Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 27 and RSS 139
2112.5MHz – 2152.5MHz

FCC ID:	**VBNFWIB-01**
IC:	**661W-FWIB**
Product Name:	**Flexi Zone Micro BTS**
Model(s):	**FWIB**
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:	**July 28, 2014**
FINAL TEST DATES:	**June 4-16, 2014**
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Prepared By:

Yunus E. Faziloglu
Wireless Manager

Approved By:

Kimberly Zavala
Quality Assurance Manager

Reviewed By:

John Ngo
General Manager

REVISION HISTORY

Rev#	Date	Comments	Modified By
	June 26, 2014	First release	Yunus Faziloglu
1	July 14, 2014	Updated product information	Yunus Faziloglu
2	July 28, 2014	Updated to address TCB questions	Yunus Faziloglu

TABLE OF CONTENTS

SCOPE

Tests have been performed on Nokia Solutions and Networks product Flexi Zone Micro BTS Model FWIB, 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 and Industry Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- Industry Canada RSS-Gen Issue 3, December 2010
- CFR 47 Part 27 Subpart C (Operation in 1710–1755 MHz, 2110–2155 MHz, and 2160–2180 MHz Bands)
- RSS 139 Issue 2, February 2009 (Advanced Wireless Services Equipment Operating in the Bands 1710-1755 MHz and 2110-2155 MHz)

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 C63.4:2003
ANSI TIA-603-C August 17, 2004
FCC KDB 971168 D01 Measurement Guidance for Certification of Licensed Digital Transmitters

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

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 Zone Micro BTS Model FWIB and therefore apply only to the tested sample. The sample was selected and prepared by Steve Mitchell 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. Prior to marketing in Canada, Class I transmitters, receivers and transceivers require 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 FWIB. No additional models were described or supplied for testing.

STATEMENT OF COMPLIANCE

The tested sample of Nokia Solutions and Networks product Flexi Zone Micro BTS Model FWIB 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 (Base Station Operating in 2110 – 2155 MHz Band) and RSS 139

FCC	Canada	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§2.1033 (c) (5) §27.5 (i) (2)	RSS 139 6.1	Frequency range(s)	2112.5 – 2152.5 (5M) 2115 – 2150 (10M) 2117.5 – 2147.5 (15M) 2120 – 2145 (20M)	2110-2155 MHz	Pass
§2.1033 (c) (4) §2.1047	RSS 139 6.2	Modulation Type	QPSK, 16QAM, 64QAM (5M, 10M, 15M, 20M channels for each)	Any allowed	Pass
§2.1033 (c) (6) §2.1033 (c) (7) §2.1046 §27.50(d)	RSS 139 6.4 SRSP-513	EIRP	Conducted Output Power Peak: 50.82dBm RMS: 39.89dBm 2x2MIMO highest combined EIRP will depend on antenna gain (unknown)	1640 Watts 62.2 dBm	Pass
§27.50(d) (6)	RSS 139	Peak to Average Ratio	10.98dB highest	<= 13 dB	Pass
§2.1049 §27.53	RSS GEN 4.6.1	99% Occupied Bandwidth	4.523MHz (5M) 9.034MHz (10M) 13.528MHz (15M) 18.058MHz (20M)	Remain in Block	Pass
-	-	Emission Designators (based on 26dB emission bandwidths)	5M00F9W (5M) 10M0F9W (10M) 15M0F9W (15M) 19M9F9W (20M)	-	-
Transmitter spurious emissions[3]					
§2.1051 §2.1053 §2.1057 §27.53(h)	RSS 139 6.5	At the antenna terminals	-21.03dBm	-16.01 dBm (per TX chain)	Pass
	RSS 139 6.5	Field strength	52.8dBuV/m at 3m Eq. to -42.4dBm EIRP	-13 dBm EIRP	Pass
Receiver spurious emissions[2]					
Other details					
§2.1055 §27.54	RSS 139 6.3	Frequency stability	3.5 ppm	N/A[1]	Pass
§2.1093	RSS 102	RF Exposure	N/A		Pass[4]
§2.1033 (c) (8)		Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	Refer to operational description	-	-
-	-	Antenna Gain	Case by case based on carrier's demand	-	-

Notes
Note 1 – The requirement for frequency stability is that the signal remains within the allocated band.
Note 2 – As the frequency of operation is above 960 MHz there are no technical requirements for spurious

emissions from the receiver. Note 3 – The measurement at the channel edge is made with a resolution bandwidth of at least 1% of the emission bandwidth. For measurements more than 1MHz from the edge of the channel, the measurement bandwidth is 1MHz. Note 4 – Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

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

The measurement of uncertainty is not included with the data in this test report.

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The equipment under test is a Nokia Solutions and Networks Flexi Zone Micro BTS (base transceiver station). The FZM BTS is a single box LTE base station. The FWIB frequency variant being tested under this effort covers 3GPP frequency band 4 (Uplink: 1710 to 1755 MHz/Downlink: 2110 to 2155 MHz). The FWIB has 2Tx and 2Rx antenna connections with each transmit port supporting 5 watts maximum rated RF output power. The FWIB BTS supports four channel bandwidths of 5, 10, 15 and 20 MHz. The FWIB BTS supports three downlink modulation types of QPSK, 16QAM and 64QAM. The FWIB supports 2x2 MIMO operations (2x2 MIMO was used for all testing). Multi carrier operation is not supported. The FWIB was configured with external interfaces including AC power, ground, LTE RF (TX/RX-M & TX/RX-D), wired Ethernet (RJ-45), optical Ethernet, GPS and Bluetooth. The BTS with applicable installation kits may be pole, wall or ceiling mounted.

The following table shows the channel numbers and frequencies for different channel bandwidth modes. The modulation type does not make a difference in this numbering scheme.

Channel BW Mode	Channel	Carrier Frequency (MHz)	Channel Number
5M	Low	2112.5	1975
	Center	2132.5	2175
	High	2152.5	2375
10M	Low	2115	2000
	Center	2132.5	2175
	High	2150	2350
15M	Low	2117.5	2025
	Center	2132.5	2175
	High	2147.5	2325
20M	Low	2120	2050
	Center	2132.5	2175
	High	2145	2300

EUT also includes a Bluetooth interface that has modular FCC and IC approval.

The sample was received on June 4, 2014 and tested on June 4-16, 2014. The EUT consisted of the following component(s):

Company	Model	Description	Serial/Part Number	FCC ID / IC#
Nokia Solutions and Networks	FWIB	Flexi Zone Micro BTS	Part 472899A.X11 Serial RY141402795	FCC ID: VBNFWIB-01 IC: 661W-FWIB

Unit does not support multiple RB modes for LTE. It was tested at the lowest and highest possible channels at highest power level for each modulation and channel bandwidth mode.

ENCLOSURE

The EUT enclosure is made of heavy duty aluminum and measures approximately 13(W) x 9.75(D) x 3(H) inches.

AUXILLARY EQUIPMENT

Company	Model	Description	Serial/Part Number	FCC ID
Finisar	FTLF5819P3BTL	Multimode SFP Optical Module (Plugs into FWIB BH A port)	Serial: PQK1XLE	N/A

SUPPORT EQUIPMENT

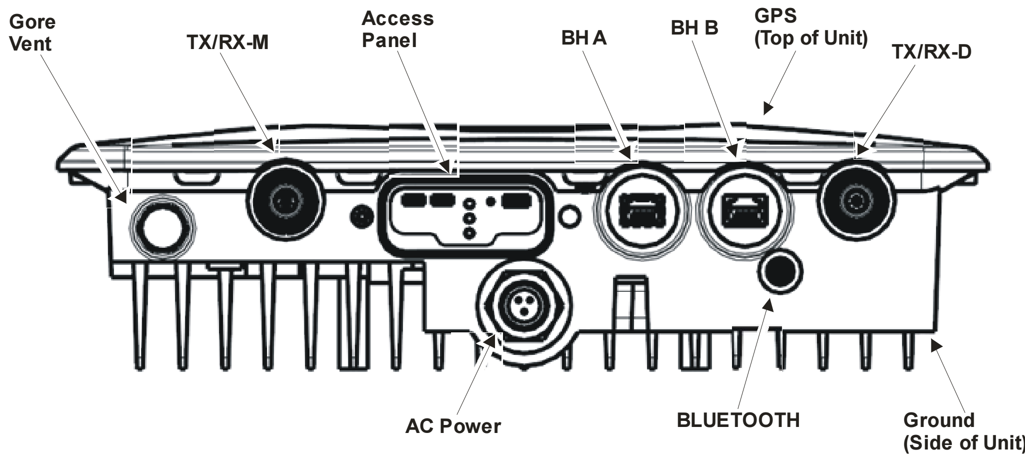
Company	Model	Description	Serial Number	FCC ID
HP	EliteBook 6930p	Laptop PC	2CE93960X5	N/A
TRENDnet	TFC-1000MGB	1000 Base-T to mini-GBIC Media Converter	C21412MG00194	N/A

EUT INTERFACE PORTS

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

Port	Connected To	Description	Cable(s)	
			Shielded or Unshielded	Length(m)
TX/RX-M	RF Load	LTE RF	Shielded	2
TX/RX-D	RF Load	LTE RF	Shielded	2
AC Power	Lab Power	Power Input	Shielded	2
BH A	PC	Fiber Optic Ethernet	Unshielded	>6
BH B	PC	Wired (RJ 45) Ethernet	Shielded	3
GPS	GPS Antenna	GPS Signal Input	Shielded	>6
Bluetooth	Antenna	Bluetooth Interface	None	N/A
Ground	Ground	Chassis Ground	Unshielded	2

The connector layout for the FWIB BTS is provided below:



EUT OPERATION

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

EUT FIRMWARE/SOFTWARE

The BTS software version used during all testing is “LNF5.0_ENB_1304_150_00”. A PC running BTS Site Manager is used to control/operate the BTS during testing. The PC connects to the FZM BTS over the Backhaul (Ethernet) ports. The BTS Site Management interface is used for commissioning, changing configuration settings, monitoring status and to execute various tests on the FZM BTS.

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.

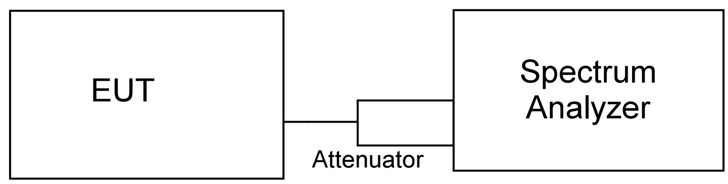
Radiated spurious emissions measurements were taken at the NTS Plano Anechoic Chamber listed below. The sites conform to the requirements of ANSI C63.4: 2003 *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range 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 100W 40dB attenuator and an RF cable. The EUT was operating in 2x2 MIMO configuration at full power for all tests. While measuring one transmit chain, the other was terminated with a 60W 50ohm termination block. 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 4.0 of FCC KDB 971168 D01 v02R01. 99% occupied bandwidth was measured in accordance with Section 4.6.1 of RSS-Gen Issue 3. 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.

Peak and average output power measurements were performed in accordance with FCC KDB 971168 D01 v02R01. 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 v02r01.

Conducted spurious emissions were captured with TILE6 software which corrected the readings for cable loss and attenuator loss across the 9kHz-22GHz 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 is varied across the specified frequency range in 10 degree increments with frequency measurements made at each temperature step. The EUT is allowed enough time to stabilize at each temperature variation. An NTS custom software tool was used to capture 10dB emission bandwidth of the signal. From this 10dB plot, the software calculates the center frequency of the signal which represents the carrier frequency.

Transmitter radiated spurious emissions measurements were made in accordance with ANSI C63.4:2003 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 for all emission bandwidth and modulation combinations to identify the worst case mode. This software corrected the measurements for antenna factors, cable losses and pre-amplifier gains. Both polarizations of the receiving antenna ware scanned from 30MHz to 22GHz 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 double ridged waveguide horn antenna was used for 18-22GHz range. The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. EUT was placed on a non-conductive RF transparent structure to provide 80cm height from the ground floor. A motorized turntable allowed it to be rotated during testing to determine the angle with the highest level of emissions.

Receiver radiated spurious emissions testing was not applicable to the EUT since its receive frequency was outside the 30MHz-960MHz range for its LTE as well as its GPS function.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH

Measurements of radiated field strength are compared directly to the specification limit (decibel form). The receiver and/or control software corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor is used when measurements are made at a test distance that is different to the specified limit distance by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS –RADIATED POWER

The erp/eirp limits for transmitter spurious measurements are converted to a field strength in free space using the following formula:

$$E = \frac{\sqrt{30 P G}}{d}$$

where:

E = Field Strength in V/m
P = Power in Watts
G = Gain of isotropic antenna (numeric gain) = 1
D = measurement distance in meters

The field strength limit is then converted to decibel form (dBuV/m) and the margin of a given emission peak relative to the limit is calculated (refer to *SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH*).

When substitution measurements are required (all signals with less than 20dB of margin relative to the calculated field strength limit) the eirp of the spurious emission is calculated using:

$$P_{EUT} = P_S - (E_S - E_{EUT})$$

and

$$P_S = G + P_{in}$$

where:

P_S = effective isotropic radiated power of the substitution antenna (dBm)
P_{in} = power input to the substitution antenna (dBm)
G = gain of the substitution antenna (dBi)
E_S = field strength the substitution antenna (dBm) at eirp P_S
E_{EUT} = field strength measured from the EUT

Where necessary the effective isotropic radiated power is converted to effective radiated power by subtracting the gain of a dipole (2.2dBi) from the eirp value.

Test Equipment

NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
E1529P	PSA	Agilent	E4446A	12 Months	2/14/2015
E1554P	PreAmp (1GHz-40GHz)	MITEQ	JS32-00104000-62-5P	12 Months	5/14/2015
E1279P	PreAmp (30MHz-1GHz)	MITEQ	AM-1431-N-1179SC	12 Months	2/8/2015
E1524P	Biconilog Antenna (30MHz-1GHz)	ETS Lindgren	3142D	12 Months	3/19/2015
E1149P	Horn Antenna (1GHz-18GHz)	EMCO	3115	12 Months	11/25/2014
E1068P	Horn Antenna (18GHz-40GHz)	EMCO	3116	12 Months	5/15/2015
E1061P	RMS Multimeter	Fluke	87III	12 Months	10/21/2014
ENV1384P	Data Acquisition Switch Unit	Agilent	34970A	12 Months	2/24/2015
E1086P	Power Supply	Elgar	SW1750AE	N/A	No Calibration Required
ENV1195P	Climatic Chamber	Thermotron	SE-300-2-2	N/A	No Calibration Required

Appendix A Test Data

TRANSMITTER RADIATED SPURIOUS EMISSIONS (FCC 2.1053 & 27.53(h), RSS 139 6.5)

Pre-scans have been performed in 30MHz – 22GHz frequency range in all channel bandwidth modes and different modulation combinations. Both antenna ports of the base station were terminated with 50ohm termination blocks rated at 60W. Unit was operating in its 2x2 MIMO configuration at full power. Filtering of the fundamental was not necessary since it did not cause overloading in any part of the measurement system. Based on those pre-scan results, 10M 16QAM mode was identified as the worst case. Final maximized peak radiated emissions were measured at the center channel in this mode as detailed below.

In the 30M-1GHz range emissions recorded were from the unintentional circuitry of the EUT. Harmonics of the fundamental were low. Emissions listed in the following table that are above 1GHz are all harmonics of the fundamental. All other emissions in the 1-22GHz range were at noise floor level. Highest noise floor level was more than 20dB below the 82.2dBuV/m at 3m limit (equivalent to -13dBm EIRP).

