

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

## INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C AND RSS 247 REQUIREMENT

OF

**Applicant:** Murata Manufacturing Co., Ltd.  
10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555  
Japan

**Product Name:** Communication Module

**Brand Name:** muRata

**FCC Model No.:** LBEE5XV1VA

**IC Model No.:** LBEE5XV1VA\_3ANT, LBEE5XV1VA\_2ANT

**Model Difference:** LBEE5XV1VA\_3ANT: Connect BT\_IN to BT\_OUT  
LBEE5XV1VA\_2ANT: Connect BT\_IN to 50 ohm termination resistor

**Report Number:** T190506W05-RP1

**FCC ID:** VPYLB1VA

**IC:** 772C-LB1VA

**FCC Rule Part:** §15.247, Cat: DSS

**IC Rule Part:** RSS-247 issue 2 Feb 2017

**Issue Date:** May 31, 2019

**Date of Test:** May 07, 2019 ~ May 24, 2018

**Date of EUT** May 07, 2019

**Received:**

**Note:** The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.  
The test results of this report relate only to the tested sample identified in this report.

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Peter Weng

Tested By:

Peter Weng / Engineer

Kevin Tsai

Approved By:

Kevin Tsai / Deputy Manager



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## Revision History

| Report Number  | Revision | Description                  | Effected Page | Issue Date   | Revised By |
|----------------|----------|------------------------------|---------------|--------------|------------|
| T190506W05-RP1 | Rev.00   | Initial creation of document | All           | May 31, 2019 | Elle Chang |

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## 1 GENERAL INFORMATION

### 1.1 Product description

|                        |                      |
|------------------------|----------------------|
| Product Name:          | Communication Module |
| Brand Name:            | muRata               |
| Model No.:             | LBEE5XV1VA           |
| Model Difference:      | N/A                  |
| Product SW/HW Version: | 1.0 / 1.0            |
| Radio SW/HW Version:   | 1.0 / 1.0            |
| Power Supply:          | 3.6Vdc               |

|                      |                                       |
|----------------------|---------------------------------------|
| Radio Technology:    | Bluetooth_BR+EDR                      |
| Channel number:      | 79 channels                           |
| Modulation type:     | GFSK + $\pi/4$ DQPSK + 8DPSK          |
| Transmit Power:      | 10.86 dBm (2ANT)<br>11.88 dBm (3ANT)  |
| Frequency Range:     | 2.402GHz – 2.480GHz                   |
| Dwell Time:          | $\leq 0.4s$                           |
| Antenna Designation: | Dipole Antenna, Antenna Gain: 5.68dBi |

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## 1.2 Test Methodology of Applied Standards

Canada RSS-247 issue 2 Feb. 2017

RSS-Gen. issue 5 Apr. 2018

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas. Guidance v05r02

ANSI C63.10:2013

**Note:** All test items have been performed and record as per the above standards.

## 1.3 Test Facility

Compliance Certification Services Inc. Wugu Lab. No.11, Wugong 6th Rd.,

Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.) (TAF code 1309)

FCC Designation number: TW1309

Canada Registration number: 2324G

## 1.4 Special Accessories

There is no special accessory used while test was conducted.

## 1.5 Equipment Modifications

There was no modification incorporated into the EUT.

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## 2 SYSTEM TEST CONFIGURATION

### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### 2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

### 2.3 Test Procedure

#### 2.3.1 Conducted Emissions

The EUT is placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50 µH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

#### 2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

#### 2.3.3 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

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## 2.4 Measurement Results Explanation Example

### For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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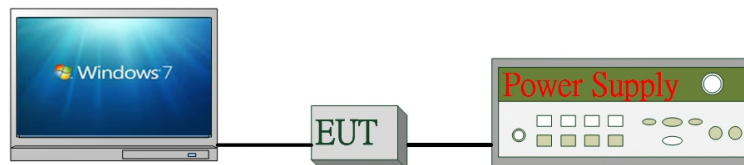
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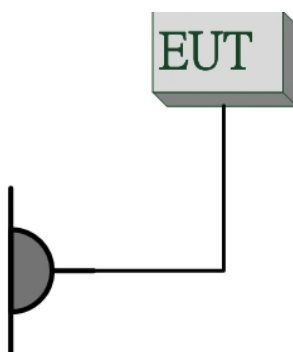


## 2.5 Configuration of Tested System

**Fig. 2-1 Radiated & Conducted Emission Configuration**



**Fig.2-2 Conducted Emission (AC power line) Configuration**



**Table 2-1 Equipment Used in Tested System**

| Item | Equipment               | Mfr/Brand | Model/Type No. | Series No. | Data Cable | Power Cord |
|------|-------------------------|-----------|----------------|------------|------------|------------|
| 1.   | Bluetooth Test Software | N/A       | N/A            | N/A        | N/A        | N/A        |
| 2.   | DC Power Supply         | Agilent   | E3640A         | KR93300208 | N/A        | Unshielded |
| 3.   | Notebook                | N/A       | N/A            | N/A        | N/A        | N/A        |

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### 3 SUMMARY OF TEST RESULTS

| FCC Rules             | IC Rules                                      | Description Of Test                          | Result    |
|-----------------------|---|--|-----------|
| §15.207(a)            | RSS-Gen §8.8                                  | AC Power Line Conducted Emission             | Compliant |
| §15.247(b)(1)         | RSS-247 §5.4 (2)                              | Peak Output Power                            | Compliant |
| §15.247(a)(1)         | RSS-247 §5.1 (1)<br>RSS-Gen §6.7              | 20dB & 99% Bandwidth                         | Compliant |
| §15.247(d)            | RSS-247 §5.5                                  | Conducted Band Edge<br>and Spurious Emission | Compliant |
| §15.247(d)            | RSS-247 §5.5<br>RSS-Gen §8.9<br>RSS-Gen §8.10 | Radiated Band Edge<br>and Spurious Emission  | Compliant |
| §15.247(a)(1)         | RSS-247 §5.1 (2)                              | Frequency Separation                         | Compliant |
| §15.247(a)(1)(iii)    | RSS-247 §5.1 (4)                              | Number of hopping frequency                  | Compliant |
| §15.247(a)(1)(iii)    | RSS-247 §5.1 (4)                              | Time of Occupancy                            | Compliant |
| §15.203<br>§15.247(b) | RSS- Gen §6.8                                 | Antenna Requirement                          | Compliant |

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## 4 DESCRIPTION OF TEST MODES

### 4.1 Operated in 2400 ~ 2483.5MHz Band

79 channels are provided for Bluetooth

| ITEM | FREQUENCY | ITEM | FREQUENCY | ITEM | FREQUENCY | ITEM | FREQUENCY |
|------|-----------|------|-----------|------|-----------|------|-----------|
| 1    | 2402 MHz  | 21   | 2422 MHz  | 41   | 2442 MHz  | 71   | 2462 MHz  |
| 2    | 2403 MHz  | 22   | 2423 MHz  | 42   | 2443 MHz  | 72   | 2463 MHz  |
| 3    | 2404 MHz  | 23   | 2424 MHz  | 43   | 2444 MHz  | 73   | 2464 MHz  |
| 4    | 2405 MHz  | 24   | 2425 MHz  | 44   | 2445 MHz  | 74   | 2465 MHz  |
| 5    | 2406 MHz  | 25   | 2426 MHz  | 45   | 2446 MHz  | 75   | 2466 MHz  |
| 6    | 2407 MHz  | 26   | 2427 MHz  | 46   | 2447 MHz  | 76   | 2467 MHz  |
| 7    | 2408 MHz  | 27   | 2428 MHz  | 47   | 2448 MHz  | 77   | 2468 MHz  |
| 8    | 2409 MHz  | 28   | 2429 MHz  | 48   | 2449 MHz  | 78   | 2469 MHz  |
| 9    | 2410 MHz  | 29   | 2430 MHz  | 49   | 2450 MHz  | 79   | 2470 MHz  |
| 10   | 2411 MHz  | 30   | 2431 MHz  | 50   | 2451 MHz  | 70   | 2471 MHz  |
| 11   | 2412 MHz  | 31   | 2432 MHz  | 51   | 2452 MHz  | 71   | 2472 MHz  |
| 12   | 2413 MHz  | 32   | 2433 MHz  | 52   | 2453 MHz  | 72   | 2473 MHz  |
| 13   | 2414 MHz  | 33   | 2434 MHz  | 53   | 2454 MHz  | 73   | 2474 MHz  |
| 14   | 2415 MHz  | 34   | 2435 MHz  | 54   | 2455 MHz  | 74   | 2475 MHz  |
| 15   | 2416 MHz  | 35   | 2436 MHz  | 55   | 2456 MHz  | 75   | 2476 MHz  |
| 16   | 2417 MHz  | 36   | 2437 MHz  | 56   | 2457 MHz  | 76   | 2477 MHz  |
| 17   | 2418 MHz  | 37   | 2438 MHz  | 57   | 2458 MHz  | 77   | 2478 MHz  |
| 18   | 2419 MHz  | 38   | 2439 MHz  | 58   | 2459 MHz  | 78   | 2479 MHz  |
| 19   | 2420 MHz  | 39   | 2440 MHz  | 59   | 2460 MHz  | 79   | 2480 MHz  |
| 20   | 2421 MHz  | 40   | 2441 MHz  | 60   | 2461 MHz  |      |           |

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## 4.2 The Worst Test Modes and Channel Details

- 1 The EUT has been tested under operating condition.
- 2 Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
- 3 Investigation has been done on all the possible configurations for searching the worst case.

### RADIATED EMISSION TEST:

| RADIATED EMISSION TEST (BELOW 1 GHz) |                           |                        |            |             |
|--------------------------------------|---------------------------|------------------------|------------|-------------|
| MODE                                 | AVAILABLE FREQUENCY (MHz) | TESTED FREQUENCY (MHz) | MODULATION | PACKET TYPE |
| Bluetooth (2ANT)                     | 2402 to 2480              | 2402, 2441, 2480       | GFSK       | DH5         |
| Bluetooth (3ANT)                     | 2402 to 2480              | 2402, 2441, 2480       | GFSK       | DH5         |
| RADIATED EMISSION TEST (ABOVE 1 GHz) |                           |                        |            |             |
| Bluetooth (2ANT)                     | 2402 to 2480              | 2402, 2441, 2480       | GFSK       | DH5         |
| Bluetooth (3ANT)                     | 2402 to 2480              | 2402, 2441, 2480       | GFSK       | DH5         |

#### Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth BR+EDR Transmitter for channel Low, Mid and High, the worst case E2 position was reported.

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**ANTENNA PORT CONDUCTED MEASUREMENT:**

| <b>CONDUCTED TEST</b>                     |                                 |                              |                              |   |
|---|---------------------------------|------------------------------|------------------------------|---|
| <b>Peak Output Power, 20dB Band Width</b> |                                 |                              |                              |   |
| MODE                                      | AVAILABLE<br>FREQUENCY<br>(MHz) | TESTED<br>FREQUENCY<br>(MHz) | MODULATION                   | PACKET<br>TYPE                                  |
| Bluetooth<br>(2ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK, $\pi/4$ -DQPSK, 8-DQPK | DH1/DH3/DH5<br>2DH1/2DH3/2DH5<br>3DH1/3DH3/3DH5 |
| Bluetooth<br>(3ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK, $\pi/4$ -DQPSK, 8-DQPK | DH1/DH3/DH5<br>2DH1/2DH3/2DH5<br>3DH1/3DH3/3DH5 |
| <b>Band Edge</b>                          |                                 |                              |                              |   |
| Bluetooth<br>(2ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK                         | DH5   |
| Bluetooth<br>(3ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK                         | DH5   |
| <b>Frequency Separation</b>               |                                 |                              |                              |   |
| Bluetooth<br>(2ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK                         | DH5   |
| Bluetooth<br>(3ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK                         | DH5   |
| <b>Number of hopping frequency</b>        |                                 |                              |                              |   |
| Bluetooth<br>(2ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK                         | DH5   |
| Bluetooth<br>(3ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK                         | DH5   |
| <b>Time of Occupancy (Dwell time)</b>     |                                 |                              |                              |   |
| Bluetooth<br>(2ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK, $\pi/4$ -DQPSK, 8-DQPK | DH1/DH3/DH5<br>2DH1/2DH3/2DH5<br>3DH1/3DH3/3DH5 |
| Bluetooth<br>(3ANT)                       | 2402 to 2480                    | 2402, 2441, 2480             | GFSK, $\pi/4$ -DQPSK, 8-DQPK | DH1/DH3/DH5<br>2DH1/2DH3/2DH5<br>3DH1/3DH3/3DH5 |

