# TEST REPORT

| | | |
|---|---|---|
| **APPLICANT** | : | MiMOMax Wireless Limited |
| **PRODUCT NAME** | : | 900MHz TornadoXR Transceiver |
| **MODEL NAME** | : | MWL-TORNADOX-*G*A/B/C |
| **BRAND NAME** | : | Ubiik Mimomax |
| **FCC ID** | : | XMK-MMXTRNXB007 |
| **STANDARD(S)** | : | 47 CFR Part 2<br>47 CFR Part 24 |
| **RECEIPT DATE** | : | 2024-02-01 |
| **TEST DATE** | : | 2024-02-21 to 2024-02-28 |
| **ISSUE DATE** | : | 2024-03-13 |

Tested by: Gan Jing

Gan Jing ( Rapporteur)

Approved by: Shen Junsheng

Shen Junsheng( Supervisor)

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MORLAB

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| Change History | | |
|---|---|---|
| Issue | Date | Reason for change |
| 1.0 | 2024-03-13 | First edition |

# 1. Technical Information

**Note:** Provide by applicant.

## 1.1. Applicant and Manufacturer Information

| | |
|---|---|
| **Applicant:** | MiMOMax Wireless Limited |
| **Applicant Address:** | 540 Wairakei Road, Christchurch 8053, New Zealand |
| **Manufacturer:** | MiMOMax Wireless Limited |
| **Manufacturer Address:** | 540 Wairakei Road, Christchurch 8053, New Zealand |

## 1.2. Equipment Under Test (EUT) Description

| | | |
|---|---|---|
| **Product Name:** | 900MHz TornadoXR Transceiver | |
| **EUT Serial No:** | (N/A, marked 1# by test site) | |
| **Hardware Version:** | P001 | |
| **Software Version:** | TRN_04.08.04 | |
| **Operating Frequency Range:** | 901-902 MHz, 2Tx/2Rx | |
| **Channel Bandwidth:** | 12.5kHz; 25kHz; 50kHz | |
| **Modulation Type:** | QPSK; 16QAM; 64QAM; 256QAM | |
| **Operating Voltage:** | 10.5-60V | |
| **Antenna Gain:** | Omni Antenna | 2.5 dBi |
| | | 4.0 dBi |
| | | 6.0 dBi |
| | Panel Antenna | 8.0 dBi |
| | | 10.0 dBi |
| | | 12.0 dBi |
| | | 16.0 dBi |
| **Emission Designator:** | BW(kHz) | Designator |
| | 12.5kHz | 10K0W1W |
| | 25.0kHz | 20K0W1W |
| | 50.0kHz | 42K0W1W |

## 1.3. Test Standards and Results

The objective of the report is to perform testing according to 47 CFR Part 2 and Part 24 for the EUT FCC ID Certification:

| No. | Identity | Document Title |
|---|---|---|
| 1 | 47 CFR Part 2 | Frequency Allocations and Radio Treaty Matters; General Rules and Regulations |
| 2 | 47 CFR Part 24 | Personal Communications Services |

Test detailed items/section required by FCC rules and results are listed as below:

| Section | Description | Test Engineer | Result | Method Determination /Remark |
|---|---|---|---|---|
| 2.1046<br>24.132 | Transmitter Conducted Output Power and ERP/EIRP | Gan Jing | PASS | No deviation |
| 2.1049 | Occupied Bandwidth | Gan Jing | PASS | No deviation |
| 2.1051<br>24.133 | Conducted Spurious Emissions | Gan Jing | PASS | No deviation |
| 2.1053<br>24.133 | Radiated Spurious Emissions | Li Hanbin | PASS | No deviation |
| 2.1055<br>24.135 | Frequency stability | Gan Jing | PASS | No deviation |

**Note 1:** The TornadoXR Transceiver complies with FCC 47 CFR Part 2 and Part 24 when tested in accordance with the test methods described in 47 CFR Part 2 and Part 24.

**Note 2:** The TornadoXR Transceiver supports 2 Tx antenna ports, which was defined as Channel H &Channel V separately.

**Note 3:** The path loss during the conducted RF test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.7dB and attenuator of 30.0dB.

**Note 4:** When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

**Note 5:** The prototype has two kinds of power under different conditions, we define Type 1 in the case of 28dBm power and Type 2 in the case of 34dBm power

## 1.4. Environmental Conditions

During the measurement, the environmental conditions were within the listed ranges:

| | |
|---|---|
| Temperature (°C): | 15 - 35 |
| Relative Humidity (%): | 30 -60 |

# 2. 47 CFR Part 2 and Part 24 Requirements

## 2.1. Radio Frequency Power Output and E.R.P.

### 2.1.1. Test result

**Type 1:**

**Nominal Frequency: 901.5 MHz Tx Port: Channel H**

| Channel Bandwidth (kHz) | Modulation Type | Voltage (Vdc) | Measured Power (dBm) | Measured Power (Watt) | Rated Power (Watt) | E.R.P. (ANT Gain = 4.0dBi) | | E.R.P. (ANT Gain = 12.0dBi) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dBm | Watt | dBm | Watt |
| 12.5 | QPSK | 24 | 28.53 | 0.713 | 0.63 | 30.38 | 1.091 | 38.38 | 6.887 |
| 12.5 | 16QAM | 24 | 28.19 | 0.659 | 0.63 | 30.04 | 1.009 | 38.04 | 6.368 |
| 12.5 | 64QAM | 24 | 28.30 | 0.676 | 0.63 | 30.15 | 1.035 | 38.15 | 6.531 |
| 12.5 | 256QAM | 24 | 28.57 | 0.719 | 0.63 | 30.42 | 1.102 | 38.42 | 6.950 |
| | | | | | | | | | |
| 25.0 | QPSK | 24 | 27.49 | 0.561 | 0.63 | 29.34 | 0.859 | 37.34 | 5.420 |
| 25.0 | 16QAM | 24 | 27.39 | 0.548 | 0.63 | 29.24 | 0.839 | 37.24 | 5.297 |
| 25.0 | 64QAM | 24 | 27.45 | 0.556 | 0.63 | 29.30 | 0.851 | 37.30 | 5.370 |
| 25.0 | 256QAM | 24 | 27.53 | 0.566 | 0.63 | 29.38 | 0.867 | 37.38 | 5.470 |
| | | | | | | | | | |
| 50.0 | QPSK | 24 | 28.15 | 0.653 | 0.63 | 30.00 | 1.000 | 38.00 | 6.310 |
| 50.0 | 16QAM | 24 | 28.42 | 0.695 | 0.63 | 30.27 | 1.064 | 38.27 | 6.714 |
| 50.0 | 64QAM | 24 | 28.05 | 0.638 | 0.63 | 29.90 | 0.977 | 37.90 | 6.166 |
| 50.0 | 256QAM | 24 | 28.42 | 0.695 | 0.63 | 30.27 | 1.064 | 38.27 | 6.714 |

**Nominal Frequency: 901.5 MHz Tx Port: Channel V**

| Channel Bandwidth (kHz) | Modulation Type | Voltage (Vdc) | Measured Power (dBm) | Measured Power (Watt) | Rated Power (Watt) | E.R.P. (ANT Gain = 4.0dBi) | | E.R.P. (ANT Gain = 12.0dBi) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dBm | Watt | dBm | Watt |
| 12.5 | QPSK | 24 | 28.51 | 0.710 | 0.63 | 30.36 | 1.086 | 38.36 | 6.855 |
| 12.5 | 16QAM | 24 | 28.55 | 0.716 | 0.63 | 30.40 | 1.096 | 38.40 | 6.918 |
| 12.5 | 64QAM | 24 | 28.41 | 0.693 | 0.63 | 30.26 | 1.062 | 38.26 | 6.699 |
| 12.5 | 256QAM | 24 | 28.47 | 0.703 | 0.63 | 30.32 | 1.076 | 38.32 | 6.792 |
| | | | | | | | | | |
| 25.0 | QPSK | 24 | 27.83 | 0.607 | 0.63 | 29.68 | 0.929 | 37.68 | 5.861 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 25.0 | 16QAM | 24 | 27.53 | 0.566 | 0.63 | 29.38 | 0.867 | 37.38 | 5.470 |
| 25.0 | 64QAM | 24 | 28.14 | 0.652 | 0.63 | 29.99 | 0.998 | 37.99 | 6.295 |
| 25.0 | 256QAM | 24 | 28.26 | 0.670 | 0.63 | 30.11 | 1.026 | 38.11 | 6.471 |
| | | | | | | | | | |
| 50.0 | QPSK | 24 | 28.36 | 0.685 | 0.63 | 30.21 | 1.050 | 38.21 | 6.622 |
| 50.0 | 16QAM | 24 | 28.04 | 0.637 | 0.63 | 29.89 | 0.975 | 37.89 | 6.152 |
| 50.0 | 64QAM | 24 | 28.35 | 0.684 | 0.63 | 30.20 | 1.047 | 38.20 | 6.607 |
| 50.0 | 256QAM | 24 | 28.68 | 0.738 | 0.63 | 30.53 | 1.130 | 38.53 | 7.129 |

**Type 2:**

**Nominal Frequency: 901.5 MHz Tx Port: Channel H**

| Channel Bandwidth (kHz) | Modulation Type | Voltage (Vdc) | Measured Power (dBm) | Measured Power (Watt) | Rated Power (Watt) | E.R.P. (ANT Gain = 4.0dBi) | | E.R.P. (ANT Gain = 6.0dBi) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dBm | Watt | dBm | Watt |
| 12.5 | QPSK | 24 | 33.84 | 2.421 | 2.50 | 35.69 | 3.707 | 37.69 | 5.875 |
| 12.5 | 16QAM | 24 | 33.61 | 2.296 | 2.50 | 35.46 | 3.516 | 37.46 | 5.572 |
| 12.5 | 64QAM | 24 | 33.86 | 2.432 | 2.50 | 35.71 | 3.724 | 37.71 | 5.902 |
| 12.5 | 256QAM | 24 | 34.01 | 2.518 | 2.50 | 35.86 | 3.855 | 37.86 | 6.109 |
| | | | | | | | | | |
| 25.0 | QPSK | 24 | 33.72 | 2.355 | 2.50 | 35.57 | 3.606 | 37.57 | 5.715 |
| 25.0 | 16QAM | 24 | 33.61 | 2.296 | 2.50 | 35.46 | 3.516 | 37.46 | 5.572 |
| 25.0 | 64QAM | 24 | 33.68 | 2.333 | 2.50 | 35.53 | 3.573 | 37.53 | 5.662 |
| 25.0 | 256QAM | 24 | 34.03 | 2.529 | 2.50 | 35.88 | 3.873 | 37.88 | 6.138 |
| | | | | | | | | | |
| 50.0 | QPSK | 24 | 33.96 | 2.489 | 2.50 | 35.81 | 3.811 | 37.81 | 6.039 |
| 50.0 | 16QAM | 24 | 33.90 | 2.455 | 2.50 | 35.75 | 3.758 | 37.75 | 5.957 |
| 50.0 | 64QAM | 24 | 33.83 | 2.415 | 2.50 | 35.68 | 3.698 | 37.68 | 5.861 |
| 50.0 | 256QAM | 24 | 34.11 | 2.576 | 2.50 | 35.96 | 3.945 | 37.96 | 6.252 |

**Nominal Frequency: 901.5 MHz Tx Port: Channel V**

| Channel Bandwidth (kHz) | Modulation Type | Voltage (Vdc) | Measured Power (dBm) | Measured Power (Watt) | Rated Power (Watt) | E.R.P. (ANT Gain = 4.0dBi) | | E.R.P. (ANT Gain = 6.0dBi) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dBm | Watt | dBm | Watt |
| 12.5 | QPSK | 24 | 33.98 | 2.500 | 2.50 | 35.83 | 3.828 | 37.83 | 6.067 |
| 12.5 | 16QAM | 24 | 33.98 | 2.500 | 2.50 | 35.83 | 3.828 | 37.83 | 6.067 |
| 12.5 | 64QAM | 24 | 33.83 | 2.415 | 2.50 | 35.68 | 3.698 | 37.68 | 5.861 |
| 12.5 | 256QAM | 24 | 34.06 | 2.547 | 2.50 | 35.91 | 3.899 | 37.91 | 6.180 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 25.0 | QPSK | 24 | 33.79 | 2.393 | 2.50 | 35.64 | 3.664 | 37.64 | 5.808 |
| 25.0 | 16QAM | 24 | 33.81 | 2.404 | 2.50 | 35.66 | 3.681 | 37.66 | 5.834 |
| 25.0 | 64QAM | 24 | 33.85 | 2.427 | 2.50 | 35.70 | 3.715 | 37.70 | 5.888 |
| 25.0 | 256QAM | 24 | 34.11 | 2.576 | 2.50 | 35.96 | 3.945 | 37.96 | 6.252 |
| | | | | | | | | | |
| 50.0 | QPSK | 24 | 34.17 | 2.612 | 2.50 | 36.02 | 3.999 | 38.02 | 6.339 |
| 50.0 | 16QAM | 24 | 33.84 | 2.421 | 2.50 | 35.69 | 3.707 | 37.69 | 5.875 |
| 50.0 | 64QAM | 24 | 33.94 | 2.477 | 2.50 | 35.79 | 3.793 | 37.79 | 6.012 |
| 50.0 | 256QAM | 24 | 34.18 | 2.618 | 2.50 | 36.03 | 4.009 | 38.03 | 6.353 |

**Note1:** Measurements were carried out at the RF output terminals of the transmitter using spectrum analyzer. The path loss during the conducted RF test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.7dB and attenuator of 30.0dB.

**Note 2:** The transmitter has a rated output power of .2.512 Watt (34dBm).The measured power has been shown to be within +/- 1 dB of the rated power.

**Note3:**E.I.R.P. (dBm) = Conducted Output Power (dBm) + Antenna Gain (dBi); E.R.P. (dBm) = E.I.R.P. (dBm) - 2.15.

**Note4:** Part 24 does not specify the transmitter output power.

Stations transmitting in the 901-902 MHz band are limited to 7 watts e.r.p.

