Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 27 Subpart C
IC RSS-195 Issue 2
2350MHz – 2360MHz

FCC ID:	**VBNFRNC-01**
IC:	**661W-FRNC**
Model:	**FRNC**
Product Name:	**Flexi Multiradio BTS**
APPLICANT:	**Nokia Solutions and Networks** **6000 Connection Drive** **Irving, TX 75039**
TEST SITE(S):	**National Technical Systems - Plano** **1701 E Plano Pkwy #150** **Plano, TX 75074**
REPORT DATE:	**May 26, 2015**
FINAL TEST DATES:	**Mar 9 – Mar 19, 2015**
TOTAL NUMBER OF PAGES:	**56**

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	Apr 13, 2015	1st release	Yunus Faziloglu
1	May 26, 2015	To address TCB comments	Yunus Faziloglu

TABLE OF CONTENTS

SCOPE

Tests have been performed on Nokia Solutions and Networks product Flexi Multiradio BTS RRH Model FRNC, pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission.

- Code of Federal Regulations (CFR) Title 47 Part 2
- CFR Title 47 Part 27 Subpart C
- RSS-Gen Issue 4 November 2014
- RSS-195 Issue 2 April 2014

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 C63.4-2009
ANSI TIA-603-C
FCC KDB 971168 D01 v02r02

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC 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 Flexi Multiradio BTS RRH Model FRNC and therefore apply only to the tested sample. The sample was selected and prepared by Hobert Smith 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, 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 FRNC. No additional models were described or supplied for testing.

STATEMENT OF COMPLIANCE

The tested sample of Nokia Solutions and Networks product Flexi Multiradio BTS RRH Model FRNC 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.

TEST RESULTS

FCC Part 27 Subpart C and RSS-195 Issue 2 (Base Stations Operating in 2350MHz-2360MHz band)

FCC	IC	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§27.5(a)	RSS-195 Section 5.2	Frequency range(s)	2352.5MHz - 2357.5MHz (5M LTE) 2355.0MHz - 2355.0MHz (10M LTE)	2350MHz - 2360MHz	Pass
§2.1033(c)(4)	RSS-195 Section 5.3	Modulation Type	QPSK, 16QAM, 64QAM (5M and 10M for each)	Digital	Pass
§27.50(a)	RSS-195 Section 5.5	Output Power	Conducted Output Power (Highest on Port 1) RMS: 44.41Bm EIRP will depend on antenna gain (unknown)	2000W EIRP	Pass
§27.50(a)	RSS-195 Section 5.5	Peak to Average Ratio	10.88dB highest	13dB	Pass
§2.1049	RSS-Gen Section 6.6	Emission Bandwidth (99%)	4.506MHz (5M LTE) 8.997MHz (10M LTE)	Remain in Block	Pass
N/A Informational	N/A Informational	Emission Bandwidth (26dB)	4.882MHz (5M LTE) 9.767MHz (10M LTE)	Remain in Block	Pass
Transmitter spurious emissions[1]					
§27.53(a)	RSS-195 Section 5.6	At the antenna terminals	< -19.03dBm	-19.03 dBm (per TX chain)	Pass
		Field strength	40.0dBuV/m at 3m Eq. to -55.2dBm EIRP	-13 dBm EIRP	Pass
Other details					
§27.54	RSS-195 Section 5.4	Frequency stability	0.0001ppm	Remain in Block	Pass
§1.1310	RSS-102 Issue 5	RF Exposure	N/A		Pass[2]

Notes

Note 1 – Based on 1MHz RBW. In 1MHz bands immediately outside and adjacent to the frequency block an RBW of at least 1% of the emission bandwidth has been used.
Note 2 – Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

	Emission Designators					
	LTE-QPSK		LTE-16QAM		LTE-64QAM	
	FCC	IC	FCC	IC	FCC	IC
5M	4M88F9W	4M49F9W	4M86F9W	4M49F9W	4M88F9W	4M51F9W
10M	9M72F9W	8M98F9W	9M71F9W	9M00F9W	9M77F9W	8M98F9W

Note: FCC based on 26dB emission bandwidth, IC based on 99% emissions 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	± 0.2ppm
RF power conducted	±1.2 dB
RF power radiated	±3.3 dB
RF power density conducted	±1.2 dB
Spurious emissions conducted	±1.2 dB
Adjacent channel power	±0.4 dB
Spurious emissions radiated	±4 dB
Temperature	±1°C
Humidity	±1.6 %
Voltage (DC)	±0.2 %
Voltage (AC)	±0.3 %

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The equipment under test (EUT) is a Nokia Solutions and Networks Flexi Multiradio Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model FRNC which operates over 3GPP frequency band 30 (BTS Rx: 2305 to 2315 MHz/BTS Tx: 2350 to 2360 MHz). The FRNC has four co-located transmitters with each transmit port supporting 30 watts maximum rated RF output power. The FRNC can be operated as MIMO or as non-MIMO. Multi-carrier operation is supported.

The FRNC is multi-standard capable (GSM/EDGE/WCDMA/LTE), but for this effort only the LTE mode is tested. The FRNC supports three downlink modulation types for LTE (QPSK, 16QAM and 64QAM). The FRNC supports two LTE channel bandwidths (5 MHz and 10 MHz).

The FRNC has external interfaces including DC power, ground, TX/RX (Ant), RX monitor (RXO), external alarm (EAC), optical OBSAI (OPT) and remote electrical tilt (RET). The RRH with applicable installation kit may be pole or wall mounted.

The FRNC LTE channel numbers and frequencies are as follows:

	Downlink EARFCN	Downlink Frequency (MHz)	LTE Channel Bandwidth	
			5 MHz	10 MHz
Band 30 (Ant 1, 2, 3, 4)	9770	2350.0	Bandedge	Bandedge
	……			
	9795	2352.5	Bottom Ch	
	……			
	9820	2355.0	Middle Ch	Bottom Ch Middle Ch Top Channel
	……			
	9845	2357.5	Top Channel	
	……			
	9870	2360.0	Bandedge	Bandedge

FRNC Downlink LTE Frequency Channels

The sample was received on Mar 9, 2015 and tested on Mar 9 - Mar 19, 2015. The EUT consisted of the following component(s):

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	FRNC	Flexi Multiradio BTS RRH	Part#: 473189A.x21 Serial#: YK150400367	FCC ID: VBNFRNC-01 IC: 661W-FRNC

ENCLOSURE

The EUT enclosure is made of heavy duty aluminum and measures approximately 12(W) x 7(D) x 24(H) inches.

AUXILLARY EQUIPMENT

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	FOSH	6GHz SFP Module (Plugs into FRNC Opt Ports 1&2)	Part#: 472579A.101 (2 units per RRH) Serial#: CE30LC5Z2 and CE30LCCBA	N/A

SUPPORT EQUIPMENT

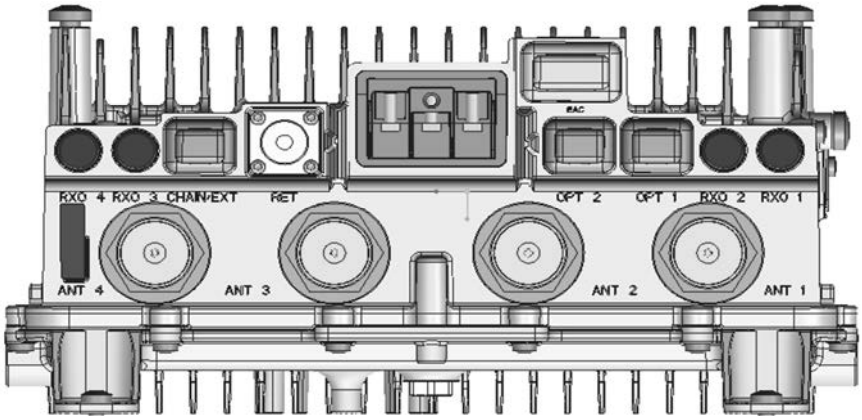
Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	FSMF	Flexi System Module	Part#: 472181A.103	N/A
Nokia Solutions and Networks	FBBA	Baseband Extension Module	Part#: 472182A.101 (2 units per FSMF)	N/A
HP	Elite Book 6930p	Laptop PC	N/A	N/A

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 Load
RX monitor	RF	Yes	~ 2 m	Yes	2	50Ω Load
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	2	System Module

The connector layout for FRNC is provided below:



FRNC External Interfaces:

Name	Qty	Connector Type	Purpose (and Description)
DC In	1	Screw Terminal	3-port Power Input -48 VDC, up to AWG 4 cable
GND	1	Screw lug (2xM5/1xM8)	Ground
ANT	4	4.3-10	RF signal for Transmitter/Receiver (50 Ohm)
RXO	4	QMA	RX output for monitoring/location services
Unit	1	LED	Unit Status LED
LMP	1	Card edge	Local Management/Test Port (Ethernet 10Base-T/100Base-Tx and others, not field accessible)
EAC	1	MDR14	External Alarm Interface (4 alarms)
OPT	3	SFP+ cage	Optical OBSAI Interface up to 6 Gps.
RET	1	8-pin circular connector conforming to IEC 60130-9 – Ed.3.0	AISG 2.0 to external devices

EUT OPERATION

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

EUT FIRMWARE/SOFTWARE

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

(1) RRH Unit Software: FRM35.02.R01

(2) System Module Software: FB_PS_REL_2013_09_016

MODIFICATIONS

No modifications were made to the EUT during testing.

TESTING

GENERAL INFORMATION

Antenna port measurements were taken at NTS Plano branch located at 1701 E Plano Pkwy #150 Plano, TX 75074.

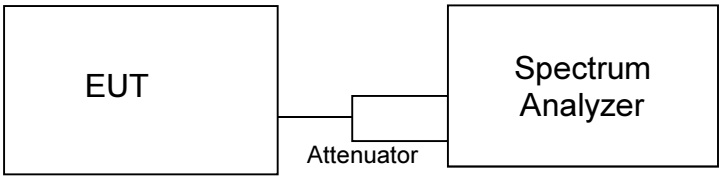
Radiated spurious emissions measurements were taken at the NTS Plano Anechoic Chamber listed below. The sites conform to the requirements of ANSI C63.4-2009 *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz* and CISPR 16-1-4:2007 - *Specification for radio disturbance and immunity measuring apparatus and methods Part 1-4: Radio disturbance and immunity measuring apparatus Ancillary equipment Radiated disturbances*. 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	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

Output power, emission bandwidth, conducted spurious, conducted bandedge and carrier frequency stability measurements were all performed via a spectrum analyzer connected to the individual RF chains via a 40dB attenuator and an RF cable. The EUT was operating in 4x4 MIMO configuration at full power for all tests. While measuring one transmit chain, others were terminated with termination blocks. All measurements were corrected for the insertion loss of the attenuator and cable inserted between the RF port of the EUT and the spectrum analyzer. Simple test diagram is shown below.



Test Configuration for Antenna Port Measurements

26dB emission bandwidth was measured in accordance with Section 4.1 of FCC KDB 971168 D01 v02r02. 99% occupied bandwidth was measured in accordance with Section 6.6 of RSS-Gen Issue 4. For both measurements an NTS custom software tool was used. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Emissions at the band-edges were also captured with an NTS custom software tool with settings described in the corresponding sections of the FCC and IC rules. Spectrum analyzer settings are shown on their corresponding plots in test results section. A notch filter supplied by the customer was characterized for insertion loss and used to measure emissions in the 2195MHz-2345MHz and 2365MHz-2400MHz ranges to reduce measurement instrumentation noise floor. Worst case insertion loss of the filter has been factored in via reference level offset to the spectrum analyzer.

Peak and average output power measurements were performed in accordance with FCC KDB 971168 D01 v02r02. An NTS custom software tool was used for power integration to compensate for resolution bandwidth limitations of the spectrum analyzer and settings are shown on their corresponding plots in test results section.

Peak to average power ratio was calculated in accordance with Section 5.7.2 of FCC KDB 971168 D01 v02r02.

Conducted spurious emissions were captured with TILE6 software which corrected the readings for cable loss and attenuator loss across the 9kHz-24GHz frequency span. Settings of the spectrum analyzer are described in the corresponding test result section.

For frequency stability, 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 signal analyzer as detailed in the test equipment section has been used for précised frequency error measurements.

Transmitter radiated spurious emissions measurements were made in accordance with ANSI C63.4-2009 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-C-2004. 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 24GHz with a peak detector (RBW=1MHz, VBW=3MHz, 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 1-18GHz range and a smaller horn antenna was used for 18-24GHz range. Measurements in the 18-24GHz range were performed at 1m distance. 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.

Test Equipment

NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
E1529P	PSA	Agilent	E4446A	12 Months	3/3/2016
E1563P	PSA	Agilent	E4440A	12 Months	9/2/2015
E1554P	PreAmp (1GHz-40GHz)	MITEQ	JS32-00104000-62-5P	12 Months	5/14/2015
E1366P	PreAmp (30MHz-1GHz)	MITEQ	AM-1431-N-1197SC	12 Months	12/12/2015
E1289P	Biconilog Antenna (30MHz-1GHz)	ETS Lindgren	3142C	12 Months	3/19/2016
E1149P	Horn Antenna (1GHz-18GHz)	EMCO	3115	12 Months	12/10/2015
E1447P	RMS Multimeter	Fluke	87V	12 Months	5/20/2015
D1131P	Data Acquisition Switch Unit	Agilent	34970A	12 Months	7/2/2015
ENV1195P	Climatic Chamber	Thermotron	SE-300-2-2	N/A	NCR
* NM04508	MXA Signal Analyzer	Agilent	N9020A	24 Months	1/27/2017

* Test equipment supplied by the customer for LTE frequency error measurements

Appendix A Test Data

RF Output Power

RF output power has been measured in both Peak and RMS Average terms for each transmit chain at the center channel for all modulations and bandwidth modes. Peak to average ratio (PAR) has been calculated as described in Section 5.7.2 of KDB971168 D01 v02r02 and all results are presented in tabular form below.

		LTE - QPSK			LTE - 16QAM			LTE - 64QAM		
		Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)
Port 1	**5M**	54.29	44.34	9.95	**54.96**	**44.41**	10.55	54.08	44.38	9.7
Center Ch	**10M**	54.13	44.03	10.1	54.54	43.81	10.73	53.94	43.96	9.98
Port 2	**5M**	54.13	44.21	9.92	54.77	44.37	10.4	54.09	44.23	9.86
Center Ch	**10M**	54.27	44.08	10.19	54.86	44.03	10.83	54.11	44.04	10.07
Port 3	**5M**	53.22	43.28	9.94	53.88	43.34	10.54	53.03	43.23	9.8
Center Ch	**10M**	53.73	43.32	10.41	54.04	43.2	10.84	53.47	43.19	10.28
Port 4	**5M**	54.17	44.15	10.02	54.85	44.23	10.62	53.98	44.15	9.83
Center Ch	**10M**	54.28	44.09	10.19	54.88	44	**10.88**	54.07	44.06	10.01
Combined	**5M**	59.99	50.04	9.95	60.66	50.13	10.53	59.84	50.04	9.8
Center Ch	**10M**	60.13	49.91	10.22	60.61	49.79	10.82	59.93	49.85	10.08

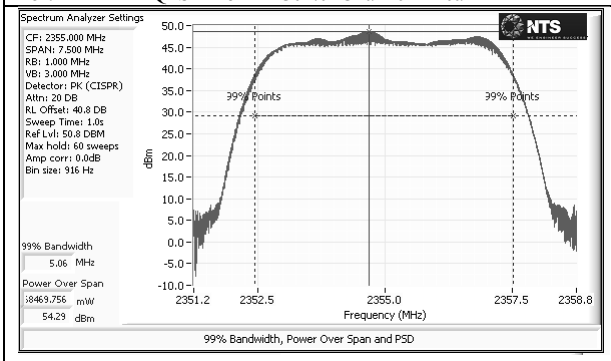
Based on the results above, Port 1 had the highest RMS average power and therefore it was selected for all the remaining antenna port tests on the product.

Subsequently output power levels on lowest and highest channels in 5MHz channel bandwidth mode were tested only at Port 1 and results presented below. 10MHz channel bandwidth mode had only 1 channel of operation at the center.

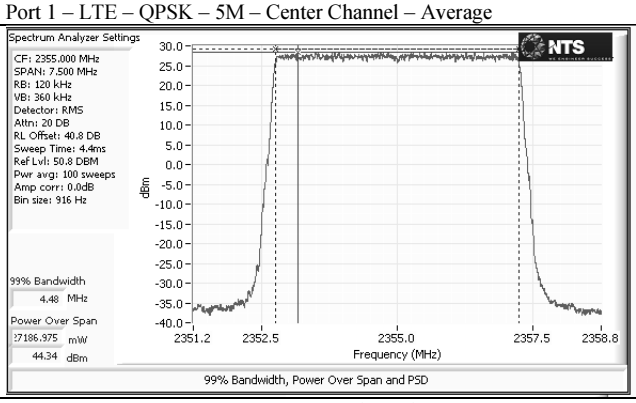
		LTE - QPSK			LTE - 16QAM			LTE - 64QAM		
		Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)
Port 1 Low Channel	**5M**	54.06	44.05	10.01	**54.9**	44.22	10.68	54.18	**44.24**	9.94
Port 1 High Channel	**5M**	54.02	43.95	10.07	54.72	43.87	**10.85**	53.9	43.98	9.92

All corresponding plots included on the following pages. Total path loss of 40.8dB (Attenuator Loss: 40dB, RF cable loss: 0.8dB) accounted in via reference level offset to the spectrum analyzer.

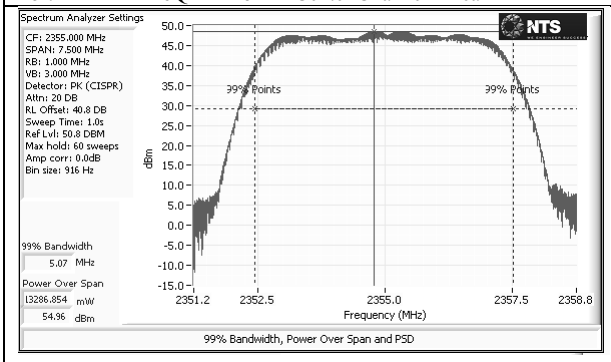
Port 1 – LTE – QPSK – 5M – Center Channel – Peak



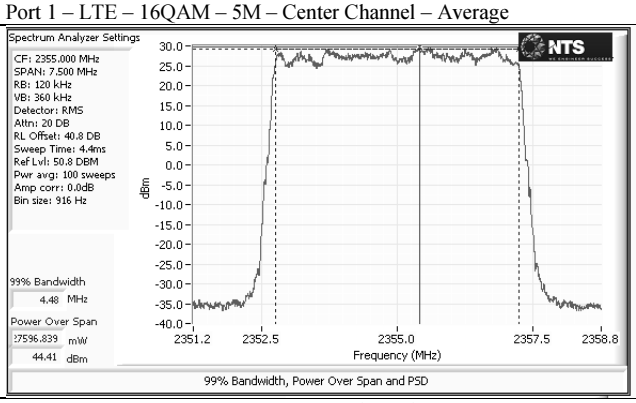
Port 1 – LTE – QPSK – 5M – Center Channel – Average



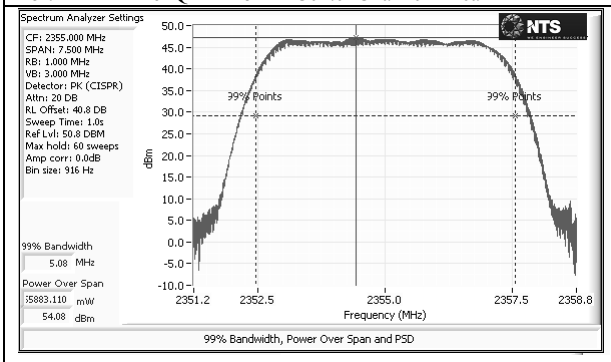
Port 1 – LTE – 16QAM – 5M – Center Channel – Peak



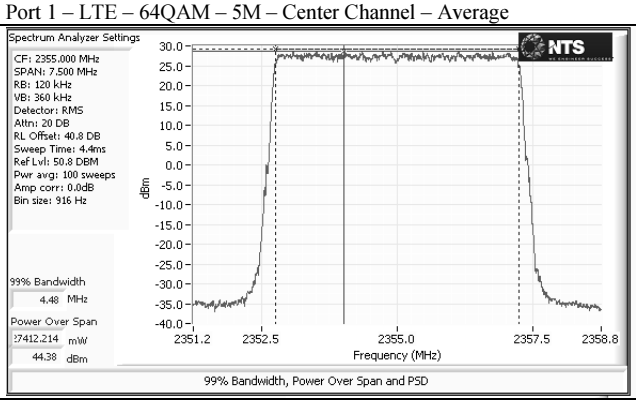
Port 1 – LTE – 16QAM – 5M – Center Channel – Average



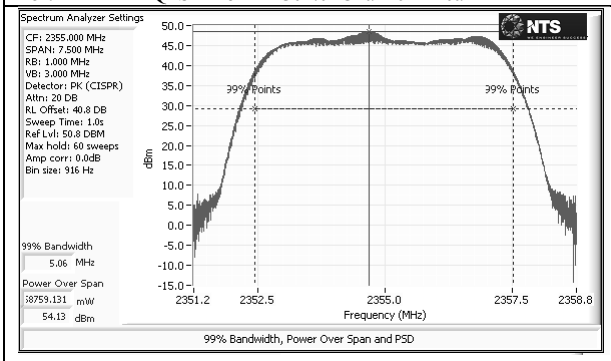
Port 1 – LTE – 64QAM – 5M – Center Channel – Peak



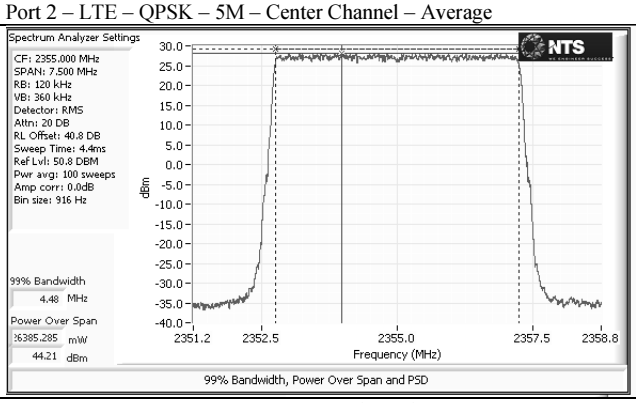
Port 1 – LTE – 64QAM – 5M – Center Channel – Average



