.08	3.83	Peak	100	96
7	7323.00	28.31	54.00	-25.69	20.19	8.12	Average	250	353
8	7323.00	58.41	74.00	-15.59	50.29	8.12	Peak	250	353

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).

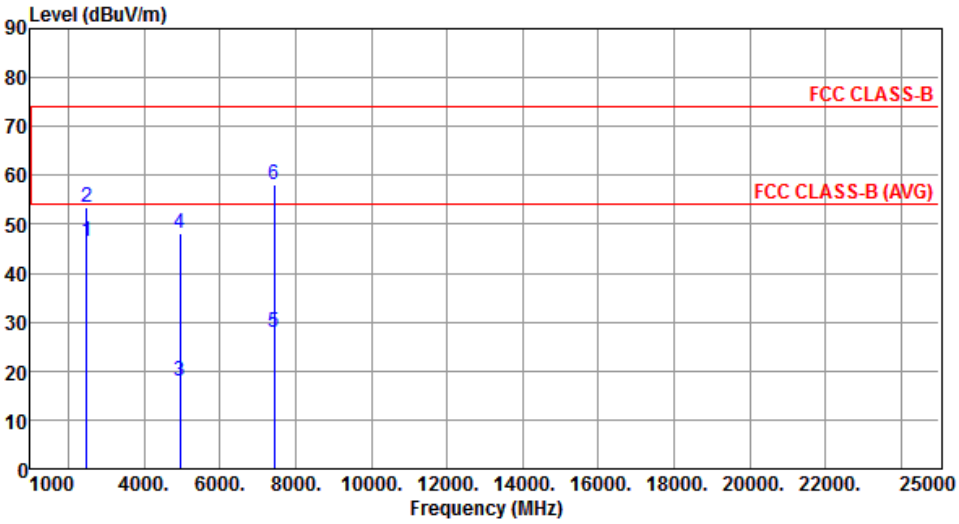
Modulation	8DPSK	**Test Freq. (MHz)**	2441
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	37.93	54.00	-16.07	41.51	-3.58	Average	100	120
2	2390.00	51.00	74.00	-23.00	54.58	-3.58	Peak	100	120
3	2483.50	38.34	54.00	-15.66	41.52	-3.18	Average	100	120
4	2483.50	56.13	74.00	-17.87	59.31	-3.18	Peak	100	120
5	4882.00	19.64	54.00	-34.36	15.81	3.83	Average	101	134
6	4882.00	49.74	74.00	-24.26	45.91	3.83	Peak	101	134
7	7323.00	29.27	54.00	-24.73	21.15	8.12	Average	119	282
8	7323.00	59.37	74.00	-14.63	51.25	8.12	Peak	119	282

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).

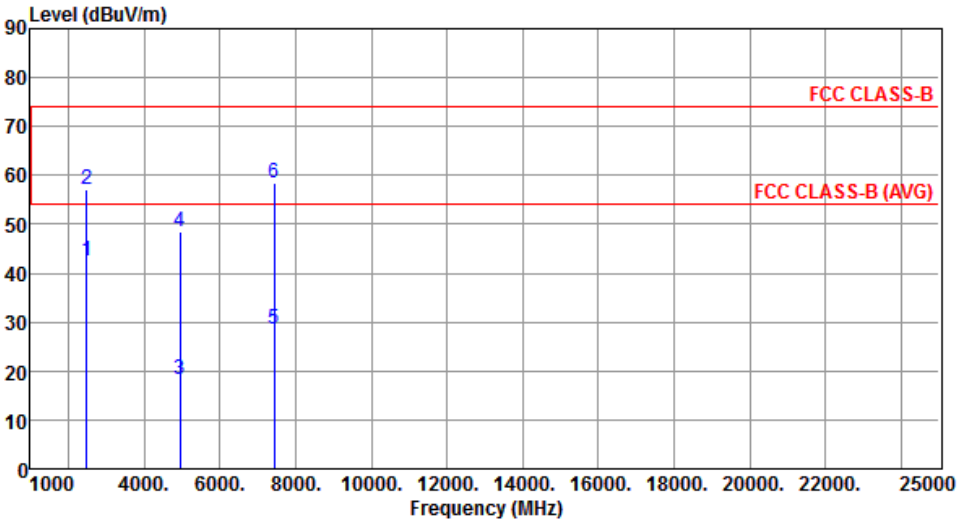
Modulation	8DPSK	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	46.65	54.00	-7.35	49.83	-3.18	Average	178	51
2	2483.50	53.53	74.00	-20.47	56.71	-3.18	Peak	178	51
3	4960.00	17.96	54.00	-36.04	13.92	4.04	Average	100	98
4	4960.00	48.06	74.00	-25.94	44.02	4.04	Peak	100	98
5	7440.00	27.94	54.00	-26.06	19.64	8.30	Average	244	353
6	7440.00	58.04	74.00	-15.96	49.74	8.30	Peak	244	353

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		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	42.39	54.00	-11.61	45.57	-3.18	Average	100	134
2	2483.50	57.13	74.00	-16.87	60.31	-3.18	Peak	100	134
3	4960.00	18.33	54.00	-35.67	14.29	4.04	Average	100	136
4	4960.00	48.43	74.00	-25.57	44.39	4.04	Peak	100	136
5	7440.00	28.46	54.00	-25.54	20.16	8.30	Average	127	287
6	7440.00	58.56	74.00	-15.44	50.26	8.30	Peak	127	287

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 Unwanted Emissions into Non-Restricted Frequency Bands

3.2.1 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.

