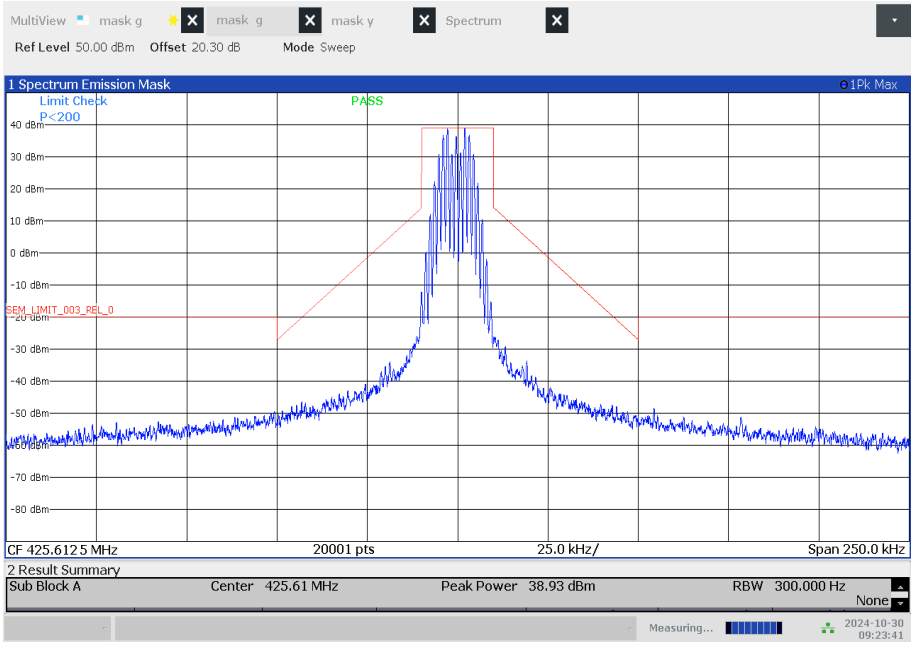
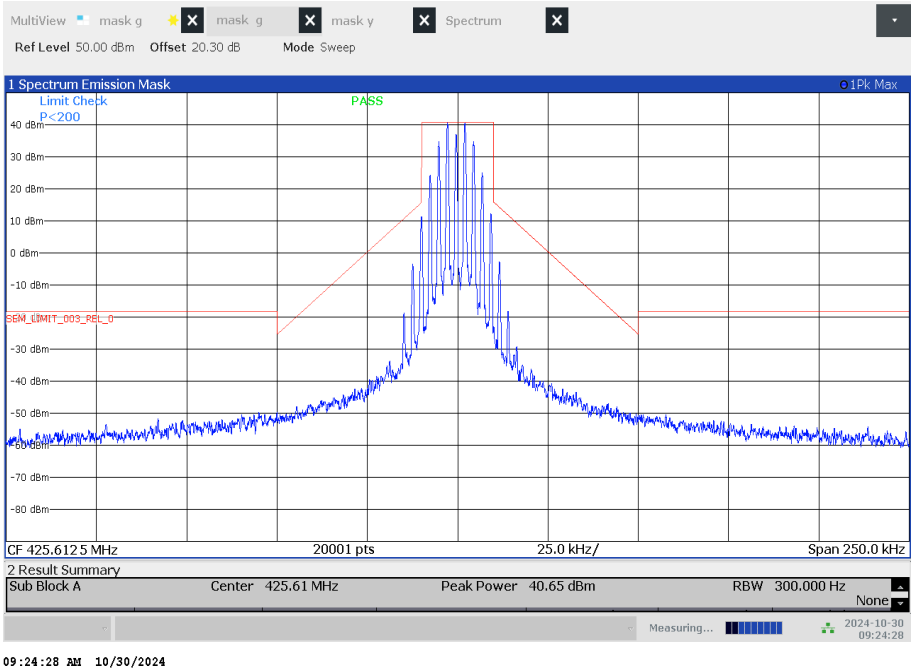
Plot 3: Emission mask G, tx @425.6125 MHz / 2400 bits per second – high power – carrier modulated

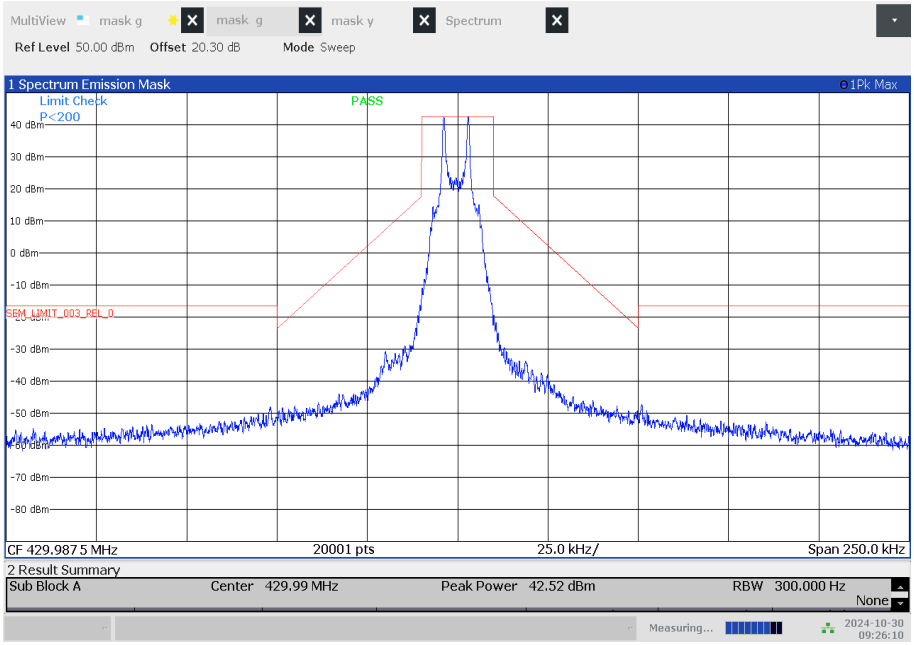


Plot 4: Emission mask G, tx @425.6125 MHz / 4800 bits per second – high power – carrier modulated

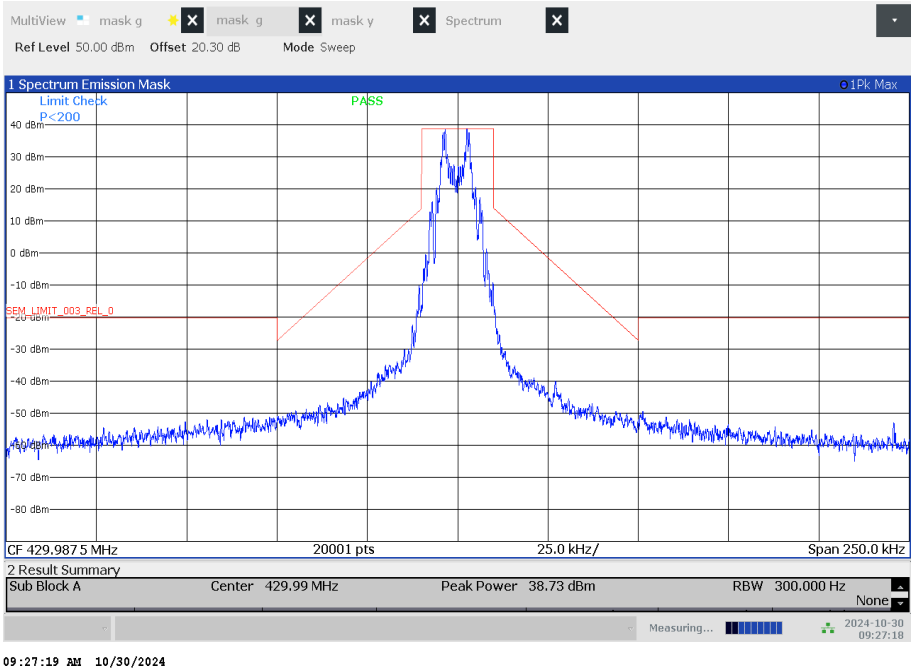


Plots 429.9875 MHz

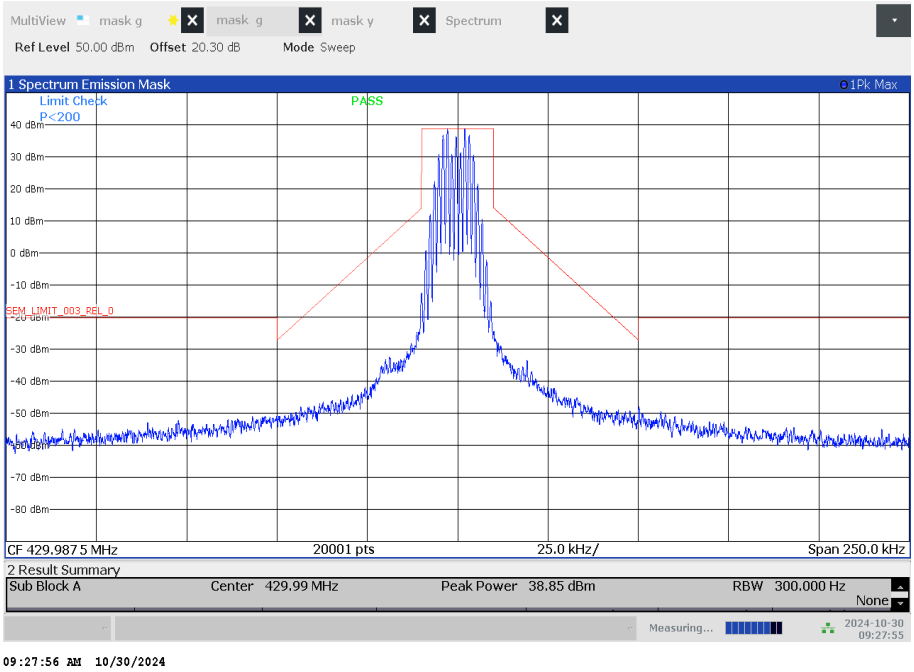
Plot 1: Emission mask G, tx @429.9875 MHz / 512 bits per second – high power – carrier modulated



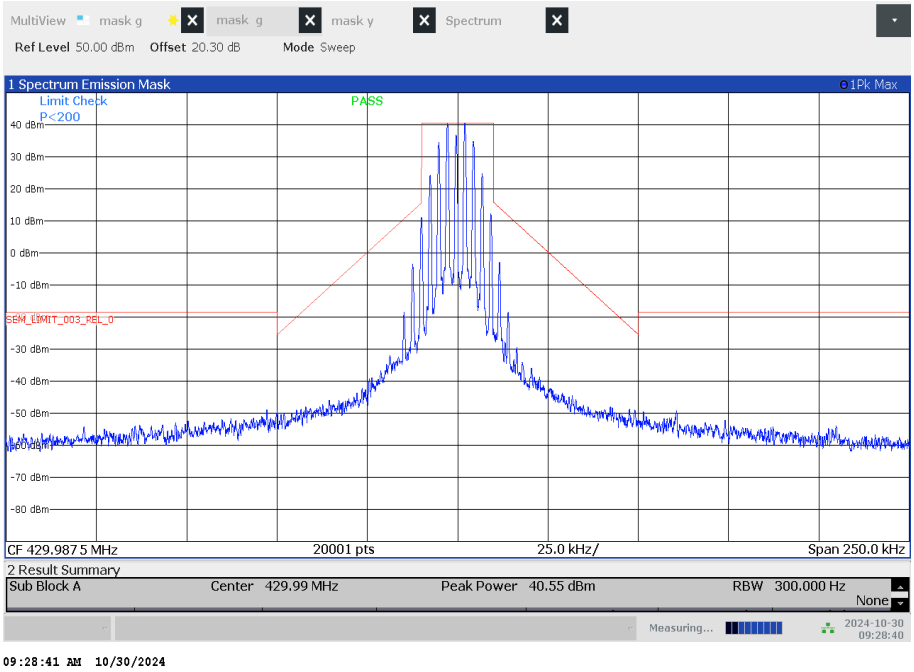
Plot 2: Emission mask G, tx @429.9875 MHz / 1200 bits per second – high power – carrier modulated



Plot 3: Emission mask G, tx @429.9875 MHz / 2400 bits per second – high power – carrier modulated

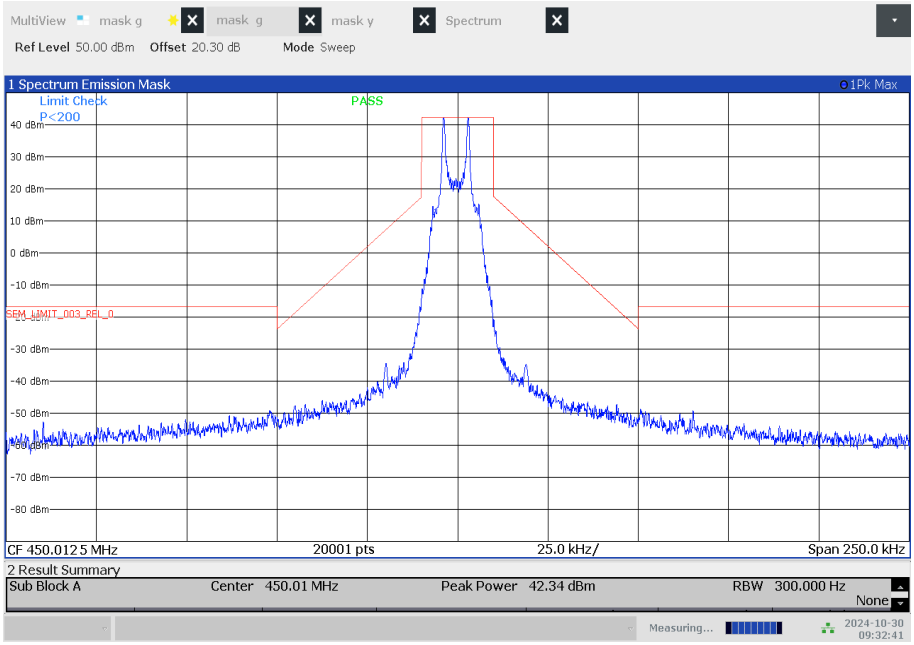


Plot 4: Emission mask G, tx @429.9875 MHz / 4800 bits per second – high power – carrier modulated

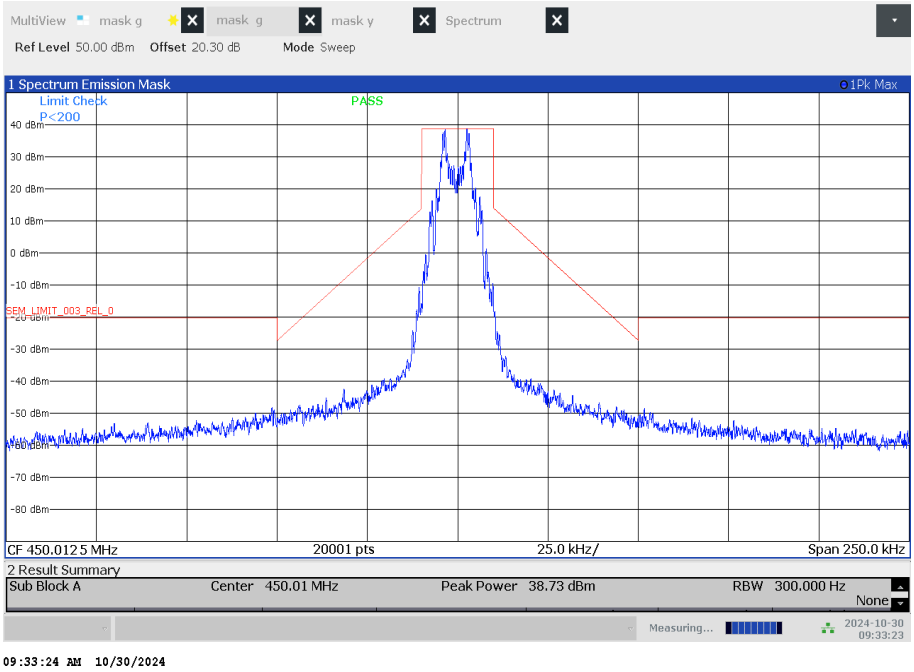


Plots 450.0125 MHz

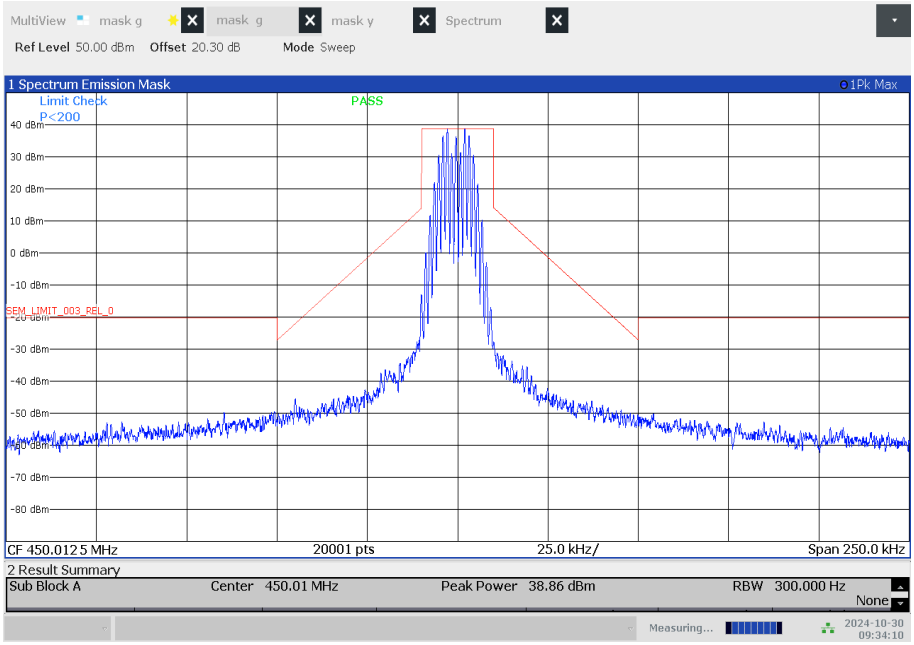
Plot 1: Emission mask G, tx @450.0125 MHz / 512 bits per second – high power – carrier modulated



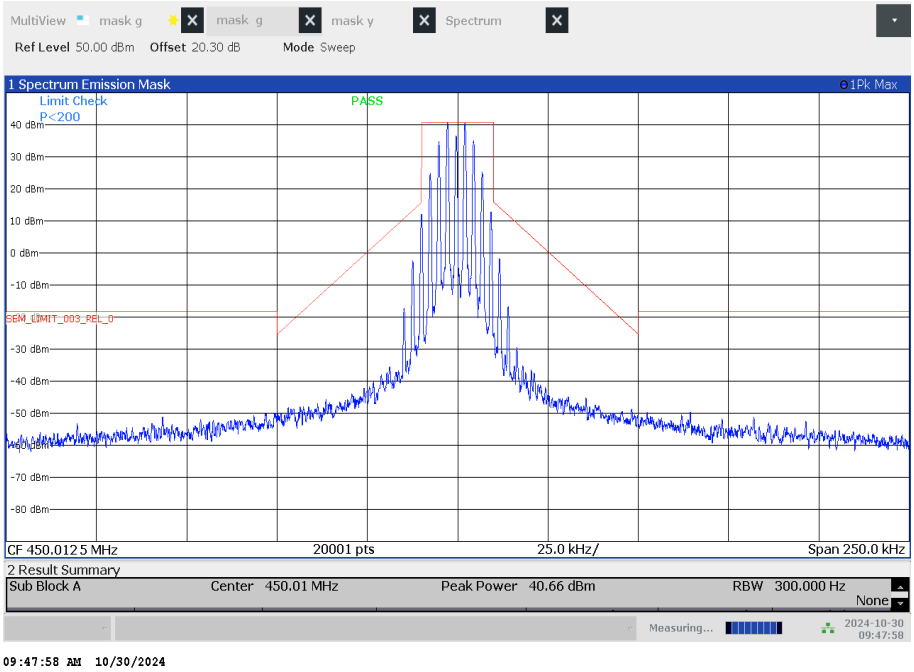
Plot 2: Emission mask G, tx @450.0125 MHz / 1200 bits per second – high power – carrier modulated



Plot 3: Emission mask G, tx @450.0125 MHz / 2400 bits per second – high power – carrier modulated

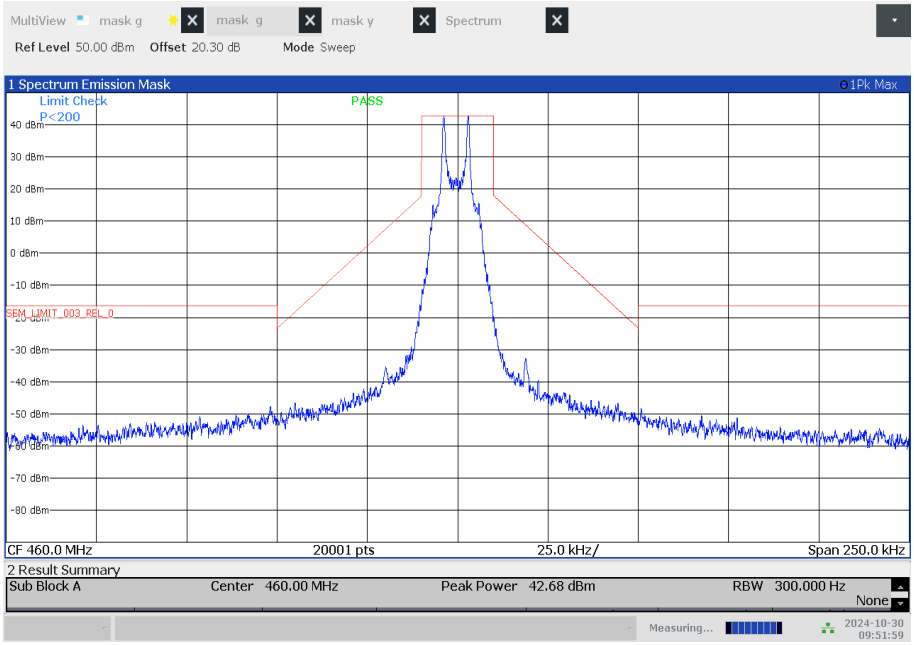


Plot 4: Emission mask G, tx @450.0125 MHz / 4800 bits per second – high power – carrier modulated

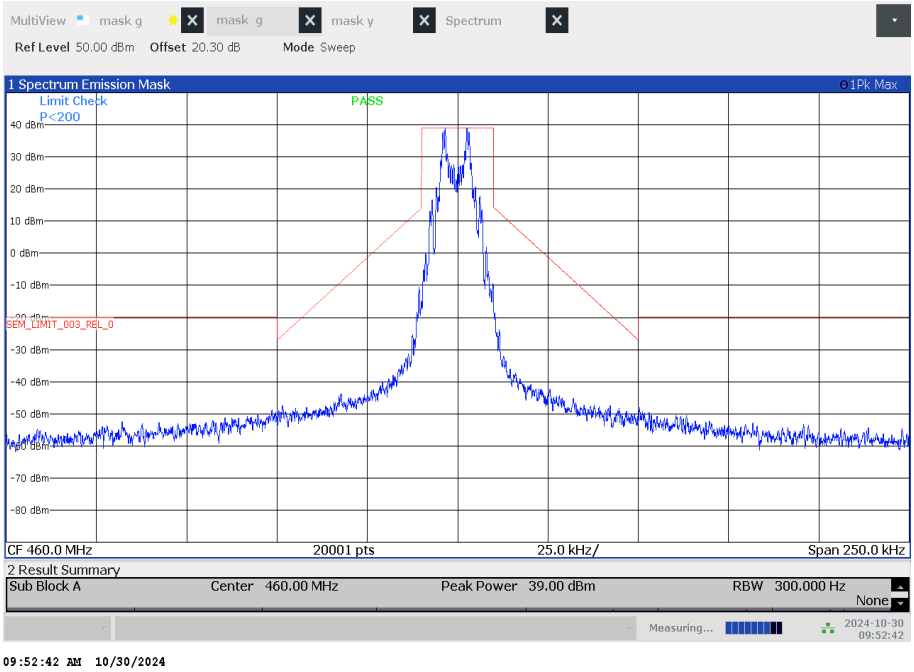


Plots 460.0 MHz

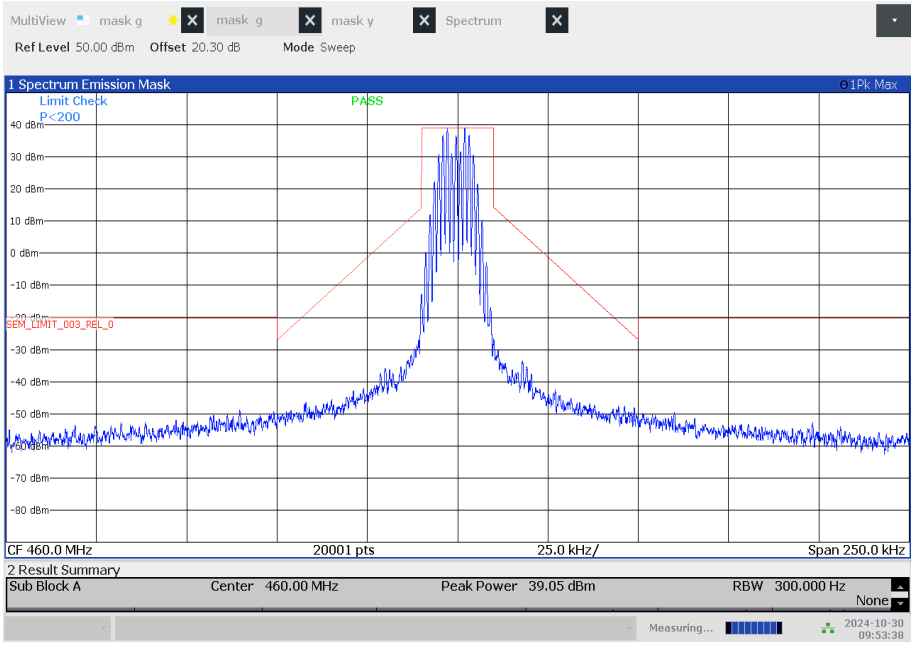
Plot 1: Emission mask G, tx @460.0 MHz / 512 bits per second – high power – carrier modulated



Plot 2: Emission mask G, tx @460.0 MHz / 1200 bits per second – high power – carrier modulated



Plot 3: Emission mask G, tx @460.0 MHz / 2400 bits per second – high power – carrier modulated



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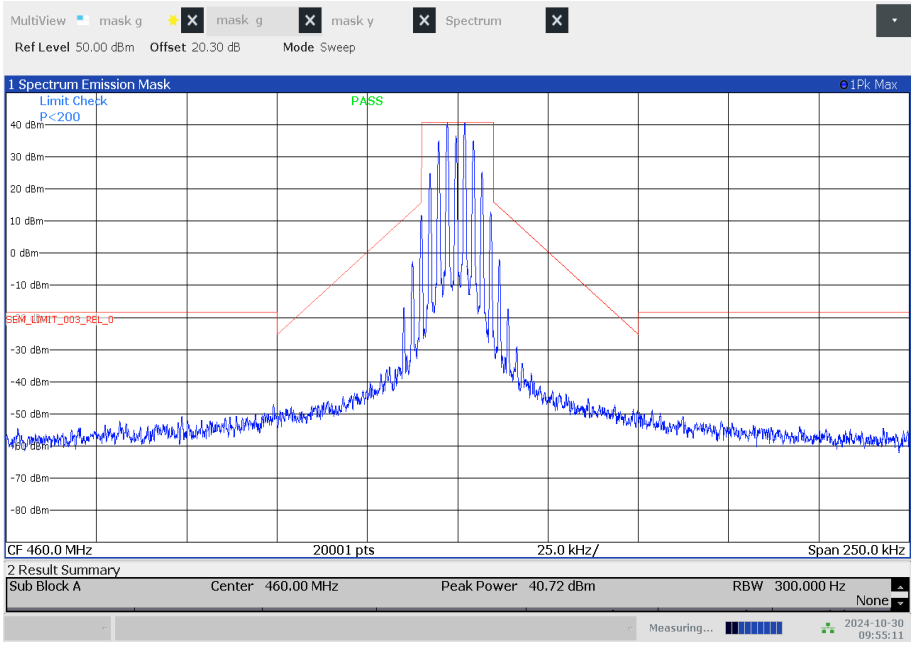
Plot 4: Emission mask G, tx @460.0 MHz / 4800 bits per second – high power – carrier modulated



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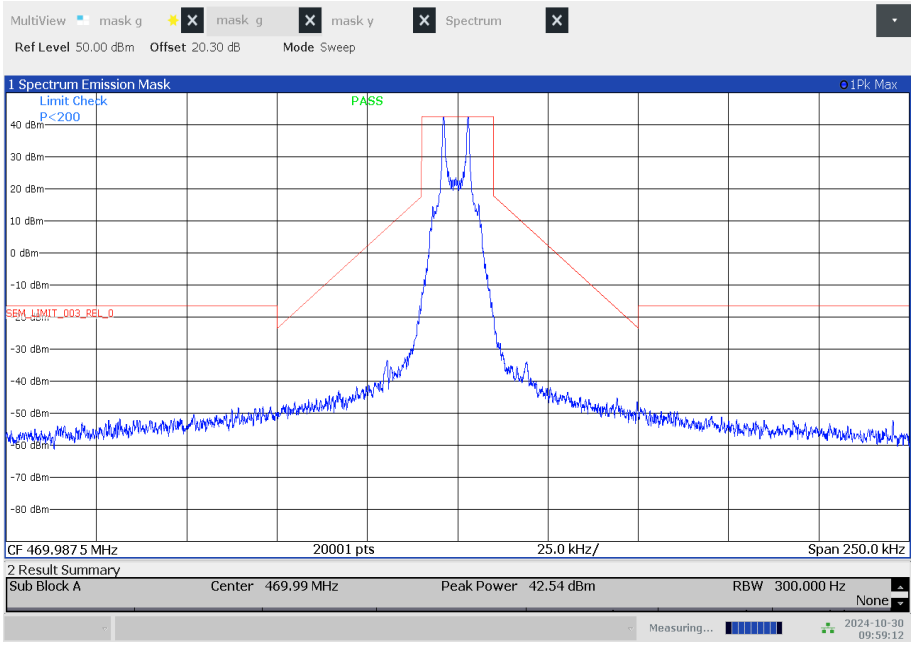
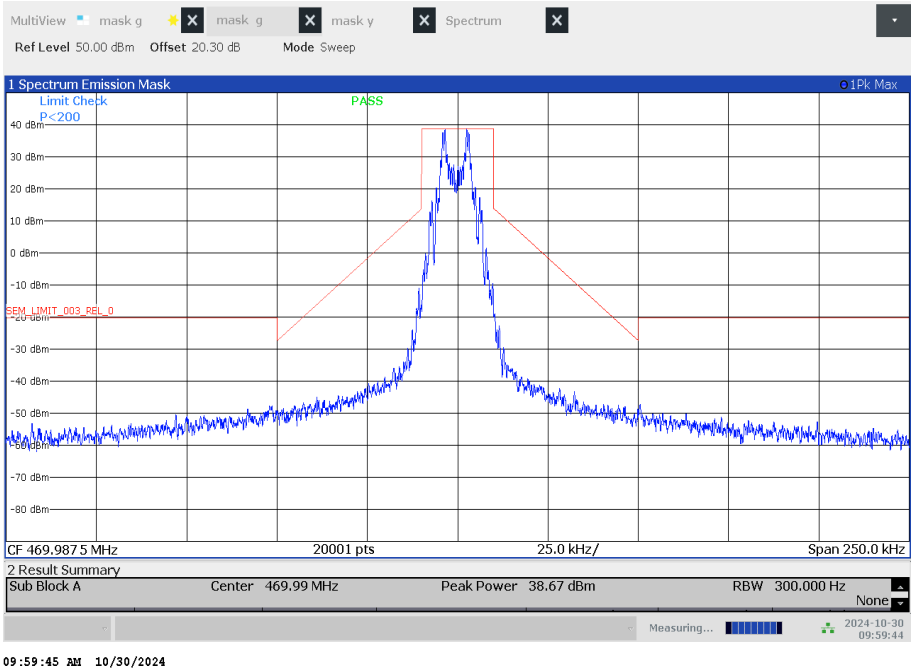
Plots 469.9875 MHz

