PCTEST
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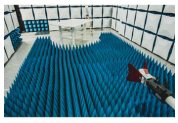


PART 27 MEASUREMENT REPORT

Applicant Name:
4RF Limited
PO Box 13-506
Wellington 6440
New Zealand

Date of Testing:
07/22/2020, 02/22- 03/02/2021
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M2103010013-01.UIP

FCC ID:	**UIP4RF55**
APPLICANT:	**4RF Limited**

Application Type:	Class II Permissive Change
Model:	Aprisa LTE
EUT Type:	LTE Module Integrated Into Multiservice Connect Router
FCC Classification:	Part 27 Subpart P
FCC Rule Part:	27
Test Procedure(s):	ANSI C63.26-2015, KDB 971168 D01 v03r01
Class II Permissive Change:	Adding LTE Band 8 Frequencies and co-locating with another FCC approved module as discussed in this filing
Original Grant Date:	03/05/2021

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

1.0 INTRODUCTION

1.1 Scope

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

1.2 PCTEST Test Location

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

1.3 Test Facility / Accreditations

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

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

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

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

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **LTE Module (FCC ID: UIP4RF55) Integrated into Multiservice Connect Router (Model: Aprisa LTE)**. The router also contains an integrated and FCC certified 2.4GHz and 5GHz WiFi module (FCC ID: SQG-60SIPT).
The router connects via unique coupling to an RF antenna (RFMax, Model: Max BR1) as shown in the test setup photographs document. This report contains data to support the addition of operating frequencies from 897.5 - 900.5MHz under LTE Band 8. Additionally, this reports contains data showing compliance for the radiated spurious emissions resulting from the co-located integration of the two modules.

Test Device Serial No.: R6510000005

2.2 Device Capabilities

This device contains the following capabilities:

LTE Band 8 operation only within the 897.5 - 900.5MHz band (3MHz bandwidth) along with WiFi Dual Ant. Transmitting at 2.4GHz & 5GHz.

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.

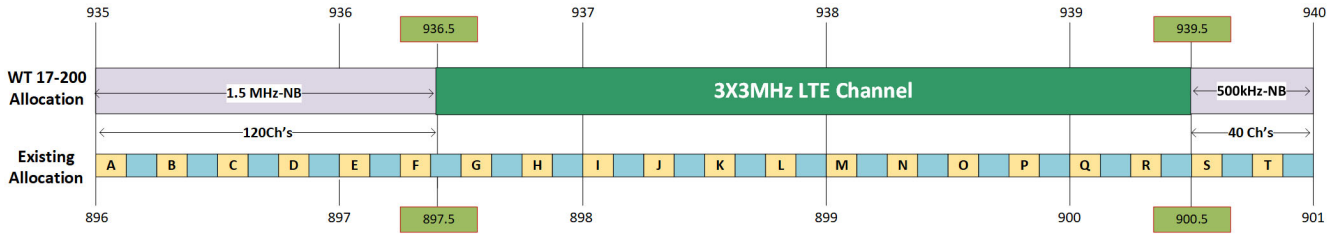
3.0 DESCRIPTION OF TESTS

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 Broadband Frequency Assignment

The spectrum for this band is allocated as shown below.



3.3 Radiated Power and Radiated Spurious Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.
The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer.

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

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

And

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

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 474788 D01.

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

4.0 MEASUREMENT UNCERTAINTY

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

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

5.0 TEST EQUIPMENT CALIBRATION DATA

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

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	AP2	EMC Cable and Switch System	9/9/2020	Annual	9/9/2021	AP2
-	AP1	EMC Cable and Switch System	9/10/2020	Annual	9/10/2021	AP1
-	LTx2	Licensed Transmitter Cable Set	9/16/2020	Annual	9/16/2021	LTx2
-	LTx3	LIcensed Transmitter Cable Set	8/28/2020	Annual	8/28/2021	LTx3
Keysight Technologies	N9038A	MXE EMI Receiver	8/11/2020	Annual	8/11/2021	MY51210133
Emco	3115	Horn Antenna (1-18GHz)	6/18/2020	Biennial	6/18/2022	9704-5182
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	7/15/2020	Annual	7/15/2021	100342
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	9/9/2020	Annual	9/9/2021	100348
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	8/10/2020	Annual	8/10/2021	103200
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	11/25/2020	Annual	11/25/2021	102134
Sunol	DRH-118	Horn Antenna (1-18 GHz)	8/27/2019	Biennial	8/27/2021	A042511
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	7/27/2020	Biennial	7/27/2022	A051107

Table 5-1. Summary of Test Results

Notes:

1. For all the testing performed on 07/22/2020, all equipment used were also up to date calibrated.
2. 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.
3. 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 25.501 dBm so this harmonic was 25.501 dBm – (-24.80).

7.0 TEST RESULTS

7.1 Summary

Company Name: 4RF Limited

FCC ID: UIP4RF55

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE/ WiFi (2.4GHz & 5GHz)

Test Condition	Test Description	FCC Part Section(s)	Test Limit	Test Result	Report Reference
CONDUCTED	Transmitter Conducted Output Power/ Effective Radiated Power	2.1046, 27.1507(a)(3)	< 10 Watts max. ERP	PASS	Section 7.2
	Occupied Bandwidth	2.1049, 27.1506	N/A	PASS	Section 7.3
	Conducted Band Edge / Spurious Emissions	2.1051, 27.1509(a)	Attenuation > 43 + 10 $\log_{10}$ (P[Watts]) for all out-of-band emissions	PASS	Section 7.4, 7.5
	Peak-Average Ratio	2.1051, 27.1507(d)	< 13dB	PASS	Section 7.6
RADIATED	Radiated Spurious Emissions	2.1051, 27.1509(a)	Attenuation > 43 + 10 $\log_{10}$ (P[Watts]) for all out-of-band emissions	PASS	Section 7.7
	Undesirable Emissions	15.407(b.1), 15.205, 15.209	Undesirable emissions must meet the limits detailed in 15.407(b) (RSS-247 [6.2]) and 15.209 (RSS-Gen [8.9])	PASS	Section 7.8

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.

7.2 Transmitter Conducted Output Power/ Effective Radiated Power

Test Overview

The transmitter conducted ouput power is a measure of the total average power contained within a 3MHz channel as defined in §27.1506. All modes of operation were investigated and the worst case configuration results are reported in this section.
Effective Radiated Power (ERP) measurements are performed using the substitution method described in ANSI/TIA-603-E-2016 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using vertically and horizontally polarized tuned dipole antennas. 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 Procedure Used

ANSI C63.26-2015 – Section 5.2.4.4.1

Test Settings

1. The signal analyzer's Channel Power measurement capability was used to perform the channel power.
2. Span = 2x to 3x times the Occupied Bandwidth
3. RBW = 1 – 5% of the expected OBW
4. VBW ≥ 3 x RBW
5. Number of measurements points ≥ 2 x span / RBW
6. Sweep = auto couple
7. Detector = power averaging (RMS)
8. Trace mode = trace averaging with no trigger (free run) over 100 sweeps
9. The trace was allowed to stabilize

Test Setup

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

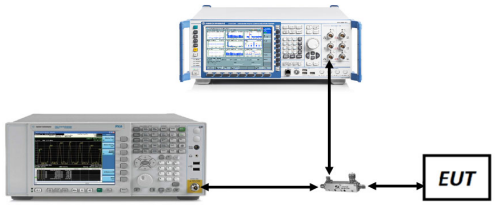


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None

LTE Band 8 3 MHz Bandwidth			
Modulation	RB Size	RB Offset	Mid Channel 21640 (899.0 MHz) Conducted Power [dBm]
QPSK	1	0	**23.62**
	1	7	23.58
	1	14	23.59
	15	0	22.37
16QAM	1	0	22.67
	1	7	22.84
	1	14	22.52
	15	0	21.42

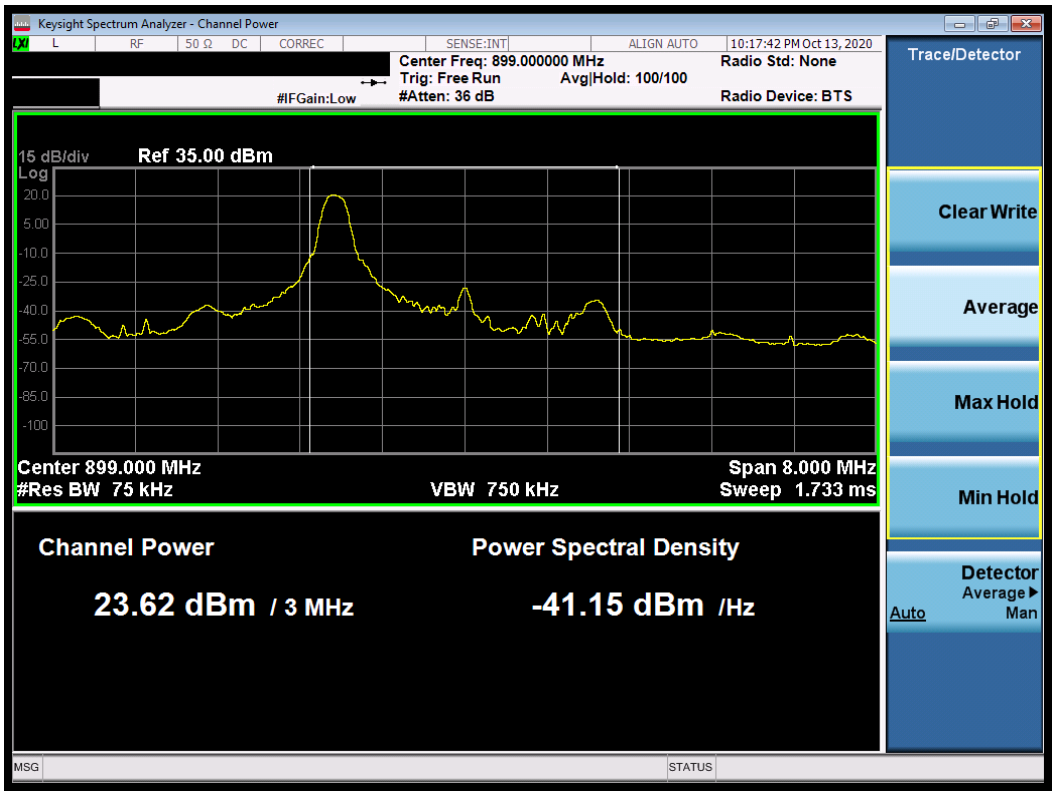
Table 7-2. Transmitter Conducted Output Power Measurements

Frequency Band [MHz]	Maximum Conducted Power [dBm]	Maximum ERP [dBm]	Maximum Antenna Gain [dBi]
899	23.62	40	18.53

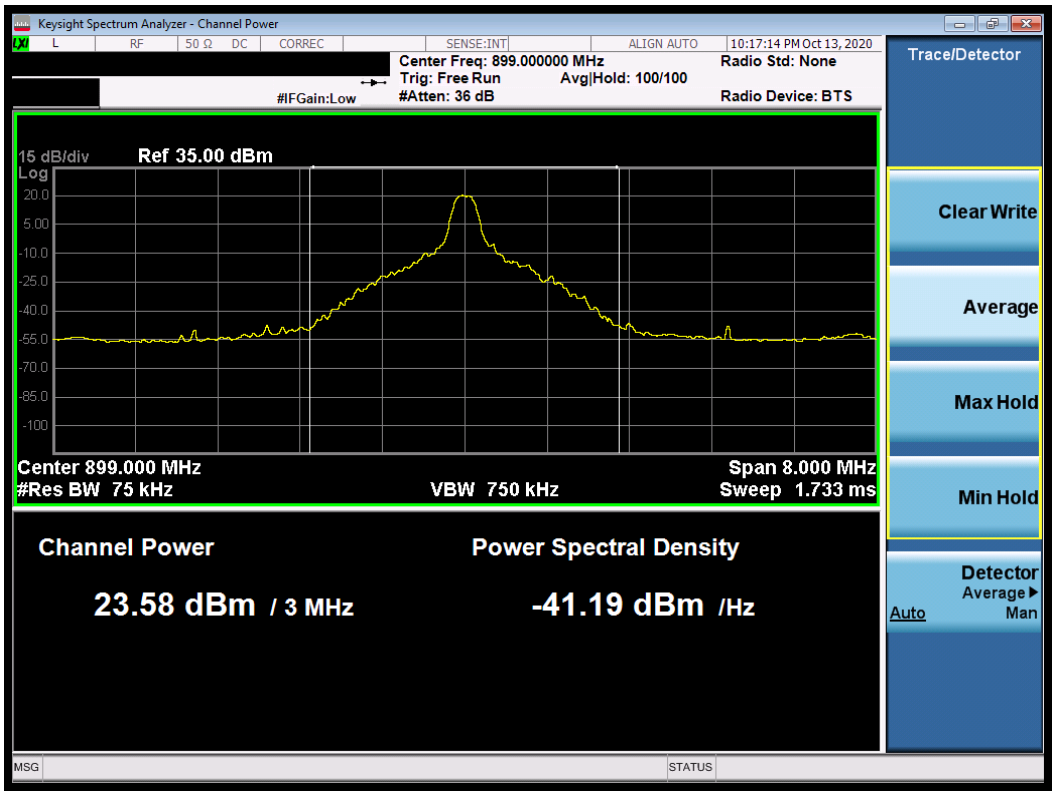
Table 7-3. ERP Data (LTE Band 8)