3.2.2 Test Procedures

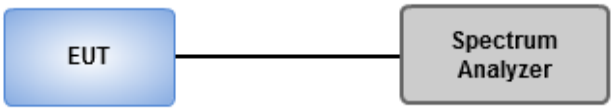
Reference Level Measurement

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

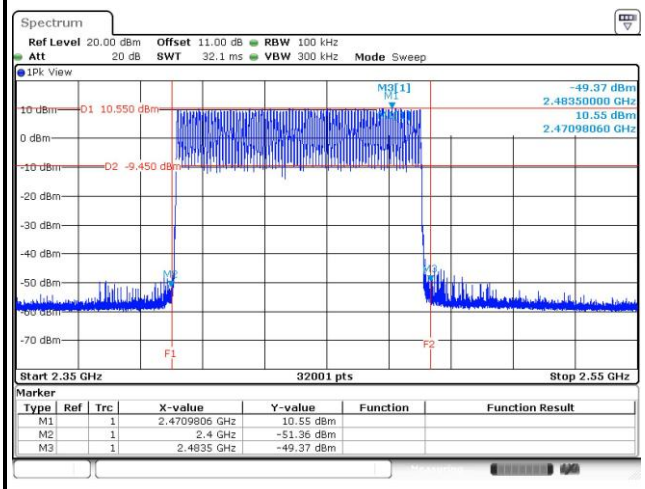
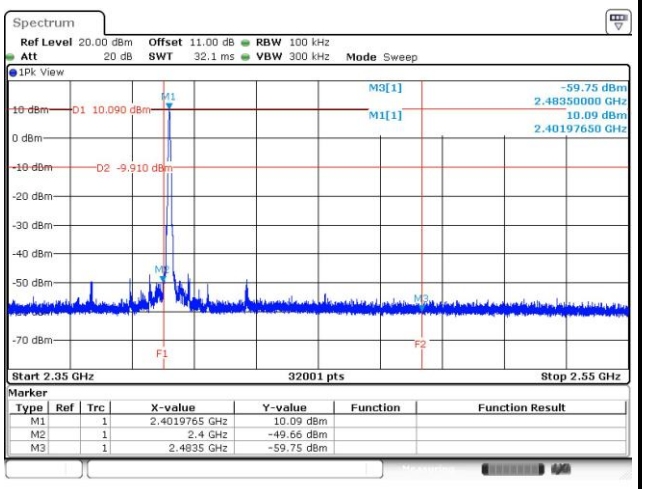
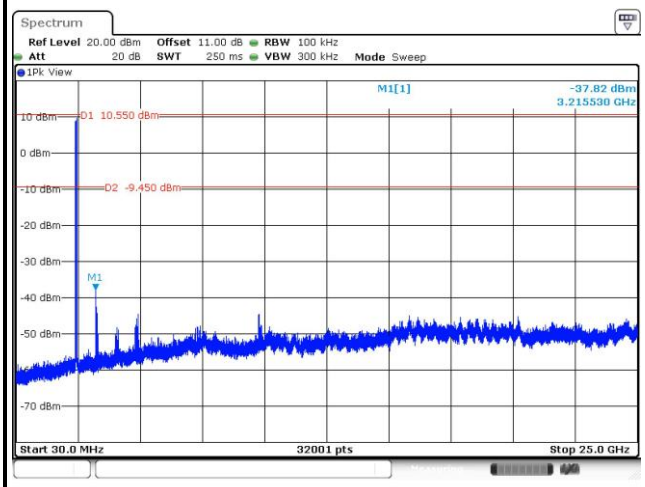
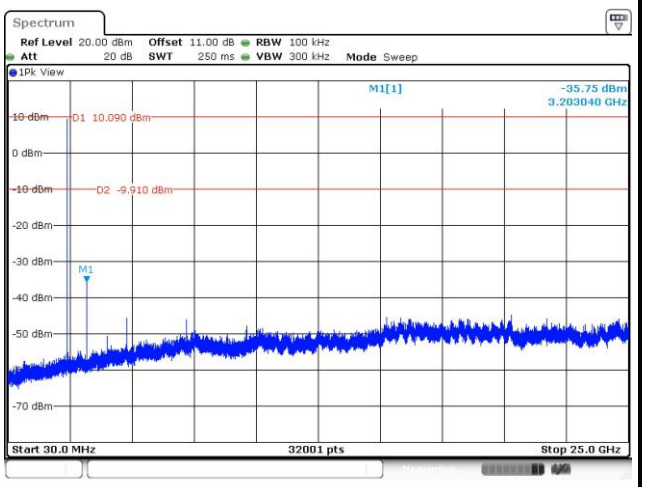
1. Set RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Trace Mode = max hold, Sweep = auto couple.
3. Allow the trace to stabilize.
4. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

