Spurious emissions (radiated) 9 kHz – 5 GHz

Standard:	ANSI C63.26-2015	
Tested by:	HEM	HEM
Date:	1 July 2023	2 July 2023
Temperature:	21 °C	20 °C
Humidity:	56 % RH	58 % RH
Barometric pressure:	997 hPa	991 hPa
Measurement uncertainty:	± 5.29 dB, level of confidence 95.45 % (k = 2)	
Test result:	**PASS**	

FCC Rule: §90.210

RSS-119 5.8

For transmitters that are not equipped with an audio low-pass filter. the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows: on any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth; at least 43 + 10 log (P) dB.

For transmitters designed to operate with a 12.5 kHz channel bandwidth. any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows: on any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: at least 50 + 10 log (P) or 70 dB. whichever is the lesser attenuation.

Frequency Band (MHz)	Channel Bandwidth (kHz)	Authorized Bandwidth (kHz)	Limit (dBm)
406.1 - 470	12.5	11.25	-20
	25	20	-13

Test plan

The test was performed in a semi-anechoic chamber. The EUT was placed on a non-conductive table standing on a turntable. The distance between the EUT and the measurement antenna was 3 m. In order to find the maximum levels of the disturbance radiation the angle of the turntable. and the height of the measuring antenna were varied during the tests. The test was performed with the measurement antenna in both horizontal and vertical polarizations.

The EUT is tested in different combinations of channel bandwidth, TX frequency and EUT orientation. If emissions near the limit are detected with any combination, other combinations are investigated as well. The antenna connector was terminated with a 50 Ω load. The last number after the figure capitation indicates the EUT orientation (1=side towards the ground, 2=display towards the ground, 3=power connector downwards).

Test results

Frequency [MHz]	TX power [mW]	Ch. Width [kHz]	Modulation	Result
406.6 - 469.5	35000	12.5	GMSK 9600	PASS
406.6 - 469.5	35000	25.0	GMSK 19200	PASS

