# FCC Test Report

| | | |
|---|---|---|
| **FCC ID** | : | **PRDMU24** |
| **Equipment** | : | **Rechargeable Bluetooth Notebook Mouse** |
| **Model No.** | : | **VP6155**<br>**(Please refer to item 1.1.1 for more details)** |
| **Brand Name** | : | **ACROX** |
| **Applicant** | : | **ACROX Technologies Co., Ltd.** |
| **Address** | : | **4F., No.89, Minshan St., Neihu Dist., Taipei City 114** |
| **Standard** | : | **47 CFR FCC Part 15.247** |
| **Received Date** | : | **Jan. 22, 2014** |
| **Tested Date** | : | **Feb. 05 ~ Feb. 10, 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

# Table of Contents


**1 GENERAL DESCRIPTION ..... 5**

1.1 Information ..... 5
1.2 Local Support Equipment List ..... 7
1.3 Test Setup Chart ..... 7
1.4 The Equipment List ..... 7
1.5 Test Standards ..... 9
1.6 Measurement Uncertainty ..... 9

**2 TEST CONFIGURATION ..... 10**

2.1 Testing Condition ..... 10
2.2 The Worst Test Modes and Channel Details ..... 10

**3 TRANSMITTER TEST RESULTS ..... 11**

3.1 Conducted Emissions ..... 11
3.2 Unwanted Emissions into Restricted Frequency Bands ..... 14
3.3 Emissions in non-restricted frequency bands ..... 24
3.4 Conducted Output Power ..... 27
3.5 Number of Hopping Frequency ..... 29
3.6 20dB and Occupied Bandwidth ..... 31
3.7 Channel Separation ..... 33
3.8 Number of Dwell Time ..... 35

**4 TEST LABORATORY INFORMATION ..... 37**

# Release Record

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| FR412204 | Rev. 01 | Initial issue | Mar. 05, 2014 |

# Summary of Test Results

| FCC Rules | Test Items | Measured | Result |
|---|---|---|---|
| 15.207 | Conducted Emissions | [dBuV]: 0.193MHz<br>57.37 (Margin 6.52dB) - QP | Pass |
| 15.247(d)<br>15.209 | Radiated Emissions | [dBuV/m at 3m]: 4882.00MHz<br>71.94 (Margin 2.06dB) - PK | Pass |
| 15.247(d) | Band Edge | Meet the requirement of limit | Pass |
| 15.247(b)(1) | Conducted Output Power | Power [dBm]: -0.55 | 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 Product Details

The following models are provided to this EUT.

| Brand Name | Model Name | Product Name |
|---|---|---|
| ACROX | VP6155 | Rechargeable Bluetooth Notebook Mouse |
| | MDQ | |
| | MDN | |
| ✦ All models are electrically identical, different model names are for marketing purpose.<br>✦ The above models, model **VP6155** was selected as a representative one for the final test and only its data was recorded in this report. | | |

### 1.1.2 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 V3.0 | 2402-2480 | 0-78 [79] | 1 Mbps |
| Note 1: RF output power specifies that Maximum Peak Conducted Output Power.<br>Note 2: EDR mode is not supported and modulation type is GFSK only. | | | | |

### 1.1.3 Antenna Details

| Ant. No. | Type | Gain (dBi) | Connector | Remark |
|---|---|---|---|---|
| 1 | PCB | 2.78 | --- | --- |

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

| | |
|---|---|
| **Power Supply Type** | 3Vdc from battery. |

Note: The equipment tests are performed using a new battery.

### 1.1.5 Accessories

| Accessories | | |
|---|---|---|
| **No.** | **Equipment** | **Description** |
| 1 | USB Cable | 1.5m shielded w/o core. |

### 1.1.6 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 | --- | --- |

### 1.1.7 Test Tool and Duty Cycle

| | |
|---|---|
| **Test Tool** | Brocom Blue Tool, Version1.4.5.4 |

### 1.1.8 Power Setting

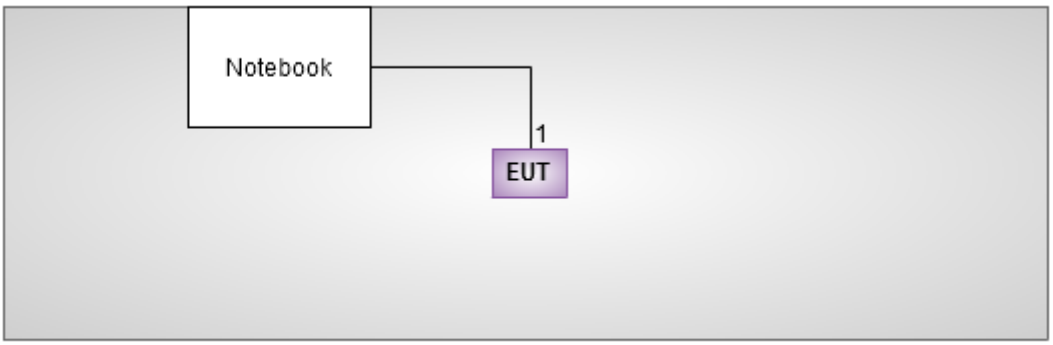
| Modulation Mode | Test Frequency (MHz) | | |
|---|---|---|---|
| | 2402 | 2441 | 2480 |
| GFSK/1Mbps | 0dBm | 0dBm | 0dBm |

## 1.2 Local Support Equipment List

| Support Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **No.** | **Equipment** | **Brand** | **Model** | **S/N** | **FCC ID** | **Signal cable / Length (m)** |
| 1 | Notebook | DELL | E6420 | --- | DoC | USB, 1.5m non-shielded w/o core |

## 1.3 Test Setup Chart

**Test Setup Diagram**




1. USB, 1.5m shielded 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 | 100169 | Oct. 15, 2013 | Oct. 14, 2014 |
| LISN | SCHWARZBECK MESS-ELEKTRONIK | Schwarzbeck 8127 | 8127-667 | Nov. 23, 2013 | Nov. 22, 2014 |
| LISN (Support Unit) | SCHWARZBECK MESS-ELEKTRONIK | Schwarzbeck 8127 | 8127-666 | Dec. 04, 2013 | Dec. 03, 2014 |
| RF Cable-CON | Woken | CFD200-NL | CFD200-NL-001 | Apr. 24, 2013 | Apr. 23, 2014 |
| 50 ohm terminal (Support Unit) | NA | 50 | 04 | Apr. 22, 2013 | Apr. 21, 2014 |
| 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 | Jan. 25, 2014 | Jan. 24, 2015 |
| Receiver | R&S | ESR3 | 101658 | Jan. 10, 2014 | Jan. 09, 2015 |
| Bilog Antenna | SCHWARZBECK | VULB9168 | VULB9168-522 | Jan. 03, 2014 | Jan. 02, 2015 |
| Horn Antenna 1G-18G | SCHWARZBECK | BBHA 9120 D | BBHA 9120 D 1096 | Feb. 18, 2013 | Feb. 17, 2014 |
| Horn Antenna 18G-40G | SCHWARZBECK | BBHA 9170 | BBHA 9170517 | Dec. 27, 2013 | Dec. 26, 2014 |
| Amplifier | Burgeon | BPA-530 | 100219 | Nov. 22, 2013 | Nov. 21, 2014 |
| Amplifier | Agilent | 83017A | MY39501308 | Dec. 16, 2013 | Dec. 15, 2014 |
| RF Cable | HUBER+SUHNER | SUCOFLEX104 | MY16014/4 | Dec. 16, 2013 | Dec. 15, 2014 |
| RF Cable | HUBER+SUHNER | SUCOFLEX104 | MY16019/4 | Dec. 16, 2013 | Dec. 15, 2014 |
| RF Cable | HUBER+SUHNER | SUCOFLEX104 | MY16139/4 | Dec. 16, 2013 | Dec. 15, 2014 |
| RF Cable-R03m | Woken | CFD400NL-LW | CFD400NL-001 | Dec. 16, 2013 | Dec. 15, 2014 |
| RF Cable-R10m | Woken | CFD400NL-LW | CFD400NL-002 | Dec. 16, 2013 | Dec. 15, 2014 |
| control | EM Electronics | EM1000 | 60612 | N/A | N/A |
| Note: Calibration Interval of instruments listed above is one year. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Loop Antenna | R&S | HFH2-Z2 | 100330 | Nov. 15, 2012 | Nov. 14, 2014 |
| Amplifier | EM | EM18G40G | 060572 | Jun. 20, 2013 | Jun. 19, 2015 |
| 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 | FSV 40 | 101063 | Feb. 18, 2013 | Feb. 17, 2014 |
| Power Meter | Anritsu | ML2495A | 1241002 | Oct. 24, 2013 | Oct. 23, 2014 |
| Power Sensor | Anritsu | MA2411B | 1027366 | Oct. 24, 2013 | Oct. 23, 2014 |
| 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

Note: The EUT has been tested and complied with FCC part 15B requirement. FCC Part 15B test results are issued to another report.

