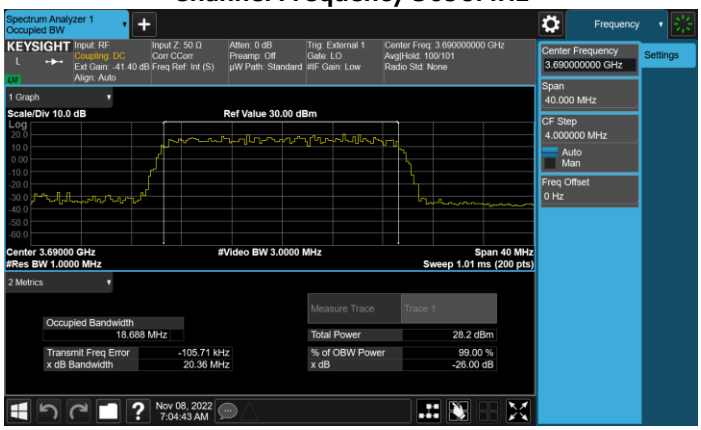
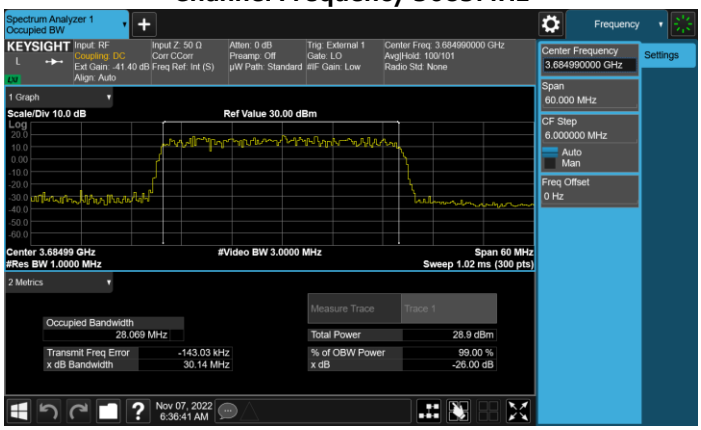
4.1.1.2 26 dB Emission Bandwidth Plots (5G-NR)

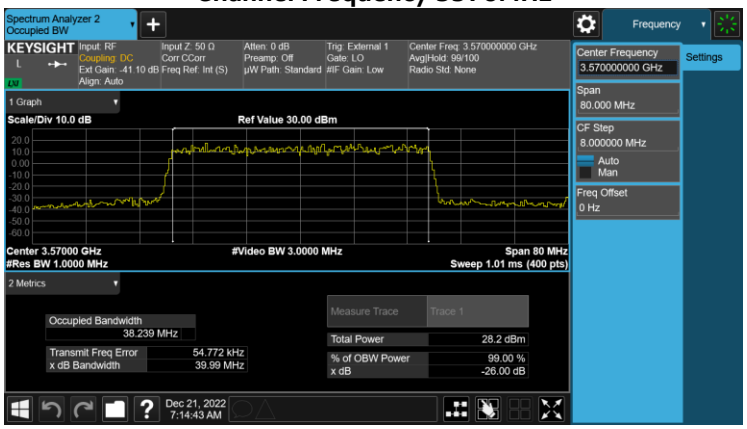
20MHz BW, TM3.1a
Channel Frequency 3690MHz



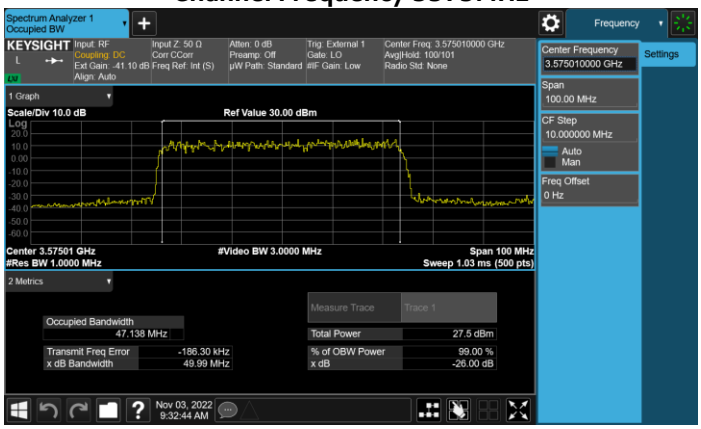
30MHz BW, TM3.1a
Channel Frequency 3685MHz



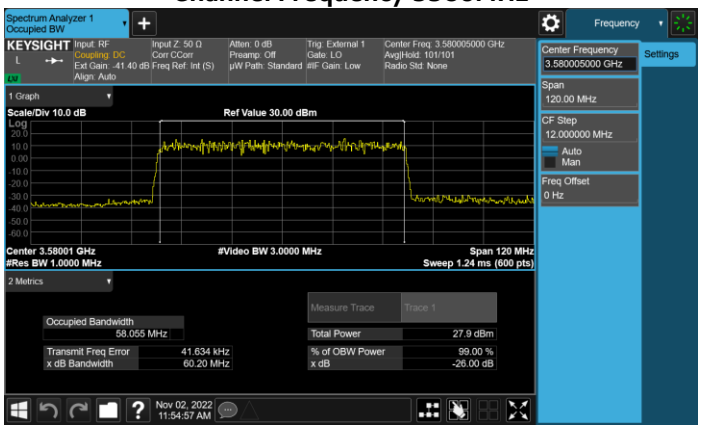
40MHz BW, TM3.1
Channel Frequency 3570MHz



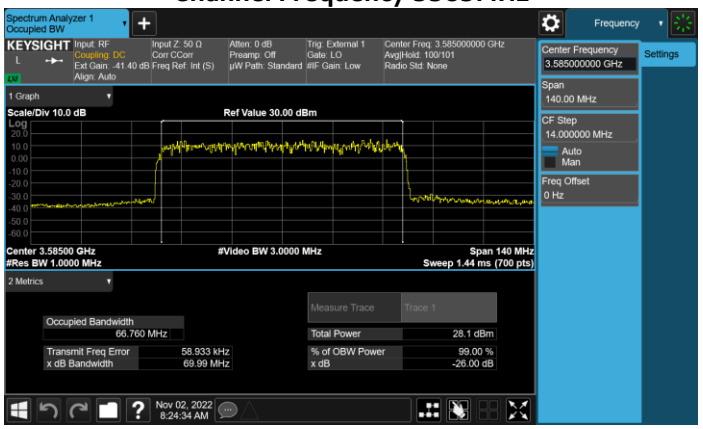
50MHz BW, TM3.1
Channel Frequency 3575MHz



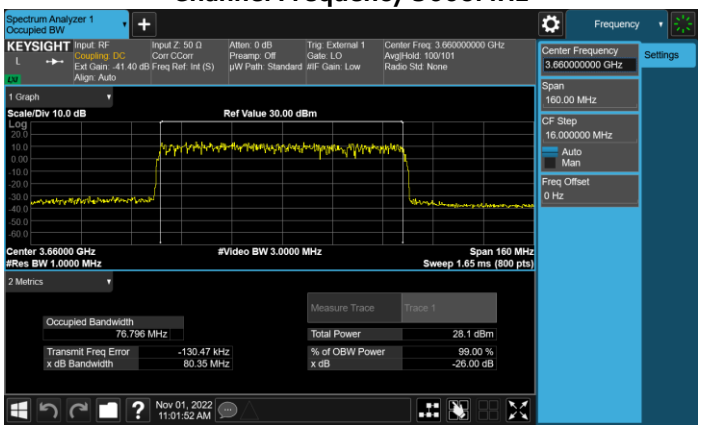
60MHz BW, TM3.1
Channel Frequency 3580MHz



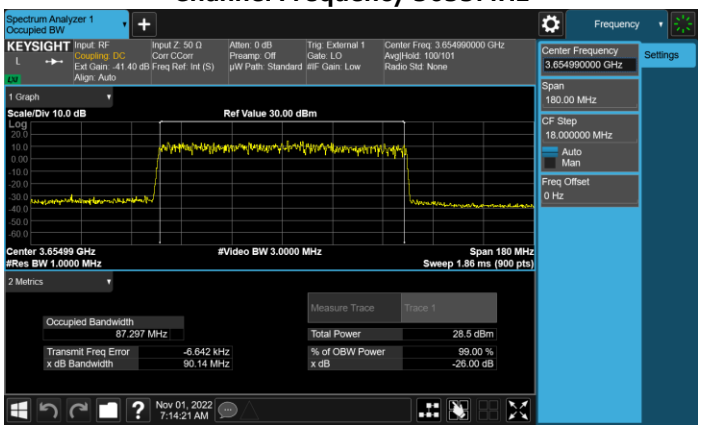
70MHz BW, TM3.1
Channel Frequency 3585MHz



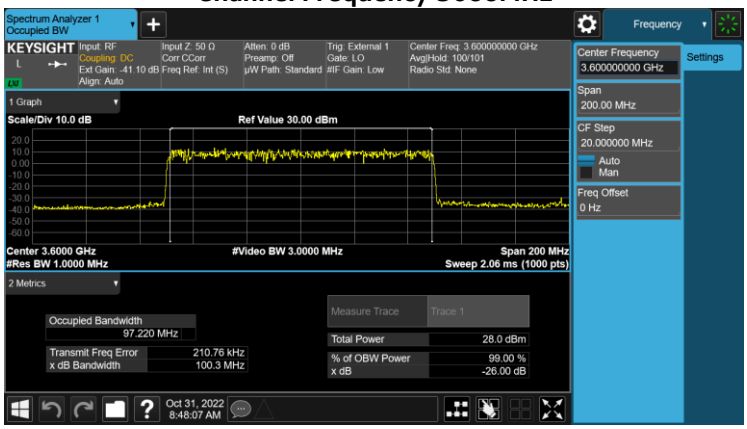
80MHz BW, TM3.1a
Channel Frequency 3660MHz



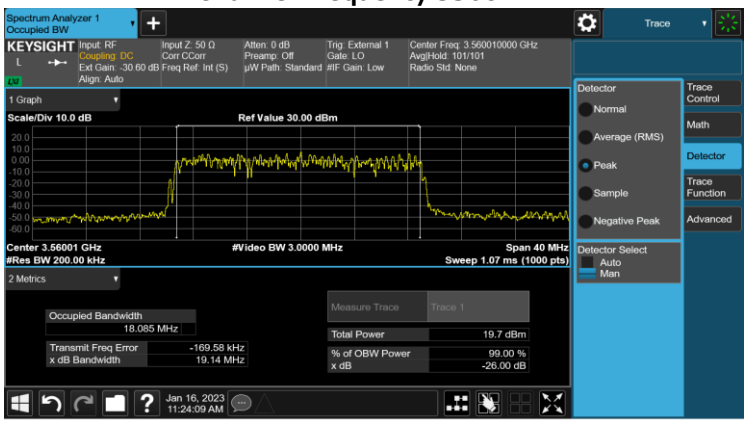
90MHz BW, TM3.1a
Channel Frequency 3655MHz