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## 5 MEASUREMENT UNCERTAINTY

| PARAMETER                                 | UNCERTAINTY    |
|---|----------------|
| AC Powerline Conducted Emission           | +/- 1.2575 dB  |
| Peak Output Power                         | +/- 1.924 dB   |
| 20dB Bandwidth                            | +/- 147.256 Hz |
| 100 kHz Bandwidth of Frequency Band Edges | +/- 1.924 dB   |
| Frequency Separation                      | +/- 147.256 Hz |
| Number of hopping frequency               | +/- 147.256 Hz |
| Time of Occupancy                         | +/- 147.256 Hz |
| 3M Semi Anechoic Chamber / 30M~200M       | +/- 4.12 dB    |
| 3M Semi Anechoic Chamber / 200M~1000M     | +/- 4.68 dB    |
| 3M Semi Anechoic Chamber / 1G~8G          | +/- 5.18 dB    |
| 3M Semi Anechoic Chamber / 8G~18G         | +/- 5.47 dB    |
| 3M Semi Anechoic Chamber / 18G~26G        | +/- 3.81 dB    |
| 3M Semi Anechoic Chamber / 26G~40G        | +/- 3.87 dB    |

### Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. Determination of compliance is based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

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## 6 CONDUCTED EMISSION TEST

### 6.1 Standard Applicable

Frequency within 150 kHz to 30MHz shall not exceed the limit table as below.

| Frequency range<br>MHz  | Limits<br>dB(uV) |          |
|---|------------------|----------|
|   | Quasi-peak       | Average  |
| 0.15 to 0.50  | 66 to 56         | 56 to 46 |
| 0.50 to 5   | 56               | 46       |
| 5 to 30   | 60               | 50       |
| Note  |                  |          |
| 1.The lower limit shall apply at the transition frequencies   |                  |          |
| 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz. |                  |          |

### 6.2 Measurement Equipment Used

| EQUIPMENT TYPE    | MFR                | MODEL NUMBER | SERIAL NUMBER | LAST CAL.  | CAL DUE.   |
|-------------------|--------------------|--------------|---------------|------------|------------|
| CABLE             | EMCI               | CFD300-NL    | CERF          | 06/29/2018 | 06/28/2019 |
| EMI Test Receiver | R&S                | ESCI         | 100064        | 07/24/2018 | 07/23/2019 |
| LISN              | SCHWARZBECK        | NSLK 8127    | 8127-541      | 01/31/2019 | 01/30/2020 |
| LISN              | SCHAFFNER          | NNB 41       | 03/10013      | 02/13/2019 | 02/12/2020 |
| Software          | EZ-EMC(CCS-3A1-CE) |              |               |            |            |

### 6.3 EUT Setup

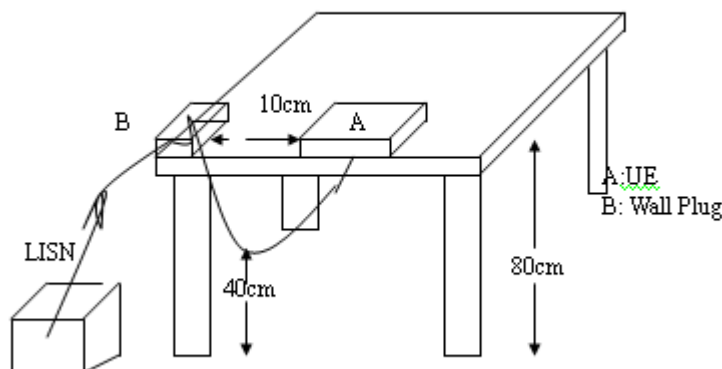
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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## 6.4 Test SET-UP (Block Diagram of Configuration)



## 6.5 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

## 6.6 Measurement Result

Note: Refer to next page for measurement data and plots.

Note2: The \* reveals the worst-case results that closet to the limit.

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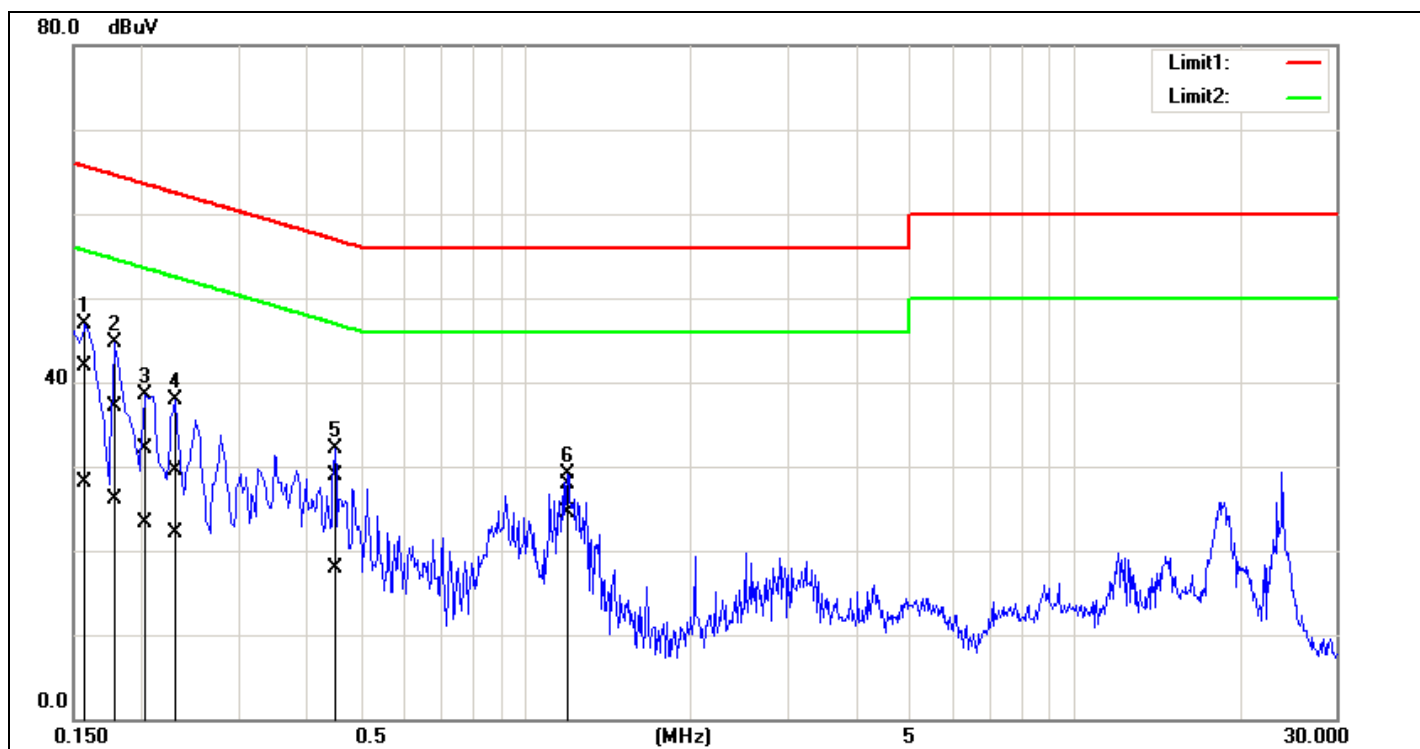
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## AC POWER LINE CONDUCTED EMISSION TEST DATA

|               |              |                    |              |
|---------------|--------------|--------------------|--------------|
| Description:  | Operation    | Date:              | 2019/5/21    |
| Line:         | L1           | Temp.(°C)/Hum.(%): | 22.5(°C)/61% |
| Test Voltage: | AC 120V/60Hz | Test By:           | Peter        |



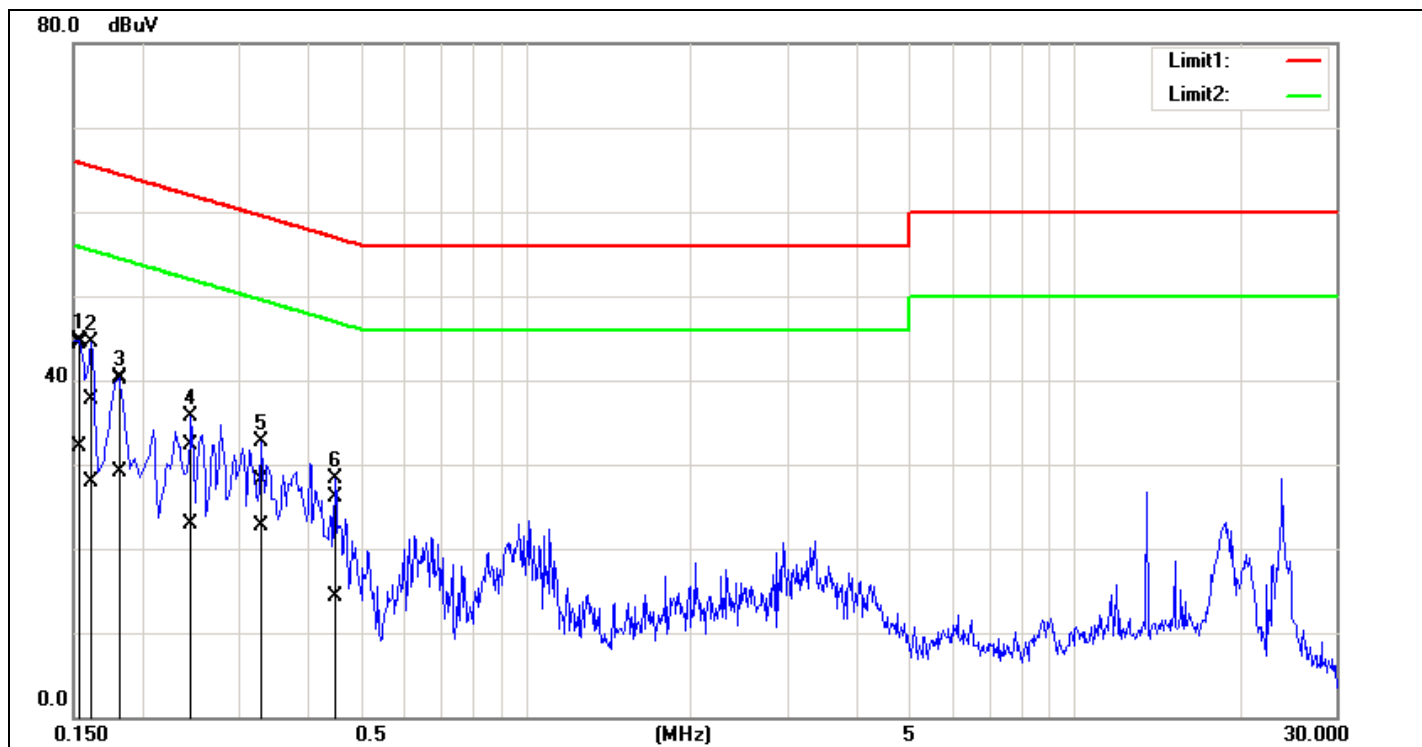
| No. | Frequency<br>(MHz) | QuasiPeak<br>reading<br>(dBuV) | Average<br>reading<br>(dBuV) | Correction<br>factor<br>(dB) | QuasiPeak<br>result<br>(dBuV) | Average<br>result<br>(dBuV) | QuasiPeak<br>limit<br>(dBuV) | Average<br>limit<br>(dBuV) | QuasiPeak<br>margin<br>(dB) | Average<br>margin<br>(dB) | Remark |
|-----|--------------------|--------------------------------|------------------------------|------------------------------|-------------------------------|-----------------------------|------------------------------|----------------------------|-----------------------------|---------------------------|--------|
| 1   | 0.1580             | 41.75                          | 28.03                        | 0.16                         | 41.91                         | 28.19                       | 65.56                        | 55.57                      | -23.65                      | -27.38                    | Pass   |
| 2   | 0.1780             | 36.99                          | 26.02                        | 0.15                         | 37.14                         | 26.17                       | 64.57                        | 54.58                      | -27.43                      | -28.41                    | Pass   |
| 3   | 0.2020             | 31.99                          | 23.18                        | 0.15                         | 32.14                         | 23.33                       | 63.52                        | 53.53                      | -31.38                      | -30.20                    | Pass   |
| 4   | 0.2300             | 29.40                          | 21.95                        | 0.15                         | 29.55                         | 22.10                       | 62.45                        | 52.45                      | -32.90                      | -30.35                    | Pass   |
| 5   | 0.4500             | 28.78                          | 17.84                        | 0.16                         | 28.94                         | 18.00                       | 56.87                        | 46.88                      | -27.93                      | -28.88                    | Pass   |
| 6*  | 1.1940             | 27.73                          | 24.30                        | 0.19                         | 27.92                         | 24.49                       | 56.00                        | 46.00                      | -28.08                      | -21.51                    | Pass   |

