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 9kHz to beyond the 10th harmonic of the specific transmit band. For this band of operation, the measurements were performed up to 9 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 required emission limitation is specified as appropriate in 22.917. The limit line was set to -19 dBm to reflect the -13 dBm limit corrected for MIMO operation using 10 log (4). The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. There were no reportable emissions. Data below documents performance up to 10 GHz.

5.1.1 Spurious Emissions at Tx Port – Plots

5.1.1.1 LTE Plots

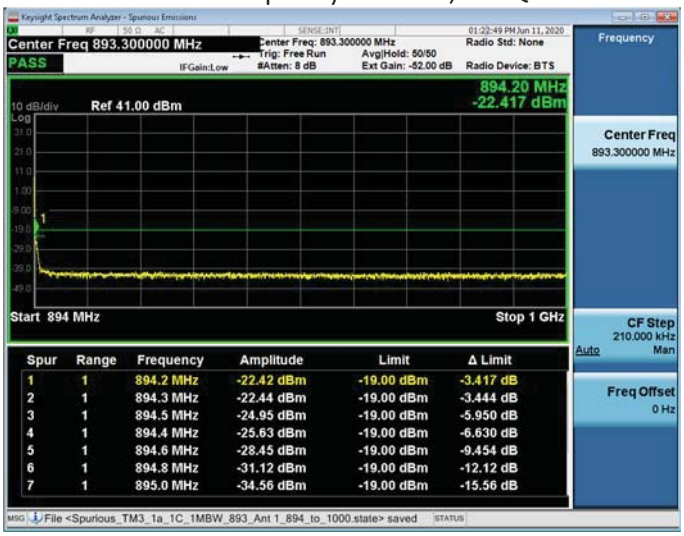
1.4MHz BW, TX1

9kHz – 150kHz
Channel Frequency 885MHz, 64QAM

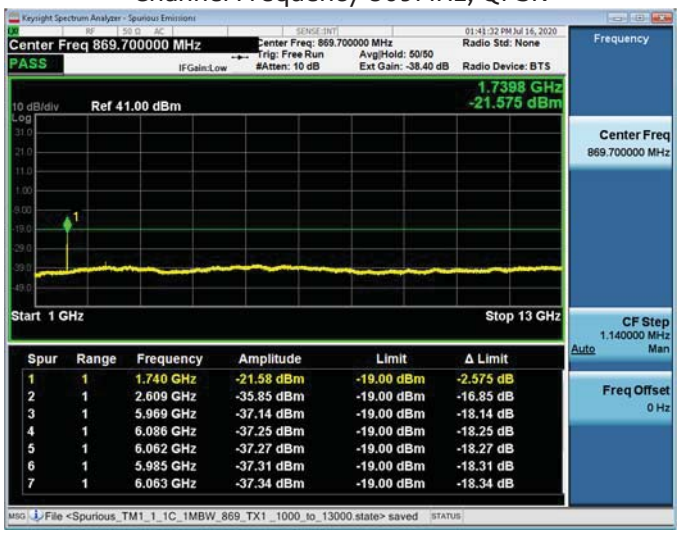
150kHz – 30MHz
Channel Frequency 893MHz, 256QAM

30MHz – 869MHz
Channel Frequency 869MHz, QPSK

894MHz – 1GHz
Channel Frequency 893MHz, 256QAM



1GHz – 1.3GHz
Channel Frequency 869MHz, QPSK



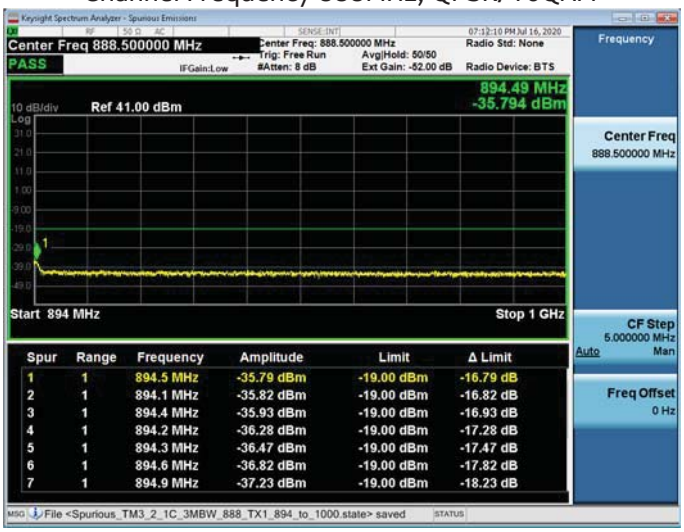
3MHz BW, TX1

9kHz – 150kHz
Channel Frequency 885MHz, 64QAM

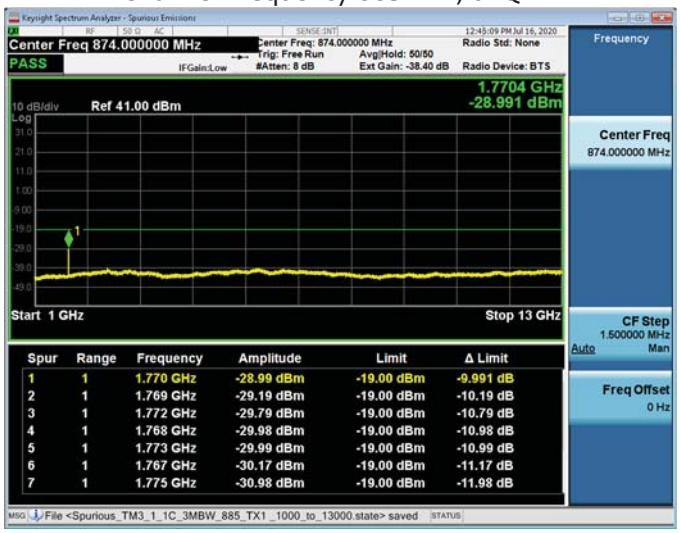
150kHz – 30MHz
Channel Frequency 885MHz, 64QAM