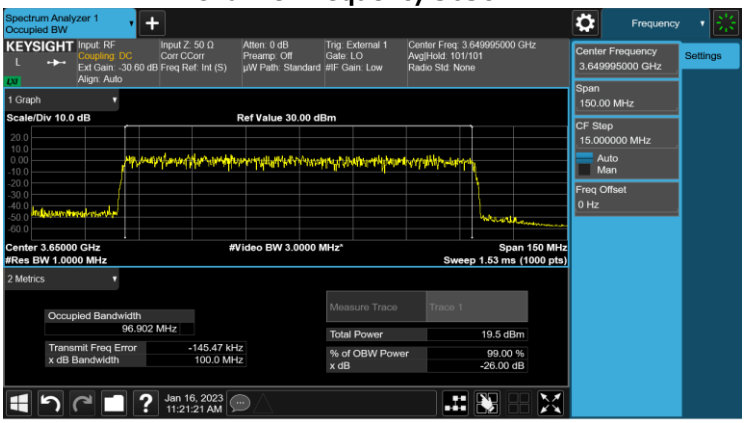
100MHz BW, TM3.1
Channel Frequency 3600MHz



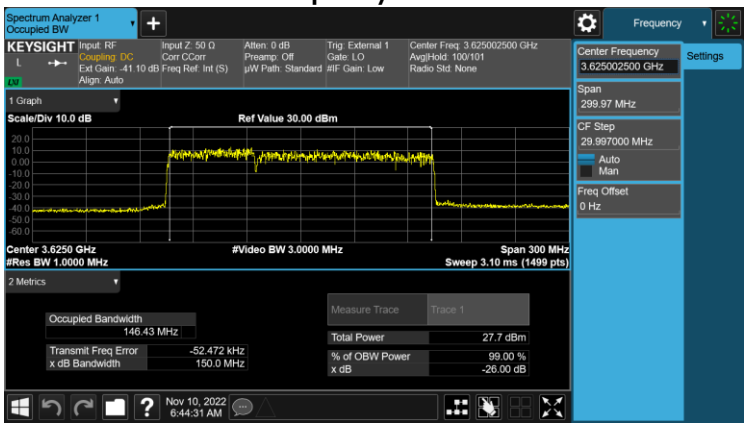
20+100MHz BW, TM3.1
Channel Frequency 3560MHz



20+100MHz BW, TM3.1
Channel Frequency 3650MHz

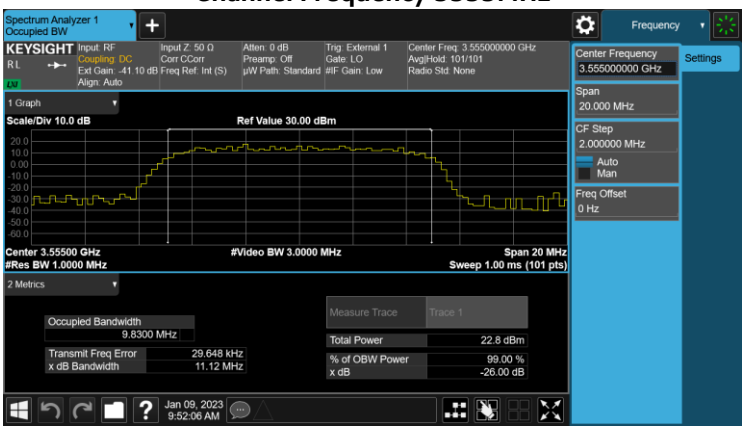


50+100MHz BW, TM3.1a
Channel Frequency 3575+3650MHz

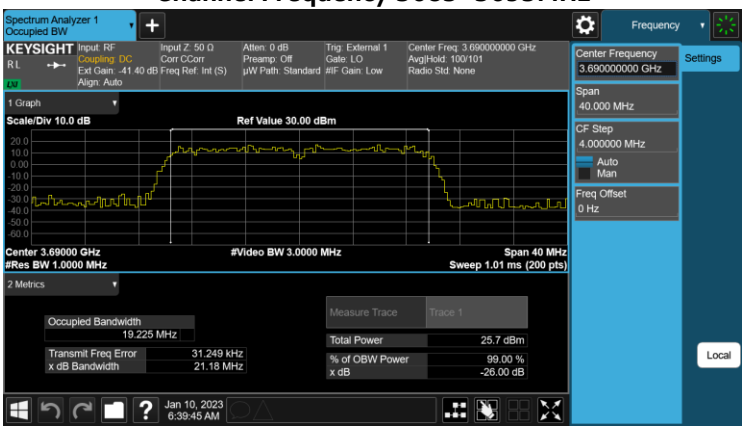


4.1.1.3 99% Occupied Bandwidth Plots (LTE)

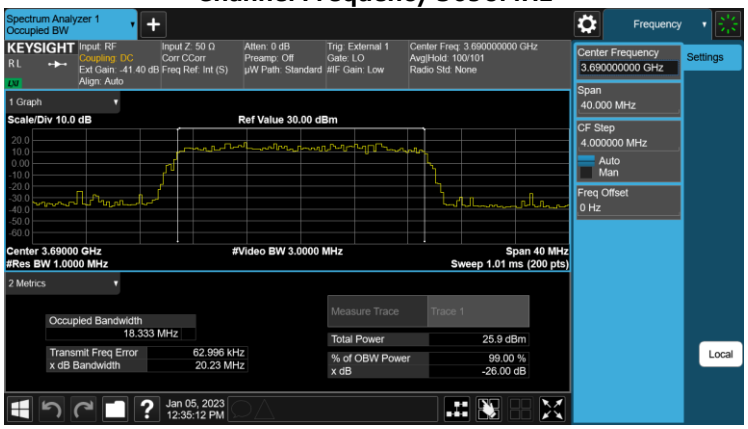
10MHz BW, TM3.1
Channel Frequency 3555MHz



10+10MHz BW, TM3.1a
Channel Frequency 3685+3695MHz

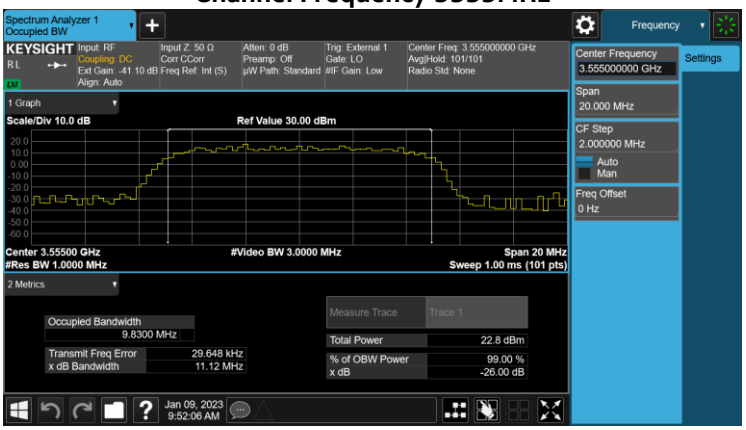


20MHz BW, TM3.1a
Channel Frequency 3690MHz

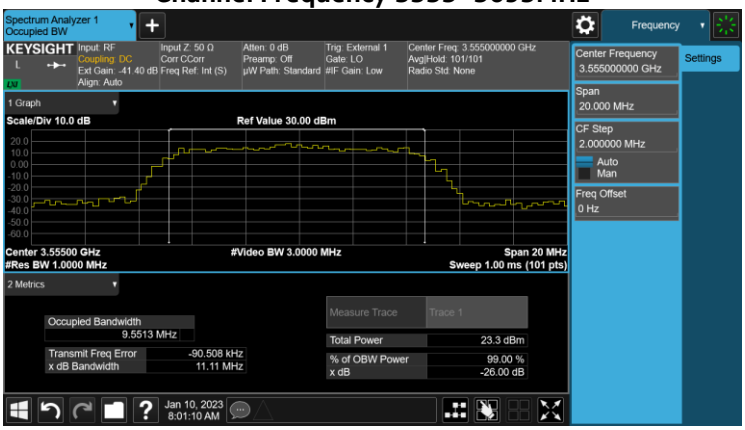


4.1.1.4 26 dB Emission Bandwidth Plots (LTE)

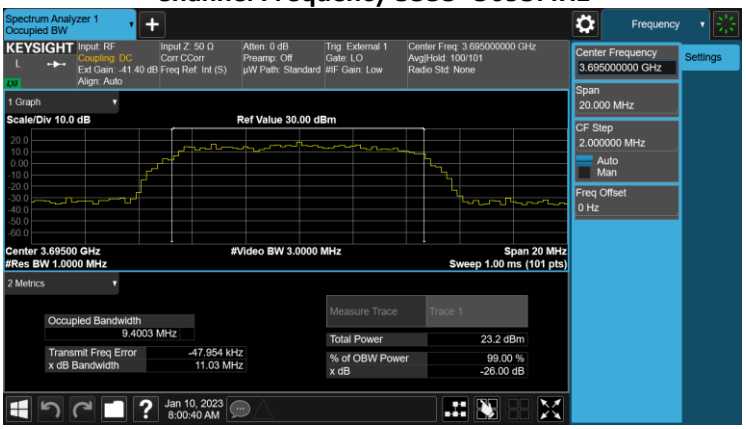
10MHz BW, TM3.1
Channel Frequency 3555MHz



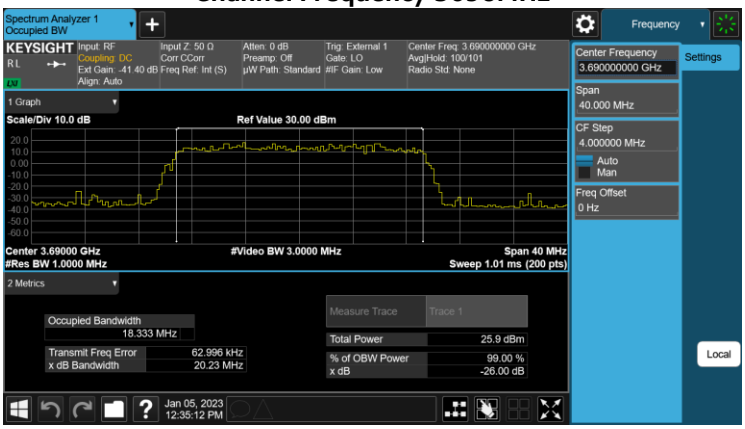
10+10MHz BW, TM3.2
Channel Frequency 3555+3695MHz



10+10MHz BW, TM3.2
Channel Frequency 3555+3695MHz



20MHz BW, TM3.1a
Channel Frequency 3690MHz



4.2 Edge of band Emissions

47CFR 96.41 (e)(1) (i) and KDB 940660 D01 Section 3.2 (b)(6) specified that the limits for the emissions outside the fundamental are as follows.

