

### 5.3. Band Edge

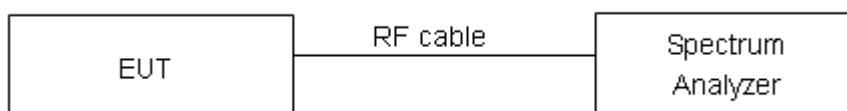
#### Ambient Condition

| Temperature | Relative humidity |
|-------------|-------------------|
| 15°C ~ 35°C | 20% ~ 80%         |

#### Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable the band edge of the lowest and highest channels were measured. The peak detector is used and RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. Spectrum analyzer plots are included on the following pages.

#### Test Setup



#### Limits

Rule Part 15.247(d) specifies that “In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.” If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.”

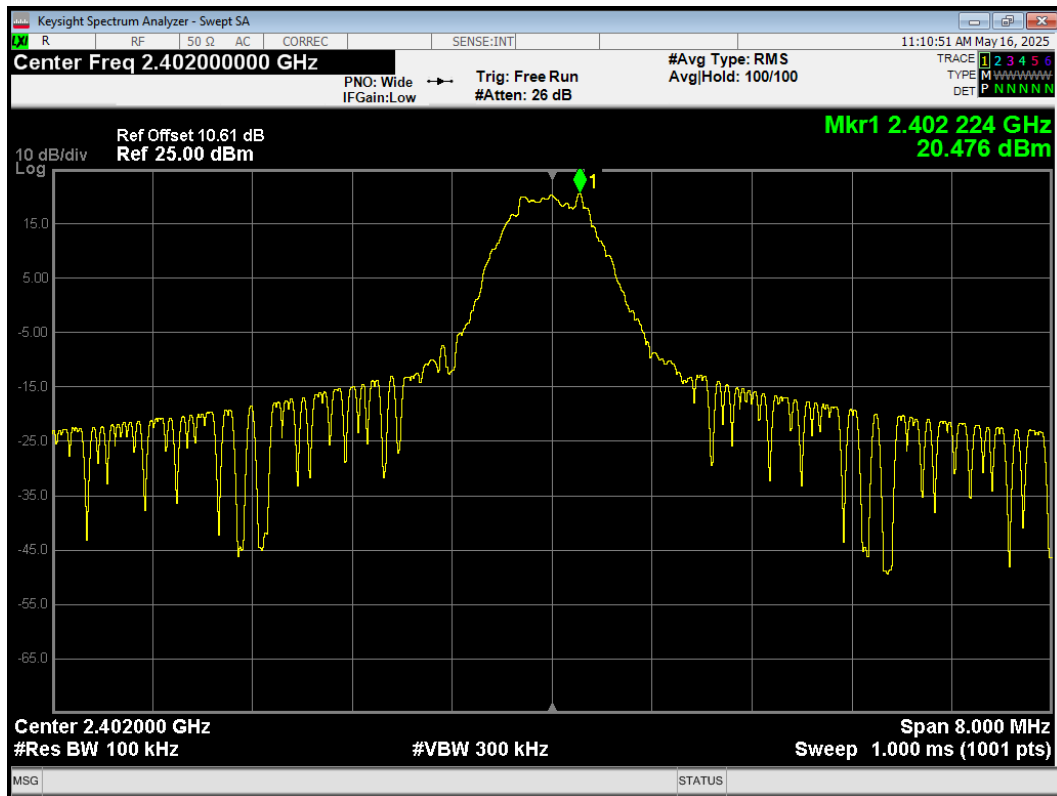
#### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 1.96$ .

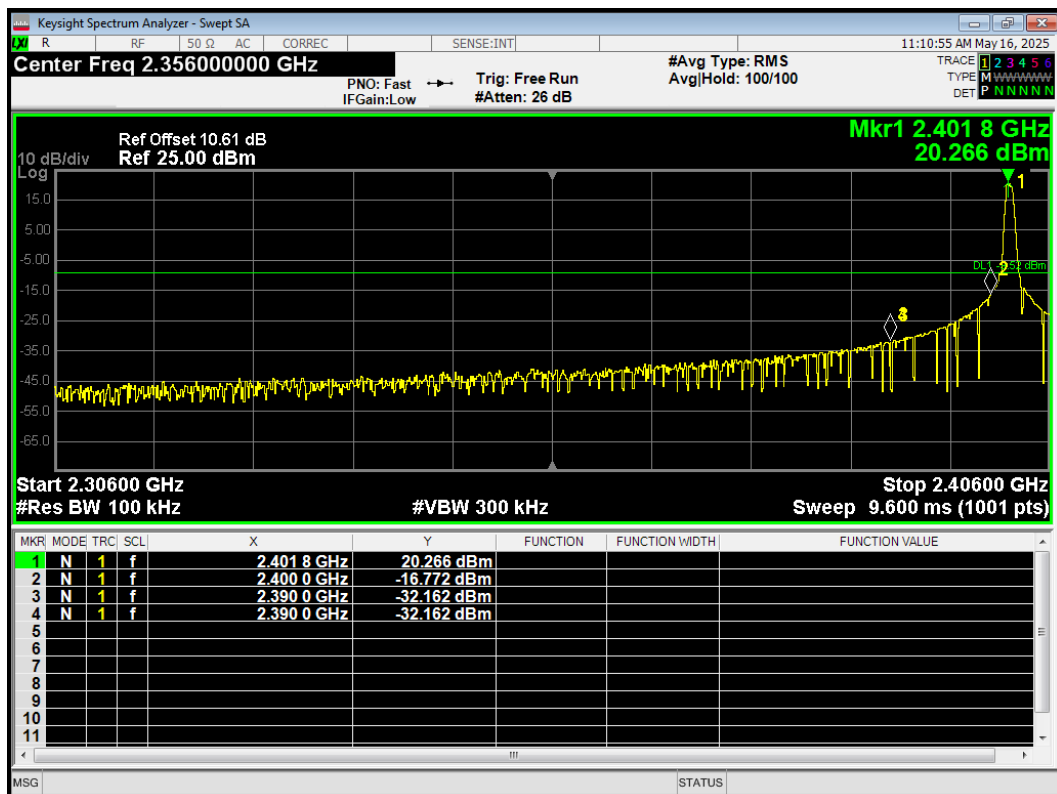
| Frequency | Uncertainty |
|-----------|-------------|
| 2GHz-3GHz | 1.407 dB    |

