

8.5 Transmitter spurious emissions

8.5.1 References and limits

- FCC 47 CFR Part 87: §87.139
 - Test method: ANSI C63.4 (5.5)
- (a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435–1525 MHz, 2345–2395 MHz, or 5091–5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:
- (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least 43 + 10 log10 pY dB.
- FCC 47 CFR Part 2: §2.1057
- (a) In all of the measurements set forth in §§ 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
- (2) If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

8.5.2 Test summary

Verdict	Pass		
Test date	April 4, 2023; April 5, 2023	Temperature	20°C; 18°C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002mbar; 1001mbar
Test location	☐ Wireless bench ☒ Other: 3M Chamber	Relative humidity	59%; 56%

8.5.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Max power found it in table 8.3-2 was selected as the representative case for this testing (wors case). Low, middle, and high channels were tested using the longest pulse and the 50 MHz declared bandwidth.

Due to the high power emitted by the EUT, several considerations were made to execute accurate testing but avoiding the damage of the receiver system:

- 1) In the range from 1-18 GHz two low-pass filters in cascade were inserted between the receiving antenna and the power amplifier with the purpose of attenuating the wanted signal and maintaining the linearity of the power amplifier. The 1 dB cut frequency of these filters is at 14 GHz gaining attenuation at the interest frequencies around 100 dB and preserving an insertion loss of 2 dB average in the frequency range under investigation. The suppressed frequencies in this section were investigated previously in section 8.4.5 where the filter was not aggregated (frequency range from 14-18 GHz).
- 2) In the range from 18-26.5 GHz two high-pass filters in cascade were inserted between the receiving antenna and the power amplifier with the purpose of attenuating the signal and maintaining the linearity of the power amplifier. The cut frequency of these filters is at 18 GHz, attenuating the interest frequencies signals with around 87 dB (minimum) and preserving an insertion loss of 2.5 dB average in the frequency range under investigation.
- 3) In the range above 26.5 GHz ranges no filters or amplifiers were used. Waveguide antennas provide enough wanted signal attenuation.

8.5.4 Setup details

EUT power input during test	28 V DC
EUT setup configuration	☒ Table-top (Above 1 GHz: 1.5m) ☐ Floor standing ☒ Other: Tripod mounted (Below 1 GHz: 80 cm)
Antenna height variation	1–4 m
Turn table position	0–360°
Measurement details	A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated, and antenna adjusted to maximize radiated emission. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings (below 1 GHz):

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-peak (final measurements)
Trace mode	Max Hold
Measurement time	5000 ms (final measurements)

Receiver settings (from 1 -40 GHz):

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (preview measurements) Peak and average (final measurements)
Trace mode	Max Hold
Measurement time	5000 ms (final measurements)

Spectrum analyzer settings (above 40 GHz):

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Average
Trace mode	Max Hold

8.5.5 Test data

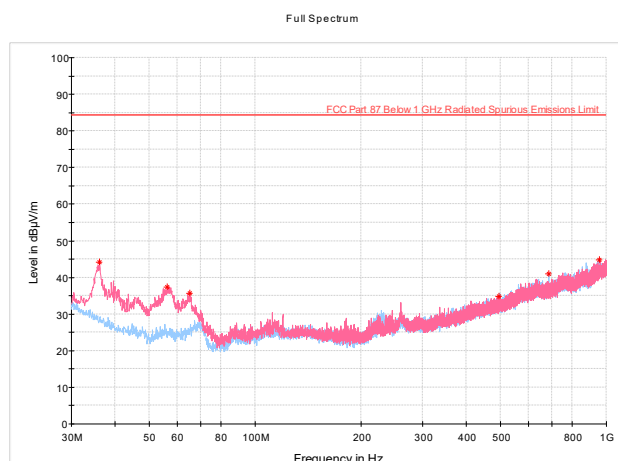


Figure 8.5-1: Unwanted emissions spurious band plot – Field strength measured from 0.030 to 1 GHz, Low channel 15.50 GHz.

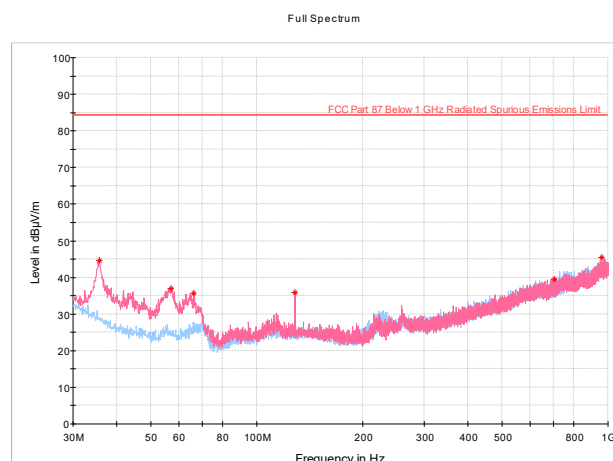


Figure 8.5-2: Unwanted emissions spurious band plot – Field strength measured from 0.030 to 1 GHz, High channel 15.60 GHz.

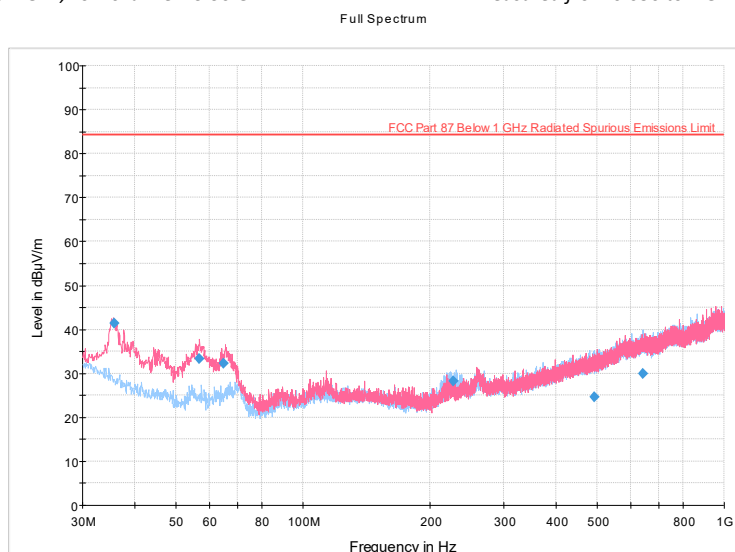


Figure 8.5-3: Unwanted emissions spurious band plot – Field strength measured from 0.030 to 1 GHz, Middle channel 15.55 GHz.

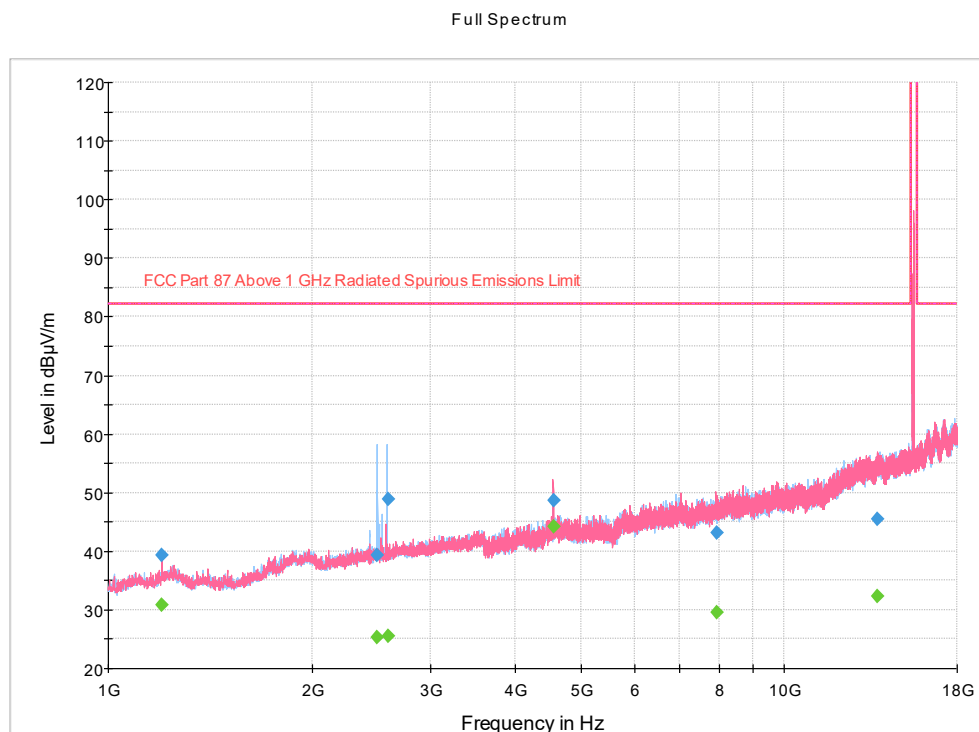
The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.769000	41.33	84.38	43.05	5000.0	120.000	100.0	V	0.0	21.8
56.909000	33.28	84.38	51.10	5000.0	120.000	132.0	V	0.0	12.6
64.782000	32.30	84.38	52.08	5000.0	120.000	111.0	V	124.0	12.3
227.576000	28.31	84.38	56.07	5000.0	120.000	200.0	H	162.0	17.6
492.387000	24.71	84.38	59.67	5000.0	120.000	201.0	H	34.0	26.5
641.635000	29.88	84.38	54.50	5000.0	120.000	350.0	H	196.0	30.3

Notes:
¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
² Correction factors = antenna factor ACF (dB) + cable loss (dB)
³ The maximum measured value observed over a period of 5 seconds was recorded.
⁴ The spectral plot shows the vertical and horizontal scan separately.
⁵ This measurement was done at 3m

Table 8.5-1: Unwanted emissions spurious band results – Field strength measured from 0.030 to 1 GHz, Middle channel 15.55 GHz.

Note: 0.030-1 GHz frequency range was evaluated using the six finals points only in the middle channel (worst case) due to the EUT response is below the limit for more than 30 dB and there are no interest frequencies related to the radio in this frequency range.



