Global Product Compliance Laboratory
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TESTING
NVLAP LAB CODE: 100275-0

Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 27

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
AHDB AirScale 2T4R B8 Sub-Band 160W

Report Number:
TR-2020-0173-FCC2-27

Date Issued:
February 11, 2021

Table of Contents

Revisions

Date	Revision	Section	Change
02/11/2021	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):	AHDB AirScale 2T4R B8 Sub-Band 160W
Serial Number:	EA201852720
FCC ID:	VBNAHDB-01
Hardware Version:	474257A.101
Software Version:	5G20A
Frequency Range:	936.5 – 939.5 MHz
GPCL Project Number:	2020-0173
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	See Section 1.5.1
Measurement Procedure(s):	See Section 1.5.2
Test Date(s):	12/15/2020 – 1/11/2021
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
Test Results: The EUT, *as tested* 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 AHDB AirScale 2T4R B8 Sub-Band 160W, hereinafter referred to as the Equipment Under Test (EUT).

The Nokia AHDB AirScale 2T4R B8 Sub-Band 160W (AHDB) is a 2 port radio head that transmits 80 Watts per port over the B8 spectrum (936.5 - 939.5 MHz). This product supports single 1.4 MHz, 3.0 MHz LTE carriers, and 0.2 MHz NB-IoT carriers utilizing QPSK, 16 QAM, 64QAM, and 256QAM modulation formats. The product supports single and multicarrier configurations of 1 - 4 carriers. The 2 individual transmit ports are identical in design, rated power and performance.

1.2 Purpose and Scope

The purpose of 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.

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Radio Access Technology	FDD-LTE
Duplex Mode	Frequency Division Duplex (FDD)
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM
Operation Frequency Range	936.5 – 939.5 MHz
Channel Bandwidth	1.4MHz, 3MHz (LTE) 0.2MHz (NB-IoT)
Number of Tx Ports per Unit	2
MIMO	Yes
Deployment Environment	Outdoor
Supply Voltage	-48.0 VDC

B8 Radio Capabilities

B8 Airscale RRH 2T4R 160W(AHDB)

Property	Value
Output power	2 x 80 W
QAM	256 QAM (DL), 64QAM (UL)
Number of TXRX	2T4R
SW supported technologies	GSM, WCDMA, FDD-LTE
IoT support	NB-IoT in band, guard band (GB), standalone (SA)
Frequency	UL: 880–915 DL: 934–960
iBW (instantaneous bandwidth)	26 MHz
oBW (occupied bandwidth)	26 MHz
Number of carriers per pipe	Up to 6
Supported bandwidths	1.4, 3, 5, 10 MHz
PIM cancellation	Yes

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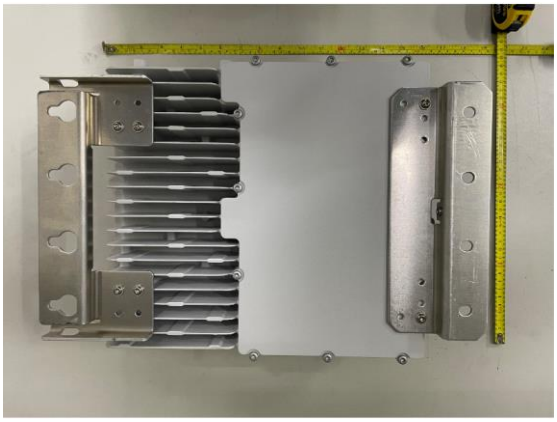
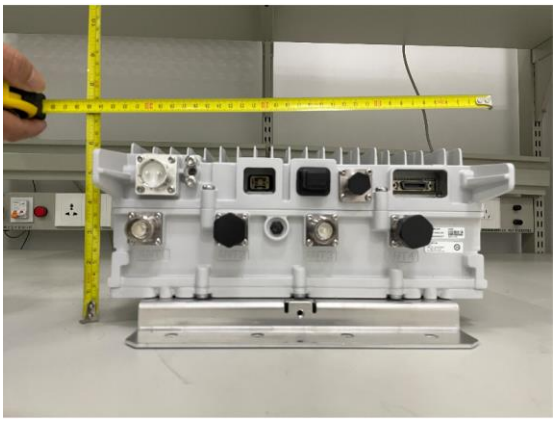
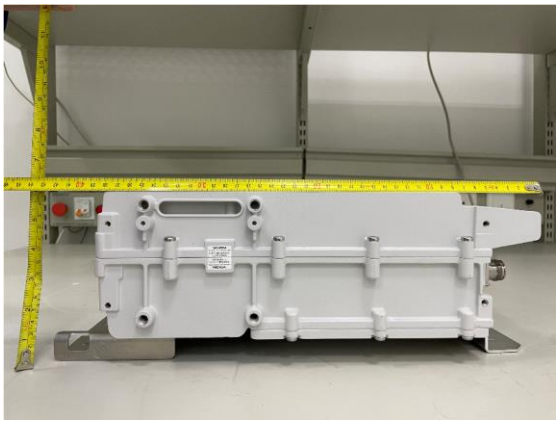
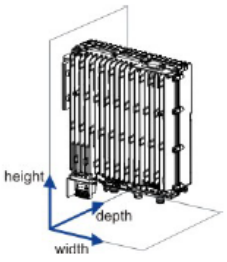
1.3.2 Photographs



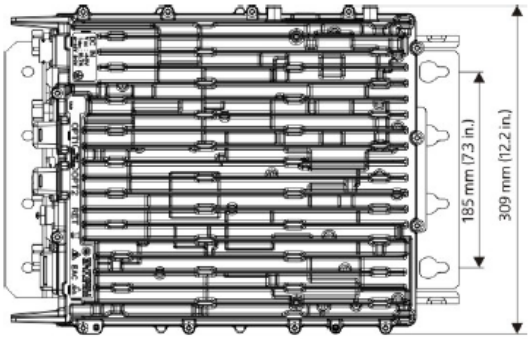


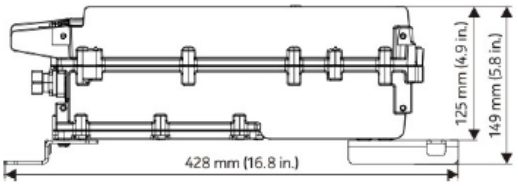


AHDB dimensions and weight

Property	Value	Dimensions orientation
Height	Core RRH: 336 mm (13.25 in.) With mounting brackets: 428 mm (16.87 in.)	
Width	309 mm (12.17 in.)	
Depth	Core RRH: 125 mm (4.92 in.) With mounting brackets: 149 mm (5.86 in.)	
Weight	max. 12.8 kg (28.2 lb)	
Volume	Without ID Cover: 12.2 l	

AHDB dimensions





Serial Number and Power Information

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.
- FCC-IC-FS – GPCL Frequency Stability Measurement Process 6-20-2019.

1.5.3 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, (*e.g.*, ANSI C63.4, CISPR 11, 14, 22, *etc.*, 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

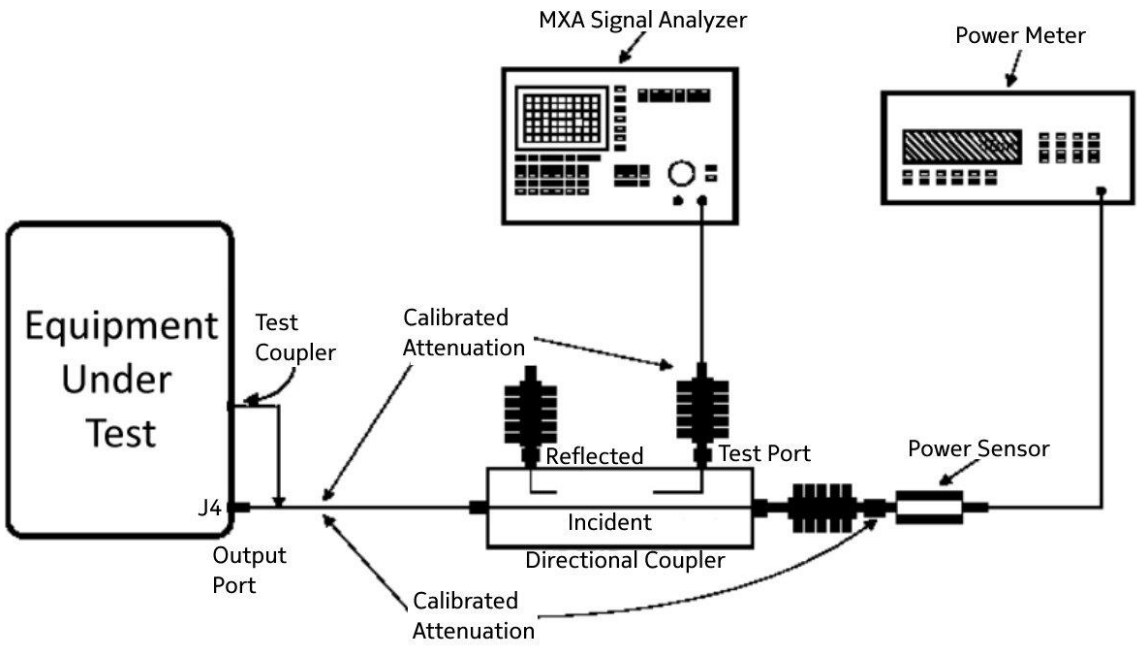
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz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

1.6 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.

