# FCC 47 CFR PART 15 SUBPART C
# ISED RSS-247 ISSUE 2

# CERTIFICATION TEST REPORT

*For*

**Communication Module**

**MODEL NUMBER: 1CQ**

**PROJECT NUMBER: 4788296310**

**REPORT NUMBER: 4788296310-2**

**FCC ID: VPYLB1CQ**

**IC ID: 772C-LB1CQ**

**ISSUE DATE: Jan. 31, 2019**

*Prepared for*

**Murata Manufacturing Co.,Ltd.**

*Prepared by*

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Revision History

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| -- | 1/31/2019 | Initial Issue | |

| Summary of Test Results | | | |
|---|---|---|---|
| **Clause** | **Test Items** | **FCC/IC Rules** | **Test Results** |
| 1 | 20dB Bandwidth And 99% Bandwidth | FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (a) | Complied |
| 2 | Peak Conducted Output Power | FCC 15.247 (b) (1)<br>RSS-247 Clause 5.1 (b) | Complied |
| 3 | Carrier Hopping Channel Separation | FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (b) | Complied |
| 4 | Number of Hopping Frequency | 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d) | Complied |
| 5 | Time of Occupancy (Dwell Time) | 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d) | Complied |
| 6 | Conducted Bandedge | FCC 15.247 (d)<br>RSS-247 Clause 5.5 | Complied |
| 7 | Radiated Bandedge and Spurious | FCC 15.247 (d)<br>FCC 15.209<br>FCC 15.205<br>RSS-247 Clause 5.5<br>RSS-GEN Clause 8.9<br>RSS-GEN Clause 8.10 | Complied |
| 8 | Conducted Emission Test for AC Power Port | FCC 15.207<br>RSS-GEN Clause 8.8 | Complied |
| 9 | Antenna Requirement | FCC 15.203<br>RSS-GEN Clause 8.3 | Complied |

# TABLE OF CONTENTS

# 1. ATTESTATION OF TESCT RESULTS

**Applicant Information**

| | |
|---|---|
| Company Name: | Murata Manufacturing Co.,Ltd. |
| Address: | 10-1,Higashikotari 1-chome,Nagaokakyo-shi,Kyoto 617-8555,Japan |

**Manufacturer Information**

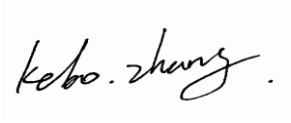
| | |
|---|---|
| Company Name: | Murata Manufacturing Co.,Ltd. |
| Address: | 10-1,Higashikotari 1-chome,Nagaokakyo-shi,Kyoto 617-8555,Japan |

**EUT Description**

| | |
|---|---|
| Product Name | Communication Module |
| Model Name | 1CQ |
| Sample ID | 1468264 |
| Sample Status | Good |
| Sample Received date | March 8, 2018 |
| Date Tested | March 8, 2018~Jan 31, 2019 |

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| CFR 47 Part 15 Subpart C | PASS |
| ISED RSS-247 Issue 2 | PASS |
| ISED RSS-GEN Issue 5 | PASS |

Tested By:



Kebo Zhang
Engineer

Checked By:

Shawn Wen
Laboratory Leader

Approved By:

Stephen Guo

Laboratory Manager

# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with KDB 558074 D01 15.247 Meas Guidance v05, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 5, and RSS-247 Issue 2.

# 3. FACILITIES AND ACCREDITATION

| | |
|---|---|
| Test Location | UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. |
| Address | Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China |
| Accreditation Certificate | UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing. The Certificate Registration Number is 4102.01.<br>UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission).<br>The Designation Number is CN1187.<br>UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. EMC Laboratory has been registered and fully described in a report filed with Industry Canada. The Company Number is 21320. |

Note:

1. All tests measurement facilities use to collect the measurement data are located at Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China
2. The test anechoic chamber in UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch had been calibrated and compared to the open field sites and the test anechoic chamber is shown to be equivalent to or worst case from the open field site.
3. For below 30MHz, lab had performed measurements at test anechoic chamber and comparing to measurements obtained on an open field site. And these measurements below 30MHz had been correlated to measurements performed on an OATS.

# 4. CALIBRATION AND UNCERTAINTY

## 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

## 4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| Test Item | Uncertainty |
|---|---|
| Uncertainty for Conduction emission test | 2.90dB |
| Uncertainty for Radiation Emission test (include Fundamental emission) (9KHz-30MHz) | 2.2dB |
| Uncertainty for Radiation Emission test (include Fundamental emission) (30MHz-1GHz) | 4.52dB |
| Uncertainty for Radiation Emission test (1GHz to 26GHz) (include Fundamental emission) | 5.04dB(1-6GHz) |
| | 5.30dB (6GHz-18Gz) |
| | 5.23dB (18GHz-26Gz) |
| Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. | |

# 5. EQUIPMENT UNDER TEST

## 5.1. DESCRIPTION OF EUT

| | | |
|---|---|---|
| Equipment | Communication Module | |
| Model Name | 1CQ | |
| Product Description (Bluetooth) | Operation Frequency | 2402 MHz ~ 2480 MHz |
| | Modulation Type | Data Rate |
| | GFSK | 1Mbps |
| | ∏/4-DQPSK | 2Mbps |
| | 8DPSK | 3Mbps |
| Power Supply | VDD_3P3/SWREG_IN/VDD_FEM:<br>Typ. DC3.3V, Max. DC3.5V, Min. DC3.1V | |
| | VDDIO_GPIO0/1/VDDIO_Xtal:<br>Typ. DC1.8V or DC3.3V, Max. DC3.46V, Min. DC1.71V | |
| Bluetooth Version | BR/EDR | |
| Hardware Version | V1.0 | |

## 5.2. MAXIMUM OUTPUT POWER

| Bluetooth Mode | Frequency (MHz) | Channel Number | Max Output Power (dBm) | EIRP (dBm) |
|---|---|---|---|---|
| GFSK | 2402-2480 | 0-78[79] | 8.72 | 8.72 |
| 8DPSK | 2402-2480 | 0-78[79] | 7.88 | 7.88 |

## 5.3. PACKET TYPE CONFIGURATION

| Test Mode | Packet Type | Setting(Packet Length) |
|---|---|---|
| GFSK | DH1 | 27 |
| | DH3 | 183 |
| | DH5 | 339 |
| ∏/4-DQPSK | 2-DH1 | 54 |
| | 2-DH3 | 367 |
| | 2-DH5 | 679 |
| 8DPSK | 3-DH1 | 83 |
| | 3-DH3 | 552 |
| | 3-DH5 | 1021 |

## 5.4. CHANNEL LIST

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 00 | 2402 | 20 | 2422 | 40 | 2442 | 60 | 2462 |
| 01 | 2403 | 21 | 2423 | 41 | 2443 | 61 | 2463 |
| 02 | 2404 | 22 | 2424 | 42 | 2444 | 62 | 2464 |
| 03 | 2405 | 23 | 2425 | 43 | 2445 | 63 | 2465 |
| 04 | 2406 | 24 | 2426 | 44 | 2446 | 64 | 2466 |
| 05 | 2407 | 25 | 2427 | 45 | 2447 | 65 | 2467 |
| 06 | 2408 | 26 | 2428 | 46 | 2448 | 66 | 2468 |
| 07 | 2409 | 27 | 2429 | 47 | 2449 | 67 | 2469 |
| 08 | 2410 | 28 | 2430 | 48 | 2450 | 68 | 2470 |
| 09 | 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 | | |

## 5.5. TEST CHANNEL CONFIGURATION

| Test Mode | Test Channel Number | Test Channel |
|---|---|---|
| GFSK | CH 00, CH 39, CH 78 | Low, Middle, High |
| 8DPSK | CH 00, CH 39, CH 78 | Low, Middle, High |

## 5.6. THE WORSE CASE POWER SETTING PARAMETER

| The Worse Case Power Setting Parameter under 2400 ~ 2483.5MHz Band | | | | |
|---|---|---|---|---|
| Test Software | | Tera Term & QRCT | | |
| Modulation Type | Transmit Antenna Number | Test Channel | | |
| | | CH 00 | CH 39 | CH 78 |
| GFSK | 1 | 9 | 9 | 9 |
| 8DPSK | 1 | 9 | 9 | 9 |

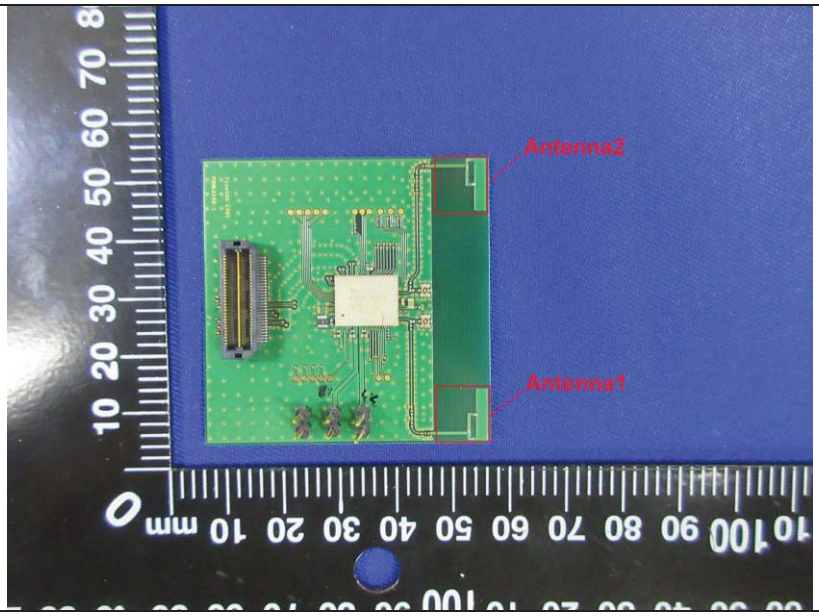
## 5.7. DESCRIPTION OF AVAILABLE ANTENNAS

| Ant. | Frequency (MHz) | Antenna Type | Antenna Gain (dBi) |
|---|---|---|---|
| 1 | 2402-2480 | PCB Antenna | 0 |

Note: There are two antennas in the EUT, only antenna 1 support BT mode.

| Test Mode | Transmit and Receive Mode | Description |
|---|---|---|
| GFSK | 1TX, 1RX | Chain 1 can be used as transmitting/receiving antenna. |
| 8DPSK | 1TX, 1RX | Chain 1 can be used as transmitting/receiving antenna. |

Antenna



## 5.8. WORST-CASE CONFIGURATIONS

| Bluetooth Mode | Modulation Technology | Modulation Type | Data Rate (Mbps) |
|---|---|---|---|
| BR | FHSS | GFSK | 1Mbit/s |
| EDR | FHSS | 8DPSK | 3Mbit/s |

Note: Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates.