- within 0 MHz to 10 MHz above and below the assigned channel $\leqslant$ −13 dBm/MHz,
- greater than 10 MHz above and below the assigned channel $\leqslant$ −25 dBm/MHz,
- any emission below 3530 MHz and above 3720 MHz $\leqslant$ −40 dBm/MHz.

47CFR 96.41 (e)(3) and KDB 940660 D01 Section 3.2 (b)(6) specified stated that (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 authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.,* 1 MHz or 1 percent of emission bandwidth, as specified). The fundamental 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 unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits. (iii) Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

KDB 940660 D01 Section 3.2 (b)(6) specified that measurements must be performed for low, mid, and high channels. It is acceptable to apply the procedures in Section 5.7 of ANSI C63.26-2015. When antenna-port conducted measurements are performed to demonstrate compliance to the applicable unwanted emission limits (Section 2.1051), a separate radiated measurement is required to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation (Section 2.1053). The Section 96.41(e) limits generally also apply to radiated unwanted emissions.

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and test coupler. The path attenuation was offset on the display and the signal for the carrier was adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths.

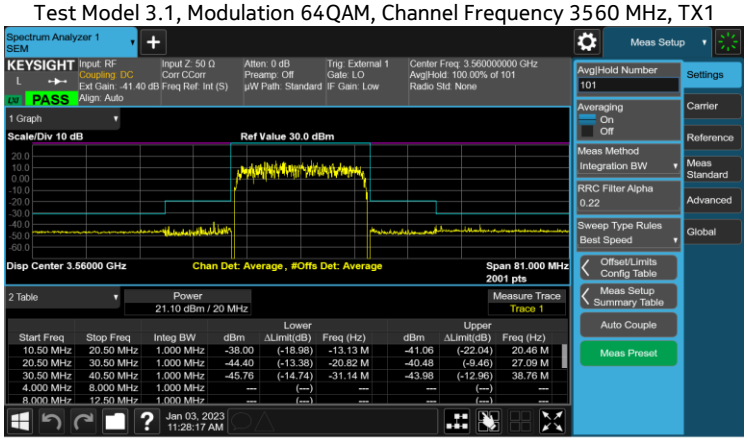
4.2.1 Edge of Band Emissions - Plots.

All of the measurements met the requirements of Part 96.41(e)(1) and KDB 940660 D01 Section 3.2 (b)(6) when measured per Part 2.1049.

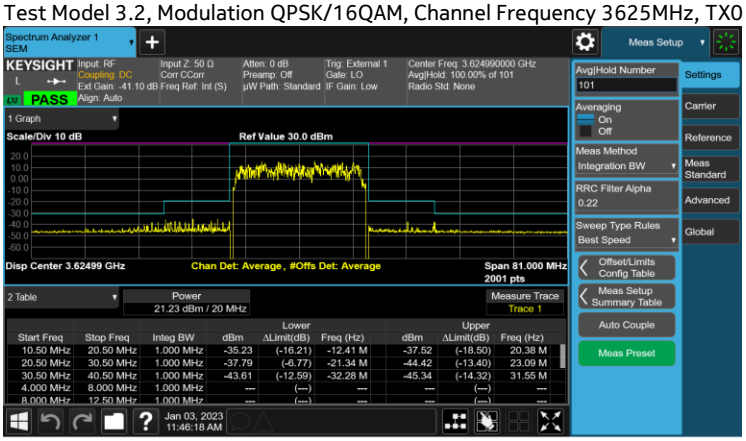
4.2.1.1 5G-NR Plots

20 MHz BW

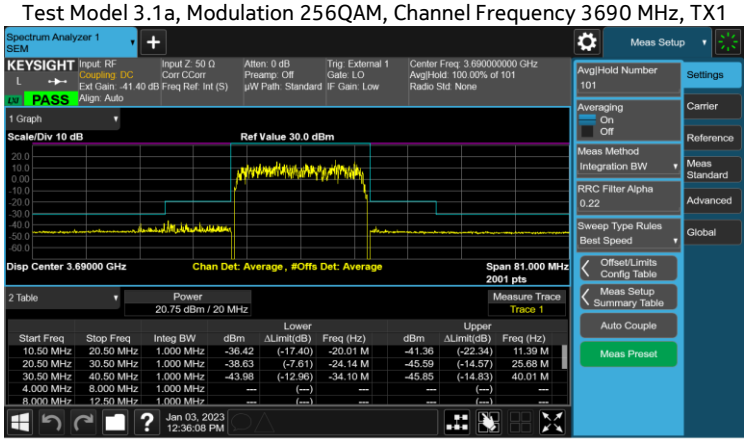
Test Model 3.1, Modulation 64QAM, Channel Frequency 3560 MHz, TX1



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX0

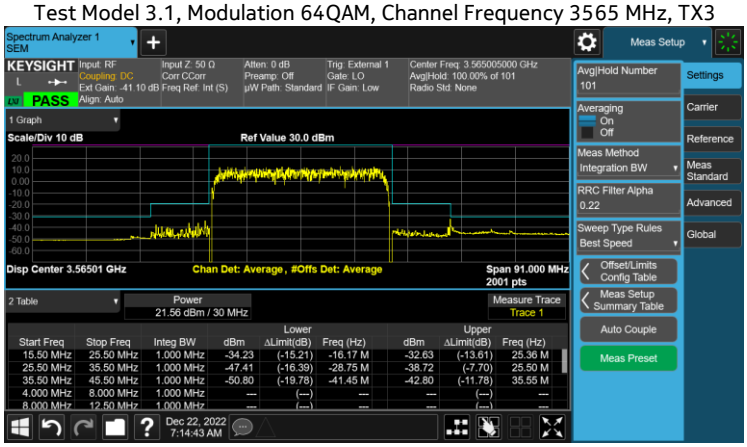


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3690 MHz, TX1



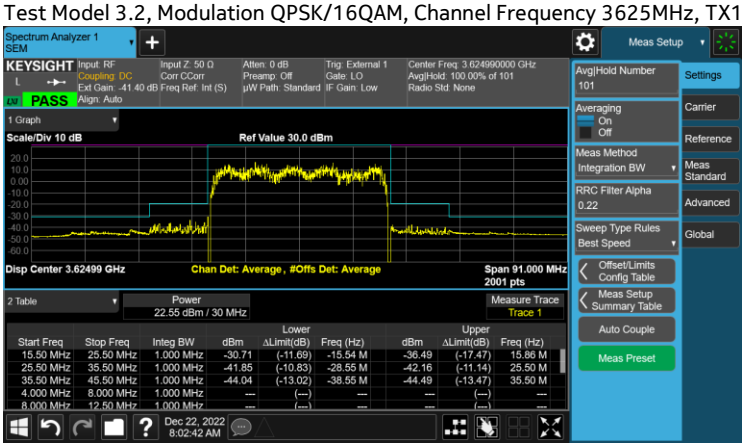
30 MHz BW

Test Model 3.1, Modulation 64QAM, Channel Frequency 3565 MHz, TX3



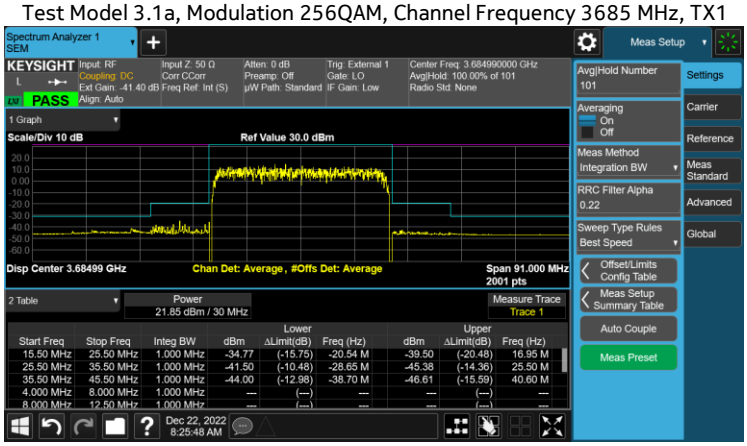
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLimit(dB)	Lower Freq (Hz)	Upper dBm	Upper ΔLimit(dB)	Upper Freq (Hz)
15.50 MHz	25.50 MHz	1.000 MHz	-34.23	(-15.21)	-16.17 M	-32.63	(-13.61)	25.36 M
25.50 MHz	35.50 MHz	1.000 MHz	-47.41	(-16.39)	-28.75 M	-38.72	(-7.70)	25.50 M
35.50 MHz	45.50 MHz	1.000 MHz	-50.80	(-19.78)	-41.45 M	-42.80	(-11.78)	35.55 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLimit(dB)	Lower Freq (Hz)	Upper dBm	Upper ΔLimit(dB)	Upper Freq (Hz)
15.50 MHz	25.50 MHz	1.000 MHz	-30.71	(-11.69)	-15.54 M	-36.49	(-17.47)	15.86 M
25.50 MHz	35.50 MHz	1.000 MHz	-41.85	(-10.83)	-28.55 M	-42.16	(-11.14)	25.50 M
35.50 MHz	45.50 MHz	1.000 MHz	-44.04	(-13.02)	-38.55 M	-44.49	(-13.47)	35.50 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---

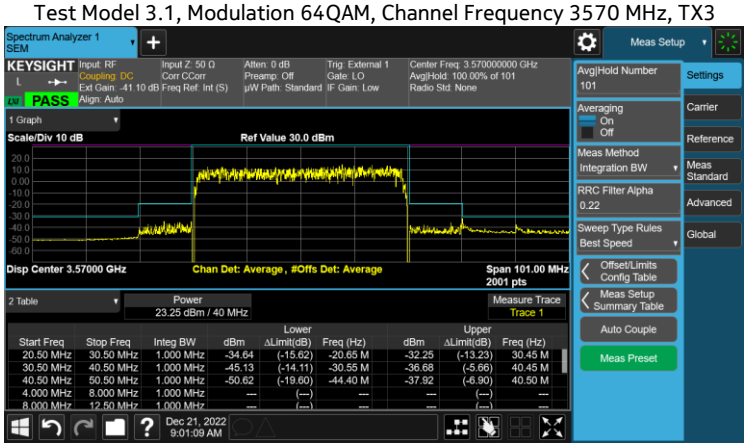
Test Model 3.1a, Modulation 256QAM, Channel Frequency 3685 MHz, TX1



