PCTEST
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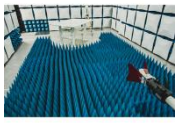


MEASUREMENT REPORT
FCC Part 22 & 90

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

Date of Testing:
06/03 - 08/04/2021
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M2106040064-05.QLJ

FCC ID:	**QLJMRU-060785**
APPLICANT:	**Tecore Networks**

Application Type:	Certification
Model:	MRU-20W060785
EUT Type:	Low Band mRU
FCC Classification:	Licensed Non-Broadcast Station Transmitter (TNB)
FCC Rule Part:	§2.1049, §22(H), §90(S), §90(R)
Test Procedure(s):	ANSI C63.26-2015, ANSI/TIA-603-E-2016, KDB 971168 D01 v03r01, KDB 971168 D02 v02r01

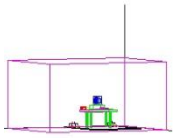
This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in §2.947. Test results reported herein relate only to the item(s) tested.

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.

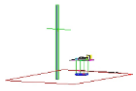
Randy Ortanez
President

ACCREDITED
CERT #2041.01

TABLE OF CONTENTS



MEASUREMENT REPORT
FCC Part 22 & 90



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	Conducted Power		Emission Designator
				Max. Power [W]	Max. Power [dBm]	
LTE Band 26	15 MHz	QPSK	866.5	20.893	43.20	13M5G7D
		QAM	866.5	20.845	43.19	13M5W7D
	10 MHz	QPSK	864.0	20.797	43.18	8M98G7D
		QAM	864.0	20.989	43.22	8M99W7D
	5 MHz	QPSK	861.5 - 866.5	21.577	43.34	4M50G7D
		QAM	861.5 - 866.5	21.878	43.40	4M51W7D
	3 MHz	QPSK	860.5 - 867.5	22.751	43.57	2M71G7D
		QAM	860.5 - 867.5	22.961	43.61	2M71W7D
	1.4 MHz	QPSK	859.7 - 868.3	22.856	43.59	1M11G7D
		QAM	859.7 - 868.3	23.121	43.64	1M10W7D
LTE Band 14	10 MHz	QPSK	763.0	21.577	43.34	8M99G7D
		QAM	763.0	21.528	43.33	9M03W7D
	5 MHz	QPSK	760.5 - 765.5	22.182	43.46	4M50G7D
		QAM	760.5 - 765.5	22.387	43.50	4M51W7D

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 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 Low Band mRU FCC ID: QLJMRU-060785**. The test data contained in this report pertains only to the emissions due to the EUT's LTE operation under the provisions of Parts 22 and 90. The EUT generates LTE signal using QPSK, 16-QAM, 64-QAM, and 256-QAM modulations. The EUT can transmit four different LTE low 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 80W 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.: 20270011
Software Version: mRU 8.0
Firmware: MRAN_015

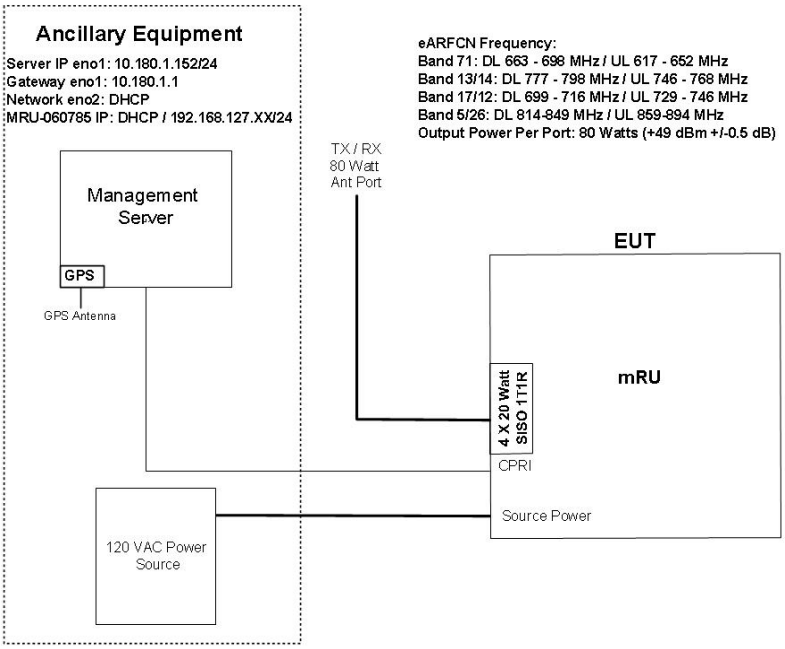


Figure 2-1. Test Setup

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 7.0 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 document titled "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI/TIA-603-E-2016) and "Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems" (KDB 971168 D01 v03r01) were used in the measurement of the EUT**.**

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 with the antenna port terminated in 50 ohms and was placed on a wooden turntable 80 cm above the ground plane and 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 powers measurements, the antenna gains declared by the manufacturer are added to the measured conducted powers to assess compliance with the ERP limit.

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

$$EIRP_{[dBm]} = E_{[dB\mu V/m]} + 20\log D - 104.8;$$ 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 D01.

Radiated power and radiated spurious emission levels are investigated with the receive antenna horizontally and vertically polarized per KDB 971168 D01.

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). Measurement 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
	ETS	EMC Cable and Switch System	3/4/2021	Annual	3/4/2022	ETS
-	WL25-1	Conducted Cable Set (25GHz)	2/23/2021	Annual	2/23/2022	WL25-1
-	WL25-3	Conducted Cable Set (25GHz)	3/12/2021	Annual	3/12/2022	WL25-3
Espec	ESX-2CA	Environmental Chamber	8/27/2020	Annual	8/27/2022	17620
Keysight Technologies	N9020A	MXA Signal Analyzer	9/22/2020	Annual	9/22/2021	MY54500644
Keysight Technologies	N9030A	PXA Signal Analyzer	9/2/2020	Annual	9/2/2021	MY55410501
Pasternack	NC-100	Torque Wrench (8in-lbs)	8/5/2020	Biennial	8/5/2022	N/A
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	5/25/2021	Annual	5/25/2022	100348

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

Emission Designator

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 – LTE Band

Example: Middle Channel LTE Mode 2nd Harmonic (1564 MHz)

The average 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 analzyer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 1564 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-060785

FCC Classification: Licensed Non-Broadcast Station Transmitter (TNB)

Mode(s): LTE

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Occupied Bandwidth	2.1049	N/A	PASS	Section 7.3
	Conducted Band Edge / Spurious Emissions (LTE Band 14)	2.1051, 90.543(c)(e)	On all frequencies between 769-775 MHz and 799-805 MHz, attenuation by a factor not less than 65 + 10 log(P) dB in a 6.25 kHz band segment, for base and fixed stations. On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, attenuation by at least 43 + 10 log(P) dB > 43 + 10log10 (P[Watts]) for all out of band emissions outside of those specified in 90.543(e)	PASS	Sections 7.4, 7.5
	Conducted Band Edge / Spurious Emissions (LTE Band 26)	2.1051, 90.691(a)	> 43 + 10 log10 (P[Watts]) for all out-of-band emissions beyond 37.5 kHz from the Block Edge > 50 + 10 log10 (P[Watts]) at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Sections 7.4, 7.5
	Frequency Stability	2.1055, 90.213	< 1.5 ppm	PASS	Section 7.7
	Transmitter Conducted Output Power	2.1046	N/A	PASS	Section 7.2
	Effective Radiated Power (LTE Band 26)	90.635	< 1000 Watts max. ERP	PASS	Section 7.2
	Effective Radiated Power (LTE Band 26 - ONLY applies for 15 MHz BW)	22.913(a)(1)(i)	< 500 Watts per emission max. ERP	PASS	Section 7.2
	Effective Radiated Power (LTE Band 14)	90.542(a)(3)	< 1000 Watts/MHz max. ERP	PASS	Section 7.2
RADIATED	Radiated Spurious Emissions (LTE Band 14)	2.1053, 90.543(e)(f)	> 43 + 10 log10 (P[Watts]) for all out-of-band emissions except emissions in the 1559 - 1610MHz band are subject to a limit of -40dBm/MHz for wideband signals	PASS	Section 7.6
	Radiated Spurious Emissions (LTE Band 26)	2.1053, 90.691(a)	> 43 + 10 log10 (P[Watts]) for all out-of-band emissions beyond 37.5 kHz from the Block Edge > 50 + 10 log10 (P[Watts]) at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Section 7.6

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 data/plots shown in Sections 7.2 – 7.5 were 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

§2.1046 §90.635

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.

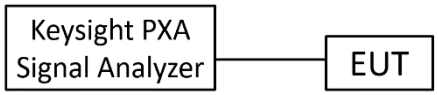


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

1. For LTE mode, the device was tested under all modulations and channel bandwidth configurations, and the worst case emissions are reported.

2. This unit was tested with an external 120 VAC power source.

3. Full channel conducted power measurements were used to compare a worst-case power to the ERP density limits specified in Part 90.

LTE Band 26

Bandwidth	Modulation	Channel	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]	Ant Gain [dBi]	ERP [dBm]	ERP [Watts]	ERP Limit [dBm]	Margin [dB]
15MHz	QPSK	8765	866.5	75 / 0	43.20	20.89	15.00	56.05	402.72	56.99	-0.94
	16QAM	8765	866.5	75 / 0	43.14	20.61	15.00	55.99	397.19	56.99	-1.00
	64QAM	8765	866.5	75 / 0	43.19	20.84	15.00	56.04	401.79	56.99	-0.95
	256QAM	8765	866.5	75 / 0	43.17	20.75	15.00	56.02	399.94	56.99	-0.97
10 MHz	QPSK	8740	864.0	50 / 0	43.18	20.80	15.00	56.03	400.87	60.00	-3.97
	16QAM	8740	864.0	50 / 0	43.22	20.99	15.00	56.07	404.58	60.00	-3.93
	64QAM	8740	864.0	50 / 0	43.16	20.70	15.00	56.01	399.02	60.00	-3.99
	256QAM	8740	864.0	50 / 0	43.17	20.75	15.00	56.02	399.94	60.00	-3.98
5 MHz	QPSK	8715	861.5	25 / 0	43.07	20.28	15.00	55.92	390.84	60.00	-4.08
		8740	864.0	25 / 0	43.25	21.13	15.00	56.10	407.38	60.00	-3.90
		8765	866.5	25 / 0	43.34	21.58	15.00	56.19	415.91	60.00	-3.81
	16QAM	8740	864.0	25 / 0	43.23	21.04	15.00	56.08	405.51	60.00	-3.92
	64QAM	8765	866.5	25 / 0	43.40	21.88	15.00	56.25	421.70	60.00	-3.75
	256QAM	8765	866.5	25 / 0	43.35	21.63	15.00	56.20	416.87	60.00	-3.80
3 MHz	QPSK	8705	860.5	15 / 0	43.08	20.32	15.00	55.93	391.74	60.00	-4.07
		8740	864.0	15 / 0	43.35	21.63	15.00	56.20	416.87	60.00	-3.80
		8775	867.5	15 / 0	43.57	22.75	15.00	56.42	438.53	60.00	-3.58
	16QAM	8775	867.5	15 / 0	43.61	22.96	15.00	56.46	442.59	60.00	-3.54
	64QAM	8775	867.5	15 / 0	43.54	22.59	15.00	56.39	435.51	60.00	-3.61
	256QAM	8775	867.5	15 / 0	43.52	22.49	15.00	56.37	433.51	60.00	-3.63
1.4 MHz	QPSK	8697	859.7	6 / 0	42.99	19.91	15.00	55.84	383.71	60.00	-4.16
		8740	864.0	6 / 0	43.41	21.93	15.00	56.26	422.67	60.00	-3.74
		8783	868.3	6 / 0	43.59	22.86	15.00	56.44	440.55	60.00	-3.56
	16QAM	8783	868.3	6 / 0	43.64	23.12	15.00	56.49	445.66	60.00	-3.51
	64QAM	8783	868.3	6 / 0	43.57	22.75	15.00	56.42	438.53	60.00	-3.58
	256QAM	8783	868.3	6 / 0	43.61	22.96	15.00	56.46	442.59	60.00	-3.54

Table 7-2. Transmitter Conducted Output Power / Effective Radiated Power (LTE Band 26)

LTE Band 14

Bandwidth	Modulation	Channel	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [Watts]	Ant Gain [dBi]	ERP [dBm/MHz]	ERP [Watts/MHz]	ERP Limit [dBm/MHz]	Margin [dB]
10 MHz	QPSK	5330	763.0	50 / 0	43.34	21.58	15.00	56.19	415.91	60.00	-3.81
	16-QAM	5330	763.0	50 / 0	43.31	21.43	15.00	56.16	413.05	60.00	-3.84
	64-QAM	5330	763.0	50 / 0	43.29	21.33	15.00	56.14	411.15	60.00	-3.86
	256-QAM	5330	763.0	50 / 0	43.33	21.53	15.00	56.18	414.95	60.00	-3.82
5 MHz	QPSK	5305	760.5	25 / 0	43.46	22.18	15.00	56.31	427.56	60.00	-3.69
		5330	763.0	25 / 0	43.40	21.88	15.00	56.25	421.70	60.00	-3.75
		5355	765.5	25 / 0	43.18	20.80	15.00	56.03	400.87	60.00	-3.97
	16-QAM	5305	760.5	25 / 0	43.44	22.08	15.00	56.29	425.60	60.00	-3.71
	64-QAM	5305	760.5	25 / 0	43.43	22.03	15.00	56.28	424.62	60.00	-3.72
	256-QAM	5305	760.5	25 / 0	43.50	22.39	15.00	56.35	431.52	60.00	-3.65

Table 7-3. Transmitter Conducted Output Power / Effective Radiated Power (LTE Band 14)

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.

