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Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 27

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
AHNA AirScale RRH 4T4R n30 100W

Report Number:
TR-2020-0157-FCC2-27

Date Issued:
January 5, 2021

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Revisions

Date	Revision	Section	Change
1/5/2021	0		Initial Release

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1. System Information and Requirements

Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in Murray-Hill, NJ.

Equipment Under Test (EUT):	AHNA AirScale RRH 4T4R n30 100W
Serial Number:	1M184225297
FCC ID:	VBNAHNA-01
Hardware Version:	474861A.X21
Software Version:	5G20B
Frequency Range:	2350-2360 MHz
GPCL Project Number:	2020-0157
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	Nokia Solutions and Networks 3201 Olympus Blvd Dallas, Texas 75019 Steve Mitchell
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	- Title 47 CFR Parts 2 and 27 - KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018. - KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 - ANSI C63.26 (2015) - ANSI C63.4 (2014)
Measurement Procedure(s):	- FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019 - FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019
Test Date(s):	11/12/2020 – 11/17/2020 (Radio) 12/8/2020 – 12/9/2020 (Frequency Stability)
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636
Product Engineer(s):	Ron Remy
Lead Engineer:	Steve Gordon
Test Engineer (s):	Jaideep Yadav, Joe Bordonaro
Test Results: The EUT, <i>as tested</i> met the above listed Test Requirements. The decision rule employed is binary (Pass/Fail) based on the measured values without accounting for Measurement Uncertainty or any Guard Band. The measured values obtained during testing were compared to a value given in the referenced regulation or normative standard. Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in New Providence, NJ.	

1.1 Introduction

This Conformity test report applies to the AHNA AirScale RRH 4T4R n30 100W (AHNA), hereinafter referred to as the Equipment Under Test (EUT).

1.2 Purpose and Scope

This document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 27 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

The purpose of this testing is to demonstrate compliance for AAHF mMIMO product for 5G NR operation. This Class II Permissive Change will be submitted to add 5G-NR to the existing Grant for FCC ID: VBNAHNA-01.

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Duplex Mode	5G-NR
Modulation Type(s)	QPSK 16QAM 64QAM 256QAM
Operation Frequency Range	DL 2350-2360 MHz UL 2305-2315 MHz
Channel Bandwidth	5,10 MHz
Tx/Rx	4T4R
Deployment Environment	Outdoor
Supply Voltage	-48.0 VDC
Max RF Output Power	100W

1.3.2 Photographs



1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 27.53	RF Power Output	Yes
2.1047, 27.53	Modulation Characteristics	Yes
2.1049, 27.53	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 27.53	Spurious Emissions at Antenna Terminals	Yes
2.1053, 27.53	Field Strength of Spurious Radiation	Yes
2.1055, 27.53	Frequency Stability	Yes

1.5 Test Standards & Measurement Procedures

1.5.1 Test Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 27.
- KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013
- ANSI C63.26-2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

1.5.2 Measurement Procedures

- FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019
- FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019

1.6 MEASUREMENT UNCERTAINTY

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

Worst-Case Estimated Measurement Uncertainties

Standard, Method or Procedure	Condition	Frequency MHz	Expanded Uncertainty (k=2)
a. Classical Emissions, (<i>e.g.</i> , ANSI C63.4, CISPR 11, 14, 22, <i>etc.</i> , using ESHS 30,	Conducted Emissions	0.009 - 30	±3.5 dB
	Radiated Emissions (AR-6 Semi-Anechoic Chamber)	30 MHz – 200MHz H 30 MHz – 200 MHz V 200 MHz – 1000 MHz H 200 MHz – 1000 MHz V 1 GHz - 18 GHz	±5.1 dB ±5.1 dB ±4.7 dB ±4.7 dB ±3.3 dB

Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	0.5 dB

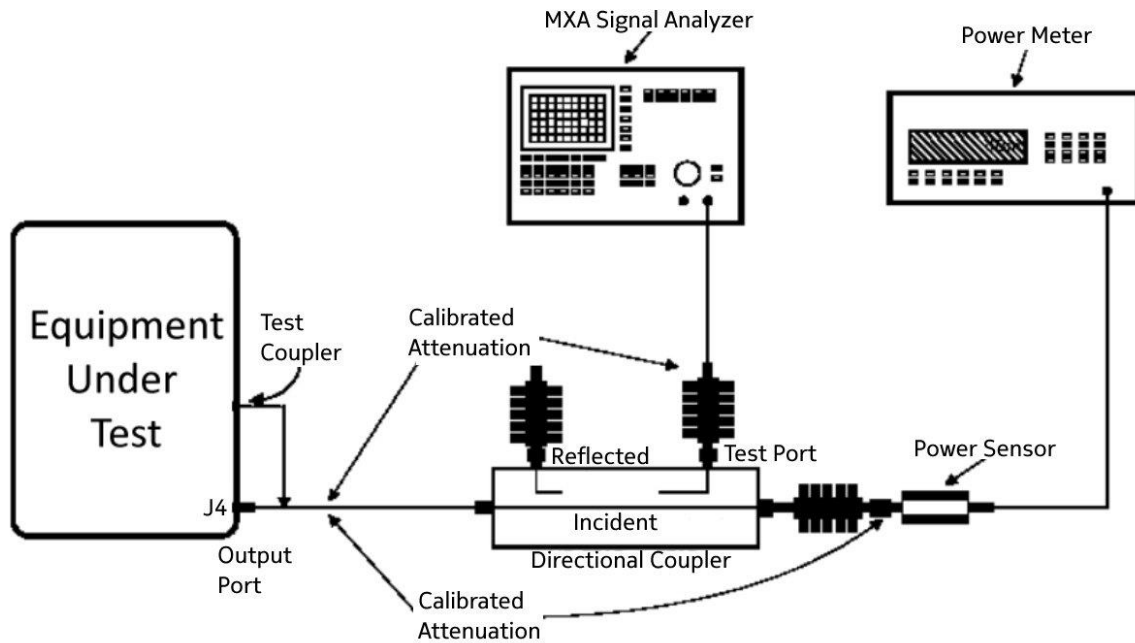
1.7 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046, 27.53	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047, 27.53	Modulation Characteristics	COMPLIES
2.1049, 27.53	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051, 27.53	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 27.53	Field Strength of Spurious Radiation	COMPLIES
2.1055, 27.53	Frequency Stability	COMPLIES

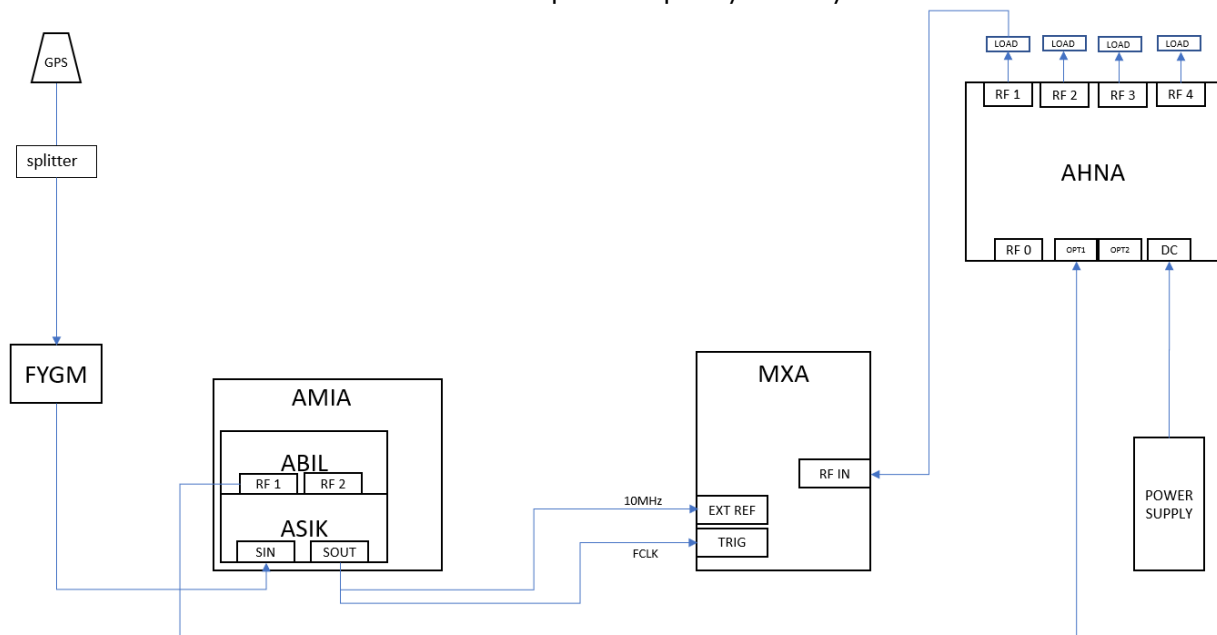
1. **COMPLIES** - Passed all applicable tests.
2. **N/A** – Not Applicable.
3. **NT** – Not Tested.

1.8 Test Configurations

Test Setup for all Antenna Port Measurements



Test Setup for Frequency Stability



2. FCC Section 2.1046 - RF Power Output

2.1 RF Power Output

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26. Power measurements were made with an MXA Signal Analyzer.

The Maximum Average RF Power Values are bolded in each configuration.

Tabular Data – Channel RF Power

Single Carrier- Signal BW 5MHz					
Test Model 3.1 Modulation 64QAM Channel Frequency 2352.5MHz		Test Model 1.1 Modulation QPSK Channel Frequency 2355MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 2357.5MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	44.21	1	43.99	1	44.07
2	43.79	2	43.46	2	43.68
3	43.60	3	43.14	3	43.37
4	44.26	4	44.08	4	44.42
Total Power (dBm)	50.00	Total Power (dBm)	49.71	Total Power (dBm)	49.93
Total Power (W)	99.93	Total Power (W)	93.50	Total Power (W)	98.32

Single Carrier - Signal BW 10MHz	
Test Model 3.1 Modulation 64QAM Channel Frequency 2355MHz	
TX Port	(dBm)
1	44.05
2	43.66
3	43.34
4	44.04
Total Power (dBm)	49.81
Total Power (W)	95.63

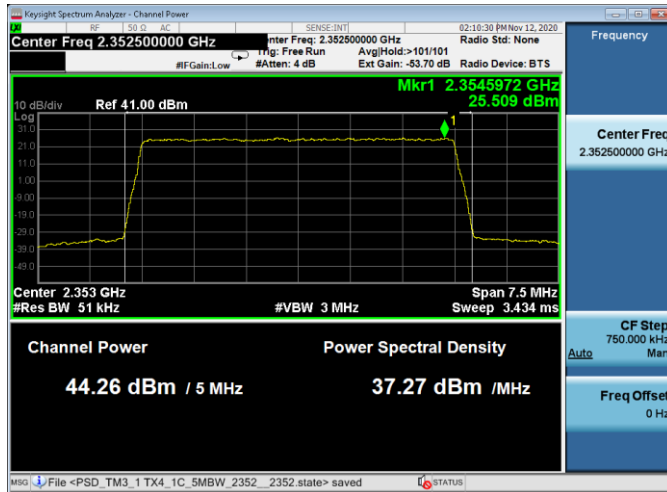
Dual Carrier - Signal BW 5+5 MHz	
Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 2352.5 + 2357.5 MHz	
TX Port	(dBm)
1	43.95
2	43.59
3	43.18
4	43.77
Total Power (dBm)	49.66
Total Power (W)	92.37

