8.4 FCC 96.41(e)(1) 3.5 GHz emissions and interference limits

8.4.1 Definitions and limits

General protection levels. Except as otherwise specified in paragraph (e)(2) of this section, for channel and frequency assignments made by the SAS to CBSDs, the conducted power of any emission outside the fundamental emission (whether in or outside of the authorized band) shall not exceed −13 dBm/MHz within 0–10 MHz above the upper SAS-assigned channel edge and within 0–10 MHz below the lower SAS-assigned channel edge. At all frequencies greater than 10 MHz above the upper SAS assigned channel edge and less than 10 MHz below the lower SAS assigned channel edge, the conducted power of any emission shall not exceed −25 dBm/MHz. The upper and lower SAS assigned channel edges are the upper and lower limits of any channel assigned to a CBSD by an SAS, or in the case of multiple contiguous channels, the upper and lower limits of the combined contiguous channels.

(3) Measurement procedure. (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (i.e., 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

8.4.2 Test summary

Verdict	Pass		
Test date	December 4, 2018	Temperature	23 °C
Test engineer	Martha Espinoza, EMC & Wireless Test Engineer	Air pressure	1005 mbar
Test location	Wireless Bench	Relative humidity	32 %

Test summary Note:
For 10MHz Emissions mask – the closest emission to the limit is -7.29dB from High Channel 16QAM plot below. Therefore since this is a conducted limit and the emissions at the antenna port would be from Ports 0 and 1 an additional worst case 3dB has to be added to the result. Therefore the EUT emissions mask worst case emission is 4.29dB under the limit. (Ports 2 and 3 are identical uncorrelcated outputs)

For 20MHz Emissions mask – the closest emission to the limit is -6.36dB from High Channel QPSK plot below. Therefore since this is a conducted limit and the emissions at the antenna port would be from Ports 0 and 1 an additional worst case 3dB has to be added to the result. Therefore the EUT emissions mask worst case emission is 3.36dB under the limit. (Ports 2 and 3 are identical uncorrelcated outputs)

8.4.3 Observations, settings and special notes

Spectrum analyser settings for measurements within 1 MHz from the SAS assigned channel edges:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	RMS
Trace mode	Power averaging
Power integration	Over 100 kHz for 10 MHz channel; Over 200 kHz for 20 MHz channel

Spectrum analyser settings for measurements outside 1 MHz from the SAS assigned channel edges:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	RMS
Trace mode	Power averaging

OFFSET Calculaton:
For 10MHz Spurious and emission mask offset is 38.2 dB. 38.2dB = 30.2dB (Attenuator) + 8dB (cable loss)

20 MHz Spurious and emission mask plots offset is 11.01. 11.01 = 10dB (Attenuator) = 1.01dB (cable loss)

The correction factor was applied properly in each case, for compensated the loss caused by the attenuator and the cables losses.

Note: The EUT has 4 identical ports with four identical configurations. Port 0 was determined to represent worse case and is displayed below to demonstrate compliance to the FCC 96.41(e)(1) 3.5 GHz emissions and interference limits. Ports 1 ,2 and 3 data measurement results are available if required.

8.4.4 Test data

Table 8.4-1 Emission mask measurements for 10 MHz channel Port 0, Low, Mid and High Channel

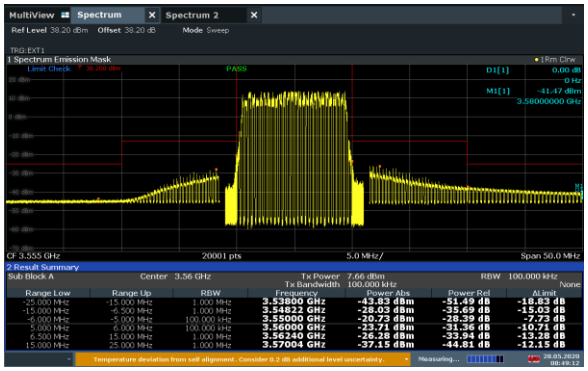


Figure 8.4-1: Emission mask measurements plot port 0, Low channel (3555 MHz), 16QAM

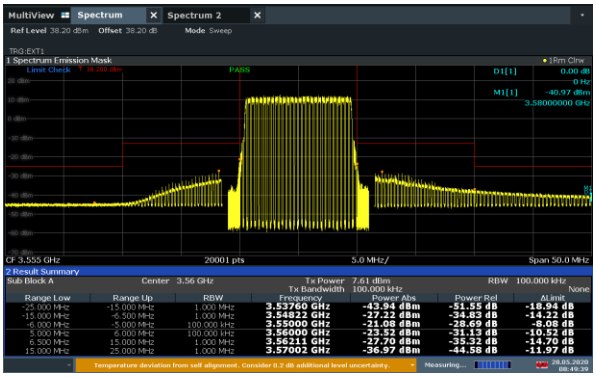


Figure 8.4-2: Emission mask measurements plot port 0, Low channel (3555 MHz), 64QAM

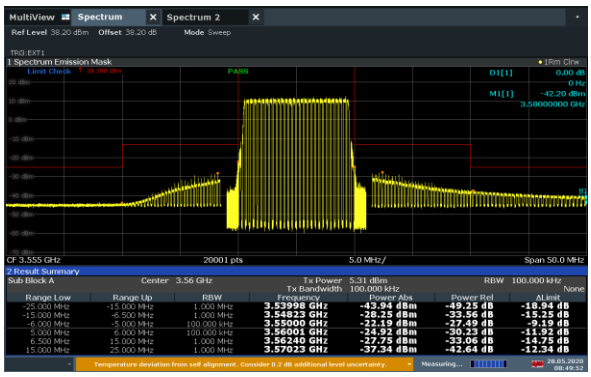


Figure 8.4-3: Emission mask measurements plot port 0, Low channel (3555 Hz), QPSK

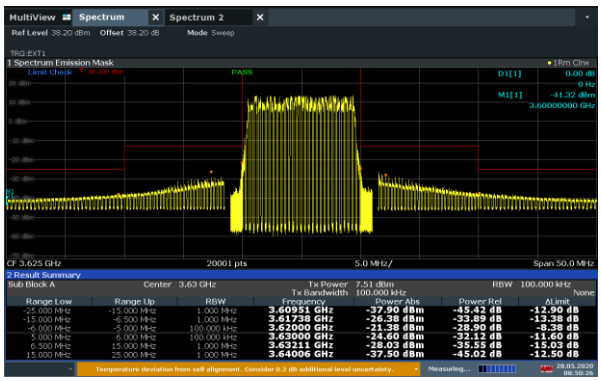


Figure 8.4-4: Emission mask measurements plot port 0, Mid channel (3625 MHz), 16QAM

8.4.4 Test data

Tables 8.4-2: Emission mask measurements for 10 MHz channel Port 0, Low, Mid and High Channel

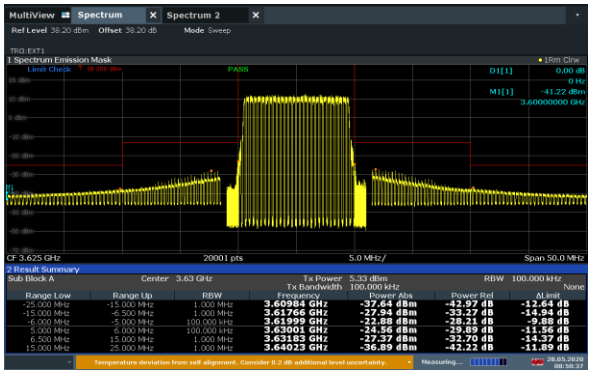


Figure 8.4-5: Emission mask measurements plot port 0, Mid channel (3625 MHz), 64QAM

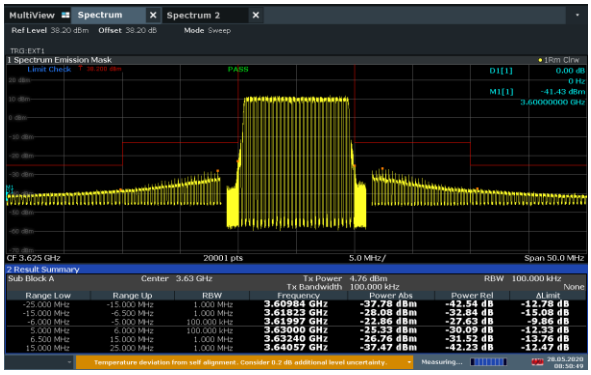


Figure 8.4-6: Emission mask measurements plot port 0, Mid channel (3555 MHz), QPSK

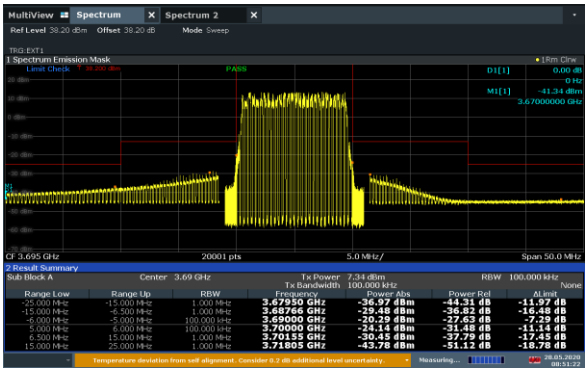


Figure 8.4-7: Emission mask measurements plot port 0, High channel (3695 MHz), 16QAM

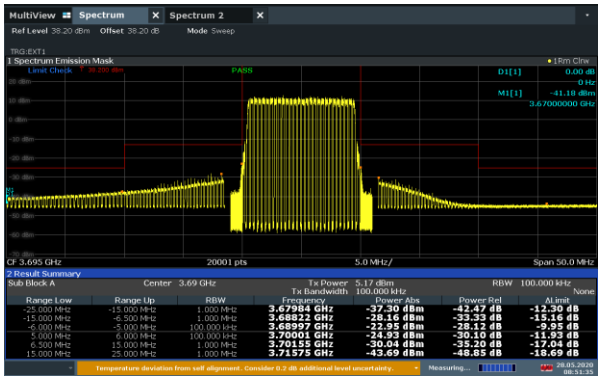


Figure 8.4-8: Emission mask measurements plot port 0, High channel (3695 MHz), 64QAM

8.4.4 Test data

Table 8.4-3: Emission mask measurements for 10 MHz channel Port 0, Showing worst case High Channel

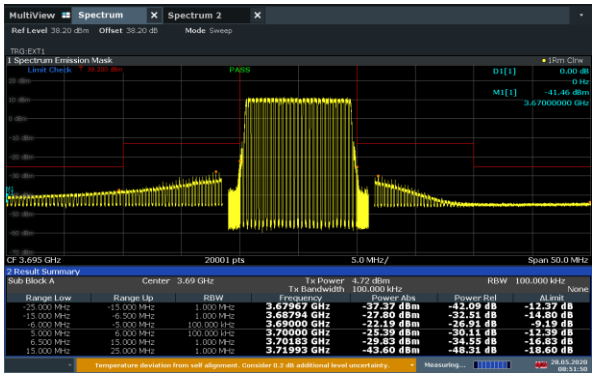


Figure 8.4-9: Emission mask measurements plot port 0, High channel (3695 MHz), QPSK

Table 8.4-4: Emission mask measurements for 20 MHz channel Port 0, Low, Mid and High Channel Worst case – QPSK Data

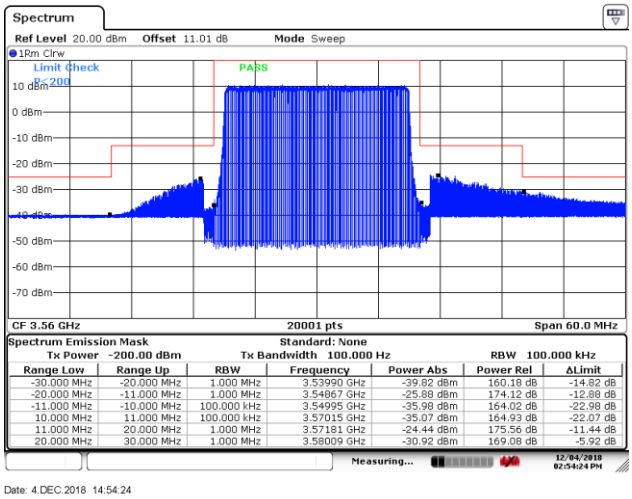


Figure 8.4-10: 20 MHz Emission mask measurements plot port 0, Low channel (3560 MHz), QPSK

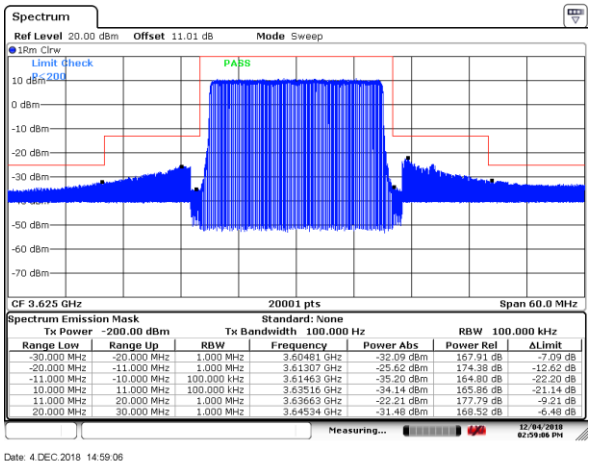


Figure 8.4-11: 20 MHz Emission mask measurements plot port 0, Mid channel (3625 MHz), QPSK

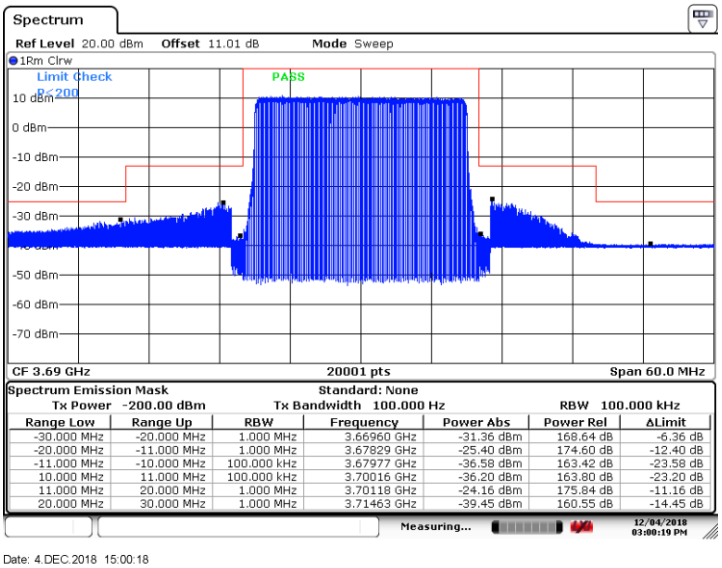


Figure 8.4-12: 20 MHz Emission mask measurements plot port 0, High channel (3690 MHz), QPSK

8.5 FCC 96.41(e)(2) Additional protection levels

8.5.1 Definitions and limits

The conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed −40dBm/MHz.

8.5.2 Test summary

Verdict	Pass		
Test date	December 10, 2018	Temperature	21 °C
Test engineer	Martha Espinoza, EMC & Wireless Test Engineer	Air pressure	1005 mbar
Test location	Wireless Bench	Relative humidity	57 %

Conducted Spurious emissions compliance note: The closest spurious emission noted during conducted scans was at least 4dB below the required limit. Therefore when adding the Port 0 and Port 1 and additional 3dB has to be added. Adding the 3dB to the Port 0 plots below still still demonstrates compliance for the EUT.

8.5.3 bservations, settings and special notes

Spurious emissions were tested from 30 MHz to the 10th harmonic. To conducted and radiated spurious measurements only worst case was measuremed (16QAM) in each port.
A 10 dB attenuator was used and a high pass filter (from the 7 to 18 GHZ only) too for making all the measurements. The correction factor was applied properly in each case, for compensated the loss caused by those devices (conducted and radiated measurements).

Spectrum analyser settings:

Resolution bandwidth	100 kHz (radiated below 1 GHz) and 1 MHz (radiated above 1 GHz); 1 MHz (conducted)
Video bandwidth	3 × RBW
Detector and trace mode	RMS Power averaging (conducted), Peak Max-hold (radiated)

8.5.4 Test data

All the measurements were done using 16QAM modulation because it was considered the worst case. Criterion based on the measurements made previously.

