

10. Maximum Conducted Output Power

10.1 Block Diagram Of Test Setup



10.2 Limit

According to FCC §15.407

■ For the band 5.15-5.25 GHz,

(a) (1) (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(a) (1) (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(a) (1) (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple colocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(a) (1) (iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

■ For the 5.25-5.35 GHz and 5.47-5.725 GHz bands

(a) (2) The maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or $11 \text{ dBm} + 10 \log B$, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

■ For the band 5.725-5.85 GHz

(a) (3) for the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations

10.3 Test Procedure

Maximum conducted output power may be measured using a spectrum analyzer/EMI receiver or an RF power meter.

1. Device Configuration

If possible, configure or modify the operation of the EUT so that it transmits continuously at its maximum power control level (see section II.B.).

a) The intent is to test at 100 percent duty cycle; however a small reduction in duty cycle (to no lower than 98 percent) is permitted if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

b) If continuous transmission (or at least 98 percent duty cycle) cannot be achieved due to hardware limitations (e.g., overheating), the EUT shall be operated at its maximum power control level with the transmit duration as long as possible and the duty cycle as high as possible.

2. Measurement using a Spectrum Analyzer or EMI Receiver (SA)

Measurement of maximum conducted output power using a spectrum analyzer requires integrating the spectrum across a frequency span that encompasses, at a minimum, either the EBW or the 99-percent occupied bandwidth of the signal.¹ However, the EBW must be used to determine bandwidth dependent limits on maximum conducted output power in accordance with § 15.407(a).

a) The test method shall be selected as follows: (i) Method SA-1 or SA-1 Alternative (averaging with the EUT transmitting at full power throughout each sweep) shall be applied if either of the following conditions can be satisfied:

- The EUT transmits continuously (or with a duty cycle ≥ 98 percent).
- Sweep triggering or gating can be implemented in a way that the device transmits at the maximum power control level throughout the duration of each of the instrument sweeps to be averaged. This condition can generally be achieved by triggering the instrument's sweep if the duration of the sweep (with the analyzer configured as in Method SA-1, below) is equal to or shorter than the duration T of each transmission from the EUT and if those transmissions exhibit full power throughout their durations.

(ii) Method SA-2 or SA-2 Alternative (averaging across on and off times of the EUT transmissions, followed by duty cycle correction) shall be applied if the conditions of (i) cannot be achieved and the transmissions exhibit a constant duty cycle during the measurement duration. Duty cycle will be considered to be constant if variations are less than ± 2 percent.

(iii) Method SA-3 (RMS detection with max hold) or SA-3 Alternative (reduced VBW with max hold) shall be applied if the conditions of (i) and (ii) cannot be achieved.

b) Method SA-1 (trace averaging with the EUT transmitting at full power throughout each sweep): (i) Set span to encompass the entire emission bandwidth (EBW) (or, alternatively, the entire 99% occupied bandwidth) of the signal.

(ii) Set RBW = 1 MHz.

(iii) Set VBW ≥ 3 MHz.

(iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is \leq RBW/2, so that narrowband signals are not lost between frequency bins.)

(v) Sweep time = auto.

(vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.

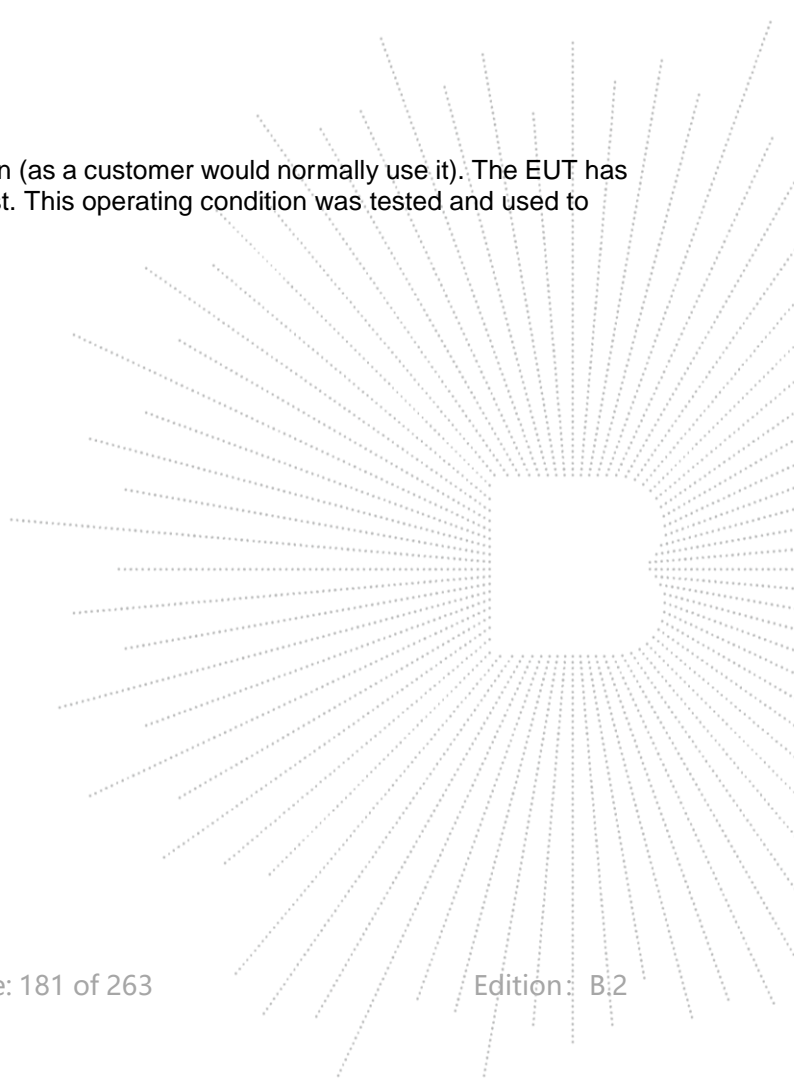
(vii) If transmit duty cycle < 98 percent, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 percent, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run".

(viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode.

(ix) Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum

10.4 EUT Operating Conditions

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.



10.5 Test Result

Temperature:	26 °C	Relative Humidity:	54%
Pressure:	101KPa	Test Voltage:	AC120/60Hz
Test Mode:	5180-5240MHz		

Condition	Mode	Frequency (MHz)	Conducted Power (dBm)		Limit (dBm)	Verdict
			Ant A	Ant B		
NVNT	a	5180	12.02	12.38	24	Pass
NVNT	a	5200	12.03	12.42	24	Pass
NVNT	a	5240	12.1	12.37	24	Pass
NVNT	n20	5180	11.45	11.43	24	Pass
NVNT	n20	5200	11.23	11.47	24	Pass
NVNT	n20	5240	11.63	11.47	24	Pass
NVNT	n40	5190	11.08	10.85	24	Pass
NVNT	n40	5230	11.15	10.96	24	Pass
NVNT	ac20	5180	11.51	11.51	24	Pass
NVNT	ac20	5200	11.17	11.46	24	Pass
NVNT	ac20	5240	11.65	11.66	24	Pass
NVNT	ac40	5190	10.92	10.8	24	Pass
NVNT	ac40	5230	10.95	10.59	24	Pass
NVNT	ac80	5210	10.22	9.89	24	Pass

For MIMO

Operating mode	Channel Freq. (MHz)	Conducted Output Power(dBm)	Limit (dBm)	Verdict
n20	5180	14.45	22.57	Pass
n20	5200	14.36	22.57	Pass
n20	5240	14.56	22.57	Pass
n40	5190	13.98	22.57	Pass
n40	5230	14.07	22.57	Pass
ac20	5180	14.52	22.57	Pass
ac20	5200	14.33	22.57	Pass
ac20	5240	14.67	22.57	Pass
ac40	5190	13.87	22.57	Pass
ac40	5230	13.78	22.57	Pass
ac80	5210	13.07	22.57	Pass

Temperature:	26 °C	Relative Humidity:	54%
Pressure:	101KPa	Test Voltage:	AC120/60Hz
Test Mode:	5260-5320MHz		

Condition	Mode	Frequency (MHz)	Conducted Power (dBm)		Limit (dBm)	Verdict
			Ant A	Ant B		
NVNT	a	5260	12.28	12.33	24	Pass
NVNT	a	5280	12.2	12.46	24	Pass
NVNT	a	5320	12.35	12.53	24	Pass
NVNT	n20	5260	11.66	11.55	24	Pass
NVNT	n20	5280	11.43	11.57	24	Pass
NVNT	n20	5320	11.52	11.54	24	Pass
NVNT	n40	5270	10.73	10.66	24	Pass
NVNT	n40	5310	10.58	10.59	24	Pass
NVNT	ac20	5260	11.67	11.57	24	Pass
NVNT	ac20	5280	11.48	11.45	24	Pass
NVNT	ac20	5320	11.57	11.63	24	Pass
NVNT	ac40	5270	10.56	10.64	24	Pass
NVNT	ac40	5310	10.54	10.65	24	Pass
NVNT	ac80	5290	10	10.02	24	Pass

For MIMO

Operating mode	Channel Freq. (MHz)	Conducted Output Power(dBm)	Limit (dBm)	Verdict
n20	5260	14.62	22.57	Pass
n20	5280	14.51	22.57	Pass
n20	5320	14.54	22.57	Pass
n40	5270	13.71	22.57	Pass
n40	5310	13.60	22.57	Pass
ac20	5260	14.63	22.57	Pass
ac20	5280	14.48	22.57	Pass
ac20	5320	14.61	22.57	Pass
ac40	5270	13.61	22.57	Pass
ac40	5310	13.61	22.57	Pass
ac80	5290	13.02	22.57	Pass

Temperature:	26 °C	Relative Humidity:	54%
Pressure:	101KPa	Test Voltage:	AC120/60Hz
Test Mode:	5500-5700MHz		

Condition	Mode	Frequency (MHz)	Conducted Power (dBm)		Limit (dBm)	Verdict
			Ant A	Ant B		
NVNT	a	5500	12.18	12.42	24	Pass
NVNT	a	5580	12.32	12.38	24	Pass
NVNT	a	5700	12.19	12.46	24	Pass
NVNT	n20	5500	11.59	11.59	24	Pass
NVNT	n20	5580	11.68	11.67	24	Pass
NVNT	n20	5700	11.65	11.67	24	Pass
NVNT	n40	5510	10.62	10.81	24	Pass
NVNT	n40	5550	10.67	10.52	24	Pass
NVNT	n40	5670	10.63	10.49	24	Pass
NVNT	ac20	5500	11.29	11.64	24	Pass
NVNT	ac20	5580	11.42	11.5	24	Pass
NVNT	ac20	5700	11.22	11.54	24	Pass
NVNT	ac40	5510	10.58	10.59	24	Pass
NVNT	ac40	5550	10.46	10.45	24	Pass
NVNT	ac40	5670	10.55	10.44	24	Pass
NVNT	ac80	5530	9.67	9.81	24	Pass

For MIMO

Operating mode	Channel Freq. (MHz)	Conducted Output Power(dBm)	Limit (dBm)	Verdict
n20	5500	14.60	22.57	Pass
n20	5580	14.69	22.57	Pass
n20	5700	14.67	22.57	Pass
n40	5510	13.73	22.57	Pass
n40	5550	13.61	22.57	Pass
n40	5670	13.57	22.57	Pass
ac20	5500	14.48	22.57	Pass
ac20	5580	14.47	22.57	Pass
ac20	5700	14.39	22.57	Pass
ac40	5510	13.60	22.57	Pass
ac40	5550	13.47	22.57	Pass
ac40	5670	13.51	22.57	Pass
ac80	5530	12.75	22.57	Pass

Temperature:	26 °C	Relative Humidity:	54%
Pressure:	101KPa	Test Voltage:	AC120/60HZ
Test Mode:	5745-5825MHz		

Condition	Mode	Frequency (MHz)	Conducted Power (dBm)		Limit (dBm)	Verdict
			Ant A	Ant B		
NVNT	a	5745	12.41	12.39	30	Pass
NVNT	a	5785	12.47	12.31	30	Pass
NVNT	a	5825	12.39	12.2	30	Pass
NVNT	n20	5745	11.56	11.77	30	Pass
NVNT	n20	5785	11.79	11.6	30	Pass
NVNT	n20	5825	11.83	11.35	30	Pass
NVNT	n40	5755	11.02	10.64	30	Pass
NVNT	n40	5795	11.03	10.77	30	Pass
NVNT	ac20	5745	11.56	11.29	30	Pass
NVNT	ac20	5785	11.53	11.18	30	Pass
NVNT	ac20	5825	11.48	11.12	30	Pass
NVNT	ac40	5755	11.02	10.55	30	Pass
NVNT	ac40	5795	10.94	10.5	30	Pass
NVNT	ac80	5775	10.45	10.07	30	Pass

For MIMO

Operating mode	Channel Freq. (MHz)	Conducted Output Power(dBm)	Limit (dBm)	Verdict
n20	5745	14.68	28.57	Pass
n20	5785	14.71	28.57	Pass
n20	5825	14.61	28.57	Pass
n40	5755	13.84	28.57	Pass
n40	5795	13.91	28.57	Pass
ac20	5745	14.44	28.57	Pass
ac20	5785	14.37	28.57	Pass
ac20	5825	14.31	28.57	Pass
ac40	5755	13.80	28.57	Pass
ac40	5795	13.74	28.57	Pass
ac80	5775	13.27	28.57	Pass

11. Out Of Band Emissions

11.1 Block Diagram Of Test Setup



11.2 Limit

According to FCC §15.407(b)

Undesirable emission limits. Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.

(2) All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

11.3 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 1 MHz with a convenient frequency span.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

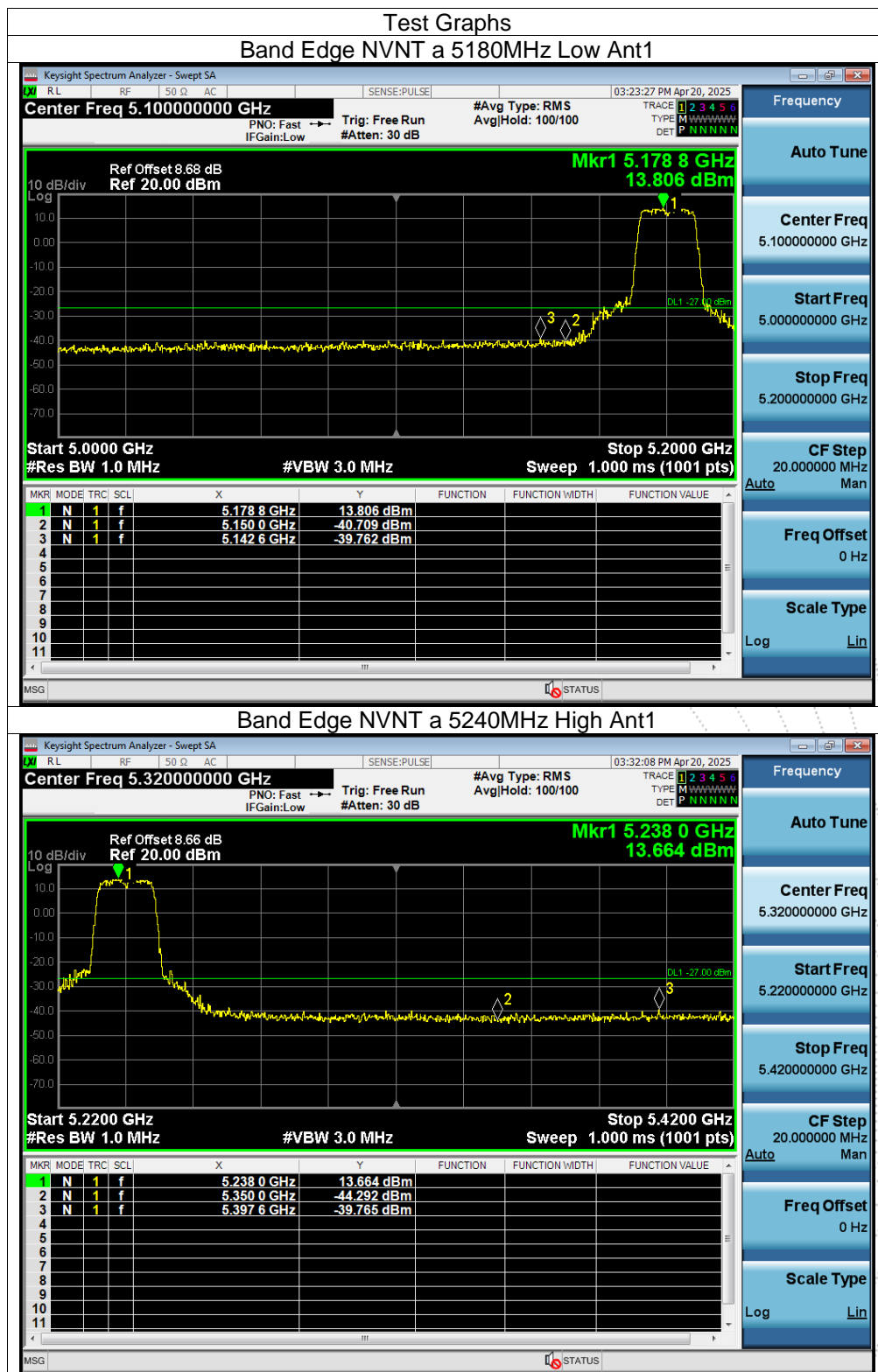
11.4 EUT Operating Conditions

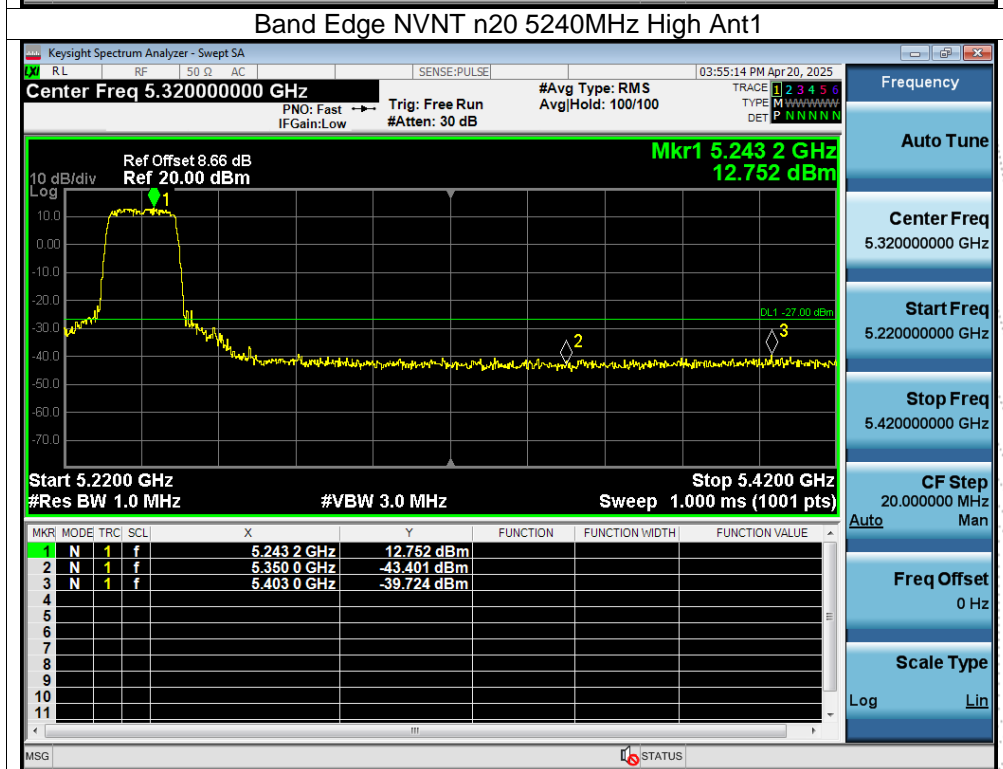
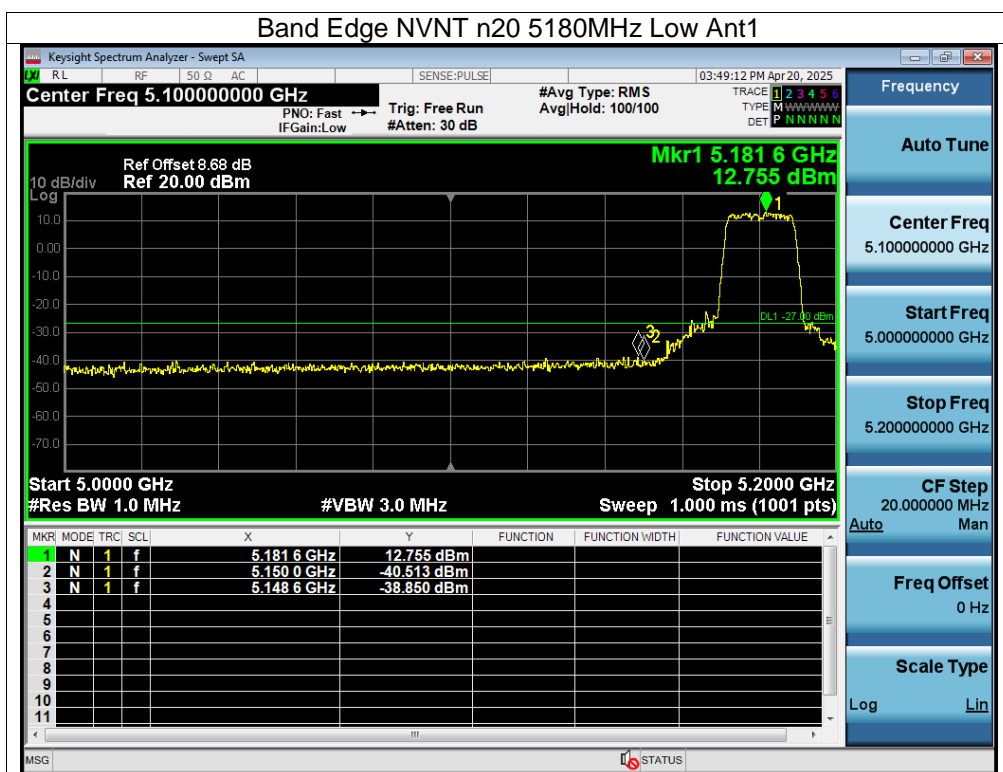
The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data

