

# TEST REPORT

**Report Number:** 15107843-E7V2

**Applicant :** Google LLC  
1600 Amphitheatre Parkway  
Mountain View, CA 94043 U.S.A.

**Model :** G2YBB

**FCC ID :** A4RG2YBB

**EUT Description :** Phone

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART C

**Date Of Issue:**  
2024-05-04

**Prepared by:**  
UL VERIFICATION SERVICES  
47173 Benicia Street  
Fremont, CA 94538 U.S.A.  
TEL: (510) 319-4000  
FAX: (510) 661-0888



## REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions                            | Revised By |
|------|------------|--------------------------------------|------------|
| V1   | 2024-04-29 | Initial Issue                        | ---        |
| V2   | 2024-05-04 | Revised Section 6.2, 8, 9.3.3, 9.4.5 | Tina Chu   |

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** Google LLC  
 1600 Amphitheatre Parkway  
 Mountain View, CA 94043 U.S.A.

**EUT DESCRIPTION:** Phone

**MODEL NUMBER:** G2YBB

**SERIAL NUMBER:** 41061FDAQ00047 ,41061FDAQ0003E (Radiated)  
 41151FDAQ0006X (Conducted)

**SAMPLE RECEIPT DATE:** 2024-01-18

**DATE TESTED:** 2024-01-30 to 2024-05-04

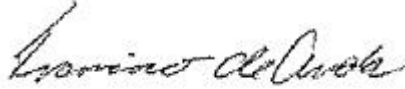
| <b>APPLICABLE STANDARDS</b> |                     |
|-----------------------------|---------------------|
| <b>STANDARD</b>             | <b>TEST RESULTS</b> |
| CFR 47 Part 15 Subpart C    | Complies            |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document.

Approved & Released For  
UL Verification Services Inc. By:



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Francisco de Anda  
Staff Engineer  
Consumer Technology Division  
UL Verification Services Inc.

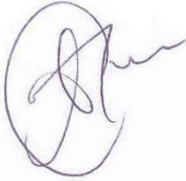
Prepared By:



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Gerardo Abrego  
Senior Test Engineer  
Consumer Technology Division  
UL Verification Services Inc.

Reviewed By:



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Tina Chu  
Senior Project Engineer  
Consumer Technology Division  
UL Verification Services Inc.

## 2. TEST RESULTS SUMMARY

This report contains data provided by the customer which can impact the validity of results. UL Verification Services Inc. is only responsible for correctly integrating customer-provided data with measurements performed by UL Verification Services Inc.

Below is a list of the data provided by the customer:

- 1) Antenna gain and type (see section 6.3)

| FCC Clause     | Requirement                  | Result                  | Comment                              |
|----------------|------------------------------|-------------------------|--------------------------------------|
| See Comment    | Duty Cycle                   | Reporting purposes only | ANSI C63.10 Section 11.6.            |
| -              | 99% OBW                      | Reporting purposes only | ANSI C63.10 Section 6.9.3.           |
| 15.247 (a) (2) | 6dB BW                       | Complies                | None.                                |
| 15.247 (b) (3) | Output Power                 | Complies                | None.                                |
| See Comment    | Average power                | Reporting purposes only | Per ANSI C63.10, Section 11.9.2.3.2. |
| 15.247 (e)     | PSD                          | Complies                | None.                                |
| 15.247 (d)     | Conducted Spurious Emissions | Complies                | None.                                |
| 15.209, 15.205 | Radiated Emissions           | Complies                | None.                                |
| 15.207         | AC Mains Conducted Emissions | Complies                | None.                                |

## 3. TEST METHODOLOGY

- FCC CFR 47 Part 2
- FCC CFR 47 Part 15
- ANSI C63.10-2013
- KDB 558074 D01 15.247 Meas Guidance
- KDB 662911 Measurement of Transmitters with Multiple Output, MIMO
- KDB 414788 D01 Radiated Test Site

## 4. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, Certificate Number 0751.05, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

|                                     | Address  | ISED CABID | ISED Company Number | FCC Registration |
|-------------------------------------|--|------------|---------------------|------------------|
| <input type="checkbox"/>            | Building 1: 47173 Benicia Street, Fremont, CA 94538, USA | US0104     | 2324A               | 550739           |
| <input type="checkbox"/>            | Building 2: 47266 Benicia Street, Fremont, CA 94538, USA |            |                     |                  |
| <input type="checkbox"/>            | Building 3: 843 Auburn Court, Fremont, CA 94538, USA     |            |                     |                  |
| <input checked="" type="checkbox"/> | Building 4: 47658 Kato Rd, Fremont, CA 94538, USA        |            |                     |                  |
| <input checked="" type="checkbox"/> | Building 5: 47670 Kato Rd, Fremont, CA 94538, USA        |            |                     |                  |

## 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

### 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

### 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

### 5.3. MEASUREMENT UNCERTAINTY

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

| PARAMETER  | $U_{Lab}$                  |
|--|----------------------------|
| Radio Frequency (Spectrum Analyzer)                  | 141.16 Hz                  |
| Occupied Bandwidth                                   | 1.22%                      |
| RF Power Measurement Direct Method Using Power Meter | 1.3 dB (PK) / 0.45 dB (AV) |
| Unwanted Emissions, Conducted                        | 1.94 dB                    |
| Power Spectral Density                               | 2.466 dB                   |
| Worst Case Conducted Disturbance, 9kHz to 0.15 MHz   | 3.78 dB                    |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz     | 3.40 dB                    |
| Worst Case Radiated Disturbance, 9kHz to 30 MHz      | 2.87 dB                    |
| Worst Case Radiated Disturbance, 30 to 1000 MHz      | 6.01 dB                    |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz   | 4.73 dB                    |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz  | 4.51 dB                    |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz  | 5.29 dB                    |
| Time Domain Measurements                             | 3.39%                      |
| Temperature  | 0.57°C                     |
| Humidity   | 3.39%                      |
| DC Supply Voltages                                   | 0.57%                      |

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



## 5.4. SAMPLE CALCULATION

### **RADIATED EMISSIONS**

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)

$$36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$$

### **MAINS CONDUCTED EMISSIONS**

Where relevant, the following sample calculation is provided:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.

$$36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} = 46.6 \text{ dBuV}$$

## 6. EQUIPMENT UNDER TEST

### 6.1. EUT DESCRIPTION

The EUT is a phone.

### 6.2. MAXIMUM OUTPUT POWER

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

| Frequency Range (MHz) | Mode                                      | Output Power (dBm) | Output Power (mW) |
|-----------------------|---|--------------------|-------------------|
| 2402 - 2480           | BT DQPSK TXBF                             | 20.83              | 121.06            |
|                       | BT 8PSK TXBF                              | 20.93              | 123.88            |
| 2402 - 2480           | BLE TXBF 1Mbps                            | 22.00              | 158.49            |
| 2404-2478             | BLE TXBF 2Mbps                            | 22.13              | 163.31            |
| 2404 - 2478           | BLE 1Mbps GFSK, MODE 0 (CHANNEL SOUNDING) | 19.98              | 99.54             |
|                       | BLE 2Mbps GFSK, MODE 0 (CHANNEL SOUNDING) | 20.00              | 100.00            |

### 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type as provided by the manufacturer' are as follows:

The radio utilizes one IFA antenna (Ant4) and one ILA antenna (Ant3) for unlicensed radios.

| Band | Antenna Peak Gain |                  |
|------|-------------------|------------------|
|      | Tx0 (Ant4) (dBi)  | Tx1 (Ant3) (dBi) |
| 2.4G | -1.1              | 0.90             |

## 6.4. WORST-CASE CONFIGURATION AND MODE

BT DQPSK/8PSK and BLE 1Mbps/2Mbps supports SISO diversity antennas and MIMO beamforming. Beamforming is chosen as worse case to cover SISO diversity antennas.

BLE Channel Sounding, mode 0 GFSK modulated 1Mbps/2Mbps only supports SISO diversity antennas.

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. There were no emissions found with less than 20dB of margin from 9kHz to 30MHz and above 18GHz.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle, and high channels.

Investigation was performed with/without adapter. Also, the fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, the following is the worst-case orientation:

- For 2Tx BT DQPSK/8PSK/BLE 1Mbps/2Mbps: Y (Landscape) orientation was worst-case orientation with adapter
- For BLE channel sounding:
  - Tx0: Z (Portrait) orientation was worst-case orientation with adapter
  - Tx1: X (Flatbed) orientation was worst case orientation with adapter

Worst-case data rates as provided by the client were:

DQPSK mode: 2-DH5

8PSK mode : 3-DH5

BLE 1Mbps: 1Mbps

BLE 2Mbps: 2Mbps

BLE 1Mbps GFSK, MODE 0 (CHANNEL SOUNDING): 1Mbps

BLE 2Mbps GFSK, MODE 0 (CHANNEL SOUNDING): 2Mbps

Plots included in the report are representative of the method and settings parameters used for the test.

## 7. MEASUREMENT METHOD

| Test Item   | Test Method   |
|---|---|
| On Time and Duty Cycle                            | ANSI C63.10 Section 11.6  |
| 6 dB BW   | ANSI C63.10 Subclause -11.8.1 RBW $\geq$ DTS BW   |
| 99% BW  | ANSI C63.10-2013, Subclause 6.9.3.  |
| Output Power                                      | ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)             |
| PSD   | ANSI C63.10 Subclause -11.10.3 Method AVGPSD-1  |
| Radiated emissions non-restricted frequency bands | ANSI C63.10 Subclause -11.11 & Clause 13  |
| Radiated emissions restricted frequency bands     | ANSI C63.10 Subclause -11.12.1 & Clause 13  |
| Conducted emissions in restricted frequency bands | ANSI C63.10 Subclause -11.12.2  |
| Band-edge   | ANSI C63.10 Subclause -11.13.3.2 & Clause 13: Integration method -Peak detection  |
| Band-edge   | ANSI C63.10 Subclause -11.13.3.4 & Clause 13: Integration method -Trace averaging across ON and OFF times DC correction |
| Radiated Spurious Emissions Below 30MHz           | ANSI C63.10-2013 Subclause 6.4 & Clause 13  |
| AC Power Line Conducted Emissions                 | ANSI C63.10-2013, Subclause 6.2   |