30MHz – 869MHz
Channel Frequency 885MHz, 64QAM

894MHz – 1GHz
Channel Frequency 888MHz, QPSK/16QAM



1GHz – 1.3GHz
Channel Frequency 885MHz, 64QAM



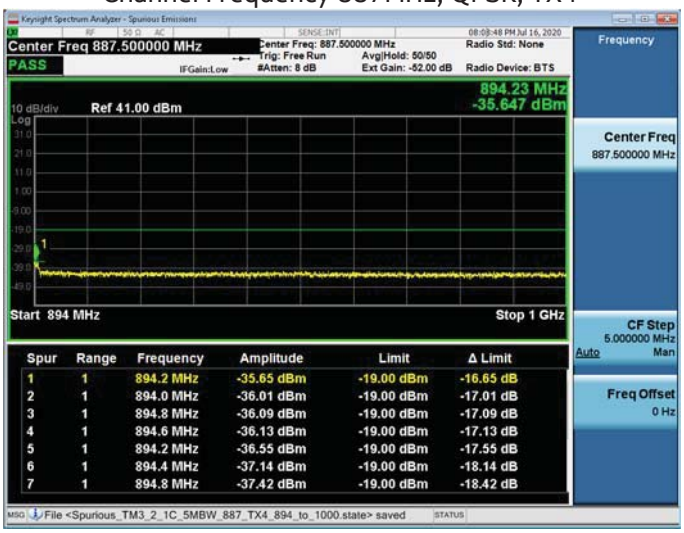
5MHz BW

9kHz – 150kHz
Channel Frequency 871MHz, 64QAM, TX1

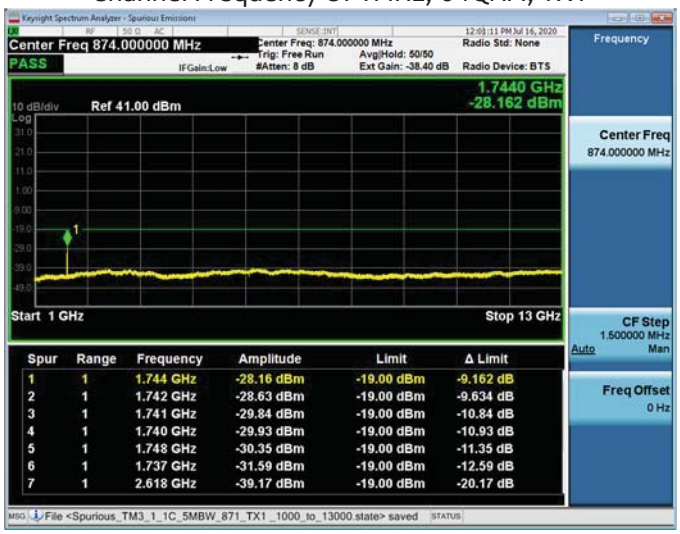
150kHz – 30MHz
Channel Frequency 871MHz, 64QAM, TX1

30MHz – 869MHz
Channel Frequency 871MHz, 64QAM, TX1

894MHz – 1GHz
Channel Frequency 887MHz, QPSK, TX4



1GHz – 1.3GHz
Channel Frequency 871MHz, 64QAM, TX1



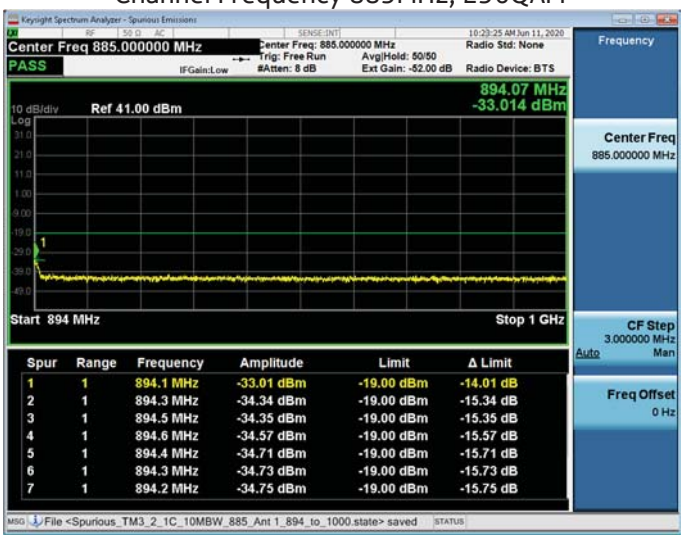
10MHz BW, TX1

9kHz – 150kHz
Channel Frequency 885MHz, 256QAM

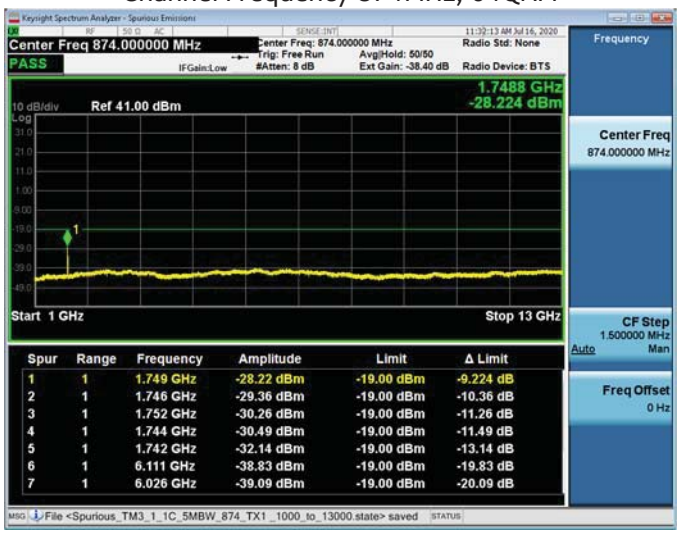
150kHz – 30MHz
Channel Frequency 885MHz, 256QAM

30MHz – 869MHz
Channel Frequency 874MHz, 64QAM

894MHz – 1GHz
Channel Frequency 885MHz, 256QAM



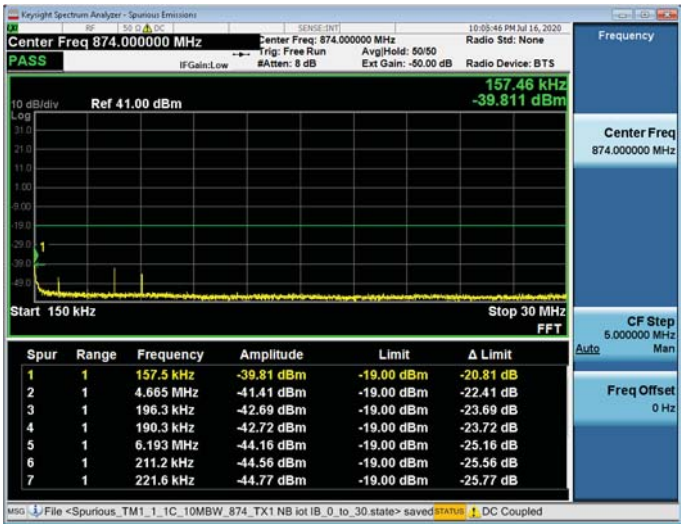
1GHz – 1.3GHz
Channel Frequency 874MHz, 64QAM