Test Results: PASS

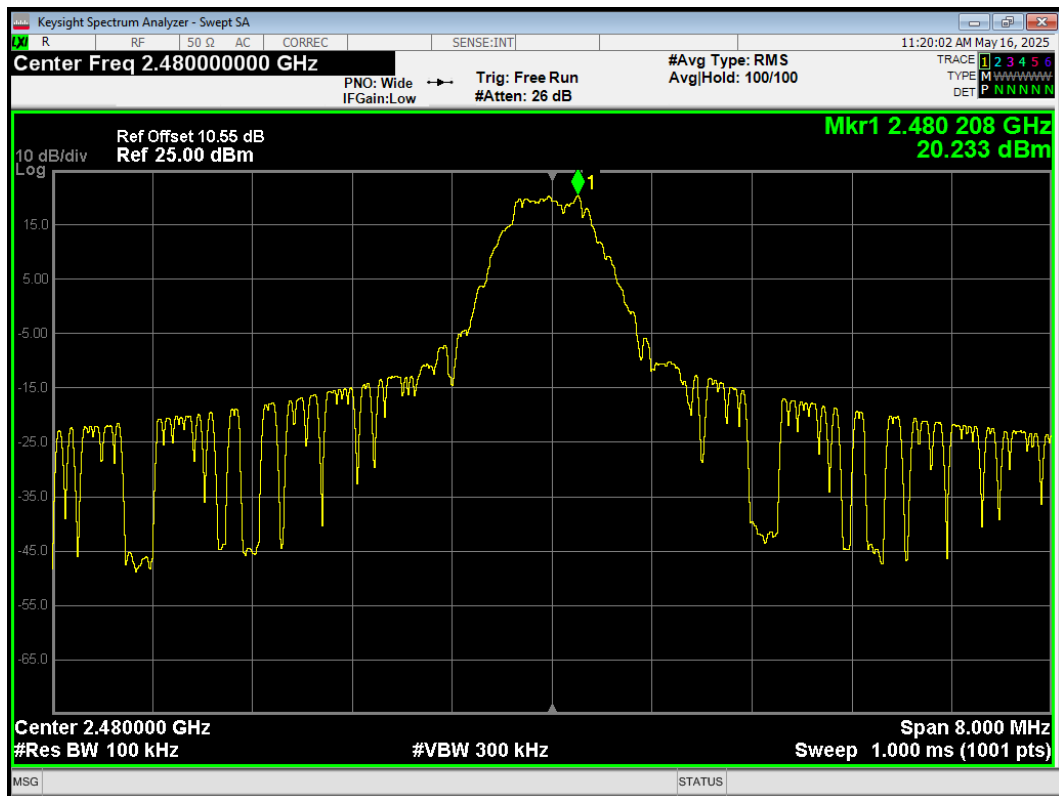
Band Edge BLE (1M) 2402MHz Ref



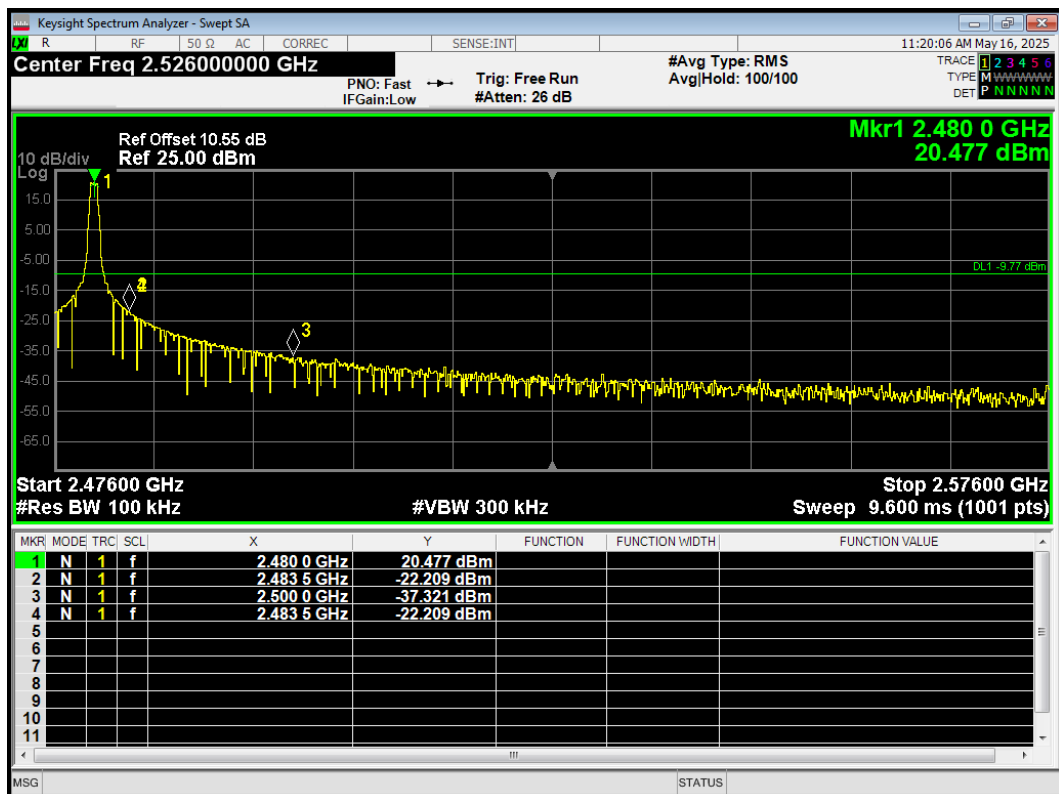
Band Edge BLE (1M) 2402MHz Emission



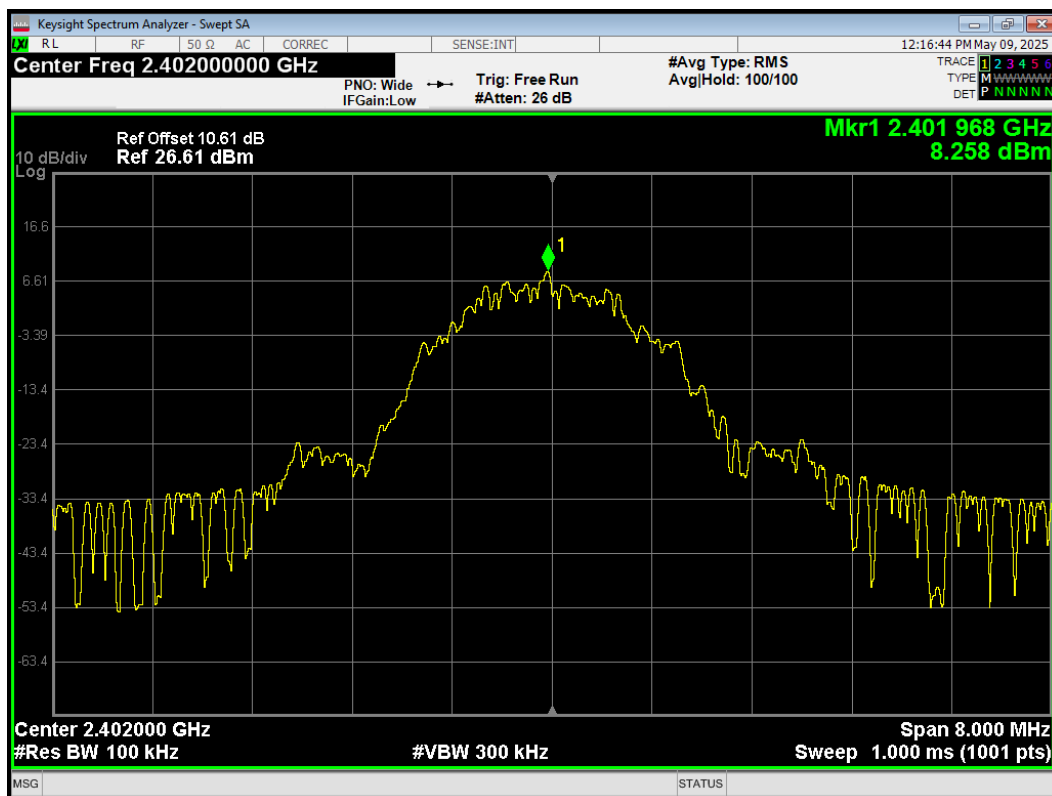
### Band Edge BLE (1M) 2480MHz Ref



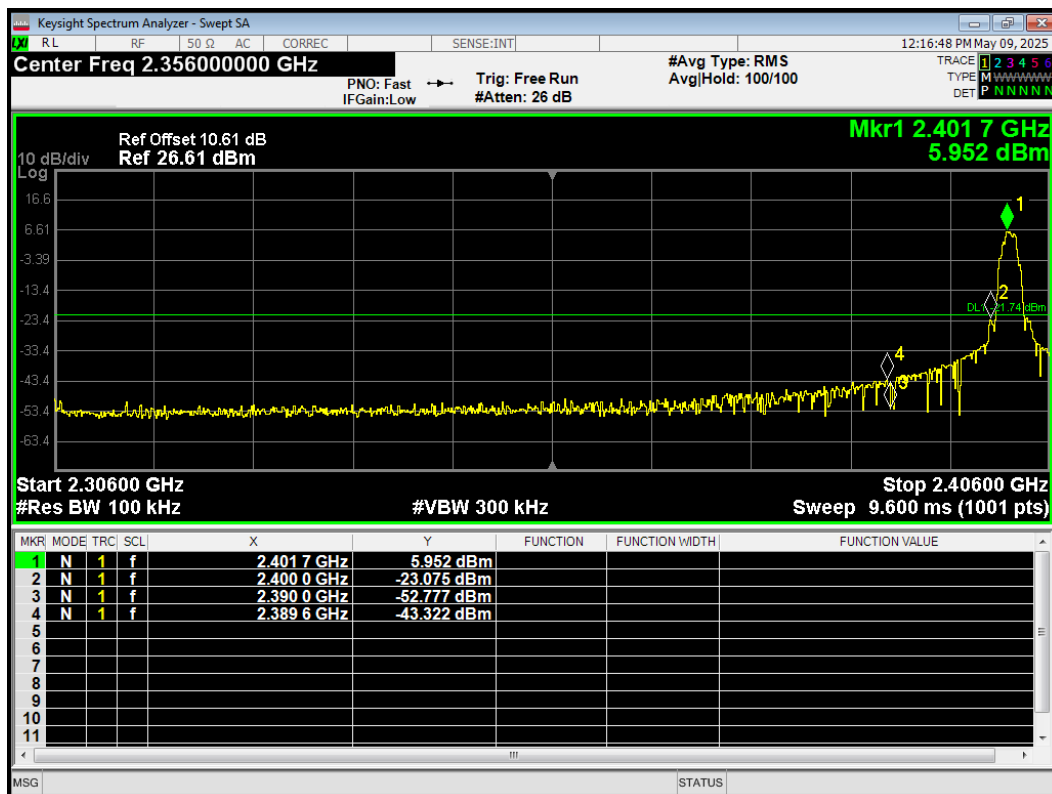
### Band Edge BLE (1M) 2480MHz Emission



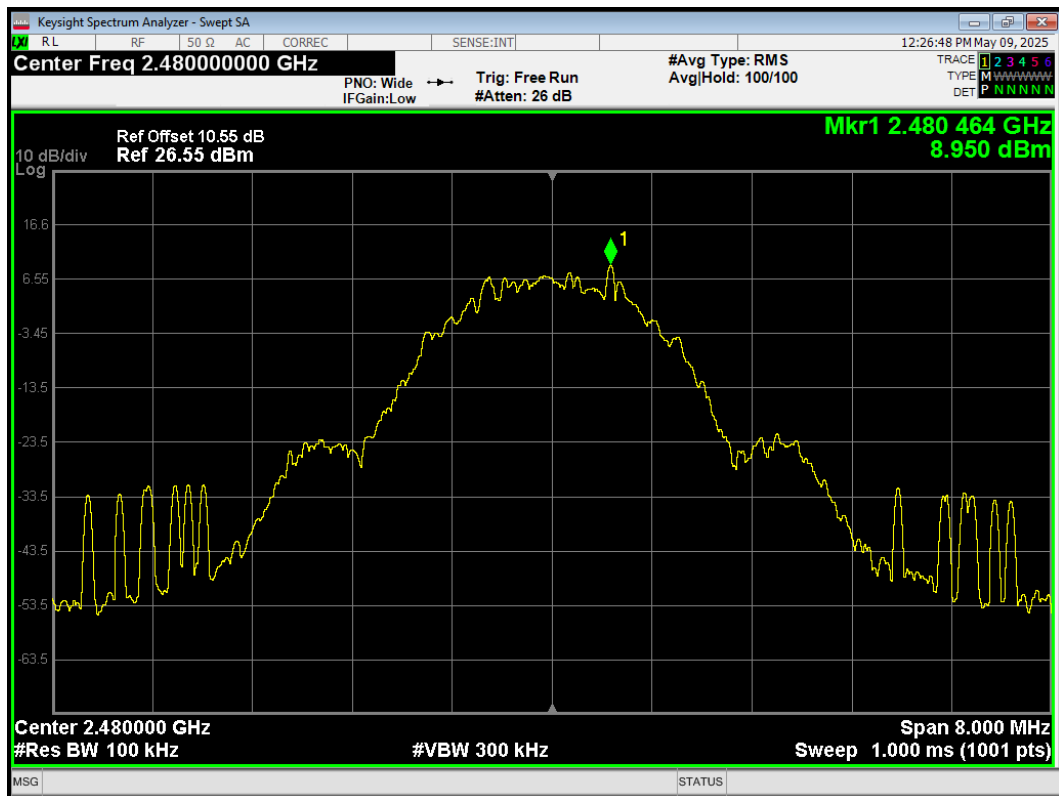
### Band Edge BLE (2M) 2402MHz Ref



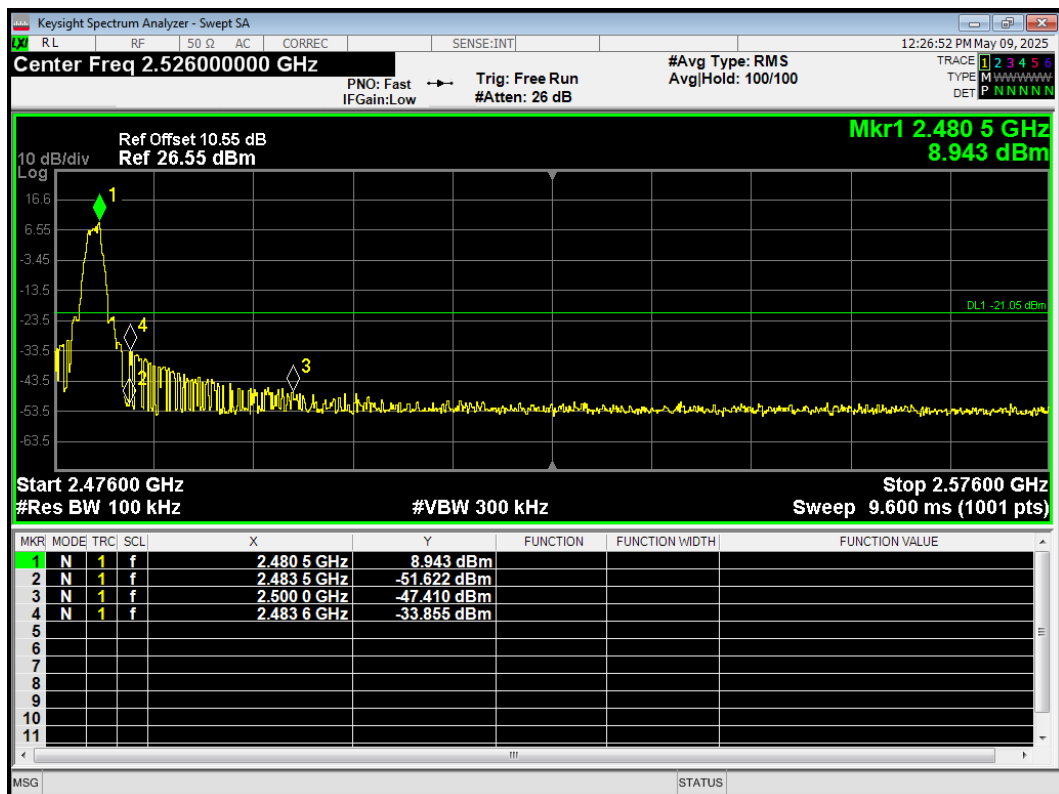
### Band Edge BLE (2M) 2402MHz Emission



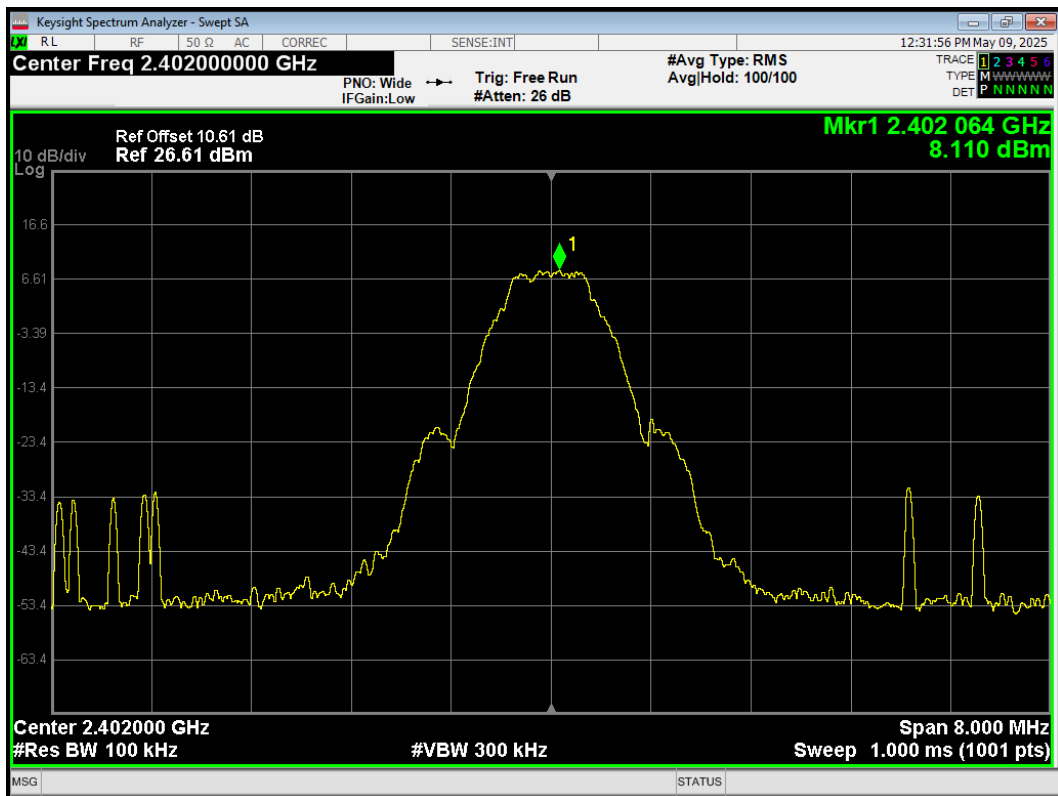
### Band Edge BLE (2M) 2480MHz Ref



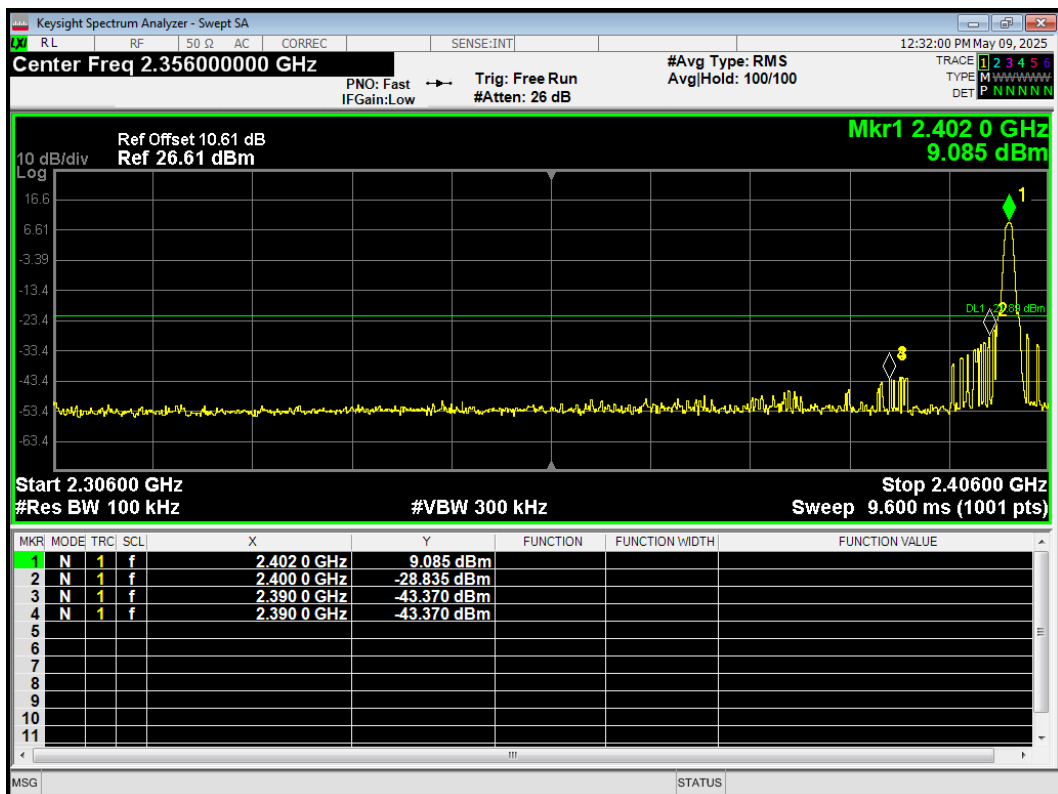
### Band Edge BLE (2M) 2480MHz Emission



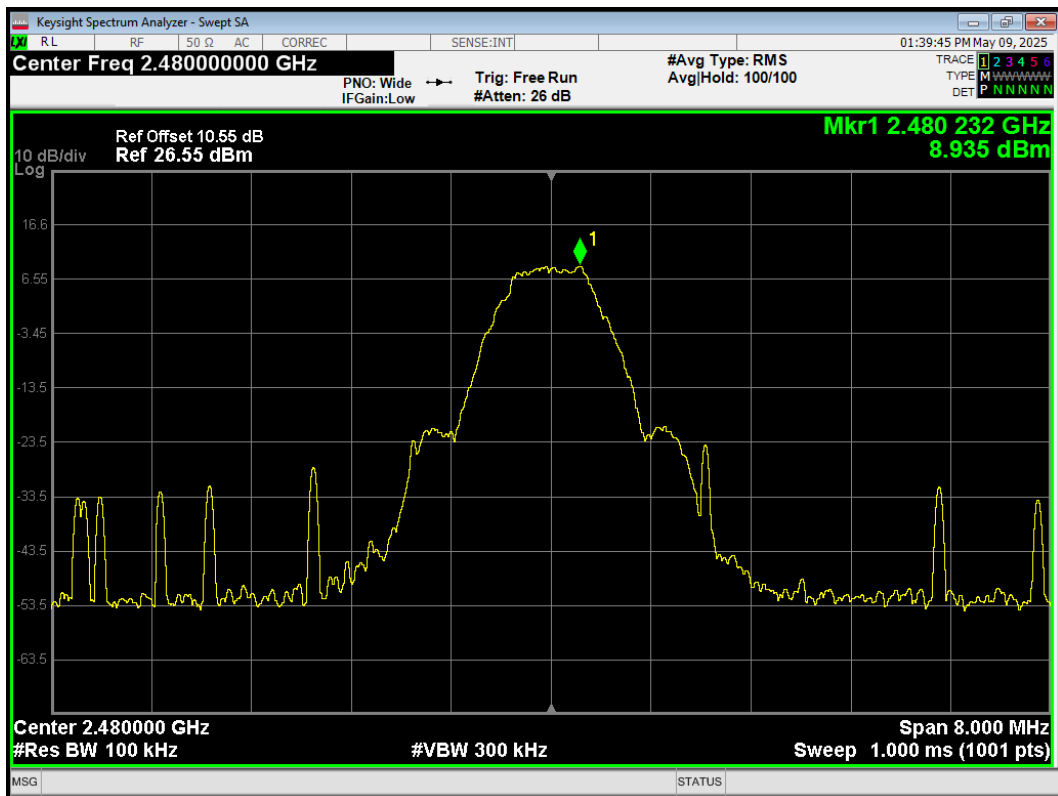
### Band Edge BLE (S=2) 2402MHz Ref



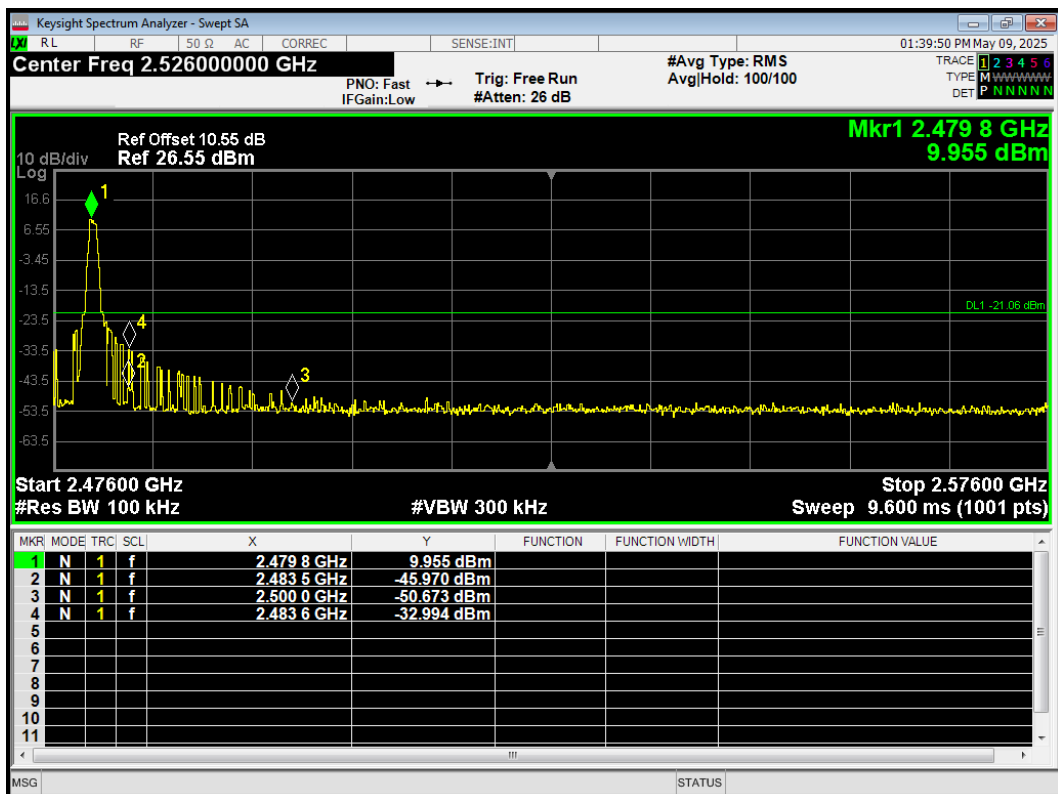
### Band Edge BLE (S=2) 2402MHz Emission



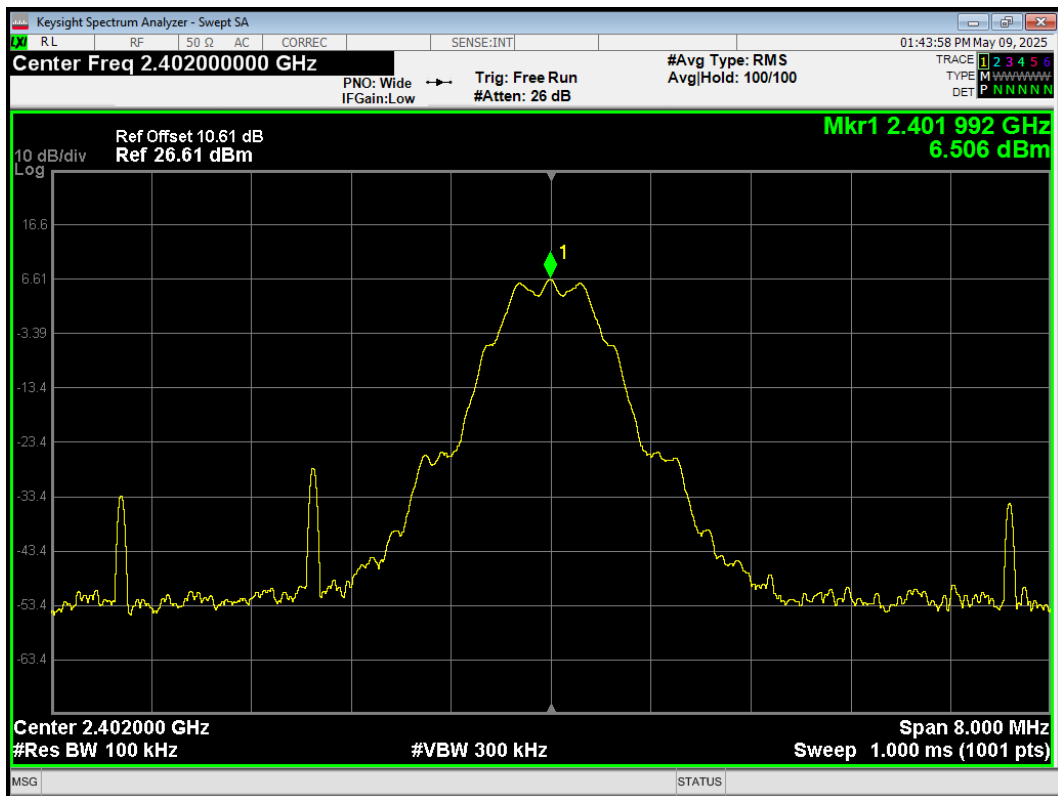
### Band Edge BLE (S=2) 2480MHz Ref



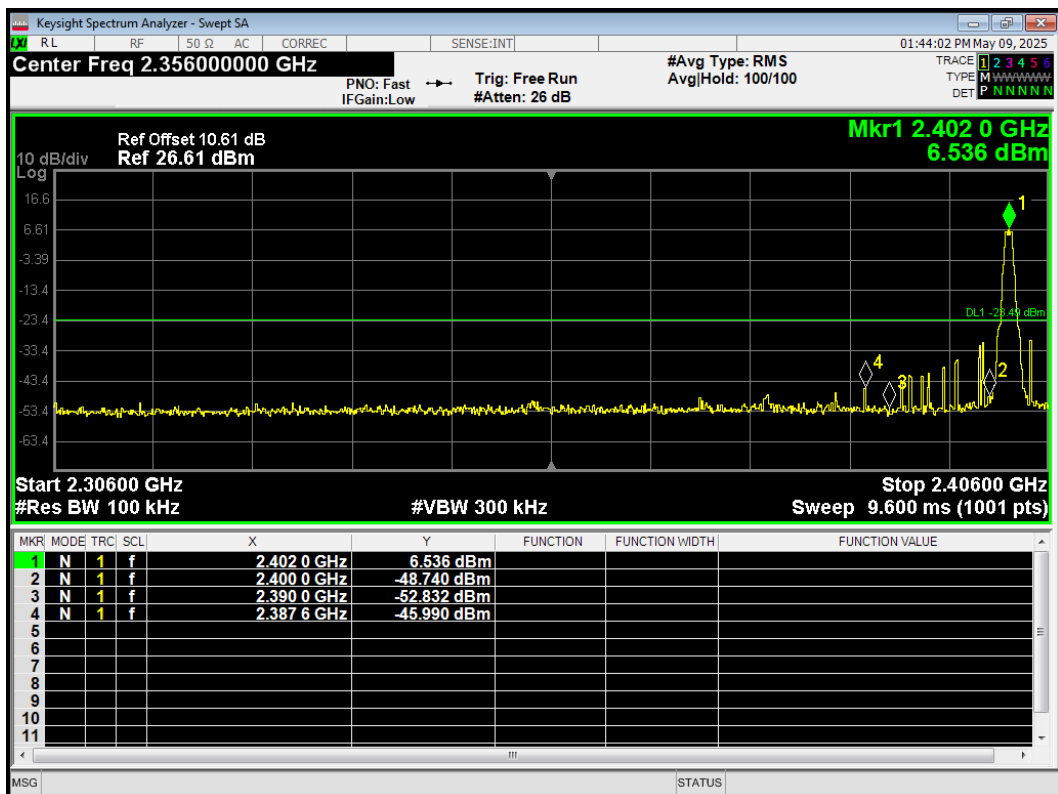
### Band Edge BLE (S=2) 2480MHz Emission



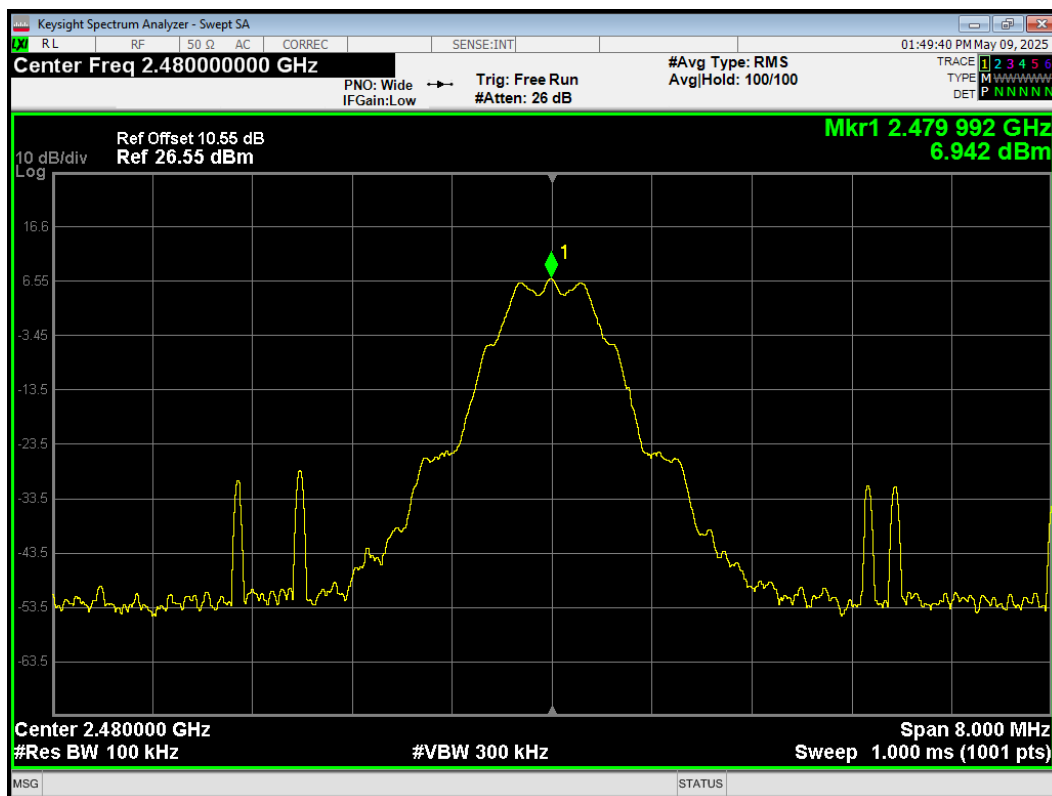
### Band Edge BLE (S=8) 2402MHz Ref



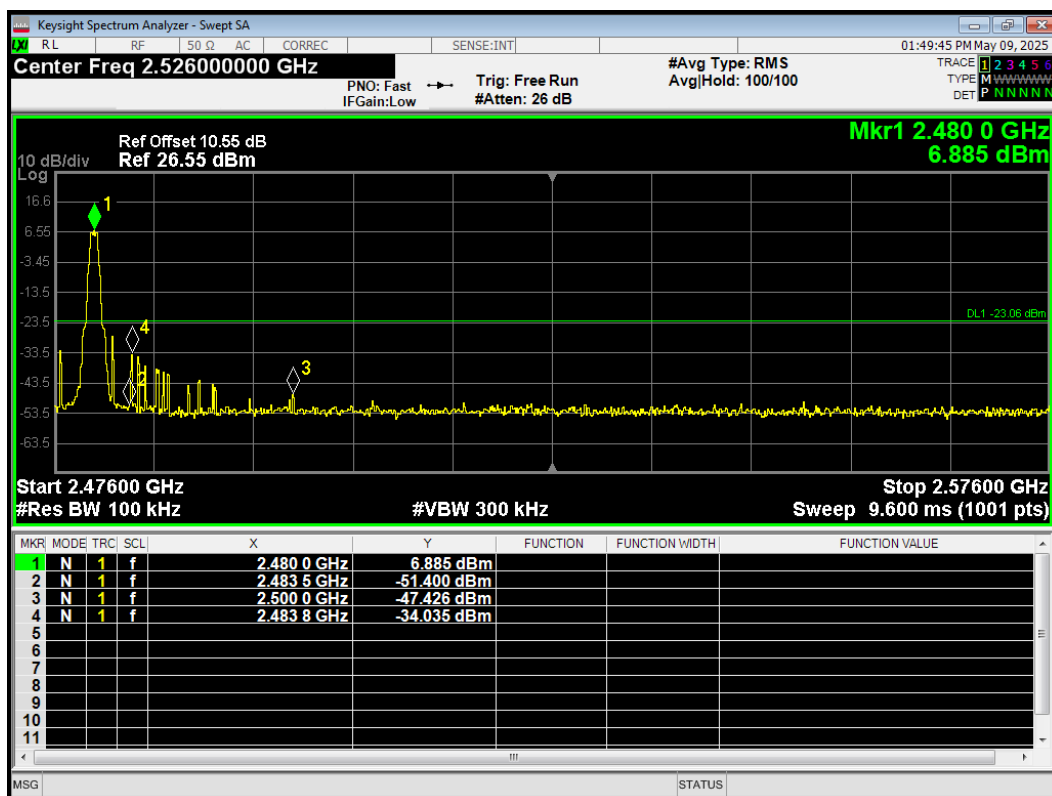
### Band Edge BLE (S=8) 2402MHz Emission