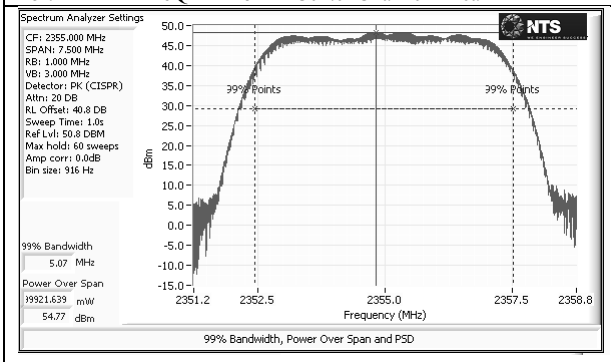
Port 2 – LTE – QPSK – 5M – Center Channel – Peak



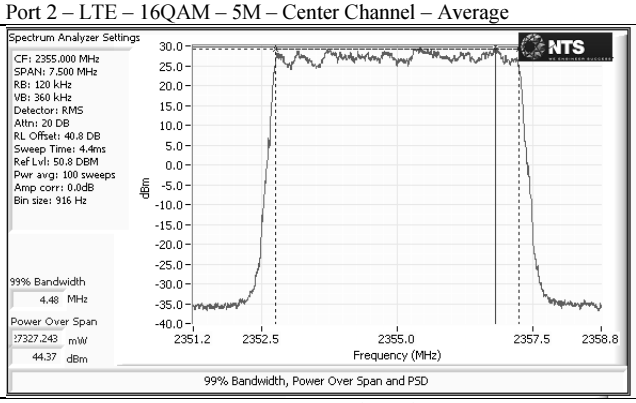
Port 2 – LTE – QPSK – 5M – Center Channel – Average



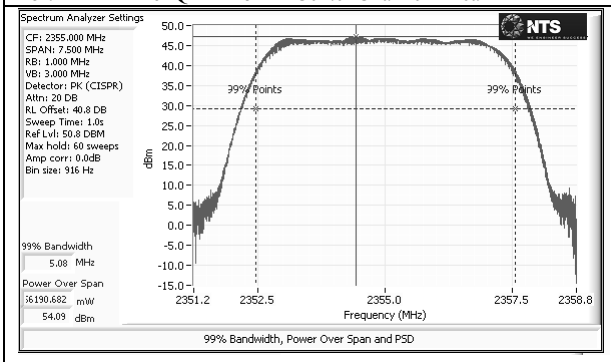
Port 2 – LTE – 16QAM – 5M – Center Channel – Peak



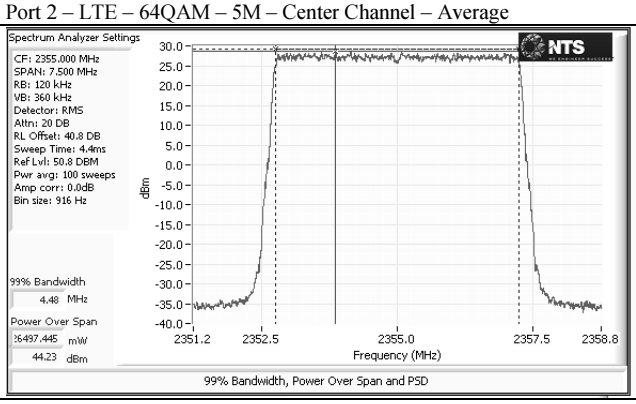
Port 2 – LTE – 16QAM – 5M – Center Channel – Average



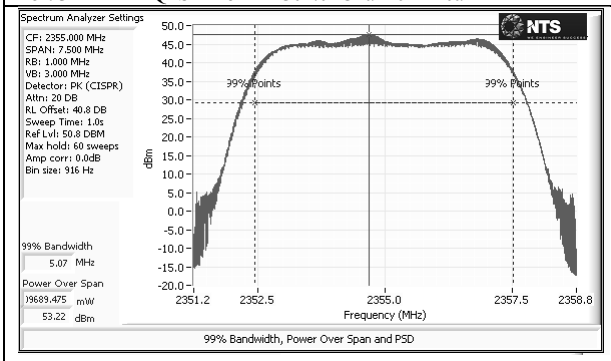
Port 2 – LTE – 64QAM – 5M – Center Channel – Peak



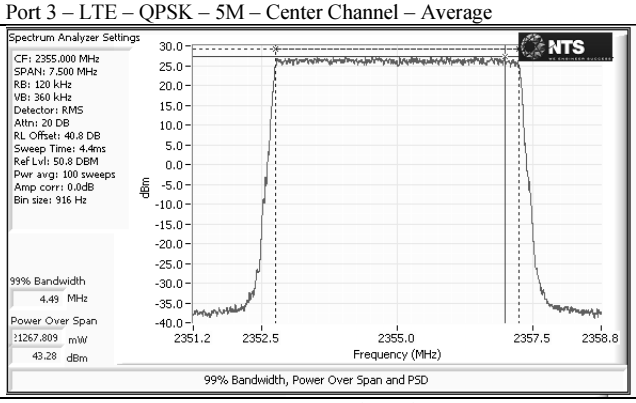
Port 2 – LTE – 64QAM – 5M – Center Channel – Average



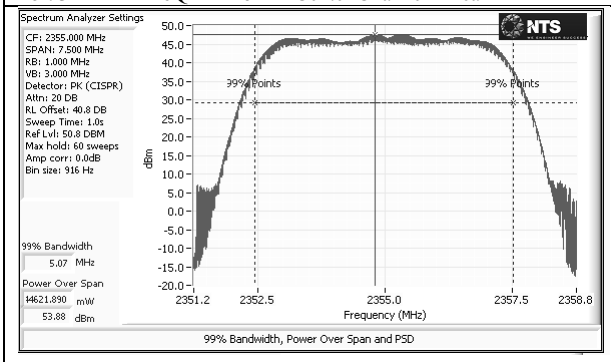
Port 3 – LTE – QPSK – 5M – Center Channel – Peak



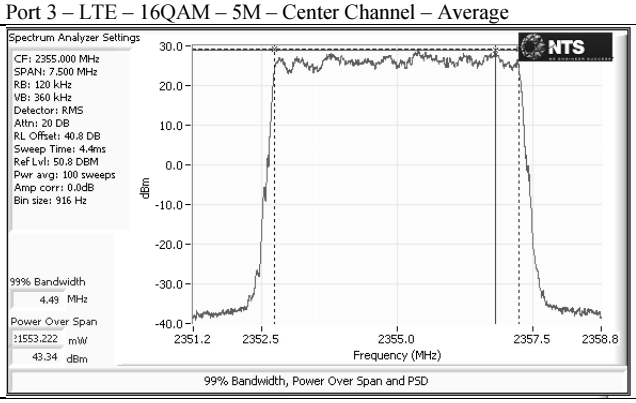
Port 3 – LTE – QPSK – 5M – Center Channel – Average



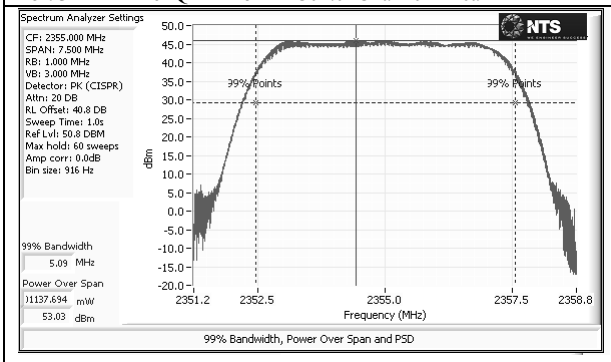
Port 3 – LTE – 16QAM – 5M – Center Channel – Peak



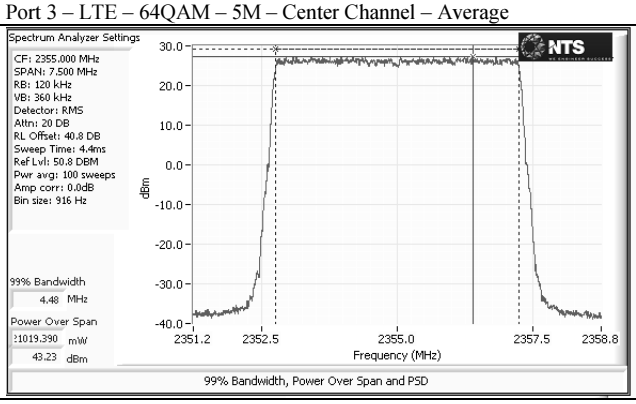
Port 3 – LTE – 16QAM – 5M – Center Channel – Average



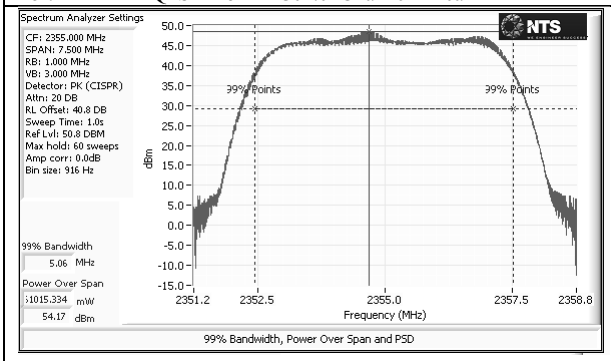
Port 3 – LTE – 64QAM – 5M – Center Channel – Peak



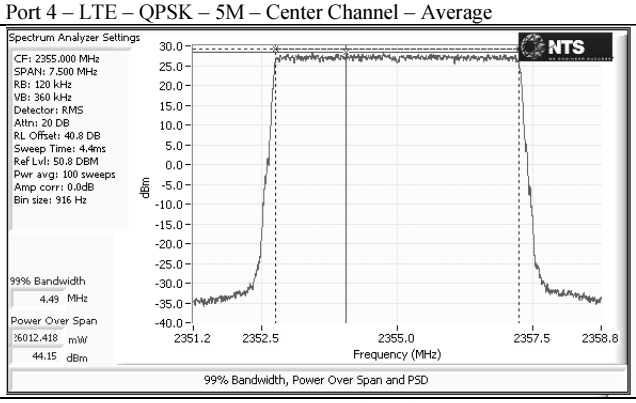
Port 3 – LTE – 64QAM – 5M – Center Channel – Average



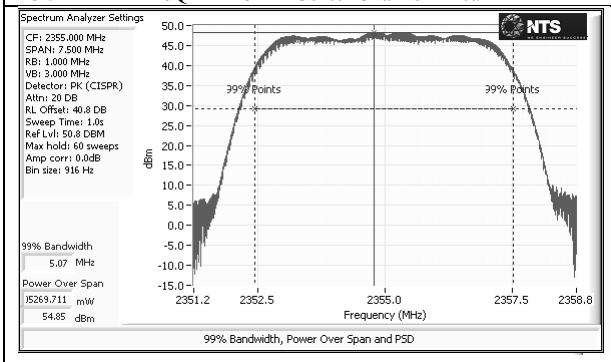
Port 4 – LTE – QPSK – 5M – Center Channel – Peak



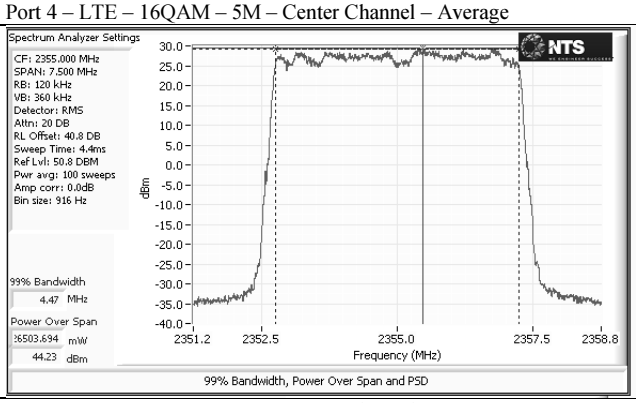
Port 4 – LTE – QPSK – 5M – Center Channel – Average



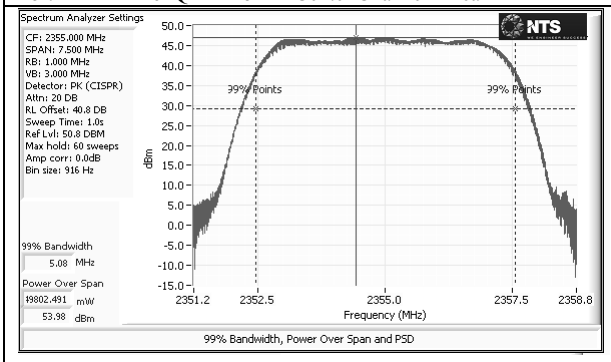
Port 4 – LTE – 16QAM – 5M – Center Channel – Peak



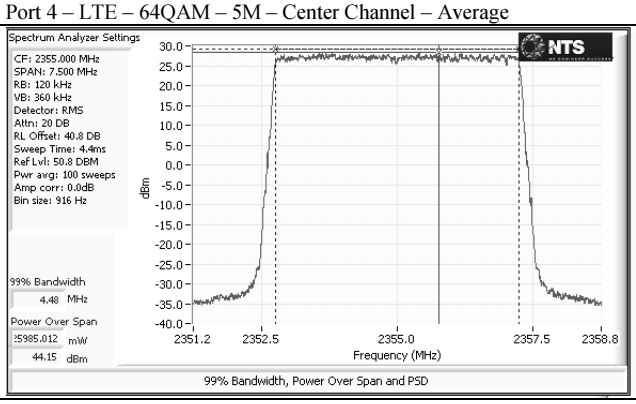
Port 4 – LTE – 16QAM – 5M – Center Channel – Average



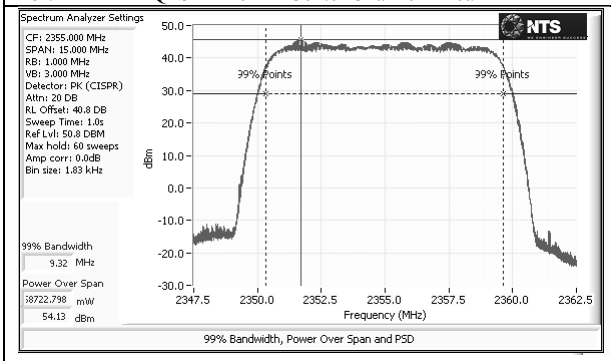
Port 4 – LTE – 64QAM – 5M – Center Channel – Peak



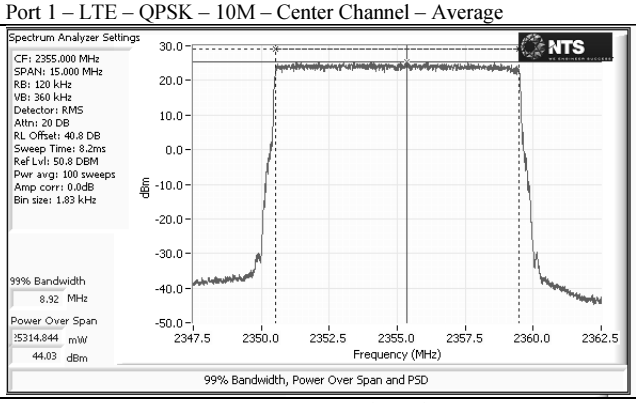
Port 4 – LTE – 64QAM – 5M – Center Channel – Average



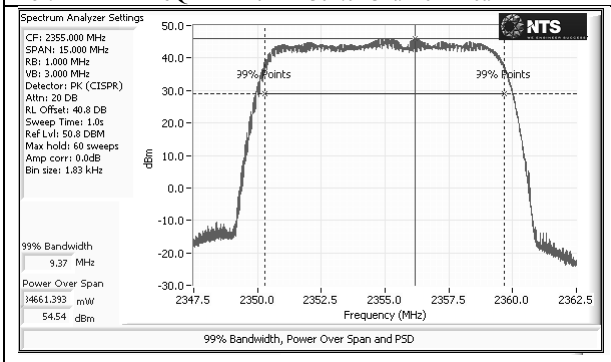
Port 1 – LTE – QPSK – 10M – Center Channel – Peak



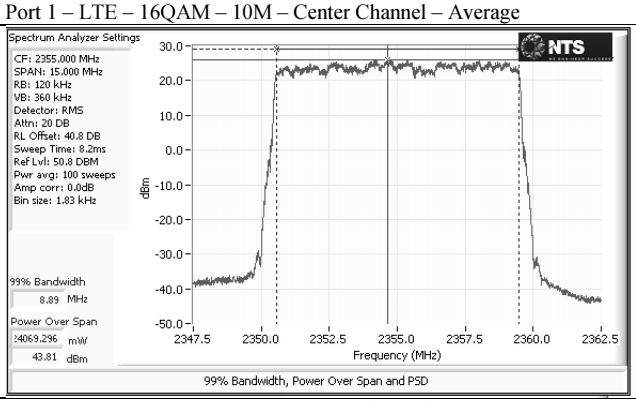
Port 1 – LTE – QPSK – 10M – Center Channel – Average



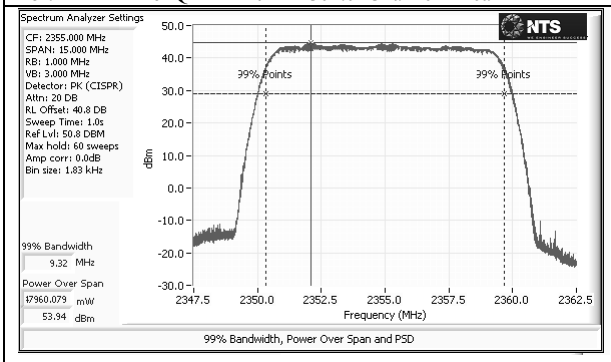
Port 1 – LTE – 16QAM – 10M – Center Channel – Peak



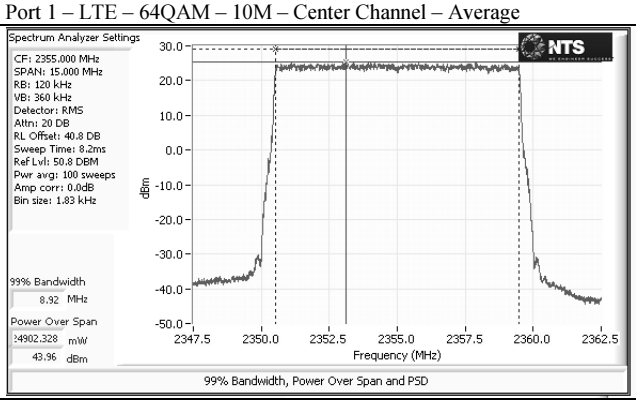
Port 1 – LTE – 16QAM – 10M – Center Channel – Average



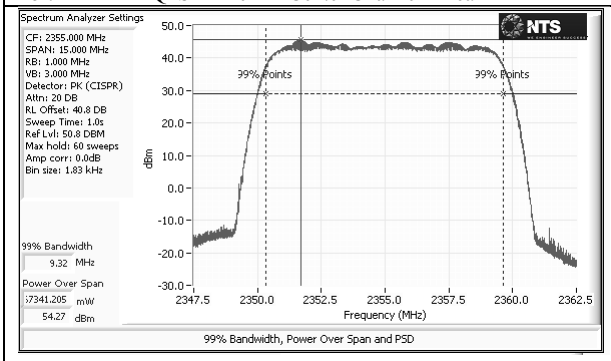
Port 1 – LTE – 64QAM – 10M – Center Channel – Peak



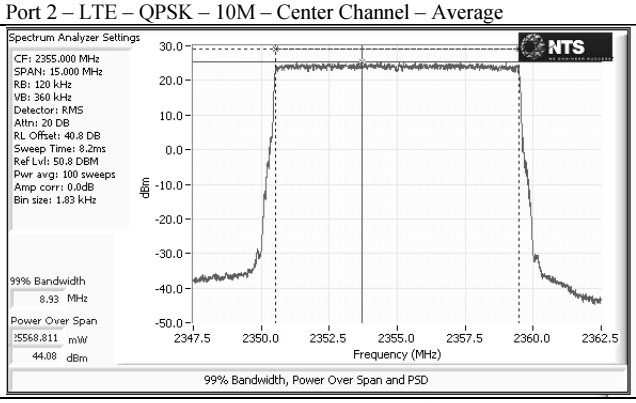
Port 1 – LTE – 64QAM – 10M – Center Channel – Average



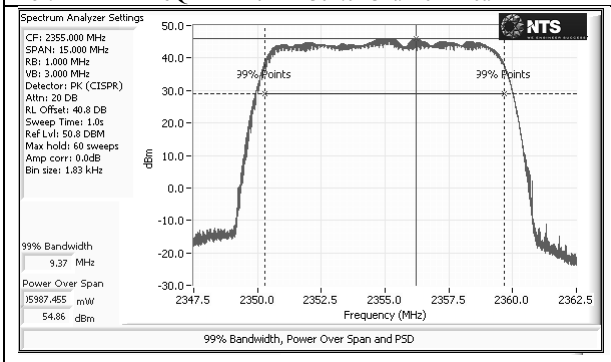
Port 2 – LTE – QPSK – 10M – Center Channel – Peak



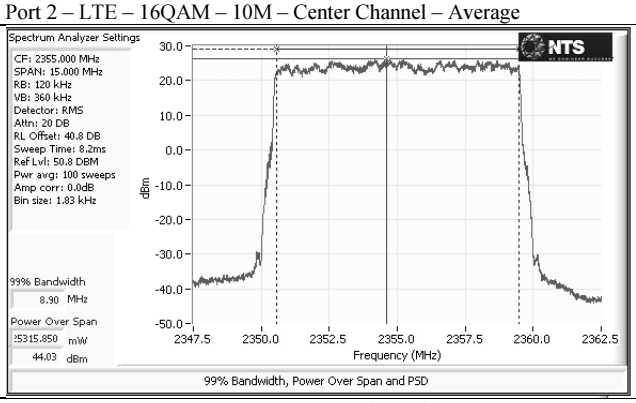
Port 2 – LTE – QPSK – 10M – Center Channel – Average