Channel RF Power – Plots

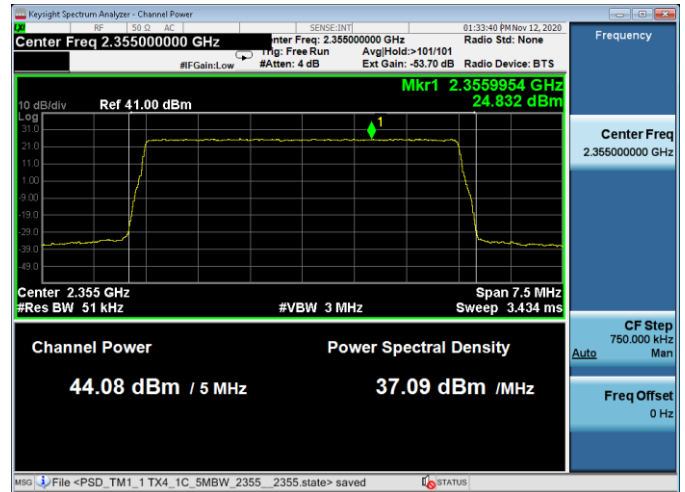
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

Single Carrier - 5 MHz BW

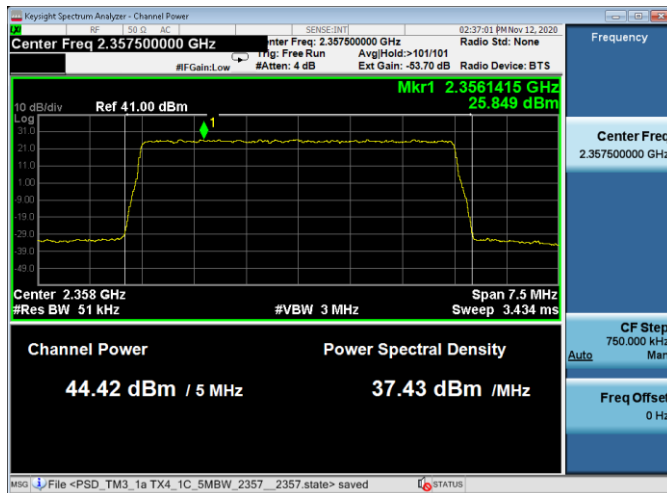
Test Model 3.1
Modulation 64QAM
Channel Frequency 2352.5MHz
TX4



Test Model 1.1
Modulation QPSK
Channel Frequency 2355MHz
TX4



Test Model 3.1a
Modulation 256QAM
Channel Frequency 2357.5MHz
TX4



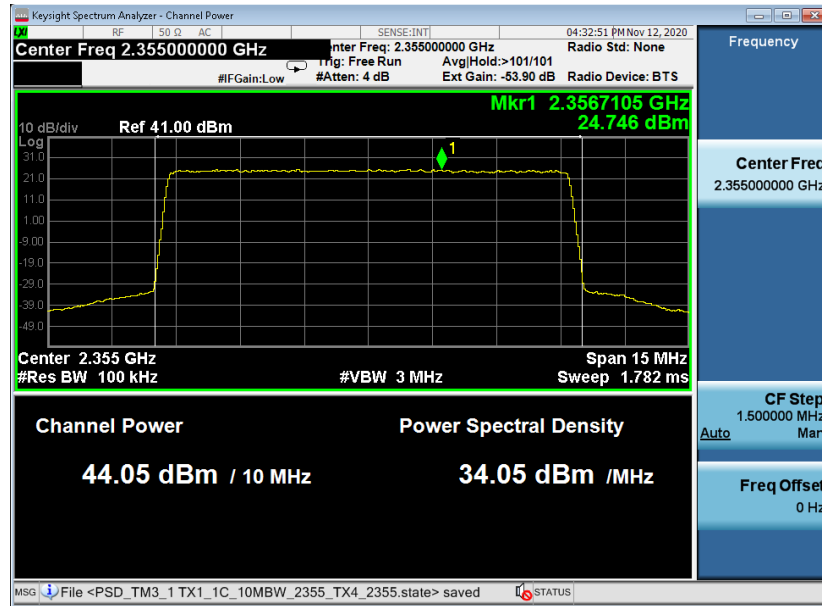
Single Carrier - 10 MHz BW

Test Model 3.1

Modulation 64QAM

Channel Frequency 2355MHz

TX1

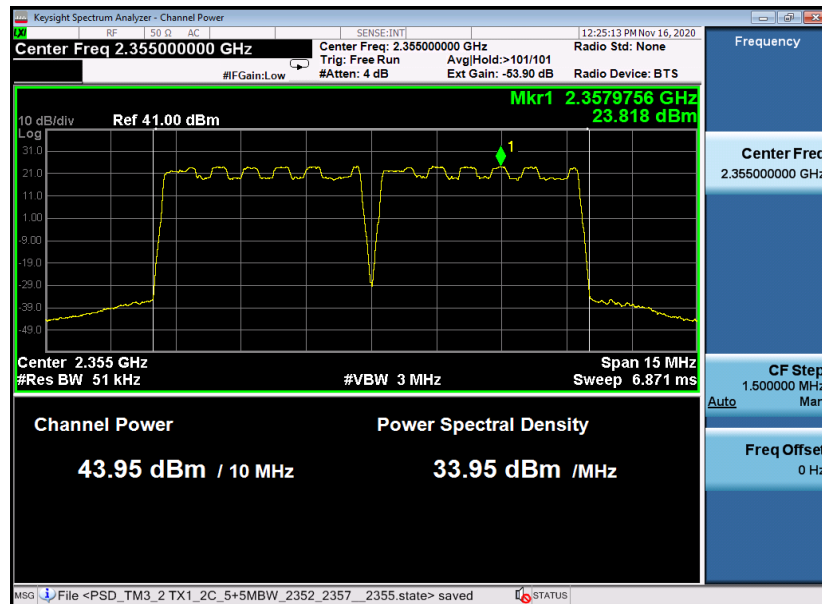
**Dual Carrier - 5+5 MHz BW**

Test Model 3.2

Modulation QPSK/16QAM

Channel Frequency 2352.5 + 2357.5 MHz

TX1

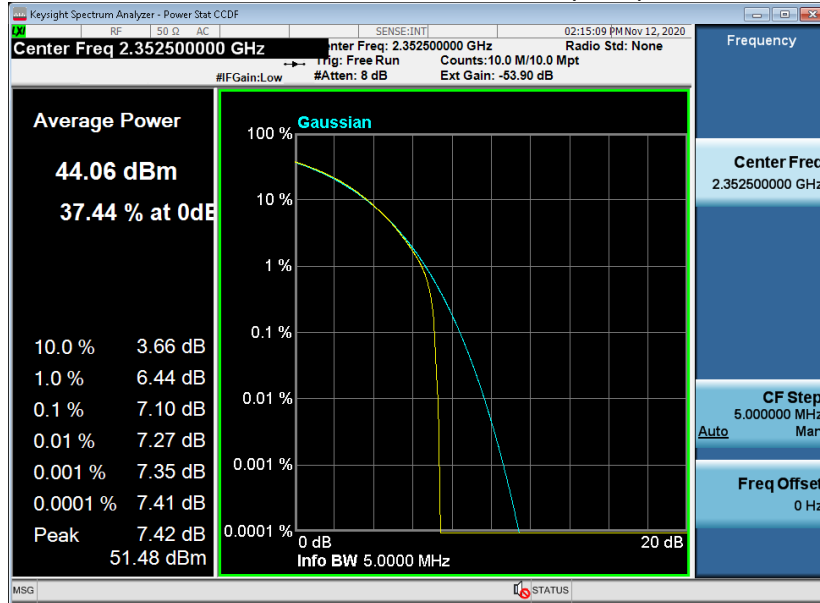


2.1.1 Peak-to-Average Power Ratio (PAPR) – Plots

The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for 5, 10, and 5+5 MHz bandwidth. The PAPR values of all carriers measured are below 13dB.