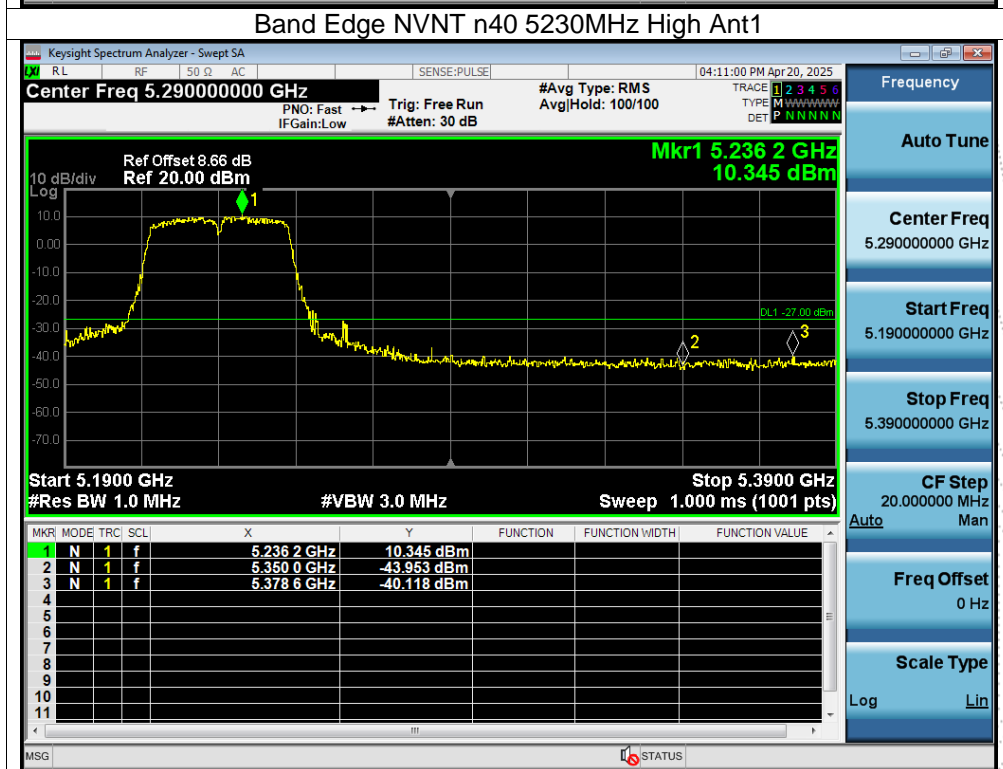
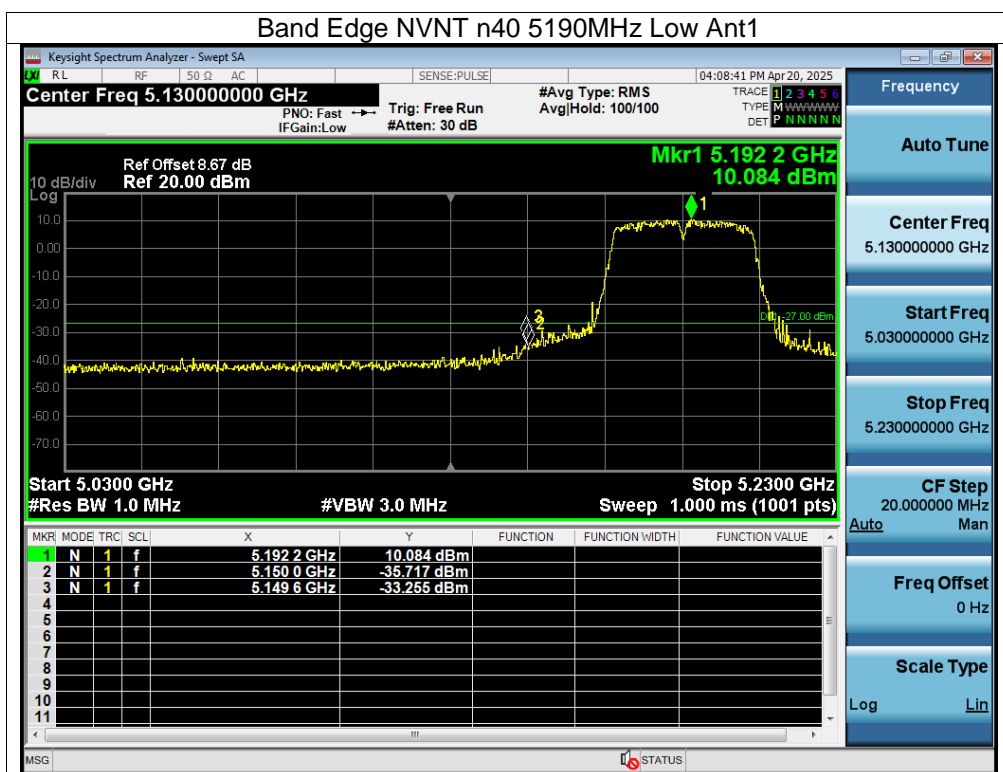
11.5 Test Result

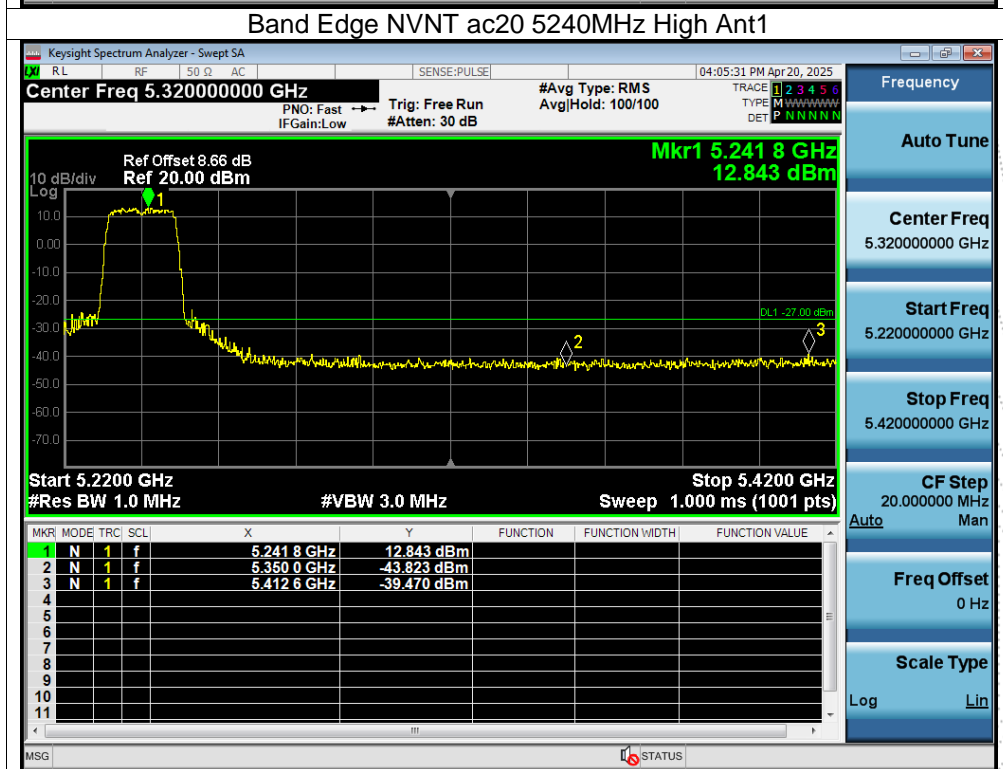
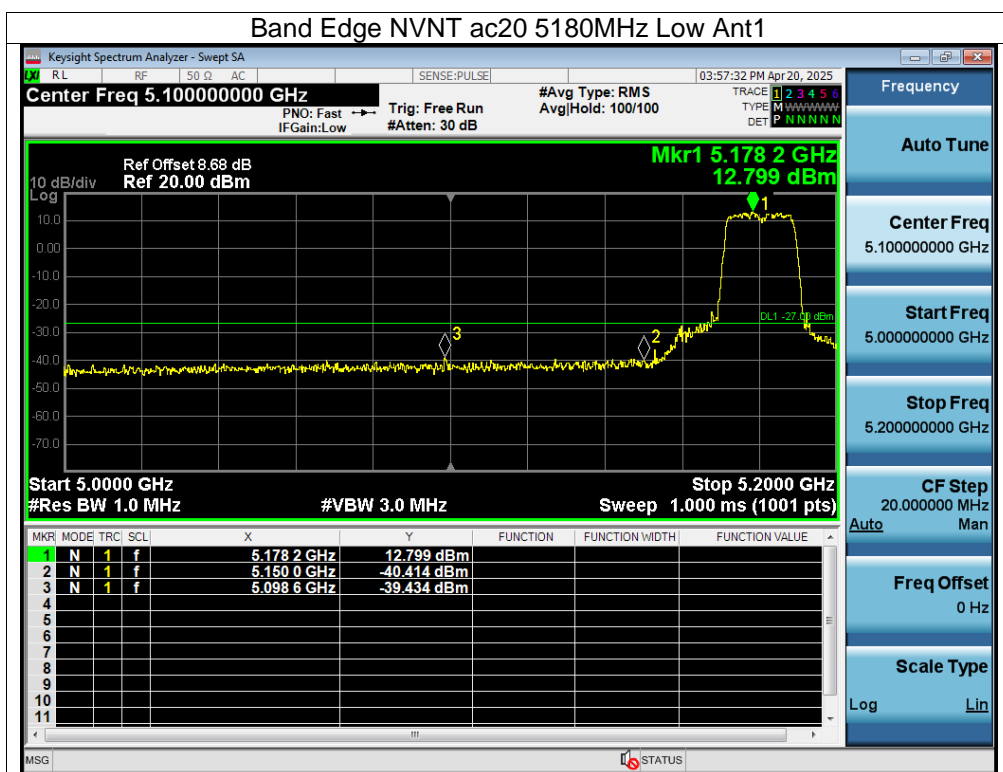
Temperature:	26 °C	Relative Humidity:	54%
Pressure:	101kPa	Test Voltage:	AC120/60Hz

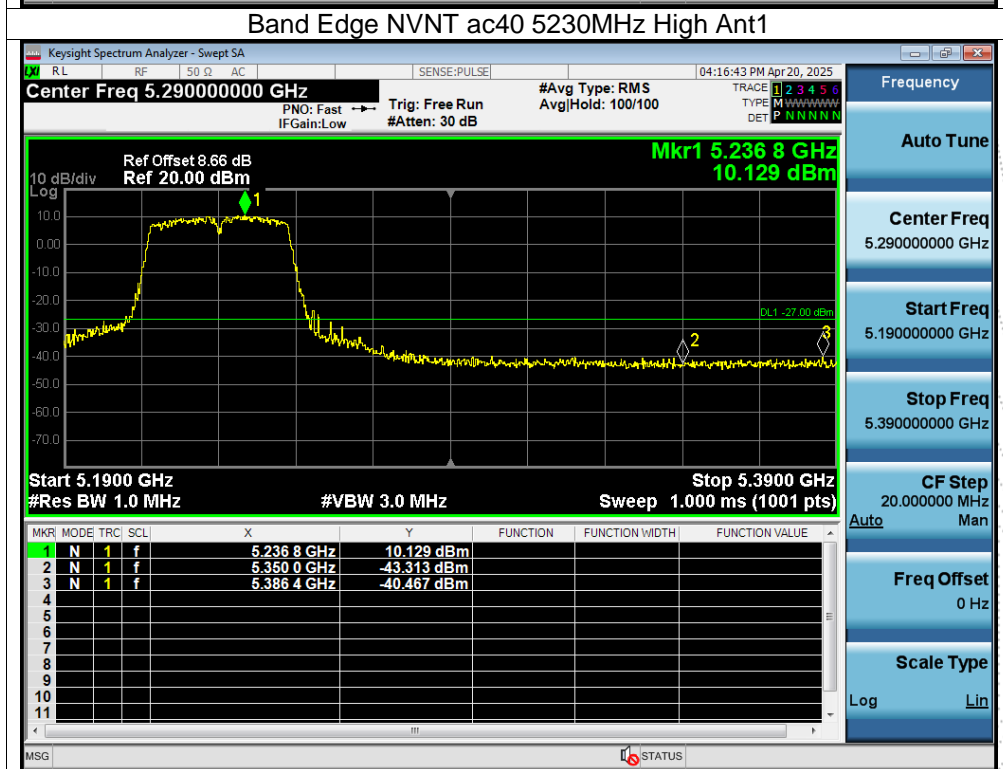
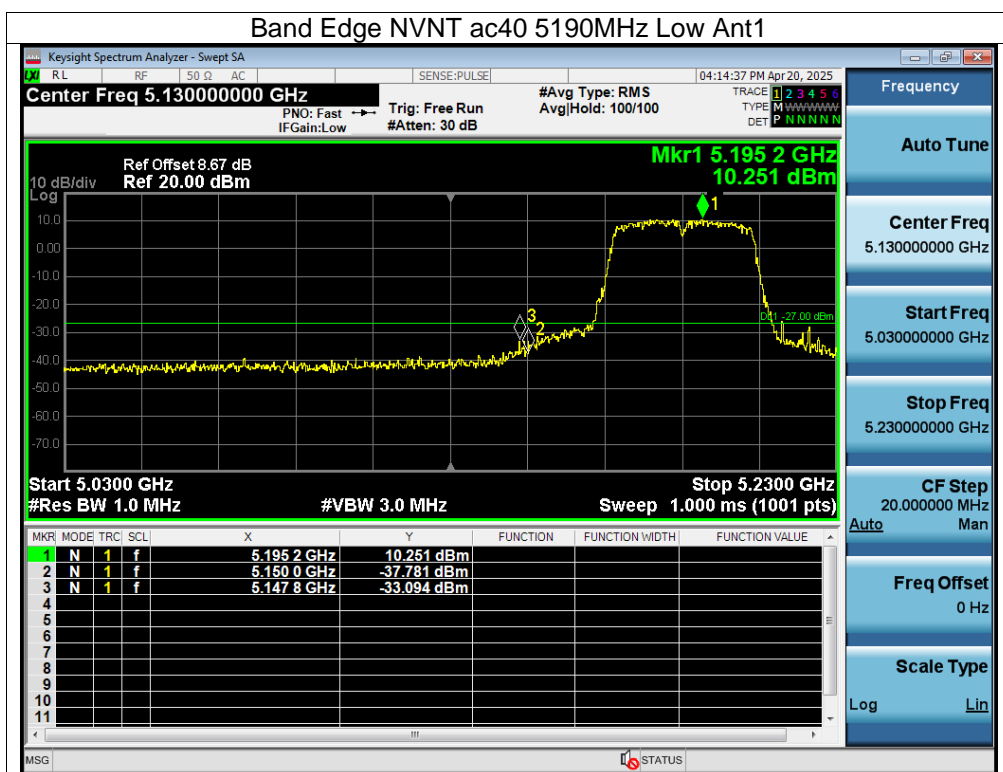
Note: A(B) Represent the value of antenna A and B, The worst data is Antenna A, only shown Antenna A.
Plot. Antenna A: 5180-5240MHz

