S T S L A B

# RADIO TEST REPORT

Report No.: STS2010381W01

Issued for

Keiga Electronic Inc.

8F-1,No 176,Jian 1ST Rd., ZhongHe Dist., New Taipei City, Taiwan.

| | |
|---|---|
| **Product Name:** | CC-BT-SoundBar |
| **Brand Name:** | Club Car |
| **Model Name:** | 47695767001 |
| **Series Model:** | 4769576700X |
| **FCC ID:** | 2AX6ZBTSOUNDBAR |
| **Test Standard:** | FCC Part 15.247 |

Any reproduction of this document must be done in full. No single part of this document may be reproduced without permission from STS, All Test Data Presented in this report is only applicable to presented Test sample.

Shenzhen STS Test Services Co., Ltd.
A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ, Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China
TEL: +86-755 3688 6288 FAX: +86-755 3688 6277 E-mail:sts@stsapp.com

# TEST RESULT CERTIFICATION

| | |
|---|---|
| Applicant's Name ..... : | Keiga Electronic Inc. |
| Address ..... : | 8F-1,No 176,Jian 1ST Rd., ZhongHe Dist., New Taipei City, Taiwan. |
| Manufacturer's Name ..... : | Keiga Electronic Inc. |
| Address ..... : | 8F-1,No 176,Jian 1ST Rd., ZhongHe Dist., New Taipei City, Taiwan. |

**Product Description**

| | |
|---|---|
| Product Name ..... : | CC-BT-SoundBar |
| Brand Name ..... : | Club Car |
| Model Name ..... : | 47695767001 |
| Series Model ..... : | 4769576700X |
| Test Standards ..... : | FCC Part15.247 |
| Test Procedure ..... : | ANSI C63.10-2013 |

This device described above has been tested by STS, the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.
This report shall not be reproduced except in full, without the written approval of STS, this document may be altered or revised by STS, personal only, and shall be noted in the revision of the document.

**Date of Test**.....:

| | |
|---|---|
| Date of receipt of test item.....: | 09 Nov. 2020 |
| Date (s) of performance of tests .: | 09 Nov. 2020 ~ 18 Nov. 2020 |
| Date of Issue .....: | 18 Nov. 2020 |
| Test Result .....: | Pass |

Testing Engineer : Chris Chen

(Chris Chen)

Technical Manager : Sean She

(Sean she)

Authorized Signatory : Vita Li

(Vita Li)

TESTING • CONSULTING • SOLUTION • CERTIFICATION
STS
APPROVAL

Table of Contents Page


**1. SUMMARY OF TEST RESULTS** **6#**

1.1 TEST FACTORY 7#

1.2 MEASUREMENT UNCERTAINTY 7#

**2. GENERAL INFORMATION** **8#**

2.1 GENERAL DESCRIPTION OF THE EUT 8#

2.2 DESCRIPTION OF THE TEST MODES 10#

2.3 FREQUENCY HOPPING SYSTEM REQUIREMENTS 10#

2.4 TABLE OF PARAMETERS OF TEST SOFTWARE SETTING 12#

2.5 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED 12#

2.6 DESCRIPTION OF NECESSARY ACCESSORIES AND SUPPORT UNITS 13#

2.7 EQUIPMENTS LIST 14#

**3. EMC EMISSION TEST** **16#**

3.1 CONDUCTED EMISSION MEASUREMENT 16#

3.2 RADIATED EMISSION MEASUREMENT 18#

**4. CONDUCTED SPURIOUS & BAND EDGE EMISSION** **30#**

4.1 LIMIT 30#

4.2 TEST PROCEDURE 30#

4.3 TEST SETUP 31#

4.4 EUT OPERATION CONDITIONS 31#

4.5 TEST RESULTS 32#

**5. NUMBER OF HOPPING CHANNEL** **47#**

5.1 LIMIT 47#

5.2 TEST PROCEDURE 47#

5.3 TEST SETUP 47#

5.4 EUT OPERATION CONDITIONS 47#

5.5 TEST RESULTS 48#

**6. AVERAGE TIME OF OCCUPANCY** **49#**

6.1 LIMIT 49#

6.2 TEST PROCEDURE 49#

6.3 TEST SETUP 49#

6.4 EUT OPERATION CONDITIONS 49#

6.5 TEST RESULTS 50#

**7. HOPPING CHANNEL SEPARATION MEASUREMEN** **56#**

**Table of Contents** **Page**

7.1 LIMIT 56#
7.2 TEST PROCEDURE 56#
7.3 TEST SETUP 56#
7.4 EUT OPERATION CONDITIONS 56#
7.5 TEST RESULTS 57#
**8. BANDWIDTH TEST 63#**
8.1 LIMIT 63#
8.2 TEST PROCEDURE 63#
8.3 TEST SETUP 63#
8.4 EUT OPERATION CONDITIONS 63#
8.5 TEST RESULTS 64#
**9. OUTPUT POWER TEST 70#**
9.1 LIMIT 70#
9.2 TEST PROCEDURE 70#
9.3 TEST SETUP 70#
9.4 EUT OPERATION CONDITIONS 70#
9.5 TEST RESULTS 71#
**10. ANTENNA REQUIREMENT 72#**
10.1 STANDARD REQUIREMENT 72#
10.2 EUT ANTENNA 72#

## Revision History

| Rev. | Issue Date | Report NO. | Effect Page | Contents |
|---|---|---|---|---|
| 00 | 18 Nov. 2020 | STS2010381W01 | ALL | Initial Issue |
| | | | | |

# 1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:
KDB 558074 D01 15.247 Meas Guidance v05r02.

| FCC Part 15.247,Subpart C | | | |
|---|---|---|---|
| Standard Section | Test Item | Judgment | Remark |
| 15.207 | Conducted Emission | N/A | -- |
| 15.247(a)(1) | Hopping Channel Separation | PASS | -- |
| 15.247(a)(1)&(b)(1) | Output Power | PASS | -- |
| 15.209 | Radiated Spurious Emission | PASS | -- |
| 15.247(d) | Conducted Spurious & Band Edge Emission | PASS | -- |
| 15.247(a)(1)(iii) | Number of Hopping Frequency | PASS | -- |
| 15.247(a)(1)(iii) | Dwell Time | PASS | -- |
| 15.247(a)(1) | Bandwidth | PASS | -- |
| 15.205 | Restricted bands of operation | PASS | -- |
| Part 15.247(d)/part 15.209(a) | Band Edge Emission | PASS | -- |
| 15.203 | Antenna Requirement | PASS | -- |

NOTE:

(1) 'N/A' denotes test is not applicable in this Test Report.

(2) All tests are according to ANSI C63.10-2013.

## 1.1 TEST FACTORY

SHENZHEN STS TEST SERVICES CO., LTD
Add. : A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ, Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China
FCC test Firm Registration Number: 625569
IC test Firm Registration Number: 12108A
A2LA Certificate No.: 4338.01

## 1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y ±U**, where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**, providing a level of confidence of approximately **95** %.

| No. | Item | Uncertainty |
|---|---|---|
| 1 | RF output power, conducted | ±0.68dB |
| 2 | Unwanted Emissions, conducted | ±2.988dB |
| 3 | All emissions, radiated 9K-30MHz | ±2.68dB |
| 4 | All emissions, radiated 30M-1GHz | ±4.39dB |
| 5 | All emissions, radiated 1G-6GHz | ±5.10dB |
| 6 | All emissions, radiated>6G | ±5.58dB |
| 7 | Conducted Emission (9KHz-150KHz) | ±2.79dB |
| 8 | Conducted Emission (150KHz-30MHz) | ±2.80dB |

# 2. GENERAL INFORMATION

## 2.1 GENERAL DESCRIPTION OF THE EUT

| | |
|---|---|
| Product Name | CC-BT-SoundBar |
| Trade Name | Club Car |
| Model Name | 47695767001 |
| Series Model | 4769576700X |
| Model Difference | 4769576700X (X=1~9, A~Z), the main function & PCB board/circuit/internal structure remain the same, only the LEDs & connectors are different. |
| Channel List | Please refer to the Note 2. |
| Bluetooth | Frequency:2402 – 2480 MHz<br>Modulation: GFSK(1Mbps), π/4-DQPSK(2Mbps), 8DPSK(3Mbps) |
| Bluetooth Version | 4.0 |
| Bluetooth Configuration | BR+EDR |
| Antenna Type | Please refer to the Note 3. |
| Power Rating | Input: DC 12V |
| Hardware version number | N/A |
| Software version number | N/A |
| Connecting I/O Port(s) | Please refer to the Note 1. |

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User Manual.

2.

| Channel List | | | | | |
|---|---|---|---|---|---|
| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
| 00 | 2402 | 27 | 2429 | 54 | 2456 |
| 01 | 2403 | 28 | 2430 | 55 | 2457 |
| 02 | 2404 | 29 | 2431 | 56 | 2458 |
| 03 | 2405 | 30 | 2432 | 57 | 2459 |
| 04 | 2406 | 31 | 2433 | 58 | 2460 |
| 05 | 2407 | 32 | 2434 | 59 | 2461 |
| 06 | 2408 | 33 | 2435 | 60 | 2462 |
| 07 | 2409 | 34 | 2436 | 61 | 2463 |
| 08 | 2410 | 35 | 2437 | 62 | 2464 |
| 09 | 2411 | 36 | 2438 | 63 | 2465 |
| 10 | 2412 | 37 | 2439 | 64 | 2466 |
| 11 | 2413 | 38 | 2440 | 65 | 2467 |
| 12 | 2414 | 39 | 2441 | 66 | 2468 |
| 13 | 2415 | 40 | 2442 | 67 | 2469 |
| 14 | 2416 | 41 | 2443 | 68 | 2470 |
| 15 | 2417 | 42 | 2444 | 69 | 2471 |
| 16 | 2418 | 43 | 2445 | 70 | 2472 |
| 17 | 2419 | 44 | 2446 | 71 | 2473 |
| 18 | 2420 | 45 | 2447 | 72 | 2474 |
| 19 | 2421 | 46 | 2448 | 73 | 2475 |
| 20 | 2422 | 47 | 2449 | 74 | 2476 |
| 21 | 2423 | 48 | 2450 | 75 | 2477 |
| 22 | 2424 | 49 | 2451 | 76 | 2478 |
| 23 | 2425 | 50 | 2452 | 77 | 2479 |
| 24 | 2426 | 51 | 2453 | 78 | 2480 |
| 25 | 2427 | 52 | 2454 | | |
| 26 | 2428 | 53 | 2455 | | |

3. Table for Filed Antenna

| Ant. | Brand | Model Name | Antenna Type | Connector | Gain (dBi) | NOTE |
|---|---|---|---|---|---|---|
| 1 | N/A | 47695767001 | Dipole | N/A | 1.16 dBi | BT Antenna |

## 2.2 DESCRIPTION OF THE TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

| Worst Mode | Description | Data Rate/Modulation |
|---|---|---|
| Mode 1 | TX CH00 | 1Mbps/GFSK |
| Mode 2 | TX CH39 | 1Mbps/GFSK |
| Mode 3 | TX CH78 | 1Mbps/GFSK |
| Mode 4 | TX CH00 | 2 Mbps/π/4-DQPSK |
| Mode 5 | TX CH39 | 2 Mbps/π/4-DQPSK |
| Mode 6 | TX CH78 | 2 Mbps/π/4-DQPSK |
| Mode7 | TX CH00 | 3 Mbps/8DPSK |
| Mode 8 | TX CH39 | 3 Mbps/8DPSK |
| Mode 9 | TX CH78 | 3 Mbps/8DPSK |
| Mode 10 | Hopping | GFSK |
| Mode 11 | Hopping | π/4-DQPSK |
| Mode 12 | Hopping | 8DPSK |

Note:

(1) The measurements are performed at all Bit Rate of Transmitter, the worst data was reported.

## 2.3 FREQUENCY HOPPING SYSTEM REQUIREMENTS

(1)Standard and Limit

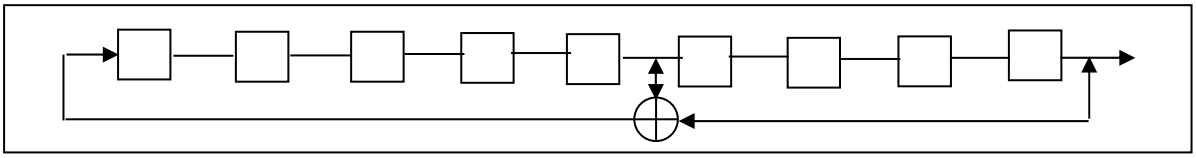
According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

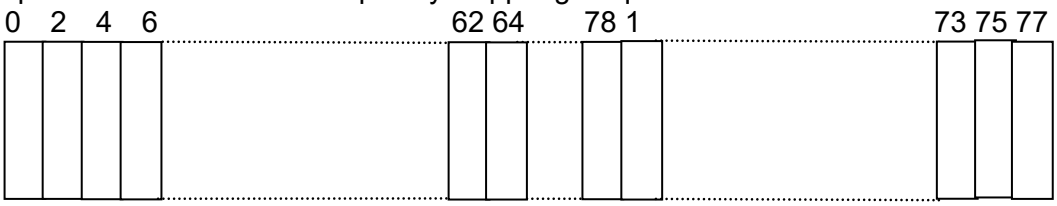
(2)The Pseudorandom sequence may be generated in a nin-stage shift register whose $5^{th}$ and $9^{th}$ stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones: i.e. the shift register is initialized with nine ones.

Numver of shift register stages:9
Length of pseudo-random sequence:$2^9$-1=511bits
Longest sequence of zeros: 8(non-inverted signal)



Liner Feedback Shift Register for Generator of the PRBS sequence

An example of Pseudorandom Frequency Hoppong Sequence as follow:




Each frequency used equally on th average by each transmitter.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies ini synchronization with the transmitted signals.

(3)Frequency Hopping System
This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule.

This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

This device was tested with a bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements FCC Part 15.247 rule.

## 2.4 TABLE OF PARAMETERS OF TEST SOFTWARE SETTING

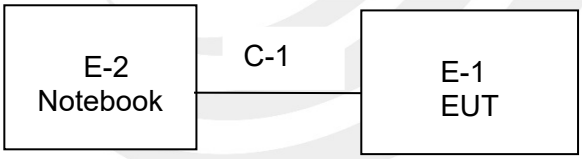
During testing channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters of FHSS.

| Test software Version | Test program: Bluetooth | | |
|---|---|---|---|
| (Power control software) Parameters(1/2/3Mbps) | Power class:<br>DH1 rate:4:27<br>2DH1 rate:20:54<br>3DH1 rate:24:83 | Power class:<br>DH3 rate:11:183<br>2DH3 rate:26:367<br>3DH3 rate:27:552 | Power class:<br>DH5 rate:15:339<br>2DH5 rate:30:679<br>3DH5 rate:31:1021 |

| RF Function | Type | Mode Or Modulation type | Ant Gain(dBi) | Power Class | Software For Testing |
|---|---|---|---|---|---|
| BT | BR+EDR | GFSK | 1.16 | default | CSR BlueSuite 2.5.8 |
| | | π/4-DQPSK | 1.16 | default | |
| | | 8DPSK | 1.16 | default | |

## 2.5 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Radiated Spurious Emission Test



## 2.6 DESCRIPTION OF NECESSARY ACCESSORIES AND SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Necessary accessories

| Item | Equipment | Mfr/Brand | Model/Type No. | Length | Note |
|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | | |
| | | | | | |
| | | | | | |

Support units

| Item | Equipment | Mfr/Brand | Model/Type No. | Length | Note |
|---|---|---|---|---|---|
| E-2 | Notebook | DELL | Inspiron 14-3467 | N/A | N/A |
| C-1 | USB Cable | N/A | N/A | 150cm | N/A |
| | | | | | |

Note:

(1) For detachable type I/O cable should be specified the length in cm in『Length』column.

