Test data, continued

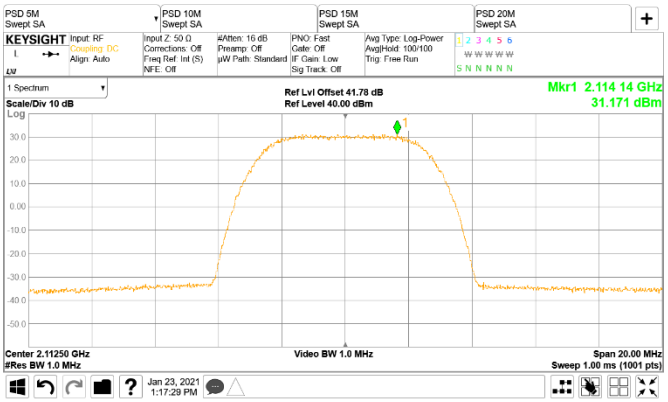

Figure 8.1-1: *PSD of 5 MHz channel bandwidth, single carrier operation, sample plot*

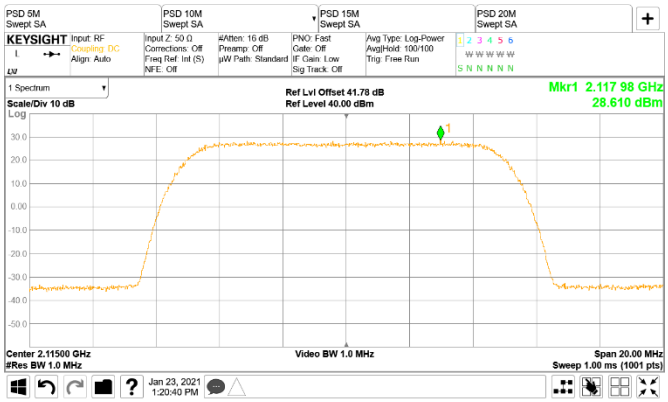

Figure 8.1-2: *PSD of 10 MHz channel bandwidth, single carrier operation, sample plot*

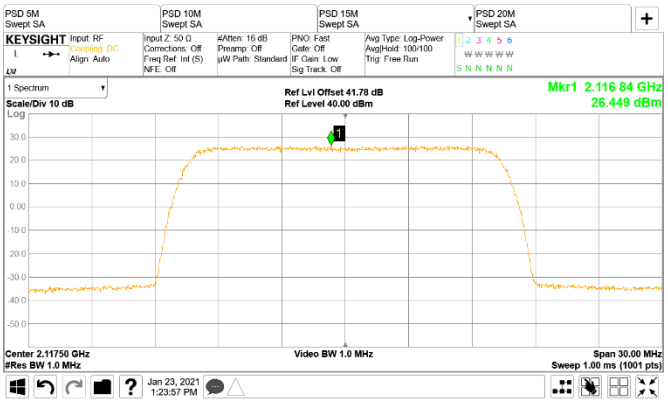

Figure 8.1-3: *PSD of 15 MHz channel bandwidth, single carrier operation, sample plot*

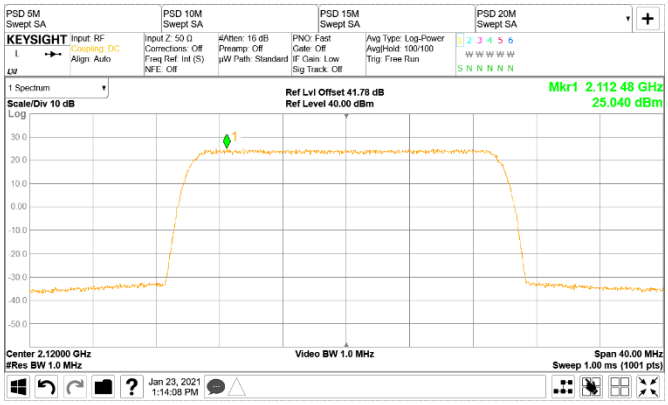

Figure 8.1-4: *PSD of 20 MHz channel bandwidth, single carrier operation, sample plot*

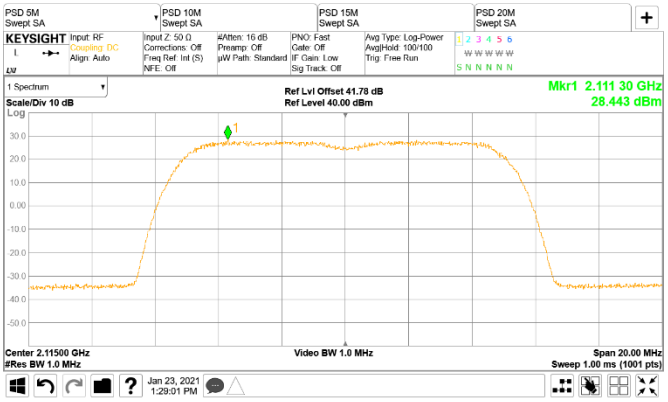

Figure 8.1-5: *PSD of 5 MHz channel bandwidth, two-carrier operation, sample plot*

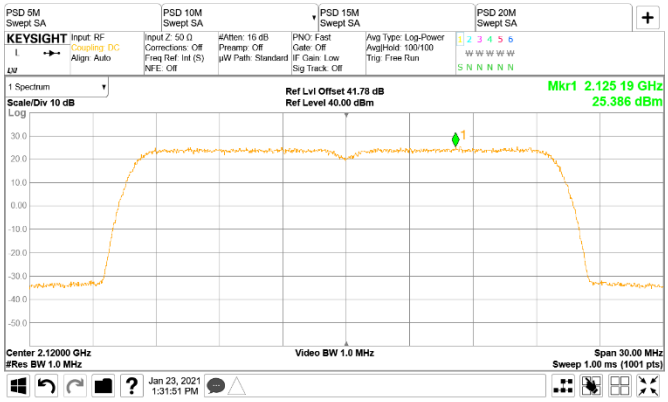

Figure 8.1-6: *PSD of 10 MHz channel bandwidth, two-carrier operation, sample plot*

Test data, continued

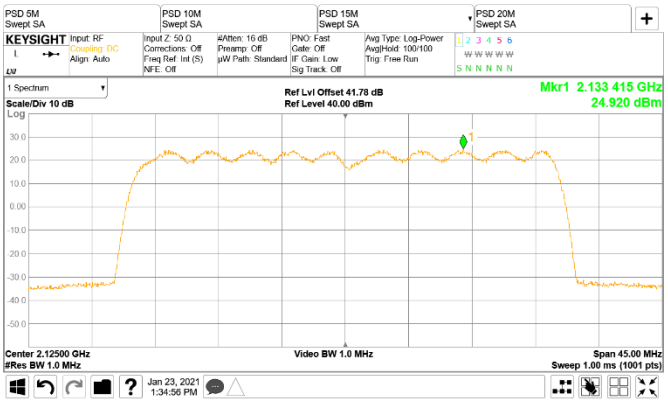

Figure 8.1-7: *PSD of 15 MHz channel bandwidth, two-carrier operation, sample plot*

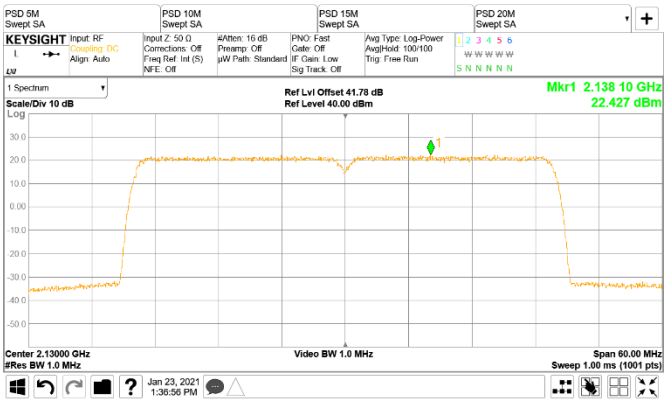

Figure 8.1-8: *PSD of 20 MHz channel bandwidth, two-carrier operation, sample plot*

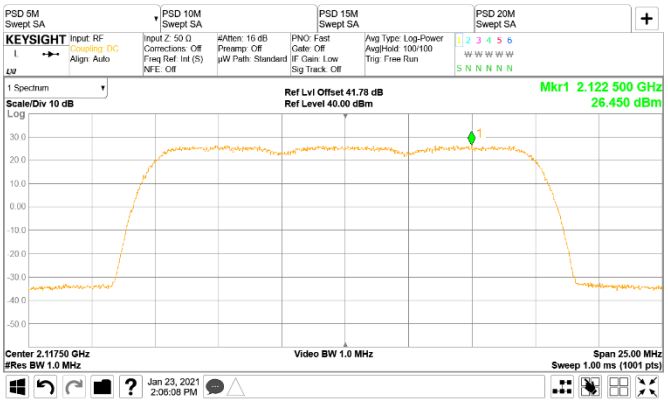

Figure 8.1-9: *PSD of 5 MHz channel bandwidth, three-carrier operation, sample plot*

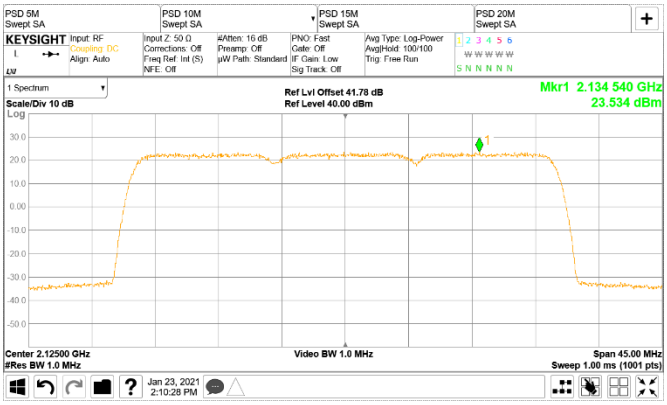

Figure 8.1-10: *PSD of 10 MHz channel bandwidth, three-carrier operation, sample plot*

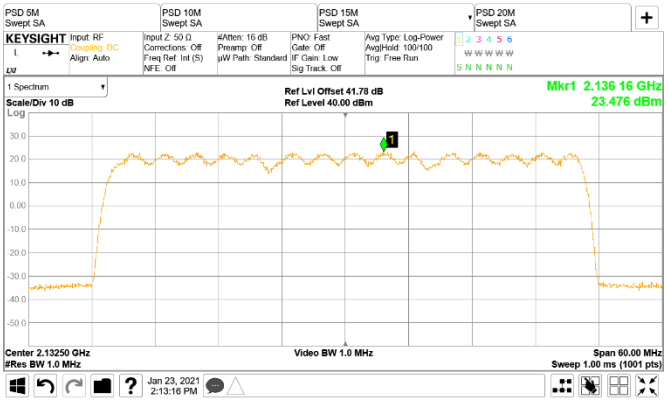

Figure 8.1-11: *PSD of 15 MHz channel bandwidth, three-carrier operation, sample plot*

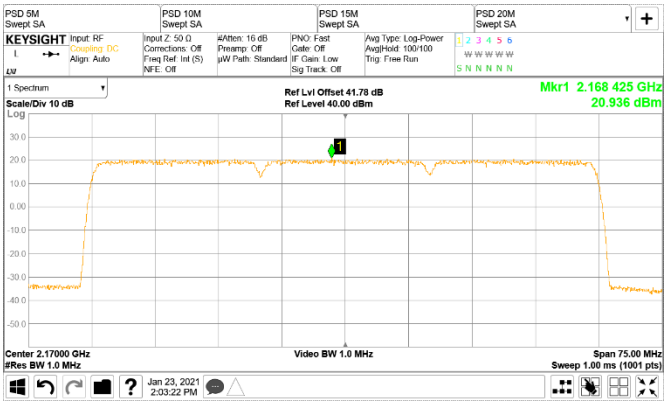

Figure 8.1-12: *PSD of 20 MHz channel bandwidth, three-carrier operation, sample plot*

Test data, continued

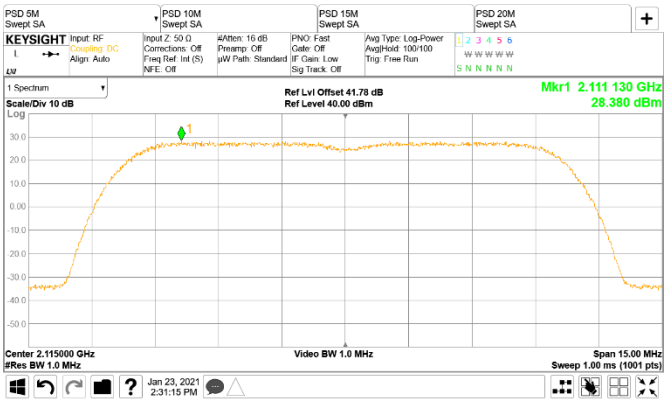

Figure 8.1-13: *PSD of 5 MHz channel bandwidth, LTE + NR operation, sample plot*

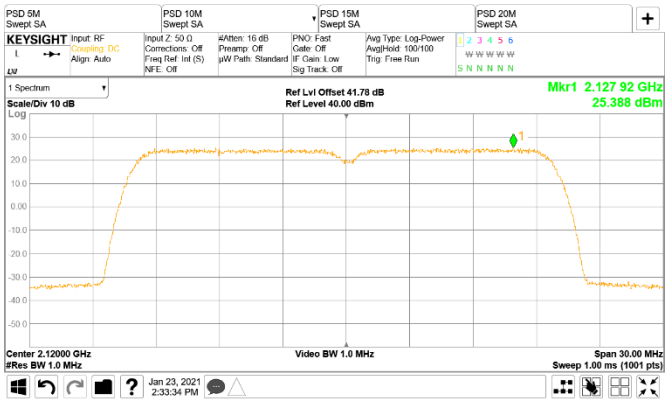

Figure 8.1-14: *PSD of 10 MHz channel bandwidth, LTE + NR operation, sample plot*