### Band Edge BLE (S=8) 2480MHz Ref

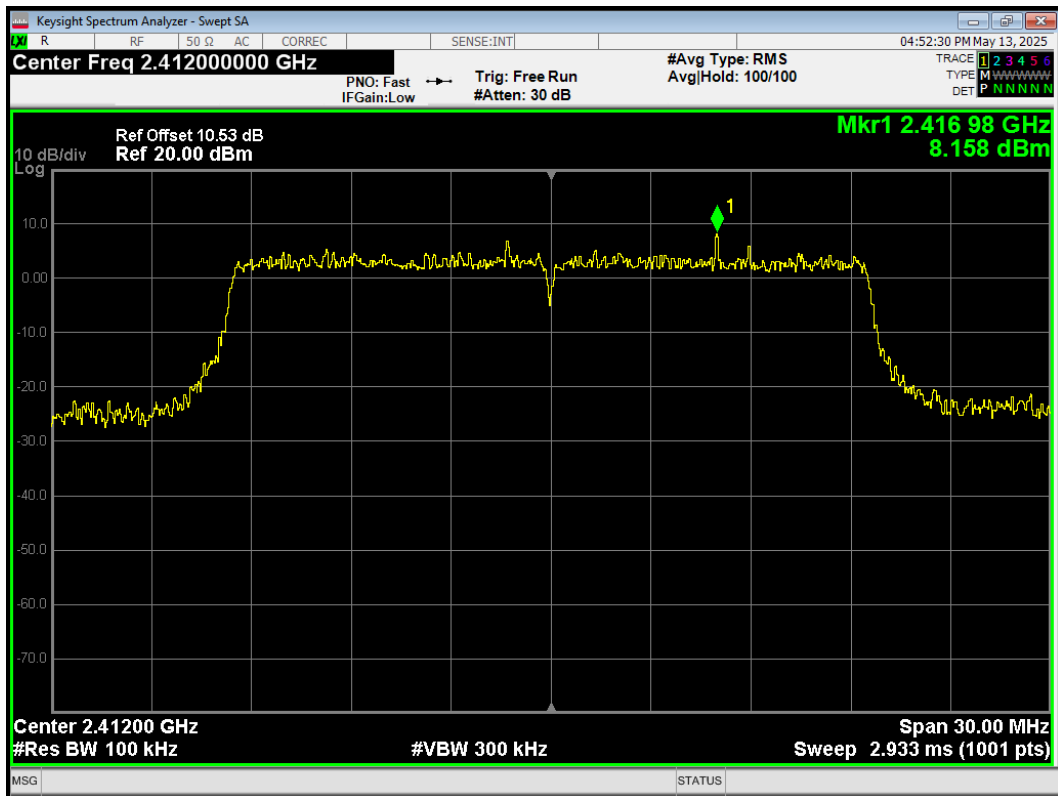


### Band Edge BLE (S=8) 2480MHz Emission

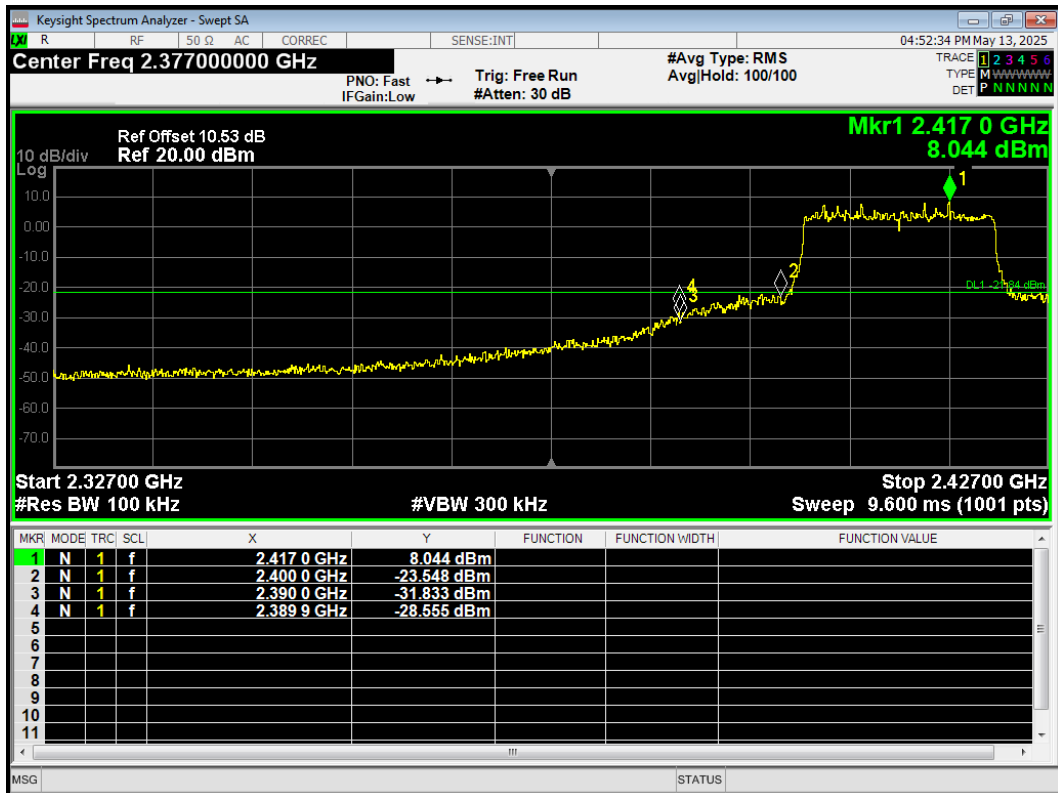


SU Mode

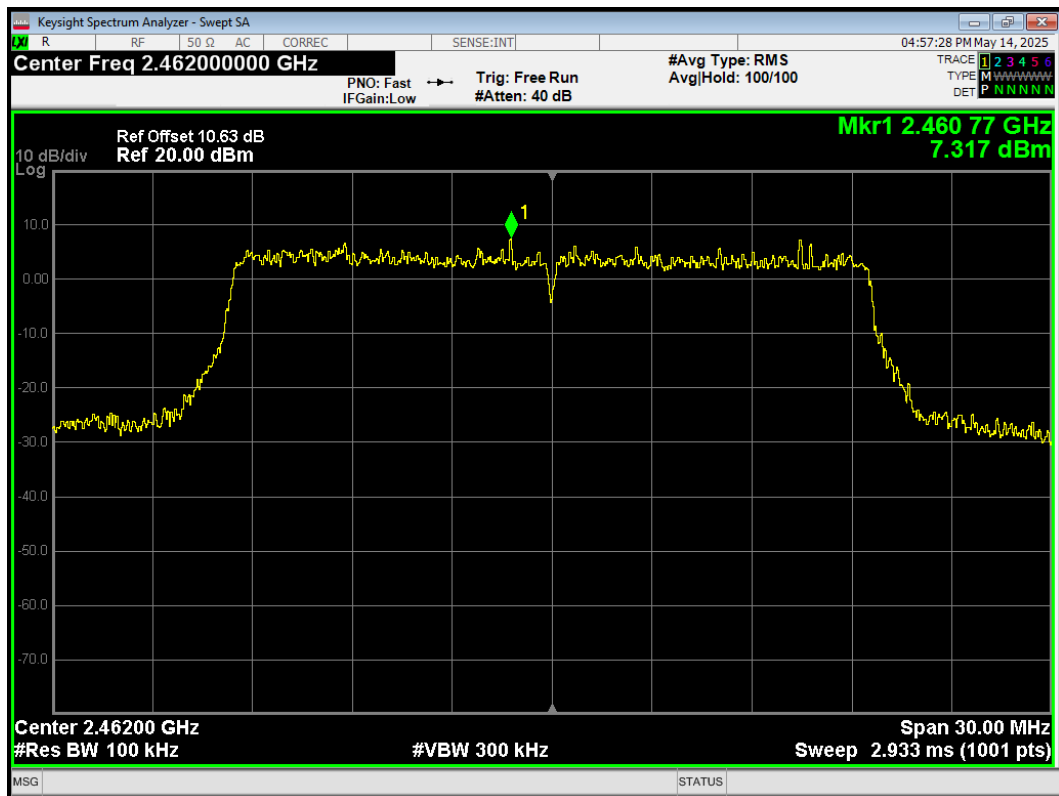
Band Edge 802.11ax(HE20) 2412MHz Ref



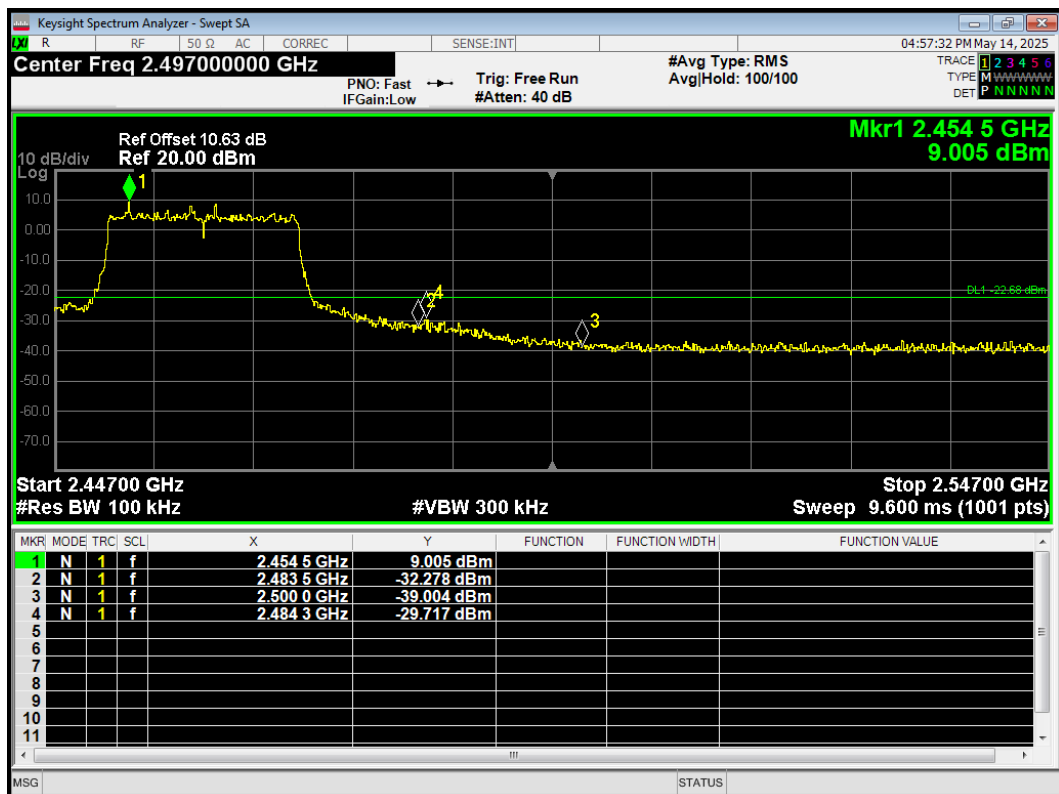
Band Edge 802.11ax(HE20) 2412MHz Emission



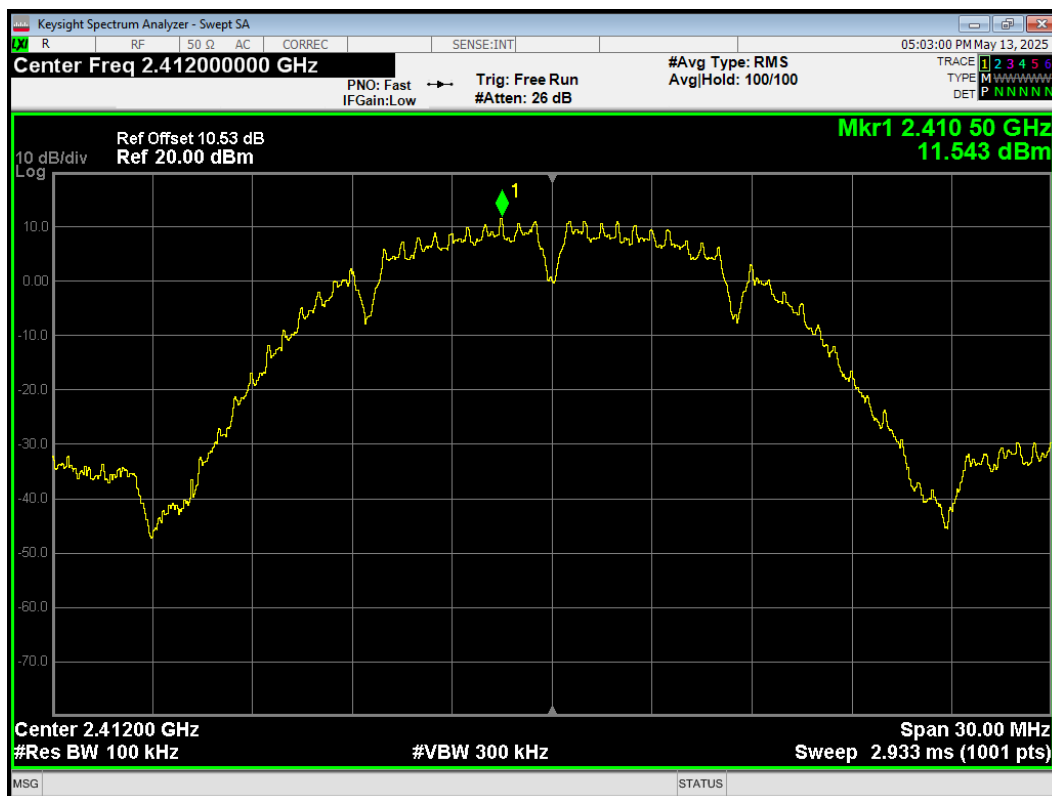
Band Edge 802.11ax(HE20) 2462MHz Ref



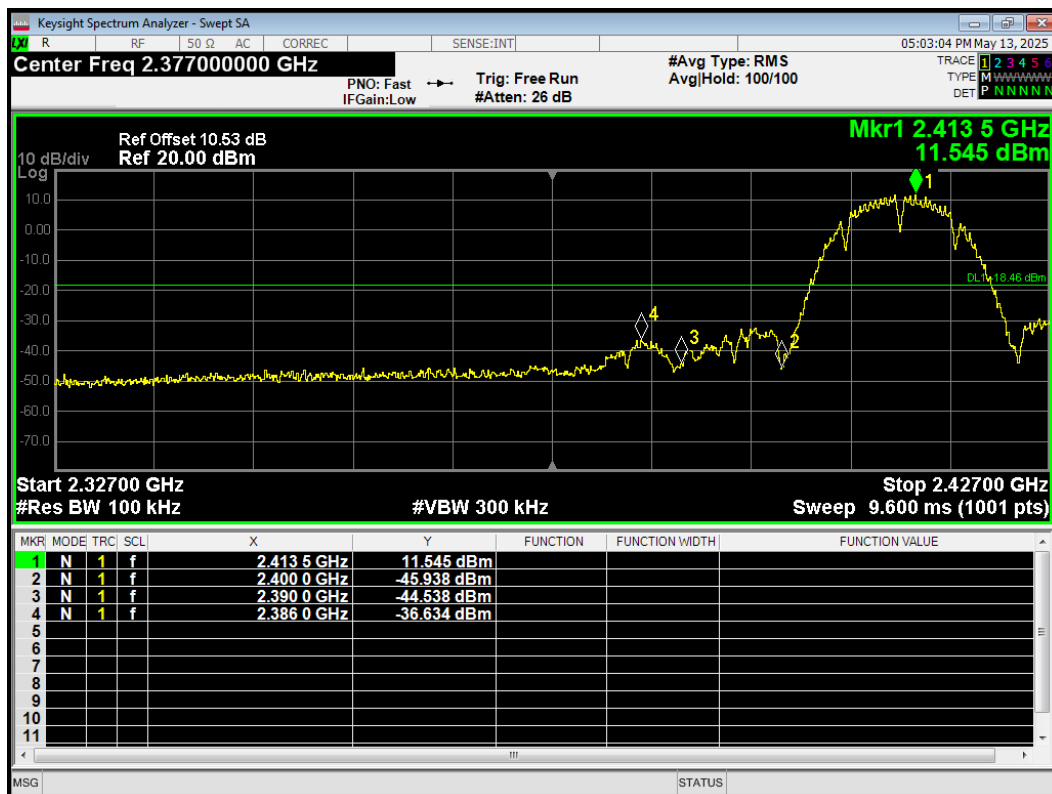
Band Edge 802.11ax(HE20) 2462MHz Emission



