



Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 22 and IC RSS-132  
[869MHz – 894MHz]

FCC Part 27 and IC RSS-130  
[746MHz – 756MHz]

FCC ID: VBNAHBCA-01  
IC ID: 661W-AHBCA

Product Name: Aircscale Base Transceiver Station Remote Radio Head  
Model: AHBCA

Applicant: Nokia Solutions and Networks  
6000 Connection Drive  
Irving, TX 75039

Test Sites: Nokia Solutions and Networks  
6000 Connection Drive  
Irving, TX 75039  
and

National Technical Systems – Plano  
1701 E Plano Pkwy #150  
Plano, TX 75074

Test Dates: June 11 - 20, 2018  
Total Number of Pages: 149

**Prepared By:**

A handwritten signature in black ink, appearing to read "Christian Booker".

**Christian Booker**  
EMI Engineer

**Approved By:**

A handwritten signature in black ink, appearing to read "Kimberly Zavala".

**Kimberly Zavala**  
Quality Assurance Rep.

**Reviewed By:**

A handwritten signature in black ink, appearing to read "Jeffrey Viel".

**Jeffrey Viel**  
General Manager

**REVISION HISTORY**

| Rev# | Date    | Comments                          | Modified By      |
|------|---------|-----------------------------------|------------------|
| 0    | 6/26/18 | Initial Draft                     | Christian Booker |
| 1    | 6/27/18 | Changes made per customer request | Christian Booker |
| 2    | 7/2/18  | Changes made per TCB request      | Christian Booker |

## TABLE OF CONTENTS

|                                                                                                      |    |
|------------------------------------------------------------------------------------------------------|----|
| REVISION HISTORY .....                                                                               | 2  |
| TABLE OF CONTENTS.....                                                                               | 3  |
| SCOPE .....                                                                                          | 5  |
| OBJECTIVE .....                                                                                      | 6  |
| STATEMENT OF COMPLIANCE.....                                                                         | 6  |
| DEVIATIONS FROM THE STANDARDS .....                                                                  | 6  |
| TEST RESULTS SUMMARY .....                                                                           | 7  |
| FCC Part 22 Subpart H and IC RSS-132 Issue 3 (Base Stations Operating in the 869 to 894MHz Band)...  | 7  |
| FCC Part 27 Subpart C and IC RSS-130 Issue 1 (Base Stations Operating in the 746 to 756MHz Band) ... | 8  |
| Extreme Conditions.....                                                                              | 9  |
| Measurement Uncertainties .....                                                                      | 9  |
| EQUIPMENT UNDER TEST (EUT) DETAILS .....                                                             | 10 |
| General.....                                                                                         | 10 |
| EUT Hardware .....                                                                                   | 13 |
| Enclosure.....                                                                                       | 13 |
| Support Equipment .....                                                                              | 13 |
| Auxillary Equipment.....                                                                             | 14 |
| EUT Interface Ports .....                                                                            | 14 |
| EUT External Interfaces.....                                                                         | 15 |
| EUT Operation.....                                                                                   | 16 |
| EUT Software .....                                                                                   | 16 |
| Modifications .....                                                                                  | 16 |

|                                                                                         |     |
|-----------------------------------------------------------------------------------------|-----|
| TESTING.....                                                                            | 17  |
| General Information .....                                                               | 17  |
| Measurement Procedures .....                                                            | 17  |
| Antenna Port Conducted RF Measurement Test Setup Diagrams.....                          | 19  |
| Test Measurement Equipment .....                                                        | 20  |
| <br>APPENDIX A: ANTENNA PORT TEST DATA FOR BAND 5 (869-894MHZ) .....                    | 21  |
| RF Output Power.....                                                                    | 22  |
| Emission Bandwidth (26 dB down and 99%) .....                                           | 30  |
| Antenna Port Conducted Band Edge .....                                                  | 35  |
| Transmitter Antenna Port Conducted Emissions.....                                       | 48  |
| Frequency Stability/Accuracy .....                                                      | 98  |
| <br>APPENDIX B: ANTENNA PORT TEST DATA FOR BAND 13 (746-756MHZ).....                    | 99  |
| RF Output Power.....                                                                    | 100 |
| Emission Bandwidth (26 dB down and 99%) .....                                           | 106 |
| Antenna Port Conducted Band Edge .....                                                  | 109 |
| Transmitter Antenna Port Conducted Emissions.....                                       | 123 |
| Transmitter Antenna Port Conducted Emissions in 1559MHz to 1610MHz Frequency Range..... | 137 |
| Transmitter Radiated Spurious Emissions .....                                           | 144 |
| Frequency Stability/Accuracy .....                                                      | 149 |

## SCOPE

Tests have been performed on Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHBCA, pursuant to the relevant requirements of the following standard(s) to obtain device certification against the regulatory requirements of the Federal Communications Commission (FCC) and Innovation, Science and Economic Development Canada (ISED).

- Code of Federal Regulations (CFR) Title 47 Part 2
- (Radio Standards Specification) RSS-Gen Issue 4 - November 2014
- CFR 47 Part 22 Subpart H
- RSS-132 Issue 3 - January 2013
- CFR Title 47 Part 27 Subpart C
- RSS-130 Issue 1 - October 2013

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards:

ANSI C63.26-2015  
ANSI C63.4-2014  
ANSI TIA-603-D  
FCC KDB 971168 D01 v02r02  
FCC KDB 971168 D03 v01  
FCC KDB 662911D01 v02r01  
TIA-102.CAAA-D

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC and ISED requirements.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHBCA and therefore apply only to the tested sample. The sample was selected and prepared by Hobert Smith and John Rattavong of Nokia Solutions and Networks.

**OBJECTIVE**

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA and Canada, the device requires certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

Testing was performed only on Model AHBCA. No additional models were described or supplied for testing.

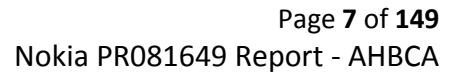
**STATEMENT OF COMPLIANCE**

The tested sample of Nokia Solutions and Networks product Airscale Base Transceiver Station Remote Radio Head (RRH) Model AHBCA complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

**DEVIATIONS FROM THE STANDARDS**

No deviations were made from the published requirements listed in the scope of this report.

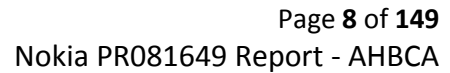


The following tables provide a summary of the test results:

| AHBCA operating in 869MHz to 894MHz Frequency Band                                                                                                                                                                                                                                                                                                         |                        |                                 |                                                                                                         |                              |                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------|-------------------|
| FCC                                                                                                                                                                                                                                                                                                                                                        | IC                     | Description                     | Measured                                                                                                | Limit                        | Results           |
| <b>Transmitter Modulation, output power and other characteristics</b>                                                                                                                                                                                                                                                                                      |                        |                                 |                                                                                                         |                              |                   |
| \$22.905                                                                                                                                                                                                                                                                                                                                                   | RSS-132<br>Section 5.1 | Frequency Ranges                | LTE1.4: 869.7 – 893.3MHz<br>LTE3: 870.5 – 892.5MHz<br>LTE5: 871.5 – 891.5MHz<br>LTE10: 874.0 – 889.0MHz | 869.0MHz to 894.0MHz         | Pass              |
| \$2.1047                                                                                                                                                                                                                                                                                                                                                   | RSS-132<br>Section 5.2 | Modulation Type                 | QPSK, 16QAM, 64QAM and 256QAM for<br>LTE 1.4, LTE3, LTE5 & LTE10                                        | Digital                      | Pass              |
| \$22.913                                                                                                                                                                                                                                                                                                                                                   | RSS-132<br>Section 5.4 | Output Power                    | Highest Conducted Power Output RMS: 46.31dBm<br>ERP depends on antenna gain which is unknown            | 1000W ERP                    | Pass              |
|                                                                                                                                                                                                                                                                                                                                                            | RSS-132<br>Section 5.4 | Peak to Average<br>Power Ratio  | Highest Measured PAPR: 8.09dB                                                                           | 13dB                         | Pass              |
|                                                                                                                                                                                                                                                                                                                                                            | RSS-Gen<br>Section 6.6 | 99%<br>Emission Bandwidth       | LTE1.4: 1.1170MHz<br>LTE3: 2.7118MHz<br>LTE5: 4.4956MHz<br>LTE10: 8.9998MHz                             | Remain in Block              | Pass              |
| \$22.917(b)                                                                                                                                                                                                                                                                                                                                                |                        | 26dB down<br>Emission Bandwidth | LTE1.4: 1.260MHz<br>LTE3: 2.931MHz<br>LTE5: 4.844MHz<br>LTE10: 9.664MHz                                 | Remain in Block              | Pass              |
| <b>Transmitter Spurious Emissions<sup>1</sup></b>                                                                                                                                                                                                                                                                                                          |                        |                                 |                                                                                                         |                              |                   |
| \$22.917                                                                                                                                                                                                                                                                                                                                                   | RSS-132<br>Section 5.5 | At the antenna<br>terminals     | < -19dBm                                                                                                | -19dBm<br>per Transmit Chain | Pass              |
|                                                                                                                                                                                                                                                                                                                                                            |                        | Field Strength                  | 53 dBuV/m at 3m<br>Eq. to -42 dBm EIRP                                                                  | -13dBm EIRP                  | Pass              |
| <b>Other Details</b>                                                                                                                                                                                                                                                                                                                                       |                        |                                 |                                                                                                         |                              |                   |
| \$2.1057                                                                                                                                                                                                                                                                                                                                                   | RSS-132<br>Section 5.3 | Frequency Stability             | 0.003ppm                                                                                                | 1.5ppm                       | Pass              |
| \$1.1310                                                                                                                                                                                                                                                                                                                                                   | RSS102                 | RF Exposure                     | N/A                                                                                                     |                              | Pass <sup>2</sup> |
| <p>Note 1: Based on 100kHz RBW. In the 1MHz immediately outside and adjacent to the frequency block a RBW of at least 1% of the emission bandwidth was used. The measurement bandwidth is 100kHz for measurements more than 1MHz from the band edge.</p> <p>Note 2: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.</p> |                        |                                 |                                                                                                         |                              |                   |

| 869MHz to 894MHz Band Emission Designators |          |         |           |         |           |         |            |         |
|--------------------------------------------|----------|---------|-----------|---------|-----------|---------|------------|---------|
| Channel Bandwidth                          | LTE-QPSK |         | LTE-16QAM |         | LTE-64QAM |         | LTE-256QAM |         |
|                                            | FCC      | IC      | FCC       | IC      | FCC       | IC      | FCC        | IC      |
| 1.4M                                       | 1M26F9W  | 1M12F9W | 1M25F9W   | 1M11F9W | 1M24F9W   | 1M11F9W | 1M25F9W    | 1M11F9W |
| 3M                                         | 2M93F9W  | 2M71F9W | 2M93F9W   | 2M71F9W | 2M92F9W   | 2M71F9W | 2M93F9W    | 2M70F9W |
| 5M                                         | 4M84F9W  | 4M49F9W | 4M83F9W   | 4M47F9W | 4M84F9W   | 4M50F9W | 4M84F9W    | 4M50F9W |
| 10M                                        | 9M65F9W  | 8M98F9W | 9M62F9W   | 9M00F9W | 9M66F9W   | 8M98F9W | 9M65F9W    | 8M97F9W |

Note: FCC based on 26dB emission bandwidth; IC based on 99% emission bandwidth.



| AHBCA operating in the 746MHz to 756MHz Frequency Band                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |                                                                                      |                                                                                                                   |                                                       |                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------|
| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | IC                       | Description                                                                          | Measured                                                                                                          | Limit                                                 | Results           |
| <b>Transmitter Modulation, output power and other characteristics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |                                                                                      |                                                                                                                   |                                                       |                   |
| 27.5(b)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | RSS-130<br>Section 4.2   | Frequency Ranges                                                                     | LTE5: 748.5 – 753.5MHz<br>LTE10: 751.0MHz                                                                         | 746.0 – 756.0MHz                                      | Pass              |
| 2.1033(c)(4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | RSS-130<br>Section 4.1   | Modulation Type                                                                      | QPSK, 16QAM, 64QAM and 256QAM for<br>LTE5 & LTE10                                                                 | Digital                                               | Pass              |
| 27.50(b)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | RSS-130<br>Section 4.4   | Output Power                                                                         | Highest Conducted Power Output RMS: 46.22dBm<br>ERP depends on antenna gain which is unknown                      | 1000W ERP                                             | Pass              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | RSS-130<br>Section 4.4   | Peak to Average<br>Power Ratio                                                       | Highest Measured PAPR: 8.02dB                                                                                     | 13dB                                                  | Pass              |
| 2.1049                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | RSS-Gen<br>Section 6.6   | 99%<br>Emission Bandwidth                                                            | LTE5: 4.4951MHz<br>LTE10: 8.9922MHz                                                                               | Remain in Block                                       | Pass              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          | 26dB down<br>Emission Bandwidth                                                      | LTE5: 4.849MHz<br>LTE10: 9.672MHz                                                                                 | Remain in Block                                       | Pass              |
| <b>Transmitter Spurious Emissions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |                                                                                      |                                                                                                                   |                                                       |                   |
| 27.53(c)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | RSS-130<br>Section 4.6.1 | At the antenna<br>terminals                                                          | < -19dBm                                                                                                          | -19dBm per<br>Transmit Chain                          | Pass <sup>1</sup> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          | Field strength                                                                       | 53 dBuV/m at 3m<br>Eq. to -42 dBm ERP                                                                             | -13 dBm ERP                                           | Pass              |
| 27.53(c)(3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | RSS-130<br>Section 4.6.2 | At the Ant terminals:<br>Maximum emissions in<br>763-775 MHz and<br>793-806MHz bands | Conducted emissions were less than -55.329dBm<br>for RBW of 6.25kHz                                               | -52dBm per 6.25kHz<br>bandwidth                       | Pass <sup>2</sup> |
| 27.53f                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | RSS-130<br>Section 4.6.2 | At the Ant terminals:<br>Maximum emissions in<br>1559-1610MHz band                   | Conducted emissions were not observed above<br>measurement instrumentation noise floor or less<br>than -99dBW/MHz | EIRP≤<br>Wideband: -76dBW/MHz<br>Discrete: -86dBW/MHz | Pass <sup>3</sup> |
| <b>Other Details</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                          |                                                                                      |                                                                                                                   |                                                       |                   |
| 27.54                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | RSS-130<br>Sec 4.3       | Frequency Stability                                                                  | Stays within authorized frequency block<br>0.002ppm                                                               | Stays within block                                    | Pass              |
| 1.1310                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | RSS102                   | RF Exposure                                                                          | N/A                                                                                                               |                                                       | Pass <sup>4</sup> |
| <p>Note 1: Based on 100kHz RBW. In the 100kHz immediately outside and adjacent to the frequency block a RBW of 30kHz was used. The measurement bandwidth is 100kHz for measurements more than 100kHz from the band edge. See Section 27.53(c)(5) and RSS 130 4.6 for details.</p> <p>Note 2: Section 27.53(c)(3) and RSS-130 4.6.2 requires an emission limit of -46dBm for any 6.25 kHz bandwidth between frequency bands 763-775 MHz and 793-806MHz. Adjusting for the four port MIMO requirement the emission limit in these frequency ranges is -52 dBm [i.e.: Limit = -46 dBm/6.25kHz (FCC/IC Limit) – 6dB (4 port MIMO)].</p> <p>Note 3: Section 27.53(f) and RSS 130 4.6.2(b), the EIRP limit for the frequency range 1559-1610 MHz is -70dBW/MHz for wideband signals and -80dBW for discrete emissions of bandwidths less than 700Hz. Adjusting for the four port MIMO requirement, the limit is -76 dBW [-70 dBW -10 log (4)] for wideband signals and -86dBW [-80 dBW -10 log (4)] for discrete emissions.</p> <p>Note 4: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.</p> |                          |                                                                                      |                                                                                                                   |                                                       |                   |

| 746MHz to 756MHz Band Emission Designators |          |         |           |         |           |         |            |         |
|--------------------------------------------|----------|---------|-----------|---------|-----------|---------|------------|---------|
| Channel Bandwidth                          | LTE-QPSK |         | LTE-16QAM |         | LTE-64QAM |         | LTE-256QAM |         |
|                                            | FCC      | IC      | FCC       | IC      | FCC       | IC      | FCC        | IC      |
| 5M                                         | 4M85F9W  | 4M49F9W | 4M83F9W   | 4M47F9W | 4M84F9W   | 4M49F9W | 4M85F9W    | 4M50F9W |
| 10M                                        | 9M65F9W  | 8M98F9W | 9M63F9W   | 8M99F9W | 9M67F9W   | 8M99F9W | 9M64F9W    | 8M97F9W |

Note: FCC based on 26dB emission bandwidth; IC based on 99% emission bandwidth.

## Extreme Conditions

Frequency stability is determined over extremes of temperature and voltage.

The extremes of voltage were 85 to 115 percent of the nominal value.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

## Measurement Uncertainties

Measurement uncertainties of the test facility based on a 95% confidence level are as follows:

| Test                         | Uncertainty           |
|------------------------------|-----------------------|
| Radio frequency              | $\pm 0.2\text{ppm}$   |
| RF power conducted           | $\pm 1.2\text{ dB}$   |
| RF power radiated            | $\pm 3.3\text{ dB}$   |
| RF power density conducted   | $\pm 1.2\text{ dB}$   |
| Spurious emissions conducted | $\pm 1.2\text{ dB}$   |
| Adjacent channel power       | $\pm 0.4\text{ dB}$   |
| Spurious emissions radiated  | $\pm 4\text{ dB}$     |
| Temperature                  | $\pm 1^\circ\text{C}$ |
| Humidity                     | $\pm 1.6\%$           |
| Voltage (DC)                 | $\pm 0.2\%$           |
| Voltage (AC)                 | $\pm 0.3\%$           |

## **EQUIPMENT UNDER TEST (EUT) DETAILS**

### **General**

The equipment under test (EUT) is a Nokia Solutions and Networks AirScale Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model AHBCA. The AHBCA remote radio head is a multistandard multicarrier radio module designed to support LTE, and narrow band IoT (internet of things) operations (in-band, guard band, standalone). The scope of testing in this effort is for LTE-FDD operations.

The AHBCA RRH has four transmit/four receive antenna ports (4TX/4RX for Band 5 and 4TX/4RX for Band 13). Each antenna port supports 3GPP frequency band 5 (BTS Rx: 824 to 849 MHz/BTS TX: 869 to 894 MHz) and 3GPP frequency band 13 (BTS Rx: 777 to 787 MHz/BTS TX: 746 to 756 MHz). The maximum RF output power of the RRH is 160 Watts (40 watts per carrier, 40 watts per antenna port). The RRH can be operated as a 4x4 MIMO, 2x2 MIMO or as non-MIMO. The TX and RX instantaneous bandwidth cover the full operational bandwidth. The RRH supports LTE bandwidths of 1.4, 3, 5 and 10MHz for 3GPP frequency band 5 operations. The RRH supports LTE bandwidths of 5 and 10MHz for 3GPP frequency band 13 operations. The RRH supports four LTE downlink modulation types (QPSK, 16QAM, 64QAM and 256QAM). Multi-carrier operation is supported.

The RRH has external interfaces including DC power (DC In), ground, transmit/receive (ANT), external alarm (EAC), optical CPRI (OPT) and remote electrical tilt (RET). The RRH with applicable installation kit may be pole or wall mounted. The RRH may be configured with optional cooling fan.