## 8. 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                        | ID Num                                 | Cal Due                           | Last Cal   |
| Antenna, Passive Loop 30Hz - 1MHz                  | ELECTRO METRICS                    | EM-6871                      | 219908                                 | 2024-09-30                        | 2023-09-13 |
| Antenna, Passive Loop 100KHz - 30MHz               | ELECTRO METRICS                    | EM-6872                      | 219910                                 | 2024-05-31                        | 2023-05-31 |
| Antenna, Broadband Hybrid, 30MHz to 2000MHz        | Sunol Sciences Corp.               | JB1                          | 80293                                  | 2024-04-30                        | 2023-04-11 |
| Amplifier, 9KHz to 1GHz, 32dB                      | SONOMA INSTRUMENT                  | 310                          | 213877                                 | 2024-12-31                        | 2023-12-27 |
| Antenna, Horn 1-18GHz (Chamber T)                  | ETS-Lindgren                       | 3117                         | 80430                                  | 2024-08-31                        | 2022-08-08 |
| Antenna, Horn 1-18GHz (Chamber J)                  | ETS-Lindgren                       | 3117                         | 222741                                 | 2024-08-31                        | 2022-08-22 |
| RF Filter Box, 1-18GHz (Chamber T)                 | UL-FR1                             | RATS 2                       | 226781                                 | 2024-09-30                        | 2023-09-30 |
| RF Filter Box, 1-18GHz (Chamber J)                 | UL-FR1                             | NA                           | 171875                                 | 2024-05-31                        | 2023-05-30 |
| EMI TEST RECEIVER (Chamber T)                      | Rohde & Schwarz                    | ESW44                        | 169935                                 | 2025-02-28                        | 2024-02-11 |
| EMI TEST RECEIVER (Chamber J)                      | Rohde & Schwarz                    | ESW44                        | 171875                                 | 2024-05-31                        | 2023-05-30 |
| Antenna, Horn 18 to 26.5GHz                        | A.R.A.                             | MWH-1826/B                   | 199659                                 | 2024-12-31                        | 2022-12-06 |
| Amplifier 18-26.5GHz, +5Vdc, -54dBm P1dB           | AMPLICAL                           | AMP18G26.5-60                | 234683                                 | *2024-03-31                       | 2023-03-18 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz               | Keysight Technologies Inc          | N9030B                       | 222074                                 | 2024-08-31                        | 2023-08-14 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz               | Keysight Technologies Inc          | N9030B                       | 222073                                 | 2024-08-31                        | 2023-08-14 |
| 10dB Fixed Attenuator, up to 26GHz                 | Pasternack Enterprises             | PE7087-10                    | 236189                                 | Verified/characterized before use |            |
| Power Meter, P-series single channel               | Keysight Technologies Inc          | N1921A                       | 90731                                  | 2025-01-31                        | 2024-01-25 |
| Power Sensor, P - series, 50MHz to 18GHz, Wideband | Keysight Technologies Inc          | N1911A                       | 90388                                  | 2024-06-30                        | 2023-06-23 |
| AC Line Conducted                                  |                                    |                              |  |                                   |            |
| LISN   | Fischer Custom Communications, Inc | FCC-LISN-50/250-25-2-01-480V | 175765                                 | 2025-01-31                        | 2024-01-26 |
| EMI TEST RECEIVER                                  | Rohde & Schwarz                    | ESR                          | 171646                                 | 2025-02-28                        | 2024-02-27 |
| Transient Limiter                                  | TE                                 | TBFL1                        | 127455                                 | 2025-02-28                        | 2024-02-27 |
| UL TEST SOFTWARE LIST                              |                                    |                              |  |                                   |            |
| Radiated Software                                  | UL                                 | UL EMC                       | Ver 2023-01-18, 2023-03-03, 2023-05-01 |                                   |            |
| Antenna Port Software                              | UL                                 | UL RF                        | Ver 2022-08-16                         |                                   |            |
| AC Line Conducted Software                         | UL                                 | UL EMC                       | Rev 9.5, 2022-02-17                    |                                   |            |

\*Test was performed before calibration due date

## 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

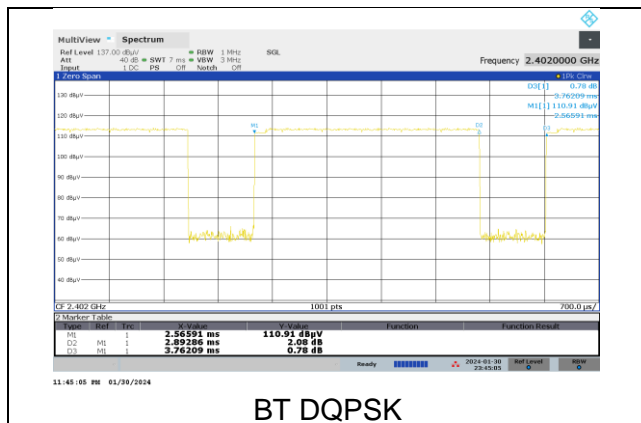
#### PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

#### ON TIME AND DUTY CYCLE RESULTS

Test Engineer: 32933 LM

| Mode   | ON Time<br>T<br>(msec) | Period<br>(msec) | Duty Cycle<br>x<br>(linear) | Duty<br>Cycle<br>(%) | DCCF<br>(dB) | 1/T<br>Minimum VBW<br>(kHz) |
|--|------------------------|------------------|-----------------------------|----------------------|--------------|-----------------------------|
| BT DQPSK                                     | 2.89286                | 3.76209          | 0.77                        | 76.90                | 1.14         | 0.35                        |
| BT 8PSK                                      | 2.88647                | 3.74647          | 0.77                        | 77.05                | 1.13         | 0.35                        |
| BLE 1Mbps                                    | 0.37653                | 0.62675          | 0.60                        | 60.08                | 2.21         | 2.66                        |
| BLE 2Mbps                                    | 1.06782                | 1.8759           | 0.57                        | 56.92                | 2.45         | 0.94                        |
| BLE 1Mbps (channel sounding, GFSK modulated) | 0.043363               | 0.288217         | 0.15                        | 15.05                | 8.23         | 23.06                       |
| BLE 2Mbps (channel sounding, GFSK modulated) | 0.025003               | 0.251497         | 0.10                        | 9.94                 | 10.03        | 40.00                       |



## 9.2. 6dB AND 99% BANDWIDTH

### 99% BANDWIDTH LIMITS

None; for reporting purposes only.

### 6dB BANDWIDTH LIMITS

FCC §15.247 (a) (2)

The minimum 6 dB bandwidth shall be at least 500 kHz.

### RESULTS

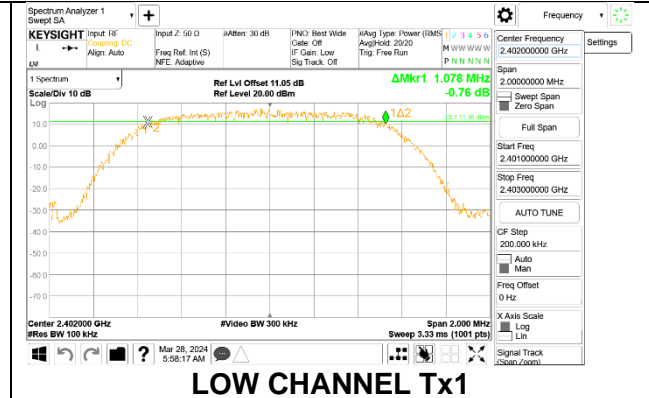
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| <b>Test Engineer:</b> | BN 24971 |
|-----------------------|----------|

### 9.2.1. BT DQPSK TXBF

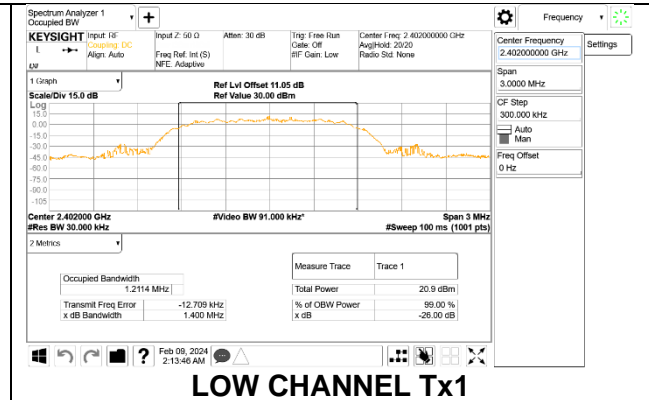
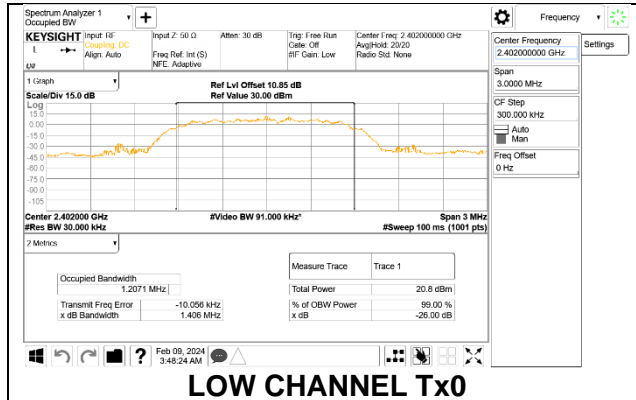
#### 2Tx

| No. of Tx | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) |       | 99% Bandwidth (MHz) |        |
|-----------|---------|-----------------|---------------------|-------|---------------------|--------|
|           |         |                 | Tx0                 | Tx1   | Tx0                 | Tx1    |
| 2         | Low     | 2402            | 1.056               | 1.078 | 1.2071              | 1.2114 |
|           | Mid     | 2441            | 1.048               | 1.010 | 1.2043              | 1.2091 |
|           | High    | 2480            | 1.004               | 1.032 | 1.2040              | 1.2093 |

#### 6dB BANDWIDTH



#### 99% BANDWIDTH



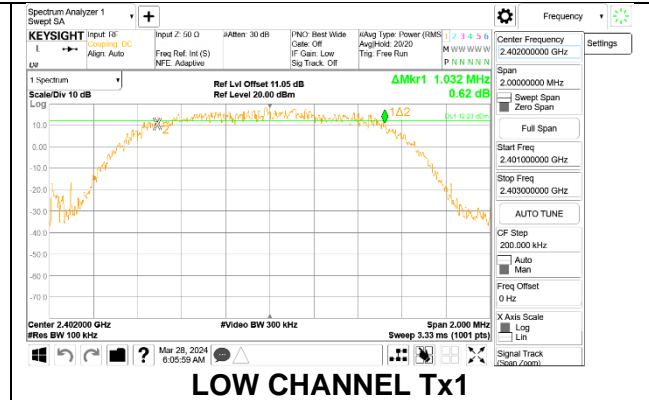
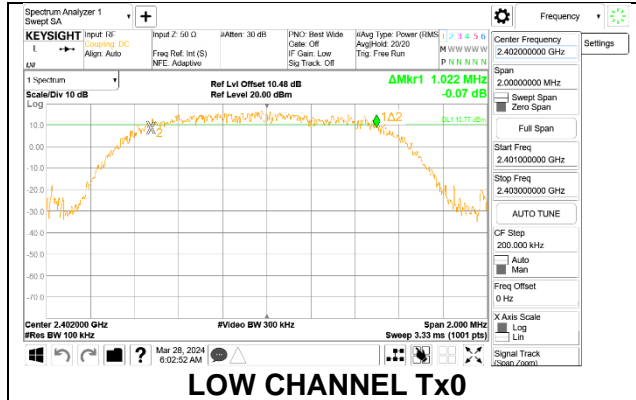