## 5.9. TEST ENVIRONMENT

| Environment Parameter | Selected Values During Tests | |
|---|---|---|
| Relative Humidity | 55 ~ 65% | |
| Atmospheric Pressure: | 1005Pa | |
| Temperature | TN | -20 ~ 70°C |
| Voltage | VL | N/A |
| | VN | VDD_3P3/SWREG_IN/VDD_FEM:DC3.3V<br>VDDIO_GPIO0/1/VDDIO_Xtal:DC1.8V |
| | VH | N/A |

Note: VL= Lower Extreme Test Voltage
VN= Nominal Voltage.
VH= Upper Extreme Test Voltage
TN= Normal Temperature

## 5.10. DESCRIPTION OF TEST SETUP

**SUPPORT EQUIPMENT**

| Item | Equipment | Brand Name | Model Name | Remarks |
|---|---|---|---|---|
| 1 | Laptop | ThinkPad | E450 | N/A |

**I/O CABLES**

| Cable No | Port | Connector Type | Cable Type | Cable Length(m) | Remarks |
|---|---|---|---|---|---|
| 1 | LAN | LAN | N/A | 0.2 | N/A |
| 2 | USB | USB | Unshielded | 0.5 | N/A |

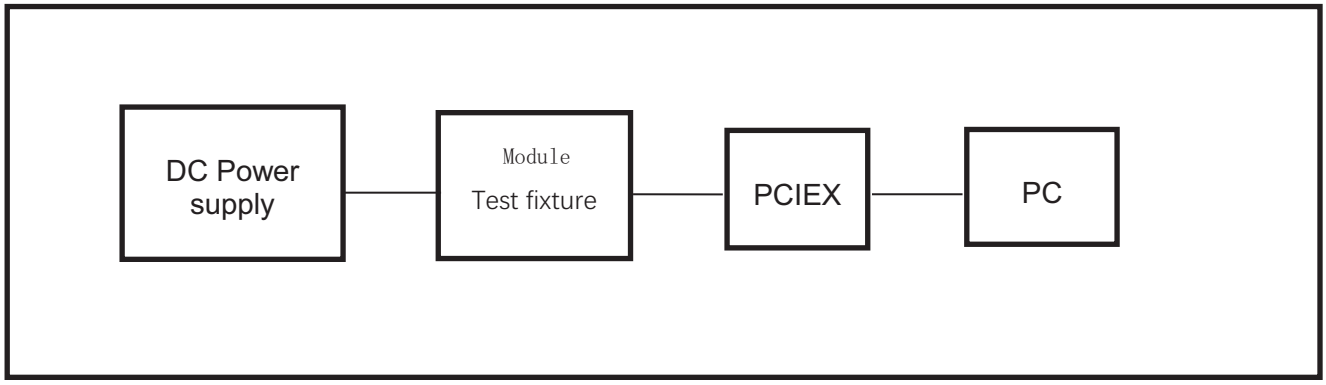
**ACCESSORY**

| Item | Accessory | Brand Name | Model Name | Description |
|---|---|---|---|---|
| 1 | N/A | N/A | N/A | N/A |

**TEST SETUP**

The EUT can work in an engineer mode with a software through a PC.

**SETUP DIAGRAM FOR TESTS**



## 5.11. MEASURING INSTRUMENT AND SOFTWARE USED

| Conducted Emissions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Used | Equipment | Manufactur | Model No. | Serial No. | Upper Cal. | Last Cal. | Next Cal. |
| ☑ | EMI Test Receiver | R&S | ESR3 | 101961 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |
| ☑ | Two-Line V-Network | R&S | ENV216 | 101983 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |

| Software | | | | | |
|---|---|---|---|---|---|
| Used | Description | Manufacturer | Name | Version | |
| ☑ | Test Software for Conducted disturbance | UL | Antenna port | Ver. 7.2 | |

| Radiated Emissions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Used | Equipment | Manufactur | Model No. | Serial No. | Upper Cal. | Last Cal. | Next Cal. |
| ☑ | MXE EMI Receiver | KESIGHT | N9038A | MY564000 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |
| ☑ | Hybrid Log Periodic Antenna | TDK | HLP-3003C | 130960 | Jan.09, 2016 | Sept. 17, 2018 | Sept.17, 2021 |
| ☑ | Preamplifier | HP | 8447D | 2944A0909 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |
| ☑ | EMI Measurement Receiver | R&S | ESR26 | 101377 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |
| ☑ | Horn Antenna | TDK | HRN-0118 | 130939 | Jan. 09, 2016 | Sept. 17, 2018 | Sept.17, 2021 |
| ☑ | High Gain Horn | Schwarzbe | BBHA-9170 | 691 | Jan.06, 2016 | Aug.11, 2018 | Aug.11, 2019 |
| ☑ | Preamplifier | TDK | PA-02-0118 | TRS-305-00066 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |
| ☑ | Preamplifier | TDK | PA-02-2 | TRS-307-00003 | Dec.12,2017 | Dec.10, 2018 | Dec.10, 2019 |
| ☑ | Loop antenna | Schwarzbe | 1519B | 00008 | Mar. 26, | Mar. 26, 2016 | Mar. 26, 2019 |

| Software | | | | | |
|---|---|---|---|---|---|
| Used | Description | Manufacturer | Name | Version | |
| ☑ | Test Software for Radiated disturbance | Farad | EZ-EMC | Ver. UL-3A1 | |

| Other instruments | | | | | | | |
|---|---|---|---|---|---|---|---|
| Used | Equipment | Manufacturer | Model No. | Serial No. | Upper Cal. | Last Cal. | Next Cal. |
| ☑ | Spectrum Analyzer | Keysight | N9030A | MY55410512 | Dec.12,2017 | Dec.10,2018 | Dec.10,2019 |
| ☑ | Power Sensor | Keysight | U2021XA | MY57030004 | Dec.12,2017 | Dec.10,2018 | Dec.10,2019 |
| ☑ | Power Meter | Keysight | N1911A | MY55416024 | Dec.12,2017 | Dec.11,2018 | Dec.10,2019 |
| ☑ | High Pass Filter | Wainwright | WHKX10-5850-6500-1800-40SS | 4 | Dec.12,2017 | Dec.11,2018 | Dec.10,2019 |
| ☑ | Band Reject Filter | Wainwright | WRCJV20-5440-5470-5725-5755-60SS | 1 | Dec.12,2017 | Dec.11,2018 | Dec.10,2019 |

# 6. ANTENNA PORT TEST RESULTS

## 6.1. ON TIME AND DUTY CYCLE

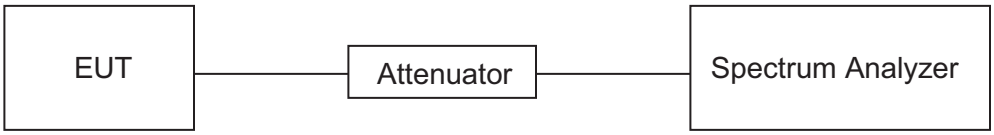
**LIMITS**

None; for reporting purposes only

**PROCEDURE**

KDB 558074 Zero-Span Spectrum Analyzer Method

**TEST SETUP**

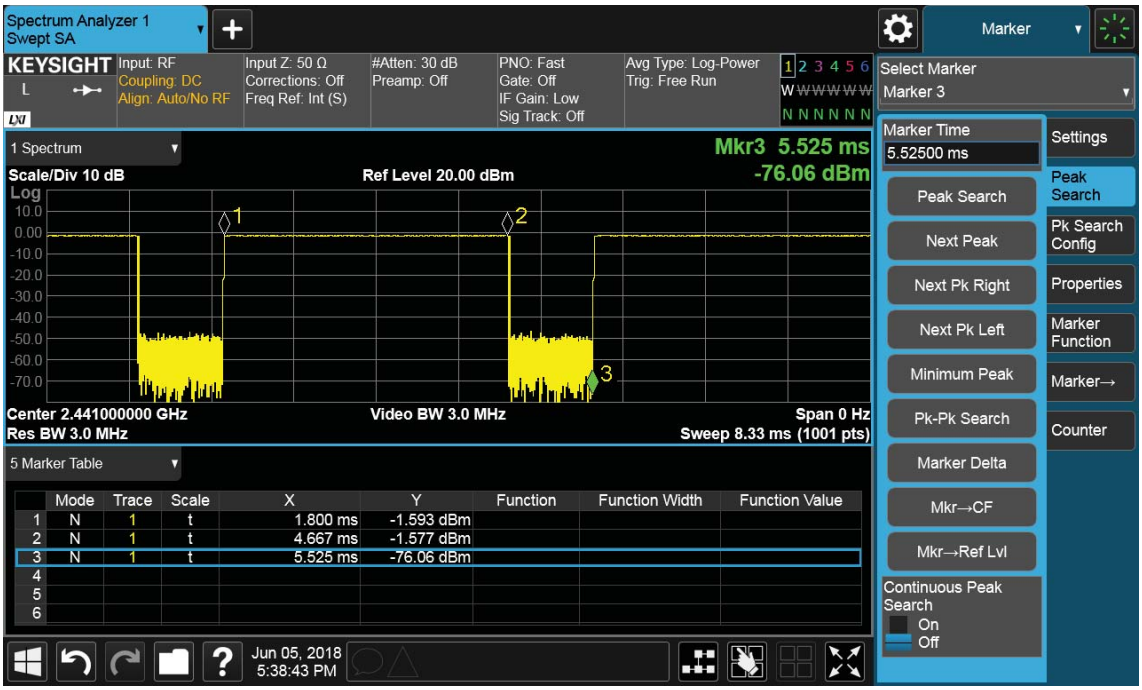



**RESULTS**

| Mode | On Time (msec) | Period (msec) | Duty Cycle x (Linear) | Duty Cycle (%) | Duty Cycle Correction Factor (db) | 1/T Minimum VBW (KHz) |
|---|---|---|---|---|---|---|
| GFSK | 2.867 | 3.725 | 0.770 | 77.0 | 1.13 | 3.488 |
| 8DPSK | 2.883 | 3.725 | 0.774 | 77.4 | 1.11 | 3.469 |

Note: Duty Cycle Correction Factor=10log(1/x).
Where: x is Duty Cycle (Linear)
Where: T is On Time (transmit duration)

DH5 ON TIME AND DUTY CYCLE MID CH




3DH5 ON TIME AND DUTY CYCLE MID CH

## 6.2. 20 dB BANDWIDTH AND 99% BANDWIDTH

**LIMITS**

| FCC Part15 (15.247) Subpart C<br>RSS-247 ISSUE 2 | | | |
|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) |
| FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (a) | 20dB Bandwidth | NA | 2400-2483.5 |
| RSS-Gen Clause 6.6 | 99% Bandwidth | N/A | 2400-2483.5 |

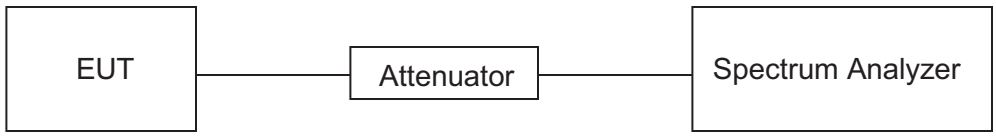
**TEST PROCEDURE**

Connect the UUT to the spectrum Analyzer and use the following settings:

| | |
|---|---|
| Center Frequency | The centre frequency of the channel under test |
| Detector | Peak |
| RBW | For 20dB Bandwidth:1% of the 20 dB bandwidth<br>For 99% Bandwidth: 1% to 5% of the occupied bandwidth |
| VBW | For 20dB Bandwidth: ≥ RBW<br>For 99% Bandwidth: approximately 3×RBW |
| Span | approximately 2 to 3 times the 20 dB bandwidth |
| Trace | Max hold |
| Sweep | Auto couple |

Allow the trace to stabilize and measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