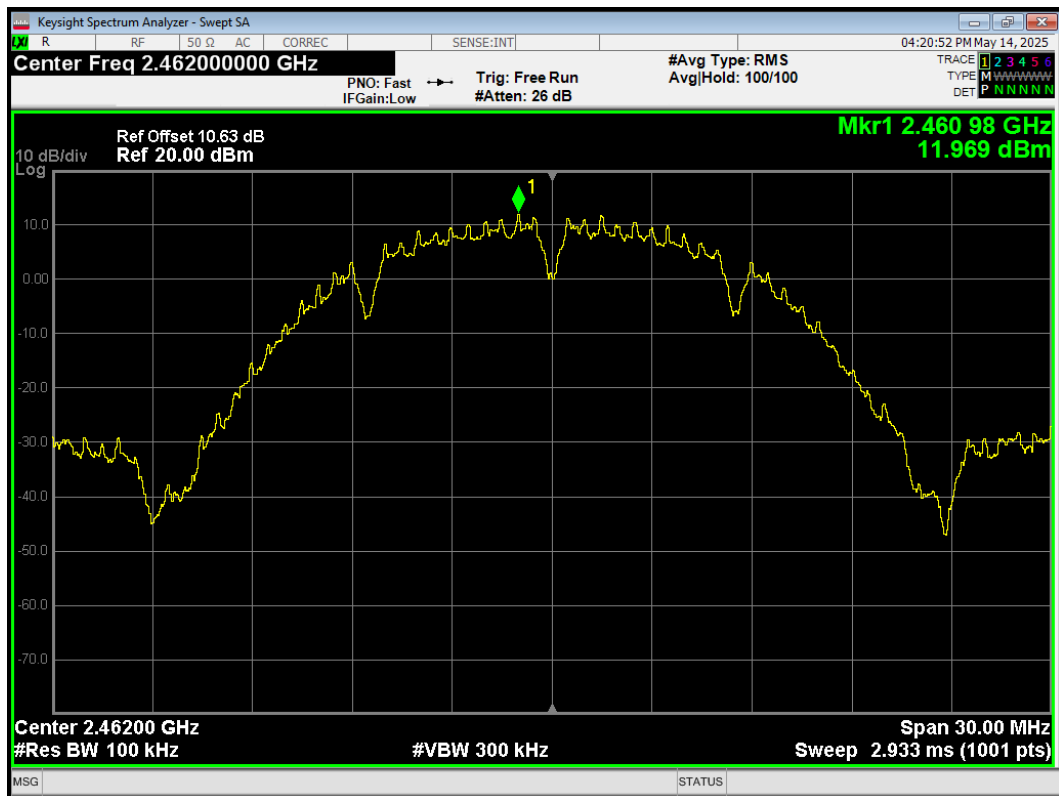
# Band Edge 802.11b 2412MHz Ref



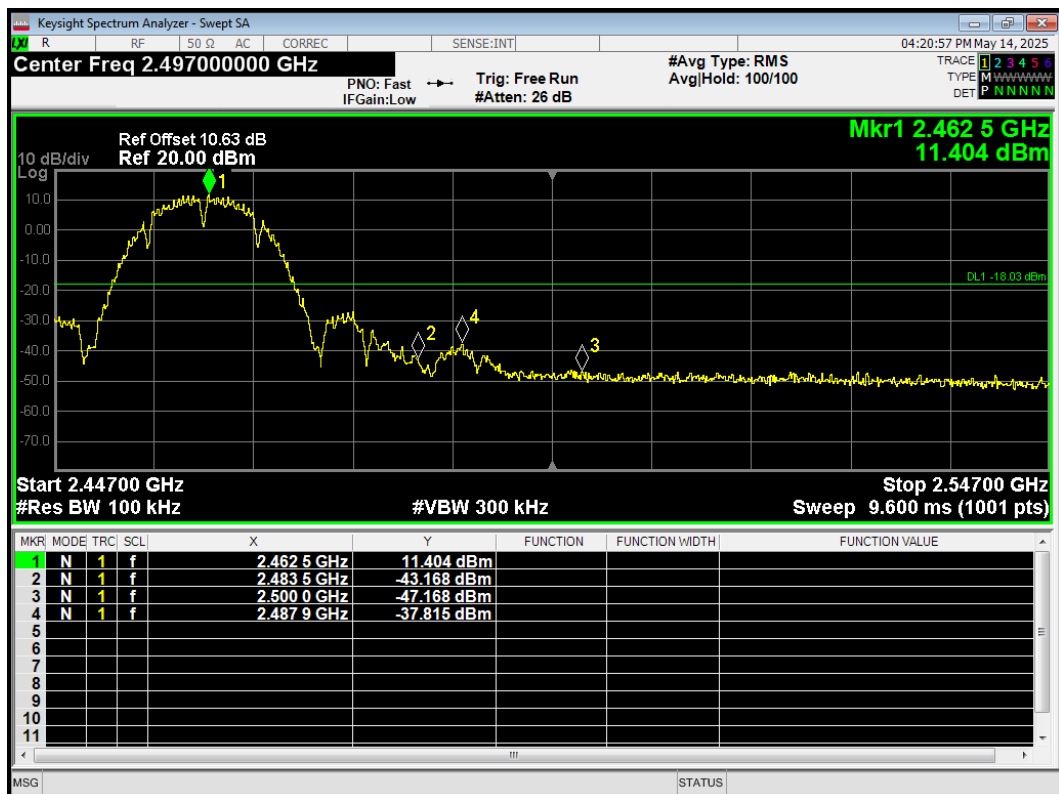
# Band Edge 802.11b 2412MHz Emission



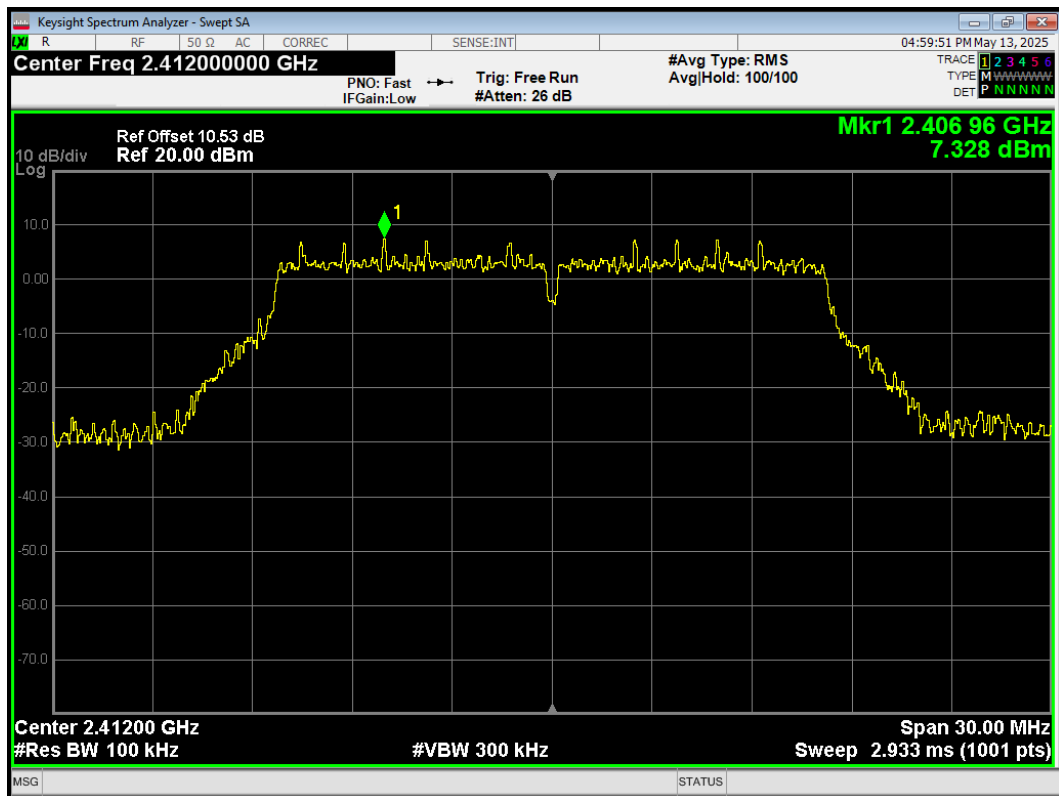
Band Edge 802.11b 2462MHz Ref



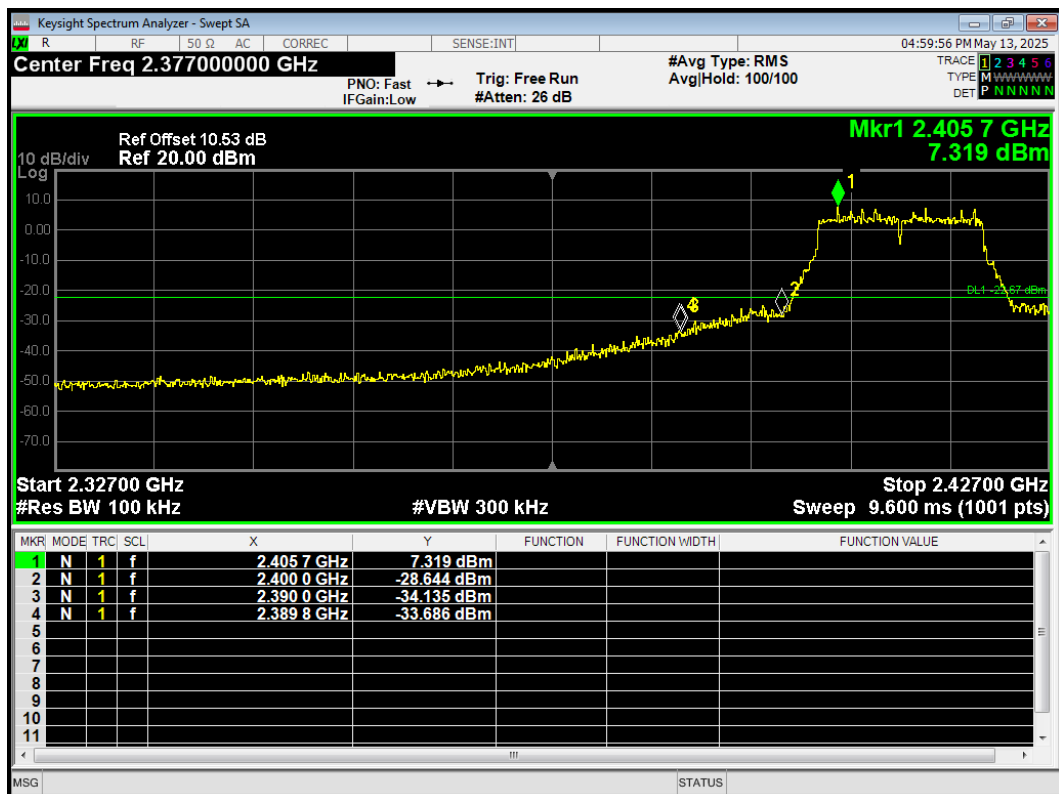
Band Edge 802.11b 2462MHz Emission



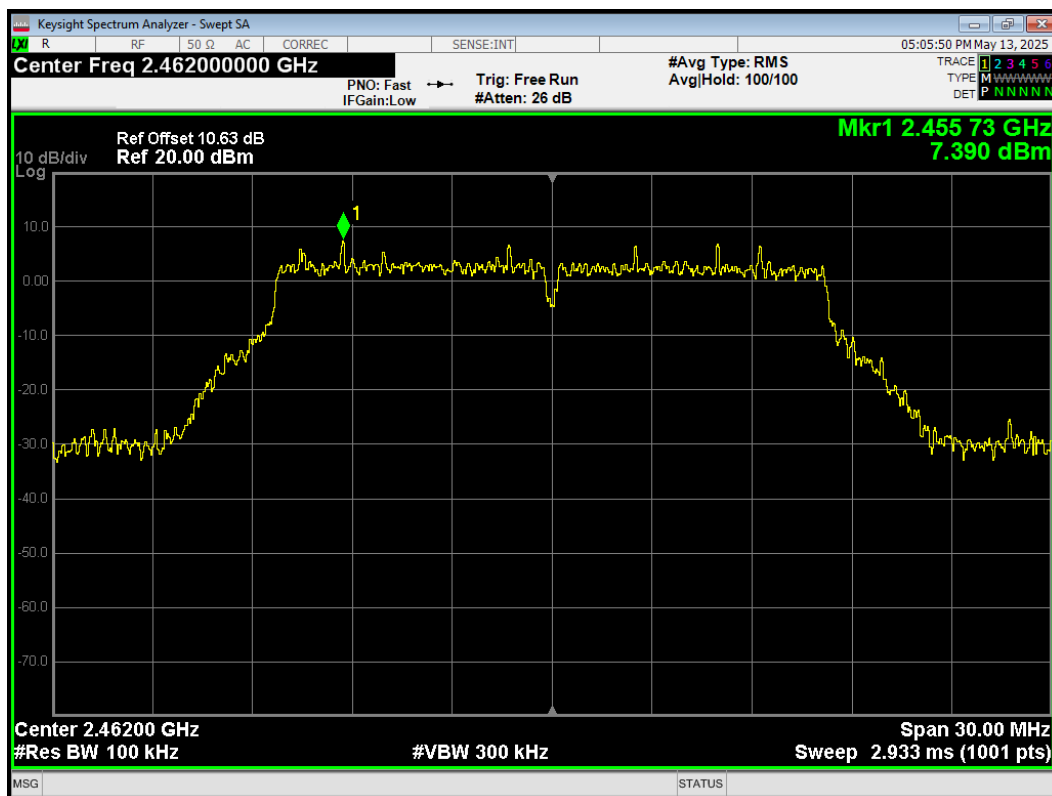
### Band Edge 802.11g 2412MHz Ref



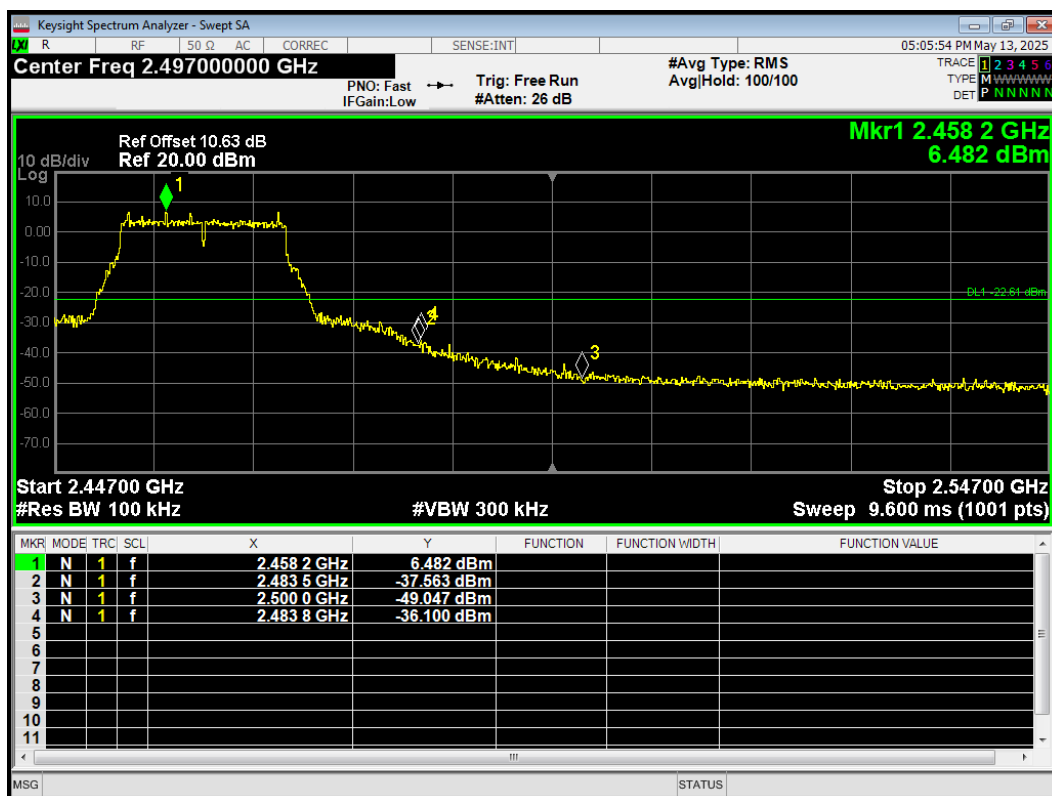
### Band Edge 802.11g 2412MHz Emission



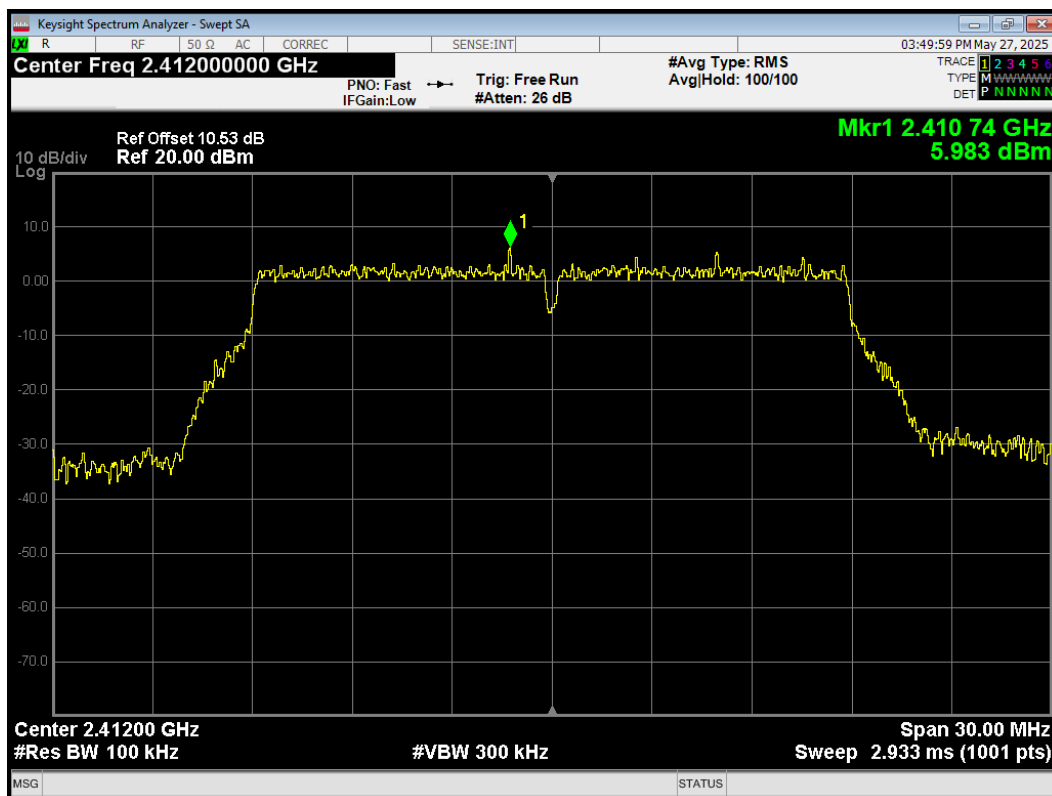
### Band Edge 802.11g 2462MHz Ref



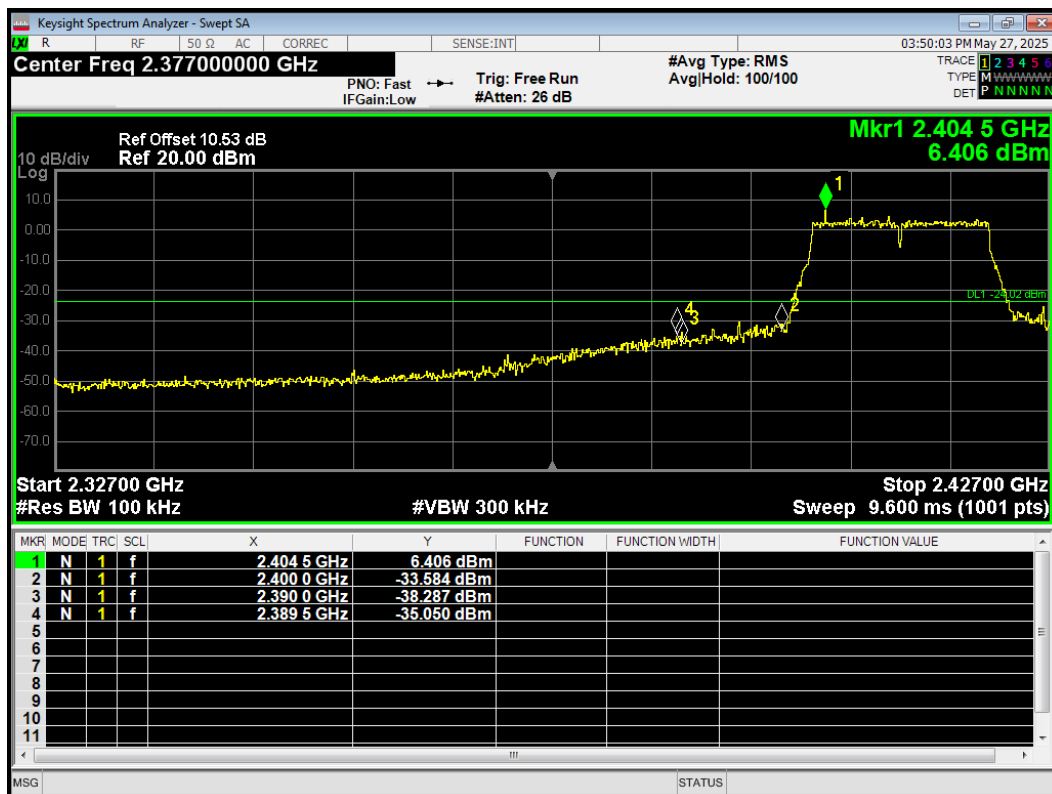
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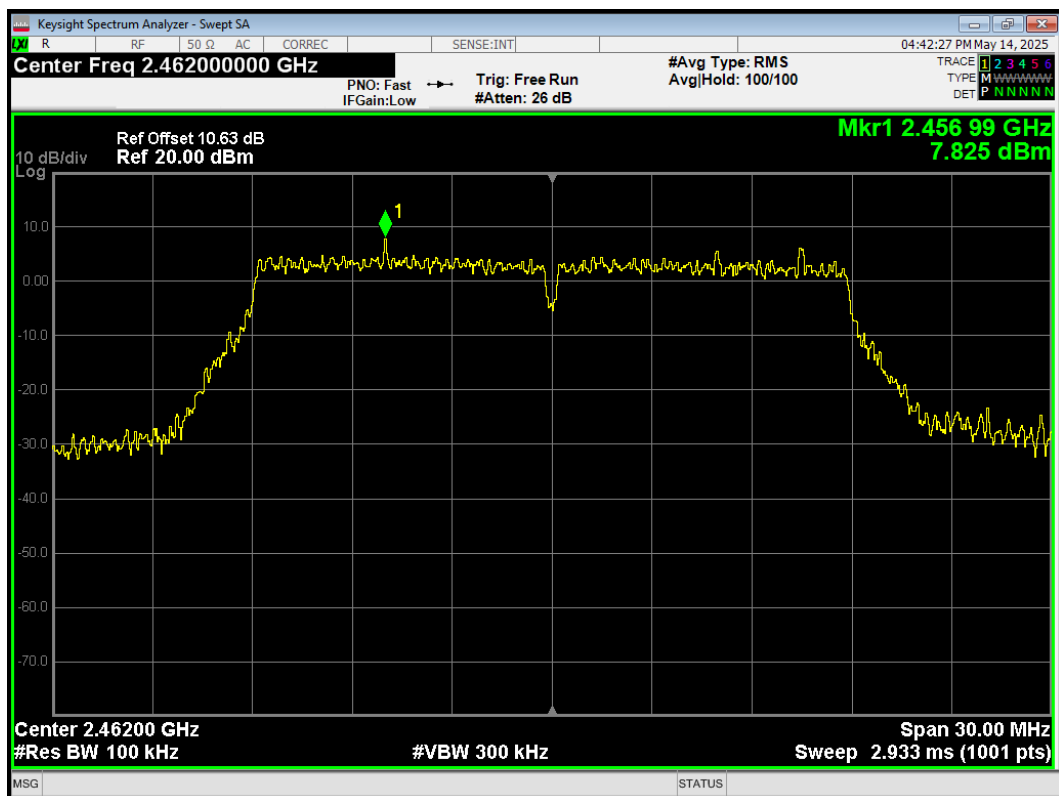
Band Edge 802.11n(HT20) 2412MHz Ref



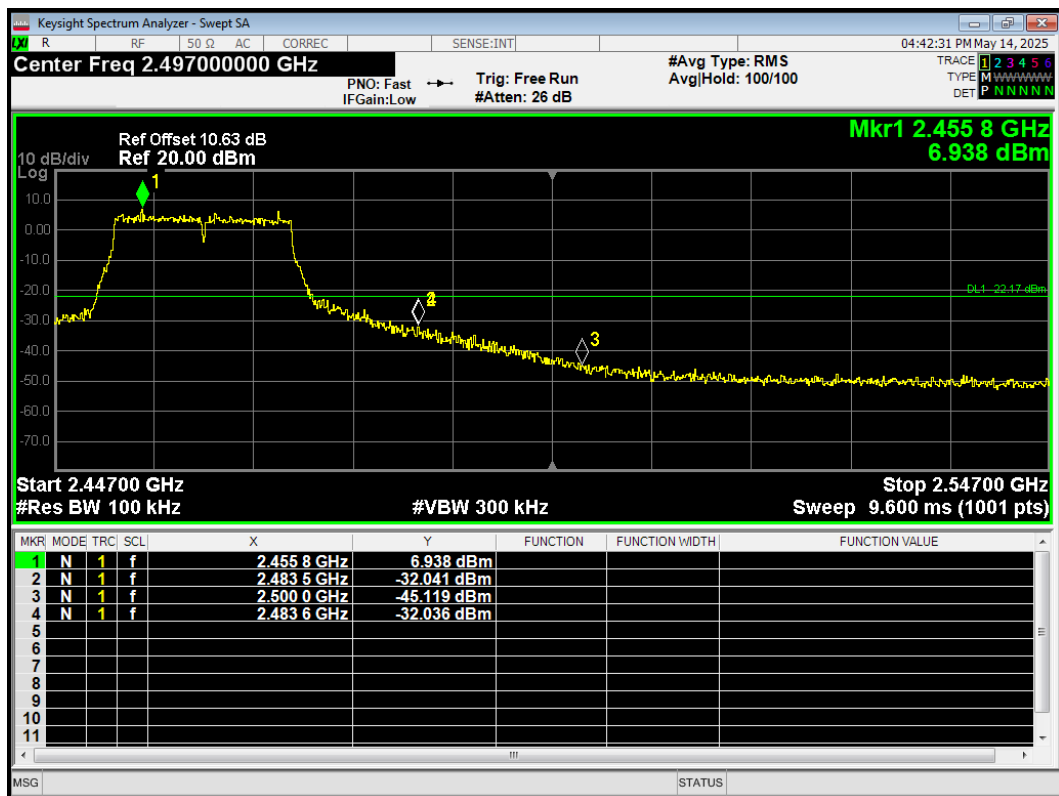
Band Edge 802.11n(HT20) 2412MHz Emission



