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 FCC Part 90

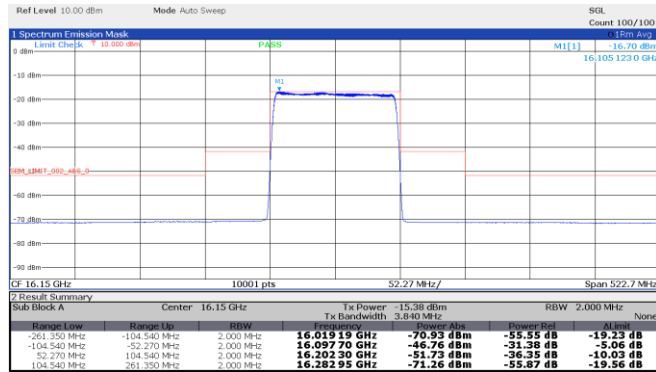


Figure 8.4-23: Emission mask, Middle channel: 16.15 GHz, longest pulse. (100 MHz BW)

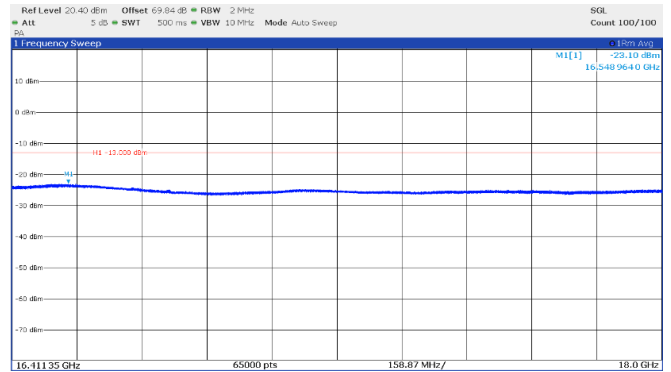


Figure 8.4-24: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Middle channel: 16.15 GHz, longest pulse. (100 MHz BW)

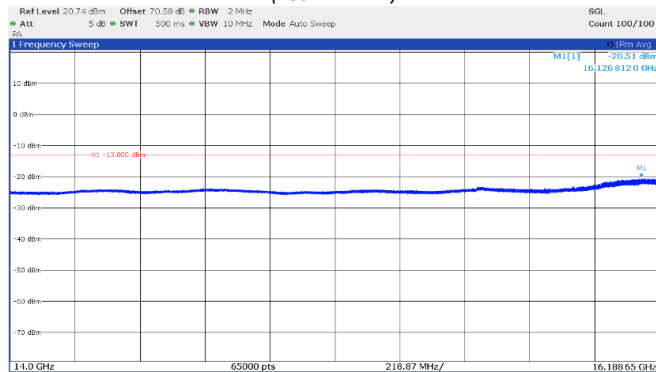


Figure 8.4-25: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), High channel: 16.45 GHz, longest pulse. (100 MHz BW)

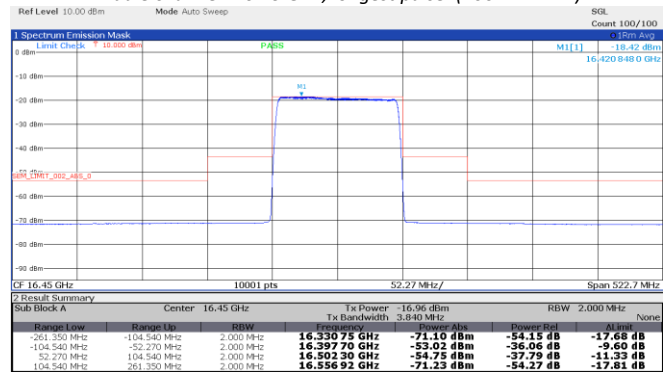


Figure 8.4-26: Emission mask, High channel: 16.45 GHz, longest pulse. (100 MHz BW)

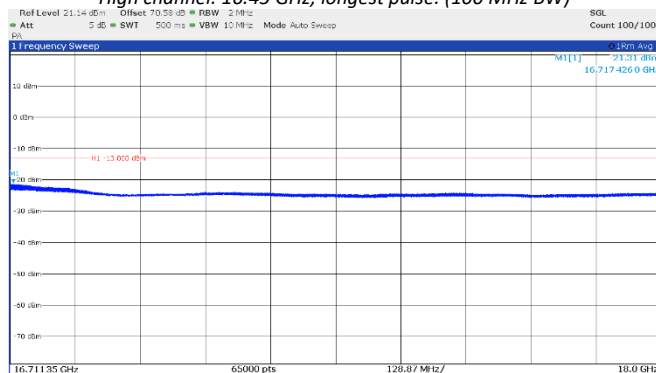


Figure 8.4-27: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), High channel: 16.45 GHz, longest pulse. (100 MHz BW)

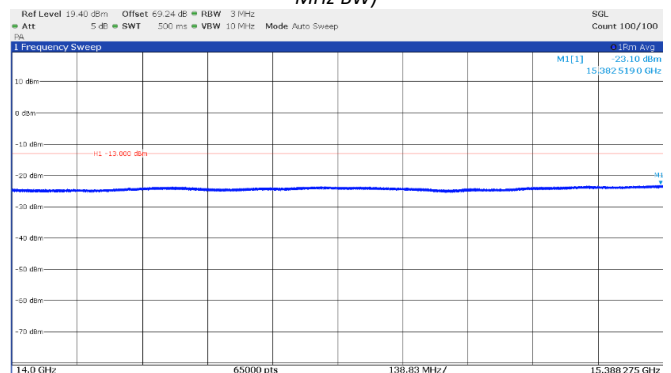


Figure 8.4-28: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Low channel: 15.90 GHz, longest pulse. (200 MHz BW)

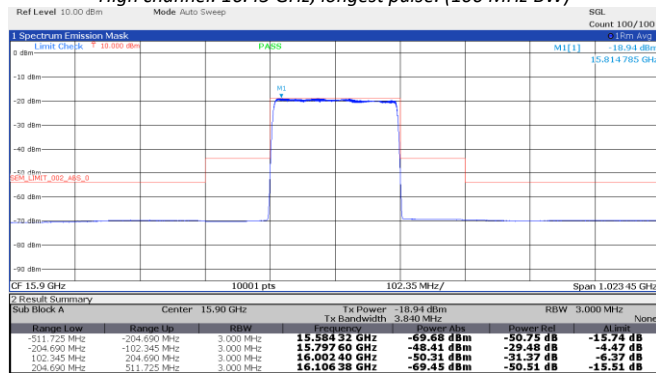


Figure 8.4-29: Emission mask, Low channel: 15.90 GHz, longest pulse. (200 MHz BW)

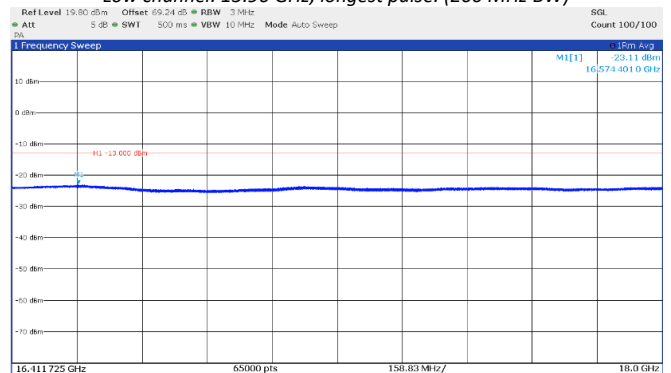


Figure 8.4-30: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Low channel: 15.90 GHz, longest pulse. (200 MHz BW)

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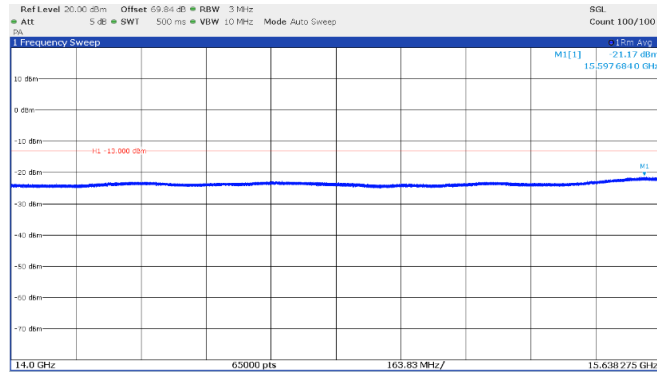


Figure 8.4-31: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Middle channel: 16.15 GHz, longest pulse. (200 MHz BW)

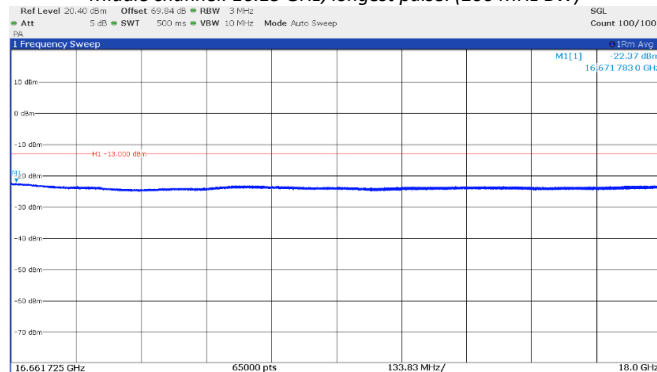


Figure 8.4-33: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Middle channel: 16.15 GHz, longest pulse. (200 MHz BW)

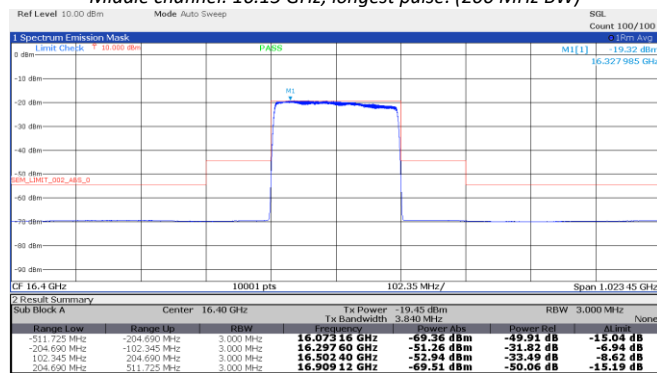


Figure 8.4-35: Emission mask, High channel: 16.40 GHz, longest pulse. (200 MHz BW)

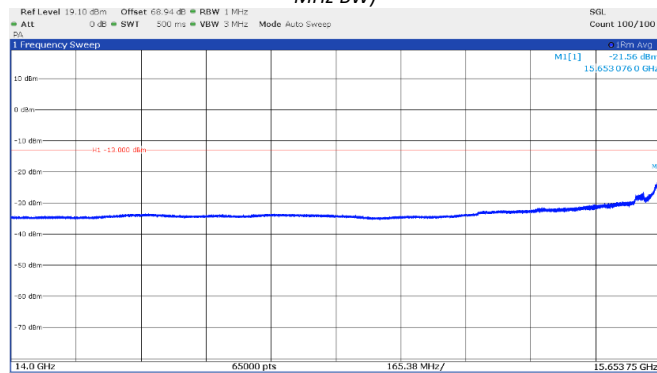


Figure 8.4-37: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Low channel: 15.75 GHz, shortest pulse. (25 MHz BW)

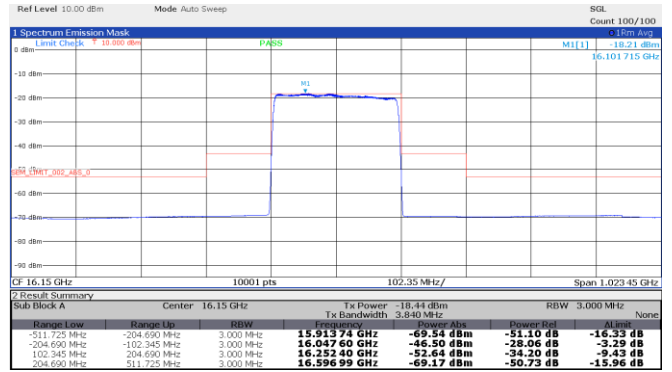


Figure 8.4-32: Emission mask, Middle channel: 16.15 GHz, longest pulse. (200 MHz BW)

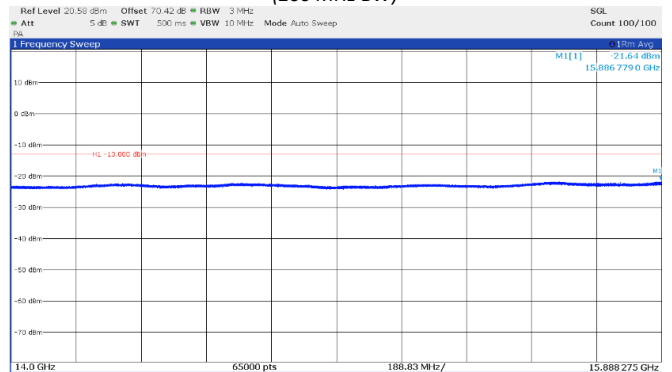


Figure 8.4-34: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), High channel: 16.40 GHz, longest pulse. (200 MHz BW)

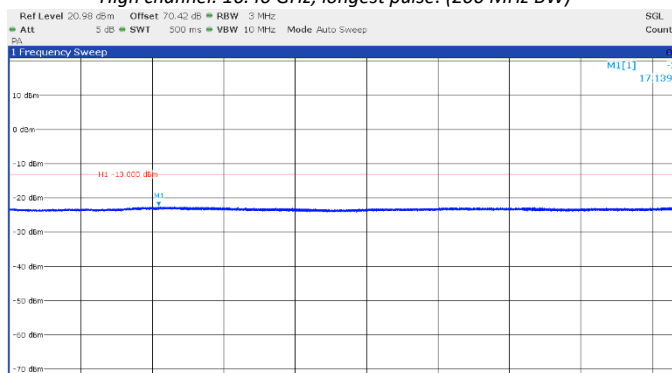


Figure 8.4-36: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), High channel: 16.40 GHz, longest pulse. (200 MHz BW)

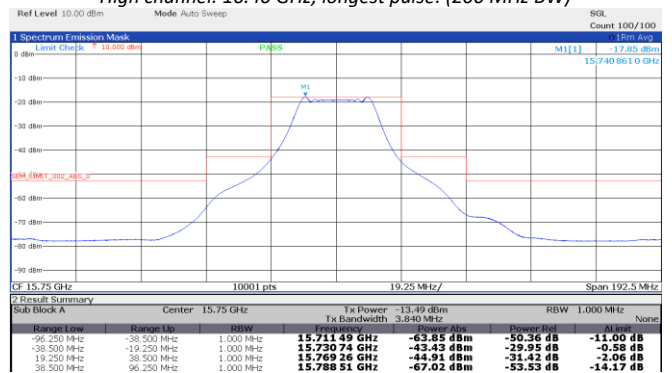


Figure 8.4-38: Emission mask, Low channel: 15.75 GHz, shortest pulse. (25 MHz BW)