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|               |              |                    |              |
|---------------|--------------|--------------------|--------------|
| Description:  | Operation    | Date:              | 2019/5/21    |
| Line:         | N            | Temp.(°C)/Hum.(%): | 22.5(°C)/61% |
| Test Voltage: | AC 120V/60Hz | Test By:           | Peter        |



| No. | Frequency<br>(MHz) | QuasiPeak<br>reading<br>(dBuV) | Average<br>reading<br>(dBuV) | Correction<br>factor<br>(dB) | QuasiPeak<br>result<br>(dBuV) | Average<br>result<br>(dBuV) | QuasiPeak<br>limit<br>(dBuV) | Average<br>limit<br>(dBuV) | QuasiPeak<br>margin<br>(dB) | Average<br>margin<br>(dB) | Remark |
|-----|--------------------|--------------------------------|------------------------------|------------------------------|-------------------------------|-----------------------------|------------------------------|----------------------------|-----------------------------|---------------------------|--------|
| 1*  | 0.1539             | 44.30                          | 32.05                        | 0.10                         | 44.40                         | 32.15                       | 65.78                        | 55.79                      | -21.38                      | -23.64                    | Pass   |
| 2   | 0.1620             | 37.55                          | 27.72                        | 0.10                         | 37.65                         | 27.82                       | 65.36                        | 55.36                      | -27.71                      | -27.54                    | Pass   |
| 3   | 0.1819             | 40.04                          | 28.95                        | 0.10                         | 40.14                         | 29.05                       | 64.39                        | 54.40                      | -24.25                      | -25.35                    | Pass   |
| 4   | 0.2460             | 32.21                          | 22.84                        | 0.10                         | 32.31                         | 22.94                       | 61.89                        | 51.89                      | -29.58                      | -28.95                    | Pass   |
| 5   | 0.3300             | 27.90                          | 22.56                        | 0.11                         | 28.01                         | 22.67                       | 59.45                        | 49.45                      | -31.44                      | -26.78                    | Pass   |
| 6   | 0.4500             | 26.06                          | 14.13                        | 0.11                         | 26.17                         | 14.24                       | 56.87                        | 46.88                      | -30.70                      | -32.64                    | Pass   |

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## 7 PEAK OUTPUT POWER MEASUREMENT

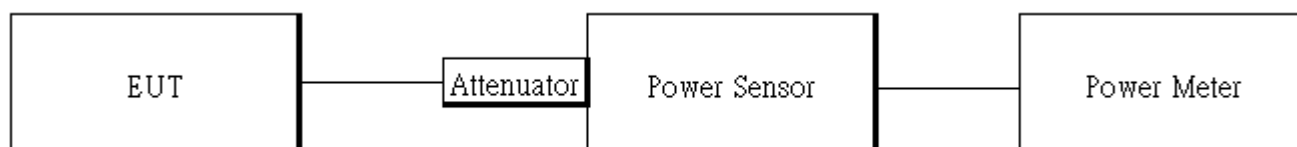
### 7.1 Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts and the e.i.r.p. shall not exceed 0.5 W if the hop set uses less than 75 hopping channels.

### 7.2 Measurement Equipment Used

| EQUIPMENT TYPE  | MFR          | MODEL NUMBER | SERIAL NUMBER | LAST CAL.  | CAL DUE.   |
|-----------------|--------------|--------------|---------------|------------|------------|
| Power Meter     | Anritsu      | ML2496A      | 1242004       | 10/23/2018 | 10/22/2019 |
| Power Sensor    | Anritsu      | MA2411B      | 1207365       | 10/23/2018 | 10/22/2019 |
| Power Sensor    | Anritsu      | MA2411B      | 1207368       | 10/24/2018 | 10/23/2019 |
| DC Power Supply | Agilent      | E3640A       | KR93300208    | 08/15/2018 | 08/14/2019 |
| DC Power Supply | GWINSTEK     | SPS-3610     | GPE880163     | 01/14/2019 | 01/13/2020 |
| Attenuator      | Mini-Circuit | BW-S10W2+    | 1             | 02/26/2019 | 02/25/2020 |
| Attenuator      | Mini-Circuit | BW-S10W2+    | 3             | 02/26/2019 | 02/25/2020 |

### 7.3 Test Set-up:



### 7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013. Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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## 7.5 Measurement Result

### 2ANT

#### 1M BR mode (Peak):

| CH   | Freq. (MHz) | Peak Output Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|-------------------------|-------------------|------------|
| Low  | 2402        | 10.49                   | 11.194            | 1000       |
| Mid  | 2441        | <b>10.86</b>            | 12.190            | 1000       |
| High | 2480        | 10.15                   | 10.351            | 1000       |

#### 1M BR mode (Average):

| CH   | Freq. (MHz) | Max. Output include tune up tolerance Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|---|-------------------|------------|
| Low  | 2402        | 10.37   | 10.899            | 1000       |
| Mid  | 2441        | 10.18   | 10.432            | 1000       |
| High | 2480        | 10.01   | 10.032            | 1000       |

#### 2M EDR mode (Peak):

| CH   | Freq. (MHz) | Peak Output Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|-------------------------|-------------------|------------|
| Low  | 2402        | 7.95                    | 6.237             | 125        |
| Mid  | 2441        | <b>9.07</b>             | 8.072             | 125        |
| High | 2480        | 8.52                    | 7.112             | 125        |

#### 2M EDR mode (Average):

| CH   | Freq. (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|--|-------------------|------------|
| Low  | 2402        | 5.49   | 3.537             | 125        |
| Mid  | 2441        | 5.59   | 3.619             | 125        |
| High | 2480        | 6.01   | 3.987             | 125        |

#### 3M EDR mode (Peak):

| CH   | Freq. (MHz) | Peak Output Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|-------------------------|-------------------|------------|
| Low  | 2402        | 8.23                    | 6.653             | 125        |
| Mid  | 2441        | <b>9.28</b>             | 8.472             | 125        |
| High | 2480        | 8.65                    | 7.328             | 125        |

#### 3M EDR mode (Average):

| CH   | Freq. (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|--|-------------------|------------|
| Low  | 2402        | 5.56   | 3.595             | 125        |
| Mid  | 2441        | 5.62   | 3.645             | 125        |
| High | 2480        | 6.03   | 4.005             | 125        |

**NOTE:** cable loss as 0.957dB that offsets in the sp

**\*Note:** Max. Output include tune up tolerance Power measured by using average detector.

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### 1M BR mode EIRP

| Channel | Frequency (MHz) | Max. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (mW) | Limit (mW) |
|---------|-----------------|---|--------------------|-----------|------------|
| Low     | 2402            | 10.37   | 5.68               | 40.307    | 4000       |
| Mid     | 2441            | 10.18   | 5.68               | 38.582    | 4000       |
| High    | 2480            | 10.01   | 5.68               | 37.101    | 4000       |

### 2M EDR mode EIRP

| Channel | Frequency (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (mW) | Limit (mW) |
|---------|-----------------|--|--------------------|-----------|------------|
| Low     | 2402            | 5.49   | 5.68               | 13.081    | 4000       |
| Mid     | 2441            | 5.59   | 5.68               | 13.386    | 4000       |
| High    | 2480            | 6.01   | 5.68               | 14.745    | 4000       |

### 3M EDR mode EIRP

| Channel | Frequency (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (mW) | Limit (mW) |
|---------|-----------------|--|--------------------|-----------|------------|
| Low     | 2402            | 5.56   | 5.68               | 13.293    | 4000       |
| Mid     | 2441            | 5.62   | 5.68               | 13.478    | 4000       |
| High    | 2480            | 6.03   | 5.68               | 14.813    | 4000       |

\* **Note:** EIRP = Average Power + Gain

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### 3ANT

#### 1M BR mode (Peak):

| CH   | Freq. (MHz) | Peak Output Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|-------------------------|-------------------|------------|
| Low  | 2402        | 11.57                   | 14.355            | 1000       |
| Mid  | 2441        | <b>11.88</b>            | 15.417            | 1000       |
| High | 2480        | 11.15                   | 13.032            | 1000       |

#### 1M BR mode (Average):

| CH   | Freq. (MHz) | Max. Output include tune up tolerance Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|---|-------------------|------------|
| Low  | 2402        | 10.98   | 12.542            | 1000       |
| Mid  | 2441        | 10.93   | 12.399            | 1000       |
| High | 2480        | 10.96   | 12.485            | 1000       |

#### 2M EDR mode (Peak):

| CH   | Freq. (MHz) | Peak Output Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|-------------------------|-------------------|------------|
| Low  | 2402        | 9.95                    | 9.886             | 125        |
| Mid  | 2441        | <b>10.53</b>            | 11.298            | 125        |
| High | 2480        | 9.89                    | 9.750             | 125        |

#### 2M EDR mode (Average):

| CH   | Freq. (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|--|-------------------|------------|
| Low  | 2402        | 7.85   | 6.101             | 125        |
| Mid  | 2441        | 7.81   | 6.045             | 125        |
| High | 2480        | 7.76   | 5.976             | 125        |

#### 3M EDR mode (Peak):

| CH   | Freq. (MHz) | Peak Output Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|-------------------------|-------------------|------------|
| Low  | 2402        | 10.04                   | 10.093            | 125        |
| Mid  | 2441        | <b>10.63</b>            | 11.561            | 125        |
| High | 2480        | 10.02                   | 10.046            | 125        |

#### 3M EDR mode (Average):

| CH   | Freq. (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Output Power (mW) | Limit (mW) |
|------|-------------|--|-------------------|------------|
| Low  | 2402        | 7.83   | 6.073             | 125        |
| Mid  | 2441        | 7.76   | 5.976             | 125        |
| High | 2480        | 7.76   | 5.976             | 125        |

**NOTE:** cable loss as 0.843dB that offsets in the sp

**\*Note:** Max. Output include tune up tolerance Power measured by using average detector.

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### 1M BR mode EIRP

| Channel | Frequency (MHz) | Max. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (mW) | Limit (mW) |
|---------|-----------------|---|--------------------|-----------|------------|
| Low     | 2402            | 10.98   | 5.68               | 46.386    | 4000       |
| Mid     | 2441            | 10.93   | 5.68               | 45.855    | 4000       |
| High    | 2480            | 10.96   | 5.68               | 46.172    | 4000       |

### 2M EDR mode EIRP

| Channel | Frequency (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (mW) | Limit (mW) |
|---------|-----------------|--|--------------------|-----------|------------|
| Low     | 2402            | 7.85   | 5.68               | 22.562    | 4000       |
| Mid     | 2441            | 7.81   | 5.68               | 22.355    | 4000       |
| High    | 2480            | 7.76   | 5.68               | 22.100    | 4000       |

### 3M EDR mode EIRP

| Channel | Frequency (MHz) | Max. Avg. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (mW) | Limit (mW) |
|---------|-----------------|--|--------------------|-----------|------------|
| Low     | 2402            | 7.83   | 5.68               | 22.459    | 4000       |
| Mid     | 2441            | 7.76   | 5.68               | 22.100    | 4000       |
| High    | 2480            | 7.76   | 5.68               | 22.100    | 4000       |

\* **Note:** EIRP = Average Power + Gain

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## 8 20dB & 99% BANDWIDTH MEASUREMENT

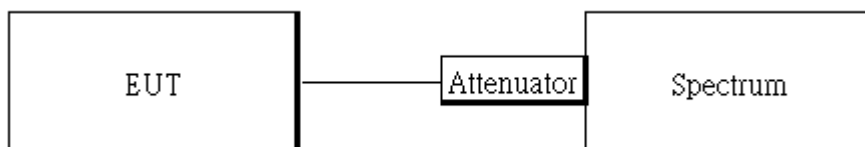
### 8.1 Standard Applicable

For frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

### 8.2 Measurement Equipment Used

| EQUIPMENT TYPE    | MFR           | MODEL NUMBER | SERIAL NUMBER | LAST CAL.  | CAL DUE.   |
|-------------------|---------------|--------------|---------------|------------|------------|
| DC Power Supply   | Agilent       | E3640A       | KR93300208    | 08/15/2018 | 08/14/2019 |
| Spectrum Analyzer | Agilent       | N9010A       | MY53400256    | 11/21/2018 | 11/20/2019 |
| DC Power Supply   | GWINSTEK      | SPS-3610     | GPE880163     | 01/14/2019 | 01/13/2020 |
| DC Block          | Mini-Circuits | BLK-18-S+    | 31129(1)      | 02/26/2019 | 02/25/2020 |
| Attenuator        | Mini-Circuit  | BW-S10W2+    | 1             | 02/26/2019 | 02/25/2020 |

