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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	HCOT30SNI1A
Model Number	*t*30-SNI-1NB
Product Description	Public Safety 800 Remote Unit, Single-Band
Date Sample Received	Apr 6th, 2015
Date Sample Tested	Apr 6th to Apr 10th, 2015
Tested by	Guihua Sophie Piao
Approved by	Harry Deo
Report No.	T30-SNI-1NB
Test Results	Compliant

Revision History

Revision	Date	Reason For Change	Author(s)
0.1	April 13th, 2015	Initial Data	S. Piao
1.0	May 4th, 2015	First version	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
ERP	Effective 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
MHz	Mega Hertz
NB	Narrow Band
NF	Noise Figure
NPSPAC	National Public Safety Planning Advisory Committee
OBW	Occupied Bandwidth
PS	Public Safety
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 and Part 90I 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: Apr 10th, 2015

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, and 90I requirements for a single band DAS system.
Applicable Rule Parts	FCC CFR 47 Part 2.1046 (a), 90.219 FCC CFR 47 Part 2.1049, 90.209 FCC CFR 47 Part 90.210(c), (g) and (h) 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 Relative Humidity: 60% 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	800 Remote Unit, Single-Band Bi-directional Distributed Antenna System/Repeater.
FCC ID	HCOT30SNI1A
Model Name	*t*30-SNI-1NB
Operating Frequency	Downlink 851 – 862 MHz, Uplink 806 – 817 MHz, where the uplink does not transmit over the air.
Emission Designators	F9W, D9W, F8E
Modulations	Analog FM, 1kHz / 4kHz P25 Phase I C4FM P25 Phase I CQPSK P25 Phase II HCPM P25 Phase II HDQPSK
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	Keysight	MXA-N9010A	MY52220398	2 years	Sep-29-2016
Signal Generator	Keysight	MXG-N5182B	MY53050168	3 years	Jul-25-2017
Signal Generator	Keysight	EXG-N5182B	MY53051031	3 years	Jun-25-2017
Noise Source	Keysight	N4001A SNS	MY44420489	1 year	10-Feb-2015
Power Sensor	Keysight	U2000A	MY51370011	1 year	Aug-24-2015

1.9 Test Procedure

General

The *t*30 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 30 dB for the band under consideration.

The passing band of the equipment under test (EUT) is covering 800 MHz (851 – 862 MHz) public safety (PS) bands. The 800 MHz passing band covers NPSPAC in 851 – 854 MHz and interleaved PS-B/ILT-SMR in 854 – 862 MHz.

The EUT is only intended to operate on qualified PS licenses on 800 Band. P25 phase I and phase II modulations were tested in the full passing band. Also, analog FM was tested in NPSPAC band.

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 input power 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.

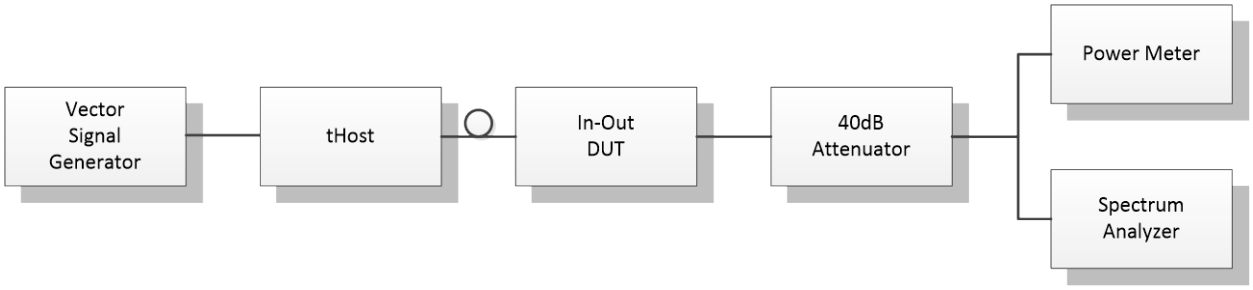
Spectrum Emission Mask
Spectrum Emission Mask is measured by connecting a Spectrum Analyzer to the RF output connector.
The input power was adjusted to produce maximum output power on the antenna port. The reference level was measured with integrated BW 2 times of the channel BW. The emission was measured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

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.

Noise Figure
A Keysight noise source was used to measure the uplink noise figure**.**