## 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 | ±35.286 Hz |
| Conducted power | ±0.536 dB |
| Frequency error | ±35.286 Hz |
| Temperature | ±0.3 $^{o}$C |
| Conducted emission | ±2.946 dB |
| AC conducted emission | ±2.43 dB |
| Radiated emission | ±2.49 dB |

# 2 Test Configuration

## 2.1 Testing Condition

| Test Item | Test Site | Ambient Condition | Tested By |
|---|---|---|---|
| AC Conduction | CO01-WS | 22°C / 69% | Alex Tsai |
| Radiated Emissions | 03CH01-WS | 23°C / 64% | Haru Yang |
| RF Conducted | TH01-WS | 22°C / 63% | Felix Sung |

- FCC site registration No.: 657002
- 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 |
|---|---|---|---|---|
| Conducted Emissions | GFSK | 2480 | 1Mbps | - |
| Radiated Emissions < 1GHz | GFSK | 2480 | 1Mbps | - |
| Radiated Emissions > 1GHz | GFSK | 2402, 2441, 2480 | 1Mbps | - |
| Conducted Output Power | GFSK | 2402, 2441, 2480 | 1Mbps | - |
| Number of Hopping Channels | GFSK | 2402~2480 | 1Mbps | - |
| Hopping Channel Separation | GFSK | 2402, 2441, 2480 | 1Mbps | - |
| Dwell Time | GFSK | 2402 | 1Mbps | - |

# 3 Transmitter Test Results

## 3.1 Conducted Emissions

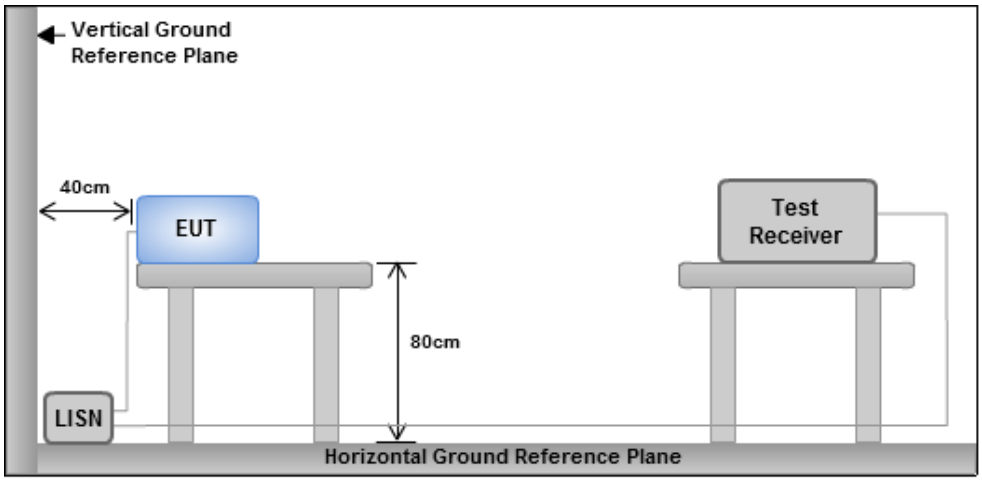
### 3.1.1 Limit of Conducted Emissions

| 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.

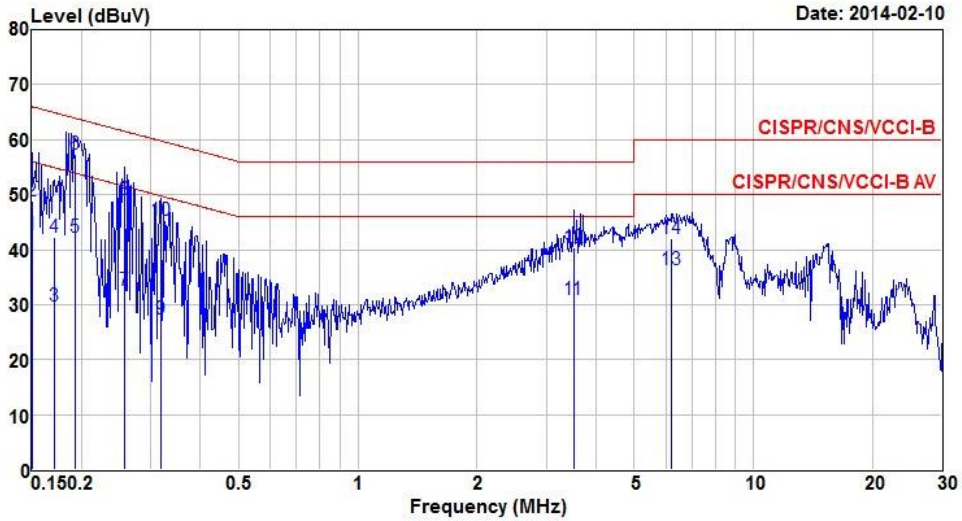
### 3.1.3 Test Setup




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

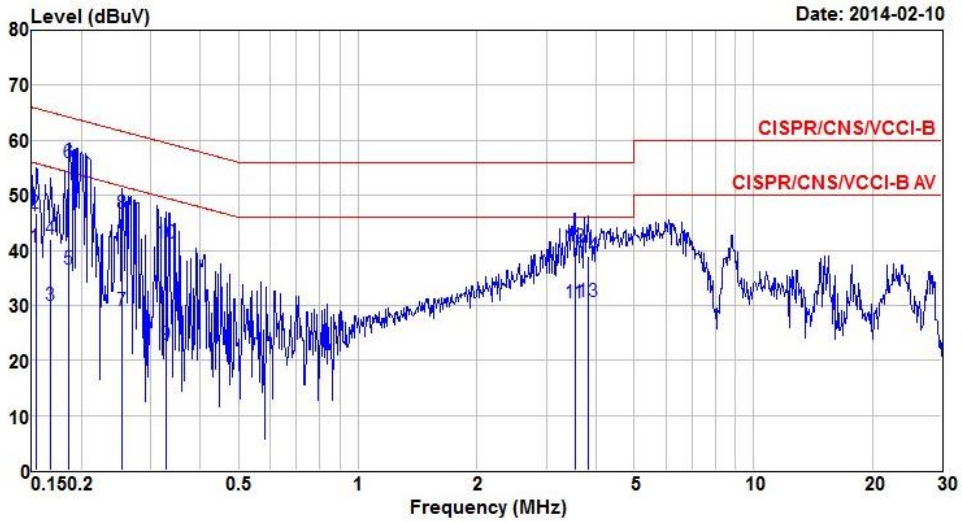
| Power Phase | Line | Test Freq. (MHz) | 2480 |
|---|---|---|---|
| Test Mode | - | | |




| | | Freq MHz | Level dBuV | Limit Line dBuV | Over Limit dB | Read Level dBuV | LISN factor dB | cable loss dB | Remark |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.150 | 42.71 | 56.00 | -13.29 | 42.25 | 0.40 | 0.06 | Average |
| 2 | | 0.150 | 48.84 | 66.00 | -17.16 | 48.38 | 0.40 | 0.06 | QP |
| 3 | | 0.171 | 29.70 | 54.90 | -25.20 | 29.19 | 0.40 | 0.11 | Average |
| 4 | | 0.171 | 42.34 | 64.90 | -22.56 | 41.83 | 0.40 | 0.11 | QP |
| 5 | | 0.193 | 42.15 | 53.89 | -11.74 | 41.59 | 0.39 | 0.17 | Average |
| 6 | * | 0.193 | 57.37 | 63.89 | -6.52 | 56.81 | 0.39 | 0.17 | QP |
| 7 | | 0.258 | 32.50 | 51.51 | -19.01 | 31.98 | 0.39 | 0.13 | Average |
| 8 | | 0.258 | 49.08 | 61.51 | -12.43 | 48.56 | 0.39 | 0.13 | QP |
| 9 | | 0.317 | 27.39 | 49.80 | -22.41 | 26.91 | 0.39 | 0.09 | Average |
| 10 | | 0.317 | 45.20 | 59.80 | -14.60 | 44.72 | 0.39 | 0.09 | QP |
| 11 | | 3.509 | 30.82 | 46.00 | -15.18 | 30.15 | 0.45 | 0.22 | Average |
| 12 | | 3.509 | 40.45 | 56.00 | -15.55 | 39.78 | 0.45 | 0.22 | QP |
| 13 | | 6.219 | 36.30 | 50.00 | -13.70 | 35.62 | 0.50 | 0.18 | Average |
| 14 | | 6.219 | 42.03 | 60.00 | -17.97 | 41.35 | 0.50 | 0.18 | QP |