Note

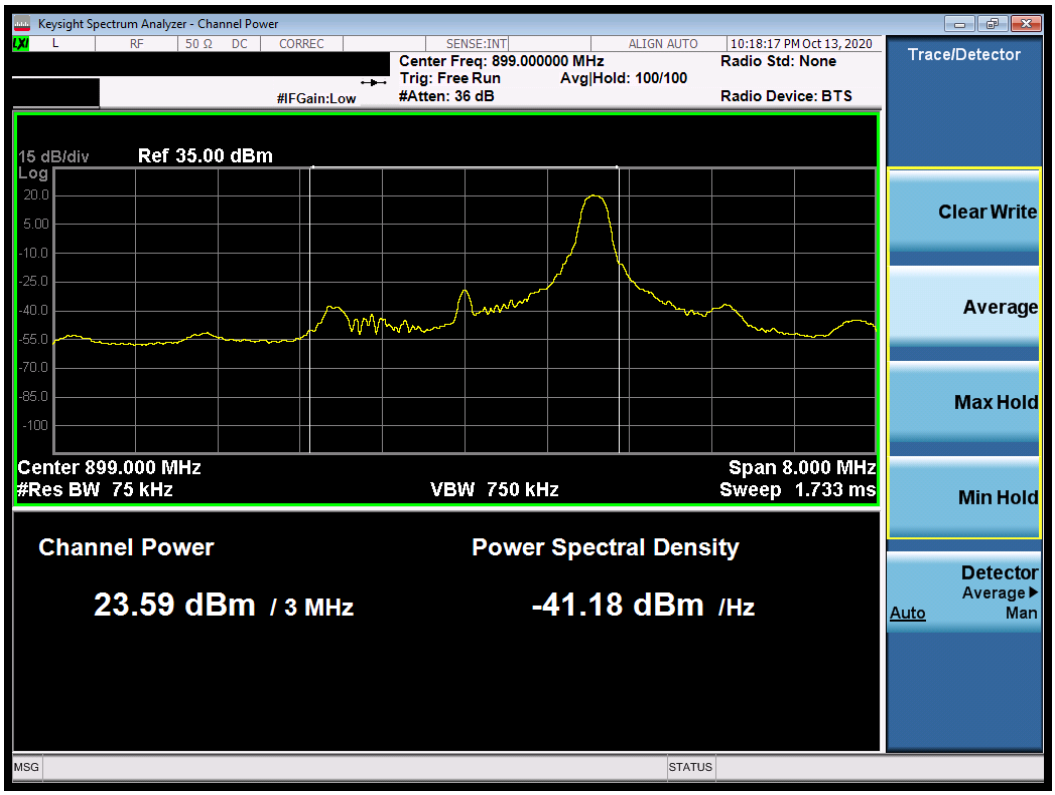
The 18.53dBi antenna gain shown in the table above is the maximum theoretical antenna gain that can be used by this device in order to reach the 10W ERP limit (42.15dBm EIRP) for operation in this band. An actual antenna was not used for testing to determine ERP compliance.



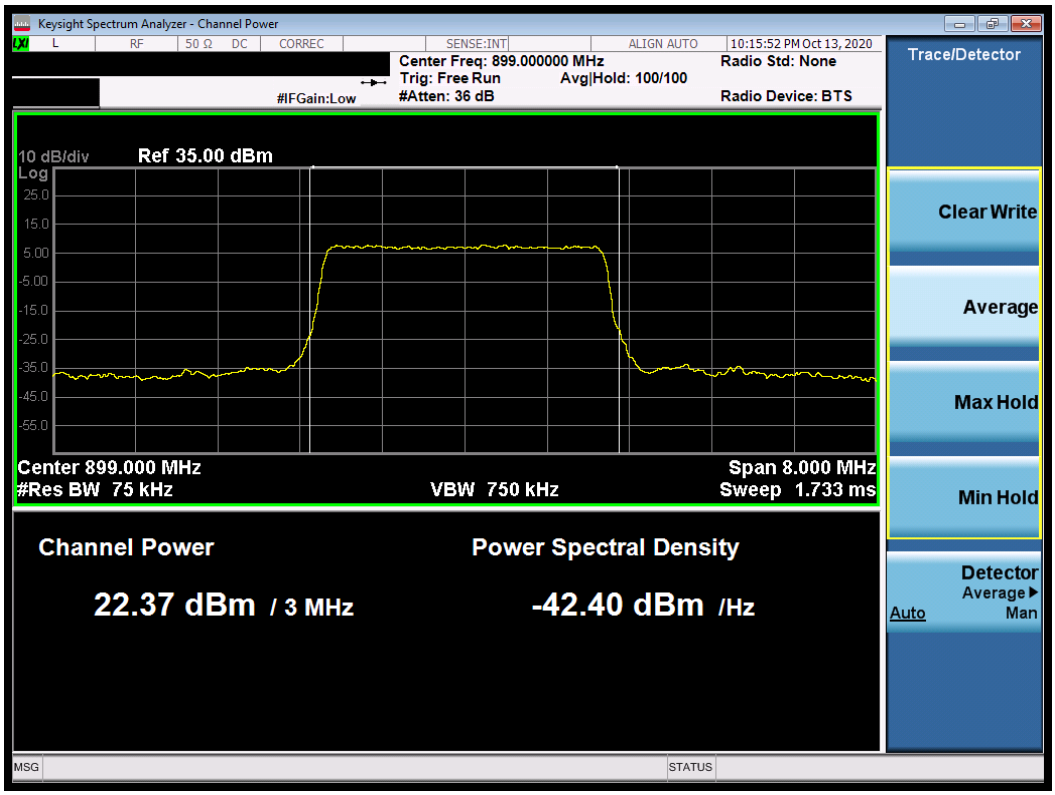
Plot 7-1. Conducted Output Power (QPSK, 1RB, RB Offset 0)



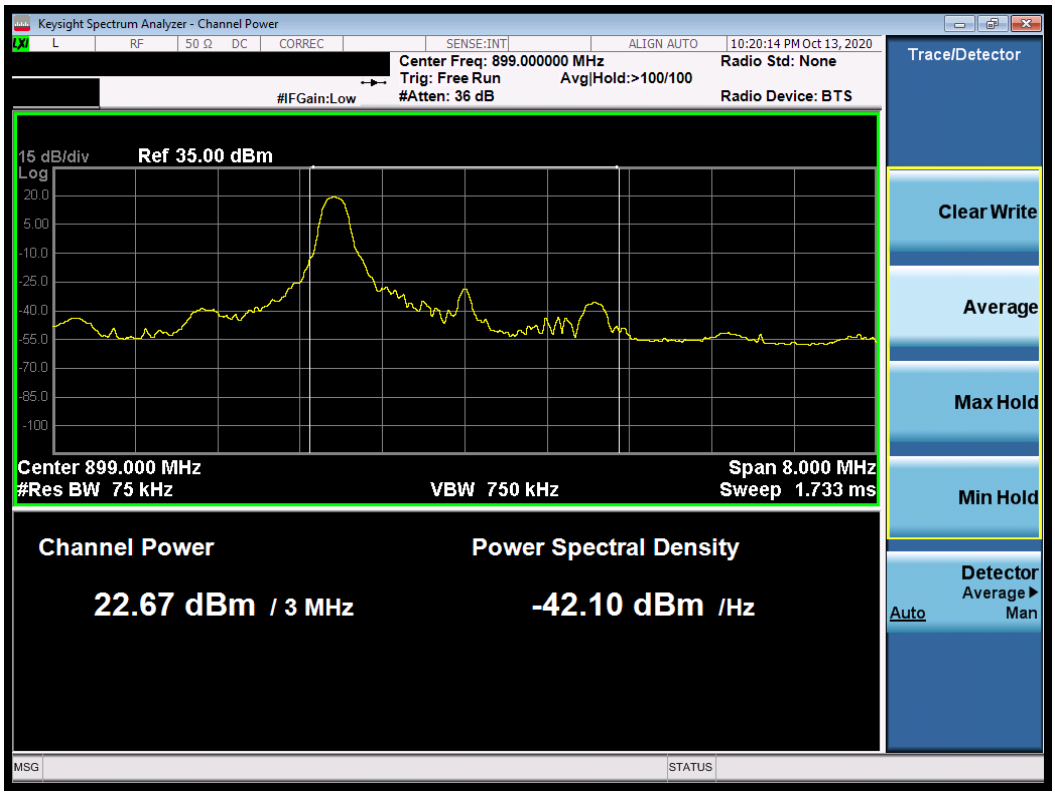
Plot 7-2. Conducted Output Power (QPSK, 1RB, RB Offset 7)



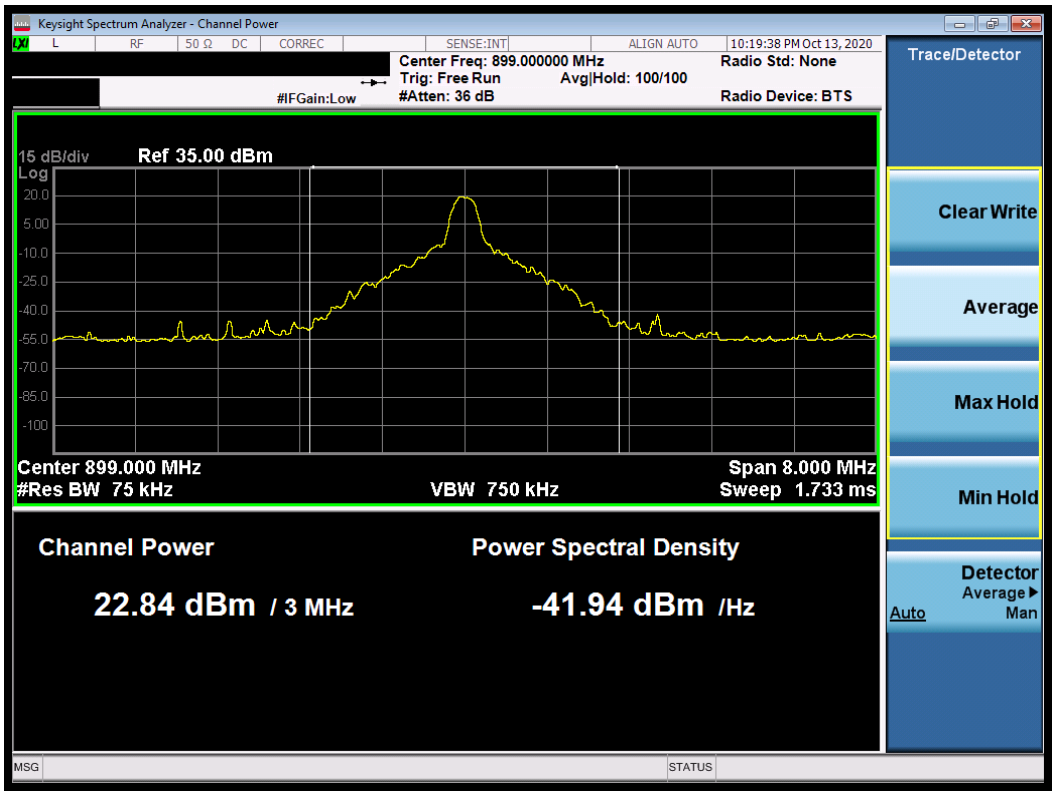
Plot 7-3. Conducted Output Power (QPSK, 1RB, RB Offset 14)



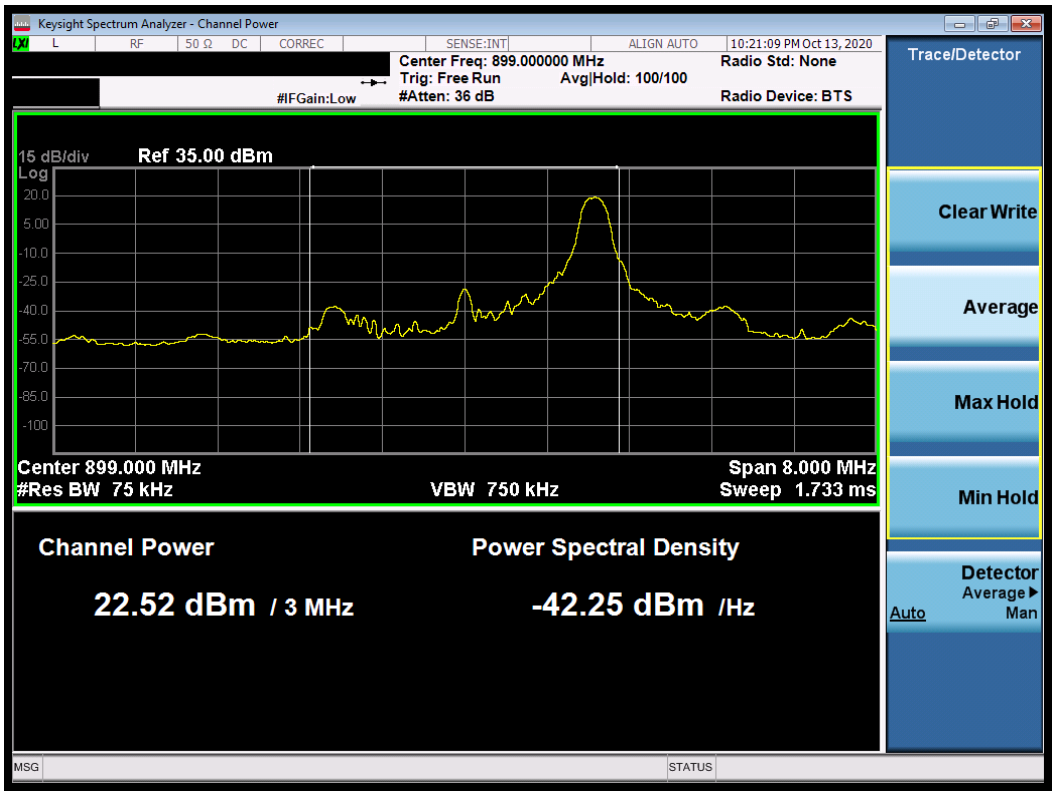
Plot 7-4. Conducted Output Power (QPSK, 15RB (Full), RB Offset 0)