**Note 5:** The product's antenna is a special MIMO antenna with cross-polarization which is able to transmit and receive on both the vertical and horizontal polarizations at the same time, the MIMO antennas are essentially two antennas in one.

**Note 6:** According to KDB 662911, the MIMO directional gain is the gain of an individual antenna.

**Note 7:** The DUT transmitter ports are completely uncorrelated. According to KDB 662911 the conducted power or E.R.P is measured on each port individually and it complies with the regulations.

**Note 8:** This product is based on the interactive calculation of erp limits and conducted power. In the 901-902MHz range, an antenna with a maximum gain of 12dBi can be used when the conducted power is 28dBm, or an antenna with a maximum gain of 6dBi can be used when the conducted power is 34dBm to meet the erp requirements.

## 2.2. Occupied Bandwidth

### 2.2.1. Definition

**Emission Designator:**

| Frequency (MHz) | BW(kHz) | Designator |
|---|---|---|
| 901-902MHz | 12.5kHz | 10K0W1W |
| | 25.0kHz | 20K0W1W |
| | 50.0kHz | 42K0W1W |

Note: The above data combined with uncertainty and rounding calculations are consistent with the actual test data.

According to FCC section 2.1049, the occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.
Occupied bandwidth is also known as the 99% emission bandwidth.

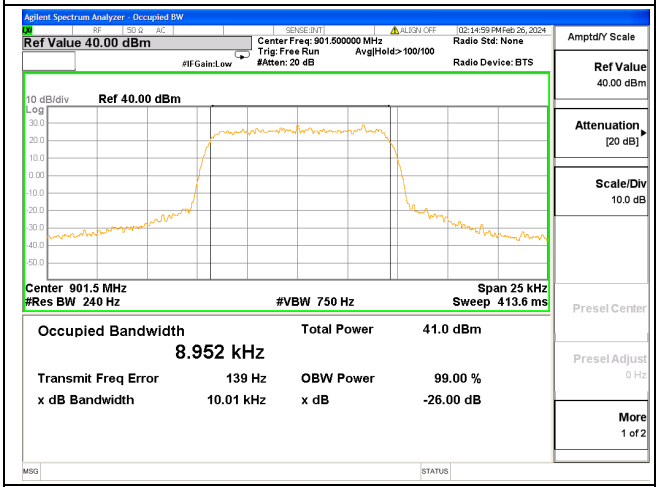
### 2.2.2. Test Description

Measurements have been made of each modulation type using a spectrum analyzer operating in occupied bandwidth mode.

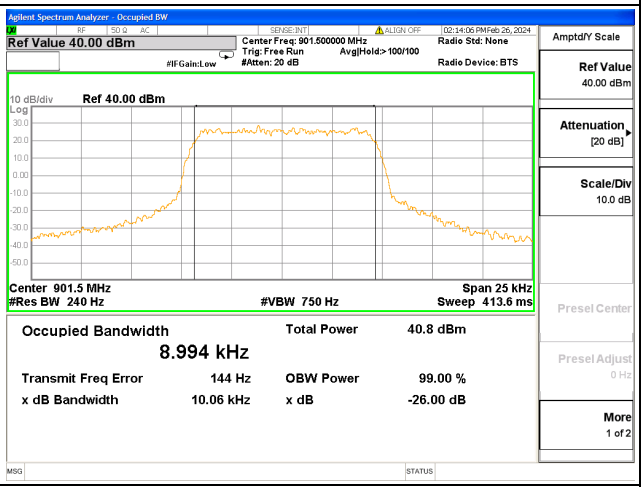
### 2.2.3. Test Result

| 901.50 MHz | | | |
|---|---|---|---|
| **Tx Port** | **Channel Bandwidth(kHz)** | **Emission Type** | **Occupied Bandwidth(kHz)** |
| **H** | 12.5 | QPSK | 8.952 |
| | | 16QAM | 8.994 |
| | | 64QAM | 9.024 |
| | | 256QAM | 9.014 |
| | 25.0 | QPSK | 18.689 |
| | | 16QAM | 18.719 |
| | | 64QAM | 18.772 |
| | | 256QAM | 18.698 |
| | 50.0 | QPSK | 41.387 |
| | | 16QAM | 41.277 |
| | | 64QAM | 41.180 |
| | | 256QAM | 41.446 |
| | | | |
| **V** | 12.5 | QPSK | 9.059 |
| | | 16QAM | 8.987 |
| | | 64QAM | 9.041 |
| | | 256QAM | 9.044 |
| | 25.0 | QPSK | 18.782 |
| | | 16QAM | 18.774 |
| | | 64QAM | 18.634 |
| | | 256QAM | 18.817 |
| | 50.0 | QPSK | 41.633 |
| | | 16QAM | 41.284 |
| | | 64QAM | 41.414 |
| | | 256QAM | 41.122 |