### 9.2.2. BT 8PSK TXBF

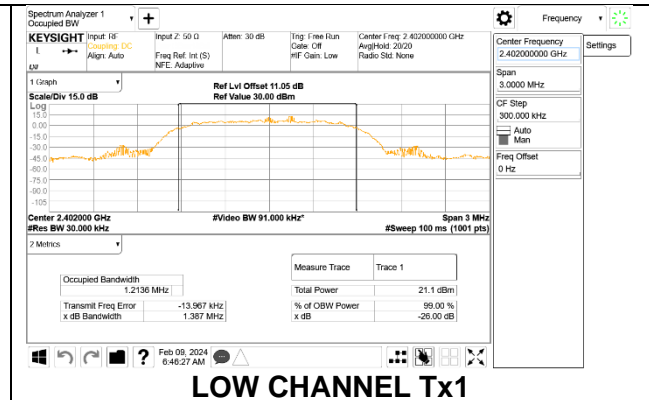
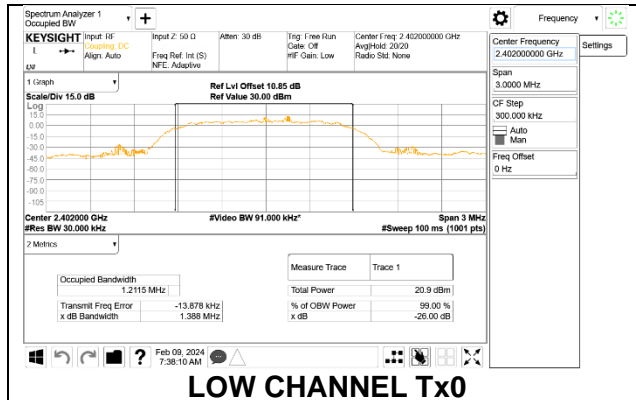
#### 2Tx

| No. of Tx | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) |       | 99% Bandwidth (MHz) |        |
|-----------|---------|-----------------|---------------------|-------|---------------------|--------|
|           |         |                 | Tx0                 | Tx1   | Tx0                 | Tx1    |
| 2         | Low     | 2402            | 1.022               | 1.032 | 1.2115              | 1.2136 |
|           | Mid     | 2441            | 1.050               | 1.032 | 1.2146              | 1.2154 |
|           | High    | 2480            | 1.050               | 1.018 | 1.2129              | 1.2149 |

#### 6dB BANDWIDTH



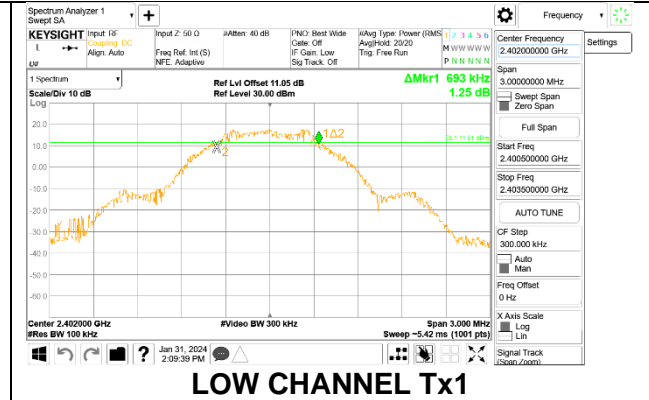
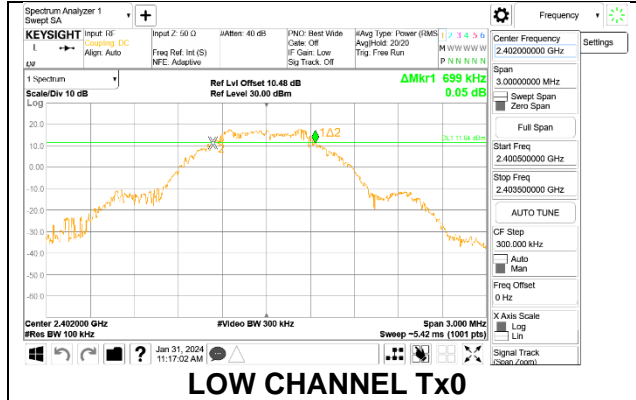
#### 99% BANDWIDTH



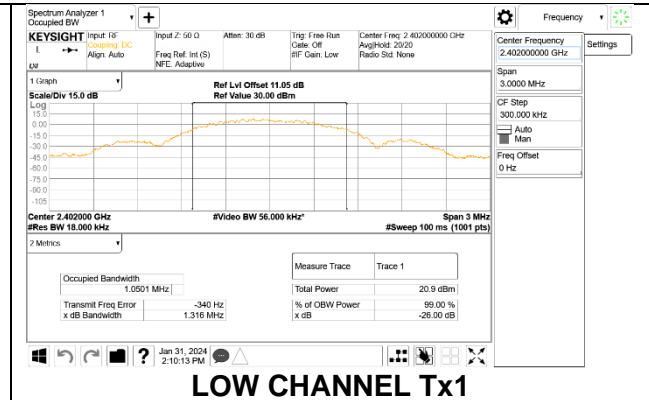
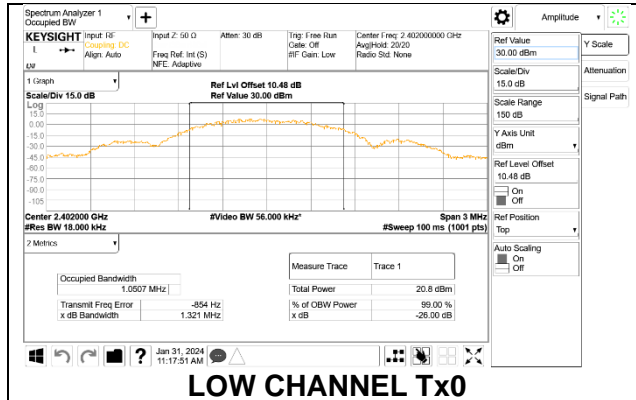
### 9.2.3. BLE TXBF 1Mbps

| No. of Tx | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) |       | 99% Bandwidth (MHz) |        |
|-----------|---------|-----------------|---------------------|-------|---------------------|--------|
|           |         |                 | Tx0                 | Tx1   | Tx0                 | Tx1    |
| 2         | Low     | 2402            | 0.699               | 0.693 | 1.0507              | 1.0501 |
|           | Mid     | 2440            | 0.690               | 0.690 | 1.0517              | 1.0519 |
|           | High    | 2480            | 0.687               | 0.693 | 1.0486              | 1.0506 |

#### 6dB BANDWIDTH



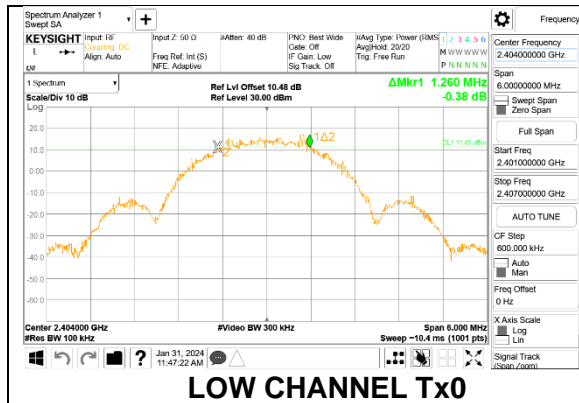
#### 99% BANDWIDTH



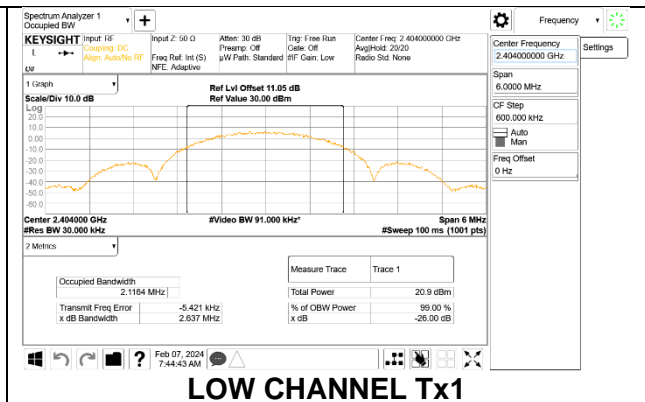
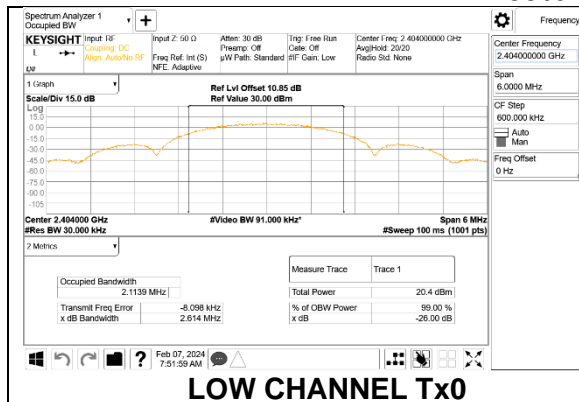
### 9.2.4. BLE TXBF 2Mbps

| No. of Tx | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) |       | 99% Bandwidth (MHz) |        |
|-----------|---------|-----------------|---------------------|-------|---------------------|--------|
|           |         |                 | Tx0                 | Tx1   | Tx0                 | Tx1    |
| 2         | Low     | 2404            | 1.260               | 1.218 | 2.1139              | 2.1164 |
|           | Mid     | 2440            | 1.242               | 1.206 | 2.1155              | 2.1195 |
|           | High    | 2478            | 1.254               | 1.266 | 2.1178              | 2.1218 |

#### 6dB BANDWIDTH



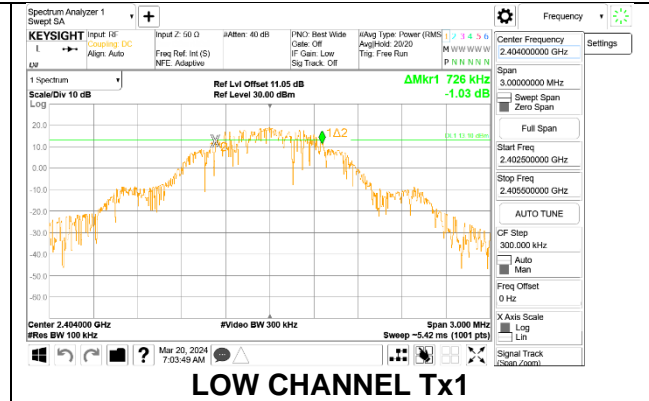
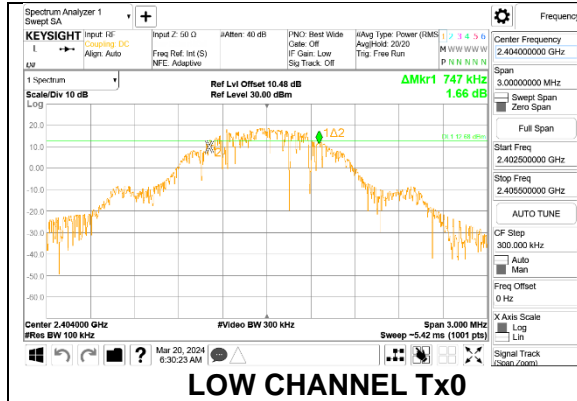
#### 99% BANDWIDTH