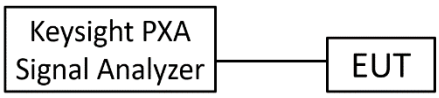
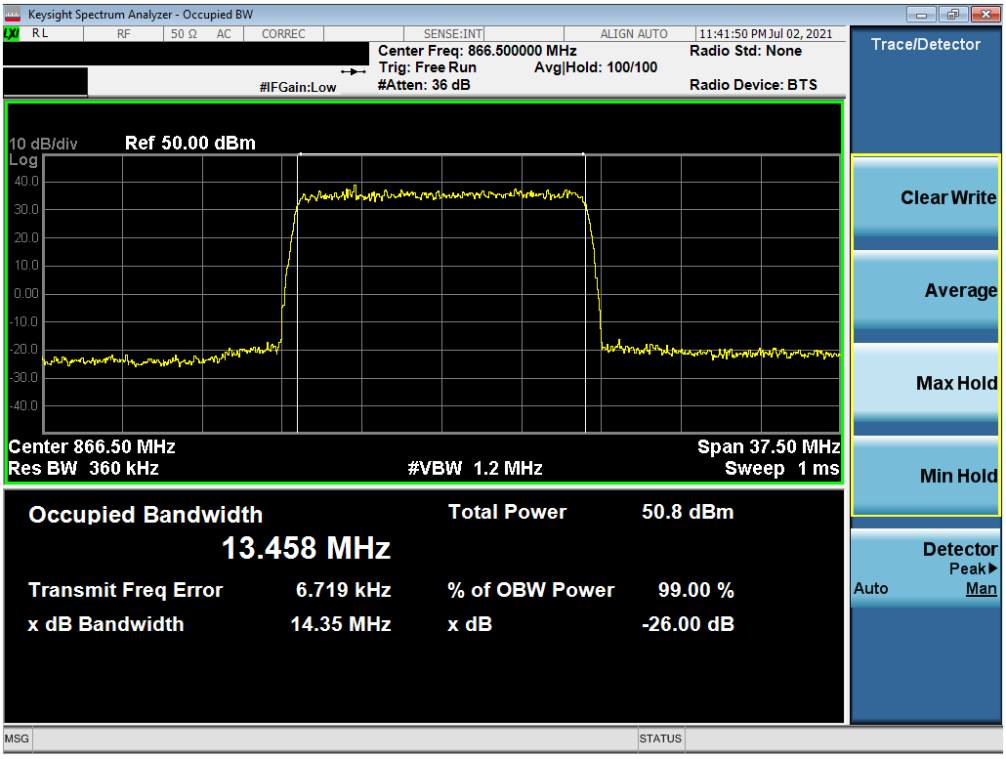


Figure 7-2. Test Instrument & Measurement Setup

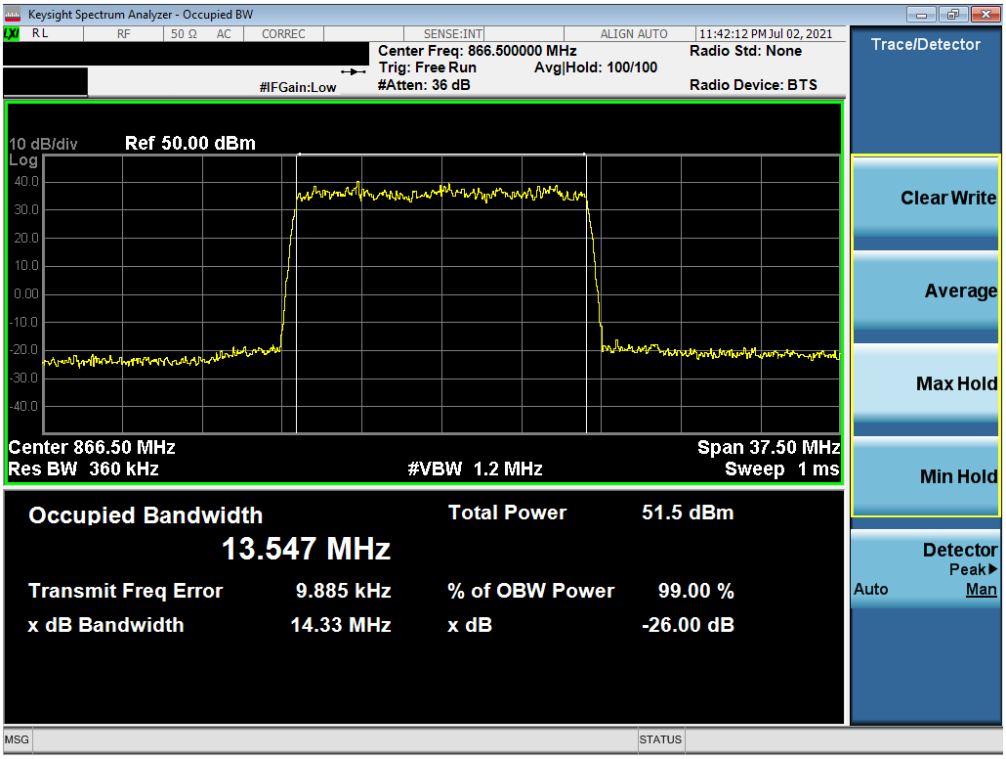
Test Notes

None.

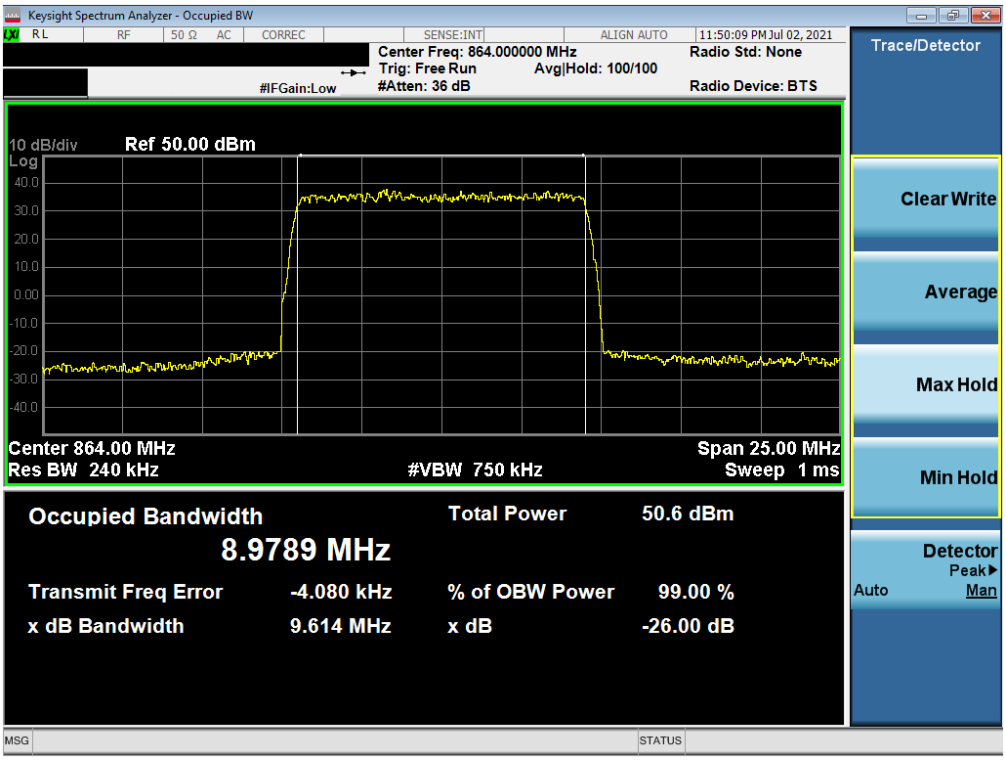
LTE Band 26



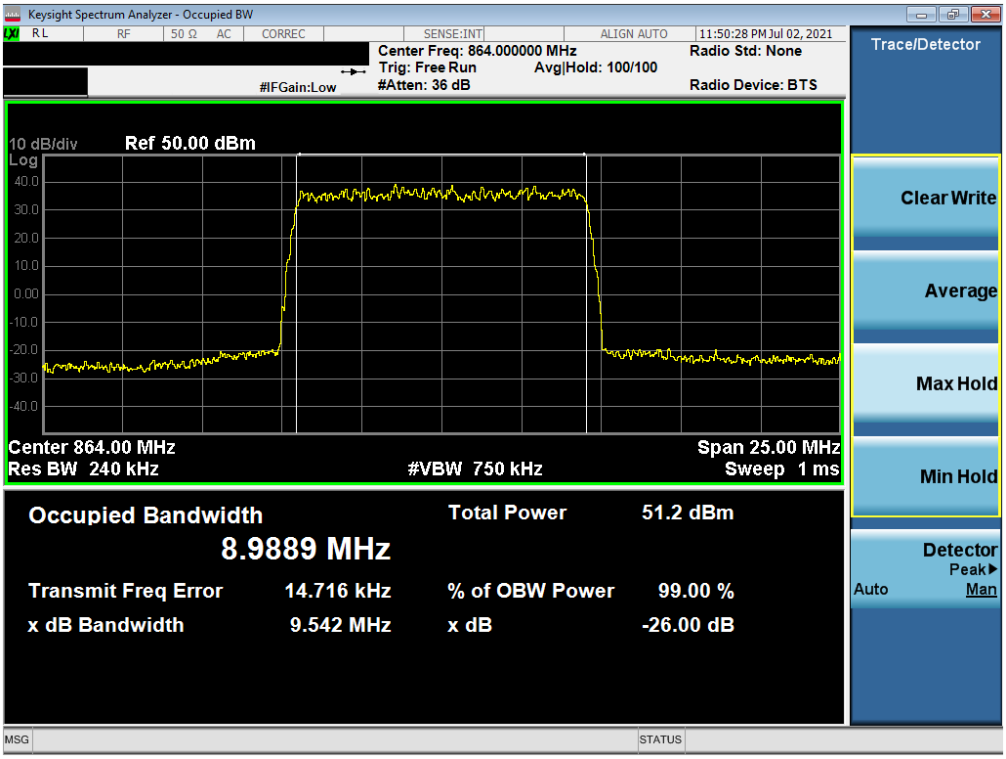
Plot 7-1. Occupied Bandwidth Plot (LTE Band 26 - 15MHz QPSK - Full RB)



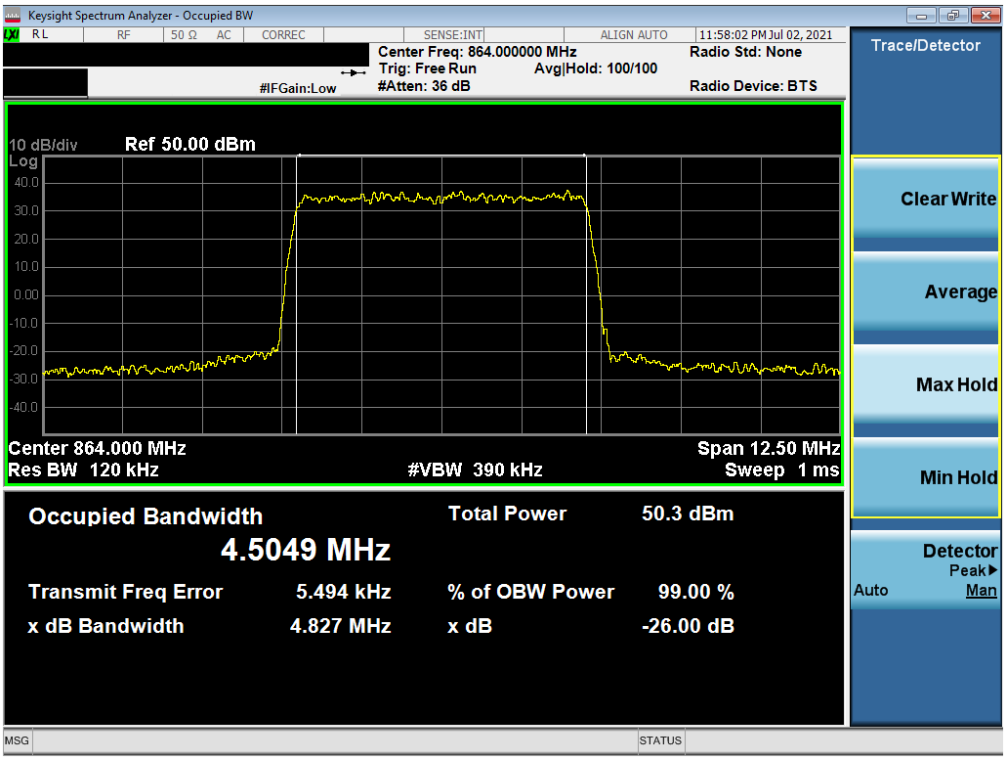
Plot 7-2. Occupied Bandwidth Plot (LTE Band 26 - 15MHz 16-QAM - Full RB)



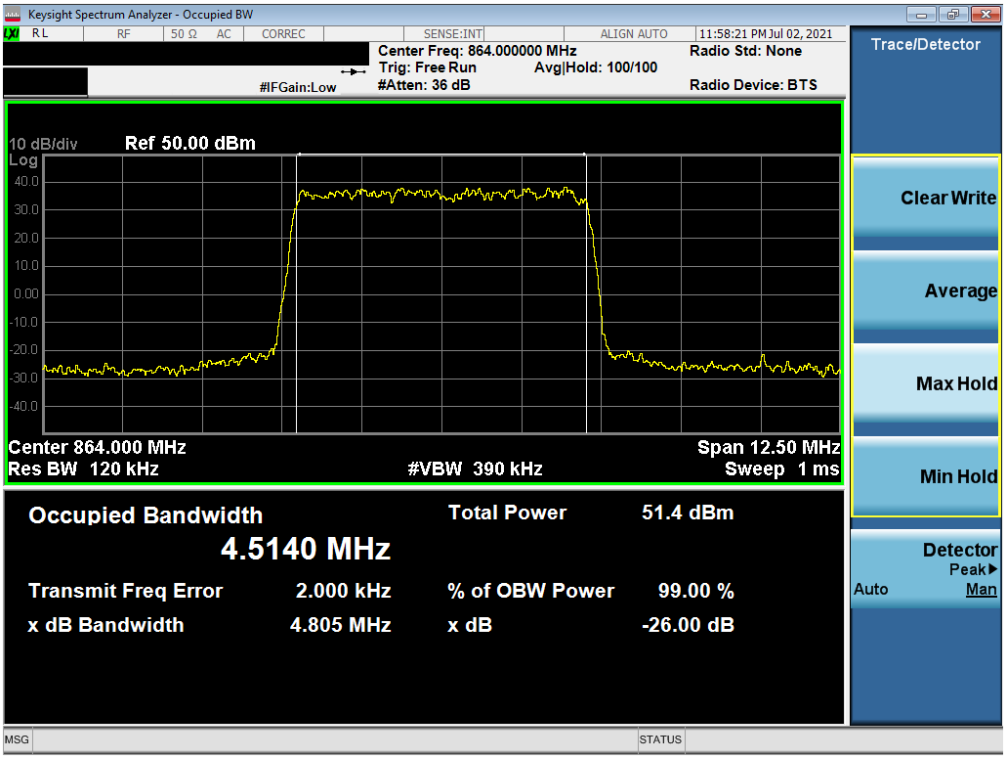
Plot 7-3. Occupied Bandwidth Plot (LTE Band 26 - 10MHz QPSK - Full RB)



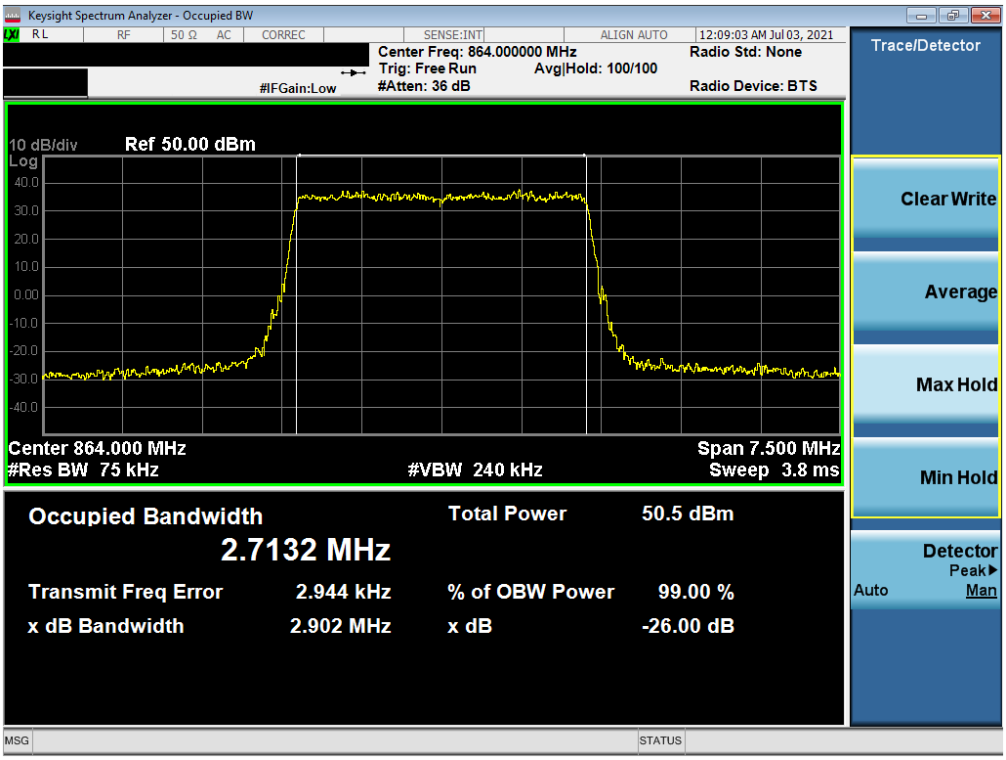
Plot 7-4. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 16-QAM - Full RB)



