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# FCC PARTS 2, 90 TEST REPORT

| | |
|---|---|
| **Applicant** | Dali Wireless, Inc. |
| **Address** | 8618 Commerce Court, Burnaby, British Columbia, V5A 4N6, Canada |
| **FCC ID** | HCOT43DQDD1A |
| **Model Number** | t43-DQD-D1D |
| **Product Description** | 700, 800 Remote Unit, Dual-Band High Power |
| **Date Sample Received** | July 21th, 2014 |
| **Date Sample Tested** | July 21th to August 11th, 2014 |
| **Tested by** | Guihua Sophie Piao |
| **Approved by** | Daryl Meerkerk |
| **Report No.** | T43-DQD-D1D |
| **Test Results** | Compliant |



## Revision History

| Revision | Date | Reason For Change | Author(s) |
|---|---|---|---|
| 0.1 | July 30th, 2014 | Initial Data | S. Piao |
| 0.2 | August 4th, 2014 | TIMCO Feedback | S. Piao |
| 0.3 | August 11th, 2014 | TIMCO Feedback,<br>separate 700MHz band into 758MHz-763MHz and 763MHz-775MHz, where part27 and part 90 applied, respectively;<br>separate 800MHz band into 851MHz – 854MHz and 854MHz – 869MHz, where part 90S and part 90I applied, respectively;<br>part 20 industrial booster report presented. | S. Piao |
| 0.4 | August 12th, 2014 | TIMCO Feedback,<br>Changed FCC ID referred from<br>HCOT43DQDD1B<br>to<br>HCOT43DQDD1A | S. Piao |
| 0.5 | Oct. 06th , 2014 | FCC Review | S.Piao |
| 0.6 | Nov. 24th, 2014 | FCC Audit Response | S.Piao |

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## *ACRONYMS AND ABBREVIATIONS*

| | |
|---|---|
| BTS | Base Transceiver Station |
| BW | Band Width |
| CW | Continuous Wave |
| dB | deciBel (logarithmic ratio) |
| dBc | deciBels related to the RF carrier amplitude |
| dBm | deciBels related to 1 mW |
| DL | Downlink |
| EIRP | Effective Isotropic Radiated Power |
| FH | Frequency High (Top edge of band) |
| FL | Frequency Low (Bottom edge of band) |
| FM | Frequency Mid (Center of band) |
| IF | Intermediate Frequency |
| IMD | Inter-Modulation Distortion |
| kHz | kilo Hertz |
| LTE | Long Term Evolution |
| MHz | Mega Hertz |
| NB | Narrow Band |
| NPSPAC | National Public Safety Planning Advisory Committee |
| OBW | Occupied Bandwidth |
| PS | Public Safety |
| PSBB | Public Safety Broad Band |
| PS-B/ILT-SMR | Public Safety – Business, Industrial/Land Transportation, Specialized Mobile Radio |
| RF | Radio Frequency |
| RX | Receiver |
| SEM | Spectrum Emission Mask |
| TX | Transmit |
| UL | Uplink |

# 1.0 Overview

## *1.1* Scope

The purpose of this document is to present test results in the context of a conformance test report for FCC Part 2, 90I, 90R and 90S as applicable to the equipment under test, in the setup of conducted connection. The scope of this document is limited to the tests listed below in the downlink mode where the antenna port resides.

## *1.2* Attestation Statement

The device under test does fulfill the general approval requirements as identified in this test report.

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report. All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025:2005 requirements.

I attest that the necessary measurements were made, under my supervision, at DALI WIRELESS, INC. located at 8618 Commerce Court, Burnaby, British Columbia, V5A 4N6, Canada.

Authorized Signatory:

Signature:
Guihua Sophie Piao
Function: Test Engineer
Date: August 11th, 2014

## *1.3* Report Summary

| | |
|---|---|
| Disclaimer | The test results relate only to the items tested. |

| | |
|---|---|
| Report Purpose | To demonstrate the DUT compliance with FCC Parts 2, 90I, 90R, 90S requirements for a dual band digital repeater. |
| Applicable Rule Parts | FCC CFR 47 Part 2.1046 (a), 90.219<br>FCC CFR 47 Part 2.1049, 90.209<br>FCC CFR 47 Part 90.543 (c), (e)<br>FCC CFR 47 Part 90.210(c), (h)<br>FCC CFR 47 Part 2.1055, 90.213 |
| Test Procedures | ANSI/TIA-603-C: 2004 |
| Test Status | PASS |

## *1.4* Test Environment

| | |
|---|---|
| Test Facilities | Tests were performed by Dali Wireless Inc. located at 8618 Commerce Court, Burnaby, BC, V5A 4N6, Canada. |
| Test Conditions | Temperature: 25° C<br>Relative Humidity: 60%<br>Atmospheric Pressure: 98.1 kPa |

## *1.5* Test Setup

| | |
|---|---|
| Deviation to the rules | There was no deviation from the test standards. |
| Modification to the DUT | No modification was made to the DUT. |
| Test Exercise | The DUT was placed in continuous transmit mode of operation. |

## *1.6* Device Under Test Information

| | |
|---|---|
| Manufactured by | Dali Wireless Inc. |
| DUT Description | 700, 800 Remote Unit, Dual-Band Bi-directional Distributed Antenna System/Repeater. |
| FCC ID | HCOT43DQDD1A |
| Model Name | *t*43™ – DQD-D1D |
| Operating Frequency | Downlink 758 – 775 MHz, Uplink 788 – 805 MHz;<br>Downlink 85 – 869 MHz, Uplink 806 – 824 Mhz;<br>where the uplink does not transmit over the air. |
| Emission Designators | F9W, D9W |
| Modulations | LTE in 700 MHz PS BB (FirstNet)<br>P25 in 700MHz PS NB<br>incumbent PS in 763-768MHz<br>P25 in 851 – 862 MHz<br>incumbent PS in 862-869 MHz |
| User Power Range and Control | There are NO user power controls |
| Test Item | Production |
| DC Voltage and Current into final amplifier | Powered 115 or 230 VAC |
| Type of Equipment | Fixed |

## 1.7 Measurement Uncertainty

| | |
|---|---|
| Radio Frequency | ±1 ppm |
| Total RF Power: Conducted | ±1 dB |
| RF Power Density: Conducted | ±2.75 dB |
| Spurious Emissions: Conducted | ±3 dB |
| Temperature | ±1ºC |
| Humidity | ±5 % |
| DC and Low Frequency Voltages | ±3 % |

## 1.8 Equipment List

| Description | Manufacturer | Model | Serial Number | Cal Interval | Cal Due Date |
|---|---|---|---|---|---|
| Spectrum Analyzer | Agilent | MXA-N9020A | MY52090907 | 2 years | 10-Oct-2014 |
| Spectrum Analyzer | Agilent | EXA-N9010A | MY50210629 | 2 years | 13-Jun-2015 |
| Power Meter | Agilent | U2000A | MY50000426 | 1 year | 19-Sep-2014 |
| Power Meter | Agilent | U2000A | MY48000438 | 1 year | 06-Mar-2015 |
| Signal Generator | Agilent | MXG-N5182B | MY53050168 | 3 years | 25-Jul-2017 |
| Signal Generator | Agilent | EXG-N5182A | MY50140256 | 3 years | 15-Jul-2017 |

## 1.9 Test Procedure

**General**

The *t*43 remote, is connected to the *t*Host in a manner consistent with a typical installation. A digital modulation signal generator is connected to the TX_IN port of the appropriate band of

the *t*Host and spectrum analyzer is connected to the appropriate downlink antenna output through an attenuator, nominally 40 dB for the band under consideration.

The passing band of the equipment under test (EUT) is covering 700 (758 – 775 MHz) MHz and 800 MHz (851 – 869 MHz) public safety (PS) bands.
Inside the 700 MHz passing band, the APCO FirstNet PS BB (758 – 768 MHz) as well as the private land mobile service (PS NB) is supported. The 800 MHz passing band covers NPSPAC for 851 – 854 MHz, interleaved PS-B/ILT-SMR for 854 – 862 MHz and the ESMR band for 862 – 869 MHz.

LTE signal was tested in 758 – 768 MHz. On the upper 5 MHz in the PS BB spectrum, the device is intended to operate on qualified PS NB licenses. So P25 was also tested in this spectrum and the PS NB spectrum (769 – 775 MHz).

The EUT is only intended to operate on qualified PS licenses on 800 Band. P25 signal was the modulation tested on PS bands (851- 854 MHz and 854 – 862 MHz), also on the ESMR spectrum (862 – 869 MHz).

**RF Power Output**
RF power is measured by connecting a spectrum analyzer and coupling to a 50-ohm, resistive power meter to the RF output connector. With a nominal voltage and the amplifier properly adjusted the RF output is measured**.**

**Occupied Bandwidth**
Occupied Bandwidth is measured by connecting a Spectrum Analyzer to the RF output connector.
The required measurement resolution bandwidth (RBW) is 1% of the emission bandwidth. 99% energy rule was applied to measure the occupied channel bandwidth. The emission bandwidth is measured as the width of the signal between two frequency points on the channel edge, outside of which the transmission power is attenuated at least 26dB below the transmitter output power.

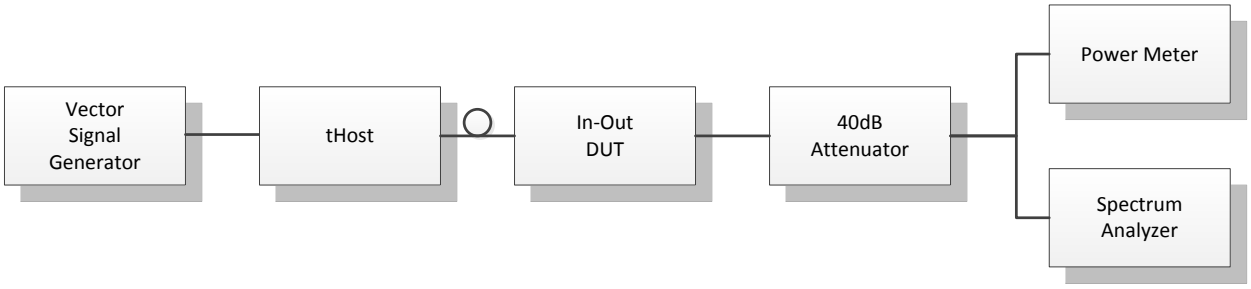
**Spectrum Emission Mask**
Spectrum Emission Mask is measured by connecting a Spectrum Analyzer to the RF output connector.
The input power was adjusted to produce maximum output power on the antenna port. The reference level was measured with integrated BW 2 times of the channel BW. The emission was measured with RBW 100 Hz for ESMR modulations and 100 kHz for LTE modulation.

**Spurious Emissions at Antenna Terminals**
The procedure used was ANSI/TIA-603-C: 2004. The spectrum was scanned from 9 kHz to at least the tenth harmonic of the fundamental using a spectrum analyzer. Data on the following page shows the level of conducted spurious responses. For digital modulation, the carrier is modulated to its maximum extent. The measurements were made in accordance with standard ANSI/TIA-603-C: 2004. The maximum output power was set for each test.

**Frequency Stability**
All test conditions and measurement procedures were performed in accordance with FCC CFR47 part 2 subpart J Clause 2.1055.

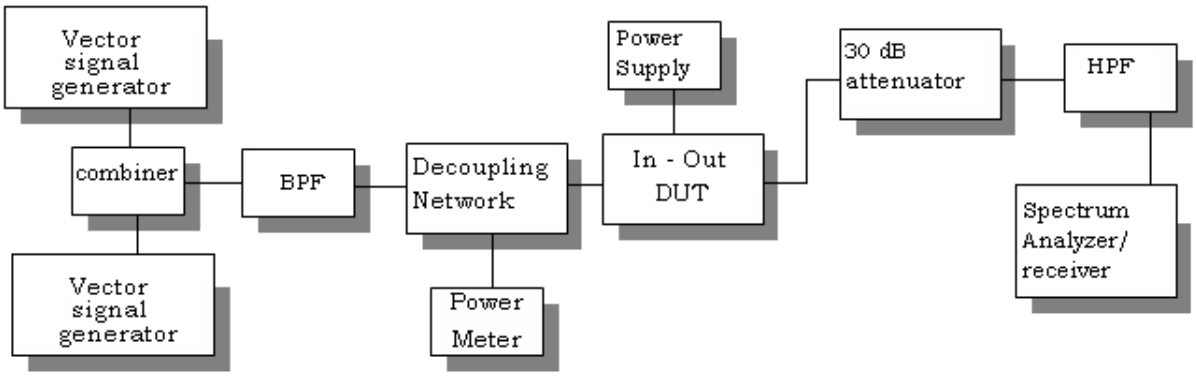
**RF Passband Gain and Bandwidth**
The procedure used was RSS-131 Issue 2. RF frequency response is measured by connecting a 50-ohm, resistive power meter to the RF output connector. With a nominal voltage and the internal gain control properly adjusted the RF output is measured by sweeping the input frequency**.**

**Test Setup for Output Power, Occupied Bandwidth, Spectrum Emission Mask, Conducted Spurious Emission, Frequency Stability, and Passband Gain and Bandwith**




**Intermodulation Product Spurious Emissions**
The procedure used was ANSI/TIA-603-C: 2004. The spectrum was scanned from 9 kHz to at least the tenth harmonic of the fundamental using a spectrum analyzer. Two tones (CW) method was used. The input power to the amplifier was set at maximum drive level by combining the two tones. The two tones were chosen in such a way (1) the third order intermodulation product frequencies are located within the pass band of the DUT and (2) they produce the worst-case emissions out of band.
All signals were modulated.