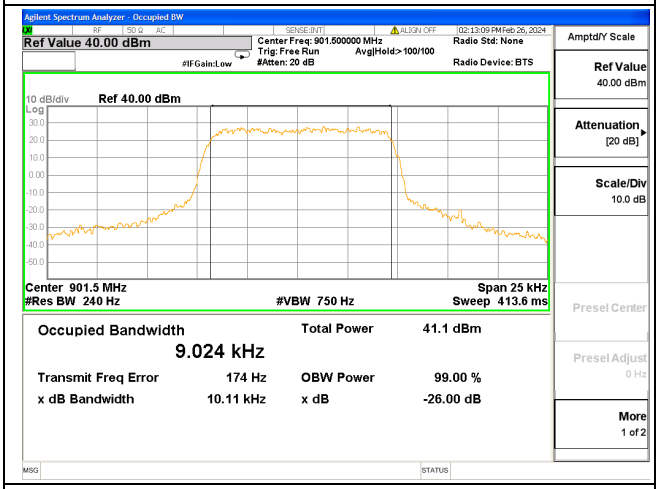
## 901.50MHz/Channel H/12.5kHz/QPSK



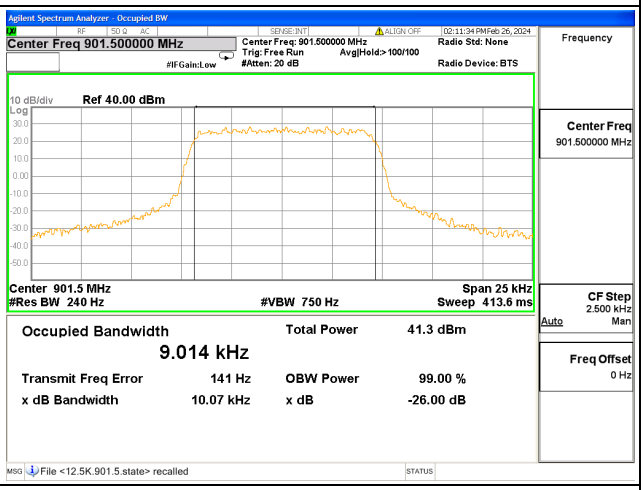

## 901.50MHz/Channel H/12.5kHz/16QAM



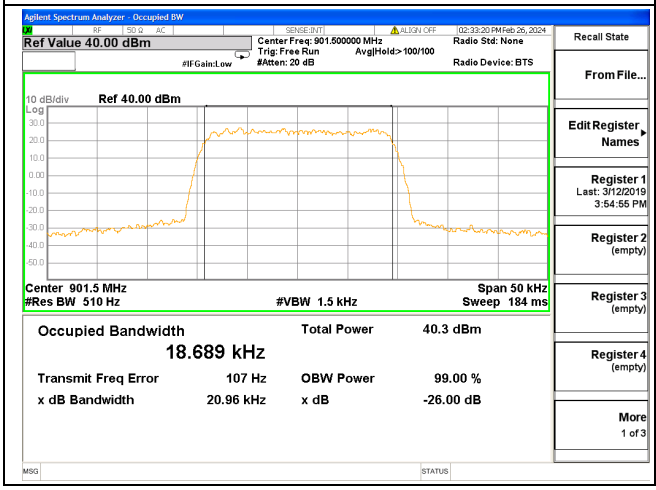

## 901.50MHz/Channel H/12.5kHz/64QAM



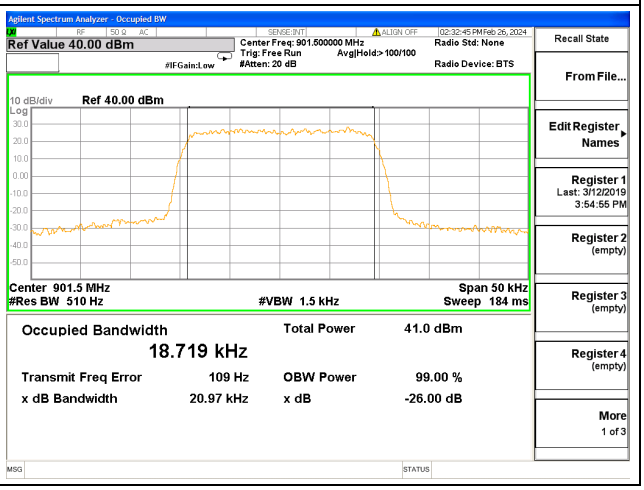

## 901.50MHz/Channel H/12.5 kHz/256QAM



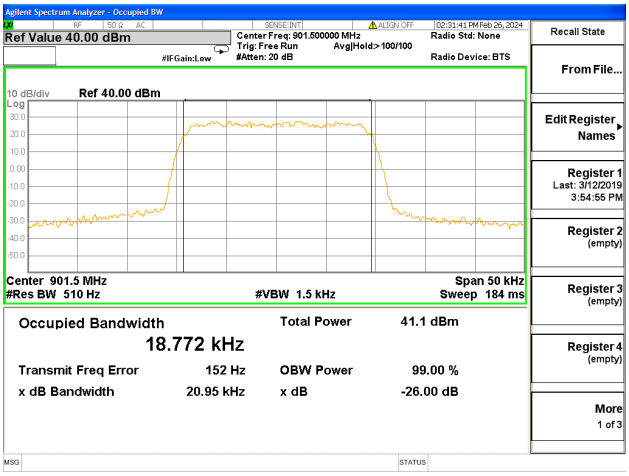

## 901.50MHz/Channel H/25.0 kHz/QPSK



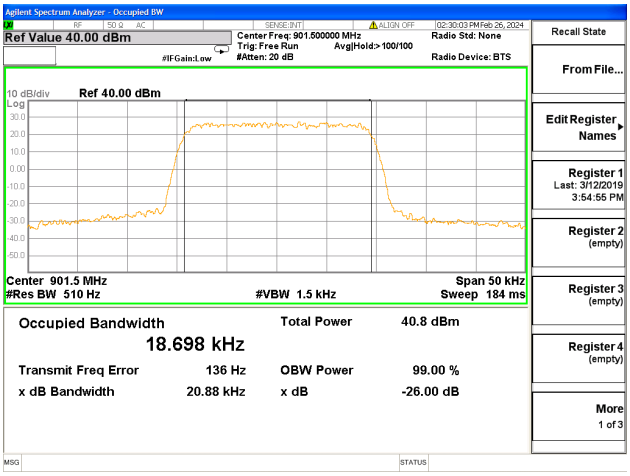

## 901.50MHz/Channel H/25.0 kHz/16QAM



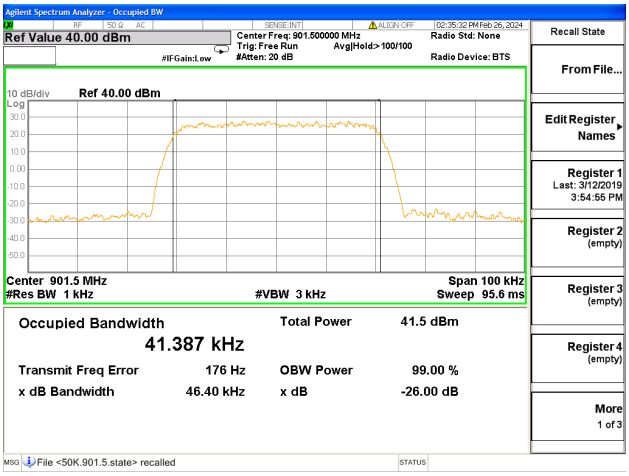
## 901.50MHz/Channel H/25.0 kHz/64QAM



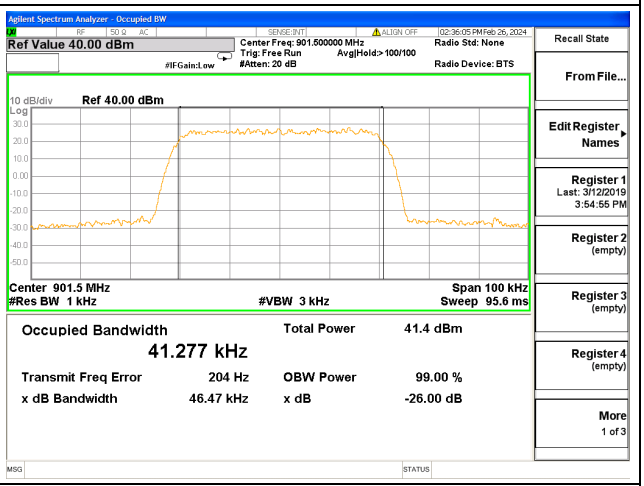

## 901.50MHz/Channel H/25.0 kHz/256QAM



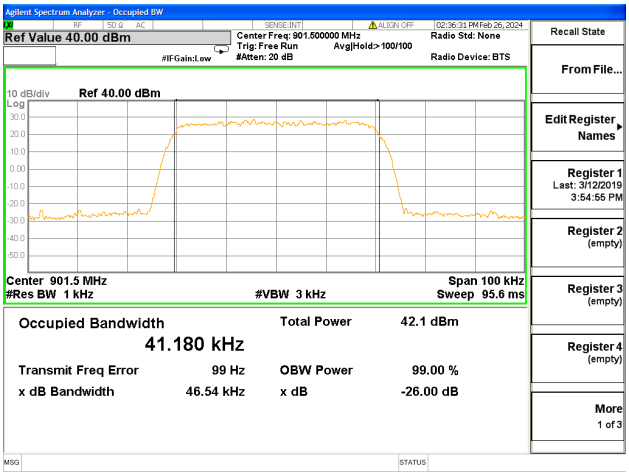

## 901.50MHz/Channel H/50.0 kHz/QPSK



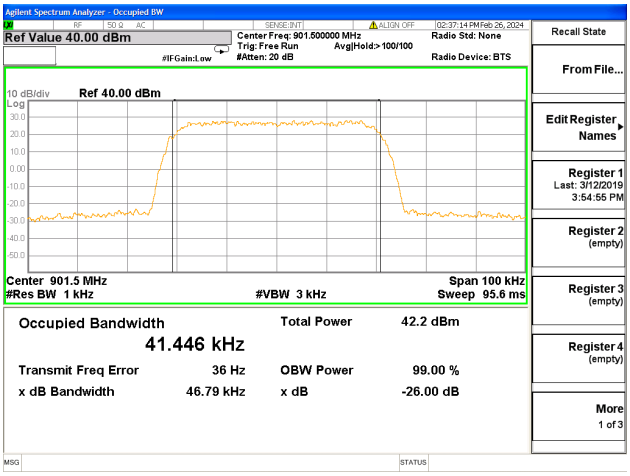

## 901.50MHz/Channel H/50.0 kHz/16QAM



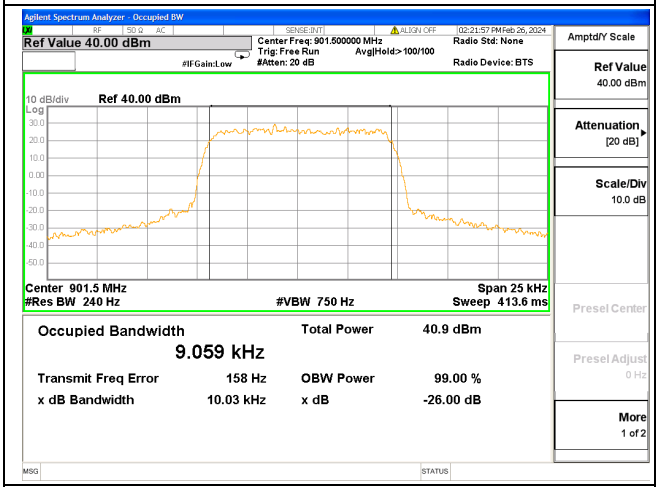

## 901.50MHz/Channel H/50.0 kHz/64QAM



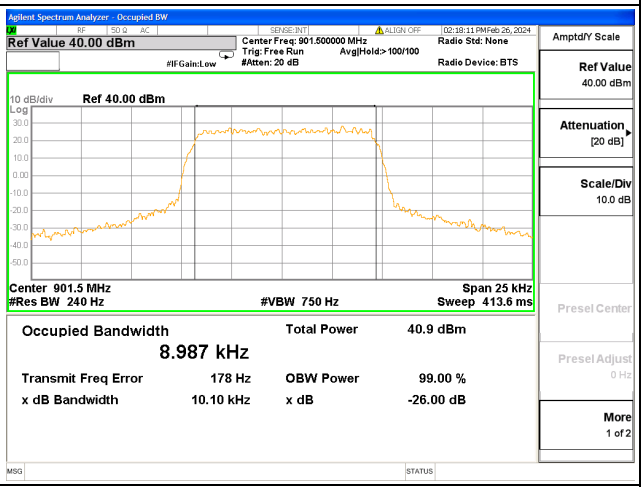

## 901.50MHz/Channel H/50.0 kHz/256QAM



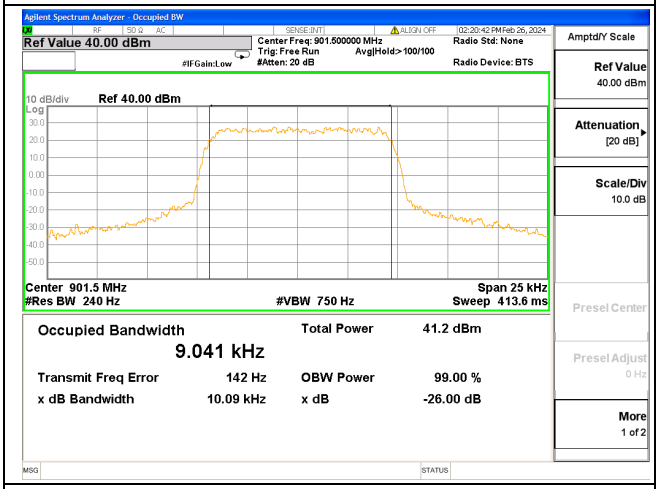
## 901.50MHz/Channel V/12.5kHz/QPSK



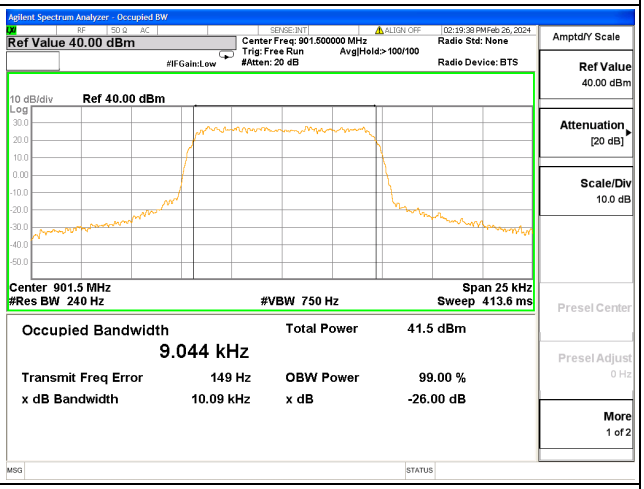

## 901.50MHz/Channel V/12.5kHz/16QAM



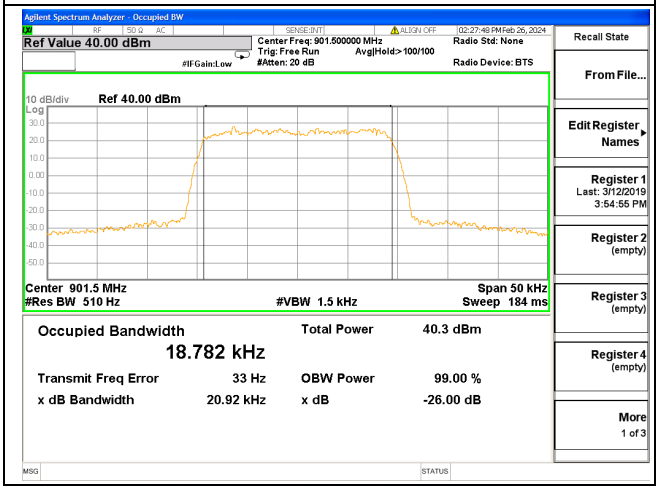

## 901.50MHz/Channel V/12.5kHz/64QAM



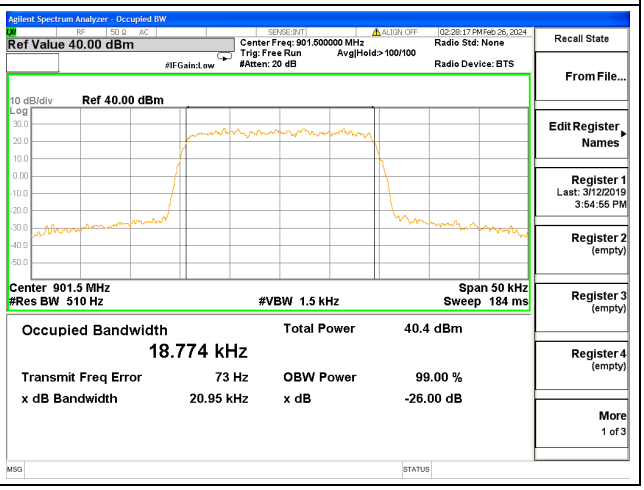

## 901.50MHz/Channel V/12.5 kHz/256QAM



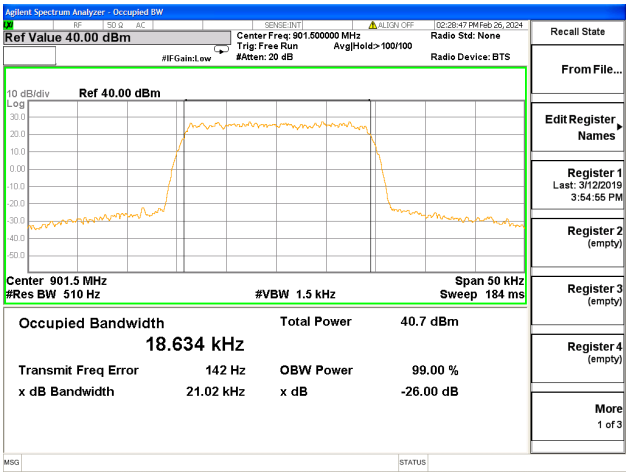

## 901.50MHz/Channel V/25.0 kHz/QPSK



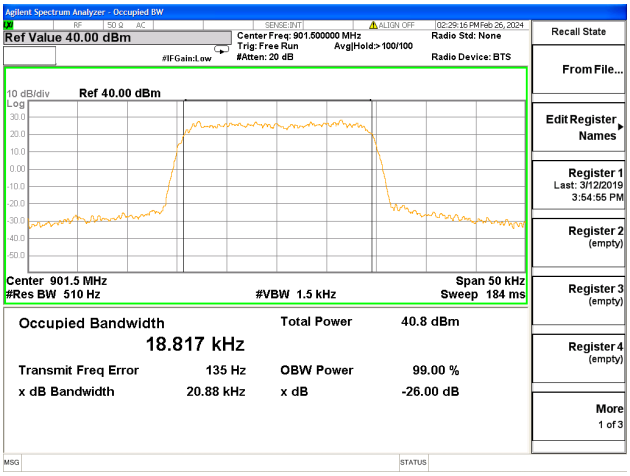

## 901.50MHz/Channel V/25.0 kHz/16QAM



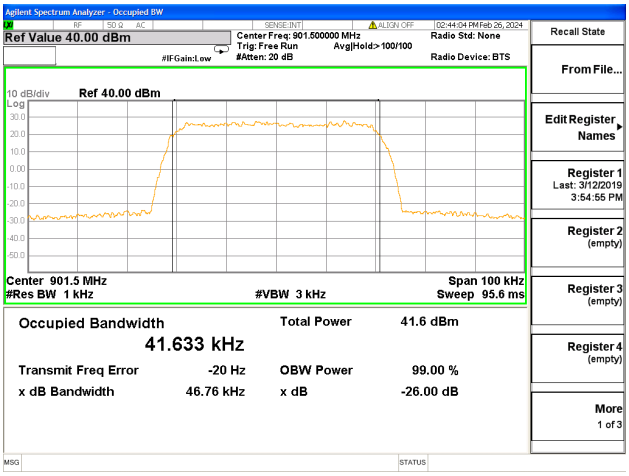
## 901.50MHz/Channel V/25.0 kHz/64QAM



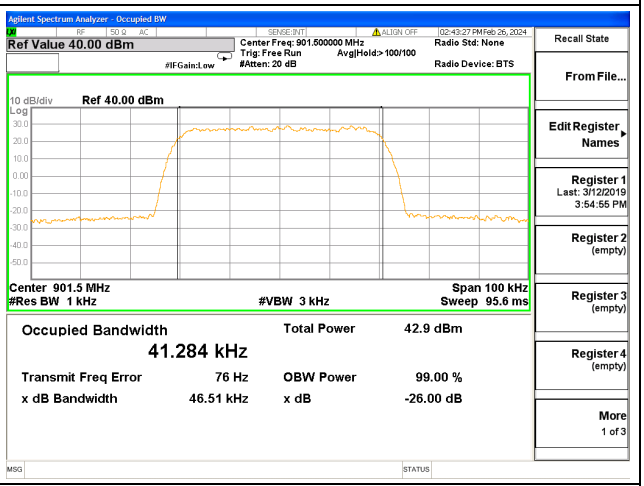

## 901.50MHz/Channel V/25.0 kHz/256QAM



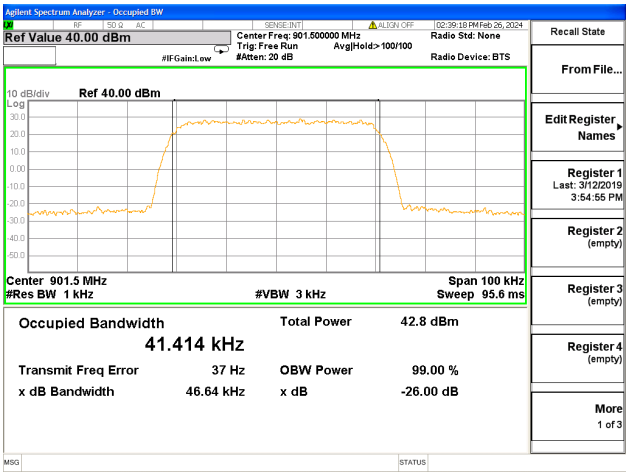

## 901.50MHz/Channel V/50.0 kHz/QPSK



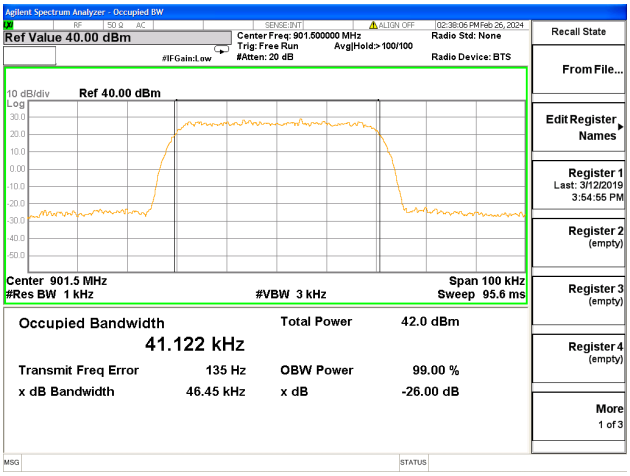

## 901.50MHz/Channel V/50.0 kHz/16QAM




## 901.50MHz/Channel V/50.0 kHz/64QAM




## 901.50MHz/Channel V/50.0 kHz/256QAM



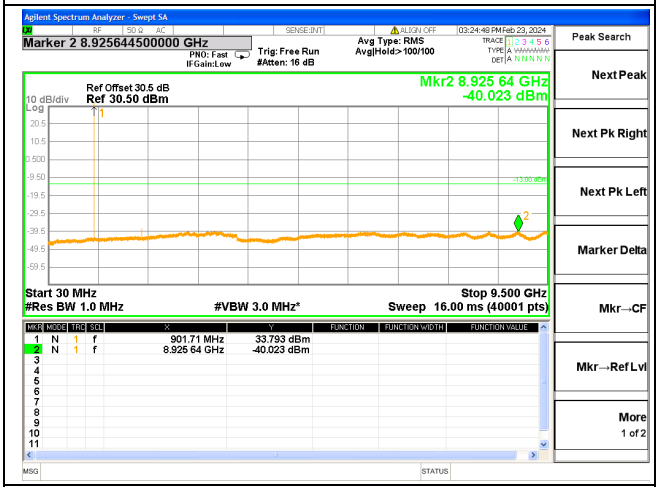
## 2.3. Spurious Emissions At Antenna Terminals

