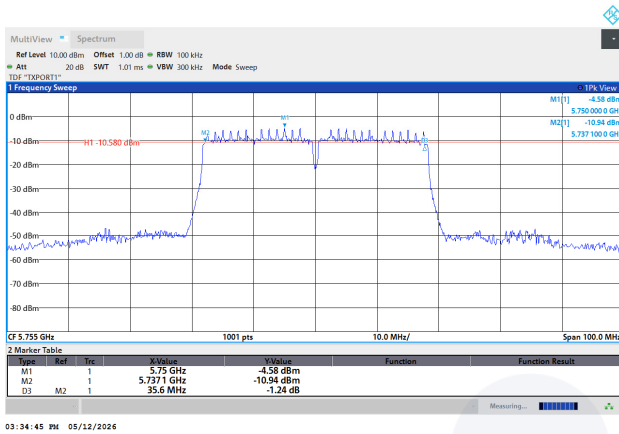


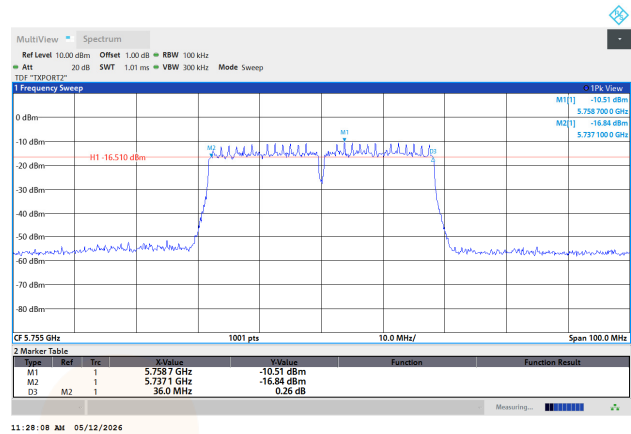
MIMO_ANT1

UNII-3 / 802.11n HT40 / 5 755 MHz

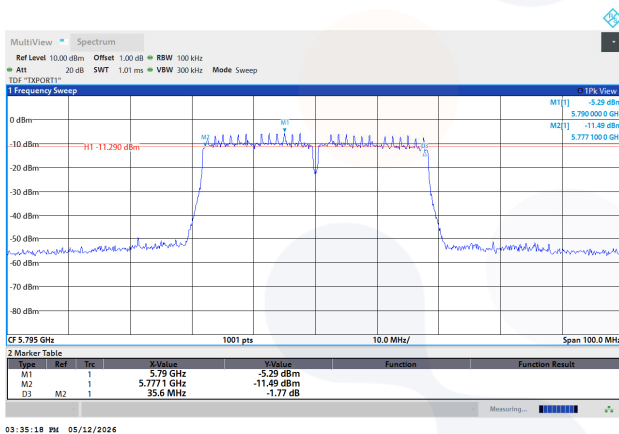


MIMO_ANT2

UNII-3 / 802.11n HT40 / 5 755 MHz



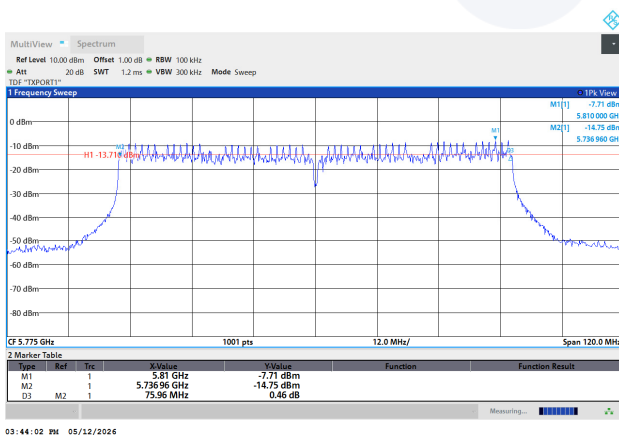
UNII-3 / 802.11n HT40 / 5 795 MHz



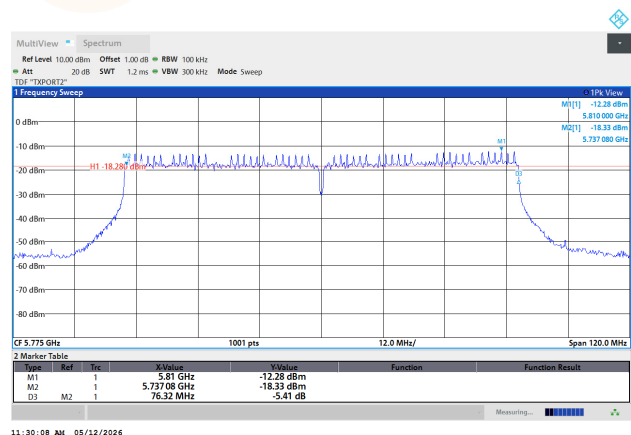
UNII-3 / 802.11n HT40 / 5 795 MHz



