Element Washington DC LLC
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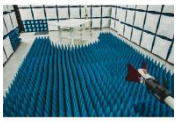

MEASUREMENT REPORT
FCC Part 90

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
4/6/2022 - 8/12/2022
Test Site/Location:
Element Washington DC LLC
Morgan Hill, CA, USA
Test Report Serial No.:
1C2205090042-05.BCG

FCC ID:	**BCG-A2622**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model:	A2622
EUT Type:	Watch
FCC Classification:	PCS Licensed Transmitter Worn on Body (PCT)
FCC Rule Part:	§2.1049, §90(S), §90(R)
Test Procedure(s):	ANSI C63.26-2015, 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.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.02

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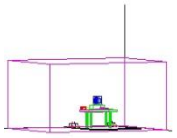
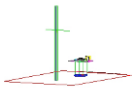


MEASUREMENT REPORT
FCC Part 90



Mode	Bandwidth	Modulation	Tx Frequency Range [MHz]	Measurement	OBW [MHz]	Max. Power [mW]	Max. Power [dBm]	Emission Designator
LTE Band 26	1.4 MHz	QPSK	814.7 - 823.3	Conducted	1.0992	315.500	24.99	1M10G7W
		16QAM	814.7 - 823.3	Conducted	1.1023	278.612	24.45	1M10D7W
	3 MHz	QPSK	815.5 - 822.5	Conducted	2.7363	322.849	25.09	2M74G7W
		16QAM	815.5 - 822.5	Conducted	2.7219	285.759	24.56	2M72D7W
	5 MHz	QPSK	816.5 - 821.5	Conducted	4.5640	343.558	25.36	4M56G7W
		16QAM	816.5 - 821.5	Conducted	4.5623	299.916	24.77	4M56D7W
	10 MHz	QPSK	819.0	Conducted	9.0570	311.889	24.94	9M06G7W
		16QAM	819.0	Conducted	5.3323	267.917	24.28	5M33D7W
LTE Band 14	5 MHz	QPSK	790.5 - 795.5	ERP	4.5518	0.497	-3.04	4M55G7W
		16QAM	790.5 - 795.5	ERP	4.5481	0.436	-3.61	4M55D7W
	10 MHz	QPSK	793.0	ERP	9.1206	0.471	-3.27	9M12G7W
		16QAM	793.0	ERP	5.1632	0.415	-3.82	5M16D7W

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 Element Washington DC LLC Test Location

These measurement tests were conducted at the Element Washington DC LLC facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Washington DC LLC located in Morgan Hill, CA 95037, U.S.A.

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 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.

- Element Washington DC LLC 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).

- Element Washington DC LLC facility is a registered (22831) 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 **Apple Watch FCC ID: BCG-A2622**. 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 90.

Test Device Serial No.: CGXT979P3W, V09L43KXK4, D60XJGQ37M, TG95334DJ6, FN622240PG017WQ4U

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n WLAN, 802.11a/n UNII, Bluetooth (1x, EDR, HDR4, HDR8, LE1M, LE2M), NFC, UWB, 60.5GHz Transmitter.

This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows all configurations possible.

Simultaneous Tx Config	Antenna FCM				
	WLAN	Bluetooth	LTE/WCDMA	UNII	UWB
	802.11 b/g/n	BDR, EDR, HDR4/8, LE1/2M	Mid band/ High band	802.11 a/n	Ch.5, Ch.9
Config 1	✓	×	×	×	✓
Config 2	×	✓	×	×	✓
Config 3	×	×	✓	×	✓
Config 4	×	✓	✓	×	×
Config 5	✓	×	✓	×	×
Config 6	×	×	✓	✓	×
Config 7	×	×	✓	×	✓
Config 8	×	✓	✓	×	✓
Config 9	✓	×	✓	×	✓
Config 10	×	✓	✓	✓	×

Table 2-1. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

Note:

All the above simultaneous transmission configurations have been tested and the worst case configuration was found to be config 10 and reported in RF UNII, RF Bluetooth and RF Part 27b test reports.

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Band	Antenna Gain (dBi)
	Antenna BCM
LTE Band 14	-26.1
LTE Band 26	-25.7

Table 2-2. Highest Antenna Gain

Note: Antenna Specifications has been attached to Appendix A

2.4 Test Support Equipment

1	Apple Macbook	Model:	A1398	S/N:	C2QKP008F6F3
	w/AC/DC Adapter	Model:	A1435	S/N:	N/A
	Apple iPhone	Model:	993-89846LL/A	S/N:	QHLHY57CJ9
2	Apple USB-C cable	Model:	N/A	S/N:	N/A
	w/ Charging Dock	Model:	N/A	S/N:	LF09D601GH
	w/ Cradle	Model:	LE1-POR-P1	S/N:	CYV1427015UE1EN01MP1J
3	Apple Magnetic Charger	Model:	A2515	S/N:	DLC035200UJMFR0AJ
4	Pathfinder Falcon	Model:	920-11647-01	S/N:	HV007825
	SiP Socket	Model:	N/A	S/N:	X2920 P1 PF 142
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A
6	Store Sample Wristband	Model:	N/A	S/N:	DLC219400361YDQ2W

Table 2-3. Test Support Equipment

2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.26 2015, 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.

The worst case configuration was investigated for all combinations of various types of non-metal wristbands. The EUT was also investigated with and without wireless charger. The worst case configuration found was used for all testing.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

This device only supports 27RBs or less for 16-QAM uplink.

2.6 Software and Firmware

The test was conducted with firmware version watchOS 9.0 installed on the EUT.

2.7 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 C63.26-2015 and 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.

Deviation from Measurement Procedure……..None

3.2 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 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.

Per KDB 414788 D01 v01r01, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was used while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

Radiated spurious emission levels are investigated with the receive antenna horizontally and vertically polarized per ANSI C63.26-2015 and TIA-603-E-2016.

4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. 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	1.77
Radiated Disturbance (<30MHz)	4.38
Radiated Disturbance (30MHz-1GHz)	4.75
Radiated Disturbance (1-18GHz)	5.20
Radiated Disturbance (>18GHz)	4.72

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
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	6/10/2022	Annual	6/10/2023	MY49430244
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	8/13/2021	Annual	8/13/2022	T058701-01
ESPEC	SU-241	Tabletop Temperature Chamber	10/26/2021	Annual	10/26/2022	92009574
ETS-Lindgren	3142E	BiConiLog Antenna (30MHz - 6GHz)	10/21/2021	Annual	10/21/2022	208204
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	5/11/2022	Annual	5/11/2023	205956
Keysight Technology	N9040B	UXA Signal Analyzer	2/8/2022	Annual	2/8/2023	MY57212015
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz - 18GHz)	1/62022	Annual	1/6/2023	101639
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	3/4/2022	Annual	3/4/2023	101619
Rohde & Schwarz	ESW26	EMI Test Receiver	5/19/2022	Annual	5/19/2023	101299
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	1/6/2022	Annual	1/6/2023	102327
Rohde & Schwarz	ESW44	EMI Test Receiver	12/2/2021	Annual	12/2/2022	101570
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	10/11/2021	Annual	10/11/2022	161616
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	11/4/2021	Annual	11/4/2022	151888
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	4/18/2022	Annual	4/18/2023	100050
Rohde & Schwarz	TC-TA18	Cross Polarized Vivaldi Antenna (400MHz-18GHz)	1/25/2022	Annual	1/25/2023	101063
Rohde & Schwarz	HFH2-Z2	Loop Antenna	4/3/2022	Annual	4/3/2023	100546

Table 5-1. Test Equipment List

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.

6.0 SAMPLE CALCULATIONS

Emission Designator

QPSK Modulation

Emission Designator = 8M62G7W

LTE BW = 8.62 MHz
G = Phase Modulation
7 = Quantized/Digital Info
W = Combination of Any

16QAM Modulation

Emission Designator = 8M45D7W

LTE BW = 8.45 MHz
D = Amplitude/Angle Modulated
7 = Quantized/Digital Info
W = Combination of Any

Spurious Radiated Emission

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 25.501 dBm so this harmonic was 25.501 dBm – (-24.80).

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCG-A2622

FCC Classification: PCS Licensed Transmitter Worn on Body (PCT)

Mode(s): LTE

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Reference
CONDUCTED	Occupied Bandwidth	2.1049	N/A	N/A	Section 7.2
	Conducted Band Edge / Spurious Emissions (LTE Band 14)	2.1051, 90.543(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 mobile and portable stations. On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, attenuation by at least 43 + 10 log(P) dB	PASS	Sections 7.3, 7.4
	Conducted Band Edge / Spurious Emissions (LTE Band 26)	2.1051, 90.691(a)	-13 dBm for all out-of-band emissions except -30 dBm at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	PASS	Sections 7.3, 7.4
	Frequency Stability (LTE Band 14)	2.1055	Fundamental emissions stay within authorized frequency block over the temperature and voltage range as tested.	PASS	Section 7.8
	Frequency Stability (LTE Band 26)	90.213	< 2.5 ppm	PASS	Section 7.8
	Conducted Power	2.1046, 90.635	< 100 Watts	PASS	Section 7.5
	Effective Radiated Power (LTE Band 14)	90.542(a)(7)	< 3 Watts max. ERP	PASS	Section 7.6
RADIATED	Radiated Spurious Emissions (LTE Band 14)	2.1053, 90.543(e)	> 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 7.7
	Radiated Spurious Emissions (LTE Band 26)	2.1053, 90.691(a)	-13 dBm for all out-of-band emissions except -30 dBm at Band Edge and for all out-of-band emissions within 37.5kHz of Block Edge	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 shown in Section 7.0 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 Element EMC Software Tool v1.1.

7.2 Occupied Bandwidth

§2.1049

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.

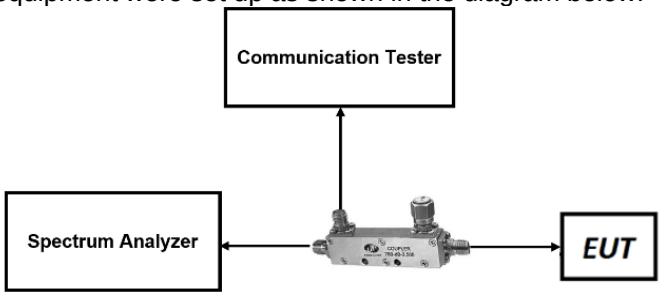
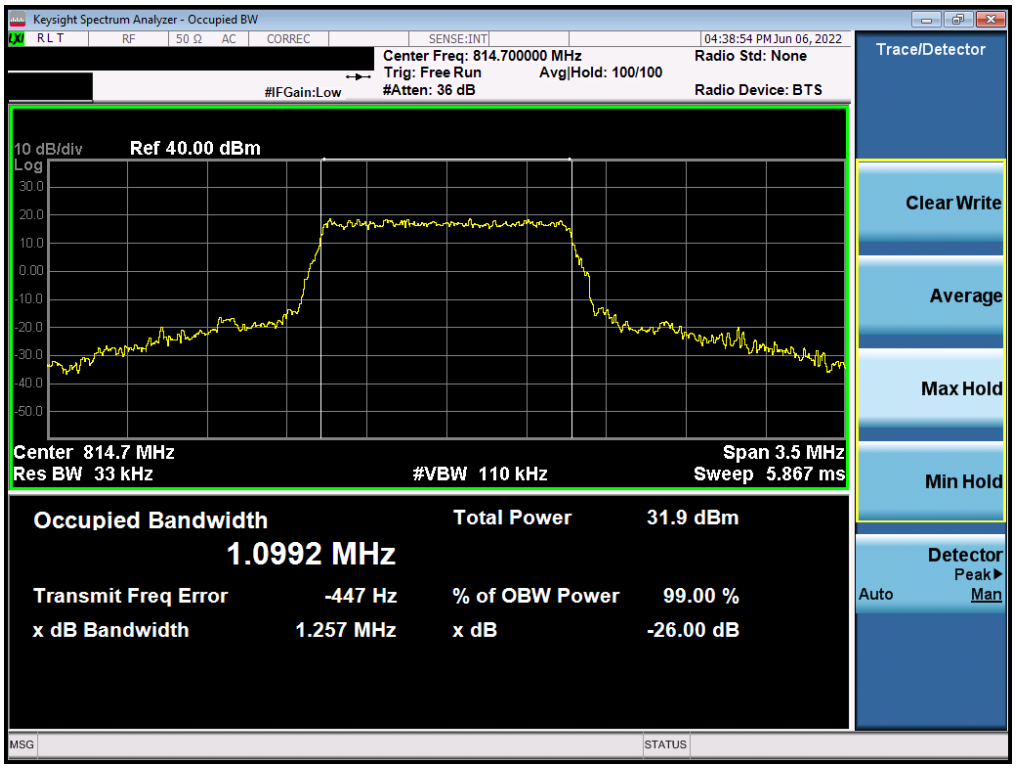


Figure 7-1. Test Instrument & Measurement Setup

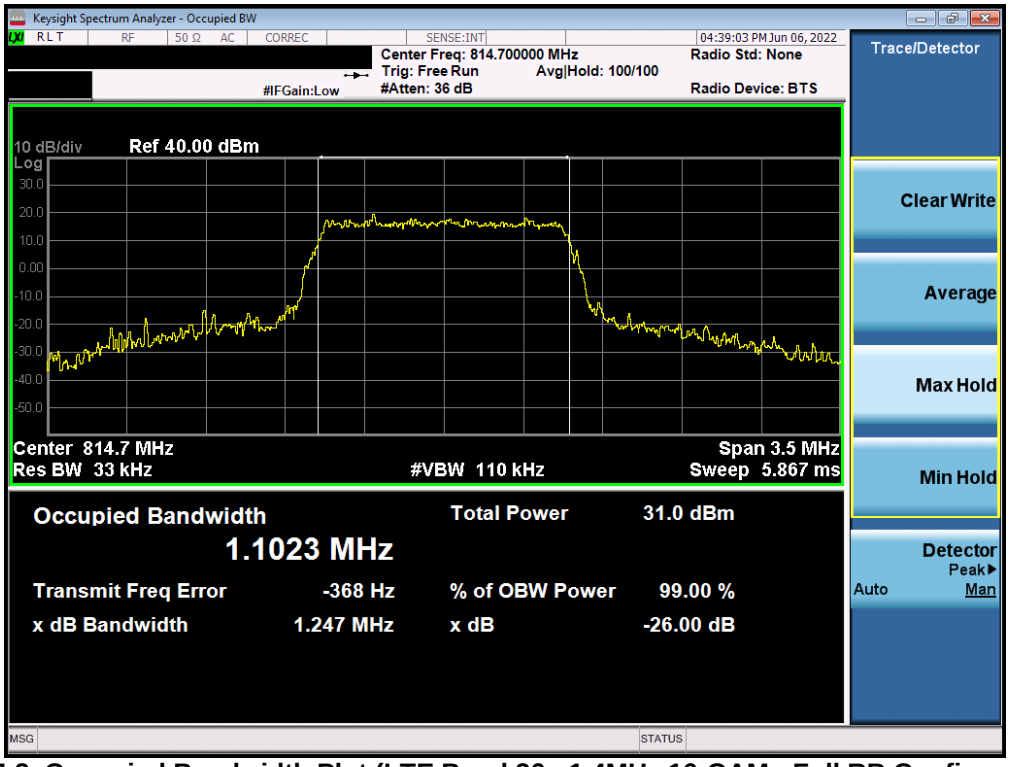
Test Notes

None.