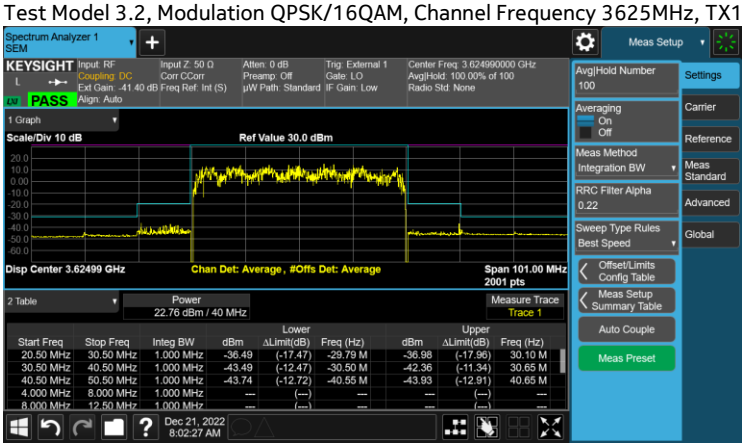
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLimit(dB)	Lower Freq (Hz)	Upper dBm	Upper ΔLimit(dB)	Upper Freq (Hz)
15.50 MHz	25.50 MHz	1.000 MHz	-34.77	(-15.75)	-20.54 M	-39.50	(-20.48)	16.95 M
25.50 MHz	35.50 MHz	1.000 MHz	-41.50	(-10.48)	-28.65 M	-45.38	(-14.36)	25.50 M
35.50 MHz	45.50 MHz	1.000 MHz	-44.00	(-12.98)	-38.70 M	-46.61	(-15.59)	40.60 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---

40 MHz BW

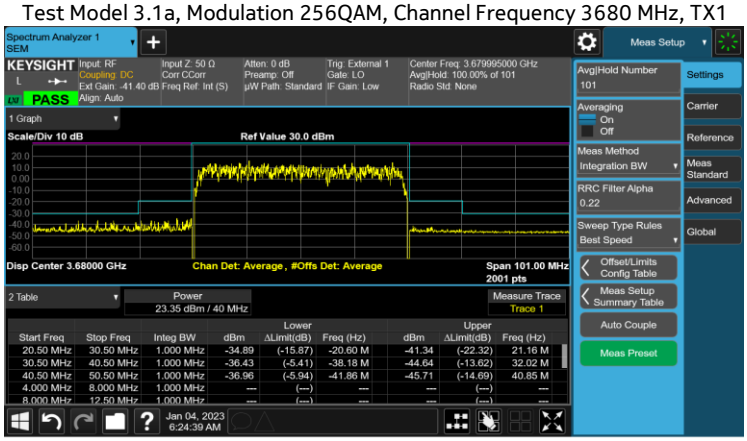
Test Model 3.1, Modulation 64QAM, Channel Frequency 3570 MHz, TX3



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

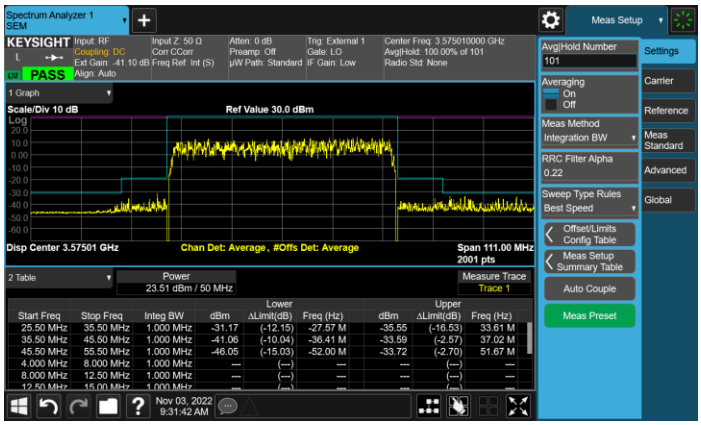


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3680 MHz, TX1

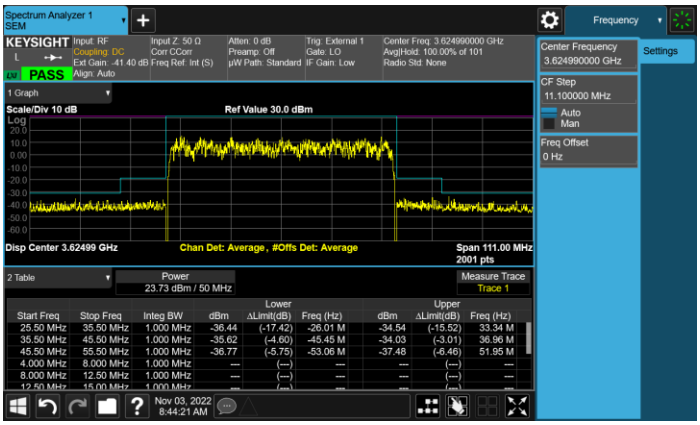


50 MHz BW

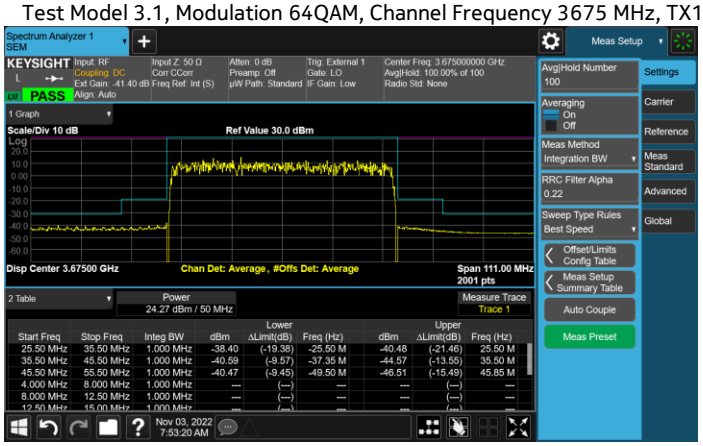
Test Model 3.1, Modulation 64QAM, Channel Frequency 3575 MHz, TX0



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

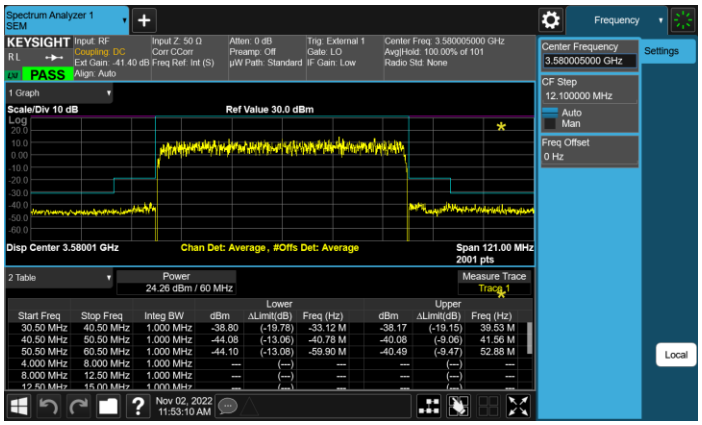


Test Model 3.1, Modulation 64QAM, Channel Frequency 3675 MHz, TX1

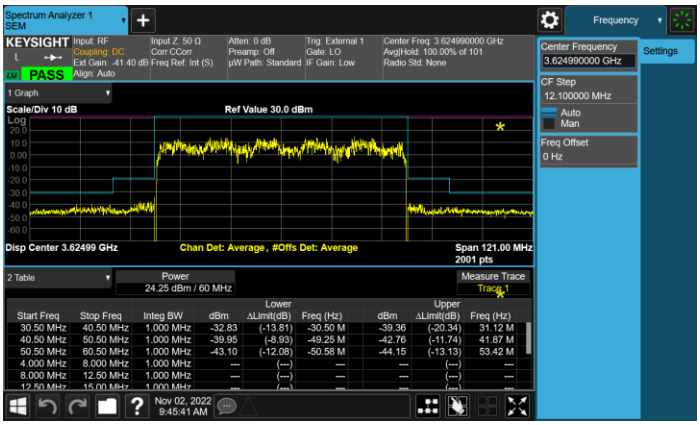


60 MHz BW

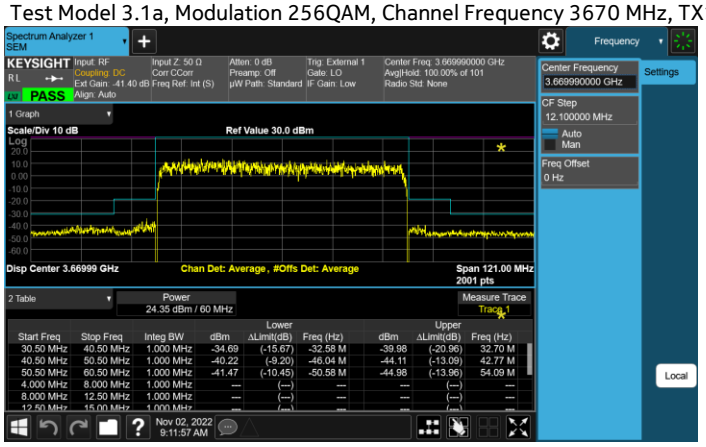
Test Model 3.1, Modulation 64QAM, Channel Frequency 3580 MHz, TX1



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

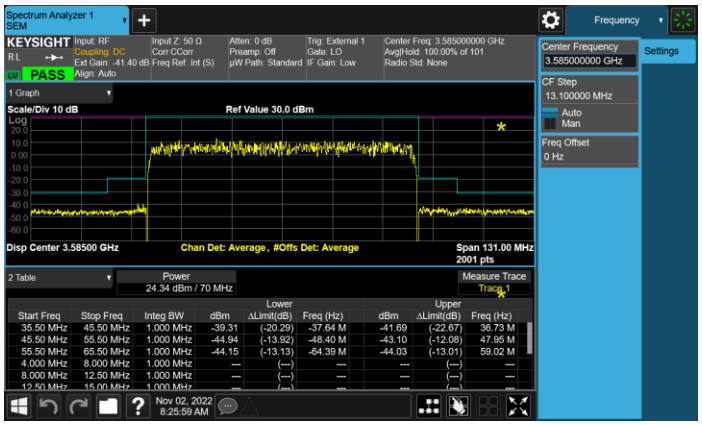


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3670 MHz, TX1

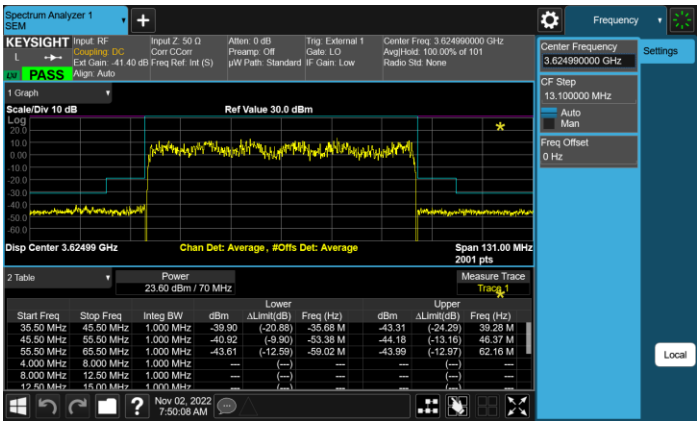


70 MHz BW

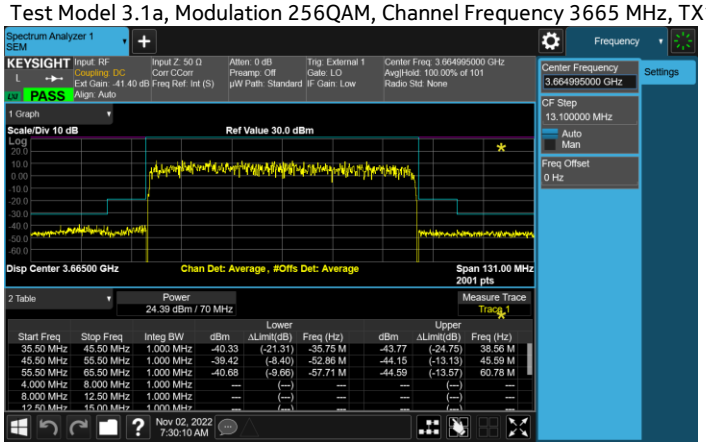
Test Model 3.1, Modulation 64QAM, Channel Frequency 3585 MHz, TX1