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)
4263.54	V	54.5	-46.738	32.023	3.857	43.642	82.2	-38.558
4260.8	H	61.9	-46.737	32.024	3.857	51.044	82.2	-31.156
6406.0	H	46.86	-45.553	34.403	4.348	40.058	82.2	-42.142
8534.0	H	48.75	-44.99	37.176	5.986	46.922	82.2	-35.278
10656.0	H	49.92	-45.173	38.344	4.958	48.049	82.2	-34.151
12798.0	H	47.76	-45.794	39.525	5.861	47.352	82.2	-34.848
14928.6	H	48.06	-45.766	41.347	8.334	51.975	82.2	-30.225
17062.4	H	46.36	-45.832	40.995	5.161	46.684	82.2	-35.516
6406.33	V	48.04	-45.552	34.403	4.348	41.239	82.2	-40.961
8538.29	V	49.66	-44.987	37.177	5.985	47.835	82.2	-34.365
10662.6	V	50.19	-45.188	38.352	4.954	48.308	82.2	-33.892
12796.6	V	48.07	-45.789	39.522	5.859	47.662	82.2	-34.538
14926.4	V	48.46	-45.77	41.352	8.333	52.375	82.2	-29.825
17061	V	46.01	-45.829	40.999	5.16	46.34	82.2	-35.86
50.536	V	81.89	-40.639	9.238	0.27	50.759	82.2	-31.441
100.46	V	84.1	-40.551	8.846	0.39	52.785	82.2	-29.415
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**								

Since all maximized readings were more than 20dB below the 82.2dBuV/m at 3m limit (equivalent to -13dBm EIRP), substitution measurements were not performed.

TRANSMITTER ANTENNA PORT CONDUCTED SPURIOUS EMISSIONS (FCC 2.1051 & 27.53(h), RSS 139 6.5)

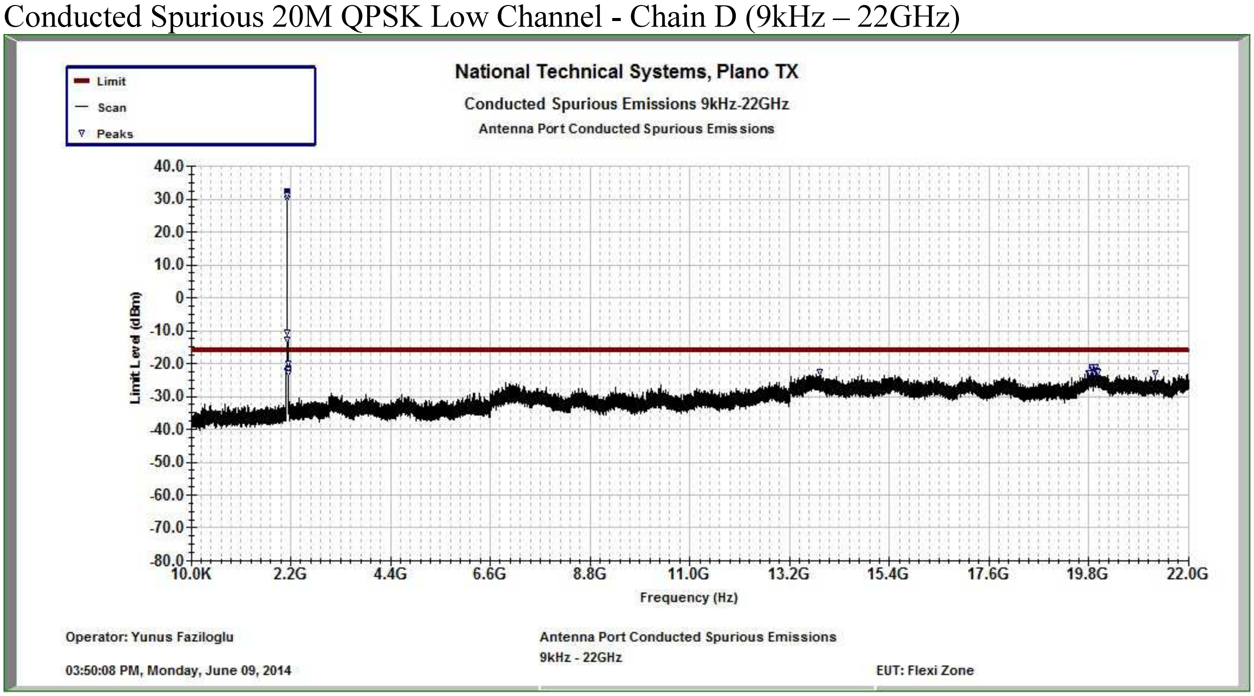
EUT has 2 transmit chains and the test was performed on both chains separately. Limit is adjusted to -13dBm – 10*log(2) = -16.01dBm per FCC KDB 662911D01 v02r01.
Attenuator Loss: 40dB, RF cable loss is frequency dependent. TILE6 measurement software automatically corrects for frequency dependent total path loss.

Conducted Spurious Emissions (Highest Readings)											
			QPSK			16QAM			64QAM		
			Low	Center	High	Low	Center	High	Low	Center	High
Chain M	5M	Peak (dBm)	-22.36	-22.31	-22.43	-22.05	-22.35	-21.85	-21.75	-21.26	-21.98
		Freq (GHz)	13.879	19.951	19.814	15.525	13.887	19.968	19.819	20.072	19.896
	10M	Peak (dBm)	-21.22	-21.93	-21.56	-21.86	-21.73	-21.99	-21.28	-21.54	-21.94
		Freq (GHz)	20.009	19.925	20.033	19.886	19.984	19.8	20.002	19.837	19.939
	15M	Peak (dBm)	-21.55	-22.44	-21.05	-22.18	-21.86	-22.56	-22.35	-21.26	-21.59
		Freq (GHz)	19.84	15.46	19.867	19.922	20.008	13.7	19.966	20.01	19.86
	20M	Peak (dBm)	-22.02	-22.16	-21.68	-21.88	-21.8	-22.27	-22.49	-22.15	-22.06
		Freq (GHz)	19.801	13.702	15.418	19.893	19.707	19.916	20.032	19.805	19.935
Chain D	5M	Peak (dBm)	-22.18	-21.6	-21.99	-21.97	-22.13	-22.4	-21.42	-21.63	-22.21
		Freq (GHz)	13.904	19.849	19.936	15.48	19.967	20.014	19.85	20.068	19.957
	10M	Peak (dBm)	-21.72	-22.15	-22.31	-21.38	-21.3	-21.41	-21.75	-21.78	-21.92
		Freq (GHz)	13.668	19.902	19.879	20.009	19.924	19.943	19.811	13.633	19.859
	15M	Peak (dBm)	-22.25	-22.18	-22.39	-21.65	-21.79	-21.76	-22.26	-21.89	-21.36
		Freq (GHz)	19.792	13.732	19.973	19.895	19.941	19.979	19.871	20.093	19.904
	20M	Peak (dBm)	**-21.03**	-21.12	-22.57	-21.73	-22.25	-21.62	-21.93	-22.14	-22.12
		Freq (GHz)	19.939	19.959	19.854	19.821	19.882	19.965	19.872	19.941	20.051

Measurements taken 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 segment	Peak	Auto	50 sweeps
1.5MHz-22GHz	1MHz	3MHz	8000	8 segments	Peak	Auto	50 sweeps

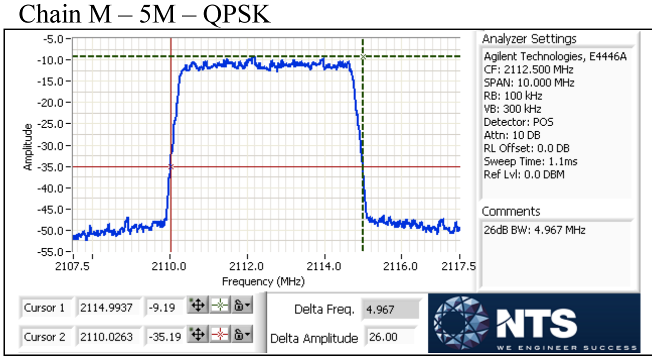
Conducted Spurious 20M QPSK Low Channel - Chain D (9kHz – 22GHz)

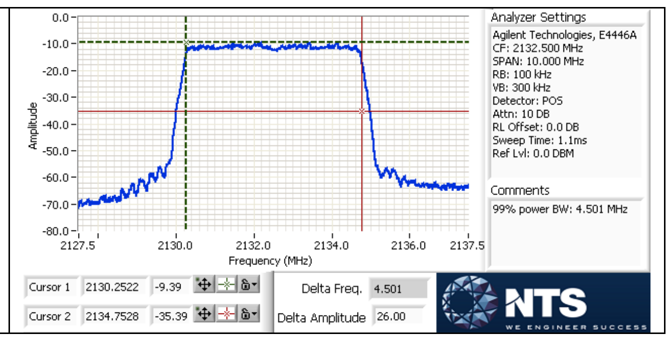


Emission Bandwidth (26dB) and Occupied Bandwidth (99%) (FCC 2.1049 & 27.53, RSS Gen 4.6.1)

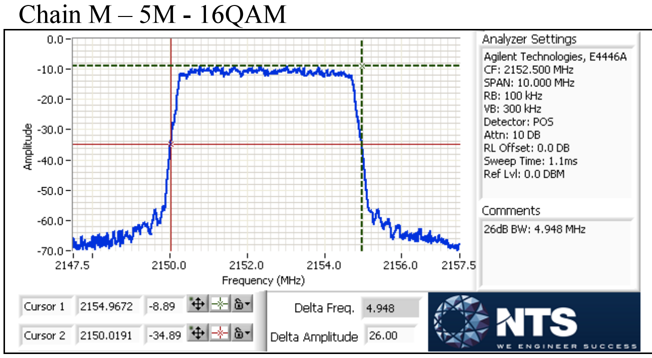
26dB Bandwidth and 99% Occupied Bandwidth			QPSK			16QAM			64QAM		
			Low	Center	High	Low	Center	High	Low	Center	High
Chain M	5M	26dB BW (MHz)	**4.967**	4.961	4.966	4.926	4.919	**4.948**	**5**	4.976	4.996
		99% OBW (MHz)	4.5	**4.501**	4.496	**4.491**	4.489	4.489	4.521	**4.523**	4.513
	10M	26dB BW (MHz)	**9.947**	9.945	9.92	**9.944**	9.913	9.915	9.921	9.972	**9.977**
		99% OBW (MHz)	8.994	8.999	**9.004**	9.03	9.019	**9.031**	9.013	**9.024**	8.991
	15M	26dB BW (MHz)	**14.906**	14.887	14.872	14.76	**14.812**	14.749	14.959	14.955	**14.966**
		99% OBW (MHz)	13.506	**13.51**	13.491	13.513	**13.517**	13.498	13.506	13.506	**13.528**
	20M	26dB BW (MHz)	**19.935**	19.845	19.8	19.73	**19.755**	19.73	**19.89**	19.885	19.865
		99% OBW (MHz)	17.973	**17.988**	17.988	18.033	**18.058**	18.043	**17.963**	17.963	17.958
Chain D	5M	26dB BW (MHz)	**4.982**	4.963	4.962	4.937	4.925	**4.946**	4.969	4.974	**4.989**
		99% OBW (MHz)	**4.5**	4.498	4.499	**4.489**	4.483	4.487	4.518	**4.519**	4.499
	10M	26dB BW (MHz)	9.91	9.94	**9.945**	9.947	**9.948**	9.89	9.935	9.945	**9.997**
		99% OBW (MHz)	8.984	**9.016**	9.014	**9.034**	9.026	9.014	9.014	9.021	**9.024**
	15M	26dB BW (MHz)	14.886	**14.899**	14.884	14.668	**14.771**	14.745	**14.912**	14.902	14.88
		99% OBW (MHz)	**13.508**	13.495	13.495	**13.511**	13.51	13.502	13.504	**13.513**	13.502
	20M	26dB BW (MHz)	19.885	**19.92**	19.775	19.755	19.745	**19.79**	**19.91**	19.805	19.87
		99% OBW (MHz)	**17.988**	17.983	17.983	18.023	**18.053**	18.033	17.963	**17.973**	17.968