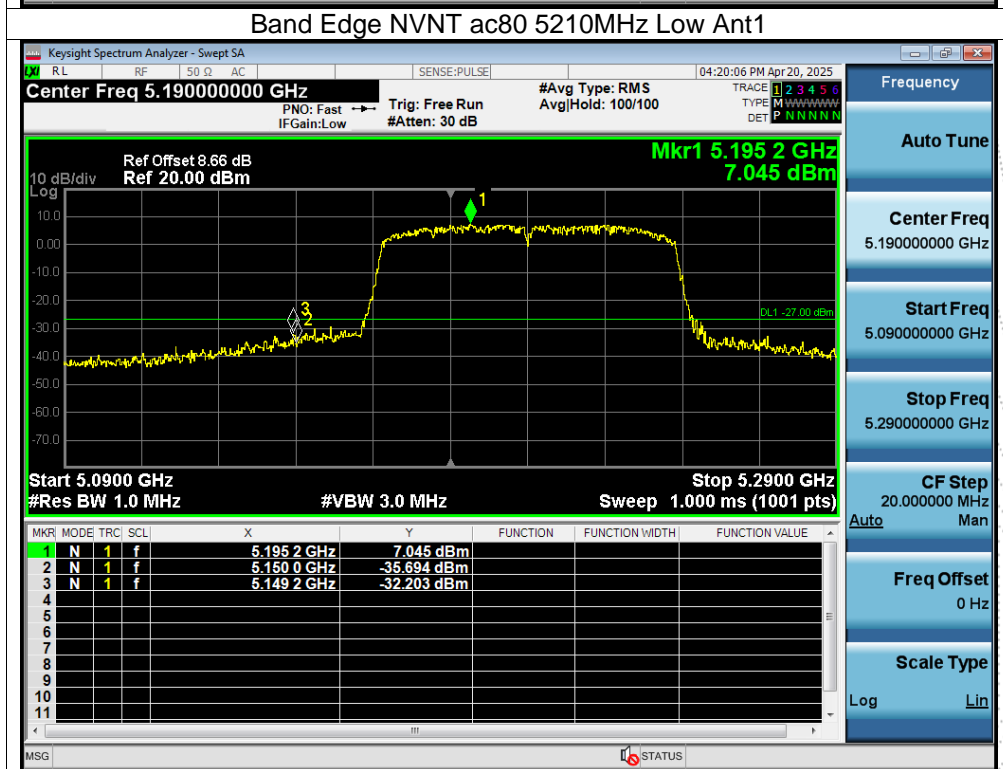
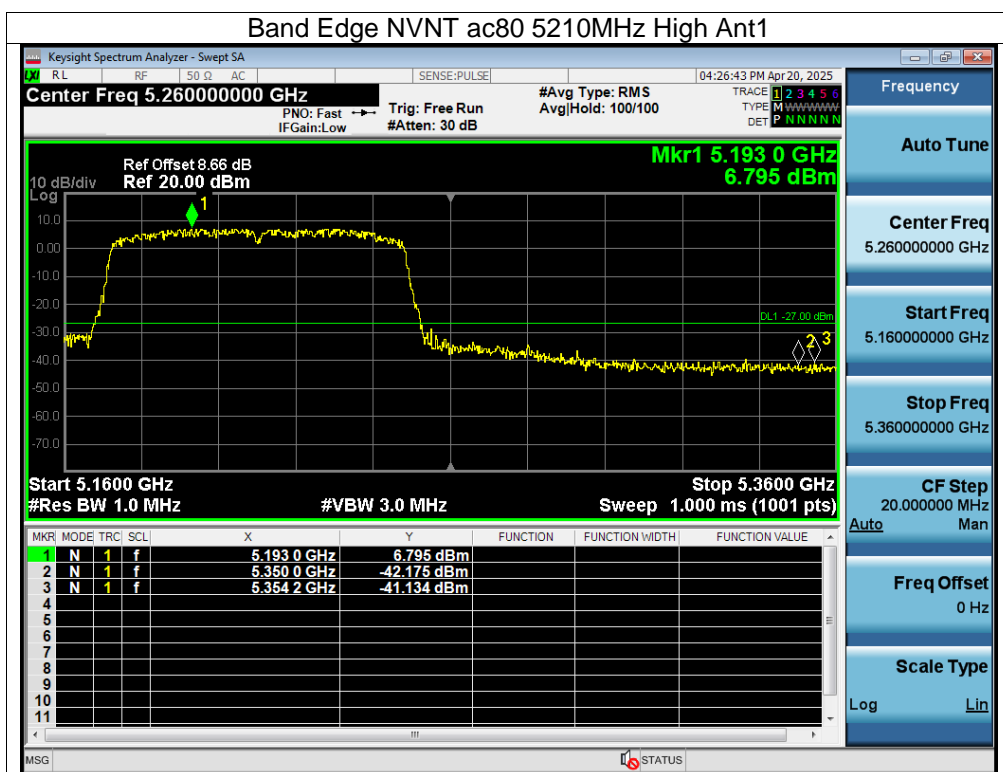




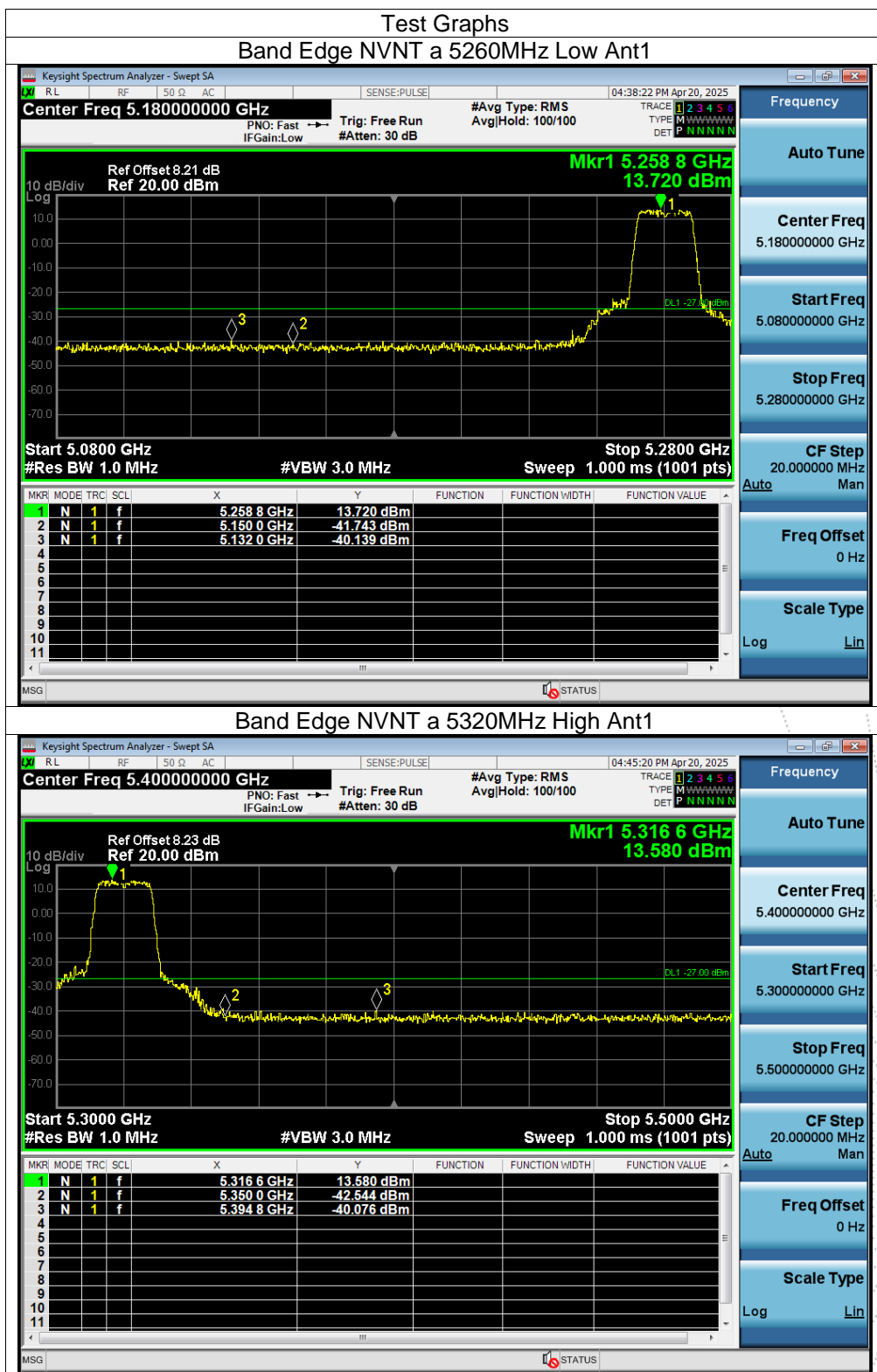


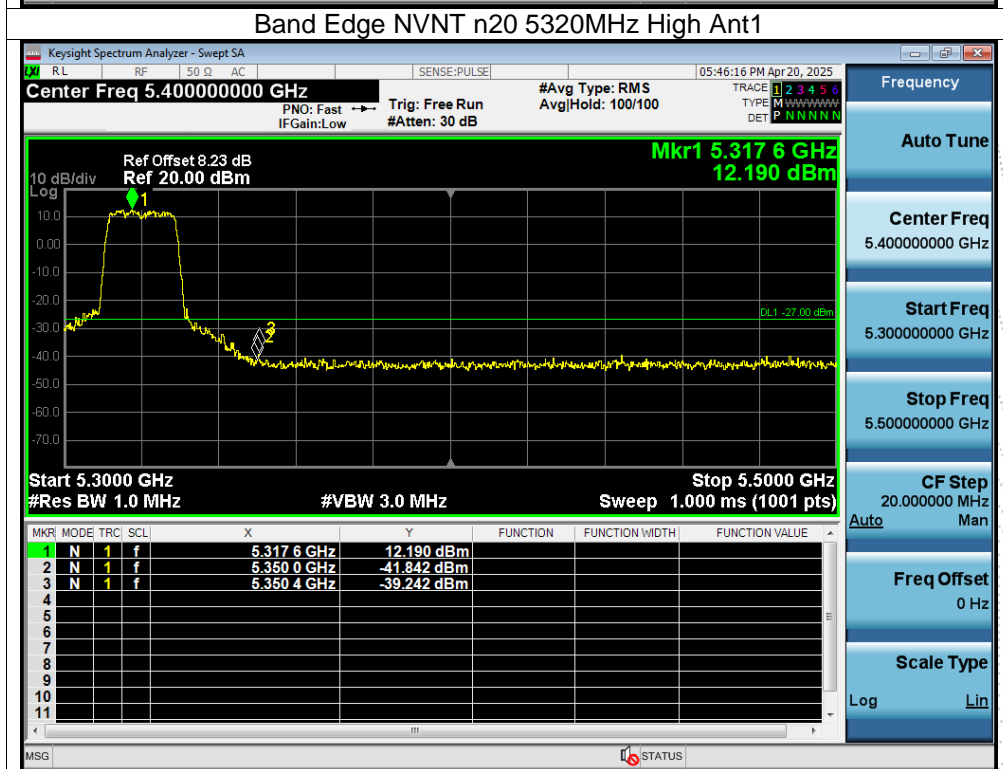
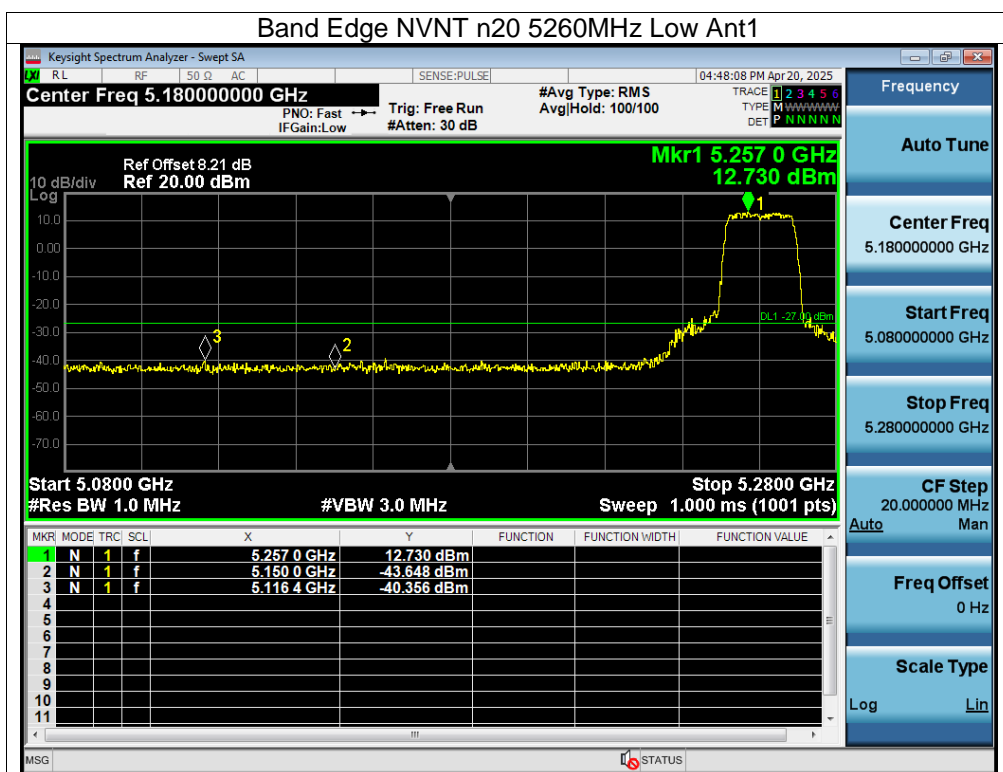


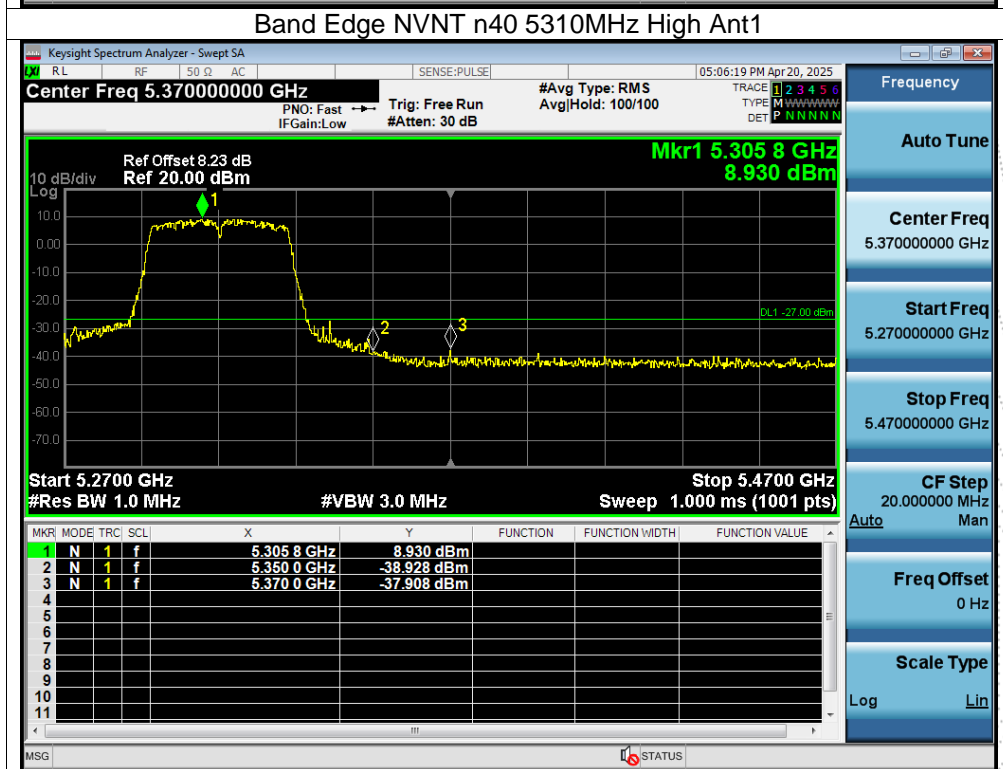
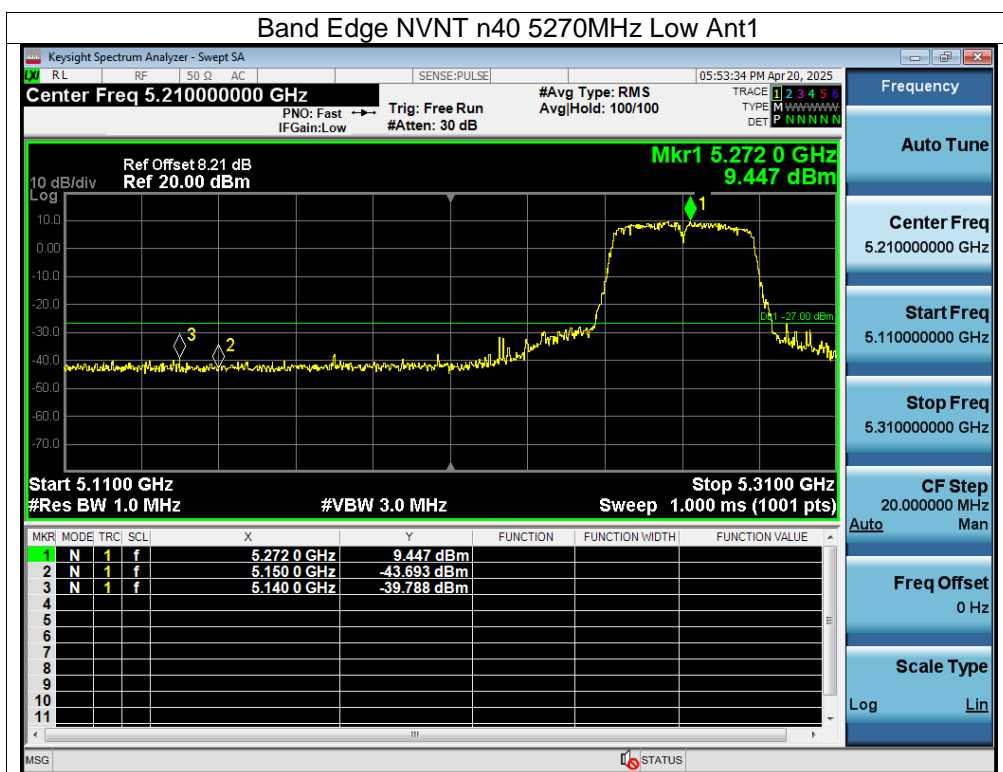


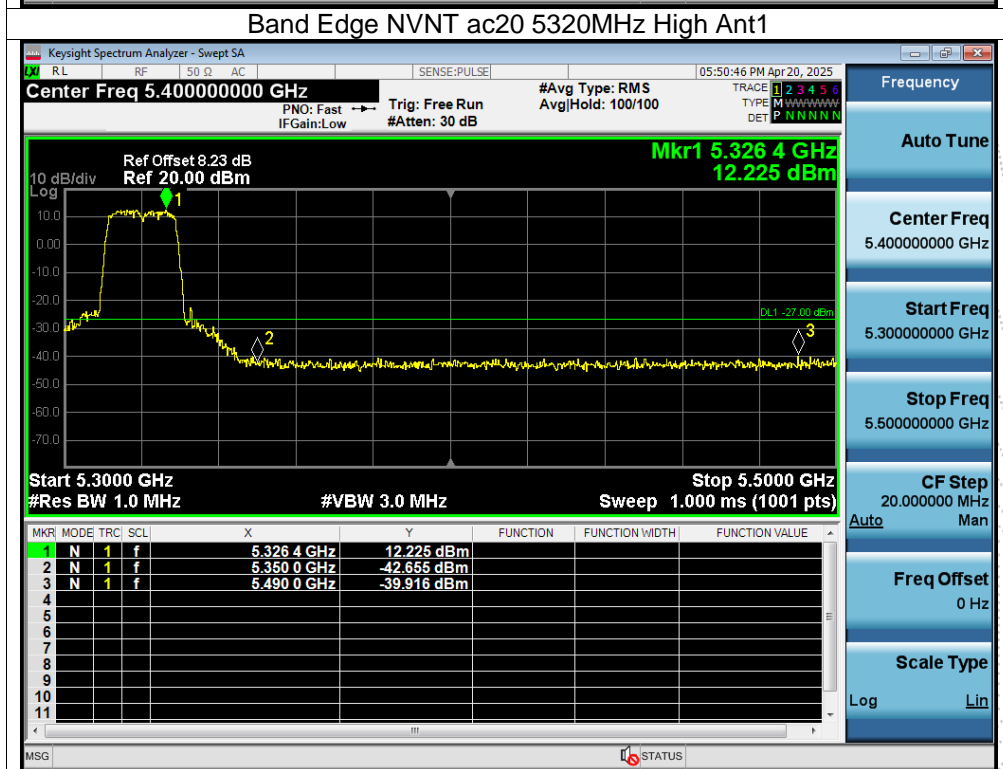
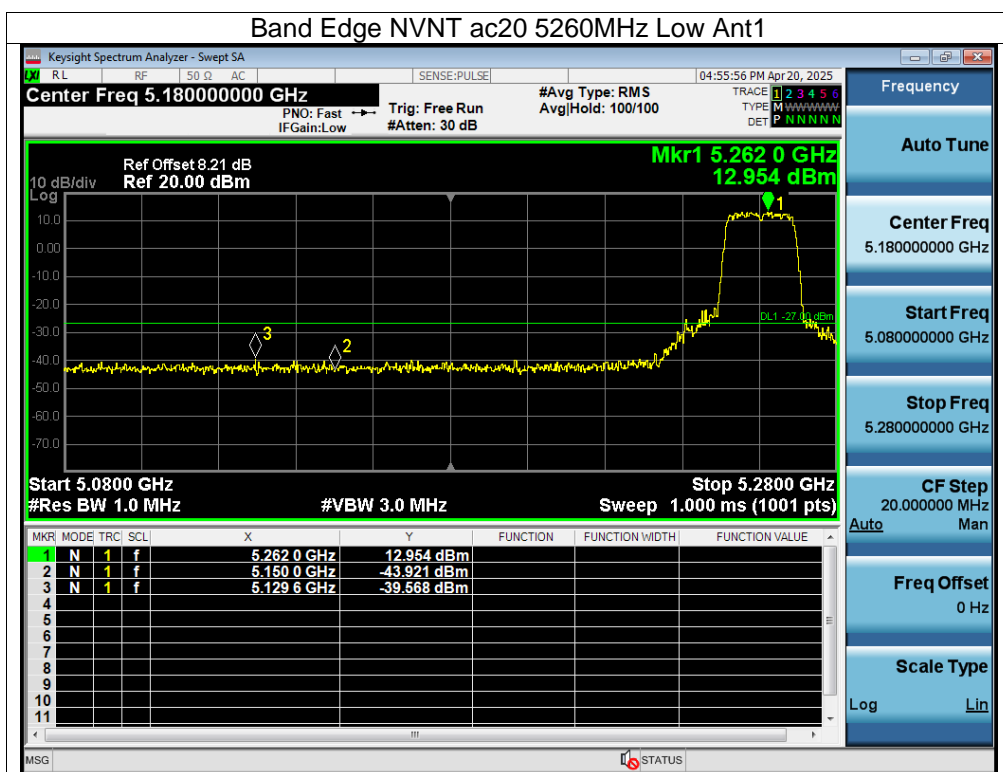