TX 35 W, GMSK, 9 kHz - 30 MHz

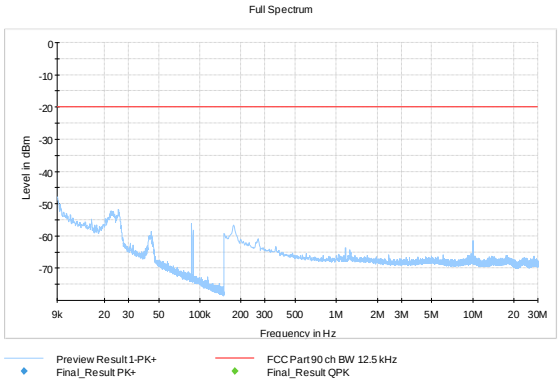

Figure 76: 406.6 MHz, 9600 bps, 12.5 kHz, 1

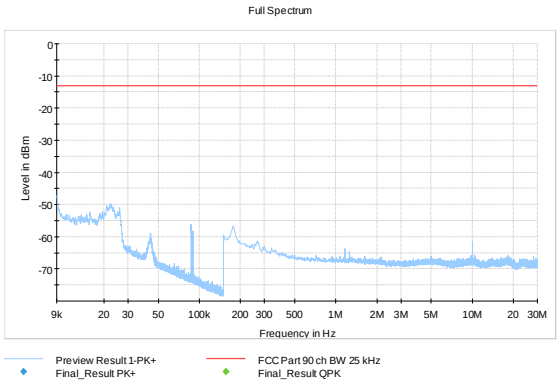

Figure 77: 406.6 MHz, 19200 bps, 25 kHz, 2

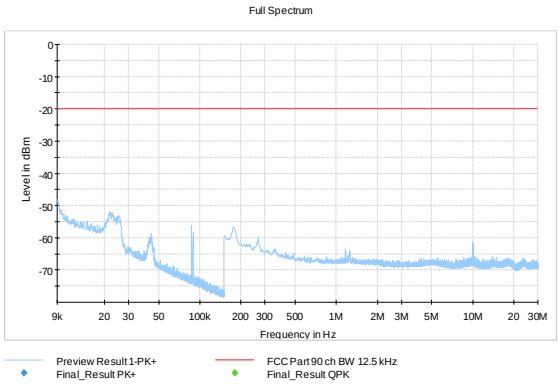

Figure 78: 429.5 MHz, 9600 bps, 12.5 kHz, 1

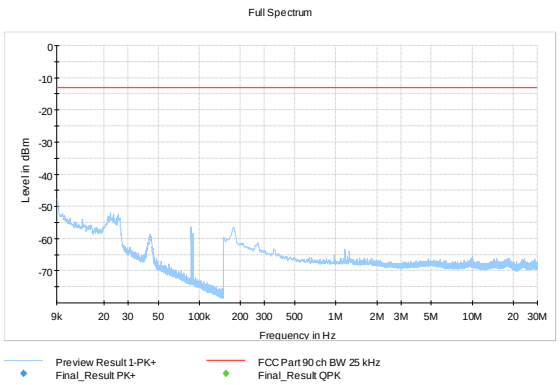

Figure 79: 429.5 MHz, 19200 bps, 25 kHz, 3

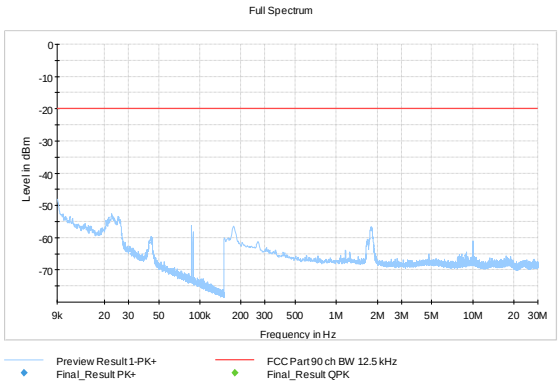

Figure 80: 440.0 MHz, 9600 bps, 12.5 kHz, 2

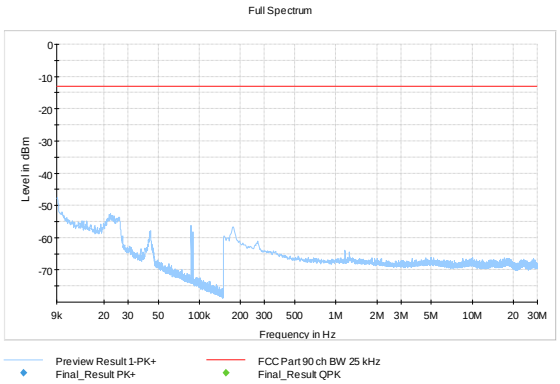

Figure 81: 440.0 MHz, 19200 bps, 25 kHz, 3

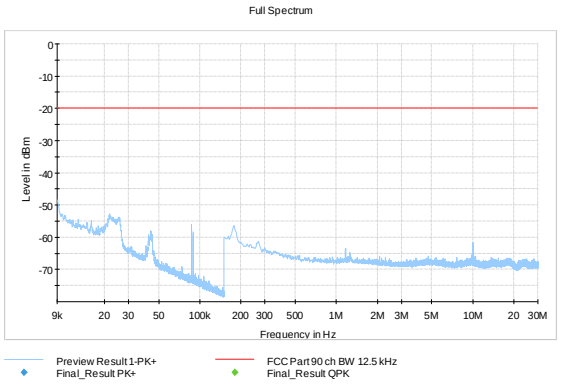

Figure 82: 450.5 MHz, 9600 bps, 12.5 kHz, 2

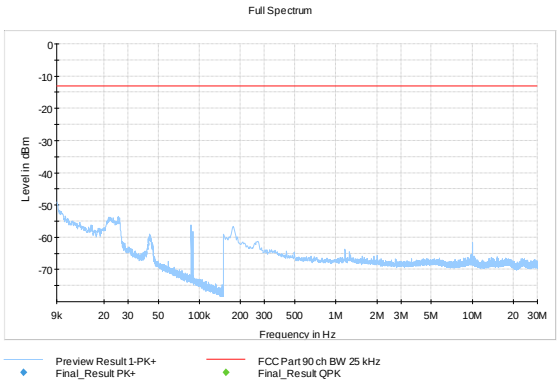

Figure 83: 450.5 MHz, 19200 bps, 25 kHz, 1

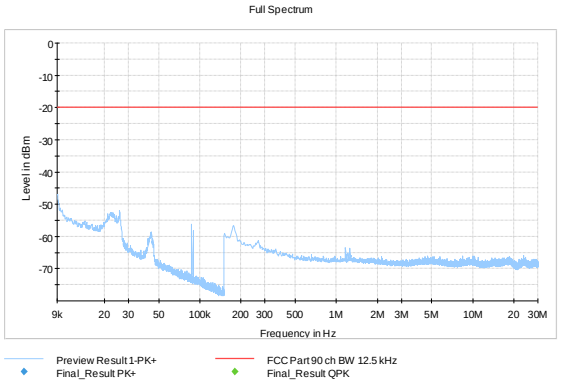

Figure 84: 469.5 MHz, 9600 bps, 12.5 kHz, 3

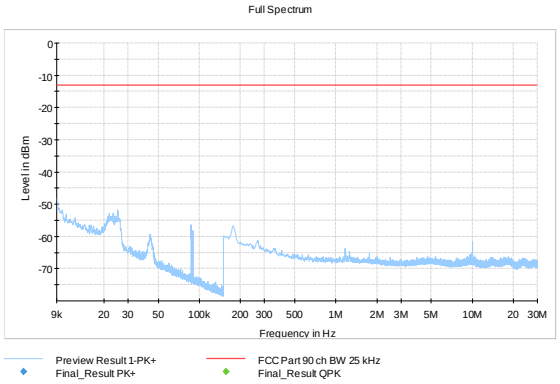

Figure 85: 469.5 MHz, 19200 bps, 25 kHz, 1

TX 35 W, GMSK, 30 - 1000 MHz

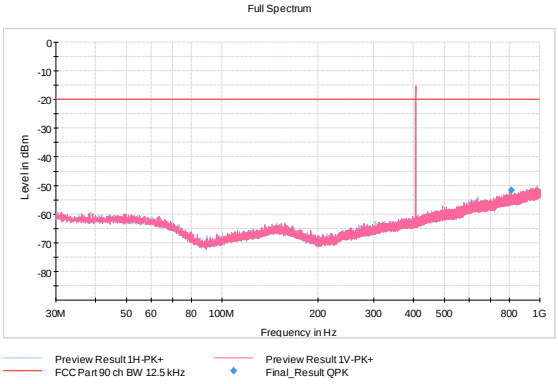

Figure 86: 406.6 MHz, 9600 bps, 12.5 kHz, 1

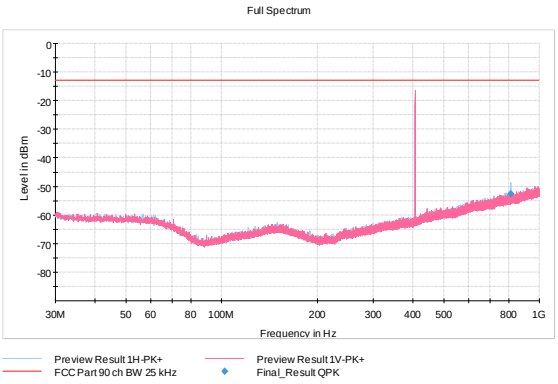

Figure 87: 406.6 MHz, 19200 bps, 25 kHz, 2

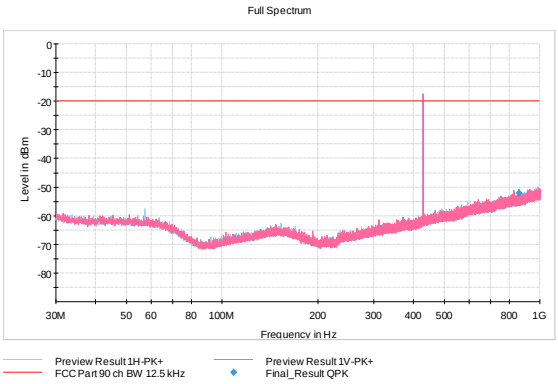

Figure 88: 429.5 MHz, 9600 bps, 12.5 kHz, 1

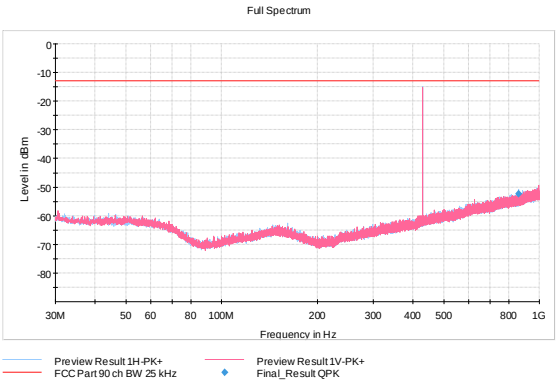

Figure 89: 429.5 MHz, 19200 bps, 25 kHz, 3

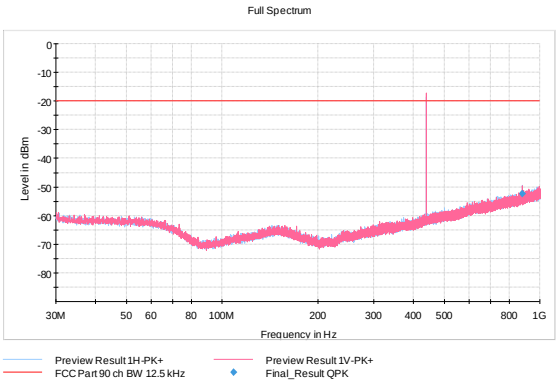

Figure 90: 440.0 MHz, 9600 bps, 12.5 kHz, 2

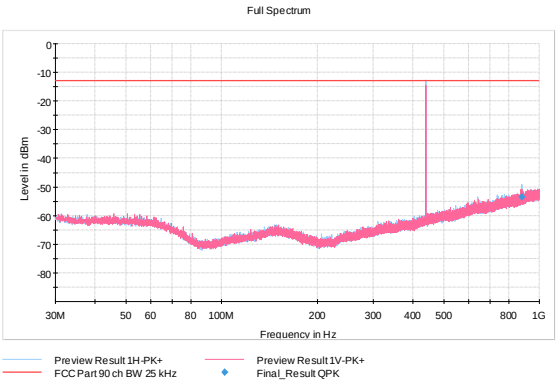

Figure 91: 440.0 MHz, 19200 bps, 25 kHz, 3

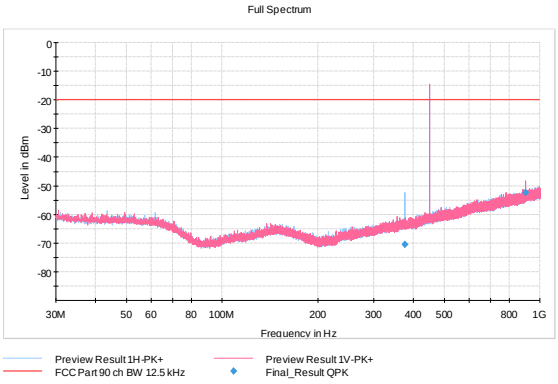

Figure 92: 450.5 MHz, 9600 bps, 12.5 kHz, 2

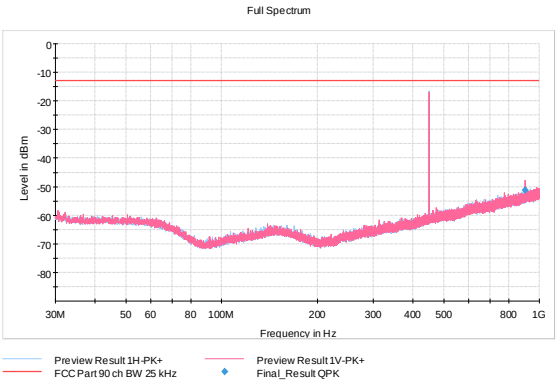

Figure 93: 450.5 MHz, 19200 bps, 25 kHz, 1

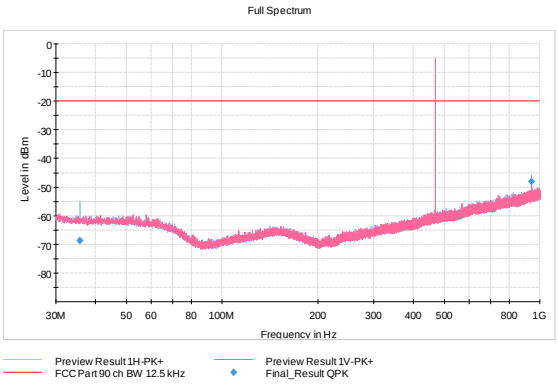

Figure 94: 469.5 MHz, 9600 bps, 12.5 kHz, 3

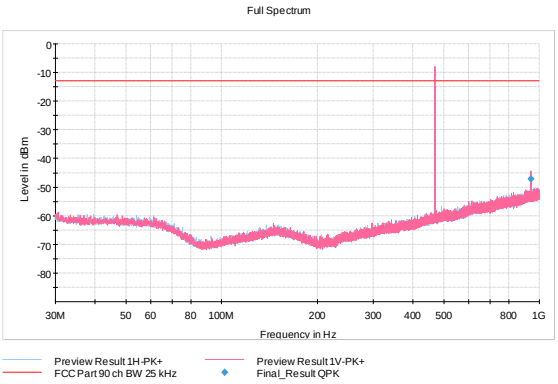

Figure 95: 469.5 MHz, 19200 bps, 25 kHz, 1

TX 35 W, GMSK, 1 - 5 GHz

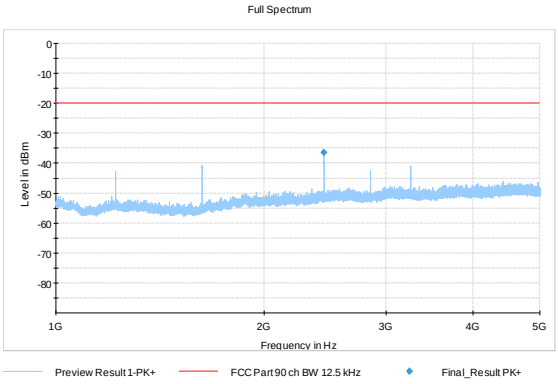

Figure 96: 406.6 MHz, 9600 bps, 12.5 kHz, 1

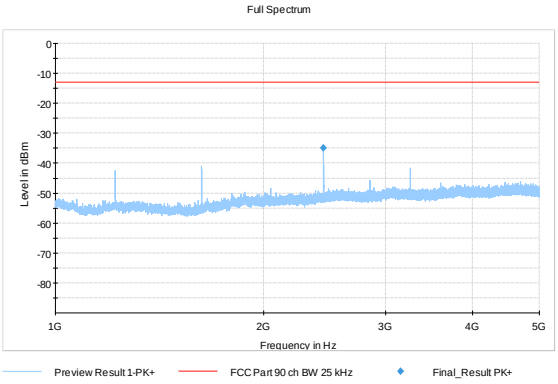

Figure 97: 406.6 MHz, 19200 bps, 25 kHz, 2

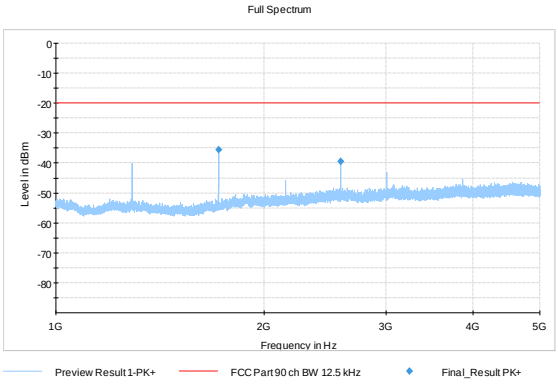

Figure 98: 429.5 MHz, 9600 bps, 12.5 kHz, 1

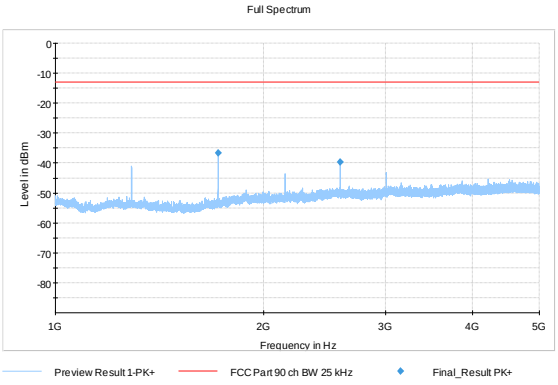

Figure 99: 429.5 MHz, 19200 bps, 25 kHz, 3

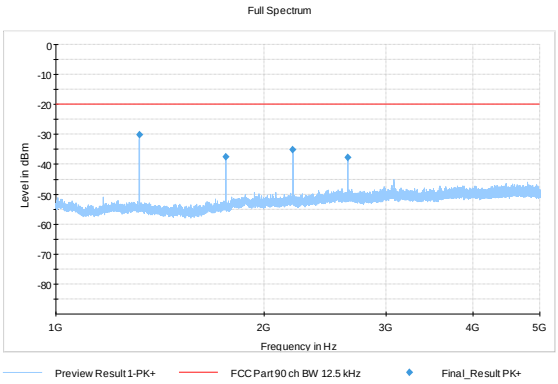

Figure 100: 440.0 MHz, 9600 bps, 12.5 kHz, 2

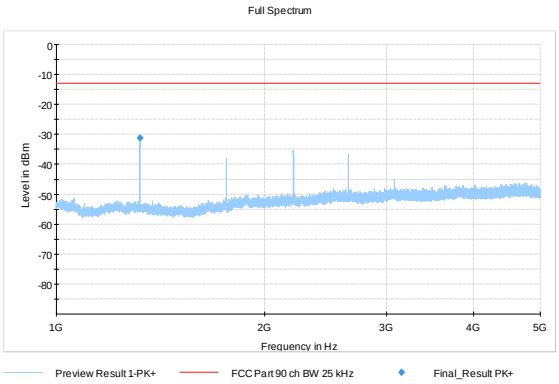

Figure 101: 440.0 MHz, 19200 bps, 25 kHz, 3

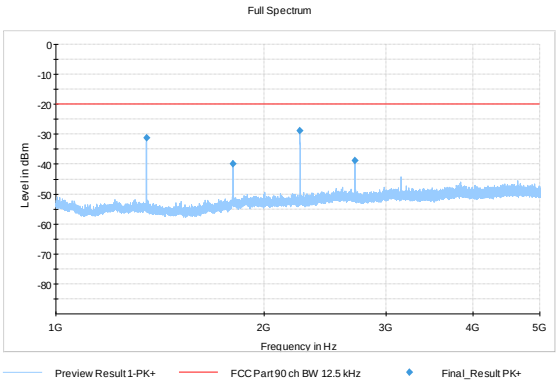

Figure 102:450.5 MHz, 9600 bps, 12.5 kHz, 2

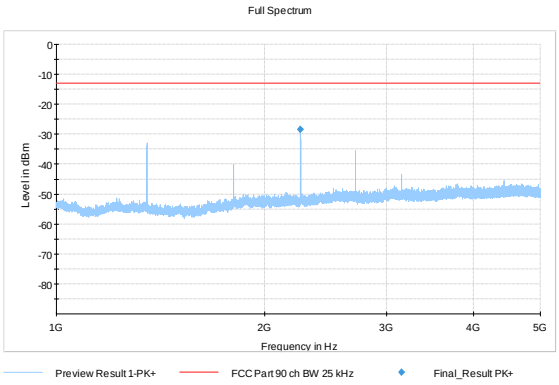

Figure 103: 450.5 MHz, 19200 bps, 25 kHz, 1

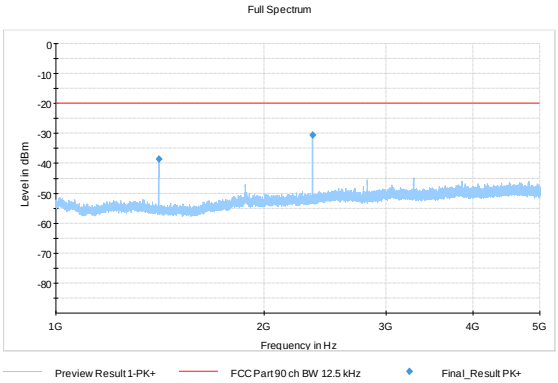

Figure 104: 469.5 MHz, 9600 bps, 12.5 kHz, 3

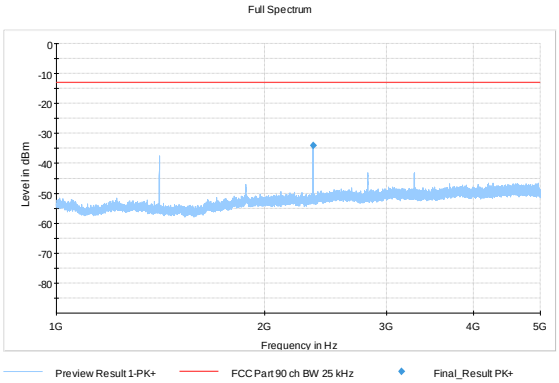

Figure 105: 469.5 MHz, 19200 bps, 25 kHz, 1

Frequency stability

Standard:	ANSI C63.26-2015		
Tested by:	HAM	HAM	HAM
Date:	10 July 2023	11 July 2023	12 July 2023
Temperature:	23 °C	22 °C	24 °C
Humidity:	39 % RH	42 % RH	44 % RH
Barometric pressure:	989 hPa	1005 hPa	1010 hPa
Measurement uncertainty:	± 0.470 dB (level of confidence 95.45 % (k = 2))		
Test result:	**PASS**		

FCC Rule: §90.213

RSS-119 5.3

Frequency stability is a measure of drift due to temperature and supply voltage variations. with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage. The carrier frequency shall not depart from the nominal frequency in excess of the values specified for the equipment's frequency band:

Frequency Band (MHz)	Channel Bandwidth (kHz)	Frequency Stability (ppm)
406.1 - 470	12.5	± 2.5
	25.0	± 5

The test was performed with unmodulated carrier at maximum power level when possible. With low supply voltages the output power is restricted to 5 W.

The power levels more than 5 W requires supply voltage 12.0 to 30.0 VDC. Power levels 5 W or less operates also with voltage levels 9.0 to 11.00 VDC.

Test results channel width 12.5 kHz

Table 6: Frequency stability (normal temperature)

Test Conditions		Frequency (MHz)		Deviation from Nominal (ppm)	Result
Temperature (°C)	Voltage (V)	Nominal	Measured		