LTE Band 26



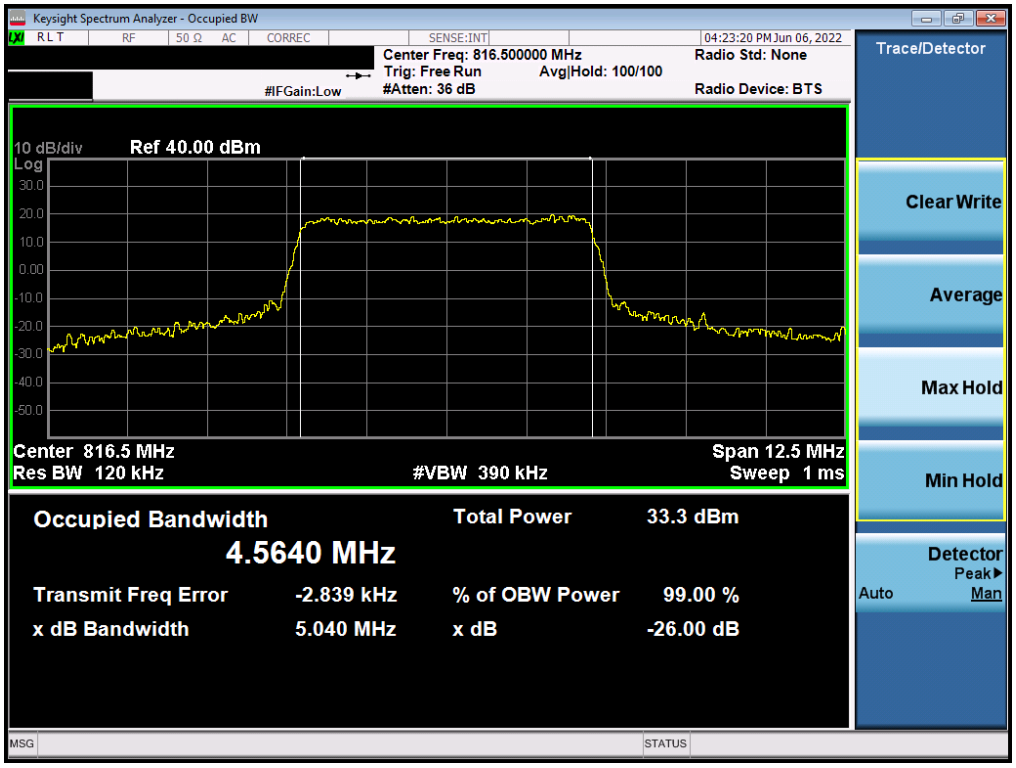
Plot 7-1. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz QPSK - Full RB Configuration)



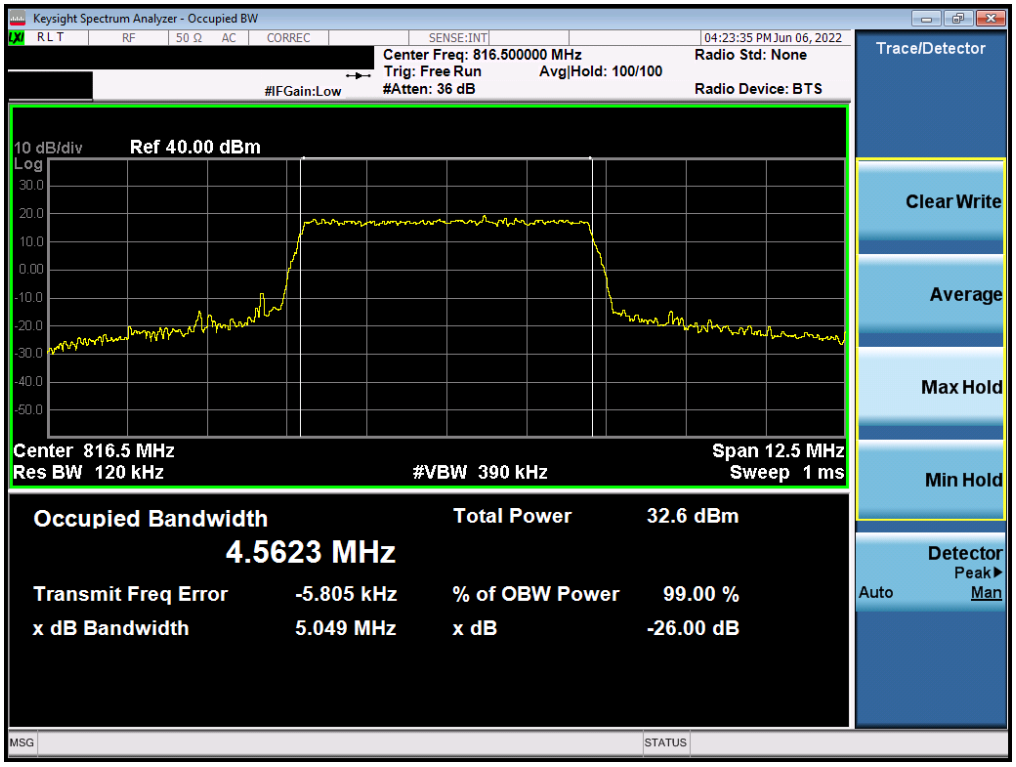
Plot 7-2. Occupied Bandwidth Plot (LTE Band 26 - 1.4MHz 16-QAM - Full RB Configuration)

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

Plot 7-4. Occupied Bandwidth Plot (LTE Band 26 - 3MHz 16-QAM - Full RB Configuration)

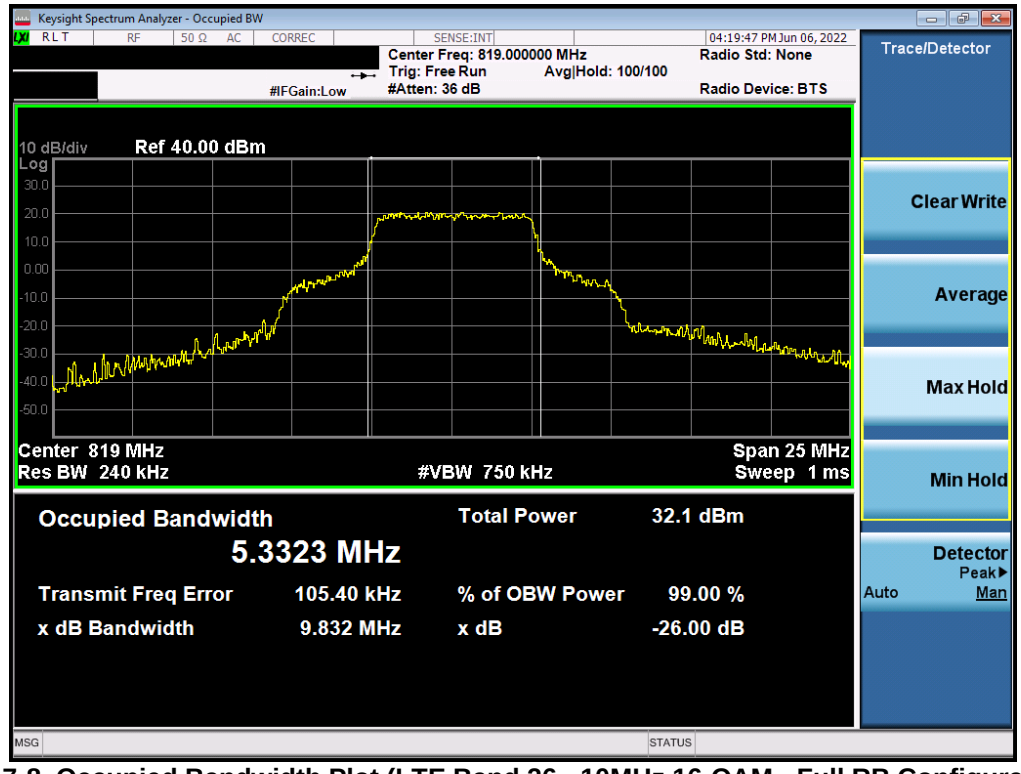


Plot 7-5. Occupied Bandwidth Plot (LTE Band 26 - 5MHz QPSK - Full RB Configuration)



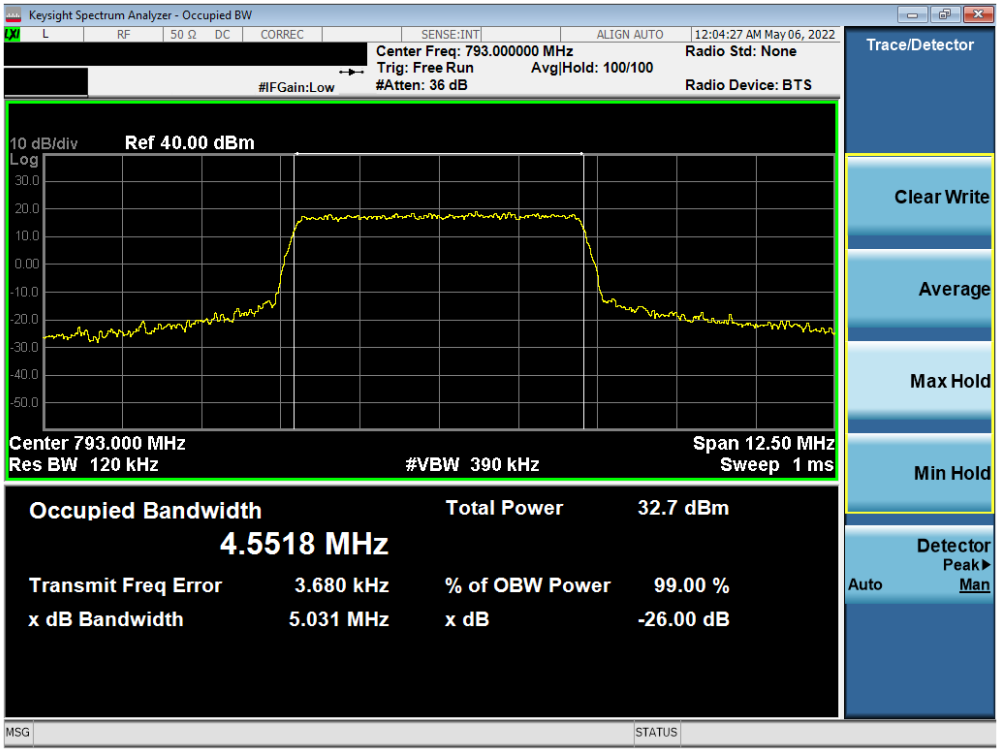
Plot 7-6. Occupied Bandwidth Plot (LTE Band 26 - 5MHz 16-QAM - Full RB Configuration)

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

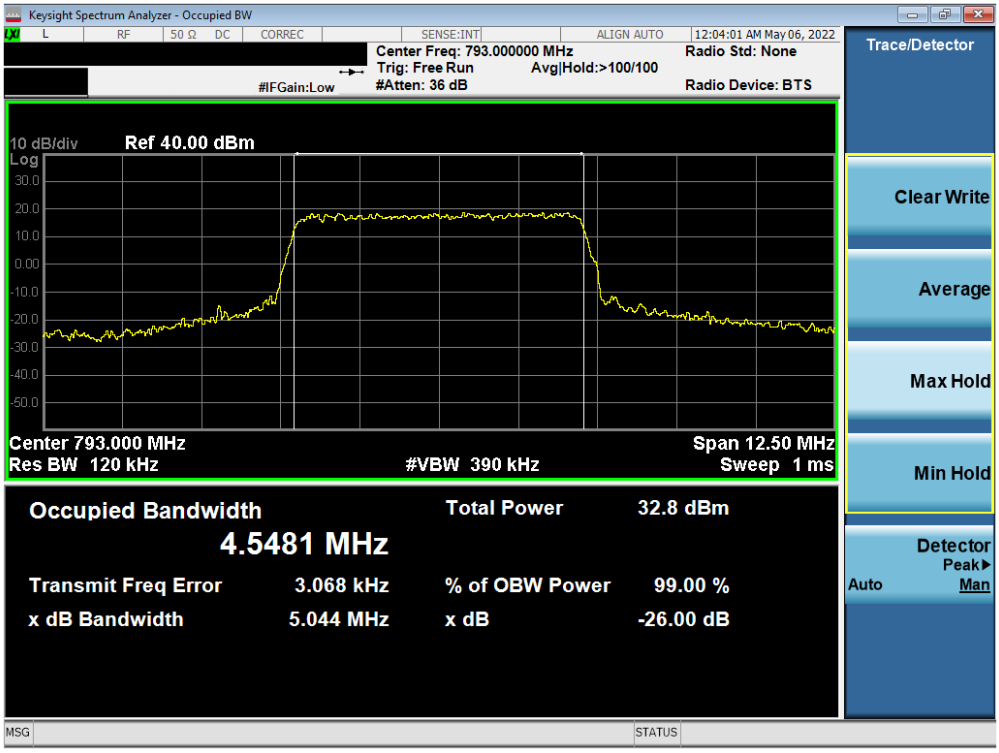


Plot 7-8. Occupied Bandwidth Plot (LTE Band 26 - 10MHz 16-QAM - Full RB Configuration)

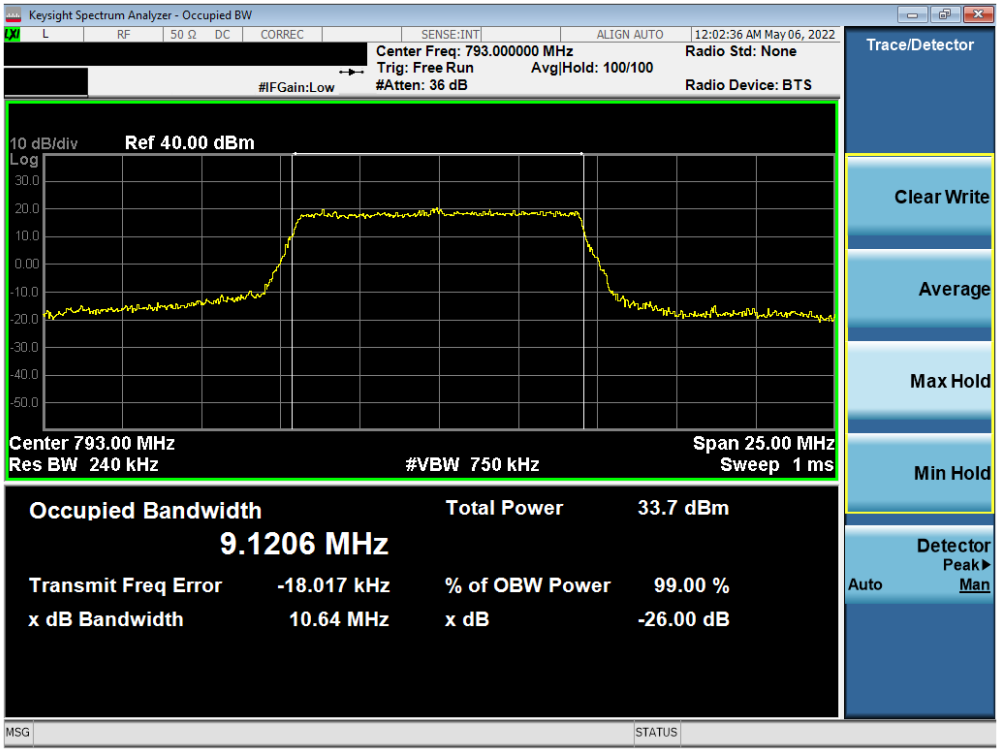
LTE Band 14



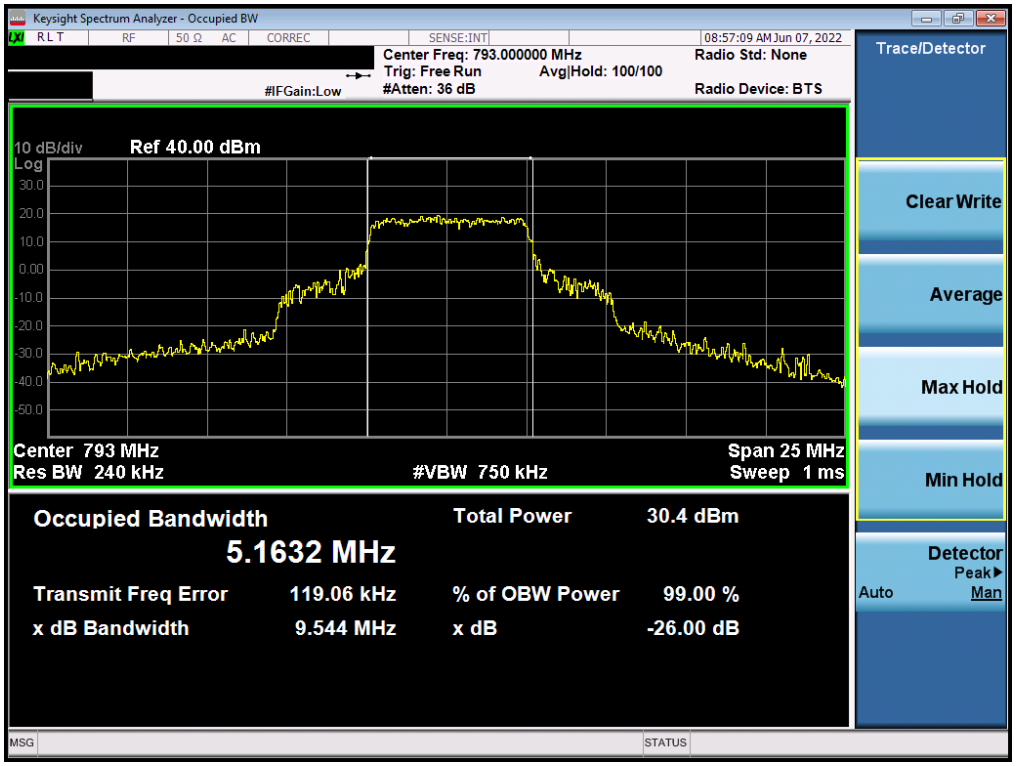
Plot 7-9. Occupied Bandwidth Plot (LTE Band 14 - 5MHz QPSK - Full RB Configuration)



Plot 7-10. Occupied Bandwidth Plot (LTE Band 14 - 5MHz 16-QAM - Full RB Configuration)



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



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

7.3 Spurious and Harmonic Emissions at Antenna Terminal

§2.1051 §90.691(a) §90.543(e)

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.