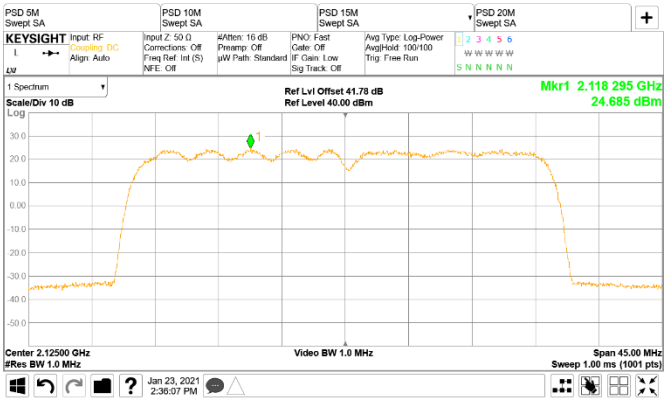

Figure 8.1-15: *PSD of 15 MHz channel bandwidth, LTE + NR operation, sample plot*

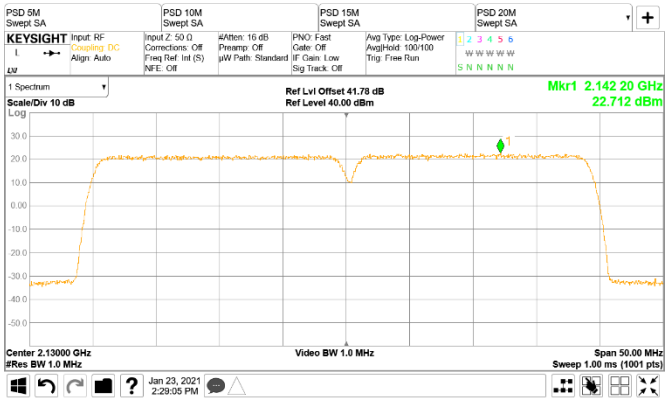

Figure 8.1-16: *PSD of 20 MHz channel bandwidth, LTE + NR operation, sample plot*

Test data, continued

Table 8.1-38: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 5 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 5 MHz, Low channel	2112.5	7.34	13.00	5.66
16QAM, 5 MHz, Low channel	2112.5	7.33	13.00	5.67
64QAM, 5 MHz, Low channel	2112.5	7.39	13.00	5.61
256QAM, 5 MHz, Low channel	2112.5	7.40	13.00	5.60
QPSK, 5 MHz, Mid channel	2155.0	7.34	13.00	5.66
QPSK, 5 MHz, High channel	2197.5	7.33	13.00	5.67

Table 8.1-39: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 10 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 10 MHz, Low channel	2115.0	7.36	13.00	5.64
16QAM, 10 MHz, Low channel	2115.0	7.37	13.00	5.63
64QAM, 10 MHz, Low channel	2115.0	7.39	13.00	5.61
256QAM, 10 MHz, Low channel	2115.0	7.36	13.00	5.64
QPSK, 10 MHz, Mid channel	2155.0	7.35	13.00	5.65
QPSK, 10 MHz, High channel	2195.0	7.37	13.00	5.63

Table 8.1-40: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 15 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 15 MHz, Low channel	2117.5	7.43	13.00	5.57
16QAM, 15 MHz, Low channel	2117.5	7.39	13.00	5.61
64QAM, 15 MHz, Low channel	2117.5	7.43	13.00	5.57
256QAM, 15 MHz, Low channel	2117.5	7.42	13.00	5.58
16QAM, 15 MHz, Mid channel	2155.0	7.38	13.00	5.62
16QAM, 15 MHz, High channel	2192.5	7.42	13.00	5.58

Table 8.1-41: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 20 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 20 MHz, Low channel	2120.0	7.39	13.00	5.61
16QAM, 20 MHz, Low channel	2120.0	7.37	13.00	5.63
64QAM, 20 MHz, Low channel	2120.0	7.38	13.00	5.62
256QAM, 20 MHz, Low channel	2120.0	7.40	13.00	5.60
QPSK, 20 MHz, Mid channel	2155.0	7.37	13.00	5.63
QPSK, 20 MHz, High channel	2190.0	7.42	13.00	5.58

Test data, continued

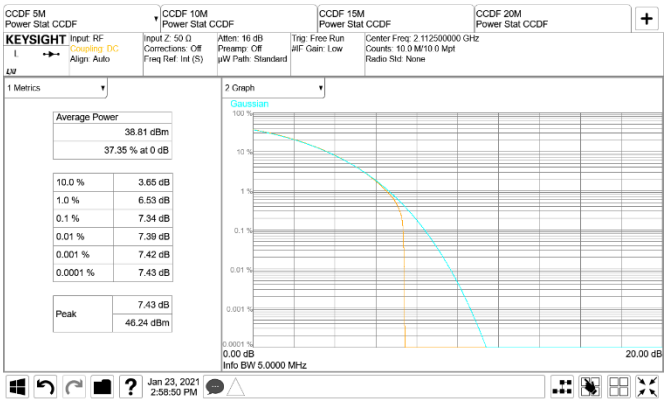

Figure 8.1-17: *CCDF sample plot, 5 MHz channel*

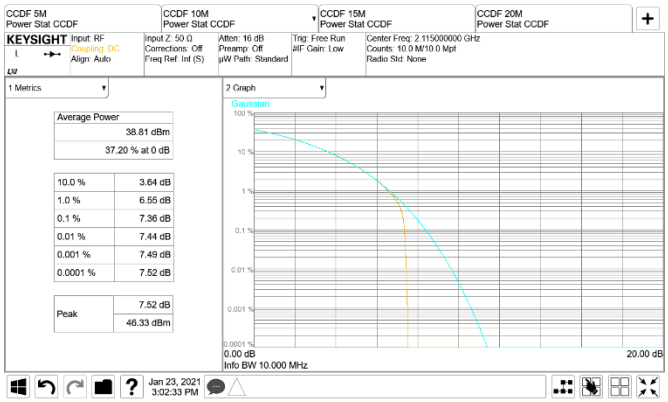

Figure 8.1-18: *CCDF sample plot, 10 MHz channel*

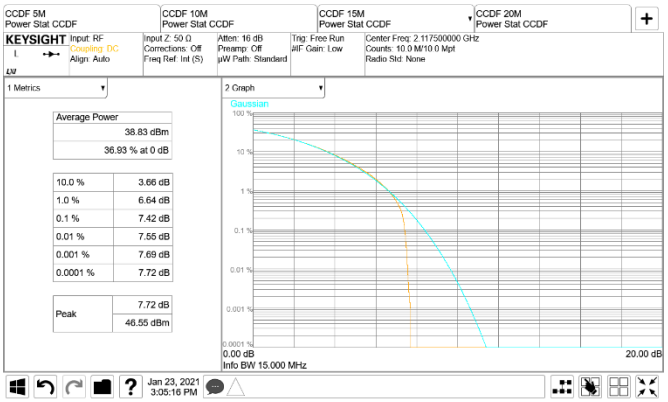

Figure 8.1-19: *CCDF sample plot, 15 MHz channel*

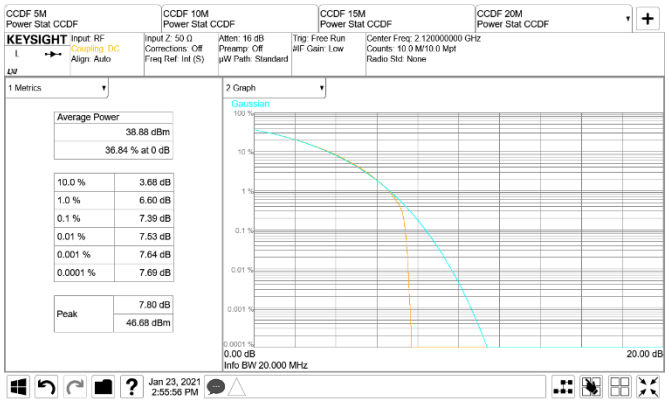

Figure 8.1-20: *CCDF sample plot, 20 MHz channel*

Test data, continued

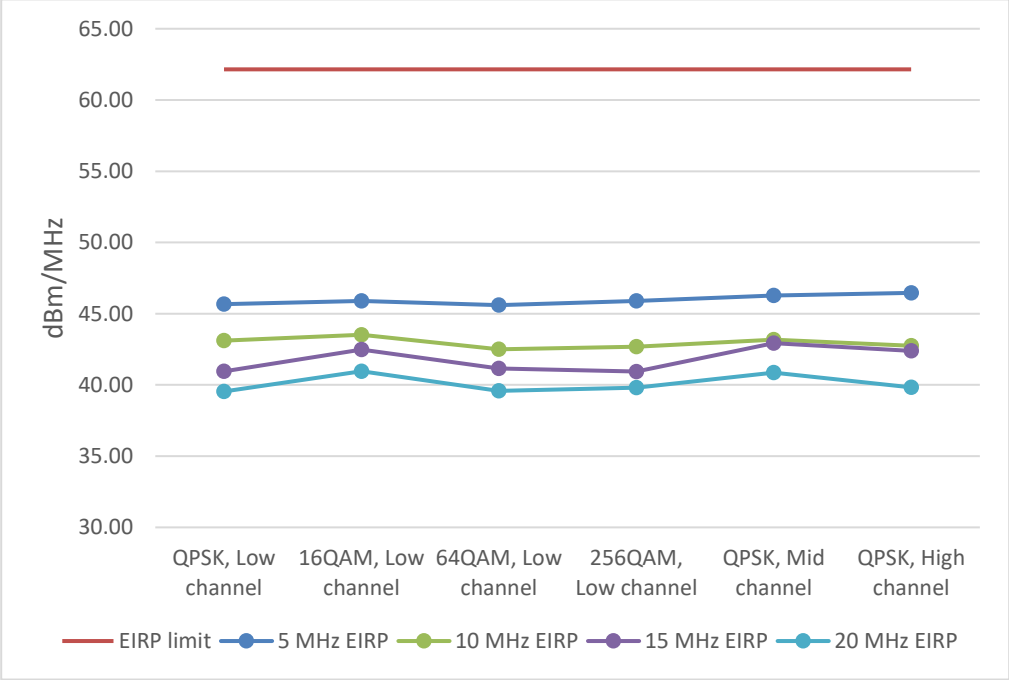

Figure 8.1-21: *EIRP summary for single-carrier operation*

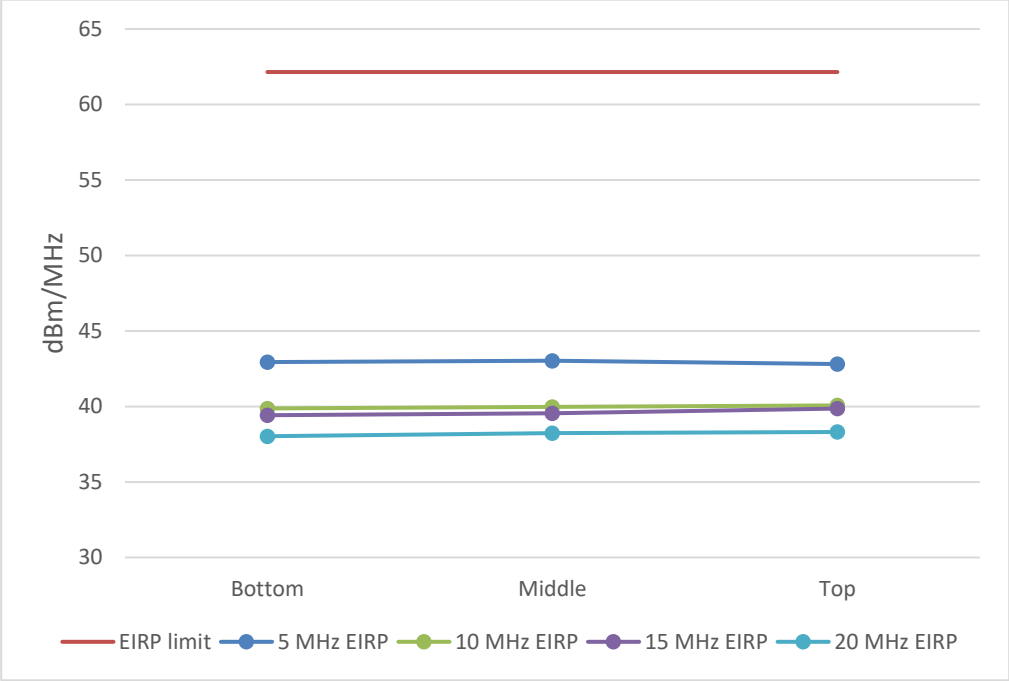

Figure 8.1-22: *EIRP summary for two-carrier operation*

Test data, continued

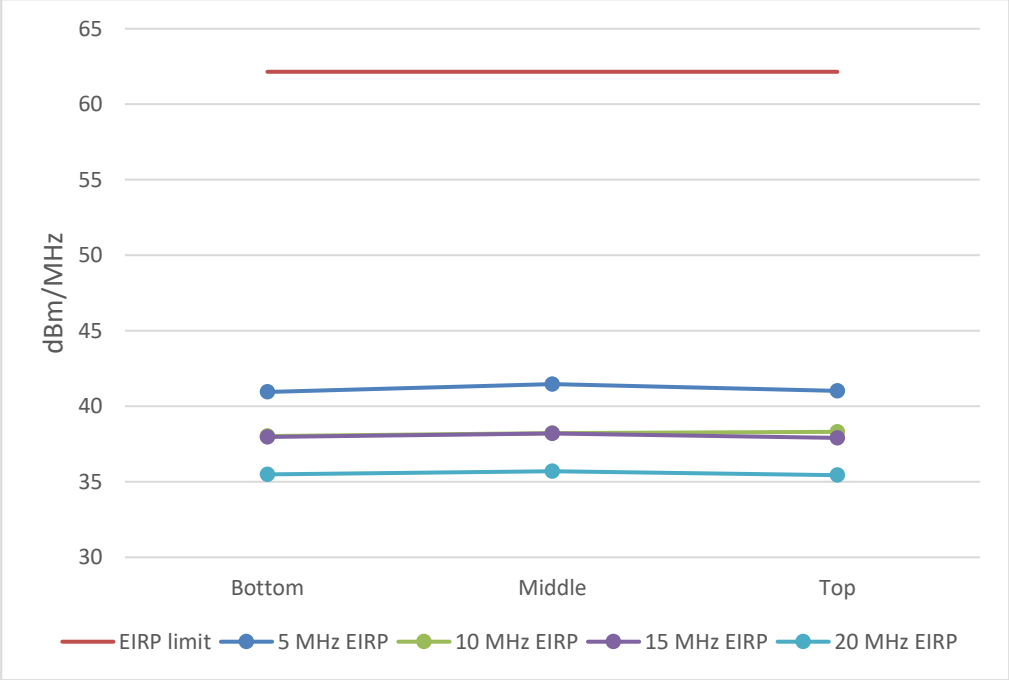

Figure 8.1-23: *EIRP summary for three-carrier operation*

8.2 Transmitter output power (EIRP) and antenna height (Band 2/25a)

8.2.1 Definitions and limits

FCC §24.232(a)(2):

Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.
(2) Base station antenna heights may exceed 300 meters HAAT with a corresponding reduction in power; see table below.
(b)(1) Base stations that are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census, with an emission bandwidth of 1 MHz or less are limited to 3280 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.
(d) Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

RSS-133, Section 6.4
The equivalent isotropically radiated power (e.i.r.p.) for transmitters shall not exceed the limits given in SRSP-510.
In addition, the transmitter's peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.
SRSP-510, Section 5.1
5.1.1 Base stations
For base stations with a channel bandwidth greater than 1 MHz, the maximum e.i.r.p. is limited to 3280 watts/MHz e.i.r.p. (i.e., no more than 3280 watts e.i.r.p. in any 1 MHz band segment) with an antenna height above average terrain (HAAT) up to 300 metres. Fixed or base stations operating in urban areas are limited to a maximum allowable e.i.r.p. of 1640 watts/MHz e.i.r.p. Base station antenna heights above average terrain may exceed 300 metres with a corresponding reduction in e.i.r.p. according to the following table.

Table 8.2-1: *Reduction to Maximum Allowable E.I.R.P. for HAAT > 300 m*

HAAT (m)	Maximum EIRP, W/MHz
HAAT ≤ 300	1640
300 < HAAT ≤ 500	1070
500 < HAAT ≤ 1000	490
1000 < HAAT ≤ 1500	270
1500 < HAAT ≤ 2000	160

8.2.2 Test summary

Test date	January 22, 2021
Test engineer	Andrey Adelberg

8.2.3 Observations, settings and special notes

- Output power was measured with RMS power meter per ANSI C63.26 Paragraph 5.2.4.2 method. PSD was measured using method described in paragraph 5.2.4.4.
- Antenna sub-array gain is 14.5 dBi with uncorrelated signals.
- EIRP Limits for the specific RBS (Radio Base Station) are deployment dependent. To ensure compliance with legal limits detailed in section 8.2.1, RBS set up and carrier configurations are addressed during site commissioning.

Spectrum analyzer settings for PSD:

Detector mode	RMS
Resolution bandwidth	1 MHz
Video bandwidth	>RBW
Measurement mode	Power over emission bandwidth
Trace mode	Averaging

8.2.1 Test data

Table 8.2-2: *Output power density measurement results of a single-carrier operation for 5 MHz channel*

Remarks	Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
QPSK, 5 MHz, Low channel	1932.5	38.74	30.53	14.50	45.03	62.15	17.12
16QAM, 5 MHz, Low channel	1932.5	38.77	31.16	14.50	45.66	62.15	16.49
64QAM, 5 MHz, Low channel	1932.5	38.65	30.72	14.50	45.22	62.15	16.93
256QAM, 5 MHz, Low channel	1932.5	38.66	30.65	14.50	45.15	62.15	17.00
QPSK, 5 MHz, Mid channel	1962.5	39.42	31.46	14.50	45.96	62.15	16.19
QPSK, 5 MHz, High channel	1992.5	39.02	31.32	14.50	45.82	62.15	16.33

Table 8.2-3: *Total EIRP calculation for a single-carrier operation for 5 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
40.49	14.50	9.03	64.02	2524.00

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 31.46 dBm/MHz. Maximum PSD sum = 31.46 dBm/MHz + 10 × $Log_{10}(8)$ = 40.49 dBm/MHz
[2] Antenna Array Column Gain = 10 × $Log_{10}(8)$
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-4: *Total EIRP calculation for a single Macro Narrow traffic beam operation for 5 MHz channel*

Maximum PSD sum, dBm/MHz	Directional beam gain, dBi	Total EIRP, dBm/MHz	Total EIRP, W/MHz
40.49	25.00	65.49	3540.71

Table 8.2-5: *Output power density measurement results of a single-carrier operation for 10 MHz channel*

Remarks	Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
QPSK, 10 MHz, Low channel	1935.0	38.87	28.04	14.50	42.54	62.15	19.61
16QAM, 10 MHz, Low channel	1935.0	38.89	28.41	14.50	42.91	62.15	19.24
64QAM, 10 MHz, Low channel	1935.0	38.86	28.19	14.50	42.69	62.15	19.46
256QAM, 10 MHz, Low channel	1935.0	38.84	28.25	14.50	42.75	62.15	19.40
QPSK, 10 MHz, Mid channel	1962.5	39.42	28.78	14.50	43.28	62.15	18.87
QPSK, 10 MHz, High channel	1990.0	39.11	29.17	14.50	43.67	62.15	18.48

Table 8.2-6: *Total EIRP calculation for a single-carrier operation for 10 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
38.20	14.50	9.03	61.73	1489.67

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 29.17 dBm/MHz. Maximum PSD sum = 29.17 dBm/MHz + 10 × $Log_{10}(8)$ = 38.20 dBm/MHz
[2] Antenna Array Column Gain = 10 × $Log_{10}(8)$
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-7: *Total EIRP calculation for a single Macro Narrow traffic beam operation for 10 MHz channel*

Maximum PSD sum, dBm/MHz	Directional beam gain, dBi	Total EIRP, dBm/MHz	Total EIRP, W/MHz
38.20	25.00	63.20	2089.73

Test data, continued

Table 8.2-8: *Output power density measurement results of a single-carrier operation for 15 MHz channel*

Remarks	Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
QPSK, 15 MHz, Low channel	1937.5	38.98	27.00	14.50	41.50	62.15	20.65
16QAM, 15 MHz, Low channel	1937.5	39.04	28.00	14.50	42.50	62.15	19.65
64QAM, 15 MHz, Low channel	1937.5	39.00	26.71	14.50	41.21	62.15	20.94
256QAM, 15 MHz, Low channel	1937.5	38.99	27.01	14.50	41.51	62.15	20.64
16QAM, 15 MHz, Mid channel	1962.5	39.45	28.56	14.50	43.06	62.15	19.09
16QAM, 15 MHz, High channel	1987.5	39.25	28.23	14.50	42.73	62.15	19.42

Table 8.2-9: *Total EIRP calculation for a single-carrier operation for 15 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
37.59	14.50	9.03	61.12	1294.46

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 28.56 dBm/MHz. Maximum PSD sum = 28.56 dBm/MHz + 10 × $Log_{10}(8)$ = 37.59 dBm/MHz
[2] Antenna Array Column Gain = 10 × $Log_{10}(8)$
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-10: *Total EIRP calculation for a single Macro Narrow traffic beam operation for 15 MHz channel*

Maximum PSD sum, dBm/MHz	Directional beam gain, dBi	Total EIRP, dBm/MHz	Total EIRP, W/MHz
37.59	25.00	62.59	1815.89

Table 8.2-11: *Output power density measurement results of a single-carrier operation for 20 MHz channel*

Remarks	Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
QPSK, 20 MHz, Low channel	1940.0	39.09	25.94	14.50	40.44	62.15	21.71
16QAM, 20 MHz, Low channel	1940.0	39.09	26.99	14.50	41.49	62.15	20.66
64QAM, 20 MHz, Low channel	1940.0	39.09	25.87	14.50	40.37	62.15	21.78
256QAM, 20 MHz, Low channel	1940.0	39.08	25.67	14.50	40.17	62.15	21.98
QPSK, 20 MHz, Mid channel	1962.5	39.47	25.93	14.50	40.43	62.15	21.72
QPSK, 20 MHz, High channel	1985.0	39.29	25.80	14.50	40.30	62.15	21.85

Table 8.2-12: *Total EIRP calculation for a single-carrier operation for 20 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
36.02	14.50	9.03	59.55	901.76

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 26.99 dBm/MHz. Maximum PSD sum = 26.99 dBm/MHz + 10 × $Log_{10}(8)$ = 36.02 dBm/MHz
[2] Antenna Array Column Gain = 10 × $Log_{10}(8)$
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-13: *Total EIRP calculation for a single Macro Narrow traffic beam operation for 20 MHz channel*

Maximum PSD sum, dBm/MHz	Directional beam gain, dBi	Total EIRP, dBm/MHz	Total EIRP, W/MHz
36.02	25.00	61.02	1265.00

Test data, continued

Table 8.2-14: *Output power density measurement results of a two-carrier operation for 5 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1932.5 + 1937.5	38.90	28.42	14.50	42.92	62.15	19.23
1960.0 + 1965.0	39.45	28.78	14.50	43.28	62.15	18.87
1987.5 + 1992.5	39.12	28.62	14.50	43.12	62.15	19.03

Table 8.2-15: *Total EIRP calculation for a two-carrier operation for 5 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
37.81	14.50	9.03	61.34	1361.73

Notes: [1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 28.78 dBm/MHz. Maximum PSD sum = 28.78 dBm/MHz + 10 × Log_{10}(8) = 37.81 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-16: *Output power density measurement results of a two-carrier operation for 10 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1935.0 + 1945.0	39.07	25.62	14.5	40.12	62.15	22.03
1957.5 + 1967.5	39.44	25.83	14.50	40.33	62.15	21.82
1980.0 + 1990.0	39.27	26.08	14.50	40.58	62.15	21.57

Table 8.2-17: *Total EIRP calculation for a two-carrier operation for 10 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
35.11	14.50	9.03	58.64	731.29

Notes: [1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 26.08 dBm/MHz. Maximum PSD sum = 26.08 dBm/MHz + 10 × Log_{10}(8) = 35.11 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Test data, continued

Table 8.2-18: *Output power density measurement results of a two-carrier operation for 15 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1937.5 + 1952.5	39.20	25.37	14.50	39.87	62.15	22.28
1955.0 + 1970.0	39.42	25.48	14.50	39.98	62.15	22.17
1972.5 + 1987.5	39.33	25.46	14.50	39.96	62.15	22.19

Table 8.2-19: *Total EIRP calculation for a two-carrier operation for 15 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
34.51	14.50	9.03	58.04	636.93

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 25.48 dBm/MHz. Maximum PSD sum = 25.48 dBm/MHz + 10 × Log_{10}(8) = 34.51 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-20: *Output power density measurement results of a two-carrier operation for 20 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1940.0 + 1960.0	39.27	23.10	14.50	37.60	62.15	24.55
1952.5 + 1972.5	39.42	23.19	14.50	37.69	62.15	24.46
1965.0 + 1985.0	39.35	22.84	14.50	37.34	62.15	24.81

Table 8.2-21: *Total EIRP calculation for a two-carrier operation for 20 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
32.22	14.50	9.03	55.75	375.92

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 23.19 dBm/MHz. Maximum PSD sum = 23.19 dBm/MHz + 10 × Log_{10}(8) = 32.22 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Test data, continued

Table 8.2-22: *Output power density measurement results of a three-carrier operation for 5 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1932.5 + 1937.5 + 1942.5	39.00	27.05	14.50	41.55	62.15	20.60
1957.5 + 1962.5 + 1967.5	39.42	27.51	14.50	42.01	62.15	20.14
1982.5 + 1987.5 + 1992.5	39.21	27.01	14.50	41.51	62.15	20.64

Table 8.2-23: *Total EIRP calculation for a three-carrier operation for 5 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
36.54	14.50	9.03	60.07	1016.46

Notes: [1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 27.51 dBm/MHz. Maximum PSD sum = 27.51 dBm/MHz + 10 × Log_{10}(8) = 36.54 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-24: *Output power density measurement results of a three-carrier operation for 10 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1935.0 + 1945.0 + 1955.0	39.21	24.02	14.50	38.52	62.15	23.63
1952.5 + 1962.5 + 1972.5	39.41	24.23	14.50	38.73	62.15	23.42
1970.0 + 1980.0 + 1990.0	39.35	24.46	14.50	38.96	62.15	23.19

Table 8.2-25: *Total EIRP calculation for a three-carrier operation for 10 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
33.49	14.50	9.03	57.02	503.60

Notes: [1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 24.46 dBm/MHz. Maximum PSD sum = 24.46 dBm/MHz + 10 × Log_{10}(8) = 33.49 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Test data, continued

Table 8.2-26: *Output power density measurement results of a three-carrier operation for 15 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1937.5 + 1952.5 + 1967.5	39.29	23.91	14.50	38.41	62.15	23.74
1947.5 + 1962.5 + 1977.5	39.40	23.99	14.50	38.49	62.15	23.66
1957.5 + 1972.5 + 1987.5	39.35	23.76	14.50	38.26	62.15	23.89

Table 8.2-27: *Total EIRP calculation for a three-carrier operation for 15 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
33.02	14.50	9.03	56.55	451.95

