PCTEST
7185 Oakland Mills Road, Columbia, MD 21046 USA
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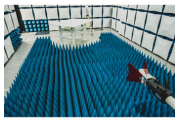

PART 24 MEASUREMENT REPORT

Applicant Name:
Tecore Networks
7030 Hi Tech Drive
Hanover, MD 21076
USA

Date of Testing:
6/23/2021 – 10/09/2021
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M2106040064-01.QLJ

FCC ID:	**QLJMRU-19212326**
Applicant Name:	**Tecore Networks**

Application Type:	Certification
Model:	MRU-20W19212326
EUT Type:	Mid Band mRU
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part:	24
Test Procedure(s):	ANSI C63.26-2015, ANSI/TIA-603-E-2016, KDB 971168 D01 v03r01

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in §2.947. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ACCREDITED
CERT #2041.01

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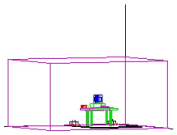
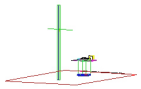


PART 24 MEASUREMENT REPORT



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	Conducted Power		Emission Designator
				Max. Power [W]	Max. Power [dBm]	
LTE Band 25/2	20 MHz	QPSK	1940 - 1985	22.233	43.47	18M0G7D
		16QAM	1940 - 1985	21.677	43.36	18M0W7D
	15 MHz	QPSK	1937.5 - 1987.5	22.131	43.45	13M5G7D
		16QAM	1937.5 - 1987.5	21.727	43.37	13M5W7D
	10 MHz	QPSK	1935 - 1990	21.878	43.40	9M01G7D
		16QAM	1935 - 1990	22.542	43.53	9M05W7D
	5 MHz	QPSK	1932.5 - 1992.5	22.542	43.53	4M51G7D
		16QAM	1932.5 - 1992.5	22.909	43.60	4M50W7D
	3 MHz	QPSK	1931.5 - 1993.5	22.542	43.53	2M71G7D
		16QAM	1931.5 - 1993.5	22.961	43.61	2M71W7D
	1.4 MHz	QPSK	1930.7 - 1994.3	22.803	43.58	1M10G7D
		16QAM	1930.7 - 1994.3	22.491	43.52	1M11W7D

EUT Overview

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.

- PCTEST is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

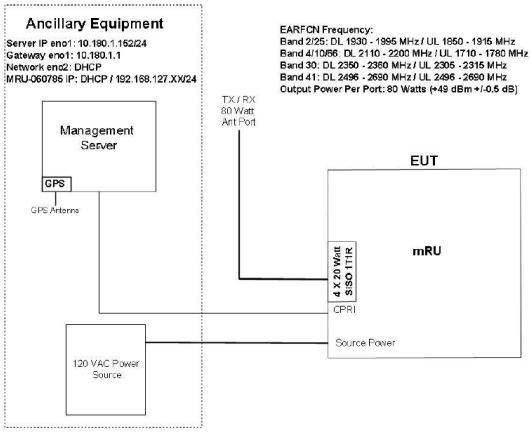
- PCTEST facility is a registered (2451B) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Tecore Mid Band mRU FCC ID:QLJMRU-19212326**. The test data contained in this report pertains only to the emissions due to the EUT's licensed transmitters that operate under the provisions of Part 24. The EUT generates LTE signal using QPSK, 16-QAM, 64-QAM, and 256-QAM modulations. The EUT can transmit three different LTE mid band signals at the same time with its single antenna port. The signal output level is set to 20W output per band for a total of 60W output from the antenna port and it is fed via a low loss cable to the input of a spectrum analyzer or a 50Ω load, depending on the type of testing performed. EUT was set up to operate as shown below with a 120 VAC power source. Server equipment was used to control the RF functions of the EUT.

Test Device Serial No.: 20270009, 20270007
Software Revision: mRU 8.0
Firmware: MRAN_015



2.2 Device Capabilities

This device contains the following capabilities:

Multi-Band LTE

2.3 Test Configuration

The EUT was tested per the guidance of ANSI/TIA-603-E-2016 and KDB 971168 D01 v03r01. See Section 0 of this test report for a description of the radiated and antenna port conducted emissions tests.

2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI/TIA-603-E-2016) and "Measurement Guidance for Certification of Licensed Digital Transmitters" (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

Deviation from Measurement Procedure……..None

3.2 Radiated Power and Radiated Spurious Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer.

For radiated power measurements, substitution method is used per the guidance of ANSI/TIA-603-E-2016. A half-wave dipole is substituted in place of the EUT. For emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator with the level of the signal generator being adjusted to obtain the same receive spectrum analyzer level previously recorded from the spurious emission from the EUT. The power of the emission is calculated using the following formula:

$$P_{d\ [dBm]} = P_{g\ [dBm]} - \text{cable loss}_{\ [dB]} + \text{antenna gain}_{\ [dBd/dBi]};$$

where P_d is the dipole equivalent power, P_g is the generator output into the substitution antenna, and the antenna gain is the gain of the substitute antenna used relative to either a half-wave dipole (dBd) or an isotropic source (dBi). The substitute level is equal to $P_{g\ [dBm]}$ – cable loss $_{[dB]}$.

For radiated spurious emissions measurements and calculations, conversion method is used per the formulas in KDB 971168 Section 5.8.4. Field Strength (EIRP) is calculated using the following formulas:

$$E_{[dB\mu V/m]} = \text{Measured amplitude level}_{[dBm]} + 107 + \text{Cable Loss}_{[dB]} + \text{Antenna Factor}_{[dB/m]}$$

And

$$EIRP_{[dBm]} = E_{[dB\mu V/m]} + 20\log D - 104.8;\ \text{where D is the measurement distance in meters.}$$

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 414788 v01r01.

4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.13
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	AP2	EMC Cable and Switch System	3/4/2021	Annual	3/4/2022	AP2
-	ETS	EMC Cable and Switch System	3/4/2021	Annual	3/4/2022	ETS
-	LTx1	Licensed Transmitter Cable Set	3/12/2021	Annual	3/12/2022	LTx1
-	LTx2	Licensed Transmitter Cable Set	3/12/2021	Annual	3/12/2022	LTx2
Agilent	N9030A	50GHz PXA Signal Analyzer	1/20/2021	Annual	1/20/2022	US51350301
Emco	3115	Horn Antenna (1-18GHz)	6/18/2020	Biennial	6/18/2022	9704-5182
Espec	ESX-2CA	Environmental Chamber	8/27/2020	Annual	8/27/2022	17620
ETS Lindgren	3164-08	Quad Ridge Horn Antenna	3/12/2020	Biennial	3/12/2022	128337
Rohde & Schwarz	ESW44	EMI Test Receiver 2Hz to 44 GHz	1/21/2021	Annual	1/21/2022	101716
Sunol	JB6	LB6 Antenna	11/13/2020	Biennial	11/13/2022	A082816

Table 5-1. Test Equipment

Notes:

1. For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

2. Equipment with a calibration date of “N/A” shown in this list was not used to make direct calibrated measurements.

6.0 SAMPLE CALCULATIONS

QPSK Modulation

Emission Designator = 8M62G7D
LTE BW = 8.62 MHz
G = Phase Modulation
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

QAM Modulation

Emission Designator = 8M45W7D
LTE BW = 8.45 MHz
W = Amplitude/Angle Modulated
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

Spurious Radiated Emission

Example: Spurious emission at 3700.40 MHz

The receive spectrum analyzer reading at 3 meters with the EUT on the turntable was –81.0 dBm. The gain of the substituted antenna is 8.1 dBi. The signal generator connected to the substituted antenna terminals is adjusted to produce a reading of –81.0 dBm on the spectrum analyzer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 3700.40 MHz. So 6.1 dB is added to the signal generator reading of –30.9 dBm yielding –24.80 dBm. The fundamental EIRP was 25.50 dBm so this harmonic was 25.50 dBm – (-24.80) = 50.3 dBc.

7.0 TEST RESULTS

7.1 Summary

Company Name: Tecore Networks

FCC ID: QLJMRU-19212326

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Transmitter Conducted Output Power/ Equivalent Isotropic Radiated Power	2.1046, 24.232	1640W/MHz	PASS	Section 7.2
	Occupied Bandwidth	2.1049	N/A	PASS	Section 7.3
	Conducted Band Edge / Spurious Emissions	2.1051, 24.238(a)	> 43 + 10log10(P[Watts]) at Band Edge and for all out-of-band emissions	PASS	Sections 7.4, 7.5
	Peak-Average Ratio (PAR)	24.232(d)	13 dB	PASS	Section 7.6
	Frequency Stability	2.1055, 24.235	Fundamental emissions stay within authorized frequency block	PASS	Section 7.8
RADIATED	Radiated Spurious Emissions	2.1053, 24.238(a)	> 43 + 10 log10 (P[Watts]) for all out-of-band emissions	PASS	Section 7.7

Table 7-1. Summary of Test Results

Notes:

1) All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT at all frequencies of interest.
3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST EMC Software Tool Ver. 1.1.
5) For the Radiated Emissions test, the EUT was tested for case radiated spurious emissions with the antenna port terminated in 50 ohms while the EUT was set to transmit from antenna port (1 x 20W) at maximum power.

7.2 Transmitter Conducted Output Power / Effective Radiated Power

Test Overview

The EUT was set to transmit in all four available modulations of LTE mode at the maximum output power of 20W for this band or as applicable for the channel through a management server. The output terminal of the EUT was connected through a calibrated cable and 30 dB of external attenuation to a signal analyzer. The signal analyzers' "Channel Power" function was used to measure the conducted output powers in accordance with the guidance of KDB 971168 D01 v03r01.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 5.2.1

Test Settings

1. Power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.
2. Span = 2 - 3 times the OBW
3. RBW = 1 – 5% of the expected OBW
4. VBW ≥ 3 x RBW
5. No. of sweep points ≥ 2 x span / RBW
6. Sweep time = auto-couple
7. Detector = RMS
8. Trigger is set to "free run" for signals with continuous operation.
9. The integration bandwidth was roughly set equal to the measured OBW of the signal for signals with continuous operation.
10. Trace mode = trace averaging (RMS) over 100 sweeps
11. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

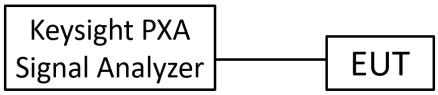


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None.

LTE Band 25/2

Bandwidth	Modulation	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]	Ant Gain [dBi]	EIRP [dBm/MHz]	EIRP Limit [dBm/MHz]	Margin [dB]
20 MHz	QPSK	1940.0	100 / 0	43.47	22.23	15.00	58.47	62.15	-3.68
		1962.5	100 / 0	43.28	21.28	15.00	58.28	62.15	-3.87
		1985.0	100 / 0	43.27	21.23	15.00	58.27	62.15	-3.88
	16-QAM	1962.5	100 / 0	43.30	21.38	15.00	58.30	62.15	-3.85
	64-QAM	1962.5	100 / 0	43.36	21.68	15.00	58.36	62.15	-3.79
	256-QAM	1962.5	100 / 0	43.26	21.18	15.00	58.26	62.15	-3.89
15 MHz	QPSK	1937.5	75 / 0	43.45	22.13	15.00	58.45	62.15	-3.70
		1962.5	75 / 0	43.40	21.88	15.00	58.40	62.15	-3.75
		1987.5	75 / 0	43.30	21.38	15.00	58.30	62.15	-3.85
	16-QAM	1962.5	75 / 0	43.32	21.48	15.00	58.32	62.15	-3.83
	64-QAM	1962.5	75 / 0	43.06	20.23	15.00	58.06	62.15	-4.09
	256-QAM	1962.5	75 / 0	43.37	21.73	15.00	58.37	62.15	-3.78
10 MHz	QPSK	1935.0	50 / 0	43.31	21.43	15.00	58.31	62.15	-3.84
		1962.5	50 / 0	43.40	21.88	15.00	58.40	62.15	-3.75
		1990.0	50 / 0	43.21	20.94	15.00	58.21	62.15	-3.94
	16-QAM	1962.5	50 / 0	43.47	22.23	15.00	58.47	62.15	-3.68
	64-QAM	1962.5	50 / 0	43.52	22.49	15.00	58.52	62.15	-3.63
	256-QAM	1962.5	50 / 0	43.53	22.54	15.00	58.53	62.15	-3.62
5 MHz	QPSK	1932.5	25 / 0	43.11	20.46	15.00	58.11	62.15	-4.04
		1962.5	25 / 0	43.53	22.54	15.00	58.53	62.15	-3.62
		1992.5	25 / 0	43.28	21.28	15.00	58.28	62.15	-3.87
	16-QAM	1962.5	25 / 0	43.59	22.86	15.00	58.59	62.15	-3.56
	64-QAM	1962.5	25 / 0	43.60	22.91	15.00	58.60	62.15	-3.55
	256-QAM	1962.5	25 / 0	43.55	22.65	15.00	58.55	62.15	-3.60
3 MHz	QPSK	1931.5	15 / 0	42.97	19.82	15.00	57.97	62.15	-4.18
		1962.5	15 / 0	43.53	22.54	15.00	58.53	62.15	-3.62
		1993.5	15 / 0	43.07	20.28	15.00	58.07	62.15	-4.08
	16-QAM	1962.5	15 / 0	43.52	22.49	15.00	58.52	62.15	-3.63
	64-QAM	1962.5	15 / 0	43.57	22.75	15.00	58.57	62.15	-3.58
	256-QAM	1962.5	15 / 0	43.61	22.96	15.00	58.61	62.15	-3.54
1.4 MHz	QPSK	1930.7	6 / 0	42.90	19.50	15.00	57.90	62.15	-4.25
		1962.5	6 / 0	43.58	22.80	15.00	58.58	62.15	-3.57
		1994.3	6 / 0	42.96	19.77	15.00	57.96	62.15	-4.19
	16-QAM	1962.5	6 / 0	43.47	22.23	15.00	58.47	62.15	-3.68
	64-QAM	1962.5	6 / 0	43.49	22.34	15.00	58.49	62.15	-3.66
	256-QAM	1962.5	6 / 0	43.52	22.49	15.00	58.52	62.15	-3.63

Table 7-2. Transmitter Conducted Output Power / Effective Radiated Power (LTE Band 25/2)

Note:

The EIRP limit (dBm/MHz) was compared to the full channel BW power (dBm). The full channel BW measurement is expected to be higher than the 1MHz BW measurement so this data represents a worst-case condition.

7.3 Occupied Bandwidth

Test Overview

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. All modes of operation were investigated and the worst case configuration results are reported in this section.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 4.2

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

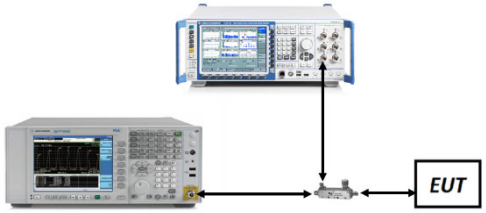
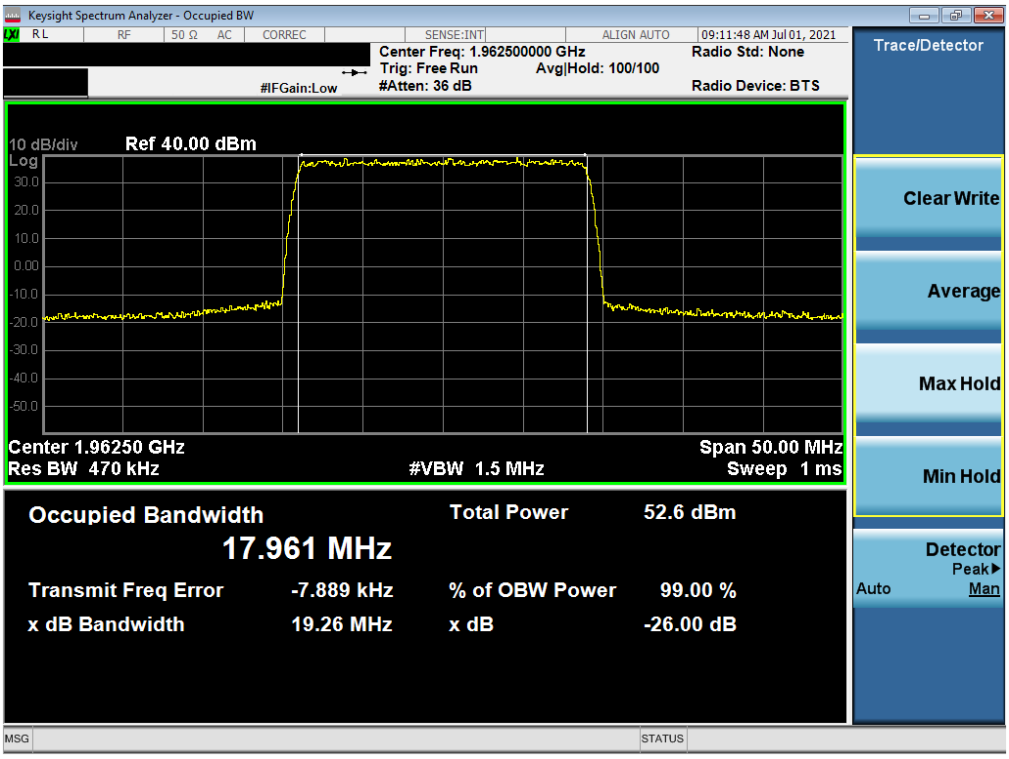


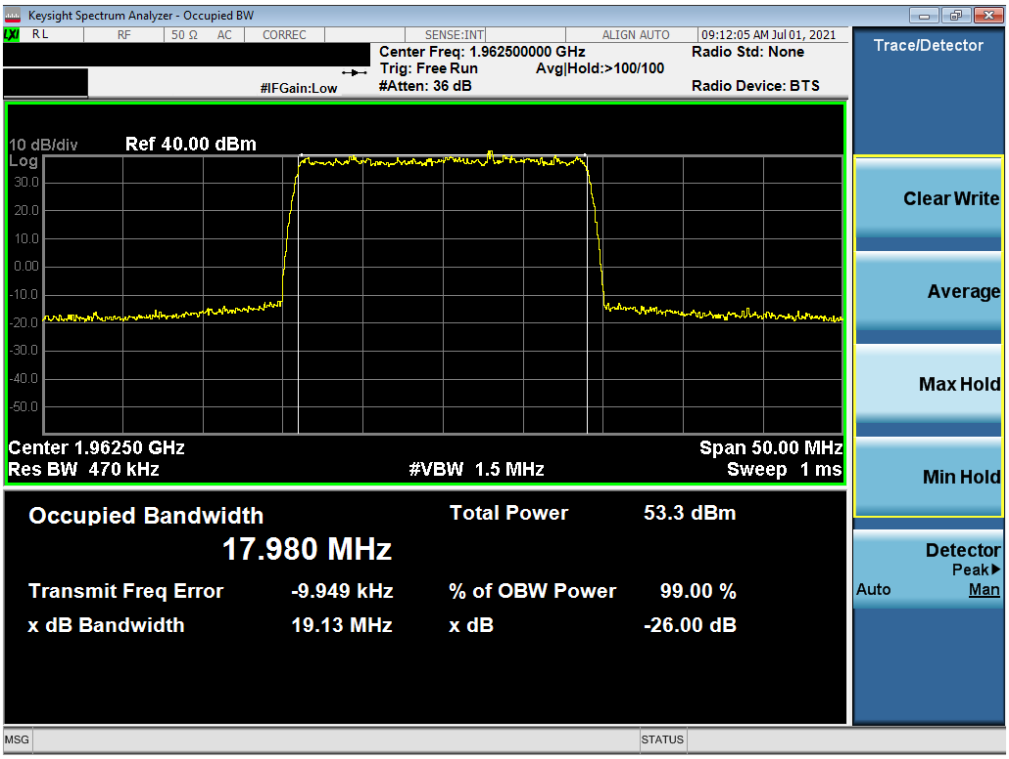
Figure 7-2. Test Instrument & Measurement Setup

Test Notes

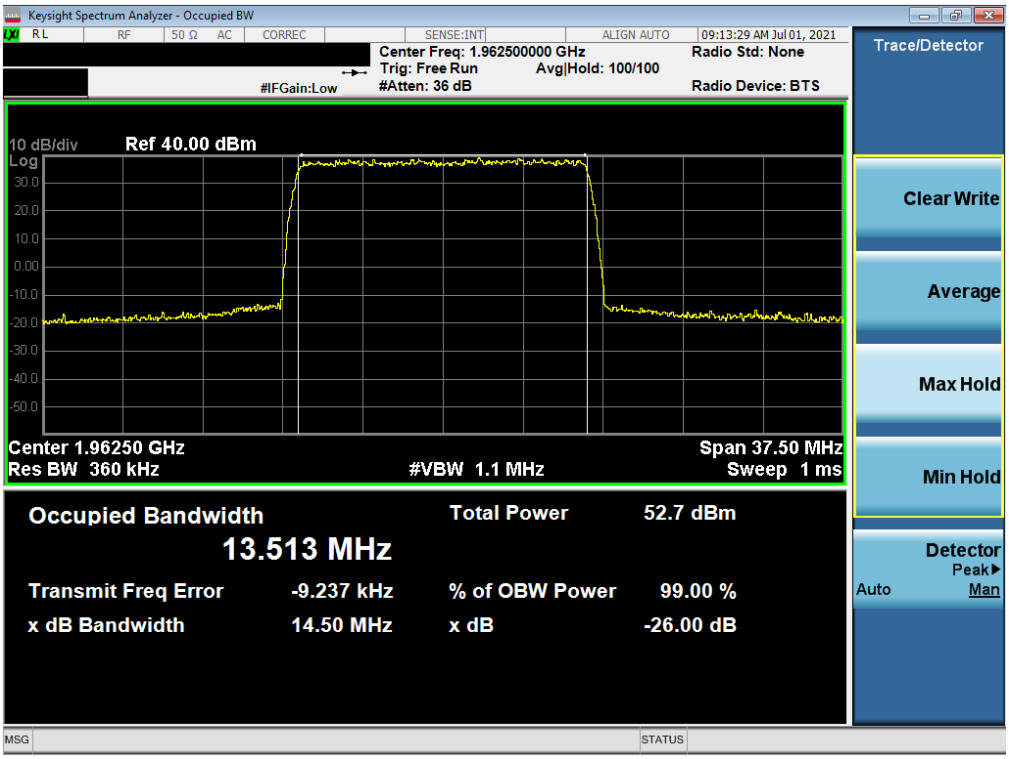
None.