1.7 Test Configuration for all Antenna Port Measurements.



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 the 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.

2.1.1 1-Carrier Data

Tabular Data – Channel RF Power (1-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
937.2	1.4	64QAM	1	45.72
			3	45.48
938.8	1.4	256QAM	1	45.62
			3	45.60
938.0	3	64QAM	1	45.73
			3	45.72

2.1.2 1-Carrier with NB-IoT Data

Tabular Data – PSD (1-Carrier with NB-IoT) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
936.7	0.2	QPSK	1	41.68
938.8	1.4			42.63
936.7	0.2		3	41.55
938.8	1.4			42.50

Tabular Data – Channel RF Power (1-Carrier with and without NB-IoT) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
937 + 939	1.4 + 0.2	QPSK	1	45.17
937.2	1.4			42.52
939.3	0.2			41.70
937 + 939	1.4 + 0.2		3	45.25
937.2	1.4			42.53
939.3	0.2			41.71

2.1.3 2-Carrier Data

Tabular Data – Channel RF Power (2-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
938 + 938	1.4 + 1.4	256QAM	1	45.48
			3	45.40

Tabular Data – PSD (2-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
937.2	1.4	256QAM	1	42.39
938.8				42.44
937.2	1.4		3	42.27
938.8				42.37

2.1.4 3-Carrier Data

Tabular Data – Channel RF Power (3-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
937.2	1.4	QPSK	1	42.56
939.0	0.2			38.58
939.3	0.2			38.80
937.2	1.4		3	42.48
939.0	0.2			38.50
939.3	0.2			38.80

2.1.5 4-Carrier Data

Tabular Data – Channel RF Power (4-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
936 + 937 + 937 + 938	0.2 + 0.2 + 0.2 + 1.4	QPSK	1	45.14
			3	45.03

Tabular Data – PSD (4-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
936.7	0.2	QPSK	1	36.55
937.3	0.2			36.68
937.3	0.2			36.66
938.8	1.4			42.68
936.7	0.2		3	36.53
937.3	0.2			36.54
937.3	0.2			36.60
938.8	1.4			42.57

2.1.6 NB-IoT Only Data

Tabular Data – Channel RF Power (NB-IoT) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
936.7	0.2	QPSK	1	41.99
			3	41.70
939.3	0.2		1	41.90
			3	41.87
939 + 939	0.2 + 0.2		1	40.13
			3	41.65
936 + 937 + 937	0.2 + 0.2 + 0.2		1	41.70
			3	41.66

Tabular Data – PSD (3-Carrier) 40W

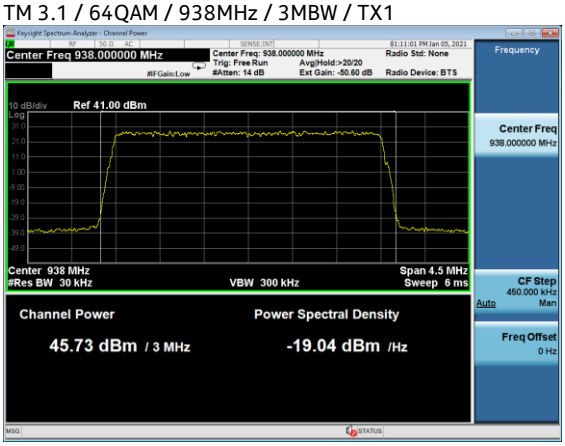
Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Channel Power dBm
936.7	0.2	QPSK	1	36.77
937.0				36.83
937.3				36.82
936.7			3	36.70
937.0				36.79
937.3				36.74

2.2 Channel RF Power – Plots

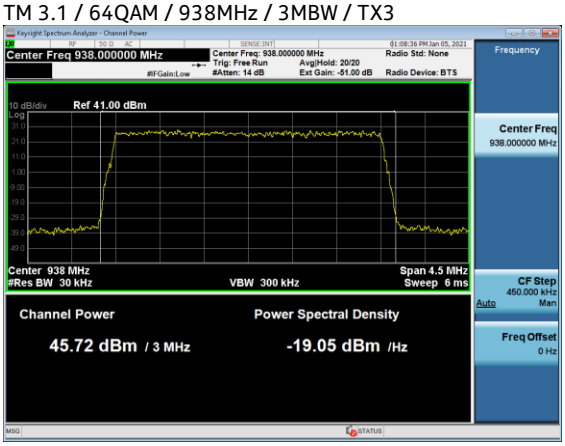
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

2.2.1 1-Carrier Plots (40W)

TM 3.1 / 64QAM / 938MHz / 3MBW / TX1

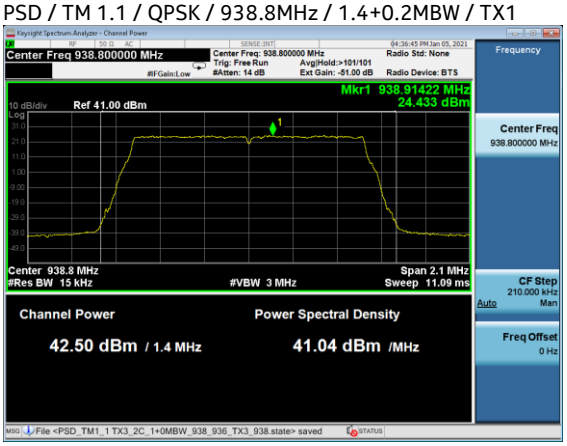


TM 3.1 / 64QAM / 938MHz / 3MBW / TX3

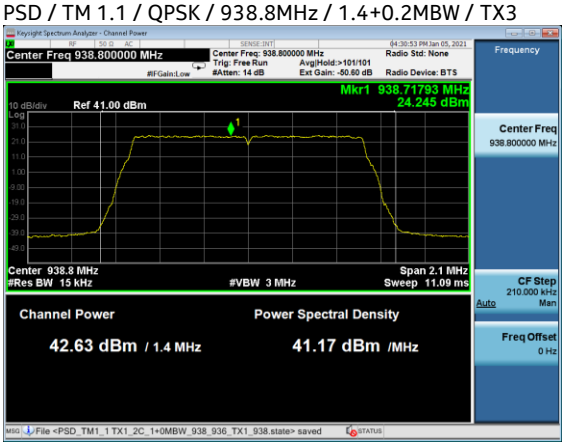


2.2.2 1-Carrier with NB-IoT Plots (40W)

PSD / TM 1.1 / QPSK / 938.8MHz / 1.4+0.2MBW / TX1

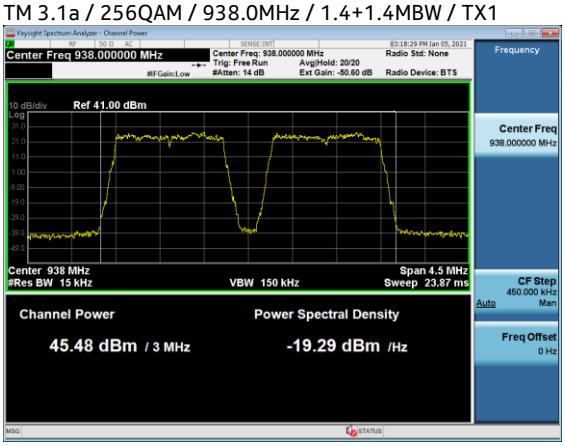


PSD / TM 1.1 / QPSK / 938.8MHz / 1.4+0.2MBW / TX3

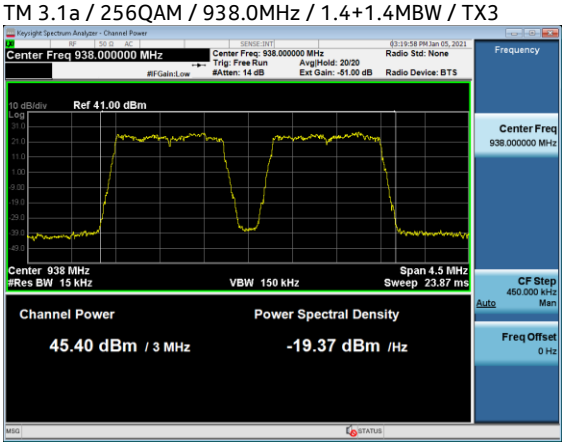


2.2.3 2-Carrier Plots (40W)