**Test Setup for Intermodulation**



## *1.10* Operational Description

Dali's all-digital, high power, dual-band radio remote, ***t*43ps,** (43 dBm, 20 W) is designed for distributed antenna system applications. It bi-directionally transfers two public safety bands over a single optical fiber (SFP –Single Mode Fiber) to/from the RF Router, *t*Host® at 6 Gb/s up to 40 km. It can be easily combined with a second unit to create a compact, integrated quad-band transceiver. It also accommodates 1 Gb/s Ethernet backhaul as well. This smart radio remote enables multiple network topologies that cater to different deployments scenarios including star, chain, hybrid and loop topologies.

## *1.11* RF Signal Configuration

**Table 1-1 700 MHz DL Measurement Matrix**

| Modulation | # Carriers | Notation | Frequency (MHz) |
|---|---|---|---|
| LTE 5MHz BW QPSK | 1 | LTE5M | 760.5, 765.5 |
| LTE 1.4MHz BW QPSK | 2 | LTE1.4M | 760.5, 765.5 |
| P25 Phase I 12.5kHz C4FM | 1 | P25 I-F | 769.0125, 772, 774.9875 |
| P25 Phase II 12.5kHz H-DQPSK | 1 | P25 II | 769.0125, 772, 774.9875 |
| P25 Phase I 6.5kHz CQPSK | 1 | P25 I-P | 763.00625, 760.50625, 767.99375<br>769.00625, 772.50625, 774.99375 |

**Table 1-2 800 MHz DL Measurement Matrix**

| Modulation | # Carriers | Notation | Frequency (MHz) |
|---|---|---|---|
| P25 Phase I 6.5kHz CQPSK | 1 | P25 I-P | 851.0125, 861.9875<br>862.0125, 868.9875 |
| P25 Phase I 12.5kHz C4FM | 1 | P25 I-F | 851.0125, 861.9875<br>862.0125, 868.9875 |
| P25 Phase II 12.5kHz H-DQPSK | 1 | P25 II | 851.0125, 861.9875<br>862.0125, 868.9875 |

For measurement of output power and occupied bandwidth, a representative LTE signal with 5 MHz of bandwidth was tested in the 700 MHz PS BB (758 MHz – 769 MHz).

In order to measure the unwanted spurious emission, two E-TM1.1 channels according to the TS36.141 of 1.4 MHz bandwidth generated on separate center frequencies since the passing

band  of the 700 MHz PS BB is wider than 2.8 MHz. Single carrier of P25 signal with different modulation types was injected in the 700 MHz PS NB.

Single carrier P25 of different modulations was tested in the band of NPSPAC 851 – 854 MHz and PB-ILT/SMR 854 – 862 MHz. Due to the fact of coexistence of multiple technologies designated on the ESMR band 862 – 869 MHz before the reconfiguration completed, P25 signal was also tested on this band.

## 2.0 Output Power – Pursuant 47 CFR Part 2.1046(a) and 90.219 (d) (3)

### *2.1* Methodology

A brief summary of applicable FCC specifications is listed in the table below.

**2.1046 Measurements required: RF power output.**
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the
RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

**90.219 (d) Deployment rules.**
Deployment of signal boosters must be carried out in accordance with the rules in this paragraph.
(3) Signal boosters must be deployed such that the radiated power of the each retransmitted channel, on the forward link and on the reverse link, does not exceed 5 Watts effective radiated power (ERP).

Measurements were performed at

LTE5M within the 700 D block (758 MHz – 763 MHz),
LTE5M and P25 I-P within the Band14 PSBB band (763MHz – 768 MHz),
P25 I-P, P25 I-F and P25 II within the PS NB (769 MHz – 775 MHz)

P25 I-P, I-F and P25 II within the 800 band (851 MHz – 869 MHz).

The output power plots are shown in section 2.2 for the all bands.

### *2.2* Test Results

The following two tables show radiated power in ERP taking into account a minimum distribution loss (cable loss) of 6.7 dB for 700 MHz band and 800 MHz band.

**700 D Block and B14 PSBB**

| ***Signal*** | ***758MHz – 763MHz (ERP)*** | ***763MHz – 768MHz (ERP)*** |
|---|---|---|
| LTE5M | 36.37 dBm | 36.44 dBm |
| P25 I-P | - | 36.7 dBm |

| ***Signal*** | ***769 MHz – 775 MHz (ERP)*** | | |
|---|---|---|---|
| | ***Low*** | ***Mid*** | ***High*** |
| P25 I-P | 36.42 dBm | 36.18 dBm | 35.51 dBm |
| P25 I-F | 36.99 dBm | 36.51 dBm | 36.29 dBm |
| P25 II | 36.95 dBm | 36.5 dBm | 36.37 dBm |

**800 MHz band**

| *Signal* | *851 – 862 MHz (ERP)* | | *862 – 869 MHz (ERP)* | |
|---|---|---|---|---|
| | Low | High | Low | High |
| P25 I-P | 36.4 dBm | 36.51 dBm | 36.46 dBm | 36.49 dBm |
| P25 I-P | 36.5 dBm | 36.29 dBm | 36.3 dBm | 36.31 dBm |
| P25 II | 36.5 dBm | 36.4 dBm | 36.44 dBm | 36.52 dBm |

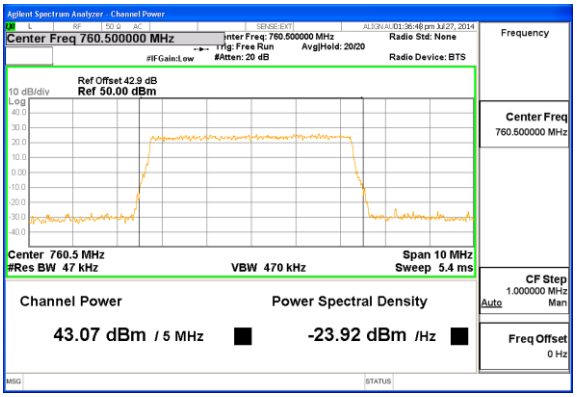
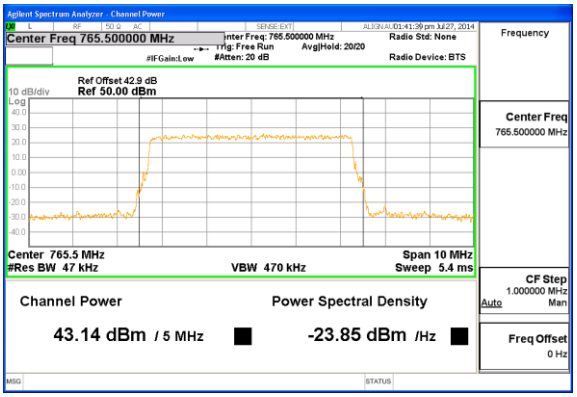
**Table 2-1 Output Power Measurement**

**Conclusion:** As the table above indicates, the maximum power output value of 36.99 dBm was obtained with C4FM modulation at 769 MHz within PS NB.

In order to comply with condition that the radiated power of any retransmitted channel should not exceed 5 W ERP (pursuant 90.219), the sum of the minimum cable loss and maximum antenna gain applied to the t43 remote unit should be more than 6.7 dB.

The conducted power measurement plots were shown as follows:

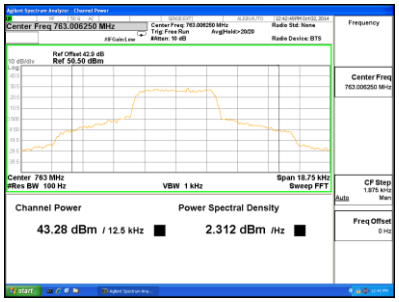
## LTE5M in 700 Band

| In D Block | Band14 PSBB |
|---|---|
|  |  |

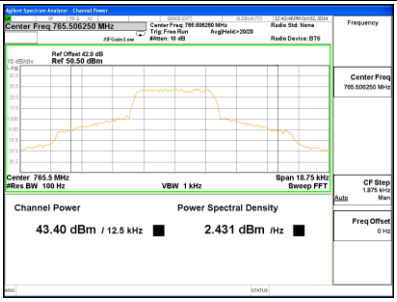




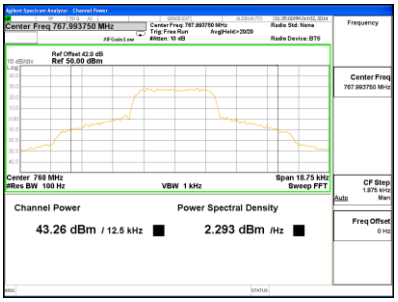
## P25 I-P in 763 – 768 MHz Band





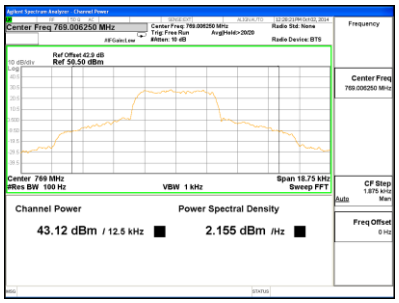




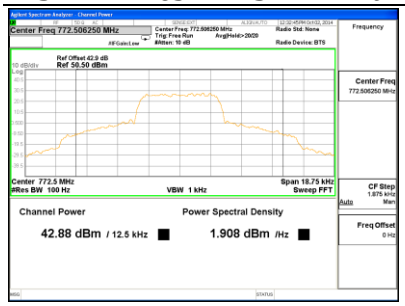




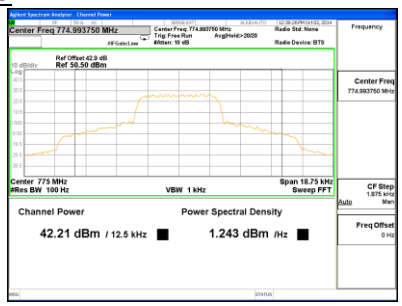
## P25 I-P in 769 – 775 MHz Band





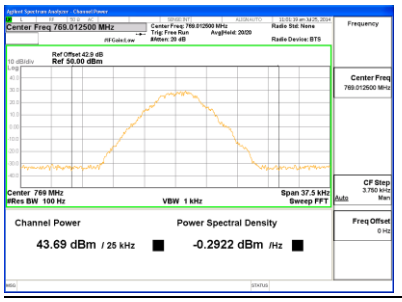




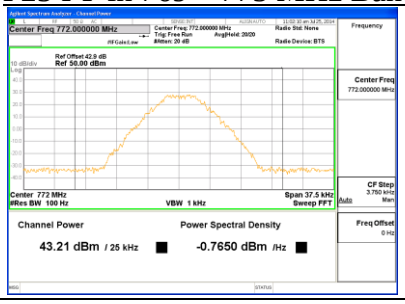




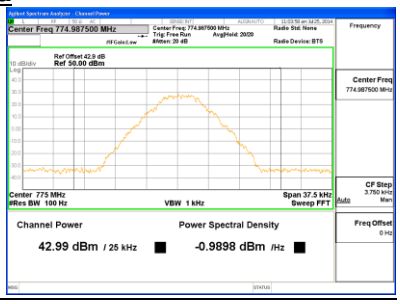
## P25 I-F in 769 – 775 MHz Band



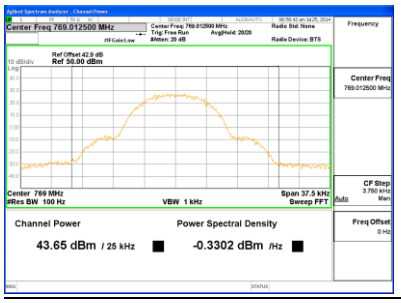


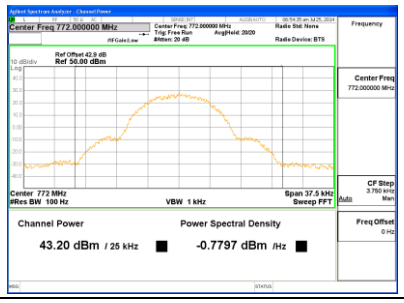


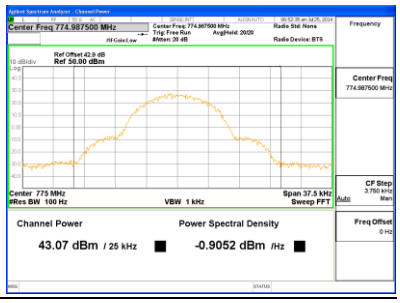




## P25 II in 769 – 775 MHz Band

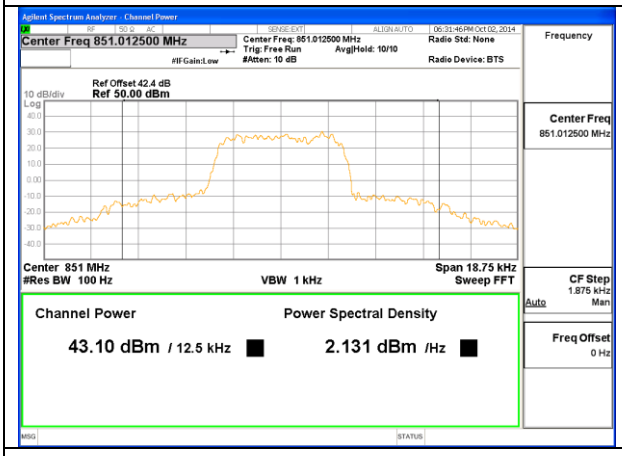


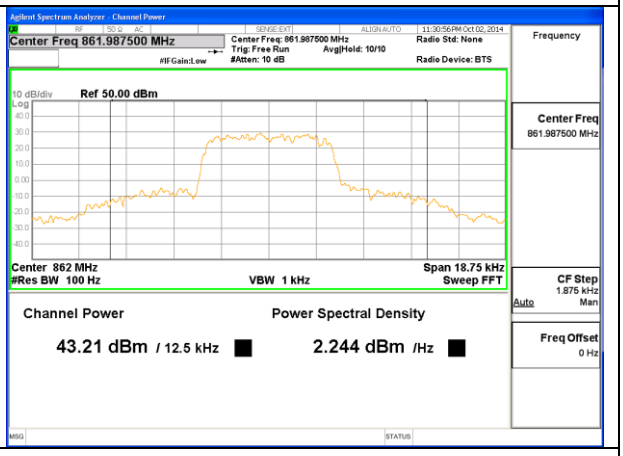



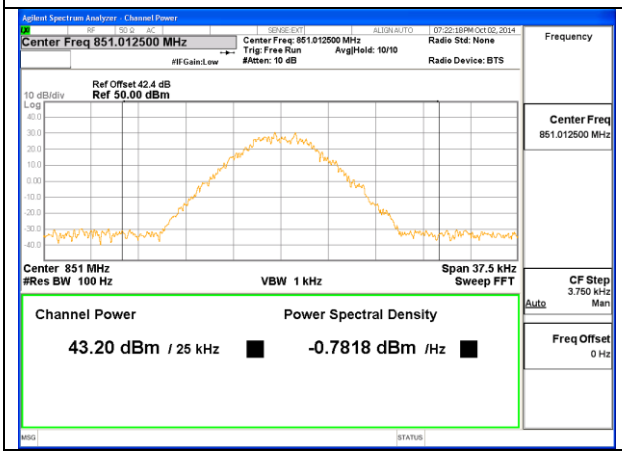

## 851 – 862 MHz Band

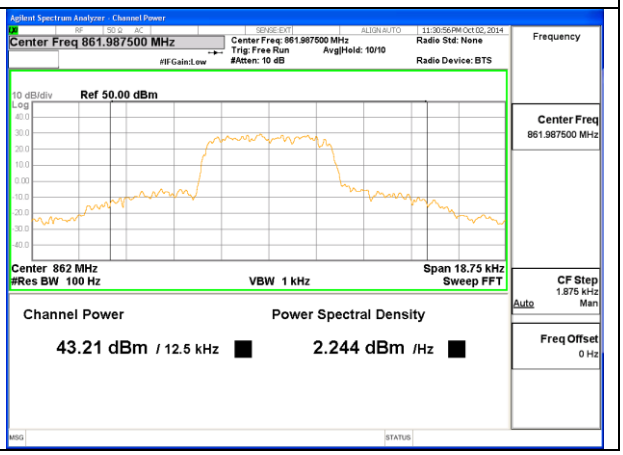
### P25 I-P



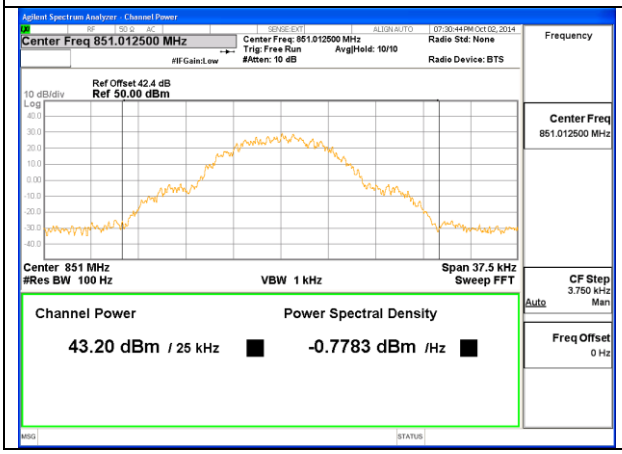



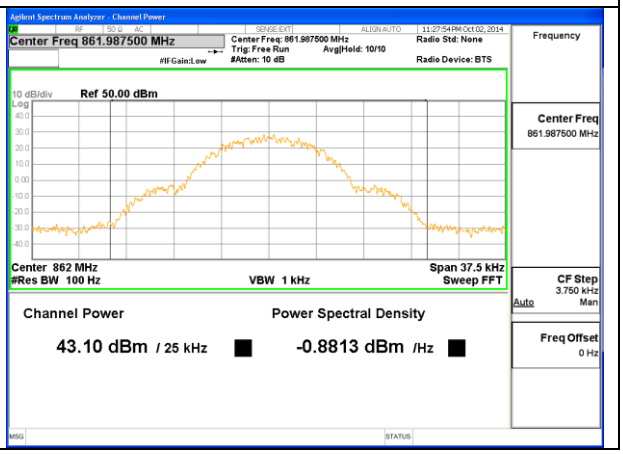

### P25 I-F



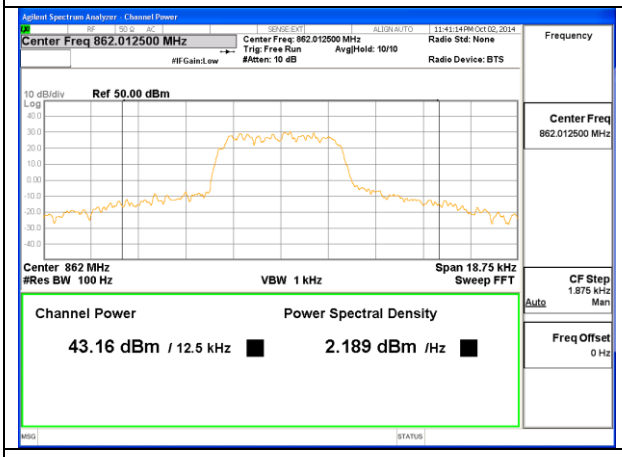
P25 II

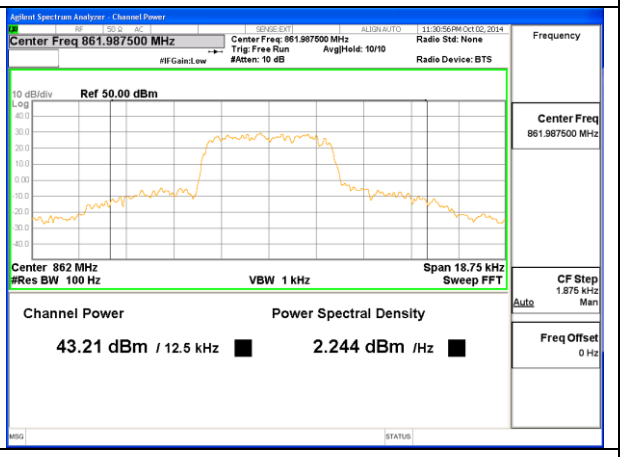


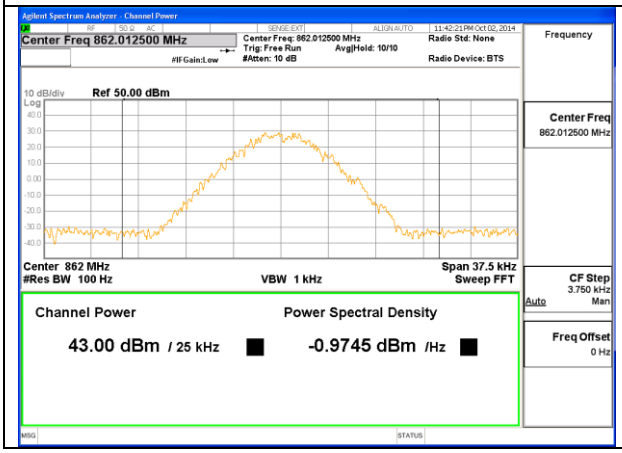

862 – 869 MHz

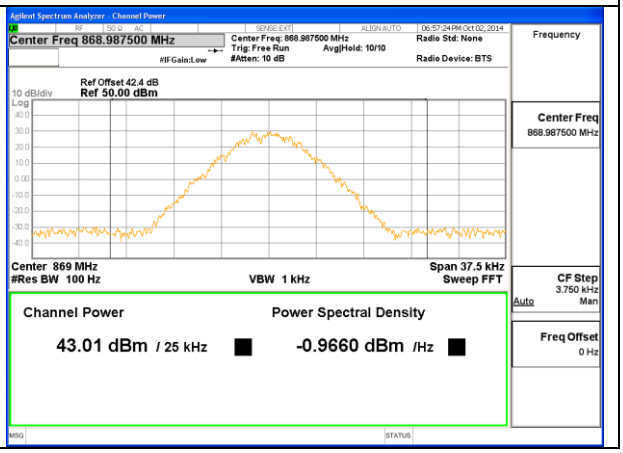
P25 I-P



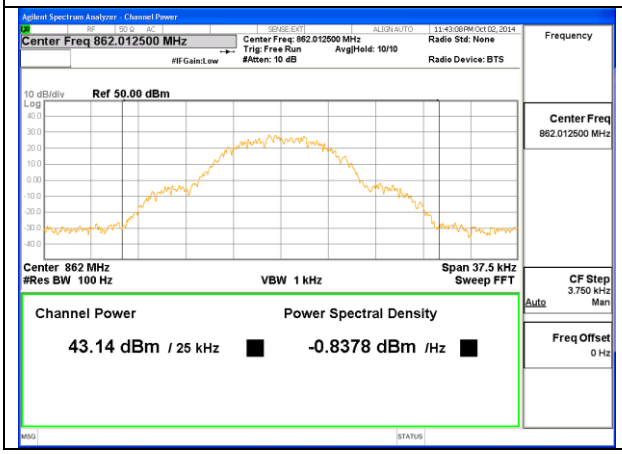



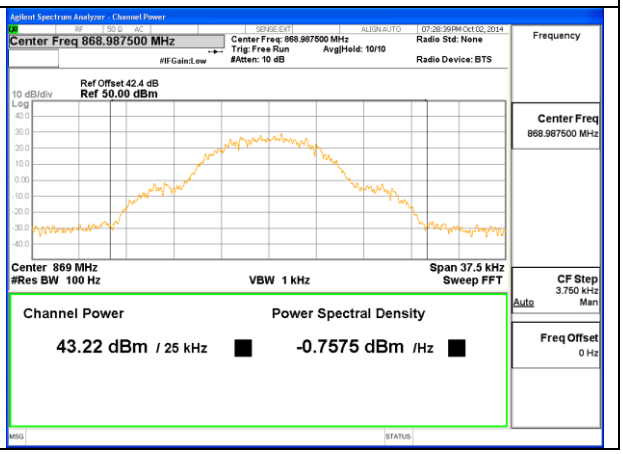

P25 I-F



P25 II


Agilent Spectrum Analyzer - Channel Power
Center Freq 862.012500 MHz
Center Freq: 862.012500 MHz
Trig: Free Run
Avg|Hold: 10/10
#Atten: 10 dB
Radio Std: None
Radio Device: BTS
Frequency
10 dB/div
Log
Ref 50.00 dBm
Center Freq
862.012500 MHz
Center 862 MHz
#Res BW 100 Hz
VBW 1 kHz
Span 37.5 kHz
Sweep FFT
CF Step
3.750 kHz
Auto
Man
Channel Power
Power Spectral Density
43.14 dBm / 25 kHz
-0.8378 dBm /Hz
Freq Offset
0 Hz
MSG
STATUS


Agilent Spectrum Analyzer - Channel Power
Center Freq 868.987500 MHz
Center Freq: 868.987500 MHz
Trig: Free Run
Avg|Hold: 10/10
#Atten: 10 dB
Radio Std: None
Radio Device: BTS
Frequency
10 dB/div
Log
Ref Offset 42.4 dB
Ref 50.00 dBm
Center Freq
868.987500 MHz
Center 869 MHz
#Res BW 100 Hz
VBW 1 kHz
Span 37.5 kHz
Sweep FFT
CF Step
3.750 kHz
Auto
Man
Channel Power
Power Spectral Density
43.22 dBm / 25 kHz
-0.7575 dBm /Hz
Freq Offset
0 Hz
MSG
STATUS

# 3.0 Occupied Bandwidth Pursuant 47 CFR Part 2 and Part 90I

## *3.1* Methodology

Measurements were performed at

LTE5M within the 700 D block (758 MHz – 763 MHz),
LTE5M and P25 I-P within the Band14 PSBB band (763MHz – 768 MHz),
P25 I-P, P25 I-F and P25 II within the PS NB (769 MHz – 775 MHz)

P25 I-P, I-F and P25 II within the 800 band (851 MHz – 869 MHz).

