

# FCC Test Report

**FCC ID** : SUFTRKRF07  
**Equipment** : 2.4G RF MODULE\_BL02  
**Model No.** : TRK-RF-07  
**Brand Name** : DIGI  
**Applicant** : DIGI SINGAPORE PTE. LTD.  
**Address** : 4 Leng Kee Rd, #05-03/04/05&11, SIS Building,  
Singapore 159088  
**Standard** : 47 CFR FCC Part 15.247  
**Received Date** : Nov. 21, 2016  
**Tested Date** : Jan. 20 ~ Feb. 16, 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:

  
Along Chen / Assistant Manager

Approved by:

  
Gary Chang / Manager



## Table of Contents

<b>1</b>	<b>GENERAL DESCRIPTION .....</b>	<b>5</b>
1.1	Information.....	5
1.2	Local Support Equipment List .....	7
1.3	Test Setup Chart .....	7
1.4	The Equipment List .....	9
1.5	Test Standards .....	10
1.6	Measurement Uncertainty .....	10
<b>2</b>	<b>TEST CONFIGURATION .....</b>	<b>11</b>
2.1	Testing Condition .....	11
2.2	The Worst Test Modes and Channel Details .....	11
<b>3</b>	<b>TRANSMITTER TEST RESULTS.....</b>	<b>12</b>
3.1	Conducted Emissions.....	12
3.2	6dB and Occupied Bandwidth .....	17
3.3	RF Output Power .....	19
3.4	Power Spectral Density .....	21
3.5	Unwanted Emissions into Restricted Frequency Bands .....	23
3.6	Emissions in Non-Restricted Frequency Bands .....	41
<b>4</b>	<b>TEST LABORATORY INFORMATION .....</b>	<b>44</b>

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## Release Record

Report No.	Version	Description	Issued Date
FR6N2105	Rev. 01	Initial issue	Apr. 21, 2017

## Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 4.407MHz 40.21 (Margin -15.79dB) - QP	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 2370.00MHz 52.99 (Margin -1.01dB) – AV 2483.50MHz 52.99 (Margin -1.01dB) - AV	Pass
15.247(b)(3)	Maximum Output Power	Max Power [dBm]: 21.62	Pass
15.247(a)(2)	6dB Bandwidth	Meet the requirement of limit	Pass
15.247(e)	Power Spectral Density	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)	Modulation Mode	Ch. Freq. (MHz)	Channel Number	Transmit Chains (N <sub>TX</sub> )	Data Rate
2400-2483.5	GFSK	2402-2479	0-77 [78]	1	2 Mbps

### 1.1.2 Antenna Details

Ant. No.	Brand	Model	Type	Gain (dBi)	Connector	Remark
1	Green Antenna Pte Ltd	BL02	CHIP ANTENNA	4.21	PCB SURFACE MOUNT	-
2	Green Antenna Pte Ltd	GA-E24110-RPW	DIPOLE	1.41	RESERVE SMA	-

### 1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	DC 5V
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### 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	---	---
19	2421	39	2441	59	2461	---	---

### 1.1.6 Test Tool and Duty Cycle

Test Tool	SmartRF Studio, V7		
Duty Cycle and Duty Factor	Modulation Mode	Duty cycle (%)	Duty factor (dB)
	GFSK	100.00%	0.00

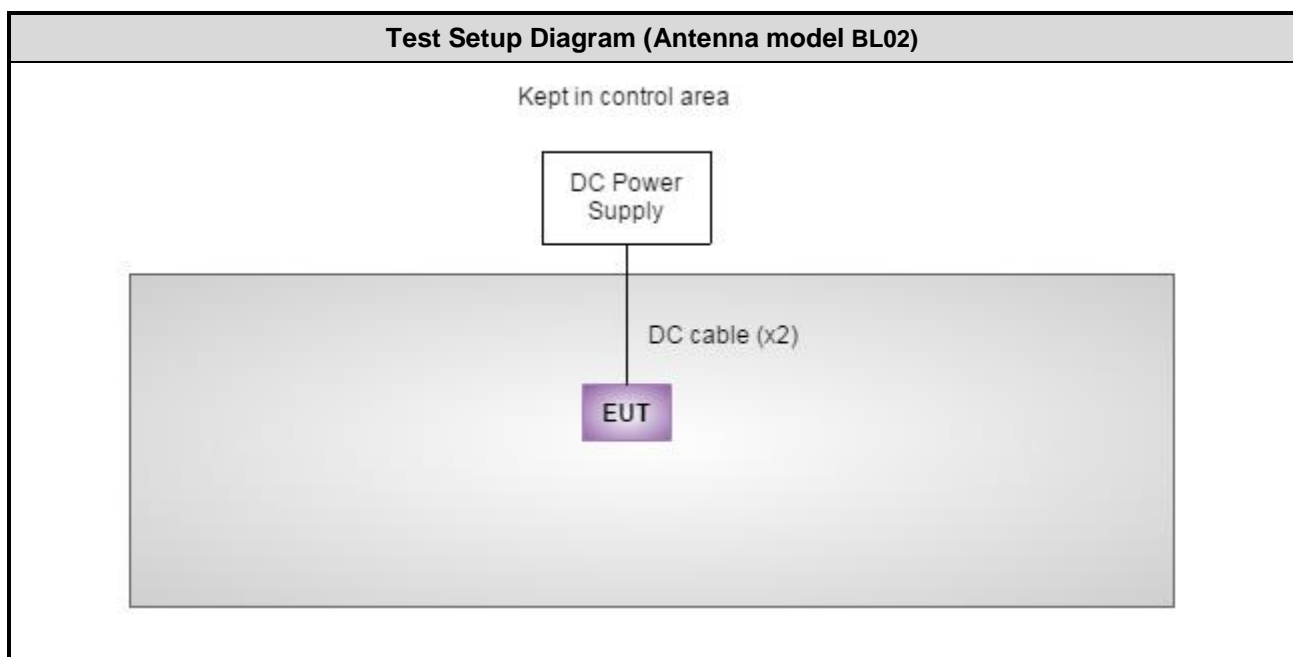
### 1.1.7 Power Setting

Modulation Mode	Test Frequency (MHz)	Power Set
GFSK	2402	D1
GFSK	2441	E1
GFSK	2479	C1

## 1.2 Local Support Equipment List

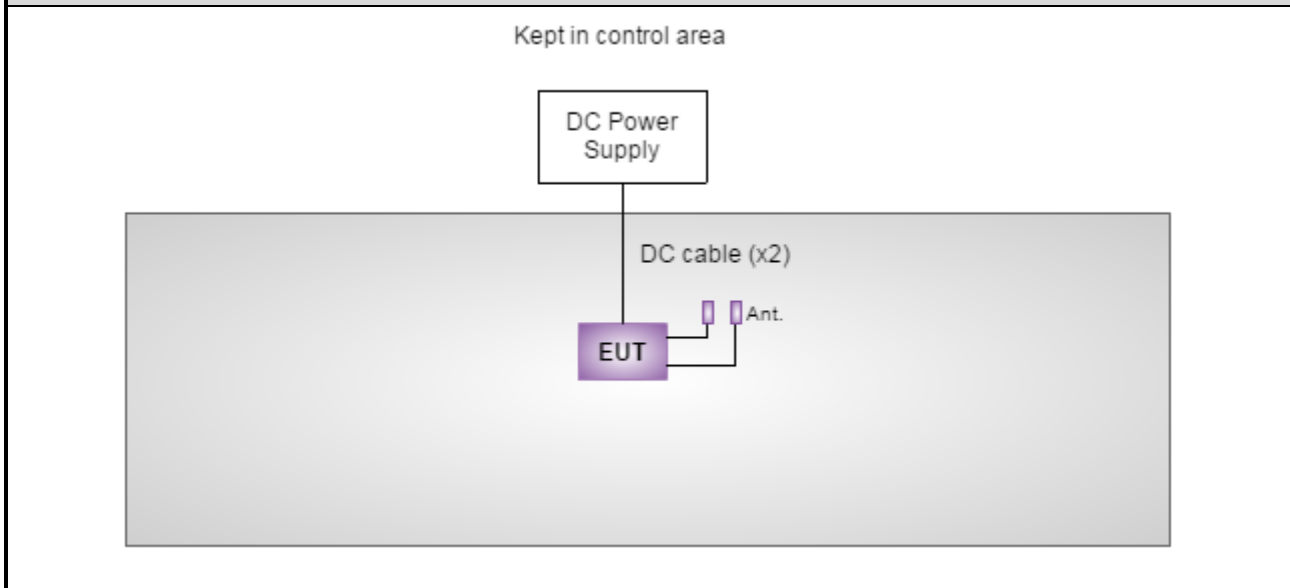
Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Signal cable / Length (m)
1	Notebook	DELL	Latitude E5420	DoC	---

## 1.3 Test Setup Chart



Note: The support notebook was disconnected from EUT and removed from test table when EUT is set to transmit/receive continuously

### Test Setup Diagram (Antenna model GA-E24110-RPW)



Note:

1. The support notebook was disconnected from EUT and removed from test table when EUT is set to transmit/receive continuously
2. The device supports TX diversity function.