The AHBCA LTE channel numbers and frequencies are as follows:

|                               | Downlink EARFCN | Downlink Frequency (MHz) | LTE Channel Bandwidth |             |             |             |
|-------------------------------|-----------------|--------------------------|-----------------------|-------------|-------------|-------------|
|                               |                 |                          | 1.4 MHz               | 3 MHz       | 5 MHz       | 10 MHz      |
| AHBCA Band 5 (Ant 1, 2, 3, 4) | 2400            | 869.0                    | Band Edge             | Band Edge   | Band Edge   | Band Edge   |
|                               | .....           |                          |                       |             |             |             |
|                               | 2407            | 869.7                    | Bottom Ch             |             |             |             |
|                               | .....           |                          |                       |             |             |             |
|                               | 2415            | 870.5                    |                       | Bottom Ch   |             |             |
|                               | .....           |                          |                       |             |             |             |
|                               | 2425            | 871.5                    |                       |             | Bottom Ch   |             |
|                               | .....           |                          |                       |             |             |             |
|                               | 2450            | 874.0                    |                       |             |             | Bottom Ch   |
|                               | .....           |                          |                       |             |             |             |
|                               | 2525            | 881.5                    | Middle Ch             | Middle Ch   | Middle Ch   | Middle Ch   |
|                               | .....           |                          |                       |             |             |             |
|                               | 2600            | 889.0                    |                       |             |             | Top Channel |
|                               | .....           |                          |                       |             |             |             |
|                               | 2625            | 891.5                    |                       |             | Top Channel |             |
|                               | .....           |                          |                       |             |             |             |
|                               | 2635            | 892.5                    |                       | Top Channel |             |             |
|                               | .....           |                          |                       |             |             |             |
|                               | 2643            | 893.3                    | Top Channel           |             |             |             |
|                               | .....           |                          |                       |             |             |             |
|                               | 2650            | 894.0                    | Band Edge             | Band Edge   | Band Edge   | Band Edge   |

AHBCA Downlink Band Edge LTE Band 5 Frequency Channels

Multicarrier Test Case: Dual Carriers at the Lower Band Edge 869.7MHz (ARFCN 2407) & 871.1MHz (ARFCN 2421) and a Single Carrier at the Upper Band Edge 893.3MHz (ARFCN 2643).

|                                | Downlink<br>EARFCN | Downlink<br>Frequency<br>(MHz) | LTE Channel Bandwidth |                                                 |
|--------------------------------|--------------------|--------------------------------|-----------------------|-------------------------------------------------|
|                                |                    |                                | 5 MHz                 | 10 MHz                                          |
| AHBCA Band 13 (Ant 1, 2, 3, 4) | 5180               | 746.0                          | Band Edge             | Band Edge                                       |
|                                | .....              |                                |                       |                                                 |
|                                | 5205               | 748.5                          | Bottom Channel        |                                                 |
|                                | .....              |                                |                       |                                                 |
|                                | 5230               | 751                            | Middle Channel        | Bottom Channel<br>Middle Channel<br>Top Channel |
|                                | .....              |                                |                       |                                                 |
|                                | 5255               | 753.5                          | Top Channel           |                                                 |
|                                | .....              |                                |                       |                                                 |
|                                | 5280               | 756                            | Band Edge             | Band Edge                                       |

AHBCA Downlink Band Edge LTE Band 13 Frequency Channels

Multicarrier Test Case: Dual Carriers at the Lower and Upper Band Edges 748.5MHz (ARFCN 5205) and 753.5MHz (ARFCN 5255). Two carriers cover the entire channel bandwidth so three carrier operation is not available.

Multiband Multicarrier Test Case: A total of three carriers at 13 watts per carrier. One LTE10 carrier at Band 13 middle channel (ARFCN 5230 at 751MHz). Two LTE1.4 carriers at Band 5 top channel and top channel-1 (ARFCN 2643 at 893.3MHz and ARFCN 2629 at 891.9MHz).

**EUT Hardware**

The EUT hardware used in testing on June 11 - 20, 2018.

| Company                      | Model | Description      | Part/Serial Number                         | FCC ID/IC Number                         |
|------------------------------|-------|------------------|--------------------------------------------|------------------------------------------|
| Nokia Solutions and Networks | AHBCA | AirScale BTS RRH | Part#: 474241A.101<br>Serial#: BL1818M0028 | FCC ID: VBNAHBCA-01<br>IC ID: 661W-AHBCA |

**Enclosure**

The EUT enclosure is made of heavy duty aluminum.

**Support Equipment**

| Company                      | Model            | Description            | Part/Serial Number                         | FCC ID/IC Number |
|------------------------------|------------------|------------------------|--------------------------------------------|------------------|
| Nokia Solutions and Networks | ASIA             | Airscale System Module | Part#: 473095A.203<br>Serial#: AH173111443 | N/A              |
| HP                           | Elite Book 6930p | Laptop PC              | N/A                                        | N/A              |
| Dell                         | Studio XPS       | Instrumentation PC     | N/A                                        | N/A              |

### Auxillary Equipment

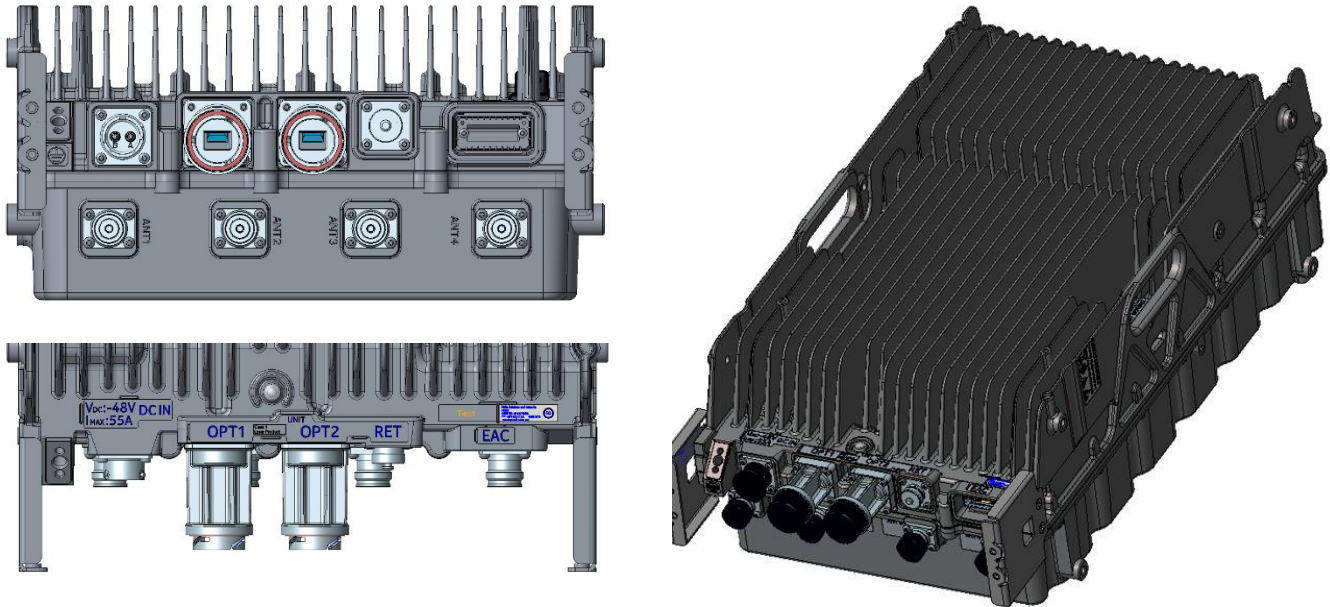
| Company                                                          | Description                                         | Part Number  | Serial Number |
|------------------------------------------------------------------|-----------------------------------------------------|--------------|---------------|
| Nokia                                                            | FOUC 10GHz SFP Module<br>(Plugs into RRH Opt Ports) | 473842A.101  | KR16180010011 |
| RLC Electronics                                                  | 1.1GHz High Pass Filter <sup>1</sup>                | F-14699      | 0050          |
| Weinschel                                                        | Attenuator 40dB-250 Watt <sup>1</sup>               | 58-40-43-LIM | TC909         |
| Weinschel                                                        | Attenuator 20dB-150 Watt <sup>1</sup>               | 66-20-33     | BZ2075        |
| Huber & Suhner                                                   | RF Cable – 0.5 meter <sup>1</sup>                   | Sucoflex 104 | 553624/4      |
| Huber & Suhner                                                   | RF Cable - 1 meter <sup>1</sup>                     | Sucoflex 106 | 297370        |
| Note 1: Used only in antenna port RF conducted emission testing. |                                                     |              |               |

### EUT Interface Ports

The I/O cabling configuration during testing was as follows:

| Cable                  | Type    | Shield | Length | Used in Test | Quantity | Termination      |
|------------------------|---------|--------|--------|--------------|----------|------------------|
| Power Input            | Power   | No     | ~ 3 m  | Yes          | 1        | Power Supply     |
| Earth                  | Earth   | No     | ~ 1 m  | Yes          | 1        | Lab earth ground |
| Antenna                | RF      | Yes    | ~ 3 m  | Yes          | 4        | 50Ω Loads        |
| External Alarm         | Signal  | Yes    | ~ 3 m  | Yes          | 1        | Un-terminated    |
| Remote Electrical Tilt | Signal  | Yes    | ~ 3 m  | Yes          | 1        | Un-terminated    |
| Multimode Optical      | Optical | No     | >6 m   | Yes          | 1        | System Module    |

#### AHBCA Connector Layout:



#### EUT External Interfaces

| Name  | Qty | Connector Type                                              | Purpose (and Description)                      |
|-------|-----|-------------------------------------------------------------|------------------------------------------------|
| DC In | 1   | Quick Disconnect                                            | 2-pole Power Circular Connector                |
| GND   | 1   | Screw lug (2xM5/1xM8)                                       | Ground                                         |
| ANT   | 4   | 4.3-10                                                      | RF signal for Transmitter/Receiver (50 Ohm)    |
| Unit  | 1   | LED                                                         | Unit Status LED                                |
| EAC   | 1   | MDR26                                                       | External Alarm Interface (4 alarms)            |
| OPT   | 2   | SFP+ cage                                                   | Optical CPRI Interface up to 10 Gps.           |
| RET   | 1   | 8-pin circular connector conforming to IEC 60130-9 – Ed.3.0 | AISG 2.0 to external devices                   |
| Fan   | 1   | Molex Microfit                                              | Power for RRH Fan. Located on the side of RRH. |

## **EUT Operation**

During testing, the EUT was transmitting continuously with 100% duty-cycle at full power on all chains.

### **EUT Software**

The laptop PC connects to the System Module over the LMP (Ethernet) port. The system module controls the RRH via the optical (CPRI) interface. The laptop is used for changing configuration settings, monitoring tests and controlling the BTS. The following software versions are used for the testing:

- (1) RRH Unit Software: FRM58.06.R11
- (2) System Module Software: FL18SP\_ENB\_0000\_000015\_000000
- (3) BTS Site Manager: BTS Site EM – FL18SP\_0000\_000485\_000000

### **Modifications**

No modifications were made to the EUT during testing.

## TESTING

### General Information

Antenna port measurements were taken with NTS personnel (Daniel Ramirez) at Nokia premises located at 6000 Connection Drive; Irving, Texas 75309.

Radiated emissions and frequency accuracy/stability measurements were taken at NTS Plano branch located at 1701 E Plano Pkwy #150 Plano, TX 75074.

Radiated spurious emissions measurements were taken at the NTS Plano Anechoic Chamber listed below. The sites conform to the requirements of ANSI C63.4-2014: *"American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"* and CISPR 16-1-4:2010-04: *"Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements"*. They are on file with the FCC and Industry Canada.

| Site      | Registration Numbers                      |            | Location                                |
|-----------|-------------------------------------------|------------|-----------------------------------------|
|           | FCC                                       | Canada     |                                         |
| Chamber 1 | A2LA Accredited Designation Number US1077 | IC 4319A-2 | 1701 E Plano Pkwy #150 Plano, TX 75074. |

Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

### Measurement Procedures

The output power, emission bandwidth, conducted spurious and conducted band edge measurements were performed with a spectrum analyzer. The carrier frequency accuracy/stability measurements were performed with a LTE signal analyzer. The EUT was operated at maximum RF output power for all tests. While measuring one transmit chain, the others were terminated with termination blocks. All measurements were corrected for the insertion loss of the RF network (attenuators, filters, and cables) inserted between the RF port of the EUT and the spectrum analyzer. Block diagrams and photographs of the test setups are provided below.

The 26dB emission bandwidth was measured in accordance with Section 4.1 of FCC KDB 971168 D01 v02r02. The 99% occupied bandwidth was measured in accordance with Section 6.6 of RSS-Gen Issue 4. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used and Keysight Benchvue Software was used to capture the spectrum analyzer screenshots. Spectrum analyzer settings are shown on their corresponding plots in test results section.

The emissions at the band edges were captured with Keysight Benchvue Software with settings described in the corresponding sections of the FCC and IC regulatory requirements. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Peak and average output power measurements were performed in accordance with FCC KDB 971168 D01 v02r02. Measurements were performed with the built-in power meter function found in the spectrum analyzer and the screenshots were captured using Keysight Benchvue Software. Peak to average power ratio (PAPR) was calculated in accordance with Section 5.7.2 of FCC KDB 971168 D01 v02r02. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Conducted spurious emissions were captured with Keysight Benchvue Software across the 9kHz-9GHz frequency span. A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 1.1GHz. The total measurement RF path loss of the test setup (attenuators, high pass filter and test cables) were accounted for by the spectrum analyzer reference level offset. Spectrum analyzer settings are described in the corresponding test result section.

For frequency stability/accuracy measurements, the EUT was placed inside a temperature chamber with all support and test equipment located outside of the chamber. Temperature was varied across the specified range in 10 degree increments and EUT was allowed enough time to stabilize at each temperature step (a minimum of 30 minutes per step). The input voltage was varied as required by FCC/IC regulatory requirements. An LTE signal analyzer as detailed in the test equipment section was used for frequency stability/accuracy measurements.

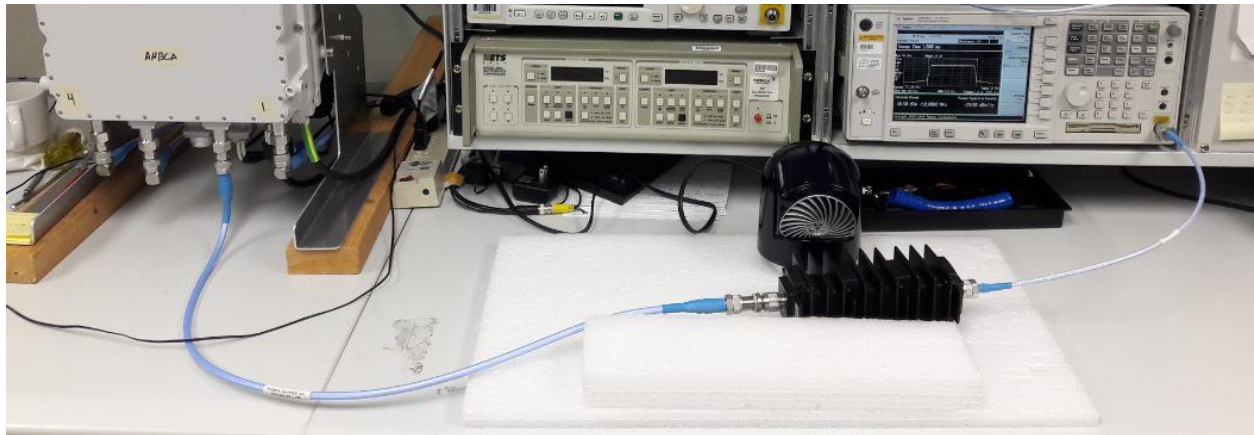
Transmitter radiated spurious emissions measurements were made in accordance with ANSI C63.4-2014 by measuring the field strength of the emissions from the device at 3m test distance. The eirp limit as specified in the relevant rule part(s) is converted to a field strength at the test distance and the emissions from the EUT are then compared to that limit. Only emissions within 20dB of this limit are subjected to a substitution measurement in accordance with TIA-603. Both preliminary and final measurements were performed at the same FCC listed test chamber. Preliminary scans were performed with TILE6 software. This software corrected the measurements for antenna factors, cable losses and pre-amplifier gains. Both polarizations of the receiving antenna were scanned from 30MHz to 9GHz with a peak detector (RBW=100kHz, VBW=300kHz, with trace max hold over multiple sweeps). Based on the preliminary scan results, frequencies of interest have been maximized via rotating the EUT 360 degrees and varying the height of the test antenna (1m to 4m). Final measurements were also taken with the peak detector as described above. A biconilog antenna was used for 30MHz-1GHz range. A double ridged waveguide horn antenna was used for 1-9GHz range. The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. EUT was placed on a non-conductive RF transparent structure to provide 80cm height from the ground floor. A motorized turntable allowed it to be rotated during testing to determine the angle with the highest level of emissions.

## Antenna Port Conducted RF Measurement Test Setup Diagrams

The following setups were used in the RF conducted emissions testing. Photographs of the test setups are also provided.



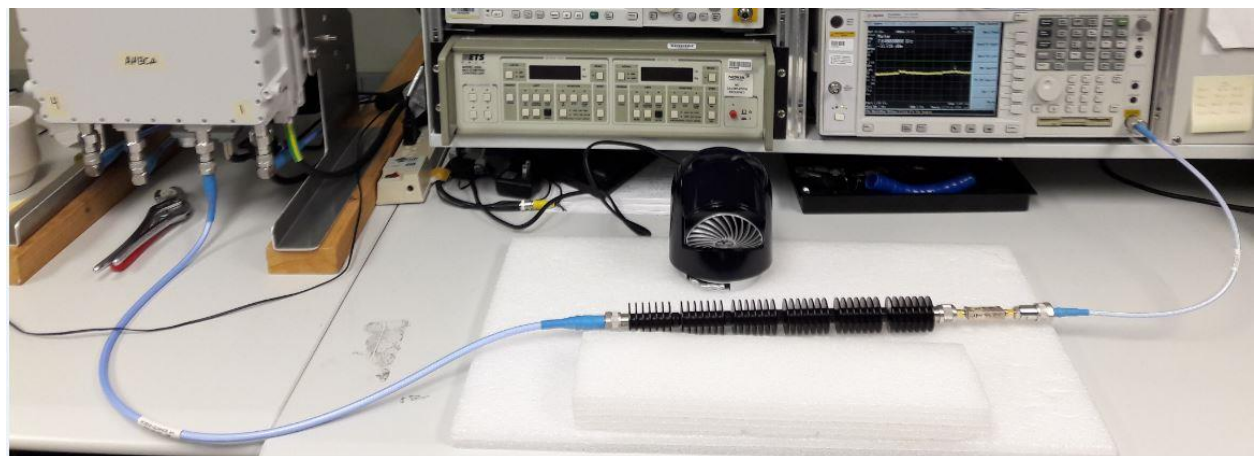
Setup for 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 700MHz, and 700MHz to 1.1GHz Measurements



Photograph of 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 700MHz, and 700MHz to 1.1GHz Test Setup



Setup for 1.1GHz to 9GHz Measurements



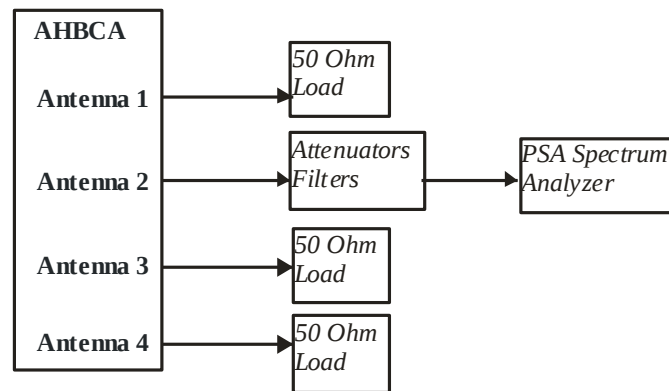
Photograph of 1.1GHz to 9GHz Test Setup

## Test Measurement Equipment

| NTS Equipment #                                                                   | Description           | Manufacturer    | Model               | Calibration Duration | Calibration Due Date |
|-----------------------------------------------------------------------------------|-----------------------|-----------------|---------------------|----------------------|----------------------|
| WC025240                                                                          | Spectrum Analyzer     | Agilent         | E4446A              | 12 Months            | 3/3/2019             |
| WC021478                                                                          | Preamp                | HP              | 8449B               | 12 Months            | 3/19/2019            |
| WC021480                                                                          | Preamp                | MITEQ           | AM-1431-N1179-WP    | 12 Months            | 10/16/2018           |
| WC021206                                                                          | Small Horn Antenna    | ETS             | 3115                | 12 Months            | 1/12/2019            |
| WC020917                                                                          | Biconilog Antenna     | ETS             | 3142D               | 24 Months            | 1/15/2019            |
| WC021208                                                                          | Antenna               | EMCO            | 3116                | 12 Months            | 11/15/2018           |
| WC038434                                                                          | Preamp                | MITEQ           | JS32-00104000-62-5P | 12 Months            | 10/13/2018           |
| WC038515                                                                          | Digital Multimeter    | OWON            | B35T                | 24Months             | 5/30/2019            |
| 120194 <sup>1</sup>                                                               | PSA Spectrum Analyzer | Agilent         | E4440A              | 12 Months            | 10/25/2018           |
| NM04509 <sup>1</sup>                                                              | Network Analyzer      | Rohde & Schwarz | ZVL 3               | 12 Months            | 02/03/2019           |
| NM06345 <sup>1</sup>                                                              | Network Analyzer      | Keysight        | E5063A              | 12 Months            | 11/20/2018           |
| NM04508 <sup>2</sup>                                                              | MXA Signal Analyzer   | Agilent         | N9020A              | 24 Months            | 5/2/2019             |
| Note 1: Customer equipment used in antenna port RF conducted emission testing.    |                       |                 |                     |                      |                      |
| Note 2: Customer equipment used in LTE frequency accuracy/stability measurements. |                       |                 |                     |                      |                      |

**APPENDIX A: ANTENNA PORT TEST DATA FOR BAND 5 (869-894MHZ)**

All conducted RF measurements in this section were made at AHBCA antenna ports. The test setup used is provided below.