### 2.3.1. Test Requirement

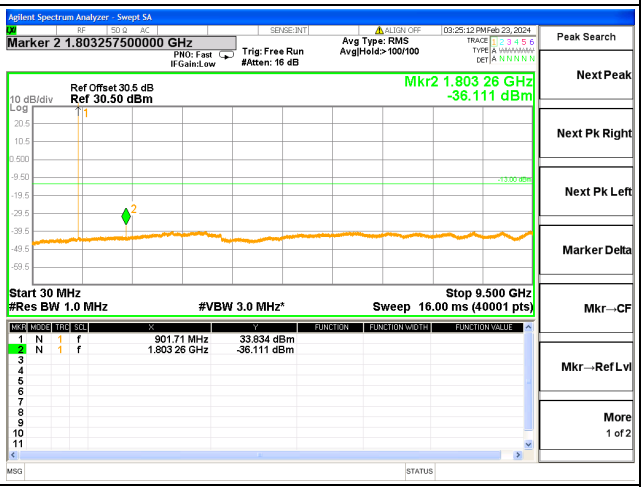
According to FCC section 2.1051, 24.131 and 24. 133(a) section
The authorized bandwidth of narrowband PCS channels will be 10 kHz for 12.5 kHz channels and 45 kHz for 50 kHz channels. For aggregated adjacent channels, a maximum authorized bandwidth of 5 kHz less than the total aggregated channel width is permitted.
For transmitters authorized a bandwidth greater than 10 kHz**:**
1. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of up to and including 40 kHz: at least 116 Log10 ((fd + 10)/6.1) decibels or 50 plus 10 Log10 (P) decibels or 70 decibels, whichever is the lesser attenuation;
2. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 40 kHz: at least 43 + 10 Log10 (P) decibels or 80 decibels, whichever is the lesser attenuation;
For transmitters authorized a bandwidth of 10 kHz**:**
1. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of up to and including 20 kHz: at least 116 × Log10 ((fd + 5)/3.05) decibels or 50 + 10 × Log10 (P) decibels or 70 decibels, whichever is the lesser attenuation;
2. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 20 kHz: at least 43 + 10 Log10 (P) decibels or 80 decibels, whichever is the lesser attenuation.