## 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
Receiver	R&S	ESR3	101657	Dec. 21, 2016	Dec. 20, 2017
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 08, 2016	Nov. 07, 2017
RF Cable-CON	EMC	EMCCFD300-BM-B M-6000	50821	Dec. 20, 2016	Dec. 19, 2017
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 chamber1 / (03CH01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Nov. 25, 2016	Nov. 24, 2017
Receiver	R&S	ESR3	101658	Nov. 24, 2016	Nov. 23, 2017
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Aug. 04, 2016	Aug. 03, 2017
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	Oct. 25, 2016	Oct. 24, 2017
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 10, 2016	Nov. 09, 2017
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 09, 2016	Dec. 08, 2017
Preamplifier	EMC	EMC02325	980225	Aug. 05, 2016	Aug. 04, 2017
Preamplifier	Agilent	83017A	MY39501308	Oct. 06, 2016	Oct. 05, 2017
Preamplifier	EMC	EMC184045B	980192	Aug. 24, 2016	Aug. 23, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 09, 2016	Dec. 08, 2017
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	16052	Dec. 09, 2016	Dec. 08, 2017
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 09, 2016	Dec. 08, 2017
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 09, 2016	Dec. 08, 2017
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

<b>Test Item</b>	RF Conducted				
<b>Test Site</b>	(TH01-WS)				
<b>Instrument</b>	<b>Manufacturer</b>	<b>Model No.</b>	<b>Serial No.</b>	<b>Calibration Date</b>	<b>Calibration Until</b>
Spectrum Analyzer	R&S	FSV40	101499	Dec. 16, 2016	Dec. 15, 2017
Power Meter	Anritsu	ML2495A	1241002	Oct. 06, 2016	Oct. 05, 2017
Power Sensor	Anritsu	MA2411B	1207366	Oct. 06, 2016	Oct. 05, 2017
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 20, 2016	Oct. 19, 2017
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

ANSI C63.10-2013

FCC KDB 558074 D01 DTS Meas Guidance v03r05

## 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
AC conducted emission	±2.90 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
AC Conduction	CO01-WS	20°C / 63%	Alex Tsai
Radiated Emissions	03CH01-WS	20°C / 63%	Vincent Yeh Aska Huang
RF Conducted	TH01-WS	22°C / 63%	Alex Huang

- 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	Modulation Mode	Test Frequency (MHz)	Data Rate	Test Configuration
Conducted Emissions	GFSK	2441	2 Mbps	1, 2
Radiated Emissions ≤1GHz	GFSK	2441	2 Mbps	1, 2
Radiated Emissions >1GHz Maximum Output Power 6dB bandwidth Power spectral density	GFSK	2402 / 2441 / 2479	2 Mbps	1

**NOTE:**

1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report. .
2. 2 types antenna are used for this device, each type is selected to perform radiated and conducted emission test as below test configuration.
  - 1) Configuration 1: Antenna model BL02, Internal antenna, Z-plane
  - 2) Configuration 2: Antenna model GA-E24110-RPW, External antenna, Z-plane

### 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  $\Omega$  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.

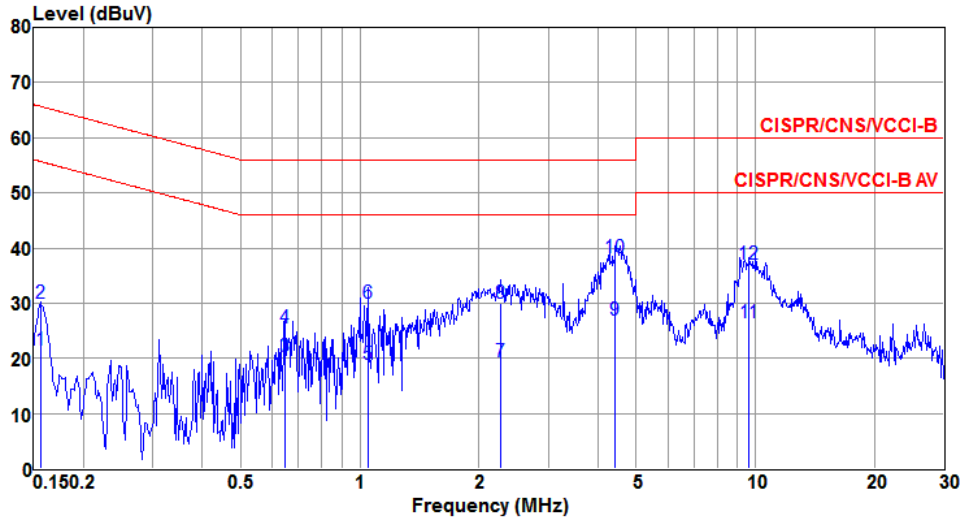
##### 3.1.3 Test Setup



- 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

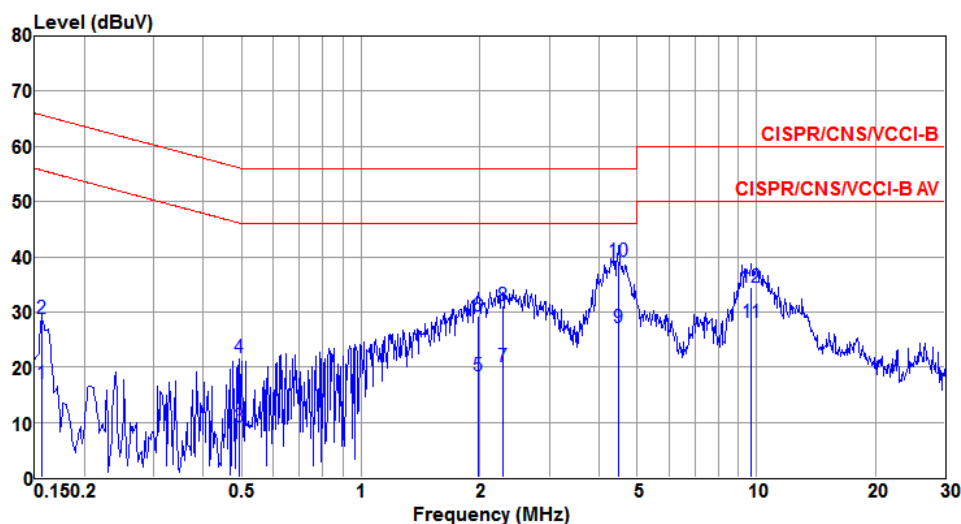
Modulation Mode	GFSK	Test Freq. (MHz)	2441
Power Phase	Line	Test Configuration	1

	Freq	Level	Limit	Over	Read	LISN	cable	
	MHz	dBuV	Line	Limit	Level	factor	loss	Remark
			dBuV	dB	dBuV	dB	dB	
1	0.156	21.42	55.69	-34.27	21.33	0.07	0.02	Average
2	0.156	30.07	65.69	-35.62	29.98	0.07	0.02	QP
3	0.647	20.34	46.00	-25.66	20.22	0.07	0.05	Average
4	0.647	25.50	56.00	-30.50	25.38	0.07	0.05	QP
5	1.049	18.96	46.00	-27.04	18.83	0.07	0.06	Average
6	1.049	30.05	56.00	-25.95	29.92	0.07	0.06	QP
7	2.273	19.32	46.00	-26.68	19.09	0.14	0.09	Average
8	2.273	30.02	56.00	-25.98	29.79	0.14	0.09	QP
9	4.430	26.93	46.00	-19.07	26.64	0.17	0.12	Average
10	4.430	38.25	56.00	-17.75	37.96	0.17	0.12	QP
11	9.654	26.34	50.00	-23.66	25.98	0.20	0.16	Average
12	9.654	37.03	60.00	-22.97	36.67	0.20	0.16	QP

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

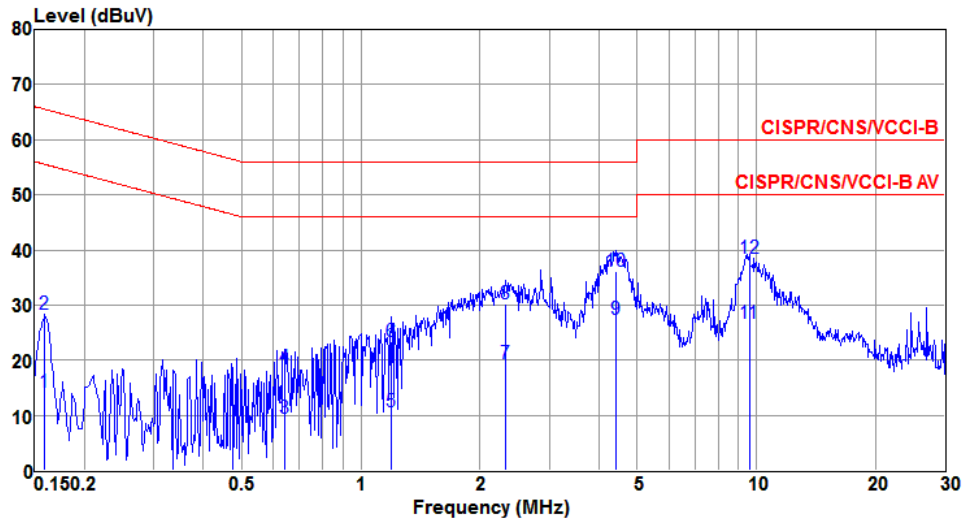
Modulation Mode	GFSK	Test Freq. (MHz)	2441
Power Phase	Line	Test Configuration	1



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.156	16.95	55.69	-38.74	16.83	0.10	0.02	Average
2	0.156	28.91	65.69	-36.78	28.79	0.10	0.02	QP
3	0.491	9.31	46.14	-36.83	9.15	0.12	0.04	Average
4	0.491	21.65	56.14	-34.49	21.49	0.12	0.04	QP
5	1.980	18.52	46.00	-27.48	18.28	0.16	0.08	Average
6	1.980	29.30	56.00	-26.70	29.06	0.16	0.08	QP
7	2.285	20.10	46.00	-25.90	19.85	0.16	0.09	Average
8	2.285	31.25	56.00	-24.75	31.00	0.16	0.09	QP
9	4.478	27.14	46.00	-18.86	26.86	0.16	0.12	Average
10	4.478	39.10	56.00	-16.90	38.82	0.16	0.12	QP
11	9.705	28.14	50.00	-21.86	27.68	0.30	0.16	Average
12	9.705	34.53	60.00	-25.47	34.07	0.30	0.16	QP

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

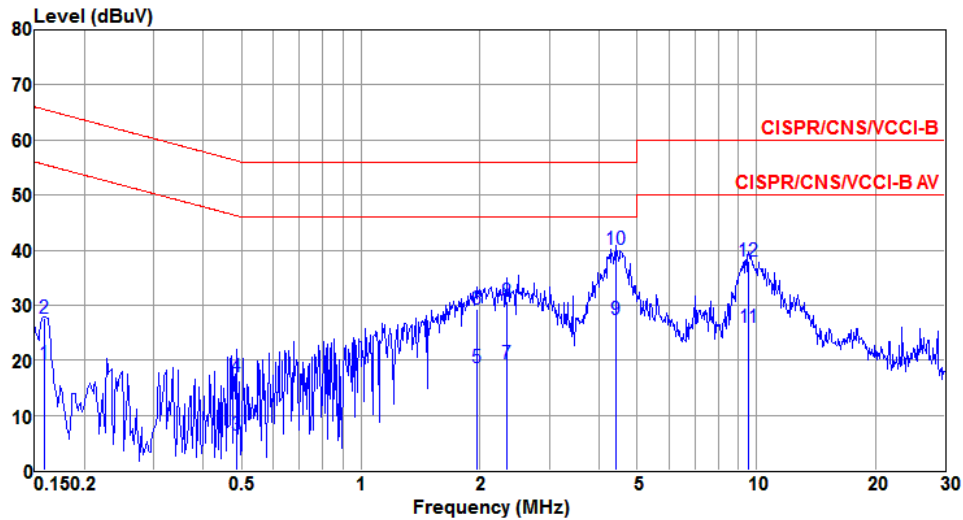
Modulation Mode	GFSK	Test Freq. (MHz)	2441
Power Phase	Line	Test Configuration	2