### 8.3 Test Set-up



### 8.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013. Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set the spectrum analyzer as RBW=10 kHz (1 % of 20 dB Bandwidth.), VBW = 30 kHz, Span= 3MHz, Sweep=auto, Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and -20dB (upper and lower) frequency
6. Turn on the 99% bandwidth function, max reading.
7. Repeat above procedures until all test default channel is completed

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## 8.5 Measurement Result

### 2ANT

#### GFSK

| CH   | 20 dB BW (MHz) | 2/3 BW (MHz) |
|------|----------------|--------------|
| Low  | 0.9405         | 0.63         |
| Mid  | 0.9235         | 0.62         |
| High | 0.9245         | 0.62         |

#### $\pi/4$ -DQPSK

| CH   | 20 dB BW (MHz) | 2/3 BW (MHz) |
|------|----------------|--------------|
| Low  | 1.328          | 0.89         |
| Mid  | 1.330          | 0.89         |
| High | 1.329          | 0.89         |

#### 8-DPSK

| CH   | 20 dB BW (MHz) | 2/3 BW (MHz) |
|------|----------------|--------------|
| Low  | 1.288          | 0.86         |
| Mid  | 1.291          | 0.86         |
| High | 1.306          | 0.87         |

#### GFSK

| CH   | 99% Bandwidth (MHz) |
|------|---------------------|
| Low  | 0.88146             |
| Mid  | 0.87978             |
| High | 0.88019             |

#### $\pi/4$ -DQPSK

| CH   | 99% Bandwidth (MHz) |
|------|---------------------|
| Low  | 1.2142              |
| Mid  | 1.2183              |
| High | 1.2176              |

#### 8-DPSK

| CH   | 99% Bandwidth (MHz) |
|------|---------------------|
| Low  | 1.2172              |
| Mid  | 1.2185              |
| High | 1.2176              |

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### 3ANT

#### GFSK

| CH   | 20 dB BW (MHz) | 2/3 BW (MHz) |
|------|----------------|--------------|
| Low  | 0.9237         | 0.62         |
| Mid  | 0.9243         | 0.62         |
| High | 0.9242         | 0.62         |

#### $\pi/4$ -DQPSK

| CH   | 20 dB BW (MHz) | 2/3 BW (MHz) |
|------|----------------|--------------|
| Low  | 1.330          | 0.89         |
| Mid  | 1.331          | 0.89         |
| High | 1.331          | 0.89         |

#### 8-DPSK

| CH   | 20 dB BW (MHz) | 2/3 BW (MHz) |
|------|----------------|--------------|
| Low  | 1.287          | 0.86         |
| Mid  | 1.290          | 0.86         |
| High | 1.290          | 0.86         |

#### GFSK

| CH   | 99% Bandwidth (MHz) |
|------|---------------------|
| Low  | 0.87075             |
| Mid  | 0.87134             |
| High | 0.87177             |

#### $\pi/4$ -DQPSK

| CH   | 99% Bandwidth (MHz) |
|------|---------------------|
| Low  | 1.2125              |
| Mid  | 1.2169              |
| High | 1.2117              |

#### 8-DPSK

| CH   | 99% Bandwidth (MHz) |
|------|---------------------|
| Low  | 1.2176              |
| Mid  | 1.2187              |
| High | 1.2160              |

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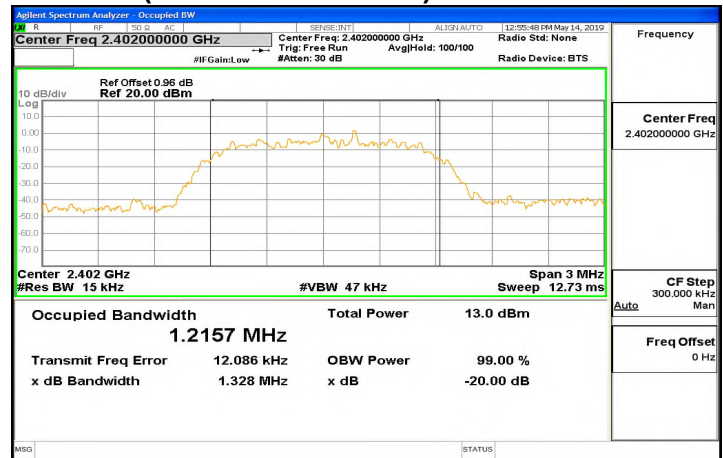
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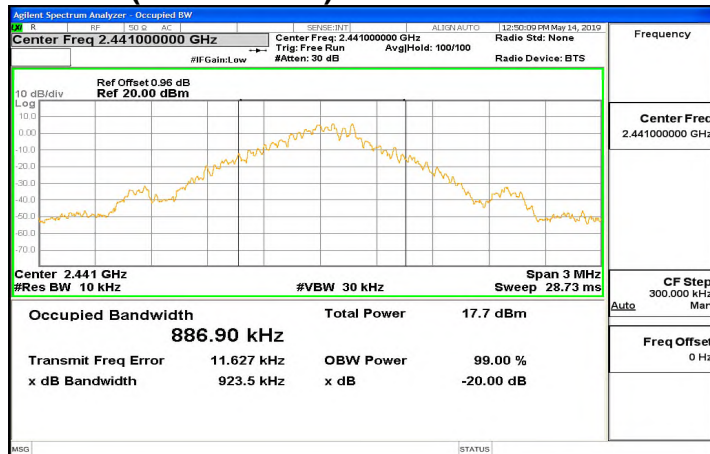
## 2ANT 20 dB BW CH-Low (GFSK mode)



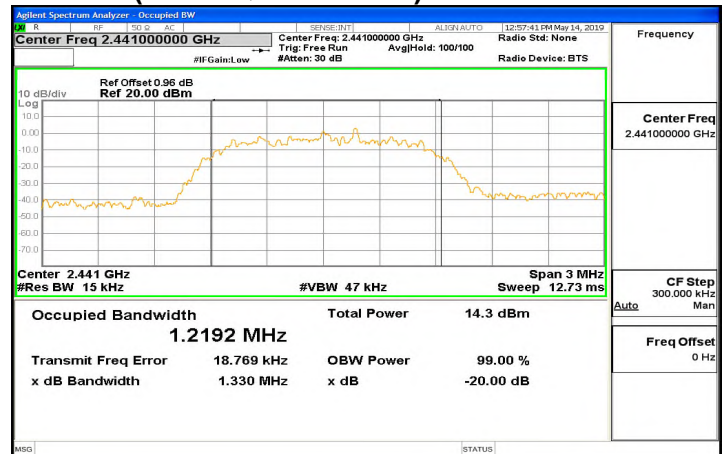
## CH-Low ( $\pi/4$ -DQPSK mode)



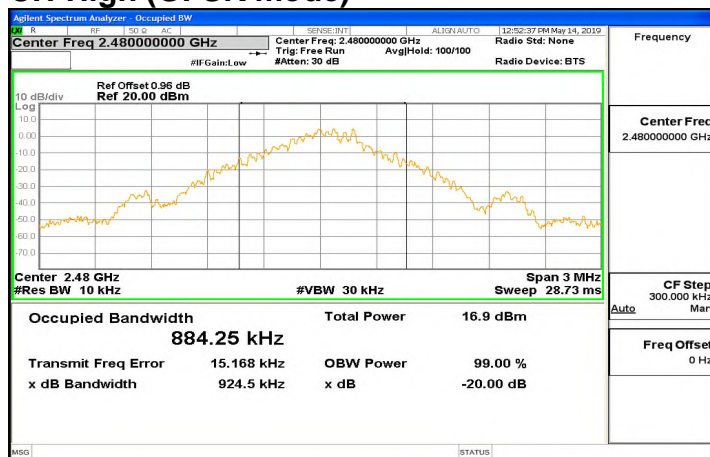
## CH-Mid (GFSK mode)



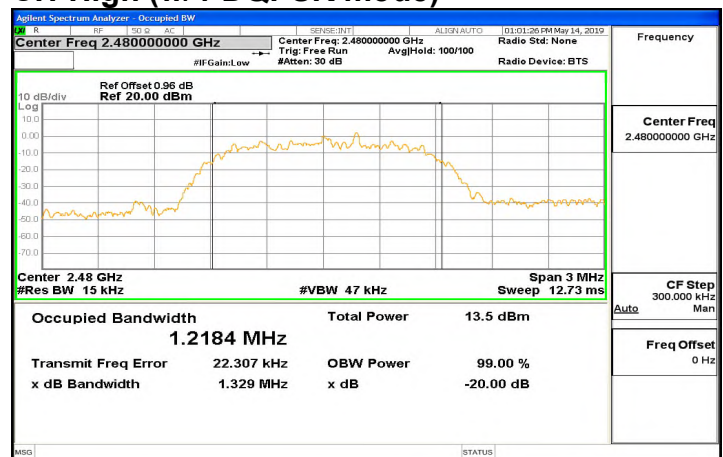
## CH-Mid ( $\pi/4$ -DQPSK mode)



## CH-High (GFSK mode)



## CH-High ( $\pi/4$ -DQPSK mode)

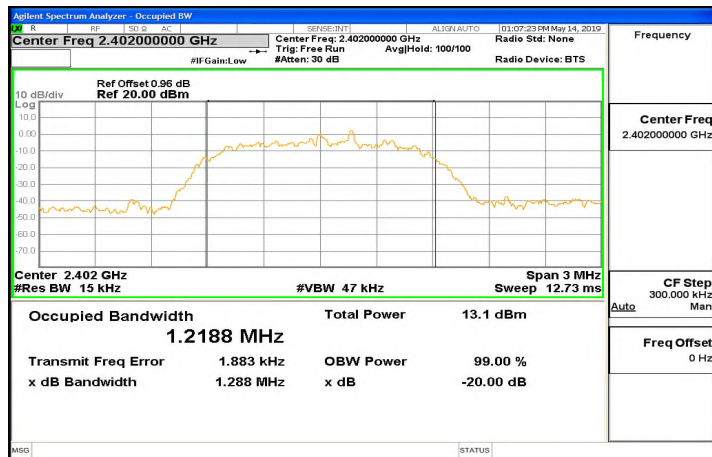


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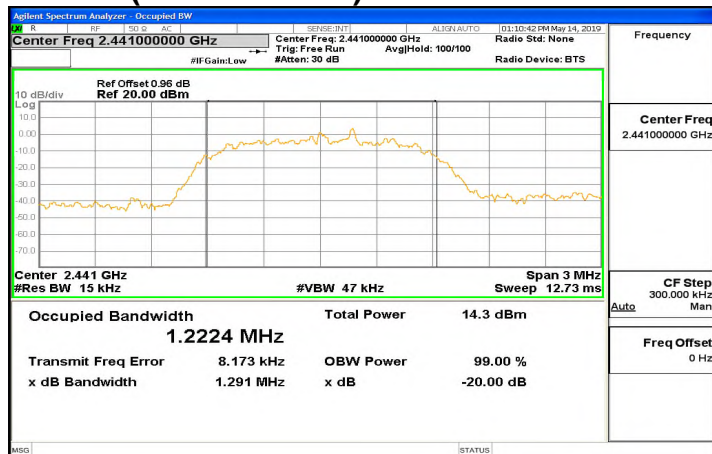
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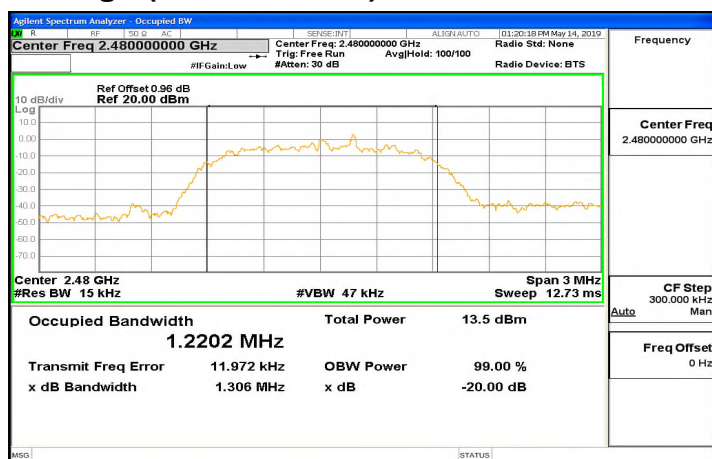
## CH-Low (8-DPSK mode)