Notes: [1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 23.99 dBm/MHz. Maximum PSD sum = 23.99 dBm/MHz + 10 × Log_{10}(8) = 33.02 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-28: *Output power density measurement results of a three-carrier operation for 20 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1940.0 + 1960.0 + 1980.0	39.32	21.07	14.50	35.57	62.15	26.58
1942.5 + 1962.5 + 1982.5	39.32	21.21	14.50	35.71	62.15	26.44
1945.0 + 1965.0 + 1985.0	39.32	21.19	14.50	35.69	62.15	26.46

Table 8.2-29: *Total EIRP calculation for a three-carrier operation for 20 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
30.24	14.50	9.03	53.77	238.28

Notes: [1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 21.21 dBm/MHz. Maximum PSD sum = 21.21 dBm/MHz + 10 × Log_{10}(8) = 30.24 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Test data, continued

Table 8.2-30: *Output power density measurement results of LTE + NR* operation for 5 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1932.5 + 1937.5	38.77	28.52	14.50	43.02	62.15	19.13
1960.0 + 1965.0	39.41	29.11	14.50	43.61	62.15	18.54
1987.5 + 1992.5	39.06	28.57	14.50	43.07	62.15	19.08

Note: *NR 5 MHz + LTE 5 MHz

Table 8.2-31: *Total EIRP calculation for LTE + NR operation for 5 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
38.14	14.50	9.03	61.67	1469.23

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 29.11 dBm/MHz. Maximum PSD sum = 29.11 dBm/MHz + 10 × $Log_{10}(8)$ = 38.14 dBm/MHz
[2] Antenna Array Column Gain = 10 × $Log_{10}(8)$
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-32: *Output power density measurement results of LTE + NR* operation for 10 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1935.0 + 1945.0	39.02	25.68	14.50	40.18	62.15	21.97
1957.5 + 1967.5	39.37	26.09	14.50	40.59	62.15	21.56
1980.0 + 1990.0	39.22	26.06	14.50	40.56	62.15	21.59

Note: *NR 10 MHz + LTE 10 MHz

Table 8.2-33: *Total EIRP calculation for LTE + NR operation for 10 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
35.12	14.50	9.03	58.65	732.98

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 26.09 dBm/MHz. Maximum PSD sum = 26.09 dBm/MHz + 10 × $Log_{10}(8)$ = 35.12 dBm/MHz
[2] Antenna Array Column Gain = 10 × $Log_{10}(8)$
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Test data, continued

Table 8.2-34: *Output power density measurement results of LTE + NR* operation for 15 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1937.5 + 1952.5	39.12	25.24	14.50	39.74	62.15	22.41
1955.0 + 1970.0	39.35	25.35	14.50	39.85	62.15	22.30
1972.5 + 1987.5	39.27	25.34	14.50	39.84	62.15	22.31

Note: *NR 15 MHz + LTE 15 MHz

Table 8.2-35: *Total EIRP calculation for LTE + NR operation for 15 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
34.38	14.50	9.03	57.91	618.14

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 25.35 dBm/MHz. Maximum PSD sum = 25.35 dBm/MHz + 10 × Log_{10}(8) = 34.38 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.2-36: *Output power density measurement results of LTE + NR* operation for 20 MHz channel*

Frequency, MHz	Total RF power, dBm	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
1940.0 + 1960.0	39.16	23.16	14.50	37.66	62.15	24.49
1952.5 + 1972.5	39.32	23.03	14.50	37.53	62.15	24.62
1965.0 + 1985.0	39.27	23.04	14.50	37.54	62.15	24.61

Note: *NR 20 MHz + LTE 20 MHz

Table 8.2-37: *Total EIRP calculation for LTE + NR operation for 20 MHz channel*

Maximum PSD sum[1], dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[2], dB	EIRP per polarization[3], dBm/MHz	EIRP per polarization, W/MHz
32.19	14.50	9.03	55.72	373.33

Notes:
[1] Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 23.16 dBm/MHz. Maximum PSD sum = 23.16 dBm/MHz + 10 × Log_{10}(8) = 32.19 dBm/MHz
[2] Antenna Array Column Gain = 10 × Log_{10}(8)
[3] EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Test data, continued

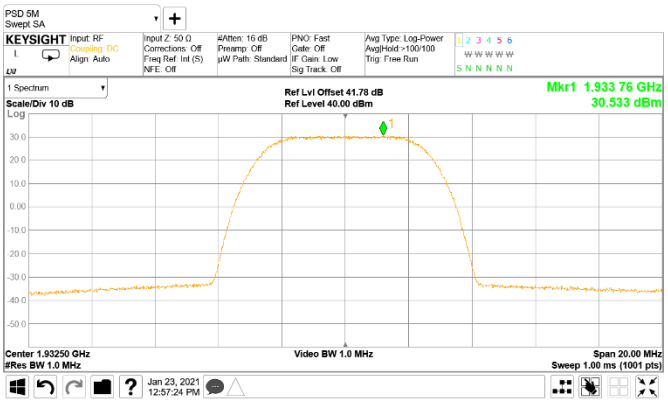

Figure 8.2-1: *PSD of 5 MHz channel bandwidth, single carrier operation, sample plot*

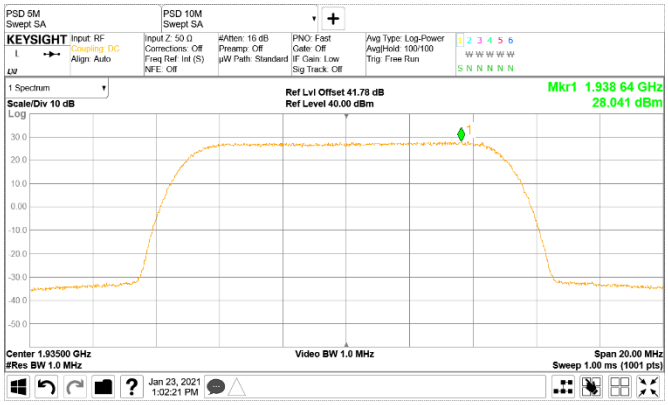

Figure 8.2-2: *PSD of 10 MHz channel bandwidth, single carrier operation, sample plot*

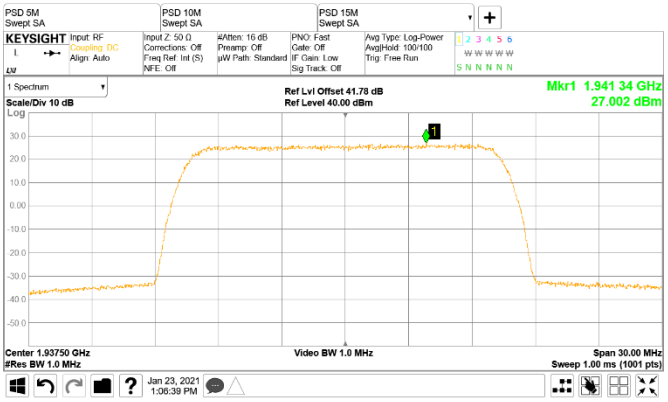

Figure 8.2-3: *PSD of 15 MHz channel bandwidth, single carrier operation, sample plot*

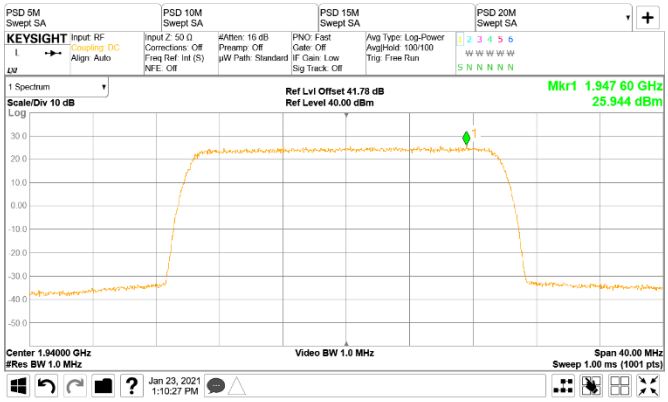

Figure 8.2-4: *PSD of 20 MHz channel bandwidth, single carrier operation, sample plot*

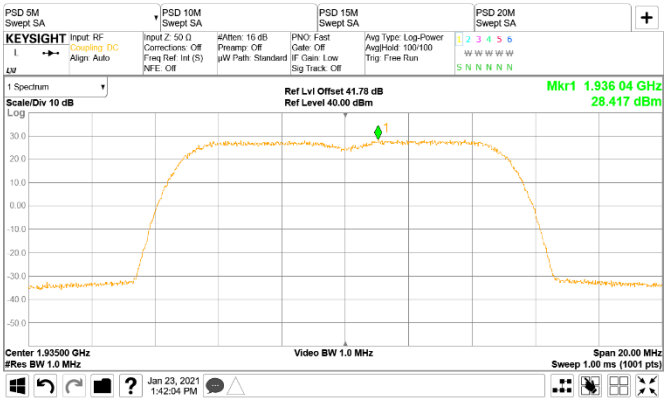

Figure 8.2-5: *PSD of 5 MHz channel bandwidth, two-carrier operation, sample plot*

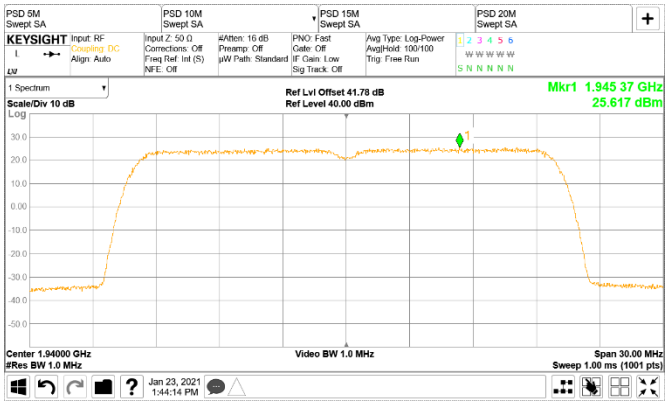

Figure 8.2-6: *PSD of 10 MHz channel bandwidth, two-carrier operation, sample plot*

Test data, continued

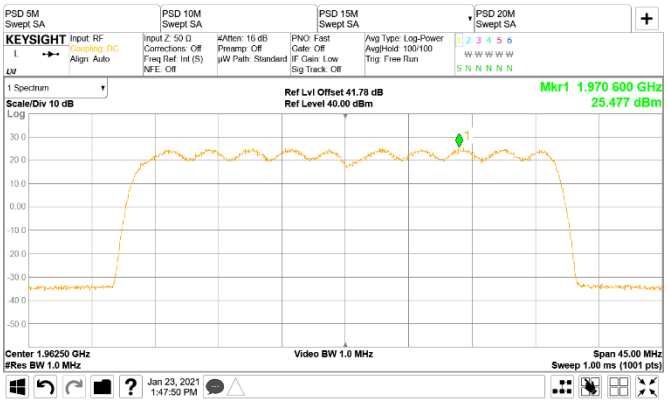

Figure 8.2-7: *PSD of 15 MHz channel bandwidth, two-carrier operation, sample plot*

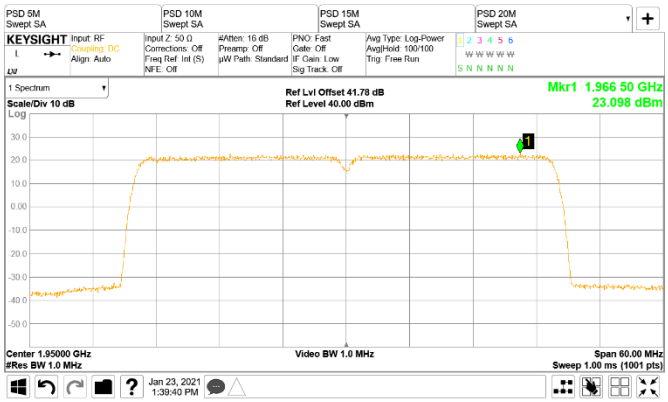

Figure 8.2-8: *PSD of 20 MHz channel bandwidth, two-carrier operation, sample plot*

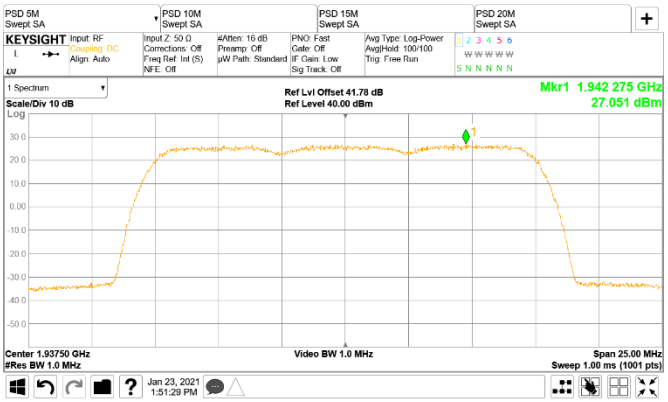

Figure 8.2-9: *PSD of 5 MHz channel bandwidth, three-carrier operation, sample plot*

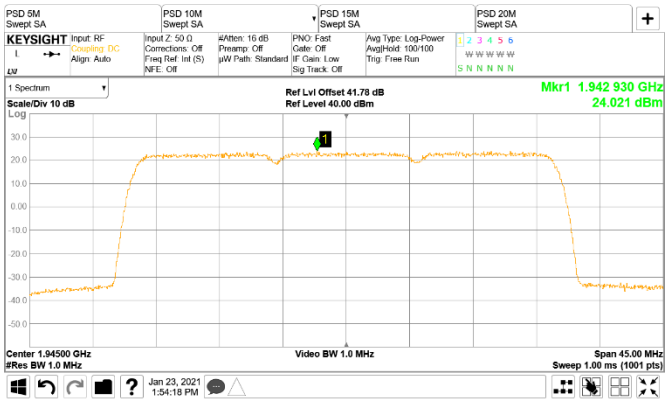

Figure 8.2-10: *PSD of 10 MHz channel bandwidth, three-carrier operation, sample plot*