	Freq	Level	Limit	Over	Read	LISN	cable	
	MHz	dBuV	Line	Limit	Level	factor	loss	Remark
			dBuV	dB	dBuV	dB	dB	
1	0.159	14.25	55.52	-41.27	14.15	0.08	0.02	Average
2	0.159	28.30	65.52	-37.22	28.20	0.08	0.02	QP
3	0.641	9.34	46.00	-36.66	9.22	0.07	0.05	Average
4	0.641	18.60	56.00	-37.40	18.48	0.07	0.05	QP
5	1.197	10.73	46.00	-35.27	10.57	0.09	0.07	Average
6	1.197	23.27	56.00	-32.73	23.11	0.09	0.07	QP
7	2.321	19.31	46.00	-26.69	19.08	0.14	0.09	Average
8	2.321	30.30	56.00	-25.70	30.07	0.14	0.09	QP
9@	4.407	27.40	46.00	-18.60	27.11	0.17	0.12	Average
10	4.407	36.14	56.00	-19.86	35.85	0.17	0.12	QP
11	9.603	26.78	50.00	-23.22	26.42	0.20	0.16	Average
12	9.603	38.50	60.00	-21.50	38.14	0.20	0.16	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	Line	Test Configuration	2



	Freq	Level	Limit	Over	Read	LISN	cable	
	MHz	dBuV	Line	Limit	Level	factor	loss	Remark
			dBuV	dB	dBuV	dB	dB	
1	0.159	19.30	55.52	-36.22	19.18	0.10	0.02	Average
2	0.159	27.62	65.52	-37.90	27.50	0.10	0.02	QP
3	0.484	6.44	46.27	-39.83	6.28	0.12	0.04	Average
4	0.484	16.99	56.27	-39.28	16.83	0.12	0.04	QP
5	1.970	18.76	46.00	-27.24	18.52	0.16	0.08	Average
6	1.970	29.39	56.00	-26.61	29.15	0.16	0.08	QP
7	2.334	19.39	46.00	-26.61	19.14	0.16	0.09	Average
8	2.334	30.61	56.00	-25.39	30.36	0.16	0.09	QP
9	4.407	27.46	46.00	-18.54	27.18	0.16	0.12	Average
10	4.407	40.21	56.00	-15.79	39.93	0.16	0.12	QP
11	9.552	25.89	50.00	-24.11	25.43	0.30	0.16	Average
12	9.552	38.07	60.00	-21.93	37.61	0.30	0.16	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 6dB and Occupied Bandwidth

### 3.2.1 Limit of 6dB Bandwidth

The minimum 6dB bandwidth shall be at least 500 kHz.

### 3.2.2 Test Procedures

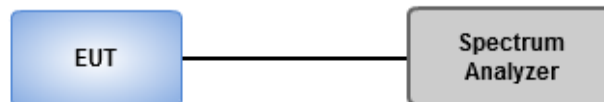
#### 6dB Bandwidth

1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. 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 6dB relative to the maximum level measured in the fundamental emission.

#### Occupied Bandwidth

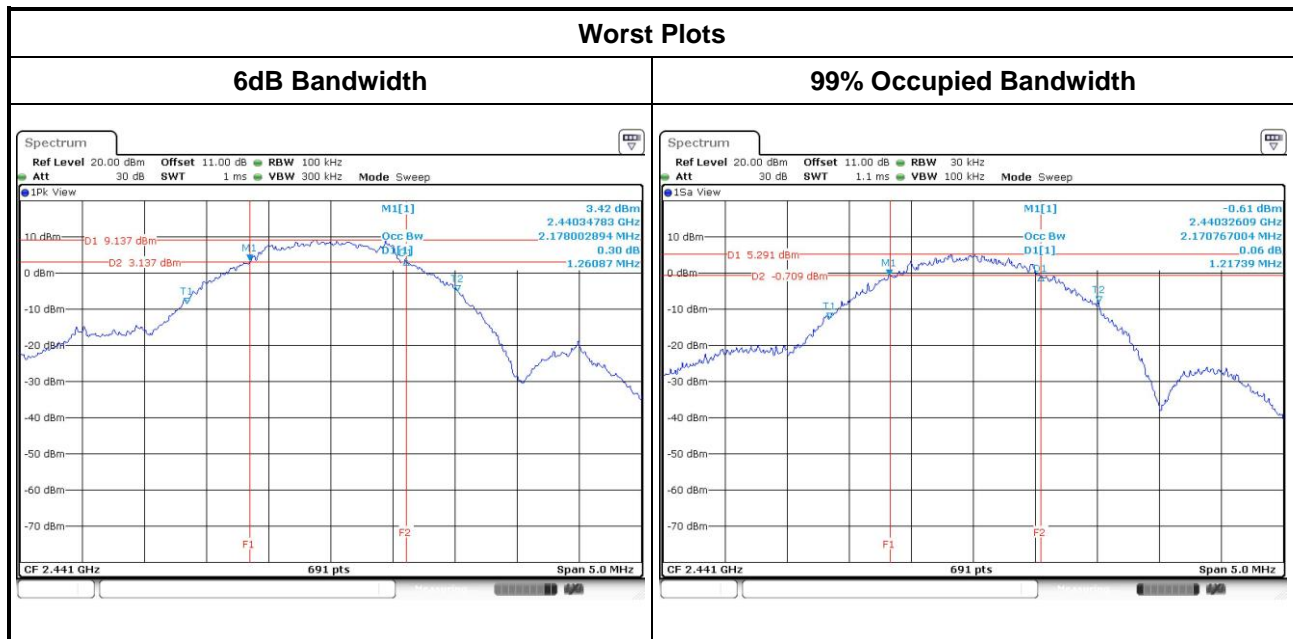
1. Set resolution bandwidth (RBW) = 1 MHz, Video bandwidth = 3 MHz.
2. Detector = Sample, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

### 3.2.3 Test Setup



### 3.2.4 Test Result of 6dB and Occupied Bandwidth

Modulation Mode	Freq. (MHz)	6dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Limit (kHz)
GFSK	2402	1.348	2.13	500
GFSK	2441	1.261	2.17	500
GFSK	2479	1.304	2.10	500



### 3.3 RF Output Power

#### 3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1Watt.

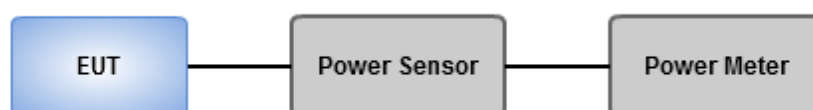
- ☒ Antenna gain  $\leq 6\text{dBi}$ , no any corresponding reduction is in output power limit.
- ☐ Antenna gain  $> 6\text{dBi}$ 
  - ☐ Non Fixed, point to point operations.  
The conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dB
  - ☐ Fixed, point to point operations  
Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point Operations, maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations ,no any corresponding reduction is in transmitter peak output power

#### 3.3.2 Test Procedures

- ☒ Maximum Peak Conducted Output Power
  - ☐ **Spectrum analyzer**
    1. Set RBW = 1MHz, VBW = 3MHz, Detector = Peak.
    2. Sweep time = auto, Trace mode = max hold, Allow trace to fully stabilize.
    3. Use the spectrum analyzer channel power measurement function with the band limits set equal to the DTS bandwidth edges.
  - ☒ **Power meter**
    1. A broadband Peak RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. 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.
- ☒ Maximum Conducted Output Power ( For reference only )
  - ☒ **Power meter**
    1. A broadband Average RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. 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 Maximum Output Power

Modulation Mode	Freq. (MHz)	Peak Power			Antenna gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)
		Power (mW)	Power (dBm)	Limit (dBm)			
GFSK	2402	109.144	20.38	30	4.21	24.59	36
GFSK	2441	145.211	<b>21.62</b>	30	4.21	25.83	36
GFSK	2479	59.020	17.71	30	4.21	21.92	36

Modulation Mode	Freq. (MHz)	AV Power (mW)	AV Power (dBm)	Limit (dBm)
GFSK	2402	97.051	19.87	---
GFSK	2441	123.027	20.90	---
GFSK	2479	50.699	17.05	---

Note: Conducted average output power is for reference only.

### 3.4 Power Spectral Density

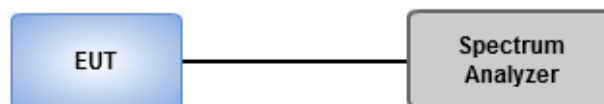
#### 3.4.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band.