## 2.7 EQUIPMENTS LIST

Radiation Test equipment

| Kind of Equipment | Manufacturer | Type No. | Serial No. | Last calibration | Calibrated until |
|---|---|---|---|---|---|
| Test Receiver | R&S | ESCI | 101427 | 2020.10.12 | 2022.10.11 |
| Signal Analyzer | R&S | FSV 40-N | 101823 | 2020.10.10 | 2021.10.09 |
| Active loop Antenna | ZHINAN | ZN30900C | 16035 | 2019.07.11 | 2021.07.10 |
| Bilog Antenna | TESEQ | CBL6111D | 34678 | 2020.10.12 | 2022.10.11 |
| Horn Antenna | SCHWARZBECK | BBHA 9120D | 02014 | 2019.10.15 | 2021.10.14 |
| SHF-EHF Horn Antenna (18G-40GHz) | A-INFO | LB-180400-KF | J211020657 | 2020.10.12 | 2022.10.11 |
| Pre-Amplifier (0.1M-3GHz) | EM | EM330 | 060665 | 2020.10.12 | 2021.10.11 |
| Pre-Amplifier (1G-18GHz) | SKET | LNPA-01018G-45 | SK2018080901 | 2020.10.12 | 2021.10.11 |
| Pre-Amplifier (18G-40GHz) | SKET | LNPA-1840-50 | SK2018101801 | 2020.10.10 | 2021.10.09 |
| Temperature & Humidity | HH660 | Mieo | N/A | 2020.10.13 | 2021.10.12 |
| Turn table | EM | SC100_1 | 60531 | N/A | N/A |
| Antenna mast | EM | SC100 | N/A | N/A | N/A |
| Test SW | FARAD | EZ-EMC(Ver.STSLAB-03A1 RE) | | | |

Conduction Test equipment

| Kind of Equipment | Manufacturer | Type No. | Serial No. | Last calibration | Calibrated until |
|---|---|---|---|---|---|
| Test Receiver | R&S | ESCI | 101427 | 2020.10.12 | 2022.10.11 |
| LISN | R&S | ENV216 | 101242 | 2020.10.12 | 2022.10.11 |
| LISN | EMCO | 3810/2NM | 23625 | 2020.10.12 | 2022.10.11 |
| Temperature & Humidity | HH660 | Mieo | N/A | 2020.10.13 | 2021.10.12 |
| Test SW | FARAD | EZ-EMC(Ver.STSLAB-03A1 RE) | | | |

RF Connected Test

| Kind of Equipment | Manufacturer | Type No. | Serial No. | Last calibration | Calibrated until |
|---|---|---|---|---|---|
| MIMO Power measurement test Set | Keysight | U2021XA | MY55520005 | 2020.10.10 | 2021.10.09 |
| | | | MY55520006 | 2020.10.10 | 2021.10.09 |
| | | | MY56120038 | 2020.10.10 | 2021.10.09 |
| | | | MY56280002 | 2020.10.10 | 2021.10.09 |
| Signal Analyzer | Agilent | N9020A | MY51110105 | 2020.03.05 | 2021.03.04 |
| Temperature & Humidity | HH660 | Mieo | N/A | 2020.10.13 | 2021.10.12 |
| MIMO Power measurement test Set | Keysight | U2021XA | MY55520005 | 2020.10.10 | 2021.10.09 |
| Test SW | FARAD | EZ-EMC(Ver.STSLAB-03A1 RE) | | | |

# 3. EMC EMISSION TEST

## 3.1 CONDUCTED EMISSION MEASUREMENT

### 3.1.1 POWER LINE CONDUCTED EMISSION LIMITS

The radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table.

| FREQUENCY (MHz) | Conducted Emissionlimit (dBuV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 -0.5 | 66 - 56 * | 56 - 46 * |
| 0.50 -5.0 | 56.00 | 46.00 |
| 5.0 -30.0 | 60.00 | 50.00 |

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

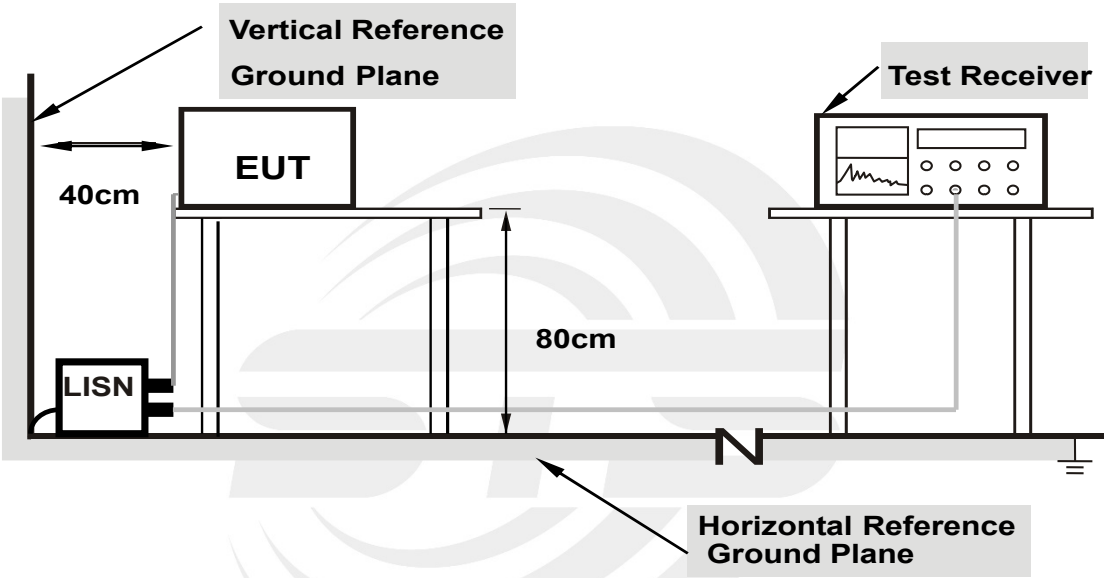
The following table is the setting of the receiver

| **Receiver Parameters** | **Setting** |
|---|---|
| Attenuation | 10 dB |
| Start Frequency | 0.15 MHz |
| Stop Frequency | 30 MHz |
| IF Bandwidth | 9 kHz |

3.1.2 TEST PROCEDURE

a. The EUT is 0.8 m from the horizontal ground plane and 0.4 m from the vertical ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments are powered from additional LISN(s). The LISN provides 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
d. LISN is at least 80 cm from the nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

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 support units.**

3.1.4 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

3.1.5 TEST RESULT

| | | | |
|---|---|---|---|
| Temperature: | --(C) | Relative Humidity: | --%RH |
| Test Voltage: | N/A | Phase: | L/N |
| Test Mode: | N/A | | |

Note: EUT is only power by DC Power, so it is not applicable for this test.

## 3.2 RADIATED EMISSION MEASUREMENT

### 3.2.1 RADIATED EMISSION LIMITS

In any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the Restricted band specified on Part15.205 (a)&209(a) limit in the table and according to ANSI C63.10-2013 below has to be followed.

LIMITS OF RADIATED EMISSION MEASUREMENT (0.009MHz - 1000MHz)

| Frequencies (MHz) | Field Strength (micorvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009~0.490 | 2400/F(KHz) | 300 |
| 0.490~1.705 | 24000/F(KHz) | 30 |
| 1.705~30.0 | 30 | 30 |
| 30~88 | 100 | 3 |
| 88~216 | 150 | 3 |
| 216~960 | 200 | 3 |
| Above 960 | 500 | 3 |

LIMITS OF RADIATED EMISSION MEASUREMENT (1GHz-25 GHz)

| FREQUENCY (MHz) | (dBuV/m) (at 3M) | |
|---|---|---|
| | PEAK | AVERAGE |
| Above 1000 | 74 | 54 |

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBuV/m)=20log Emission level (uV/m).

LIMITS OF RESTRICTED FREQUENCY BANDS

| FREQUENCY (MHz) | FREQUENCY (MHz) | FREQUENCY (MHz) | FREQUENCY (GHz) |
|---|---|---|---|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| 0.495-0.505 | 16.69475-16.69525 | 608-614 | 5.35-5.46 |
| 2.1735-2.1905 | 16.80425-16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475-156.52525 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.7-156.9 | 2690-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3600-4400 | Above 38.6 |
| 13.36-13.41 | | | |

For Radiated Emission

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Detector | Peak/QP/AV |
| Start Frequency | 9 KHz/150KHz(Peak/QP/AV) |
| Stop Frequency | 150KHz/30MHz(Peak/QP/AV) |
| RB / VB (emission in restricted band) | 200Hz (From 9kHz to 0.15MHz)/<br>9KHz (From 0.15MHz to 30MHz);<br>200Hz (From 9kHz to 0.15MHz)/<br>9KHz (From 0.15MHz to 30MHz) |

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Detector | Peak/QP |
| Start Frequency | 30 MHz(Peak/QP) |
| Stop Frequency | 1000 MHz (Peak/QP) |
| RB / VB (emission in restricted band) | 120 KHz / 300 KHz |

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Detector | Peak/AV |
| Start Frequency | 1000 MHz(Peak/AV) |
| Stop Frequency | 10th carrier hamonic(Peak/AV) |
| RB / VB (emission in restricted band) | 1 MHz / 3 MHz(Peak)<br>1 MHz/1/T MHz(AVG) |

For Restricted band

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak/AV |
| Start/Stop Frequency | Lower Band Edge: 2310 to 2410 MHz<br>Upper Band Edge: 2476 to 2500 MHz |
| RB / VB | 1 MHz / 3 MHz(Peak)<br>1 MHz/1/T MHz(AVG) |

| Receiver Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Start ~ Stop Frequency | 9kHz~90kHz / RB 200Hz for PK & AV |
| Start ~ Stop Frequency | 90kHz~110kHz / RB 200Hz for QP |
| Start ~ Stop Frequency | 110kHz~490kHz / RB 200Hz for PK & AV |
| Start ~ Stop Frequency | 490kHz~30MHz / RB 9kHz for QP |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB 120kHz for QP |

3.2.2 TEST PROCEDURE

a. The measuring distance at 3 m shall be used for measurements at frequency 0.009MHz up to 1GHz, and above 1GHz.
b. The EUT was placed on the top of a rotating table 0.8 m (above 1GHz is 1.5 m) above the ground at a 3 m anechoic chamber test site. The table was rotated 360 degree to determine the position of the highest radiation.
c. The height of the equipment shall be 0.8 m (above 1GHz is 1.5 m); the height of the test antenna shall vary between 1 m to 4 m. Horizontal and vertical polarization of the antenna are set to make the measurement.
d. The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and QuasiPeak detector mode will be re-measured.
e. If the Peak Mode measured value is compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and no additional QP Mode measurement was performed.
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note:

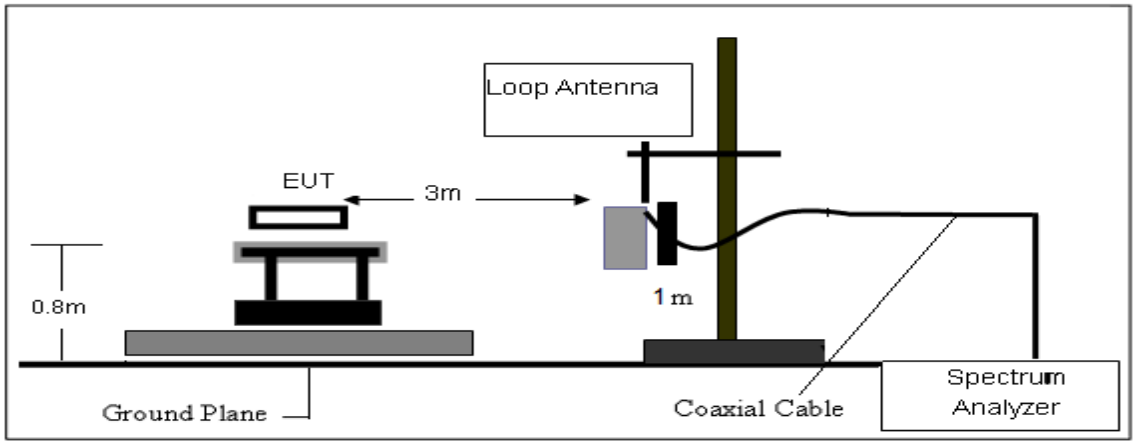
Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

3.2.3 DEVIATION FROM TEST STANDARD

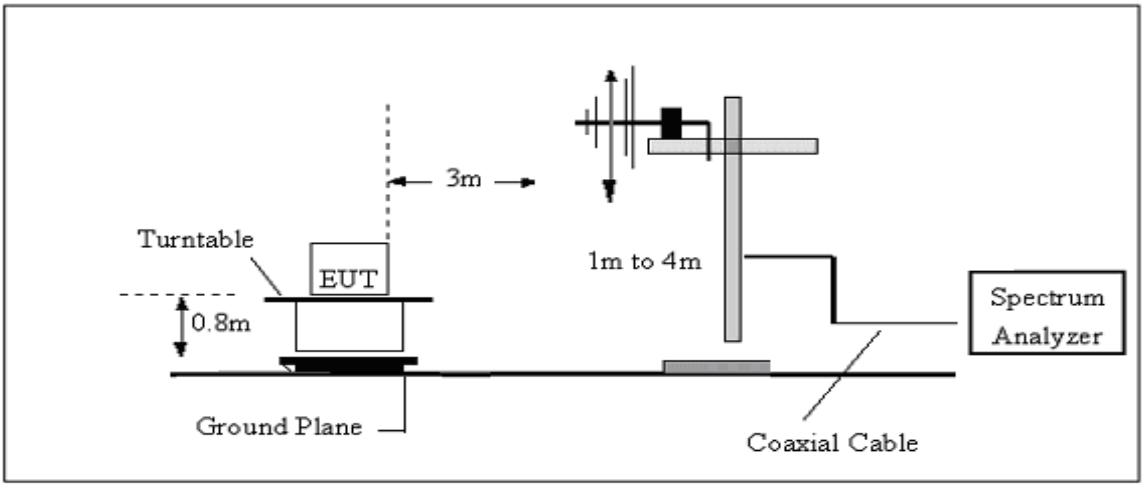
No deviation.

3.2.4 TESTSETUP

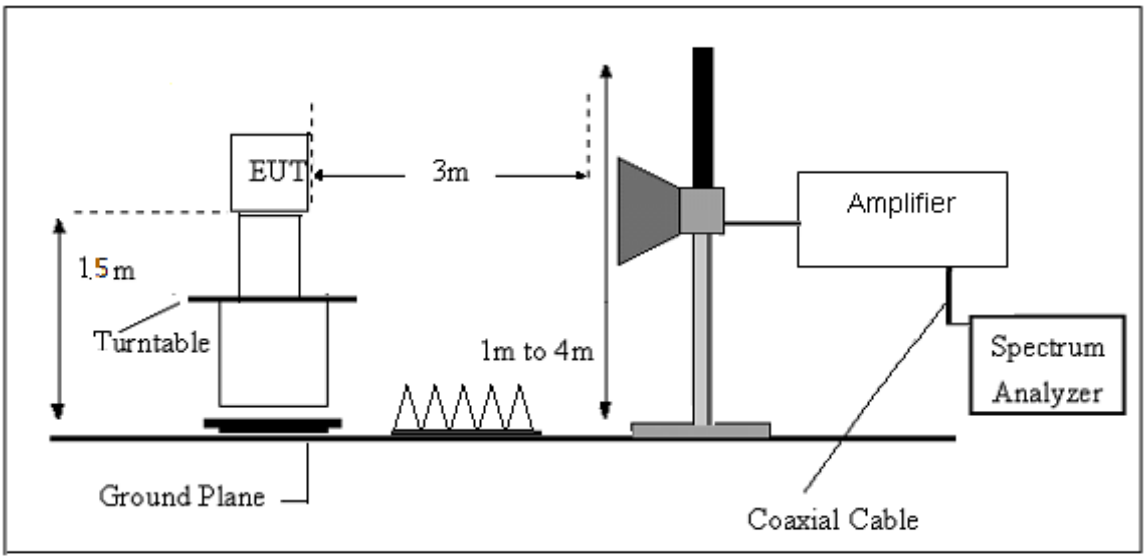
(A) Radiated Emission Test-Up Frequency Below 30MHz




(B) Radiated Emission Test-Up Frequency 30MHz~1GHz




(C) Radiated Emission Test-Up Frequency Above 1GHz




3.2.5 EUT OPERATING CONDITIONS

Please refer to section 3.1.4 of this report.

3.2.6 FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where

FS = Field Strength

CL = Cable Attenuation Factor (Cable Loss)

RA = Reading Amplitude

AG = Amplifier Gain

AF = Antenna Factor

For example

| Frequency | FS | RA | AF | CL | AG | Factor |
|---|---|---|---|---|---|---|
| (MHz) | (dBμV/m) | (dBμV/m) | (dB) | (dB) | (dB) | (dB) |
| 300 | 40 | 58.1 | 12.2 | 1.6 | 31.9 | -18.1 |

Factor=AF+CL-AG

3.2.7 TEST RESULTS

(9KHz-30MHz)

| | | | |
|---|---|---|---|
| Temperature: | 23.1(C) | Relative Humidity: | 60%RH |
| Test Voltage: | DC 12V | Test Mode: | TX Mode |

| Freq. | Reading | Limit | Margin | State | Test Result |
|---|---|---|---|---|---|
| (MHz) | (dBuV/m) | (dBuV/m) | (dB) | P/F | |
| -- | -- | -- | -- | -- | PASS |
| -- | -- | -- | -- | -- | PASS |

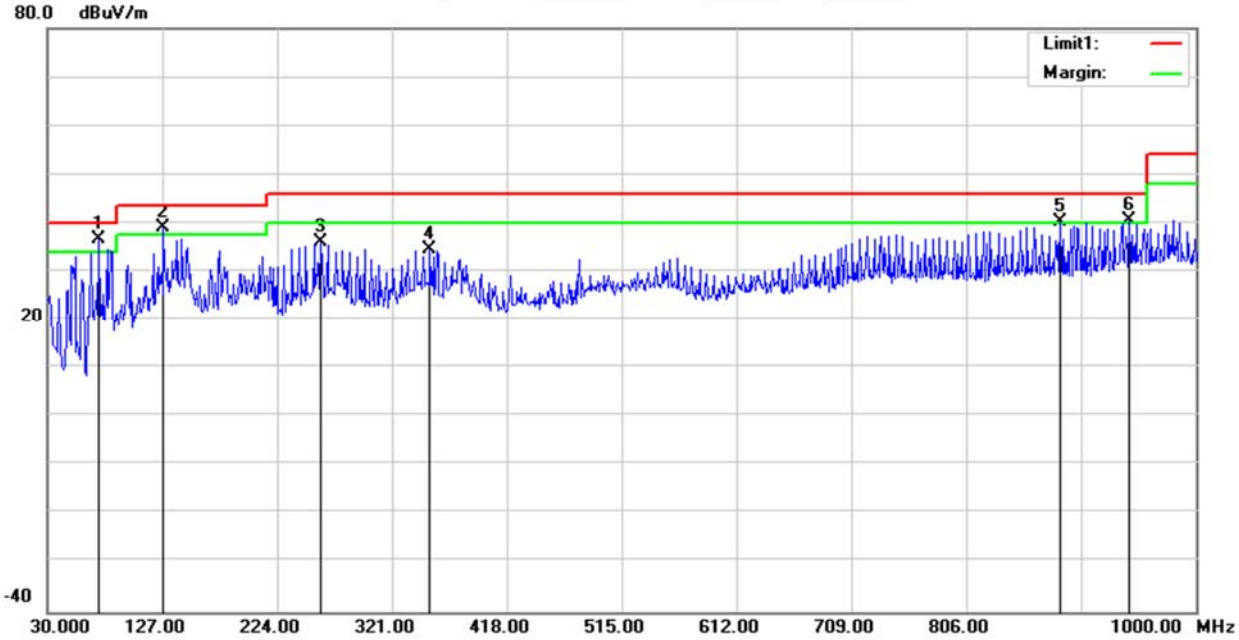
Note:
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits (dBuv) + distance extrapolation factor.