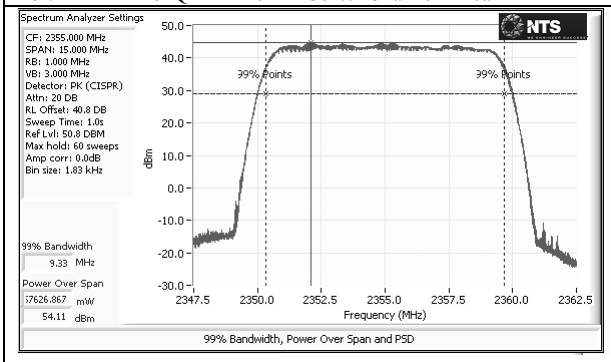
Port 2 – LTE – 16QAM – 10M – Center Channel – Peak



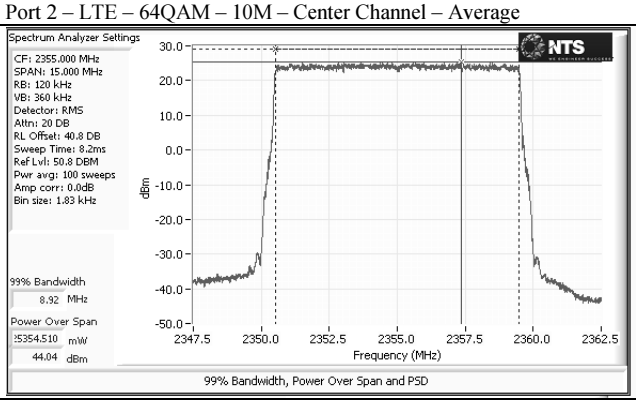
Port 2 – LTE – 16QAM – 10M – Center Channel – Average



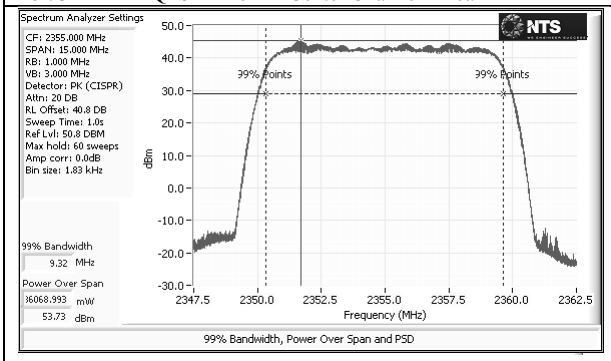
Port 2 – LTE – 64QAM – 10M – Center Channel – Peak



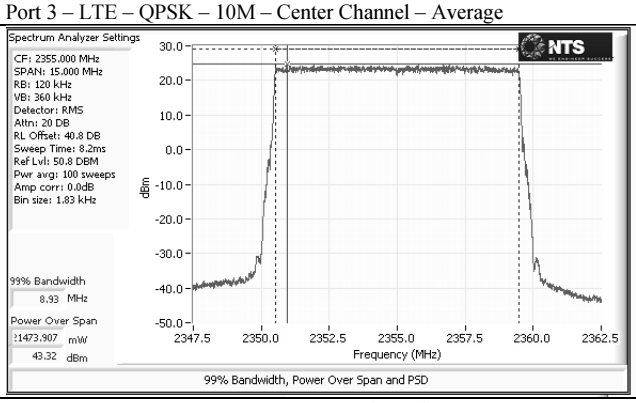
Port 2 – LTE – 64QAM – 10M – Center Channel – Average



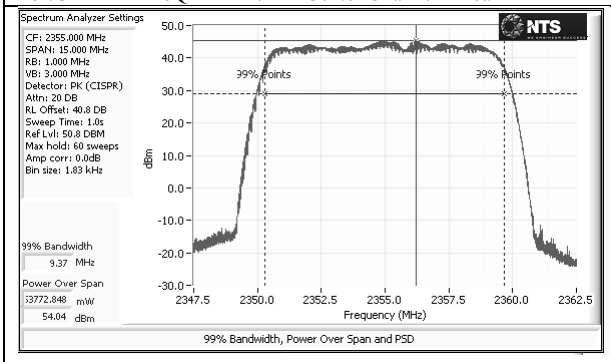
Port 3 – LTE – QPSK – 10M – Center Channel – Peak



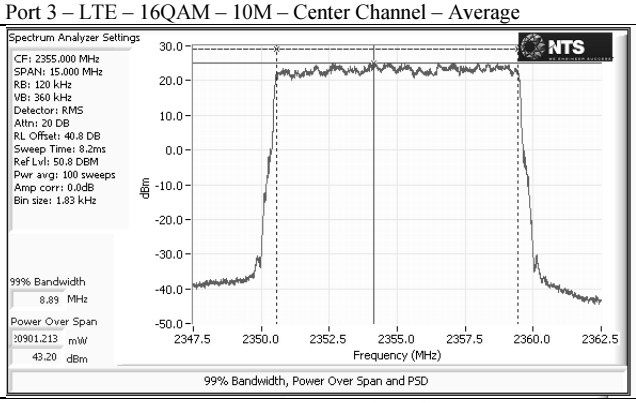
Port 3 – LTE – QPSK – 10M – Center Channel – Average



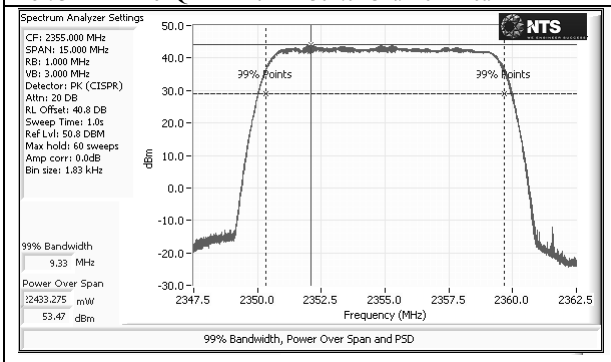
Port 3 – LTE – 16QAM – 10M – Center Channel – Peak



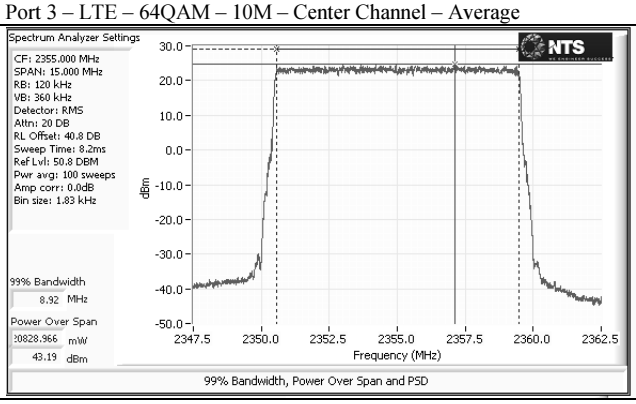
Port 3 – LTE – 16QAM – 10M – Center Channel – Average



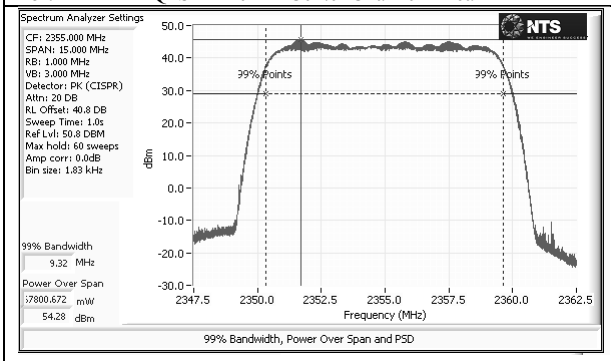
Port 3 – LTE – 64QAM – 10M – Center Channel – Peak



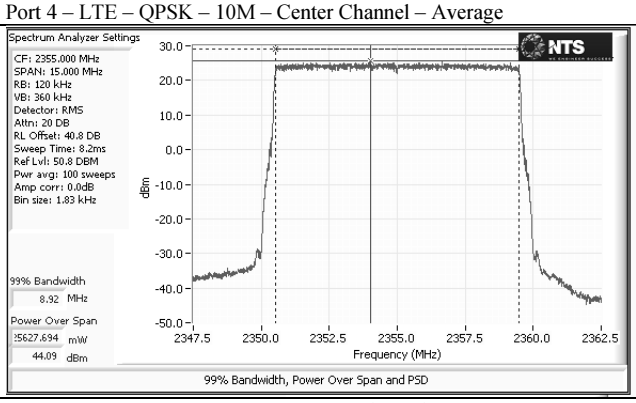
Port 3 – LTE – 64QAM – 10M – Center Channel – Average



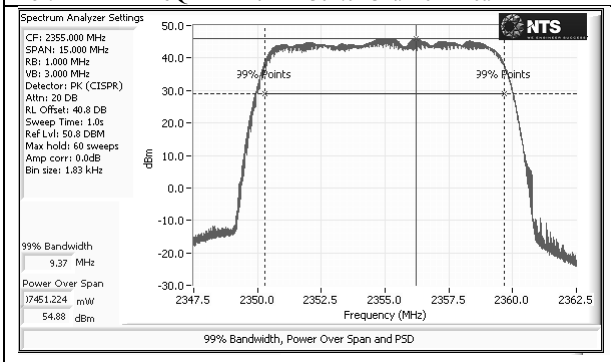
Port 4 – LTE – QPSK – 10M – Center Channel – Peak



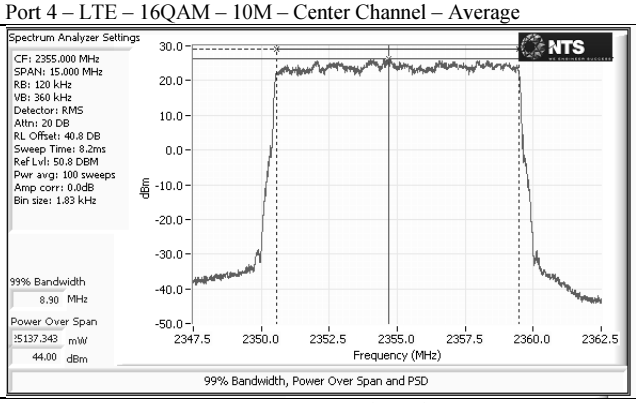
Port 4 – LTE – QPSK – 10M – Center Channel – Average



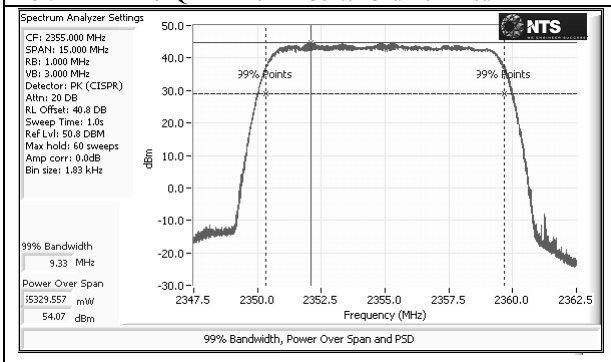
Port 4 – LTE – 16QAM – 10M – Center Channel – Peak



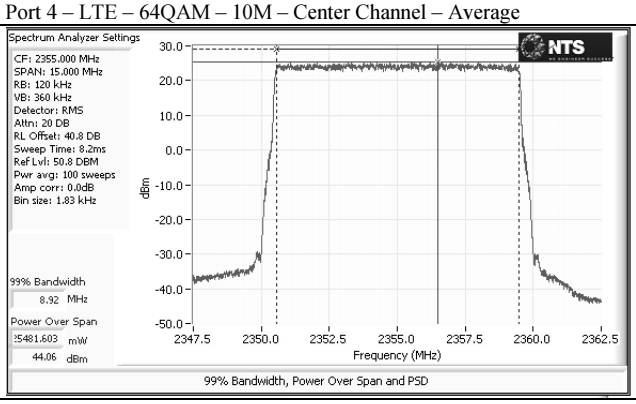
Port 4 – LTE – 16QAM – 10M – Center Channel – Average



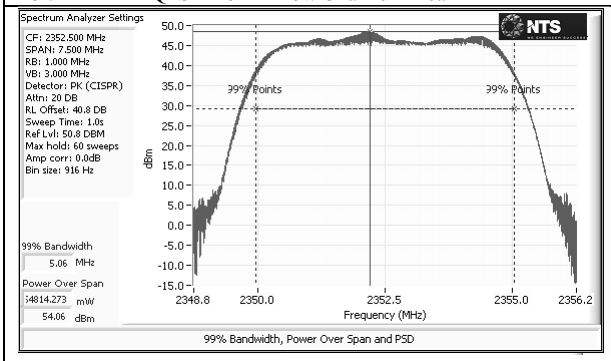
Port 4 – LTE – 64QAM – 10M – Center Channel – Peak



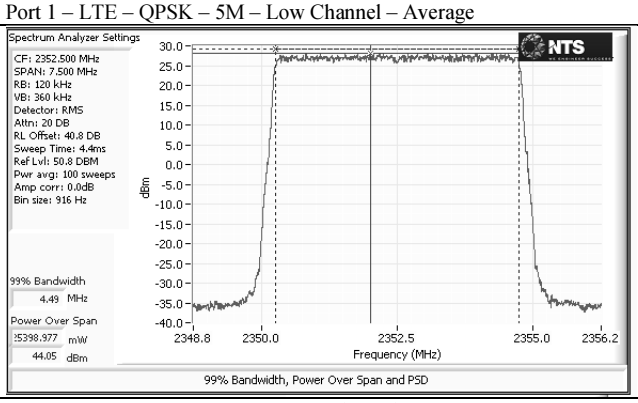
Port 4 – LTE – 64QAM – 10M – Center Channel – Average



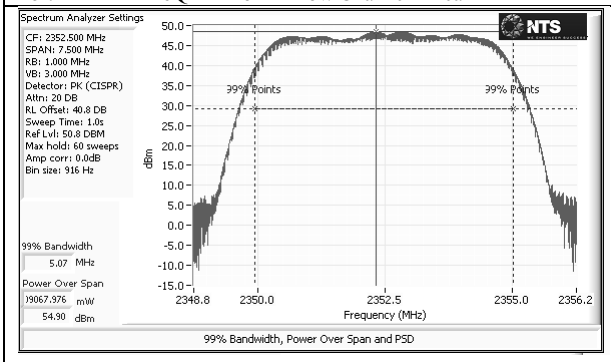
Port 1 – LTE – QPSK – 5M – Low Channel – Peak



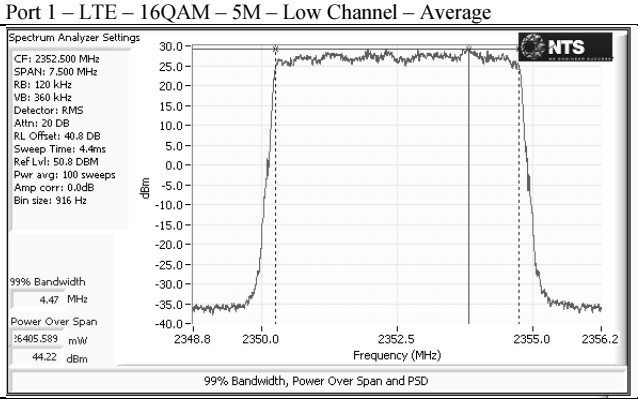
Port 1 – LTE – QPSK – 5M – Low Channel – Average



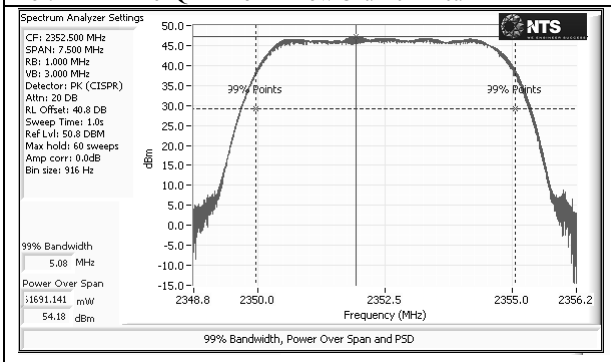
Port 1 – LTE – 16QAM – 5M – Low Channel – Peak



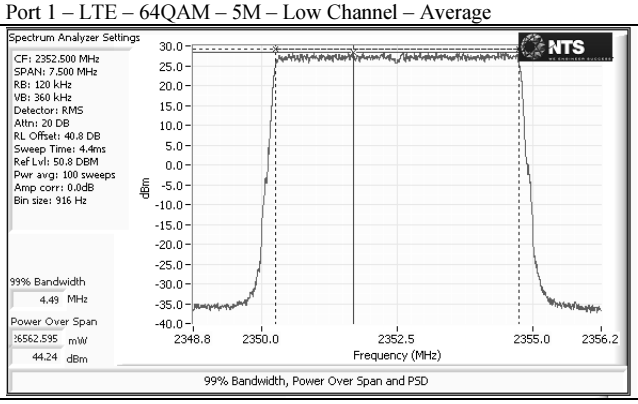
Port 1 – LTE – 16QAM – 5M – Low Channel – Average



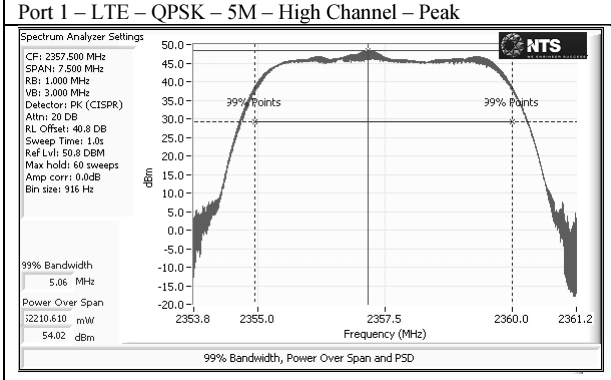
Port 1 – LTE – 64QAM – 5M – Low Channel – Peak



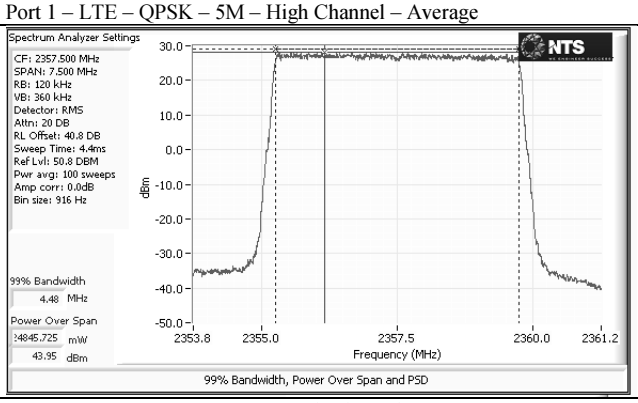
Port 1 – LTE – 64QAM – 5M – Low Channel – Average



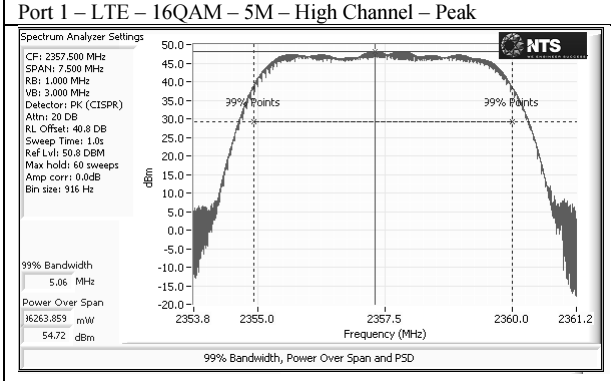
Port 1 – LTE – QPSK – 5M – High Channel – Peak



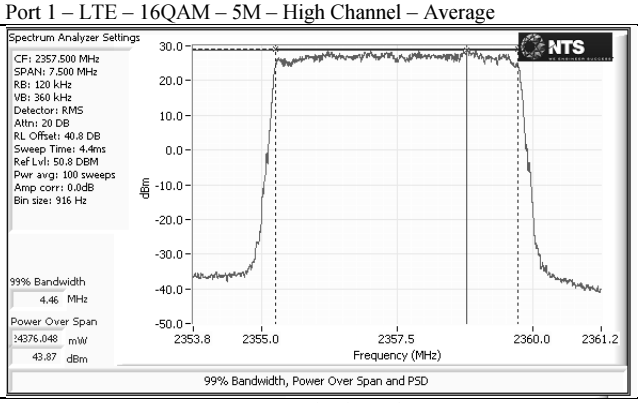
Port 1 – LTE – QPSK – 5M – High Channel – Average



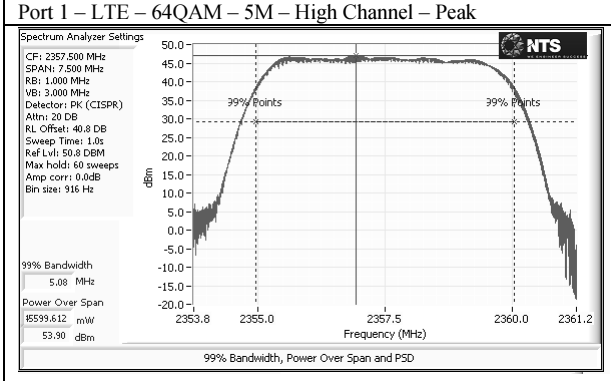
Port 1 – LTE – 16QAM – 5M – High Channel – Peak



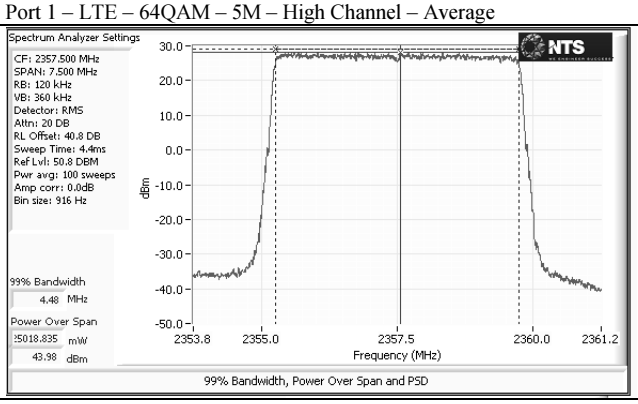
Port 1 – LTE – 16QAM – 5M – High Channel – Average



Port 1 – LTE – 64QAM – 5M – High Channel – Peak



Port 1 – LTE – 64QAM – 5M – High Channel – Average



Emission Bandwidths (26dB and 99%)

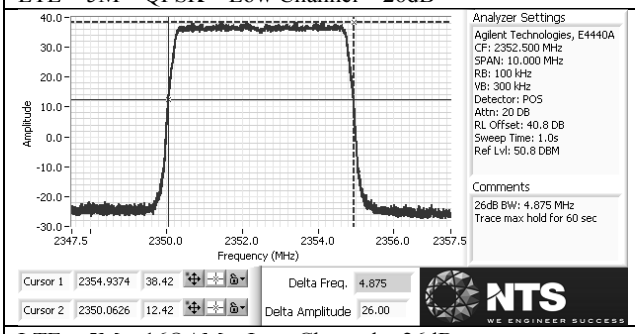
Emissions bandwidths were measured at Port 1 on low and high channels in 5MHz channel bandwidth mode and on center channel in 10MHz channel bandwidth mode for all modulations and results presented below.