## CH-Mid (8-DPSK mode)



## CH-High (8-DPSK mode)



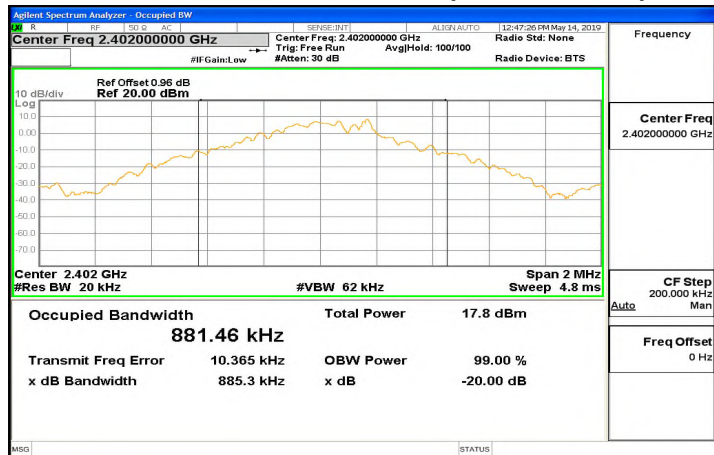
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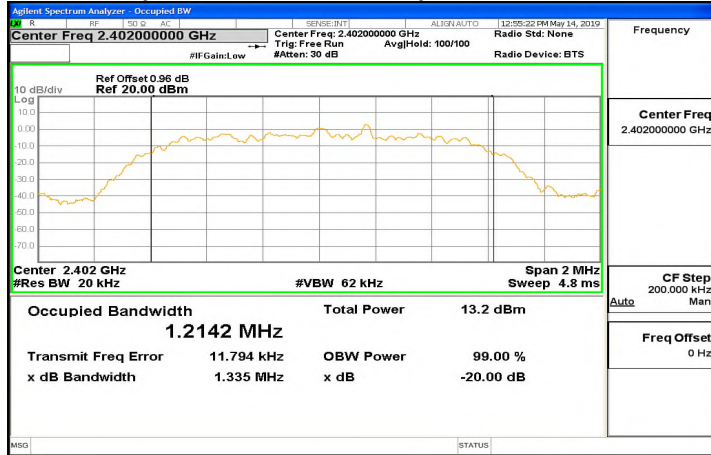
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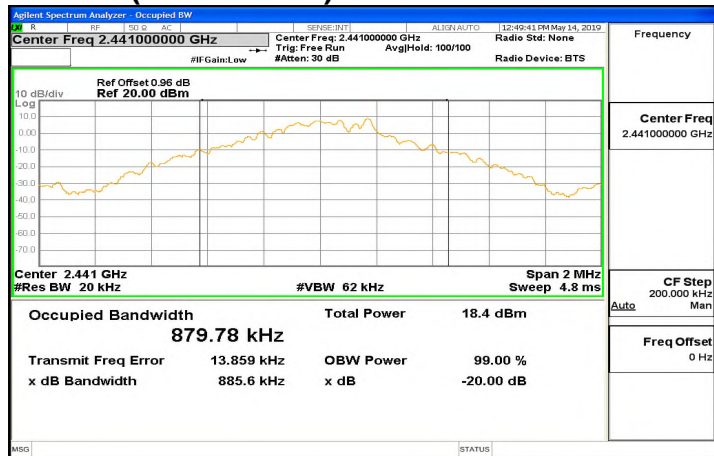
## 99% Bandwidth BW CH-Low (GFSK mode)



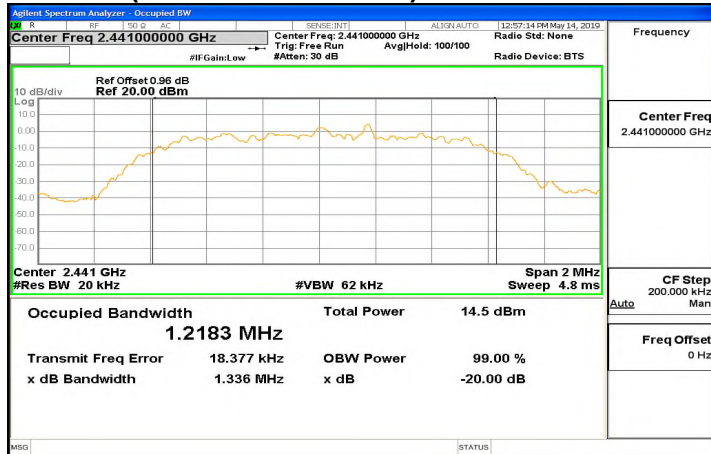
## CH-Low ( $\pi/4$ -DQPSK mode)



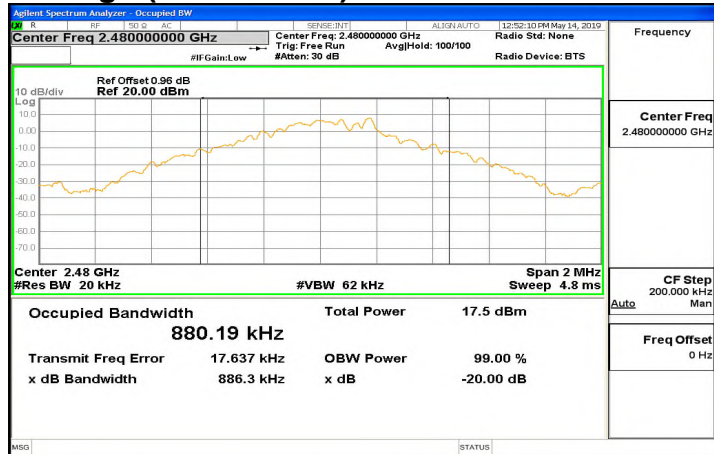
## CH-Mid (GFSK mode)



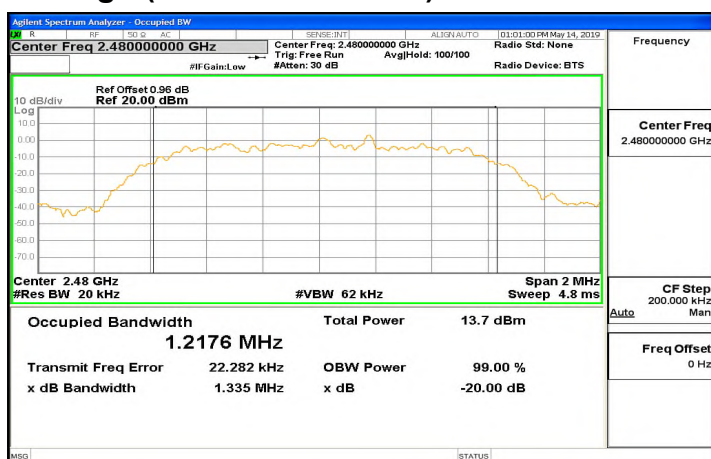
## CH-Mid ( $\pi/4$ -DQPSK mode)



## CH-High (GFSK mode)



## CH-High ( $\pi/4$ -DQPSK mode)

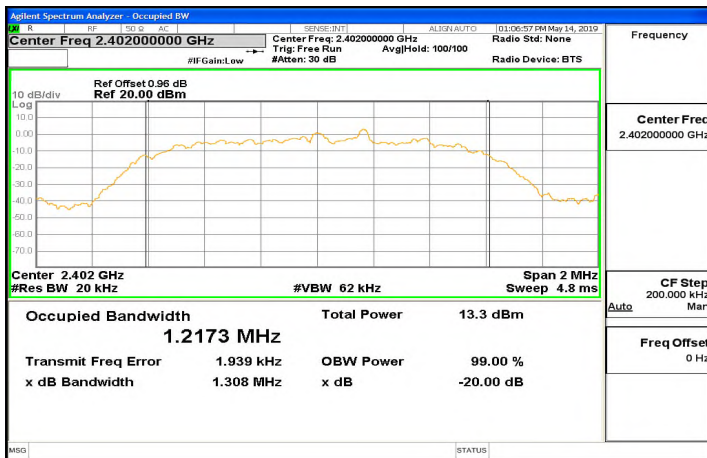


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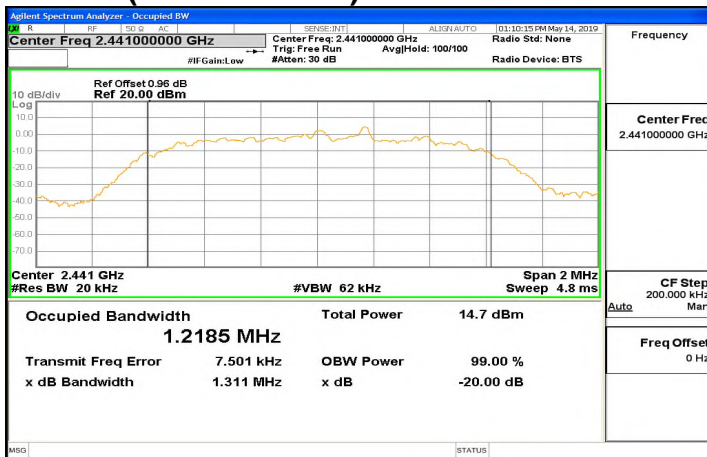
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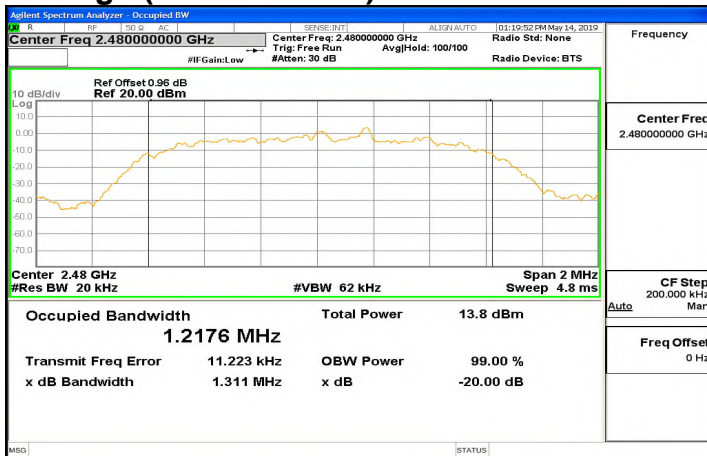
## CH-Low (8-DPSK mode)



## CH-Mid (8-DPSK mode)



## CH-High (8-DPSK mode)



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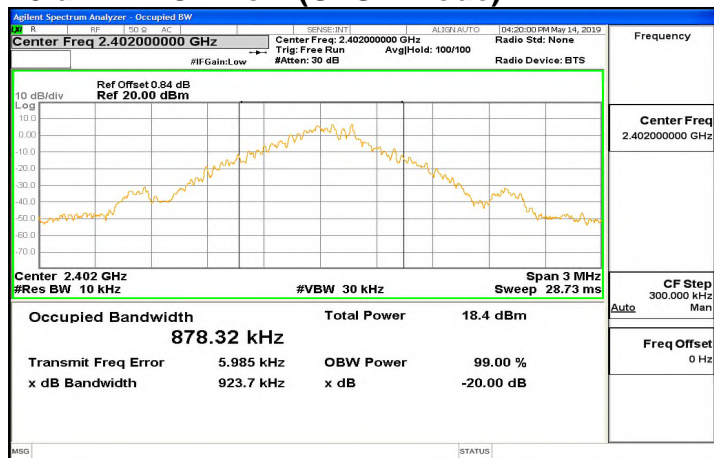
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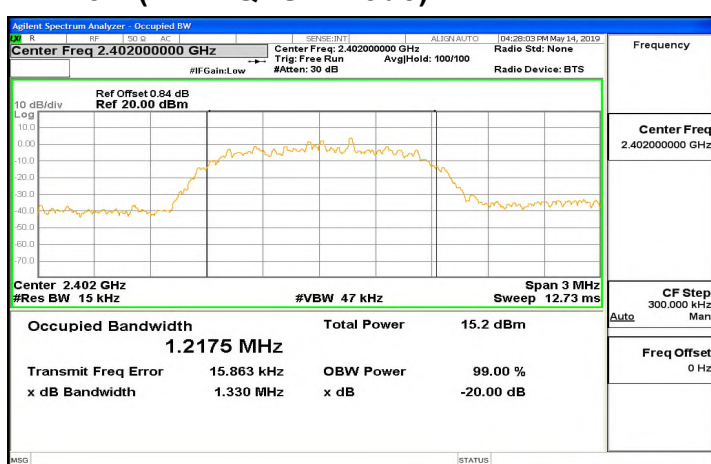


### 3ANT

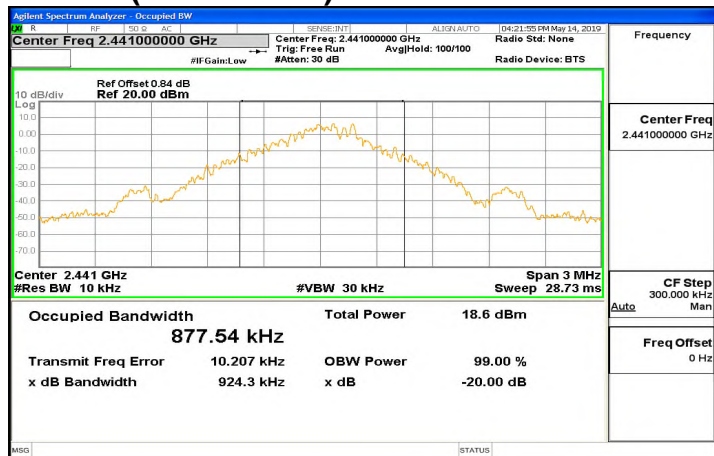
#### 20 dB BW CH-Low (GFSK mode)