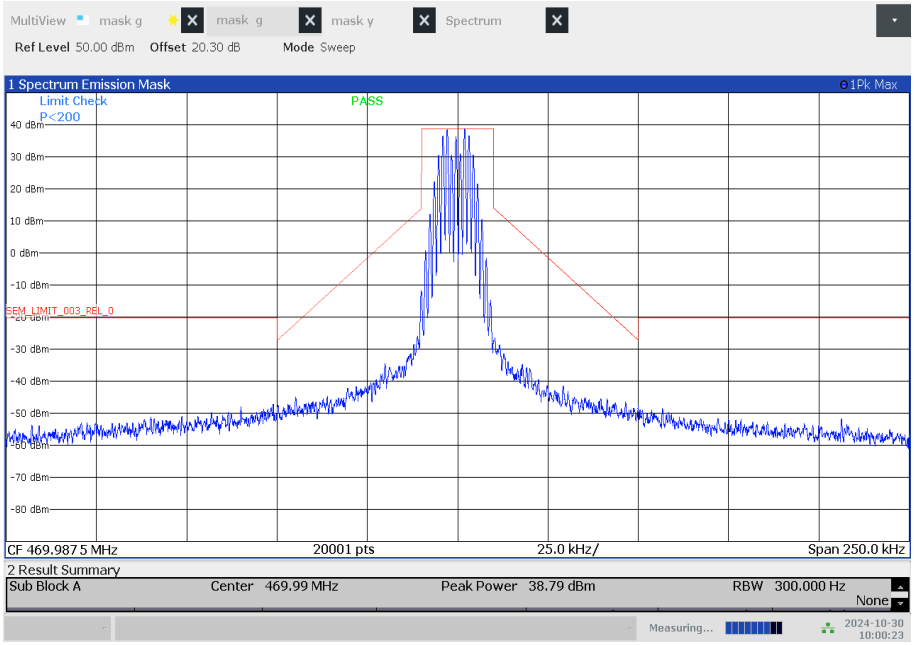
Plot 1: Emission mask G, tx @469.9875 MHz / 512 bits per second – high power – carrier modulated



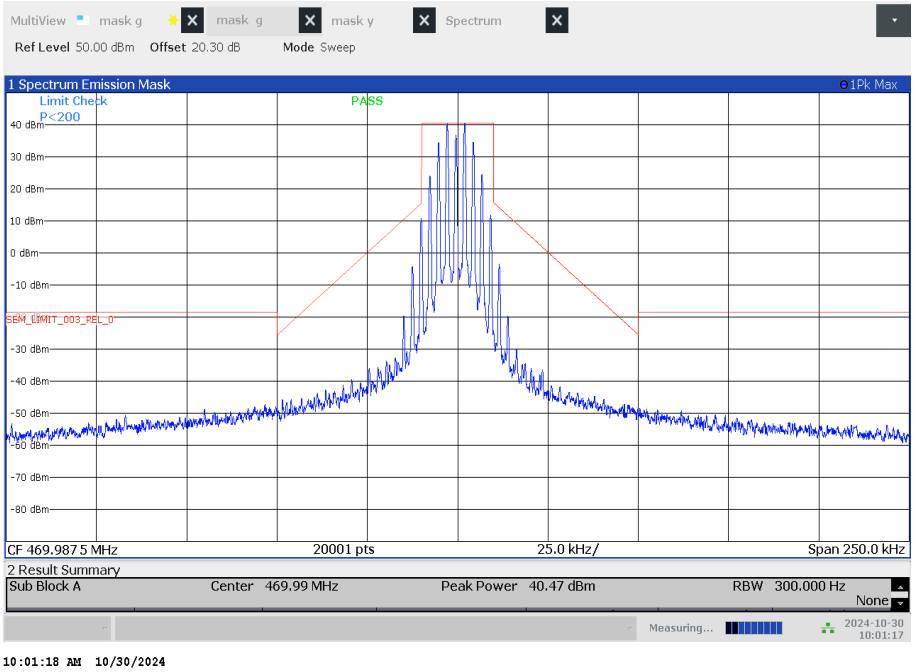
Plot 2: Emission mask G, tx @469.9875 MHz / 1200 bits per second – high power – carrier modulated



Plot 3: Emission mask G, tx @469.9875 MHz / 2400 bits per second – high power – carrier modulated



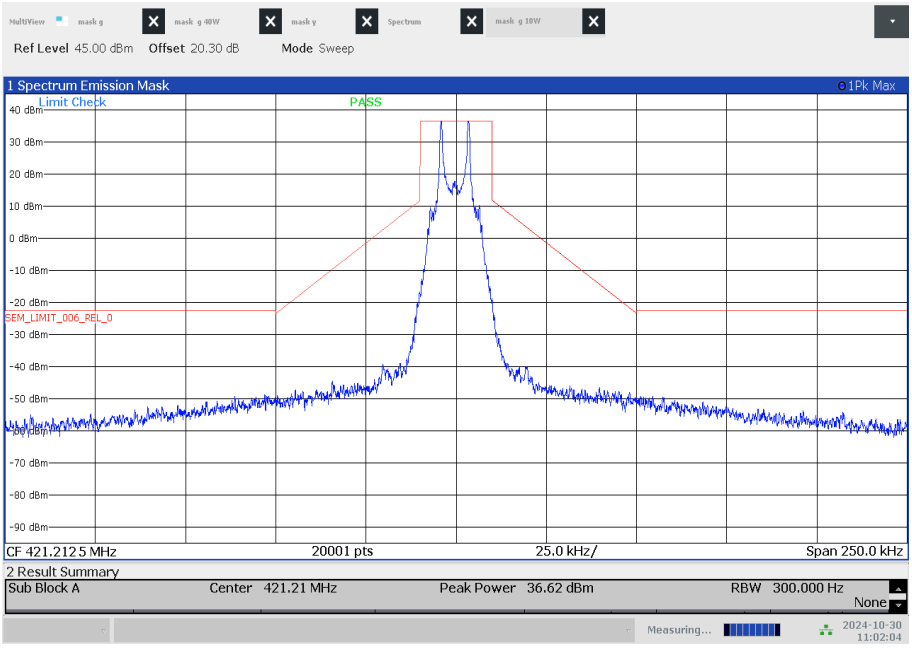
Plot 4: Emission mask G, tx @469.9875 MHz / 4800 bits per second – high power – carrier modulated



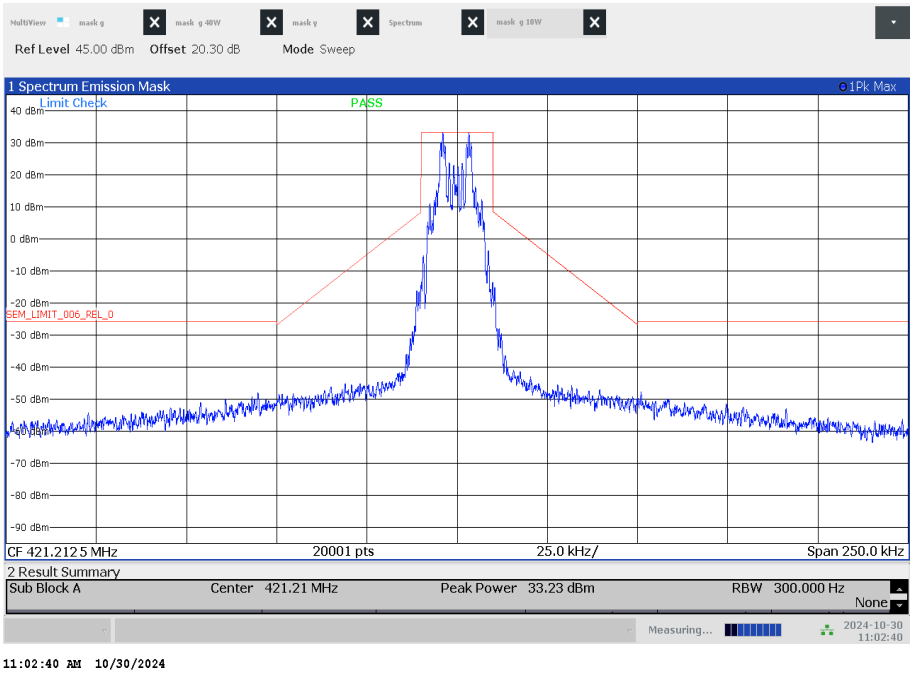
13.4.4 Spectrum masks 25 kHz bandwidth (Emission mask G)

Plots 421.2125 MHz

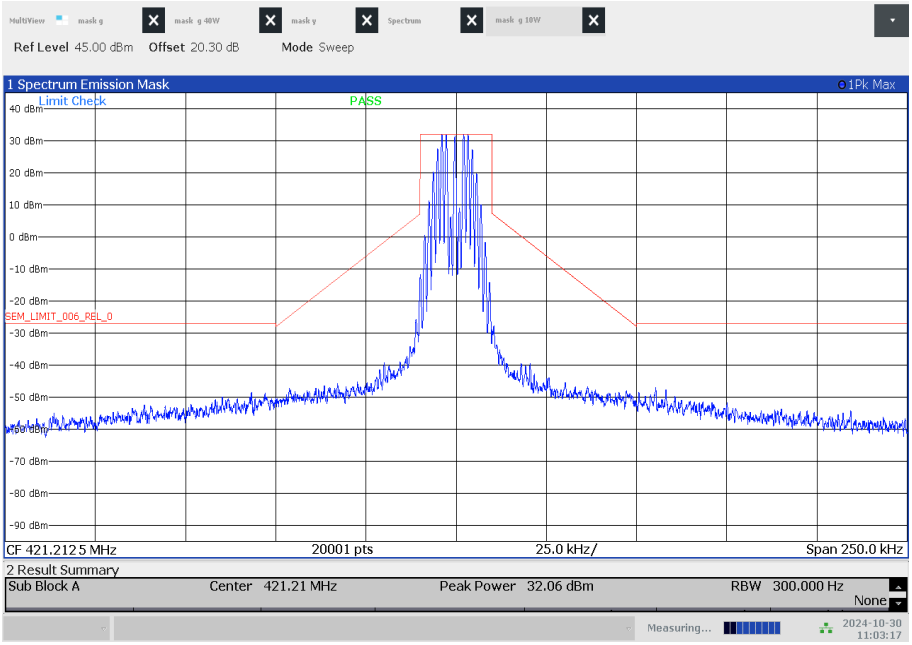
Plot 1: Emission mask G, tx @421.2125 MHz / 512 bits per second – low power – carrier modulated



Plot 2: Emission mask G, tx @421.2125 MHz / 1200 bits per second – low power – carrier modulated

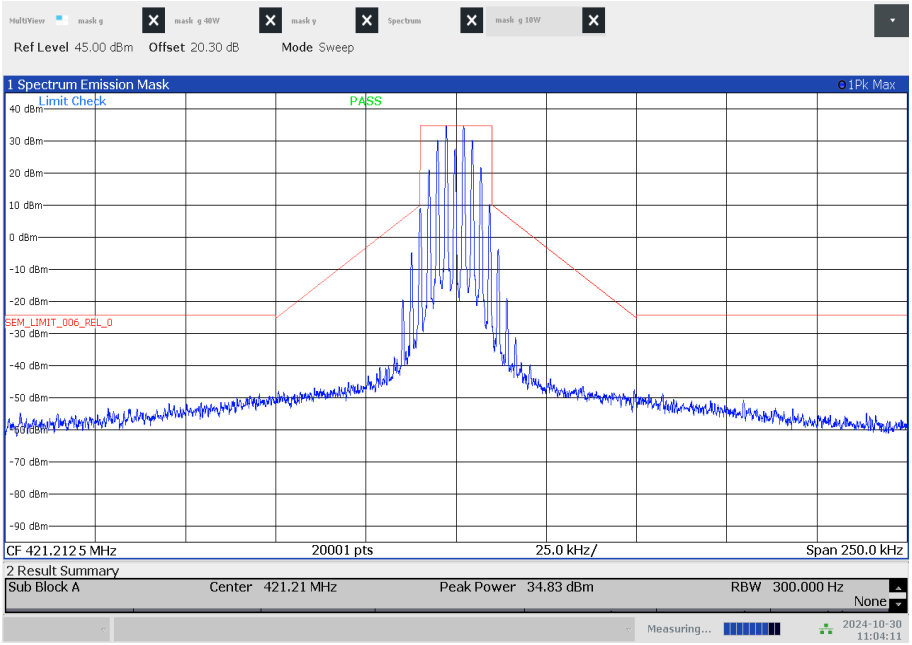


Plot 3: Emission mask G, tx @421.2125 MHz / 2400 bits per second – low power – carrier modulated



11:03:17 AM 10/30/2024

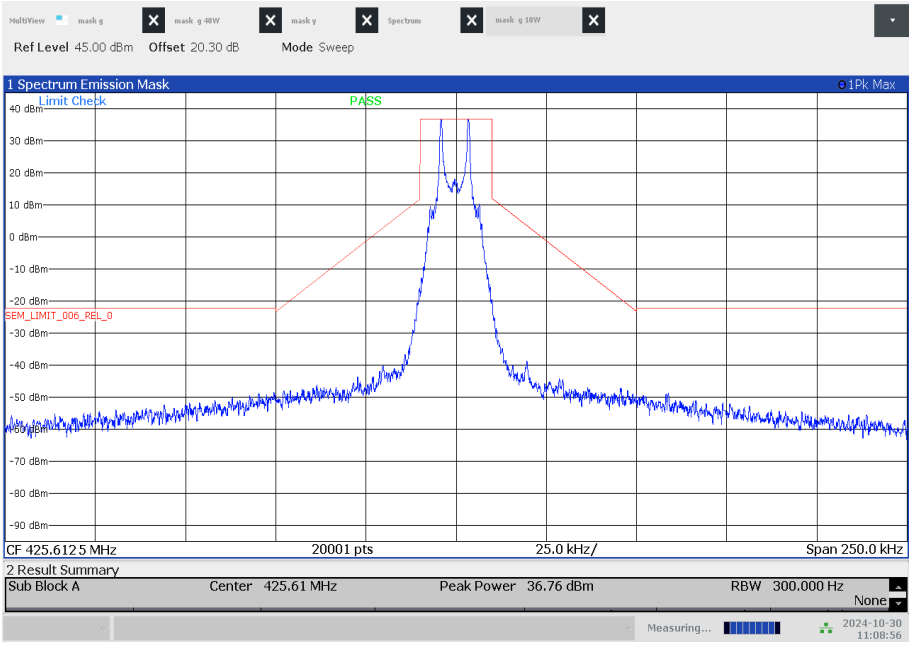
Plot 4: Emission mask G, tx @421.2125 MHz / 4800 bits per second – low power – carrier modulated



11:04:12 AM 10/30/2024

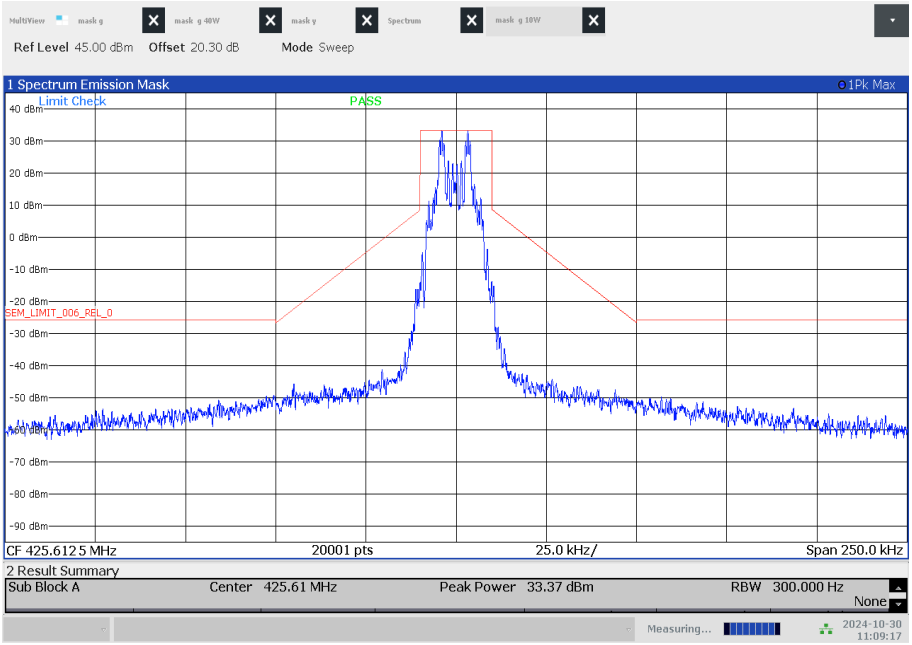
Plots 425.6125 MHz

Plot 1: Emission mask G, tx @425.6125 MHz / 512 bits per second – low power – carrier modulated



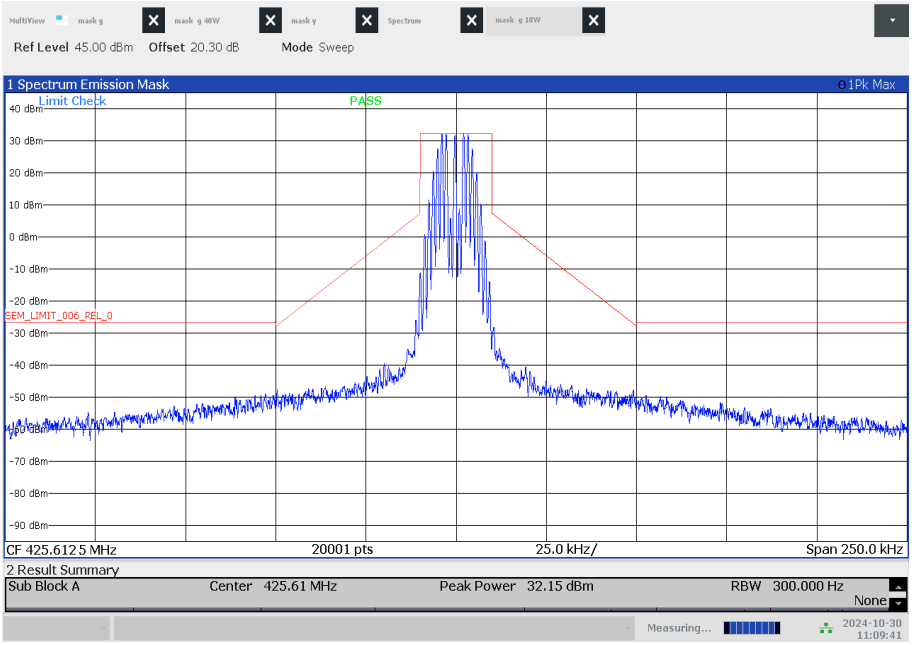
11:08:56 AM 10/30/2024

Plot 2: Emission mask G, tx @425.6125 MHz / 1200 bits per second – low power – carrier modulated

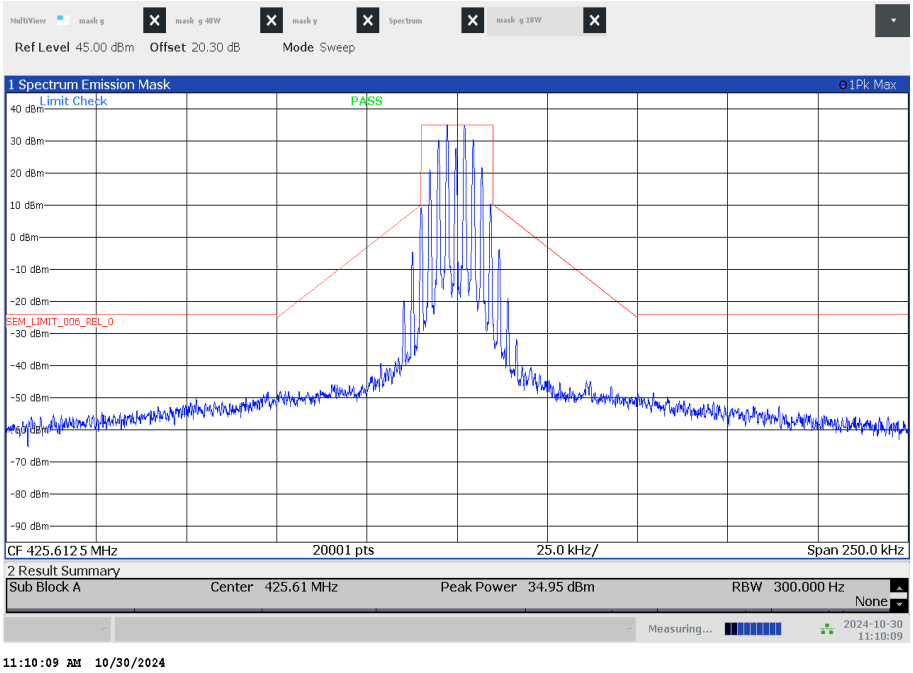


11:09:18 AM 10/30/2024

Plot 3: Emission mask G tx @425.6125 MHz / 2400 bits per second – low power – carrier modulated

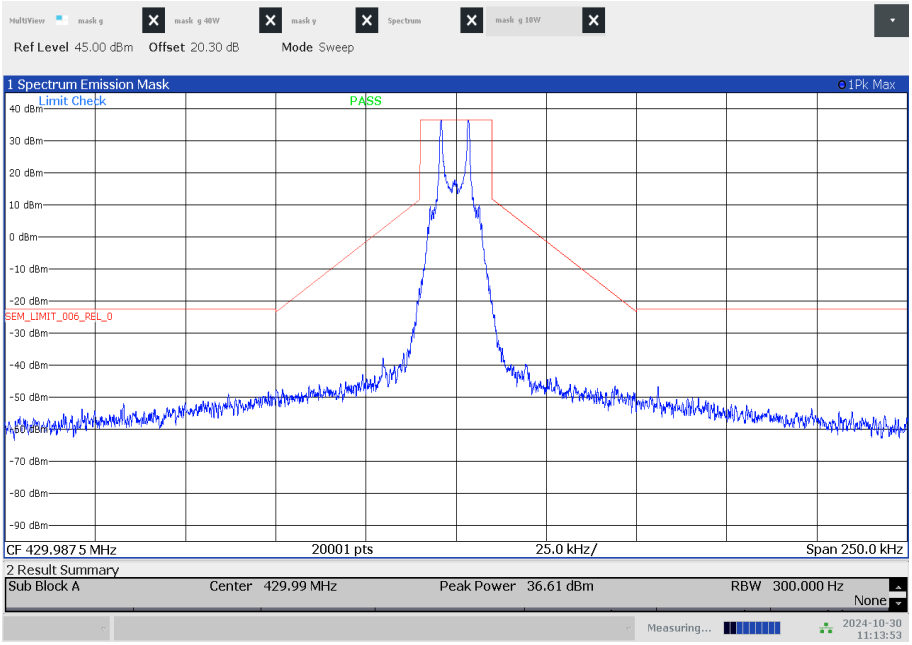


Plot 4: Emission mask G, tx @425.6125 MHz / 4800 bits per second – low power – carrier modulated

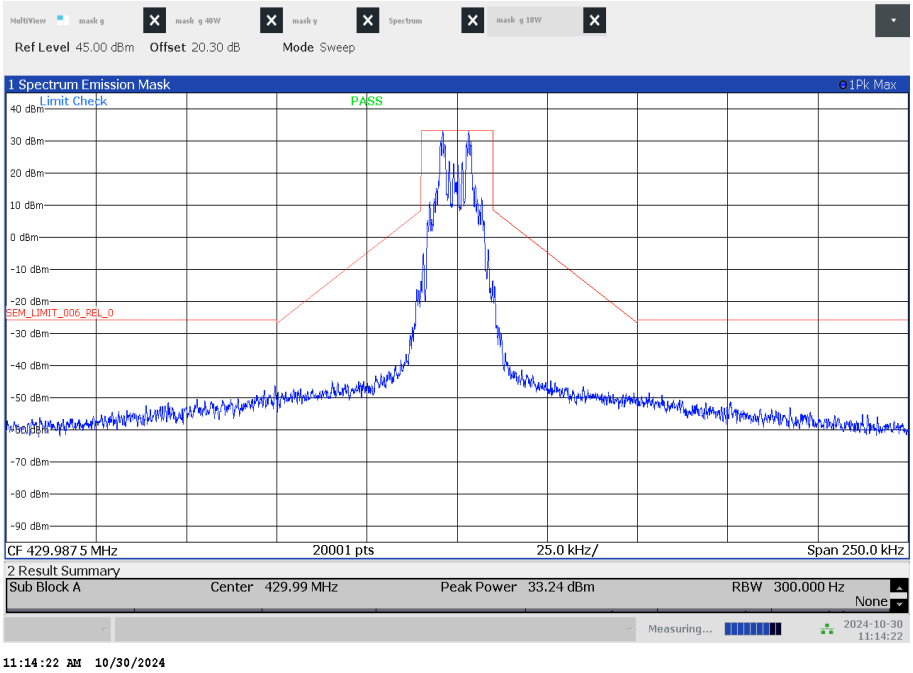


Plots 429.9875 MHz

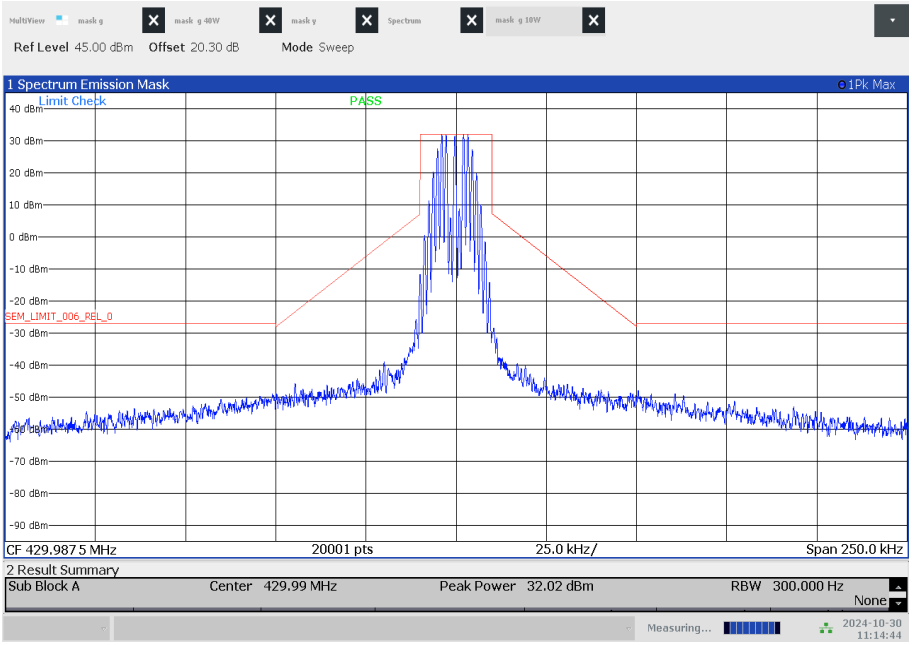
Plot 1: Emission mask G, tx @429.9875 MHz / 512 bits per second – low power – carrier modulated



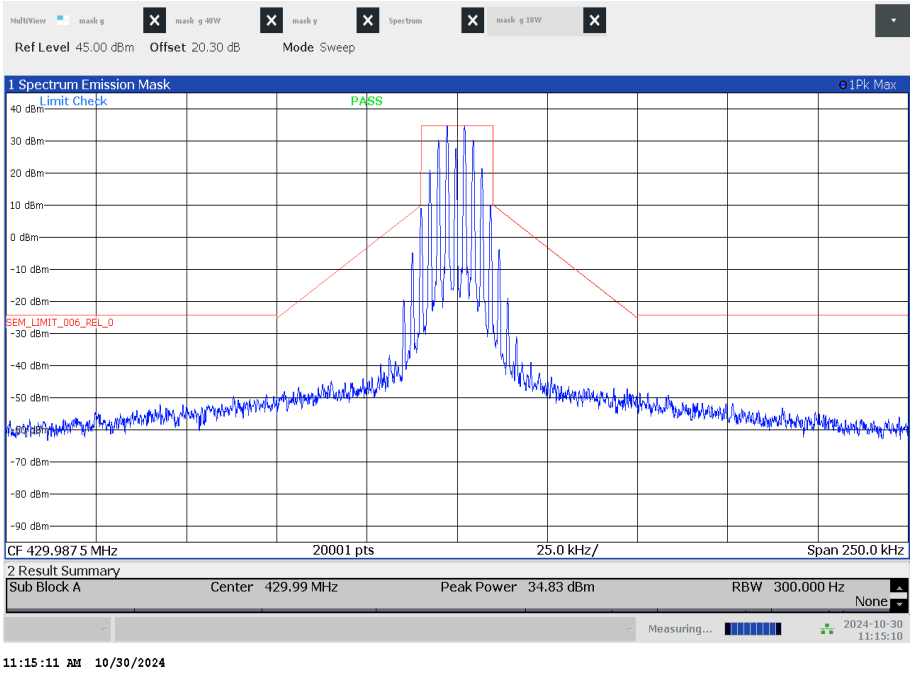
Plot 2: Emission mask G, tx @429.9875 MHz / 1200 bits per second – low power – carrier modulated



Plot 3: Emission mask G, tx @429.9875 MHz / 2400 bits per second – low power – carrier modulated

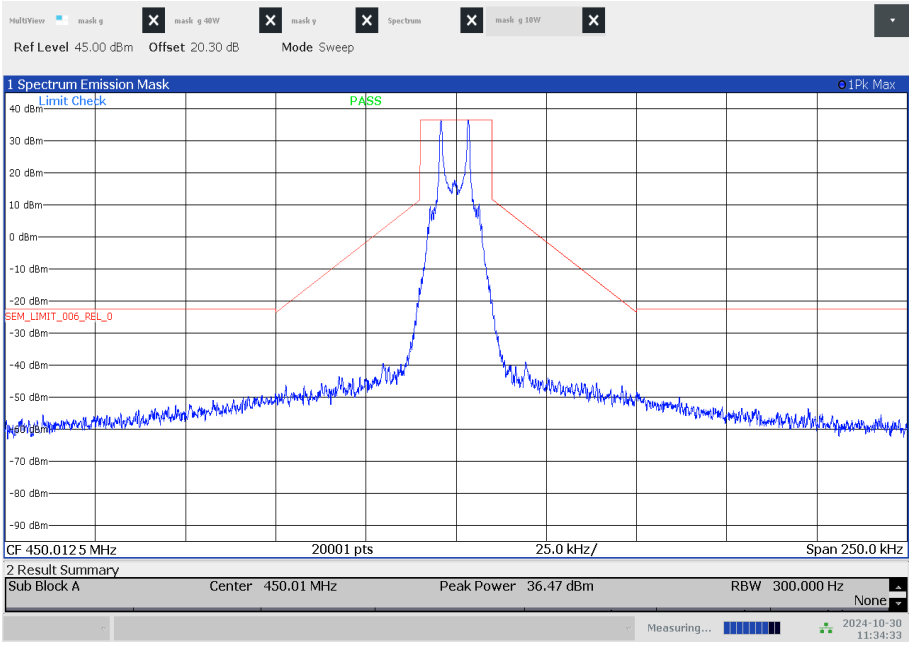


Plot 4: Emission mask G, tx @429.9875 MHz / 4800 bits per second – low power – carrier modulated