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

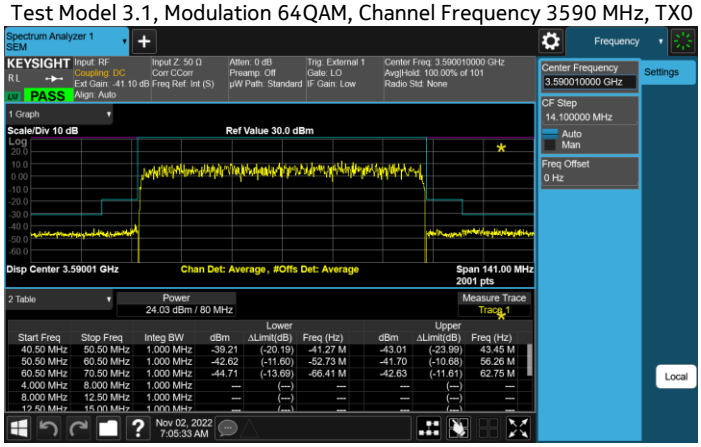


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3665 MHz, TX1

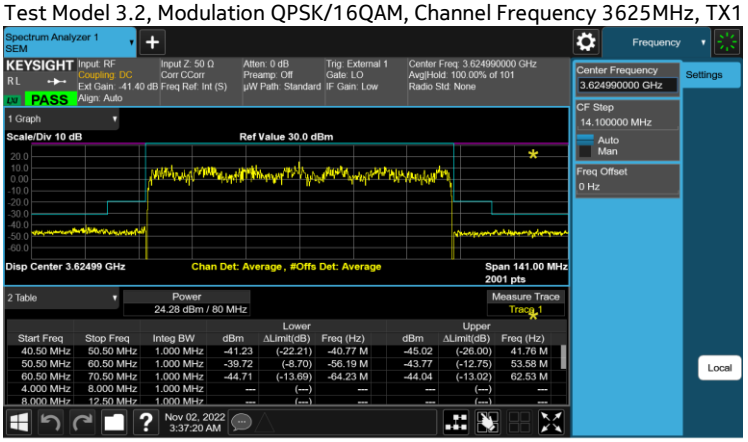


80 MHz BW

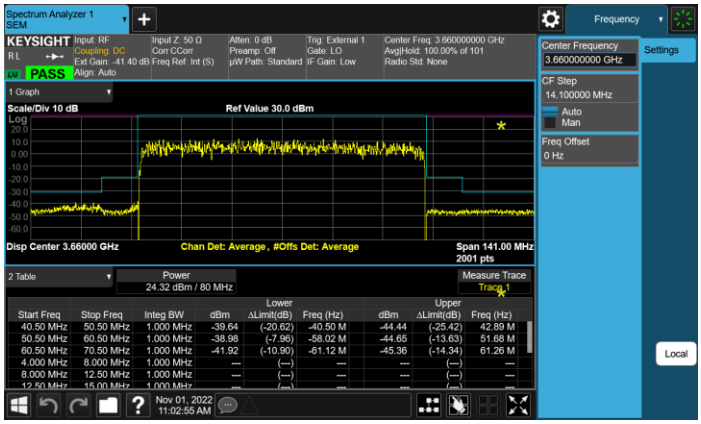
Test Model 3.1, Modulation 64QAM, Channel Frequency 3590 MHz, TX0



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

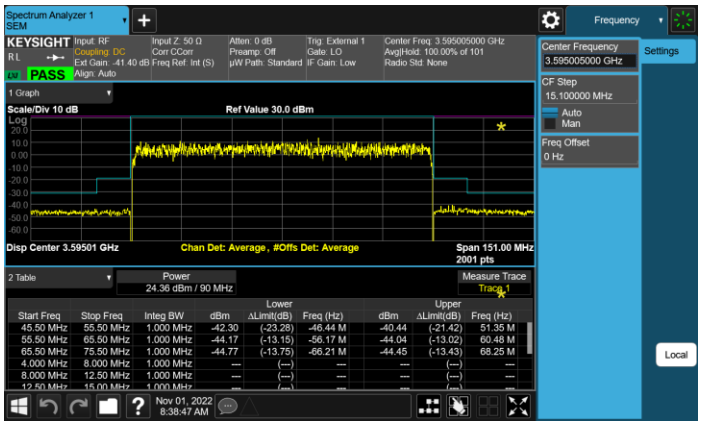


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3660 MHz, TX1

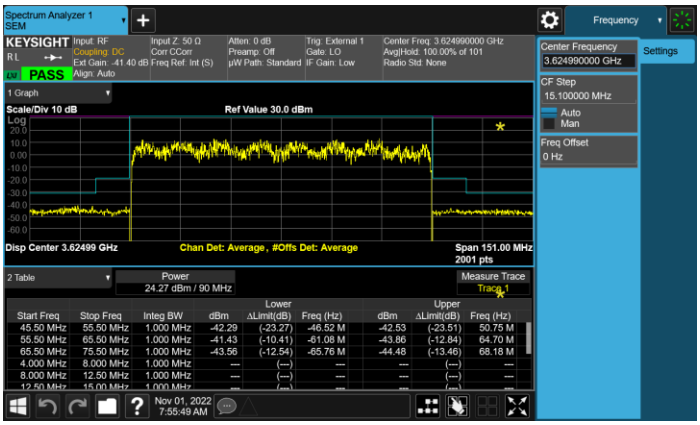


90 MHz BW

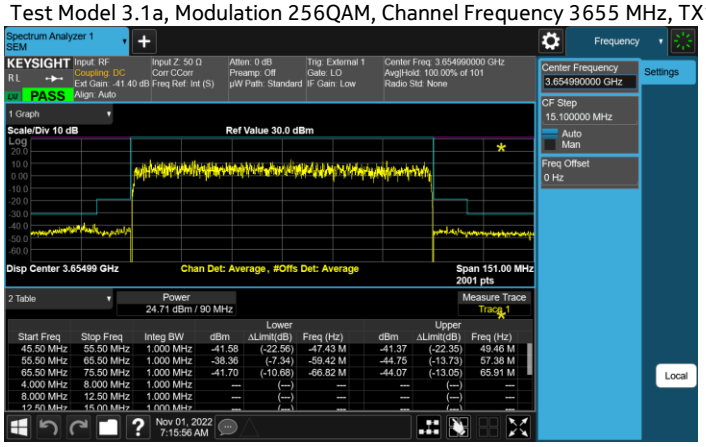
Test Model 3.1, Modulation 64QAM, Channel Frequency 3595 MHz, TX1



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

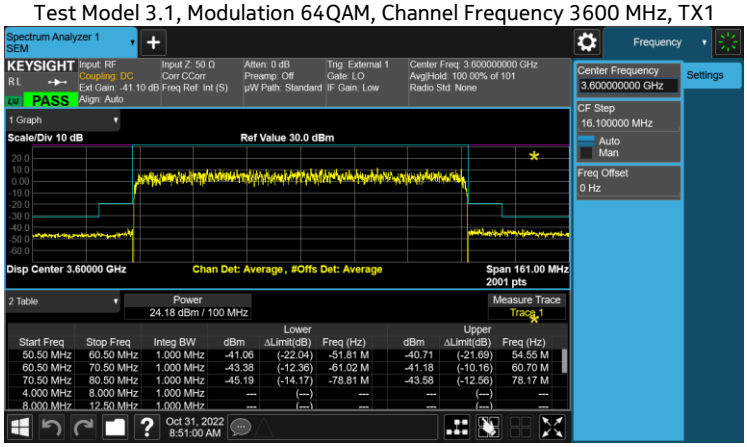


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3655 MHz, TX1

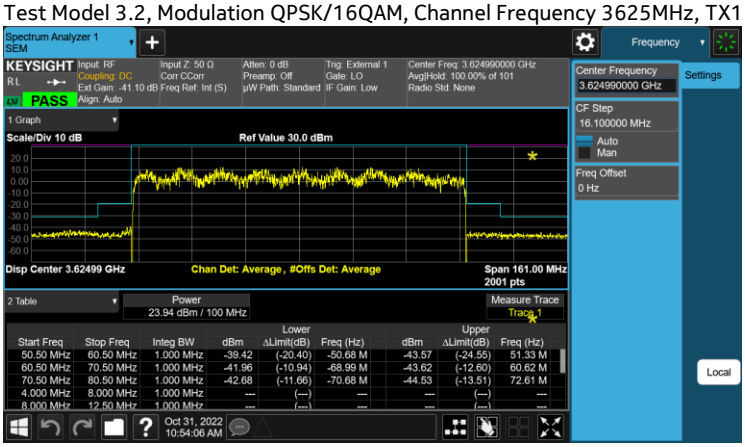


100 MHz BW

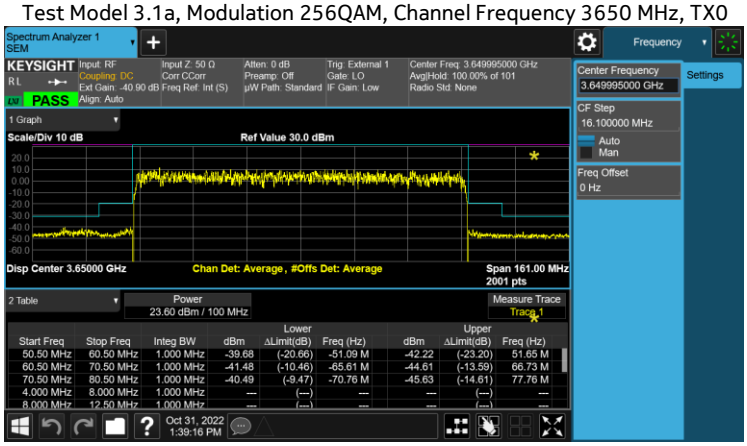
Test Model 3.1, Modulation 64QAM, Channel Frequency 3600 MHz, TX1