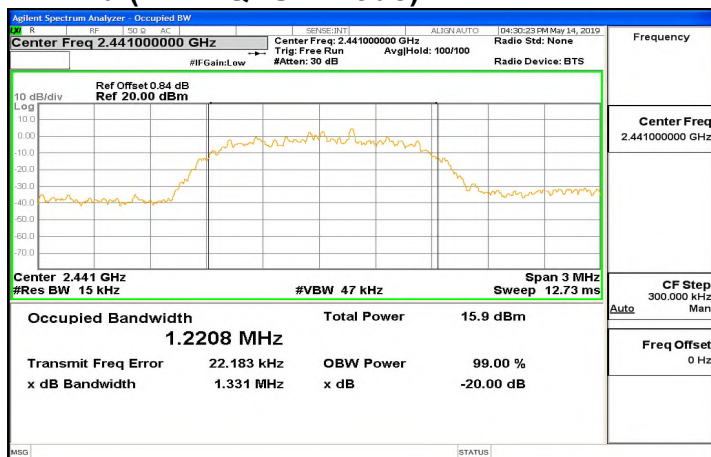
#### CH-Low ( $\pi/4$ -DQPSK mode)



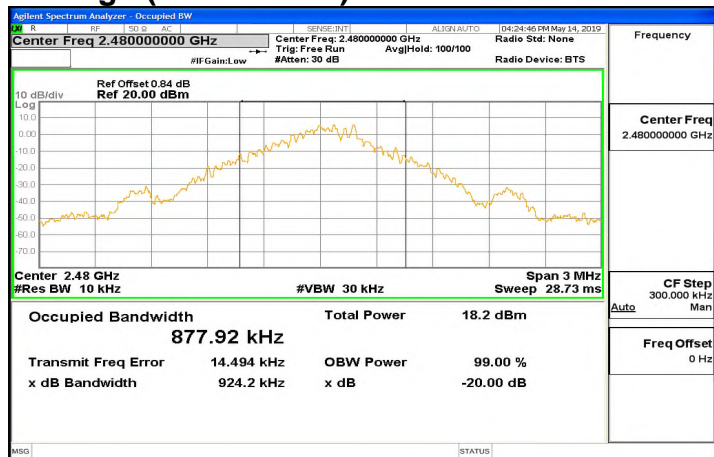
#### CH-Mid (GFSK mode)



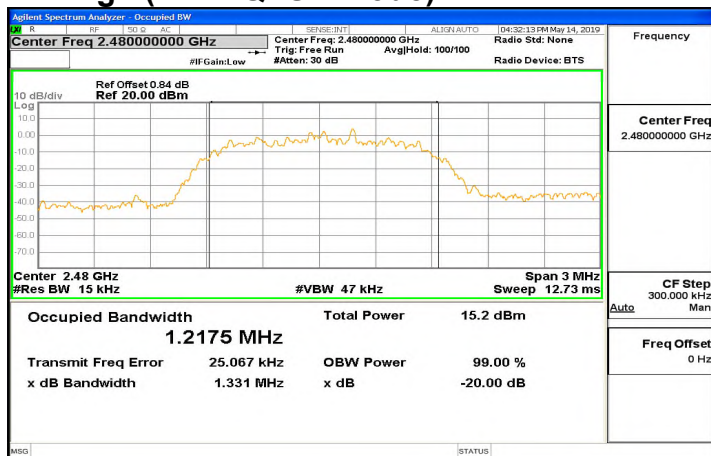
#### CH-Mid ( $\pi/4$ -DQPSK mode)



#### CH-High (GFSK mode)



#### CH-High ( $\pi/4$ -DQPSK mode)

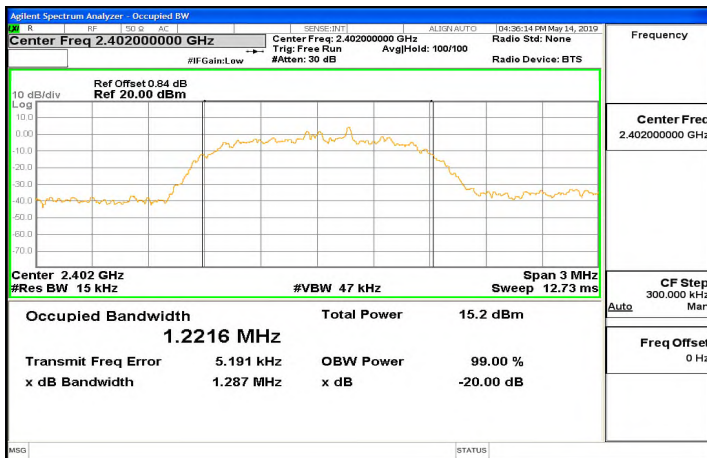


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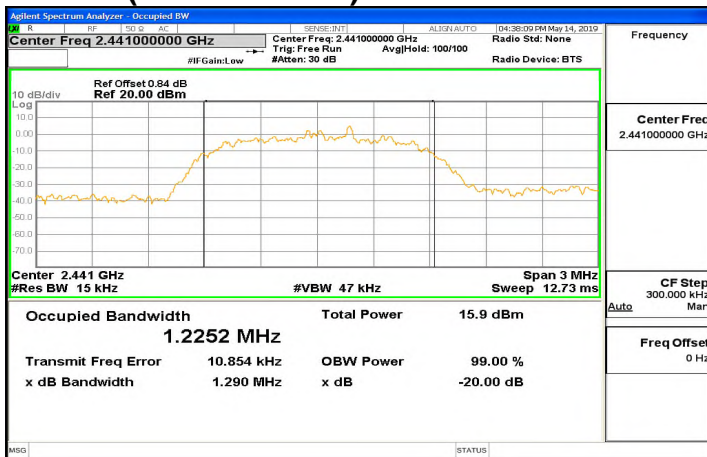
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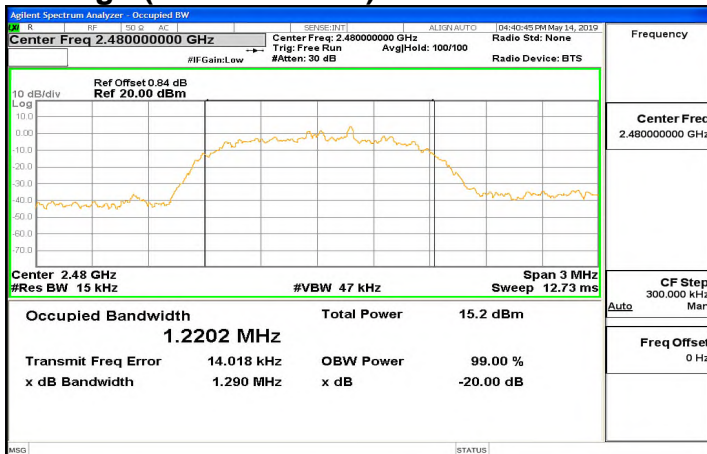
## CH-Low (8-DPSK mode)



## CH-Mid (8-DPSK mode)



## CH-High (8-DPSK mode)



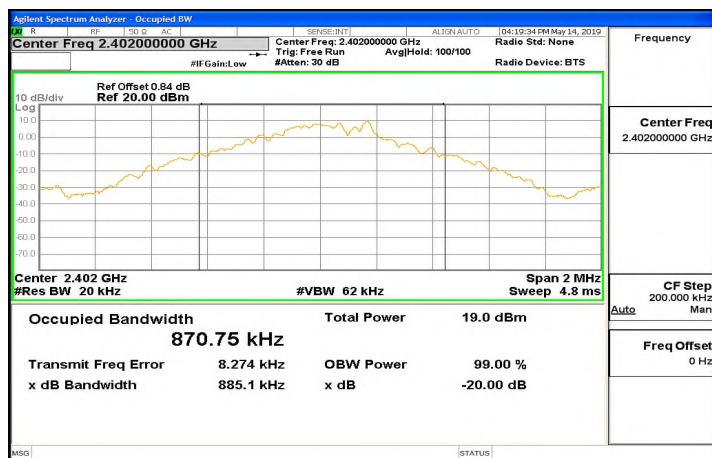
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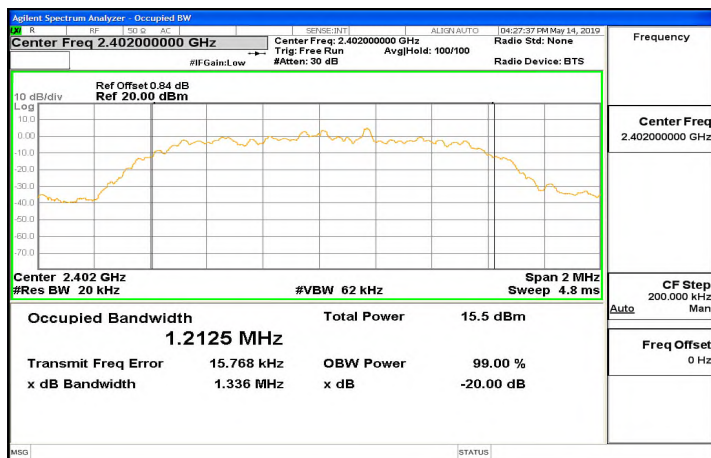
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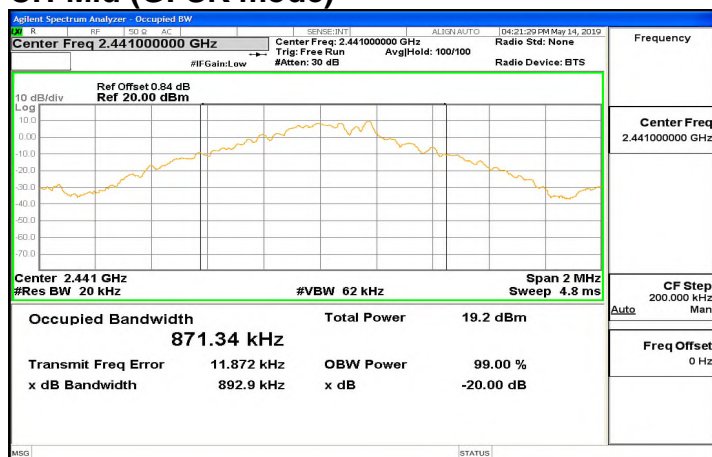
## 99% Bandwidth BW CH-Low (GFSK mode)



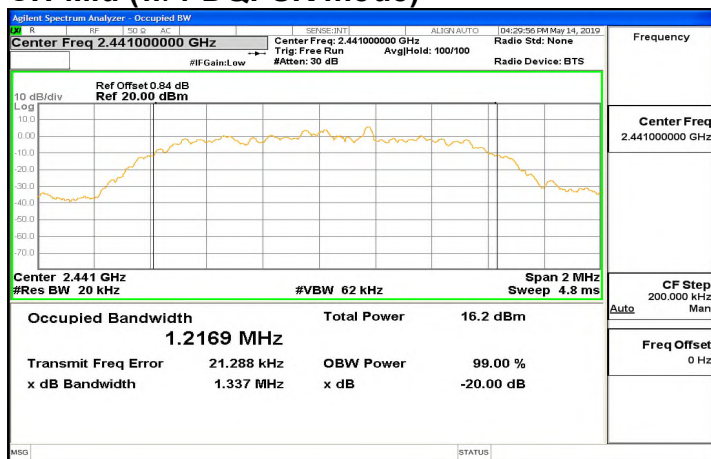
## CH-Low ( $\pi/4$ -DQPSK mode)



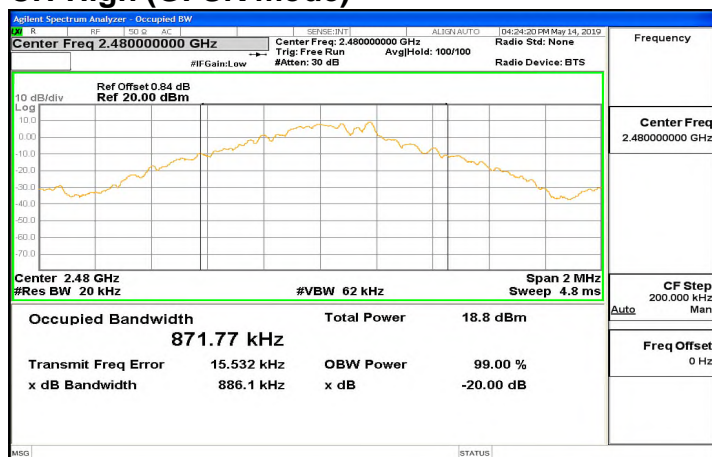
## CH-Mid (GFSK mode)



