

Date: 5.APR.2022 20:48:23

425 MHz, Highest Channel

10.3 Spurious Radiated Emissions

Date of Test	2022-04-04 to 2022-04-07
Operator	Alex Fink
Test Site	Fully anechoic room, cabin no. 2 Semi anechoic room, cabin no. 11

Test Result	
<input checked="" type="checkbox"/>	Passed
<input type="checkbox"/>	Not Passed

Barometric pressure:	969 hPa
Relative humidity:	31 %
Ambient temperature:	22 °C

Specifications:	CFR 47, Part 95, Subpart M, § 95.3379(a) RSS-251 Issue 2, Section 10
Description:	The power density of any emissions outside the 76 – 81 GHz band shall consist solely of spurious emissions and shall not exceed the following: Radiated emissions below 40 GHz shall not exceed the field strength as shown in the Table 1. The power density of radiated of radiated emissions outside the 76 – 81 GHz band above 40 GHz shall not exceed the power density as shown in the tables on the next page.s
Operation mode:	This test was performed as radiated test in the frequency range 30 MHz to 300 GHz. No significant spurious emissions were observed. The test distance was 3 m in the frequency ranges 30 MHz to 1 GHz and 18 to 40 GHz, 1 m in the frequency ranges 1GHz to 18 GHz, 40 GHz to 60 GHz and 0.5 m in the frequency range 60 GHz to 300 GHz.
Comment :	The measurement below was done using EMC 32 V10.40.00 automated software. Based on the antenna power measurement this test was performed with 175 MHz BW on middle frequency and 425 MHz BW on lowest and highest frequency; these modes are considered to cover the worst case scenario. See plots for details.

Sample calculation of field final values:

$$\text{Final Value (dB}\mu\text{V/m)} = \text{Reading Value (dB}\mu\text{V)} + (\text{Antenna Correction Factor (dB/m)} + \text{Cable Correction Factor (dB)})$$

<i>Radiated emission limits 9 kHz – 40 GHz</i>		
<i>Frequency (MHz)</i>	<i>Field strength ($\mu\text{V}/\text{m}$)</i>	<i>Measurement distance (m)</i>
0.009 – 0.490	2400/f(kHz)	300
0.490 – 1.705	24000/f(kHz)	30
1.705 – 30	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
960 – 40000	500	3

Note(s):

- 1 In the emissions table the tighter limit applies at the band edges.
- 2 The limits are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emission shall not exceed the level of the fundamental frequency.
- 3 The emissions limits shown in the table are based on measurement employing CISPR quasi-peak detector except for the frequency bands 9.0 – 90 kHz, 110.0 – 490 kHz, and above 1 GHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with 1 MHz RBW.

Table 1: Radiated emission limits 9 kHz – 40 GHz

<i>Radiated emission limits 40 GHz – 231 GHz</i>		
<i>Frequency (GHz)</i>	<i>Power Density (pW/cm^2)</i>	<i>Measurement distance (m)</i>
40 – 200	600	3
above	1000	3

Note(s):

- 1 According to 47 CFR, Part 95, § 95.3379(a)(3) the spectrum shall be investigated up to 231 GHz.
- 2 The power density of 600 pW/cm² corresponds to a transmit power of -1.69 dBm, a field strength of 93.5 dB $\mu\text{V}/\text{m}$ for 3 m distance and 103.1 dB $\mu\text{V}/\text{m}$ for 1 m distance
- 3 The power density of 1000 pW/cm² corresponds to a field strength of 95.8 dB $\mu\text{V}/\text{m}$ for 3 m distance, 105.3 dB $\mu\text{V}/\text{m}$ for 1 m distance and 111.3 dB $\mu\text{V}/\text{m}$ for 0.5 m distance.

Table 2: FCC Radiated emission limits above 40 GHz



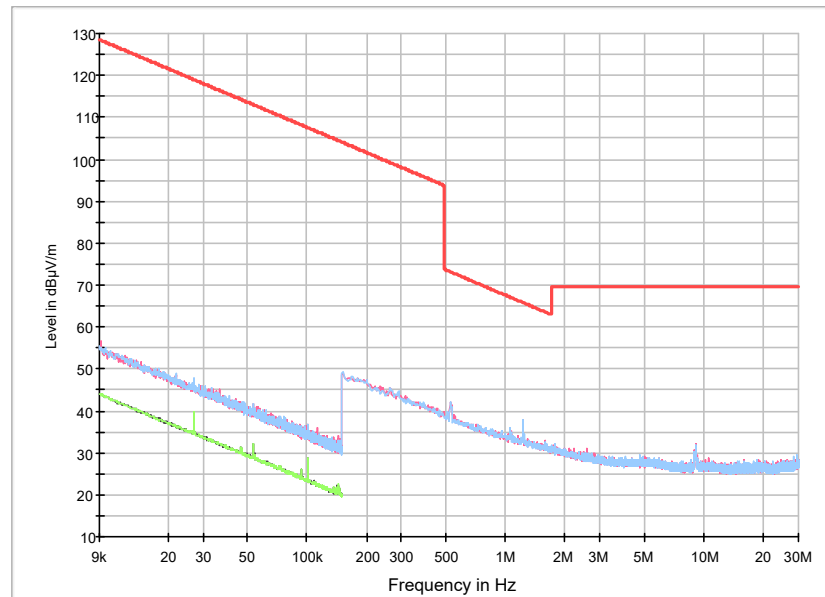
<i>Radiated emission limits 40 GHz –162 GHz</i>		
<i>Frequency (GHz)</i>	<i>Limit (dBm/MHz e.i.r.p.)</i>	<i>Detector</i>
40 – 162	-30	RMS

Note(s):

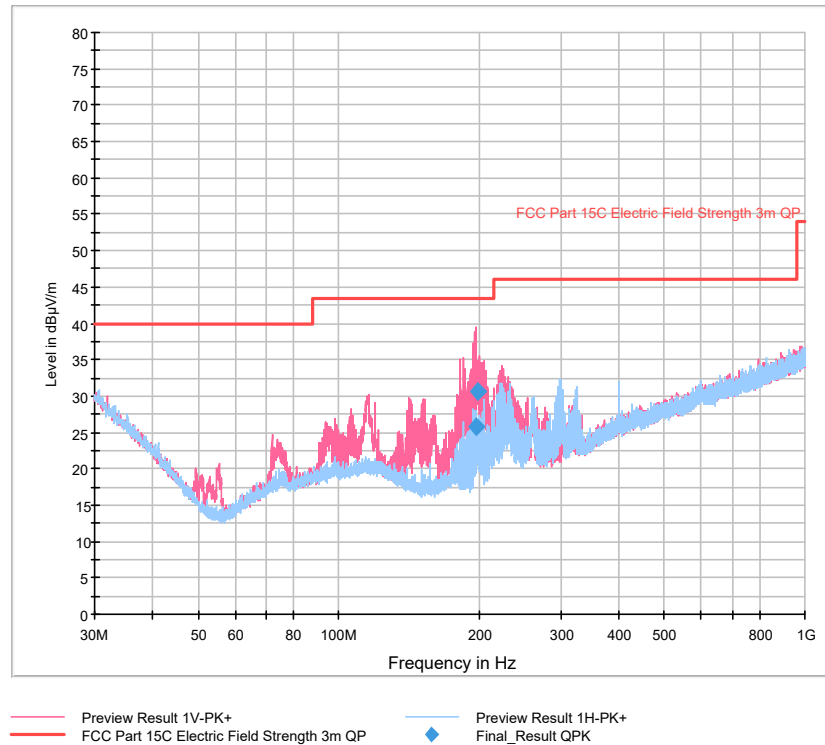
- For radar devices that operate solely in the 76 – 76 GHz Band (i.e. the occupied bandwidth is entirely contained in the 76 – 77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5 – 76 GHz band. Outside the 73.5 – 76 GHz band, the unwanted emission limits prescribed above shall apply.

Table 3: ISED Radiated emission limits above 40 GHz

Plots taken during measurement: Lowest channel, 425 MHz BW

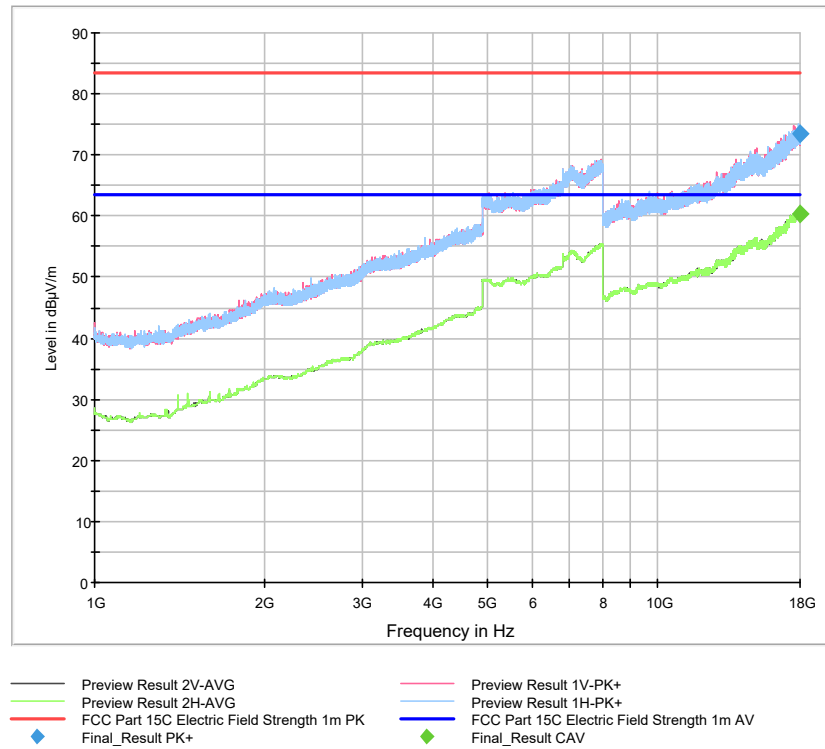


- Preview Result 2V-AVG
- Preview Result 1V-PK+
- Preview Result 2H-AVG
- Preview Result 1H-PK+
- FCC Part 15C Electric Field Strength 3m QP+AV (9k-30M)
- ◆ Final_Result QPK
- ◆ Final_Result CAV