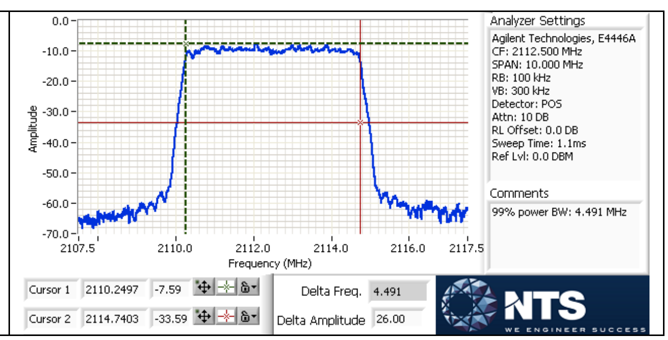
Chain M – 5M – QPSK



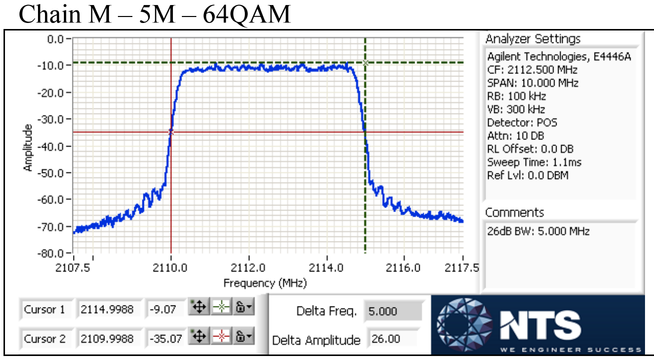


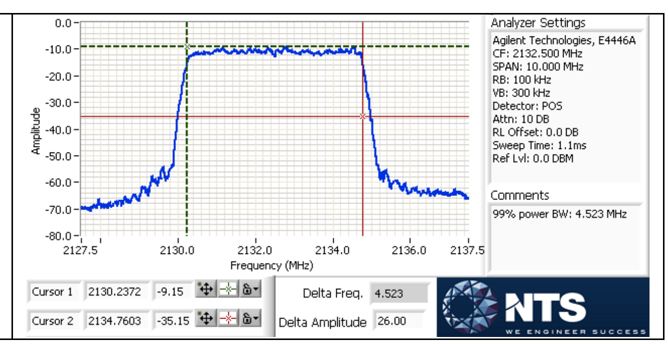
Chain M – 5M - 16QAM



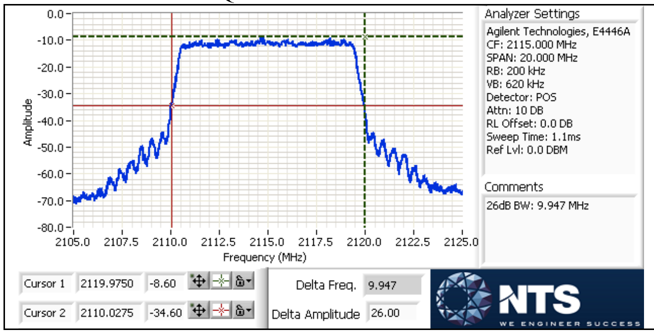


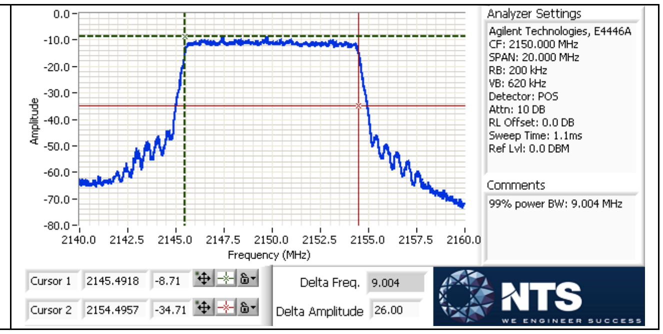
Chain M – 5M – 64QAM



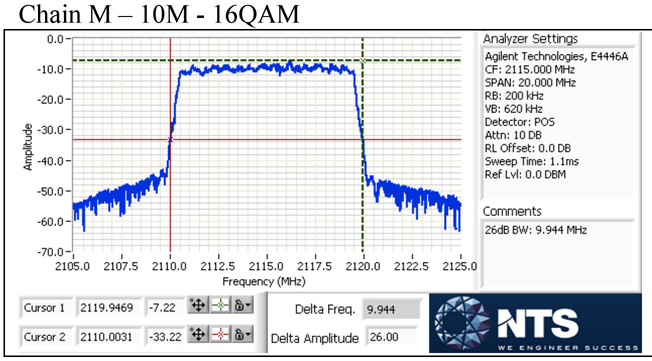


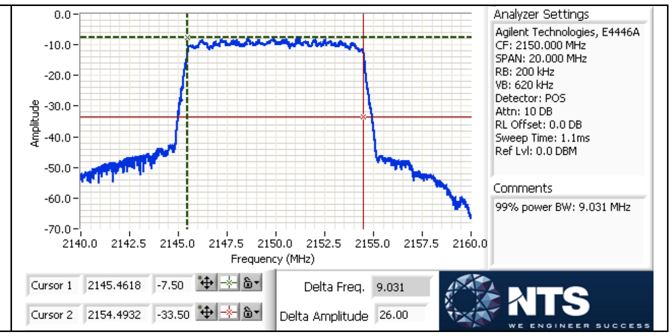
Chain M – 10M – QPSK



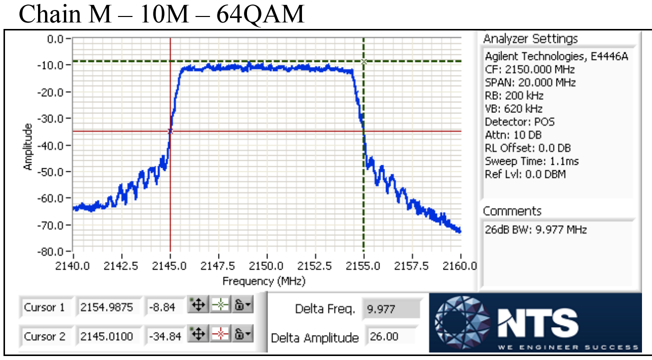


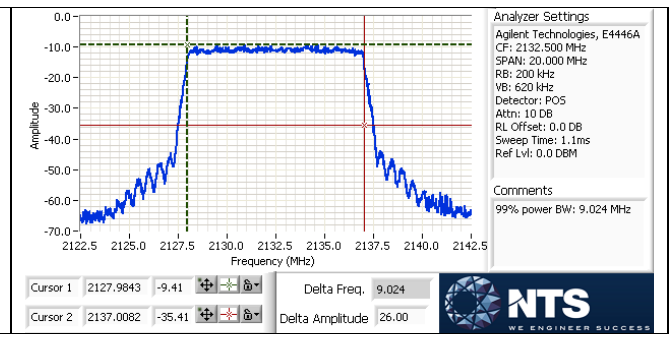
Chain M – 10M - 16QAM



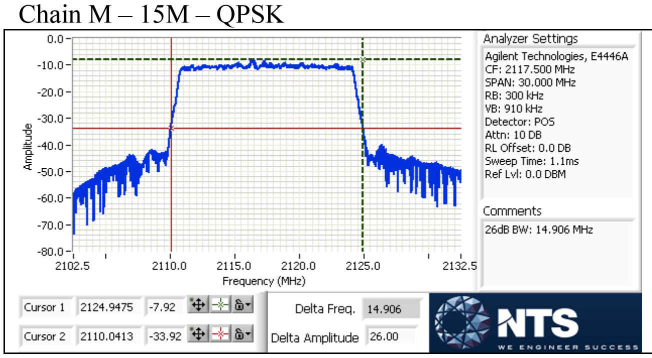


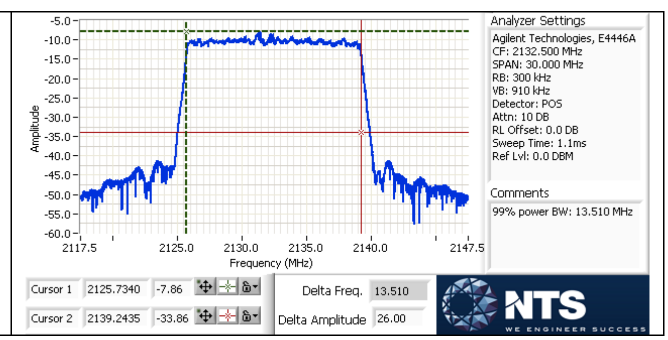
Chain M – 10M – 64QAM



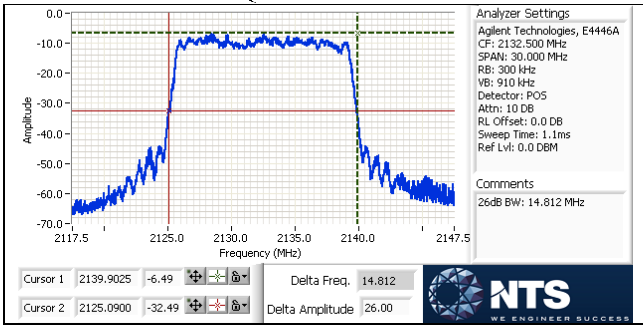


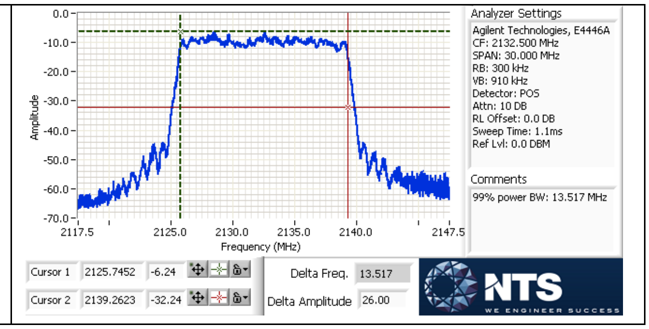
Chain M – 15M – QPSK



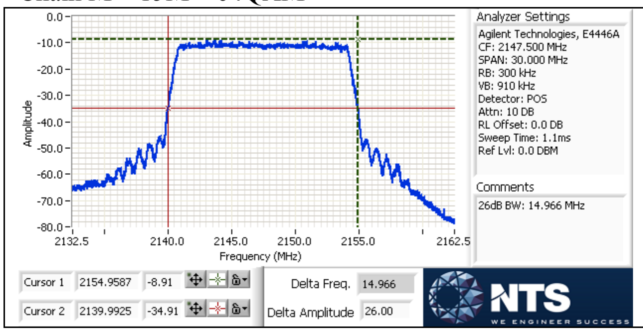


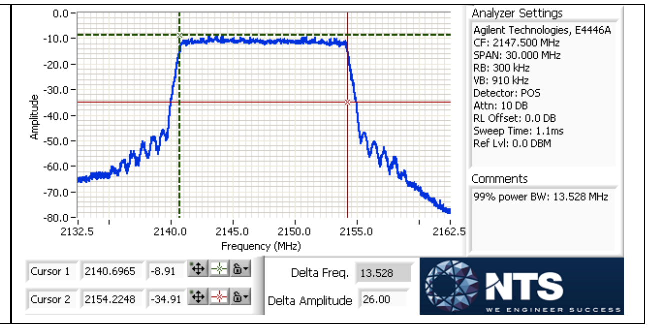
Chain M – 15M - 16QAM



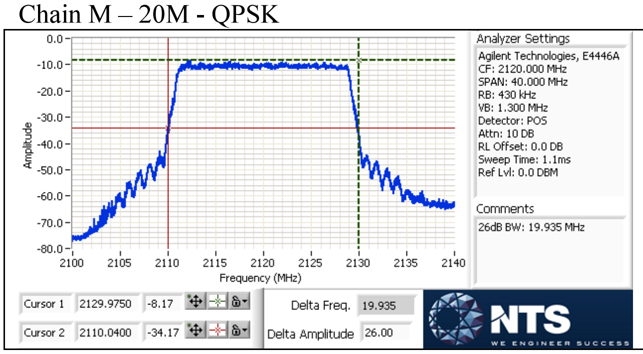


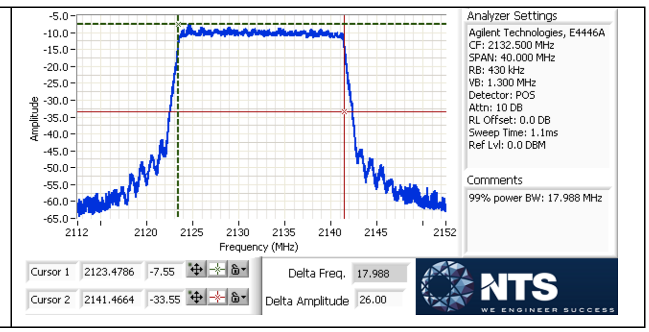
Chain M – 15M – 64QAM



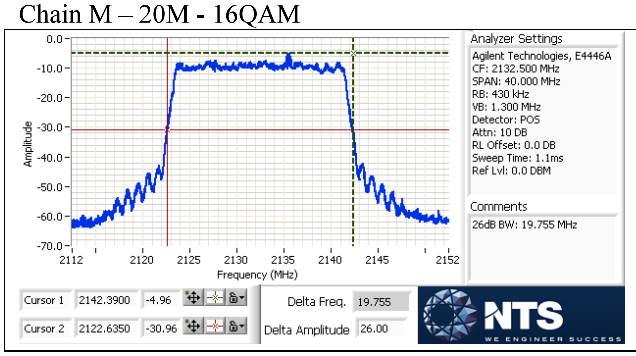


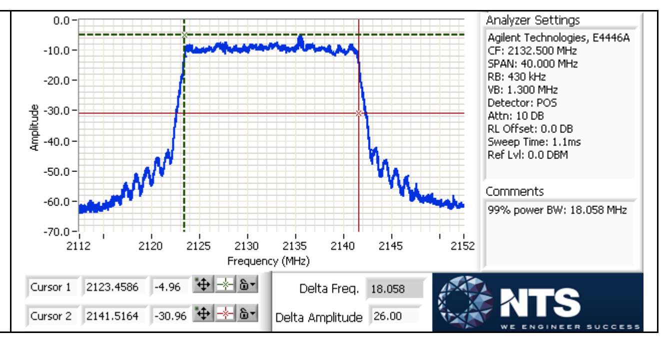
Chain M – 20M - QPSK



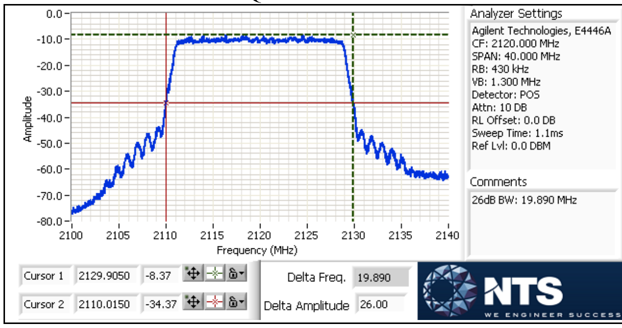


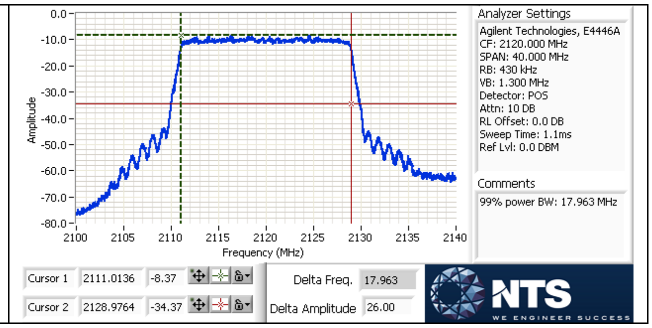
Chain M – 20M - 16QAM



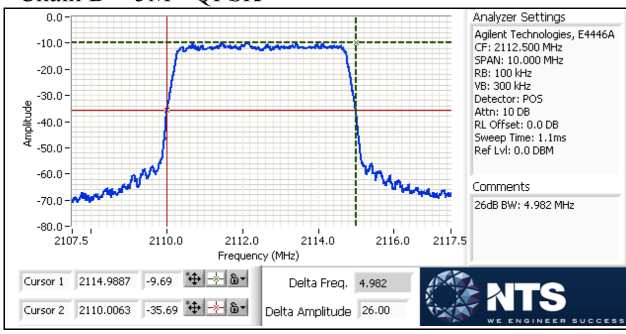


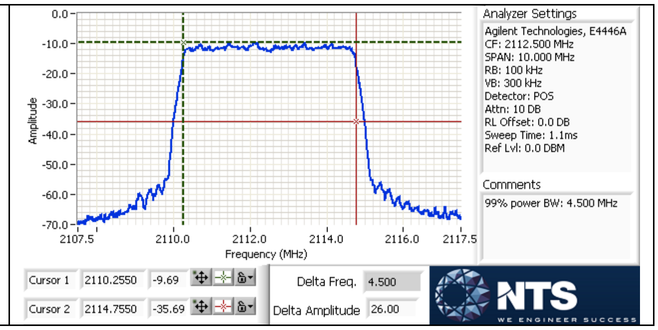
Chain M – 20M – 64QAM



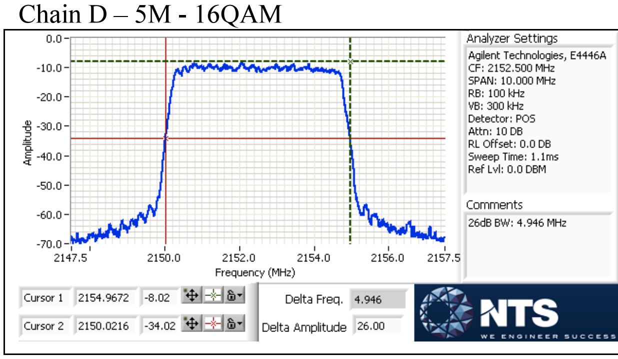


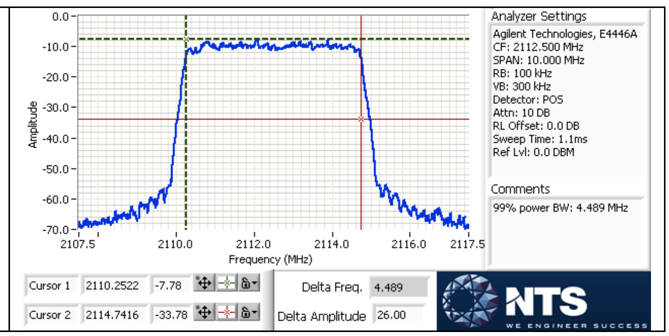
Chain D – 5M - QPSK