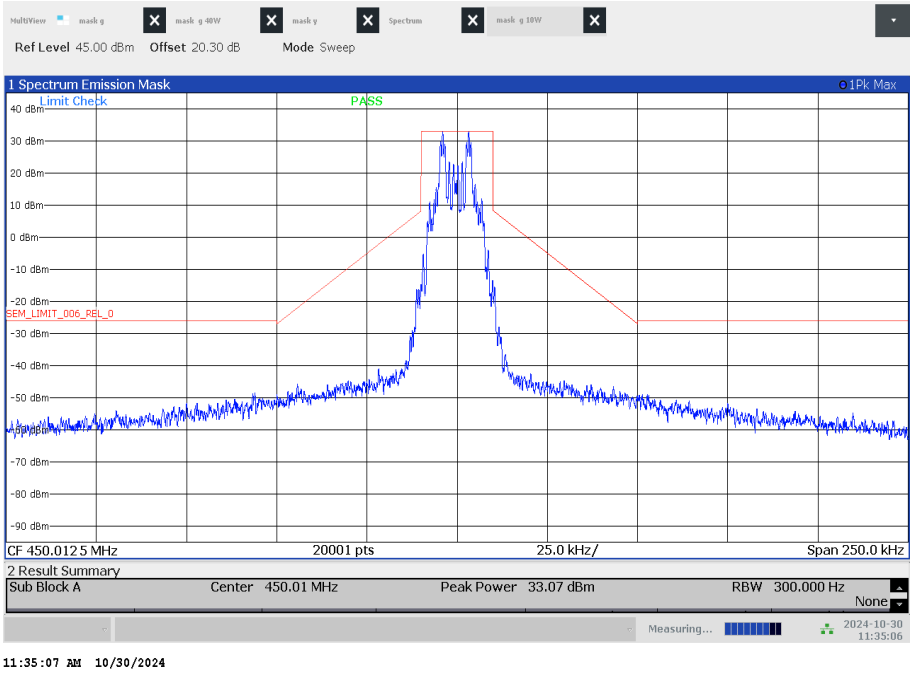


Plots 450.0125 MHz

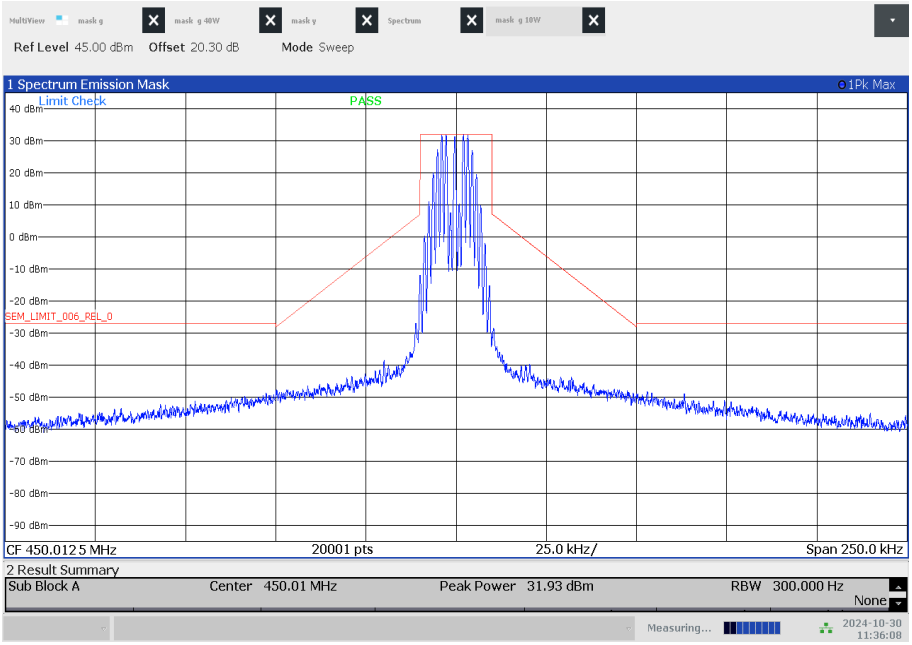
Plot 1: Emission mask G, tx @450.0125 MHz / 512 bits per second – low power – carrier modulated



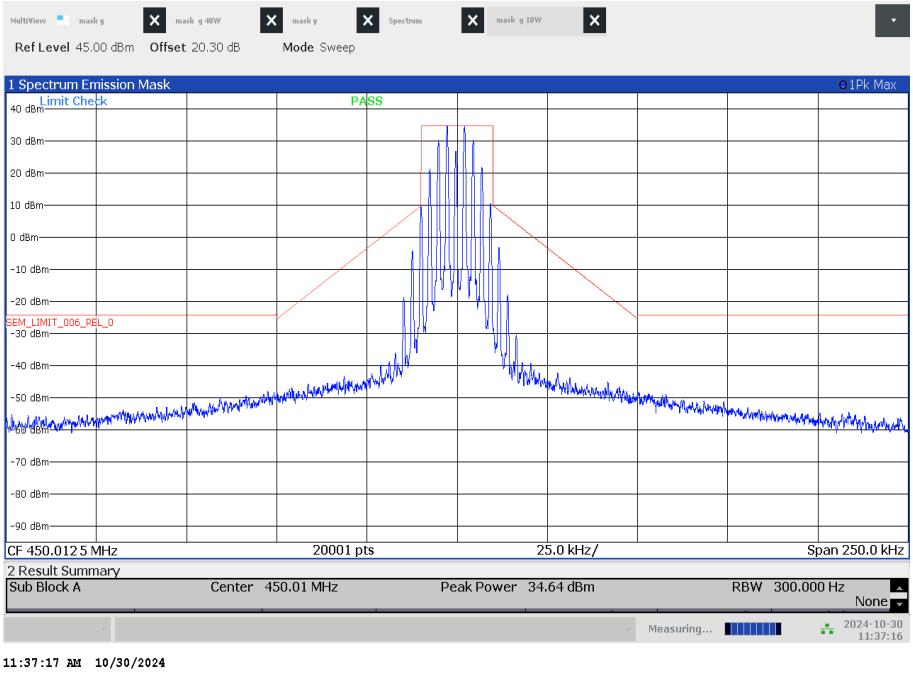
Plot 2: Emission mask G, tx @450.0125 MHz / 1200 bits per second – low power – carrier modulated



Plot 3: Emission mask G, tx @450.0125 MHz / 2400 bits per second – low power – carrier modulated

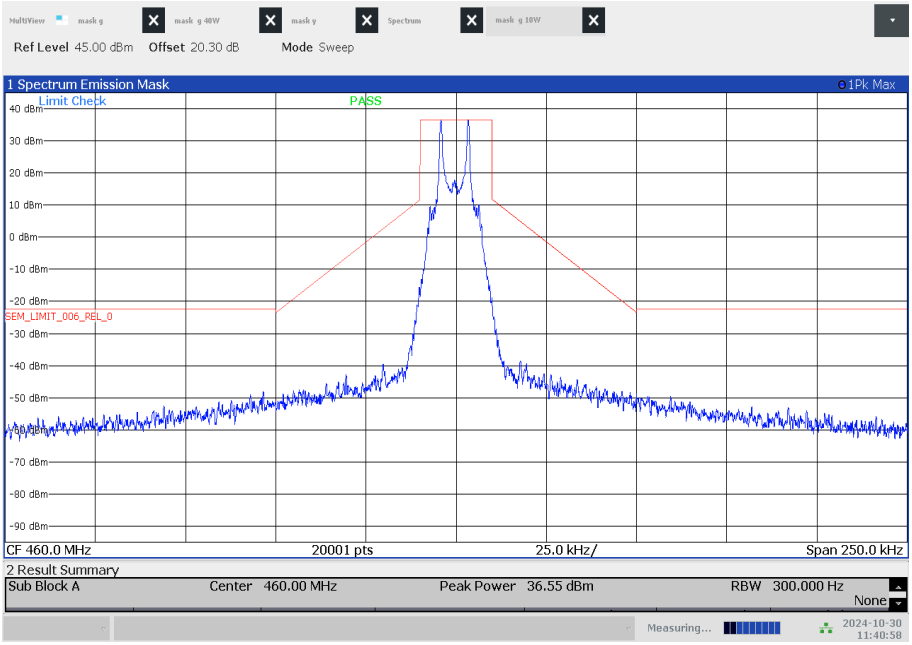


Plot 4: Emission mask G, tx @450.0125 MHz / 4800 bits per second – low power – carrier modulated

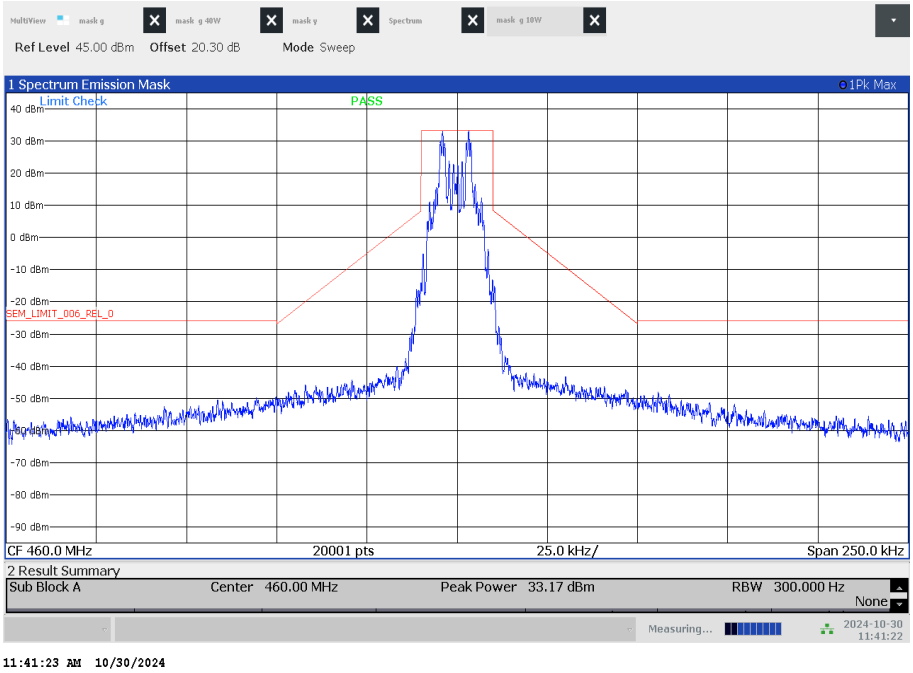


Plots 460.0 MHz

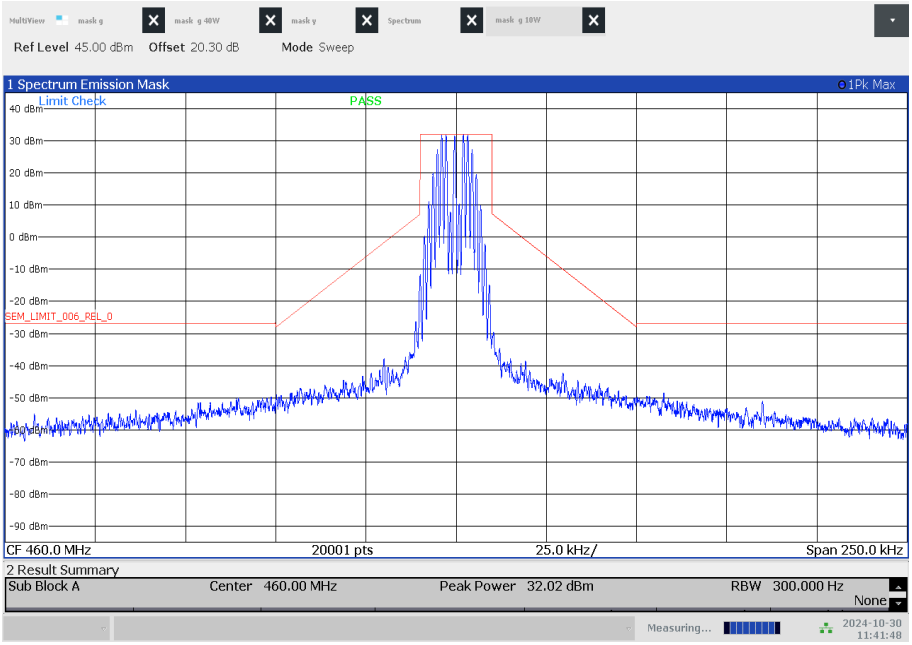
Plot 1: Emission mask G, tx @460.0 MHz / 512 bits per second – low power – carrier modulated



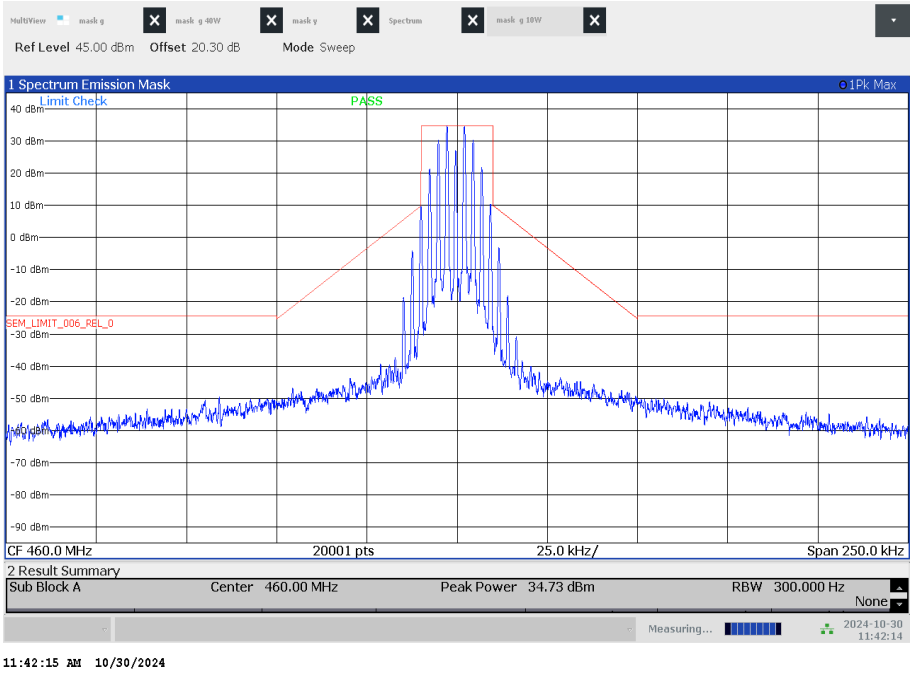
Plot 2: Emission mask G, tx @460.0 MHz / 1200 bits per second – low power – carrier modulated



Plot 3: Emission mask G, tx @460.0 MHz / 2400 bits per second – low power – carrier modulated

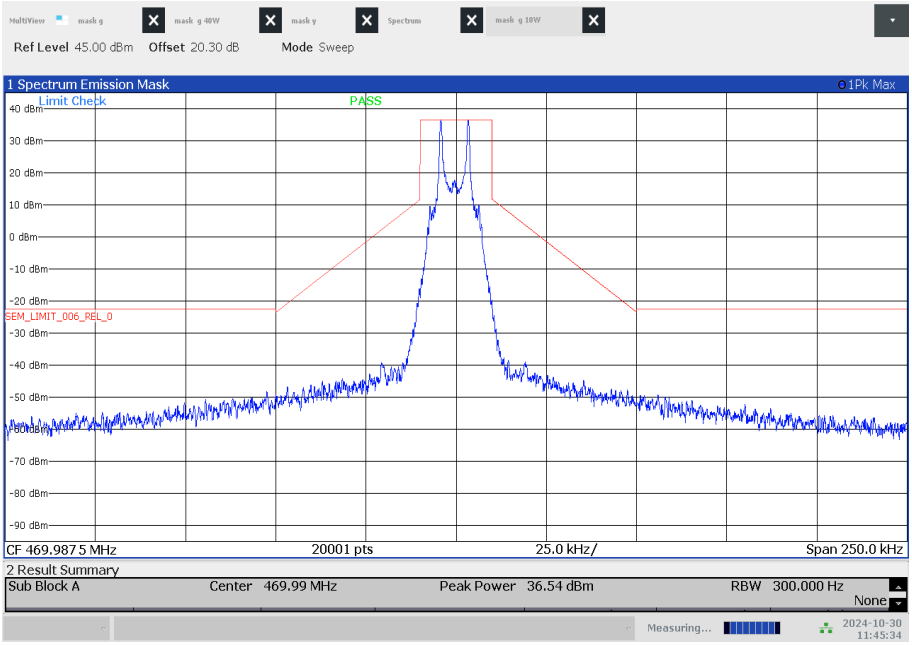


Plot 4: Emission mask G, tx @460.0 MHz / 4800 bits per second – low power – carrier modulated



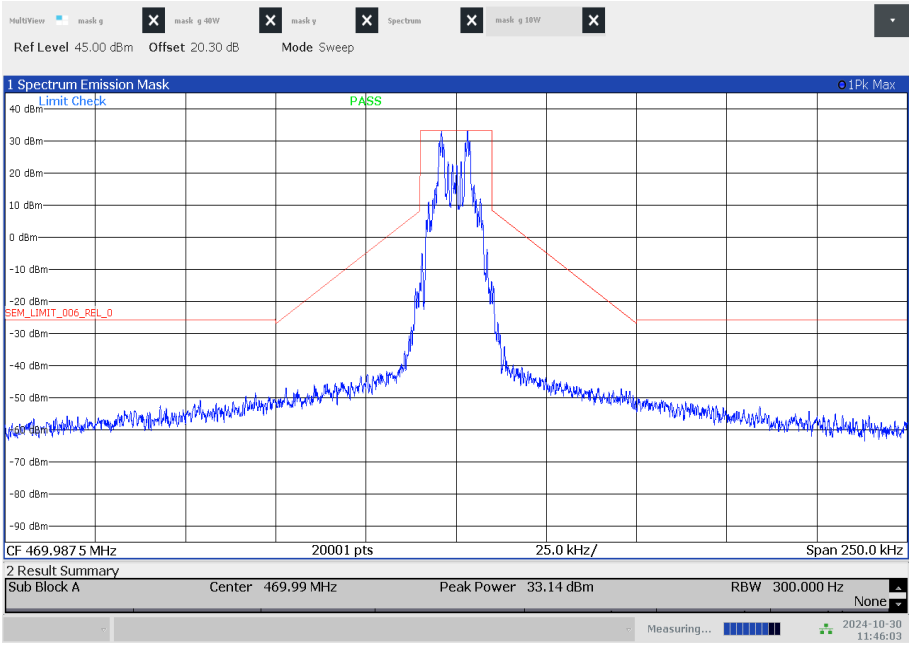
Plots 469.9875 MHz

Plot 1: Emission mask G, tx @469.9875 MHz / 512 bits per second – low power – carrier modulated



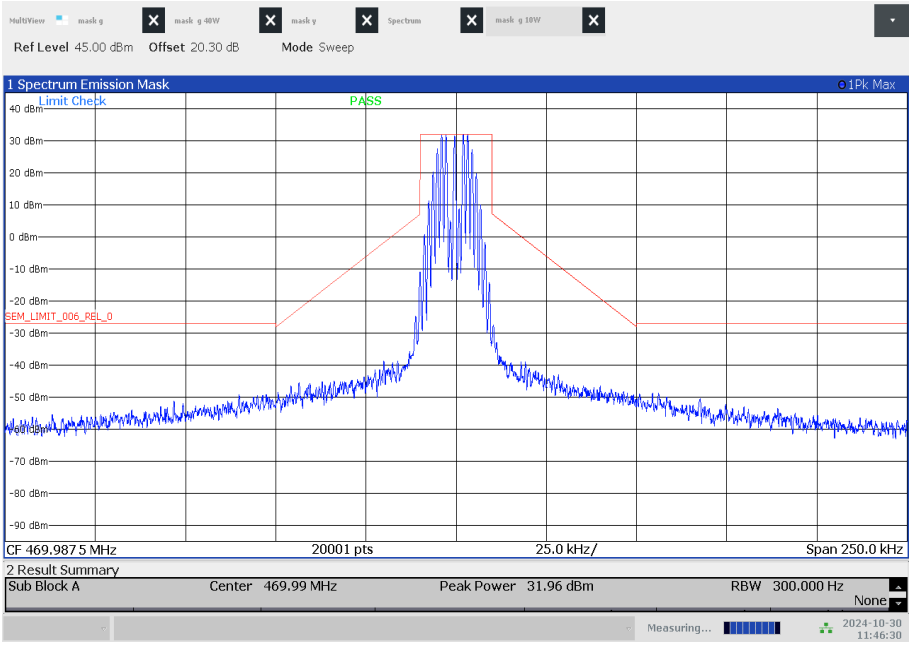
11:45:35 AM 10/30/2024

Plot 2: Emission mask G, tx @469.9875 MHz / 1200 bits per second – low power – carrier modulated



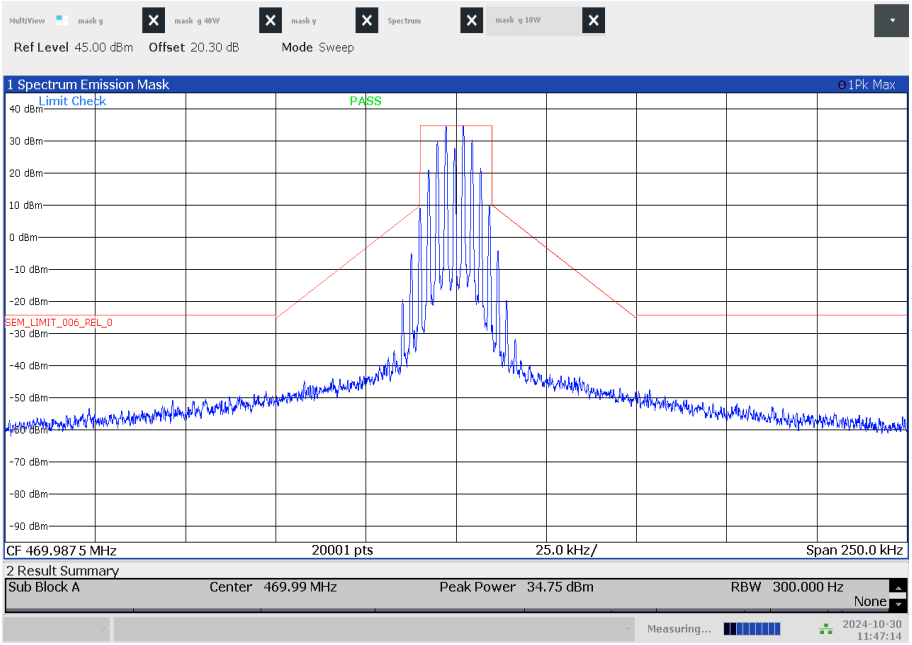
11:46:04 AM 10/30/2024

Plot 3: Emission mask G, tx @469.9875 MHz / 2400 bits per second – low power – carrier modulated



11:46:31 AM 10/30/2024

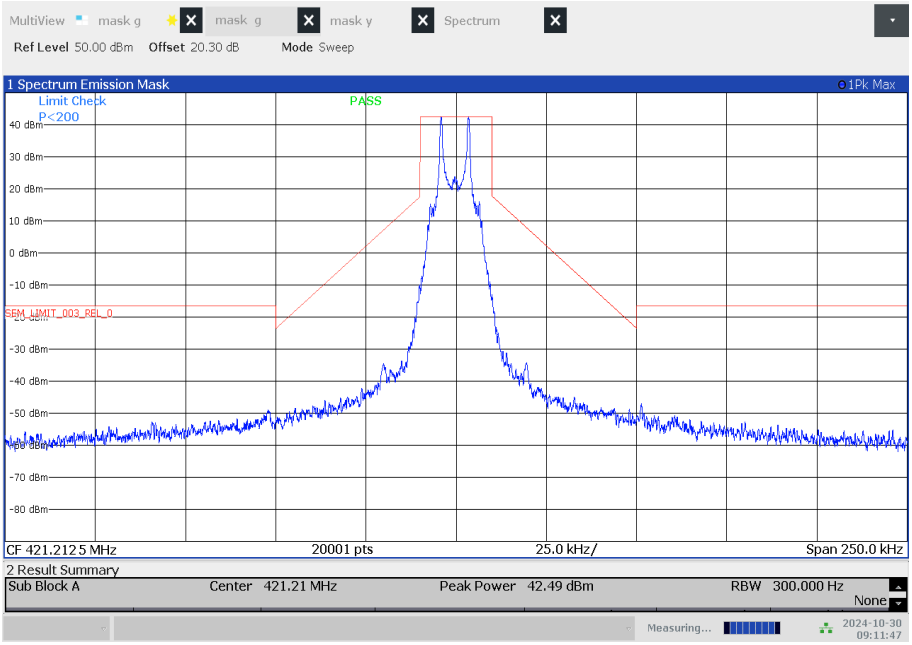
Plot 4: Emission mask G, tx @469.9875 MHz / 4800 bits per second –low power – carrier modulated



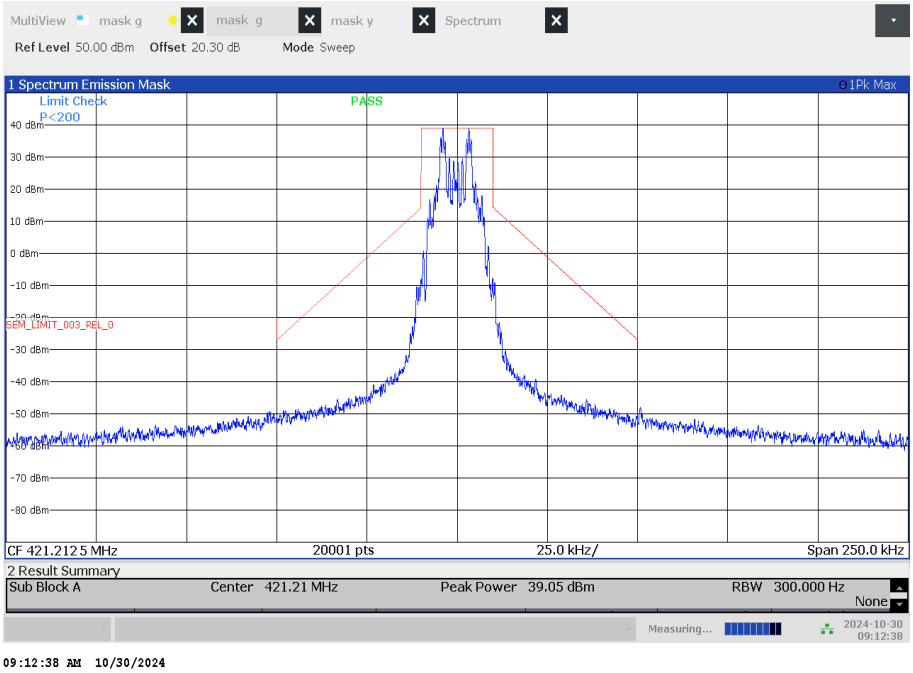
11:47:15 AM 10/30/2024

Plots 421.2125 MHz

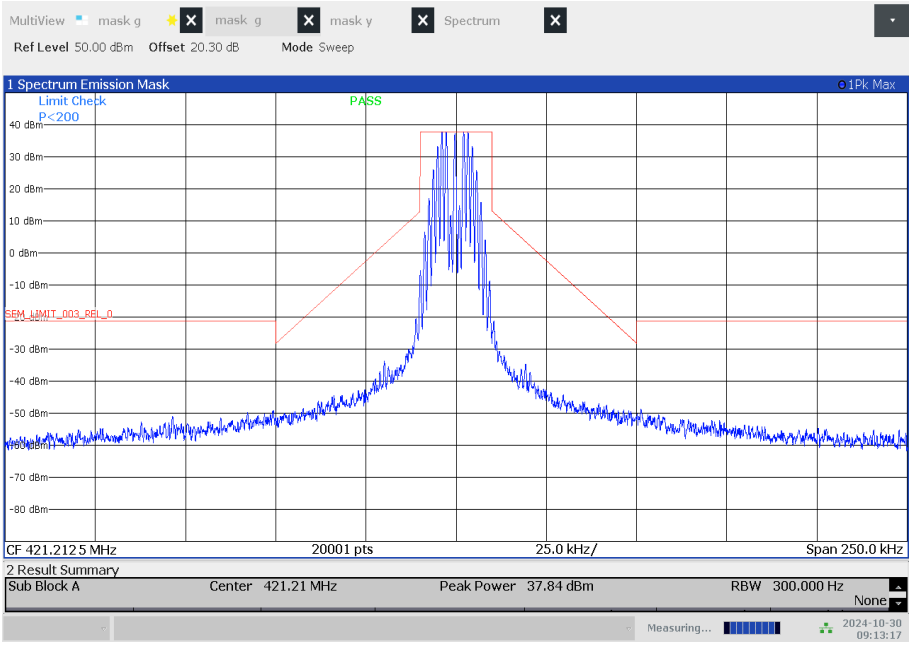
Plot 1: Emission mask G, tx @421.2125 MHz / 512 bits per second – high power – carrier modulated



Plot 2: Emission mask G, tx @421.2125 MHz / 1200 bits per second – high power – carrier modulated

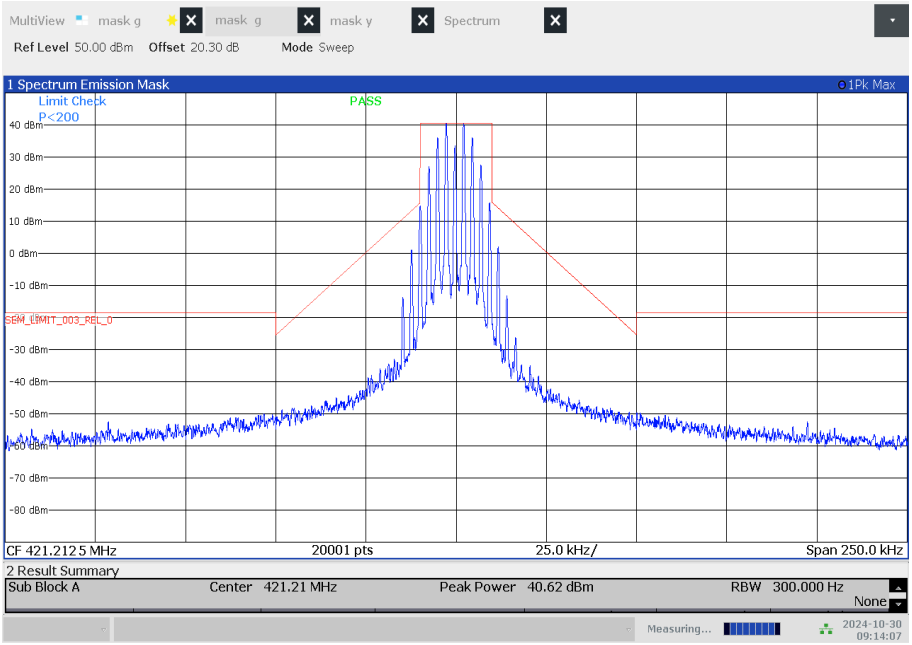


Plot 3: Emission mask G, tx @421.2125 MHz / 2400 bits per second – high power – carrier modulated



09:13:17 AM 10/30/2024

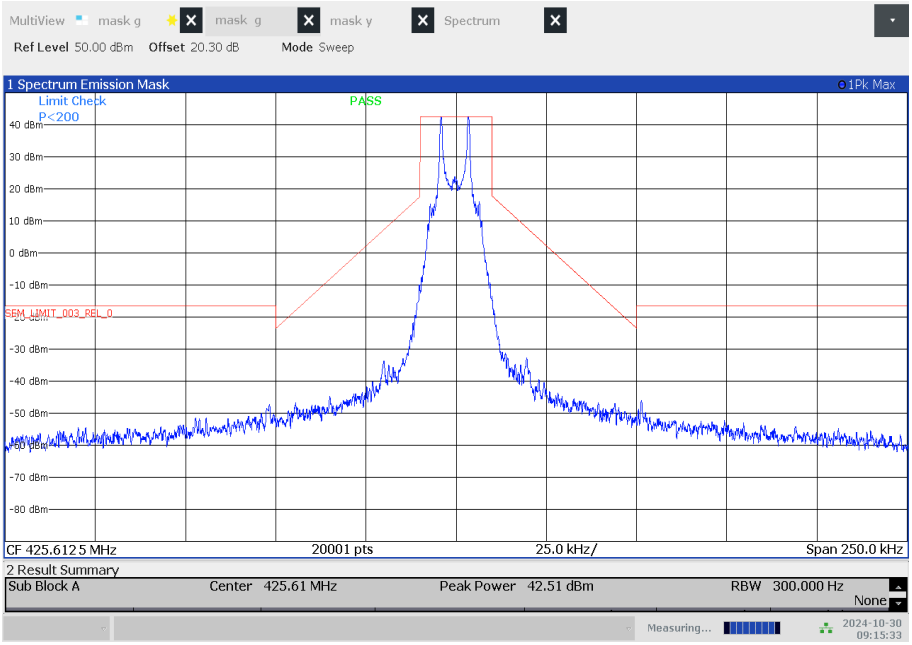
Plot 4: Emission mask G, tx @421.2125 MHz / 4800 bits per second – high power – carrier modulated