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

| Power Phase | Neutral | Test Freq. (MHz) | 2480 |
|---|---|---|---|
| Test Mode | - | | |




| | | Freq MHz | Level dBuV | Limit Line dBuV | Over Limit dB | Read Level dBuV | LISN factor dB | cable loss dB | Remark |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.153 | 40.58 | 55.82 | -15.24 | 40.03 | 0.48 | 0.07 | Average |
| 2 | | 0.153 | 46.84 | 65.82 | -18.98 | 46.29 | 0.48 | 0.07 | QP |
| 3 | | 0.168 | 30.00 | 55.08 | -25.08 | 29.41 | 0.48 | 0.11 | Average |
| 4 | | 0.168 | 42.02 | 65.08 | -23.06 | 41.43 | 0.48 | 0.11 | QP |
| 5 | | 0.186 | 36.57 | 54.20 | -17.63 | 35.94 | 0.48 | 0.15 | Average |
| 6 | * | 0.186 | 56.03 | 64.20 | -8.17 | 55.40 | 0.48 | 0.15 | QP |
| 7 | | 0.253 | 28.93 | 51.64 | -22.71 | 28.31 | 0.48 | 0.14 | Average |
| 8 | | 0.253 | 46.80 | 61.64 | -14.84 | 46.18 | 0.48 | 0.14 | QP |
| 9 | | 0.327 | 22.98 | 49.53 | -26.55 | 22.42 | 0.47 | 0.09 | Average |
| 10 | | 0.327 | 41.20 | 59.53 | -18.33 | 40.64 | 0.47 | 0.09 | QP |
| 11 | | 3.547 | 30.38 | 46.00 | -15.62 | 29.63 | 0.52 | 0.23 | Average |
| 12 | | 3.547 | 40.67 | 56.00 | -15.33 | 39.92 | 0.52 | 0.23 | QP |
| 13 | | 3.820 | 30.77 | 46.00 | -15.23 | 30.02 | 0.52 | 0.23 | Average |
| 14 | | 3.820 | 39.01 | 56.00 | -16.99 | 38.26 | 0.52 | 0.23 | QP |

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

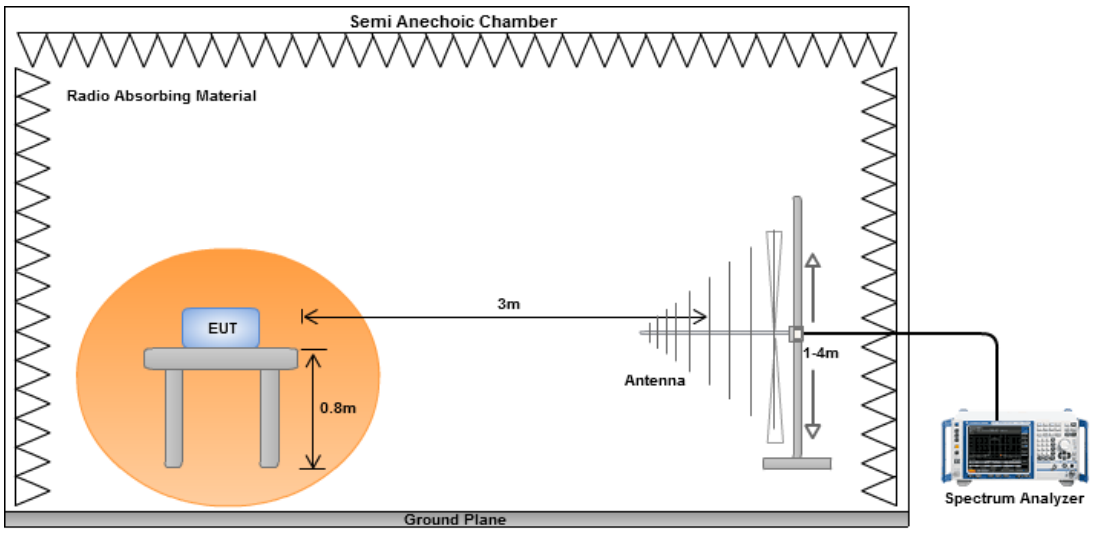
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. Radiated emission above 1GHz / Peak value
   RBW=1MHz, VBW=3MHz and Peak detector
3. Radiated emission above 1GHz / Average value for fundamental and harmonics
   The average value is: Average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

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

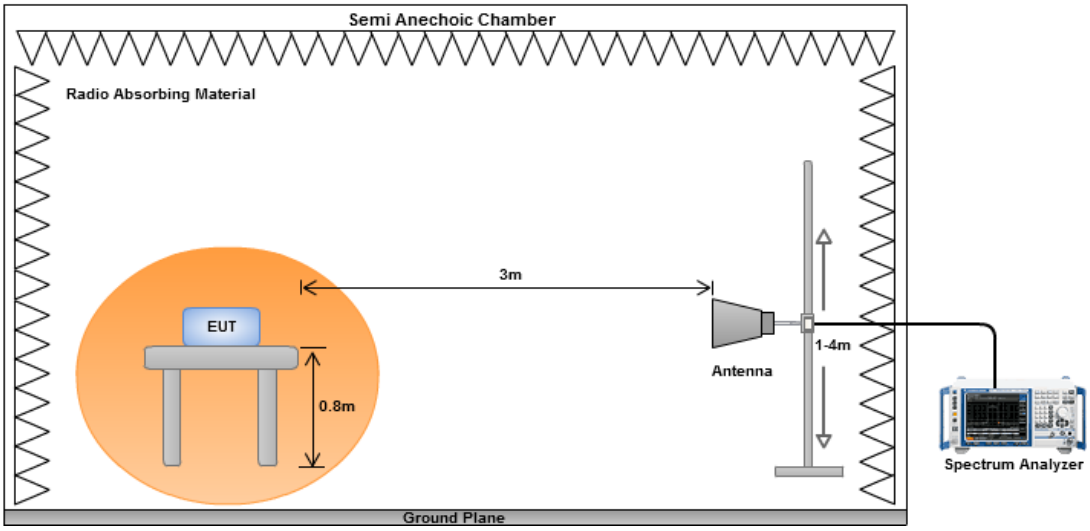
4. Radiated emission above 1GHz / Average value for other emissions
   RBW=1MHz, VBW=1/T and Peak detector

### 3.2.3 Test Setup

**Radiated Emissions below 1 GHz**

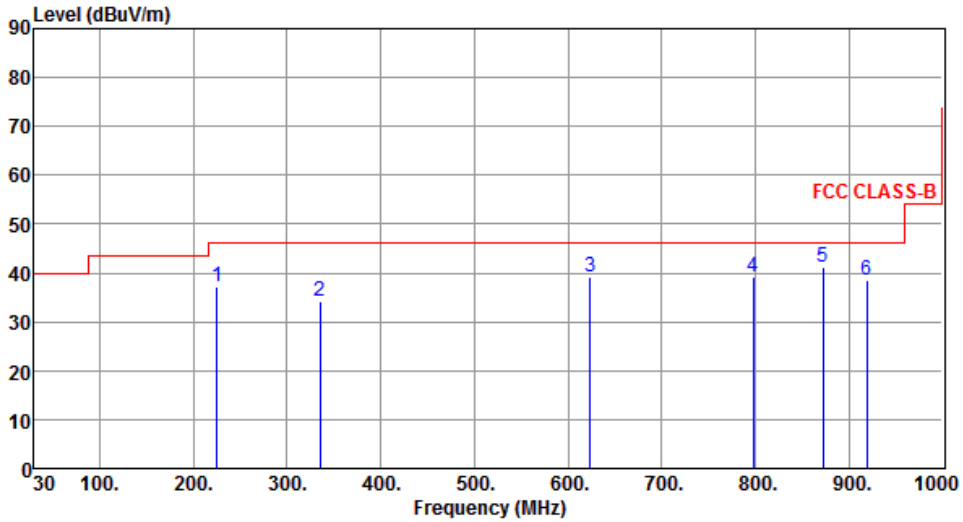



**Radiated Emissions above 1 GHz**



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

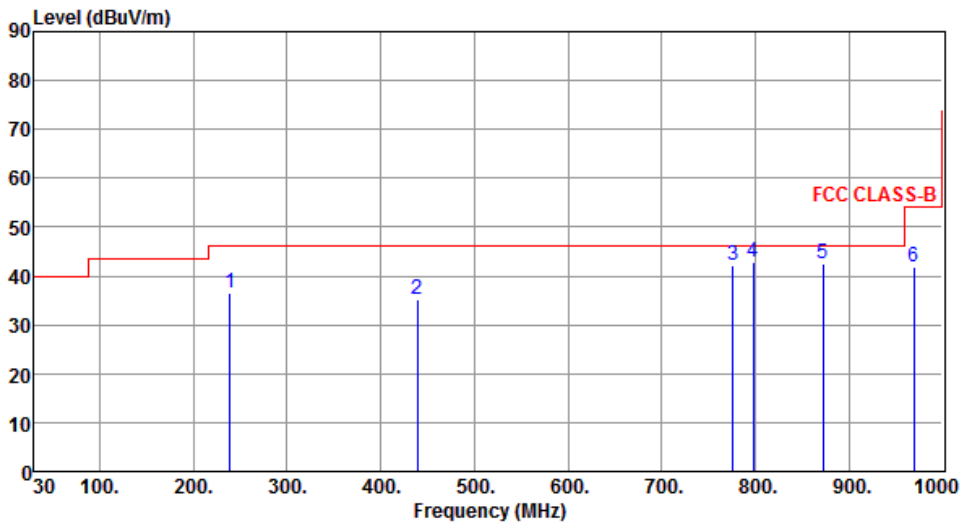
| **Modulation** | GFSK | **Test Freq. (MHz)** | 2480 |
|---|---|---|---|
| **Polarization** | Horizontal | | |