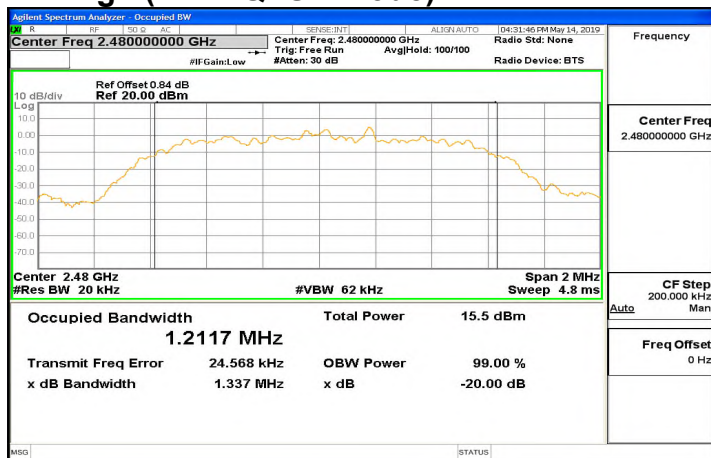
## CH-Mid ( $\pi/4$ -DQPSK mode)



## CH-High (GFSK mode)



## CH-High ( $\pi/4$ -DQPSK mode)

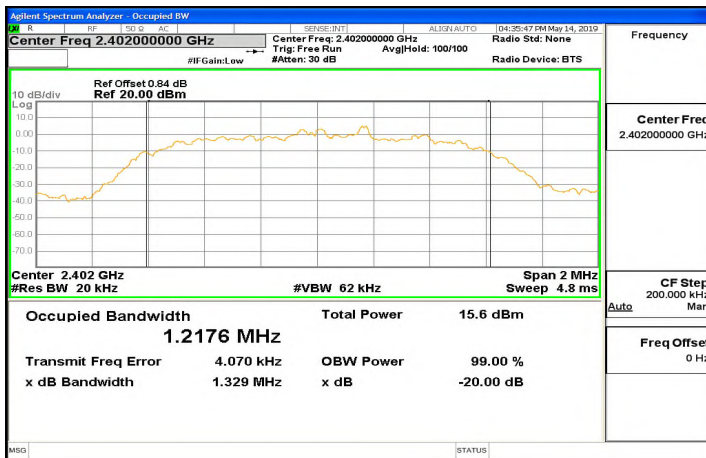


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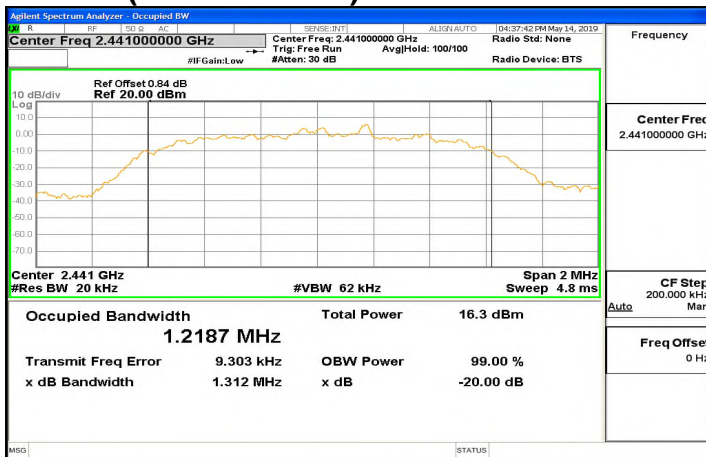
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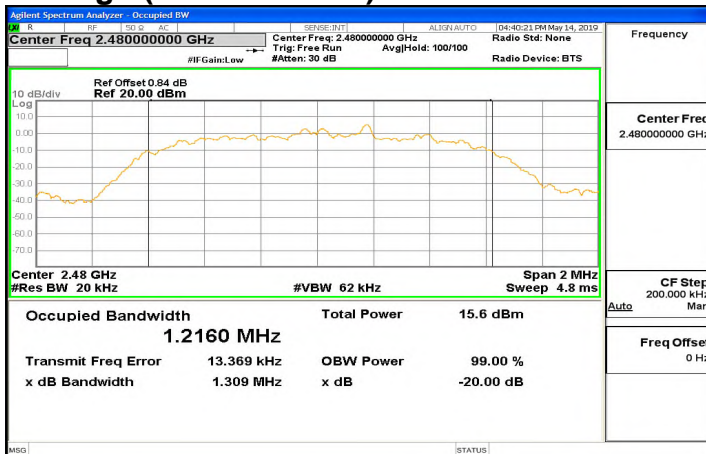
## CH-Low (8-DPSK mode)



## CH-Mid (8-DPSK mode)



## CH-High (8-DPSK mode)



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## 9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

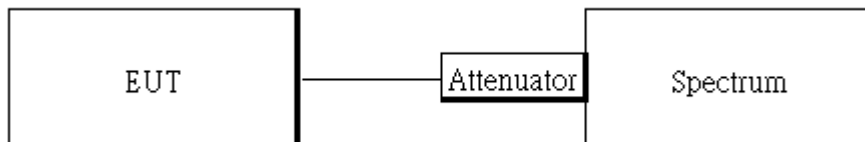
### 9.1 Standard Applicable

In any 100 kHz 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 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9 limit.

### 9.2 Measurement Equipment Used

| EQUIPMENT TYPE    | MFR           | MODEL NUMBER | SERIAL NUMBER | LAST CAL.  | CAL DUE.   |
|-------------------|---------------|--------------|---------------|------------|------------|
| DC Power Supply   | Agilent       | E3640A       | KR93300208    | 08/15/2018 | 08/14/2019 |
| Spectrum Analyzer | Agilent       | N9010A       | MY53400256    | 11/21/2018 | 11/20/2019 |
| DC Power Supply   | GWINSTEK      | SPS-3610     | GPE880163     | 01/14/2019 | 01/13/2020 |
| DC Block          | Mini-Circuits | BLK-18-S+    | 31129(1)      | 02/26/2019 | 02/25/2020 |
| Attenuator        | Mini-Circuit  | BW-S10W2+    | 1             | 02/26/2019 | 02/25/2020 |

### 9.3 Test SET-UP



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## 9.4 Measurement Procedure

### Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013. Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Sweep = auto
6. Mark Peak, 2.3999GHz and 2.4836GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

### Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2013. Measurement Guidelines.
3. Set RBW = 100 kHz & VBW = 300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

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    |  |

## 9.5 Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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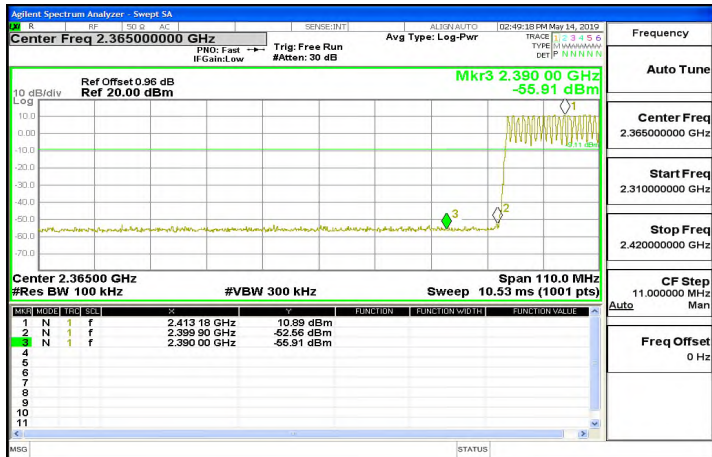
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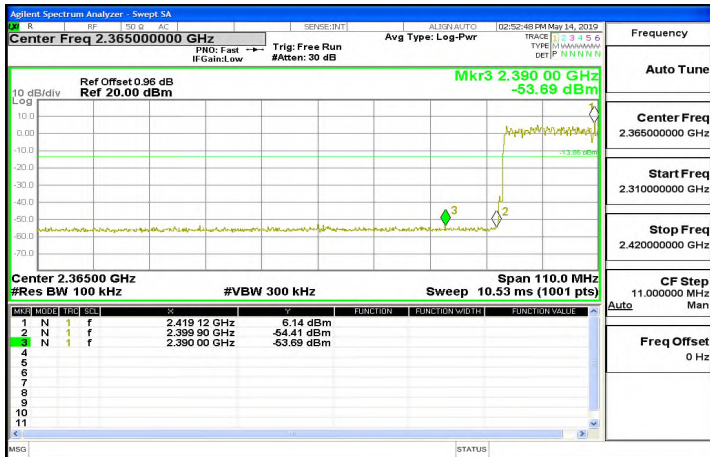
## 2ANT