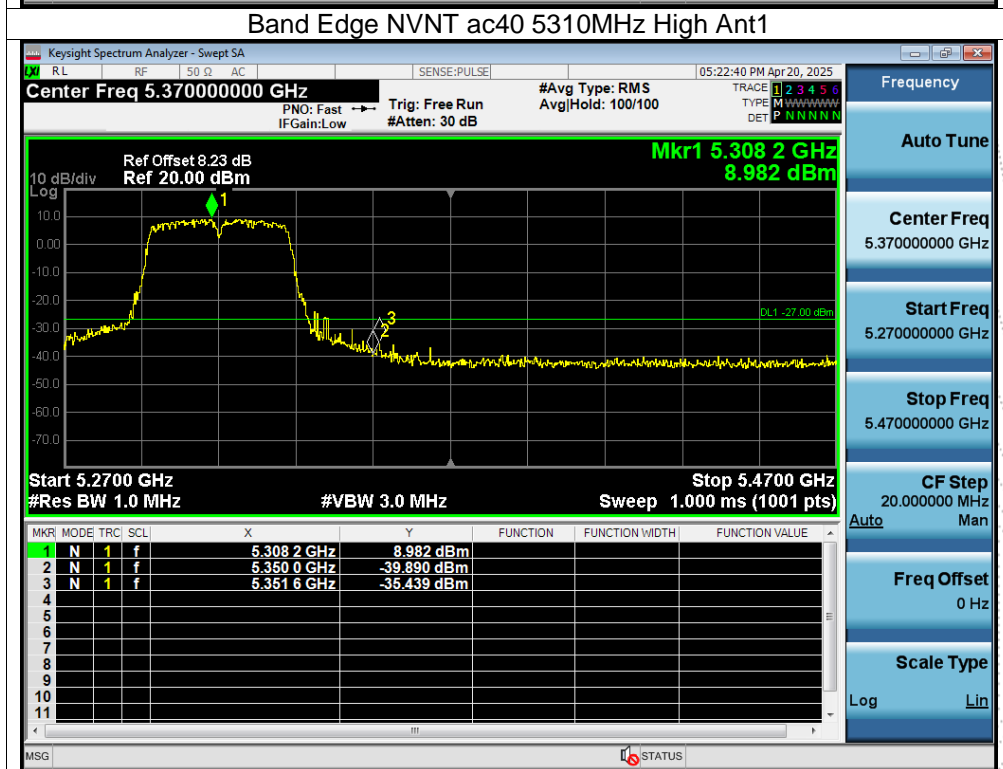
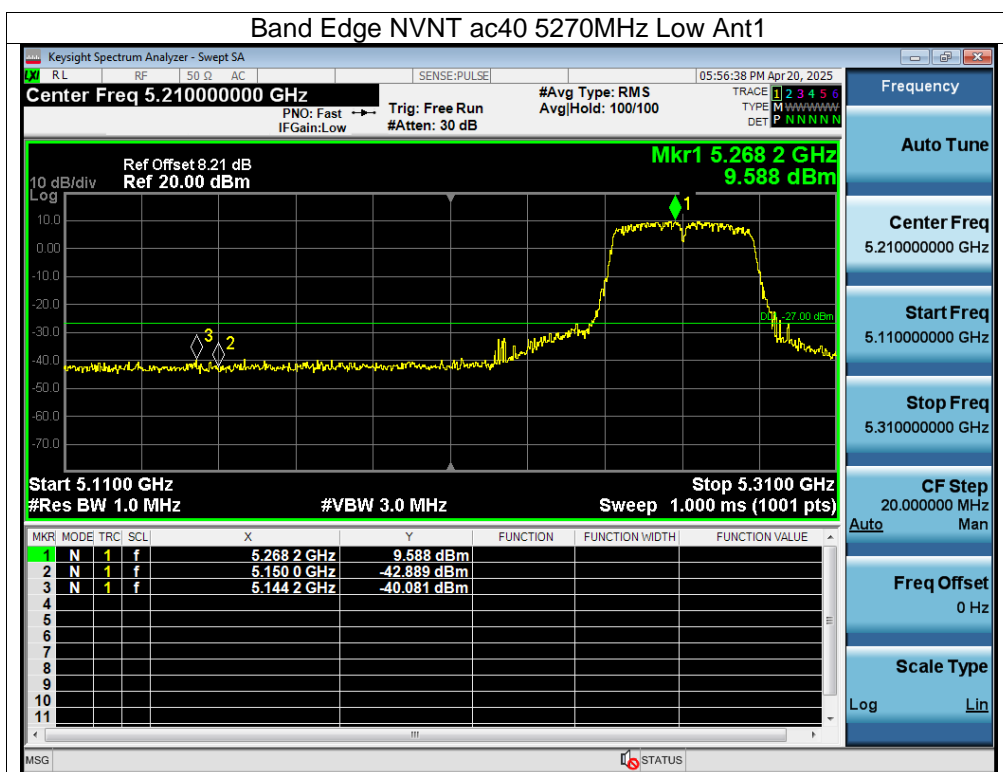
Note: A(B) Represent the value of antenna A and B, The worst data is Antenna A, only shown Antenna A.
Antenna A: 5260-5230MHz

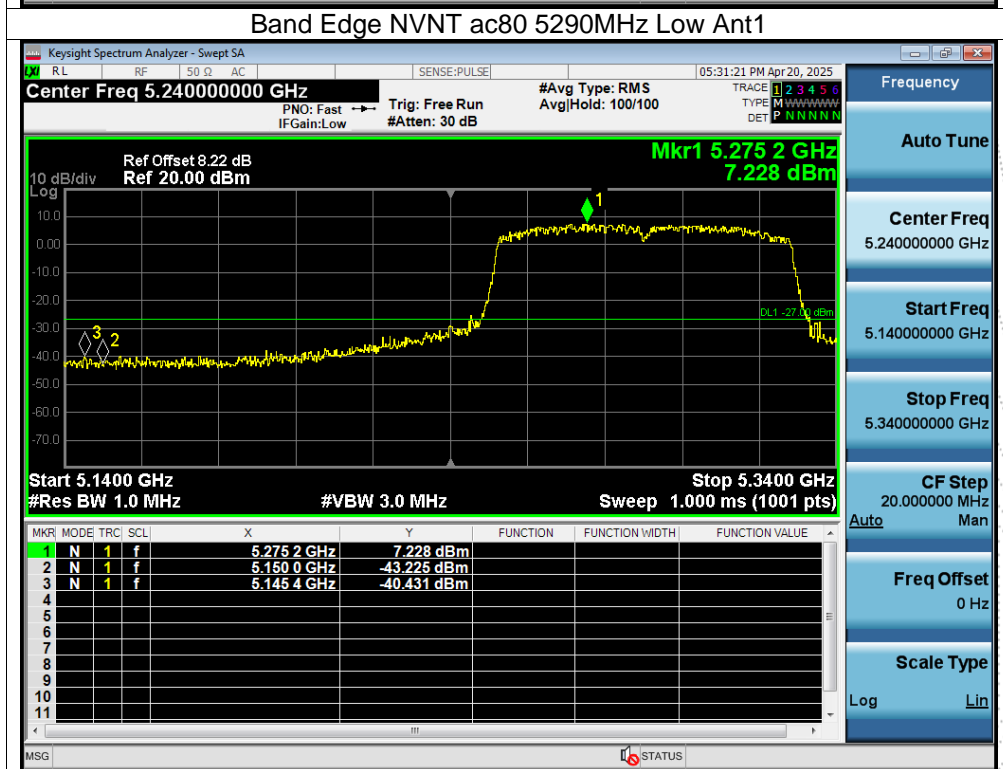
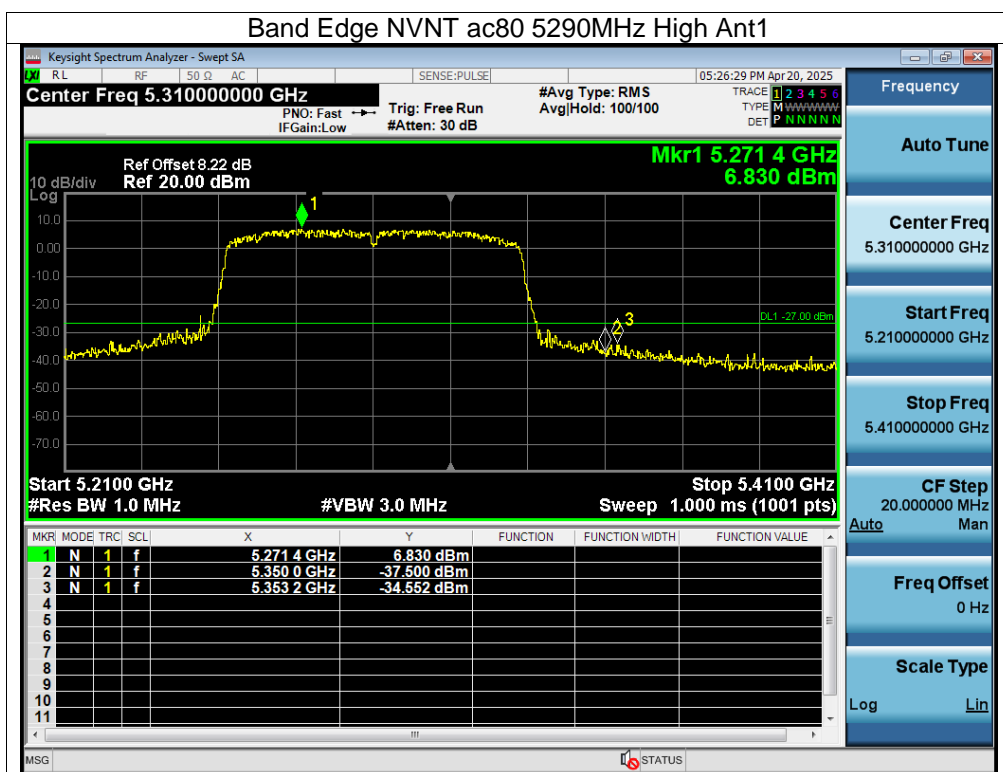




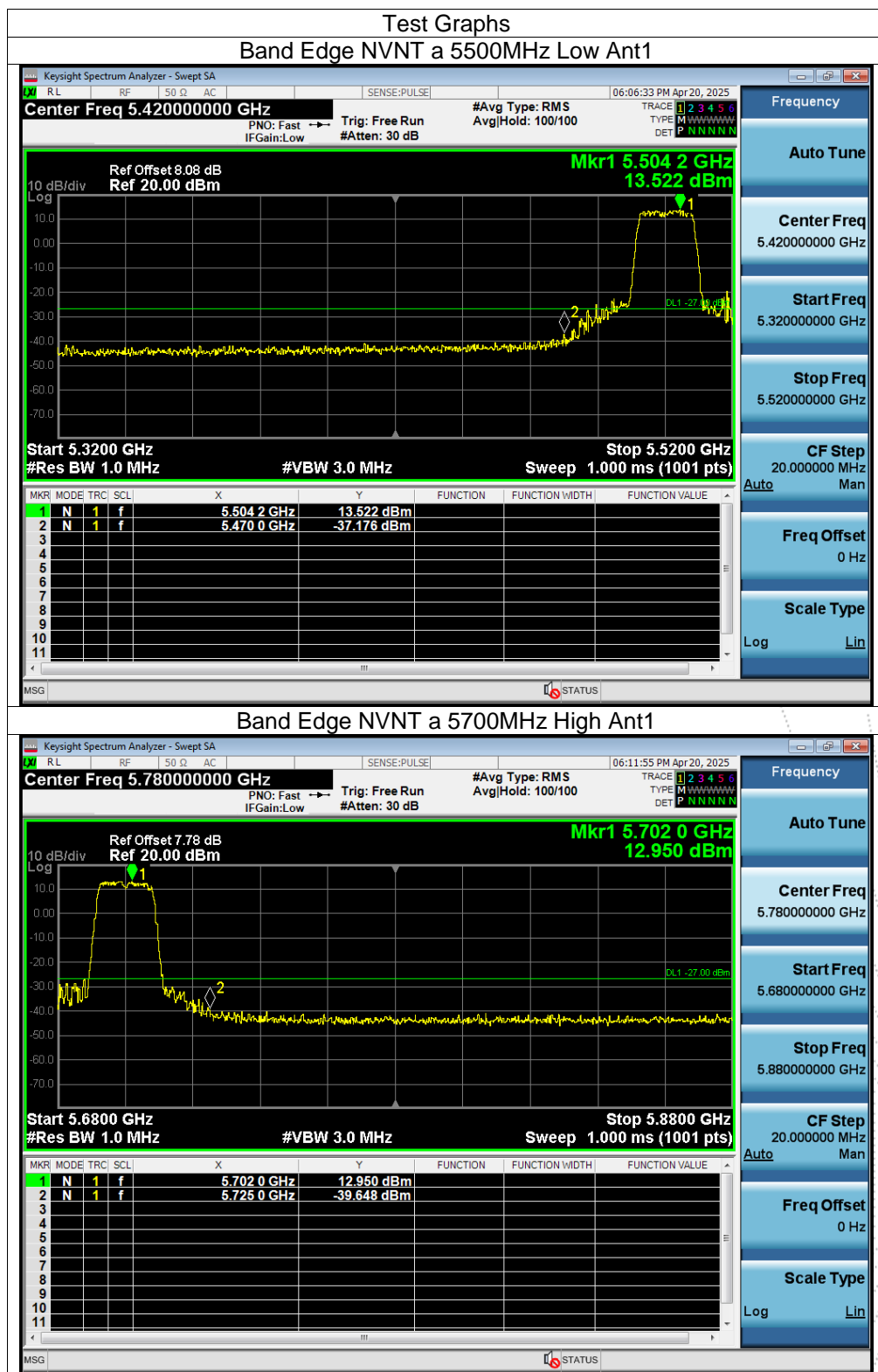


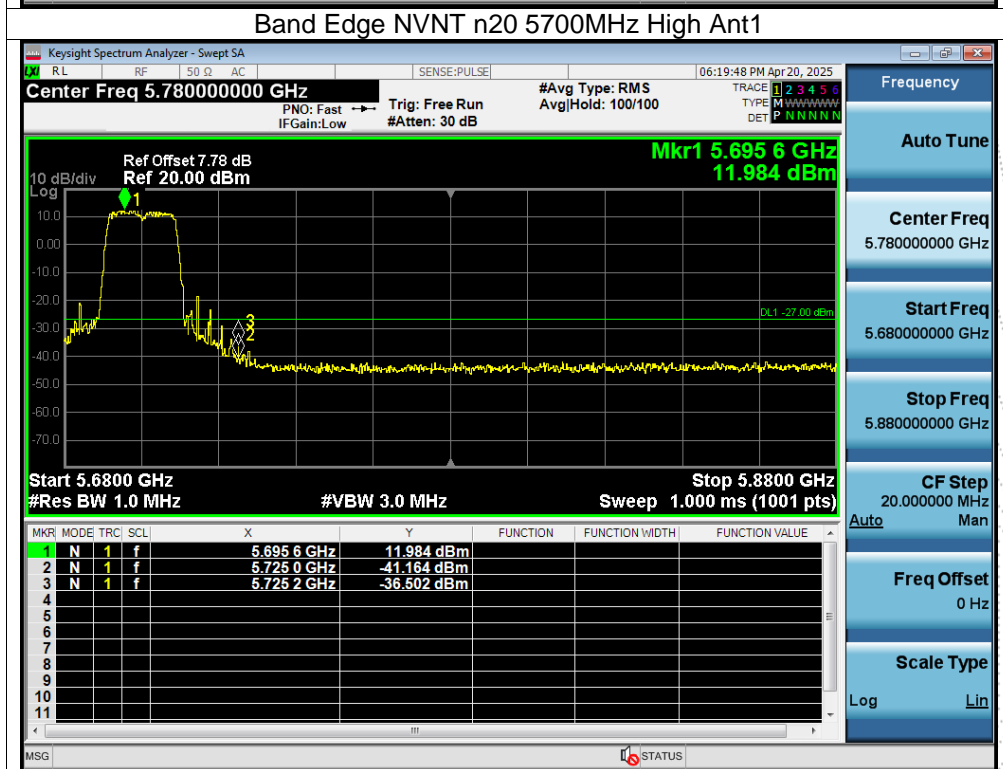
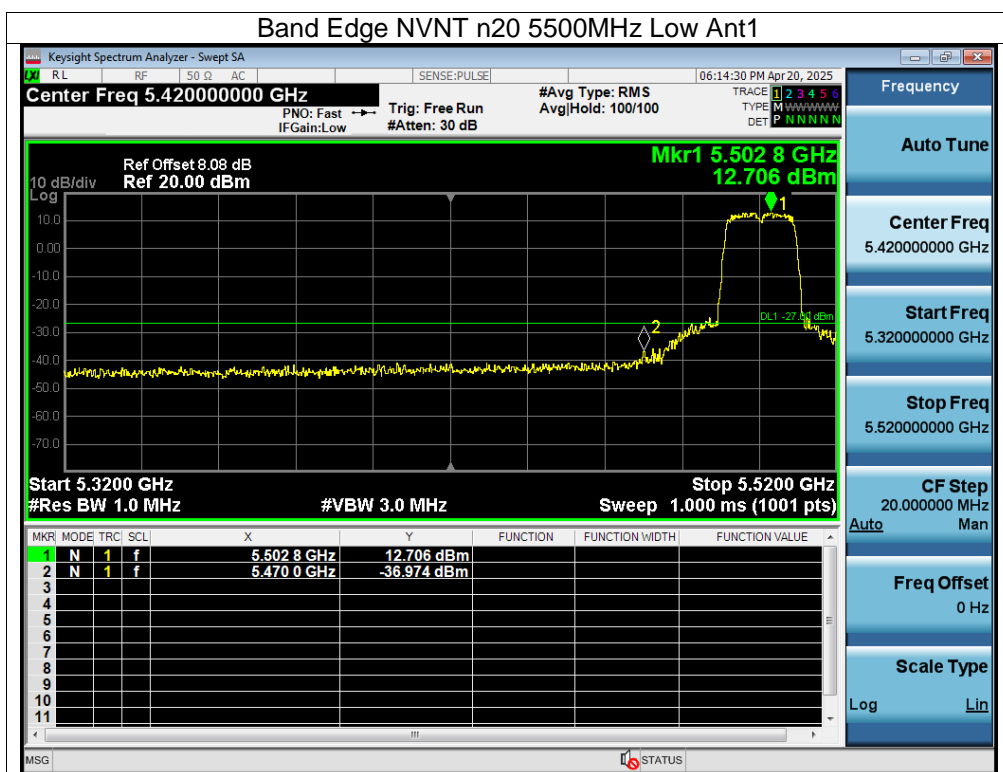