UNII-3 / 802.11ac VHT80 / 5 775 MHz

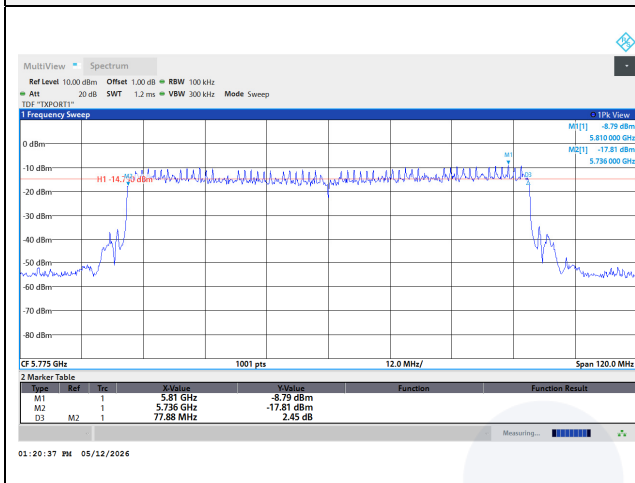


UNII-3 / 802.11ac VHT80 / 5 775 MHz



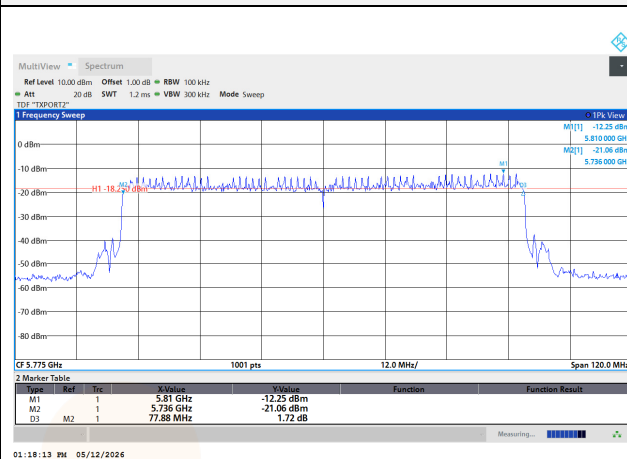
MIMO_ANT1

UNII-3 / 802.11ax HE80 / SU / 5 775 MHz

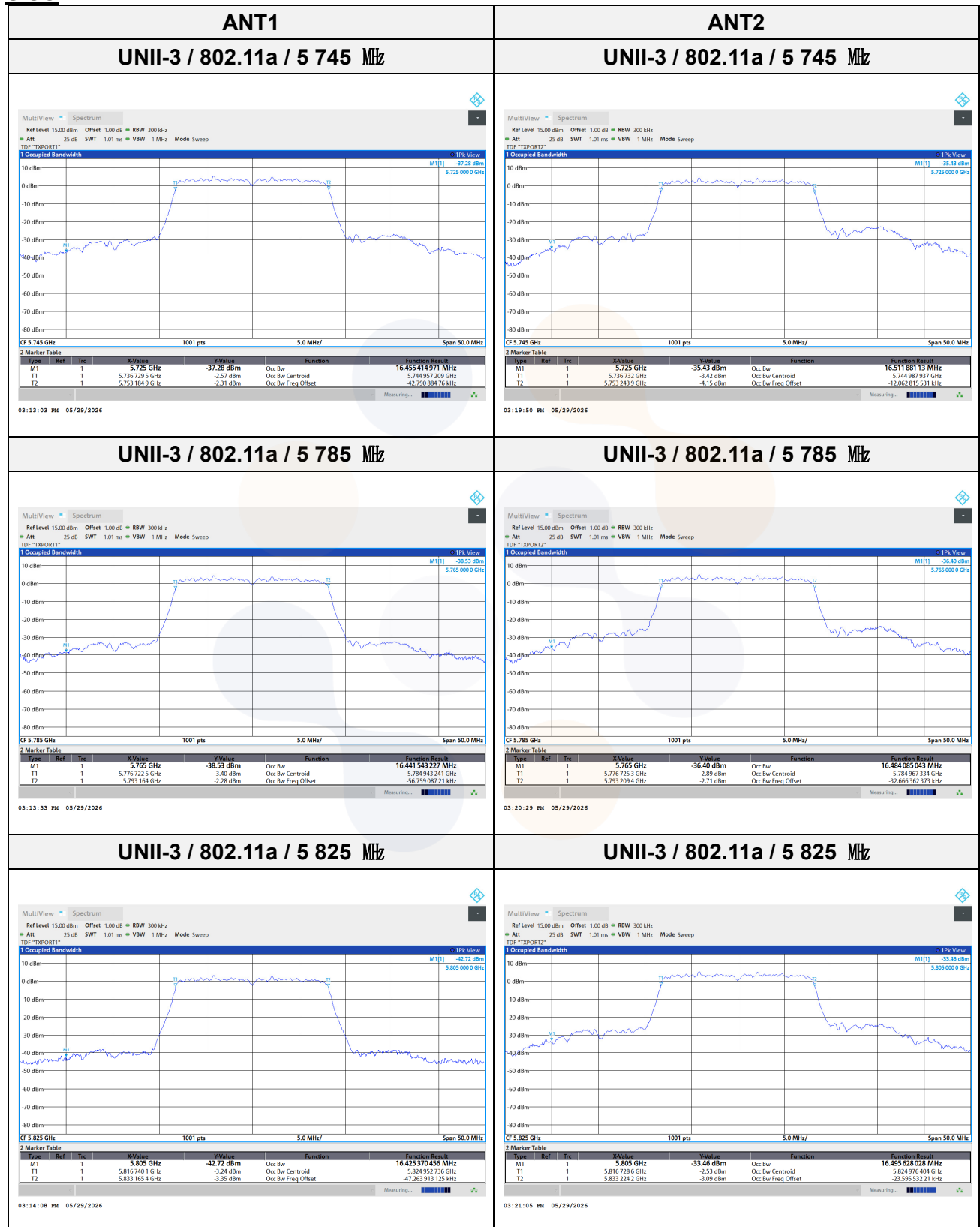


MIMO_ANT2

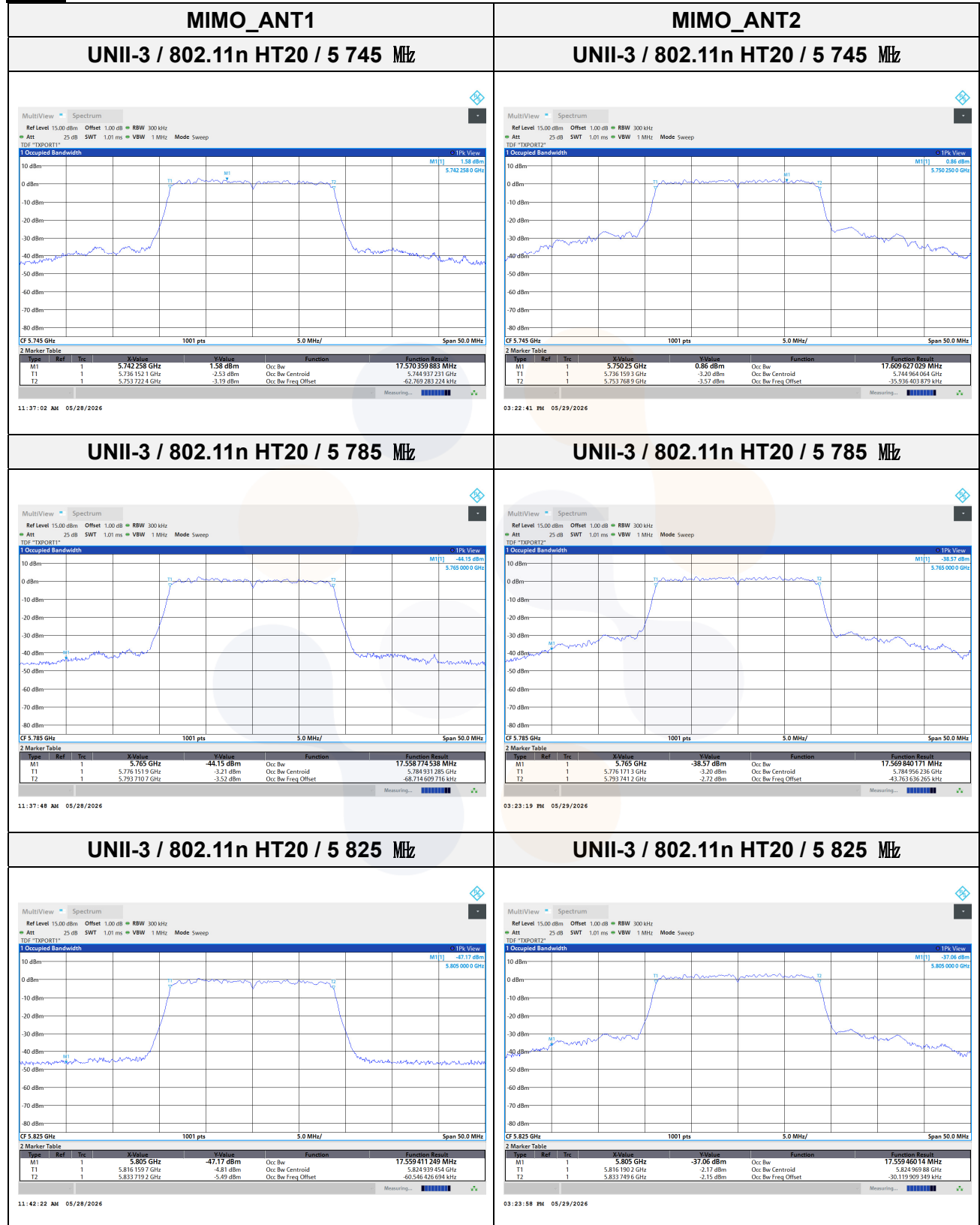
UNII-3 / 802.11ax HE80 / SU / 5 775 MHz



99% bandwidth
SISO

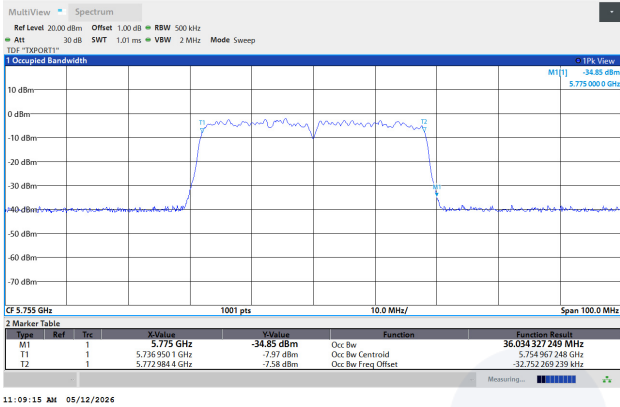