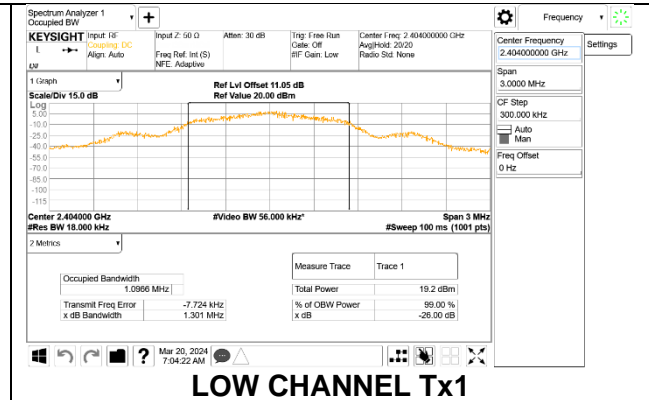
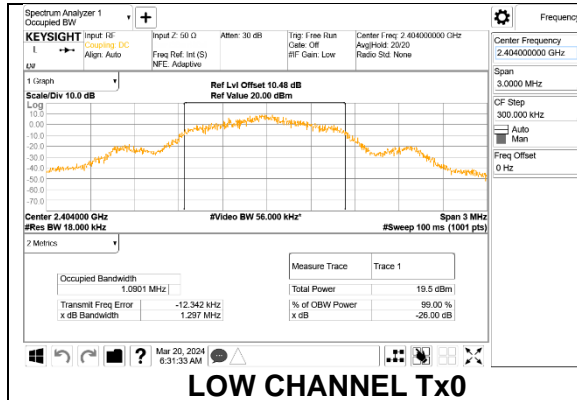
### 9.2.5. BLE 1Mbps GFSK, MODE 0 (CHANNEL SOUNDING)

| No. of Tx | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) |       | 99% Bandwidth (MHz) |        |
|-----------|---------|-----------------|---------------------|-------|---------------------|--------|
|           |         |                 | Tx0                 | Tx1   | Tx0                 | Tx1    |
| 1         | Low     | 2404            | 0.747               | 0.726 | 1.0901              | 1.0966 |
|           | Mid     | 2440            | 0.636               | 0.612 | 1.0983              | 1.0935 |
|           | High    | 2478            | 0.666               | 0.666 | 1.0945              | 1.0962 |

#### 6dB BANDWIDTH



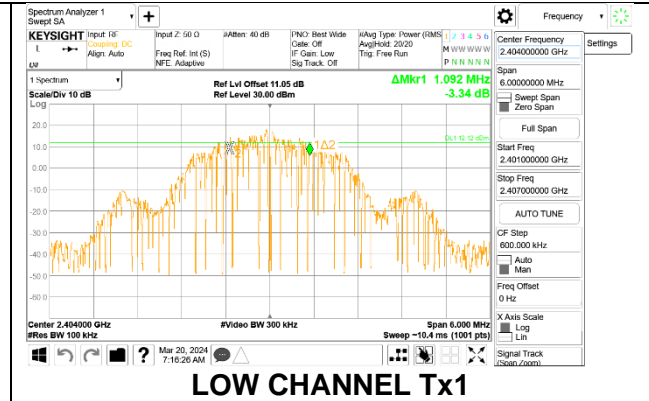
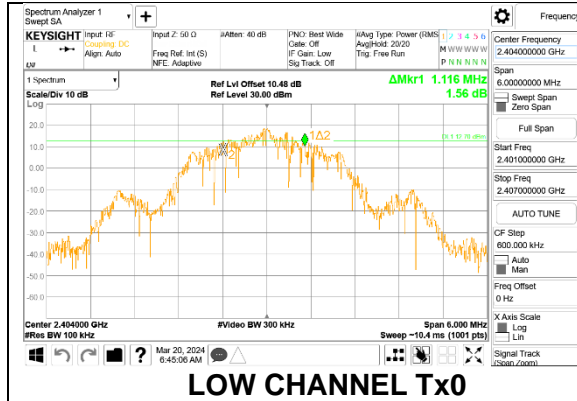
#### 99% BANDWIDTH



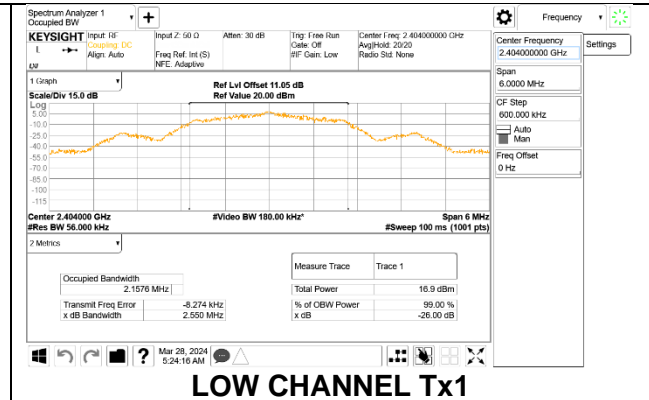
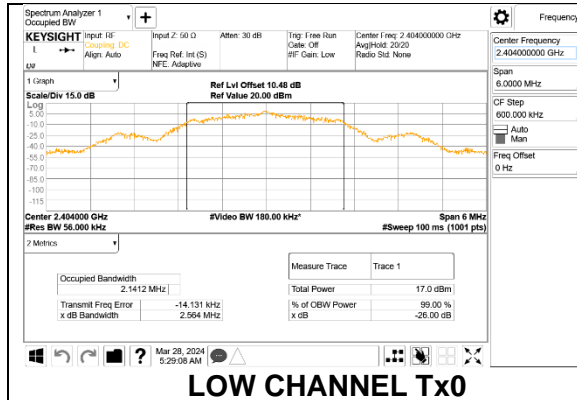
### 9.2.6. BLE 2Mbps GFSK, MODE 0 (CHANNEL SOUNDING)

| No. of Tx | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) |       | 99% Bandwidth (MHz) |        |
|-----------|---------|-----------------|---------------------|-------|---------------------|--------|
|           |         |                 | Tx0                 | Tx1   | Tx0                 | Tx1    |
| 1         | Low     | 2404            | 1.116               | 1.092 | 2.1412              | 2.1576 |
|           | Mid     | 2440            | 1.026               | 1.116 | 2.1429              | 2.1331 |
|           | High    | 2478            | 0.930               | 1.026 | 2.1486              | 2.1496 |

#### 6dB BANDWIDTH



#### 99% BANDWIDTH



### **9.3. OUTPUT POWER & POWER SPECTRAL DENSITY**

#### **OUTPUT POWER LIMITS**

FCC §15.247 (b) (3)

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

#### **AVERAGE OUTPUT POWER TEST PROCEDURE**

The transmitter output is connected to a power meter.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband power sensor. Gated average output power was read directly from power meter.

#### **POWER DENSITY**

##### **LIMITS**

FCC §15.247 (e)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 30 kHz band during any time interval of continuous transmission.

**DIRECTIONAL GAIN CALCULATION:**

For 1 TX:

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

| Band (GHz)                              | Antenna Gain (dBi) | Uncorrelated Directional Gain (dBi) | Correlated Directional Gain (dBi) | FCC Power Limit (dBm) | ISED Power Limit (dBm) | FCC/ISED Power Limit (dBm) | FCC/ISED PSD Limit (dBm/3kHz) |
|---|--------------------|-------------------------------------|-----------------------------------|-----------------------|------------------------|----------------------------|-------------------------------|
| BLE GFSK, MODE 0 (Channel Sounding) Tx0 | -1.10              | -1.10                               | -1.10                             | 30.00                 | 30.00                  | 30.00                      | 8.00                          |
| BLE GFSK, MODE 0 (Channel Sounding) Tx1 | 0.90               | 0.90                                | 0.90                              | 30.00                 | 30.00                  | 30.00                      | 8.00                          |

For 2 TX:

Tx chains are correlated for power due to the device supporting Beamforming. The directional gains are as follows:

| Band (GHz)            | Antenna Tx0 Gain (dBi) | Antenna Tx1 Gain (dBi) | Uncorrelated Directional Gain (dBi) | Correlated Directional Gain (dBi) | FCC Power Limit (dBm) | ISED Power Limit (dBm) | FCC/ISED Power Limit (dBm) | FCC/ISED PSD Limit (dBm/3kHz) |
|-----------------------|------------------------|------------------------|-------------------------------------|-----------------------------------|-----------------------|------------------------|----------------------------|-------------------------------|
| BT /BLE (Beamforming) | -1.10                  | 0.90                   | 0.01                                | 2.97                              | 30.00                 | 30.00                  | 30.00                      | 8.00                          |

**DIRECTIONAL ANTENNA GAIN CALCULATION**

ANSI C63.10-2013 section 14.4.3

Uncorrelated directional gain= $10 \cdot \text{LOG}((10^{(\text{Ant1}/10)} + 10^{(\text{Ant2}/10)})/2)$

Correlated directional Gain= $10 \cdot \text{LOG}(((10^{(\text{Ant1}/20)} + 10^{(\text{Ant2}/20)})^2)/2)$

Sample Calculation:

$\text{Tx0} = -1.1 \text{dBi}$ ,  $\text{Tx1} = 0.9 \text{dBi}$

Uncorrelated Antenna gain= $10 \log[(10^{(-1.1/10)} + 10^{(0.9/10)})/2] = 0.01 \text{dBi}$

Correlated Antenna gain= $10 \log[(10^{(-1.1/20)} + 10^{(0.9/20)})^2/2] = 2.97 \text{dBi}$