(30MHz-1000MHz)

| | | | |
|---|---|---|---|
| Temperature: | 23.1(C) | Relative Humidity: | 60%RH |
| Test Voltage: | DC 12V | Phase: | Horizontal |
| Test Mode: | Mode 1/2/3/4/5/6/7/8/9(Mode 3 worst mode) | | |

| No. | Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 73.6500 | 60.97 | -24.20 | 36.77 | 40.00 | -3.23 | QP |
| 2 | 127.9700 | 57.20 | -18.25 | 38.95 | 43.50 | -4.55 | QP |
| 3 | 260.8600 | 50.82 | -14.78 | 36.04 | 46.00 | -9.96 | QP |
| 4 | 353.0100 | 47.41 | -13.00 | 34.41 | 46.00 | -11.59 | QP |
| 5 | 885.5400 | 41.01 | -0.67 | 40.34 | 46.00 | -5.66 | QP |
| 6 | 943.7400 | 39.08 | 1.46 | 40.54 | 46.00 | -5.46 | QP |

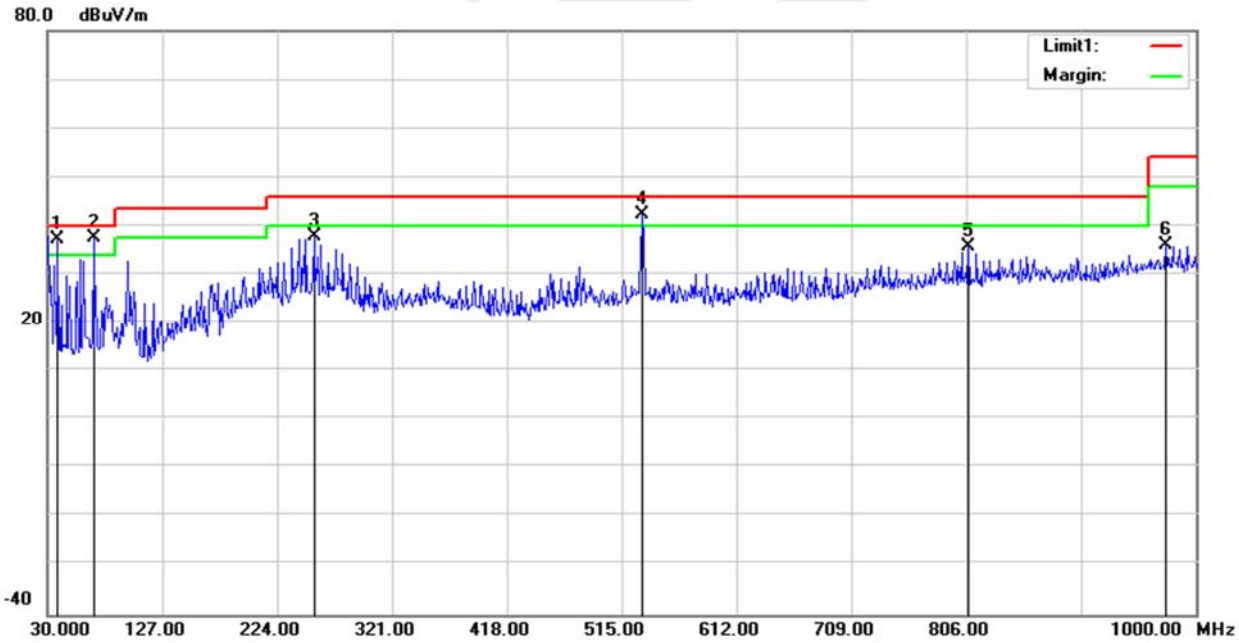
Remark:
1. Margin = Result (Result =Reading + Factor )–Limit
2. Factor= Antenna factor+Cable attenuation factor(cable loss)-Amplifier gain



| | | | |
|---|---|---|---|
| Temperature: | 23.1(C) | Relative Humidity: | 60%RH |
| Test Voltage: | DC 12V | Phase: | Vertical |
| Test Mode: | Mode 1/2/3/4/5/6/7/8/9(Mode 3 worst mode) | | |

| No. | Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 38.7300 | 54.57 | -17.36 | 37.21 | 40.00 | -2.79 | QP |
| 2 | 68.8000 | 62.65 | -25.09 | 37.56 | 40.00 | -2.44 | QP |
| 3 | 255.0400 | 53.29 | -15.35 | 37.94 | 46.00 | -8.06 | QP |
| 4 | 532.4600 | 49.66 | -7.31 | 42.35 | 46.00 | -3.65 | QP |
| 5 | 807.9400 | 37.60 | -2.00 | 35.60 | 46.00 | -10.40 | QP |
| 6 | 974.7800 | 33.59 | 2.32 | 35.91 | 54.00 | -18.09 | QP |

Remark:
1. Margin = Result (Result =Reading + Factor )–Limit
2. Factor= Antenna factor+Cable attenuation factor(cable loss)-Amplifier gain



(1GHz~25GHz)#Spurious emission Requirements

| Frequency | Meter Reading | Amplifier | Loss | Antenna Factor | Orrected Factor | Emission Level | Limits | Margin | Detector | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBμV) | （dB） | （dB） | （dB/m） | （dB） | (dBμV/m) | (dBμV/m) | (dB) | Type | |
| Low Channel (GFSK/2402 MHz) | | | | | | | | | | |
| 3264.87 | 61.10 | 44.70 | 6.70 | 28.20 | -9.80 | 51.30 | 74.00 | -22.70 | PK | Vertical |
| 3264.87 | 50.80 | 44.70 | 6.70 | 28.20 | -9.80 | 41.00 | 54.00 | -13.00 | AV | Vertical |
| 3264.68 | 61.27 | 44.70 | 6.70 | 28.20 | -9.80 | 51.47 | 74.00 | -22.53 | PK | Horizontal |
| 3264.68 | 50.31 | 44.70 | 6.70 | 28.20 | -9.80 | 40.51 | 54.00 | -13.49 | AV | Horizontal |
| 4804.51 | 59.21 | 44.20 | 9.04 | 31.60 | -3.56 | 55.65 | 74.00 | -18.35 | PK | Vertical |
| 4804.51 | 49.88 | 44.20 | 9.04 | 31.60 | -3.56 | 46.32 | 54.00 | -7.68 | AV | Vertical |
| 4804.48 | 59.54 | 44.20 | 9.04 | 31.60 | -3.56 | 55.98 | 74.00 | -18.02 | PK | Horizontal |
| 4804.48 | 49.94 | 44.20 | 9.04 | 31.60 | -3.56 | 46.38 | 54.00 | -7.62 | AV | Horizontal |
| 5359.69 | 48.96 | 44.20 | 9.86 | 32.00 | -2.34 | 46.62 | 74.00 | -27.38 | PK | Vertical |
| 5359.69 | 39.47 | 44.20 | 9.86 | 32.00 | -2.34 | 37.12 | 54.00 | -16.88 | AV | Vertical |
| 5359.60 | 47.62 | 44.20 | 9.86 | 32.00 | -2.34 | 45.28 | 74.00 | -28.72 | PK | Horizontal |
| 5359.60 | 39.34 | 44.20 | 9.86 | 32.00 | -2.34 | 36.99 | 54.00 | -17.01 | AV | Horizontal |
| 7205.92 | 54.98 | 43.50 | 11.40 | 35.50 | 3.40 | 58.38 | 74.00 | -15.62 | PK | Vertical |
| 7205.92 | 44.42 | 43.50 | 11.40 | 35.50 | 3.40 | 47.82 | 54.00 | -6.18 | AV | Vertical |
| 7205.68 | 54.00 | 43.50 | 11.40 | 35.50 | 3.40 | 57.40 | 74.00 | -16.60 | PK | Horizontal |
| 7205.68 | 44.40 | 43.50 | 11.40 | 35.50 | 3.40 | 47.80 | 54.00 | -6.20 | AV | Horizontal |
| Middle Channel (GFSK/2441 MHz) | | | | | | | | | | |
| 3264.76 | 60.99 | 44.70 | 6.70 | 28.20 | -9.80 | 51.19 | 74.00 | -22.81 | PK | Vertical |
| 3264.76 | 50.22 | 44.70 | 6.70 | 28.20 | -9.80 | 40.42 | 54.00 | -13.58 | AV | Vertical |
| 3264.81 | 60.84 | 44.70 | 6.70 | 28.20 | -9.80 | 51.04 | 74.00 | -22.96 | PK | Horizontal |
| 3264.81 | 50.82 | 44.70 | 6.70 | 28.20 | -9.80 | 41.02 | 54.00 | -12.98 | AV | Horizontal |
| 4882.55 | 59.51 | 44.20 | 9.04 | 31.60 | -3.56 | 55.95 | 74.00 | -18.05 | PK | Vertical |
| 4882.55 | 50.34 | 44.20 | 9.04 | 31.60 | -3.56 | 46.78 | 54.00 | -7.22 | AV | Vertical |
| 4882.57 | 58.64 | 44.20 | 9.04 | 31.60 | -3.56 | 55.08 | 74.00 | -18.92 | PK | Horizontal |
| 4882.57 | 49.16 | 44.20 | 9.04 | 31.60 | -3.56 | 45.60 | 54.00 | -8.40 | AV | Horizontal |
| 5359.60 | 48.50 | 44.20 | 9.86 | 32.00 | -2.34 | 46.15 | 74.00 | -27.85 | PK | Vertical |
| 5359.60 | 40.01 | 44.20 | 9.86 | 32.00 | -2.34 | 37.66 | 54.00 | -16.34 | AV | Vertical |
| 5359.60 | 47.69 | 44.20 | 9.86 | 32.00 | -2.34 | 45.35 | 74.00 | -28.65 | PK | Horizontal |
| 5359.60 | 38.89 | 44.20 | 9.86 | 32.00 | -2.34 | 36.55 | 54.00 | -17.45 | AV | Horizontal |
| 7323.83 | 54.37 | 43.50 | 11.40 | 35.50 | 3.40 | 57.77 | 74.00 | -16.23 | PK | Vertical |
| 7323.83 | 44.19 | 43.50 | 11.40 | 35.50 | 3.40 | 47.59 | 54.00 | -6.41 | AV | Vertical |
| 7323.94 | 54.97 | 43.50 | 11.40 | 35.50 | 3.40 | 58.37 | 74.00 | -15.63 | PK | Horizontal |
| 7323.94 | 44.40 | 43.50 | 11.40 | 35.50 | 3.40 | 47.80 | 54.00 | -6.20 | AV | Horizontal |

| High Channel (GFSK/2480 MHz) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3264.76 | 62.00 | 44.70 | 6.70 | 28.20 | -9.80 | 52.20 | 74.00 | -21.80 | PK | Vertical |
| 3264.76 | 50.91 | 44.70 | 6.70 | 28.20 | -9.80 | 41.11 | 54.00 | -12.89 | AV | Vertical |
| 3264.71 | 61.82 | 44.70 | 6.70 | 28.20 | -9.80 | 52.02 | 74.00 | -21.98 | PK | Horizontal |
| 3264.71 | 50.90 | 44.70 | 6.70 | 28.20 | -9.80 | 41.10 | 54.00 | -12.90 | AV | Horizontal |
| 4960.58 | 58.84 | 44.20 | 9.04 | 31.60 | -3.56 | 55.28 | 74.00 | -18.72 | PK | Vertical |
| 4960.58 | 49.94 | 44.20 | 9.04 | 31.60 | -3.56 | 46.38 | 54.00 | -7.62 | AV | Vertical |
| 4960.52 | 59.11 | 44.20 | 9.04 | 31.60 | -3.56 | 55.55 | 74.00 | -18.45 | PK | Horizontal |
| 4960.52 | 49.48 | 44.20 | 9.04 | 31.60 | -3.56 | 45.92 | 54.00 | -8.08 | AV | Horizontal |
| 5359.87 | 48.42 | 44.20 | 9.86 | 32.00 | -2.34 | 46.08 | 74.00 | -27.92 | PK | Vertical |
| 5359.87 | 39.10 | 44.20 | 9.86 | 32.00 | -2.34 | 36.76 | 54.00 | -17.24 | AV | Vertical |
| 5359.85 | 47.94 | 44.20 | 9.86 | 32.00 | -2.34 | 45.60 | 74.00 | -28.40 | PK | Horizontal |
| 5359.85 | 39.03 | 44.20 | 9.86 | 32.00 | -2.34 | 36.69 | 54.00 | -17.31 | AV | Horizontal |
| 7439.70 | 53.73 | 43.50 | 11.40 | 35.50 | 3.40 | 57.13 | 74.00 | -16.87 | PK | Vertical |
| 7439.70 | 44.68 | 43.50 | 11.40 | 35.50 | 3.40 | 48.08 | 54.00 | -5.92 | AV | Vertical |
| 7439.89 | 53.90 | 43.50 | 11.40 | 35.50 | 3.40 | 57.30 | 74.00 | -16.70 | PK | Horizontal |
| 7439.89 | 44.44 | 43.50 | 11.40 | 35.50 | 3.40 | 47.84 | 54.00 | -6.16 | AV | Horizontal |

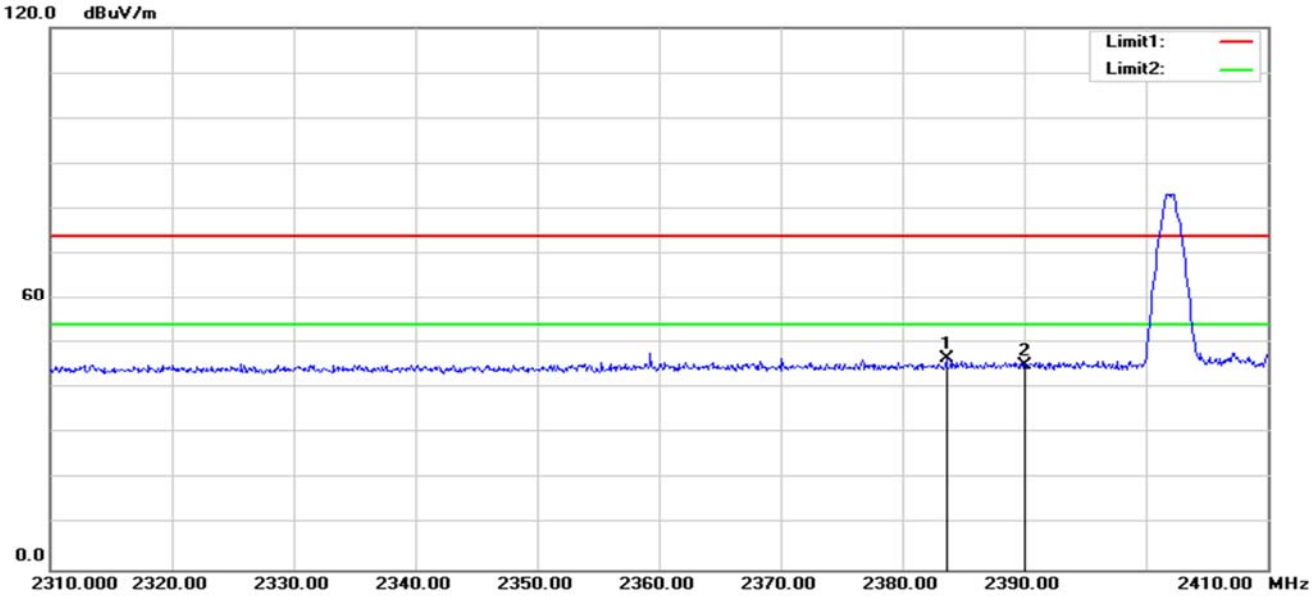
Note:

1) Scan with GFSK, π/4-DQPSK, 8DPSK, the worst case is GFSK Mode.
2) Factor = Antenna Factor + Cable Loss – Pre-amplifier.
   Emission Level = Reading + Factor
3) The frequency emission of peak points that did not show above the forms are at least 20dB below the limit, the frequency emission is mainly from the environment noise.

Restricted band Requirements

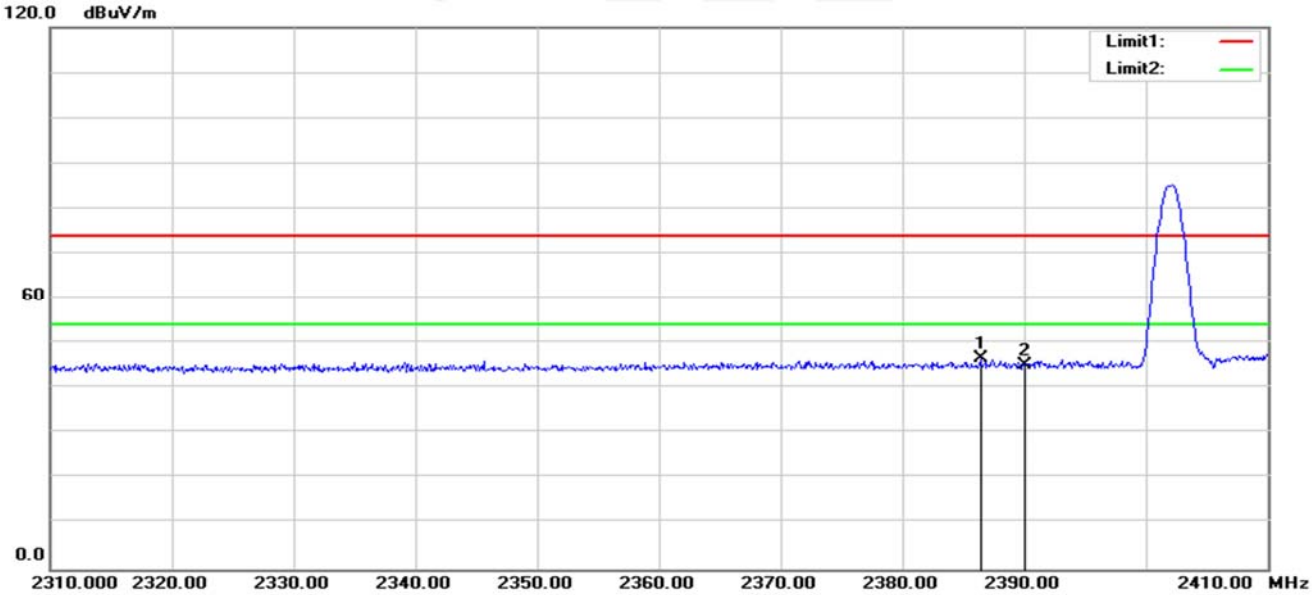
**GFSK-Low**

Horizontal




| No. | Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 2383.600 | 42.29 | 4.24 | 46.53 | 74.00 | -27.47 | peak |
| 2 | 2390.000 | 40.72 | 4.34 | 45.06 | 74.00 | -28.94 | peak |