TM 3.1a / 256QAM / 938.0MHz / 1.4+1.4MBW / TX1

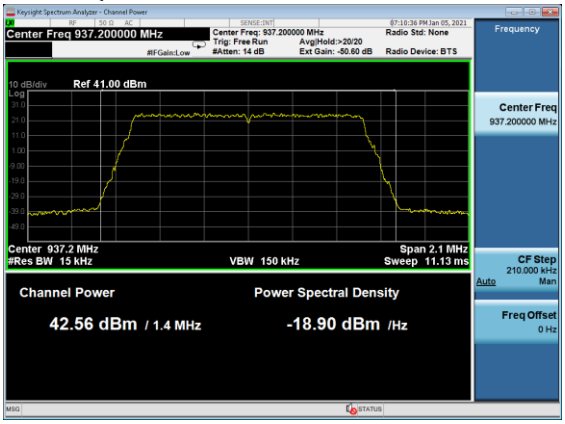


TM 3.1a / 256QAM / 938.0MHz / 1.4+1.4MBW / TX3

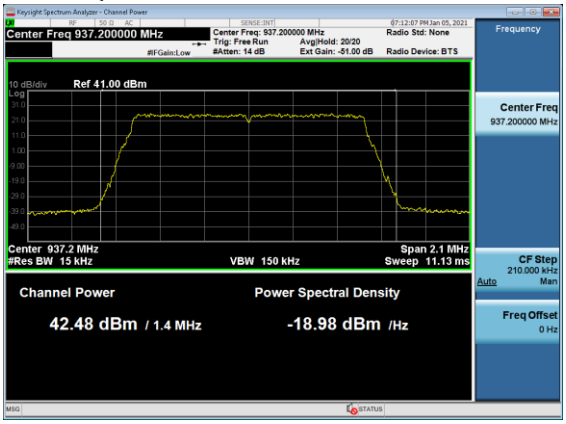


2.2.4 3-Carrier Plots (40W)

TM 1.1 / QPSK / 937.2MHz / 1.4+0.2+0.2MBW / TX1

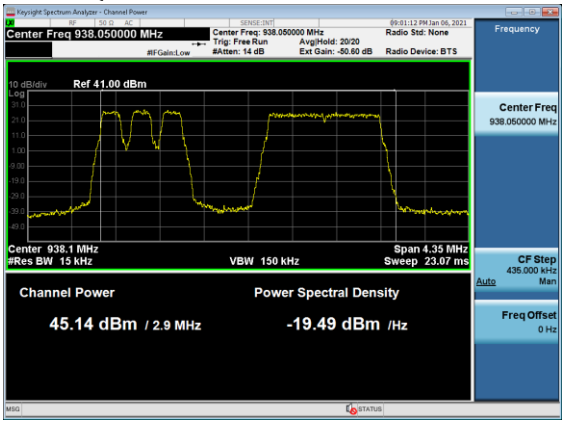


TM 1.1 / QPSK / 937.2MHz / 1.4+0.2+0.2MBW / TX3

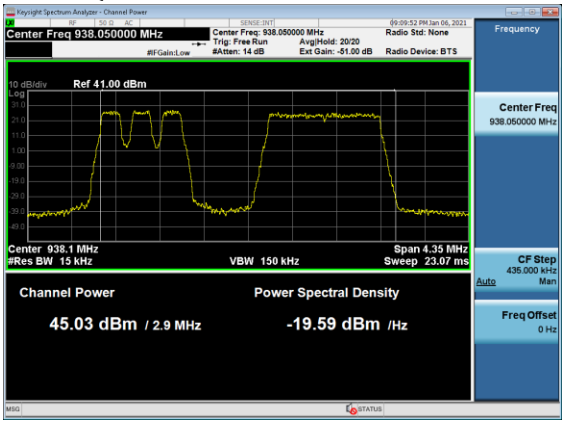


2.2.4.1.1 4-Carrier Plots (40W)

TM 1.1 / QPSK / 938.05MHz / 0.2+0.2+0.2+1.4MBW / TX1

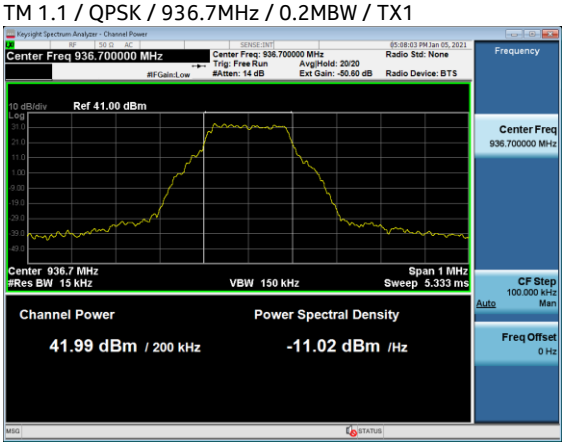


TM 1.1 / QPSK / 938.05MHz / 0.2+0.2+0.2+1.4MBW / TX3

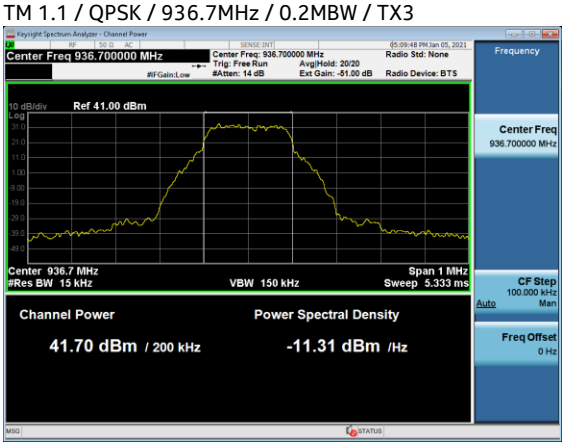


2.2.4.1.2 NB-IoT Plots (40W)

TM 1.1 / QPSK / 936.7MHz / 0.2MBW / TX1



TM 1.1 / QPSK / 936.7MHz / 0.2MBW / TX3

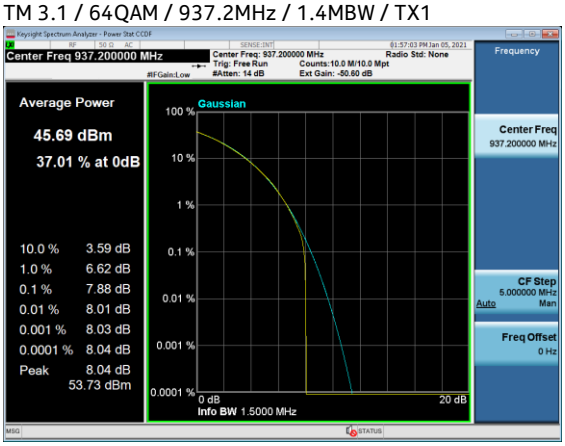


2.3 Peak-to-Average Power Ratio (PAPR) – Plots

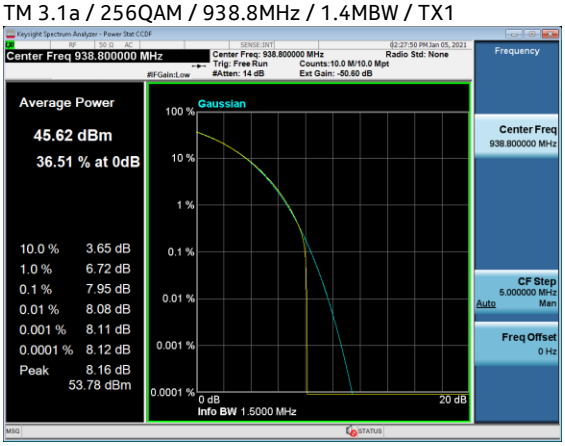
The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for Single and Multiple Carriers. The PAPR values of all carriers measured are below 13dB.