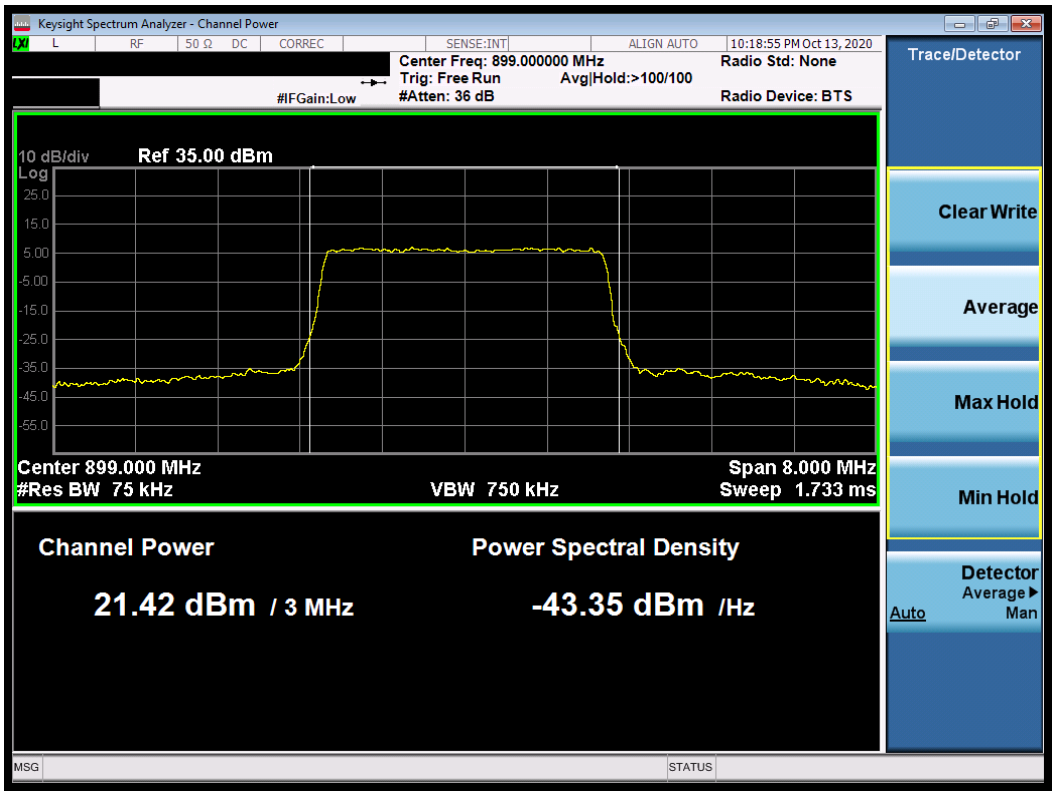
Plot 7-5. Conducted Output Power (16-QAM, 1RB, RB Offset 0)



Plot 7-6. Conducted Output Power (16-QAM, 1RB, RB Offset 7)



Plot 7-7. Conducted Output Power (16-QAM, 1RB, RB Offset 14)



Plot 7-8. Conducted Output Power (16-QAM, 15RB (Full), RB Offset 0)

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

ANSI C63.26-2015 – Section 5.4.4

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.

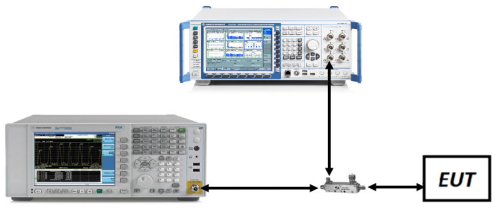


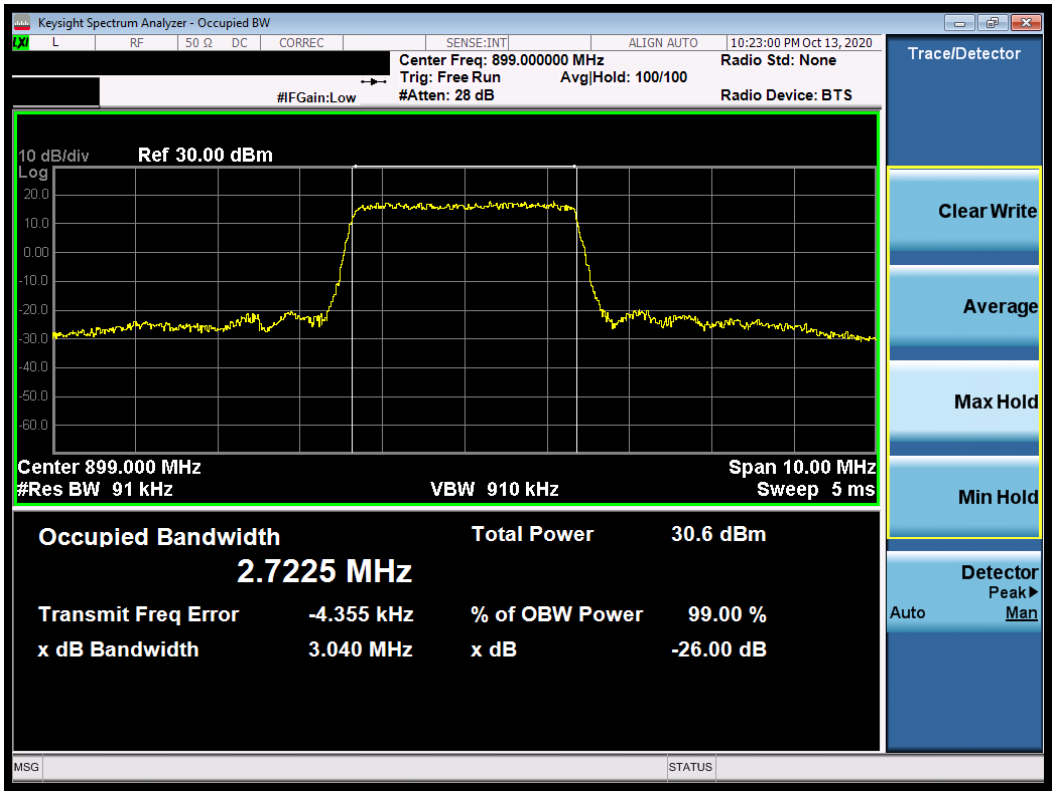
Figure 7-2. Test Instrument & Measurement Setup

Test Notes

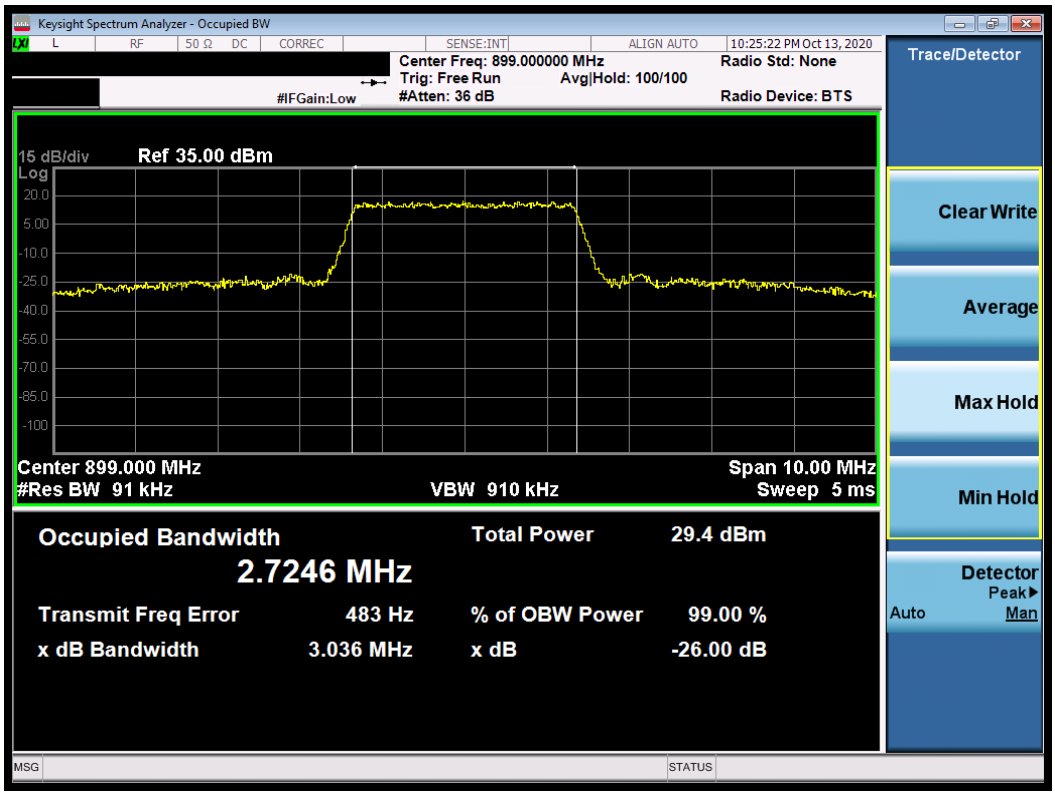
None

Mode	Channel Bandwidth (MHz)	Modulation	RB Size	RB Offset	Occupied BW [MHz]
LTE Band 8	3	QPSK	15	0	2.7225
LTE Band 8	3	16-QAM	15	0	2.7246

Table 7-4. Occupied Bandwidth Measurements



Plot 7-9. Occupied Bandwidth Plot (QPSK, 15RB (Full), RB Offset 0)



Plot 7-10. Occupied Bandwidth Plot (16-QAM, 15RB (Full), RB Offset 0)

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 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 + 10log$_{10}$(P$_{[Watts]}$), where P is the transmitter power in Watts.

Test Procedure Used

ANSI C63.26-2015 – Section 5.7.4

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 10GHz.
2. Detector = RMS
3. Trace mode = trace average for continuous emissions, max hold for pulse emissions
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

Test Setup

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

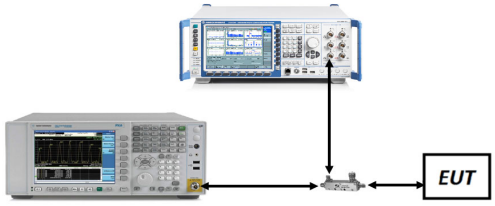
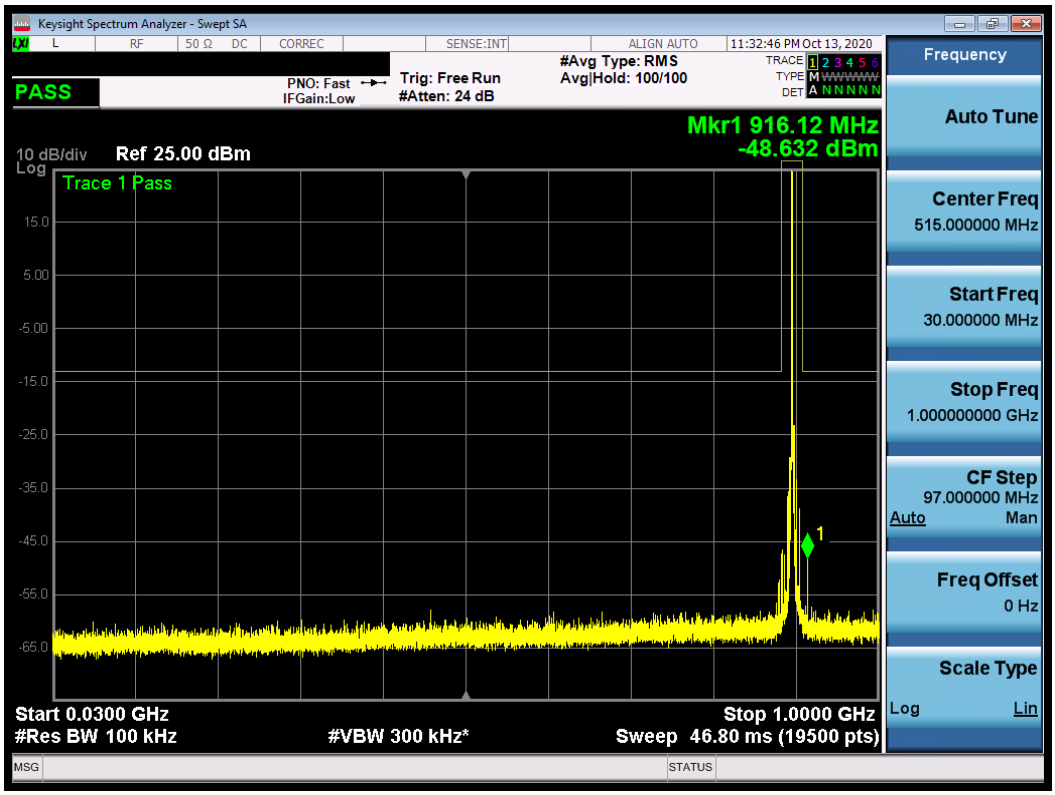