	LTE - QPSK				LTE - 16QAM				LTE - 64QAM			
	Low		High		Low		High		Low		High	
	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)
5M	4.875	4.491	4.875	4.49	4.859	4.485	4.849	4.482	**4.882**	**4.506**	4.882	4.5

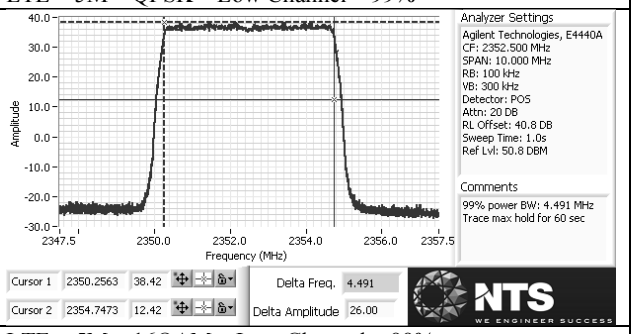
	LTE - QPSK		LTE - 16QAM		LTE - 64QAM	
	Center		Center		Center	
	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)
10M	9.72	8.984	9.708	**8.997**	**9.767**	8.979

Corresponding plots included on the following pages.

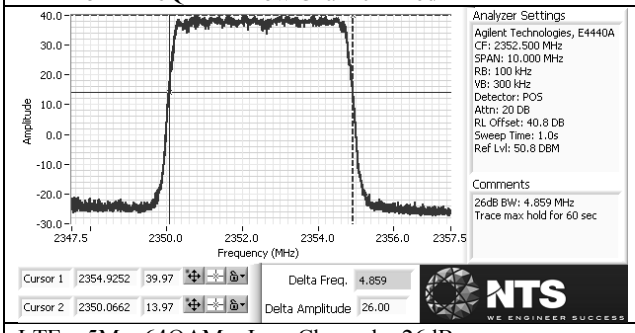
LTE – 5M – QPSK – Low Channel – 26dB



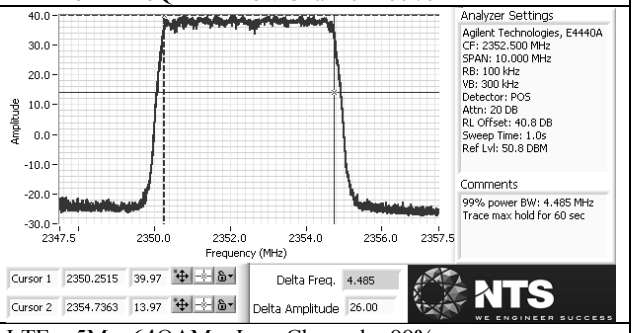
LTE – 5M – QPSK – Low Channel – 99%



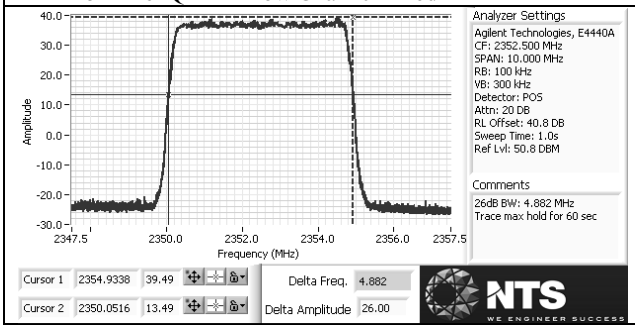
LTE – 5M – 16QAM – Low Channel – 26dB



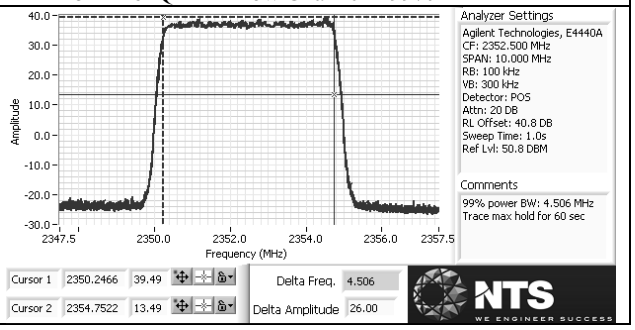
LTE – 5M – 16QAM – Low Channel – 99%



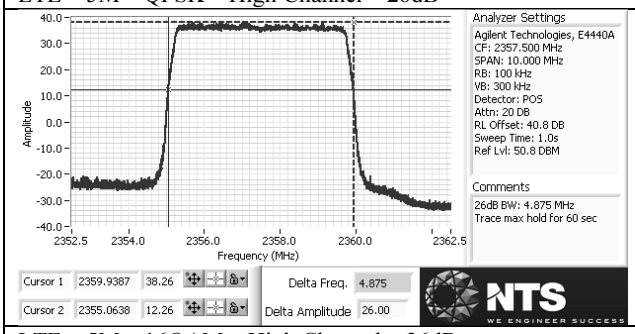
LTE – 5M – 64QAM – Low Channel – 26dB



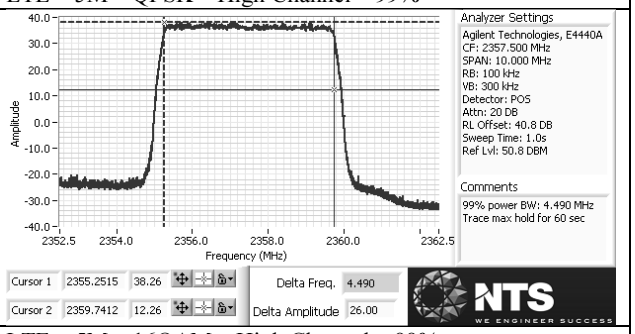
LTE – 5M – 64QAM – Low Channel – 99%



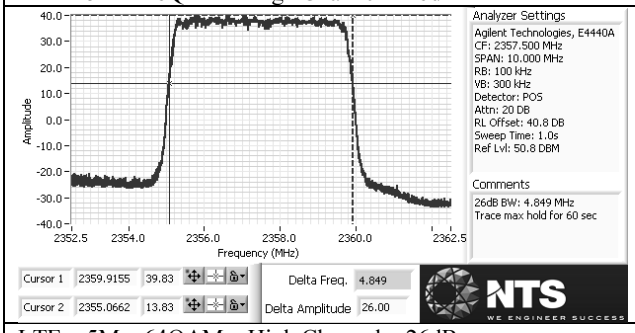
LTE – 5M – QPSK – High Channel – 26dB



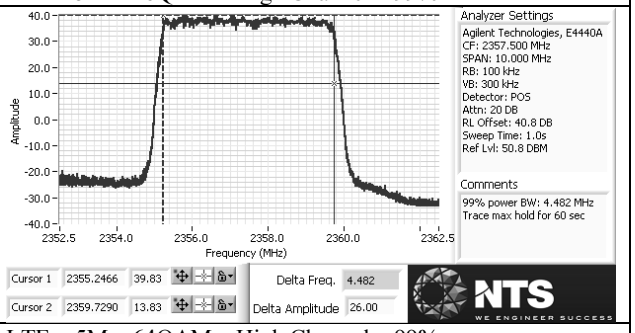
LTE – 5M – QPSK – High Channel – 99%



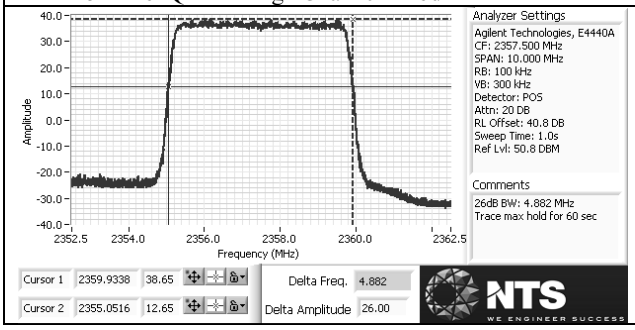
LTE – 5M – 16QAM – High Channel – 26dB



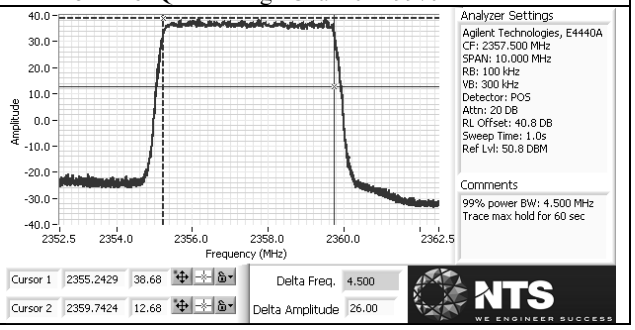
LTE – 5M – 16QAM – High Channel – 99%



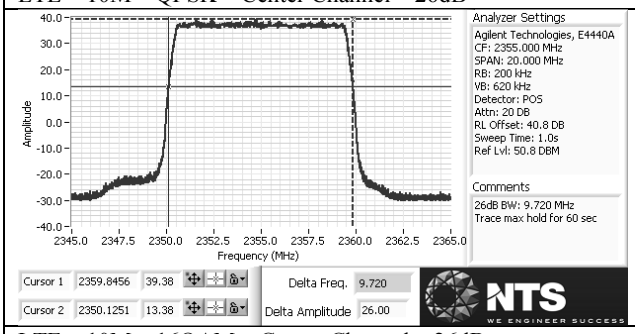
LTE – 5M – 64QAM – High Channel – 26dB



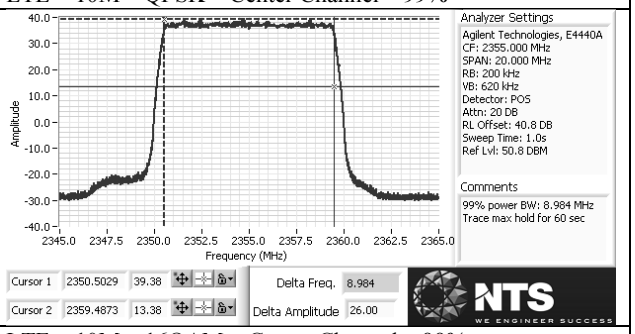
LTE – 5M – 64QAM – High Channel – 99%



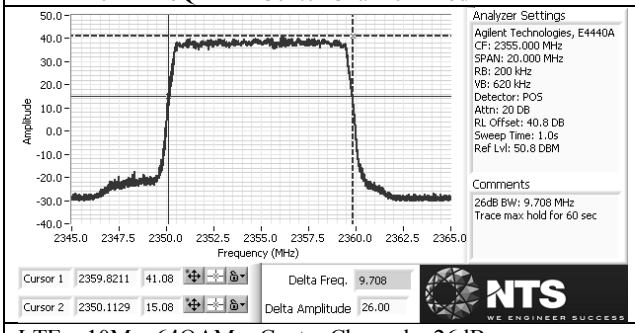
LTE – 10M – QPSK – Center Channel – 26dB



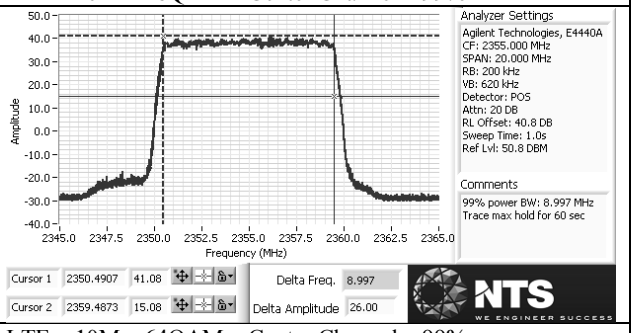
LTE – 10M – QPSK – Center Channel – 99%



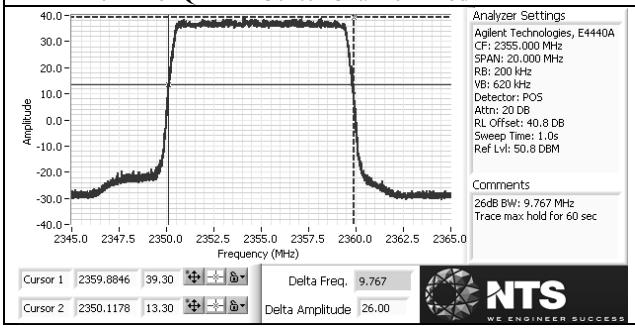
LTE – 10M – 16QAM – Center Channel – 26dB



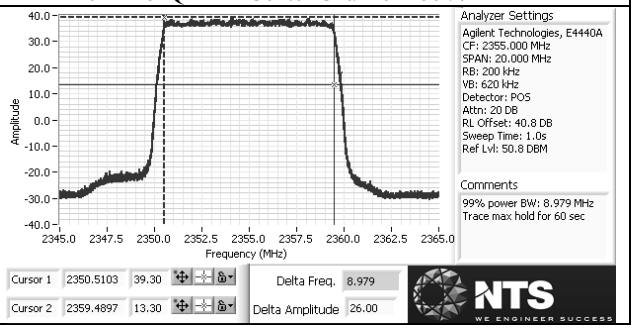
LTE – 10M – 16QAM – Center Channel – 99%



LTE – 10M – 64QAM – Center Channel – 26dB



LTE – 10M – 64QAM – Center Channel – 99%



Antenna Port Conducted Bandedge

Limits below reflect reduction by 10*log(4) per FCC KDB 662911D01 v02r01 due to 4x4 MIMO operation.

Frequency (MHz)		Limit (dBm)
<2200		-19.0206
2200	2285	-51.0206
2285	2287.5	-48.0206
2287.5	2300	-46.0206
2300	2305	-19.0206
2305	2320	-19.0206
2320	2345	-51.0206
2345	2360	-19.0206
2360	2362.5	-19.0206
2362.5	2365	-31.0206
2365	2367.5	-46.0206
2367.5	2370	-48.0206
2370	2395	-51.0206
>2395		-19.0206

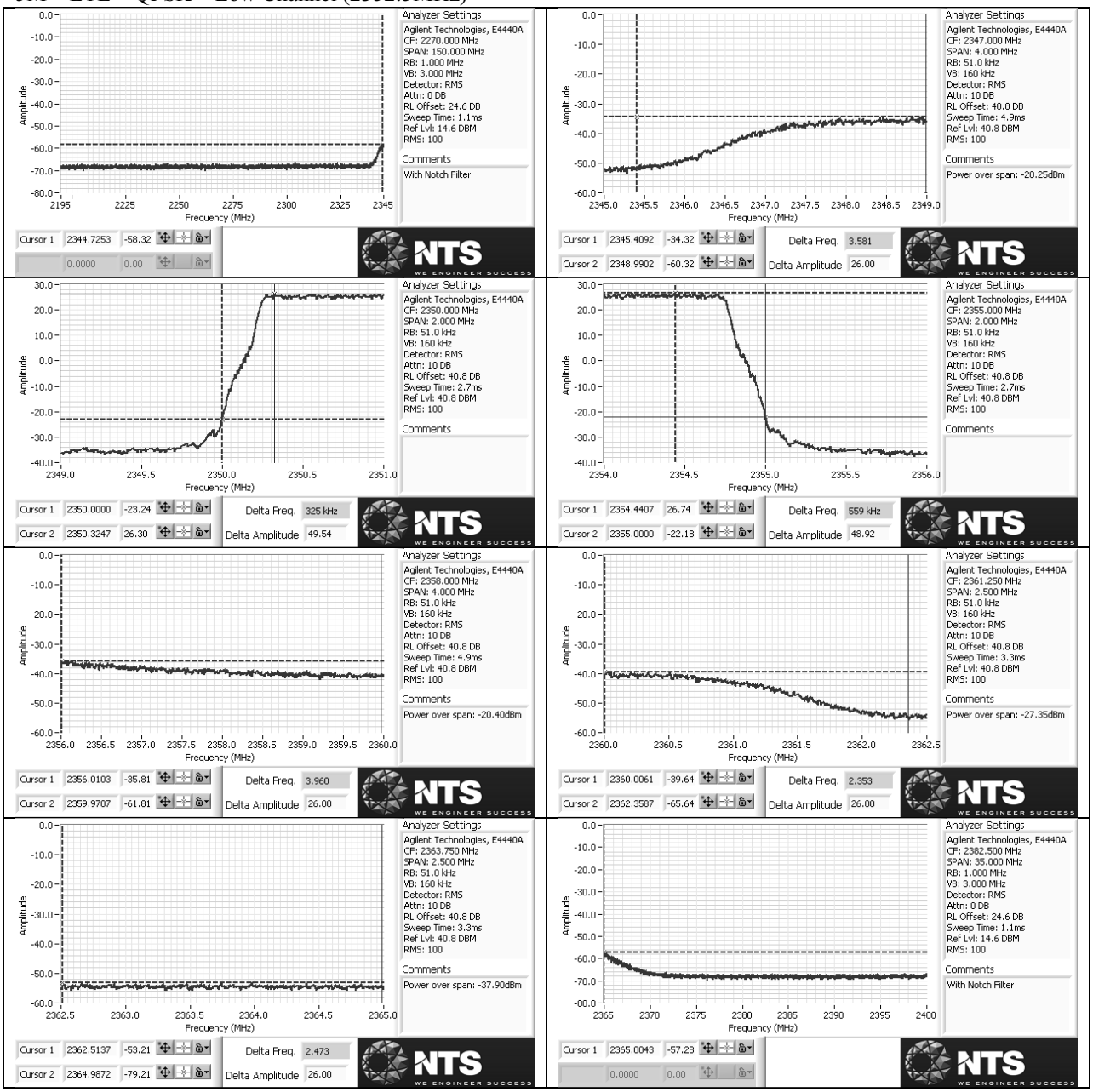
In 5MHz channel bandwidth mode, low and high channels as well as dual carrier mode (low channel + high channel) configurations were tested. In 10MHz channel bandwidth mode, unit can only operate in single carrier mode at the center channel.

Results summary:

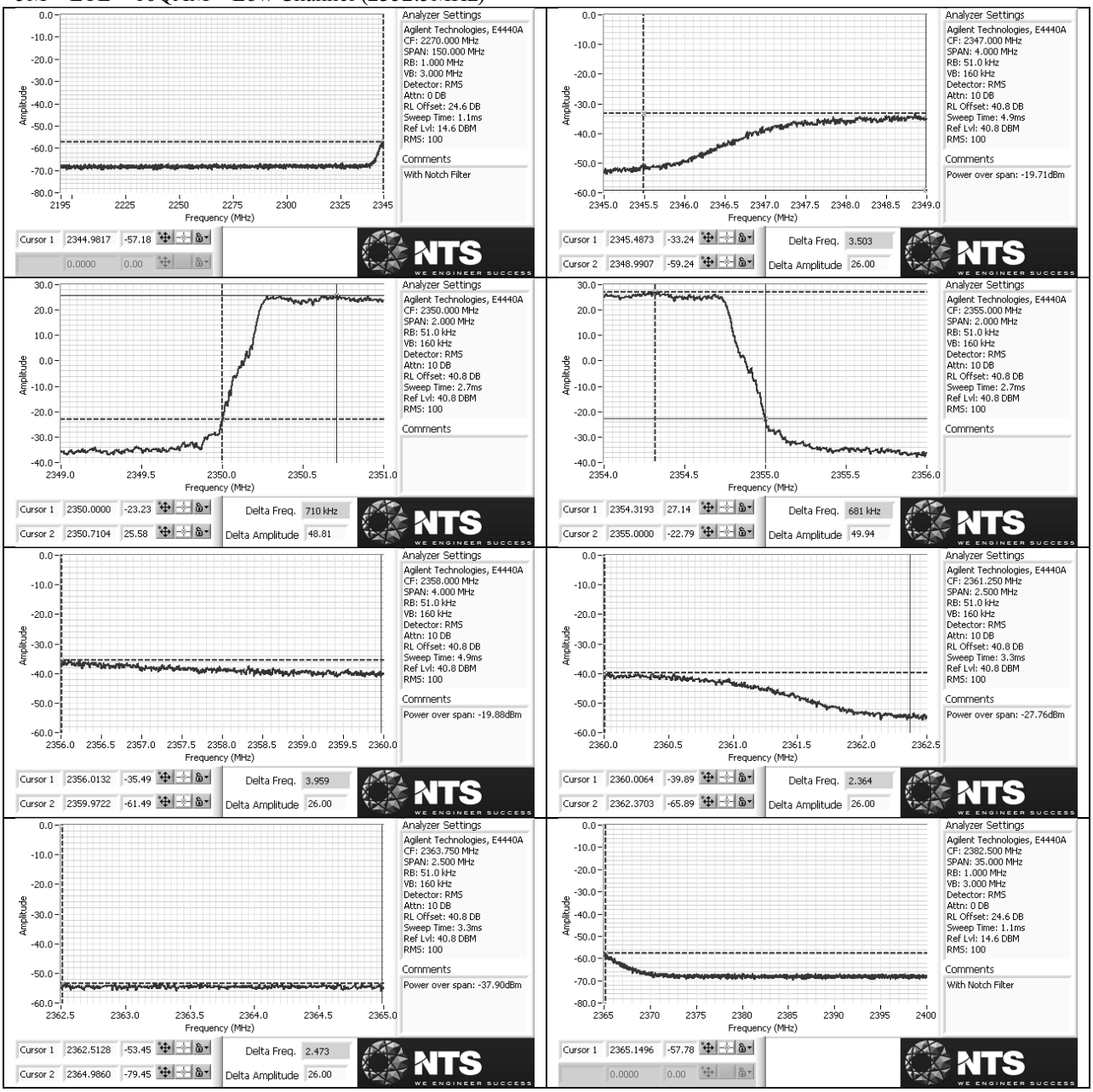
	LTE - QPSK				LTE - 16QAM				LTE - 64QAM			
	Low		High		Low		High		Low		High	
5M	-23.24	-22.18	-23.05	-23.94	-23.23	-22.79	-24.1	-24.11	-23.78	-22.11	-24.84	-22.61
10M	-24.46		-24.33		-25.8		-26.37		-25.68		-25.56	
5M Dual	-25.7		-25.63		-26.57		-25.99		-26.42		-25.25	

Measurements were performed at Port 1 in RMS average mode over 100 traces. In 1MHz bands immediately outside and adjacent to the frequency blocks, RBW was reduced to 1% of the emission bandwidth. In 2345-2354MHz and 2361-2365MHz bands, RBW was again reduced to 1% of the emission bandwidth and power was integrated. A notch filter supplied by the customer was characterized for insertion loss and used to measure emissions in the 2195MHz-2345MHz and 2365MHz-2400MHz ranges to reduce measurement instrumentation noise floor. For all measurements insertion losses were factored in via reference level offset to the spectrum analyzer and settings are shown on corresponding plots on the following pages.