2.3.1 1-Carrier Plots (40W)

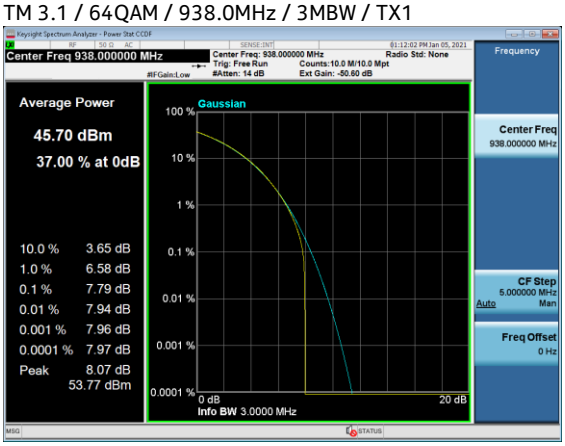
TM 3.1 / 64QAM / 937.2MHz / 1.4MBW / TX1



TM 3.1a / 256QAM / 938.8MHz / 1.4MBW / TX1

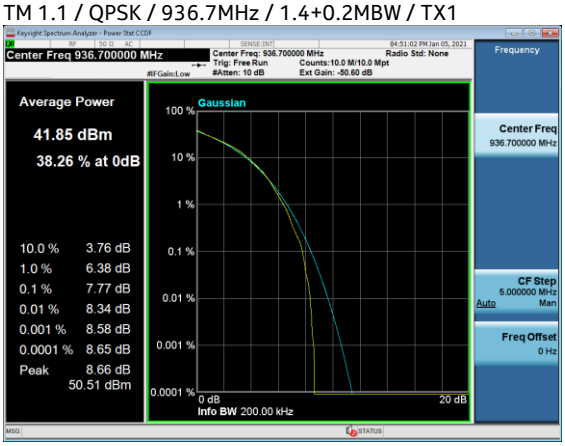


TM 3.1 / 64QAM / 938.0MHz / 3MBW / TX1

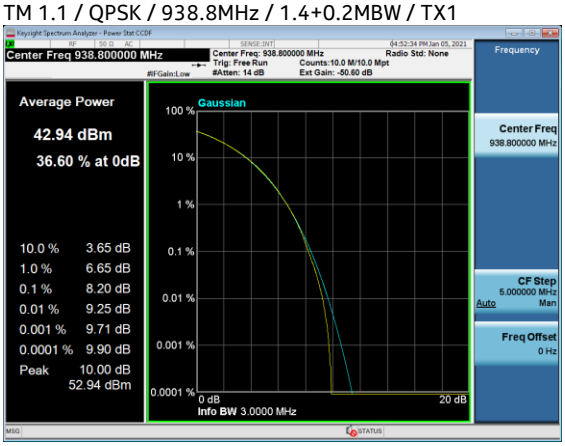


2.3.2 1-Carrier with NB-IoT Plots (40W)

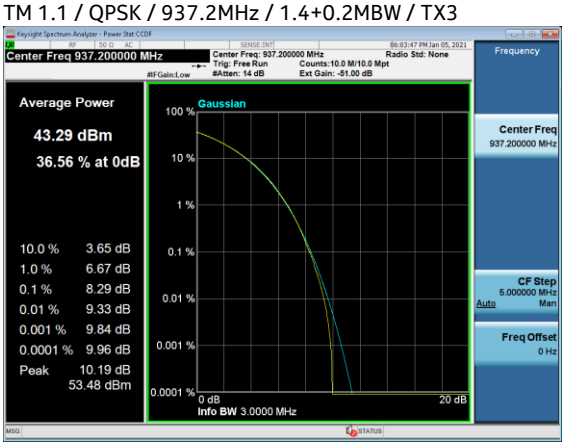
TM 1.1 / QPSK / 936.7MHz / 1.4+0.2MBW / TX1



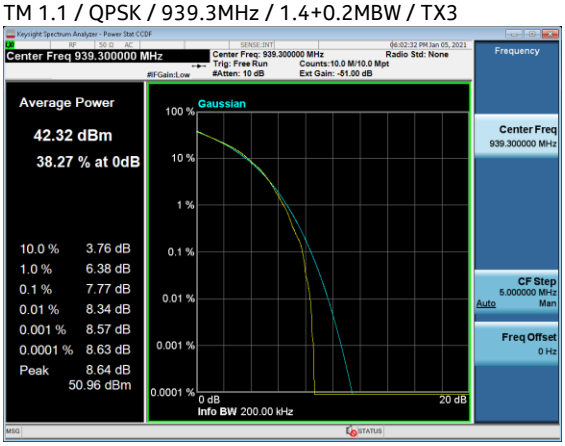
TM 1.1 / QPSK / 938.8MHz / 1.4+0.2MBW / TX1



TM 1.1 / QPSK / 937.2MHz / 1.4+0.2MBW / TX3

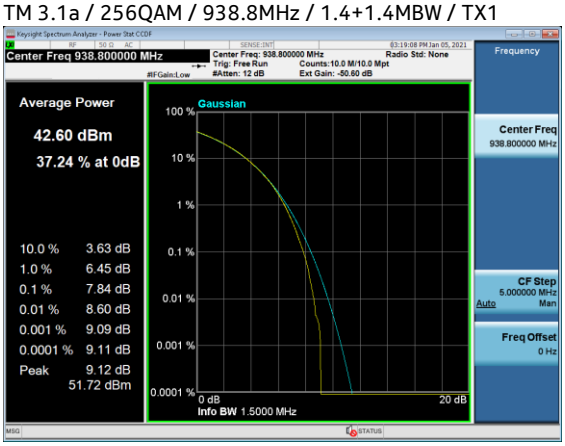


TM 1.1 / QPSK / 939.3MHz / 1.4+0.2MBW / TX3



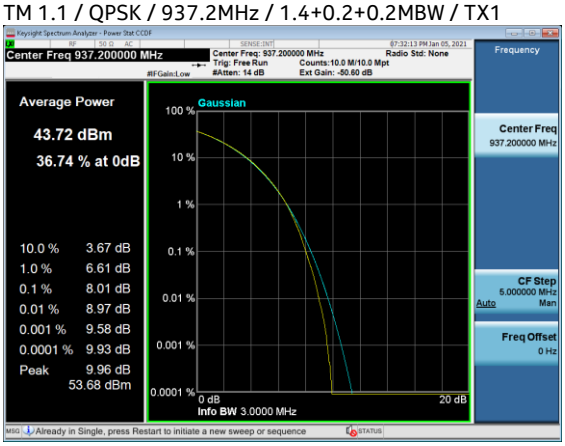
2.3.3 2-Carrier Plots (40W)

TM 3.1a / 256QAM / 938.8MHz / 1.4+1.4MBW / TX1

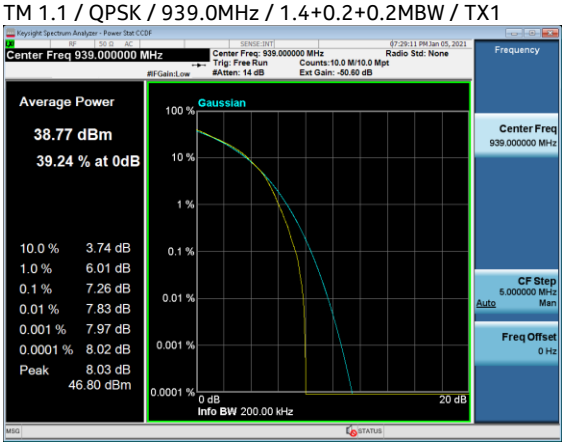


2.3.4 3-Carrier Plots (40W)

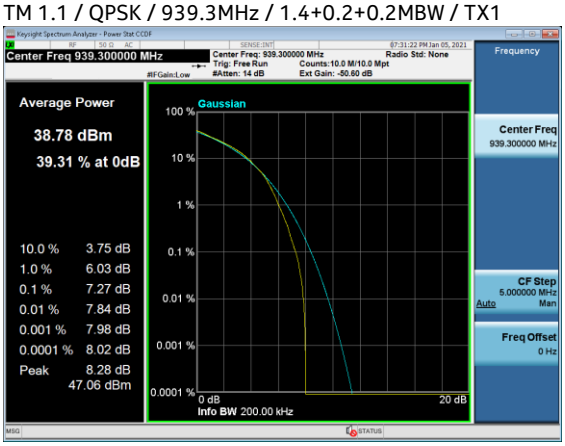
TM 1.1 / QPSK / 937.2MHz / 1.4+0.2+0.2MBW / TX1