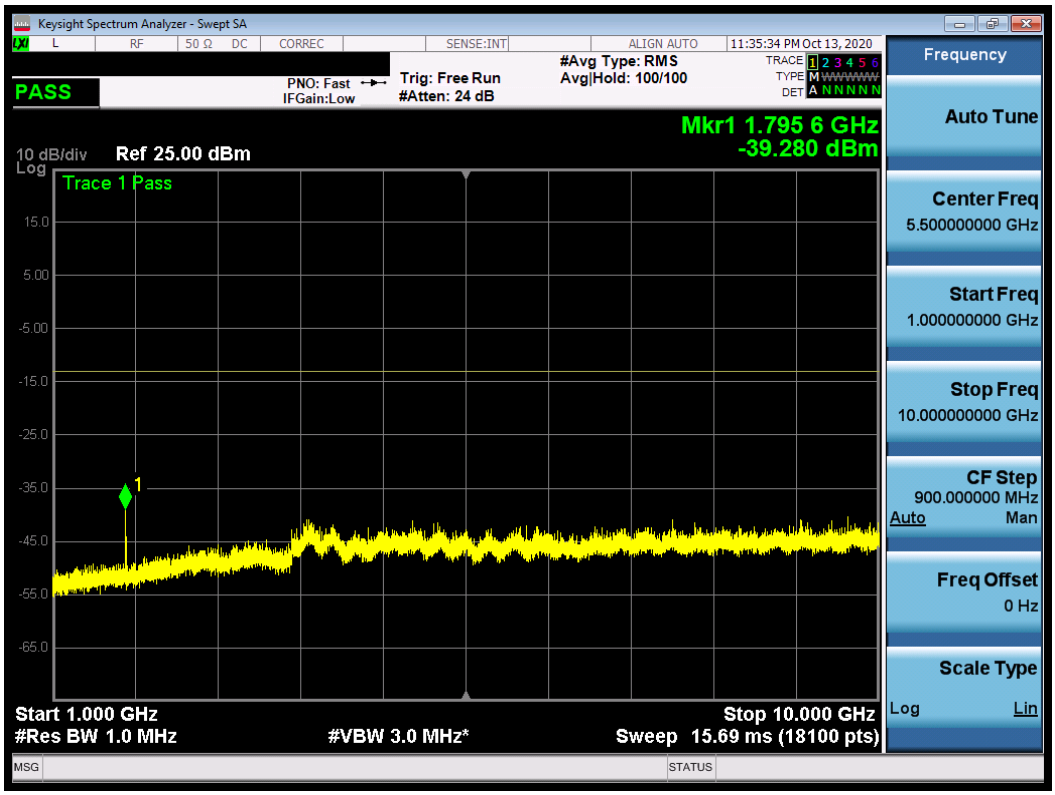
Figure 7-3. Test Instrument & Measurement Setup

Test Notes

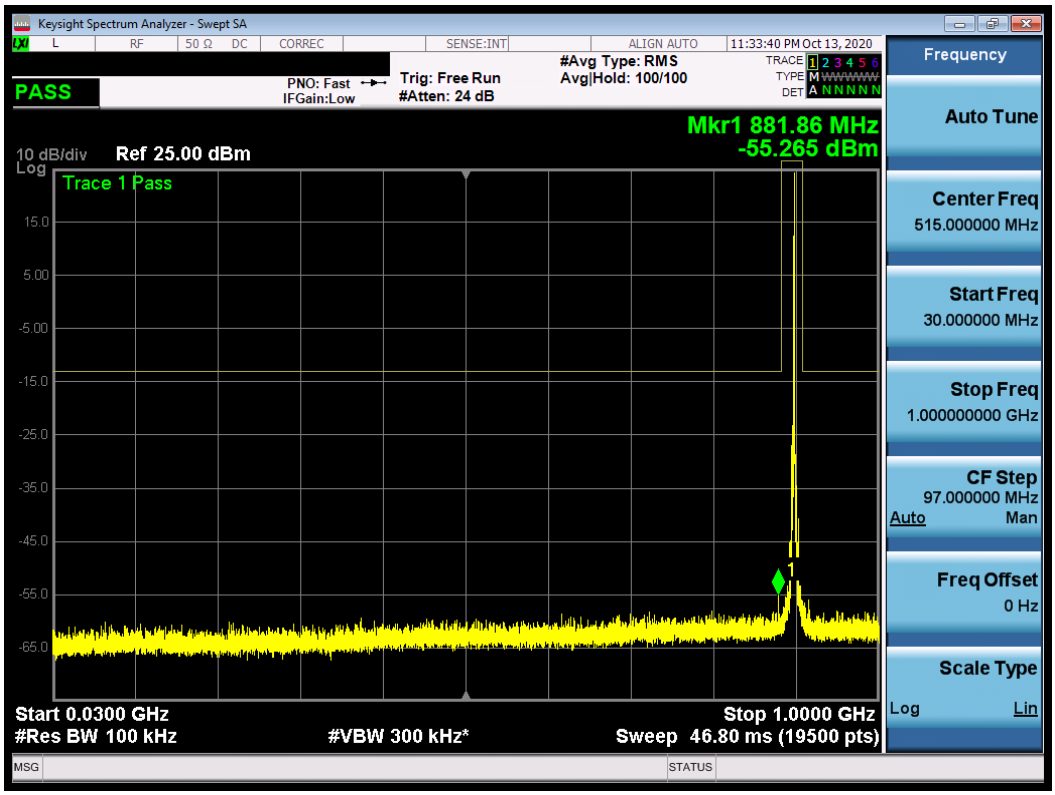
Per §27.1509(c), compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the 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.



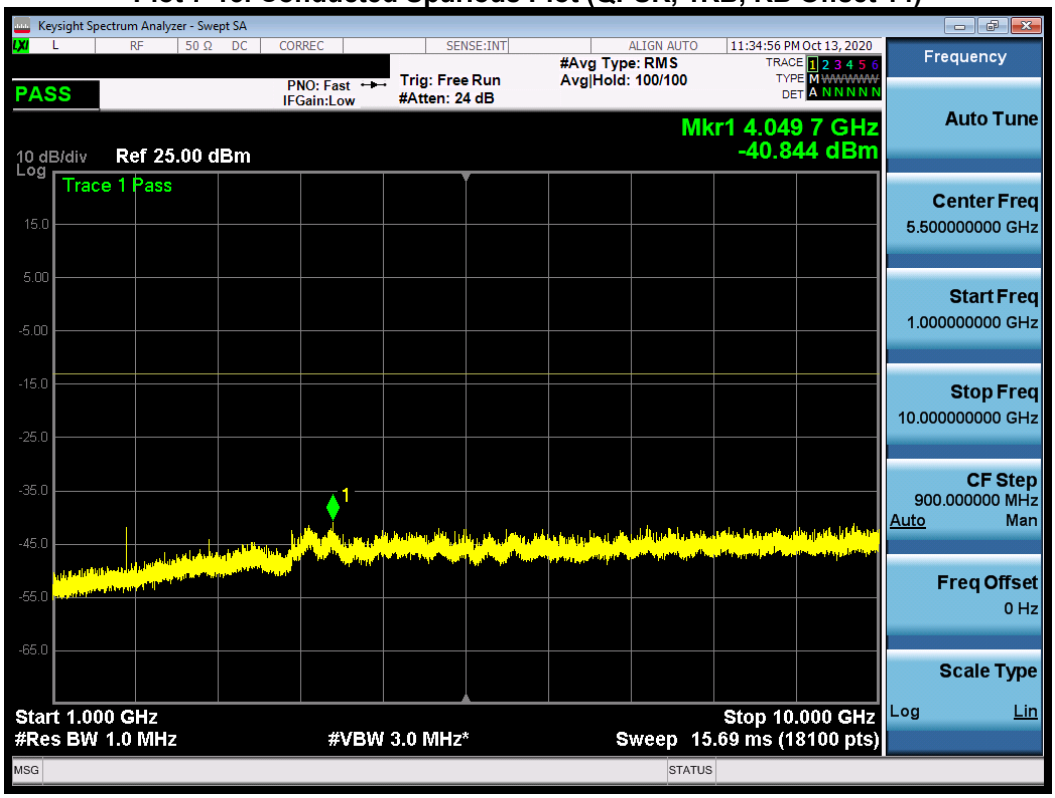
Plot 7-11. Conducted Spurious Plot (QPSK, 1RB, RB Offset 0)



Plot 7-12. Conducted Spurious Plot (QPSK, 1RB, RB Offset 0)



Plot 7-13. Conducted Spurious Plot (QPSK, 1RB, RB Offset 14)



Plot 7-14. Conducted Spurious Plot (QPSK, 1RB, RB Offset 14)

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 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

ANSI C63.26-2015 – Section 5.7.3

Test Settings

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

Test Setup

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

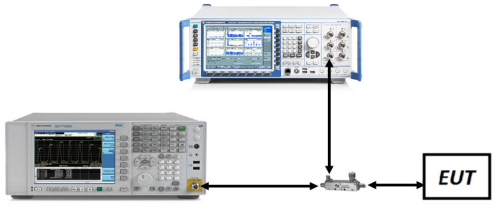


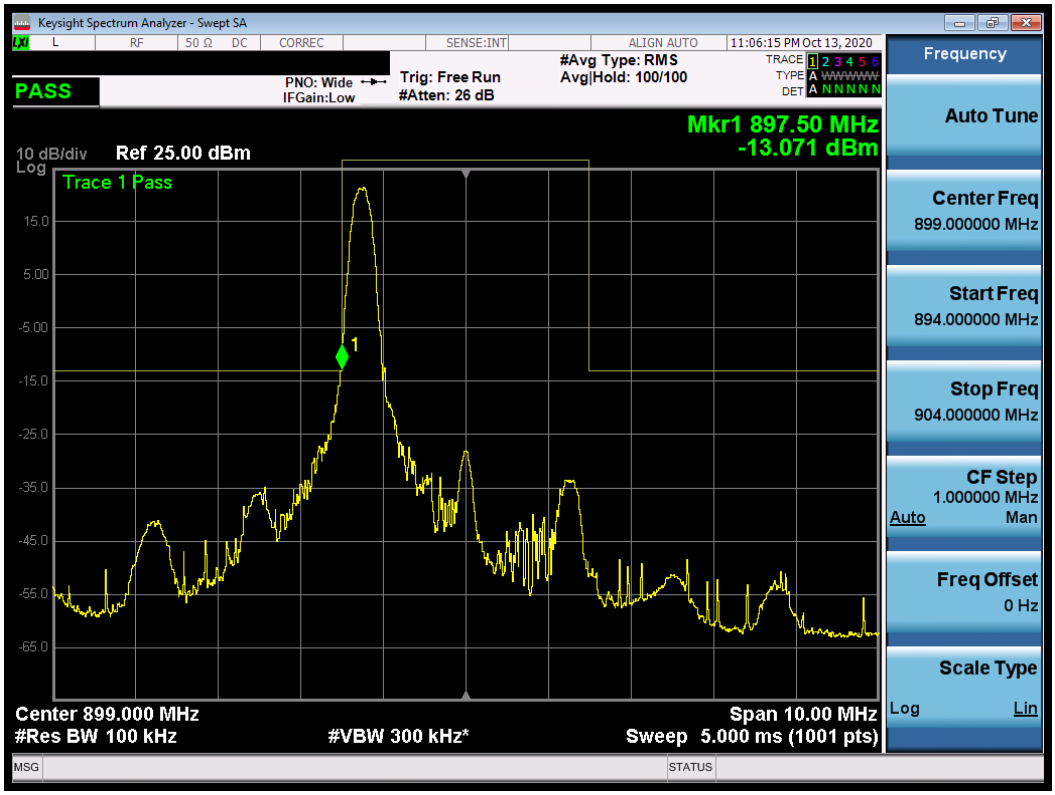
Figure 7-4. Test Instrument & Measurement Setup