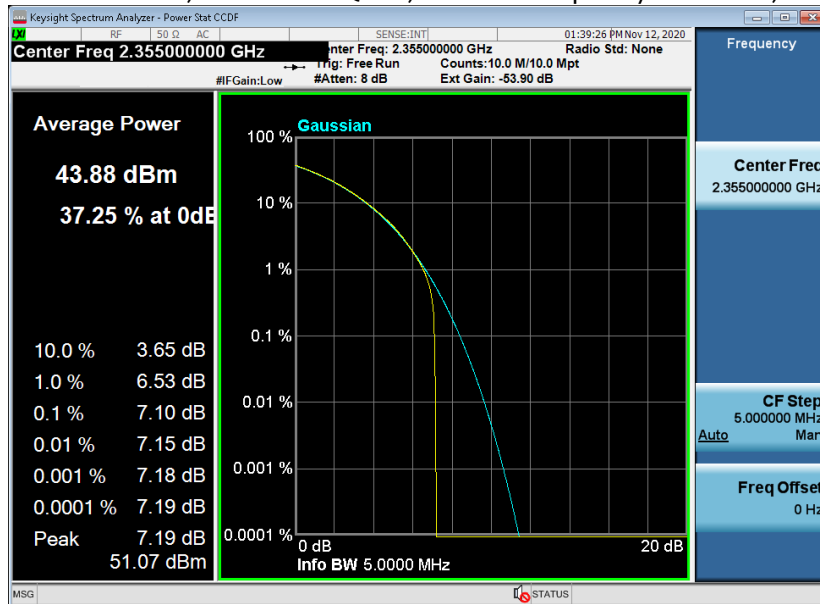
Single Carrier - 5 MHz BW

Test Model 3.1, Modulation 64QAM, Channel Frequency 2352.5MHz, TX1



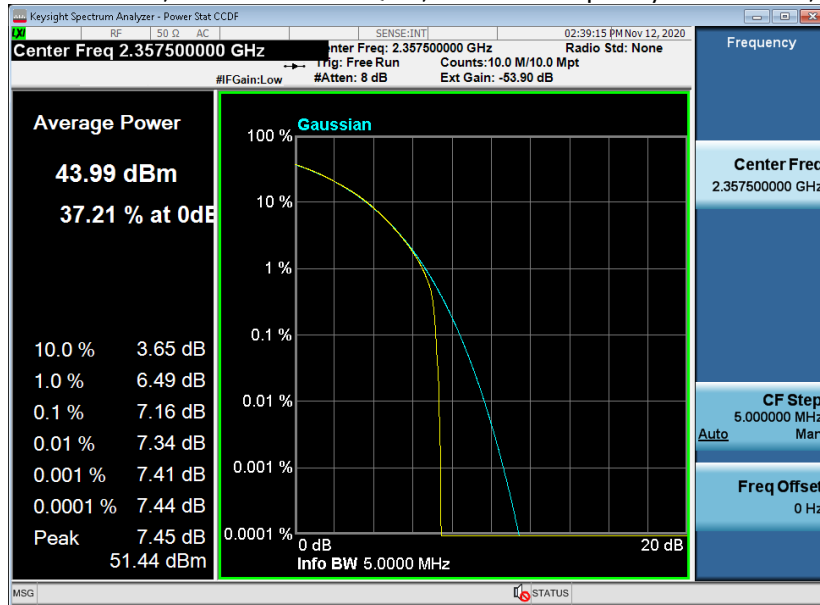
Single Carrier - 5 MHz BW

Test Model 1.1, Modulation QPSK, Channel Frequency 2355MHz, TX1



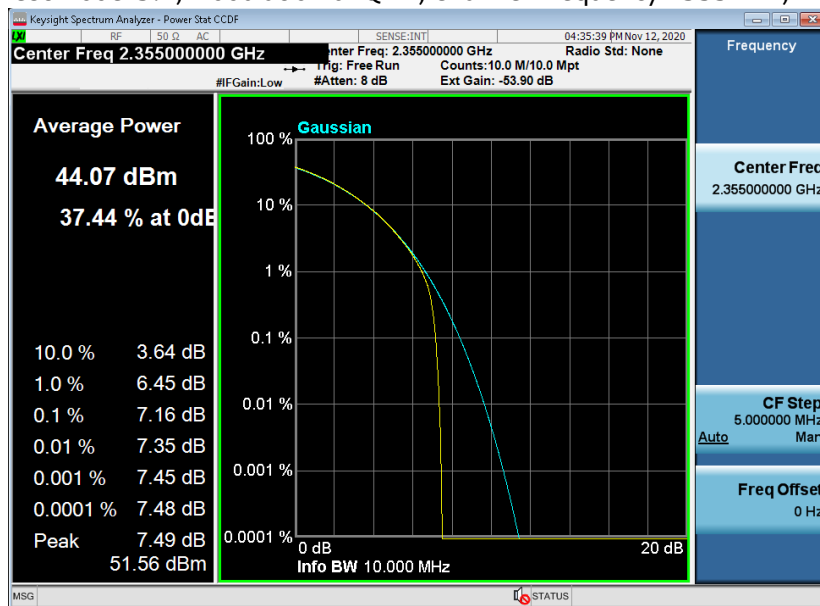
Single Carrier - 5 MHz BW

Test Model 3.1a, Modulation 256QAM, Channel Frequency 2357.5MHz, TX1

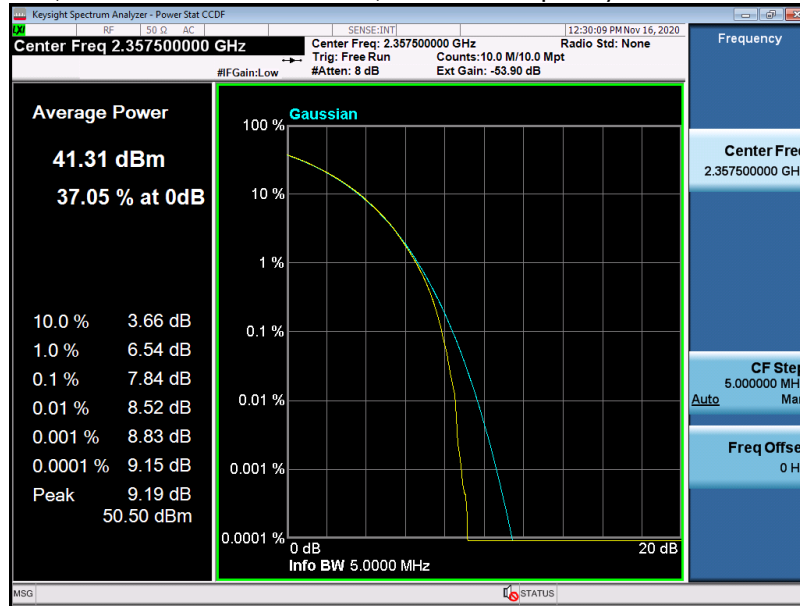


Single Carrier - 10MHz BW

Test Model 3.1, Modulation 64QAM, Channel Frequency 2355MHz, TX4



Dual Carrier - 5+5 MHz BW
Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 2352.5 + 2357.5 MHz, TX1