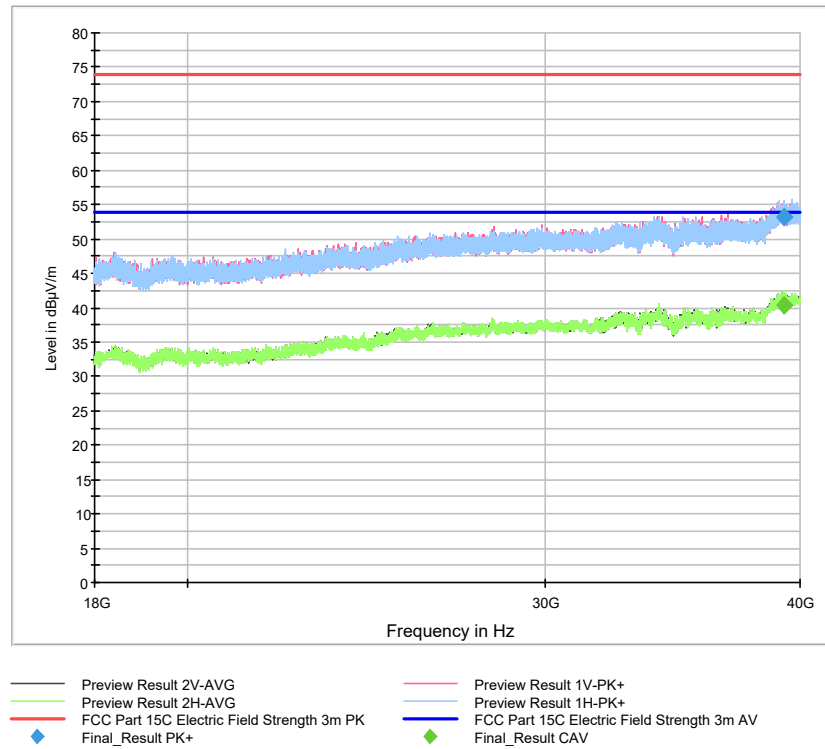
Final Results:

Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB/m
197.010000	25.89	43.50	17.61	1000.0	120.000	139.0	V	172.0	15.4
198.990000	30.64	43.50	12.86	1000.0	120.000	100.0	V	169.0	15.6



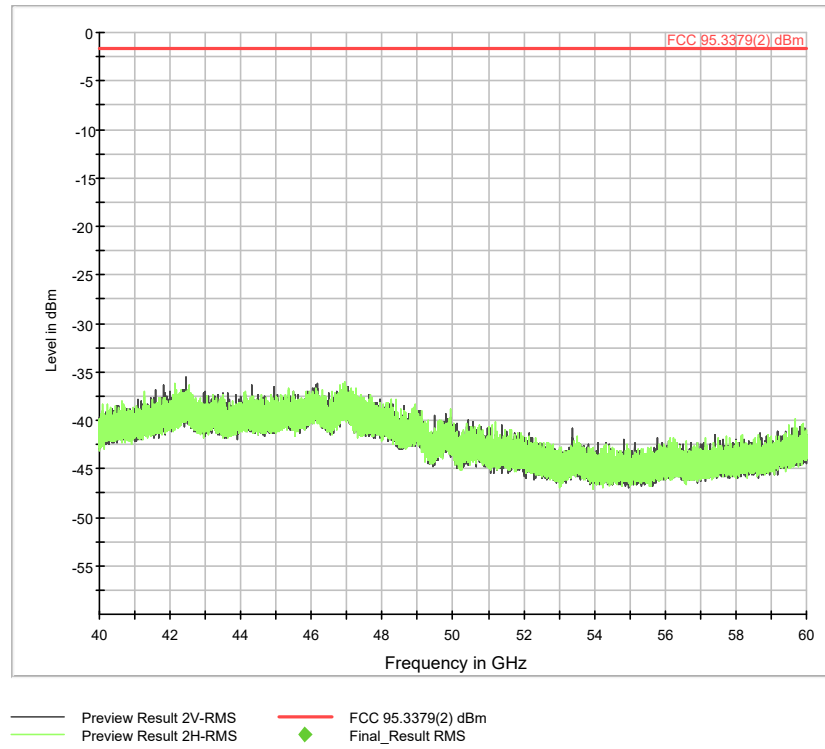
Final Results:

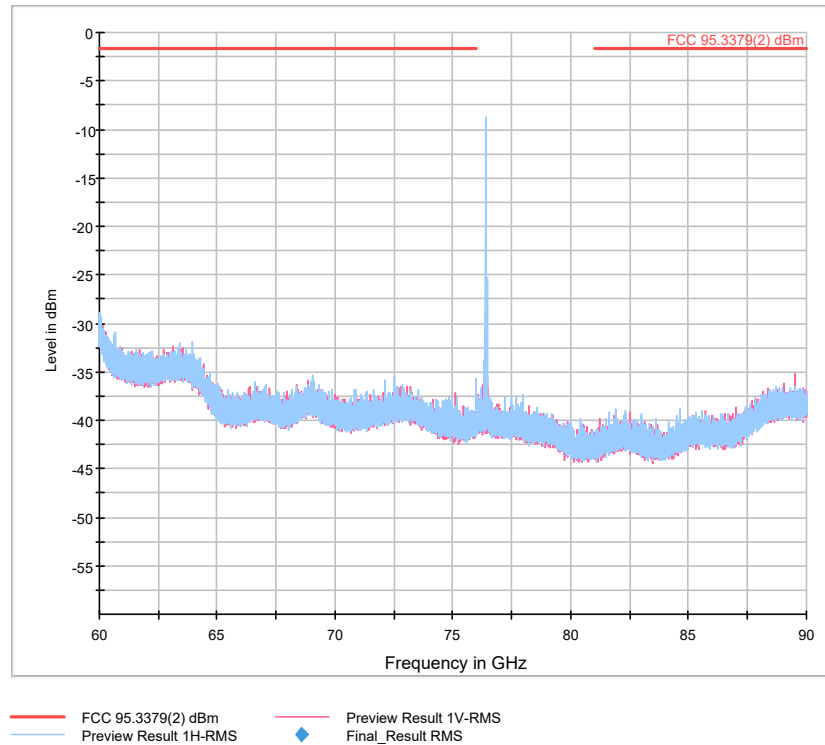
Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
17998.000000	---	60.35	63.50	3.15	1000.0	1000.000	200.0	H	-51.0	59.3
17998.000000	73.45	---	83.50	10.05	1000.0	1000.000	200.0	H	-51.0	59.3



Final Results:

Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
39249.500000	---	40.40	53.98	13.58	1000.0	1000.000	151.0	H	-69.0	36.5
39249.500000	53.23	---	73.98	20.74	1000.0	1000.000	151.0	H	-69.0	36.5

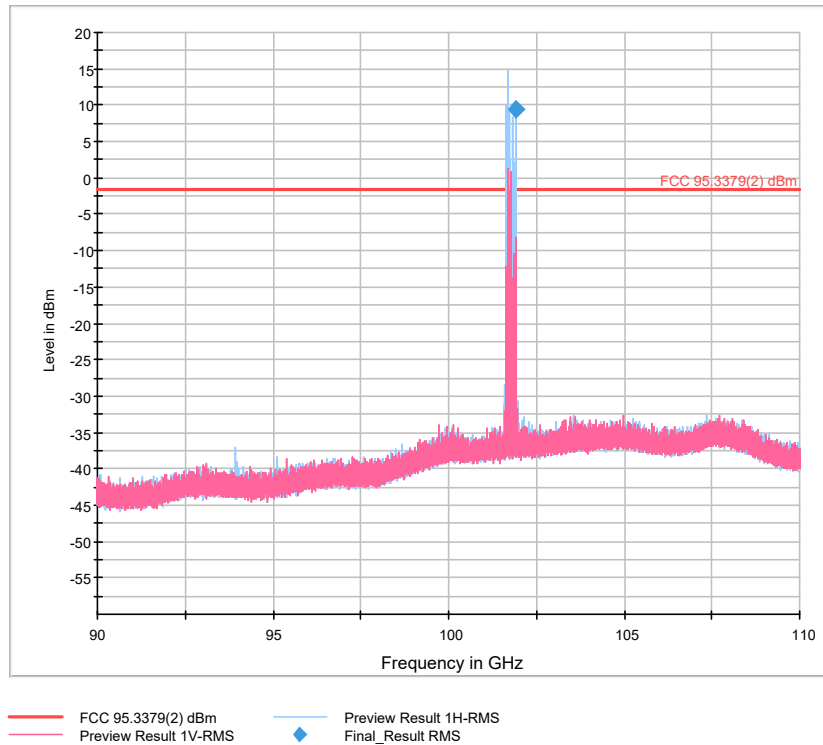




Final Results:

Frequency MHz	RMS dBm	Limit dBm	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
60199.687500	-30.68	-1.69	28.99	5.0	1000.000	150.0	H	217.0	-63.0
76369.687500	-8.74	#1	#1	5.0	1000.000	150.0	H	45.0	-62.9