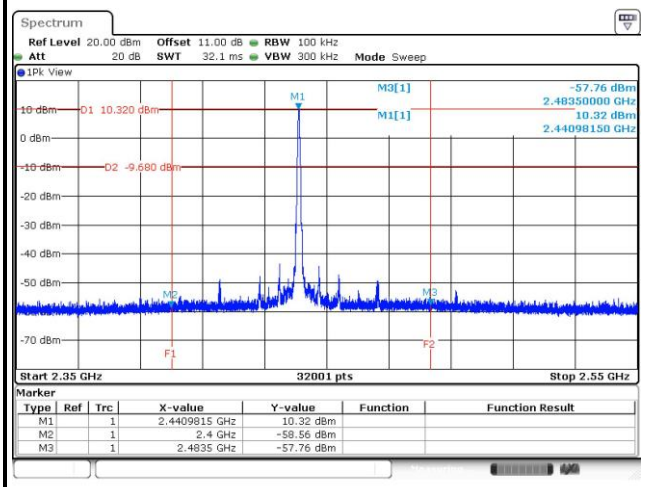
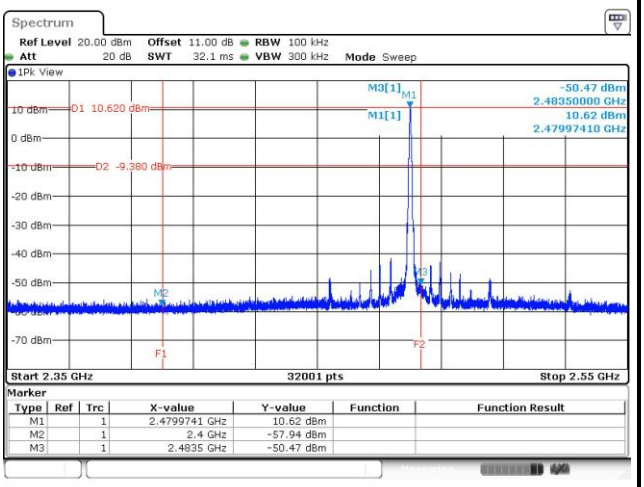
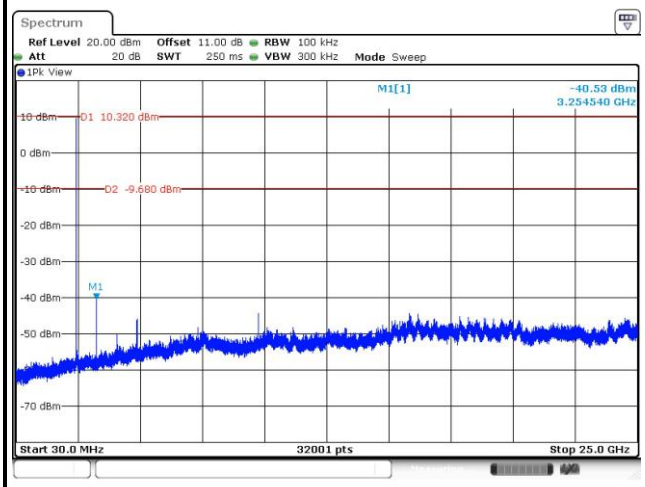
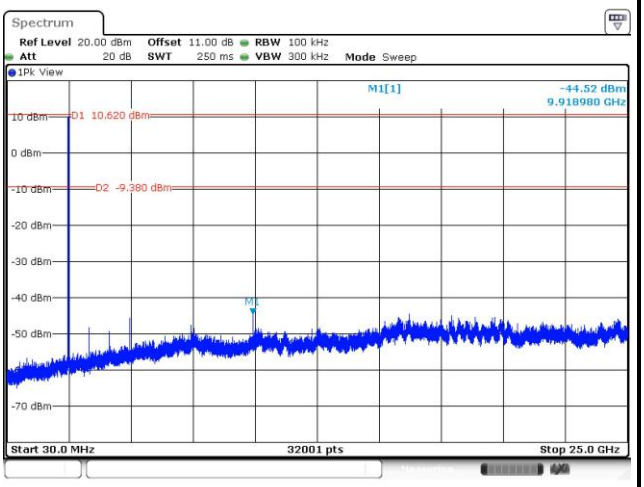
3.2.3 Test Setup



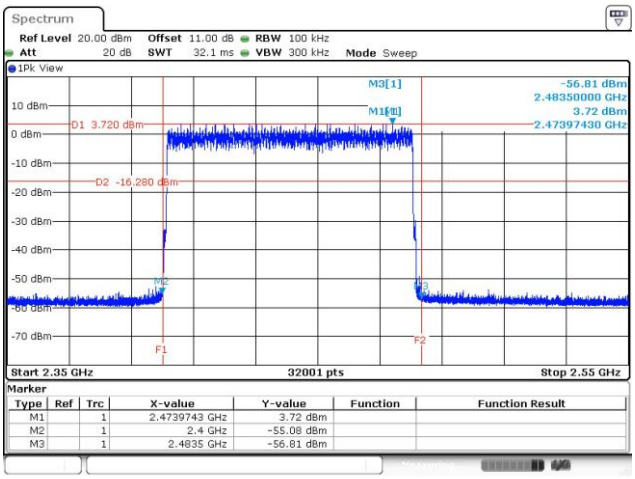
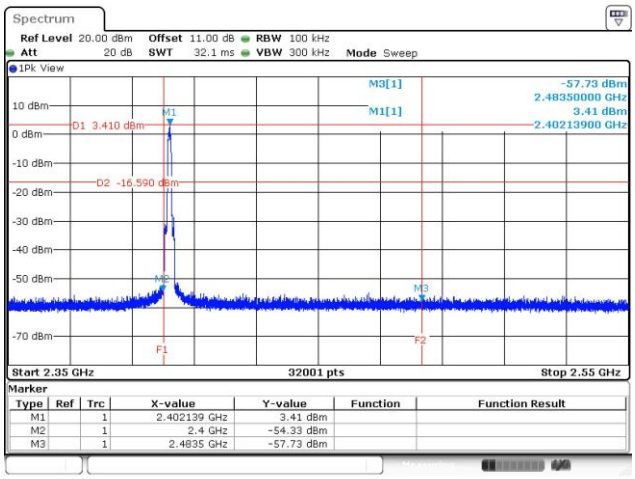
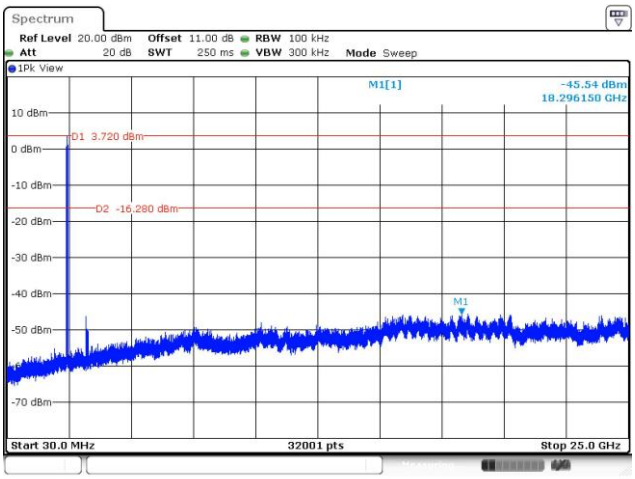
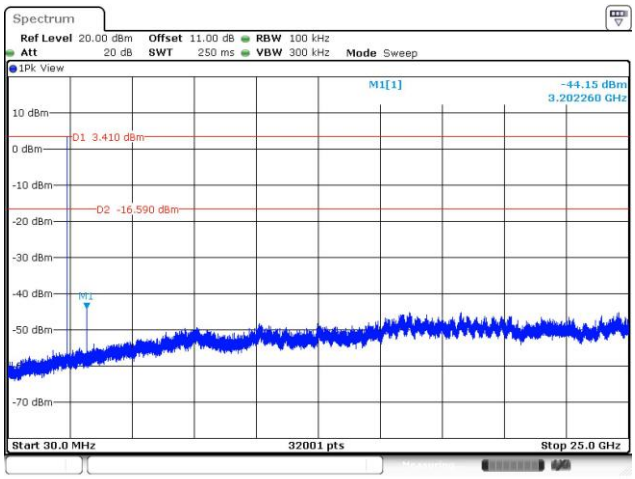
3.2.4 Unwanted Emissions into Non-Restricted Frequency Bands