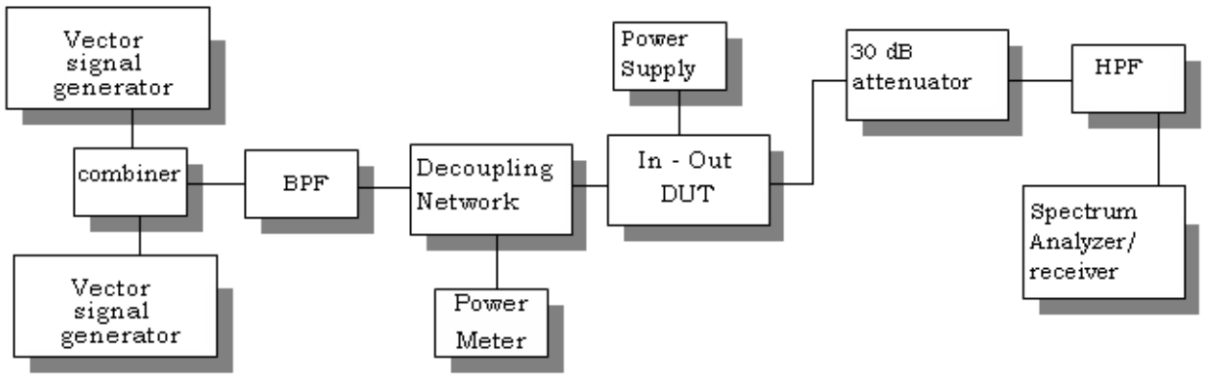
Test Setup for Output Power, Occupied Bandwidth, Spectrum Emission Mask, Conducted Spurious Emission and Frequency Stability



Intermodulation Product Spurious Emissions

The procedure used was ANSI/TIA-603-C: 2004. 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 *t*30SNI1NB**,** (30 dBm, 1 W) is an all-digital, low power, single-band radio remote. It bi-directionally transfers 800 MHz 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 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 1-1 800 MHz DL Measurement Matrix

Modulation	# Carriers	Notation	Frequency (MHz)
Analog FM	1	FM	851.0125, 852.5 853.9875
P25 Phase I 12.5kHz C4FM	1	P25 I-F	851.0125, 865.5 861.9875
P25 Phase I 6.5kHz CQPSK	1	P25 I-P	851.0125, 865.5 861.9875
P25 Phase II 12.5kHz HCPM	1	P25 II-CP	851.0125, 865.5 861.9875
P25 Phase II 12.5kHz H-DQPSK	1	P25 II-DP	851.0125, 865.5 861.9875

Single carrier P25 of different modulations was tested in the band of NPSPAC 851 – 854 MHz and PB-ILT/SMR 854 – 862 MHz. Also, analog FM modulation was tested in the band of NPSPAC 851 – 854 MHz.

Intended Emissions for the 851-862 MHz Band

Datasheet / OpDes Ref	Tested Signal	Individual Emission Designators	Emission Designators for Multiple Channels (Form 731)	Explanations
Analog FM	4kHz FM	16K0F3E	F8E	851-854 MHz Only
P25 Phase II	P25 Phase II 12.5kHz HDQPSK	9K80D7W, 9K80F1D, 9K80F1E	D9W, F9W	P25 Phase II Channels carrying a Combination of Voice and Data
Digital FM / P25 Phase I	P25 Phase I 6.5kHz CQPSK	5K76G1E	D9W	1 or More Digital FM Channels carrying a Combination of Voice and Data
	P25 Phase I 12.5kHz C4FM	8K10F1D, 8K10F1E	F9W	
EDACS		7K60FXD, 7K60FXE, 8K50F9W	F9W	OpenSky 2, EDACS AEGIS Digital Voice, and DMR have similar emissions characteristics to modulations tested above. Since testing performed was done on similar or worse case signals these modulation types should also be included in the grant.

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

FM, P25 I-F, I-P, P25 II-CP and P25 II-DP within the 800 band (851 MHz – 862 MHz) at low, middle and high carrier locations.

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

2.2 Test Results

Output Power in 800 MHz Band

Signal	***851 – 862 MHz (dBm)***		
	Low	Mid	High
P25 I-F	29.81	30	29.96
P25 I-P	29.87	30.03	30.00
P25 II-CP	29.88	30.01	29.97
P25 II-DP	29.90	30.03	29.99
	851 – 854 MHz (dBm)		
FM	29.84	29.85	29.90

Table 2-1 Output Power Measurement

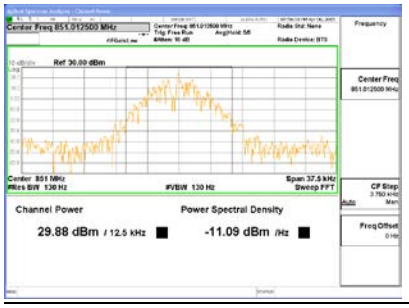
Conclusion: As the table above indicates, the maximum power output value of 30.03 dBm was obtained with CQPSK modulation at 856.5 MHz.
The output power is lower than 5 W (37dBm).

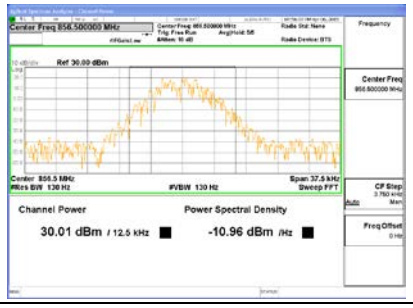
The conducted power measurement plots were shown as follows:

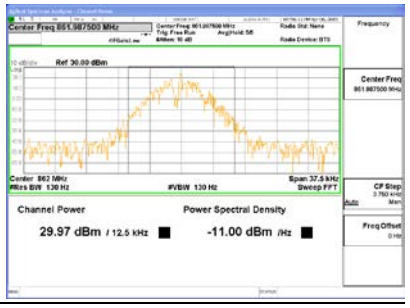
P25 I-F in 851 – 862 MHz Band

P25 I-P in 851 – 862 MHz Band

P25 II-CP in 851 – 862 MHz Band







P25 II-DP in 851 – 862 MHz Band

FM in 851 – 854 MHz Band

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

3.1 Methodology

Measurements were performed at

FM, P25 I-F, I-P, P25 II-CP and P25 II-DP within the 800 band (851 MHz – 862 MHz) at low, middle and high carrier locations.