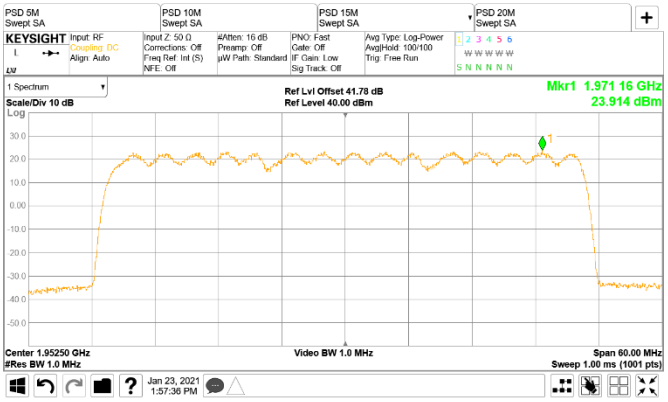

Figure 8.2-11: *PSD of 15 MHz channel bandwidth, three-carrier operation, sample plot*

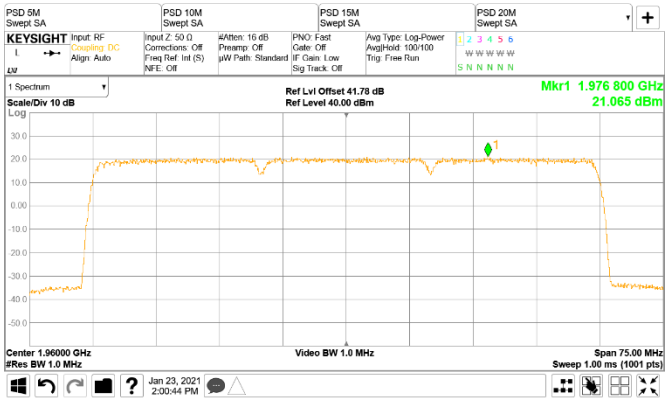

Figure 8.2-12: *PSD of 20 MHz channel bandwidth, three-carrier operation, sample plot*

Test data, continued

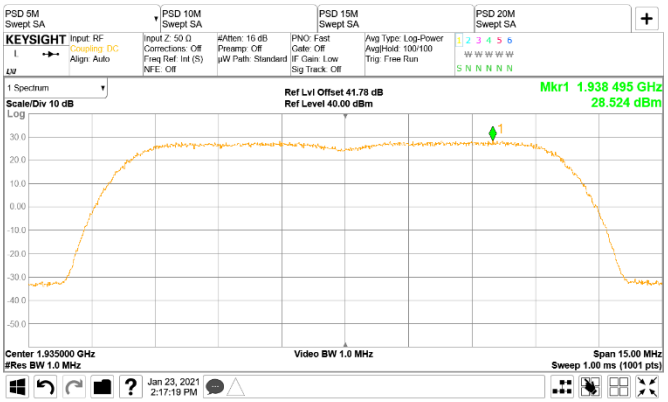

Figure 8.2-13: *PSD of 5 MHz channel bandwidth, LTE + NR operation, sample plot*

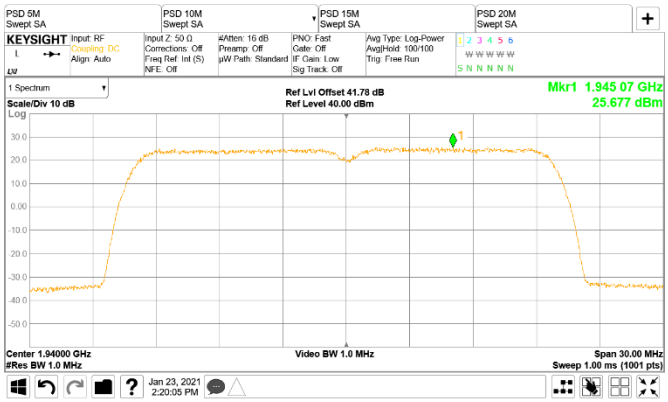

Figure 8.2-14: *PSD of 10 MHz channel bandwidth, LTE + NR operation, sample plot*

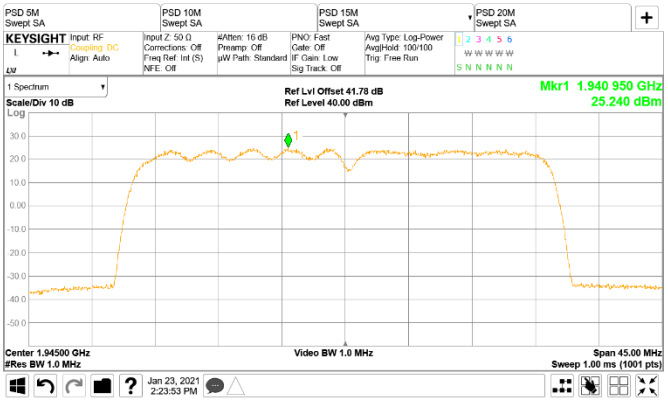

Figure 8.2-15: *PSD of 15 MHz channel bandwidth, LTE + NR operation, sample plot*

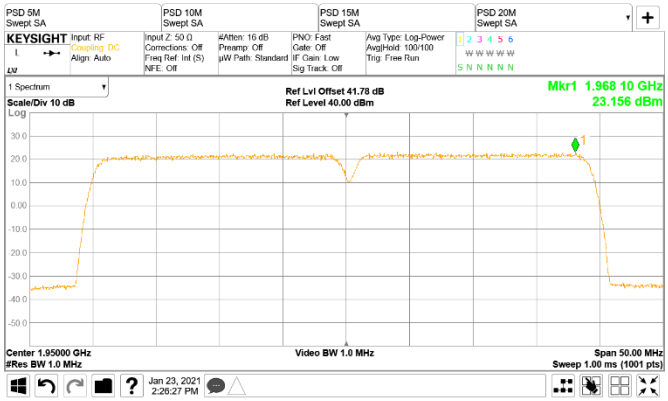

Figure 8.2-16: *PSD of 20 MHz channel bandwidth, LTE + NR operation, sample plot*

Test data, continued

Table 8.2-38: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 5 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 5 MHz, Low channel	1932.5	7.35	13.00	5.65
16QAM, 5 MHz, Low channel	1932.5	7.37	13.00	5.63
64QAM, 5 MHz, Low channel	1932.5	7.39	13.00	5.61
256QAM, 5 MHz, Low channel	1932.5	7.42	13.00	5.58
QPSK, 5 MHz, Mid channel	1962.5	7.33	13.00	5.67
QPSK, 5 MHz, High channel	1992.5	7.39	13.00	5.61

Table 8.2-39: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 10 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 10 MHz, Low channel	1935.0	7.39	13.00	5.61
16QAM, 10 MHz, Low channel	1935.0	7.41	13.00	5.59
64QAM, 10 MHz, Low channel	1935.0	7.42	13.00	5.58
256QAM, 10 MHz, Low channel	1935.0	7.43	13.00	5.57
QPSK, 10 MHz, Mid channel	1962.5	7.36	13.00	5.64
QPSK, 10 MHz, High channel	1990.0	7.40	13.00	5.60

Table 8.2-40: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 15 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 15 MHz, Low channel	1937.5	7.49	13.00	5.51
16QAM, 15 MHz, Low channel	1937.5	7.46	13.00	5.54
64QAM, 15 MHz, Low channel	1937.5	7.52	13.00	5.48
256QAM, 15 MHz, Low channel	1937.5	7.50	13.00	5.50
16QAM, 15 MHz, Mid channel	1962.5	7.39	13.00	5.61
16QAM, 15 MHz, High channel	1987.5	7.44	13.00	5.56

Table 8.2-41: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation for 20 MHz*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 20 MHz, Low channel	1940.0	7.52	13.00	5.48
16QAM, 20 MHz, Low channel	1940.0	7.48	13.00	5.52
64QAM, 20 MHz, Low channel	1940.0	7.48	13.00	5.52
256QAM, 20 MHz, Low channel	1940.0	7.53	13.00	5.47
QPSK, 20 MHz, Mid channel	1962.5	7.37	13.00	5.63
QPSK, 20 MHz, High channel	1985.0	7.45	13.00	5.55