TM 1.1 / QPSK / 939.0MHz / 1.4+0.2+0.2MBW / TX1

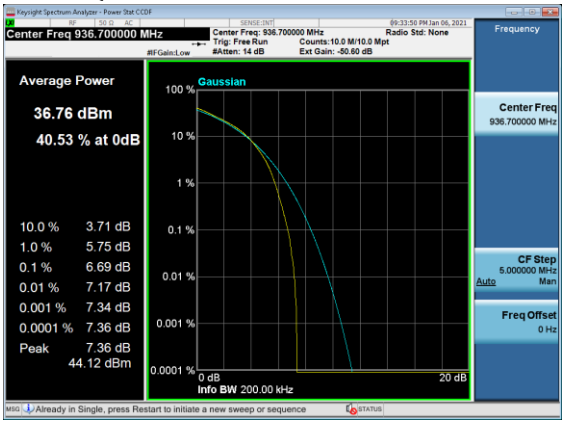


TM 1.1 / QPSK / 939.3MHz / 1.4+0.2+0.2MBW / TX1

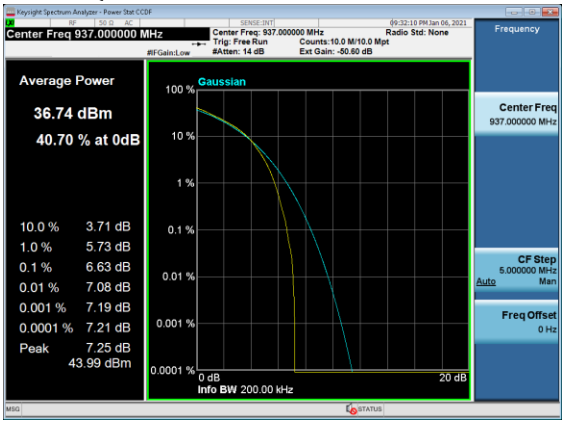


2.3.5 4-Carrier Plots (40W)

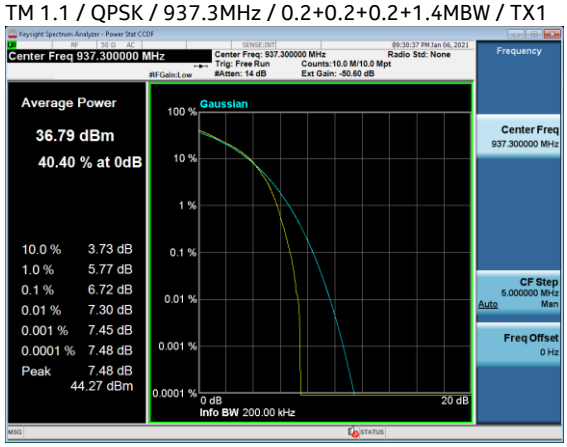
TM 1.1 / QPSK / 936.7MHz / 0.2+0.2+0.2+1.4MBW / TX1



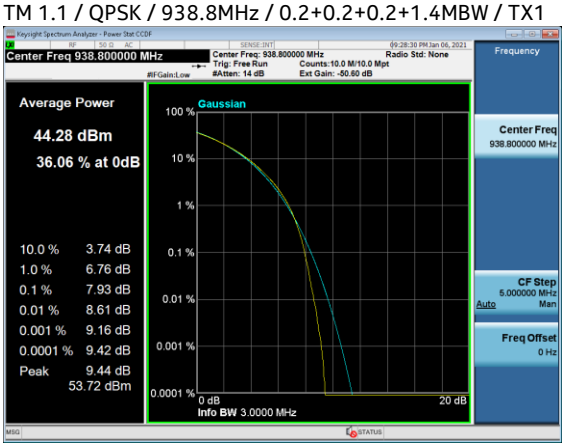
TM 1.1 / QPSK / 937.0MHz / 0.2+0.2+0.2+1.4MBW / TX1



TM 1.1 / QPSK / 937.3MHz / 0.2+0.2+0.2+1.4MBW / TX1

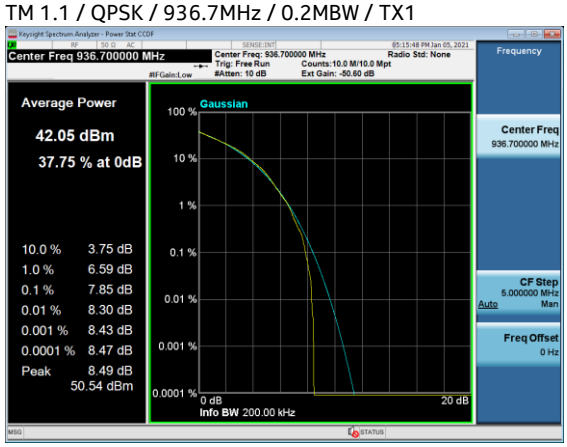


TM 1.1 / QPSK / 938.8MHz / 0.2+0.2+0.2+1.4MBW / TX1

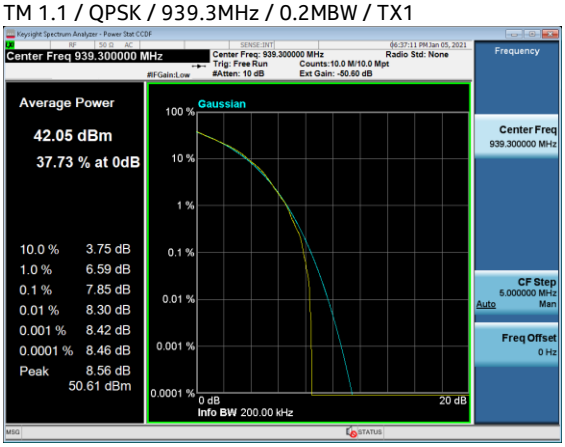


2.3.6 NB-IoT Plots (40W)

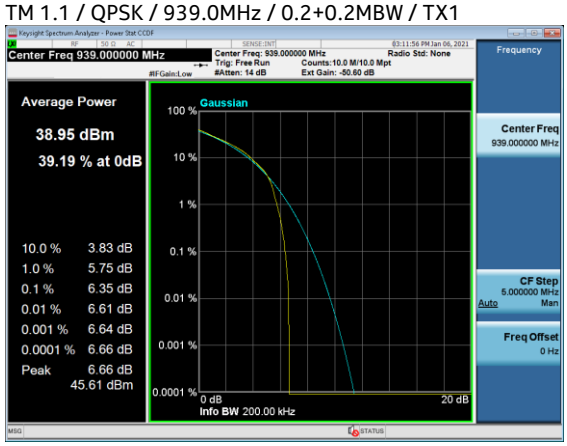
TM 1.1 / QPSK / 936.7MHz / 0.2MBW / TX1



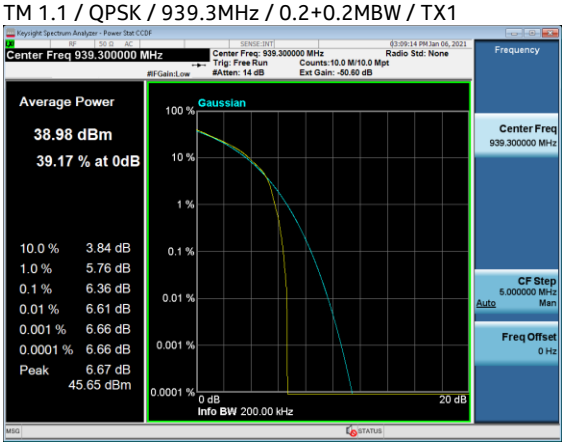
TM 1.1 / QPSK / 939.3MHz / 0.2MBW / TX1



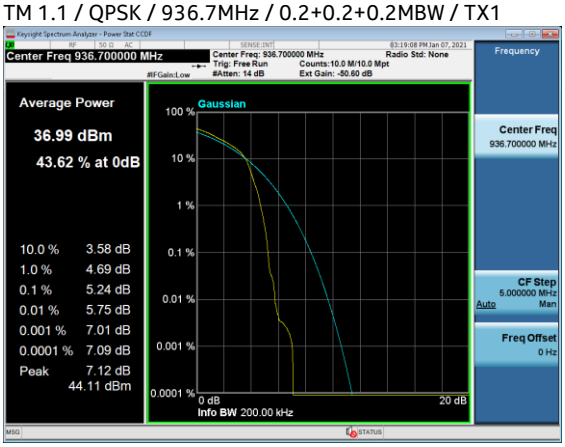
TM 1.1 / QPSK / 939.0MHz / 0.2+0.2MBW / TX1