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

Occupied Bandwidth in 800 MHz Band

Authorized BW	Low Out / In (kHz)	Mid Out / In (kHz)	High Out / In (kHz)	Max. In and Out difference
P25 I-F 12.5kHz (851 – 862 MHz)	8.395 / 8.142	7.708 / 7.863	8.054 / 7.614	5.8%
P25 I-P 6.25kHz (851 – 862 MHz)	4.842 / 4.78	4.910 / 4.84	4.907 / 4.836	1.5%
P25 II-CP 12.5kHz (851 – 862 MHz)	7.788 / 7.995	8.114 / 7.949	8.139 / 8.317	2.6%
P25 II-DP 12.5kHz (851 – 862 MHz)	9.803 / 9.910	9.804 / 9.83	9.708 / 9.738	1.1%
FM 25kHz (851 – 854 MHz)	10.245 / 10.243	10.244 / 10.243	10.244 / 10.243	0.0%

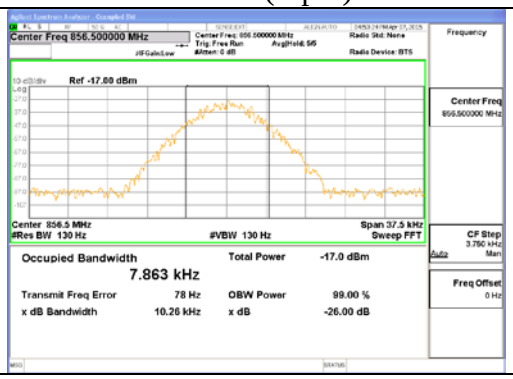
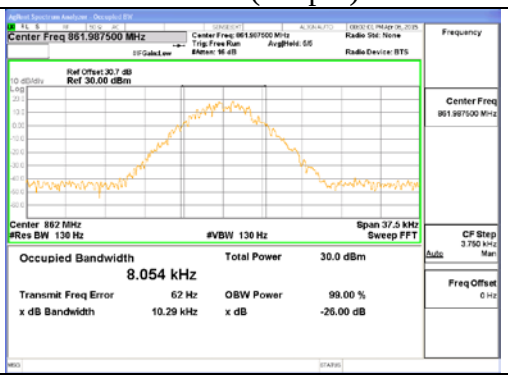
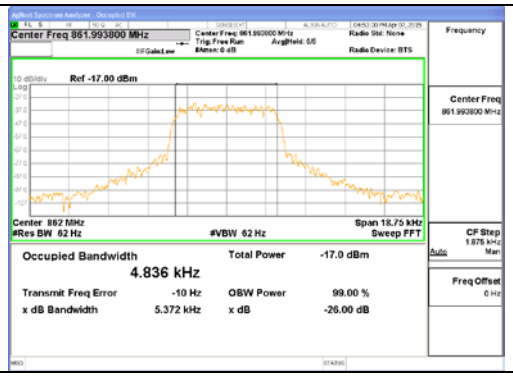
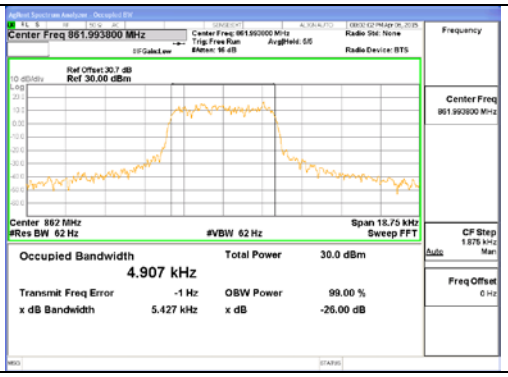
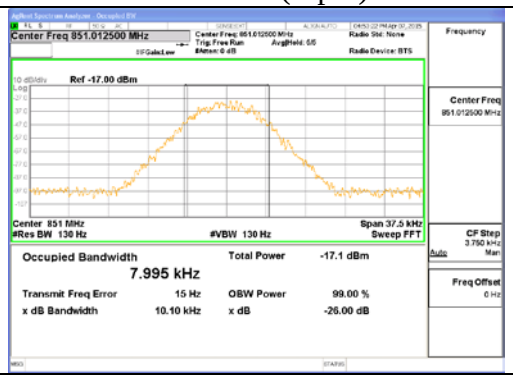
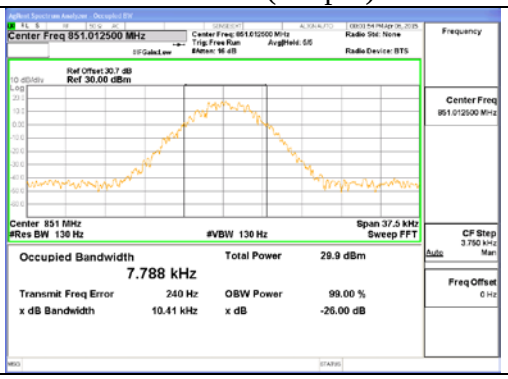
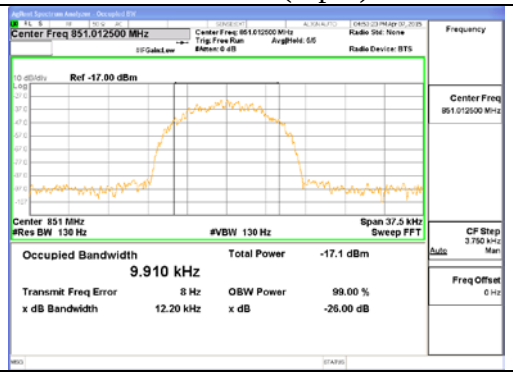
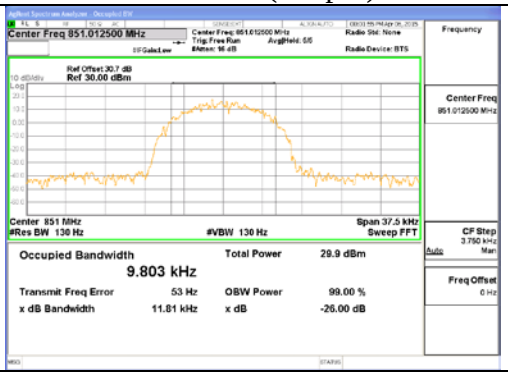
Table 3-1. Occupied bandwidth measurements (Output signal)

