# CERTIFICATION TEST REPORT

**Report Number.** : 4790379717-FR1V1

| | | |
|---|---|---|
| **Applicant** | : | Cresyn Co., Ltd.<br>5 Gangnam-daero 107-gil, Seocho-gu, Seoul, Korea |
| **Model** | : | TN0620 |
| **FCC ID** | : | V2R-TN0620 |
| **IC** | : | 10488A-TN0620 |
| **EUT Description** | : | True Wireless Earphones |
| **Test Standard(s)** | : | FCC 47 CFR PART 15 SUBPART C<br>INDUSTRY CANADA RSS-247 Issue 2<br>INDUSTRY CANADA RSS-GEN Issue 5 |

**Date Of Issue:**
2022-06-15

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IAS ACCREDITED
TL-637

## Revision History

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| V1 | 06/15/22 | Initial issue | Myeongjun Kwon |

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** Cresyn Co., Ltd.

**EUT DESCRIPTION:** True Wireless Earphones

**MODEL:** TN0620

**SERIAL NUMBER:** Proto type

**DATE TESTED:** 2022-04-27 ~ 2022-06-14;

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

UL Korea, Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by IAS, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Korea, Ltd. By:

Anthony Kim
Senior Laboratory Engineer
UL Korea, Ltd.

Tested By:

Myeongjun Kwon
Laboratory Engineer
UL Korea, Ltd.

# 2. TEST METHODOLOGY

1. FCC CFR 47 Part 2.
2. FCC CFR 47 Part 15.
3. KDB 558074 D01 15.247 Meas Guidance v05r02.
4. ANSI C63.10-2013.
5. IC RSS-GEN Issue 5.
6. IC RSS-247 Issue 2.

# 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 218 Maeyeong-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16675, Korea. Line conducted emissions are measured only at the 218 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

| 218 Maeyeong-ro |
|---|
| ☒ Chamber 1 |
| ☐ Chamber 2 |
| ☒ Chamber 3 |

Used ISED Test Site Reg.(company number): 2324L
CAB Identifier: KR0161

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637. The full scope of accreditation can be viewed at https://www.iasonline.org/wp-content/uploads/2017/05/TL-637-cert-New.pdf.

# 4. DECISION RULES AND MEASUREMENT UNCERTAINTY

## 4.1. METROLOGICAL TRACEABILITY

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. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

28.9 dBuV/m = 36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB

## 4.3. MEASUREMENT UNCERTAINTY

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

| PARAMETER | UNCERTAINTY |
|---|---|
| Conducted Disturbance, 0.15 to 30 MHz | 2.87 dB |
| Radiated Disturbance, 30 MHz to 1 GHz | 4.05 dB |
| Radiated Disturbance, 1 GHz to 18 GHz | 5.78 dB |
| Radiated Disturbance, 18 GHz to 40 GHz | 5.58 dB |

Uncertainty figures are valid to a confidence level of 95%.

## 4.4. DECISION RULES

Decision rule for statement(s) of conformity is based on Procedure 1, Clause 4.4.2 in IEC Guide 115:2007.

# 5. EQUIPMENT UNDER TEST

## 5.1. EUT DESCRIPTION

The EUT are Bluetooth Earphones.
This test report addresses the BT (DSS) operational mode.

## 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

- **Left**

| Frequency range [MHz] | Mode | Power Mode | Output Power [dBm] | Output Power [mW] |
|---|---|---|---|---|
| 2402 ~ 2480 | Basic GFSK | Peak | **6.750** | **4.73** |
| | | Average | 6.553 | 4.52 |
| | Enhanced Pi/4-DQPSK | Peak | 4.570 | 2.86 |
| | | Average | 2.697 | 1.86 |
| | Enhanced 8DPSK | Peak | 5.300 | 3.39 |
| | | Average | 3.092 | 2.04 |

- **Right**

| Frequency range [MHz] | Mode | Power Mode | Output Power [dBm] | Output Power [mW] |
|---|---|---|---|---|
| 2402 ~ 2480 | Basic GFSK | Peak | **7.230** | **5.28** |
| | | Average | 6.947 | 4.95 |
| | Enhanced Pi/4-DQPSK | Peak | 5.100 | 3.24 |
| | | Average | 2.957 | 1.98 |
| | Enhanced 8DPSK | Peak | 5.830 | 3.83 |
| | | Average | 3.339 | 2.16 |

## 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

**The internal antenna was Permanently attached.**
**Therefore this E.U.T Complies with the requirement of §15.203.**

Left earphone,
The radio utilizes an internal antennas, with maximum gain of -1.00 dBi.

Right earphone,
The radio utilizes an internal antennas, with maximum gain of -0.57 dBi.

## 5.4. WORST-CASE CONFIGURATION AND MODE

Radiated emission below 1GHz and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Radiated emission above 1GHz was performed with the EUT set to transmit low/mid/high channels.

The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z.
It was determined that X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

GFSK, Pi/4-DQPSK, 8DPSK average Power are all investigated, The GFSK & 8DPSK Power are the worst case. Testing is based on this mode to showing compliance.

## 5.5. DESCRIPTION OF TEST SETUP

**SUPPORT EQUIPMENT**

| Support Equipment List | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **FCC ID** |
| Notebook | LG | 15UD490 | MEZ66836767 | N/A |
| Adaptor (for Notebook) | Chicony Power Technology (SuZhou) Co.,Ltd. | A12-065N2A | AG19034C140 | N/A |
| Test Jig Board | CRESYN | N/A | N/A | N/A |

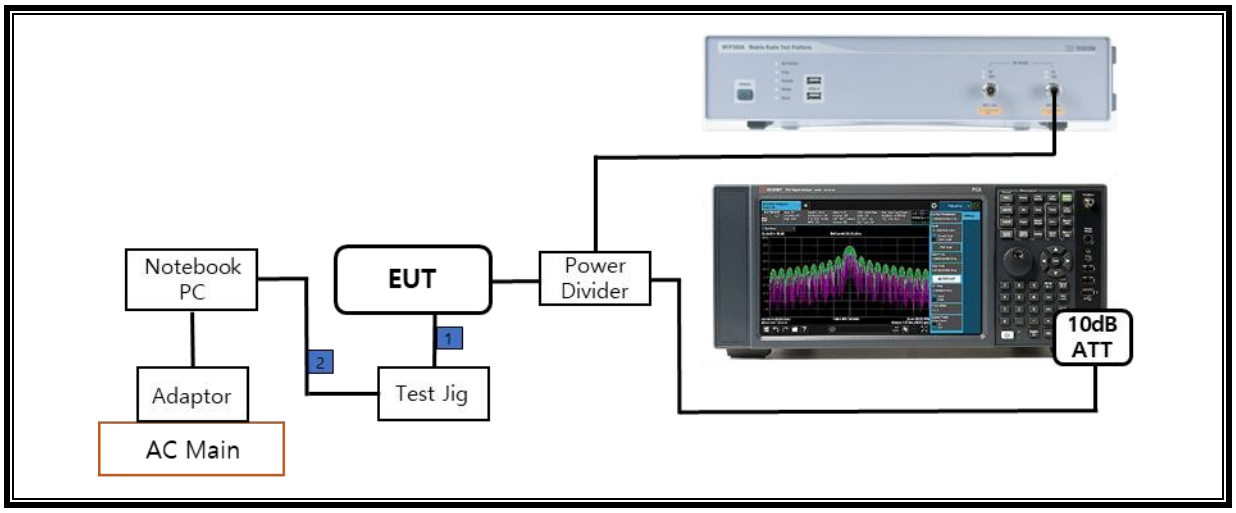
**I/O CABLE**

| I/O Cable List | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of identical ports** | **Connector Type** | **Cable Type** | **Cable Length (m)** | **Remarks** |
| 1 | DC Power & Data | 2 | 4 Pin to USB C | Unshielded | 0.25 m | N/A |
| 2 | DC Power & Data | 1 | USB A to C | Shielded | 1.8 m | N/A |

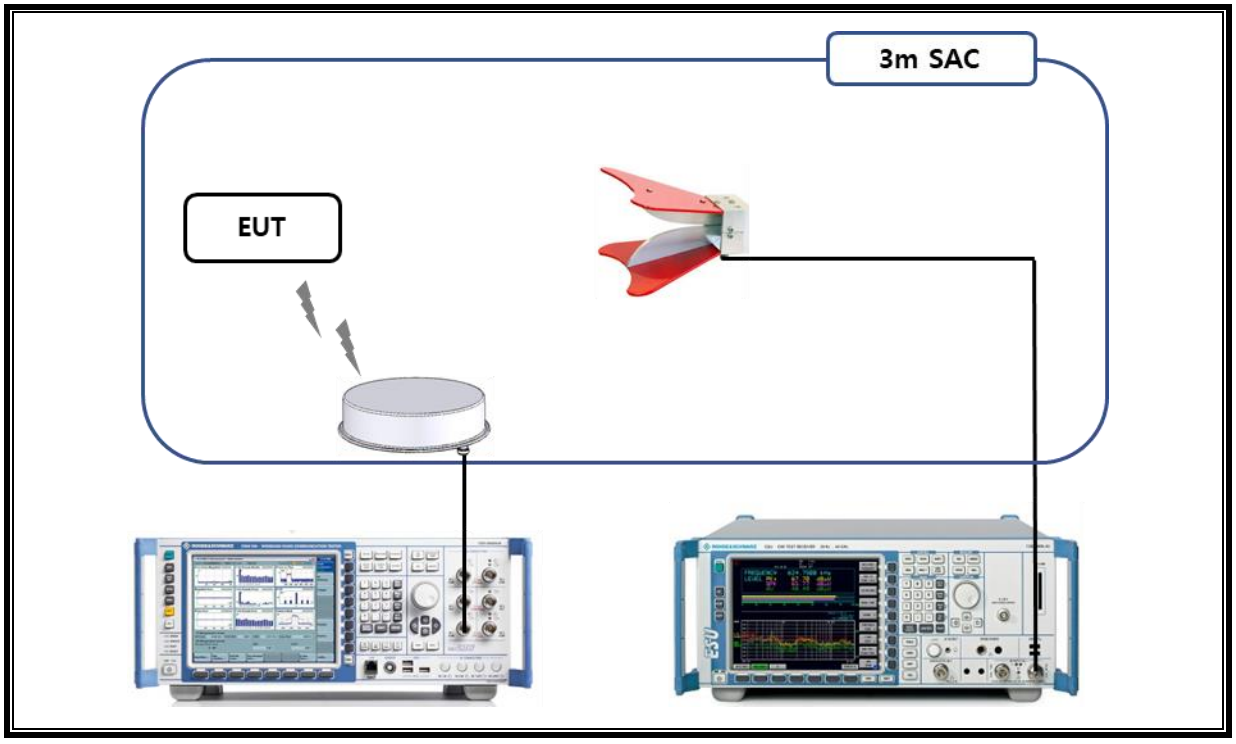
**TEST SETUP**

The EUT is a unit with test jig board during the tests.
It was controlled by entering the test mode using a Notebook.

**SETUP DIAGRAM FOR TESTS (CONDUCTED TEST SETUP)**




**SETUP DIAGRAM FOR TESTS (RADIATED TEST SETUP)**



# 6. MEASUREMENT METHOD

20dB BW : ANSI C63.10, Section 6.9.2

99% BW : ANSI C63.10, Section 6.9.3

HOPPING FREQUENCY SEPARATION : ANSI C63.10, Section 7.8.2

NUMBER OF HOPPING CHANNELS : ANSI C63.10, Section 7.8.3

AVERAGE TIME OF OCCUPANCY : ANSI C63.10, Section 7.8.4

OUTPUT POWER : ANSI C63.10, Section 7.8.5.

Out-of-band EMISSIONS (Conducted) : ANSI C63.10, Section 7.8.6, 7.8.8

Out-of-band EMISSIONS IN NON-RESTRICTED BANDS: ANSI C63.10, Section 6.

Out-of-band EMISSIONS IN RESTRICTED BANDS : ANSI C63.10, Section 6.

AC Power Line Conducted Emission : ANSI C63.10-2013, Section 6.2.