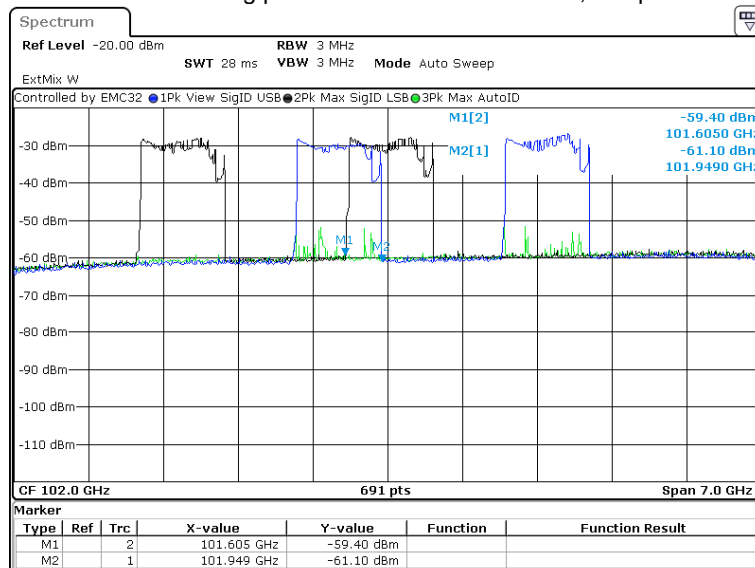
Note #1: intentional radiation



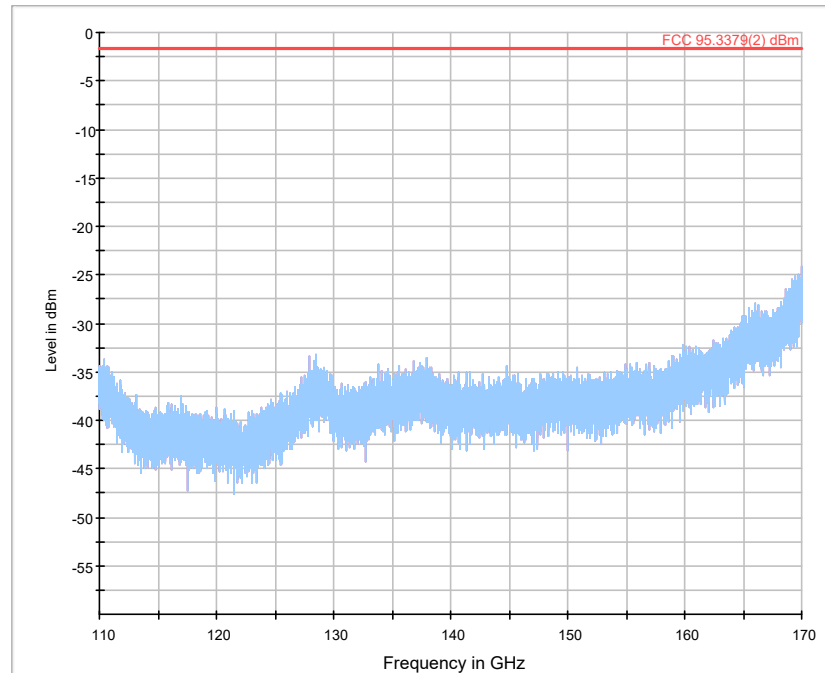
Final Results:

Frequency MHz	RMS dBm	Limit dBm	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
101633.750000	15.49	-1.69	#1	5.0	1000.000	150.0	V	349.0	-67
101689.375000	14.80	-1.69	#1	5.0	1000.000	150.0	H	307.0	-67
101915.625000	9.37	-1.69	#1	5.0	1000.000	150.0	H	307.0	-67

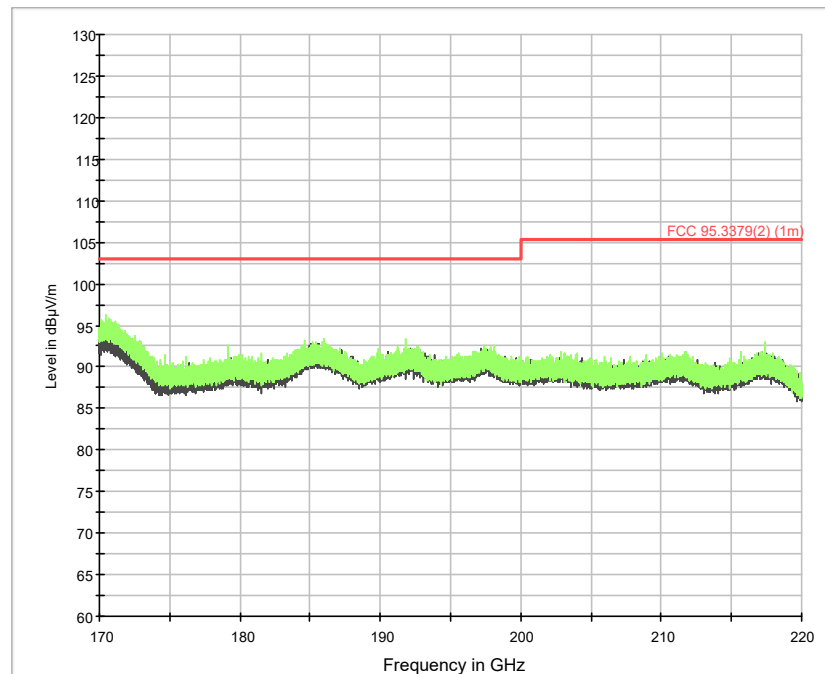
Note #1: Emissions around 102 GHz are a mixing product and therefore not real, see plot below.



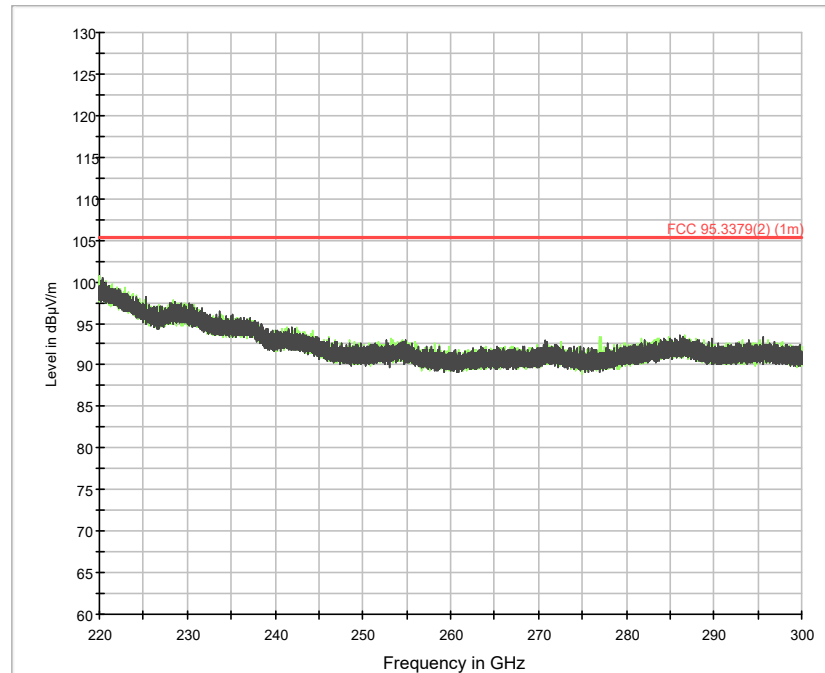
Date: 5 APR.2022 17:23:07



— Preview Result 1V-RMS — Preview Result 1H-RMS * RMS
— FCC 95.3379(2) dBm ◆ Final_Result RMS

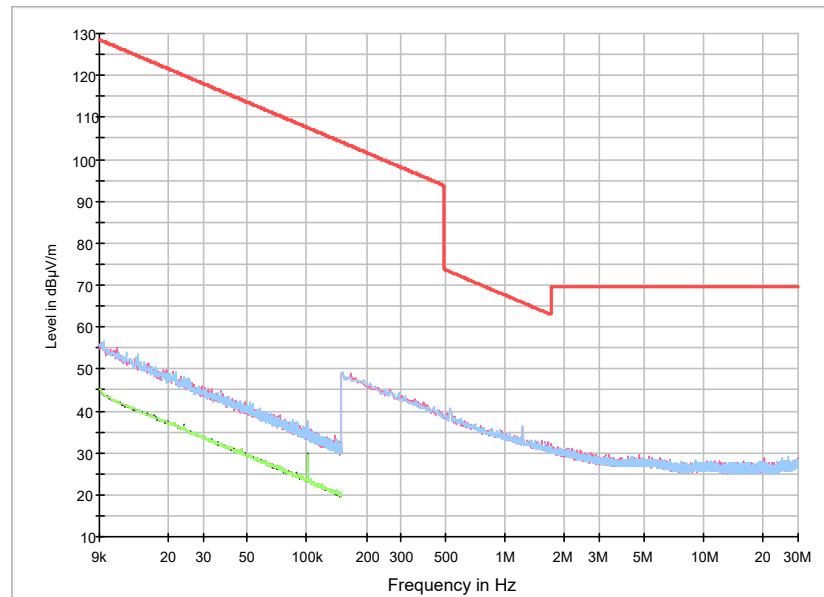


— Preview Result 2V-RMS — FCC 95.3379(2) (1m)
— Preview Result 2H-RMS ◆ Final_Result RMS

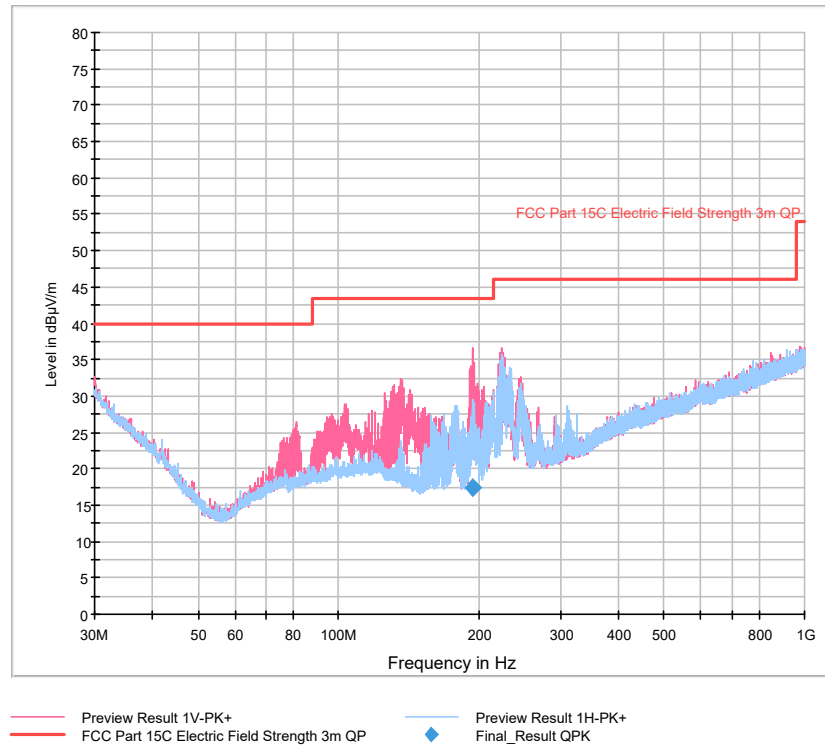


— Preview Result 2H-RMS — FCC 95.3379(2) (1m)
— Preview Result 2V-RMS ◆ Final_Result RMS