Conclusion:

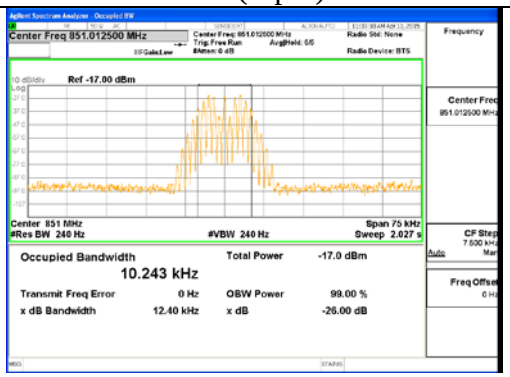
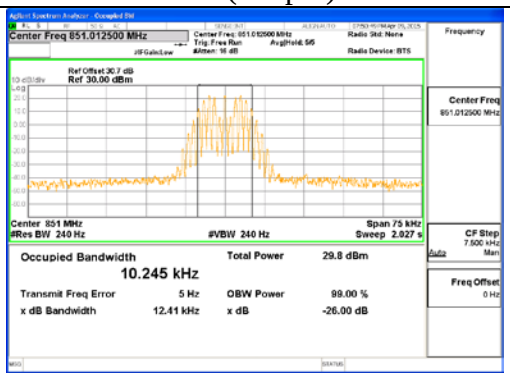
- The difference of the output signal and input signal bandwidth is less than 6%. The spectrum shapes of output are similar to the input.

- The measured bandwidth is less than the authorized bandwidth.

P25 Phase I and Phase II Channel Bandwidth in 851 - 862 MHz Band

P25 I-F (Input)	P25 I-F (Output)
	
P25 I-P (Input)	P25 I-P (Output)
	
P25 II-CP (Input)	P25 II-CP (Output)
	
P25 II-DP (Input)	P25 II-DP (Output)
	

Analog FM Channel Bandwidth in 851 - 854 MHz Band

FM (Input)	FM (Output)
	

4.0 Unwanted Emissions - Conducted Spurious Pursuant 47 CFR 90.210 (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

FM, P25 I-F, I-P, P25 II-CP and P25 II-DP within the 800 band (851 MHz – 862 MHz) at low, middle and high carrier locations.

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.