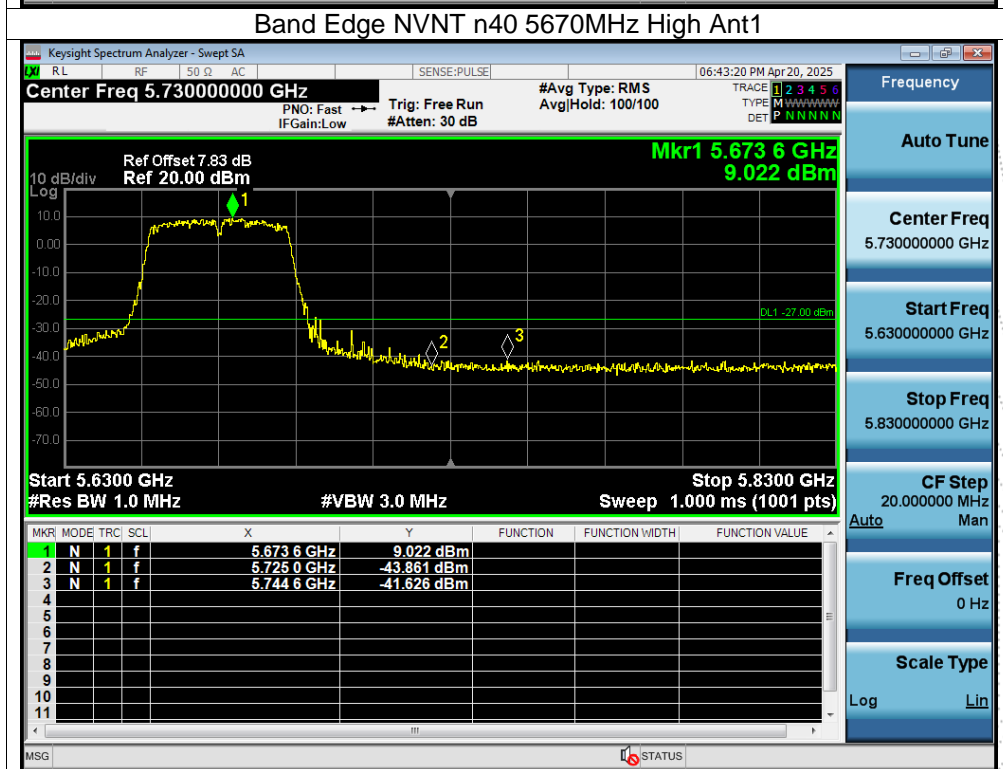
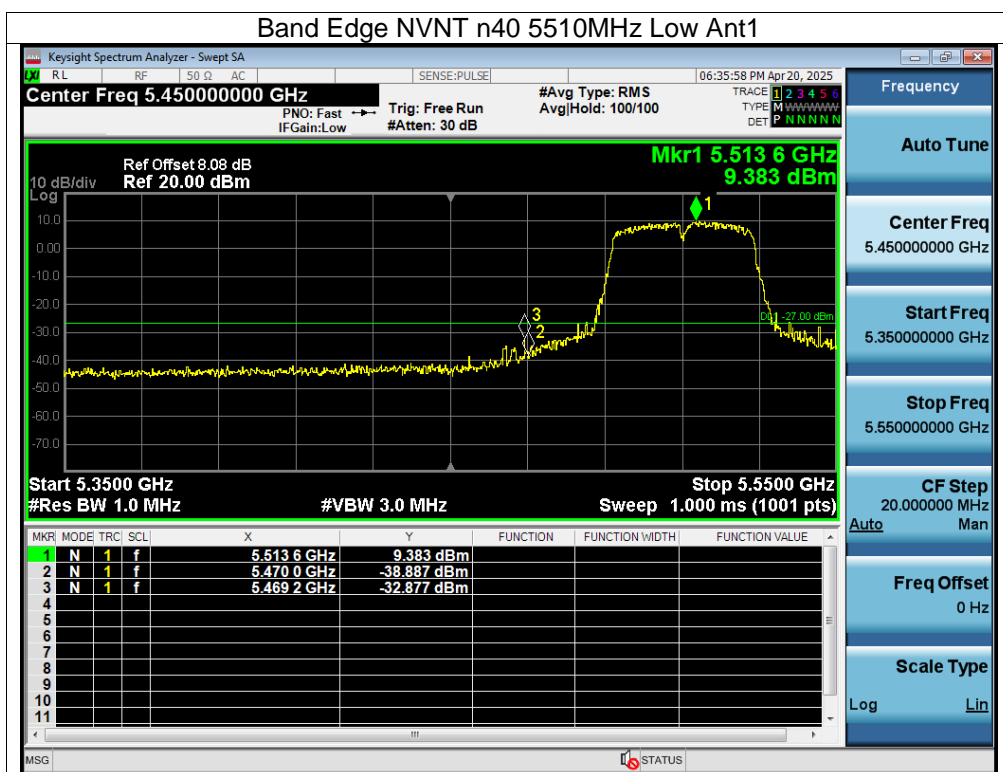


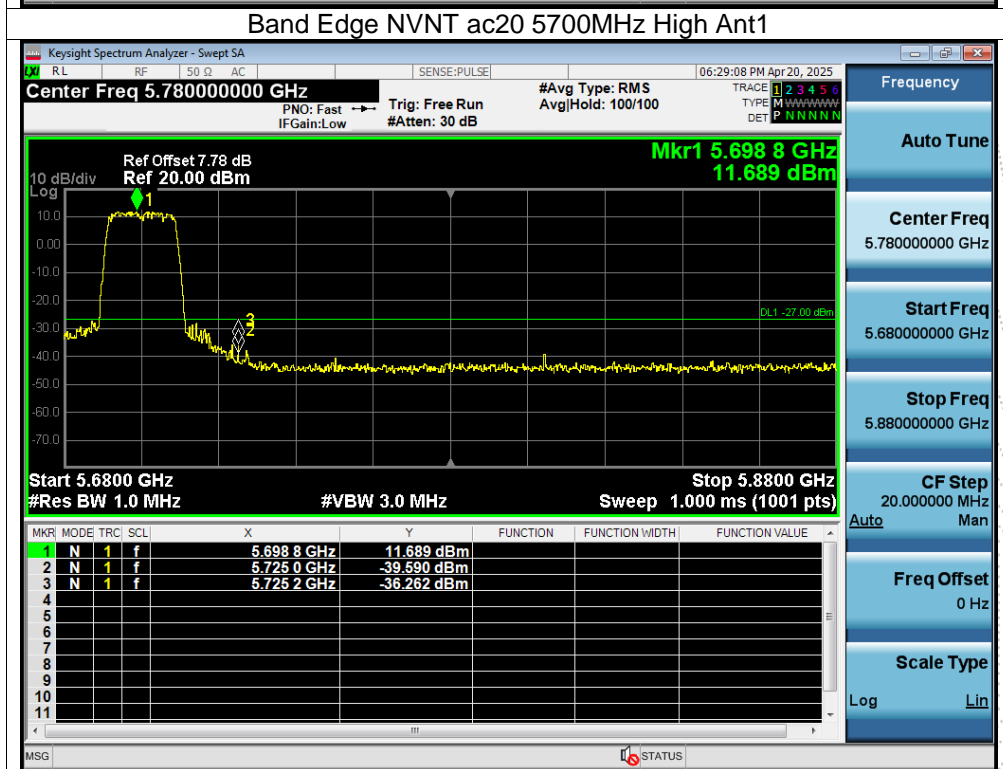
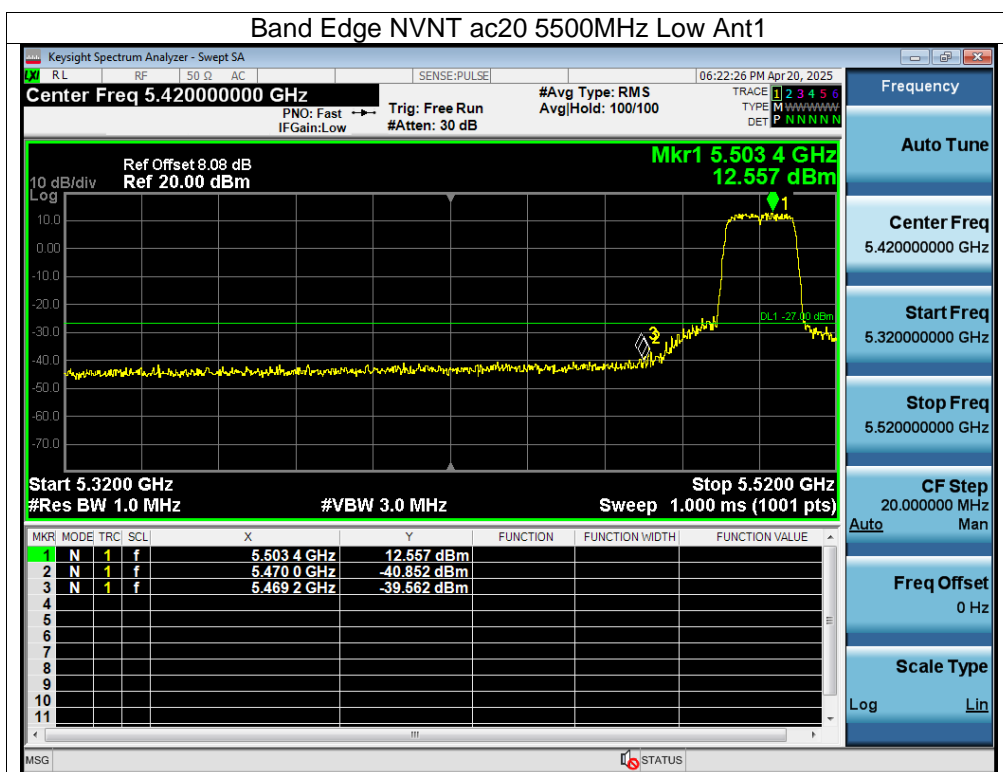


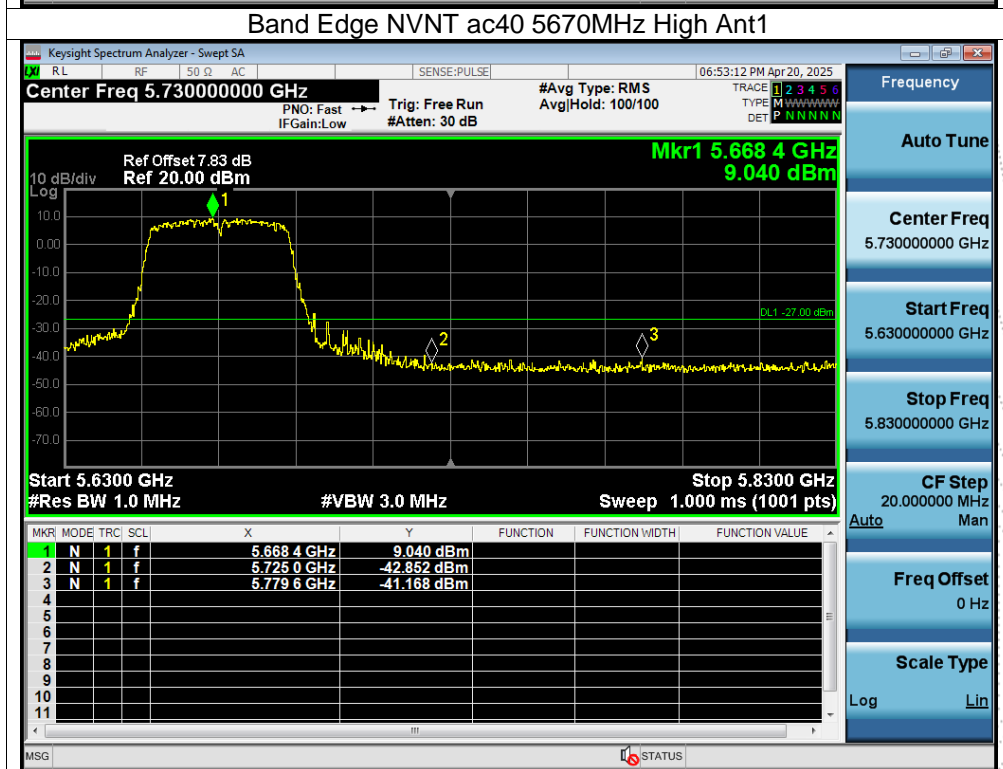
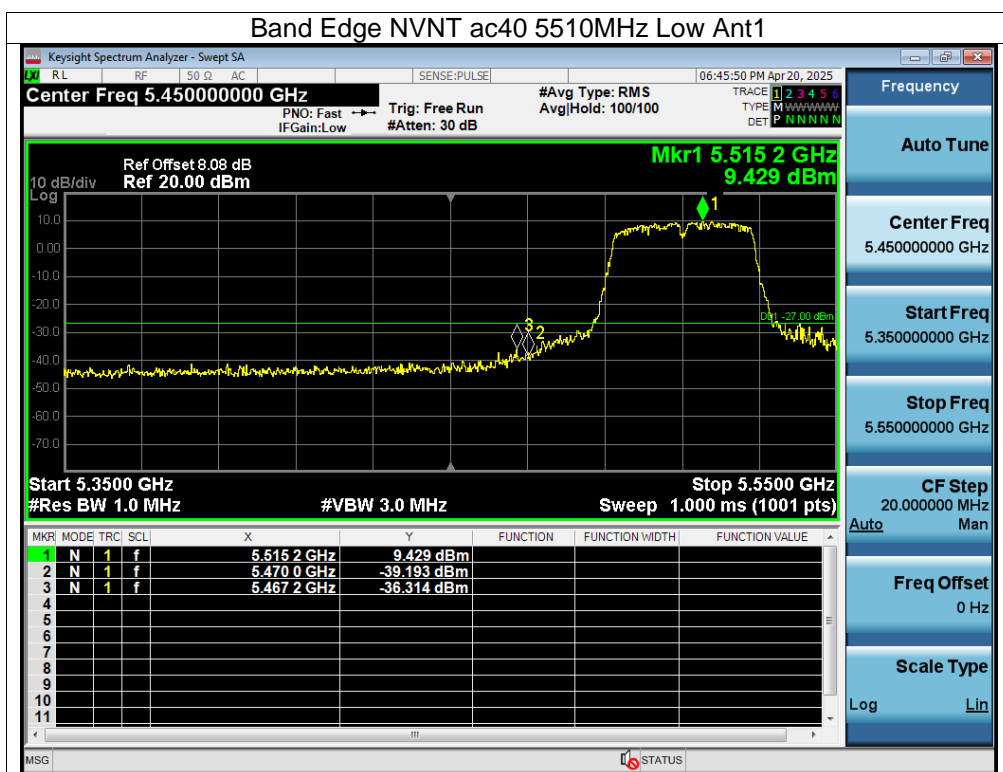
Note: A(B) Represent the value of antenna A and B, The worst data is Antenna A, only shown Antenna A.
Antenna A: 5500-5700MHz

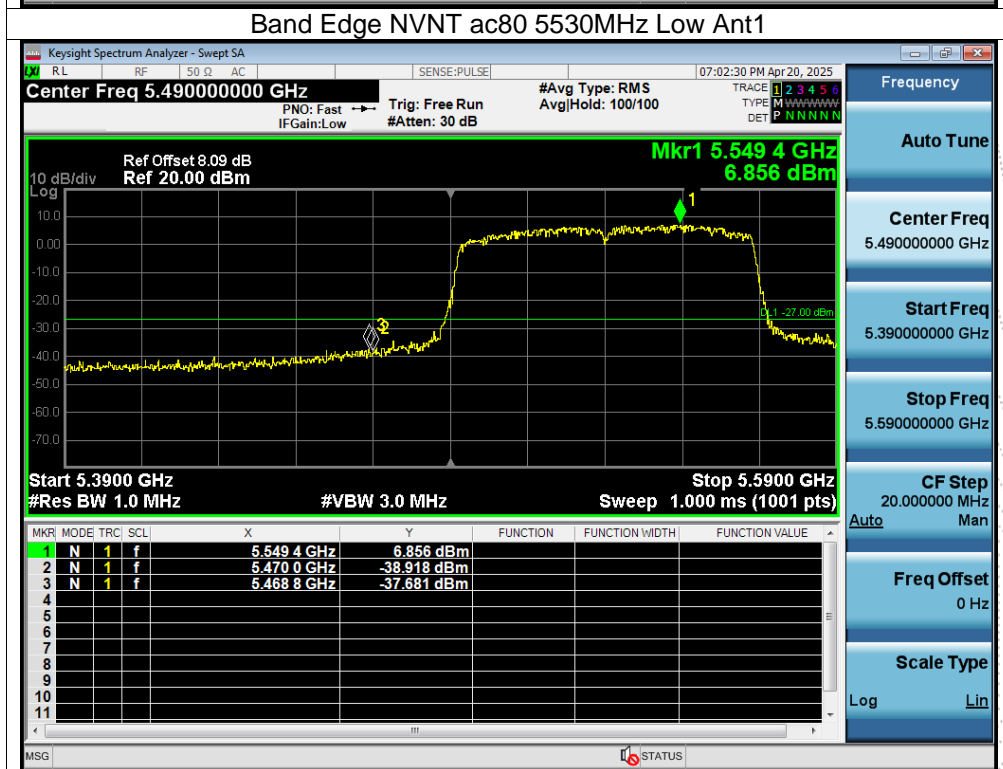
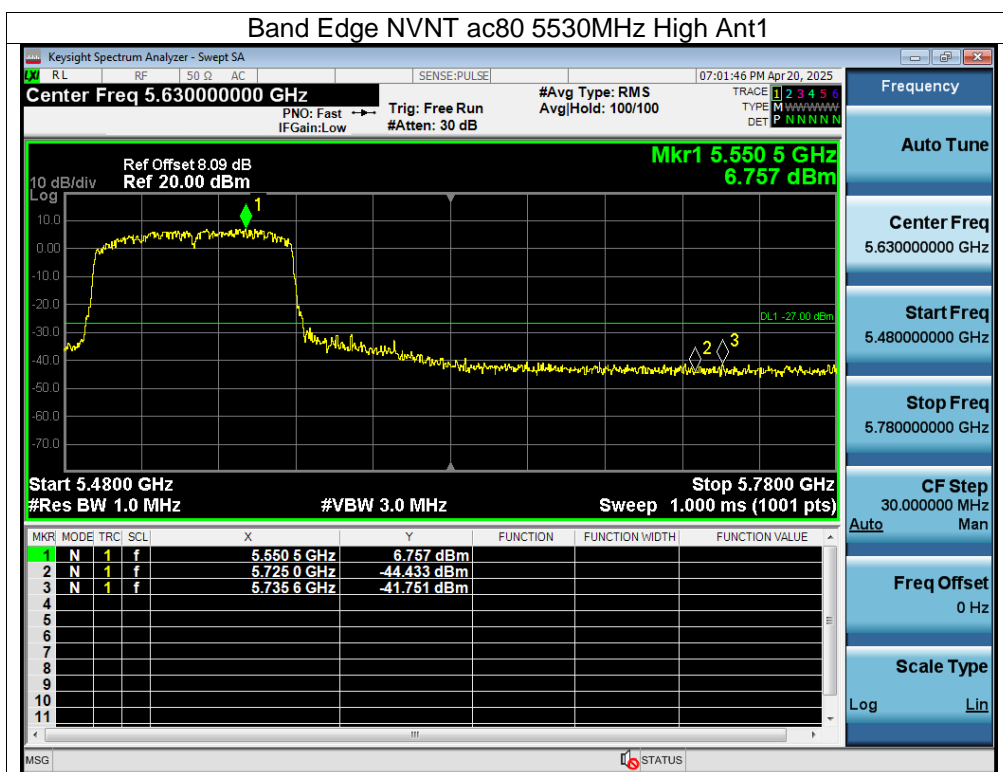