Test Notes

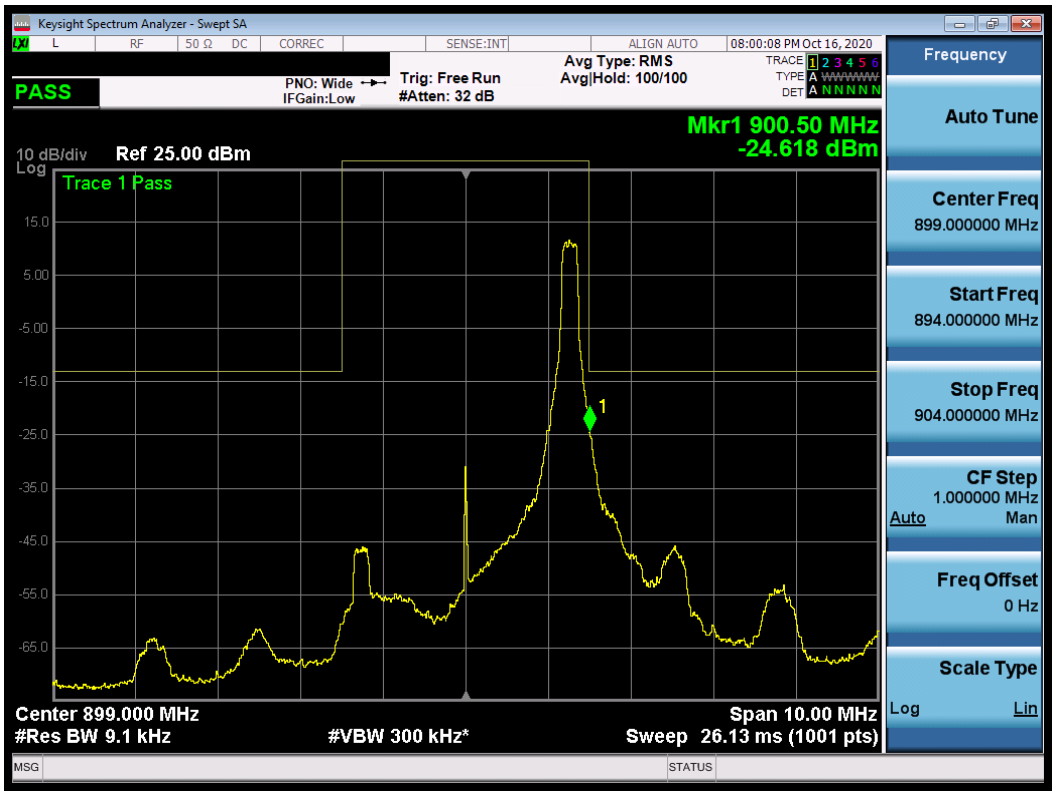
Per §27.1509(c), in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed to demonstrate compliance with the out-of-band emissions limit. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

Mode	Channel Bandwidth (MHz)	Modulation	RB Size	RB Offset	Band Edge Level [dBm]	Limit [dBm]	Margin [dB]
LTE Band 8	3	QPSK	1	0	-13.071	-13	-0.07
LTE Band 8	3	QPSK	1	14	-24.618	-13	-11.62
LTE Band 8	3	QPSK	6	5	-29.576	-13	-16.58
LTE Band 8	3	QPSK	6	5	-28.488	-13	-15.49
LTE Band 8	3	QPSK	15	0	-22.184	-13	-9.18
LTE Band 8	3	QPSK	15	0	-20.480	-13	-7.48

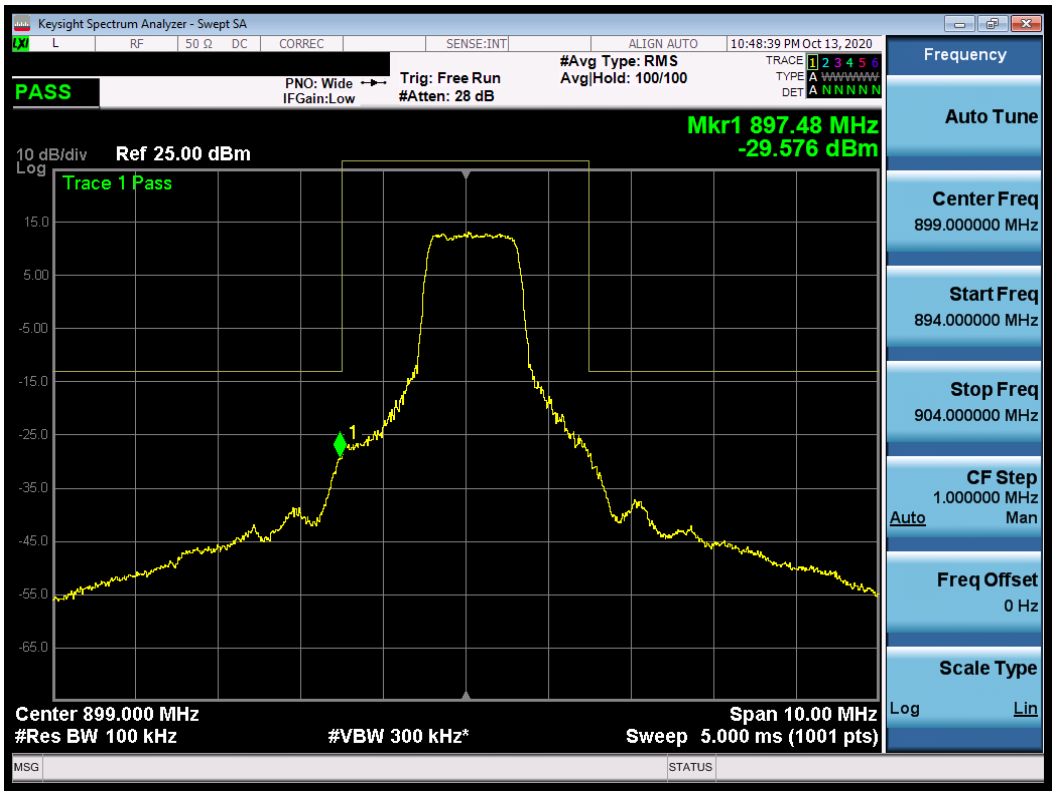
Table 7-5. Band Edge Summary Table



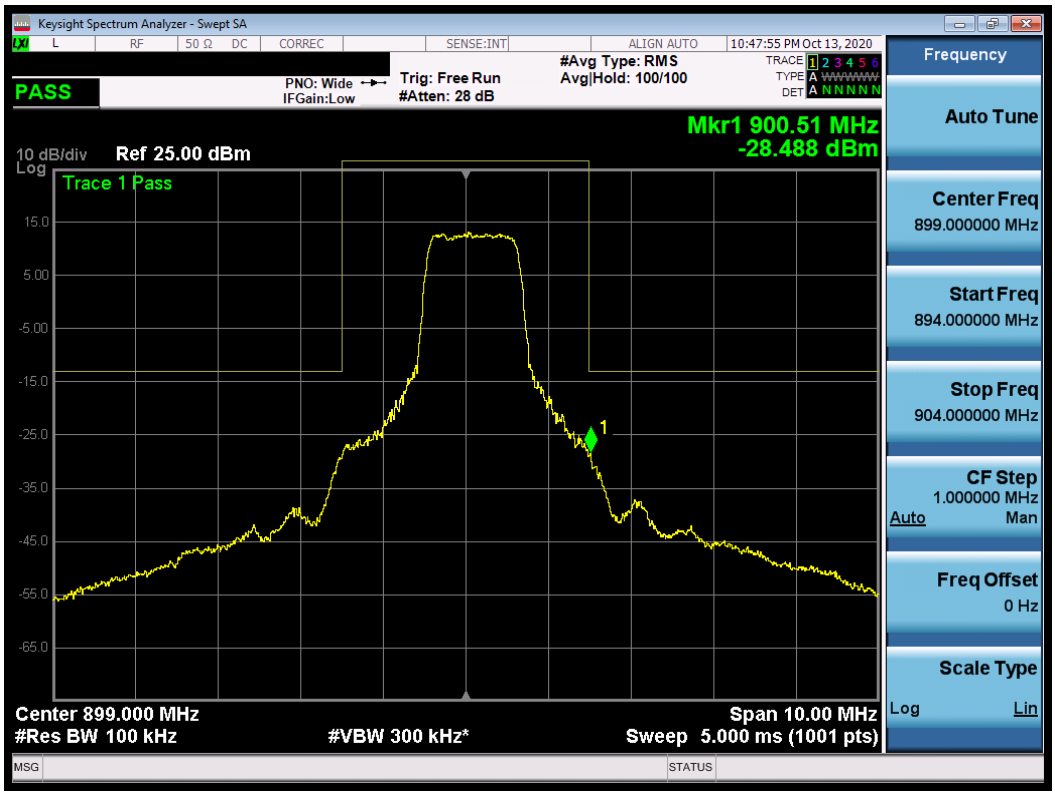
Plot 7-15. Band Edge Plot (QPSK, 1RB, RB Offset 0)



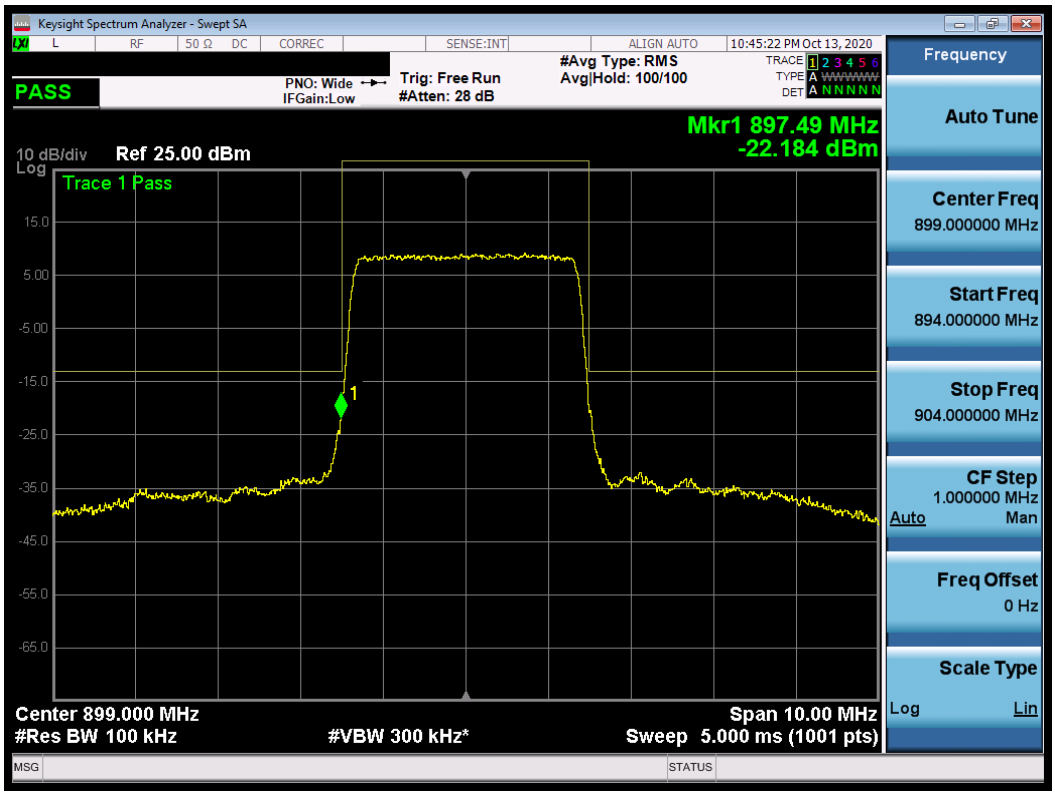
Plot 7-16. Band Edge Plot (QPSK, 1RB, RB Offset 14)



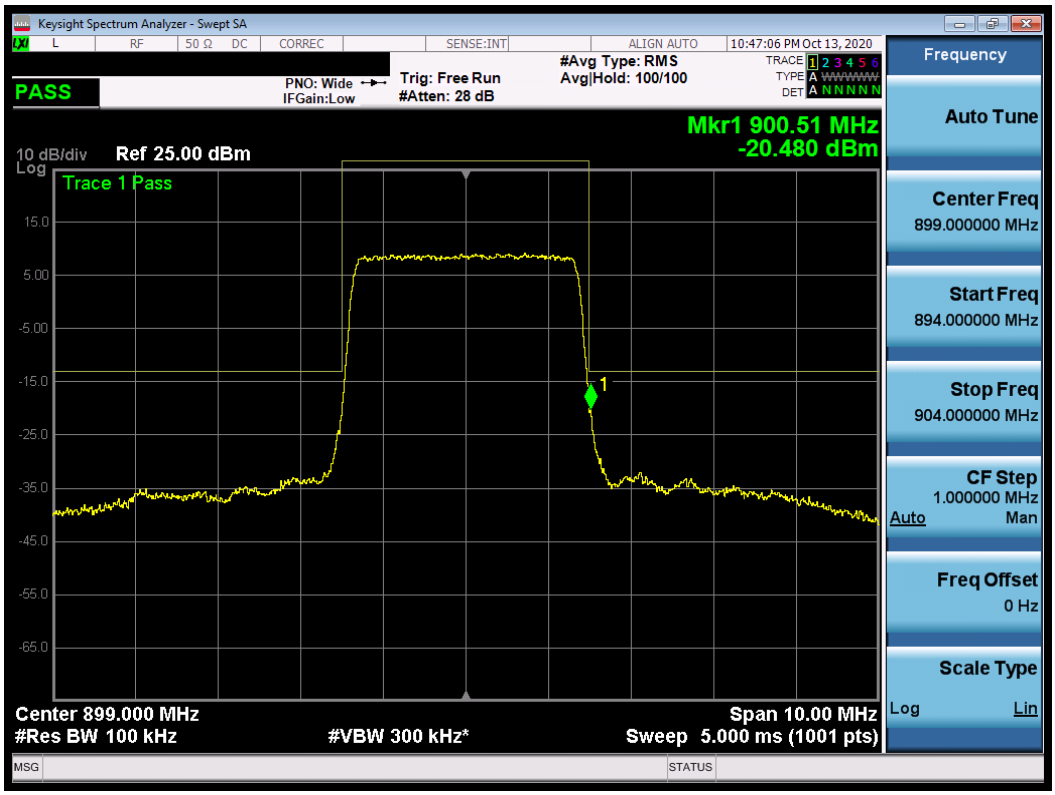
Plot 7-17. Band Edge Plot (QPSK, 6RB, RB Offset 5)