### 2.3.2. Test Result

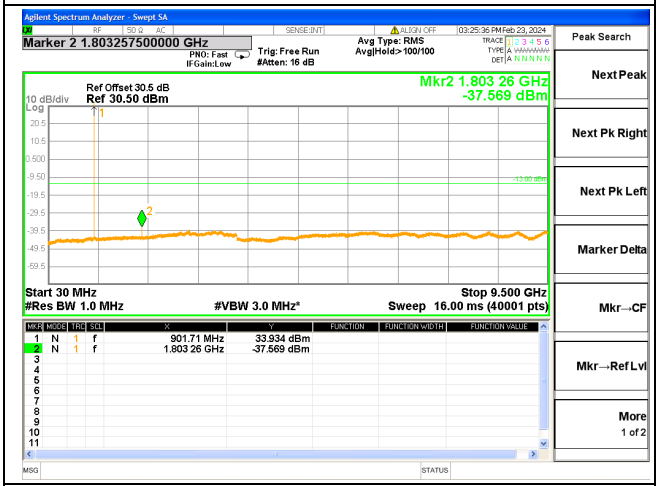
## 12.5kHz/QPSK



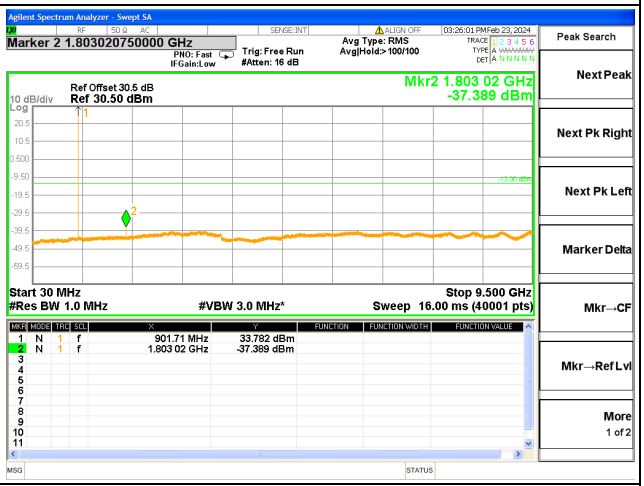

## 12.5kHz/16QAM




## 12.5kHz/64QAM

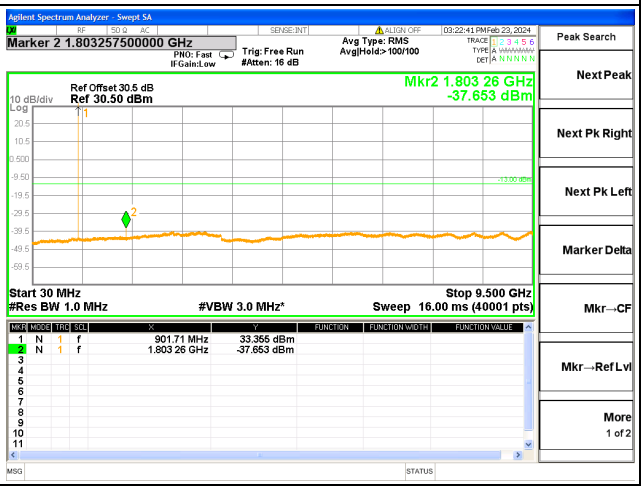



## 12.5kHz/256QAM

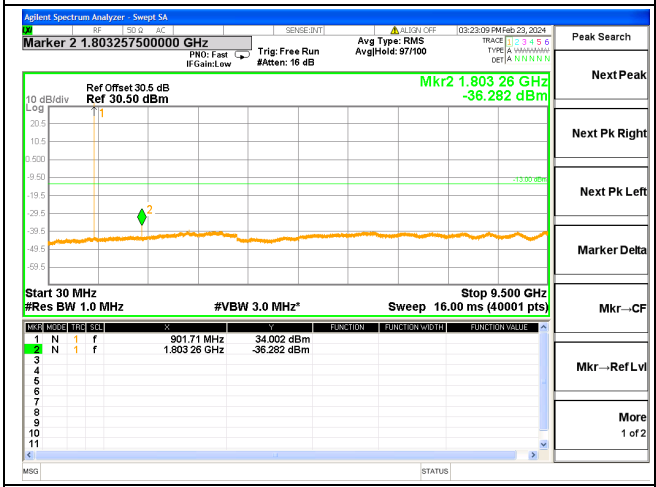



## 25.0kHz/QPSK

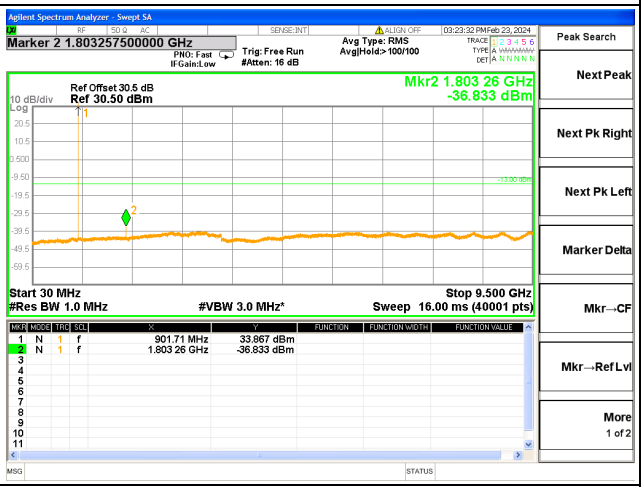
## 25.0kHz /16QAM



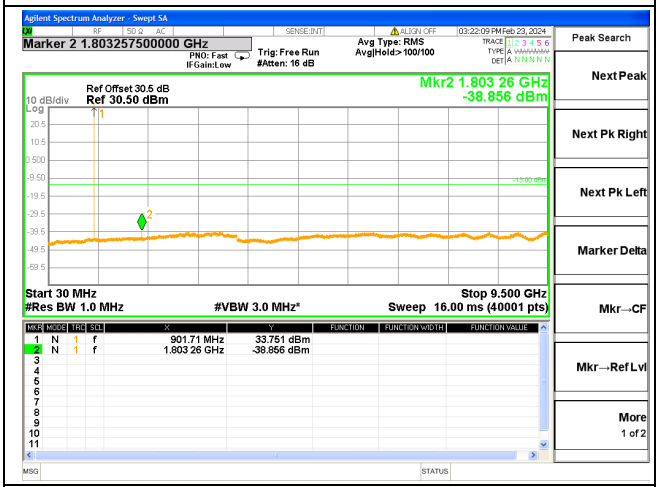
## 25.0kHz /64QAM



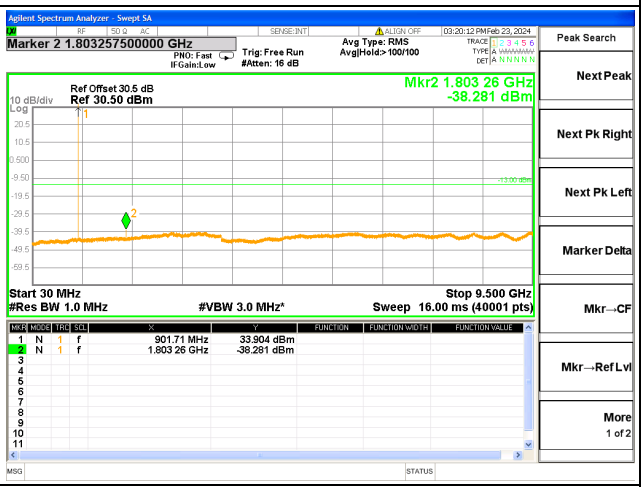

## 25.0kHz /256QAM



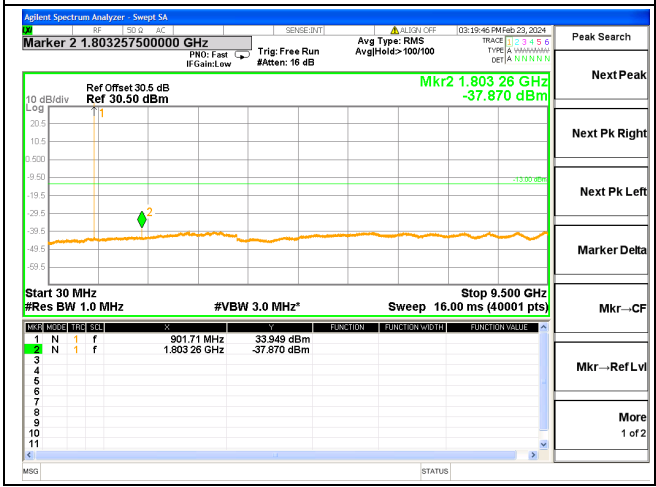

## 50.0kHz/QPSK



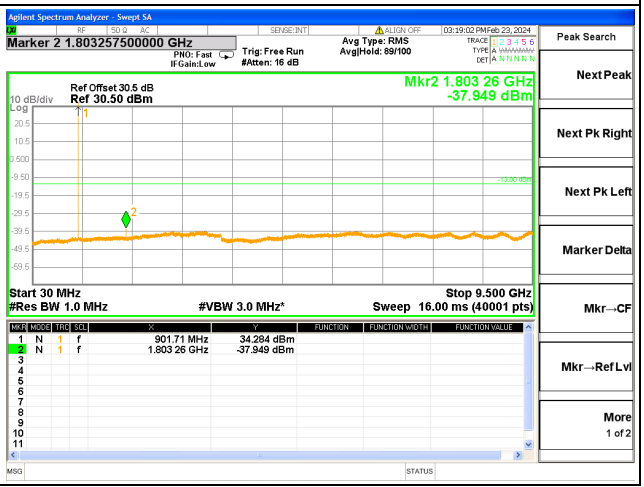

## 50.0kHz /16QAM




## 50.0kHz /64QAM

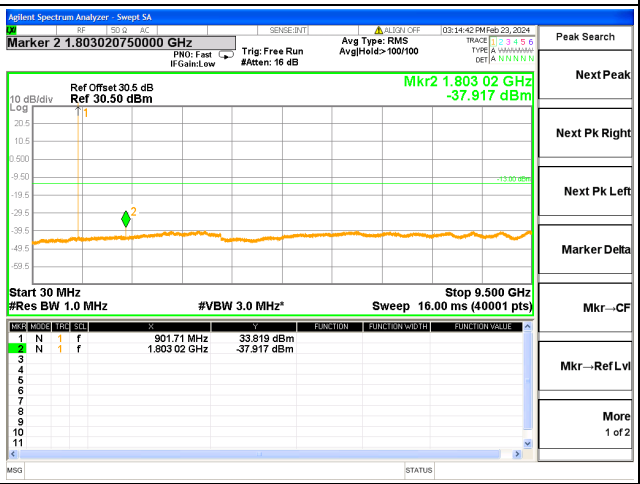



## 50.0kHz /256QAM

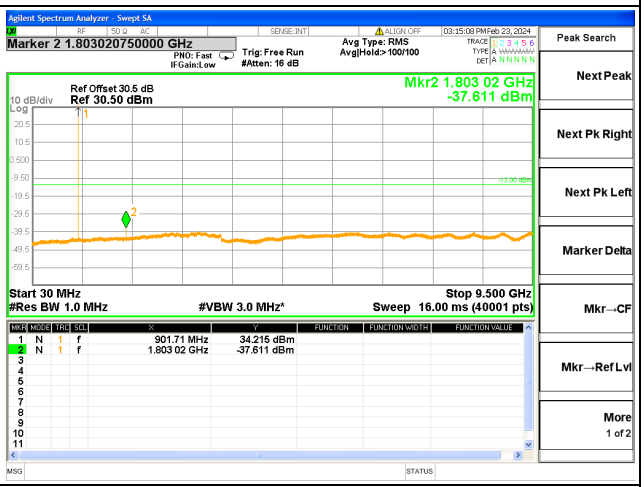


Nominal Frequency: 901.50 MHz Tx Port: Channel V

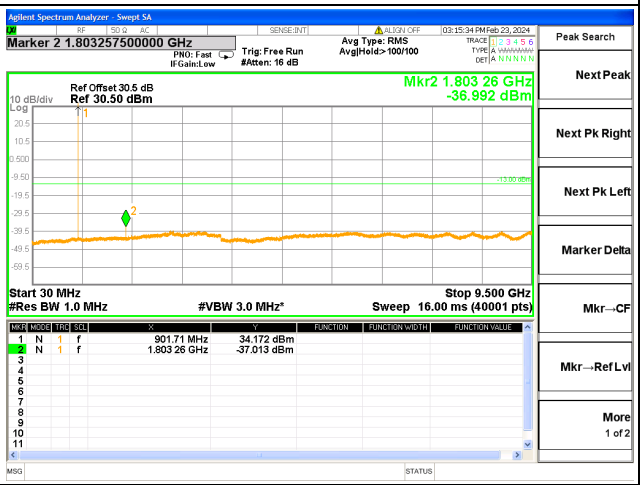
**12.5kHz/QPSK**



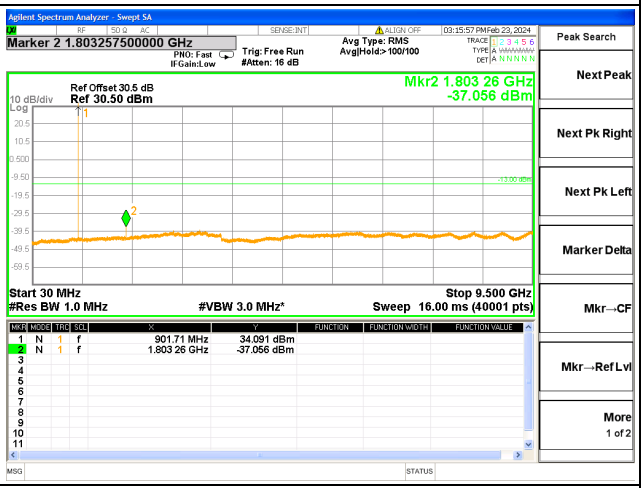

**12.5kHz/16QAM**



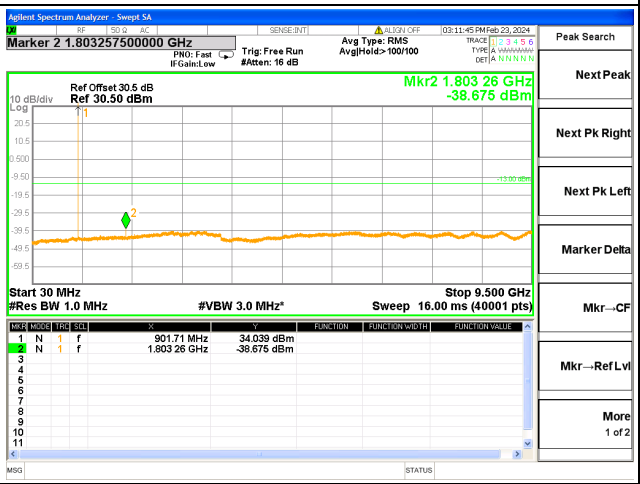

**12.5kHz/64QAM**



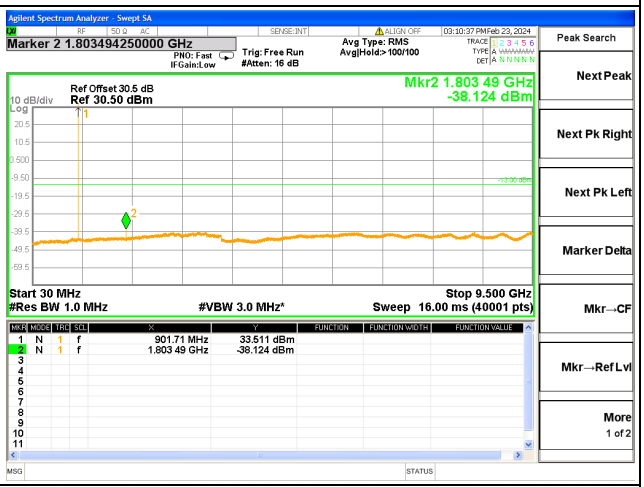