Plots taken during measurement: Middle channel, 175 MHz BW

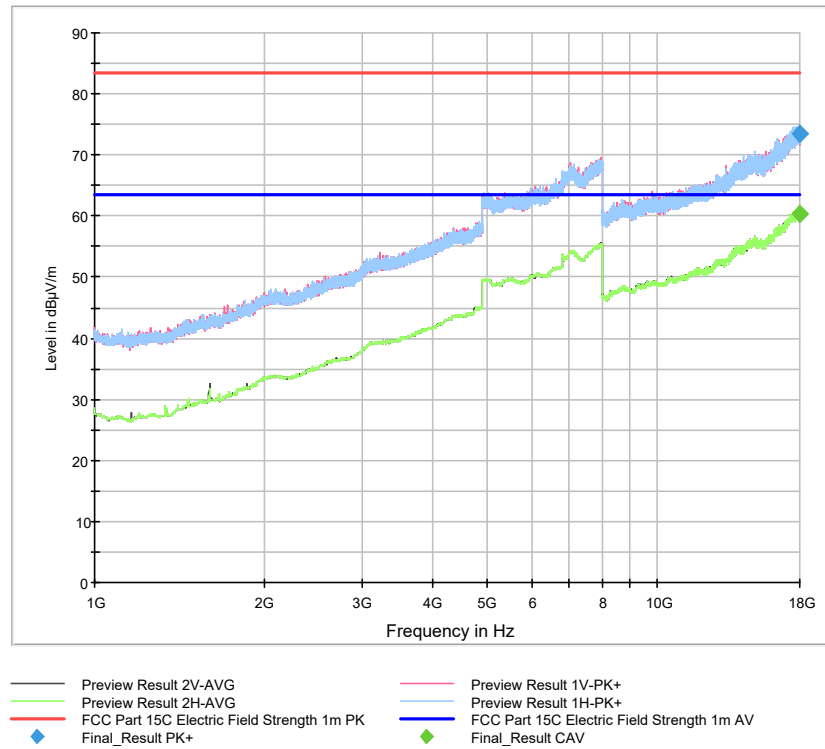


- Preview Result 2V-AVG
- Preview Result 1V-PK+
- Preview Result 2H-AVG
- Preview Result 1H-PK+
- FCC Part 15C Electric Field Strength 3m QP+AV (9k-30M)
- Final_Result QPK
- Final_Result CAV



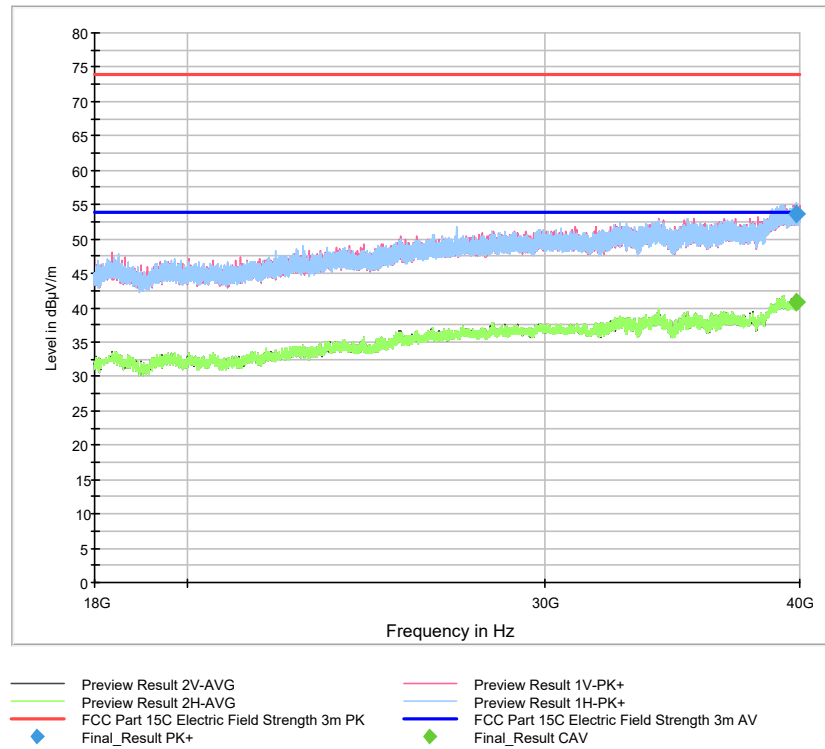
Final Results:

Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB/m
194.010000	17.37	43.50	26.13	1000.0	120.000	339.0	V	-13.0	15.2



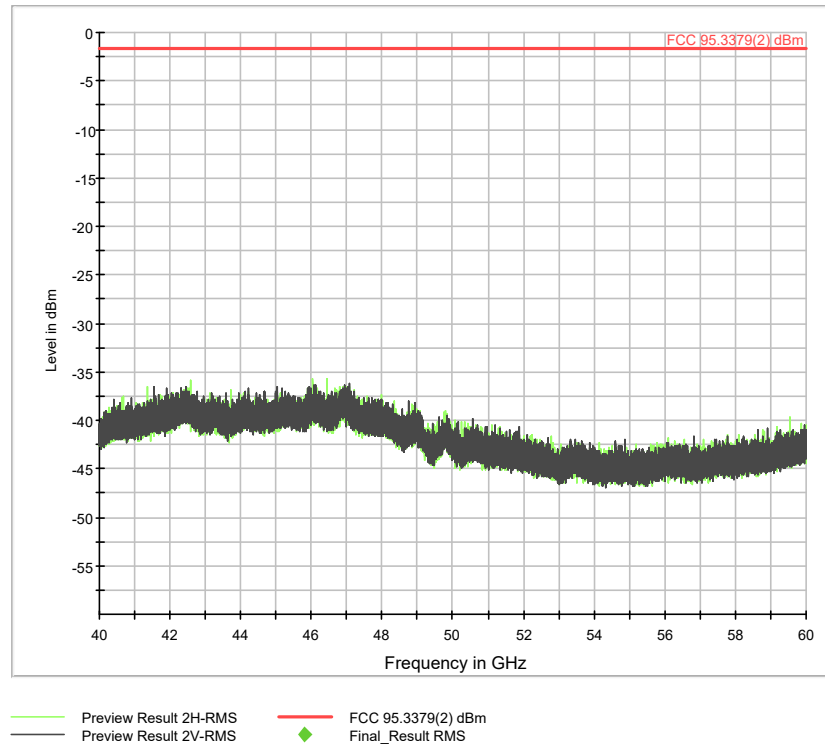
Final Results:

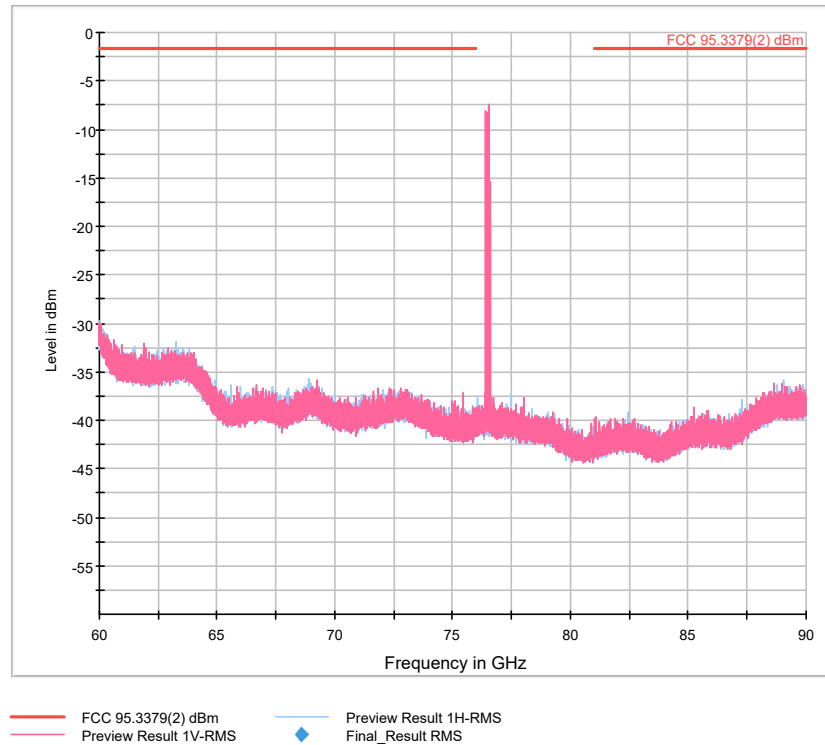
Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
17998.750000	---	60.29	63.50	3.21	1000.0	1000.000	201.0	V	-178.0	59.3
17998.750000	73.37	---	83.50	10.13	1000.0	1000.000	201.0	V	-178.0	59.3



Final Results:

Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
39822.000000	---	40.83	53.98	13.15	1000.0	1000.000	159.0	H	180.0	36.4
39822.000000	53.70	---	73.98	20.28	1000.0	1000.000	159.0	H	180.0	36.4