Test Setup Used for Conducted RF Measurements on AHBCA

## RF Output Power

RF output power has been measured in both Peak and RMS Average terms for each Band 5 (869 to 894MHz) transmit chain at the middle channel for 256QAM modulation and LTE5 bandwidth. Peak to average power ratio (PAPR) has been calculated as described in Section 5.7.2 of KDB971168 D01 v02r02 and all results are presented in tabular form below.

| Antenna                  | LTE Bandwidth | LTE - 256QAM |               |           |
|--------------------------|---------------|--------------|---------------|-----------|
|                          |               | Peak (dBm)   | Average (dBm) | PAPR (dB) |
| Port 1<br>Middle Channel | 5M            | 53.90        | 46.08         | 7.82      |
| Port 2<br>Middle Channel | 5M            | 54.01        | 46.23         | 7.78      |
| Port 3<br>Middle Channel | 5M            | 53.85        | 46.04         | 7.81      |
| Port 4<br>Middle Channel | 5M            | 53.90        | 46.15         | 7.75      |

The variation in RMS output power levels between the antenna ports is 0.19 dB per data sample provided above. Pre-compliance testing (and testing of similar EUTs) shows that the output power variation between antenna ports is small (the output ports are essentially electrically identical). The highest power port was selected as the worst case.

Pre-compliance testing has shown that the output power variation between modulation types is small. Antenna port 2 power output measurements for the LTE5 bandwidth for all modulation types on the middle (center) channel are provided below.

|                                          | Modulation Type |           |            |           |            |           |            |           |
|------------------------------------------|-----------------|-----------|------------|-----------|------------|-----------|------------|-----------|
|                                          | QPSK            |           | 16QAM      |           | 64QAM      |           | 256QAM     |           |
|                                          | Peak (dBm)      | Ave (dBm) | Peak (dBm) | Ave (dBm) | Peak (dBm) | Ave (dBm) | Peak (dBm) | Ave (dBm) |
| Antenna Port 2<br>Middle Channel<br>LTE5 | 54.07           | 46.22     | 53.99      | 46.21     | 54.02      | 46.24     | 54.01      | 46.23     |

The output power variation between modulation types is small in this measurement snapshot (and from past efforts on similar hardware as well). The variation of average power output versus modulation type is 0.03dB for the data snapshot provided. The variation of peak power output versus modulation type is 0.08dB for the data snapshot provided. All power measurements in this report (except the sample test noted above) were performed with the EUT operating with 256QAM modulation.

Based on the results above, Port 2 had the highest RMS average power for Band 5 (represents the worst case) and therefore it was selected for all the remaining antenna port tests. Port 2 has the highest combined RMS average power for Band 5 + Band 13.

Subsequently output power levels on bottom, middle, and top channels in all 4 LTE channel bandwidths using 256QAM modulation type were tested only at Port 2 and the results presented below. The highest measured values are highlighted.

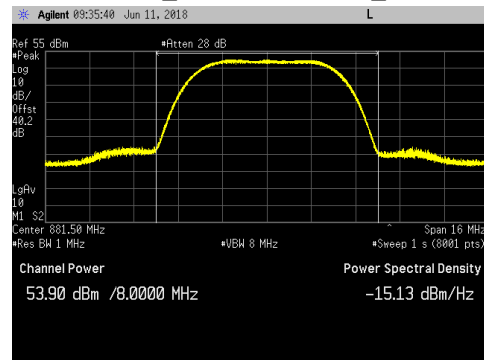
| Antenna<br>LTE Channel      | LTE Bandwidth | LTE - 256QAM  |              |              |
|-----------------------------|---------------|---------------|--------------|--------------|
|                             |               | Peak<br>(dBm) | Ave<br>(dBm) | PAPR<br>(dB) |
| Port 2<br>Bottom<br>Channel | 1.4M          | 53.03         | 46.02        | 7.01         |
|                             | 3M            | 53.67         | 46.21        | 7.46         |
|                             | 5M            | 54.08         | 46.22        | 7.86         |
|                             | 10M           | <b>54.34</b>  | <b>46.31</b> | 8.03         |
| Port 2<br>Middle<br>Channel | 1.4M          | 53.31         | 46.24        | 7.07         |
|                             | 3M            | 53.76         | 46.23        | 7.53         |
|                             | 5M            | 54.01         | 46.23        | 7.78         |
|                             | 10M           | 54.31         | 46.22        | <b>8.09</b>  |
| Port 2<br>Top Channel       | 1.4M          | 52.85         | 45.91        | 6.94         |
|                             | 3M            | 53.55         | 46.09        | 7.46         |
|                             | 5M            | 53.97         | 46.19        | 7.78         |
|                             | 10M           | 54.28         | 46.29        | 7.99         |

The data provided in the table shows (and testing of similar EUTs) that the output RMS power variation between channel bandwidths at the center frequency channel is small (0.02dB).

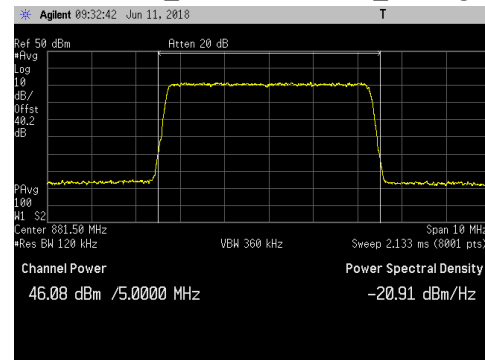
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset.

## LTE5 Channel Power Plots at Middle Channel and 256QAM Modulation:

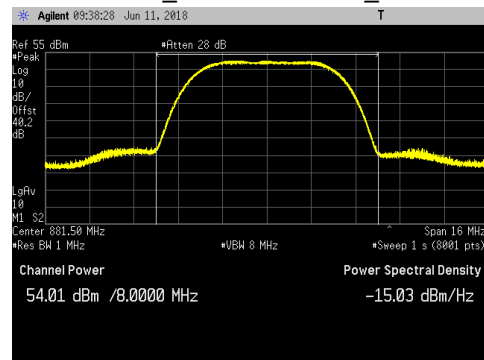
Port 1 - LTE5\_ Middle Channel\_Peak



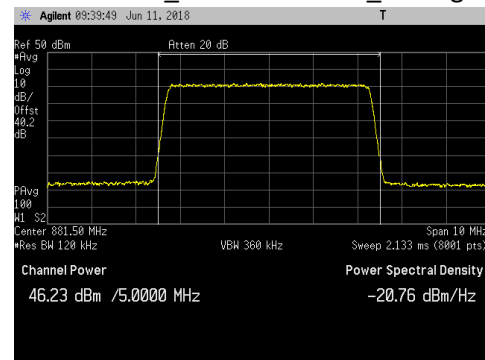
Port 1 - LTE5\_ Middle Channel\_Average



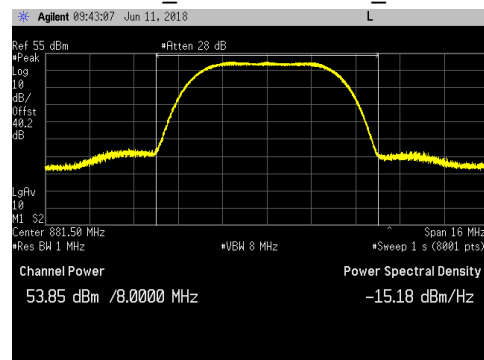
Port 2 - LTE5\_ Middle Channel\_Peak



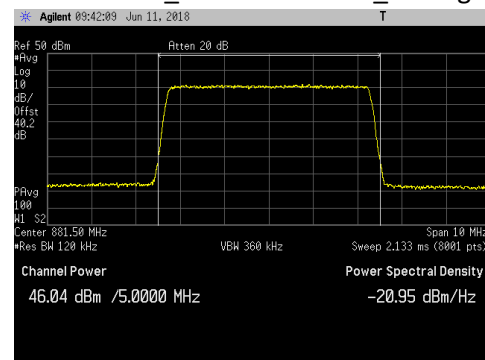
Port 2 - LTE5\_ Middle Channel\_Average



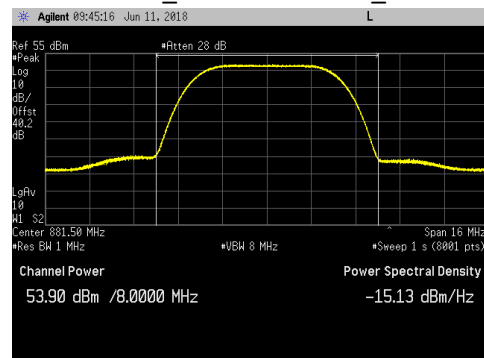
Port 3 - LTE5\_ Middle Channel\_Peak



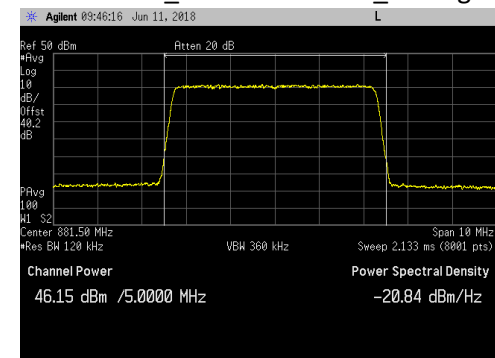
Port 3 - LTE5\_ Middle Channel\_Average



Port 4 - LTE5\_ Middle Channel\_Peak

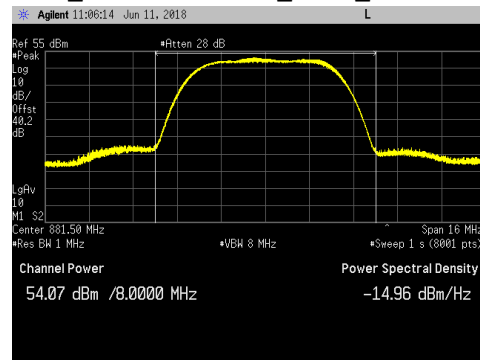


Port 4 - LTE5\_ Middle Channel\_Average

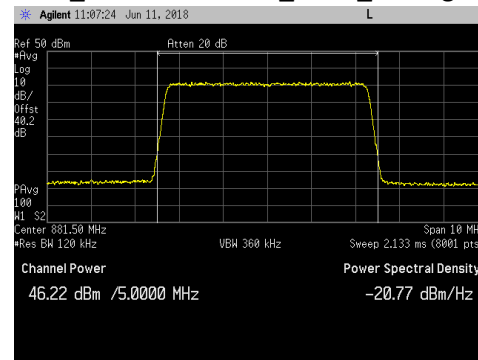


LTE5 Channel Power Plots for Antenna Port 2 at Middle Channel and all Modulation Types:

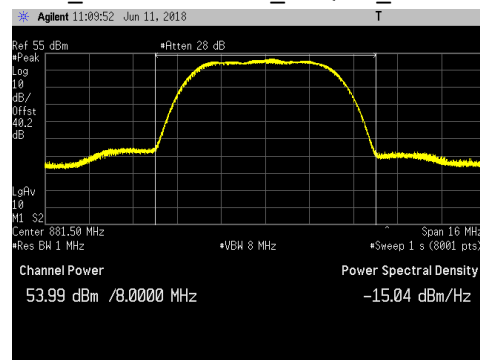
LTE5\_Middle Channel\_QPSK\_Peak



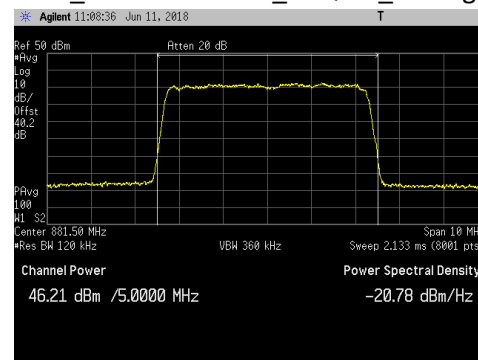
LTE5\_Middle Channel\_QPSK\_Average



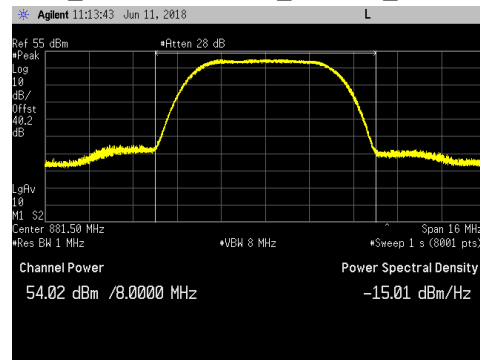
LTE5\_Middle Channel\_16QAM\_Peak



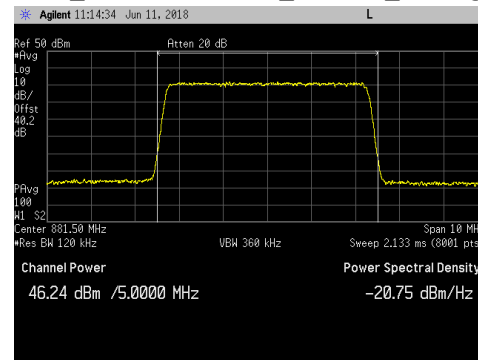
LTE5\_Middle Channel\_16QAM\_Average



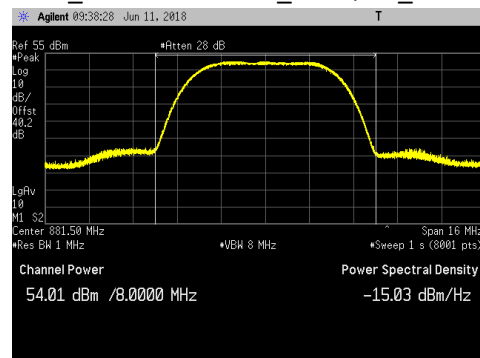
LTE5\_Middle Channel\_64QAM\_Peak



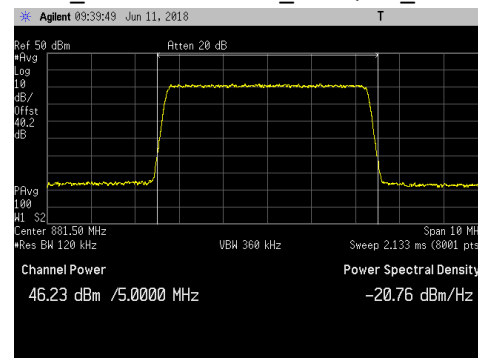
LTE5\_Middle Channel\_64QAM\_Average



LTE5\_Middle Channel\_256QAM\_Peak

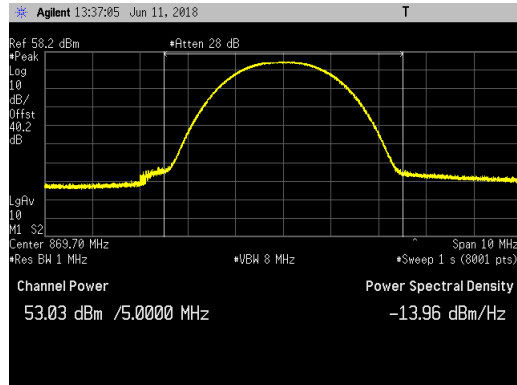


LTE5\_Middle Channel\_256QAM\_Average

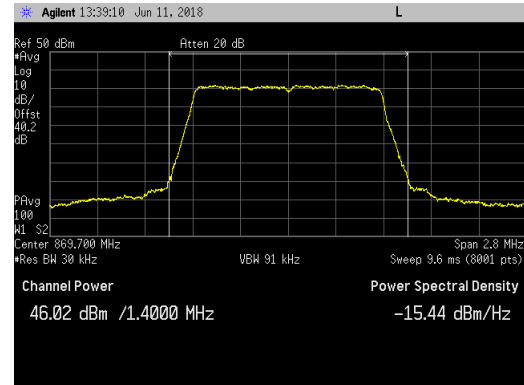


## LTE1.4 Channel Power Plots for Antenna Port 2 and 256QAM Modulation:

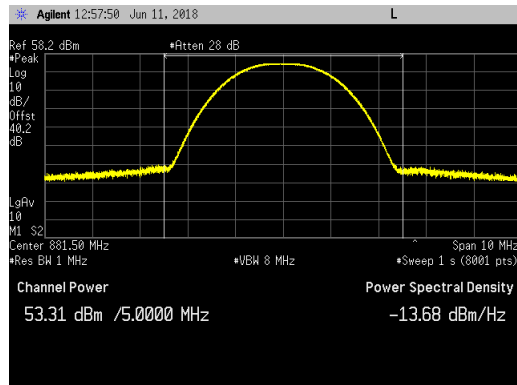
LTE1.4\_Bottom Channel\_Peak



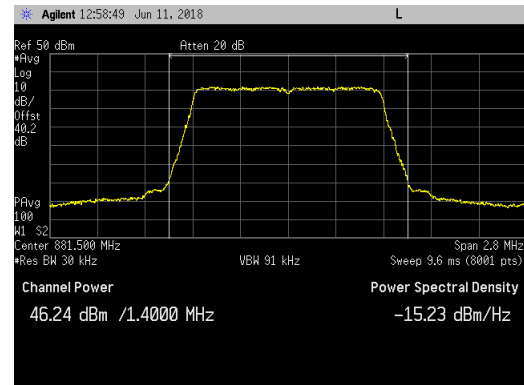
LTE1.4\_Bottom Channel\_Average



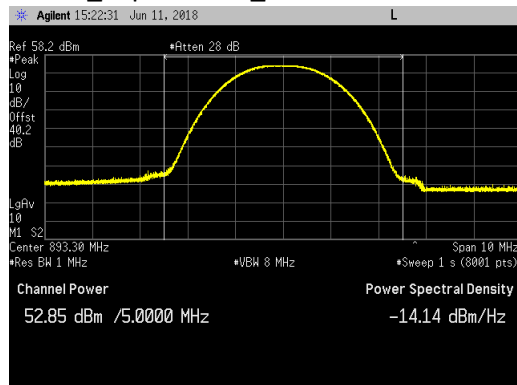
LTE1.4\_Middle Channel\_Peak



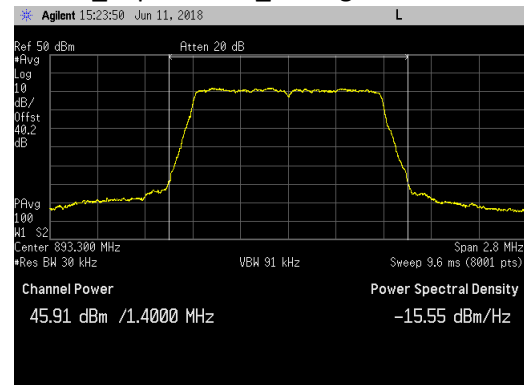
LTE1.4\_Middle Channel\_Average



LTE1.4\_Top Channel\_Peak

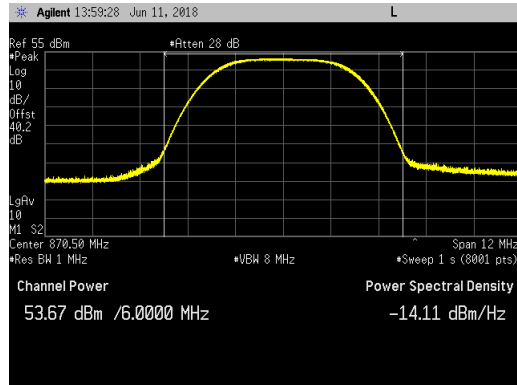


LTE1.4\_Top Channel\_Average

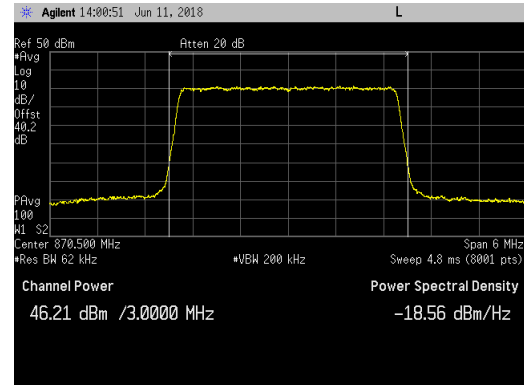


## LTE3 Channel Power Plots for Antenna Port 2 and 256QAM Modulation:

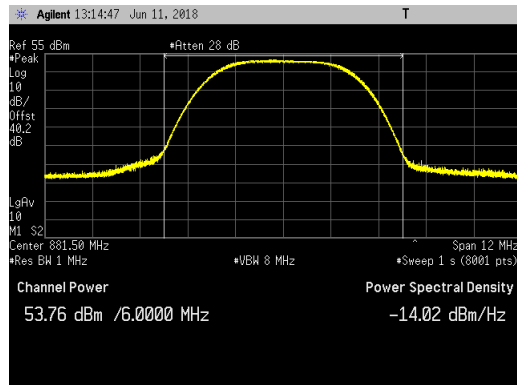
LTE3\_Bottom Channel\_Peak



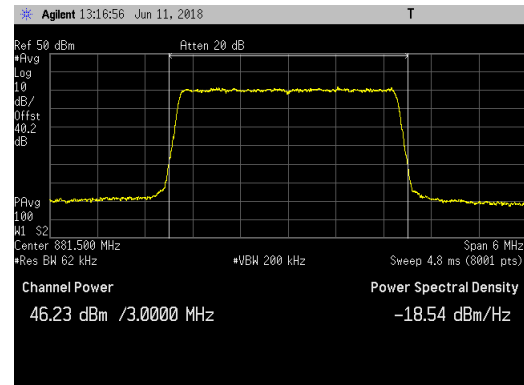
LTE3\_Bottom Channel\_Average



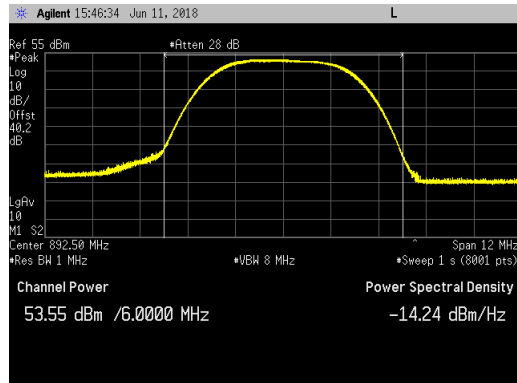
LTE3\_Middle Channel\_Peak



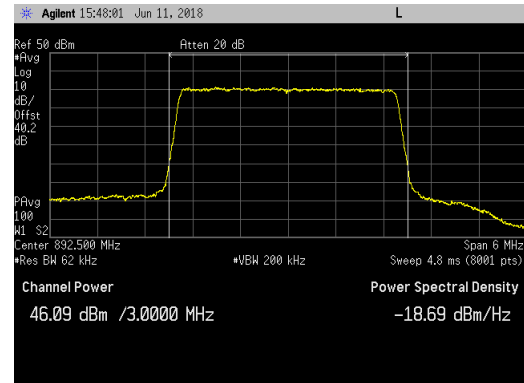
LTE3\_Middle Channel\_Average



LTE3\_Top Channel\_Peak

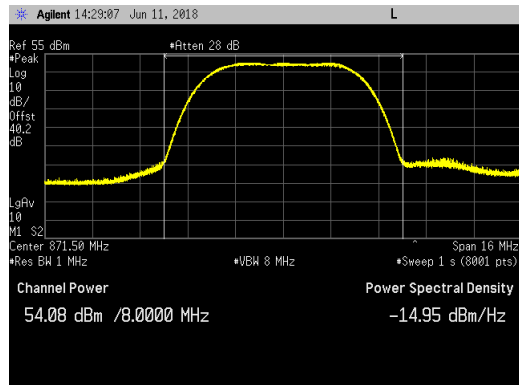


LTE3\_Top Channel\_Average

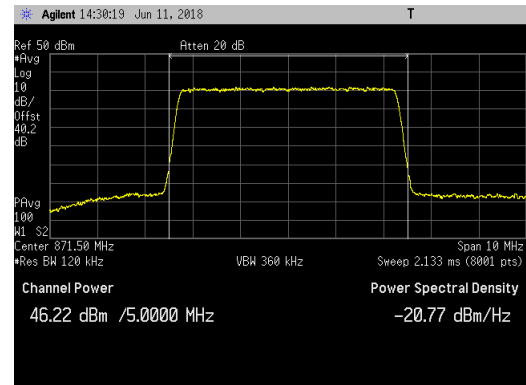


## LTE5 Channel Power Plots for Antenna Port 2 and 256QAM Modulation:

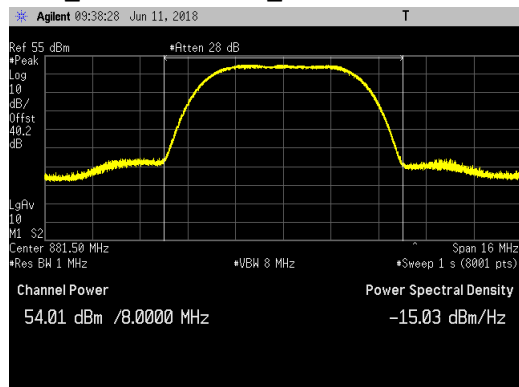
LTE5\_Bottom Channel\_Peak



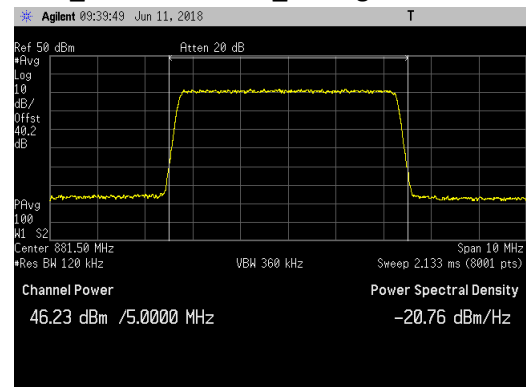
LTE5\_Bottom Channel\_Average



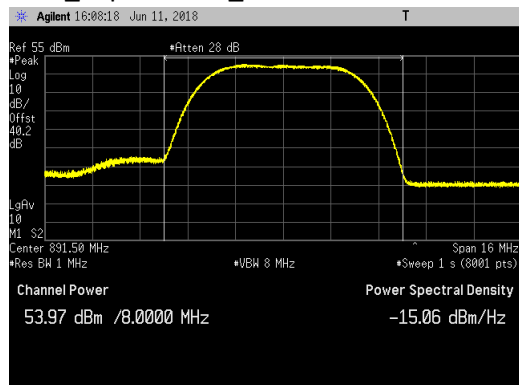
LTE5\_Middle Channel\_Peak



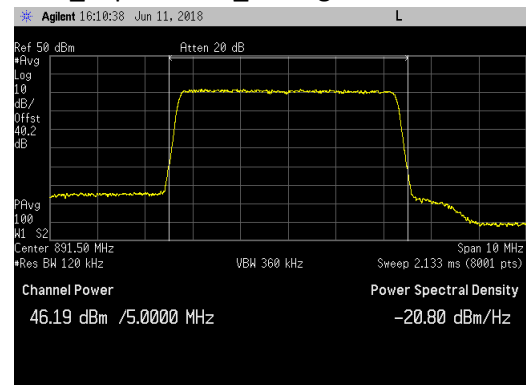
LTE5\_Middle Channel\_Average



LTE5\_Top Channel\_Peak

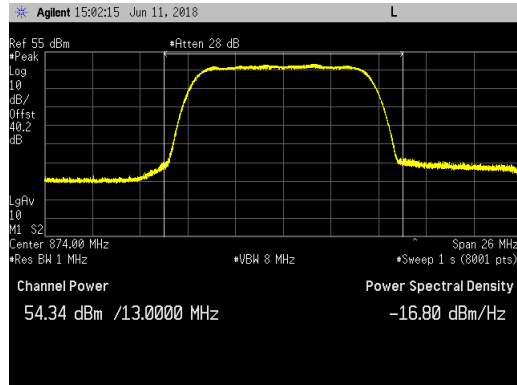


LTE5\_Top Channel\_Average

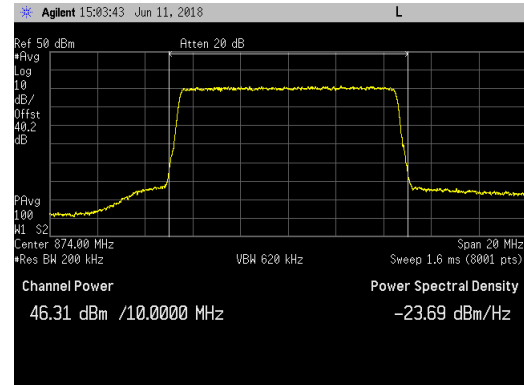


## LTE10 Channel Power Plots for Antenna Port 2 and 256QAM Modulation:

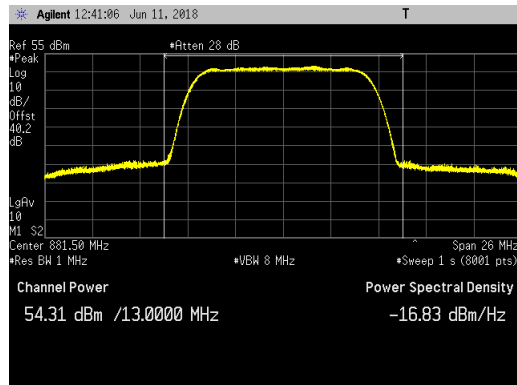
LTE10\_Bottom Channel\_Peak



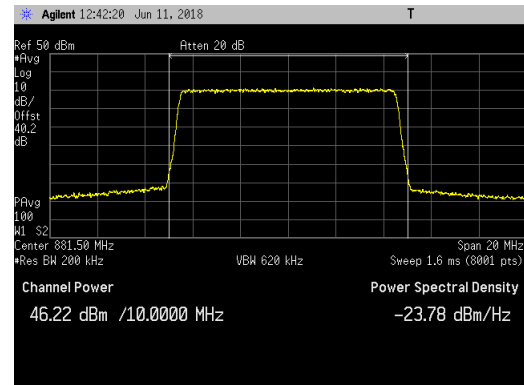
LTE10\_Bottom Channel\_Average



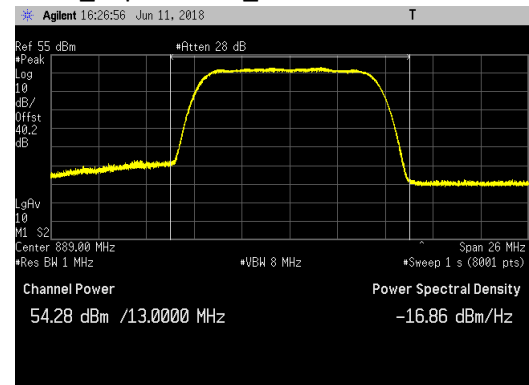
LTE10\_Middle Channel\_Peak



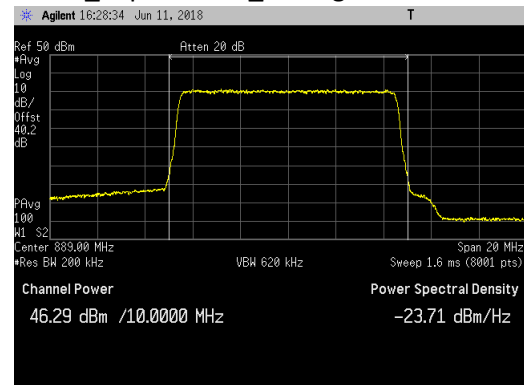
LTE10\_Middle Channel\_Average



LTE10\_Top Channel\_Peak



LTE10\_Top Channel\_Average



## Emission Bandwidth (26 dB down and 99%)

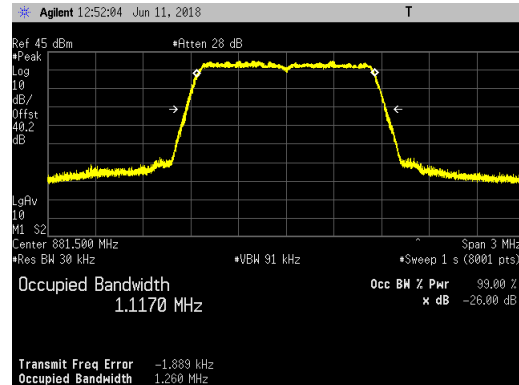
Emission bandwidth measurements were made at antenna port 2 on the middle channel with maximum RF output power. All available LTE modulations (QPSK, 16QAM, 64QAM, 256QAM) were used. All available LTE channel bandwidths (1.4MHz, 3MHz, 5MHz, and 10MHz) were used. The results are provided in the following table. The largest emission bandwidths in each channel type are highlighted.

| LTE<br>Ch<br>BW |               |               | Modulation Type |               |               |               |               |              |
|-----------------|---------------|---------------|-----------------|---------------|---------------|---------------|---------------|--------------|
|                 | QPSK          |               | 16QAM           |               | 64QAM         |               | 256QAM        |              |
|                 | 26dB<br>(MHz) | 99%<br>(MHz)  | 26dB<br>(MHz)   | 99%<br>(MHz)  | 26dB<br>(MHz) | 99%<br>(MHz)  | 26dB<br>(MHz) | 99%<br>(MHz) |
| <b>1.4M</b>     | <b>1.260</b>  | <b>1.1170</b> | 1.245           | 1.1090        | 1.244         | 1.1086        | 1.246         | 1.1088       |
| <b>3M</b>       | <b>2.931</b>  | 2.7107        | 2.927           | 2.7057        | 2.918         | <b>2.7118</b> | 2.929         | 2.7043       |
| <b>5M</b>       | 4.839         | 4.4860        | 4.827           | 4.4733        | 4.838         | <b>4.4956</b> | <b>4.844</b>  | 4.4946       |
| <b>10M</b>      | 9.654         | 8.9787        | 9.620           | <b>8.9998</b> | <b>9.664</b>  | 8.9766        | 9.646         | 8.9735       |

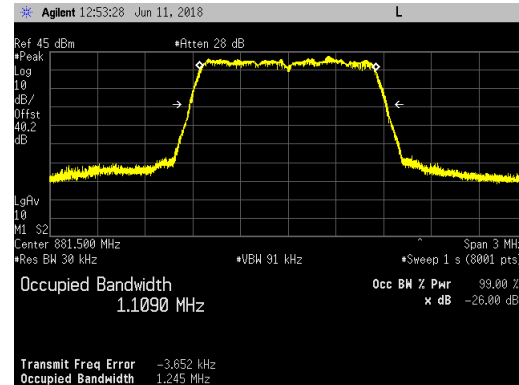
Emission bandwidth measurement data are provided in the following pages.