+20	8.0 (5 W)	406.6	406.600069370	0.17	PASS
		440.0	440.000183120	0.42	PASS
		469.5	469.500075940	0.16	PASS
	9.0 (5 W)	406.6	406.600068750	0.17	PASS
		440.0	440.000186870	0.42	PASS
		469.5	469.500076250	0.16	PASS
	11.0 (5 W)	406.6	406.600068120	0.17	PASS
		440.0	440.000180930	0.41	PASS
		469.5	469.500076560	0.16	PASS
	12.0	406.6	406.600067500	0.17	PASS
		440.0	440.000182490	0.41	PASS
		469.5	469.500076870	0.16	PASS
	30.0	406.6	406.600067500	0.17	PASS
		440.0	440.000183740	0.42	PASS
		469.5	469.500077190	0.16	PASS
	34.5	406.6	406.600067810	0.17	PASS
		440.0	440.000185620	0.42	PASS
		469.5	469.500077190	0.16	PASS

Frequency stability

Table 7: Frequency stability (extreme temperature. input voltage 12.0 V)

Temperature (°C)	Frequency (MHz)		Deviation from Nominal (ppm)	Result
	Nominal	Measured		
-35	406.6	406.600082500	0,20	PASS
	440.0	440.000161240	0,37	PASS
	469.5	469.500045310	0,10	PASS
-30	406.6	406.600016870	0,04	PASS
	440.0	440.000170310	0,39	PASS
	469.5	469.500014060	0,03	PASS
-20	406.6	406.600026560	0,07	PASS
	440.0	440.000164060	0,37	PASS
	469.5	469.500030940	0,07	PASS
-10	406.6	406.600040620	0,10	PASS
	440.0	440.000162180	0,37	PASS
	469.5	469.500038750	0,08	PASS
0	406.6	406.600069060	0,17	PASS
	440.0	440.000190620	0,43	PASS
	469.5	469.500088750	0,19	PASS
+10	406.6	406.600101870	0,25	PASS
	440.0	440.000218740	0,50	PASS
	469.5	469.500120000	0,26	PASS
+20	406.6	406.600092810	0,23	PASS
	440.0	440.000213120	0,48	PASS
	469.5	469.500098430	0,21	PASS
+30	406.6	406.600057190	0,14	PASS
	440.0	440.000204370	0,46	PASS
	469.5	469.500060000	0,13	PASS
+40	406.6	406.600035620	0,09	PASS
	440.0	440.000234060	0,53	PASS
	469.5	469.500035310	0,08	PASS
+50	406.6	406.599985310	-0,04	PASS
	440.0	440.000246550	0,56	PASS
	469.5	469.499967810	-0,07	PASS
+60	406.6	406.599939380	-0,15	PASS
	440.0	440.000255930	0,58	PASS
	469.5	469.499927190	-0,16	PASS

Test results channel width 25 kHz

Table 8: Frequency stability (normal temperature)

Test Conditions		Frequency (MHz)		Deviation from Nominal (ppm)	Result
Temperature (°C)	Voltage (V)	Nominal	Measured		
+20	8.0 (5 W)	406.6	406.600065620	0.16	PASS
		440.0	440.000189370	0.43	PASS
		469.5	469.500073750	0.16	PASS
	9.0 (5 W)	406.6	406.600065000	0.16	PASS
		440.0	440.000189060	0.43	PASS
		469.5	469.500074060	0.16	PASS
	11.0 (5 W)	406.6	406.600065310	0.16	PASS
		440.0	440.000189370	0.43	PASS
		469.5	469.500073750	0.16	PASS
	12.0	406.6	406.600065000	0.16	PASS
		440.0	440.000186560	0.42	PASS
		469.5	469.500073440	0.16	PASS
	30.0	406.6	406.600065310	0.16	PASS
		440.0	440.000186560	0.42	PASS
		469.5	469.500073440	0.16	PASS
	34.5	406.6	406.600065310	0.16	PASS
		440.0	440.000185310	0.42	PASS
		469.5	469.500073440	0.16	PASS

Table 9: Frequency stability (extreme temperature. input voltage 12.0 V)

Temperature (°C)	Frequency (MHz)		Deviation from Nominal (ppm)	Result
	Nominal	Measured		
-35	406.6	406.600025000	0.06	PASS
	440.0	440.000162810	0.37	PASS
	469.5	469.500040000	0.09	PASS
-30	406.6	406.600021870	0.05	PASS
	440.0	440.000170930	0.39	PASS
	469.5	469.500017190	0.04	PASS
-20	406.6	406.600028120	0.07	PASS
	440.0	440.000160310	0.36	PASS
	469.5	469.500029060	0.06	PASS
-10	406.6	406.600031870	0.08	PASS
	440.0	440.000158430	0.36	PASS
	469.5	469.500040620	0.09	PASS
0	406.6	406.600083120	0.20	PASS
	440.0	440.000194370	0.44	PASS
	469.5	469.500087180	0.19	PASS
+10	406.6	406.600102180	0.25	PASS
	440.0	440.000217180	0.49	PASS
	469.5	469.500119680	0.25	PASS
+20	406.6	406.600080000	0.20	PASS
	440.0	440.000208430	0.47	PASS
	469.5	469.500095620	0.20	PASS
+30	406.6	406.600049690	0.12	PASS
	440.0	440.000205310	0.47	PASS
	469.5	469.500057500	0.12	PASS
+40	406.6	406.600026250	0.06	PASS
	440.0	440.000244050	0.55	PASS
	469.5	469.500032810	0.07	PASS
+50	406.6	406.599963440	-0.09	PASS
	440.0	440.000247180	0.56	PASS
	469.5	469.499964060	-0.08	PASS
+60	406.6	406.599941250	-0.14	PASS
	440.0	440.000261240	0.59	PASS
	469.5	469.499926250	-0.16	PASS