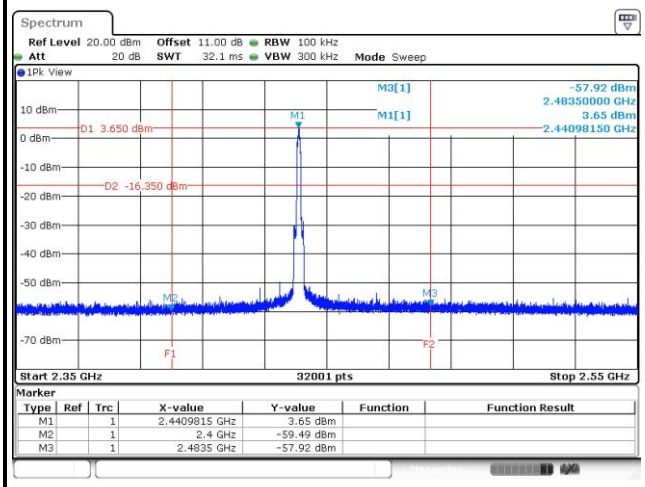
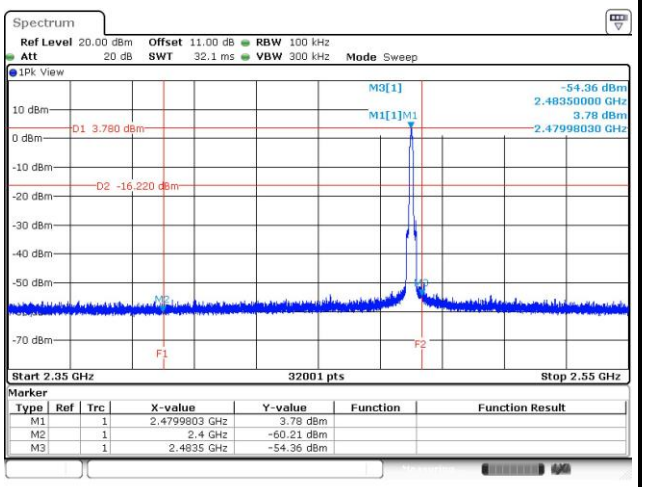
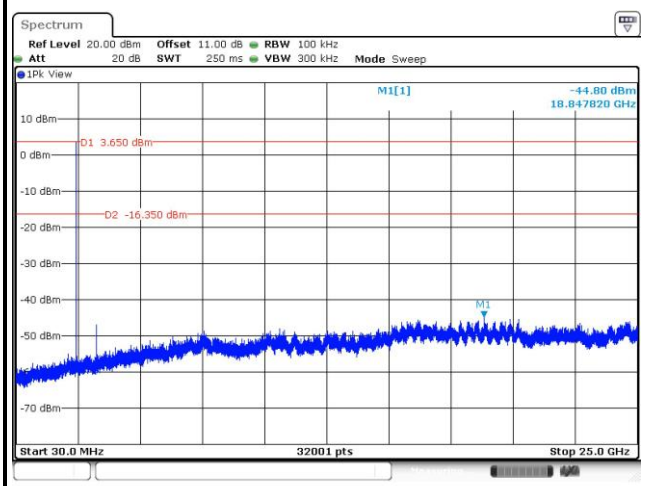
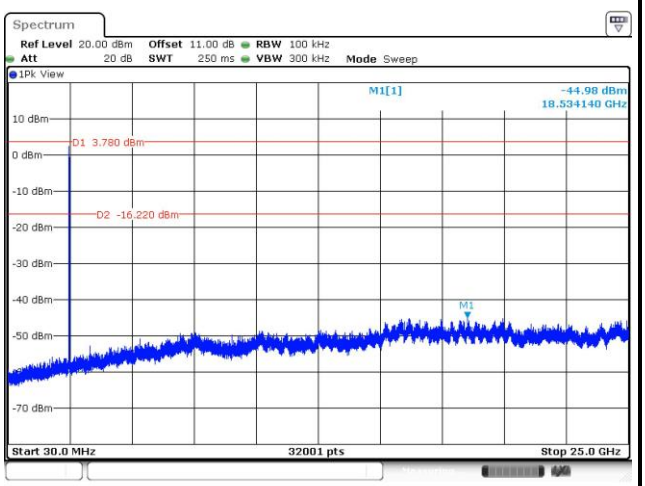
GFSK