MIMO



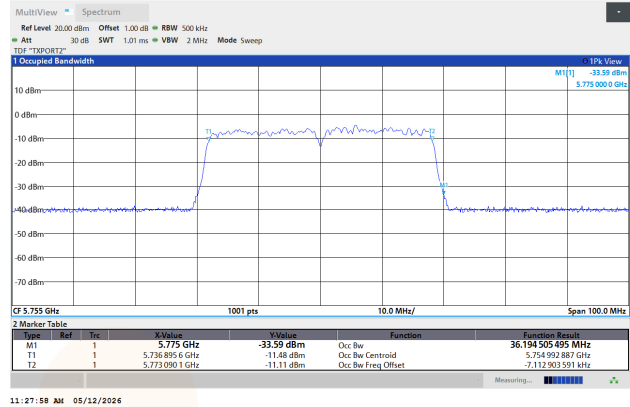
MIMO_ANT1

UNII-3 / 802.11n HT40 / 5 755 MHz

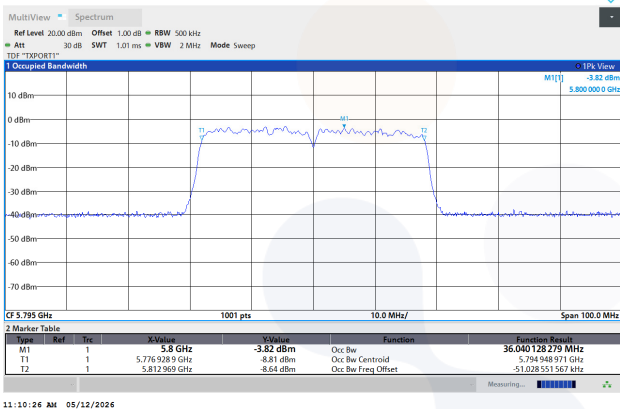


MIMO_ANT2

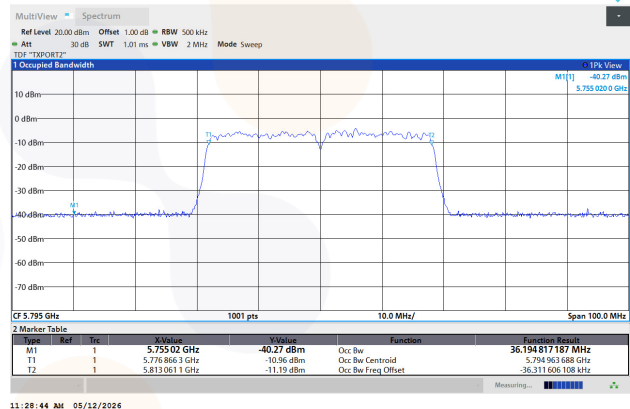
UNII-3 / 802.11n HT40 / 5 755 MHz



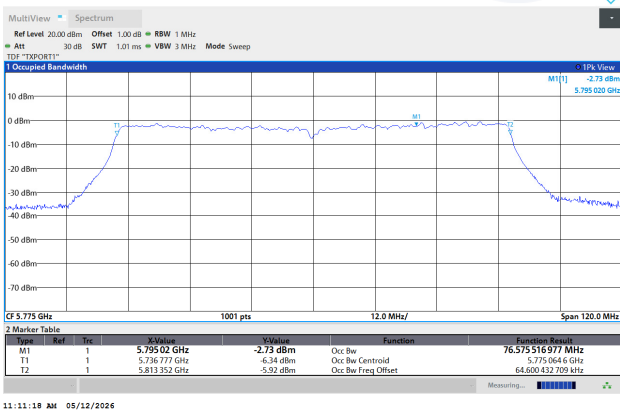
UNII-3 / 802.11n HT40 / 5 795 MHz



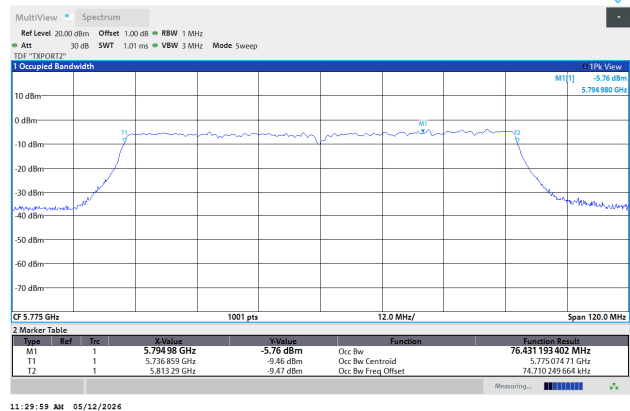
UNII-3 / 802.11n HT40 / 5 795 MHz