Transient frequency behaviour

Standard:	ANSI C63.26-2015	
Tested by:	HAM	HAM
Date:	4 July 2023	10 July 2023
Temperature:	25 °C	23 °C
Humidity:	42 % RH	39 % RH
Barometric pressure:	998 hPa	1021 hPa
Test result:	**PASS**	

FCC Rule: §90.214

RSS-119 5.9

When a transmitter is turned on or off. the radio frequency may take some time to stabilize. During this initial period. the frequency error or frequency difference (i.e., between the instantaneous and the steady state frequencies) shall not exceed the limits specified for the equipment's frequency band and channel bandwidth:

Channel Bandwidth (kHz)	Time Intervals	Maximum Frequency Difference (kHz)	Transient Duration Limit (ms)
12.5	t_1	±12.5	10
	t_2	±6.25	25
	t_3	±12.5	10
25	t_1	±25	10
	t_2	±12.5	25
	t_3	±25	10

- t_{on} is the instant when a 1 kHz test signal is completely suppressed. including any capture time due to phasing
- t_1 is the time period immediately following t_{on}
- t_2 is the time period immediately following t_1
- t_3 is the time period from the instant when the transmitter is turned off until t_{off}
- t_{off} is the instant when the 1 kHz test signal starts to rise

The test was performed with unmodulated carrier at maximum power level.

Test results

Frequency [MHz]	TX power [mW]	Ch. Width [kHz]	Result
406.6	35000	12.5	PASS
429.5	35000	12.5	PASS
440.0	35000	12.5	PASS
450.5	35000	12.5	PASS
469.5	35000	12.5	PASS
406.6	35000	25	PASS
429.5	35000	25	PASS
440.0	35000	25	PASS
450.5	35000	25	PASS
469.5	35000	25	PASS

Transmitter OFF to ON (12.5 kHz channel bandwidth)