Channel Frequency 874MHz, 1C, QPSK, 10MHz BW, TX1, Guardband

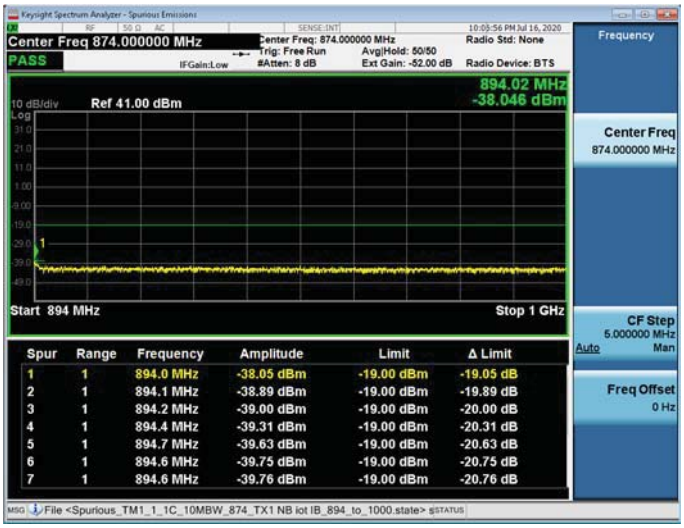
90kHz – 150kHz

150kHz – 30MHz



30MHz – 869MHz

894MHz – 1GHz



1GHz – 1.3GHz

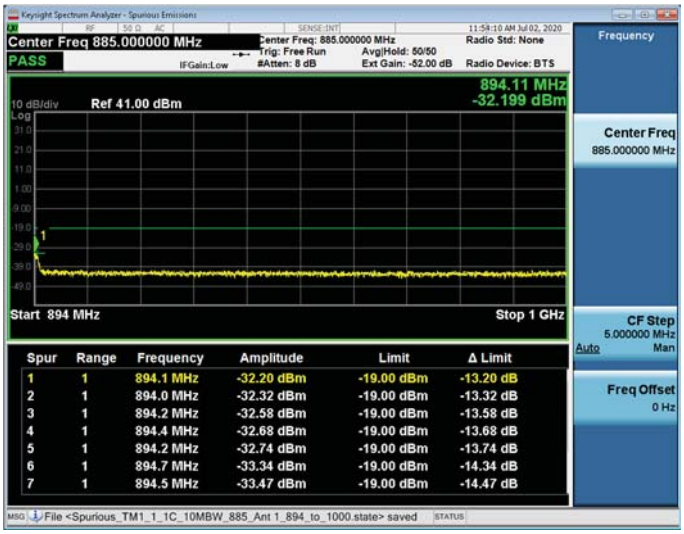
Channel Frequency 885MHz, 1C, QPSK, 10MHz BW, TX1, Guardband

90kHz – 150kHz

150kHz – 30MHz

30MHz – 869MHz

894MHz – 1GHz

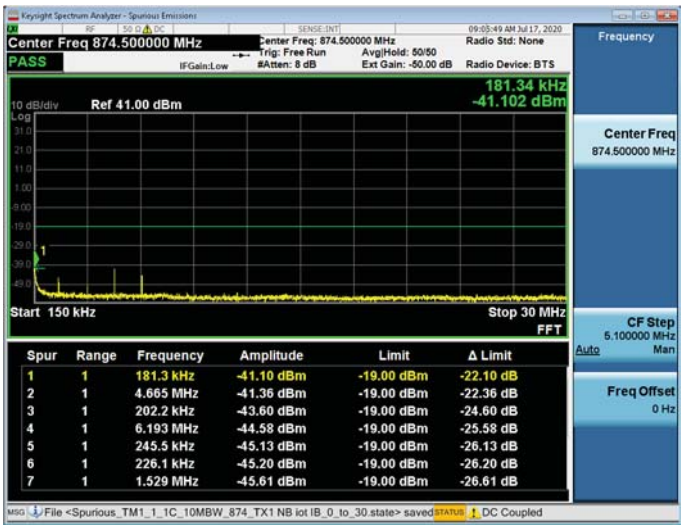


1GHz – 1.3GHz

Channel Frequency 874MHz, 1C, QPSK, 10MHz BW, TX1, Inband

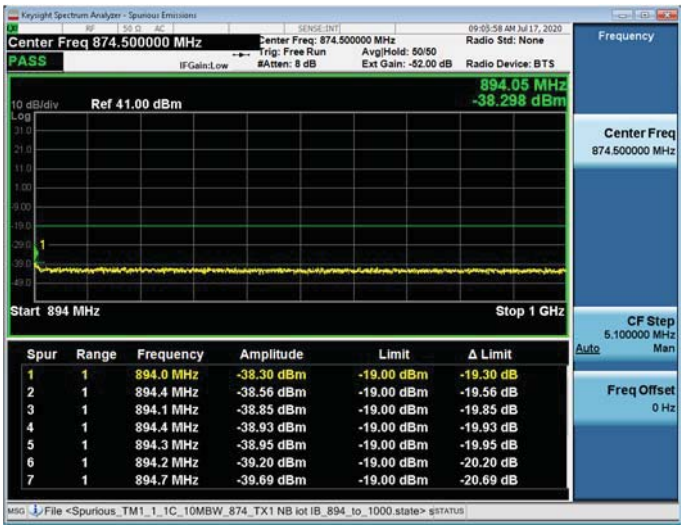
90kHz – 150kHz

150kHz – 30MHz



30MHz – 869MHz

894MHz – 1GHz



1GHz – 1.3GHz

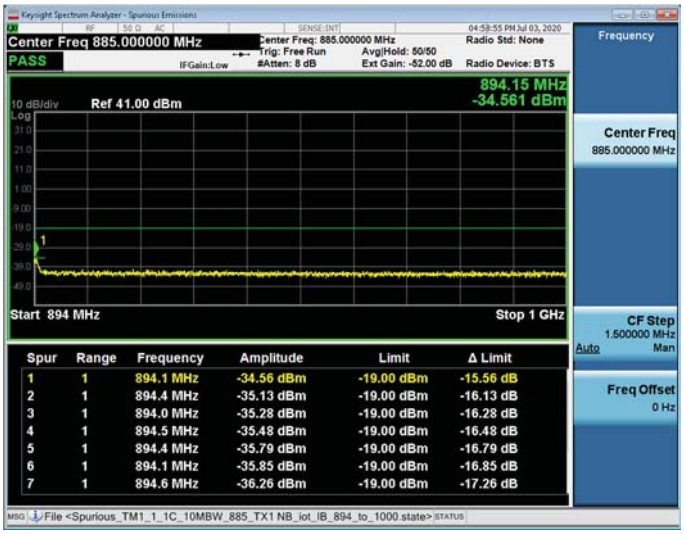
Channel Frequency 885MHz, 1C, QPSK, 10MHz BW, TX1, Inband

90kHz – 150kHz

150kHz – 30MHz

30MHz – 869MHz

894MHz – 1GHz

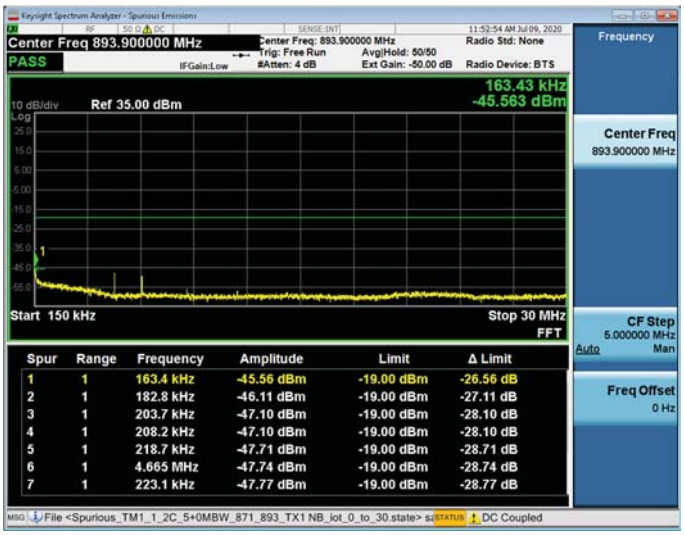


1GHz – 1.3GHz

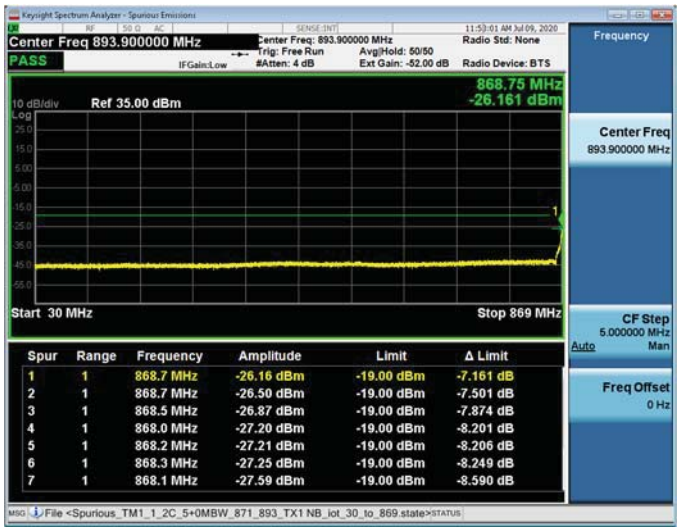
Channel Frequency 871+893MHz, 2C, QPSK, 5+0.2MHz BW, TX1