Test data, continued

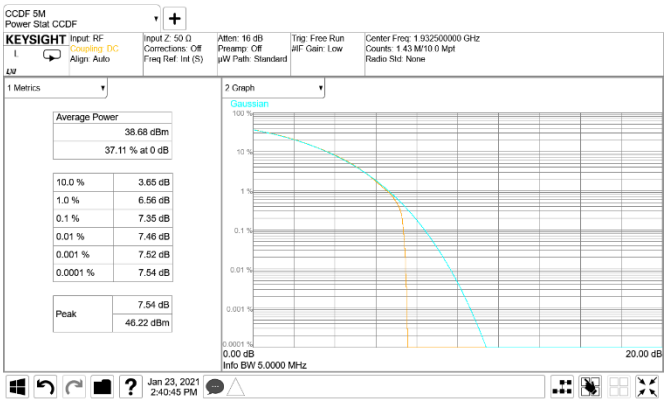

Figure 8.2-17: *CCDF sample plot, 5 MHz channel*

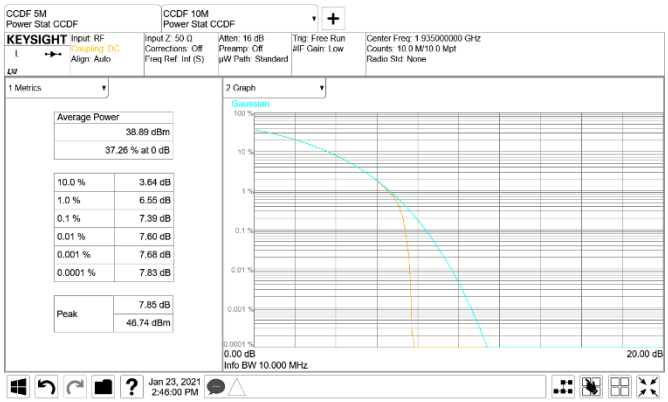

Figure 8.2-18: *CCDF sample plot, 10 MHz channel*

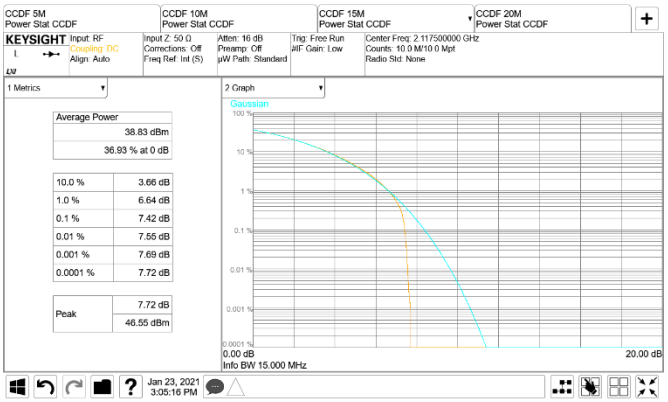

Figure 8.2-19: *CCDF sample plot, 15 MHz channel*

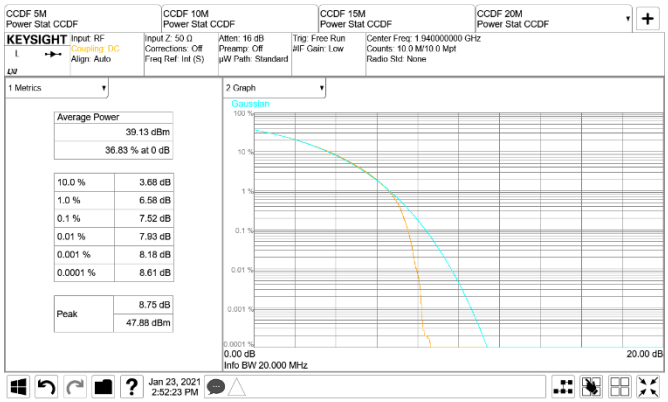

Figure 8.2-20: *CCDF sample plot, 20 MHz channel*

Test data, continued

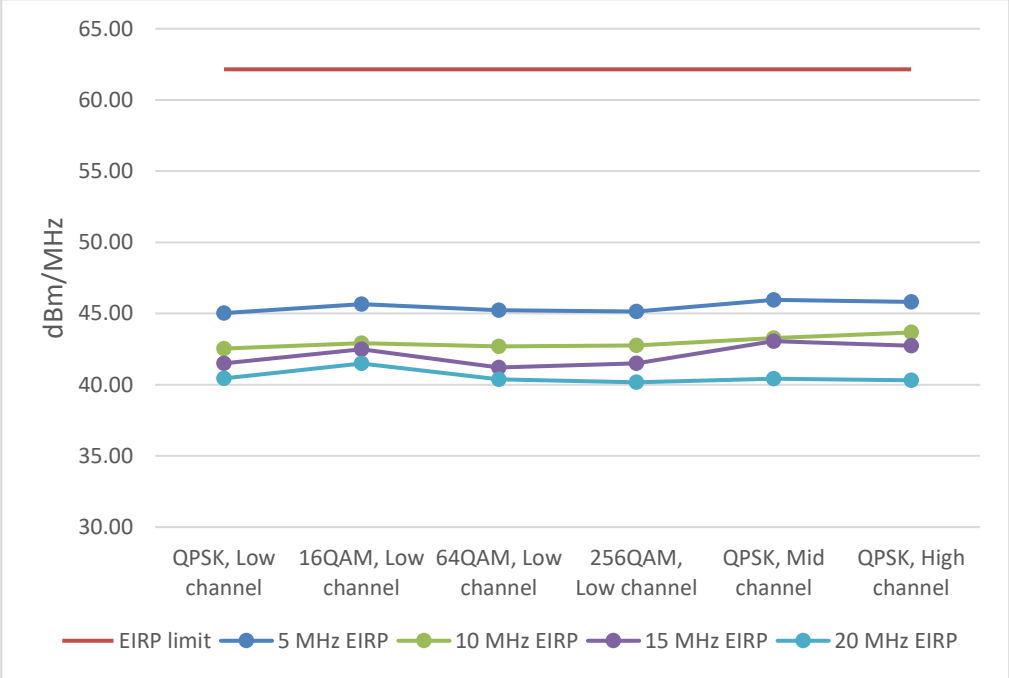

Figure 8.2-21: *EIRP summary for single-carrier operation*

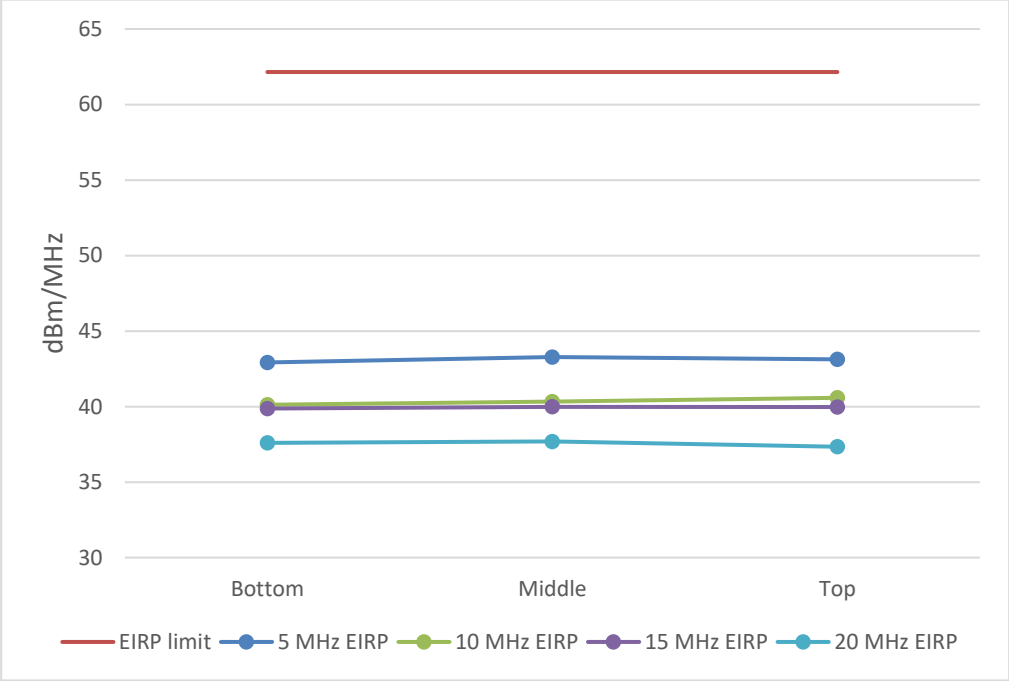

Figure 8.2-22: *EIRP summary for two-carrier operation*

Test data, continued

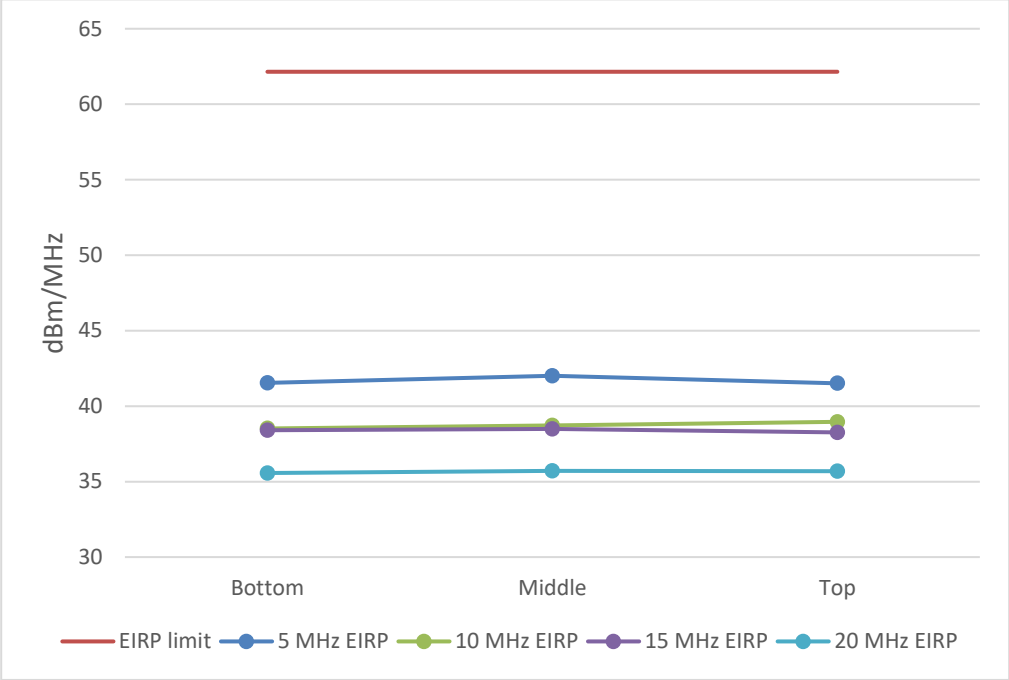

Figure 8.2-23: *EIRP summary for three-carrier operation*

8.3 Spurious emissions at RF antenna connector (Band 66)

8.3.1 Definitions and limits

FCC §27.53:
(h) AWS emission limits
(1) General protection levels. Except as otherwise specified below, for operations in the 1695–1710 MHz, 1710–1755 MHz, 1755–1780 MHz, 1915–1920 MHz, 1995–2000 MHz, 2000–2020 MHz, 2110–2155 MHz, 2155–2180 MHz, and 2180–2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}$ (P) dB.

(3) Measurement procedure.

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1-megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(ii) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.
(iii) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

RSS-139, Section 6.6:
i. In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least $43 + 10 \log_{10}$ p (watts) dB.
ii. After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least $43 + 10 \log_{10}$ p (watts) dB.

RSS-170, Section 5.4:
The transmitter unwanted emissions shall be measured for all channel bandwidths with the carrier frequency set at both the highest and lowest channels in which the equipment is designed to operate.

The e.i.r.p. density of unwanted and carrier-off state emissions outlined in this section (Section 5.4) shall be averaged over any 2-ms active transmission using an RMS detector with a resolution bandwidth of 1 MHz for broadband emissions and a resolution bandwidth of 1 kHz for discrete emissions, unless stated otherwise.

For ATC equipment operating in the bands 2000–2020 MHz and 2180–2200 MHz, the unwanted emission limits shall be determined using a measurement bandwidth of 1 MHz or greater. However, in the 1 MHz band immediately outside and adjacent to the equipment's operating frequency block, a resolution bandwidth of at least 1% of the occupied bandwidth may be employed.
5.4.1.2 ATC Base Station Equipment operating in bands 2000–2020 MHz and 2180–2200 MHz
The unwanted emissions of ATC base station equipment transmitting in the bands 2000-2020 MHz and 2180-2200 MHz shall comply with the following:

(1) The power of any unwanted emissions at frequencies outside the equipment's operating frequency block shall be attenuated below the transmitter power P (dBW), by 43 + 10 log p (watts), dB.
(2) *For equipment operating in the band 2180–2200 MHz, in addition to (1), the power of any emissions on all frequencies between 2200 MHz and 2290 MHz shall not exceed an e.i.r.p. of −100.6 dBW/4 kHz (−70.6 dBm/4 kHz).

**** This requirement is for implementation and is enforced at the time of licensing. Therefore, results are not included in this report.***

8.3.2 Test summary

Test date	January 25, 2021
Test engineer	Andrey Adelberg

8.3.3 Observations, settings and special notes

- The spectrum was searched from 30 MHz to the 10th harmonic.
- All measurements were performed using an average (RMS) detector per ANSI C63.26 Paragraph 5.7.2 method.
- Limit line (43 + 10 $\log_{10}$ (P) or −13 dBm) was adjusted for MIMO operation by 12.04 dB*: −13 dBm – 12.04 dB = −25.04 dBm
  *MIMO correction factor for 16 antenna ports: 10 × Log_{10}(16) = 12.04 dB
- RBW 1 MHz, VBW was wider than RBW.

8.3.4 Test data

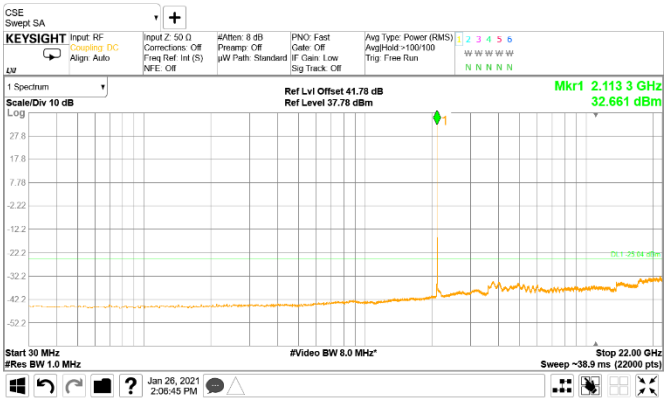

Figure 8.3-1: *Conducted spurious emissions of 5 MHz low channel, single carrier operation*

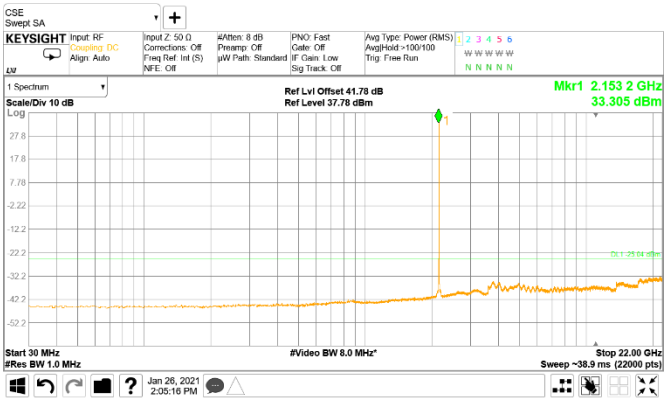

Figure 8.3-2: *Conducted spurious emissions of 5 MHz mid channel, single carrier operation*

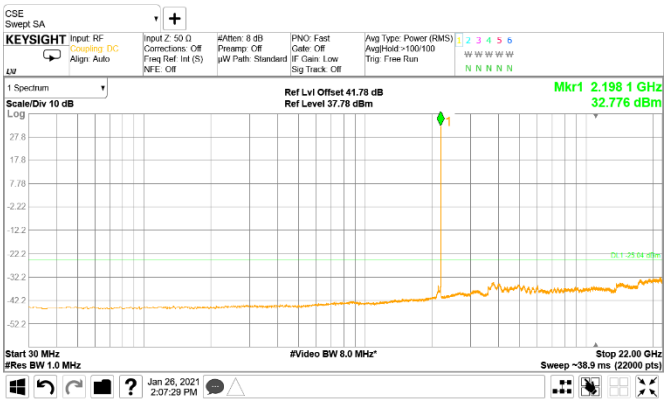

Figure 8.3-3: *Conducted spurious emissions of 5 MHz top channel, single carrier operation*

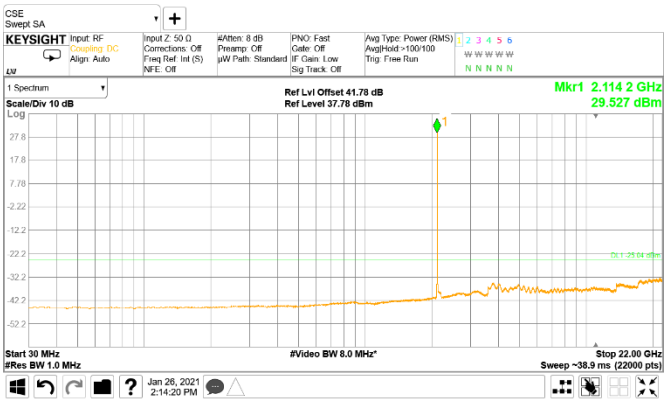

Figure 8.3-4: *Conducted spurious emissions of 10 MHz low channel, single carrier operation*

Test data, continued

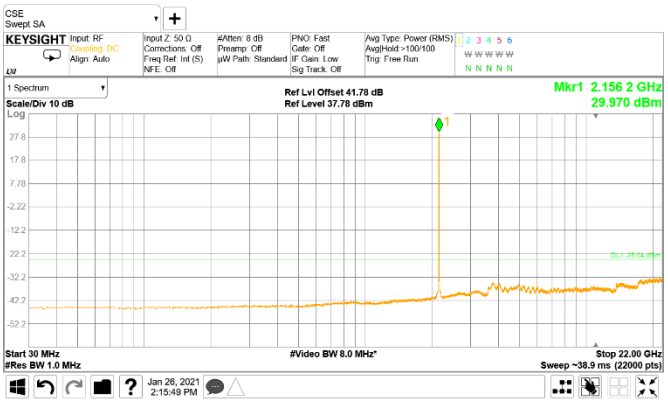

Figure 8.3-5: *Conducted spurious emissions of 10 MHz mid channel, single carrier operation*

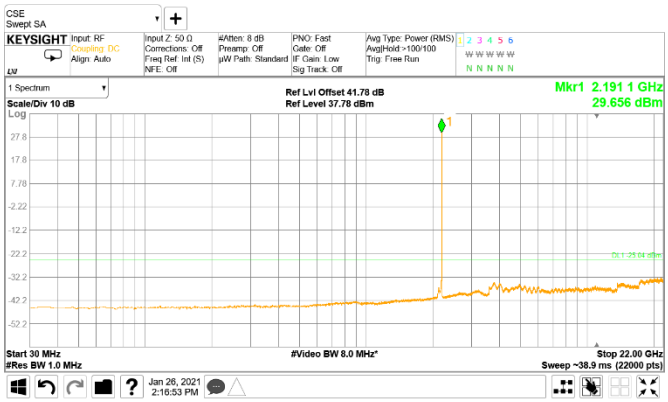

Figure 8.3-6: *Conducted spurious emissions of 10 MHz top channel, single carrier operation*