| | Freq. MHz | Emission level dBuV/m | Limit dBuV/m | Margin dB | SA reading dBuV | Factor dB | Remark | ANT High cm | Turn Table deg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 224.97 | 37.27 | 46.00 | -8.73 | 56.12 | -18.85 | Peak | --- | --- |
| 2 | 335.55 | 34.30 | 46.00 | -11.70 | 49.68 | -15.38 | Peak | --- | --- |
| 3 | 623.64 | 39.19 | 46.00 | -6.81 | 48.40 | -9.21 | Peak | --- | --- |
| 4 | 798.24 | 39.23 | 46.00 | -6.77 | 46.02 | -6.79 | Peak | --- | --- |
| 5 | 871.96 | 41.23 | 46.00 | -4.77 | 47.10 | -5.87 | Peak | --- | --- |
| 6 | 919.49 | 38.48 | 46.00 | -7.52 | 43.65 | -5.17 | 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 | | |

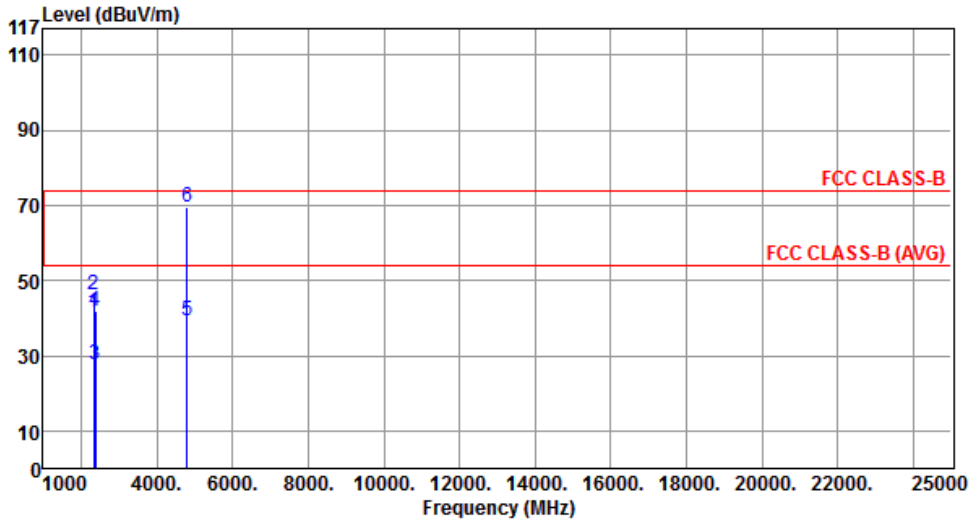



| | Freq. MHz | Emission level dBuV/m | Limit dBuV/m | Margin dB | SA reading dBuV | Factor dB | Remark | ANT High cm | Turn Table deg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 239.52 | 36.56 | 46.00 | -9.44 | 54.73 | -18.17 | Peak | --- | --- |
| 2 | 439.34 | 35.37 | 46.00 | -10.63 | 48.13 | -12.76 | Peak | --- | --- |
| 3 | 775.93 | 42.13 | 46.00 | -3.87 | 49.12 | -6.99 | Peak | --- | --- |
| 4 | 798.24 | 42.97 | 46.00 | -3.03 | 49.76 | -6.79 | QP | --- | --- |
| 5 | 871.96 | 42.59 | 46.00 | -3.41 | 48.46 | -5.87 | Peak | --- | --- |
| 6 | 968.96 | 41.76 | 54.00 | -12.24 | 46.33 | -4.57 | 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

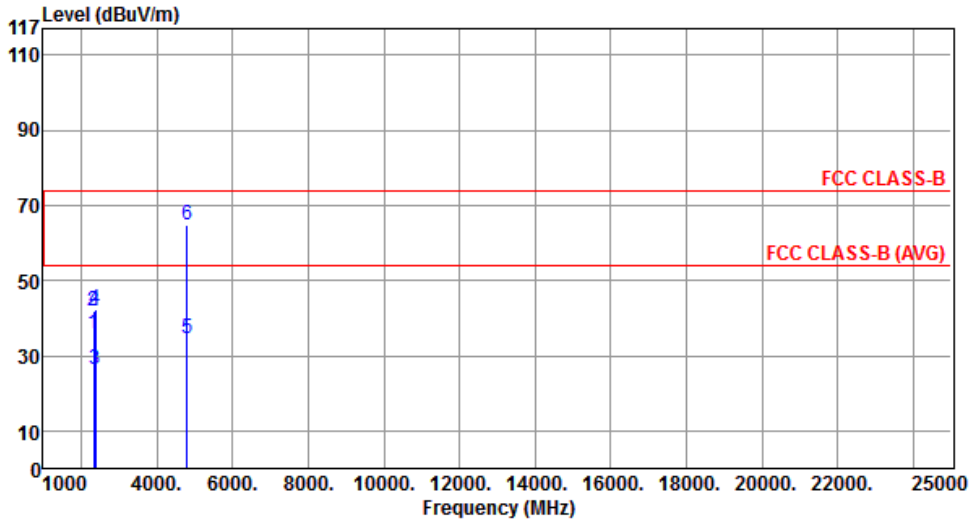
| **Modulation** | GFSK | **Test Freq. (MHz)** | 2402 |
|---|---|---|---|
| **Polarization** | Horizontal | | |




| | Freq. MHz | Emission level dBuV/m | Limit dBuV/m | Margin dB | SA reading dBuV | Factor dB | Remark | ANT High cm | Turn Table deg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2330.00 | 41.58 | 54.00 | -12.42 | 45.31 | -3.73 | Average | --- | --- |
| 2 | 2330.00 | 46.03 | 74.00 | -27.97 | 49.76 | -3.73 | Peak | --- | --- |
| 3 | 2390.00 | 27.42 | 54.00 | -26.58 | 30.90 | -3.48 | Average | --- | --- |
| 4 | 2390.00 | 41.84 | 74.00 | -32.16 | 45.32 | -3.48 | Peak | --- | --- |
| 5 | 4804.00 | 39.40 | 54.00 | -14.60 | 34.30 | 5.10 | Average | --- | --- |
| 6 | 4804.00 | 69.50 | 74.00 | -4.50 | 64.40 | 5.10 | 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).