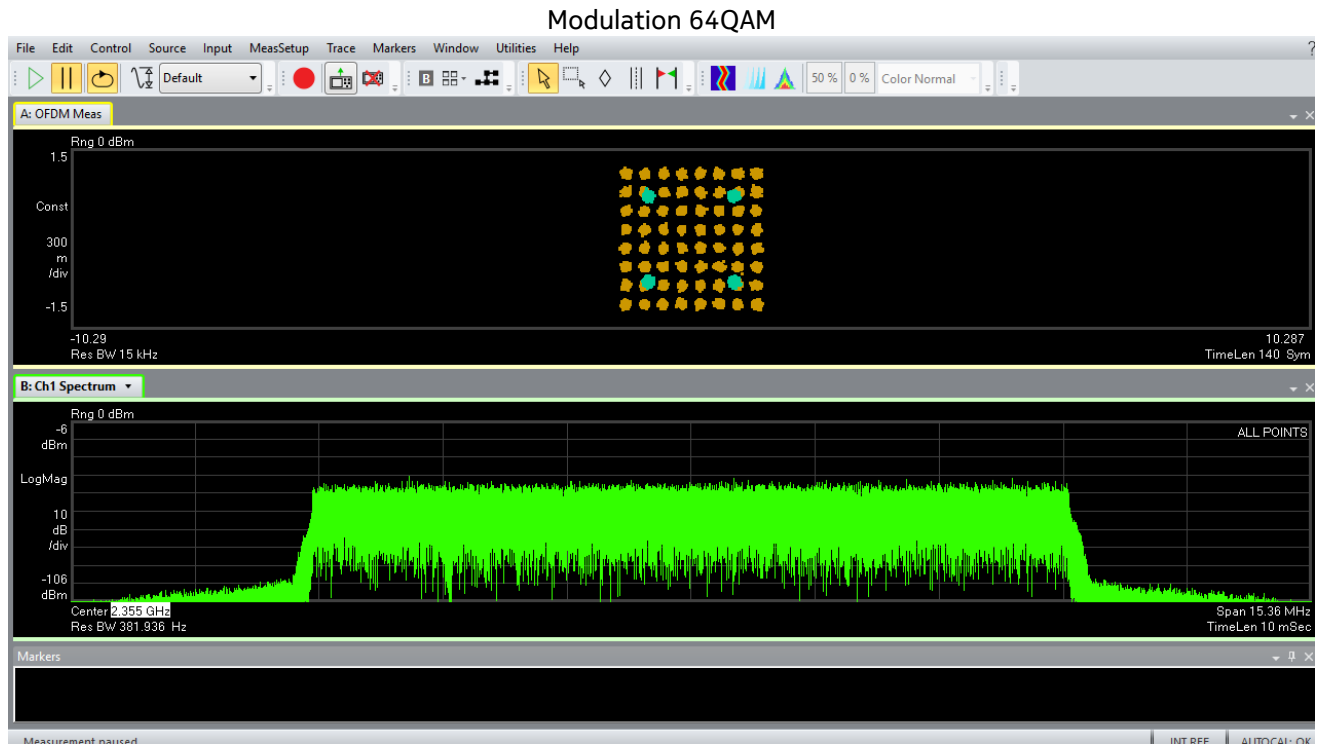


3. FCC Section 2.1047 - Modulation Characteristics

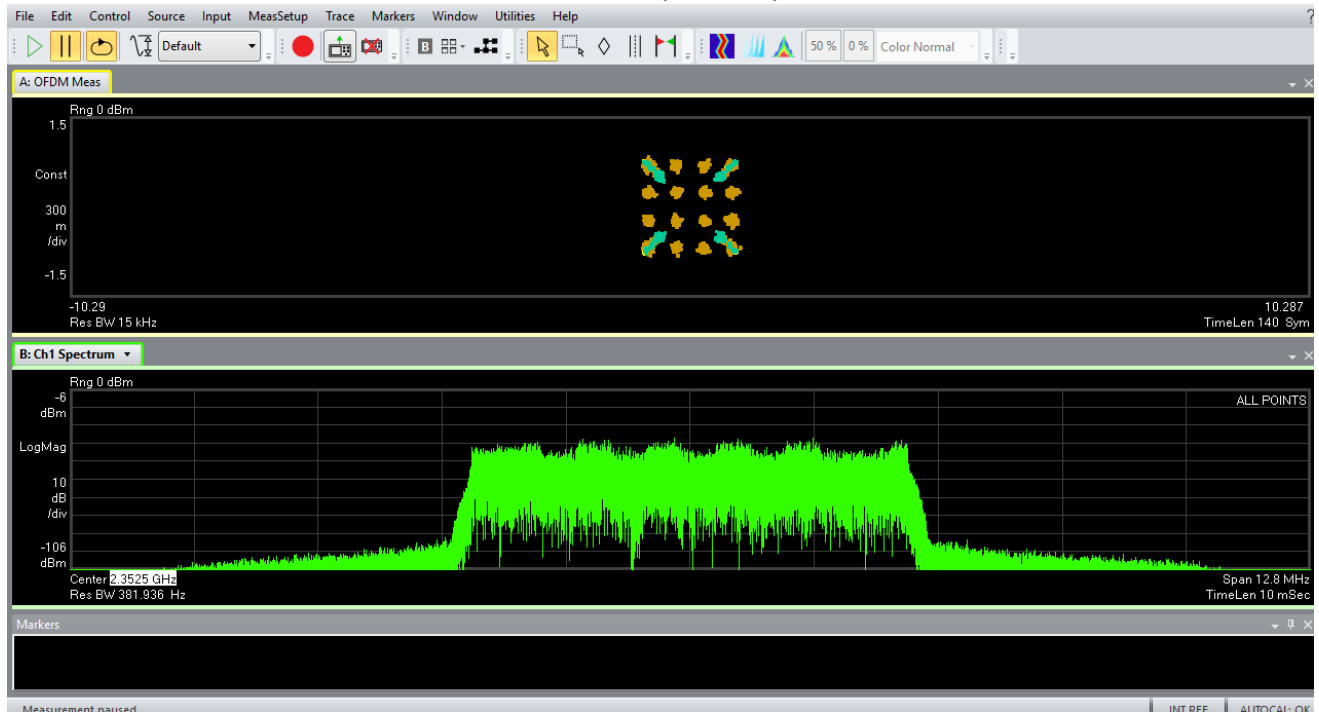
3.1 Modulation Characteristics

The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

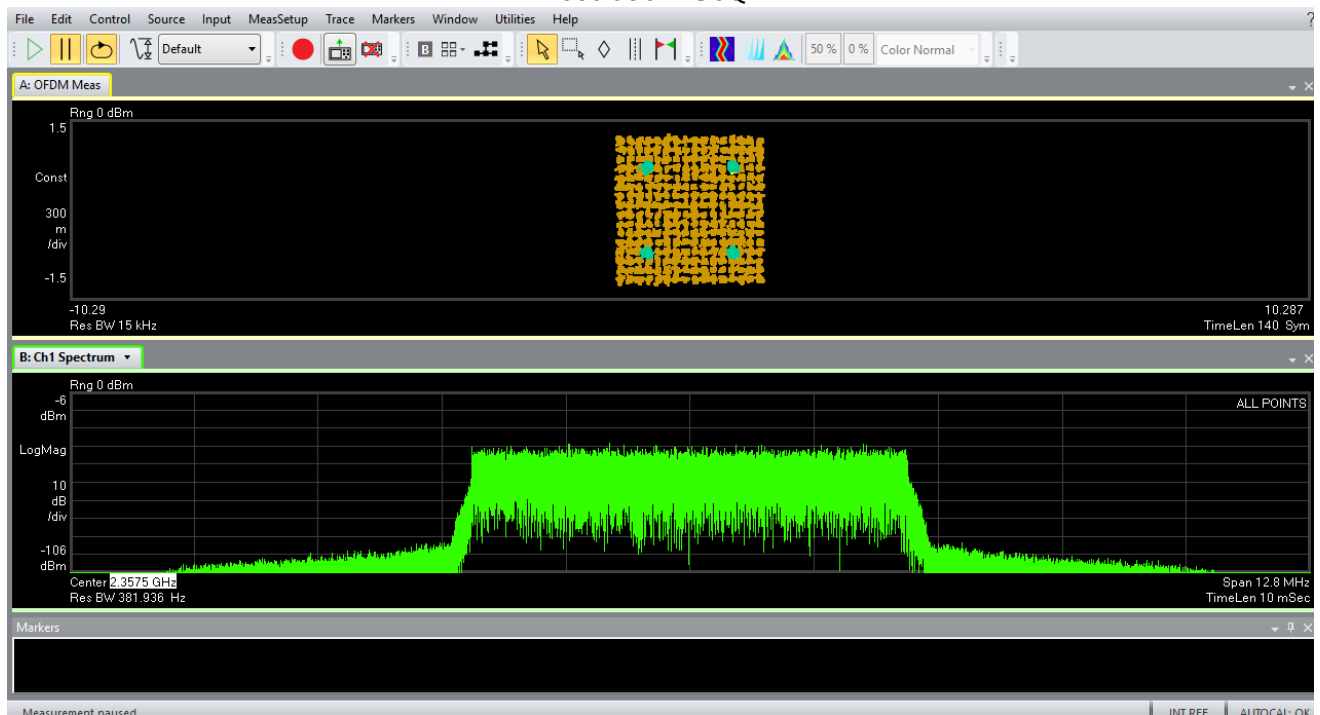
3.1.1 Modulation Characteristics – Plots



Modulation QPSK/16QAM



Modulation 256QAM



4. FCC Section 2.1049 – Occupied Bandwidth/Edge of Band Emissions

4.1 Occupied Bandwidth

In 47CFR 2.1049 the FCC requires:

“The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable.”

This required measurement is the 99% Occupied Bandwidth, also called the designated signal bandwidth and needs to be within the parameters of the products specified emissions designator. During these measurements it is customary to evaluate the Edge of Band emissions at block/band edges.

The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer. All emissions were within the parameters as required.

Tabular Data – Occupied Bandwidth

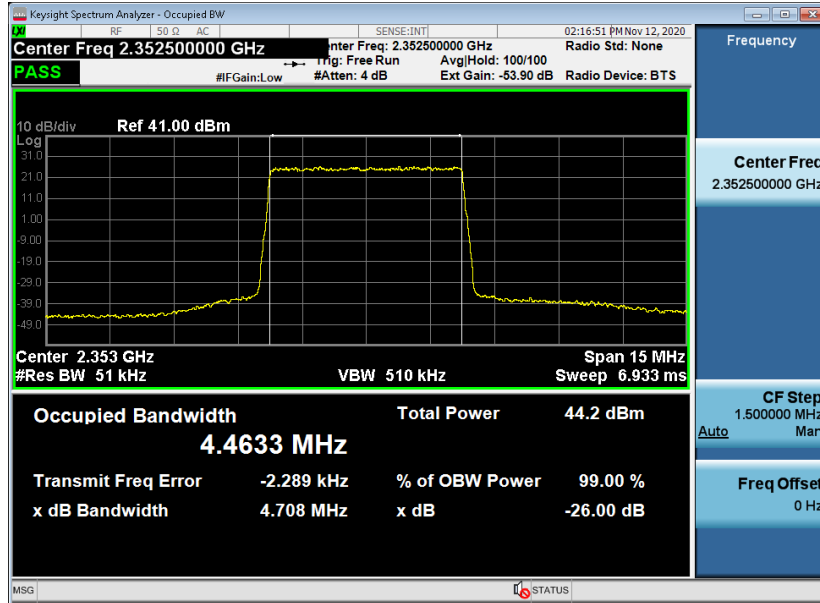
# of Carriers	Signal BW (MHz)	Test Model (TM)	Modulation	Channel Frequency (MHz)	TX	Occupied BW (MHz)
1	5	3.1	64QAM	2352.5	1	4.4633
1	5	1.1	QPSK	2355	1	4.4608
1	5	3.1a	256QAM	2357.5	1	4.4557
1	10	3.1	64QAM	2355	4	9.2639
2	5+5	3.2	QPSK/16QAM	2352.5 + 2357.5	1	9.425

4.1.1 Occupied Bandwidth – Plots

NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

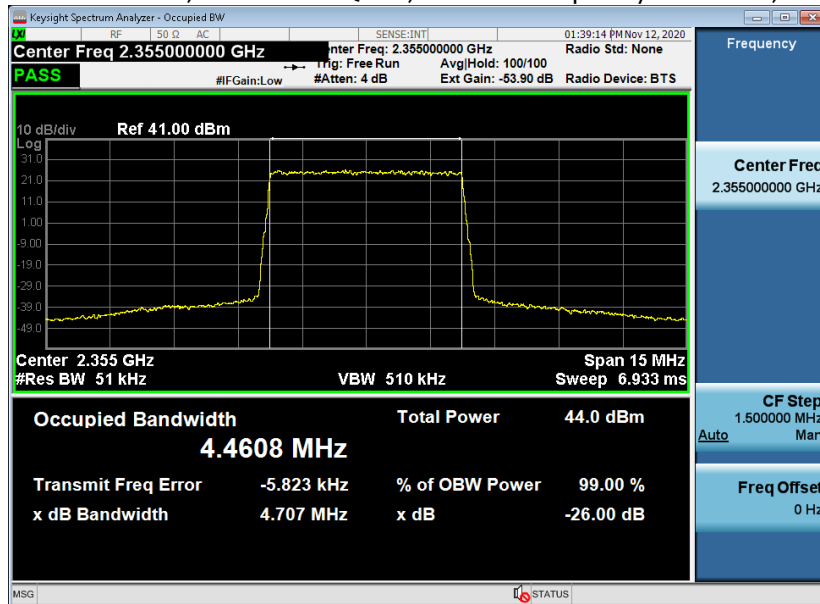
Single Carrier - 5 MHz BW

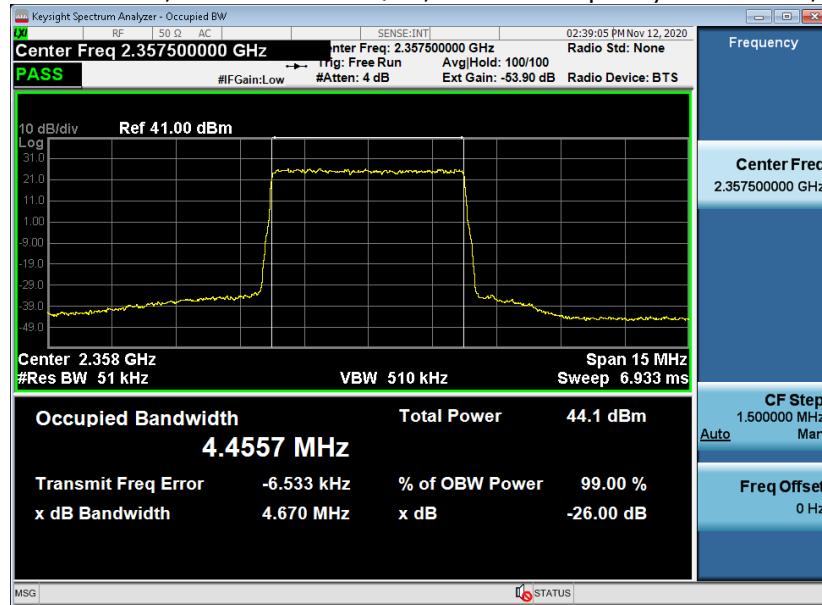
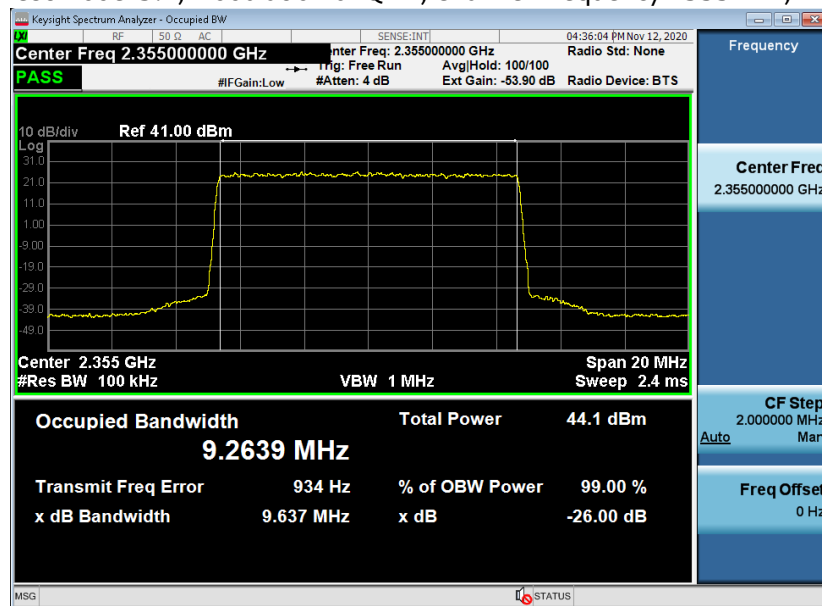
Test Model 3.1, Modulation 64QAM, Channel Frequency 2352.5MHz, TX1