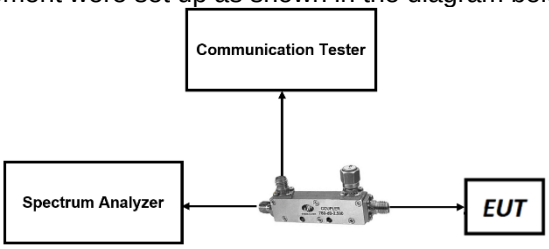
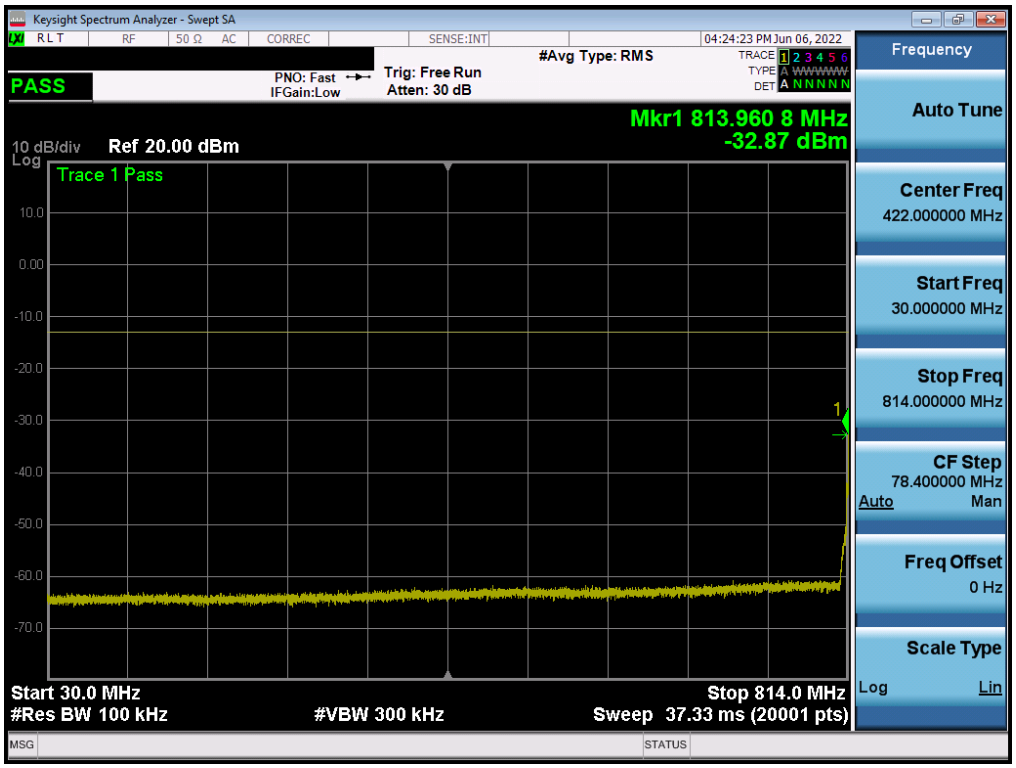


Figure 7-2. Test Instrument & Measurement Setup

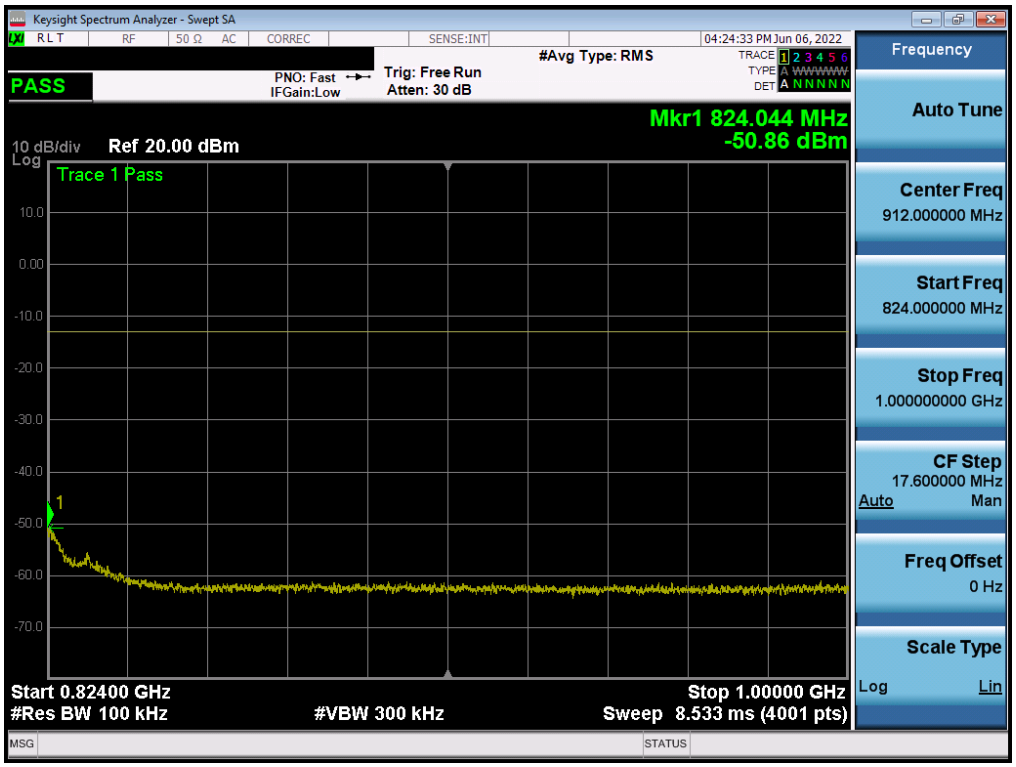
Test Notes

Compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater for Part 90. 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 26

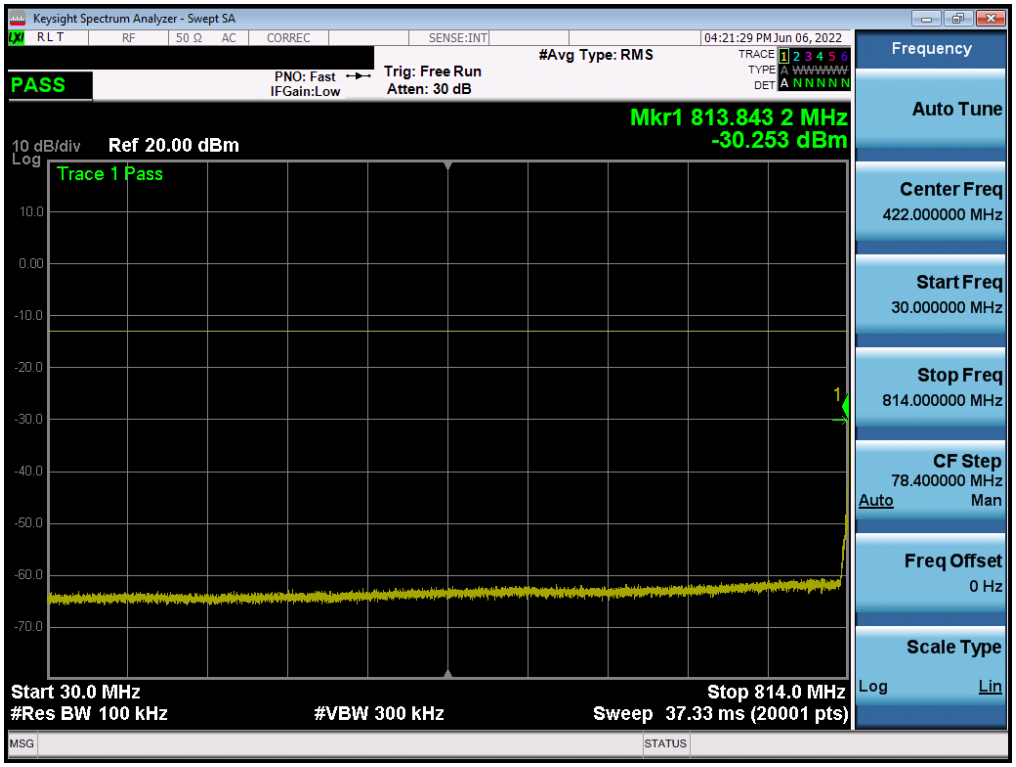


Plot 7-13. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – Low Channel)

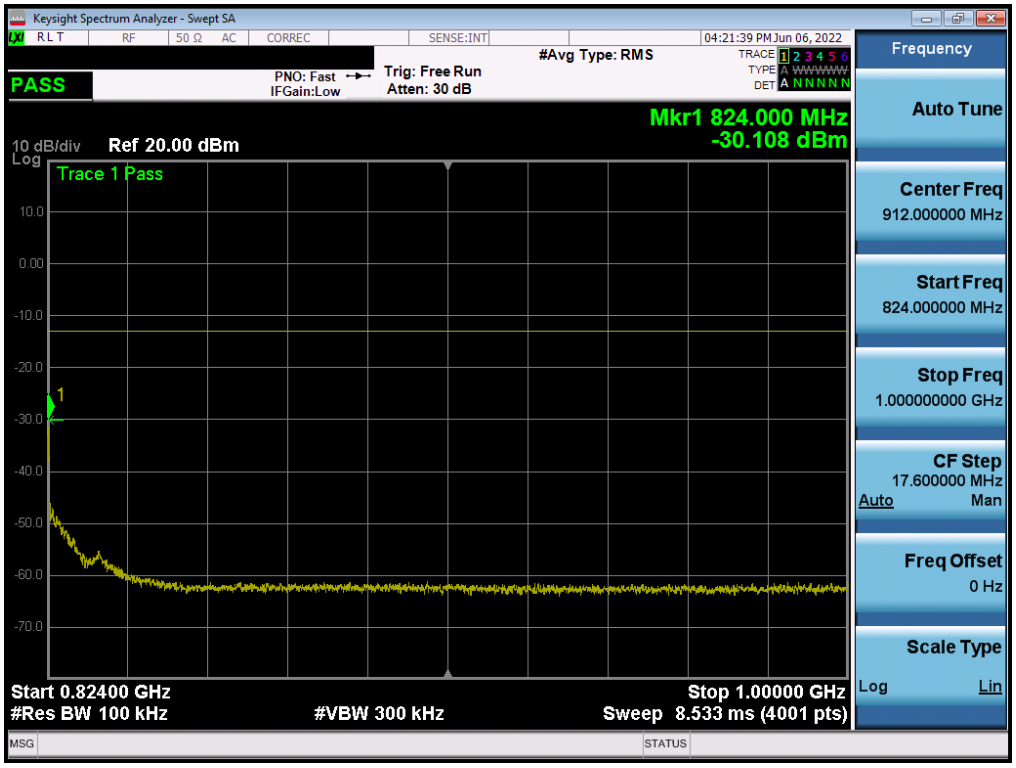


Plot 7-14. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – Low Channel)

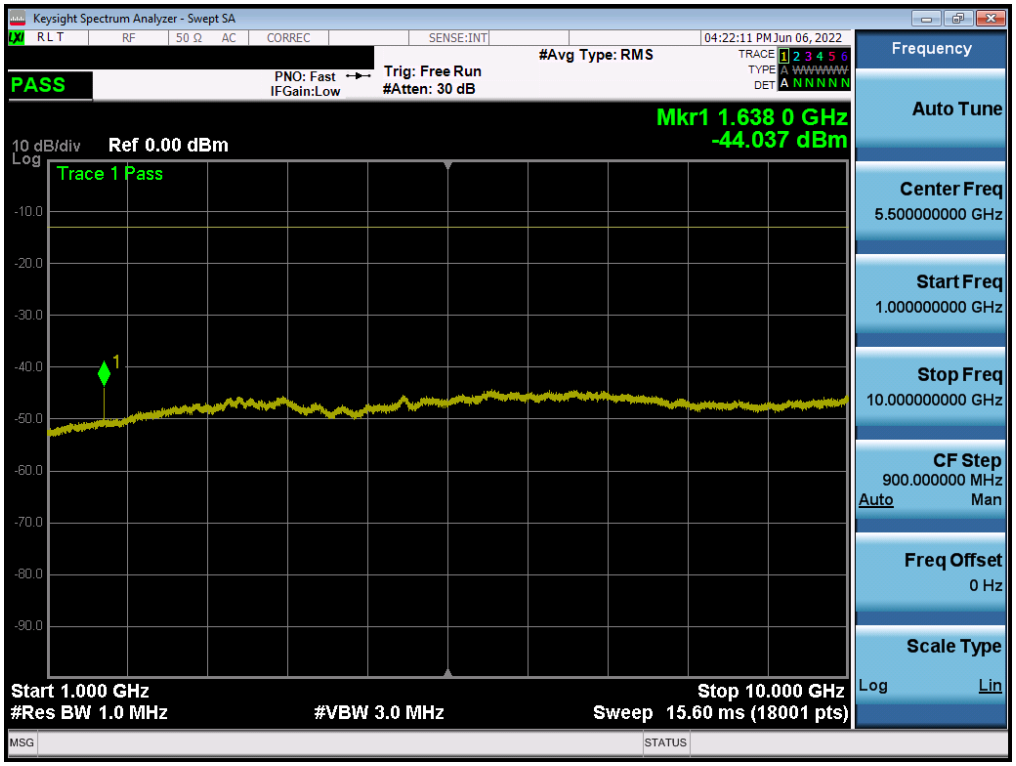
Plot 7-15. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – Low Channel)



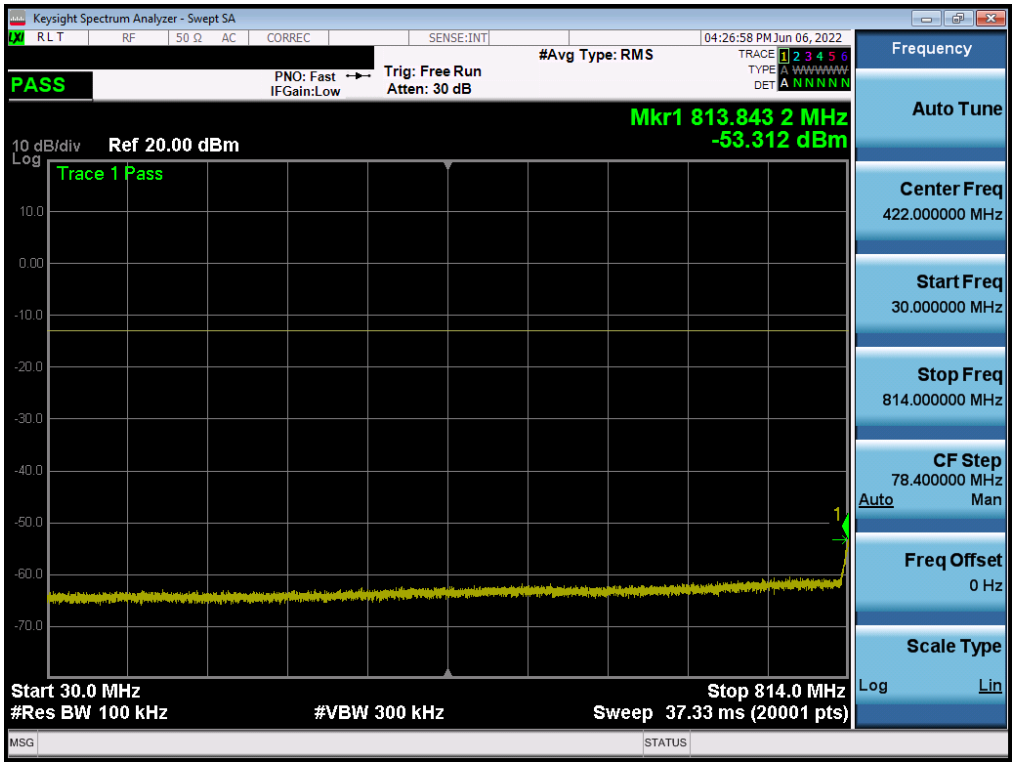
Plot 7-16. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)