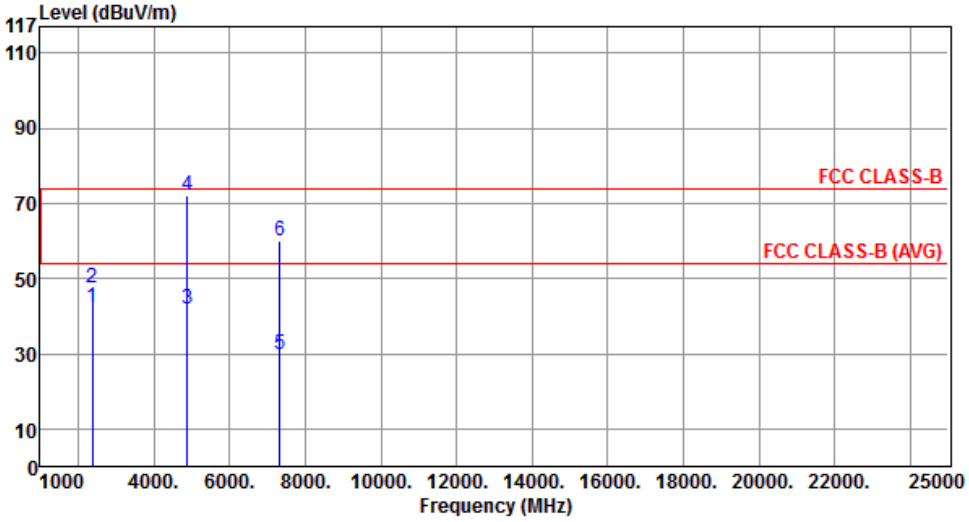
| Modulation | GFSK | Test Freq. (MHz) | 2402 |
|---|---|---|---|
| Polarization | Vertical | | |




| | Freq. MHz | Emission level dBuV/m | Limit dBuV/m | Margin dB | SA reading dBuV | Factor dB | Remark | ANT High cm | Turn Table deg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2330.00 | 35.84 | 54.00 | -18.16 | 39.57 | -3.73 | Average | --- | --- |
| 2 | 2330.00 | 41.86 | 74.00 | -32.14 | 45.59 | -3.73 | Peak | --- | --- |
| 3 | 2390.00 | 26.24 | 54.00 | -27.76 | 29.72 | -3.48 | Average | --- | --- |
| 4 | 2390.00 | 42.50 | 74.00 | -31.50 | 45.98 | -3.48 | Peak | --- | --- |
| 5 | 4804.00 | 34.60 | 54.00 | -19.40 | 29.50 | 5.10 | Average | --- | --- |
| 6 | 4804.00 | 64.70 | 74.00 | -9.30 | 59.60 | 5.10 | 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).

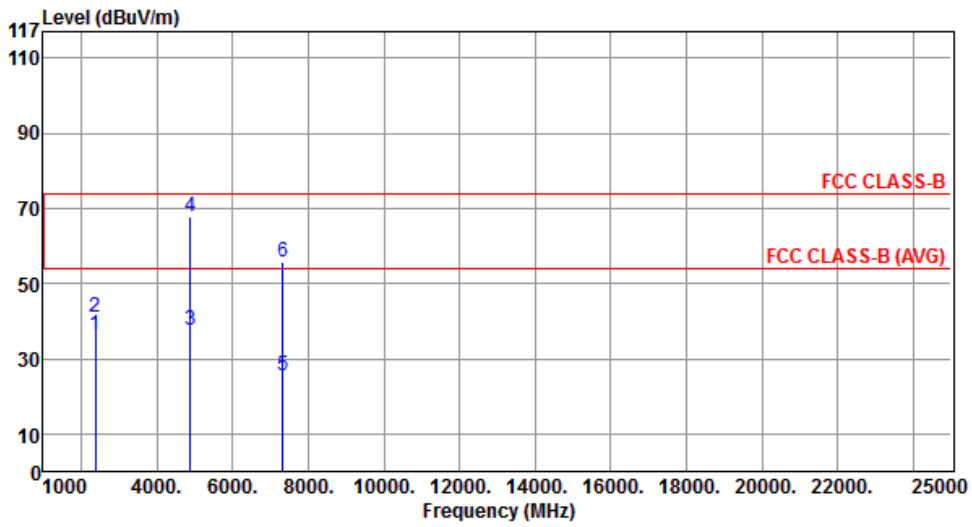
| Modulation | GFSK | Test Freq. (MHz) | 2441 |
|---|---|---|---|
| Polarization | Horizontal | | |




| | 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 | 42.11 | 54.00 | -11.89 | 45.68 | -3.57 | Average | --- | --- |
| 2 | 2370.00 | 47.30 | 74.00 | -26.70 | 50.87 | -3.57 | Peak | --- | --- |
| 3 | 4882.00 | 41.84 | 54.00 | -12.16 | 36.60 | 5.24 | Average | --- | --- |
| 4 | 4882.00 | 71.94 | 74.00 | -2.06 | 66.70 | 5.24 | Peak | --- | --- |
| 5 | 7323.00 | 29.94 | 54.00 | -24.06 | 20.50 | 9.44 | Average | --- | --- |
| 6 | 7323.00 | 60.04 | 74.00 | -13.96 | 50.60 | 9.44 | 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).

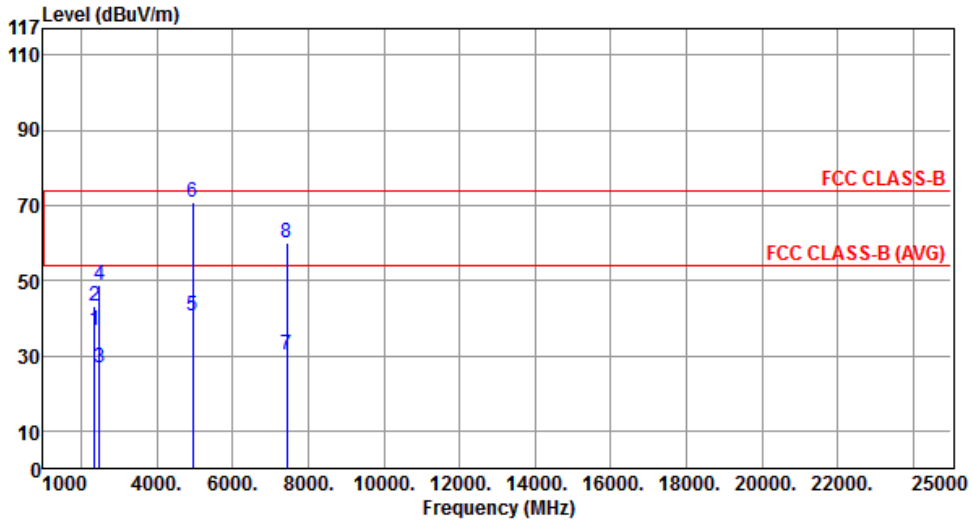
| Modulation | GFSK | Test Freq. (MHz) | 2441 |
|---|---|---|---|
| Polarization | Vertical | | |




| | 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 | 36.24 | 54.00 | -17.76 | 39.81 | -3.57 | Average | --- | --- |
| 2 | 2370.00 | 41.21 | 74.00 | -32.79 | 44.78 | -3.57 | Peak | --- | --- |
| 3 | 4882.00 | 37.76 | 54.00 | -16.24 | 32.52 | 5.24 | Average | --- | --- |
| 4 | 4882.00 | 67.86 | 74.00 | -6.14 | 62.62 | 5.24 | Peak | --- | --- |
| 5 | 7323.00 | 25.53 | 54.00 | -28.47 | 16.09 | 9.44 | Average | --- | --- |
| 6 | 7323.00 | 55.63 | 74.00 | -18.37 | 46.19 | 9.44 | 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).

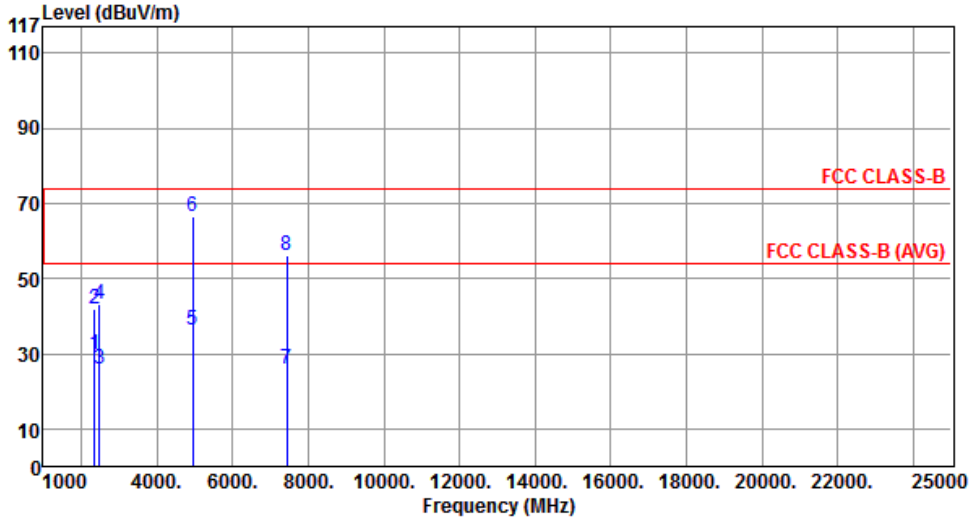
| Modulation | GFSK | Test Freq. (MHz) | 2480 |
|---|---|---|---|
| Polarization | Horizontal | | |