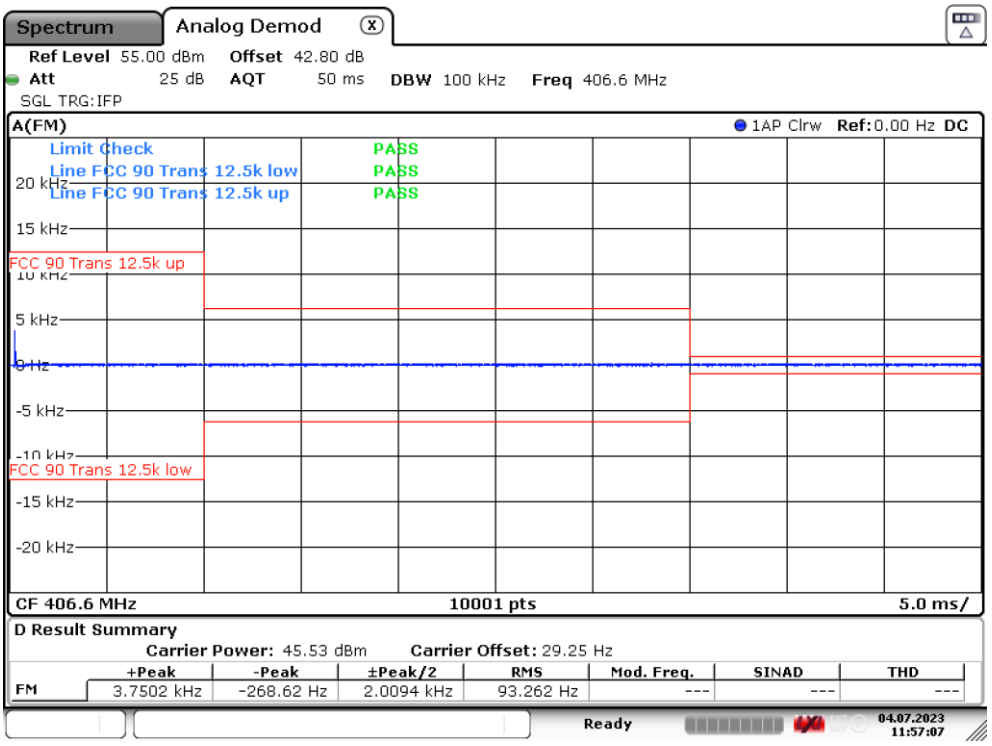

Figure 106: 406.6 MHz

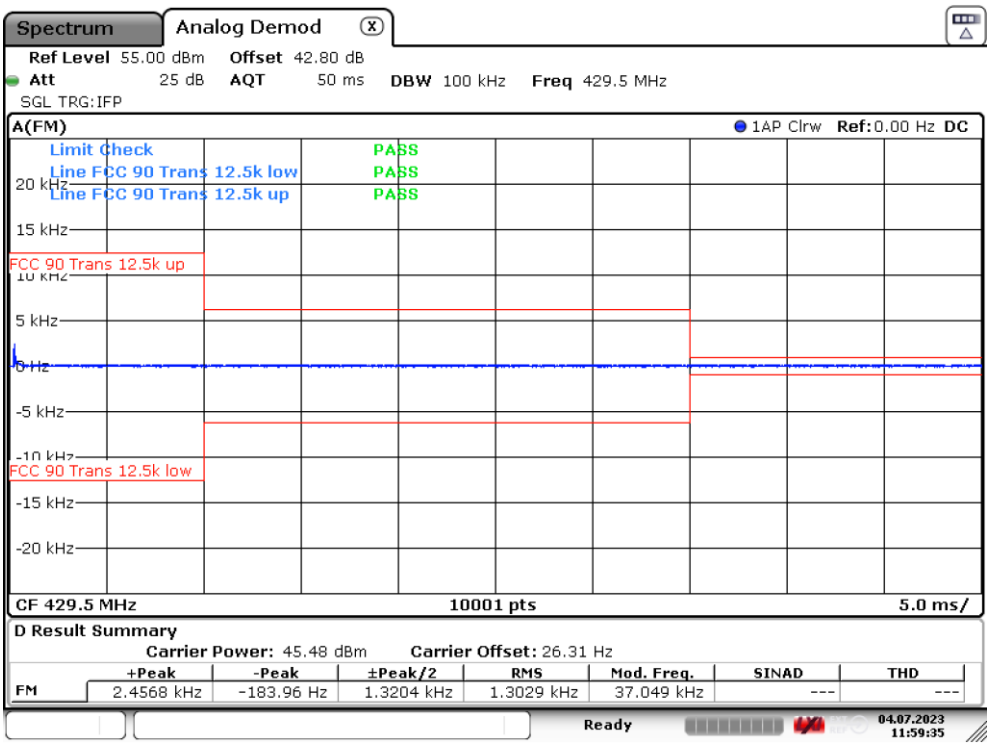

Figure 107: 429.5 MHz

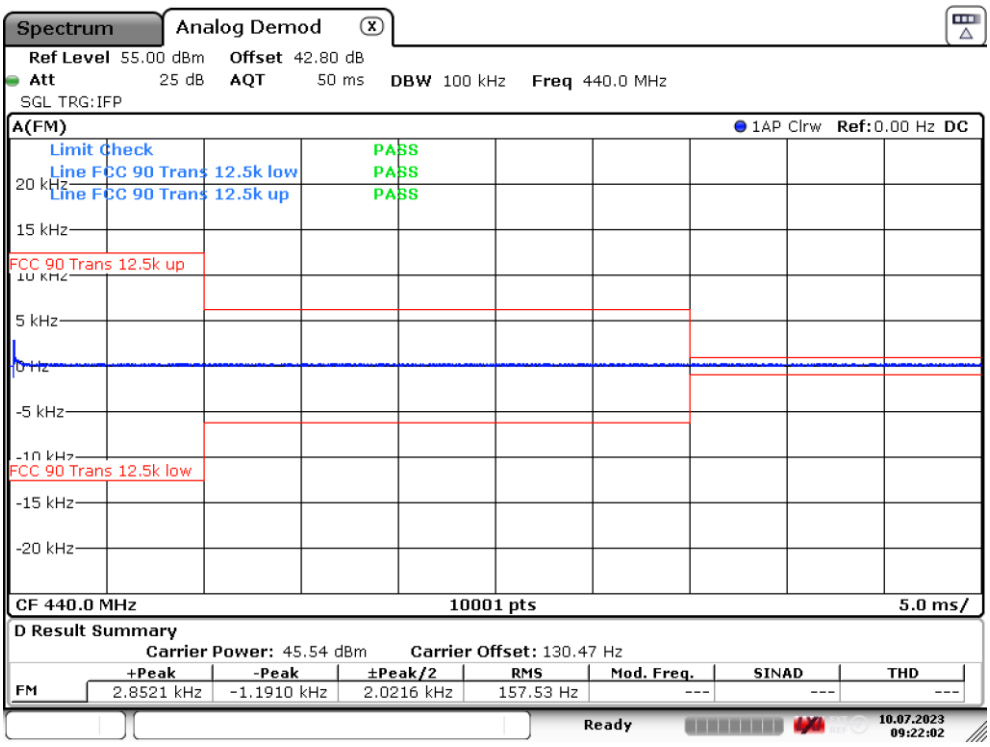

Figure 108: 440.0 MHz

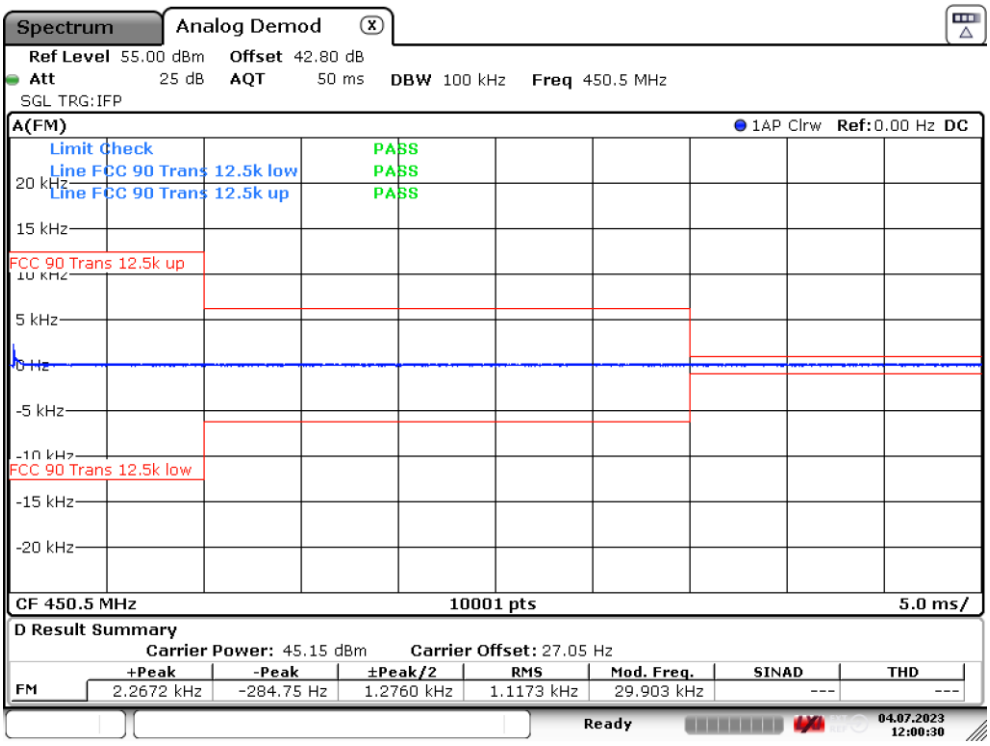

Figure 109: 450.5 MHz

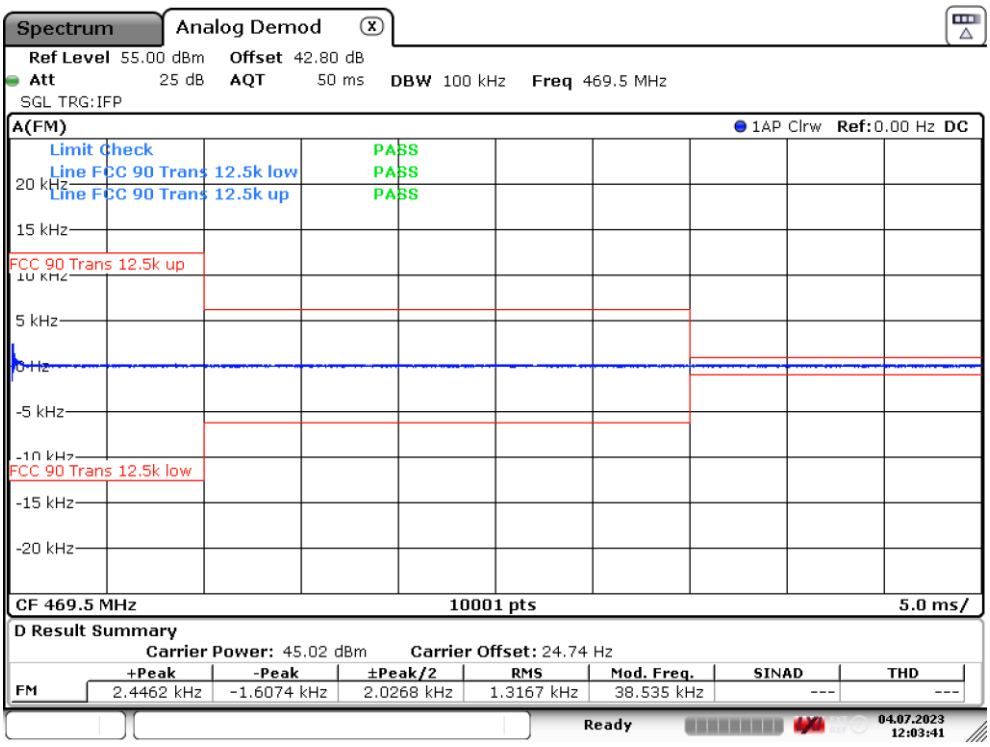

Figure 110: 469.5 MHz

Transmitter OFF to ON (25 kHz channel bandwidth)