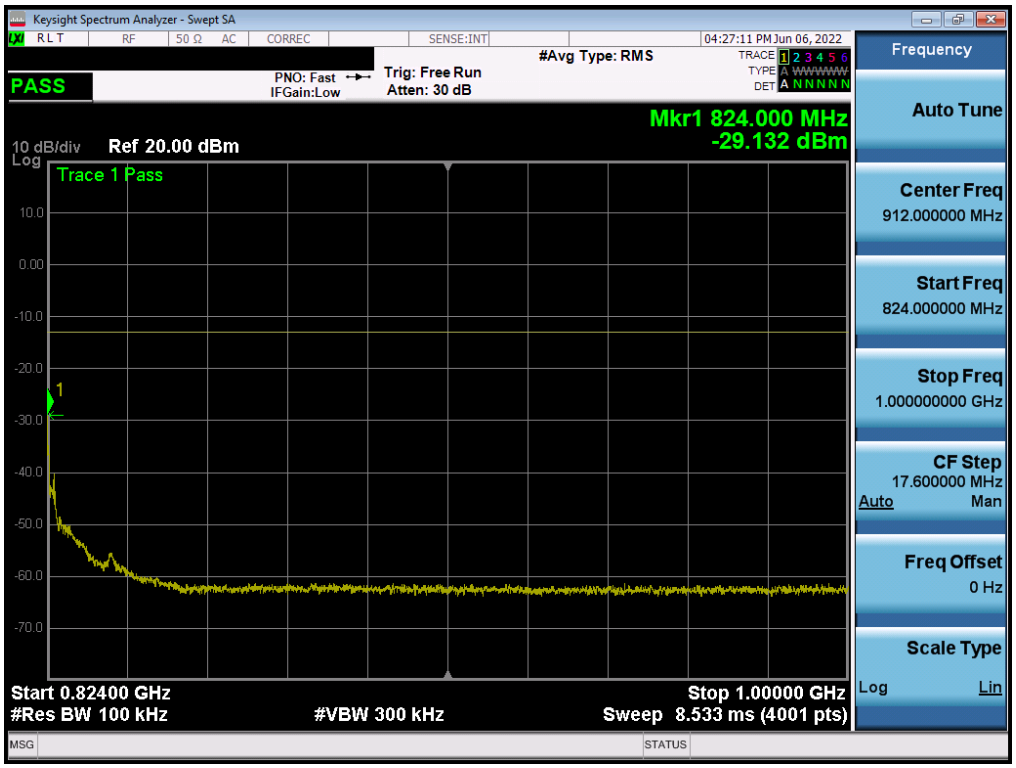
Plot 7-17. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)



Plot 7-18. Conducted Spurious Plot (LTE Band 26 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)



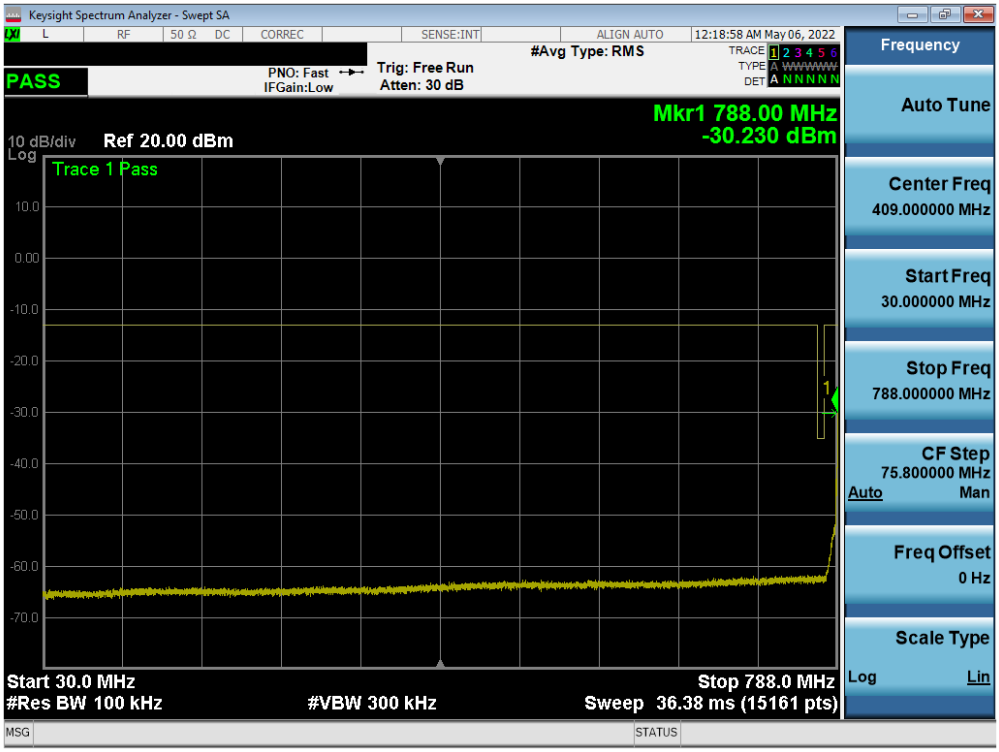
Plot 7-19. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – High Channel)



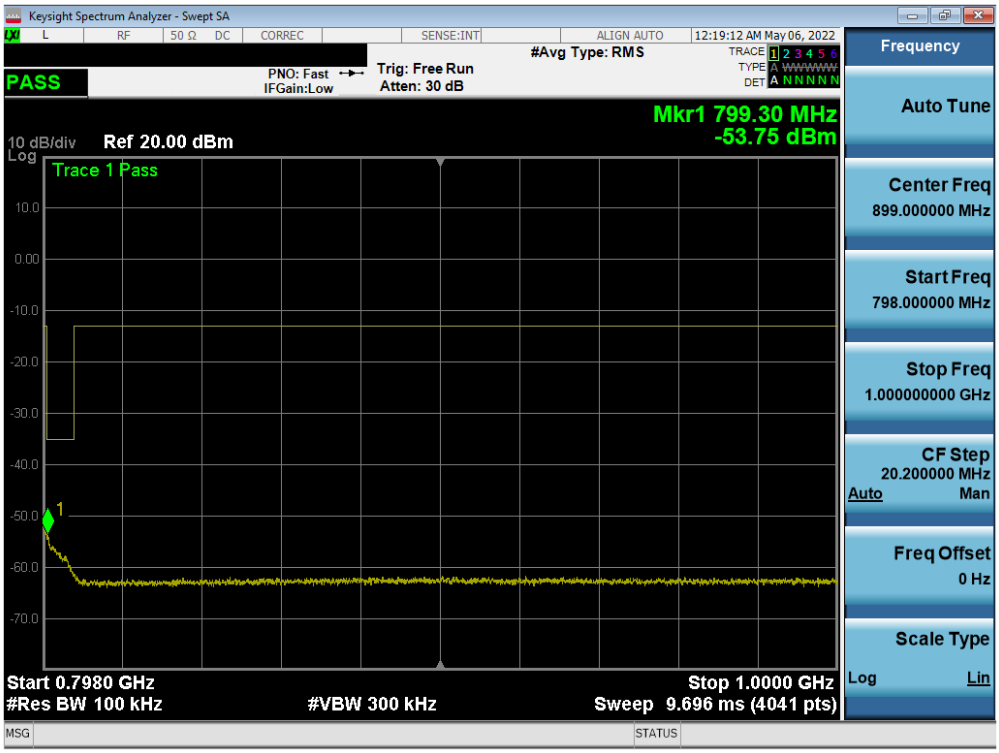
Plot 7-20. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – High Channel)

Plot 7-21. Conducted Spurious Plot (LTE Band 26 - 5MHz QPSK - RB Size 1, RB Offset 0 – High Channel)

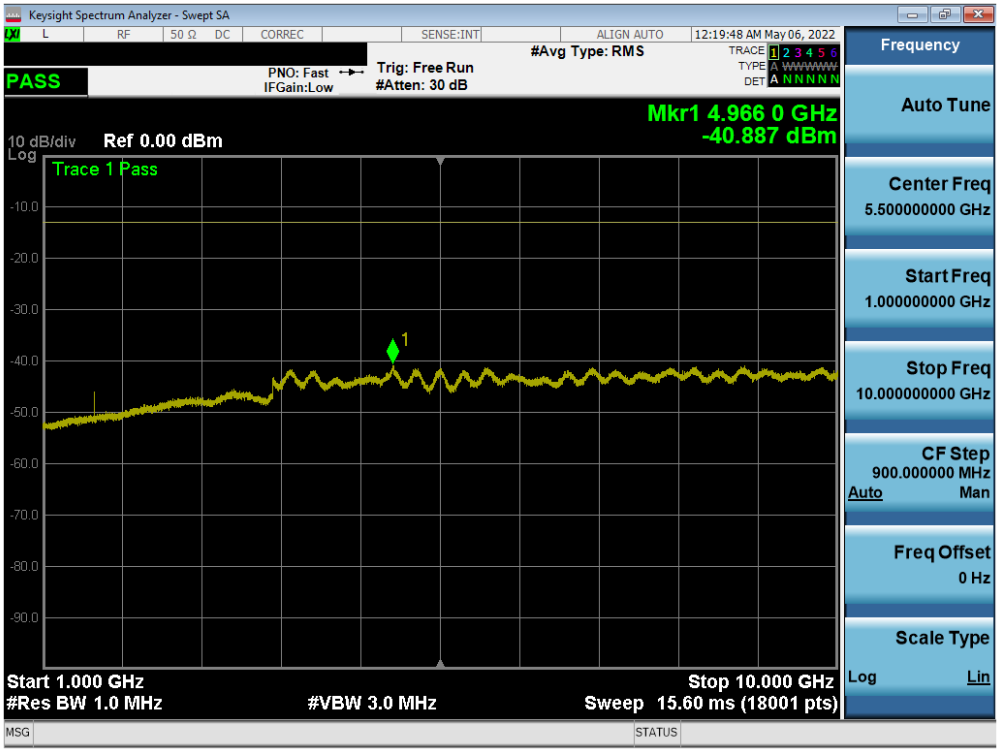
LTE Band 14



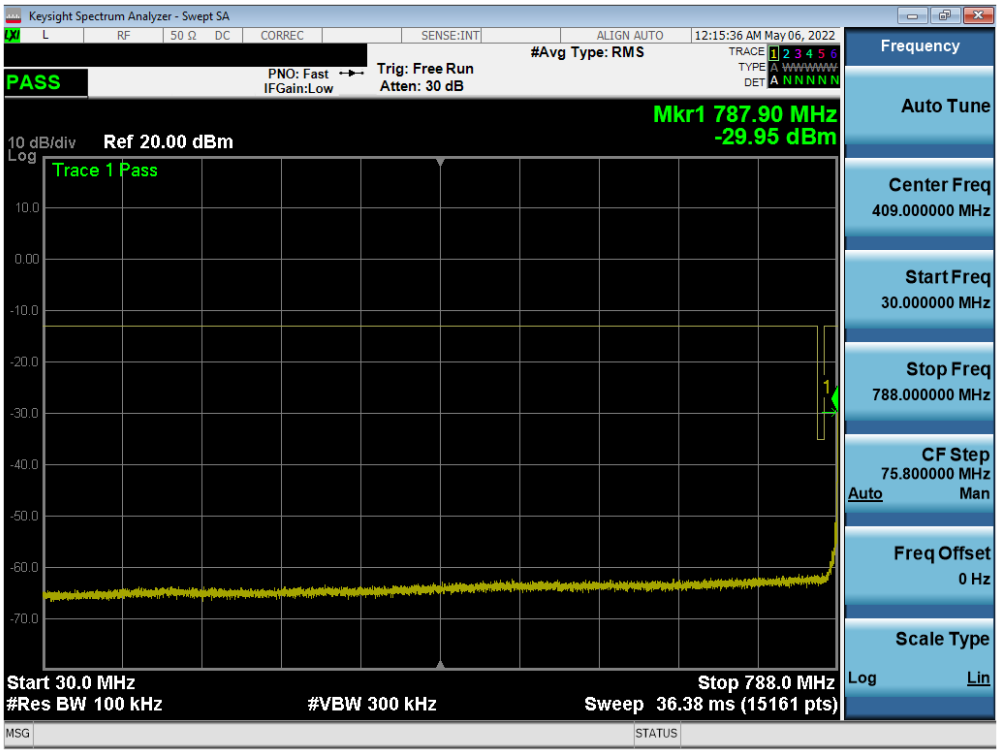
Plot 7-22. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



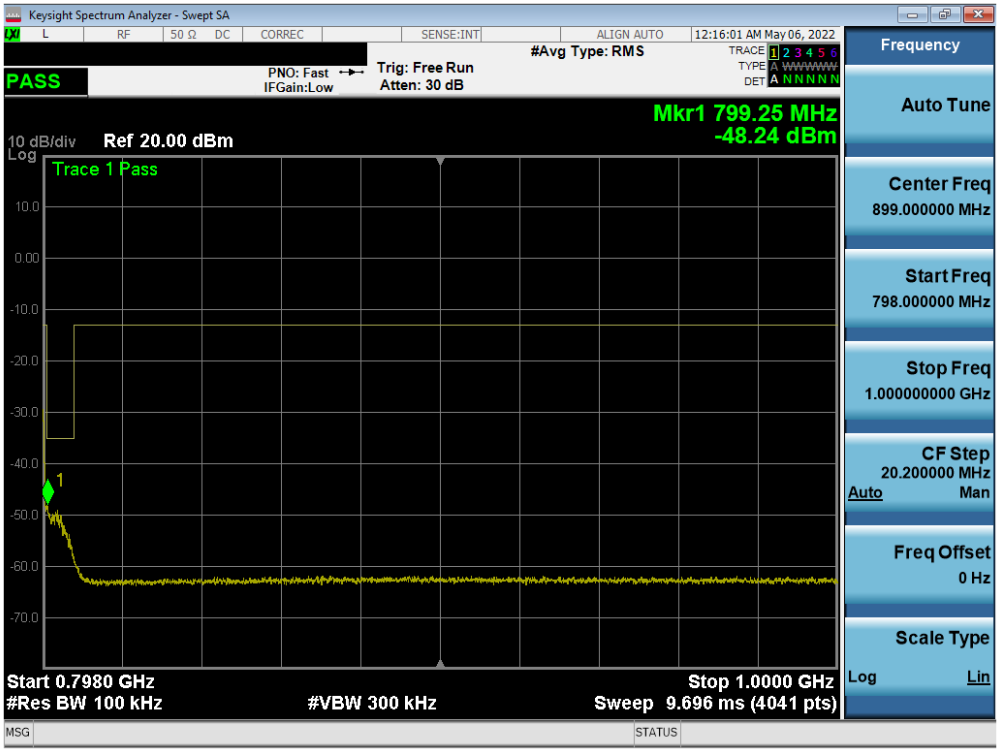
Plot 7-23. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