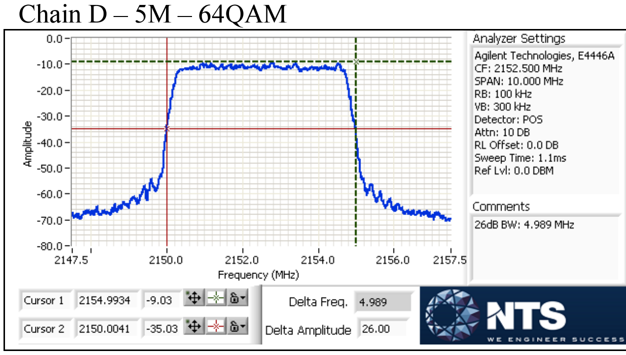


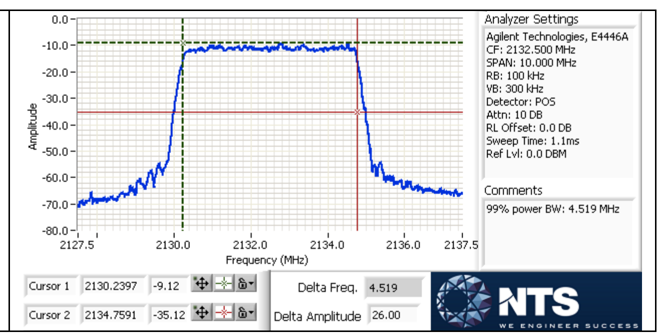
Chain D – 5M - 16QAM



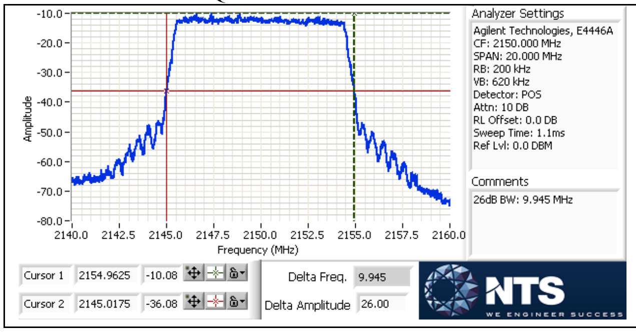


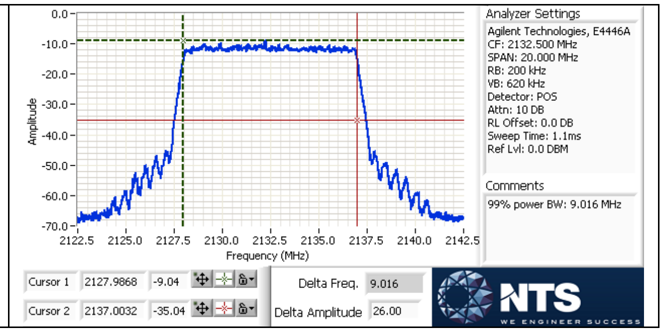
Chain D – 5M – 64QAM



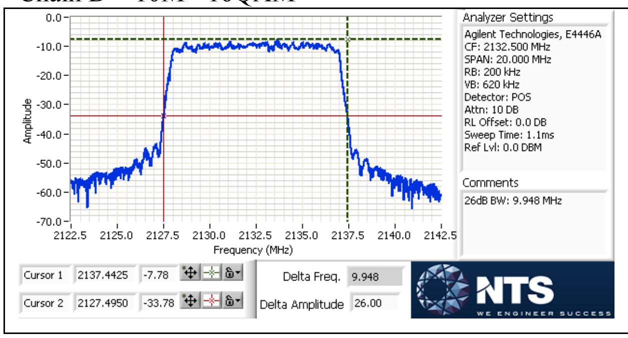


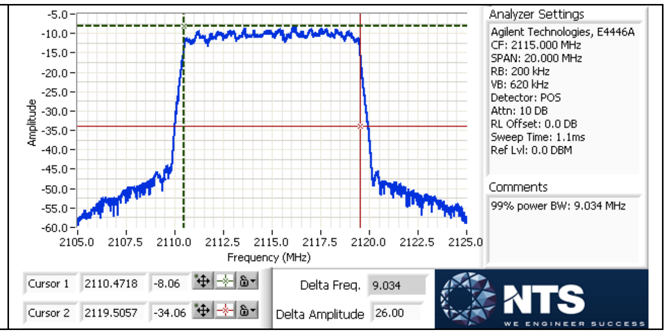
Chain D – 10M - QPSK



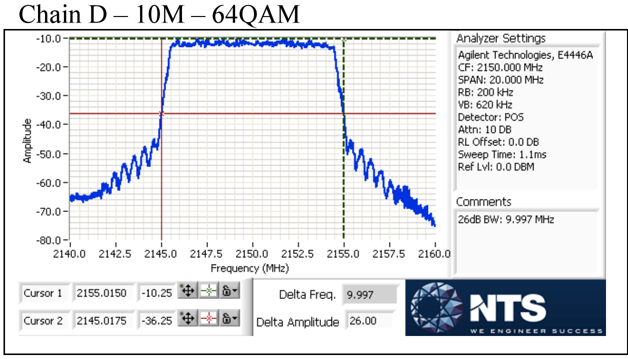


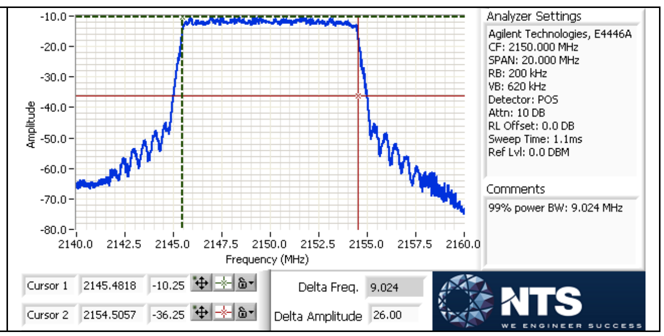
Chain D – 10M - 16QAM



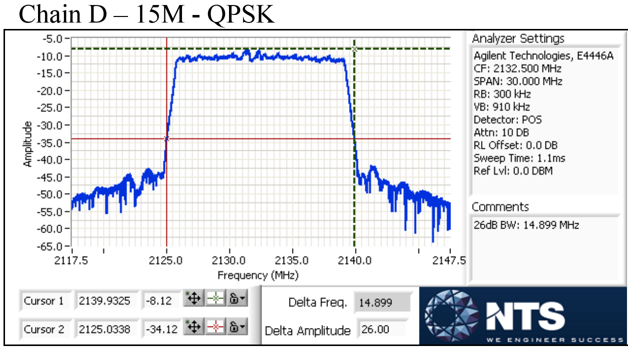


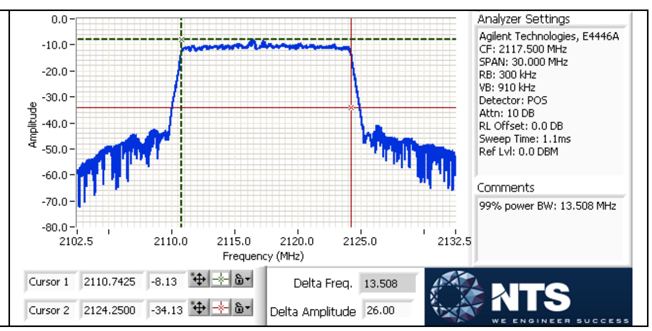
Chain D – 10M – 64QAM



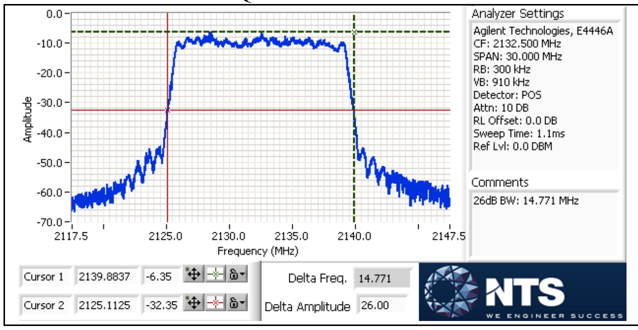


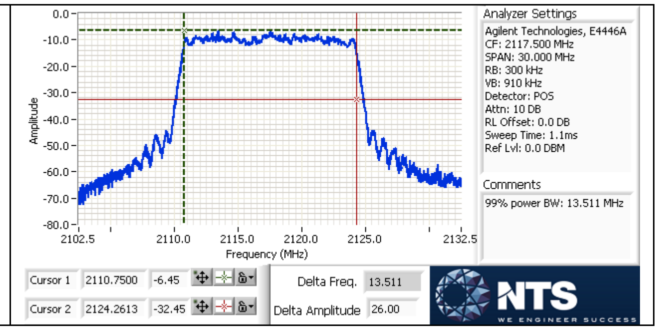
Chain D – 15M - QPSK



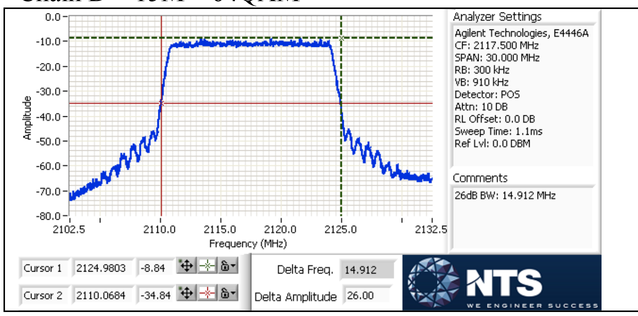


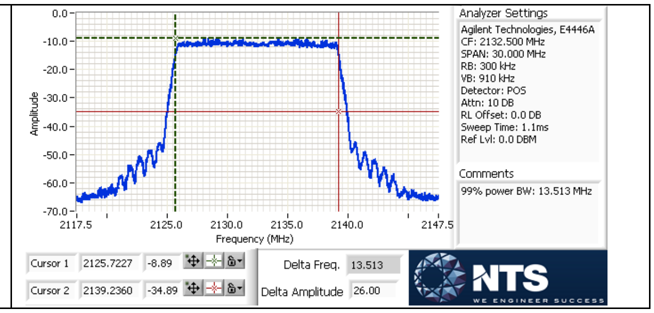
Chain D – 15M - 16QAM



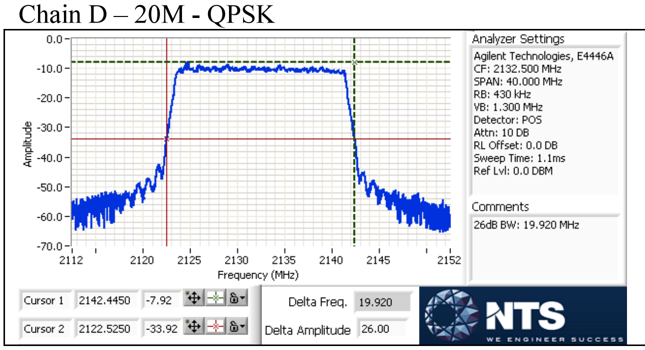


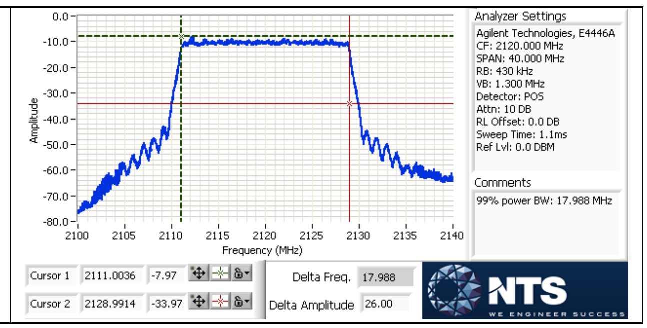
Chain D – 15M – 64QAM



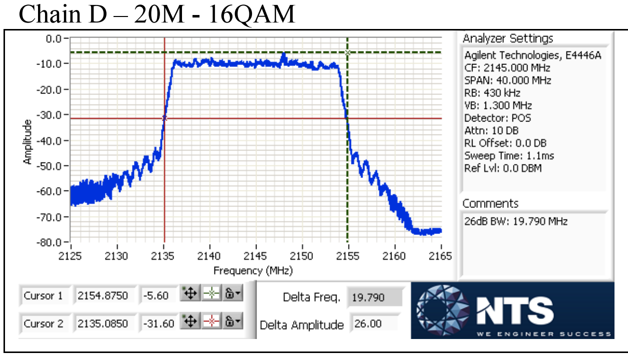


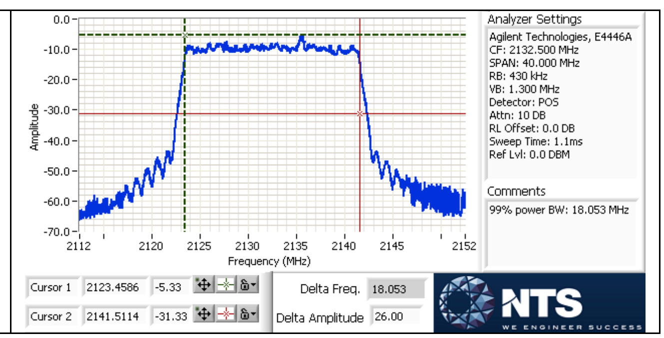
Chain D – 20M - QPSK



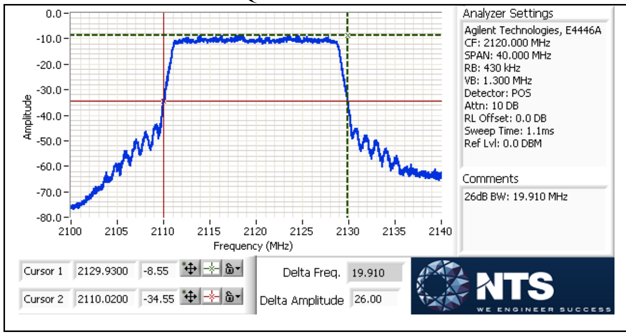


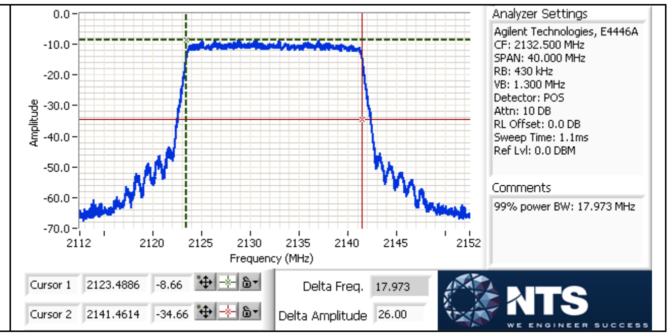
Chain D – 20M - 16QAM





Chain D – 20M – 64QAM





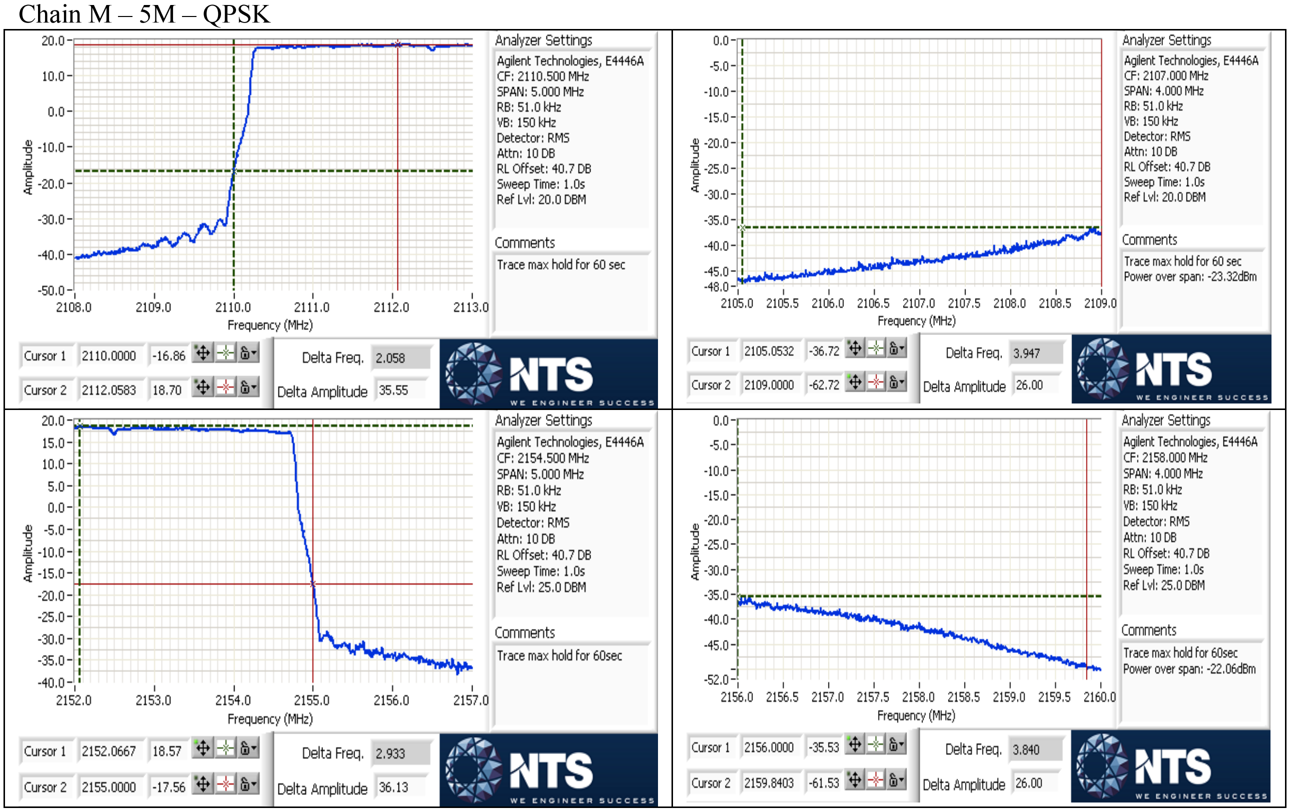
ANTENNA PORT CONDUCTED BANDEDGE (FCC 2.1051 & 27.53(h), RSS 139 6.5)

EUT has 2 transmit chains and the test was performed on both chains separately. Limit is adjusted to -13dBm – 10*log(2) = -16.01dBm per FCC KDB 662911D01 v02r01.