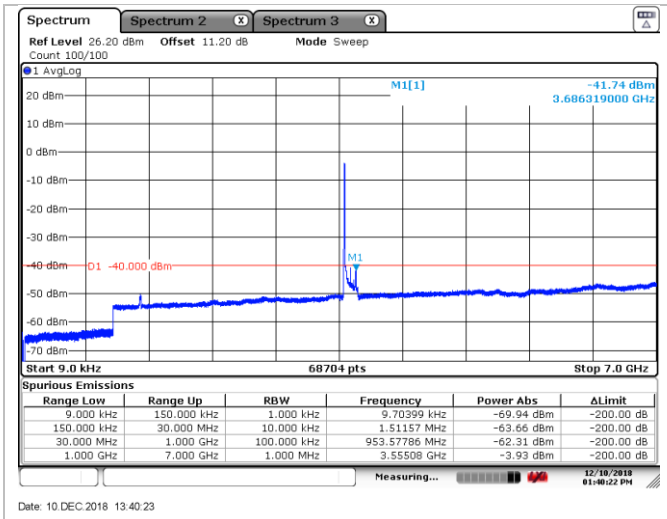


Figure 8.5-1: Conducted spurious graphic. Port 0, low channel (3555 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

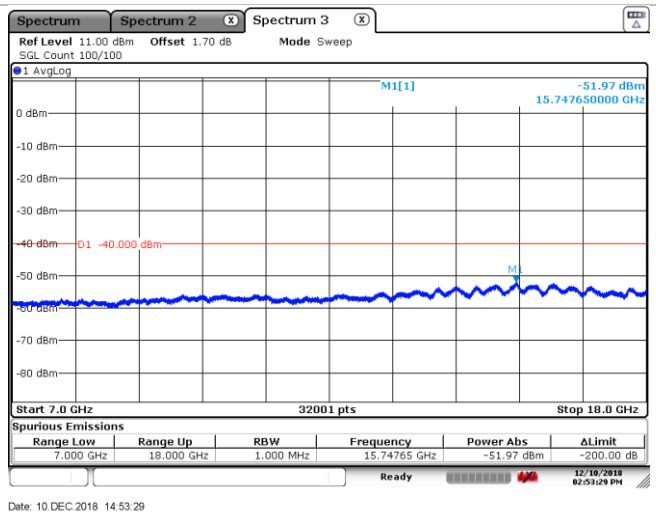


Figure 8.5-2: Conducted spurious graphic.Port 0, low channel (3555 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

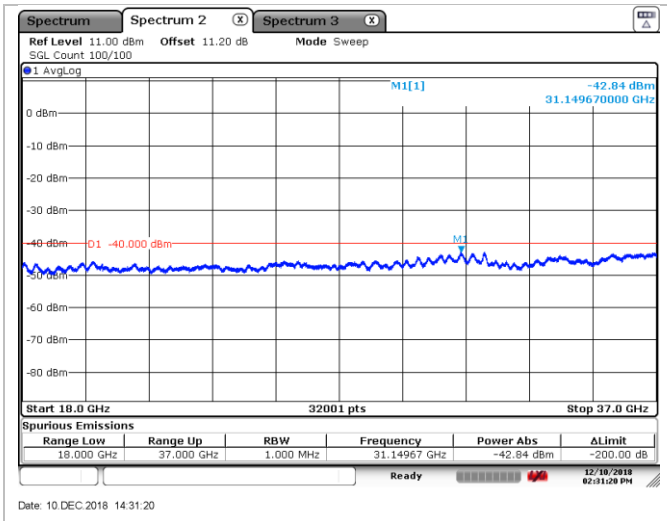


Figure 8.5-3: Conducted spurious graphic. Port 0, low channel (3555 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

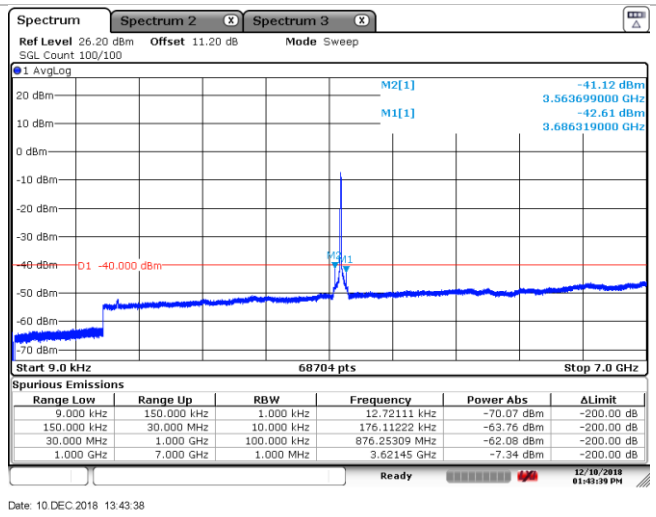


Figure 8.5-4: Conducted spurious graphic. Port 0, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

8.5.4 Test data, continued

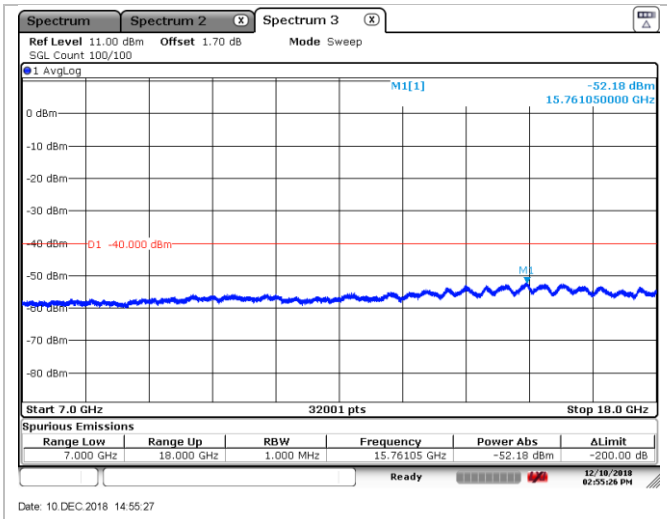


Figure 8.5-5: Conducted spurious graphic. Port 0, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

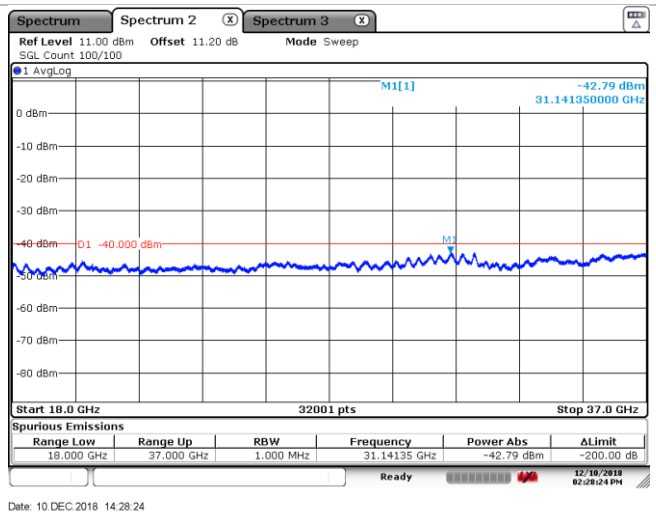


Figure 8.5-6: Conducted spurious graphic.Port 0, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

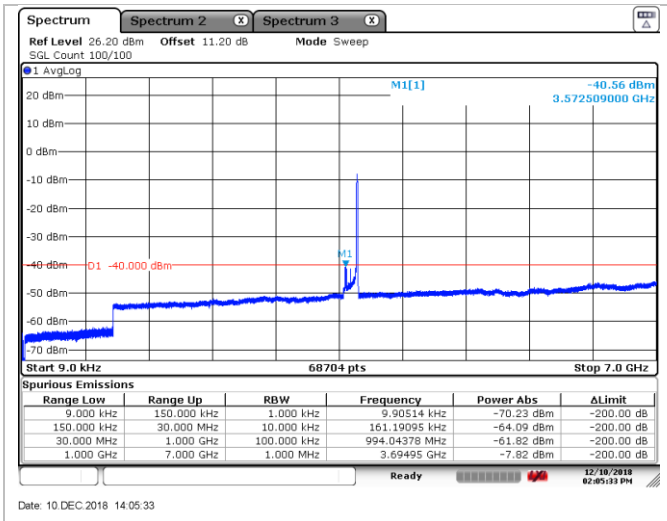


Figure 8.5-7: Conducted spurious graphic. Port 0, high channel (3695 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

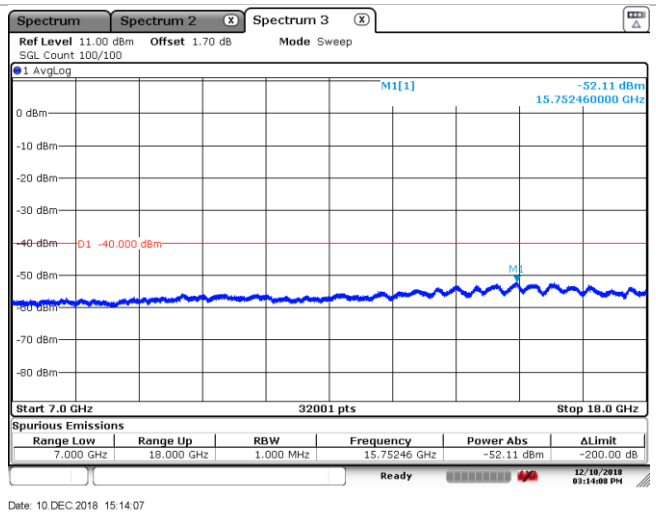


Figure 8.5-8: Conducted spurious graphic. Port 0, high channel (3695 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

8.5.4 Test data, continued

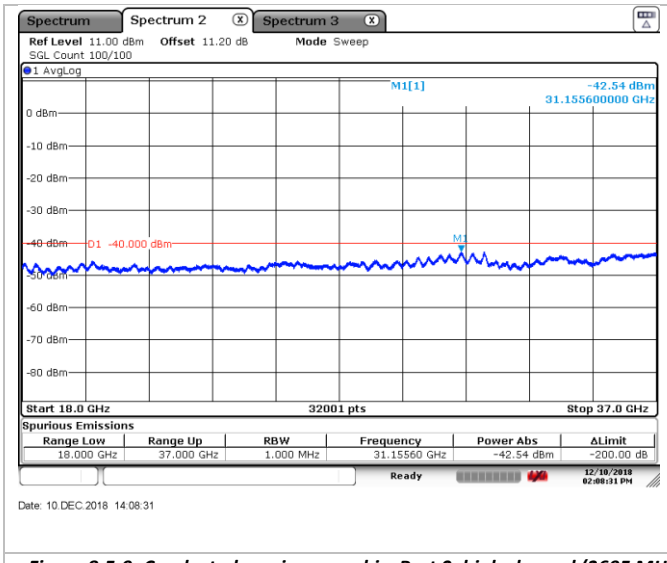


Figure 8.5-9: Conducted spurious graphic. Port 0, high channel (3695 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

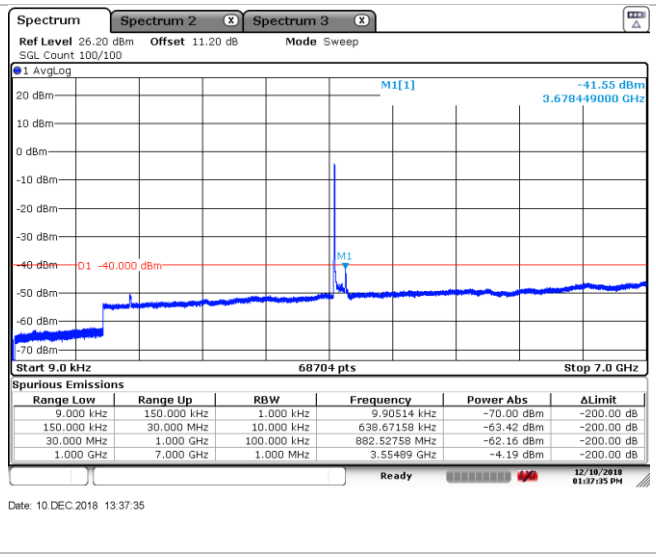


Figure 8.5-10: Conducted spurious graphic. Port 1, low channel (3555 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

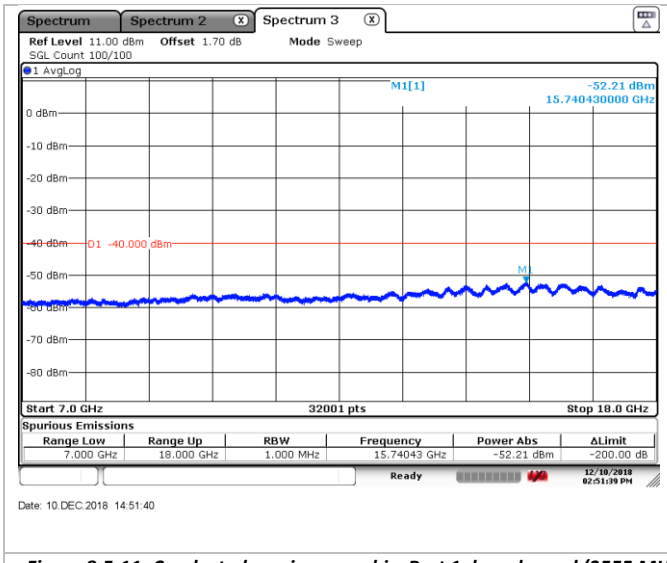


Figure 8.5-11: Conducted spurious graphic. Port 1, low channel (3555 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

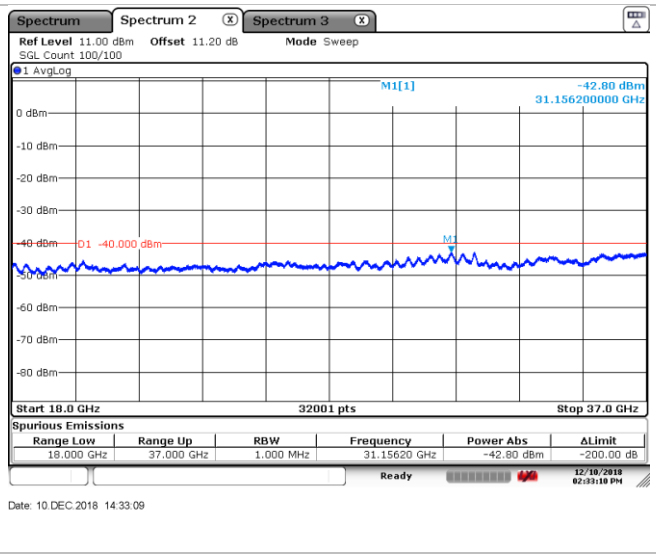


Figure 8.5-12: Conducted spurious graphic. Port 1, low channel (3555 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

8.5.4 Test data, continued

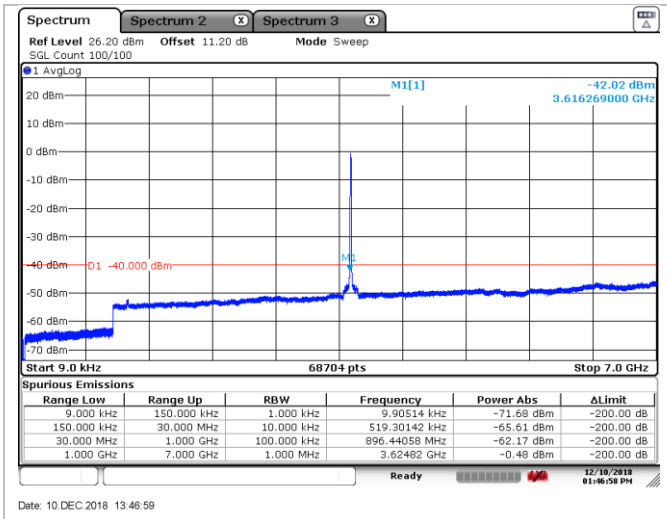


Figure 8.5-13: Conducted spurious graphic. Port 1, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

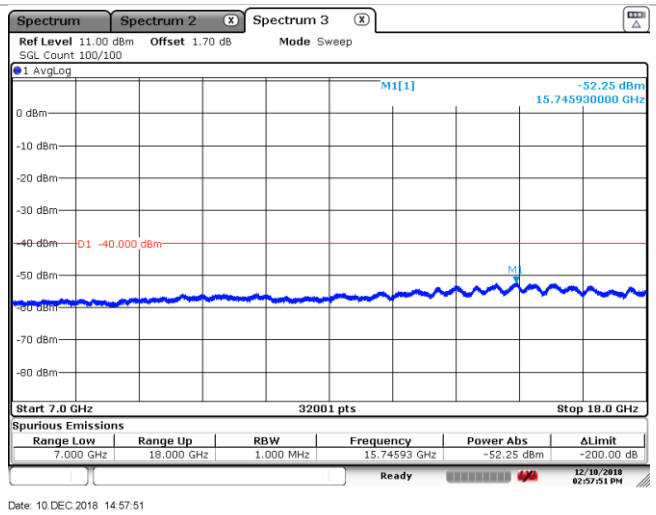


Figure 8.5-14: Conducted spurious graphic.Port 1, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