## LTE1.4 Emission Bandwidth Plots on the Middle Channel for Antenna Port 2:

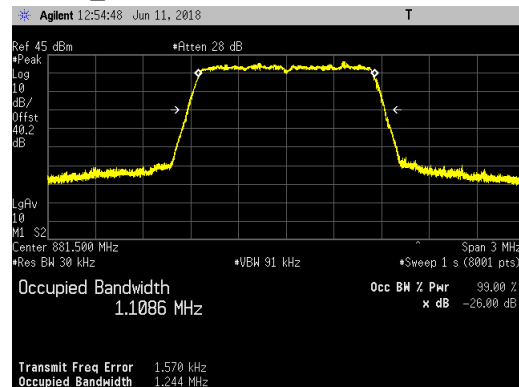
## LTE1.4\_QPSK



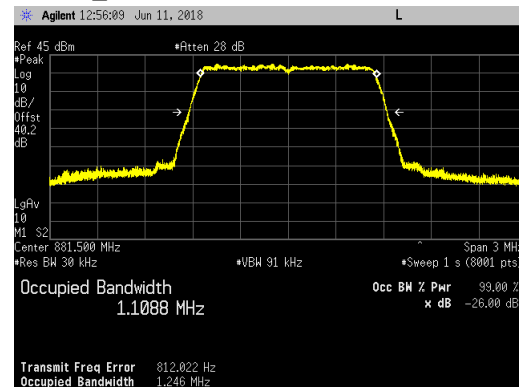
## LTE1.4\_16QAM



## LTE1.4\_64QAM

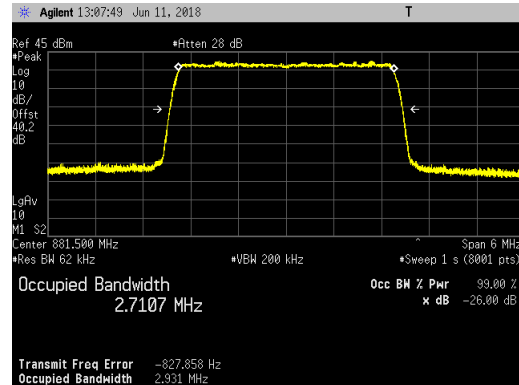


## LTE1.4\_256QAM

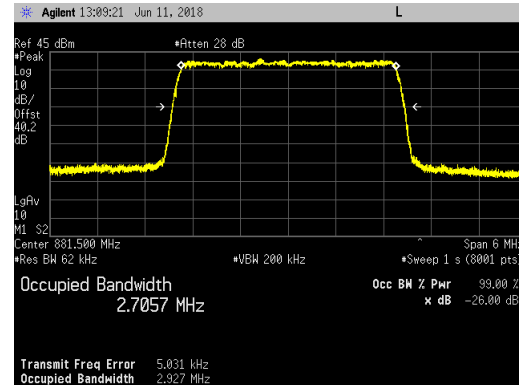


## LTE3 Emission Bandwidth Plots on the Middle Channel for Antenna Port 2:

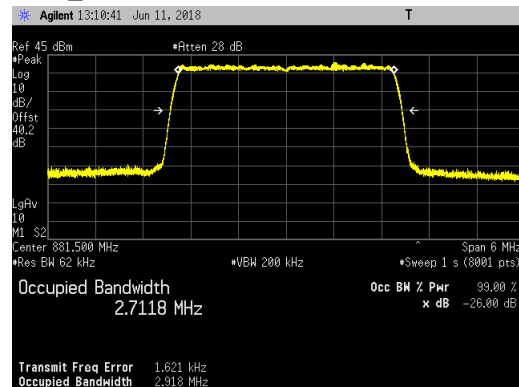
## LTE3\_QPSK



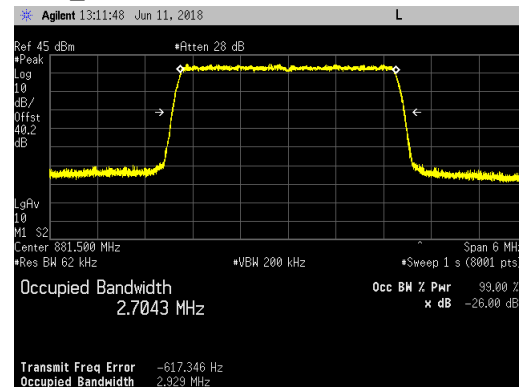
## LTE3\_16QAM



## LTE3\_64QAM

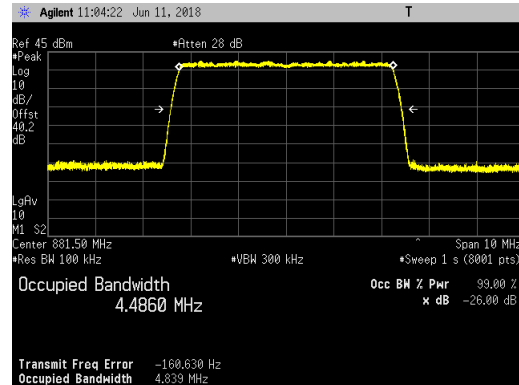


## LTE3\_256QAM

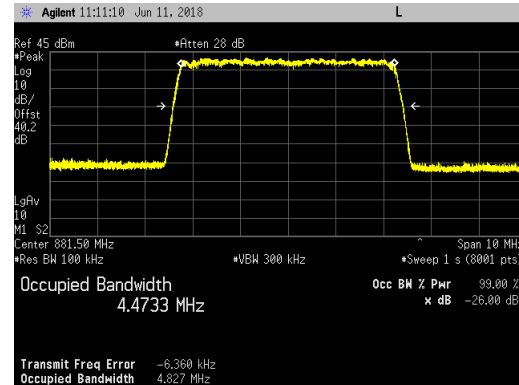


## LTE5 Emission Bandwidth Plots on the Middle Channel for Antenna Port 2:

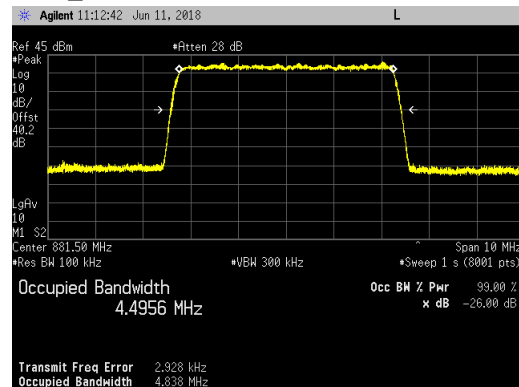
LTE5\_QPSK



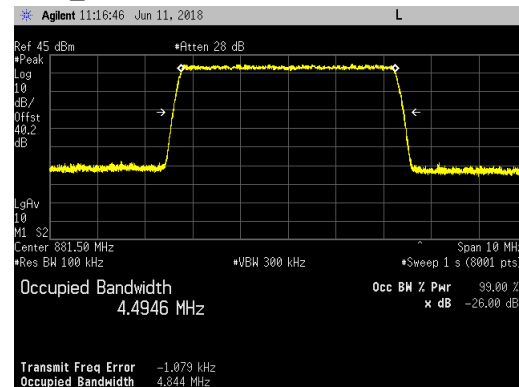
LTE5\_16QAM



LTE5\_64QAM

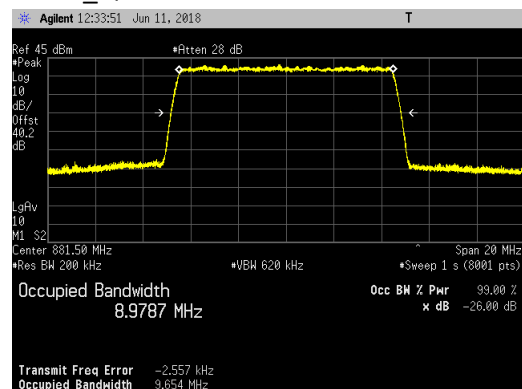


LTE5\_256QAM

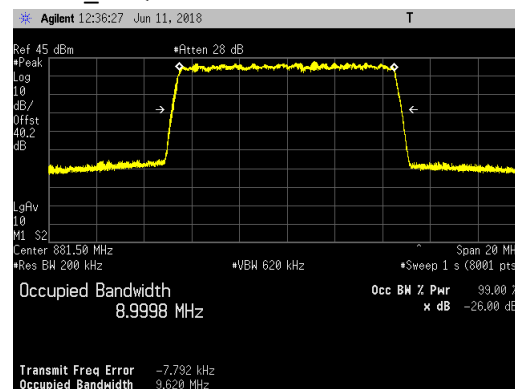


## LTE10 Emission Bandwidth Plots on the Middle Channel for Antenna Port 2:

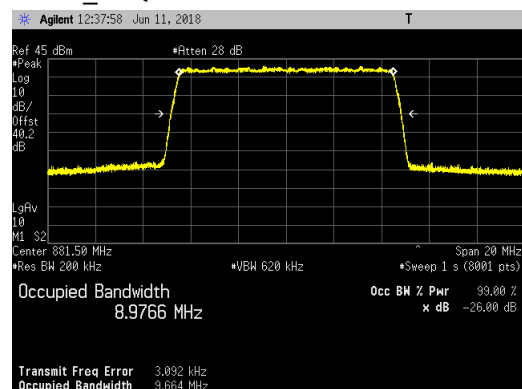
## LTE10\_QPSK



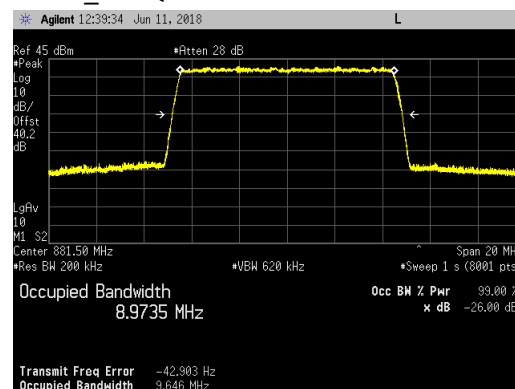
## LTE10\_16QAM



## LTE10\_64QAM



## LTE10\_256QAM



### Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 2. The RRH was operated at the band edge frequencies with all modulation types (QPSK, 16QAM, 64QAM, 256QAM) for 1.4MHz, 3MHz, 5MHz and 10MHz LTE bandwidths. The multicarrier test cases are based upon KDB 971168 D03v01 requirements using three carriers.

The limit of -19dBm was used in the certification testing. The limit is adjusted to -19dBm  $[-13\text{dBm} - 10 \log(4)]$  per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter.

Measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces. In the 1MHz bands outside and adjacent to the frequency block, a resolution bandwidth of 1% of the emission bandwidth was used. In the 1 to 20MHz frequency range outside the band edge (i.e.: 848 to 868MHz and 895 to 915MHz bands) a 100kHz RBW and 300kHz VBW was used.

The results are summarized in the following table. The highest (worst case) emissions from the measurement data are provided. The worst case (highest) measurement is -19.622 dBm.

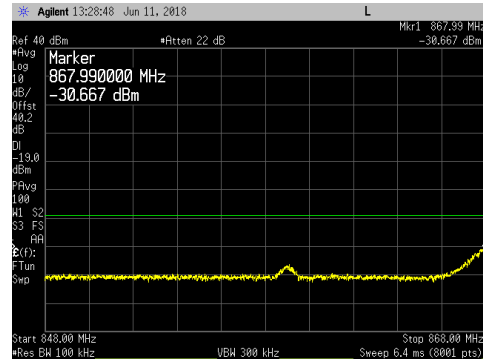
| Channel BW, Carrier Frequency,<br>Carrier Power           |                   | QPSK<br>(dBm) |         | 16QAM<br>(dBm) |                | 64QAM<br>(dBm) |         | 256QAM<br>(dBm) |         |
|-----------------------------------------------------------|-------------------|---------------|---------|----------------|----------------|----------------|---------|-----------------|---------|
| Band 5                                                    | Band 13           | Bottom        | Top     | Bottom         | Top            | Bottom         | Top     | Bottom          | Top     |
| LTE1.4, BC & TC,<br>40W                                   | Carrier Off       | -23.487       | -23.532 | -24.598        | -24.393        | -24.396        | -25.427 | -23.823         | -23.753 |
| LTE3, BC & TC,<br>40W                                     | Carrier Off       | -20.547       | -20.199 | -20.428        | <b>-19.622</b> | -20.246        | -19.981 | -20.146         | -20.191 |
| LTE5, BC & TC,<br>40W                                     | Carrier Off       | -22.950       | -22.318 | -21.811        | -23.527        | -22.444        | -21.952 | -22.264         | -23.021 |
| LTE10, BC & TC,<br>40W                                    | Carrier Off       | -22.513       | -23.445 | -22.755        | -23.140        | -21.934        | -22.881 | -21.554         | -22.613 |
| Multicarrier LTE1.4,<br>BC, BC+1 & TC,<br>13W + 13W + 13W | Carrier Off       | -24.148       | -23.782 | -24.234        | -24.850        | -23.049        | -25.024 | -23.727         | -26.013 |
| Multicarrier LTE1.4,<br>TC-1 & TC,<br>13W + 13W           | LTE10, MC,<br>13W | -37.767       | -26.472 | -37.618        | -26.237        | -36.366        | -26.058 | -37.169         | -28.001 |

The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

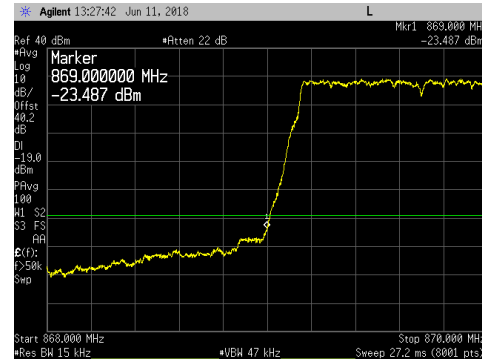
Conducted band edge measurements are provided in the following pages.

## Band 5 LTE1.4 40W Carrier Lower Band Edge Plots for Antenna Port 2:

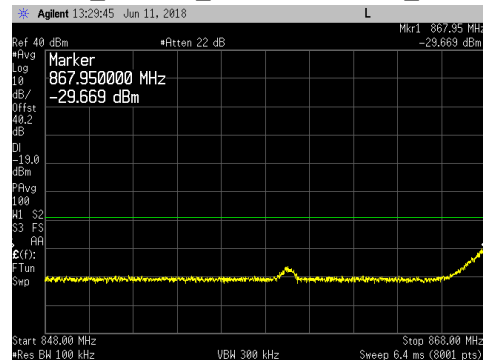
LTE1.4\_QPSK\_Bottom Channel\_848 to 868MHz



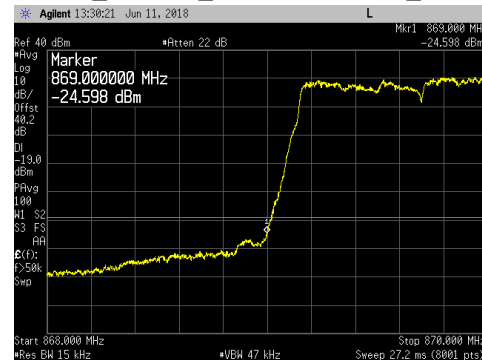
LTE1.4\_QPSK\_Bottom Channel\_868 to 870MHz



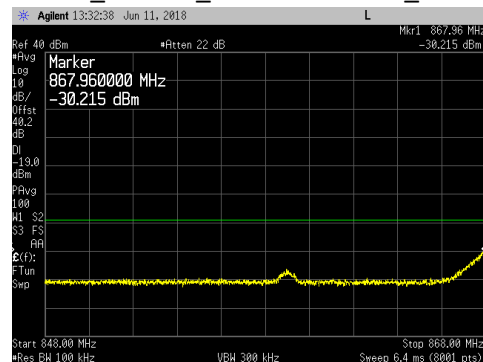
LTE1.4\_16QAM\_Bottom Channel\_848 to 868MHz



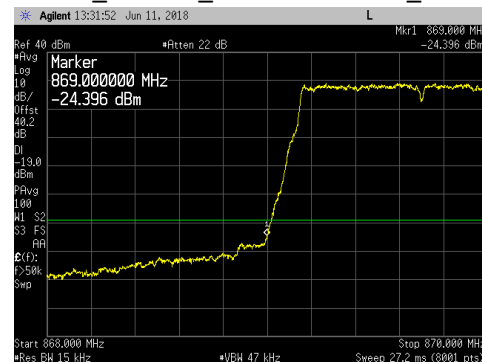
LTE1.4\_16QAM\_Bottom Channel\_868 to 870MHz



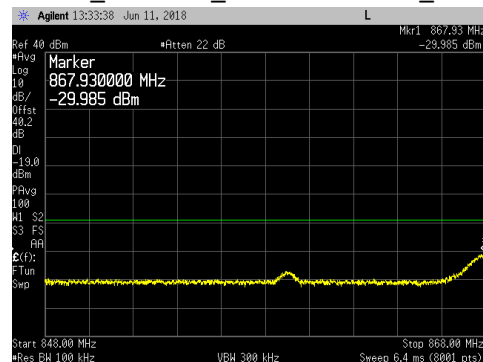
LTE1.4\_64QAM\_Bottom Channel\_848 to 868MHz



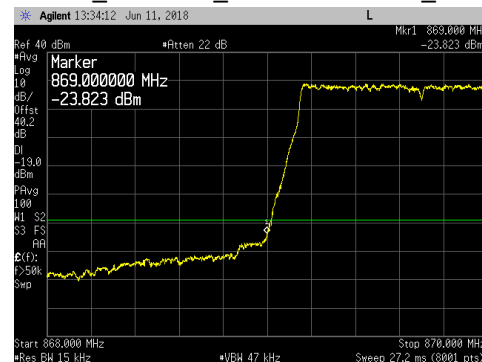
LTE1.4\_64QAM\_Bottom Channel\_868 to 870MHz



LTE1.4\_256QAM\_Bottom Channel\_848 to 868MHz

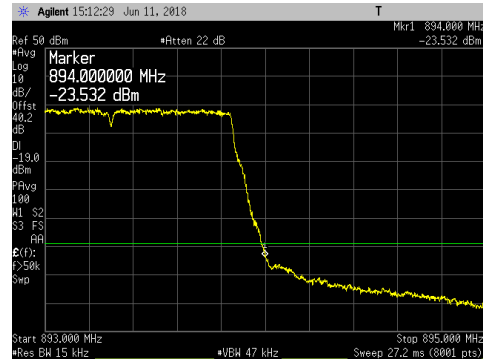


LTE1.4\_256QAM\_Bottom Channel\_868 to 870MHz

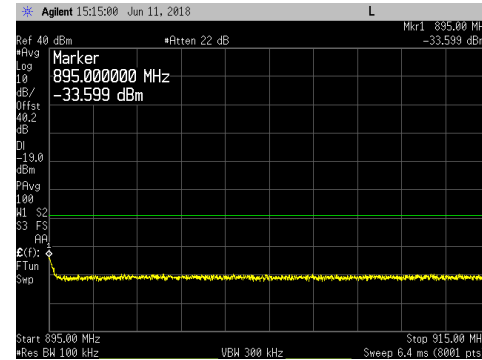


## Band 5 LTE1.4 40W Carrier Upper Band Edge Plots for Antenna Port 2:

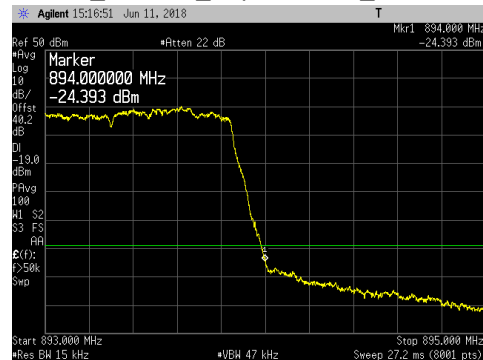
LTE1.4\_QPSK\_Top Channel\_893 to 895MHz



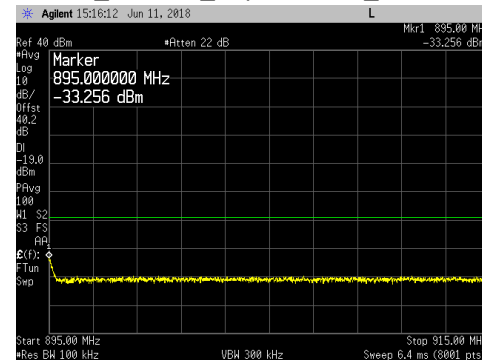
LTE1.4\_QPSK\_Top Channel\_895 to 915MHz



LTE1.4\_16QAM\_Top Channel\_893 to 895MHz



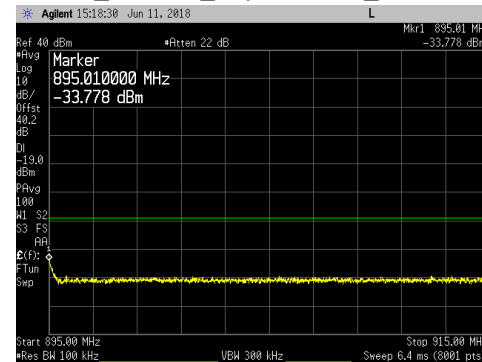
LTE1.4\_16QAM\_Top Channel\_895 to 915MHz



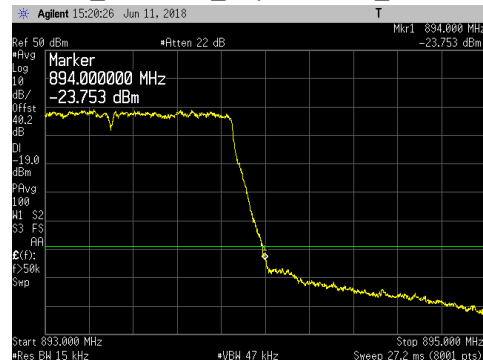
LTE1.4\_64QAM\_Top Channel\_893 to 895MHz



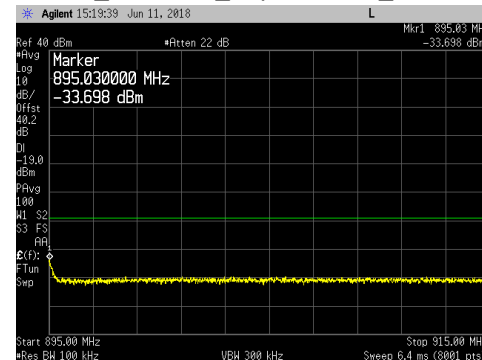
LTE1.4\_64QAM\_Top Channel\_895 to 915MHz



LTE1.4\_256QAM\_Top Channel\_893 to 895MHz

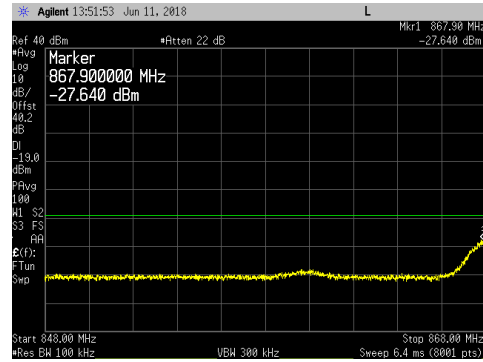


LTE1.4\_256QAM\_Top Channel\_895 to 915MHz

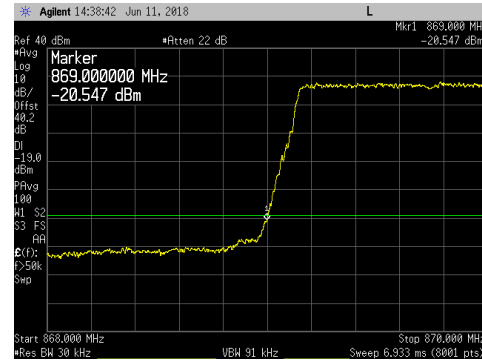


## Band 5 LTE3 40W Carrier Lower Band Edge Plots for Antenna Port 2:

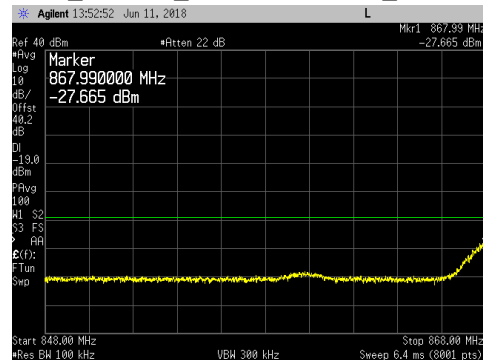
LTE3\_QPSK\_Bottom Channel\_848 to 868MHz