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-4: Unwanted emissions spurious band plot – Field strength measured from 1-18 GHz, Low channel 15.50 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1200.077778	39.25	---	82.23	42.98	5000.0	1000.000	298.0	H	0.0	-13.8
1200.077778	---	30.80	82.23	51.43	5000.0	1000.000	298.0	H	0.0	-13.8
2496.288889	---	25.40	82.23	56.83	5000.0	1000.000	400.0	H	162.0	-9.6
2496.288889	39.30	---	82.23	42.93	5000.0	1000.000	400.0	H	162.0	-9.6
2590.666667	48.88	---	82.23	33.35	5000.0	1000.000	206.0	H	20.0	-9.5
2590.666667	---	25.56	82.23	56.67	5000.0	1000.000	206.0	H	20.0	-9.5
4550.022222	48.65	---	82.23	33.58	5000.0	1000.000	194.0	V	190.0	-2.1
4550.022222	---	44.28	82.23	37.95	5000.0	1000.000	194.0	V	190.0	-2.1
7927.833333	---	29.57	82.23	52.66	5000.0	1000.000	178.0	V	143.0	1.8
7927.833333	43.14	---	82.23	39.09	5000.0	1000.000	178.0	V	143.0	1.8
13702.166667	45.52	---	82.23	36.71	5000.0	1000.000	273.0	V	0.0	9.4
13702.166667	---	32.31	82.23	49.92	5000.0	1000.000	273.0	V	0.0	9.4

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

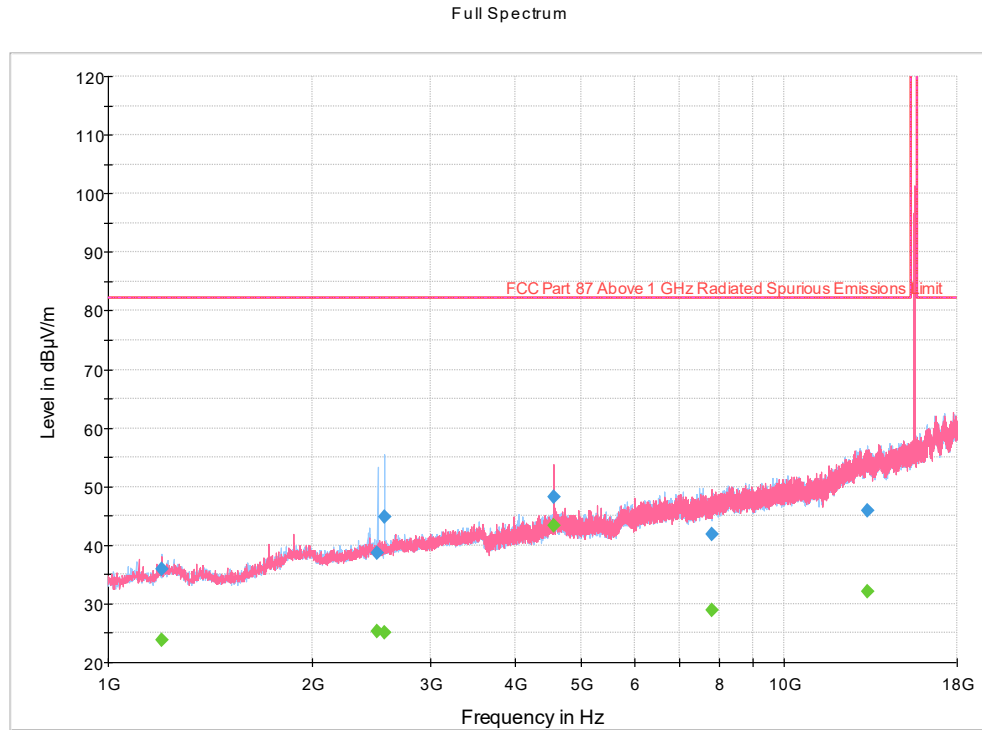
³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

⁶ Two low pass filter in cascade were used in this range for avoid the receiver system damage and to maintain power amplifier linearity.

Table 8.5-2: Unwanted emissions spurious band results – Field strength measured from 1-18 GHz, Low channel 15.50 GHz.



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-5: Unwanted emissions spurious band plot – Field strength measured from 1-18 GHz, Middle channel 15.55 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1199.677778	35.89	---	82.23	46.34	5000.0	1000.000	253.0	H	173.0	-13.8
1199.677778	---	23.89	82.23	58.34	5000.0	1000.000	253.0	H	173.0	-13.8
2502.755556	38.76	---	82.23	43.47	5000.0	1000.000	288.0	H	20.0	-9.5
2502.755556	---	25.34	82.23	56.89	5000.0	1000.000	288.0	H	20.0	-9.5
2560.255556	---	25.18	82.23	57.05	5000.0	1000.000	208.0	H	77.0	-9.6
2560.255556	44.82	---	82.23	37.41	5000.0	1000.000	208.0	H	77.0	-9.6
4567.022222	48.26	---	82.23	33.97	5000.0	1000.000	219.0	V	190.0	-2.1
4567.022222	---	43.34	82.23	38.89	5000.0	1000.000	219.0	V	190.0	-2.1
7809.044444	41.96	---	82.23	40.27	5000.0	1000.000	166.0	V	64.0	1.2
7809.044444	---	29.01	82.23	53.22	5000.0	1000.000	166.0	V	64.0	1.2
13290.088889	---	32.14	82.23	50.09	5000.0	1000.000	223.0	H	325.0	9.4
13290.088889	45.99	---	82.23	36.24	5000.0	1000.000	223.0	H	325.0	9.4

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

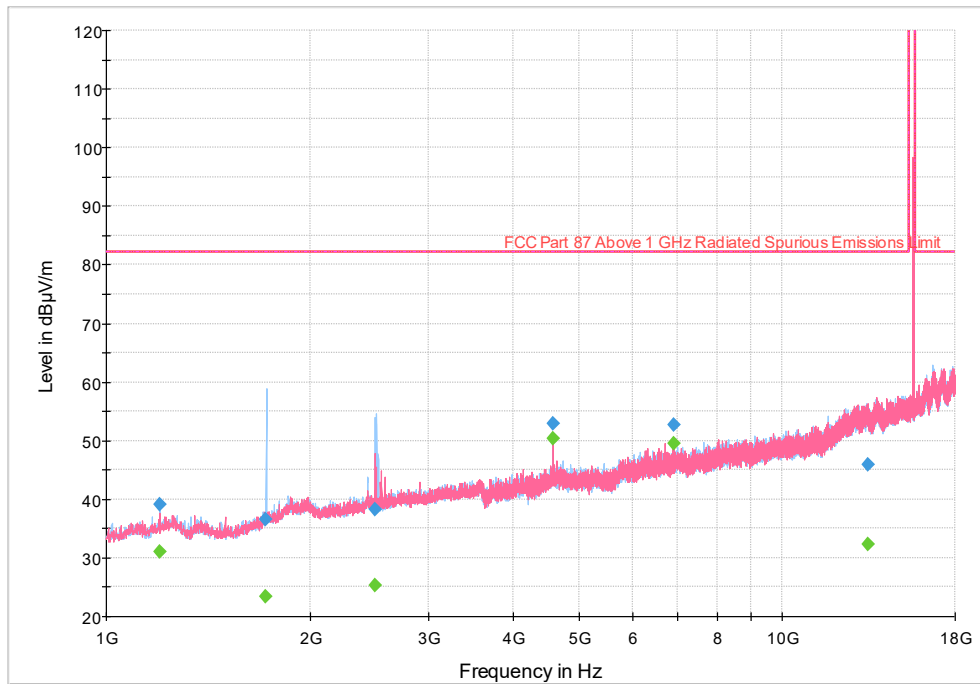
⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

⁶ Two low pass filter in cascade were used in this range for avoid the receiver system damage and to maintain power amplifier linearity.

Table 8.5-3: Unwanted emissions spurious band results – Field strength measured from 1-18 GHz, Middle channel 15.55 GHz.

Full Spectrum



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-6: Unwanted emissions spurious band plot – Field strength measured from 1-18 GHz, High channel 15.60 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1200.077778	39.03	---	82.23	43.20	5000.0	1000.000	298.0	H	11.0	-13.8
1200.077778	---	31.08	82.23	51.15	5000.0	1000.000	298.0	H	11.0	-13.8
1723.333333	---	23.39	82.23	58.84	5000.0	1000.000	216.0	H	77.0	-12.9
1723.333333	36.52	---	82.23	45.71	5000.0	1000.000	216.0	H	77.0	-12.9
2494.033333	---	25.21	82.23	57.02	5000.0	1000.000	120.0	H	88.0	-9.6
2494.033333	38.29	---	82.23	43.94	5000.0	1000.000	120.0	H	88.0	-9.6
4583.477778	---	50.32	82.23	31.91	5000.0	1000.000	212.0	V	199.0	-2.0
4583.477778	52.90	---	82.23	29.33	5000.0	1000.000	212.0	V	199.0	-2.0
6900.200000	---	49.58	82.23	32.65	5000.0	1000.000	168.0	H	0.0	0.7
6900.200000	52.71	---	82.23	29.52	5000.0	1000.000	168.0	H	0.0	0.7
13376.188889	45.86	---	82.23	36.37	5000.0	1000.000	107.0	V	11.0	9.1
13376.188889	---	32.32	82.23	49.91	5000.0	1000.000	107.0	V	11.0	9.1

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

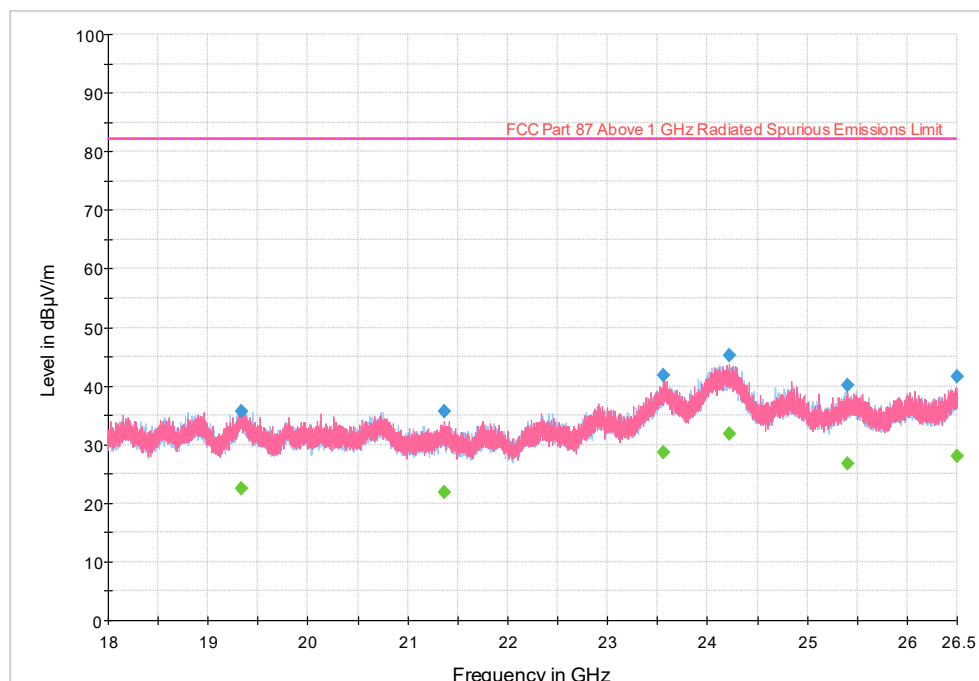
⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

⁶ Two low pass filter in cascade were used in this range for avoid the receiver system damage and to maintain power amplifier linearity.