Band Edge 802.11n(HT20) 2462MHz Ref

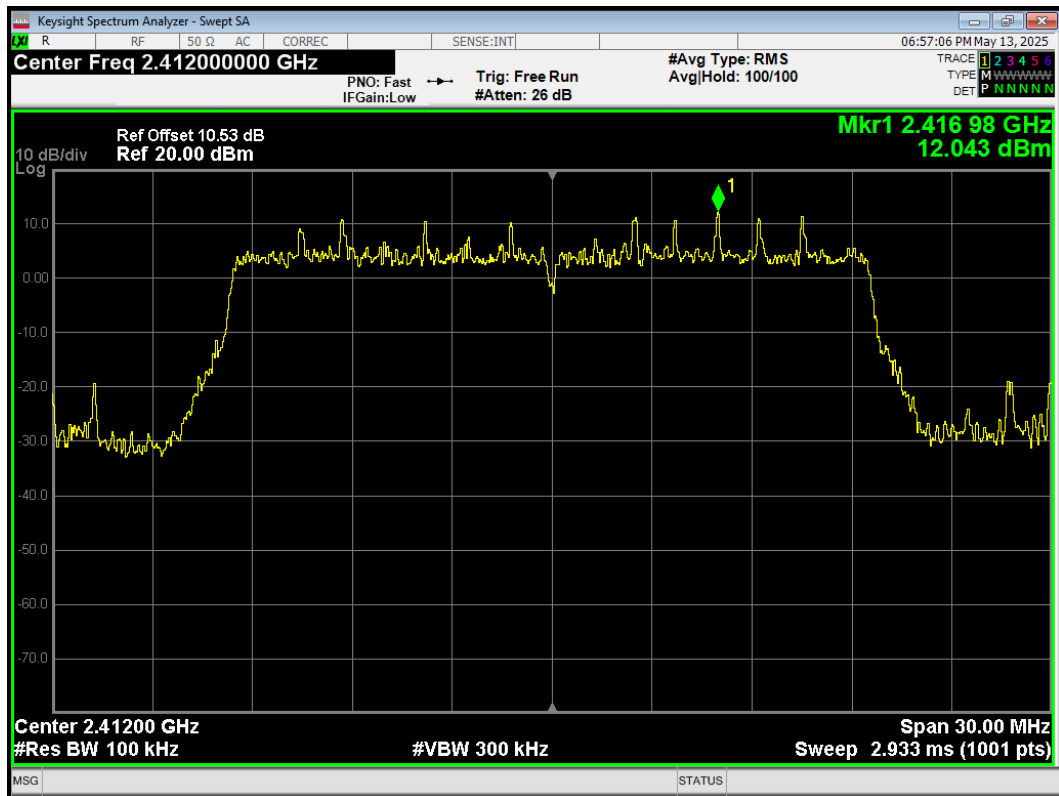


Band Edge 802.11n(HT20) 2462MHz Emission

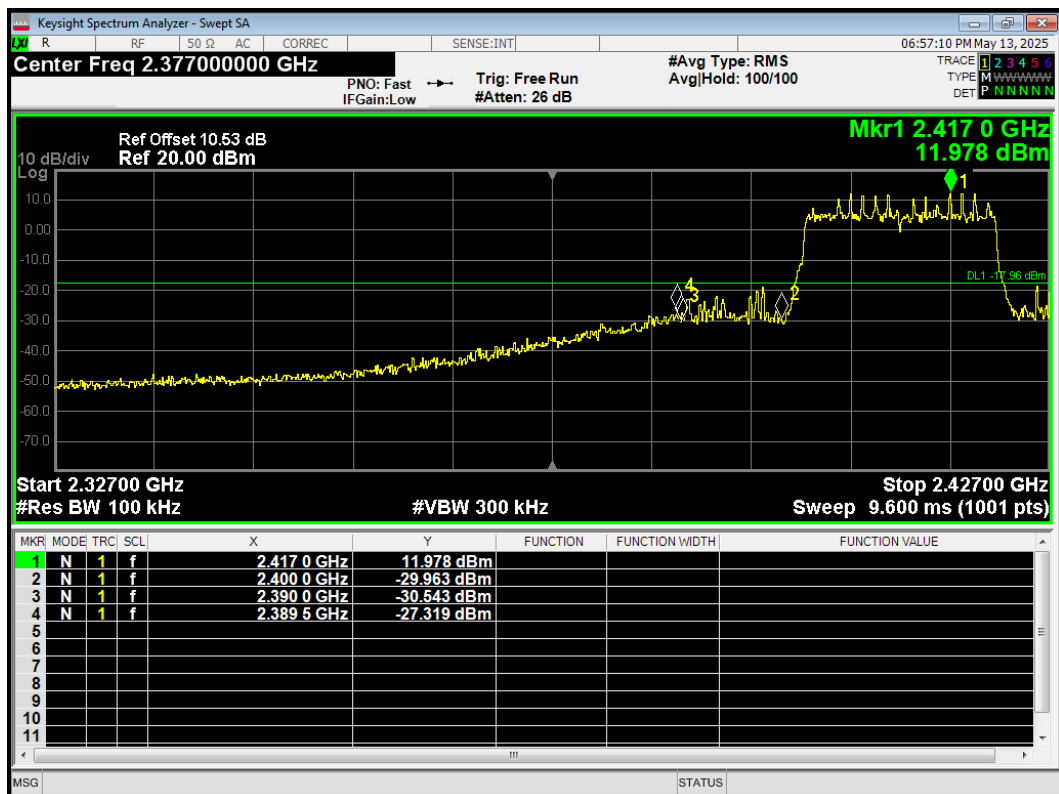


ERSU Mode

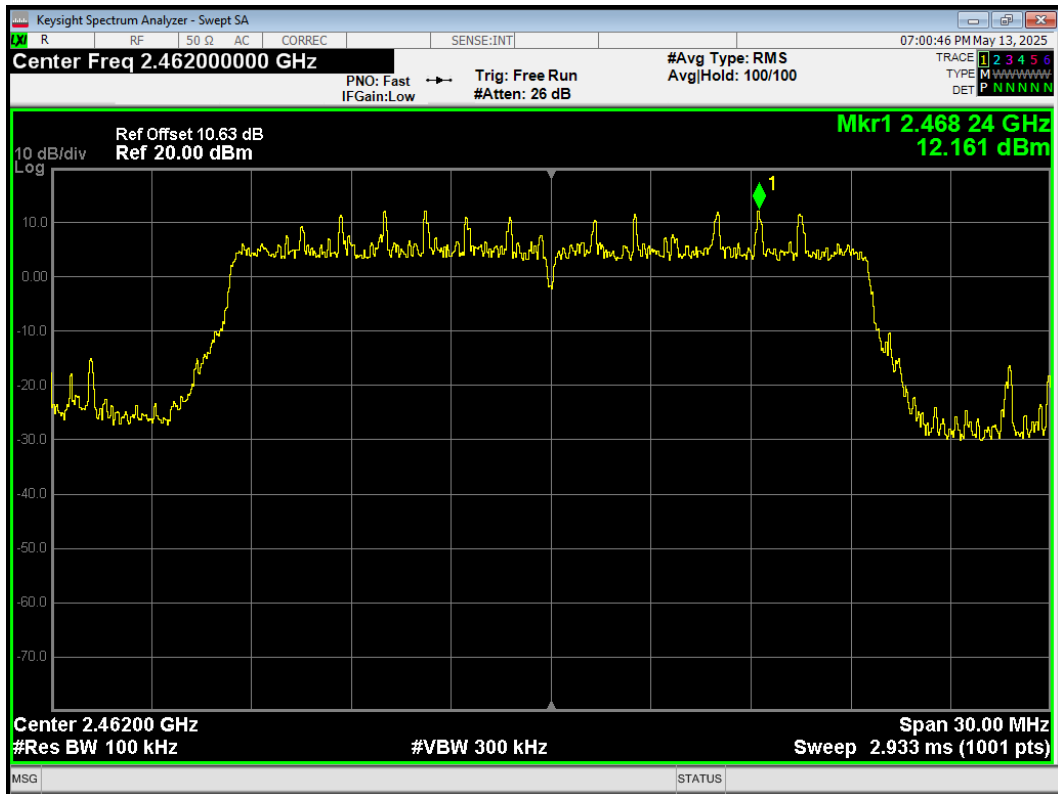
Band Edge 802.11ax(HE20) 242-Tones 2412MHz Ref



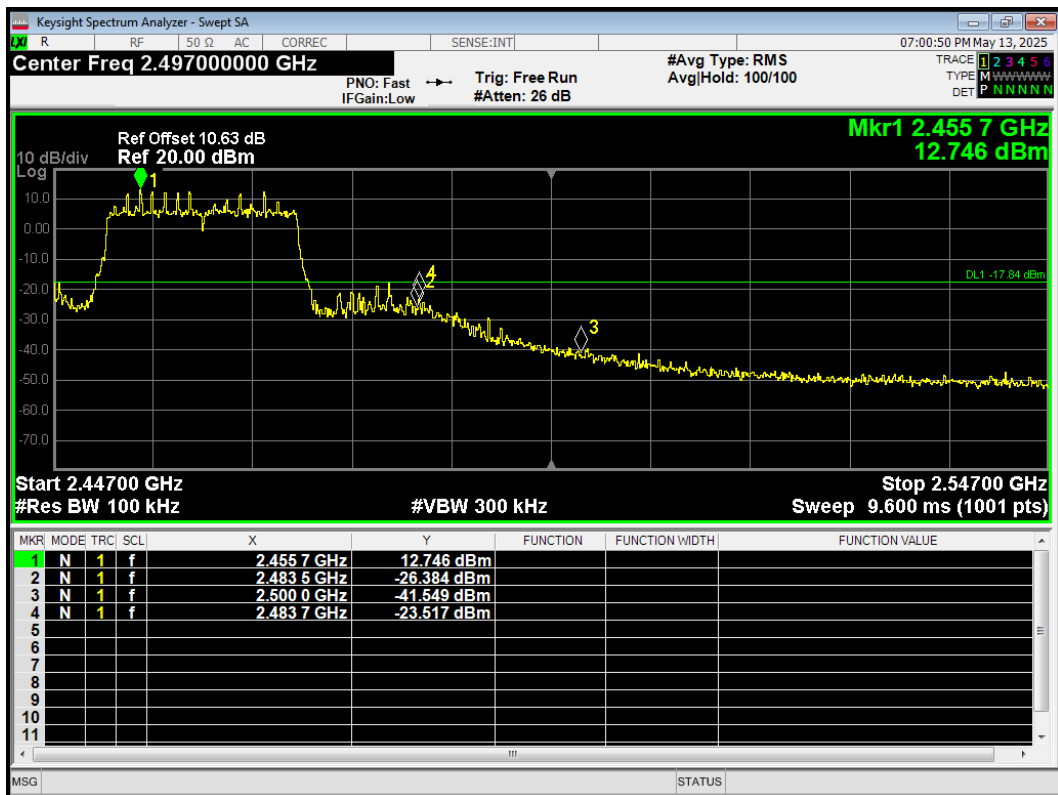
Band Edge 802.11ax(HE20) 242-Tones 2412MHz Emission



Band Edge 802.11ax(HE20) 242-Tones 2462MHz Ref

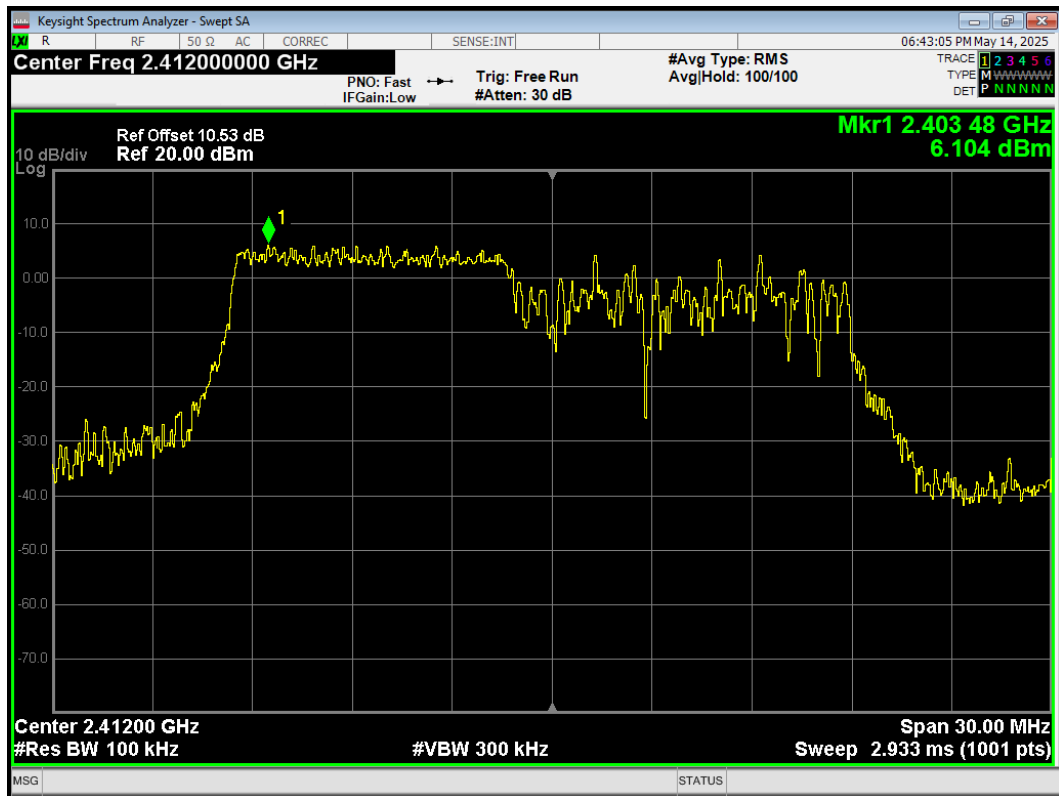


Band Edge 802.11ax(HE20) 242-Tones 2462MHz Emission

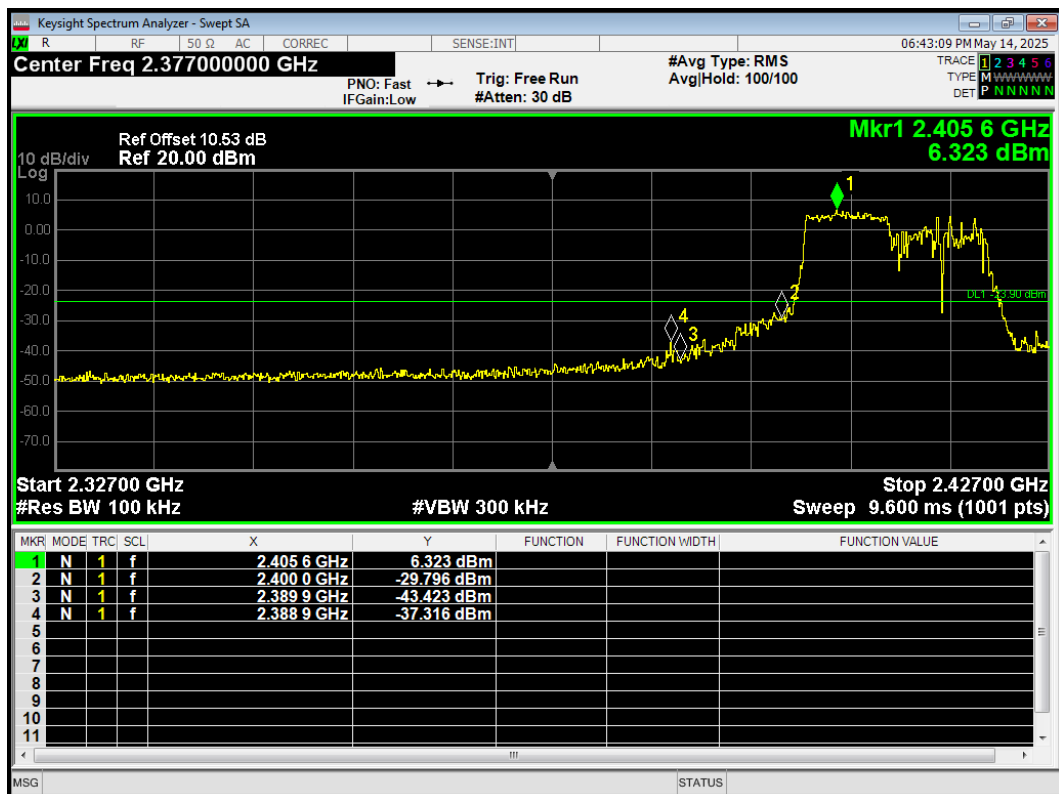


TB Mode

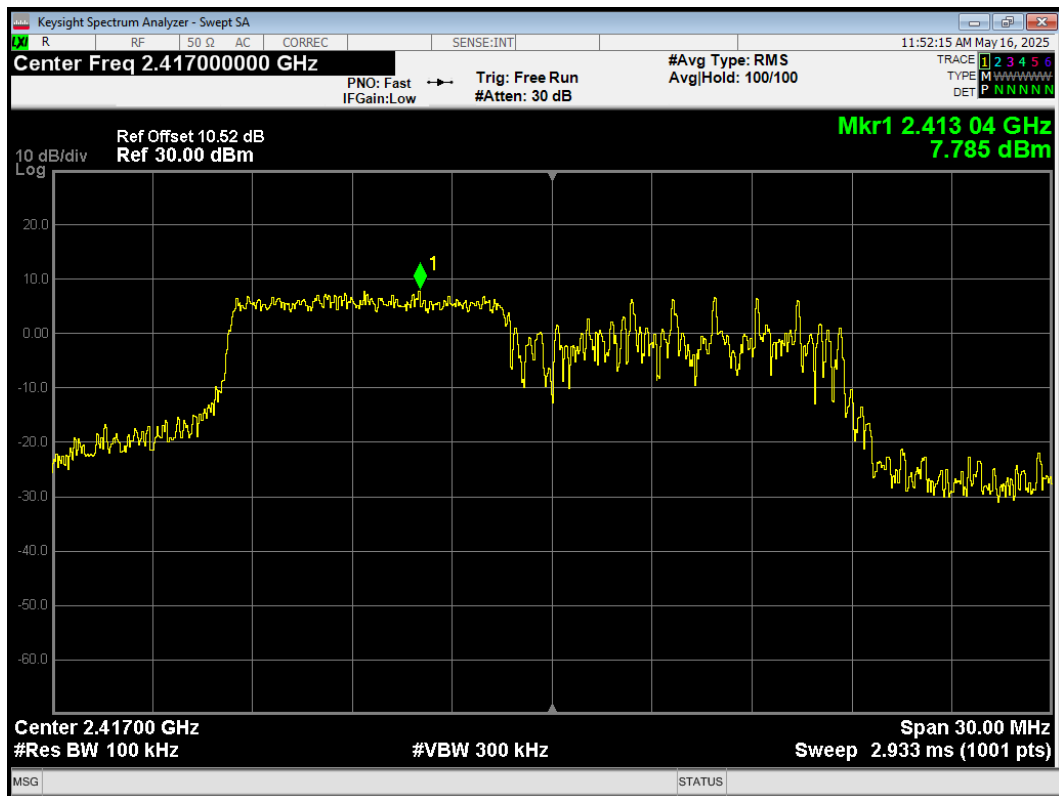
Band Edge 802.11ax(HE20) 106T 2412MHz Ref



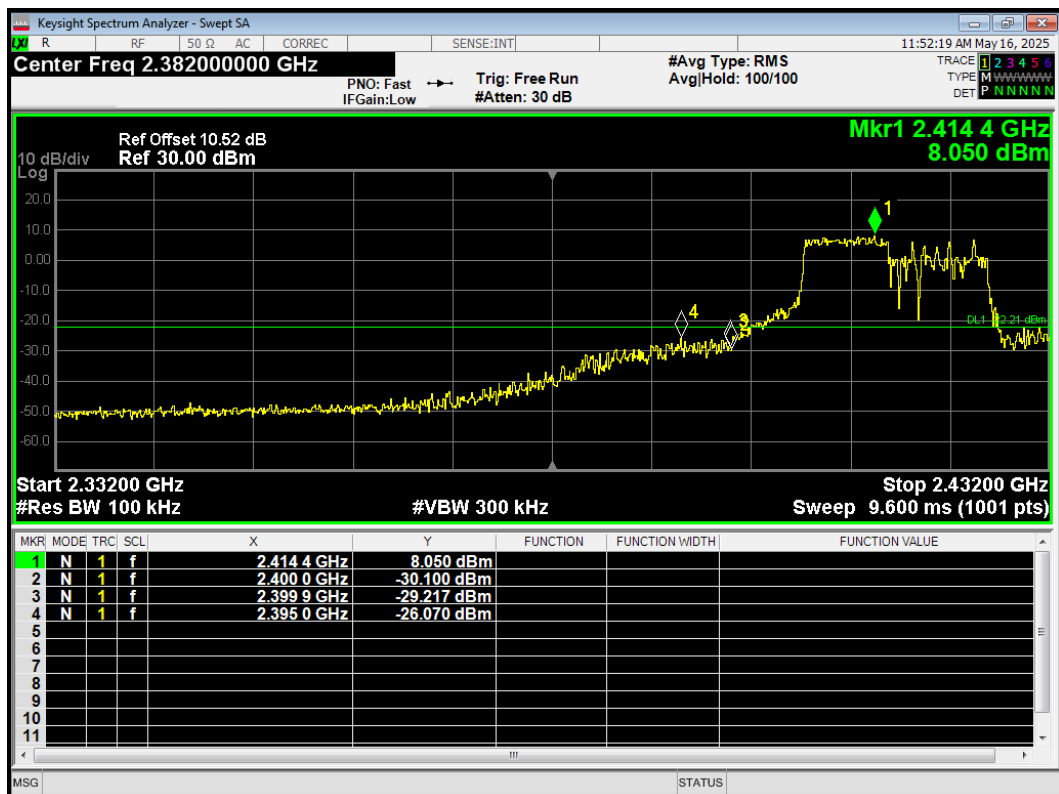
Band Edge 802.11ax(HE20) 106T 2412MHz Emission



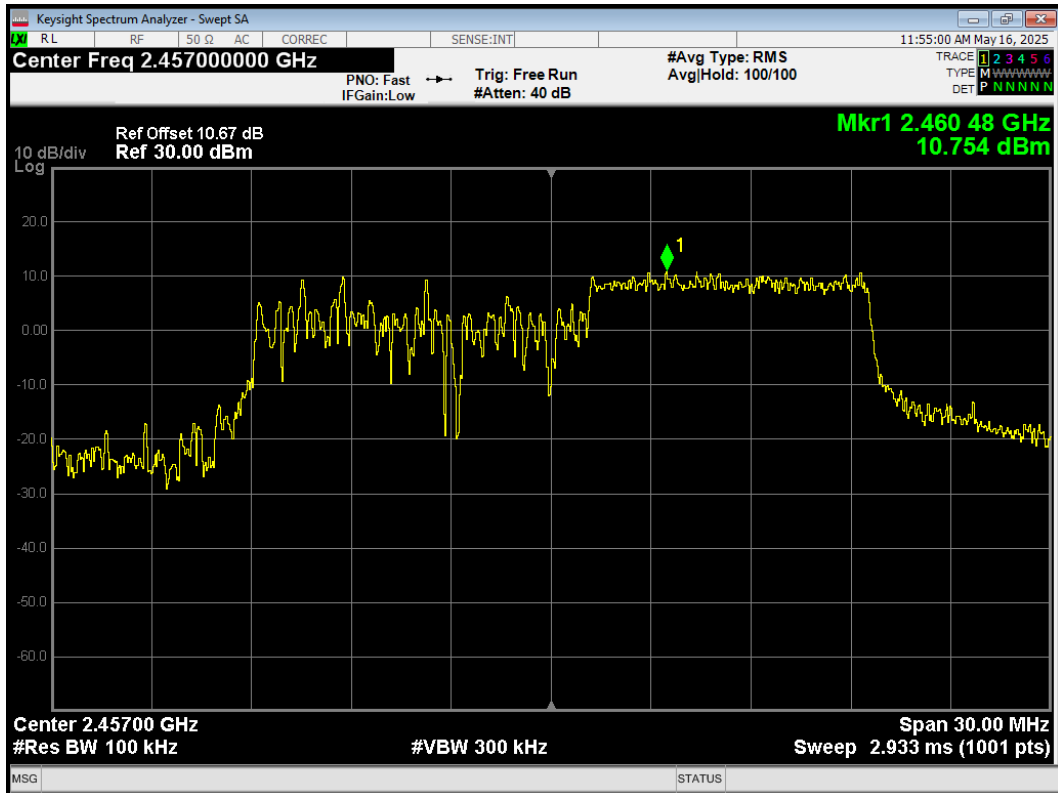
Band Edge 802.11ax(HE20) 106T 2417MHz Ref