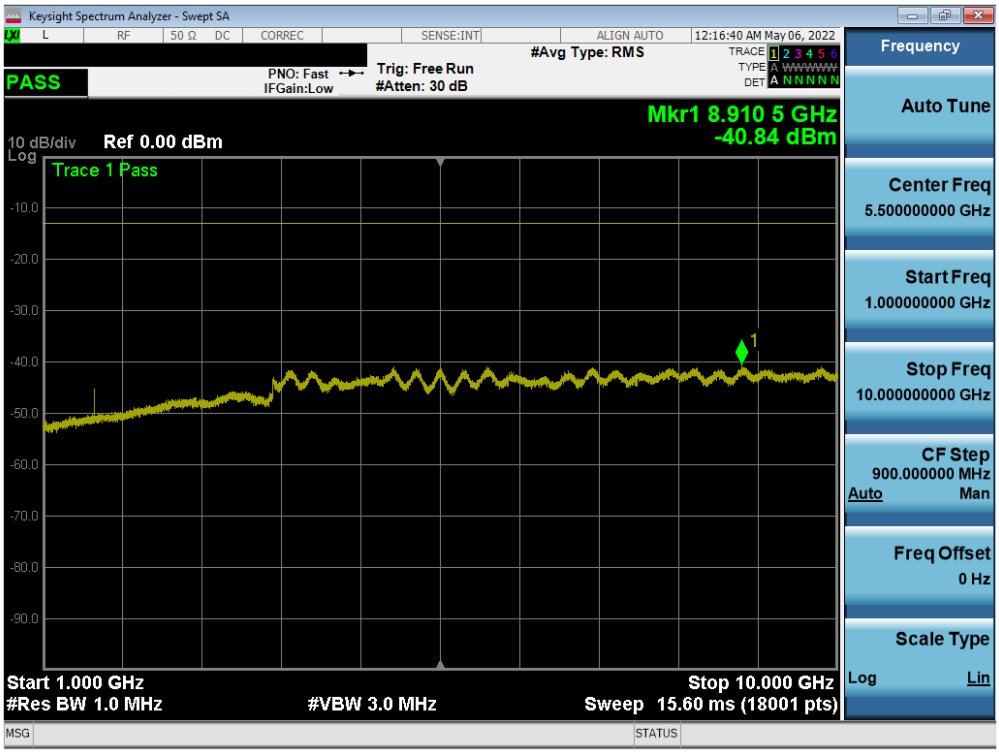
Plot 7-24. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



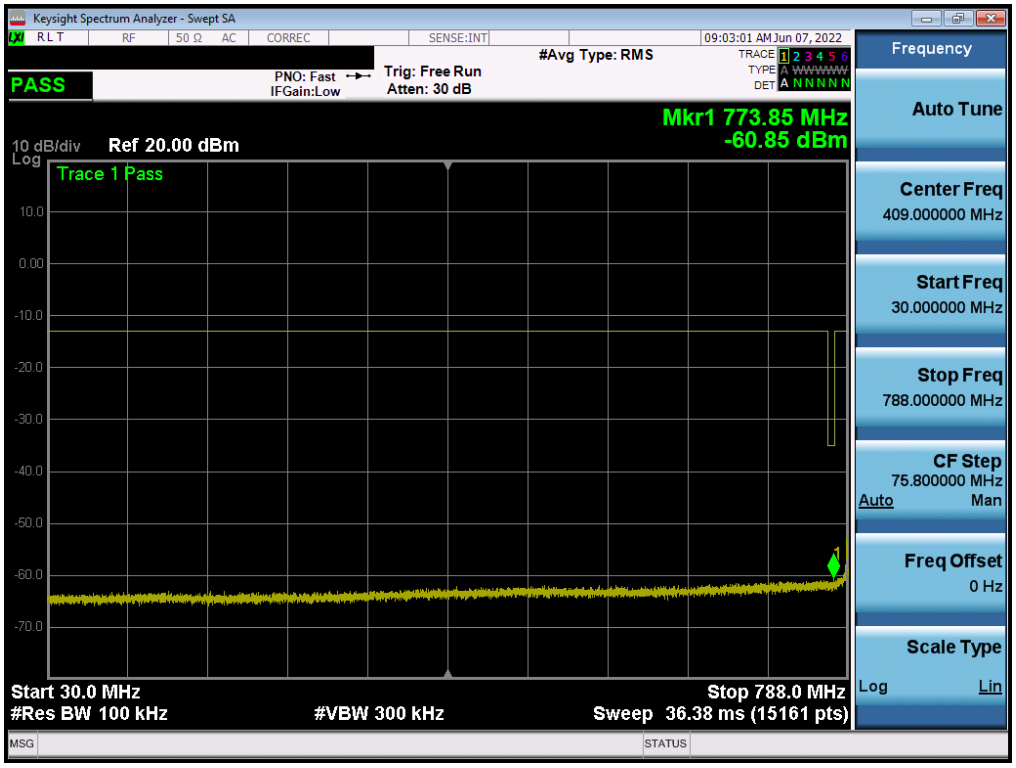
Plot 7-25. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



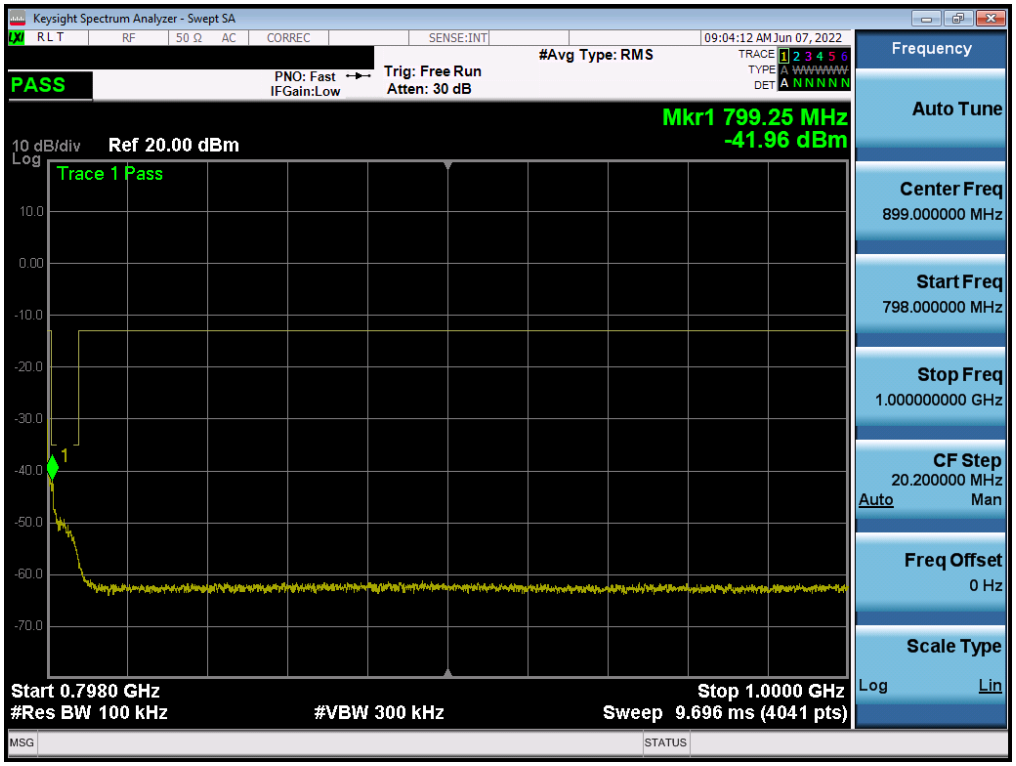
Plot 7-26. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)



Plot 7-27. Conducted Spurious Plot (LTE Band 14 - 10MHz QPSK - RB Size 1, RB Offset 0 – Mid Channel)



Plot 7-28. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-29. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

Plot 7-30. Conducted Spurious Plot (LTE Band 14 - 5MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

7.4 Band Edge Emissions at Antenna Terminal

§2.1051 §90.691(a) §90.543(e)

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 + $10\log_{10}(P_{[Watts]})$, 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 + $10\log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. 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.

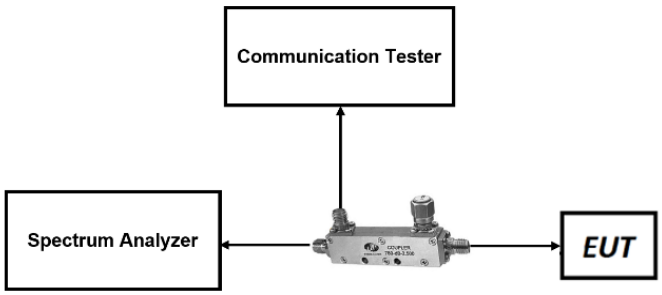


Figure 7-3. Test Instrument & Measurement Setup

Test Notes

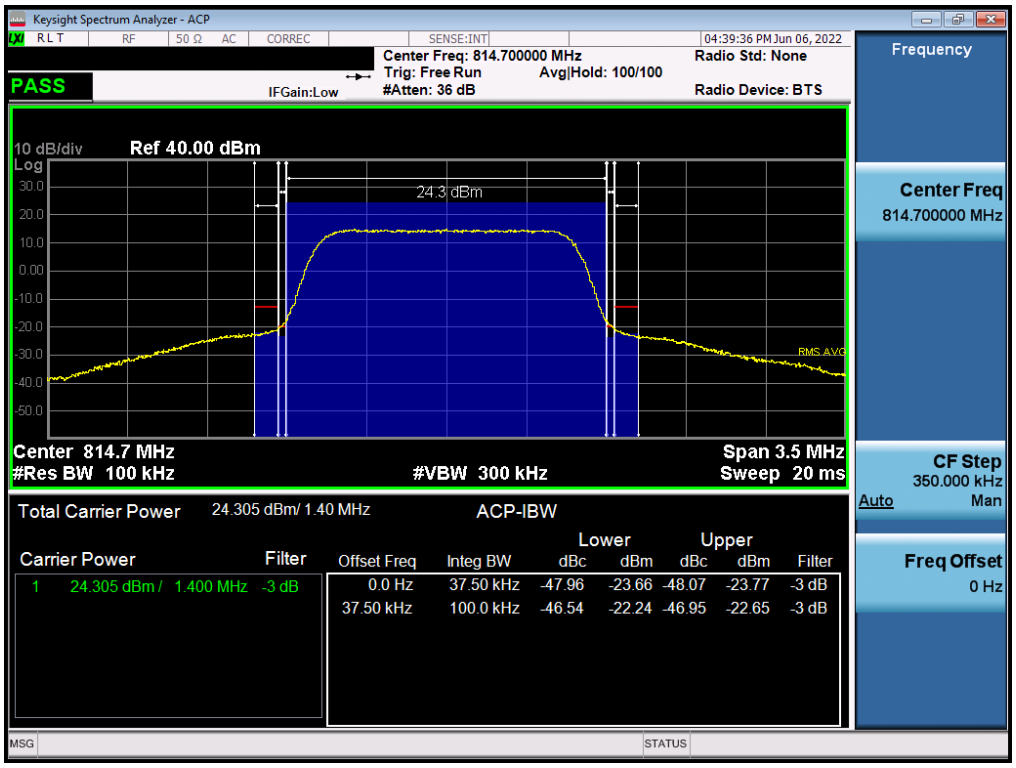
1. For channel edge emission, the signal analyzer's "ACP" measurement capability is used.

2. Per Part 90, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz 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.

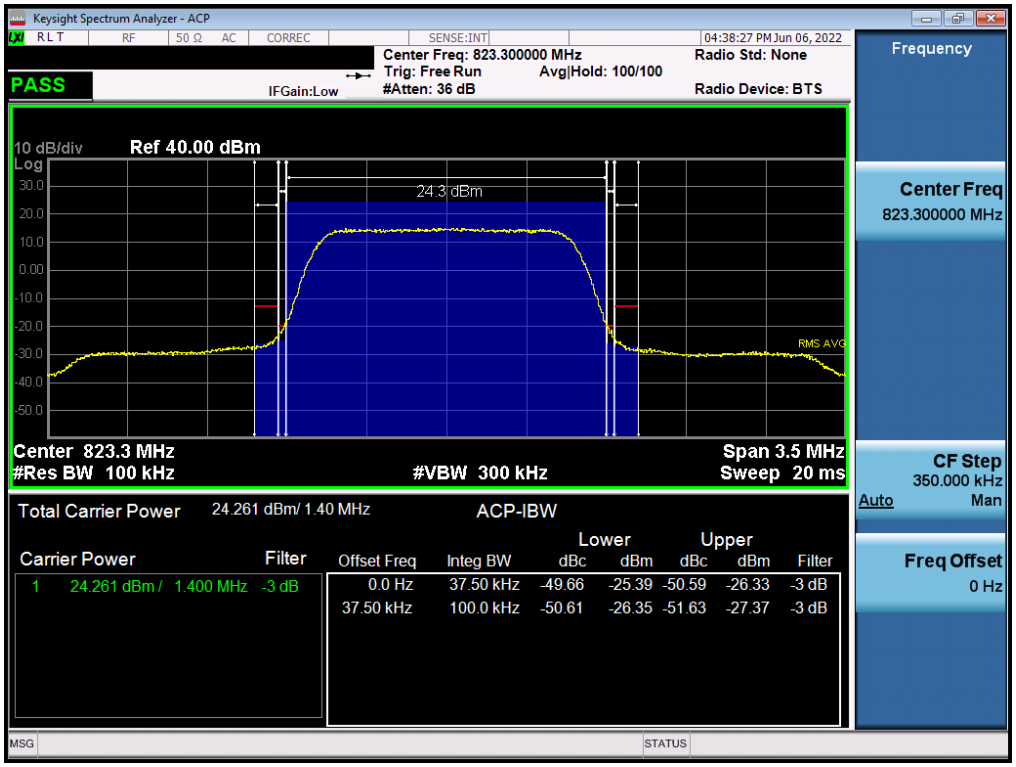
3. For LTE Band 14 operation under Part 90.543, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

4. 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 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

