

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 G	SHz):
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	Н	162.0	17.6
492.387000	24.71	84.38	59.67	5000.0	120.000	201.0	Н	34.0	26.5
641.635000	29.88	84.38	54.50	5000.0	120.000	350.0	Н	196.0	30.3
Notes: ¹ Field	strength (dBµV/m) = r	eceiver/spectrum ar	nalyzer value (di	BμV) + correction facto	r (dB)			•	

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.

⁴The spectral plot shows the vertical and horizontal scan separately. ⁵This 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.



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 15.50 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	Н	0.0	-13.8
1200.077778		30.80	82.23	51.43	5000.0	1000.000	298.0	Н	0.0	-13.8
2496.288889		25.40	82.23	56.83	5000.0	1000.000	400.0	Н	162.0	-9.6
2496.288889	39.30		82.23	42.93	5000.0	1000.000	400.0	Н	162.0	-9.6
2590.666667	48.88		82.23	33.35	5000.0	1000.000	206.0	Н	20.0	-9.5
2590.666667		25.56	82.23	56.67	5000.0	1000.000	206.0	Н	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.

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

⁵This measurement was done at 3m. ⁶Two 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.



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 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	Н	173.0	-13.8
1199.677778		23.89	82.23	58.34	5000.0	1000.000	253.0	Н	173.0	-13.8
2502.755556	38.76		82.23	43.47	5000.0	1000.000	288.0	Н	20.0	-9.5
2502.755556		25.34	82.23	56.89	5000.0	1000.000	288.0	Н	20.0	-9.5
2560.255556		25.18	82.23	57.05	5000.0	1000.000	208.0	Н	77.0	-9.6
2560.255556	44.82		82.23	37.41	5000.0	1000.000	208.0	Н	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	Н	325.0	9.4
13290.088889	45.99		82.23	36.24	5000.0	1000.000	223.0	Н	325.0	9.4
Notes:	¹ Field strength	(dBµV/m) = receiver,	/spectrum analyzer v	/alue (dBμV) + co	prrection 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.

⁴The spectral plot shows the vertical and horizontal scan separately. ⁵This measurement was done at 3m. ⁶Two 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	Н	11.0	-13.8
1200.077778		31.08	82.23	51.15	5000.0	1000.000	298.0	Н	11.0	-13.8
1723.333333		23.39	82.23	58.84	5000.0	1000.000	216.0	Н	77.0	-12.9
1723.333333	36.52		82.23	45.71	5000.0	1000.000	216.0	Н	77.0	-12.9
2494.033333		25.21	82.23	57.02	5000.0	1000.000	120.0	Н	88.0	-9.6
2494.033333	38.29		82.23	43.94	5000.0	1000.000	120.0	Н	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	Н	0.0	0.7
6900.200000	52.71		82.23	29.52	5000.0	1000.000	168.0	Н	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.

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

⁵This measurement was done at 3m. ⁶Two 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	Н	103.0	16.7
19327.356250	35.61		82.23	46.62	5000.0	1000.000	363.0	Н	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	Н	54.0	23.4
26499.000000		27.95	82.23	54.28	5000.0	1000.000	153.0	Н	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.

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

⁵This measurement was done at 3m. ⁶Two 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	Н	267.0	18.7
22791.156250		22.28	82.23	59.95	5000.0	1000.000	320.0	Н	267.0	18.7
23580.612500	41.39		82.23	40.84	5000.0	1000.000	233.0	Н	344.0	23.9
23580.612500		27.84	82.23	54.39	5000.0	1000.000	233.0	Н	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.

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

⁵This measurement was done at 3m. ⁶Two 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	Н	144.0	16.8
19324.706250		23.06	82.23	59.17	5000.0	1000.000	273.0	Н	144.0	16.8
21933.456250		21.14	82.23	61.09	5000.0	1000.000	311.0	Н	0.0	17.0
21933.456250	34.00		82.23	48.23	5000.0	1000.000	311.0	Н	0.0	17.0
22925.031250		24.21	82.23	58.02	5000.0	1000.000	307.0	Н	79.0	19.0
22925.031250	37.60		82.23	44.63	5000.0	1000.000	307.0	Н	79.0	19.0
23544.875000	41.30		82.23	40.93	5000.0	1000.000	322.0	Н	114.0	23.6
23544.875000		28.31	82.23	53.92	5000.0	1000.000	322.0	Н	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.