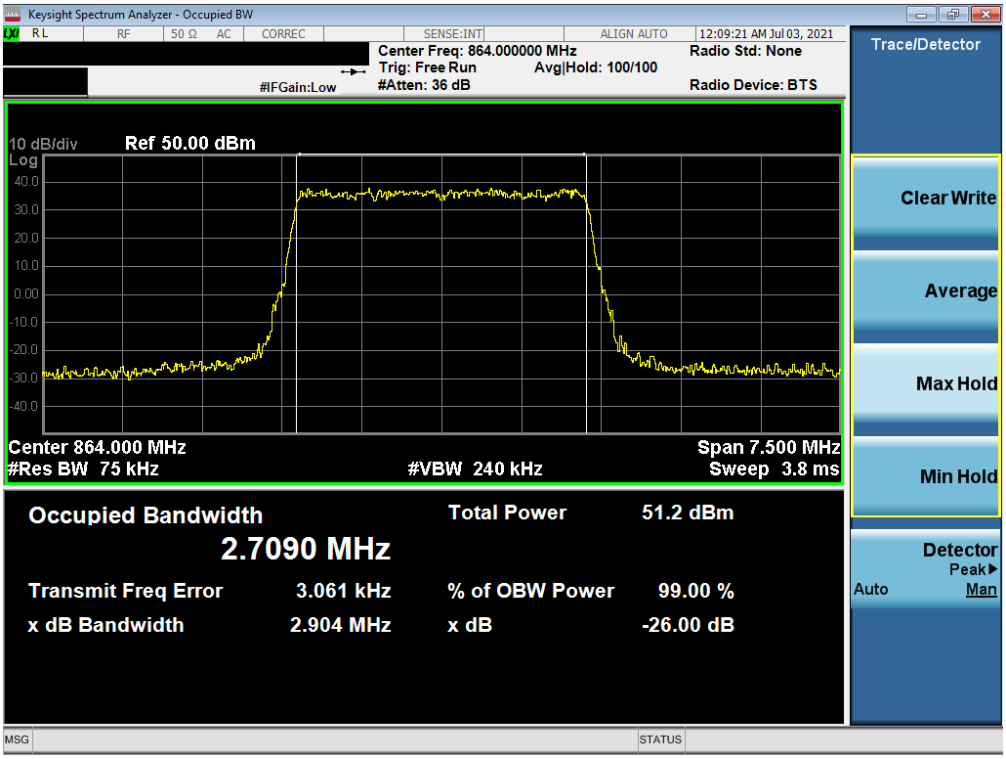
Plot 7-5. Occupied Bandwidth Plot (LTE Band 26 - 5MHz QPSK - Full RB)



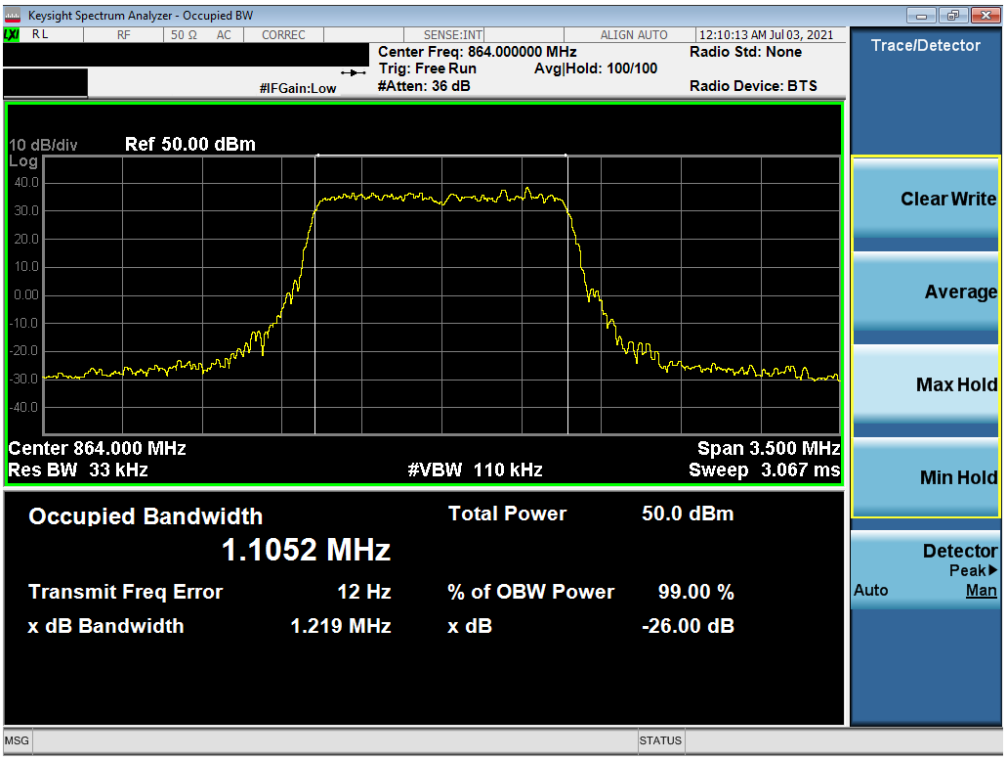
Plot 7-6. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 16-QAM - Full RB)



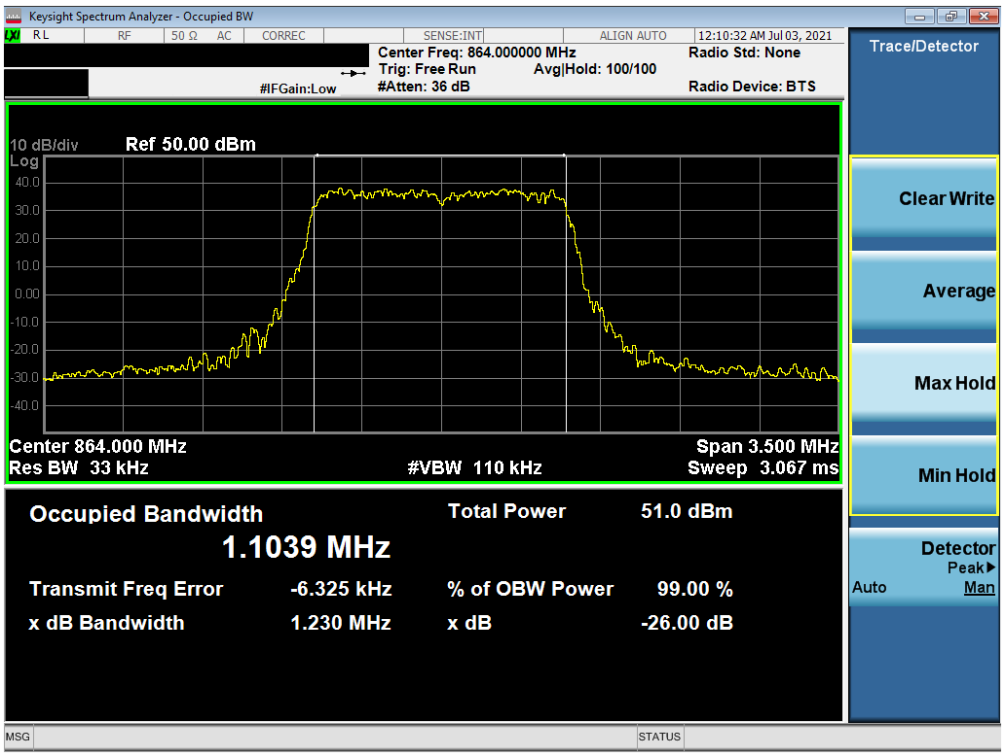
Plot 7-7. Occupied Bandwidth Plot (LTE Band 26 - 3MHz QPSK - Full RB)



Plot 7-8. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 16-QAM - Full RB)

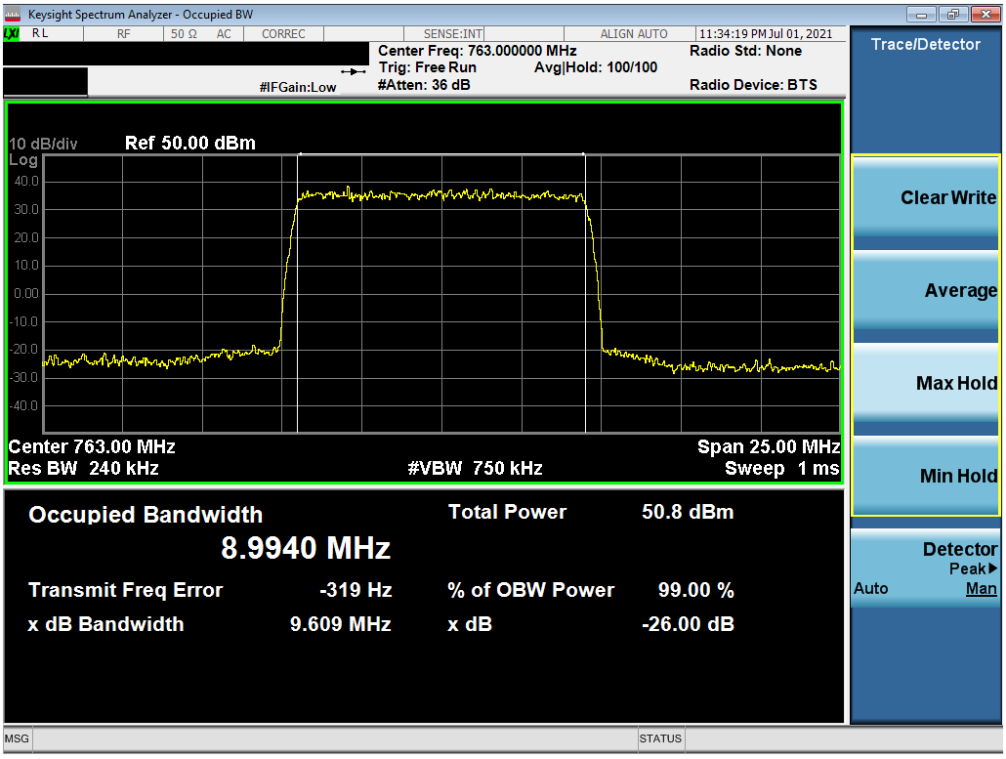


Plot 7-9. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz QPSK - Full RB)

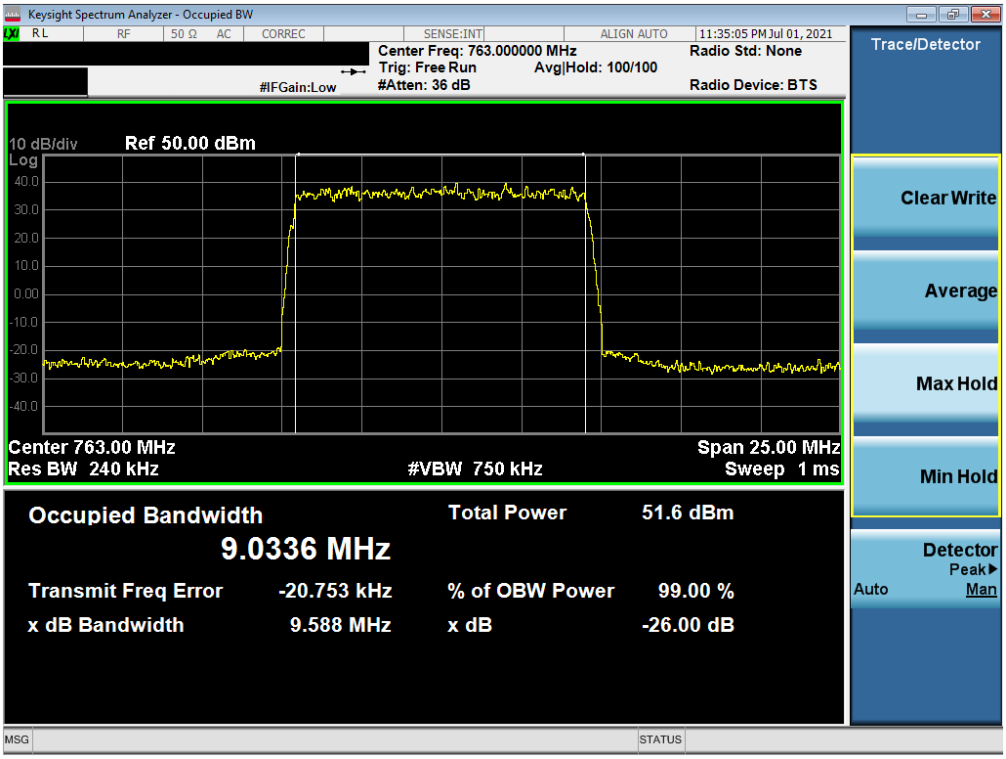


Plot 7-10. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 16-QAM - Full RB)

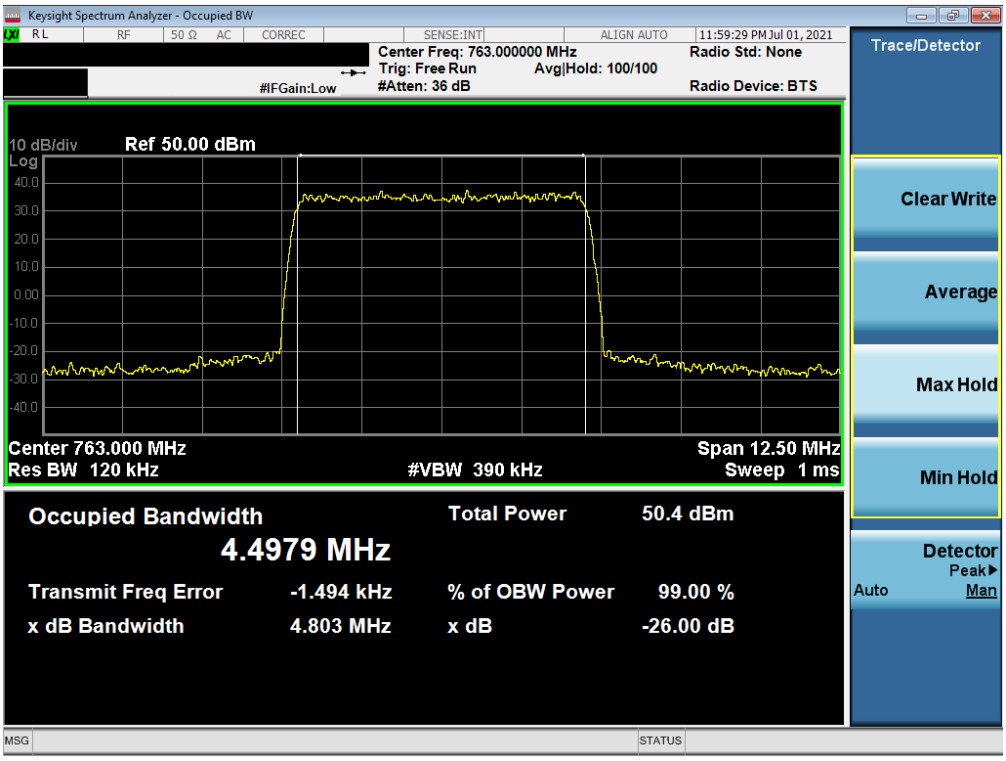
LTE Band 14



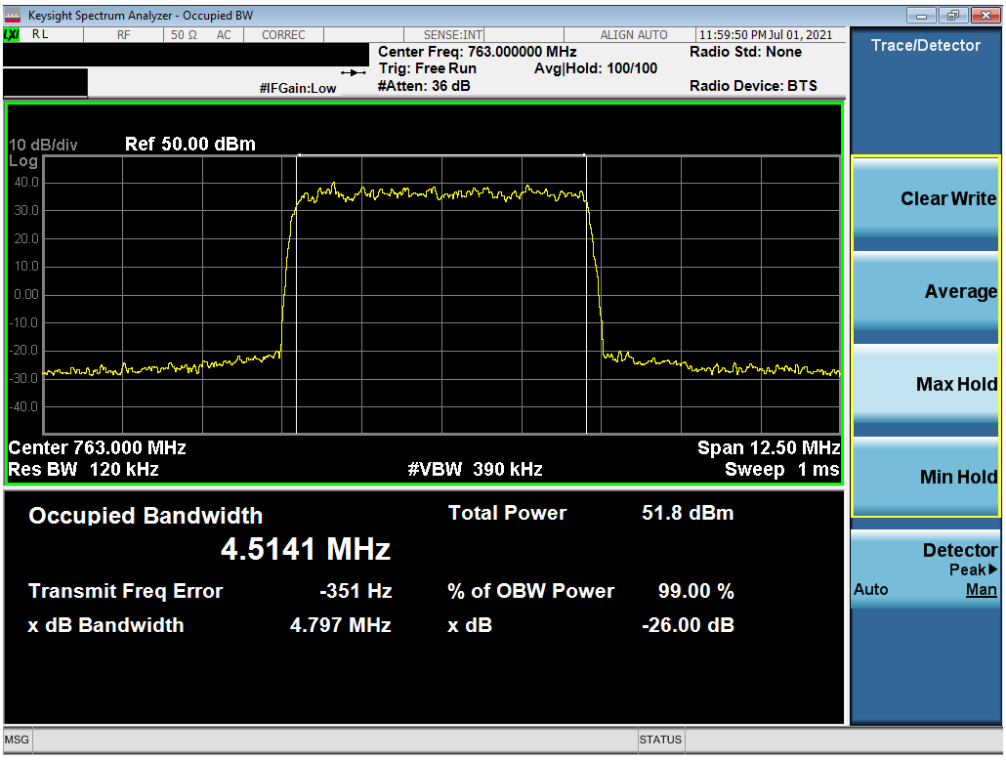
Plot 7-11. Occupied Bandwidth Plot (LTE Band 14 - 10MHz QPSK - Full RB)