**12.5kHz/256QAM**




**25.0kHz/QPSK**



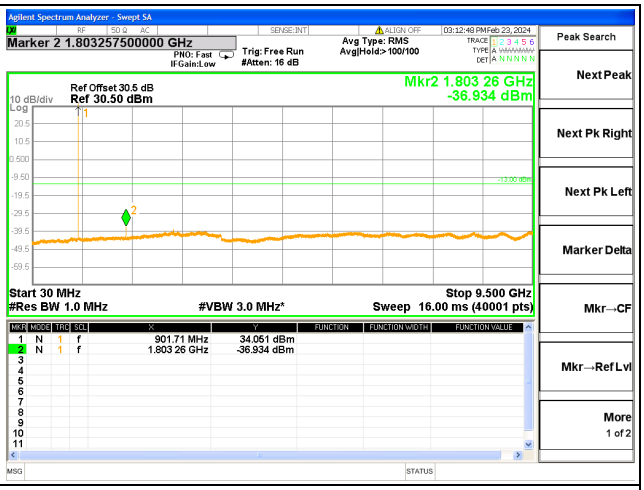

**25.0kHz /16QAM**



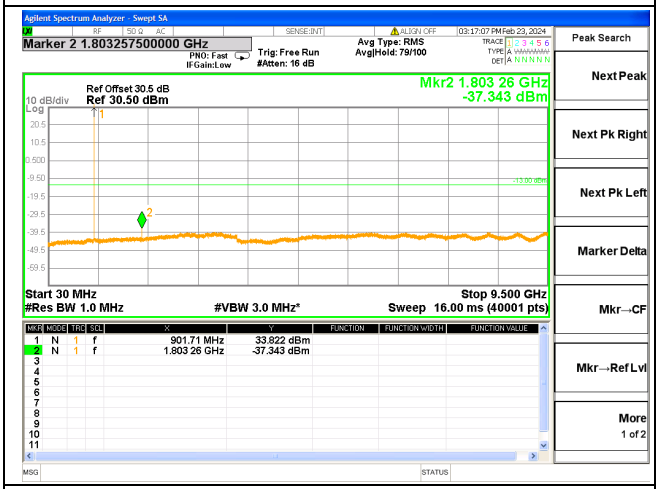

**25.0kHz /64QAM**

**25.0kHz /256QAM**

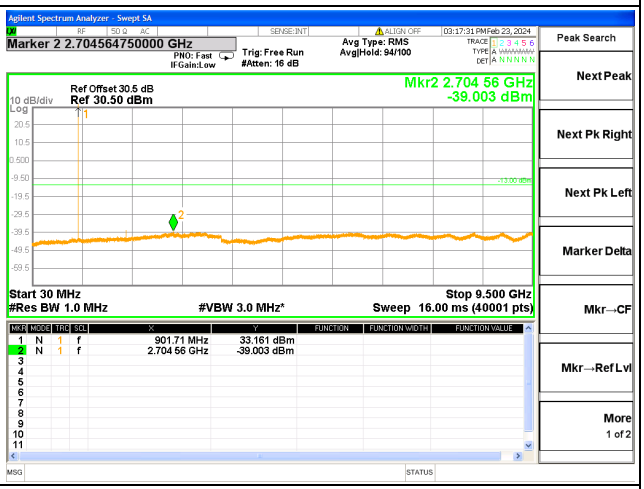
50.0kHz/QPSK



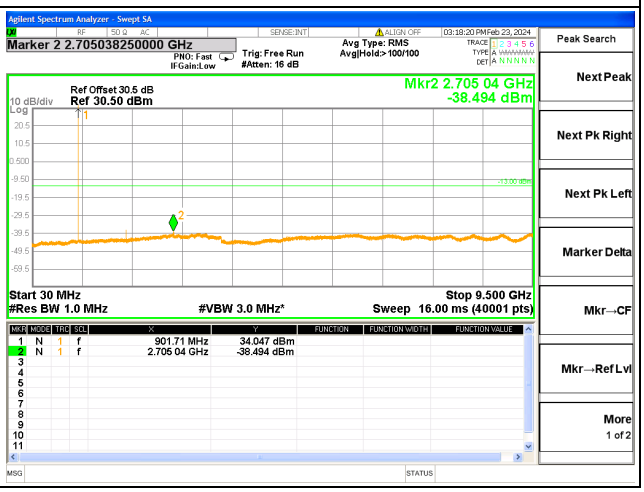

50.0kHz /16QAM




50.0kHz /64QAM

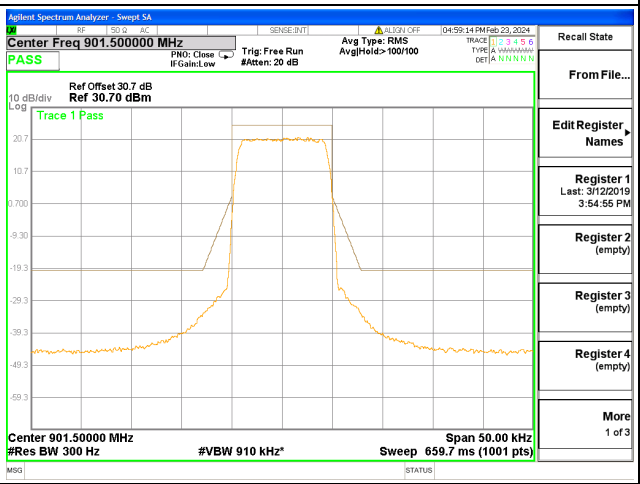



50.0kHz /256QAM

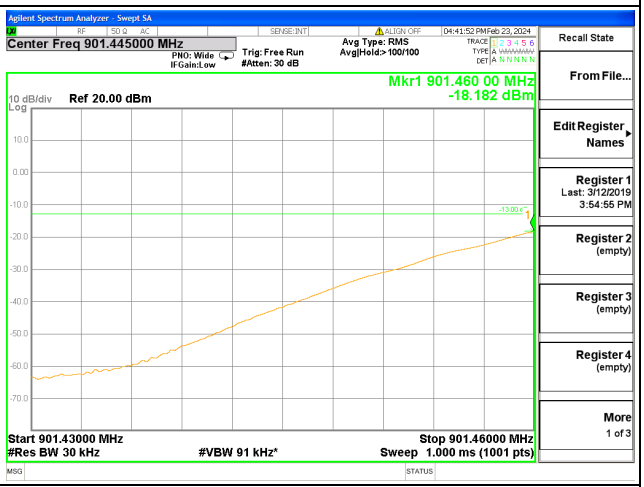


Nominal Frequency: 901.50 MHz Tx Port: Channel H

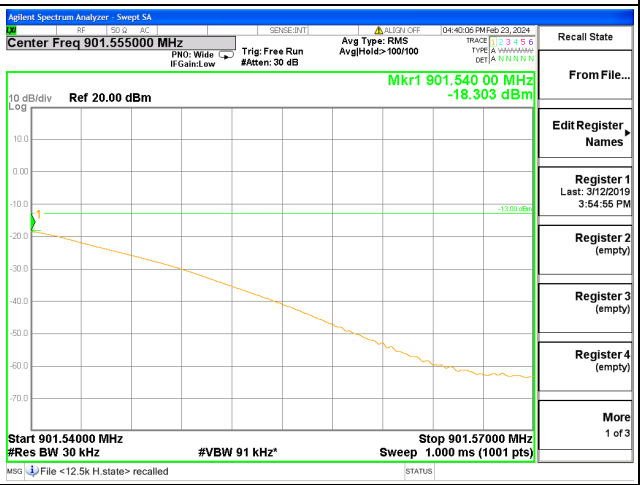
## 12.5kHz/ QPSK



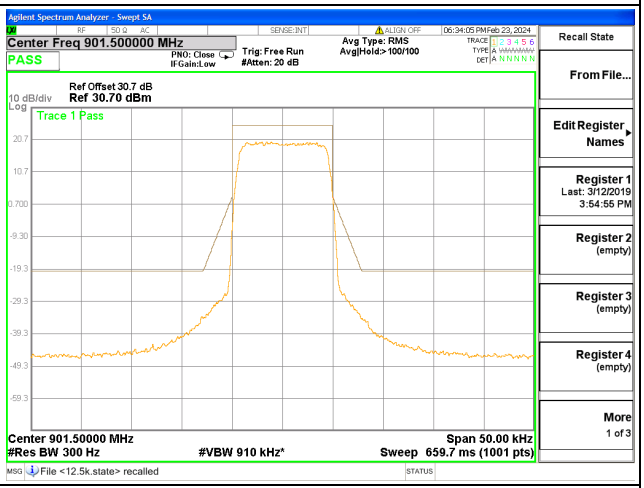

## 12.5kHz/ QPSK/901.4300 -901.4600 MHz



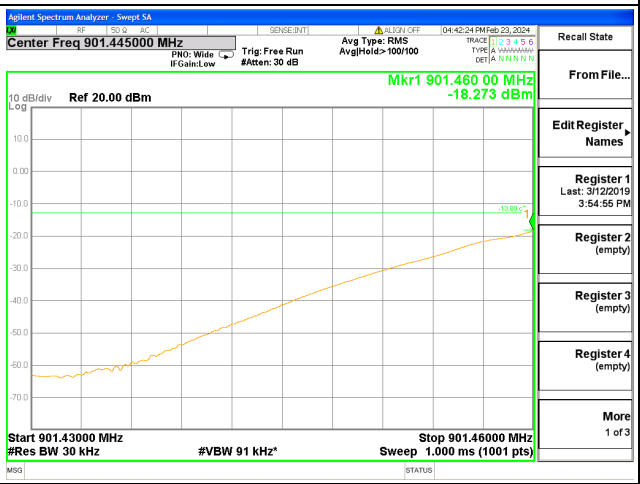

## 12.5kHz/ QPSK/901.5400 -901.5700 MHz



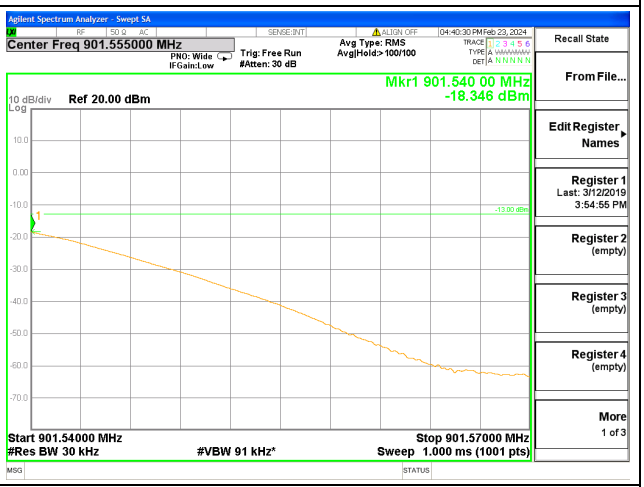

## 12.5kHz/16QAM




## 12.5kHz/ 16QAM /901.4300 -901.4600 MHz

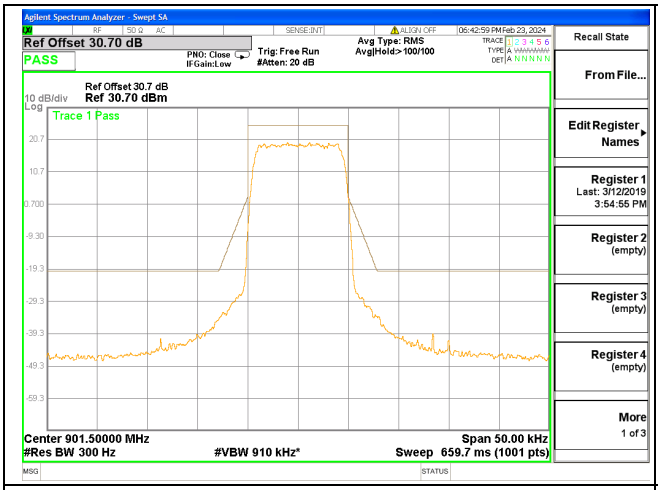


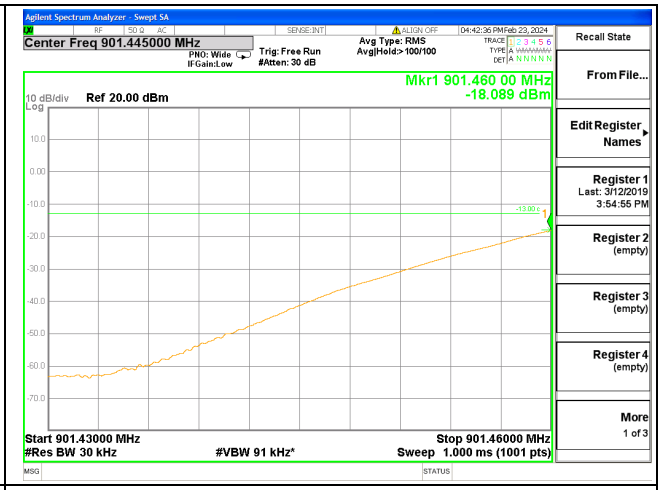

## 12.5kHz/ 16QAM /901.5400 -901.5700 MHz




## 12.5kHz/ 64QAM

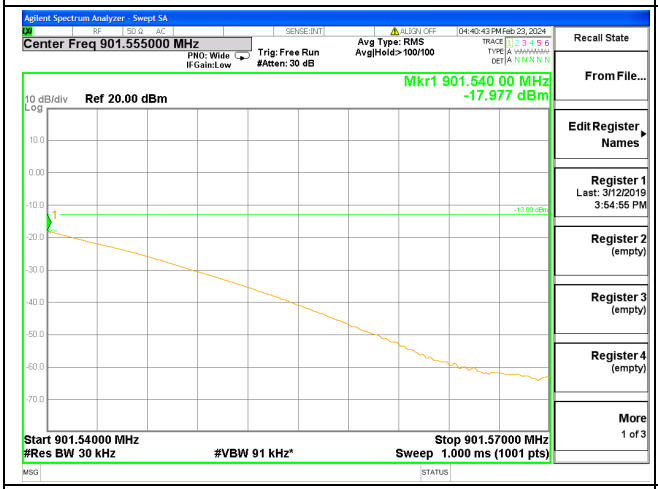
## 12.5kHz/ 64QAM /901.4300 -901.4600 MHz