90kHz – 150kHz

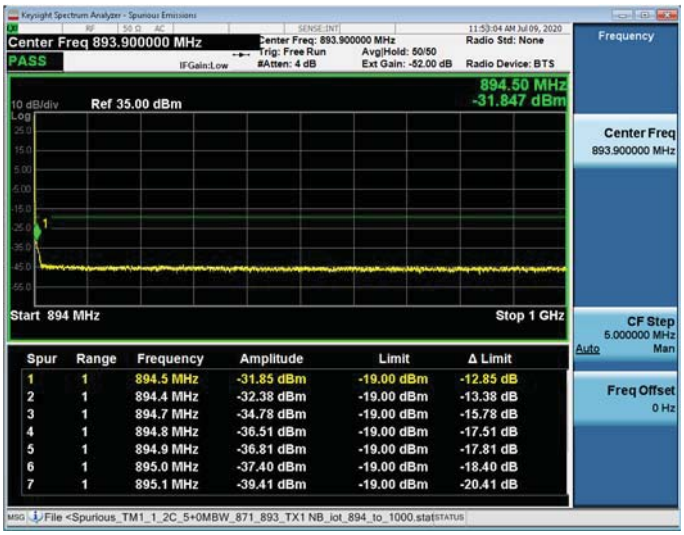
150kHz – 30MHz



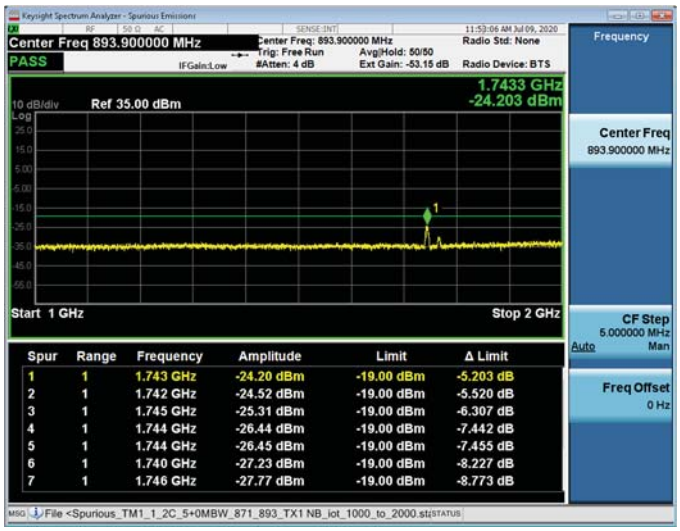
30MHz – 869MHz



894MHz – 1GHz



1GHz – 2GHz



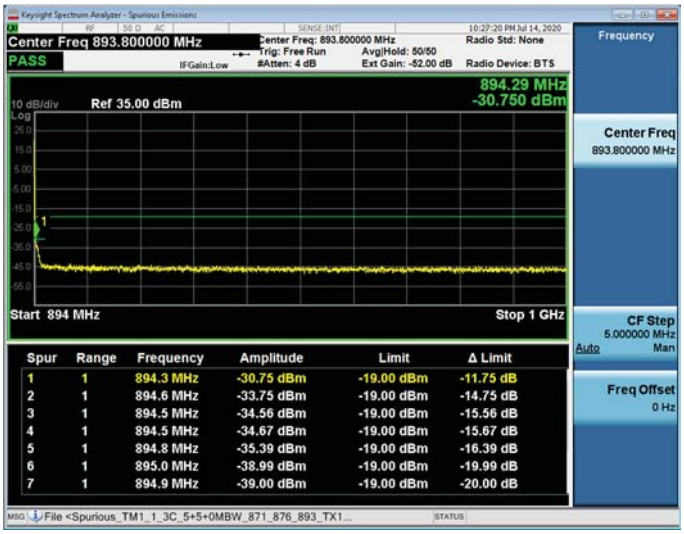
Channel Frequency 871+876+893MHz, 3C, QPSK, 5+5+0.2MHz BW, TX1

90kHz – 150kHz

150kHz – 30MHz

30MHz – 869MHz

894MHz – 1GHz



1GHz – 1.3GHz

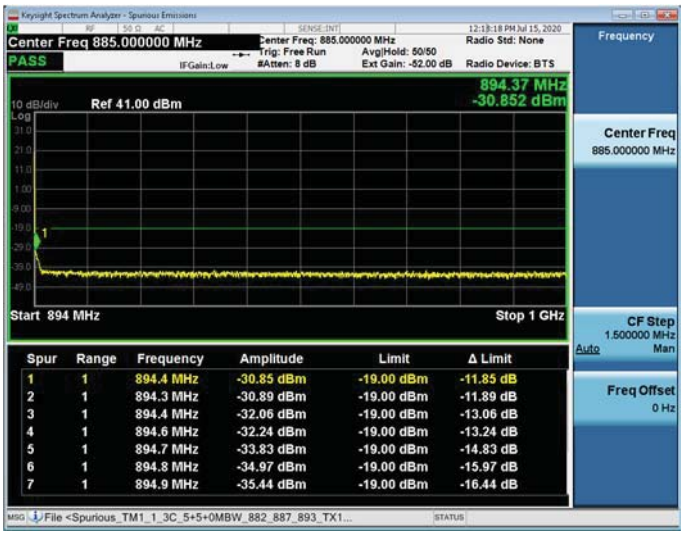
Channel Frequency 882+887+893MHz, 3C, QPSK, 5+5+0.2MHz BW, TX1