**TEST SETUP**



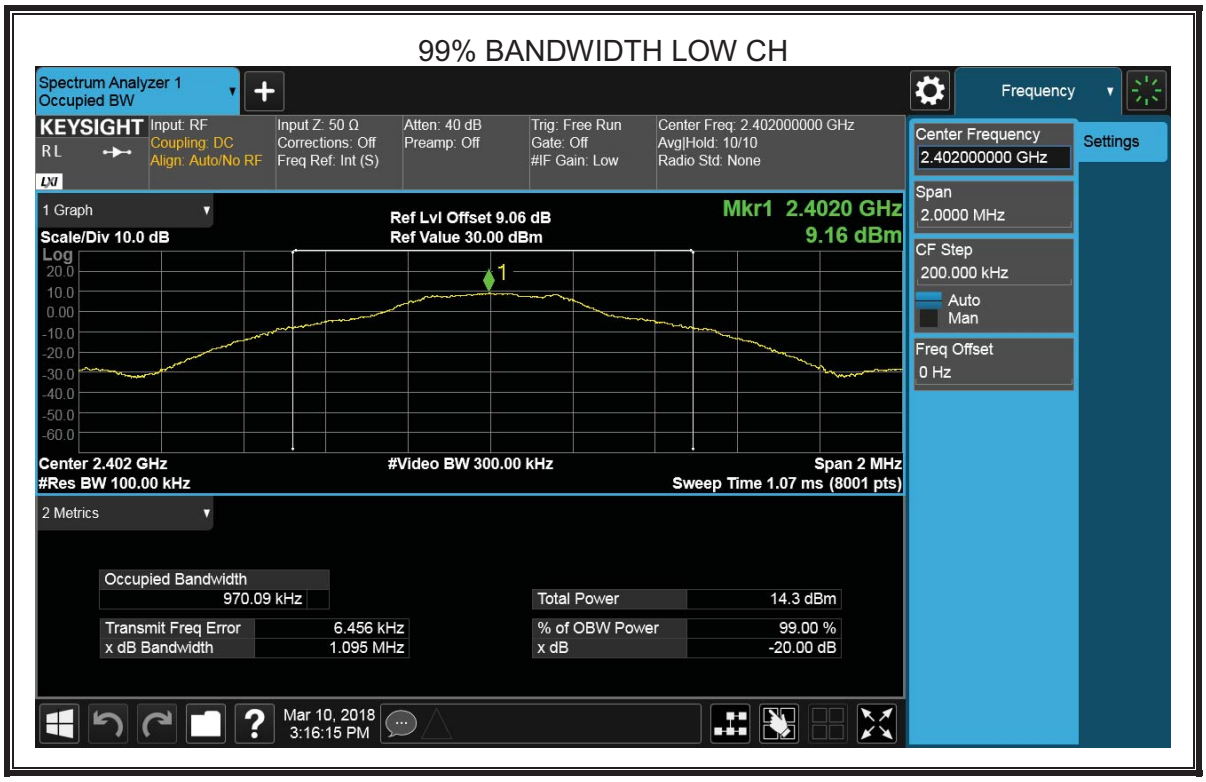
**RESULTS**

## 6.2.1. GFSK MODE

| Channel | Frequency (MHz) | 20dB bandwidth (MHz) | 99% bandwidth (MHz) | Result |
|---|---|---|---|---|
| Low | 2402 | 1.095 | 0.970 | PASS |
| Middle | 2441 | 1.100 | 0.973 | PASS |
| High | 2480 | 1.105 | 0.973 | PASS |

**Test Graph**

99% BANDWIDTH LOW CH



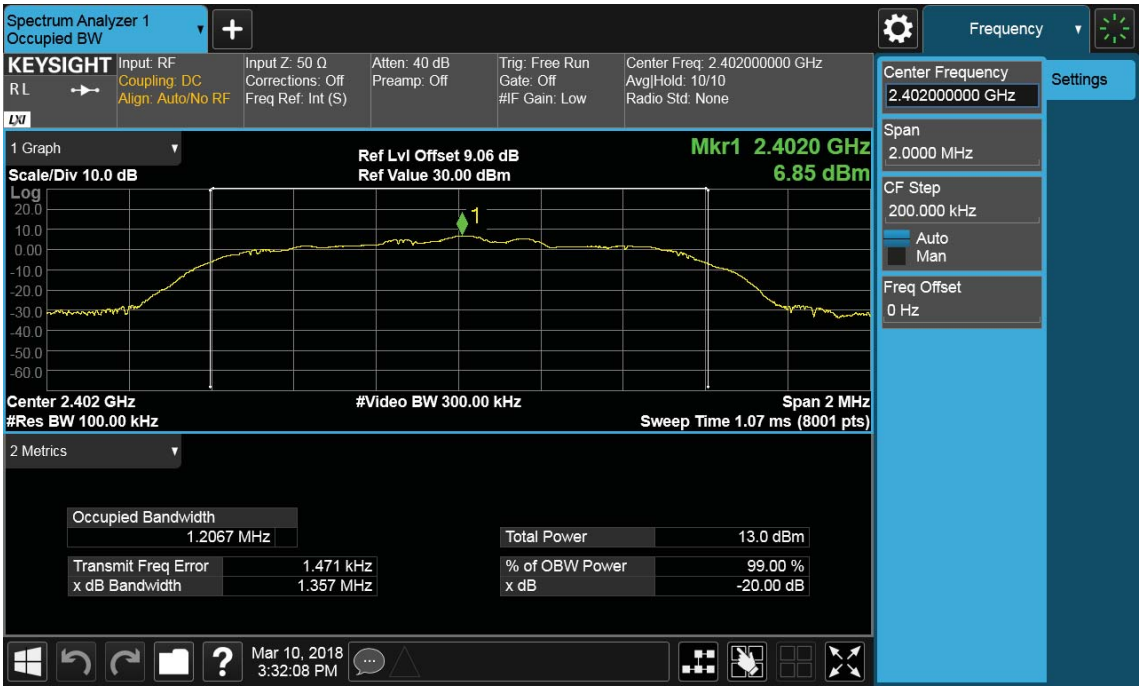
99% BANDWIDTH MID CH


99% BANDWIDTH HIGH CH

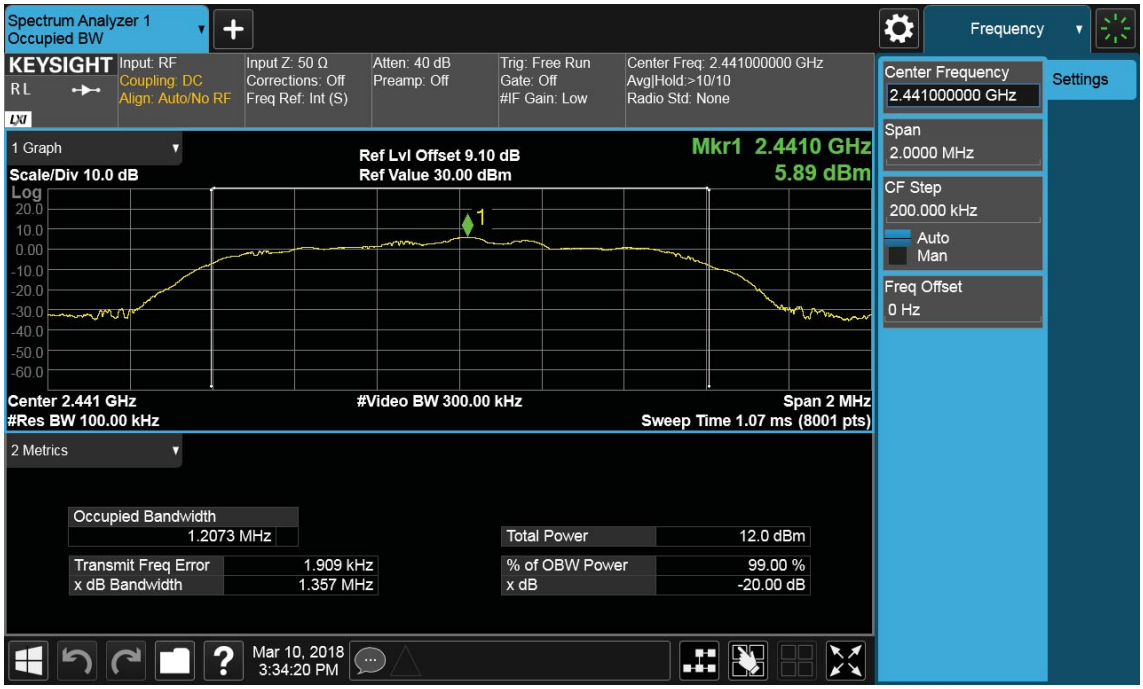
### 6.2.2. 8DPSK MODE

| Channel | Frequency (MHz) | 20dB bandwidth (MHz) | 99% bandwidth (MHz) | Result |
|---|---|---|---|---|
| Low | 2402 | 1.357 | 1.2067 | Pass |
| Middle | 2441 | 1.357 | 1.2073 | Pass |
| High | 2480 | 1.356 | 1.2081 | Pass |

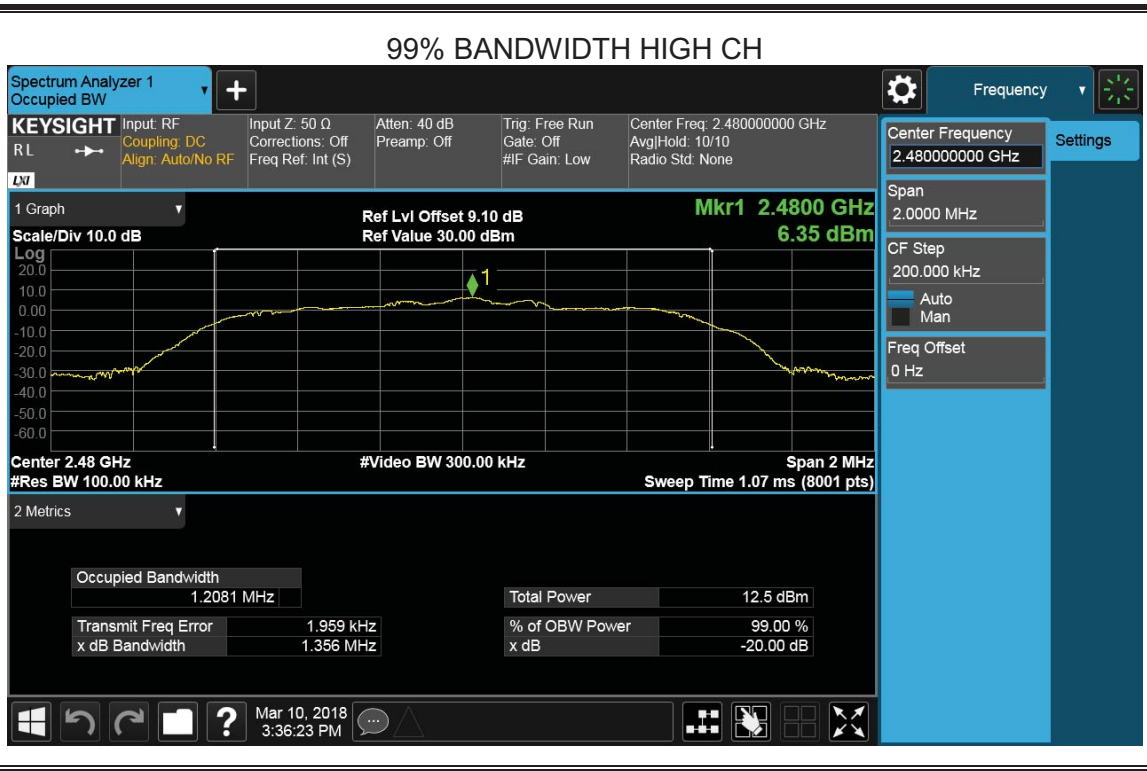
99% BANDWIDTH LOW CH



99% BANDWIDTH MID CH




99% BANDWIDTH HIGH CH



## 6.3. PEAK CONDUCTED OUTPUT POWER

**LIMITS**

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 | | | |
|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) |
| FCC 15.247 (b) (1)<br>RSS-247 Clause 5.4 (b) | Peak Conducted Output Power | 1 watt or 30dBm | 2400-2483.5 |

**TEST PROCEDURE**

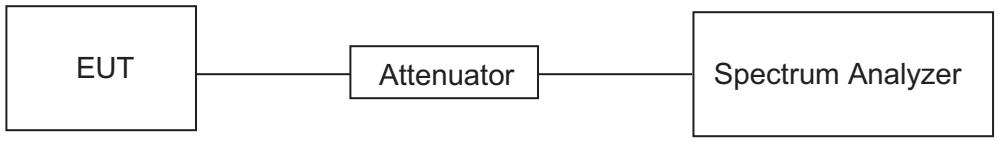
Connect the UUT to the spectrum Analyzer and use the following settings:

| | |
|---|---|
| Center Frequency | The center frequency of the channel under test |
| Detector | Peak |
| RBW | ≥ 20 dB bandwidth |
| VBW | ≥RBW |
| Span | Approximately five times the 20 dB bandwidth |
| Trace | Max hold |
| Sweep time | Auto couple |

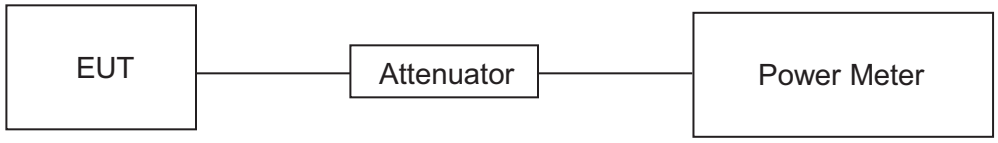
Allow trace to fully stabilize and use peak marker function to determine the peak amplitude level.