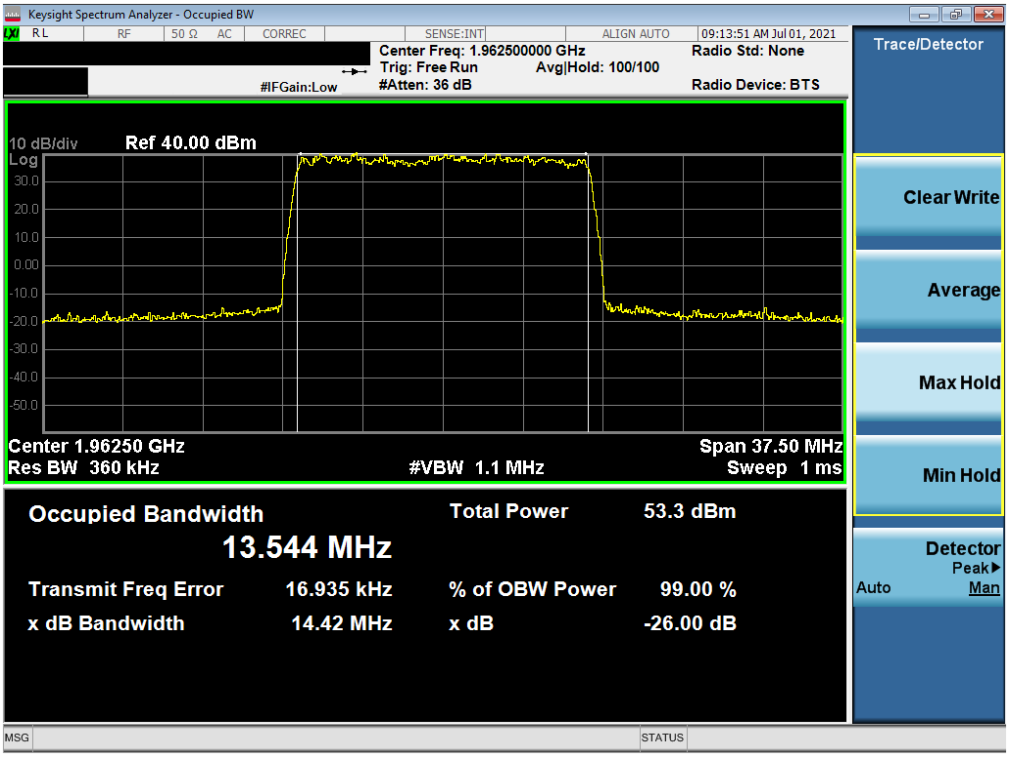
Plot 7-1. Occupied Bandwidth Plot (LTE Band 25/2 - 20MHz QPSK - Full RB)



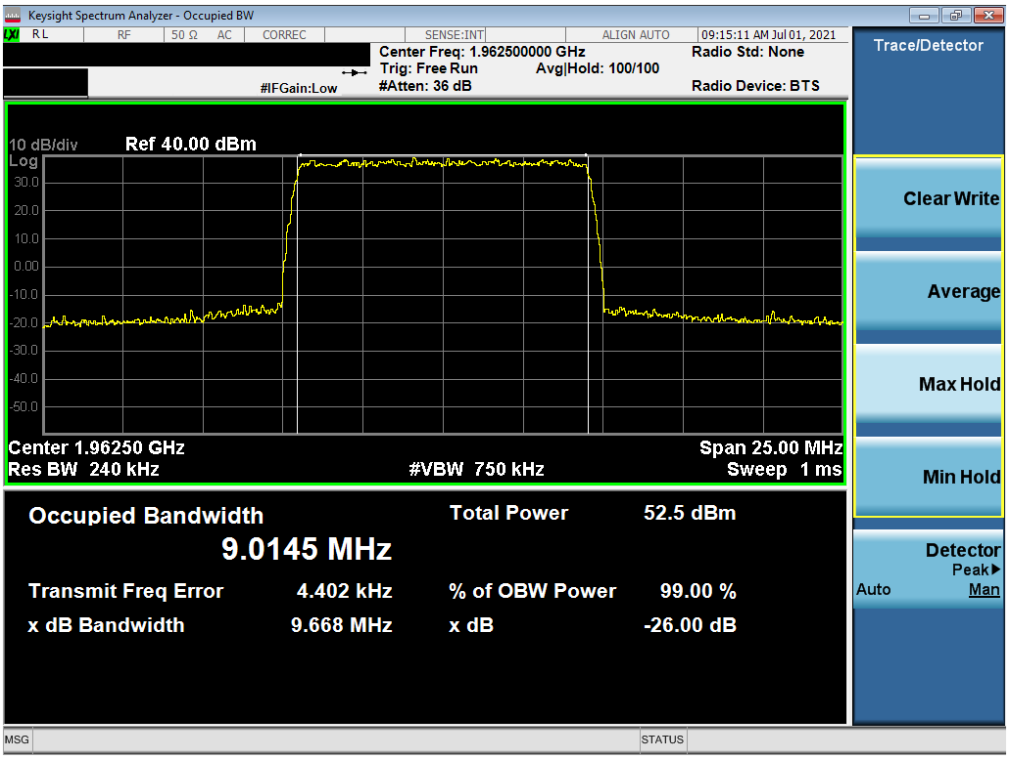
Plot 7-2. Occupied Bandwidth Plot (LTE Band 25/2 - 20MHz 16-QAM - Full RB)



Plot 7-3. Occupied Bandwidth Plot (LTE Band 25/2 - 15MHz QPSK - Full RB)

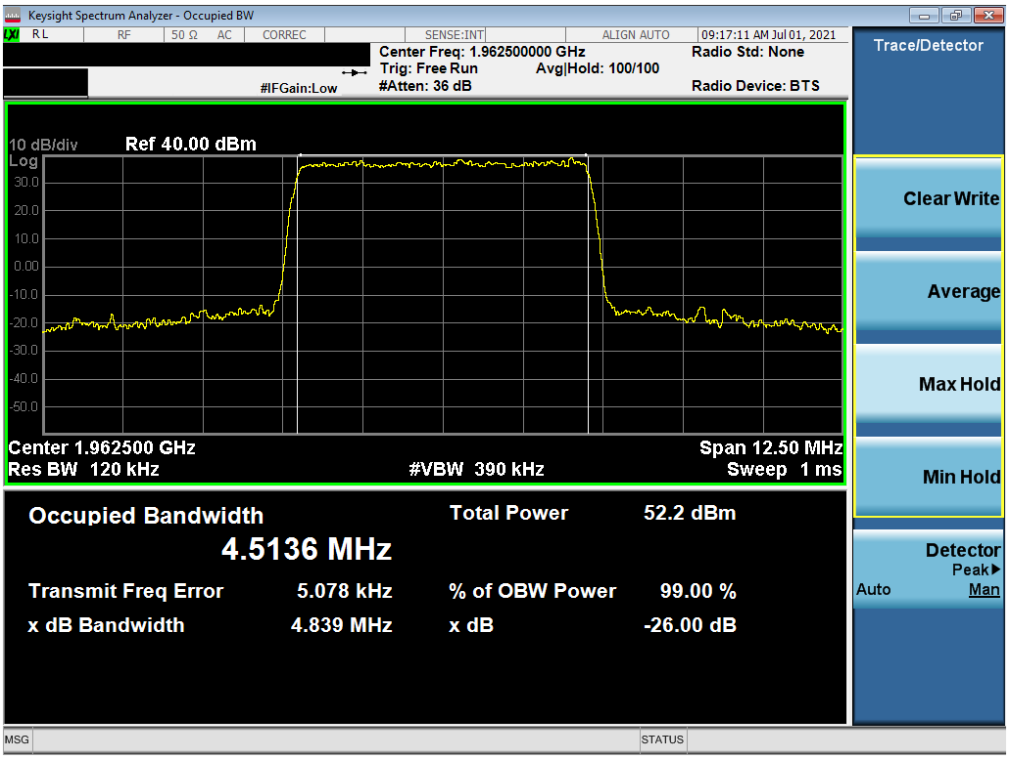


Plot 7-4. Occupied Bandwidth Plot (LTE Band 25/2 - 15MHz 16-QAM - Full RB)

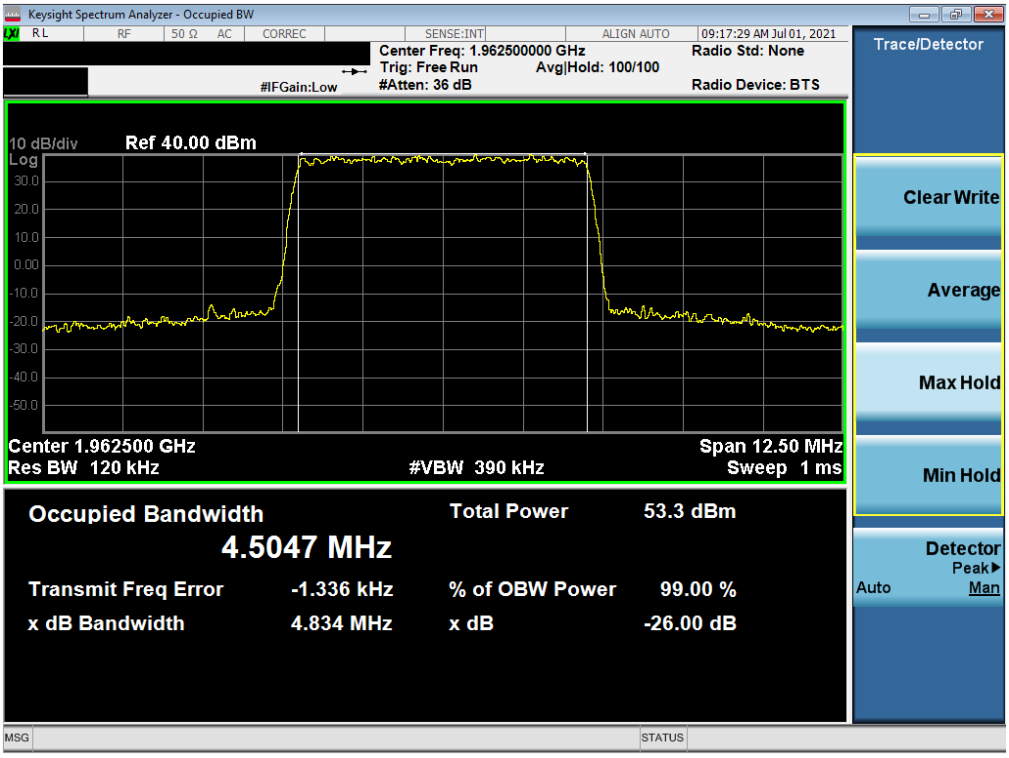


Plot 7-5. Occupied Bandwidth Plot (LTE Band 25/2 - 10MHz QPSK - Full RB)

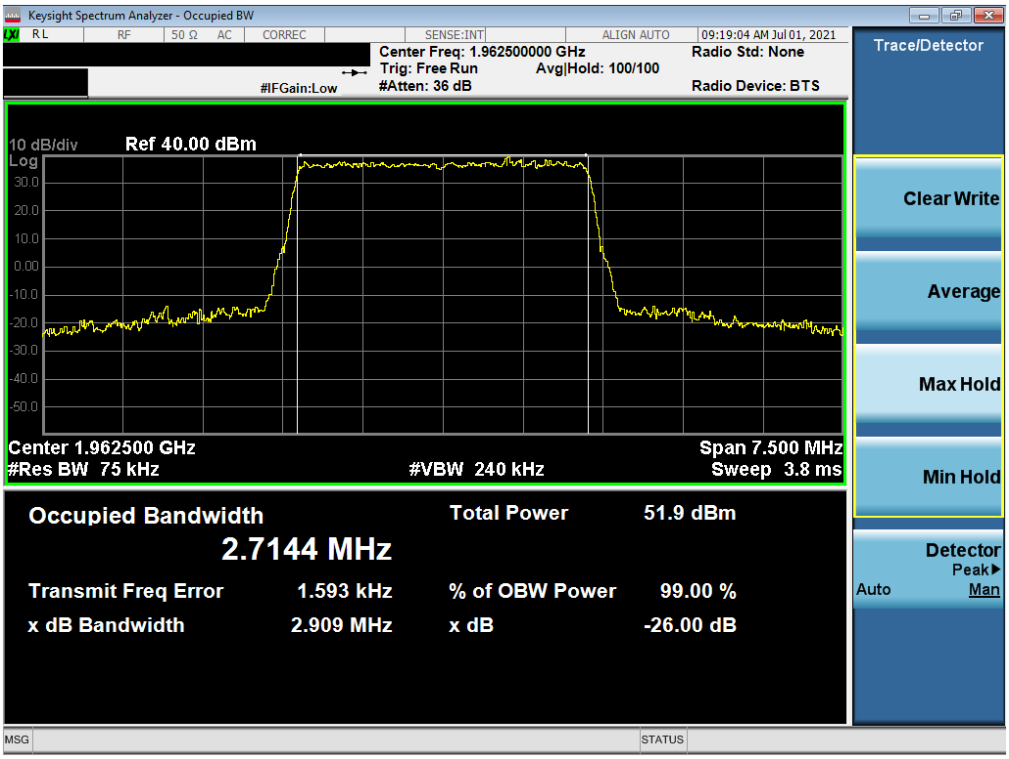
Plot 7-6. Occupied Bandwidth Plot (LTE Band 25/2 - 10MHz 16-QAM - Full RB)



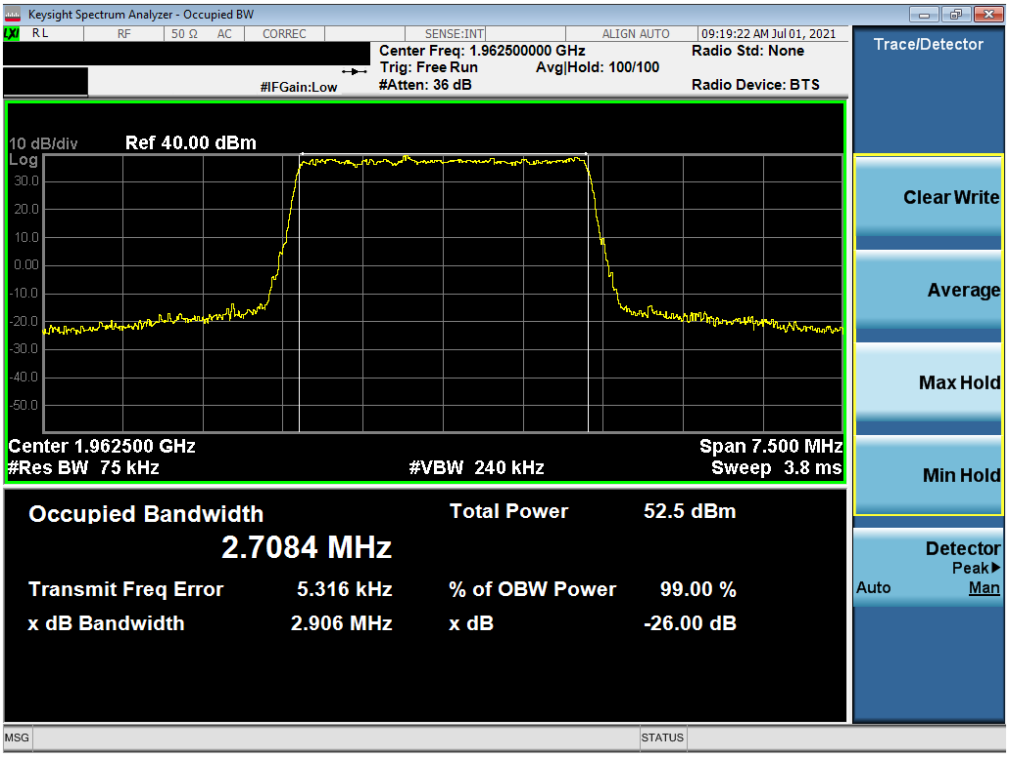
Plot 7-7. Occupied Bandwidth Plot (LTE Band 25/2 - 5MHz QPSK - Full RB)



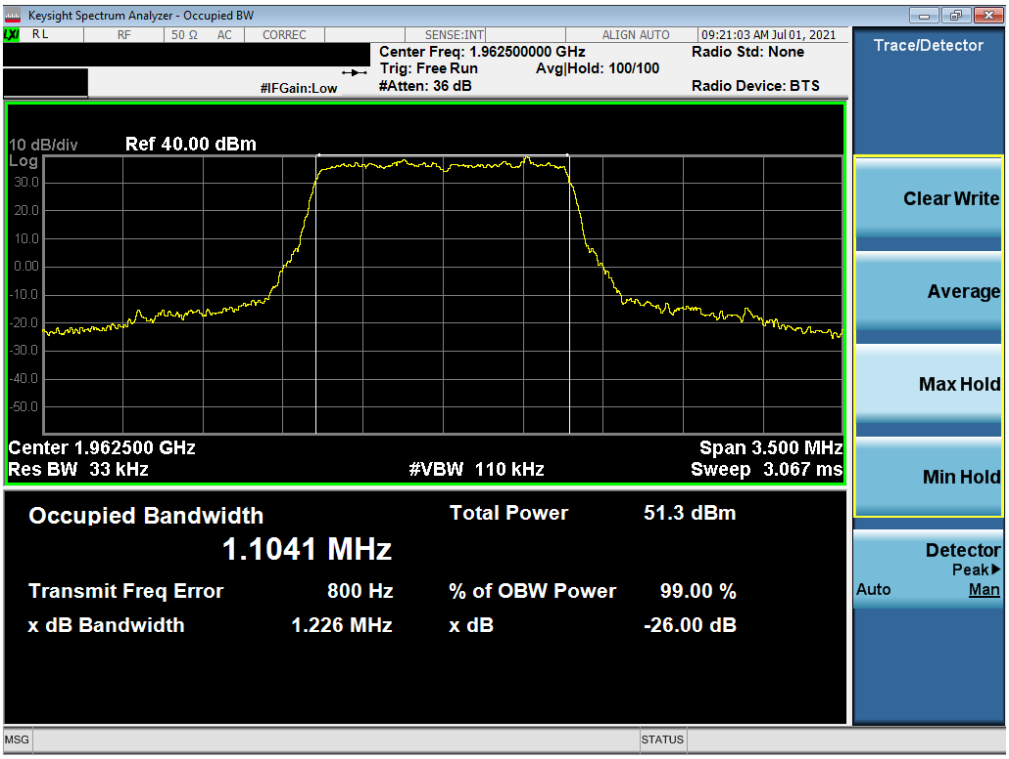
Plot 7-8. Occupied Bandwidth Plot (LTE Band 25/2 - 5MHz 16-QAM - Full RB)



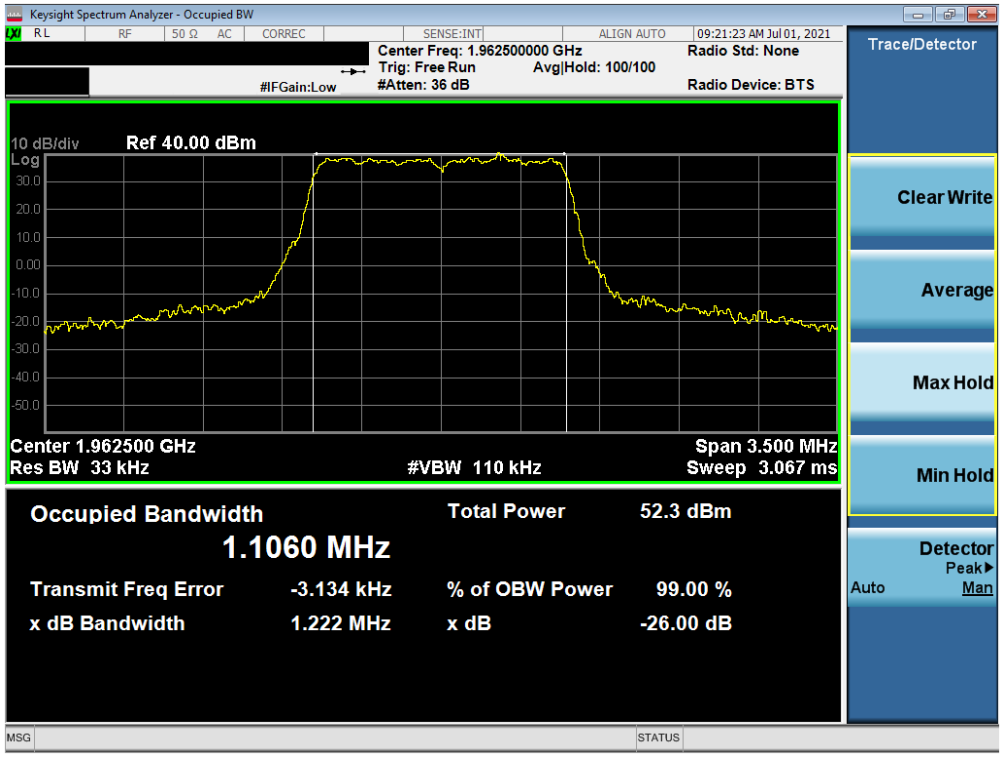
Plot 7-9. Occupied Bandwidth Plot (LTE Band 25/2 - 3MHz QPSK - Full RB)



Plot 7-10. Occupied Bandwidth Plot (LTE Band 25/2 - 3MHz 16-QAM - Full RB)



Plot 7-11. Occupied Bandwidth Plot (LTE Band 25/2 - 1.4MHz QPSK - Full RB)



Plot 7-12. Occupied Bandwidth Plot (LTE Band 25/2 - 1.4MHz 16-QAM - Full RB)

7.4 Spurious and Harmonic Emissions at Antenna Terminal

Test Overview

The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible attenuation level of any spurious emission is 43 + 10 $log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

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Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 20GHz (separated into at least two plots per channel)
2. Detector = RMS
3. Trace mode = trace average for continuous emissions, max hold for pulse emissions
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

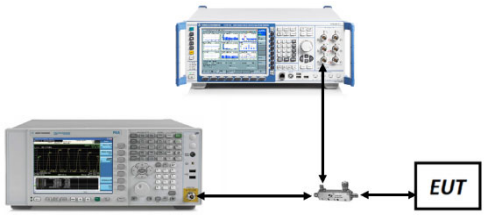
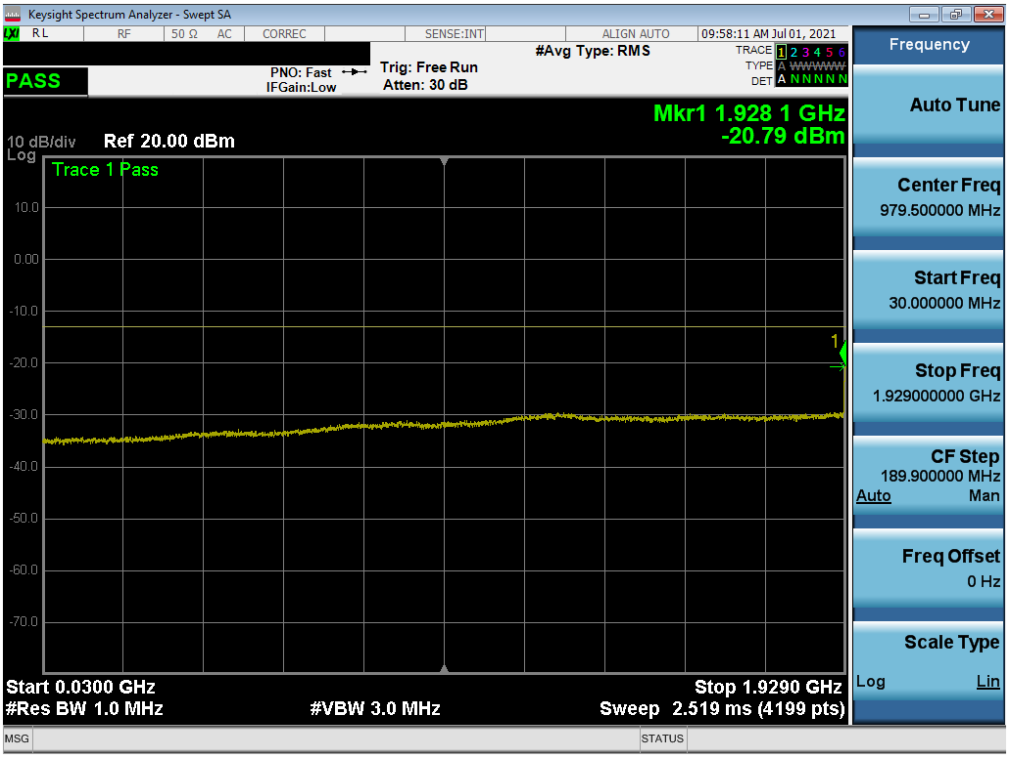


Figure 7-3. Test Instrument & Measurement Setup

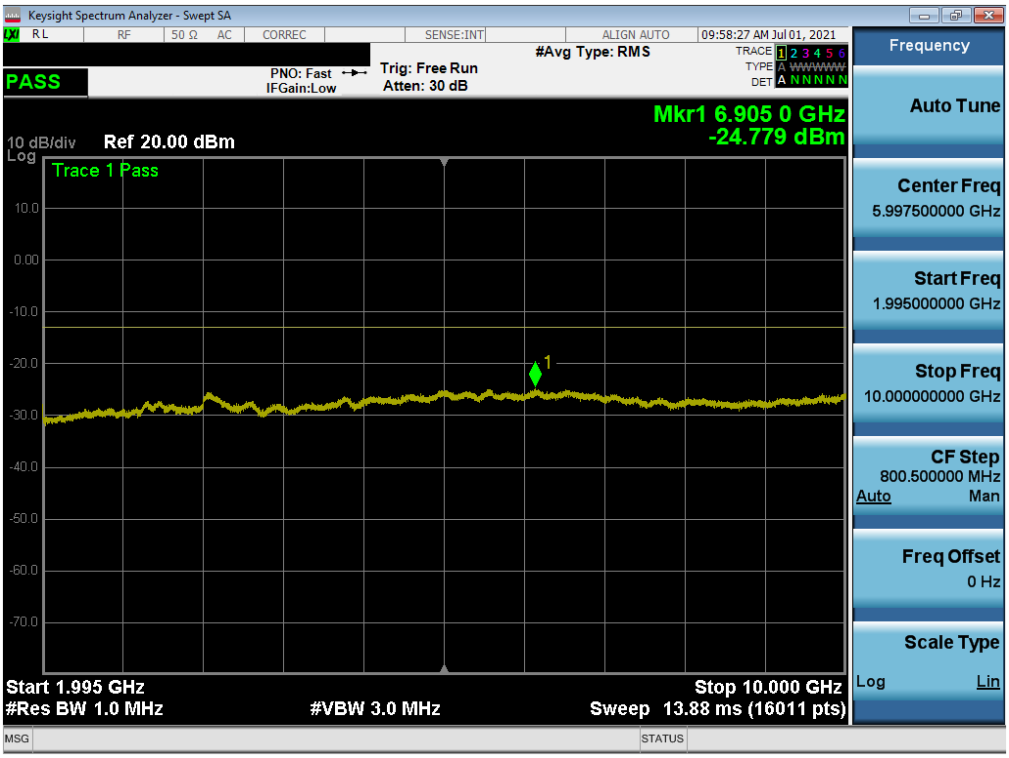
Test Notes

Per Part 24, compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth 100 kHz or greater for measurements below 1GHz. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The 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 emission are attenuated at least 26 dB below the transmitter power.