UNII-3 / 802.11ac VHT80 / 5 775 MHz

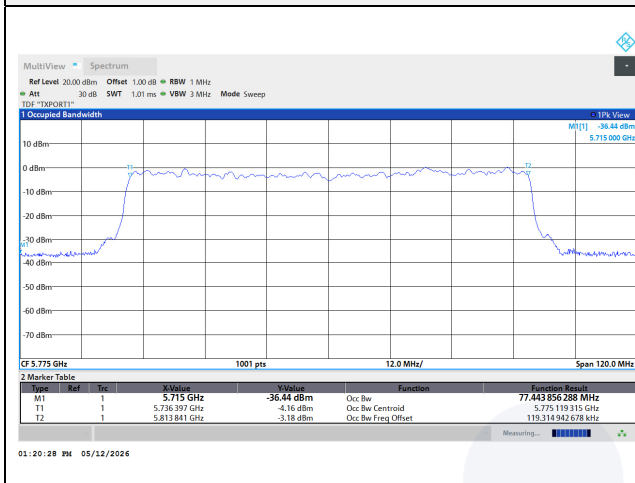


UNII-3 / 802.11ac VHT80 / 5 775 MHz



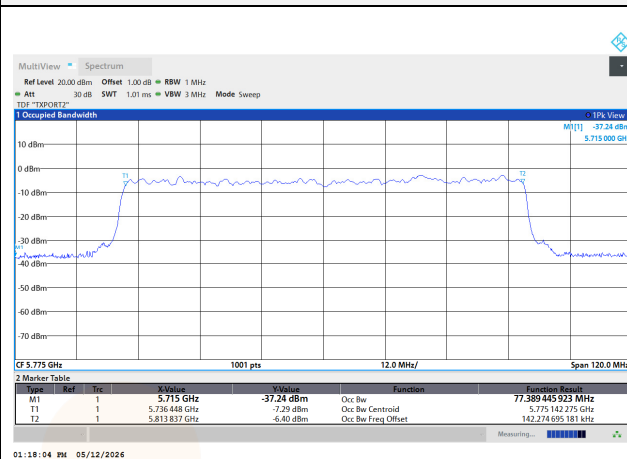
MIMO_ANT1

UNII-3 / 802.11ax HE80 / SU / 5 775 MHz



MIMO_ANT2

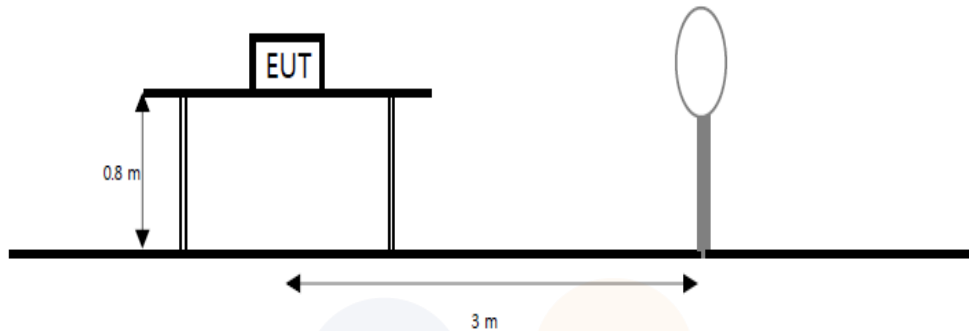
UNII-3 / 802.11ax HE80 / SU / 5 775 MHz



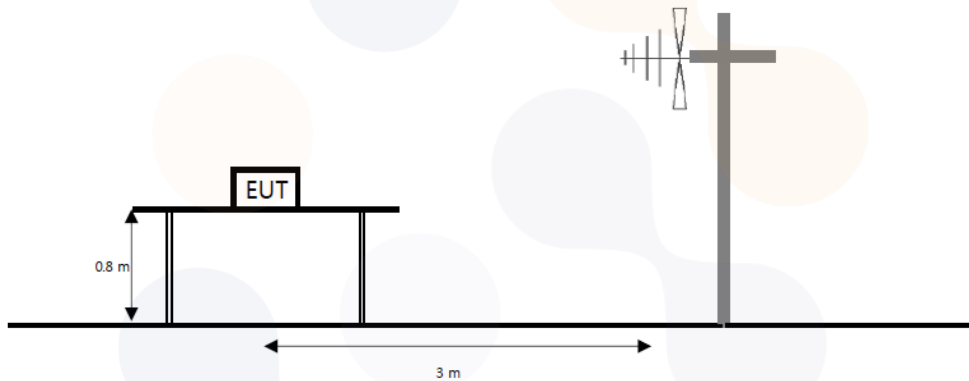