**TEST SETUP**

for peak power measurement:




for average power measurement:



**RESULTS**

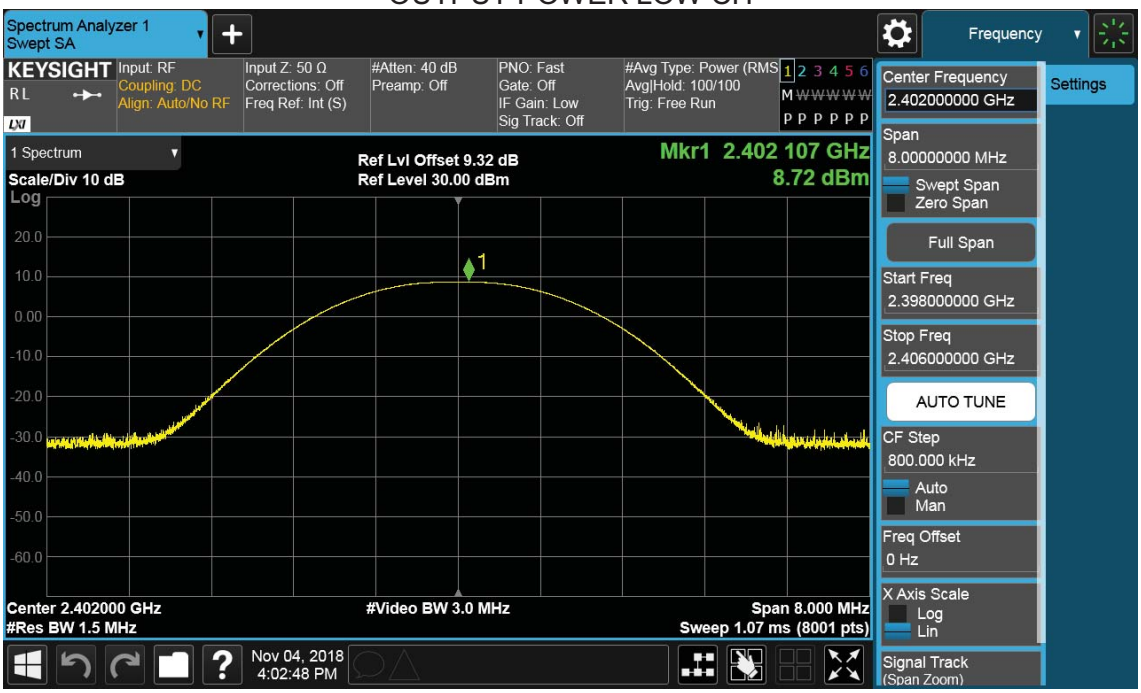
### 6.3.1. GFSK MODE

| Channel | Frequency | Maximum Conducted Output Power(PK) | EIRP | Result |
|---|---|---|---|---|
| | (MHz) | (dBm) | (dBm) | |
| Low | 2402 | 8.72 | 8.72 | Pass |
| Middle | 2441 | 8.27 | 8.27 | Pass |
| High | 2480 | 8.70 | 8.70 | Pass |

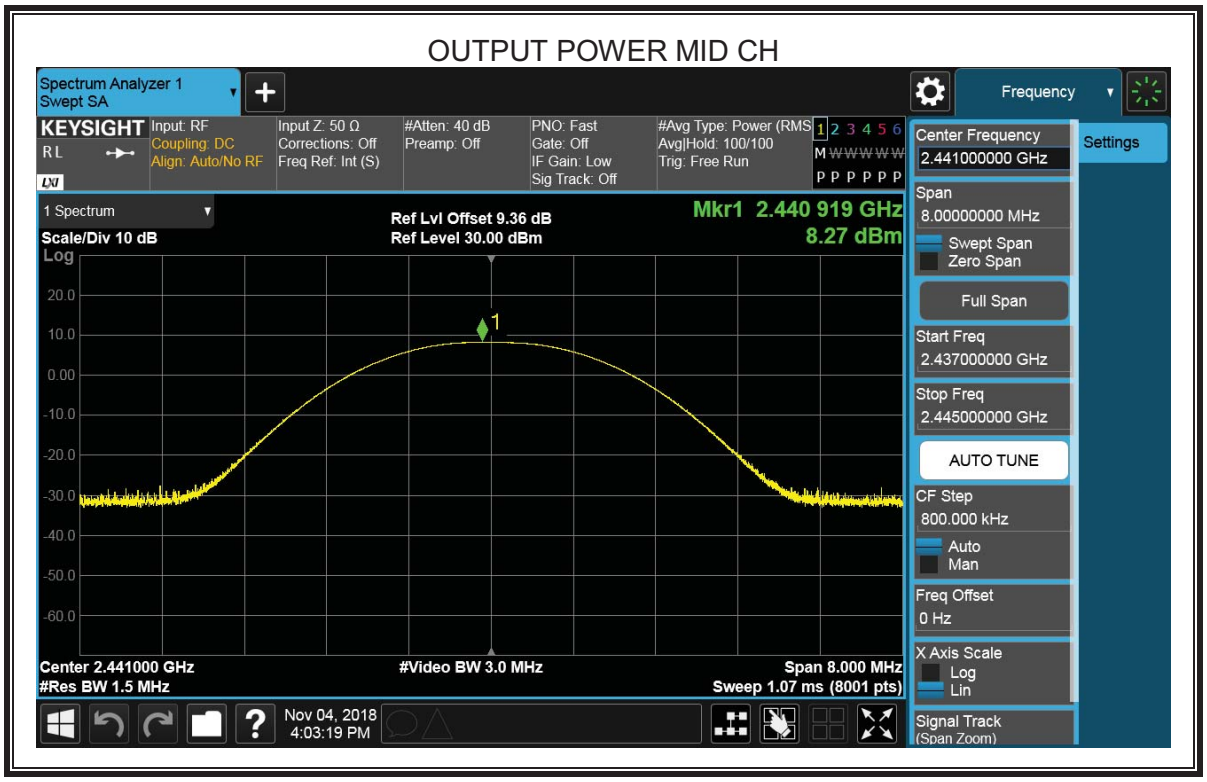
| Channel | Frequency | Maximum Average Conducted Output Power(dBm) | EIRP | Result |
|---|---|---|---|---|
| | (MHz) | (dBm) | (dBm) | |
| Low | 2402 | 7.47 | 7.47 | Pass |
| Middle | 2441 | 6.76 | 6.76 | Pass |
| High | 2480 | 7.05 | 7.05 | Pass |

Note:
1. The average conducted output power is measured by power meter for calculating the tune-up power.
2. Average conducted output power = power meter reading level + duty cycle correction factor.
3. For duty cycle correction factor please refer to clause 6.1. ON TIME AND DUTY CYCLE.

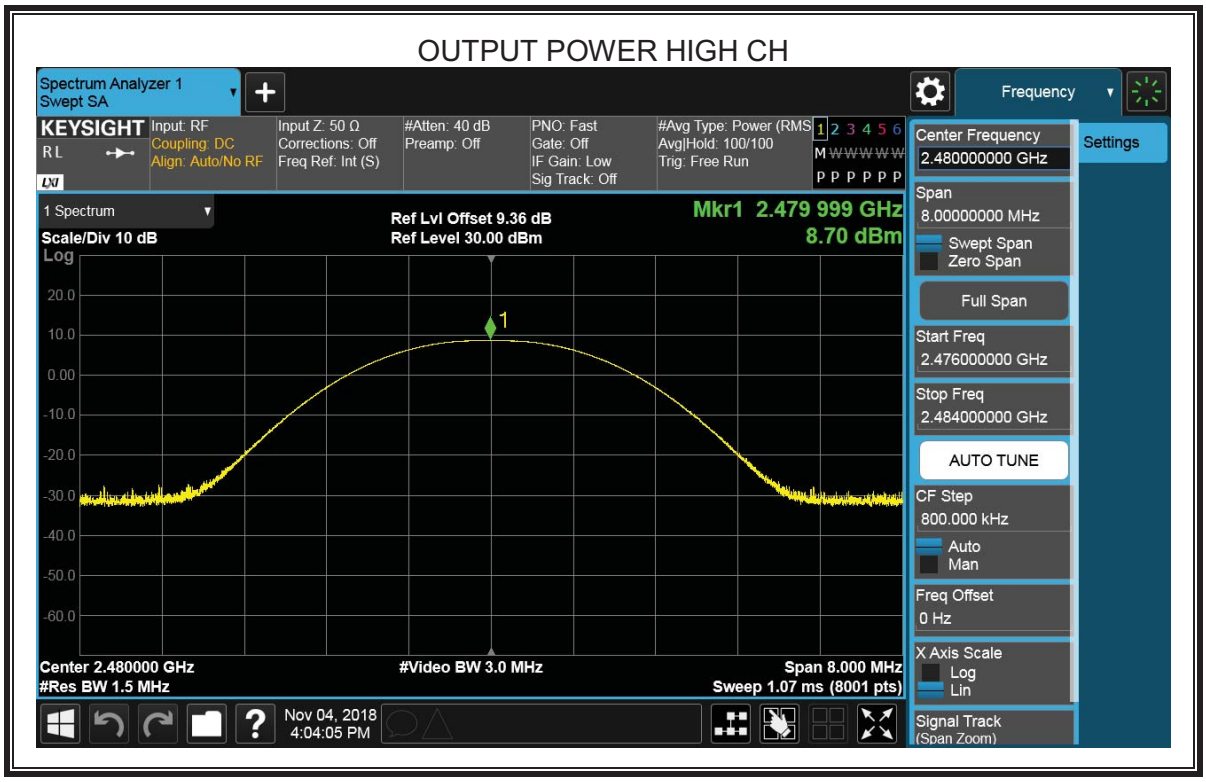
OUTPUT POWER LOW CH



OUTPUT POWER MID CH




OUTPUT POWER HIGH CH



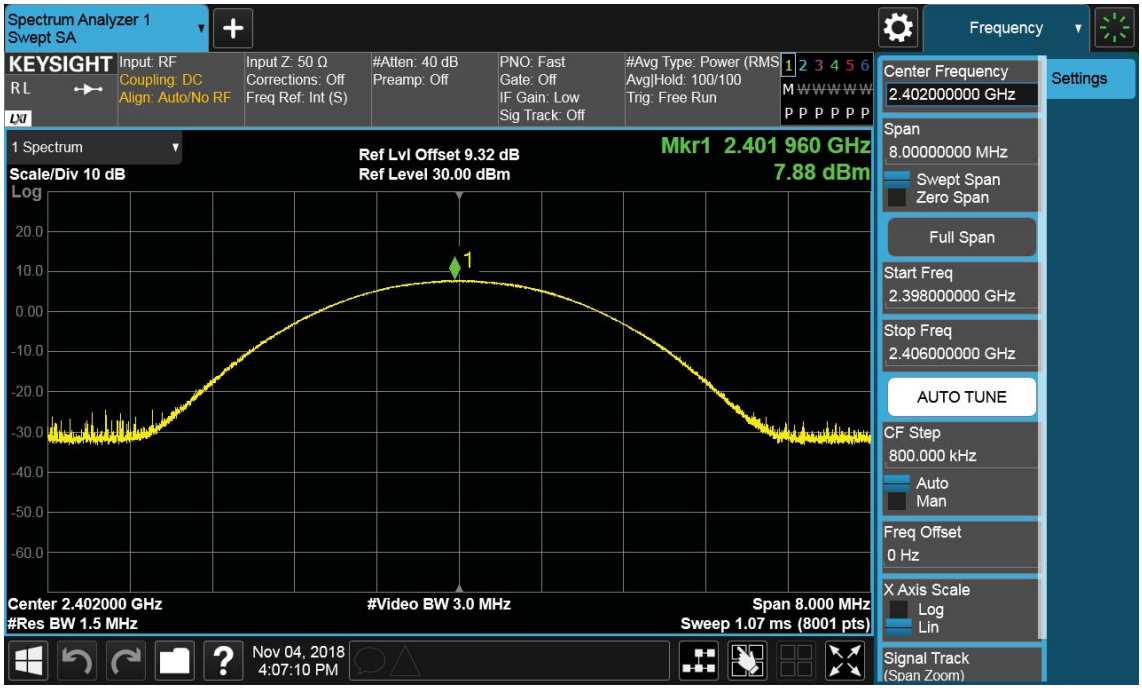
### 6.3.2. 8DPSK MODE

| Channel | Frequency | Maximum Conducted Output Power(PK) | EIRP | Result |
|---|---|---|---|---|
| | (MHz) | (dBm) | (dBm) | |
| Low | 2402 | 7.88 | 7.88 | Pass |
| Middle | 2441 | 7.41 | 7.41 | Pass |
| High | 2480 | 7.84 | 7.84 | Pass |