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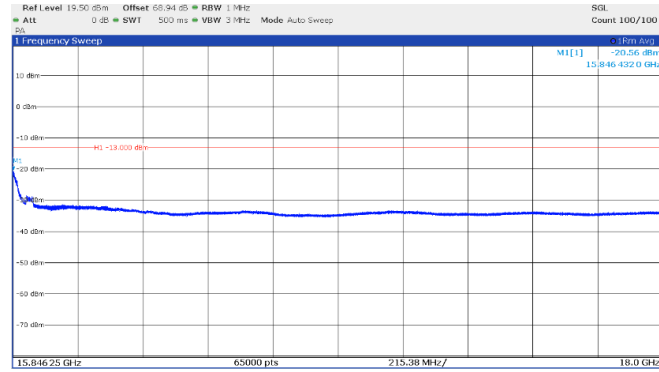


Figure 8.4-39: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Low channel: 15.75 GHz, shortest pulse. (25 MHz BW)

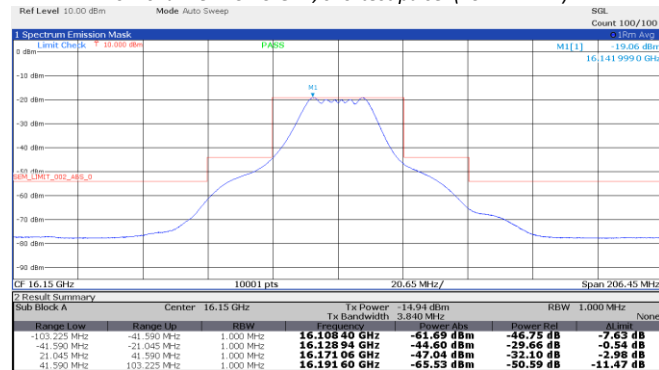


Figure 8.4-41: Emission mask, Middle channel: 16.15 GHz, shortest pulse. (25 MHz BW)

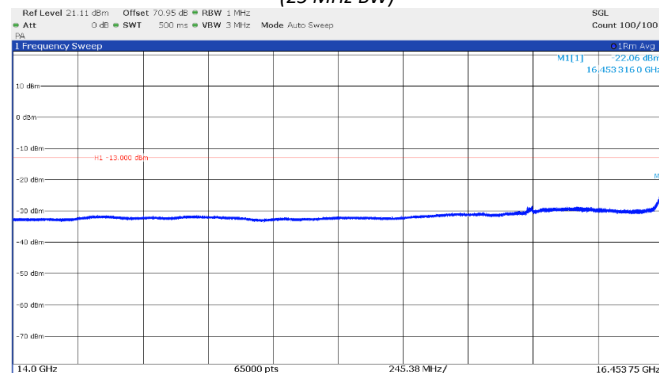


Figure 8.4-43: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), High channel: 16.55 GHz, shortest pulse. (25 MHz BW)

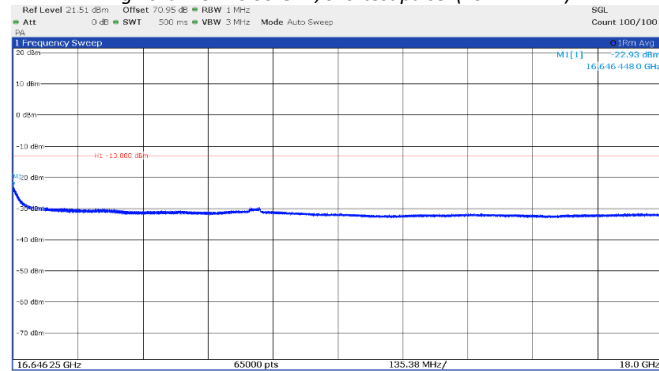


Figure 8.4-45: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), High channel: 16.55 GHz, shortest pulse. (25 MHz BW)

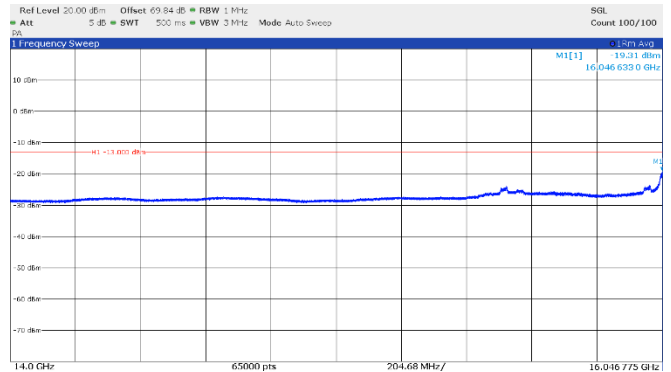


Figure 8.4-40: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Middle channel: 16.15 GHz, shortest pulse. (25 MHz BW)

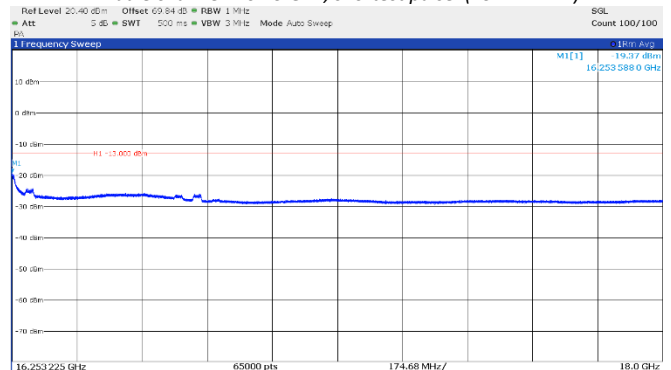


Figure 8.4-42: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Middle channel: 16.15 GHz, shortest pulse. (25 MHz BW)

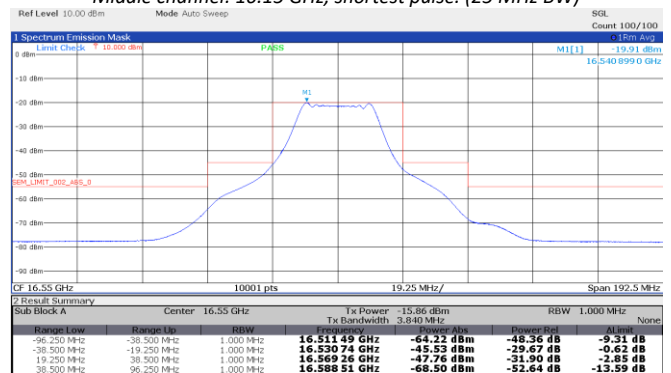


Figure 8.4-44: Emission mask, High channel: 16.55 GHz, shortest pulse. (25 MHz BW)

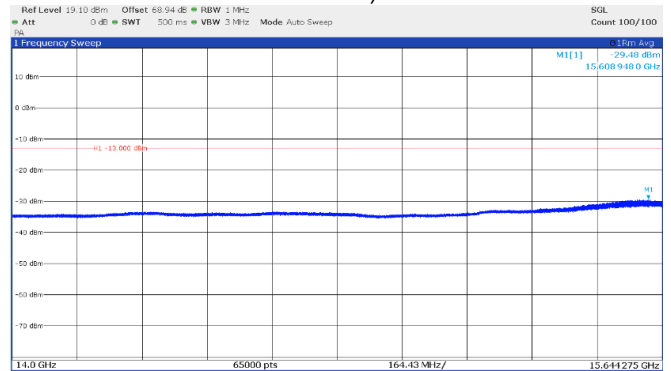


Figure 8.4-46: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Low channel: 15.80 GHz, shortest pulse. (50 MHz BW)

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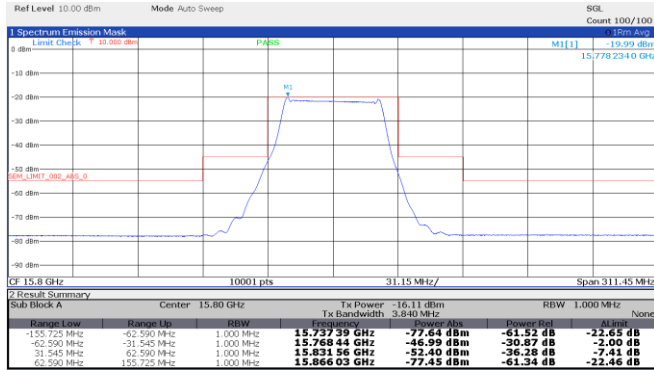


Figure 8.4-47: Emission mask, Low channel: 15.80 GHz, shortest pulse. (50 MHz BW)

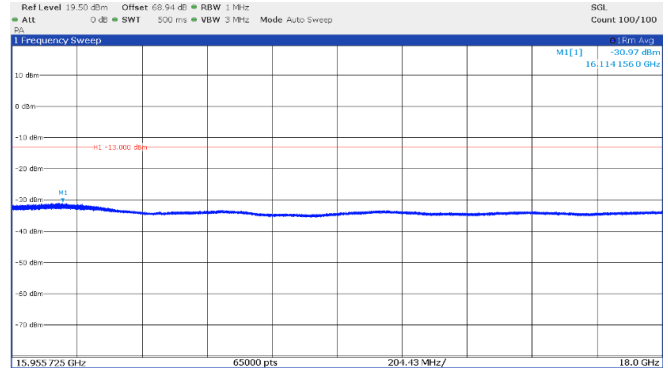


Figure 8.4-48: Emission mask, beyond ±250% of BW (high frequency range), Low channel: 15.80 GHz, shortest pulse. (50 MHz BW)

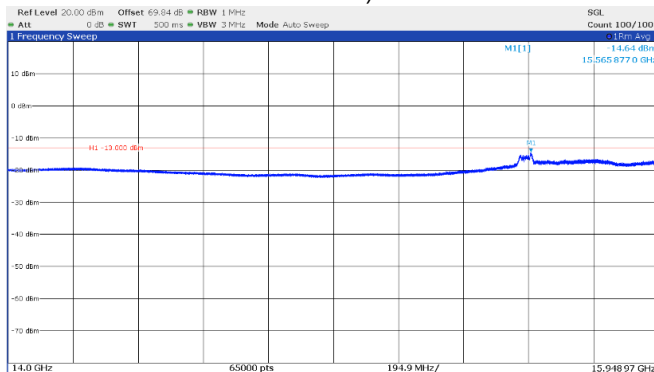


Figure 8.4-49: Emission mask, beyond ±250% of BW (low frequency range), Middle channel: 16.15 GHz, shortest pulse. (50 MHz BW)

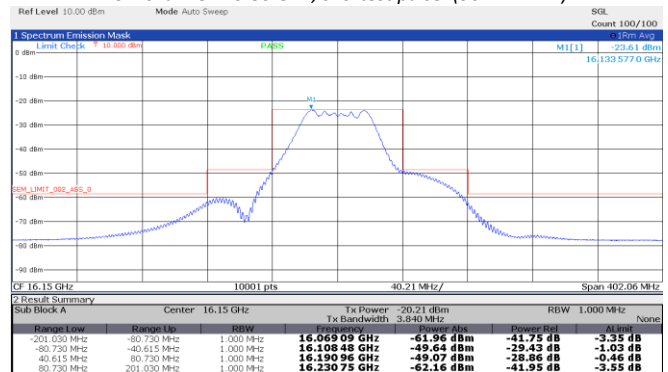


Figure 8.4-50: Emission mask, Middle channel: 16.15 GHz, shortest pulse. (50 MHz BW)

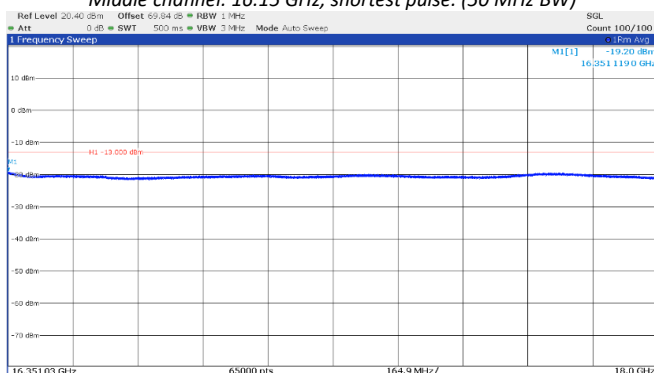


Figure 8.4-51: Emission mask, beyond ±250% of BW (high frequency range), Middle channel: 16.15 GHz, shortest pulse. (50 MHz BW)

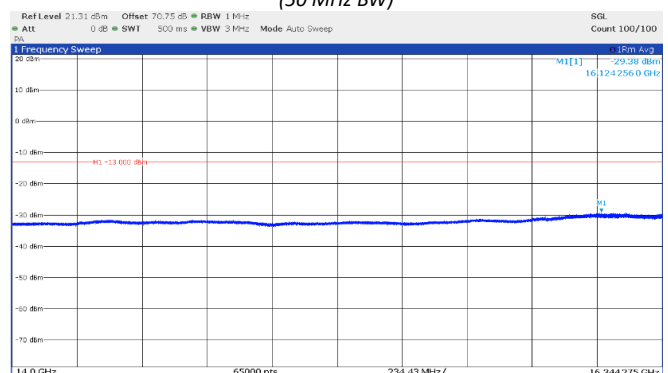


Figure 8.4-52: Emission mask, beyond ±250% of BW (low frequency range), High channel: 16.50 GHz, shortest pulse. (50 MHz BW)

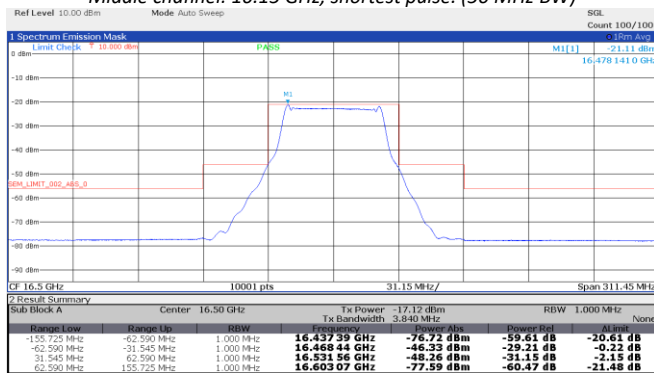


Figure 8.4-53: Emission mask, High channel: 16.50 GHz, shortest pulse. (50 MHz BW)

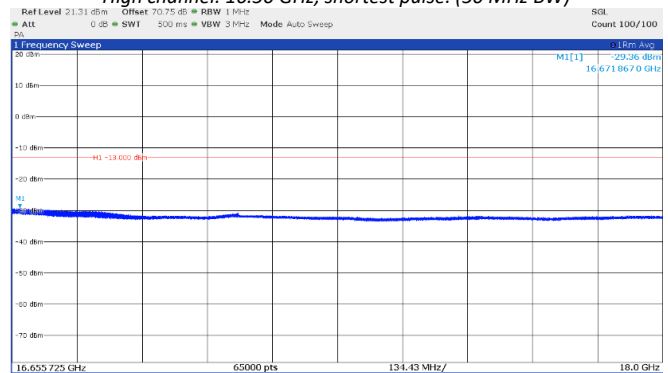


Figure 8.4-54: Emission mask, beyond ±250% of BW (high frequency range), High channel: 16.50 GHz, shortest pulse. (50 MHz BW)

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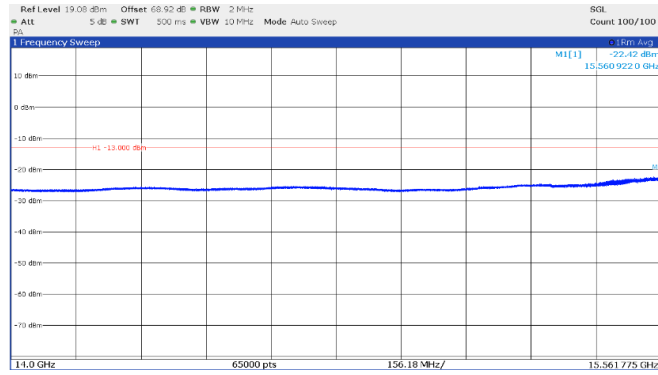