09:14:07 AM 10/30/2024

Plots 425.6125 MHz

Plot 1: Emission mask G, tx @425.6125 MHz / 512 bits per second – high power – carrier modulated



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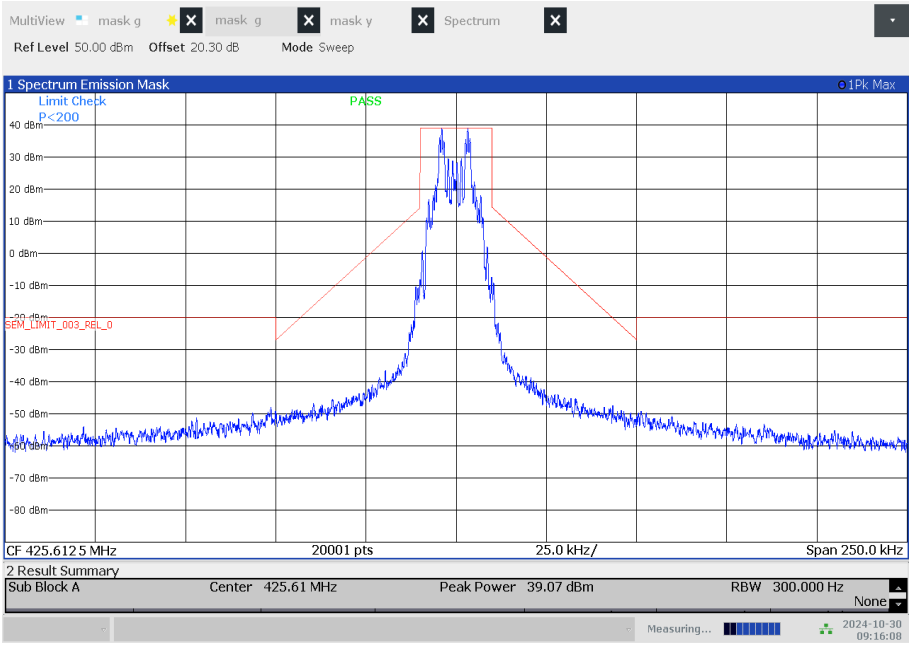
Plot 2: Emission mask G, tx @425.6125 MHz / 1200 bits per second – high power – carrier modulated



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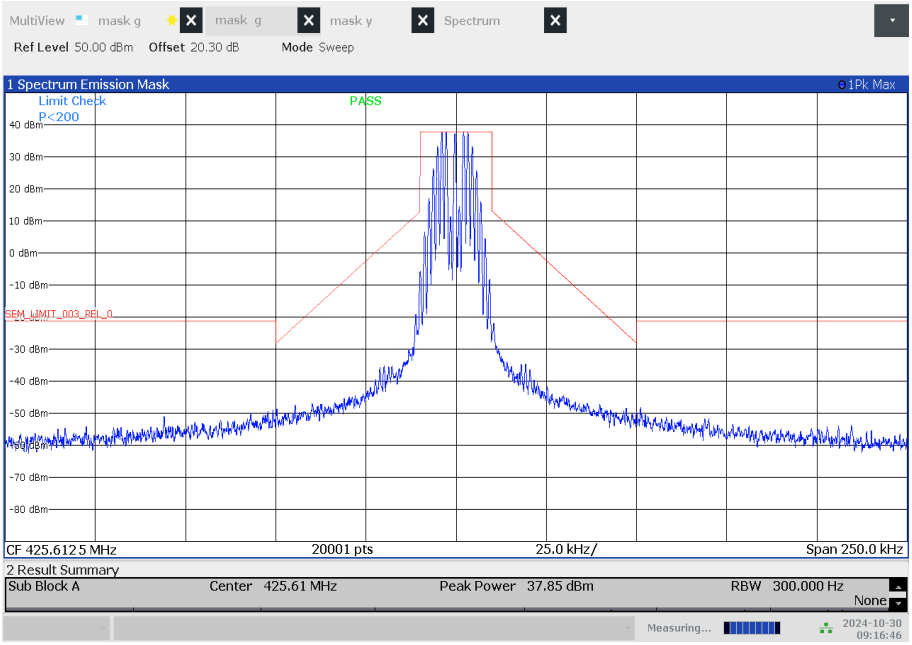
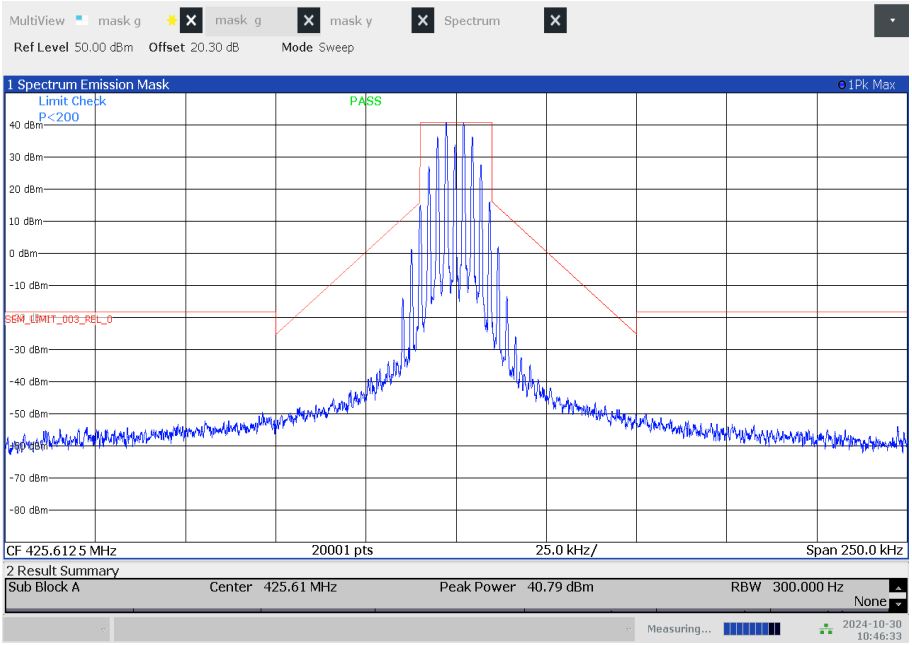
Plot 3: Emission mask G, tx @425.6125 MHz / 2400 bits per second – high power – carrier modulated



09:16:46 AM 10/30/2024

Plot 4: Emission mask G, tx @425.6125 MHz / 4800 bits per second – high power – carrier modulated



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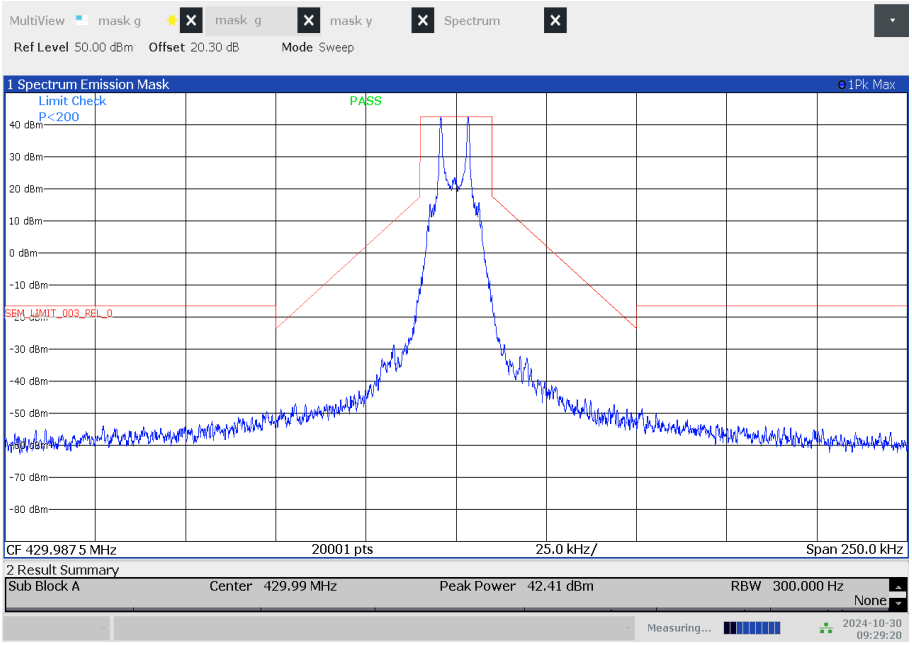
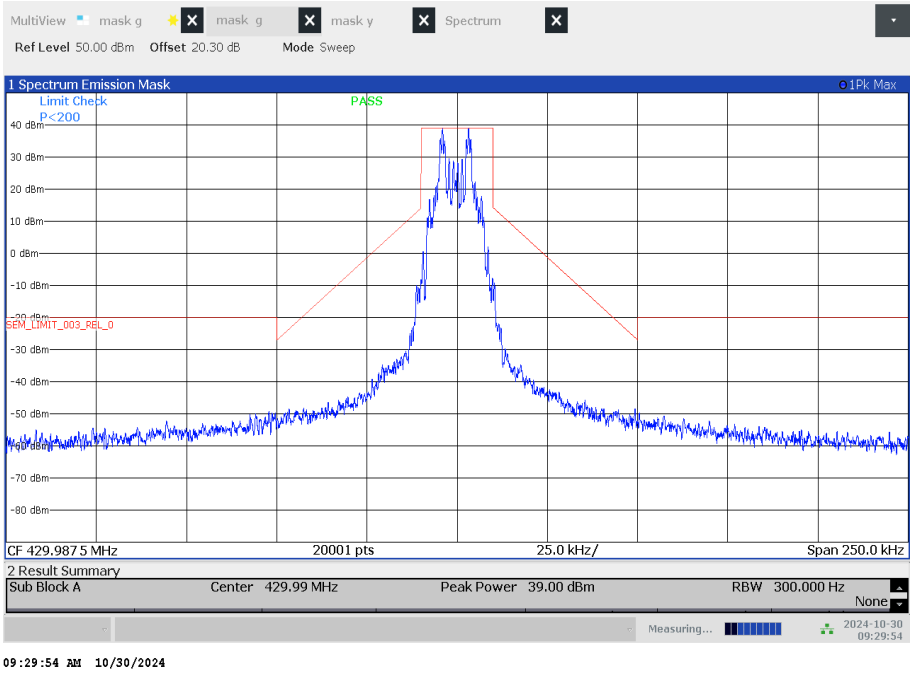
Plots 429.9875 MHz

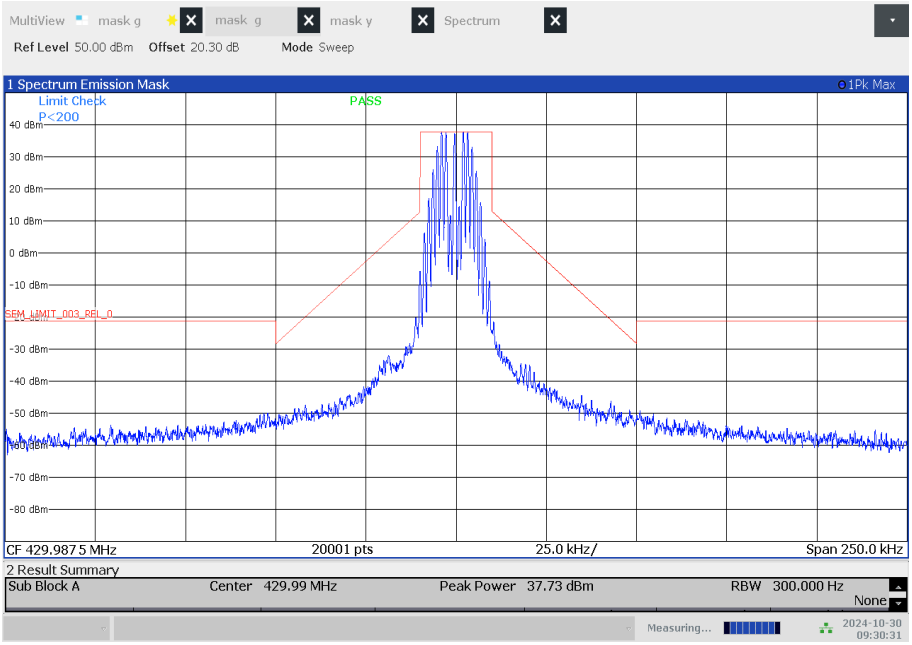
Plot 1: Emission mask G, tx @429.9875 MHz / 512 bits per second – high power – carrier modulated



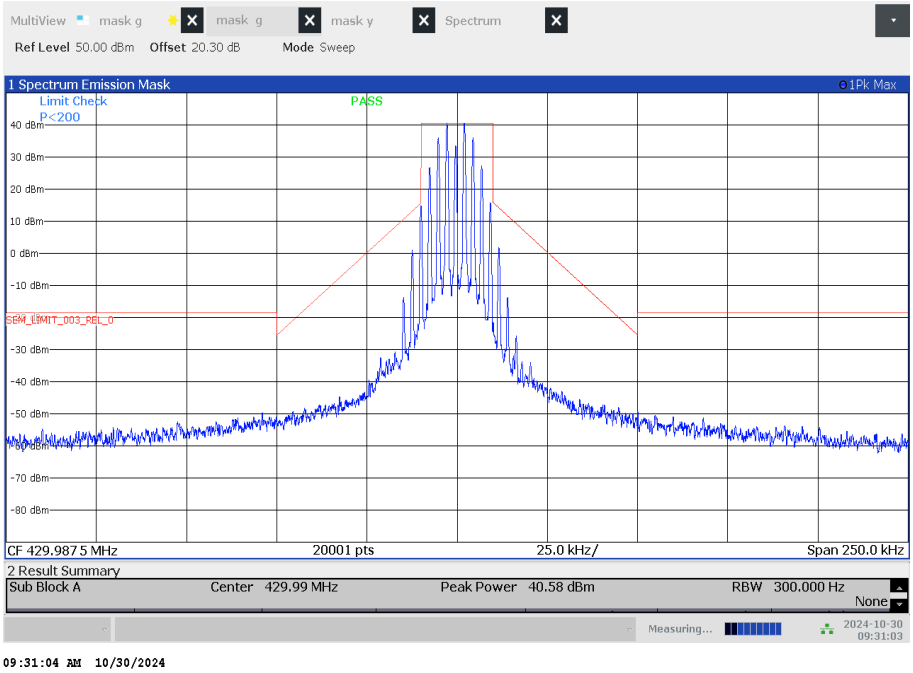
Plot 2: Emission mask G, tx @429.9875 MHz / 1200 bits per second – high power – carrier modulated



Plot 3: Emission mask G, tx @429.9875 MHz / 2400 bits per second – high power – carrier modulated

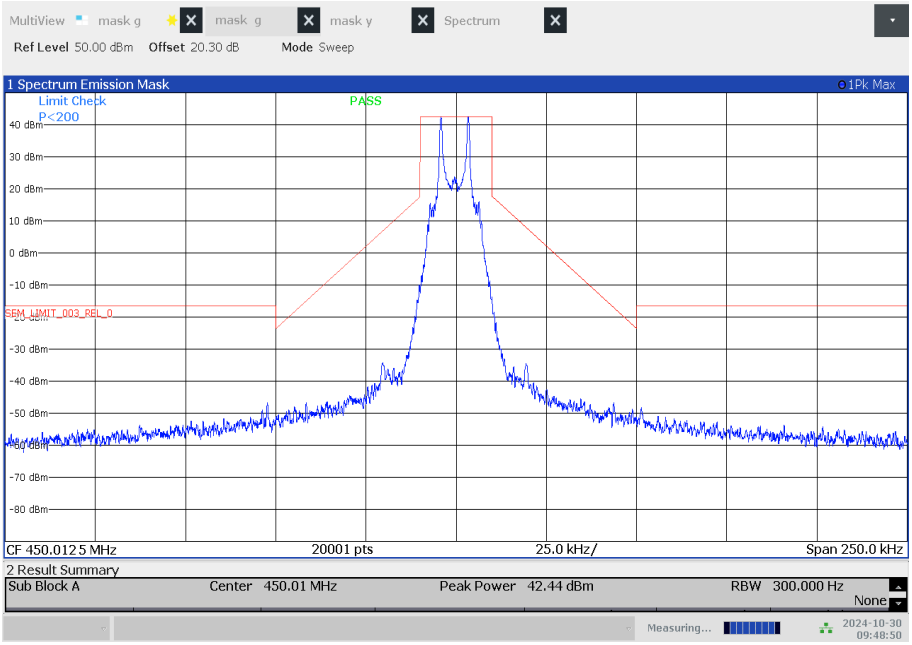


Plot 4: Emission mask G, tx @429.9875 MHz / 4800 bits per second – high power – carrier modulated



Plots 450.0125 MHz

Plot 1: Emission mask G, tx @450.0125 MHz / 512 bits per second – high power – carrier modulated



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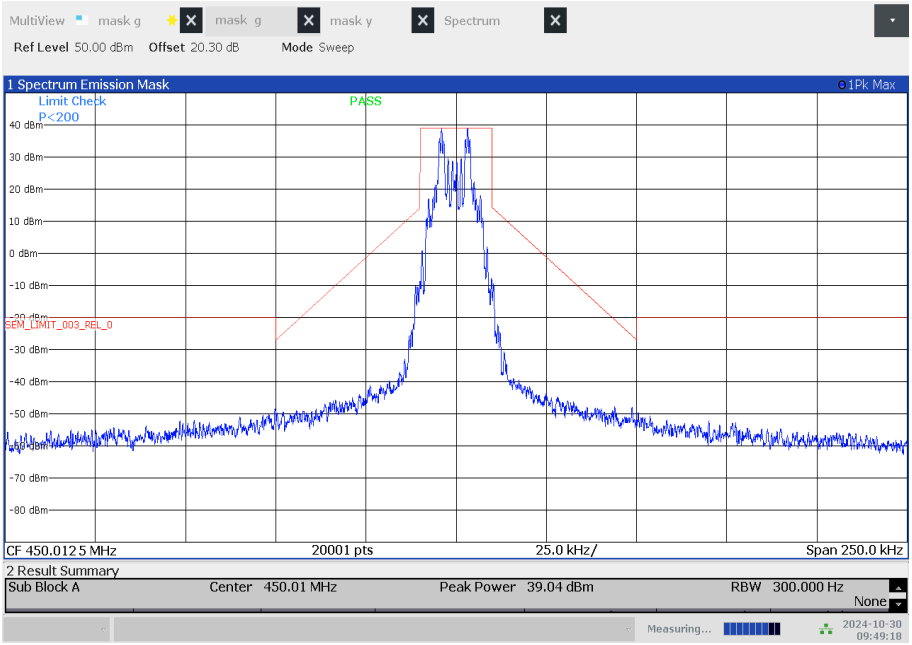
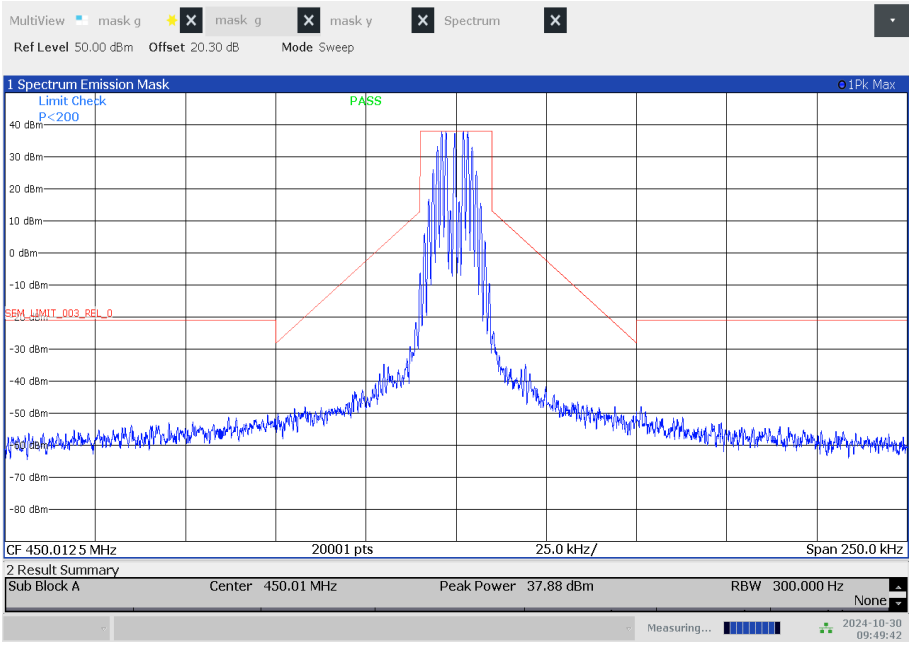
Plot 2: Emission mask G, tx @450.0125 MHz / 1200 bits per second – high power – carrier modulated



09:49:18 AM 10/30/2024

Plot 3: Emission mask G, tx @450.0125 MHz / 2400 bits per second – high power – carrier modulated



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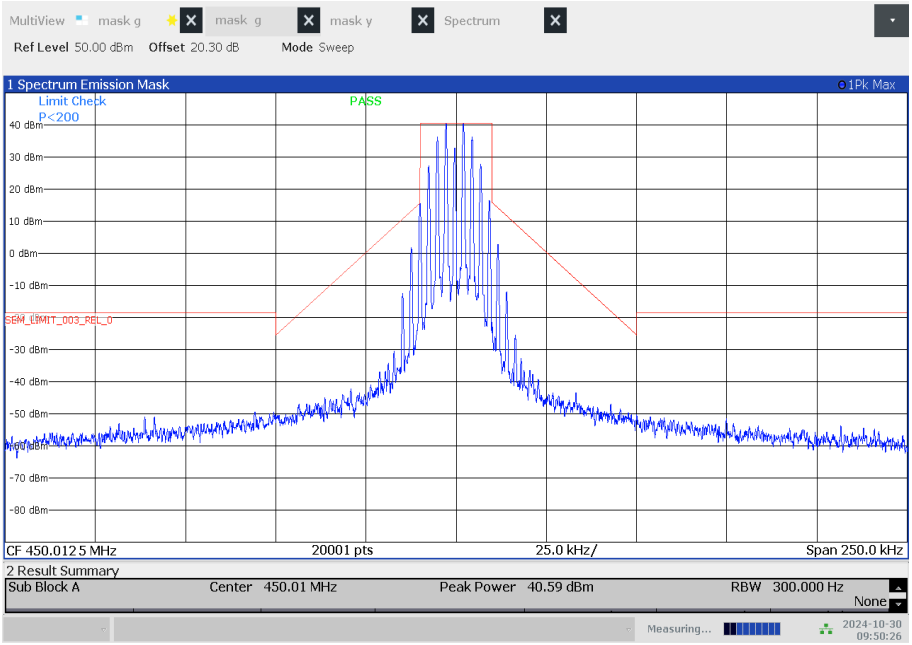
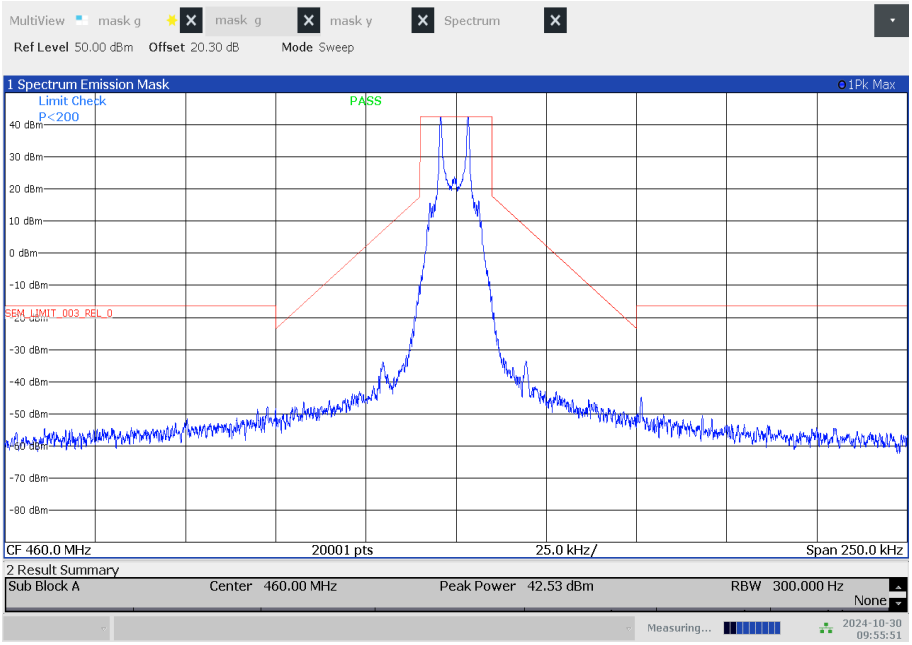
Plot 4: Emission mask G, tx @450.0125 MHz / 4800 bits per second – high power – carrier modulated



09:50:27 AM 10/30/2024

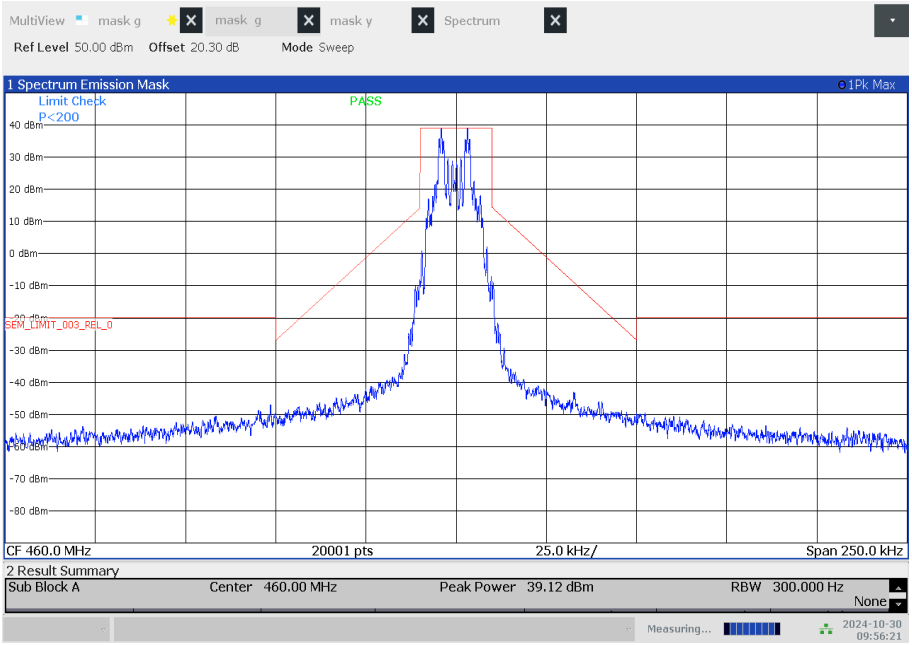
Plots 460.0 MHz

Plot 1: Emission mask G, tx @460.0 MHz / 512 bits per second – high power – carrier modulated



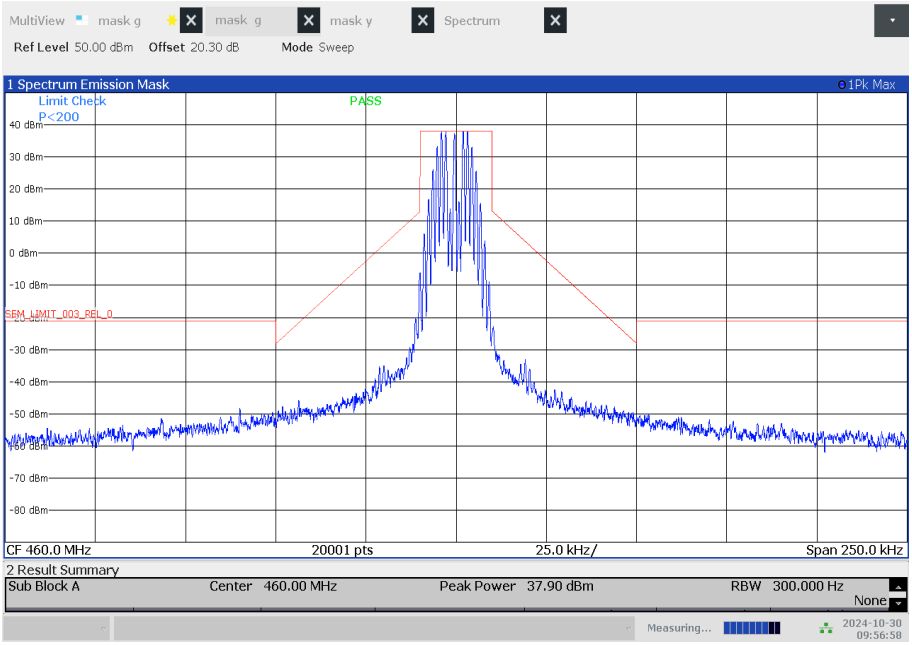
09:55:52 AM 10/30/2024

Plot 2: Emission mask G, tx @460.0 MHz / 1200 bits per second – high power – carrier modulated

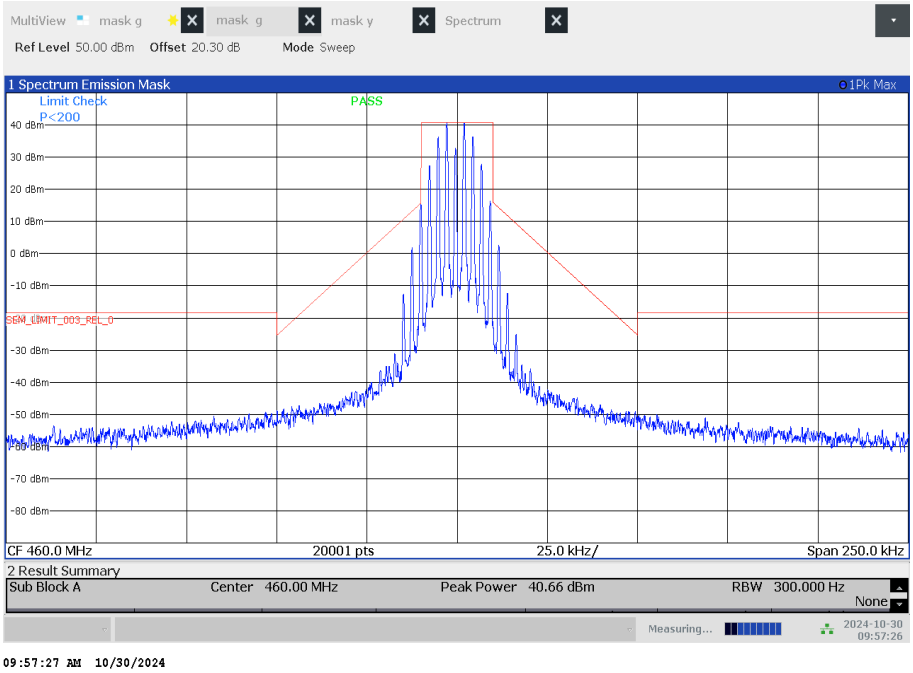


09:56:21 AM 10/30/2024

Plot 3: Emission mask G, tx @460.0 MHz / 2400 bits per second – high power – carrier modulated