# 7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| Test Equipment List | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **S/N** | **Cal Due** |
| Antenna, Bilog, 30MHz-1GHz | SCHWARZBECK | VULB9163 | 750 | 2022-08-19 |
| Antenna, Bilog, 30MHz-1GHz | SCHWARZBECK | VULB9163 | 749 | 2022-08-13 |
| Antenna, Bilog, 30MHz-1GHz | SCHWARZBECK | VULB9163 | 845 | 2022-08-13 |
| Antenna, Loop, 9kHz-30MHz | R&S | HFH2-Z2 | 100418 | 2023-10-06 |
| Antenna, Horn, 18 GHz | ETS | 3115 | 00167211 | 2022-07-27 |
| Antenna, Horn, 18 GHz | ETS | 3115 | 00161451 | 2022-08-15 |
| Antenna, Horn, 18 GHz | ETS | 3117 | 00168724 | 2022-07-27 |
| Antenna, Horn, 18 GHz | ETS | 3117 | 00168717 | 2022-08-15 |
| Antenna, Horn, 40 GHz | ETS | 3116C | 00166155 | 2022-08-04 |
| Preamplifier | ETS | 3116C-PA | 00168841 | 2022-08-04 |
| Directional Antenna | Cobham | FPA3-0.8-6.0R/1329 | 110367-0008 | N/A |
| Preamplifier, 1000 MHz | Sonoma | 310N | 341282 | 2022-08-02 |
| Preamplifier, 1000 MHz | Sonoma | 310N | 351741 | 2022-08-02 |
| Preamplifier, 1000 MHz | Sonoma | 310N | 370599 | 2022-08-02 |
| Preamplifier, 18 GHz | Miteq | AFS42-00101800-25-S-42 | 1876511 | 2022-08-02 |
| Preamplifier, 18 GHz | Miteq | AFS42-00101800-25-S-42 | 1896138 | 2022-08-02 |
| Preamplifier, 18 GHz | Miteq | AFS42-00101800-25-S-42 | 2029168 | 2022-08-02 |
| Power Sensor | R&S | NRP-Z91 | 102681 | 2022-08-04 |
| Spectrum Analyzer, 44 GHz | KEYSIGHT | N9030B | MY57143652 | 2023-01-11 |
| Bluetooth Tester | TESCOM | MTP300A | MTP300A010266 | 2022-08-04 |
| Power Divider | WEINSCHEL | 1580 | SQ373 | 2022-08-04 |
| 10dB ATTENUATOR | MINI-CIRCUITS | BW-K10-2W44+ | 2117 | 2022-10-22 |
| EMI Test Receive, 40 GHz | R&S | ESU40 | 100439 | 2022-08-02 |
| EMI Test Receive, 40 GHz | R&S | ESU40 | 100457 | 2022-08-02 |
| Low Pass Filter 5GHz | Micro-Tronics | LPS17541 | 009 | 2022-08-02 |
| Low Pass Filter 5GHz | Micro-Tronics | LPS17541 | 015 | 2022-08-02 |
| Low Pass Filter 5GHz | Micro-Tronics | LPS17541 | 019 | 2022-08-02 |
| High Pass Filter 3GHz | Micro-Tronics | HPM17543 | 010 | 2022-08-02 |
| High Pass Filter 3GHz | Micro-Tronics | HPM17543 | 015 | 2022-08-02 |
| High Pass Filter 3GHz | Micro-Tronics | HPM17543 | 020 | 2022-08-02 |
| High Pass Filter 6GHz | Micro-Tronics | HPS17542 | 009 | 2022-08-02 |
| High Pass Filter 6GHz | Micro-Tronics | HPS17542 | 016 | 2022-08-02 |
| High Pass Filter 6GHz | Micro-Tronics | HPS17542 | 020 | 2022-08-02 |
| **UL Software** | | | | |
| **Description** | **Manufacturer** | **Model** | **Version** | |
| Radiated software | UL | UL EMC | Ver 9.5 | |

# 8. TEST RESULTS SUMMARY

| FCC Part Section | IC Section | Test Description | Test Limit | Test Condition | Test Result |
|---|---|---|---|---|---|
| 2.1051, 15.247 (d) | RSS-247(5.5) | Band Edge / Conducted Spurious Emission | -20dBc | Conducted | PASS |
| 15.247 (b)(1) | RSS-247, (5.4)(b) | TX conducted output power | <21dBm | | PASS |
| 15.247 (a)(1) | RSS-247, (5.1)(b) | Hopping frequency separation | > two-thirds of the 20 dB bandwidth | | PASS |
| 15.247 (a)(1)(iii) | RSS-247, (5.1)(d) | Number of Hopping channels | More than 15 non-overlapping channels | | PASS |
| 15.247 (a)(1)(iii) | RSS-247, (5.1)(d) | Avg Time of Occupancy | < 0.4sec | | PASS |
| 15.205, 15.209 | RSS-GEN (8.9), (8.10) | Radiated Spurious Emission | < 54dBuV/m | Radiated | PASS |
| 15.207 (a) | RSS-GEN (8.8) | AC Power Line Conducted Emission | Section 11 | Power Line Conducted | N/P |

Note. The AC power line test was not performed because the EUT does not operate Bluetooth mode while charging.

# 9. ANTENNA PORT TEST RESULTS

## 9.1. ON TIME AND DUTY CYCLE

**LIMITS**

None; for reporting purposes only.

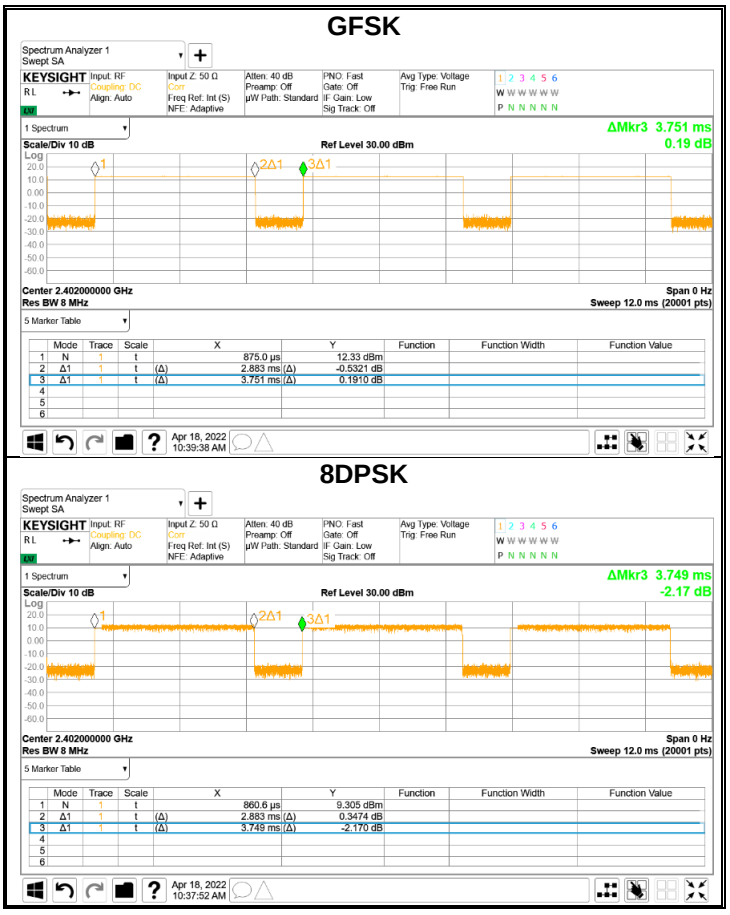
**PROCEDURE**

ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

**ON TIME AND DUTY CYCLE RESULTS**

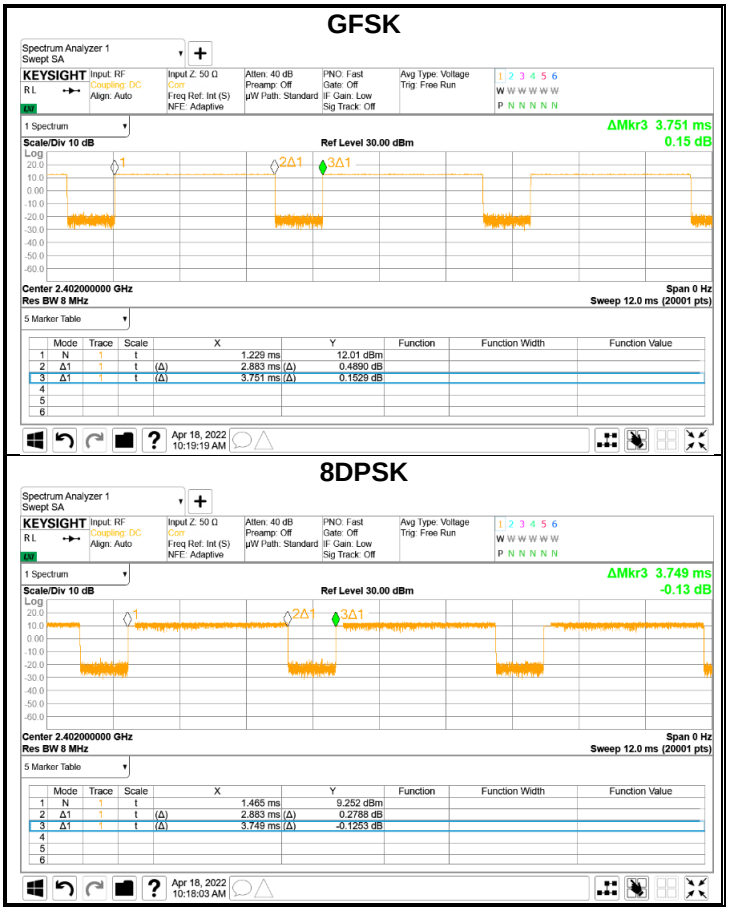
- **Left**

| Mode | On time [msec] | Period [msec] | Duty Cycle [%] | Duty Cycle Correction Factor [dB] | 1/T Minimum VBW [kHz] |
|---|---|---|---|---|---|
| 2 400 ~ 2 483.5 MHz Bands | | | | | |
| GFSK | 2.883 | 3.751 | 76.86 | 1.14 | 0.347 |
| 8DPSK | 2.883 | 3.749 | 76.90 | 1.14 | 0.347 |



- **Right**

| Mode | On time [msec] | Period [msec] | Duty Cycle [%] | Duty Cycle Correction Factor [dB] | 1/T Minimum CBW [kHz] |
|---|---|---|---|---|---|
| 2 400 ~ 2 483.5 MHz Bands | | | | | |
| GFSK | 2.883 | 3.751 | 76.86 | 1.14 | 0.347 |
| 8DPSK | 2.883 | 3.749 | 76.90 | 1.14 | 0.347 |



## 9.2. 20 dB AND 99% BANDWIDTH

**LIMITS**

None; for reporting purposes only.

**PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

**RESULTS**

- **Left**

### 9.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| Channel | Frequency [MHz] | 20 dB Bandwidth [MHz] | 99% Bandwidth [MHz] |
|---|---|---|---|
| Low | 2402 | 0.954 | 0.885 |
| Mid | 2441 | 0.954 | 0.878 |
| High | 2480 | 0.955 | 0.885 |
| **Worst** | | **0.955** | **0.885** |

### 9.2.2. BLUETOOTH ENHANCED DATA RATE 8DPSK MODULATION

| Channel | Frequency [MHz] | 20 dB Bandwidth [MHz] | 99% Bandwidth [MHz] |
|---|---|---|---|
| Low | 2402 | 1.303 | 1.195 |
| Mid | 2441 | 1.302 | 1.192 |
| High | 2480 | 1.301 | 1.192 |
| **Worst** | | **1.303** | **1.195** |

- **Right**

## 9.2.3. BLUETOOTH BASIC DATA RATE GFSK MODULATION

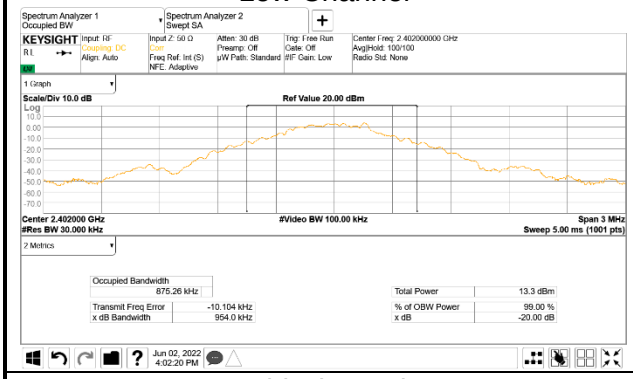
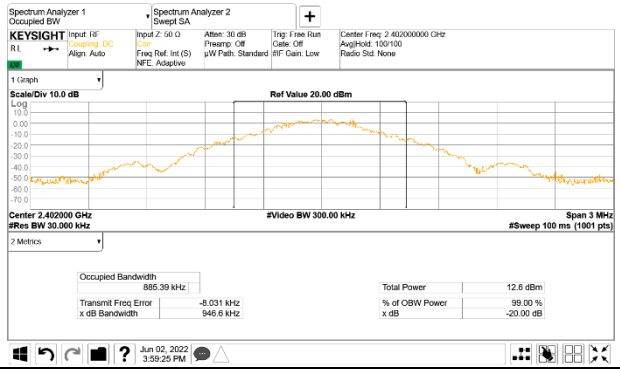
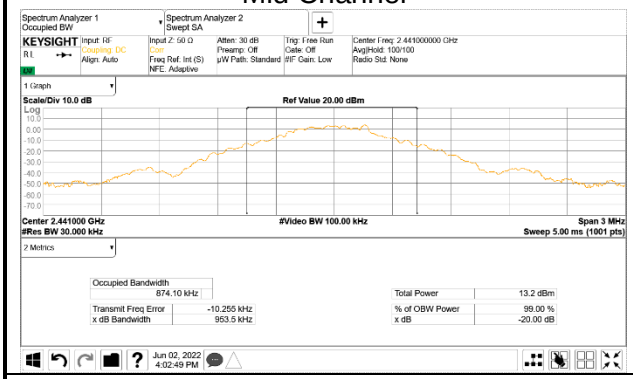
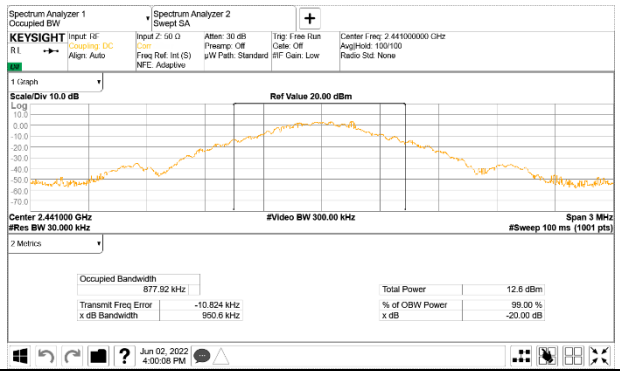
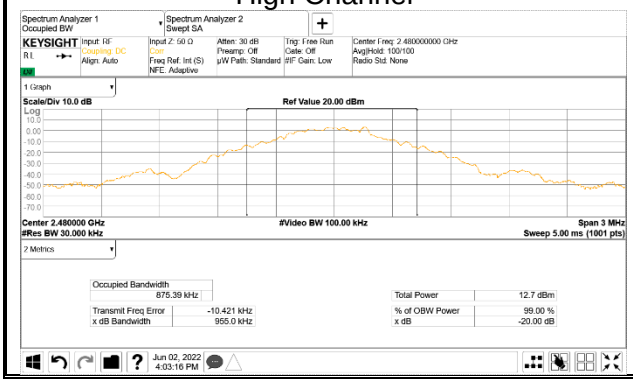
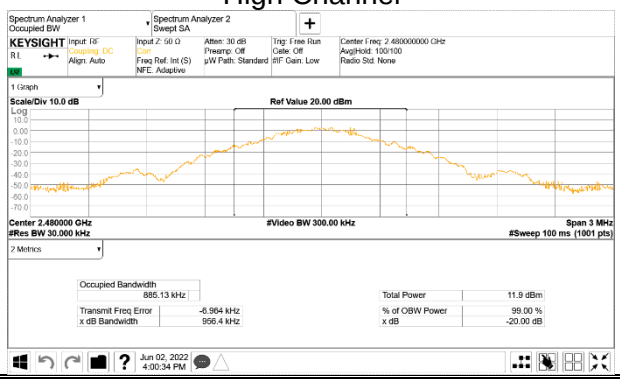
| Channel | Frequency [MHz] | 20 dB Bandwidth [MHz] | 99% Bandwidth [MHz] |
|---|---|---|---|
| Low | 2402 | 0.954 | 0.886 |
| Mid | 2441 | 0.952 | 0.890 |
| High | 2480 | 0.953 | 0.886 |
| **Worst** | | **0.954** | **0.890** |