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX1

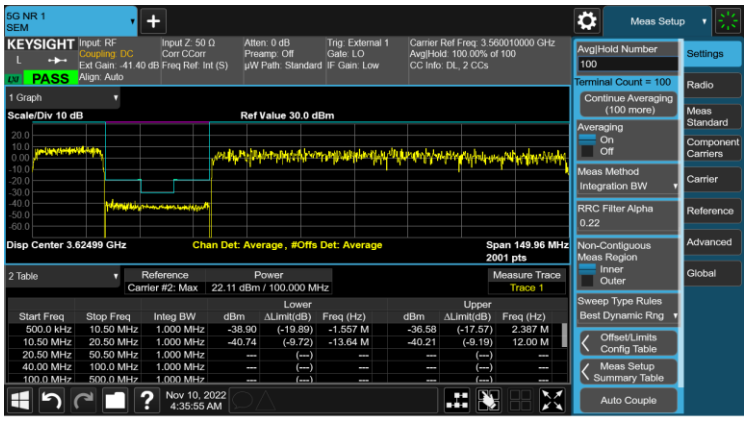


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3650 MHz, TX0



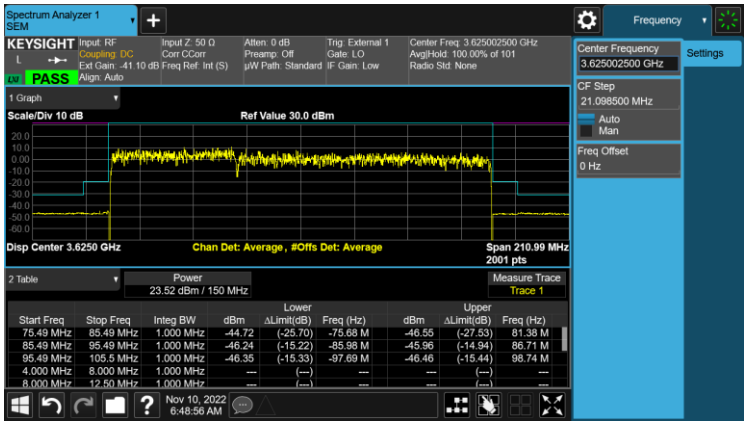
20+100 MHz BW

Test Model 3.1, Modulation 64QAM, Channel Frequency 3560+3650 MHz, TX1



50+100 MHz BW

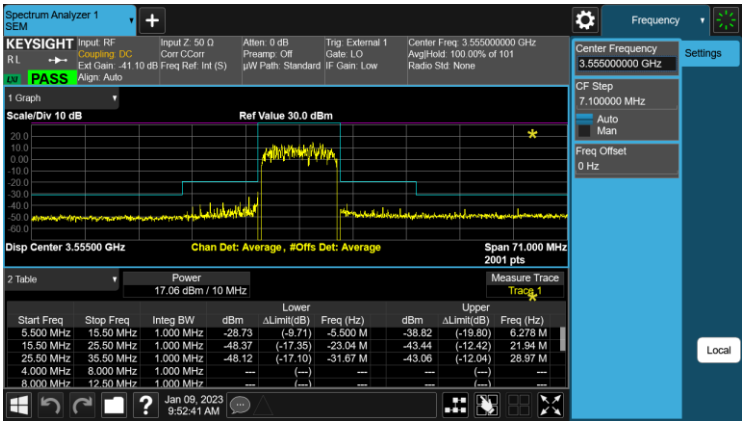
Test Model 3.1a, Modulation 256QAM, Channel Frequency 3575+3650 MHz, TX0



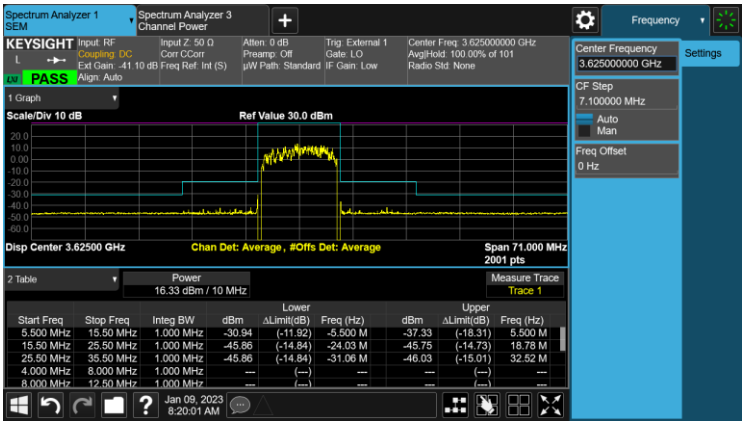
4.2.1.2 LTE Plots

10 MHz BW

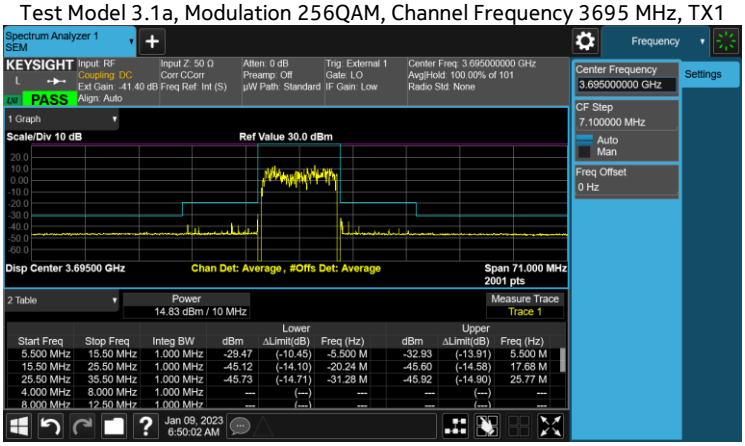
Test Model 3.1, Modulation 64QAM, Channel Frequency 3555 MHz, TX3



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX0

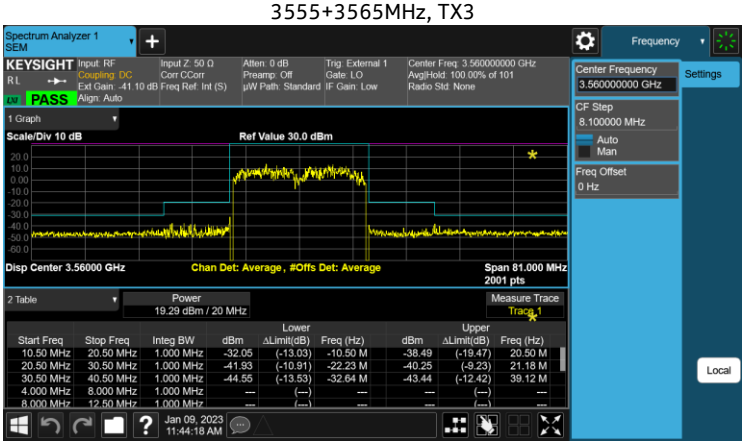


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3695 MHz, TX1

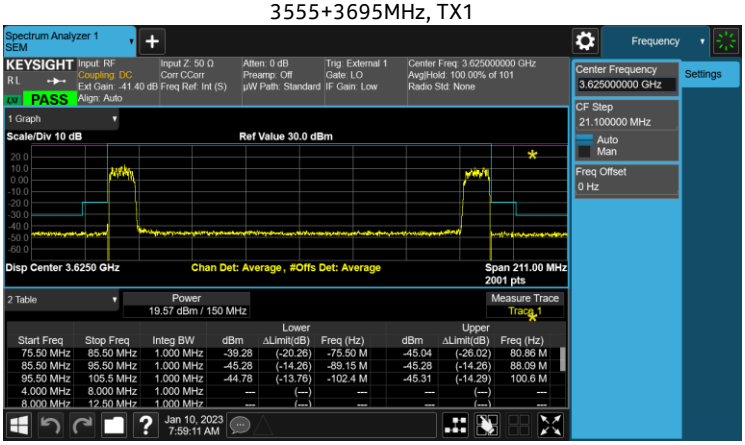


10+10 MHz BW

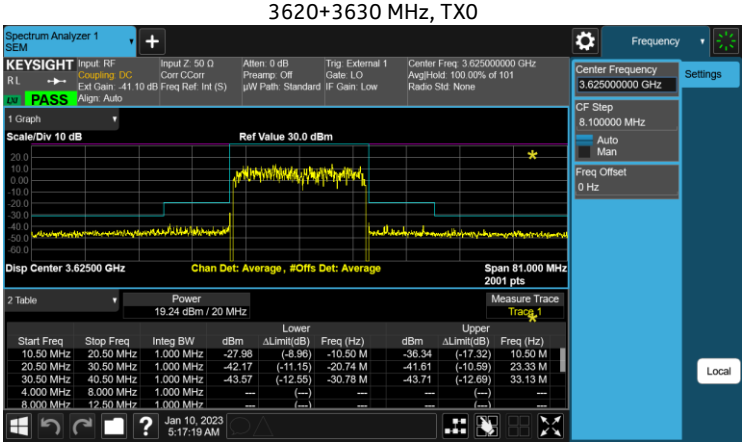
Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3555+3565MHz, TX3



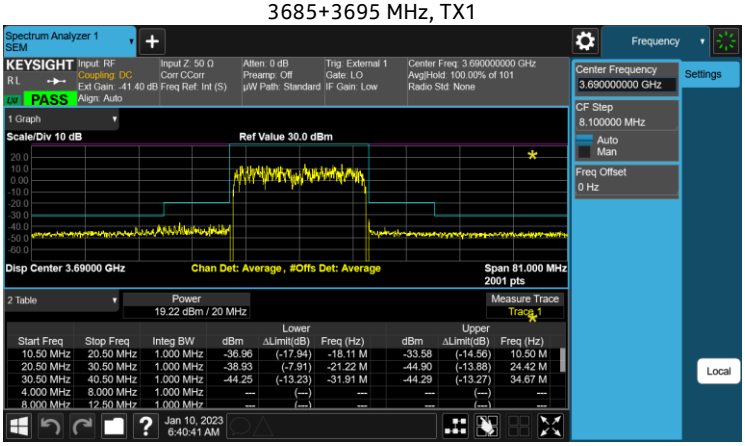
Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3555+3695MHz, TX1