Table 8.5-4: Unwanted emissions spurious band results – Field strength measured from 1-18 GHz, High channel 15.60 GHz.

Full Spectrum



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-7: Unwanted emissions spurious band plot – Field strength measured from 18-26.5 GHz, Low channel 15.50 GHz.

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19327.356250	---	22.59	82.23	59.64	5000.0	1000.000	363.0	H	103.0	16.7
19327.356250	35.61	---	82.23	46.62	5000.0	1000.000	363.0	H	103.0	16.7
21362.625000	35.68	---	82.23	46.55	5000.0	1000.000	223.0	V	230.0	17.0
21362.625000	---	21.94	82.23	60.29	5000.0	1000.000	223.0	V	230.0	17.0
23563.718750	---	28.63	82.23	53.60	5000.0	1000.000	400.0	V	325.0	23.8
23563.718750	41.82	---	82.23	40.41	5000.0	1000.000	400.0	V	325.0	23.8
24218.493750	45.16	---	82.23	37.07	5000.0	1000.000	158.0	V	187.0	27.0
24218.493750	---	31.82	82.23	50.41	5000.0	1000.000	158.0	V	187.0	27.0
25397.568750	40.22	---	82.23	42.01	5000.0	1000.000	118.0	V	351.0	21.5
25397.568750	---	26.83	82.23	55.40	5000.0	1000.000	118.0	V	351.0	21.5
26499.000000	41.58	---	82.23	40.65	5000.0	1000.000	153.0	H	54.0	23.4
26499.000000	---	27.95	82.23	54.28	5000.0	1000.000	153.0	H	54.0	23.4

Notes:

¹ Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

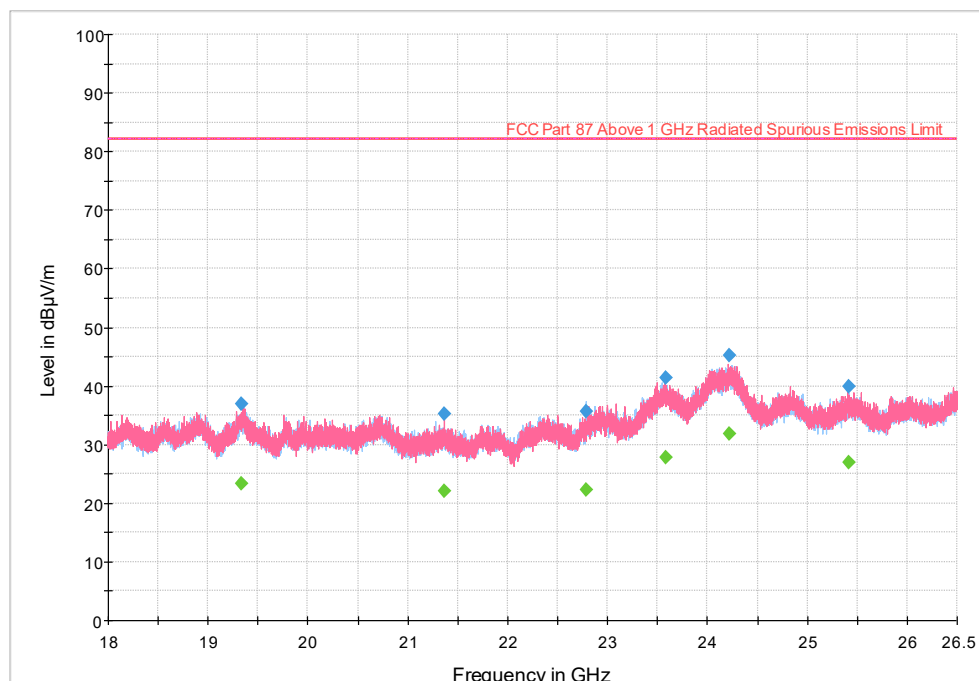
⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

⁶ Two high pass filter in cascade were used in this range for avoid the receiver system damage and to maintain power amplifier linearity.

Table 8.5-5: Unwanted emissions spurious band results – Field strength measured from 18-26.5 GHz, Low channel 15.50 GHz.

Full Spectrum



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-8: Unwanted emissions spurious band plot – Field strength measured from 18-26.5 GHz, Middle channel 15.55 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19331.993750	37.02	---	82.23	45.21	5000.0	1000.000	237.0	V	56.0	16.7
19331.993750	---	23.27	82.23	58.96	5000.0	1000.000	237.0	V	56.0	16.7
21363.925000	---	21.99	82.23	60.24	5000.0	1000.000	289.0	V	0.0	17.0
21363.925000	35.18	---	82.23	47.05	5000.0	1000.000	289.0	V	0.0	17.0
22791.156250	35.65	---	82.23	46.58	5000.0	1000.000	320.0	H	267.0	18.7
22791.156250	---	22.28	82.23	59.95	5000.0	1000.000	320.0	H	267.0	18.7
23580.612500	41.39	---	82.23	40.84	5000.0	1000.000	233.0	H	344.0	23.9
23580.612500	---	27.84	82.23	54.39	5000.0	1000.000	233.0	H	344.0	23.9
24221.568750	---	31.85	82.23	50.38	5000.0	1000.000	216.0	V	174.0	27.0
24221.568750	45.18	---	82.23	37.05	5000.0	1000.000	216.0	V	174.0	27.0
25413.687500	39.98	---	82.23	42.25	5000.0	1000.000	118.0	V	106.0	21.6
25413.687500	---	26.92	82.23	55.31	5000.0	1000.000	118.0	V	106.0	21.6

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

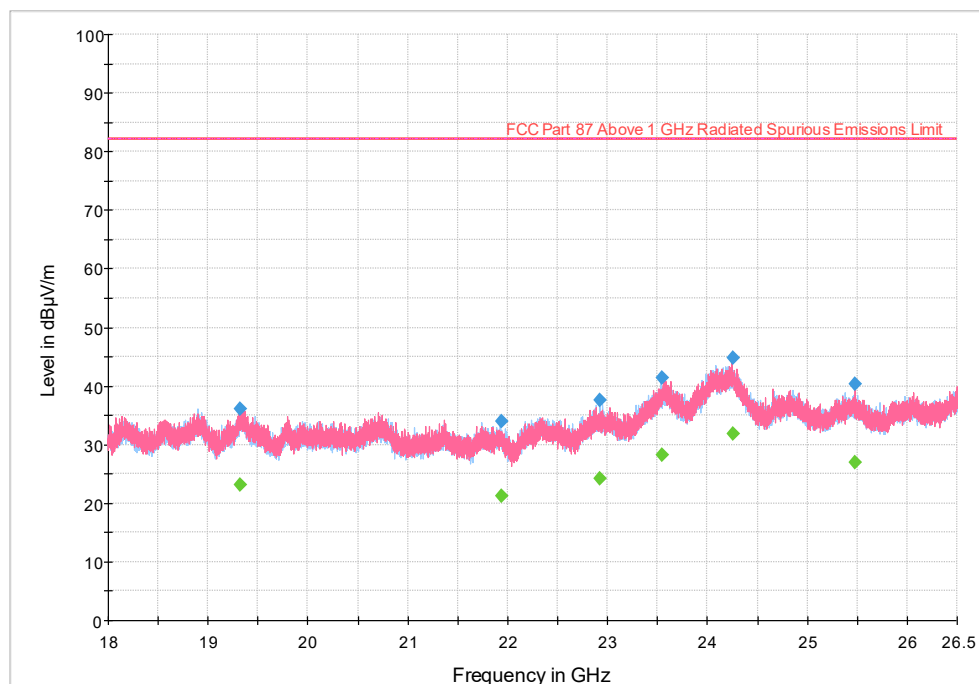
⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

⁶ Two high pass filter in cascade were used in this range for avoid the receiver system damage and to maintain power amplifier linearity.

Table 8.5-6: Unwanted emissions spurious band results – Field strength measured from 18-26.5 GHz, Middle channel 15.55 GHz.