Plot 7-12. Occupied Bandwidth Plot (LTE Band 14 - 10MHz 16-QAM - Full RB)



Plot 7-13. Occupied Bandwidth Plot (LTE Band 14 - 5MHz QPSK - Full RB)



Plot 7-14. Occupied Bandwidth Plot (LTE Band 14 - 5MHz 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

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 10GHz (separated into at least two plots per channel)
2. RBW ≥ 100kHz
3. VBW ≥ 3 x RBW
4. Detector = RMS
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

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

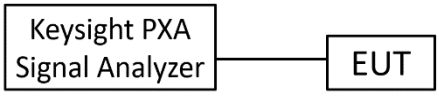
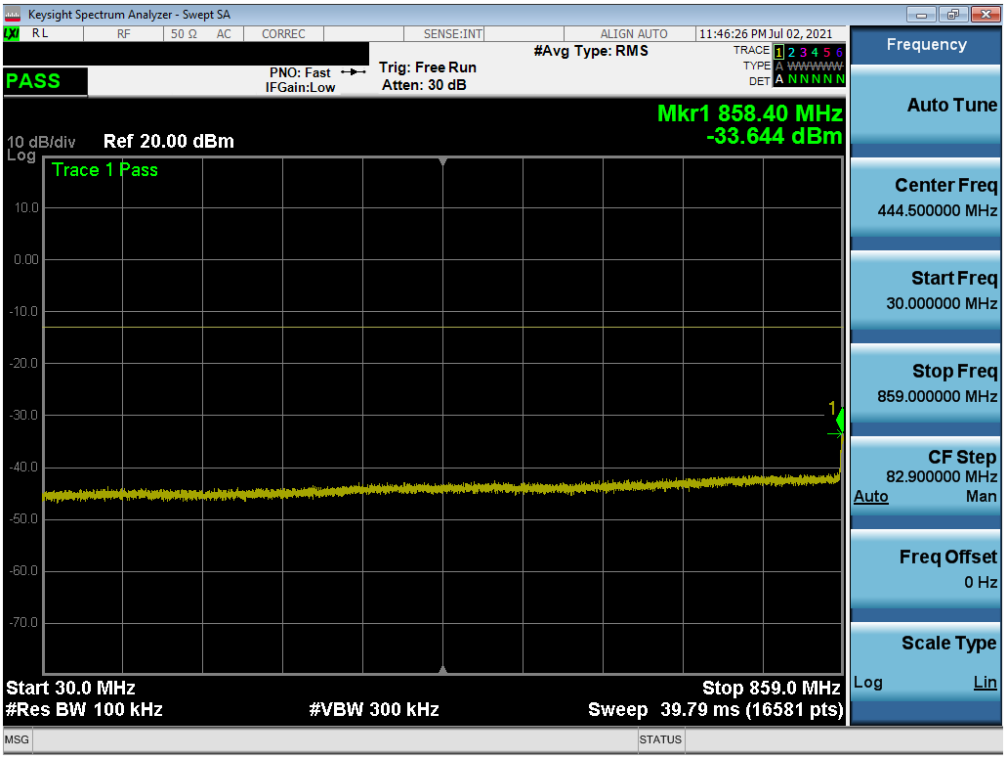


Figure 7-3. Test Instrument & Measurement Setup

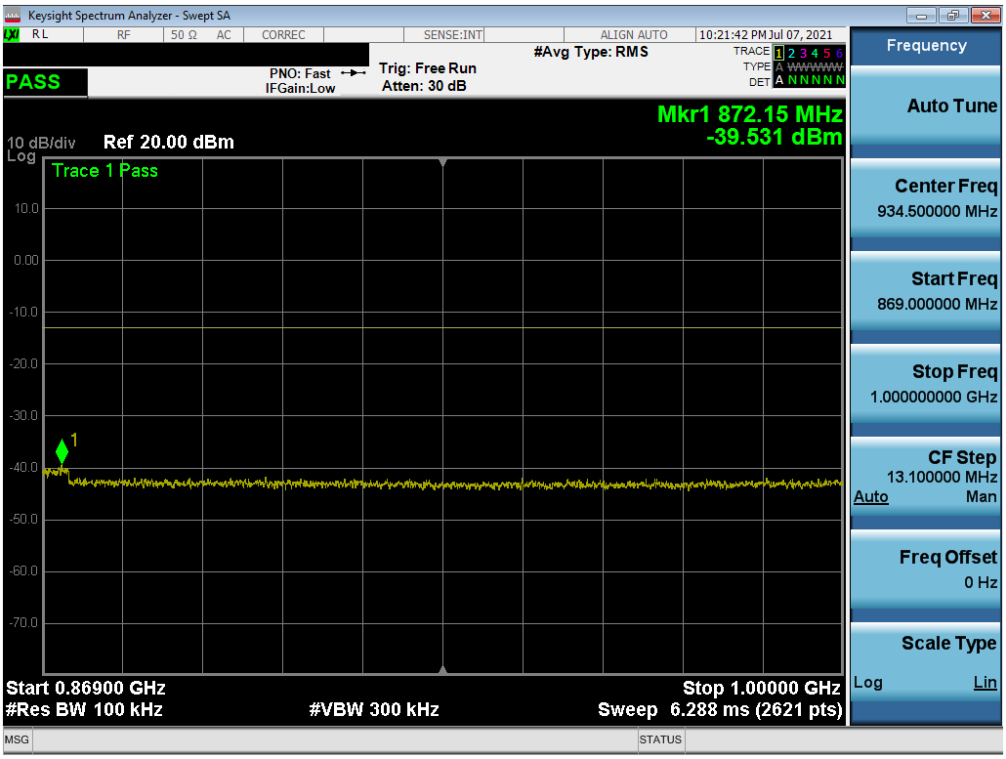
Test Notes

None.

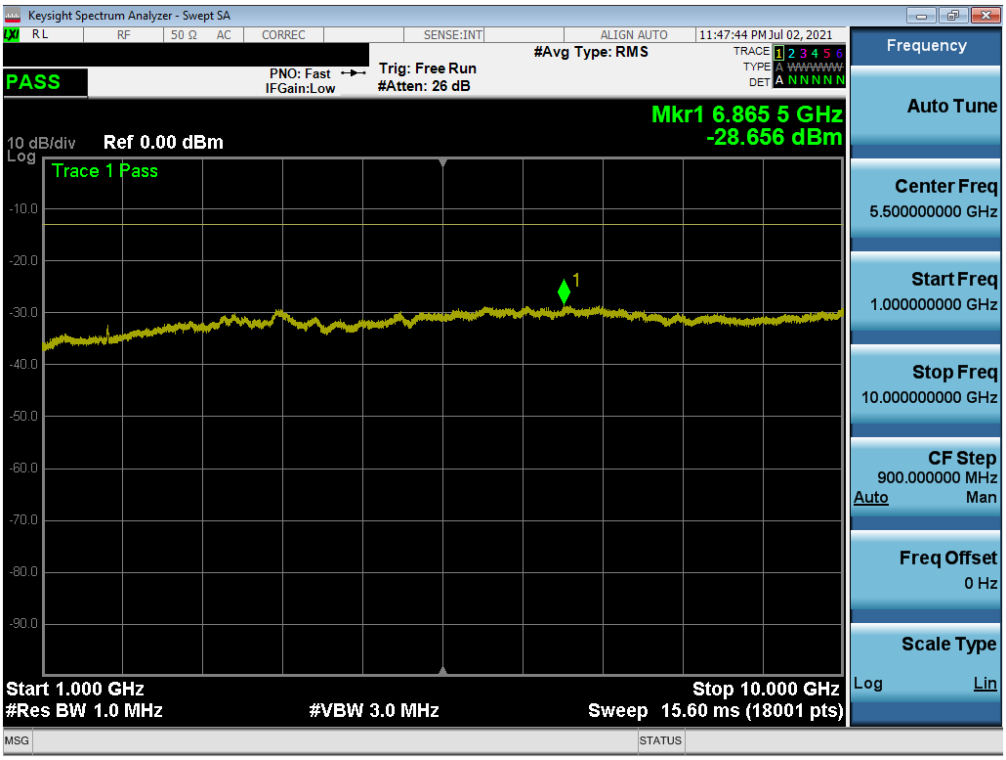
LTE Band 26



Plot 7-15. Conducted Spurious Plot (LTE Band 26 - 15MHz QPSK - Full RB)

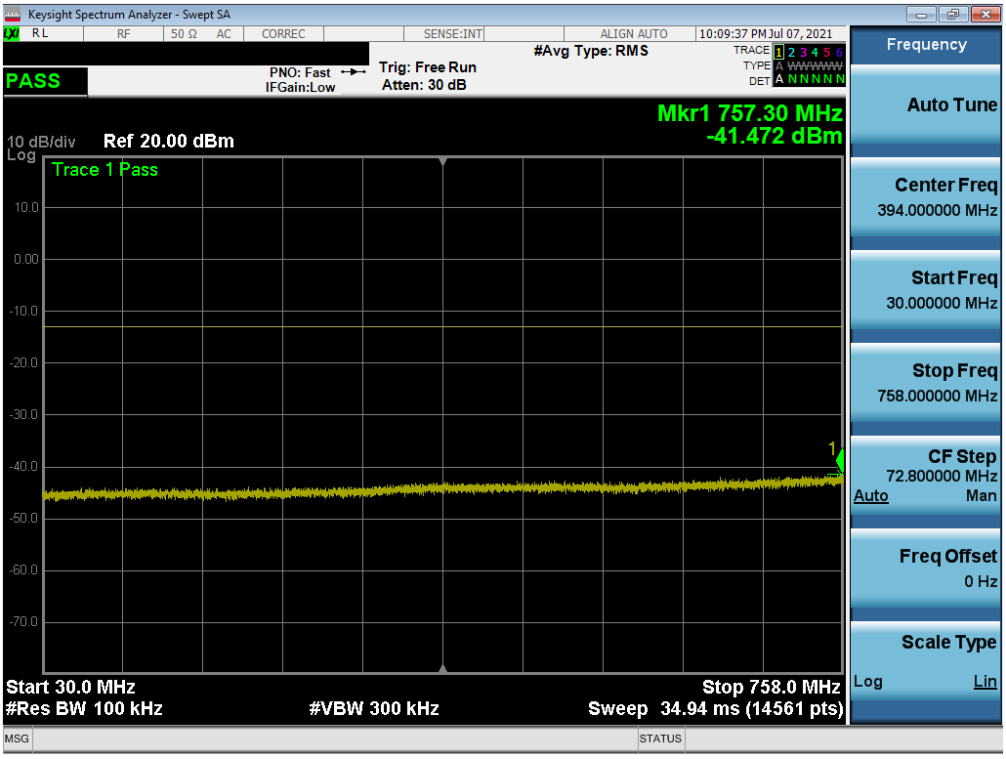


Plot 7-16. Conducted Spurious Plot (LTE Band 26 - 15MHz QPSK - Full RB)

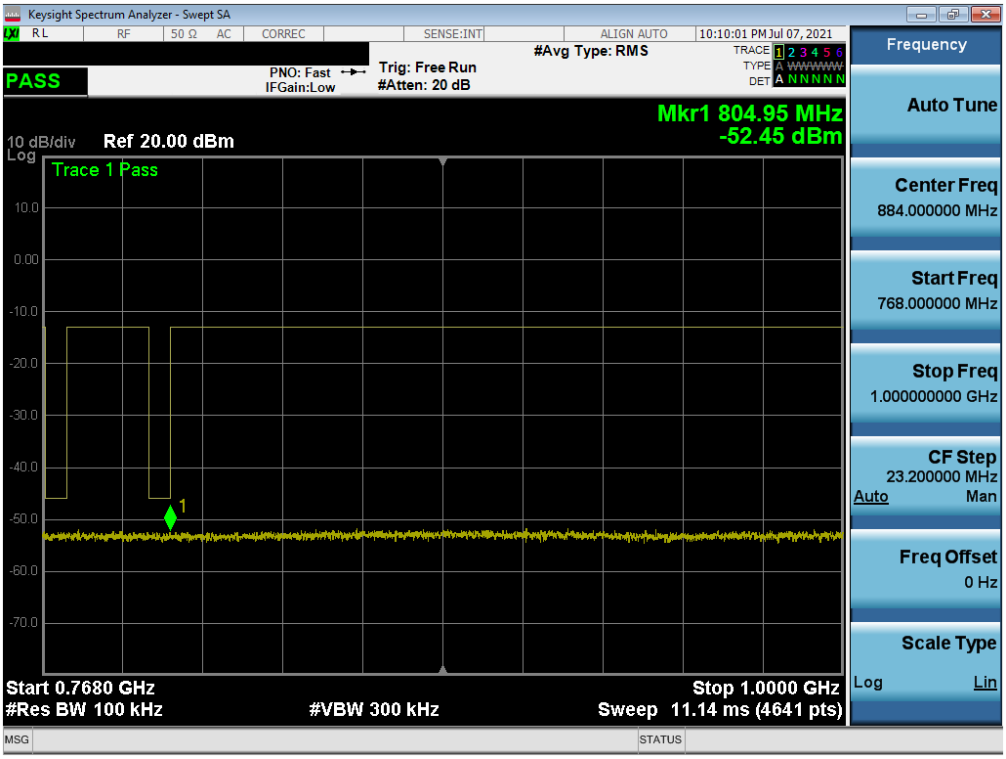


Plot 7-17. Conducted Spurious Plot (LTE Band 26 - 15MHz QPSK - Full RB)

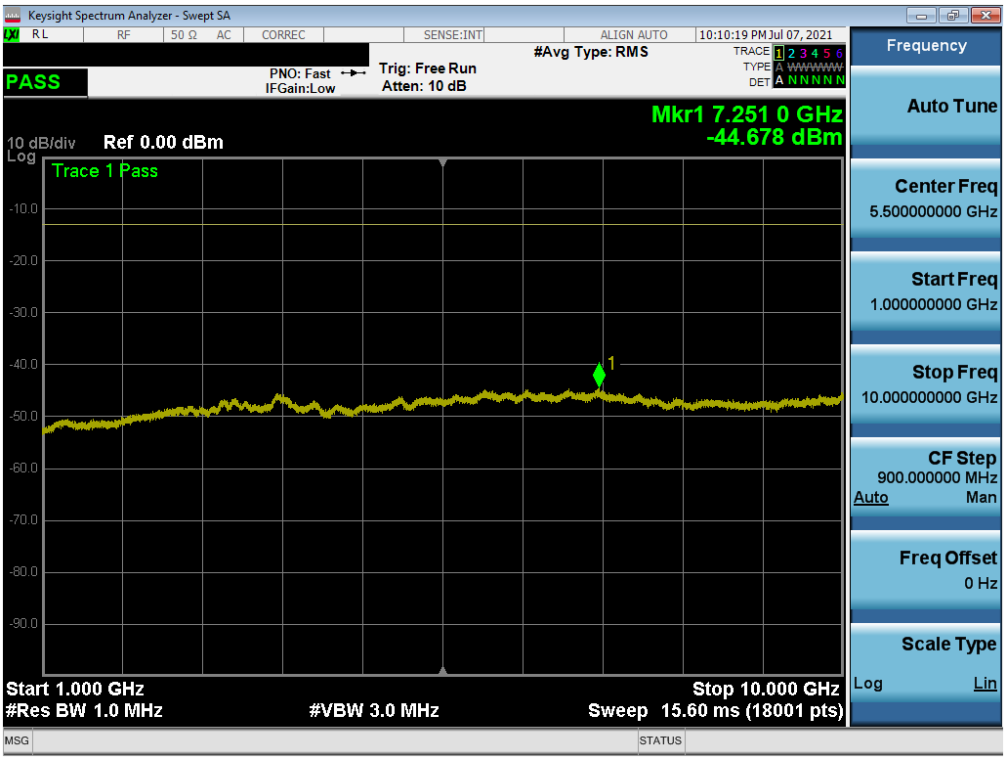
LTE Band 14



Plot 7-18. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - Full RB)



Plot 7-19. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - Full RB)



Plot 7-20. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - Full RB)

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.