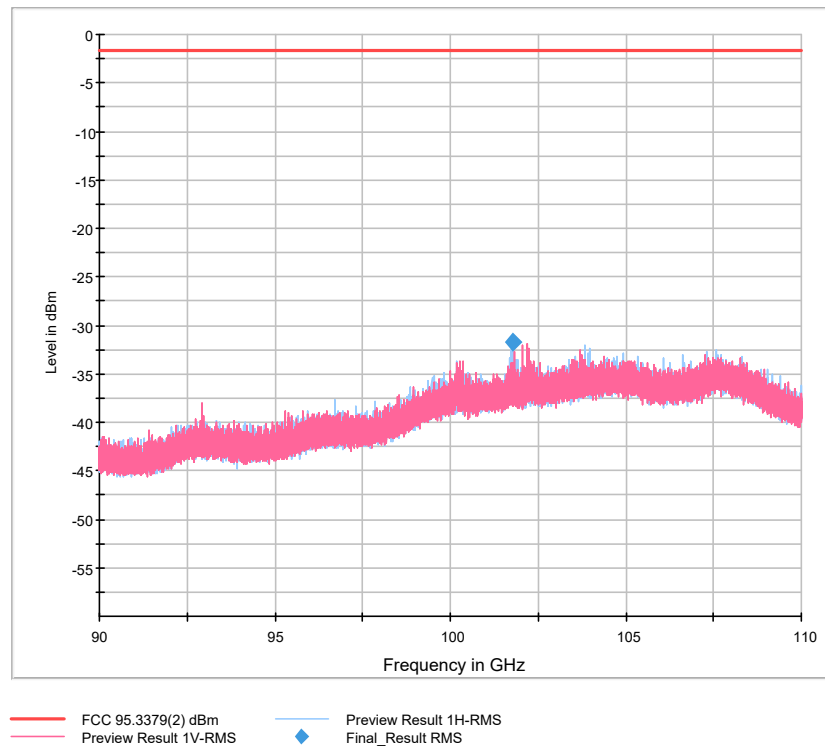




Final Results:

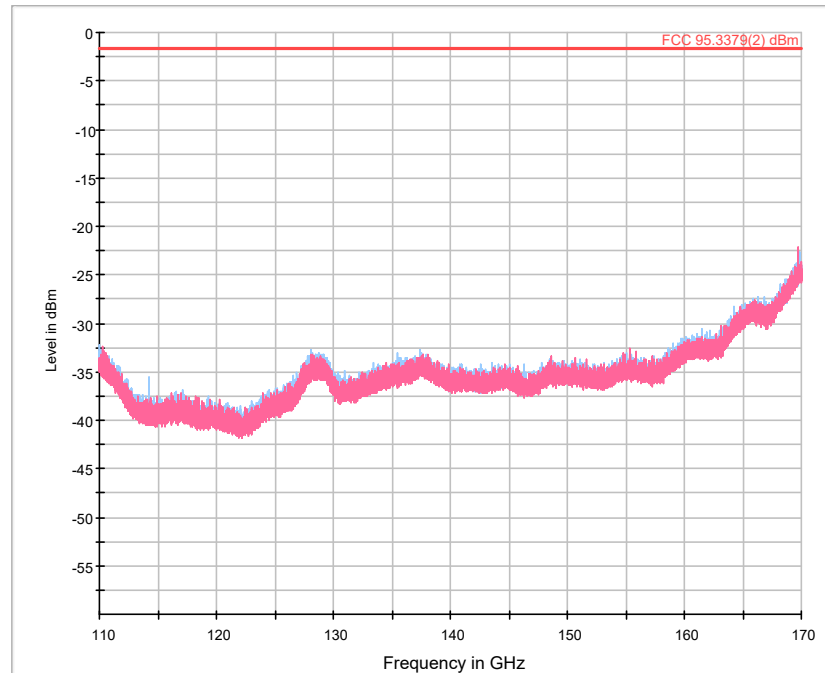
Frequency MHz	RMS dBm	Limit dBm	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
60079.687500	-30.06	-1.69	28.37	5.0	1000.000	150.0	H	138.0	-63.0
76415.625000	-8.10	-1.69	#1	5.0	1000.000	150.0	V	15.0	-62.9
76611.562500	-15.34	-1.69	#1	5.0	1000.000	150.0	V	15.0	-62.9

Note #1: intentional radiation

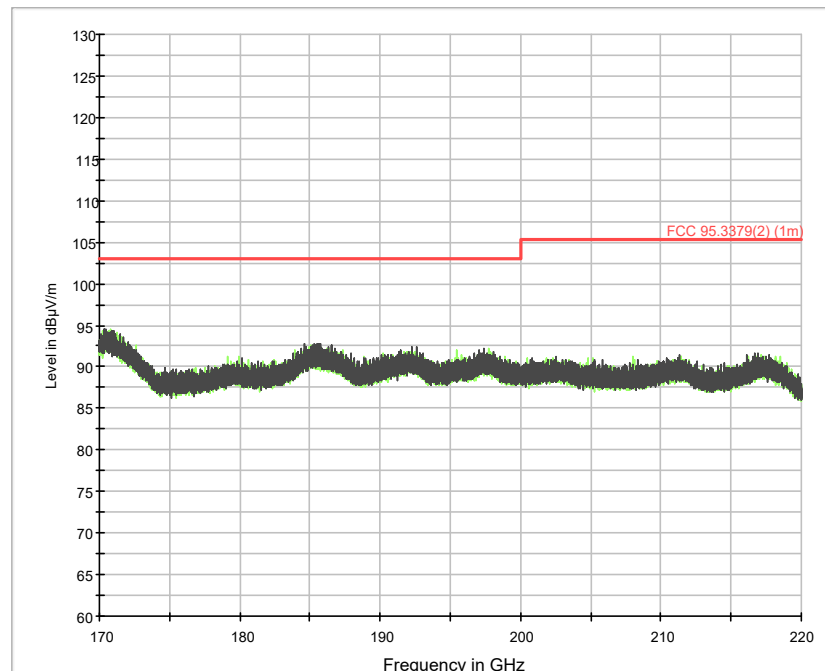


Final Results:

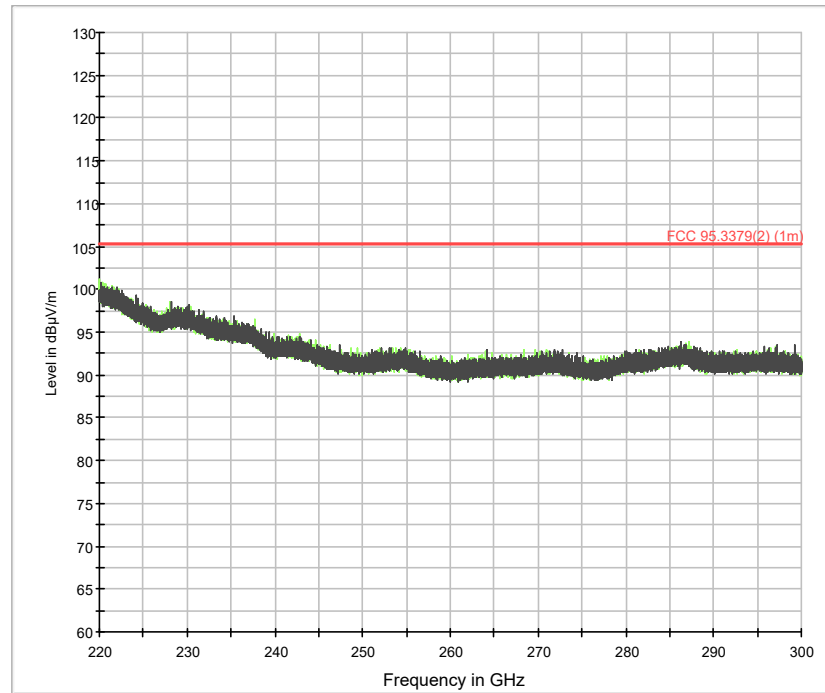
Frequency MHz	RMS dBm	Limit dBm	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
101783.750000	-31.74	-1.69	30.05	5.0	1000.000	150.0	H	359.0	-67.1