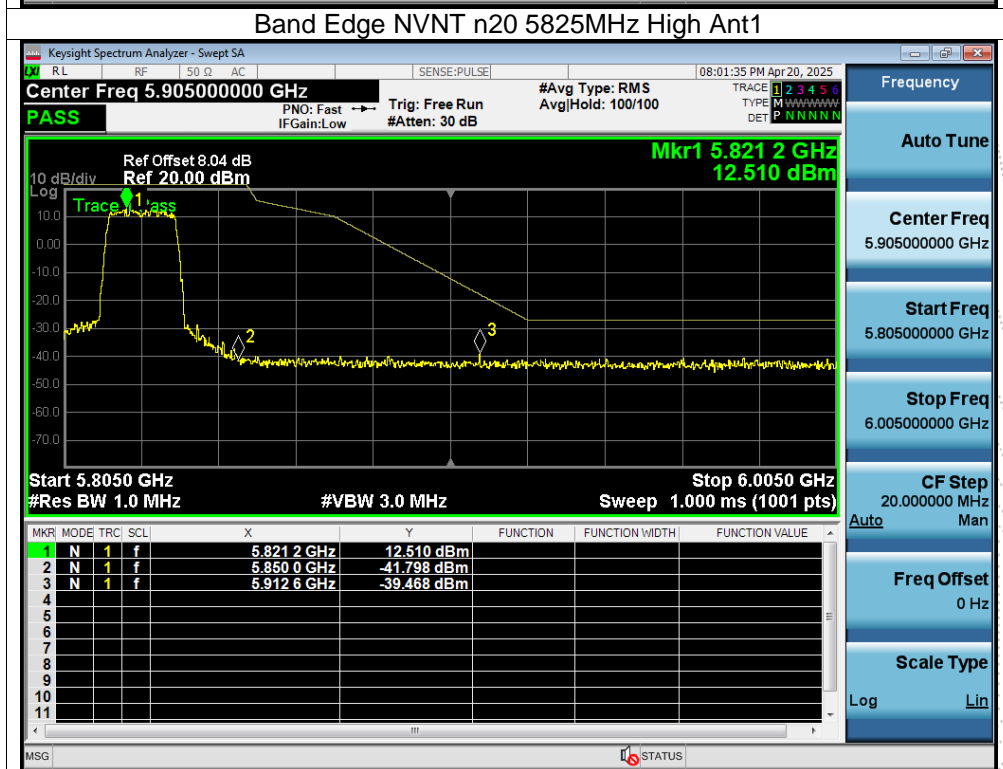
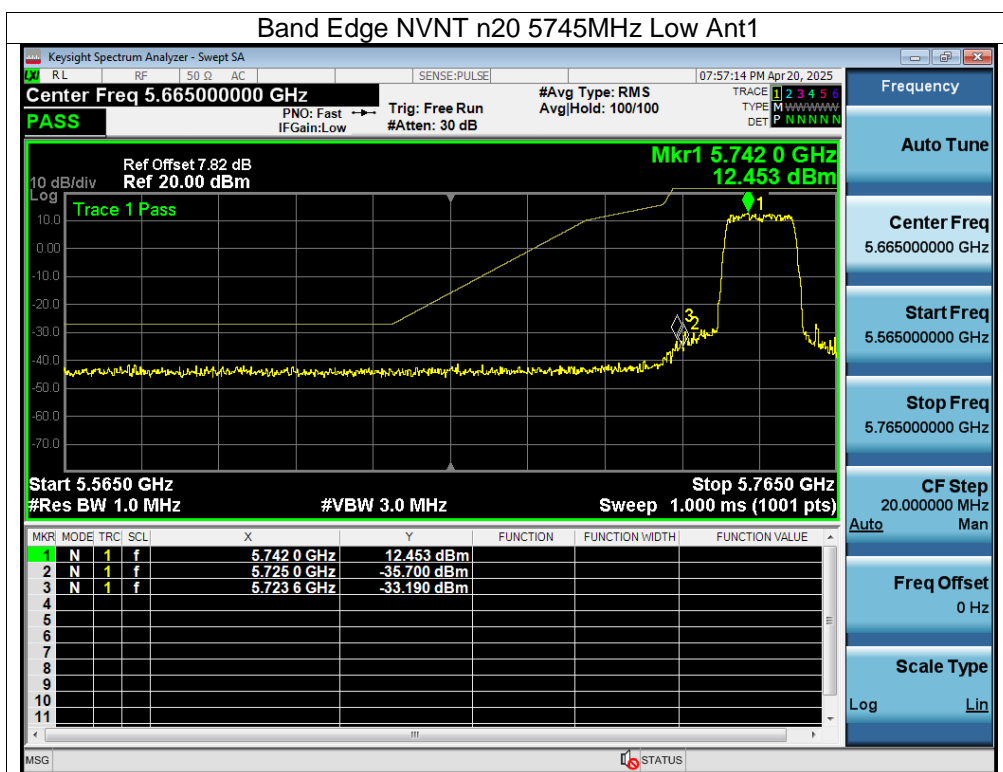


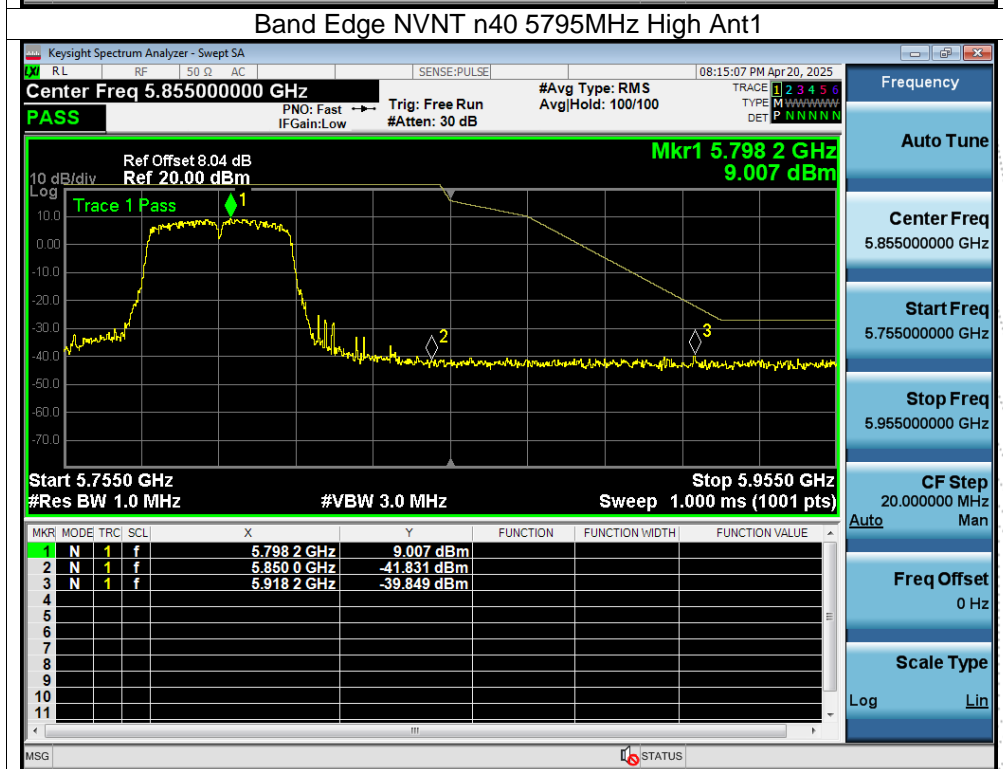
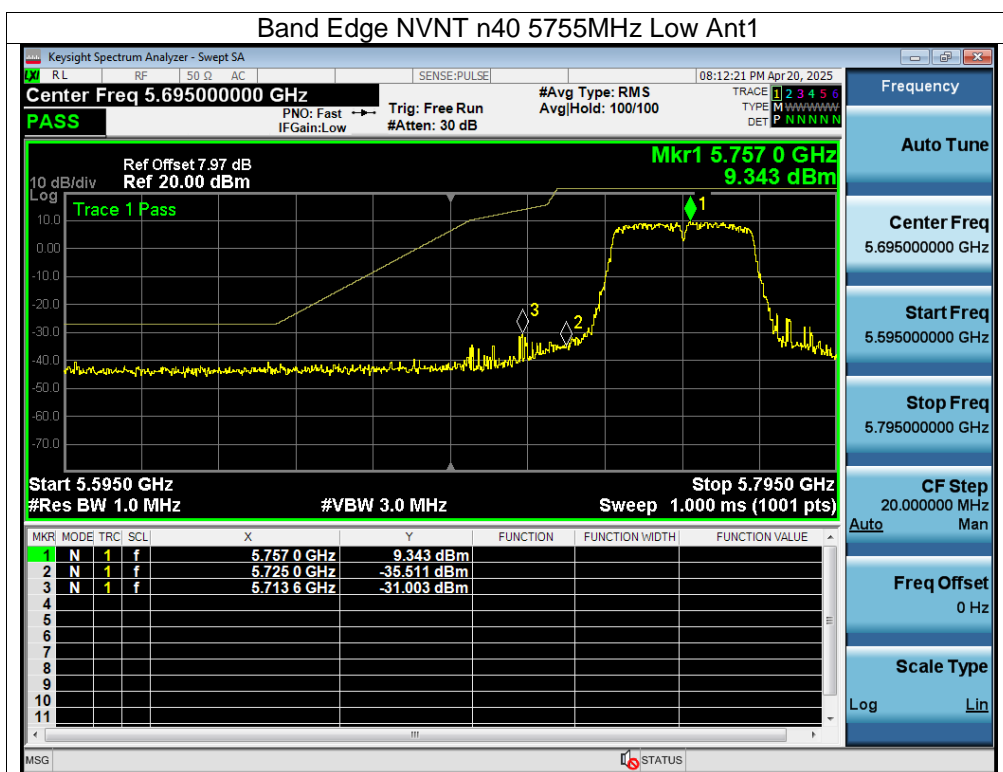


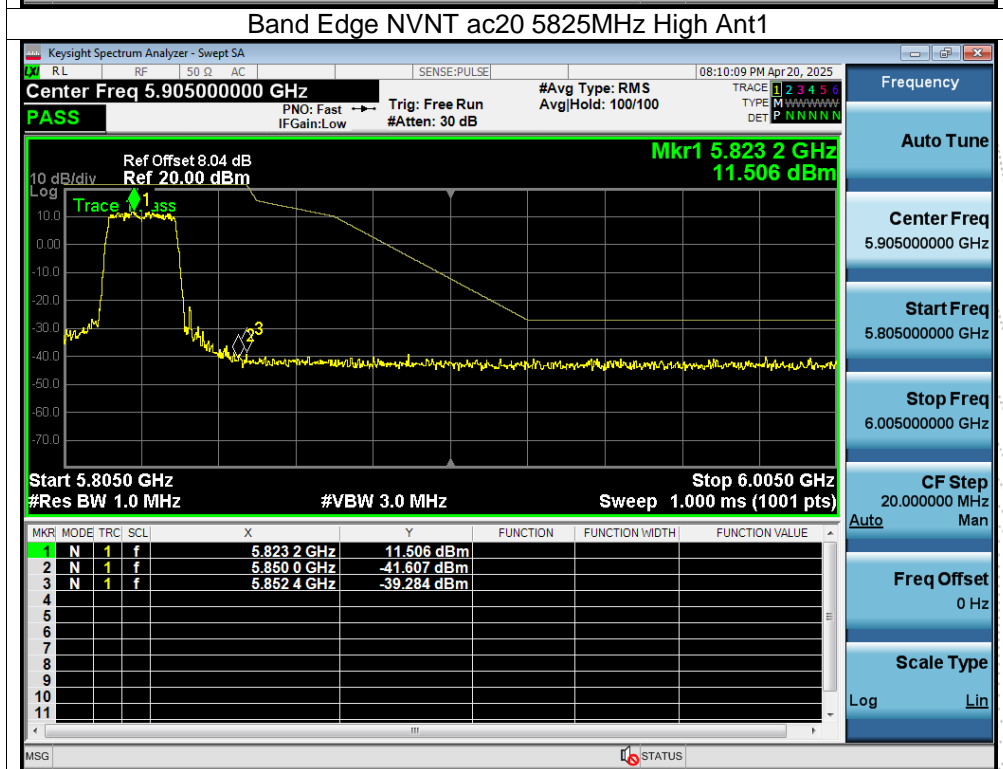
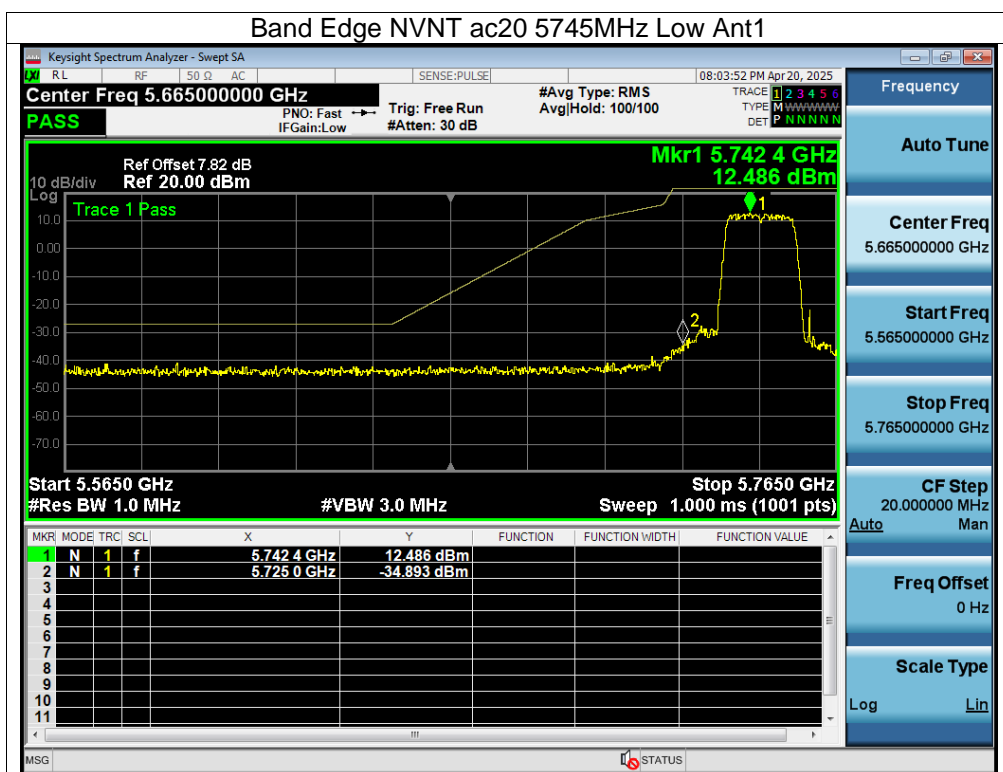


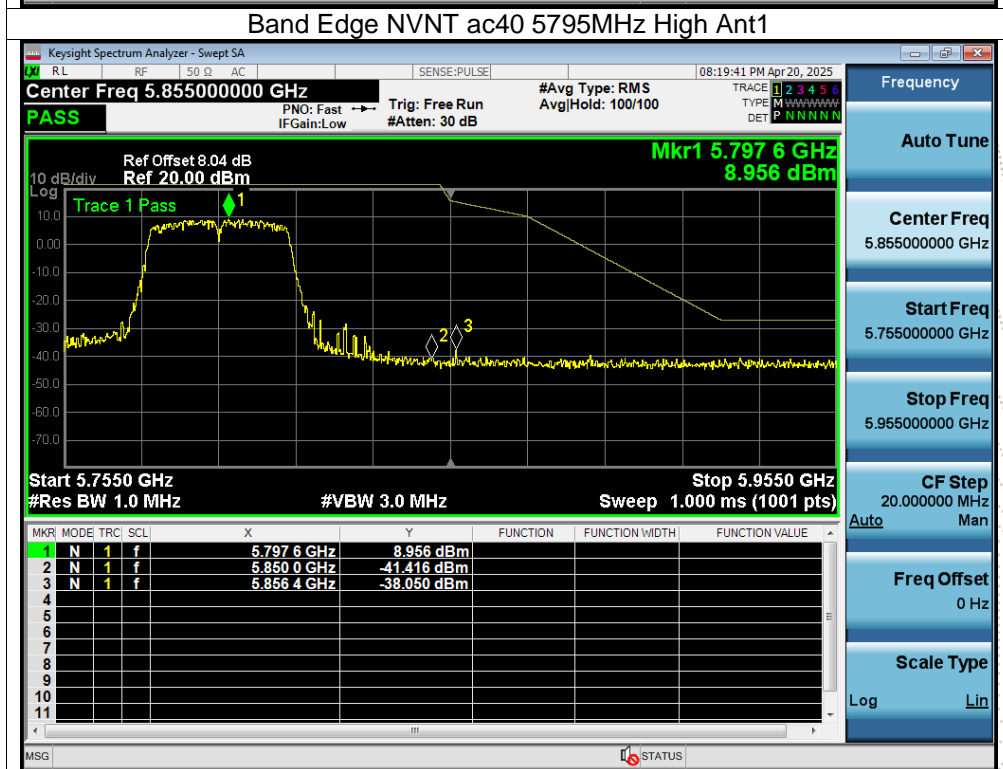
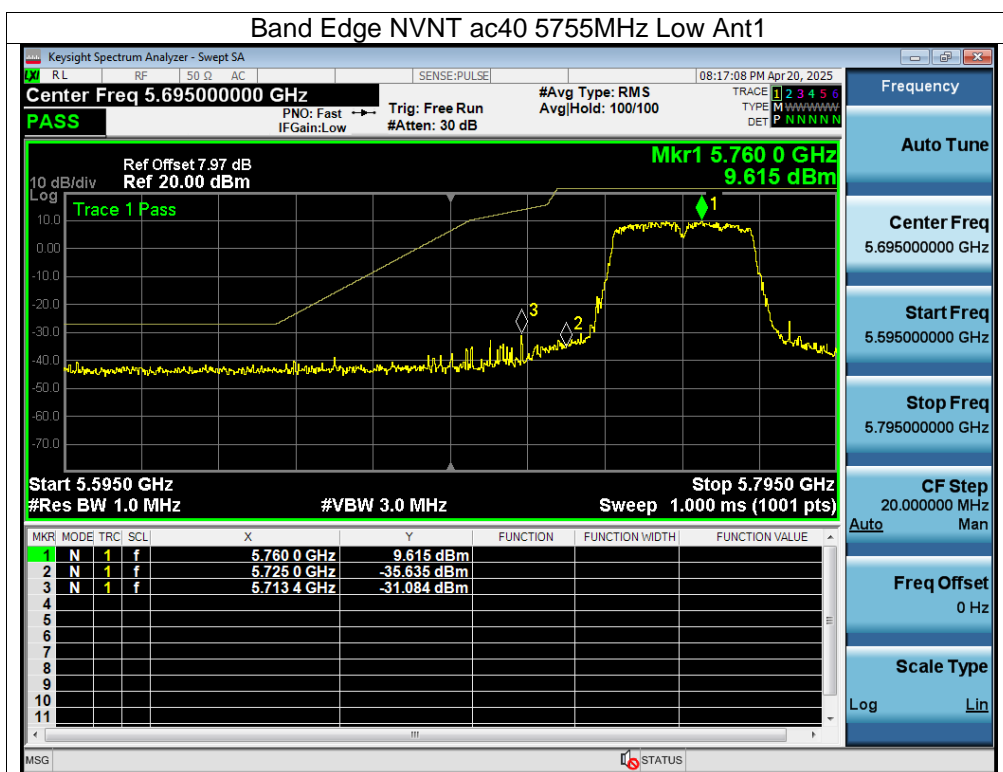
Note: A(B) Represent the value of antenna A and B, The worst data is Antenna A, only shown Antenna A.
Antenna A: 5745-5825MHz