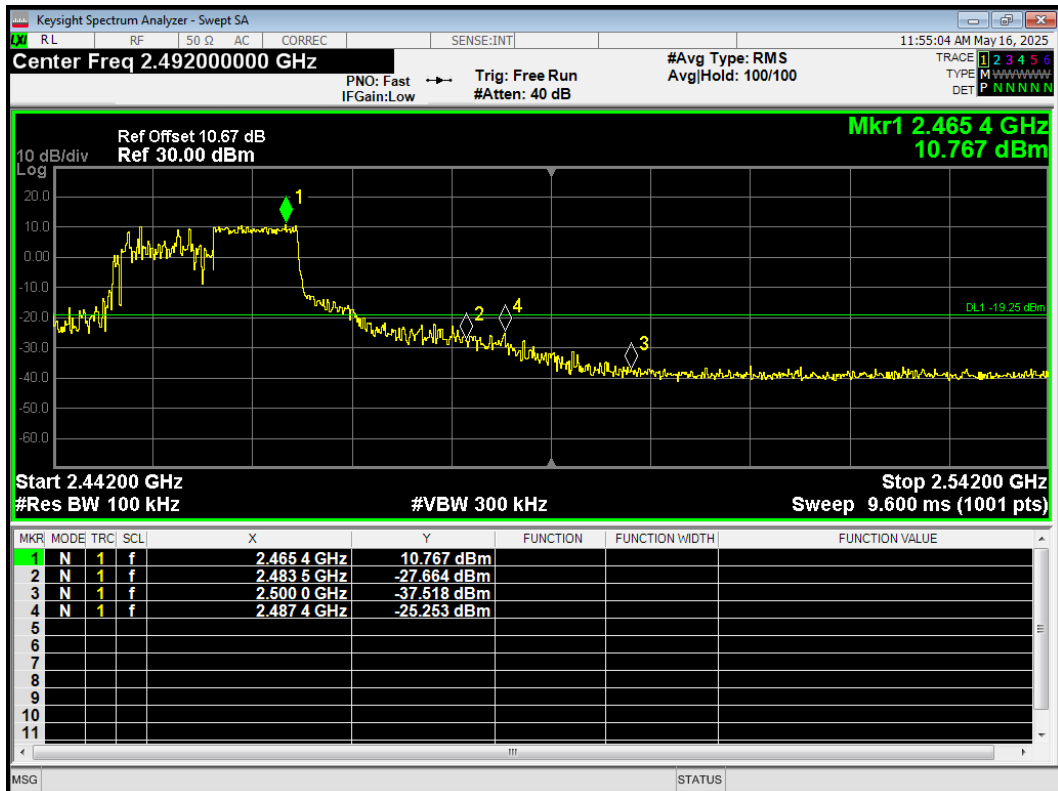
Band Edge 802.11ax(HE20) 106T 2417MHz Emission



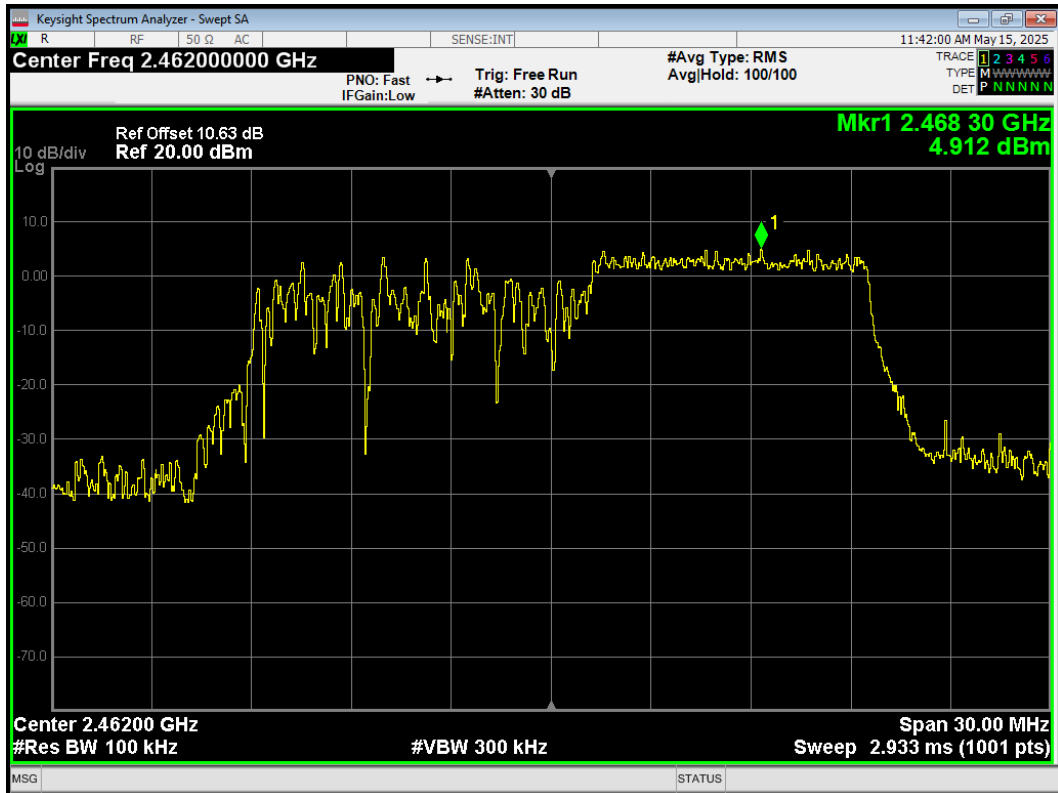
Band Edge 802.11ax(HE20) 106T 2457MHz Ref



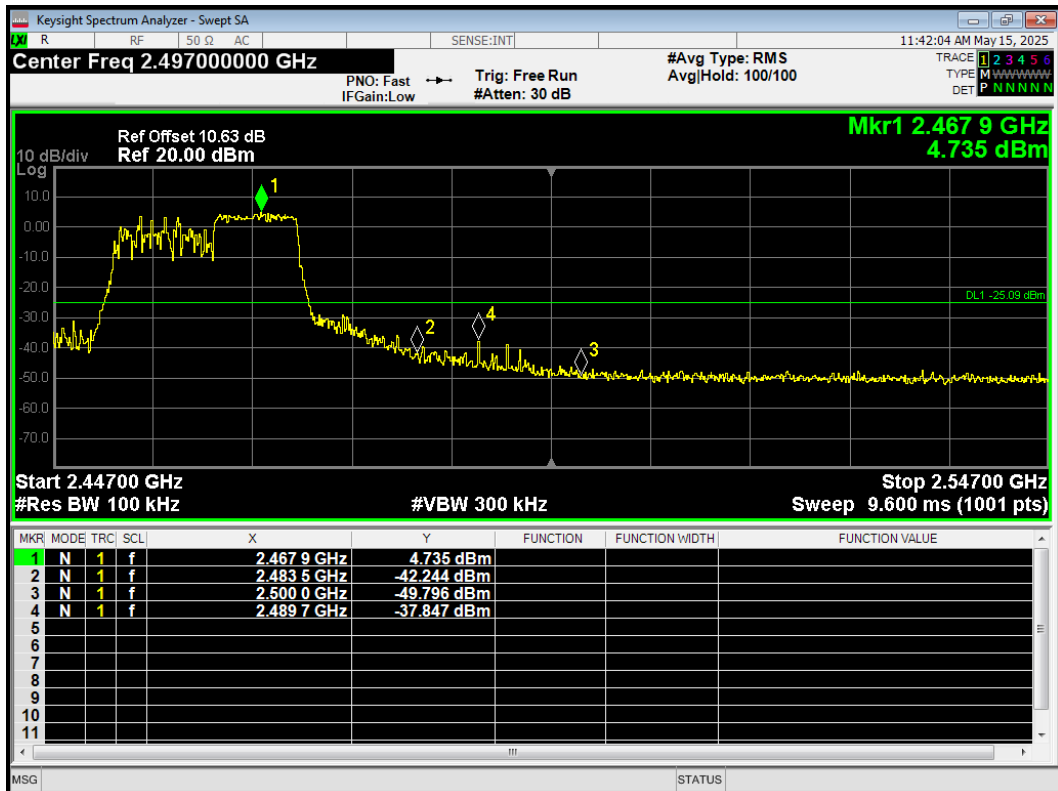
Band Edge 802.11ax(HE20) 106T 2457MHz Emission



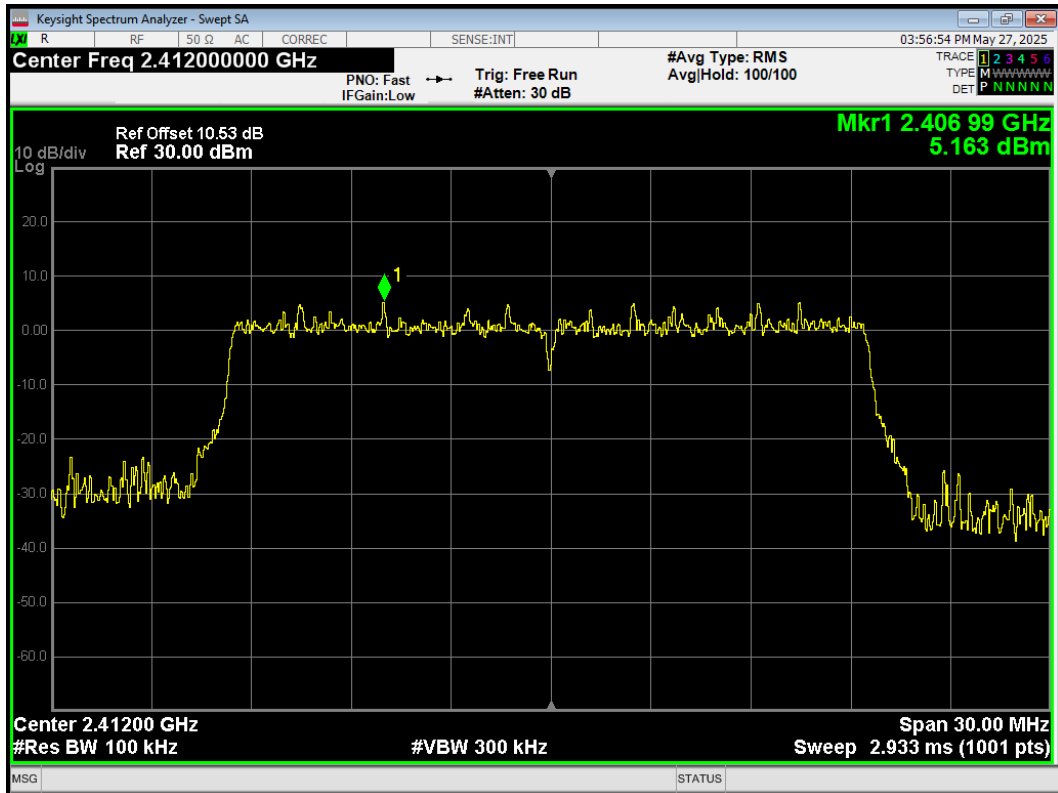
Band Edge 802.11ax(HE20) 106T 2462MHz Ref



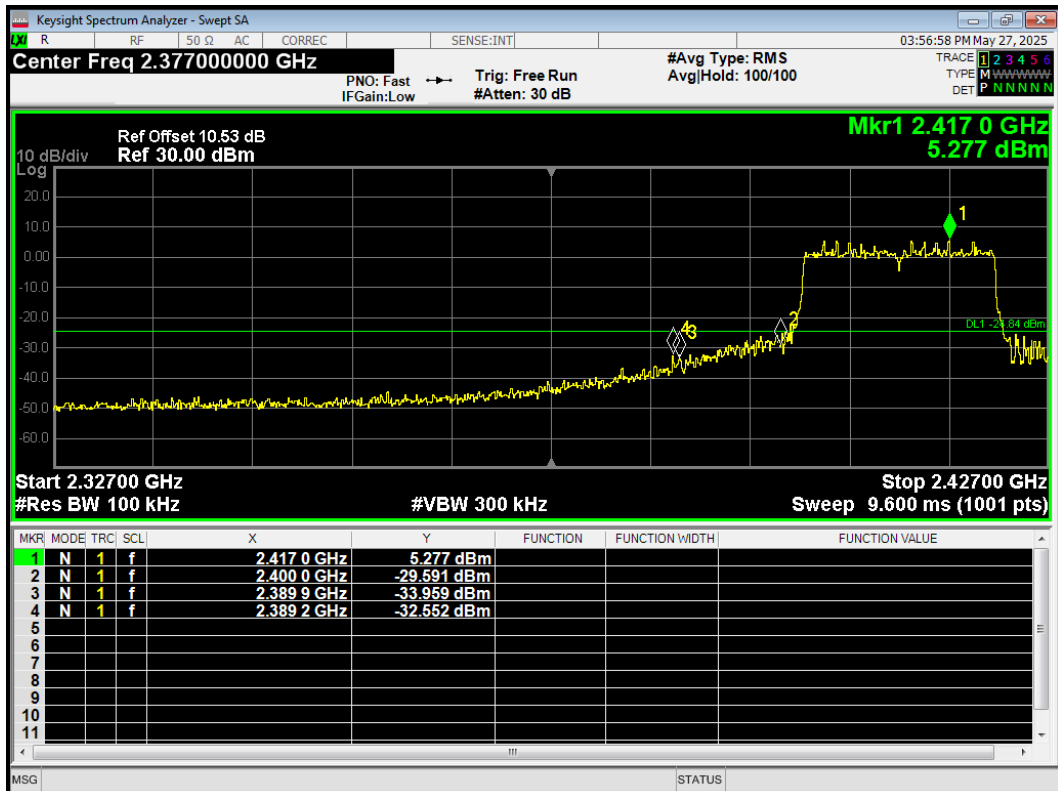
Band Edge 802.11ax(HE20) 106T 2462MHz Emission



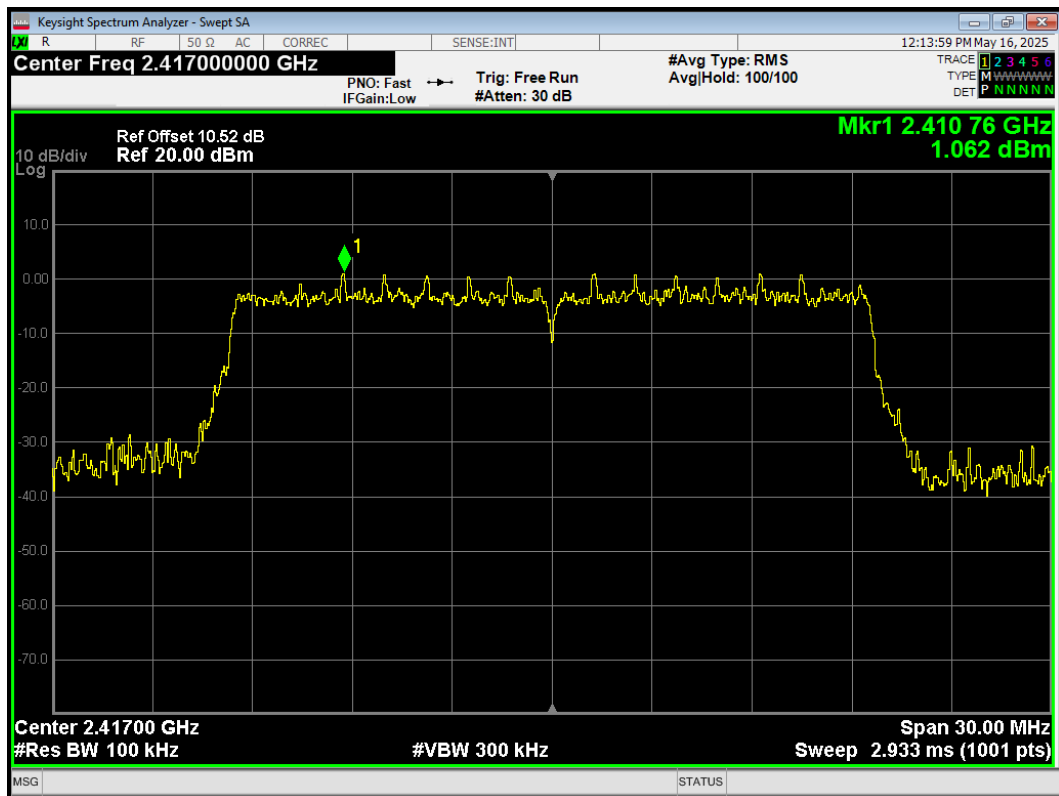
Band Edge 802.11ax(HE20) 242T 2412MHz Ref



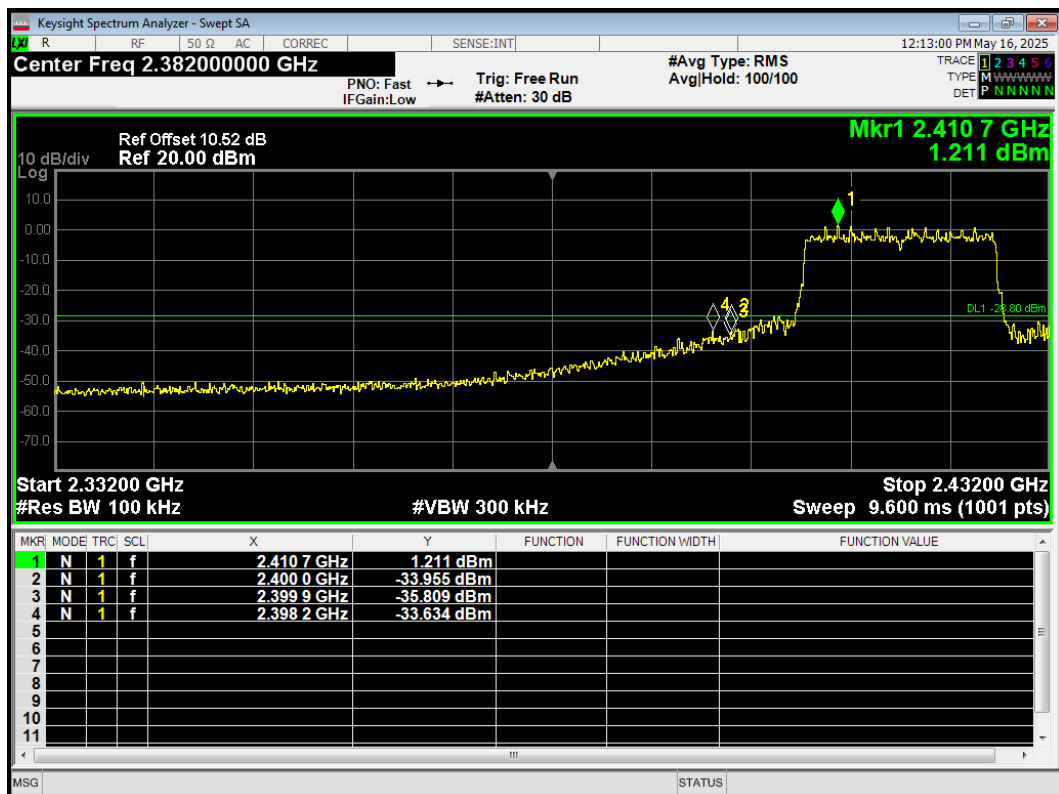
Band Edge 802.11ax(HE20) 242T 2412MHz Emission



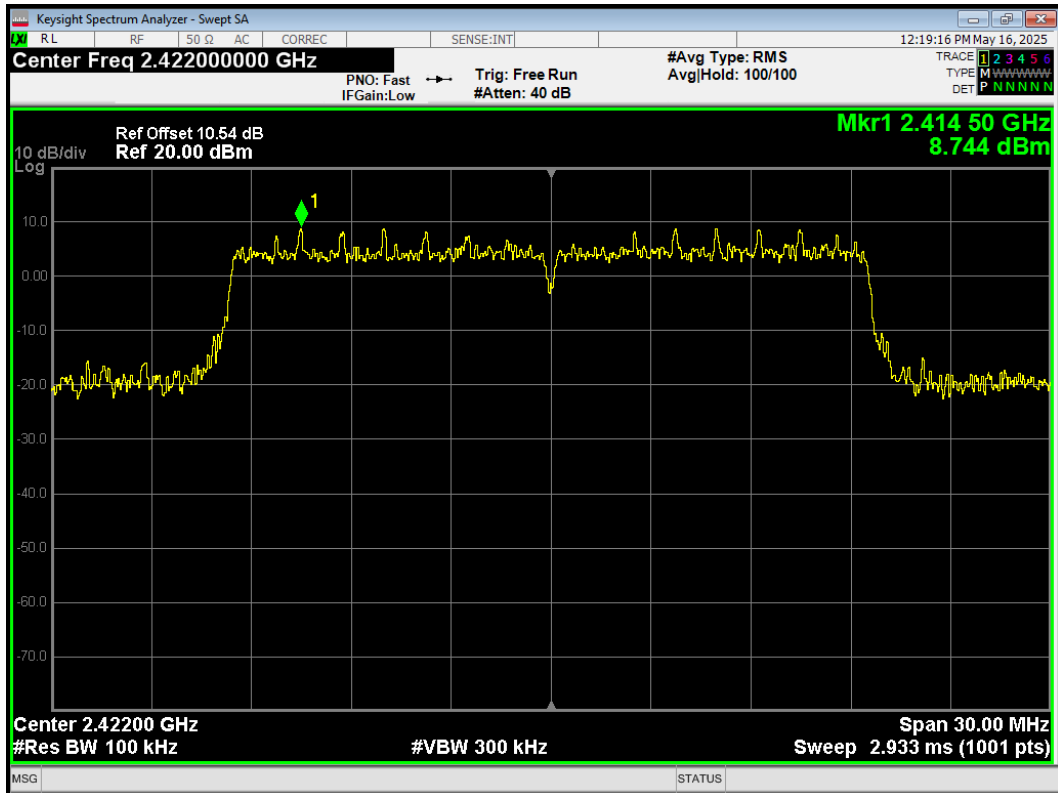
Band Edge 802.11ax(HE20) 242T 2417MHz Ref



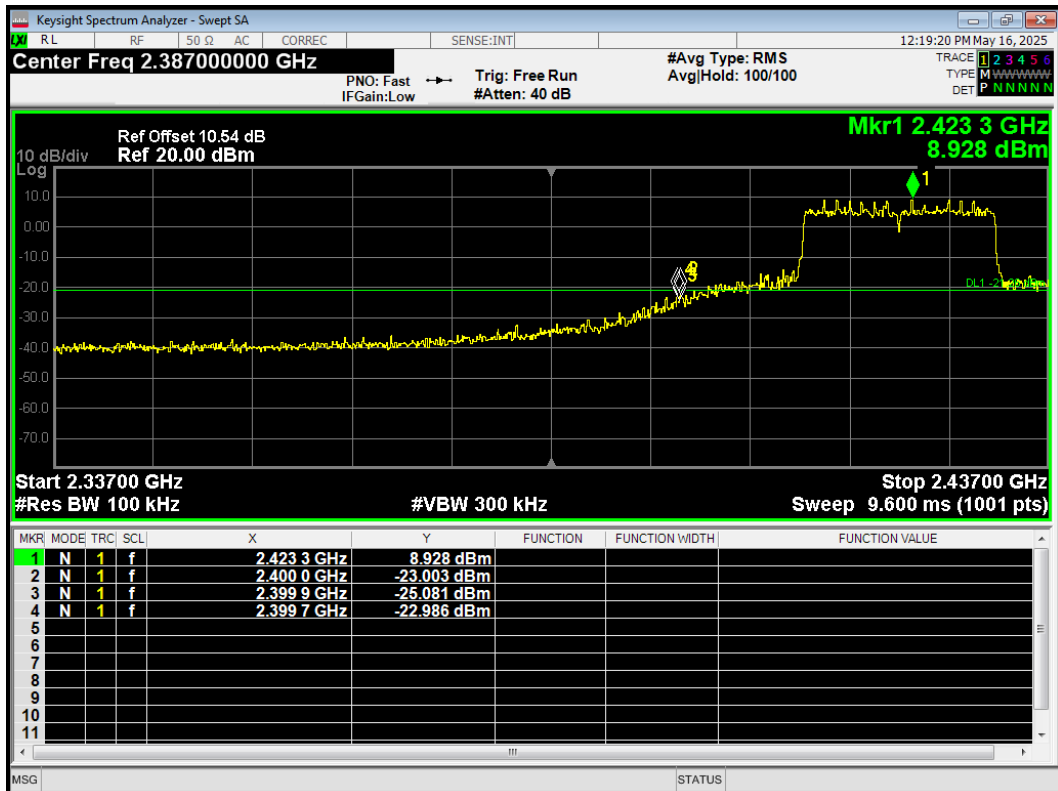
Band Edge 802.11ax(HE20) 242T 2417MHz Emission