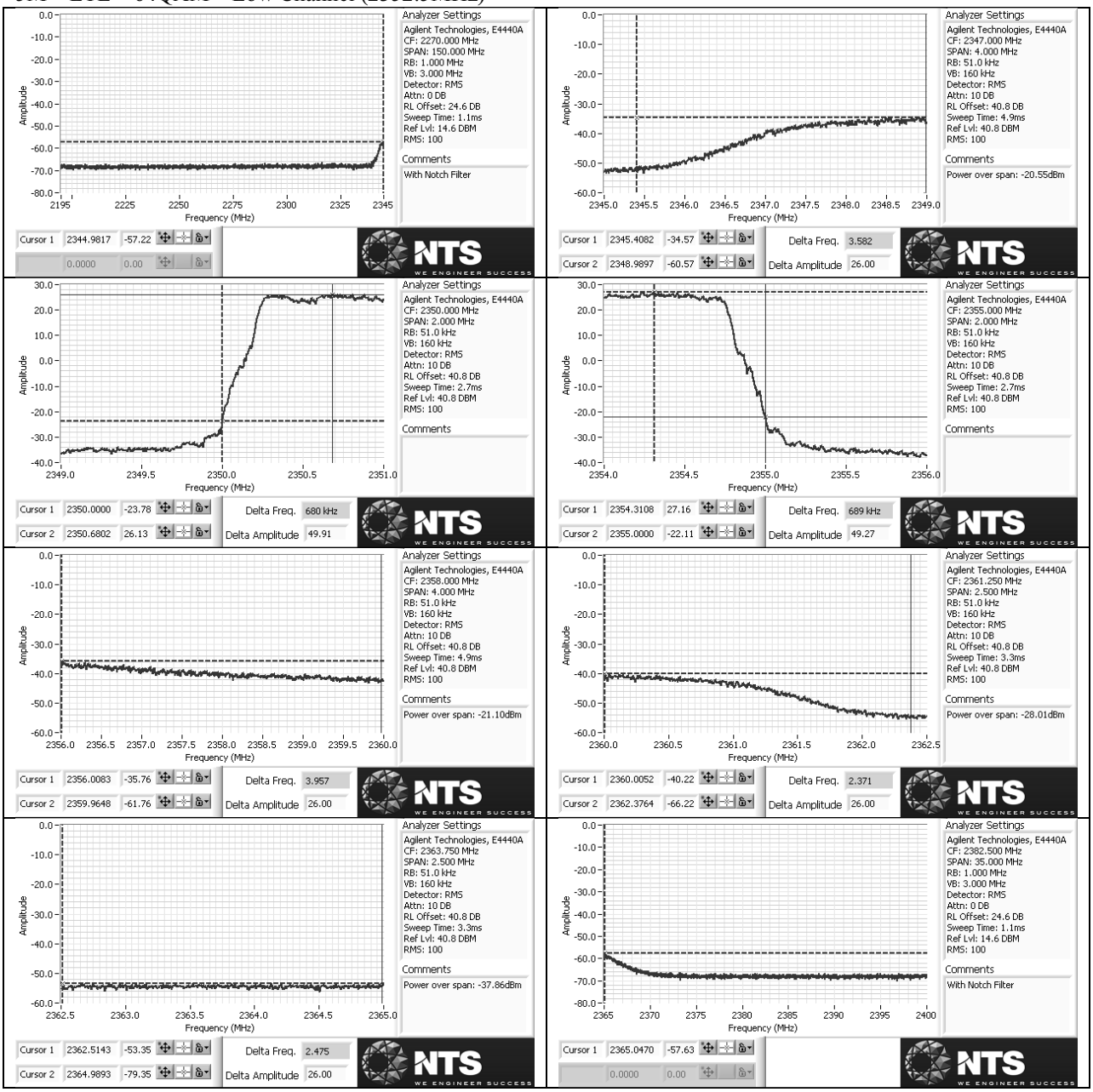
5M – LTE – QPSK – Low Channel (2352.5MHz)



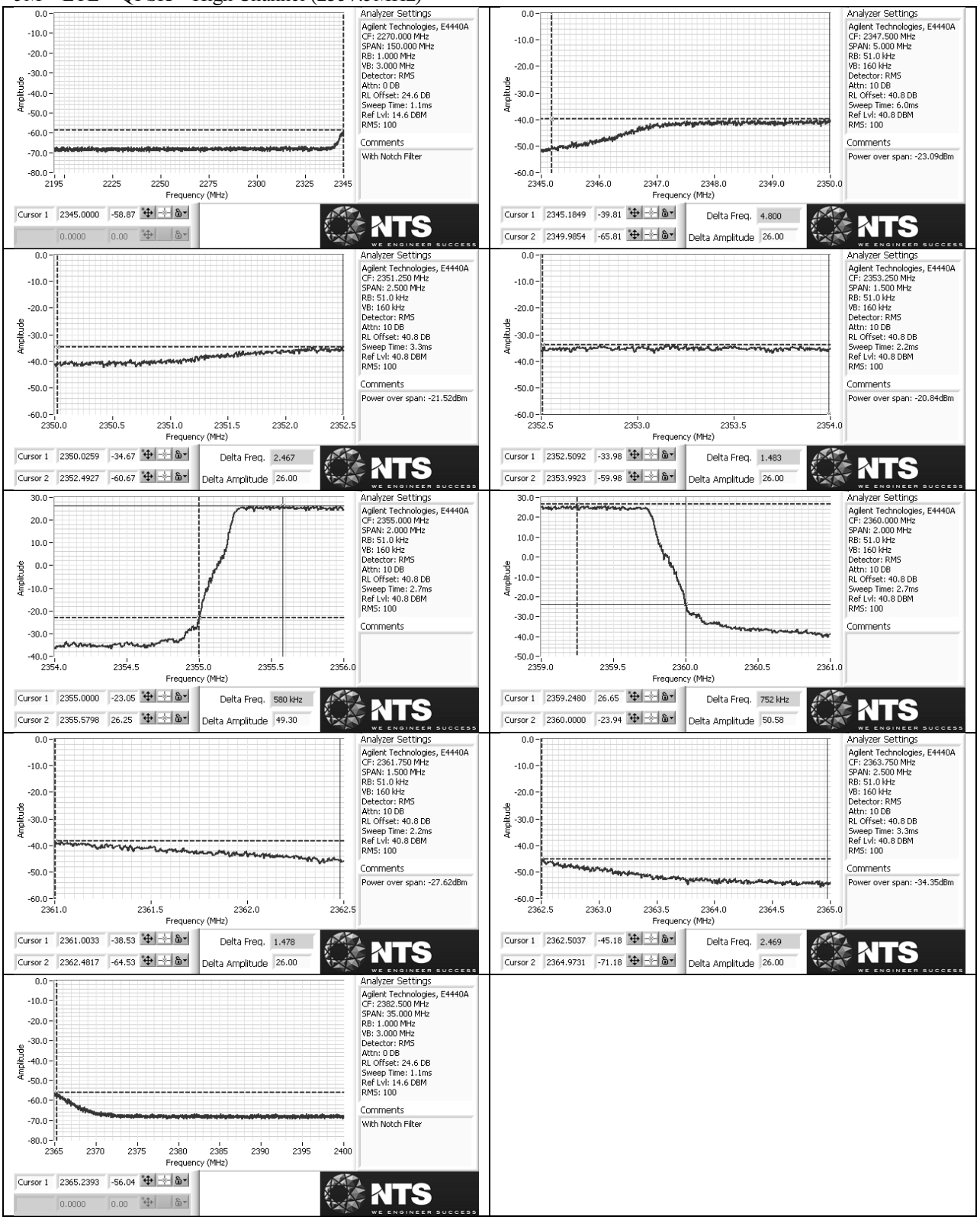
5M – LTE – 16QAM – Low Channel (2352.5MHz)



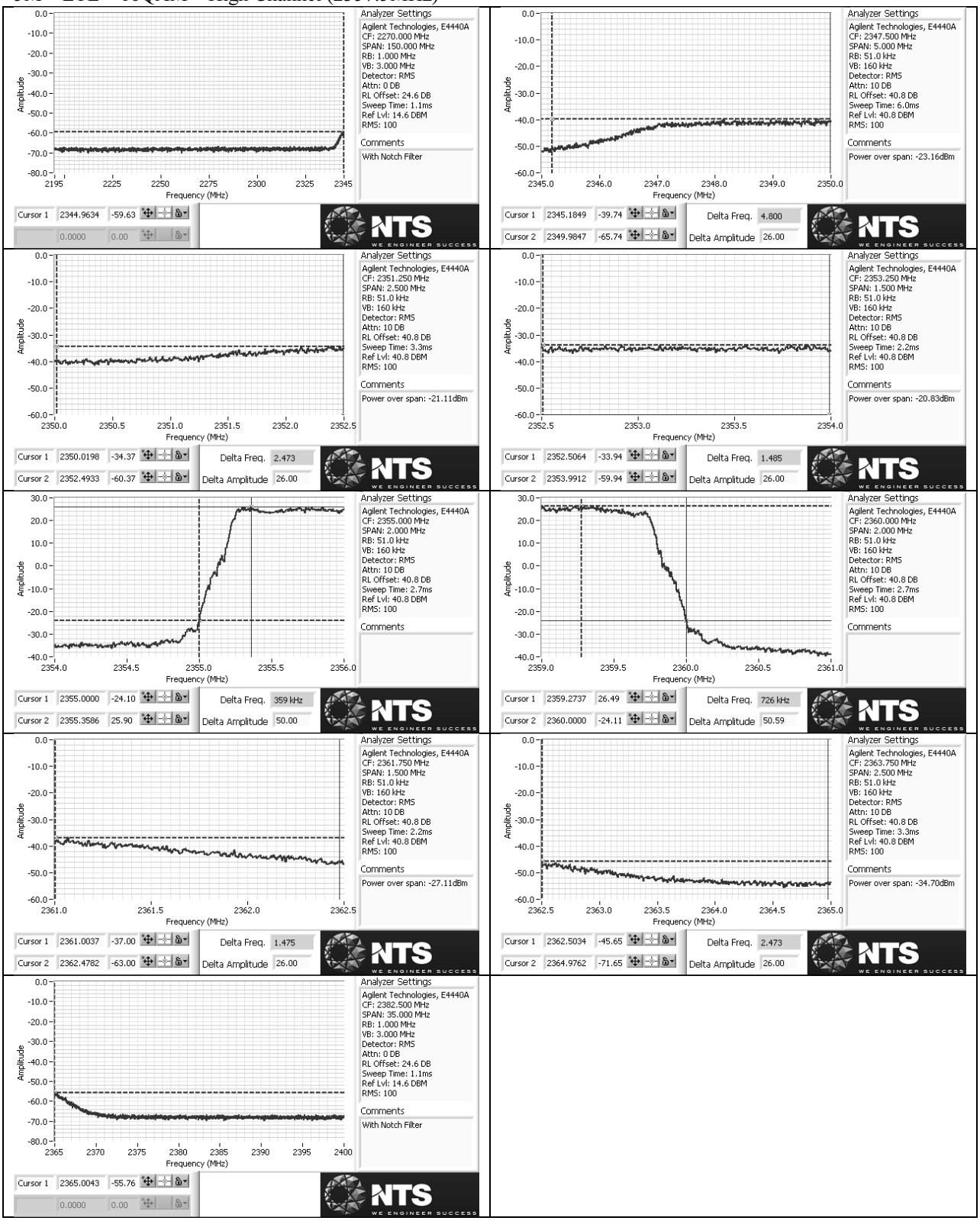
5M – LTE – 64QAM – Low Channel (2352.5MHz)



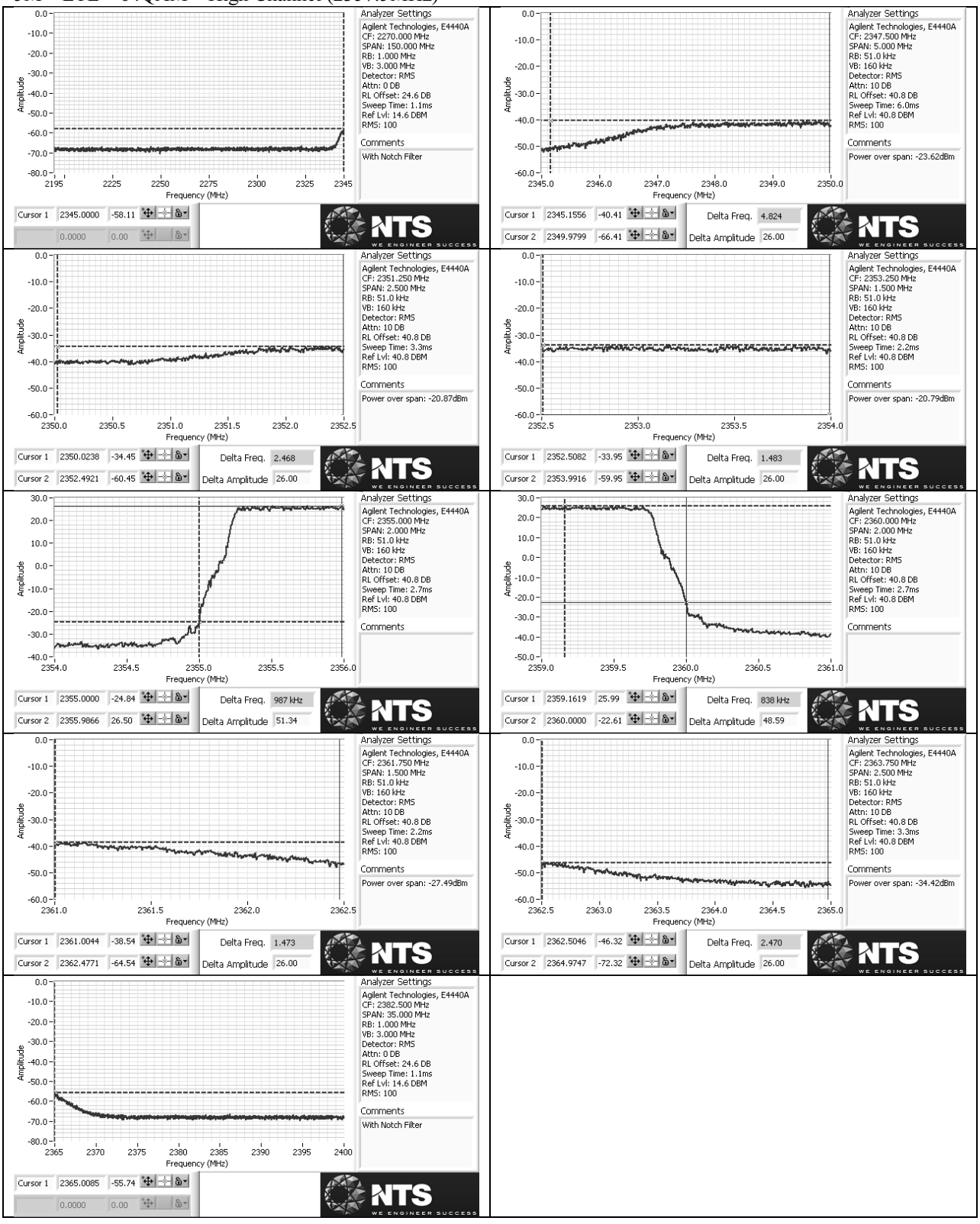
5M – LTE – QPSK – High Channel (2357.5MHz)



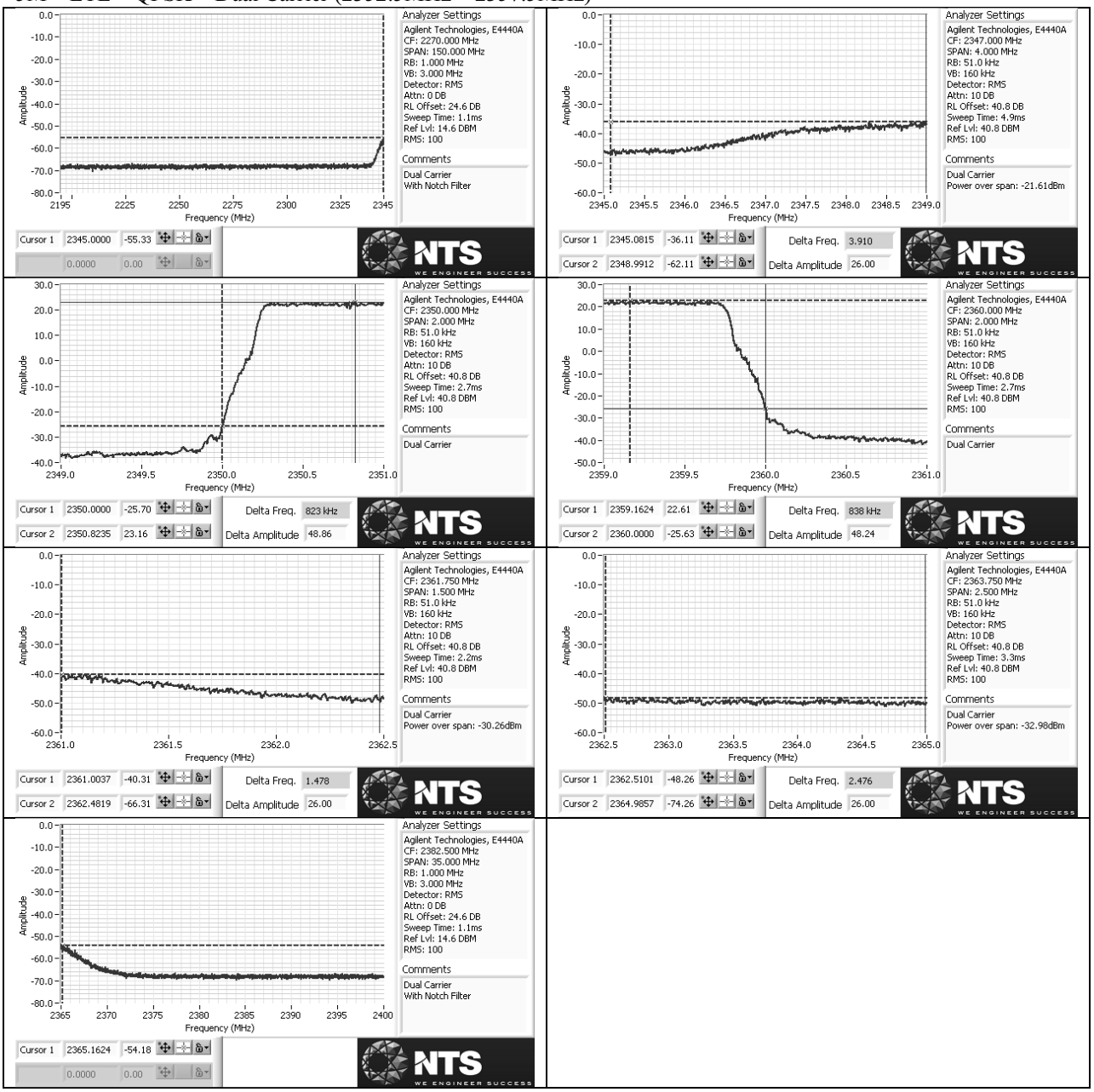
5M – LTE – 16QAM – High Channel (2357.5MHz)