90.210(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

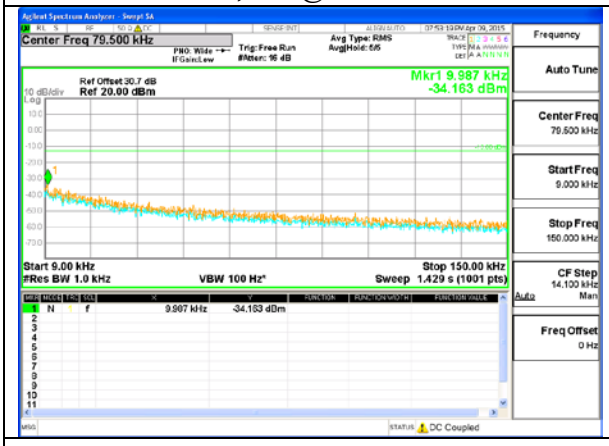
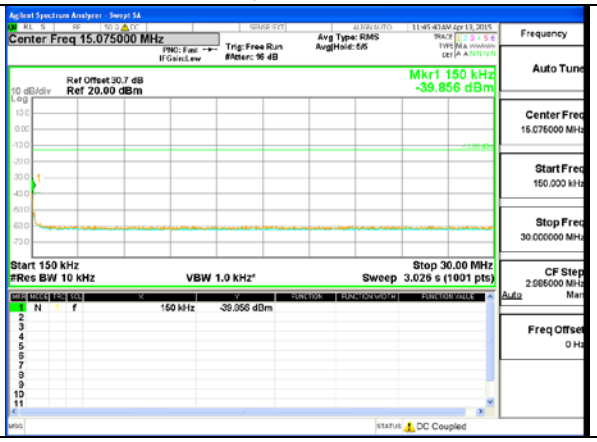
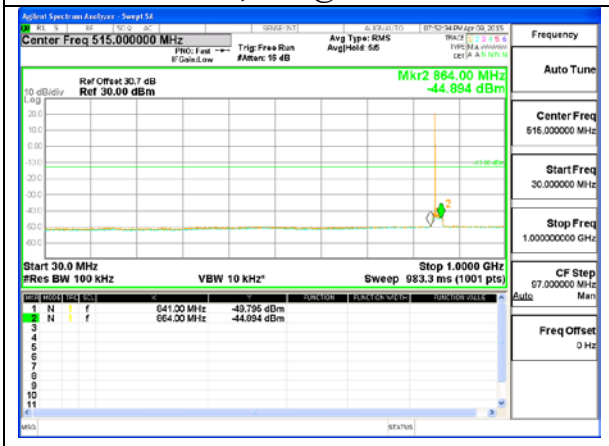
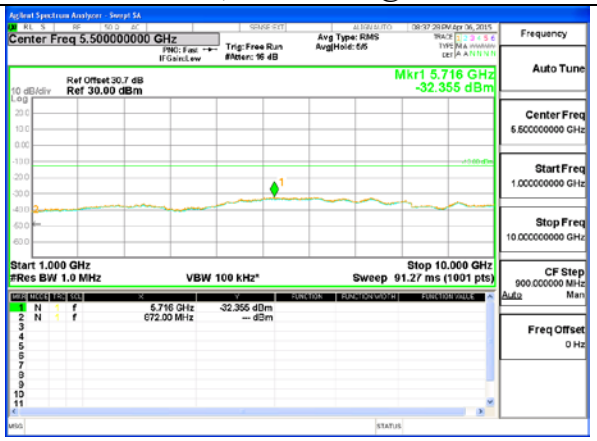
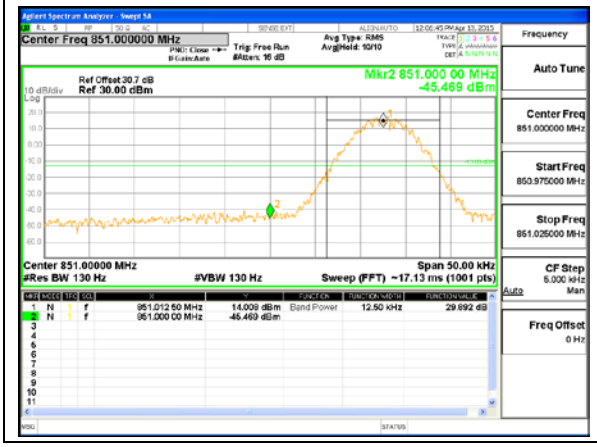
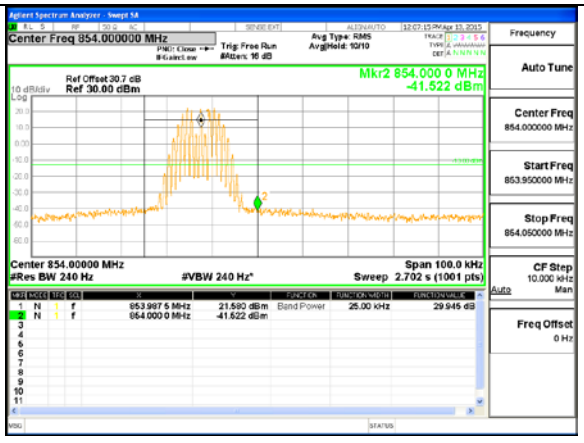
- -13 dBm

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.

Spurious Emission in 851 MHz – 862 MHz
Part 90I Applied

9 kHz – 150 kHz, FM@853.9875MHz	150 kHz – 30 MHz, P25 II
	
30 MHz – 1 GHz, FM @ 851.0125MHz	1 GHz – 10 GHz, P25 II-DP @ 861.9875MHz
	
Zoom in, P25 II-CP, Left edge of 851MHz	Zoom in, P25I-P, Right edge of 854MHz
	

5.0 Spectrum Emission Mask Pursuant 47 CFR Part 90.210

5.1 Methodology

Measurements were performed at

> FM, P25 I-F, I-P, P25 II-CP and P25 II-DP within the 800 band (851 MHz – 862 MHz) at low, middle and high carrier locations.