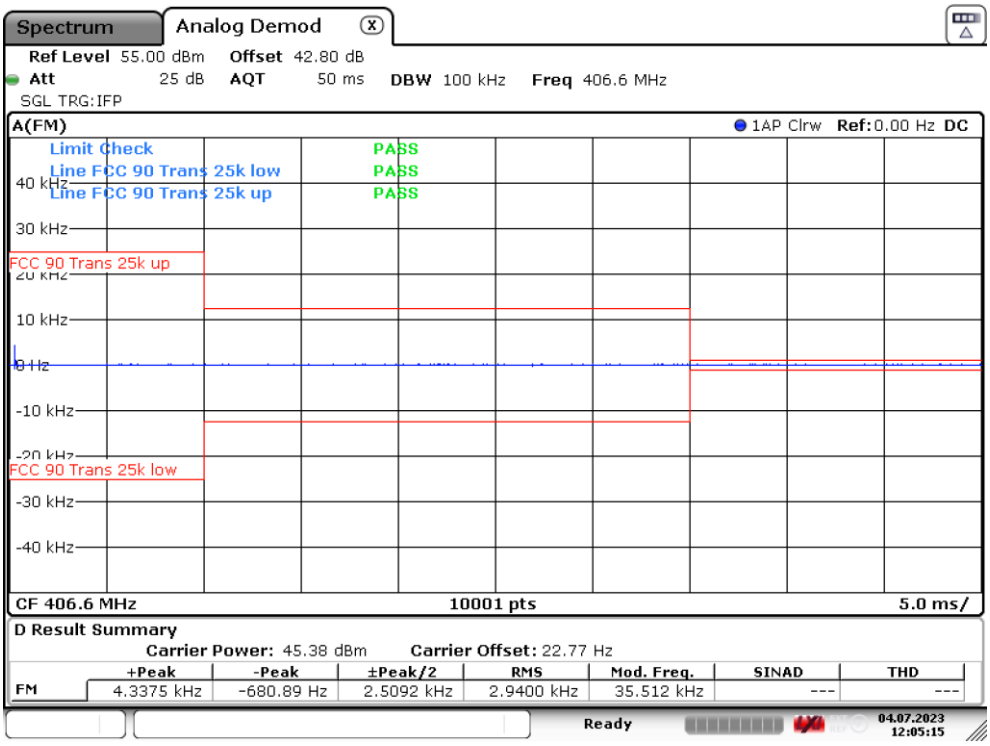

Figure 111: 406.6 MHz

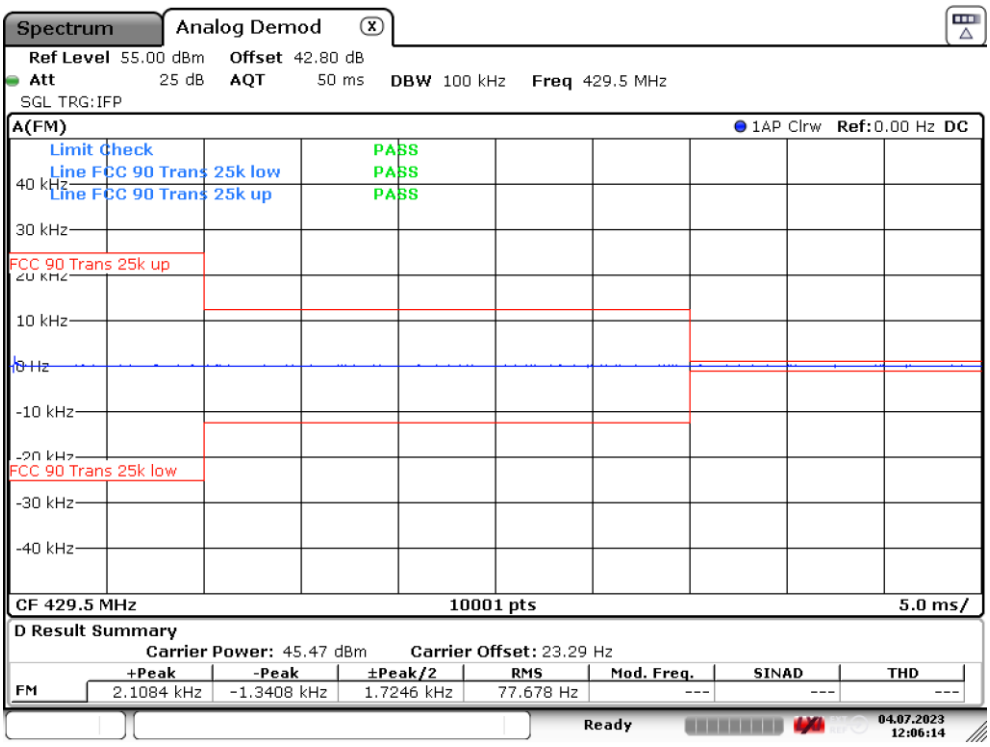

Figure 112: 429.5 MHz

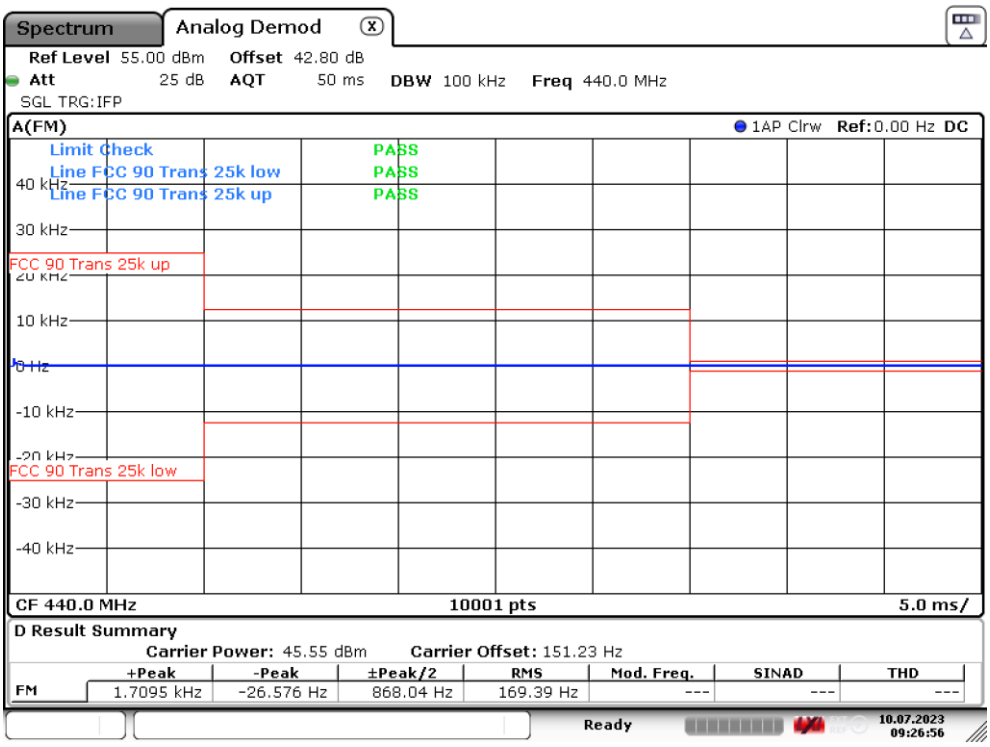

Figure 113: 440.0 MHz

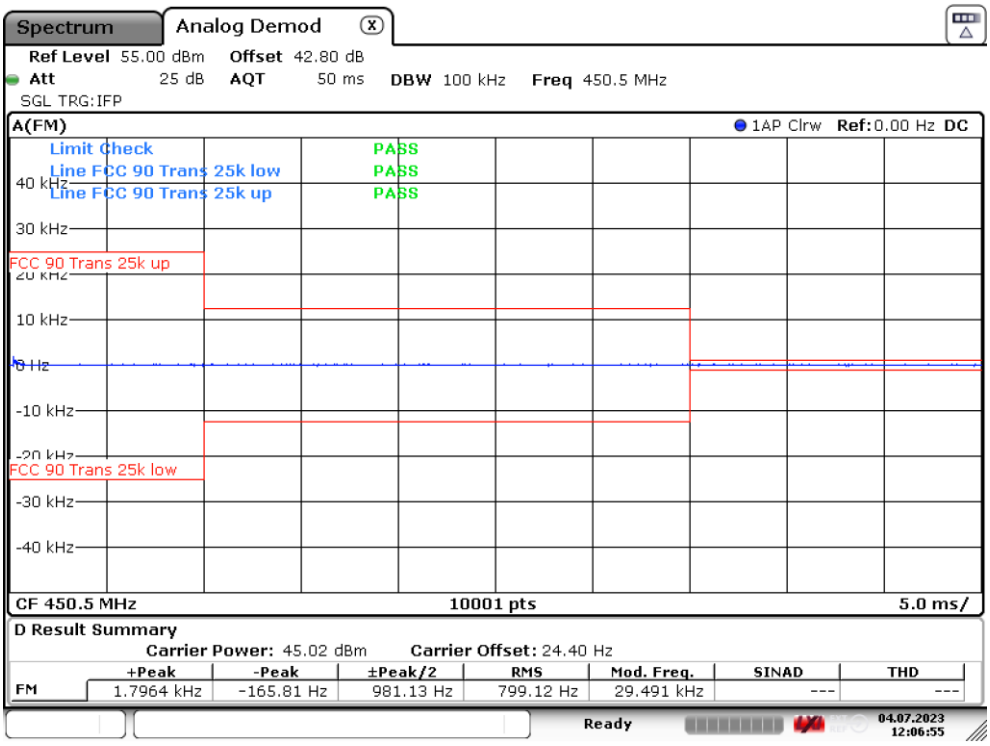

Figure 114: 450.5 MHz

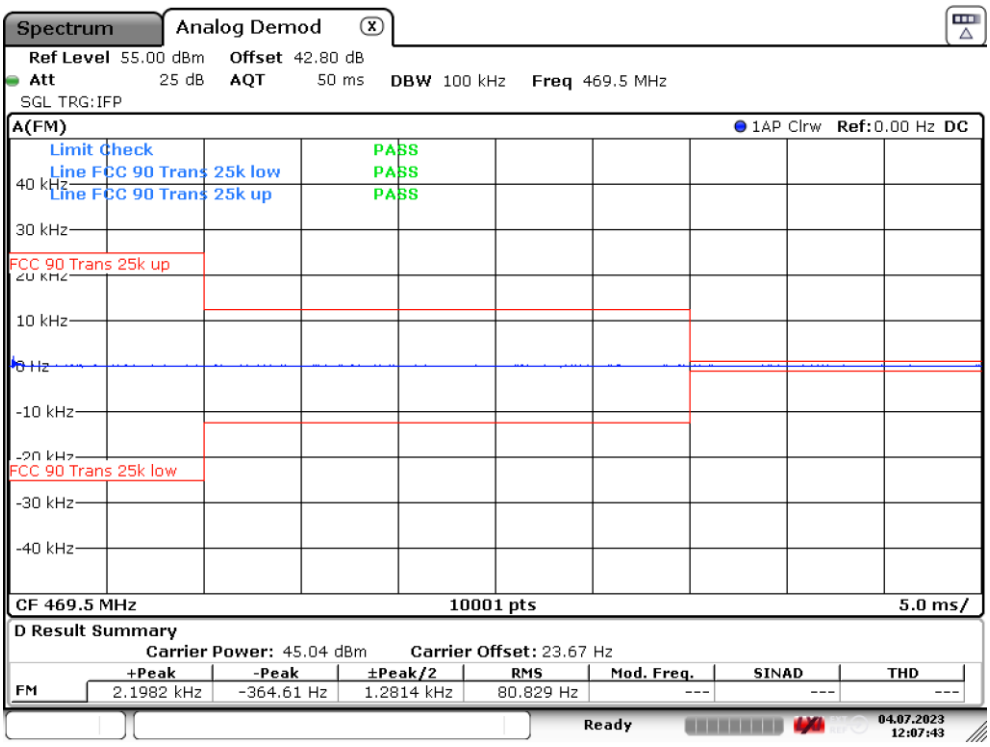

Figure 115: 469.5 MHz

Transmitter ON to OFF (12.5 kHz channel bandwidth)