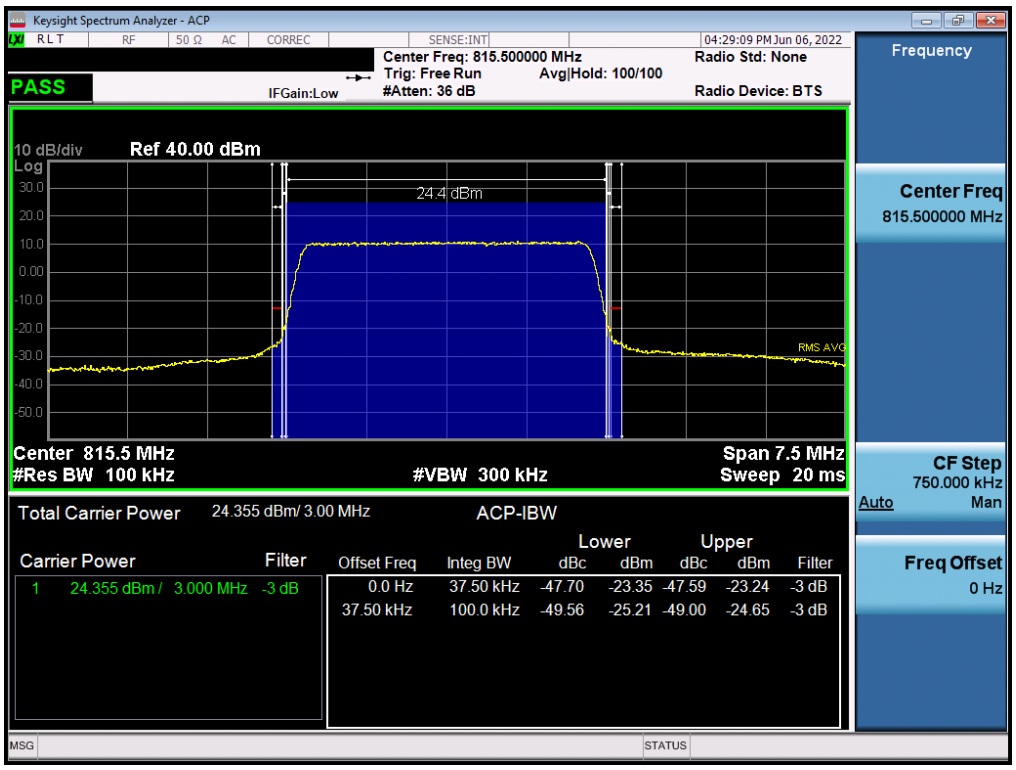
LTE Band 26



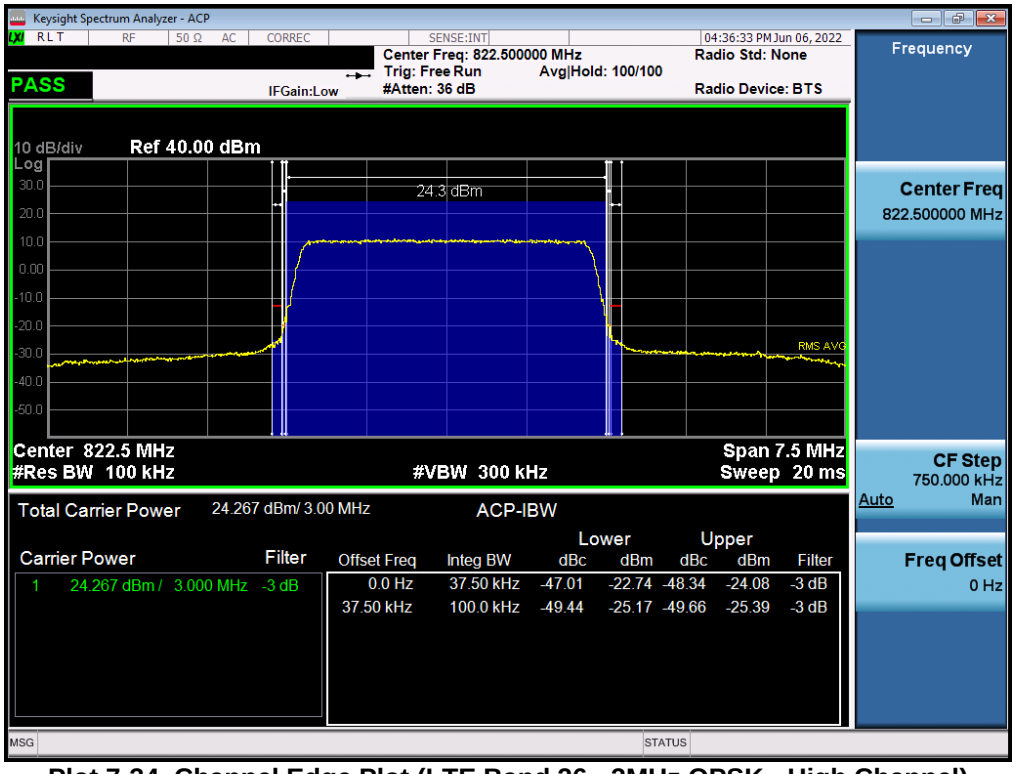
Plot 7-31. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - Low Channel)



Plot 7-32. Channel Edge Plot (LTE Band 26 - 1.4MHz QPSK - High Channel)

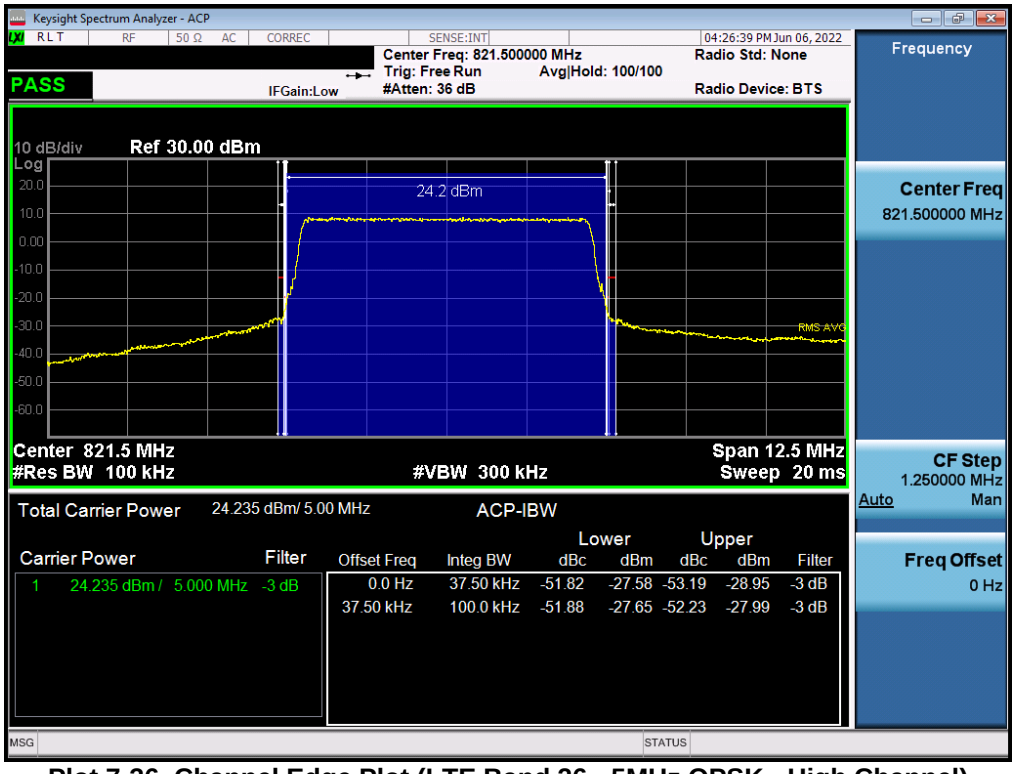


Plot 7-33. Channel Edge Plot (LTE Band 26 - 3MHz QPSK - Low Channel)

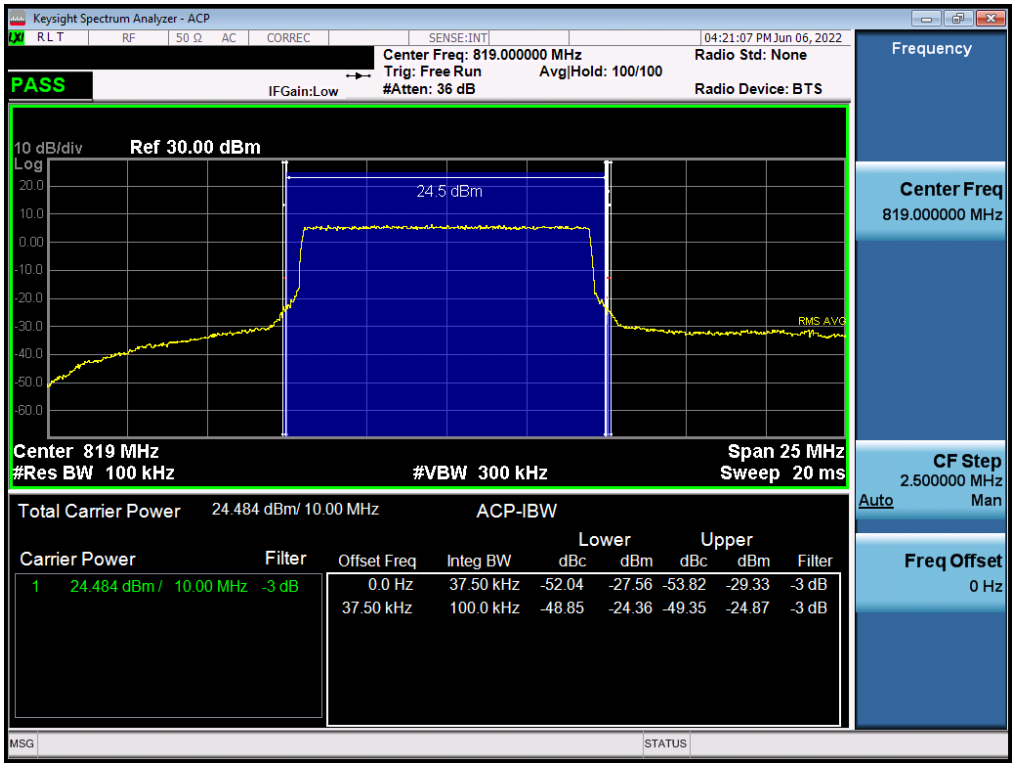


Plot 7-34. Channel Edge Plot (LTE Band 26 - 3MHz QPSK - High Channel)

Plot 7-35. Channel Edge Plot (LTE Band 26 - 5MHz QPSK - Low Channel)

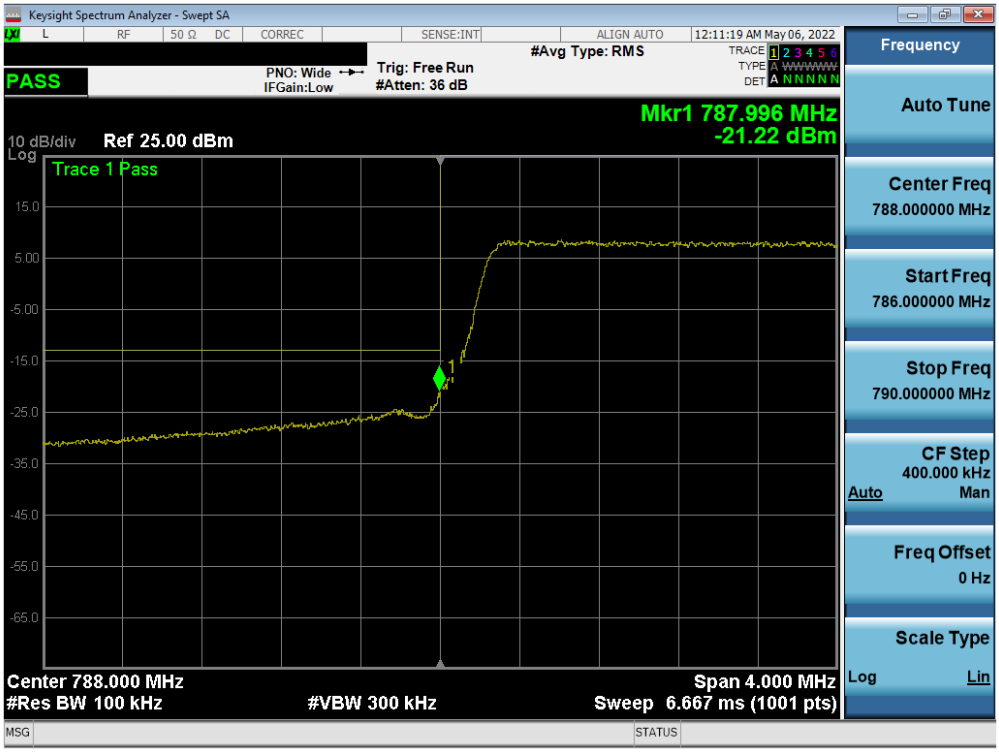


Plot 7-36. Channel Edge Plot (LTE Band 26 - 5MHz QPSK - High Channel)

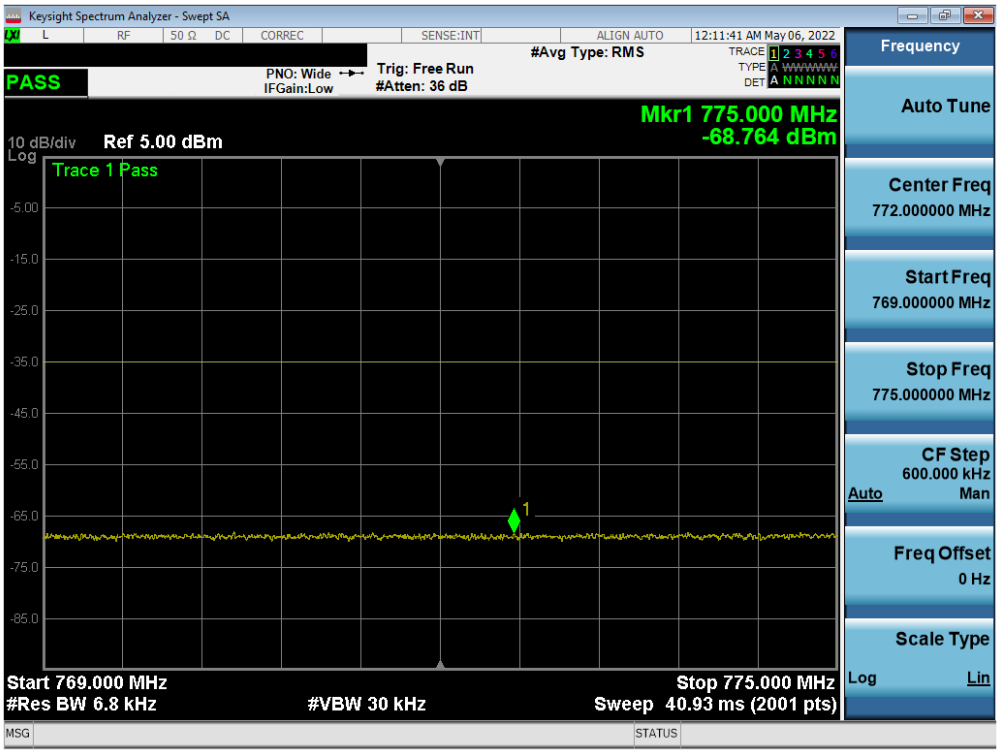


Plot 7-37. Channel Edge Plot (LTE Band 26 - 10MHz QPSK - Mid Channel)

LTE Band 14

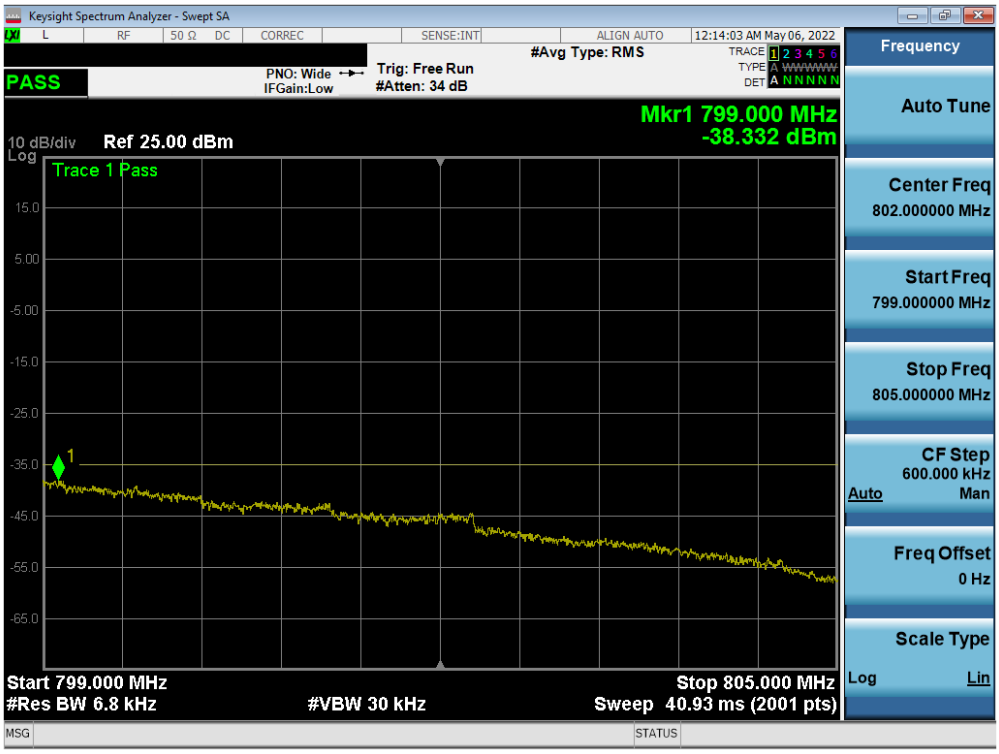


Plot 7-38. Lower Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

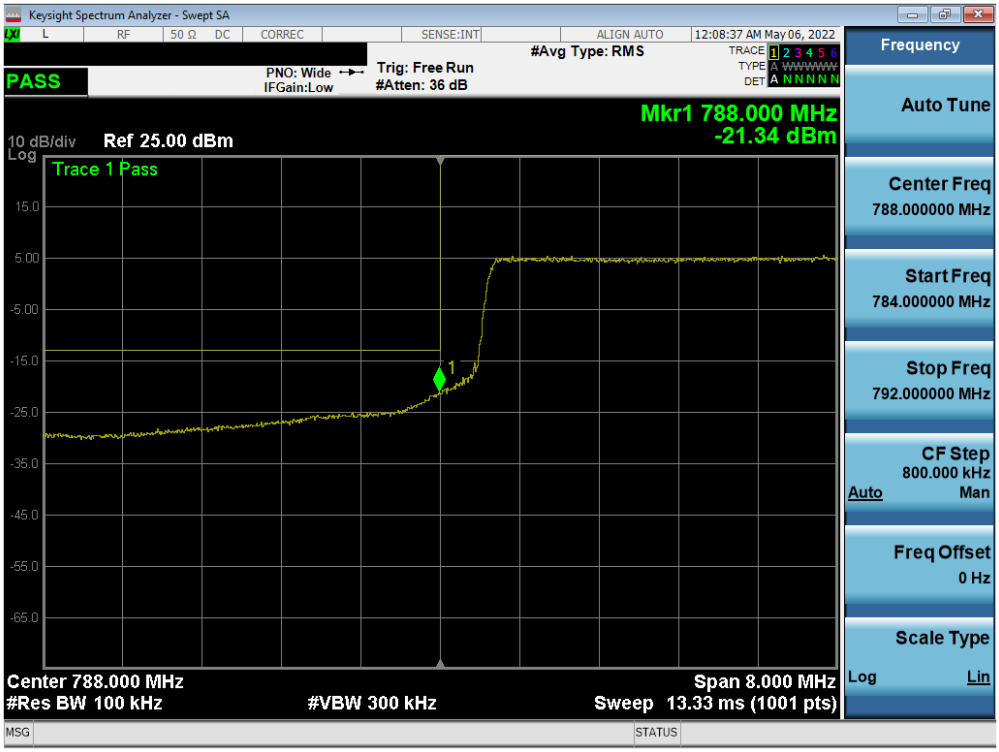


Plot 7-39. Lower Emission Mask Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