| | Freq. MHz | Emission level dBuV/m | Limit dBuV/m | Margin dB | SA reading dBuV | Factor dB | Remark | ANT High cm | Turn Table deg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2360.00 | 36.52 | 54.00 | -17.48 | 40.13 | -3.61 | Average | --- | --- |
| 2 | 2360.00 | 43.18 | 74.00 | -30.82 | 46.79 | -3.61 | Peak | --- | --- |
| 3 | 2483.50 | 26.70 | 54.00 | -27.30 | 29.80 | -3.10 | Average | --- | --- |
| 4 | 2483.50 | 48.95 | 74.00 | -25.05 | 52.05 | -3.10 | Peak | --- | --- |
| 5 | 4960.00 | 40.79 | 54.00 | -13.21 | 35.41 | 5.38 | Average | --- | --- |
| 6 | 4960.00 | 70.89 | 74.00 | -3.11 | 65.51 | 5.38 | Peak | --- | --- |
| 7 | 7440.00 | 30.11 | 54.00 | -23.89 | 20.42 | 9.69 | Average | --- | --- |
| 8 | 7440.00 | 60.21 | 74.00 | -13.79 | 50.52 | 9.69 | 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 | | |




| | Freq. MHz | Emission level dBuV/m | Limit dBuV/m | Margin dB | SA reading dBuV | Factor dB | Remark | ANT High cm | Turn Table deg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2360.00 | 29.66 | 54.00 | -24.34 | 33.27 | -3.61 | Average | --- | --- |
| 2 | 2360.00 | 41.90 | 74.00 | -32.10 | 45.51 | -3.61 | Peak | --- | --- |
| 3 | 2483.50 | 25.87 | 54.00 | -28.13 | 28.97 | -3.10 | Average | --- | --- |
| 4 | 2483.50 | 43.32 | 74.00 | -30.68 | 46.42 | -3.10 | Peak | --- | --- |
| 5 | 4960.00 | 36.26 | 54.00 | -17.74 | 30.88 | 5.38 | Average | --- | --- |
| 6 | 4960.00 | 66.36 | 74.00 | -7.64 | 60.98 | 5.38 | Peak | --- | --- |
| 7 | 7440.00 | 26.05 | 54.00 | -27.95 | 16.36 | 9.69 | Average | --- | --- |
| 8 | 7440.00 | 56.15 | 74.00 | -17.85 | 46.46 | 9.69 | 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 Emissions in non-restricted frequency bands

### 3.3.1 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

### 3.3.2 Measuring Instruments

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

### 3.3.3 Test Procedures

**Reference level measurement**

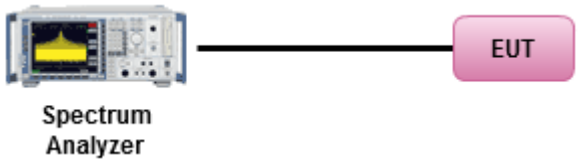
1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

**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

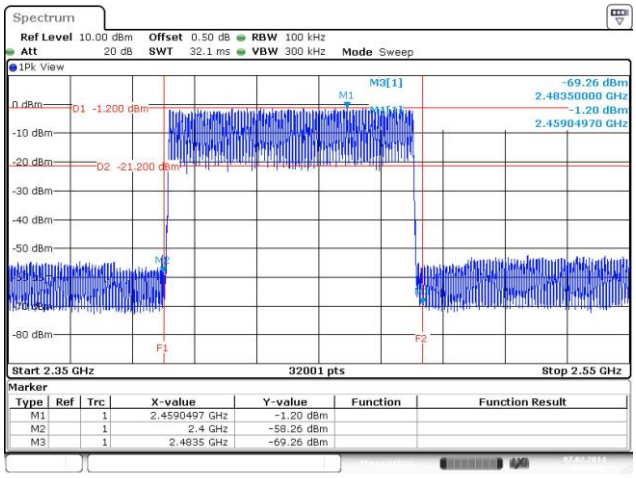
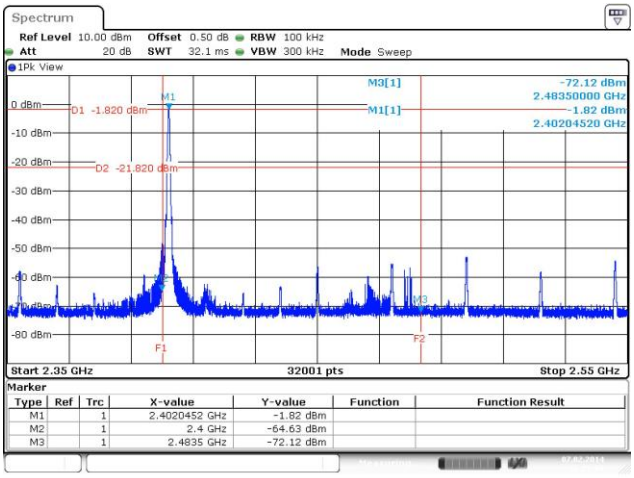
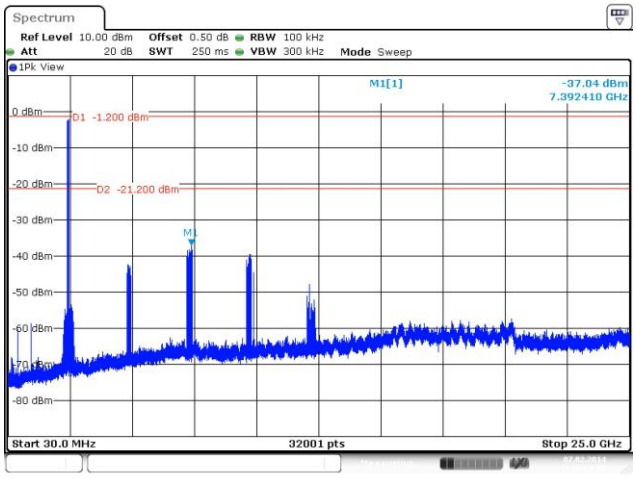
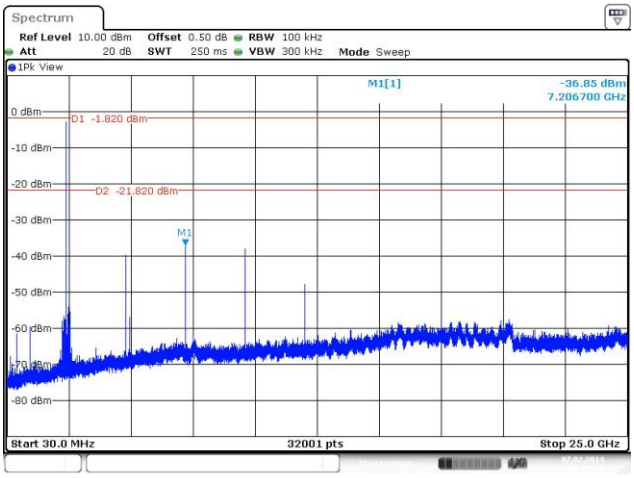
### 3.3.4 Test Setup

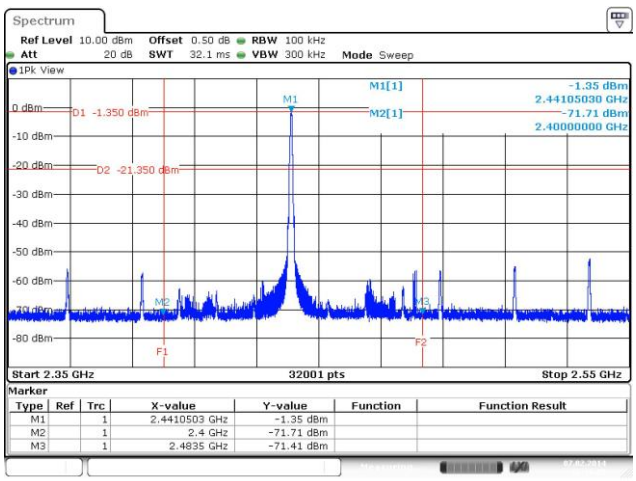
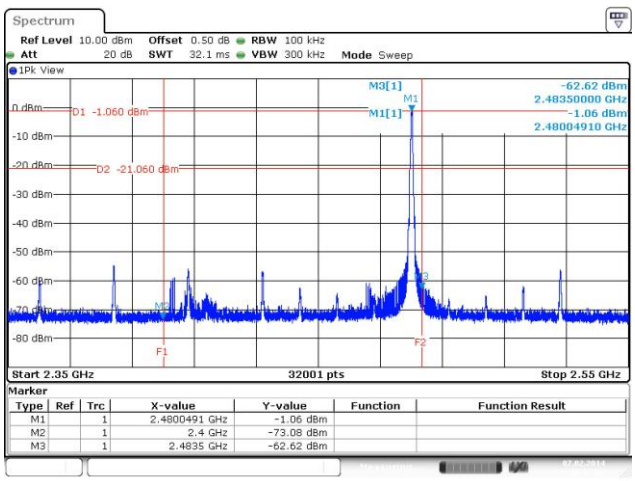
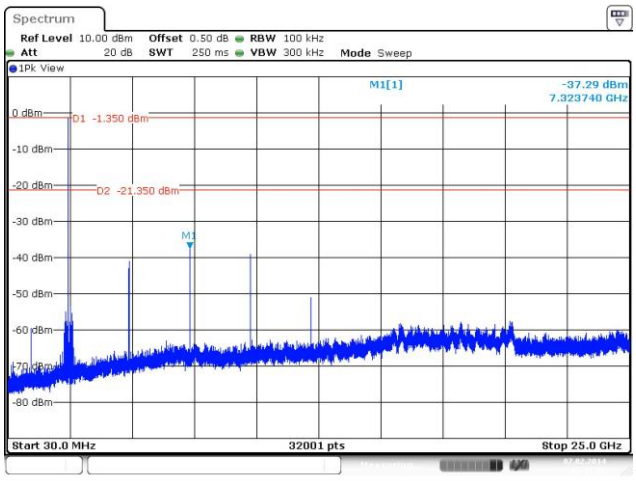
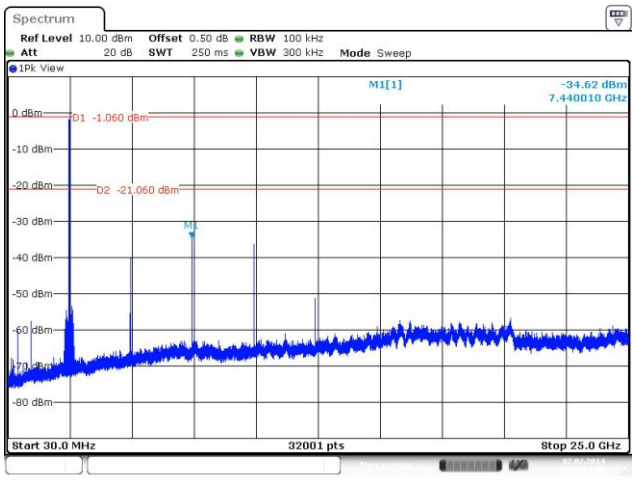
**Transmitter Radiated Bandedge Emissions**