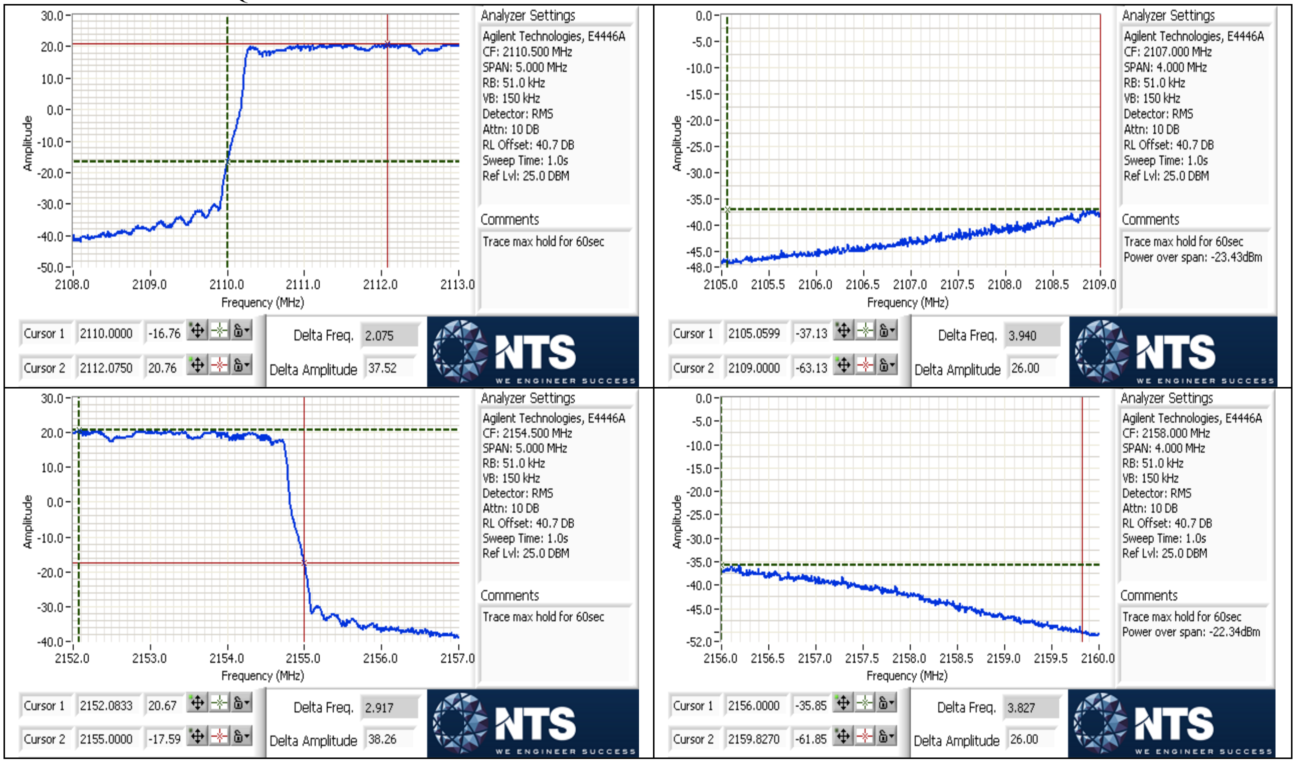
Conducted Bandedge							
		QPSK		16QAM		64QAM	
		Low	High	Low	High	Low	High
Chain M	5M	-16.86	-17.56	-16.76	-17.59	-16.89	-17.88
	10M	-17.22	-17.45	-17.59	-17.66	-17.73	-18.42
	15M	-18.27	-19.71	-17.82	-19.8	-18.2	-19.54
	20M	-19.04	-20.21	-19.61	-19.75	-19.41	-20.22
Chain D	5M	-16.91	-17.4	-16.98	-17.37	-17.22	-17.22
	10M	-17.48	-18.03	-17.78	-17.54	-17.87	-18.29
	15M	-18.83	-19.53	-17.94	-19.65	-18.38	-19.64
	20M	-19.01	-20.11	-19.72	-19.94	-19.28	-20.34

RMS readings with 1s sweep and 60s max hold.
Attenuator loss = 40dB, Cable Loss = 0.7dB, Total Path Loss = 40.7dB
In order to read corrected levels directly, total path loss accounted in via reference level offset to the spectrum analyzer.