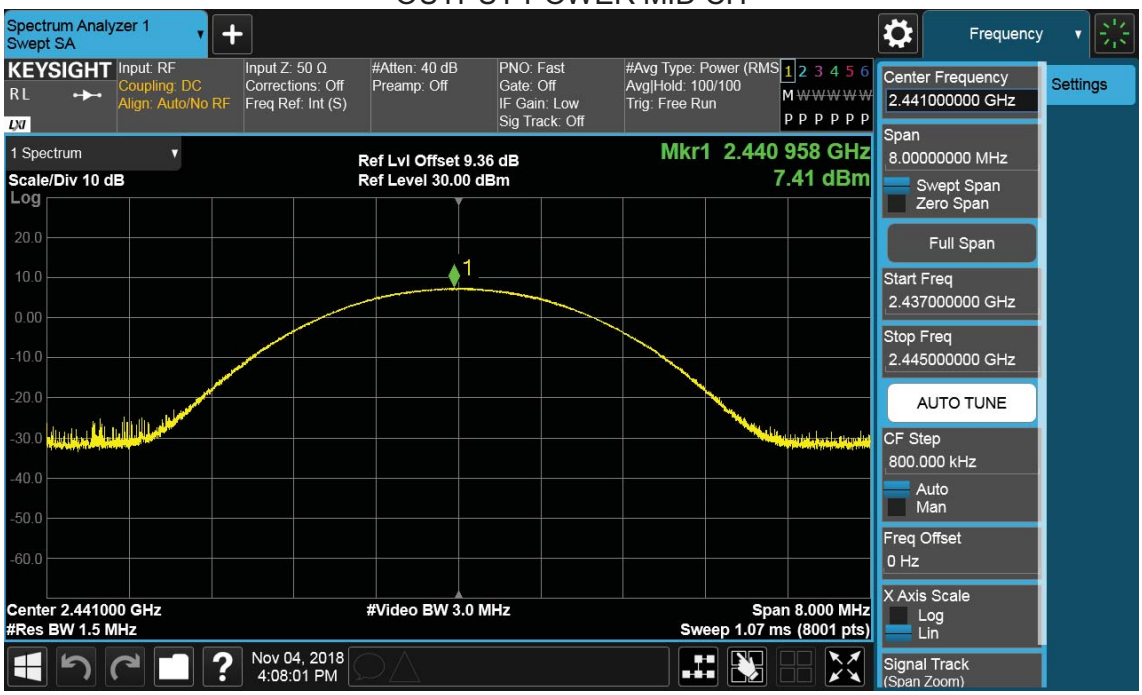
| Channel | Frequency | Maximum Average Conducted Output Power(dBm) | EIRP | Result |
|---|---|---|---|---|
| | (MHz) | (dBm) | (dBm) | |
| Low | 2402 | 3.80 | 3.80 | Pass |
| Middle | 2441 | 3.15 | 3.15 | Pass |
| High | 2480 | 3.54 | 3.54 | Pass |

Note:
1. The average conducted output power is measured by power meter for calculating the tune-up power.
2. Average conducted output power = power meter reading level + duty cycle correction factor.
3. For duty cycle correction factor please refer to clause 6.1. ON TIME AND DUTY CYCLE.

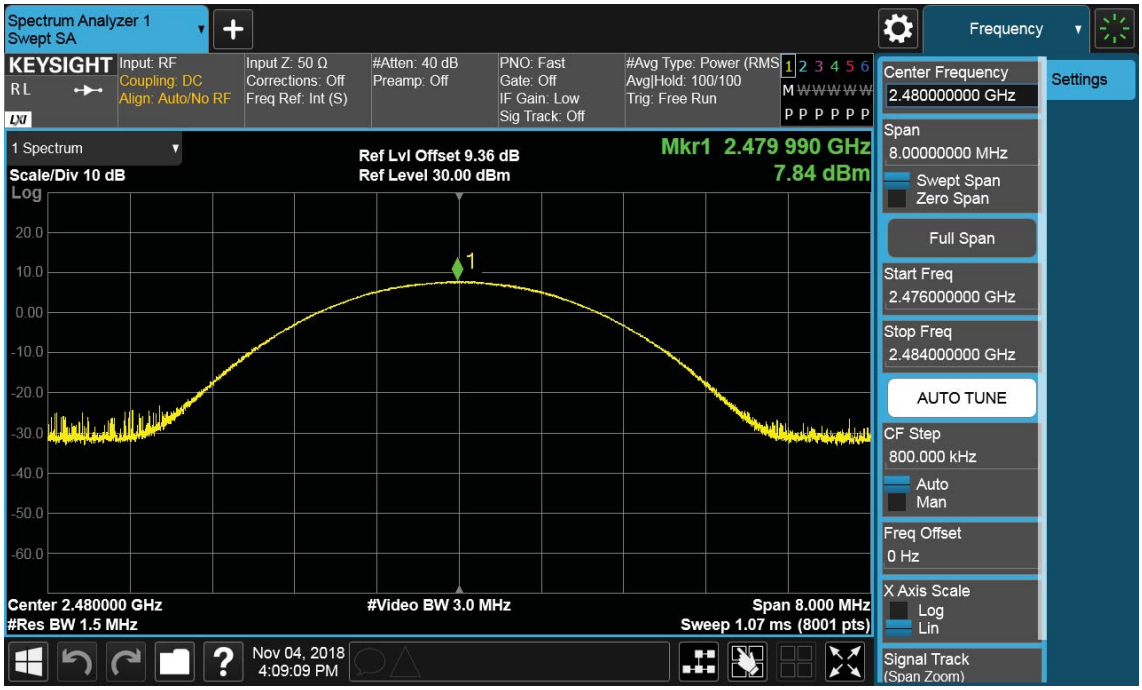
OUTPUT POWER LOW CH



OUTPUT POWER MID CH




OUTPUT POWER HIGH CH



## 6.4. CARRIER HOPPING CHANNEL SEPARATION

**LIMITS**

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 | | | |
|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) |
| FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (b) | Carrier Hopping Channel Separation | 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater. | 2400-2483.5 |

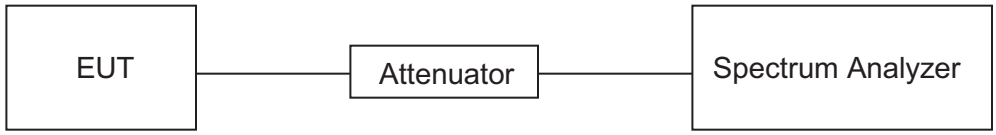
**TEST PROCEDURE**

Connect the UUT to the spectrum Analyzer and use the following settings:

| | |
|---|---|
| Center Frequency | The center frequency of the channel under test |
| Span | wide enough to capture the peaks of two adjacent channels |
| Detector | Peak |
| RBW | ≥ 1% of the span |
| VBW | ≥RBW |
| Trace | Max hold |
| Sweep time | Auto couple |

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

**TEST SETUP**



**RESULTS**

### 6.4.1. GFSK MODE

| Channel | Carrier Hopping Channel Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|
| Middle | 1.043 | ≥ two-thirds of the 20 dB Bandwidth Of The Hopping Channel | PASS |

Channel Separation MID CH


Note: For 20 dB Bandwidth of The Hopping Channel, please refer to clause 6.2.1.

### 6.4.2. 8DPSK MODE

| Channel | Carrier Hopping Channel Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|
| Middle | 1.007 | ≥ two-thirds of the 20 dB Bandwidth Of The Hopping Channel | PASS |

Channel Separation MID CH


Note: For 20 dB Bandwidth of The Hopping Channel, please refer to clause 6.2.1.

## 6.5. NUMBER OF HOPPING FREQUENCY

**LIMITS**

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 | | |
|---|---|---|
| Section | Test Item | Limit |
| 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d) | Number of Hopping Frequency | at least 15 hopping channels |

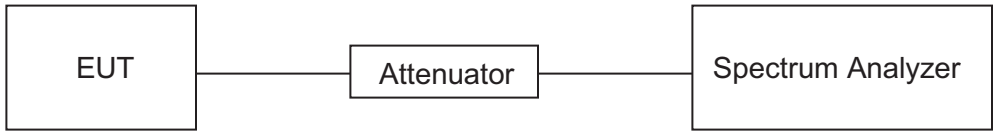
**TEST PROCEDURE**

Connect the EUT to the spectrum Analyzer and use the following settings:

| | |
|---|---|
| Detector | Peak |
| RBW | 1% of the span |
| VBW | ≥RBW |
| Span | The frequency band of operation |
| Trace | Max hold |
| Sweep time | Auto couple |

Set EUT to transmit maximum output power and switch on frequency hopping function. then set enough count time (larger than 5000 times) to get all the hopping frequency channel displayed on the screen of spectrum analyzer.
Count the quantity of peaks to get the number of hopping channels.
Normal Mode: 79 Channels observed.
AFH Mode: 20 Channels declared.