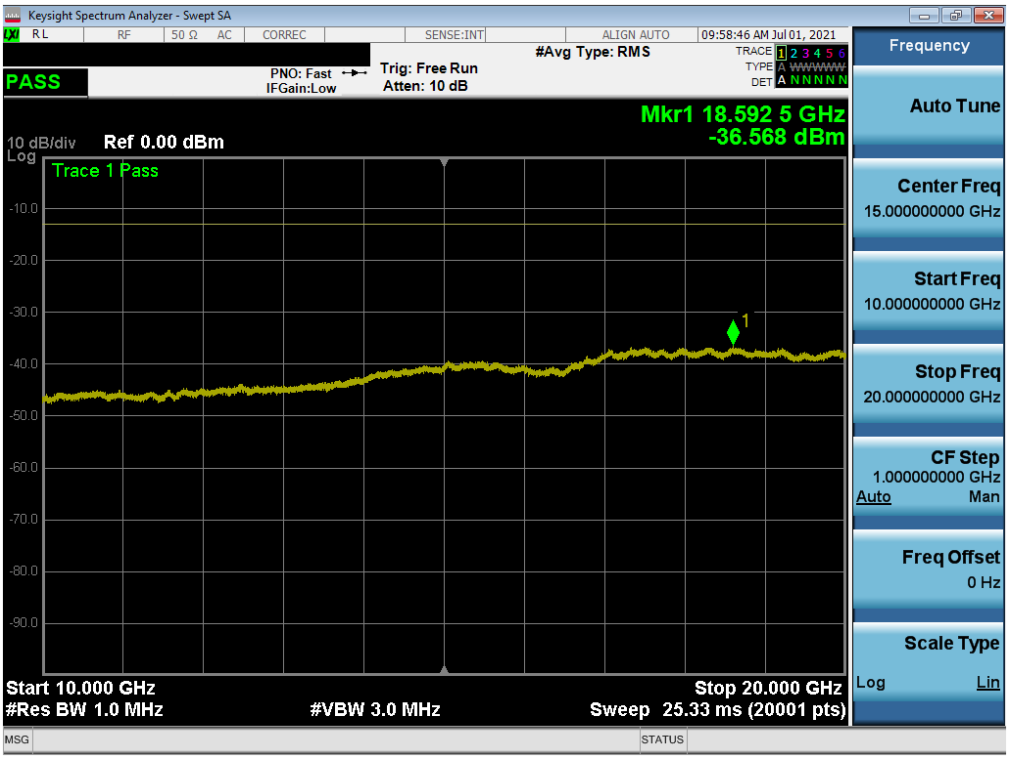
LTE Band 25/2



Plot 7-13. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - Low Channel)

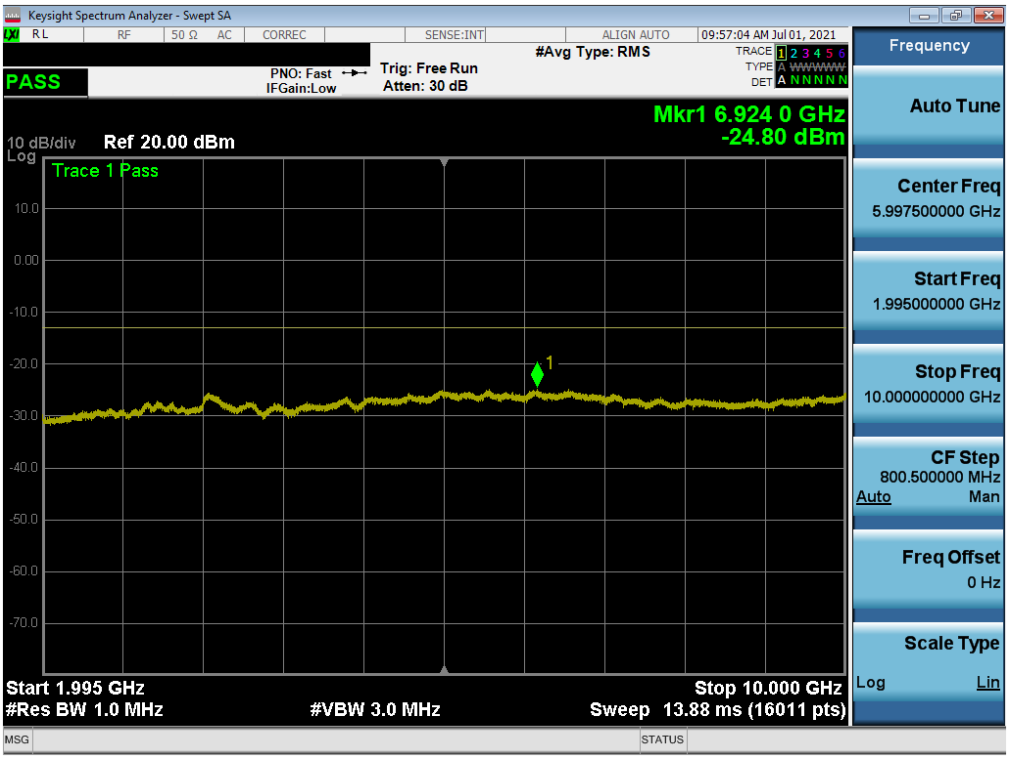


Plot 7-14. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - Low Channel)

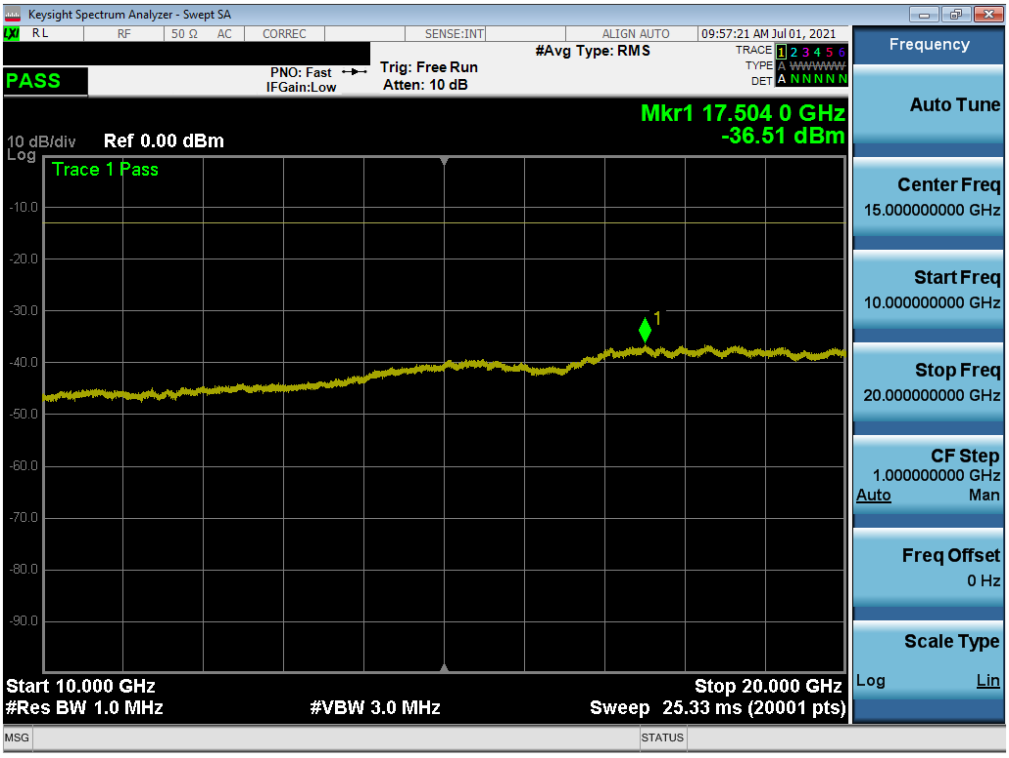


Plot 7-15. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - Low Channel)

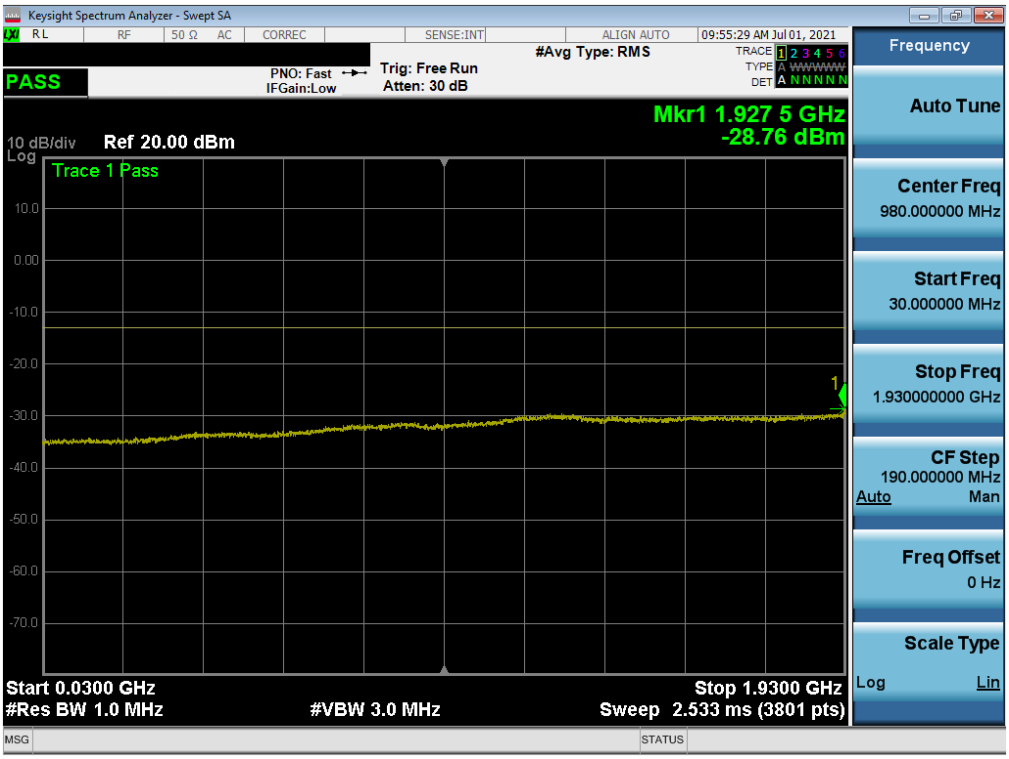
Plot 7-16. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - Mid Channel)



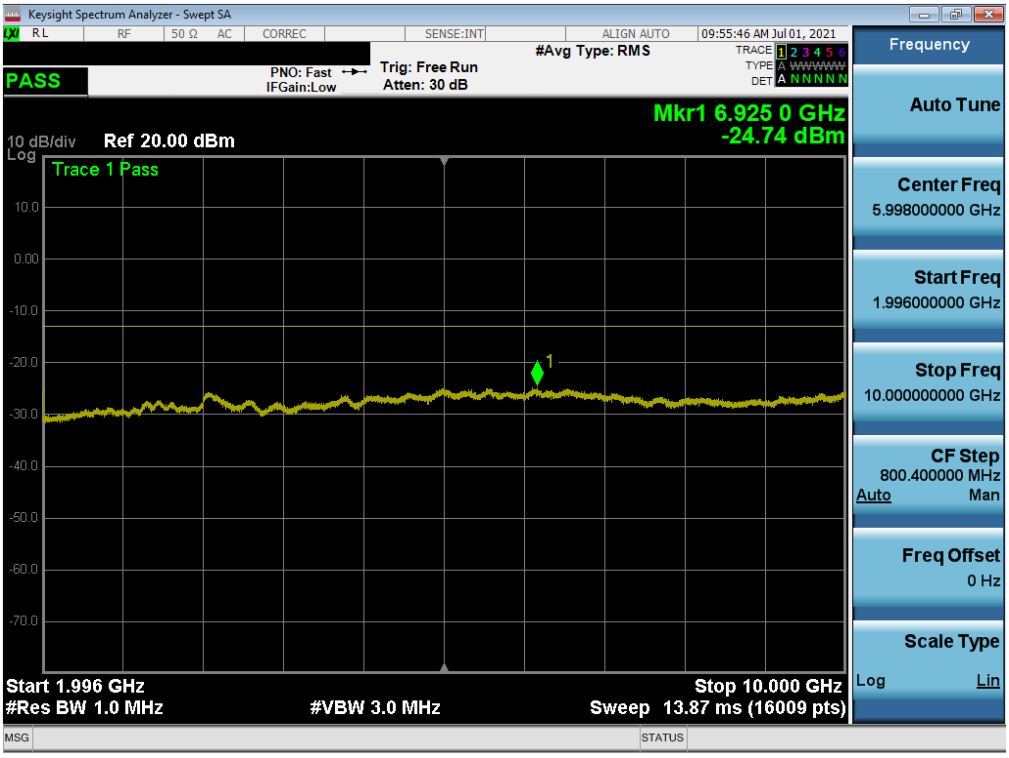
Plot 7-17. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - Mid Channel)



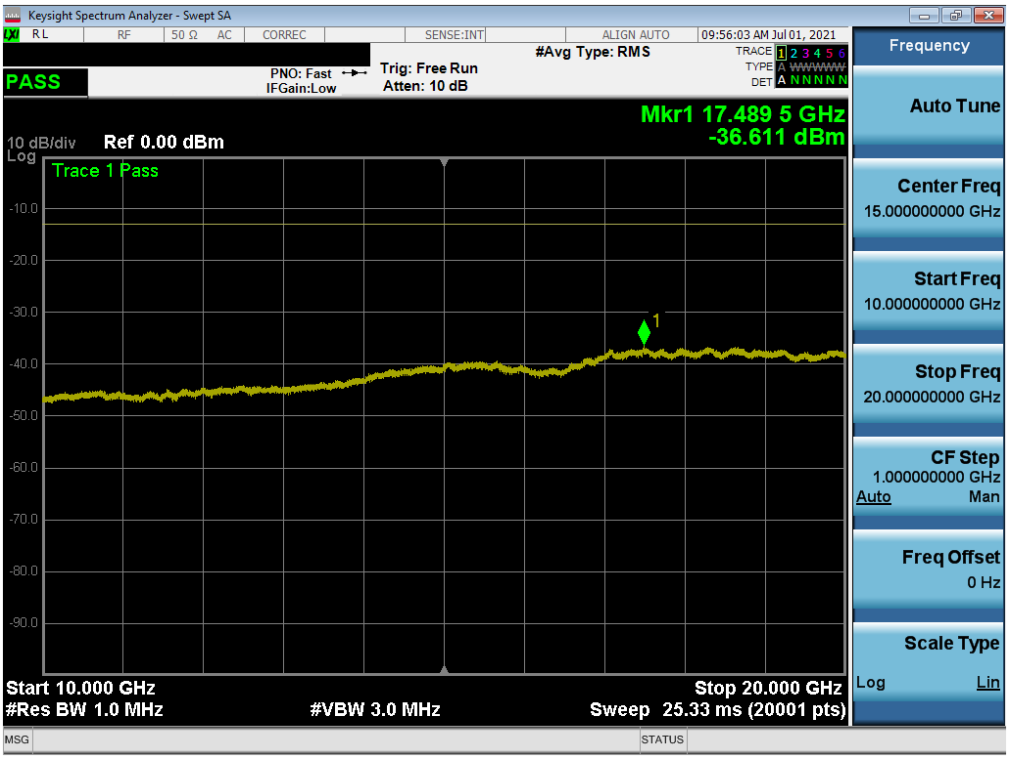
Plot 7-18. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - Mid Channel)



Plot 7-19. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - High Channel)



Plot 7-20. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - High Channel)



Plot 7-21. Conducted Spurious Plot (LTE Band 25/2 - 20MHz QPSK - 1RB - High Channel)

7.5 Band Edge Emissions at Antenna Terminal

Test Overview

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible attenuation level of any spurious emission is 43 + 10 $log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

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Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW ≥ 1% of the emission bandwidth
4. VBW ≥ 3 x RBW
5. Detector = RMS
6. Number of sweep points ≥ 2 x Span/RBW
7. Trace mode = trace average for continuous emissions, max hold for pulse emissions
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

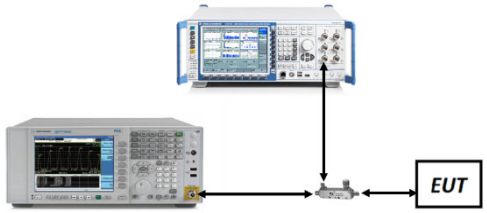


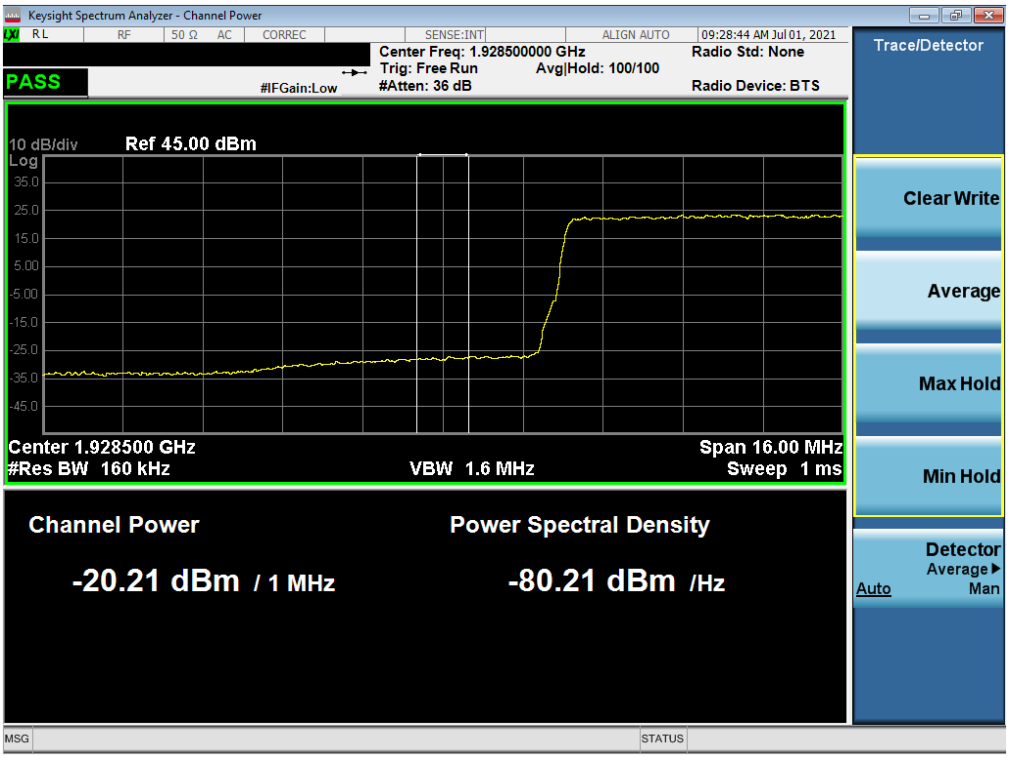
Figure 7-4. Test Instrument & Measurement Setup

Test Notes

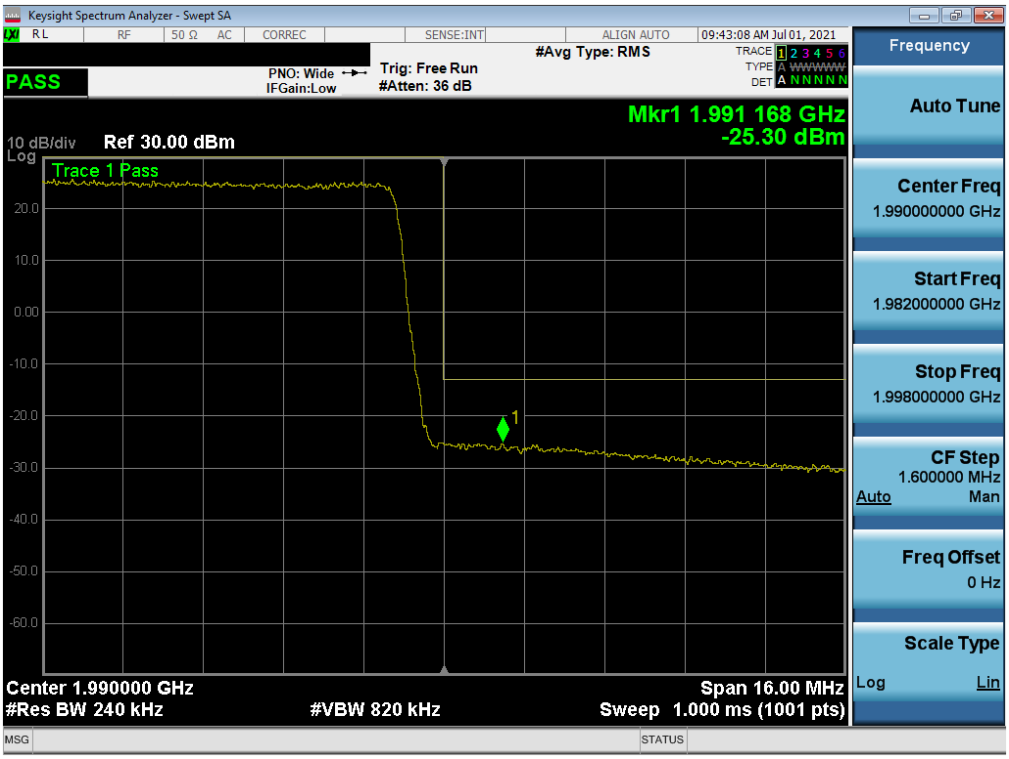
Per 24.238(a), in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed to demonstrate compliance with the out-of-band emissions limit. The emission 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 emission are attenuated at least 26 dB below the transmitter power.

LTE Band 25/2

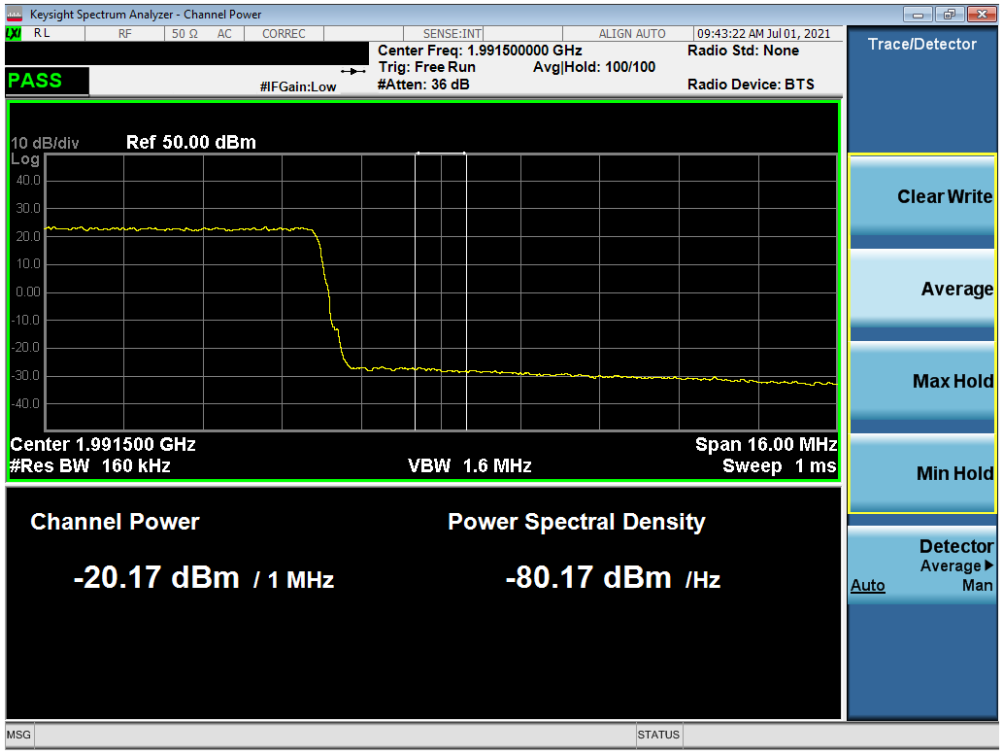
Plot 7-22. Lower Band Edge Plot (LTE Band 25/2 - 20MHz QPSK – Full RB)



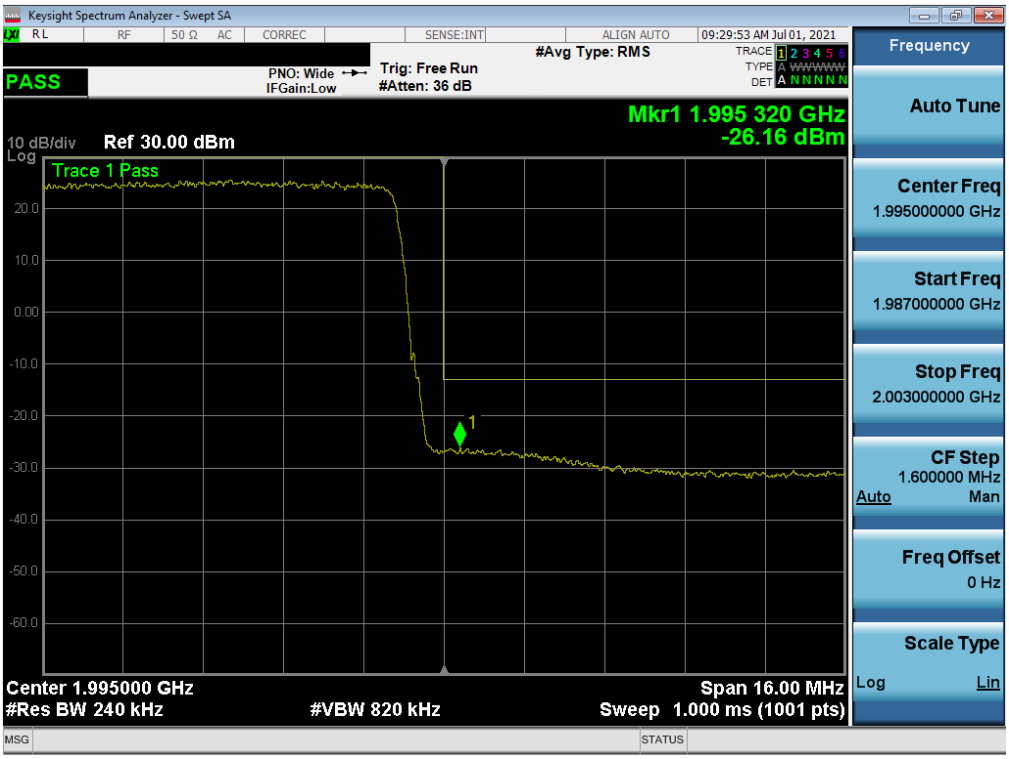
Plot 7-23. Extended Lower Band Edge Plot (LTE Band 25/2 - 20MHz QPSK – Full RB)



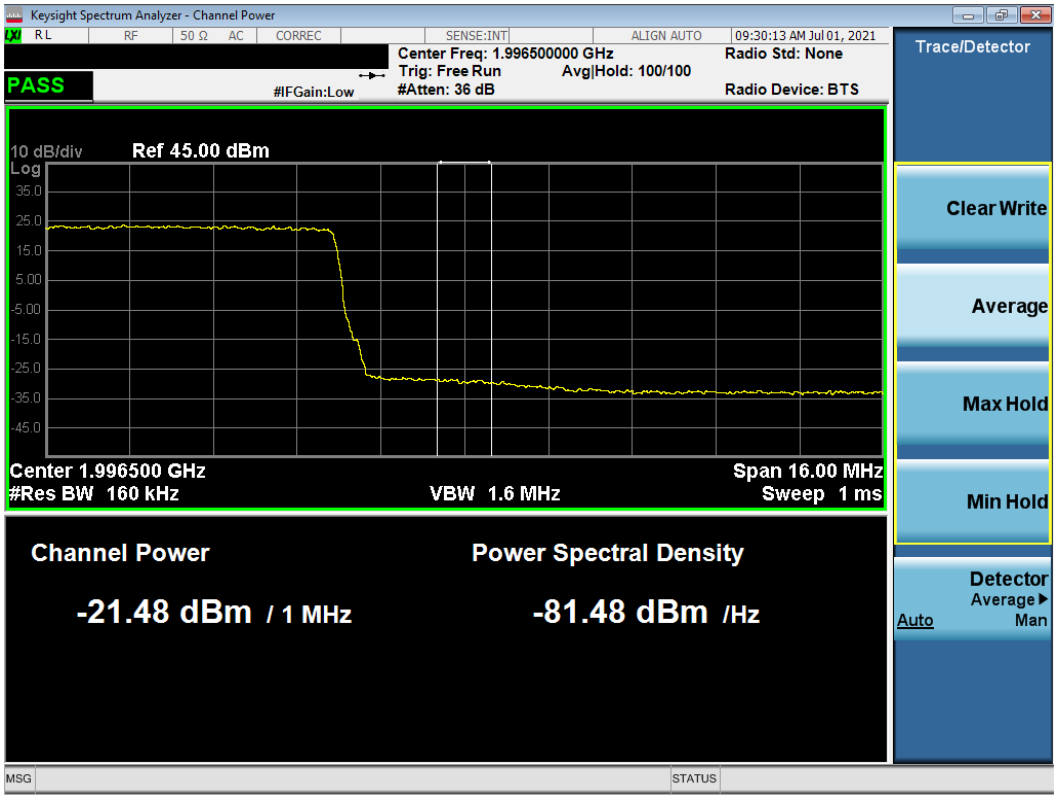
Plot 7-24. Upper Band Edge Plot (LTE Band 2 - 20MHz QPSK – Full RB)