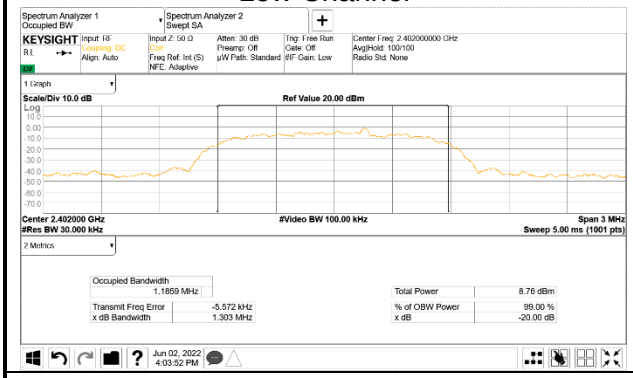
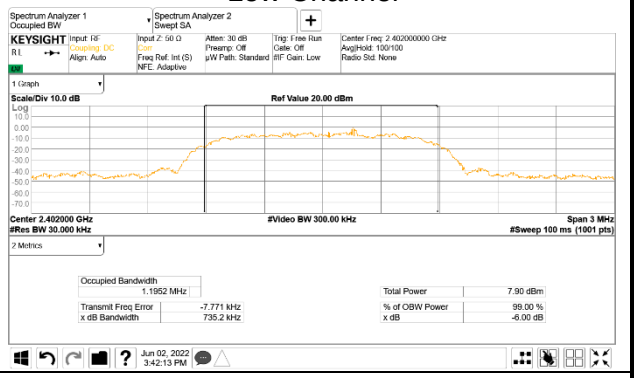
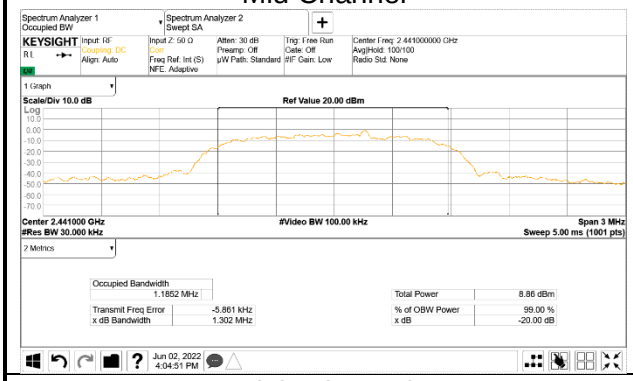
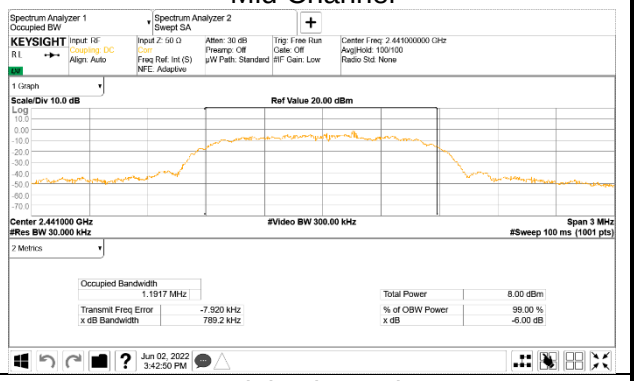
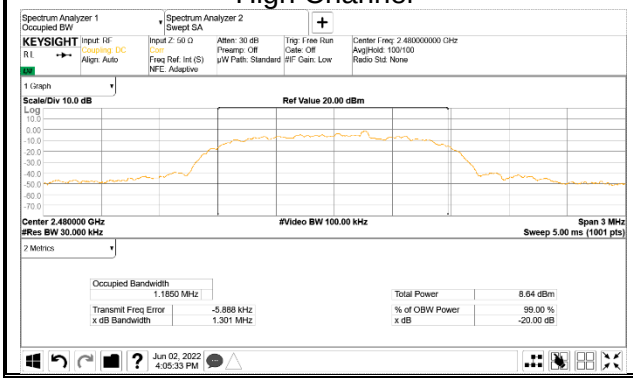
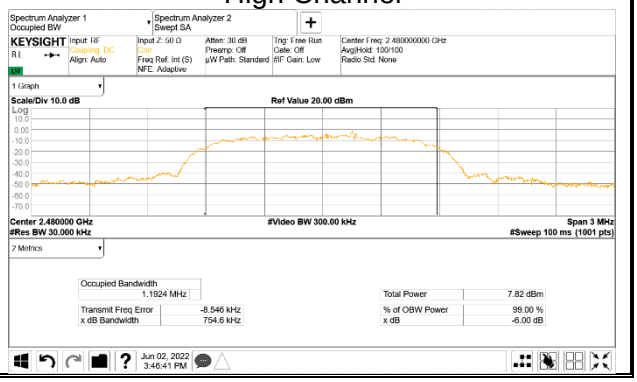
## 9.2.4. BLUETOOTH ENHANCED DATA RATE 8DPSK MODULATION

| Channel | Frequency [MHz] | 20 dB Bandwidth [MHz] | 99% Bandwidth [MHz] |
|---|---|---|---|
| Low | 2402 | 1.303 | 1.192 |
| Mid | 2441 | 1.304 | 1.193 |
| High | 2480 | 1.301 | 1.195 |
| **Worst** | | **1.304** | **1.195** |

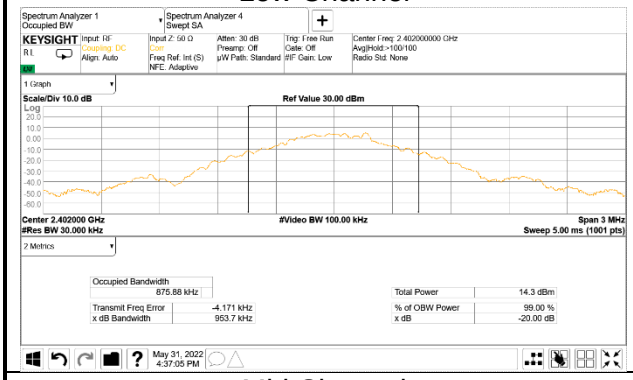
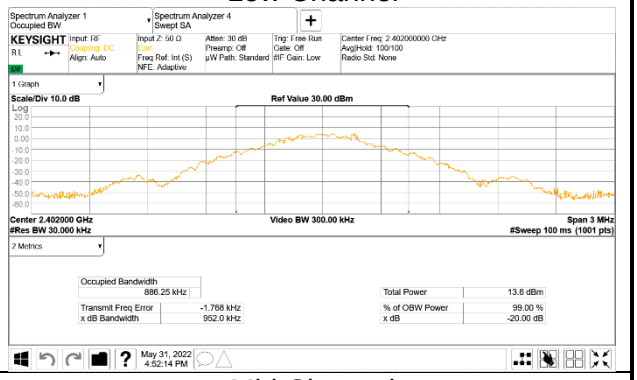
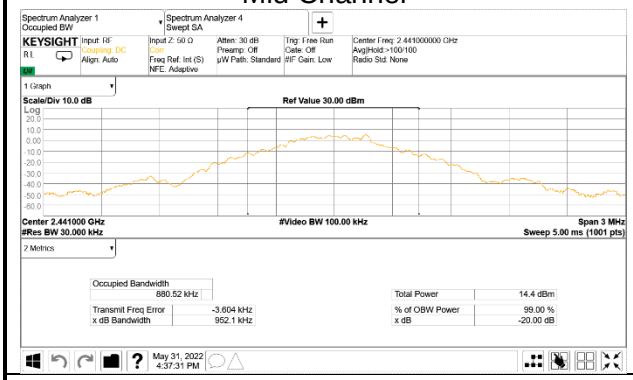
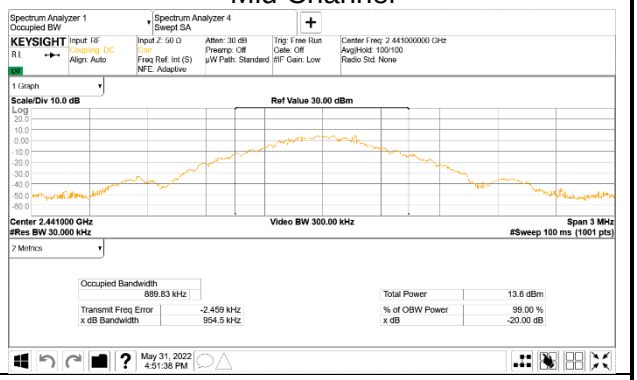
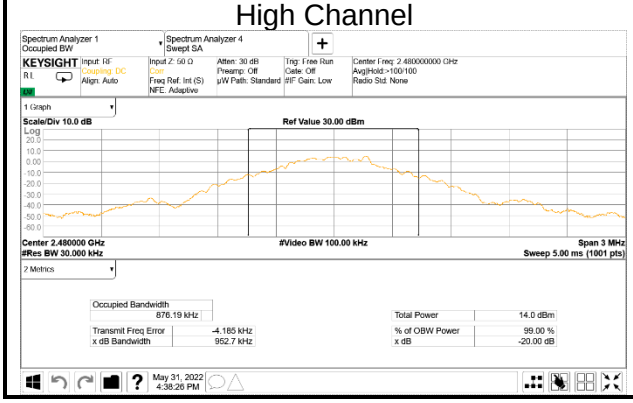
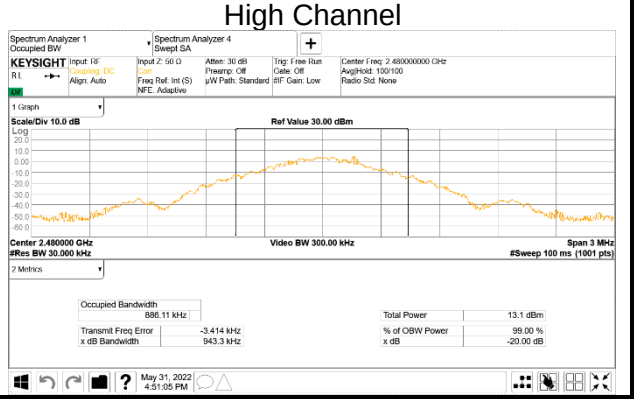
## 20 dB AND 99% BANDWIDTH PLOTS