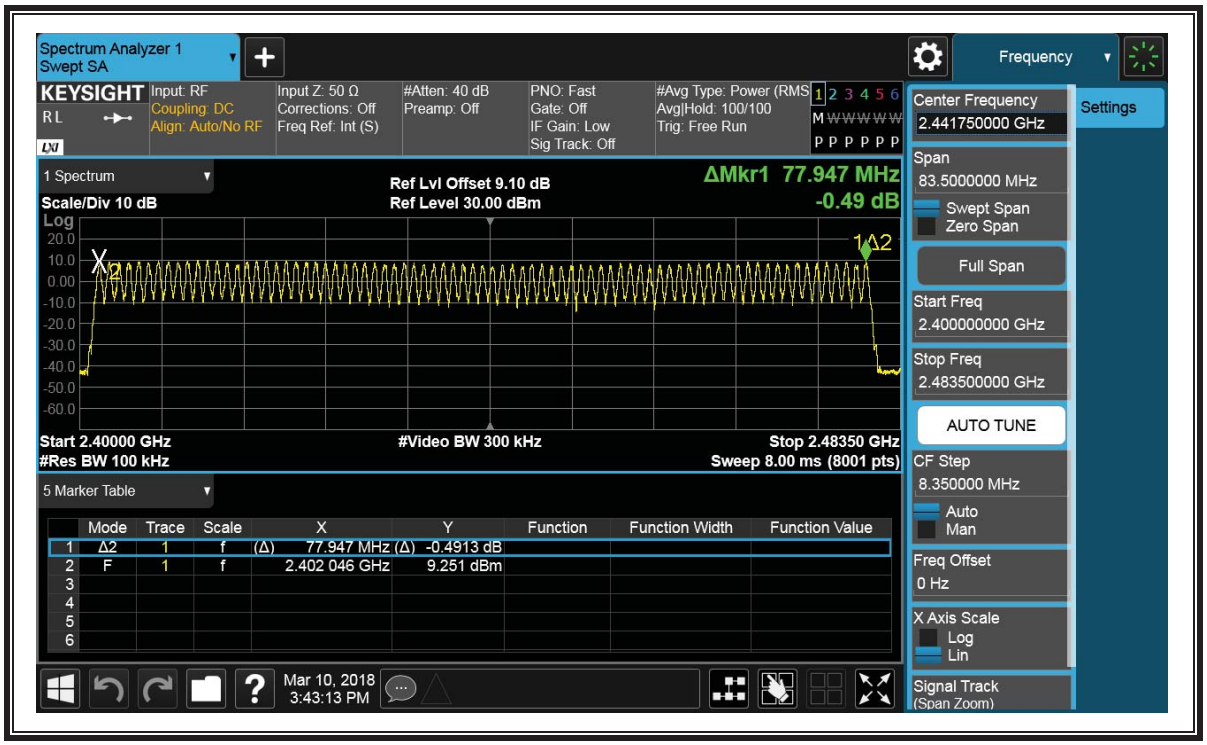
**TEST SETUP**



**RESULTS**

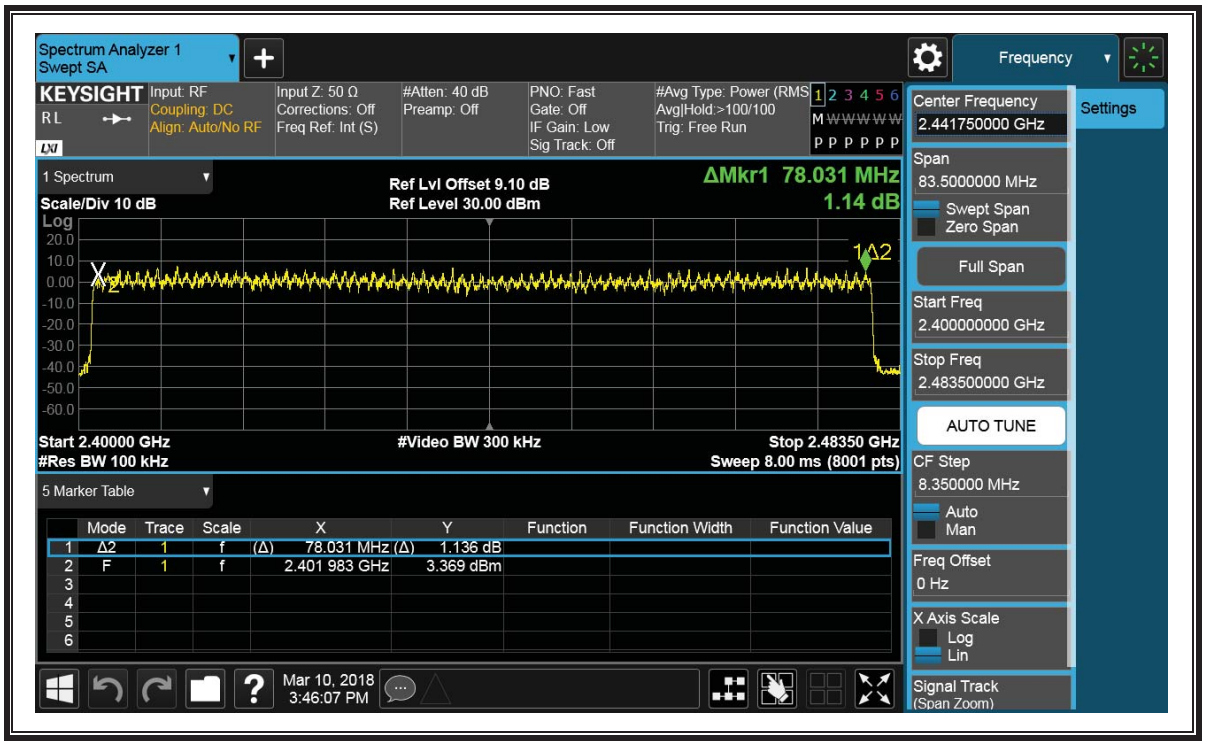
### 6.5.1. GFSK MODE

| Hopping numbers | Limit | Results |
|---|---|---|
| 79 | >15 | Pass |



### 6.5.2. 8DPSK MODE

| Hopping numbers | Limit | Results |
|---|---|---|
| 79 | >15 | Pass |



## 6.6. TIME OF OCCUPANCY (DWELL TIME)

**LIMITS**

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 | | |
|---|---|---|
| Section | Test Item | Limit |
| 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d) | Time of Occupancy (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. |

**TEST PROCEDURE**

Connect the UUT to the spectrum Analyzer and use the following settings:

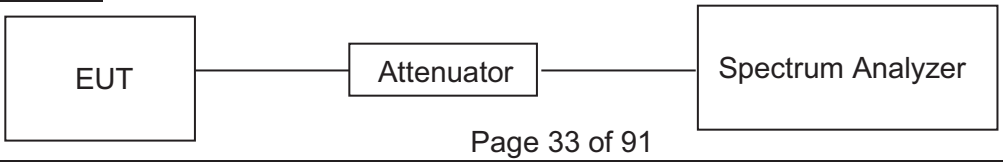
| | |
|---|---|
| Center Frequency | The centre frequency of the channel under test |
| Detector | Peak |
| RBW | 1 MHz |
| VBW | ≥RBW |
| Span | zero span |
| Trace | Max hold |
| Sweep time | As necessary to capture the entire dwell time per hopping channel |

a. The transmitter output (antenna port) was connected to the spectrum analyzer
b. Set RBW of spectrum analyzer to 1MHz and VBW to 1MHz.
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.
A Period Time = (channel number)*0.4

For Normal Mode (79 Channel):
DH1 Time Slot: Reading * (1600/2)*31.6/(channel number)
DH3 Time Slot: Reading * (1600/4)*31.6/(channel number)
DH5 Time Slot: Reading * (1600/6)*31.6/(channel number)

For AFH Mode (20 Channel):
DH1 Time Slot: Reading * (1600/2)*8/(channel number)
DH3 Time Slot: Reading * (1600/4)*8/(channel number)
DH5 Time Slot: Reading * (1600/6)*8/(channel number)

**TEST SETUP**



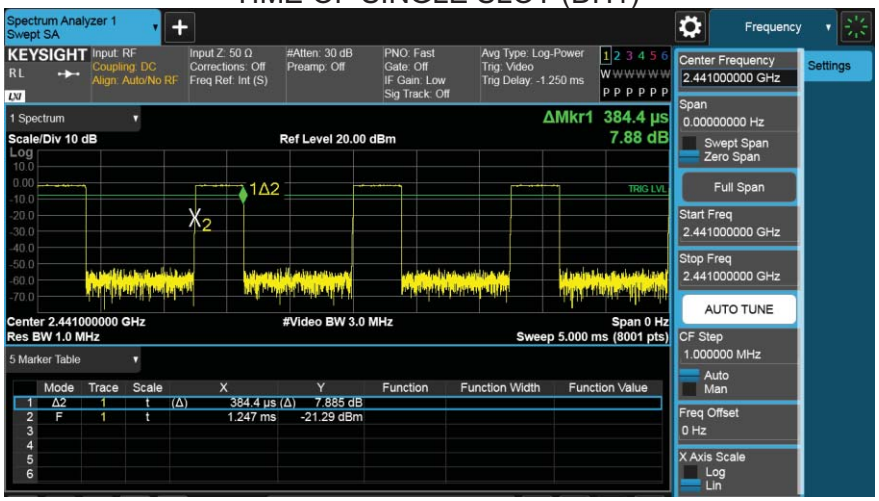
**RESULTS**

### 6.6.1. GFSK MODE

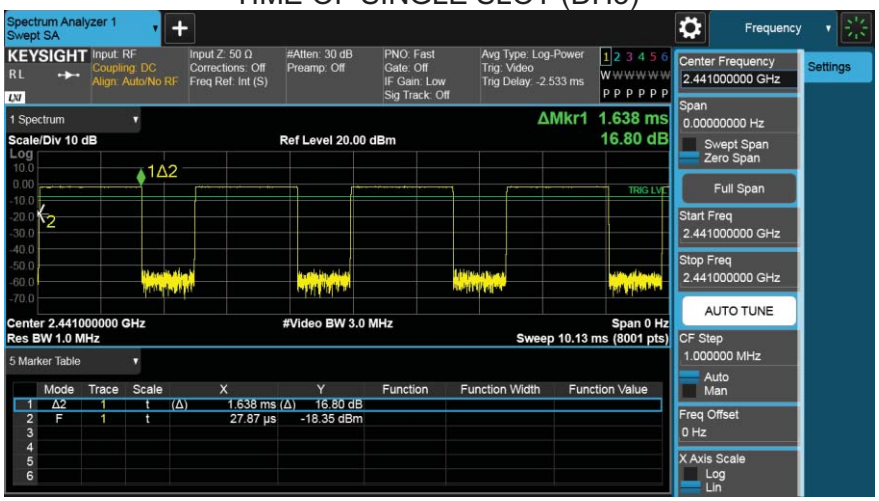
| Normal Mode | | | | |
|---|---|---|---|---|
| **Packet** | **Channel** | **Burst Width [ms/hop/ch]** | **Dwell Time [ms]** | **Results** |
| DH1 | MCH | 0.384 | 0.123 | PASS |
| DH3 | MCH | 1.638 | 0.524 | PASS |
| DH5 | MCH | 2.888 | 0.924 | PASS |
| **AFH Mode** | | | | |
| DH1 | MCH | 0.384 | 0.123 | PASS |
| DH3 | MCH | 1.638 | 0.524 | PASS |
| DH5 | MCH | 2.888 | 0.924 | PASS |

**Test Graph**

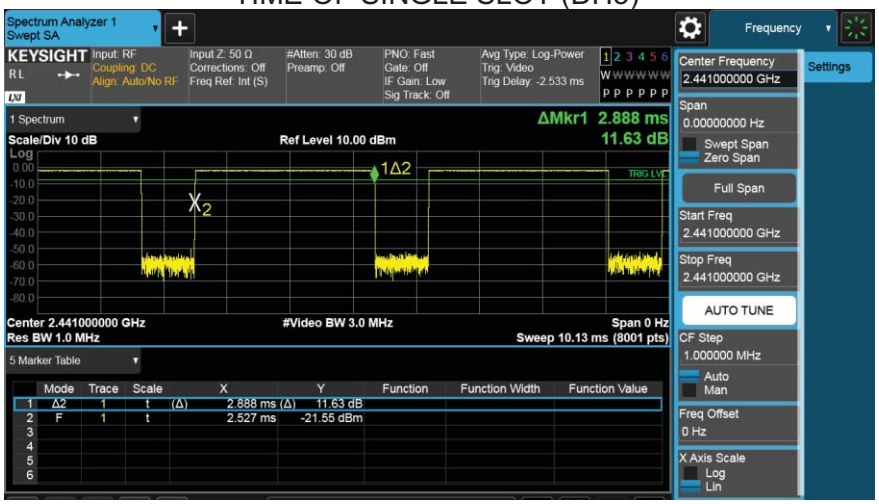
TIME OF SINGLE SLOT (DH1)



TIME OF SINGLE SLOT (DH3)