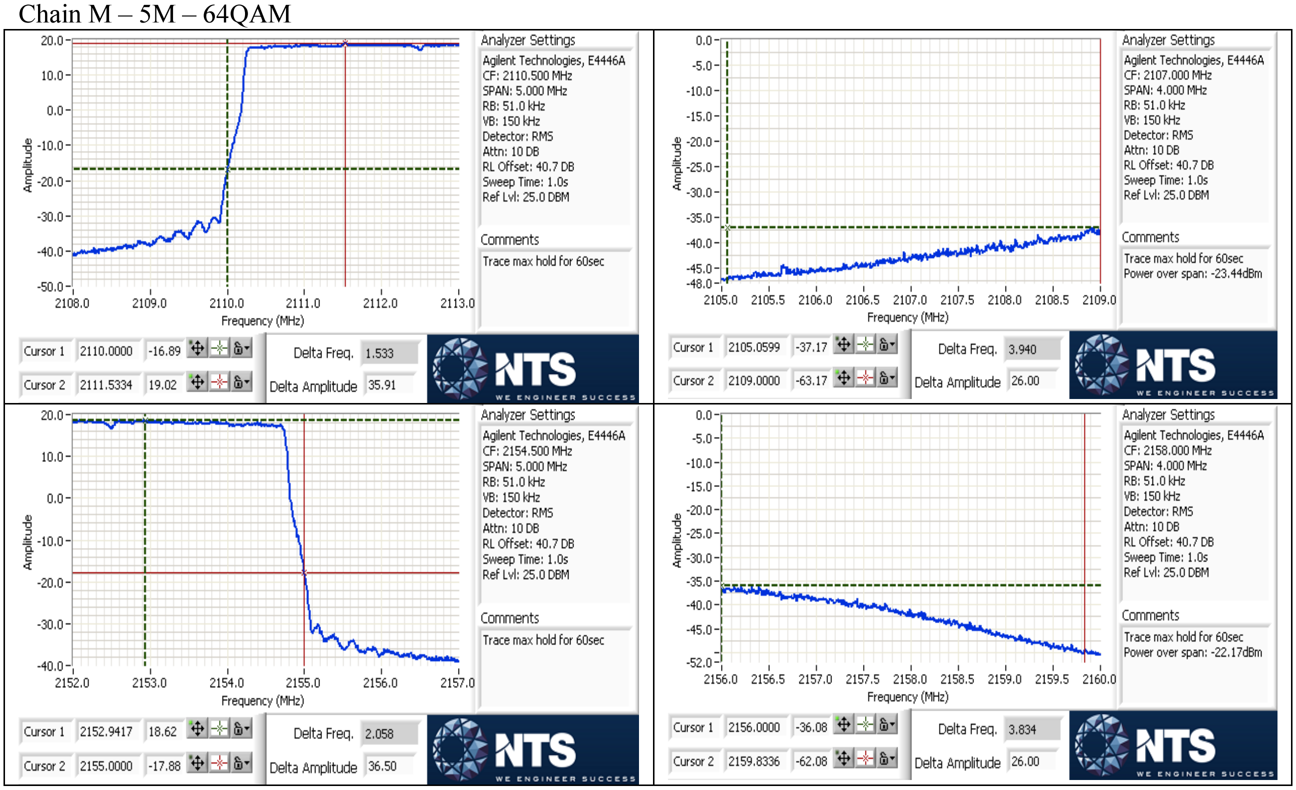
Chain M – 5M – QPSK



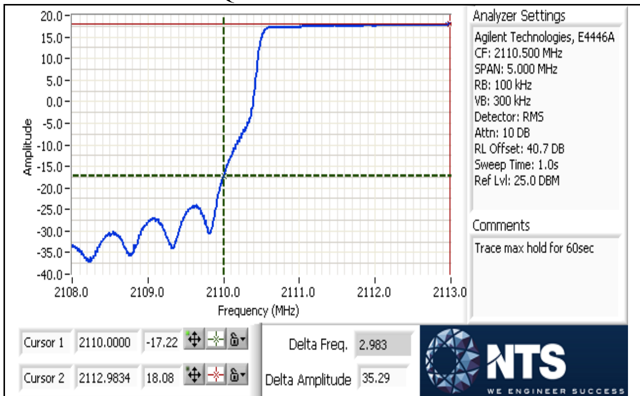
Chain M – 5M – 16QAM

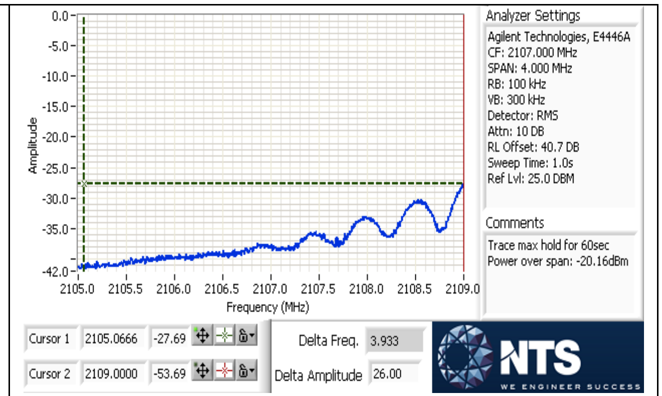


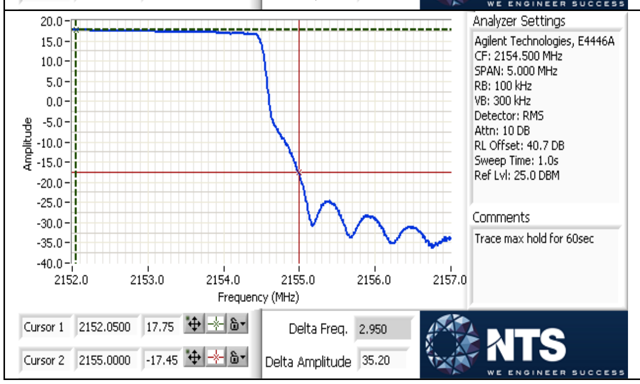
Chain M – 5M – 64QAM

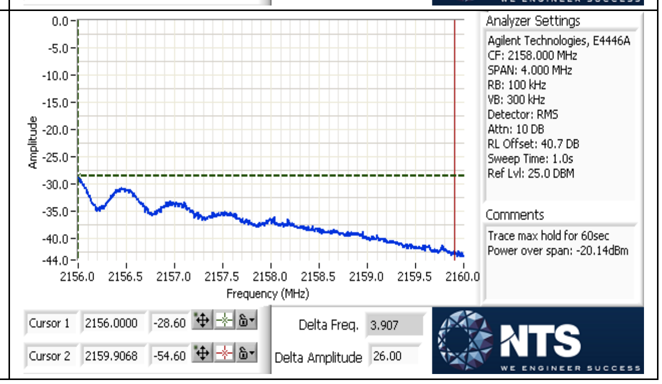


Chain M – 10M – QPSK

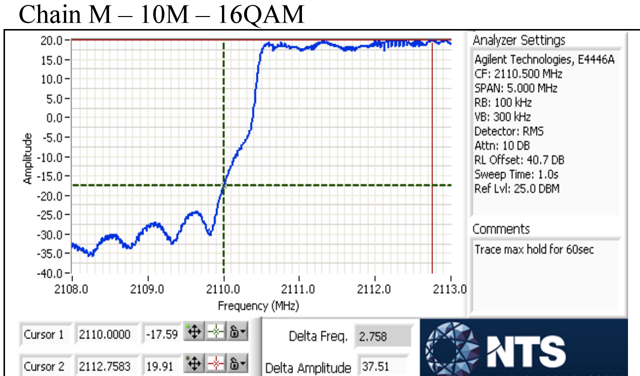


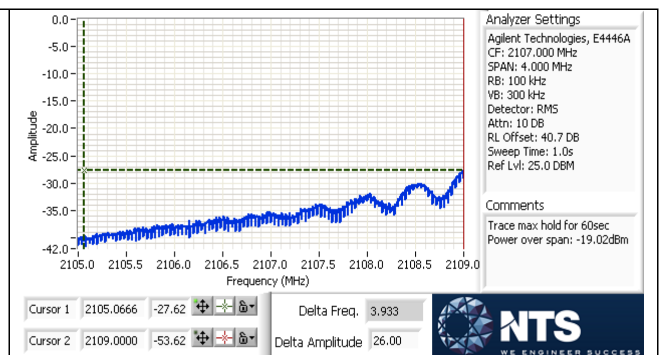


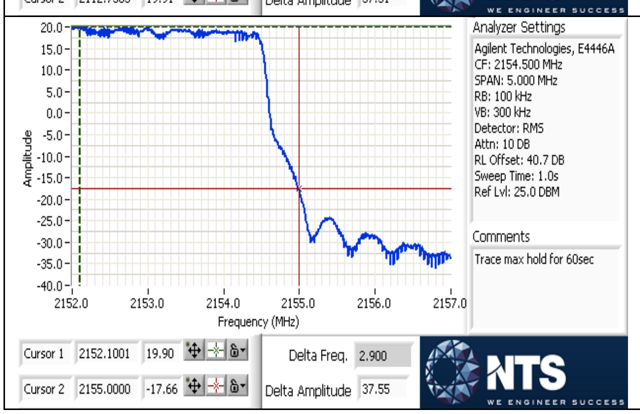


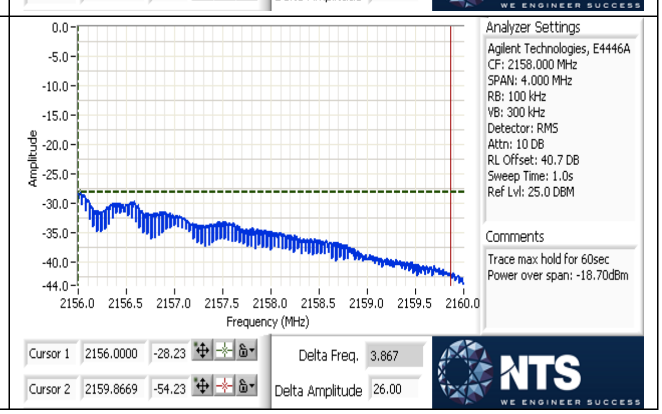


Chain M – 10M – 16QAM

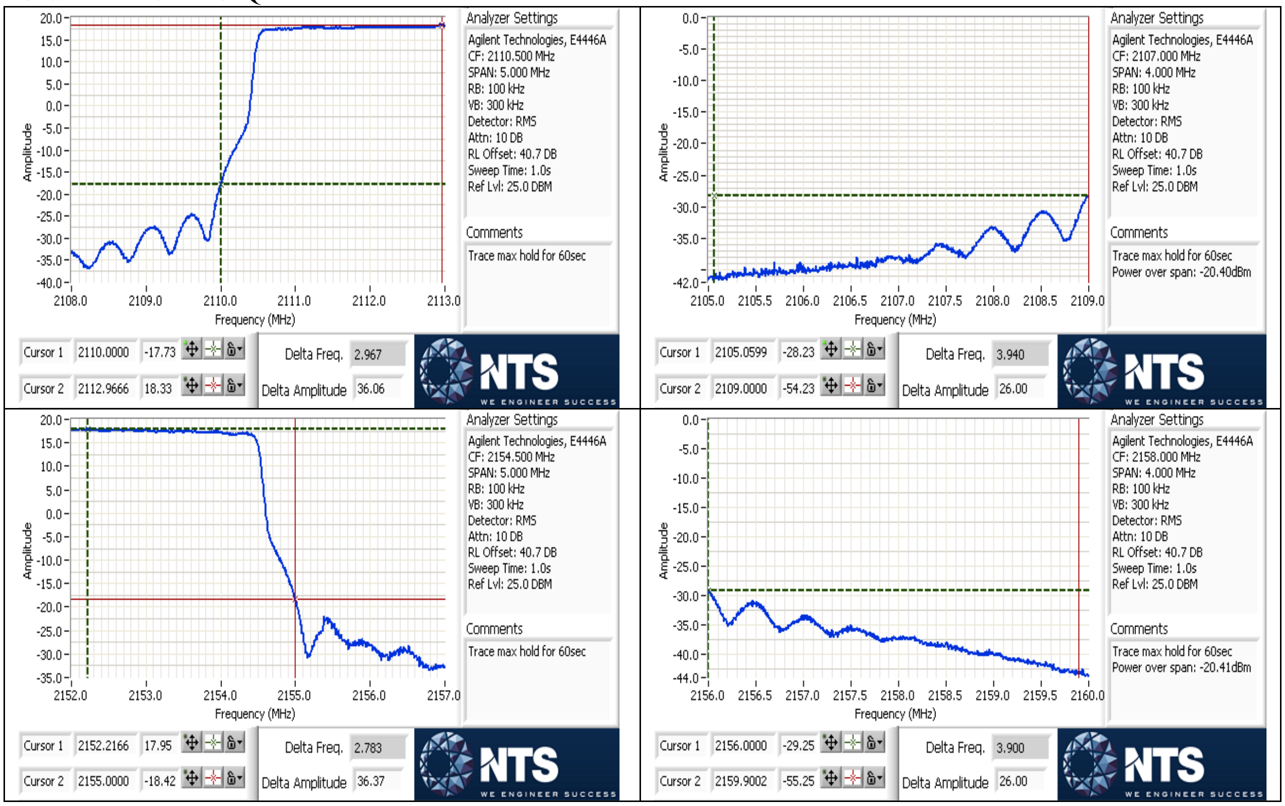




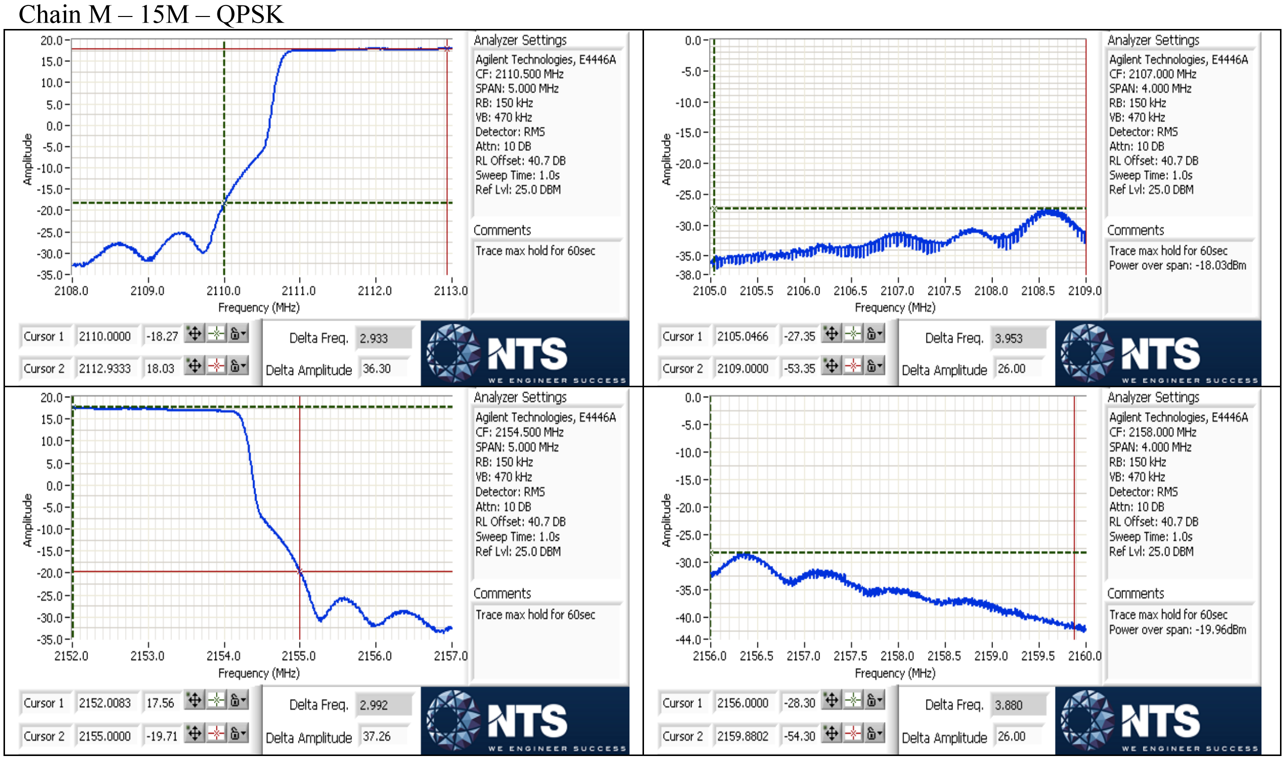




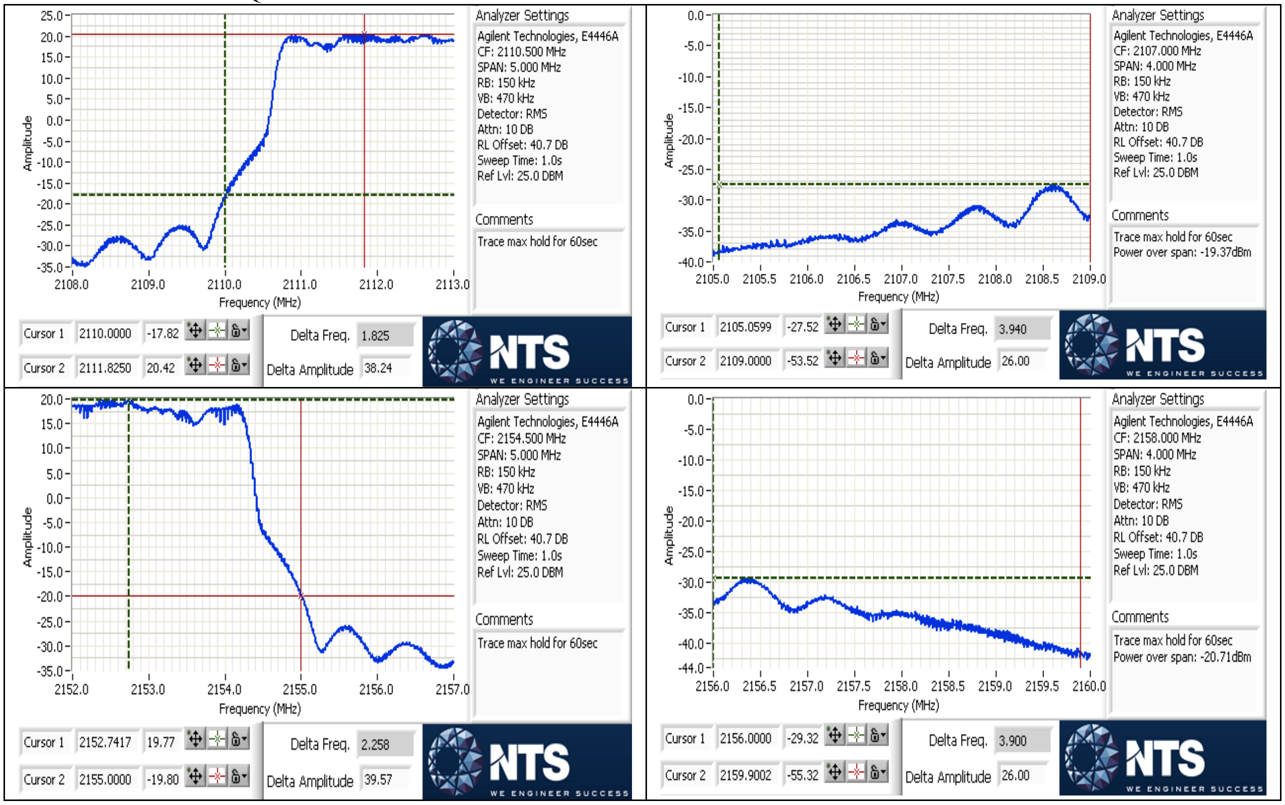
Chain M – 10M – 64QAM