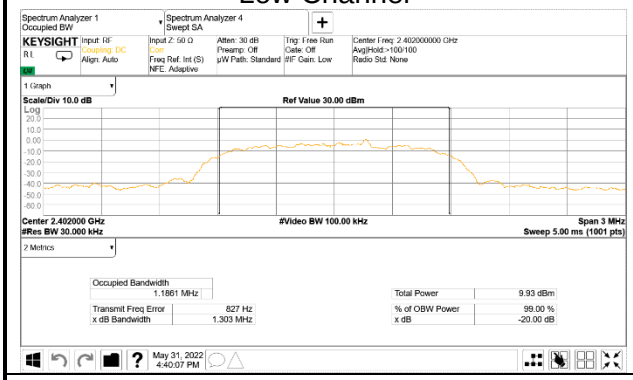
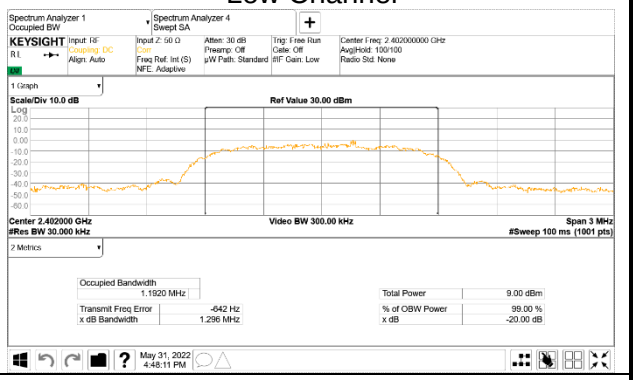
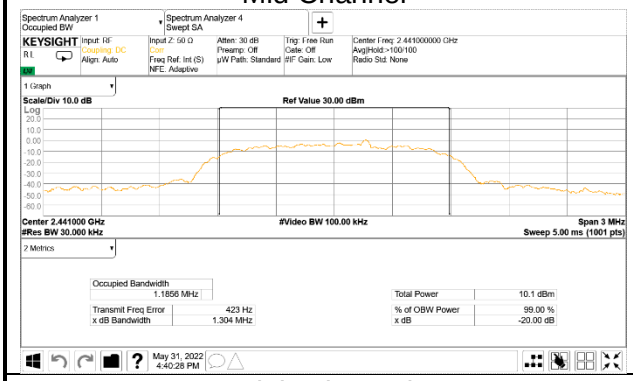
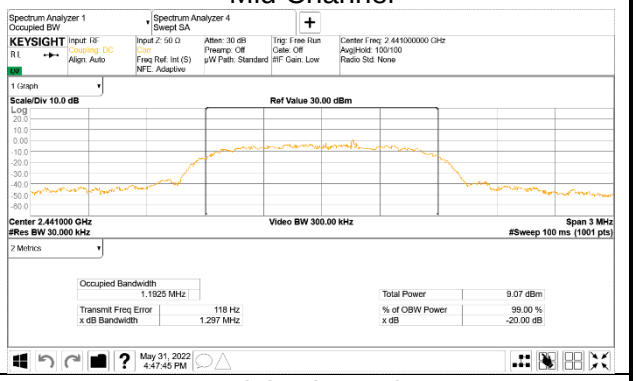
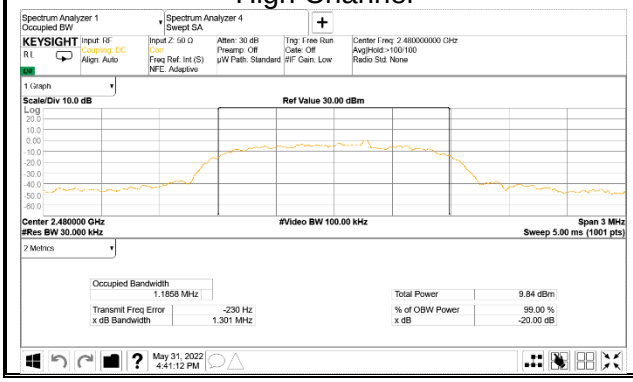
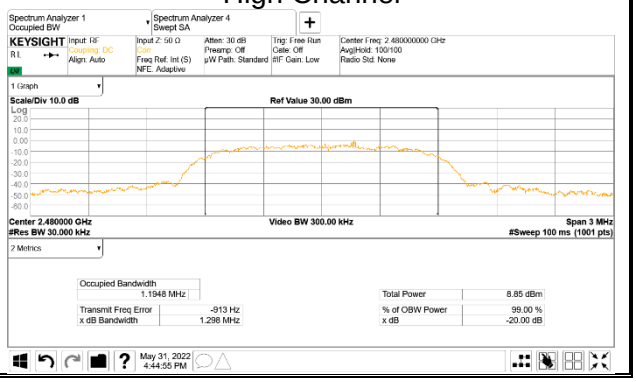
- **Left**

| GFSK / 20 dB Bandwidth | GFSK / 99% Bandwidth |
|---|---|
| Low Channel | Low Channel |
|  |  |
| Mid Channel | Mid Channel |
|  |  |
| High Channel | High Channel |
|  |  |

| 8DPSK / 20 dB Bandwidth | 8DPSK / 99% Bandwidth |
|---|---|
| Low Channel | Low Channel |
|  |  |
| Mid Channel | Mid Channel |
|  |  |
| High Channel | High Channel |
|  |  |

- **Right**

| GFSK / 20 dB Bandwidth | GFSK / 99% Bandwidth |
|---|---|
| Low Channel | Low Channel |
|  |  |
| Mid Channel | Mid Channel |
|  |  |
| High Channel | High Channel |
|  |  |

| 8DPSK / 20 dB Bandwidth | 8DPSK / 99% Bandwidth |
|---|---|
| Low Channel | Low Channel |
|  |  |
| Mid Channel | Mid Channel |
|  |  |
| High Channel | High Channel |
|  |  |

## 9.3. HOPPING FREQUENCY SEPARATION

**LIMITS**

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

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

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

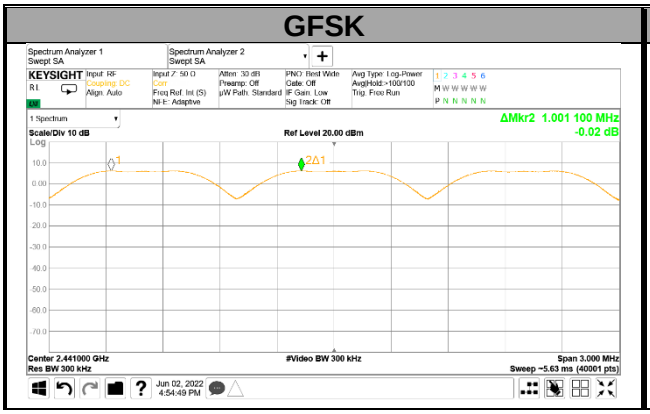
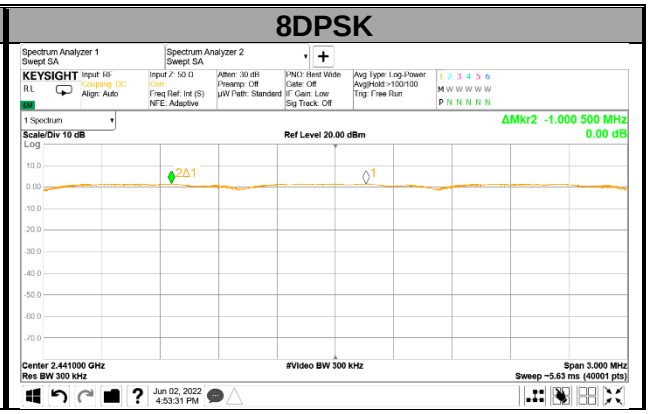
**TEST PROCEDURE**

Span = wide enough to capture the peaks of two adjacent channels
RBW = Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
VBW $\geq$ RBW
Sweep = Auto
Detector function = Peak
Trace = Max hold

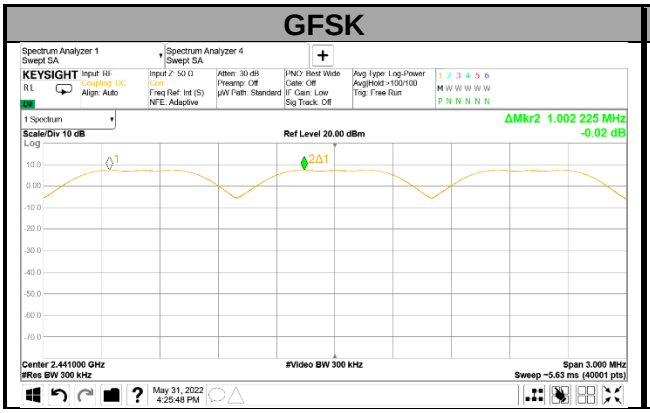
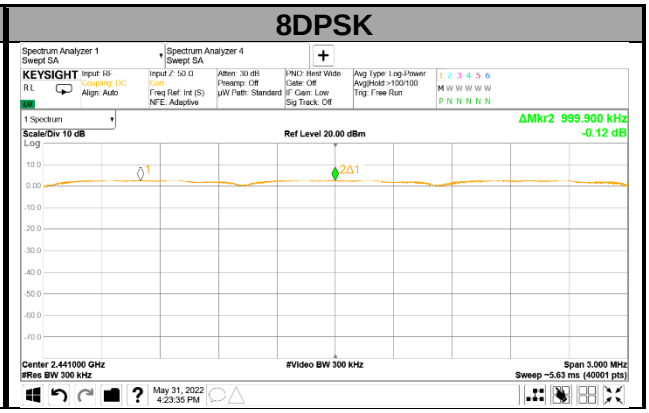
**RESULTS**

HOPPING FREQUENCY SEPARATION PLOT

- **Left**

| GFSK | 8DPSK |
|---|---|
|  |  |

- **Right**

| GFSK | 8DPSK |
|---|---|
|  |  |

## 9.4. NUMBER OF HOPPING CHANNELS

**LIMITS**

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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

**TEST PROCEDURE**

RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
VBW $\geq$ RBW
Sweep = Auto
Detector function = Peak
Trace = Max hold