7.5. Spurious Emission, Band Edge and Restricted bands

Test setup

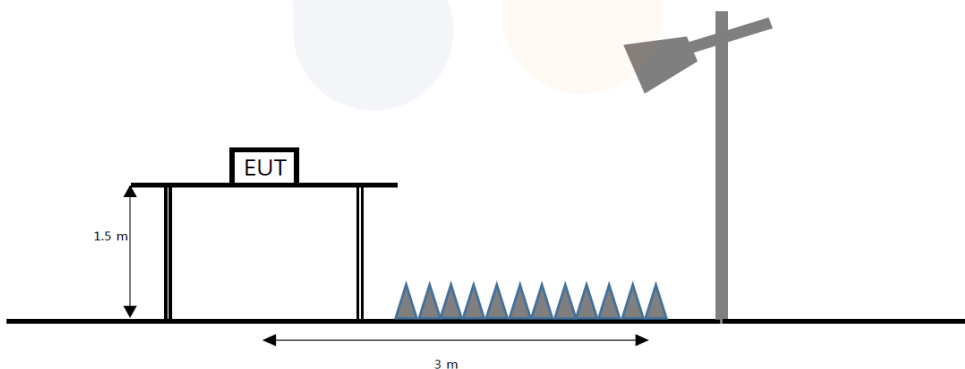
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz emissions, whichever is lower.



Limit

According to section 15.209(a),

except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	Measurement distance (m)
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section 15.231 and 15.241.