Figure 8.4-55: Emission mask, beyond ±250% of BW (low frequency range), Low channel: 15.85 GHz, shortest pulse. (100 MHz BW)

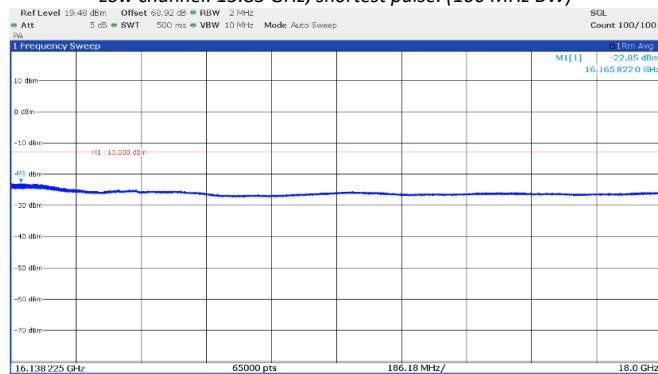


Figure 8.4-57: Emission mask, beyond ±250% of BW (high frequency range), Low channel: 15.85 GHz, shortest pulse. (100 MHz BW)

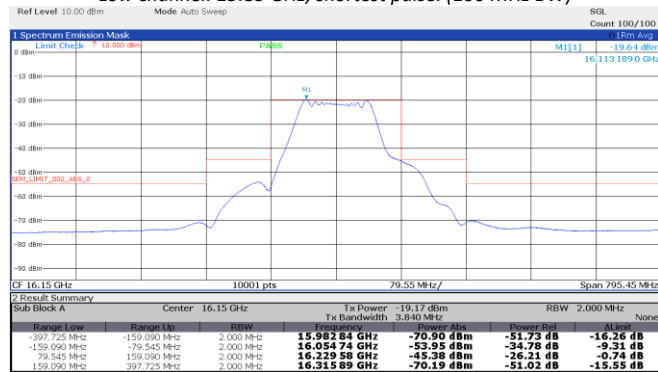


Figure 8.4-59: Emission mask, Middle channel: 16.15 GHz, shortest pulse. (100 MHz BW)

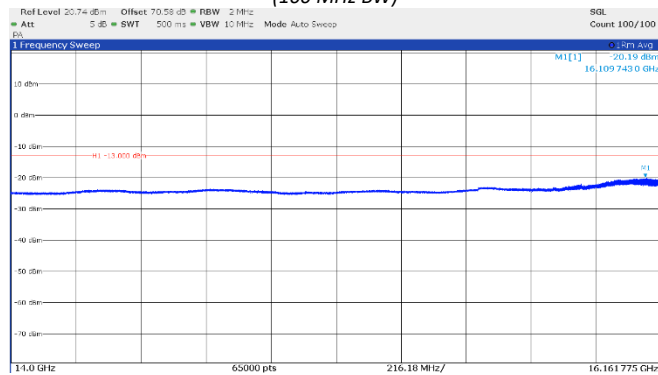


Figure 8.4-61: Emission mask, beyond ±250% of BW (low frequency range), High channel: 16.45 GHz, shortest pulse. (100 MHz BW)

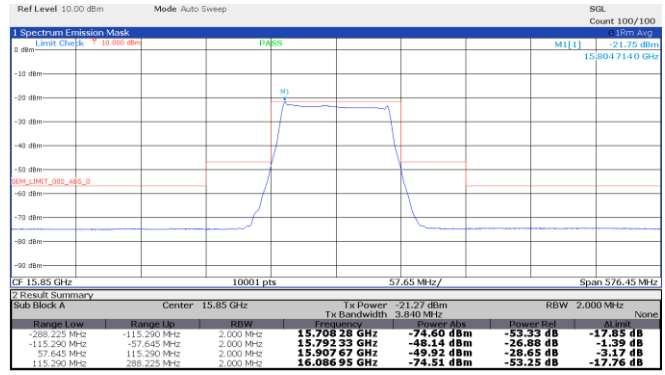


Figure 8.4-56: Emission mask, Low channel: 15.85 GHz, shortest pulse. (100 MHz BW)

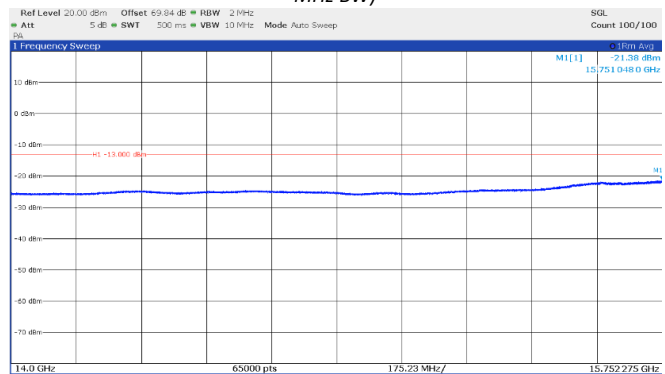


Figure 8.4-58: Emission mask, beyond ±250% of BW (low frequency range), Middle channel: 16.15 GHz, shortest pulse. (100 MHz BW)

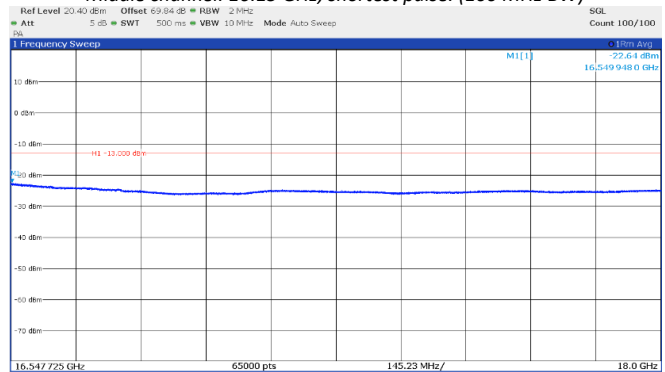


Figure 8.4-60: Emission mask, beyond ±250% of BW (high frequency range), Middle channel: 16.15 GHz, shortest pulse. (100 MHz BW)

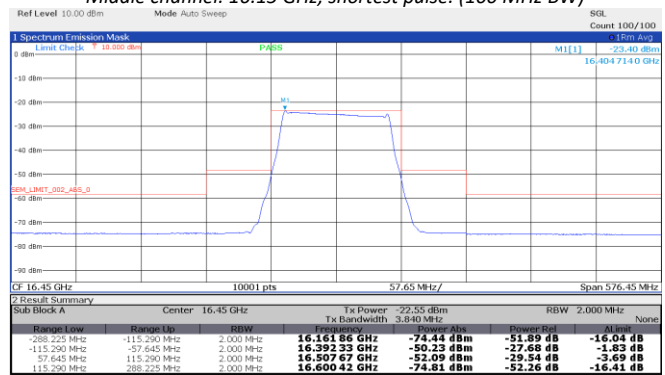


Figure 8.4-62: Emission mask, High channel: 16.45 GHz, shortest pulse. (100 MHz BW)

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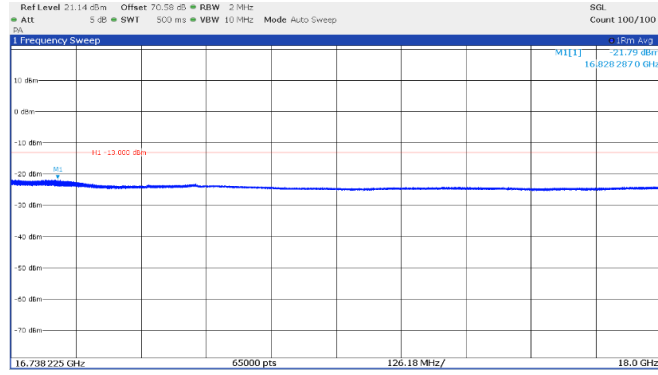


Figure 8.4-63: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), High channel: 16.45 GHz, shortest pulse. (100 MHz BW)

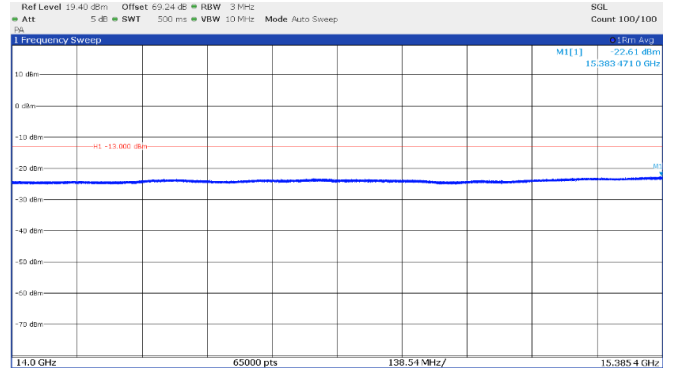


Figure 8.4-64: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Low channel: 15.90 GHz, shortest pulse. (200 MHz BW)

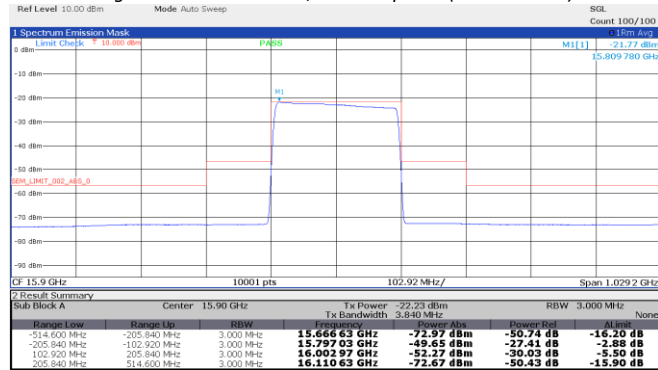


Figure 8.4-65: Emission mask, Low channel: 15.90 GHz, shortest pulse. (200 MHz BW)

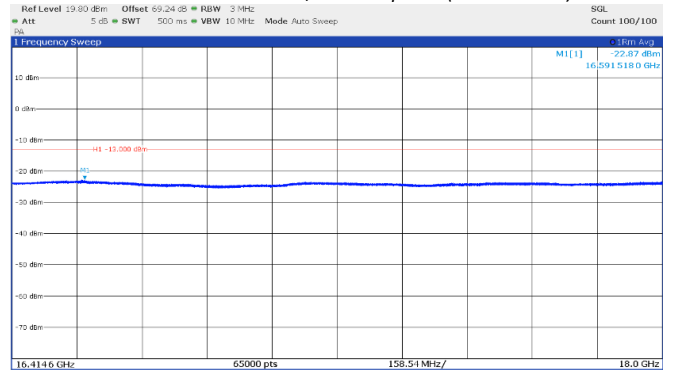


Figure 8.4-66: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Low channel: 15.90 GHz, shortest pulse. (200 MHz BW)

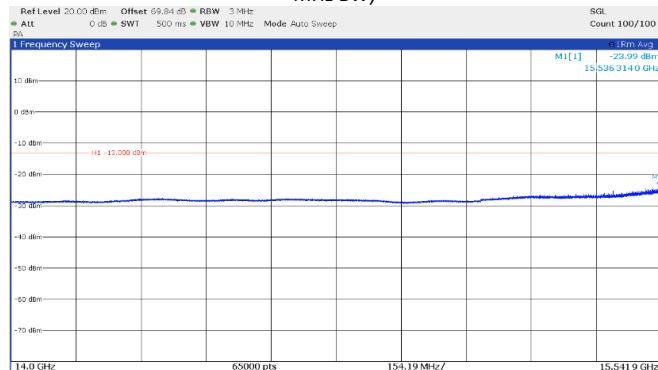


Figure 8.4-67: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), Middle channel: 16.15 GHz, shortest pulse. (200 MHz BW)

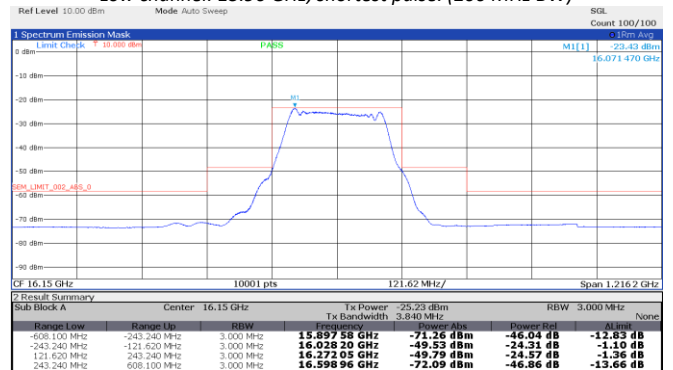


Figure 8.4-68: Emission mask, Middle channel: 16.15 GHz, shortest pulse. (200 MHz BW)

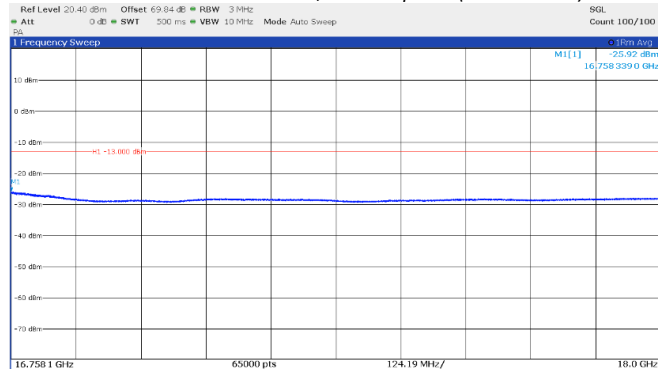


Figure 8.4-69: Emission mask, beyond $\pm 250\%$ of BW (high frequency range), Middle channel: 16.15 GHz, shortest pulse. (200 MHz BW)

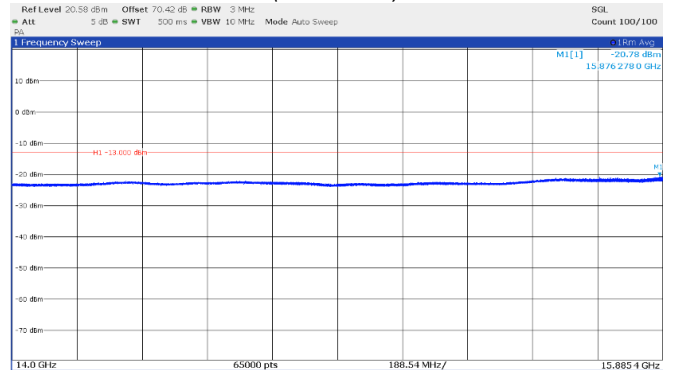


Figure 8.4-70: Emission mask, beyond $\pm 250\%$ of BW (low frequency range), High channel: 16.40 GHz, shortest pulse. (200 MHz BW)

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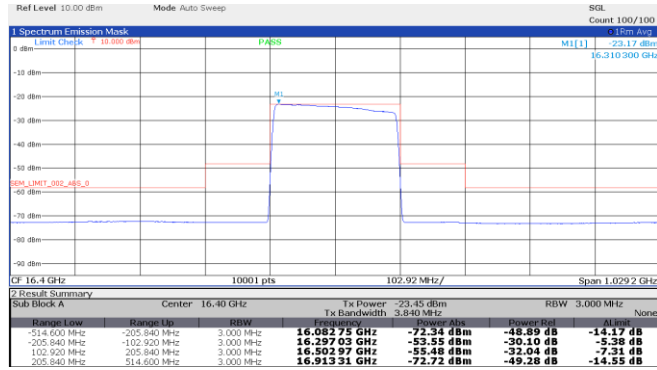


Figure 8.4-71: Emission mask, High channel: 16.40 GHz, shortest pulse. (200 MHz BW)

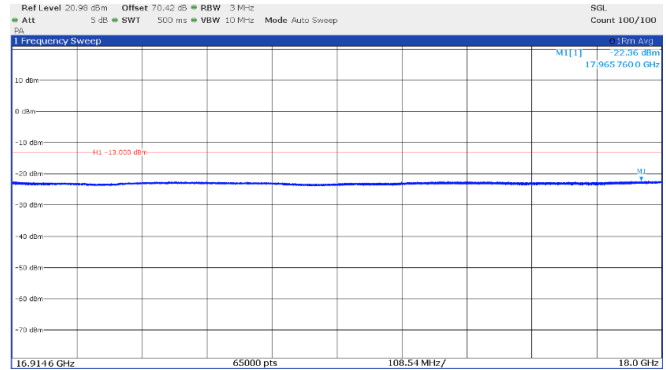


Figure 8.4-72: Emission mask, beyond ±250% of BW (high frequency range), High channel: 16.40 GHz, shortest pulse. (200 MHz BW)

8.5 Transmitter spurious emissions

8.5.1 References and limits

- FCC 47 CFR Part 90: §90.210
- Test method: ANSI C63.26-2014 (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) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ 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	<input type="checkbox"/> Wireless bench <input checked="" type="checkbox"/> 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 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 100 MHz declared bandwidth.