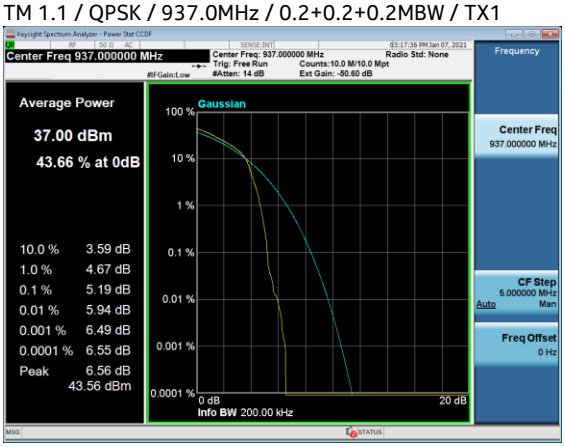
TM 1.1 / QPSK / 939.3MHz / 0.2+0.2MBW / TX1



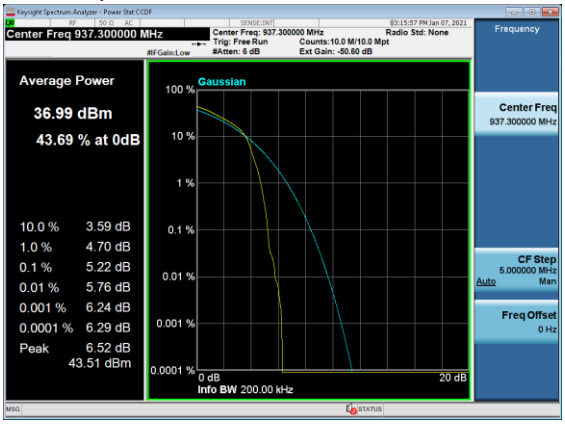
TM 1.1 / QPSK / 936.7MHz / 0.2+0.2+0.2MBW / TX1



TM 1.1 / QPSK / 937.0MHz / 0.2+0.2+0.2MBW / TX1



TM 1.1 / QPSK / 937.3MHz / 0.2+0.2+0.2MBW / TX1



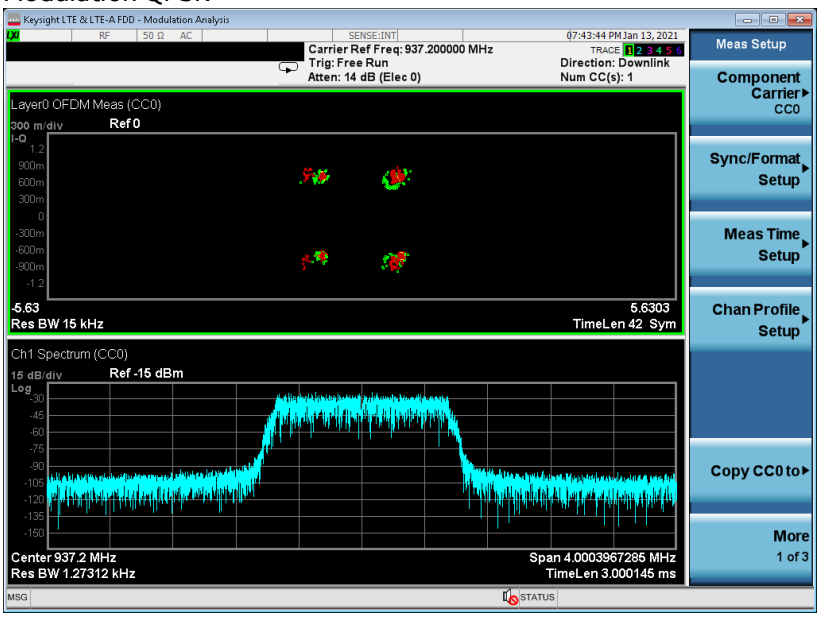
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

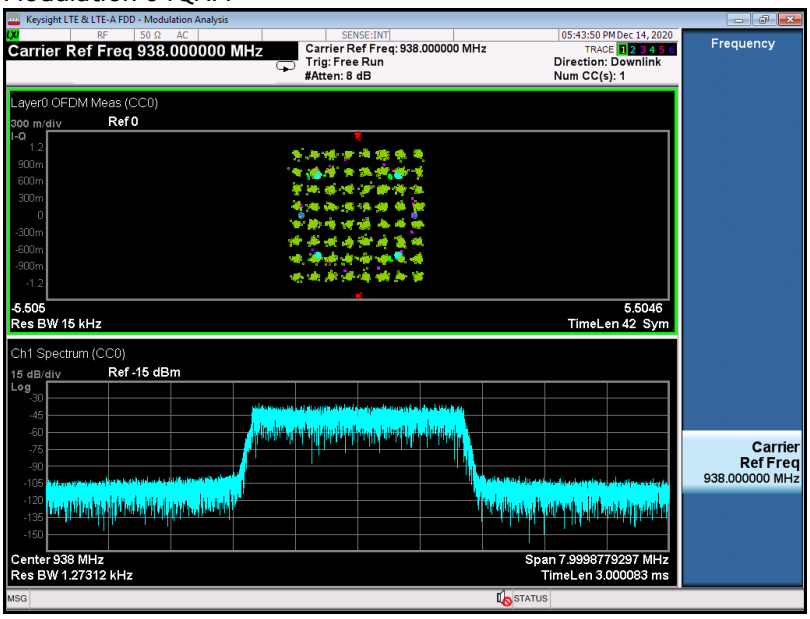
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

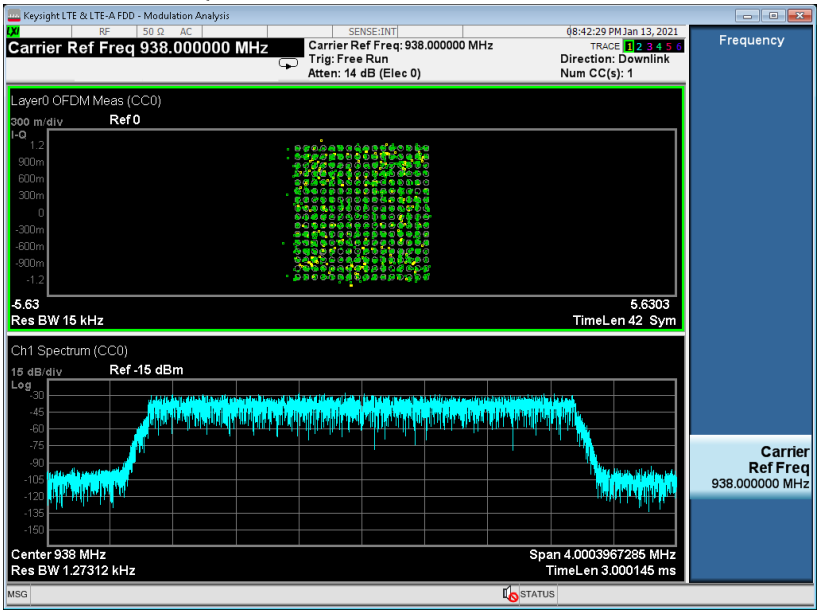
Modulation QPSK



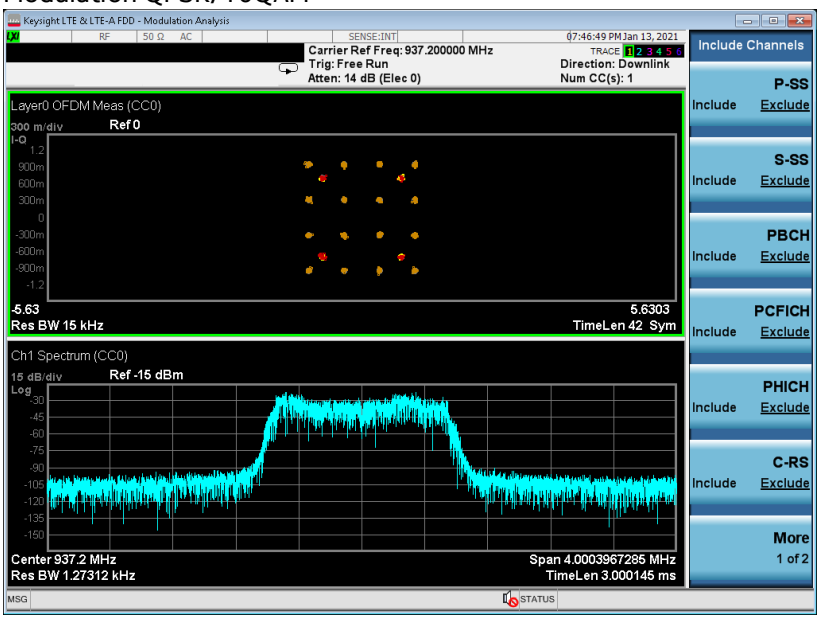
Modulation 64QAM



Modulation 256QAM



Modulation QPSK/16QAM



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.