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)
	
	

3.3 Conducted Output Power

3.3.1 Limit of Conducted Output Power

☐ 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.

3.3.2 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

3.3.3 Test Setup

3.3.4 Test Result of Conducted Output Power

Modulation Mode	Freq. (MHz)	Output Power (mW)	Output Power (dBm)	Limit (mW)
GFSK	2402	10.26	10.11	125
GFSK	2441	11.17	10.48	125
GFSK	2480	12.27	**10.89**	125
л/4 DQPSK	2402	4.06	6.08	125
л/4 DQPSK	2441	4.32	6.35	125
л/4 DQPSK	2480	4.70	6.72	125
8DPSK	2402	4.67	6.69	125
8DPSK	2441	5.00	6.99	125
8DPSK	2480	5.45	7.36	125

Modulation Mode	Freq. (MHz)	AV Output Power (mW)	AV Output Power (dBm)
GFSK	2402	10.14	10.06
GFSK	2441	11.07	10.44
GFSK	2480	12.13	10.84
л/4 DQPSK	2402	2.10	3.22
л/4 DQPSK	2441	2.24	3.51
л/4 DQPSK	2480	2.43	3.85
8DPSK	2402	2.10	3.23
8DPSK	2441	2.24	3.50
8DPSK	2480	2.42	3.84

Note: Average power is for reference only.

3.4 Number of Hopping Frequency

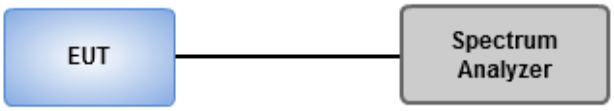
3.4.1 Limit of Number of Hopping Frequency

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

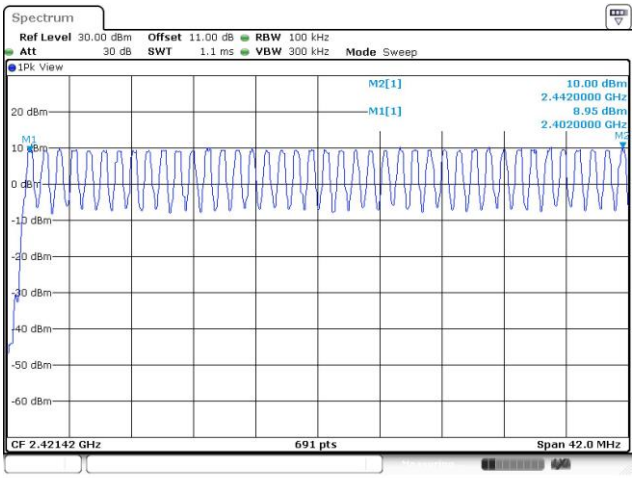
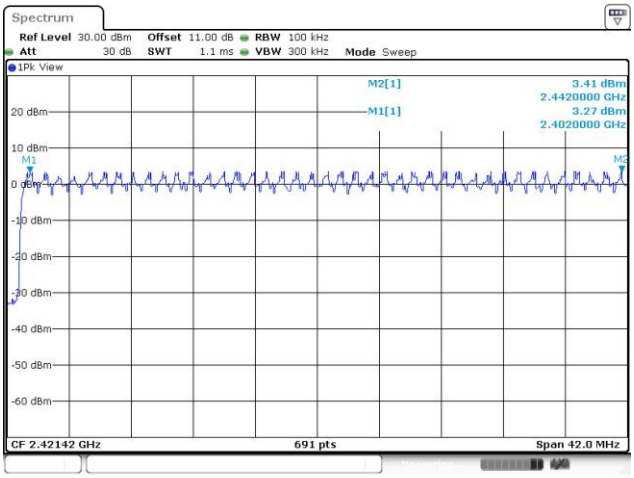
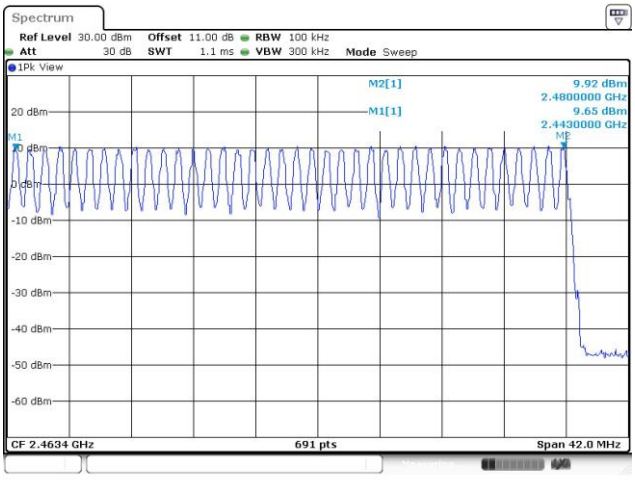
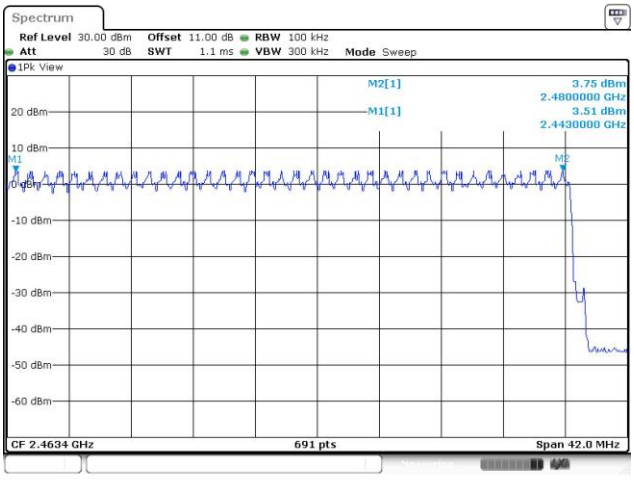
3.4.2 Test Procedures