Due to the high power emitted by the EUT, several considerations were made to execute accuracy 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 a power amplifier with the purpose of attenuating the 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 a 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 carrier attenuation.

8.5.4 Setup details

EUT power input during test	28 V DC
EUT setup configuration	<input checked="" type="checkbox"/> Table-top (Above 1 GHz: 1.5 m) <input type="checkbox"/> Floor standing <input checked="" type="checkbox"/> 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

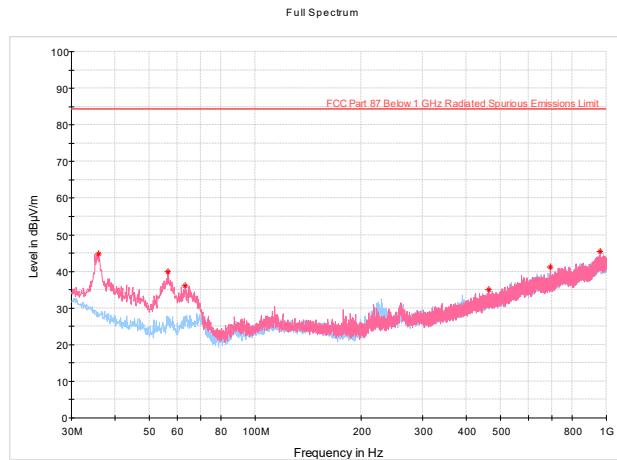


Figure 8.5-1: Unwanted emissions spurious band plot – Field strength measured from 0.030 to 1 GHz, Low channel 15.85 GHz.

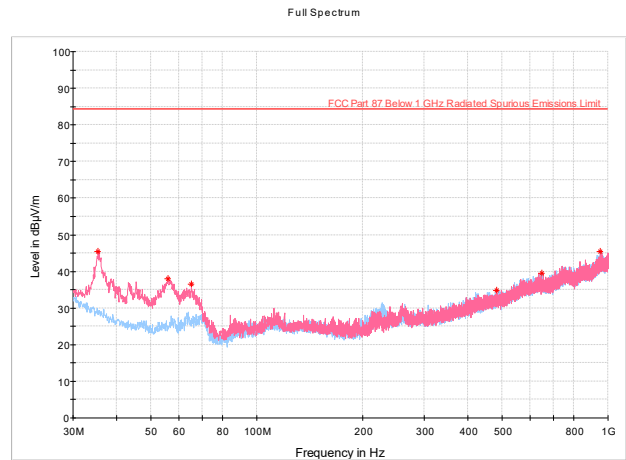
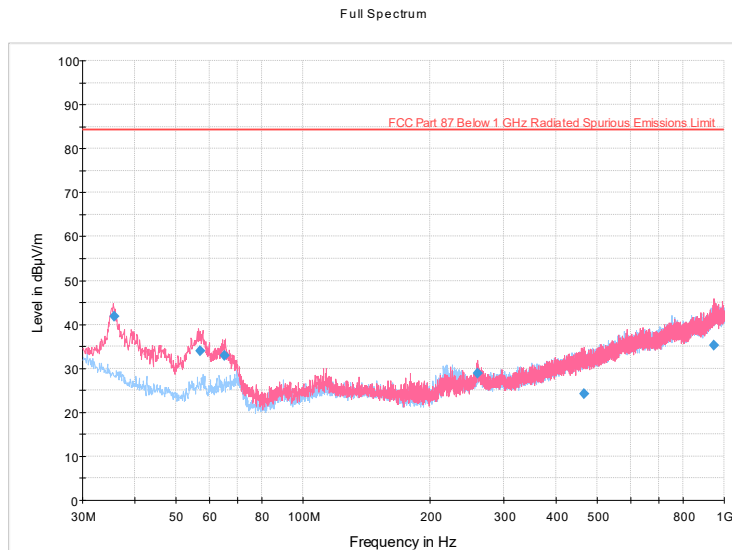


Figure 8.5-2: Unwanted emissions spurious band plot – Field strength measured from 0.030 to 1 GHz, High channel 16.45 GHz.



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 8.5-3: Unwanted emissions spurious band plot – Field strength measured from 0.030 to 1 GHz, Middle channel 16.15 GHz.

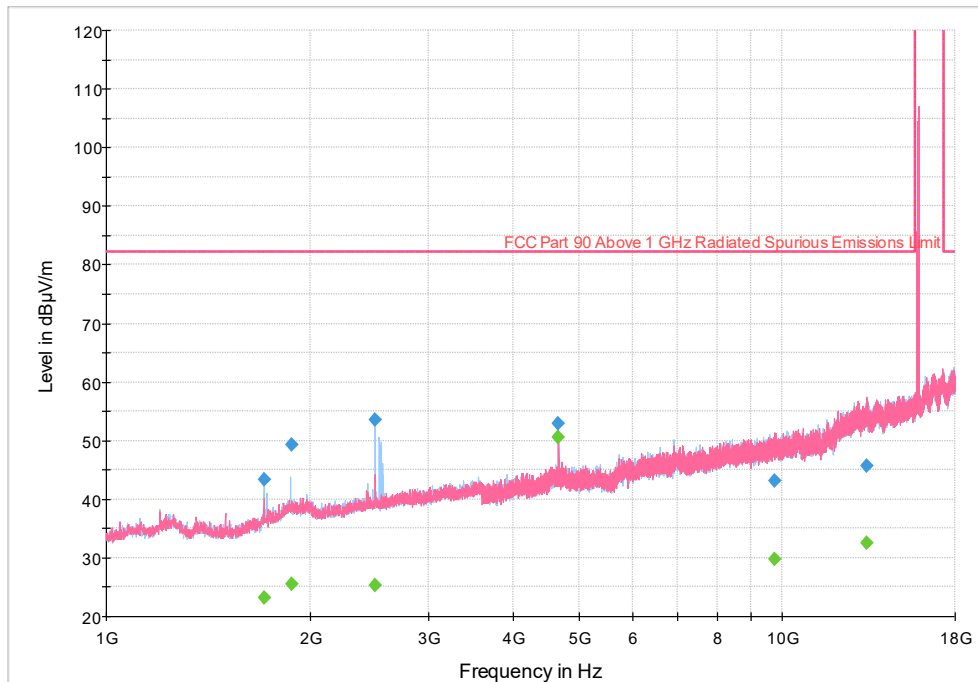
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.672000	41.82	84.38	42.56	5000.0	120.000	107.0	V	0.0	21.8
56.978000	33.91	84.38	50.47	5000.0	120.000	129.0	V	11.0	12.6
65.285000	33.01	84.38	51.37	5000.0	120.000	104.0	V	144.0	12.4
259.444000	28.88	84.38	55.50	5000.0	120.000	129.0	V	181.0	21.7
464.903000	24.25	84.38	60.13	5000.0	120.000	230.0	V	195.0	26.1
946.497000	35.28	84.38	49.10	5000.0	120.000	376.0	V	259.0	35.6

- 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 8.5-1: Unwanted emissions spurious band results – Field strength measured from 0.030 to 1 GHz, Middle channel 16.15 GHz.

Note: 0.030-1 GHz frequency range was evaluated using the six final 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.

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).

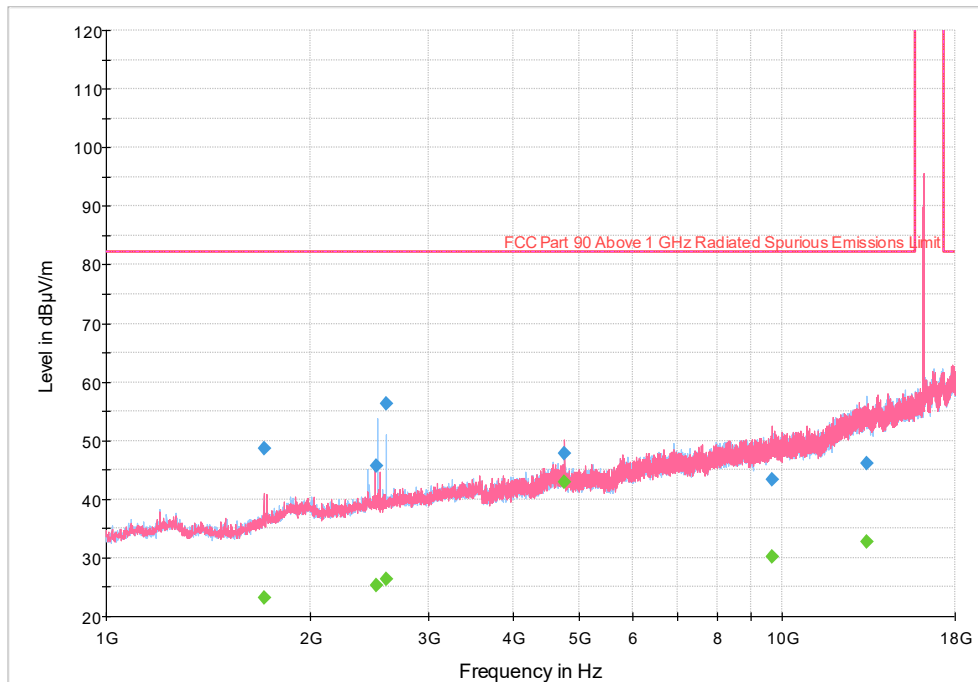
Figure 8.5-4: Unwanted emissions spurious band plot – Field strength measured from 1-18 GHz, Low channel 15.85 GHz.

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)
1711.822222	43.46	---	82.23	38.77	5000.0	1000.000	178.0	H	217.0	-13.1
1711.822222	---	23.10	82.23	59.13	5000.0	1000.000	178.0	H	217.0	-13.1
1877.722222	---	25.42	82.23	56.81	5000.0	1000.000	282.0	H	166.0	-10.7
1877.722222	49.39	---	82.23	32.84	5000.0	1000.000	282.0	H	166.0	-10.7
2499.233333	---	25.37	82.23	56.86	5000.0	1000.000	186.0	H	292.0	-9.6
2499.233333	53.49	---	82.23	28.74	5000.0	1000.000	186.0	H	292.0	-9.6
4666.733333	52.80	---	82.23	29.43	5000.0	1000.000	199.0	V	200.0	-2.0
4666.733333	---	50.50	82.23	31.73	5000.0	1000.000	199.0	V	200.0	-2.0
9728.088889	---	29.81	82.23	52.42	5000.0	1000.000	297.0	H	148.0	3.6
9728.088889	43.19	---	82.23	39.04	5000.0	1000.000	297.0	H	148.0	3.6
13345.922222	---	32.53	82.23	49.70	5000.0	1000.000	245.0	V	32.0	9.3
13345.922222	45.79	---	82.23	36.44	5000.0	1000.000	245.0	V	32.0	9.3

- 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.
 - 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 15.85 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).

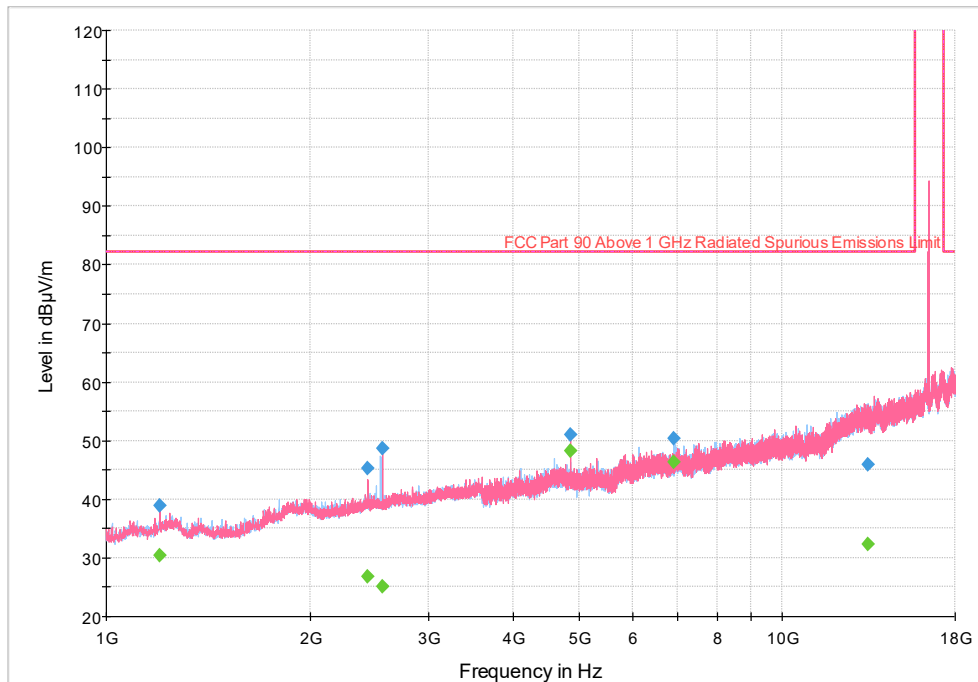
Figure 8.5-5: Unwanted emissions spurious band plot – Field strength measured from 1-18 GHz, Middle channel 16.15 GHz.