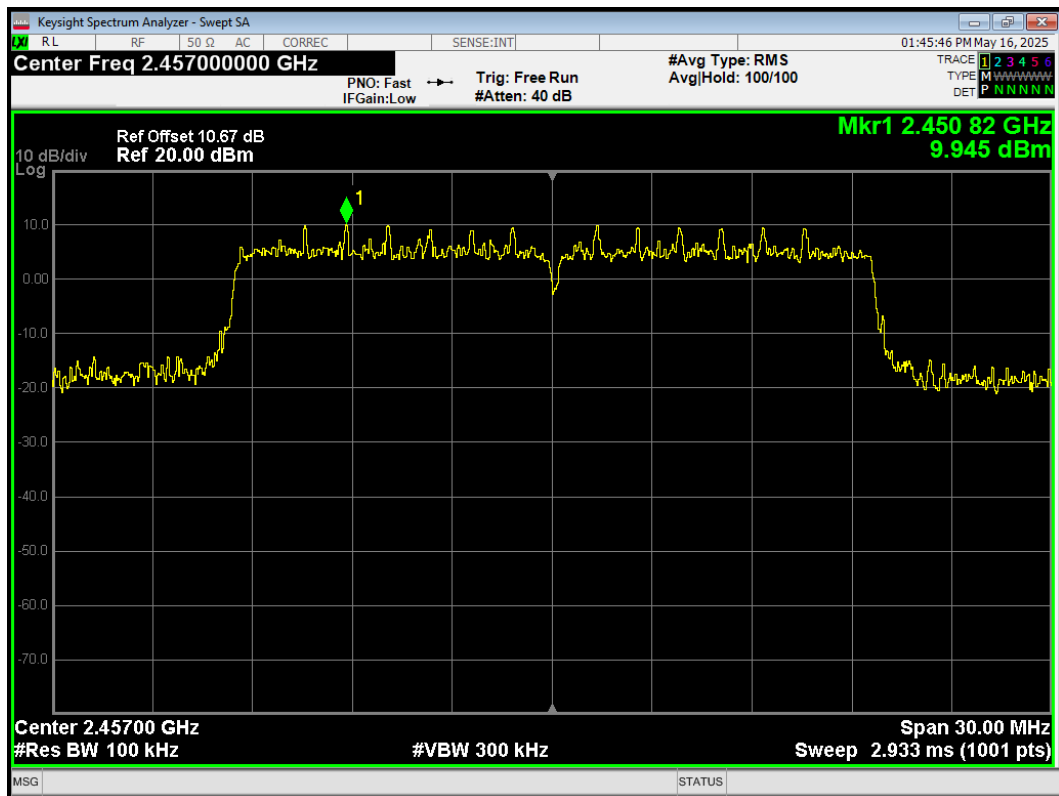
Band Edge 802.11ax(HE20) 242T 2422MHz Ref



Band Edge 802.11ax(HE20) 242T 2422MHz Emission



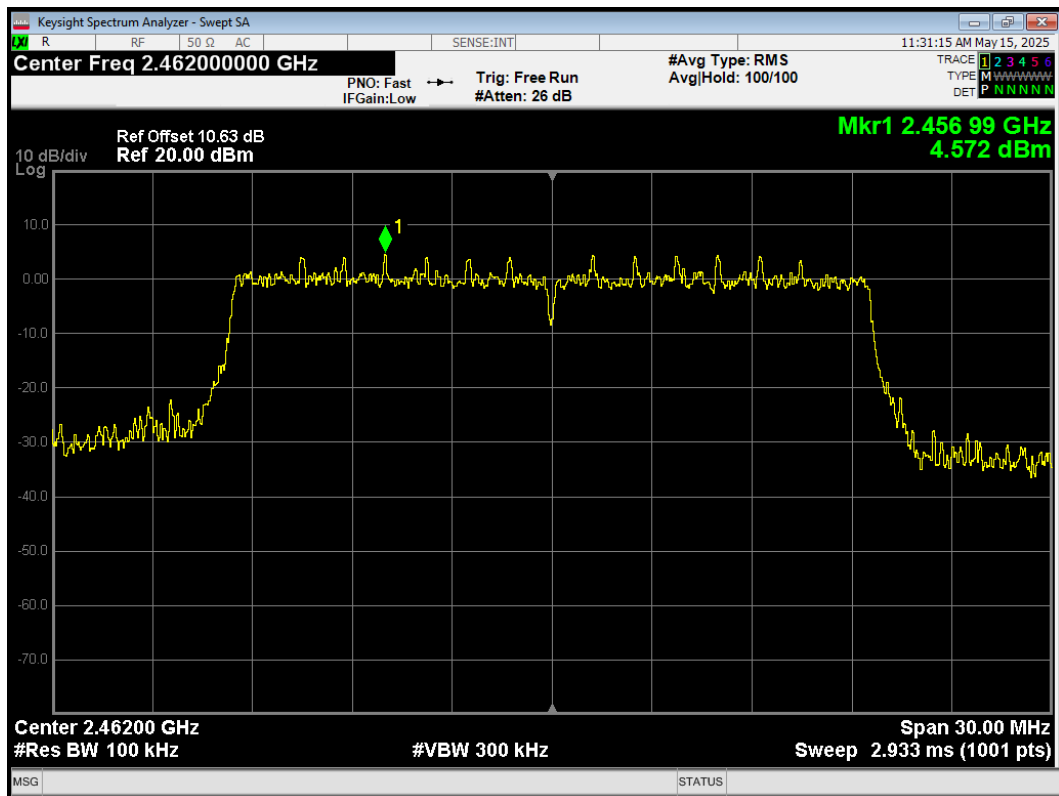
Band Edge 802.11ax(HE20) 242T 2457MHz Ref



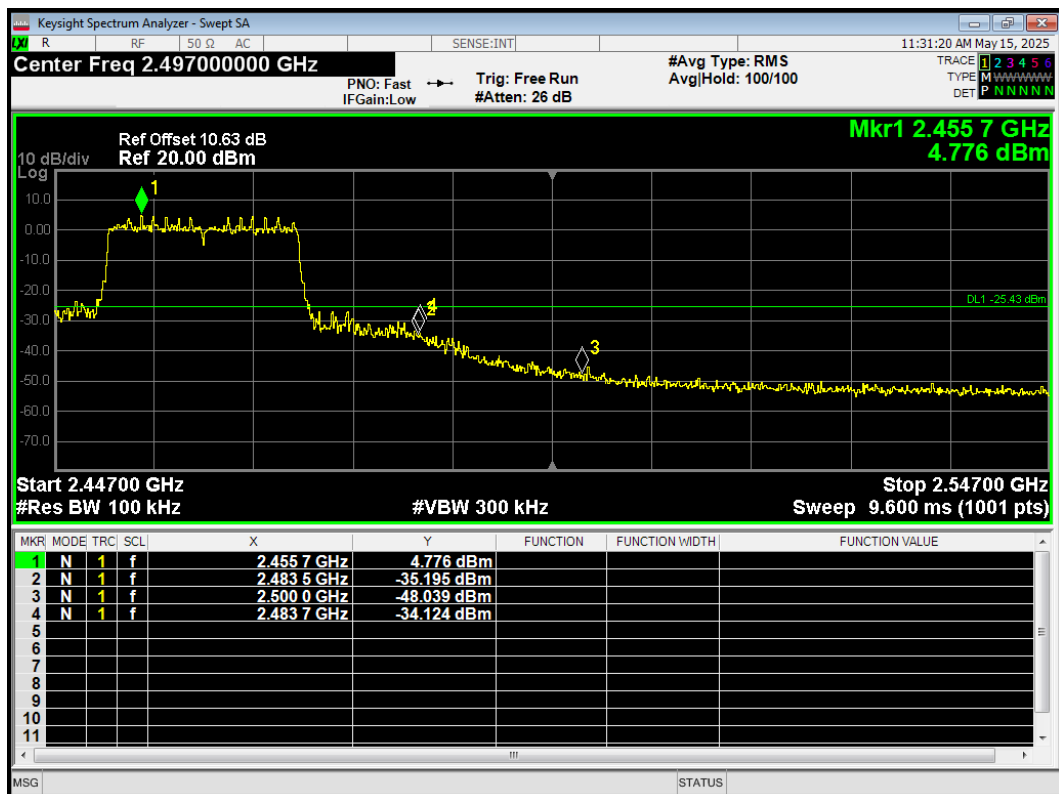
Band Edge 802.11ax(HE20) 242T 2457MHz Emission



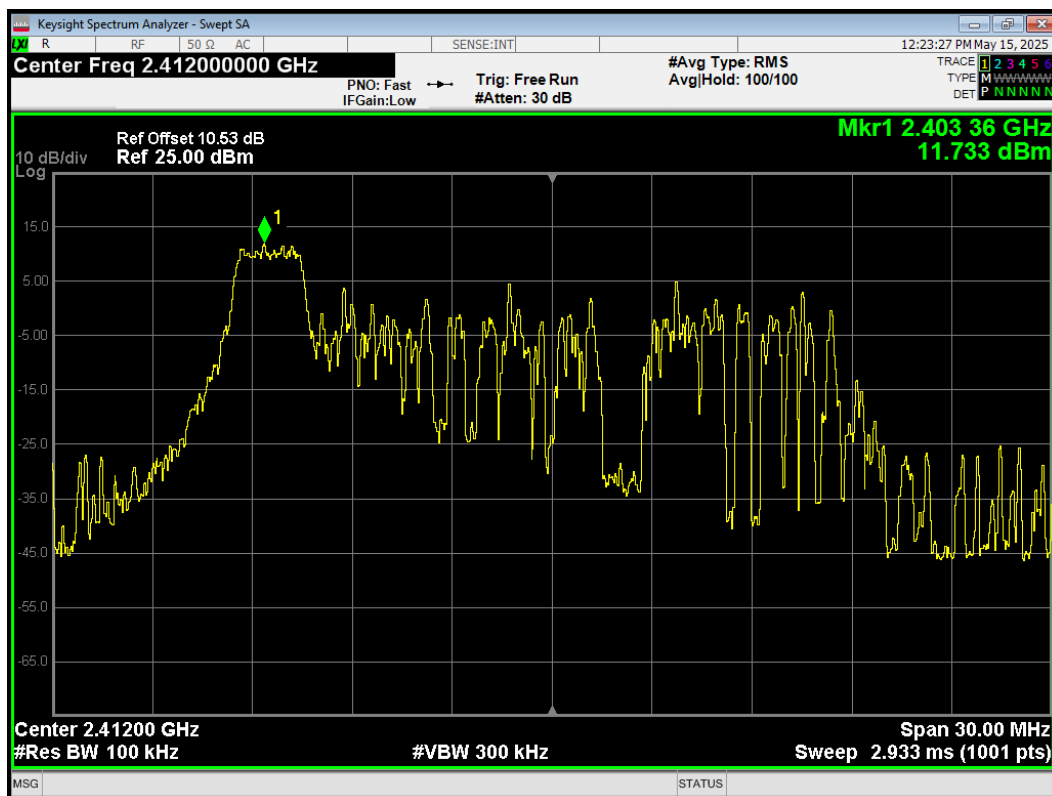
Band Edge 802.11ax(HE20) 242T 2462MHz Ref



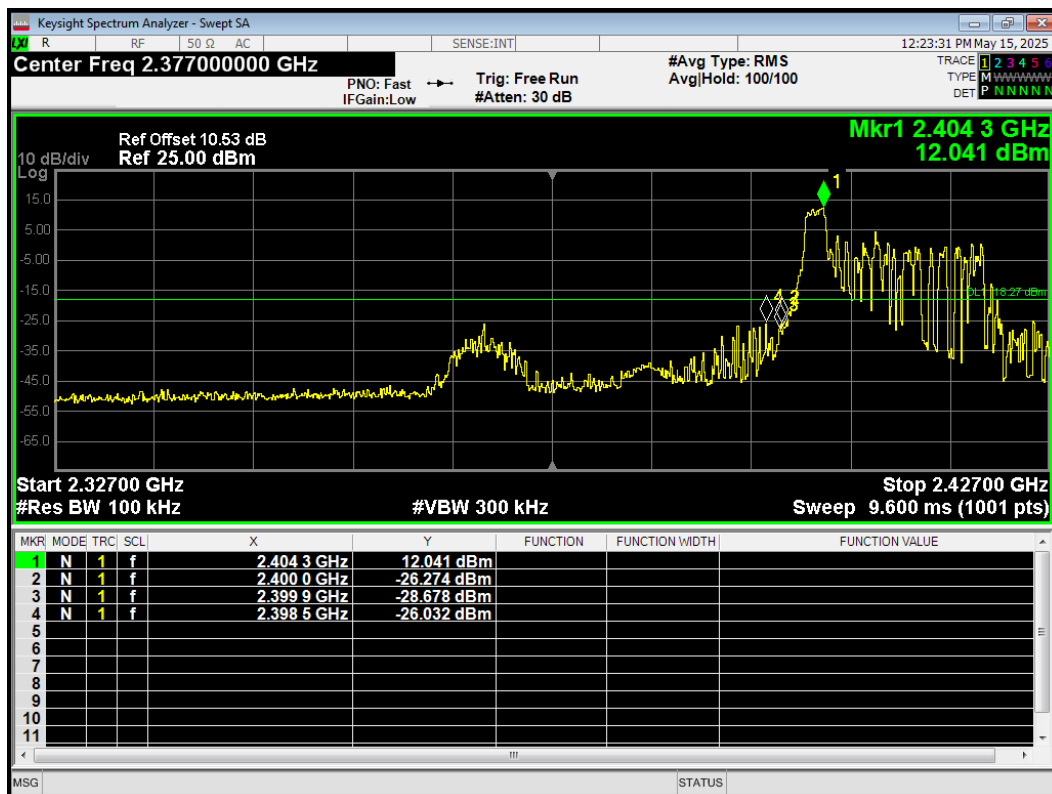
Band Edge 802.11ax(HE20) 242T 2462MHz Emission



Band Edge 802.11ax(HE20) 26T 2412MHz Ref



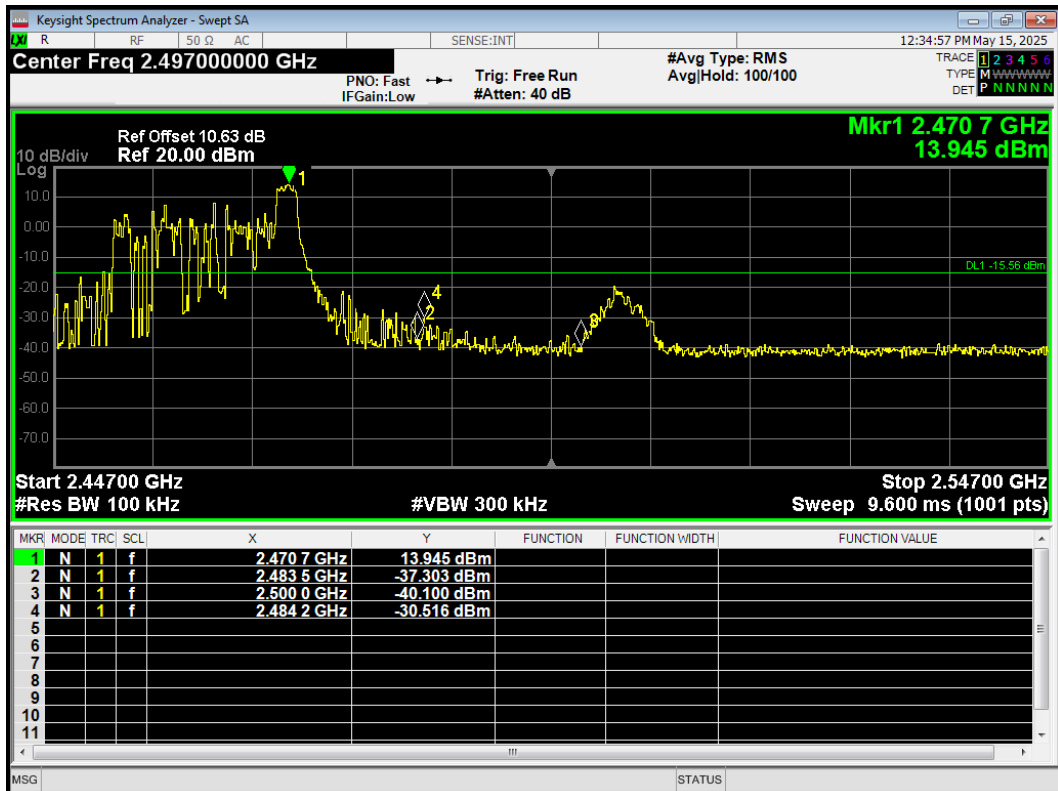
Band Edge 802.11ax(HE20) 26T 2412MHz Emission



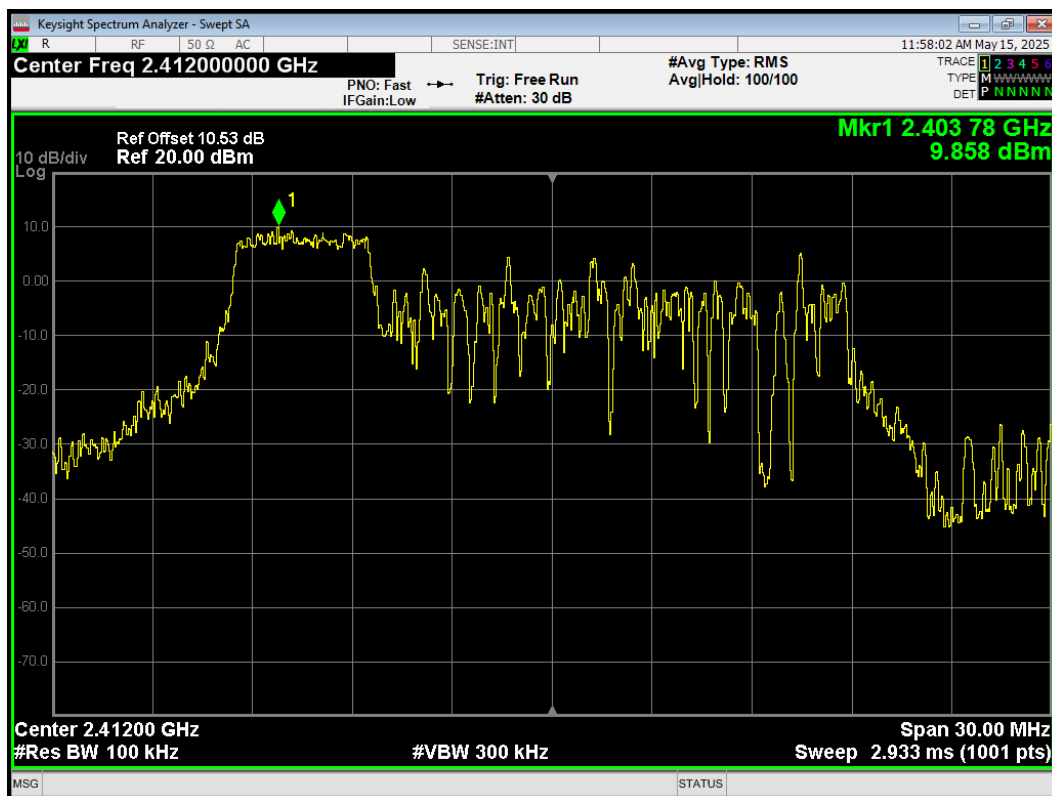
Band Edge 802.11ax(HE20) 26T 2462MHz Ref



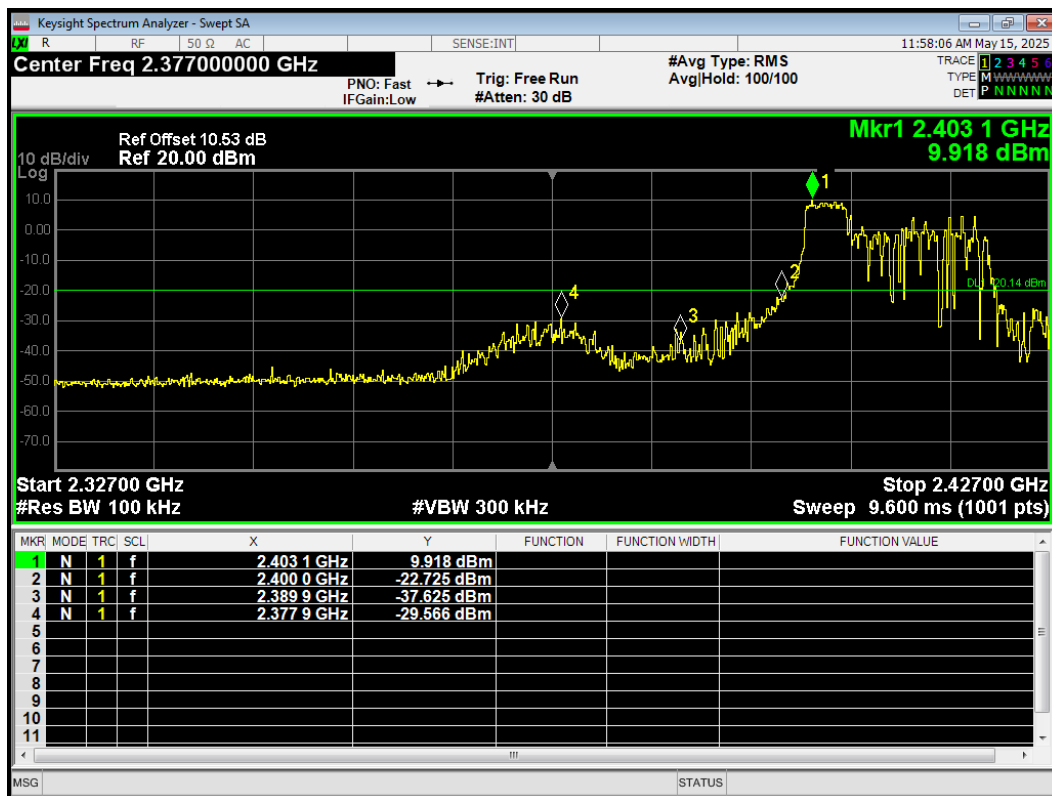
Band Edge 802.11ax(HE20) 26T 2462MHz Emission