Plot 7-18. Band Edge Plot (QPSK, 6RB, RB Offset 5)



Plot 7-19. Band Edge Plot (QPSK, 15RB (Full), RB Offset 0)



Plot 7-20. 4MHz Span Plot (QPSK, 15RB (Full), RB Offset 0)

7.6 Peak-Average Ratio

Test Overview

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

Test Procedure Used

KDB 971168 D01 v03r01 – Section 5.7.1

Test Settings

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

Test Setup

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

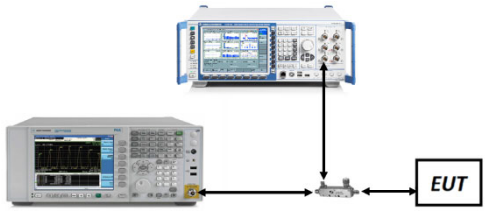
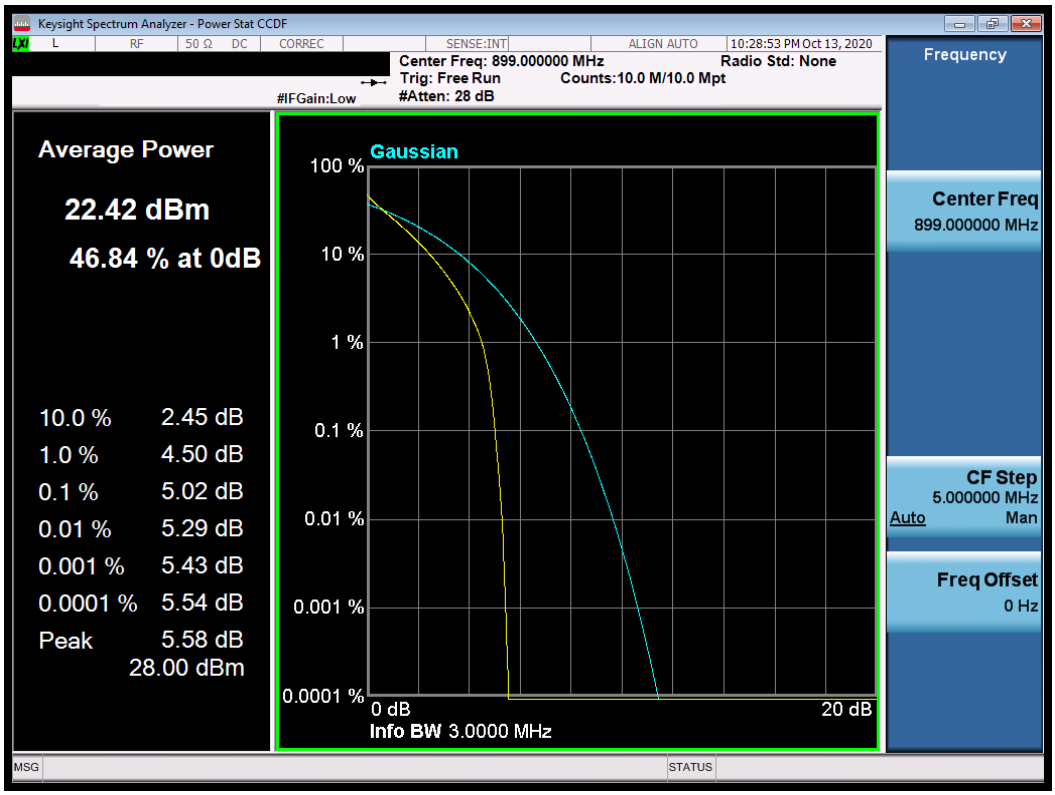


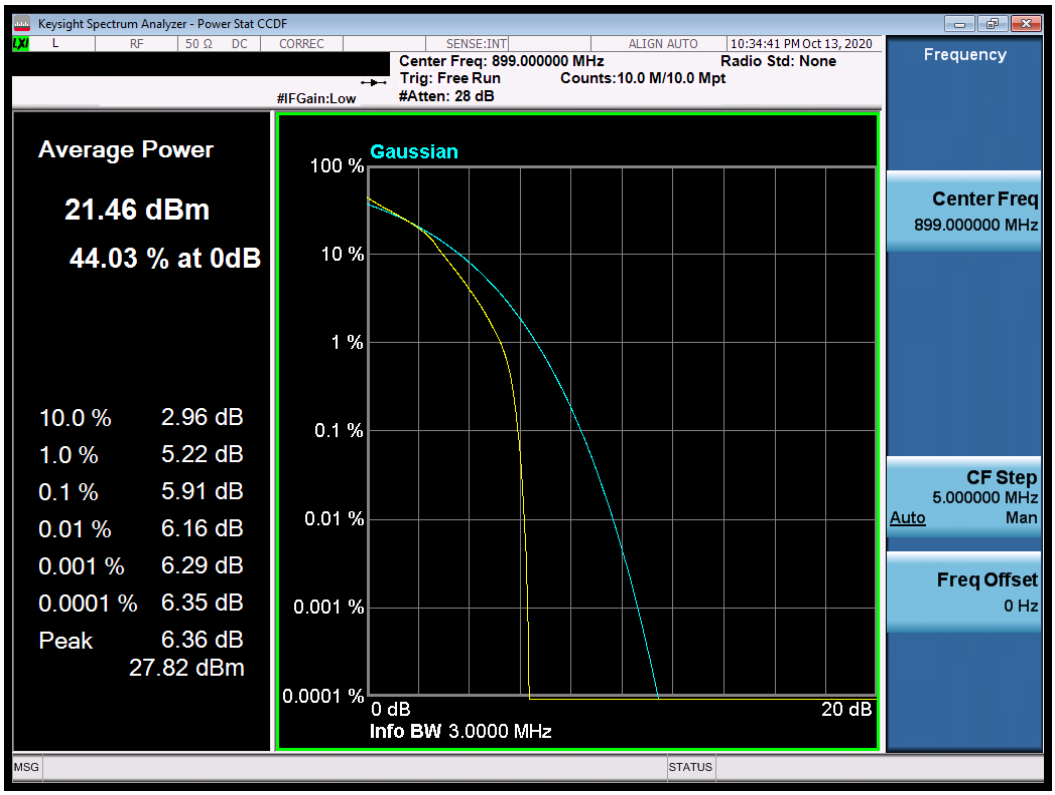
Figure 7-5. Test Instrument & Measurement Setup

Test Notes

None.



Plot 7-21. Peak to Average Ratio (QPSK, Full RB)



Plot 7-22. Peak to Average Ratio (16-QAM, Full RB)

7.7 Radiated Spurious Emissions Measurements

Test Overview

Radiated spurious emissions measurements are performed using the direct field strength conversion method described in KDB 971168 with the EUT transmitting into a 50Ω 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 peak measurements while the EUT is operating at maximum power, and at the appropriate frequencies.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.8

ANSI/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.

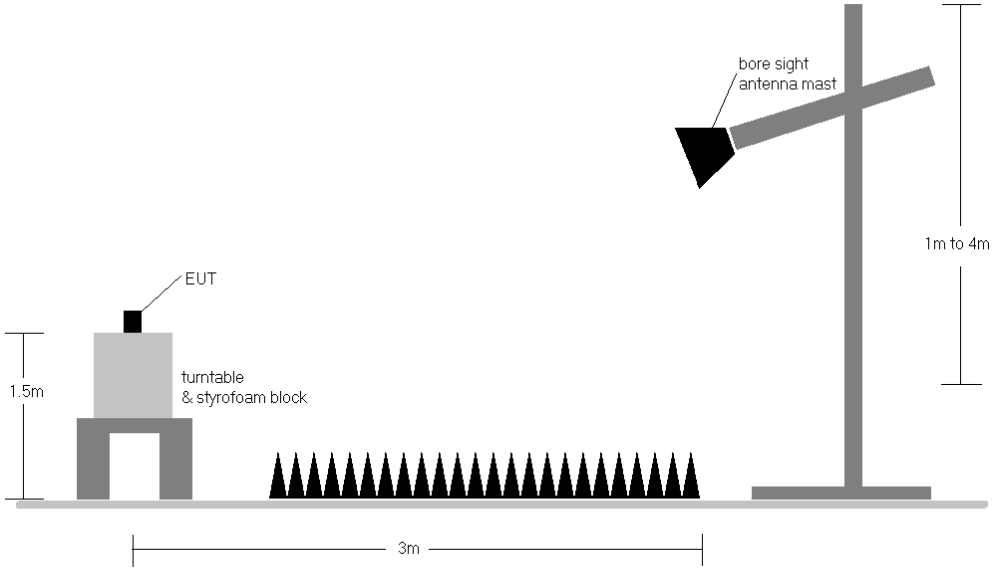


Figure 7-6. Test Instrument & Measurement Setup

Test Notes

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

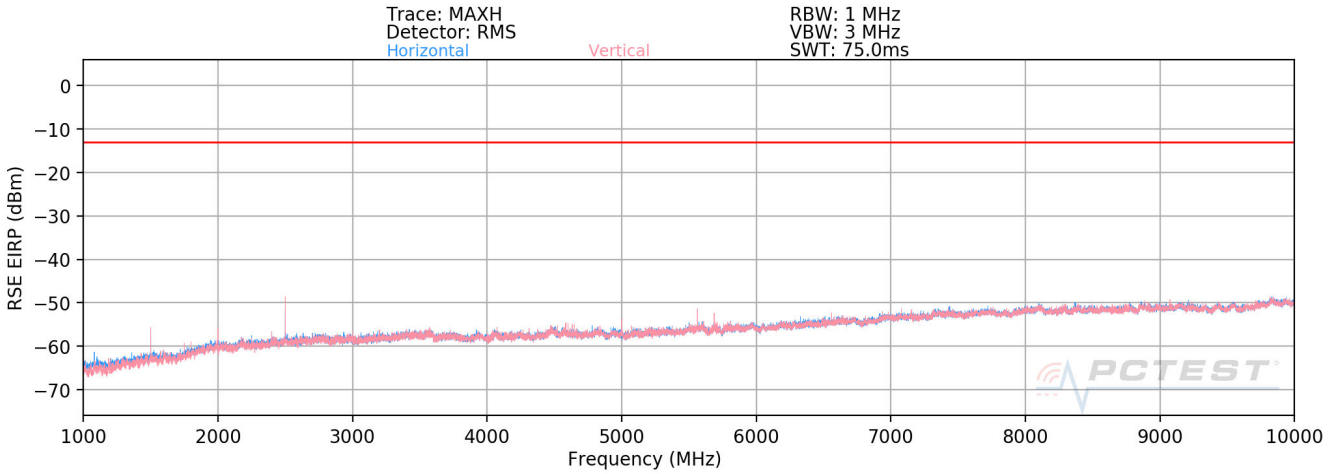
2) The EUT was tested in three orthogonal planes and in all possible test configurations and positioning. The worst case emissions are reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the tables below.

3) 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.

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

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

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



Plot 7-23. Radiated Spurious Plot (LTE Band 8)

Bandwidth (MHz):	3
Frequency (MHz):	899.0
RB / Offset:	1 / 7

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]
1200.0	V	115	205	-76.37	-3.06	27.57	-67.68	-13.00	-54.68
1500.0	V	220	249	-68.03	-0.51	38.46	-56.80	-13.00	-43.80
1798.0	V	208	271	-75.61	0.50	31.89	-63.37	-13.00	-50.37
1999.9	V	104	87	-72.40	2.40	37.00	-58.26	-13.00	-45.26
2500.1	V	102	265	-73.90	3.54	36.64	-58.62	-13.00	-45.62
3596.0	V	-	-	-78.73	4.91	33.18	-62.08	-13.00	-49.08
4495.0	V	-	-	-79.01	6.57	34.56	-60.70	-13.00	-47.70
5394.0	V	-	-	-79.54	7.59	35.05	-60.20	-13.00	-47.20
5687.4	V	102	226	-73.05	8.47	42.42	-52.84	-13.00	-39.84
5812.0	V	116	223	-77.89	8.73	37.84	-57.42	-13.00	-44.42
6293.0	V	-	-	-81.97	9.13	34.16	-61.10	-13.00	-48.10
7192.0	V	-	-	-82.27	11.39	36.12	-68.68	-13.00	-55.68

Table 7-6. Radiated Spurious Data (LTE Band 8)

7.8 Simultaneous Tx Radiated Spurious Emission Measurements

§15.407(b), §15.209, §15.247(d), §27.1509(a)

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating with LTE Band 8 and 2.4GHz or 5GHz WiFi transmissions at the appropriate frequencies. 802.11a (20MHz BW) was investigated among UNII bands and 802.11g was investigated for WLAN for simultaneous transmission. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

The test cases for this device includes:

1. **LTE+ 5GHz WiFi**

For transmitters operating in the 5.15-5.25 GHz and 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of −27 dBm/MHz. For LTE Band 8 transmitters, the minimum permissible attenuation level of spurious emission is 43 + 10log10(P[Watts]), where P is the transmitter power in Watts.