Test Model 3.1, Modulation 64QAM, Channel Frequency 3620+3630 MHz, TX0

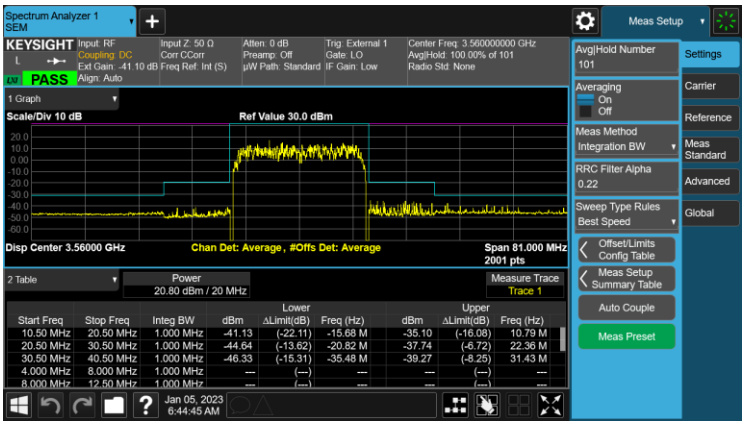


Test Model 3.1a, Modulation 256QAM, Channel Frequency 3685+3695 MHz, TX1



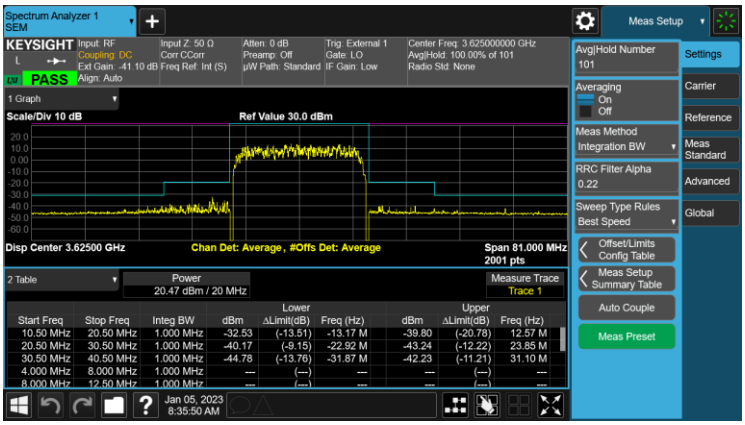
20 MHz BW

Test Model 3.1, Modulation 64QAM, Channel Frequency 3560 MHz, TX3



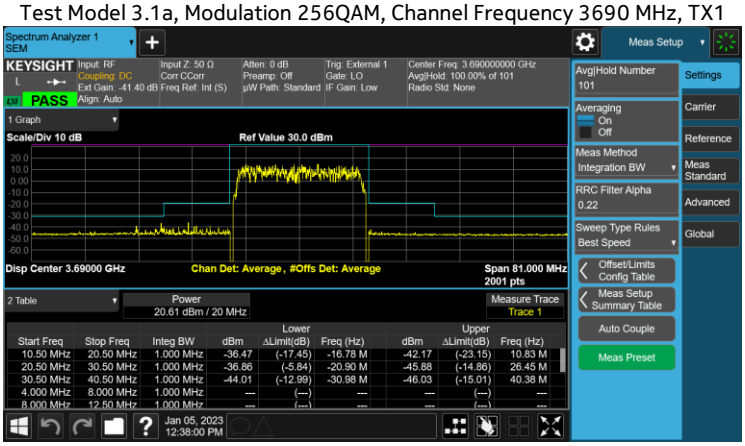
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLimit(dB)	Lower Freq (Hz)	dBm	Upper ΔLimit(dB)	Upper Freq (Hz)
10.50 MHz	20.50 MHz	1.000 MHz	-41.13	(-22.11)	-15.68 M	-35.10	(-16.08)	10.79 M
20.50 MHz	30.50 MHz	1.000 MHz	-44.64	(-13.62)	-20.82 M	-37.74	(-6.72)	22.36 M
30.50 MHz	40.50 MHz	1.000 MHz	-46.33	(-15.31)	-35.48 M	-39.27	(-8.25)	31.43 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 3625MHz, TX3



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLimit(dB)	Lower Freq (Hz)	dBm	Upper ΔLimit(dB)	Upper Freq (Hz)
10.50 MHz	20.50 MHz	1.000 MHz	-32.53	(-13.51)	-13.17 M	-39.80	(-20.78)	12.57 M
20.50 MHz	30.50 MHz	1.000 MHz	-40.17	(-9.15)	-22.92 M	-43.24	(-12.22)	23.85 M
30.50 MHz	40.50 MHz	1.000 MHz	-44.78	(-13.76)	-31.87 M	-42.23	(-11.21)	31.10 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Test Model 3.1a, Modulation 256QAM, Channel Frequency 3690 MHz, TX1



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLimit(dB)	Lower Freq (Hz)	dBm	Upper ΔLimit(dB)	Upper Freq (Hz)
10.50 MHz	20.50 MHz	1.000 MHz	-36.47	(-17.45)	-16.78 M	-42.17	(-23.15)	10.83 M
20.50 MHz	30.50 MHz	1.000 MHz	-36.86	(-5.84)	-20.90 M	-45.88	(-14.86)	26.45 M
30.50 MHz	40.50 MHz	1.000 MHz	-44.01	(-12.99)	-30.98 M	-46.03	(-15.01)	40.38 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---

5. FCC Section 2.1051 - Spurious Emissions at Transmit Antenna Port

This test measures the emissions of spurious signals which may come from harmonic, parasitic, intermodulation and frequency conversion products and are outside the necessary bandwidth but excludes Edge-of-Band emissions.

5.1 Section 2.1051 Spurious Emissions at Antenna Terminals

Spurious Emissions at the antenna terminals were investigated per 47CFR Section 2.1057(a)(1) over the frequency range of 10 MHz to 37 GHz which is beyond the 10th harmonic of the carrier frequency. A test coupler which incorporates a low intermod broadband RF attenuator was used to reduce the transceiver's amplitude to a level usable by the spectrum analyzer. The test configuration is shown in Figure 4.4.1 which documents the test set up used for the measurements. In this set up the complete RF test path was calibrated over the 10 MHz-37 GHz range.

The spurious measurements were made using an MXA Signal Analyzer. These measurements are performed in compliance with ANSI C63.26 and our ISO17025 process. The measurement meets the ANSI C63.26 requirements in paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be > 2 × Span/RBW. The MXA signal analyzer measurements examine the 10 MHz to 37 GHz range.

Measurements were performed for all of the test configurations in Table 5.1 and these matches the test configurations used for Occupied Bandwidth / Edge of Band Emissions, RF Power and modulation.

5.2 Required Limit

The required emission limitation specified in **47CFR 96.41 (e)** was applied to these tests. Based upon the criterion given in Section 96 of the Code and as developed in 4.3.3, the required emission limit for emissions outside a licensee's frequency block is:

47CFR 96.41 (e)(2) *Additional protection levels.* Notwithstanding paragraph (e)(1) of this section, the conducted power of any emissions below 3540 MHz or above 3710 MHz shall not exceed −25 dBm/MHz, and the conducted power of emissions below 3530 MHz or above 3720 MHz shall not exceed −40 dBm/MHz.

In order to account for the spectral adding of identical signals from the primary and diversity ports, per KDB 662911 D01 Multiple Transmitter Output v01r01, the level needs be adjusted by 10LOG(n) where n=number of outputs.

The adjustment for n=4 is: 6.02 dB = 10LOG(4)

Therefore, the limit for emissions below 3540 MHz or above 3710 MHz frequency block when measured with a RBW of 1 MHz is:

-25 dBm - 6.02 dB = -31.02 dBm for 4x MIMO

Therefore, the limit for emissions below 3530 MHz or above 3720 MHz frequency block when measured with a RBW of 1 MHz is:

-40 dBm - 6.02 dB = -46.02 dBm for 4x MIMO

5.3 Spurious Emissions at Antenna Terminals Results

NOTE: Only plots with lowest margin in each frequency range are used in this report. The full suite of raw data resides at the MH, New Jersey location.

Tabular Data – Spurious Emissions at Antenna Terminals (5G-NR)

Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Conducted Spurious Emissions Results Pass/ Fail
3.1	64QAM	56	3560	20	Pass
3.1	64QAM	56	3560	20	Pass
3.2	QPSK/16QAM	56	3625	20	Pass
3.1a	256QAM	56	3690	20	Pass
3.1	64QAM	56	3565	30	Pass
3.2	QPSK/16QAM	56	3625	30	Pass
3.1a	256QAM	56	3685	30	Pass
3.1	64QAM	56	3570	40	Pass
3.2	QPSK/16QAM	56	3625	40	Pass
3.1a	256QAM	56	3680	40	Pass
3.1	64QAM	56	3575	50	Pass
3.2	QPSK/16QAM	56	3625	50	Pass
3.1	64QAM	56	3675	50	Pass
3.1	64QAM	56	3580	60	Pass
3.2	QPSK/16QAM	56	3625	60	Pass
3.1a	256QAM	56	3670	60	Pass
3.1	64QAM	56	3585	70	Pass
3.2	QPSK/16QAM	56	3625	70	Pass
3.1a	256QAM	56	3665	70	Pass
3.1	64QAM	56	3590	80	Pass
3.2	QPSK/16QAM	56	3625	80	Pass
3.1a	256QAM	56	3660	80	Pass
3.1	64QAM	56	3595	90	Pass
3.2	QPSK/16QAM	56	3625	90	Pass
3.1a	256QAM	56	3655	90	Pass
3.1	64QAM	56	3600	100	Pass
3.2	QPSK/16QAM	56	3625	100	Pass
3.1a	256QAM	56	3650	100	Pass

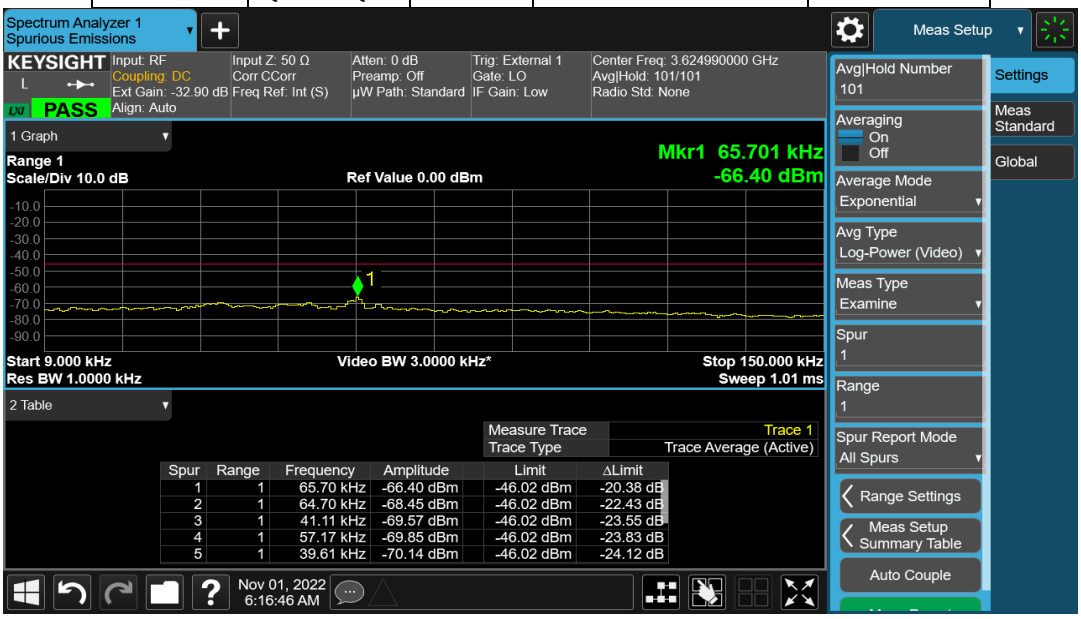
Tabular Data – Spurious Emissions at Antenna Terminals (LTE)

Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Conducted Spurious Emissions Results Pass/ Fail
3.1	64QAM	3	3555	10	Pass
3.2	QPSK/16QAM	0	3625	10	Pass
3.1a	256QAM	3	3695	10	Pass
3.2	QPSK/16QAM	1	3555+3695	10+10	Pass
3.1	64QAM	3	3560	20	Pass
3.2	QPSK/16QAM	3	3625	20	Pass
3.1a	256QAM	3	3690	20	Pass

5.3.1 5G-NR Plots

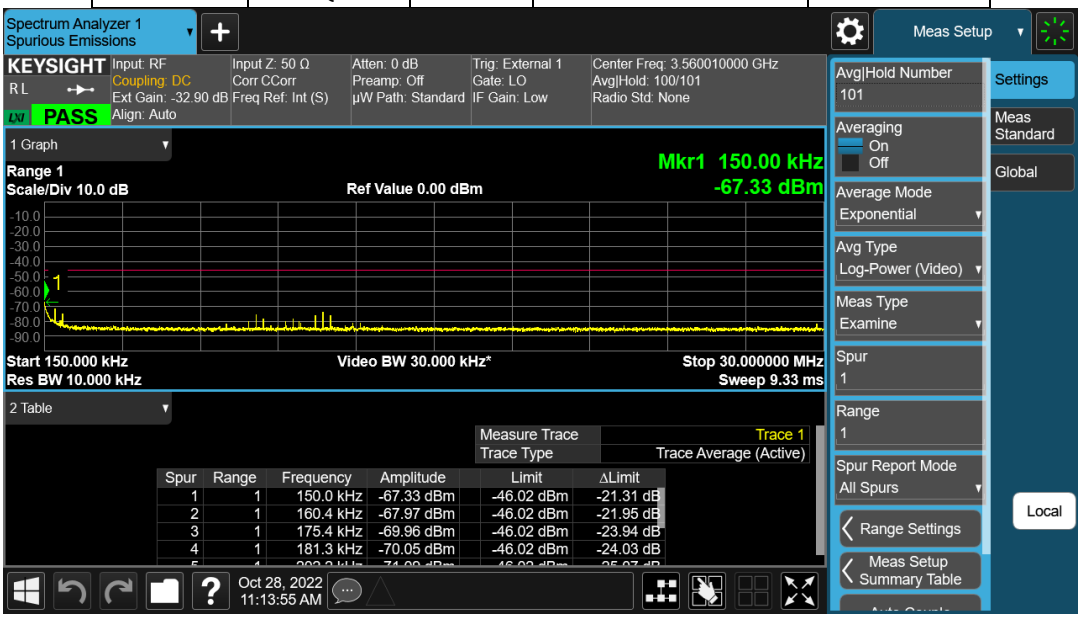
9KHz – 150kHz

Test Model	Modulation	TX Port	Channel Frequency (MHz)	Signal BW (MHz)
3.2	QPSK/16QAM	1	3625	100



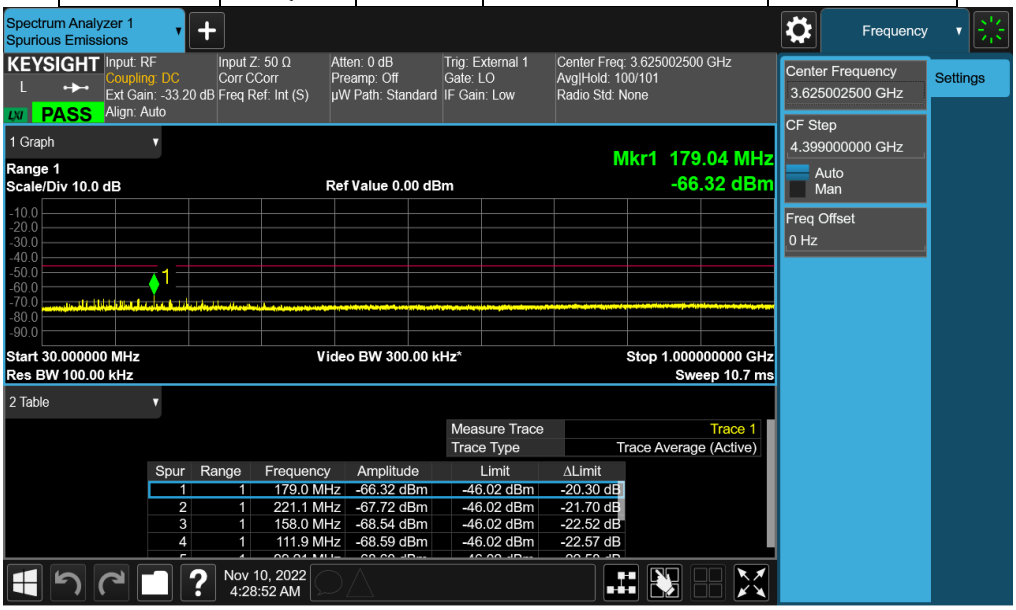
150kHz – 30MHz

Test Model	Modulation	TX Port	Channel Frequency (MHz)	Signal BW (MHz)
3.1	64QAM	1	3560	20



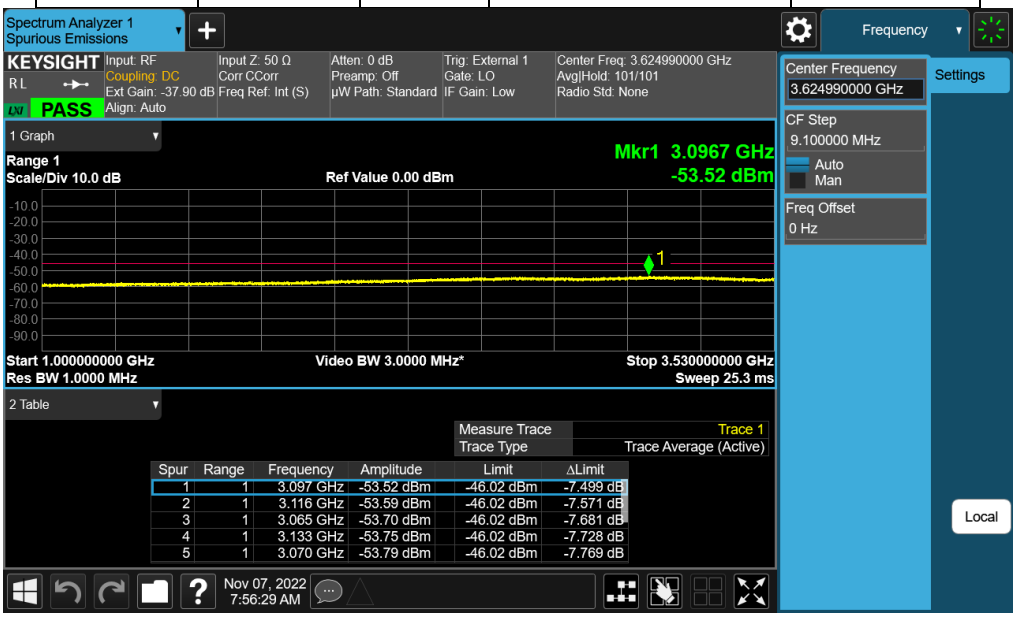
30MHz – 1GHz

Test Model	Modulation	TX Port	Channel Frequency (MHz)	Signal BW (MHz)
3.1	64QAM	1	3560+3650	20+100



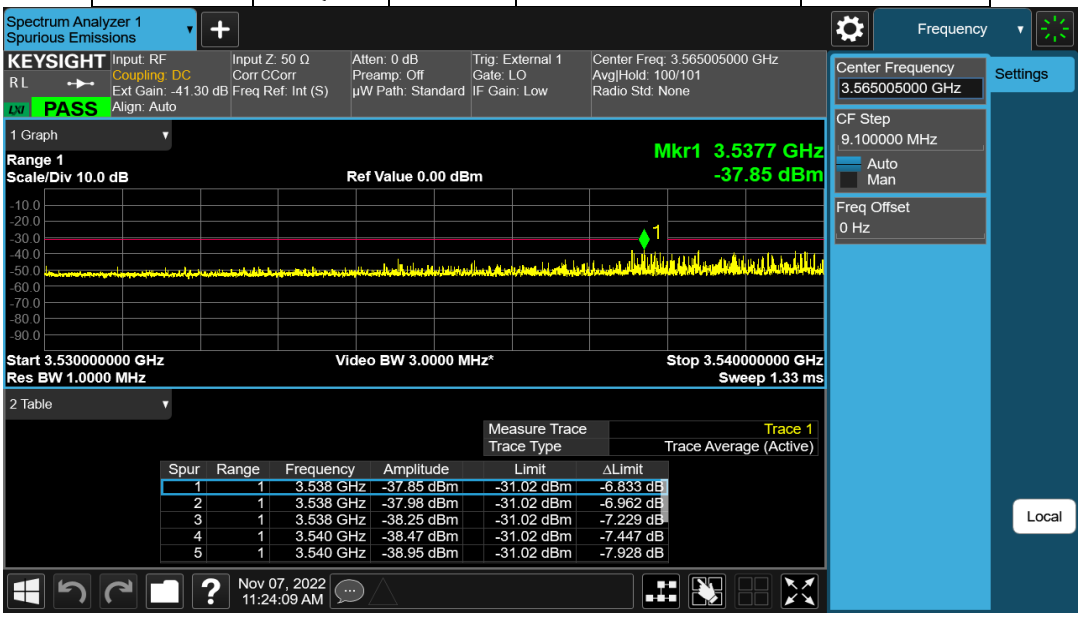
1GHz – 3.53GHz

Test Model	Modulation	TX Port	Channel Frequency (MHz)	Signal BW (MHz)
3.2	QPSK/16QAM	1	3625	30



3.53GHz – 3.72GHz

Test Model	Modulation	TX Port	Channel Frequency (MHz)	Signal BW (MHz)
3.1	64QAM	1	3565	30



3.72GHz – 20GHz

Test Model	Modulation	TX Port	Channel Frequency (MHz)	Signal BW (MHz)
3.2	QPSK/16QAM	1	3650	100