For LTE B26 operation under Part 90.691, the minimum permissible attenuation level of any spurious emission removed from the EA licensee's frequency block by greater than 37.5 kHz is 43 + 10log$_{10}$(P$_{[Watts]}$), where P is the transmitter power in Watts. The minimum permissible attenuation level of any spurious emission removed from the EA licensee's frequency block by up to and including 37.5 kHz is 50 + 10log$_{10}$(P$_{[Watts]}$), where P is the transmitter power in Watts.

For LTE Band 14 operation under Part 90.543, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

Additionally, for LTE Band 14 operation, on all frequencies between 769-775 MHz and 799-805 MHz, the power of any emission shall be attenuated by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0
KDB 971168 D02 v02r01 – Section VIII

Test Settings

1. Span was set large enough so as to capture all out of band emissions near the band edge
2. RBW = 100 kHz
3. VBW = 300 kHz
4. Detector = RMS
5. Trace mode = trace average
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

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

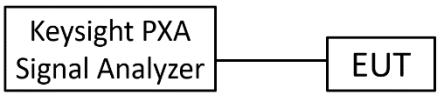


Figure 7-4. Test Instrument & Measurement Setup

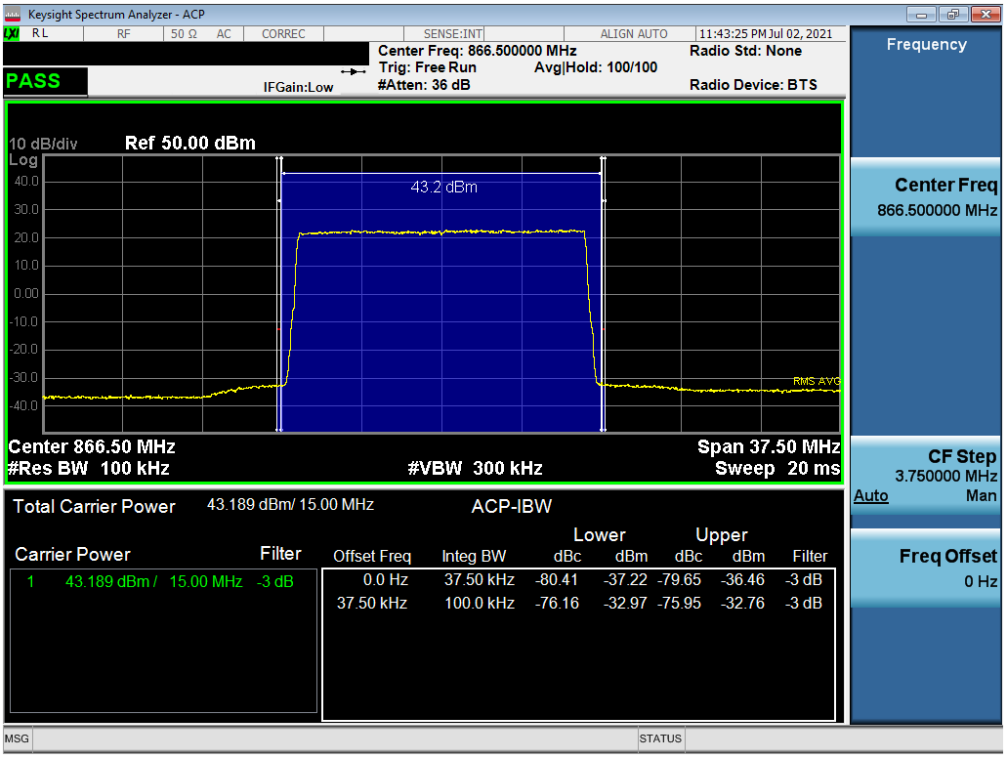
Test Notes

1) For LTE Band 26 channel edge emission, the signal analyzer's "ACP" measurement capability is used.

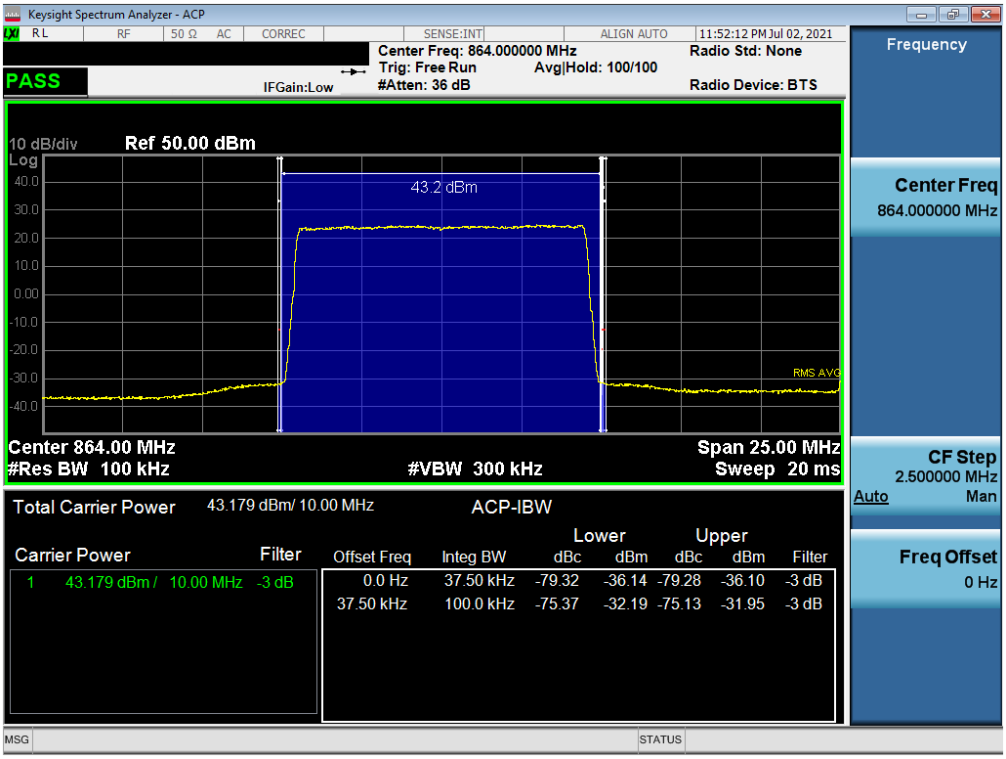
2) For LTE Band 26 channel edge emission compliance testing, an RBW = 300 Hz for offsets less than 37.5 kHz from a channel edge; RBW = 100 kHz for offsets greater than 37.5 kHz was used.

3) Per 90.543(e)(5) for Band 14 operations, in the 100kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30kHz may be employed.

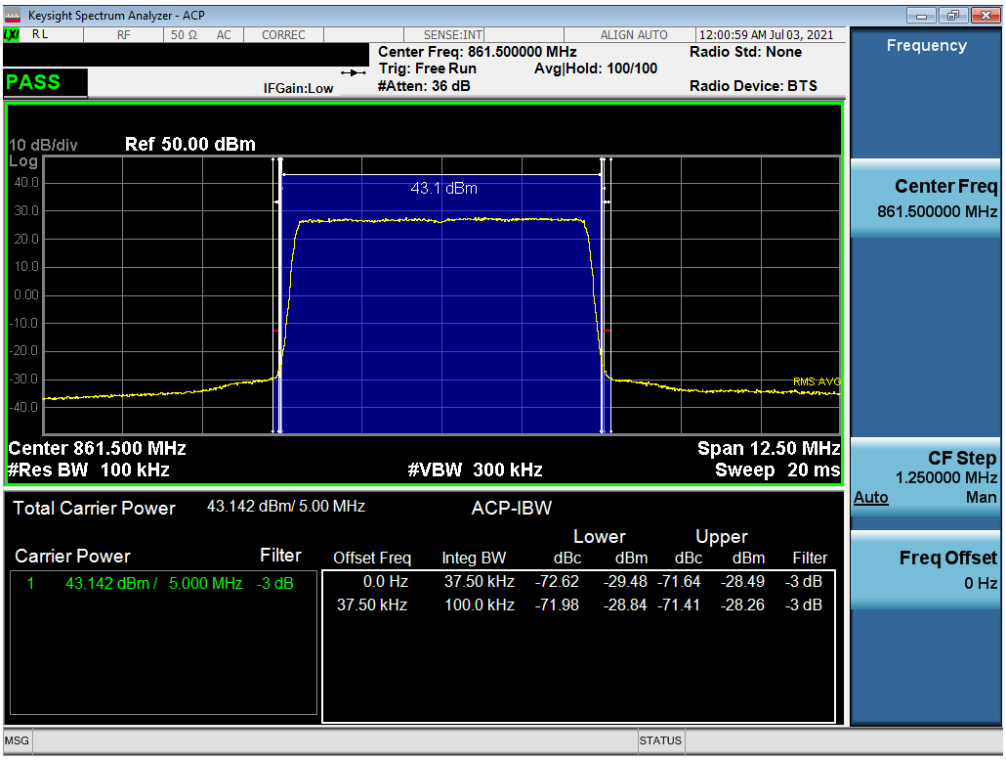
LTE Band 26



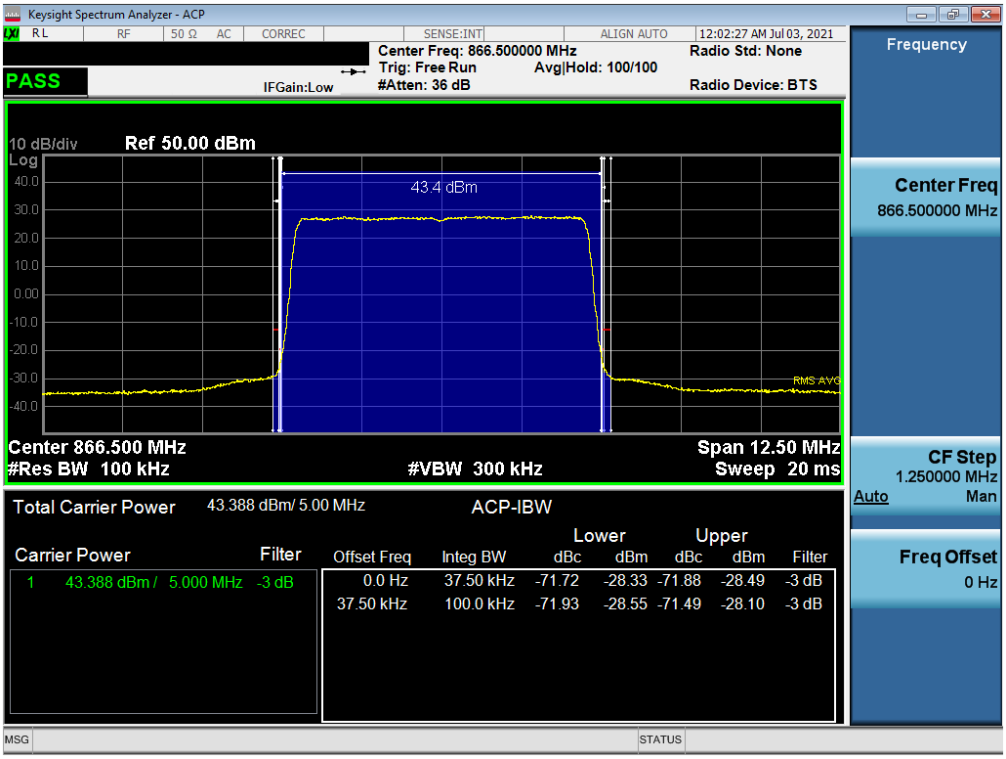
Plot 7-21. Channel Edge Plot (LTE Band 26 - 15MHz QPSK - Mid Channel)



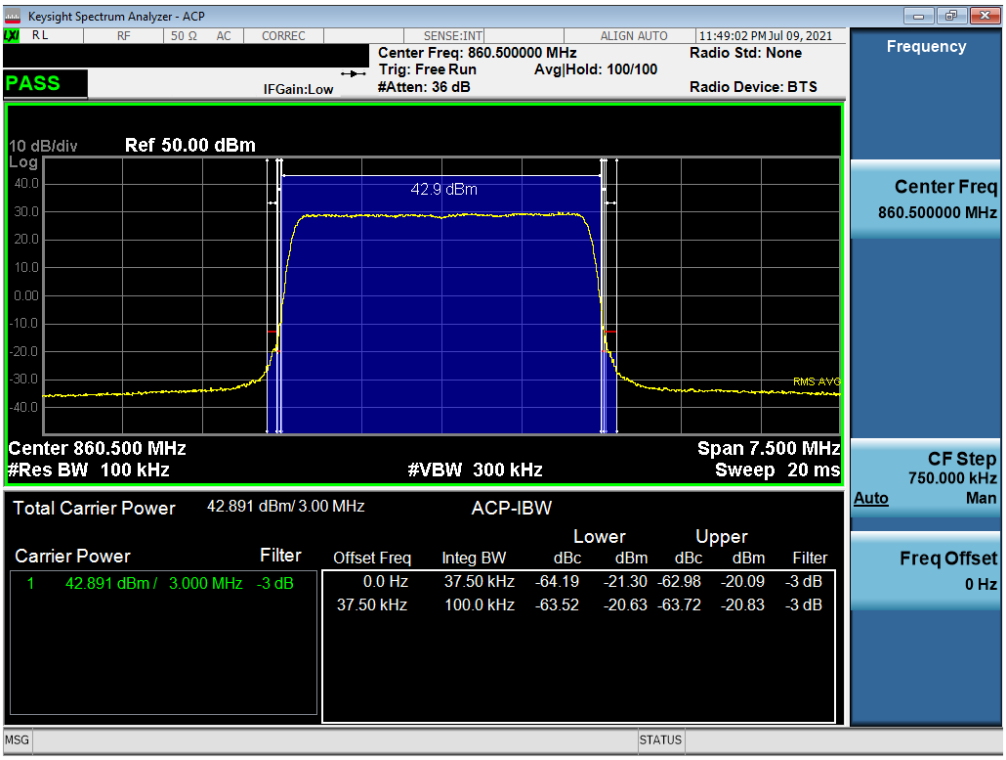
Plot 7-22. Channel Edge Plot (LTE Band 26 - 10MHz QPSK - Mid Channel)