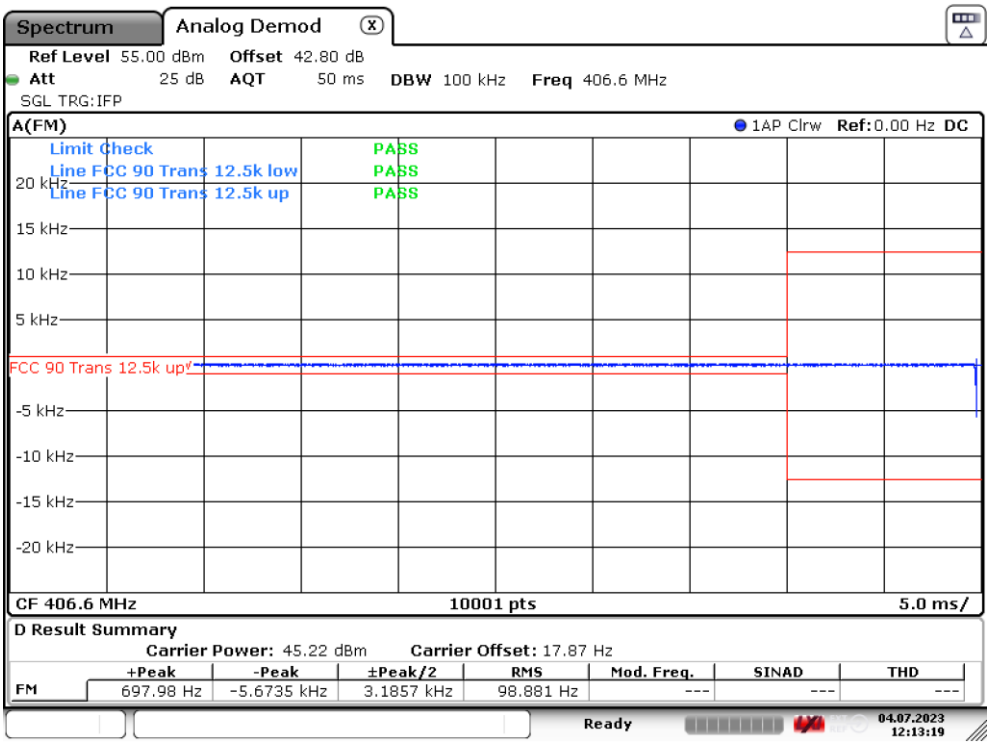

Figure 116: 406.6 MHz

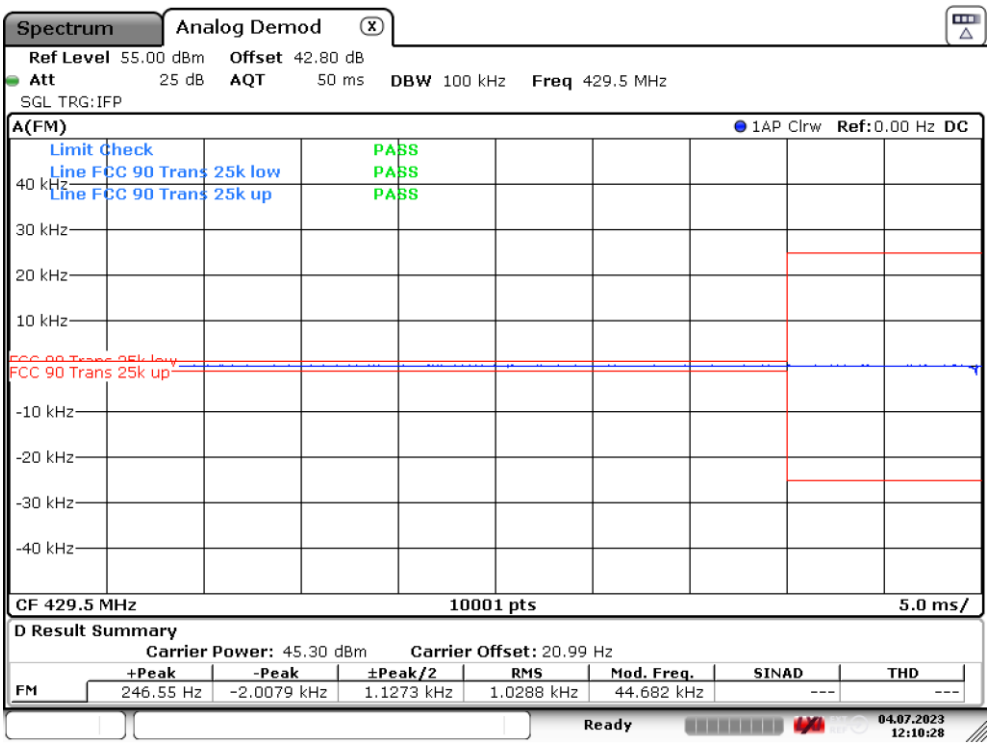

Figure 117: 429.5 MHz

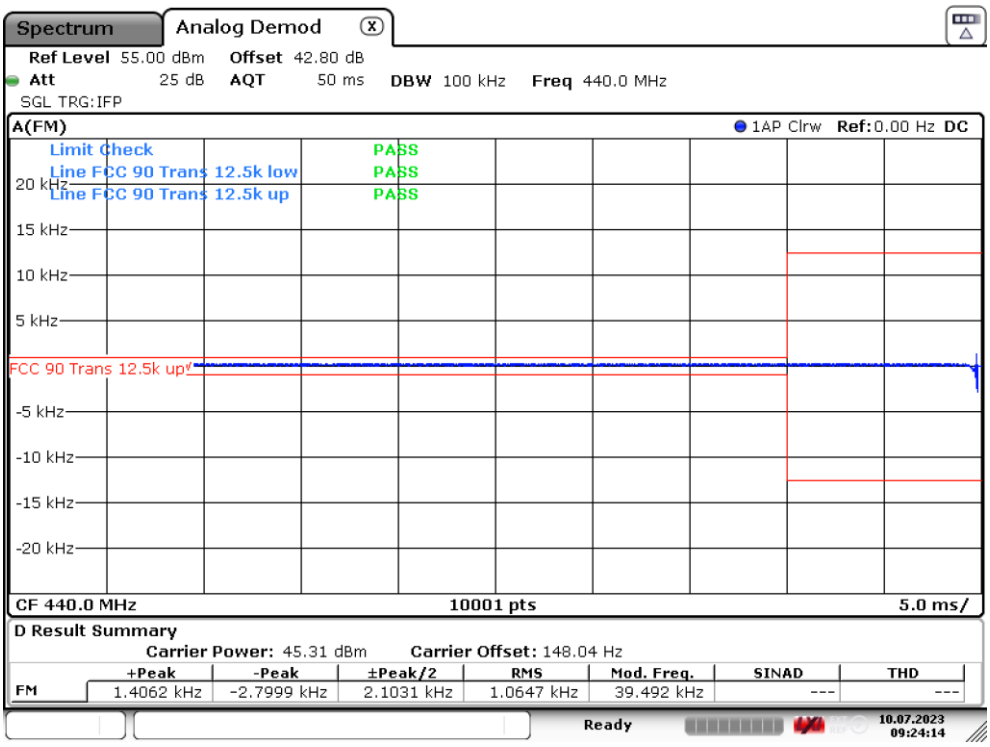

Figure 118: 440.0 MHz

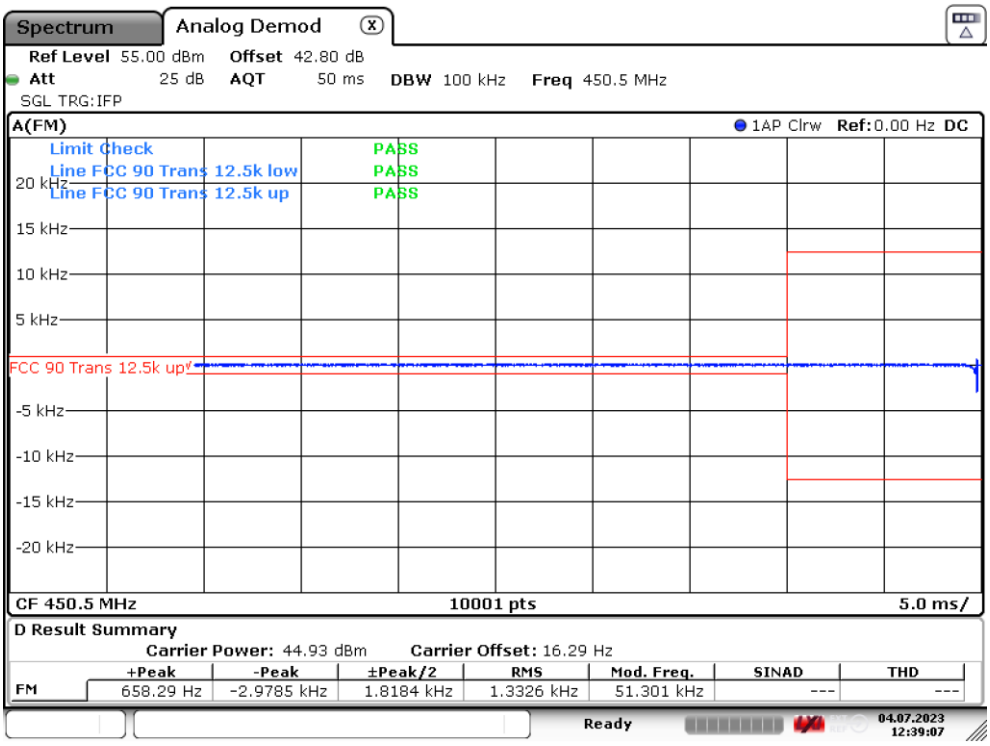

Figure 119: 450.5 MHz

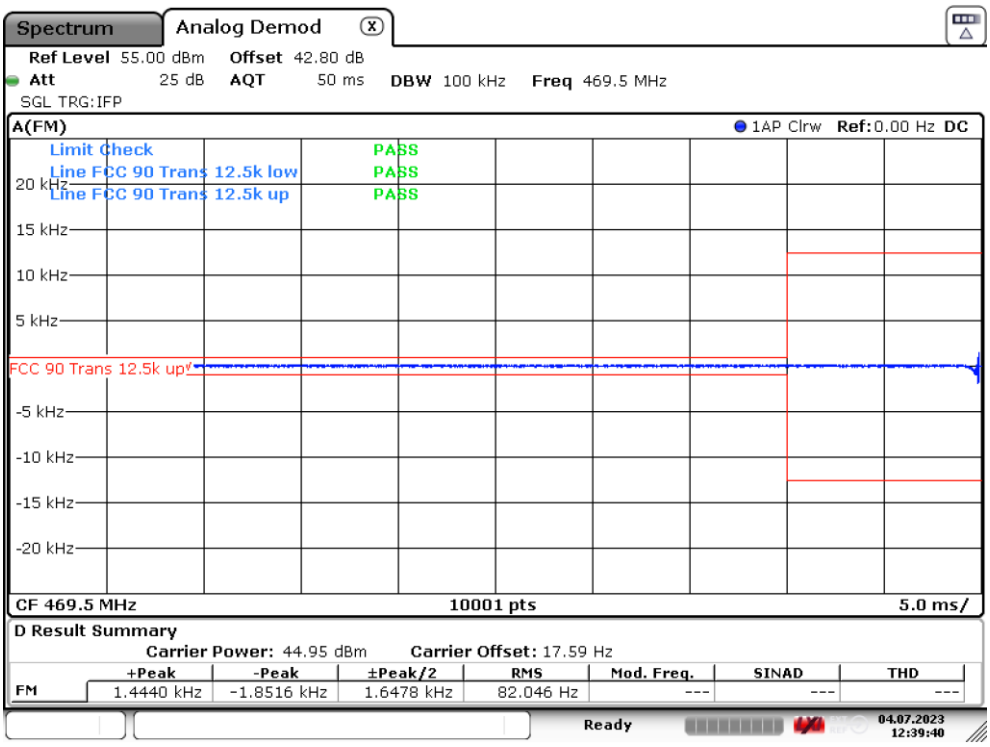

Figure 120: 469.5 MHz

Transmitter ON to OFF (25 kHz channel bandwidth)