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)
1716.222222	---	23.22	82.23	59.01	5000.0	1000.000	201.0	V	78.0	-13.0
1716.222222	48.71	---	82.23	33.52	5000.0	1000.000	201.0	V	78.0	-13.0
2511.355556	45.69	---	82.23	36.54	5000.0	1000.000	177.0	H	276.0	-9.5
2511.355556	---	25.28	82.23	56.95	5000.0	1000.000	177.0	H	276.0	-9.5
2591.533333	---	26.42	82.23	55.81	5000.0	1000.000	151.0	H	217.0	-9.5
2591.533333	56.21	---	82.23	26.02	5000.0	1000.000	151.0	H	217.0	-9.5
4766.444444	---	42.85	82.23	39.38	5000.0	1000.000	202.0	V	194.0	-2.2
4766.444444	47.86	---	82.23	34.37	5000.0	1000.000	202.0	V	194.0	-2.2
9644.611111	---	30.11	82.23	52.12	5000.0	1000.000	205.0	V	98.0	3.6
9644.611111	43.29	---	82.23	38.94	5000.0	1000.000	205.0	V	98.0	3.6
13344.977778	46.21	---	82.23	36.02	5000.0	1000.000	383.0	H	0.0	9.3
13344.977778	---	32.77	82.23	49.46	5000.0	1000.000	383.0	H	0.0	9.3

- 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.
 - 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 16.15 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).

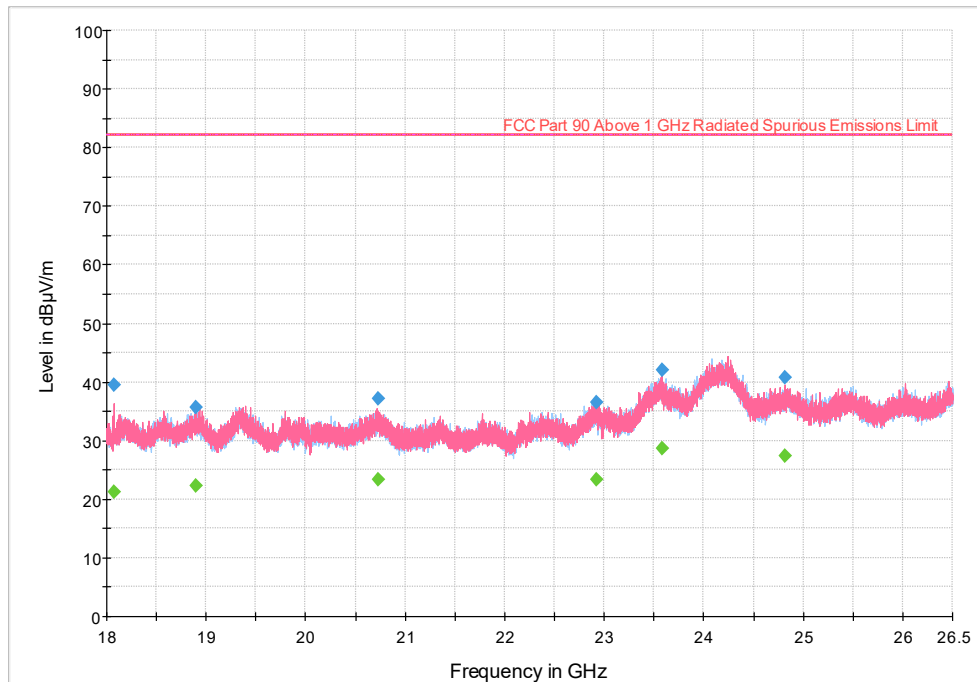
Figure 8.5-6: Unwanted emissions spurious band plot – Field strength measured from 1-18 GHz, High channel 16.45 GHz.

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	38.81	---	82.23	43.42	5000.0	1000.000	297.0	H	154.0	-13.8
1200.077778	---	30.37	82.23	51.86	5000.0	1000.000	297.0	H	154.0	-13.8
2440.133333	---	26.71	82.23	55.52	5000.0	1000.000	314.0	V	0.0	-9.8
2440.133333	45.33	---	82.23	36.90	5000.0	1000.000	314.0	V	0.0	-9.8
2562.255556	48.59	---	82.23	33.64	5000.0	1000.000	307.0	V	153.0	-9.6
2562.255556	---	25.14	82.23	57.09	5000.0	1000.000	307.0	V	153.0	-9.6
4866.811111	---	48.22	82.23	34.01	5000.0	1000.000	260.0	V	234.0	-2.3
4866.811111	51.00	---	82.23	31.23	5000.0	1000.000	260.0	V	234.0	-2.3
6900.200000	50.34	---	82.23	31.89	5000.0	1000.000	140.0	H	311.0	0.7
6900.200000	---	46.29	82.23	35.94	5000.0	1000.000	140.0	H	311.0	0.7
13361.188889	45.80	---	82.23	36.43	5000.0	1000.000	299.0	H	270.0	9.2
13361.188889	---	32.41	82.23	49.82	5000.0	1000.000	299.0	H	270.0	9.2

- 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 16.45 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).

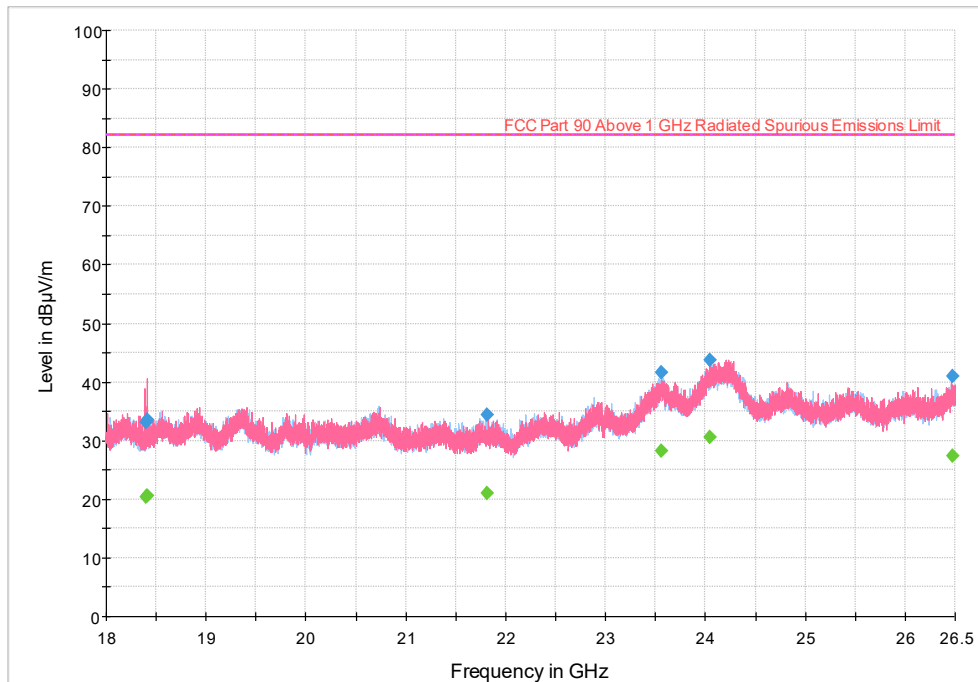
Figure 8.5-7: Unwanted emissions spurious band plot – Field strength measured from 18-26.5 GHz, Low channel 15.85 GHz.

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)
18079.368750	39.39	---	82.23	42.84	5000.0	1000.000	149.0	V	32.0	15.7
18079.368750	---	21.28	82.23	60.95	5000.0	1000.000	149.0	V	32.0	15.7
18891.925000	35.61	---	82.23	46.62	5000.0	1000.000	324.0	H	301.0	15.9
18891.925000	---	22.32	82.23	59.91	5000.0	1000.000	324.0	H	301.0	15.9
20734.175000	37.14	---	82.23	45.09	5000.0	1000.000	121.0	V	0.0	18.2
20734.175000	---	23.39	82.23	58.84	5000.0	1000.000	121.0	V	0.0	18.2
22927.956250	---	23.43	82.23	58.80	5000.0	1000.000	234.0	V	0.0	19.0
22927.956250	36.47	---	82.23	45.76	5000.0	1000.000	234.0	V	0.0	19.0
23579.793750	---	28.72	82.23	53.51	5000.0	1000.000	136.0	V	0.0	23.9
23579.793750	42.05	---	82.23	40.18	5000.0	1000.000	136.0	V	0.0	23.9
24822.662500	40.71	---	82.23	41.52	5000.0	1000.000	107.0	V	172.0	22.3
24822.662500	---	27.39	82.23	54.84	5000.0	1000.000	107.0	V	172.0	22.3

- 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.
 - 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 15.85 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).

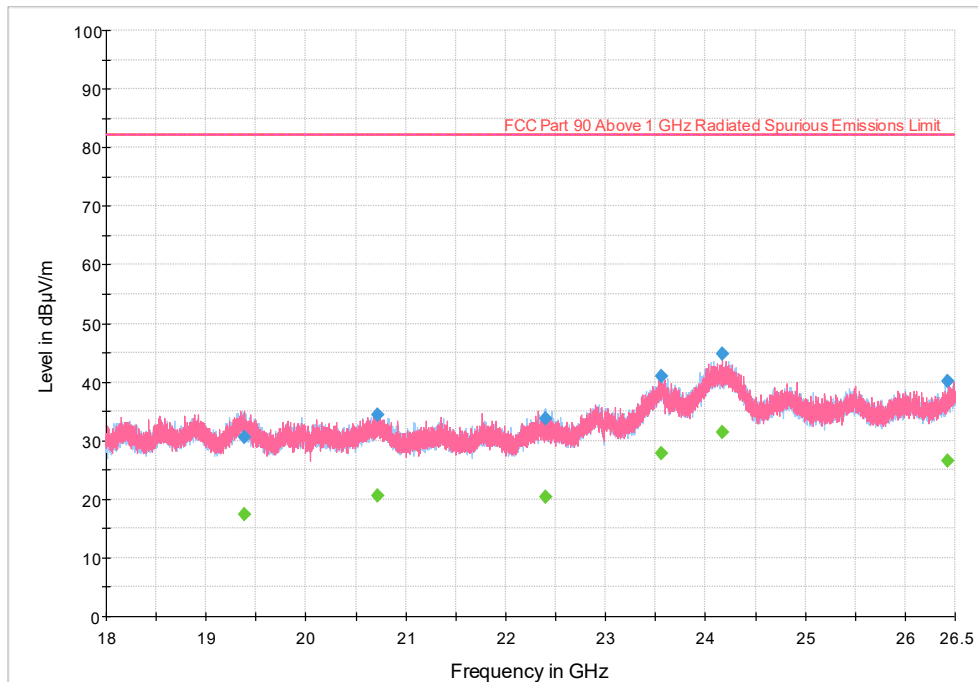
Figure 8.5-8: Unwanted emissions spurious band plot – Field strength measured from 18-26.5 GHz, Middle channel 16.15 GHz.

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)
18394.275000	33.17	---	82.23	49.06	5000.0	1000.000	104.0	V	20.0	15.3
18394.275000	---	20.35	82.23	61.88	5000.0	1000.000	104.0	V	20.0	15.3
18411.387500	---	20.65	82.23	61.58	5000.0	1000.000	376.0	V	55.0	15.4
18411.387500	33.63	---	82.23	48.60	5000.0	1000.000	376.0	V	55.0	15.4
21809.700000	34.29	---	82.23	47.94	5000.0	1000.000	262.0	H	260.0	17.4
21809.700000	---	21.07	82.23	61.16	5000.0	1000.000	262.0	H	260.0	17.4
23564.275000	41.71	---	82.23	40.52	5000.0	1000.000	344.0	H	79.0	23.8
23564.275000	---	28.24	82.23	53.99	5000.0	1000.000	344.0	H	79.0	23.8
24050.306250	---	30.59	82.23	51.64	5000.0	1000.000	128.0	H	0.0	27.6
24050.306250	43.66	---	82.23	38.57	5000.0	1000.000	128.0	H	0.0	27.6
26473.262500	41.08	---	82.23	41.15	5000.0	1000.000	400.0	V	324.0	23.3
26473.262500	---	27.41	82.23	54.82	5000.0	1000.000	400.0	V	324.0	23.3

- 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.
 - 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 16.15 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).

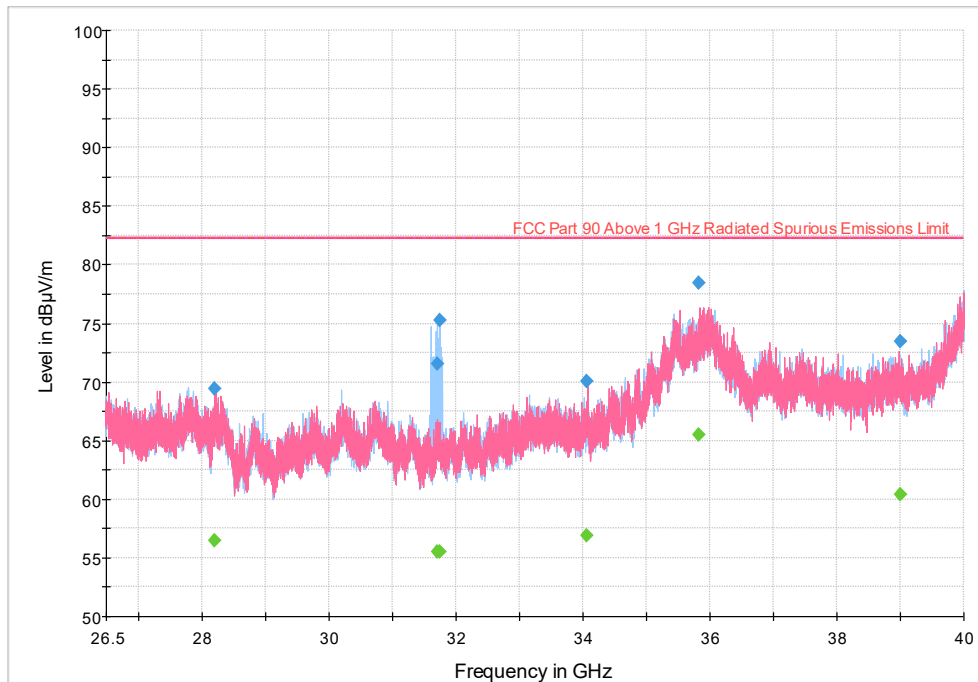
Figure 8.5-9: Unwanted emissions spurious band plot – Field strength measured from 18-26.5 GHz, High channel 16.45 GHz.

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)
19380.256250	---	17.38	82.23	64.85	5000.0	1000.000	191.0	V	102.0	16.6
19380.256250	30.60	---	82.23	51.63	5000.0	1000.000	191.0	V	102.0	16.6
20711.487500	---	20.60	82.23	61.63	5000.0	1000.000	132.0	V	48.0	18.4
20711.487500	34.31	---	82.23	47.92	5000.0	1000.000	132.0	V	48.0	18.4
22405.500000	---	20.40	82.23	61.83	5000.0	1000.000	207.0	H	11.0	17.3
22405.500000	33.83	---	82.23	48.40	5000.0	1000.000	207.0	H	11.0	17.3
23564.275000	40.95	---	82.23	41.28	5000.0	1000.000	179.0	V	10.0	23.8
23564.275000	---	27.88	82.23	54.35	5000.0	1000.000	179.0	V	10.0	23.8
24174.131250	44.82	---	82.23	37.41	5000.0	1000.000	374.0	V	78.0	27.2
24174.131250	---	31.44	82.23	50.79	5000.0	1000.000	374.0	V	78.0	27.2
26430.825000	---	26.46	82.23	55.77	5000.0	1000.000	345.0	V	128.0	23.1
26430.825000	40.11	---	82.23	42.12	5000.0	1000.000	345.0	V	128.0	23.1

- 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 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 16.45 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).