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

3.4.3 Test Setup



3.4.4 Test Result of Number of Hopping Frequency

GFSK	8DPSK
	
	

3.5 20dB and Occupied Bandwidth

3.5.1 Test Procedures

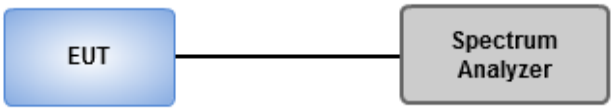
20dB Bandwidth

1. Set RBW=30kHz, VBW=100kHz,Sweep time = Auto, Detector=Peak, Trace max hold
2 Allow trace to stabilize
3 Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

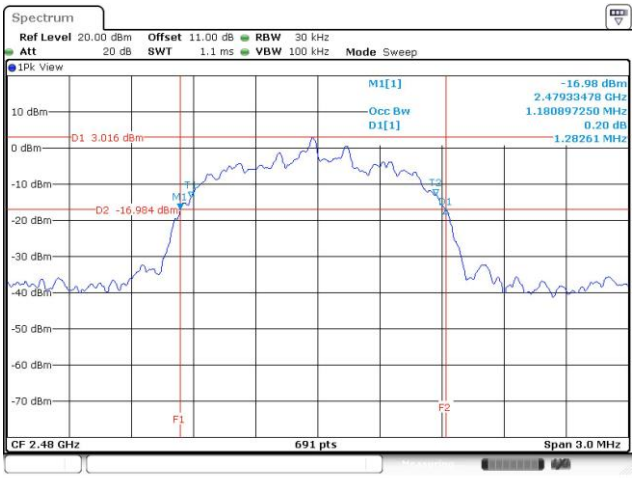
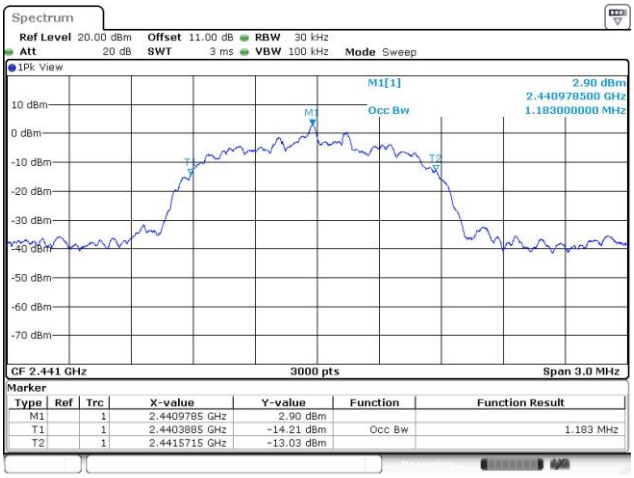
1. Set RBW=30kHz, VBW=100kHz,Sweep time = Auto, Detector=Sample, Trace max hold
2 Allow trace to stabilize
3. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth

3.5.2 Test Setup



3.5.3 Test result of 20dB and Occupied Bandwidth

Modulation Mode	Freq. (MHz)	20dB Bandwidth (MHz)	Occupied Bandwidth (MHz)
GFSK	2402	0.865	0.821
GFSK	2441	0.865	0.847
GFSK	2480	0.865	0.846
8DPSK	2402	1.283	1.182
8DPSK	2441	1.283	1.183
8DPSK	2480	1.283	1.182

Worst Plot of 20dB Bandwidth	Worst Plot of Occupied Bandwidth
	

3.6 Channel Separation

3.6.1 Limit of Channel Separation

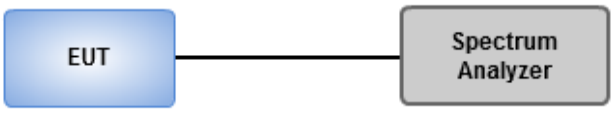
☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ 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.