For transmitters operating in the 5.15-5.25 GHz band and LTE band 8 simultaneously: Spurious emissions caused by the Part 27 device must meet the Part 27 requirements. If the spurious emission is caused by the simultaneous operation of both devices, the limit is the highest level allowed by either rule part which in this case will be the limit line of LTE Band 8.

2. **LTE+ 2.4GHz WiFi**

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-7 per Section 15.209. For LTE Band 8, the minimum permissible attenuation level of spurious emission is 43 + 10log10(P[Watts]), where P is the transmitter power in Watts.

For transmitters operating in the 2.4GHz band and LTE band 8 simultaneously: Spurious emission caused by the Part 27 device must meet the Part 27 requirements. If the spurious emission is caused by the simultaneous operation of both devices, the limit is the highest level allowed by either rule part which in this case will be the limit line of LTE Band 8.

Frequency	Limit [dBm]	Measured Distance [Meters]
LTE + 2.4GHz WiFi	-13	3
LTE+ 5GHz WiFi	-13	3

Table 7-7. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Sections 12.7.7.2, 12.7.6, 12.7.5
KDB 789033 D02 v02r01 – Section G
KDB 971168 D01 v03r01

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.

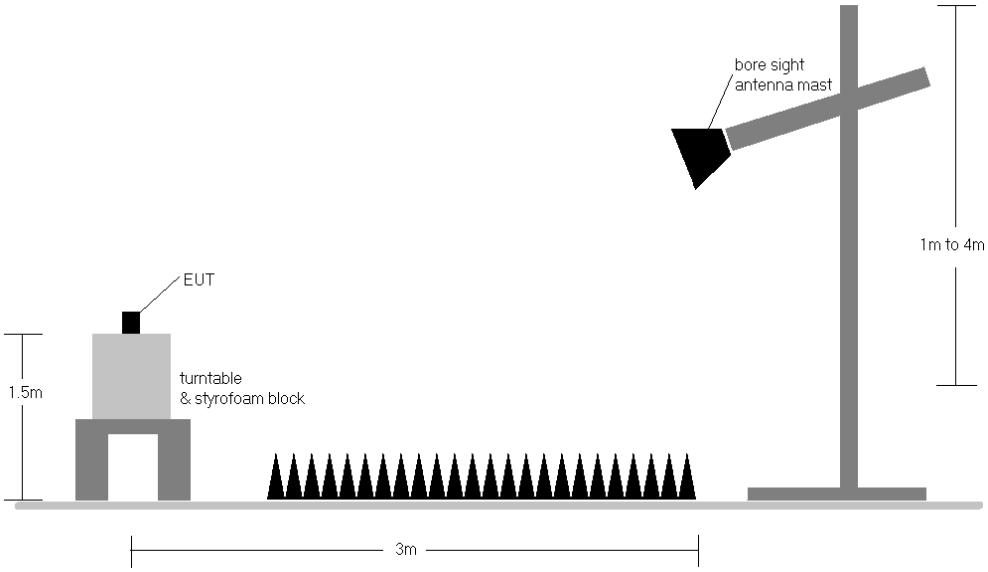


Figure 7-7. Test Instrument & Measurement Setup

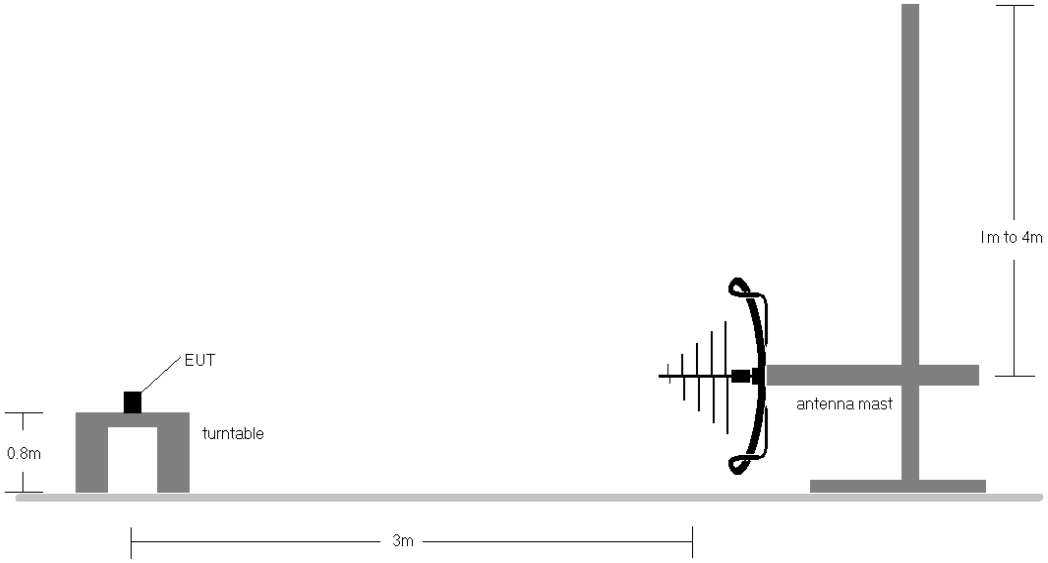


Figure 7-8. Test Instrument & Measurement Setup (<1GHz)

Test Notes

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

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

3) 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.

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

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

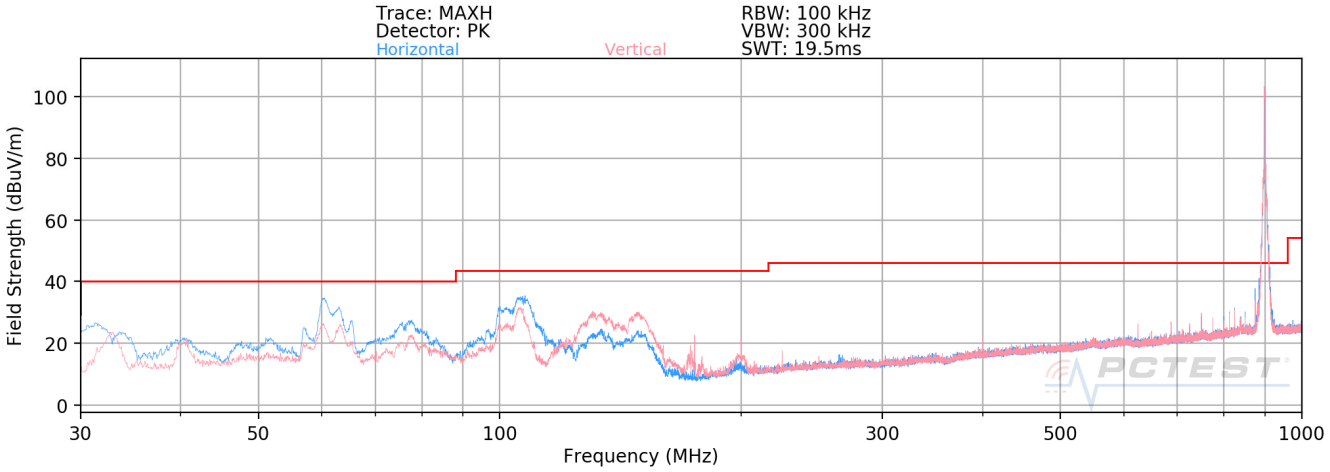
6) The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

Determining Spurious Emissions Levels

- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$
- AFCL $_{[dB/m]}$ = Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V/m]}$ – Limit $_{[dB\mu V/m]}$

7.8.1 LTE Band 8 + 5GHz WiFi Radiated Spurious Emission Measurements



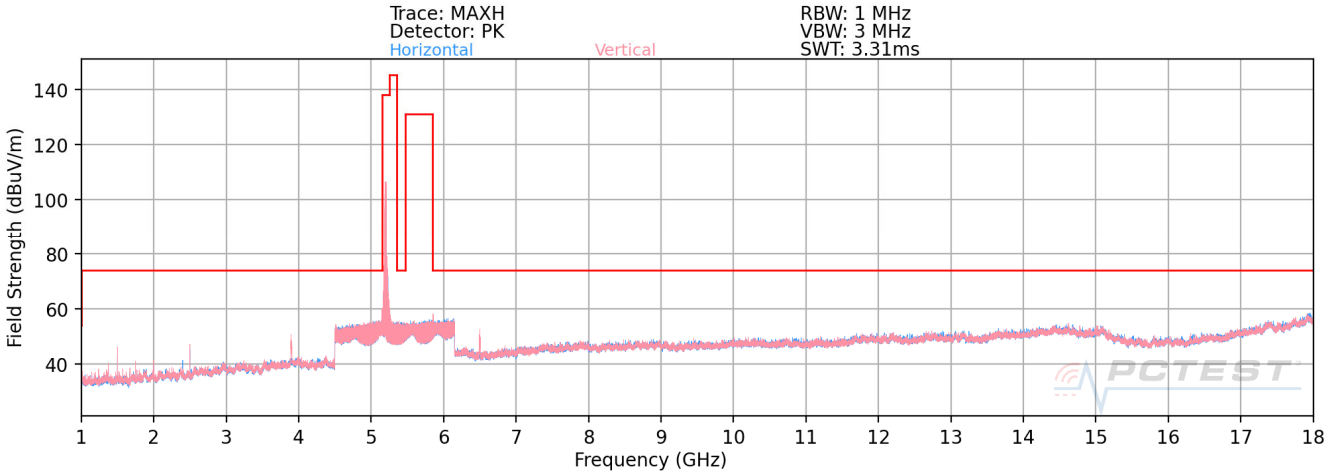
Plot 7-24. Radiated Spurious Plot below 1GHz (802.11a – U1 Ch. 40 MIMO & LTE Band 8)

Note: The emission at 899MHz was recorded in the plot as fundamental transmitting frequency for LTE Band 8.

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
200.00	Quasi-Peak	V	154	76	-66.33	-16.07	24.60	43.52	-18.93
400.00	Quasi-Peak	V	104	175	-72.78	-11.03	23.19	46.02	-22.83
624.94	Quasi-Peak	V	150	358	-73.00	-7.33	26.67	46.02	-19.36
874.94	Quasi-Peak	V	151	119	-66.44	-3.49	37.07	46.02	-8.95
924.90	Quasi-Peak	V	131	121	-74.47	-2.65	29.88	46.02	-16.14
750.00	Quasi-Peak	V	102	66	-74.54	-4.81	27.65	46.02	-18.37

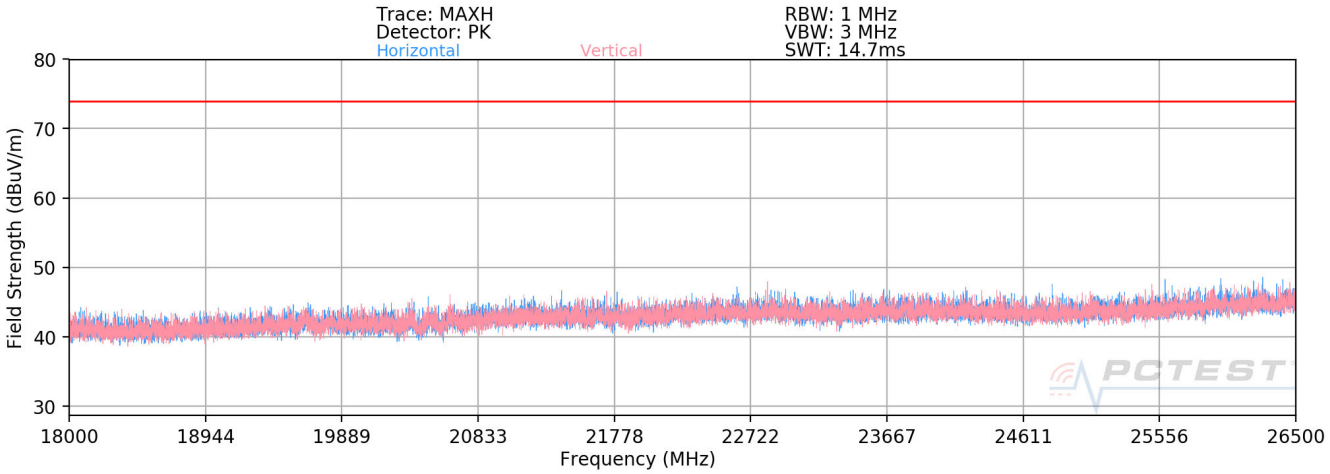
Table 7-8. Radiated Measurements (5GHz & 899 MHz)

Note: The emission was recorded in the plot above as a Peak level. The final measurement, as shown in the table above, was performed with a QP detector and is compliant.