According to section 15.205(a) and (b),

Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 - 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 - 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 - 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 - 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 - 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 - 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 - 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 - 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525	2 483.5 - 2 500	17.7 - 21.4
8.376 25 - 8.386 75	25	2 690 - 2 900	22.01 - 23.12
8.414 25 - 8.414 75	156.7 - 156.9	3 260 - 3 267	23.6 - 24.0
12.29 - 12.293	162.012 5 - 167.17	3 332 - 3 339	31.2 - 31.8
12.519 75 - 12.520 25	167.72 - 173.2	3 345.8 - 3 358	36.43 - 36.5
12.576 75 - 12.577 25	240 - 285	3 600 - 4 400	Above 38.6
13.36 - 13.41	322 - 335.4		

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in section 15.35 apply to these measurements.

According to section 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:

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

For transmitters operating in the 5.25-5.35 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.

Test procedure

ANSI C63.10-2020 Section 12.7.5, 12.7.6, 12.7.7.2

KDB 789033 D02 V02r01 – Section G

Test settings

Peak field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW $\geq$ [3 $\times$ RBW]
4. Detector = peak
5. Sweep time = No faster than coupled (auto) time
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

Table. RBW as a function of frequency

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1 000 MHz	100 kHz to 120 kHz
> 1 000 MHz	1 MHz

Average field strength measurements

Trace averaging with continuous EUT transmission at full power

If the EUT can be configured or modified to transmit continuously ($D \geq 98\%$), then the average emission levels shall be measured using the following method (with EUT transmitting continuously):

- a) RBW = 1 MHz (unless otherwise specified).
- b) VBW $\geq$ [3 $\times$ RBW].
- c) Detector = Power averaging (RMS), if $[\text{span} / (\# \text{ of points in sweep})] \leq (\text{RBW} / 2)$. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition is not satisfied, then the detector mode shall be set to peak.
- d) Averaging type = power (i.e., rms):
- e) As an alternative, the detector and averaging type may be set for linear voltage averaging.
- f) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
- g) Sweep time = auto.
- h) Perform a trace average of at least 100 traces.

Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT ($D \geq 98\%$) cannot be achieved and the duty cycle is constant (duty cycle variations are less than $\pm 2\%$), then the following procedure shall be used:

- a) The EUT shall be configured to operate at the maximum achievable duty cycle.
- b) Measure the duty cycle D of the transmitter output signal as described in 11.6.
- c) $RBW = 1 \text{ MHz}$ (unless otherwise specified).
- d) $VBW \geq [3 \times RBW]$.
- e) Detector = Power averaging (RMS), if $[\text{span} / (\# \text{ of points in sweep})] \leq (RBW / 2)$. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
- f) Averaging type = power (i.e., rms):
- g) As an alternative, the detector and averaging type may be set for linear voltage averaging.
- h) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
- i) Sweep time = auto.
- j) Perform a trace average of at least 100 traces.
- k) A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
 - l) If power averaging (rms) mode was used in step e), then the applicable correction factor is $[10 \log (1 / D)]$, where D is the duty cycle.
 - m) If linear voltage averaging mode was used in step e), then the applicable correction factor is $[20 \log (1 / D)]$, where D is the duty cycle.

Band edge measurements

Integration Method

If continuous transmission of the EUT ($D \geq 98\%$) cannot be achieved and the duty cycle is constant (duty cycle variations are less $\pm 2\%$), then the following procedure may be used to measure the average power of unwanted emissions within 2 MHz of the authorized band-edge:

- a) The EUT shall be configured to operate at the maximum achievable duty cycle.
- b) Measure the duty cycle D of the transmitter output signal as described in 11.6.
- c) Set instrument center frequency to the frequency of the emission to be measured.
- d) Set span to 2 MHz.
- e) RBW = 100 kHz.
- f) $VBW \geq 3 \times RBW$.
- g) Detector = Power averaging (rms), if $[\text{span} / (\# \text{ of points in sweep})] \leq (RBW / 2)$. Satisfying this condition might require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
- h) Averaging type = power (i.e., rms):
 - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
 - 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
- i) Sweep time = auto.
- j) Perform a trace average of at least 100 traces.
- k) Compute the power by integrating the spectrum over 1 MHz using the instrument's band-power measurement function with band limits set equal to the emission frequency ($f_{\text{emission}} \pm 0.5 \text{ MHz}$). If the spectrum analyzer does not have a band-power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by $f_{\text{emission}} \pm 0.5 \text{ MHz}$.
- l) A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
 - 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is $[10 \log (1 / D)]$, where D is the duty cycle.
 - 2) If linear voltage averaging mode was used in step f), then the applicable correction factor is $[20 \log (1 / D)]$, where D is the duty cycle.
 - 3) If a specific emission is demonstrated to be continuous ($D \geq 98\%$) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission. Reduction of the measured emission amplitude levels to account for operational duty cycle is not permitted. Determining compliance is based on emission levels occurring during transmission it is not based on an average across ON and OFF times of the transmitter.