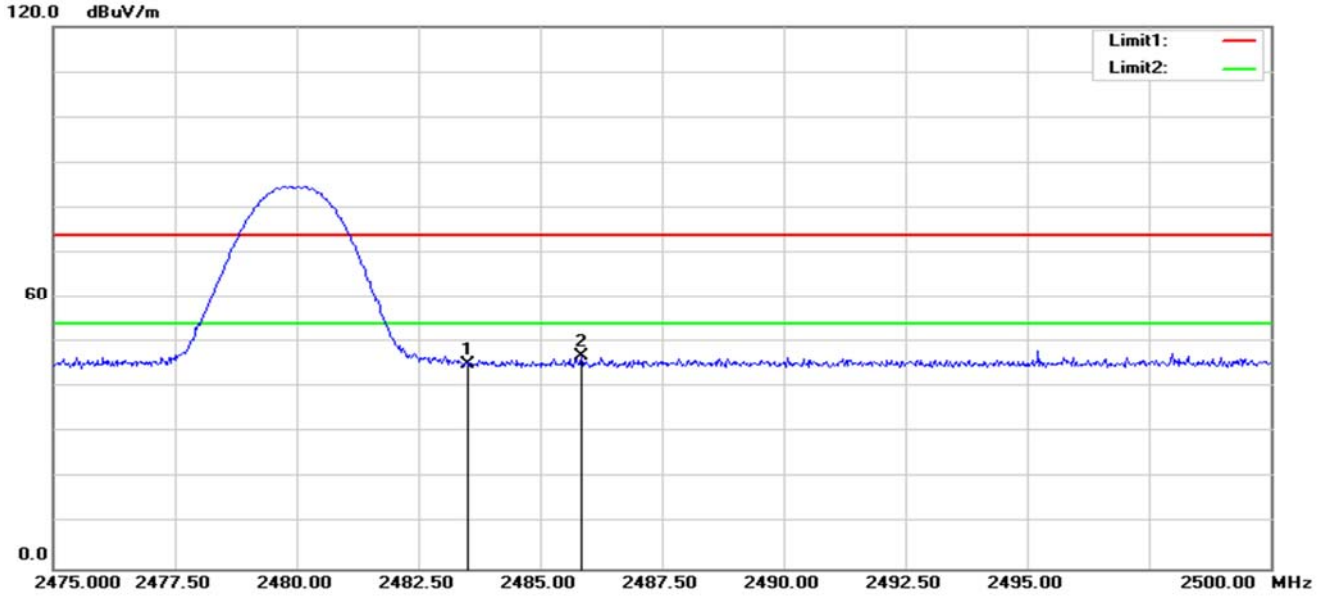
Vertical




| No. | Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 2386.400 | 42.23 | 4.28 | 46.51 | 74.00 | -27.49 | peak |
| 2 | 2390.000 | 40.75 | 4.34 | 45.09 | 74.00 | -28.91 | peak |

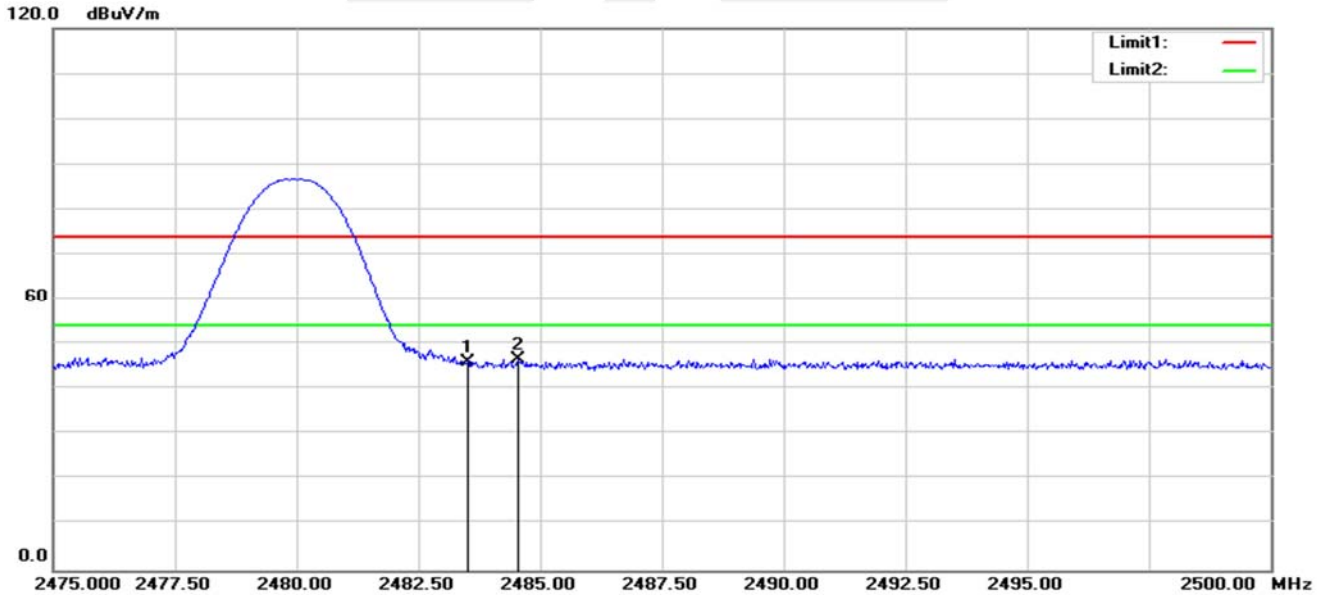
**GFSK-High**

Horizontal




| No. | Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 2483.500 | 40.41 | 4.60 | 45.01 | 74.00 | -28.99 | peak |
| 2 | 2485.850 | 42.26 | 4.61 | 46.87 | 74.00 | -27.13 | peak |

Vertical




| No. | Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 2483.500 | 41.35 | 4.60 | 45.95 | 74.00 | -28.05 | peak |
| 2 | 2484.550 | 41.97 | 4.61 | 46.58 | 74.00 | -27.42 | peak |

Note: GFSK, π/4-DQPSK, 8DPSK of the nohopping and hopping mode all have been test, the worst case is GFSK of the nohopping mode, this report only show the worst case.

# 4. CONDUCTED SPURIOUS & BAND EDGE EMISSION

## 4.1 LIMIT

According to FCC section 15.247(d), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

## 4.2 TEST PROCEDURE

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | 30 MHz to 10th carrier harmonic |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

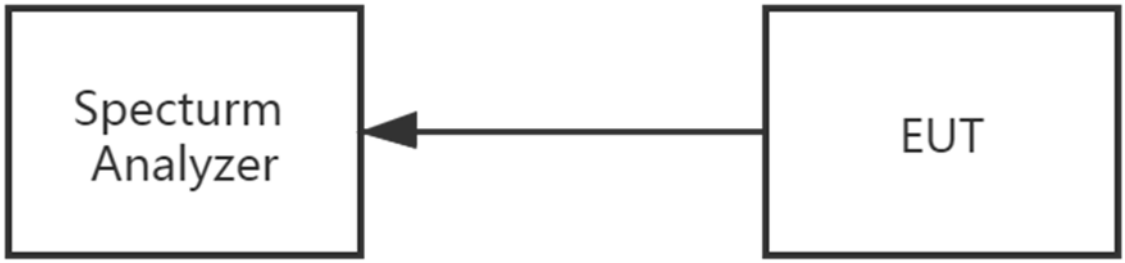
For Band edge

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | Lower Band Edge: 2300 – 2407 MHz<br>Upper Band Edge: 2475 – 2500 MHz |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

For Hopping Band edge

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | Lower Band Edge: 2300– 2403 MHz<br>Upper Band Edge: 2479 – 2500 MHz |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

4.3 TEST SETUP




The EUT is connected to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading. Tune the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, the span is set to be greater than RBW.

4.4 EUT OPERATION CONDITIONS

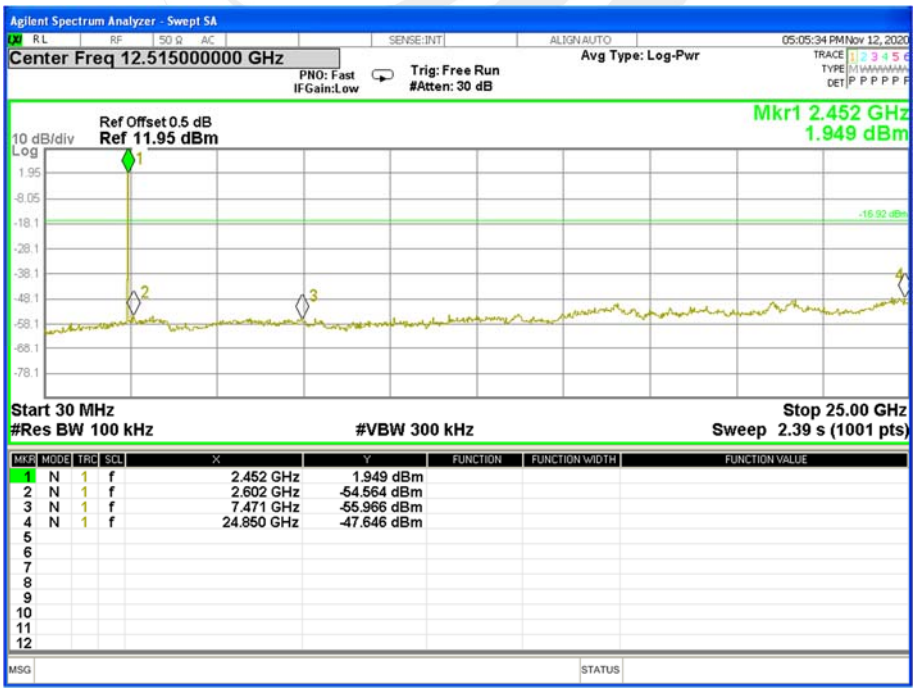
Please refer to section 3.1.4 of this report.

## 4.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | GFSK(1Mbps)-00/39/78 CH | Test Voltage: | DC 12V |

00 CH

39 CH

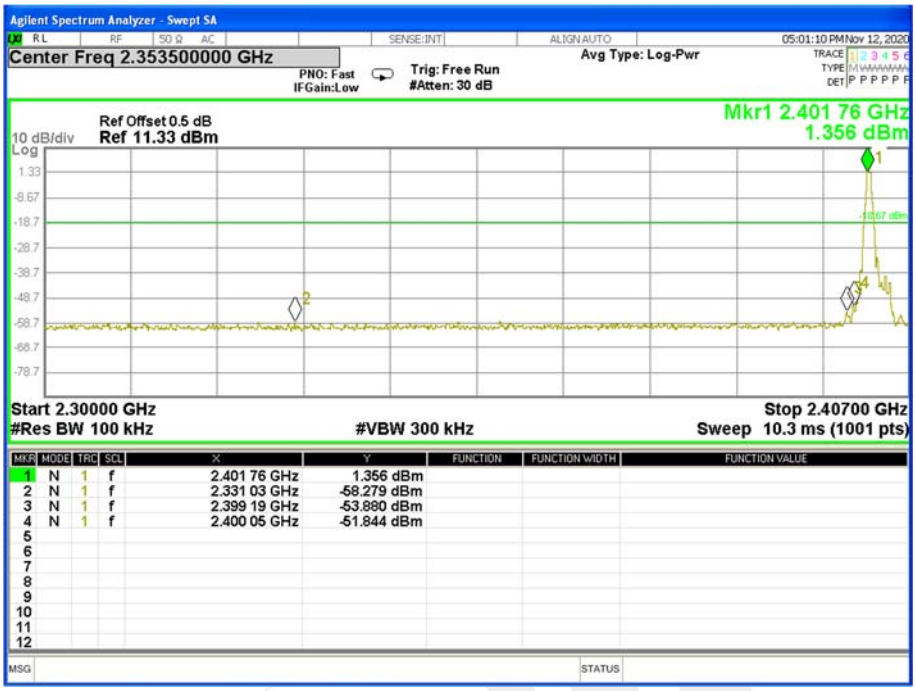


78 CH

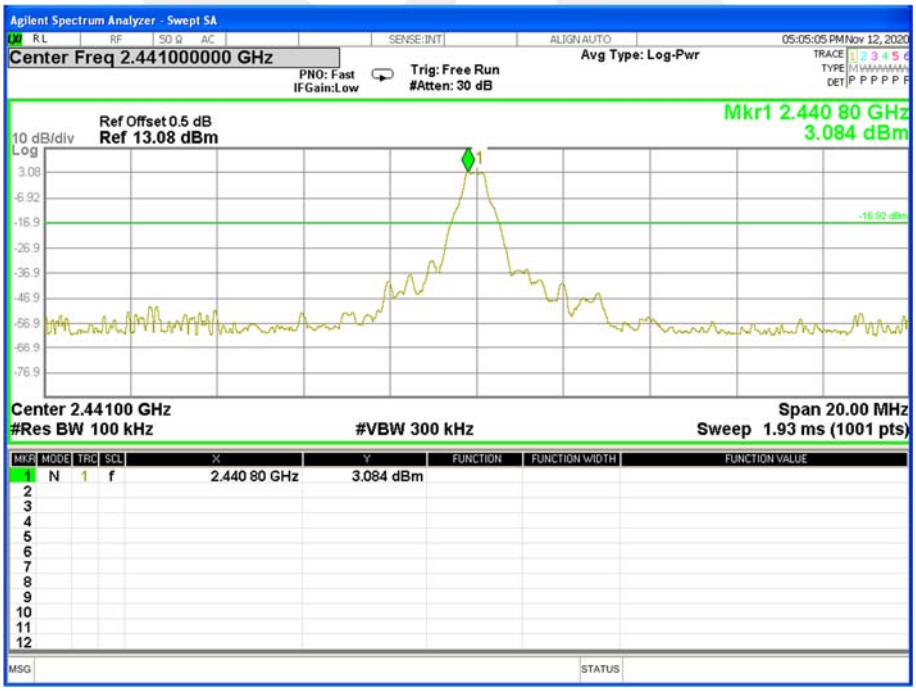
Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:08:26 PM Nov 12, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 13.56 dBm
Mkr1 2.477 GHz
3.557 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.39 s (1001 pts)
1 N 1 f 2.477 GHz 3.557 dBm
2 N 1 f 3.201 GHz -54.506 dBm
3 N 1 f 7.995 GHz -55.264 dBm
4 N 1 f 24.700 GHz -48.111 dBm

For Band edge(it's also the reference level for conducted spurious emission)

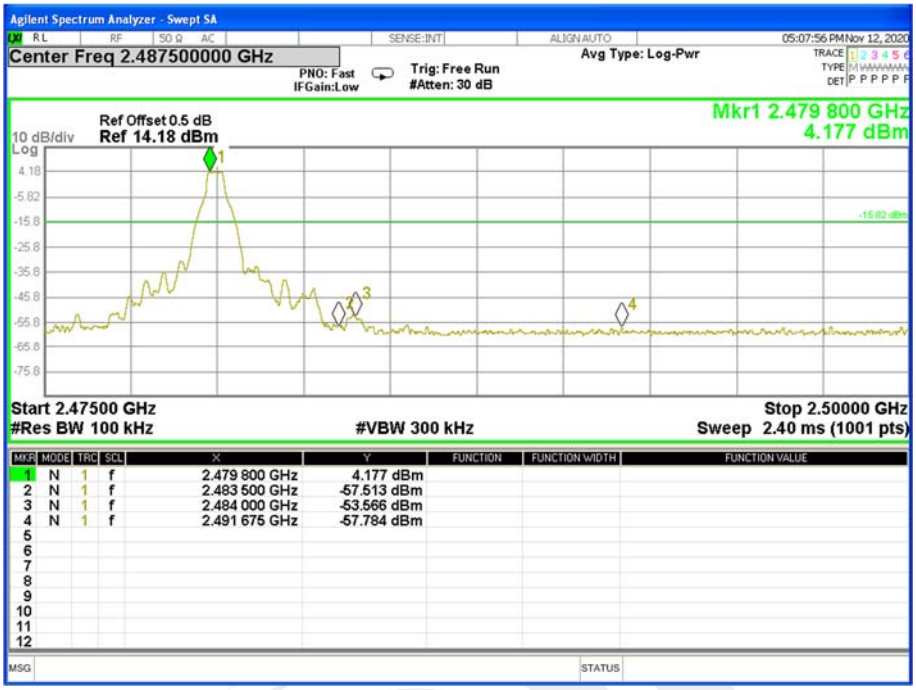
00 CH




39 CH

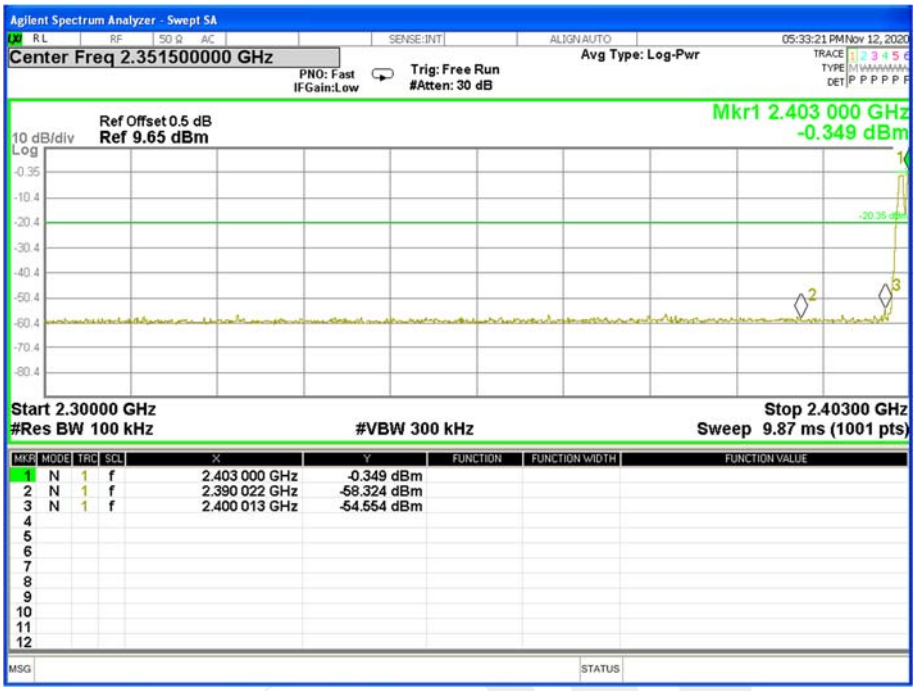


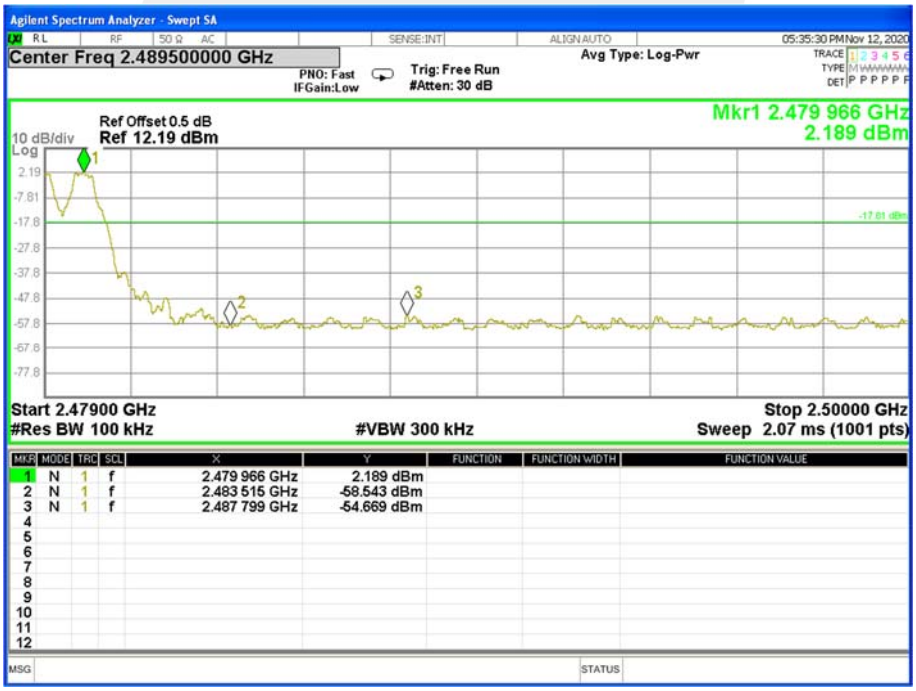
78 CH


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:07:56 PM Nov 12, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 14.18 dBm
Log
Mkr1 2.479 800 GHz
4.177 dBm
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.40 ms (1001 pts)
1 N 1 f 2.479 800 GHz 4.177 dBm
2 N 1 f 2.483 500 GHz -57.513 dBm
3 N 1 f 2.484 000 GHz -53.566 dBm
4 N 1 f 2.491 675 GHz -57.784 dBm