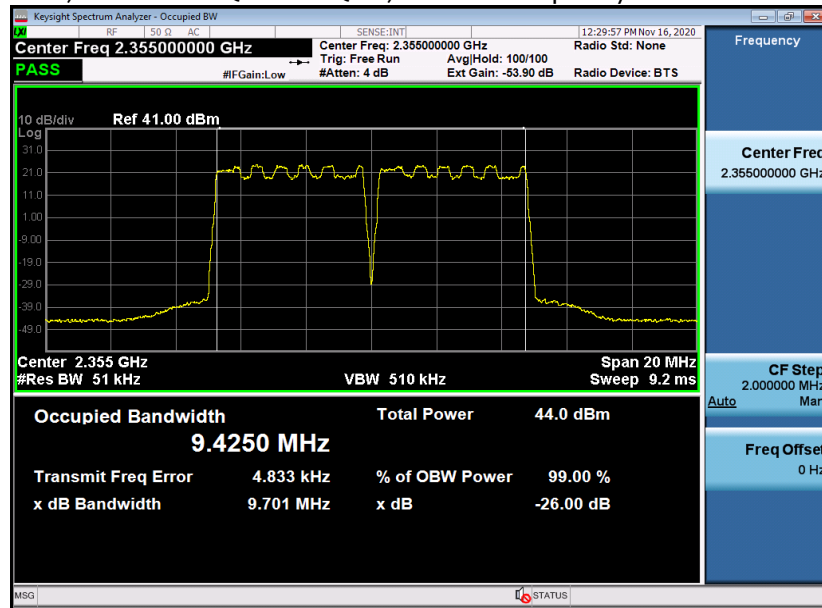


Single Carrier - 5 MHz BW

Test Model 1.1, Modulation QPSK, Channel Frequency 2355MHz, TX1



Single Carrier - 5 MHz BW
Test Model 3.1a, Modulation 256QAM, Channel Frequency 2357.5MHz, TX1Single Carrier - 10MHz BW
Test Model 3.1, Modulation 64QAM, Channel Frequency 2355MHz, TX4

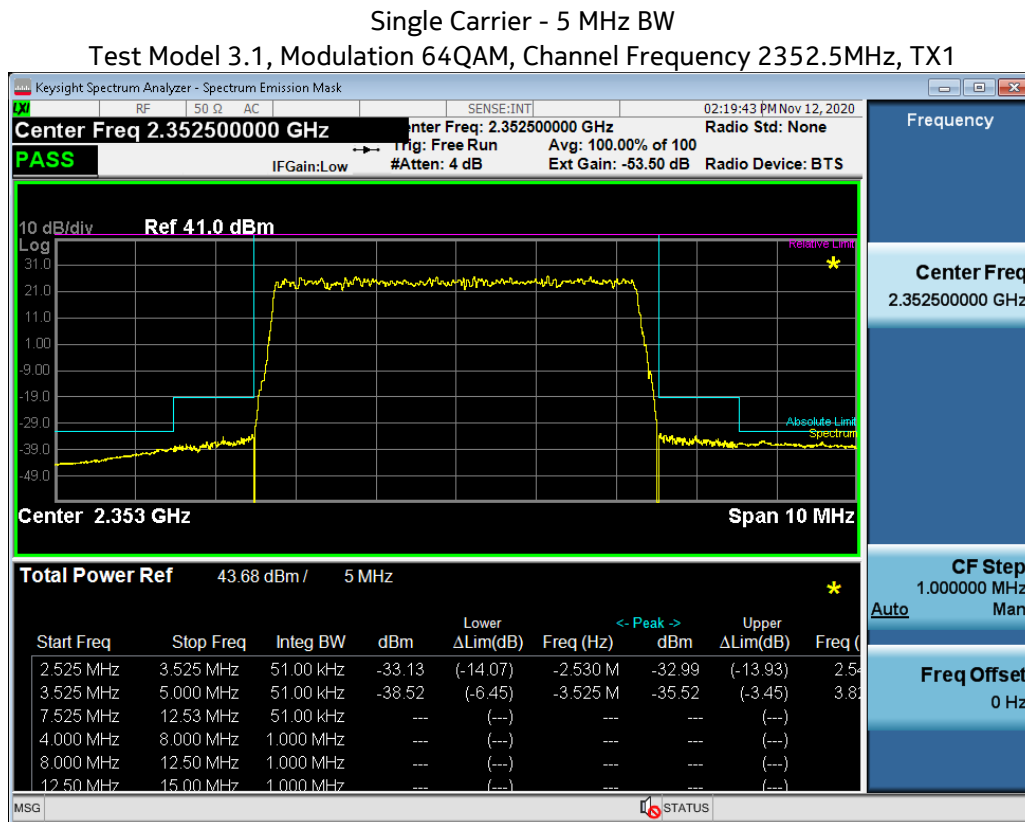
Dual Carrier - 5+5 MHz BW
Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 2352.5 + 2357.5 MHz, TX1

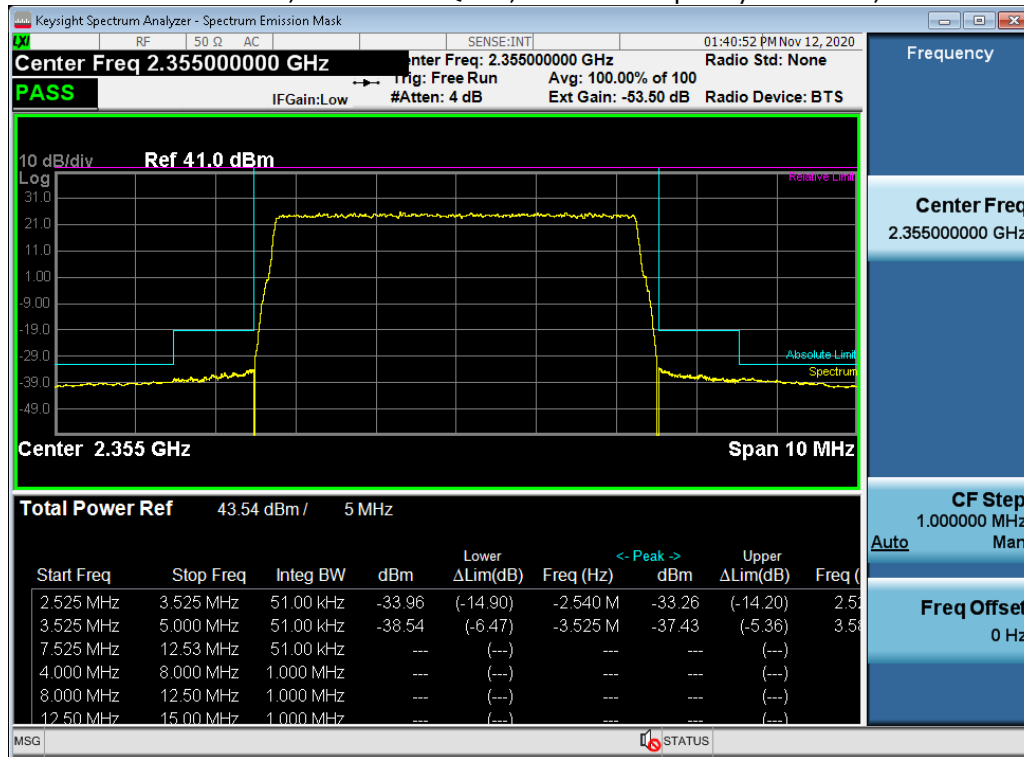
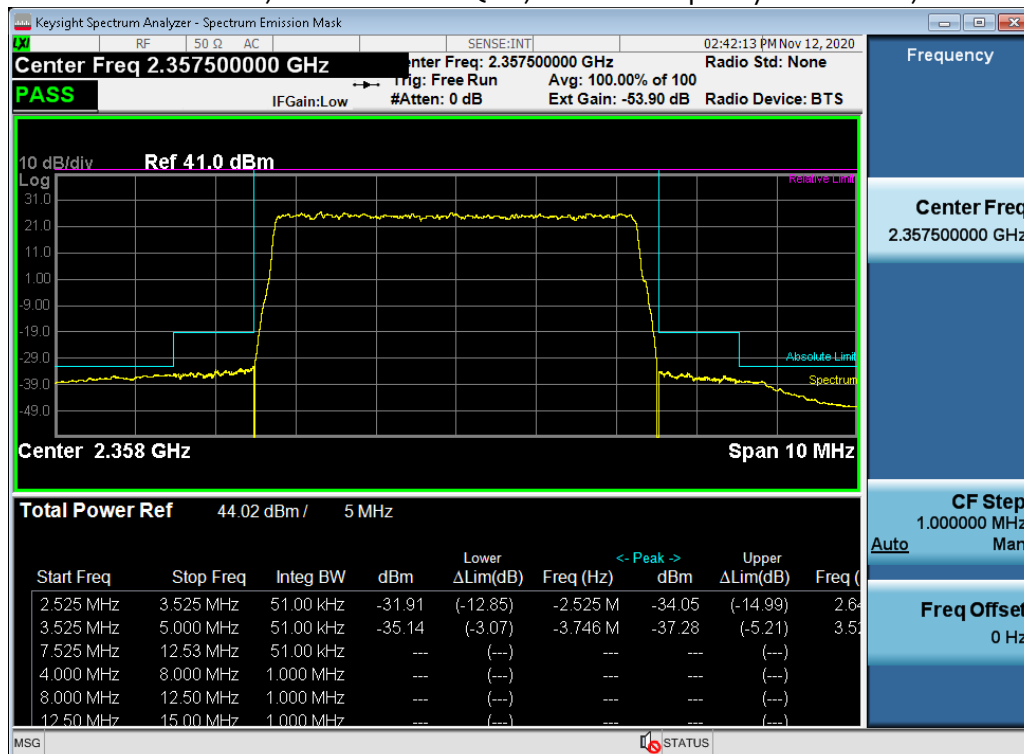
4.2 Edge of band Emissions