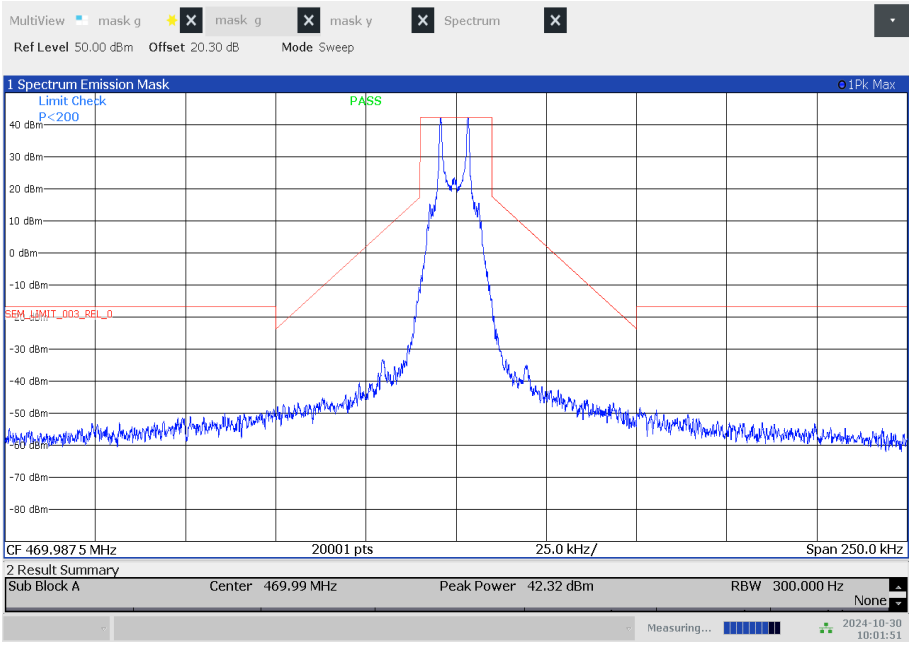


Plot 4: Emission mask G, tx @460.0 MHz / 4800 bits per second – high power – carrier modulated

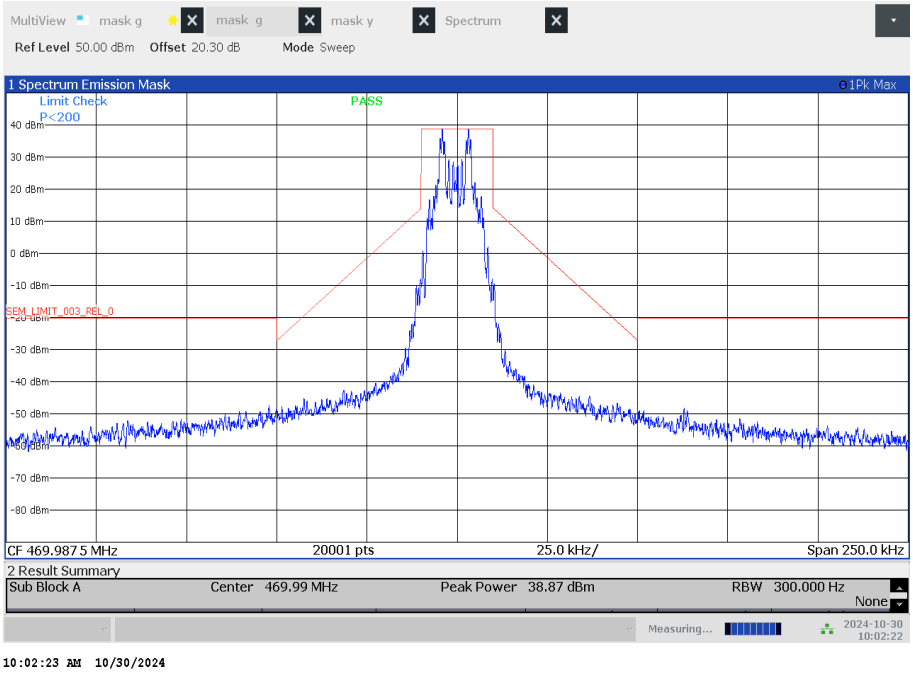


Plots 469.9875 MHz

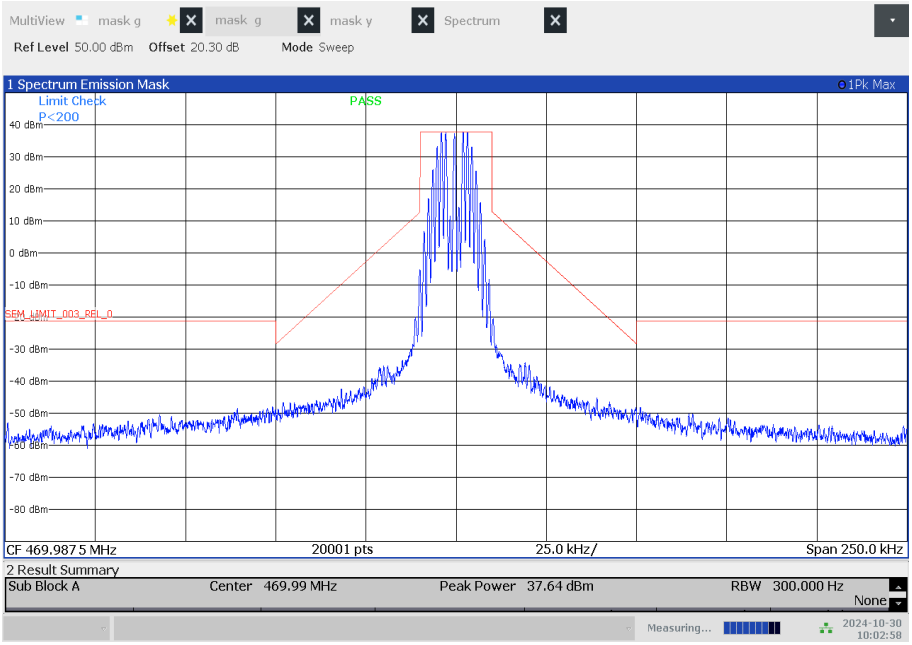
Plot 1: Emission mask G, tx @469.9875 MHz / 512 bits per second – high power – carrier modulated



Plot 2: Emission mask G, tx @469.9875 MHz / 1200 bits per second – high power – carrier modulated



Plot 3: Emission mask G, tx @469.9875 MHz / 2400 bits per second – high power – carrier modulated



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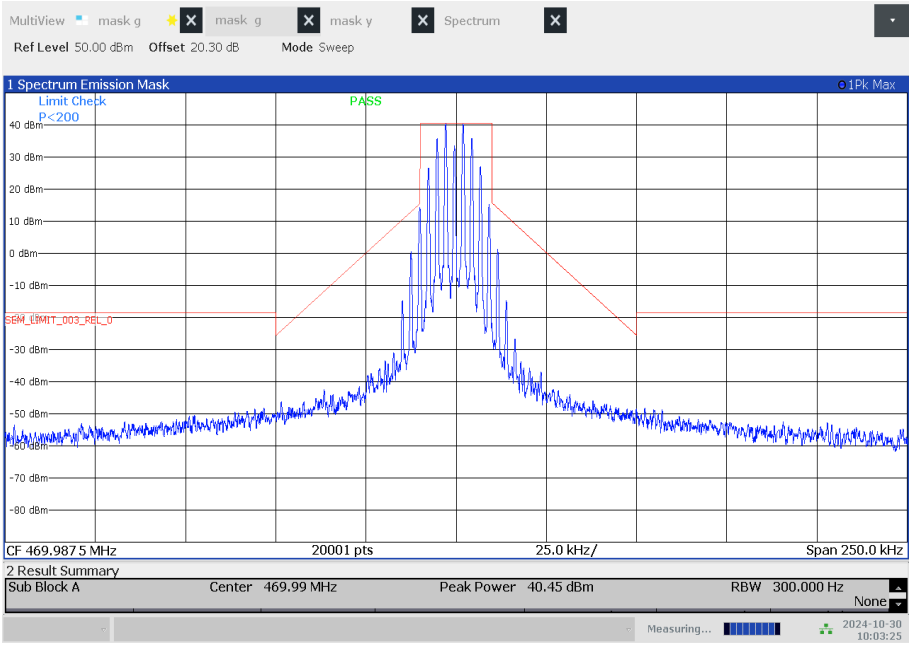
Plot 4: Emission mask G, tx @469.9875 MHz / 4800 bits per second – high power – carrier modulated



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13.5 Adjacent channel power

Limits:

Maximum adjacent power levels for frequencies in the 450-470 MHz band:

Frequency offset	Maximum ACP (dBc) for devices 1 watt and less	Maximum ACP (dBc) for devices above 1 watt
25 kHz	-55 dBc	-60 dBc
50 kHz	-70 dBc	-70 dBc
75 kHz	-70 dBc	-70 dBc

Result 20kHz bandwidth:

frequency	baudrate	adjacent channel power dBc					
		-75 kHz	-50 kHz	-25 kHz	+25 kHz	+50 kHz	+75 kHz
450.0125 MHz	512	-85.35	-82.18	-72.38	-73.06	-82.53	-85.76
	1200	-83.67	-80.56	-72.01	-73.03	-80.89	-84.01
	2400	-83.19	-79.92	-71.33	-71.37	-80.43	-83.52
	4800	-80.17	-77.15	-67.90	-68.24	-77.79	-80.55
460.0000 MHz	512	-83.43	-80.02	-70.94	-71.21	-80.46	-83.88
	1200	-82.99	-79.95	-71.88	-72.57	-80.44	-83.41
	2400	-81.81	-78.93	-69.64	-70.35	-78.63	-81.88
	4800	-79.39	-76.54	-67.37	-67.07	-76.57	-79.84
469.9875 MHz	512	-82.56	-79.38	-70.27	-71.20	-80.06	-83.28
	1200	-82.38	-78.81	-70.61	-71.77	-79.78	-83.23
	2400	-80.37	-77.53	-68.29	-68.93	-78.10	-81.16
	4800	-78.77	-75.85	-66.07	-66.59	-76.35	-79.27

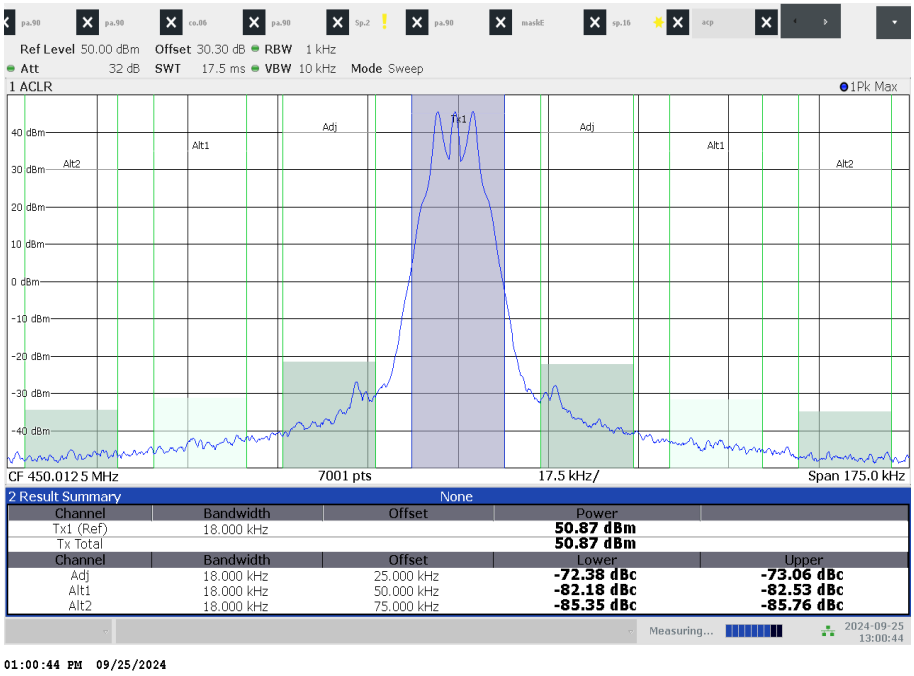
Result 25kHz bandwidth:

frequency	baudrate	adjacent channel power dBc					
		-75 kHz	-50 kHz	-25 kHz	+25 kHz	+50 kHz	+75 kHz
450.0125 MHz	512	-83.62	-80.36	-69.99	-71.23	-80.98	-84.23
	1200	-83.39	-79.68	-71.27	-72.40	-80.17	-83.31
	2400	-81.64	-78.50	-69.10	-69.47	-78.70	-82.07
	4800	-82.78	-79.68	-68.84	-68.52	-79.70	-83.06
460.0000 MHz	512	-84.00	-80.65	-70.93	-71.50	-80.99	-84.23
	1200	-83.54	-79.93	-72.20	-72.60	-80.60	-83.93
	2400	-81.83	-78.92	-69.55	-69.84	-79.02	-82.34
	4800	-79.78	-76.77	-66.67	-66.56	-77.03	-80.50
469.9875 MHz	512	-82.33	-79.28	-69.59	-69.78	-79.33	-83.14
	1200	-81.81	-78.96	-70.42	-71.35	-79.55	-82.79
	2400	-80.32	-77.18	-68.20	-68.32	-77.71	-81.38
	4800	-78.67	-75.94	-65.43	-65.94	-76.34	-79.81

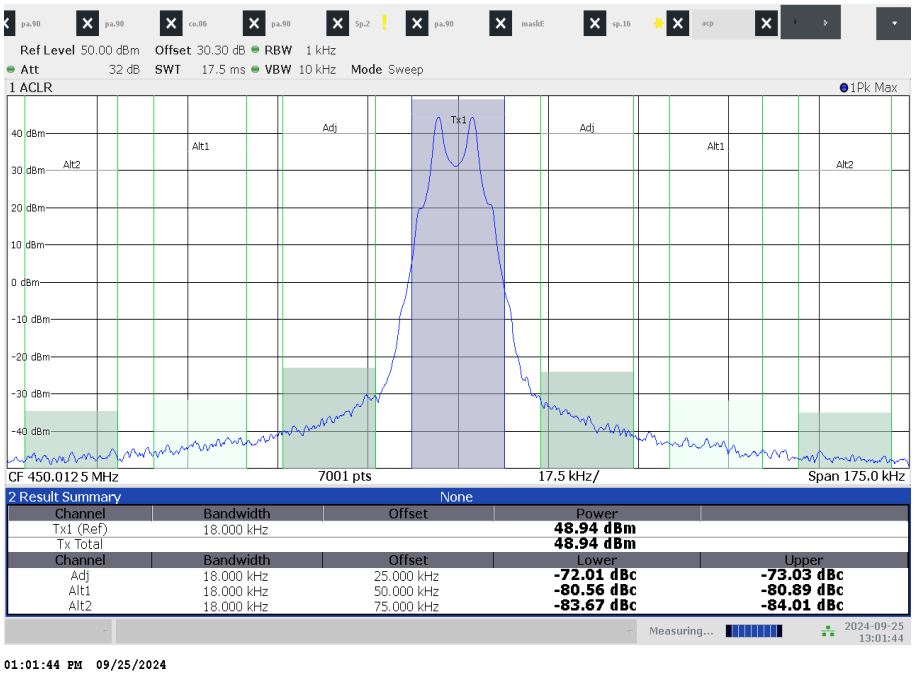
13.5.1 Plots 20 kHz bandwidth

Plots 450.0125 MHz:

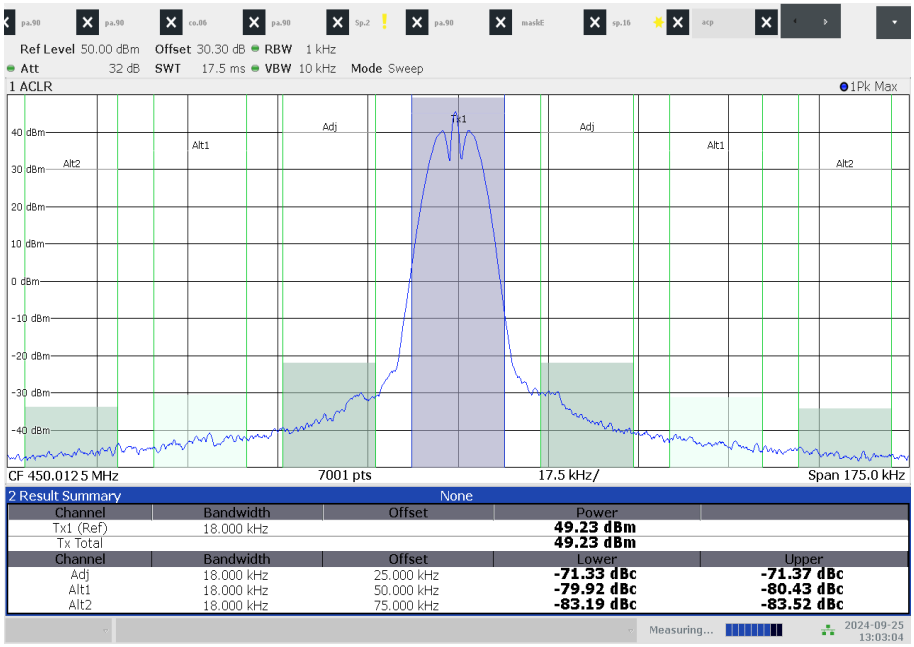
Plot 1: 512 bits per second



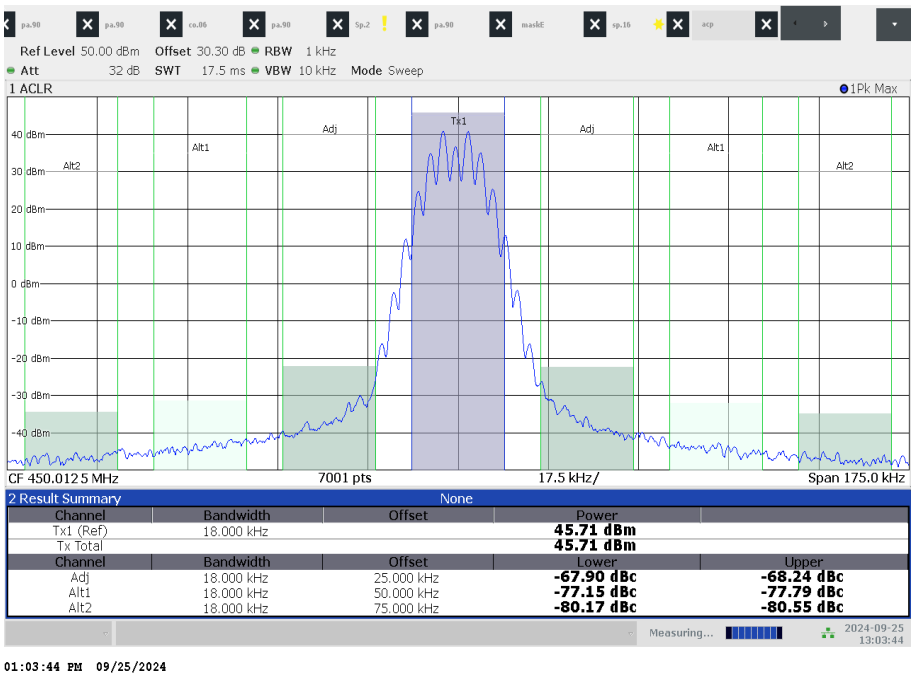
Plot 2: 1200 bits per second



Plot 3: 2400 bits per second

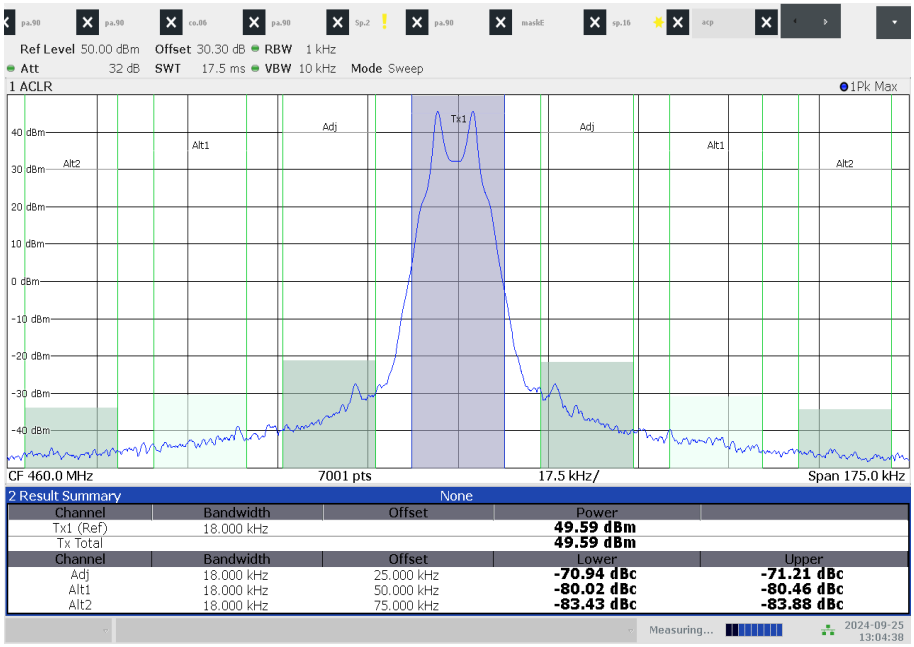


Plot 4: 4800 bits per second

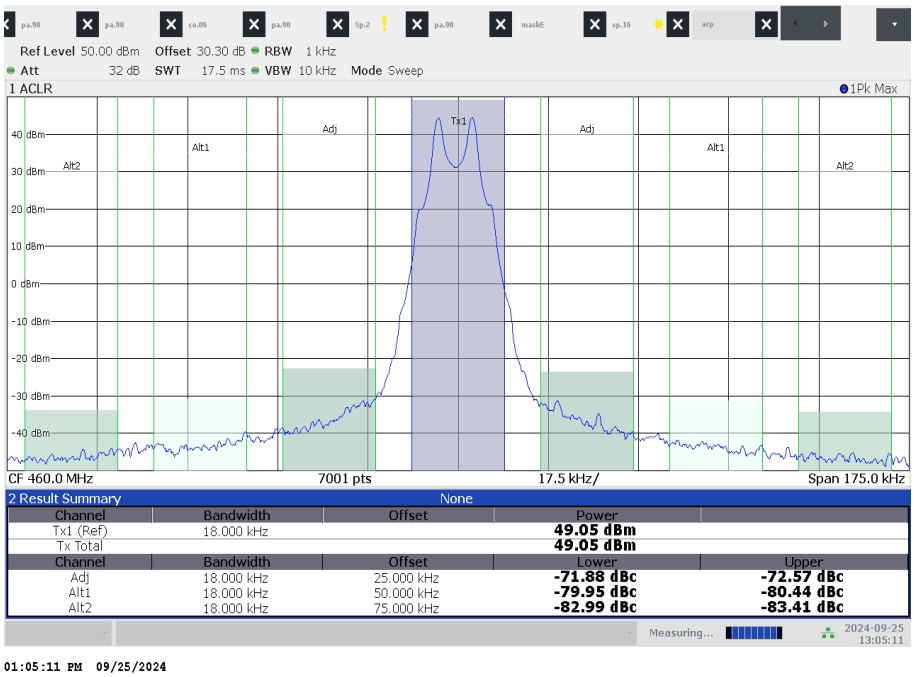


Plots 460.0000 MHz:

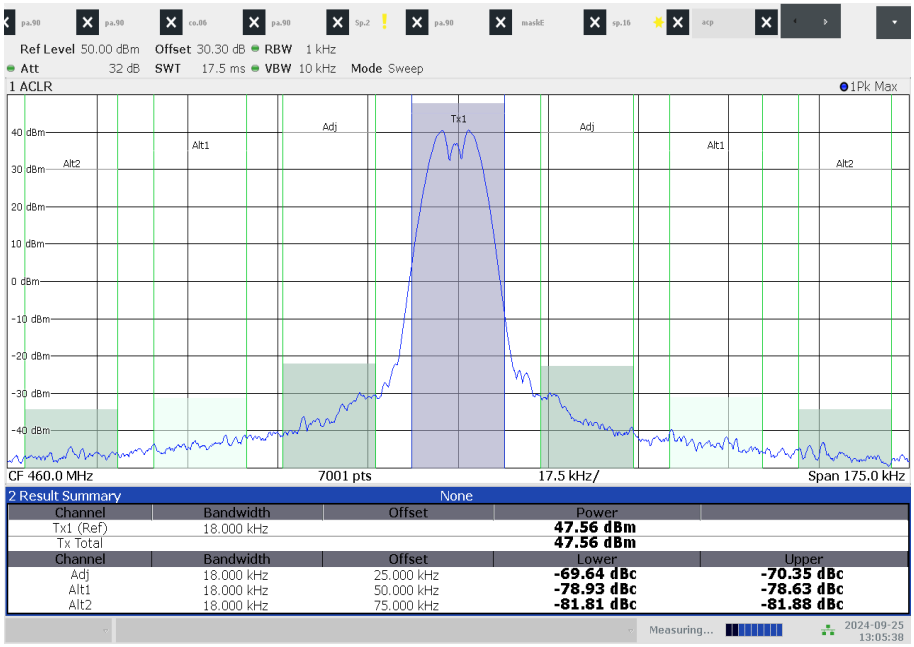
Plot 1: 512 bits per second



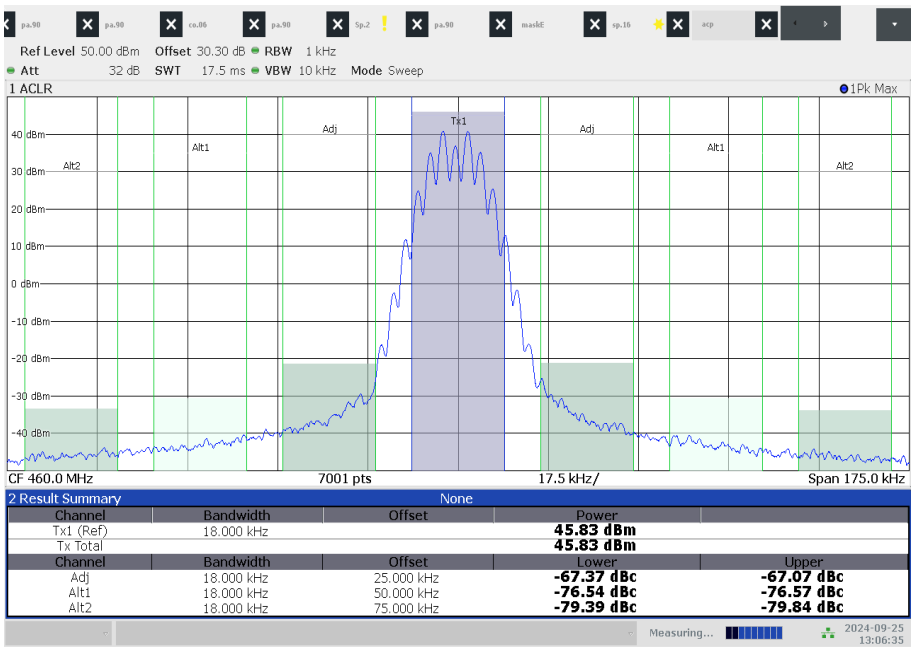
Plot 2: 1200 bits per second



Plot 3: 2400 bits per second

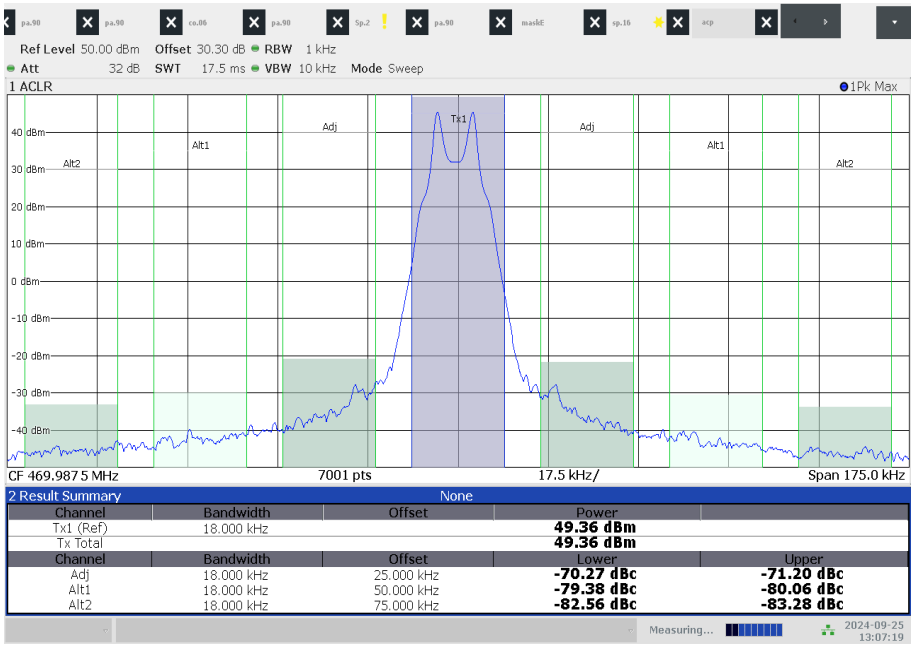


Plot 4: 4800 bits per second

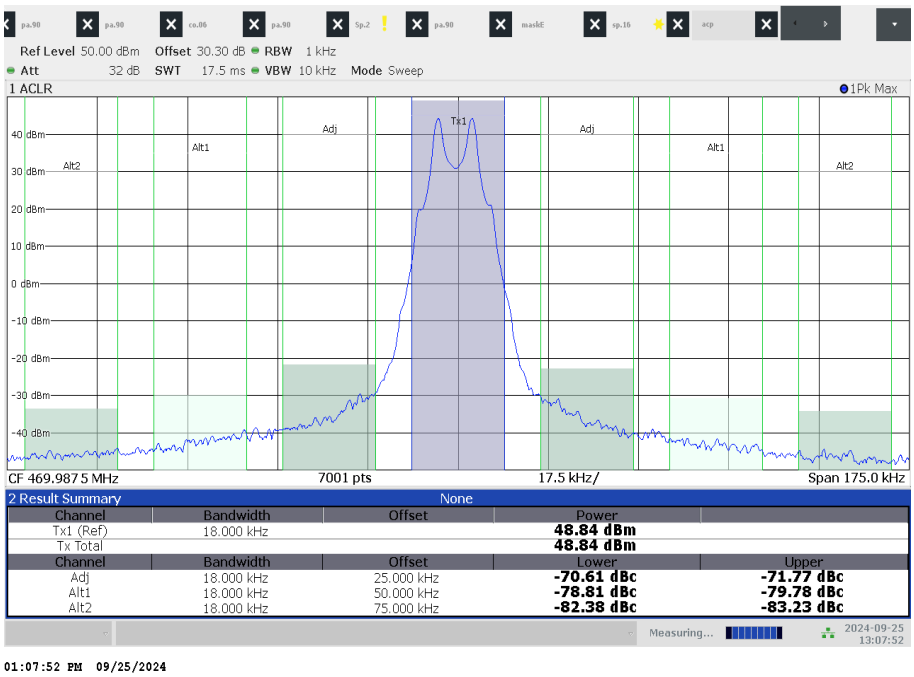


Plots 469.9875 MHz:

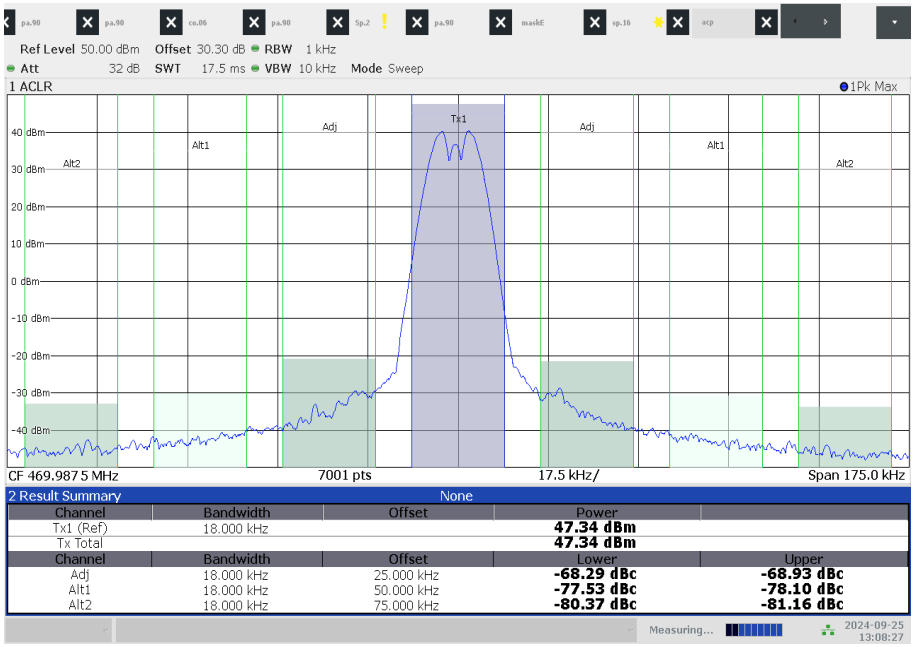
Plot 1: 512 bits per second



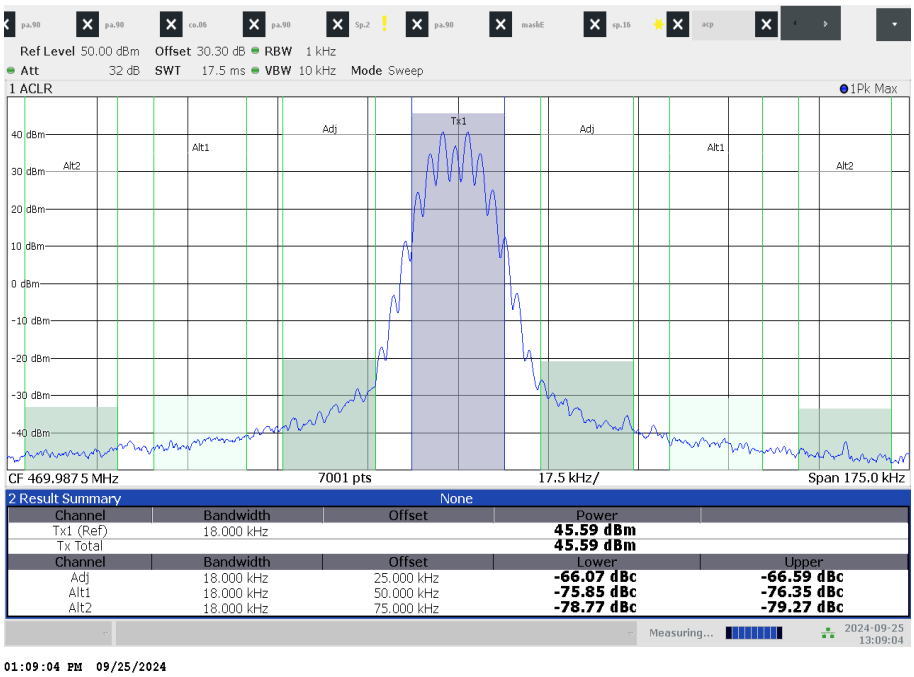
Plot 2: 1200 bits per second



Plot 3: 2400 bits per second



Plot 4: 4800 bits per second

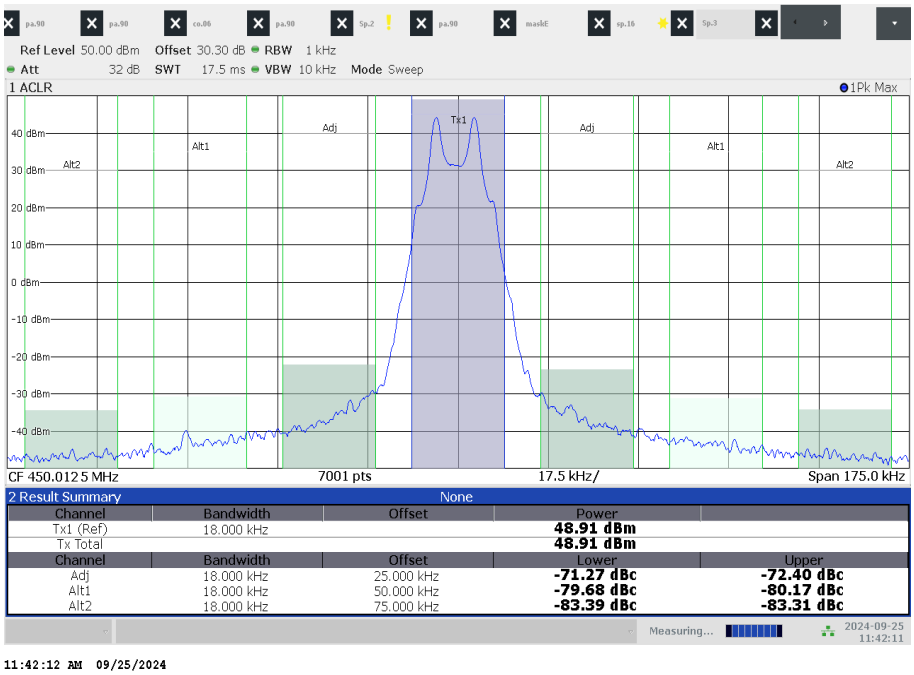


13.5.2 Plots 25 kHz bandwidth

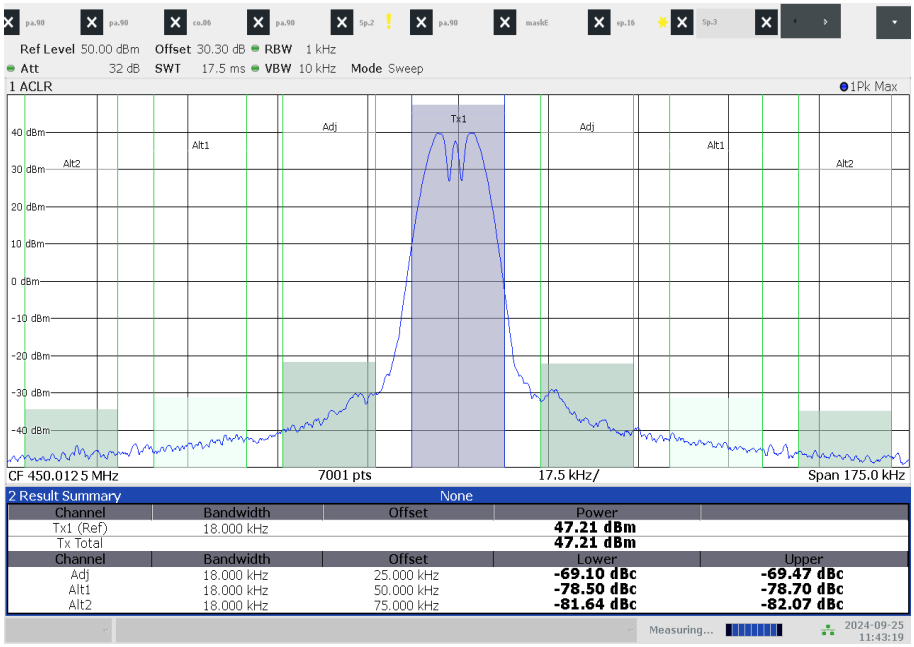
Plots 450.0125 MHz:

Plot 1: 512 bits per second

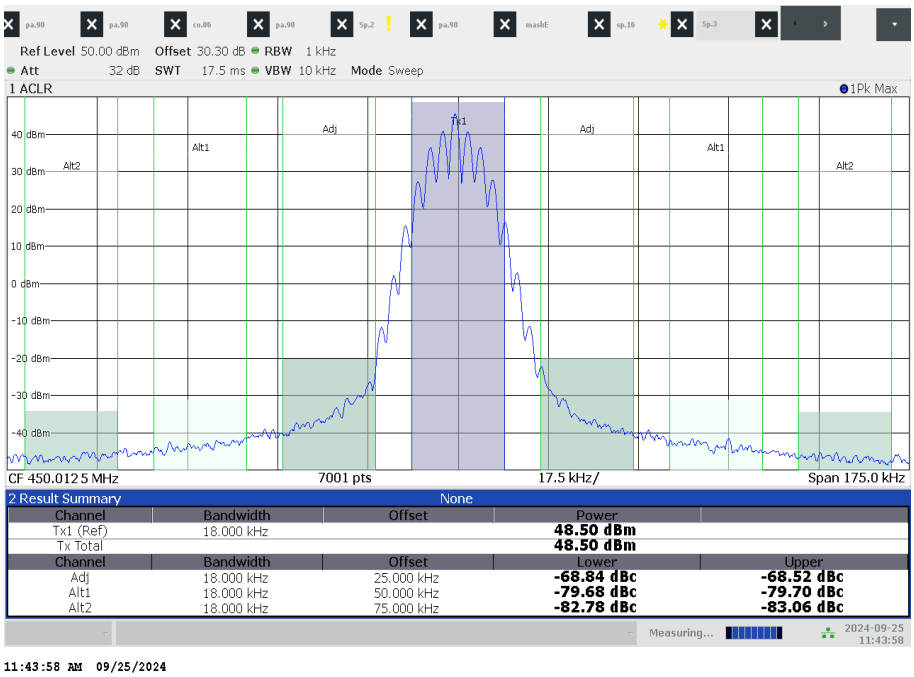
Plot 2: 1200 bits per second



Plot 3: 2400 bits per second

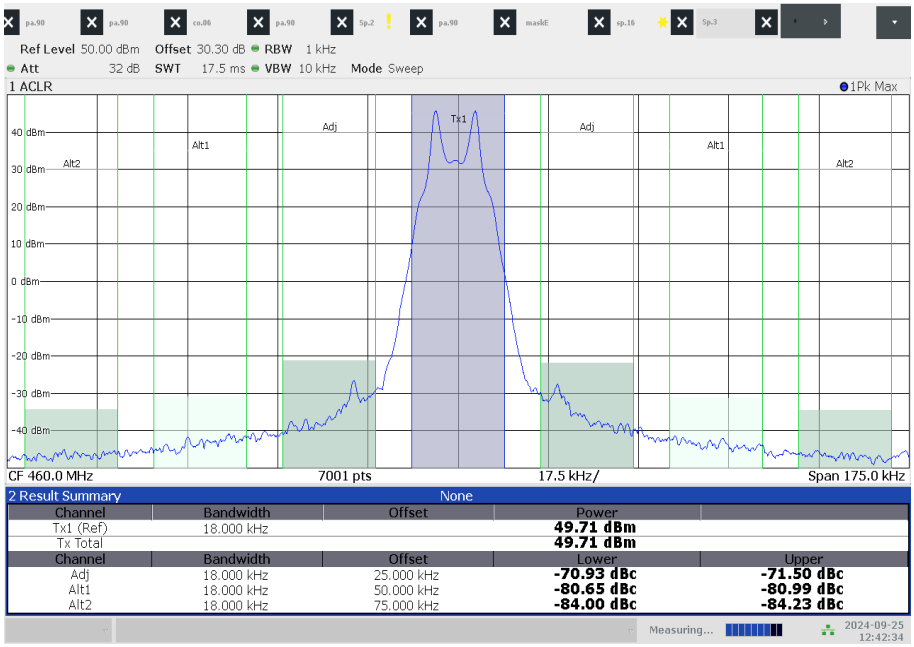


Plot 4: 4800 bits per second

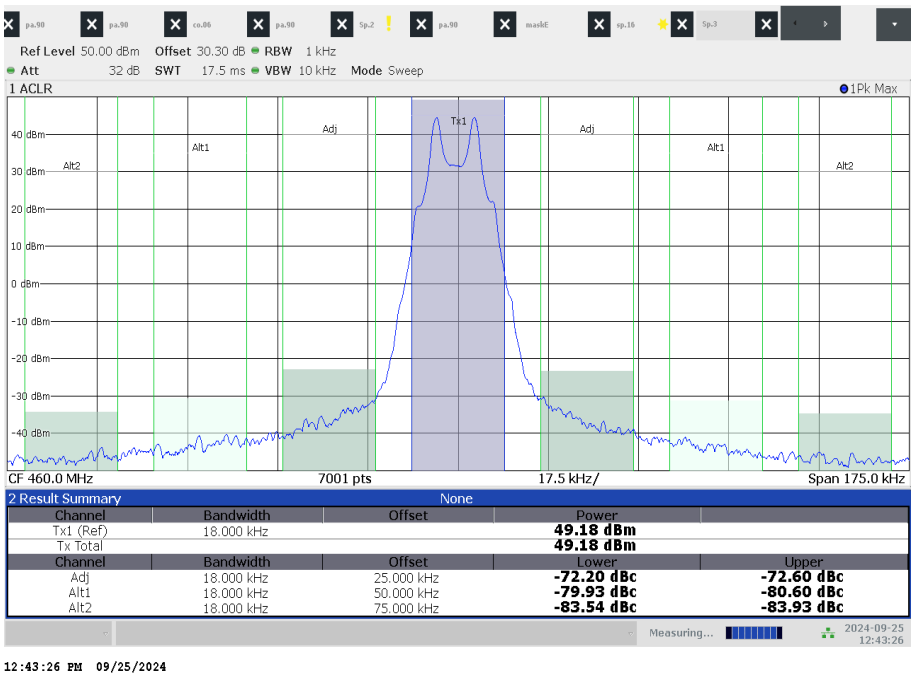


Plots 460.0000 MHz:

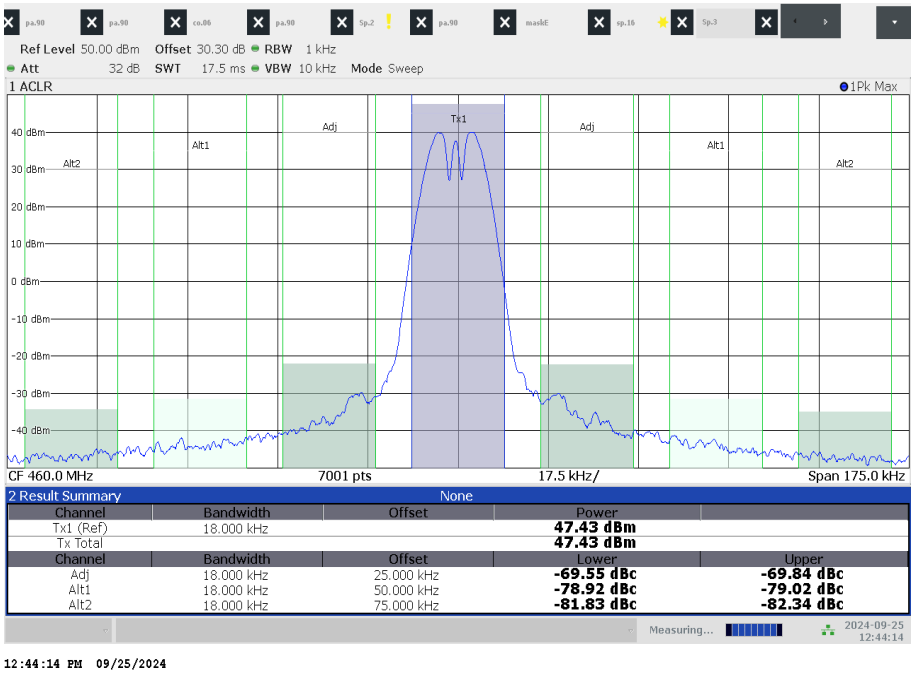
Plot 1: 512 bits per second



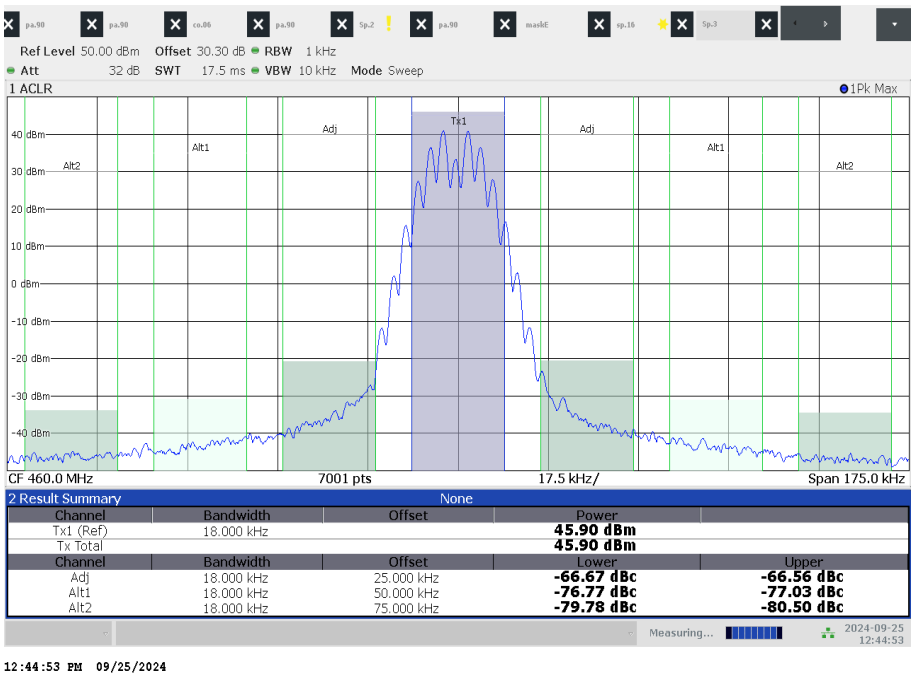
Plot 2: 1200 bits per second



Plot 3: 2400 bits per second

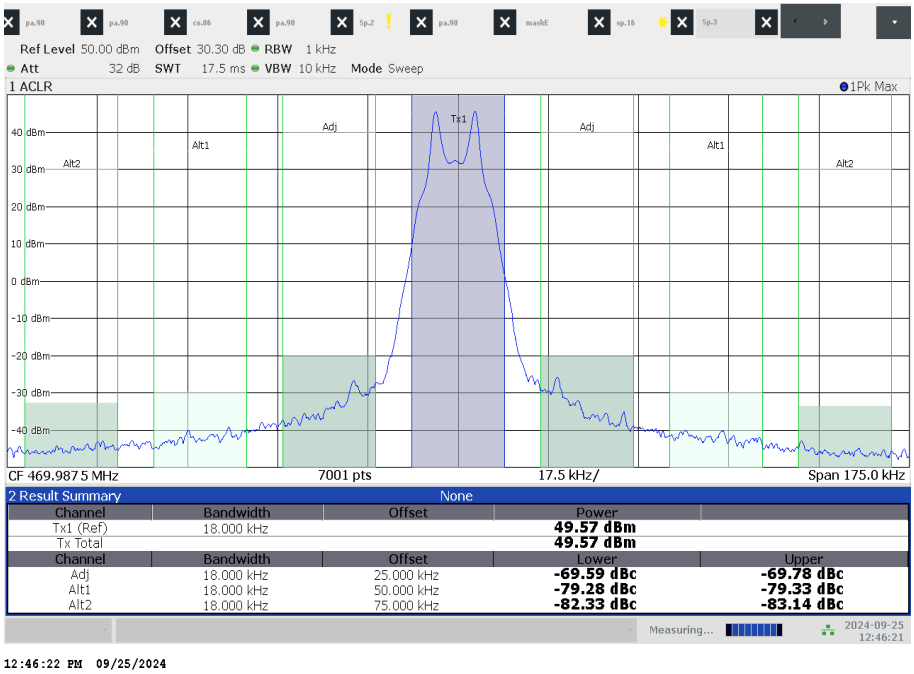


Plot 4: 4800 bits per second

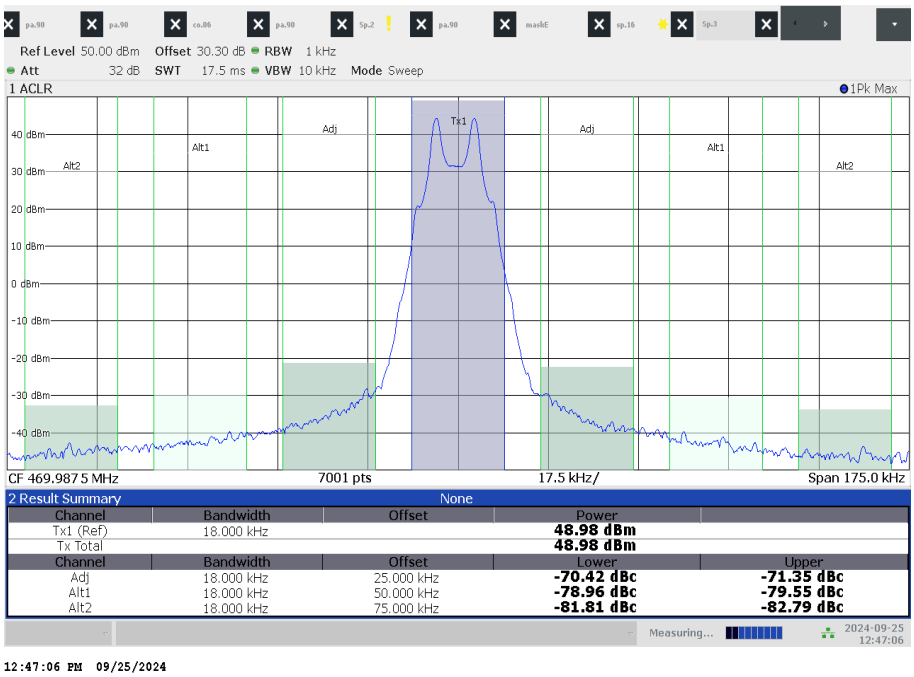


Plots 469.9875 MHz:

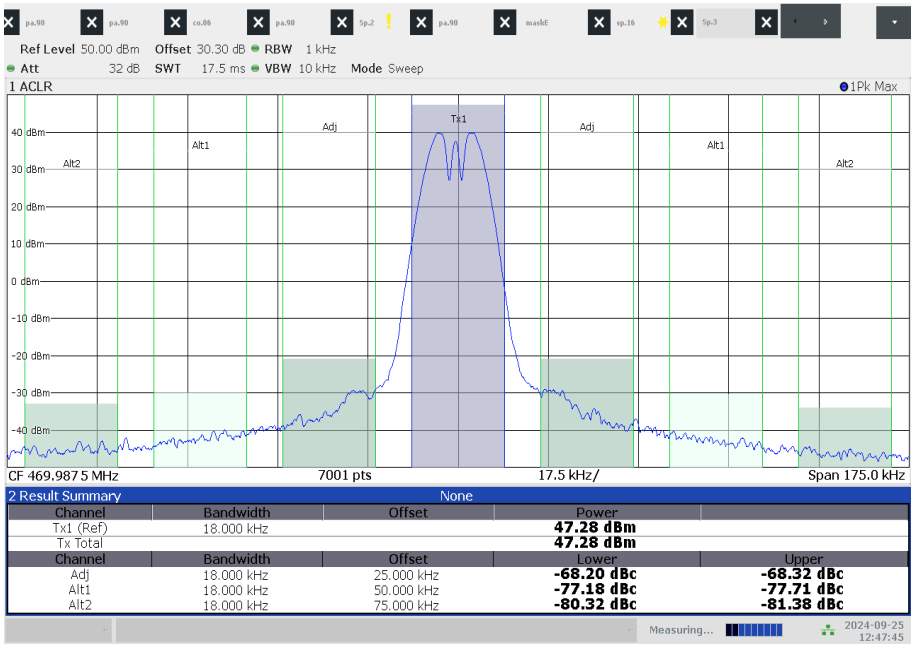
Plot 1: 512 bits per second



Plot 2: 1200 bits per second

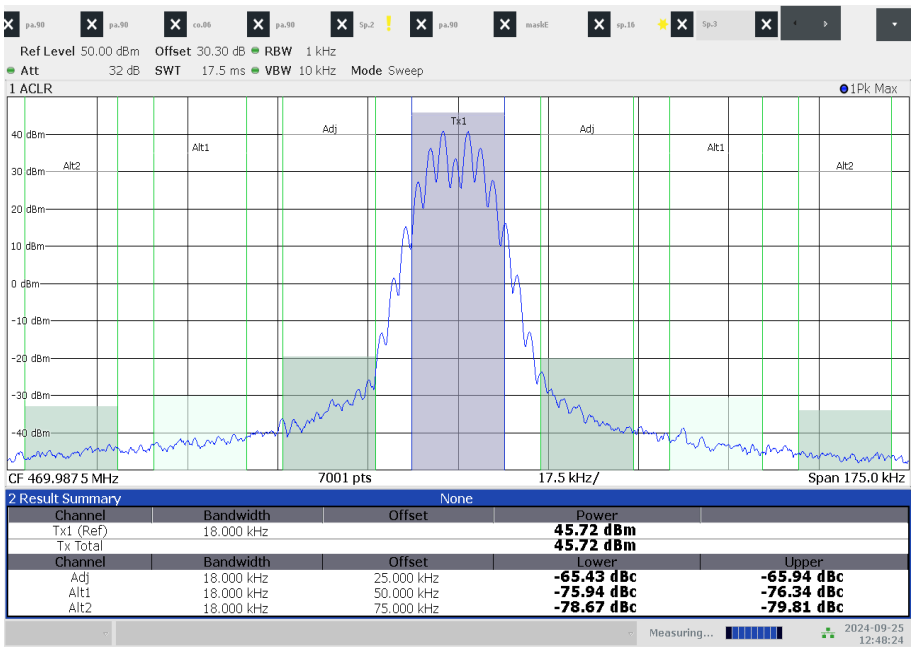


Plot 3: 2400 bits per second



12:47:45 PM 09/25/2024

Plot 4: 4800 bits per second



12:48:25 PM 09/25/2024

13.6 Transient frequency behavior

13.6.1 Transient frequency behavior 6.25 kHz bandwidth channels

Measurement:

The first plot shows the measurement of the carrier signal to show that a clean carrier is transmitted which results in a measured bandwidth of nearly twice the used RBW.
The following plots show triggered measurements in the time domain with a RBW of 3 kHz (3-dB filter).
A decrease of this power level of 3 dB can be correlated to a frequency error of a half RBW (1.5 kHz).
Therefore the frequency error is less than ± 1.5 kHz as long as the power level is in the 3 dB range. This criteria was taken as worst case condition to show compliance.

Limits:

FCC		IC	
FCC 47 CFR § 90.214		RSS 119 Issue 12 5.9	
Transient frequency behavior			
Time intervals	Maximum frequency difference	Frequency range	
		150 – 174 MHz	421 - 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1	±25.0 kHz	5 ms	10 ms
t_2	±12.5 kHz	20 ms	25 ms
t_3	±25.0 kHz	5 ms	10 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1	±12.5 kHz	5 ms	10 ms
t_2	±6.25 kHz	20 ms	25 ms
t_3	±12.5 kHz	5 ms	10 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1	±6.25 kHz	5 ms	10 ms
t_2	±3.125 kHz	20 ms	25 ms
t_3	±6.25 kHz	5 ms	10 ms

t1 is the time period immediately following ton.
t2 is the time period immediately following t1.
t3 is the time period from the instant when the transmitter is turned off until t_{off}.

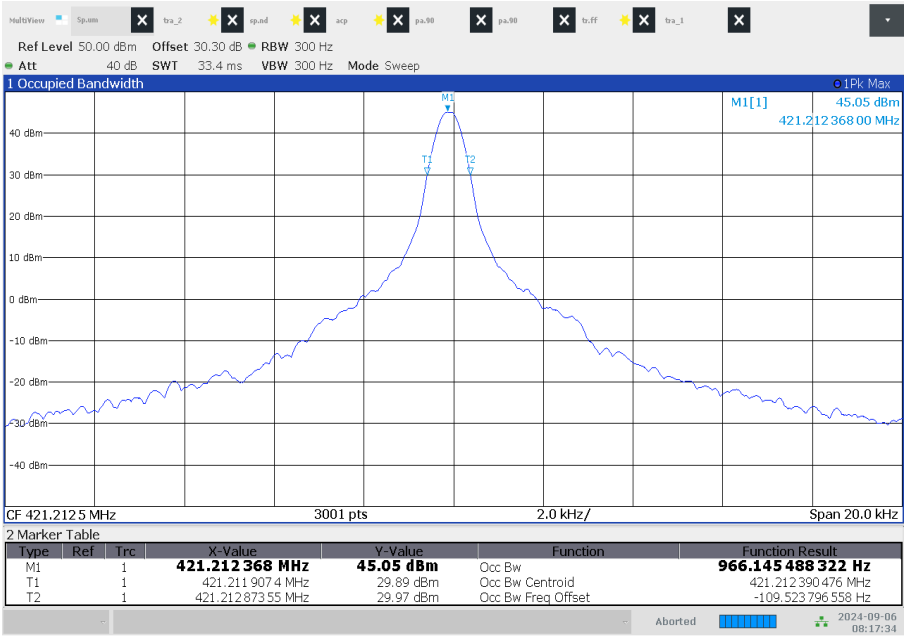
	Transmit frequency MHz					
Test scenario	421.2125	425.6125	429.9875	450.0125	460.0000	469.9875
The frequency stabilizes within the required frequency tolerance range after switching on the transmitter during period t_1 after:	0.45ms	0.45ms	0.45ms	0.44ms	0.44ms	0.43ms
Maximum power deviation during t_2: (power deviation below 3 dB conforms a frequency deviation below ± 1.5 kHz)	0.13 dB	0.20dB	0.16dB	0.25dB	0.21dB	0.04dB
Switch off time (t_3):	0.89ms	0.93ms	0.89ms	0.93ms	0.87ms	0.89ms

Result:

Confirm that during periods t_1 and t_3 the frequency difference does not exceed the value of one cannel separation	Passed
Confirm that during period t_2 the frequency difference does not exceed half a cannel separation	Passed
Confirm that during periods t_2 to t_3 the frequency difference does not exceed the frequency error limit	Passed

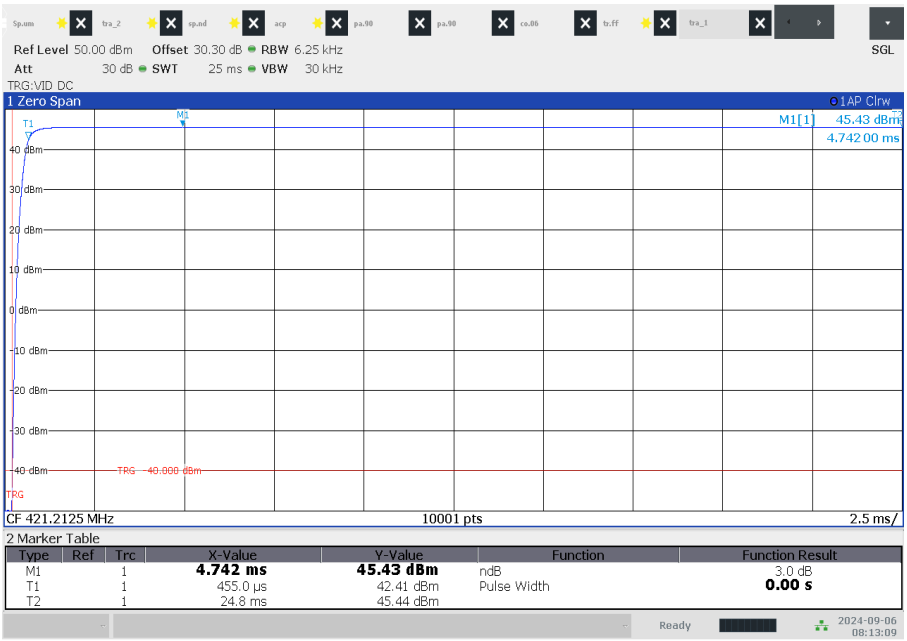
Plots of the measurement (512 bits per second):

Plot 1: 421.2125 MHz – carrier



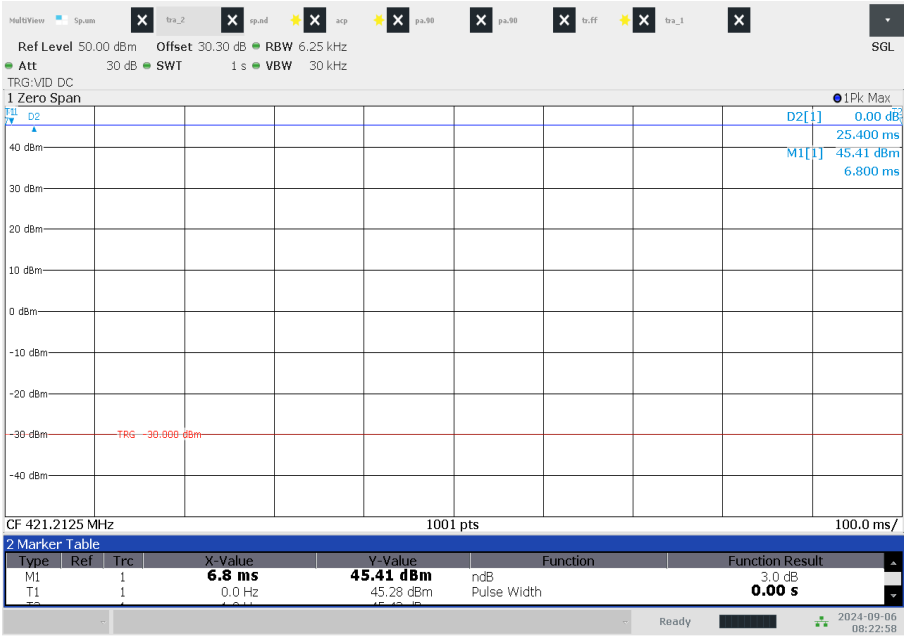
08:17:34 AM 09/06/2024

Plot 2: 421.2125 MHz – switch on (zoomed)