#### 3.4.2 Test Procedures

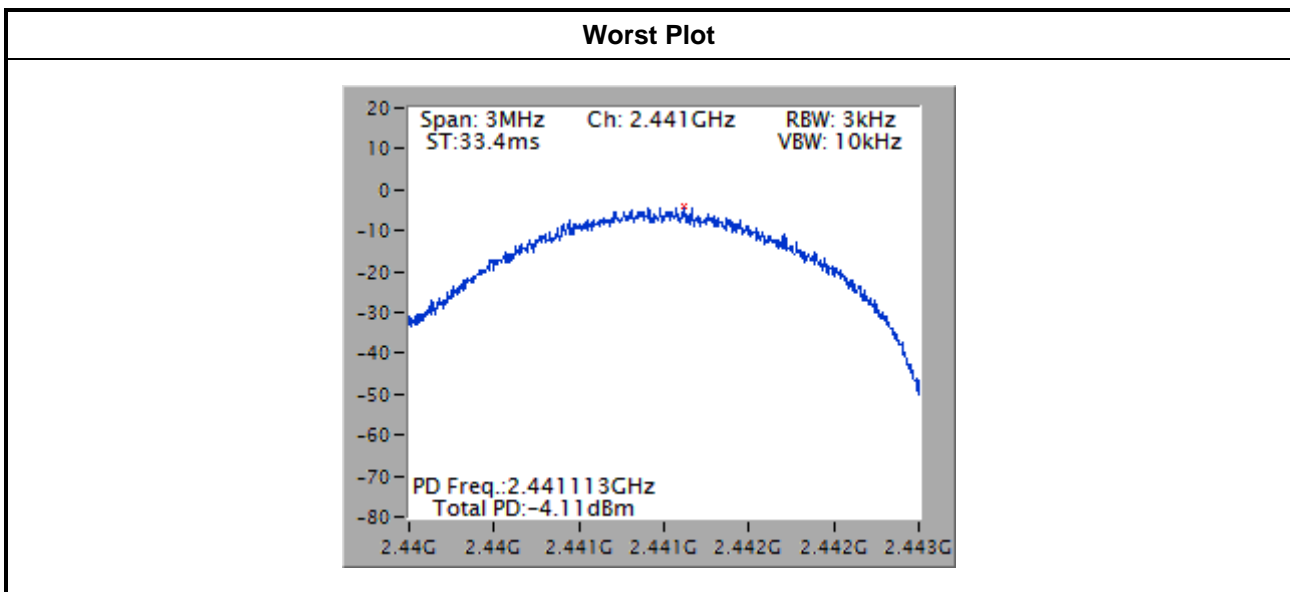
- ☒ Maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit.
  1. Set the RBW = 3kHz, VBW = 10kHz.
  2. Detector = Peak, Sweep time = auto couple.
  3. Trace mode = max hold, allow trace to fully stabilize.
  4. Use the peak marker function to determine the maximum amplitude level.
- ☐ Maximum (average) conducted output power was used to demonstrate compliance to the fundamental output power limit.
  1. Set the RBW = 100kHz, VBW = 300 kHz.
  2. Detector = RMS, Sweep time = auto couple.
  3. Set the sweep time to:  $\geq 10 \times (\text{number of measurement points in sweep}) \times (\text{maximum data rate per stream})$ .
  4. Perform the measurement over a single sweep.
  5. Use the peak marker function to determine the maximum amplitude level.

#### 3.4.3 Test Setup



### 3.4.4 Test Result of Power Spectral Density

Modulation Mode	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
GFSK	2402	-6.26	8.00
GFSK	2441	-4.11	8.00
GFSK	2479	-9.15	8.00



## 3.5 Unwanted Emissions into Restricted Frequency Bands

### 3.5.1 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:**  
Quasi-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.

### 3.5.2 Test Procedures

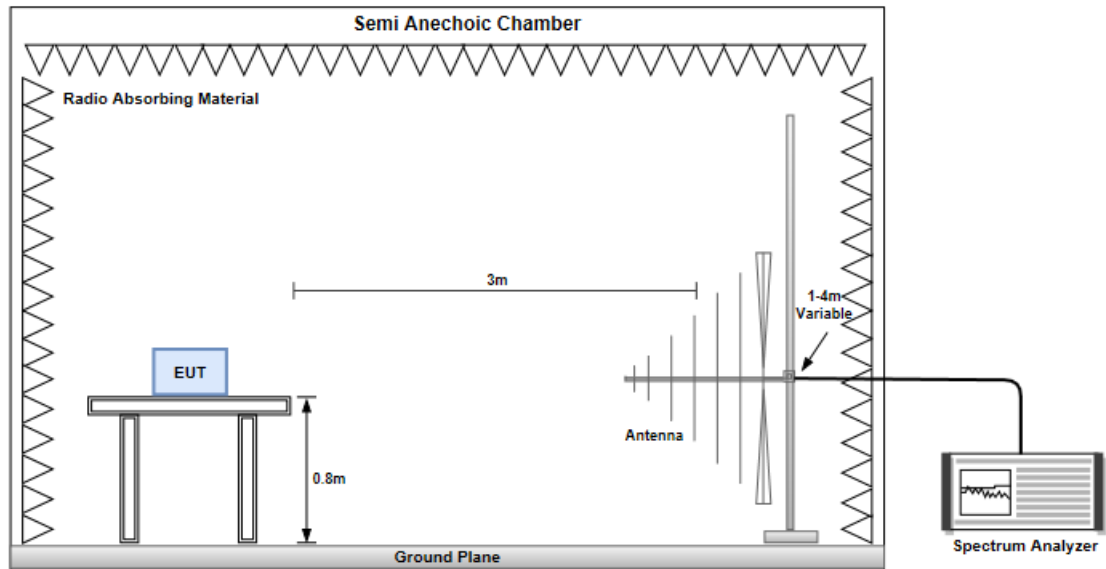
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

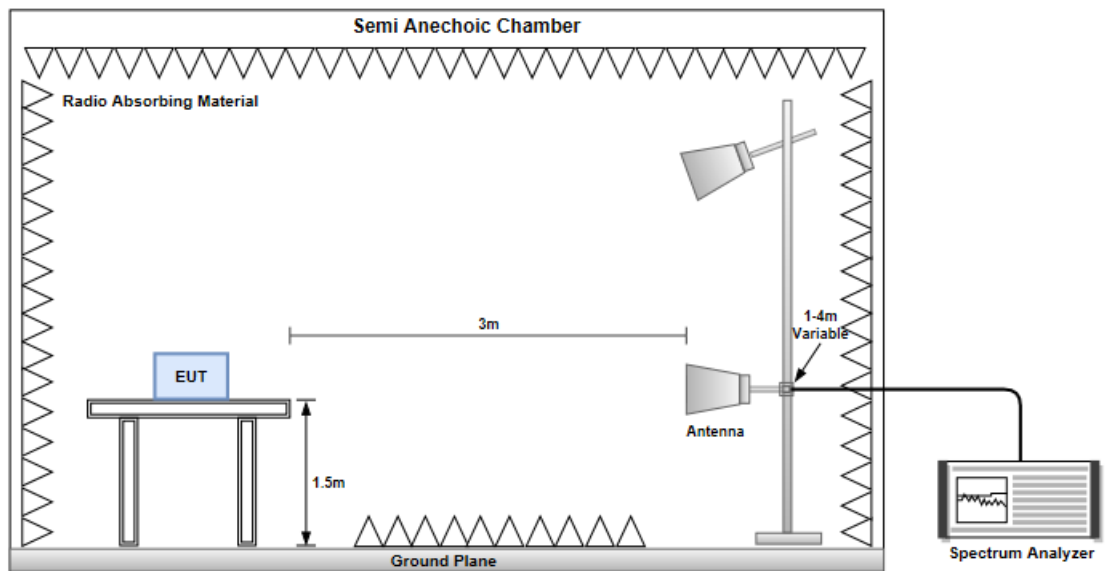
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

### 3.5.3 Test Setup

#### Radiated Emissions below 1 GHz



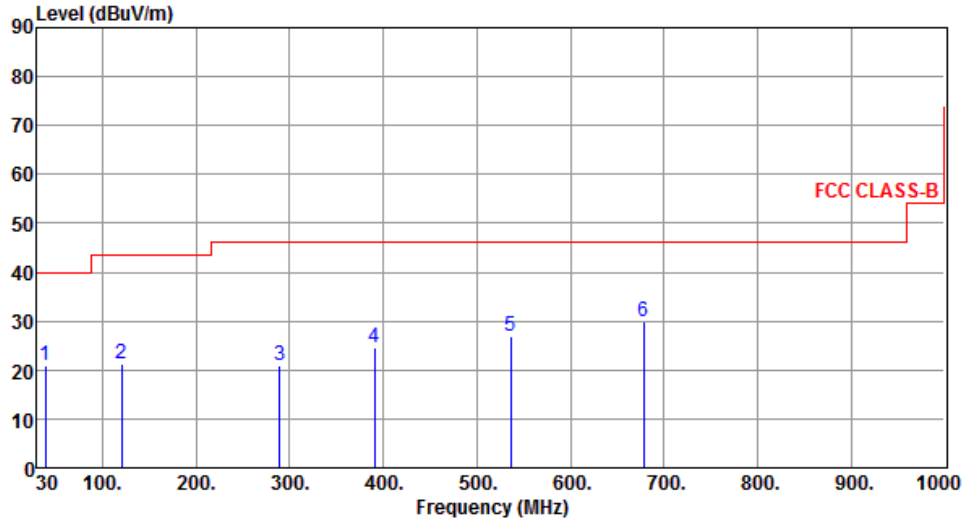
#### Radiated Emissions above 1 GHz





### 3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

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

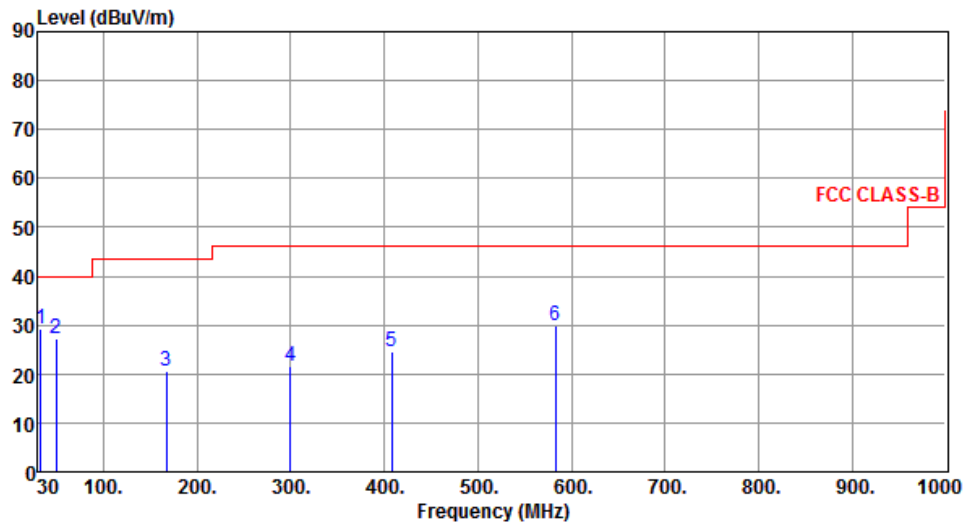
  


The graph displays the radiated unwanted emissions for a transmitter. The y-axis represents the Level in dBUV/m, ranging from 0 to 90. The x-axis represents the Frequency in MHz, ranging from 30 to 1000. A red line indicates the FCC CLASS-B limit, which is 40 dBUV/m from 30 to 100 MHz, 45 dBUV/m from 100 to 1000 MHz. Six measured peaks are shown as blue vertical lines, labeled 1 through 6. The peak levels are approximately 21, 21, 21, 25, 27, and 30 dBUV/m respectively.