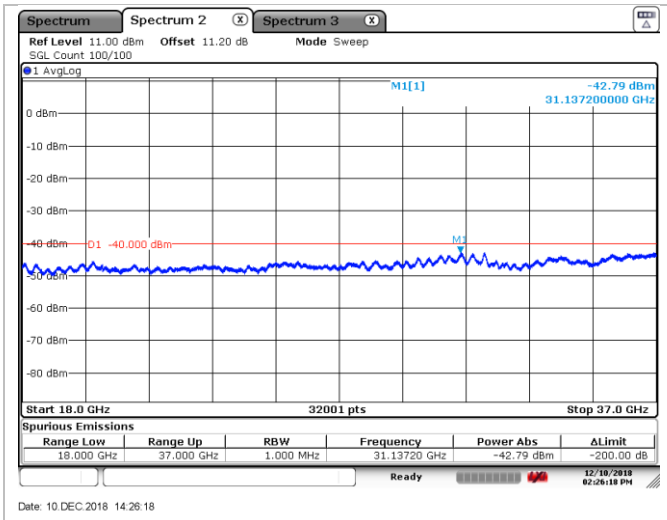


Figure 8.5-15: Conducted spurious graphic. Port 1, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

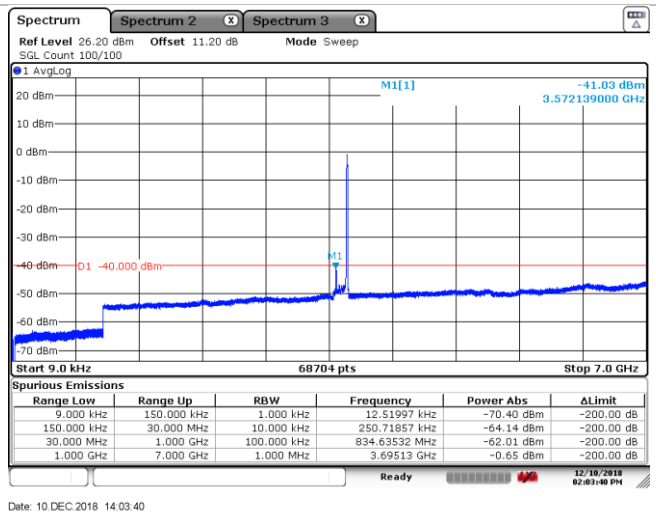


Figure 8.5-16: Conducted spurious graphic. Port 1, high channel (3695 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

8.5.4 Test data, continued

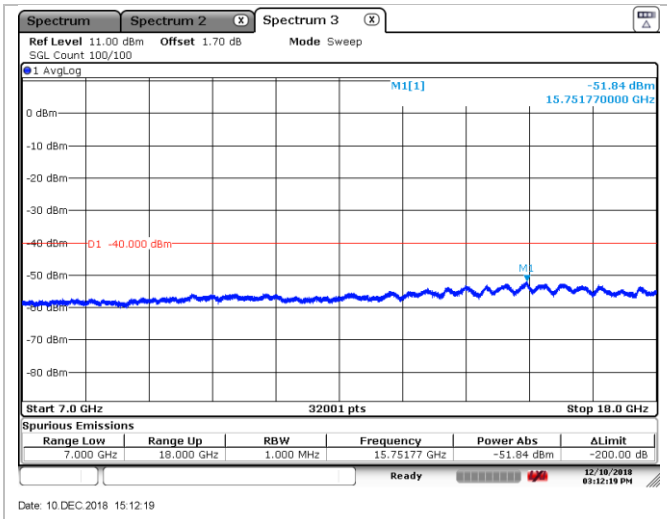


Figure 8.5-17: Conducted spurious graphic. Port 1, high channel (3695 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

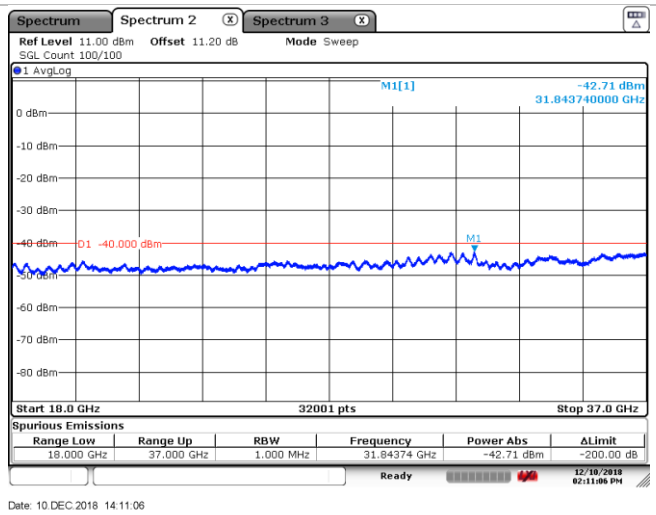


Figure 8.5-18: Conducted spurious graphic. Port 1, high channel (3695 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

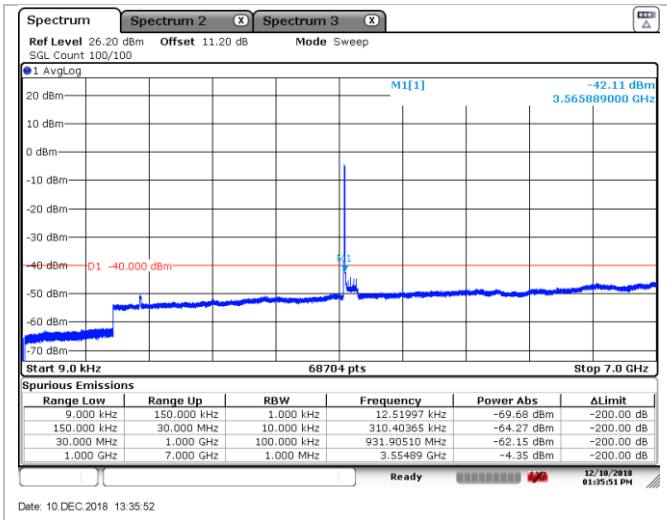


Figure 8.5-19: Conducted spurious graphic. Port 2, low channel (3555 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

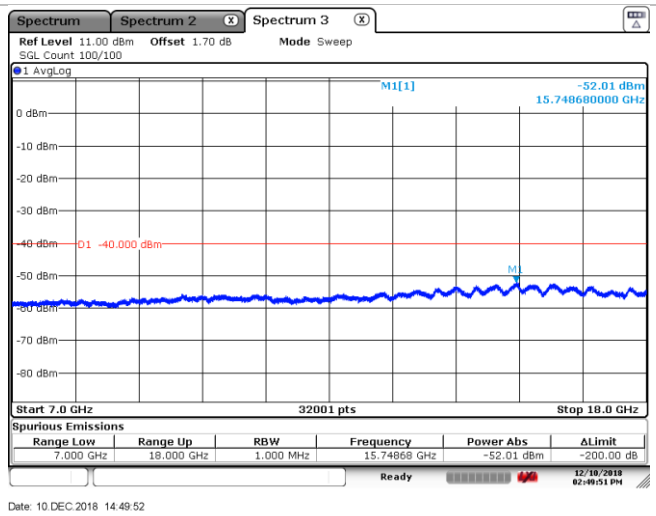


Figure 8.5-20: Conducted spurious graphic. Port 2, low channel (3555 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

8.5.4 Test data, continued

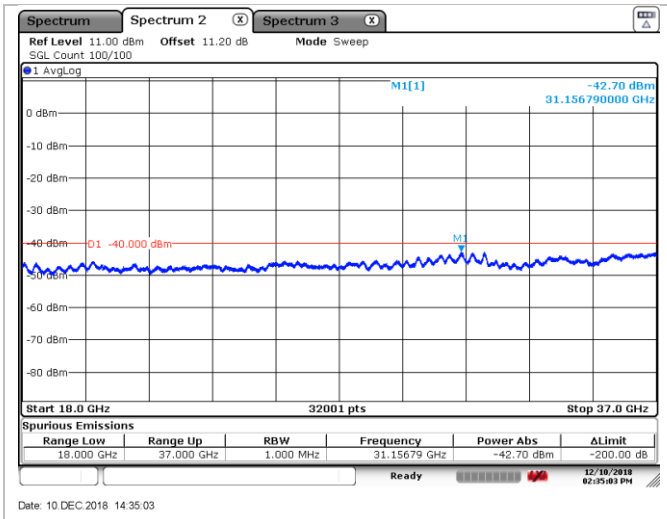


Figure 8.5-21: Conducted spurious graphic. Port 2, low channel (3555 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

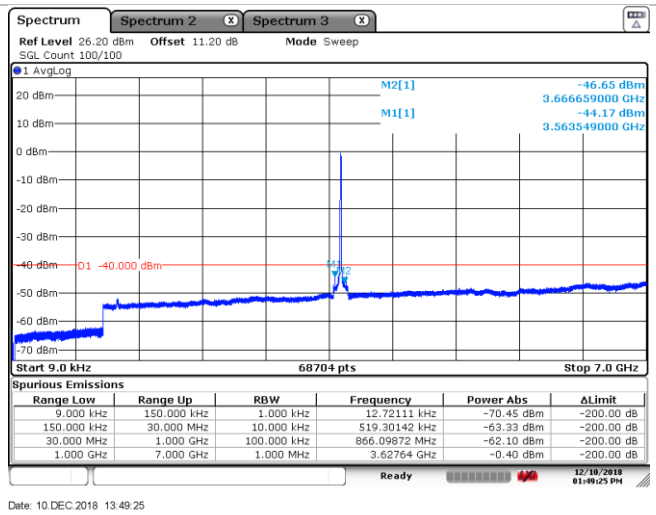


Figure 8.5-22: Conducted spurious graphic. Port 2, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

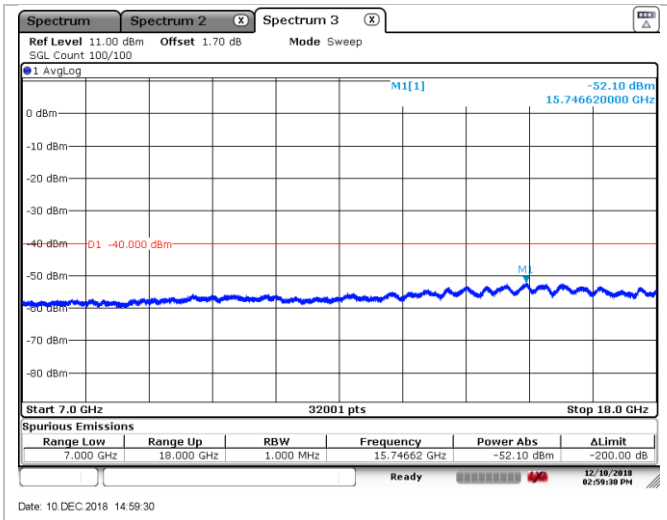


Figure 8.5-23: Conducted spurious graphic. Port 2, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

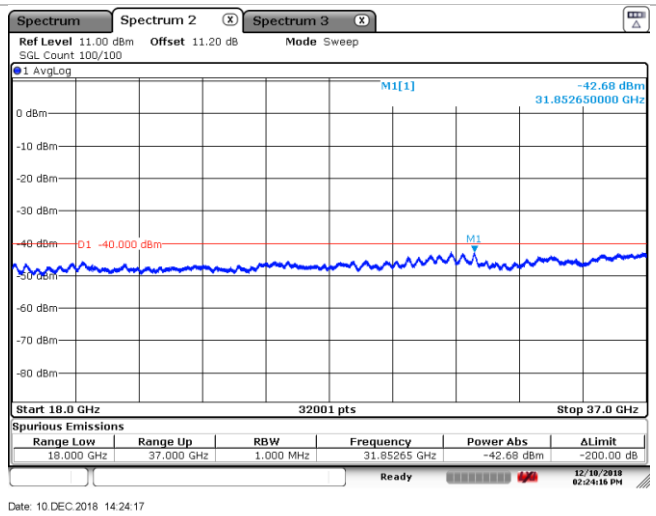


Figure 8.5-24: Conducted spurious graphic. Port 2, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

8.5.4 Test data, continued

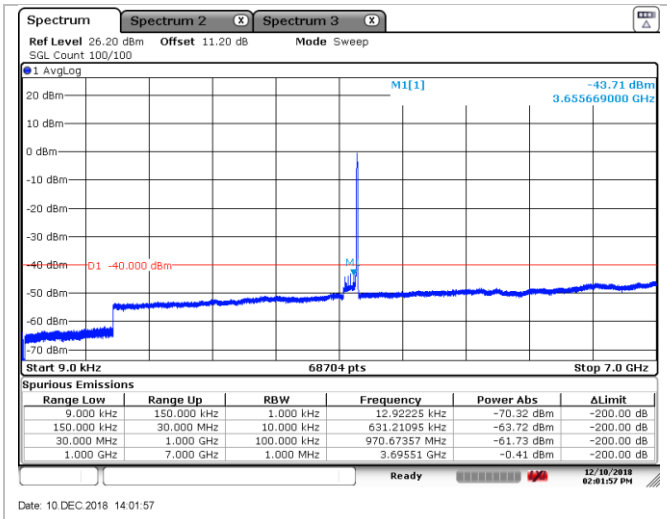


Figure 8.5-25: Conducted spurious graphic. Port 2, high channel (3695 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

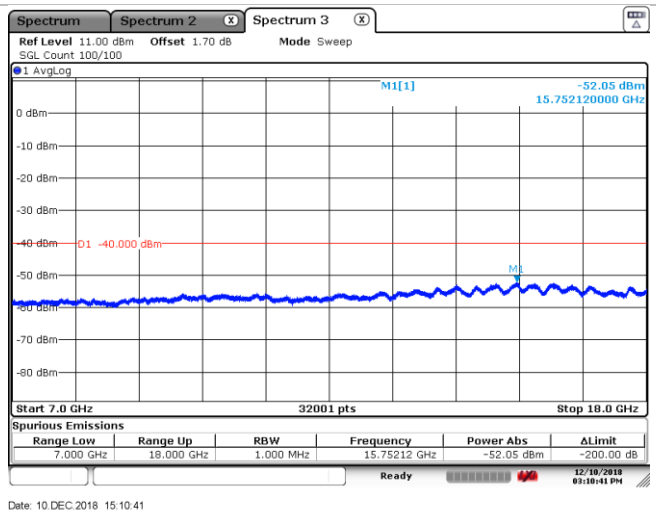


Figure 8.5-26: Conducted spurious graphic. Port 2, high channel (3695 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

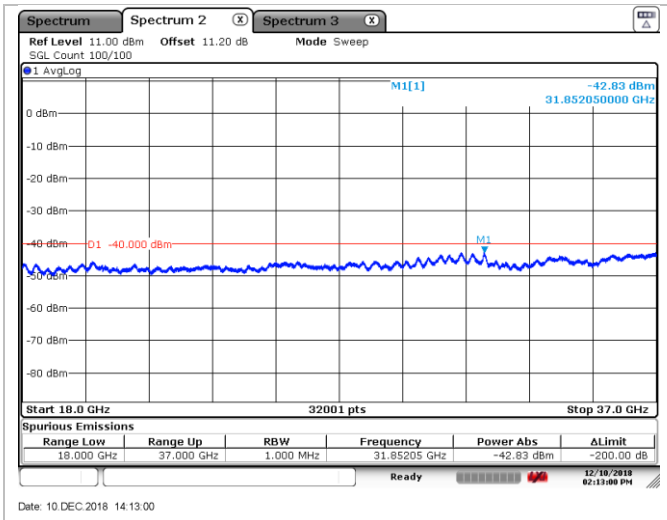


Figure 8.5-27: Conducted spurious graphic. Port 2, high channel (3695 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

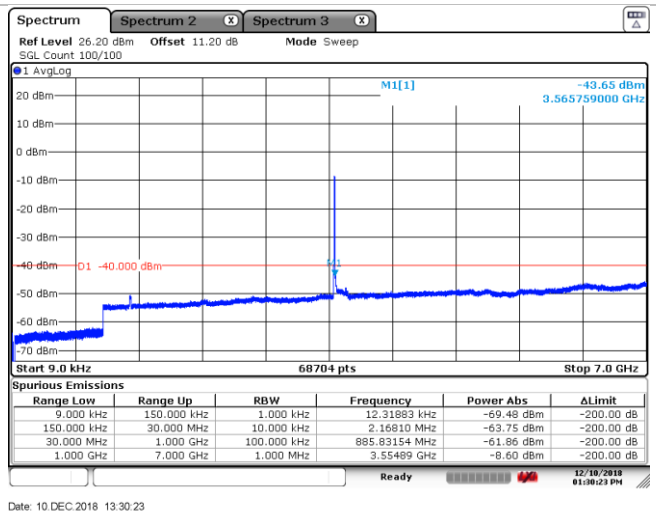


Figure 8.5-28: Conducted spurious graphic. Port 3, low channel (3555 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