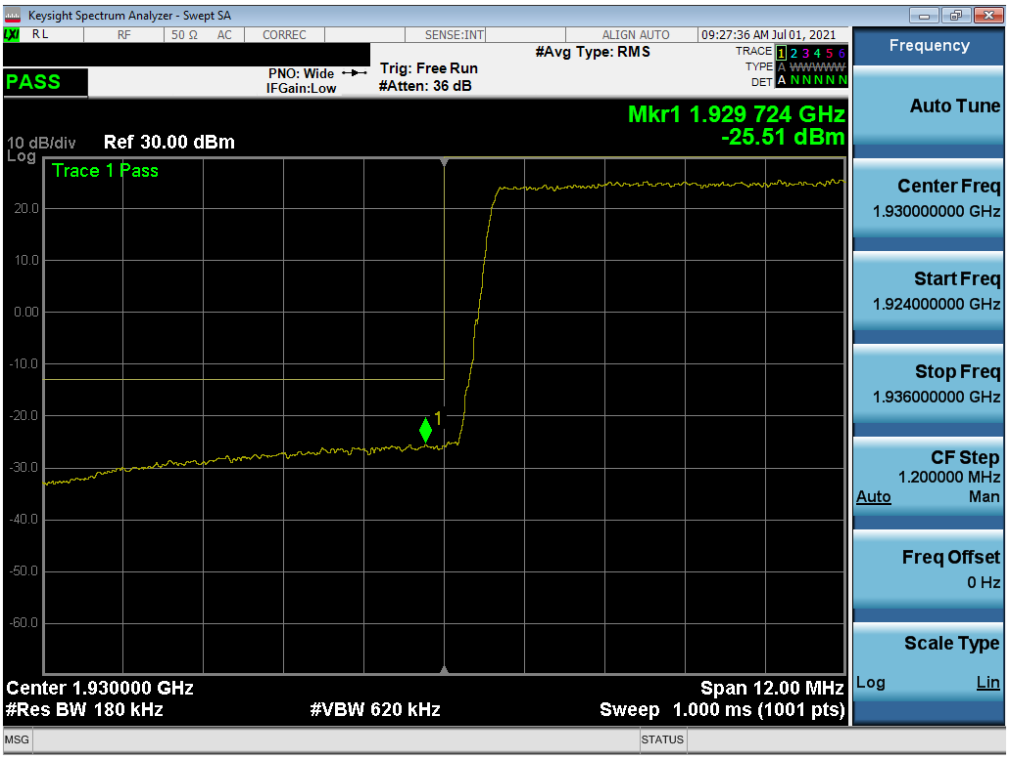
Plot 7-25. Extended Upper Band Edge Plot (LTE Band 2 - 20MHz QPSK – Full RB)



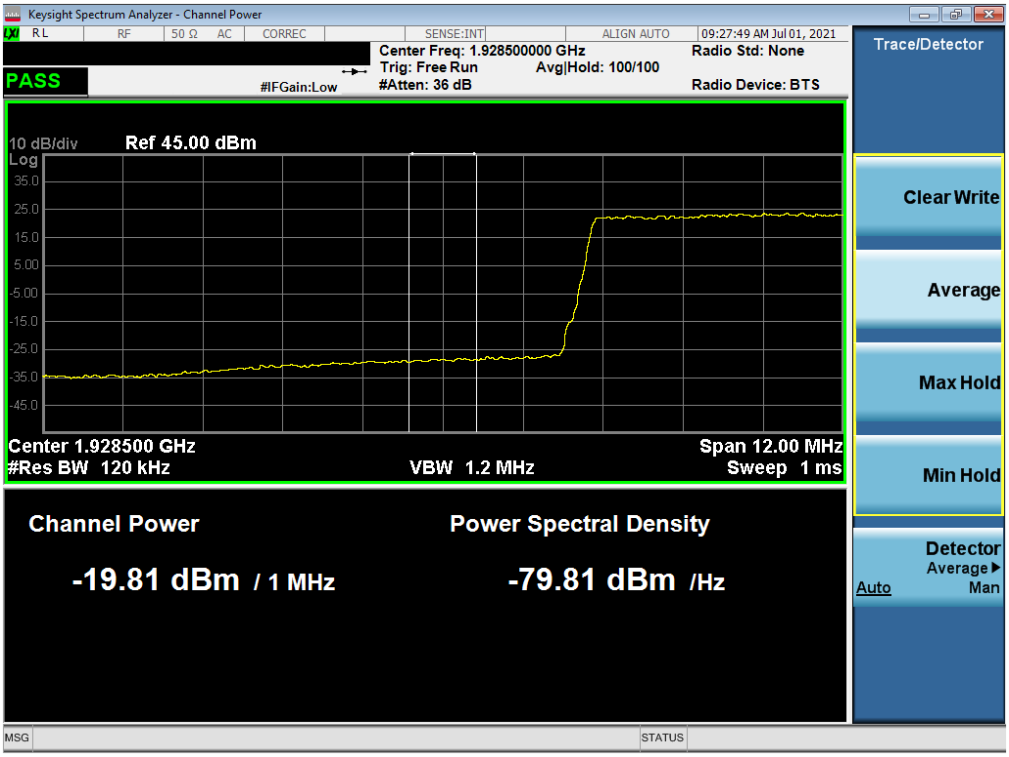
Plot 7-26. Upper Band Edge Plot (LTE Band 25 - 20MHz QPSK – Full RB)



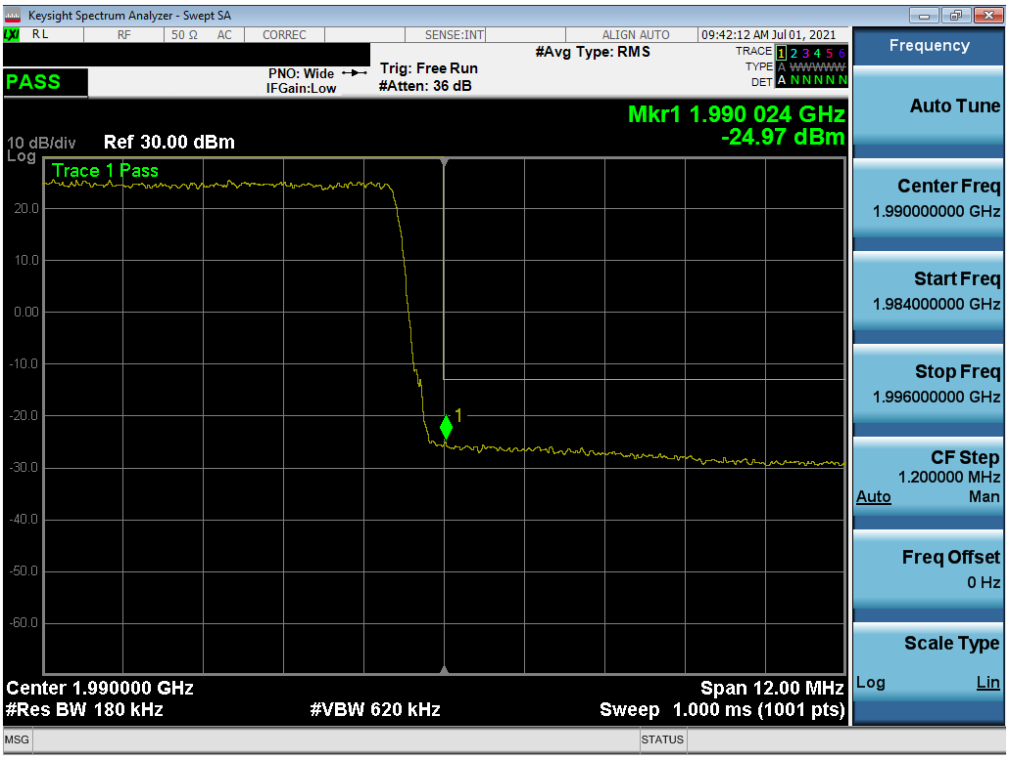
Plot 7-27. Extended Upper Band Edge Plot (LTE Band 25 - 20MHz QPSK – Full RB)



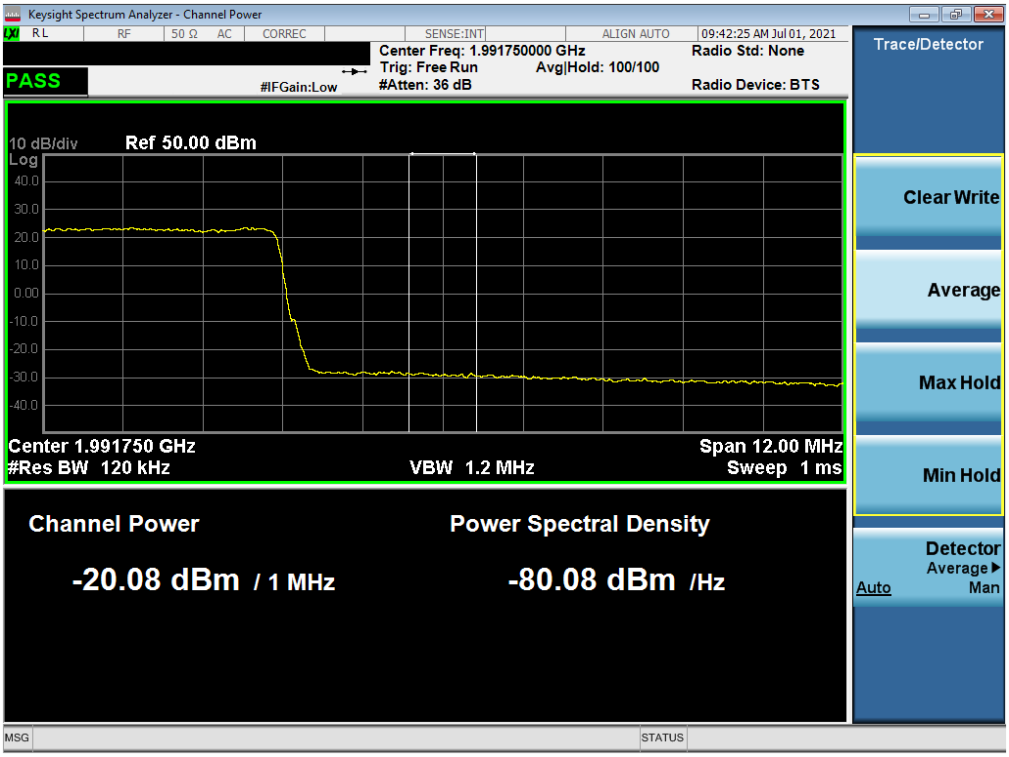
Plot 7-28. Lower Band Edge Plot (LTE Band 25/2 - 15MHz QPSK – Full RB)



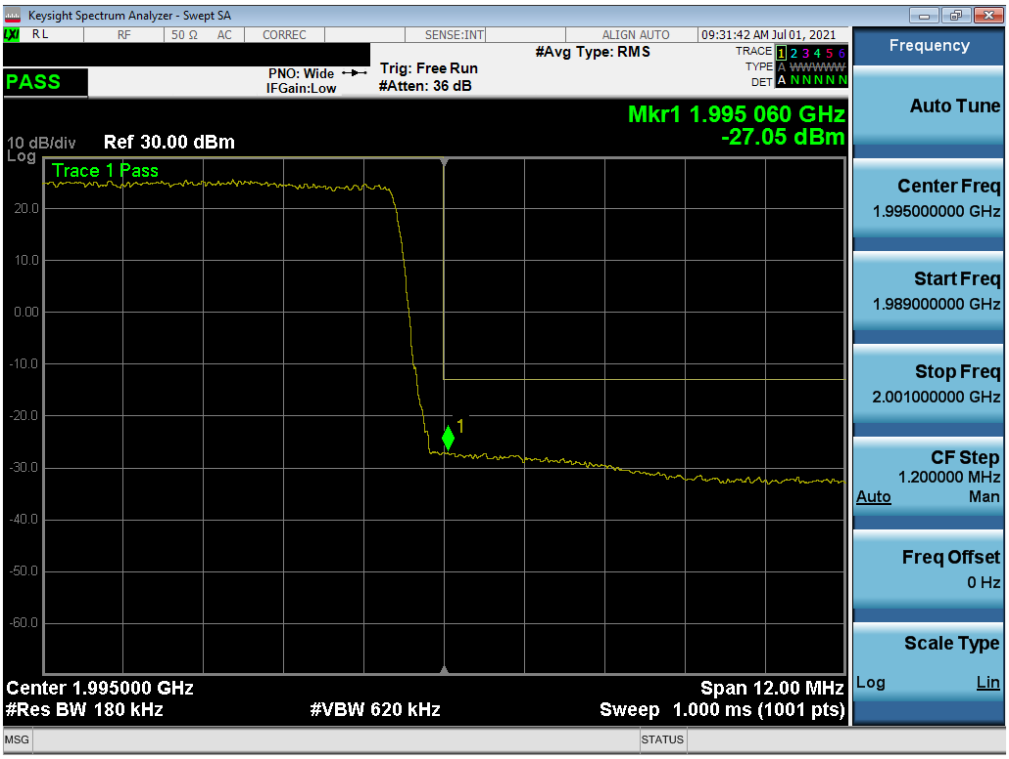
Plot 7-29. Extended Lower Band Edge Plot (LTE Band 25/2 - 15MHz QPSK – Full RB)



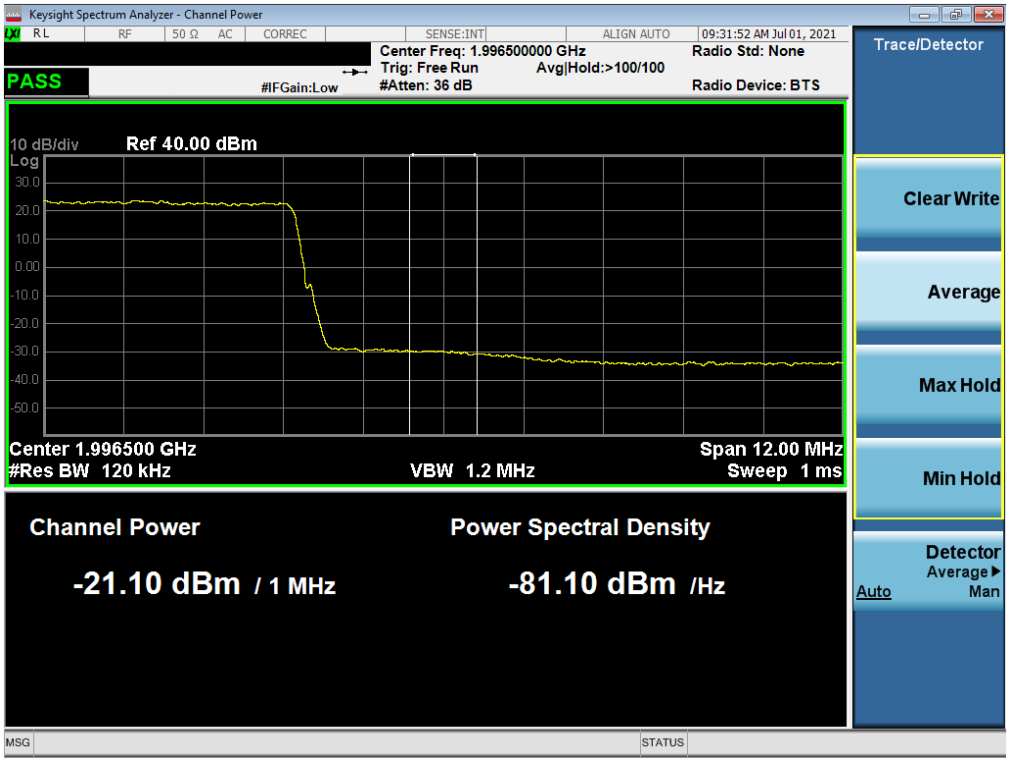
Plot 7-30. Upper Band Edge Plot (LTE Band 2 - 15MHz QPSK – Full RB)



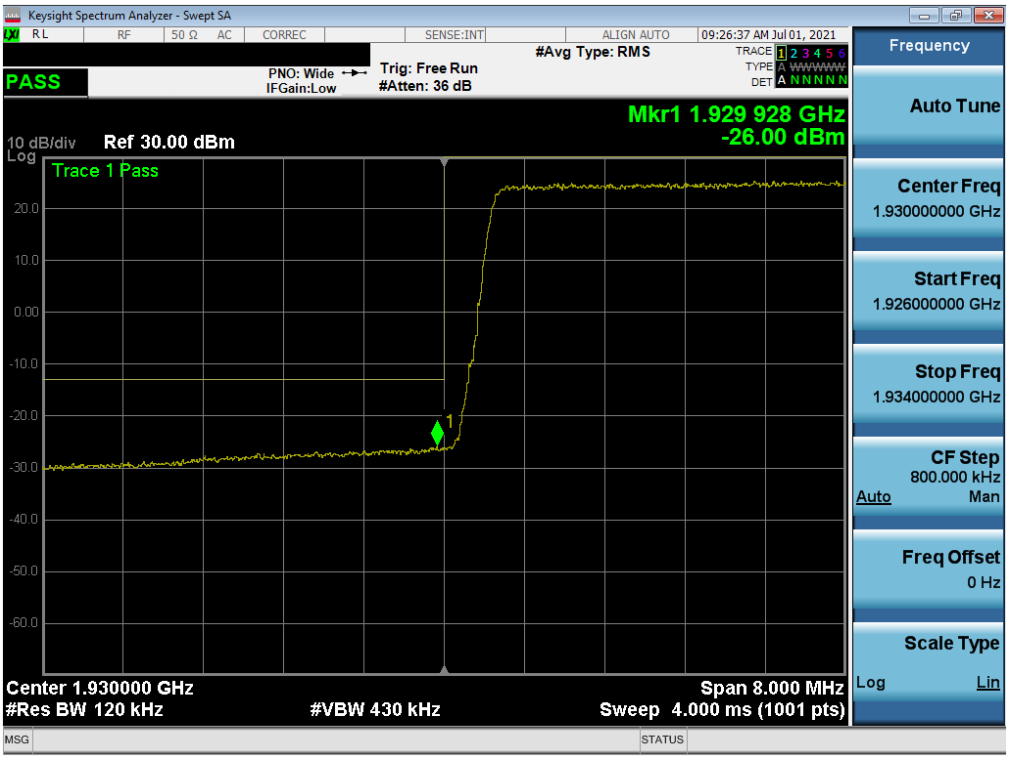
Plot 7-31. Extended Upper Band Edge Plot (LTE Band 2 - 15MHz QPSK – Full RB)



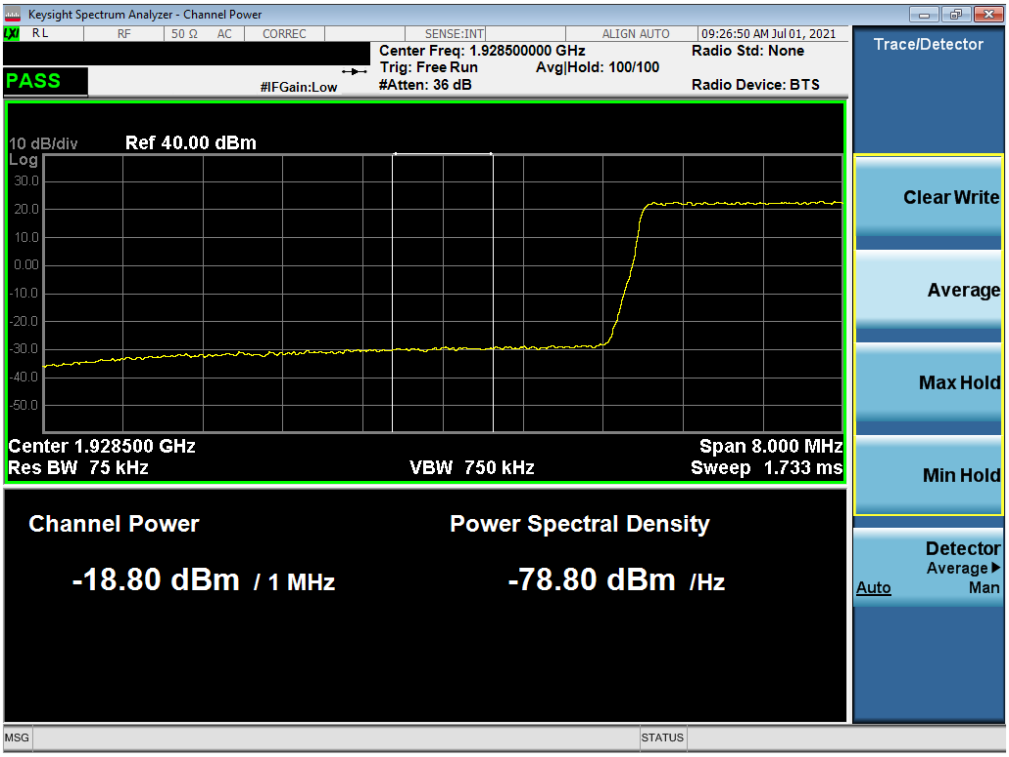
Plot 7-32. Upper Band Edge Plot (LTE Band 25 - 15MHz QPSK – Full RB)



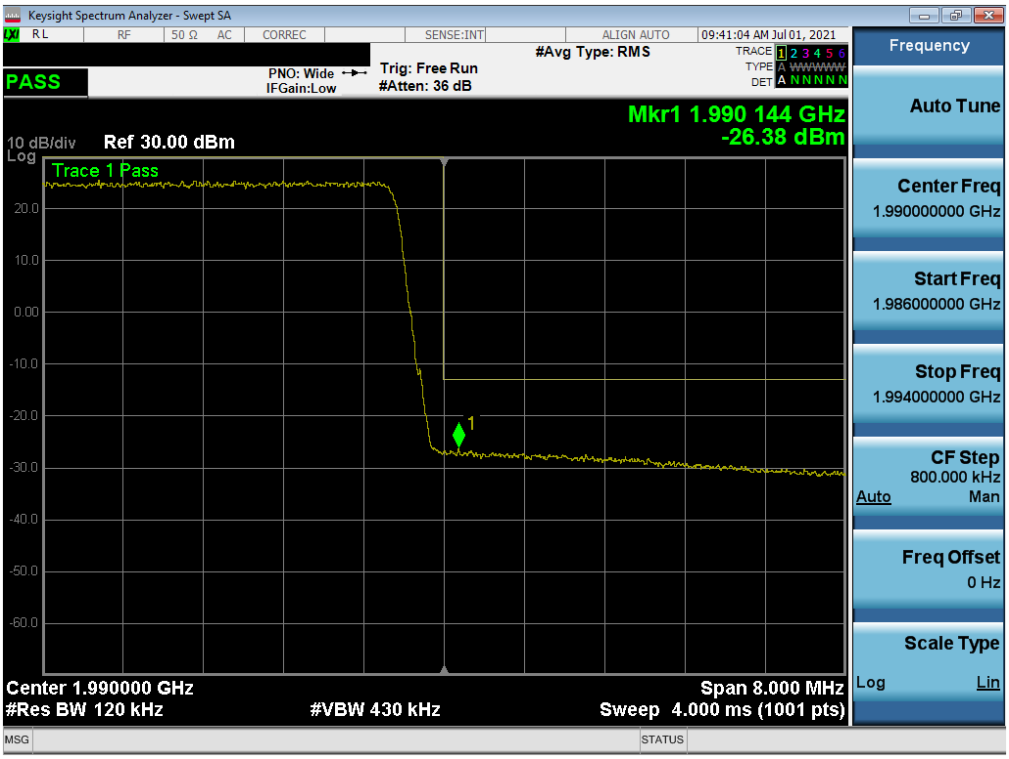
Plot 7-33. Extended Upper Band Edge Plot (LTE Band 25 - 15MHz QPSK – Full RB)