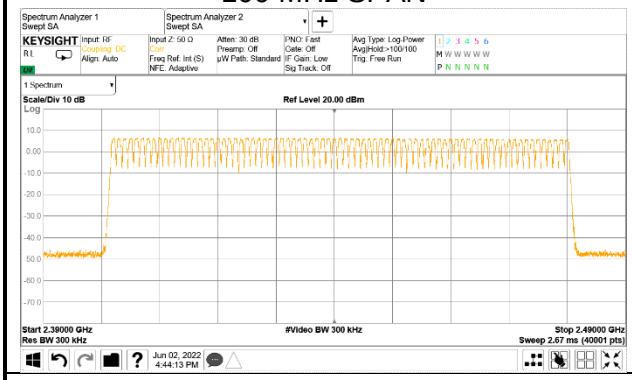
**RESULTS**

Normal Mode: 79 Channels Observed

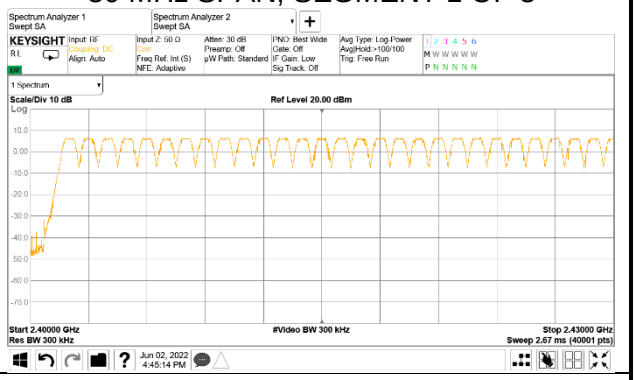
- **Left**

## 9.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

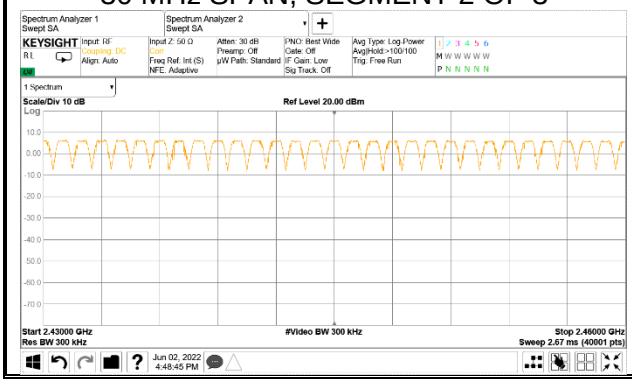
100 MHz SPAN



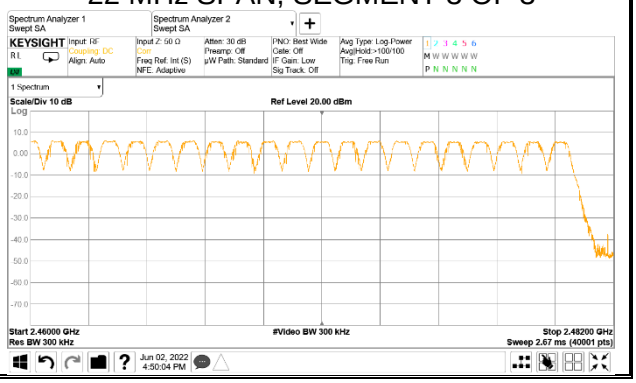

30 MHz SPAN, SEGMENT 1 OF 3




30 MHz SPAN, SEGMENT 2 OF 3

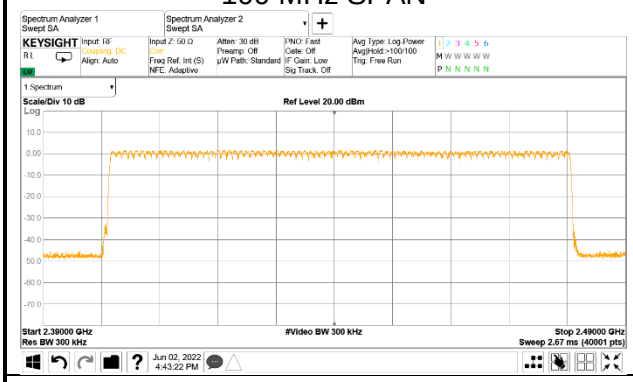



22 MHz SPAN, SEGMENT 3 OF 3

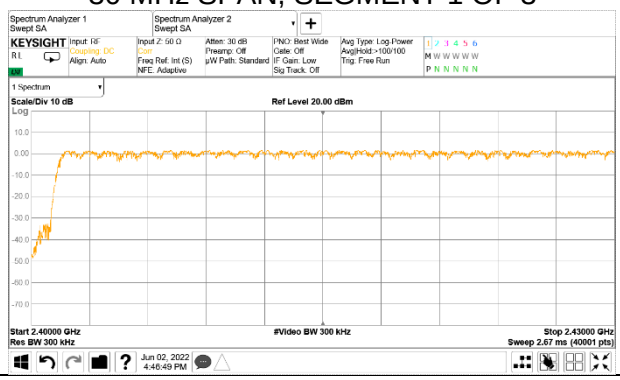


## 9.4.2. BLUETOOTH ENHANCED DATA RATE 8DPSK MODULATION

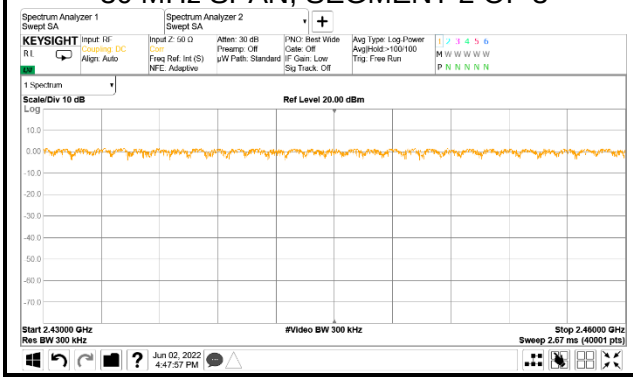
100 MHz SPAN



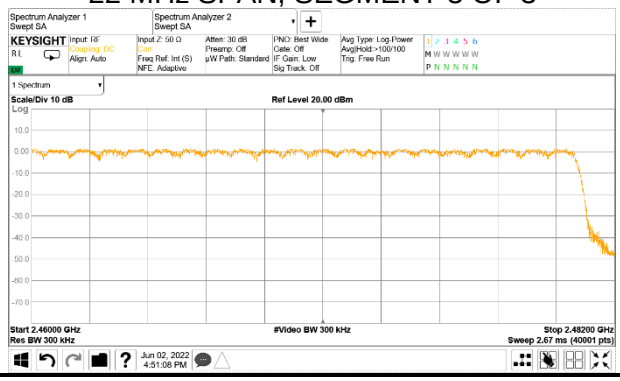

30 MHz SPAN, SEGMENT 1 OF 3




30 MHz SPAN, SEGMENT 2 OF 3



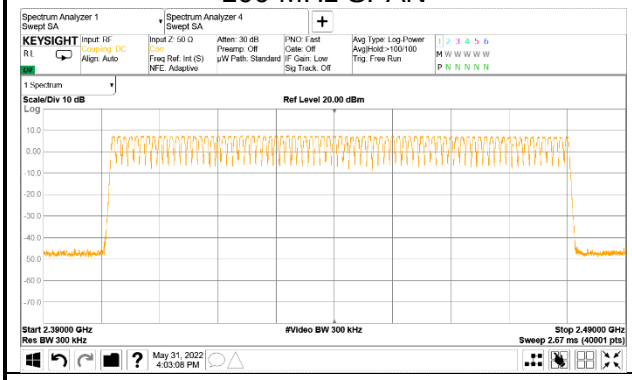

22 MHz SPAN, SEGMENT 3 OF 3



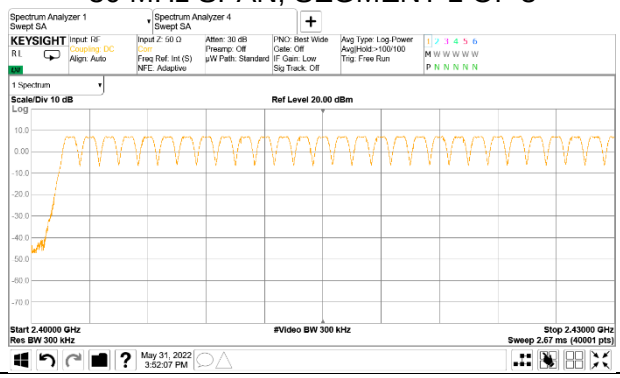
- **Right**

## 9.4.3. BLUETOOTH BASIC DATA RATE GFSK MODULATION

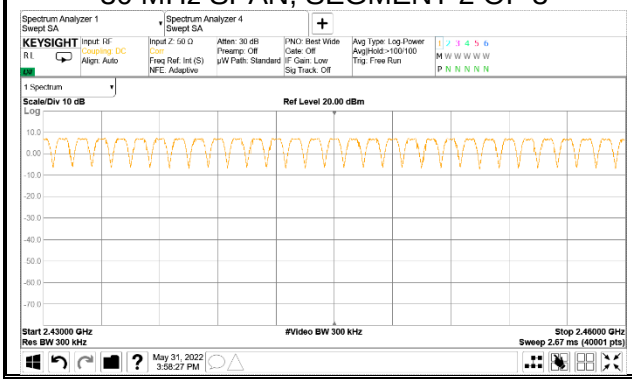
100 MHz SPAN



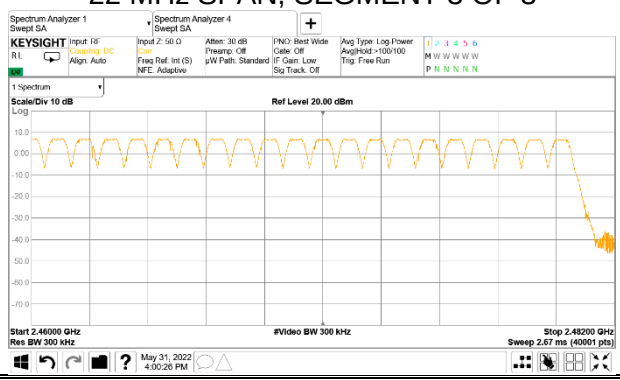

30 MHz SPAN, SEGMENT 1 OF 3




30 MHz SPAN, SEGMENT 2 OF 3

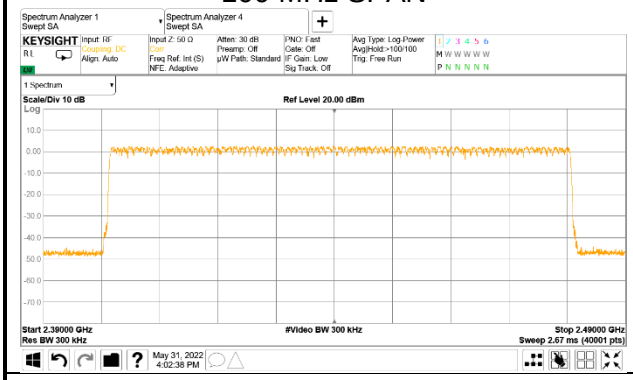



22 MHz SPAN, SEGMENT 3 OF 3

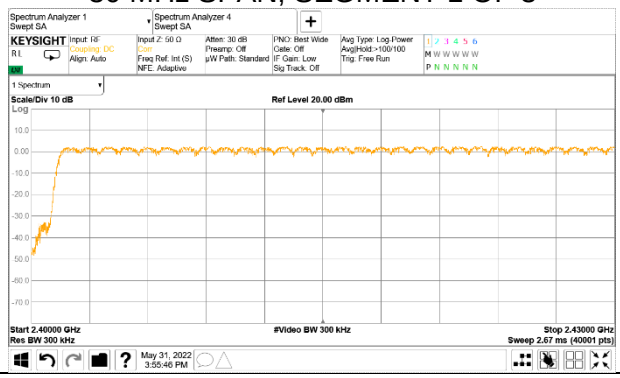


## 9.4.4. BLUETOOTH ENHANCED DATA RATE 8DPSK MODULATION

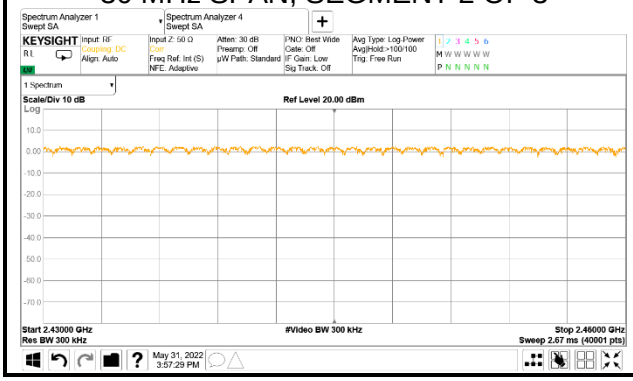
100 MHz SPAN



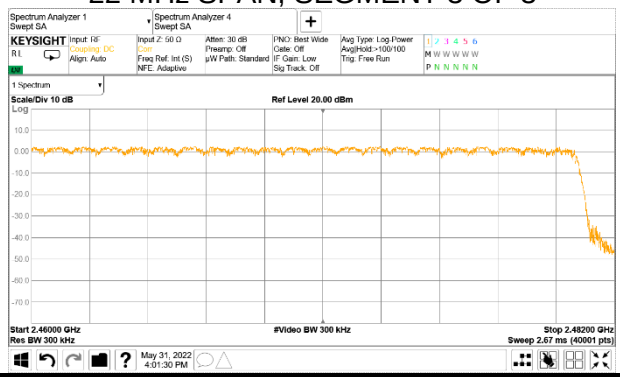

30 MHz SPAN, SEGMENT 1 OF 3




30 MHz SPAN, SEGMENT 2 OF 3




22 MHz SPAN, SEGMENT 3 OF 3



## 9.5. AVERAGE TIME OF OCCUPANCY

**LIMITS**

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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**

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 3.16 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

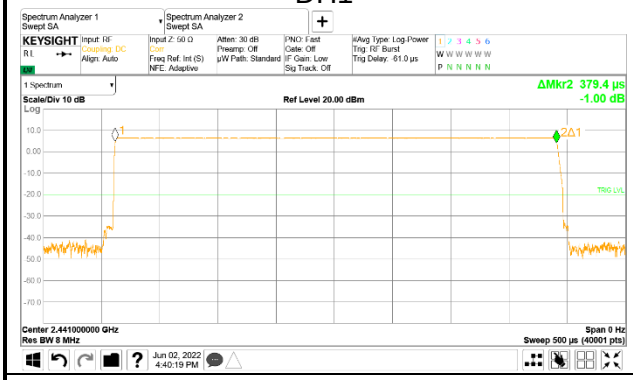
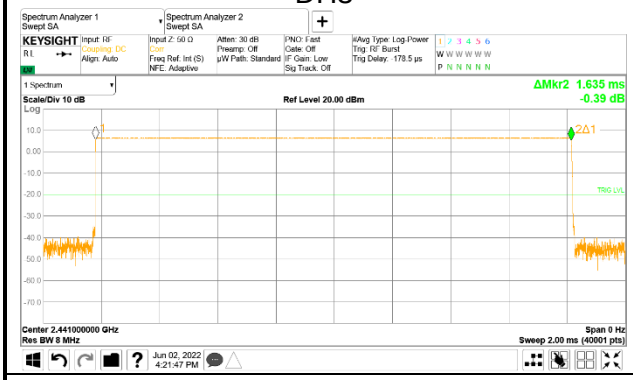
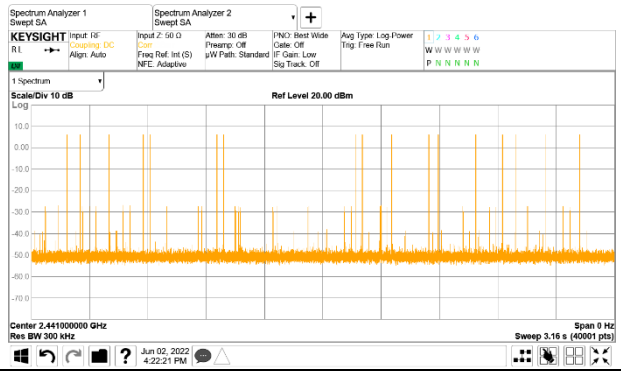
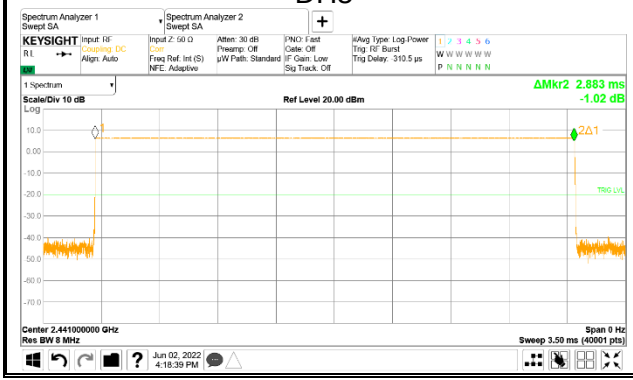
For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to 10 * (# of pulses in 0.8 s) * pulse width.

**RESULTS**

- **Left**

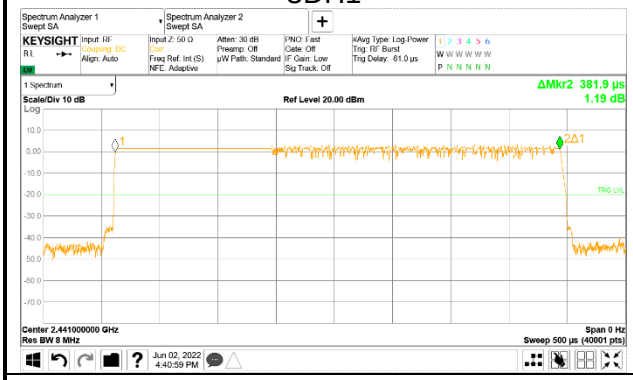
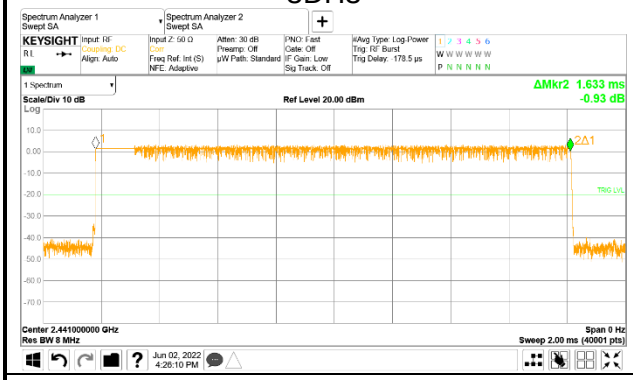
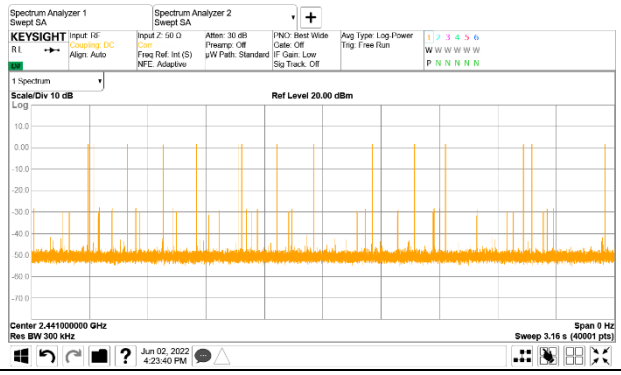
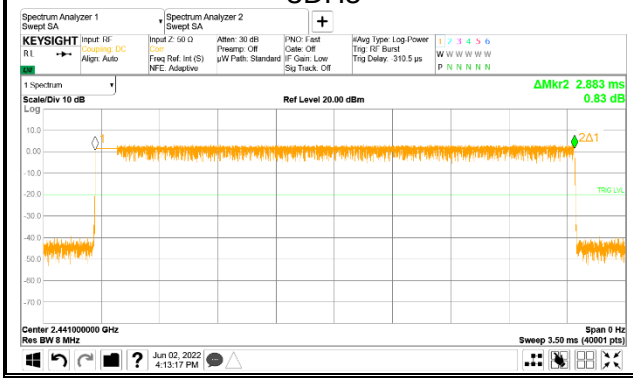
## 9.5.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| DH Packet | Pulse Width [msec] | Number of Pulses in 3.16 seconds | Average Time of Occupancy [sec] | Limit [sec] | Margin [sec] |
|---|---|---|---|---|---|
| GFSK Normal | | | | | |
| DH1 | 0.379 | 30 | 0.114 | 0.4 | -0.286 |
| DH3 | 1.635 | 17 | 0.278 | 0.4 | -0.122 |
| DH5 | 2.883 | 10 | 0.288 | 0.4 | -0.112 |
| | | | | | |
| **DH Packet** | **Pulse Width [msec]** | **Number of Pulses in 0.8 seconds** | **Average Time of Occupancy [sec]** | **Limit [sec]** | **Margin [sec]** |
| GFSK AFH | | | | | |
| DH1 | 0.379 | 32 | 0.121 | 0.4 | -0.279 |
| DH3 | 1.635 | 16 | 0.262 | 0.4 | -0.138 |
| DH5 | 2.883 | 11 | 0.317 | 0.4 | -0.083 |

| GFSK / PULSE WIDTH | GFSK / NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD |
|---|---|
| DH1 | DH1 |
|  |  |
| DH3 | DH3 |
|  |  |
| DH5 | DH5 |
|  |  |