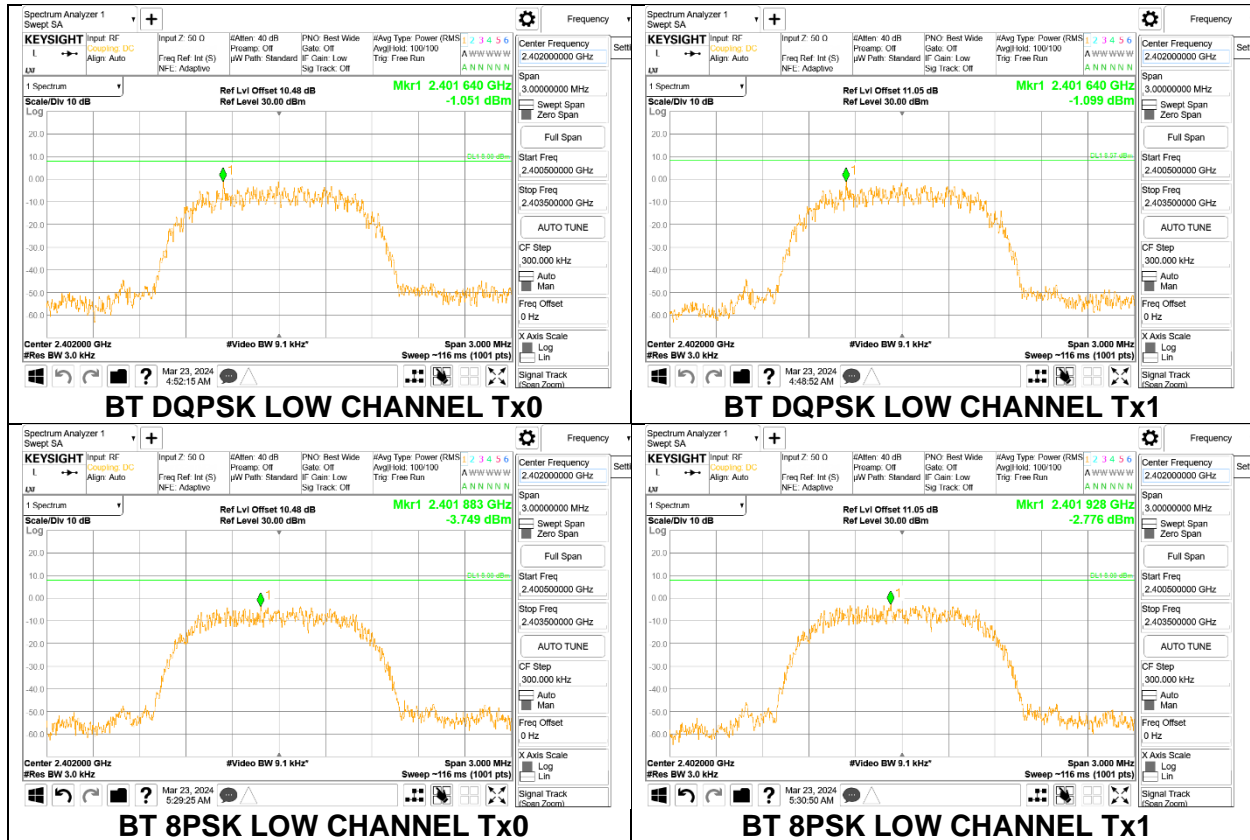
**RESULTS**

|                       |                          |
|-----------------------|--------------------------|
| <b>Test Engineer:</b> | HN 27979 & 24971 BN      |
| <b>Test Date:</b>     | 2024-03-22 TO 2024-04-08 |

**9.3.1. BT DQPSK/8PSK TXBF**

**2TX**

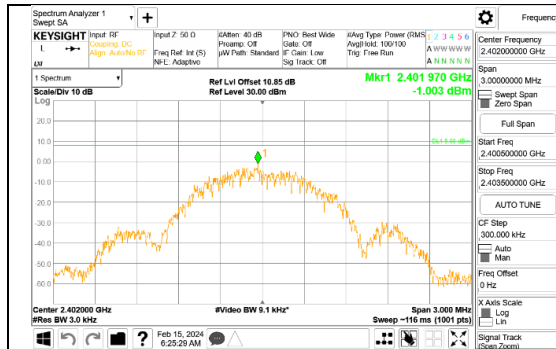
| Mode                   | No. of Tx | Channel | Freq (MHz) | Measured Conducted Avg Power (dBm) | Measured Conducted Avg Power (dBm) | Measured Total Conducted Avg Power (dBm) | Output Power Limit (dBm) | Output Power Margin (dB) | Measured PSD (dBm/3kHz) | Measured PSD (dBm/3kHz) | Measured Corrected Total PSD with DCCF (dBm/3kHz) | PSD Limit (dBm/3kHz) | PSD Margin (dB) |
|------------------------|-----------|---------|------------|------------------------------------|------------------------------------|--|--------------------------|--------------------------|-------------------------|-------------------------|---|----------------------|-----------------|
|                        |           |         |            | Tx0                                | Tx1                                |  |                          | Tx0                      | Tx1                     |                         |   |                      |                 |
| BT DQPSK (Beamforming) | 2         | 2       | 2402       | 17.60                              | 17.10                              | 20.37                                    | 30.00                    | -9.63                    | -1.051                  | -1.099                  | 3.08  | 8.00                 | -4.92           |
|                        |           | 39      | 2441       | 18.05                              | 17.58                              | <b>20.83</b>                             | 30.00                    | -9.17                    | -0.814                  | -0.969                  | 3.26  | 8.00                 | -4.74           |
|                        |           | 76      | 2480       | 18.02                              | 17.07                              | 20.58                                    | 30.00                    | -9.42                    | -1.800                  | -1.602                  | 2.45  | 8.00                 | -5.55           |
| BT 8PSK (Beamforming)  | 2         | 2       | 2402       | 17.60                              | 17.05                              | 20.34                                    | 30.00                    | -9.66                    | -3.749                  | -2.776                  | 0.91  | 8.00                 | -7.09           |
|                        |           | 39      | 2441       | 18.05                              | 17.78                              | <b>20.93</b>                             | 30.00                    | -9.07                    | -3.584                  | -2.343                  | 1.22  | 8.00                 | -6.78           |
|                        |           | 76      | 2480       | 18.01                              | 17.05                              | 20.57                                    | 30.00                    | -9.43                    | -3.395                  | -2.782                  | 1.07  | 8.00                 | -6.93           |





### 9.3.2. BLE TXBF 1Mbps/2Mbps

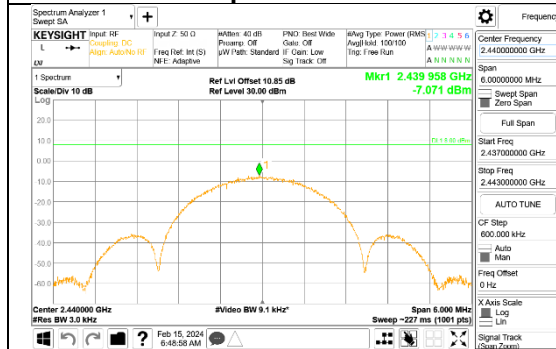
| Mode                    | No. of Tx | Channel | Freq (MHz) | Measured Conducted Avg Power (dBm) Tx0 | Measured Conducted Avg Power (dBm) Tx1 | Measured Total Conducted Avg Power (dBm) | Output Power Limit (dBm) | Output Power Margin (dB) | Measured PSD (dBm/3kHz) Tx0 | Measured PSD (dBm/3kHz) Tx1 | Measured Corrected Total PSD with DCCF (dBm/3kHz) | PSD Limit (dBm/3kHz) | PSD Margin (dB) |
|-------------------------|-----------|---------|------------|--|--|--|--------------------------|--------------------------|-----------------------------|-----------------------------|---|----------------------|-----------------|
| BLE 1Mbps (Beamforming) | 2         | 0       | 2402       | 18.15                                  | 17.77                                  | 20.97                                    | 30.00                    | -9.03                    | -1.003                      | -1.394                      | 4.03  | 8.00                 | -3.97           |
|                         |           | 19      | 2440       | 18.91                                  | 19.07                                  | 22.00                                    | 30.00                    | -8.00                    | -1.536                      | -3.708                      | 2.74  | 8.00                 | -5.26           |
|                         |           | 39      | 2480       | 18.93                                  | 18.56                                  | 21.76                                    | 30.00                    | -8.24                    | -1.684                      | -1.296                      | 3.74  | 8.00                 | -4.26           |
| BLE 2Mbps (Beamforming) | 2         | 1       | 2404       | 18.28                                  | 17.87                                  | 21.09                                    | 30.00                    | -8.91                    | -7.740                      | -7.358                      | -2.09   | 8.00                 | -10.09          |
|                         |           | 19      | 2440       | 19.06                                  | 19.18                                  | 22.13                                    | 30.00                    | -7.87                    | -7.071                      | -6.752                      | -1.45   | 8.00                 | -9.45           |
|                         |           | 38      | 2478       | 19.06                                  | 18.69                                  | 21.89                                    | 30.00                    | -8.11                    | -7.967                      | -6.781                      | -1.88   | 8.00                 | -9.88           |