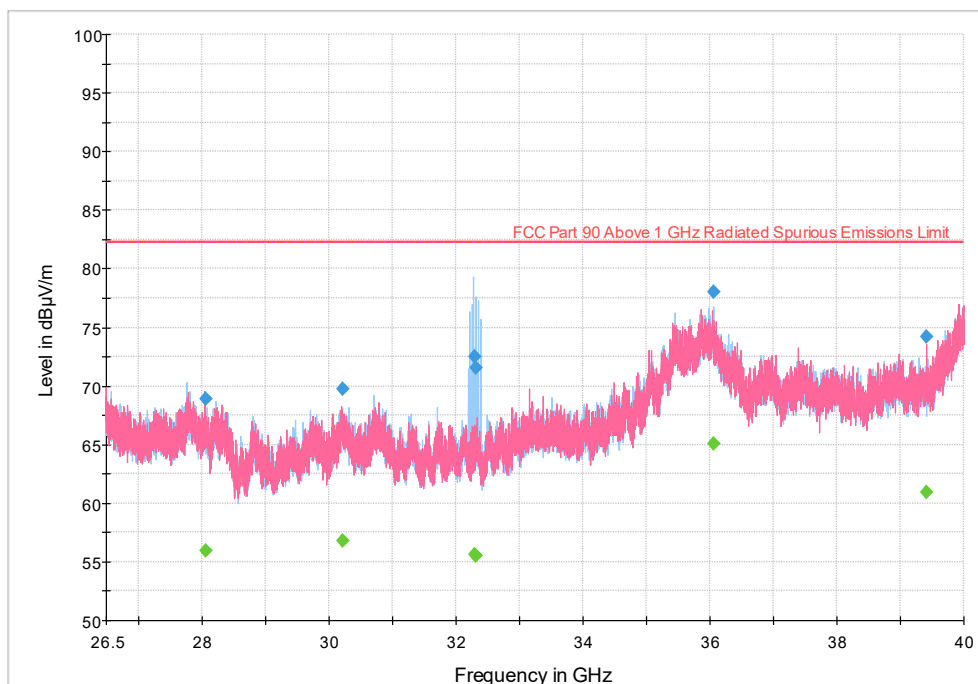
Figure 8.5-10: Unwanted emissions spurious band plot – Field strength measured from 26.5-40 GHz, Low channel 15.85 GHz.

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)
28194.931250	69.40	---	82.23	12.83	5000.0	1000.000	116.0	V	324.0	52.4
28194.931250	---	56.43	82.23	25.80	5000.0	1000.000	116.0	V	324.0	52.4
31709.025000	---	55.56	82.23	26.67	5000.0	1000.000	175.0	H	348.0	50.7
31709.025000	71.59	---	82.23	10.64	5000.0	1000.000	175.0	H	348.0	50.7
31750.275000	75.22	---	82.23	7.01	5000.0	1000.000	198.0	H	320.0	50.7
31750.275000	---	55.53	82.23	26.70	5000.0	1000.000	198.0	H	320.0	50.7
34068.718750	70.04	---	82.23	12.19	5000.0	1000.000	148.0	V	348.0	51.2
34068.718750	---	56.95	82.23	25.28	5000.0	1000.000	148.0	V	348.0	51.2
35833.581250	---	65.49	82.23	16.74	5000.0	1000.000	200.0	V	294.0	58.8
35833.581250	78.44	---	82.23	3.79	5000.0	1000.000	200.0	V	294.0	58.8
38991.831250	73.49	---	82.23	8.74	5000.0	1000.000	175.0	V	78.0	52.8
38991.831250	---	60.45	82.23	21.78	5000.0	1000.000	175.0	V	78.0	52.8

- 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 15.85 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).

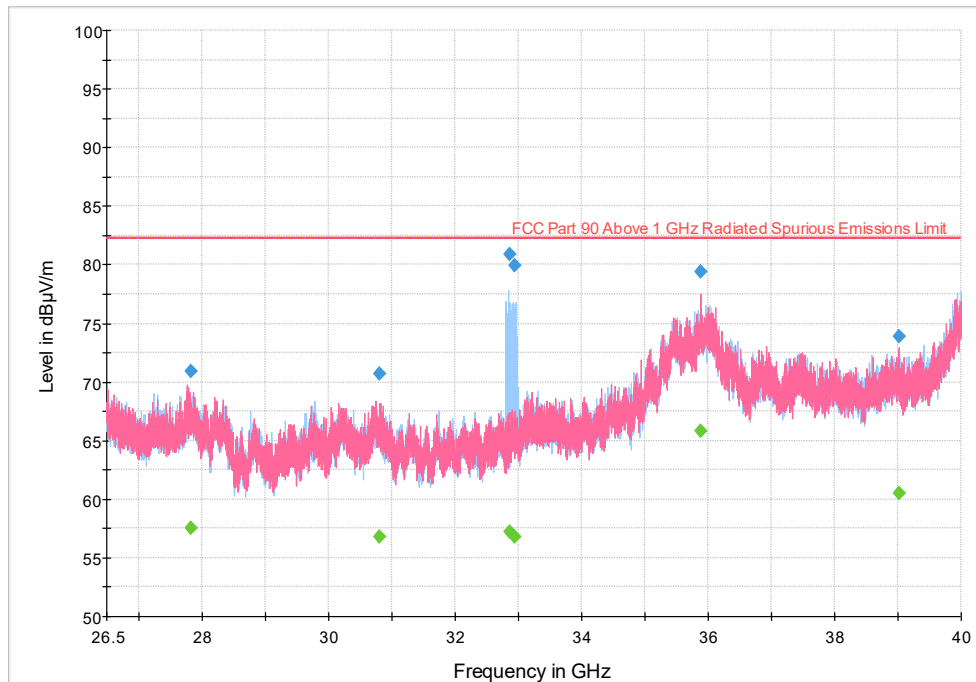
Figure 8.5-11: Unwanted emissions spurious band plot – Field strength measured from 26.5-40 GHz, Middle channel 16.15 GHz.

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)
28064.162500	68.89	---	82.23	13.34	5000.0	1000.000	125.0	V	238.0	52.8
28064.162500	---	55.99	82.23	26.24	5000.0	1000.000	125.0	V	238.0	52.8
30219.100000	---	56.78	82.23	25.45	5000.0	1000.000	125.0	V	120.0	51.2
30219.100000	69.73	---	82.23	12.50	5000.0	1000.000	125.0	V	120.0	51.2
32291.037500	72.49	---	82.23	9.74	5000.0	1000.000	179.0	H	311.0	50.9
32291.037500	---	55.65	82.23	26.58	5000.0	1000.000	179.0	H	311.0	50.9
32324.875000	71.51	---	82.23	10.72	5000.0	1000.000	182.0	H	311.0	50.9
32324.875000	---	55.54	82.23	26.69	5000.0	1000.000	182.0	H	311.0	50.9
36066.825000	78.07	---	82.23	4.16	5000.0	1000.000	131.0	H	10.0	58.6
36066.825000	---	65.09	82.23	17.14	5000.0	1000.000	131.0	H	10.0	58.6
39411.968750	---	60.97	82.23	21.26	5000.0	1000.000	179.0	V	277.0	52.5
39411.968750	74.17	---	82.23	8.06	5000.0	1000.000	179.0	V	277.0	52.5

- 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 16.15 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 8.5-12: Unwanted emissions spurious band plot – Field strength measured from 26.5-40 GHz, High channel 16.45 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)
27825.468750	70.95	---	82.23	11.28	5000.0	1000.000	106.0	V	57.0	52.6
27825.468750	---	57.56	82.23	24.67	5000.0	1000.000	106.0	V	57.0	52.6
30801.056250	70.66	---	82.23	11.57	5000.0	1000.000	161.0	V	320.0	51.5
30801.056250	---	56.84	82.23	25.39	5000.0	1000.000	161.0	V	320.0	51.5
32858.612500	80.89	---	82.23	1.34	5000.0	1000.000	191.0	H	-1.0	51.0
32858.612500	---	57.24	82.23	24.99	5000.0	1000.000	191.0	H	-1.0	51.0
32937.393750	---	56.83	82.23	25.40	5000.0	1000.000	200.0	H	-1.0	51.0
32937.393750	79.95	---	82.23	2.28	5000.0	1000.000	200.0	H	-1.0	51.0
35880.656250	---	65.80	82.23	16.43	5000.0	1000.000	185.0	V	68.0	58.9
35880.656250	79.40	---	82.23	2.83	5000.0	1000.000	185.0	V	68.0	58.9
39023.325000	73.91	---	82.23	8.32	5000.0	1000.000	125.0	V	83.0	52.7
39023.325000	---	60.49	82.23	21.74	5000.0	1000.000	125.0	V	83.0	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 8.5-10: Unwanted emissions spurious band results – Field strength measured from 26.5-40 GHz, High channel 16.45 GHz.

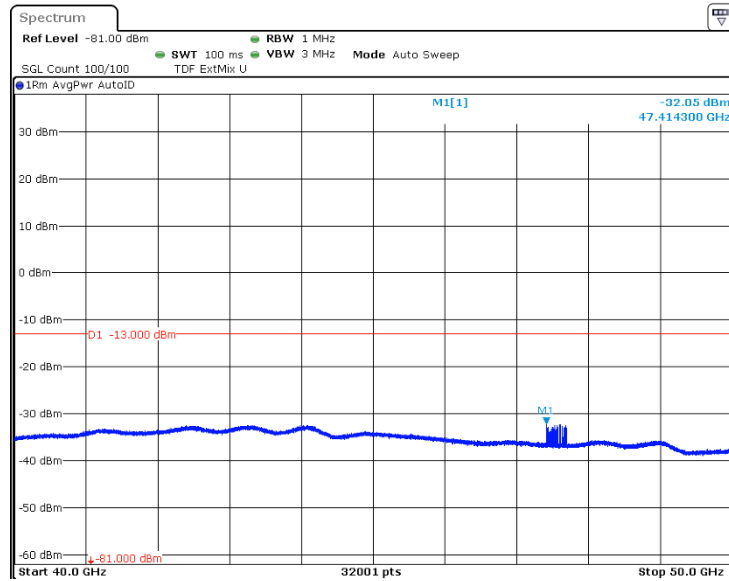


Figure 8.5-13: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, horizontal polarization, Low channel 15.85 GHz.

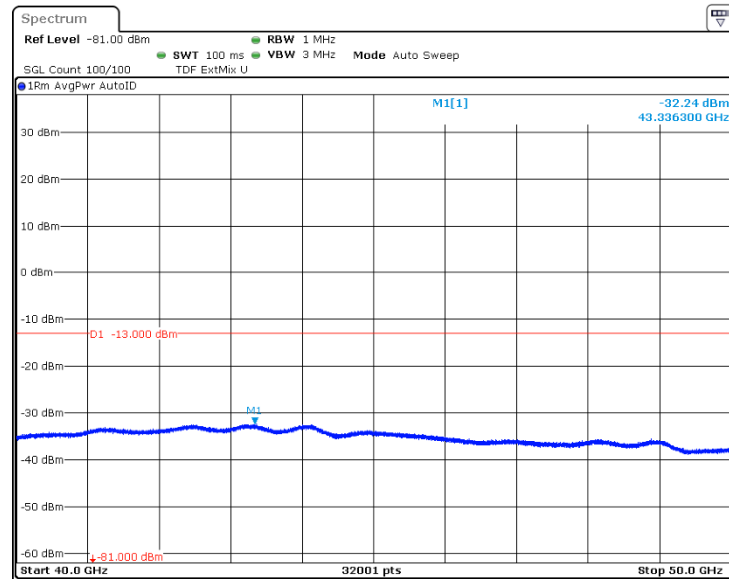


Figure 8.5-14: Unwanted emissions spurious band plot – Field strength measured, 40-50 GHz, vertical polarization, Low channel 15.85 GHz.

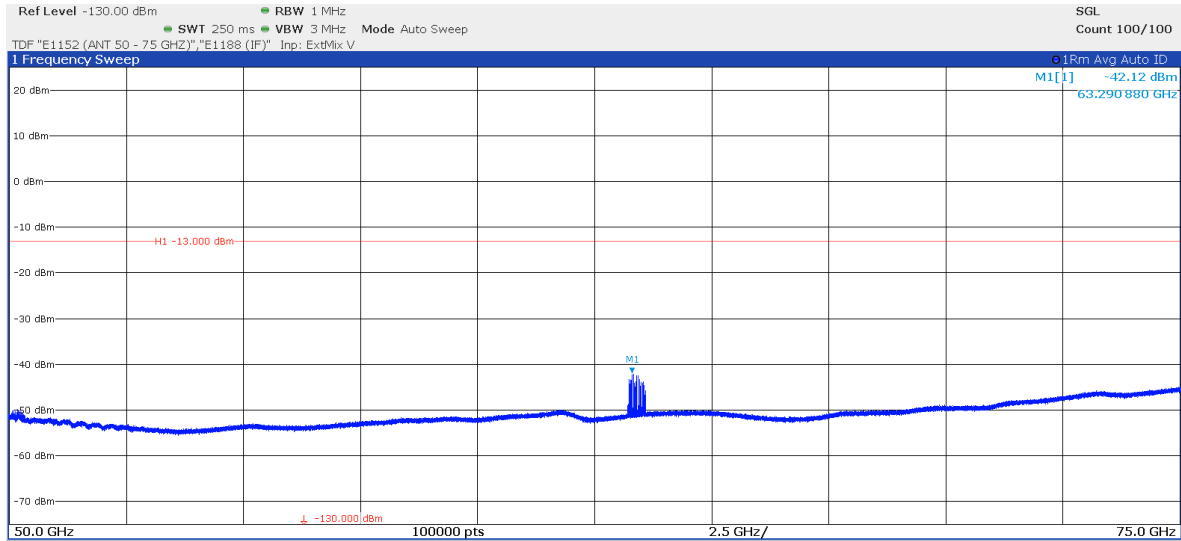


Figure 8.5-15: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, horizontal polarization, Low channel 15.85 GHz.