3.6.2 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

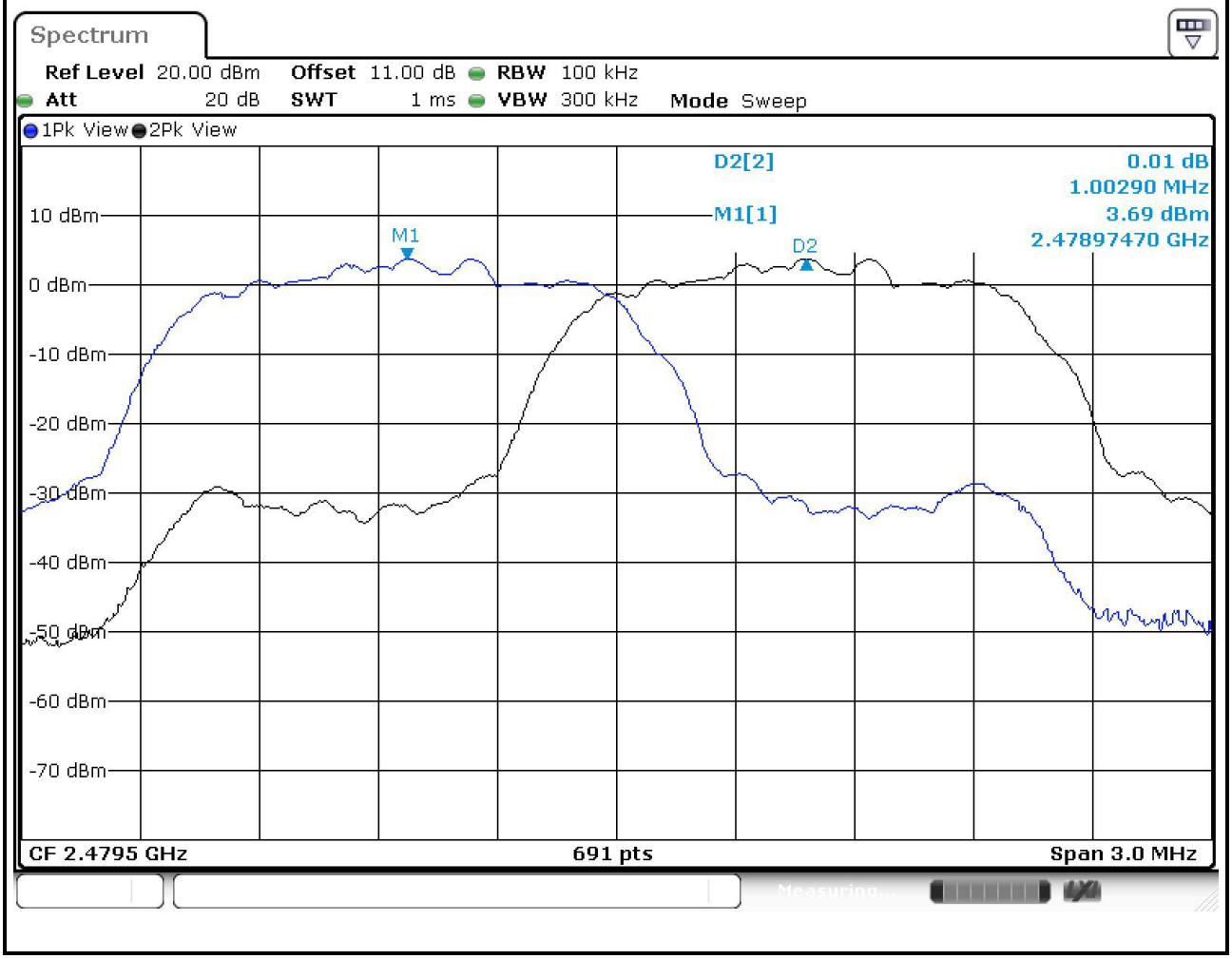
3.6.3 Test Setup



3.6.4 Test result of Channel Separation

Modulation Mode	Freq. (MHz)	Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)
GFSK	2402	1.003	0.865	0.577
GFSK	2441	1.003	0.865	0.577
GFSK	2480	1.003	0.865	0.577
8DPSK	2402	1.003	1.283	0.855
8DPSK	2441	1.003	1.283	0.855
8DPSK	2480	1.003	1.283	0.855

Worst Plot



3.7 Number of Dwell Time

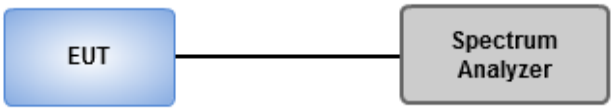
3.7.1 Limit of Dwell time

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.