8.5.4 Test data, continued

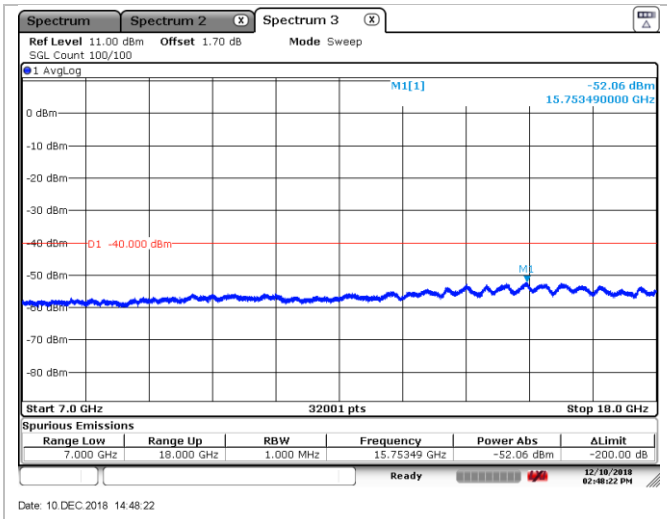


Figure 8.5-29: Conducted spurious graphic. Port 3, low channel (3555 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

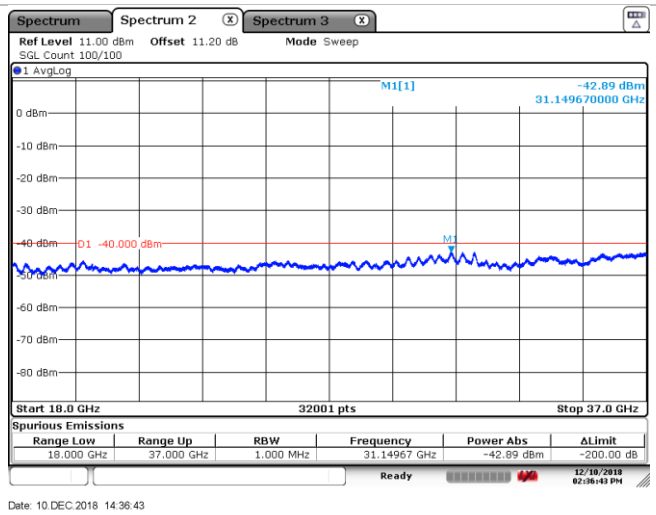


Figure 8.5-30: Conducted spurious graphic. Port 3, low channel (3555 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

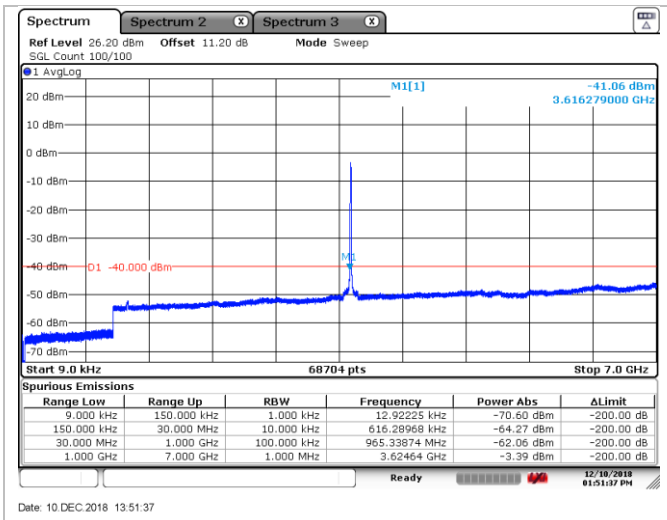


Figure 8.5-31: Conducted spurious graphic. Port 3, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

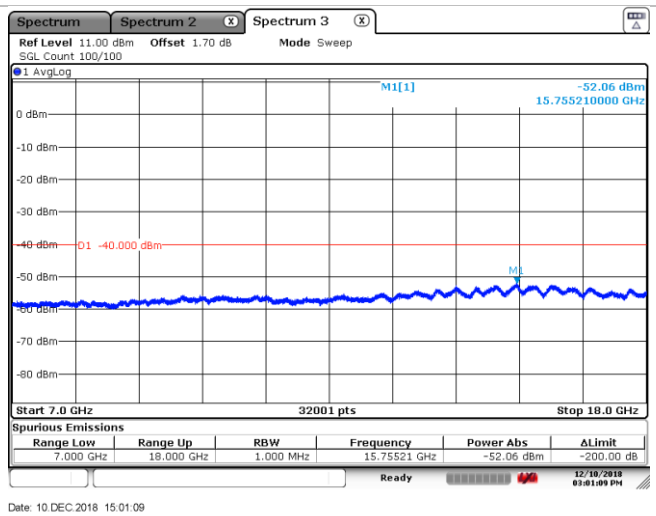


Figure 8.5-32: Conducted spurious graphic. Port 3, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

8.5.4 Test data, continued

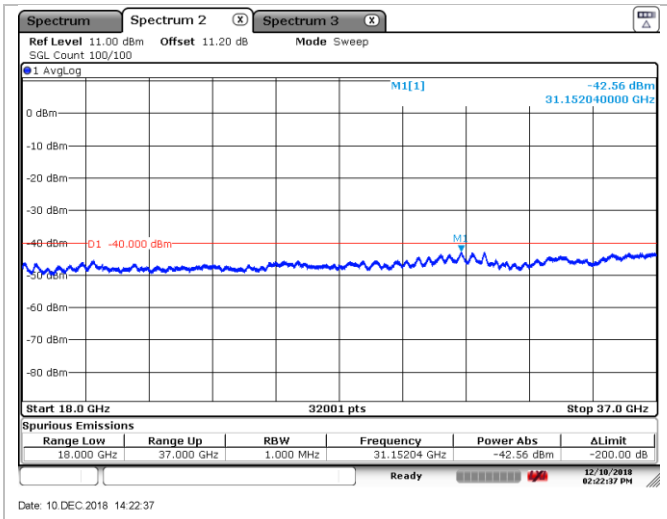


Figure 8.5-33: Conducted spurious graphic. Port 3, mid channel (3625 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

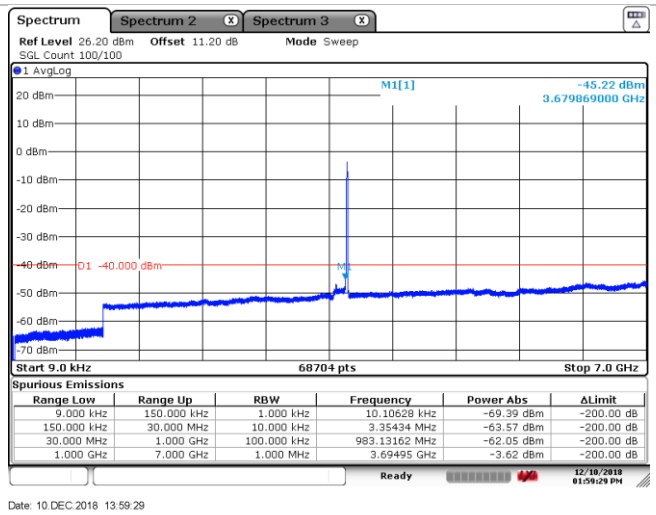


Figure 8.5-34: Conducted spurious graphic. Port 3, high channel (3695 MHz), 10 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

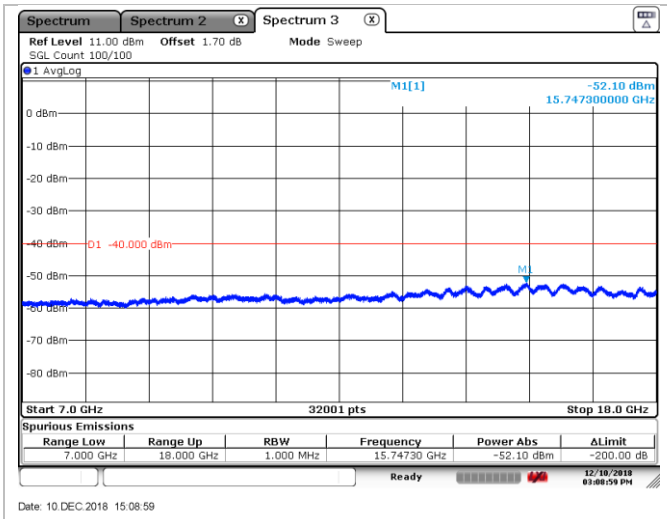


Figure 8.5-35: Conducted spurious graphic. Port 3, high channel (3695 MHz), 10 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

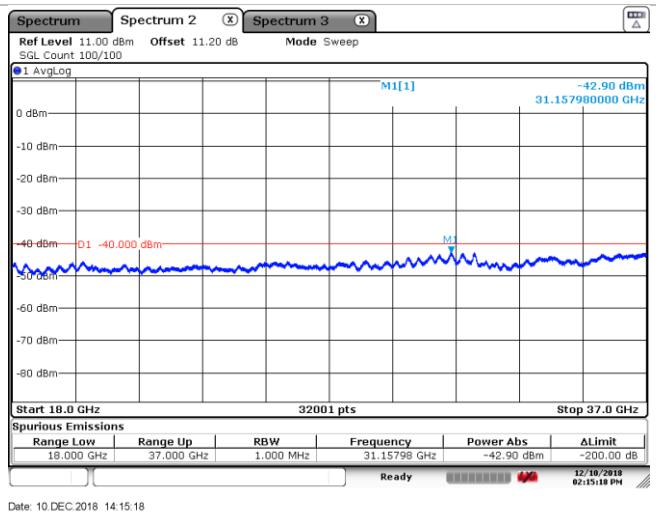


Figure 8.5-36: Conducted spurious graphic. Port 3, high channel (3695 MHz), 10 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

8.5.4 Test data, continued

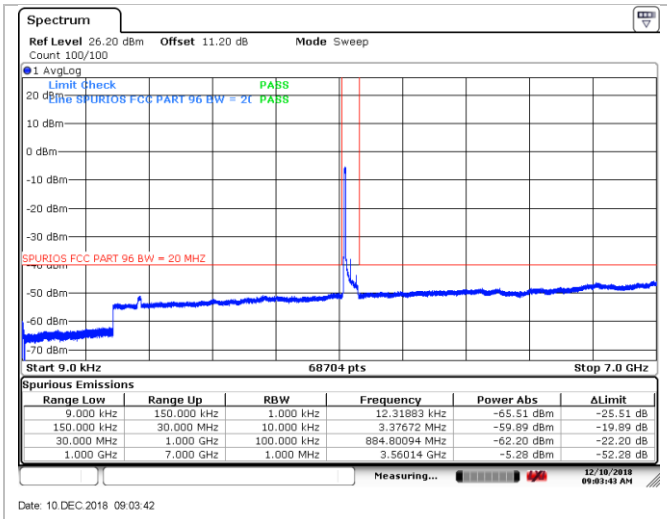


Figure 8.5-37: Conducted spurious graphic. Port 0, low channel (3560 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

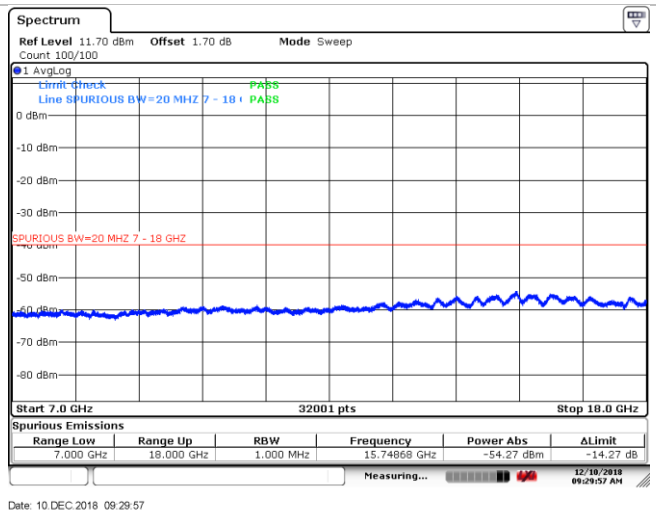


Figure 8.5-38: Conducted spurious graphic.Port 0, low channel (3560 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

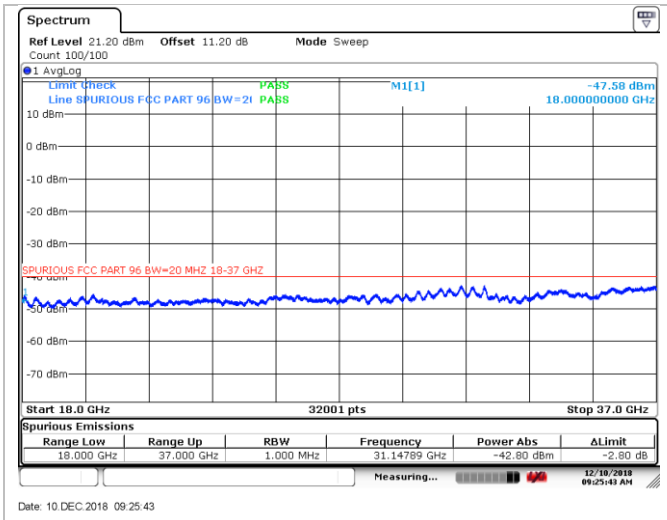


Figure 8.5-39: Conducted spurious graphic. Port 0, low channel (3560 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

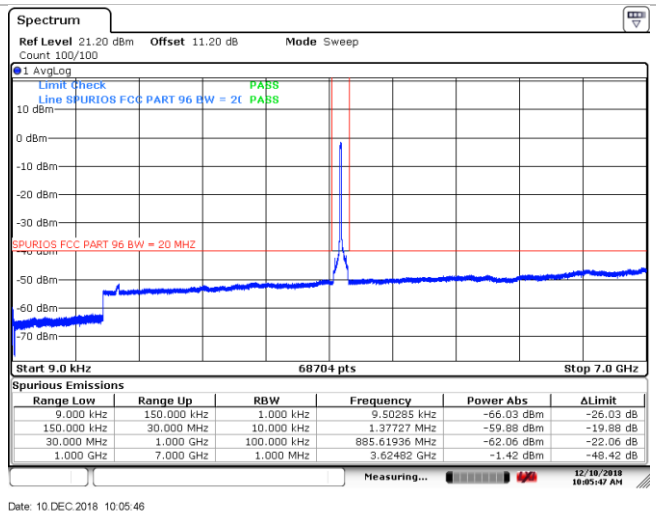


Figure 8.5-40: Conducted spurious graphic. Port 0, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

8.5.4 Test data, continued

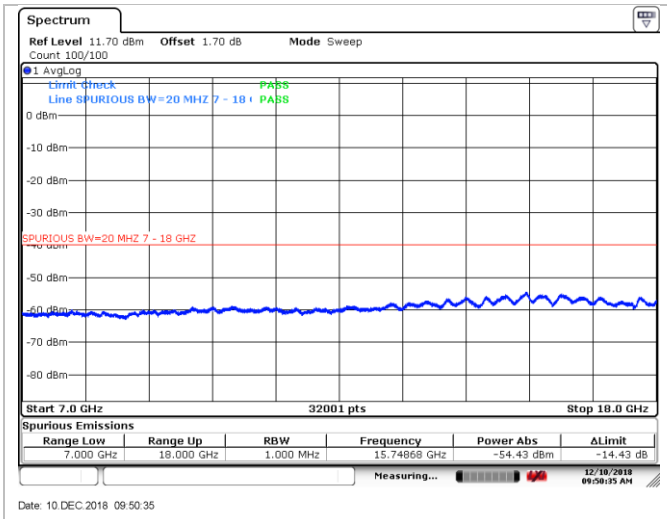


Figure 8.5-41: Conducted spurious graphic. Port 0, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

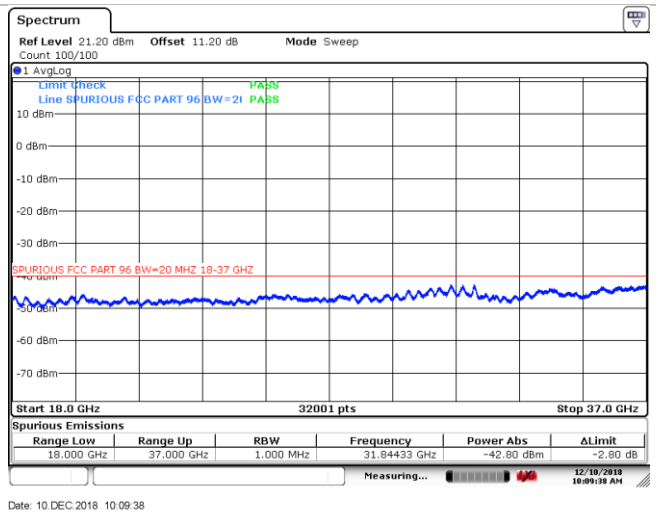


Figure 8.5-42: Conducted spurious graphic.Port 0, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