A brief summary of applicable FCC specifications is listed in the table below.

**2.1049 Measurements required: Occupied bandwidth.**
The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

**90.209 Bandwidth limitations:**
Occupied channel bandwidth should be less than the corresponding authorized bandwidth.

Full results for occupied bandwidth measurements are shown in Table **3-1**.

The worst case measurement plots are shown in section 3.2, comparing input and output signal side by side.

## *3.2* Test Results

### 700 MHz band

| Authorized BW | OBW (kHz) @ low frequency Out / In | OBW (kHz) @ center frequency Out / In | OBW (kHz) @ high frequency Out / In | Max. In and Out difference |
|---|---|---|---|---|
| LTE5M 5MHz | 4,482.2 / 4,481.1 | 4,482.4 / 4, 480.7 | - | 0.04 % |
| P25 I-P 6.25kHz (763 – 768 MHz) | 4.836 / 4.834 | 4.843 / 4.87 | 4.885 / 4.794 | 1.90 % |
| P25 I-P 6.25kHz (769 – 775 MHz) | 4. 833 / 4.868 | 4.884 / 4.888 | 4.878 / 4.860 | 0.72 % |
| P25 I-F 6.25kHz (769 – 775 MHz) | 8.086 / 8.119 | 8.147 / 8.229 | 8.069 / 8.178 | 1.33 % |
| P25 II 6.25kHz (769 – 775 MHz) | 9.938 / 9.857 | 9.978 / 9.849 | 9.922 / 9.849 | 1.31 % |

## 800 MHz band

| Authorized BW | OBW (kHz) @ low frequency Out / In | OBW (kHz) @ high frequency Out / In | Max. In and Out difference |
|---|---|---|---|
| P25 I-P 6.25kHz (851 – 862 MHz) | 4.858 / 4.799 | 4.911 / 4.86 | 1.23 % |
| P25 I-F 6.25kHz (851 – 862 MHz) | 8.158 / 8.062 | 8.004 / 7.917 | 1.19 % |
| P25 II 12.5kHz (851 – 862 MHz) | 10.014 / 9.813 | 10.126 / 9.769 | 3. 65 % |
| P25 I-P 6.25kHz (862 – 869 MHz) | 4.831 / 4.813 | 4.907 / 4.841 | 1.36 % |
| P25 I-F 12.5kHz (862 – 869 MHz) | 7.955 / 8.331 | 8.132 / 8.032 | 4.72 % |
| P25 II 12.5kHz (862 – 869 MHz) | 10.077 / 9.754 | 10.126 / 9.731 | 4.06 % |

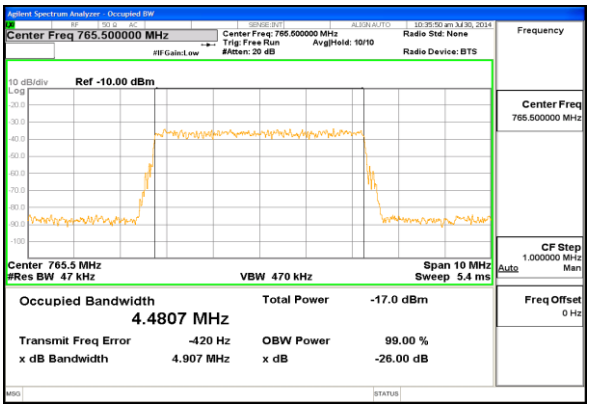
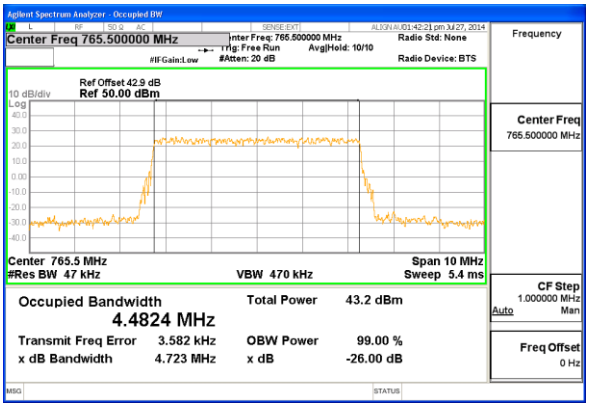
**Table 3-1. Occupied bandwidth measurements (Output signal)**

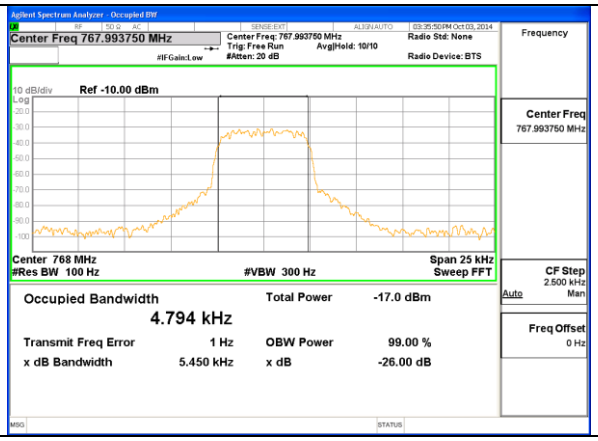
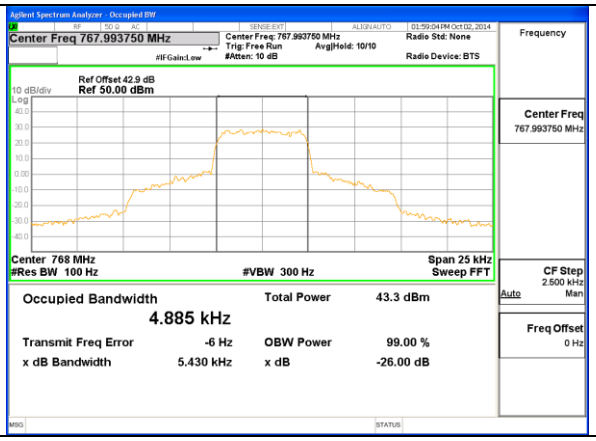
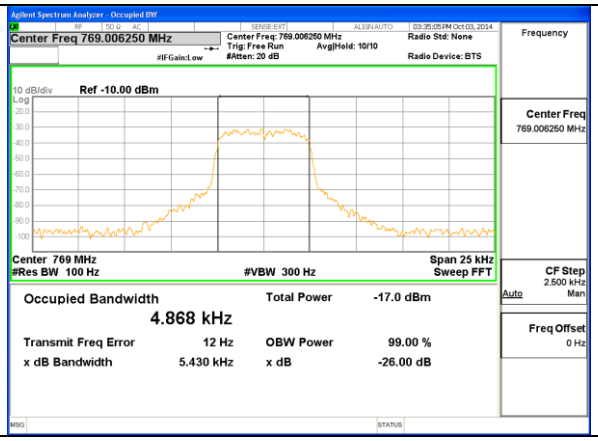
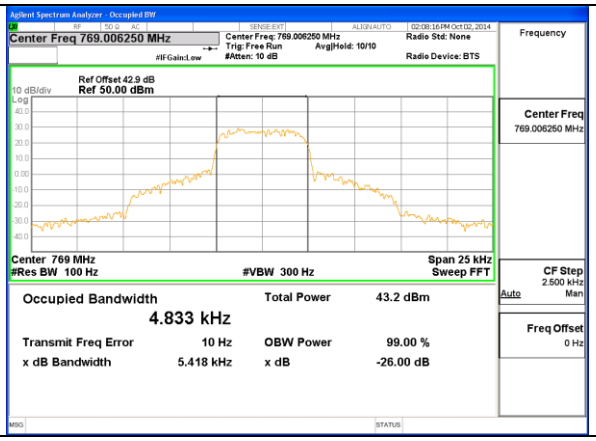
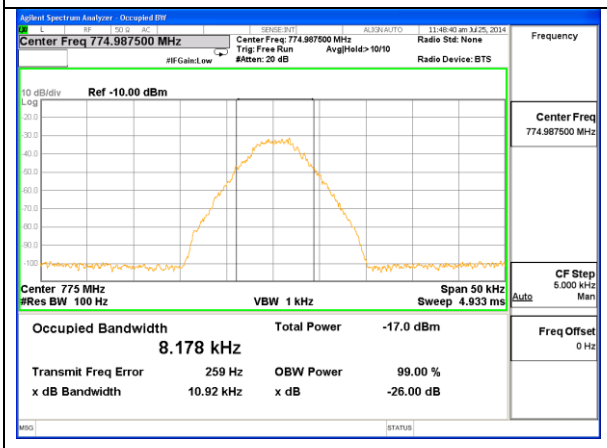
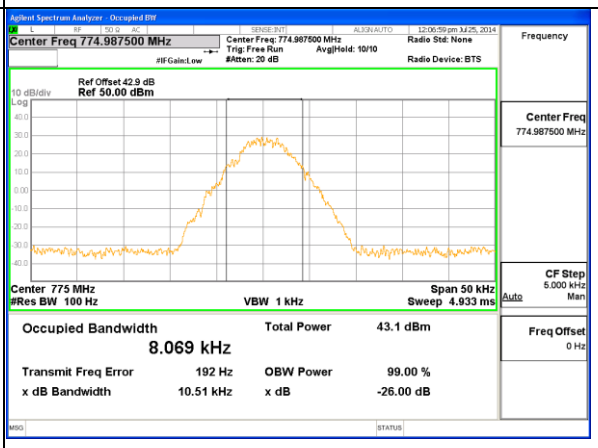
**Note:**

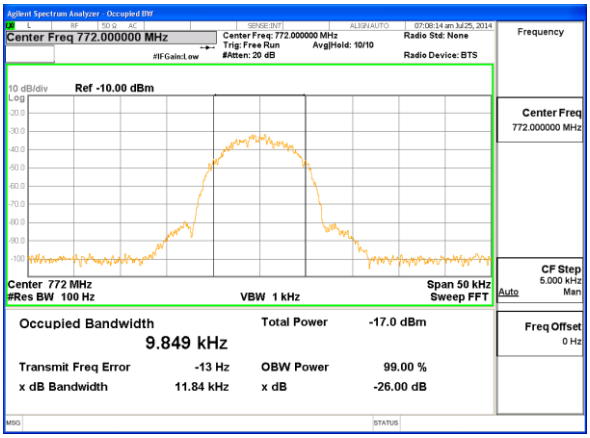
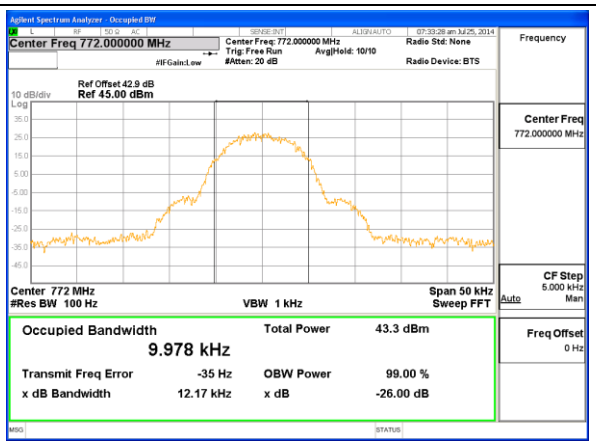
- The difference of the output signal and input signal bandwidth is less than 5%. The spectrum shapes of output are similar to the input.

- The measured bandwidth is less than the authorized bandwidth.