For Hopping Band edge

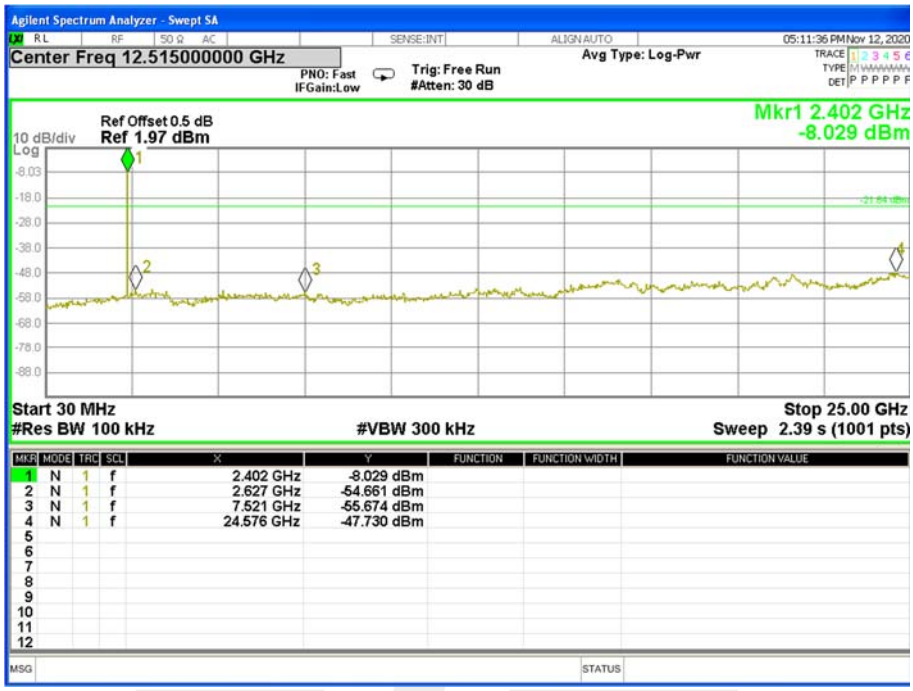
GFSK



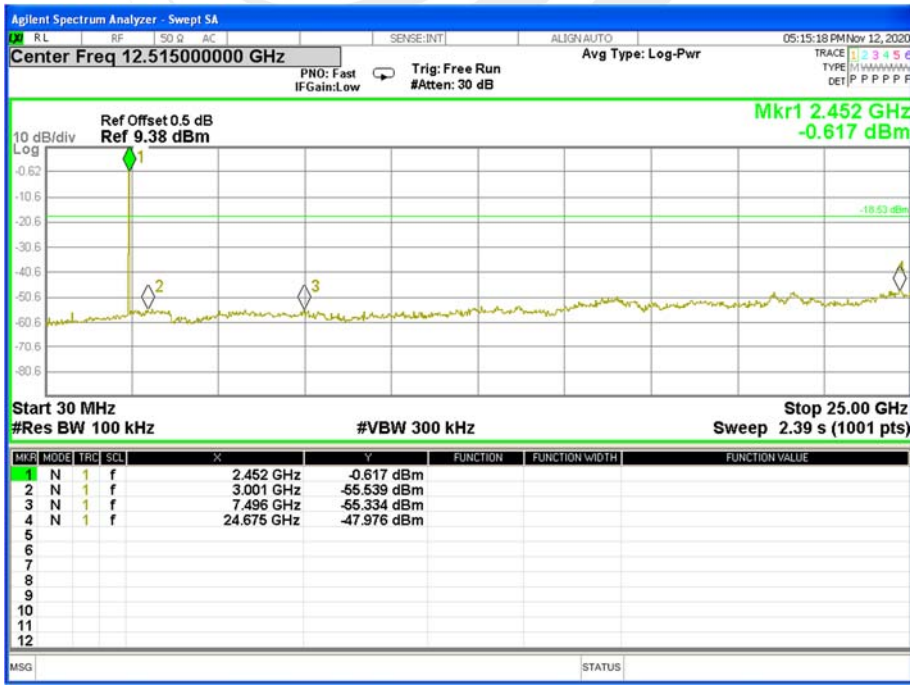



| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | π/4-DQPSK(2Mbps)–00/39/78 CH | Test Voltage: | DC 12V |

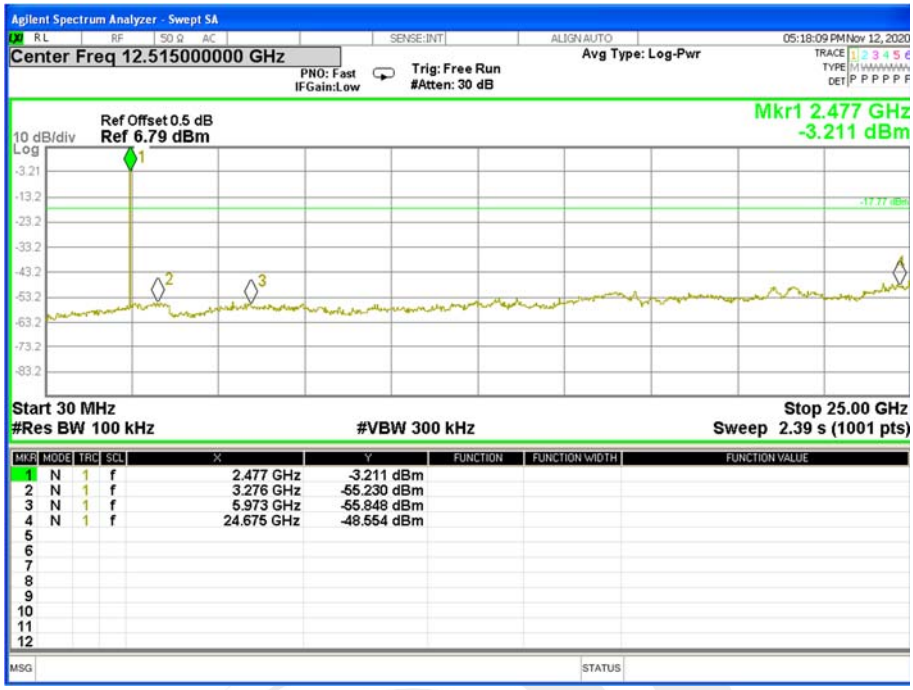
00 CH




39 CH

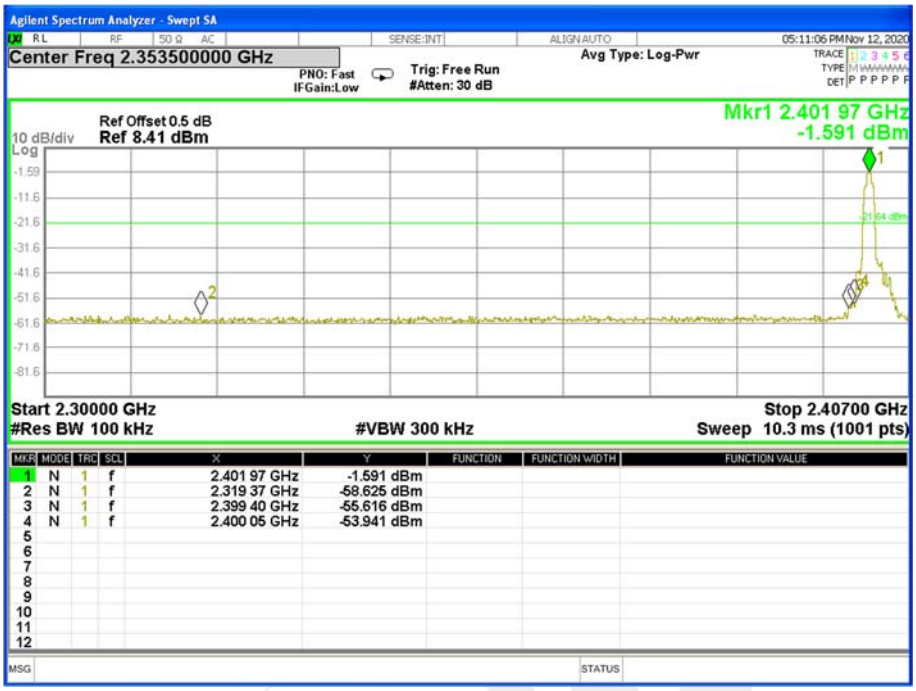


78 CH

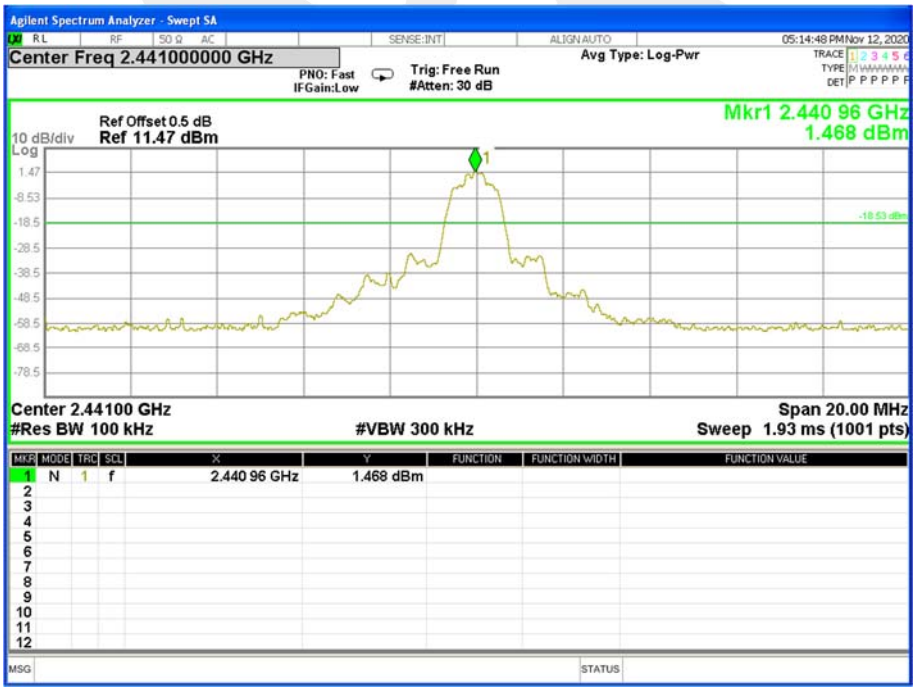

Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:18:09 PM Nov 12, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 6.79 dBm
Mkr1 2.477 GHz
-3.211 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.39 s (1001 pts)
1 N 1 f 2.477 GHz -3.211 dBm
2 N 1 f 3.276 GHz -55.230 dBm
3 N 1 f 5.973 GHz -55.848 dBm
4 N 1 f 24.675 GHz -48.554 dBm

For Band edge(it's also the reference level for conducted spurious emission)

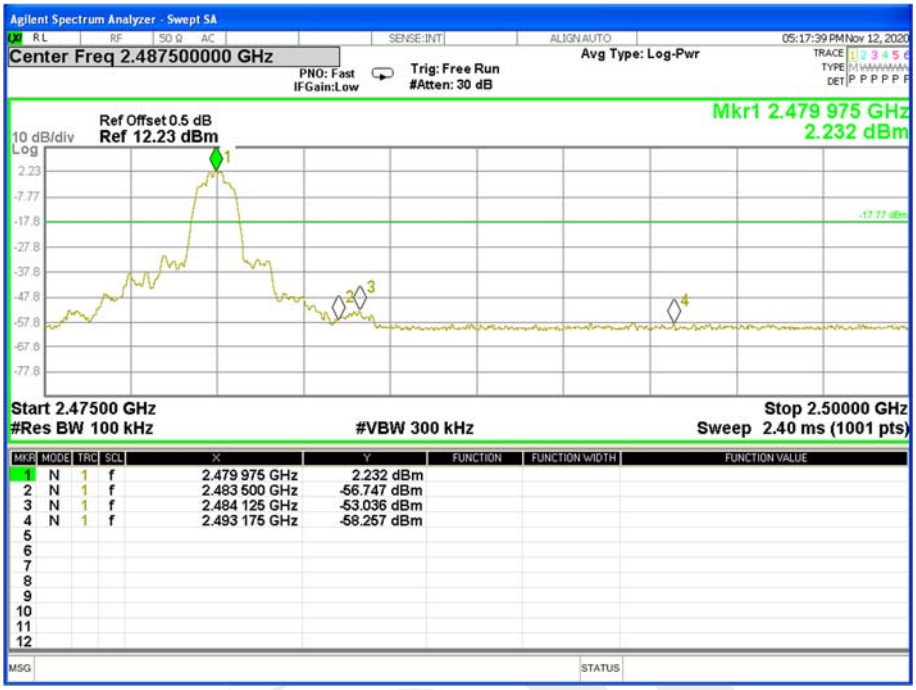
00 CH




39 CH

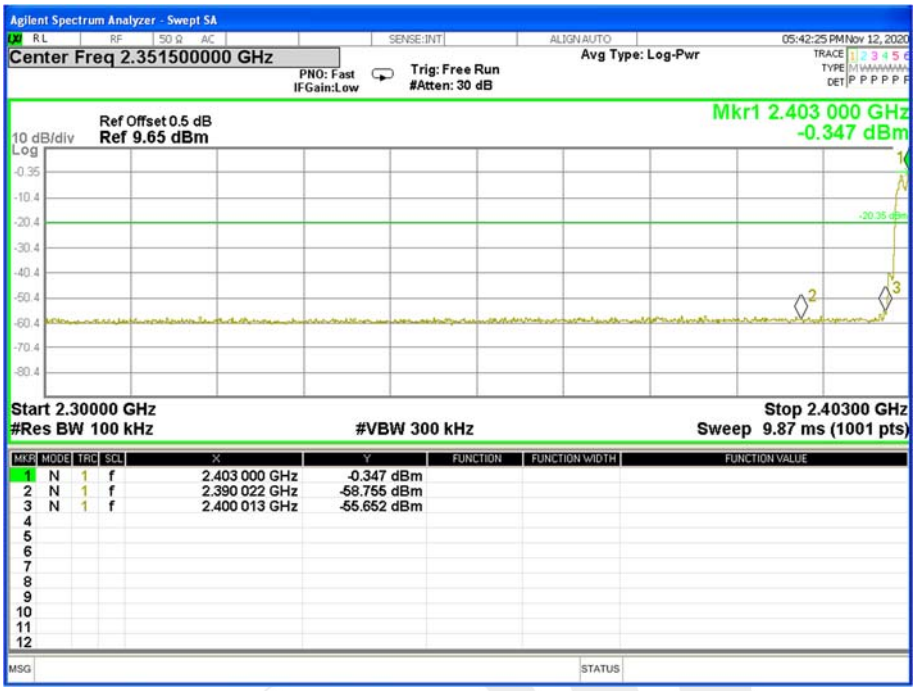


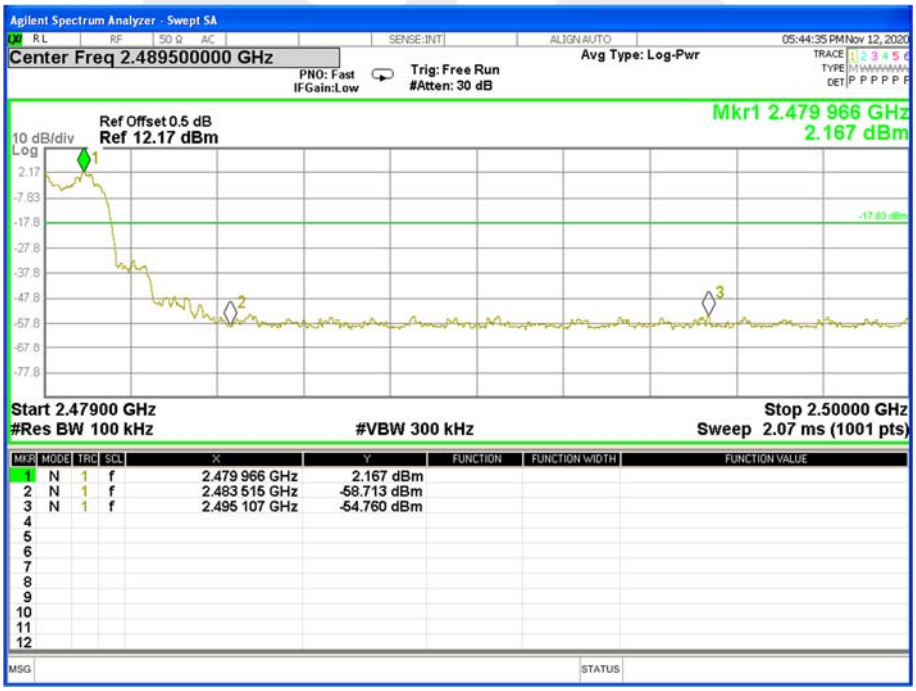
78 CH


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:17:39 PM Nov 12, 2020
Mkr1 2.479 975 GHz
2.232 dBm
Ref Offset 0.5 dB
10 dB/div
Ref 12.23 dBm
Log
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.40 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.479 975 GHz 2.232 dBm
2 N 1 f 2.483 500 GHz -56.747 dBm
3 N 1 f 2.484 125 GHz -53.036 dBm
4 N 1 f 2.493 175 GHz -58.257 dBm
MSG
STATUS