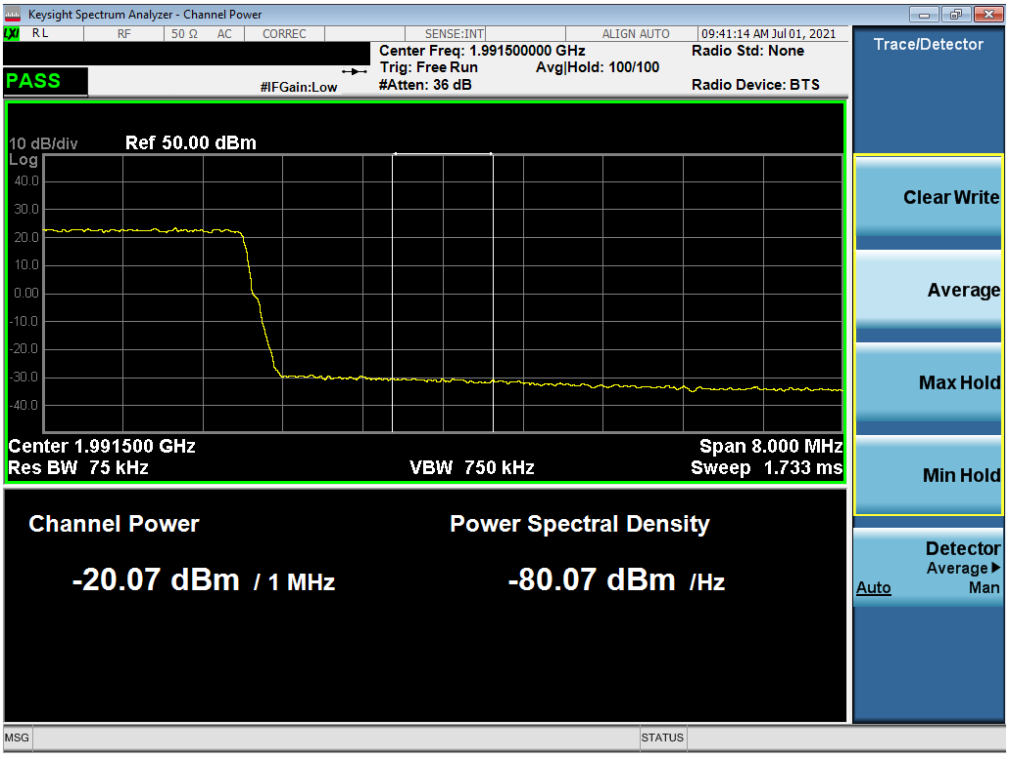
Plot 7-34. Lower Band Edge Plot (LTE Band 25/2 - 10MHz QPSK – Full RB)



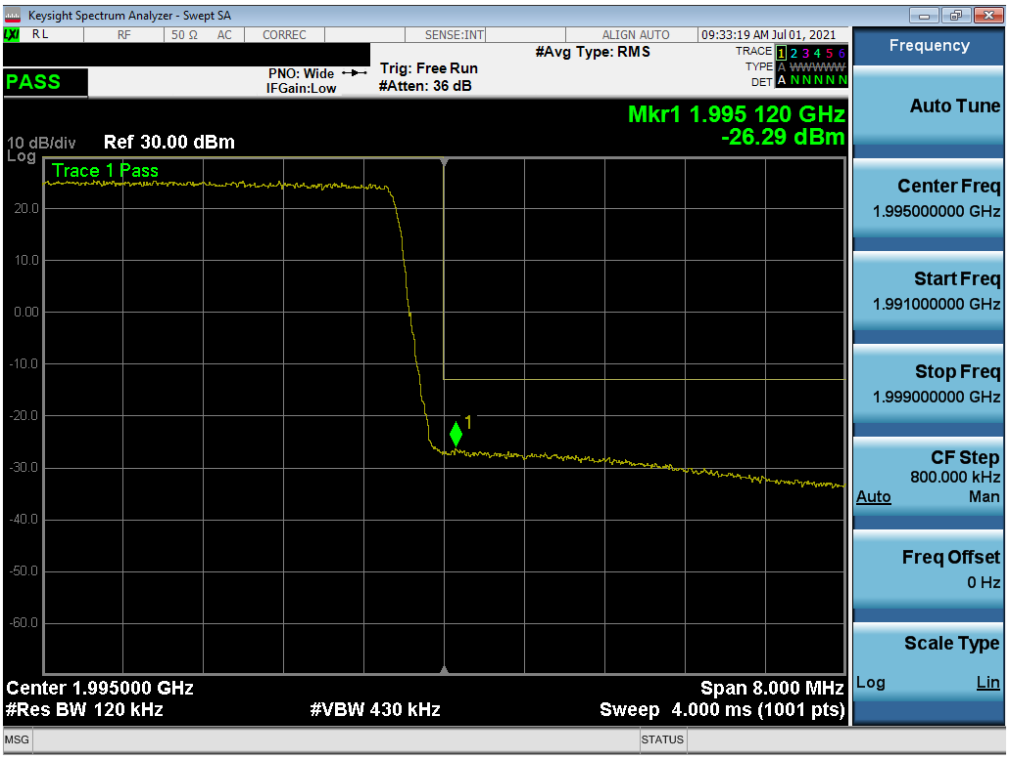
Plot 7-35. Extended Lower Band Edge Plot (LTE Band 25/2 - 10MHz QPSK – Full RB)



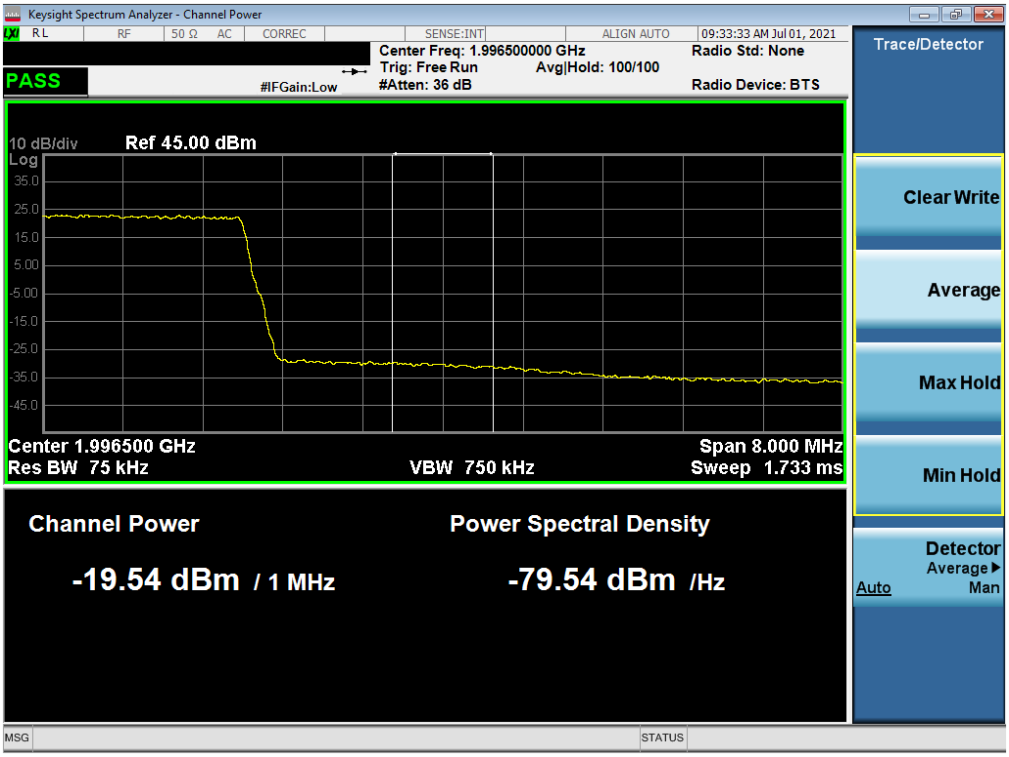
Plot 7-36. Upper Band Edge Plot (LTE Band 2 - 10MHz QPSK – Full RB)



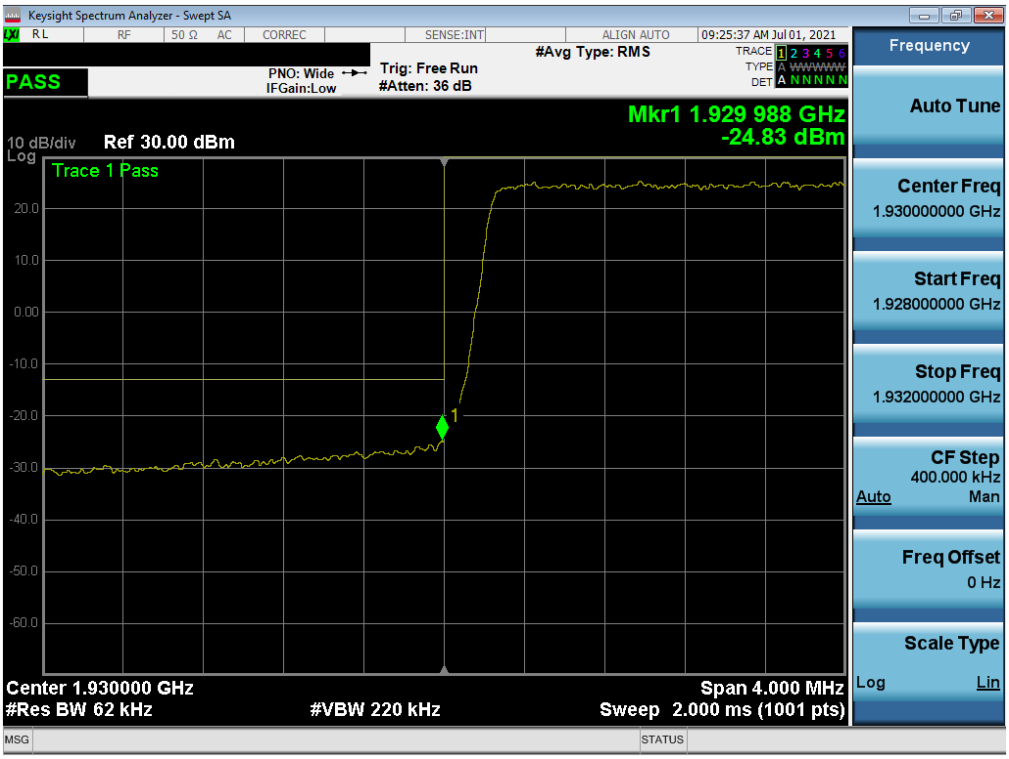
Plot 7-37. Extended Upper Band Edge Plot (LTE Band 2 - 10MHz QPSK – Full RB)



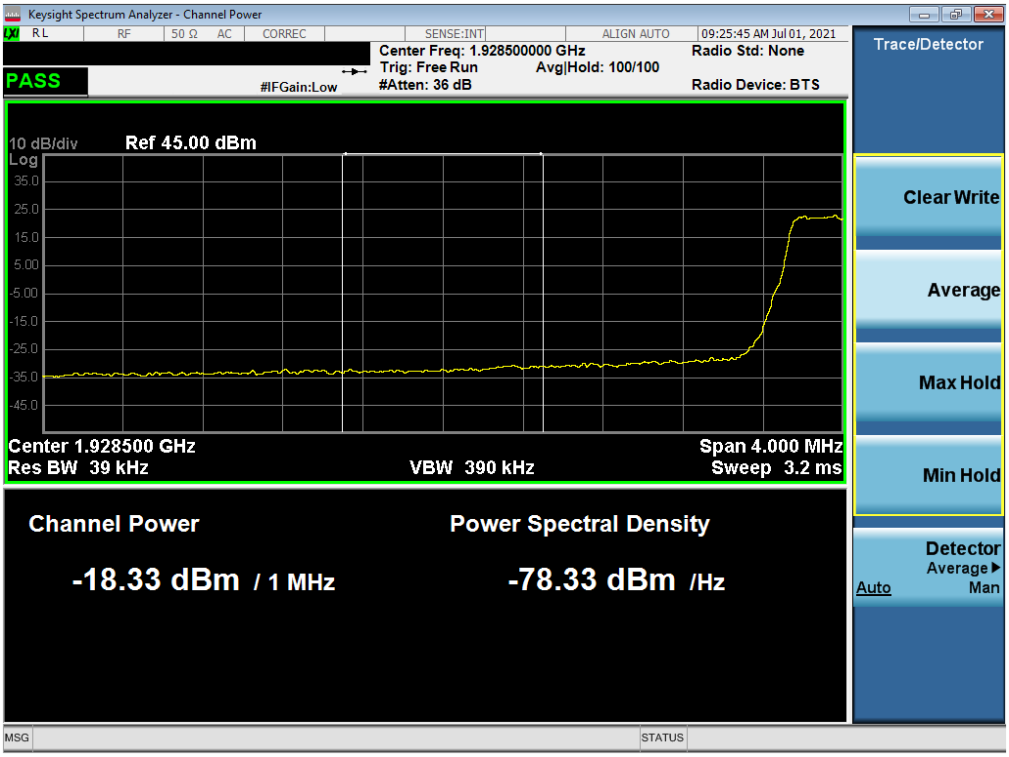
Plot 7-38. Upper Band Edge Plot (LTE Band 25 - 10MHz QPSK – Full RB)



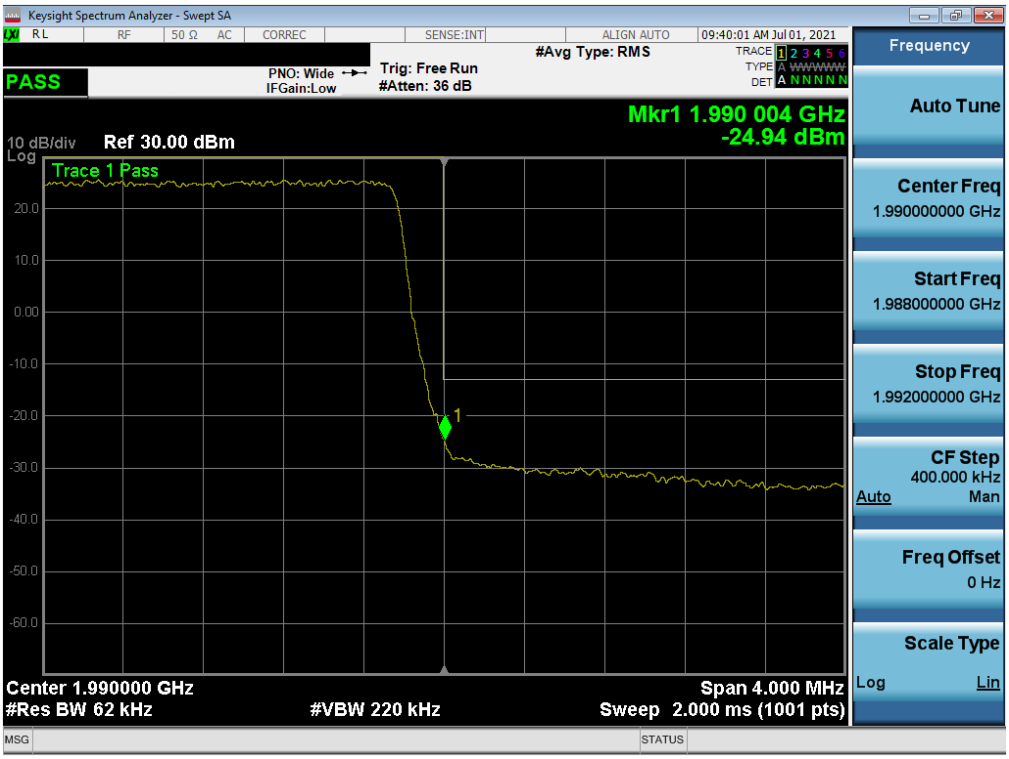
Plot 7-39. Extended Upper Band Edge Plot (LTE Band 25 - 10MHz QPSK – Full RB)



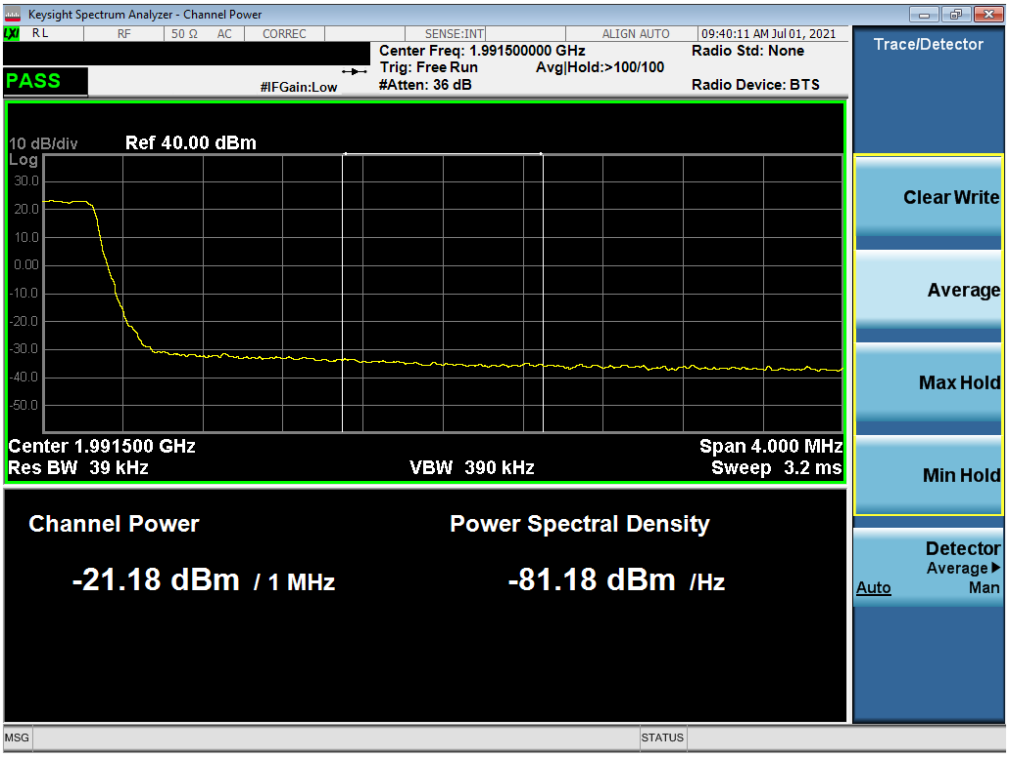
Plot 7-40. Lower Band Edge Plot (LTE Band 25/2 - 5MHz QPSK – Full RB)



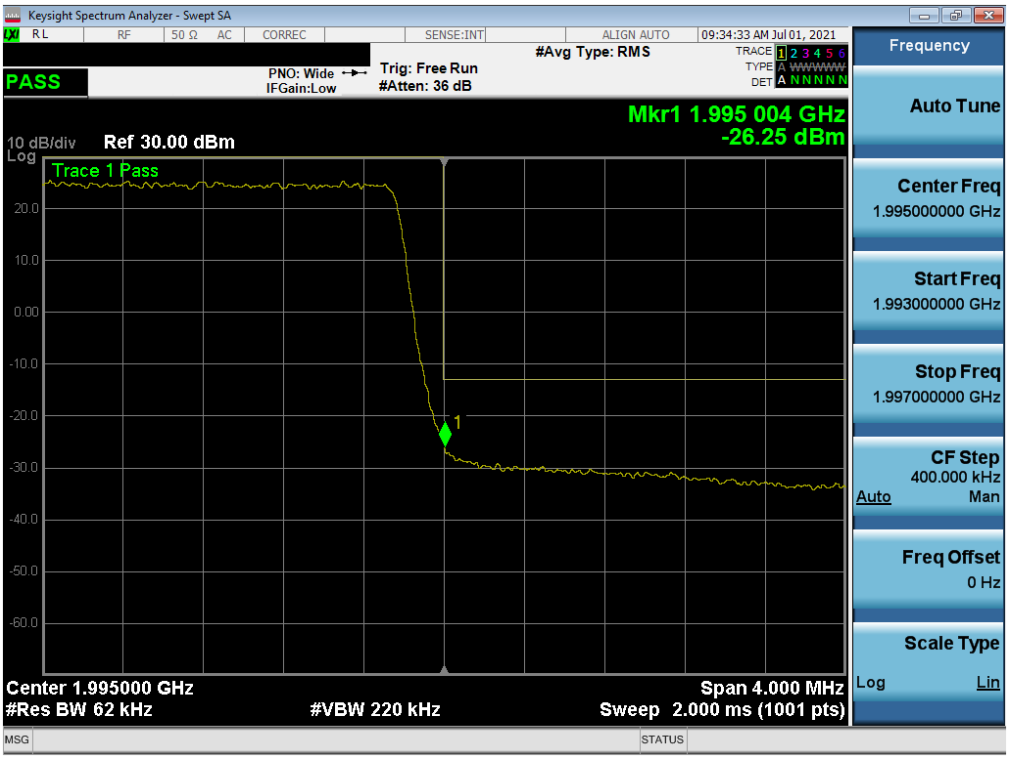
Plot 7-41. Extended Lower Band Edge Plot (LTE Band 25/2 - 5MHz QPSK – Full RB)



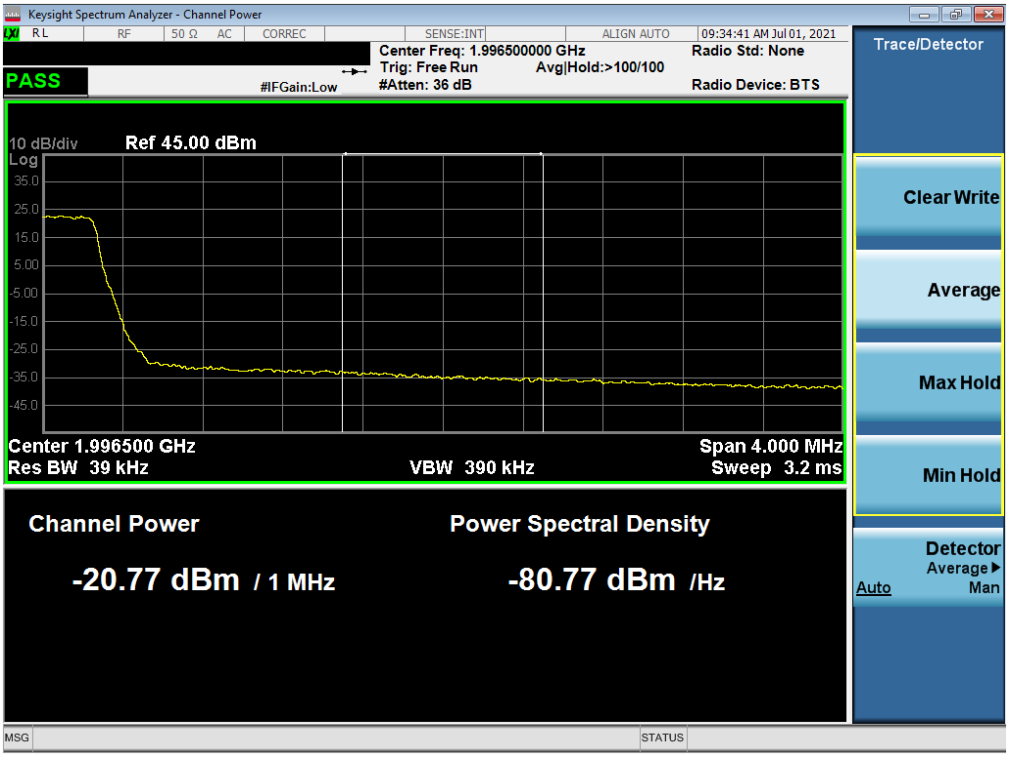
Plot 7-42. Upper Band Edge Plot (LTE Band 2 - 5MHz QPSK – Full RB)



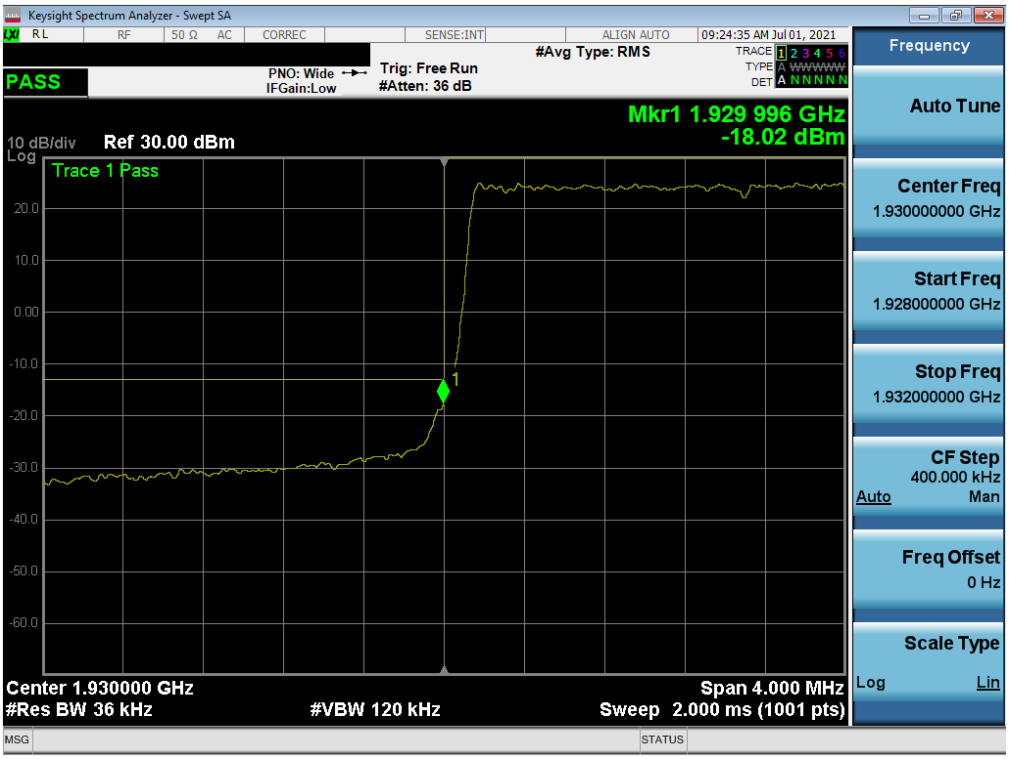
Plot 7-43. Extended Upper Band Edge Plot (LTE Band 2 - 5MHz QPSK – Full RB)