TIME OF SINGLE SLOT (DH5)

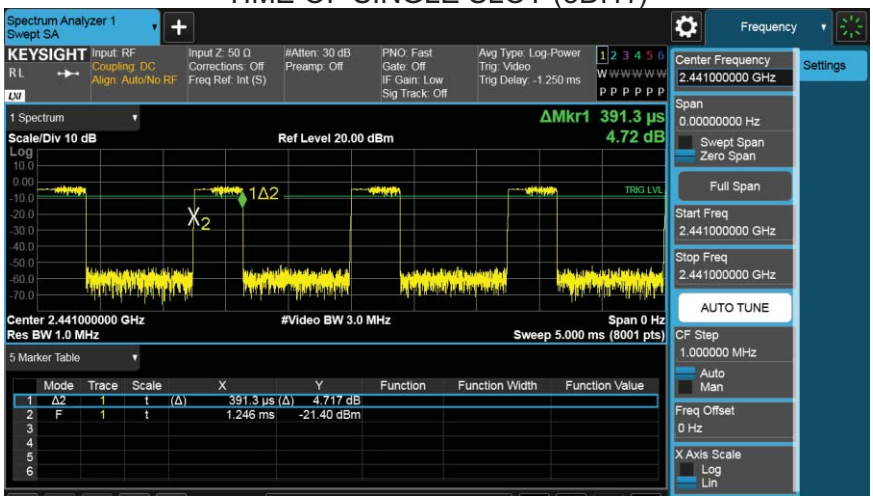


### 6.6.2. 8DPSK MODE

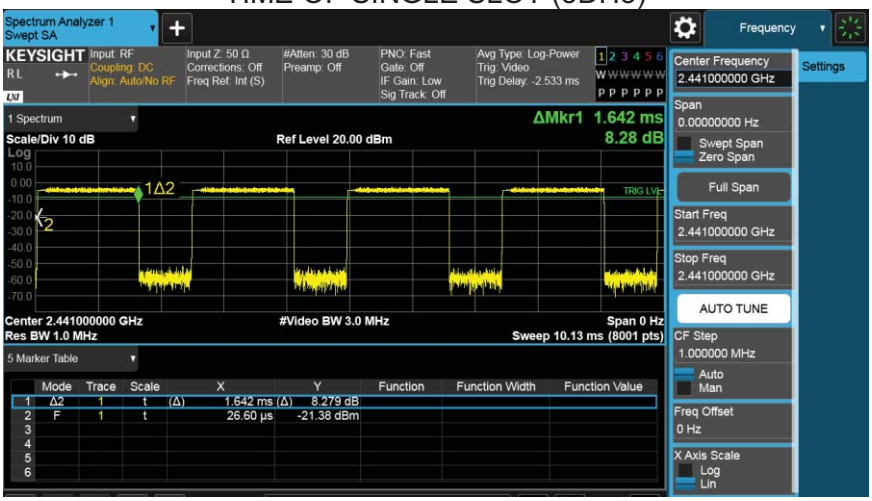
| Normal Mode | | | | |
|---|---|---|---|---|
| Packet | Channel | Burst Width [ms/hop/ch] | Dwell Time [ms] | Results |
| 3DH1 | MCH | 0.391 | 0.125 | PASS |
| 3DH3 | MCH | 1.642 | 0.525 | PASS |
| 3DH5 | MCH | 2.883 | 0.923 | PASS |
| AFH Mode | | | | |
| 3DH1 | MCH | 0.367 | 0.125 | PASS |
| 3DH3 | MCH | 1.633 | 0.525 | PASS |
| 3DH5 | MCH | 2.890 | 0.923 | PASS |

**Test Graph**

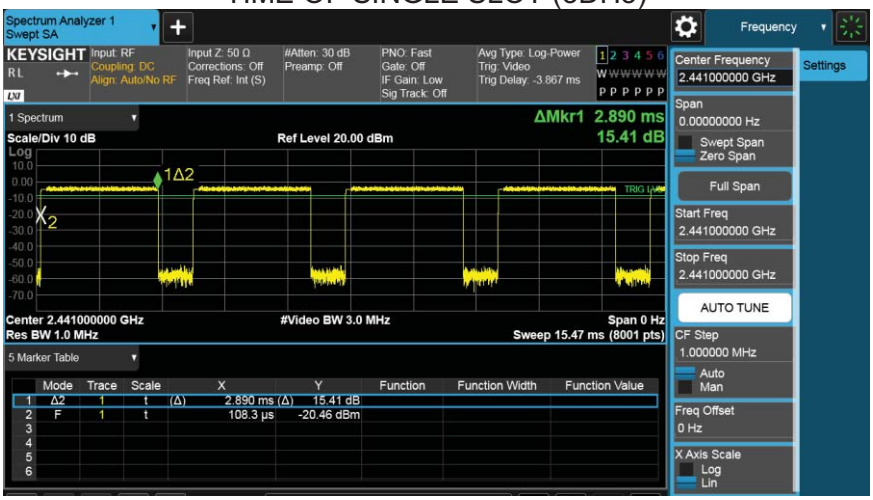
TIME OF SINGLE SLOT (3DH1)



TIME OF SINGLE SLOT (3DH3)




TIME OF SINGLE SLOT (3DH5)



## 6.7. CONDUCTED SPURIOUS EMISSION

**LIMITS**

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 | | |
|---|---|---|
| Section | Test Item | Limit |
| FCC §15.247 (d)<br>RSS-247 5.5 | Conducted Spurious Emission | at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power |

**TEST PROCEDURE**

For Band-edge use the following settings:

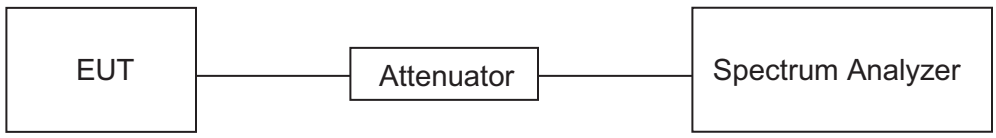
| | |
|---|---|
| Detector | Peak |
| RBW | RBW ≥ 1% of the span |
| VBW | ≥RBW |
| Span | wide enough to fully capture the emission being measured |
| Trace | Max hold |
| Sweep time | Auto couple. |

For Spurious Emission use the following settings:

| | |
|---|---|
| Detector | Peak |
| RBW | 100K |
| VBW | ≥ RBW |
| Span | wide enough to fully capture the emission being measured |
| Trace | Max hold |
| Sweep time | Auto couple. |

Use the peak marker function to determine the maximum amplitude level.