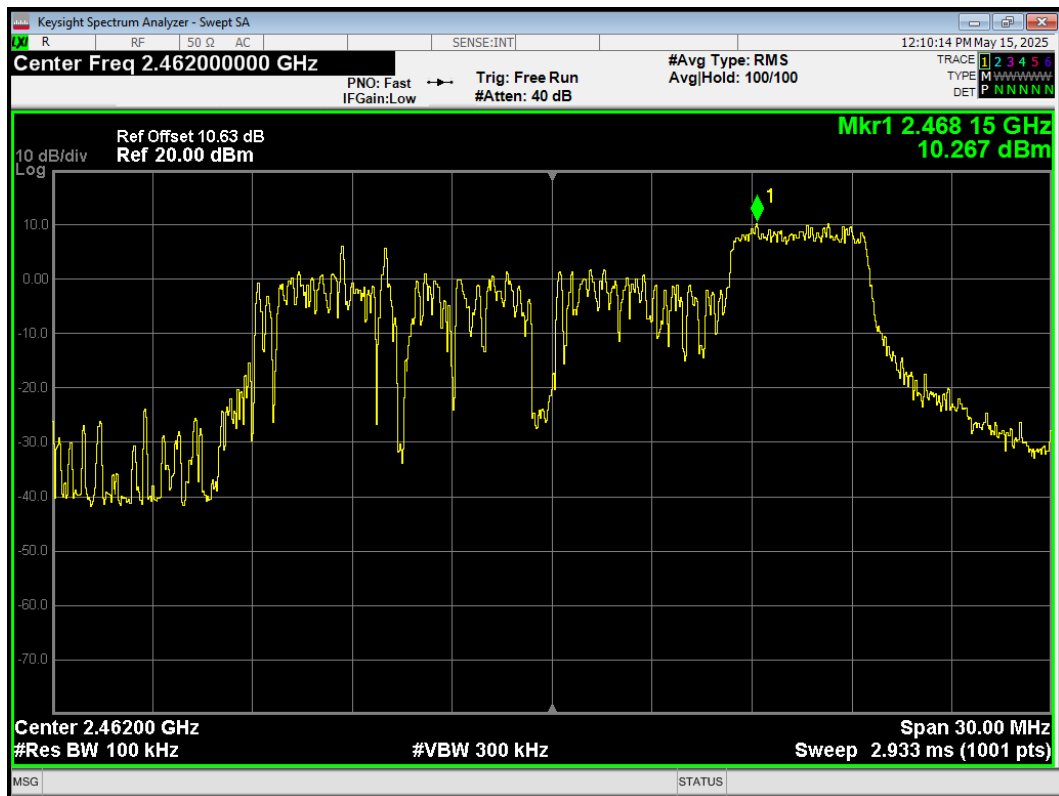
Band Edge 802.11ax(HE20) 52T 2412MHz Ref



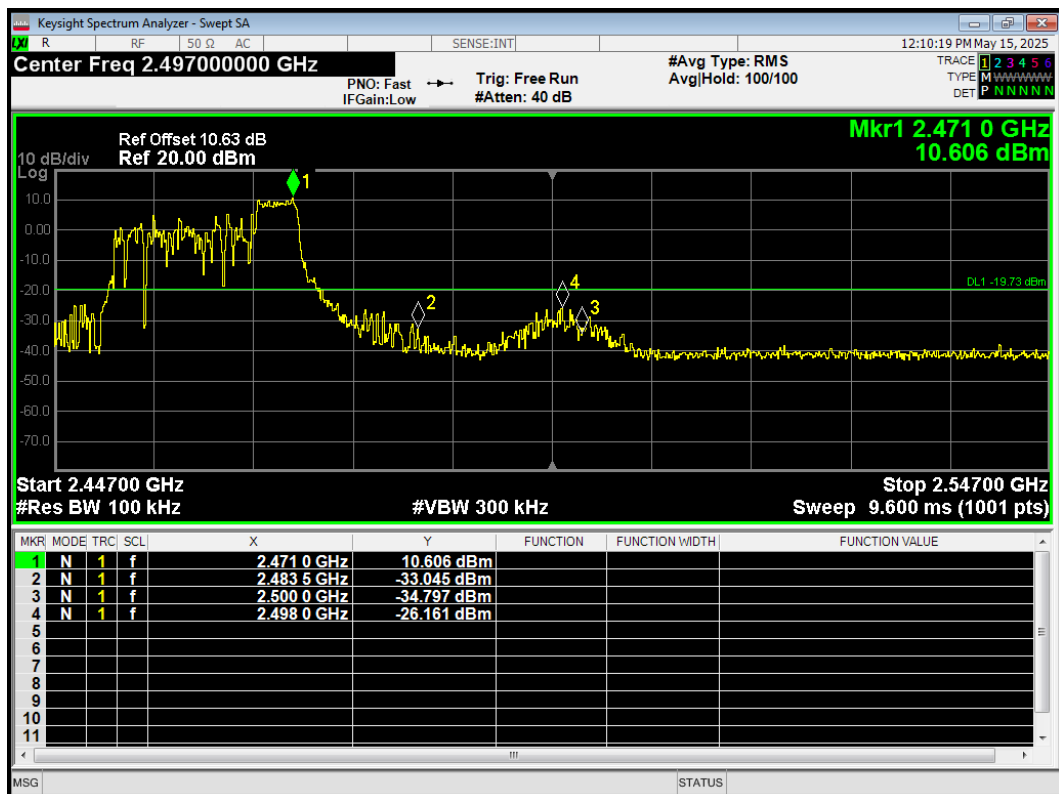
Band Edge 802.11ax(HE20) 52T 2412MHz Emission



Band Edge 802.11ax(HE20) 52T 2462MHz Ref



Band Edge 802.11ax(HE20) 52T 2462MHz Emission



## 5.4. Power Spectral Density

### Ambient Condition

| Temperature | Relative humidity |
|-------------|-------------------|
| 15°C ~ 35°C | 20% ~ 80%         |

### Method of Measurement

During the process of the testing, The EUT was connected to Spectrum Analyzer with a known loss. The EUT is max power transmission with proper modulation.

Method AVGPS-1 was used for this test.

- Set instrument center frequency to DTS channel center frequency
- Set span to at least 1.5 times the OBW
- Set RBW to:  $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$
- Set VBW  $\geq [3 \times \text{RBW}]$
- Detector=power averaging (rms) or sample detector (when rms not available)
- Ensure that the number of measurement points in the sweep  $\geq [2 \times \text{span}/\text{RBW}]$
- Sweep time auto couple
- Employ trace averaging (rms) mode over a minimum of 100 traces
- Use the peak marker function to determine the maximum amplitude level.
- If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

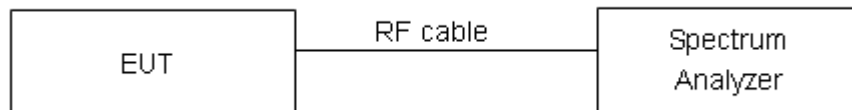
Method AVGPS-2 was used for this test.

- Measure the duty cycle (D) of the transmitter output signal as described in 11.6
- Set instrument center frequency to DTS channel center frequency
- Set span to at least 1.5 times the OBW
- Set RBW to:  $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$
- Set VBW  $\geq [3 \times \text{RBW}]$
- Detector= power averaging (rms) or sample detector (when rms not available)
- Ensure that the number of measurement points in the sweep  $\geq [2 \times \text{span}/\text{RBW}]$
- Sweep time =auto couple
- Do not use sweep triggering; allow sweep to "free run"
- Employ trace averaging (rms) mode over a minimum of 100 traces
- Use the peak marker function to determine the maximum amplitude level

l) Add  $[10 \log(1/D)]$ , where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time

m) If measured value exceeds requirement specified by regulatory agency then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

### Test setup



### Limits

Rule Part 15.247(e) specifies that "For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. "

|        |                                    |
|--------|------------------------------------|
| Limits | $\leq 8 \text{ dBm} / 3\text{kHz}$ |
|--------|------------------------------------|

### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 2$ ,  $U = 0.75\text{dB}$ .

**Test Results:**

| Test Mode                                                             | Carrier frequency (MHz)/ Channel | Read Value (dBm / 3kHz) | Power Spectral Density (dBm / 3kHz) | Limit (dBm / 3kHz) | Conclusion |
|-----------------------------------------------------------------------|----------------------------------|-------------------------|-------------------------------------|--------------------|------------|
| Bluetooth<br>(Low Energy)<br>(1M)                                     | 2402/CH0                         | -0.08                   | 3.13                                | 8                  | PASS       |
|                                                                       | 2440/CH19                        | 0.84                    | 4.05                                | 8                  | PASS       |
|                                                                       | 2480/CH39                        | -0.49                   | 2.72                                | 8                  | PASS       |
| Bluetooth<br>(Low Energy)<br>(2M)                                     | 2402/CH0                         | -16.71                  | -14.25                              | 8                  | PASS       |
|                                                                       | 2440/CH19                        | -15.58                  | -13.12                              | 8                  | PASS       |
|                                                                       | 2480/CH39                        | -16.27                  | -13.81                              | 8                  | PASS       |
| Bluetooth<br>(Low Energy)<br>(S=2)                                    | 2402/CH0                         | -9.81                   | -9.39                               | 8                  | PASS       |
|                                                                       | 2440/CH19                        | -8.09                   | -7.67                               | 8                  | PASS       |
|                                                                       | 2480/CH39                        | -6.81                   | -6.39                               | 8                  | PASS       |
| Bluetooth<br>(Low Energy)<br>(S=8)                                    | 2402/CH0                         | 1.82                    | 1.93                                | 8                  | PASS       |
|                                                                       | 2440/CH19                        | 3.06                    | 3.17                                | 8                  | PASS       |
|                                                                       | 2480/CH39                        | 3.06                    | 3.17                                | 8                  | PASS       |
| Note: Power Spectral Density =Read Value+Duty cycle correction factor |                                  |                         |                                     |                    |            |

**SU Mode**

| Test Mode                                                                                         | Carrier frequency (MHz) / Channel | Read Value (dBm / 30kHz) | Power Spectral Density (dBm / 3kHz) | Limit (dBm / 3kHz) | Conclusion |
|---------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------|-------------------------------------|--------------------|------------|
| 802.11b                                                                                           | 2412/CH 1                         | -3.43                    | -13.43                              | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | -0.60                    | -10.60                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | -1.06                    | -11.06                              | 8                  | PASS       |
| 802.11g                                                                                           | 2412/CH 1                         | -6.75                    | -16.75                              | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | -5.24                    | -15.24                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | -5.06                    | -15.06                              | 8                  | PASS       |
| 802.11n<br>HT20                                                                                   | 2412/CH 1                         | -6.42                    | -16.42                              | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | -5.81                    | -15.81                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | -5.60                    | -15.60                              | 8                  | PASS       |
| 802.11ax<br>HE20                                                                                  | 2412/CH 1                         | -7.71                    | -17.71                              | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | -7.47                    | -17.47                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | -6.55                    | -16.55                              | 8                  | PASS       |
| Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30) |                                   |                          |                                     |                    |            |

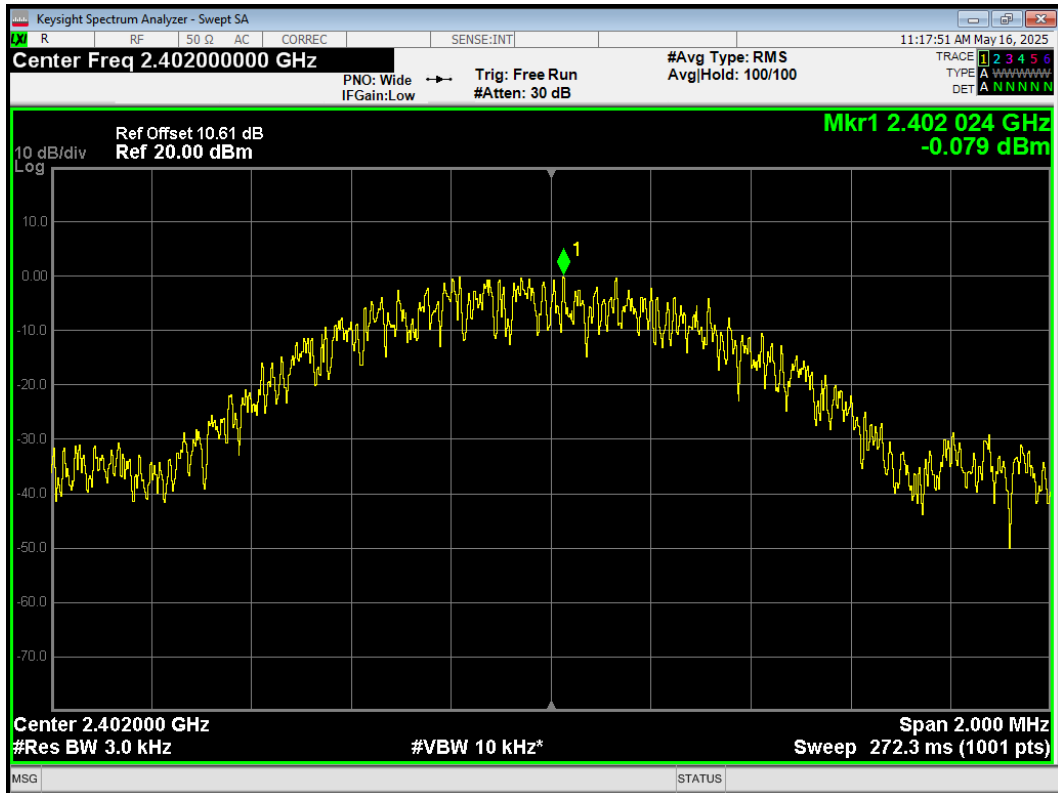
**ERSU Mode**

| Test Mode                                                                                         | Carrier frequency (MHz) / Channel | RU Index | Read Value (dBm / 30kHz) | Power Spectral Density (dBm / 3kHz) | Limit (dBm / 3kHz) | Conclusion |
|---------------------------------------------------------------------------------------------------|-----------------------------------|----------|--------------------------|-------------------------------------|--------------------|------------|
| 802.11ax HE20<br>242-Tones                                                                        | 2412/CH 1                         | 61       | -8.82                    | -18.71                              | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | 61       | -4.74                    | -14.63                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | 61       | -2.35                    | -12.24                              | 8                  | PASS       |
| Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30) |                                   |          |                          |                                     |                    |            |

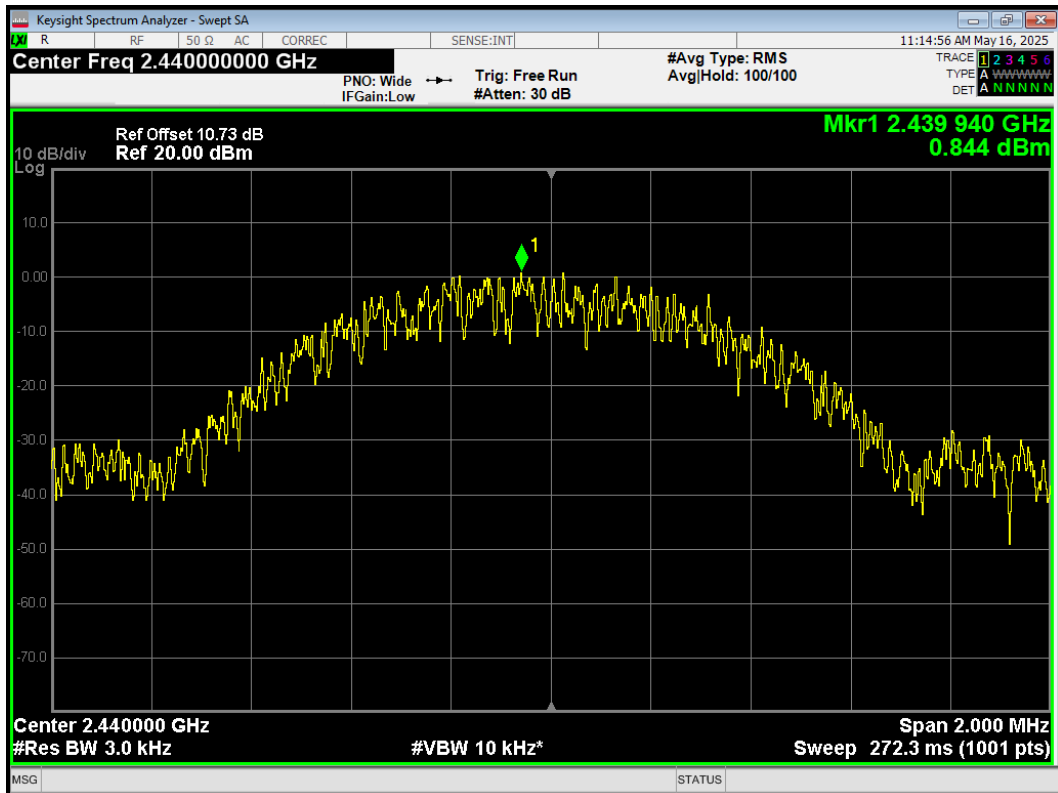
**TB Mode**

| Test Mode                                                                                         | Carrier frequency (MHz) / Channel | RU Index | Read Value (dBm / 30kHz) | Power Spectral Density (dBm / 3kHz) | Limit (dBm / 3kHz) | Conclusion |
|---------------------------------------------------------------------------------------------------|-----------------------------------|----------|--------------------------|-------------------------------------|--------------------|------------|
| 802.11ax HE20<br>26-Tones                                                                         | 2412/CH 1                         | 0        | 0.11                     | -9.89                               | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | 4        | 1.42                     | -8.58                               | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | 8        | 2.02                     | -7.98                               | 8                  | PASS       |
| 802.11ax HE20<br>52-Tones                                                                         | 2412/CH 1                         | 37       | -3.10                    | -13.10                              | 8                  | PASS       |
|                                                                                                   | 2437/CH 6                         | 38       | -1.03                    | -11.03                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | 40       | -2.31                    | -12.31                              | 8                  | PASS       |
| 802.11ax HE20<br>106-Tones                                                                        | 2412/CH 1                         | 53       | -6.92                    | -16.80                              | 8                  | PASS       |
|                                                                                                   | 2417/CH2                          | 53       | -2.53                    | -12.41                              | 8                  | PASS       |
|                                                                                                   | 2437/CH6                          | 53       | -4.01                    | -13.89                              | 8                  | PASS       |
|                                                                                                   | 2457/CH10                         | 54       | -1.60                    | -11.48                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | 54       | -7.28                    | -17.16                              | 8                  | PASS       |
| 802.11ax HE20<br>242-Tones                                                                        | 2412/CH 1                         | 61       | -7.30                    | -17.06                              | 8                  | PASS       |
|                                                                                                   | 2417/CH2                          | 61       | -7.44                    | -17.20                              | 8                  | PASS       |
|                                                                                                   | 2422/CH3                          | 61       | -3.81                    | -13.57                              | 8                  | PASS       |
|                                                                                                   | 2437/CH6                          | 61       | -3.41                    | -13.17                              | 8                  | PASS       |
|                                                                                                   | 2457/CH10                         | 61       | -3.07                    | -12.83                              | 8                  | PASS       |
|                                                                                                   | 2462/CH11                         | 61       | -8.98                    | -18.74                              | 8                  | PASS       |
| Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30) |                                   |          |                          |                                     |                    |            |

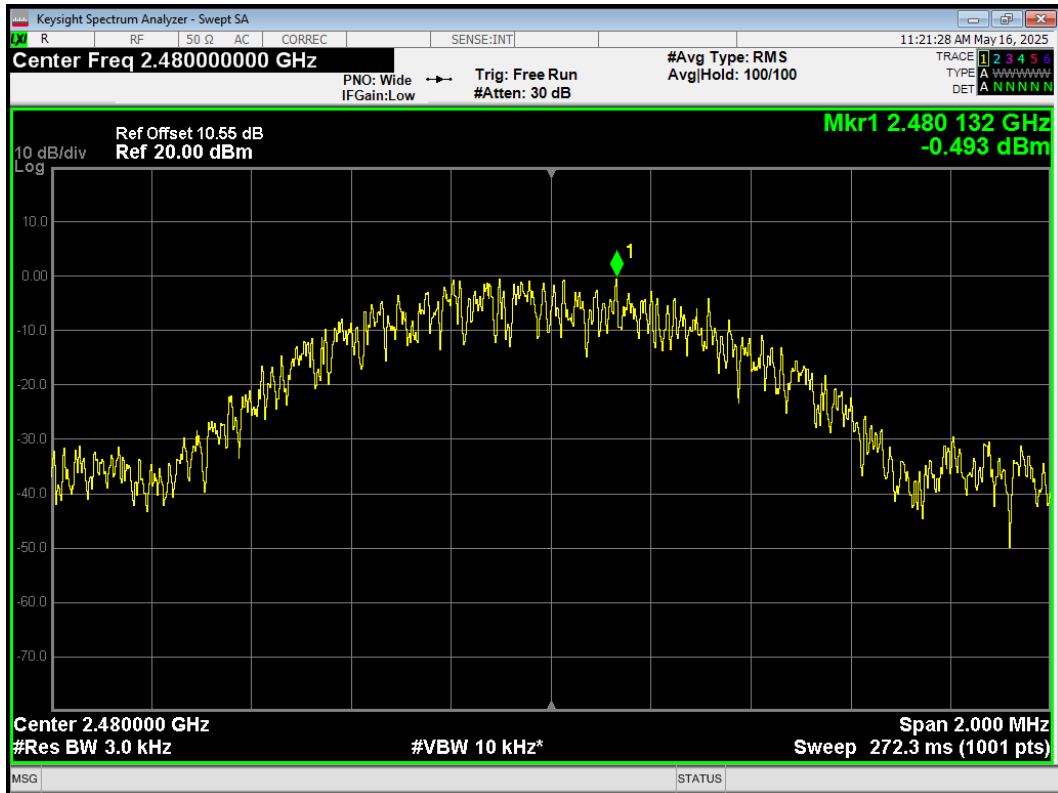
PSD BLE (1M) 2402MHz



PSD BLE (1M) 2440MHz



PSD BLE (1M) 2480MHz



PSD BLE (2M) 2402MHz