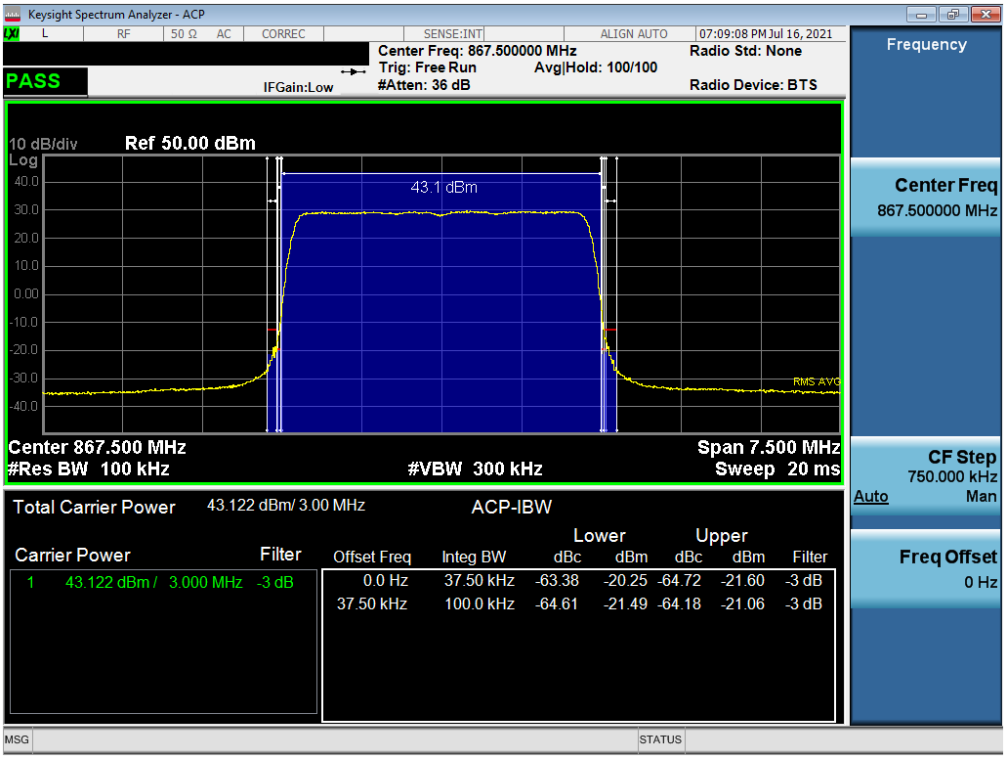
Plot 7-23. Channel Edge Plot (LTE Band 26 - 5MHz QPSK - Low Channel)



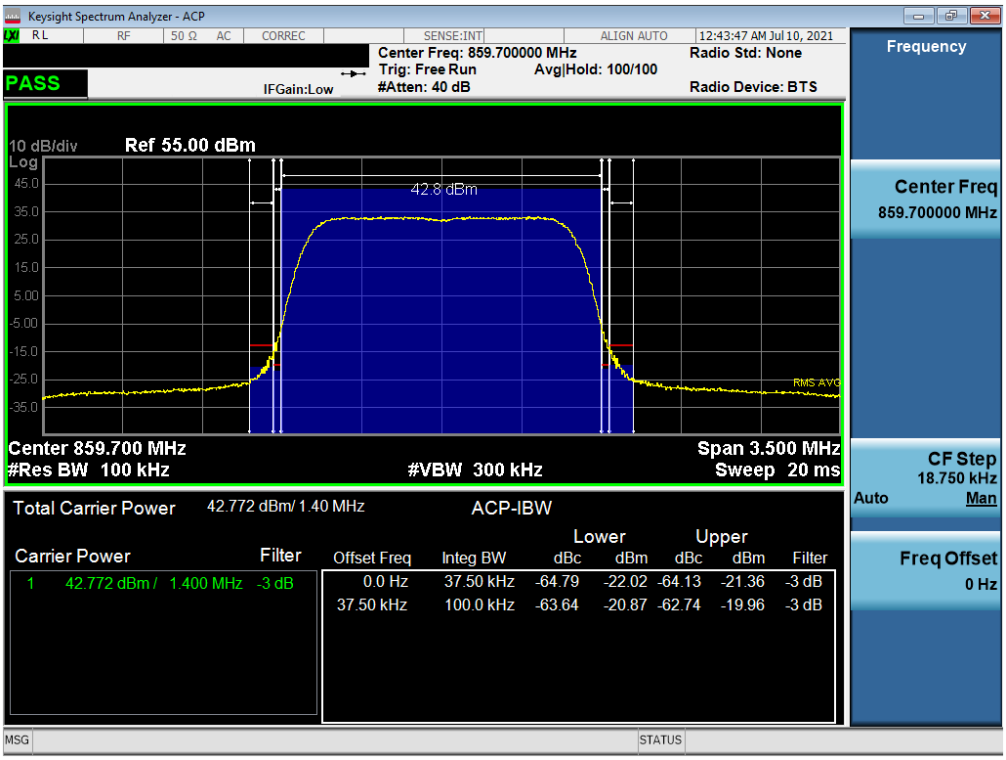
Plot 7-24. Channel Edge Plot (LTE Band 26 - 5MHz QPSK - High Channel)



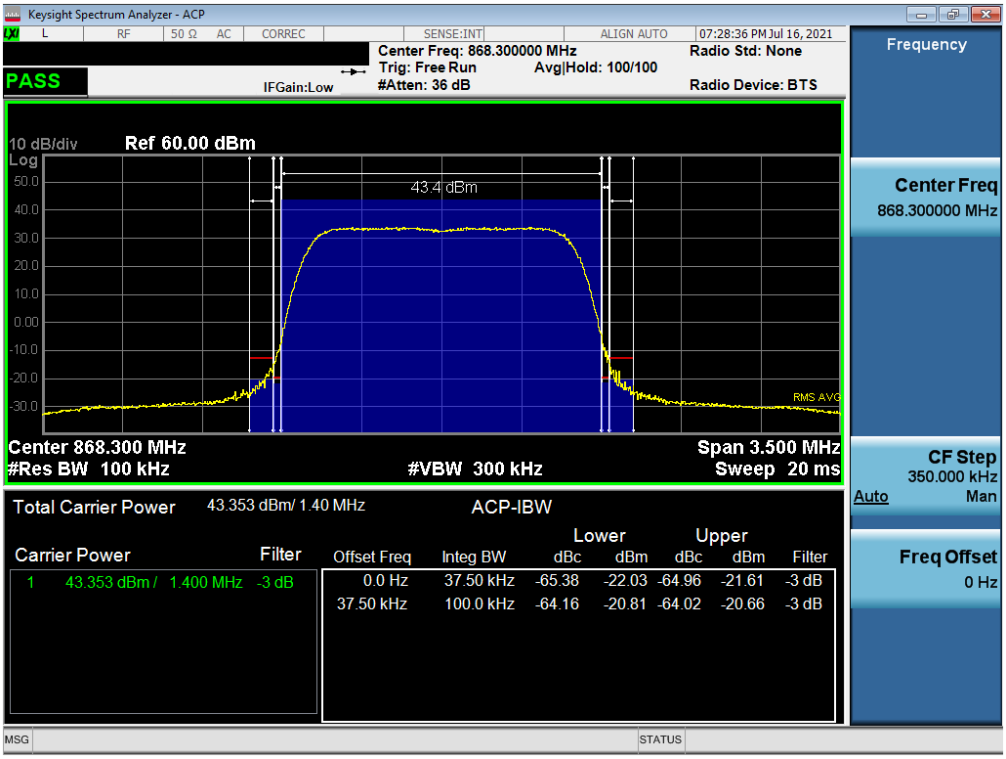
Plot 7-25. Channel Edge Plot (LTE Band 26 - 3MHz QPSK - Low Channel)



Plot 7-26. Channel Edge Plot (LTE Band 26 - 3MHz QPSK - High Channel)

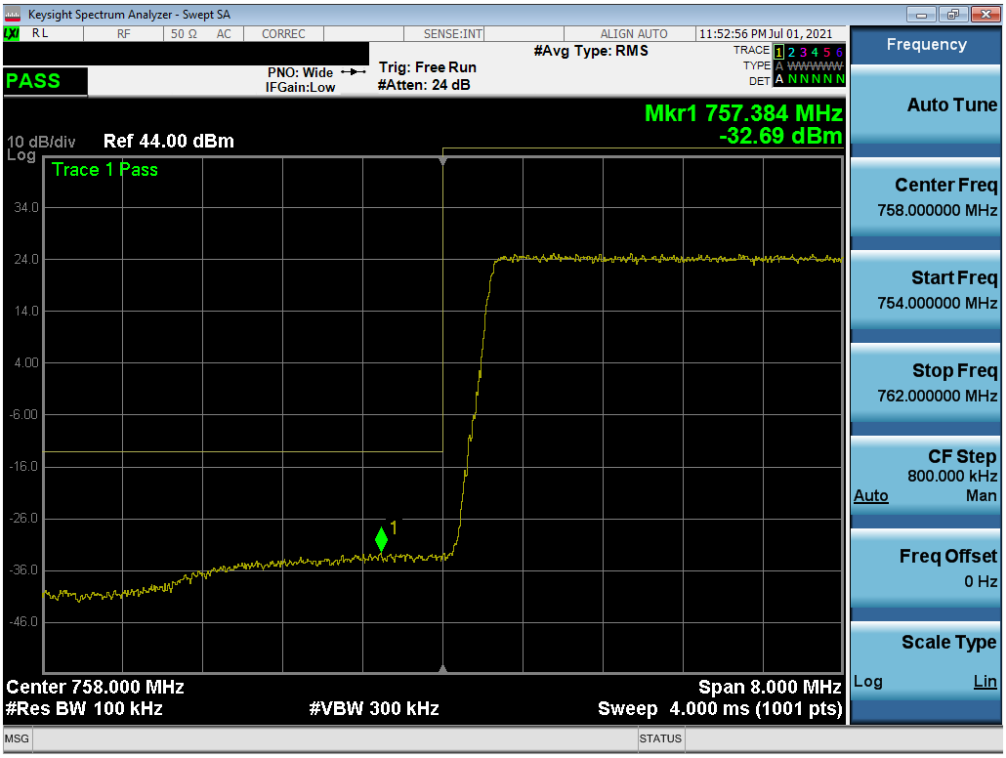


Plot 7-27. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - Low Channel)

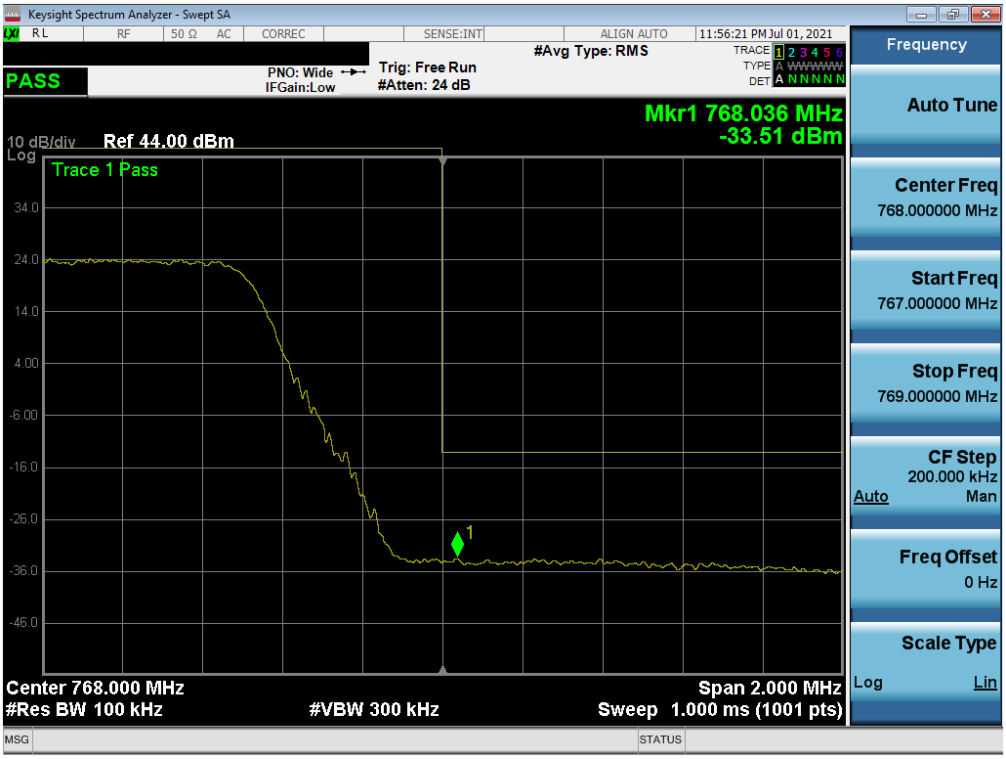


Plot 7-28. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - High Channel)

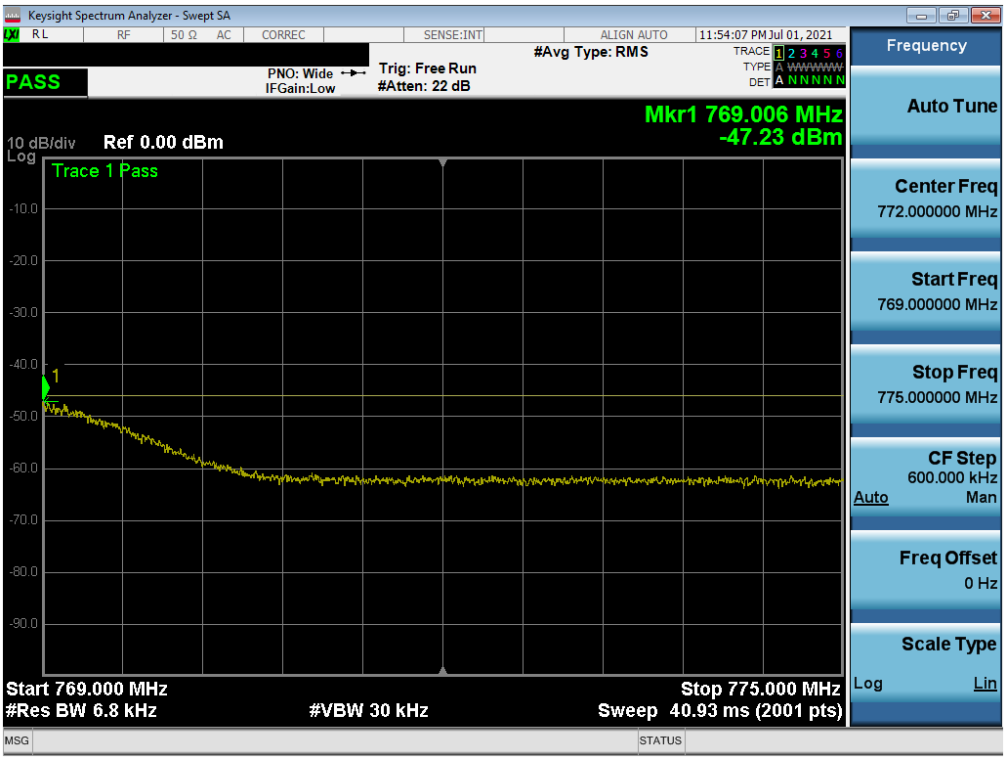
LTE Band 14



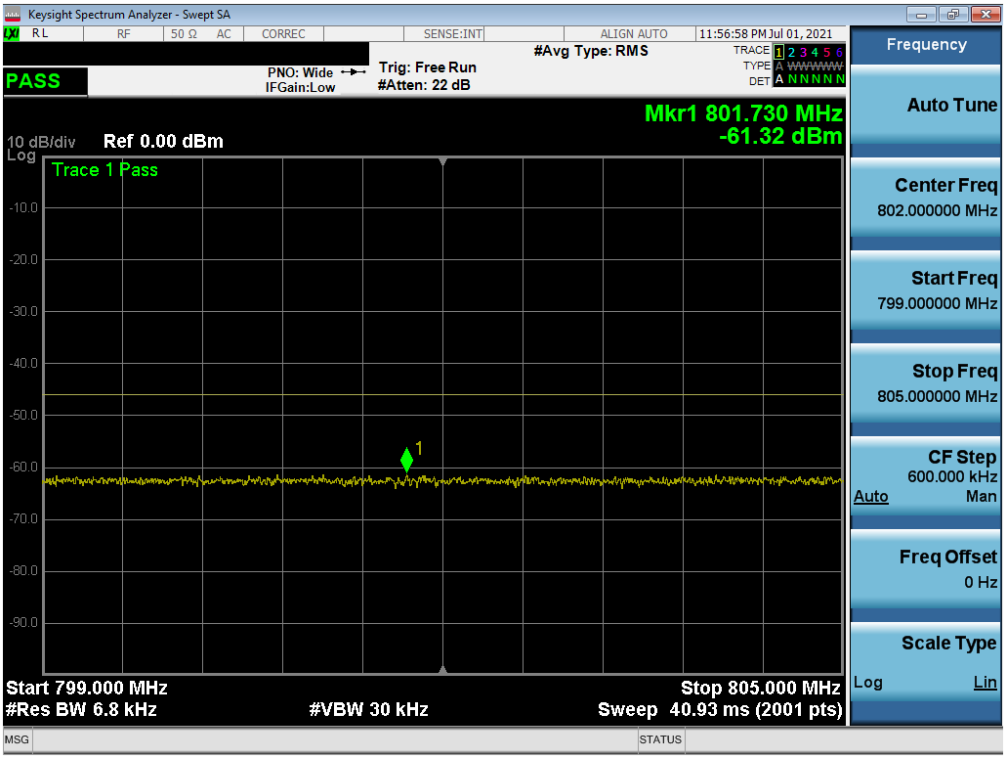
Plot 7-29. Lower Band Edge Plot (LTE Band 14, 10MHz QPSK - RB Size 50)