### 3.3.5 Test Result of Emissions in 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)** |
|  |  |
|  |  |

## 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 | 0.75 | -1.23 | 125 |
| GFSK | 2441 | 0.82 | -0.84 | 125 |
| GFSK | 2480 | 0.88 | -0.55 | 125 |

| Modulation Mode | Freq. (MHz) | AV Output Power (mW) | AV Output Power (dBm) |
|---|---|---|---|
| GFSK | 2402 | 0.70 | -1.52 |
| GFSK | 2441 | 0.76 | -1.17 |
| GFSK | 2480 | 0.82 | -0.86 |

Note: Average power is for reference only

## 3.5 Number of Hopping Frequency

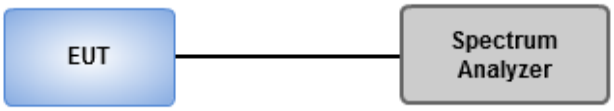
### 3.5.1 Limit of Number of Hopping Frequency

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

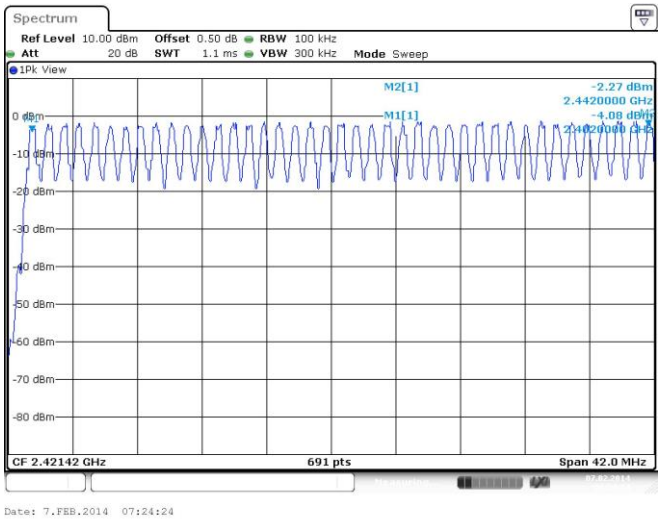
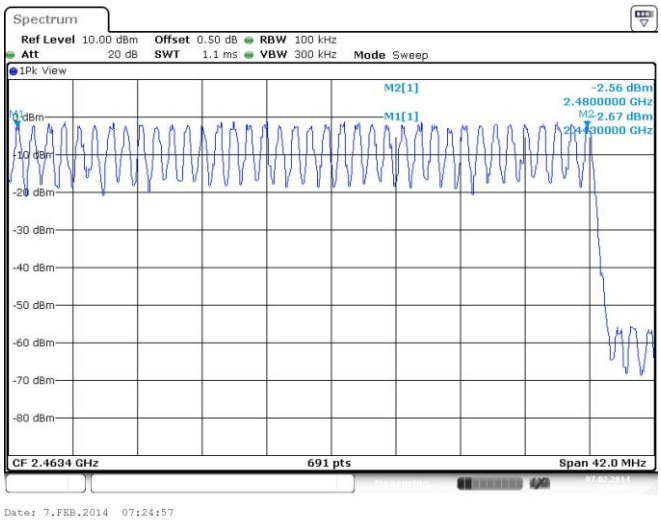
### 3.5.2 Test Procedures

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

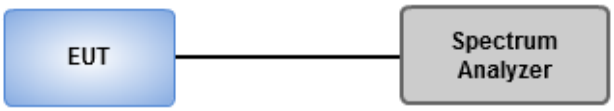
| GFSK |
| --- |
|   |
|   |

## 3.6 20dB and Occupied Bandwidth

### 3.6.1 Test Procedures

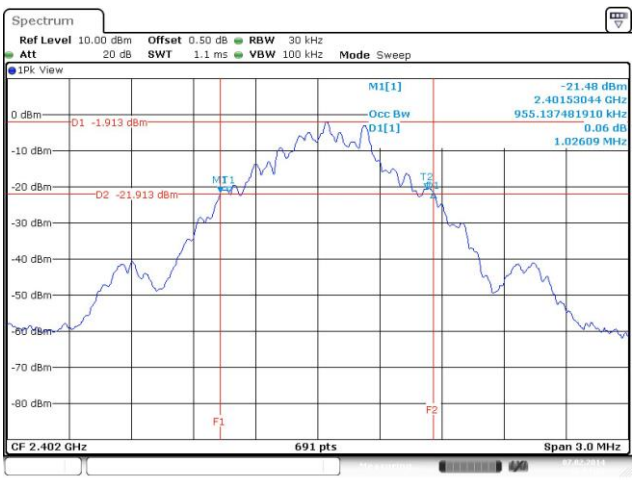
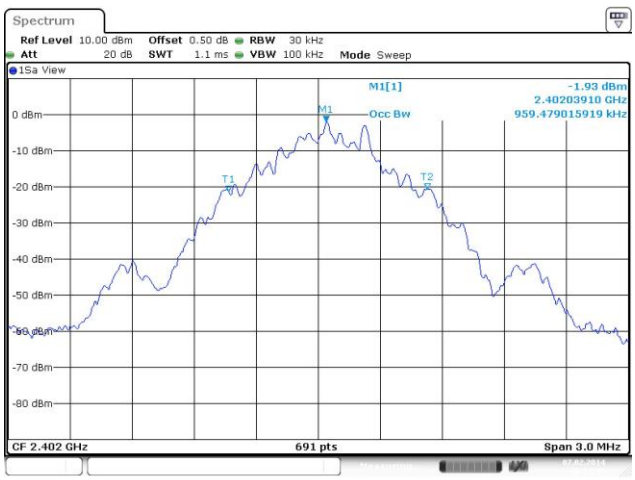
1. Set RBW=30kHz, VBW=100kHz,Sweep time = Auto, Detector=Peak Trace max hold
2 Allow trace to stabilize
3 Use N dB function of spectrum analyzer to measuring 20 dB bandwidth
4. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth

### 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 | 1.0261 | 0.9595 |
| GFSK | 2441 | 1.0261 | 0.9508 |
| GFSK | 2480 | 1.0217 | 0.9421 |

| Worst Plots of 20dB Bandwidth | Worst Plots of Occupied Bandwidth |
|---|---|
|  |  |

## 3.7 Channel Separation

### 3.7.1 Limit of Channel Separation

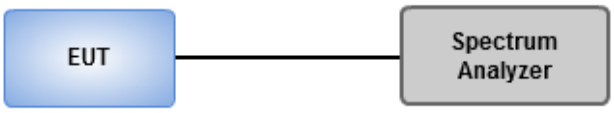
☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ 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