90kHz – 150kHz

150kHz – 30MHz

30MHz – 869MHz

894MHz – 1GHz



1GHz – 1.3GHz

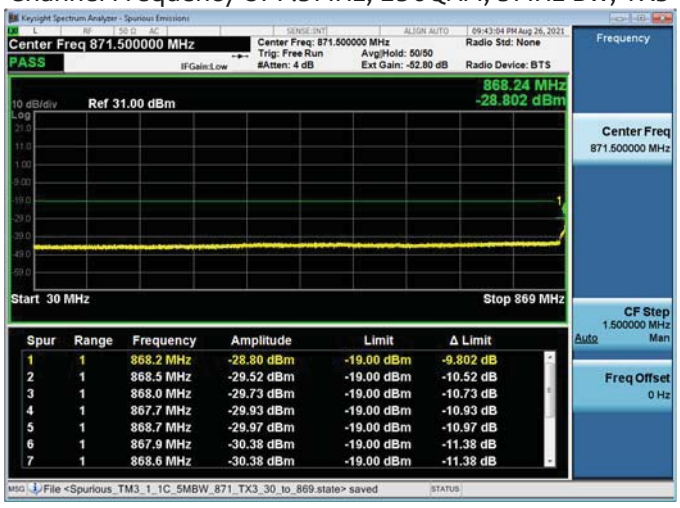
5.1.1.2 5GNR 40W Plots

1 Carrier

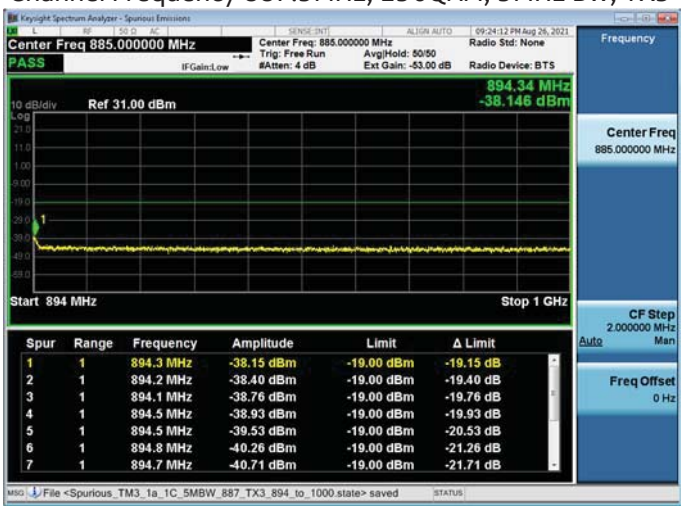
9kHz – 150kHz
Channel Frequency 871.5MHz, 64QAM, 5MHz BW, TX3

150kHz – 30MHz
Channel Frequency 871.5MHz, 64QAM, 10MHz BW, TX3

30MHz – 869MHz
Channel Frequency 877.5MHz, 256QAM, 5MHz BW, TX3

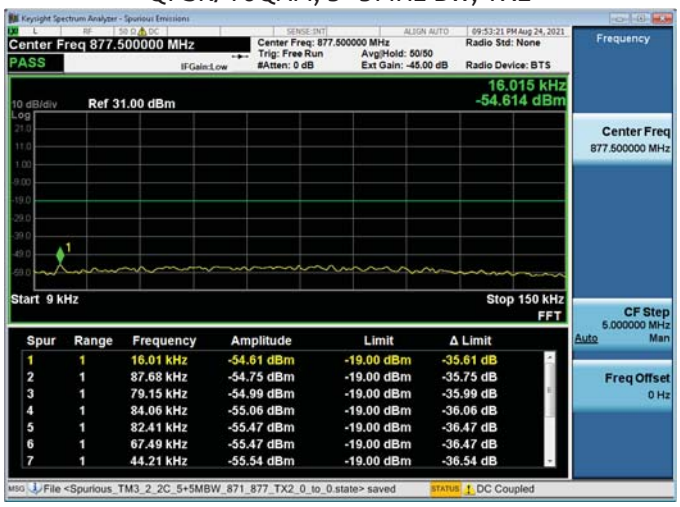


894MHz – 1GHz
Channel Frequency 887.5MHz, 256QAM, 5MHz BW, TX3



2 Carrier

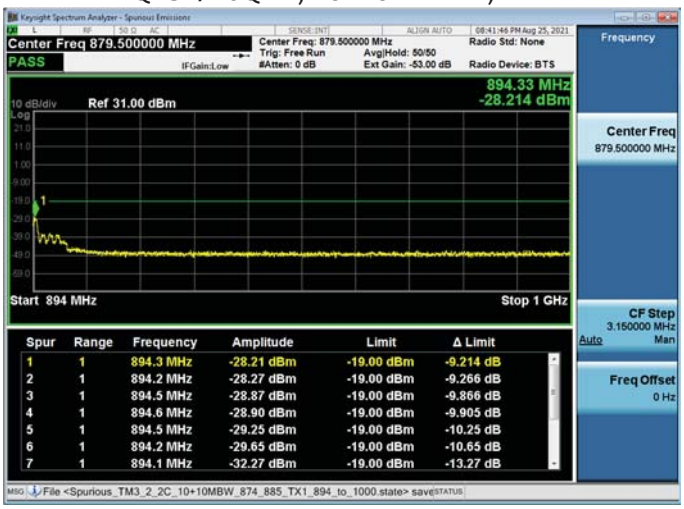
9kHz – 150kHz
Channel Frequency 871.5+877.5MHz,
QPSK/16QAM, 5+5MHz BW, TX2



150kHz – 30MHz
Channel Frequency 871.5+877.5MHz,
QPSK/16QAM, 5+5MHz BW, TX2

30MHz – 869MHz
Channel Frequency 871.5+877.5MHz,
QPSK/16QAM, 5+5MHz BW, TX2

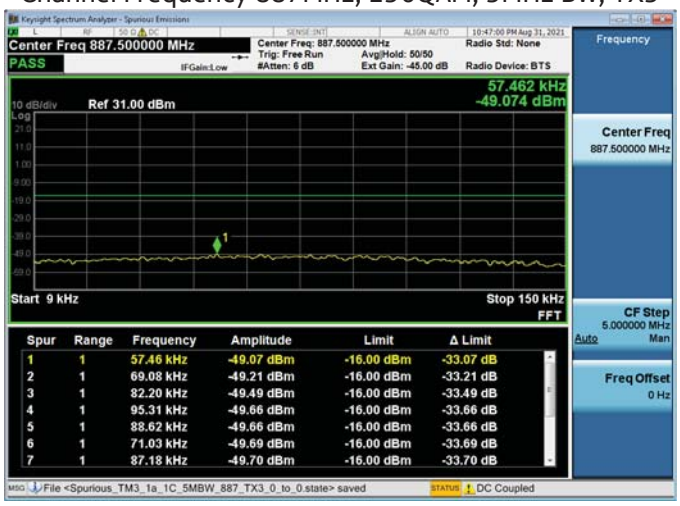
894MHz – 1GHz
Channel Frequency 874+885MHz,
QPSK/16QAM, 10+10MHz BW, TX1