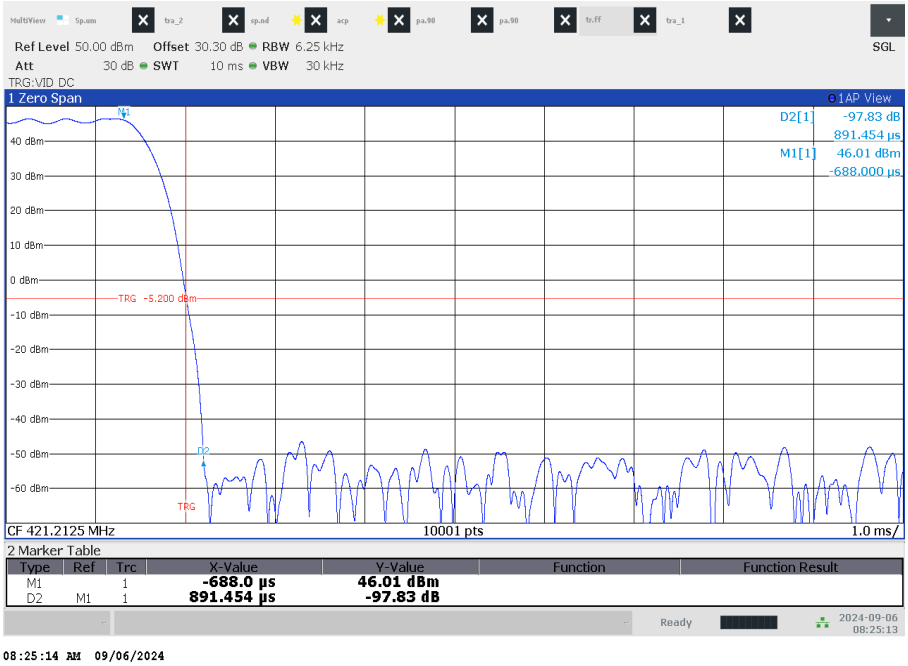


08:13:10 AM 09/06/2024

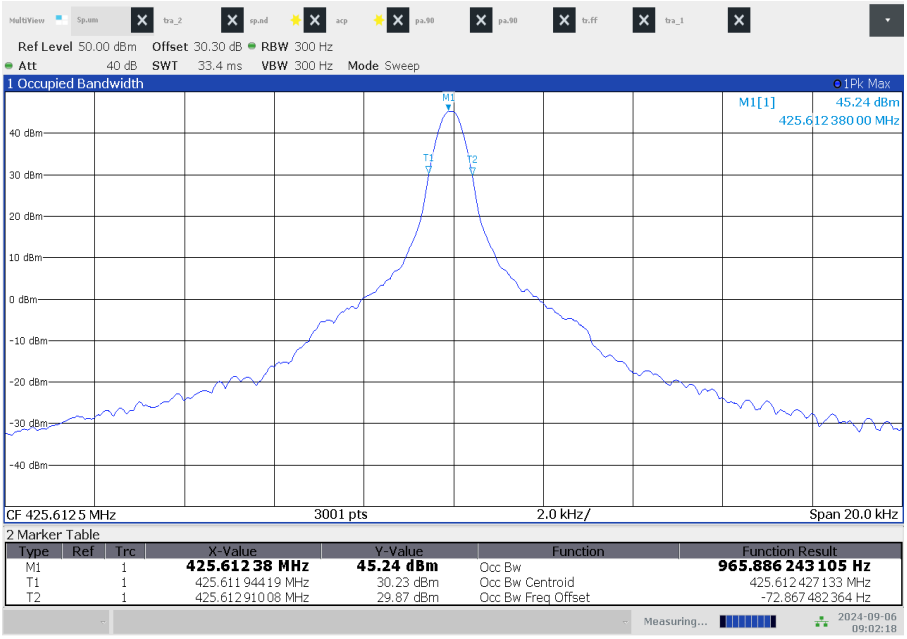
Plot 3: 421.2125 MHz – operating



Plot 4: 421.2125 MHz – switch off (zoomed)

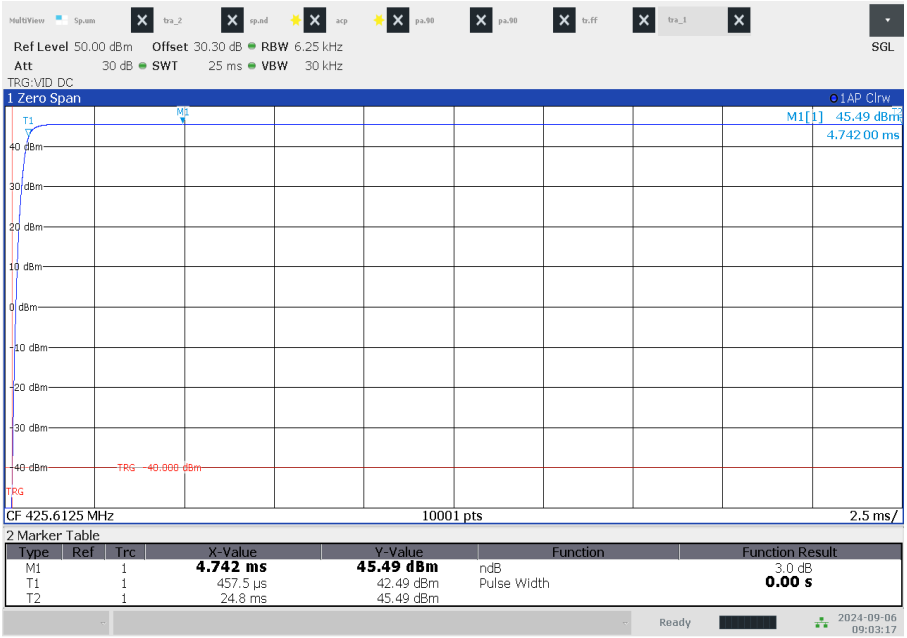


Plot 5: 425.6125 MHz – carrier



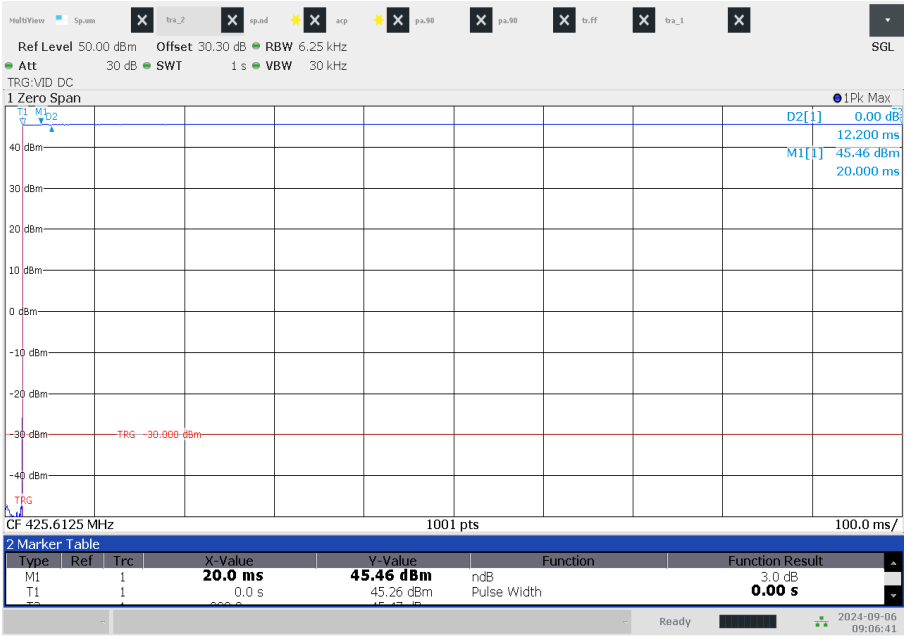
09:02:19 AM 09/06/2024

Plot 6: 425.6125 MHz – switch on (zoomed)

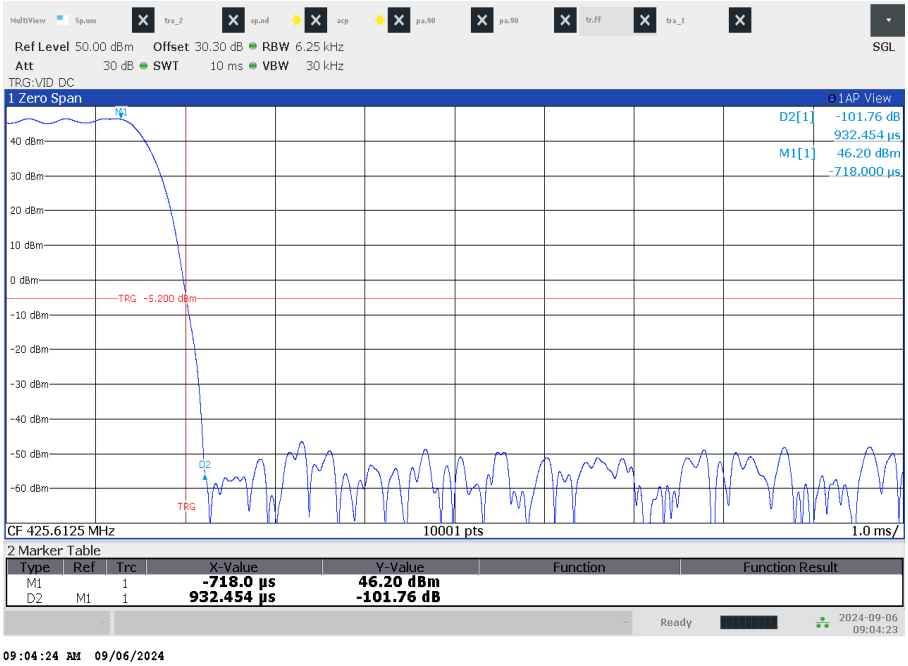


09:03:18 AM 09/06/2024

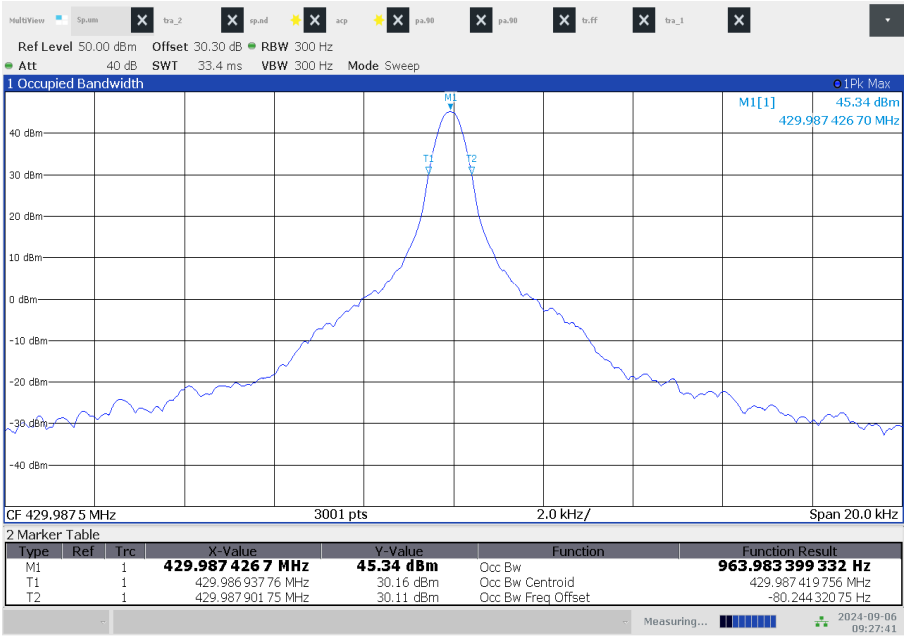
Plot 7: 425.6125 MHz – operating



Plot 8: 425.6125 MHz – switch off (zoomed)



Plot 9: 429.9875 MHz – carrier



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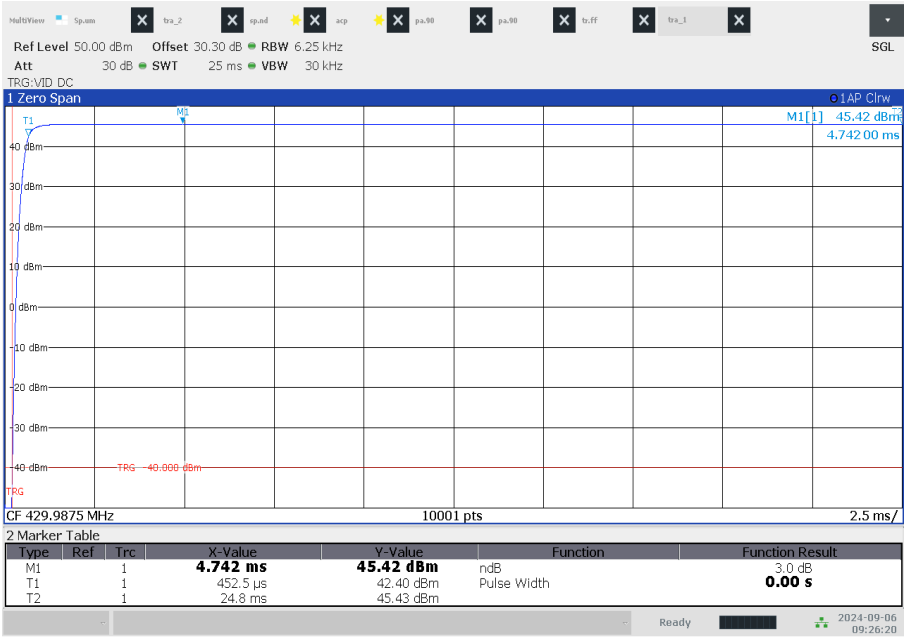
Plot 10: 429.9875 MHz – switch on (zoomed)



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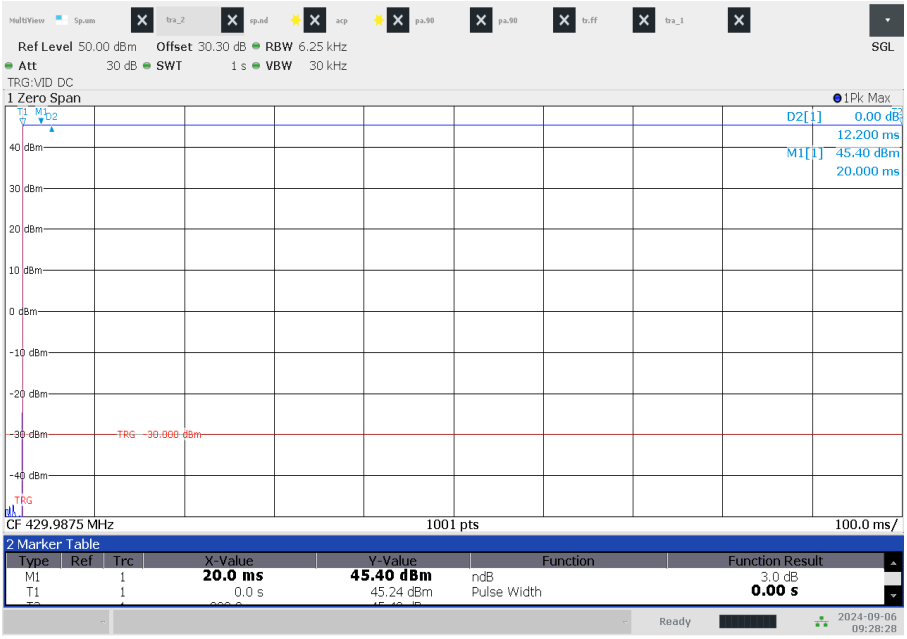
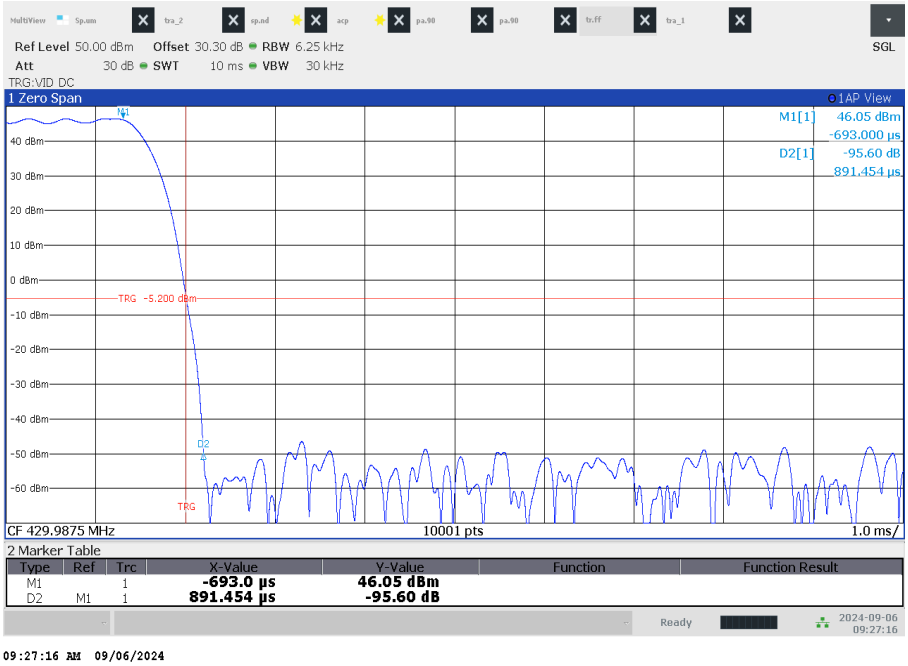
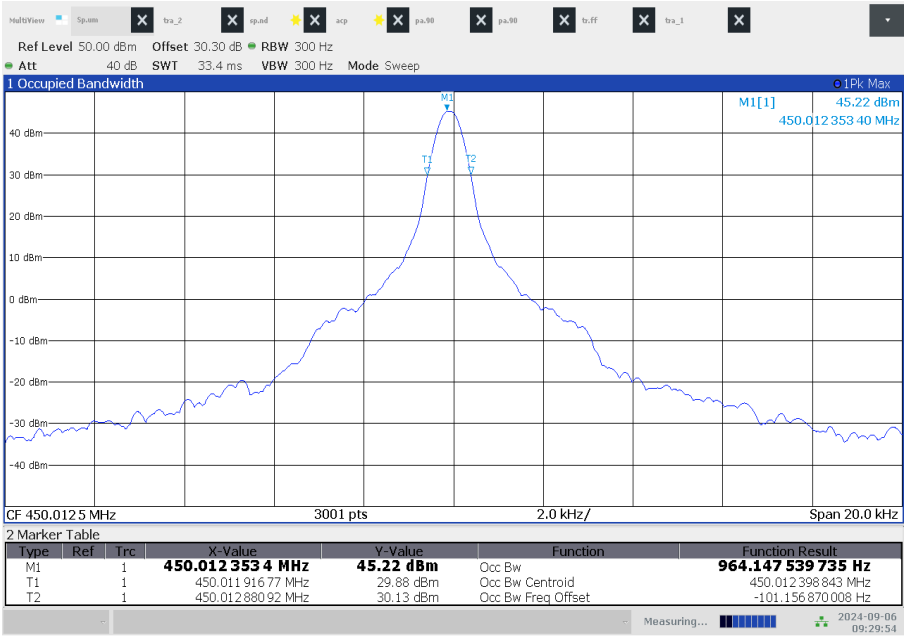
Plot 11: 429.9875 MHz – operating



Plot 12: 429.9875 MHz – switch off (zoomed)

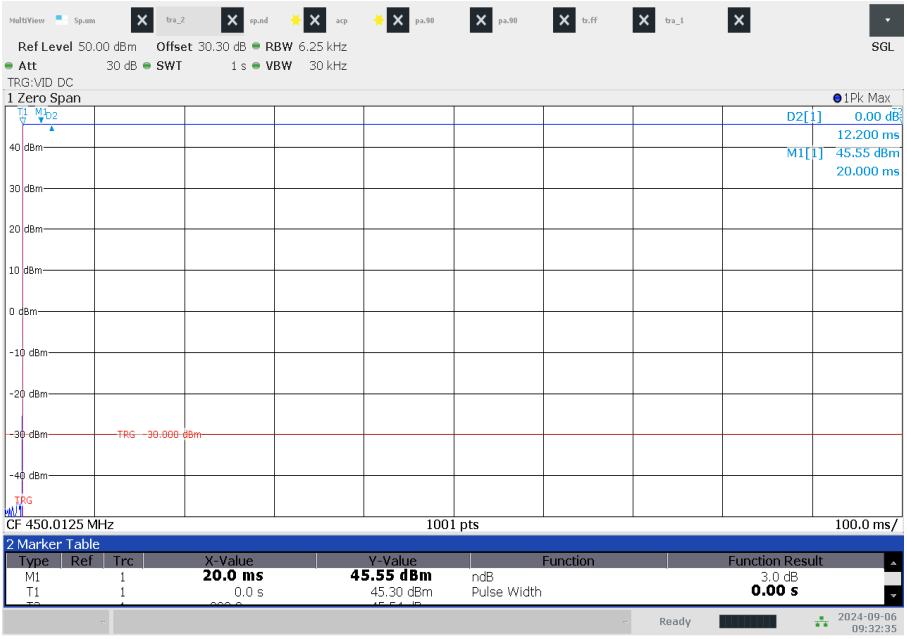


Plot 13: 450.0125 MHz – carrier



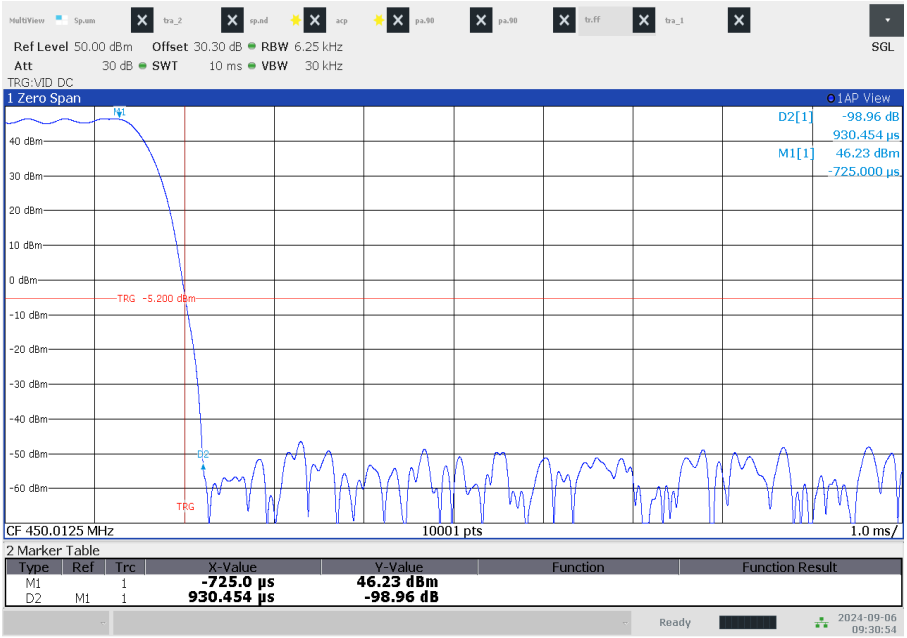
Plot 14: 450.0125 MHz – switch on (zoomed)

Plot 15: 450.0125 MHz – operating



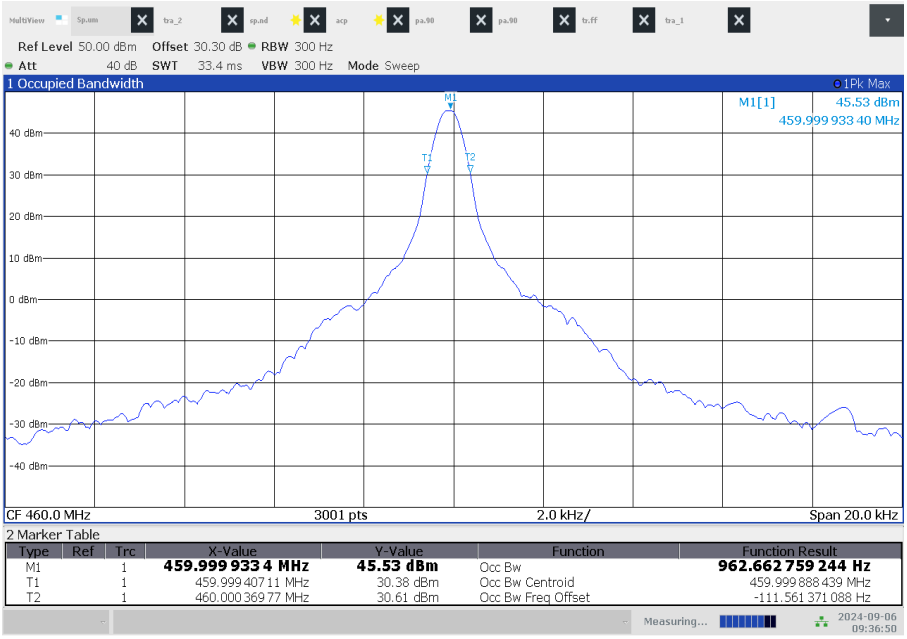
09:32:35 AM 09/06/2024

Plot 16: 450.0125 MHz – switch off (zoomed)



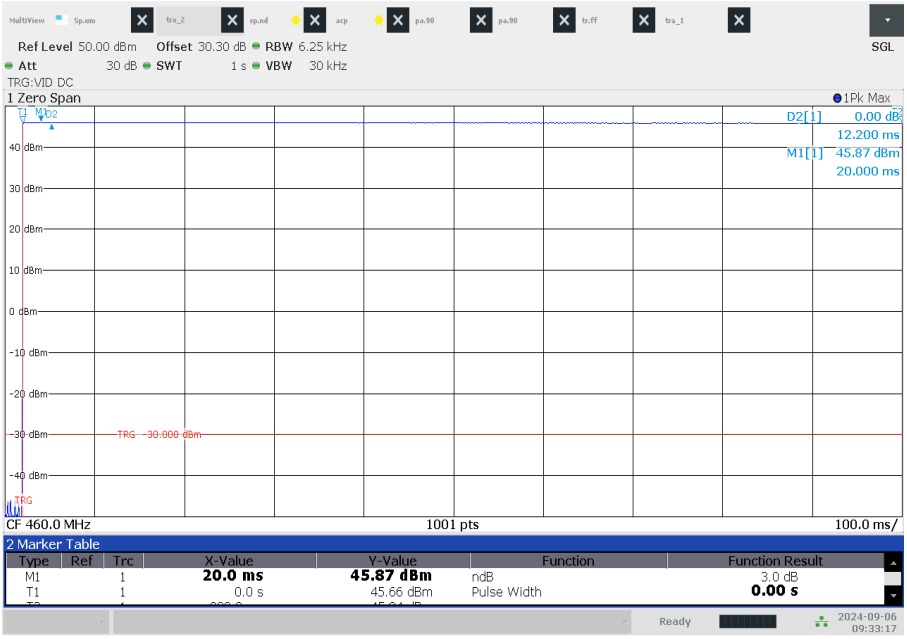
09:30:55 AM 09/06/2024

Plot 17: 460.0 MHz – carrier



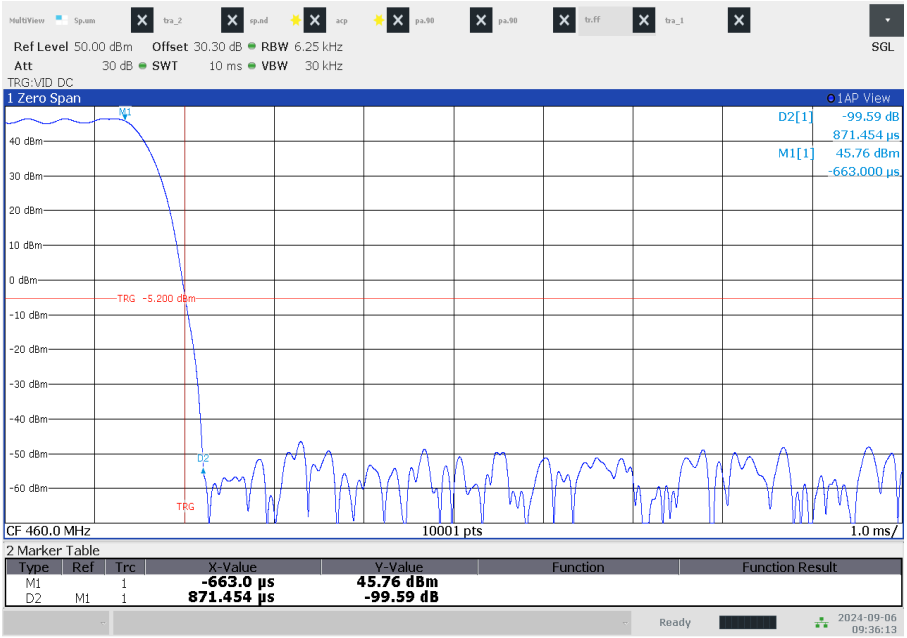
Plot 18: 460.0 MHz – switch on (zoomed)

Plot 19: 460.0 MHz – operating



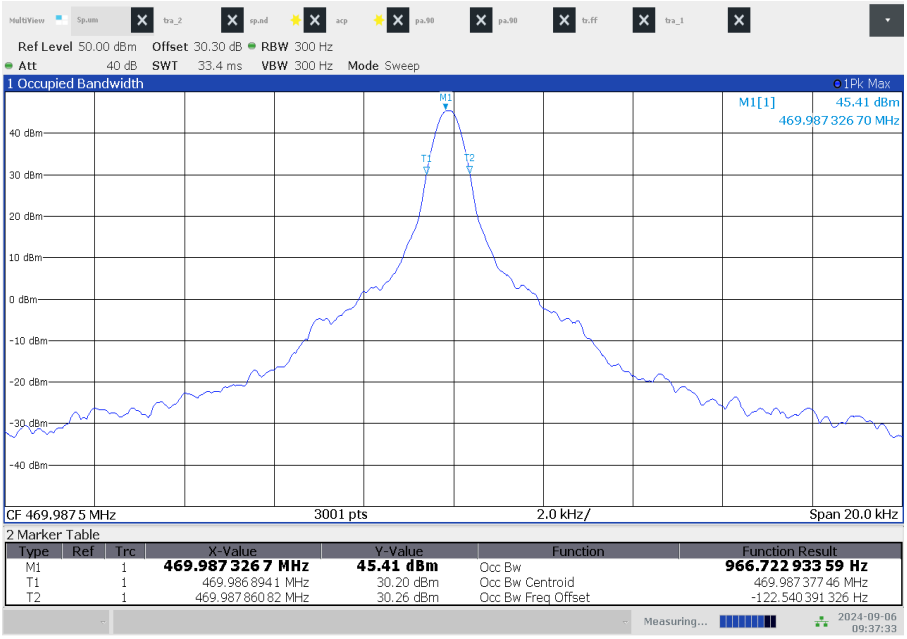
09:33:18 AM 09/06/2024

Plot 20: 460.0 MHz – switch off (zoomed)



