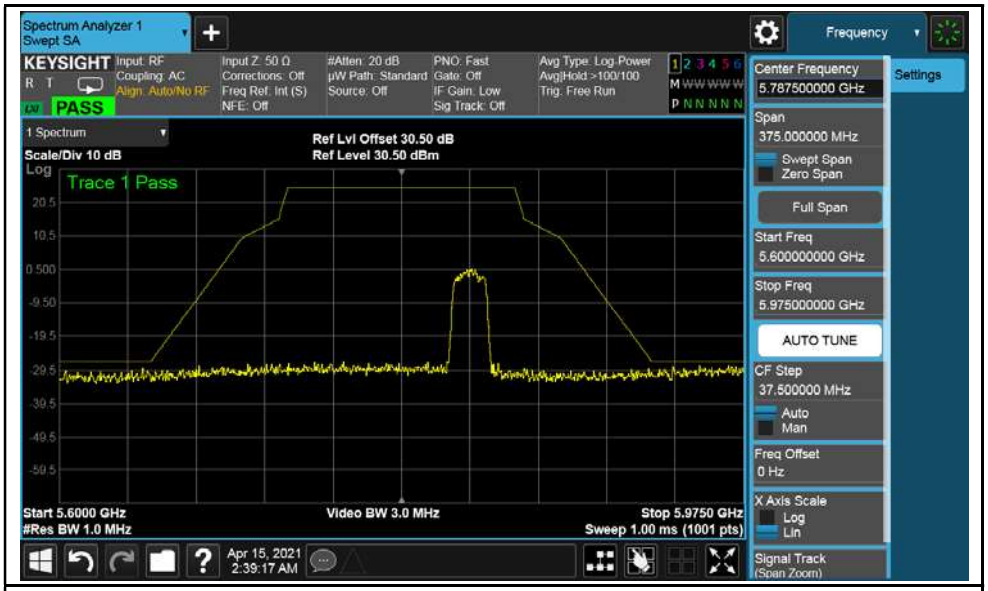
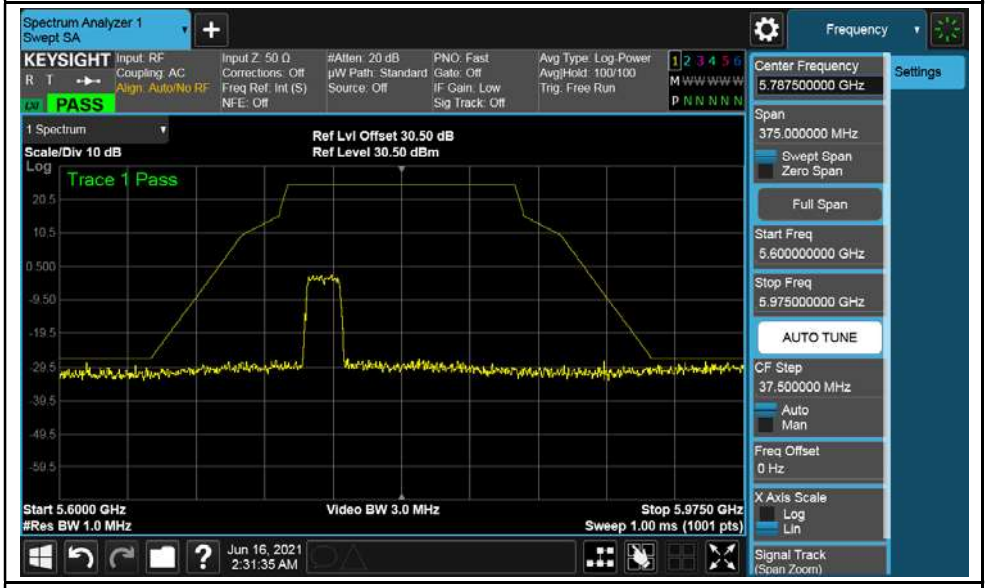
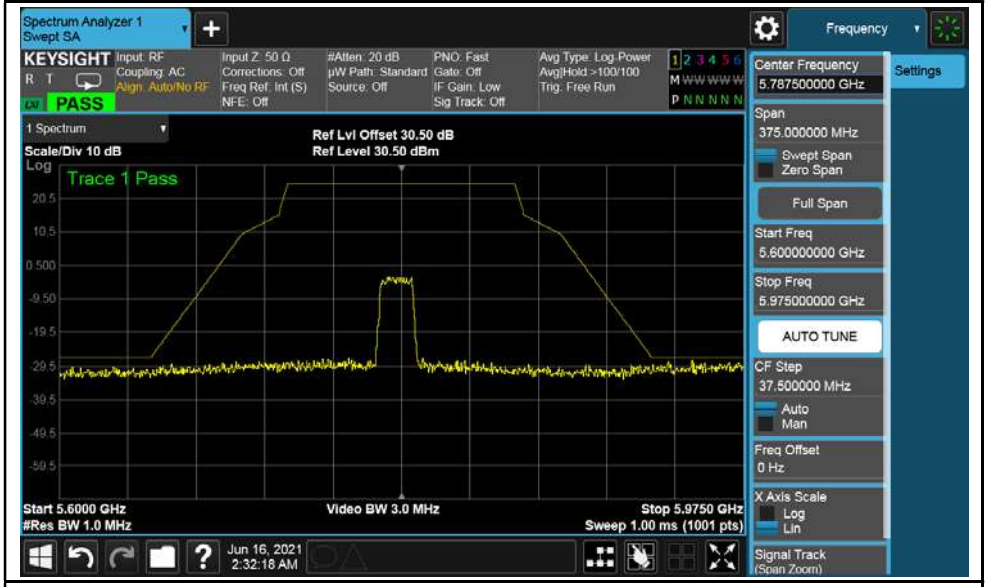