Full Spectrum



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-9: Unwanted emissions spurious band plot – Field strength measured from 18-26.5 GHz, High channel 15.60 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19324.706250	36.20	---	82.23	46.03	5000.0	1000.000	273.0	H	144.0	16.8
19324.706250	---	23.06	82.23	59.17	5000.0	1000.000	273.0	H	144.0	16.8
21933.456250	---	21.14	82.23	61.09	5000.0	1000.000	311.0	H	0.0	17.0
21933.456250	34.00	---	82.23	48.23	5000.0	1000.000	311.0	H	0.0	17.0
22925.031250	---	24.21	82.23	58.02	5000.0	1000.000	307.0	H	79.0	19.0
22925.031250	37.60	---	82.23	44.63	5000.0	1000.000	307.0	H	79.0	19.0
23544.875000	41.30	---	82.23	40.93	5000.0	1000.000	322.0	H	114.0	23.6
23544.875000	---	28.31	82.23	53.92	5000.0	1000.000	322.0	H	114.0	23.6
24257.300000	---	31.79	82.23	50.44	5000.0	1000.000	385.0	V	342.0	26.9
24257.300000	44.84	---	82.23	37.39	5000.0	1000.000	385.0	V	342.0	26.9
25477.012500	---	26.91	82.23	55.32	5000.0	1000.000	275.0	V	127.0	21.9
25477.012500	40.33	---	82.23	41.90	5000.0	1000.000	275.0	V	127.0	21.9

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

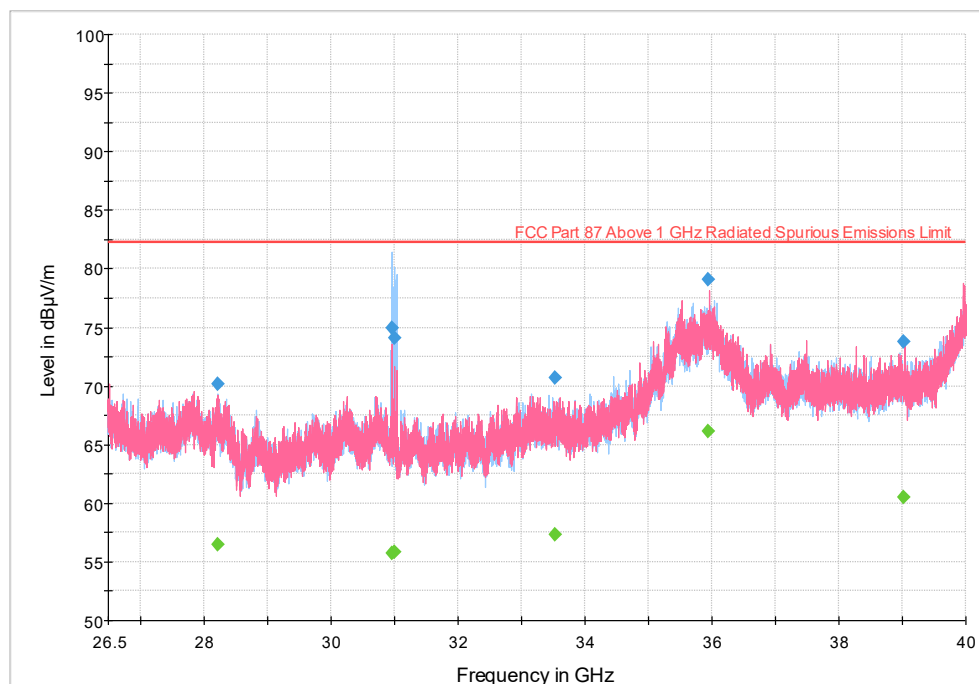
⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

⁶ Two high pass filter in cascade were used in this range for avoid the receiver system damage and to maintain power amplifier linearity.

Table 8.5-7: Unwanted emissions spurious band results – Field strength measured from 18-26.5 GHz, High channel 15.60 GHz.

Full Spectrum



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-10: Unwanted emissions spurious band plot – Field strength measured from 26.5-40 GHz, Low channel 15.50 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
28215.412500	70.15	---	82.23	12.08	5000.0	1000.000	200.0	V	11.0	52.3
28215.412500	---	56.50	82.23	25.73	5000.0	1000.000	200.0	V	11.0	52.3
30965.987500	---	55.72	82.23	26.51	5000.0	1000.000	163.0	H	316.0	51.5
30965.987500	74.93	---	82.23	7.30	5000.0	1000.000	163.0	H	316.0	51.5
31005.825000	---	55.81	82.23	26.42	5000.0	1000.000	160.0	H	316.0	51.5
31005.825000	74.07	---	82.23	8.16	5000.0	1000.000	160.0	H	316.0	51.5
33540.268750	---	57.27	82.23	24.96	5000.0	1000.000	125.0	V	3.0	51.5
33540.268750	70.68	---	82.23	11.55	5000.0	1000.000	125.0	V	3.0	51.5
35944.550000	79.06	---	82.23	3.17	5000.0	1000.000	200.0	V	11.0	59.1
35944.550000	---	66.08	82.23	16.15	5000.0	1000.000	200.0	V	11.0	59.1
39014.043750	---	60.50	82.23	21.73	5000.0	1000.000	116.0	H	236.0	52.7
39014.043750	73.75	---	82.23	8.48	5000.0	1000.000	116.0	H	236.0	52.7

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

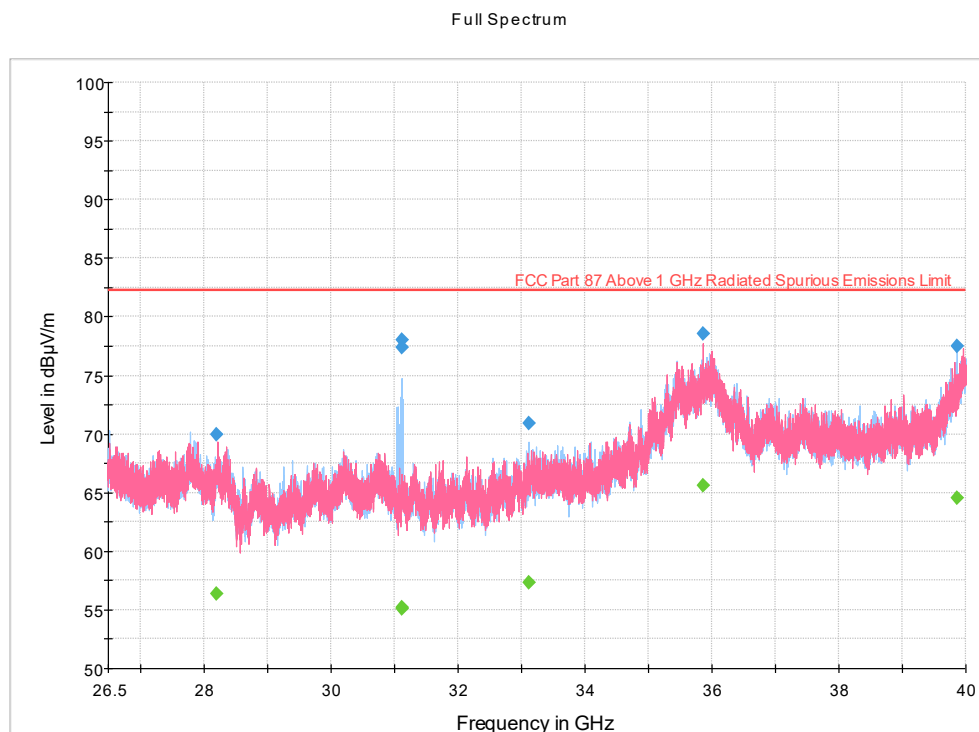
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

Table 8.5-8: Unwanted emissions spurious band results – Field strength measured from 26.5-40 GHz, Low channel 15.50 GHz.



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-11: Unwanted emissions spurious band plot – Field strength measured from 26.5-40 GHz, Middle channel 15.55 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
28210.831250	69.91	---	82.23	12.32	5000.0	1000.000	117.0	V	294.0	52.3
28210.831250	---	56.38	82.23	25.85	5000.0	1000.000	117.0	V	294.0	52.3
31118.700000	77.39	---	82.23	4.84	5000.0	1000.000	200.0	H	348.0	50.9
31118.700000	---	55.14	82.23	27.09	5000.0	1000.000	200.0	H	348.0	50.9
31131.062500	78.04	---	82.23	4.19	5000.0	1000.000	200.0	H	37.0	50.9
31131.062500	---	55.18	82.23	27.05	5000.0	1000.000	200.0	H	37.0	50.9
33118.537500	70.90	---	82.23	11.33	5000.0	1000.000	200.0	V	110.0	51.1
33118.537500	---	57.32	82.23	24.91	5000.0	1000.000	200.0	V	110.0	51.1
35862.762500	---	65.65	82.23	16.58	5000.0	1000.000	110.0	V	170.0	58.9
35862.762500	78.61	---	82.23	3.62	5000.0	1000.000	110.0	V	170.0	58.9
39853.250000	---	64.49	82.23	17.74	5000.0	1000.000	141.0	H	6.0	55.7
39853.250000	77.55	---	82.23	4.68	5000.0	1000.000	141.0	H	6.0	55.7

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

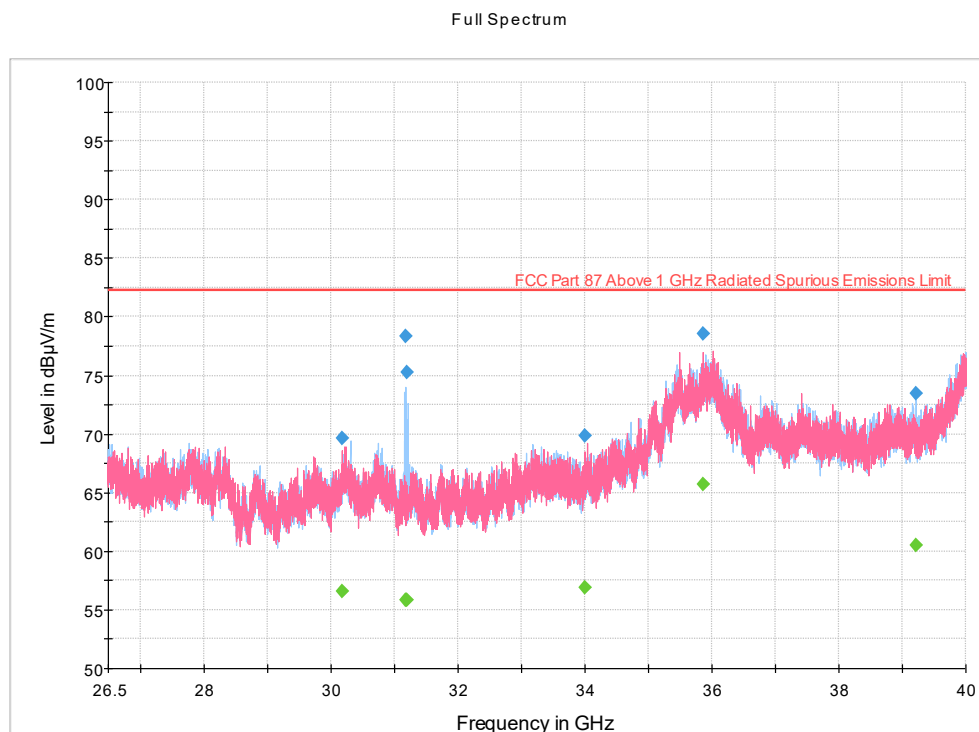
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

Table 8.5-9: Unwanted emissions spurious band results – Field strength measured from 26.5-40 GHz, Middle channel 15.55 GHz.