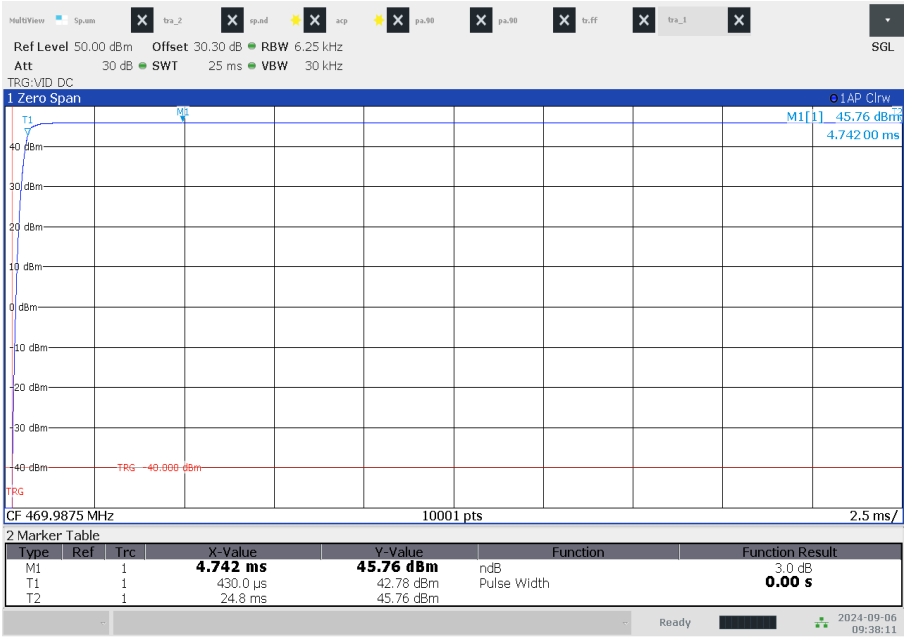
09:36:14 AM 09/06/2024

Plot 21: 469.9875 MHz – carrier



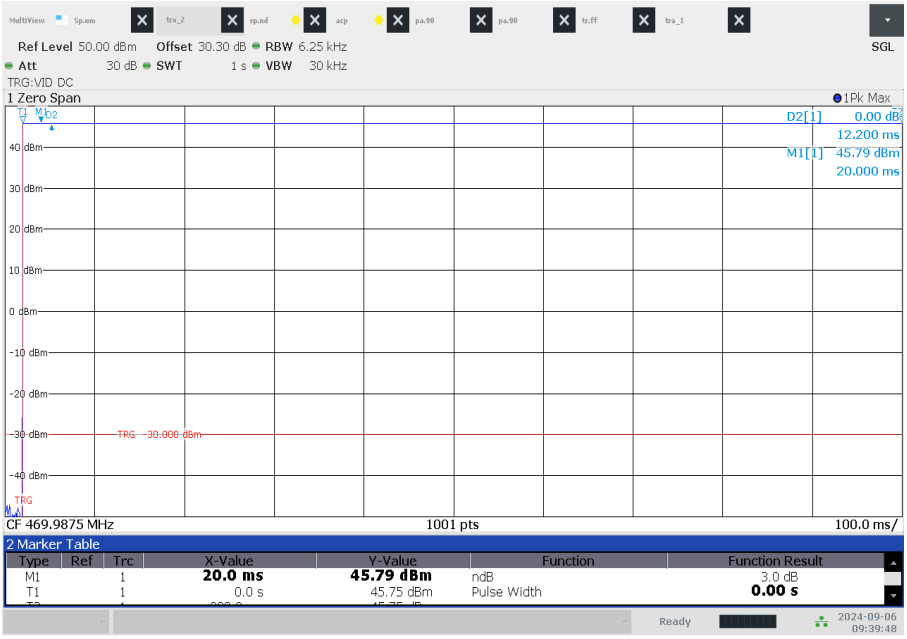
09:37:34 AM 09/06/2024

Plot 22: 469.9875 MHz – switch on (zoomed)

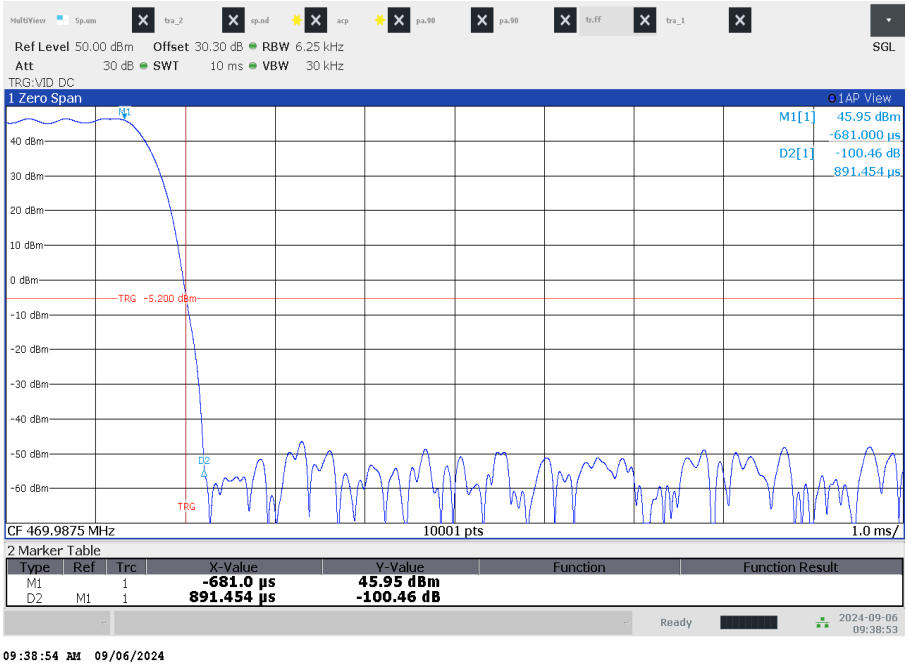


09:38:12 AM 09/06/2024

Plot 23: 469.9875 MHz – operating



Plot 24: 469.9875 MHz – switch off (zoomed)



13.6.2 Transient frequency behavior 25 kHz bandwidth channels

Measurement:
The first plot shows the measurement of the carrier signal to show that a clean carrier is transmitted which results in a measured bandwidth of nearly twice the used RBW.
The following plots show triggered measurements in the time domain with a RBW of 10 kHz (3-dB filter).
A decrease of this power level of 3 dB can be correlated to a frequency error of a half RBW (5 kHz).
Therefore the frequency error is less than ± 5 kHz as long as the power level is in the 3 dB range. This criteria was taken as worst case condition to show compliance.

Limits:

FCC		IC	
FCC 47 CFR § 90.214		RSS 119 Issue 12 5.9	
Transient frequency behavior			
Time intervals	Maximum frequency difference	Frequency range	
		150 – 174 MHz	421 - 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1	±25.0 kHz	5 ms	10 ms
t_2	±12.5 kHz	20 ms	25 ms
t_3	±25.0 kHz	5 ms	10 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1	±12.5 kHz	5 ms	10 ms
t_2	±6.25 kHz	20 ms	25 ms
t_3	±12.5 kHz	5 ms	10 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1	±6.25 kHz	5 ms	10 ms
t_2	±3.125 kHz	20 ms	25 ms
t_3	±6.25 kHz	5 ms	10 ms

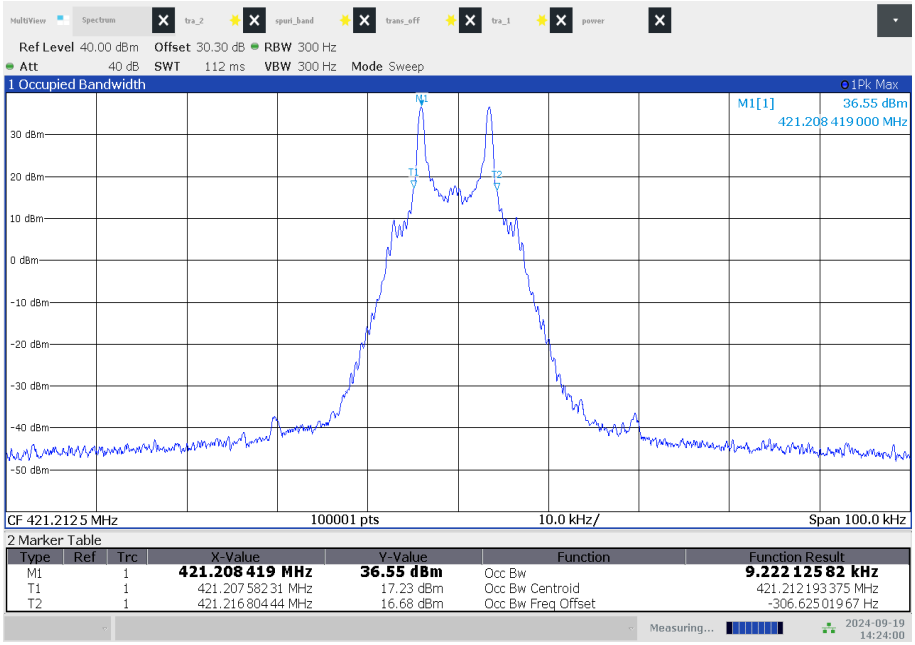
t1 is the time period immediately following ton.
t2 is the time period immediately following t1.
t3 is the time period from the instant when the transmitter is turned off until t_{off}.

Results:

	Transmit frequency MHz					
Test scenario	421.2125	425.6125	429.9875	450.0125	460.0000	469.9875
The frequency stabilizes within the required frequency tolerance range after switching on the transmitter during period t_1 after:	0.33 ms	0.32 ms	0.32 ms	0.31 ms	0.31 ms	0.31 ms
Maximum power deviation during t_2: (power deviation below 3 dB conforms a frequency deviation below ± 1.5 kHz)	0.05 dB	0.4 dB	0.59 dB	0.07 dB	0.04 dB	0.04 dB
Switch off time (t_3):	1.03 ms	1.04 ms	1.06 ms	1.01 ms	1.01 ms	1.02 ms

Plots of the measurement (512 bits per second):

Plot 1: 421.2125 MHz – carrier

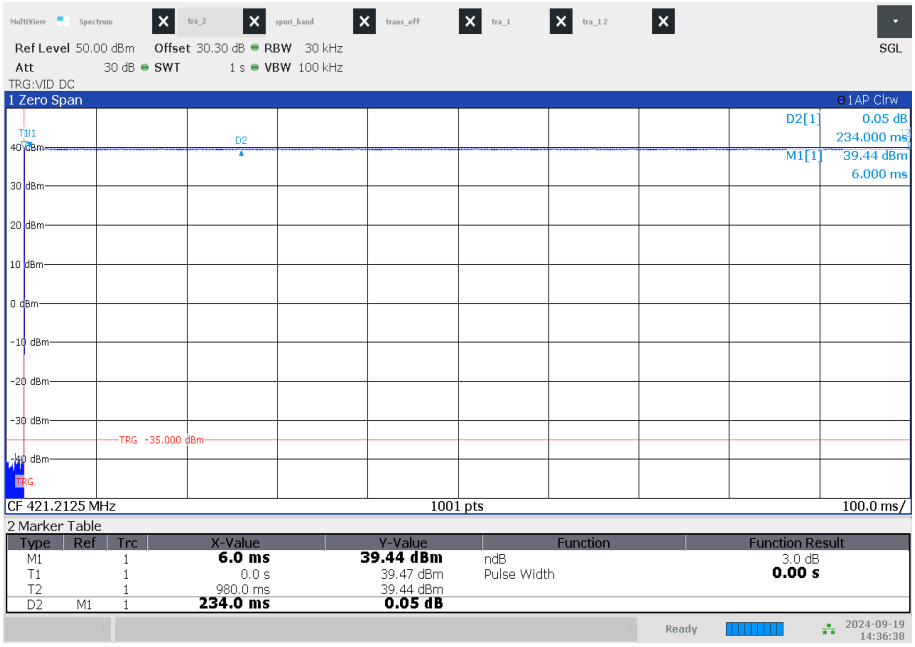


02:24:01 PM 09/19/2024

Plot 2: 421.2125 MHz – switch on (zoomed)

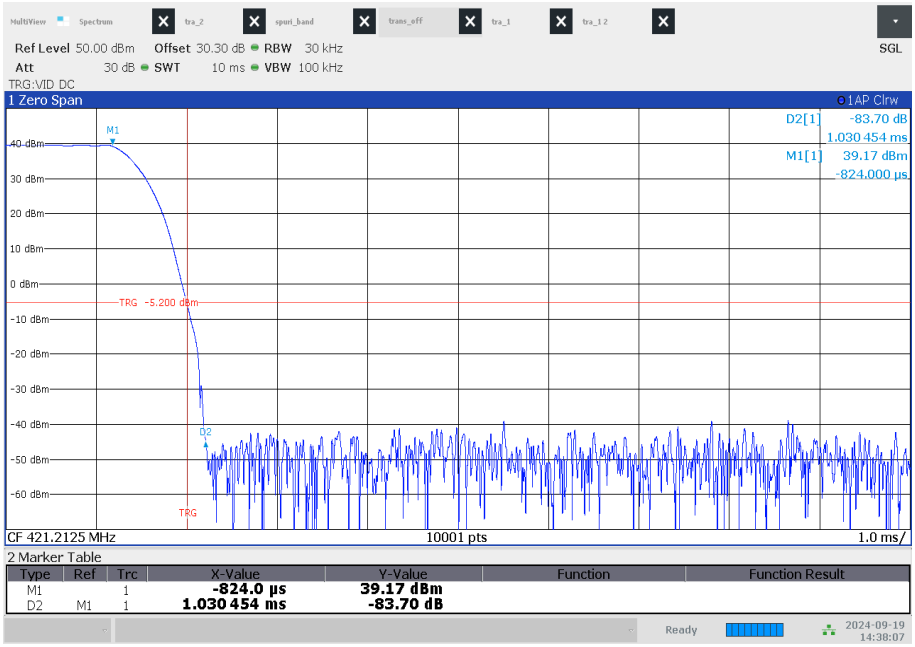
02:35:14 PM 09/19/2024

Plot 3: 421.2125 MHz – operating



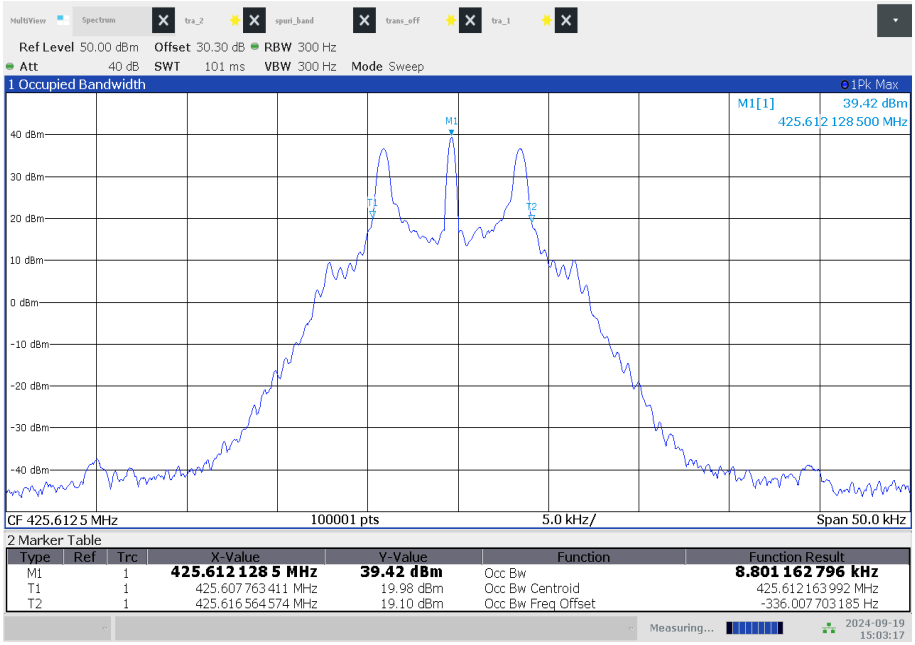
02:36:38 PM 09/19/2024

Plot 4: 421.2125 MHz – switch off (zoomed)



02:38:08 PM 09/19/2024

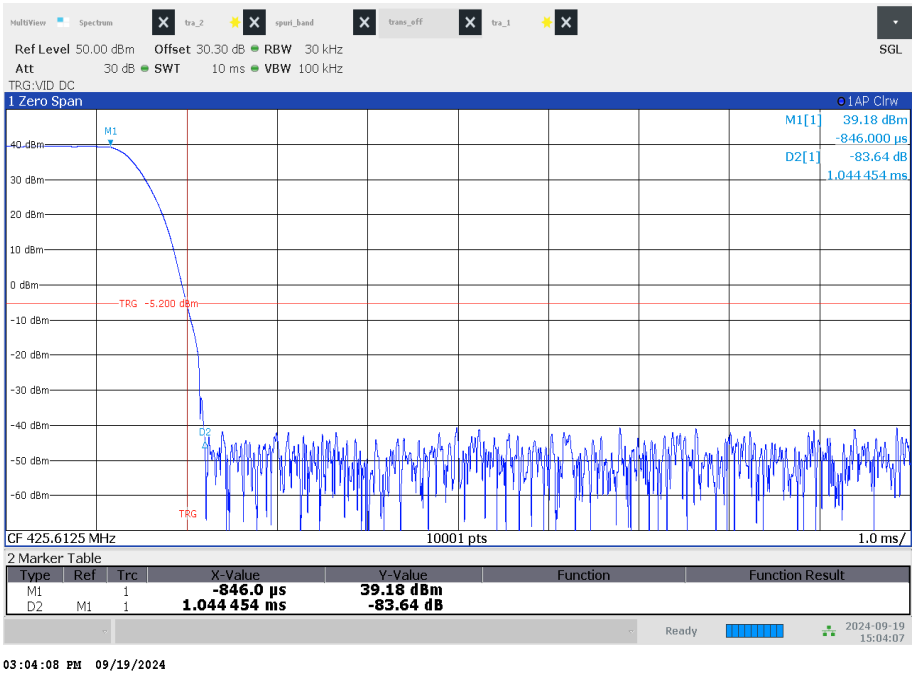
Plot 5: 425.6125 MHz – carrier



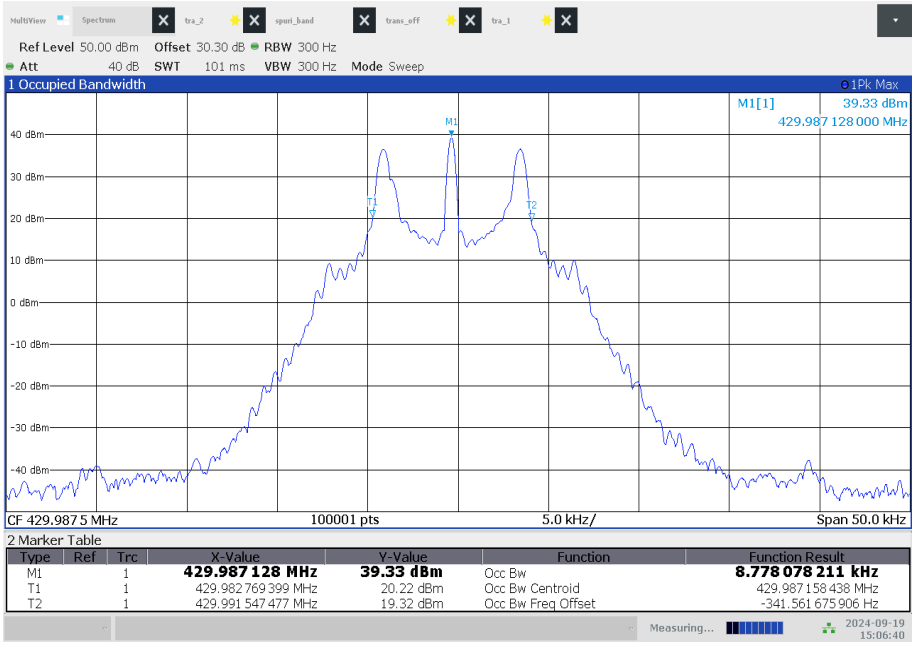
Plot 6: 425.6125 MHz – switch on (zoomed)

Plot 7: 425.6125 MHz – operating

Plot 8: 425.6125 MHz – switch off (zoomed)

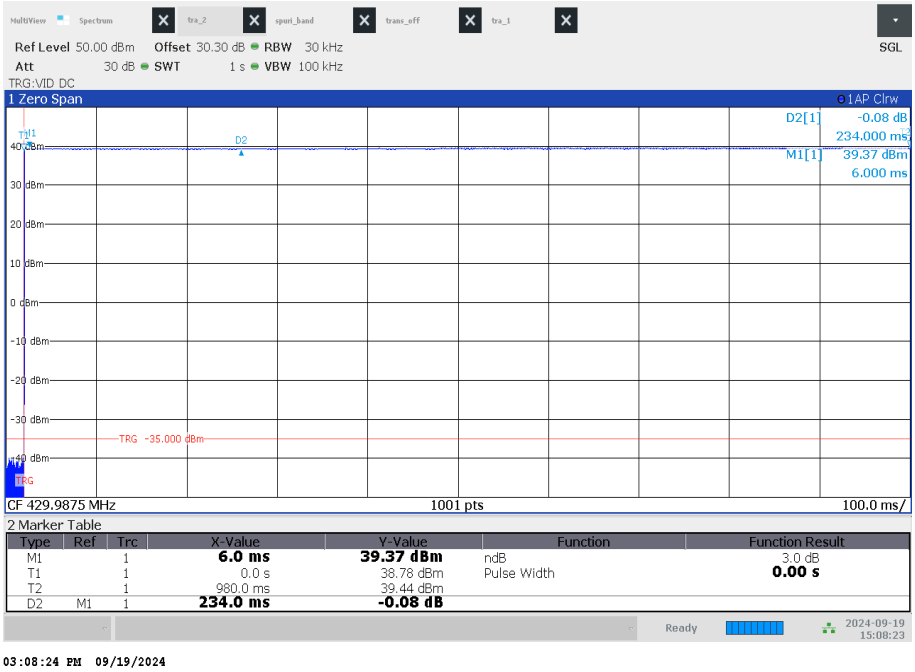


Plot 9: 429.9875 MHz – carrier

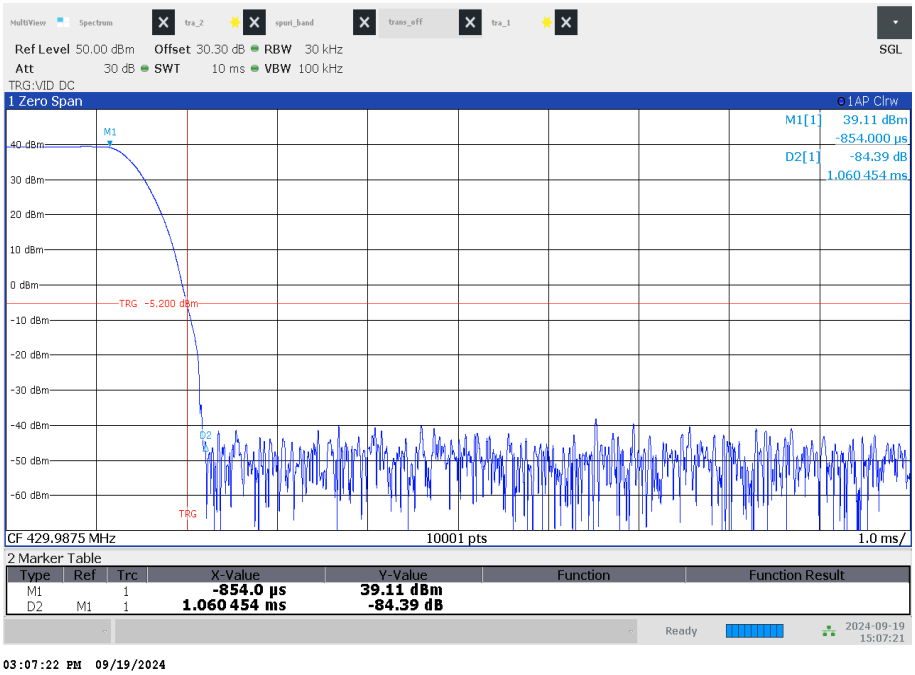


Plot 10: 429.9875 MHz – switch on (zoomed)

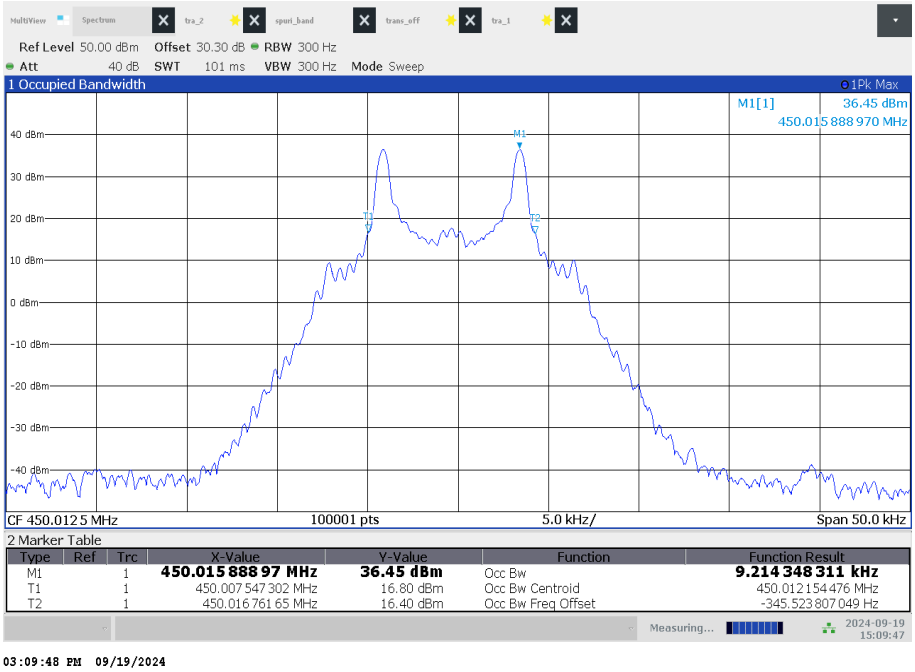
Plot 11: 429.9875 MHz – operating



Plot 12: 429.9875 MHz – switch off (zoomed)



Plot 13: 450.0125 MHz – carrier

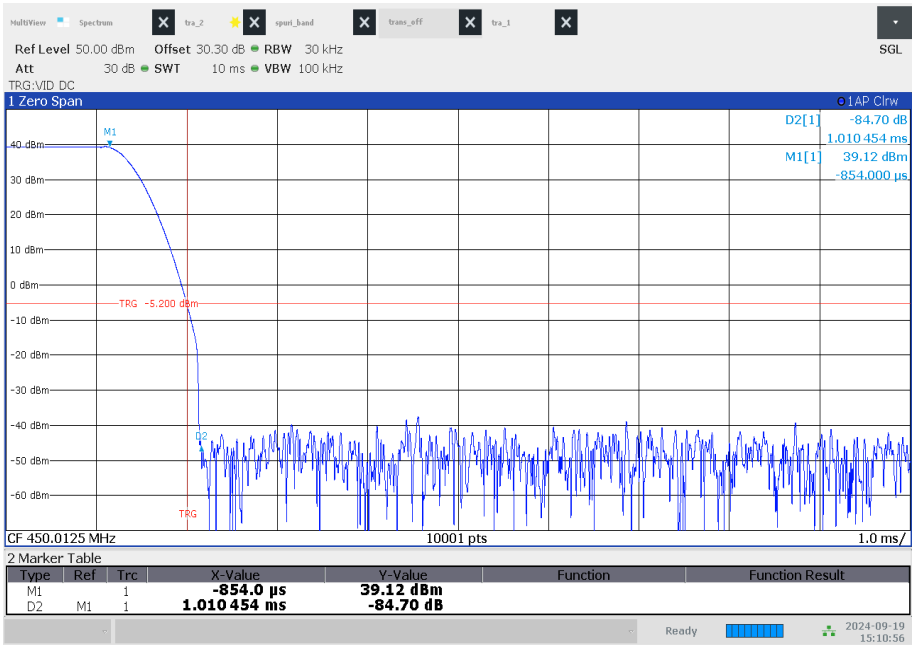


Plot 14: 450.0125 MHz – switch on (zoomed)

Plot 15: 450.0125 MHz – operating

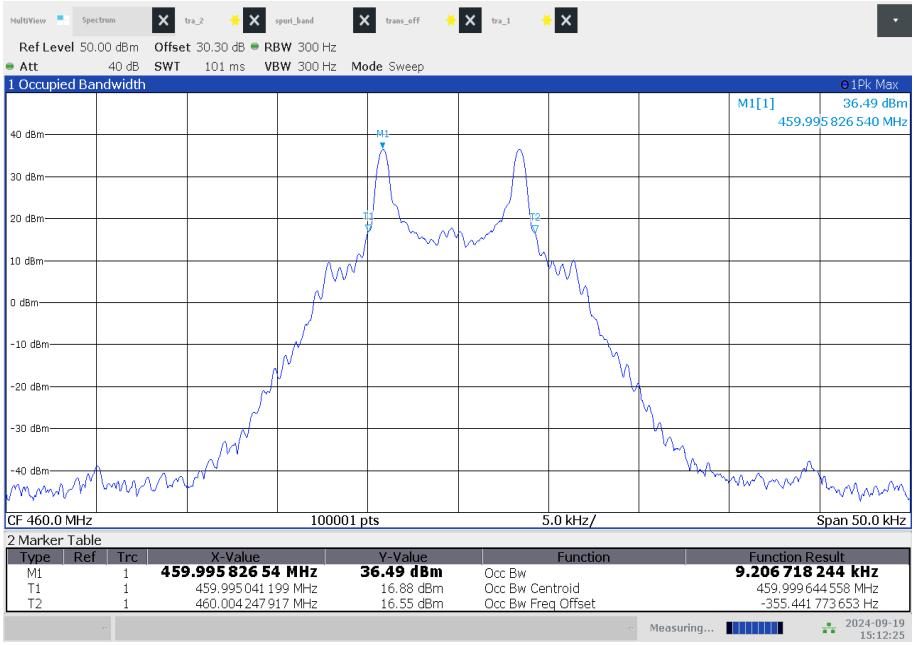
03:11:21 PM 09/19/2024

Plot 16: 450.0125 MHz – switch off (zoomed)



03:10:57 PM 09/19/2024

Plot 17: 460.000 MHz – carrier



03:12:26 PM 09/19/2024

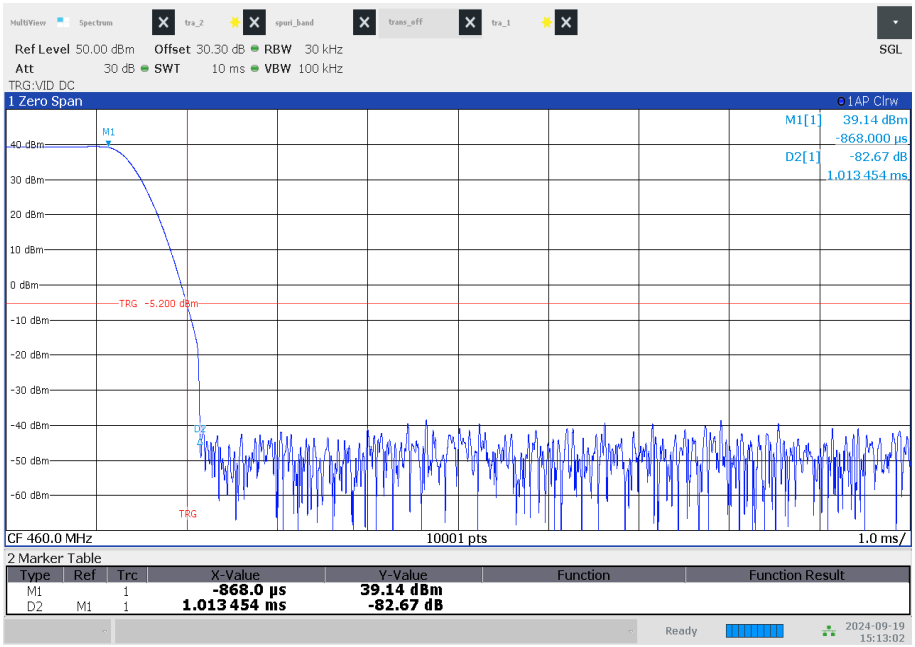
Plot 18: 460.000 MHz – switch on (zoomed)

03:14:06 PM 09/19/2024

Plot 19: 460.000 MHz – operating

03:14:35 PM 09/19/2024

Plot 20: 460.000 MHz – switch off (zoomed)



03:13:03 PM 09/19/2024