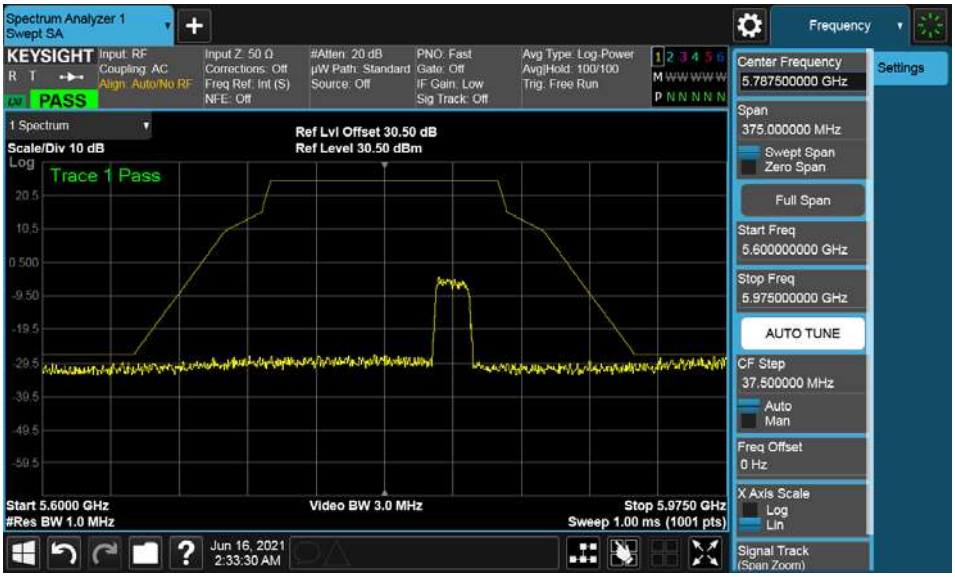

802.11n(HT20)-5825MHz




802.11ac (VHT20) – 5745MHz

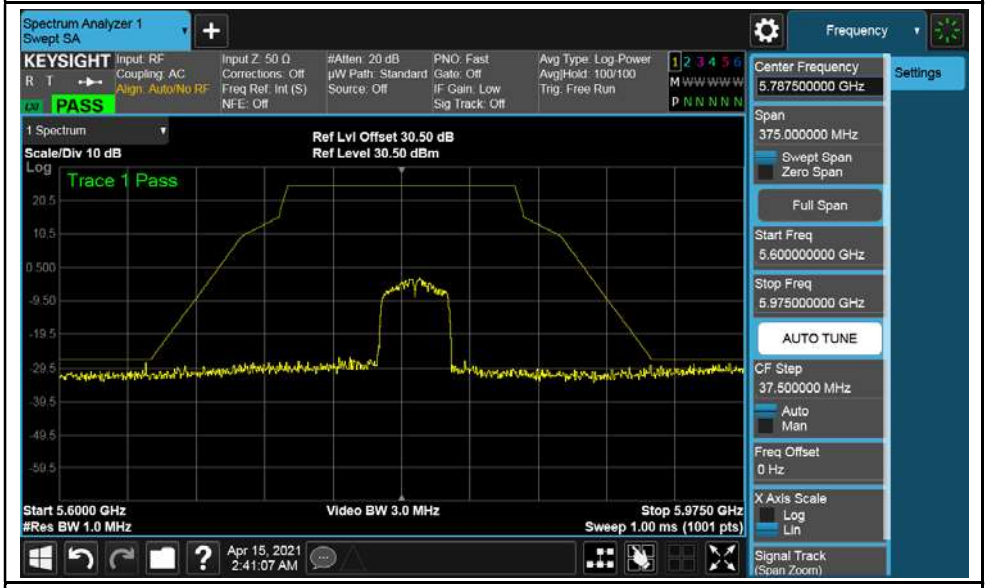



802.11ac (VHT20) – 5785MHz

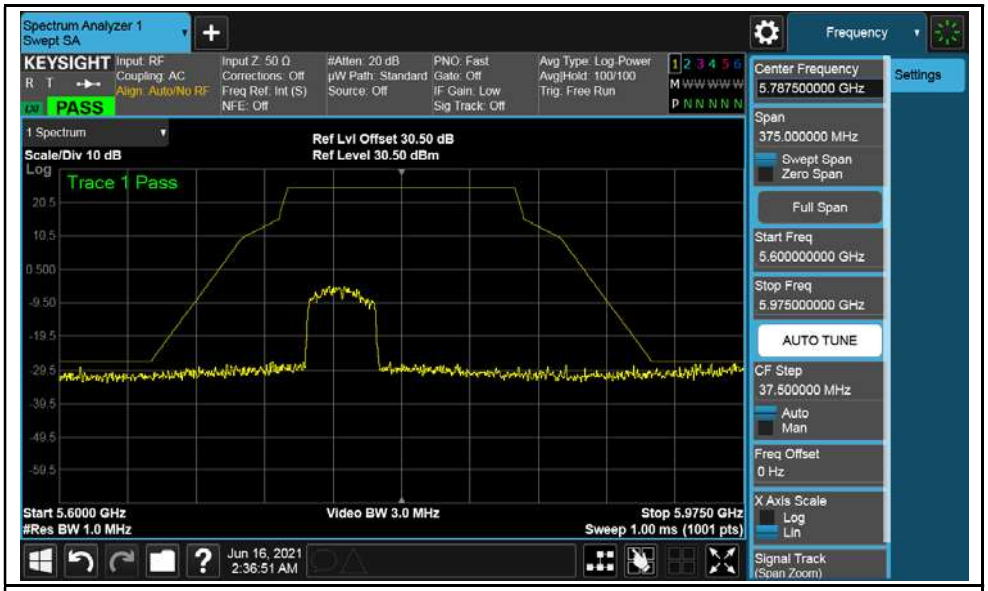



802.11ac (VHT20) – 5825MHz

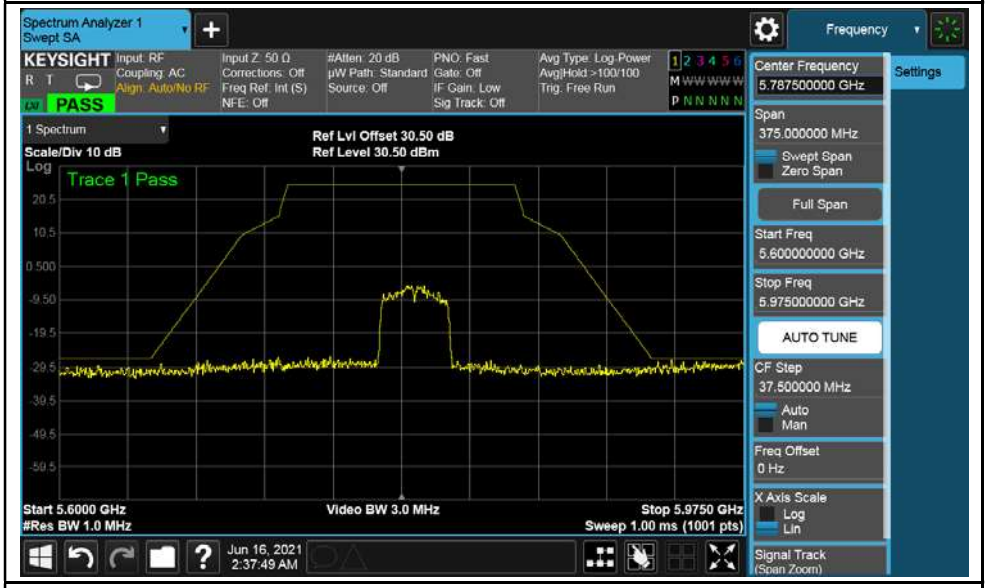

802.11n(HT40)-5755MHz



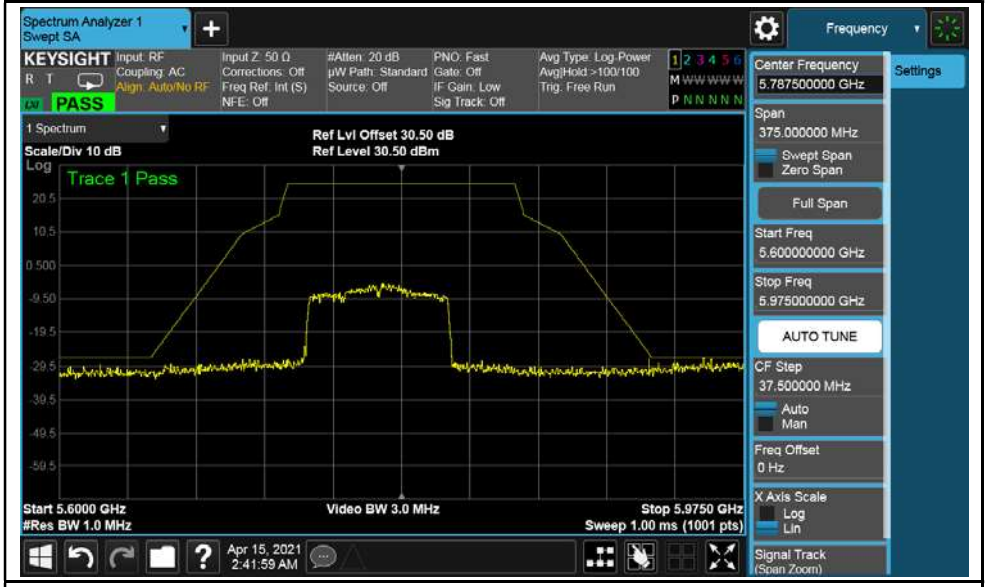

802.11n(HT40)-5795MHz




802.11ac (VHT40) - 5755MHz




802.11ac (VHT40) – 5795MHz




802.11n ac(VHT80)-5775MHz

## 4.3 Transmit Power Measurement

### 4.3.1 Limits of Transmit Power Measurement

| Operation Band | EUT Category | | Limit |
|---|---|---|---|
| U-NII-1 | | Outdoor Access Point | 1 Watt (30 dBm)<br>(Max. e.i.r.p ≦ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon) |
| | | Fixed point-to-point Access Point | 1 Watt (30 dBm) |
| | | Indoor Access Point | 1 Watt (30 dBm) |
| | √ | Client device | 250mW (24 dBm) |
| U-NII-2A | --- | | 250mW (24 dBm) or 11 dBm+10 log B* |
| U-NII-2C | --- | | 250mW (24 dBm) or 11 dBm+10 log B* |
| U-NII-3 | √ | | 1 Watt (30 dBm) |

*B is the 26 dB emission bandwidth in megahertz

Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any $N_{ANT}$;
Array Gain = 5 log($N_{ANT}/N_{SS}$) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

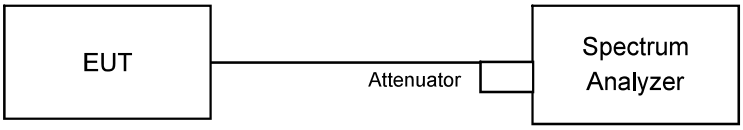
For power measurements on all other devices: Array Gain = 10 log($N_{ANT}/N_{SS}$) dB.

4.3.2 Test Setup

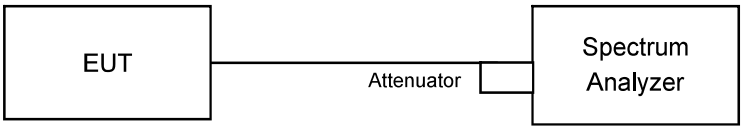
**FOR POWER OUTPUT MEASUREMENT**

◆ **Power Meter Measurement**


◆ **Spectrum Measurement**




**FOR 26dB OCCUPIED BANDWIDTH**




4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

**For Average Power Measurement**

**For 802.11a, 802.11n (HT20), 802.11n (HT40)**

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst and set the detector to AVERAGE. Duty factor is not added to measured value.