## 9.5.2. BLUETOOTH ENHANCED DATA RATE 8DPSK MODULATION

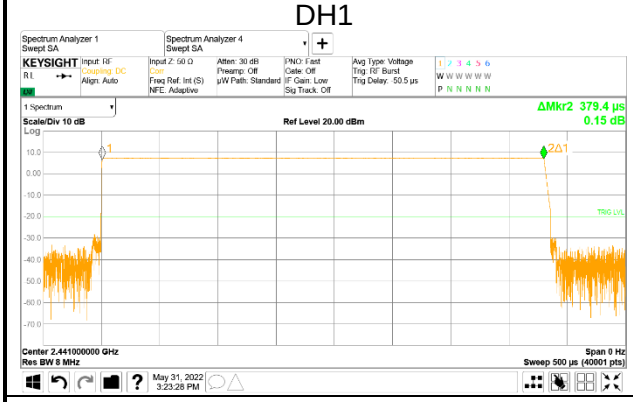
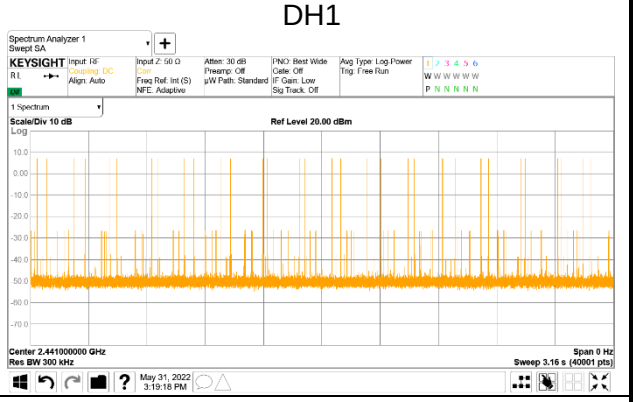
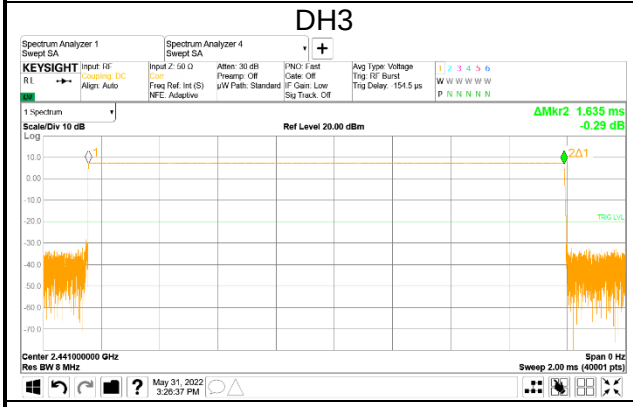
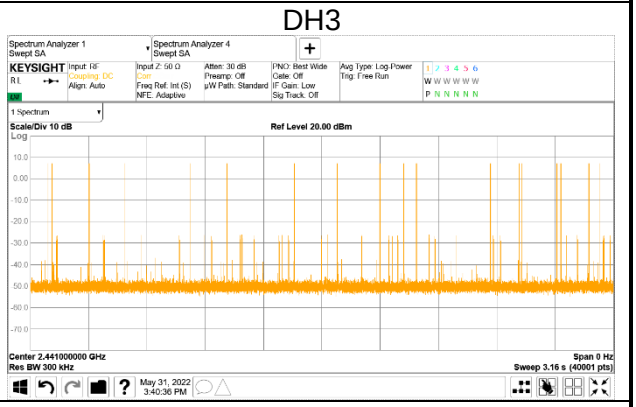
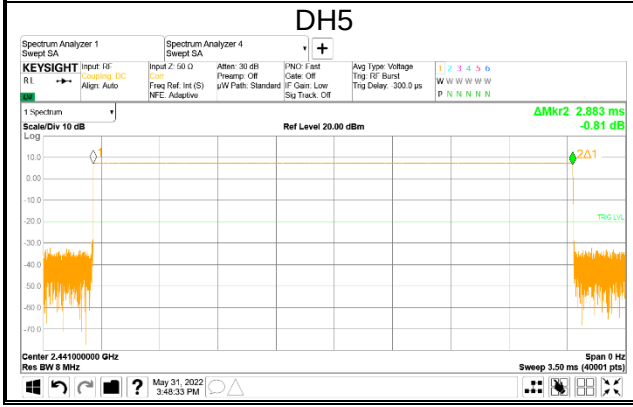
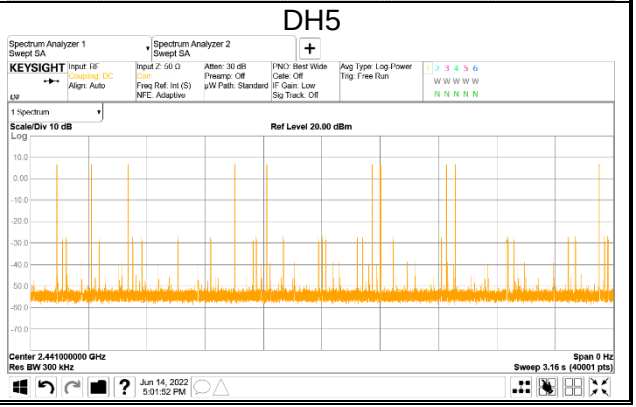
| DH Packet | Pulse Width [msec] | Number of Pulses in 3.16 seconds | Average Time of Occupancy [sec] | Limit [sec] | Margin [sec] |
|---|---|---|---|---|---|
| 8DPSK Normal | | | | | |
| 3-DH1 | 0.382 | 31 | 0.118 | 0.4 | -0.282 |
| 3-DH3 | 1.633 | 15 | 0.245 | 0.4 | -0.155 |
| 3-DH5 | 2.883 | 12 | 0.346 | 0.4 | -0.054 |
| | | | | | |
| **DH Packet** | **Pulse Width [msec]** | **Number of Pulses in 0.8 seconds** | **Average Time of Occupancy [sec]** | **Limit [sec]** | **Margin [sec]** |
| 8DPSK AFH | | | | | |
| 3-DH1 | 0.382 | 30 | 0.115 | 0.4 | -0.285 |
| 3-DH3 | 1.633 | 16 | 0.261 | 0.4 | -0.139 |
| 3-DH5 | 2.883 | 10 | 0.288 | 0.4 | -0.112 |

| 8DPSK / PULSE WIDTH | 8DPSK / NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD |
|---|---|
| 3DH1 | 3DH1 |
|  |  |
| 3DH3 | 3DH3 |
|  |  |
| 3DH5 | 3DH5 |
|  |  |

- **Right**

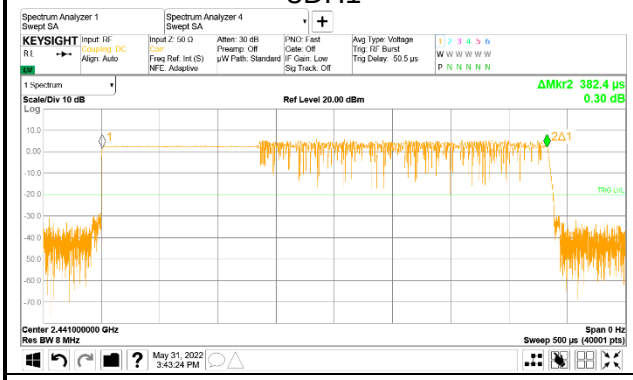
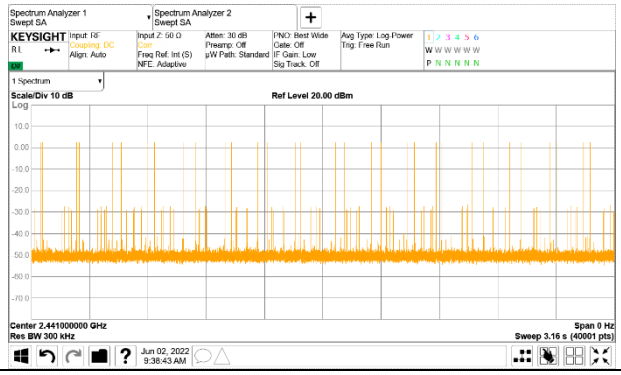
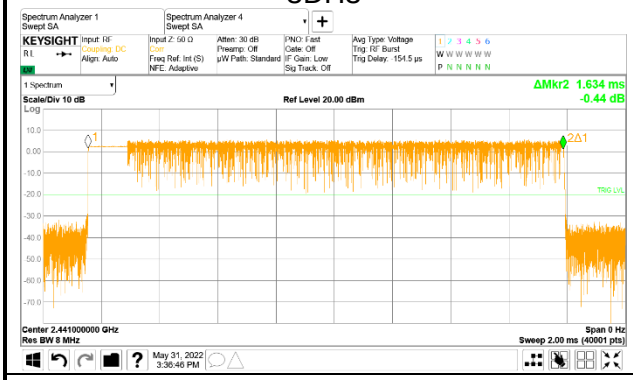
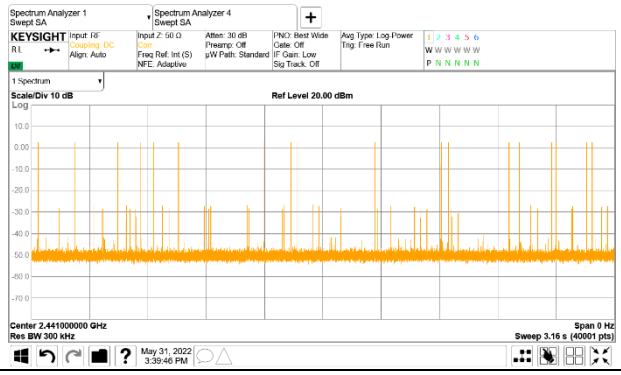
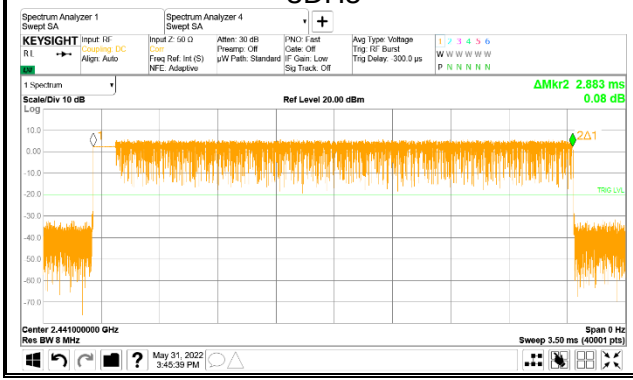
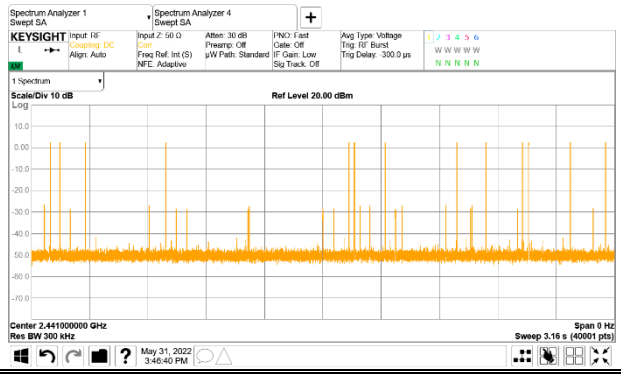
## 9.5.3. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| DH Packet | Pulse Width [msec] | Number of Pulses in 3.16 seconds | Average Time of Occupancy [sec] | Limit [sec] | Margin [sec] |
|---|---|---|---|---|---|
| GFSK Normal | | | | | |
| DH1 | 0.379 | 32 | 0.121 | 0.4 | -0.279 |
| DH3 | 1.635 | 18 | 0.294 | 0.4 | -0.106 |
| DH5 | 2.883 | 10 | 0.288 | 0.4 | -0.112 |
| | | | | | |
| **DH Packet** | **Pulse Width [msec]** | **Number of Pulses in 0.8 seconds** | **Average Time of Occupancy [sec]** | **Limit [sec]** | **Margin [sec]** |
| GFSK AFH | | | | | |
| DH1 | 0.379 | 26 | 0.099 | 0.4 | -0.301 |
| DH3 | 1.635 | 10 | 0.164 | 0.4 | -0.237 |
| DH5 | 2.883 | 6 | 0.173 | 0.4 | -0.227 |

| GFSK / PULSE WIDTH | GFSK / NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD |
|---|---|
| DH1 | DH1 |
|  |  |
| DH3 | DH3 |
|  |  |
| DH5 | DH5 |
|  |  |