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 (h) is more stringent than 90.210 (g).
90.210 (h) emission mask was applied to all 5 modulations tested.

The RBW was set to 100Hz.

5.2 Test Results

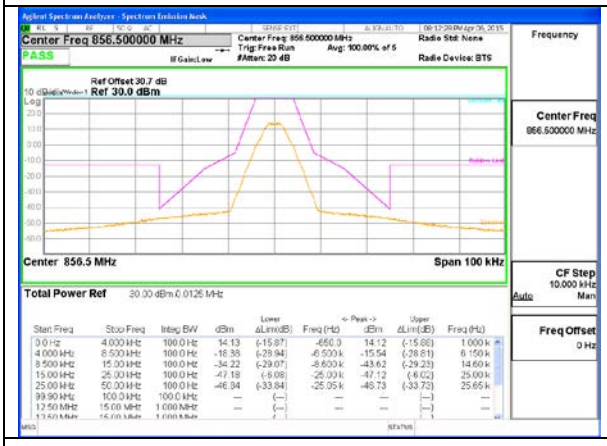
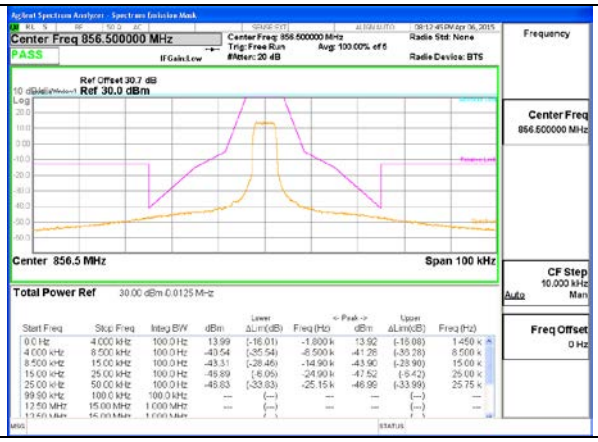
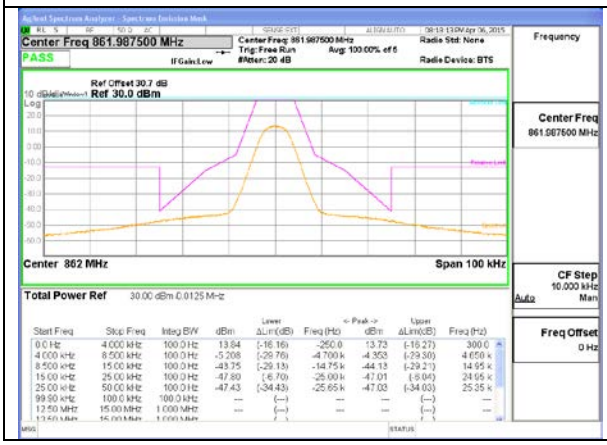
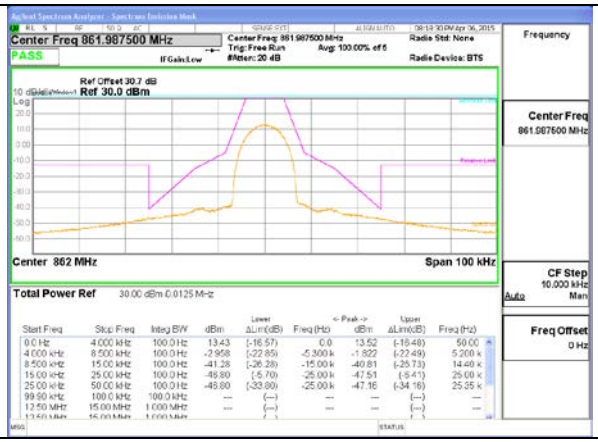
On the plots below shown the worst case when the carrier was set to the edges or center with different modulations.

Within 851 – 862 MHz band:
The emission level of P25 signal is below the limit by more than 5.7 dB.

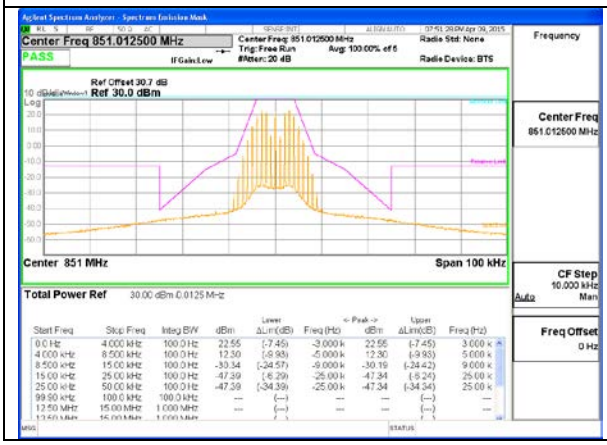
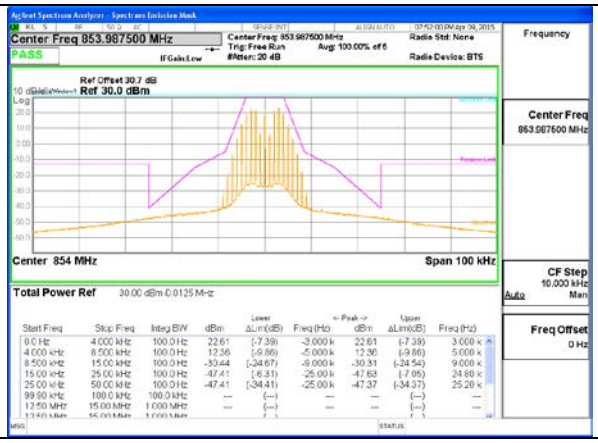
Within 851 – 854 MHz band:
The emission level of FM signal is below the limit by more than 6 dB.