For Hopping Band edge

π/4-DQPSK

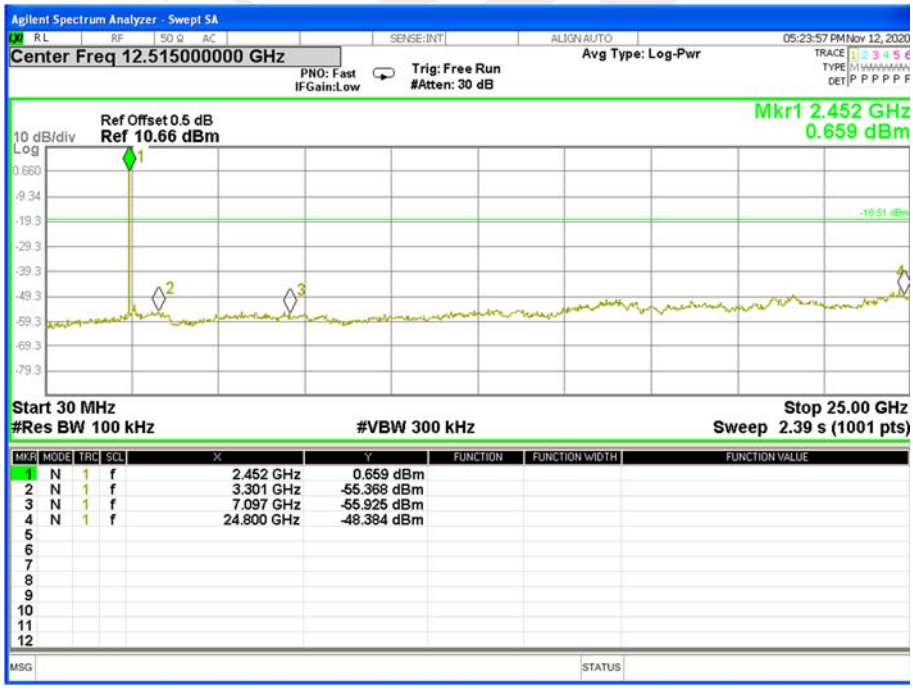


| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | 8DPSK(3Mbps) -00/39/78 CH | Test Voltage: | DC 12V |

00 CH

39 CH

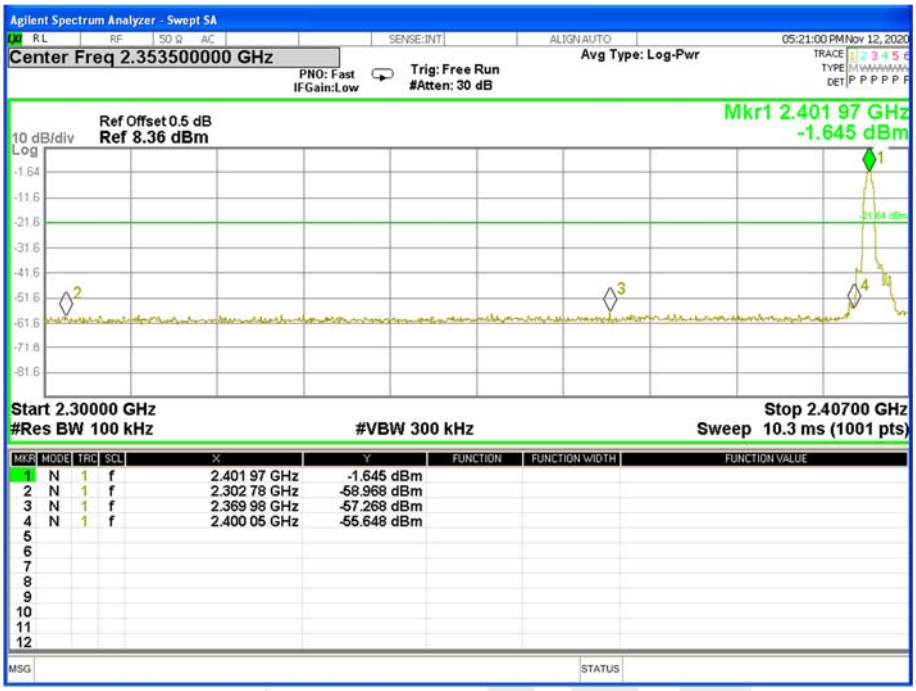


78 CH

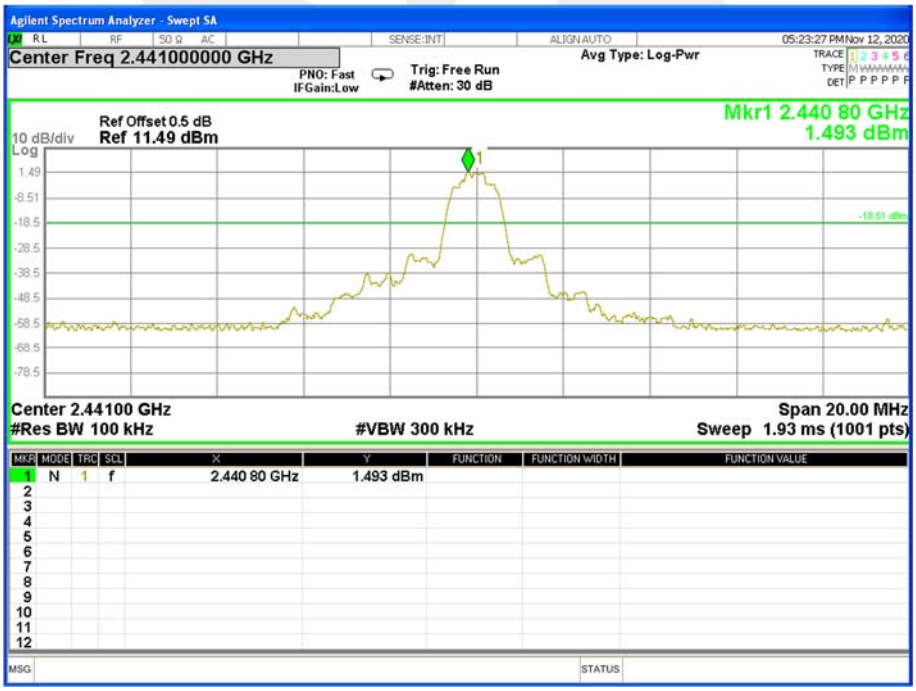
Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:27:50 PM Nov 12, 2020
Ref Offset 0.5 dB
10 dB/div
Ref 8.16 dBm
Mkr1 2.477 GHz
-1.841 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.39 s (1001 pts)
1 N 1 f 2.477 GHz -1.841 dBm
2 N 1 f 2.652 GHz -55.576 dBm
3 N 1 f 7.995 GHz -55.696 dBm
4 N 1 f 24.675 GHz -48.569 dBm

For Band edge(it's also the reference level for conducted spurious emission)

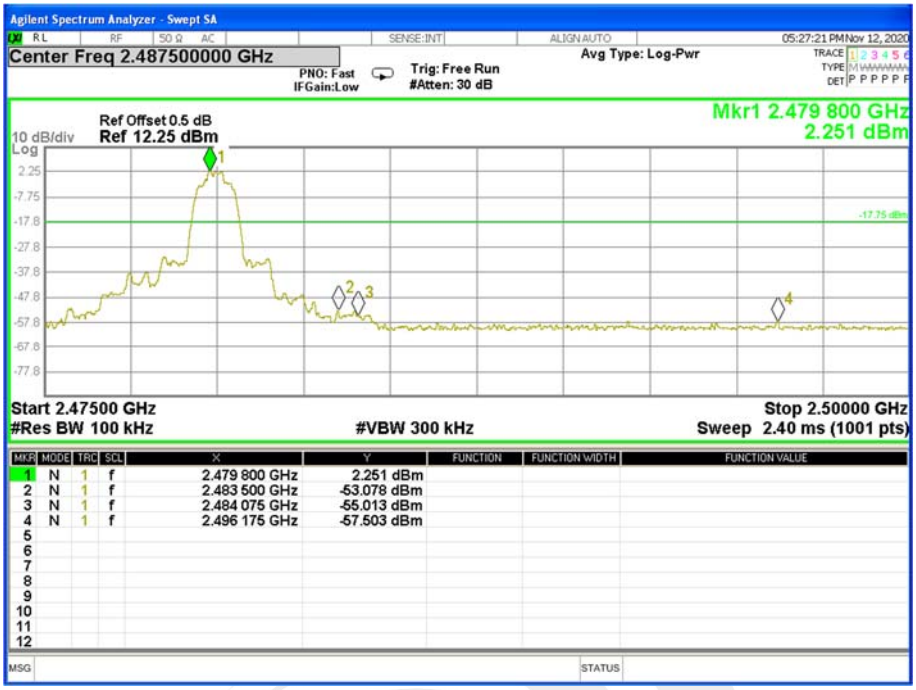
00 CH




39 CH

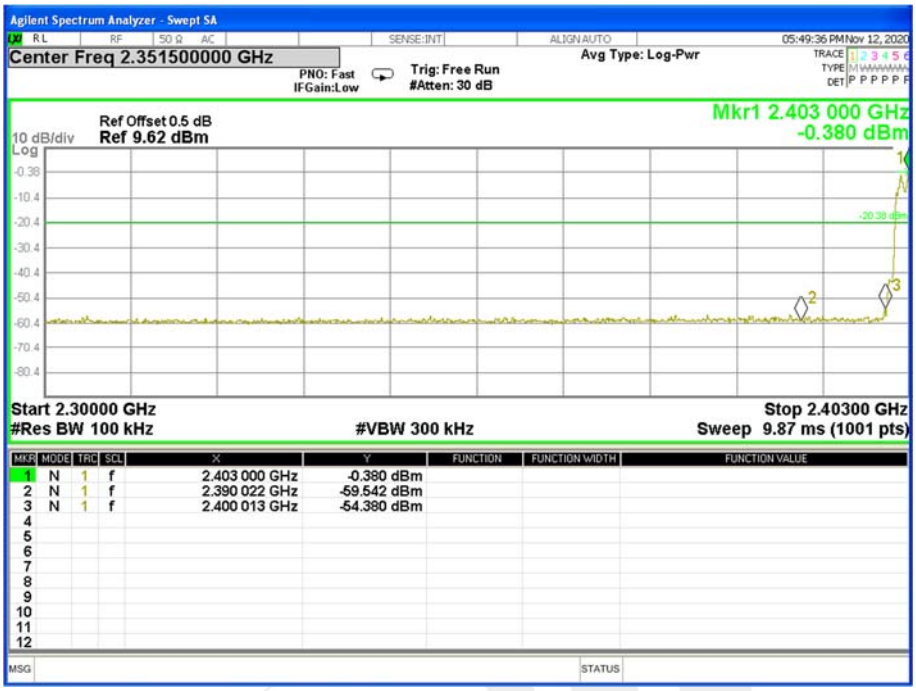


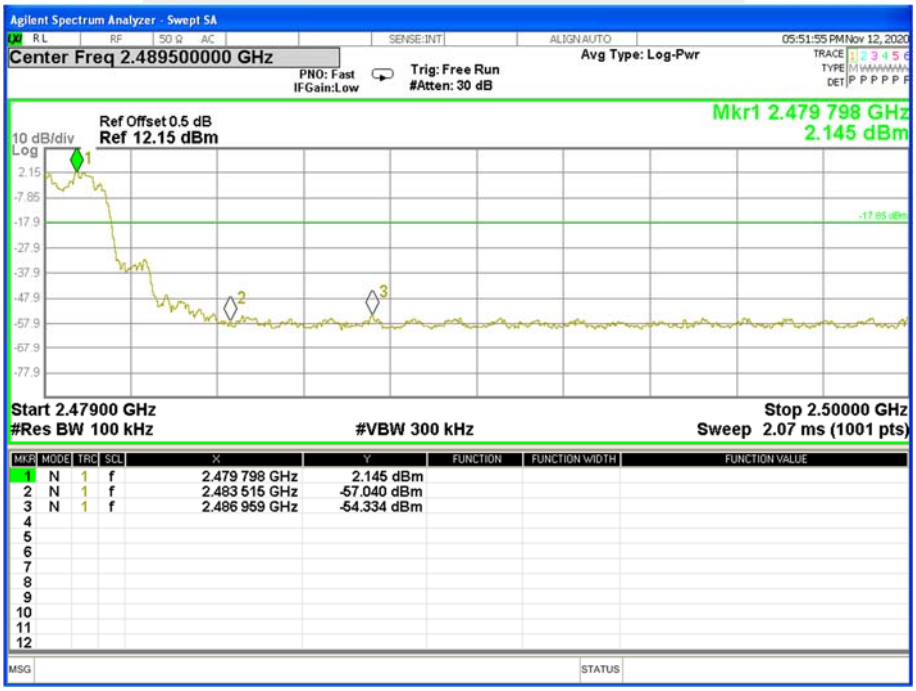
78 CH


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
05:27:21 PM Nov 12, 2020
Mkr1 2.479 800 GHz
2.251 dBm
Ref Offset 0.5 dB
10 dB/div
Ref 12.25 dBm
Log
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.40 ms (1001 pts)
1 N 1 f 2.479 800 GHz 2.251 dBm
2 N 1 f 2.483 500 GHz -53.078 dBm
3 N 1 f 2.484 075 GHz -55.013 dBm
4 N 1 f 2.496 175 GHz -57.503 dBm

For Hopping Band edge

8DPSK



# 5. NUMBER OF HOPPING CHANNEL

## 5.1 LIMIT

| FCC Part 15.247,Subpart C | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | FrequencyRange (MHz) | Result |
| 15.247 (a)(1)(iii) | Number of Hopping Channel | ≥15 | 2400-2483.5 | PASS |

| Spectrum Parameters | Setting |
|---|---|
| Attenuation | Auto |
| Span Frequency | > Operating FrequencyRange |
| RB | 300KHz |
| VB | 300KHz |
| Detector | Peak |
| Trace | Max Hold |
| Sweep Time | Auto |

## 5.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Spectrum Setting: RBW= 300KHz, VBW=300KHz, Sweep time = Auto.

## 5.3 TEST SETUP

## 5.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

5.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 60% |
| Test Mode: | Hopping Mode -GFSK Mode | Test Voltage: | DC 12V |

Number of Hopping Channel 79

**Hopping channel**

# 6. AVERAGE TIME OF OCCUPANCY

## 6.1 LIMIT

| FCC Part 15.247,Subpart C | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | FrequencyRange (MHz) | Result |
| 15.247 (a)(1)(iii) | Average Time of Occupancy | 0.4sec | 2400-2483.5 | PASS |

## 6.2 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyzer.
b. Set RBW =1MHz/VBW =3MHz.
c. Use a video trigger with the trigger level set to enable triggering only on full pulses.
d. Sweep Time is more than once pulse time.
e. Set the center frequency on any frequency would be measure and set the frequency span to zero span.
f. Measure the maximum time duration of one single pulse.
g. Set the EUT for DH5, DH3 and DH1 packet transmitting.
h. Measure the maximum time duration of one single pulse.
i. DH5 Packet permit maximum 1600/ 79 / 6 = 3.37 hops per second in each channel (5 time slots RX, 1 time slot TX). Sothe dwell time is the time duration of the pulse times 3.37 x 31.6 = 106.6 within 31.6 seconds.
j. DH3 Packet permit maximum 1600 / 79 / 4 = 5.06 hops per second in each channel (3 time slots RX, 1 time slot TX). Sothe dwell time is the time duration of the pulse times 5.06 x 31.6 = 160 within 31.6 seconds.
k. 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.