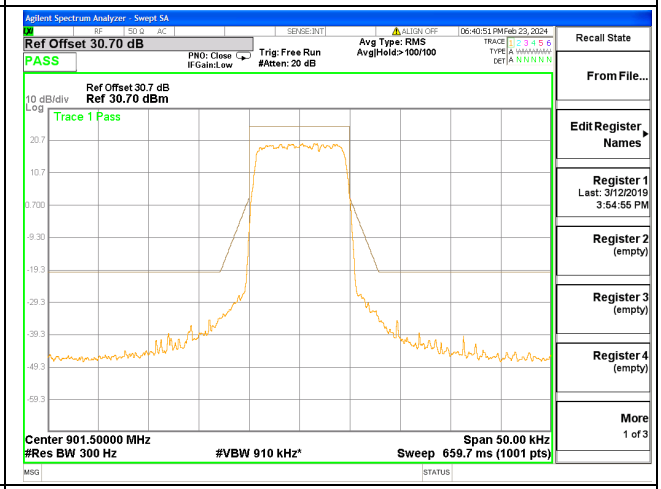



## 12.5kHz/ 64QAM /901.5400 -901.5700 MHz

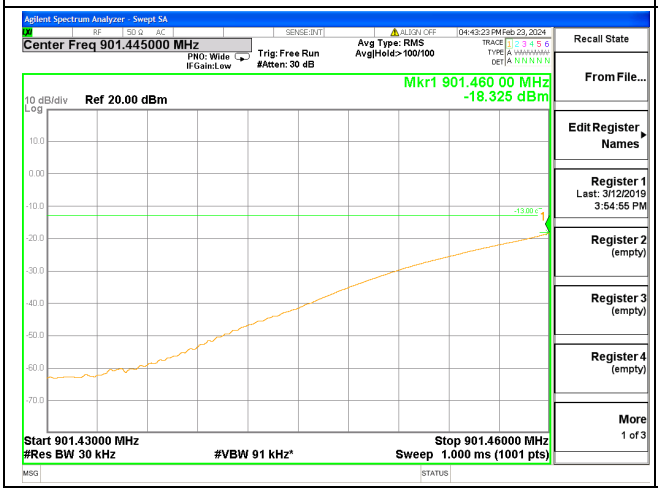
## 12.5kHz/256QAM

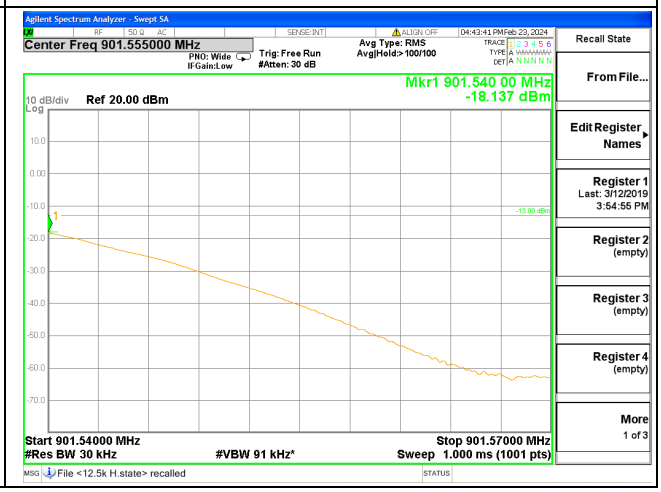


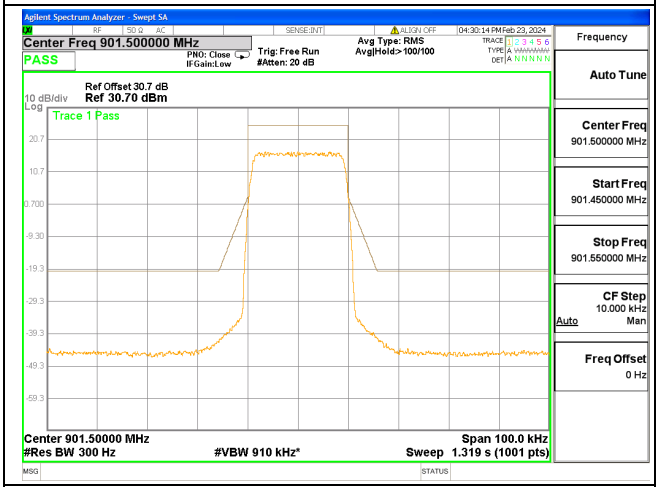

## 12.5kHz/ 256QAM /901.4300 -901.4600 MHz

## 12.5kHz/ 256QAM /901.5400 -901.5700 MHz

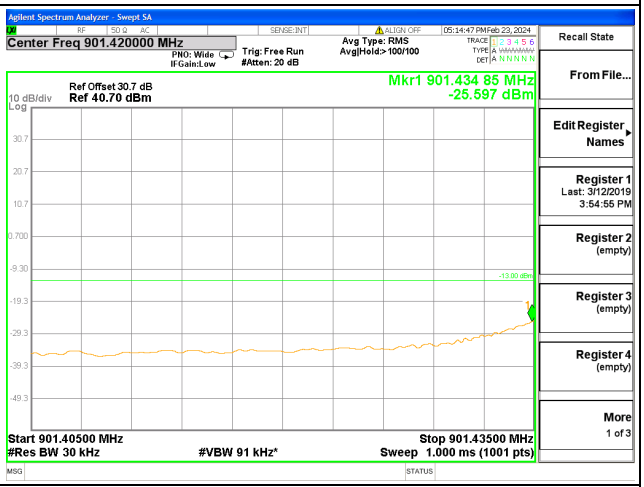


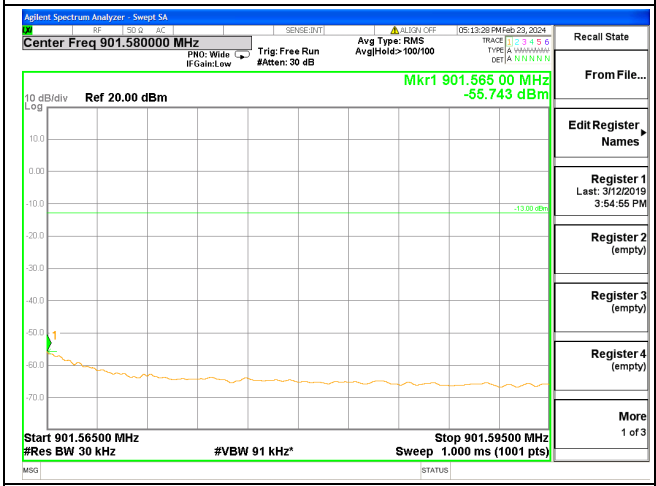
## 25kHz/ QPSK



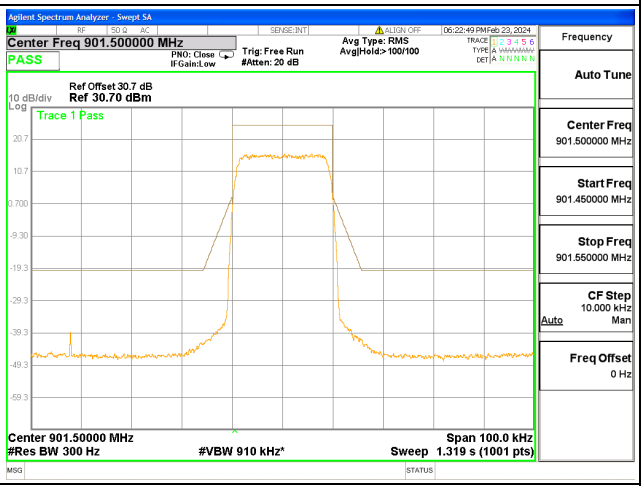

## 25kHz/ QPSK/901.4050 -901.4350 MHz



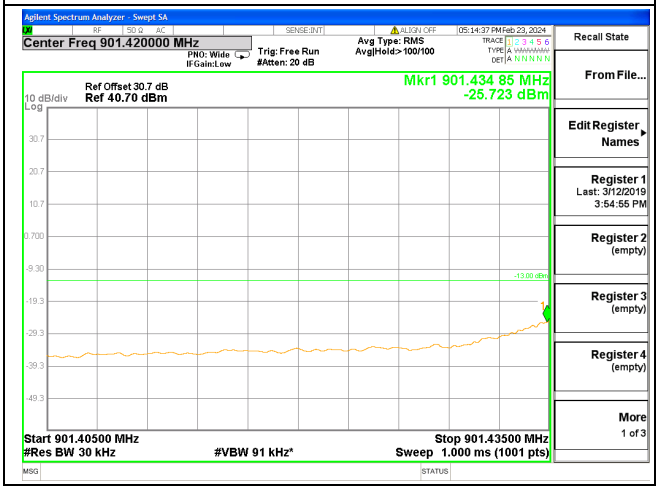

## 25kHz/ QPSK/901.5650 -901.5950 MHz



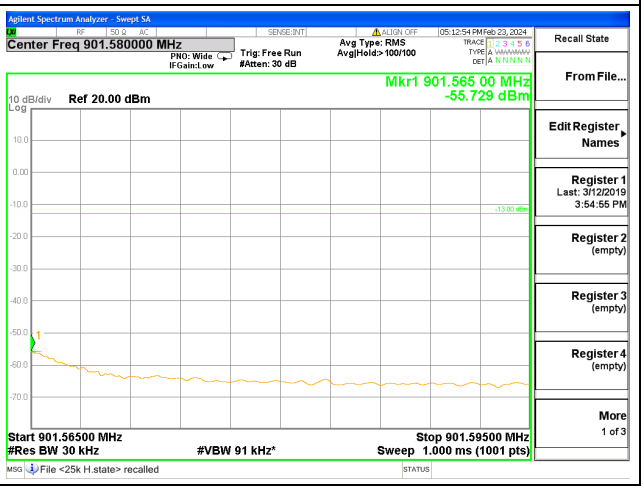

## 25kHz/16QAM



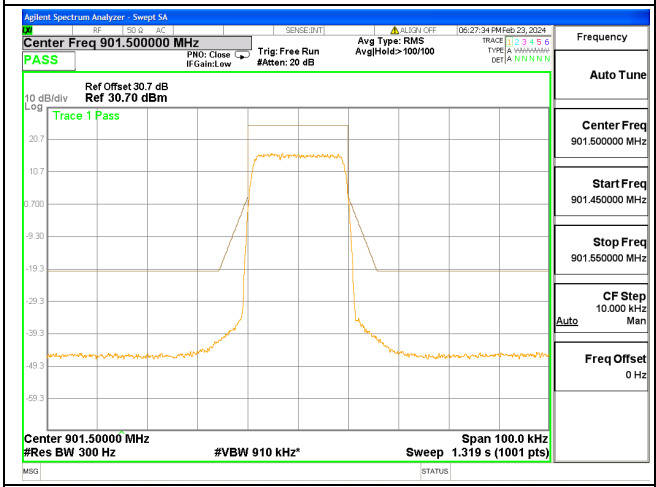

## 25kHz/ 16QAM /901.4050 -901.4350 MHz



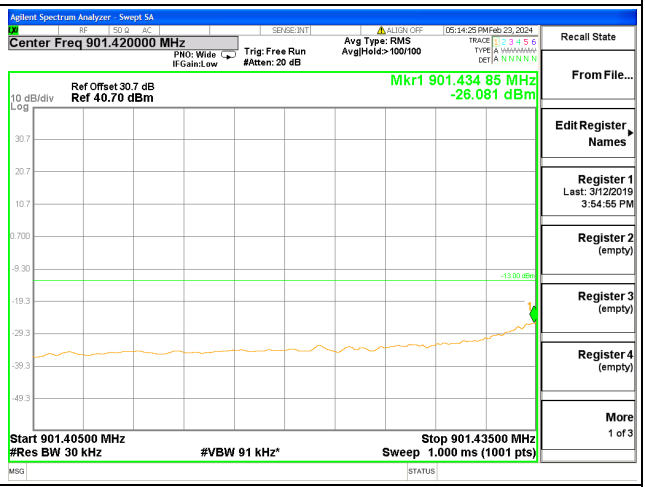

## 25kHz/ 16QAM /901.5650 -901.5950 MHz



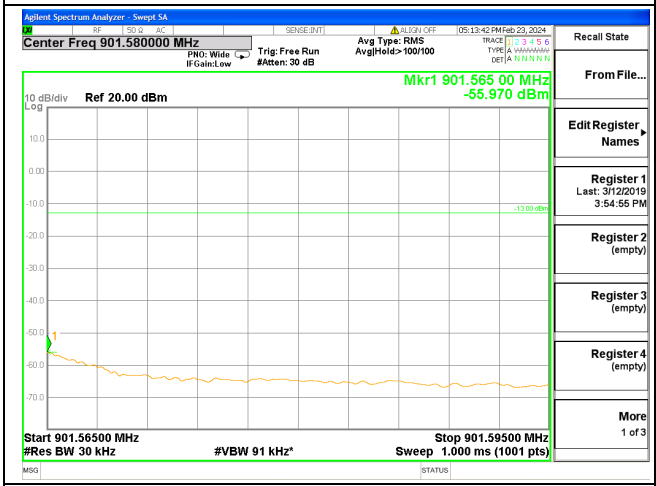
## 25kHz/ 64QAM



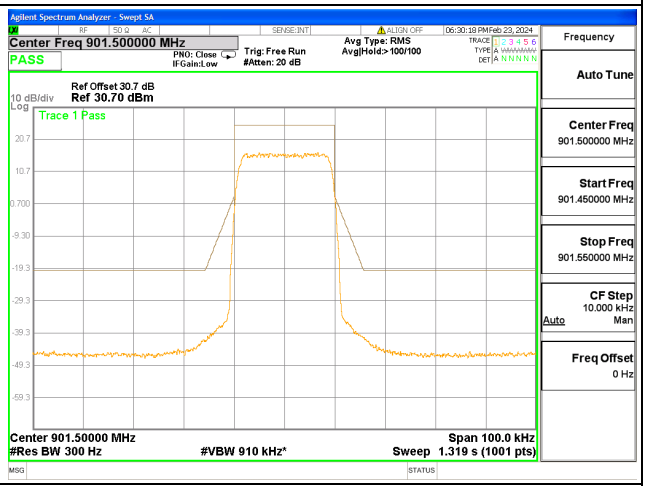

## 25kHz/ 64QAM /901.4050 -901.4350 MHz



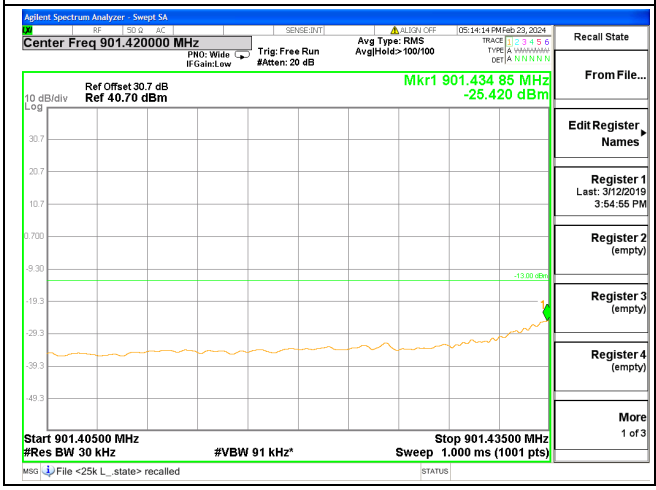

## 25kHz/ 64QAM /901.5650 -901.5950 MHz



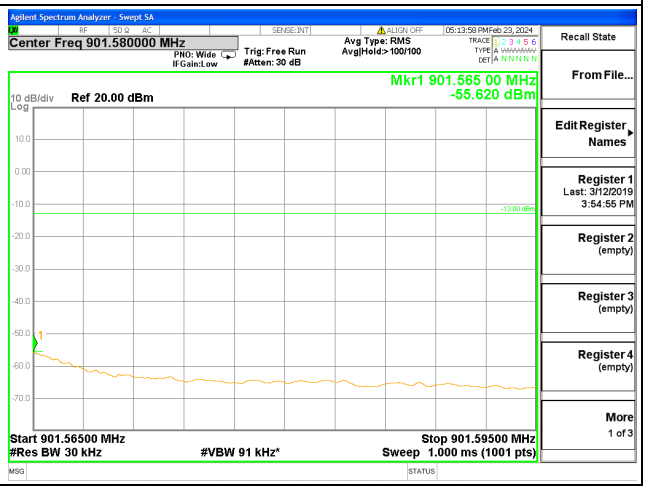

## 25kHz/256QAM



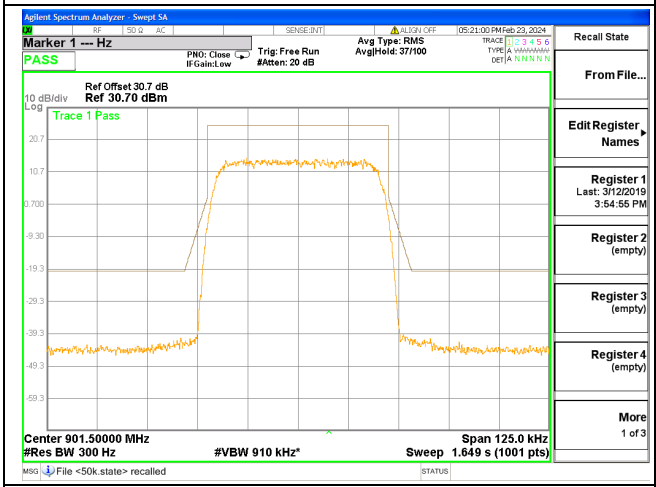

## 25kHz/ 256QAM /901.4050 -901.4350 MHz



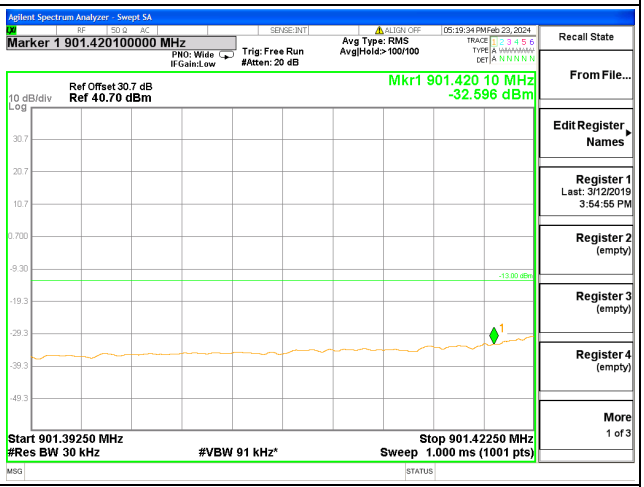

## 25kHz/ 256QAM /901.5650 -901.5950 MHz



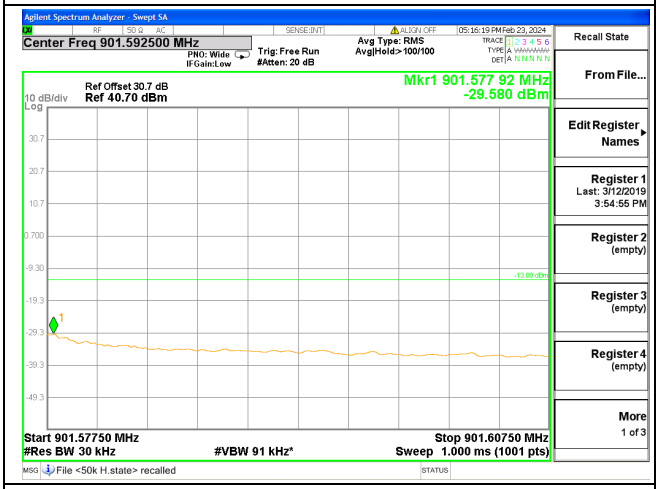