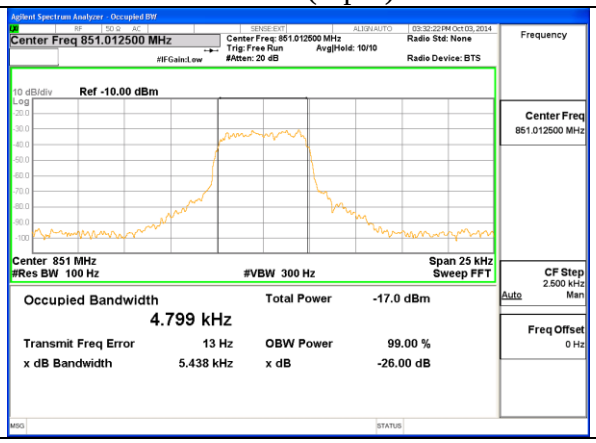
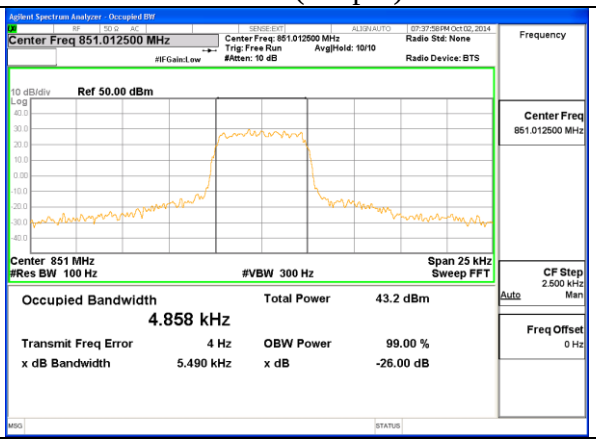
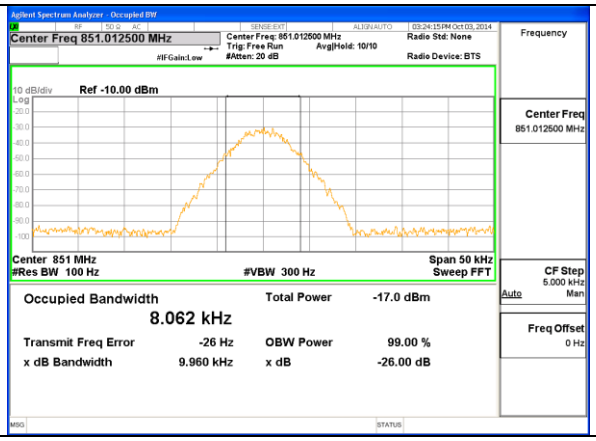
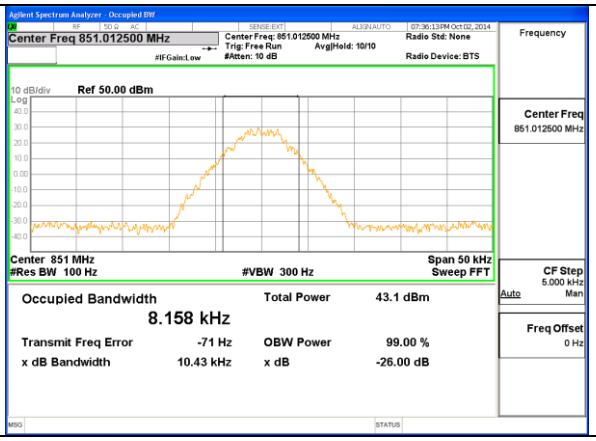
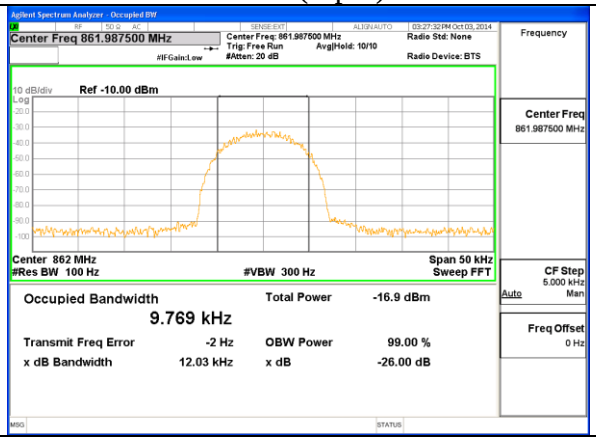
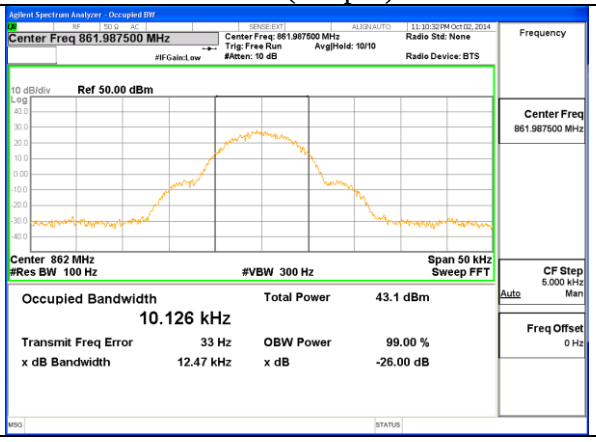
## 700 MHz Band

| LTE5M (Input) | LTE5M (Output) |
|---|---|
|  |  |

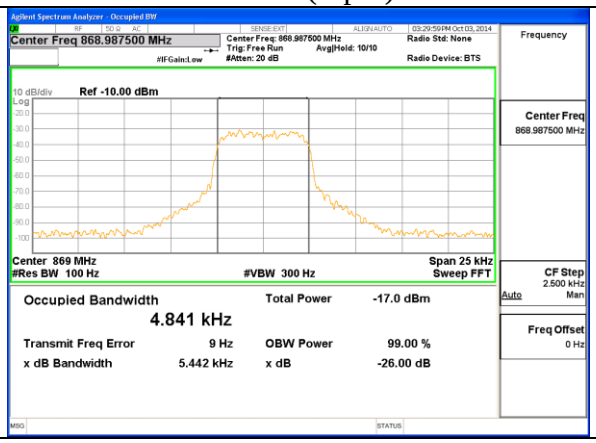
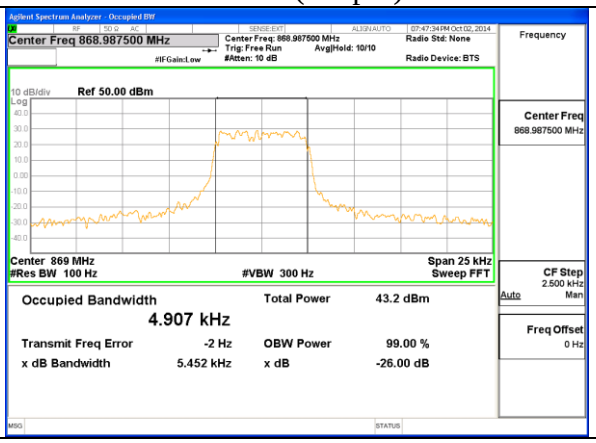
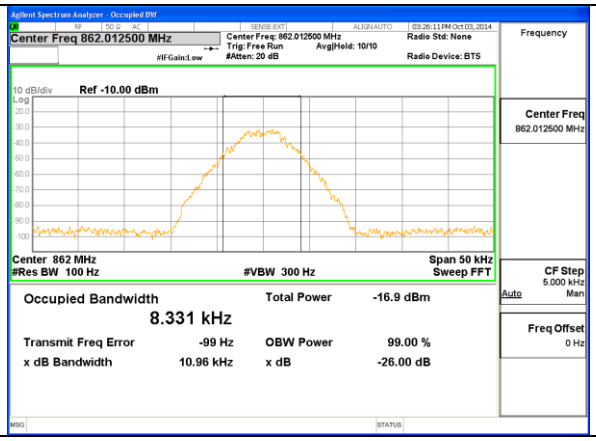
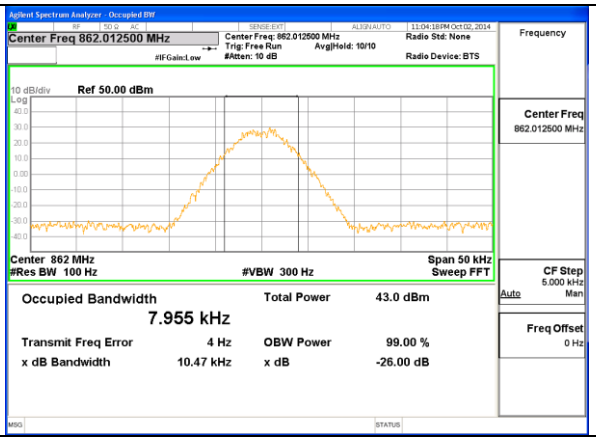
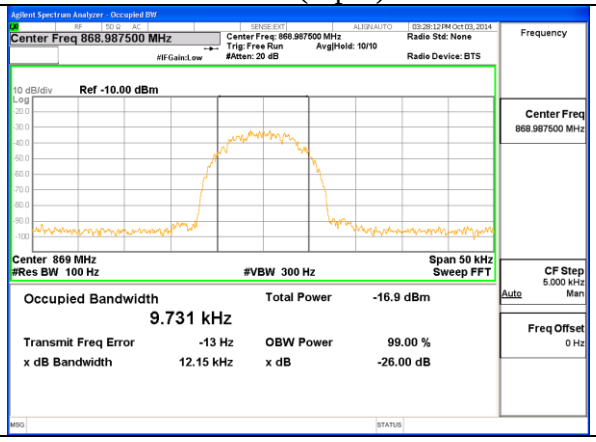
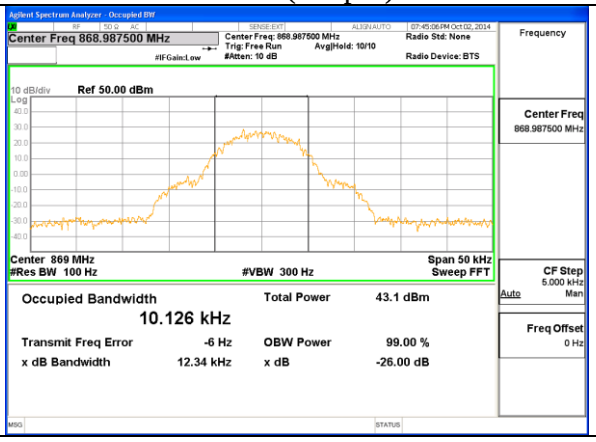
| P25 I-P (Input) | P25 I-P (Output) |
|---|---|
|  |  |
| P25 I-P (Input) | P25 I-P (Output) |
|  |  |
| P25 I-F (Input) | P25 I-F (Output) |
|  |  |

| P25 II (Input) | P25 II (Output) |
| --- | --- |
|  |  |

## 851 - 862 MHz Band

| P25 I-P (Input) | P25 I-P (Output) |
|---|---|
|  |  |
| **P25 I-F (Input)** | **P25 I-F (Output)** |
|  |  |
| **P25 II (Input)** | **P25 II (Output)** |
|  |  |

## 862 - 869 MHz Band

| P25 I-P (Input) | P25 I-P (Output) |
|---|---|
|  |  |
| **P25 I-F (Input)** | **P25 I-F (Output)** |
|  |  |
| **P25 II (Input)** | **P25 II (Output)** |
|  |  |

# 4.0 Unwanted Emissions - Conducted Spurious Pursuant 47 CFR 90.543 (c), 90.543 (e)(3), 90210 (g)(2) and 90.210 (h)(5)

## *4.1* Methodology

All test conditions and measurement procedures were performed in accordance with FCC CFR47 part 2 subpart J Clause 2.1051.
Measurements were performed at

LTE5M within the 700 D block (758 MHz – 763 MHz),
LTE5M and P25 I-P within the Band14 PSBB band (763MHz – 768 MHz),
P25 I-P, P25 I-F and P25 II within the PS NB (769 MHz – 775 MHz)

P25 I-P, I-F and P25 II within the 800 band (851 MHz – 869 MHz).

A brief summary of the applicable FCC specifications are listed in the table below.