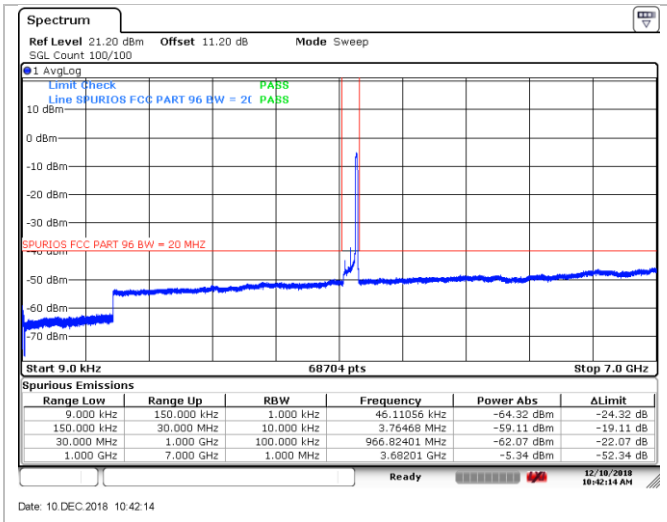


Figure 8.5-43: Conducted spurious graphic. Port 0, high channel (3690 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

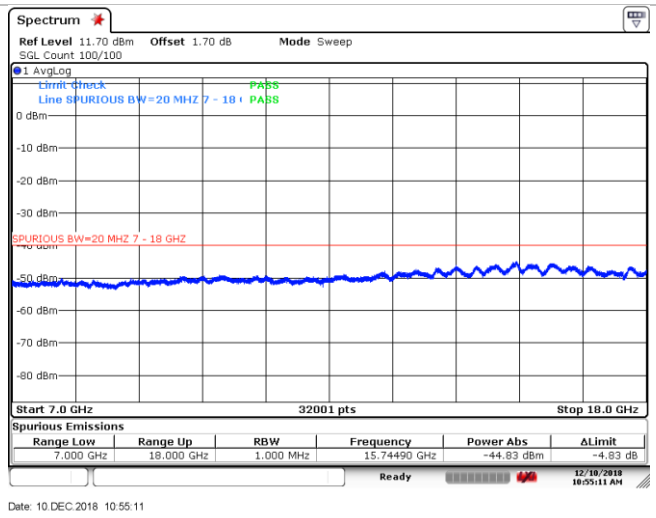


Figure 8.5-44: Conducted spurious graphic. Port 0, high channel (3690 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

8.5.4 Test data, continued

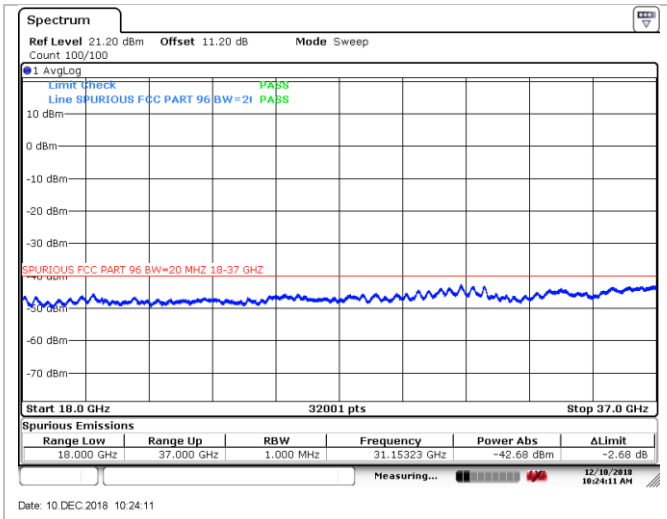


Figure 8.5-45: Conducted spurious graphic. Port 0, high channel (3690 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

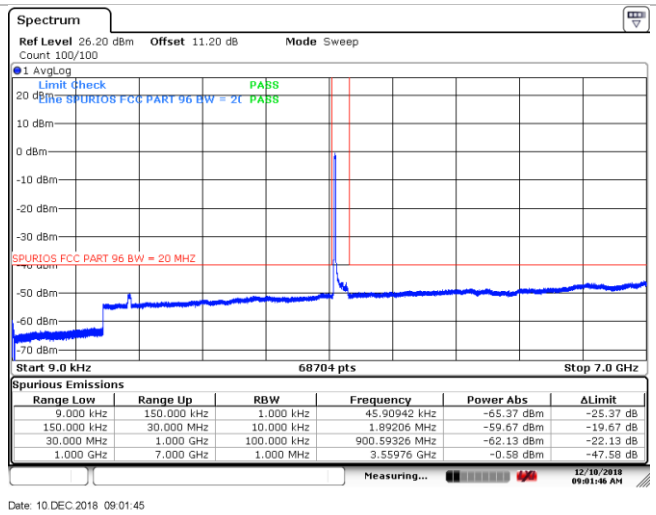


Figure 8.5-46: Conducted spurious graphic.Port 1, low channel (3560 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

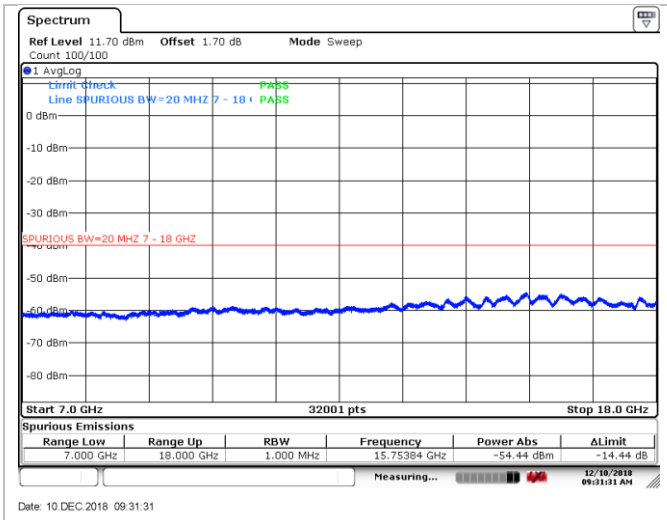


Figure 8.5-47: Conducted spurious graphic. Port 1, low channel (3560 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

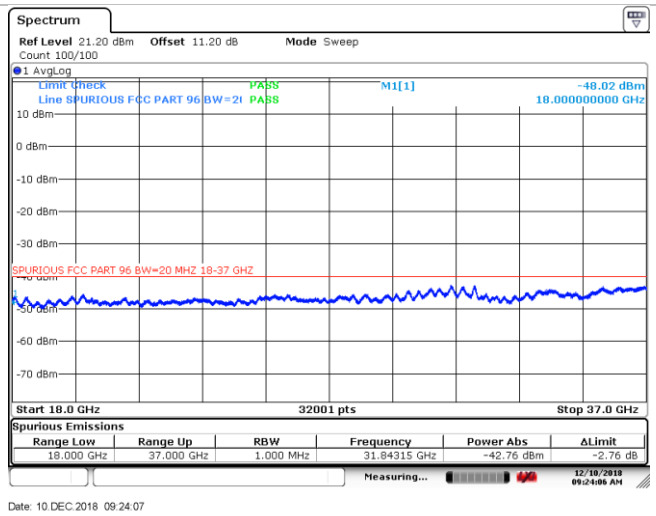


Figure 8.5-48: Conducted spurious graphic. Port 1, low channel (3560 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

8.5.4 Test data, continued

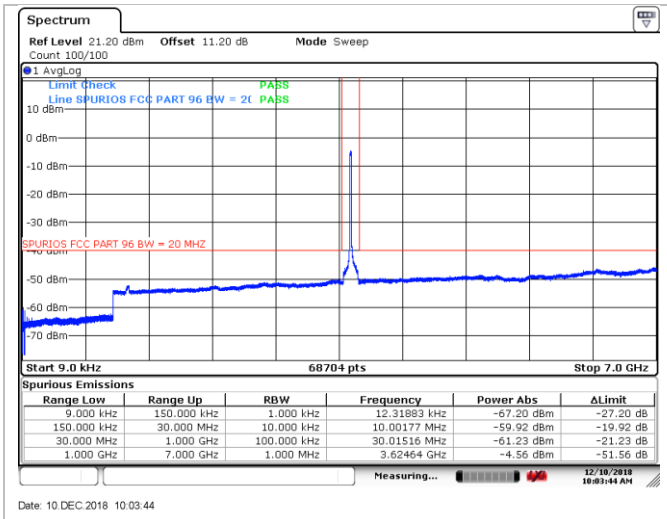


Figure 8.5-49: Conducted spurious graphic. Port 1, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

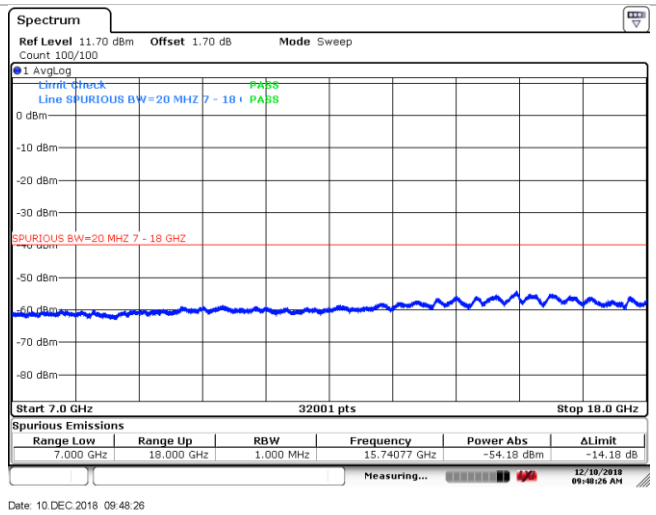


Figure 8.5-50: Conducted spurious graphic.Port 1, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

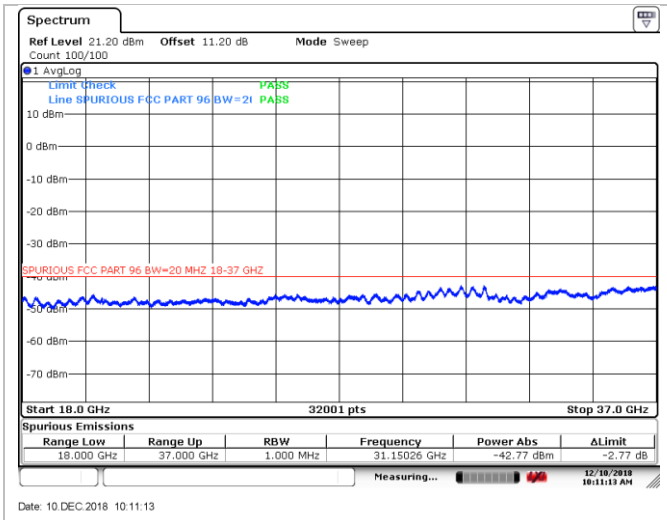


Figure 8.5-51: Conducted spurious graphic. Port 1, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

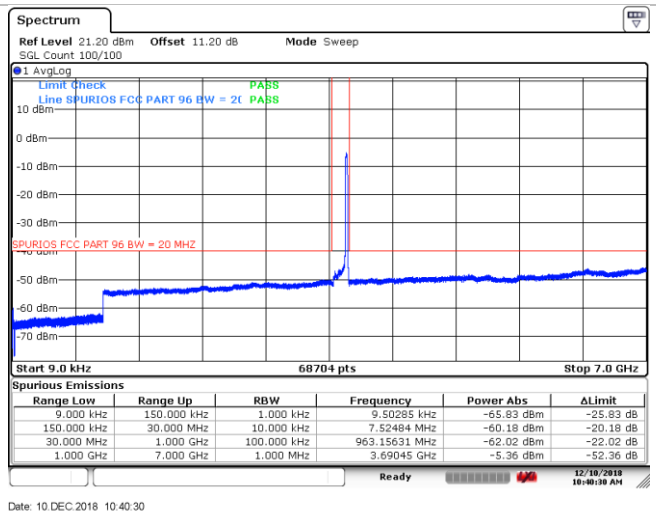


Figure 8.5-52: Conducted spurious graphic. Port 1, high channel (3690 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

8.5.4 Test data, continued

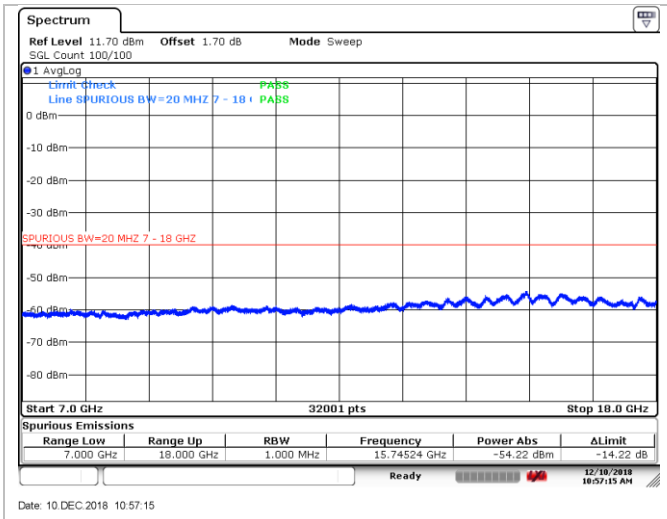


Figure 8.5-53: Conducted spurious graphic. Port 1, high channel (3690 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

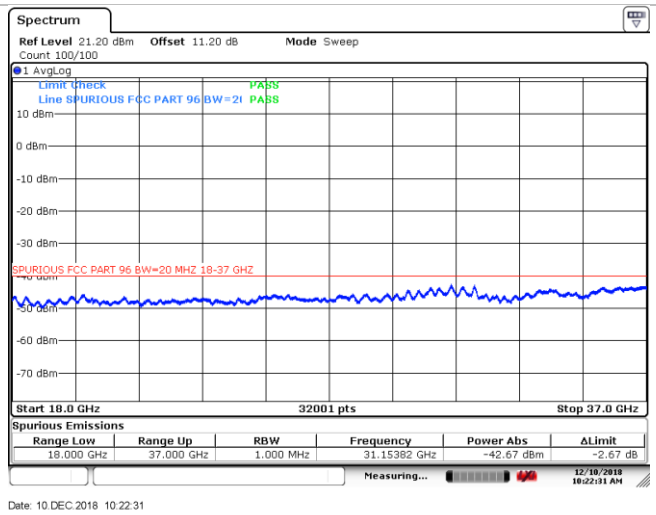


Figure 8.5-54: Conducted spurious graphic. Port 1, high channel (3690 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

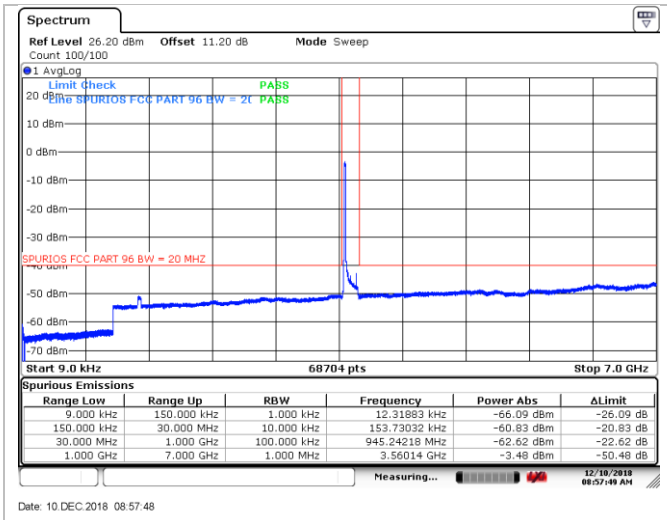


Figure 8.5-55: Conducted spurious graphic. Port 2, low channel (3560 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

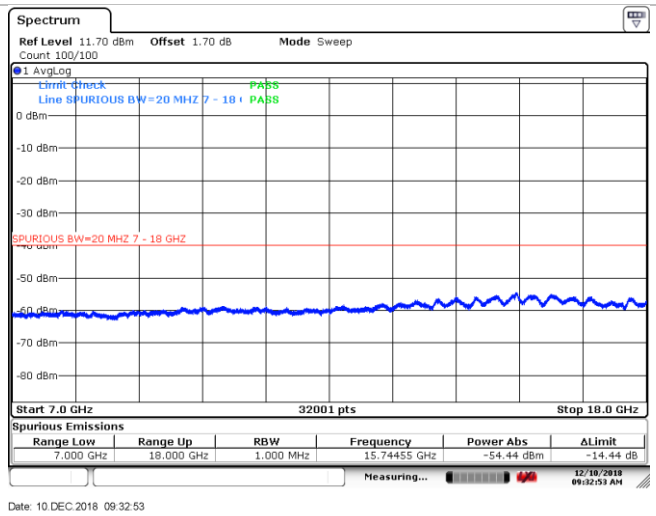


Figure 8.5-56: Conducted spurious graphic. Port 2, low channel (3560 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