	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	38.73	20.98	40.00	-19.02	28.99	-8.01	Peak	---	---
2	120.21	21.33	43.50	-22.17	31.46	-10.13	Peak	---	---
3	288.99	20.82	46.00	-25.18	28.58	-7.76	Peak	---	---
4	390.84	24.46	46.00	-21.54	29.68	-5.22	Peak	---	---
5	536.34	27.00	46.00	-19.00	29.12	-2.12	Peak	---	---
6	677.96	29.95	46.00	-16.05	29.52	0.43	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	32.91	29.28	40.00	-10.72	37.98	-8.70	Peak	---	---
2	49.40	27.19	40.00	-12.81	34.82	-7.63	Peak	---	---
3	166.77	20.55	43.50	-22.95	28.95	-8.40	Peak	---	---
4	299.66	21.70	46.00	-24.30	29.22	-7.52	Peak	---	---
5	408.30	24.62	46.00	-21.38	29.41	-4.79	Peak	---	---
6	582.90	29.88	46.00	-16.12	30.95	-1.07	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

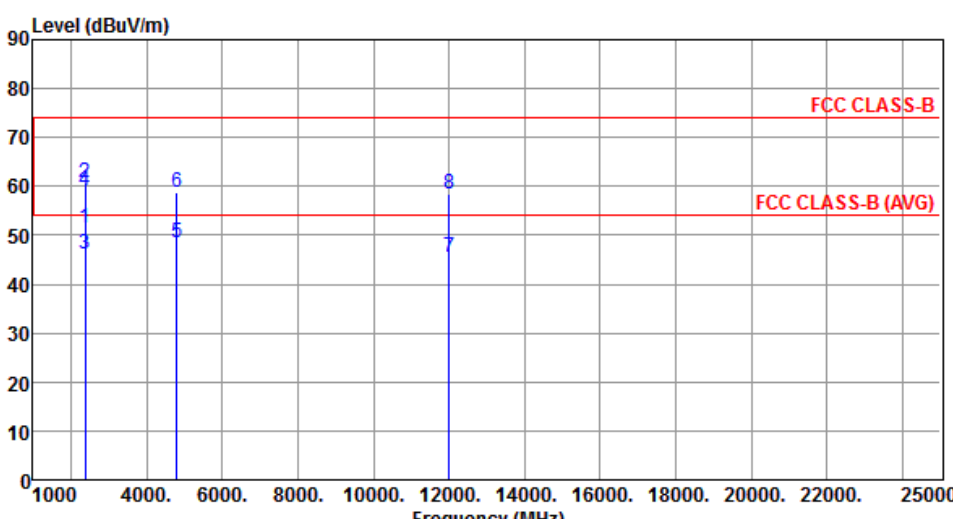
\*Factor includes antenna factor , cable loss and amplifier gain

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.

### 3.5.5 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

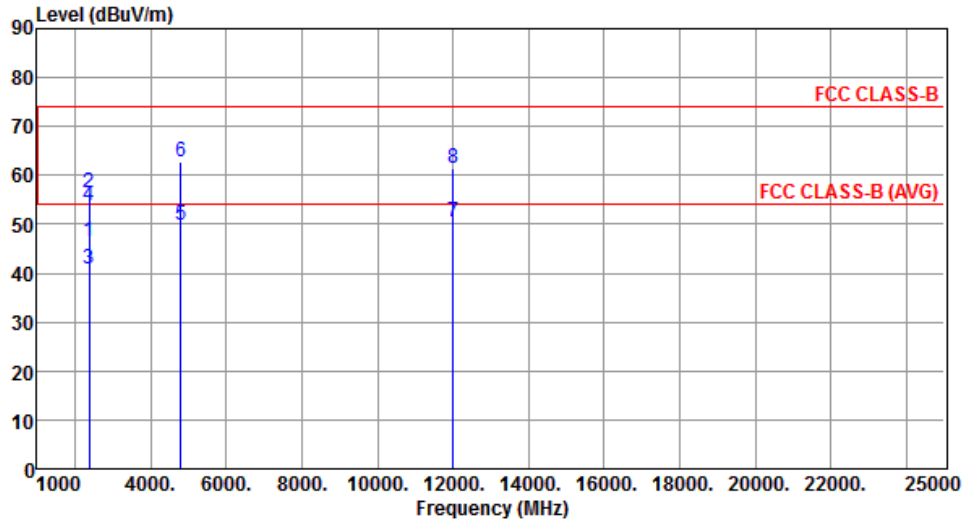
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal	Test Configuration	1

	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2370.00	51.51	54.00	-2.49	54.77	-3.26	Average	100	171
2	2370.00	60.90	74.00	-13.10	64.16	-3.26	Peak	100	171
3	2390.00	46.18	54.00	-7.82	49.36	-3.18	Average	100	171
4	2390.00	59.18	74.00	-14.82	62.36	-3.18	Peak	100	171
5	4804.00	48.55	54.00	-5.45	44.81	3.74	Average	100	154
6	4804.00	58.85	74.00	-15.15	55.11	3.74	Peak	100	154
7	12010.00	45.52	54.00	-8.48	31.97	13.55	Average	171	134
8	12010.00	58.46	74.00	-15.54	44.91	13.55	Peak	171	134

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



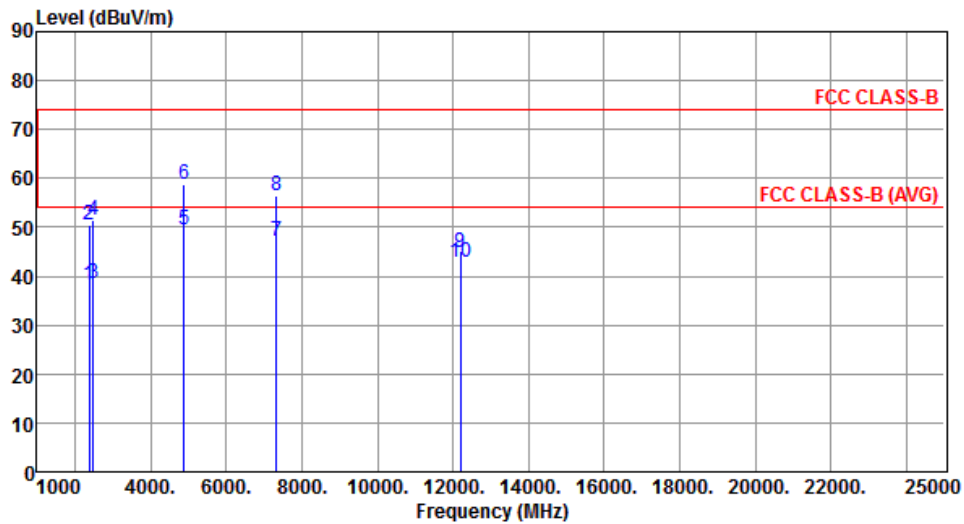
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2370.00	46.65	54.00	-7.35	49.91	-3.26	Average	322	88
2	2370.00	56.58	74.00	-17.42	59.84	-3.26	Peak	322	88
3	2390.00	40.93	54.00	-13.07	44.11	-3.18	Average	322	88
4	2390.00	53.91	74.00	-20.09	57.09	-3.18	Peak	322	88
5	4804.00	49.88	54.00	-4.12	46.14	3.74	Average	100	320
6	4804.00	62.92	74.00	-11.08	59.18	3.74	Peak	100	320
7	12010.00	50.47	54.00	-3.53	36.92	13.55	Average	100	321
8	12010.00	61.55	74.00	-12.45	48.00	13.55	Peak	100	321

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



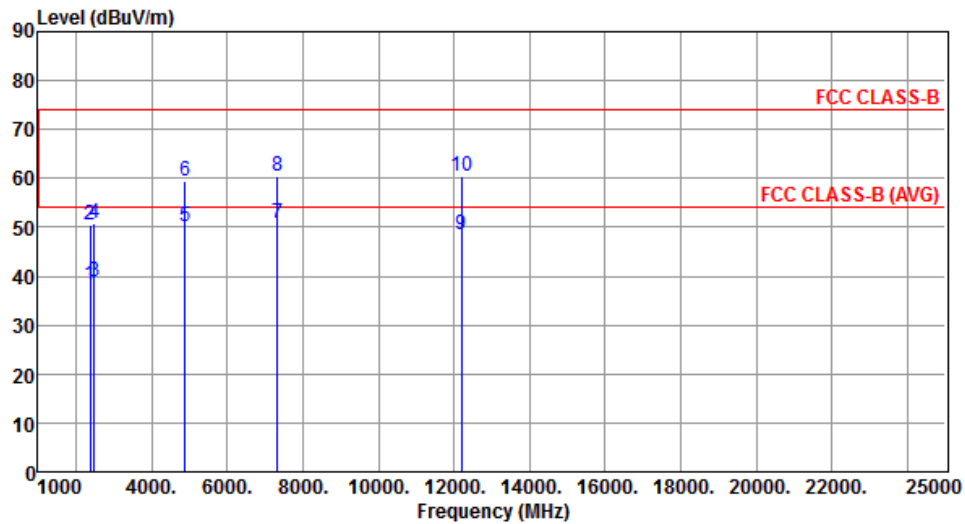
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.19	54.00	-15.81	41.37	-3.18	Average	252	173
2	2390.00	50.45	74.00	-23.55	53.63	-3.18	Peak	252	173
3	2483.50	38.69	54.00	-15.31	41.49	-2.80	Average	252	173
4	2483.50	51.50	74.00	-22.50	54.30	-2.80	Peak	252	173
5	4882.00	49.39	54.00	-4.61	45.43	3.96	Average	100	178
6	4882.00	58.77	74.00	-15.23	54.81	3.96	Peak	100	178
7	7323.00	47.24	54.00	-6.76	38.82	8.42	Average	100	132
8	7323.00	56.38	74.00	-17.62	47.96	8.42	Peak	100	132
9	12205.00	45.00	54.00	-9.00	31.31	13.69	Average	109	83
10	12205.00	42.73	74.00	-31.27	29.04	13.69	Peak	109	83