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.5-12: Unwanted emissions spurious band plot – Field strength measured from 26.5-40 GHz, High channel 15.60 GHz.

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30189.393750	69.60	---	82.23	12.63	5000.0	1000.000	129.0	V	307.0	51.1
30189.393750	---	56.56	82.23	25.67	5000.0	1000.000	129.0	V	307.0	51.1
31189.906250	---	55.83	82.23	26.40	5000.0	1000.000	179.0	H	40.0	50.7
31189.906250	78.37	---	82.23	3.86	5000.0	1000.000	179.0	H	40.0	50.7
31204.718750	---	55.83	82.23	26.40	5000.0	1000.000	191.0	H	317.0	50.6
31204.718750	75.30	---	82.23	6.93	5000.0	1000.000	191.0	H	317.0	50.6
34010.062500	---	56.91	82.23	25.32	5000.0	1000.000	125.0	V	248.0	51.0
34010.062500	69.81	---	82.23	12.42	5000.0	1000.000	125.0	V	248.0	51.0
35865.375000	---	65.72	82.23	16.51	5000.0	1000.000	174.0	V	298.0	58.9
35865.375000	78.50	---	82.23	3.73	5000.0	1000.000	174.0	V	298.0	58.9
39225.293750	73.49	---	82.23	8.74	5000.0	1000.000	125.0	H	129.0	52.6
39225.293750	---	60.53	82.23	21.70	5000.0	1000.000	125.0	H	129.0	52.6

Notes:

¹ Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴ The spectral plot shows the vertical and horizontal scan separately.

⁵ This measurement was done at 3m.

Table 8.5-10: Unwanted emissions spurious band results – Field strength measured from 26.5-40 GHz, High channel 15.60 GHz.

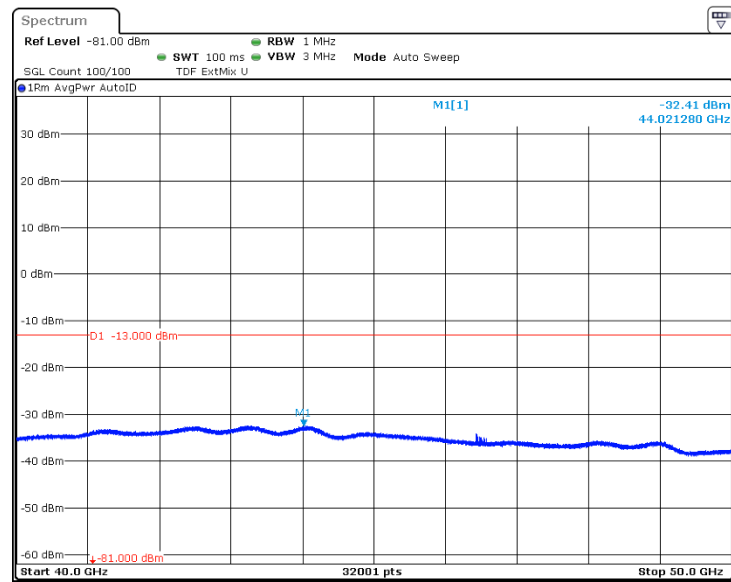


Figure 8.5-13: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, horizontal polarization, Low channel 15.50 GHz.

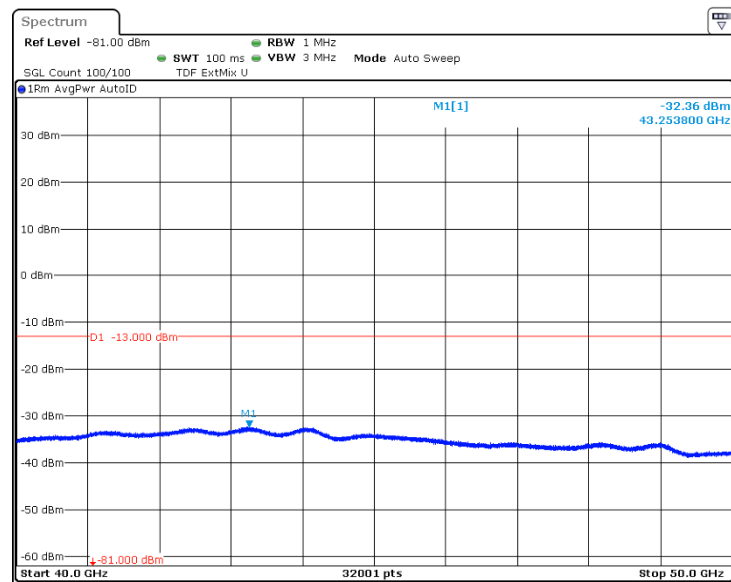


Figure 8.5-14: Unwanted emissions spurious band plot – Field strength measured, 40-50 GHz, vertical polarization, Low channel 15.50 GHz.

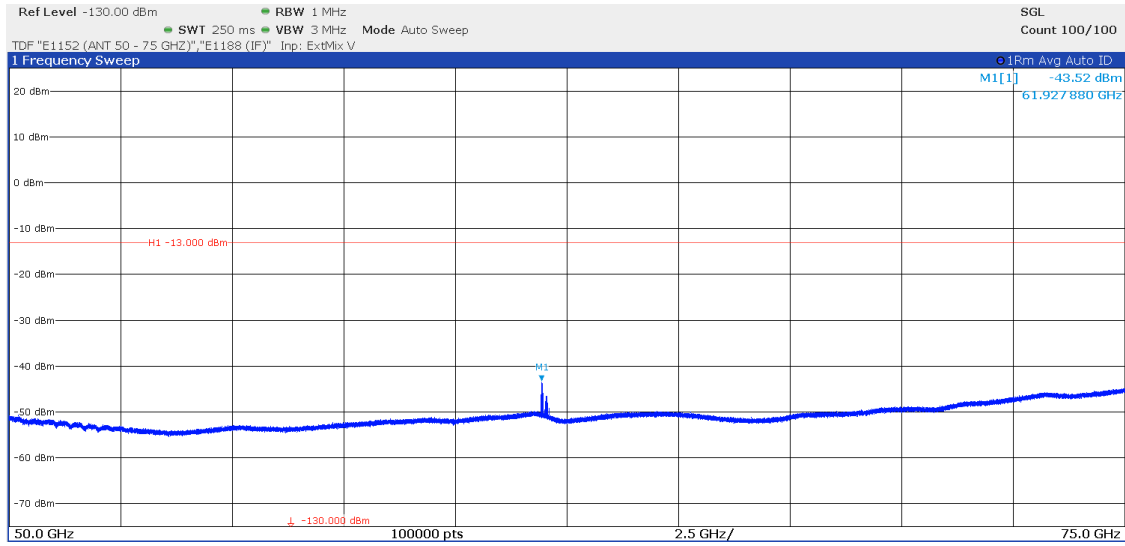


Figure 8.5-15: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, horizontal polarization, Low channel 15.50 GHz.

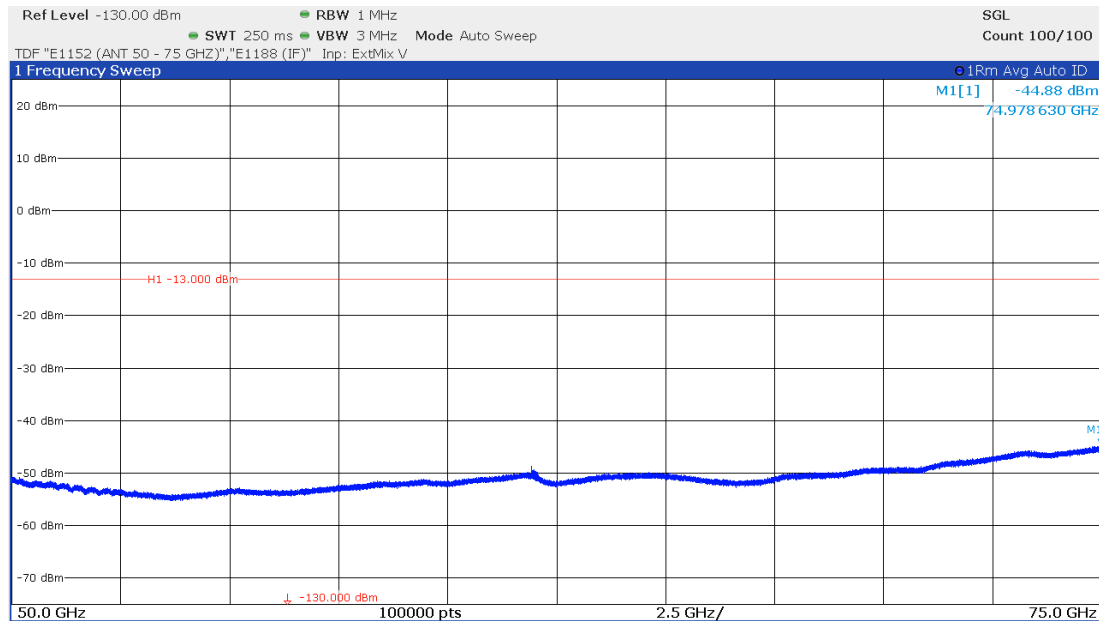


Figure 8.5-16: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, vertical polarization, Low channel 15.50 GHz.