**For 802.11ac (VHT80)**

1) Set span to encompass the entire 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
2) Set sweep trigger to “free run”.
3) Set RBW = 1 MHz.
4) Set VBW ≥ 3 MHz
5) Number of points in sweep ≥ 2 Span / RBW.
6) Sweep time ≤ (number of points in sweep) * T
7) Using emission bandwidth to determine the frequency span for integration the channel bandwidth.
8) Detector = RMS.
9) Trace mode = max hold.
10) Allow max hold to run for at least 60 seconds, or longer as needed to allow the trace to stabilize.

◆ **Power Meter Measurement**

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

◆ **Spectrum Measurement**

Follow FCC KDB 789033 UNII test procedure:
Method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Set trigger to free run (duty cycle ≥ 98 percent)
7. Detector = RMS.
8. Trace average at least 100 traces in power averaging mode
9. Compute power by integrating the spectrum across the 26 dB EBW of the signal.

Follow FCC KDB 789033 UNII test procedure:
Method SA-2

1. Set span to encompass the emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Detector = RMS.
7. Trace average at least 100 traces in power averaging mode
8. Compute power by integrating the spectrum across the 26 dB EBW of the signal.
9. Duty factor need added to measured value (duty cycle < 98 percent).

**FOR 26dB OCCUPIED BANDWIDTH**

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

### 4.3.7 Test Results

Output Power measurement result for UNII-1 Band

| Type | Test mode | Freq (MHz) | CH | Conducted Power (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|---|---|
| Output Power | 802.11a | 5180 | Low | 5.99 | 24 | Pass |
| | | 5200 | Mid | 5.72 | 24 | Pass |
| | | 5240 | High | 5.04 | 24 | Pass |
| | 802.11n-HT20 | 5180 | Low | 5.99 | 24 | Pass |
| | | 5200 | Mid | 5.72 | 24 | Pass |
| | | 5240 | High | 5.07 | 24 | Pass |
| | 802.11ac-VHT20 | 5180 | Low | 5.99 | 24 | Pass |
| | | 5200 | Mid | 5.69 | 24 | Pass |
| | | 5240 | High | 5.13 | 24 | Pass |
| | 802.11n-HT40 | 5190 | Low | 3.88 | 24 | Pass |
| | | 5230 | High | 3.65 | 24 | Pass |
| | 802.11ac-VHT40 | 5190 | Low | 3.75 | 24 | Pass |
| | | 5230 | High | 3.73 | 24 | Pass |
| | 802.11ac-VHT80 | 5210 | Low | 3.97 | 24 | Pass |

Output Power measurement result for UNII-3 Band

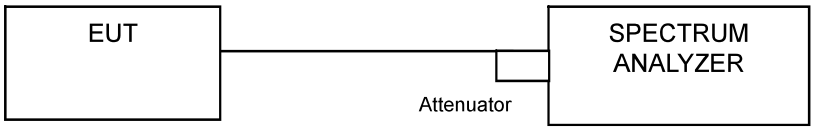
| Type | Test mode | Freq (MHz) | CH | Conducted Power (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|---|---|
| Output Power | 802.11a | 5745 | Low | 8.30 | 30 | Pass |
| | | 5785 | Mid | 8.21 | 30 | Pass |
| | | 5825 | High | 7.68 | 30 | Pass |
| | 802.11n-HT20 | 5745 | Low | 8.56 | 30 | Pass |
| | | 5785 | Mid | 8.22 | 30 | Pass |
| | | 5825 | High | 7.35 | 30 | Pass |
| | 802.11ac-VHT20 | 5745 | Low | 8.66 | 30 | Pass |
| | | 5785 | Mid | 8.51 | 30 | Pass |
| | | 5825 | High | 7.42 | 30 | Pass |
| | 802.11n-HT40 | 5755 | Low | 8.77 | 30 | Pass |
| | | 5795 | High | 8.63 | 30 | Pass |
| | 802.11ac-VHT40 | 5755 | Low | 8.96 | 30 | Pass |
| | | 5795 | High | 8.93 | 30 | Pass |
| | 802.11ac-VHT80 | 5775 | Low | 7.37 | 30 | Pass |

## 4.4 26dB Bandwidth & 6dB Bandwidth Measurement

### 4.4.1 Limits of 6 dB Bandwidth Measurement

The minimum of 6 dB Bandwidth Measurement is 0.5 MHz.

### 4.4.2 Test Setup




### 4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.4.4 Test Procedure

26dB Emission bandwidth measurement procedure (Other than 5.725-5.85 GHz)

- Allow the trace to stabilize.
- Use the spectrum analyzer built-in measurement function to determine the 26dB BW.
  Set RBW = around 1% of emission bandwidth
  Set VBW > RBW
  Detector = Peak
  Trace mode = max hold
- Capture the plot.
- Repeat above steps for different test channel and other modulation type.

6 dB Minimum emission bandwidth measurement procedure

- Allow the trace to stabilize.
- Use the spectrum analyzer built-in measurement function to determine the 6dB BW.
  Set RBW = 100 KHz
  Set VBW ≥ 3 x RBW
  Detector = Peak
  Trace mode = max hold
  Sweep = auto couple
- Capture the plot.
- Repeat above steps for different test channel and other modulation type.

4.4.5 Test Results

26dB Bandwidth measurement result for UNII-1 Band

| Type | Test mode | Freq (MHz) | CH | 99% OBW(MHz) | 26 dB OBW(MHz) |
|---|---|---|---|---|---|
| 26dB BW | 802.11a | 5180 | Low | 17.79 | 21.28 |
| | | 5200 | Mid | 17.53 | 20.90 |
| | | 5240 | High | 17.77 | 21.11 |
| | 802.11n-HT20 | 5180 | Low | 17.77 | 21.28 |
| | | 5200 | Mid | 17.78 | 20.99 |
| | | 5240 | High | 17.75 | 20.87 |
| | 802.11ac-VHT20 | 5180 | Low | 17.79 | 21.37 |
| | | 5200 | Mid | 17.74 | 21.04 |
| | | 5240 | High | 17.72 | 21.20 |
| | 802.11n-HT40 | 5190 | Low | 36.06 | 38.92 |
| | | 5230 | High | 36.13 | 39.00 |
| | 802.11ac-VHT40 | 5190 | Low | 36.03 | 38.95 |
| | | 5230 | High | 36.1 | 39.17 |
| | 802.11ac-VHT80 | 5210 | Low | 75.76 | 81.01 |

6dB Bandwidth measurement result for UNII-3 Band

| Type | Test mode | Freq (MHz) | CH | 99% OBW(MHz | 6 dB OBW(MHz) | Limit (MHz) | Result |
|---|---|---|---|---|---|---|---|
| 6dB BW | 802.11a | 5745 | Low | 17.79 | 17.67 | 0.5 | Pass |
| | | 5785 | Mid | 17.81 | 17.83 | 0.5 | Pass |
| | | 5825 | High | 17.83 | 17.88 | 0.5 | Pass |
| | 802.11n-HT20 | 5745 | Low | 17.77 | 17.77 | 0.5 | Pass |
| | | 5785 | Mid | 17.77 | 17.73 | 0.5 | Pass |
| | | 5825 | High | 17.77 | 17.77 | 0.5 | Pass |
| | 802.11ac-VHT20 | 5745 | Low | 17.79 | 17.78 | 0.5 | Pass |
| | | 5785 | Mid | 17.79 | 17.75 | 0.5 | Pass |
| | | 5825 | High | 17.75 | 17.74 | 0.5 | Pass |
| | 802.11n-HT40 | 5755 | Low | 36.04 | 35.64 | 0.5 | Pass |
| | | 5795 | High | 36.05 | 35.33 | 0.5 | Pass |
| | 802.11ac-VHT40 | 5755 | Low | 36.12 | 36.00 | 0.5 | Pass |
| | | 5795 | High | 35.98 | 35.69 | 0.5 | Pass |
| | 802.11ac-VHT80 | 5775 | Low | 75.78 | 76.21 | 0.5 | Pass |

Occupied Bandwidth Test Plots
UNII-1 Band


802.11a-5180MHz


802.11a-5200MHz


802.11a-5240MHz


802.11n-HT20-5180MHz


802.11n-HT20-5200MHz


802.11n-HT20-5240MHz


802.11ac-VHT20-5180MHz


802.11ac-VHT20-5200MHz


802.11ac-VHT20-5240MHz


802.11n-HT40-5190MHz


802.11n-HT40-5230MHz


802.11ac-VHT40-5190MHz


802.11ac-VHT40-5230MHz


802.11ac-VHT80-5210MHz

6dB Bandwidth Test Plots
U-NII-3 Band:


802.11a-5745MHz


802.11a-5785MHz


802.11a-5825MHz


802.11n-HT20-5745MHz


802.11n-HT20-5785MHz


802.11n-HT20-5825MHz


802.11ac-HT20-5745MHz


802.11ac-HT20-5785MHz


802.11ac-HT20-5825MHz


802.11n-HT40-5755MHz


802.11n-HT40-5795MHz


802.11ac-VHT40-5795MHz


802.11ac-VHT40-5795MHz

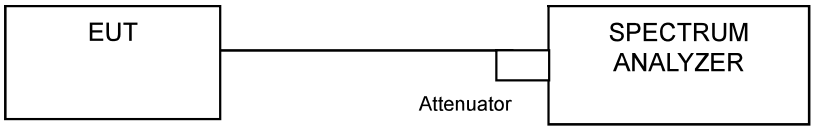

802.11ac-VHT80-5775MHz

## 4.5 Peak Power Spectral Density Measurement

### 4.5.1 Limits of Peak Power Spectral Density Measurement

| Operation Band | EUT Category | | Limit |
|---|---|---|---|
| U-NII-1 | | Outdoor Access Point | 17dBm/ MHz |
| | | Fixed point-to-point Access Point | |
| | | Indoor Access Point | |
| | √ | Client device | 11dBm/ MHz |
| U-NII-2A | --- | | 11dBm/ MHz |
| U-NII-2C | --- | | 11dBm/ MHz |
| U-NII-3 | √ | | 30dBm/ 500kHz |

### 4.5.2 Test Setup




### 4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.5.4 Test Procedure

**For U-NII-1, U-NII-2A, U-NII-2C band:**

Using method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 1 MHz, Set VBW ≥ 3 MHz, Detector = RMS
3. Sweep time = auto, trigger set to “free run”.
4. Trace average at least 100 traces in power averaging mode.
5. Record the max value

**For U-NII-3:**

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
3. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
4. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
5. Sweep time = auto, trigger set to “free run”.
6. Trace average at least 100 traces in power averaging mode.
7. Record the max value

### 4.5.5 Deviation from Test Standard

No deviation.

### 4.5.6 EUT Operating Condition

Same as Item 4.3.6.

4.5.7 Test Results

PSD measurement result for UNII-1 Band

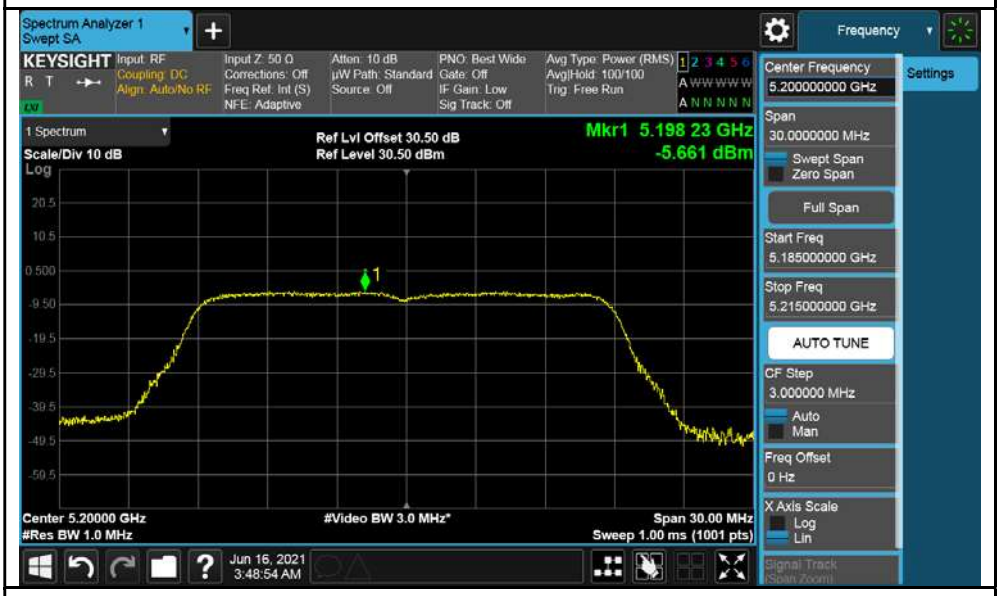
| Type | Test mode | Freq (MHz) | CH | Conducted PSD (dBm/MHz) | Limit (dBm/MHz) | Result |
|---|---|---|---|---|---|---|
| Output Power | 802.11a | 5180 | Low | -5.520 | 11 | Pass |
| | | 5200 | Mid | -5.661 | 11 | Pass |
| | | 5240 | High | -6.071 | 11 | Pass |
| | 802.11n-HT20 | 5180 | Low | -4.972 | 11 | Pass |
| | | 5200 | Mid | -5.013 | 11 | Pass |
| | | 5240 | High | -5.535 | 11 | Pass |
| | 802.11ac-VHT20 | 5180 | Low | -4.865 | 11 | Pass |
| | | 5200 | Mid | -5.330 | 11 | Pass |
| | | 5240 | High | -5.616 | 11 | Pass |
| | 802.11n-HT40 | 5190 | Low | -9.015 | 11 | Pass |
| | | 5230 | High | -8.684 | 11 | Pass |
| | 802.11ac-vHT40 | 5190 | Low | -8.702 | 11 | Pass |
| | | 5230 | High | -8.657 | 11 | Pass |
| | 802.11ac-VHT80 | 5210 | Low | -12.732 | 11 | Pass |

PSD measurement result for UNII-3 Band

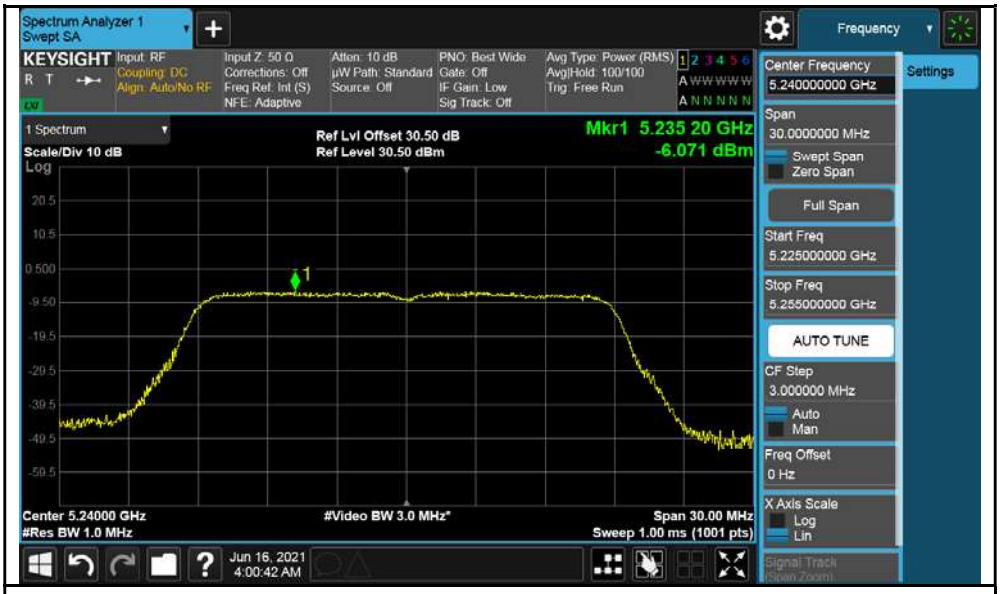
| Type | Test mode | Freq (MHz) | CH | Conducted PSD (dBm/MHz) | Correction factor (dB) | Correction PSD (dBm/MHz) | Limit (dBm/MHz) | Result |
|---|---|---|---|---|---|---|---|---|
| Output Power | 802.11a | 5745 | Low | -16.772 | 6.99 | -9.782 | 30 | Pass |
| | | 5785 | Mid | -18.049 | 6.99 | -11.059 | 30 | Pass |
| | | 5825 | High | -20.422 | 6.99 | -13.432 | 30 | Pass |
| | 802.11n-HT20 | 5745 | Low | -17.556 | 6.99 | -10.566 | 30 | Pass |
| | | 5785 | Mid | -18.392 | 6.99 | -11.402 | 30 | Pass |
| | | 5825 | High | -20.196 | 6.99 | -13.206 | 30 | Pass |
| | 802.11ac-VHT20 | 5745 | Low | -17.395 | 6.99 | -10.405 | 30 | Pass |
| | | 5785 | Mid | -19.203 | 6.99 | -12.213 | 30 | Pass |
| | | 5825 | High | -20.881 | 6.99 | -13.891 | 30 | Pass |
| | 802.11n-HT40 | 5755 | Low | -20.486 | 6.99 | -13.496 | 30 | Pass |
| | | 5795 | High | -21.688 | 6.99 | -14.698 | 30 | Pass |
| | 802.11ac-vHT40 | 5755 | Low | -20.726 | 6.99 | -13.736 | 30 | Pass |
| | | 5795 | High | -21.749 | 6.99 | -14.759 | 30 | Pass |
| | 802.11ac-VHT80 | 5775 | Low | -24.607 | 6.99 | -17.617 | 30 | Pass |
| NOTE | BW correction factor = 10log (500kHz/RBW), RBW was set to 100kHz during test. | | | | | | | |

Test Plot for UNII-1 Band:


802.11a-5180MHz



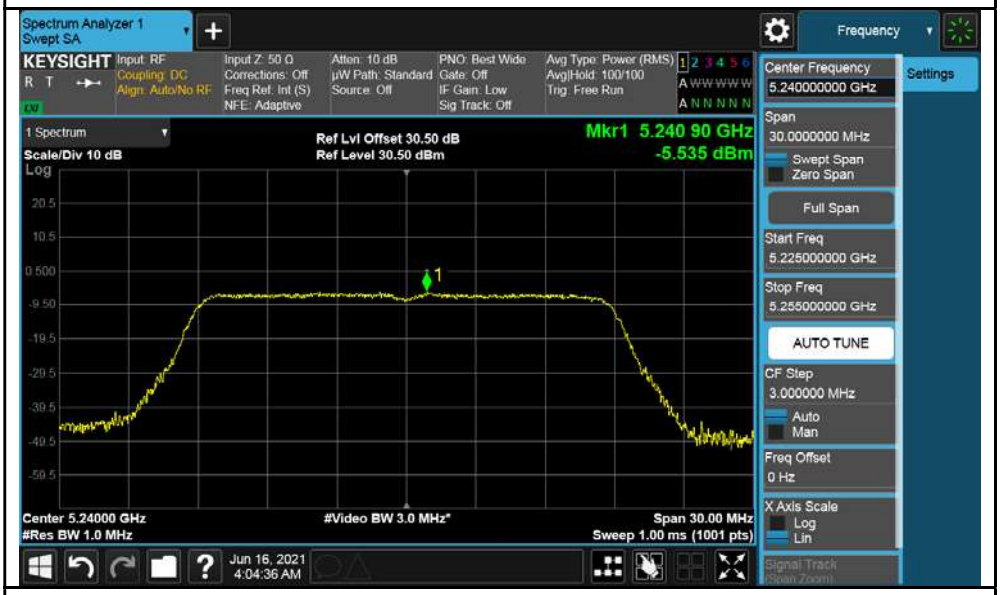

802.11a-5200MHz




802.11a-5240MHz

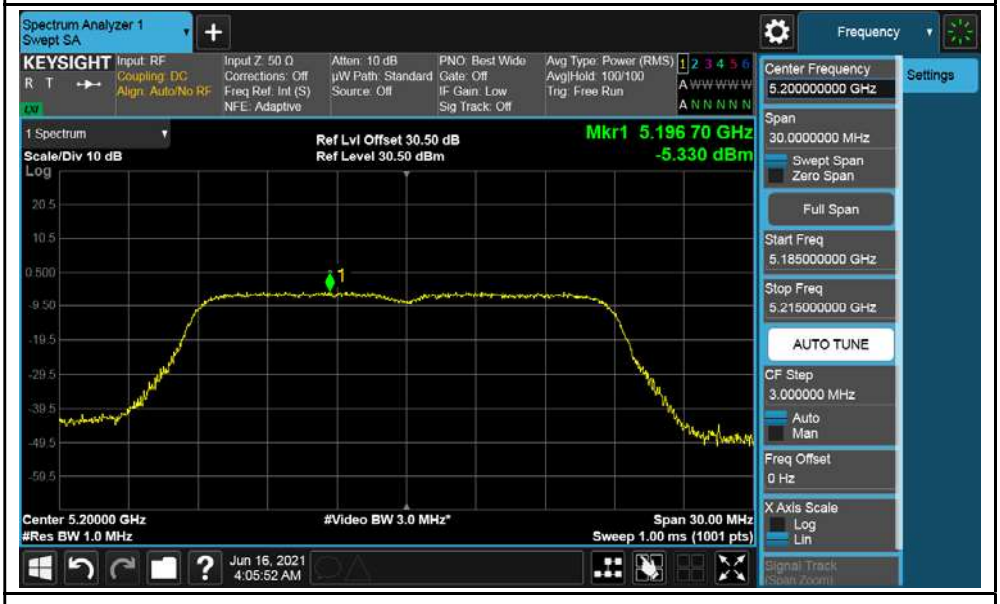

802.11n-HT20-5180MHz


802.11n-HT20-5200MHz




802.11n-HT20-5240MHz


802.11ac-VHT20-5180MHz




802.11ac-VHT20-5200MHz


802.11ac-VHT20-5240MHz


802.11n-HT40-5190MHz

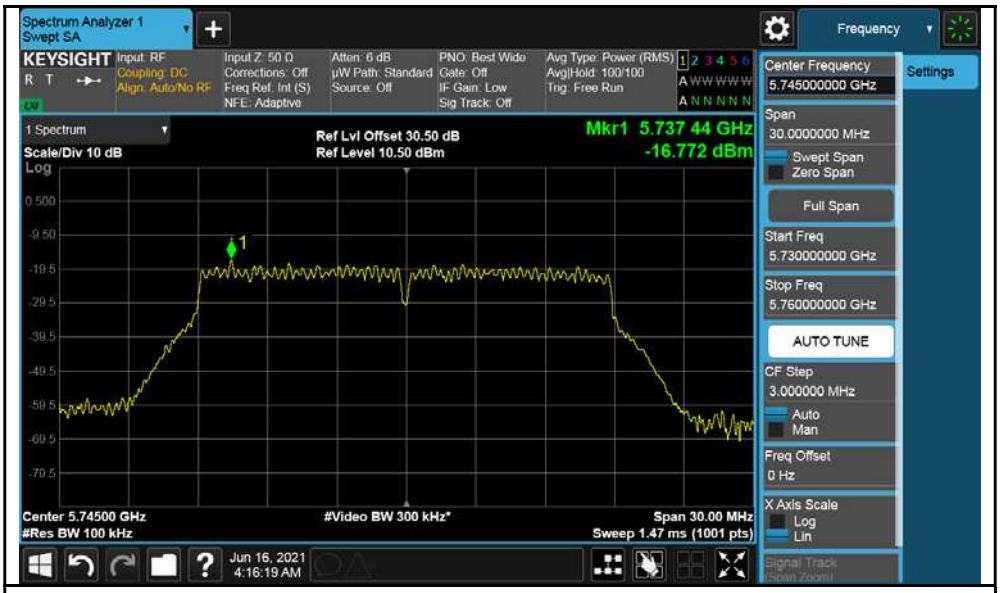

802.11n-HT40-5230MHz


802.11ac-VHT40-5190MHz

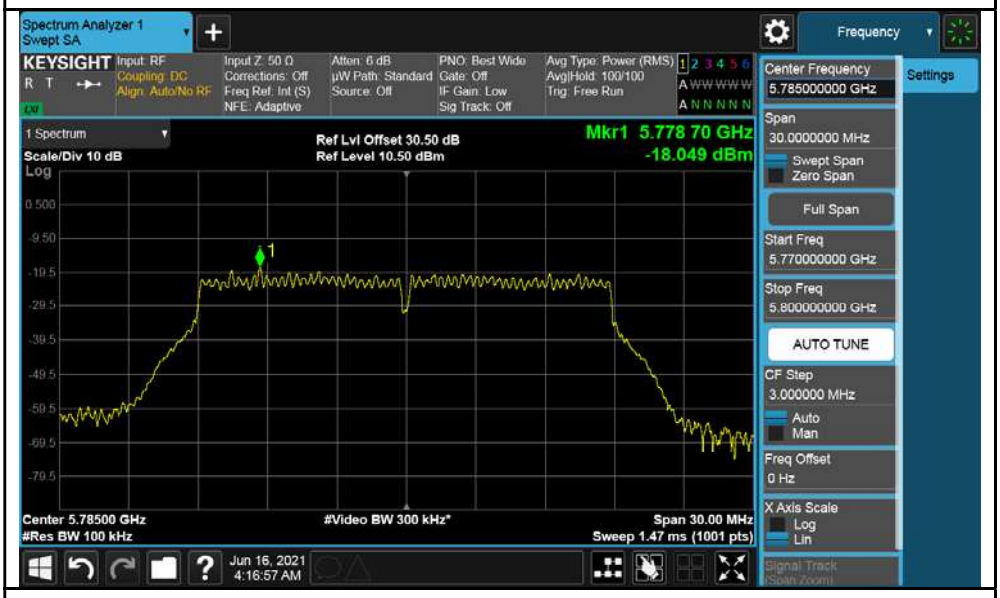

802.11ac-VHT40-5230MHz


802.11ac-VHT80-5210MHz

Test Plot for UNII-3 Band:

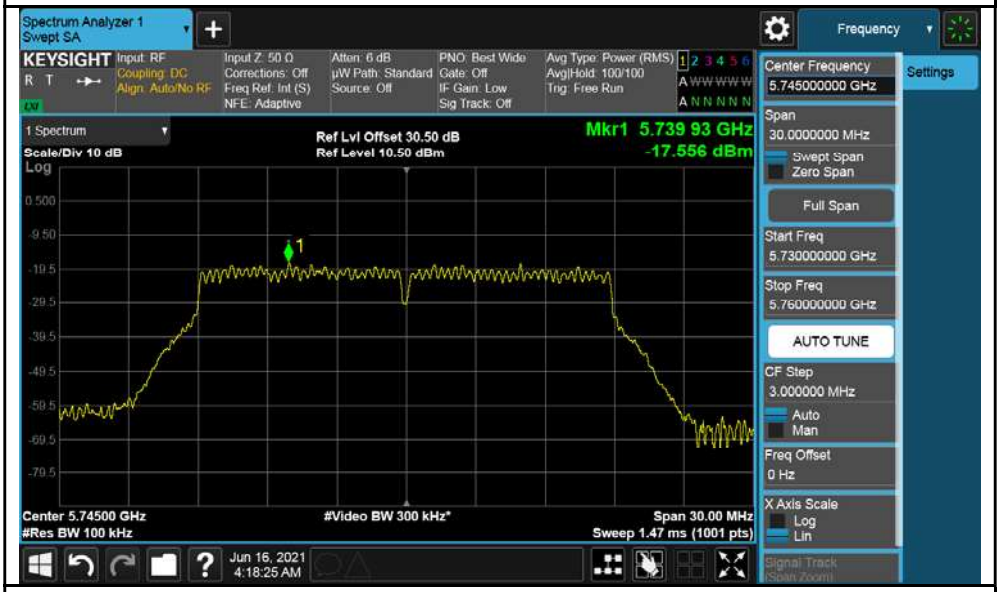



802.11a-5745MHz

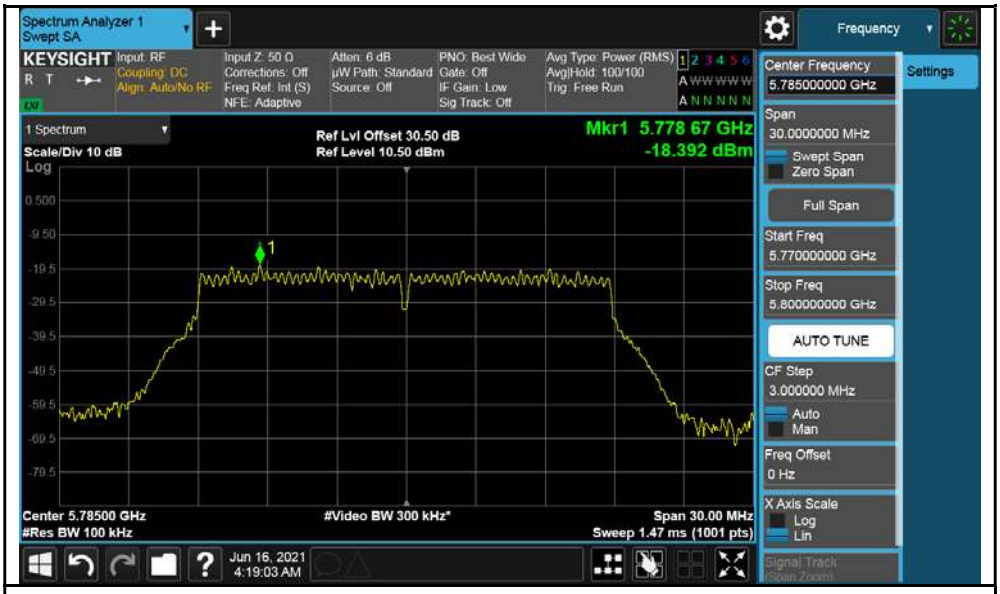



802.11a-5785MHz

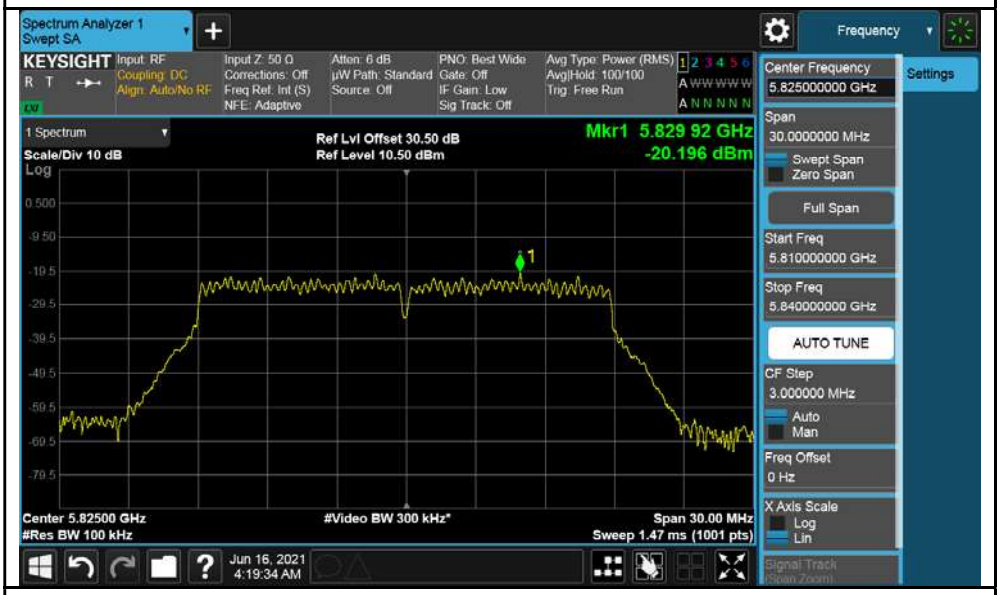

802.11a-5825MHz



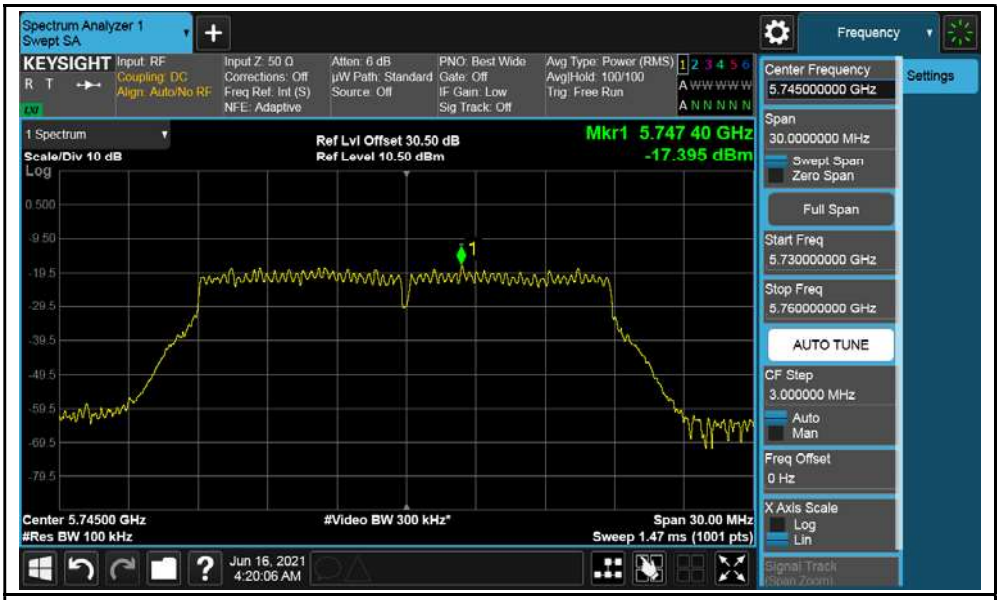

802.11n-HT20-5745MHz



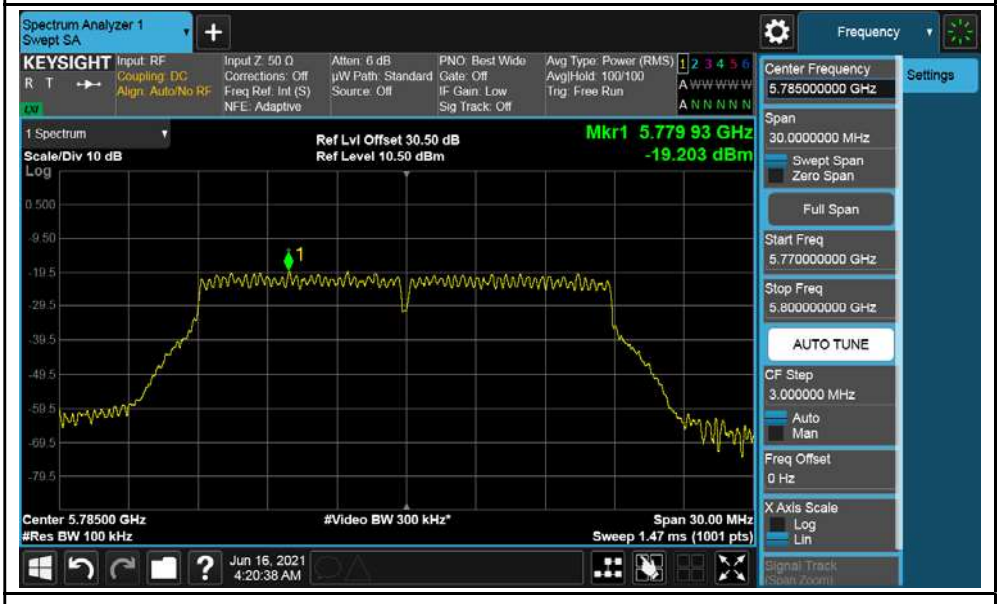

802.11n-HT20-5785MHz



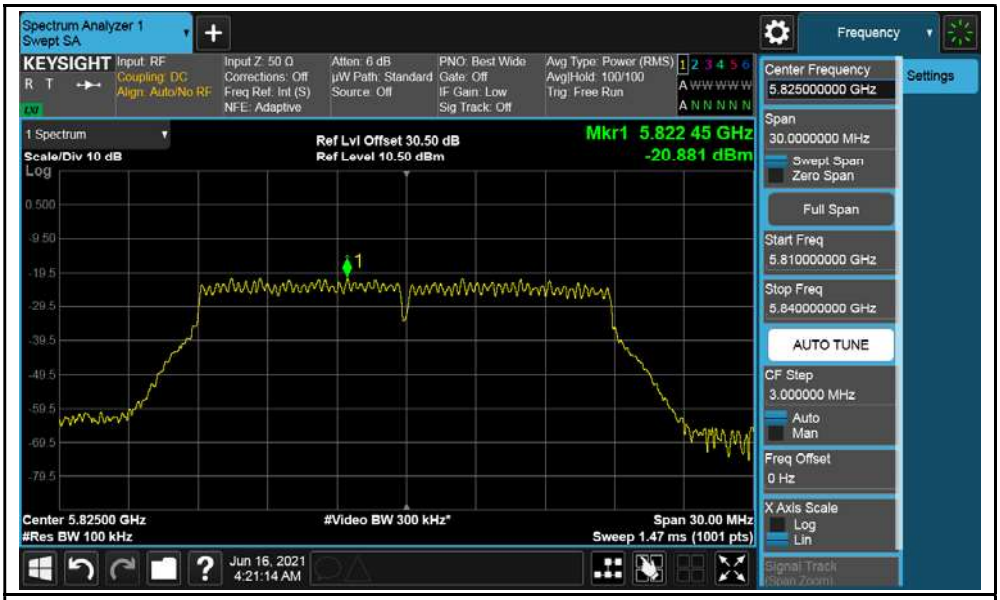

802.11n-HT20-5825MHz



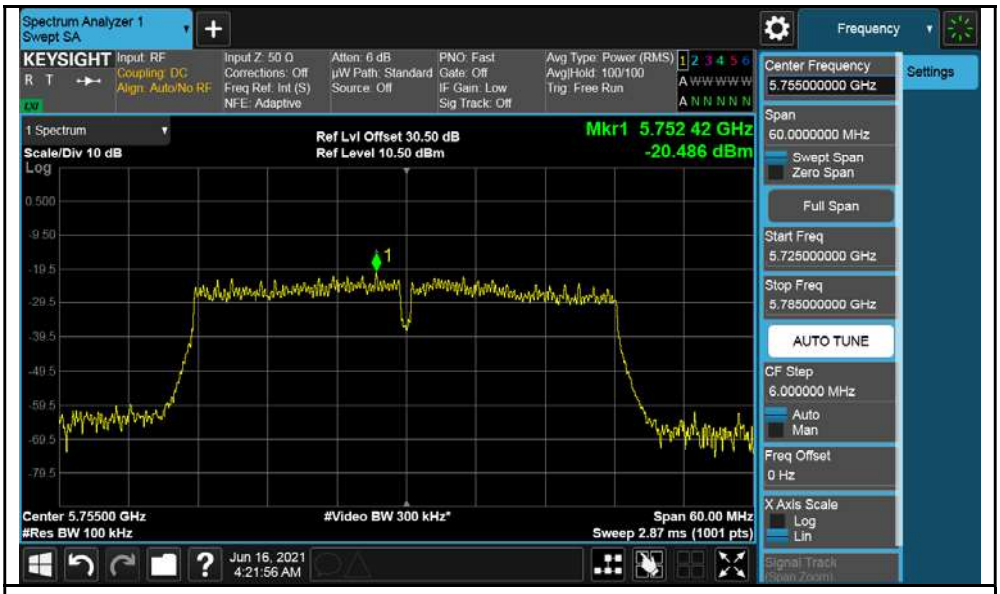

802.11ac-VHT20-5745MHz



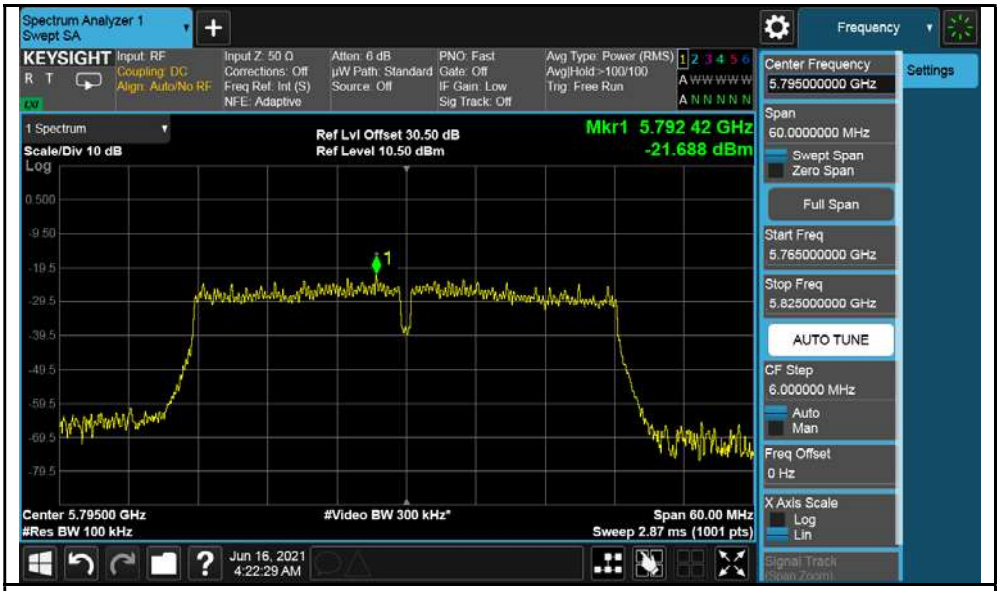

802.11ac-VHT20-5785MHz



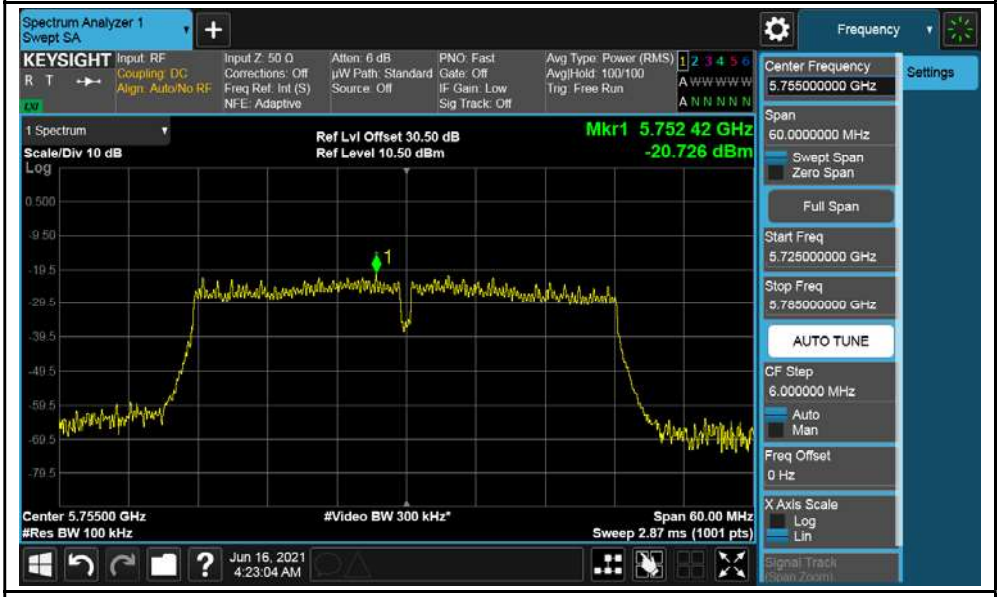

802.11ac-VHT20-5825MHz



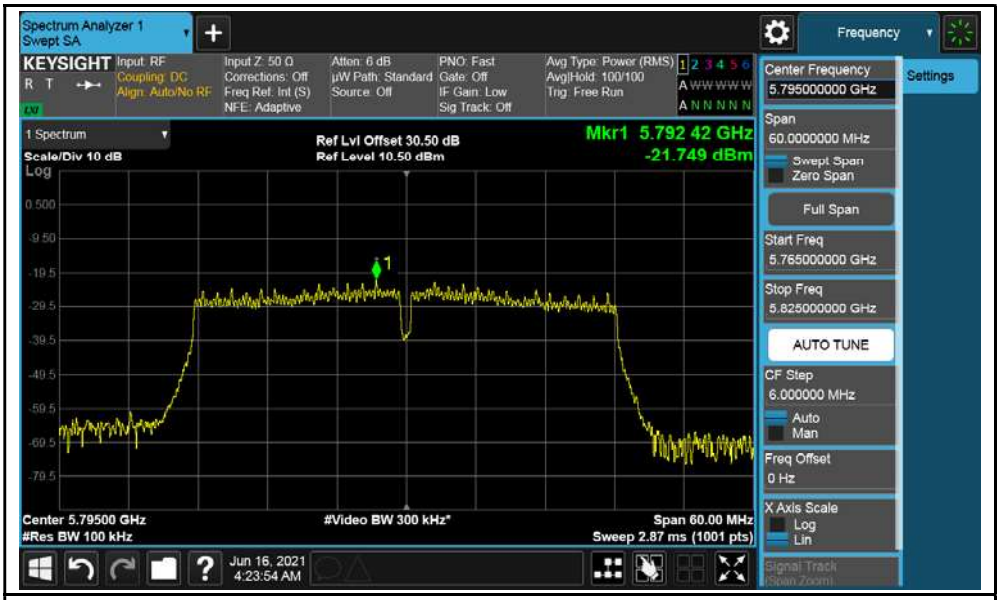

802.11n-HT40-5755MHz



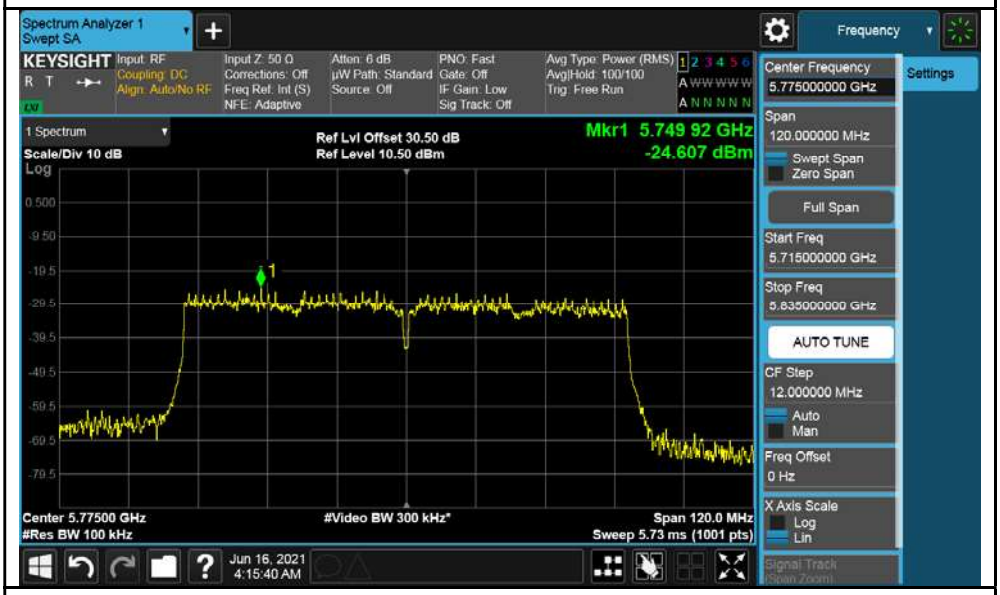

802.11n-HT40-5795MHz




802.11ac-VHT40-5755MHz




802.11ac-VHT40-5795MHz



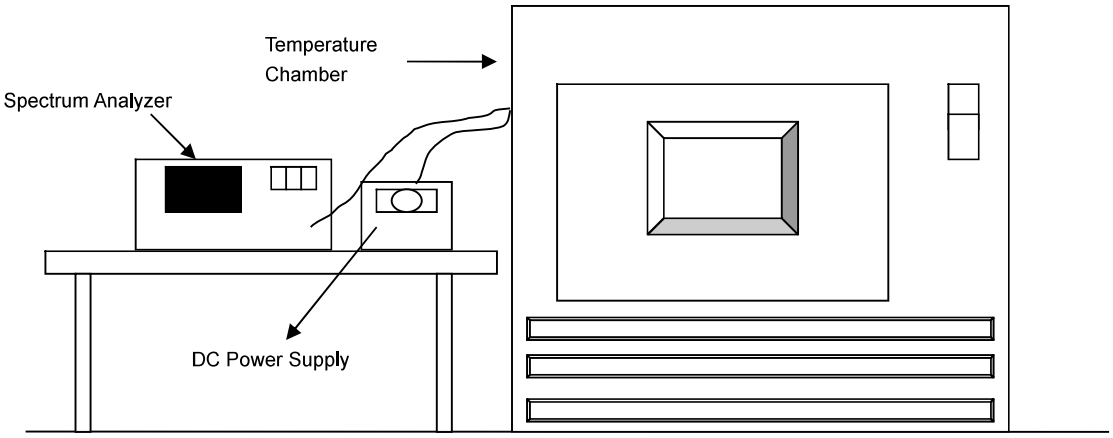

802.11n-HT40-5775MHz

## 4.6 Frequency Stability Measurement

### 4.6.1 Limits of Frequency Stability Measurement

The frequency of the carrier signal shall be maintained within band of operation.

### 4.6.2 Test Setup




### 4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.6.4 Test Procedure

a. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
b. Turn the EUT on and couple its output to a spectrum analyzer.
c. Turn the EUT off and set the chamber to the highest temperature specified.
d. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 Minutes.
e. Repeat step (d) with the temperature chamber set to the next desired temperature until measurements down to the lowest specified temperature have been completed..
f. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 Minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
.

### 4.6.5 Deviation from Test Standard

No deviation.

### 4.6.6 EUT Operating Condition

Set the EUT transmit at un-modulation mode to test frequency stability.

4.6.7 Test Results

| Frequency Stability Versus Temp. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Operating Frequency: 5180 MHz | | | | | | | | | |
| TEMP. (℃) | Power Supply (Vdc) | 0 Minute | | 2 Minute | | 5 Minute | | 10 Minute | |
| | | Measured Frequency (MHz) | Pass/Fail | Measured Frequency (MHz) | Pass/Fail | Measured Frequency (MHz) | Pass/Fail | Measured Frequency (MHz) | Pass/Fail |
| 50 | 12 | 5179.973 | Pass | 5180.06234 | Pass | 5179.98167 | Pass | 5179.98913 | Pass |
| 40 | 12 | 5180.050 | Pass | 5179.99516 | Pass | 5180.00110 | Pass | 5180.00202 | Pass |
| 30 | 12 | 5179.991 | Pass | 5180.00249 | Pass | 5179.99216 | Pass | 5179.99117 | Pass |
| 20 | 12 | 5179.994 | Pass | 5180.00197 | Pass | 5179.99441 | Pass | 5180.00916 | Pass |
| 10 | 12 | 5179.976 | Pass | 5179.97193 | Pass | 5179.998421 | Pass | 5180.00841 | Pass |