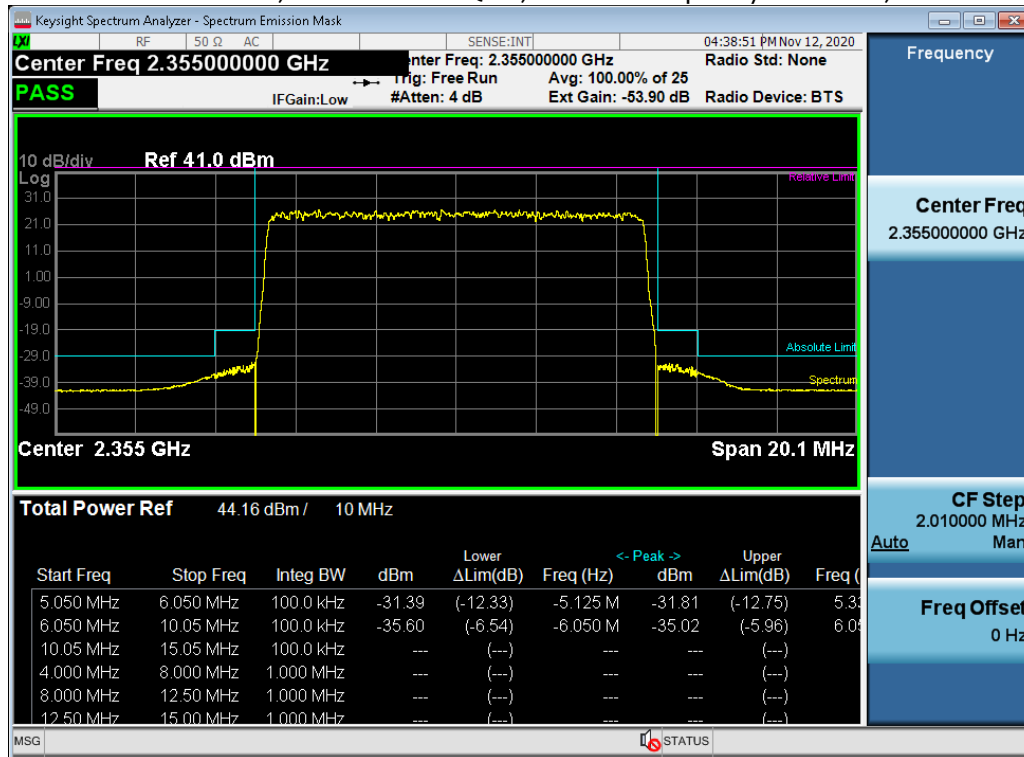
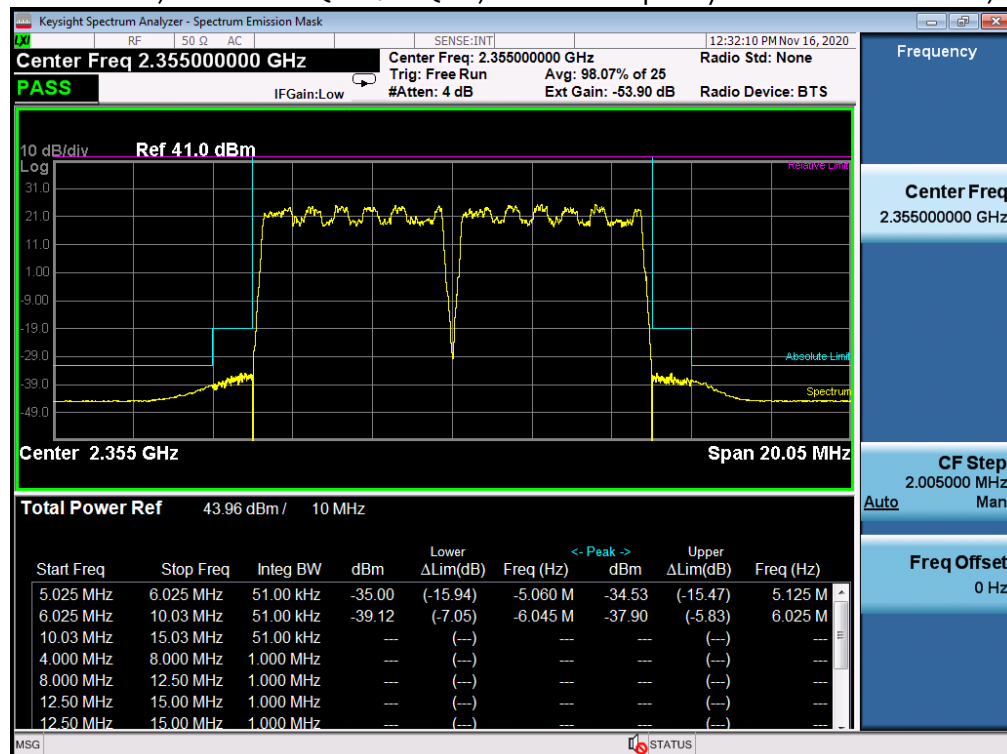
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the 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. The Top of Mask corresponds to the set rated power level as confirmed by the RF power meter.

4.2.1 Edge of Band Emissions - Plots.

All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.



Single Carrier - 5 MHz BW
Test Model 1.1, Modulation QPSK, Channel Frequency 2355MHz, TX1Single Carrier - 5 MHz BW
Test Model 3.1a, Modulation 256QAM, Channel Frequency 2357.5MHz, TX1

Single Carrier - 10MHz BW
Test Model 3.1, Modulation 64QAM, Channel Frequency 2355MHz, TX4Dual Carrier - 5+5 MHz BW
Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 2352.5 + 2357.5 MHz, TX1

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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

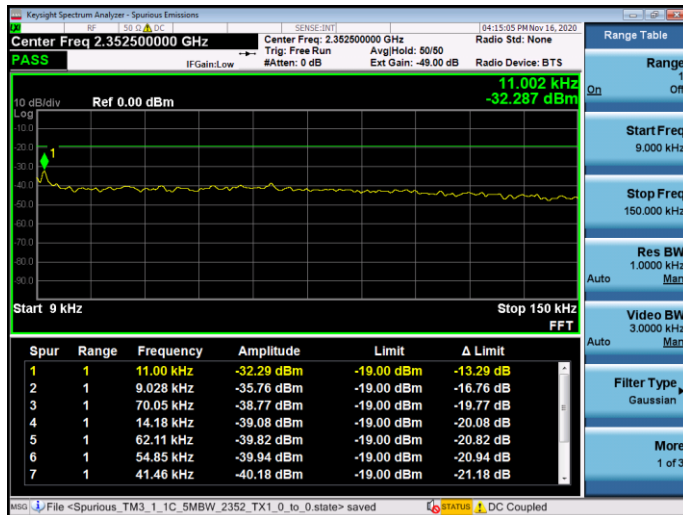
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 24 GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators. The RF power level was continuously monitored via a coupled RF Power Meter.

The required emission limitation is specified as appropriate in 27.53. The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. Data below documents performance up to 24 GHz. The limit is derived using the MIMO rule 10 Log (n for limits with n=4.

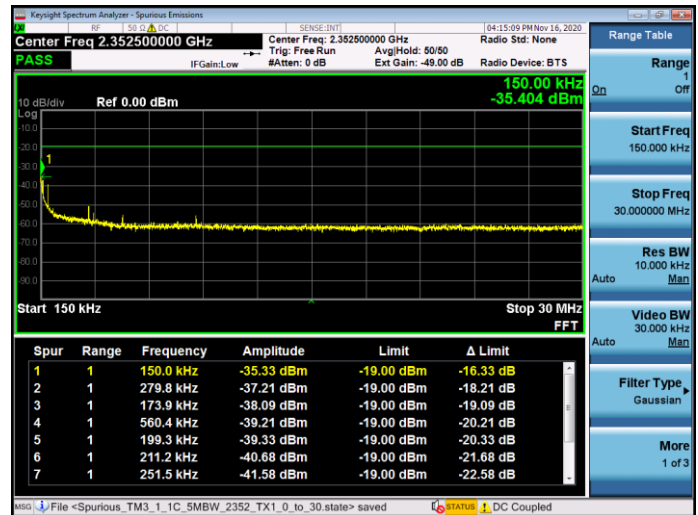
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

Single Carrier - 5 MHz BW
Test Model 3.1
Modulation 64QAM
Channel Frequency 2352.5MHz
TX1