**2.1051 Measurements required: Spurious emissions at antenna terminals**
The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in§ 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

**2.1057 Frequency spectrum to be investigated**
(a) In all of the measurements set forth in §§ 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

**90.543 (c) Out-of-band emission limit**.
For transmitters designed to operate in 769-775 MHz and 799-805 MHz frequency bands, on ay frequency outside of the frequency rages covered by the ACP tables in this section (>12 MHz), the power of any emission must be reduced below the mean output power (P) by at least 43 + 10 log10 (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

**90.543 (e)** For operations in the 758 – 768 MHz, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:
(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB

**90.210(g) (2)**
For 854MHz – 869 MHz operation band, on any frequency offset from the carrier by more than 2.5 × authorized bandwidth: at least 43 + 10 log (P) dB

**90.210(h) (5)**
For 851MHz – 854 MHz operation band, on any frequency offset from the carrier by more than 25kHz: at least 43 + 10 log (P) dB

The out-of-band emission limit is

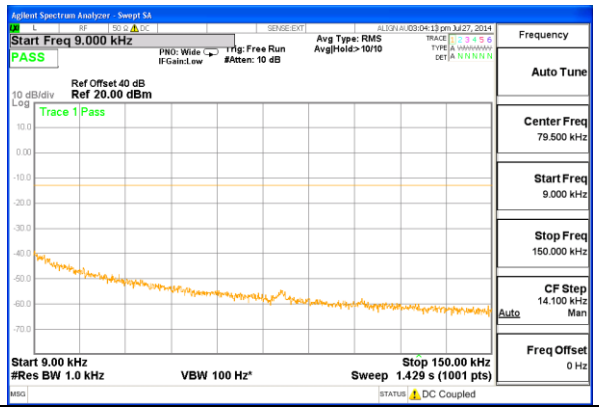
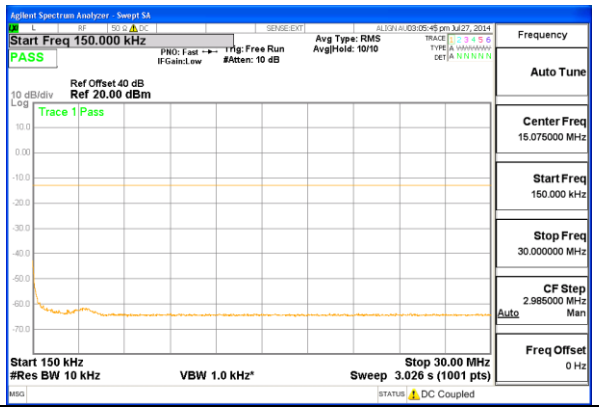
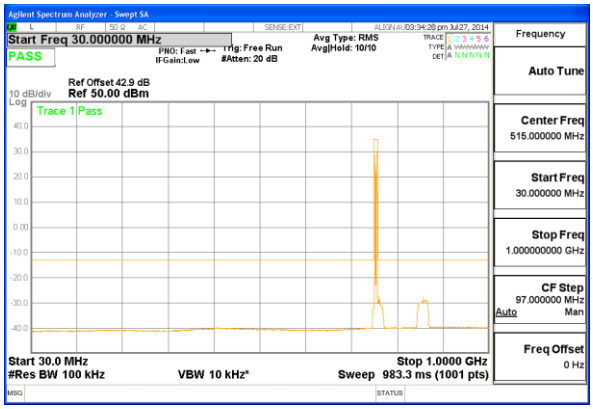
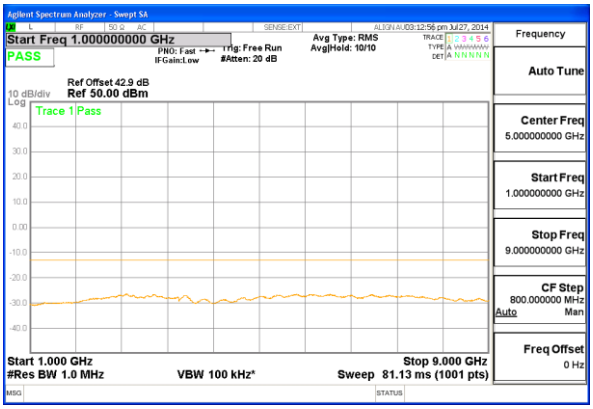
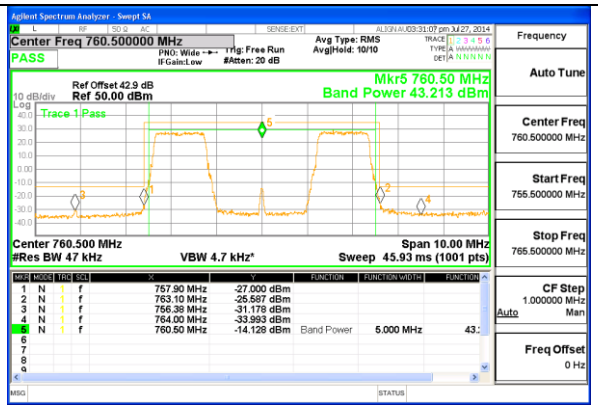
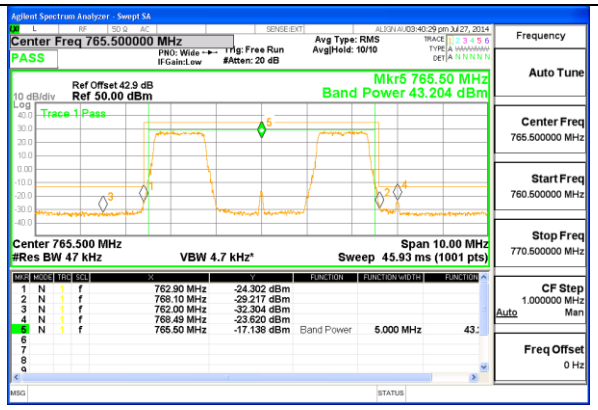
- -13 dBm for 700 MHz band and 800 MHz

## *4.2* Test Results

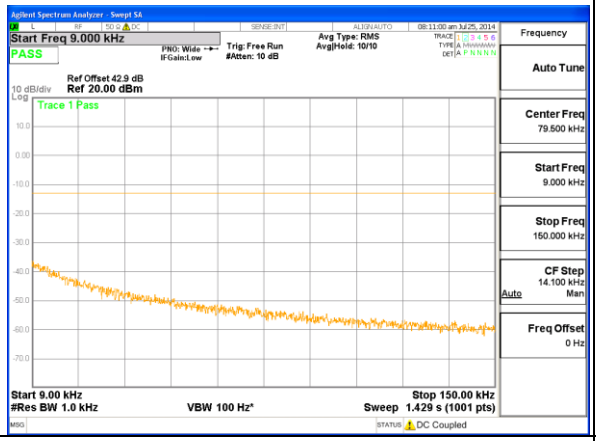
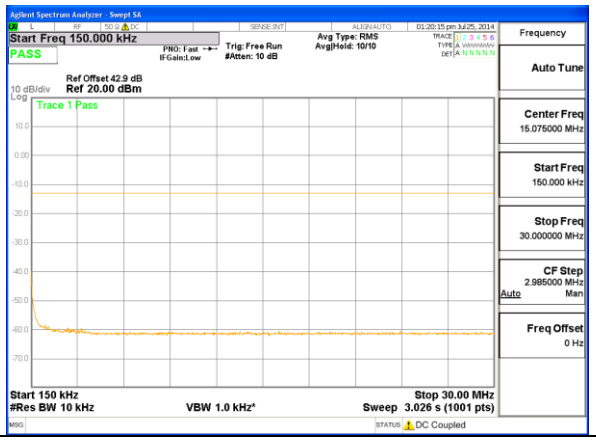
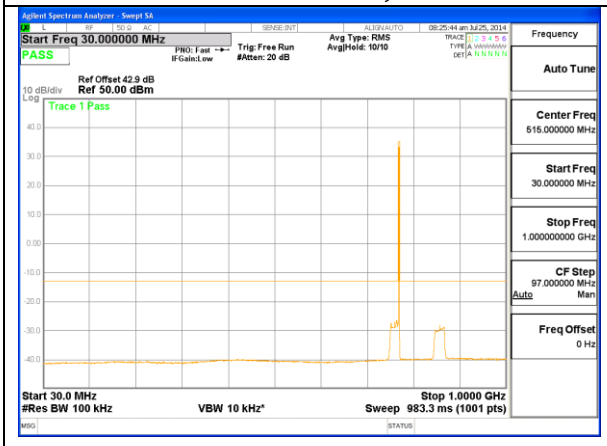
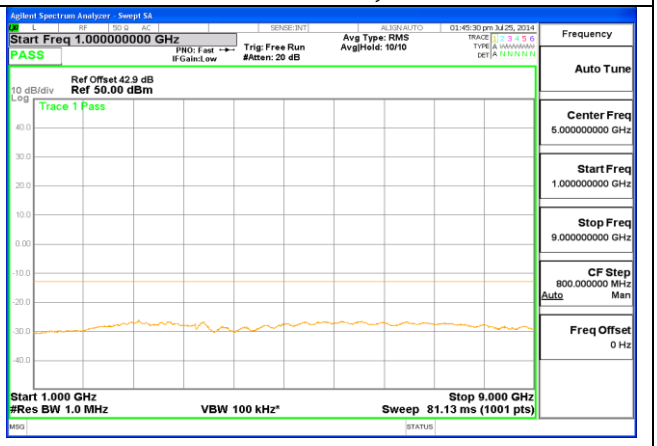
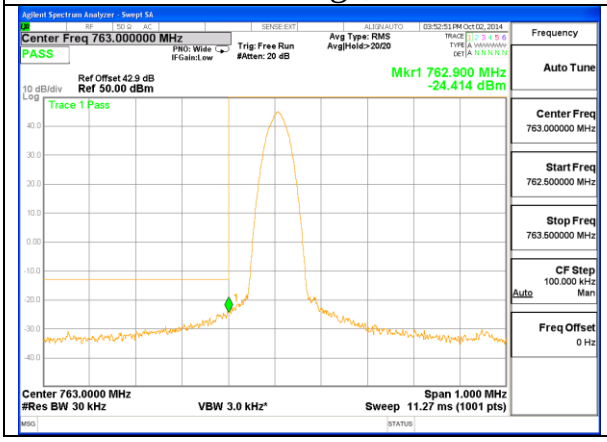
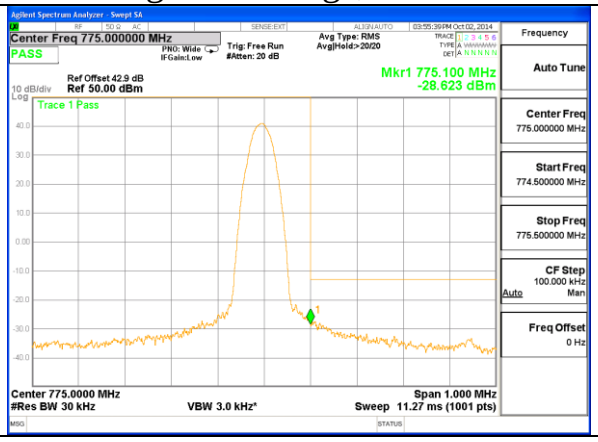
On the plots below shown the worst case when the carrier was set to the band edge with different modulations.
The horizontal straight line is marking the emission limit.
The emission level in the frequency range other than 30MHz – 1G is not affected by the modulation applied, i.e. only emissions close to the operating frequency block is affected by the modulation applied.

The emission level is below the limit. Hence the conducted emission is compliant with the FCC standard.

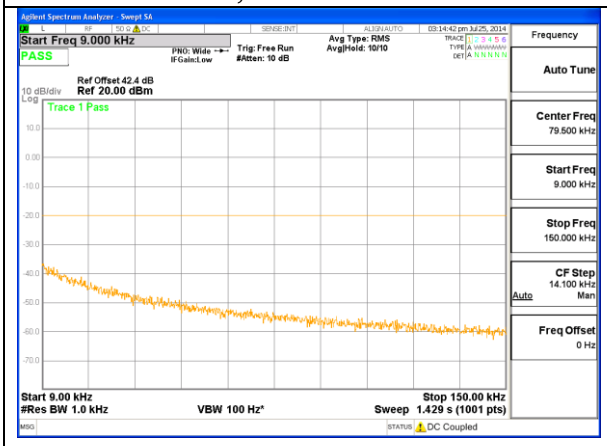
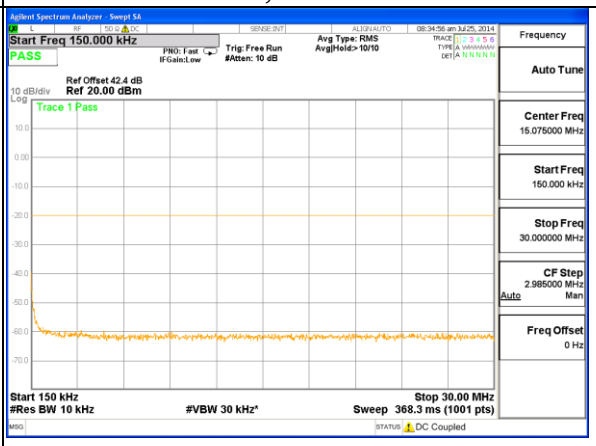
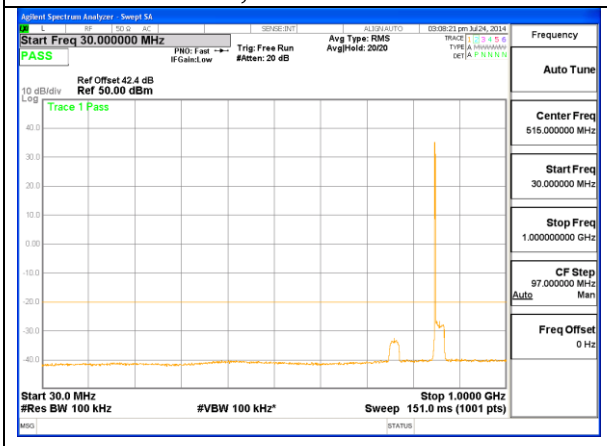
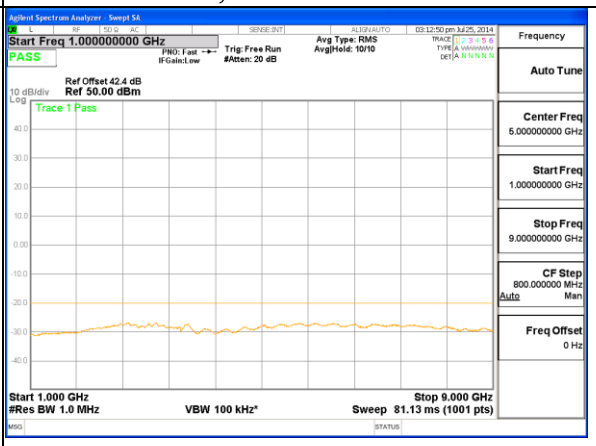
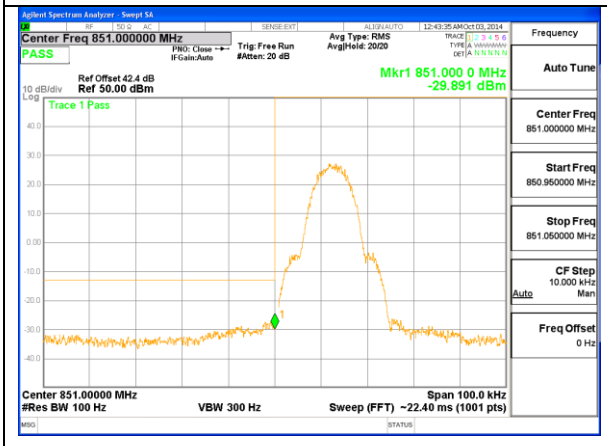
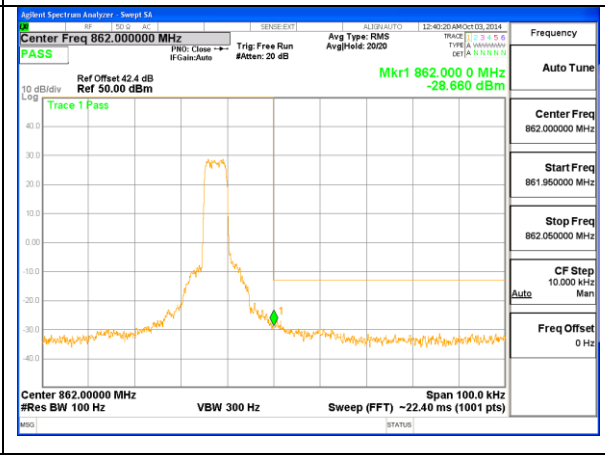
## 758 MHz – 768 MHz
## Part 90R Applied, LTE Signal Used