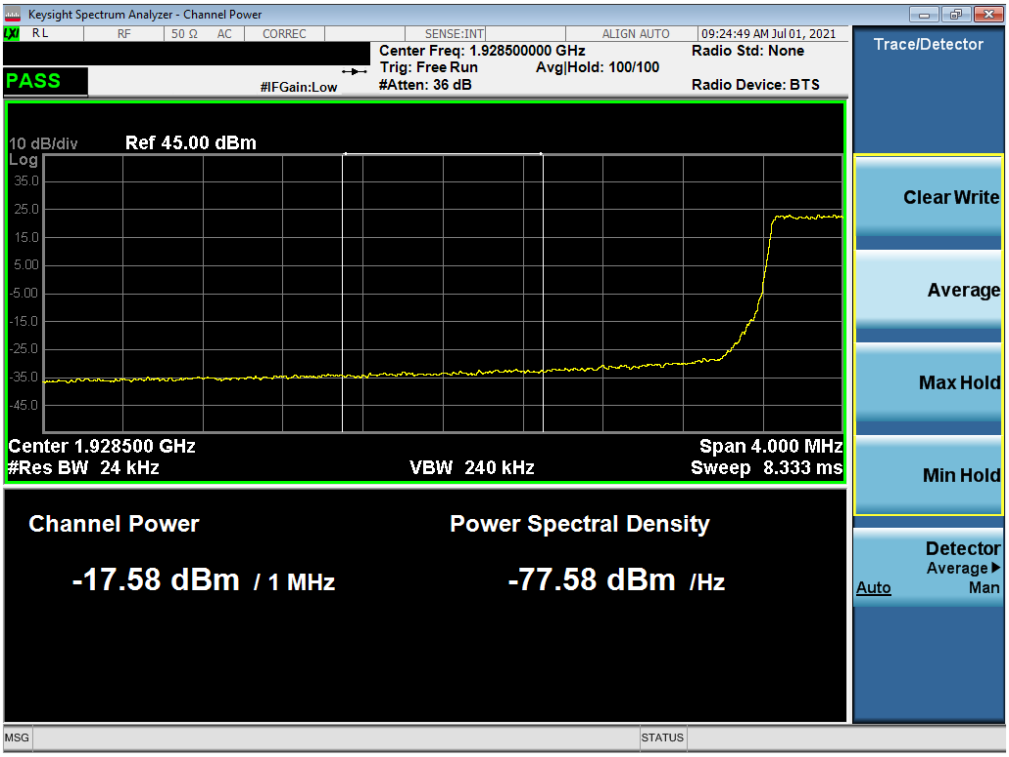
Plot 7-44. Upper Band Edge Plot (LTE Band 25 - 5MHz QPSK – Full RB)



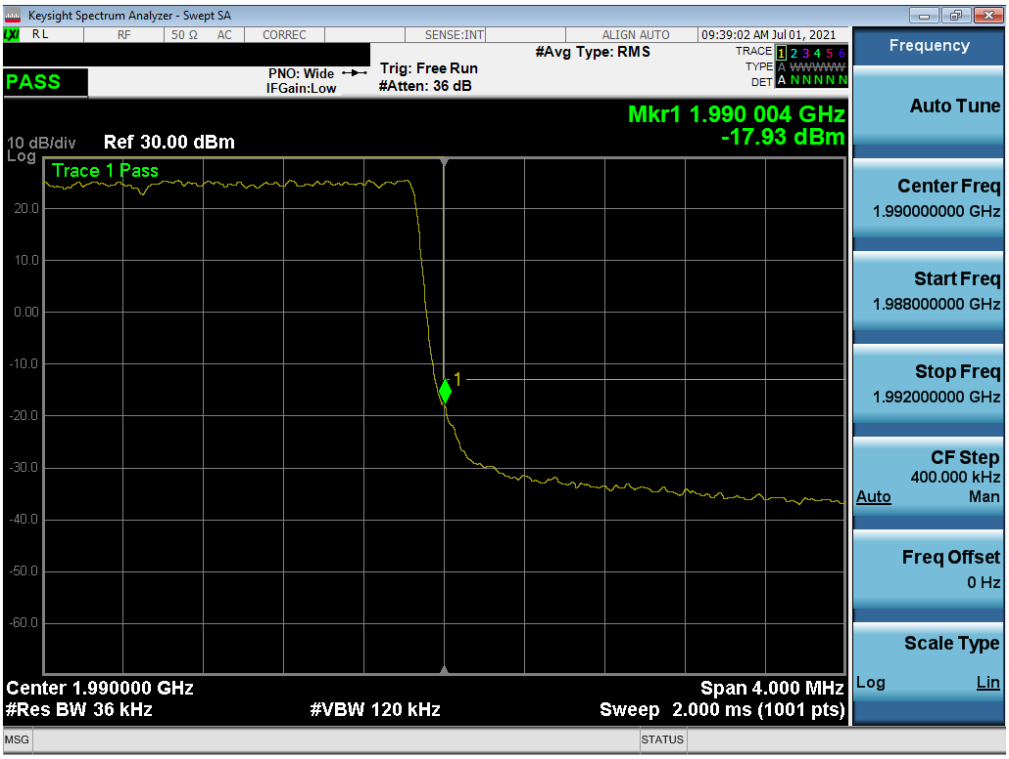
Plot 7-45. Extended Upper Band Edge Plot (LTE Band 25 - 5MHz QPSK – Full RB)



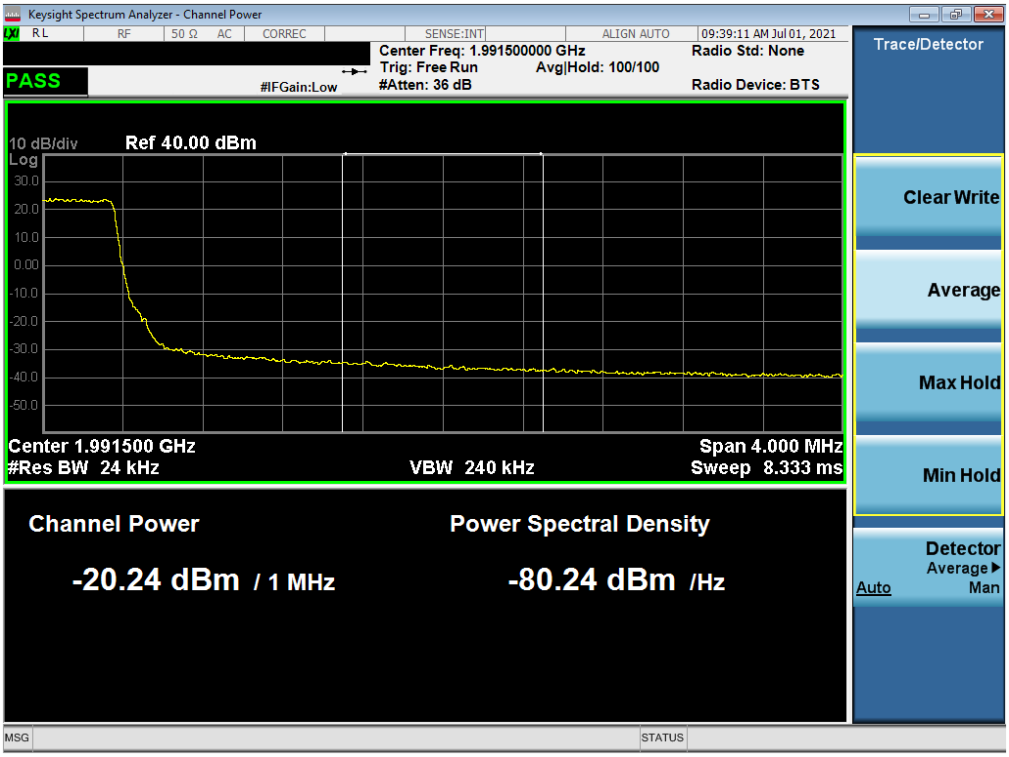
Plot 7-46. Lower Band Edge Plot (LTE Band 25/2 - 3MHz QPSK – Full RB)



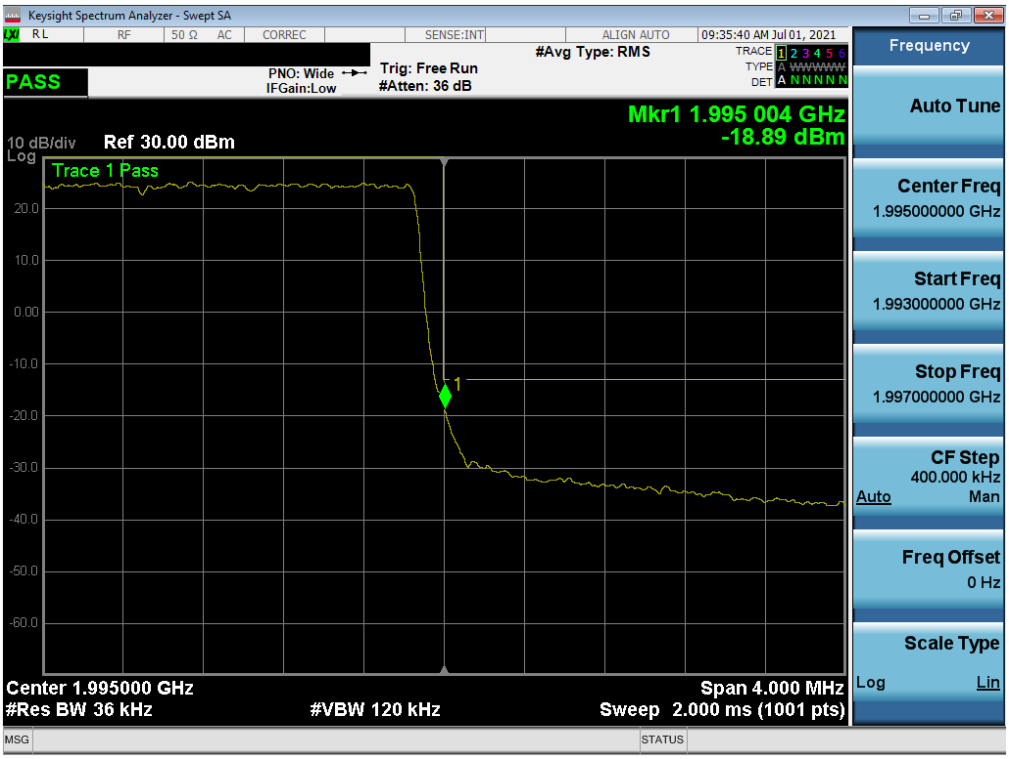
Plot 7-47. Extended Lower Band Edge Plot (LTE Band 25/2 - 3MHz QPSK – Full RB)



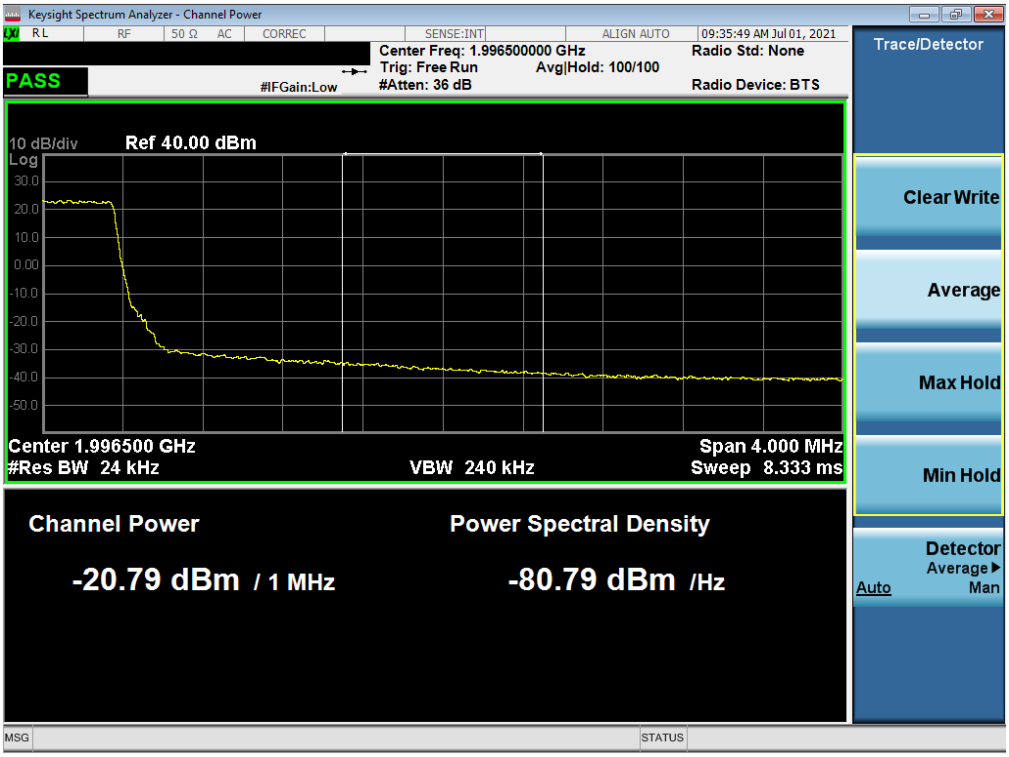
Plot 7-48. Upper Band Edge Plot (LTE Band 2 - 3MHz QPSK – Full RB)



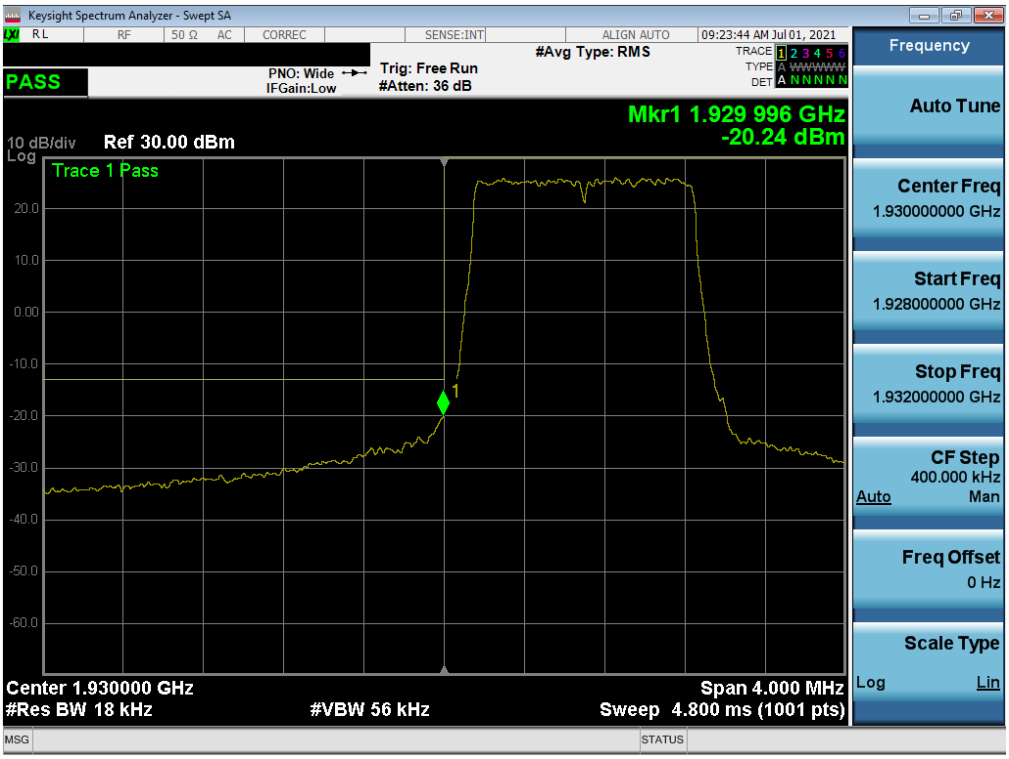
Plot 7-49. Extended Upper Band Edge Plot (LTE Band 2 - 3MHz QPSK – Full RB)



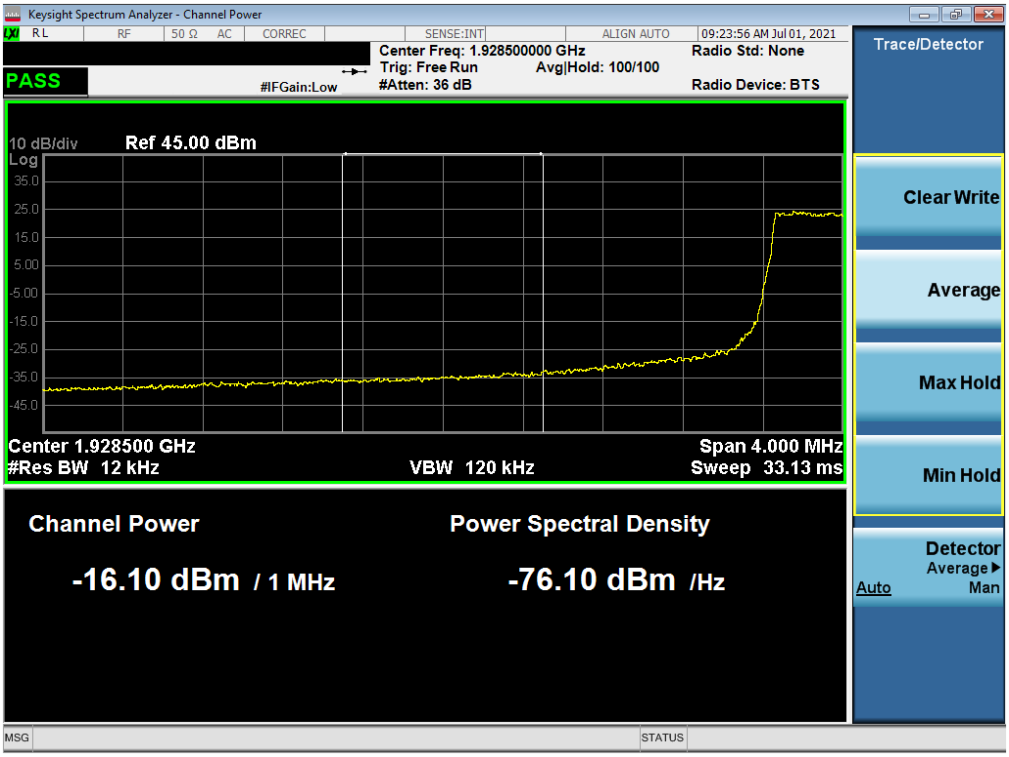
Plot 7-50. Upper Band Edge Plot (LTE Band 25 - 3MHz QPSK – Full RB)



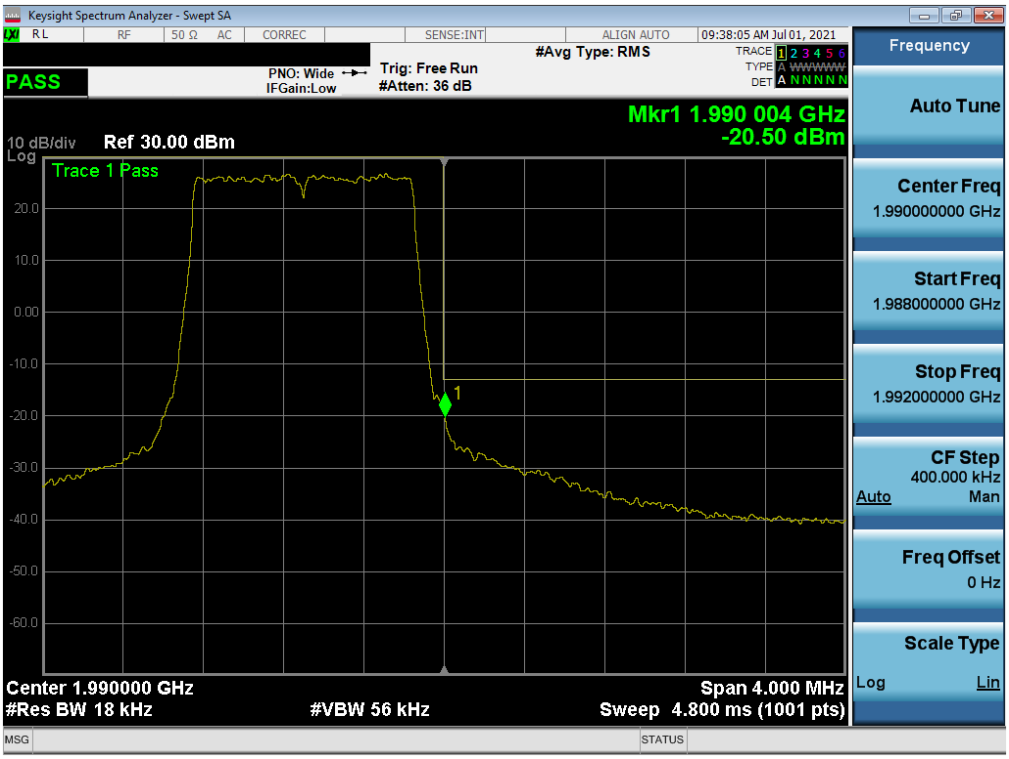
Plot 7-51. Extended Upper Band Edge Plot (LTE Band 25 - 3MHz QPSK – Full RB)



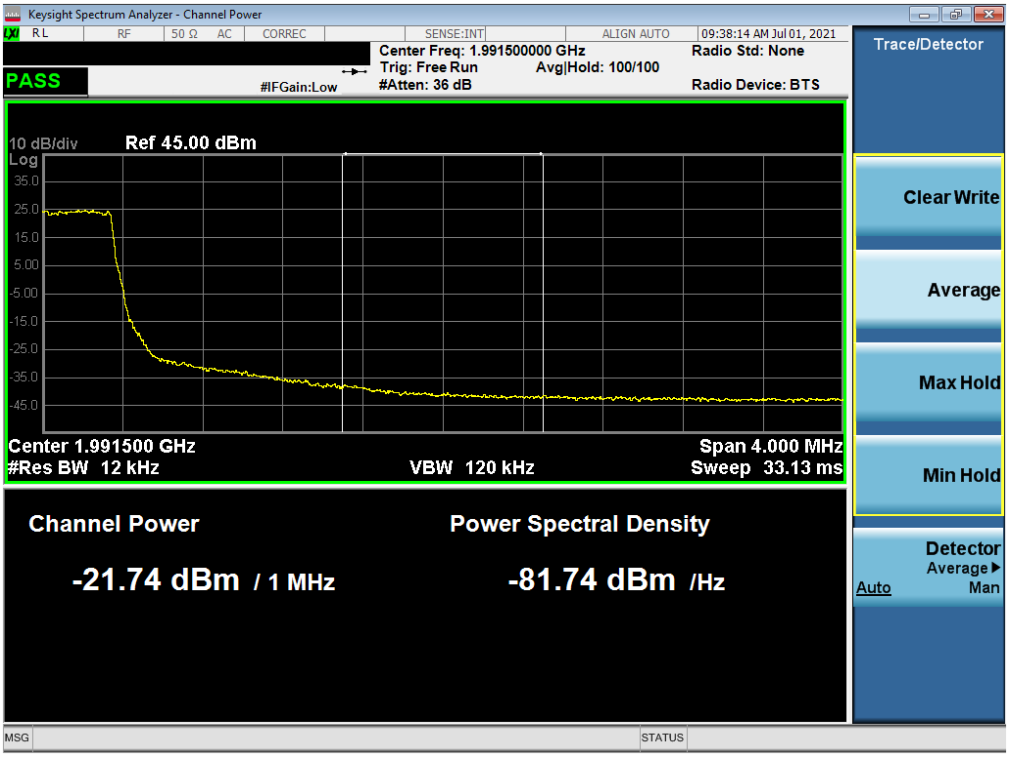
Plot 7-52. Lower Band Edge Plot (LTE Band 25/2 – 1.4MHz QPSK – Full RB)



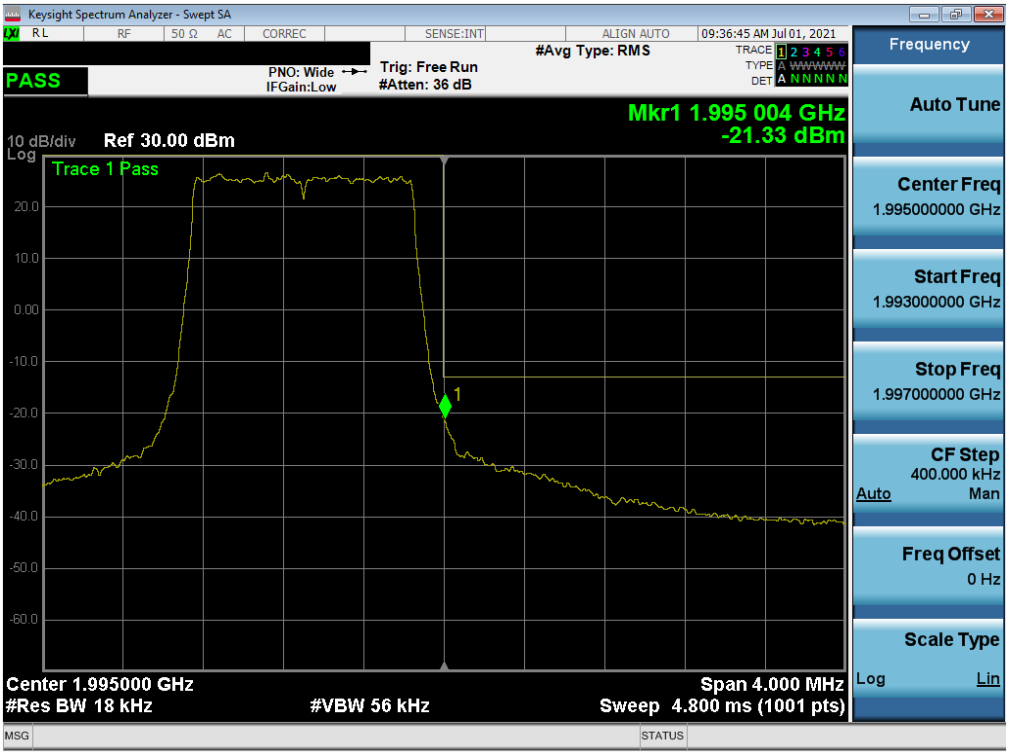
Plot 7-53. Extended Lower Band Edge Plot (LTE Band 25/2 – 1.4MHz QPSK – Full RB)