## 6.3 TEST SETUP

## 6.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

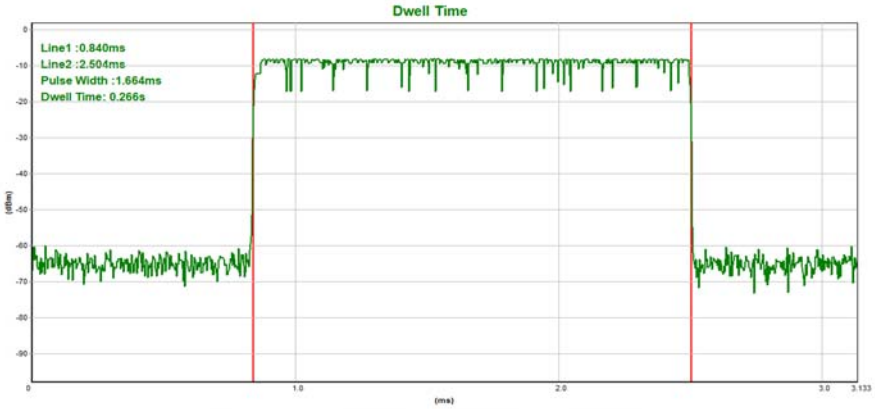
6.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | GFSK(1Mbps)-DH1/DH3/DH5 | Test Voltage: | DC 12V |

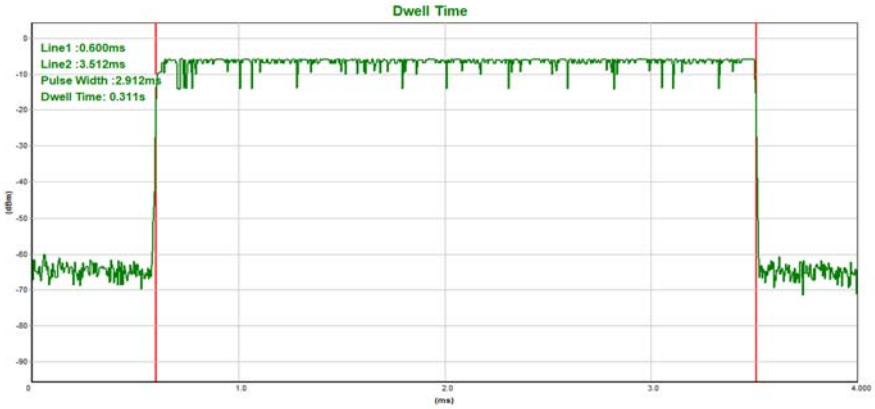
| Data Packet | Channel | pulse time(ms) | Dwell Time(s) | Limits(s) |
|---|---|---|---|---|
| DH1 | middle | 0.409 | 0.131 | 0.4 |
| DH3 | middle | 1.664 | 0.266 | 0.4 |
| DH5 | middle | 2.912 | 0.311 | 0.4 |

**CH39-DH1**

**CH39-DH3**



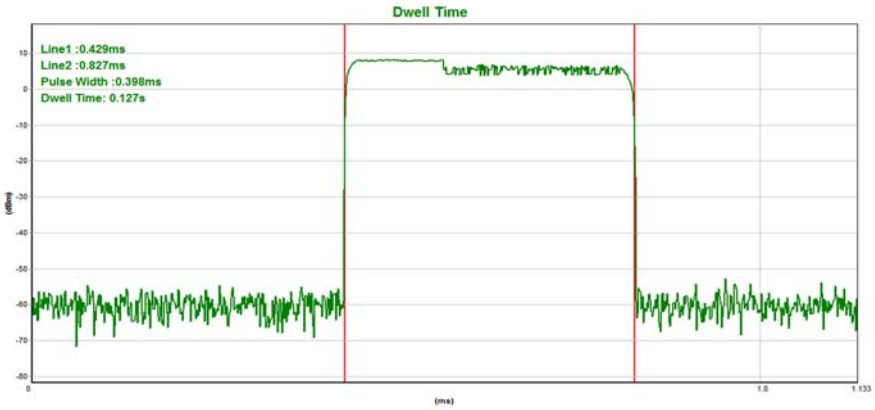

**CH39-DH5**



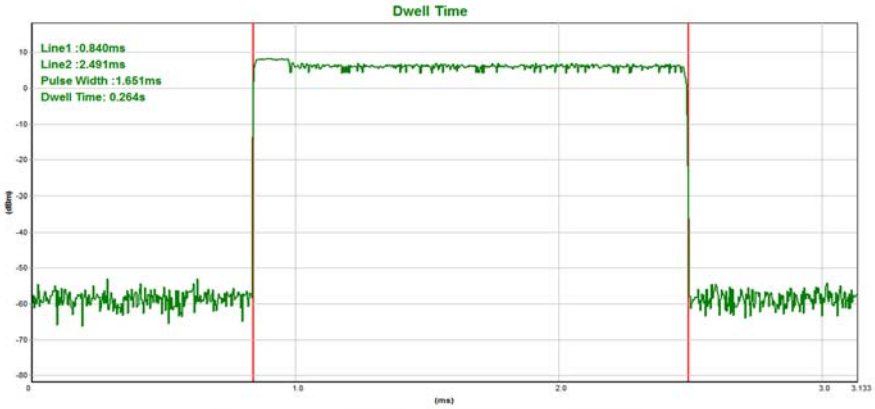
| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | π/4-DQPSK(2Mbps)–2DH1/2DH3/2DH5 | Test Voltage: | DC 12V |

| Data Packet | Channel | pulse time(ms) | Dwell Time(s) | Limits(s) |
|---|---|---|---|---|
| 2DH1 | middle | 0.398 | 0.127 | 0.4 |
| 2DH3 | middle | 1.651 | 0.264 | 0.4 |
| 2DH5 | middle | 2.908 | 0.310 | 0.4 |

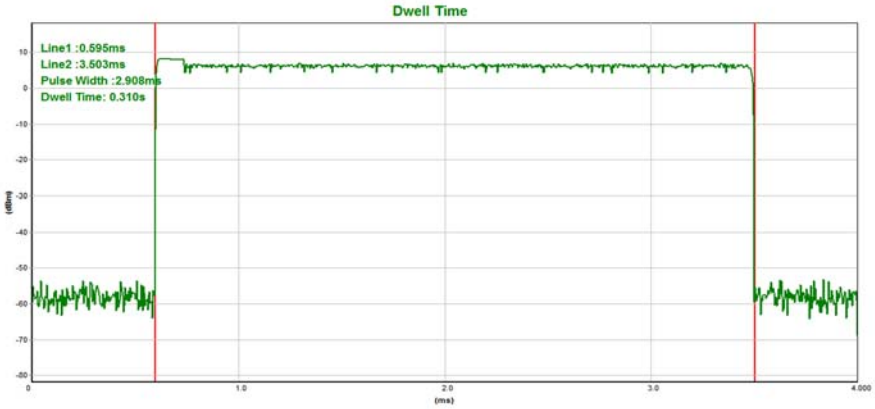
**CH39-2DH1**




**CH39-2DH3**



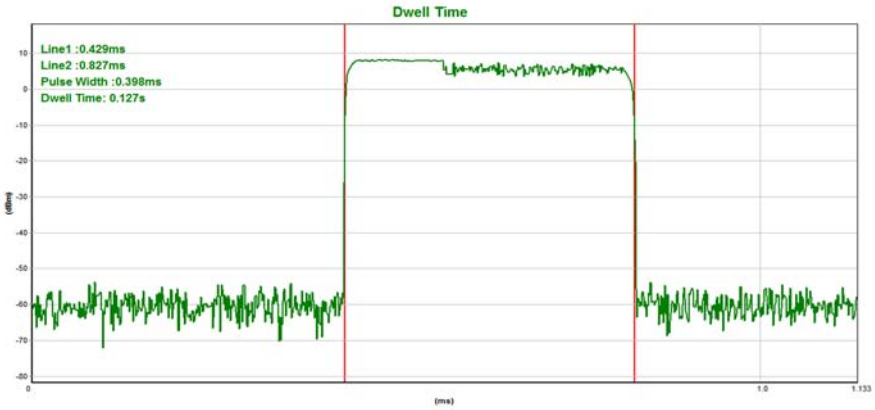

**CH39-2DH5**



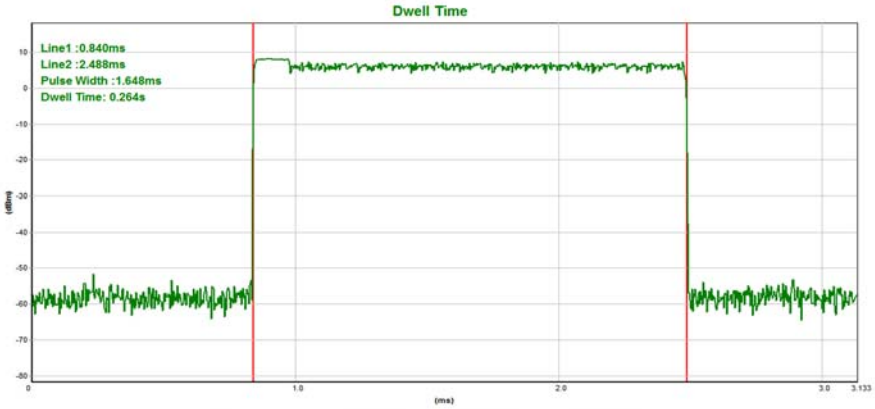
| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | 8DPSK(3Mbps)–3DH1/3DH3/3DH5 | Test Voltage: | DC 12V |

| Data Packet | Channel | pulse time(ms) | Dwell Time(s) | Limits(s) |
|---|---|---|---|---|
| 3DH1 | middle | 0.398 | 0.127 | 0.4 |
| 3DH3 | middle | 1.648 | 0.264 | 0.4 |
| 3DH5 | middle | 2.900 | 0.309 | 0.4 |

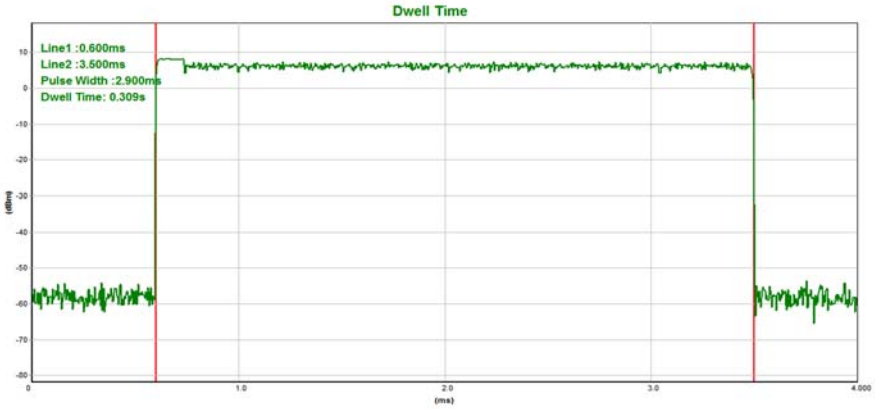
**CH39-3DH1**




**CH39-3DH3**




**CH39-3DH5**



# 7. HOPPING CHANNEL SEPARATION MEASUREMEN

## 7.1 LIMIT

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. Alternatively, 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, provided the systems operate with an output power no greater than 125 mW.

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Span Frequency | > 20 dB Bandwidth or Channel Separation |
| RB | 30 kHz (20dB Bandwidth) / 30 kHz (Channel Separation) |
| VB | 100 kHz (20dB Bandwidth) / 100 kHz (Channel Separation) |
| Detector | Peak |
| Trace | Max Hold |
| Sweep Time | Auto |

## 7.2 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyser in peak hold mode.
b. The resolution bandwidth of 30 kHz and the video bandwidth of 100 kHz were utilised for 20 dB bandwidth measurement.
c. The resolution bandwidth of 30 kHz and the video bandwidth of 100 kHz were utilised for channel separation measurement.

## 7.3 TEST SETUP

## 7.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

7.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | CH00 / CH39 / CH78 (GFSK(1Mbps) Mode) | Test Voltage: | DC 12V |

| Frequency | Mark1 Frequency （MHz） | Mark2 Frequency （MHz） | Ch. Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|---|---|
| 2402 MHz | 2401.966 | 2402.968 | 1.002 | 0.875 | Complies |
| 2441 MHz | 2440.966 | 2441.968 | 1.002 | 0.867 | Complies |
| 2480 MHz | 2478.963 | 2479.962 | 0.999 | 0.867 | Complies |

For GFSK: Ch. Separation Limits: > 20dB bandwidth

**CH00 -1Mbps**

## CH39 -1Mbps

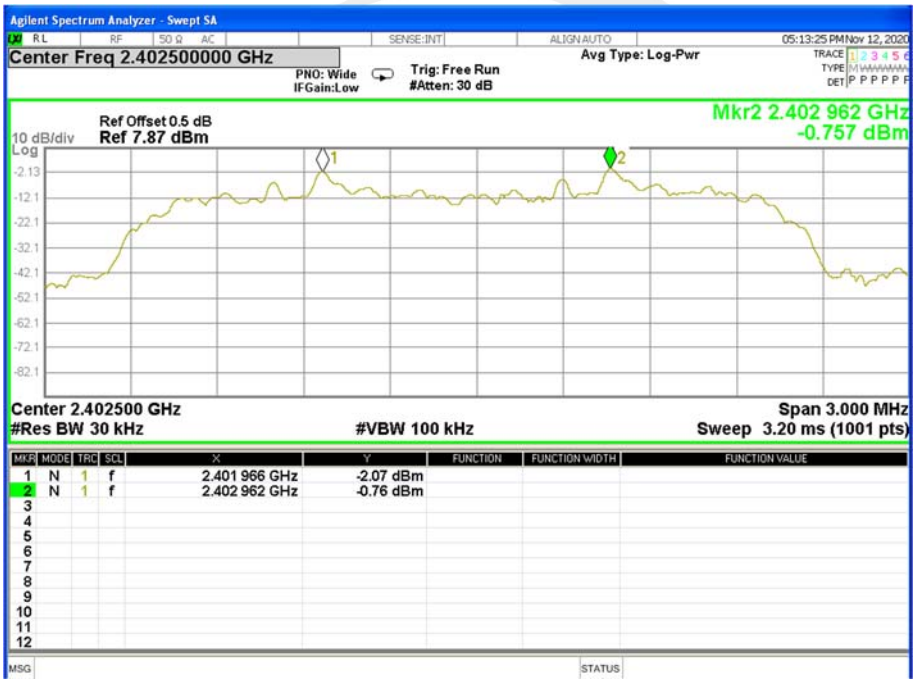
## CH78 -1Mbps

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | CH00 / CH39 / CH78 (π/4-DQPSK(2Mbps) Mode) | Test Voltage: | DC 12V |

| Frequency | Mark1 Frequency （MHz） | Mark2 Frequency （MHz） | Ch. Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|---|---|
| 2402 MHz | 2401.966 | 2402.962 | 0.996 | 0.799 | Complies |
| 2441 MHz | 2440.963 | 2441.962 | 0.999 | 0.812 | Complies |
| 2480 MHz | 2478.966 | 2479.962 | 0.996 | 0.812 | Complies |

For π/4-DQPSK(2Mbps): Ch. Separation Limits: > two-thirds 20dB bandwidth

**CH00 -2Mbps**



## CH39 -2Mbps

## CH78 -2Mbps

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | CH00 / CH39 / CH78 (8DPSK(3Mbps)Mode) | Test Voltage: | DC 12V |

| Frequency | Mark1 Frequency （MHz） | Mark2 Frequency （MHz） | Ch. Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|---|---|
| 2402 MHz | 2401.963 | 2402.968 | 1.005 | 0.803 | Complies |
| 2441 MHz | 2440.963 | 2441.965 | 1.002 | 0.805 | Complies |
| 2480 MHz | 2478.966 | 2479.965 | 0.999 | 0.805 | Complies |

For 8DPSK(3Mbps):Ch. Separation Limits: > two-thirds 20dB bandwidth

**CH00 -3Mbps**

## CH39 -3Mbps

## CH78 -3Mbps

# 8. BANDWIDTH TEST

## 8.1 LIMIT

| FCC Part15 15.247,Subpart C | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | FrequencyRange (MHz) | Result |
| 15.247 (a)(1) | Bandwidth | N/A | 2400-2483.5 | PASS |

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Span Frequency | > Measurement Bandwidth or Channel Separation |
| RB | 30 kHz (20dB Bandwidth) / 30 kHz (Channel Separation) |
| VB | 100 kHz (20dB Bandwidth) / 100 kHz (Channel Separation) |
| Detector | Peak |
| Trace | Max Hold |
| Sweep Time | Auto |

## 8.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Spectrum Setting: RBW= 30KHz, VBW=100KHz, Sweep time = Auto.

## 8.3 TEST SETUP

## 8.4 EUT OPERATION CONDITIONS

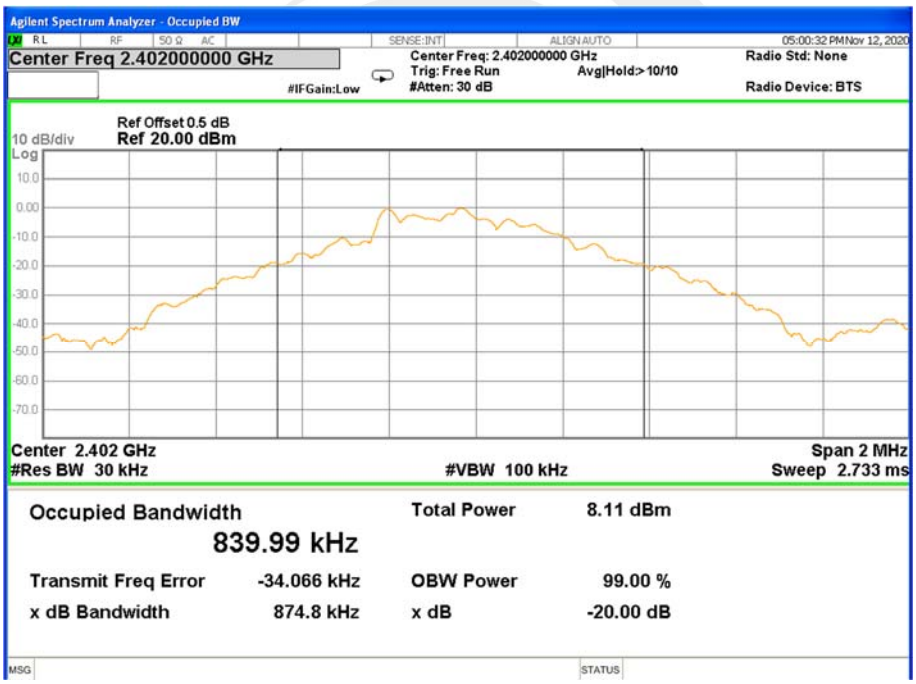
Please refer to section 3.1.4 of this report.