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

⁵This measurement was done at 3m. ⁶Two 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	Н	316.0	51.5
30965.987500	74.93		82.23	7.30	5000.0	1000.000	163.0	Н	316.0	51.5
31005.825000		55.81	82.23	26.42	5000.0	1000.000	160.0	Н	316.0	51.5
31005.825000	74.07		82.23	8.16	5000.0	1000.000	160.0	Н	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	Н	236.0	52.7
39014.043750	73.75		82.23	8.48	5000.0	1000.000	116.0	Н	236.0	52.7
Notes:	¹ Field strength	(dBµV/m) = receiver,	/spectrum analyzer v	value (dBµV) + co	rrection 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.

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

⁵This 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.



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 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	Н	348.0	50.9
31118.700000		55.14	82.23	27.09	5000.0	1000.000	200.0	Н	348.0	50.9
31131.062500	78.04		82.23	4.19	5000.0	1000.000	200.0	Н	37.0	50.9
31131.062500		55.18	82.23	27.05	5000.0	1000.000	200.0	Н	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	Н	6.0	55.7
39853.250000	77.55		82.23	4.68	5000.0	1000.000	141.0	Н	6.0	55.7
Notes:	¹ Field strength	(dBµV/m) = receiver,	/spectrum analyzer v	value (dBµV) + co	prrection 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.

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

⁵This 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.



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 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	Н	40.0	50.7
31189.906250	78.37		82.23	3.86	5000.0	1000.000	179.0	Н	40.0	50.7
31204.718750		55.83	82.23	26.40	5000.0	1000.000	191.0	Н	317.0	50.6
31204.718750	75.30		82.23	6.93	5000.0	1000.000	191.0	Н	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	Н	129.0	52.6
39225.293750		60.53	82.23	21.70	5000.0	1000.000	125.0	Н	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.

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

⁵This 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.



Spectrum								
Ref Level -81	1.00 dBm 😑 🕯	SWT 100 ms	 RBW VBW 	1 MHz 3 MHz Mo	de Auto Swe	зер		
SGL Count 100	0/100	TDF ExtMix U	J					
●1Rm AvgPwr #	lutoID							
					м	1[1]	44.	-32.41 dBm)21280 GHa
30 dBm								
20 dBm								
10 dBm								
0 dBm								
-10 dBm	-13.000 dBm							
-20 dBm								
-30 dBm				1				
						bu		
-40 dBm								
-50 dBm								
-60 dBm	31.000 dBm							
Start 40.0 GH	z			3200	1 pts		Sto	p 50.0 GHz

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

Spectrum				
Ref Level -81.00 dBm	■ RBW 1 M	1Hz		
SGL Count 100/100	TDF ExtMix U	1HZ Mode Auto Swe	эр	
●1Rm AvgPwr AutoID				
		MI	[1]	-32.36 dBm 43.253800 GHz
30 dBm				
20 dBm				
10 dBm-				
0 dBm-				
-10 dBm D1 -13.000 dB	m			
00.40-				
-20 UBIII				
-30 dBm	M1			
-Se ubin				
-40 dBm				
-50 dBm				
-60 dBm				
Start 40.0 GHz		32001 pts		Stop 50.0 GHz

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



Ref Level -13	30.00 dBm	 RBW 1 MHz 					SGL
	 SWT 250) ms 👄 VBW 3 MHz	Mode Auto Swe	ep			Count 100/100
TDF "E1152 (AN	NT 50 - 75 GHZ)","E118	8 (IF)" Inp: ExtMix	V				
1 Frequency S	Sweep					01	Rm Avg Auto ID
						M1[1] -43.52 dBm
20 dBm							61.927880 GHz
10 dBm							
0 dBm							
10 d0m							
-10 ubiii	H1 -13,000 dBm-						
-20 dBm						 	
-30 dBm							
-40 dBm							
40 0011				Ť			
-50 dBm							
60 d0							
-60 asm							
-70 dBm							
		⊥ -130.000	dBm				
50.0.GHz			100000 pt	e	2.5 GHz/		75 0 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.



Ref Level -130.00	0 dBm	RBW 1 MHz					SGL
	 SWT 250 r 	ns 🖷 VBW 3 MHz	Mode Auto Sweep				Count 100/100
TDF "E1146 (ANT 75	5 - 110 GHZ)","E118	8 (IF)" Inp: ExtMix V	V				
1 Frequency Swe	ер	1	1			0	1Rm Avg Auto ID
00 40						M1[1] -36.81 dBm
20 UBM							99.990 380 GHz
10 dBm							
0 dBm							
-10 dBm							
	H1 -13.000 dBm-						
-20 dBm							
-30 dBm							
							M1
-40 dBm							
-50 dBm							
-60 dBm							
-70 dBm							
ro dom		L -130.000	dBm				
75.0 GHz	1		100000 pt		2.5.6Hz/	1	100.0 GHz