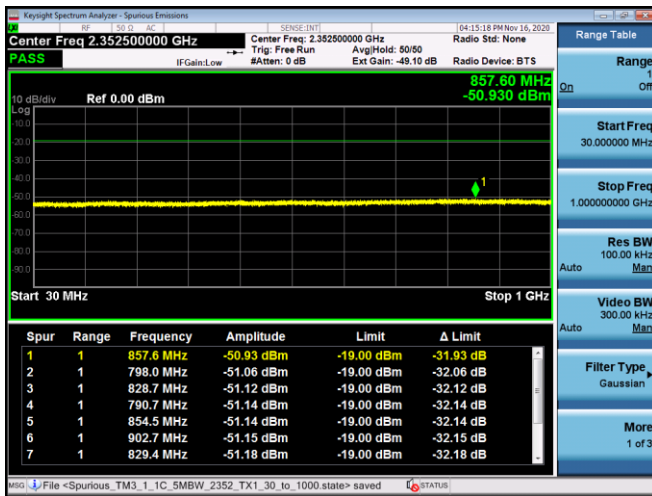
9KHz – 150kHz



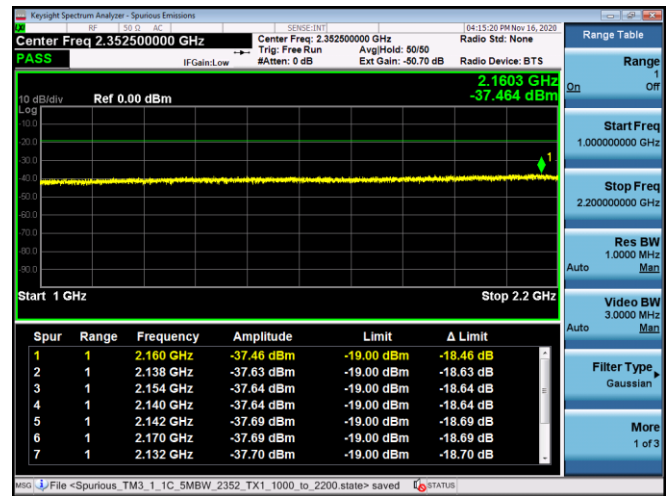
150kHz – 30MHz



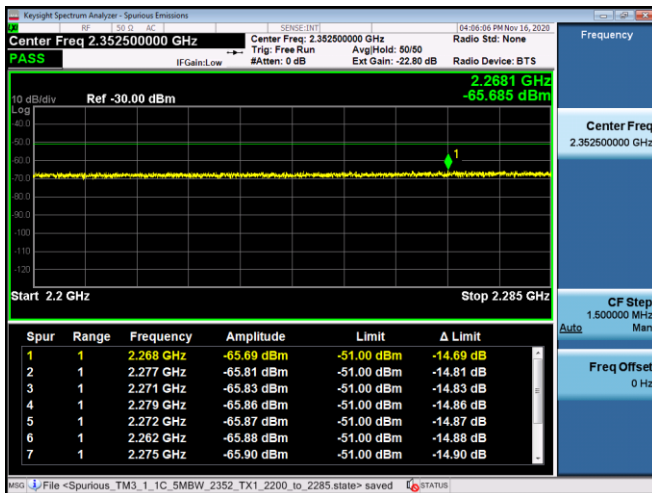
30MHz – 1GHz



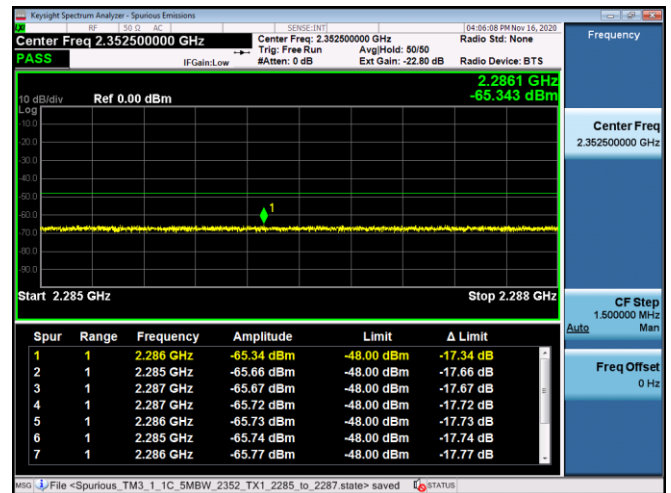
1GHz – 2.2GHz



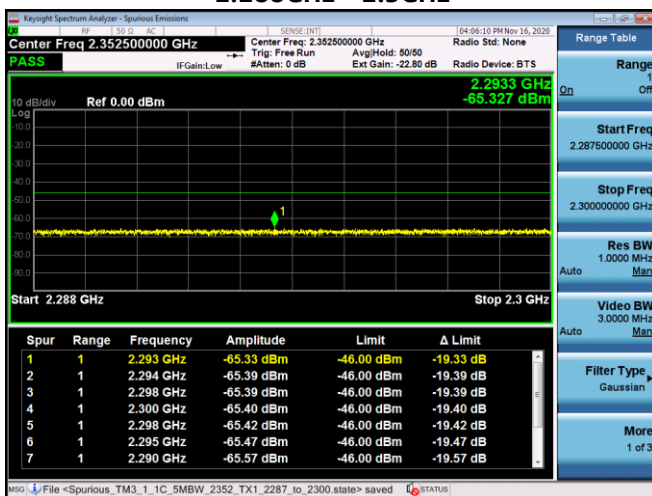
2.2GHz – 2.285GHz



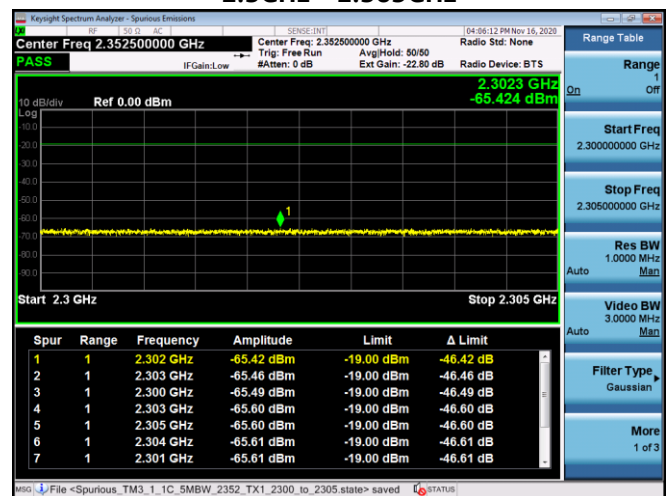
2.285GHz – 2.288GHz



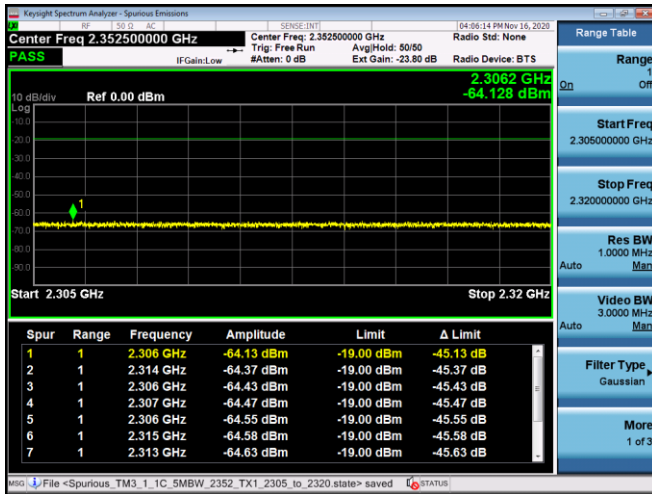
2.288GHz – 2.3GHz



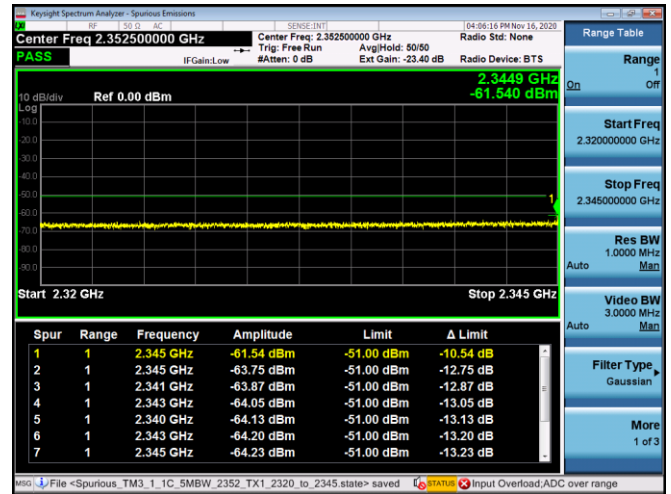
2.3GHz – 2.305GHz



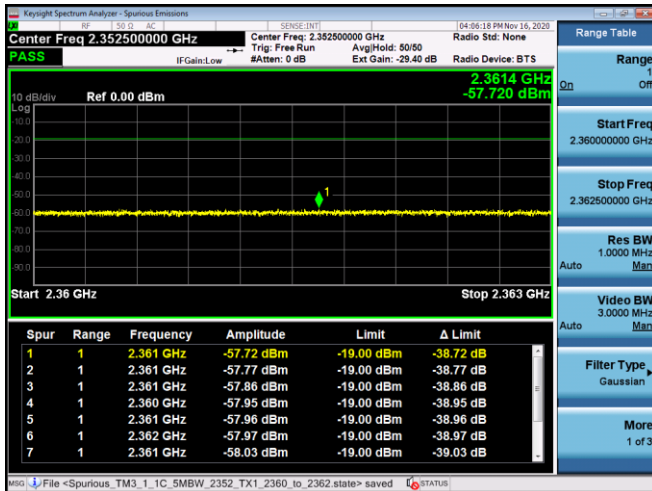
2.305GHz – 2.32GHz



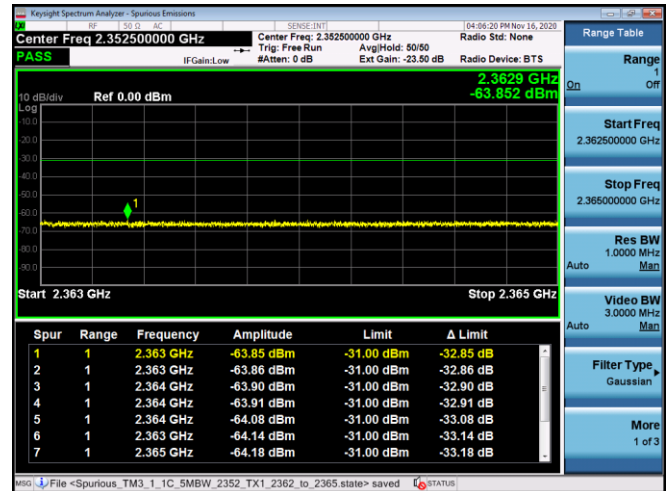
2.32GHz – 2.345GHz



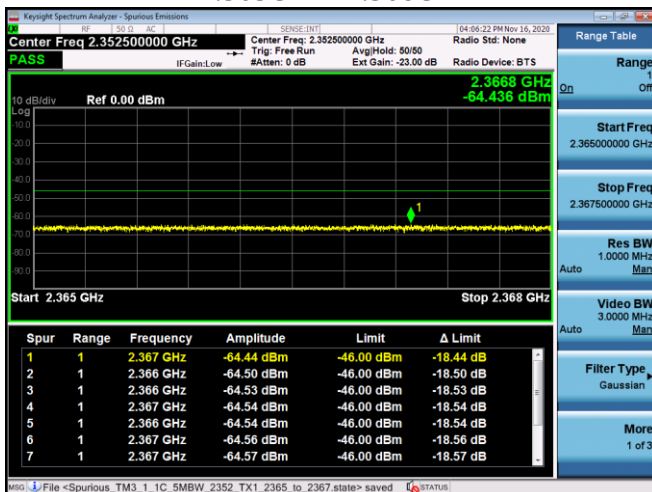
2.36GHz – 2.363GHz



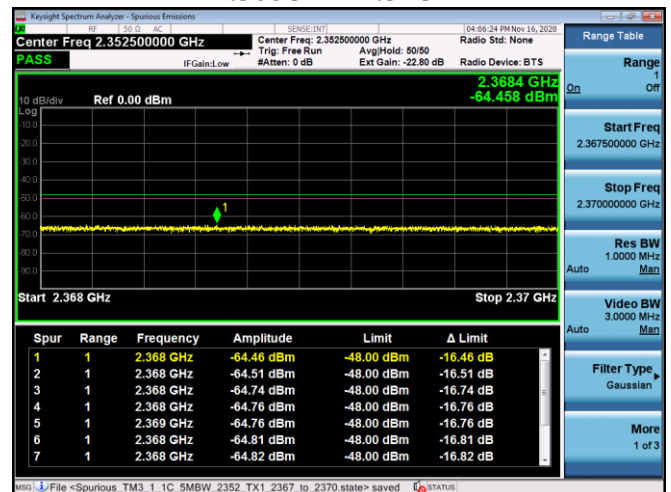
2.363GHz – 2.365GHz



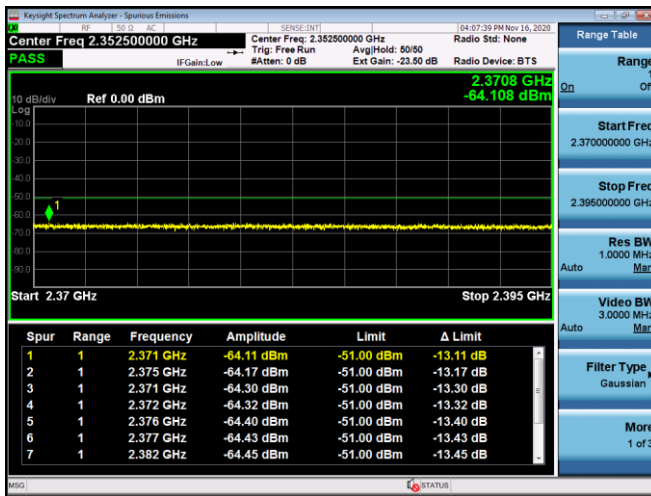
2.365GHz – 2.368GHz