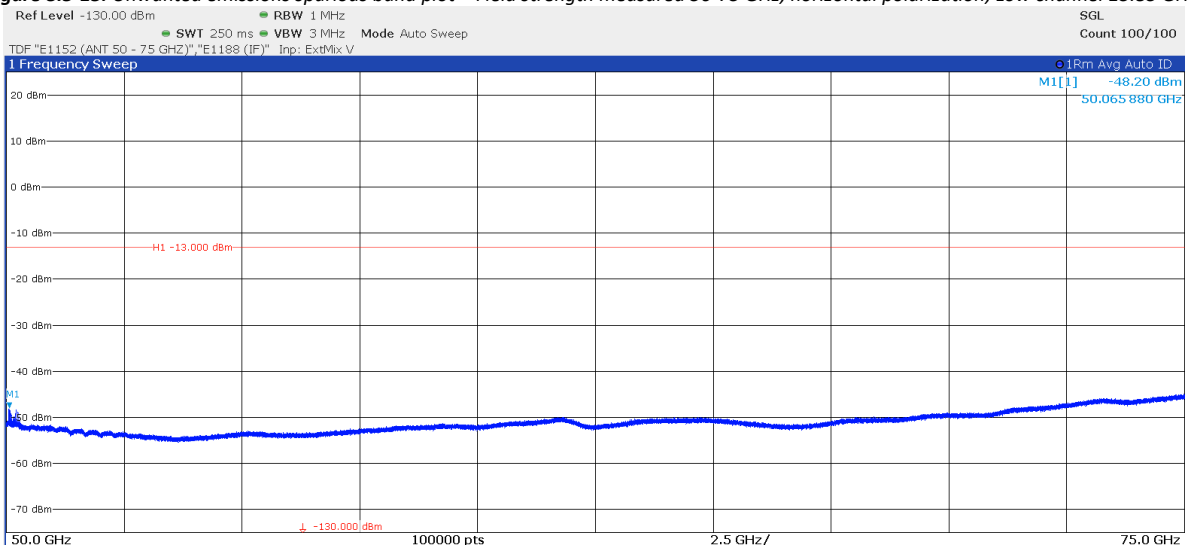


Figure 8.5-16: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, vertical polarization, Low channel 15.85 GHz

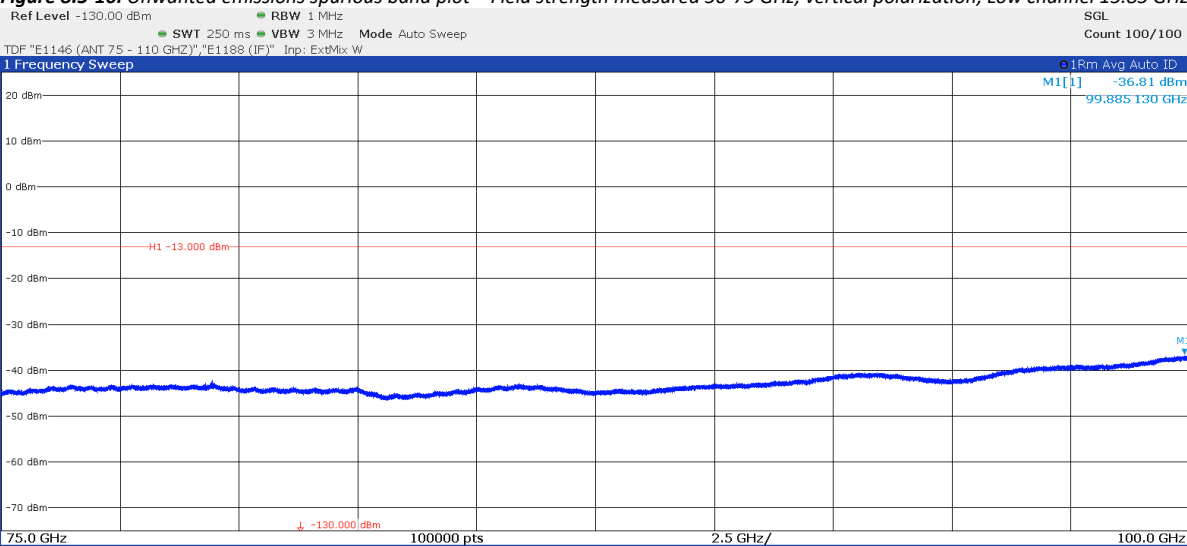


Figure 8.5-17: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, horizontal polarization, Low channel 15.85 GHz.

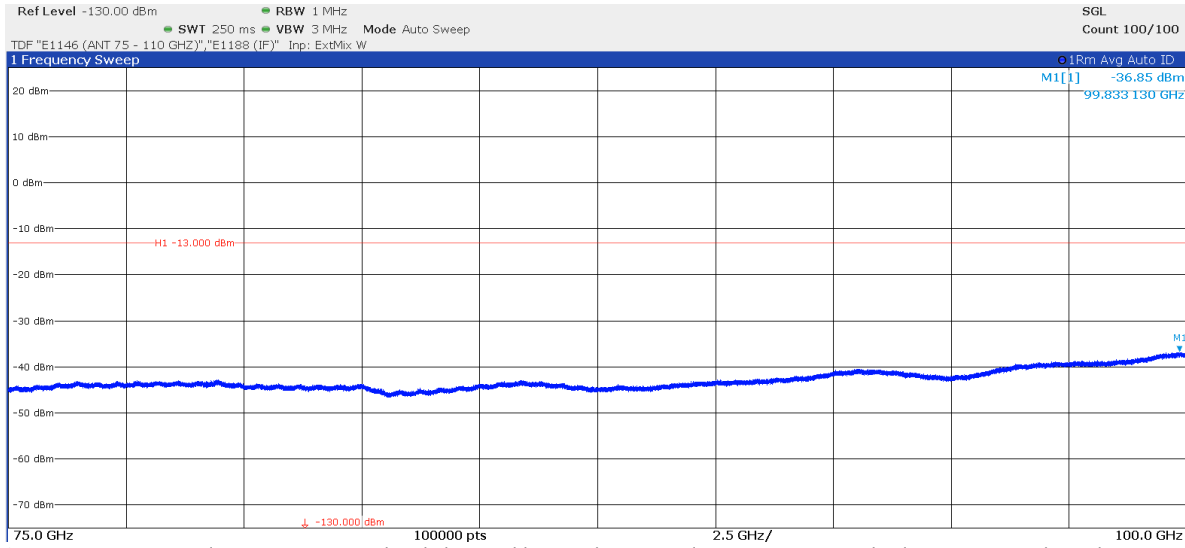


Figure 8.5-18: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, vertical polarization, Low channel 15.85 GHz.

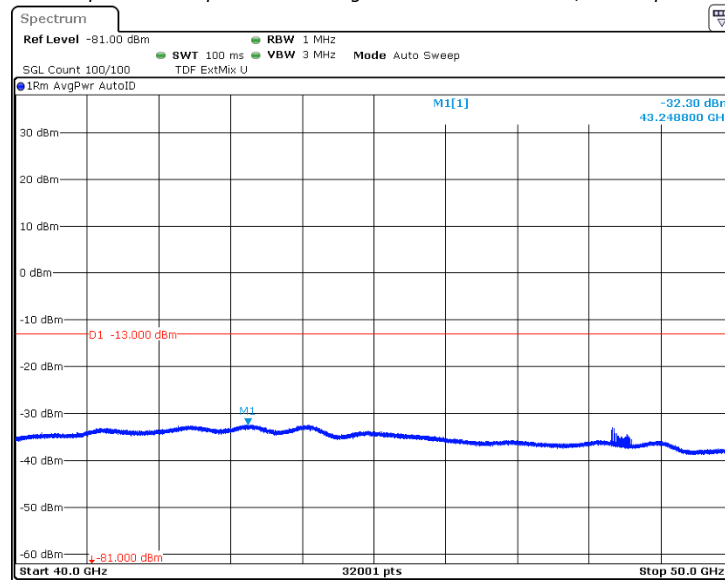


Figure 8.5-19: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, horizontal polarization, Middle channel 16.15 GHz.

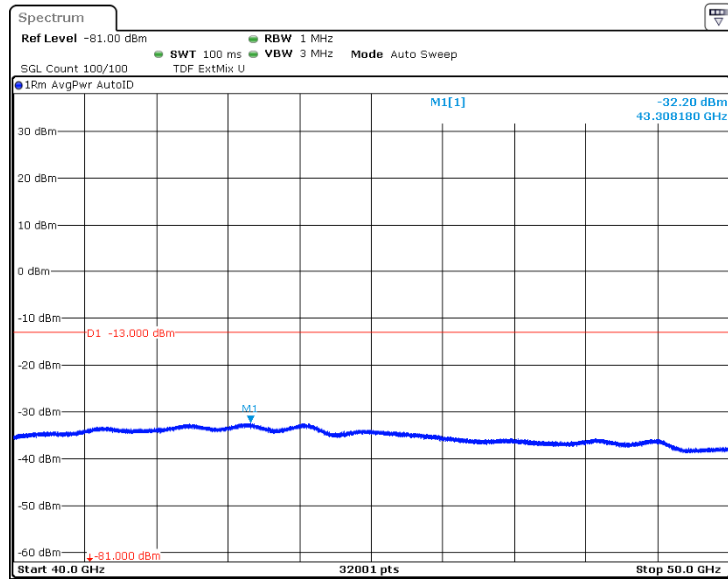


Figure 8.5-20: Unwanted emissions spurious band plot – Field strength measured, 40-50 GHz, vertical polarization, Middle channel 16.15 GHz.

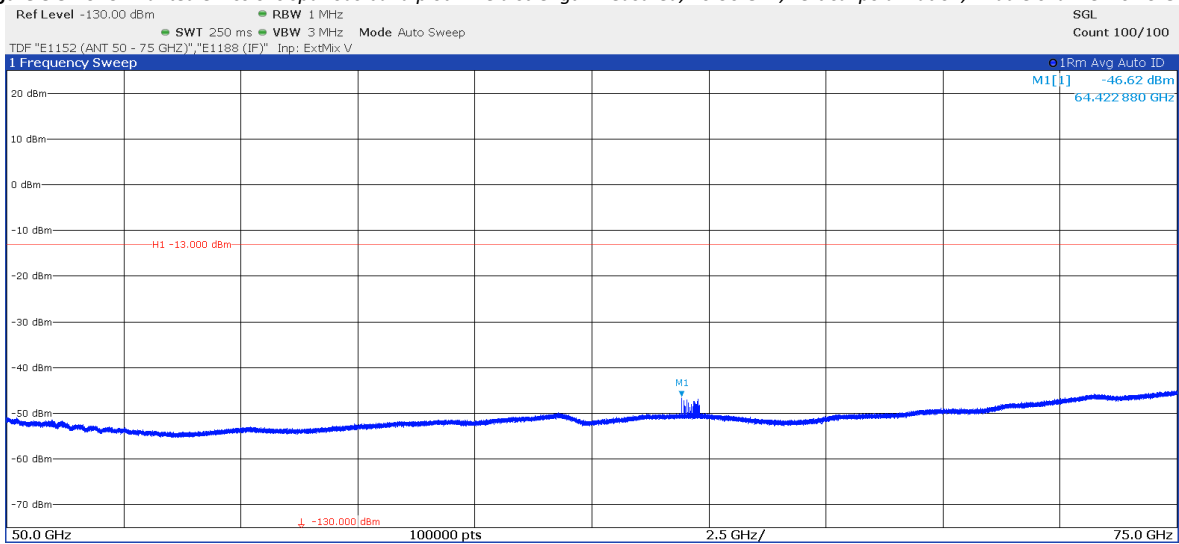


Figure 8.5-21: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, horizontal polarization, Middle channel 16.15 GHz.

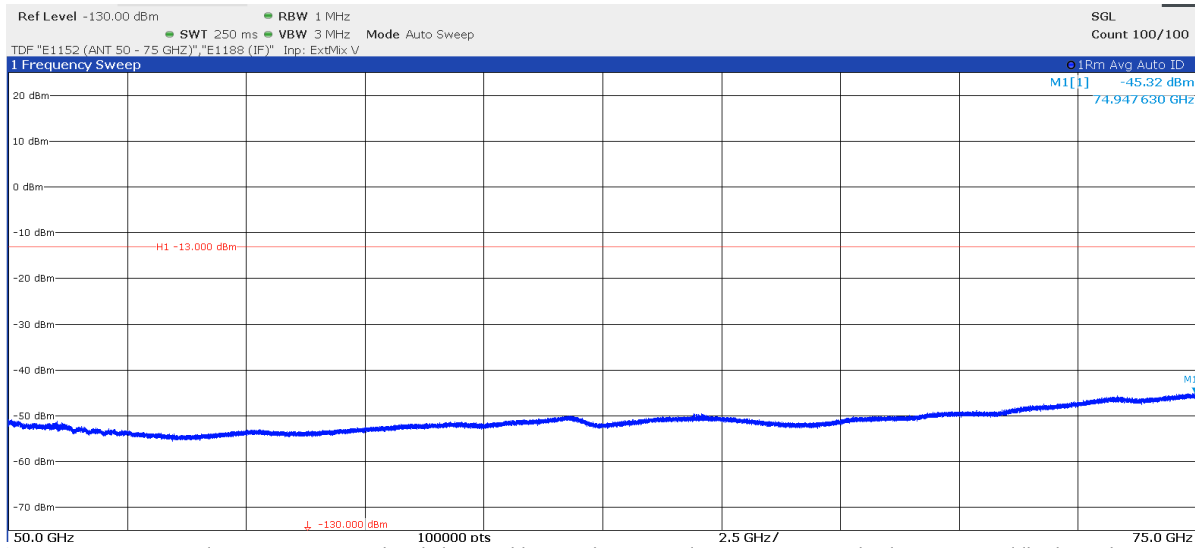


Figure 8.5-22: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, vertical polarization, Middle channel 16.15 GHz.

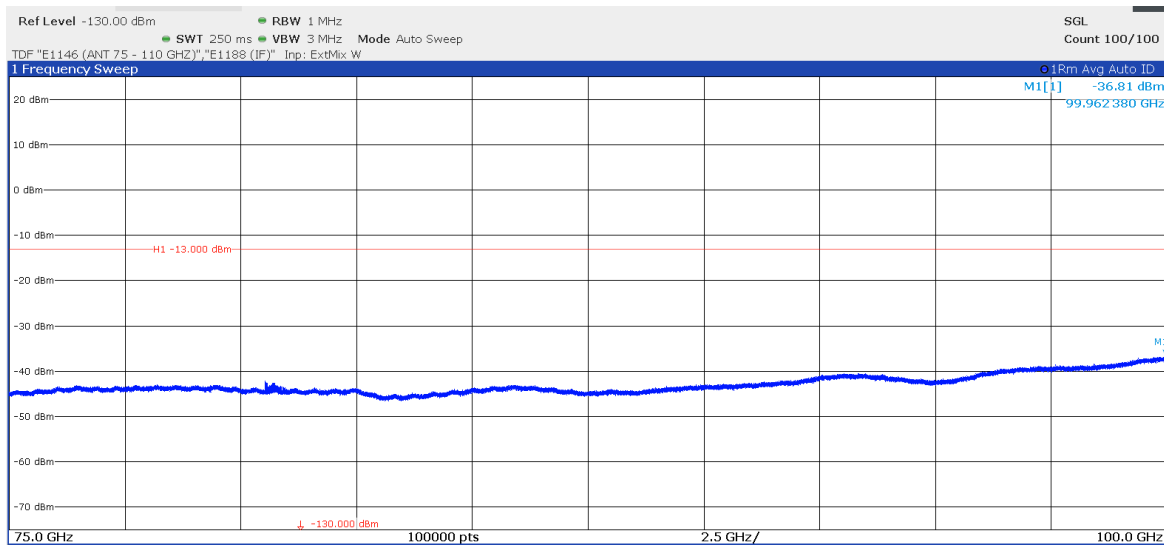


Figure 8.5-23: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, horizontal polarization, Middle channel 16.15 GHz.