## 9.5.4. BLUETOOTH ENHANCED DATA RATE 8DPSK MODULATION

| DH Packet | Pulse Width [msec] | Number of Pulses in 3.16 seconds | Average Time of Occupancy [sec] | Limit [sec] | Margin [sec] |
|---|---|---|---|---|---|
| 8DPSK Normal | | | | | |
| 3-DH1 | 0.382 | 32 | 0.122 | 0.4 | -0.278 |
| 3-DH3 | 1.638 | 18 | 0.295 | 0.4 | -0.105 |
| 3-DH5 | 2.888 | 12 | 0.347 | 0.4 | -0.053 |
| | | | | | |
| **DH Packet** | **Pulse Width [msec]** | **Number of Pulses in 0.8 seconds** | **Average Time of Occupancy [sec]** | **Limit [sec]** | **Margin [sec]** |
| 8DPSK AFH | | | | | |
| 3-DH1 | 0.382 | 28 | 0.107 | 0.4 | -0.293 |
| 3-DH3 | 1.638 | 13 | 0.213 | 0.4 | -0.187 |
| 3-DH5 | 2.888 | 8 | 0.231 | 0.4 | -0.169 |

| 8DPSK / PULSE WIDTH | 8DPSK / NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD |
|---|---|
| 3DH1 | 3DH1 |
|  |  |
| 3DH3 | 3DH3 |
|  |  |
| 3DH5 | 3DH5 |
|  |  |

## 9.6. OUTPUT POWER

**LIMITS**

§15.247 (b) (1)

The maximum antenna gain is less than 6 dBi, therefore the limit is 21 dBm.

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

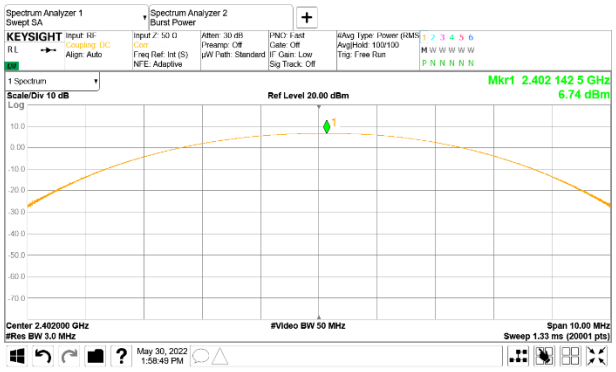
**RESULTS**

- **Left**

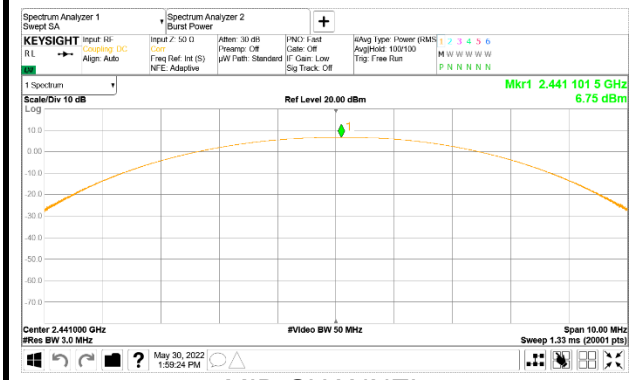
### 9.6.1. BASIC DATA RATE GFSK MODULATION

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Low | 2402 | 6.740 | 21.000 | -14.260 |
| Mid | 2441 | 6.750 | | -14.250 |
| High | 2480 | 6.280 | | -14.720 |
| **Worst** | | **6.750** | | -14.250 |

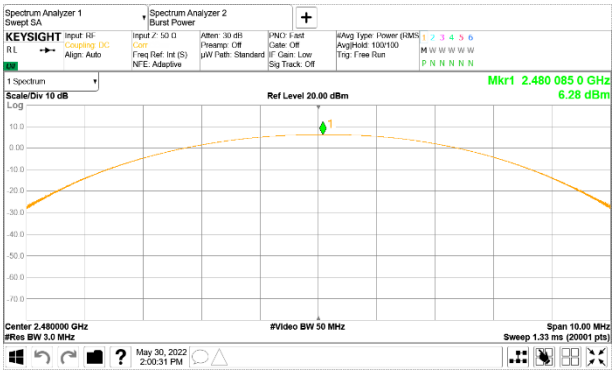
**GFSK**




LOW CHANNEL




MID CHANNEL

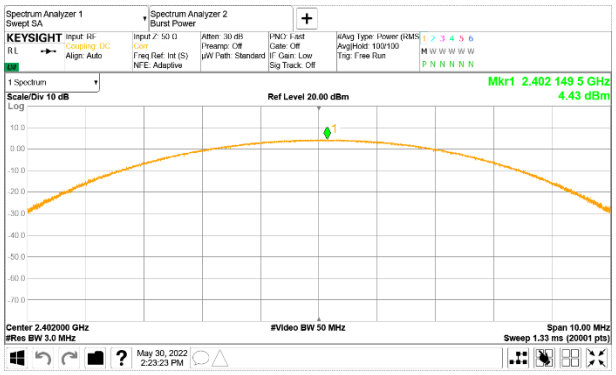



HIGH CHANNEL

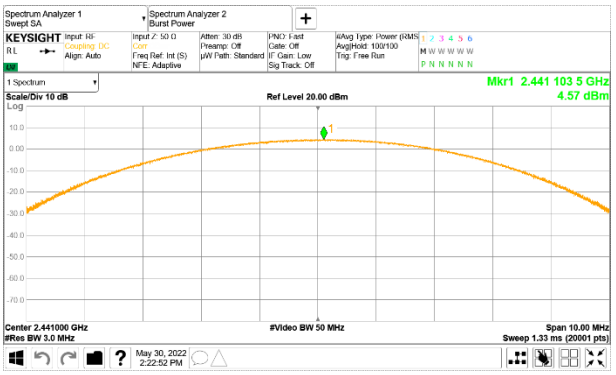
## 9.6.2. ENHANCED DATA RATE Pi/4-DQPSK MODULATION

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Low | 2402 | 4.430 | 21.000 | -16.570 |
| Mid | 2441 | 4.570 | | -16.430 |
| High | 2480 | 4.310 | | -16.690 |
| **Worst** | | **4.570** | | -16.430 |

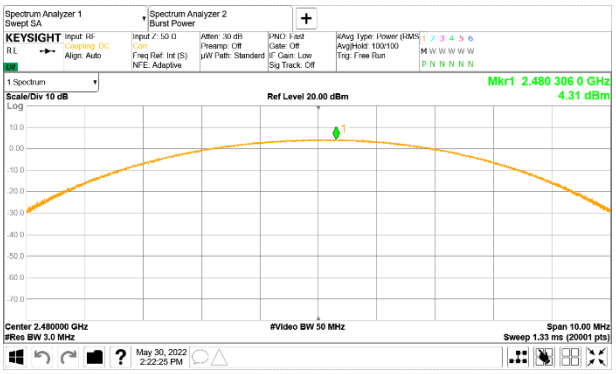
**Pi/4-DQPSK**




LOW CHANNEL




MID CHANNEL

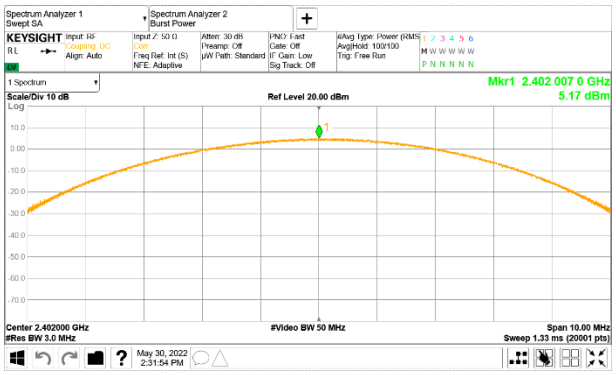



HIGH CHANNEL

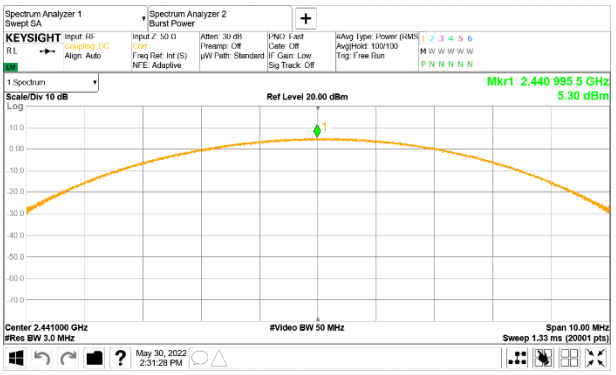
## 9.6.3. ENHANCED DATA RATE 8DPSK MODULATION

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Low | 2402 | 5.170 | 21.000 | -15.830 |
| Mid | 2441 | 5.300 | | -15.700 |
| High | 2480 | 5.000 | | -16.000 |
| **Worst** | | **5.300** | | -15.700 |

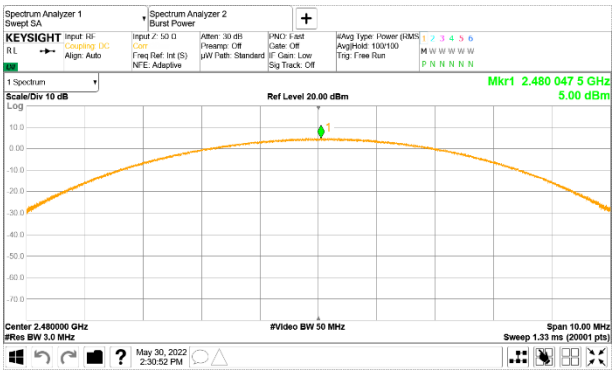
**8DPSK**




LOW CHANNEL




MID CHANNEL



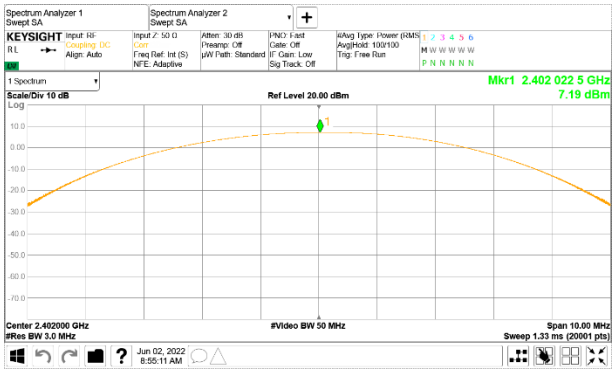

HIGH CHANNEL

- **Right**

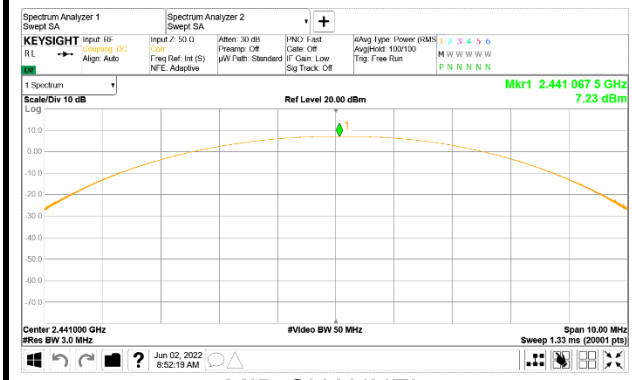
## 9.6.4. BASIC DATA RATE GFSK MODULATION

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Low | 2402 | 7.190 | 21.000 | -13.810 |
| Mid | 2441 | 7.230 | | -13.770 |
| High | 2480 | 6.770 | | -14.230 |
| **Worst** | | **7.230** | | -13.770 |

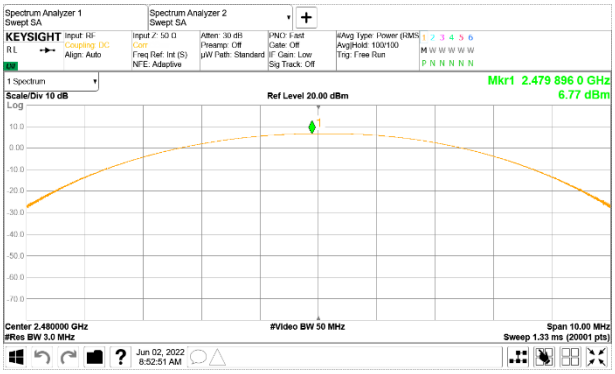
**GFSK**




LOW CHANNEL




MID CHANNEL

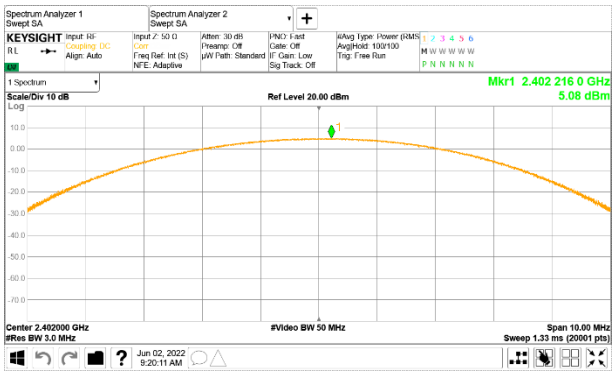



HIGH CHANNEL

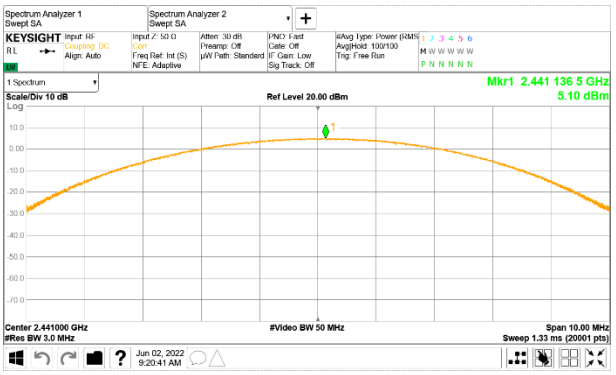
## 9.6.5. ENHANCED DATA RATE Pi/4-DQPSK MODULATION