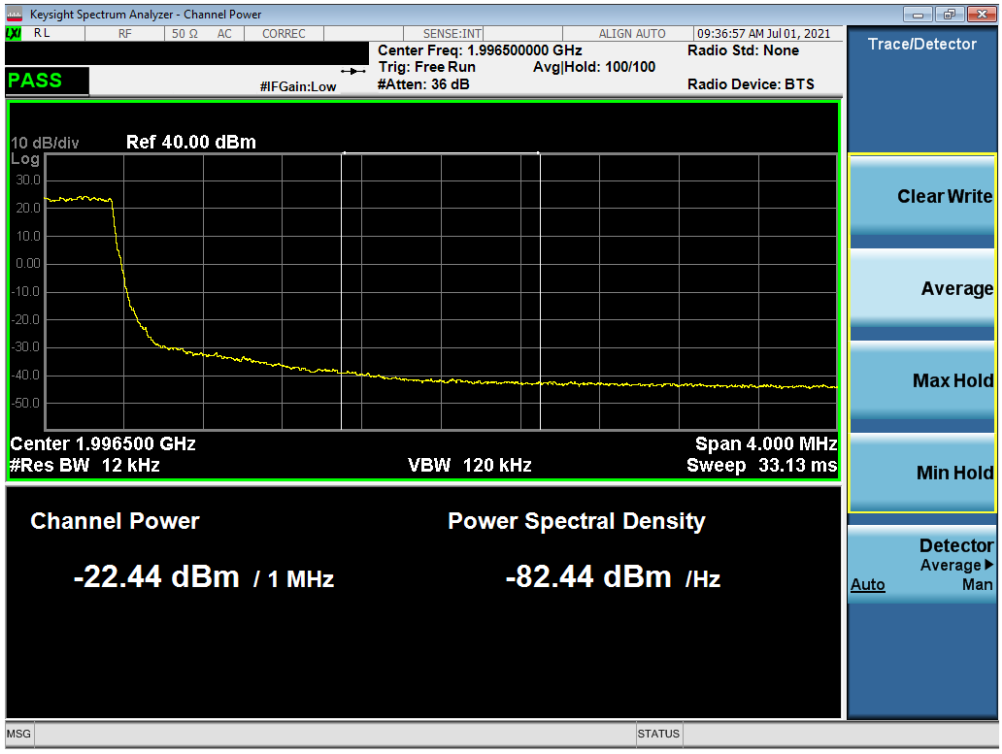
Plot 7-54. Upper Band Edge Plot (LTE Band 2 – 1.4MHz QPSK – Full RB)



Plot 7-55. Extended Upper Band Edge Plot (LTE Band 2 – 1.4MHz QPSK – Full RB)



Plot 7-56. Upper Band Edge Plot (LTE Band 25 – 1.4MHz QPSK – Full RB)



Plot 7-57. Extended Upper Band Edge Plot (LTE Band 25 – 1.4MHz QPSK – Full RB)

7.6 Peak-Average Ratio

Test Overview

A peak to average ratio measurement is performed at the conducted port of the EUT. The spectrum analyzers Complementary Cumulative Distribution Function (CCDF) measurement profile is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth. The CCDF curve shows how much time the peak waveform spends at or above a given average power level. The percent of time the signal spends at or above the level defines the probability for that particular power level.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 5.7.1

Test Settings

1. The signal analyzer's CCDF measurement profile is enabled
2. Frequency = carrier center frequency
3. Measurement BW ≥ OBW or specified reference bandwidth
4. The signal analyzer was set to collect one million samples to generate the CCDF curve
5. The measurement interval was set depending on the type of signal analyzed. For continuous signals (>98% duty cycle), the measurement interval was set to 1ms. For burst transmissions, the spectrum analyzer is set to use an internal "RF Burst" trigger that is synced with an incoming pulse and the measurement interval is set to less than the duration of the "on time" of one burst to ensure that energy is only captured during a time in which the transmitter is operating at maximum power

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

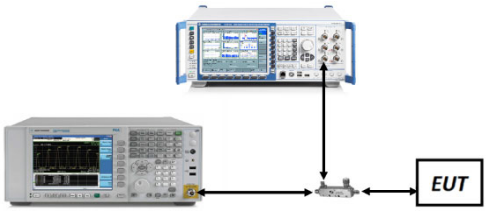
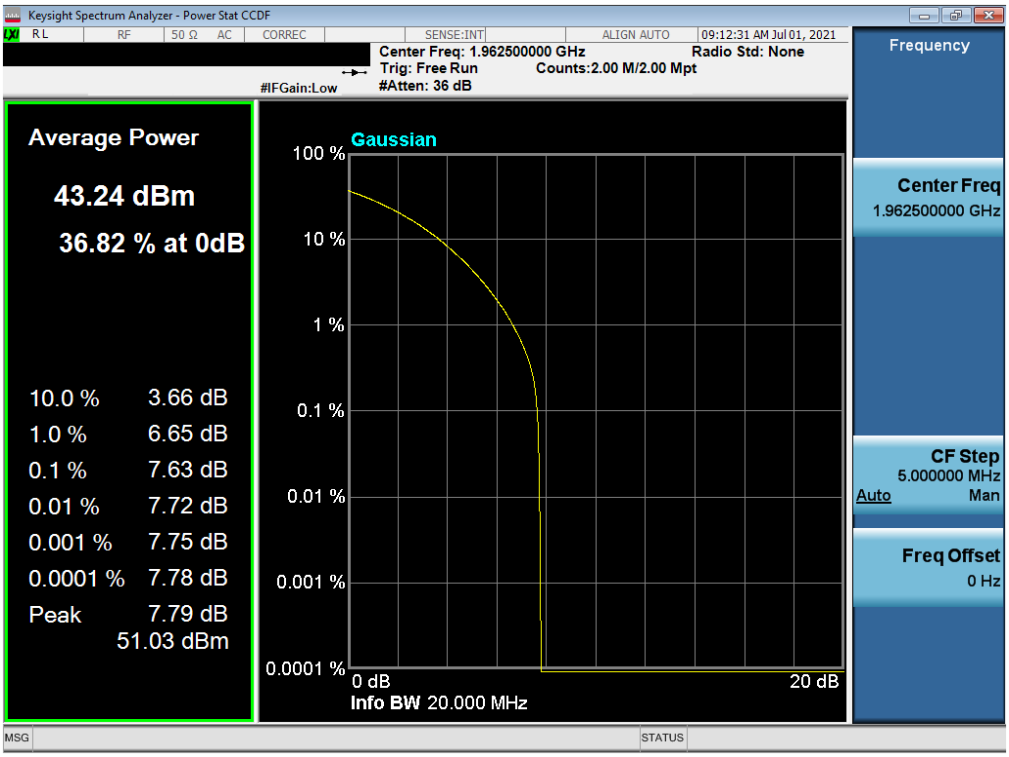


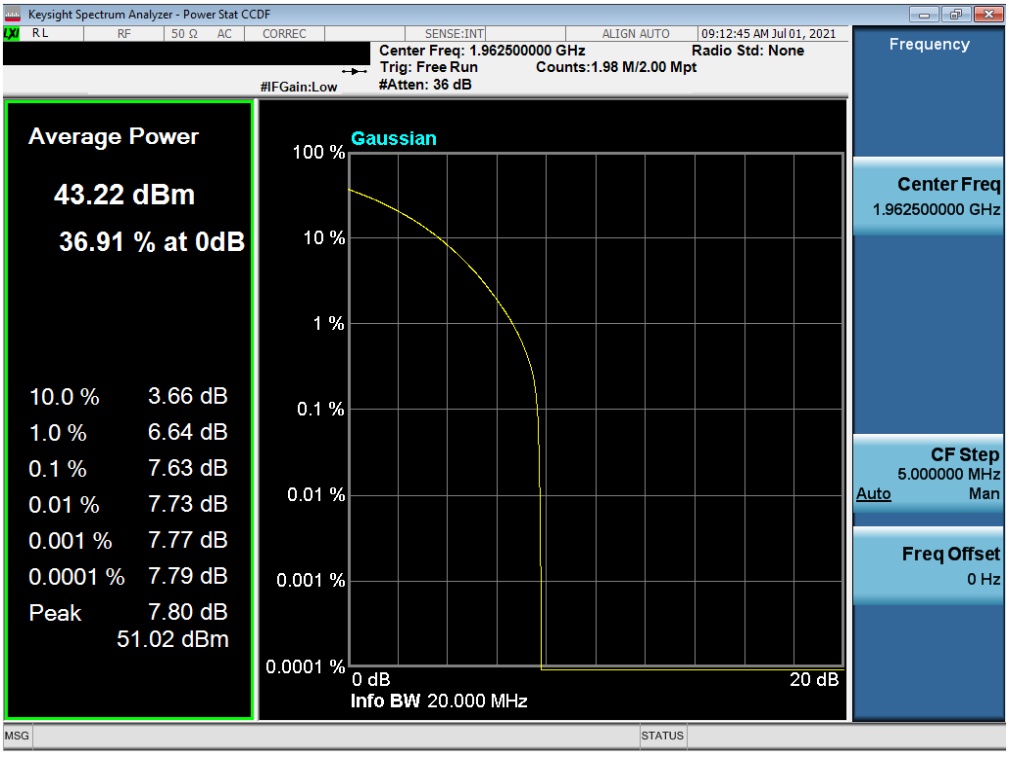
Figure 7-5. Test Instrument & Measurement Setup

Test Notes

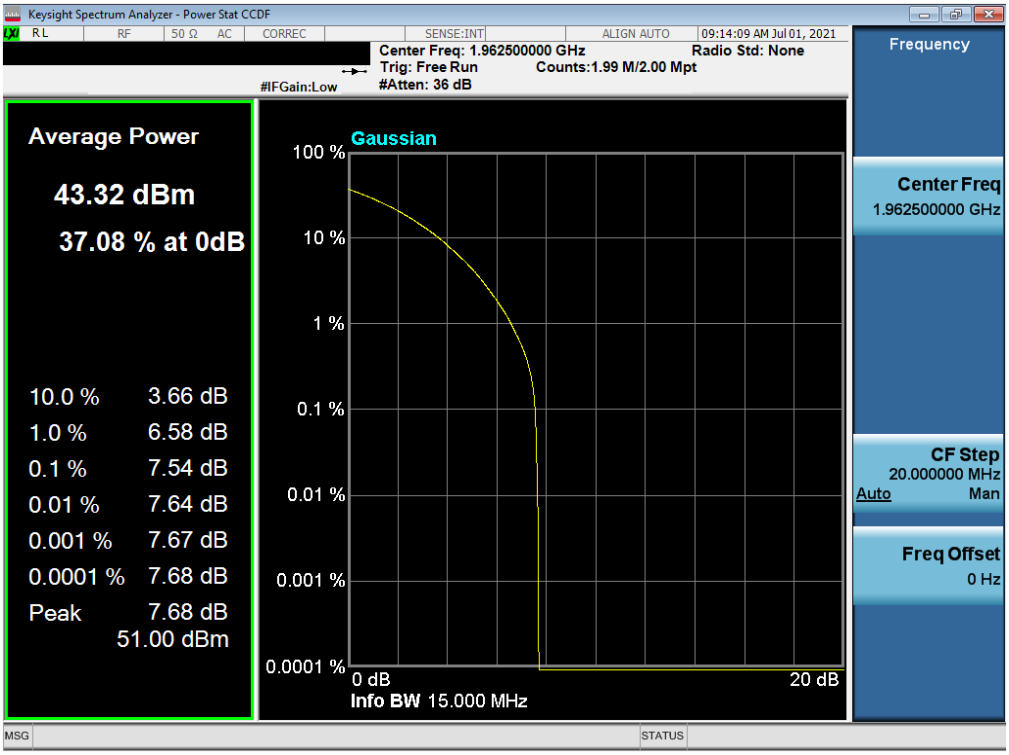
None.



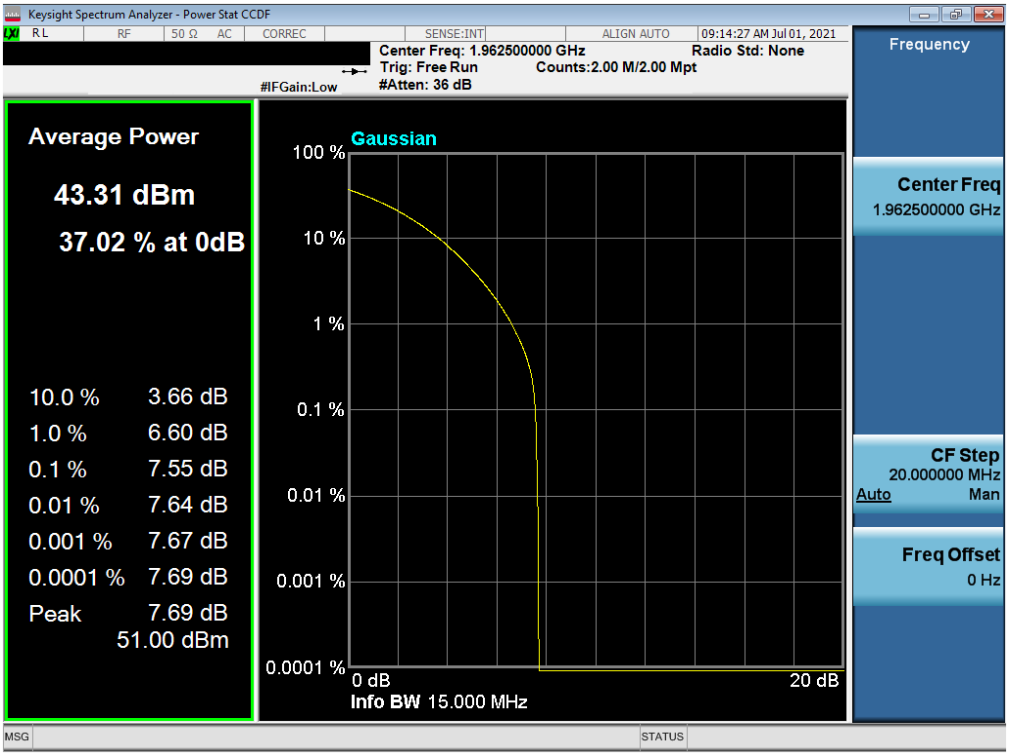
Plot 7-58. PAR Plot (LTE Band 25/2 - 20MHz QPSK - Full RB)



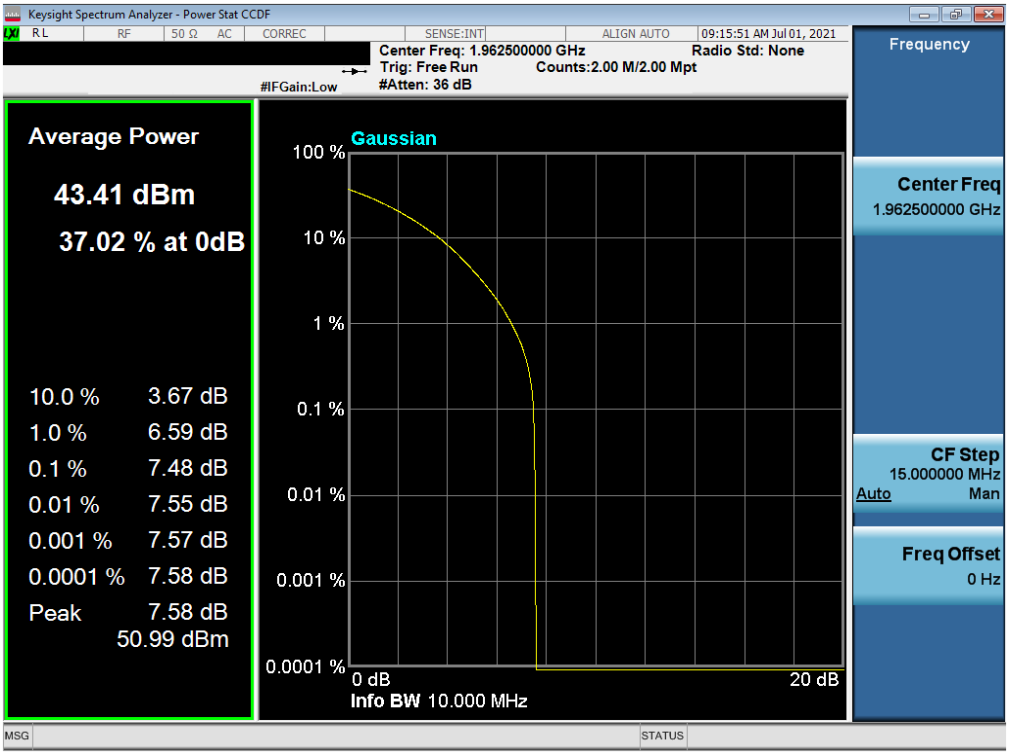
Plot 7-59. PAR Plot (LTE Band 25/2 - 20MHz 256-QAM - Full RB)



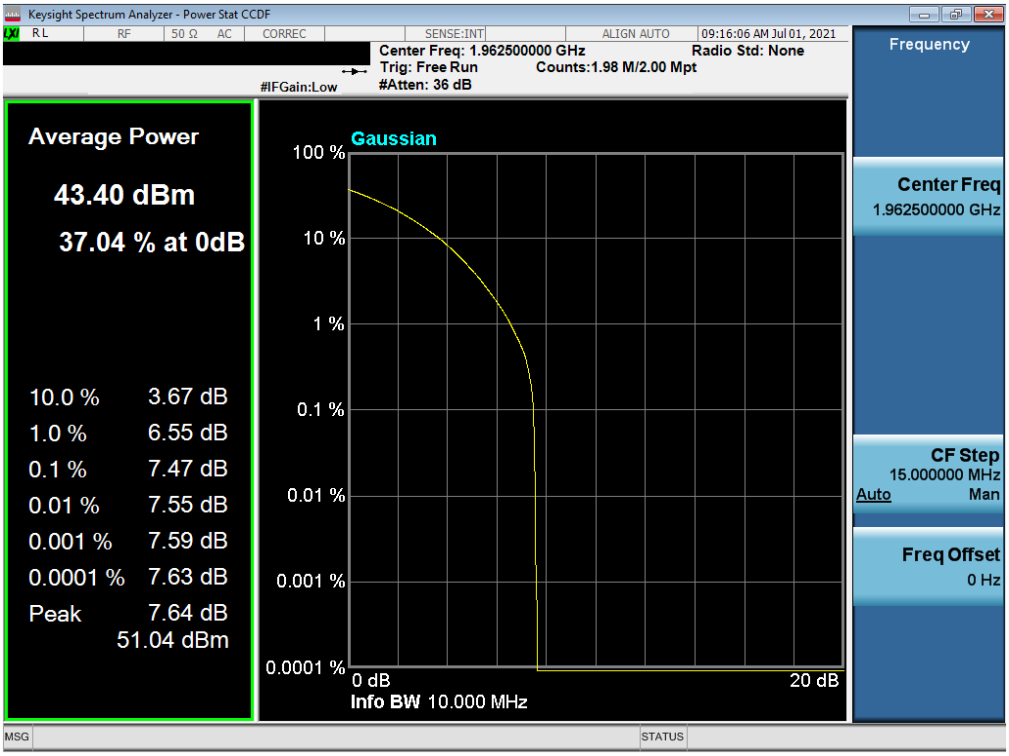
Plot 7-60. PAR Plot (LTE Band 25/2 - 15MHz QPSK - Full RB)



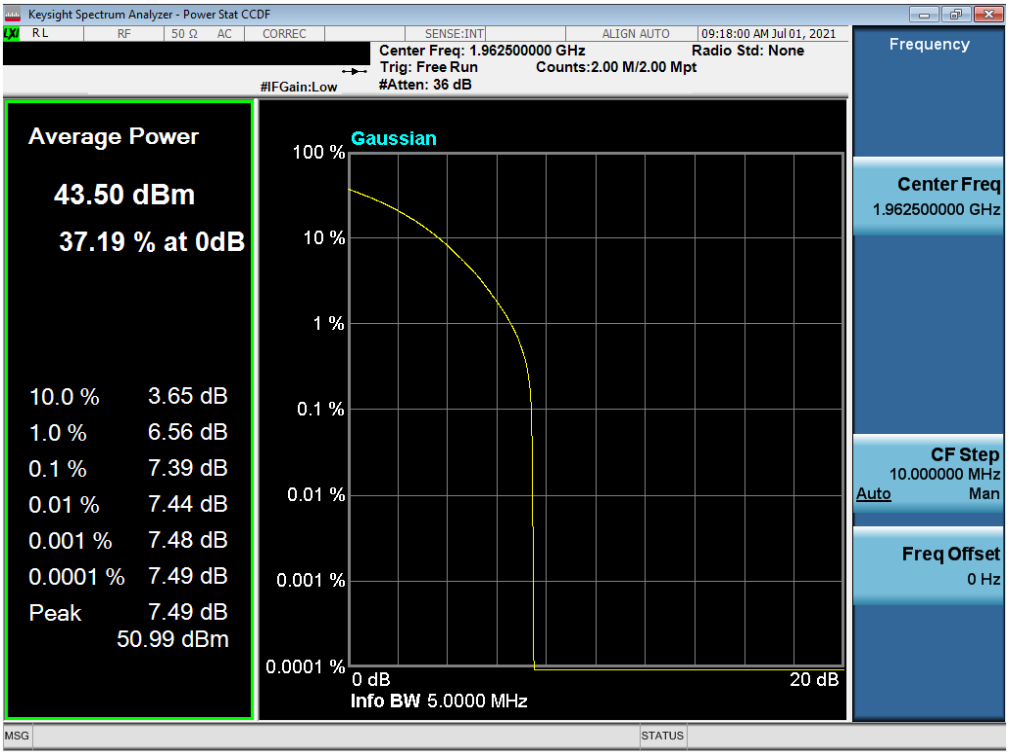
Plot 7-61. PAR Plot (LTE Band 25/2 - 15MHz 256-QAM - Full RB)



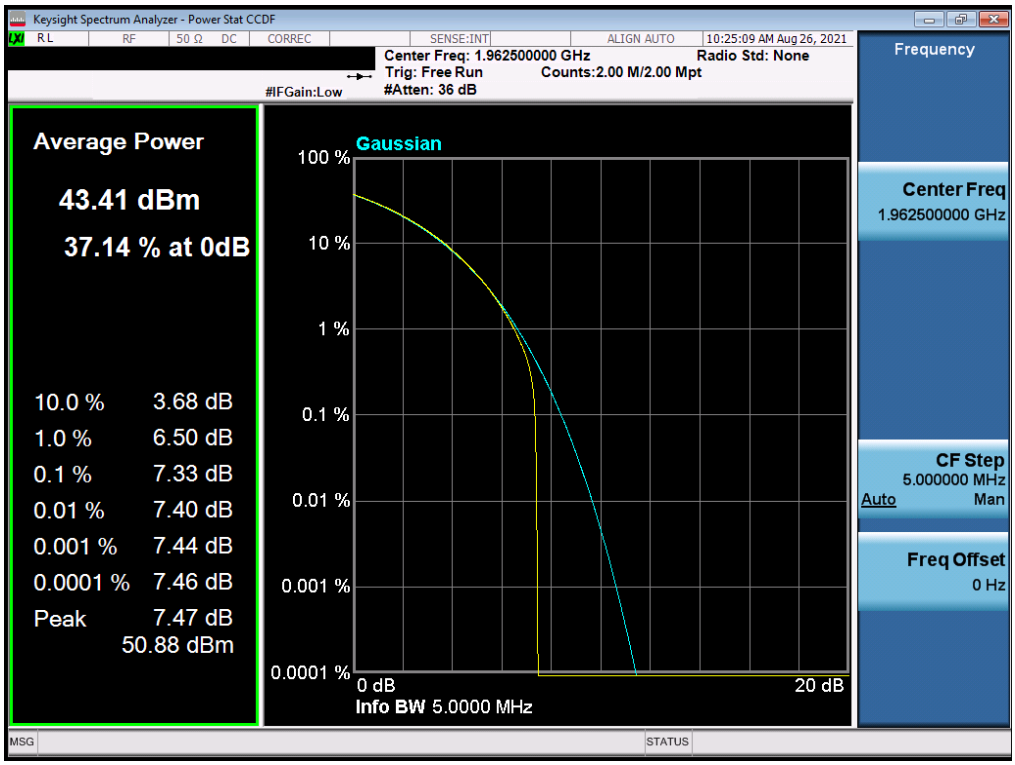
Plot 7-62. PAR Plot (LTE Band 25/2 - 10MHz QPSK - Full RB)



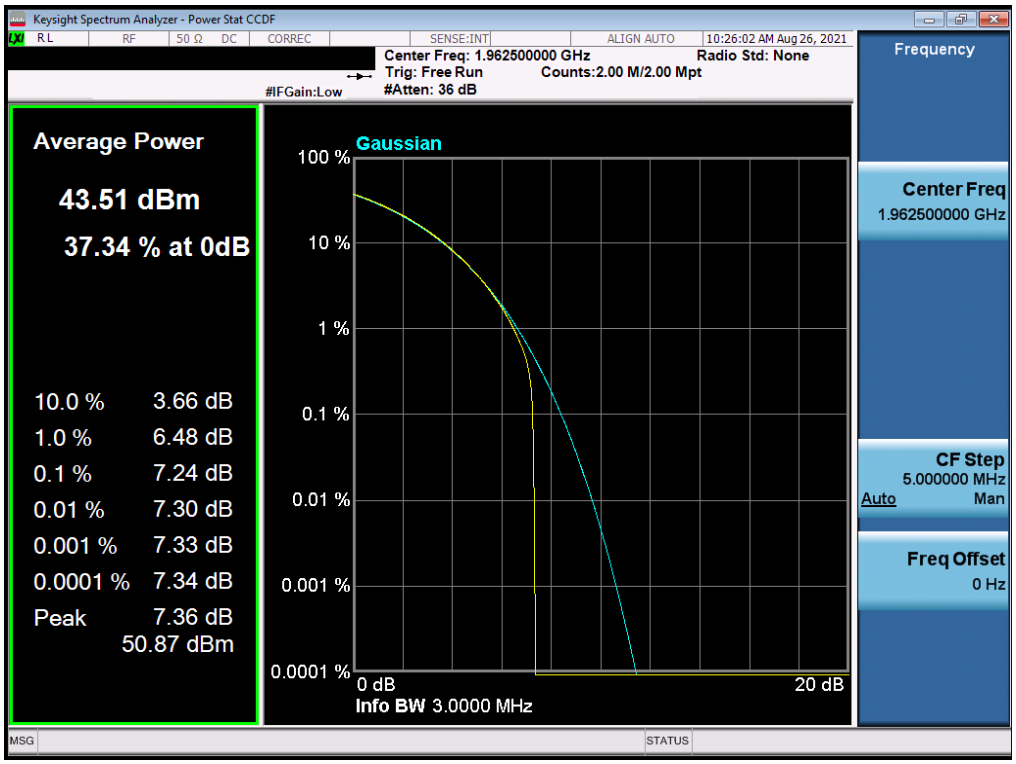
Plot 7-63. PAR Plot (LTE Band 25/2 - 10MHz 256-QAM - Full RB)