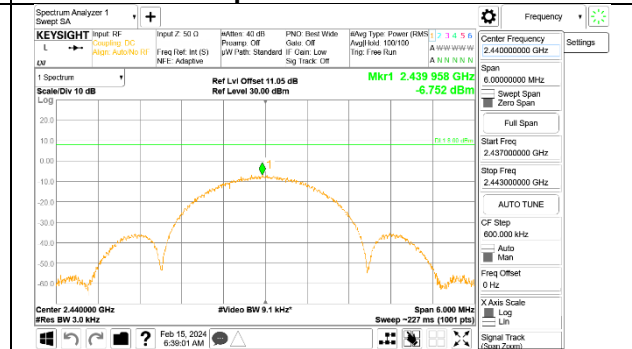
BLE 1Mbps LOW CHANNEL Tx0



BLE 1Mbps LOW CHANNEL Tx1



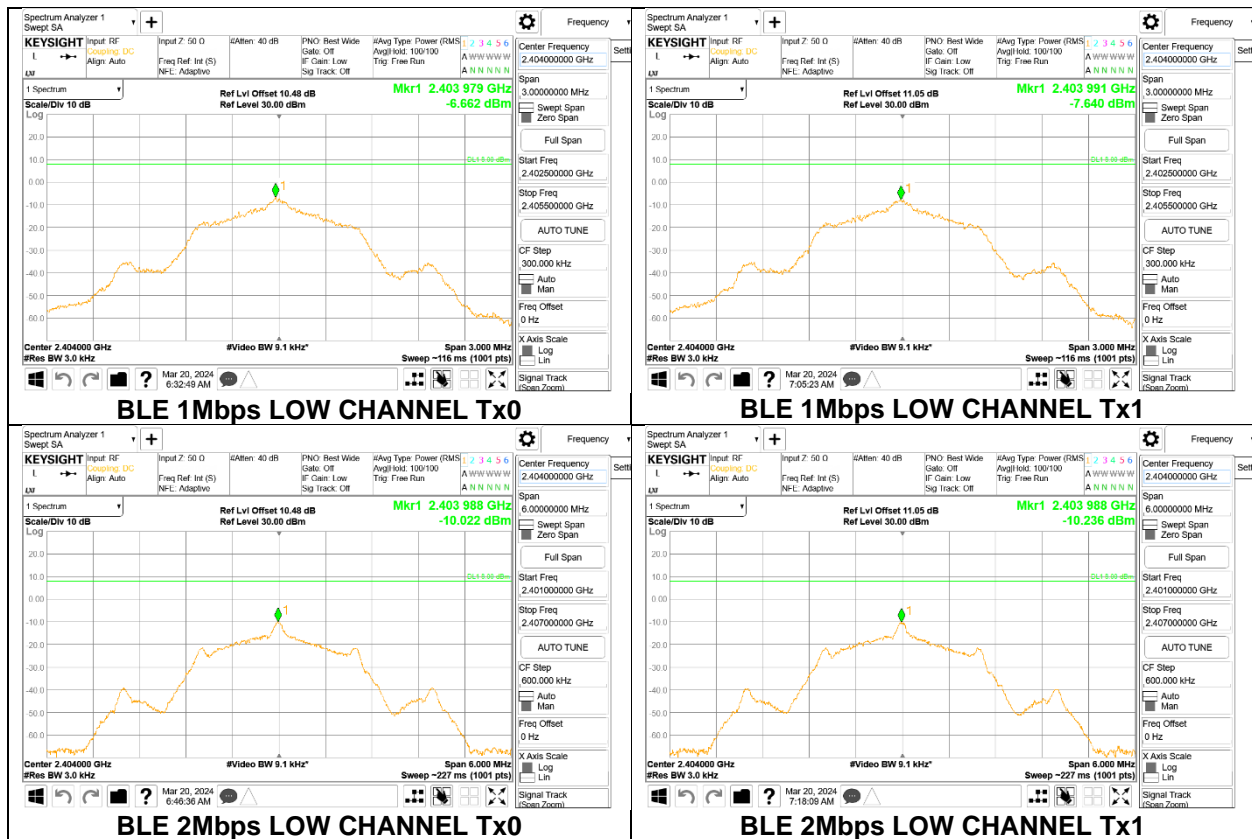
BLE 2Mbps LOW CHANNEL Tx0



BLE 2Mbps LOW CHANNEL Tx1

### 9.3.3. BLE 1Mbps/2Mbps GFSK, MODE 0 (CHANNEL SOUNDING)

| Mode   | No. of Tx | Channel | Freq (MHz) | Measured Conducted Avg Power (dBm) | Output Power Limit (dBm) | Output Power Margin (dB) | Measured PSD (dBm/3kHz) | Measured Corrected Total PSD with DCCF (dBm/3kHz) | PSD Limit (dBm/3kHz) | PSD Margin (dB) |
|--|-----------|---------|------------|------------------------------------|--------------------------|--------------------------|-------------------------|---|----------------------|-----------------|
| BLE 1Mbps (channel sounding, GFSK modulated) | 1 (Tx0)   | 1       | 2404       | 19.58                              | 30.00                    | -10.42                   | -6.662                  | 1.564   | 8.00                 | -6.44           |
|  |           | 19      | 2440       | 19.71                              | 30.00                    | -10.29                   | -6.87                   | 1.564   | 8.00                 | -6.44           |
|  |           | 38      | 2478       | 18.74                              | 30.00                    | -11.26                   | -8.137                  | 0.089   | 8.00                 | -7.91           |
|  | 1 (Tx1)   | 1       | 2404       | <b>19.98</b>                       | 30.00                    | -10.02                   | -7.640                  | 0.586   | 8.00                 | -7.41           |
|  |           | 19      | 2440       | 19.76                              | 30.00                    | -10.24                   | -7.470                  | 0.756   | 8.00                 | -7.24           |
|  |           | 38      | 2478       | 19.95                              | 30.00                    | -10.05                   | -6.869                  | 1.357   | 8.00                 | -6.64           |
| BLE 2Mbps (channel sounding, GFSK modulated) | 1 (Tx0)   | 1       | 2404       | 19.73                              | 30.00                    | -10.27                   | -10.022                 | 0.003   | 8.00                 | -8.00           |
|  |           | 19      | 2440       | 19.84                              | 30.00                    | -10.16                   | -9.747                  | 0.278   | 8.00                 | -7.72           |
|  |           | 38      | 2478       | 18.87                              | 30.00                    | -11.13                   | -10.491                 | -0.466  | 8.00                 | -8.47           |
|  | 1 (Tx1)   | 1       | 2404       | 19.62                              | 30.00                    | -10.38                   | -10.236                 | -0.211  | 8.00                 | -8.21           |
|  |           | 19      | 2440       | 19.92                              | 30.00                    | -10.08                   | -9.853                  | 0.172   | 8.00                 | -7.83           |
|  |           | 38      | 2478       | <b>20.00</b>                       | 30.00                    | -10.00                   | -9.478                  | 0.547   | 8.00                 | -7.45           |



## 9.4. CONDUCTED SPURIOUS EMISSIONS

### LIMITS

FCC §15.247 (d)

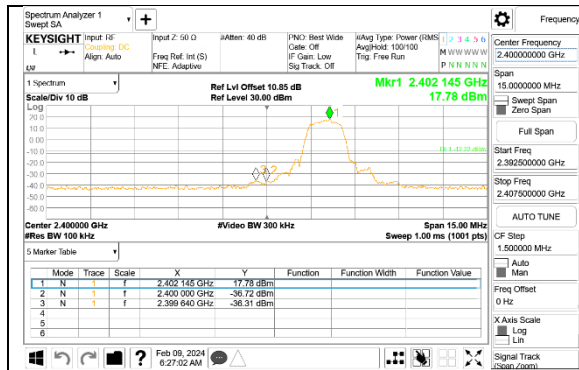
Output power was measured based on the use of a average measurement, therefore the required attenuation is 30 dBc.

### RESULTS

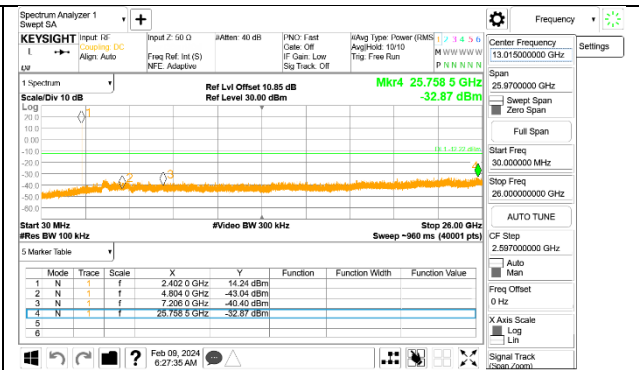
|                       |          |
|-----------------------|----------|
| <b>Test Engineer:</b> | HN 27979 |
|-----------------------|----------|