Preview Result 1H-RMS
Preview Result 1V-RMS
FCC 95.3379(2) dBm
Final_Result RMS

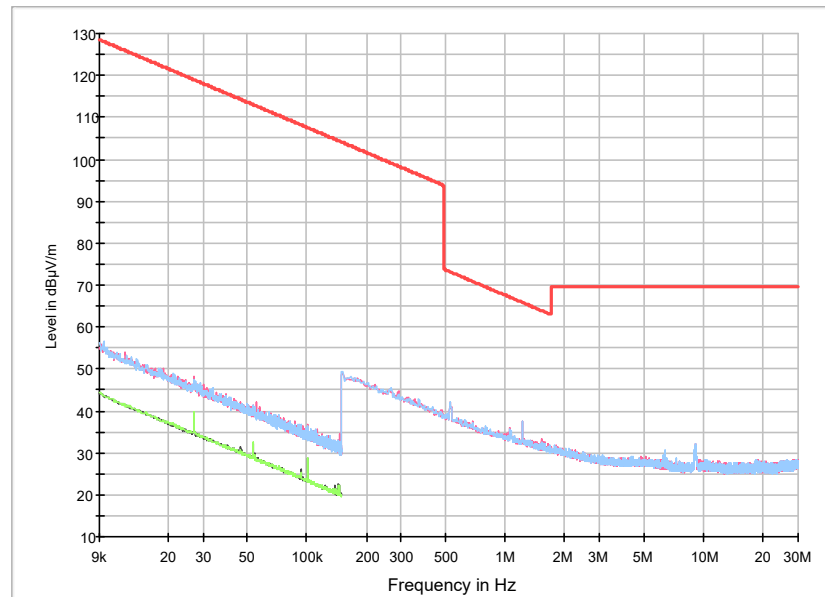


Preview Result 2H-RMS
Preview Result 2V-RMS
FCC 95.3379(2) (1m)
Final_Result RMS

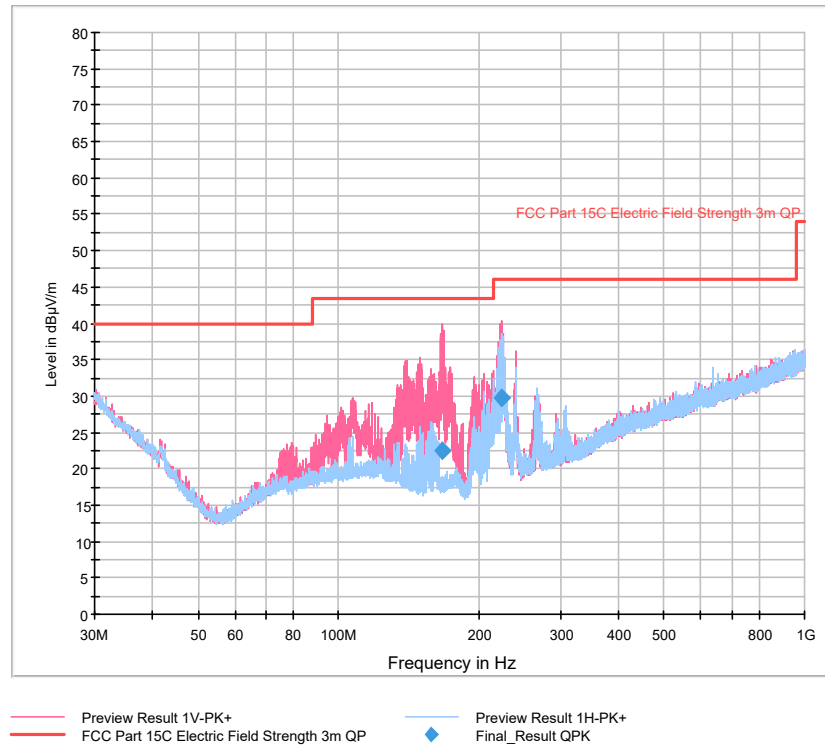


Preview Result 2H-RMS FCC 95.3379(2) (1m) Preview Result 2V-RMS

Plots taken during measurement: Highest channel, 425 MHz BW

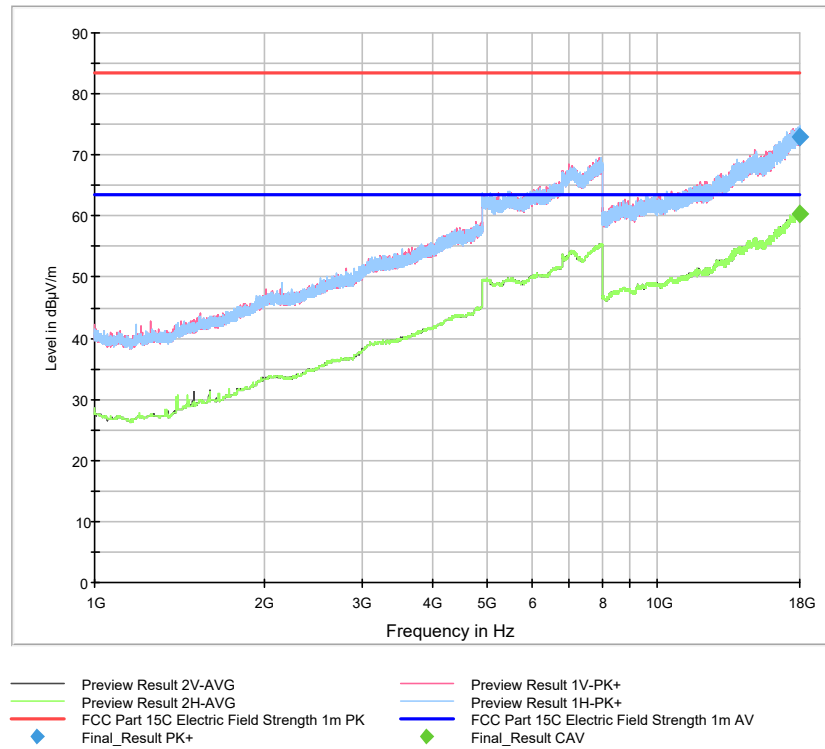


- Preview Result 2V-AVG
- Preview Result 1V-PK+
- Preview Result 2H-AVG
- Preview Result 1H-PK+
- FCC Part 15C Electric Field Strength 3m QP+AV (9k-30M)
- Final_Result QPK
- Final_Result CAV



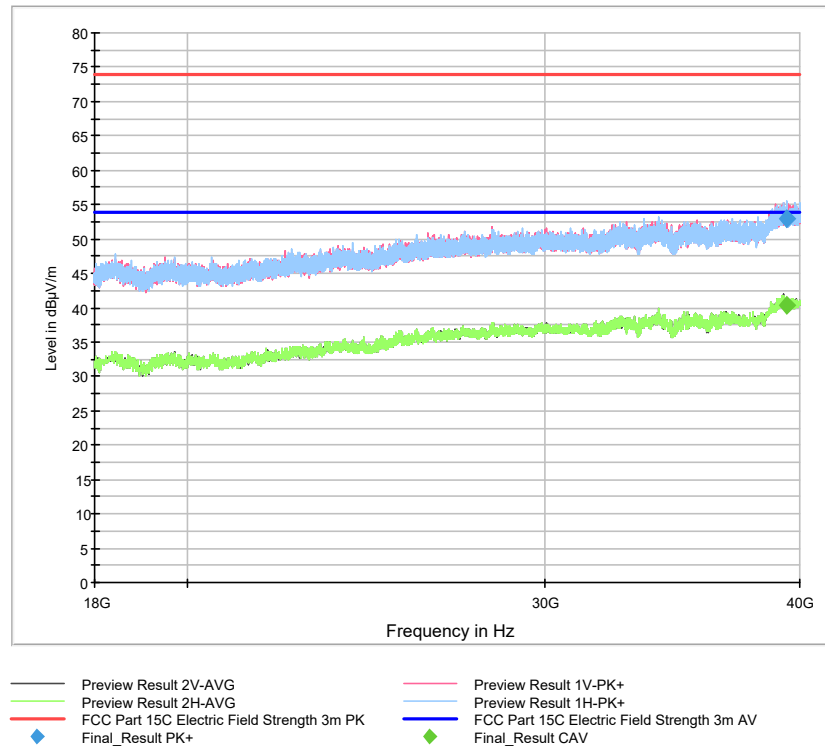
Final Results:

Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
166.740000	22.57	43.50	20.93	1000.0	120.000	131.0	V	152.0	15.4
223.980000	29.84	46.02	16.18	1000.0	120.000	100.0	V	190.0	16.2



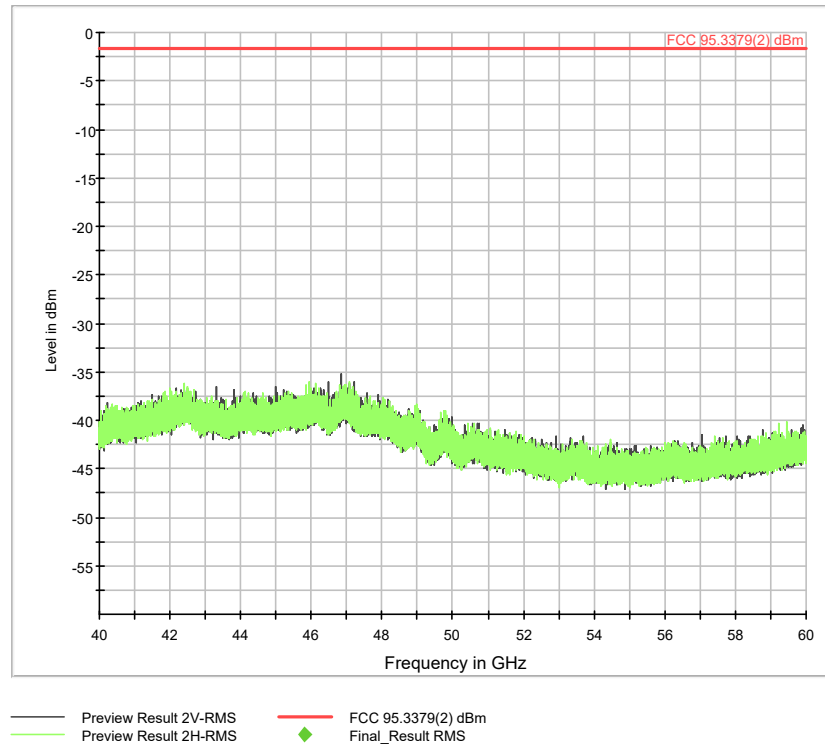
Final Results:

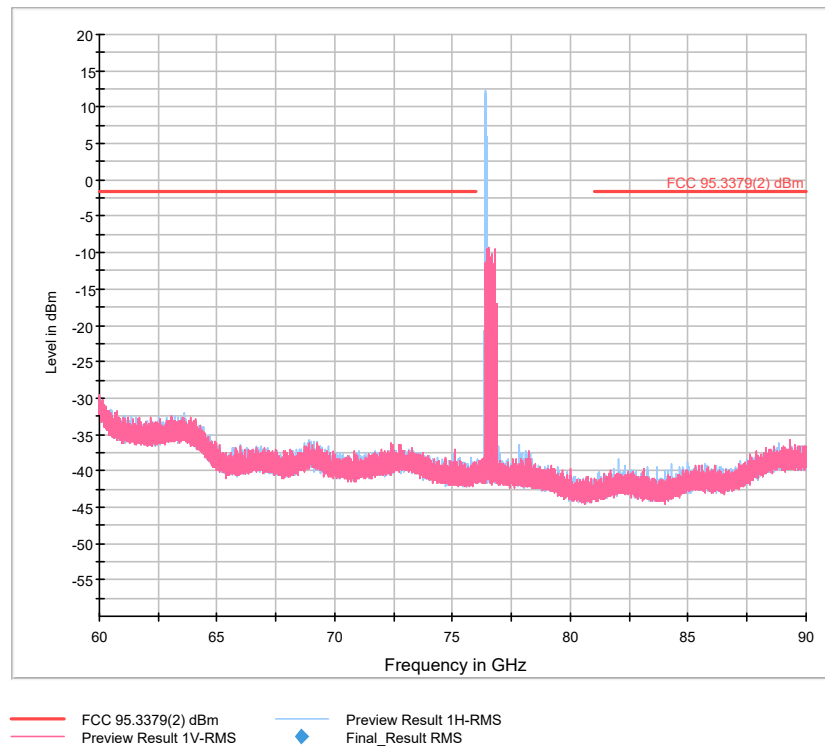
Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
17996.000000	---	60.33	63.50	3.17	1000.0	1000.000	158.0	H	33.0	59.3
17996.000000	73.00	---	83.50	10.50	1000.0	1000.000	158.0	H	33.0	59.3



Final Results:

Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
39399.000000	---	40.31	53.98	13.67	1000.0	1000.000	156.0	H	-41.0	36.3
39399.000000	53.01	---	73.98	20.97	1000.0	1000.000	156.0	H	-41.0	36.3

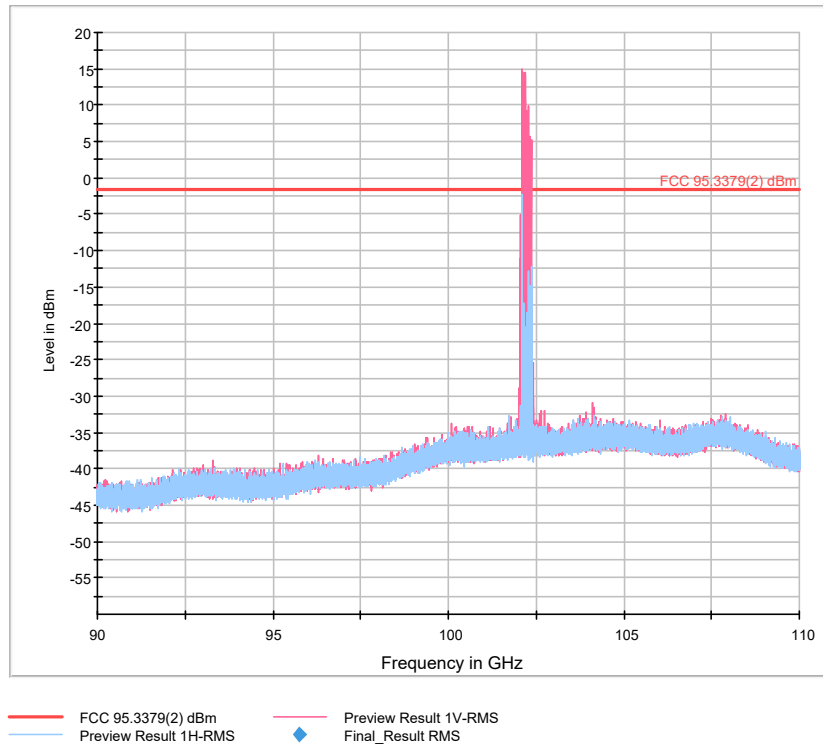




Final Results:

Frequency MHz	RMS dBm	Limit dBm	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
60147.187500	-30.17	-1.69	28.48	5.0	1000.000	150.0	H	206.0	-63
76350.000000	-23.71	#1	#1	5.0	1000.000	150.0	H	3.0	-63
76410.000000	12.24	#1	#1	5.0	1000.000	150.0	H	3.0	-63
76860.000000	-17.29	#1	#1	5.0	1000.000	150.0	V	33.0	-63

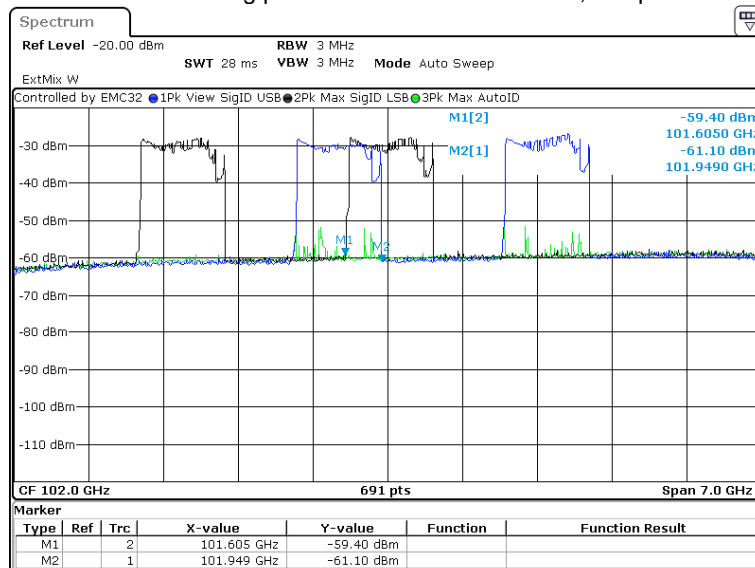
Note #1: intentional radiation



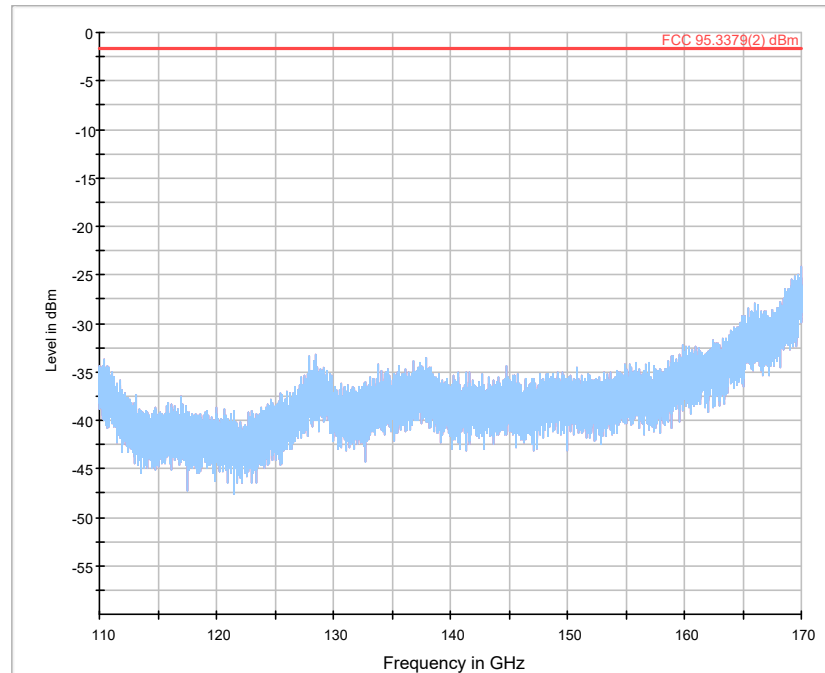
Final Results:

Frequency MHz	RMS dBm	Limit dBm	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
102000,000000	-29,84	-1.69	#1	5,0	1000,000	150,0	V	0,0	-67,1
102080,625000	14,94	-1.69	#1	5,0	1000,000	150,0	V	0,0	-67,1
102398,750000	-25,30	-1.69	#1	5,0	1000,000	150,0	V	0,0	-67,1

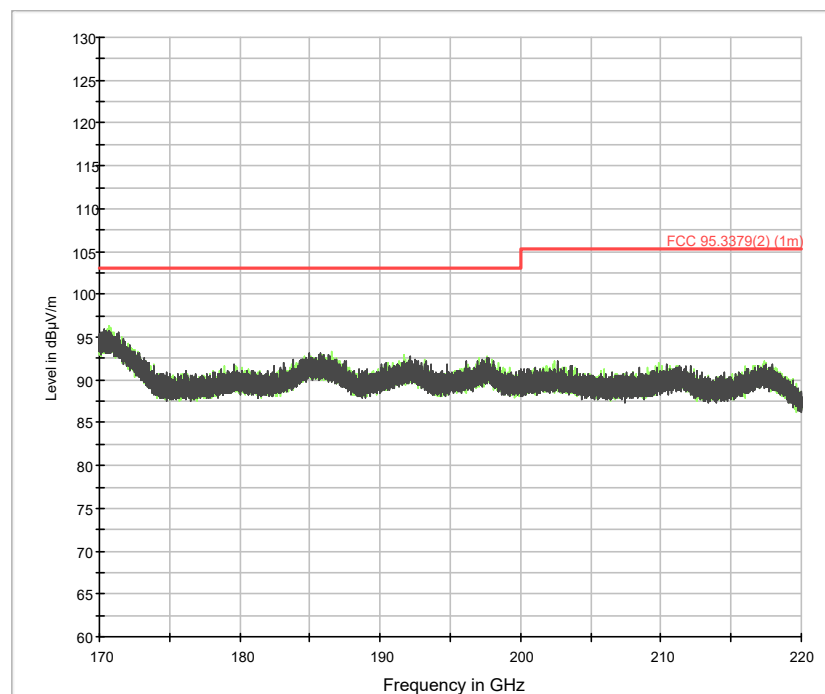
Note #1: Emissions around 102 GHz are a mixing product and therefore not real, see plot below.



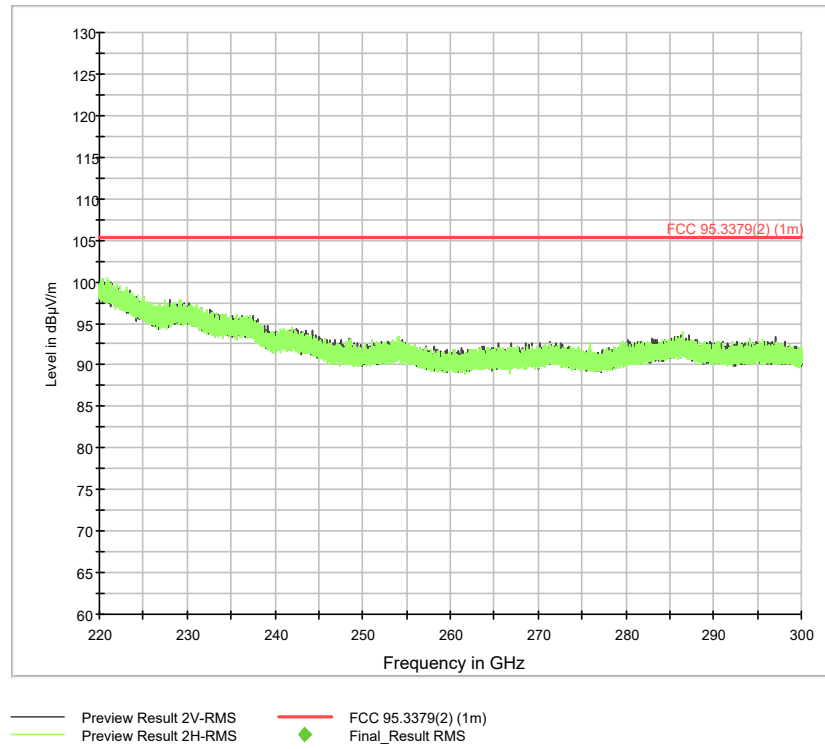
Date: 5 APR.2022 17:23:07



Preview Result 1V-RMS Preview Result 1H-RMS
FCC 95.3379(2) dBm Final_Result RMS



Preview Result 2H-RMS Preview Result 2V-RMS FCC 95.3379(2) (1m)