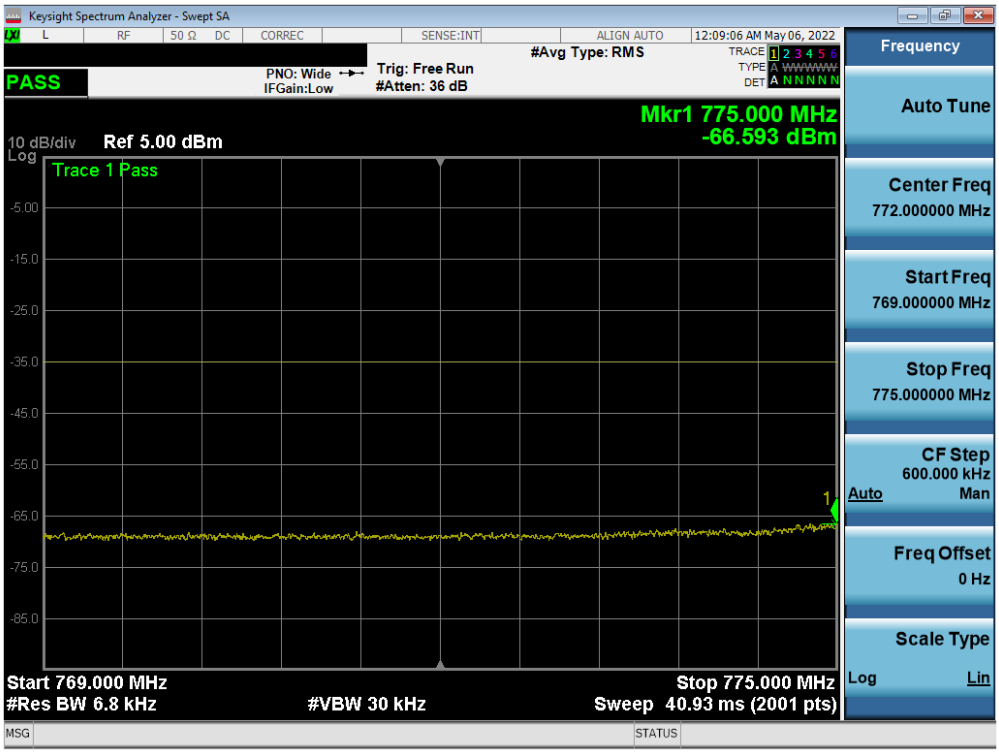
Plot 7-40. Upper Band Edge Plot (LTE Band 14, 5MHz QPSK - RB Size 25)



Plot 7-41. Upper Emission Mask Plot (LTE Band 14, 5MHz QPSK - RB Size 25)

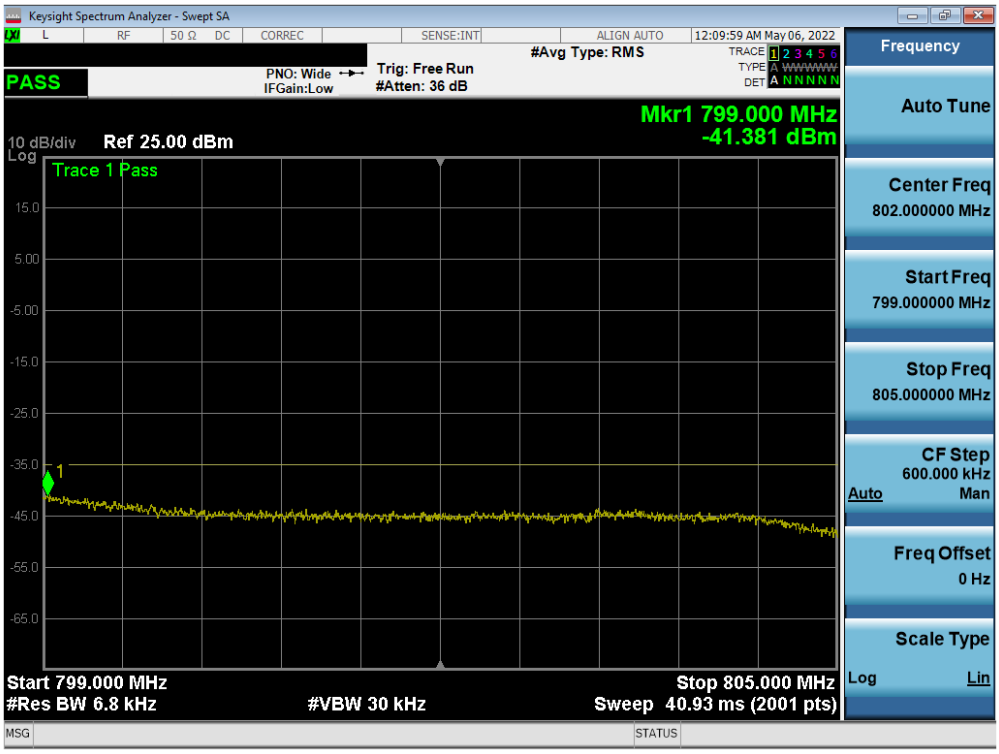


Plot 7-42. Lower Band Edge Plot (LTE Band 14, 10MHz QPSK - RB Size 50)



Plot 7-43. Lower Emission Mask Plot (LTE Band 14, 10MHz QPSK - RB Size 50)

Plot 7-44. Upper Band Edge Plot (LTE Band 14, 10MHz QPSK - RB Size 50)



Plot 7-45. Upper Emission Mask Plot (LTE Band 14, 10MHz QPSK - RB Size 50)

7.5 Conducted Power Output Data

§2.1046 §90.635

Test Overview

Conducted power measurements are performed to measure the average output power of the EUT. The averaging is to be performed only over duration of active transmissions at maximum output power level. The average measurements do not include averaging over periods when the transmitter is quiescent or when operating at reduced power level.

Test Procedures Used

KDB 971168 D01 v03r01

Test Setup

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

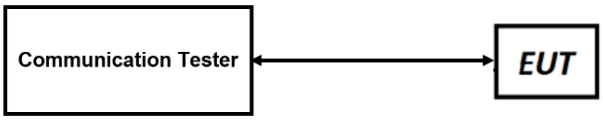


Figure 7-4. Conducted Power Measurement Setup

Test Notes

1. The EUT was tested in all possible test configurations. The worst case emissions are reported with the EUT modulations and channel bandwidth configurations shown in the tables below.

Antenna BCM

Bandwidth	Modulation	Channel	Frequency [MHz]	RB Size/Offset	Conducted Power [dBm]	Conducted Power [mW]	Conducted Power Limit [dBm]	Margin [dB]
1.4 MHz	QPSK	26697	814.7	1 / 0	24.99	315.500	50.00	-25.01
		26783	823.3	1 / 0	24.98	314.775	50.00	-25.02
	16-QAM	26783	823.3	1 / 5	24.45	278.612	50.00	-25.55
3 MHz	QPSK	26705	815.5	1 / 0	24.93	311.172	50.00	-25.07
		26775	822.5	1 / 0	25.09	322.849	50.00	-24.91
	16-QAM	26775	822.5	1 / 14	24.56	285.759	50.00	-25.44
5 MHz	QPSK	26715	816.5	1 / 0	25.14	326.588	50.00	-24.86
		26765	821.5	1 / 0	25.36	343.558	50.00	-24.64
	16-QAM	26765	821.5	1 / 24	24.77	299.916	50.00	-25.23
10 MHz	QPSK	26740	819.0	1 / 0	24.94	311.889	50.00	-25.06
	16-QAM	26740	819.0	1 / 0	24.28	267.917	50.00	-25.72

Table 7-2. Conducted Power Output Data (LTE Band 26)

7.6 Radiated Power (ERP)

§90.542(a)(7)

Test Overview

Effective Radiated Power (ERP) measurements are calculated by adding highest antenna gain to maximum measured conducted output power. All measurements are performed as RMS average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.2.1
ANSI C63.26-2015
TIA-603-E-2016 – Section 2.2.17

Test Settings

The relevant equation for determining the ERP from the conducted RF output power measured is:

ERP = PMeas – LC + GT

Where:

ERP = Effective Radiated Power (expressed in the same units as PMeas, typically dBW or dBm)

PMeas = measured transmitter output power or PSD, in dBW or dBm

LC = signal attenuation in the connecting cable between the transmitter and antenna in dB

GT = gain of the transmitting antenna, in dBd (ERP)

Test Setup

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

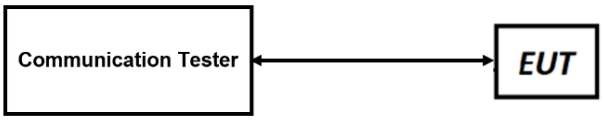


Figure 7-5. ERP Measurement Setup

Test Notes

1) The worst case emissions are reported with the modulations, RB sizes and offsets, and channel bandwidth configurations shown in the tables below.

2) This unit was tested with its standard battery.

3) The Level (dBm) readings in the table were taken with a correction table loaded into the base station simulator. The correction table was used to account for the signal attenuation in the connecting cable between the transmitter and antenna.

4) The Ant. Gains (GT) are listed in dBi.

7.6.1 Antenna BCM – ERP

Bandwidth	Mod.	Frequency [MHz]	Ant. Gain [dBi]	RB Size/Offset	Conducted Power [dBm]	ERP [dBm]	ERP [mW]	ERP Limit [dBm]	Margin [dB]
5 MHz	QPSK	790.5	-26.10	1 / 12	25.21	**-3.04**	0.497	34.77	-37.81
		793.0	-26.10	1 / 12	25.14	-3.11	0.489	34.77	-37.88
		795.5	-26.10	1 / 0	24.95	-3.30	0.468	34.77	-38.07
	16-QAM	793.0	-26.10	1 / 12	24.64	-3.61	0.436	34.77	-38.38
10 MHz	QPSK	793.0	-26.10	1 / 25	24.98	**-3.27**	0.471	34.77	-38.04
	16-QAM	793.0	-26.10	1 / 25	24.43	-3.82	0.415	34.77	-38.59

Table 7-3. ERP Data (LTE Band 14)

7.7 Radiated Spurious Emissions

§2.1051 §90.691(a) §90.543(e)

Test Overview

Radiated spurious emissions measurements are performed using the field strength conversion method described in KDB 971168 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using horizontally and vertically polarized broadband hybrid antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas. All measurements are performed while the EUT is operating at maximum power and at the appropriate frequencies.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.8

ANSI C63.26-2015

TIA-603-E-2016 – Section 2.2.12

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.

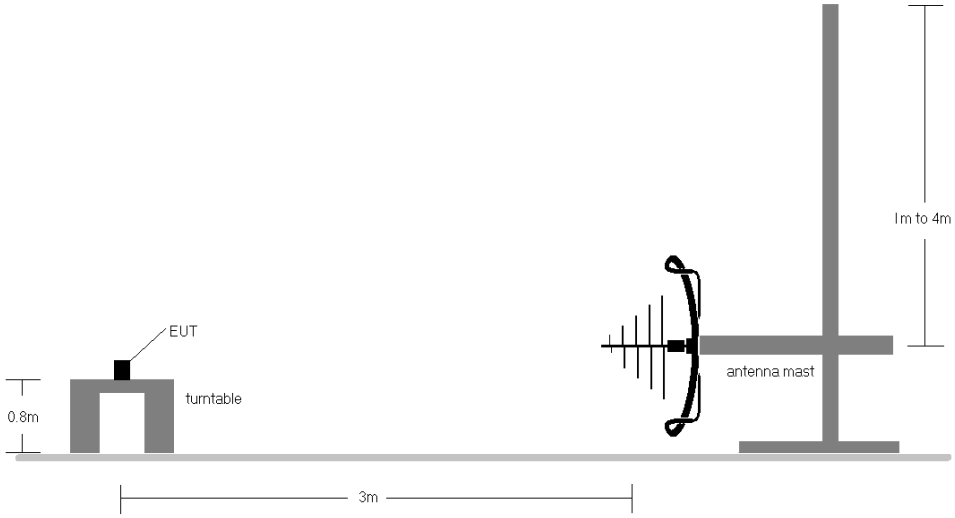


Figure 7-6. Test Instrument & Measurement Setup < 1GHz

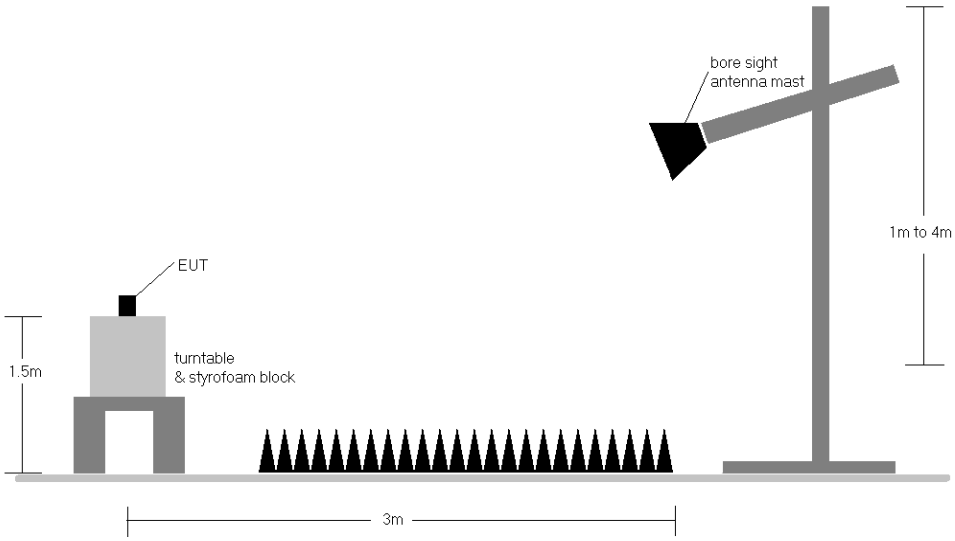


Figure 7-7. Test Instrument & Measurement Setup >1 GHz

Test Notes

1. Field strengths are calculated using the Measurement quantity conversions in KDB 971168 Section 5.8.4.
    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, RB sizes and offsets, and channel bandwidth configurations and the worst case emissions are reported with 1 RB.