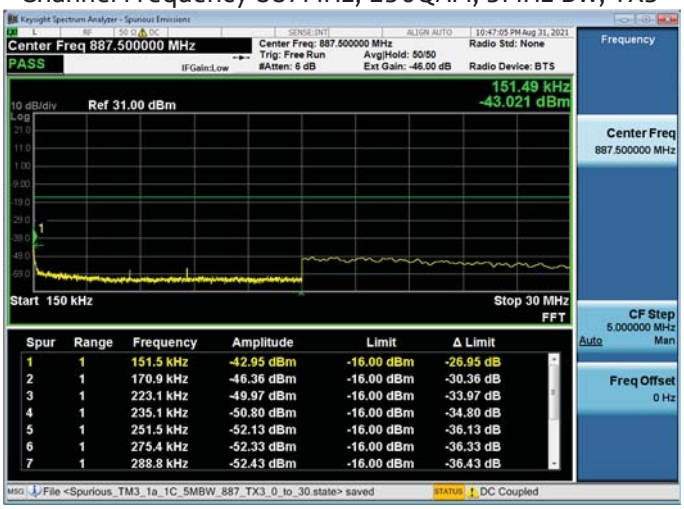
5.1.1.3 5GNR 60W Plots

1 Carrier

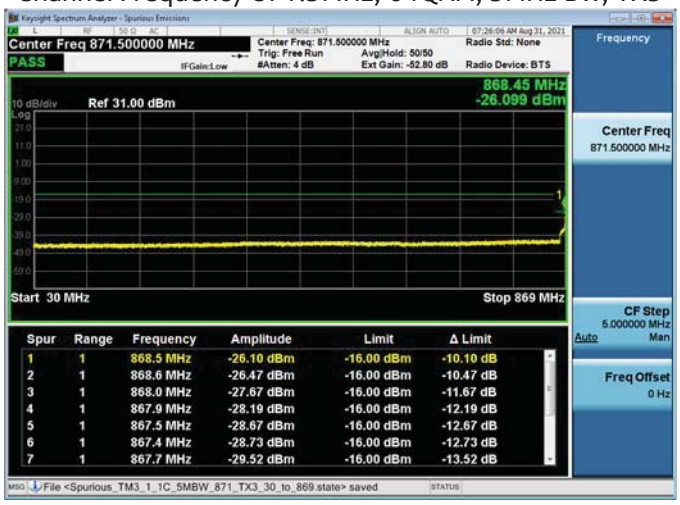
9kHz – 150kHz
Channel Frequency 887MHz, 256QAM, 5MHz BW, TX3



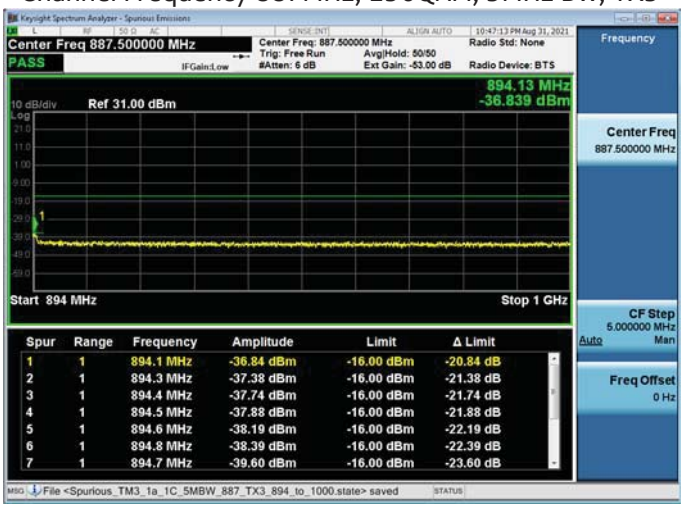
150kHz – 30MHz
Channel Frequency 887MHz, 256QAM, 5MHz BW, TX3



30MHz – 869MHz
Channel Frequency 871.5MHz, 64QAM, 5MHz BW, TX3



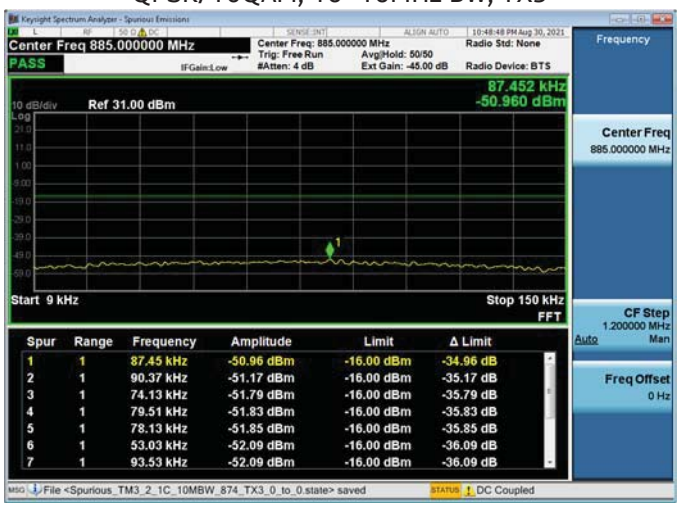
894MHz – 1GHz
Channel Frequency 887MHz, 256QAM, 5MHz BW, TX3



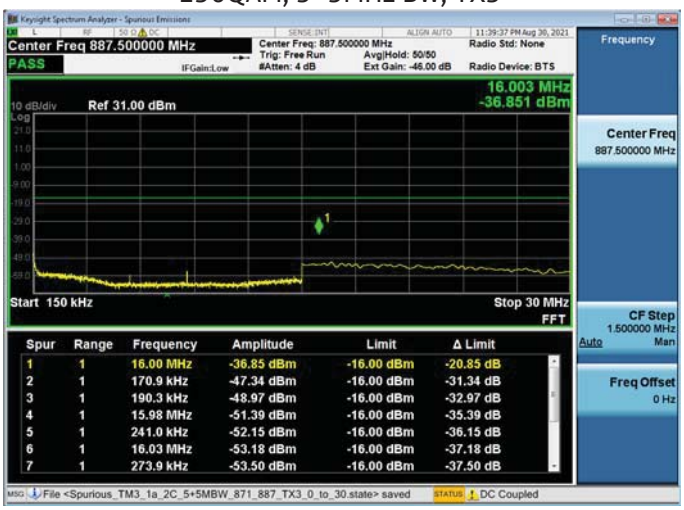
1GHz – 10GHz
Channel Frequency 874MHz, 64QAM, 10MHz BW, TX3

2 Carrier

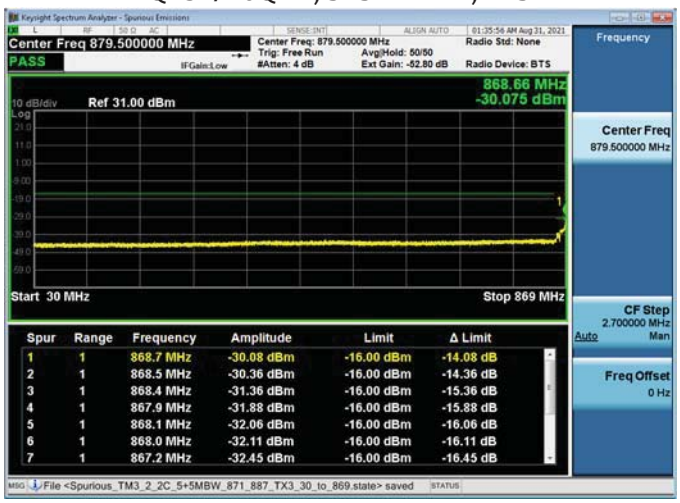
9kHz – 150kHz
Channel Frequency 874+885MHz,
QPSK/16QAM, 10+10MHz BW, TX3



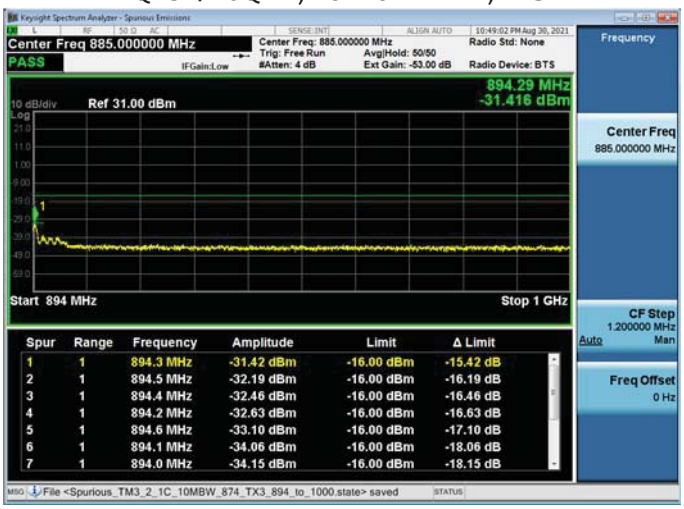
150kHz – 30MHz
Channel Frequency 871.5+887.5MHz,
256QAM, 5+5MHz BW, TX3