10.4 Frequency Stability

Date of Test	2022-04-06
Operator	Alex Fink, Martin Steindl
Test Site	Non shielded room

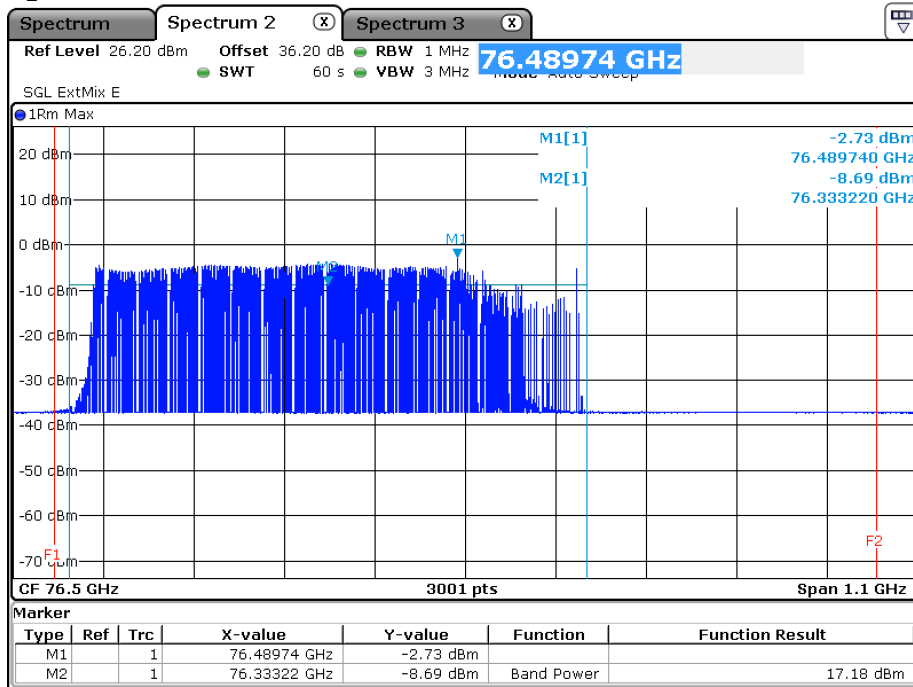
Prüfergebnis / Test Result	
<input checked="" type="checkbox"/>	Erfüllt / Passed
<input type="checkbox"/>	Nicht erfüllt / Not passed

Barometric pressure:	968 hPa
Relative humidity:	33 %
Ambient temperature:	22 °C

Specifications:	CFR 47. Part 95. Subpart M. §95.3379(b) RSS-251. Issue 2. Section 11
Description:	b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 °C to 50 °C with a input voltage variation of 85 % to 115 % of rated input voltage unless justification is presented to demonstrate otherwise.
Operation mode:	Continuously Transmitting with modulation.
Comment :	See plots of tests for details.

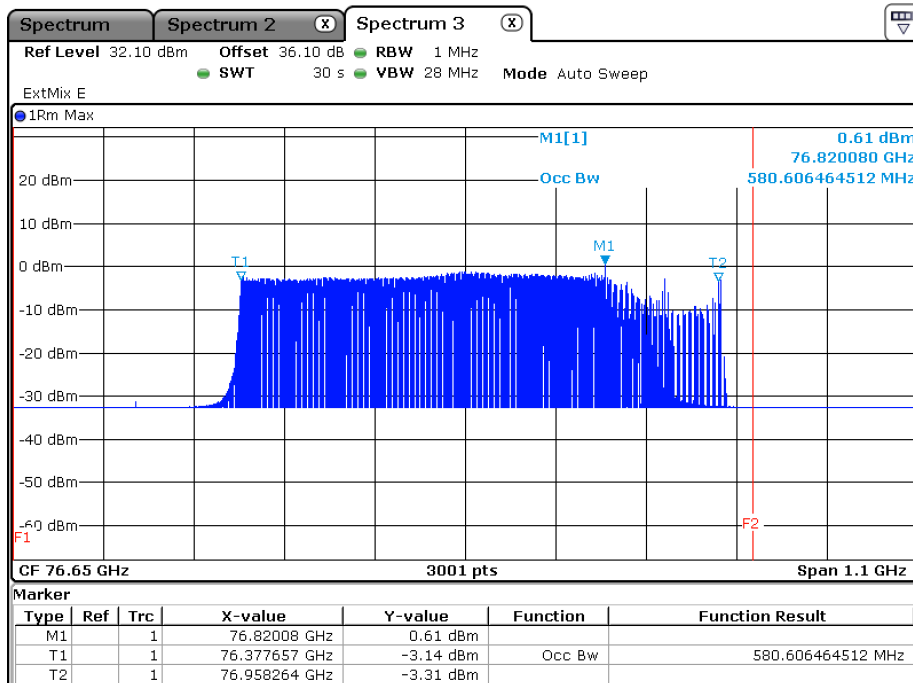
All emissions are within the 76 – 77 GHz frequency band.
 See plots for details

Plots taken during test



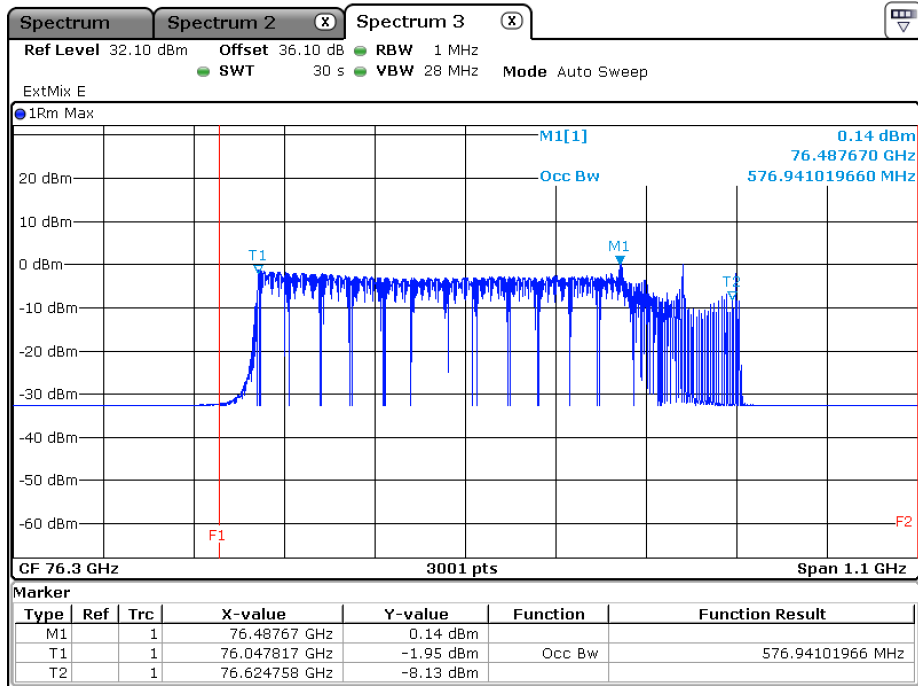
Date: 6.APR.2022 12:57:31

Continuously Transmitting with modulation - 9.2 V DC power supply



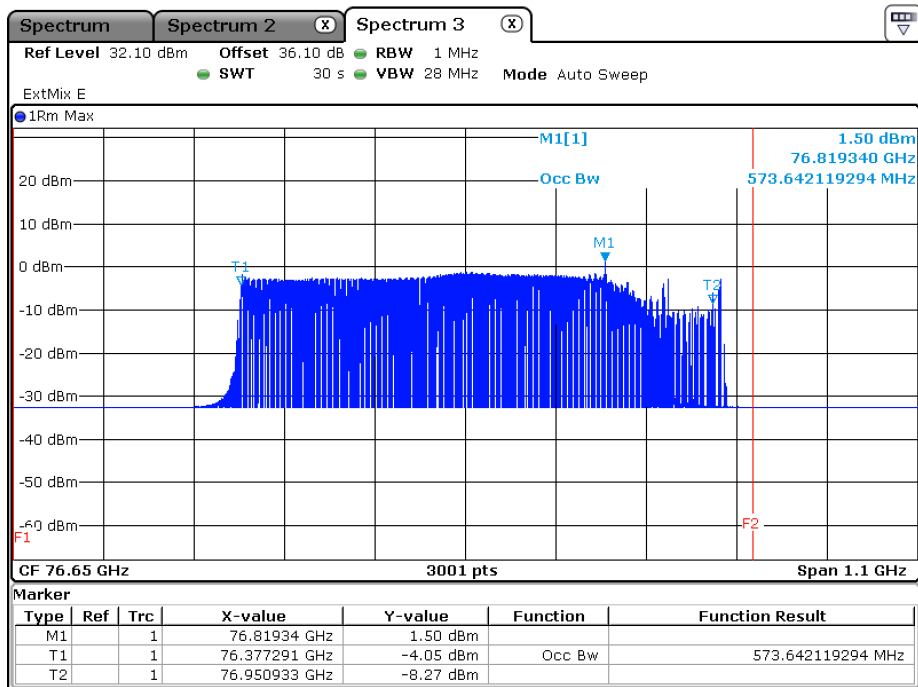
Date: 6.APR.2022 21:29:14

Continuously Transmitting with modulation - 17.0 V DC power supply



Date: 6.APR.2022 21:12:50

Continuously Transmitting with modulation - 12 V DC power supply. -40°C



Date: 6.APR.2022 21:32:10

Continuously Transmitting with modulation - 12 V DC power supply. +85°C



11 Revision History

Revision History			
<i>Revision</i>	<i>Date</i>	<i>Issued by</i>	<i>Modifications</i>
0	2022-04-13	Alex Fink	First Revision