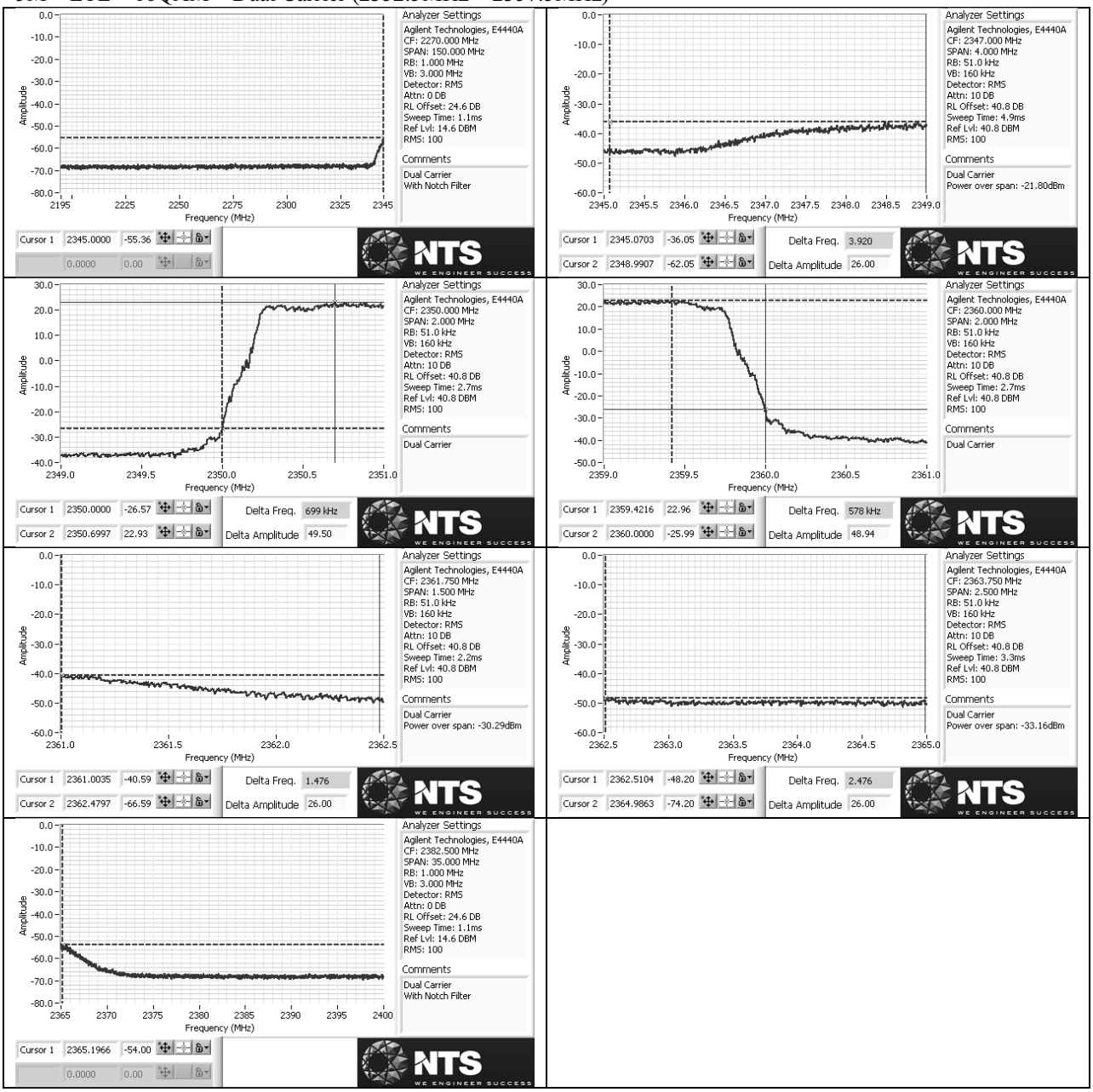
5M – LTE – 64QAM – High Channel (2357.5MHz)



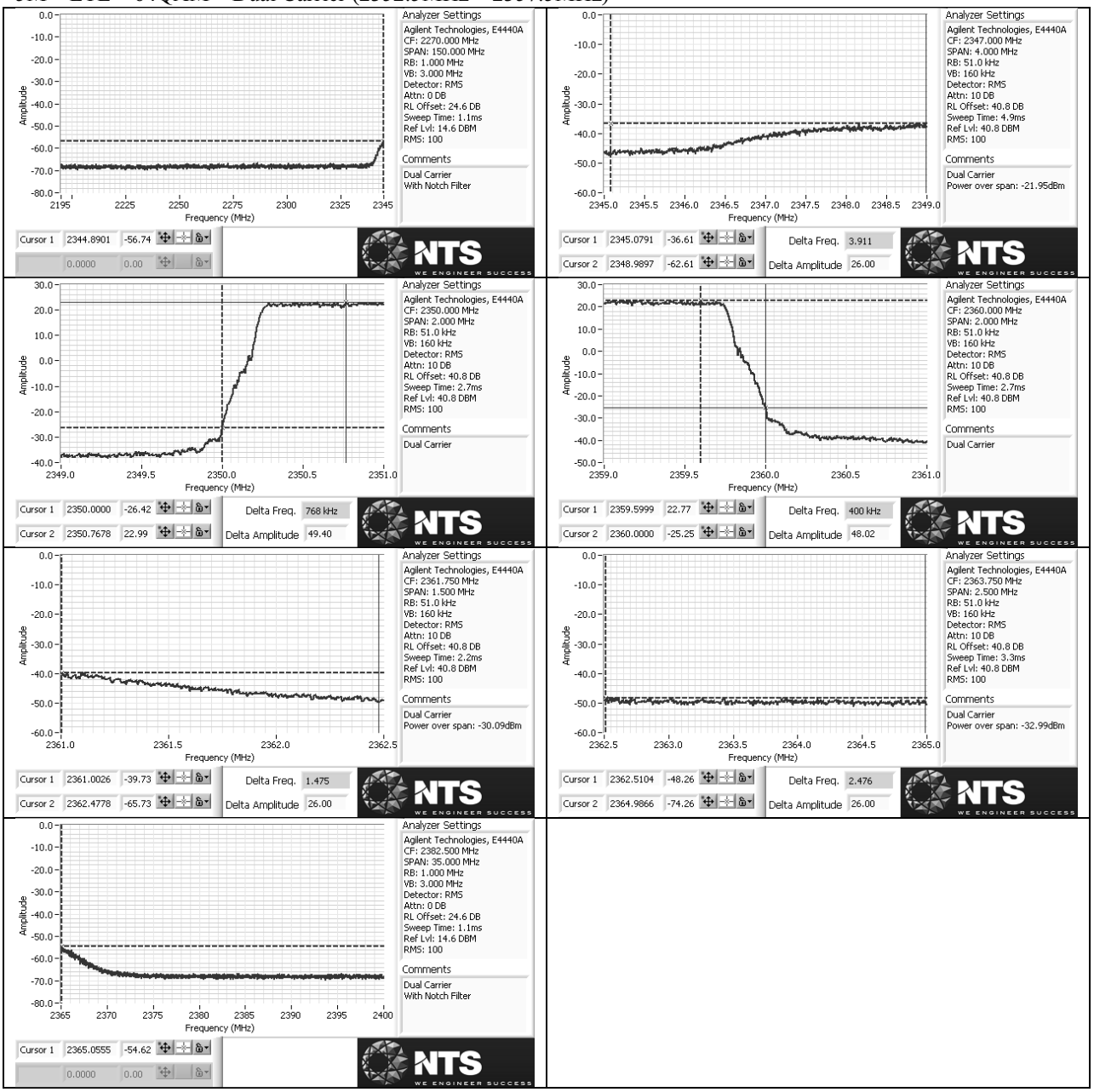
5M – LTE – QPSK – Dual Carrier (2352.5MHz + 2357.5MHz)



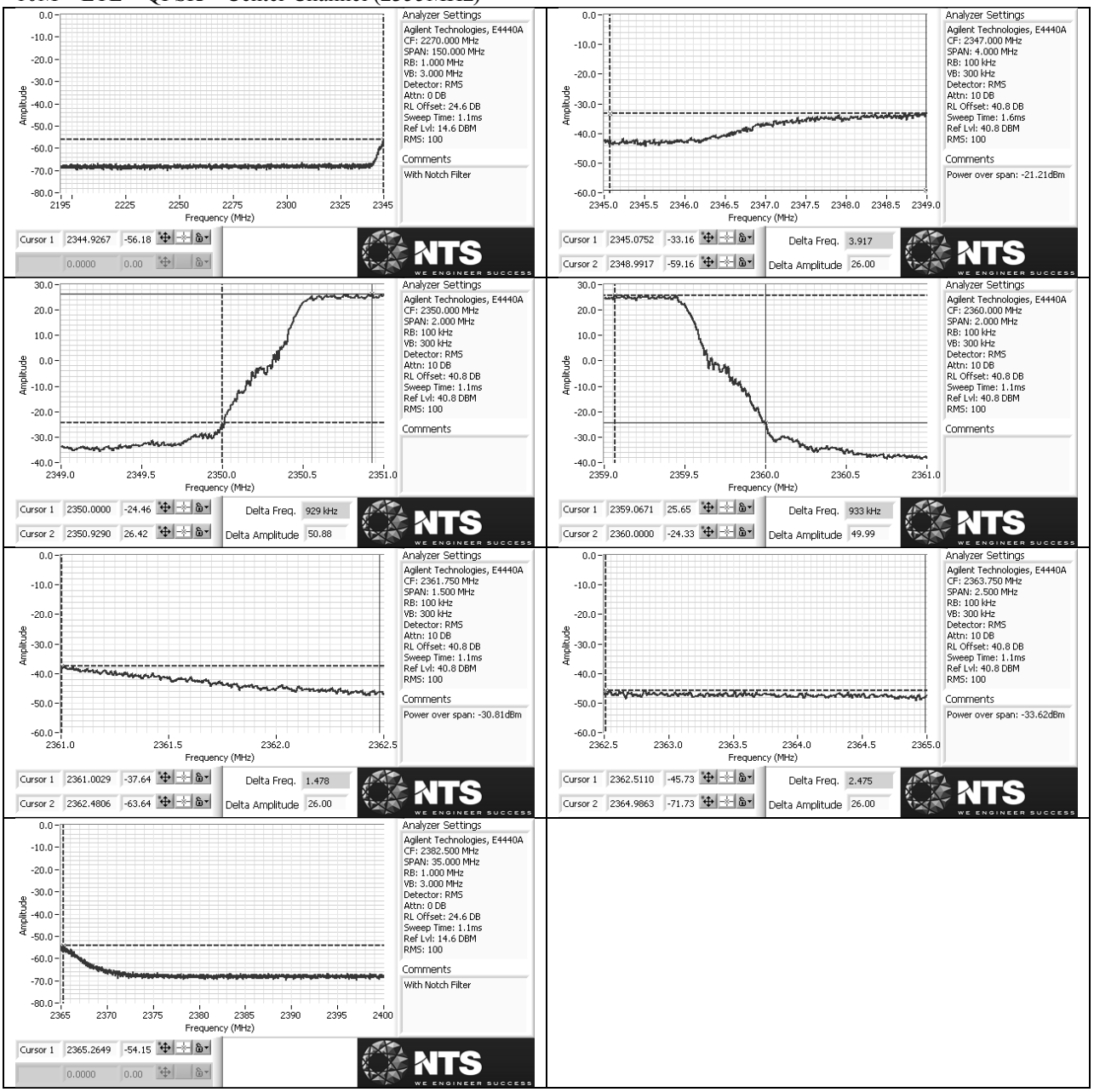
5M – LTE – 16QAM – Dual Carrier (2352.5MHz + 2357.5MHz)



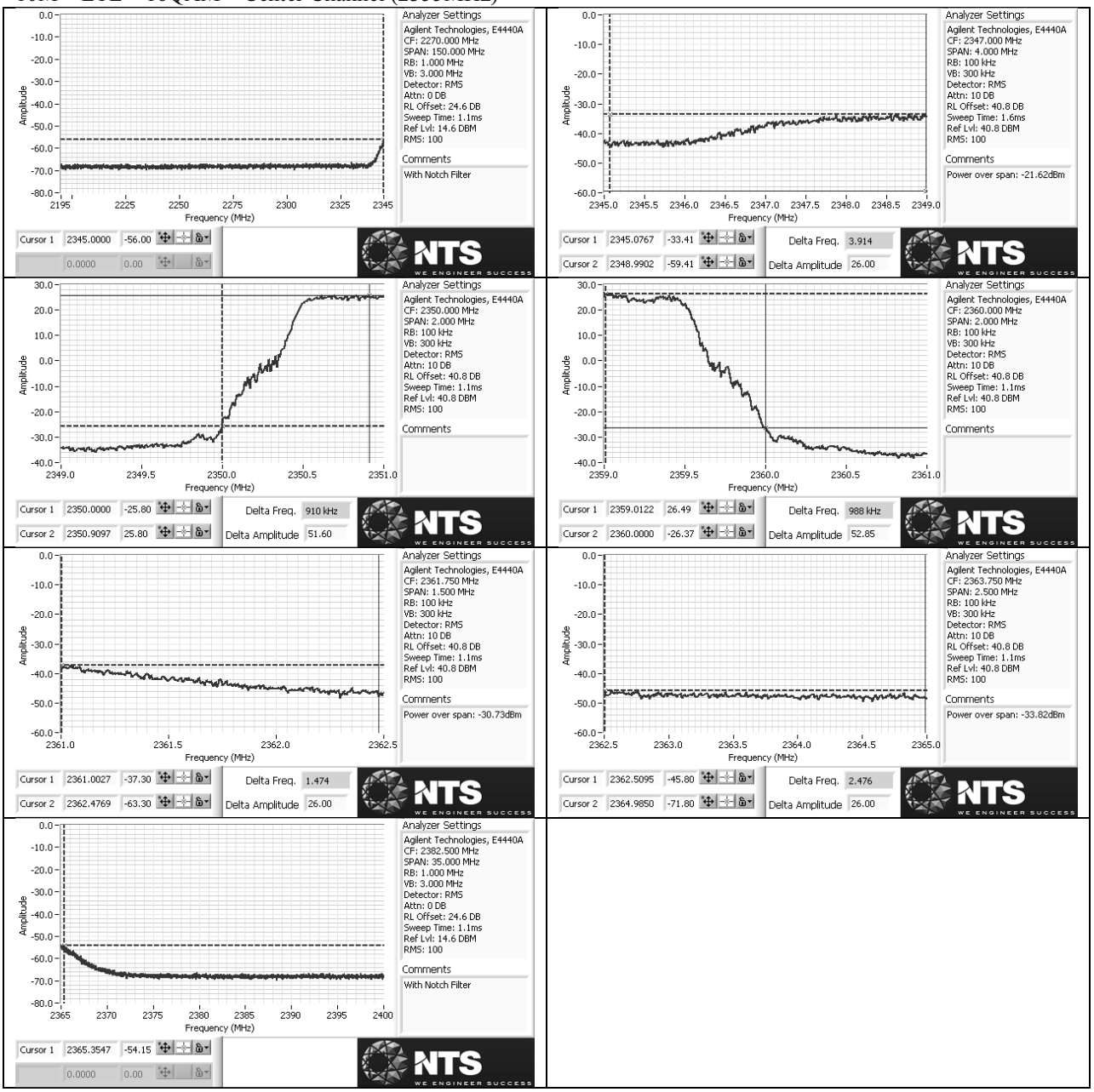
5M – LTE – 64QAM – Dual Carrier (2352.5MHz + 2357.5MHz)



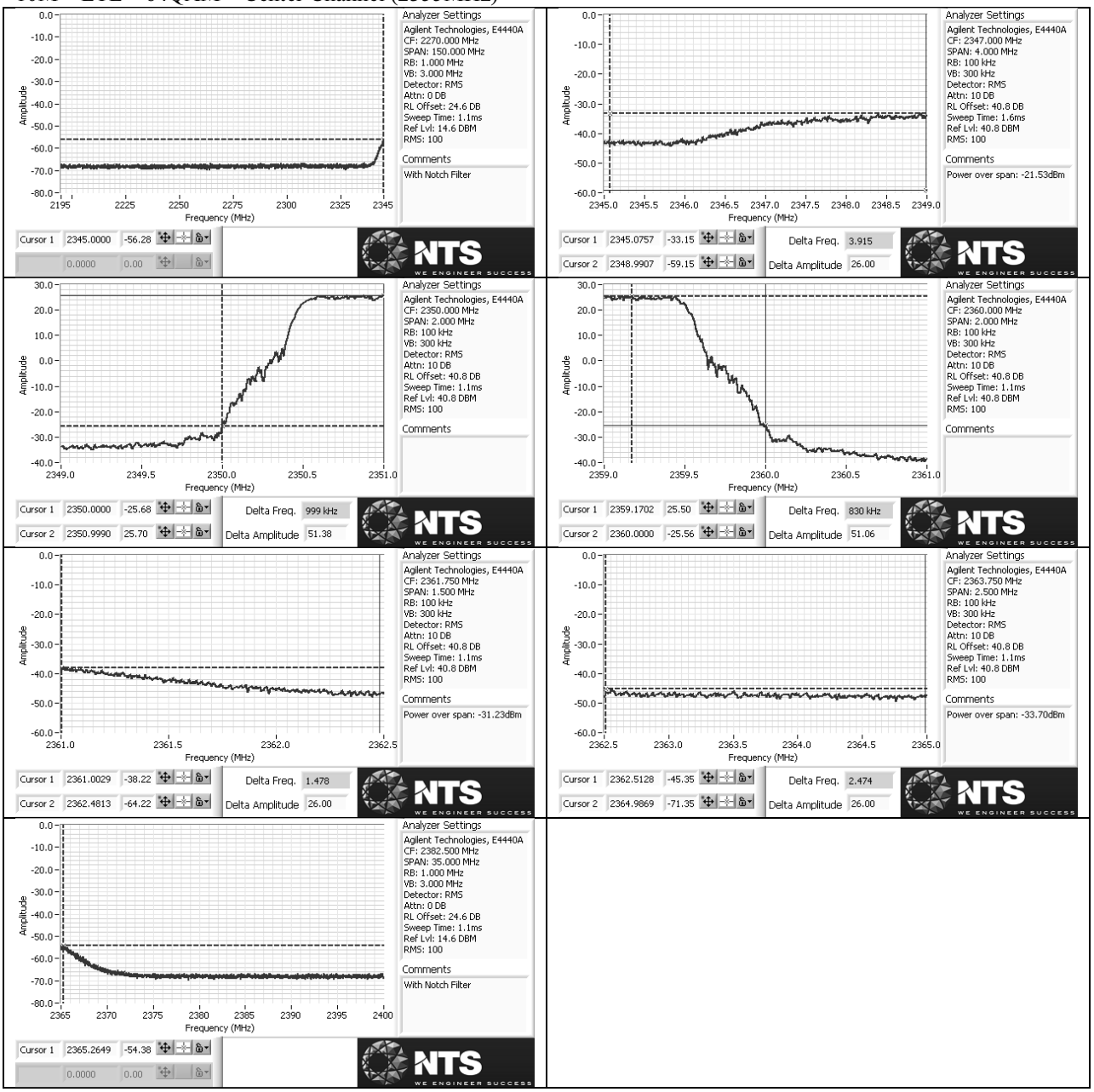
10M – LTE – QPSK – Center Channel (2355MHz)



10M – LTE – 16QAM – Center Channel (2355MHz)



10M – LTE – 64QAM – Center Channel (2355MHz)



Transmitter Antenna Port Conducted Spurious Emissions

Tests performed at Port 1 on center channel for all modulations and bandwidth modes. Due to 4x4 MIMO operation, limit is -19.03dBm (-13dBm – 10*log(4)) per FCC KDB 662911D01 v02r01.

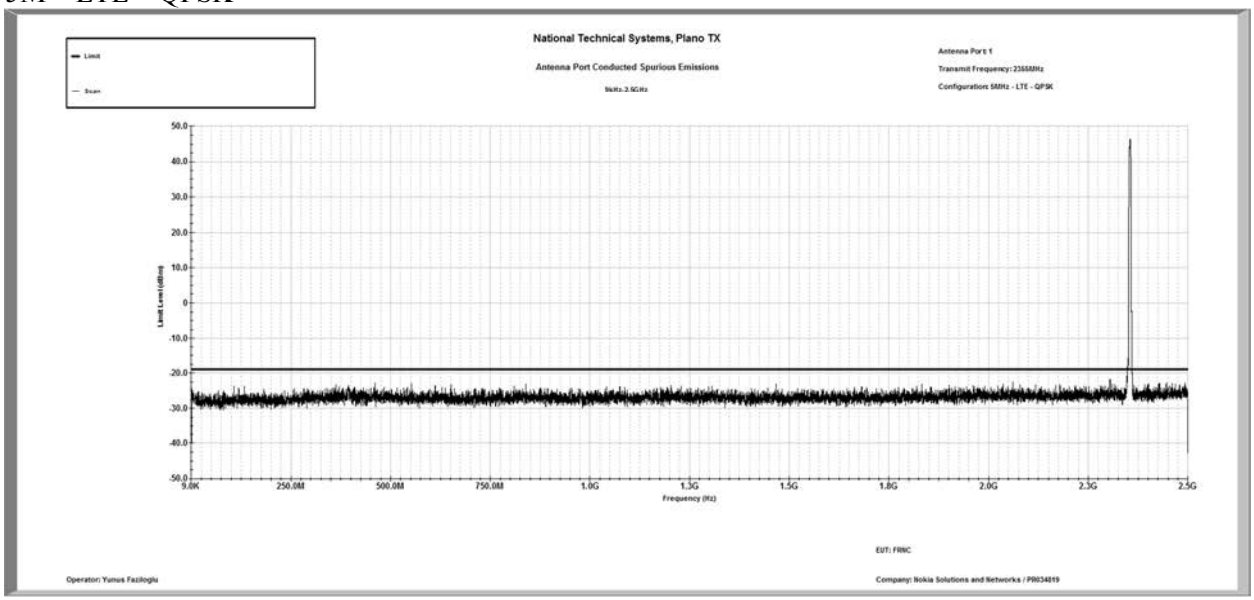
TILE6 measurement software was used during testing with the following settings:

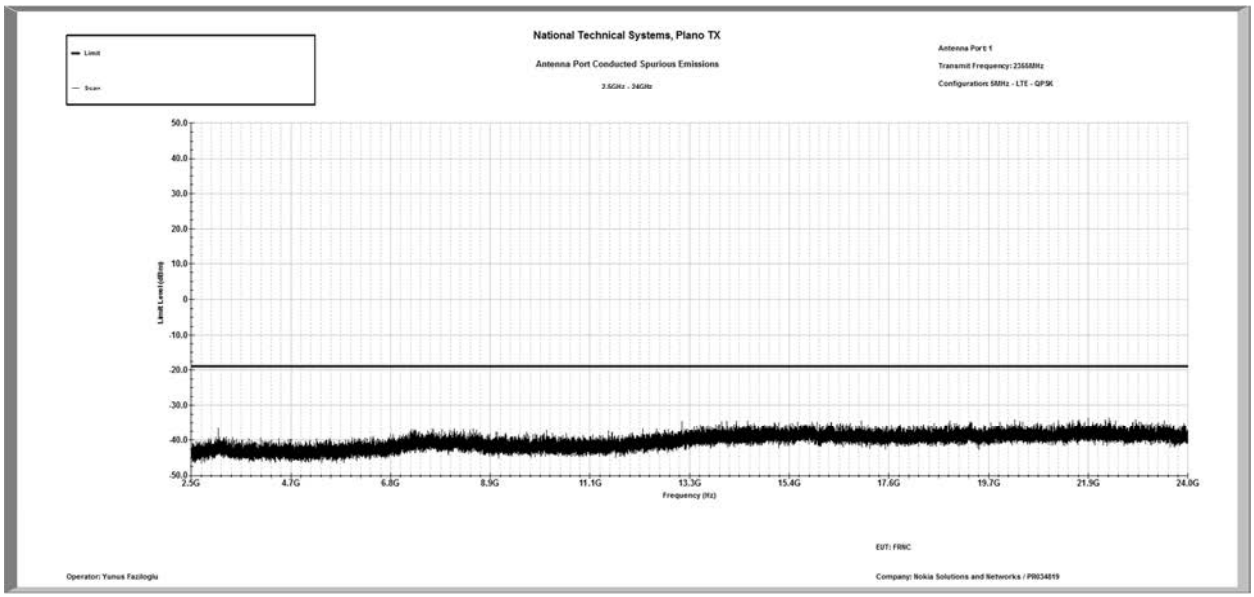
Frequency Range	RBW	VBW	Number of data points	Divided into	Detector	Sweep Time	Max hold over
9kHz-150kHz	1kHz	3kHz	8000	1 segment	Peak	Auto	50 sweeps
150kHz-1.5MHz	100kHz	300kHz	8000	1 segments	Peak	Auto	50 sweeps
1.5MHz-2.5GHz	1MHz	3MHz	8000	3 segments	Peak	Auto	50 sweeps
2.5GHz-24GHz	1MHz	3MHz	8000	10 segments	Peak	Auto	50 sweeps

Above 2.5GHz, in order to reduce the measurement instrumentation noise floor a high pass filter has been used to block the fundamental.