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Low | 2402 | 5.080 | 21.000 | -15.920 |
| Mid | 2441 | 5.100 | | -15.900 |
| High | 2480 | 4.670 | | -16.330 |
| **Worst** | | **5.100** | | -15.900 |

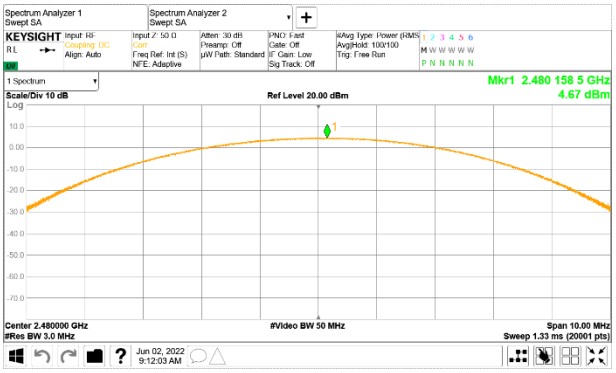
**Pi/4-DQPSK**




LOW CHANNEL




MID CHANNEL

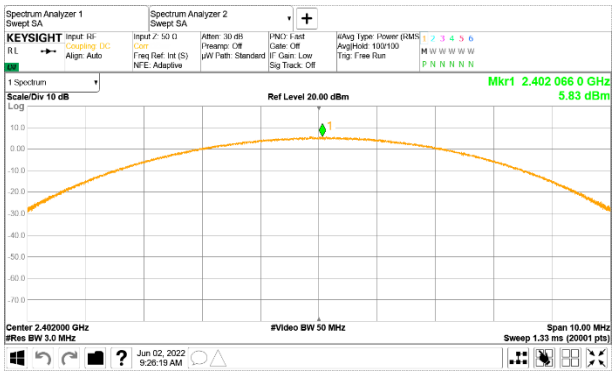



HIGH CHANNEL

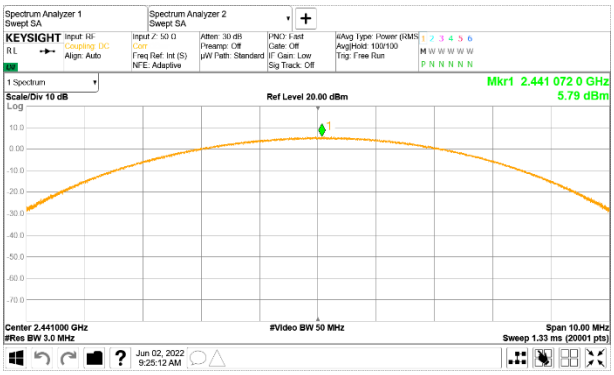
## 9.6.6. ENHANCED DATA RATE 8DPSK MODULATION

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Low | 2402 | 5.830 | 21.000 | -15.170 |
| Mid | 2441 | 5.790 | | -15.210 |
| High | 2480 | 5.310 | | -15.690 |
| **Worst** | | **5.830** | | -15.170 |

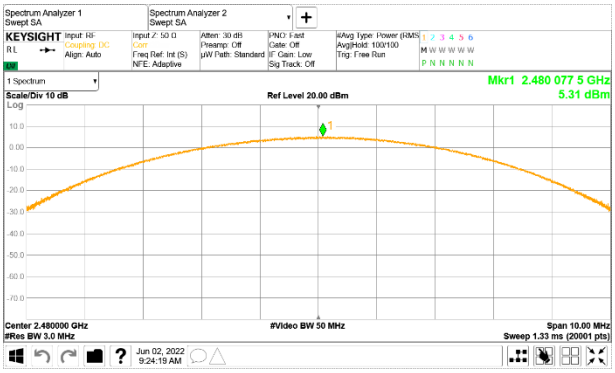
**8DPSK**




LOW CHANNEL




MID CHANNEL




HIGH CHANNEL

## 9.7. AVERAGE POWER

**LIMITS**

None; for reporting purposes only

**TEST PROCEDURE**

The transmitter output is connected to a power meter.
The cable assembly insertion loss was entered as an offset in the power meter to allow for direct reading of power.

**RESULTS**

- **Left**

### 9.7.1. BASIC DATA RATE GFSK MODULATION

| Channel | Frequency [MHz] | Av Power [dBm] | Av Power [mW] |
|---|---|---|---|
| Low | 2402 | 6.549 | 4.52 |
| Mid | 2441 | 6.553 | 4.52 |
| High | 2480 | 5.902 | 3.89 |

### 9.7.2. ENHANCED DATA RATE Pi/4-DQPSK MODULATION

| Channel | Frequency [MHz] | Av Power [dBm] | Av Power [mW] |
|---|---|---|---|
| Low | 2402 | 2.697 | 1.86 |
| Mid | 2441 | 2.693 | 1.86 |
| High | 2480 | 2.399 | 1.74 |

### 9.7.3. ENHANCED DATA RATE 8DPSK MODULATION

| Channel | Frequency [MHz] | Av Power [dBm] | Av Power [mW] |
|---|---|---|---|
| Low | 2402 | 3.077 | 2.03 |
| Mid | 2441 | 3.092 | 2.04 |
| High | 2480 | 2.738 | 1.88 |

- **Right**

### 9.7.1. BASIC DATA RATE GFSK MODULATION

| Channel | Frequency [MHz] | Av Power [dBm] | Av Power [mW] |
|---|---|---|---|
| Low | 2402 | 6.749 | 4.73 |
| Mid | 2441 | 6.947 | 4.95 |
| High | 2480 | 6.367 | 4.33 |

### 9.7.2. ENHANCED DATA RATE Pi/4-DQPSK MODULATION

| Channel | Frequency [MHz] | Av Power [dBm] | Av Power [mW] |
|---|---|---|---|
| Low | 2402 | 2.677 | 1.85 |
| Mid | 2441 | 2.957 | 1.98 |
| High | 2480 | 2.630 | 1.83 |

### 9.7.3. ENHANCED DATA RATE 8DPSK MODULATION

| Channel | Frequency [MHz] | Av Power [dBm] | Av Power [mW] |
|---|---|---|---|
| Low | 2402 | 3.066 | 2.03 |
| Mid | 2441 | 3.339 | 2.16 |
| High | 2480 | 2.974 | 1.98 |

## 9.8. CONDUCTED SPURIOUS EMISSIONS

**LIMITS**

FCC §15.247 (d)

Limit = -20 dBc

**TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

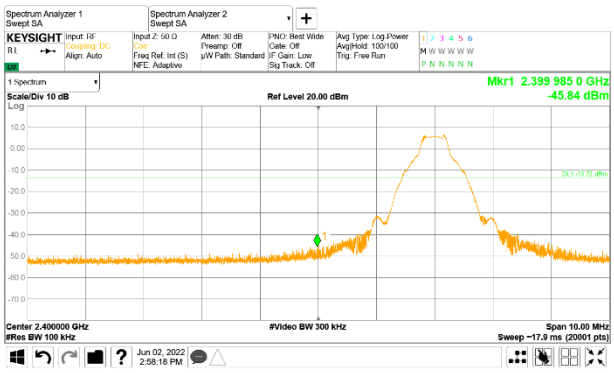
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

**RESULTS**

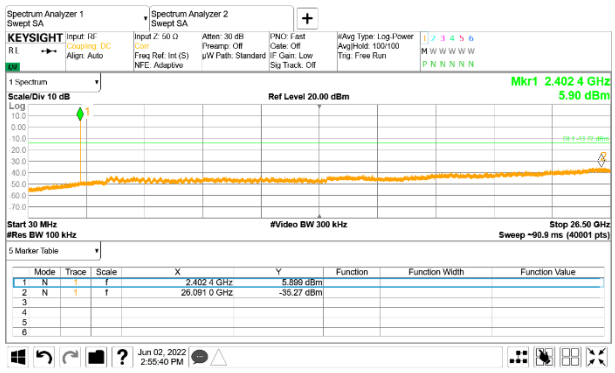
- **Left**

## 9.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

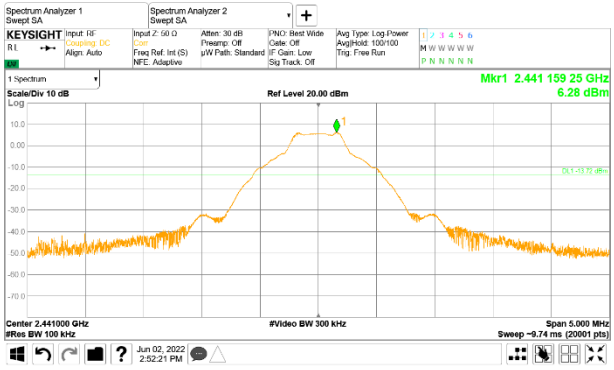
**SPURIOUS EMISSIONS, NON-HOPPING**



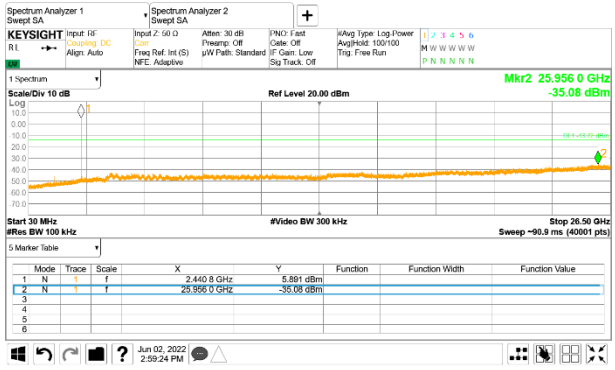

LOW CHANNEL BANDEDGE



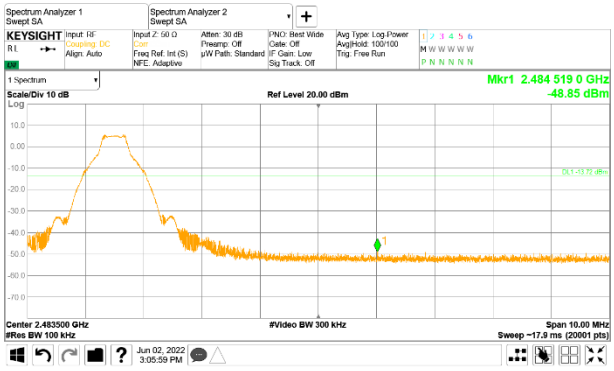

OUT-OF-BAND LOW CHANNEL



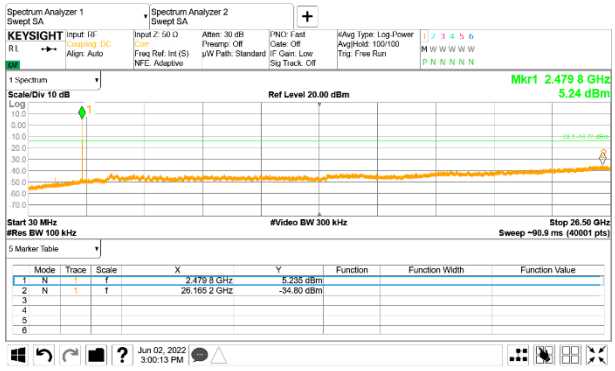

IN-BAND REFERENCE LEVEL




OUT-OF-BAND MID CHANNEL

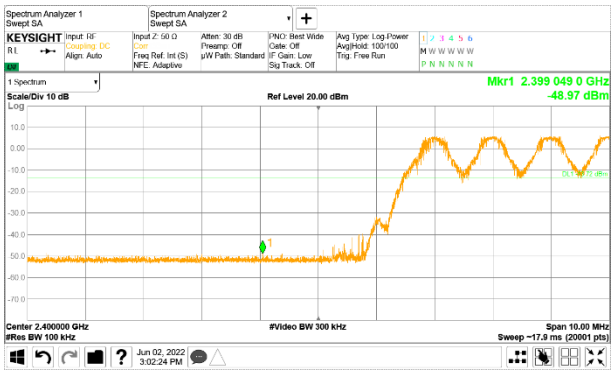



HIGH CHANNEL BANDEDGE

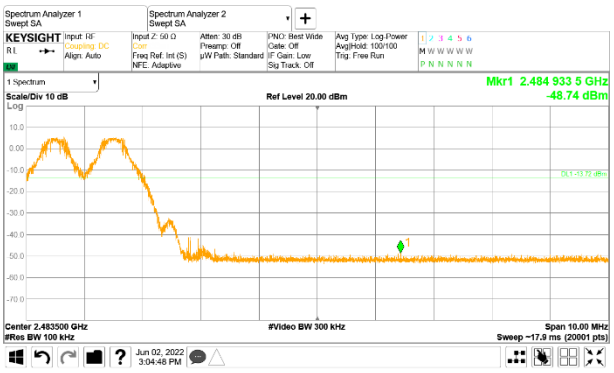



OUT-OF-BAND HIGH CHANNEL

**SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**




**LOW BANDEDGE**




**HIGH BANDEDGE**