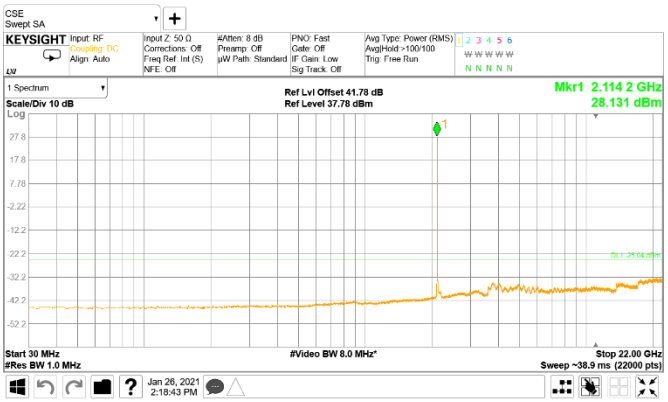

Figure 8.3-7: *Conducted spurious emissions of 15 MHz low channel, single carrier operation*

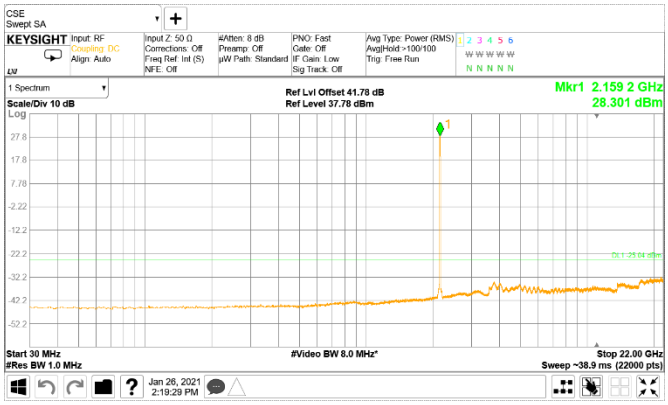

Figure 8.3-8: *Conducted spurious emissions of 15 MHz mid channel, single carrier operation*

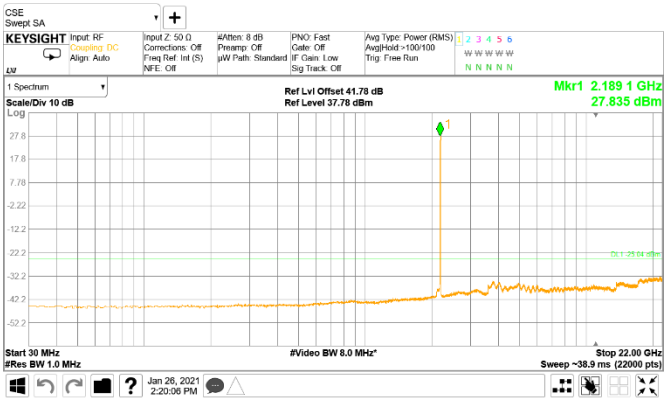

Figure 8.3-9: *Conducted spurious emissions of 15 MHz top channel, single carrier operation*

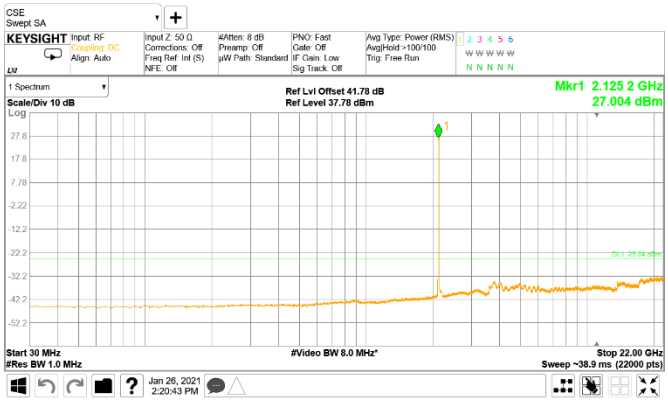

Figure 8.3-10: *Conducted spurious emissions of 20 MHz low channel, single carrier operation*

Test data, continued

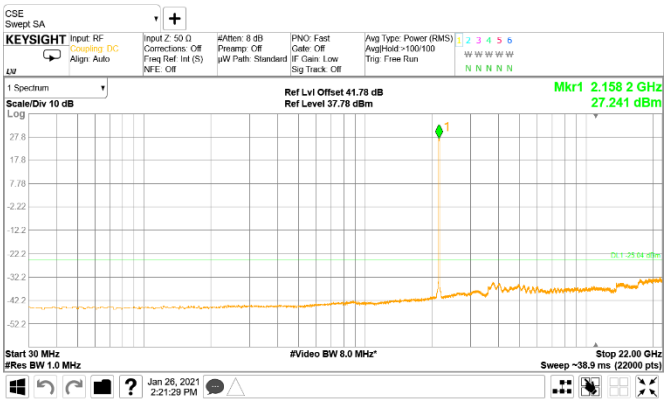

Figure 8.3-11: *Conducted spurious emissions of 20 MHz mid channel, single carrier operation*

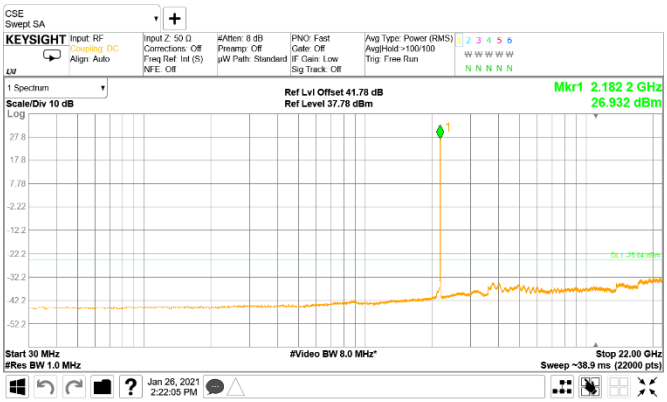

Figure 8.3-12: *Conducted spurious emissions of 20 MHz top channel, single carrier operation*

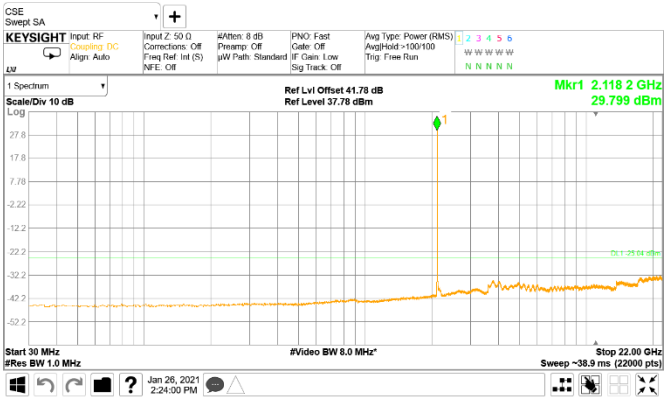

Figure 8.3-13: *Conducted spurious emissions of 5 MHz two low channels, two-carrier operation*

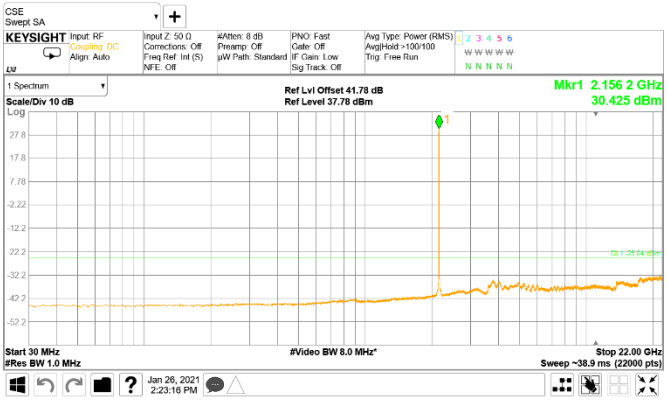

Figure 8.3-14: *Conducted spurious emissions of 5 MHz two mid channels, two-carrier operation*

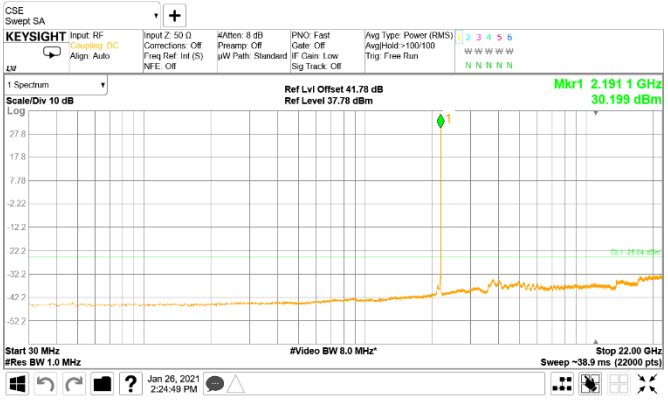

Figure 8.3-15: *Conducted spurious emissions of 5 MHz two top channels, two-carrier operation*

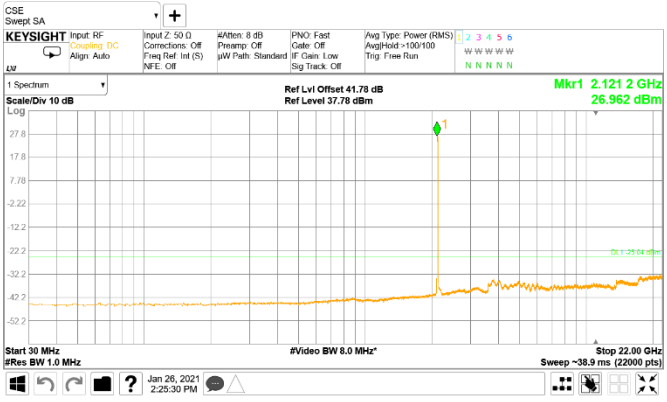

Figure 8.3-16: *Conducted spurious emissions of 10 MHz two low channels, two-carrier operation*

Test data, continued

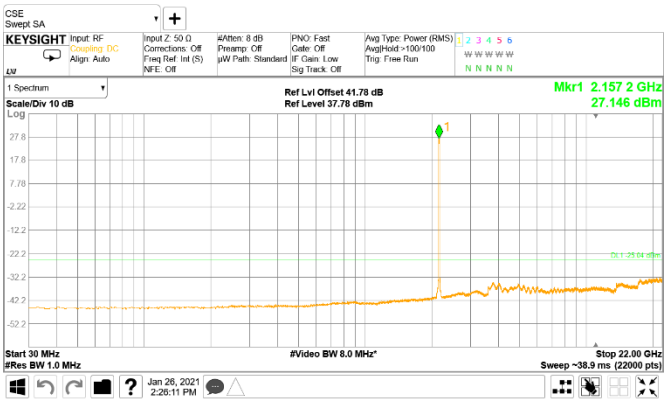

Figure 8.3-17: *Conducted spurious emissions of 10 MHz two mid channels, two-carrier operation*

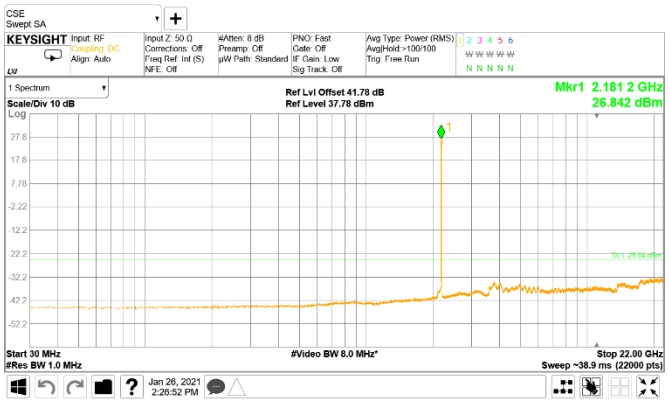

Figure 8.3-18: *Conducted spurious emissions of 10 MHz two top channels, two-carrier operation*

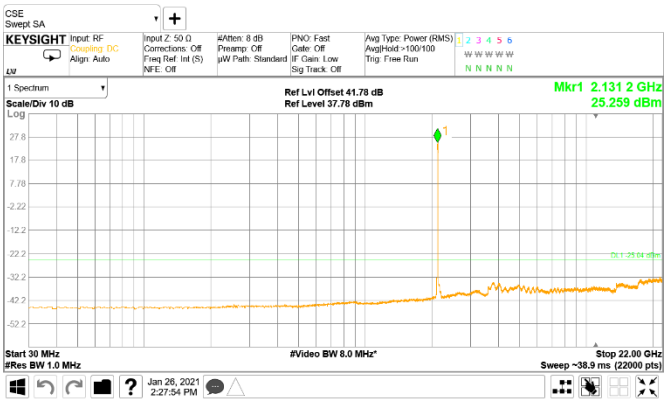

Figure 8.3-19: *Conducted spurious emissions of 15 MHz two low channels, two-carrier operation*

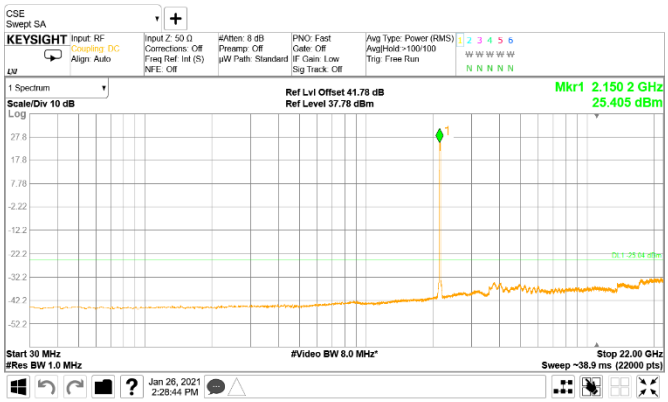

Figure 8.3-20: *Conducted spurious emissions of 15 MHz two mid channels, two-carrier operation*