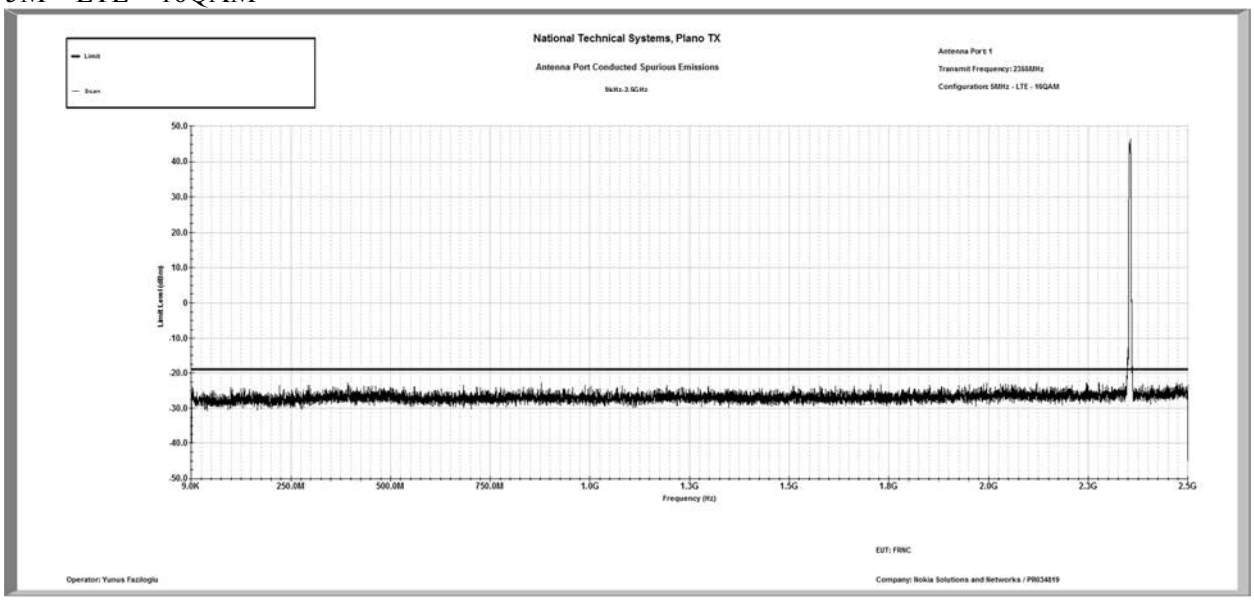
Corresponding plots are included on the following pages.

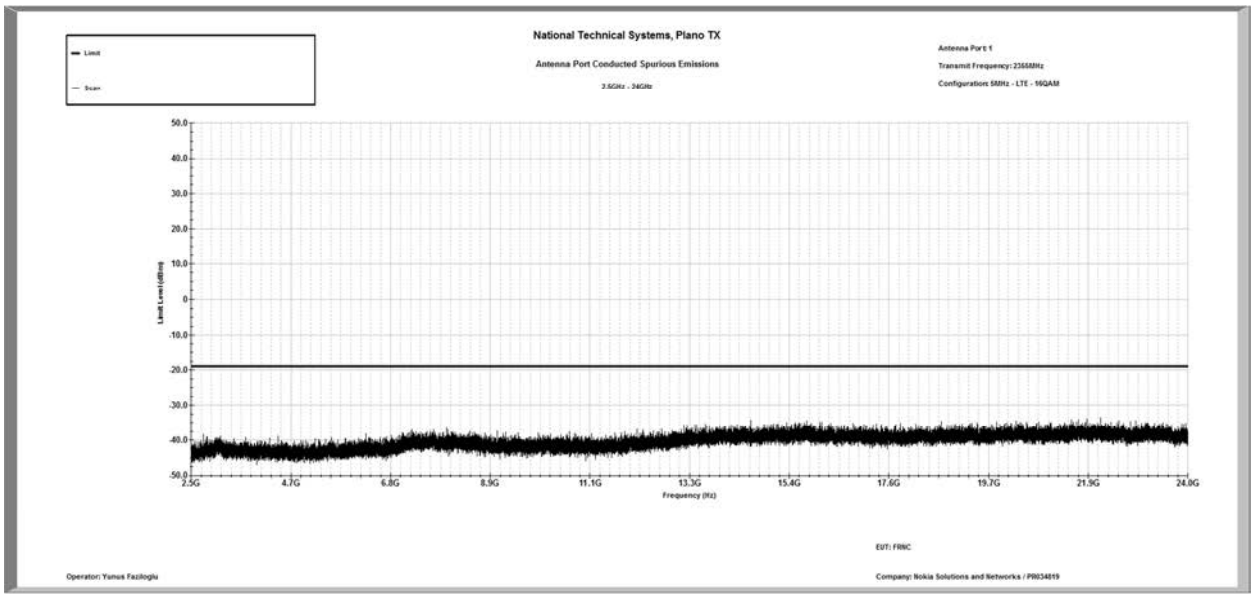
5M – LTE – QPSK


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 5MHz - LTE - QPSK
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
9.0K
250.0M
500.0M
750.0M
1.0G
1.3G
1.5G
1.8G
2.0G
2.3G
2.5G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

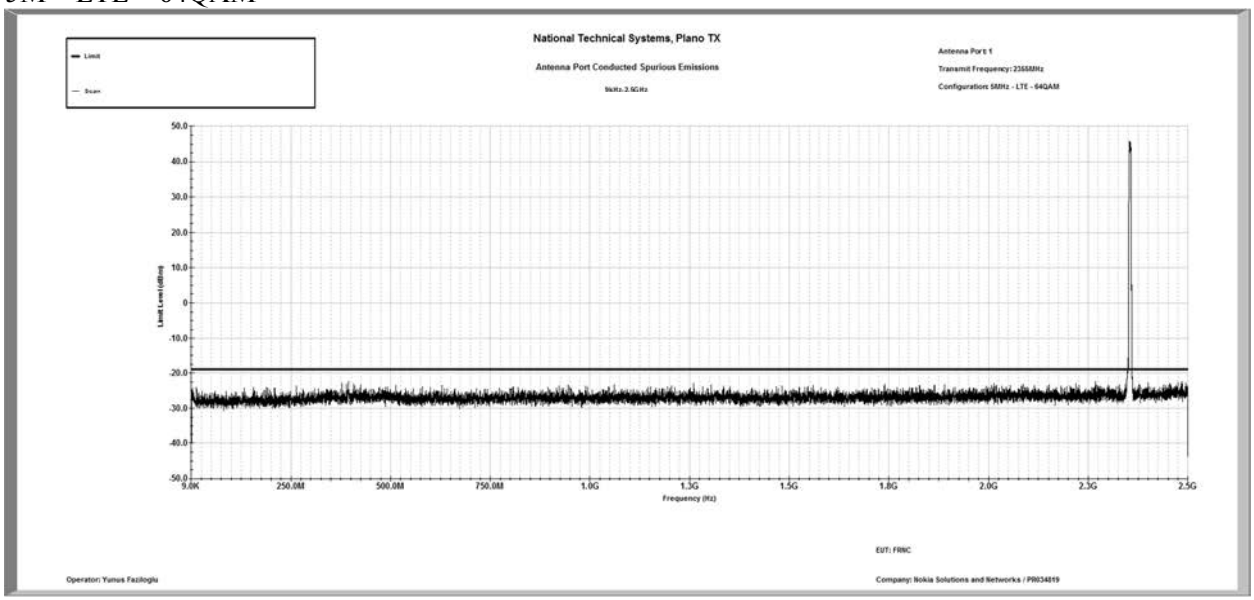

National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 5MHz - LTE - QPSK
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
2.5G
4.7G
6.8G
8.9G
11.1G
13.3G
15.4G
17.6G
19.7G
21.9G
24.0G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

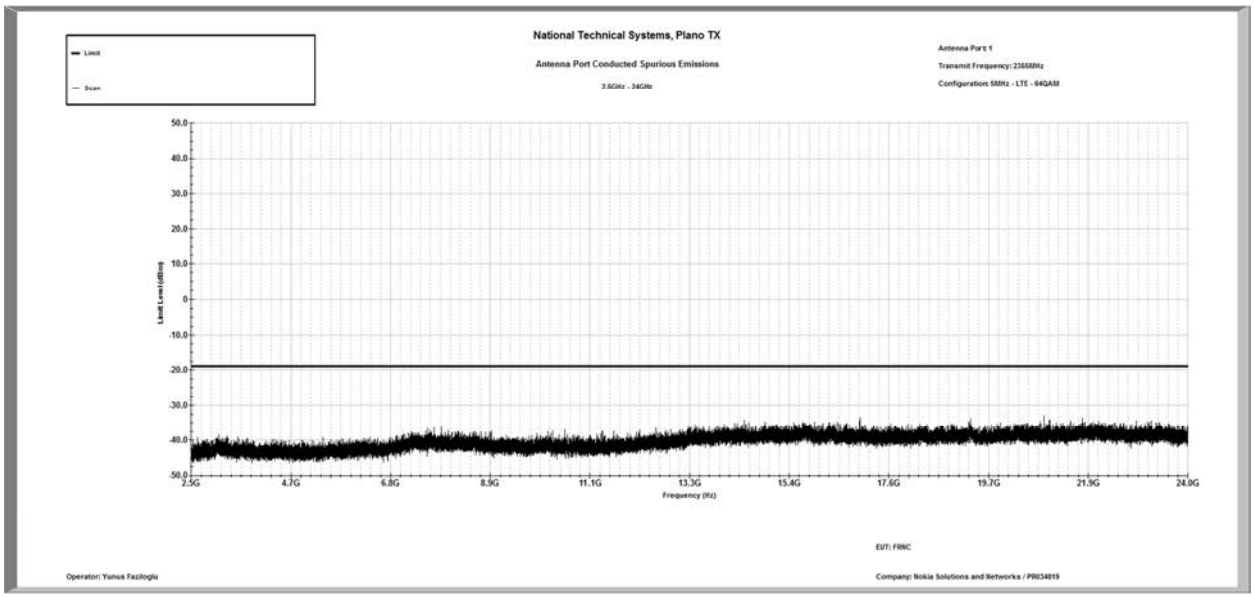
5M – LTE – 16QAM


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 5MHz - LTE - 16QAM
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
9.0K
250.0M
500.0M
750.0M
1.0G
1.3G
1.5G
1.8G
2.0G
2.3G
2.5G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

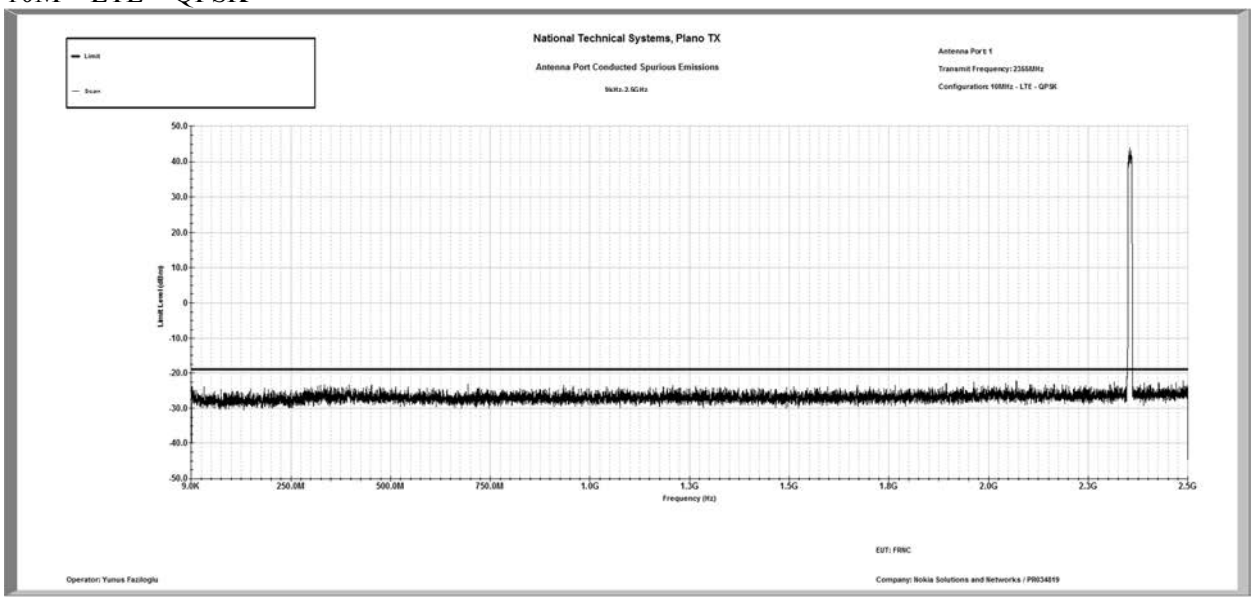

National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 5MHz - LTE - 16QAM
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
2.5G
4.7G
6.8G
8.9G
11.1G
13.3G
15.4G
17.6G
19.7G
21.9G
24.0G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

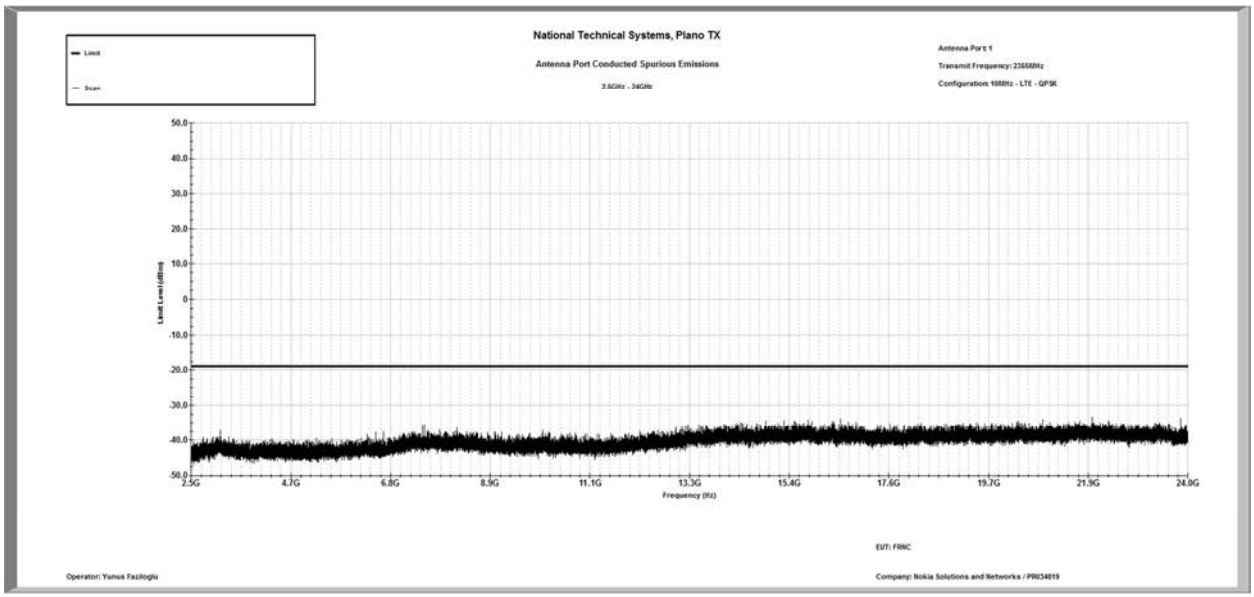
5M – LTE – 64QAM


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 5MHz - LTE - 64QAM
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
9.0K
250.0M
500.0M
750.0M
1.0G
1.3G
1.5G
1.8G
2.0G
2.3G
2.5G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

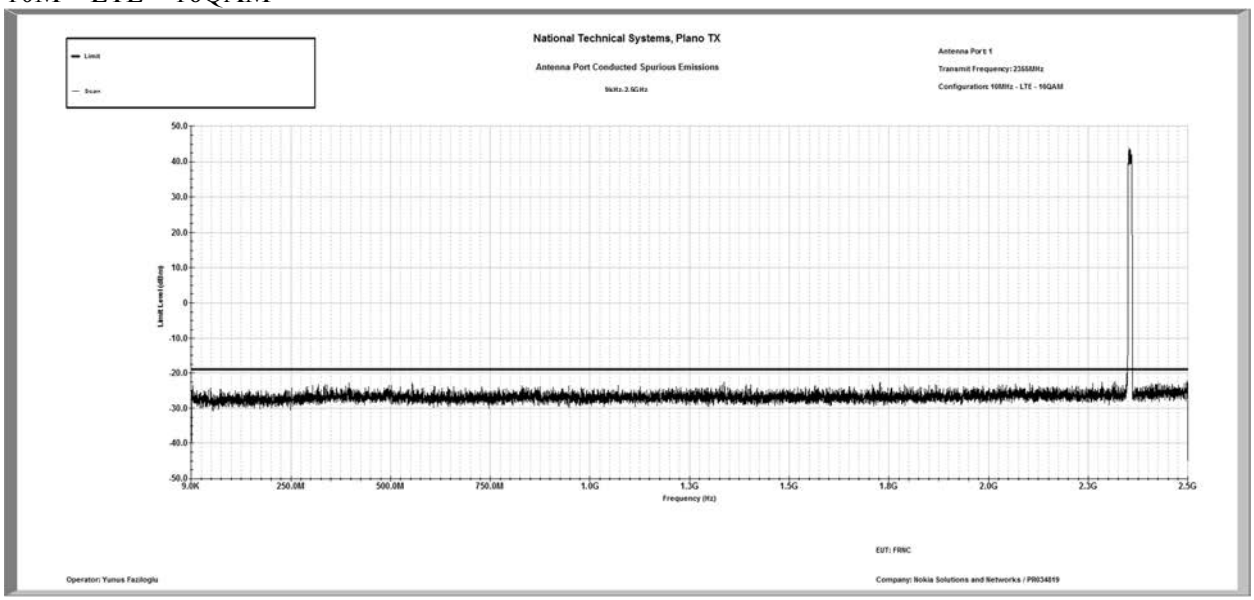

National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 5MHz - LTE - 64QAM
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
2.5G
4.7G
6.8G
8.9G
11.1G
13.3G
15.4G
17.6G
19.7G
21.9G
24.0G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

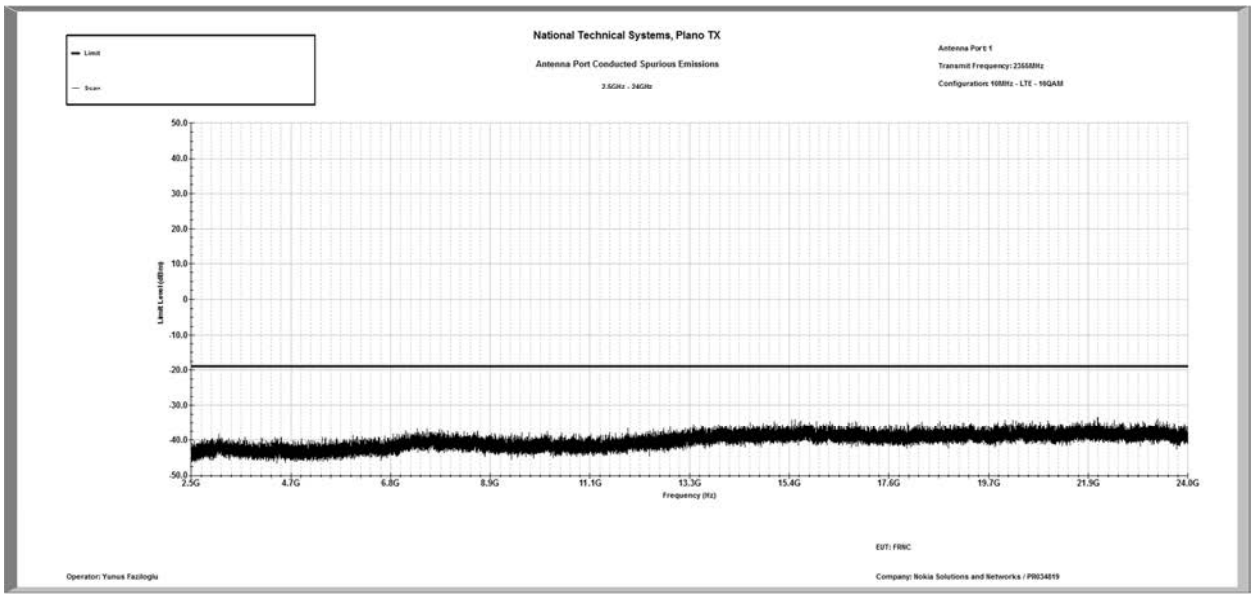
10M – LTE – QPSK


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 10MHz - LTE - QPSK
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
9.0K
250.0M
500.0M
750.0M
1.0G
1.3G
1.5G
1.8G
2.0G
2.3G
2.5G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