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

Emission Mask in 851 – 862 MHz Band, P25 Modulations

P25 I-F on 856.5 MHz	P25 I-P on 861.9875 MHz
	
P25 II-CP on 861.9875 MHz	**P25 II-DP on 861.9875 MHz**
	

Emission Mask in 851 - 854 MHz Band, Analog FM

P25 I-P on 862.0125 MHz	P25 I-P on 868.9875 MHz
	

6.0 Frequency Stability Pursuant 47 CFR 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 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 -40°C to 50°C using a max hold function.

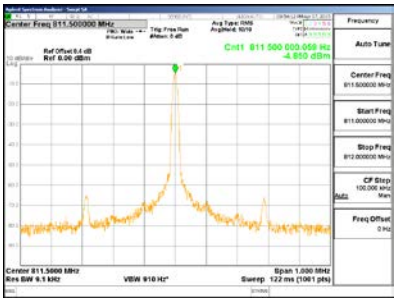
6.2 Test Results

Frequency	Output Freq @ 25°C	Output Freq @ -40°C	Output Freq @ 50°C	Change in ppm	Compliant
UL @ 811.5 MHz	811500000.059	811500000.022	811500000.043	0.000	Yes
DL @ 856.5 MHz	856500000.057	856500000.019	856499999.960	0.000	Yes

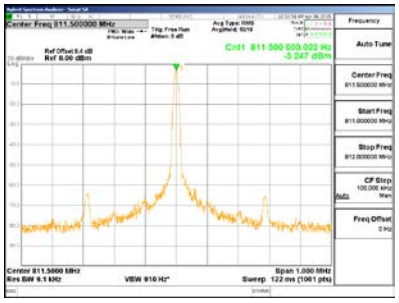
Table 6-1. Frequency Stability

UL Frequency

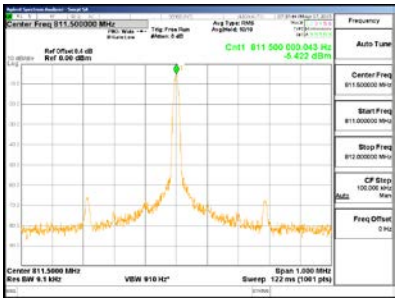
25°C



-40°C

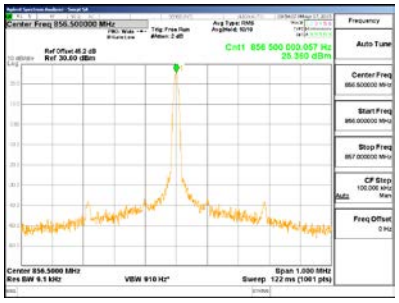


50°C

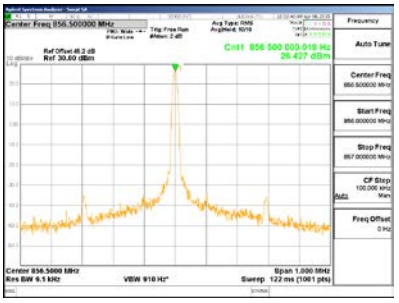


DL Frequency

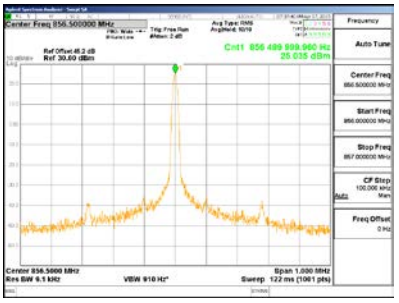
25°C



-40°C



50°C



7.0 Intermodulation Pursuant 47 CFR Part 90.219 (d)(6)(i)

7.1 Methodology

Measurements were performed with modulated -tone at identical input amplitude which produced integrated maximum rated output power. Two tests were done for low and high edge of the operating band. The 3rd order intermodulation produced was made to be on the first and the last channel location.

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

90.219 Use of signal boosters.
(d) Deployment rules.
(6) Good engineering practice must be used in regard to the radiation of intermodulation products and noise, such that interference to licensed communications systems is avoided. In the event of harmful interference caused by any given deployment, the FCC may require additional attenuation or filtering of the emissions and/or noise from signal boosters or signal booster systems, as necessary to eliminate the interference.
(i) In general, the ERP of intermodulation products should not exceed -30 dBm in 10 kHz measurement bandwidth.