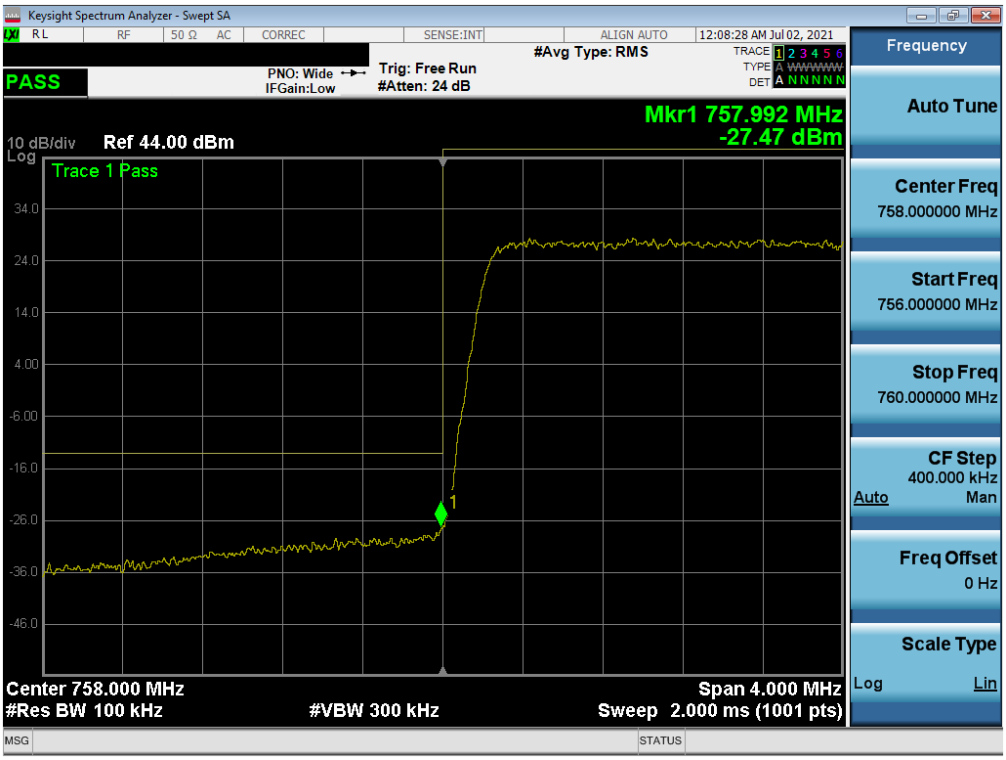
Plot 7-30. Upper Band Edge Plot (LTE Band 14, 10MHz QPSK - RB Size 50)



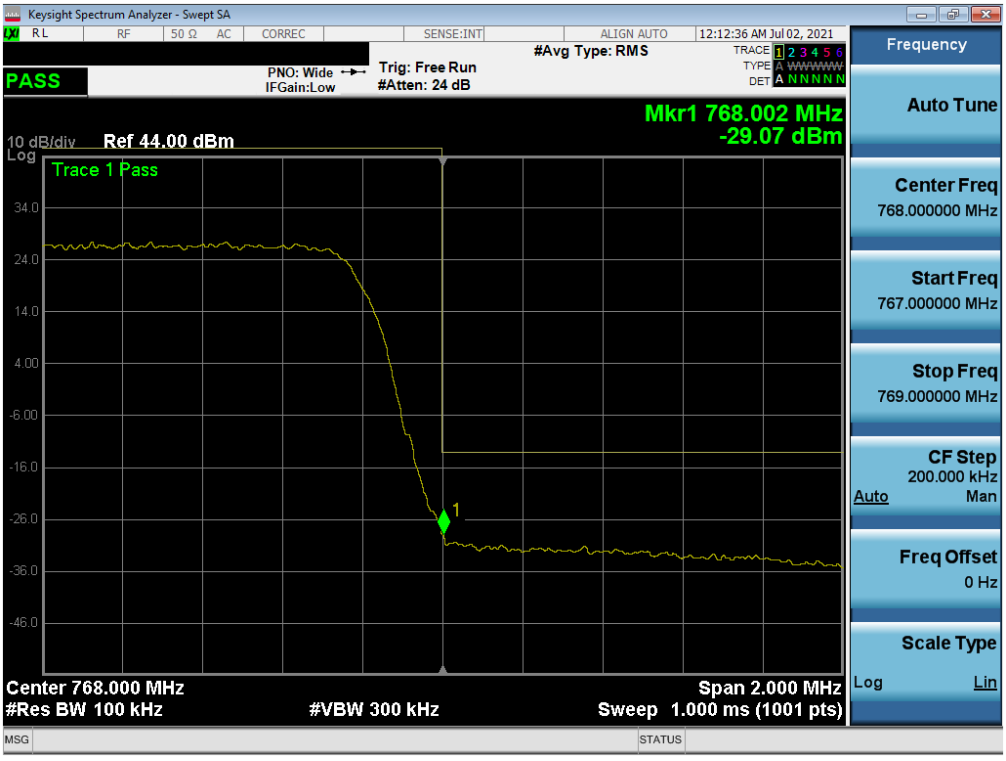
Plot 7-31. Lower Extended Band Edge Plot (LTE Band 14, 10MHz QPSK - RB Size 50)



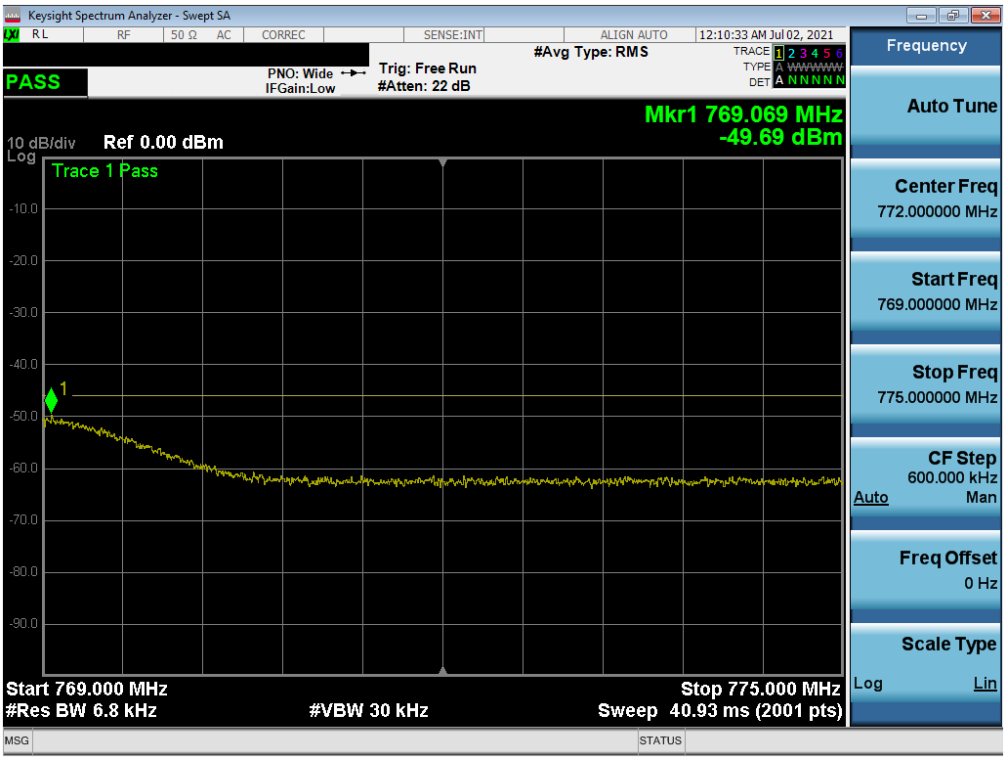
Plot 7-32. Upper Extended Band Edge Plot (LTE Band 14, 10MHz QPSK - RB Size 50)



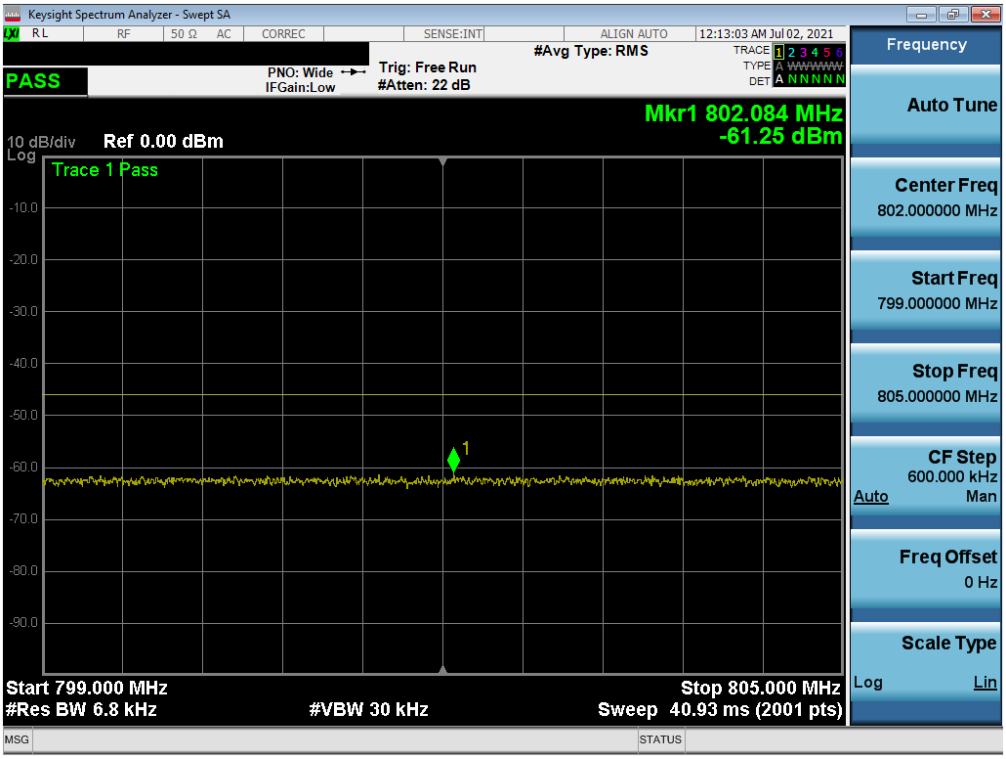
Plot 7-33. Lower Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)



Plot 7-34. Upper Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)



Plot 7-35. Lower Extended Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)



Plot 7-36. Upper Extended Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

7.6 Radiated Spurious Emissions Measurements

Test Overview

Radiated spurious emissions measurements are performed using the field strength conversion method described in KDB 971168 with the EUT transmitting into a 50-ohm termination. Measurements on signals operating below 1GHz are performed using horizontally and vertically polarized tuned dipole antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas. All measurements are performed as 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.

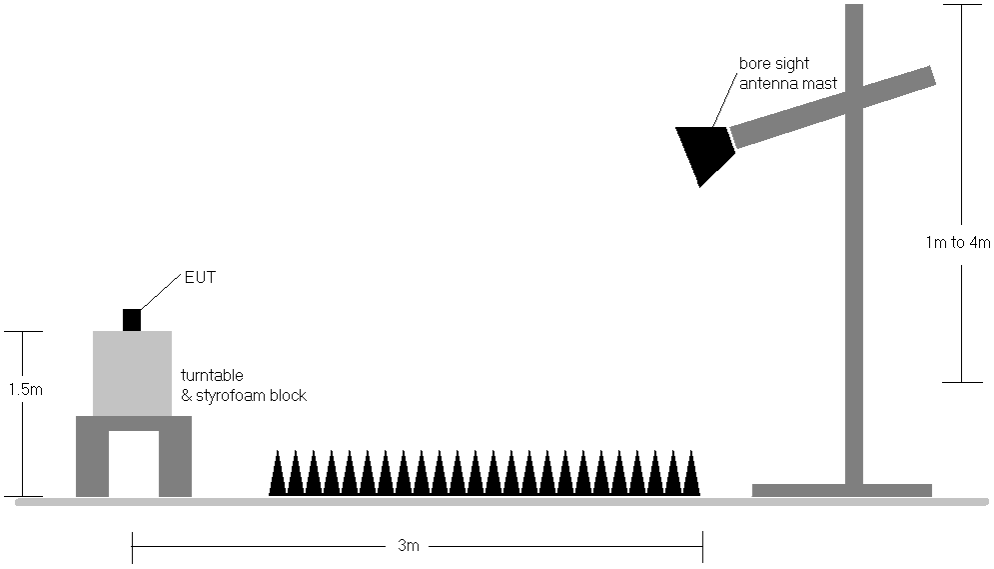


Figure 7-5. Test Instrument & Measurement Setup > 1 GHz

Test Notes

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

2. For LTE mode, the device was tested under all modulations and channel bandwidth configurations, and the worst case emissions are reported.