8.5.4 Test data, continued

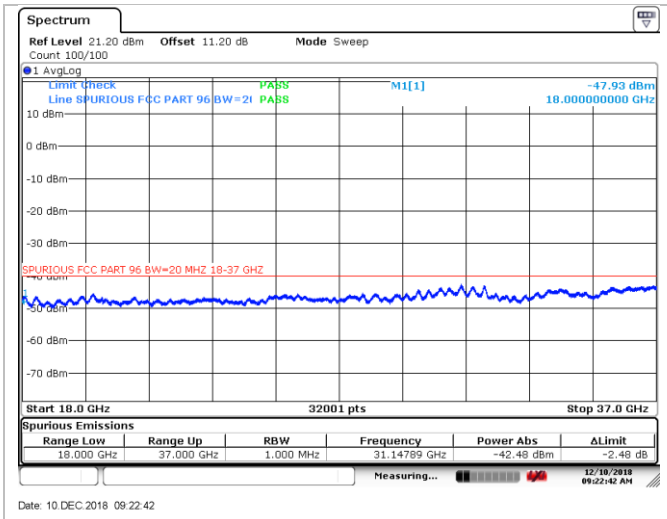


Figure 8.5-57: Conducted spurious graphic. Port 2, low channel (3560 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

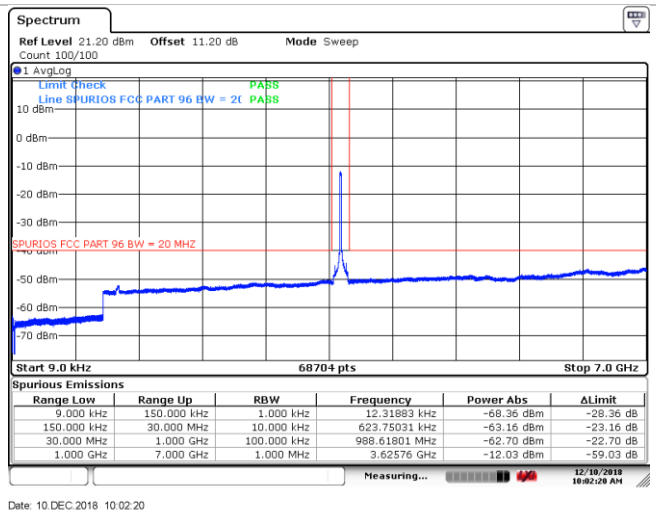


Figure 8.5-58: Conducted spurious graphic. Port 2, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

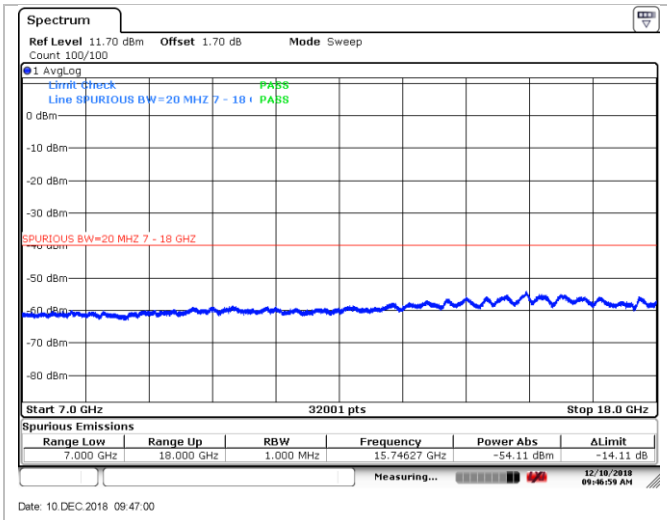


Figure 8.5-59: Conducted spurious graphic. Port 2, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

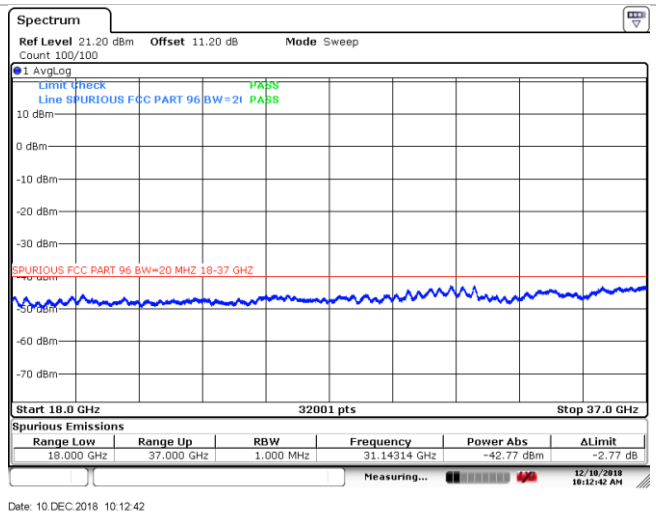


Figure 8.5-60: Conducted spurious graphic. Port 2, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

8.5.4 Test data, continued

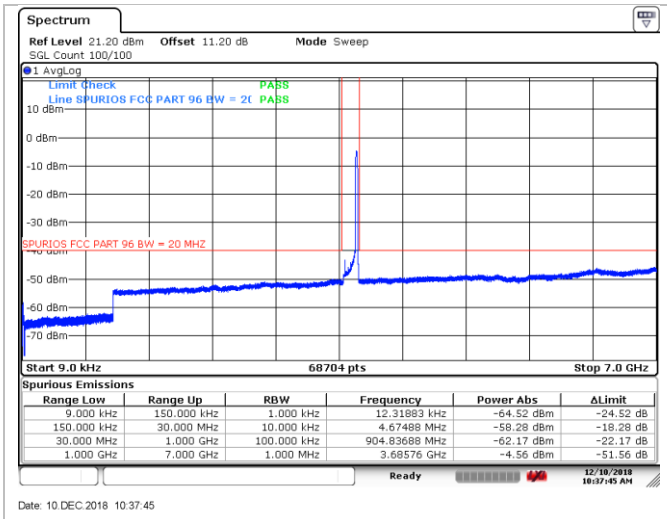


Figure 8.5-61: Conducted spurious graphic. Port 2, high channel (3690 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

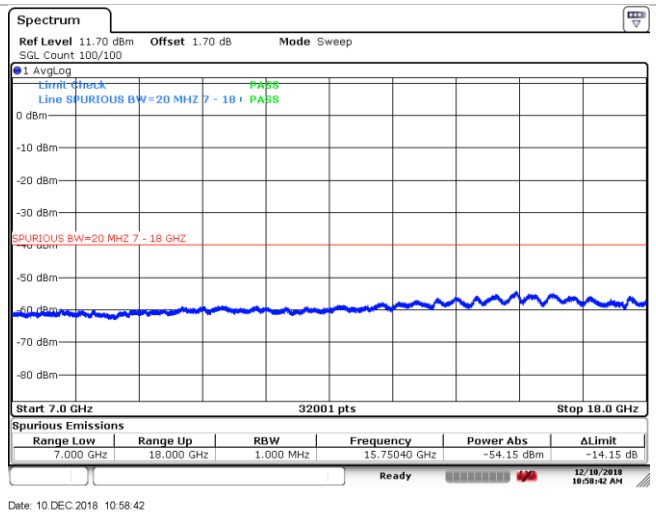


Figure 8.5-62: Conducted spurious graphic. Port 2, high channel (3690 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

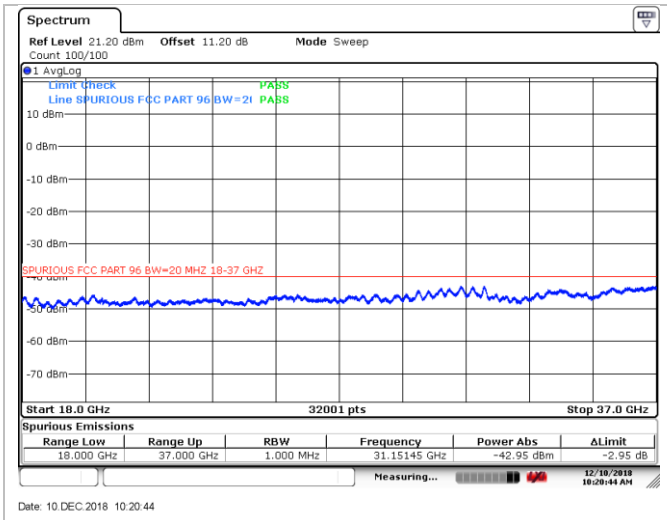


Figure 8.5-63: Conducted spurious graphic. Port 2, high channel (3690 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

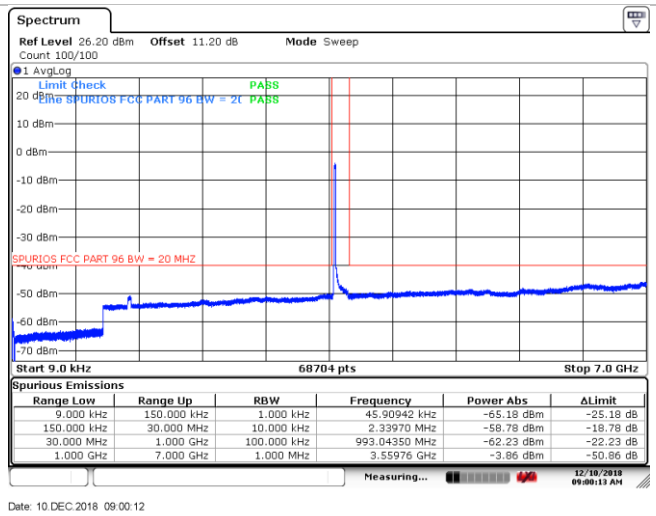


Figure 8.5-64: Conducted spurious graphic. Port 3, low channel (3560 MHz), 20 MHZ BW. Frequency range from 9 kKHZ to 7 GHZ

8.5.4 Test data, continued

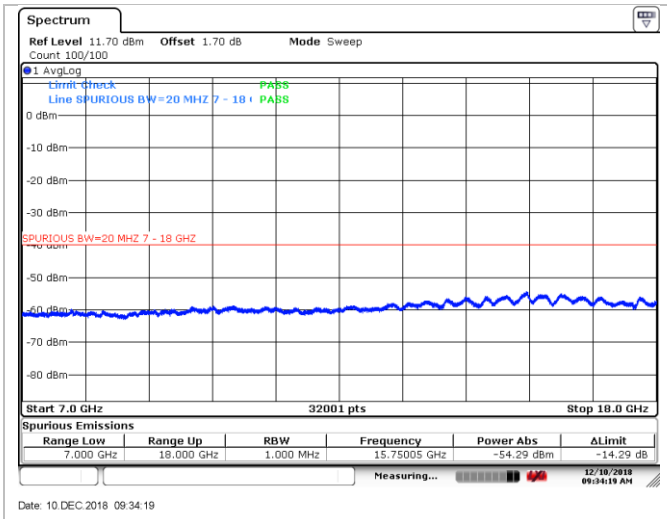


Figure 8.5-65: Conducted spurious graphic. Port 3, low channel (3560 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

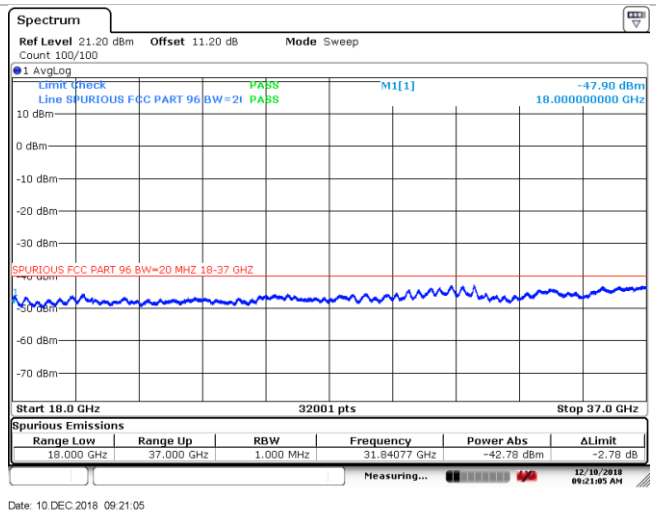


Figure 8.5-66: Conducted spurious graphic. Port 3, low channel (3560 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

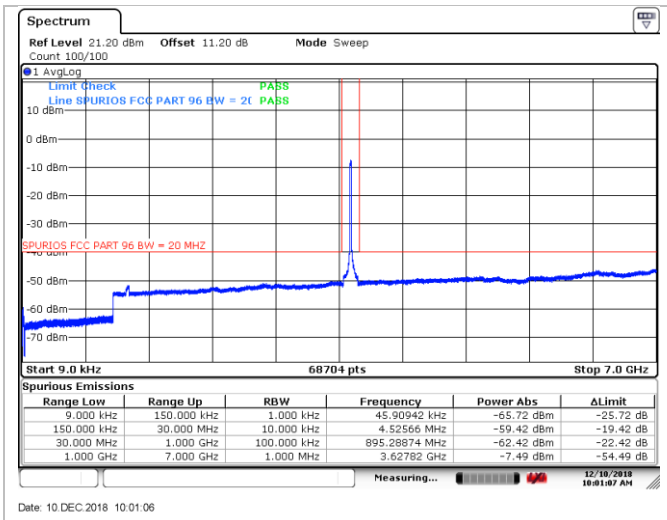


Figure 8.5-67: Conducted spurious graphic. Port 3, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

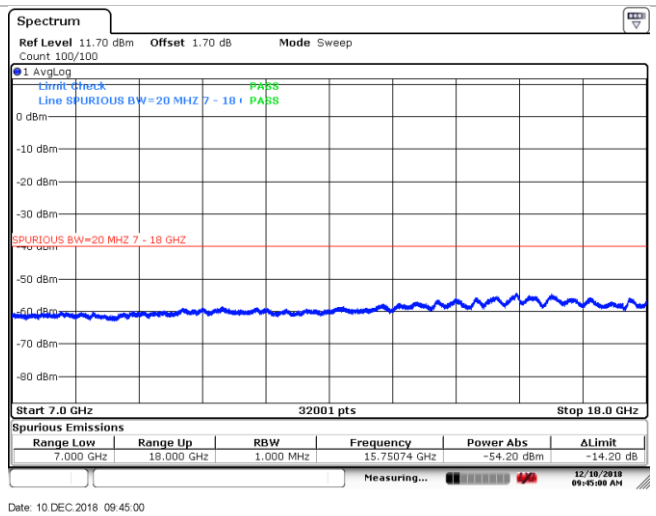


Figure 8.5-68: Conducted spurious graphic. Port 3, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

8.5.4 Test data, continued

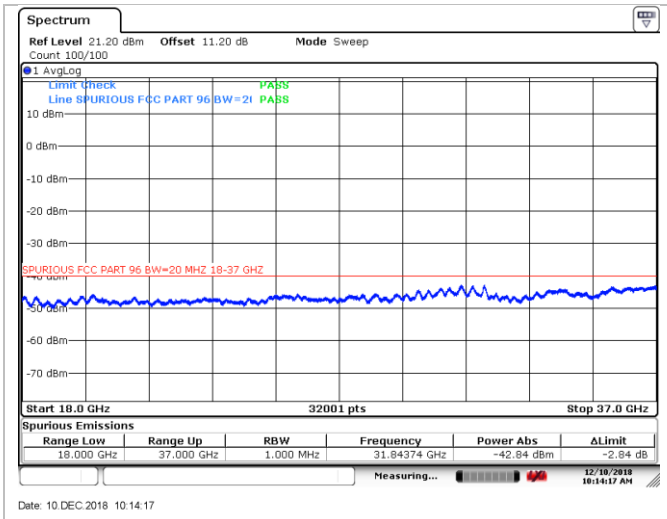


Figure 8.5-69: Conducted spurious graphic. Port 3, mid channel (3625 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

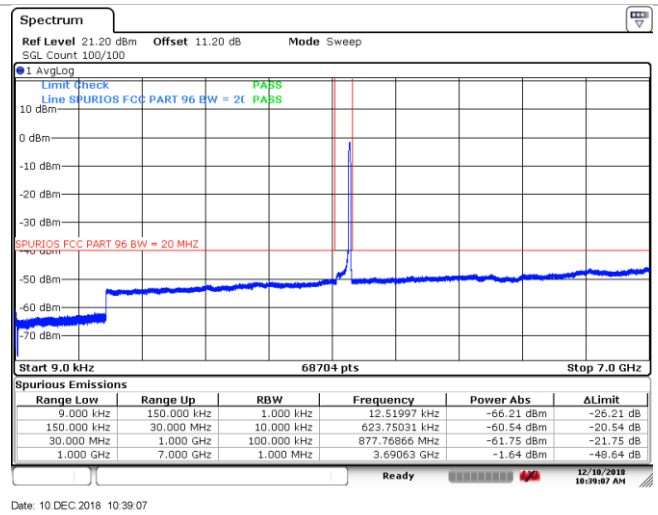


Figure 8.5-70: Conducted spurious graphic. Port 3, high channel (3690 MHz), 20 MHZ BW. Frequency range from 9 KHZ to 7 GHZ