8.5 TEST RESULTS

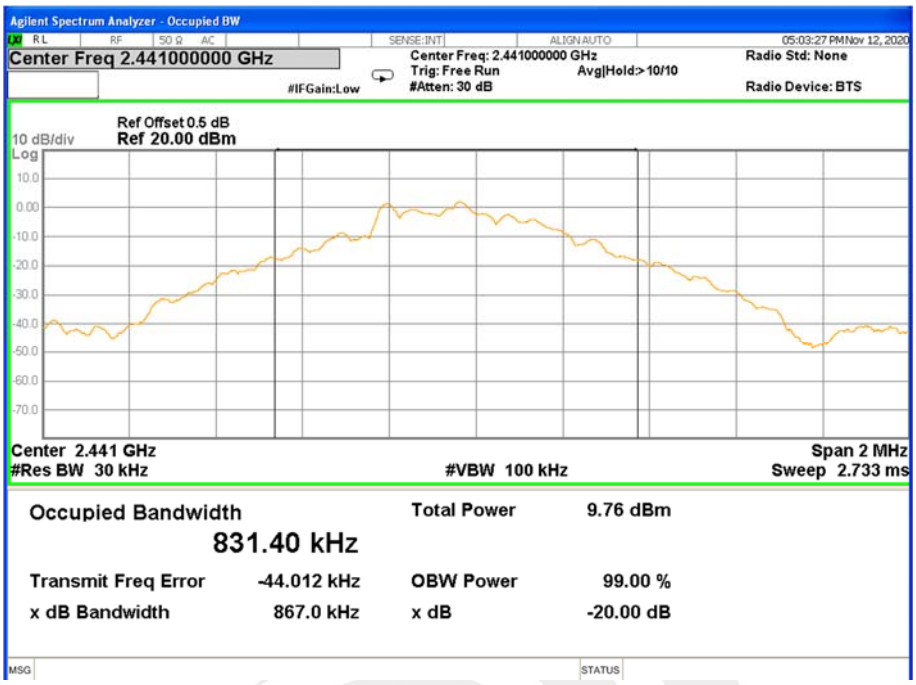
| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | GFSK(1Mbps)<br>CH00 / CH39 / C78 | Test Voltage: | DC 12V |

| Frequency | 20dB Bandwidth (MHz) | Result |
|---|---|---|
| 2402 MHz | 0.8748 | PASS |
| 2441 MHz | 0.8670 | PASS |
| 2480 MHz | 0.8674 | PASS |

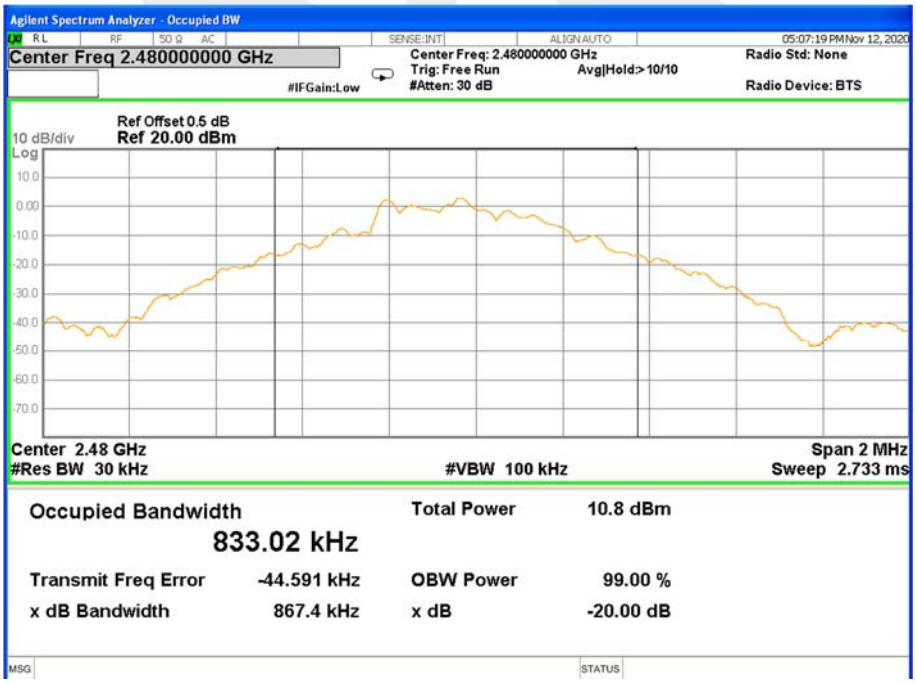
**CH00 -1Mbps**



## CH39 -1Mbps



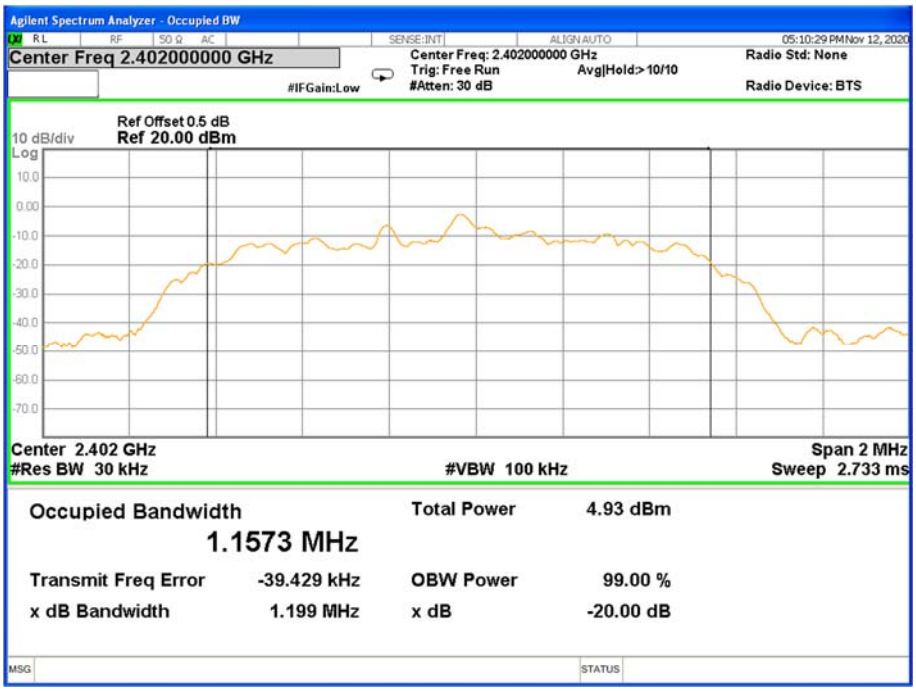

## CH78 -1Mbps



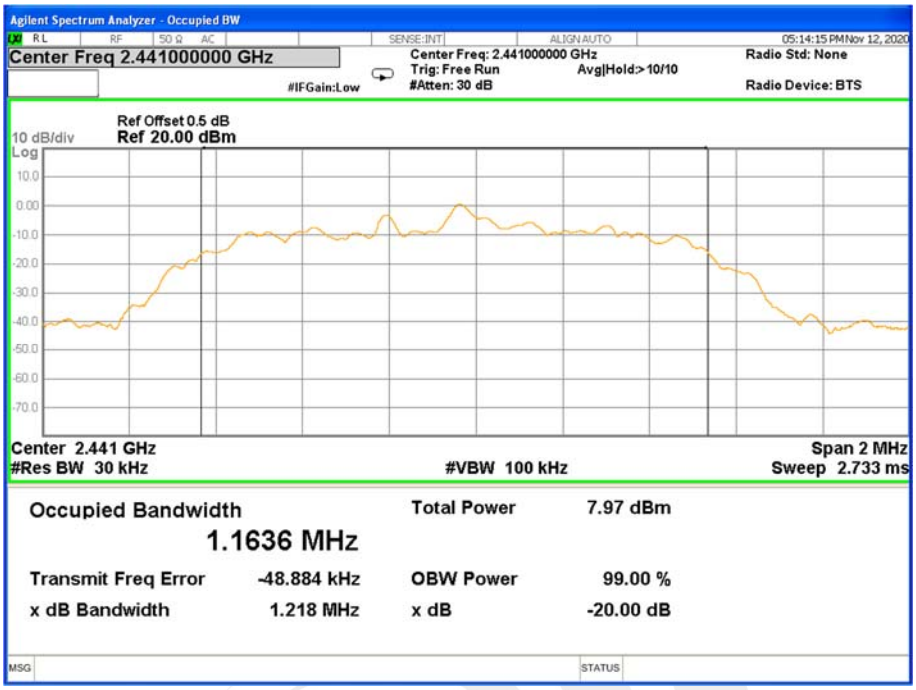
| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | π/4-DQPSK(2Mbps)<br>CH00 / CH39 / C78 | Test Voltage: | DC 12V |

| Frequency | 20dB Bandwidth (MHz) | Result |
|---|---|---|
| 2402 MHz | 1.199 | PASS |
| 2441 MHz | 1.218 | PASS |
| 2480 MHz | 1.218 | PASS |

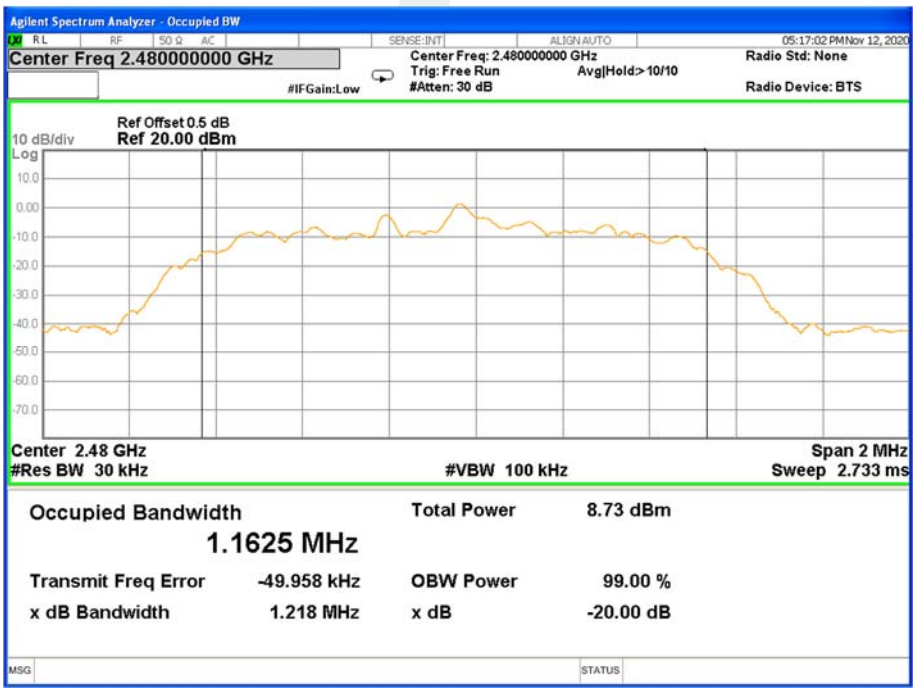
**CH00 -2Mbps**



## CH39 -2Mbps



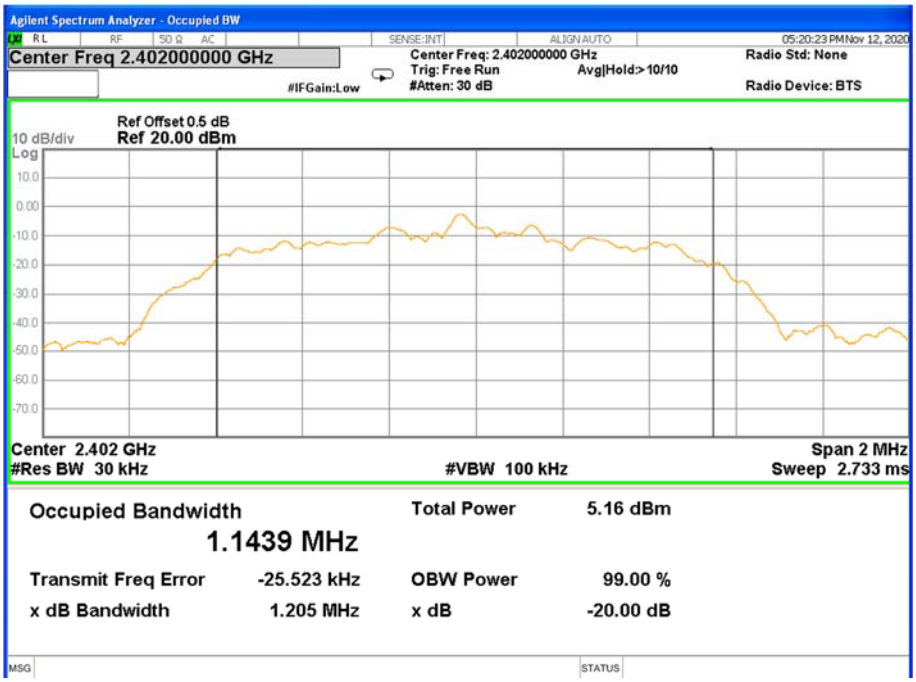

## CH78 -2Mbps



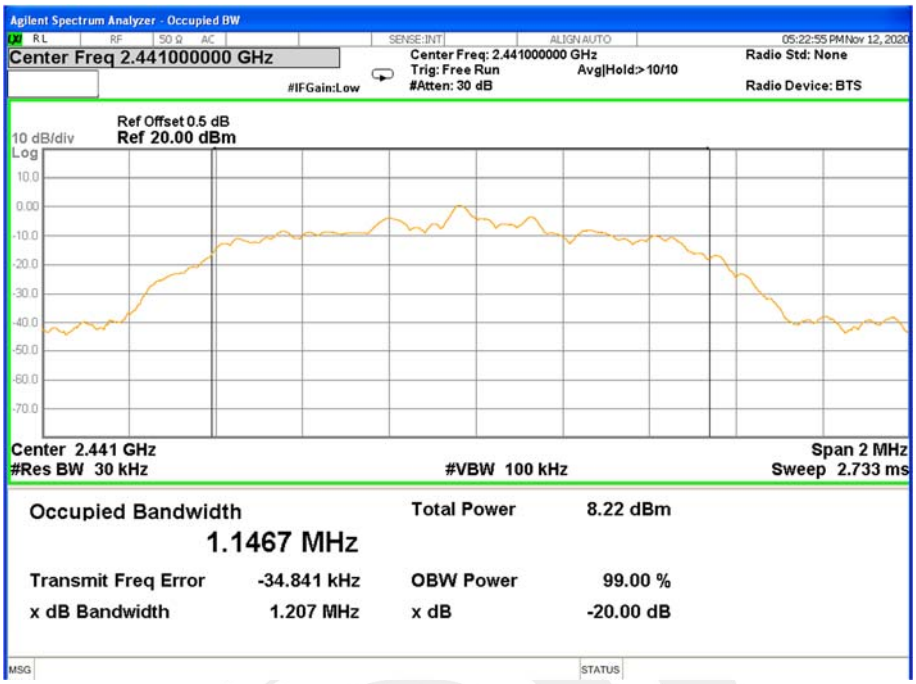
| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 50% |
| Test Mode: | 8DPSK(3Mbps)<br>CH00 / CH39 / CH78 | Test Voltage: | DC 12V |

| Frequency | 20dB Bandwidth (MHz) | Result |
|---|---|---|
| 2402 MHz | 1.205 | PASS |
| 2441 MHz | 1.207 | PASS |
| 2480 MHz | 1.208 | PASS |

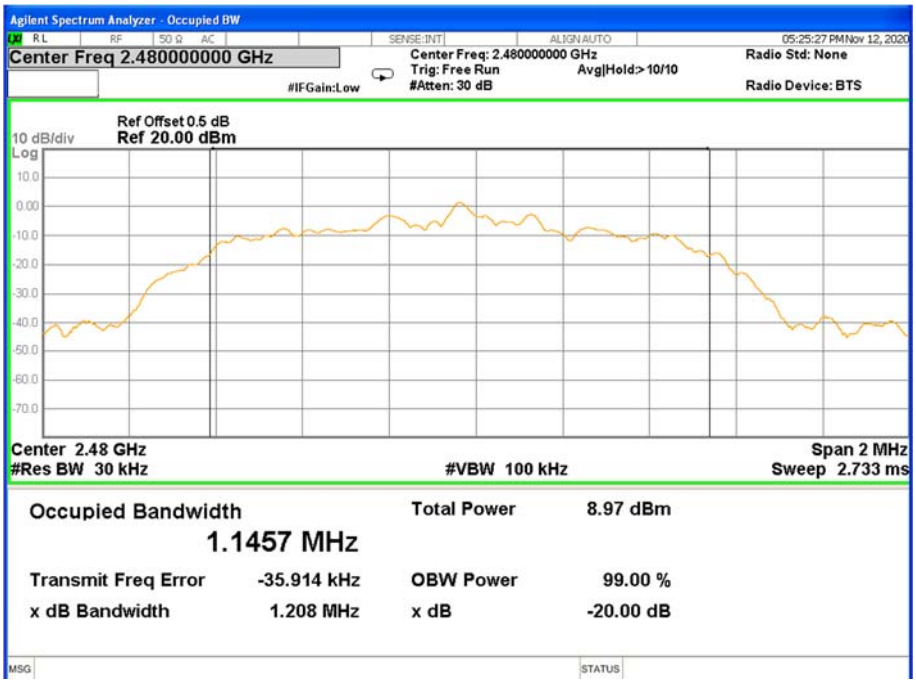
**CH00 -3Mbps**



## CH39 -3Mbps




## CH78 -3Mbps



# 9. OUTPUT POWER TEST

## 9.1 LIMIT

| FCC Part 15.247,Subpart C | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | FrequencyRange (MHz) | Result |
| 15.247 (a)(1)&(b)(1) | Output Power | 1 W or 0.125W | 2400-2483.5 | PASS |
| | | if channel separation > 2/3 bandwidthprovided thesystems operatewith an output power no greater than125 mW(20.97dBm) | | |

## 9.2 TEST PROCEDURE

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

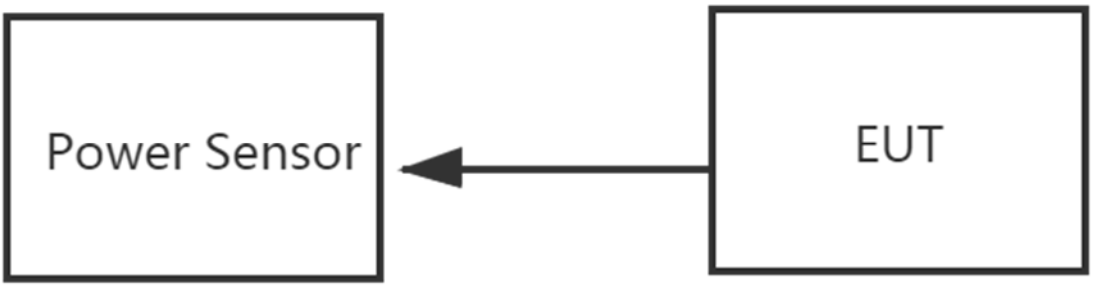
a) Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.

NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

PKPM1 Peak power meter method:

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DSS bandwidth and shall use a fast-responding diode detector.

## 9.3 TEST SETUP




## 9.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

9.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 60% |
| Test Voltage: | DC 12V | | |

| Mode | Channel Number | Frequency (MHz) | Peak Power (dBm) | Average Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| GFSK(1M) | 0 | 2402 | 1.71 | 0.26 | 30.00 |
| | 39 | 2441 | 3.74 | 2.46 | 30.00 |
| | 78 | 2480 | 4.18 | 2.87 | 30.00 |

Note: the channel separation >20dB bandwidth

| Mode | Channel Number | Frequency (MHz) | Peak Power (dBm) | Average Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| π/4-DQPSK(2M) | 0 | 2402 | -0.01 | -3.85 | 20.97 |
| | 39 | 2441 | 2.94 | -0.11 | 20.97 |
| | 78 | 2480 | 3.18 | -0.01 | 20.97 |

Note: the channel separation >2/3 20dB bandwidth

| Mode | Channel Number | Frequency (MHz) | Peak Power (dBm) | Average Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| 8-DPSK(3M) | 0 | 2402 | 0.20 | -3.88 | 20.97 |
| | 39 | 2441 | 3.07 | -0.15 | 20.97 |
| | 78 | 2480 | 3.37 | -0.06 | 20.97 |

Note: the channel separation >2/3 20dB bandwidth

# 10. ANTENNA REQUIREMENT

## 10.1 STANDARD REQUIREMENT

15.203 requirement: For intentional device, according to 15.203: an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

## 10.2 EUT ANTENNA

The EUT antenna is Dipole Antenna. It comply with the standard requirement.

## APPENDIX-PHOTOS OF TEST SETUP

Note: See test photos in setup photo document for the actual connections between Product and support equipment.

※※※※※END OF THE REPORT※※※※※