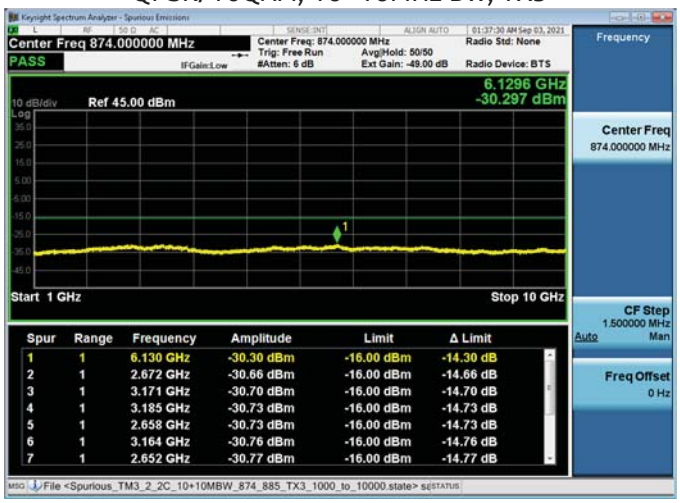
30MHz – 869MHz
Channel Frequency 871.5+887.5MHz,
QPSK/16QAM, 5+5MHz BW, TX3



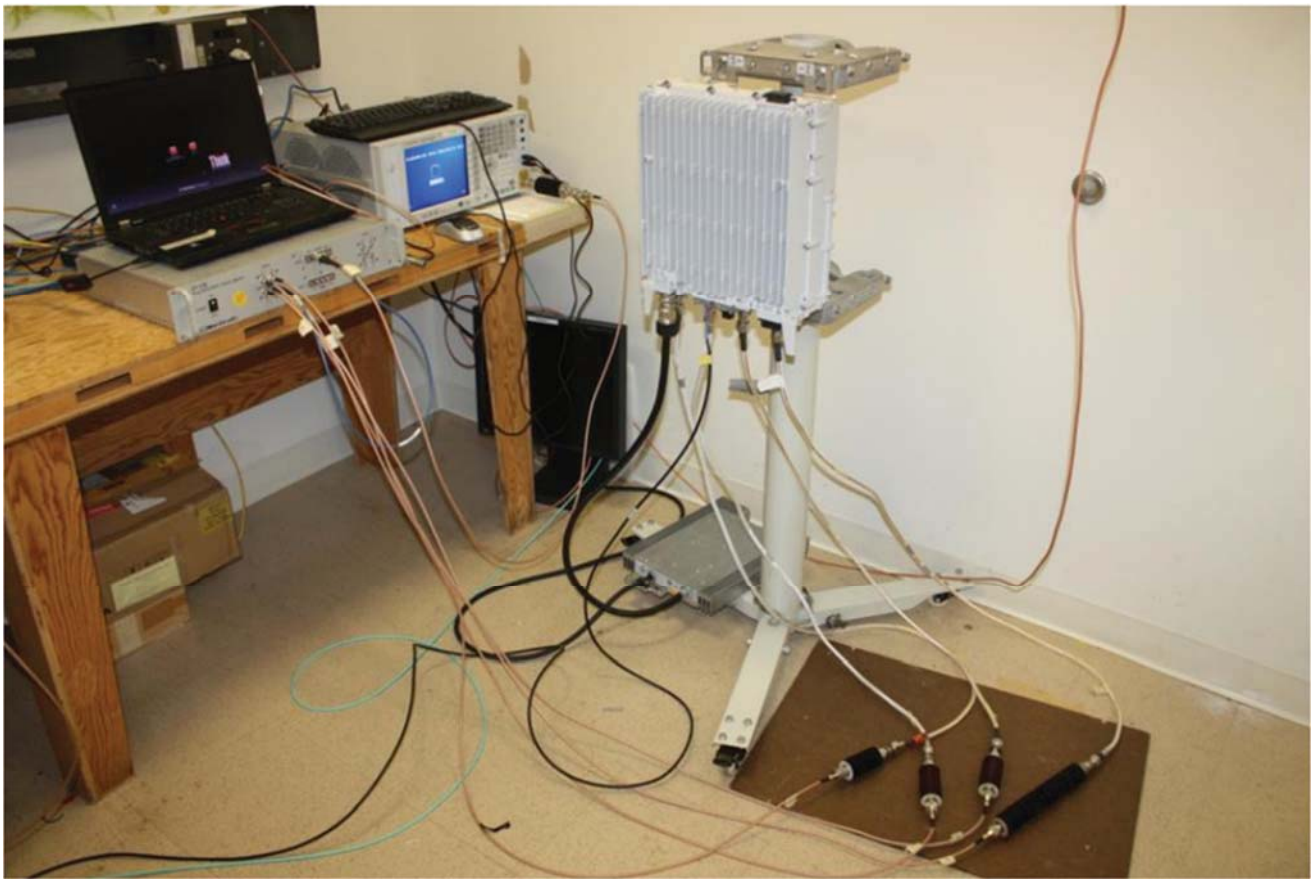
894MHz – 1GHz
Channel Frequency 874+885MHz,
QPSK/16QAM, 10+10MHz BW, TX3