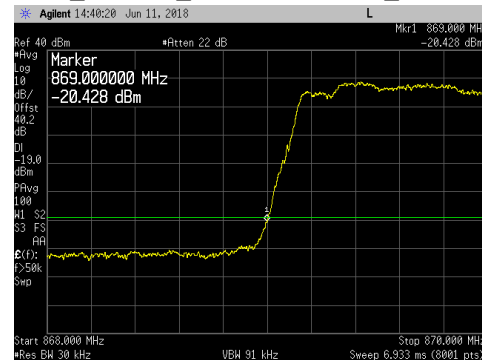
LTE3\_QPSK\_Bottom Channel\_868 to 870MHz



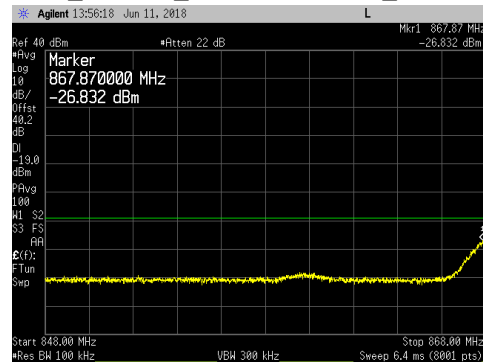
LTE3\_16QAM\_Bottom Channel\_848 to 868MHz



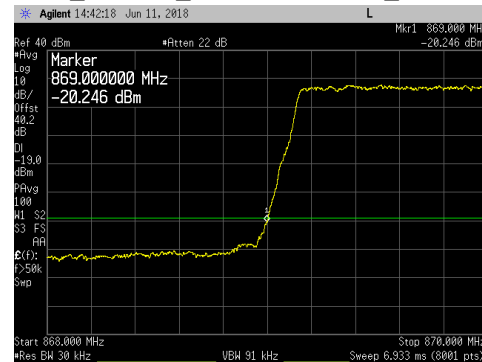
LTE3\_16QAM\_Bottom Channel\_868 to 870MHz



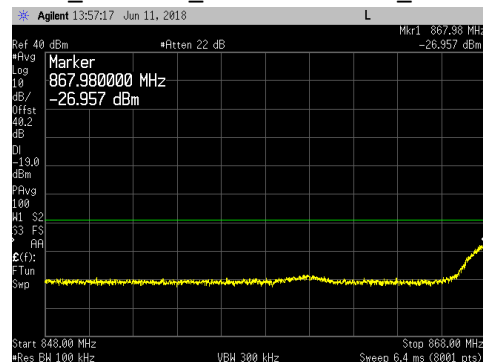
LTE3\_64QAM\_Bottom Channel\_848 to 868MHz



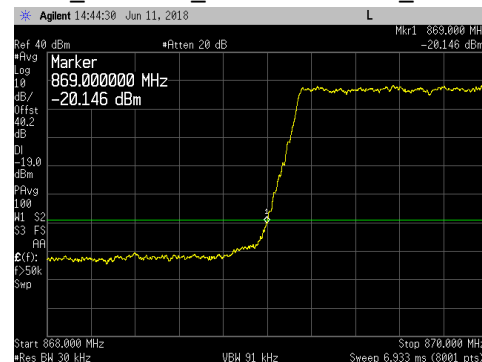
LTE3\_64QAM\_Bottom Channel\_868 to 870MHz



LTE3\_256QAM\_Bottom Channel\_848 to 868MHz

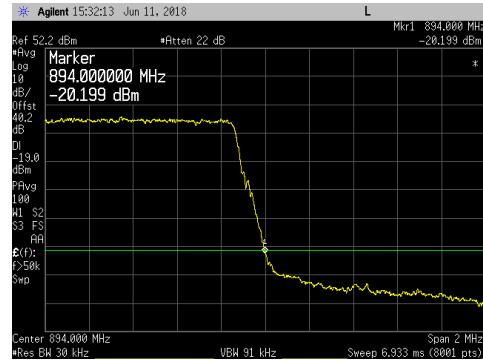


LTE3\_256QAM\_Bottom Channel\_868 to 870MHz

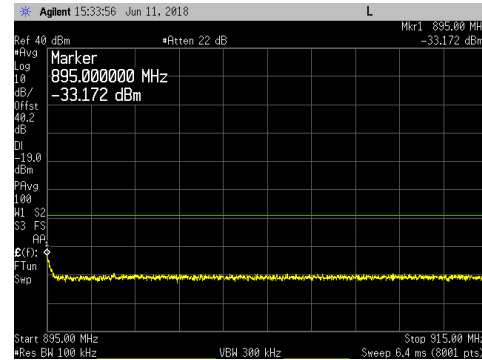


## Band 5 LTE3 40W Carrier Upper Band Edge Plots for Antenna Port 2:

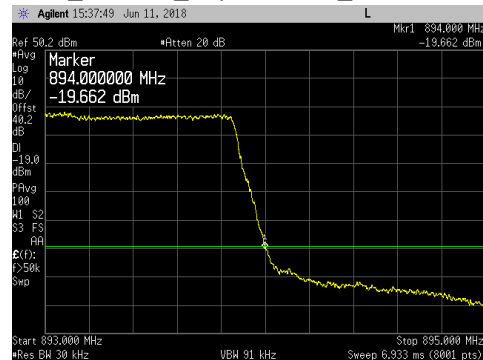
LTE3\_QPSK\_Top Channel\_893 to 895MHz



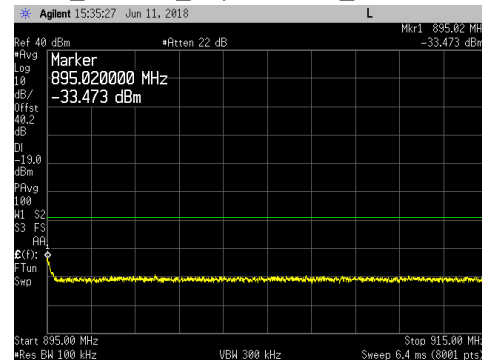
LTE3\_QPSK\_Top Channel\_895 to 915MHz



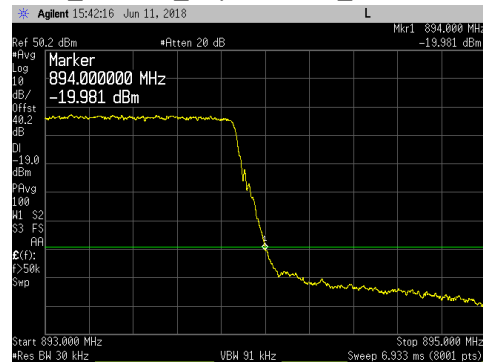
LTE3\_16QAM\_Top Channel\_893 to 895MHz



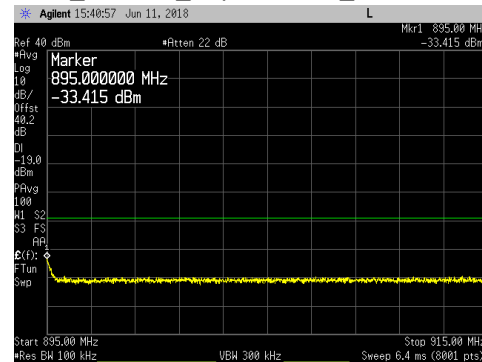
LTE3\_16QAM\_Top Channel\_895 to 915MHz



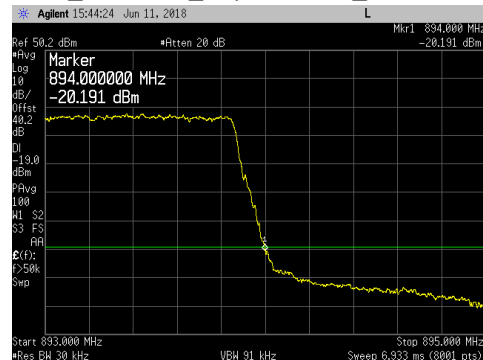
LTE3\_64QAM\_Top Channel\_893 to 895MHz



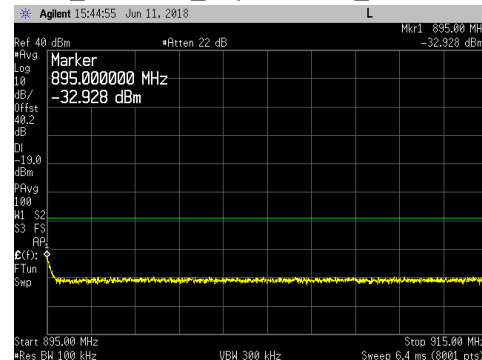
LTE3\_64QAM\_Top Channel\_895 to 915MHz



LTE3\_256QAM\_Top Channel\_893 to 895MHz

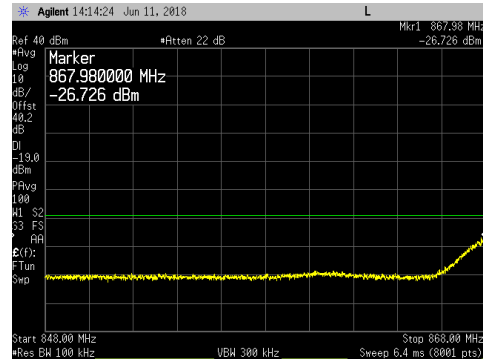


LTE3\_256QAM\_Top Channel\_895 to 915MHz

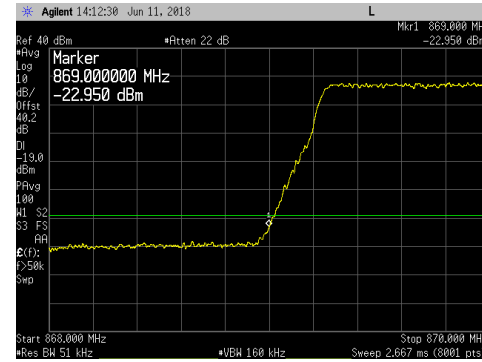


## Band 5 LTE5 40W Carrier Lower Band Edge Plots for Antenna Port 2:

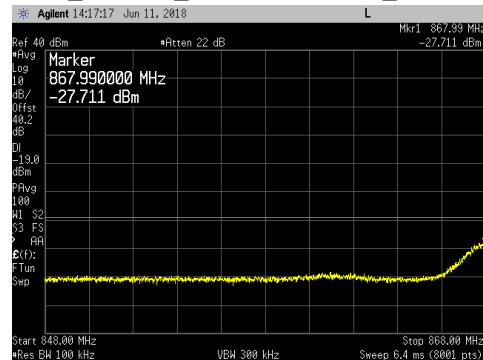
LTE5\_QPSK\_Bottom Channel\_848 to 868MHz



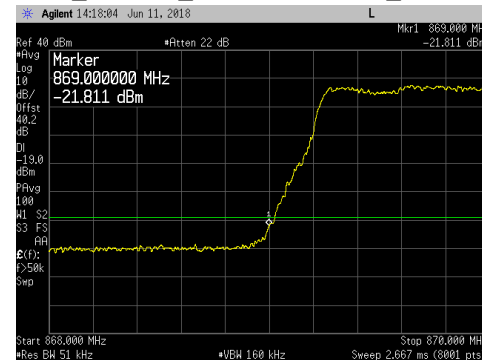
LTE5\_QPSK\_Bottom Channel\_868 to 870MHz



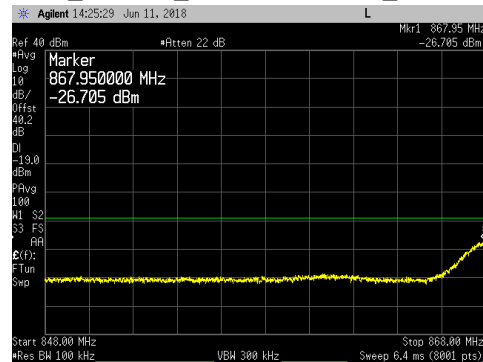
LTE5\_16QAM\_Bottom Channel\_848 to 868MHz



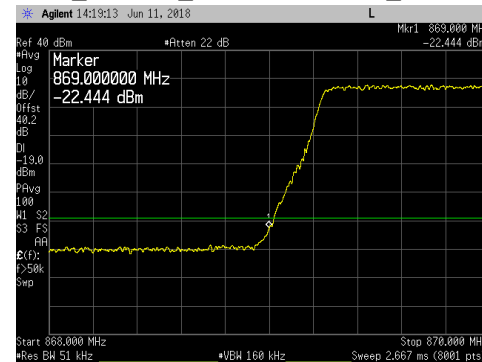
LTE5\_16QAM\_Bottom Channel\_868 to 870MHz



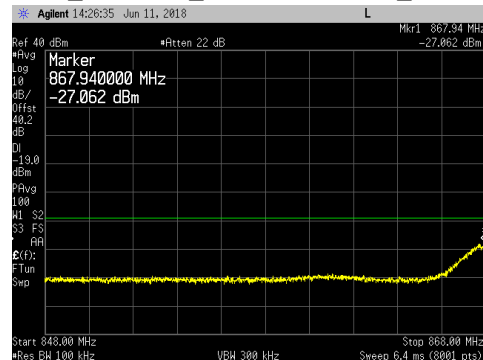
LTE5\_64QAM\_Bottom Channel\_848 to 868MHz



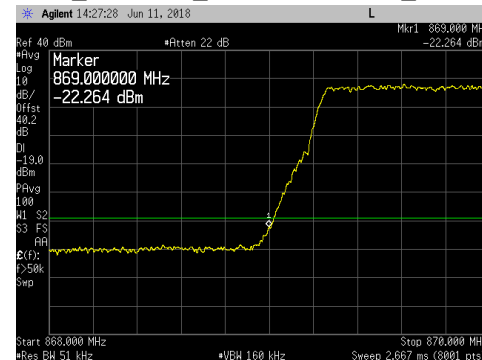
LTE5\_64QAM\_Bottom Channel\_868 to 870MHz



LTE5\_256QAM\_Bottom Channel\_848 to 868MHz

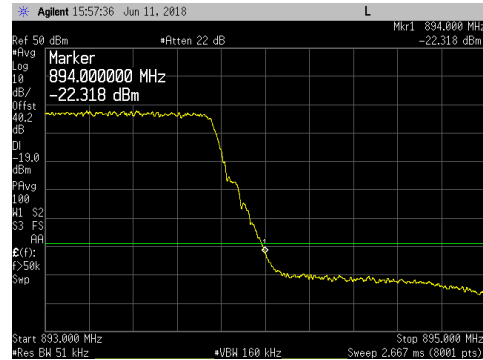


LTE5\_256QAM\_Bottom Channel\_868 to 870MHz

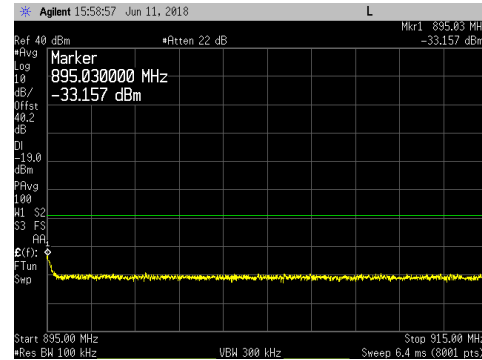


## Band 5 LTE5 40W Carrier Upper Band Edge Plots for Antenna Port 2:

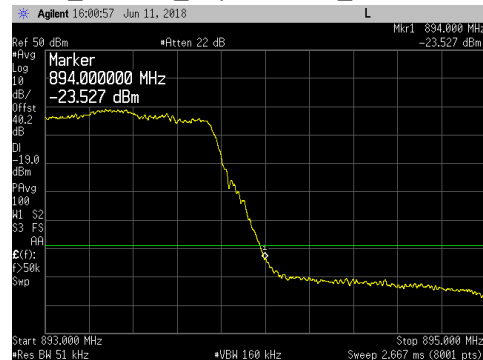
LTE5\_QPSK\_Top Channel\_893 to 895MHz



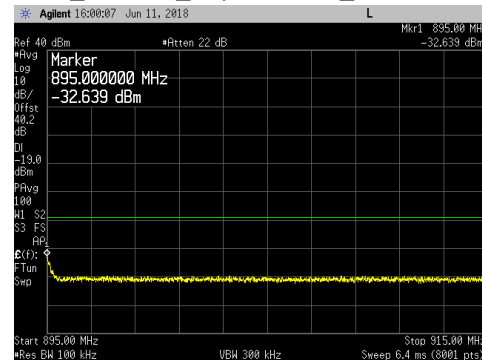
LTE5\_QPSK\_Top Channel\_895 to 915MHz



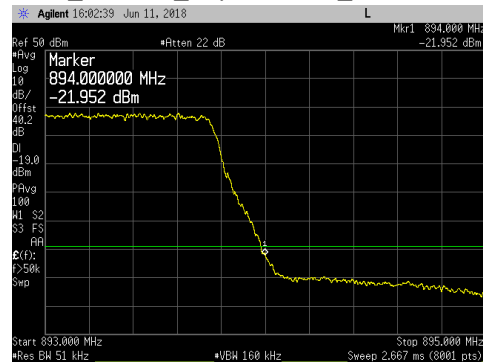
LTE5\_16QAM\_Top Channel\_893 to 895MHz



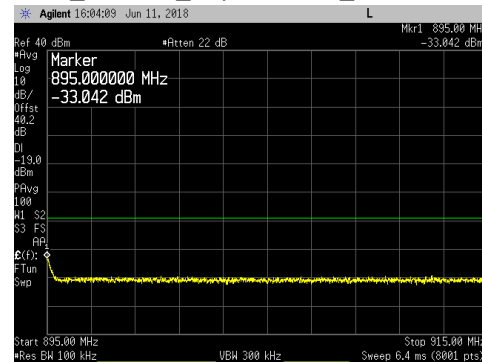
LTE5\_16QAM\_Top Channel\_895 to 915MHz



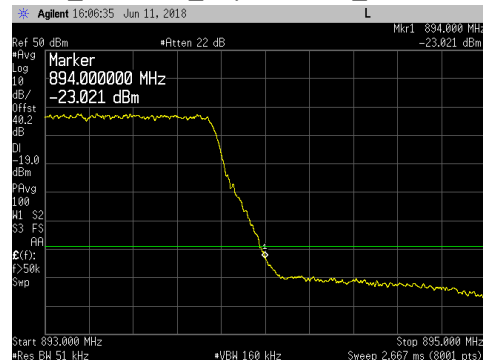
LTE5\_64QAM\_Top Channel\_893 to 895MHz



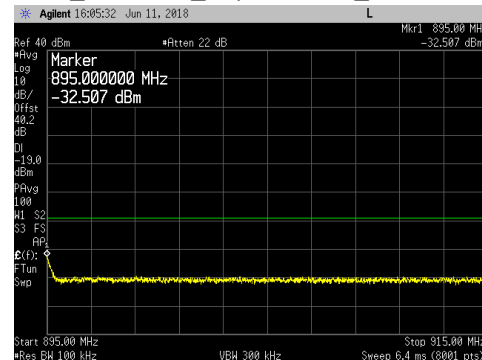
LTE5\_64QAM\_Top Channel\_895 to 915MHz



LTE5\_256QAM\_Top Channel\_893 to 895MHz

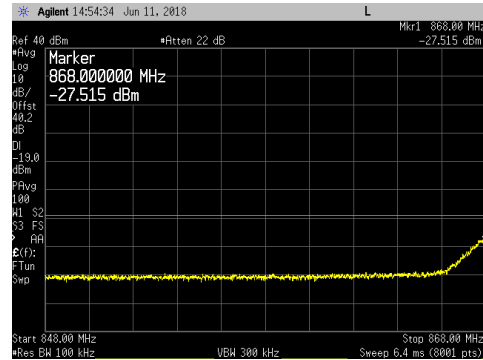


LTE5\_256QAM\_Top Channel\_895 to 915MHz

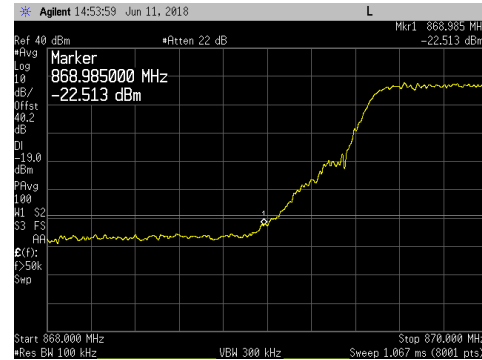


## Band 5 LTE10 40W Carrier Lower Band Edge Plots for Antenna Port 2:

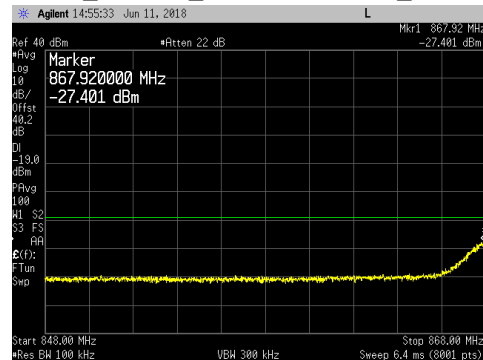
LTE10\_QPSK\_Bottom Channel\_848 to 868MHz