3.7.2 Test Procedures

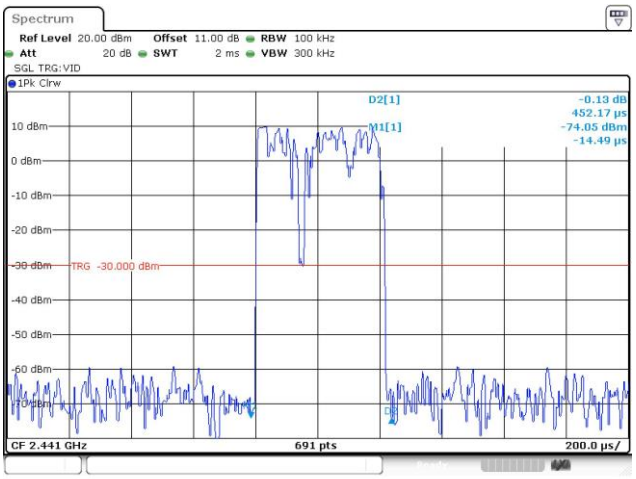
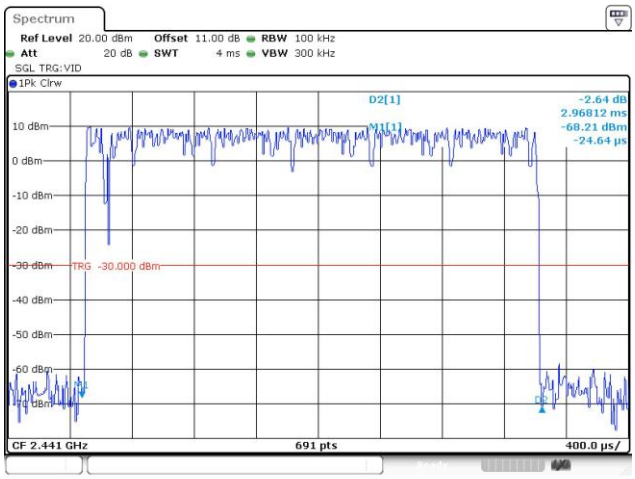
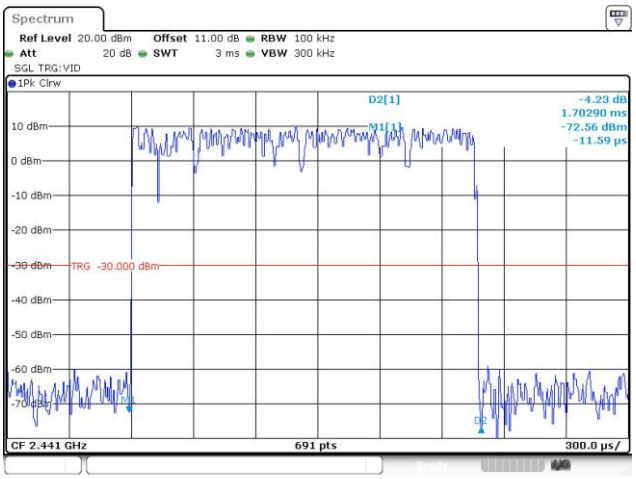
1. Set RBW=100kHz,VBW=300kHz,Sweep time = 500us(DH1),2ms(DH3),4ms(DH5), Detector=Peak, Span=0Hz,Trace max hold
2. Enable gating and trigger function of spectrum analyzer to measure burst on time.
3. The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots. The 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

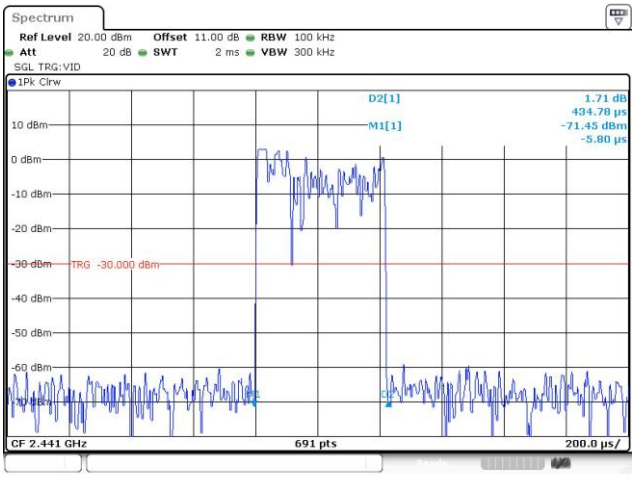
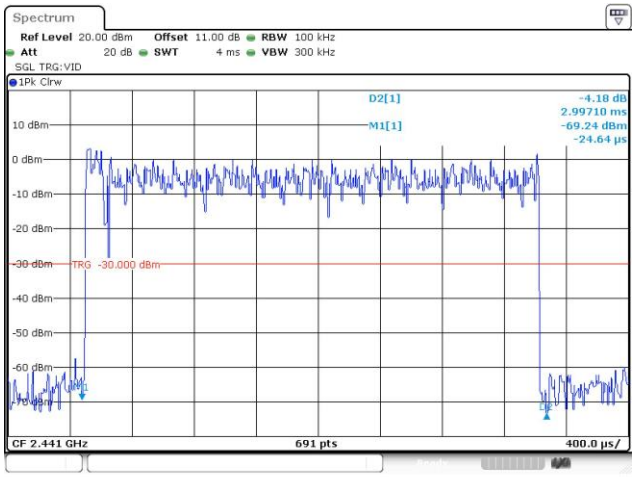
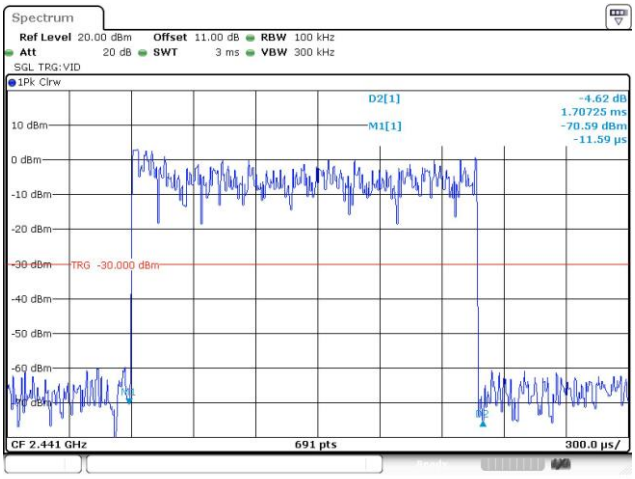
3.7.3 Test Setup



3.7.4 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	2441	0.45217	320	0.145	0.4
GFSK-DH3	2441	1.70290	160	0.272	0.4
GFSK-DH5	2441	2.96812	106.6	0.316	0.4
8DPSK-DH1	2441	0.43478	320	0.139	0.4
8DPSK-DH3	2441	1.70725	160	0.273	0.4
8DPSK-DH5	2441	2.99710	106.6	0.319	0.4

GFSK	
DH1	**DH5**
	
DH3	**--**
	--

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 (EMC and Wireless Communication Laboratory), 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 District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
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If you have any suggestion, please feel free to contact us as below information.

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