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

Ref Level -130.0	0 dBm SWT 250 r	● RBW 1 MHz ns ● VBW 3 MHz	Mode Auto Sweep				SGL Count 100/100
TDF "E1146 (ANT 7	5 - 110 GHZ)","E118	8 (IF)" Inp: E×tMi× ₩	1				
1 Frequency Swe	ep	1				0	IRm Avg Auto ID
20 dBm						MIL	1] -30,80 dBm
							991914300 0Hz
10 dBm							
0 dBm							
10 10							
-10 UBM	H1 -13.000 dBm-						
-20 dBm							
-30 dBm							
							M1
							V
-40 dBm				 			
			State of the local division of the local div				
-50 dBm							
-60 dBm-							
-70 dBm							
75.0.CHz		↓ -130.000	dBm 100000 pt		2.5.642/		100.0.647

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



Spectrum				
Ref Level -81.00 dB	im e RBW	/ 1 MHz		
SGL Count 100/100	TDF ExtMix U	V 3 MHZ Mode Auto Swi	еер	
1Rm AvgPwr AutoID				
		M	1[1]	-29.53 dBm 46.617140 GHz
30 dBm				
20 dBm				
10 dBm				
0 dBm				
-10 dBmD1 -13.0	00 dBm			
00 dB				
-20 dBm				
20 dam			M1	
oo dom				
-40 dBm				
-50 dBm				
-60 dBm-1-81 000	dBm			
Start 40.0 GHz		32001 pts		Stop 50.0 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



Ref Level -130.00) dBm	 RBW 1 MHz 					SGL
	 SWT 250 r 	ns 🖷 VBW 3 MHz	Mode Auto Sweep				Count 100/100
TDF "E1152 (ANT 50) - 75 GHZ)","E1188	(IF)" Inp: ExtMix V					
1 Frequency Swee	ер	T				0	1Rm Avg Auto ID
						M1[1] -44.92 dBm
20 dBm							74.996 630 GHz
10 dBm							
10 000							
0 dBm							
-10 dBm	111 12 000 dbm						
	H1 -13.000 UBM						
-20 dBm							
-30 dBm							
-40 dBm							M1
-50 dBm				h			
So dom							
-60 dBm							
-70 dBm							
50.0 CH2		Ļ -130.000	dBm 100000 pt				75.0.045

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

Ref Level -130.00) dBm	RBW 1 MHz							SGL
TDE "E1152 (ANT 50	= SWI 250 r 1 - 75 GHZ)" "E1188	(IE)" Inc: ExtMix V	Mode Auto Sweep						Count 100/100
1 Frequency Swee	ер	(iii) inprexume						0	1Rm Avg Auto ID
								M1[1] -44.90 dBm
20 dBm-									74.844 880 GHz
10 dBm									
0 dBm									
-10 dBm	U1 -12 000 dam-								
	11 15.000 000								
-20 dBm									
-30 dBm									
oo abiii									
-40 dBm									M1
									T
-50 dBm							No. of Concession, Name of Street, or other		
-60 dBm									
oo dom									
-70 dBm			10						
50.0 GHz		L	авт 100000 pt	S	۱:	1 2.5 GHz/		1	75.0 GHz

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



Ref Level -130.00) dBm	RBW 1 MHz					SGL
	 SWT 250 r 	ms 👄 VBW 3 MHz	Mode Auto Sweep				Count 100/100
TDF "E1146 (ANT 7.	5 - 110 GHZ)","E118	8 (IF)" Inp: ExtMix V	N				
1 Frequency Swe	ер	1	1	1	1	0	1Rm Avg Auto ID
0.0 10						M1[1] -36.75 dBm
20 dBm							99.971 130 GHz
10 dBm							
0 dBm							
-10 d9m-							
10 0000	H1 -13.000 dBm						
-20 dBm							
-30 dBm							
							MI
-40 dBm							
40 dbm							
-50 dBm					 		
-60 dBm-							
-70 dBm							
		L -130.000	dBm				
75.0.00			100000				100.0.011