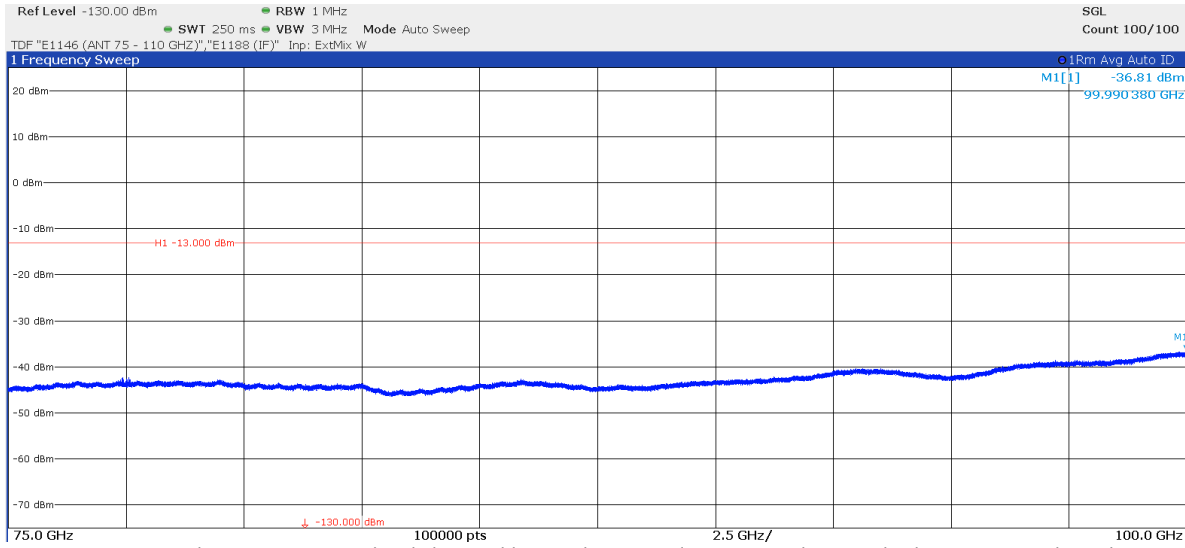


Figure 8.5-17: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, horizontal polarization, Low channel 15.50 GHz.

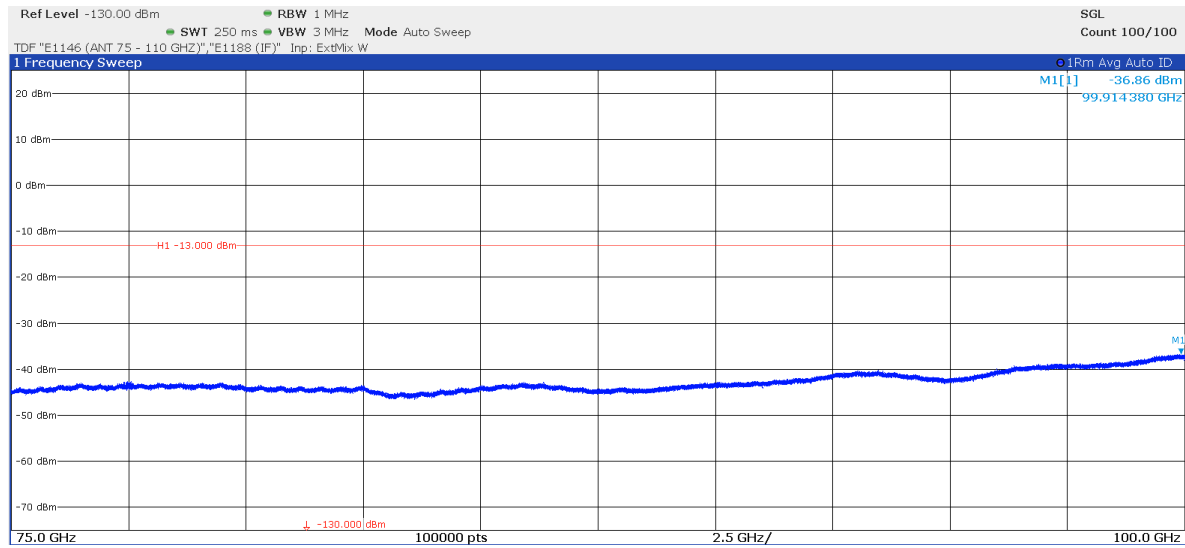


Figure 8.5-18: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, vertical polarization, Low channel 15.50 GHz.

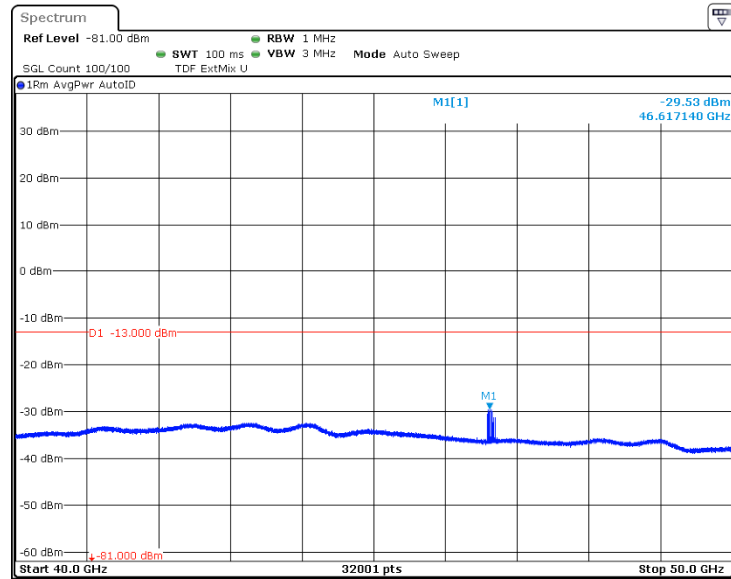


Figure 8.5-19: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, horizontal polarization, Middle channel 15.55 GHz.

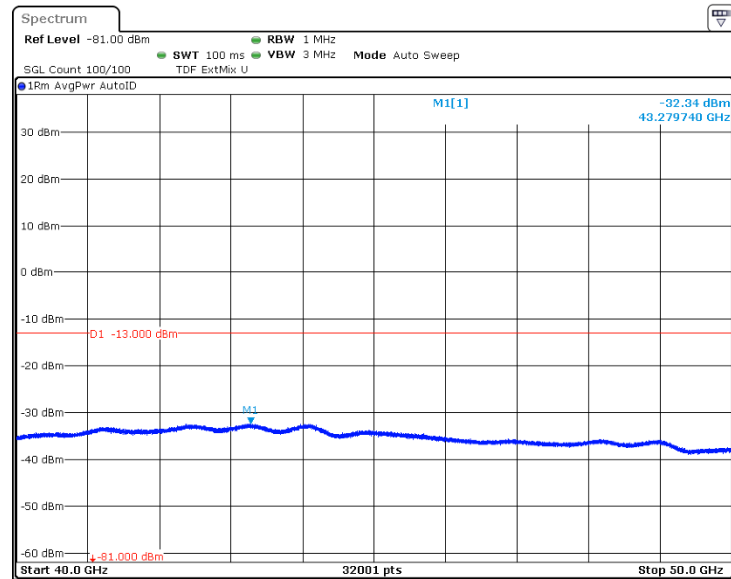


Figure 8.5-20: Unwanted emissions spurious band plot – Field strength measured, 40-50 GHz, vertical polarization, Middle channel 15.55 GHz

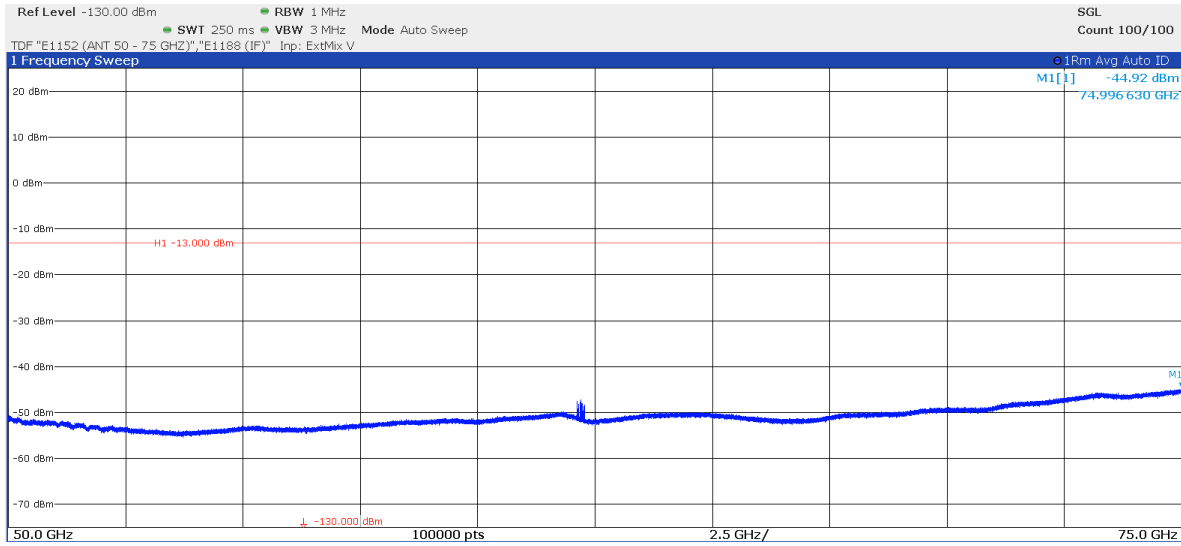


Figure 8.5-21: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, horizontal polarization, Middle channel 15.55 GHz.