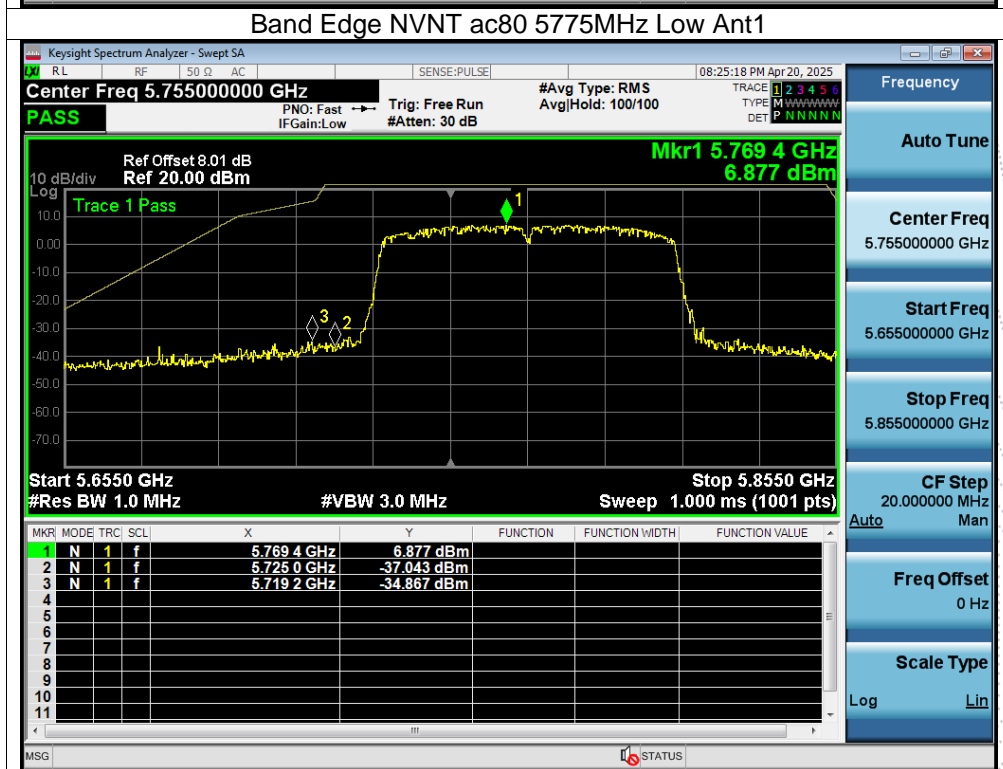
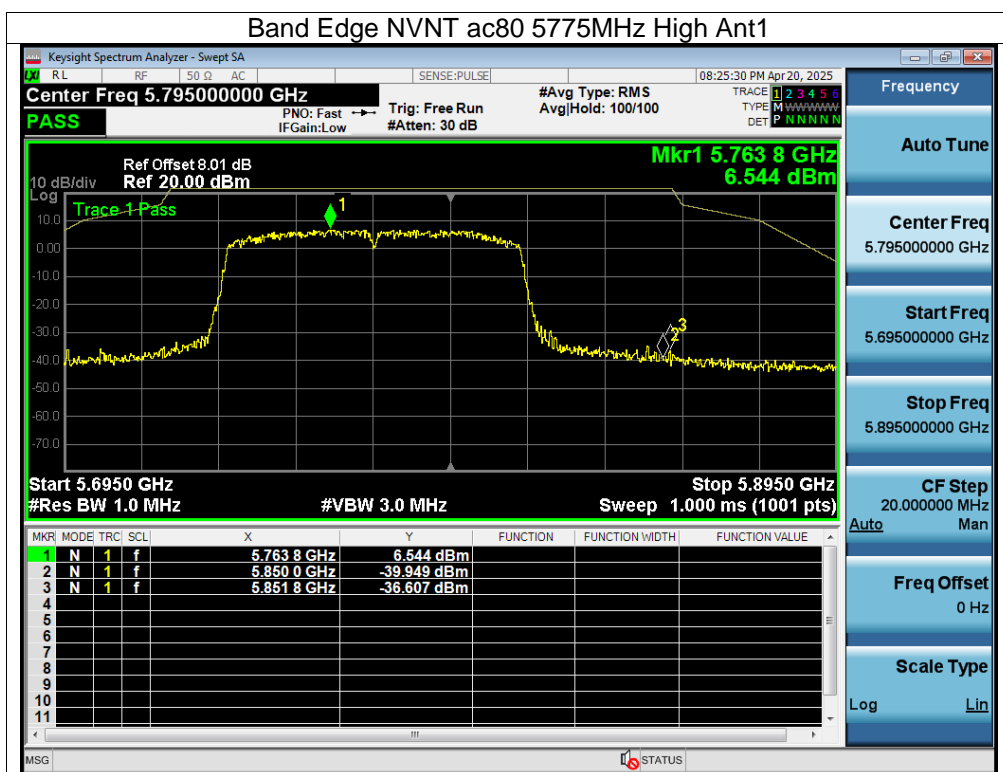












12. Spurious RF Conducted Emissions

12.1 Block Diagram Of Test Setup



12.2 Limit

Undesirable emission limits. Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.

(2) For transmitters operating in the 5.725-5.85 GHz band(i) All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge..

12.3 Test Procedure

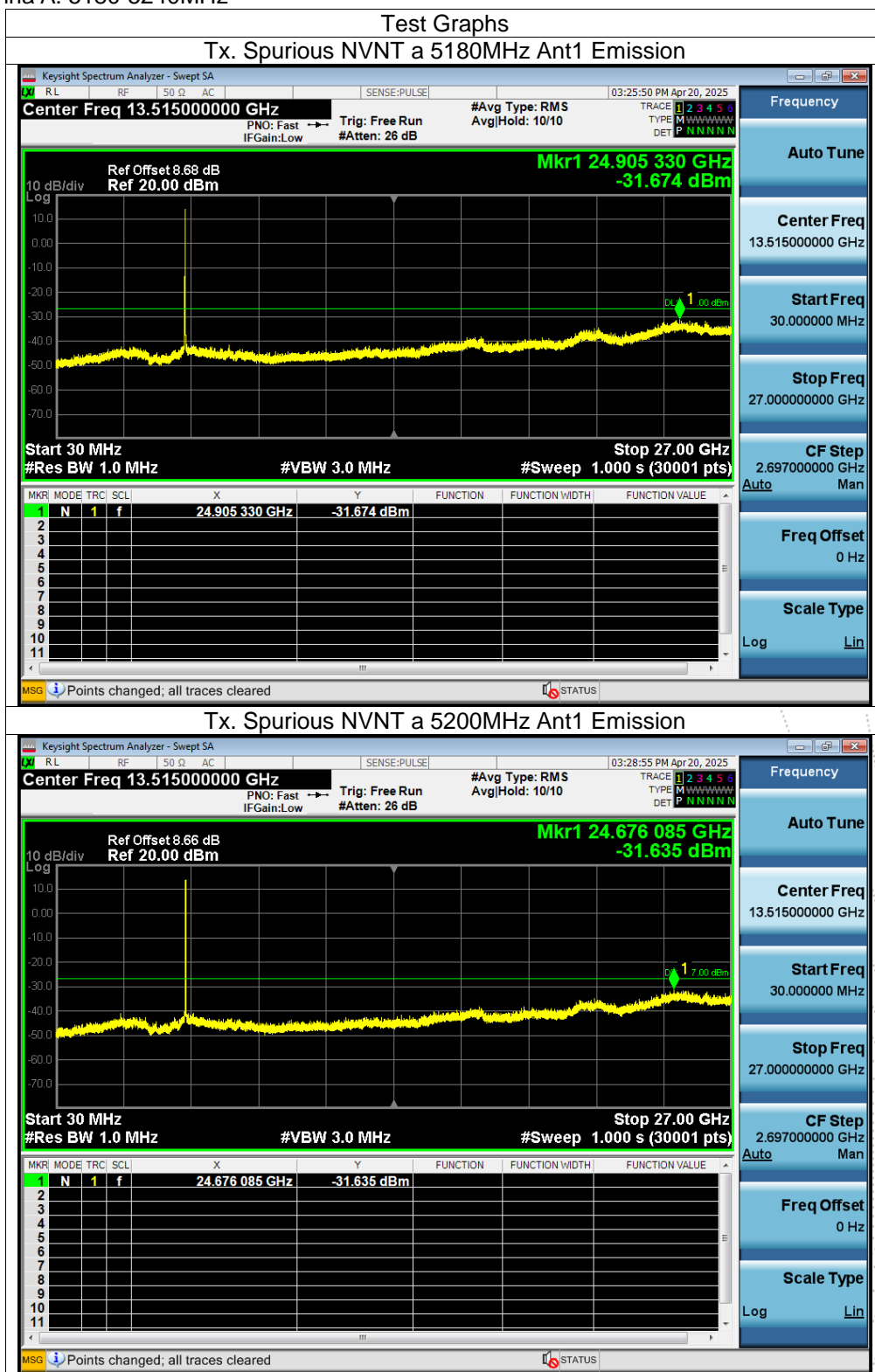
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 1 MHz with a convenient frequency span.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

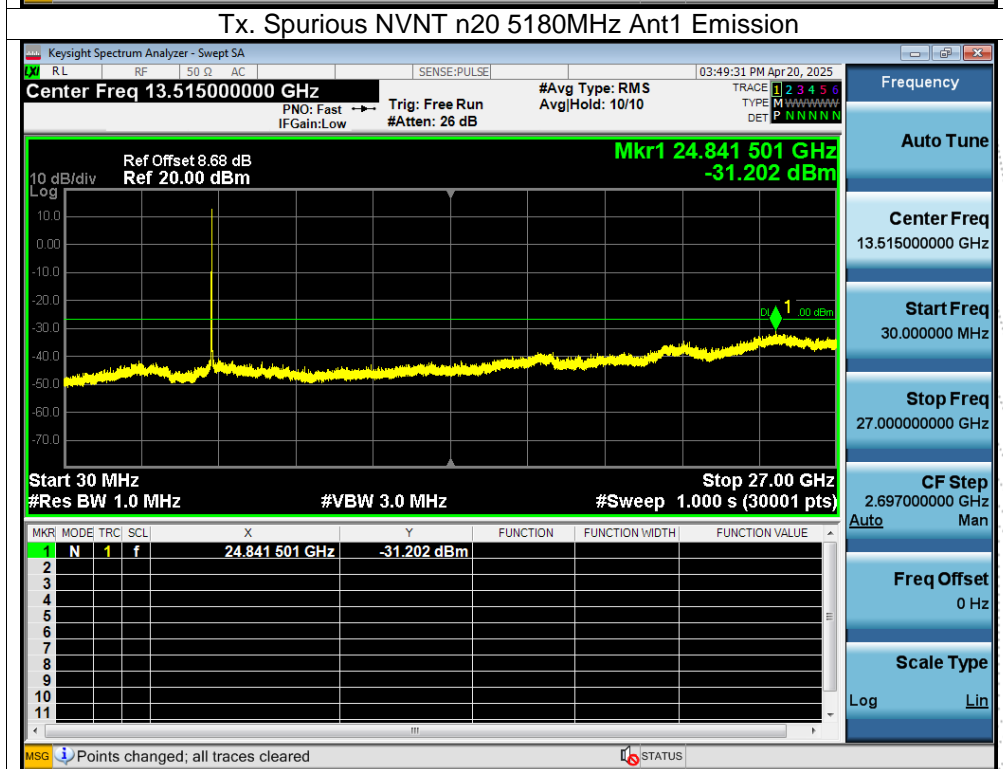
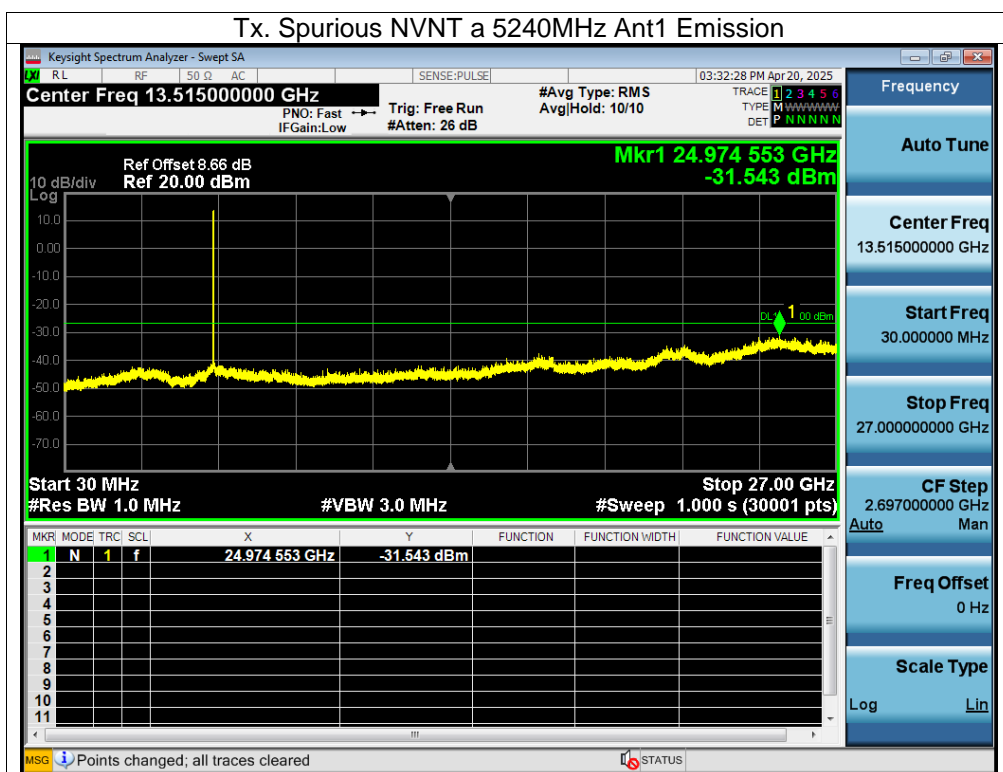
12.4 Test Result

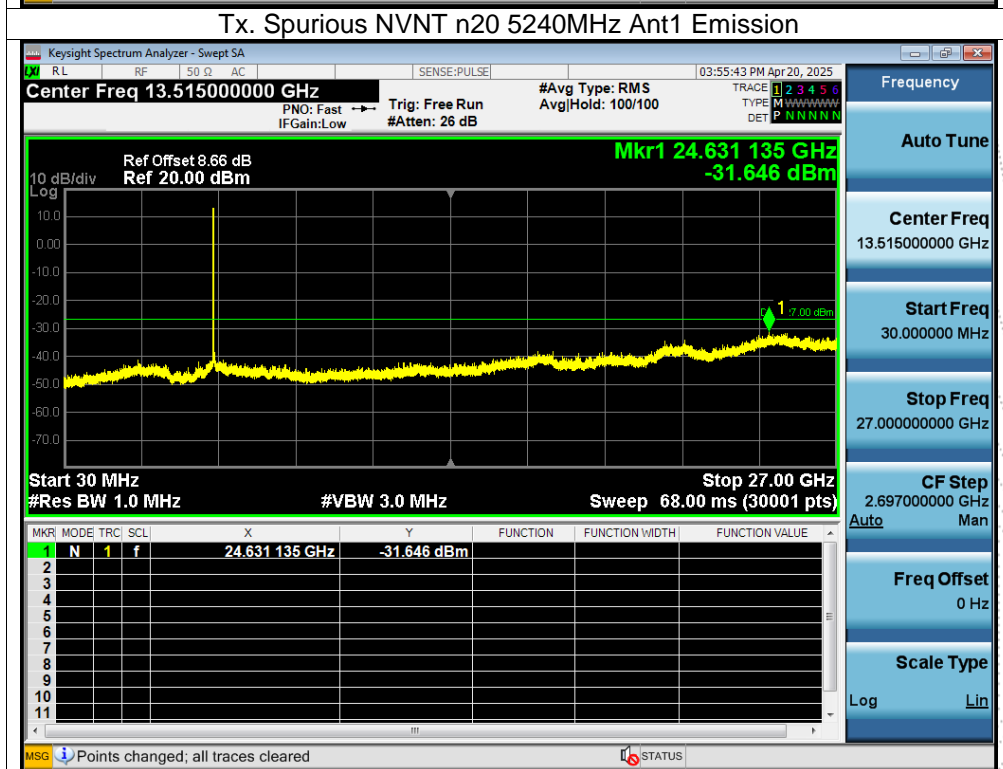
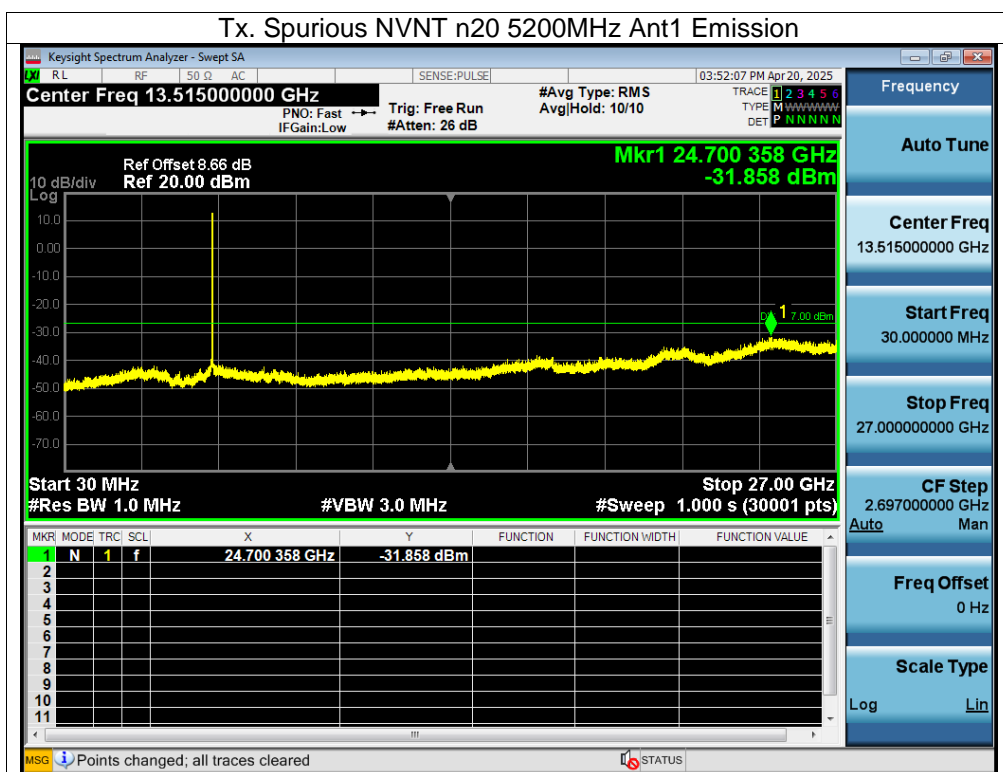
Remark: The measurement frequency range is from 9KHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandedge measurement data.