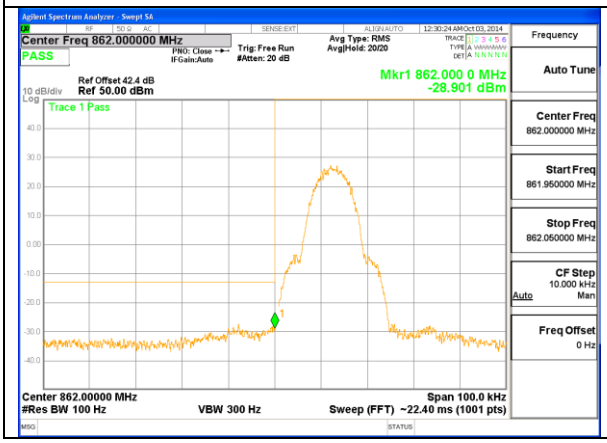
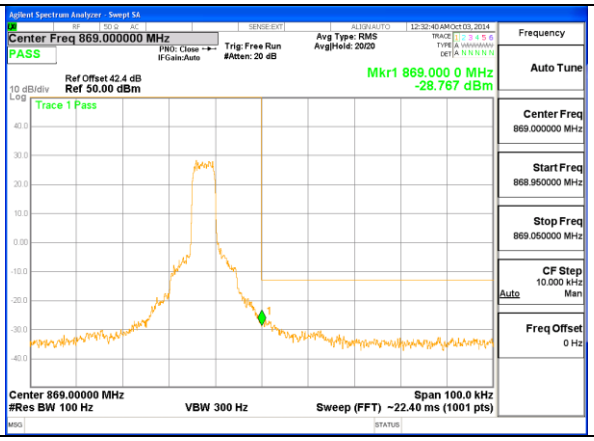
| 9 kHz – 150 kHz, LTE | 150 kHz – 30 MHz, LTE |
|---|---|
|  |  |
| **30 MHz – 1 GHz, LTE** | **1 GHz – 9 GHz, LTE** |
|  |  |
| **LTE, Band Edge (758 – 763 MHz)** | **LTE, Band Edge (763 – 768 MHz)** |
|  |  |

## 763 MHz – 775 MHz Band
## Part 90R Applied, P25 Phase I and P25 Phase II Signal Used

| 9 kHz – 150 kHz, P25 II | 150 kHz – 30 MHz, P25 I-F |
|---|---|
|  |  |
| **30 MHz – 1 GHz, P25 II** | **1 GHz – 9 GHz, P25 I-F** |
|  |  |
| **Low Band Edge, P25 I-P** | **High Band Edge, P25 I-P** |
|  |  |

# 851 MHz – 869 MHz
# Part 90S Applied, P25 Signal Used

| | |
|---|---|
| 9 kHz – 150 kHz, P25 I-P | 150 kHz – 30 MHz, P25 II |
|  |  |
| 30 MHz – 1 GHz, P25 II | 1 GHz – 9 GHz, P25 II |
|  |  |
| Zoom in, P25 II, Left edge of 851MHz | Zoom in, P25I-P, Right edge of 862MHz |
|  |  |

| Zoom in, P25 II, Left edge of 862MHz | Zoom in, P25 I-P, Right edge of 869MHz |
|---|---|
|  |  |

# 5.0 Spectrum Emission Mask Pursuant 47 CFR Part 90.210

## *5.1* Methodology

Measurements were performed at

LTE5M within the 700 D block (758 MHz – 763 MHz),
LTE5M and P25 I-P within the Band14 PSBB band (763MHz – 768 MHz),
P25 I-P, P25 I-F and P25 II within the PS NB (769 MHz – 775 MHz)

P25 I-P, I-F and P25 II within the 800 band (851 MHz – 869 MHz).

A brief summary of the applicable FCC specifications are listed in the table below.

**90.210 Emission Masks**
(h) 851MHz – 854 MHz operation band falls into the emission mask (h)
(1) fd ≤ 4 kHz: 0
(2) 4 kHz ≤ fd ≤ 8.5 kHz: at least 107 log (fd/4) dB
(3) 8.55 kHz ≤ fd ≤ 15 kHz: at least 40.5 log (fd/1.16) dB
(4) 15 kHz ≤ fd ≤ 25 kHz: at least 116 log (fd/6.1) dB
(5) fd ≥ 25 kHz: at least 43 + 10 log (P) dB

(g) 854 MHz – 869 MHz Emission Mask G. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but no more than 250 percent of the authorized bandwidth: At least 116 log (fd/6.1) dB, or 50 10 log (P) dB, or 70 dB, whichever is the lesser attenuation;
(2) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 10 log (P) dB.

**90.210 SEM for all other bands**
(c) Emission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (fd 2/11) dB or 50 dB, whichever is the lesser attenuation;
(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 10 log (P) dB.

**3GPP 36.143**
Table 9.1.5.1-2: General operating band unwanted emission limits for repeater pass bandwidth 5 MHz and above (E-UTRA bands < 1 GHz) for Category A:
(1) 0 MHz ≤ fd ≤ 5 MHz: -5.5dBm – 7/5(fd/MHz – 0.05) dB with RBW 100 kHz
(2) 5 MHz ≤ fd ≤ 10 MHz: -12.5 dBm with RBW 100kHz
(3) fd ≥ 10 MHz: -13 dBm with RBW 100 kH

90.210 (h) is more stringent than 90.210 (g).
90.210 (h) was used for P25 emission mask of 800 MHz band.

Dual-carrier TM1.1 LTE signal was used for LTE emission mask test. The combined bandwidth of the two carriers was 5 MHz.

The RBW was set to 100Hz for P25 SEM measurement as the general technical standard in Part 90.210 and 100 kHz for LTE SEM measurement.

## *5.2* Test Results

On the plots below shown the worst case when the carrier was set to the edges or center with different modulations.

Within 758 - 768 MHz band:
The emission level of LTE signal is below the limit by more than 3.5 dB.

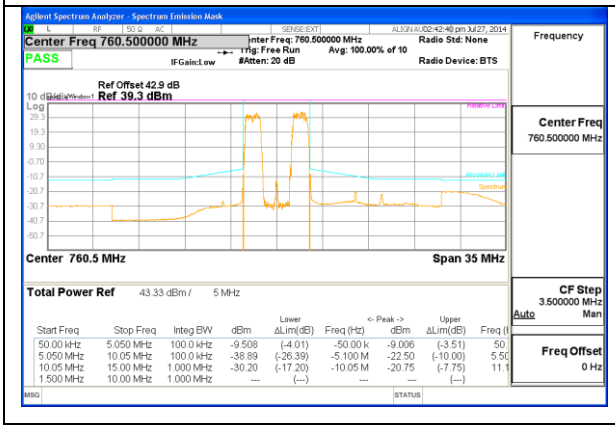
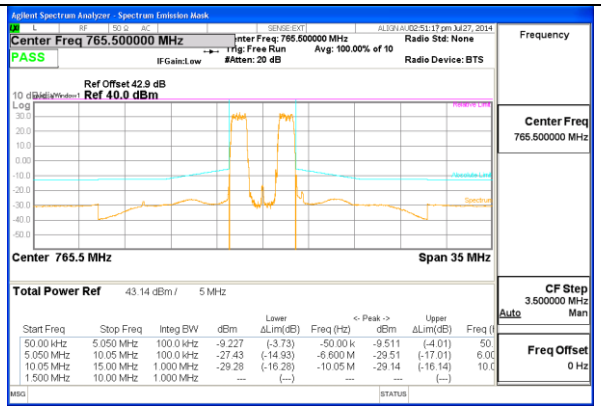
Within 763 – 775 MHz band:
The emission level of LTE signal is below the limit by more than 3.5 dB.
The emission level of P25 signal is below the limit by more than 11.8 dB.

Within 851 – 862 MHz band:
The emission level of P25 signal is below the limit by more than 4 dB.

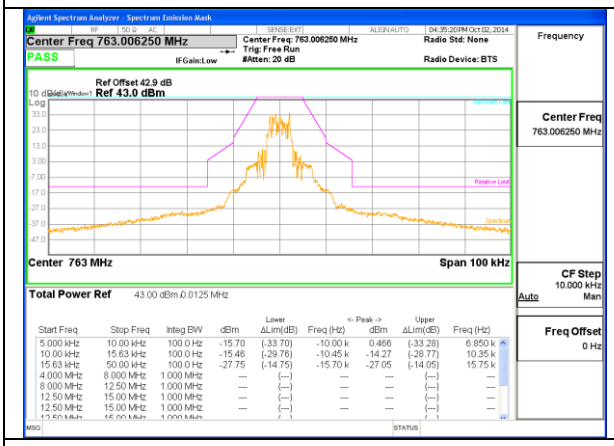
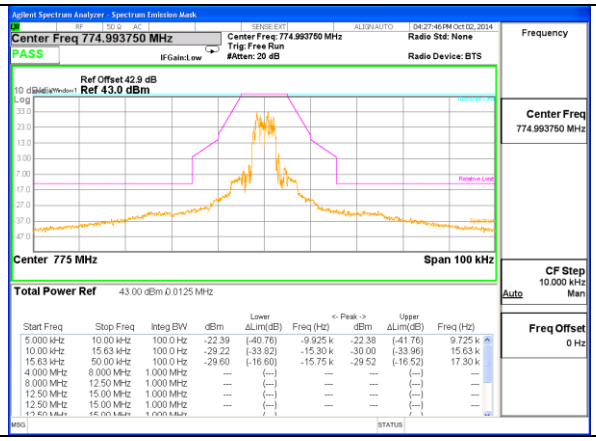
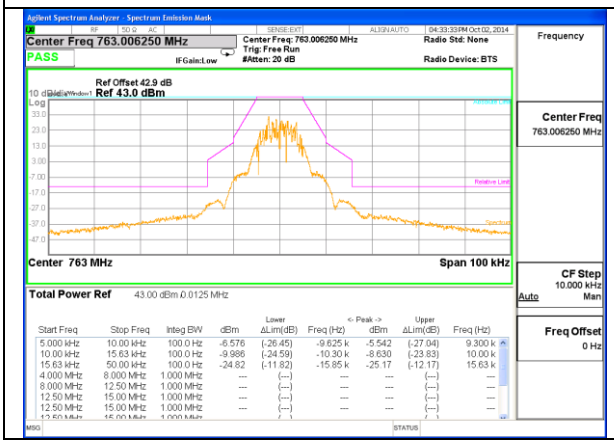
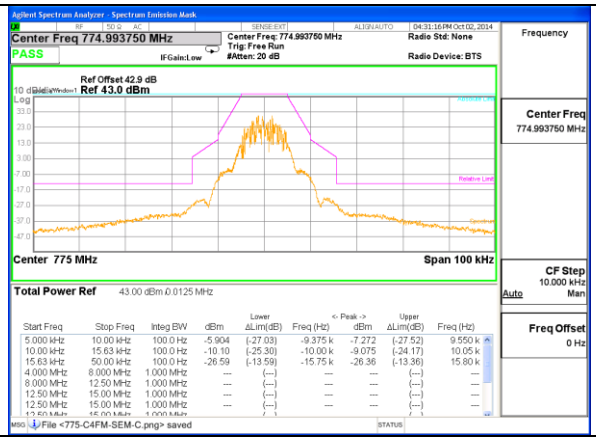
Within 862 – 869 MHz band:
The emission level of P25 signal is below the limit by more than 6 dB.