### 9.4.1. BT DQPSK TXBF

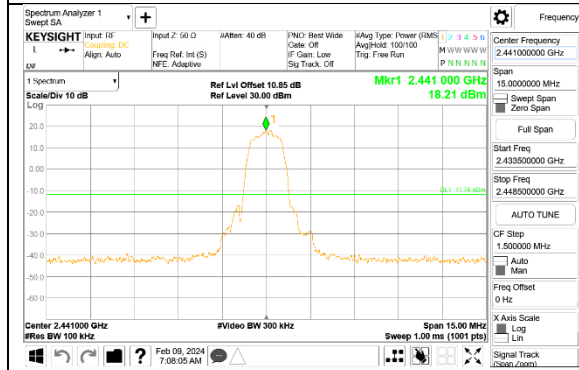
#### Tx0



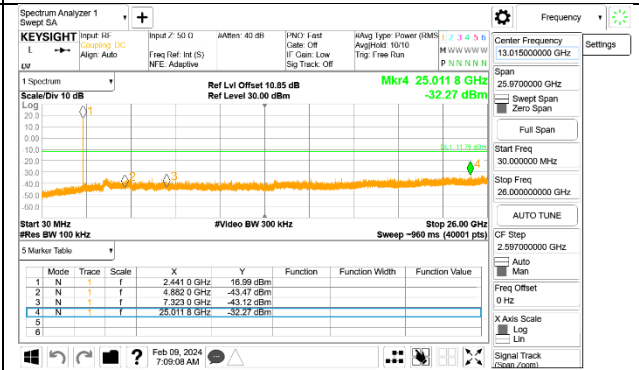
**LOW CHANNEL BANDEDGE**



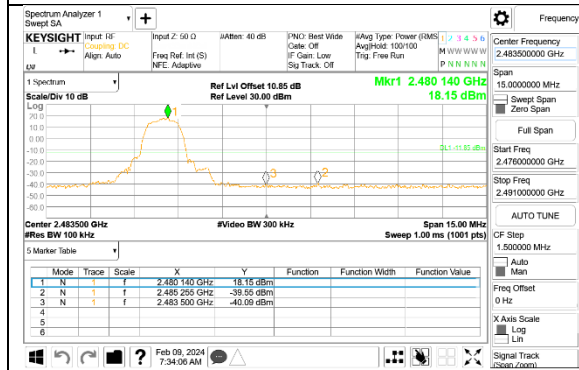
**OUT-OF-BAND LOW CHANNEL**



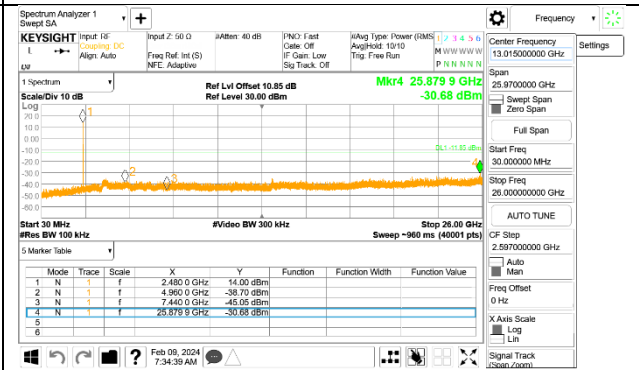
**IN-BAND REFERENCE LEVEL**



**OUT-OF-BAND MID CHANNEL**

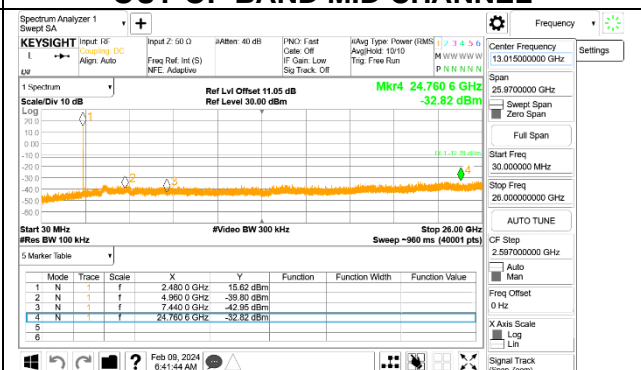
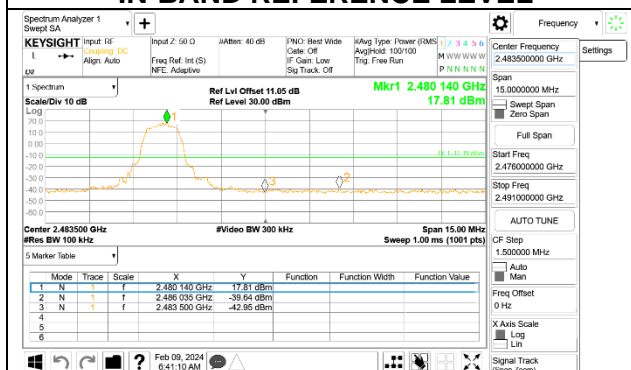
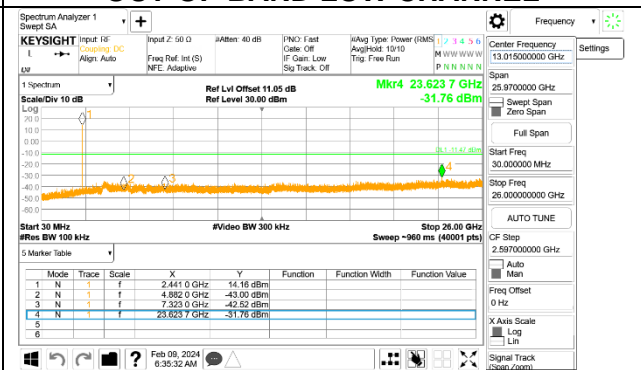
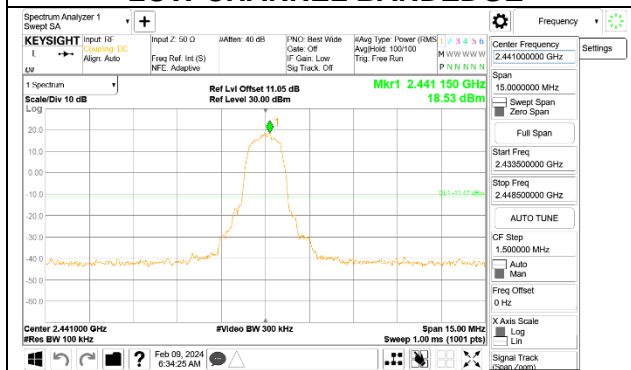
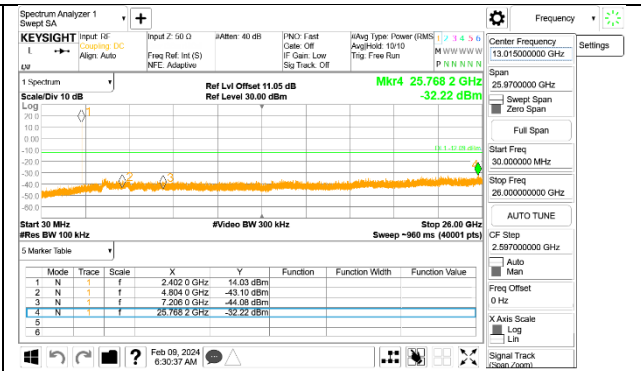
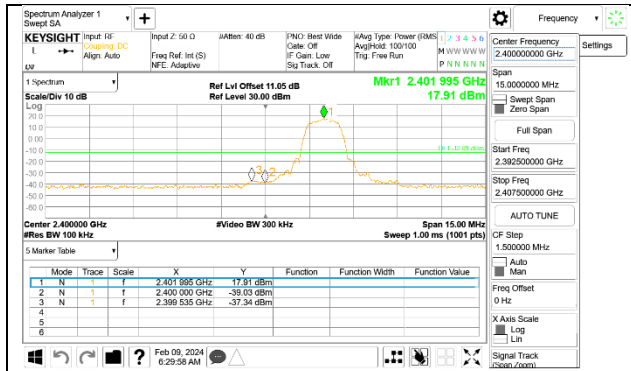


**HIGH CHANNEL BANDEDGE**



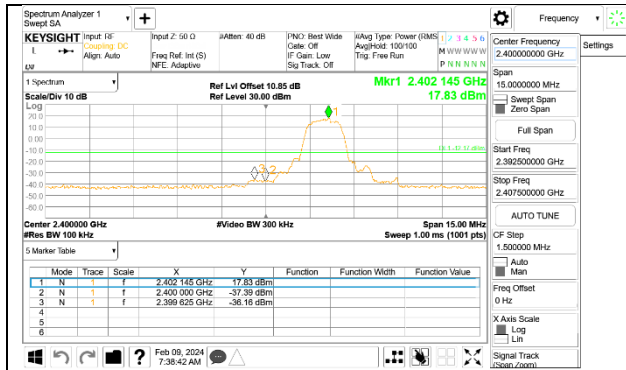
**OUT-OF-BAND HIGH CHANNEL**

Tx1

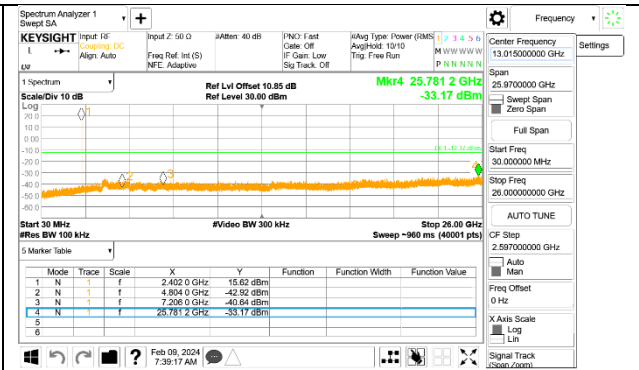


### 9.4.2. BT 8PSK TXBF

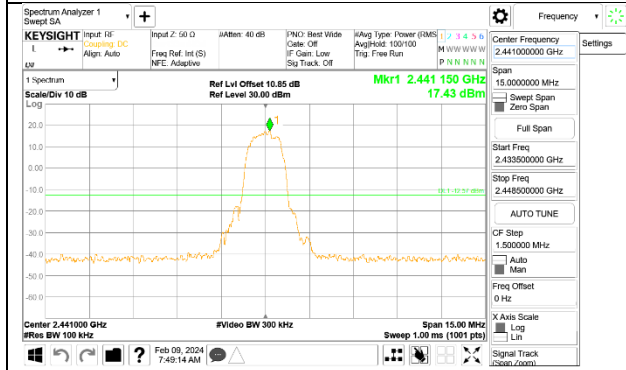
Tx0



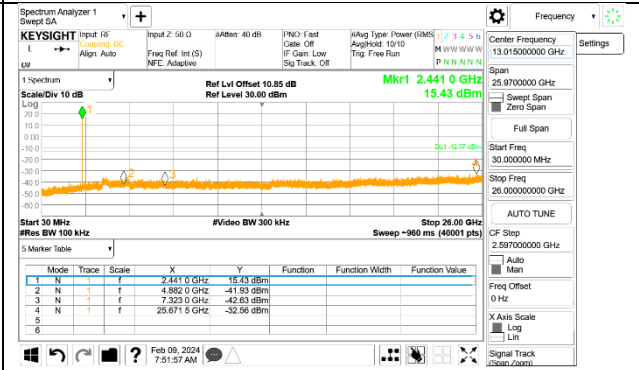
**LOW CHANNEL BANDEDGE**



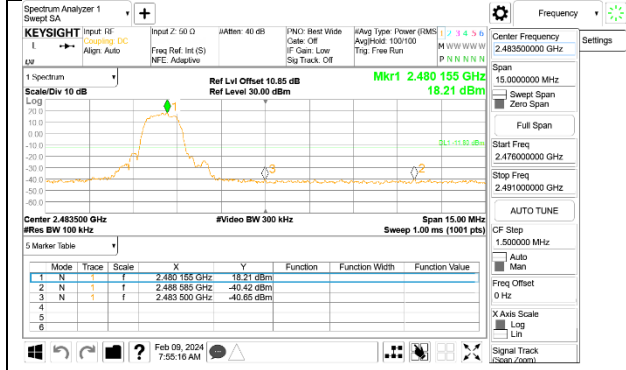
**OUT-OF-BAND LOW CHANNEL**



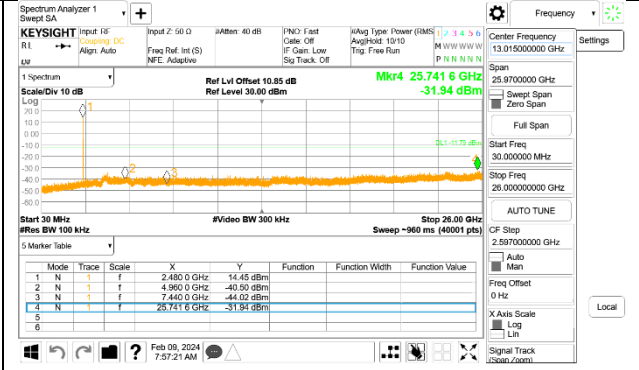
**IN-BAND REFERENCE LEVEL**



**OUT-OF-BAND MID CHANNEL**

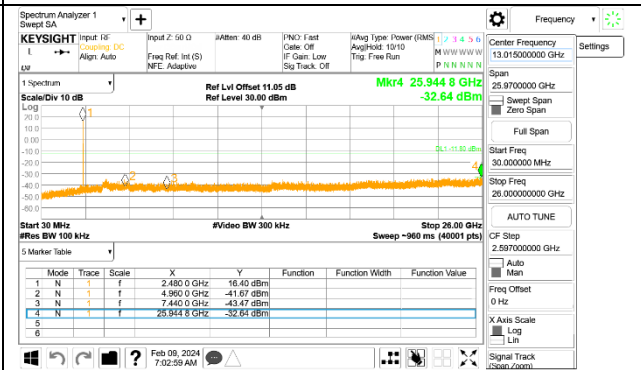
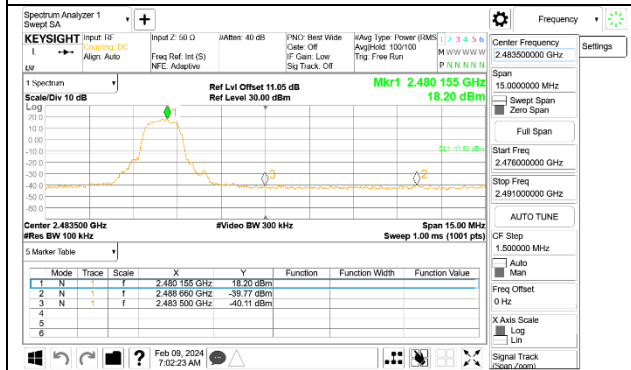
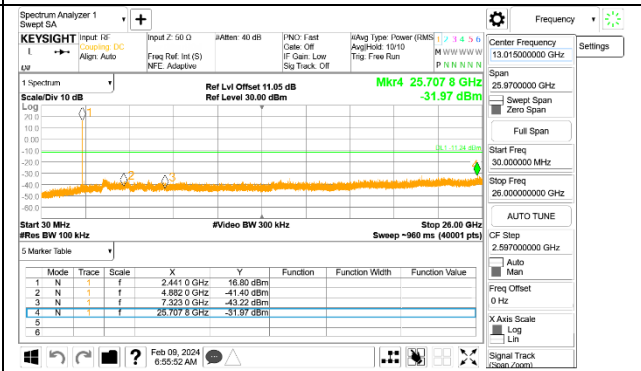
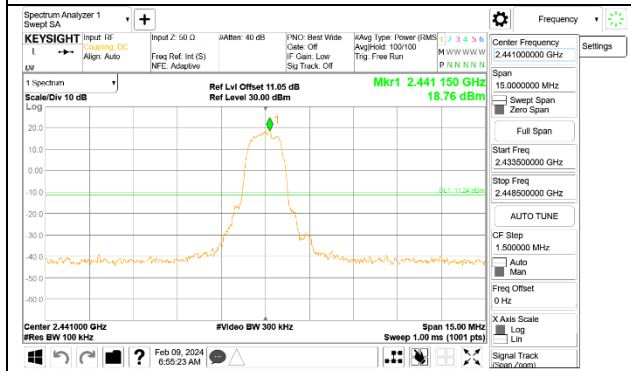
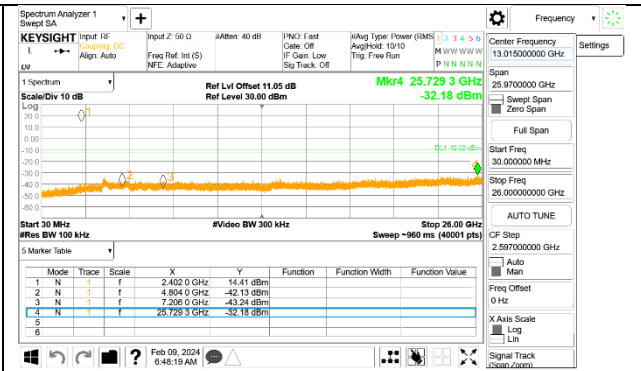
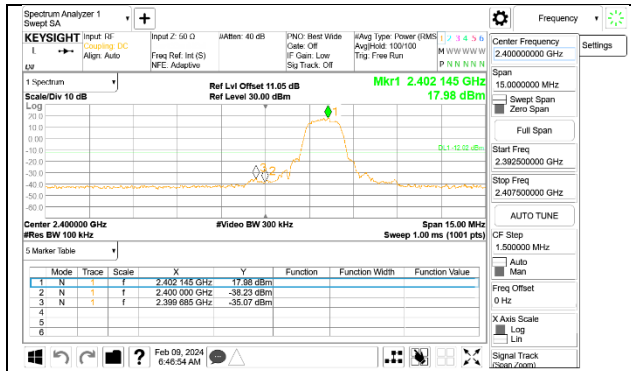