75.0 GHz 2.5 GHz/ 100000 pts 2.5 GHz/ 10000 GHz 100.0 GH

Ref Level - 130.00 dBm RBW 1 MHz SGL SGL SWT 250 ms VBW 3 MHz Mode Auto Sweep Count									
TDF "E1146 (ANT 7	5 - 110 GHZ)","E118	8 (IF)" Inp: ExtMix V	V						
1 Frequency Swe	ep	1						0	1Rm Avg Auto ID
20 dBm								MIL	1] -36.67 dBm
									99,009 100 GHz
10 dBm									
0 dBm									
-10 dBm-	H1 -12 000 dam-								
	11 13.000 000								
-20 dBm									
-30 dBm-									M1
									Y
-40 dBm									
		and the second se							
50 d0m									
-su ubin									
-60 dBm									
-70 dBm									
10 dom		L -130.000	dBm						
75.0 GHz			100000 pt	s		2.5 GHz/			100.0 GHz

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



Spectrum	(The second seco
RefLevel -81.00 dBm = SWT 100 ms =	BW 1 MHz BW 3 MHz Mode Auto Sweep
SGL Count 100/100 TDF ExtMix U	
1Rm AvgPwr AutoID	
	M1[1] -28.81 dBr
30 dBm	46./37/60 GH
20 dBm	
10 dBm	
0 dBm	
-10 dBm	
-20 dBm	
-30 dBm	MI
-40 dBm	
-50 dBm	
-60 dBm +-81.000 dBm	

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.



Ref Level -130.00 dBm	 RBW 1 MHz 					SGL
•	SWT 250 ms - VBW 3 MHz	Mode Auto Sweep				Count 100/100
TDF "E1152 (ANT 50 - 75 GH	IZ)","E1188 (IF)" Inp: ExtMix V					
1 Frequency Sweep					0	1Rm Avg Auto ID
					M1[1] -47.41 dBm
20 dBm						62.316 880 GHz
10 dam						
0 dBm						
-10 dBm						
H1 -	13.000 dBm					
-20 dBm						
20 000						
-30 dBm					 	
-40 dBm						
			M1			
Fo dow			L			
-su dBm						
-60 dBm						
-70 dBm						
	↓ -130.000	dBm				
50.0 GHz		100000 pt	s	2.5 GHZ/		75.0 GHz

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

Ref Level -130.00	0 dBm	RBW 1 MHz					SGL
	 SWT 250 r 	ns 🖷 VBW 3 MHz	Mode Auto Sweep				Count 100/100
TDF "E1152 (ANT 5)	0 - 75 GHZ)","E1188	(IF)" Inp: ExtMix V				0	1 Pm Ava Auto ID
Threquency owe						M1[11 -44.91 dBm
20 dBm						 	74.870 630 GHz
10.d9m							
10 dbill							
0 dBm							
-10 dBm							
	H1 -13.000 dBm-						
00 v/0 v							
-20 aBm-							
-30 dBm							
-40 dBm							
							M1
-50 dBm			and the second				
-60 dBm							
-70 dBm							
		⊥ -130.000	dBm				
50.0 GHz			100000 pt	s	2.5 GHz/		75.0 GHz

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



Ref Level -130.00 dBm	 RBW 1 MHz 					SGL
• SWT 2	50 ms 🗢 VBW 3 MHz 🛛 Mode A	uto Sweep				Count 100/100
TDF "E1146 (ANT 75 - 110 GHZ)","E	1188 (IF)" Inp: ExtMix W					ID to the to the TD
1 Frequency Sweep					U MIL	IRM AVG AUTO ID
20 dBm-					WIT	1 -30.71 UBIT
						991002 000 0Hz
10 dBm-						
0 dBm						
-10 dBm						
H1 -13.000 c	IBm					
-20 dBm						
-30 dBm						
						M1
-40 dBm				And in case of the local division of the loc		
-50 dBm						
-60 dBm						
00 0.011						
-70 dBm						
75.0.GHz	↓ -130.000 dBm	100000 pts	256Hz/			100.0 GHz

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

Ref Level -130.0	0 dBm	 RBW 1 MHz 						SGL
TDE "E1146 (ANT 7	 SWT 250 r 110 GHZ)" "E118 	ns VBW 3 MHz (IE)" Inn: ExtMix V	Mode Auto Sweep					Count 100/100
1 Frequency Swe	ер	o (ii) iiip: examix i	·				0	1Rm Avg Auto ID
00.40.0							M1[1] -36.74 dBm
20 UBM								99.802 130 GHz
10 dBm								
0 dBm								
-10 dBm								
	H1 -13.000 dBm-							
-20 dBm								
-30 dBm								
								M1
-40 dBm								
Same and the second								
- 50 dBm-								
SO UDIN								
(0.40m)								
-60 dBm-								
-70 dBm		L -120.000	dBm					
75.0 GHz	1	J & -130.000	100000 pt	ts	 1 2.5 GHz/	I	I	100.0 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

- 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	
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