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



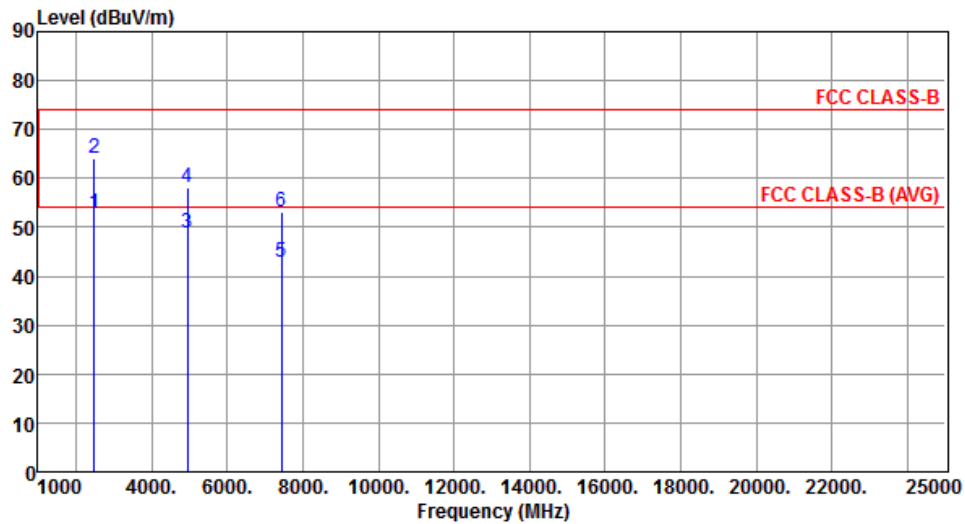
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.29	54.00	-15.71	41.47	-3.18	Average	362	93
2	2390.00	50.57	74.00	-23.43	53.75	-3.18	Peak	362	93
3	2483.50	39.02	54.00	-14.98	41.82	-2.80	Average	362	93
4	2483.50	50.89	74.00	-23.11	53.69	-2.80	Peak	362	93
5	4882.00	50.17	54.00	-3.83	46.21	3.96	Average	100	132
6	4882.00	59.59	74.00	-14.41	55.63	3.96	Peak	100	132
7	7323.00	50.81	54.00	-3.19	42.39	8.42	Average	100	315
8	7323.00	60.44	74.00	-13.56	52.02	8.42	Peak	100	315
9	12205.00	48.59	54.00	-5.41	34.90	13.69	Average	223	334
10	12205.00	60.38	74.00	-13.62	46.69	13.69	Peak	223	334

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)	2479
Polarization	Horizontal	Test Configuration	1



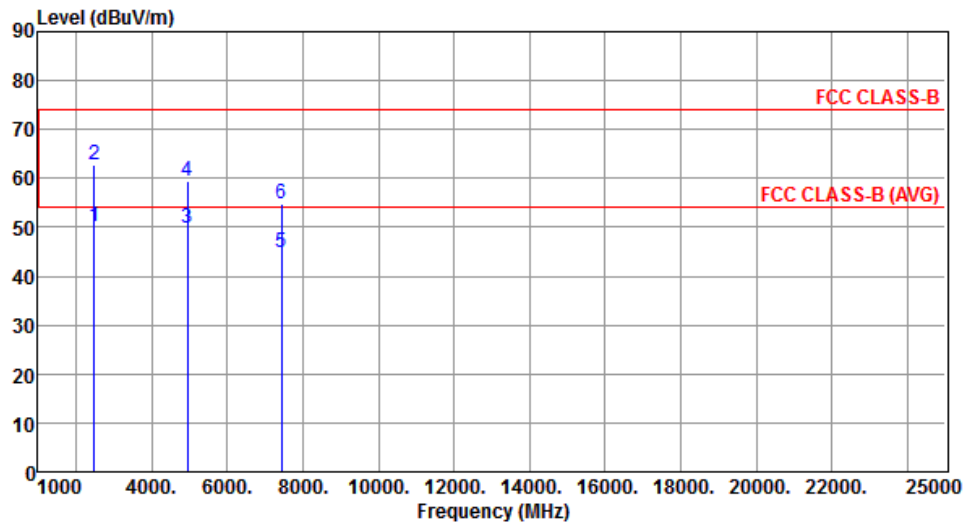
	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	52.92	54.00	-1.08	55.72	-2.80	Average	245	167
2	2483.50	64.05	74.00	-9.95	66.85	-2.80	Peak	245	167
3	4958.00	48.86	54.00	-5.14	44.65	4.21	Average	108	288
4	4958.00	58.17	74.00	-15.83	53.96	4.21	Peak	108	288
5	7437.00	42.73	54.00	-11.27	34.22	8.51	Average	305	100
6	7437.00	53.27	74.00	-20.73	44.76	8.51	Peak	305	100

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)	2479
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	2483.50	50.31	54.00	-3.69	53.11	-2.80	Average	370	85
2	2483.50	62.83	74.00	-11.17	65.63	-2.80	Peak	370	85
3	4958.00	49.93	54.00	-4.07	45.72	4.21	Average	330	183
4	4958.00	59.59	74.00	-14.41	55.38	4.21	Peak	330	183
5	7437.00	44.85	54.00	-9.15	36.34	8.51	Average	205	162
6	7437.00	54.73	74.00	-19.27	46.22	8.51	Peak	205	162

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor\* (dB)

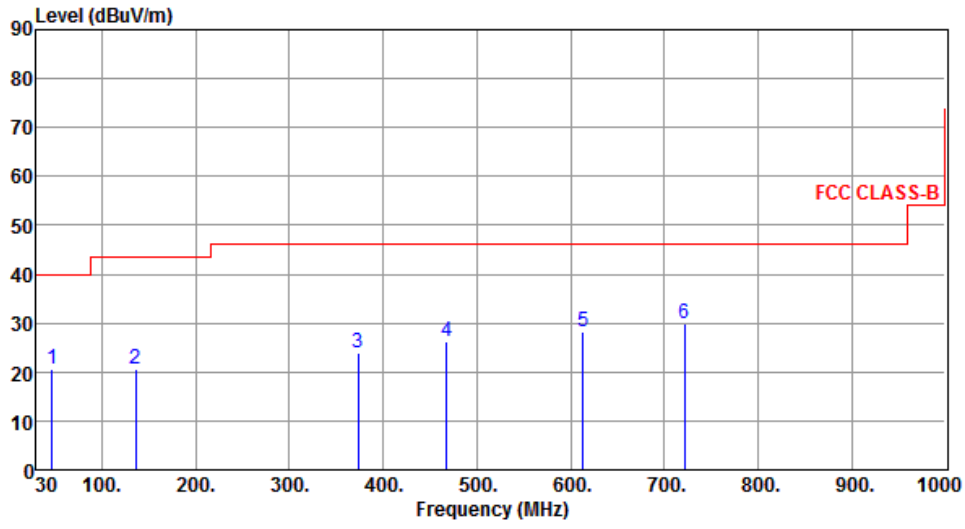
\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).



### 3.5.6 Transmitter Radiated Unwanted Emissions (Below 1GHz)

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

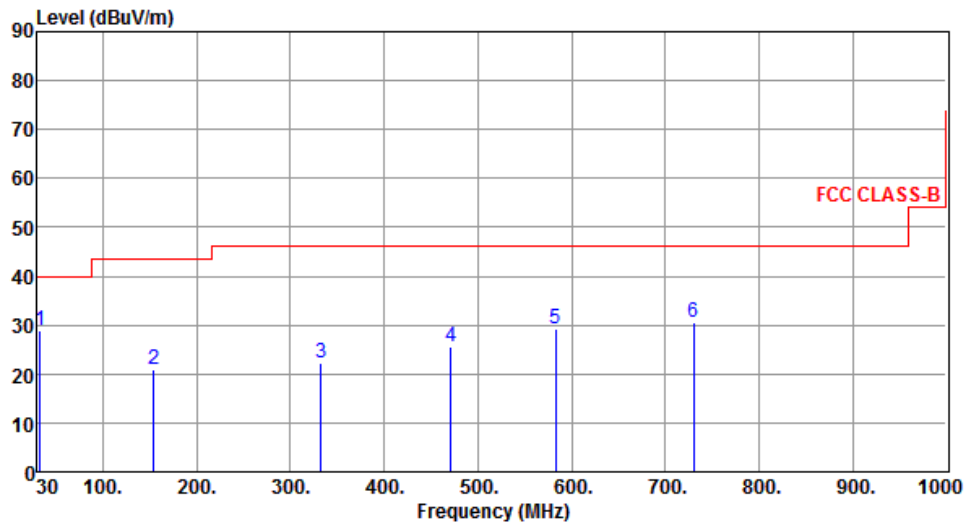
  


The graph displays the radiated unwanted emissions for a transmitter. The y-axis represents the Level in dBuV/m, ranging from 0 to 90. The x-axis represents the Frequency in MHz, ranging from 30 to 1000. A red line indicates the FCC CLASS-B limit, which is 40 dBuV/m from 30 to 100 MHz, 45 dBuV/m from 100 to 1000 MHz, and 55 dBuV/m from 1000 to 10000 MHz. Six measured peaks are labeled with blue numbers 1 through 6. The data for these peaks is provided in the table below.

	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	46.49	20.66	40.00	-19.34	28.24	-7.58	Peak	---	---
2	135.73	20.61	43.50	-22.89	29.22	-8.61	Peak	---	---
3	373.38	23.96	46.00	-22.04	29.62	-5.66	Peak	---	---
4	467.47	26.22	46.00	-19.78	29.64	-3.42	Peak	---	---
5	612.97	28.22	46.00	-17.78	28.71	-0.49	Peak	---	---
6	721.61	29.86	46.00	-16.14	28.61	1.25	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	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	32.91	29.04	40.00	-10.96	37.74	-8.70	Peak	---	---
2	154.16	20.76	43.50	-22.74	28.90	-8.14	Peak	---	---
3	332.64	22.11	46.00	-23.89	28.79	-6.68	Peak	---	---
4	471.35	25.43	46.00	-20.57	28.78	-3.35	Peak	---	---
5	582.90	29.21	46.00	-16.79	30.28	-1.07	Peak	---	---
6	730.34	30.69	46.00	-15.31	29.26	1.43	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

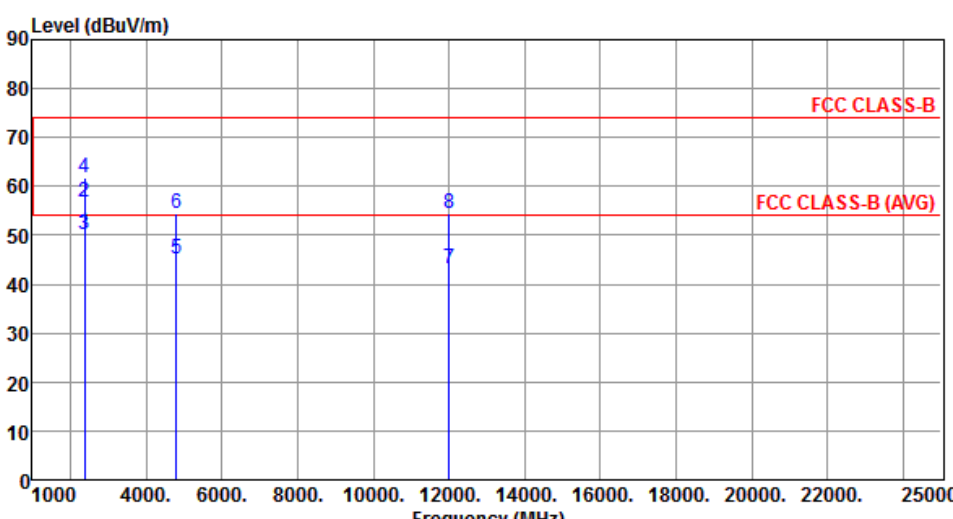
\*Factor includes antenna factor , cable loss and amplifier gain

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.