**HIGH CHANNEL BANDEDGE**



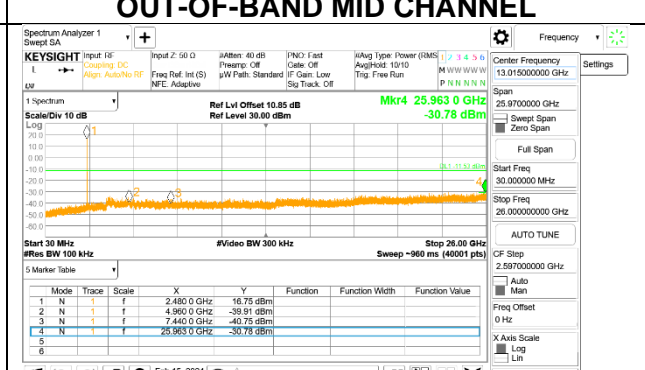
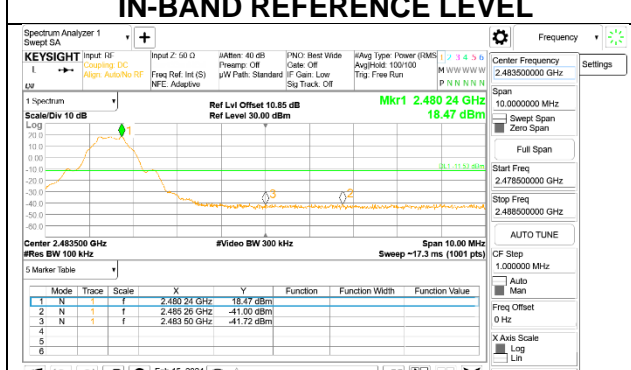
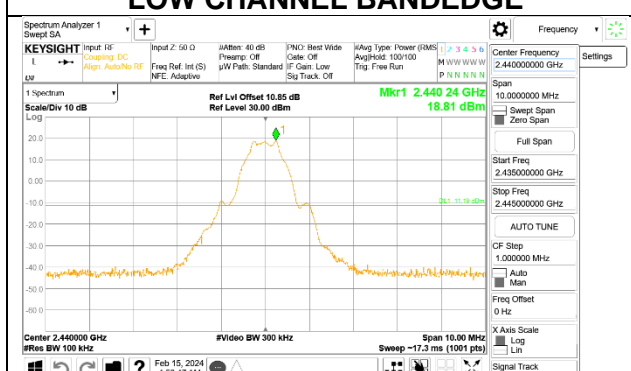
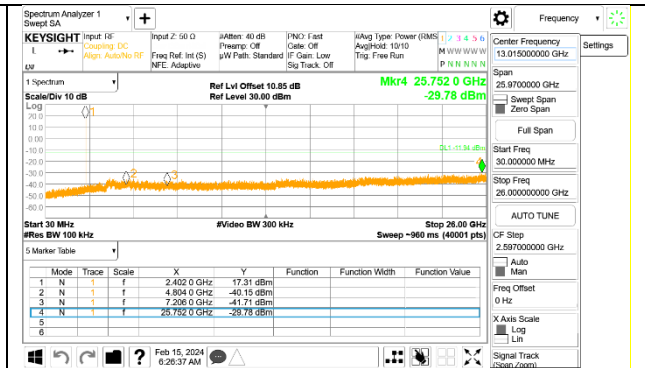
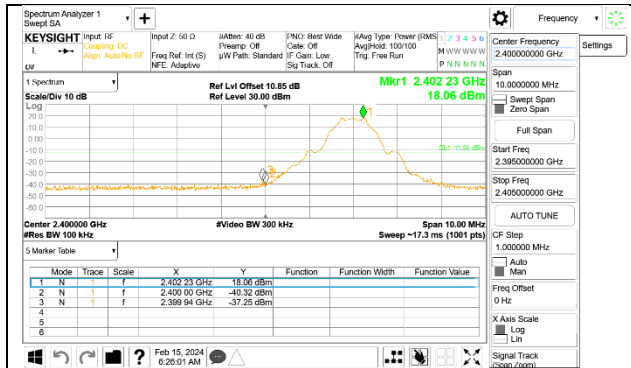
**OUT-OF-BAND HIGH CHANNEL**

Tx1



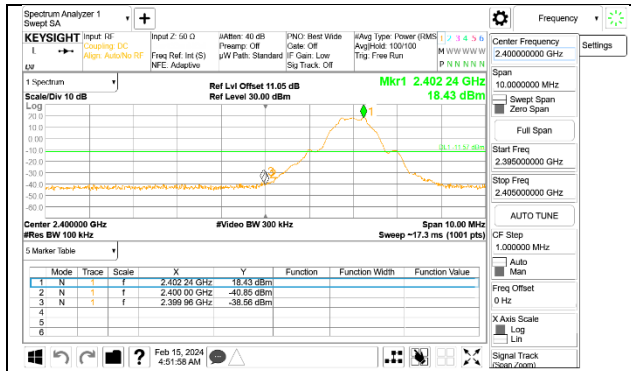
### 9.4.3. BLE 1Mbps TXBF

#### Tx0

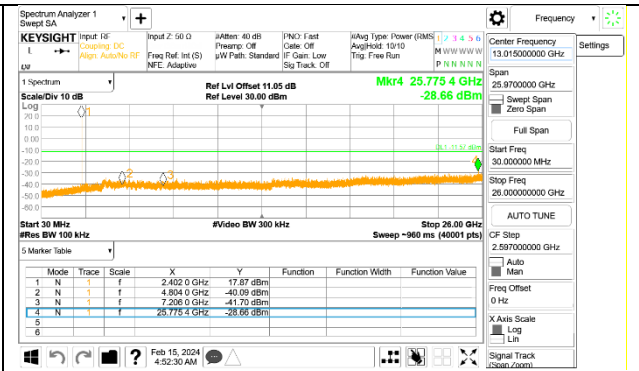




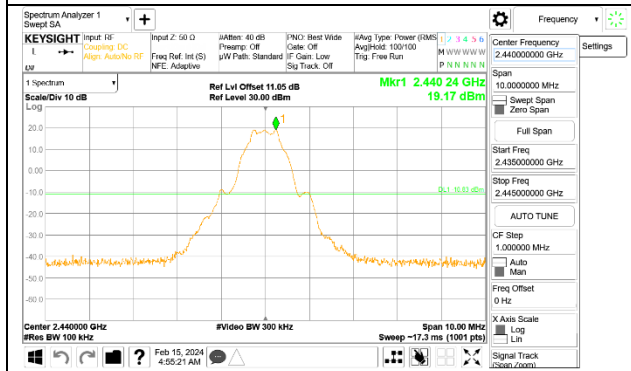
Tx1



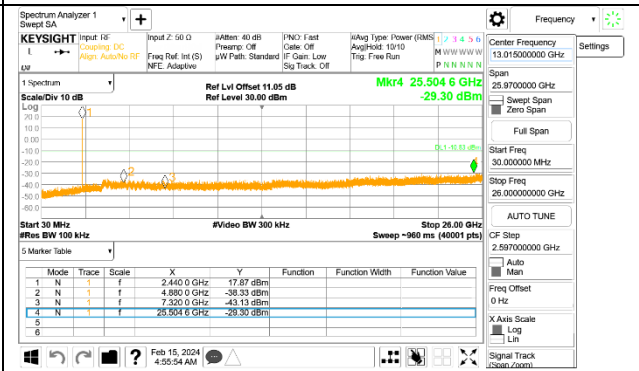
LOW CHANNEL BANDEDGE



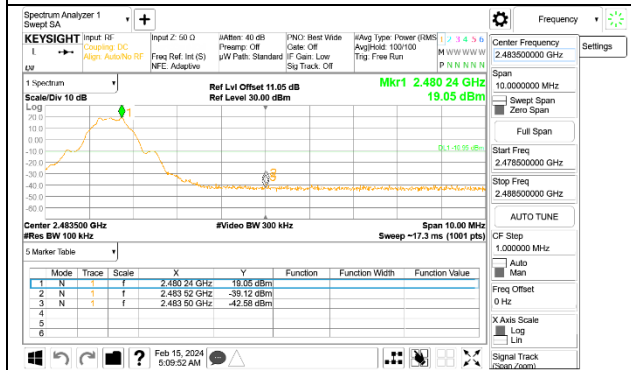
OUT-OF-BAND LOW CHANNEL



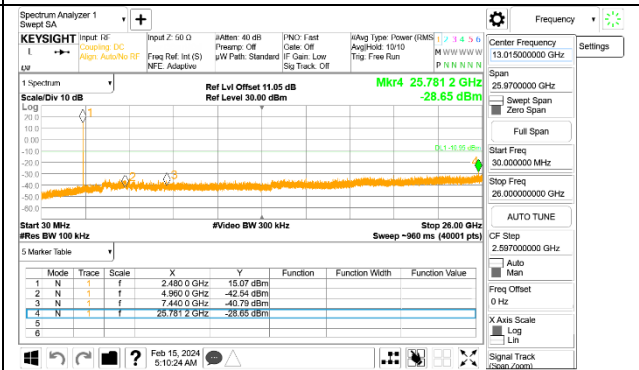
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

### 9.4.4. BLE 2Mbps TXBF

**Tx0**