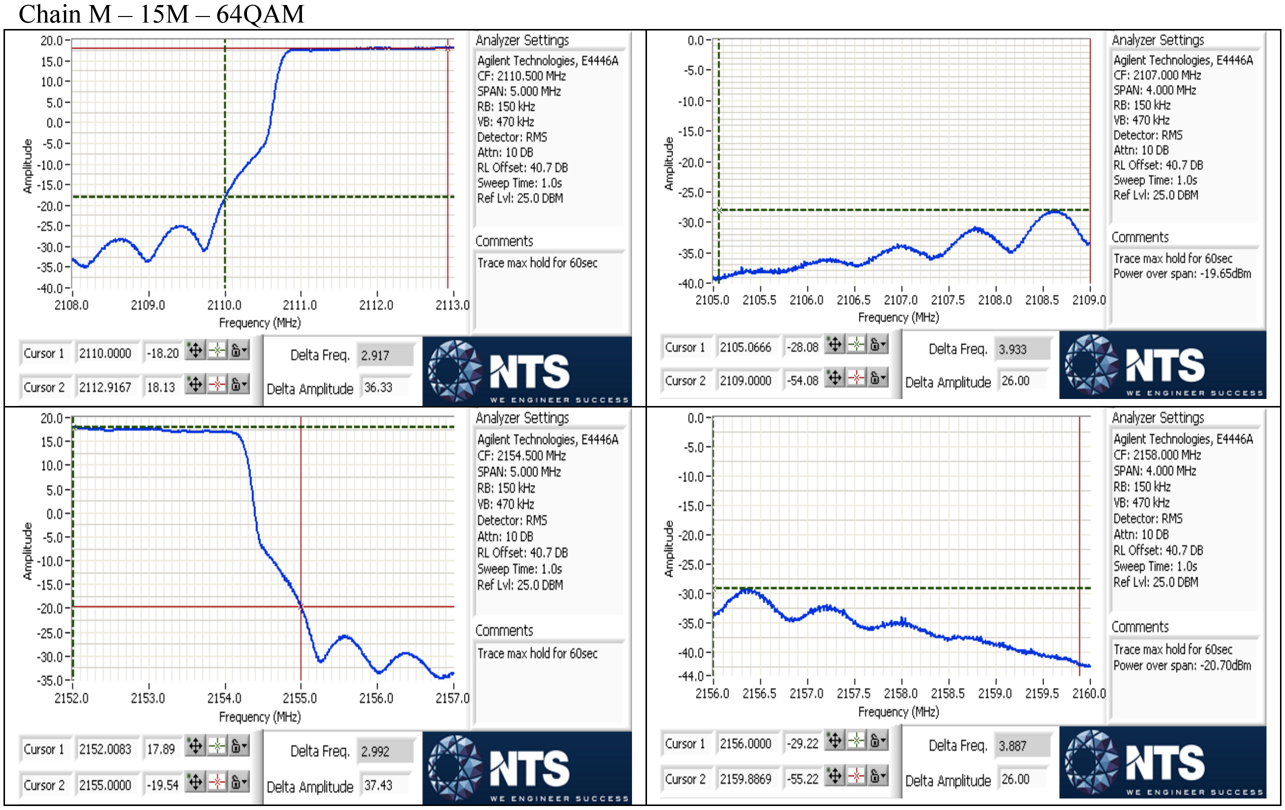
Chain M – 15M – QPSK



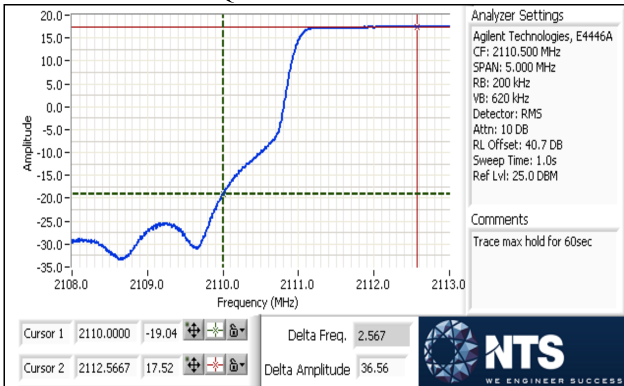
Chain M – 15M – 16QAM

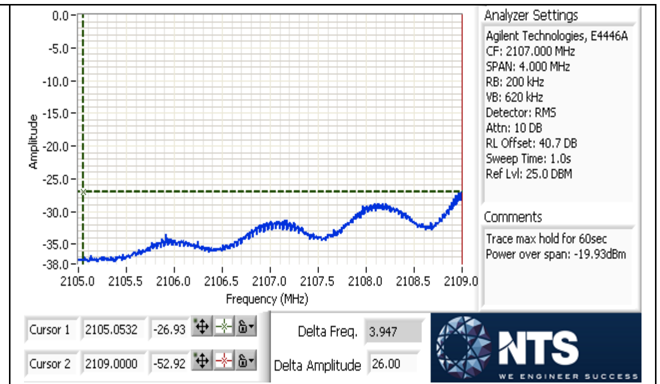


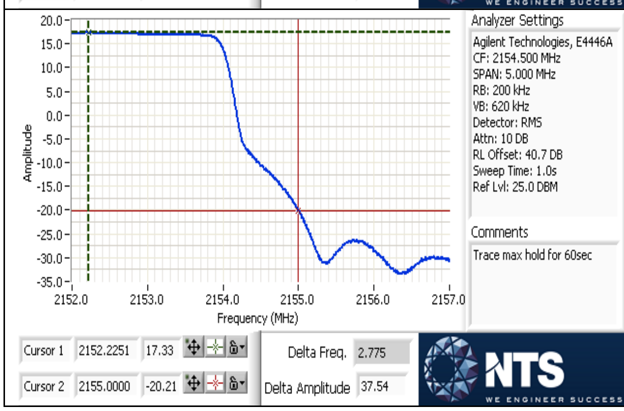
Chain M – 15M – 64QAM

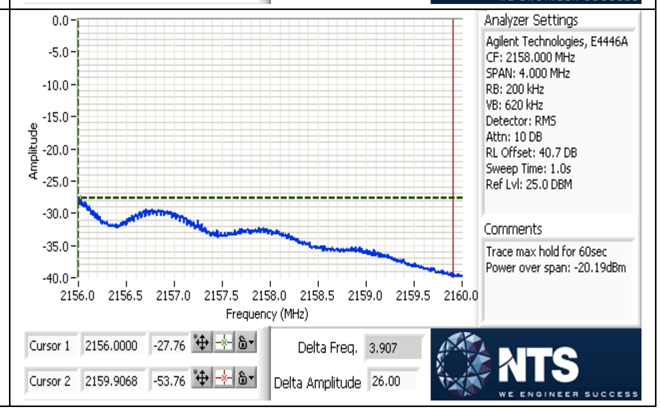


Chain M – 20M – QPSK

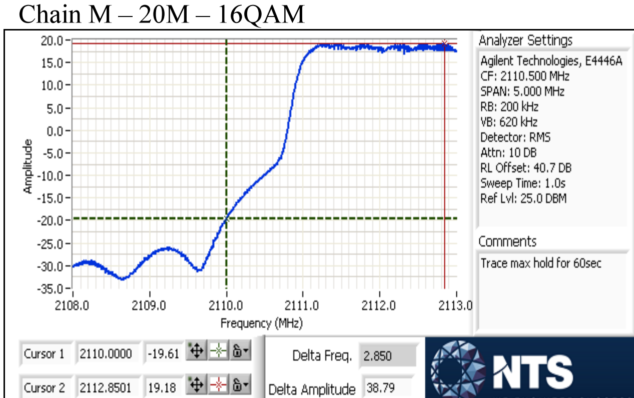


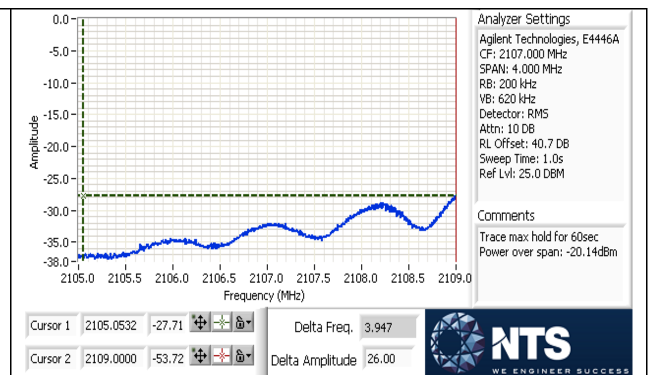


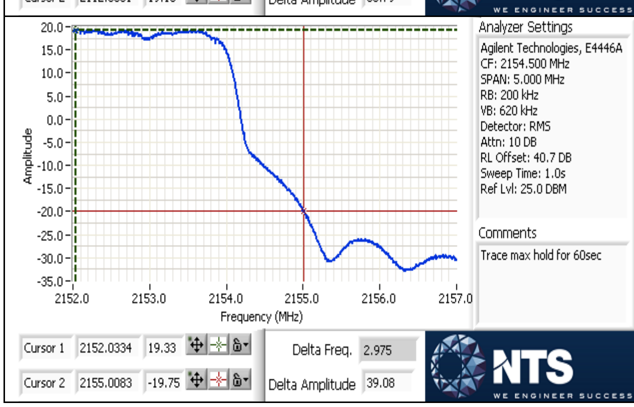


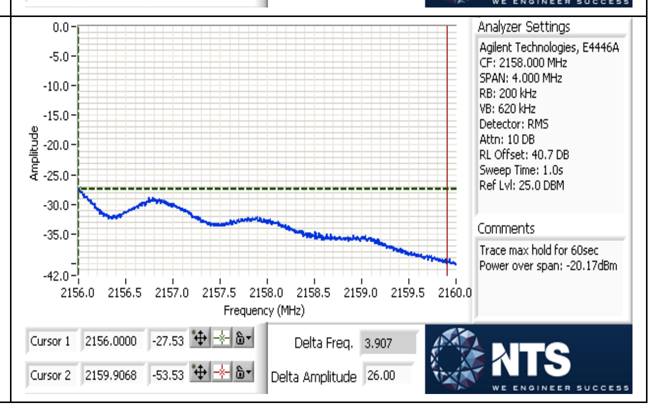


Chain M – 20M – 16QAM

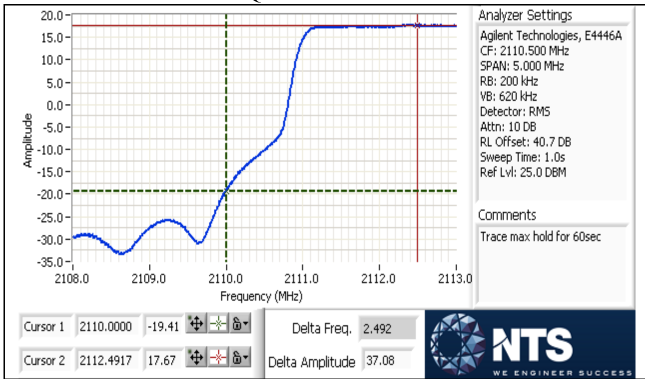


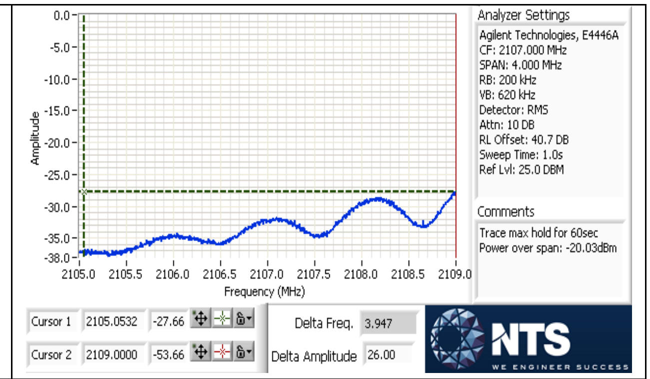


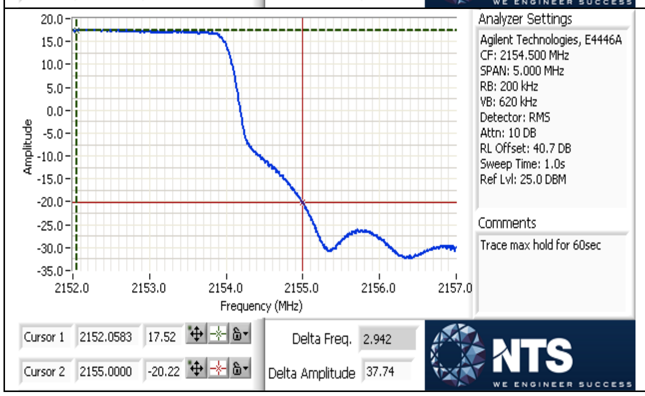


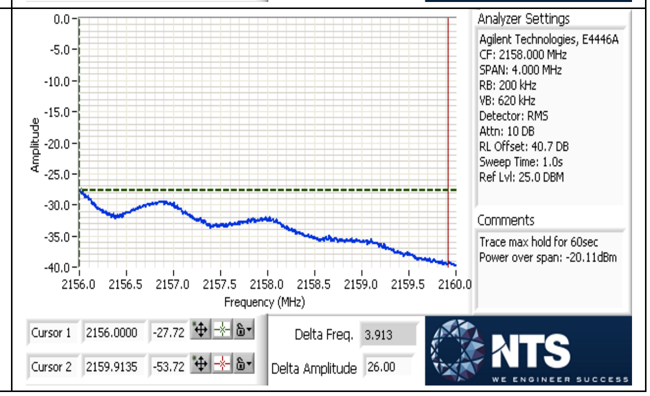