### 3.5.7 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

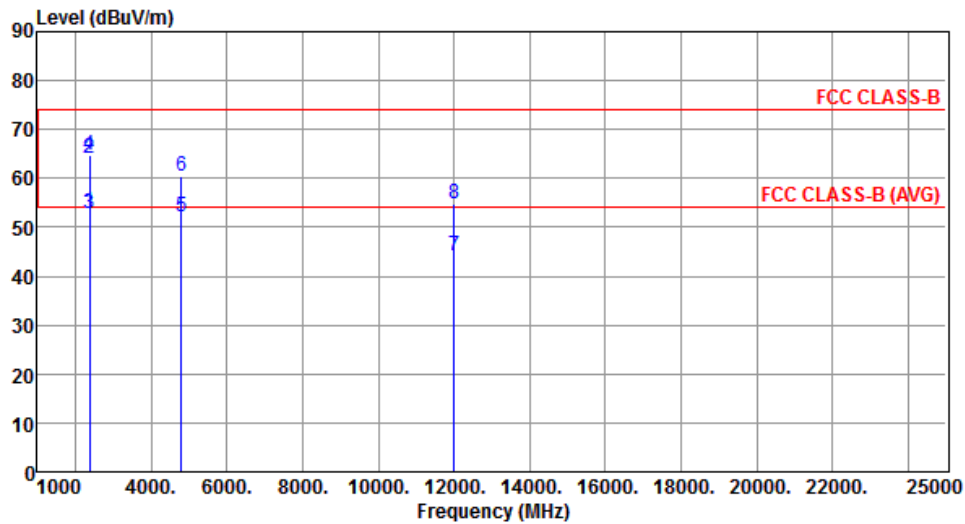
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal	Test Configuration	2

	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2370.00	50.54	54.00	-3.46	53.80	-3.26	Average	107	211
2	2370.00	56.85	74.00	-17.15	60.11	-3.26	Peak	107	211
3	2390.00	50.19	54.00	-3.81	53.37	-3.18	Average	107	211
4	2390.00	61.71	74.00	-12.29	64.89	-3.18	Peak	107	211
5	4804.00	45.14	54.00	-8.86	41.40	3.74	Average	265	203
6	4804.00	54.46	74.00	-19.54	50.72	3.74	Peak	265	203
7	12010.00	43.23	54.00	-10.77	29.68	13.55	Average	115	104
8	12010.00	54.41	74.00	-19.59	40.86	13.55	Peak	115	104

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	2



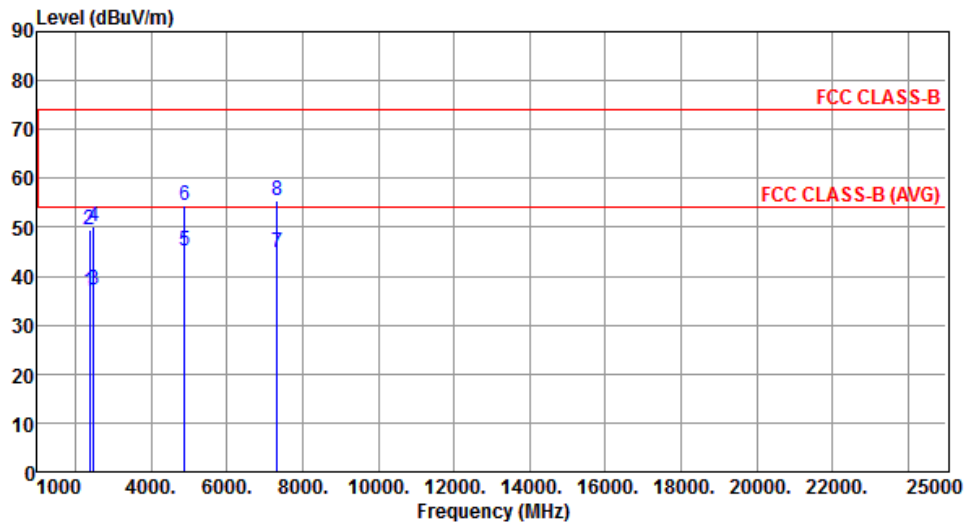
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2370.00	52.99	54.00	-1.01	56.25	-3.26	Average	100	195
2	2370.00	64.22	74.00	-9.78	67.48	-3.26	Peak	100	195
3	2390.00	52.82	54.00	-1.18	56.00	-3.18	Average	100	352
4	2390.00	64.61	74.00	-9.39	67.79	-3.18	Peak	100	352
5	4804.00	52.04	54.00	-1.96	48.30	3.74	Average	320	68
6	4804.00	60.53	74.00	-13.47	56.79	3.74	Peak	320	68
7	12010.00	44.03	54.00	-9.97	30.48	13.55	Average	152	137
8	12010.00	54.90	74.00	-19.10	41.35	13.55	Peak	152	137

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	2



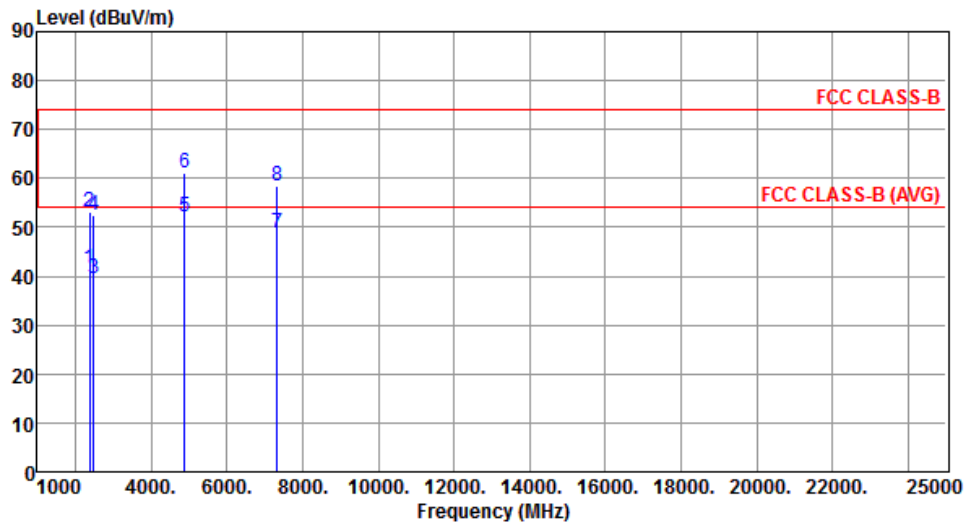
	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	36.75	54.00	-17.25	39.93	-3.18	Average	107	213
2	2390.00	49.64	74.00	-24.36	52.82	-3.18	Peak	107	213
3	2483.50	37.27	54.00	-16.73	40.07	-2.80	Average	107	213
4	2483.50	50.05	74.00	-23.95	52.85	-2.80	Peak	107	213
5	4882.00	45.25	54.00	-8.75	41.29	3.96	Average	100	283
6	4882.00	54.43	74.00	-19.57	50.47	3.96	Peak	100	283
7	7323.00	44.99	54.00	-9.01	36.57	8.42	Average	100	157
8	7323.00	55.48	74.00	-18.52	47.06	8.42	Peak	100	157

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	2



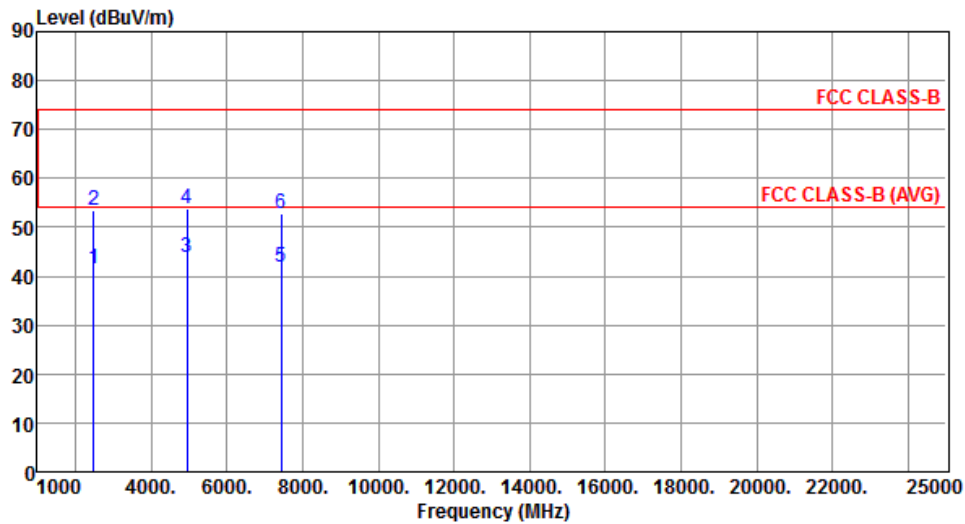
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	41.52	54.00	-12.48	44.70	-3.18	Average	140	353
2	2390.00	52.99	74.00	-21.01	56.17	-3.18	Peak	140	353
3	2483.50	39.50	54.00	-14.50	42.30	-2.80	Average	140	353
4	2483.50	52.59	74.00	-21.41	55.39	-2.80	Peak	140	353
5	4882.00	52.08	54.00	-1.92	48.12	3.96	Average	312	68
6	4882.00	61.03	74.00	-12.97	57.07	3.96	Peak	312	68
7	7323.00	48.90	54.00	-5.10	40.48	8.42	Average	234	312
8	7323.00	58.59	74.00	-15.41	50.17	8.42	Peak	234	312