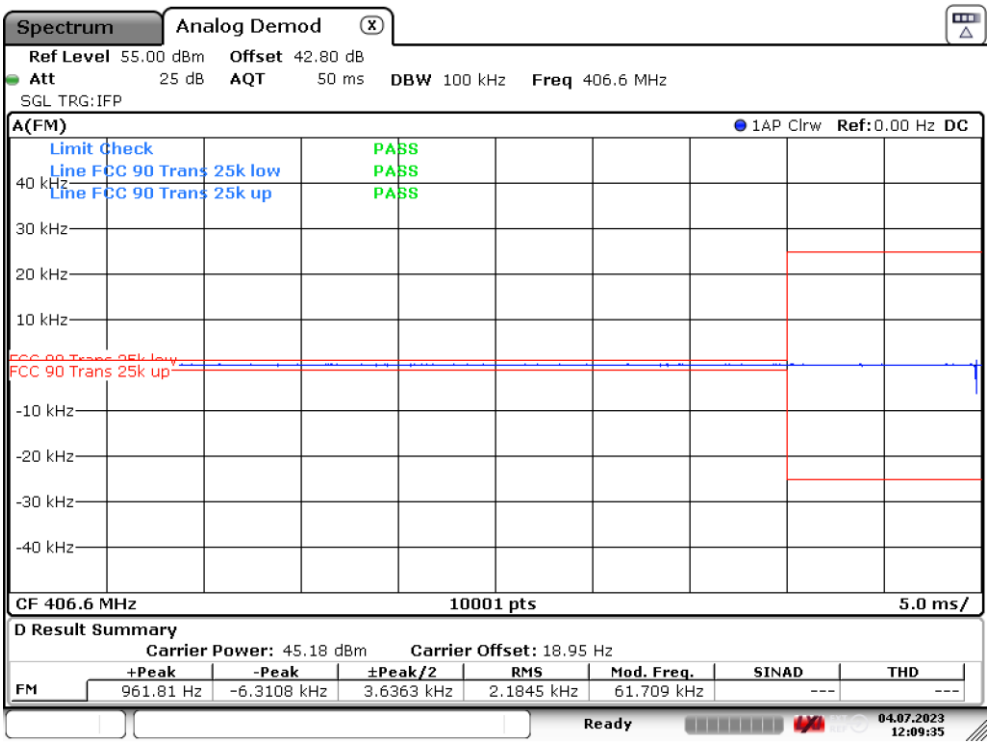

Figure 121: 406.6 MHz

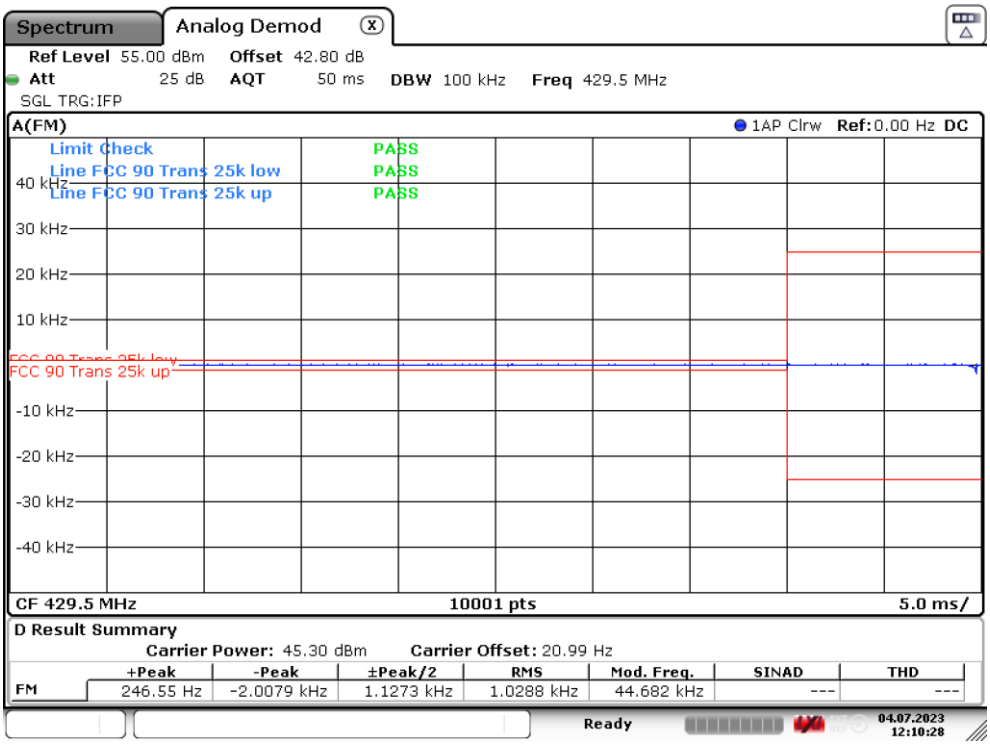

Figure 122: 429.5 MHz

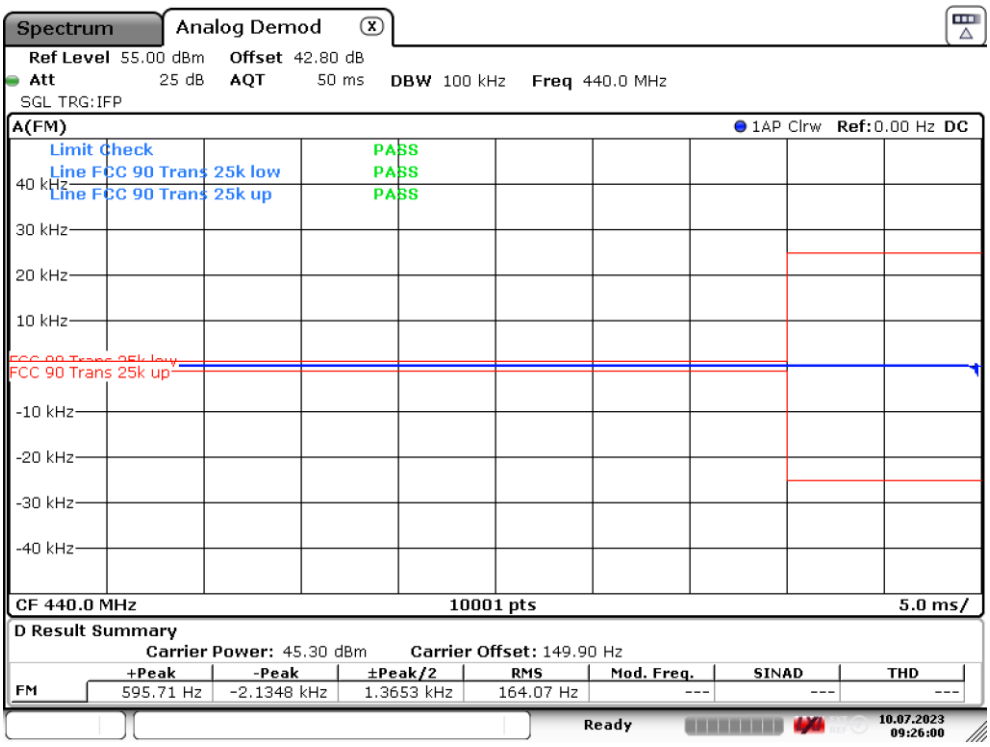

Figure 123: 440 MHz

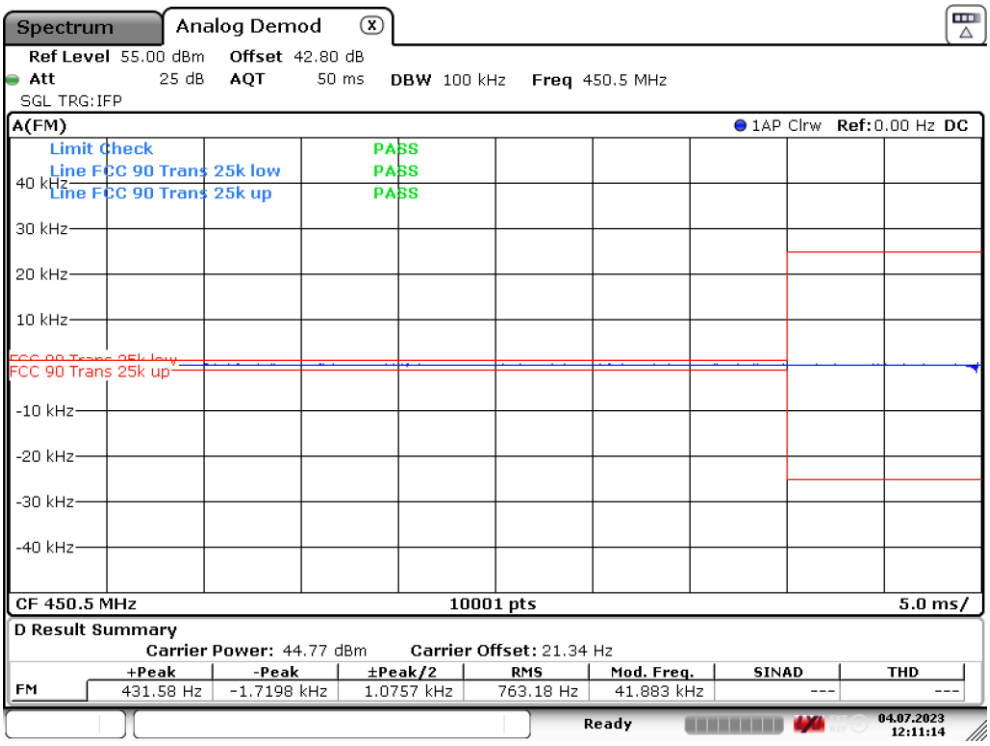

Figure 124: 450.5 MHz

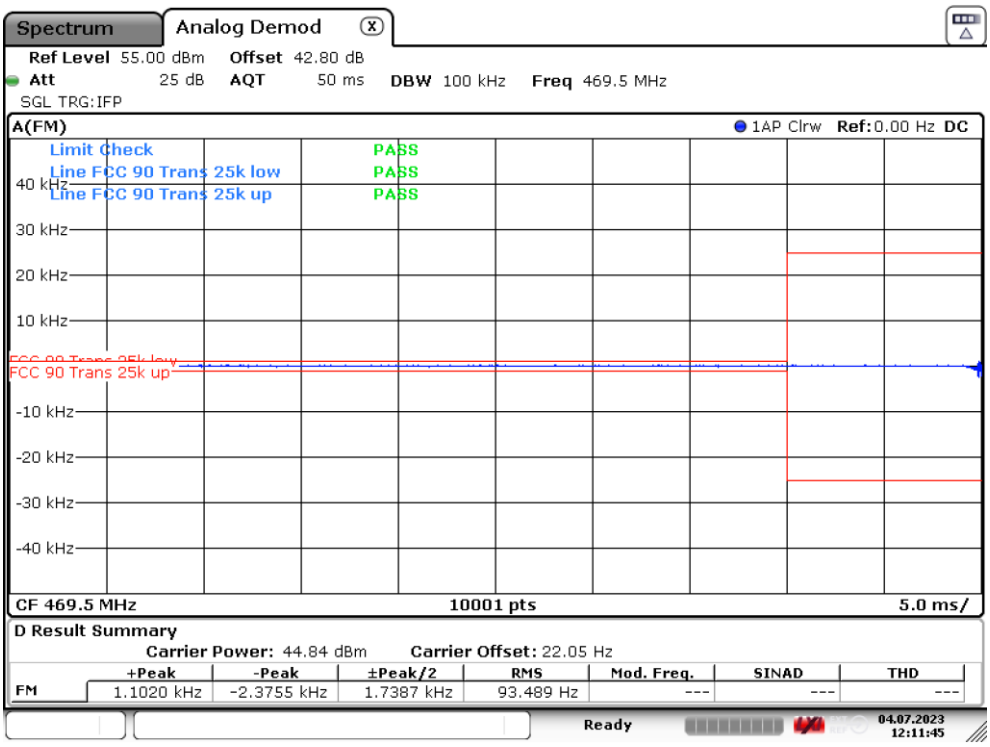

Figure 125: 469.5 MHz

TEST EQUIPMENT

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
ANTENNA	EMCO	3117, emi 1-18GHz	inv. 7293	2022-06-16	2024-06-16
ANTENNA	ROHDE & SCHWARZ	HFH2-Z2 , 335.4711.52	inv. 8013	2022-10-25	2024-10-25
ANTENNA	SCHWARZBECK	VULB 9168	inv. 8911	2022-11-29	2024-11-29
ANTENNA MAST	MATURO	TAM 4.0E	inv. 10181	NCR	NCR
ATTENUATOR	HUBER & SUHNER	6610.19.AA (10dB)	sn. A3	2023-01-04	2025-01-04
ATTENUATOR	NARDA	771 C - 20 dB	inv:9496	1)	
ATTENUATOR	PASTERNACK	PE 7004-4 (4dB)	inv. 10126	2023-03-13	2024-03-13
ATTENUATOR	WEINSCHEL	WA48-20-34-LIM	inv:9604	1)	
ATTENUATOR	WEINSCHEL	WA2-3 (3dB)	A107	1)	
COAXIAL CABLE			C120	1)	
COAXIAL CABLE			C121	1)	
COAXIAL CABLE	SUHNER	Sucoflex 104	C025	1)	
COAXIAL CABLE	SUHNER	Sucoflex 104	C050	1)	
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv. 10679	2023-06-19	2024-06-18
FILTER	TELONIC	NOTCH, TTR - 375 - 3EE	inv. 9418	NCR	NCR
FILTER	WAINWRIGHT	HP, WHKX1.0/15G-10SS	inv. 8267	2023-01-09	2025-01-09
GPS REFERENCE	PENDELUM	GPS-88	inv:8032	NCR	NCR
MULTIMETER	FLUKE	289	sn:59090035	2022-11-29	2023-11-29
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv. 10183	NA	NA
MULTIMETER	FLUKE	289	sn:59090035	2022-11-29	2023-11-29
POWER SUPPLY	DELTA	SM 130-25D	inv. 10406	NCR	NCR
RF PREAMPLIFIER	CIAO	CA118-3123	inv. 10278	2022-09-21	2023-09-21
SPECTRUM ANALYZER	AGILENT	E7405A, monitoring	inv:9746	2020-02-17	NCR
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2023-01-04	2024-01-04
TEMPERATURE/ HUMIDITY METER	VAISALA	HMT 333	inv:8638	2022-08-31	2023-08-31
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 EMC	inv:10516	2022-10-27	2023-10-27
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv. 10517	2022-10-27	2023-10-27
TEMPERATURE CHAMBER	CTS	T-65/50	inv:10521	NCR	NCR
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	NCR
TURNTABLE	MATURO	DS430 UPGRADED	inv. 10182	NCR	NCR

NCR = No Calibration Required

1) Calibrated during testing

END OF TEST REPORT