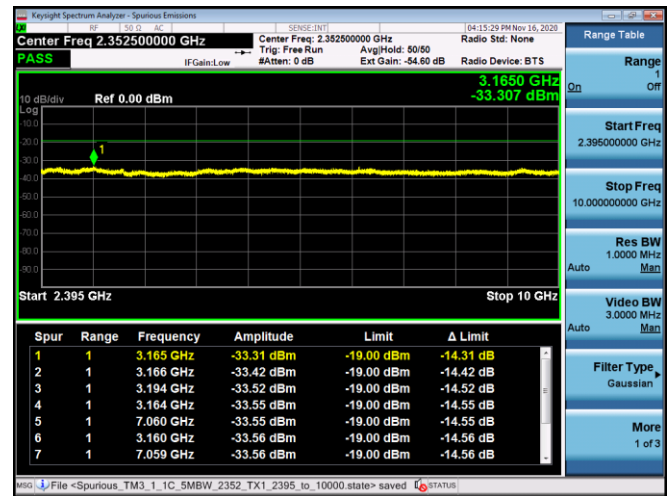
2.368GHz – 2.37GHz



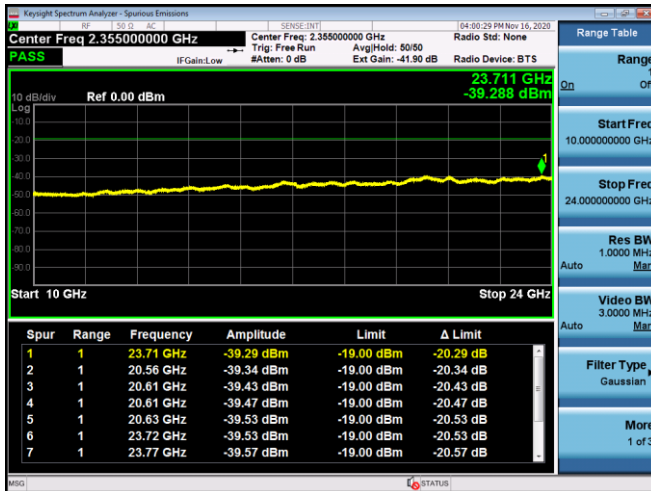
2.37GHz – 2.395GHz



2.395GHz – 10GHz

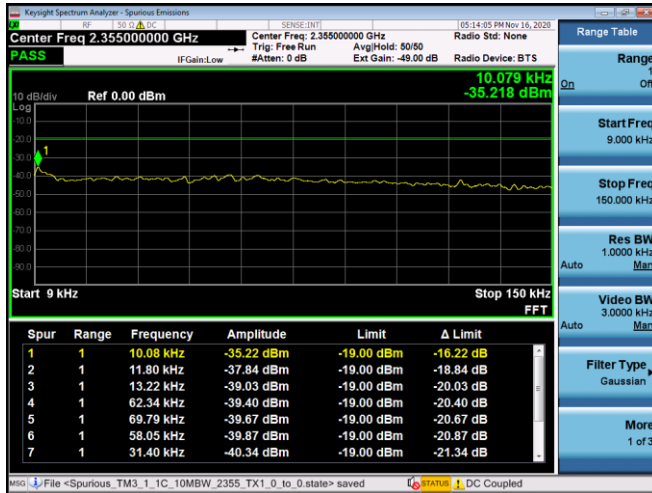


10GHz – 24GHz

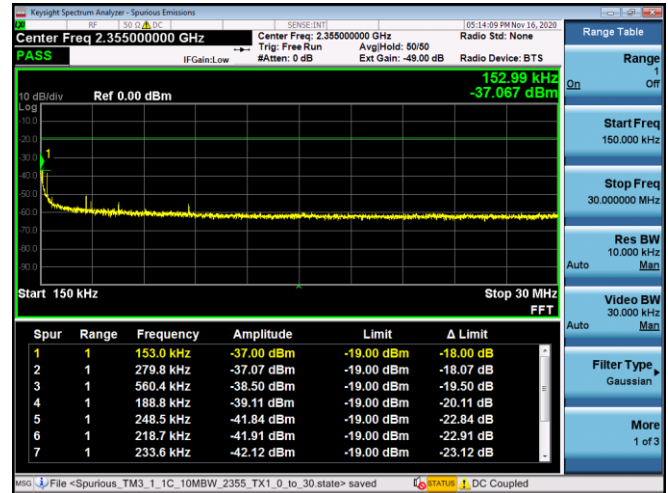


Single Carrier - 10 MHz BW
Test Model 3.1
Modulation 64QAM
Channel Frequency 2355MHz
TX1

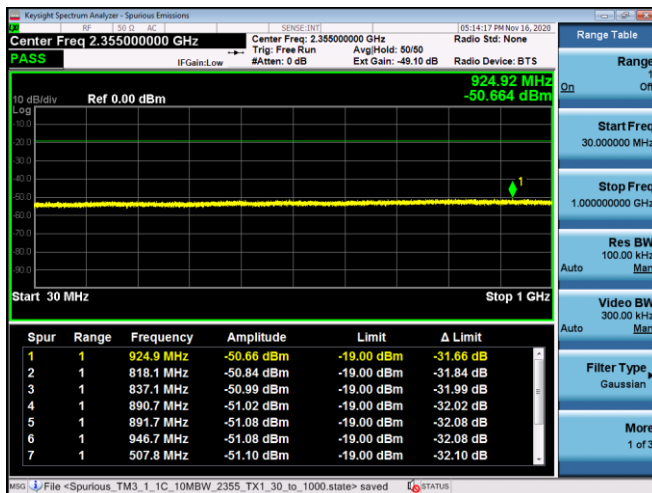
9KHz – 150kHz



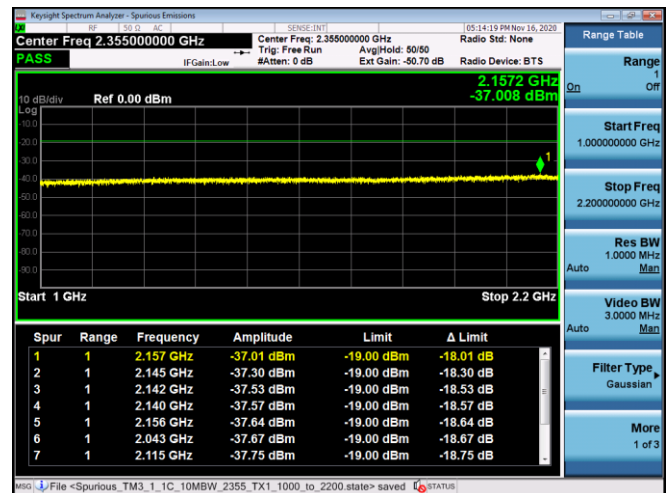
150kHz – 30MHz



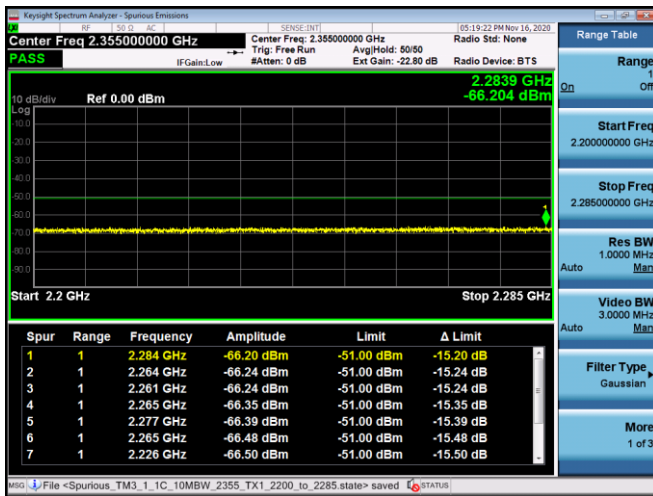
30MHz – 1GHz



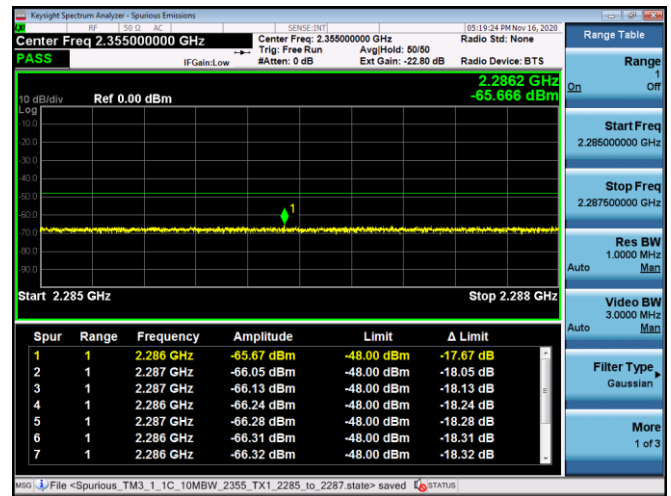
1GHz – 2.2GHz



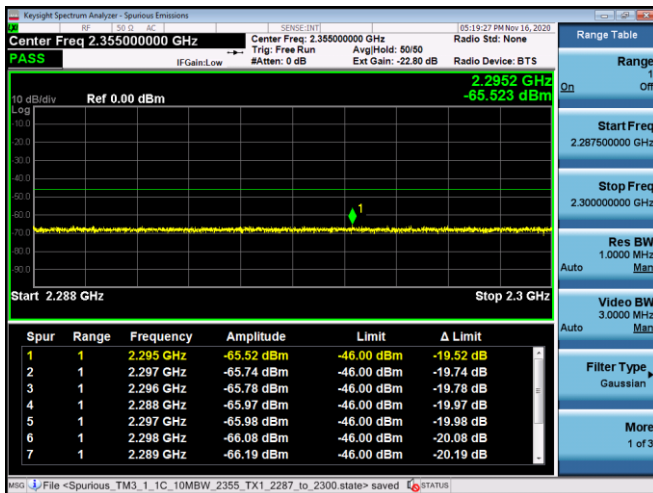
2.2GHz – 2.285GHz



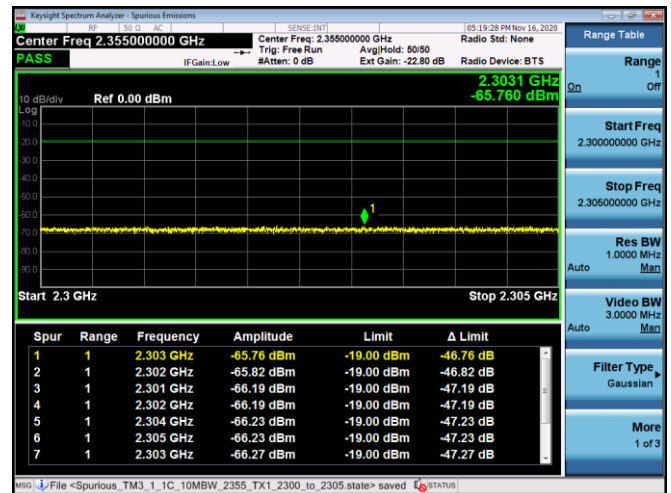
2.285GHz – 2.288GHz



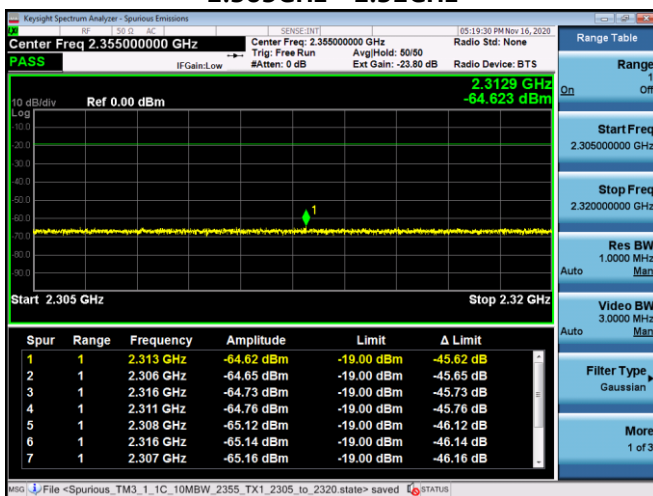
2.288GHz – 2.3GHz



2.3GHz – 2.305GHz



2.305GHz – 2.32GHz



2.32GHz – 2.345GHz