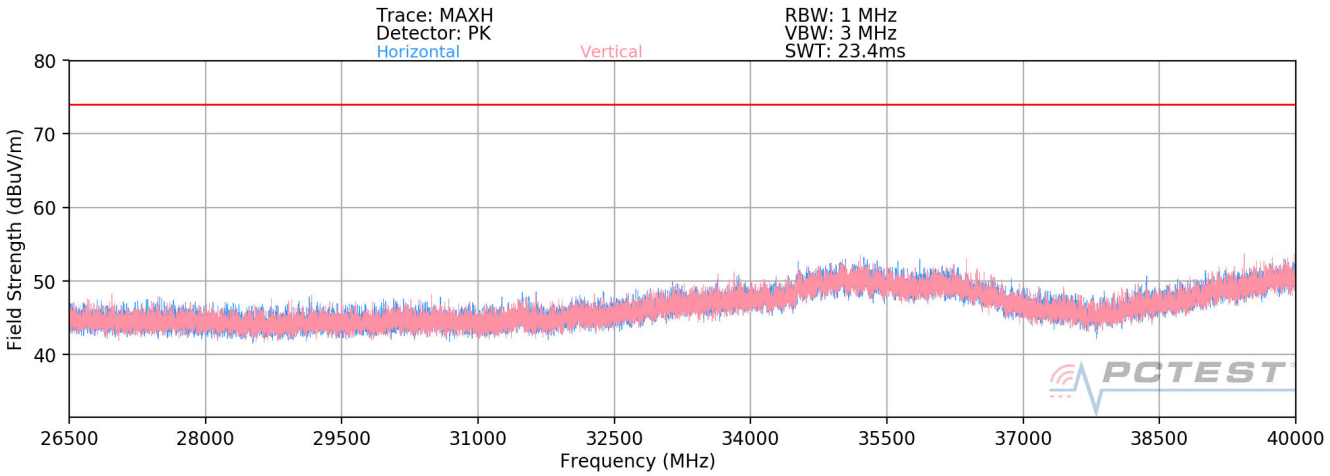


Plot 7-25. Radiated Spurious Plot above 1GHz (5GHz & 899 MHz)

Note: The emission at 5200MHz was recorded in the plot as fundamental transmitting frequency for UNII Ch.40



Plot 7-26. Radiated Spurious Plot above 18GHz - 26.5GHz (5GHz & 899 MHz)



Plot 7-27. Radiated Spurious Plot 26.5GHz - 40GHz (5GHz & 899 MHz)

Worst Case Mode:	802.11a & LTE B8
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5200MHz&899MHz
Channel:	40 & 21640

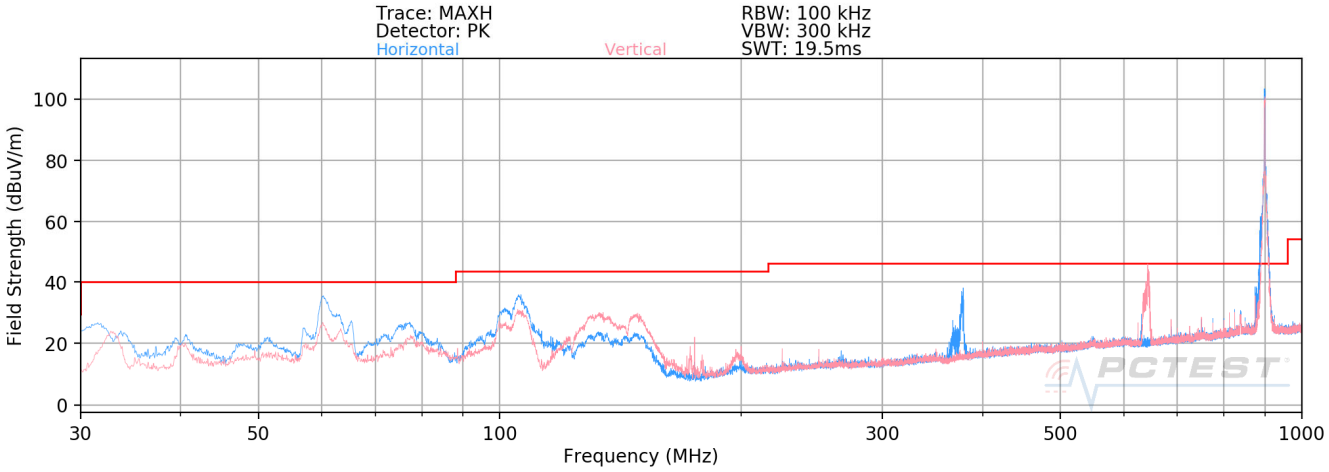
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
1499.96	Average	V	273	149	-66.80	-5.16	35.04	53.98	-18.94
1499.96	Peak	V	273	149	-57.85	-5.16	43.99	73.98	-29.99
2000.00	Peak	V	128	113	-57.99	-3.38	45.63	68.20	-22.57
2500.00	Average	V	200	105	-61.47	-2.41	43.12	53.98	-10.86
2500.00	Peak	V	200	105	-56.50	-2.41	48.09	73.98	-25.89
3880.00	Average	V	-	-	-78.24	2.81	31.57	53.98	-22.41
3880.00	Peak	V	-	-	-66.47	2.81	43.34	73.98	-30.64
6500.00	Peak	V	183	62	-69.89	12.10	49.21	68.20	-18.99
7703.00	Average	V	-	-	-79.77	9.31	36.54	53.98	-17.44
7703.00	Peak	V	-	-	-67.42	9.31	48.89	73.98	-25.09
9501.00	Peak	V	-	-	-68.91	11.38	49.47	68.20	-18.73
22838.50	Average	V	-	310	-67.22	5.28	35.52	53.98	-18.46
22838.50	Peak	V	-	310	-56.33	5.28	46.42	73.98	-27.56
35205.00	Peak	V	-	-	-57.70	10.42	50.18	68.20	-18.02

Table 7-8. Radiated Measurements (5GHz & 899 MHz)

Notes:

1) The emission at 7703MHz and 9501MHz measured above is an intermod which is the calculated product from transmitting 2 frequencies (899MHz &5200 MHz) at the same time.
2) All the other recorded RSE values are from the emission seen on the pre-scan.

7.8.2 LTE Band 8 + 2.4GHz WiFi Radiated Spurious Emission Measurements



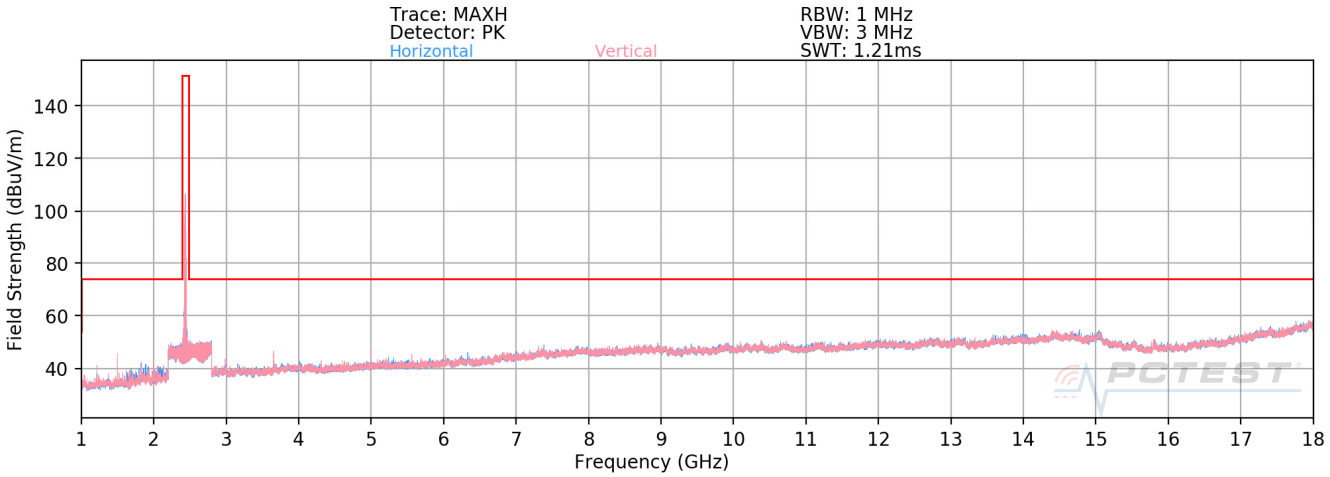
Plot 7-28. Radiated Spurious Plot Below 1GHz (802.11g – Ch. 6 MIMO & LTE Band 8)

Note: The emission at 899MHz was recorded in the plot as fundamental transmitting frequency for LTE Band 8.

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
380.00	Quasi-Peak	V	292	358	-73.04	-11.52	22.44	46.02	-23.58
624.93	Quasi-Peak	V	146	-5	-72.50	-7.33	27.17	46.02	-18.85
649.97	Quasi-Peak	V	165	205	-76.57	-6.78	23.65	46.02	-22.37
874.94	Quasi-Peak	V	148	116	-66.87	-3.49	36.64	46.02	-9.38
924.80	Quasi-Peak	V	135	113	-75.30	-2.65	29.05	46.02	-16.97
974.93	Quasi-Peak	V	143	126	-76.01	-2.82	28.17	53.98	-25.81

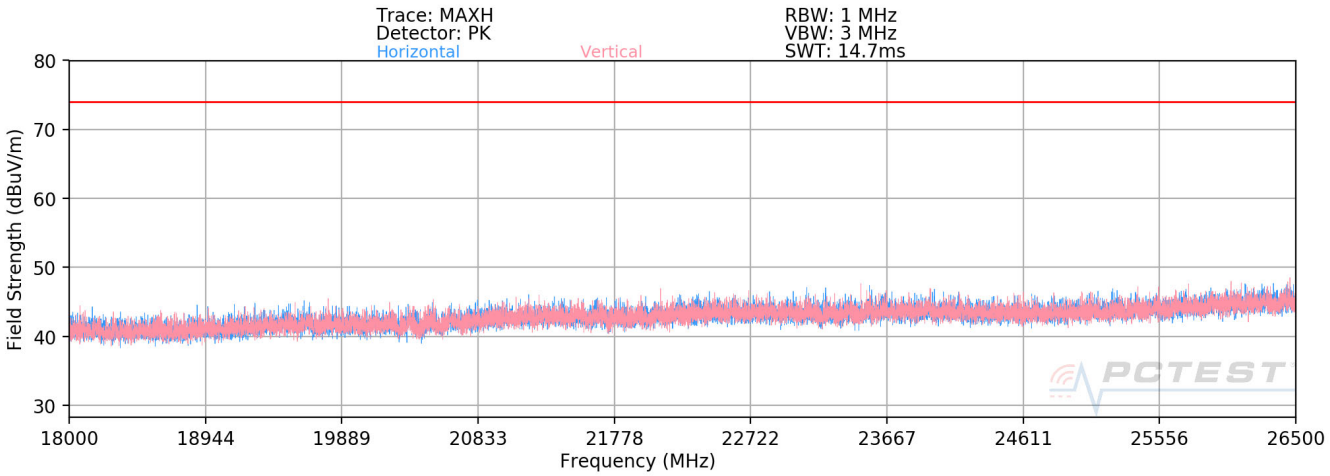
Table 7-9. Radiated Measurements (2.4GHz & 899 MHz)

Note: The emission at 624.93MHz was recorded in the plot above as a Peak level. The final measurement, as shown in the table above, was performed with a QP detector and is compliant.



Plot 7-29. Radiated Spurious Plot above 1GHz (2.4GHz & 899 MHz)

Note: The emission at 2437MHz was recorded in the plot as fundamental transmitting frequency for WLAN Ch.6



Plot 7-30. Radiated Spurious Plot above 18GHz - 26.5GHz (2.4GHz & 899 MHz)

Worst Case Mode:	802.11g & LTE B8
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	2437MHz&899MHz
Channel:	6 & 21640

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
1179.78	Avg	V	118	97	-71.90	-5.63	29.47	53.98	-24.51
1179.78	Peak	V	118	97	-61.37	-5.63	40.00	73.98	-33.98
1200.00	Avg	V	139	90	-71.35	-5.95	29.70	53.98	-24.28
1200.00	Peak	V	139	90	-62.16	-5.95	38.89	73.98	-35.09
1212.39	Avg	V	141	93	-75.25	-5.87	25.88	53.98	-28.10
1212.39	Peak	V	141	93	-60.54	-5.87	40.59	73.98	-33.39
1500.00	Avg	V	134	233	-61.54	-5.16	40.30	53.98	-13.68
1500.00	Peak	V	134	233	-52.58	-5.16	49.26	73.98	-24.72
1572.85	Avg	V	280	60	-65.07	-5.14	36.79	53.98	-17.19
1572.85	Peak	V	280	60	-59.05	-5.14	42.81	73.98	-31.17
2500.00	Avg	V	196	107	-61.23	-2.41	43.36	53.98	-10.62
2500.00	Peak	V	196	107	-55.53	-2.41	49.06	73.98	-24.92
3655.48	Avg	V	249	71	-78.15	2.20	31.05	53.98	-22.93
3655.48	Peak	V	249	71	-59.07	2.20	50.13	73.98	-23.85
5000.00	Avg	V	117	46	-67.51	3.90	43.39	53.98	-10.59
5000.00	Peak	V	117	46	-60.34	3.90	50.56	73.98	-23.42
5389.80	Avg	V	157	191	-76.76	5.01	35.25	53.98	-18.73
5389.80	Peak	V	157	191	-67.18	5.01	44.83	73.98	-29.15
21800.00	Peak	V	-	126	-56.33	5.06	55.73	68.20	-12.47
23500.00	Peak	V	-	-	-56.36	5.22	55.86	68.20	-12.34

Table 7-10. Radiated Measurements (2.4GHz & 899MHz)

Note: All the recorded RSE values are from the emission seen on the pre-scan while transmitting 2.4GHz and 899MHz at the same time

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **4RF LTE Module Integrated Into Multiservice Connect Router (Model: Aprisa LTE)** complies with all the requirements specified in FCC Part 27 Subpart P of the FCC Rules. The requirements of simultaneous transmission spurious emissions of FCC Part 15 and Part 27 Subpart P are also satisfied.