## 50kHz/ QPSK



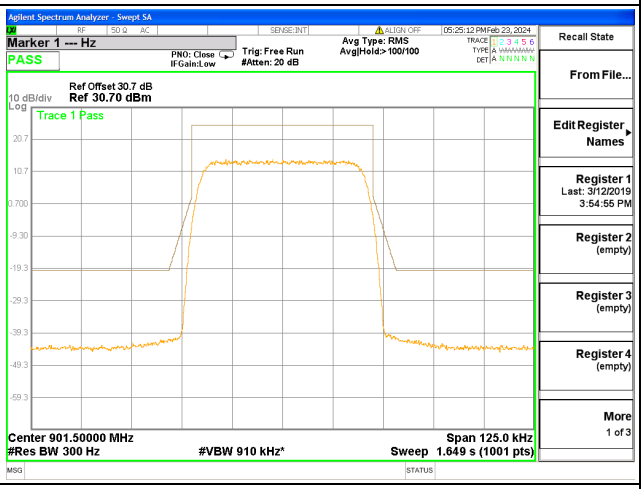

## 50kHz/ QPSK/901.3925 -901.4225 MHz



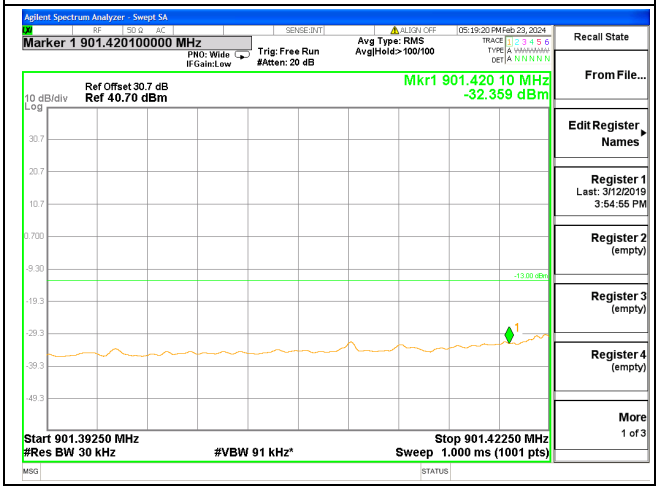

## 50kHz/ QPSK/901.5775 -901.6075 MHz



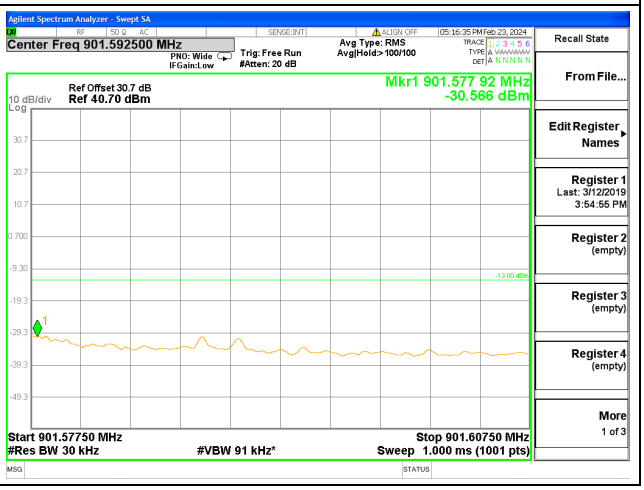

## 50kHz/16QAM



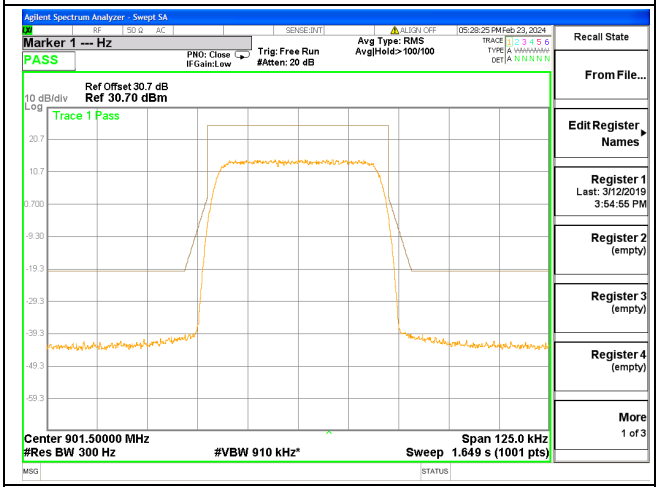

## 50kHz/ 16QAM /901.3925 -901.4225 MHz



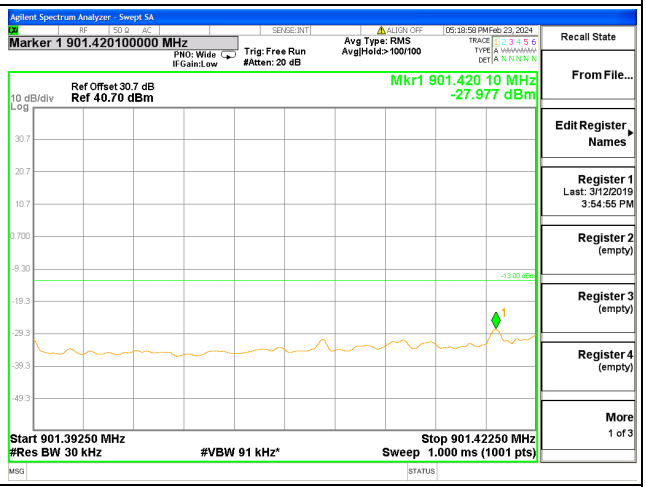

## 50kHz/ 16QAM /901.5775 -901.6075 MHz



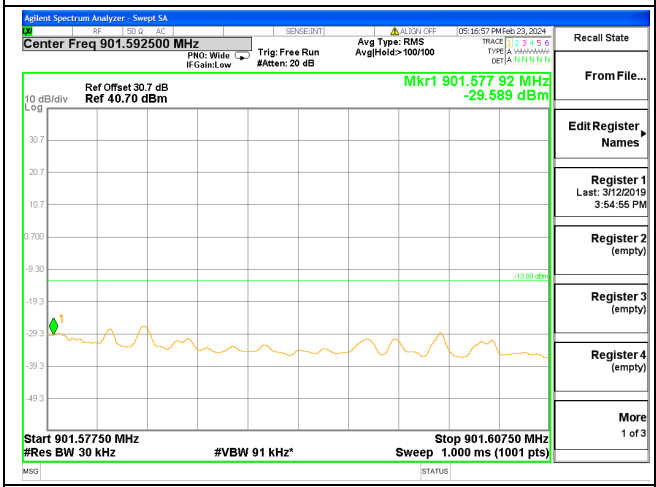
## 50kHz/ 64QAM



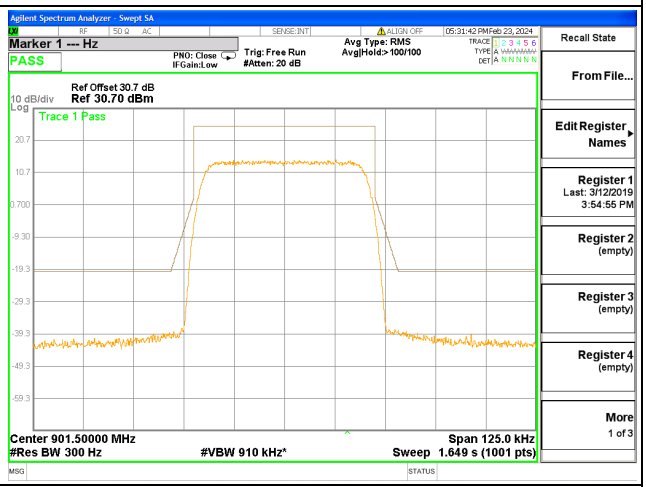

## 50kHz/ 64QAM /901.3925 -901.4225 MHz



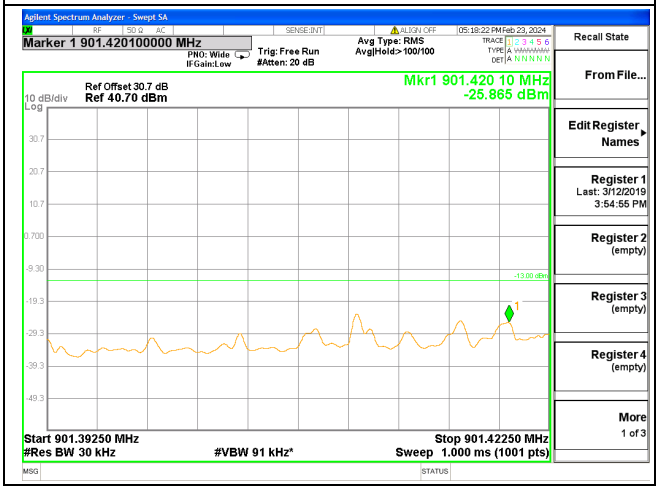

## 50kHz/ 64QAM /901.5775 -901.6075 MHz



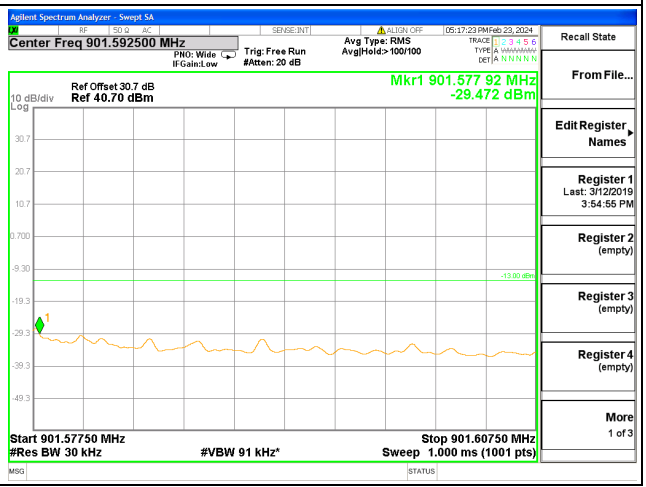

## 50kHz/256QAM




## 50kHz/ 256QAM /901.3925 -901.4225 MHz

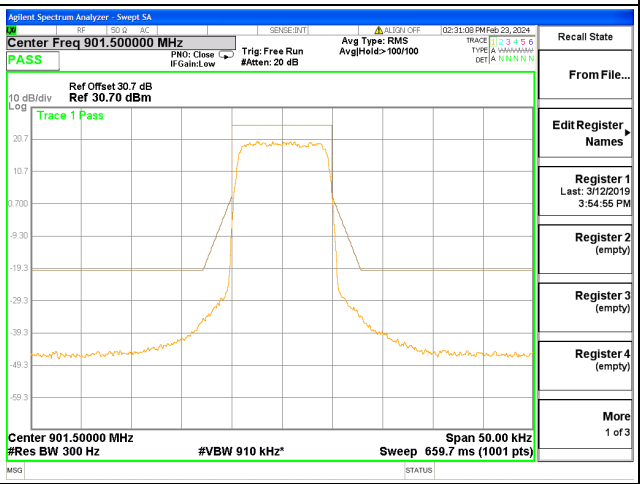



## 50kHz/ 256QAM /901.5775 -901.6075 MHz

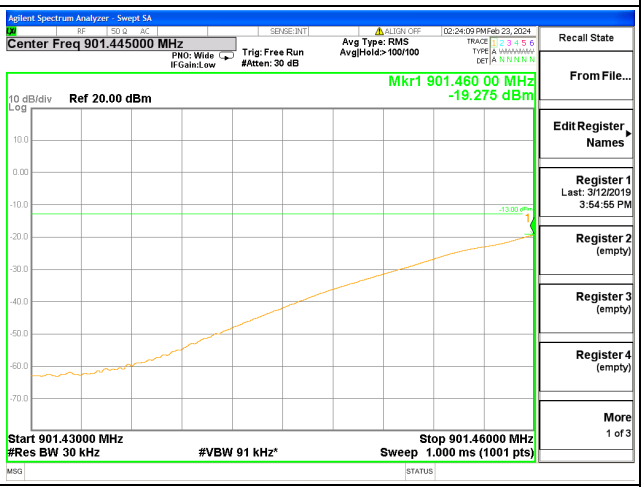


Nominal Frequency: 901.50 MHz Tx Port: Channel V

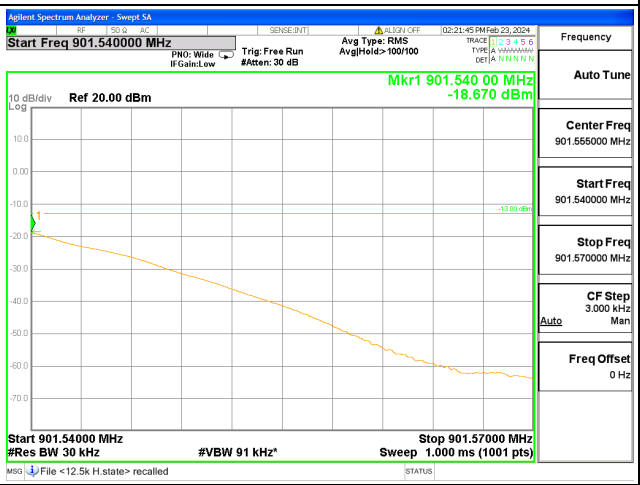
## 12.5kHz/ QPSK



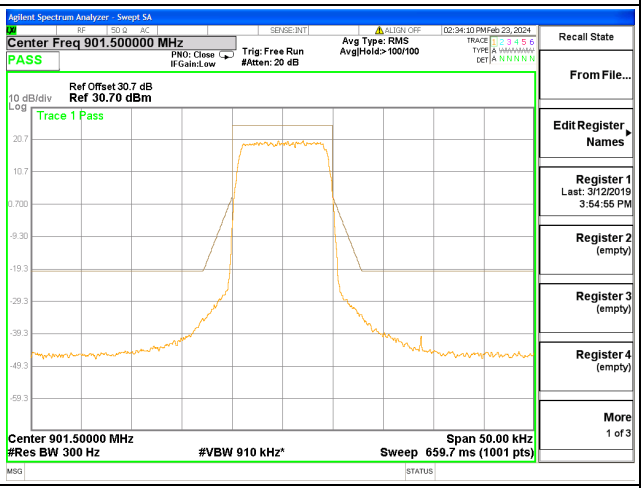

## 12.5kHz/ QPSK/901.4300 -901.4600 MHz



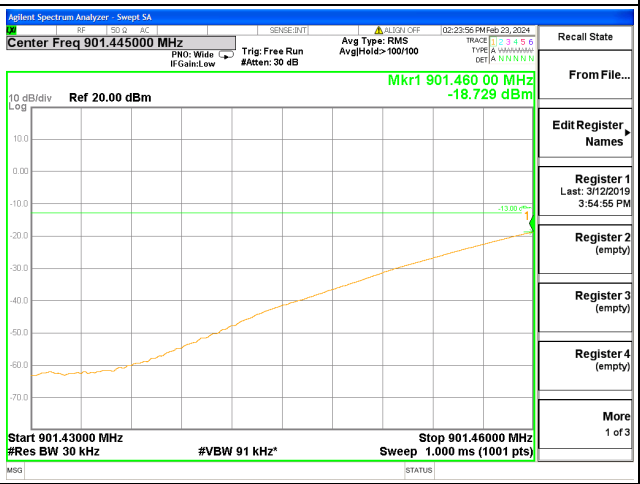

## 12.5kHz/ QPSK/901.5400 -901.5700 MHz

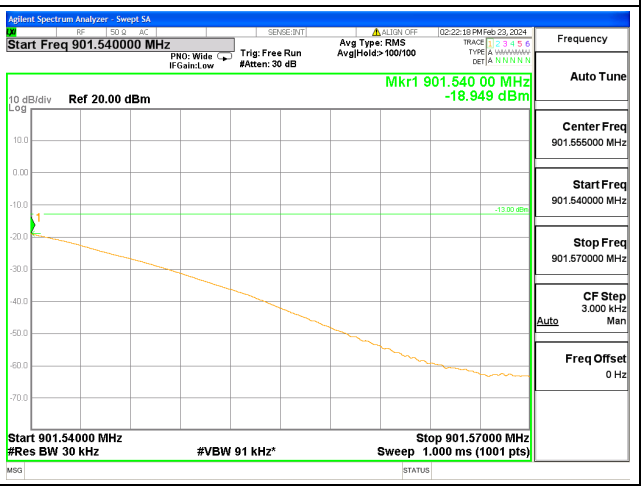



## 12.5kHz/16QAM




## 12.5kHz/ 16QAM /901.4300 -901.4600 MHz




## 12.5kHz/ 16QAM /901.5400 -901.5700 MHz