4.1.1 1-Carrier Data (40W)

Tabular Data – Occupied Bandwidth (1-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Occupied BW MHz
937.2	1.4	64QAM	1	1.0897
938.8	1.4	256QAM	1	1.0898
938.0	3	64QAM	1	2.6952

4.1.2 2-Carrier Data (40W)

Tabular Data – Occupied Bandwidth (2-Carrier) 40W

Channel Frequency MHz	Signal BW MHz	Modulation	Occupied BW MHz
937.2	1.4 + 1.4	256QAM	2.6759
938.8	1.4 + 1.4	256QAM	2.6708

4.1.3 NB-IoT Only Data (40W)

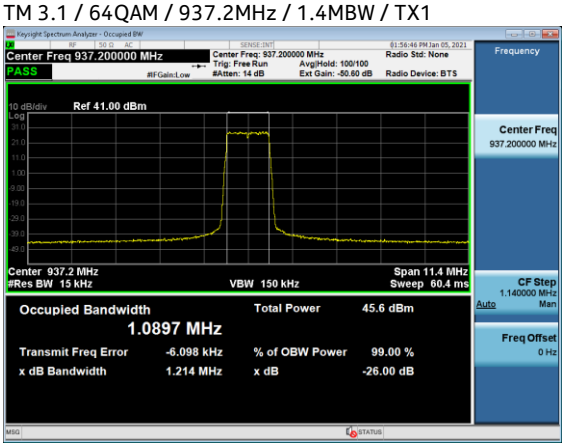
Tabular Data – Occupied Bandwidth (NB-IoT) 40W

Carriers	Channel Frequency MHz	Signal BW MHz	Modulation	TX Port	Occupied BW MHz
1	936.7	0.2	QPSK	1	0.19790
	939.3			1	0.19998
	939.3			3	0.20016
2	939	0.2 + 0.2		1	0.49113
	939.3				0.48949
3	936.7	0.2 + 0.2 + 0.2		1	0.78648
	937.0				0.78765
	937.3				0.78403

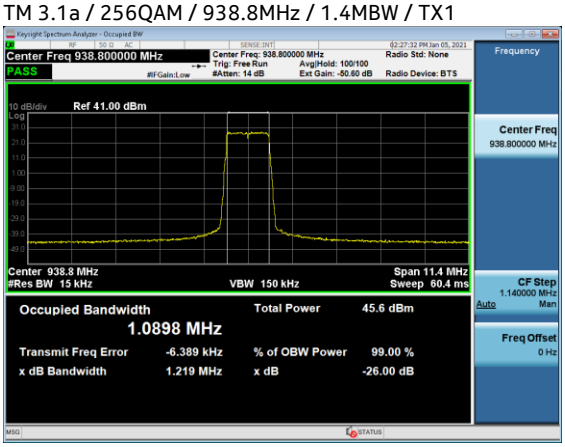
4.2 Occupied Bandwidth – Plots

4.2.1 1-Carrier Plots (40W)

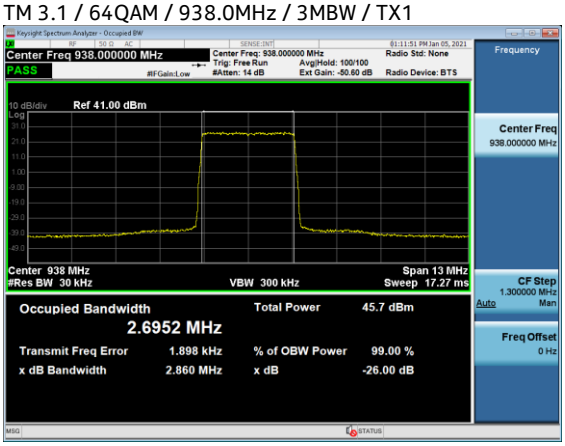
TM 3.1 / 64QAM / 937.2MHz / 1.4MBW / TX1



TM 3.1a / 256QAM / 938.8MHz / 1.4MBW / TX1

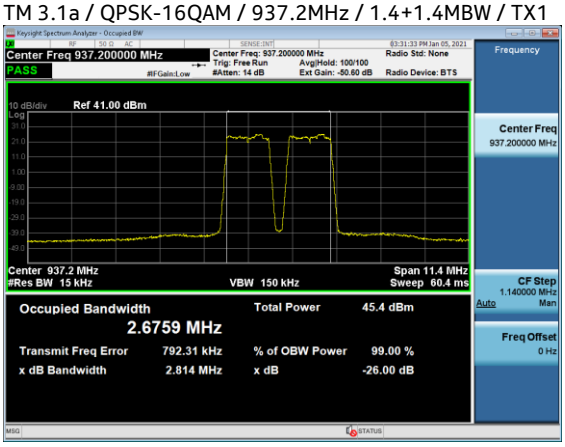


TM 3.1 / 64QAM / 938.0MHz / 3MBW / TX1

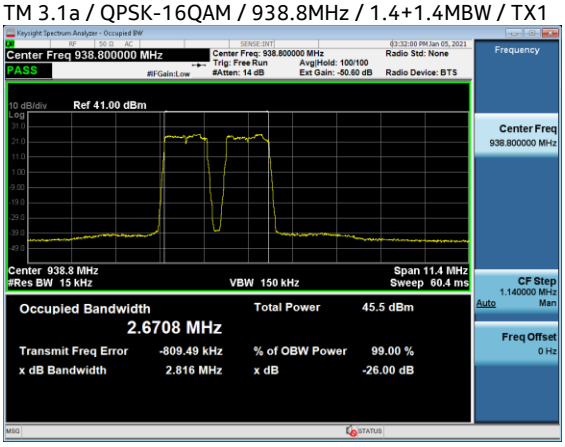


4.2.2 2-Carrier Plots (40W)

TM 3.1a / QPSK-16QAM / 937.2MHz / 1.4+1.4MBW / TX1



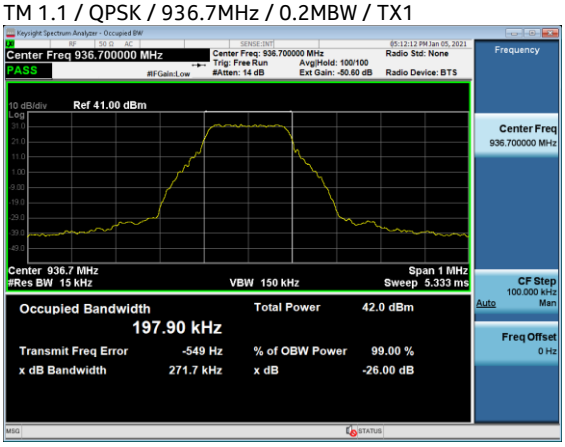
TM 3.1a / QPSK-16QAM / 938.8MHz / 1.4+1.4MBW / TX1



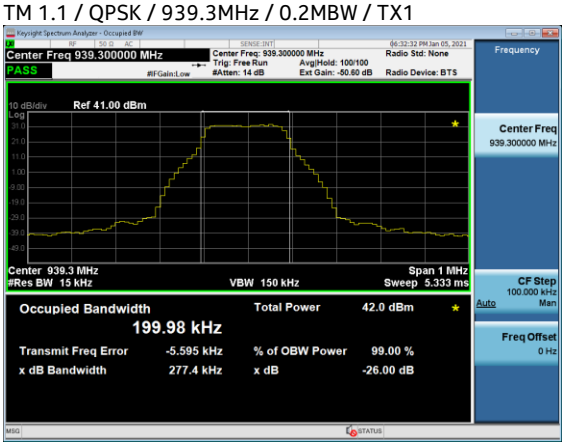
4.2.3 NB-IoT Only Plots (40W)