Marker-delta method

The following procedure shall be used for the marker-delta method:

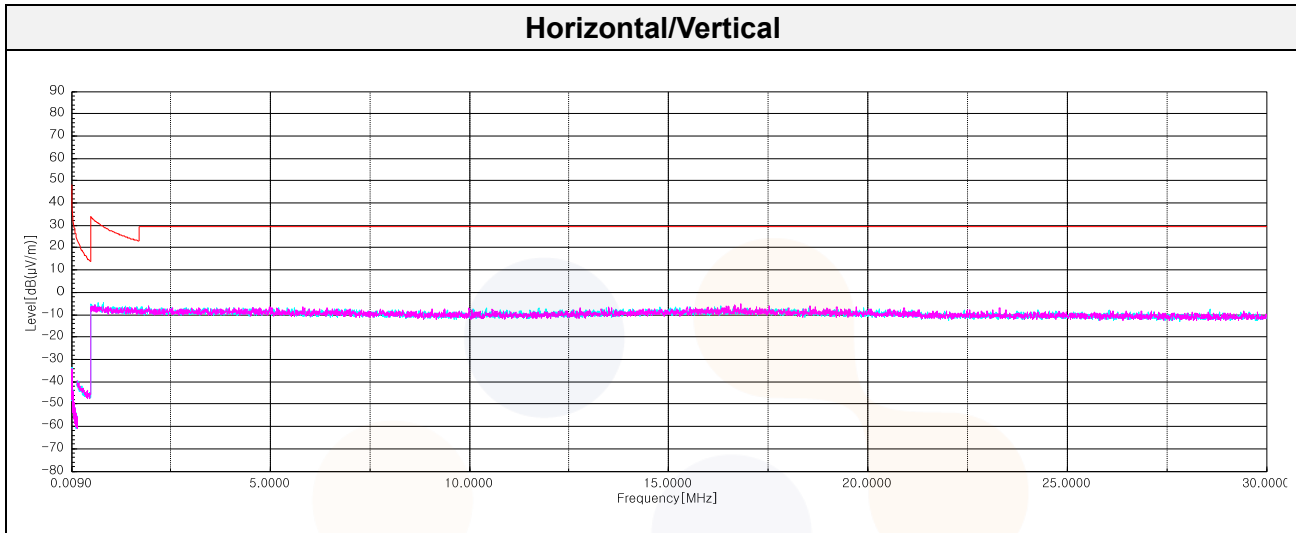
- a) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required for the frequency being measured. For example, for a device operating in the 902 MHz to 928 MHz band, use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW alternatively may be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 3 MHz VBW, and a peak detector, as required.
Repeat the measurement with an average detector (or alternatively, a peak detector and reduced VBW). For pulsed emissions, other factors shall be included; see 4.1.5.2.7.
- b) Choose an EMI receiver or spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the instrument RBW to 1% of the total span (but never less than 30 kHz), with a VBW equal to or greater than three times the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not an absolute field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.
- c) Subtract the delta measured in step b) from the field strengths measured in step a). The resulting field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge emissions compliance, where required.

Notes:

1. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40 \log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20 \log(D_m/D_s)$
Where:
 F_d = Distance factor in dB
 D_m = Measurement distance in meters
 D_s = Specification distance in meters
2. Factors(dB) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d (dB)
3. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
4. Average test would be performed if the peak result were greater than the average limit.
5. ¹⁾ means restricted band.
6. Below 30 MHz frequency range, In order to search for the worst result, all orientations about parallel, perpendicular, and ground-parallel were investigated then reported. when the emission level was higher than 20 dB of the limit, then the following statement shall be made: "No spurious emissions were detected within 20 dB of the limit."
7. Above 1 GHz the worst results between two antenna polarizations (H and V) were documented in the test report.
8. For above 1 GHz pre-scan to detect harmonic and spurious emissions, the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 kHz for peak measurements.

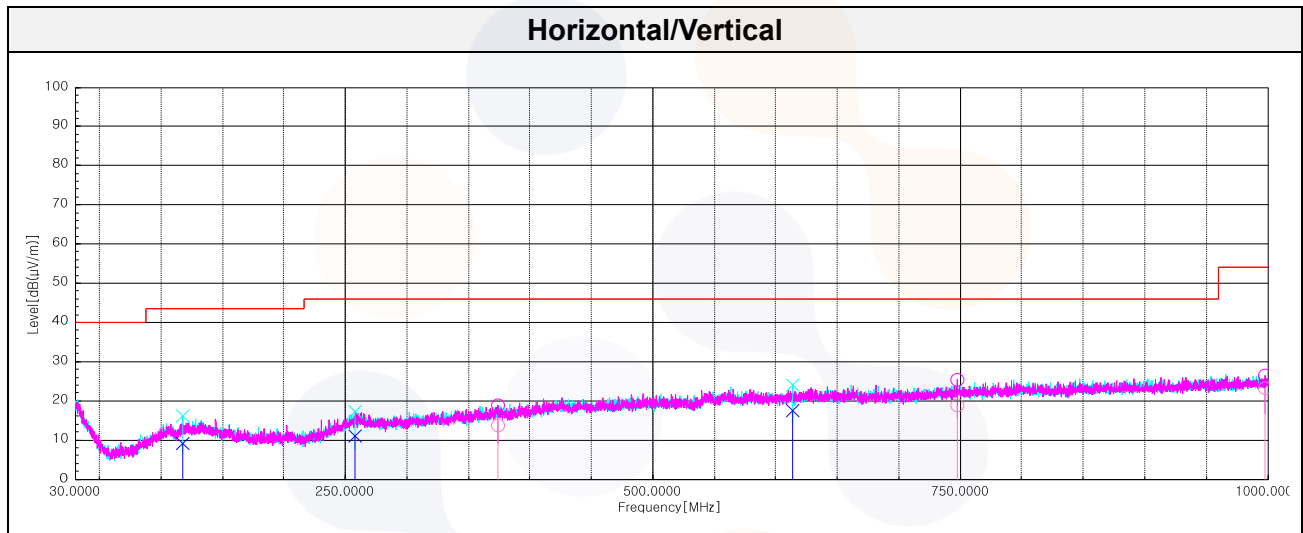
Test results (Below 30 MHz) – Worst case: 802.11n_HT20_UNII 3_5 745 MHz / MIMO

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
No spurious emissions were detected within 20 dB of the limit.									