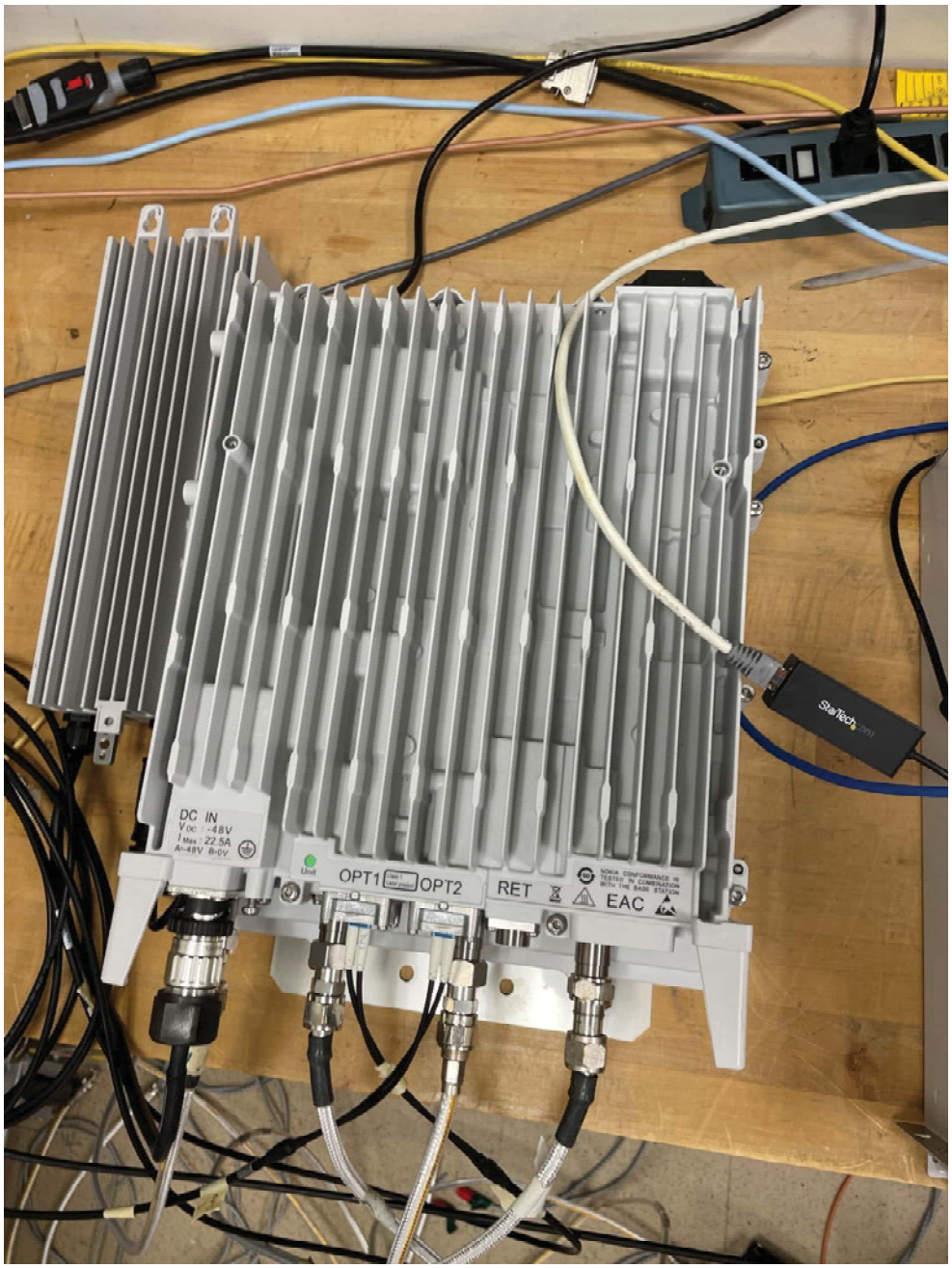


1GHz – 10GHz
Channel Frequency 874+885MHz,
QPSK/16QAM, 10+10MHz BW, TX3



Photographs




DC IN
OPT1
OPT2
RET
EAC

Test Equipment

LTE Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E831	Agilent Technologies	MXA Signal Analyzer	20Hz-26.5GHz	N9020A	MY48011791	2020-06-16	2022-06-16
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2019-01-31	2021-01-31
E1022	Weinschel	Attenuator	10dB DC-18GHz 25W	46-10-34-LIM	BN3118	CNR-V	CNR-V
E1043	Weinschel	Attenuator	30dB 50W DC-8.5GHz	24-30-43		CNR-V	CNR-V
E1344	Macom	Attenuator	3 dB, DC - 4 GHz, 2W	2082-6171-03	N/A	CNR-V	CNR-V
E1380	Pasternack	Filter, Low Pass	DC-4400 MHz, 10W, 1.5dB	PE87FL1014	1736	N/A	N/A
E1212	RLC Electronics	Filter, High Pass	10 - 30 GHz, 2W, 5dB	F-19414	1444002	CNR-V	CNR-V
E1155	Weinschel	Attenuator	10dB 25W 0.05- 26GHz	74-10-12	1068	CNR-V	CNR-V
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065	CNR-V	CNR-V
E1250	Weinschel	Attenuator	3dB Attenuator 100W	24-3-43	BB9072	CNR-V	CNR-V

CNR-V: Calibration Not Required. Must Be Verified.
Test Dates: 6/10/2020 – 7/17/2020

5G-NR Radio Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1218	KeySight Technologies	EMI Receiver	MXE EMI Receiver 26.5GHz	N9038A	MY54130037	2020-08-28	2022-08-28
E1338	KeySight Technologies	MXA Signal Analyzer		N9020B	MY57430927	2019-11-14	2021-11-14
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2021-03-03	2023-03-03
E1534	Traceable	Data Logger	Barometric Humidity Temp Data Logger	6529	200648430	2020-10-21	2022-10-21
E1212	RLC Electronics	Filter, High Pass	10 - 30 GHz, 2W, 5dB	F-19414	1444002	CNR-V	CNR-V
E1022	Weinschel	Attenuator	10dB DC-18GHz 25W	46-10-34-LIM	BN3118	CNR-V	CNR-V
E1023	Weinschel	Attenuator	20 dB DC-18 GHz 25W	46-20-34	BJ4772	CNR-V	CNR-V
E1344	Macom	Attenuator	3 dB, DC - 4 GHz, 2W	2082-6171-03	N/A	CNR-V	CNR-V
E1155	Weinschel	Attenuator	10dB 25W 0.05- 26GHz	74-10-12	1068	CNR-V	CNR-V
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065	CNR-V	CNR-V
E1250	Weinschel	Attenuator	3dB Attenuator 100W	24-3-43	BB9072	CNR-V	CNR-V

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1251	Aeroflex	Attenuator	30dB 150W DC-18GHz Attenuator	66-30-33	BV1667	CNR-V	CNR-V

CNR-V: Calibration Not Required. Must Be Verified.
Test Dates: 8/24/2021 – 9/21/2021

6. FCC Section 2.1053 - Field strength of spurious radiation

6.1 Section 2.1053 Field Strength of Spurious Emissions

Field strength measurements of radiated spurious emissions were made in an FCC registered 3m Semi-Anechoic Chamber which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. A complete description and full measurement data for the site is on file with the Commission (Site Registration Number: 515091).

The spectrum from 30 MHz to beyond the tenth harmonic of the carrier, 10 GHz, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, when the emissions are more than 20 dB below the specification limit, the use of field strength measurements for compliance determination is acceptable and those emissions are considered not reportable (Section 2.1053 and the FCC Interpretive database for 2.1053). For this case the evaluation of acceptable radiated field strength is as follows.

6.2 Field Strength of Spurious Emissions - Limits

Sections 2.1053 and 22.917 contain the requirements for the levels of spurious radiation as a function of the level of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an ideal dipole excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 676, 4th edition, IT&T Corp.

$$E= [(30*P)^{1/2}]/R$$

$$20 \log (E*10^{6}) – (43 + 10 \log P) = 82.23 \text{ dB}\mu\text{V/meter}$$

Where:
E = Field Intensity in Volts/meter P = Transmitted Power in Watts
R = Measurement distance in meters = 3 m

The Part 22 Limit is 82.23 dBµV/m at 3m and 91.77 dBµV/m at 1m
The Part 22 non-report level is 62.23 dBµV/m at 3m.

The calculated emission levels were found by:

Measured level (dBµV) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dBµV/m)

RESULTS:

For compliance with 47CFR Parts 2 and 22, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBµV/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dBµV/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 10 GHz). No reportable spurious emissions were detected.

7. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

ilac-MRA

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
Murray Hill, NJ

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2022-09-28 through 2023-09-30
Effective Dates

DEPARTMENT OF COMMERCE * UNITED STATES OF AMERICA *

For the National Voluntary Laboratory Accreditation Program

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
Murray Hill, NJ

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

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2019-09-20 through 2020-09-30
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program

United States Department of Commerce
National Institute of Standards and Technology

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Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 100275-0

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2020-09-25 through 2021-09-30
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program