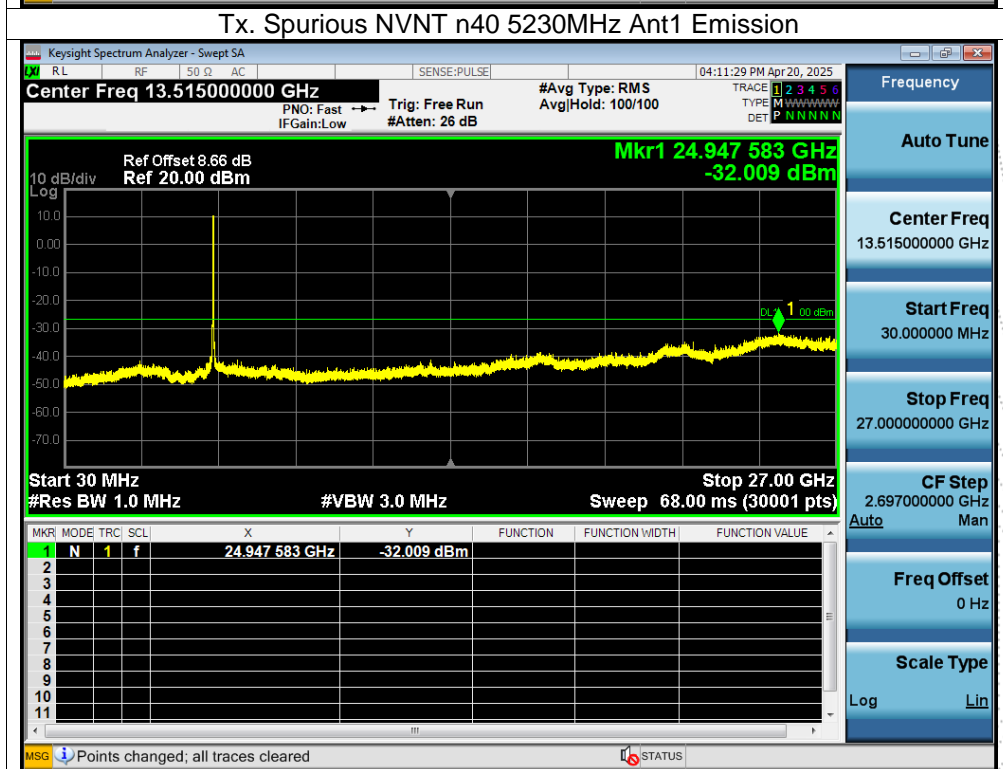
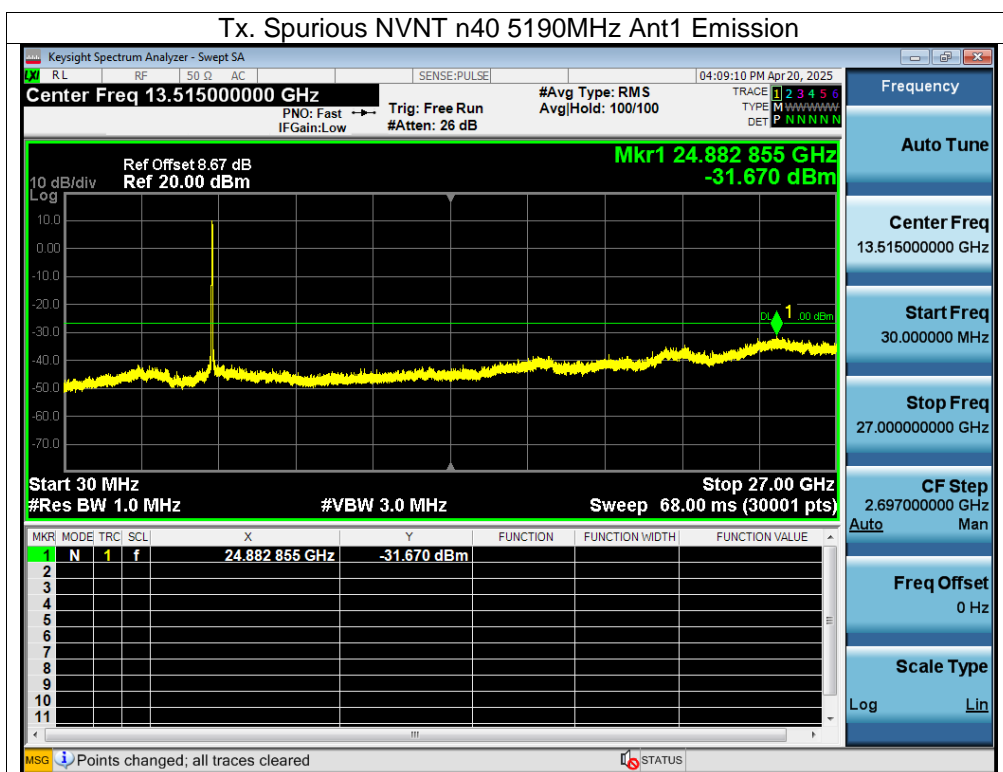
About: 26.5GHz-40GHz, The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

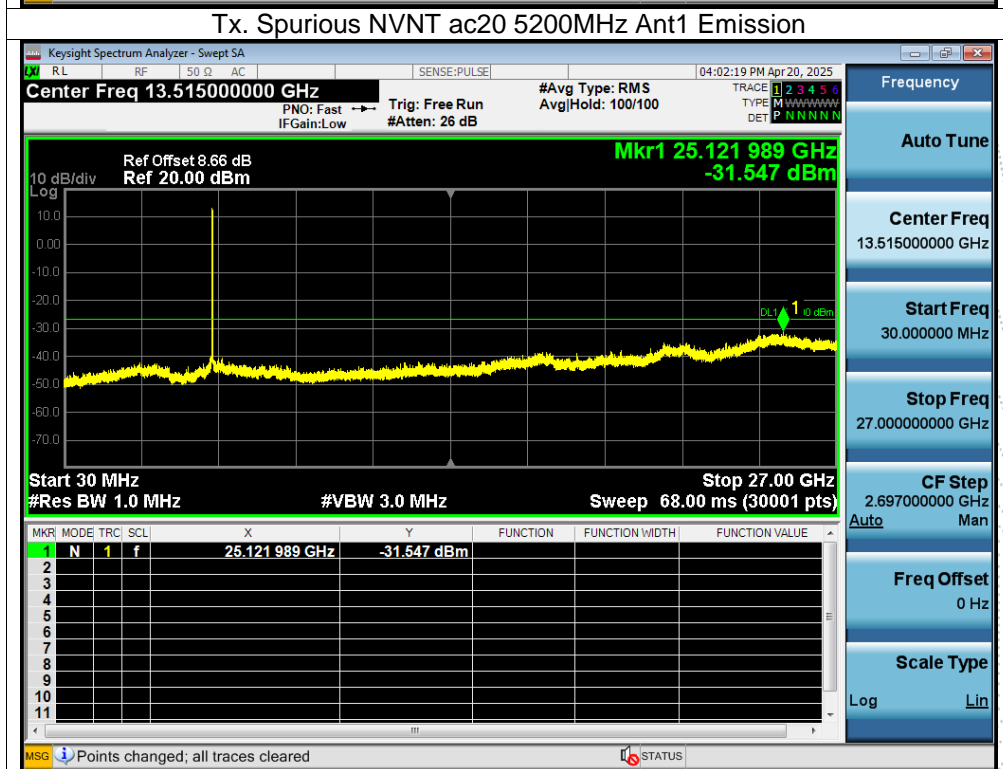
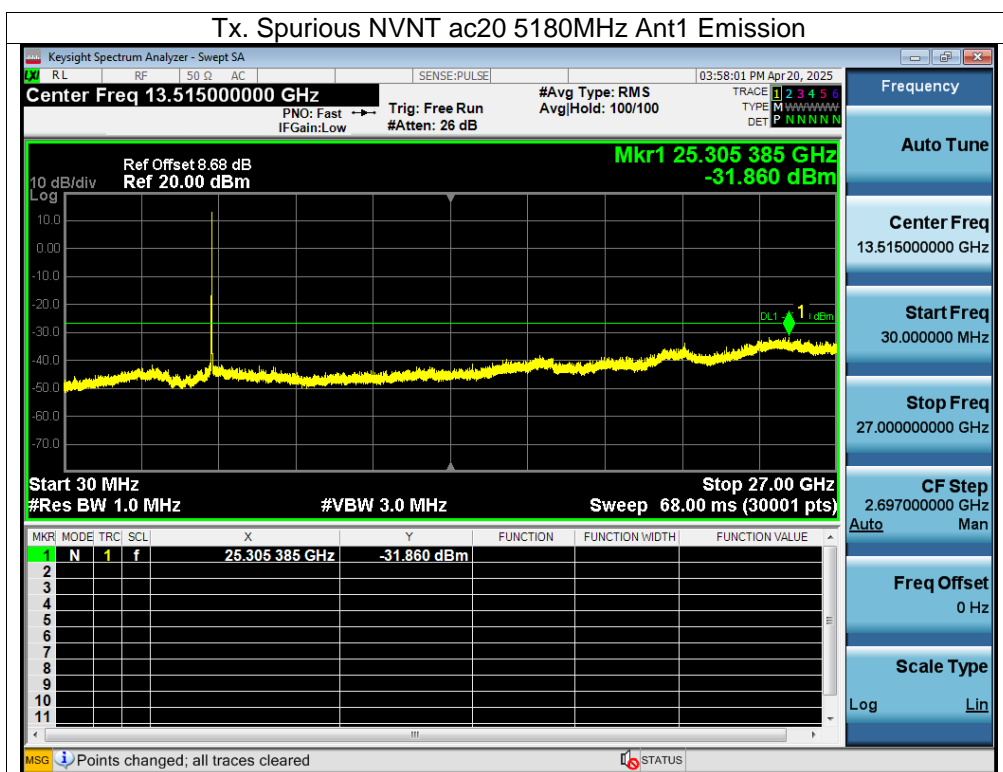
Note: A(B) Represent the value of antenna A and B, The worst data is AntennaA, only shown Antenna A .
Plot. Antenna A: 5180-5240MHz

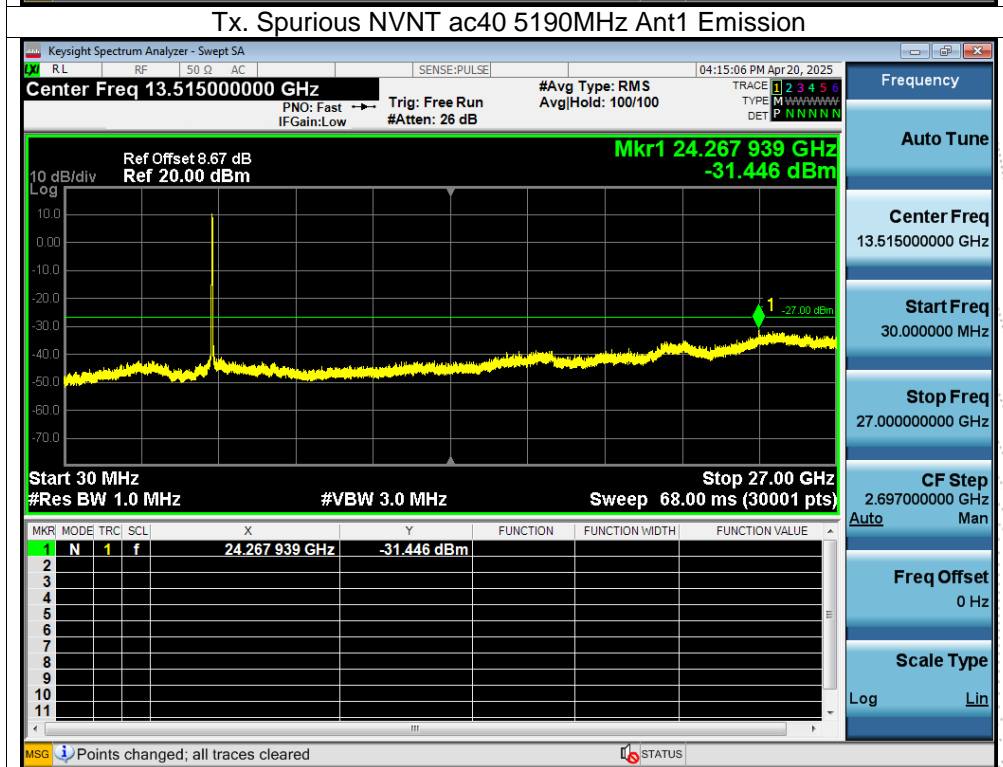
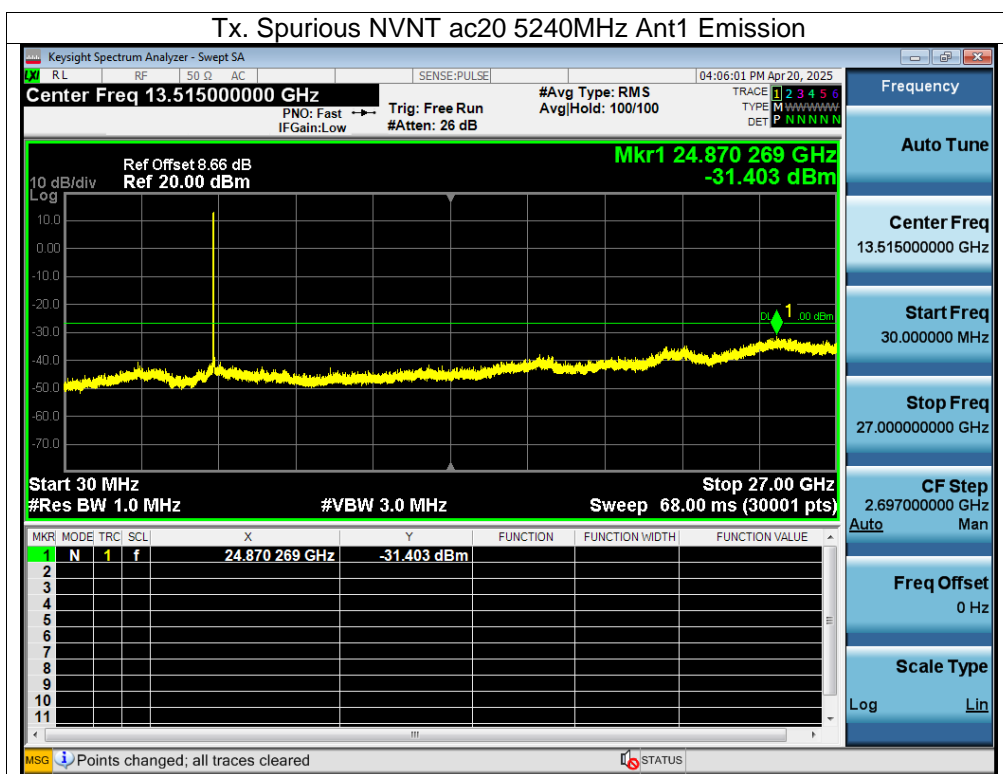


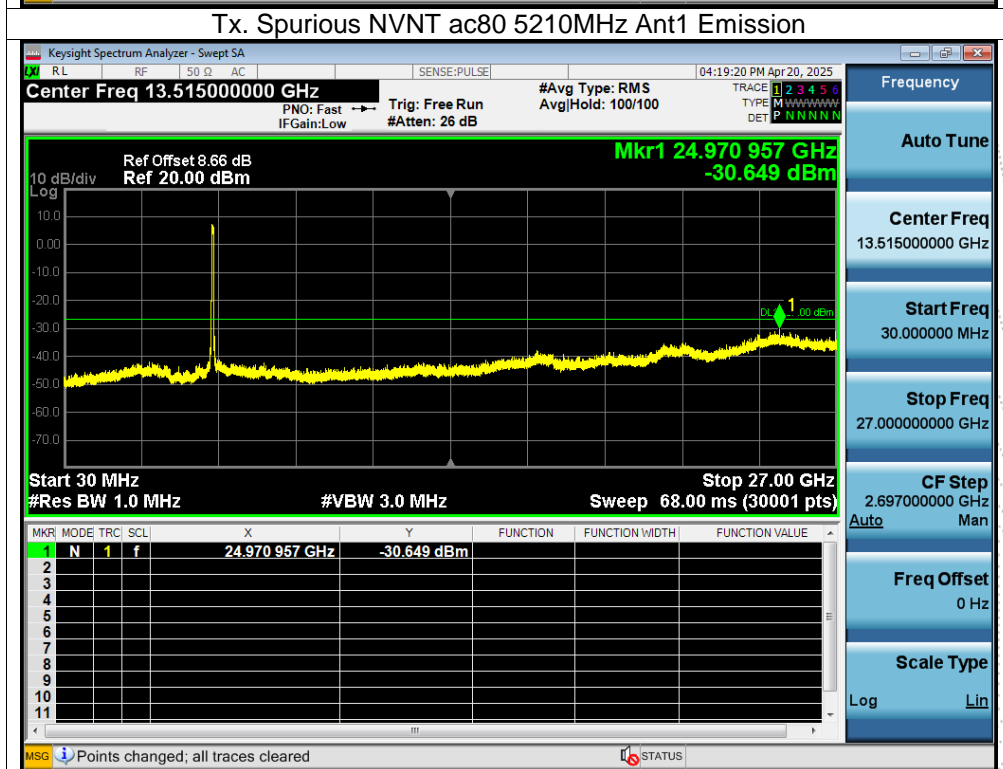
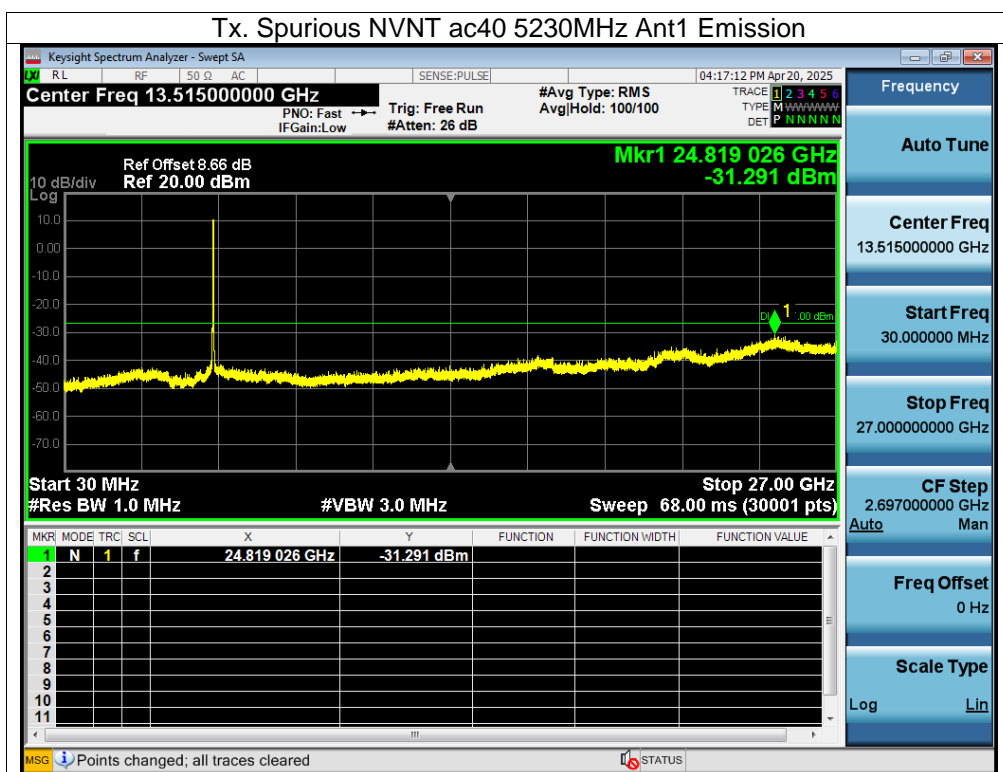












Note: A(B) Represent the value of antenna A and B, The worst data is Antenna A, only shown Antenna A.
Antenna A: 5260-5230MHz