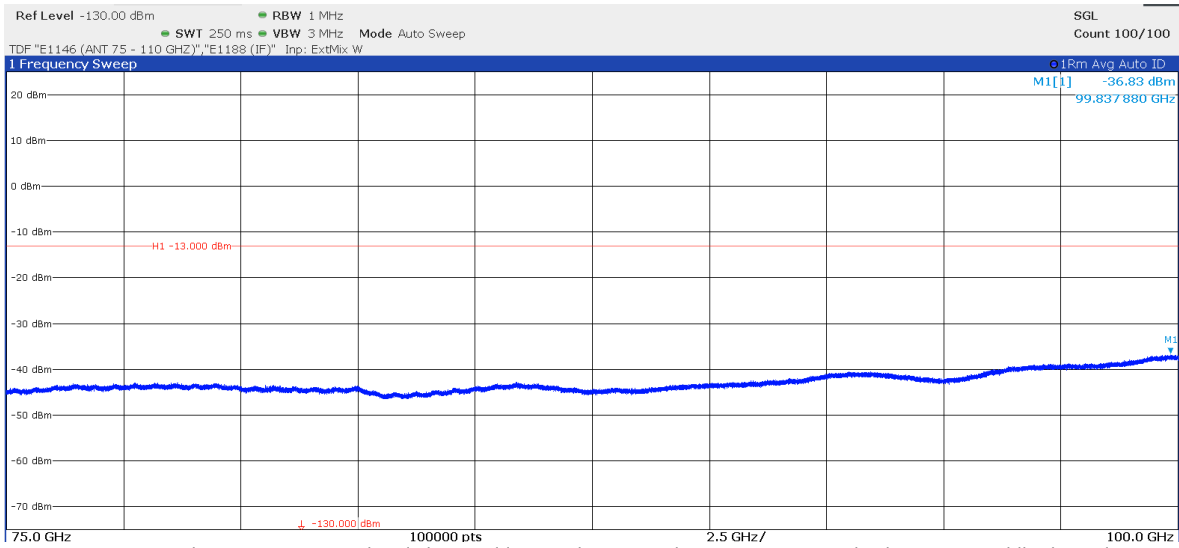


Figure 8.5-24: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, vertical polarization, Middle channel 16.15 GHz.

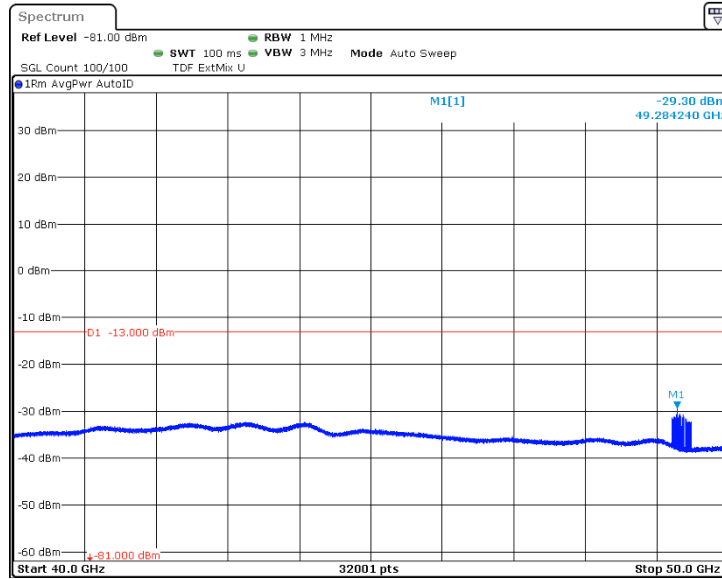


Figure 8.5-25: Unwanted emissions spurious band plot – Field strength measured, 40 -50 GHz, horizontal polarization, High channel 16.45 GHz.

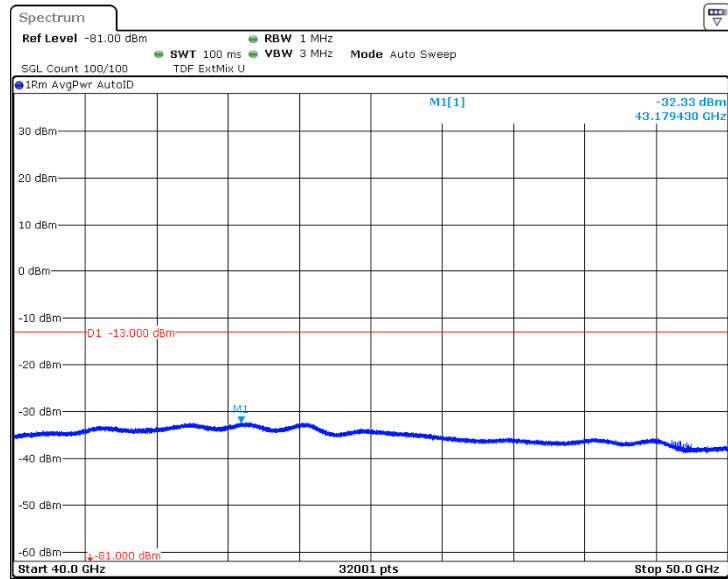


Figure 8.5-26: Unwanted emissions spurious band plot – Field strength measured, 40-50 GHz, vertical polarization, High channel 16.45 GHz.

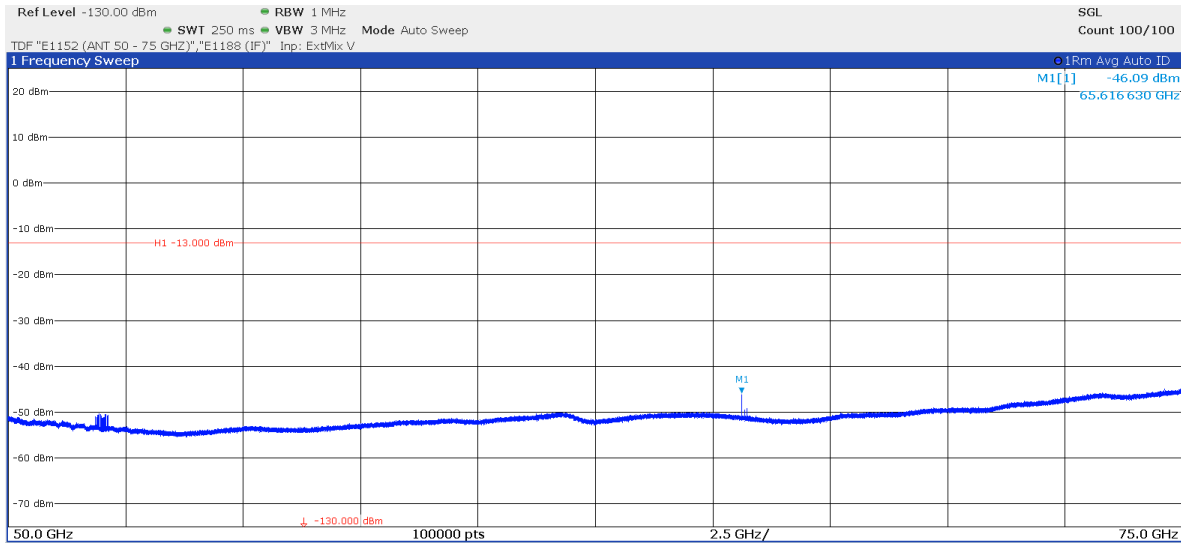


Figure 8.5-27: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, horizontal polarization, High channel 16.45 GHz.

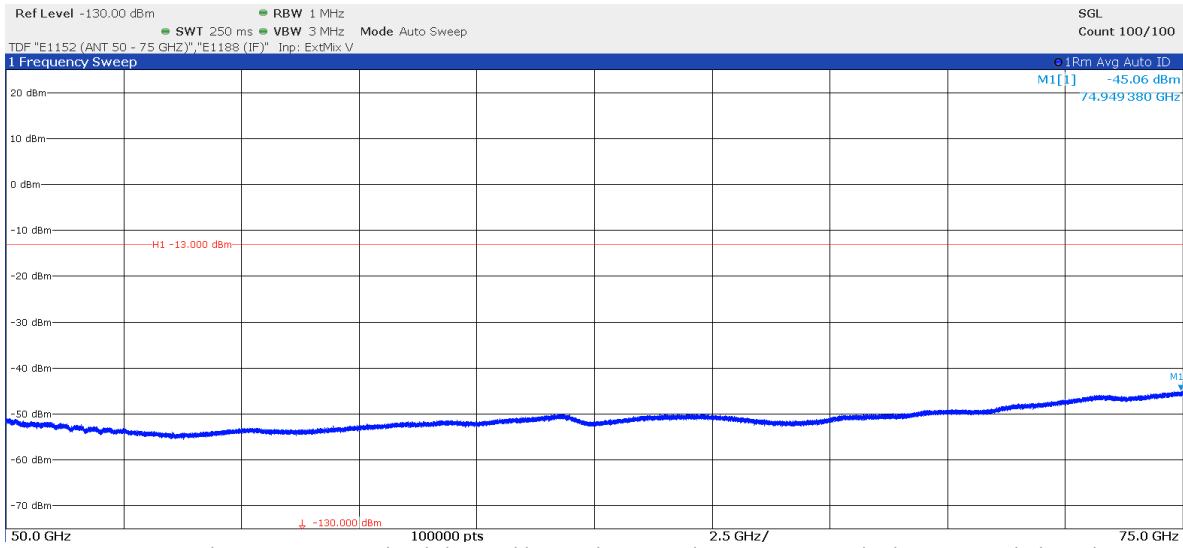


Figure 8.5-28: Unwanted emissions spurious band plot – Field strength measured 50-75 GHz, vertical polarization, High channel 16.45 GHz.

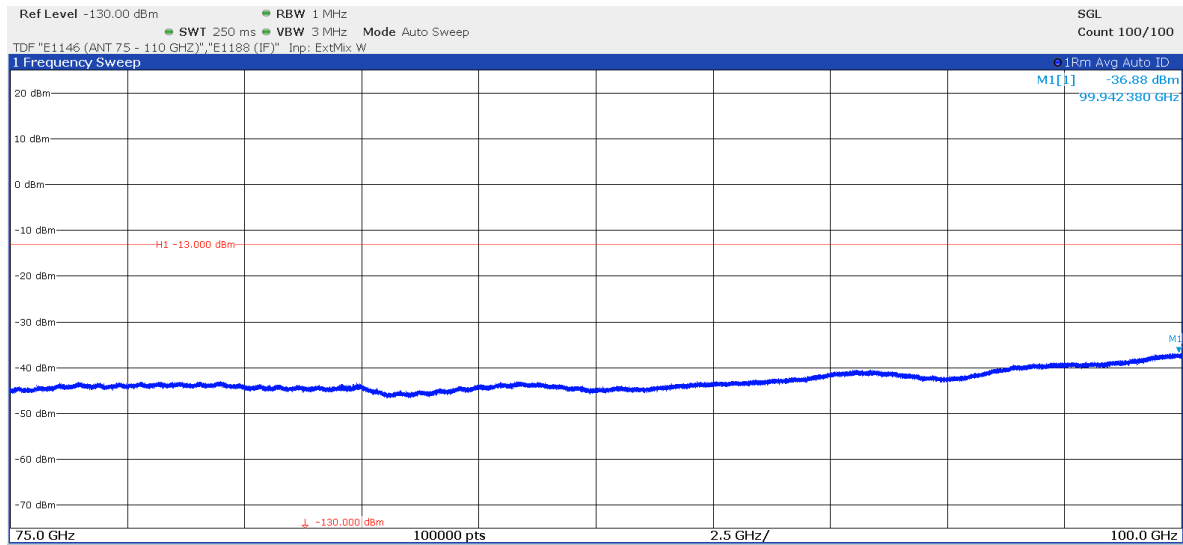


Figure 8.5-29: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, horizontal polarization, High channel 16.45 GHz.

Section 8

Testing data

Test name

Transmitter spurious emissions

Specification(s)

FCC Part 90

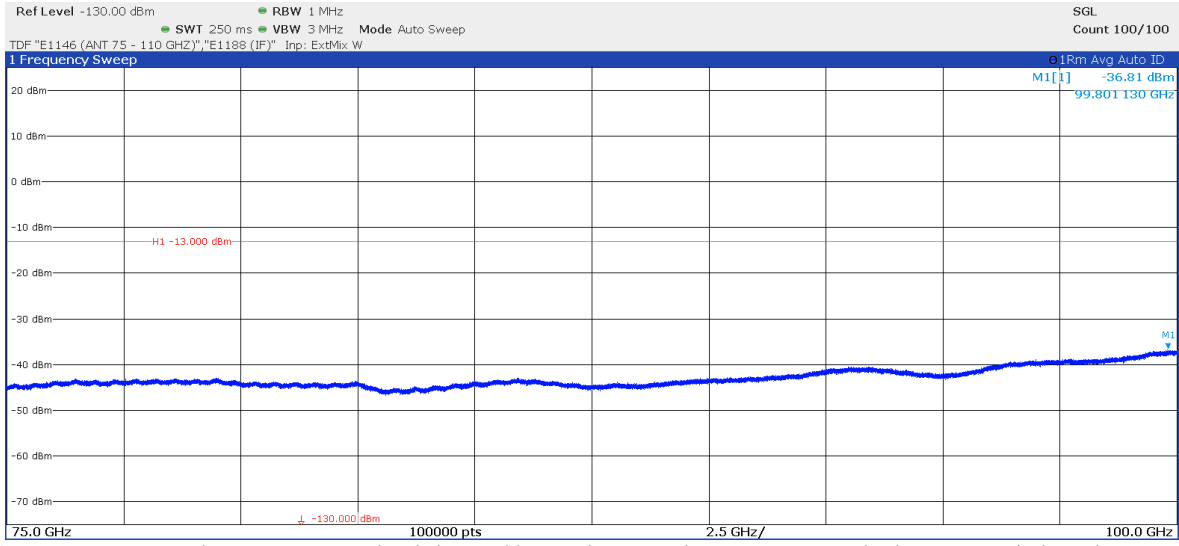


Figure 8.5-30: Unwanted emissions spurious band plot – Field strength measured 75-100 GHz, vertical polarization, High channel 16.45 GHz.

8.6 Frequency stability

8.6.1 References and limits

- FCC 47 CFR Part 90: §90.213
- Test method: ANSI C63.26 (5.6.3)
 - (a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Above 2450 ¹⁰			

¹⁰Frequency stability for DSRCS equipment in the 5895–5925 MHz band is specified in subpart M of this part. For all other equipment, frequency stability is to be specified in the station authorization.

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	<input type="checkbox"/> Wireless bench <input type="checkbox"/> 10 m semi-anechoic chamber <input type="checkbox"/> 3 m semi-anechoic chamber <input checked="" type="checkbox"/> 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 (16.15 GHz).

8.6.4 Setup details

EUT power input during test	28 V DC
EUT setup configuration	<input type="checkbox"/> Table-top <input type="checkbox"/> Floor standing <input checked="" type="checkbox"/> 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	Results
28 V	-40°C	16150000000	16149999000	0.0619	Within the band
28 V	-30°C	16150000000	16150000000	0.0000	Within the band
28 V	-20°C	16150000000	16150000000	0.0000	Within the band
28 V	-10°C	16150000000	16150000000	0.0000	Within the band
28 V	0°C	16150000000	16150000000	0.0000	Within the band
28 V	+10°C	16150000000	16149999000	0.0619	Within the band
28 V	+20°C	16150000000	16150000000	0.0000	Within the band
23.8 V (-15%)	+20°C	16150000000	16149999000	0.0619	Within the band
32.2 V (+15%)	+20°C	16150000000	16150000000	0.0000	Within the band
28 V	+30°C	16150000000	16149999000	0.0619	Within the band
28 V	+40°C	16150000000	16150000000	0.0000	Within the band
28 V	+50°C	16150000000	16150000000	0.0000	Within the band
28 V	+60°C	16150000000	16149999000	0.0619	Within the band
28 V	+70°C	16150000000	16150000000	0.0000	Within the band

End of test report