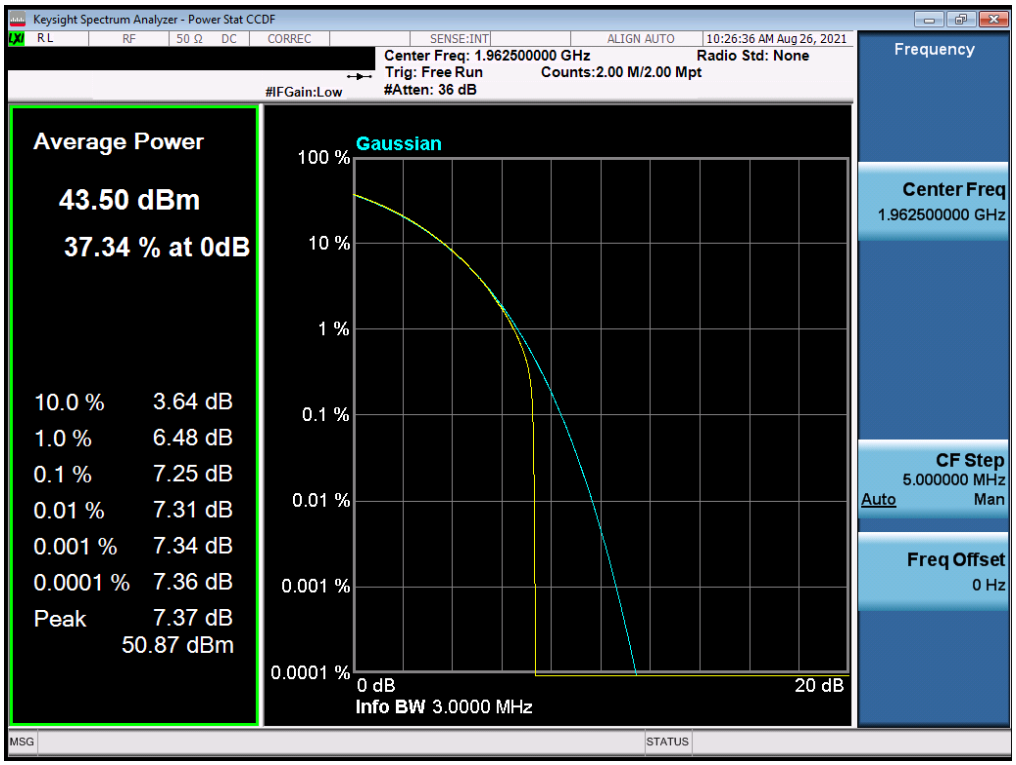
Plot 7-64. PAR Plot (LTE Band 25/2 - 5MHz QPSK - Full RB)



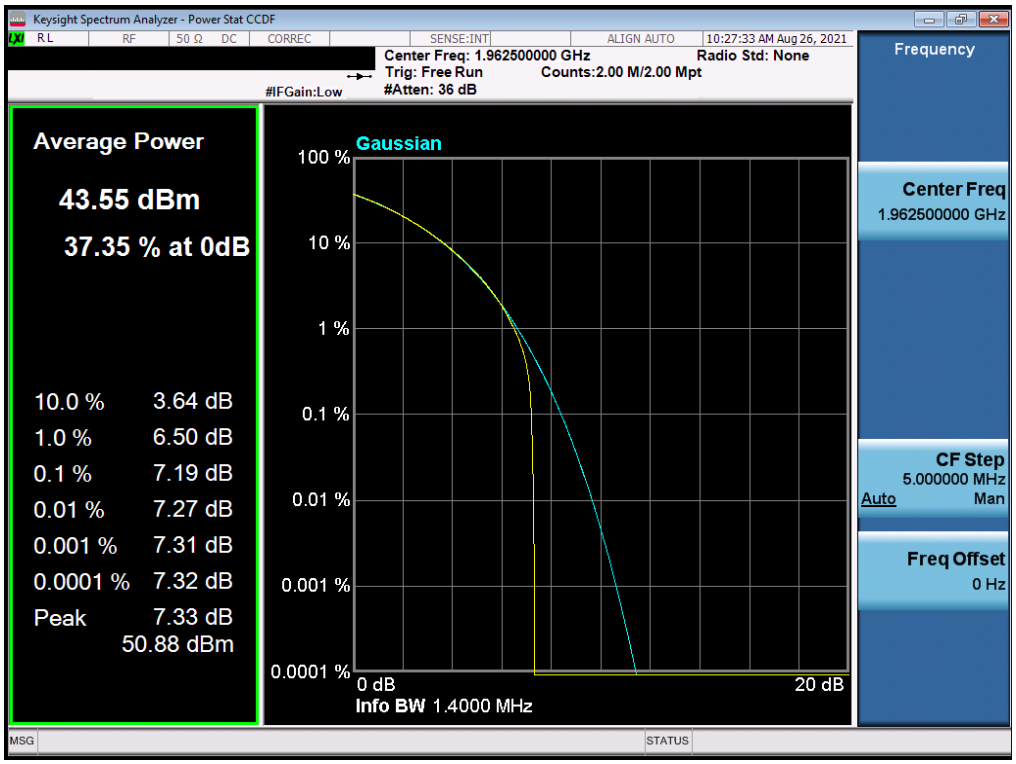
Plot 7-65. PAR Plot (LTE Band 25/2 - 5MHz 256-QAM - Full RB)



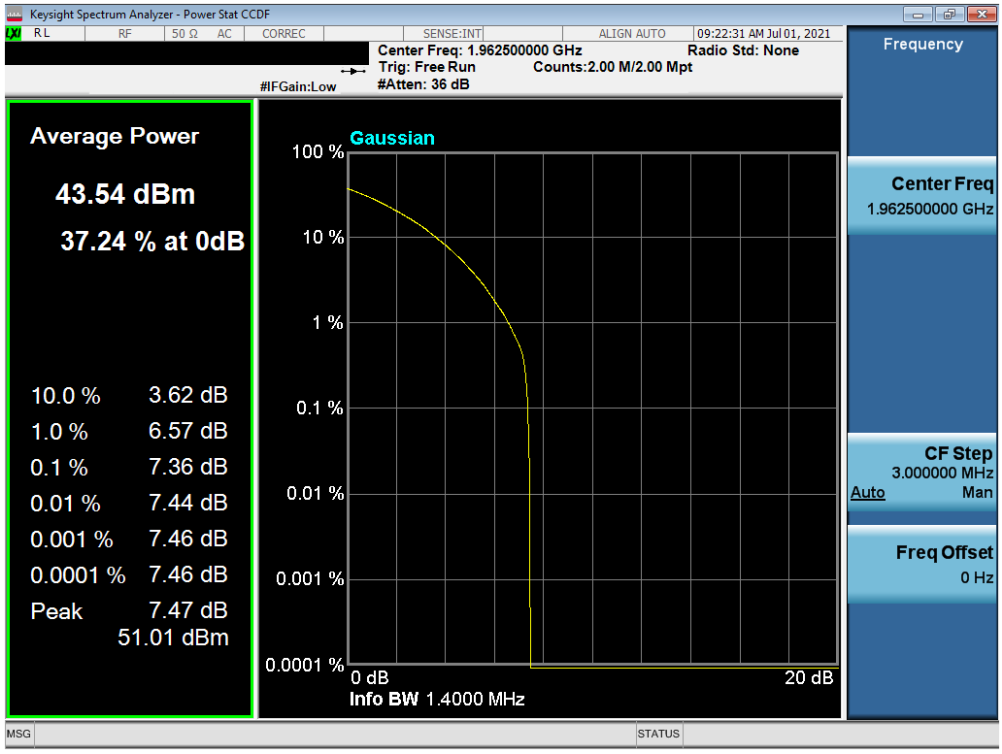
Plot 7-66. PAR Plot (LTE Band 25/2 - 3MHz QPSK - Full RB)



Plot 7-67. PAR Plot (LTE Band 25/2 - 3MHz 256-QAM - Full RB)



Plot 7-68. PAR Plot (LTE Band 25/2 - 1.4MHz QPSK - Full RB)



Plot 7-69. PAR Plot (LTE Band 25/2 - 1.4MHz 256-QAM - Full RB

7.7 Radiated Spurious Emissions Measurements

Test Overview

Radiated spurious emissions measurements are performed as average/RMS measurements described in KDB 971168 with the EUT transmitting into a 50 ohm termination. Measurements on signals operating below 1GHz are performed using hybrid bi-log antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas. All measurements are performed as Average/RMS measurements while the EUT is operating at maximum power, and at the appropriate frequencies.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.8

Test Settings

1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW ≥ 3 x RBW
3. Span = 1.5 times the OBW
4. No. of sweep points ≥ 2 x span / RBW
5. Detector = RMS
6. Trace mode = Average (Max Hold for pulsed emissions)
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

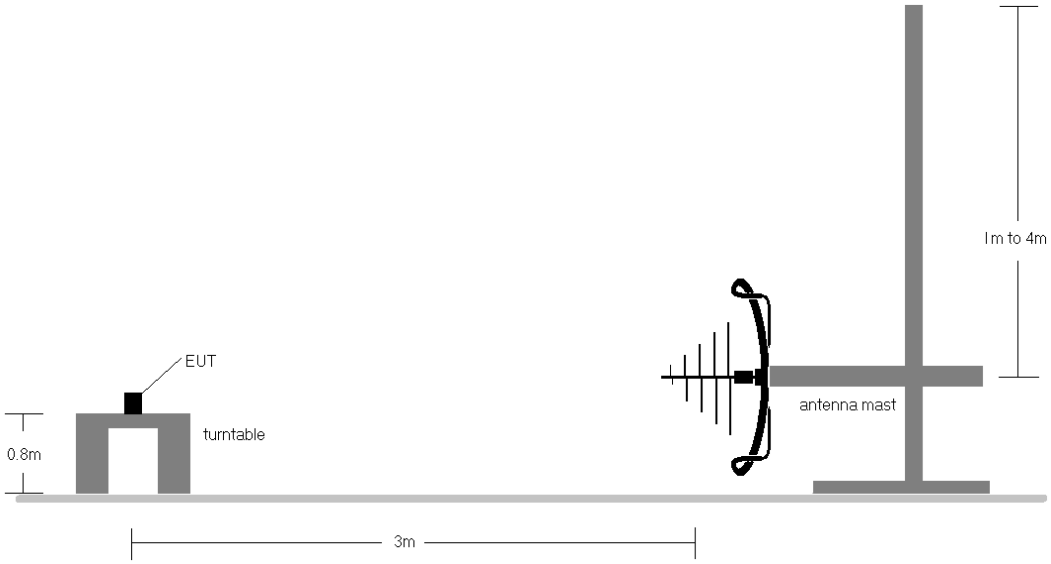


Figure 7-6. Test Instrument & Measurement Setup < 1GHz

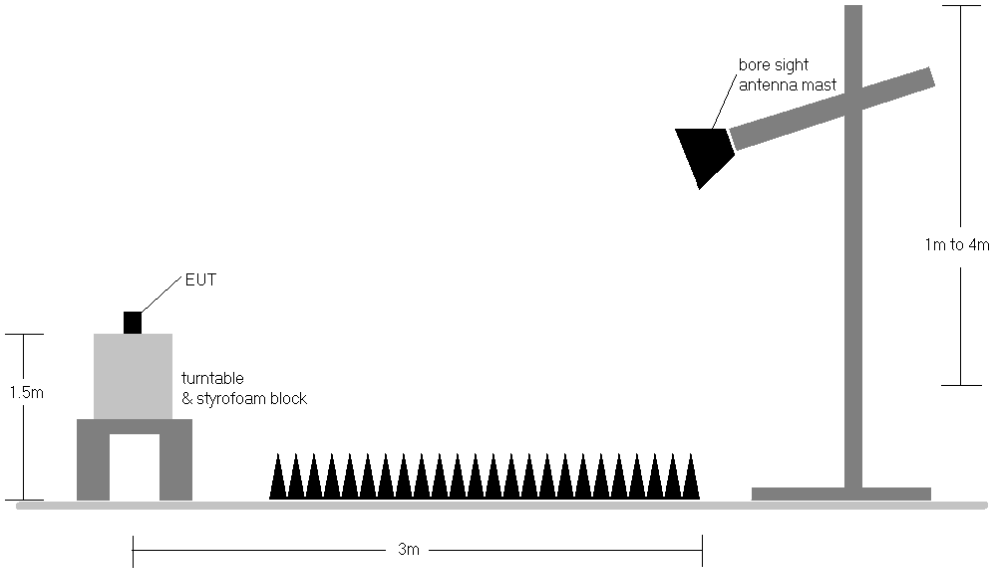


Figure 7-7. Test Instrument & Measurement Setup >1 GHz

Test Notes

1) Field strengths are calculated using the Measurement quantity conversions in KDB 971168 Section 5.8.4.
   b) E(dBµV/m) = Measured amplitude level (dBm) + 107 + Cable Loss (dB) + Antenna Factor (dB/m)
   d) EIRP (dBm) = E(dBµV/m) + 20logD – 104.8; where D is the measurement distance in meters.

2) The EUT was tested in three orthogonal planes and in all possible test configurations and positioning. The worst case emissions are reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the tables below.

3) This unit was tested with a 120VAC supply.

4) The EUT was tested in three orthogonal planes and in all possible test configurations and positioning. The worst case setup is reported in the tables below.

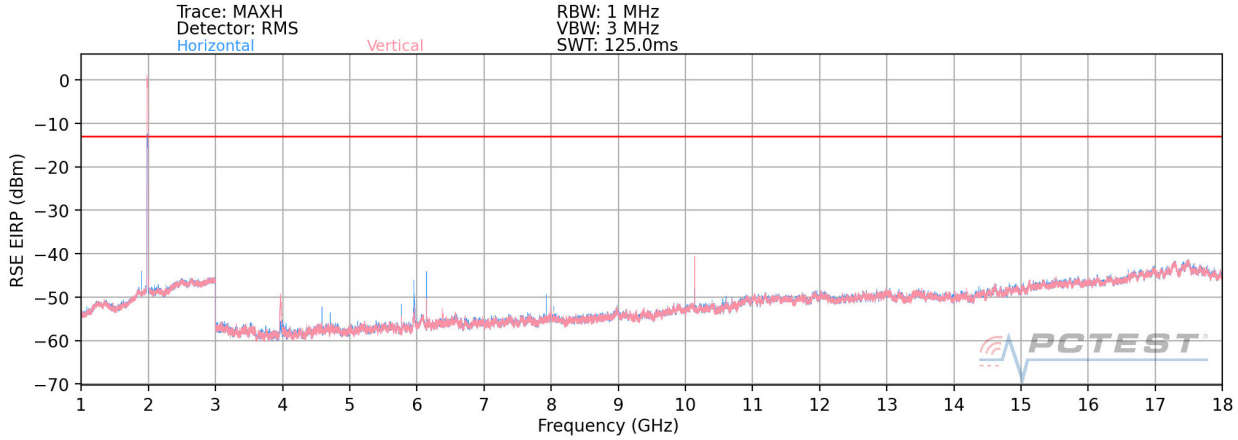
5) The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter. The worst-case emissions are reported.

6) Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.

7) The "-" shown in the following RSE tables are used to denote a noise floor measurement.

8) Radiated Emissions were also investigated for the case of all supported bands transmitting simultaneously. Data is included in the section below.

LTE Band 25/2



Plot 7-70. Radiated Spurious Plot (LTE Band 25/2)

Bandwidth (MHz):	20
Frequency (MHz):	1940.0
RB / Offset:	1 / 50
Detector / Trace Mode:	RMS / Average
RBW / VBW:	1MHz / 3MHz

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
3880.0	H	144	84	-60.27	3.34	50.07	-45.19	-13.00	-32.19
5820.0	H	152	160	-62.51	5.77	50.26	-45.00	-13.00	-32.00
7760.0	H	-	-	-74.81	7.63	39.82	-55.44	-13.00	-42.44
9700.0	H	-	-	-75.74	10.68	41.94	-53.32	-13.00	-40.32
11640.0	H	-	-	-75.99	13.34	44.35	-50.91	-13.00	-37.91
13580.0	H	-	-	-76.00	13.81	44.81	-50.45	-13.00	-37.45

Table 7-3. Radiated Spurious Data (LTE Band 25/2 – Low Channel)

Bandwidth (MHz):	20
Frequency (MHz):	1962.5
RB / Offset:	1 / 50
Detector / Trace Mode:	RMS / Average
RBW / VBW:	1MHz / 3MHz

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
3925.0	H	175	91	-61.60	3.25	48.65	-46.61	-13.00	-33.61
5887.5	H	151	157	-63.95	5.85	48.90	-46.36	-13.00	-33.36
7850.0	H	-	-	-75.07	8.75	40.68	-54.58	-13.00	-41.58
9812.5	H	400	293	-71.11	11.15	47.04	-48.22	-13.00	-35.22
11775.0	H	194	311	-73.04	14.08	48.04	-47.22	-13.00	-34.22
13737.5	H	-	-	-75.95	14.68	45.73	-49.53	-13.00	-36.53
15700.0	H	-	-	-75.84	17.59	48.75	-46.51	-13.00	-33.51

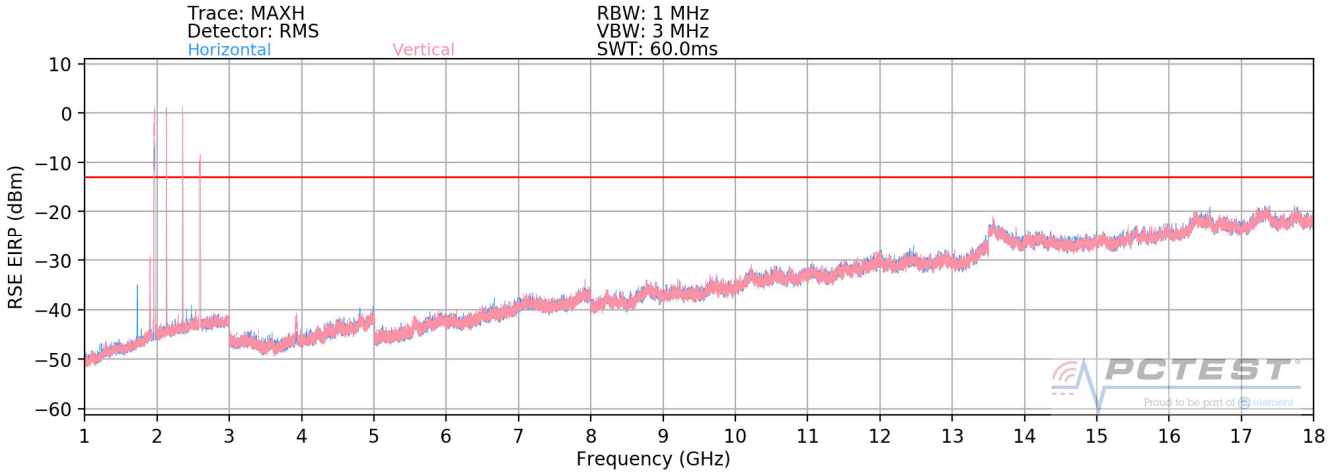
Table 7-4. Radiated Spurious Data (LTE Band 25/2 – Mid Channel)

Bandwidth (MHz):	20
Frequency (MHz):	1985.0
RB / Offset:	1 / 50
Detector / Trace Mode:	RMS / Average
RBW / VBW:	1MHz / 3MHz

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
3970.00	H	119	92	-62.83	4.15	48.32	-46.93	-13.00	-33.93
5955.00	H	125	142	-70.11	7.65	44.54	-50.72	-13.00	-37.72
7940.00	H	142	159	-72.67	8.72	43.05	-52.21	-13.00	-39.21
9925.00	H	-	-	-75.62	11.30	42.68	-52.58	-13.00	-39.58
11910.00	H	-	-	-75.81	14.69	45.88	-49.37	-13.00	-36.37

Table 7-5. Radiated Spurious Data (LTE Band 25/2 – High Channel)

LTE Band 66/10/4, Band 25/2, Band 41, Band 30



Plot 7-71. Radiated Spurious Plot (LTE Band 66/10/4 – 25/2 – 41 – 30)

Mode:	LTE Band 66 - 25 - 41 - 30
Bandwidth (MHz):	20 - 20 - 20 - 20
Frequency (MHz):	1960 + 2132.5 + 2593 + 2355
RB / Offset:	1 / 50

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1163.4	V	257	118	-64.84	2.42	44.58	-50.68	-13.00	-37.68
1093.5	V	260	111	-66.93	2.35	42.42	-52.84	-13.00	-39.84
2017.0	V	-	-	-70.77	5.98	42.21	-53.05	-13.00	-40.05
2305.0	V	146	267	-67.13	6.24	46.11	-49.15	-13.00	-36.15
2420.5	V	-	-	-72.37	7.52	42.15	-53.11	-13.00	-40.11
3754.0	V	101	222	-71.24	14.31	50.07	-45.19	-13.00	-32.19
4627.0	V	168	147	-70.66	10.40	46.74	-48.51	-13.00	-35.51
5074.5	V	122	180	-72.88	14.31	48.43	-46.83	-13.00	-33.83
6144.5	V	285	193	-70.91	15.57	51.66	-43.60	-13.00	-30.60
7779.0	V	114	217	-72.79	18.53	52.74	-42.52	-13.00	-29.52
8987.5	V	-	-	-72.50	21.21	55.71	-39.54	-13.00	-26.54
10145.0	V	120	234	-72.68	21.70	56.02	-39.24	-13.00	-26.24

Table 7-6. Radiated Spurious Data (LTE Multi-Band – Mid Channel)

7.8 Frequency Stability / Temperature Variation

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI/TIA-603-E-2016. The frequency stability of the transmitter is measured by:

a.) **Temperature:** The temperature is varied from -30°C to +50°C in 10°C increments using an environmental chamber.

b.) **Primary Supply Voltage:** The primary supply voltage is varied from 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

Test Procedure Used

ANSI/TIA-603-E-2016

Test Settings

1. The carrier frequency of the transmitter is measured at room temperature (20°C to provide a reference).
2. The equipment is turned on in a "standby" condition for fifteen minutes before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.
3. Frequency measurements are made at 10°C intervals ranging from -30°C to +50°C. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

Test Setup

The EUT was connected via an RF cable to a spectrum analyzer with the EUT placed inside an environmental chamber.

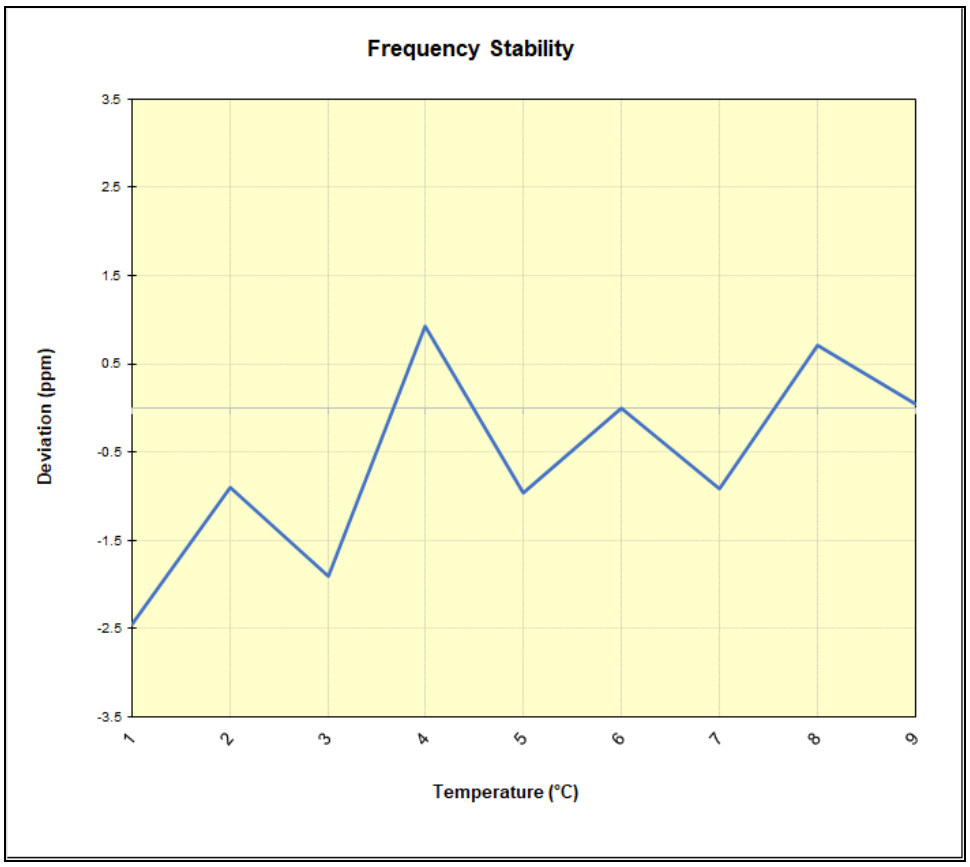
Test Notes

None

LTE Band 25/2	
Operating Frequency (Hz):	1,962,500,000
Ref. Voltage (VAC):	120.00

Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	120.00	- 30	1,962,503,237	-4,787	-0.0002439
		- 20	1,962,506,264	-1,760	-0.0000897
		- 10	1,962,504,284	-3,740	-0.0001906
		0	1,962,509,836	1,812	0.0000923
		+ 10	1,962,506,145	-1,879	-0.0000957
		+ 20 (Ref)	1,962,508,024	0	0.0000000
		+ 30	1,962,506,240	-1,784	-0.0000909
		+ 40	1,962,509,424	1,400	0.0000713
		+ 50	1,962,508,121	97	0.0000049
85 %	102.00	+ 20	1,962,507,444	-580	-0.0000296
115 %	138.00	+ 20	1,962,507,011	-1,013	-0.0000516

Table 7-7. LTE Band 25/2 Frequency Stability Data



Plot 7-72. LTE Band 25/2 Frequency Stability Chart

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the Tecore **Mid Band mRU FCC ID: QLJMRU-19212326** complies with all the requirements of Part 24 of the FCC rules.