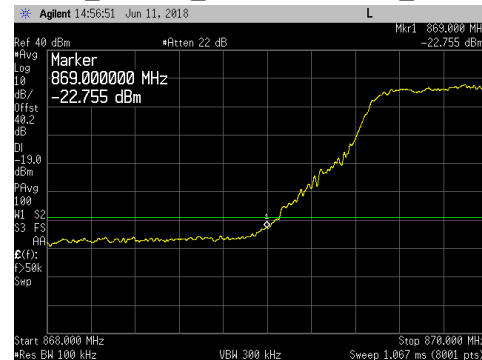
LTE10\_QPSK\_Bottom Channel\_868 to 870MHz



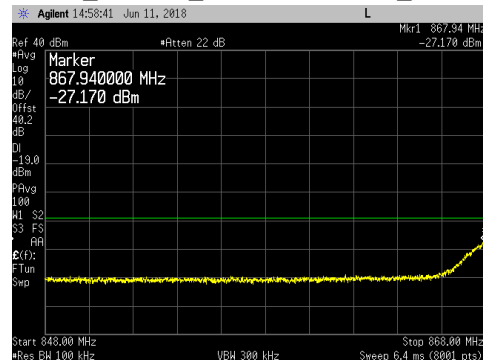
LTE10\_16QAM\_Bottom Channel\_848 to 868MHz



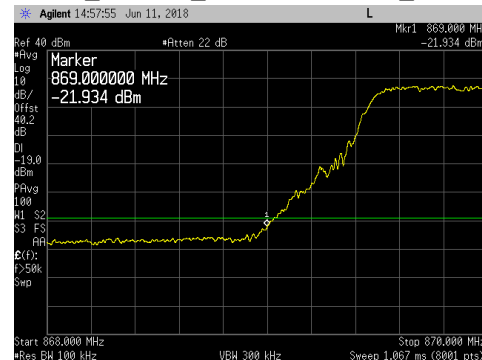
LTE10\_16QAM\_Bottom Channel\_868 to 870MHz



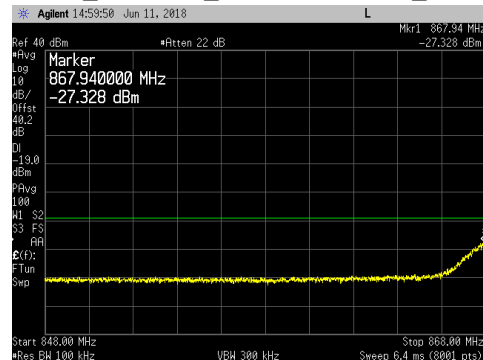
LTE10\_64QAM\_Bottom Channel\_848 to 868MHz



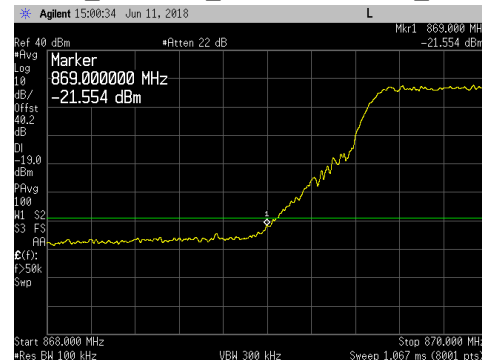
LTE10\_64QAM\_Bottom Channel\_868 to 870MHz



LTE10\_256QAM\_Bottom Channel\_848 to 868MHz

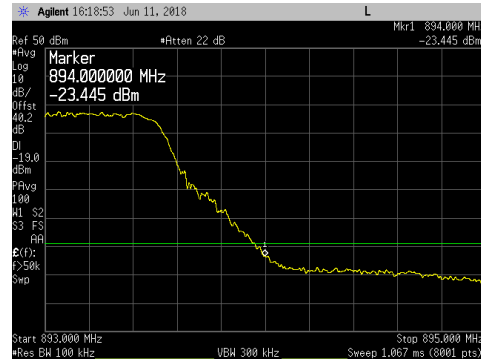


LTE10\_256QAM\_Bottom Channel\_868 to 870MHz

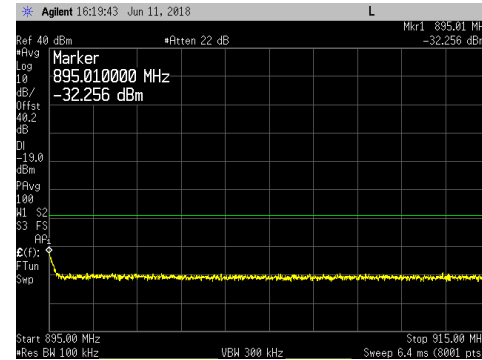


## Band 5 LTE10 40W Carrier Upper Band Edge Plots for Antenna Port 2:

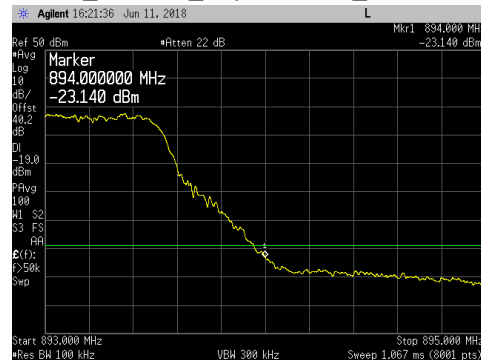
LTE10\_QPSK\_Top Channel\_893 to 895MHz



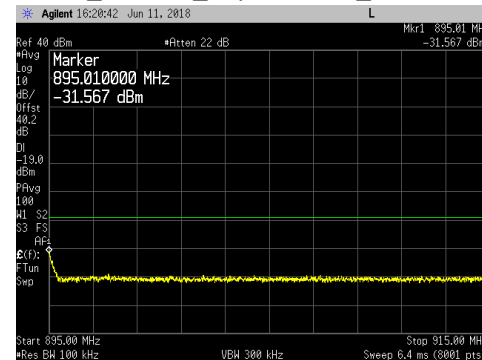
LTE10\_QPSK\_Top Channel\_895 to 915MHz



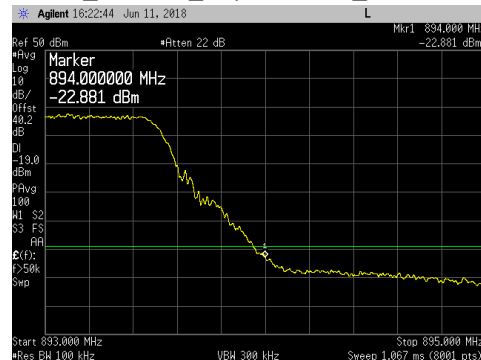
LTE10\_16QAM\_Top Channel\_893 to 895MHz



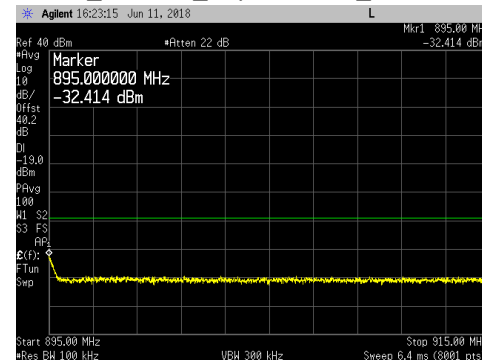
LTE10\_16QAM\_Top Channel\_895 to 915MHz



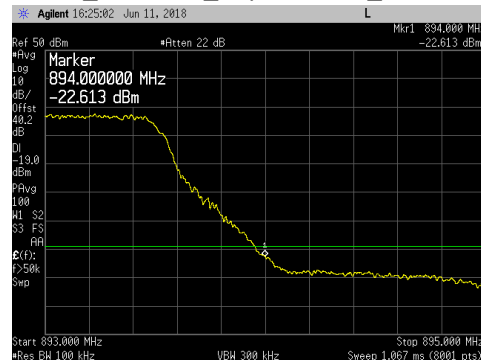
LTE10\_64QAM\_Top Channel\_893 to 895MHz



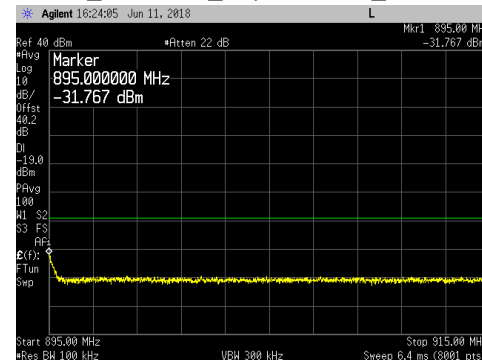
LTE10\_64QAM\_Top Channel\_895 to 915MHz



LTE10\_256QAM\_Top Channel\_893 to 895MHz

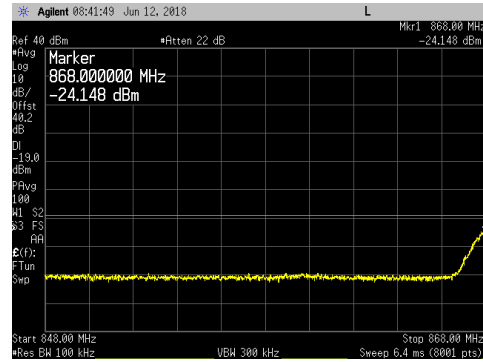


LTE10\_256QAM\_Top Channel\_895 to 915MHz

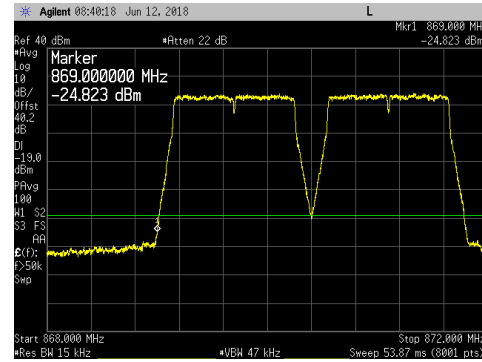


## Band 5 Multicarrier LTE1.4 13W + 13W + 13W Carriers Lower Band Edge Plots for Antenna Port 2:

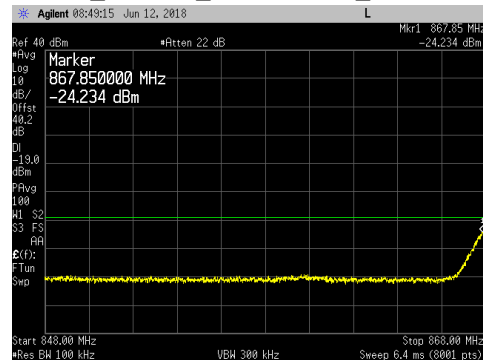
LTE1.4\_QPSK\_Bot Channel\_848 to 868MHz



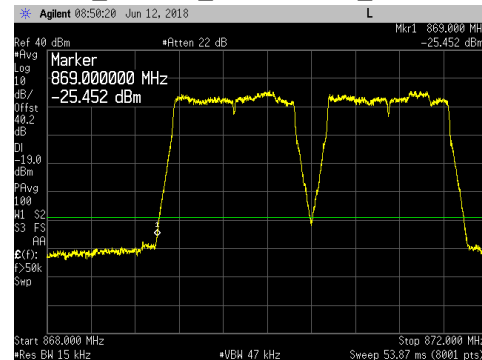
LTE1.4\_QPSK\_Bot Channel\_868 to 872MHz



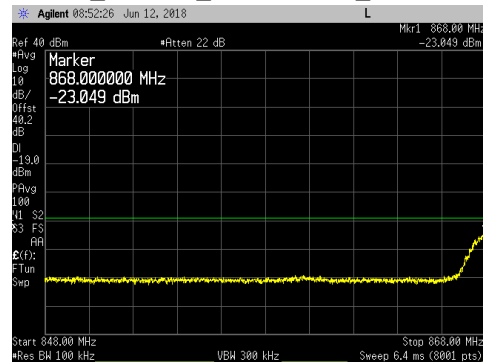
LTE1.4\_16QAM\_Bot Channel\_848 to 868MHz



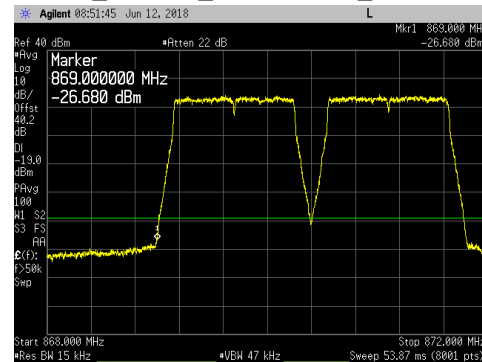
LTE1.4\_16QAM\_Bot Channel\_868 to 872MHz



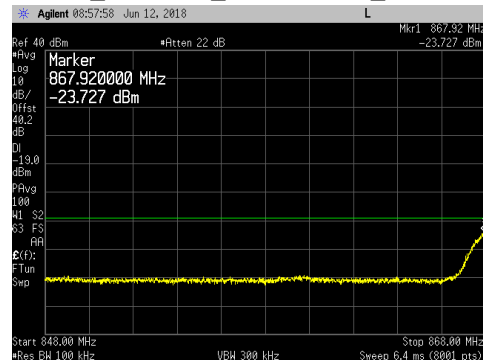
LTE1.4\_64QAM\_Bot Channel\_848 to 868MHz



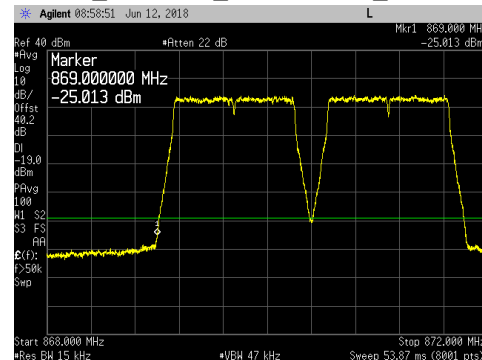
LTE1.4\_64QAM\_Bot Channel\_868 to 872MHz



LTE1.4\_256QAM\_Bot Channel\_848 to 868MHz

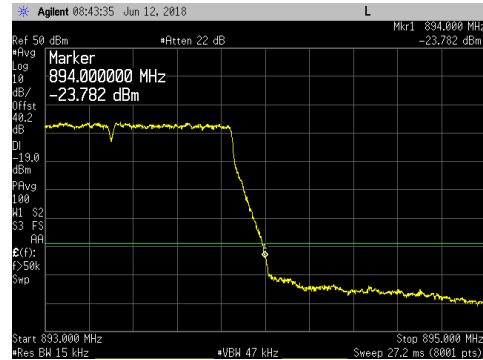


LTE1.4\_256QAM\_Bot Channel\_868 to 872MHz

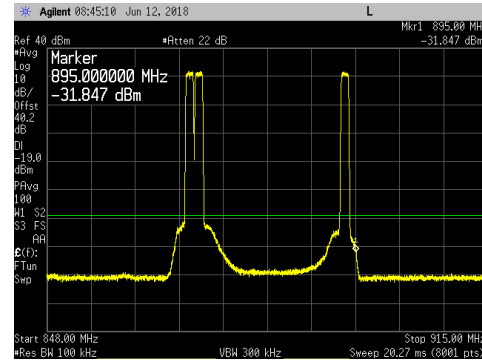


## Band 5 Multicarrier LTE1.4 13W + 13W + 13W Carriers Upper Band Edge Plots for Antenna Port 2:

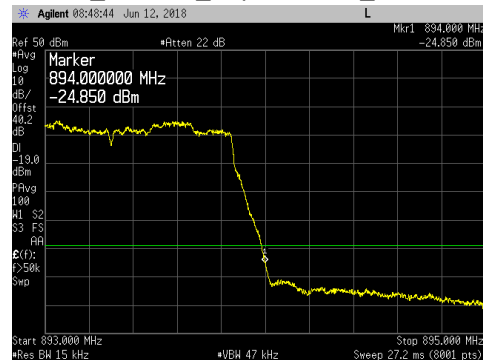
LTE1.4\_QPSK\_Top Channel\_893 to 895MHz



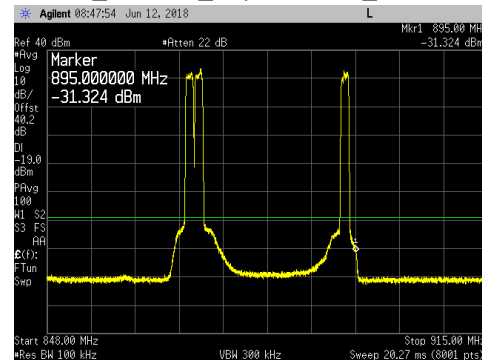
LTE1.4\_QPSK\_Top Channel\_848 to 915MHz



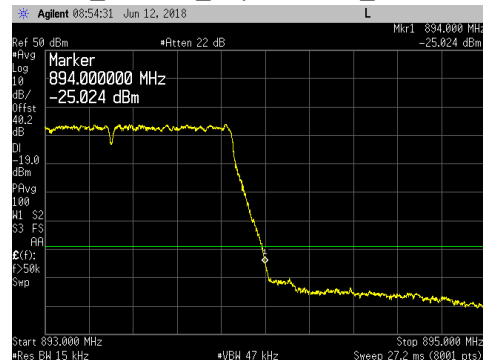
LTE1.4\_16QAM\_Top Channel\_893 to 895MHz



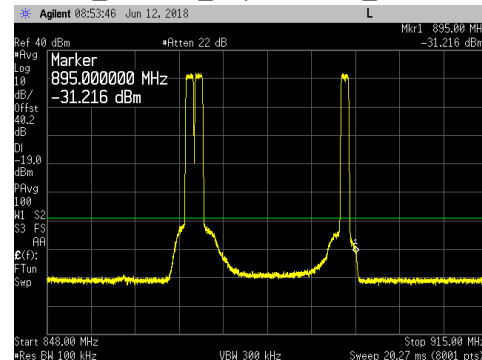
LTE1.4\_16QAM\_Top Channel\_848 to 915MHz



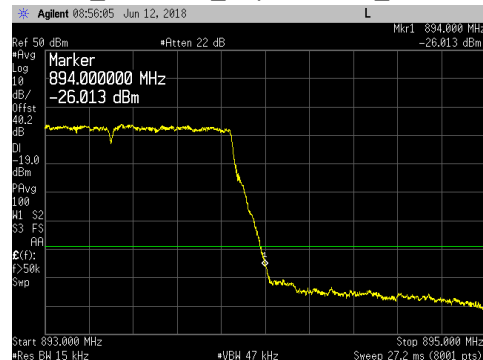
LTE1.4\_64QAM\_Top Channel\_893 to 895MHz