### Hopping mode

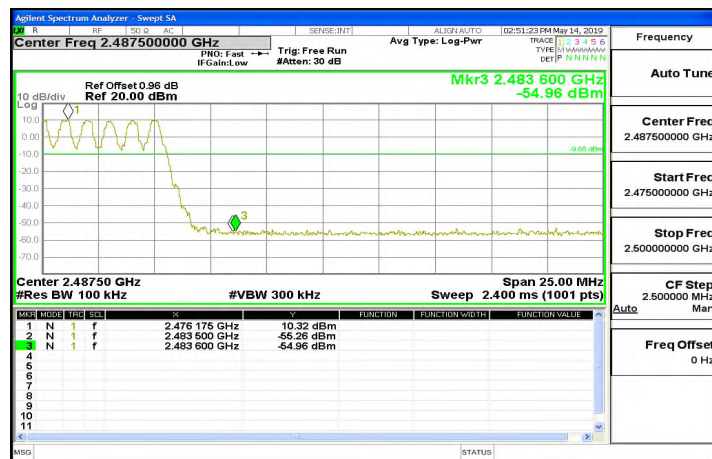
#### BR Band Edge CH-Low



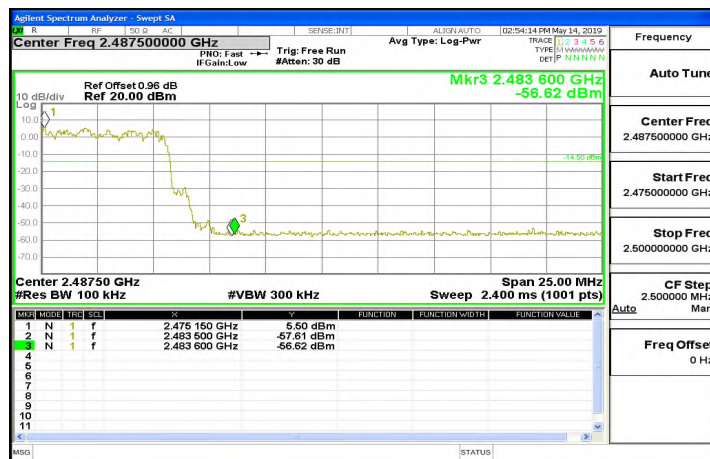
#### EDR Band Edge CH-Low



#### BR Band Edge CH-High



#### EDR Band Edge CH-High

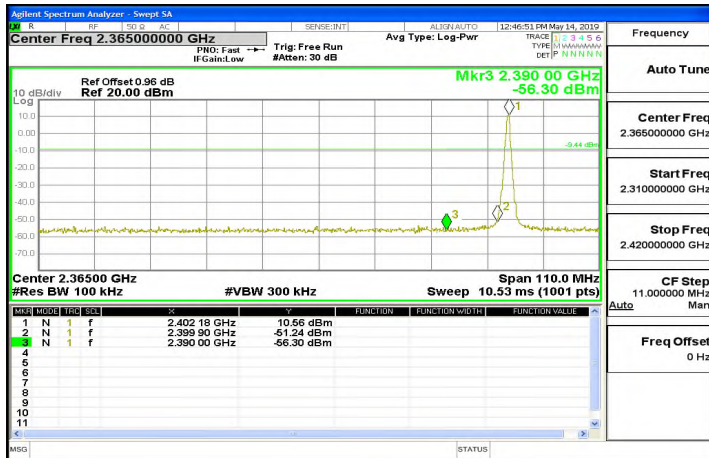


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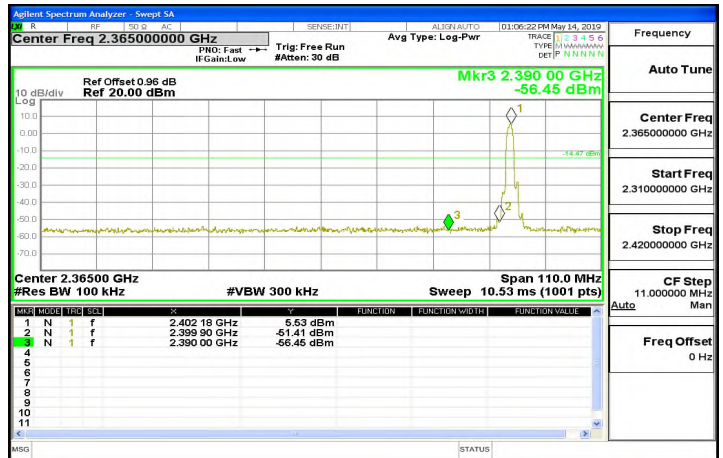
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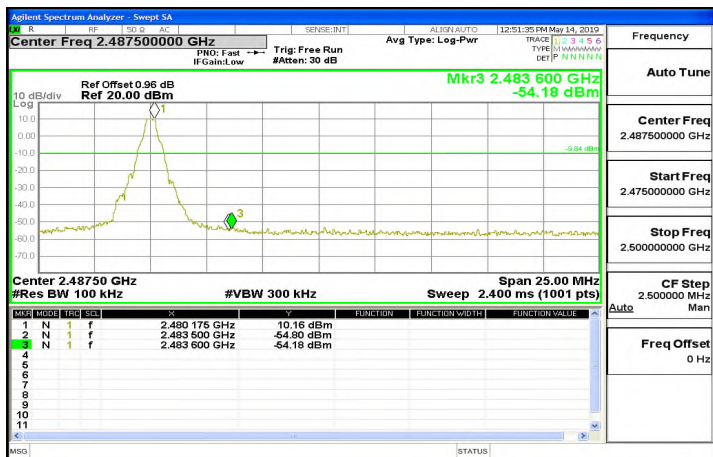
## Non-Hopping BR Band Edge CH-Low



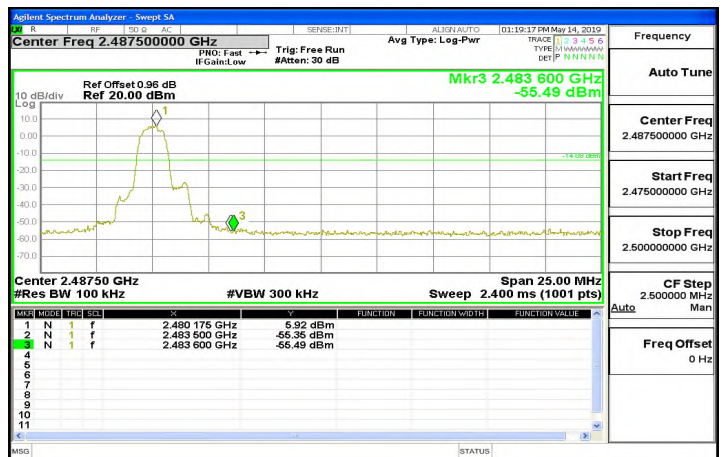
## EDR Band Edge CH-Low



## BR Band Edge CH-High



## EDR Band Edge CH-High



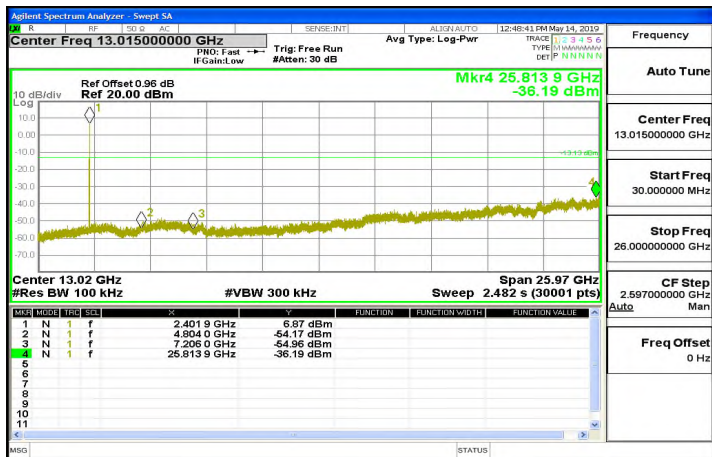
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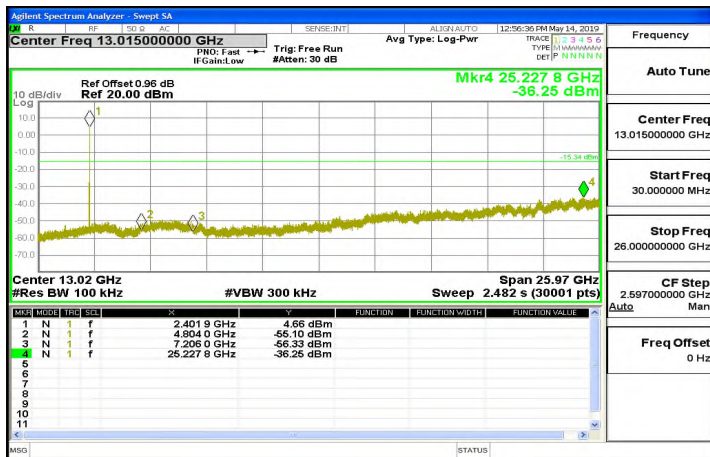
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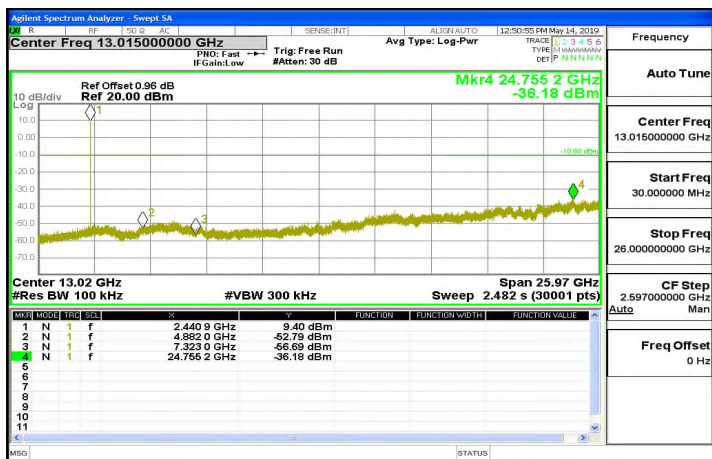
## Spurious Emission\_GFSK\_1M\_DH5\_2402MHz



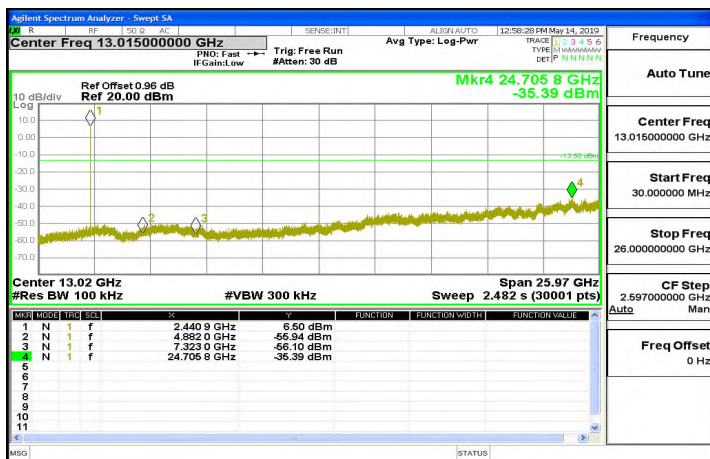
## Spurious Emission\_π4DQPSK\_2M\_DH5\_2402MHz



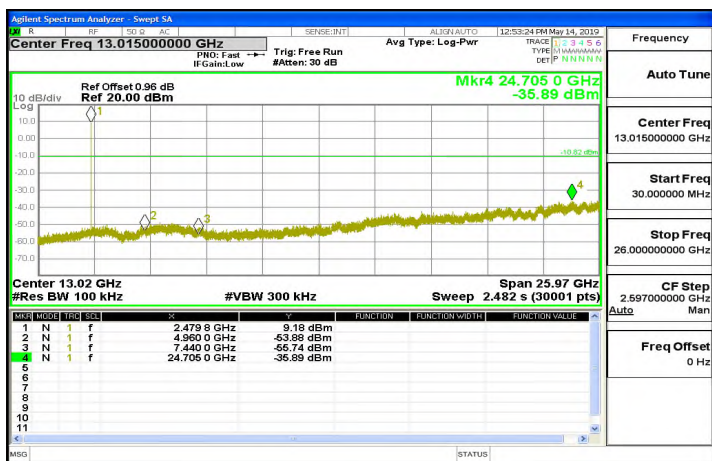
## Spurious Emission\_GFSK\_1M\_DH5\_2441MHz



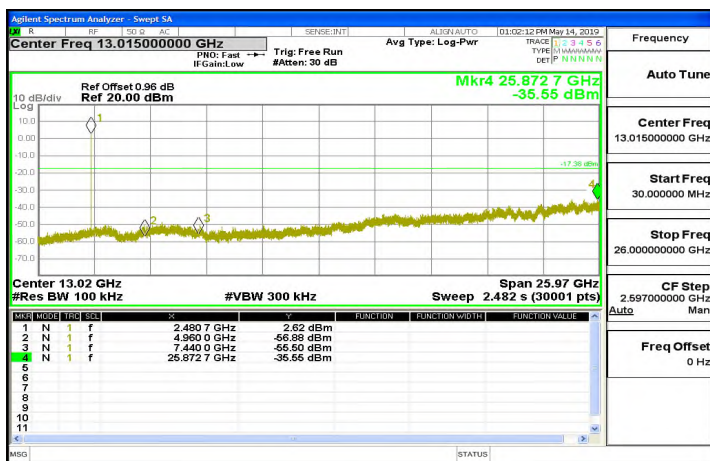
## Spurious Emission\_π4DQPSK\_2M\_DH5\_2441MHz



## Spurious Emission\_GFSK\_1M\_DH5\_2480MHz



## Spurious Emission\_π4DQPSK\_2M\_DH5\_2480MHz

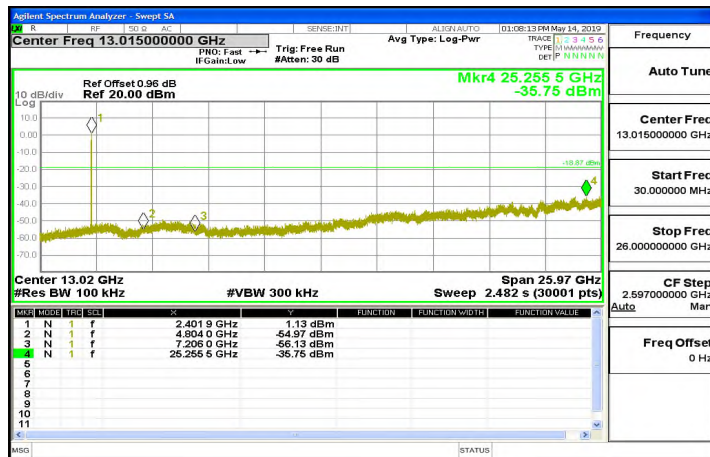


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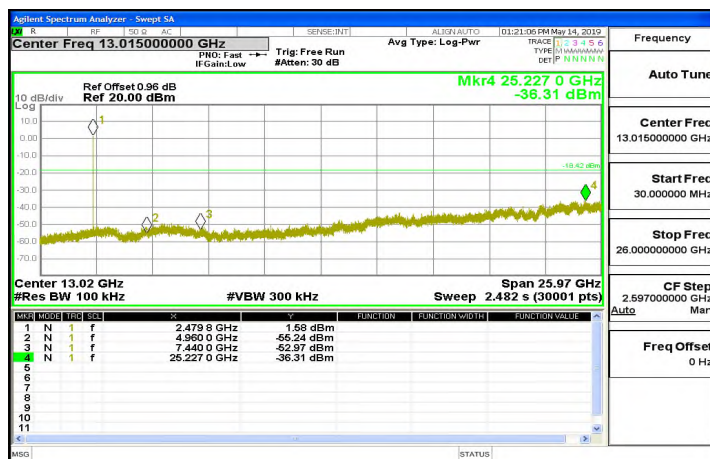
## Spurious Emission\_8DPSK\_3M\_DH5\_2402MHz



## Spurious Emission\_8DPSK\_3M\_DH5\_2441MHz



## Spurious Emission\_8DPSK\_3M\_DH5\_2480MHz



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