So the emission immediately adjacent to the signal channel is compliant with the FCC standard.

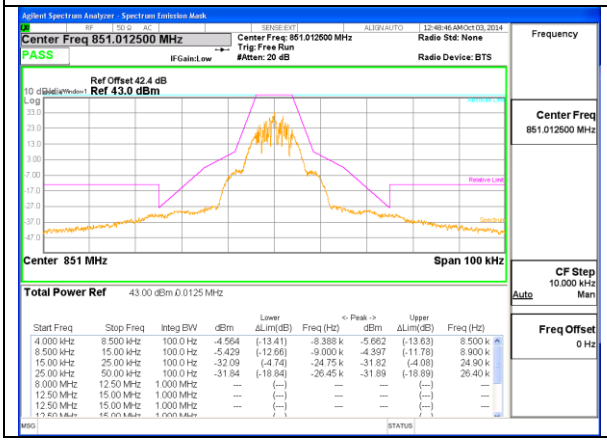
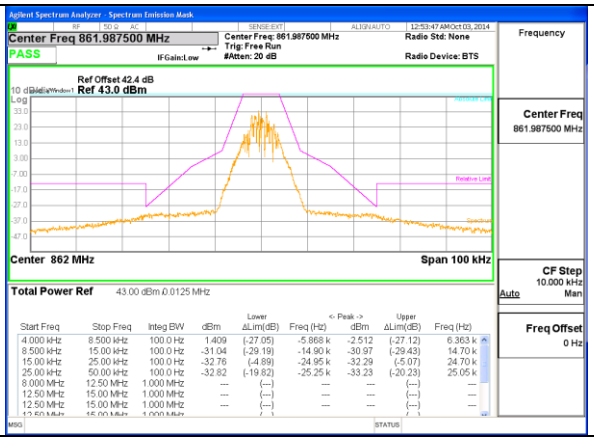
### 758 MHz – 768 MHz: 3GPP 36.143 Applied

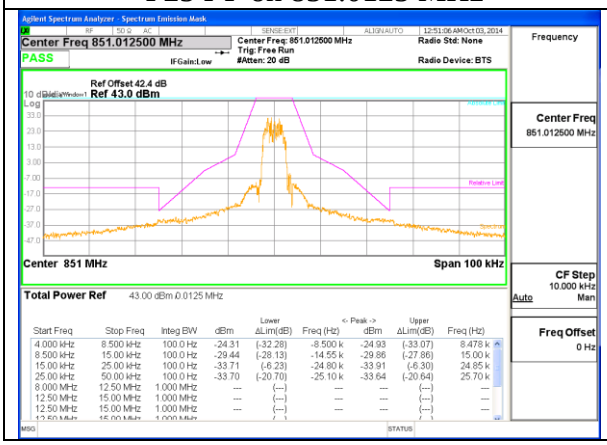
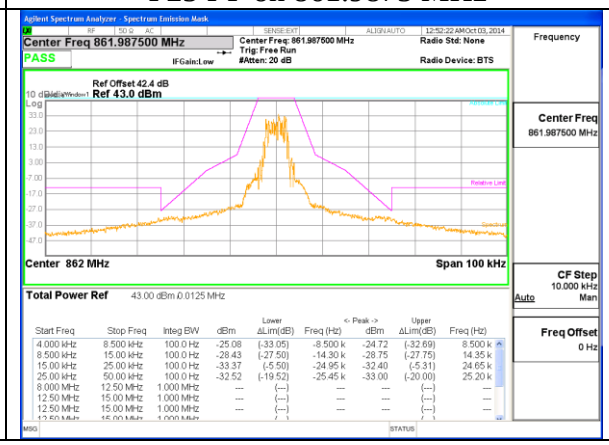
| LTE1.4M on 760.5 MHz | LTE 1.4Mon 765.5 MHz |
|---|---|
|  |  |

## 763 MHz – 775 MHz: 90.210(c) Applied

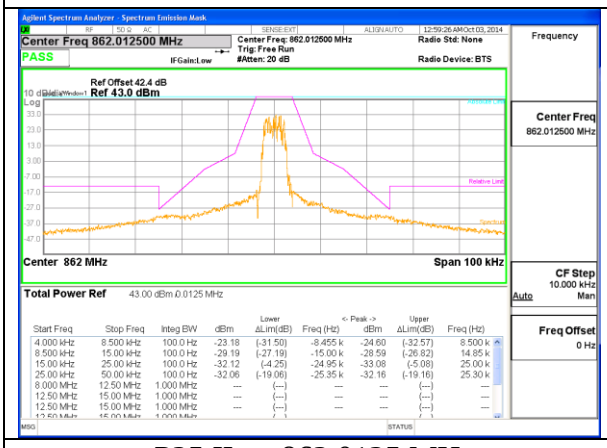
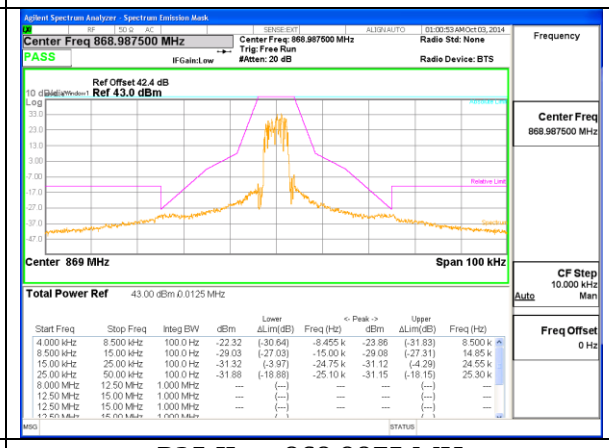
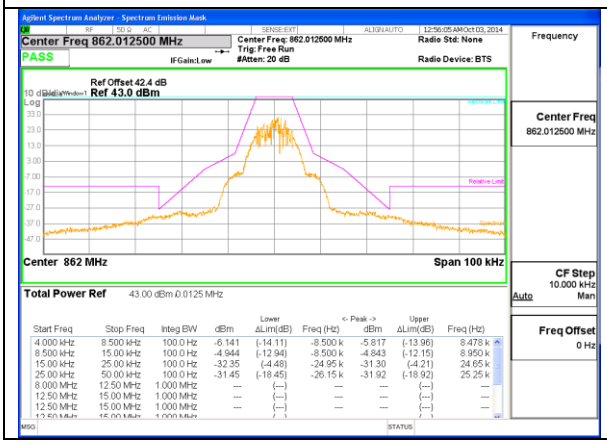
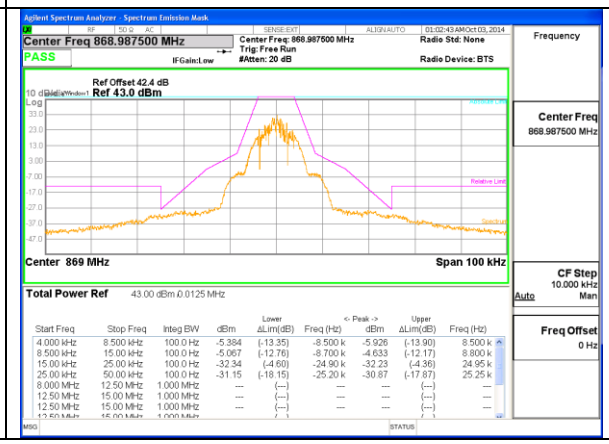
| P25 I-P on 763.00625 MHz | P25 I-P on 774.99375 MHz |
|---|---|
|  |  |
| **P25 II on 763.00625 MHz** | **P25 II on 774.99375 MHz** |
|  |  |

## 851 – 862 MHz band 90.210(h) Applied

| P25 II on 851.0125 MHz | P25 I-F on 861.9875 MHz |
|---|---|
|  |  |

| P25 I-P on 851.0125 MHz | P25 I-P on 861.9875 MHz |
|---|---|
|  |  |

## 862 - 869 MHz band 90.210(h) Applied

| P25 I-P on 862.0125 MHz | P25 I-P on 868.9875 MHz |
|---|---|
|  |  |
| **P25 II on 862.0125 MHz** | **P25 II on 868.9875 MHz** |
|  |  |

# 6.0 Frequency Stability Pursuant 47 CFR Part 27C and Part 90I

## *6.1* Methodology

Measurements were performed at CW.

Data is shown in the table in section 6.2.

A brief summary of the applicable FCC specifications are listed in the table below.

**2.1055 Frequency stability.**
(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following. The frequency stability shall be measured with variation of ambient ambient temperature as follows from -30° to +50° centigrade for all equipment… Vary primary supply voltage from85 to 115 percent of the nominal value

**90.213 Minimum Frequency Stability**
For Fixed and base stations:
Frequency range in 851 – 854 MHz: 1 ppm
Frequency range in 854 – 869 MHz: 1.5 ppm

All test conditions and measurement procedures were performed in accordance with FCC CFR47 part 2 subpart J Clause 2.1055.

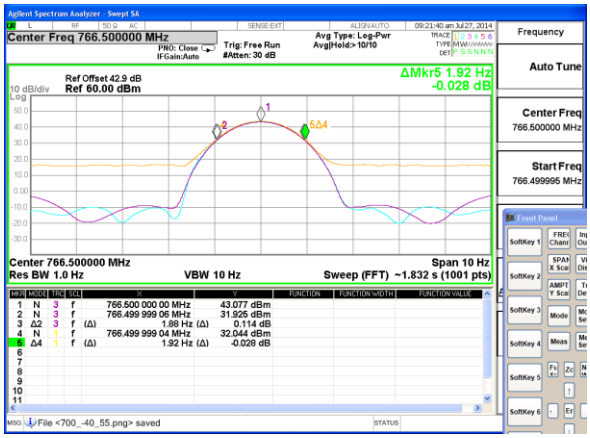
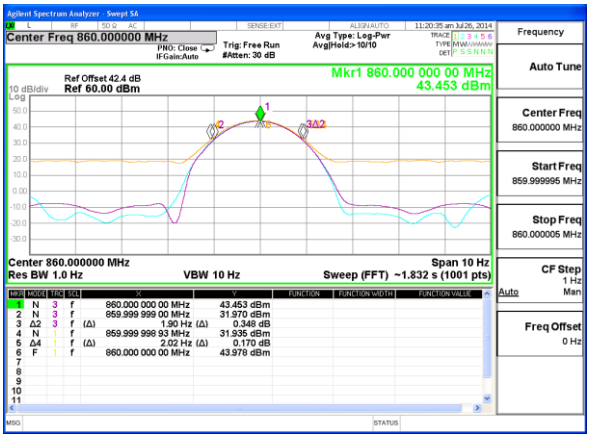
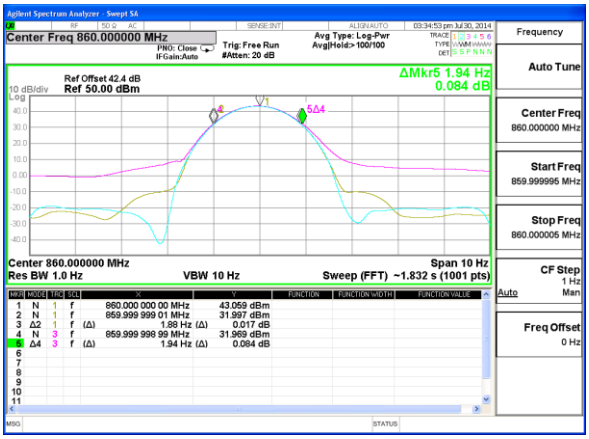
- Temperature Variation: Data was collected continuously over temperature range of -40C to 55C using a max hold function.

- Voltage Variation: Data was collected while varying the power supply voltage to the EUT from 85% to 115% of the nominal value (29V) measured at the input of the EUT.

## *6.2* Test Results

| Frequency | Change in Hz – Temperature Variation | Change in ppm | Change in Hz – Voltage Variation | Change in ppm | Compliant |
|---|---|---|---|---|---|
| 766.5 MHz | 0.04 | 0.0 | 0.05 | 0.0 | Yes |
| 860 MHz | 0.13 | 0.0 | 0.06 | 0.0 | Yes |

**Table 6-1. Frequency error in ppm**

| Frequency Stability vs Temperature Variation - 700 MHz band | Frequency Stability vs Temperature Variation - 800 MHz band |
|---|---|
|  |  |
| Frequency Stability vs Voltage Variation - 700 MHz band | Frequency Stability vs Voltage Variation - 800 MHz band |
|  |  |