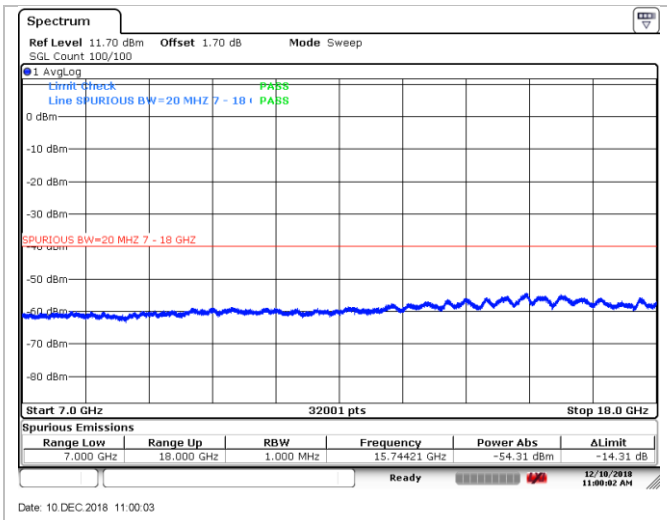


Figure 8.5-71: Conducted spurious graphic. Port 3, high channel (3690 MHz), 20 MHZ BW. Frequency range from 7 GHZ to 18 GHZ

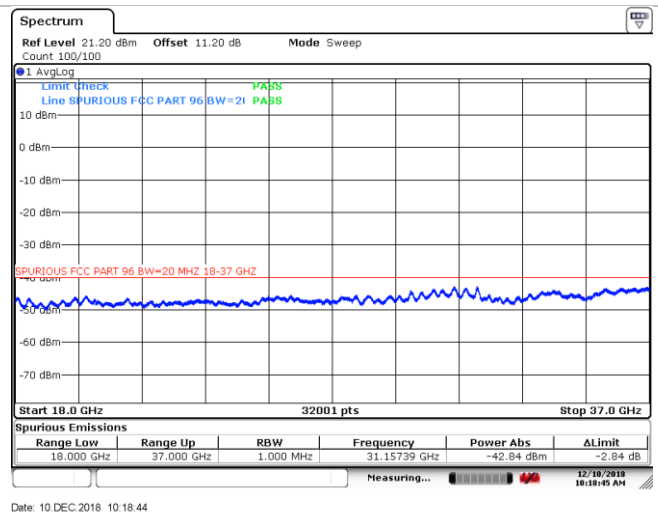


Figure 8.5-72: Conducted spurious graphic. Port 3, high channel (3690 MHz), 20 MHZ BW. Frequency range from 18 GHZ to 37 GHZ

8.5.4 Test data, continued (case radiation emissions)

For the radiated spurious measurements, two modulations were chosen: from 30 MHZ to 18 GHZ, the QPSK modulation was chosen using the three channels with a bandwidth of 20 MHz and from 18 GHZ to 40 GHz the 16QAM modulation was chosen using the three channels with a bandwidth of 20 MHZ. The measurements were done at 3 meters of distance and the results units are given in dbuv/m.

All four output ports were terminated for this testing into 50Ω loads.

The limit linefor case radiation is with respect to the -40dbm spurious limit.
Equation is: Limit (dBµVm) = -40dBm + 95.23 (55.23dBµV/m)

It is important to mention than frequency range from 1 to 18 GHz shows a fundamental transmission signal which looks has a higher value than FCC part 96 limit. However, that magnitude of the signal is not part of this test, thus, it can be ignored (this apply for all the cases).

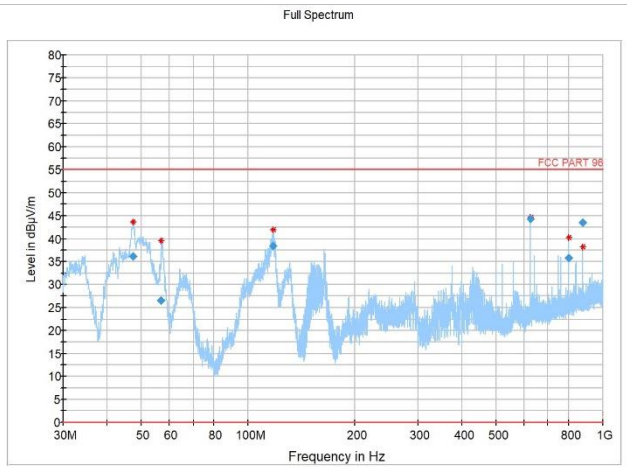


Figure 8.5-73: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 30 MHZ to 1 GHZ

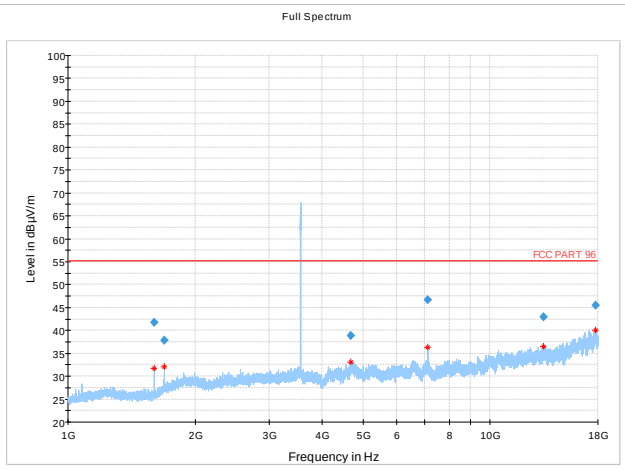


Figure 8.5-74: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 1 GHZ to 18 GHZ

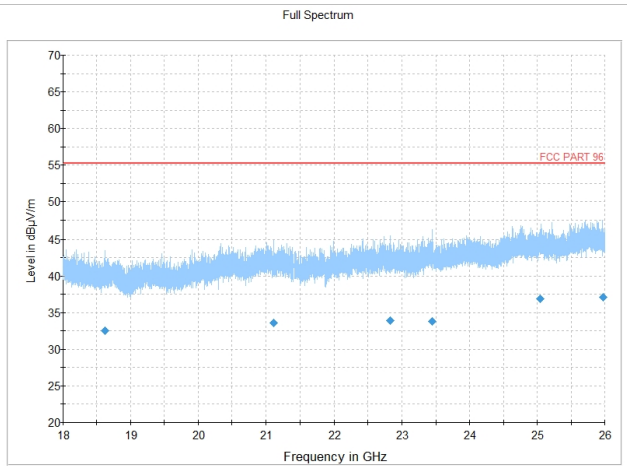


Figure 8.5-75: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 18 GHZ to 26 GHZ

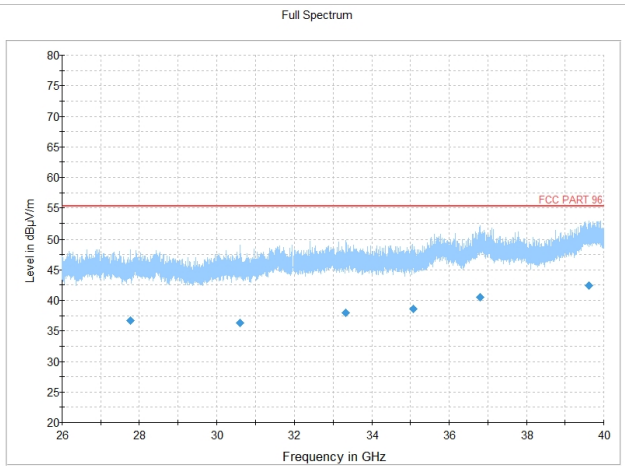


Figure 8.5-76: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 26 GHZ to 40 GHZ

8.5.4 Test data, continued

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
47.280000	36.17	55.23	19.06	5000.0	120.000	111.2	V	0.0	11.4
56.700000	26.52	55.23	28.71	5000.0	120.000	134.5	V	216.0	7.4
117.340000	38.39	55.23	16.84	5000.0	120.000	118.9	V	69.0	13.3
625.026500	44.32	55.23	10.91	5000.0	120.000	111.2	V	42.0	23.5
800.014500	35.88	55.23	19.35	5000.0	120.000	111.0	V	285.0	26.0
875.015500	43.47	55.23	11.76	5000.0	120.000	121.9	V	114.0	26.9

Table 8.5-1: Radiated spourious results. Low channel (3560 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 30 MHZ to 1 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1600.133333	41.68	55.23	13.55	5000.0	1000.000	100.0	H	124.0	-3.9
1693.800000	37.81	55.23	17.42	5000.0	1000.000	100.0	V	94.0	-2.8
4676.600000	38.86	55.23	16.37	5000.0	1000.000	276.8	V	177.0	7.9
7120.166667	46.69	55.23	8.54	5000.0	1000.000	113.7	H	38.0	10.0
13361.300000	42.92	55.23	12.32	5000.0	1000.000	110.6	V	42.0	18.3
17787.000000	45.55	55.23	9.68	5000.0	1000.000	172.1	H	243.0	23.0

Table 8.5-2: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 1 GHZ to 18 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18620.866667	32.50	55.23	22.73	5000.0	1000.000	100.0	V	45.0	13.4
21111.933333	33.64	55.23	21.59	5000.0	1000.000	130.0	V	318.0	15.8
22823.533333	33.93	55.23	21.30	5000.0	1000.000	114.0	H	340.0	16.6
23443.933333	33.78	55.23	21.45	5000.0	1000.000	115.0	H	340.0	17.2
25045.533333	36.88	55.23	18.35	5000.0	1000.000	158.0	V	139.0	19.3
25971.800000	37.09	55.23	18.14	5000.0	1000.000	115.0	V	230.0	20.8

Table 8.5-3: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 18 GHZ to 26 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27773.466667	36.64	55.23	18.59	5000.0	1000.000	112.0	V	60.0	8.9
30608.333333	36.30	55.23	18.93	5000.0	1000.000	111.0	H	207.0	11.7
33319.666667	37.94	55.23	17.29	5000.0	1000.000	175.0	V	10.0	12.5
35066.600000	38.54	55.23	16.69	5000.0	1000.000	154.0	V	189.0	13.8
36804.466667	40.56	55.23	14.67	5000.0	1000.000	117.0	H	18.0	16.3
39610.133333	42.41	55.23	12.82	5000.0	1000.000	112.0	V	6.0	18.9

Figure 8.5-4: Radiated spurious graphic. Low channel (3560 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 26 GHZ to 40 GHZ

8.5.4 Test data, continued

.

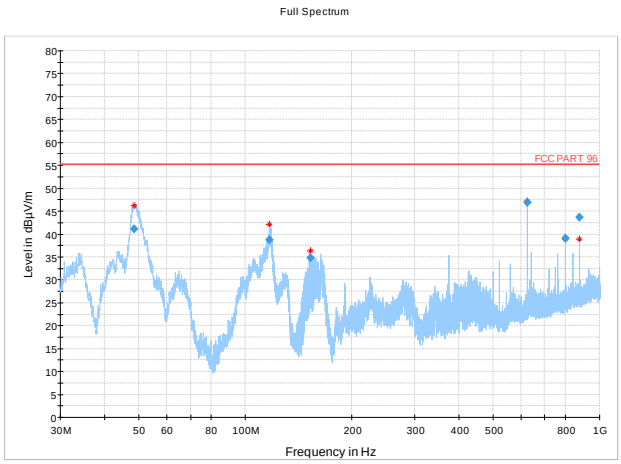


Figure 8.5-77: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 30 MHZ to 1 GHZ

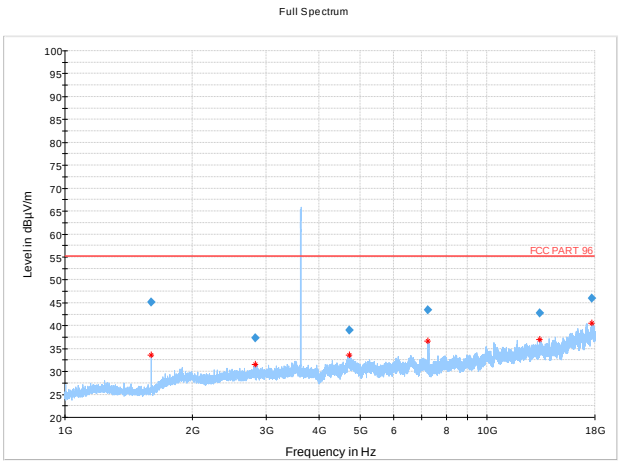


Figure 8.5-78: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 1 GHZ to 18 GHZ

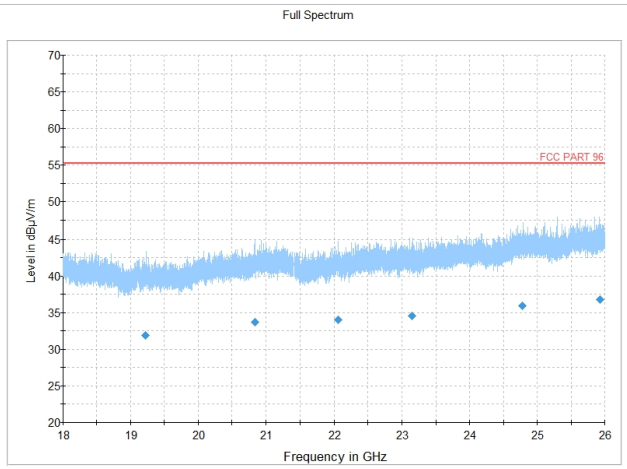


Figure 8.5-79: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 18 GHZ to 26 GHZ

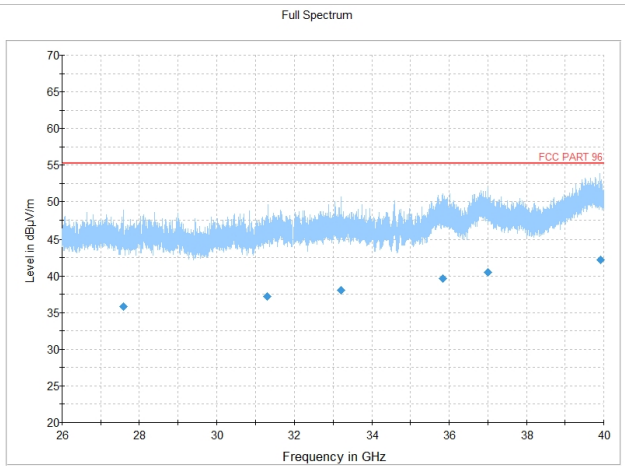


Figure 8.5-80: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 26 GHZ to 40 GHZ

8.5.4 Test data, continued

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
48.375500	41.17	55.23	14.06	5000.0	120.000	111.4	V	276.0	10.8
116.991000	38.75	55.23	16.48	5000.0	120.000	100.0	V	86.0	13.3
152.771500	34.87	55.23	20.36	5000.0	120.000	111.3	V	71.0	13.3
625.026500	46.83	55.23	8.40	5000.0	120.000	112.4	V	102.0	23.5
799.994500	39.05	55.23	16.18	5000.0	120.000	100.0	V	280.0	26.0
875.015500	43.59	55.23	11.64	5000.0	120.000	123.7	V	116.0	26.9

Table 8.5-5: Radiated spourious results. Middle channel (3625 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 30 MHZ to 1 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1600.133333	45.19	55.23	10.04	5000.0	1000.000	100.1	V	64.0	-3.9
2818.800000	37.30	55.23	17.93	5000.0	1000.000	370.7	V	208.0	1.6
4717.333333	39.05	55.23	16.18	5000.0	1000.000	410.0	H	298.0	8.0
7251.966667	43.41	55.23	11.82	5000.0	1000.000	182.7	H	56.0	9.9
13328.333333	42.78	55.23	12.45	5000.0	1000.000	188.5	V	246.0	18.3
17720.300000	45.95	55.23	9.28	5000.0	1000.000	238.1	V	0.0	22.7

Table 8.5-6: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 1 GHZ to 18 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19223.666667	31.89	55.23	23.34	5000.0	1000.000	134.0	H	22.0	14.0
20836.600000	33.68	55.23	21.55	5000.0	1000.000	131.0	H	30.0	15.8
22061.800000	34.00	55.23	21.23	5000.0	1000.000	167.0	H	0.0	16.3
23154.200000	34.54	55.23	20.69	5000.0	1000.000	166.0	H	170.0	17.1
24782.333333	35.90	55.23	19.33	5000.0	1000.000	167.0	H	256.0	19.3
25927.000000	36.77	55.23	18.46	5000.0	1000.000	175.0	V	52.0	20.8

Table 8.5-7: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 18 GHZ to 26 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27583.800000	35.87	55.23	19.36	5000.0	1000.000	115.0	V	206.0	8.6
31310.733333	37.21	55.23	18.02	5000.0	1000.000	125.0	V	332.0	12.2
33202.866667	38.02	55.23	17.21	5000.0	1000.000	112.0	V	62.0	12.5
35829.400000	39.66	55.23	15.57	5000.0	1000.000	107.0	V	4.0	15.1
36999.000000	40.53	55.23	14.70	5000.0	1000.000	137.0	H	10.0	16.3
39914.666667	42.19	55.23	13.04	5000.0	1000.000	140.0	V	40.0	18.8

Figure 8.5-8: Radiated spurious graphic. Middle channel (3625 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 26 GHZ to 40 GHZ

8.5.4 Test data, continued

.