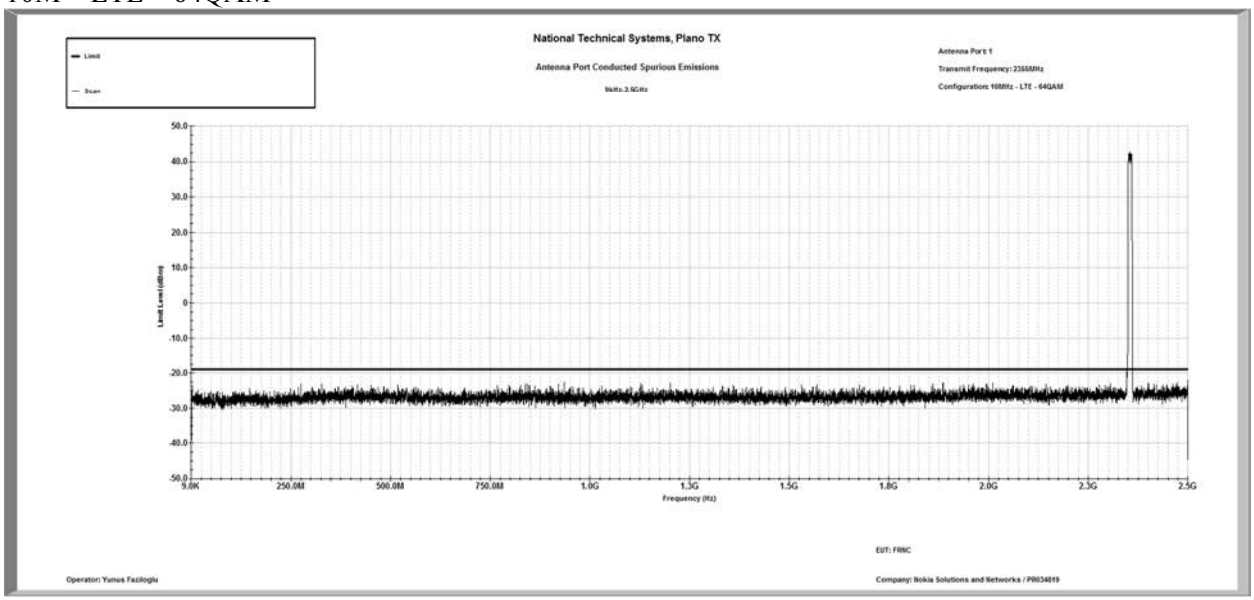

National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
Antenna Port 1
Transmit Frequency: 2366MHz
Configuration 10MHz - LTE - QPSK
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
2.5G
4.7G
6.8G
8.9G
11.1G
13.3G
15.4G
17.6G
19.7G
21.9G
24.0G
Frequency (Hz)
EUT: FRNC
Operator: Yunus Fazlioglu
Company: Nokia Solutions and Networks / PR034819

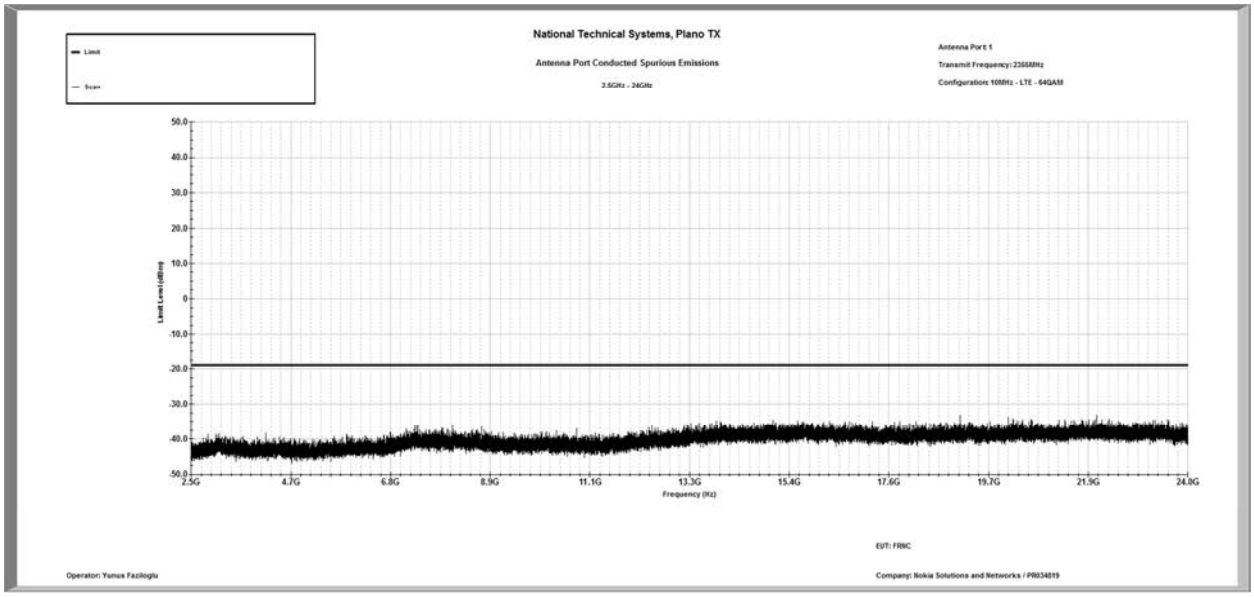
10M – LTE – 16QAM





10M – LTE – 64QAM





Transmitter Radiated Spurious Emissions

Antenna port conducted spurious emissions tests produced similar results for all modulations and channel bandwidth modes. Preliminary scans for radiated spurious emissions were performed in 30MHz – 24GHz frequency range in the following configuration:

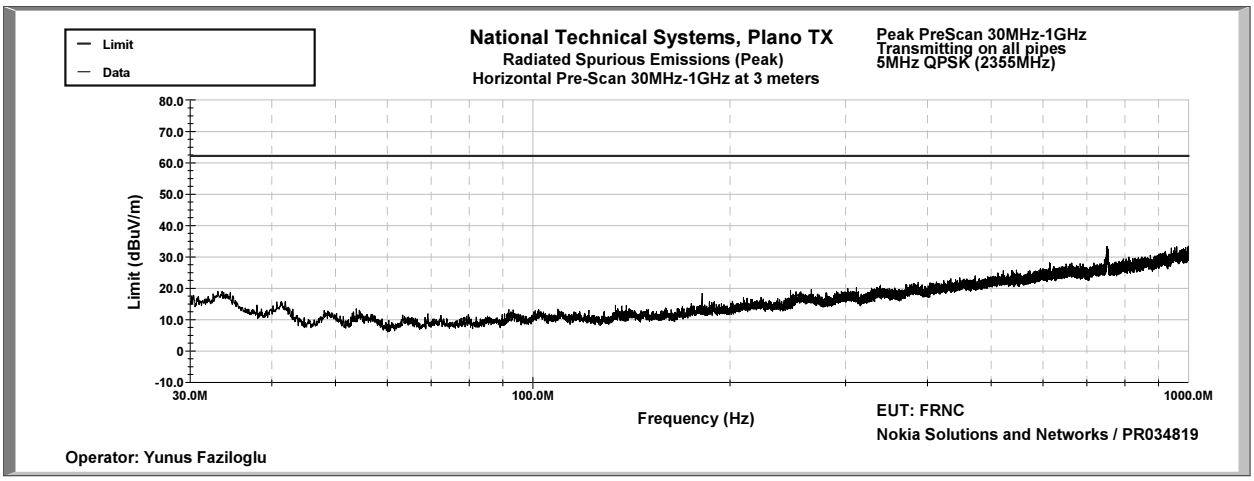
Transmitting in 5MHz-QPSK-LTE mode at center channel (2355MHz) on all 4 ports.

Final maximized peak radiated emissions were measured in this mode. Measurement distance was 3m for frequencies below 18GHz and 1m for frequencies above 18GHz. During testing all 4 antenna ports of the base station were terminated with 50ohm termination blocks and unit was transmitting on all of its ports at full power as described above.

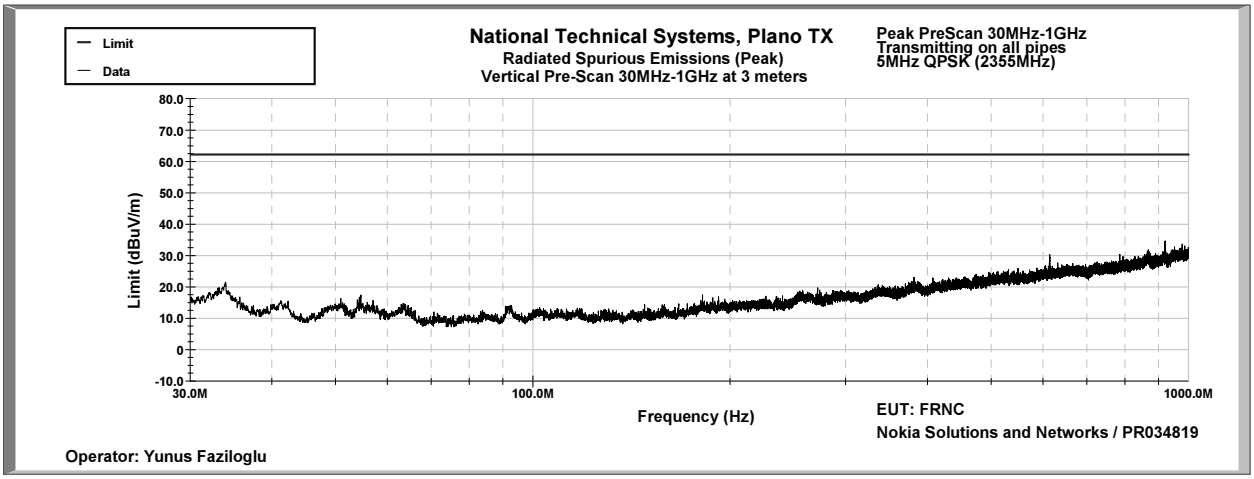
Frequency (MHz)	Polarity (H/V)	Raw Reading at 3m (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Field Strength at 3m (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)
614.4	V	49.6	-39.3	21	1.6	32.9	82.2	-49.3
614.4	H	49.5	-39.3	21	1.6	32.8	82.2	-49.4
921.6	V	48.8	-40.2	24.3	2.8	35.7	82.2	-46.5
921.6	H	48.3	-40.2	24.3	2.8	35.2	82.2	-47
1000	V	46.7	-39.8	24.3	3.2	34.4	82.2	-47.8
1000	H	47.1	-39.8	24.3	3.2	34.8	82.2	-47.4
2457.6	V	56.7	-48.2	28.4	3.1	40	82.2	-42.2
2457.6	H	55	-48.2	28.4	3.1	38.3	82.2	-43.9
17960 - NF	V	48.8	-45.5	45.9	10.7	59.9	82.2	-22.3
17960 - NF	H	48.5	-45.5	45.9	10.7	59.6	82.2	-22.6
Frequency (MHz)	**Polarity (H/V)**	**Raw Reading at 1m (dBuV)**	**Amplifier Gain (dB)**	**Antenna Factor (dB/m)**	**Cable Loss (dB)**	**Corrected Field Strength at 1m (dBuV/m)**	**Limit at 1m (dBuV/m)**	**Margin (dB)**
22233 - NF	V	46.5	-45.6	45.4	13.4	59.7	91.7	-32
21939 - NF	H	46.2	-45.2	45.2	13.3	59.5	91.7	-32.2
Corrected Field Strength = Raw Reading + Amplifier Gain + Antenna Factor + Cable Loss								
Negative margin indicates a passing result.								
Detector: Peak, RBW=1MHz, VBW=3MHz, Max-hold								
NF: Noise Floor								

Highest noise floor of the measurement instrumentation was more than 20dB below the 82.2dBuV/m at 3m limit and 91.7dBuV/m at 1m limit (both equivalent to –13dBm EIRP). Since all maximized readings were more than 20dB below these levels as well, substitution measurements were not performed. TILE software was used for all preliminary scans and plots included on the following pages. The limits shown on the plots correspond to levels 20dB below the said limits above.

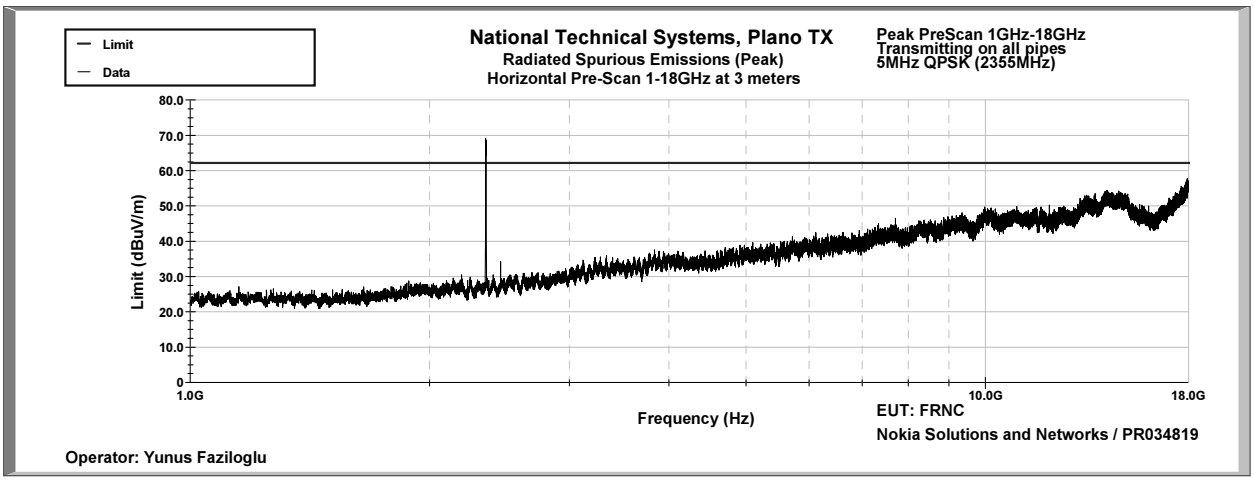
30MHz – 1GHz Peak Prescan at 3m - H



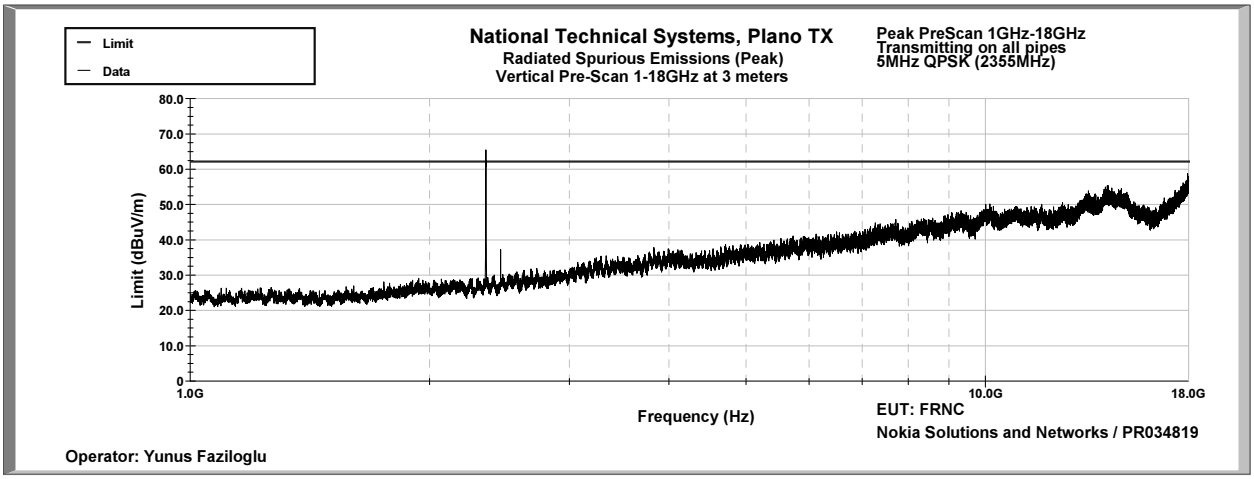
30MHz – 1GHz Peak Prescan at 3m - V



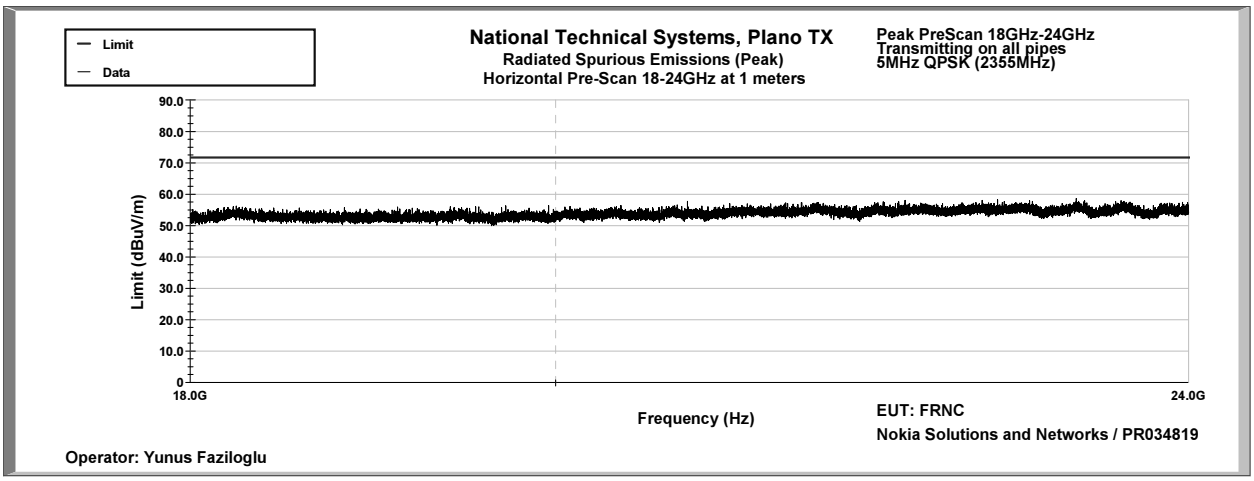
1GHz – 18GHz Peak Prescan at 3m – H



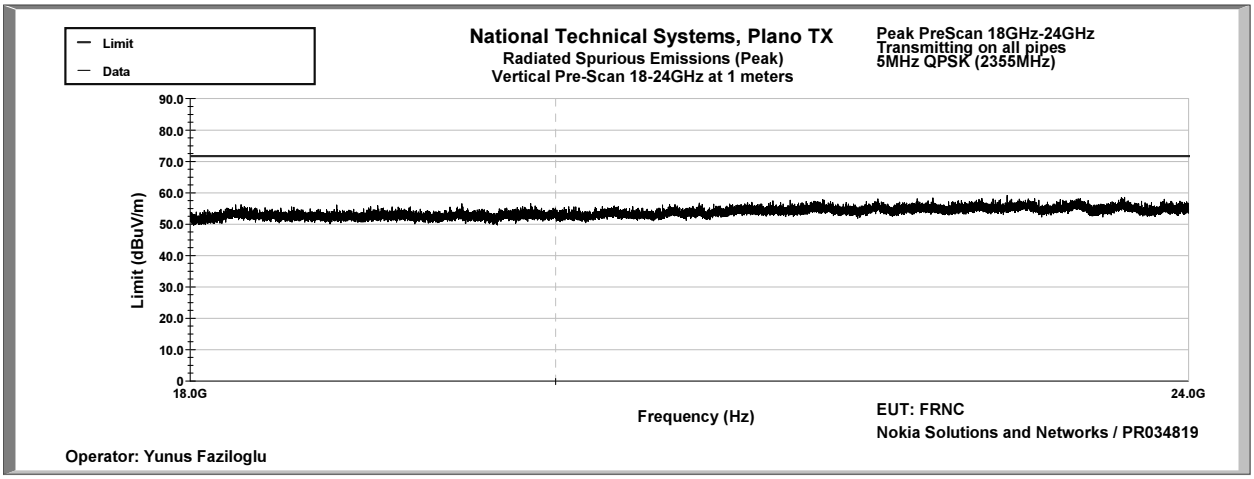
1GHz – 18GHz Peak Prescan at 3m – V



18GHz – 24GHz Peak Prescan at 1m – H



18GHz – 24GHz Peak Prescan at 1m – V



Frequency Stability

In order to demonstrate carrier frequency stability at extreme temperatures and voltages, frequency error was measured in the following configuration:

Transmitting in 10MHz-64QAM-LTE mode at center channel (2355MHz) on port 1.

Nominal operating voltage of the product is declared as 48VDC.

Frequency error results are listed below for extreme voltages and temperatures.

Extreme Voltages

20C	Freq. Error (mHz)
40.8VDC	259
55.2VDC	230

Extreme Temperatures

48VDC	Freq. Error (mHz)
-30	48
-20	9
-10	80
0	39
10	112
20	180
30	178
40	116
50	112

Based on the results above, highest recorded frequency error is equivalent to 0.0001ppm, which ensures that the transmitted signal remains in its authorized frequency block at extreme voltages and temperatures.

Results above are deemed sufficient to demonstrate carrier frequency stability for all other channel bandwidth modes and modulations since all carriers are controlled by the same frequency stabilization circuitry that was subjected to the extreme conditions under this test.

End of Report

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