**TEST SETUP**

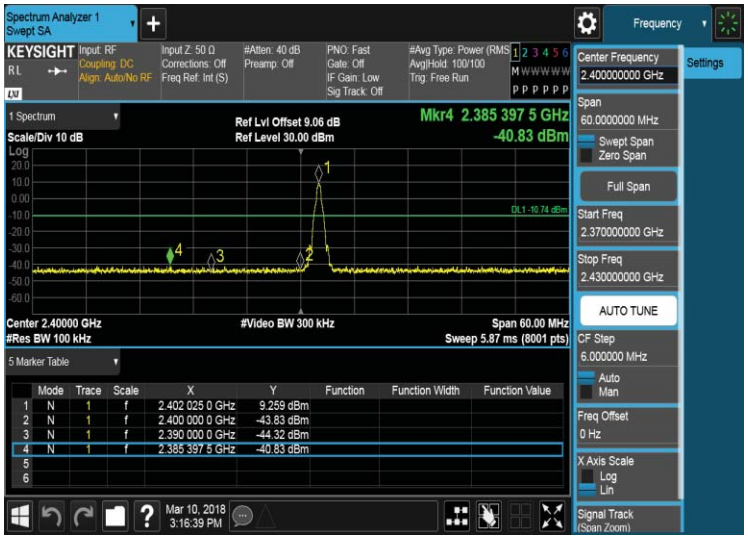


**RESULTS**

## 6.7.1. GFSK MODE

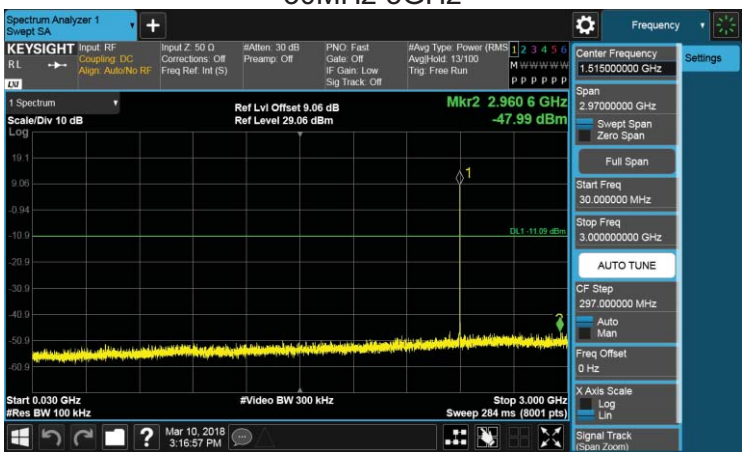
**SPURIOUS EMISSIONS, LOW CHANNEL**

LOW CH BANDEDGE

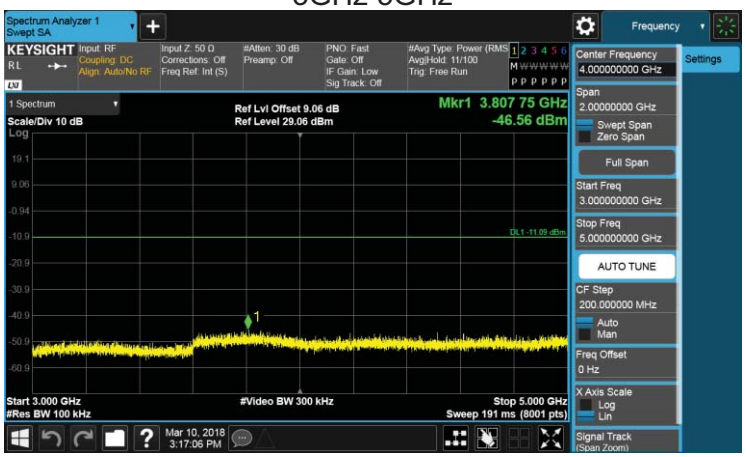


LOW CH SPURIOUS

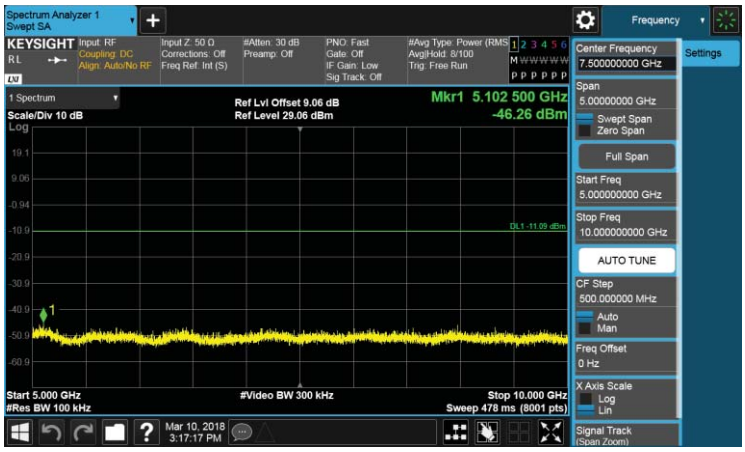

30MHz-3GHz



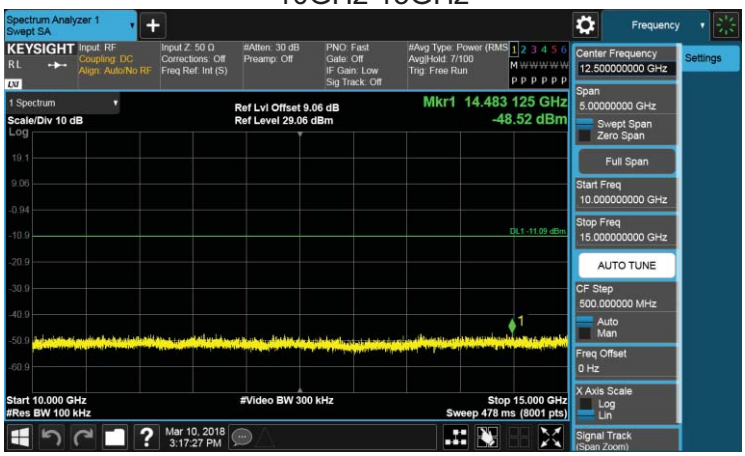

3GHz-5GHz



LOW CH SPURIOUS
5GHz - 10GHz




10GHz-15GHz

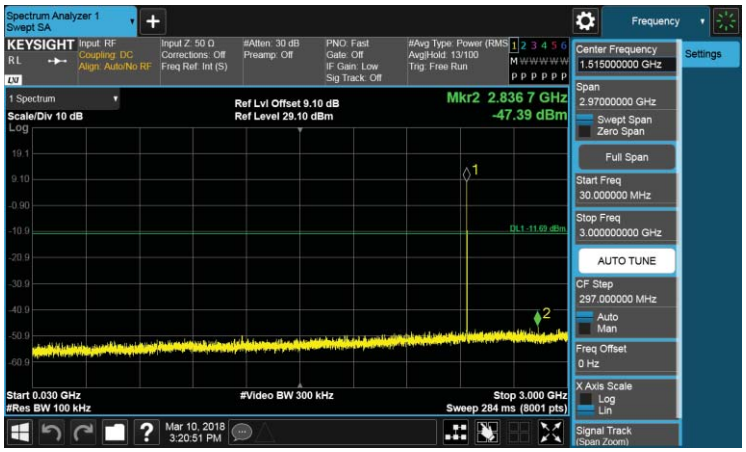



15GHz-25GHz

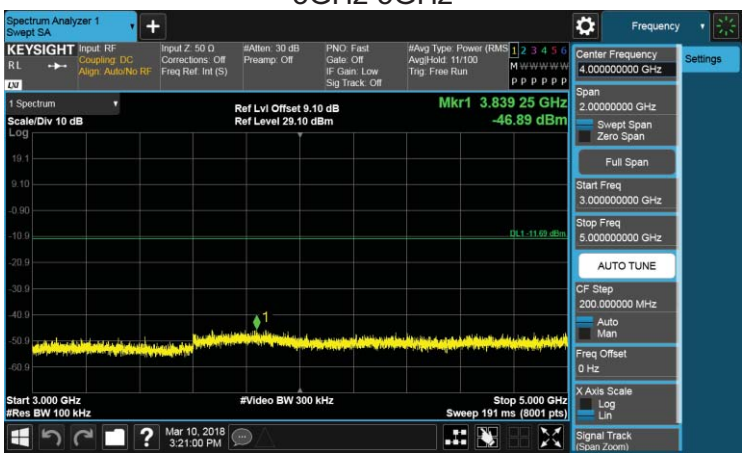
**SPURIOUS EMISSIONS, MID CHANNEL**

MID CH SPURIOUS


30MHz-3GHz

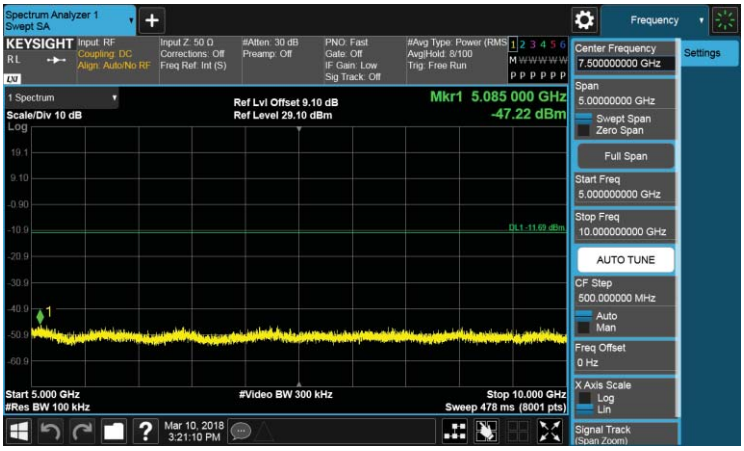



3GHz-5GHz



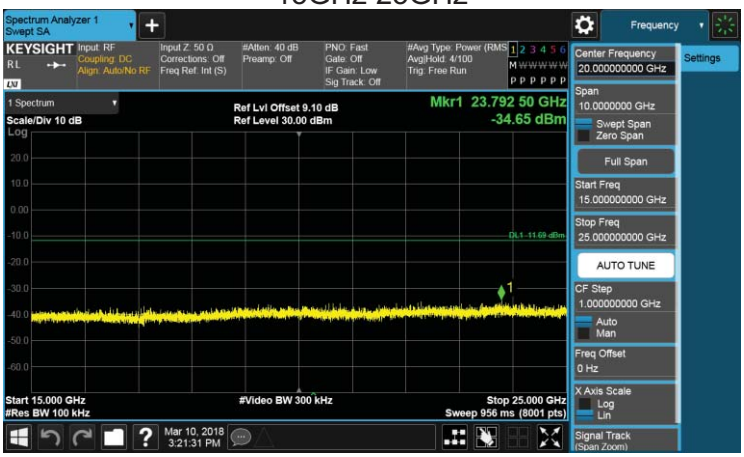
MID CH SPURIOUS

5GHz-10GHz



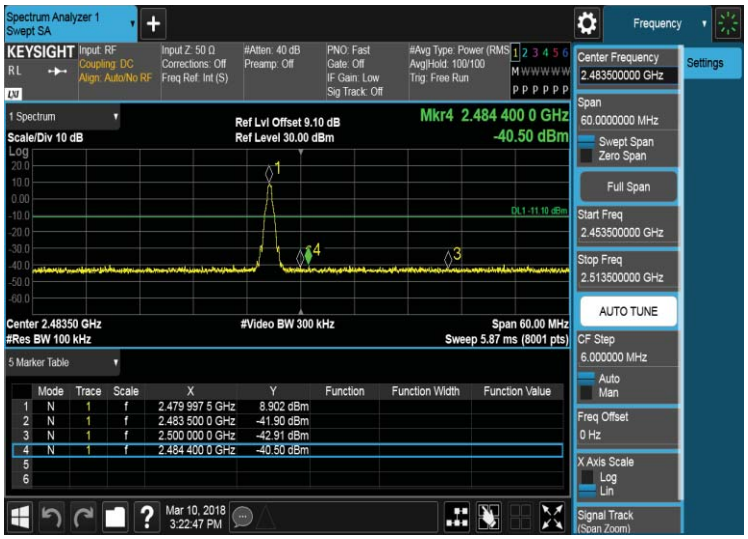

10GHz-15GHz


15GHz-25GHz



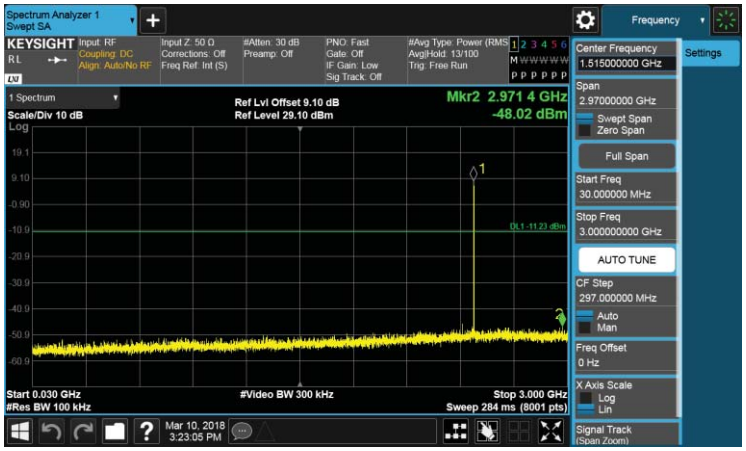
**SPURIOUS EMISSIONS, HIGH CHANNEL**

HIGH CH BANDEDGE

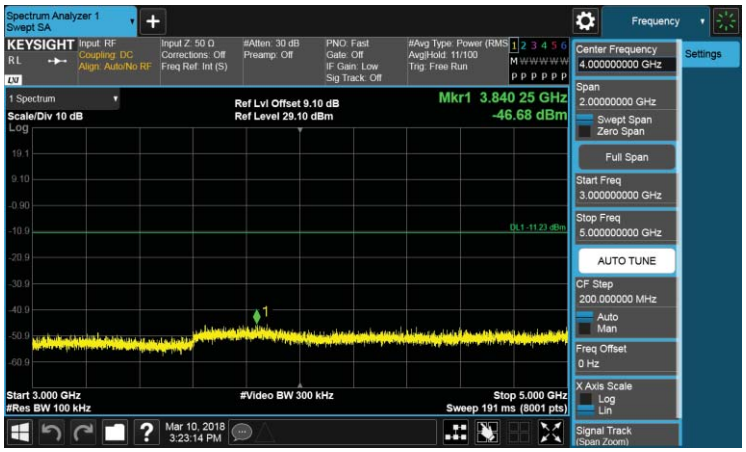


HIGH CH SPURIOUS

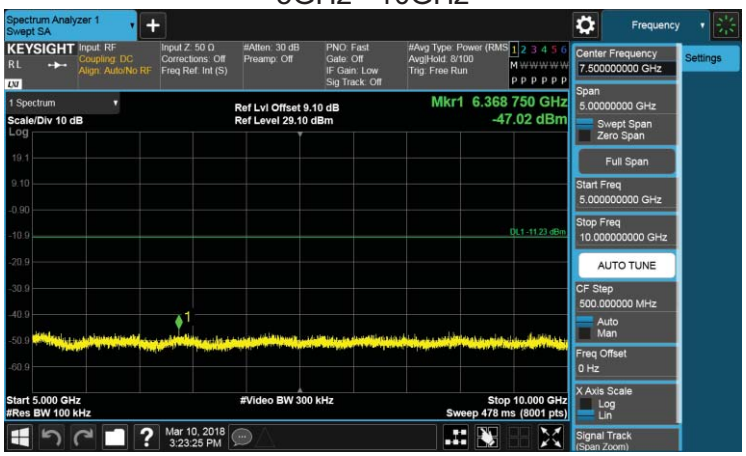

30MHz - 3GHz



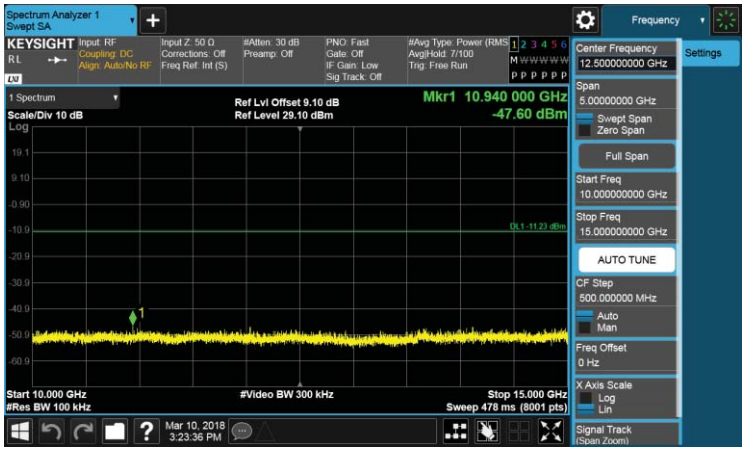

3GHz-5GHz



HIGH CH SPURIOUS
5GHz - 10GHz




10GHz - 15GHz




15GHz - 25GHz