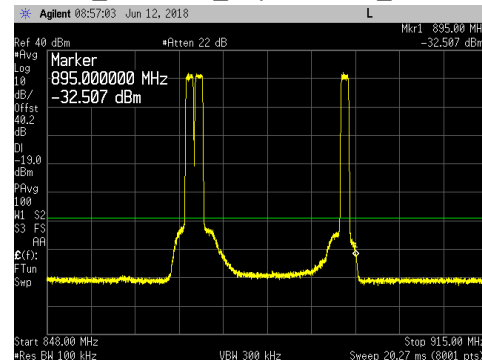
LTE1.4\_64QAM\_Top Channel\_848 to 915MHz



LTE1.4\_256QAM\_Top Channel\_893 to 895MHz

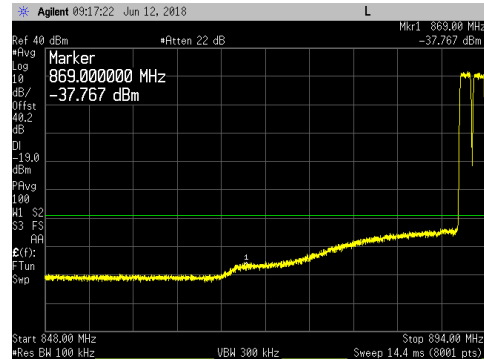


LTE1.4\_256QAM\_Top Channel\_848 to 915MHz

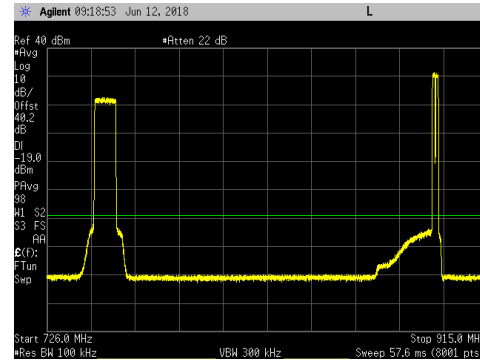


Band 5 LTE1.4 13W + 13W Carriers and Band 13 LTE10 13W Carrier Lower Band Edge Plots for Ant Port 2:

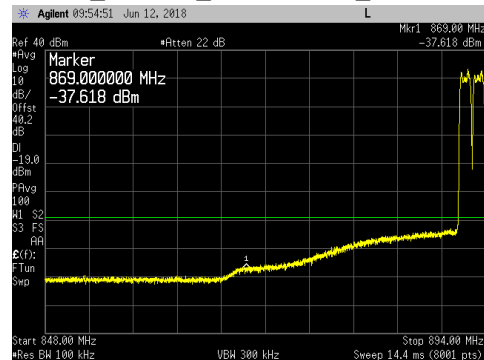
LTE1.4\_QPSK\_Bot Channel\_848 to 894MHz



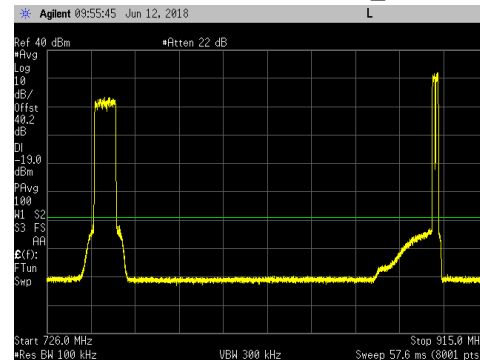
Multi-Band Multi-Carrier Scan\_726 to 915MHz



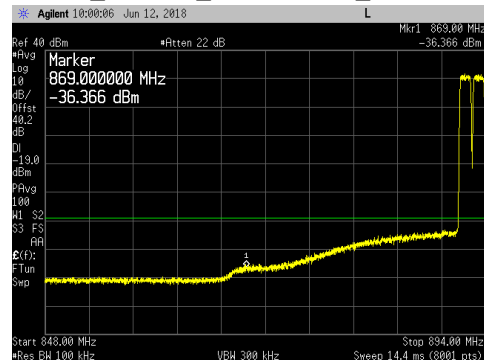
LTE1.4\_16QAM\_Bot Channel\_848 to 894MHz



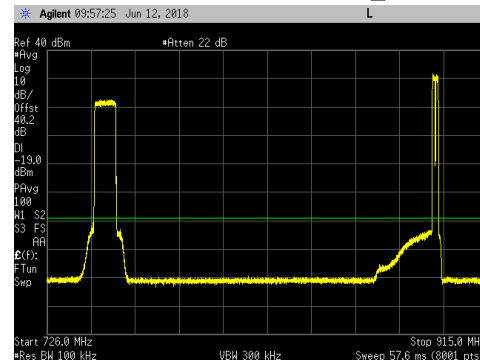
Multi-Band Multi-Carrier Scan\_726 to 915MHz



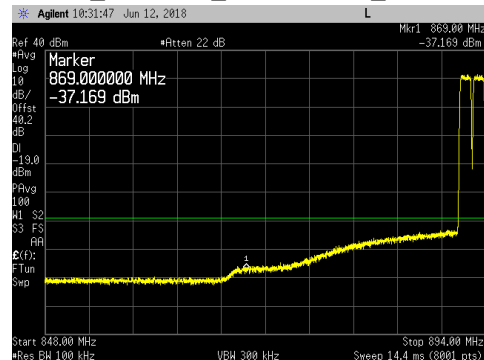
LTE1.4\_64QAM\_Bot Channel\_848 to 894MHz



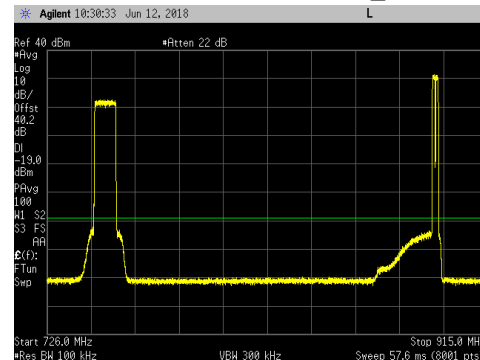
Multi-Band Multi-Carrier Scan\_726 to 915MHz



LTE1.4\_256QAM\_Bot Channel\_848 to 894MHz

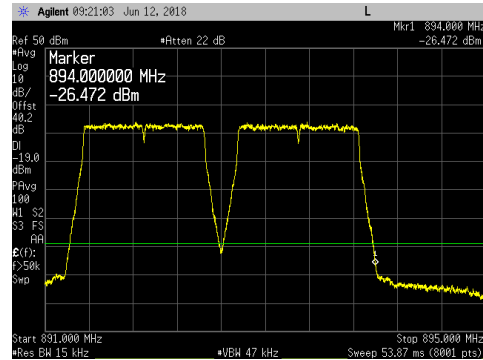


Multi-Band Multi-Carrier Scan\_726 to 915MHz

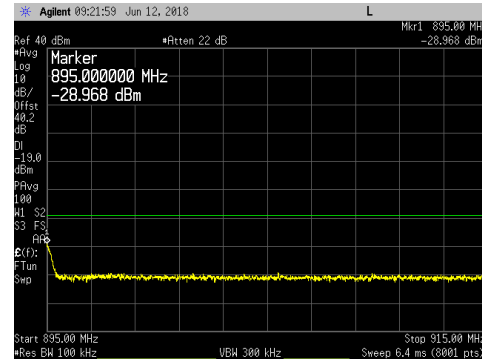


Band 5 LTE1.4 13W + 13W Carriers and Band 13 LTE10 13W Carrier Upper Band Edge Plots for Antenna Port 2:

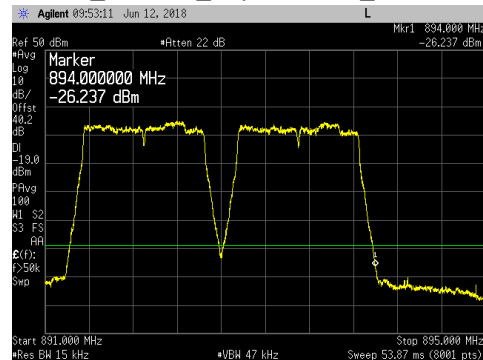
LTE1.4\_QPSK\_Top Channel\_891 to 895MHz



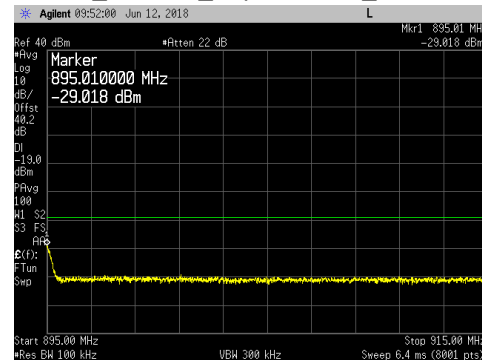
LTE1.4\_QPSK\_Top Channel\_895 to 915MHz



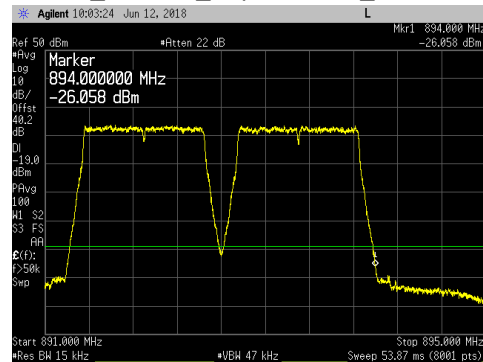
LTE1.4\_16QAM\_Top Channel\_891 to 895MHz



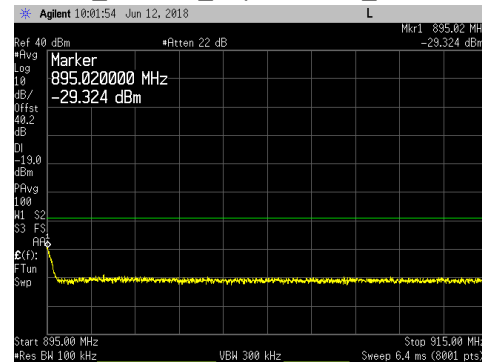
LTE1.4\_16QAM\_Top Channel\_895 to 915MHz



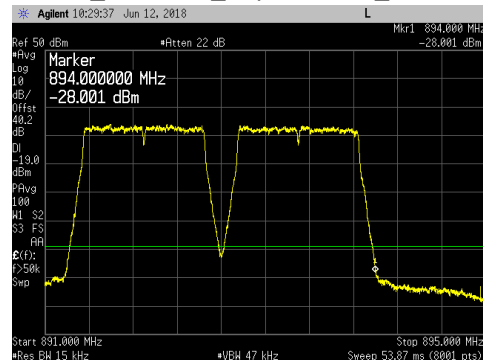
LTE1.4\_64QAM\_Top Channel\_891 to 895MHz



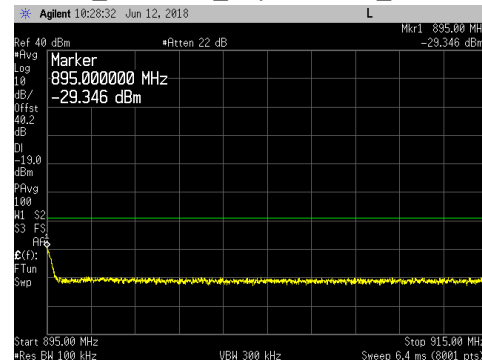
LTE1.4\_64QAM\_Top Channel\_895 to 915MHz



LTE1.4\_256QAM\_Top Channel\_891 to 895MHz



LTE1.4\_256QAM\_Top Channel\_895 to 915MHz



### zTransmitter Antenna Port Conducted Emissions

Transmitter conducted emission measurements were made at RRH antenna port 2. Measurements were performed over the 9kHz to 9GHz frequency range. Two test configurations are needed for conducted spurious emission measurements to prove compliance for the 3GPP Band 5 transmitters. The first test will be with the 3GPP Band 5 transmitters enabled at 40 watts per carrier (the 3GPP Band 13 transmitters will not be enabled). The second test will be with the 3GPP Band 5 and the 3GPP Band 13 transmitters enabled simultaneously at 40 watts/antenna port. The multicarrier test cases are based upon KDB 971168 D03v01 requirements using three carriers.

The RRH was operated (on Band 5 and Band 13) with all LTE modulation types (QPSK, 16QAM, 64QAM and 256QAM) for all available LTE bandwidths (Band 5: 1.4MHz, 3MHz, 5MHz and 10MHz; Band 13: 5MHz and 10MHz). The same LTE bandwidth was used for both frequency bands when available. If the same LTE bandwidth for both bands was not available then the smallest LTE bandwidth was used.

The test configuration parameters are provided below:

| 3GPP Band 5 Transmission Parameters          |                   |                | 3GPP Band 13 Transmission Parameters |                   |               |
|----------------------------------------------|-------------------|----------------|--------------------------------------|-------------------|---------------|
| Carrier Frequency                            | Channel Bandwidth | Carrier Power  | Carrier Frequency                    | Channel Bandwidth | Carrier Power |
| 881.5MHz (Mid Ch)                            | LTE1.4            | 40 Watts       | Carrier Idle/Off                     | N/A               | 0 Watts       |
| 881.5MHz (Mid Ch)                            | LTE3              | 40 Watts       | Carrier Idle/Off                     | N/A               | 0 Watts       |
| 881.5MHz (Mid Ch)                            | LTE5              | 40 Watts       | Carrier Idle/Off                     | N/A               | 0 Watts       |
| 881.5MHz (Mid Ch)                            | LTE10             | 40 Watts       | Carrier Idle/Off                     | N/A               | 0 Watts       |
| 869.7, 871.1 and 893.3MHz (BC, BC+1, and TC) | LTE1.4            | 13+13+13 Watts | Carrier Idle/Off                     | N/A               | 0 Watts       |
| 881.5MHz (Mid Ch)                            | LTE1.4            | 20 Watts       | 751MHz (Mid Ch)                      | LTE5              | 20 Watts      |
| 881.5MHz (Mid Ch)                            | LTE3              | 20 Watts       | 751MHz (Mid Ch)                      | LTE5              | 20 Watts      |
| 881.5MHz (Mid Ch)                            | LTE5              | 20 Watts       | 751MHz (Mid Ch)                      | LTE5              | 20 Watts      |
| 881.5MHz (Mid Ch)                            | LTE10             | 20 Watts       | 751MHz (Mid Ch)                      | LTE10             | 20 Watts      |
| 892.9 and 893.3MHz (TC-1 and TC)             | LTE1.4            | 13+13 Watts    | 751MHz (Mid Ch)                      | LTE10             | 13 Watts      |

The limit of -19dBm was used in the certification testing. The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter. The required measurement parameters include a 100kHz bandwidth with power measured in average value (since transmitter power was measured in average value).

Measurements were performed with a spectrum analyzer using a peak detector with max hold over 50 sweeps (except for the 700MHz to 1100MHz frequency range). Measurements for the 700MHz to 1100MHz frequency range were performed with the spectrum analyzer in the RMS average mode over 100 traces.

The limit for the 9kHz to 150kHz frequency range was adjusted to  $-39\text{dBm}$  to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 100kHz [i.e.:  $-39\text{dBm} = -19\text{dBm} - 10\log(100\text{kHz}/1\text{kHz})$ ]. The required limit of  $-19\text{dBm}$  with a RBW of  $\geq 100\text{kHz}$  was used for all other frequency ranges. The spectrum analyzer settings that were used for this test are summarized in the following table.

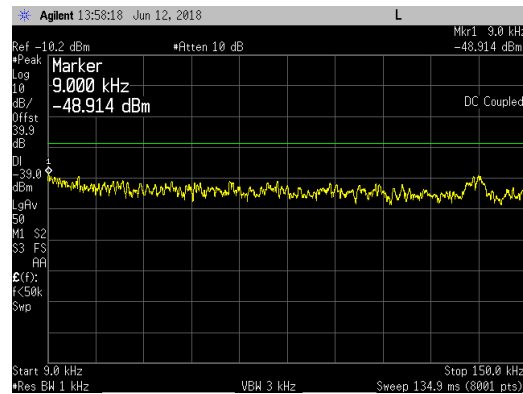
| Frequency Range                                                                                                                                                       | RBW    | VBW    | Number of Data Points | Detector | Sweep Time | Max Hold over | Offset Note 1 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|-----------------------|----------|------------|---------------|---------------|
| 9kHz to 150kHz                                                                                                                                                        | 1kHz   | 3kHz   | 8001                  | Peak     | Auto       | 50 Sweeps     | 39.9dB        |
| 150kHz to 20MHz                                                                                                                                                       | 100kHz | 300kHz | 8001                  | Peak     | Auto       | 50 Sweeps     | 40.0dB        |
| 20MHz to 700MHz                                                                                                                                                       | 300kHz | 910kHz | 8001                  | Peak     | Auto       | 50 Sweeps     | 40.2dB        |
| 700MHz to 1.1GHz                                                                                                                                                      | 100kHz | 300kHz | 8001                  | Average  | Auto       | Note 2        | 40.2dB        |
| 1.1GHz to 9GHz                                                                                                                                                        | 2MHz   | 6MHz   | 8001                  | Peak     | Auto       | 50 Sweeps     | 22.5dB        |
| Note 1: The total measurement RF path loss of the test setup (attenuators, filters and test cables) is accounted for by the spectrum analyzer reference level offset. |        |        |                       |          |            |               |               |
| Note 2: Max Hold not used and instead measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces.                                 |        |        |                       |          |            |               |               |

A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 1100MHz. The total measurement RF path loss of the test setup (attenuators, high pass filter and test cables) as shown in the table is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

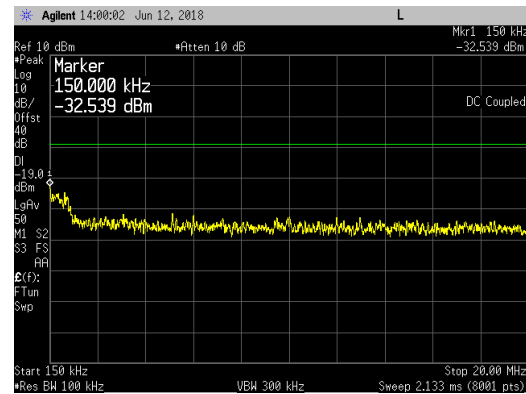
Conducted spurious emission plots/measurements are provided in the following pages.

Band 5 LTE1.4 Ch BW \_ QPSK \_ Middle Channel (881.5MHz) at 40 watts/carrier:

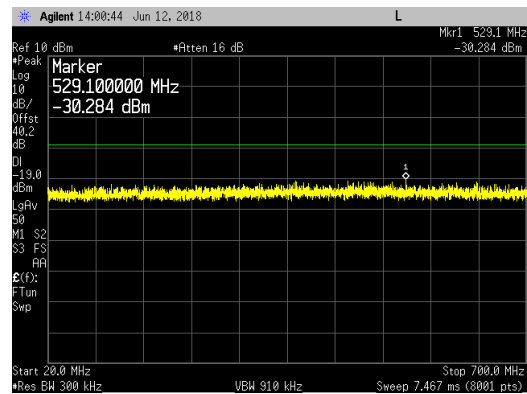
9kHz to 150kHz



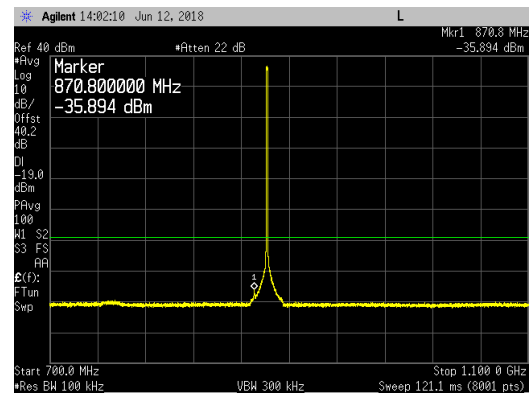
150kHz to 20MHz



20MHz to 700MHz



700MHz to 1.1GHz



1.1GHz to 9GHz