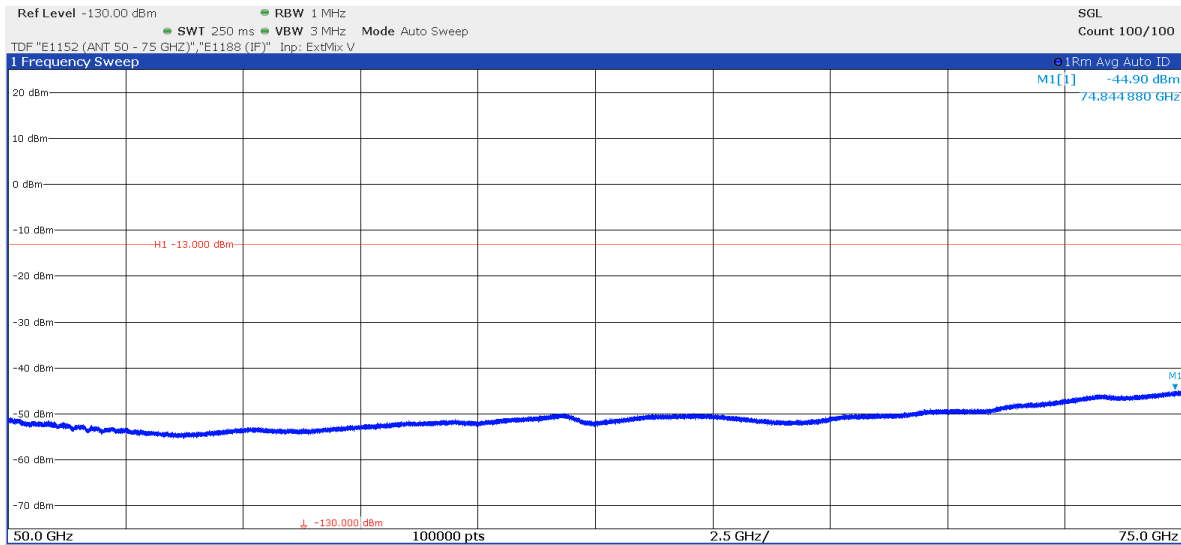


Figure 8.5-22: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, vertical polarization, Middle channel 15.55 GHz.

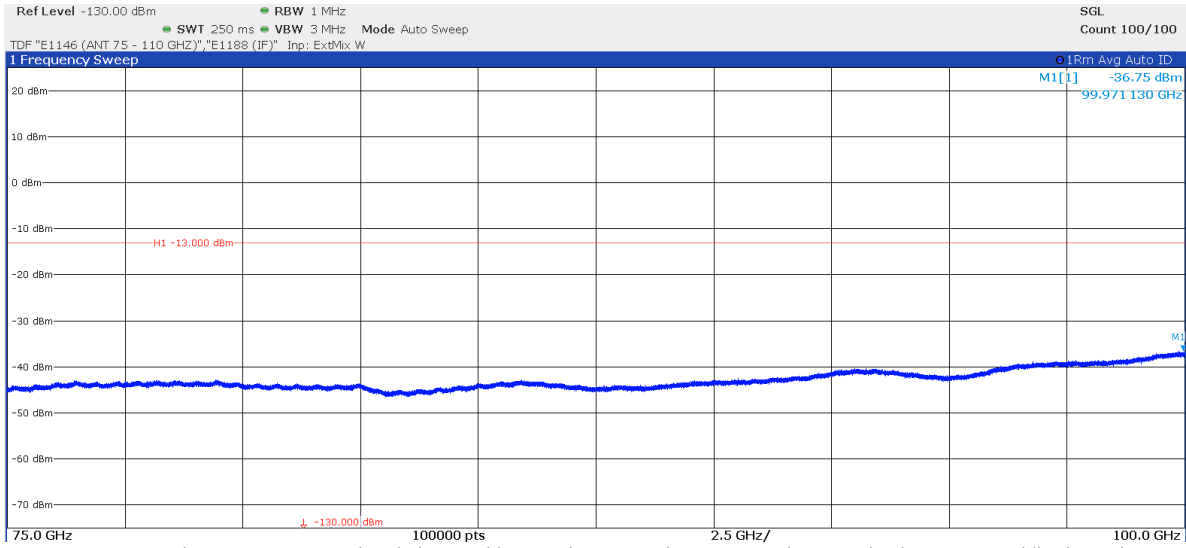


Figure 8.5-23: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, horizontal polarization, Middle channel 15.55 GHz.

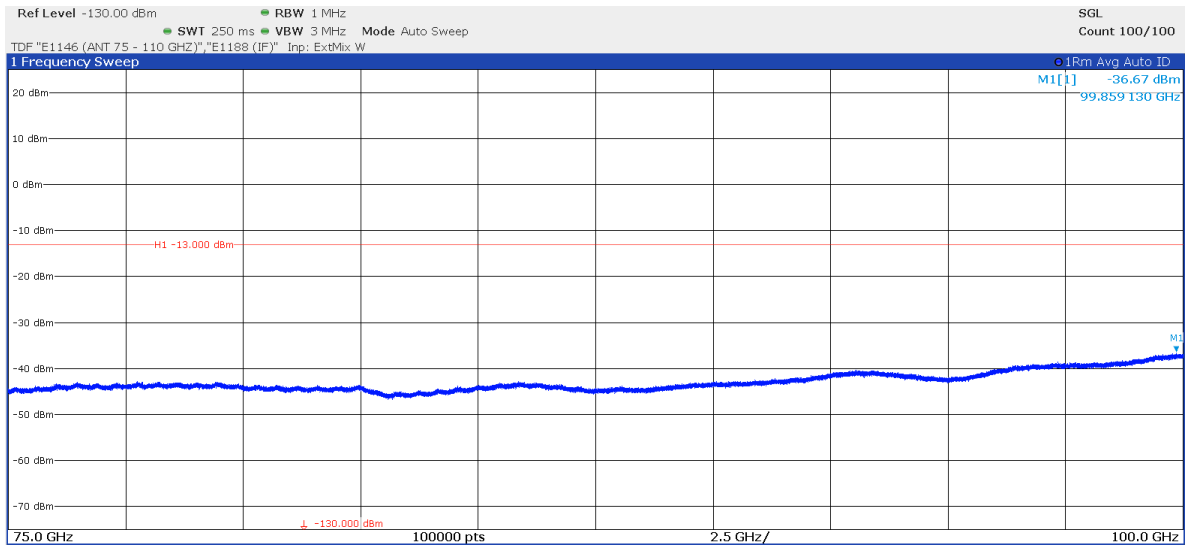


Figure 8.5-24: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, vertical polarization, Middle channel 15.55 GHz.

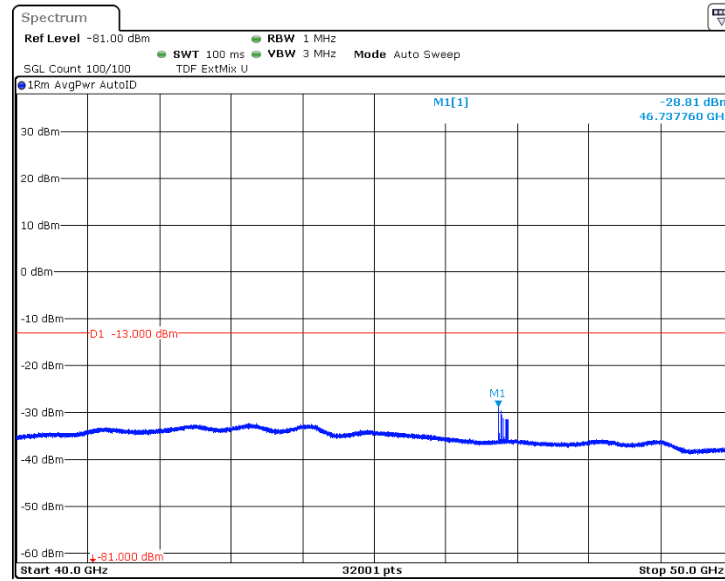


Figure 8.5-25: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, horizontal polarization, High channel 15.60 GHz.

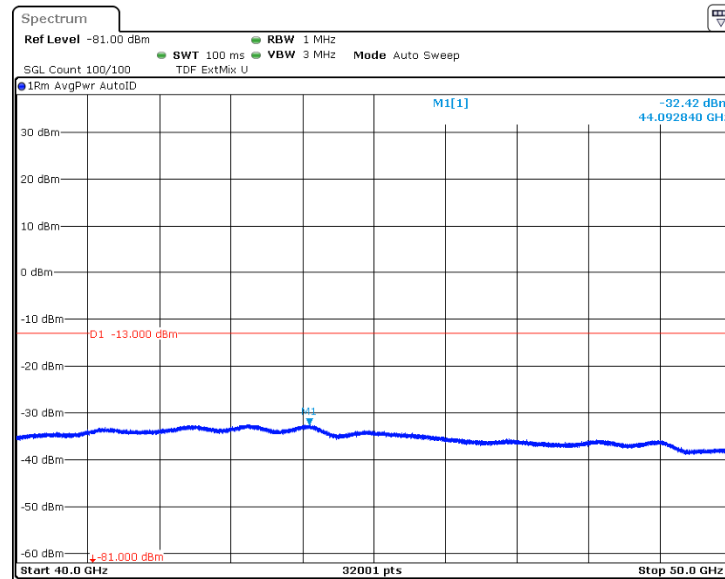


Figure 8.5-26: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, vertical polarization, High channel 15.60 GHz.

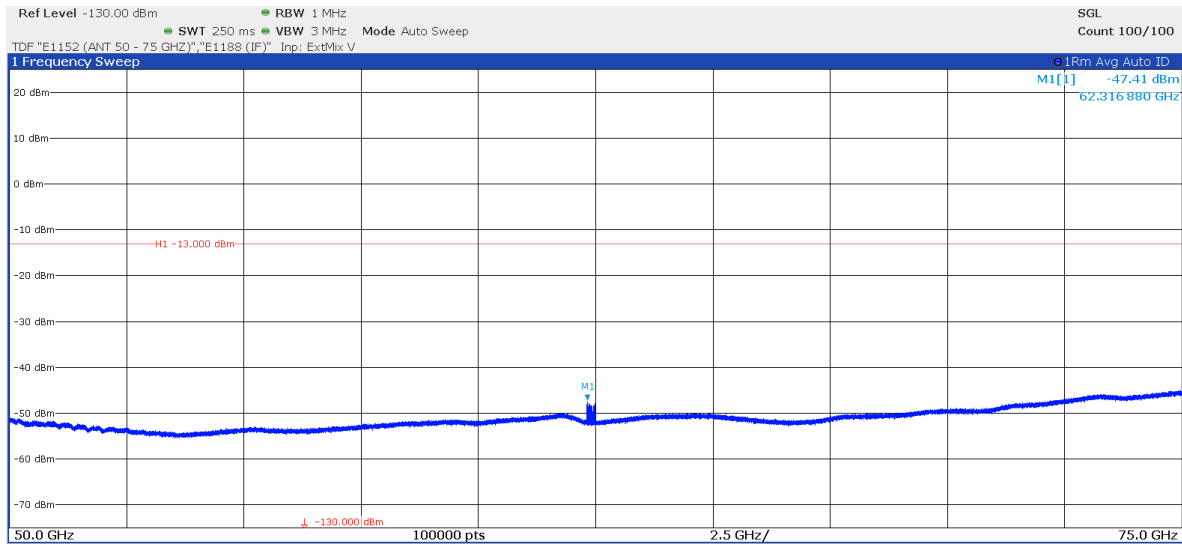


Figure 8.5-27: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, horizontal polarization, High channel 15.60 GHz.