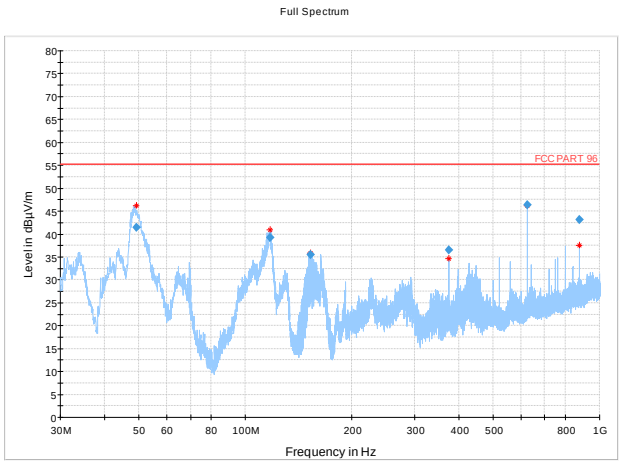


Figure 8.5-81: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 30 MHZ to 1 GHZ

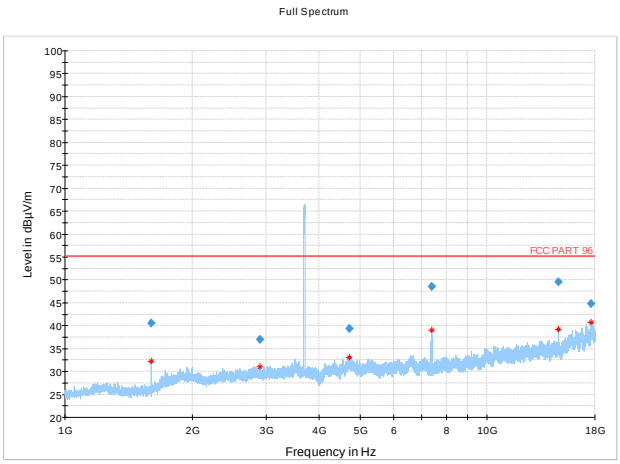


Figure 8.5-82: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 1 GHZ to 18 GHZ

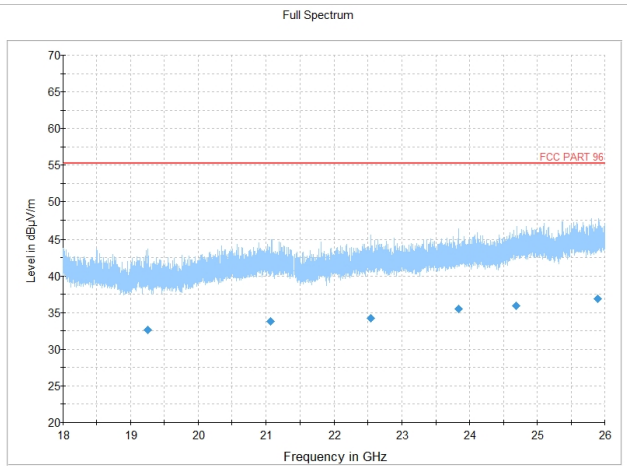


Figure 8.5-83: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 18 GHZ to 26 GHZ

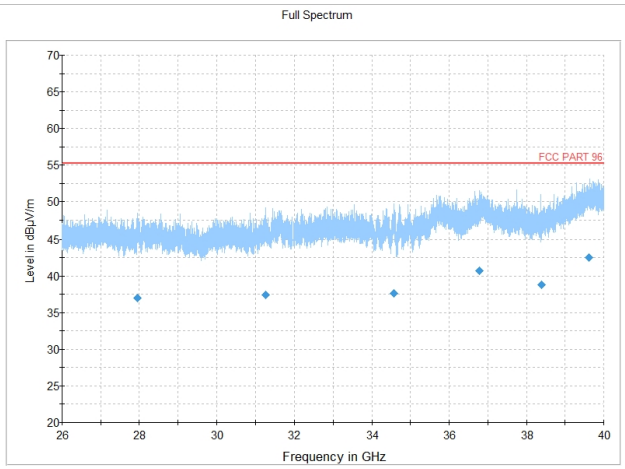


Figure 8.5-84: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 26 GHZ to 40 GHZ

8.5.4 Test data, continued

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
49.135500	41.51	55.23	13.72	5000.0	120.000	115.3	V	238.0	10.4
117.492000	39.28	55.23	15.95	5000.0	120.000	100.0	V	72.0	13.4
152.748000	35.55	55.23	19.68	5000.0	120.000	100.0	V	71.0	13.3
375.020500	36.49	55.23	18.74	5000.0	120.000	156.0	V	54.0	18.2
625.026500	46.35	55.23	8.88	5000.0	120.000	111.3	V	116.0	23.5
875.015500	43.16	55.23	12.07	5000.0	120.000	125.3	V	102.0	26.9

Table 8.5-9: Radiated spourious results. High channel (3690 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 30 MHZ to 1 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1599.733333	40.56	55.23	14.67	5000.0	1000.000	100.0	H	120.0	-3.9
2898.566667	37.06	55.23	18.17	5000.0	1000.000	367.5	H	325.0	1.7
4717.700000	39.39	55.23	15.84	5000.0	1000.000	340.3	V	298.0	8.0
7378.433333	48.52	55.23	6.71	5000.0	1000.000	100.0	H	56.0	10.2
14760.166667	49.61	55.23	5.62	5000.0	1000.000	158.8	H	124.0	18.0
17646.933333	44.86	55.23	10.37	5000.0	1000.000	284.5	V	33.0	22.0

Table 8.5-10: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, QPSK Modulation. Frequency range from 1 GHZ to 18 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19257.533333	32.65	55.23	22.58	5000.0	1000.000	157.0	H	357.0	14.1
21073.133333	33.76	55.23	21.47	5000.0	1000.000	125.0	H	226.0	15.9
22534.866667	34.18	55.23	21.05	5000.0	1000.000	157.0	V	22.0	16.7
23837.000000	35.52	55.23	19.71	5000.0	1000.000	111.0	V	338.0	17.7
24695.000000	35.96	55.23	19.27	5000.0	1000.000	172.0	H	328.0	19.1
25899.800000	36.83	55.23	18.40	5000.0	1000.000	125.0	H	137.0	20.8

Table 8.5-11: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 18 GHZ to 26 GHZ

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27958.866667	36.93	55.23	18.30	5000.0	1000.000	125.0	H	352.0	9.2
31274.466667	37.44	55.23	17.79	5000.0	1000.000	100.0	V	15.0	12.1
34574.800000	37.61	55.23	17.62	5000.0	1000.000	125.0	V	42.0	13.2
36780.066667	40.65	55.23	14.58	5000.0	1000.000	125.0	V	82.0	16.2
38386.866667	38.79	55.23	16.44	5000.0	1000.000	172.0	H	358.0	15.3
39620.600000	42.51	55.23	12.72	5000.0	1000.000	125.0	V	10.0	18.9

Figure 8.5-12: Radiated spurious graphic. High channel (3690 MHz), 20 MHZ BW, 16QAM Modulation. Frequency range from 26 GHZ to 40 GHZ

8.6 FCC 2.1055 Frequency stability

8.6.1 Definitions and limits

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From −30°C to +50°C for all equipment except that specified in paragraphs (a)(2) and (3) of this section
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° C through the range.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

8.6.2 Test summary

Verdict	Pass		
Test date	December 11 & 12, 2018	Temperature	22 – 20 °C
Test engineer	Martha Espinoza, EMC & Wireless Test Engineer	Air pressure	1005 - 1003 mbar
Test location	Wireless Bench	Relative humidity	55 - 58 %

8.6.3 Observations, settings and special notes

For this testing, only the port three was measured using 20 MHZ of bandwith and the three channels for each selected temperature. Also, a voltage variation measurements is included at room temperature (20°C)

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission bandwidth
Video bandwidth	≥ 3 × RBW
Frequency span	Wider than emission bandwidth
Detector mode	Peak

8.6.1 Test data

Table 8.6-1: Frequency drift measurement results, low channel (3560 MHZ)

Test conditions	Frequency, MHz	Offset, ppm
+65 °C, Nominal	3560.007	3.932
+60 °C, Nominal	3560.000	1.966
+50 °C, Nominal	3559.987	-1.685
+40 °C, Nominal	3560.013	5.617
+30 °C, Nominal	3560.013	5.617
+20 °C, Nominal	**3559.993**	Reference
+10 °C, Nominal	3559.994	0.280
0 °C, Nominal	3560.013	5.617
−10 °C, Nominal	3560.027	9.550
−20 °C, Nominal	3560.007	3.932
−30 °C, Nominal	3559.967	-7.303
−40 °C, Nominal	3559.967	-7.303

Table 8.6-2: Frequency drift measurement results, middle channel (3625 MHZ)

Test conditions	Frequency, MHz	Offset, ppm
+65 °C, Nominal	3625.000	5.517
+60 °C, Nominal	3624.987	1.931
+50 °C, Nominal	3625.000	5.517
+40 °C, Nominal	3625.007	7.448
+30 °C, Nominal	3624.980	0.000
+20 °C, Nominal	**3624.980**	Reference
+10 °C, Nominal	3624.980	0.000
0 °C, Nominal	3624.994	3.862
−10 °C, Nominal	3624.987	1.931
−20 °C, Nominal	3625.014	9.379
−30 °C, Nominal	3625.000	5.517
−40 °C, Nominal	3625.014	9.379

Table 8.6-3: Frequency drift measurement results, high channel (3690 MHZ)

Test conditions	Frequency, MHz	Offset, ppm
+65 °C, Nominal	3689.980	-3.794
+60 °C, Nominal	3690.014	5.420
+50 °C, Nominal	3689.980	-3.794
+40 °C, Nominal	3689.934	-16.260
+30 °C, Nominal	3689.960	-9.214
+20 °C, Nominal	**3689.994**	Reference
+10 °C, Nominal	3689.974	-5.420
0 °C, Nominal	3689.974	-5.420
−10 °C, Nominal	3689.993	-0.271
−20 °C, Nominal	3690.007	3.523
−30 °C, Nominal	3690.013	5.149
−40 °C, Nominal	3690.014	5.420

8.6.1 Test data, continued

Table 8.6-4: Frequency drift measurement results, voltage variation, low channel (3560 MHz).

Test conditions	Frequency, MHz	Offset, ppm
+20 °C, +15 %	3559.980	-3.651
+20 °C	**3559.993**	Reference
+20 °C, -15 %	3559.974	-5.337

Table 8.6-5: Frequency drift measurement results, voltage variation, middle channel (3625 MHz).

Test conditions	Frequency, MHz	Offset, ppm
+20 °C, +15 %	3625.000	5.517
+20 °C	**3624.980**	Reference
+20 °C, -15 %	3624.987	1.931

Table 8.6-6: Frequency drift measurement results, voltage variation, high channel (3690 MHz).

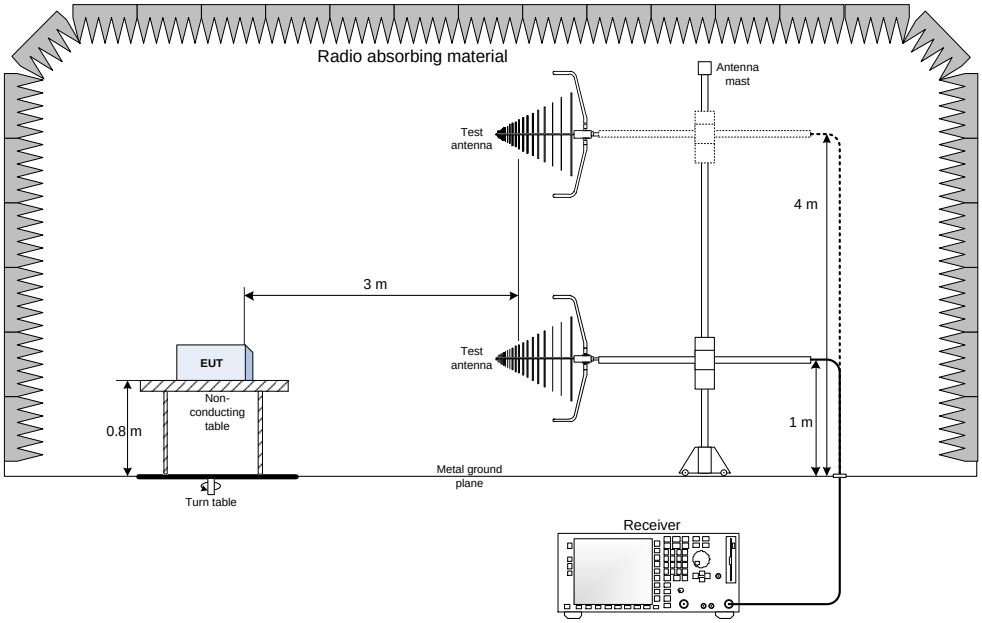
Test conditions	Frequency, MHz	Offset, ppm
+20 °C, +15 %	3689.994	0.000
+20 °C	**3689.994**	Reference
+20 °C, -15 %	3689.987	-1.897

Note: Offset was calculated as per the following formula:

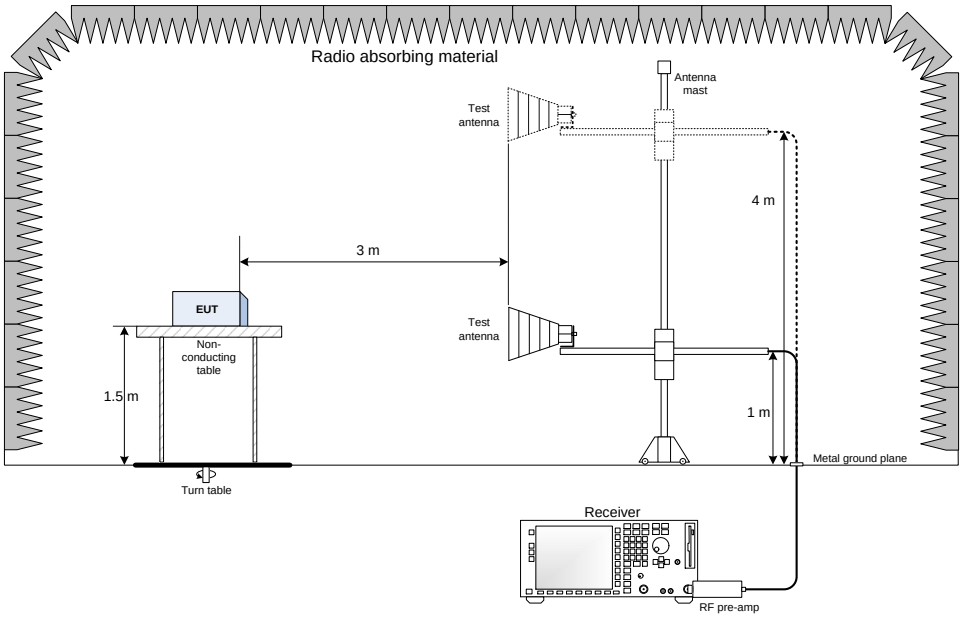
$$\frac{F_{Measured} - F_{reference}}{F_{reference}} \times 1 \cdot 10^6$$

Section 9. Block diagrams of test set-ups

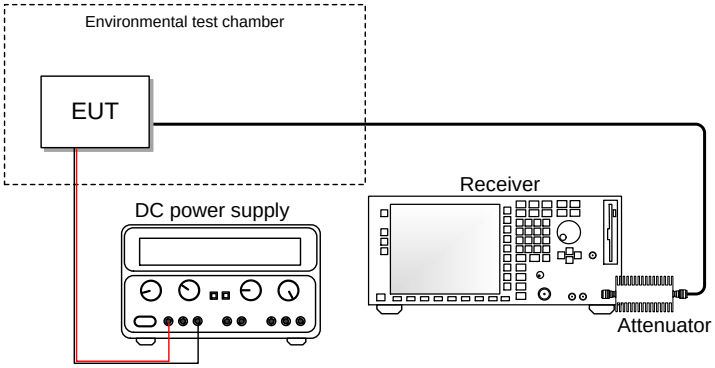
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



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