4.2.3.1 1-Carrier

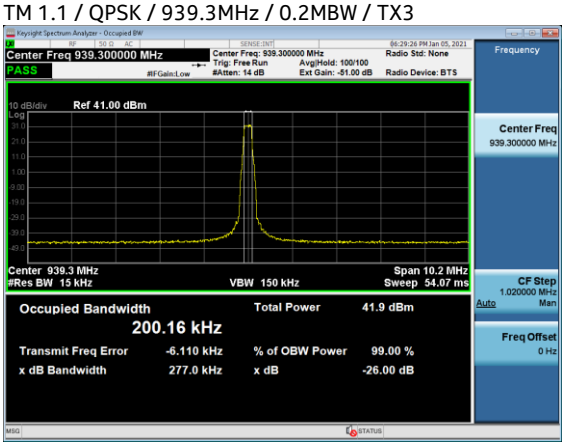
TM 1.1 / QPSK / 936.7MHz / 0.2MBW / TX1



TM 1.1 / QPSK / 939.3MHz / 0.2MBW / TX1

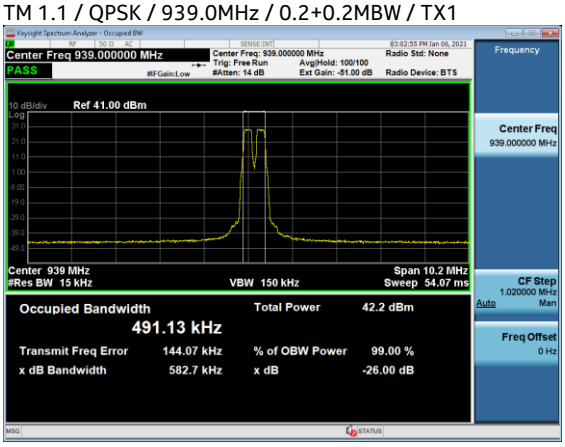


TM 1.1 / QPSK / 939.3MHz / 0.2MBW / TX3

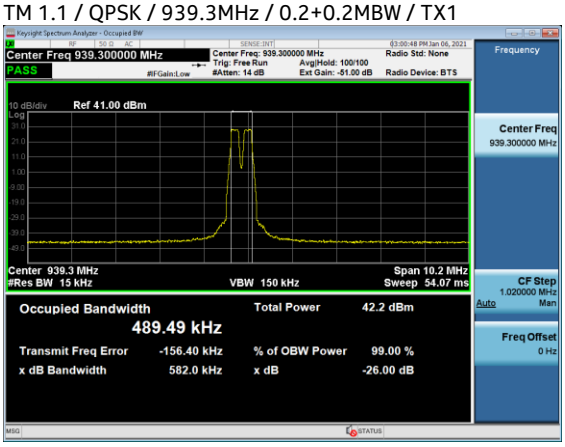


4.2.3.2 2-Carrier

TM 1.1 / QPSK / 939.0MHz / 0.2+0.2MBW / TX1

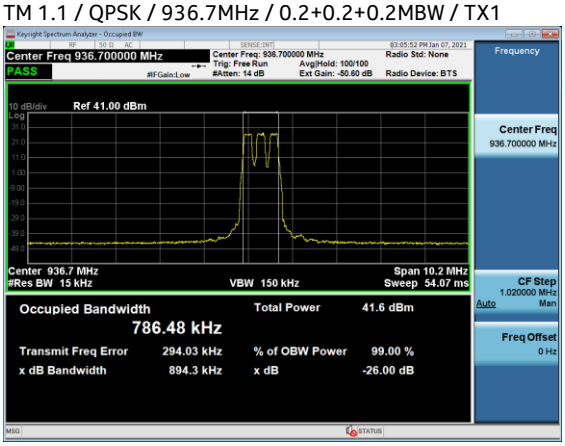


TM 1.1 / QPSK / 939.3MHz / 0.2+0.2MBW / TX1

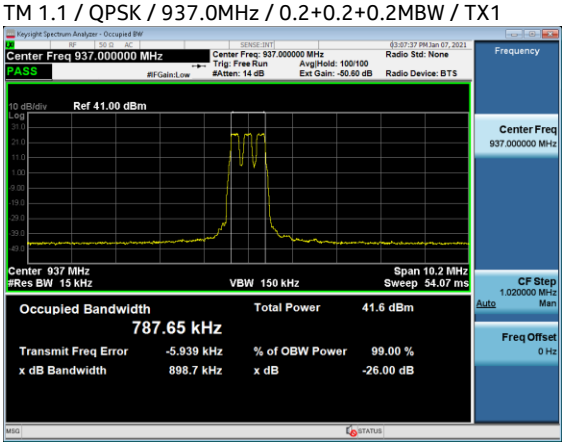


4.2.3.3 3-Carrier

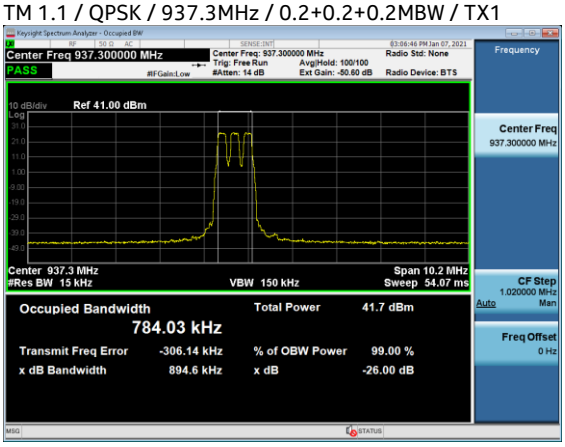
TM 1.1 / QPSK / 936.7MHz / 0.2+0.2+0.2MBW / TX1



TM 1.1 / QPSK / 937.0MHz / 0.2+0.2+0.2MBW / TX1



TM 1.1 / QPSK / 937.3MHz / 0.2+0.2+0.2MBW / TX1



4.3 Edge of band Emissions

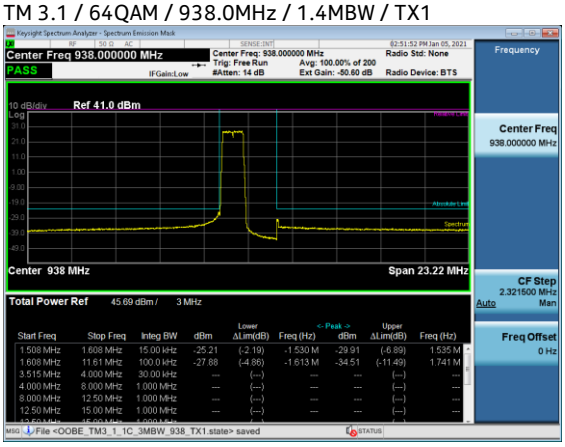
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the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

4.3.1 Edge of Band Emissions – Plots

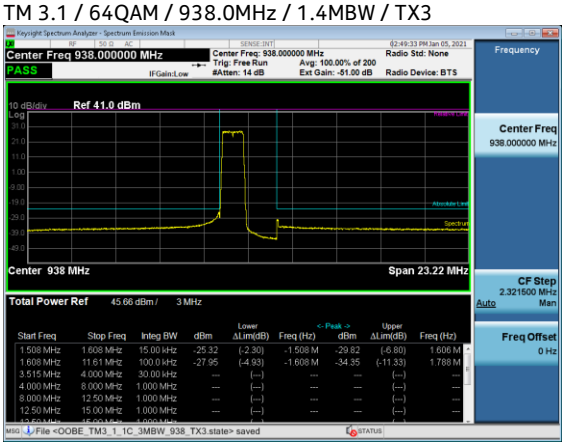
All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.

4.3.1.1 1-Carrier Plots (40W)

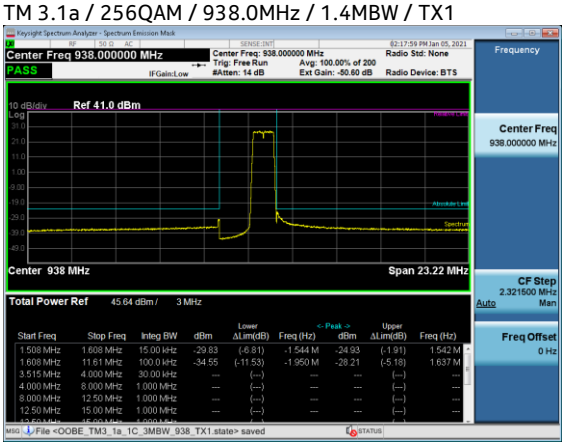
TM 3.1 / 64QAM / 938.0MHz / 1.4MBW / TX1



TM 3.1 / 64QAM / 938.0MHz / 1.4MBW / TX3



TM 3.1a / 256QAM / 938.0MHz / 1.4MBW / TX1



TM 3.1a / 256QAM / 938.0MHz / 1.4MBW / TX3