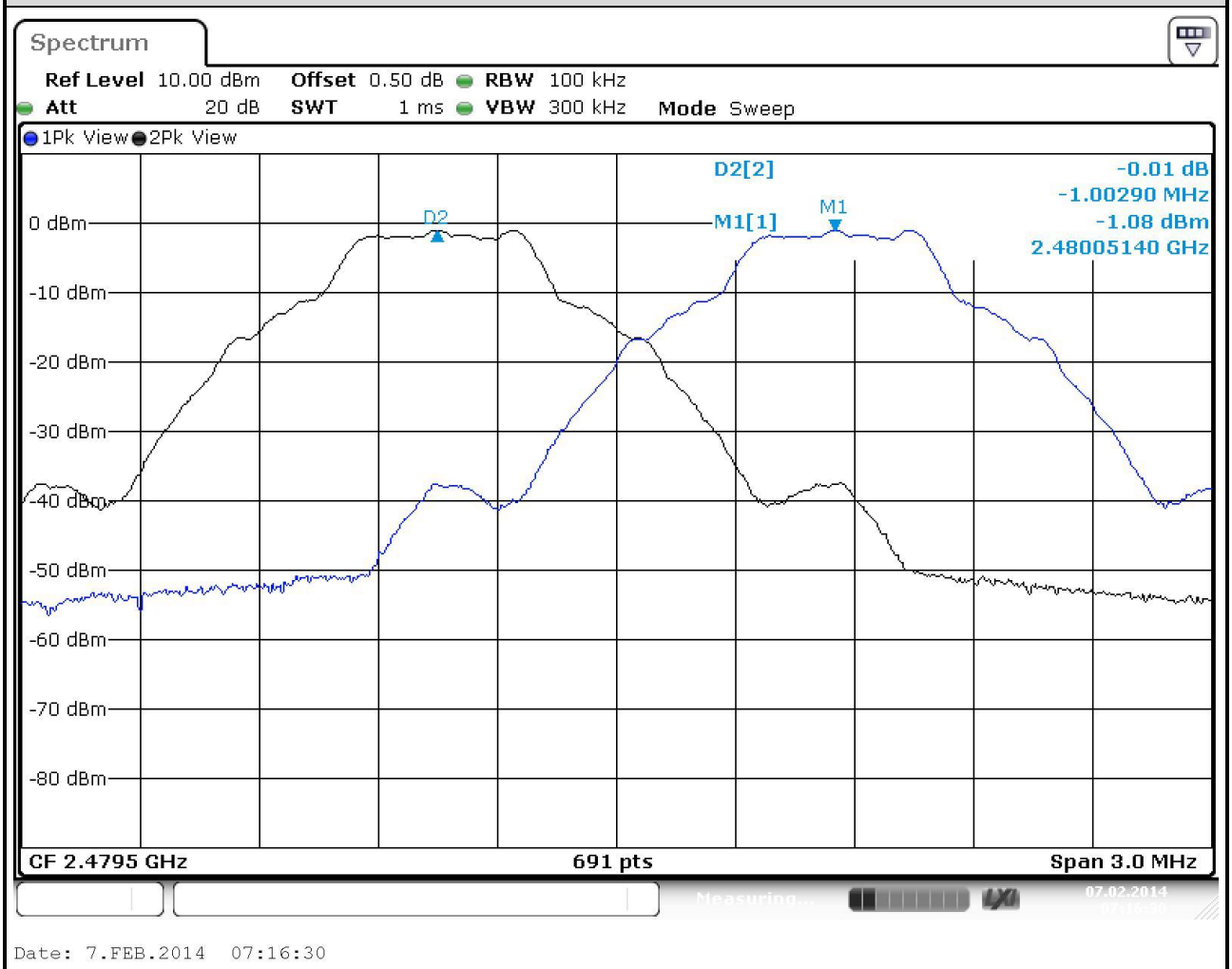
### 3.7.3 Test Setup



### 3.7.4 Test result of Channel Separation

| Modulation Mode | Freq. (MHz) | Channel Separation (MHz) | 20dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---|---|---|---|---|
| GFSK | 2402 | 1.0029 | 1.0261 | 0.684 |
| GFSK | 2441 | 1.0029 | 1.0261 | 0.684 |
| GFSK | 2480 | 1.0029 | 1.0217 | 0.681 |

**Worst Plots**



## 3.8 Number of Dwell Time

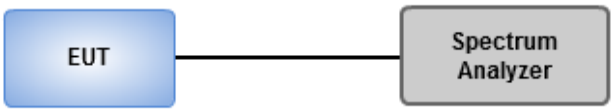
### 3.8.1 Limit of Dwell time

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

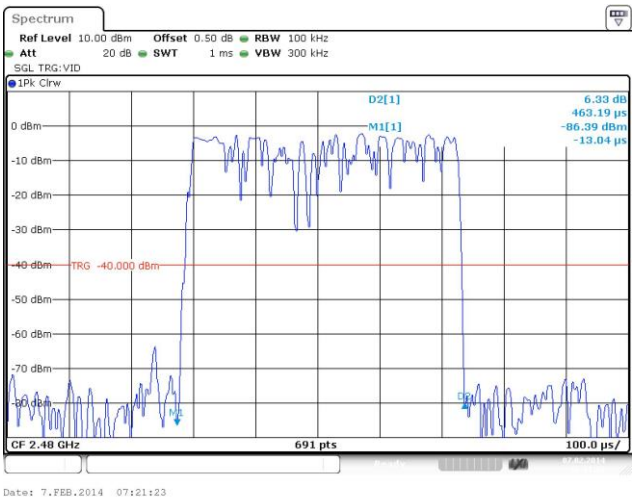
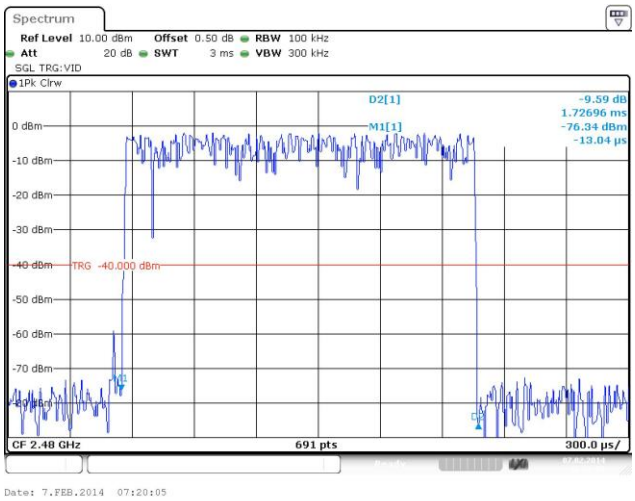
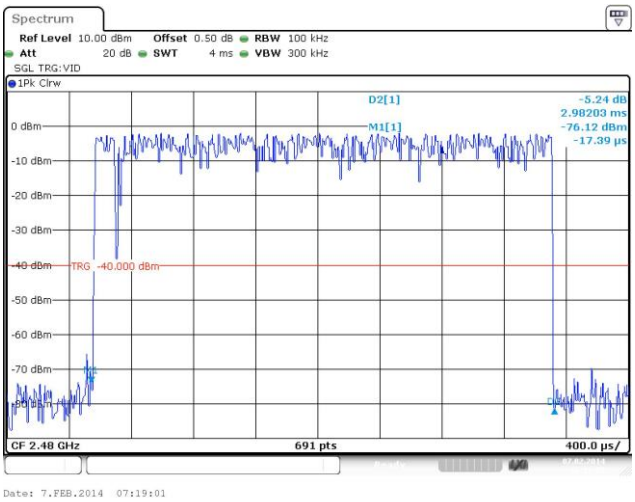
1. Set RBW=100kHz,VBW=300kHz,Sweep time = 500us(DH1),2ms(DH3),4ms(DH5), Detector=Peak, Span=0Hz,Trace max hold
2 Enable gating and trigger function of spectrum analyzer to measure burst on time.
3. The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots. The 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 RX, 1 time slot TX). 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 RX, 1 time slot TX). 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 RX, 1 time slot TX). 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) | No. of Pulse in a 31.6 (79Hopping*0.4) | Length of Pulse Time (msec) | Result (msec) | Limit (msec) |
|---|---|---|---|---|---|
| GFSK | 2402 | 320 | 0.46319 | 0.148 | 400 |
| GFSK | 2441 | 160 | 1.72696 | 0.276 | 400 |
| GFSK | 2480 | 106.6 | 2.98203 | 0.318 | 400 |

| GFSK | |
|---|---|
| DH1 | DH5 |
|   |   |
| DH3 | - |
|   | - |

# 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**

Tel: 886-2-2601-1640

No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.

**Kwei Shan**

Tel: 886-3-271-8666

No. 3-1, Lane 6, 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

**═END═**