Test results (Below 1 000 MHz) – Worst case: 802.11n_HT20_UNII 3_5 745 MHz / MIMO

Frequency	Pol.	Reading	Amp. + Cable	Antenna Factor	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Quasi peak data								
117.91 ¹⁾	V	22.80	17.80	-31.48	-	9.12	43.52	34.40
258.07 ¹⁾	V	22.60	19.41	-31.00	-	11.01	46.02	35.01
373.99	H	23.40	20.90	-30.57	-	13.73	46.02	32.29
613.46 ¹⁾	V	23.10	24.70	-30.23	-	17.57	46.02	28.45
747.32	H	22.70	25.70	-29.71	-	18.69	46.02	27.33
998.18 ¹⁾	H	23.40	27.30	-27.45	-	23.25	54.00	30.75



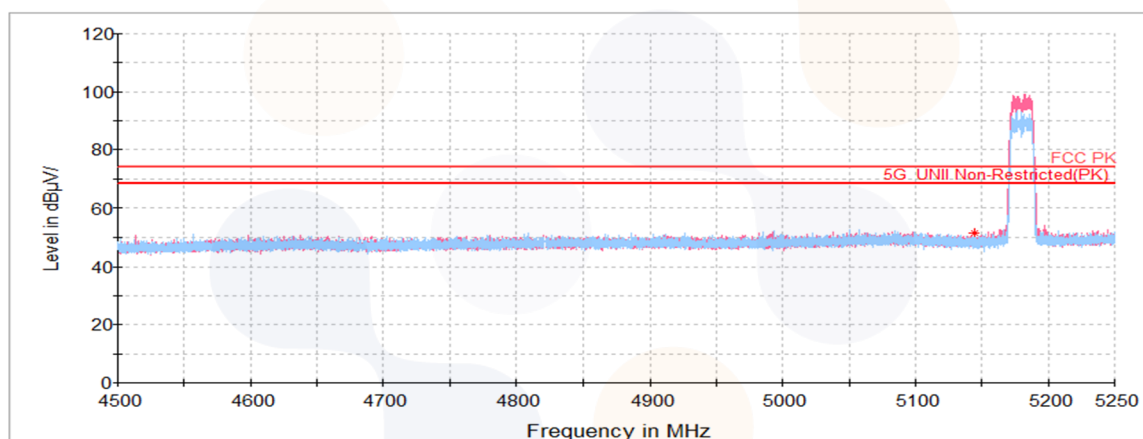
Test results (Above 1 000 MHz)

SISO ANT1 UNII 1 802.11a

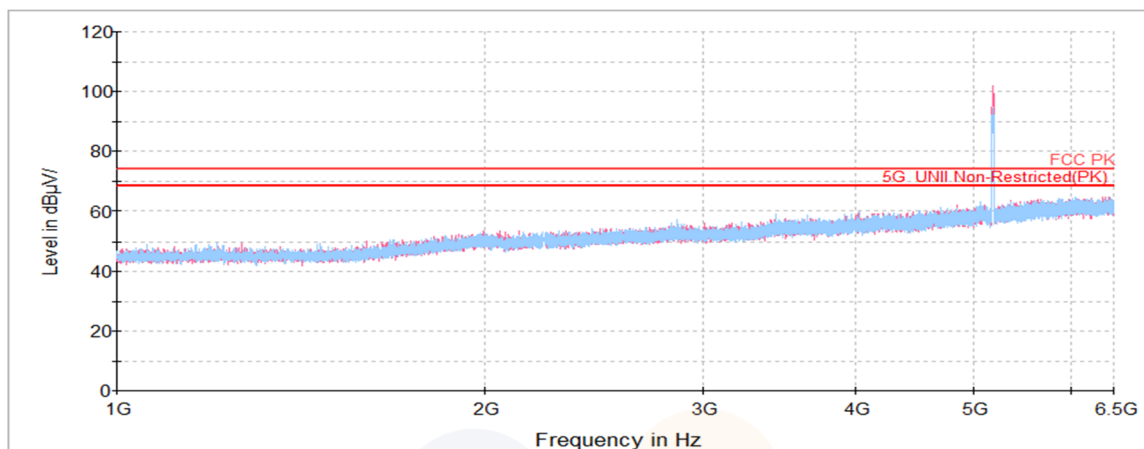
Lowest Channel (5 180 MHz)

Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
5 144.77 ¹⁾	V	41.52	34.24	-24.29	-	51.47	74.00	22.53
10 354.42	V	51.83	37.48	-38.52	-	50.79	68.20	17.41
15 529.42 ¹⁾	H	48.90	39.80	-35.28	-	53.42	74.00	20.58
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 GHz ~ 6.5 GHz



Horizontal/Vertical for 6.5 GHz ~ 18 GHz