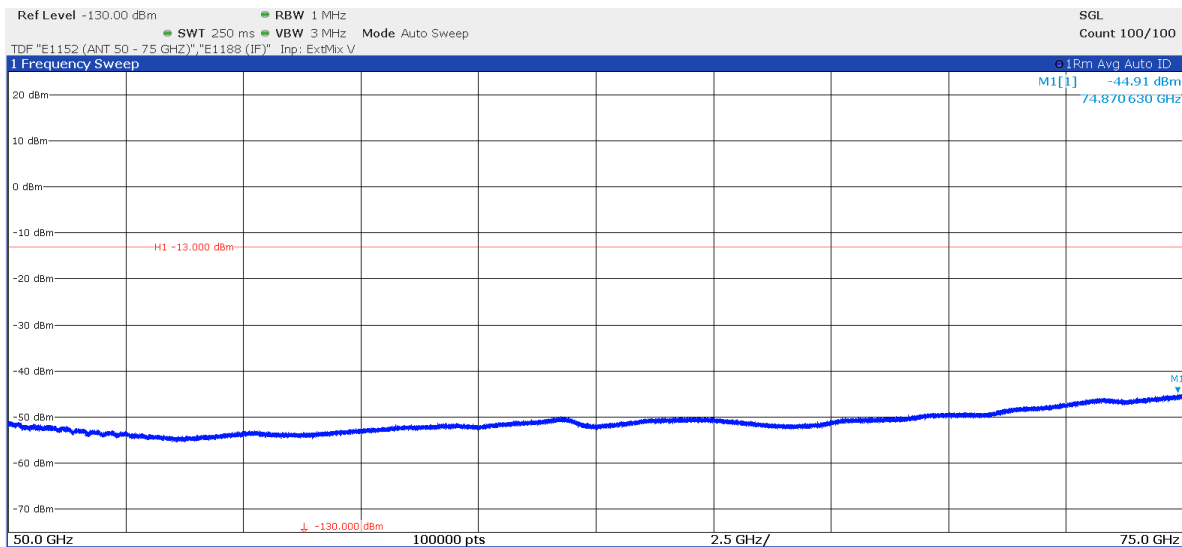


Figure 8.5-28: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, vertical polarization, High channel 15.60 GHz.

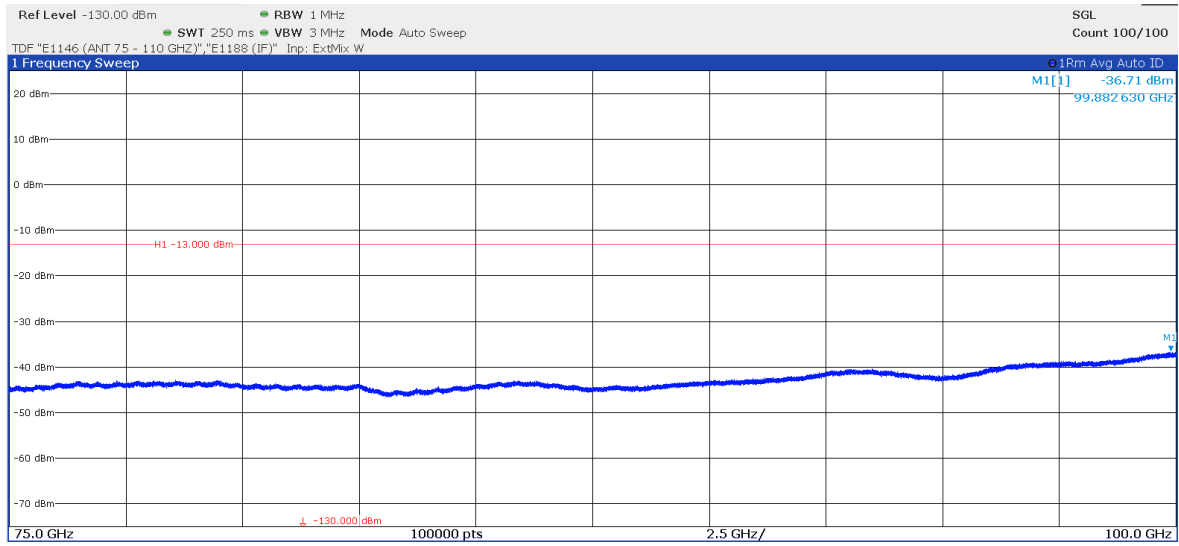


Figure 8.5-29: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, horizontal polarization, High channel 15.60 GHz.

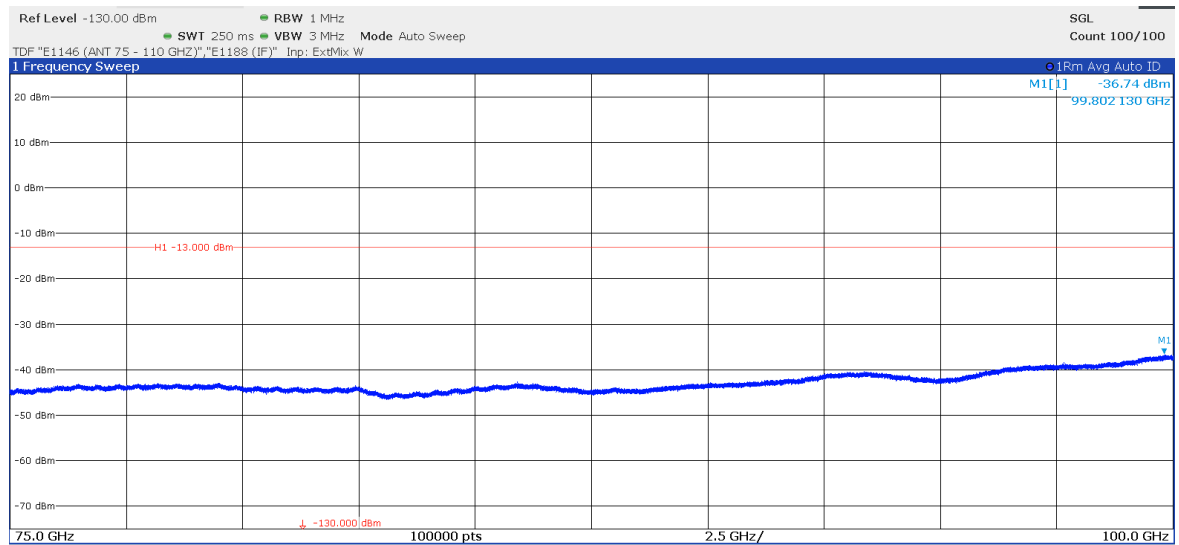


Figure 8.5-30: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, vertical polarization, High channel 15.60 GHz.

8.6 Frequency stability

8.6.1 References and limits

- FCC 47 CFR Part 87: §87.133
- Test method: ANSI C63.26 (5.6.3)
 - (a) Except as provided in paragraphs (c), (d), (f), and (g) of this section, the carrier frequency of each station must be maintained within these tolerances:

Frequency band (lower limit exclusive, upper limit inclusive), and categories of stations	Tolerance ¹	Tolerance ²
Radionavigation stations	5000	5000

8.6.2 Test summary

Verdict	Pass		
Test date	April 6, 2023	Temperature	20°C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1007mbar
Test location	☐ Wireless bench ☐ 10 m semi-anechoic chamber ☐ 3 m semi-anechoic chamber ☒ Other: Environmental chamber	Relative humidity	53 %

8.6.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. An unmodulated signal with a frequency center in the middle channel was selected for this test (15.55 GHz).

8.6.4 Setup details

EUT power input during test	28 V DC
EUT setup configuration	☐ Table-top ☐ Floor standing ☒ Other: Mounted on a fixture provided by client

Spectrum analyzer settings:

Resolution bandwidth	30 kHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

8.6.5 Test data

Table 8.6-1: Frequency stability results.

Voltage	Temperature	Channel frequency (Hz)	Measured frequency (Hz)	ppm	Limit (ppm)	Result
28 V	-40°C	15550000000	15550000000	0.0000	5000	Pass
28 V	-30°C	15550000000	15549999000	0.0643	5000	Pass
28 V	-20°C	15550000000	15550000000	0.0000	5000	Pass
28 V	-10°C	15550000000	15549999000	0.0643	5000	Pass
28 V	0°C	15550000000	15549999000	0.0643	5000	Pass
28 V	+10°C	15550000000	15550000000	0.0000	5000	Pass
28 V	+20°C	15550000000	15549999000	0.0643	5000	Pass
23.8 V (-15%)	+20°C	15550000000	15550000000	0.0000	5000	Pass
32.2 V (+15%)	+20°C	15550000000	15550000000	0.0000	5000	Pass
28 V	+30°C	15550000000	15549999000	0.0643	5000	Pass
28 V	+40°C	15550000000	15550000000	0.0000	5000	Pass
28 V	+50°C	15550000000	15550000000	0.0000	5000	Pass
28 V	+60°C	15550000000	15550001000	-0.0643	5000	Pass
28 V	+70°C	15550000000	15549999000	0.0643	5000	Pass

End of test report