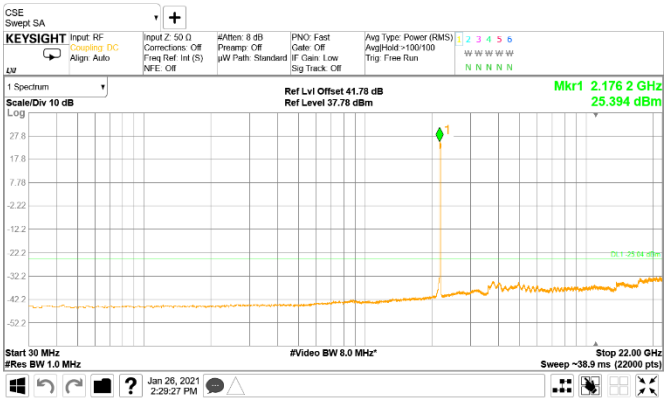

Figure 8.3-21: *Conducted spurious emissions of 15 MHz two top channels, two-carrier operation*

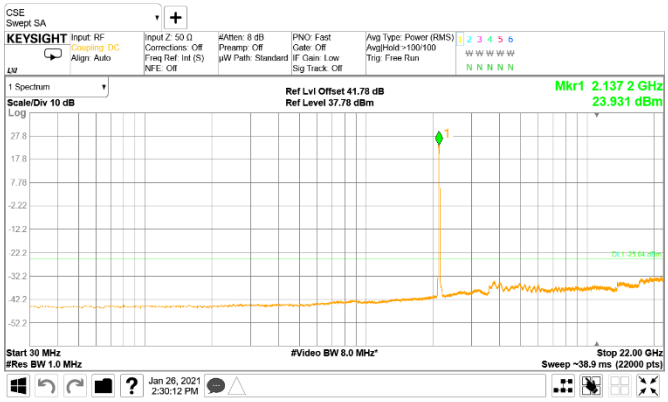

Figure 8.3-22: *Conducted spurious emissions of 20 MHz two low channels, two-carrier operation*

Test data, continued

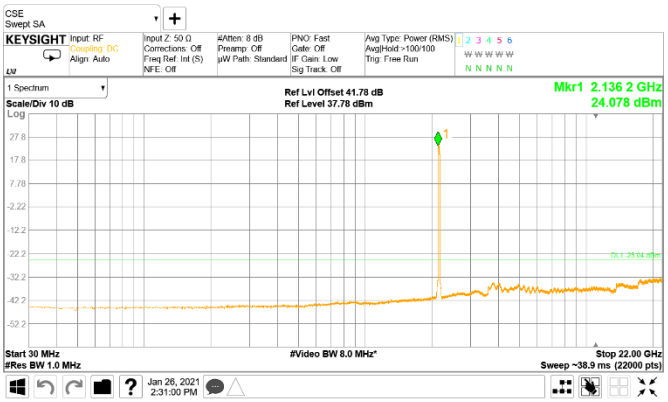

Figure 8.3-23: *Conducted spurious emissions of 20 MHz two mid channels, two-carrier operation*

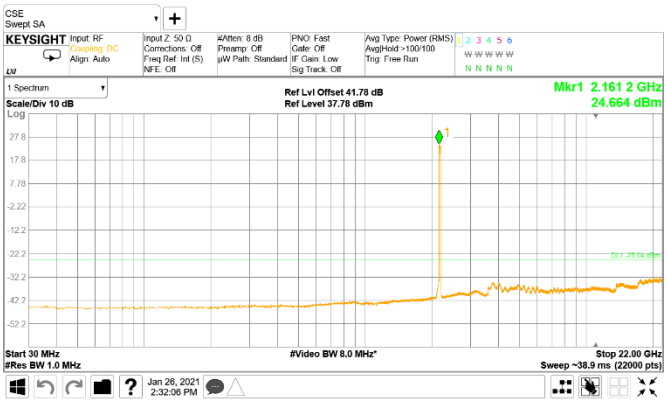

Figure 8.3-24: *Conducted spurious emissions of 20 MHz two top channels, two-carrier operation*

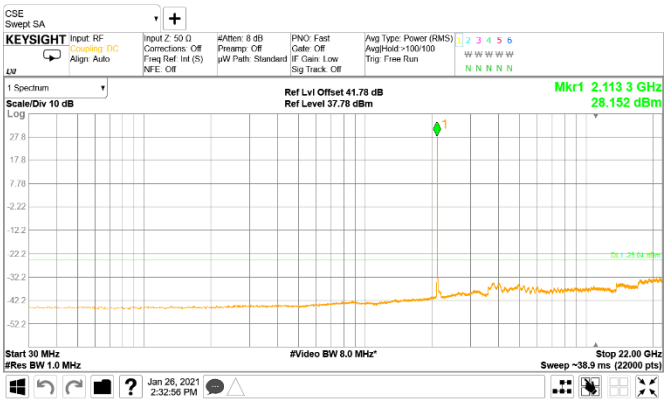

Figure 8.3-25: *Conducted spurious emissions of 5 MHz three low channels, three-carrier operation*

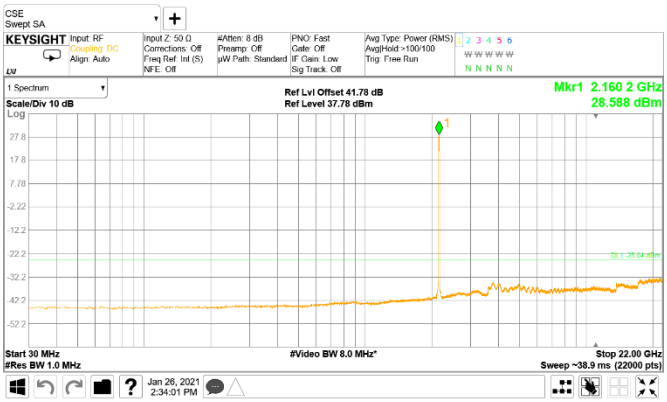

Figure 8.3-26: *Conducted spurious emissions of 5 MHz three mid channels, three-carrier operation*

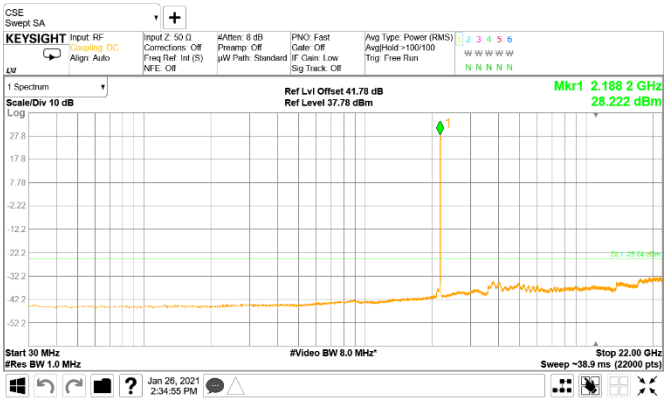

Figure 8.3-27: *Conducted spurious emissions of 5 MHz three top channels, three-carrier operation*

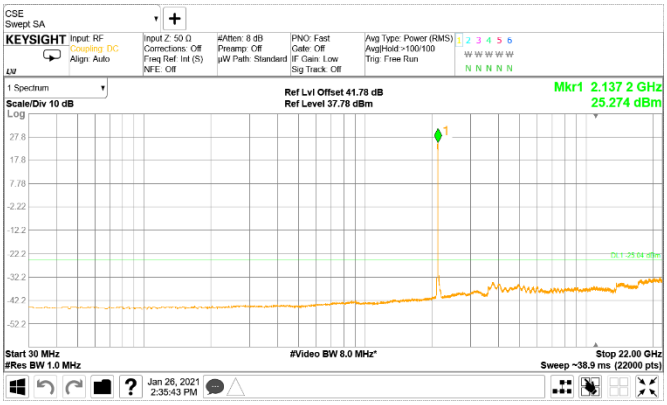

Figure 8.3-28: *Conducted spurious emissions of 10 MHz three low channels, three-carrier operation*

Test data, continued

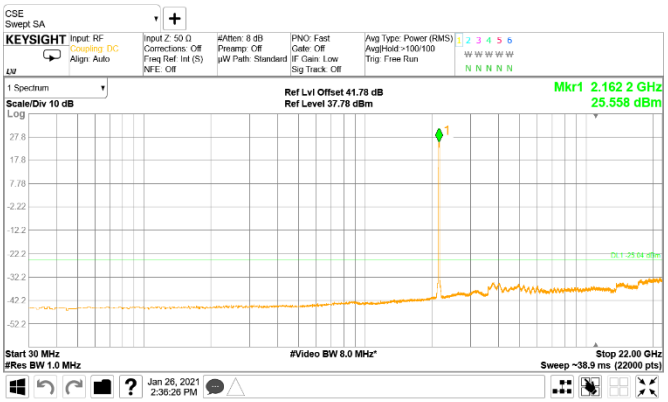

Figure 8.3-29: *Conducted spurious emissions of 10 MHz three mid channels, three-carrier operation*

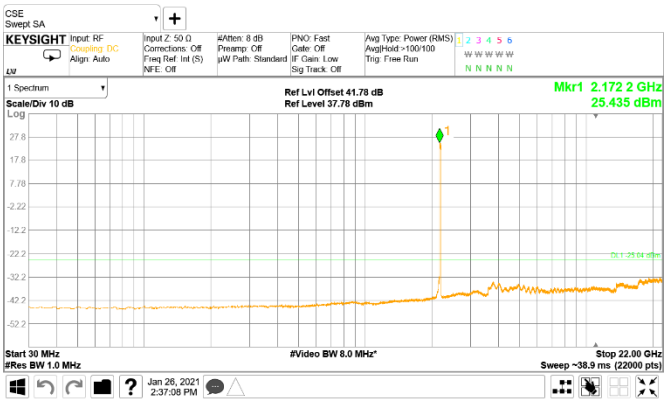

Figure 8.3-30: *Conducted spurious emissions of 10 MHz three top channels, three-carrier operation*

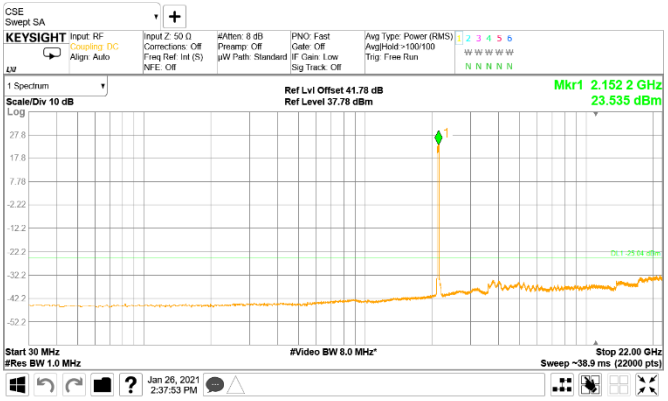

Figure 8.3-31: *Conducted spurious emissions of 15 MHz three low channels, three-carrier operation*

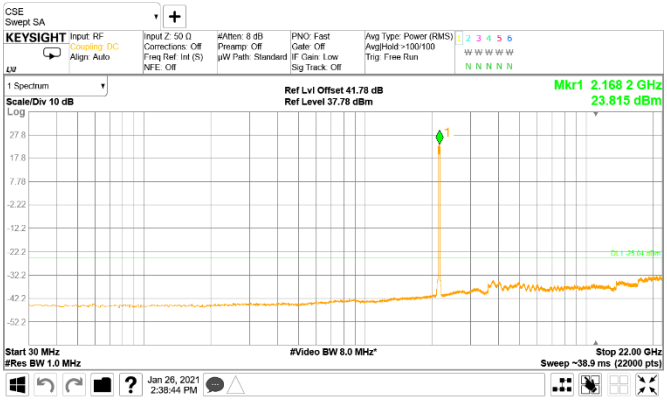

Figure 8.3-32: *Conducted spurious emissions of 15 MHz three mid channels, three-carrier operation*

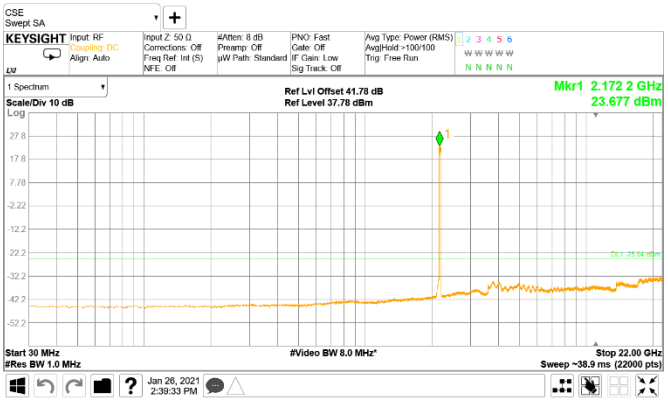

Figure 8.3-33: *Conducted spurious emissions of 15 MHz three top channels, three-carrier operation*

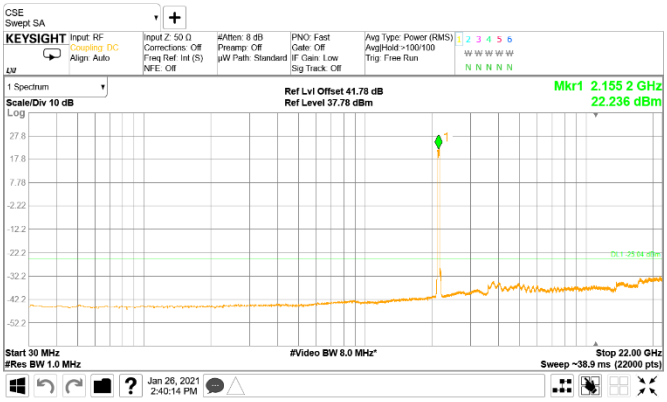

Figure 8.3-34: *Conducted spurious emissions of 20 MHz three low channels, three-carrier operation*