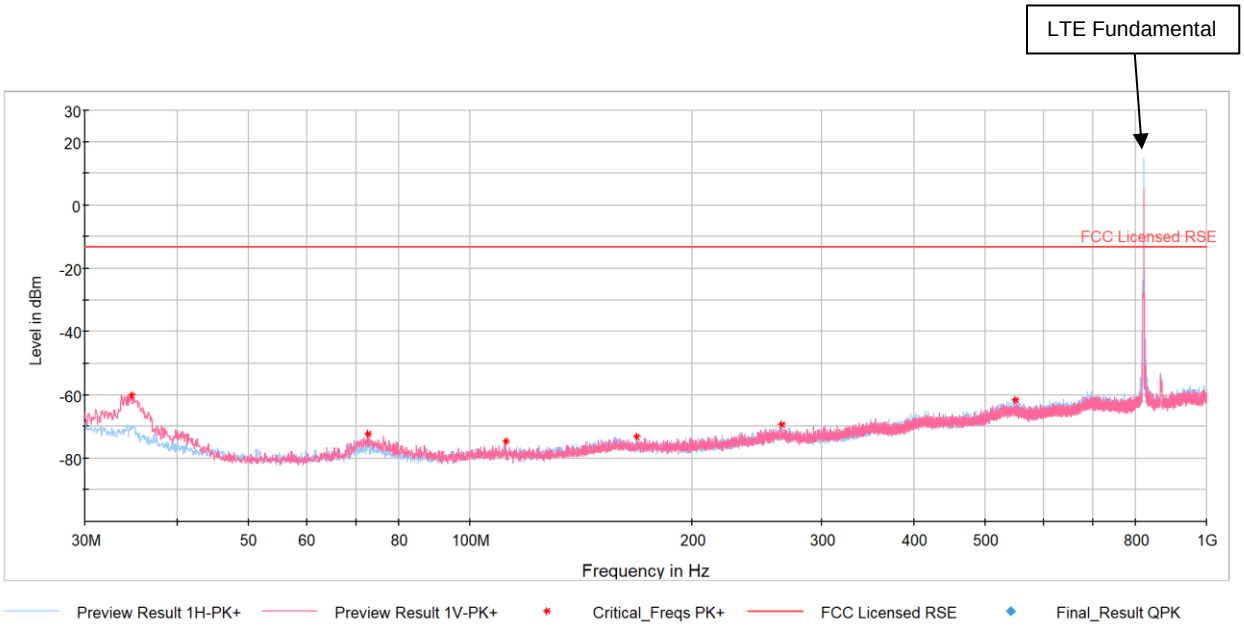
3. This unit was tested with its standard battery.

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.

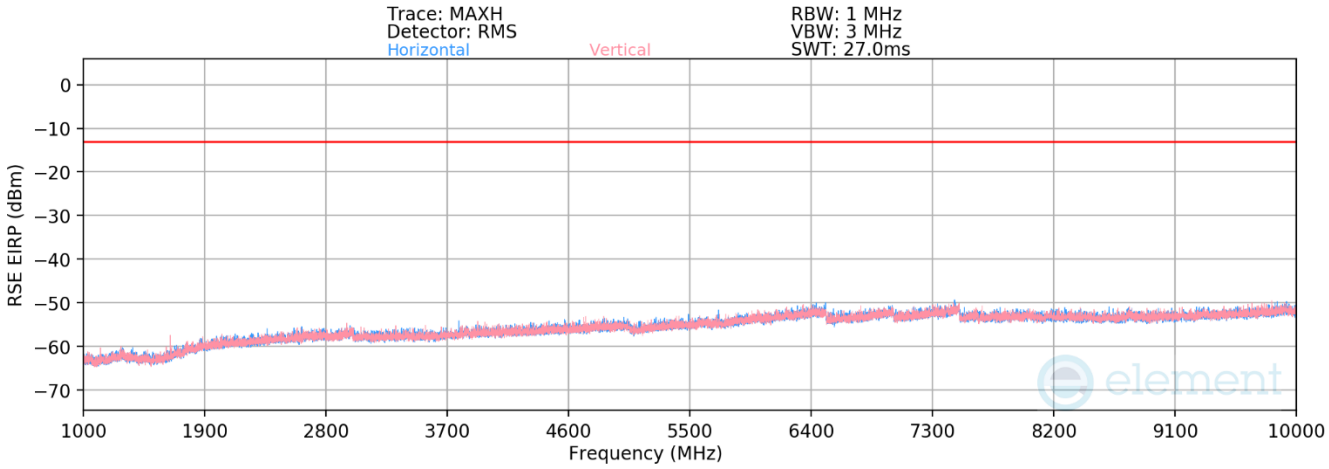
5. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

7.7.1 Antenna BCM – Radiated Spurious Emission Measurements

LTE Band 26



Plot 7-46. Antenna BCM Radiated Spurious Plot below 1GHz (LTE Band 26)



Plot 7-47. Antenna BCM Radiated Spurious Plot above 1GHz (LTE Band 26)

Bandwidth (MHz):	5
Frequency (MHz):	816.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

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]
1633.0	V	153	274	-75.84	-4.66	26.50	-68.76	-13.00	-55.76
2449.5	V	-	-	-77.70	-0.03	29.27	-65.99	-13.00	-52.99
3266.0	V	-	-	-78.02	1.24	30.22	-65.04	-13.00	-52.04
4082.5	V	-	-	-78.91	2.69	30.78	-64.47	-13.00	-51.47

Table 7-4. Antenna BCM Radiated Spurious Data (LTE Band 26 – Low Channel)

Bandwidth (MHz):	5
Frequency (MHz):	819.0
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

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]
1638.0	V	236	288	-74.07	-4.66	28.27	-66.99	-13.00	-53.99
2457.0	V	229	275	-75.73	-0.03	31.24	-64.02	-13.00	-51.02
3276.0	V	-	-	-77.98	1.24	30.26	-65.00	-13.00	-52.00
4095.0	V	-	-	-78.99	2.69	30.70	-64.55	-13.00	-51.55
4914.0	V	-	-	-79.84	4.43	31.59	-63.67	-13.00	-50.67

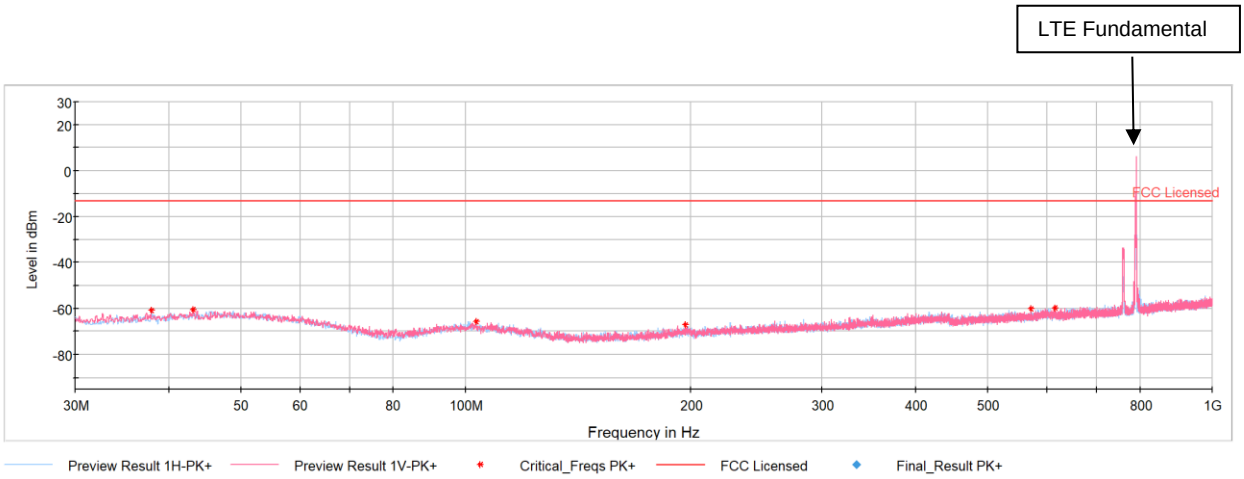
Table 7-5. Antenna BCM Radiated Spurious Data (LTE Band 26 – Mid Channel)

Bandwidth (MHz):	5
Frequency (MHz):	821.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

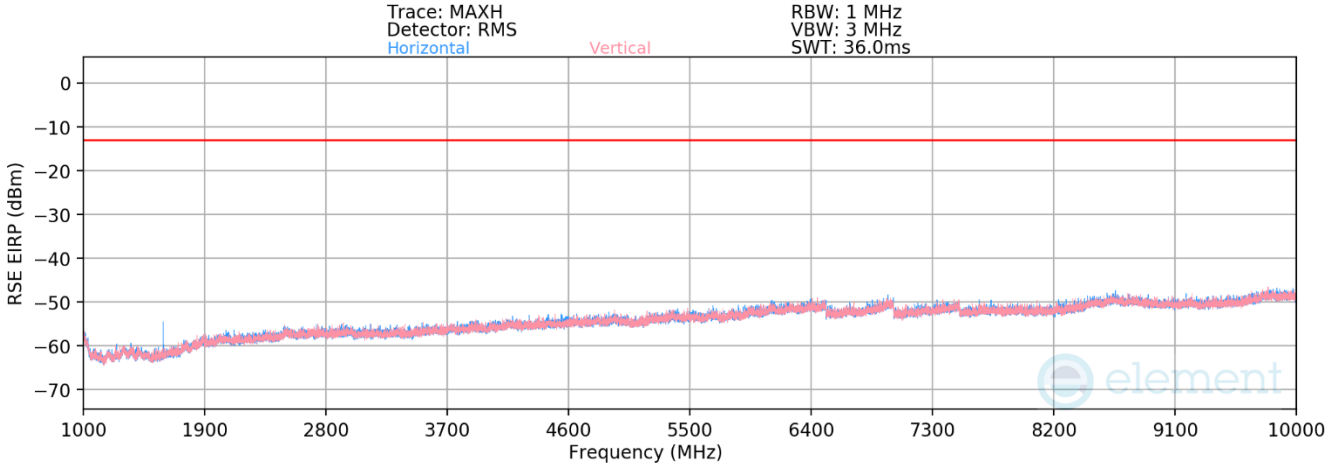
Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm]	Limit [dBm]	Margin [dB]
1643.0	V	346	247	-73.70	-4.66	28.64	-66.62	-13.00	-53.62
2464.5	V	395	316	-75.75	-0.03	31.22	-64.04	-13.00	-51.04
3286.0	V	-	-	-77.66	1.24	30.58	-64.68	-13.00	-51.68
4107.5	V	-	-	-78.61	2.69	31.08	-64.17	-13.00	-51.17
4929.0	V	-	-	-79.39	4.43	32.04	-63.22	-13.00	-50.22

Table 7-6. Antenna BCM Radiated Spurious Data (LTE Band 26 – High Channel)

LTE Band 14



Plot 7-48. Antenna BCM Radiated Spurious Plot below 1GHz (LTE Band 14)



Plot 7-49. Antenna BCM Radiated Spurious Plot above 1GHz (LTE Band 14)

Bandwidth (MHz):	5
Frequency (MHz):	790.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

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]
1581.0	V	264	139	-75.73	-2.78	28.49	-66.76	-40.00	-26.76
2371.5	V	263	149	-77.92	1.81	30.89	-64.36	-13.00	-51.36
3162.0	V	-	-	-78.71	3.70	31.99	-63.27	-13.00	-50.27
3952.5	V	-	-	-78.95	4.41	32.46	-62.79	-13.00	-49.79
4743.0	V	-	-	-79.05	6.24	34.19	-61.06	-13.00	-48.06

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

Bandwidth (MHz):	5
Frequency (MHz):	793.0
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

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]
1586.0	V	319	143	-76.77	-2.71	27.52	-67.74	-40.00	-27.74
2379.0	V	117	136	-77.43	1.75	31.32	-63.94	-13.00	-50.94
3172.0	V	-	-	-78.61	3.69	32.08	-63.18	-13.00	-50.18
3965.0	V	-	-	-78.94	4.40	32.46	-62.80	-13.00	-49.80
4758.0	V	-	-	-79.53	6.44	33.91	-61.34	-13.00	-48.34

Table 7-8. Antenna BCM Radiated Spurious Data (LTE Band 14 – Mid Channel)

Bandwidth (MHz):	5
Frequency (MHz):	795.5
Modulation Signal:	QPSK
RB Config (Size / Offset):	1 / 12

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]
1591.0	V	305	136	-76.26	-2.64	28.10	-67.16	-40.00	-27.16
2386.5	V	215	145	-76.80	1.70	31.90	-63.36	-13.00	-50.36
3182.0	V	-	-	-78.59	3.61	32.02	-63.24	-13.00	-50.24
3977.5	V	-	-	-78.85	4.41	32.56	-62.70	-13.00	-49.70
4773.0	V	-	-	-79.73	6.54	33.81	-61.45	-13.00	-48.45

Table 7-9. Antenna BCM Radiated Spurious Data (LTE Band 14 – High Channel)

7.8 Frequency Stability / Temperature Variation

§2.1055 §90.213

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.26-2015 and 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.

For Band 26, the frequency stability of the transmitter shall be maintained within ±0.00025% (±2.5 ppm) of the center frequency. For Band 14 the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

Test Procedure Used

ANSI C63.26-2015

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

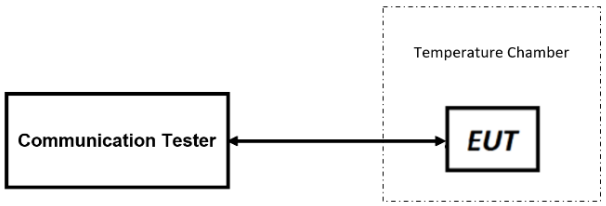


Figure 7-8. Test Instrument & Measurement Setup

Test Notes

None

Frequency Stability / Temperature Variation

LTE Band 26

Operating Frequency (Hz):	819,000,000
Ref. Voltage (VDC):	3.80
Deviation Limit:	± 0.00025% or 2.5 ppm

Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 30	819,000,001	0.70	0.0000001
		- 20	819,000,001	0.50	0.0000001
		- 10	819,000,000	0.40	0.0000000
		0	819,000,001	0.52	0.0000001
		+ 10	819,000,000	0.39	0.0000000
		+ 20 (Ref)	819,000,000	0.00	0.0000000
		+ 30	819,000,001	0.92	0.0000001
		+ 40	819,000,001	0.84	0.0000001
		+ 50	819,000,001	0.72	0.0000001
Battery Endpoint	3.40	+ 20	819,000,001	0.64	0.0000001

Table 7-10. LTE Band 26 Frequency Stability Data

LTE Band 14

Low Channel Frequency (Hz):	790,500,000
High Channel Frequency (Hz):	795,500,000
Ref. Voltage (VDC):	3.80

Voltage (%)	Power (VDC)	Temp (°C)	Low Freq. (Hz)	High Freq. (Hz)	Low Freq. Dev. (Hz)	High Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 30	790,500,002	790,500,002	1.98	2.19	0.0000003
		- 20	790,500,002	790,500,002	1.80	2.02	0.0000003
		- 10	790,500,002	790,500,002	1.99	2.02	0.0000003
		0	790,500,002	790,500,002	1.75	1.98	0.0000003
		+ 10	790,500,002	790,500,002	1.97	2.15	0.0000003
		+ 20 (Ref)	790,500,000	790,500,000	0.00	0.00	0.0000000
		'+ 30	790,500,002	790,500,002	2.20	2.09	0.0000003
		+ 40	790,500,002	790,500,002	2.04	1.87	0.0000003
		+ 50	790,500,002	790,500,002	1.95	1.72	0.0000002
Battery Endpoint	3.40	+ 20	790,500,001	790,500,002	1.09	1.67	0.0000002

Table 7-11. LTE Band 14 Frequency Stability Data

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Watch FCC ID: BCG-A2622** complies with all the requirements of Part 90 of the FCC rules.

9.0 APPENDIX A

Antenna gains provided by the manufacturer:

A2622 Antenna Specifications

Cellular Antenna Gain (BCM), Type: LDS			
Band	**Frequency (MHz)**	**Horizontal (dBi)**	**Vertical (dBi)**
12	700.0	-33.5	-30.3
12	707.4	-33.3	-29.7
12	715.0	-33.8	-29.8
13	778.6	-29.2	-26.4
13	782.0	-29.5	-26.5
13	785.4	-28.7	-26.1
26	815.0	-29.6	-26.8
26	831.4	-29.3	-26.1
26	848.0	-29.1	-25.7
40	2397.4	-11.7	-11.5

Table 9-1. Antenna Gains