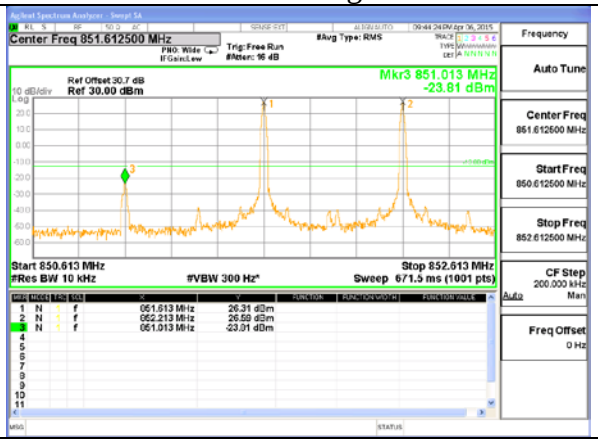
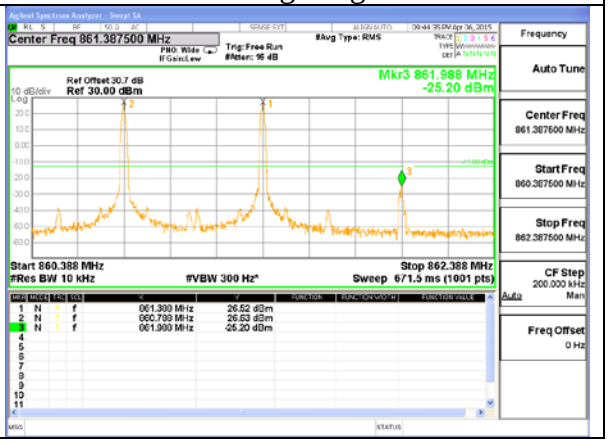
Worst-case data is shown in the figures in sections 7.2.

7.2 Test Results

The worst intermodulation product was with amplitude of -23.81 dBm when the integrated transmission power of two tones was 30 dBm.

A sum of the minimum cable loss and maximum antenna gain of 6.2dB is proposed for deploying the t30 remote unit in order to comply with condition that the ERP of the intermodulation product would be less than -30 dBm / 10 kHz and therefore meets the booster's deployment rule.

851 - 862 MHz Band

on low edge	on high edge
	

8.0 Noise Figure Pursuant 47 CFR Part 90.219 (e)(2)

8.1 Methodology

Agilent SNS Noise Source was used to test the noise figure on the uplink path. The noise figure was measured by a proceeding noise path calibration.

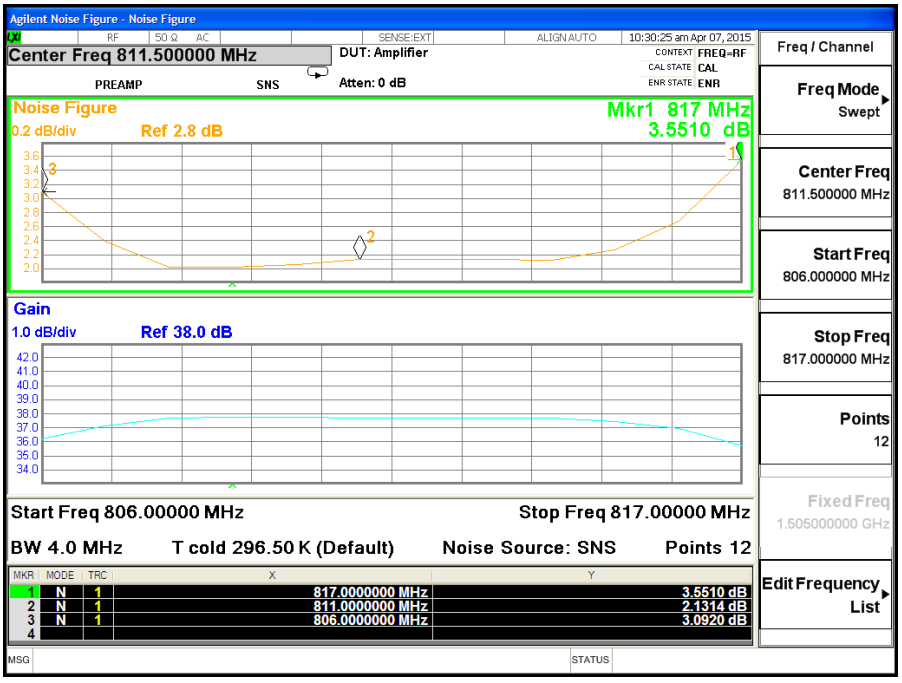
A brief summary of the applicable FCC specifications are listed in the table below.

90.219 (e) A signal booster must meet (2) The noise figure of a signal booster must not exceed 9 dB in either direction

Test data were shown in section 8.2.

8.2 Test Results

The noise figure is maximum 3.551 dB, which is below the 9 dB limit of booster's deployment rule.



Appendix A: Test Setup Photos