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)	2479
Polarization	Horizontal	Test Configuration	2



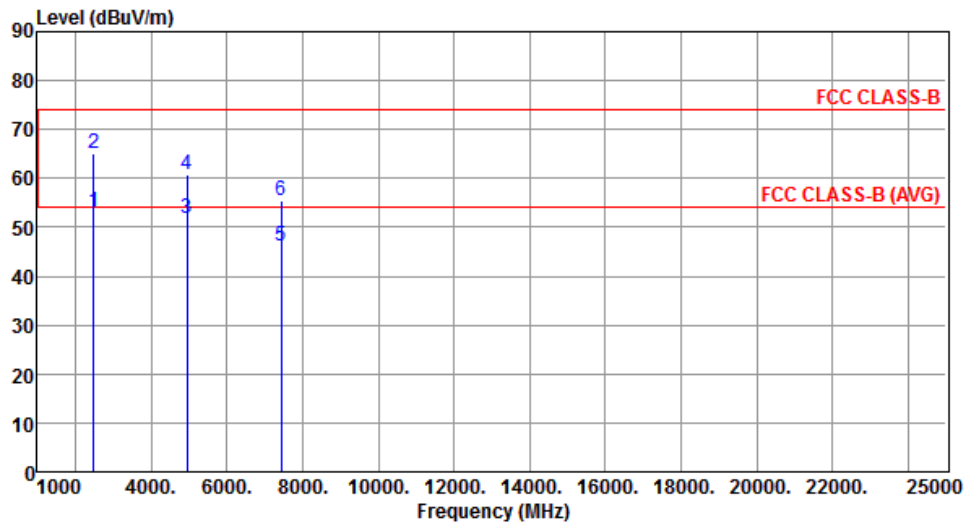
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	41.59	54.00	-12.41	44.39	-2.80	Average	109	24
2	2483.50	53.40	74.00	-20.60	56.20	-2.80	Peak	109	24
3	4958.00	43.97	54.00	-10.03	39.76	4.21	Average	100	153
4	4958.00	53.86	74.00	-20.14	49.65	4.21	Peak	100	153
5	7437.00	41.95	54.00	-12.05	33.44	8.51	Average	100	196
6	7437.00	52.68	74.00	-21.32	44.17	8.51	Peak	100	196

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)	2479
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	2483.50	52.99	54.00	-1.01	55.79	-2.80	Average	100	93
2	2483.50	64.94	74.00	-9.06	67.74	-2.80	Peak	100	93
3	4958.00	51.84	54.00	-2.16	47.63	4.21	Average	272	219
4	4958.00	60.66	74.00	-13.34	56.45	4.21	Peak	272	219
5	7437.00	46.10	54.00	-7.90	37.59	8.51	Average	220	156
6	7437.00	55.40	74.00	-18.60	46.89	8.51	Peak	220	156

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).



## 3.6 Emissions in Non-Restricted Frequency Bands

### 3.6.1 Emissions in Non-Restricted Frequency Bands Limit

Peak power 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

### 3.6.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

### 3.6.3 Test Procedures

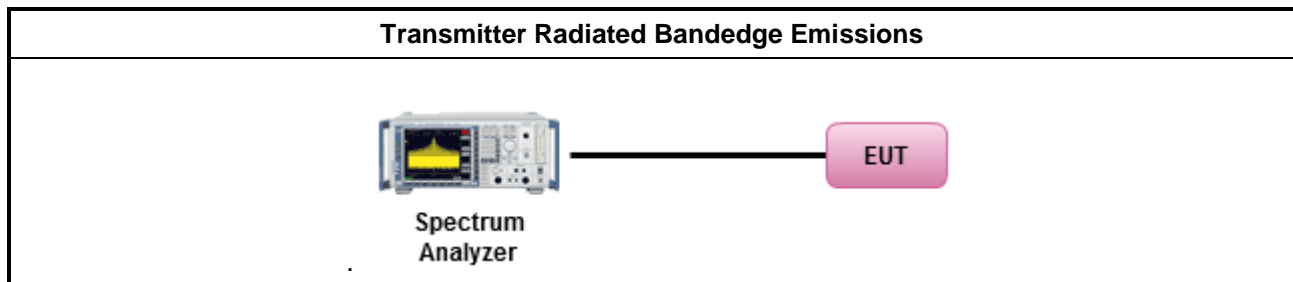
#### Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

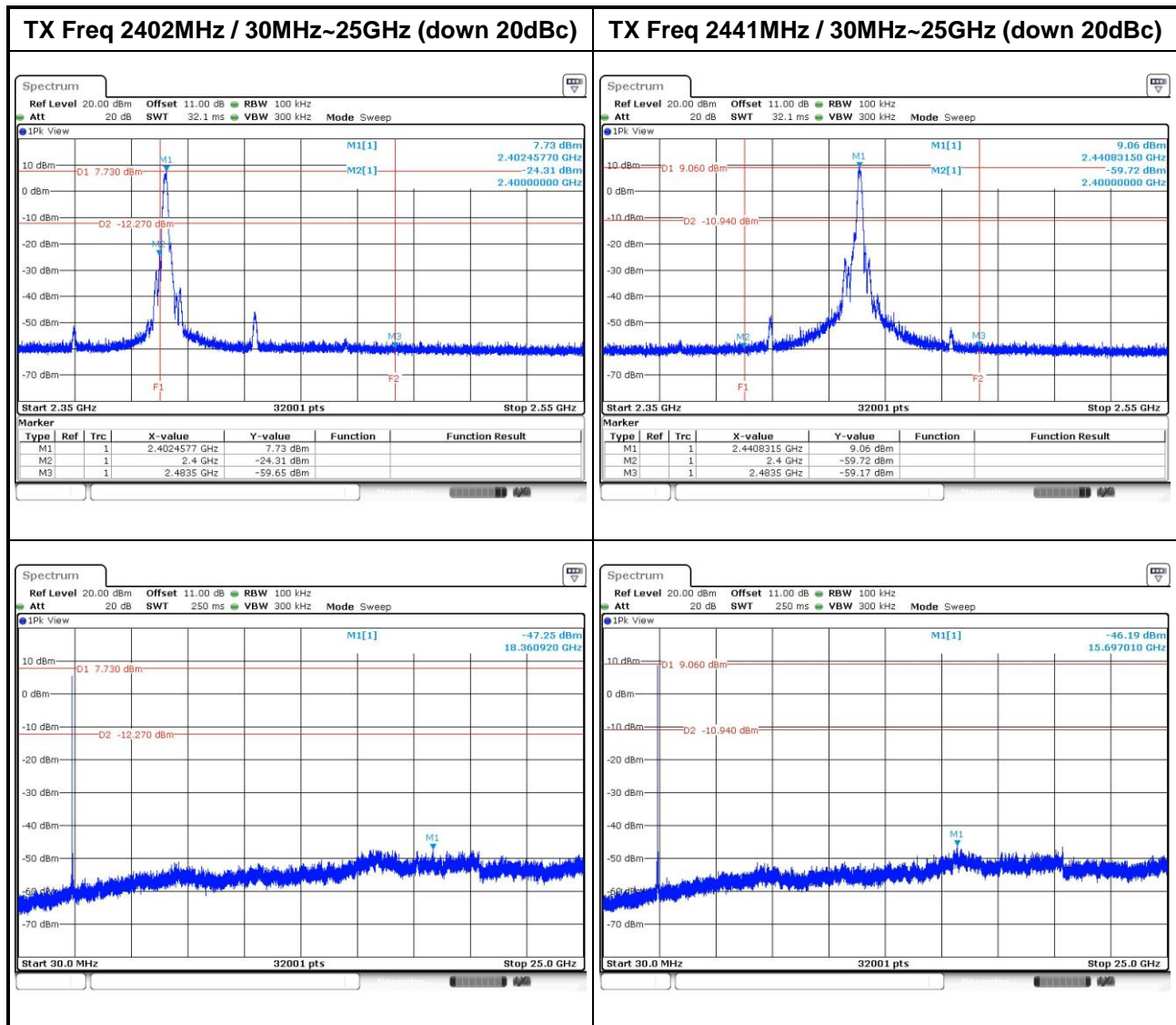
#### Emission level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

### 3.6.4 Test Setup

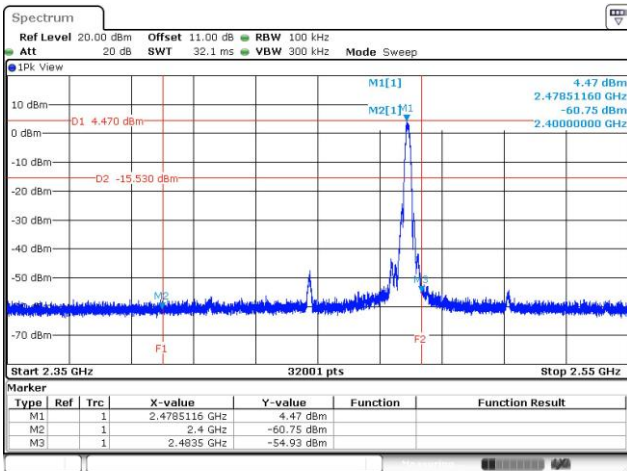


### 3.6.5 Unwanted Emissions into Non-Restricted Frequency Bands

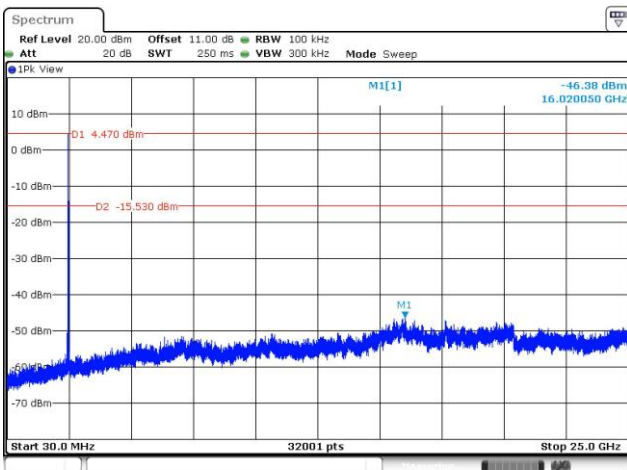


# TX Freq 2479MHz / 30MHz~25GHz (down 20dBc)

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## 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>.

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Taiwan, R.O.C.

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333, Taiwan, R.O.C.

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City 333, Taiwan, R.O.C.

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

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