| 0 | 12 | 5180.003 | Pass | 5180.00419 | Pass | 5179.97138 | Pass | 5180.98419 | Pass |
| -10 | 12 | 5179.974 | Pass | 5179.98167 | Pass | 5179.97419 | Pass | 5179.99555 | Pass |
| -20 | 12 | 5179.905 | Pass | 5179.99128 | Pass | 5180.00298 | Pass | 5180.00916 | Pass |
| -30 | 12 | 5180.004 | Pass | 5179.98792 | Pass | 5179.99110 | Pass | 5179.99188 | Pass |

| Frequency Stability Versus Voltage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Operating Frequency: 5180 MHz | | | | | | | | | |
| TEMP. (℃) | Power Supply (Vdc) | 0 Minute | | 2 Minute | | 5 Minute | | 10 Minute | |
| | | Measured Frequency (MHz) | Pass/Fail | Measured Frequency (MHz) | Pass/Fail | Measured Frequency (MHz) | Pass/Fail | Measured Frequency (MHz) | Pass/Fail |
| 20 | 13.8 | 5180.010 | Pass | 5179.980 | Pass | 5180.009 | Pass | 5180.0023 | Pass |
| | 12 | 5179.986 | Pass | 5179.916 | Pass | 5180.023 | Pass | 5180.0018 | Pass |
| | 10.2 | 5180.120 | Pass | 5180.012 | Pass | 5179.889 | Pass | 5179.9812 | Pass |

## 5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

**Appendix – Information on the Testing Laboratories**

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following: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The address and road map of all our labs can be found in our web site also.

**--- END ---**