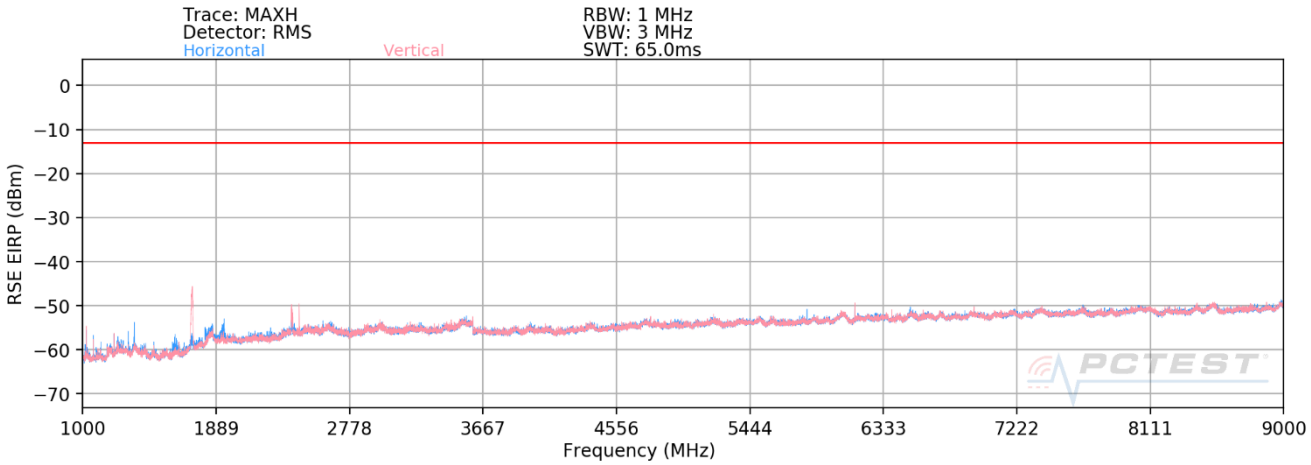
3. This unit was tested with an external 120 VAC power source

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

5. The EUT was also tested with all four LTE bands transmitting at the same time for a total of 80W output power. The worst-case emissions are reported.

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

LTE Band 26



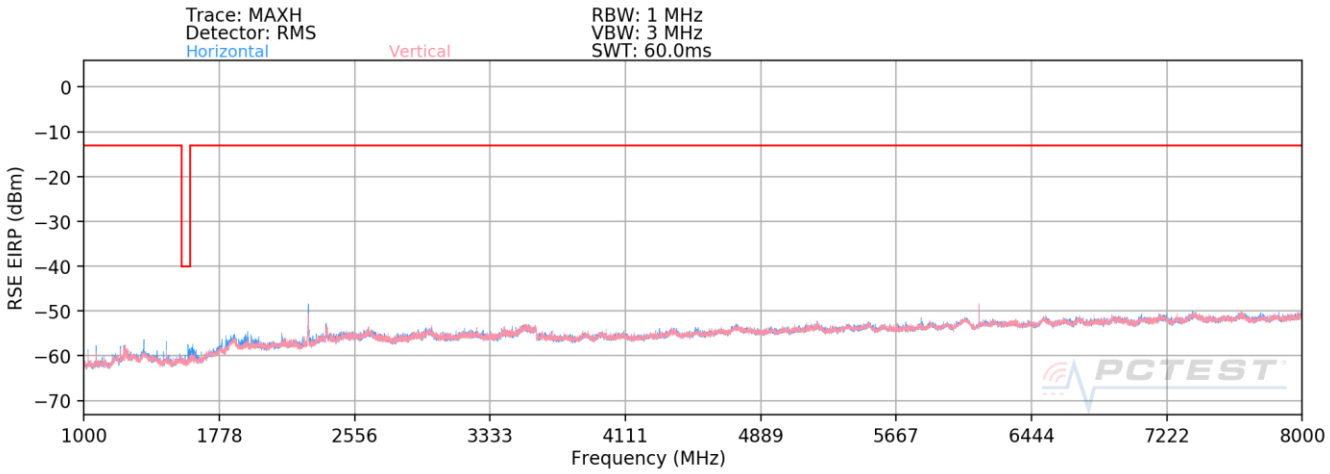
Plot 7-37. Radiated Spurious Plot (LTE Band 26)

Bandwidth (MHz):	10
Frequency (MHz):	864.0
Modulation Signal:	QPSK
RB Config (Size / Offset):	50 / 0

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]
1728.0	V	214	8	-59.47	-2.46	45.07	-50.19	-13.00	-37.19
2592.0	V	-	-	-76.49	1.55	32.06	-63.20	-13.00	-50.20
3456.0	V	192	12	-73.68	2.76	36.08	-59.18	-13.00	-46.18
4320.0	V	-	-	-77.82	3.94	33.12	-62.14	-13.00	-49.14
5184.0	V	-	-	-78.91	4.58	32.67	-62.59	-13.00	-49.59
6048.0	V	-	-	-78.93	5.98	34.05	-61.20	-13.00	-48.20

Table 7-4. Radiated Spurious Data (LTE Band 26 – Mid Channel)

LTE Band 14



Plot 7-38. Radiated Spurious Plot (LTE Band 14)

Bandwidth (MHz):	5
Frequency (MHz):	760.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	25 / 0

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]
1521.0	H	174	49	-73.66	-2.88	30.46	-64.80	-13.00	-51.80
2281.5	H	234	278	-70.94	1.11	37.17	-58.09	-13.00	-45.09
3042.0	H	-	-	-75.81	2.43	33.62	-61.64	-13.00	-48.64
3802.5	H	-	-	-77.27	3.13	32.86	-62.40	-13.00	-49.40
4563.0	H	-	-	-78.01	4.20	33.19	-62.06	-13.00	-49.06

Table 7-5. Radiated Spurious Data (LTE Band 14 – Low Channel)

Bandwidth (MHz):	5
Frequency (MHz):	763.0
Modulation Signal:	QPSK
RB Config (Size / Offset):	25 / 0

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]
1526.0	H	365	266	-76.01	-2.74	28.25	-67.01	-13.00	-54.01
2289.0	H	197	212	-66.46	1.02	41.56	-53.69	-13.00	-40.69
3052.0	H	-	-	-75.66	2.37	33.71	-61.55	-13.00	-48.55
3815.0	H	-	-	-77.53	3.15	32.62	-62.64	-13.00	-49.64
4578.0	H	-	-	-77.57	4.30	33.73	-61.53	-13.00	-48.53
5341.0	H	-	-	-78.22	5.42	34.20	-61.05	-13.00	-48.05
6104.0	H	-	-	-79.15	6.37	34.22	-61.04	-13.00	-48.04

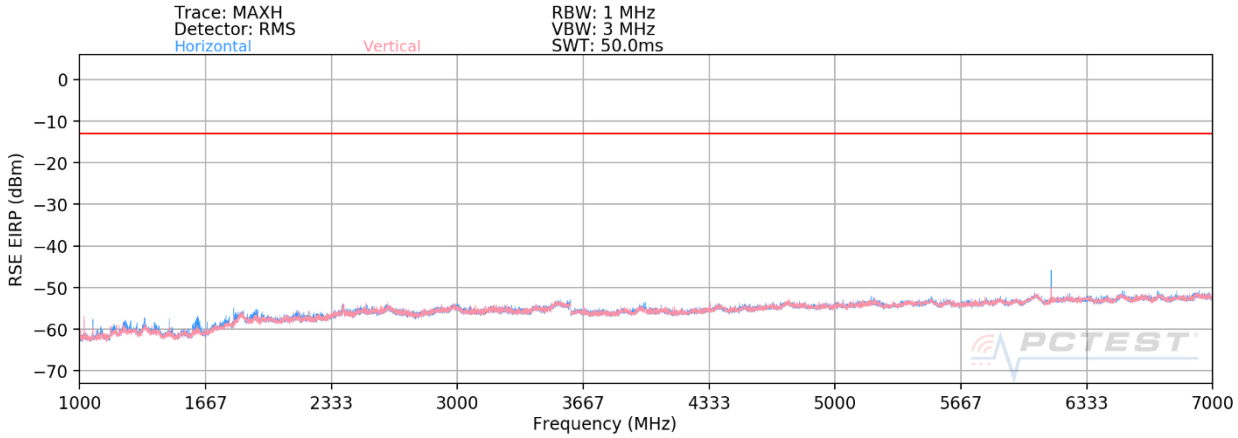
Table 7-6. Radiated Spurious Data (LTE Band 14 – Mid Channel)

Bandwidth (MHz):	5
Frequency (MHz):	765.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	25 / 0

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]
1531.0	H	153	237	-74.62	-2.61	29.77	-65.48	-13.00	-52.48
2296.5	H	286	21	-75.06	0.98	32.92	-62.34	-13.00	-49.34
3062.0	H	-	-	-76.88	2.28	32.40	-62.86	-13.00	-49.86
3827.5	H	-	-	-77.94	3.12	32.18	-63.08	-13.00	-50.08
4593.0	H	-	-	-77.47	4.53	34.06	-61.20	-13.00	-48.20

Table 7-7. Radiated Spurious Data (LTE Band 14 – High Channel)

LTE Band 71 – 12 – 14 – 26



Plot 7-39. Radiated Spurious Plot (LTE Band 71 – 12 – 14 – 26)

Mode:	LTE Band 71 + 12 + 14 + 26
Bandwidth (MHz):	20 + 10 + 10 + 15
Frequency (MHz):	634.5 + 737.5 + 763 + 881.5

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]
1023.5	H	149	347	-67.43	-3.76	35.81	-59.45	-13.00	-46.45
1070.3	H	136	346	-65.65	-3.42	37.93	-57.32	-13.00	-44.32
1966.1	H	269	287	-69.66	1.04	38.38	-56.88	-13.00	-43.88
6144.0	H	180	174	-64.93	6.70	48.77	-46.49	-13.00	-33.49
7052.0	H	-	-	-78.54	7.12	35.58	-59.68	-13.00	-46.68

Table 7-8. Radiated Spurious Data (LTE Band 71 – 12 – 14 – 26) – Mid Channel)

7.7 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.

The frequency stability of the transmitter shall be maintained within ±0.00015% (±1.5 ppm) of the center frequency.

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

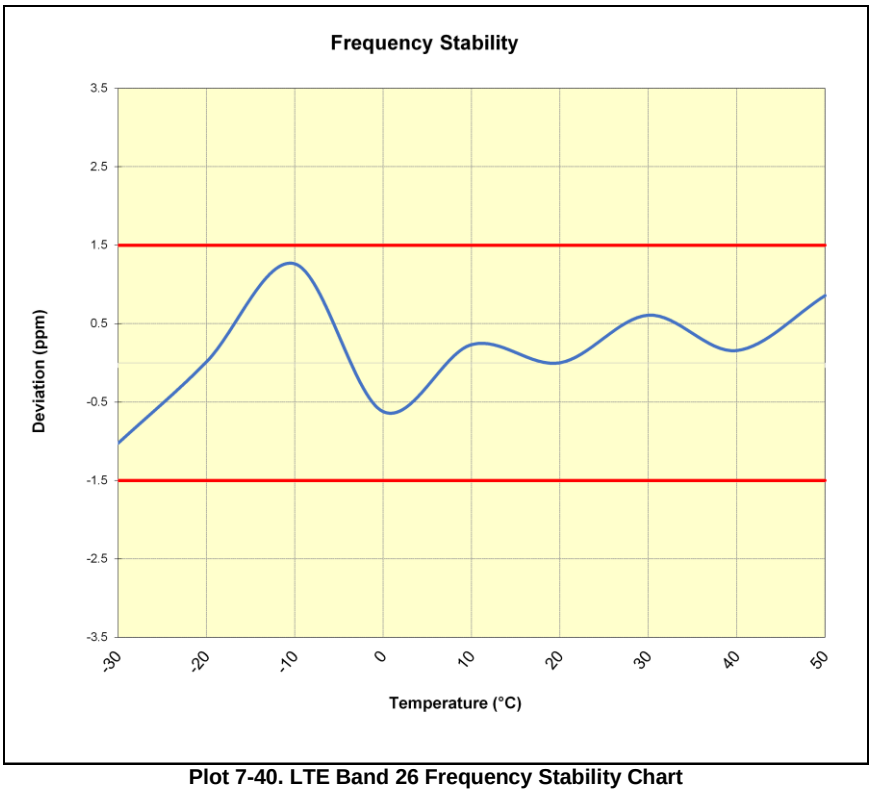
None

LTE Band 26

	Operating Frequency (Hz):	864,000,000
	Ref. Voltage (VAC):	120.00
	Deviation Limit:	± 0.00015% or 1.5 ppm

Voltage (%)	Power (VAC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	120.00	- 30	864,000,969	-887	-0.0001027
		- 20	864,001,864	8	0.0000009
		- 10	864,002,946	1,090	0.0001262
		0	864,001,319	-537	-0.0000622
		+ 10	864,002,056	200	0.0000231
		+ 20 (Ref)	864,001,856	0	0.0000000
		+ 30	864,002,380	524	0.0000606
		+ 40	864,001,991	135	0.0000156
		+ 50	864,002,596	740	0.0000856
85 %	102.00	+ 20	864,003,079	1,223	0.0001416
115 %	138.00	+ 20	863,999,825	-2,031	-0.0002351

Table 7-9. LTE Band 26 Frequency Stability Data



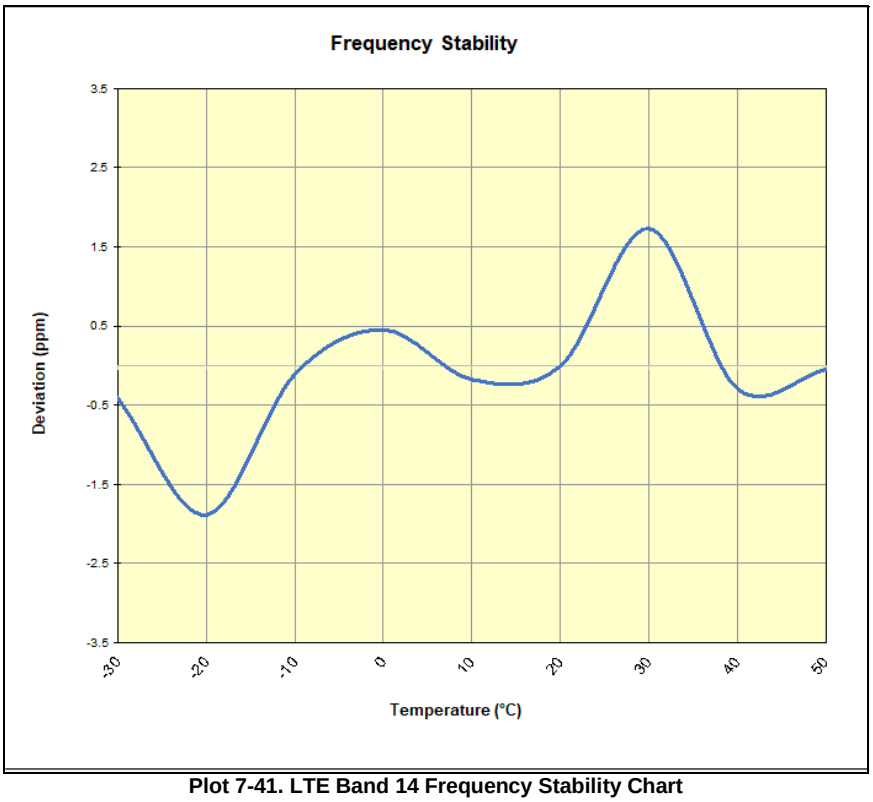
Plot 7-40. LTE Band 26 Frequency Stability Chart

LTE Band 14

Operating Frequency (Hz):	763,000,000
Ref. Voltage (VAC):	120.00

Voltage (%)	Power (VAC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	120.00	- 30	763,000,632	-309	-0.0000405
		- 20	762,999,508	-1,433	-0.0001878
		- 10	763,000,862	-79	-0.0000104
		0	763,001,289	348	0.0000456
		+ 10	763,000,809	-132	-0.0000173
		+ 20 (Ref)	763,000,941	0	0.0000000
		+ 30	763,002,261	1,320	0.0001730
		+ 40	763,000,718	-223	-0.0000292
		+ 50	763,000,911	-30	-0.0000039
85 %	102.00	+ 20	762,999,870	-1,071	-0.0001404
115 %	138.00	+ 20	763,001,593	652	0.0000855

Table 7-10. LTE Band 14 Frequency Stability Data



Plot 7-41. LTE Band 14 Frequency Stability Chart

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Tecore Low Band mRU FCC ID: QLJMRU-060785** complies with all the requirements of Parts 22(H) and 90 of the FCC rules.