Chain M – 20M – 64QAM

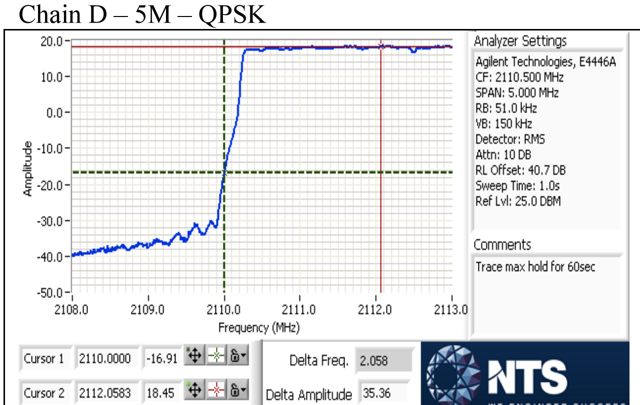


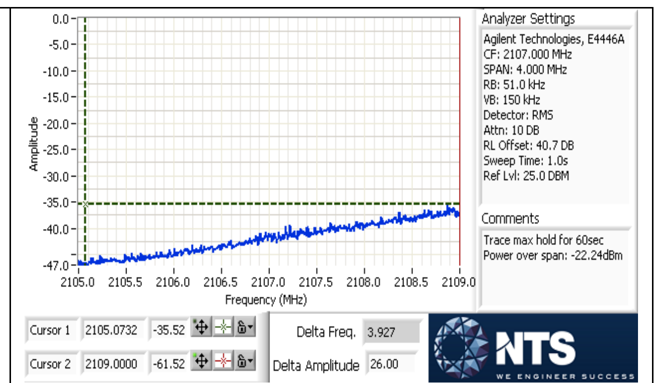


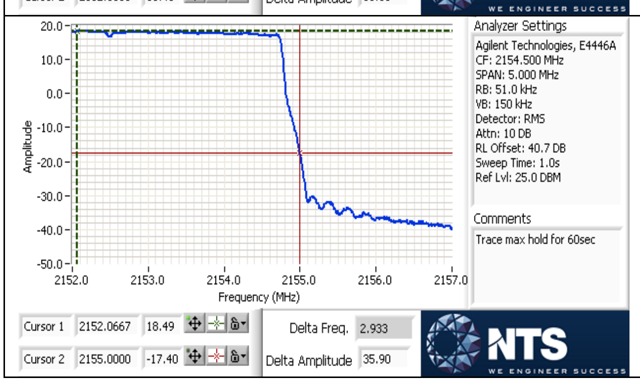


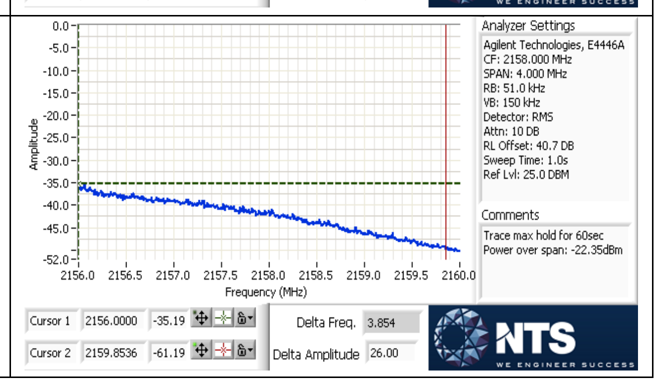


Chain D – 5M – QPSK

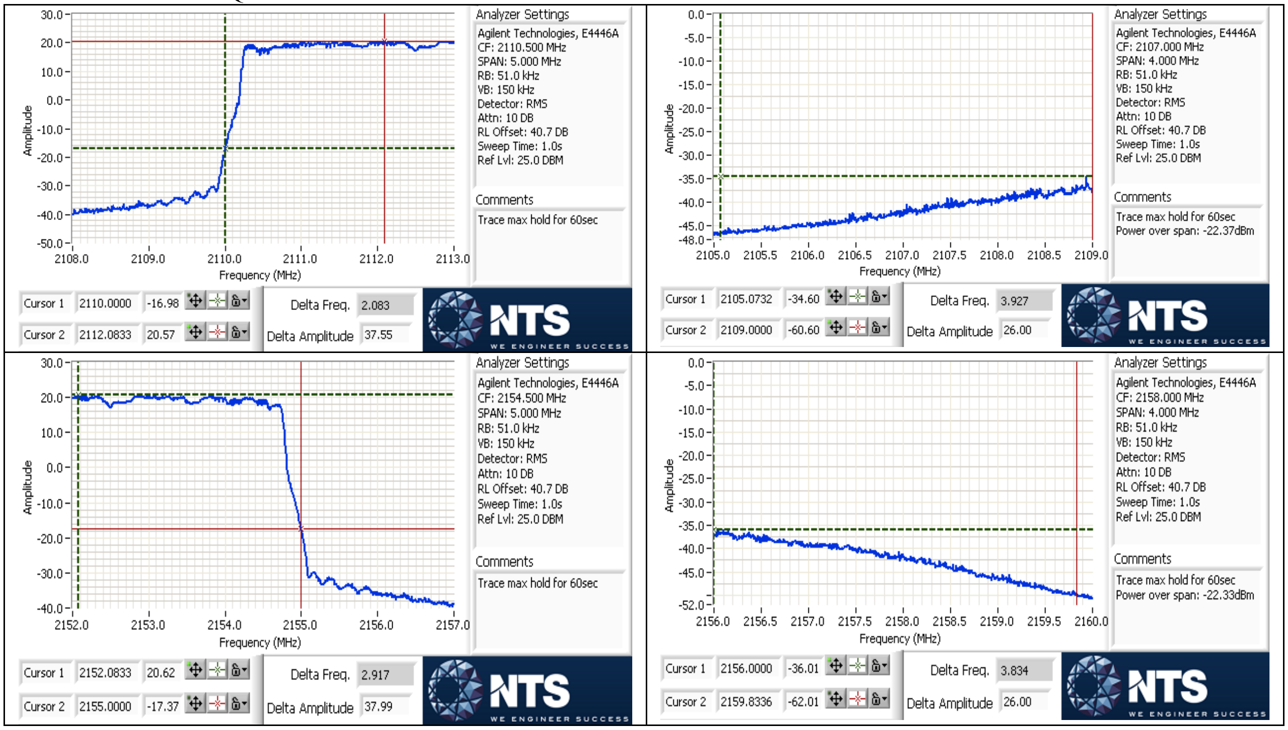




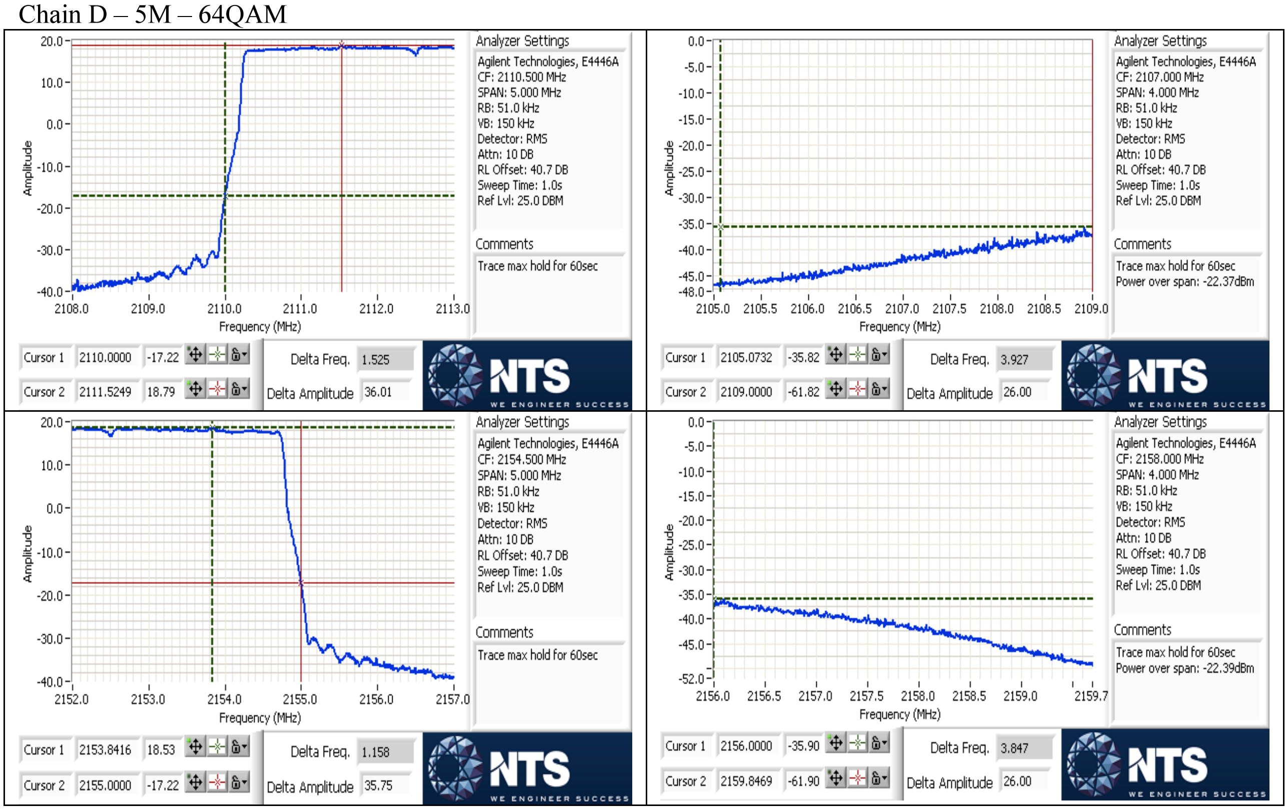




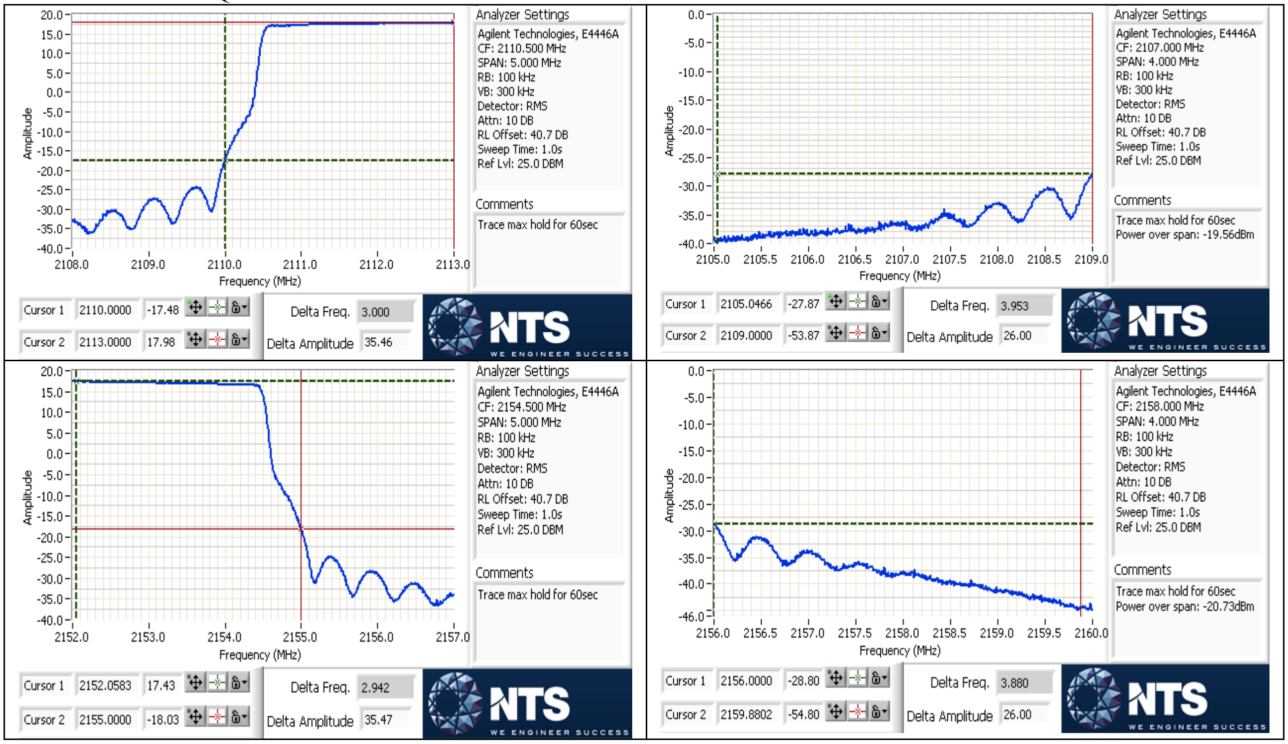
Chain D – 5M – 16QAM



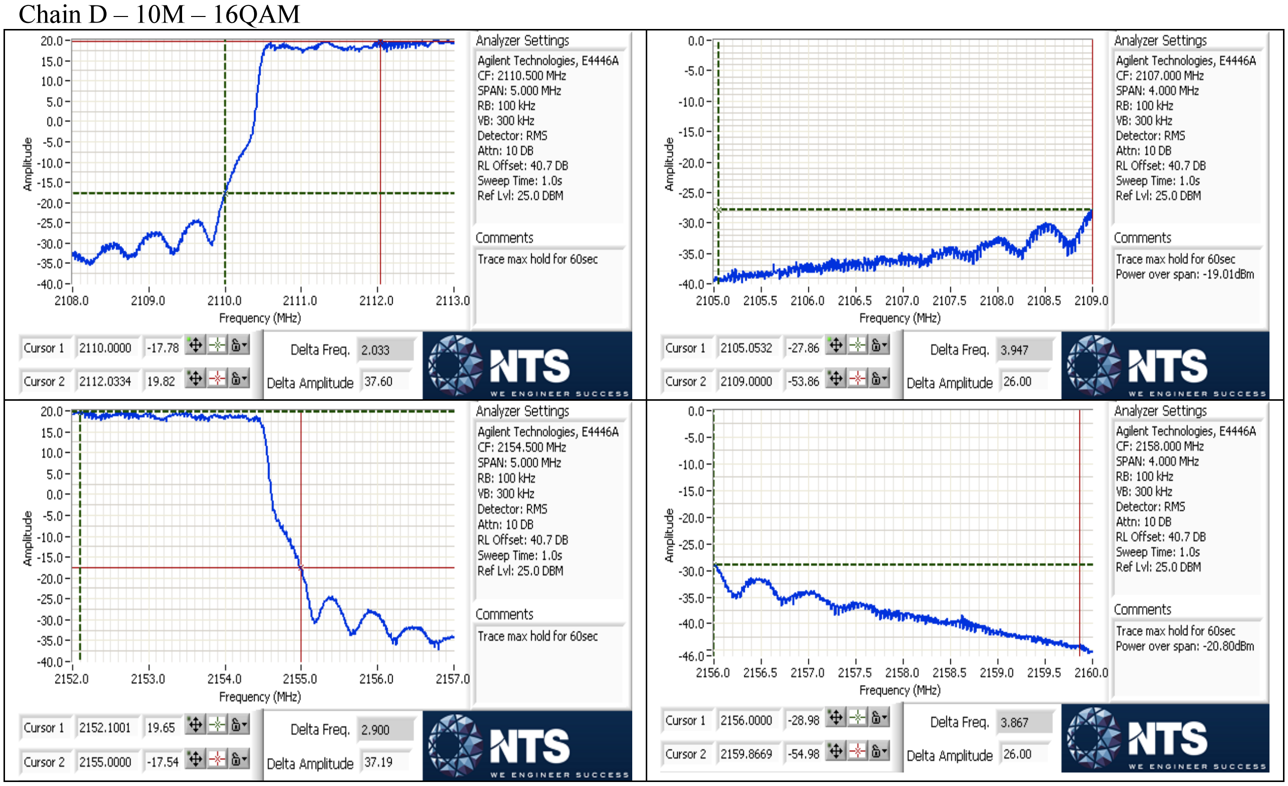
Chain D – 5M – 64QAM



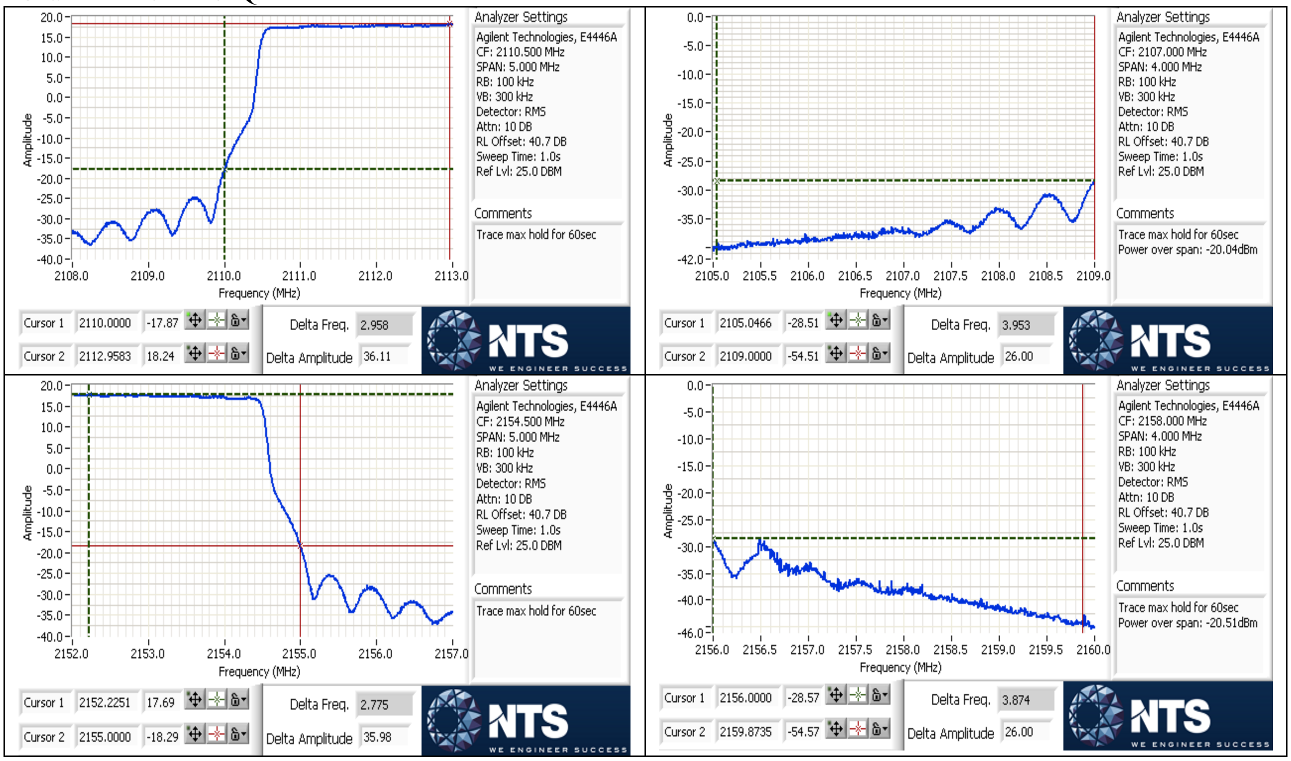
Chain D – 10M – QPSK



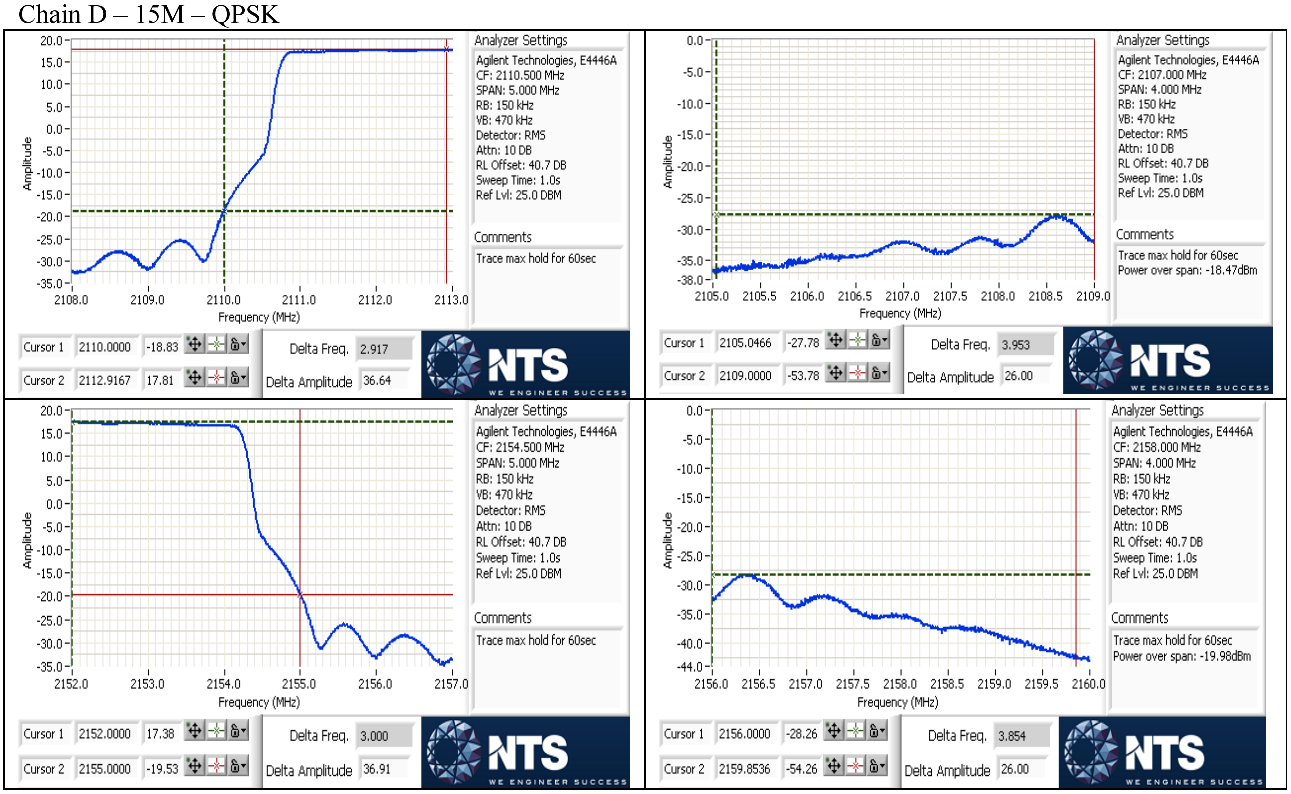
Chain D – 10M – 16QAM



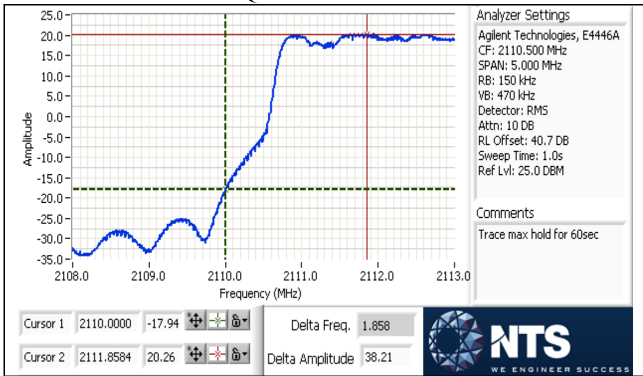
Chain D – 10M – 64QAM

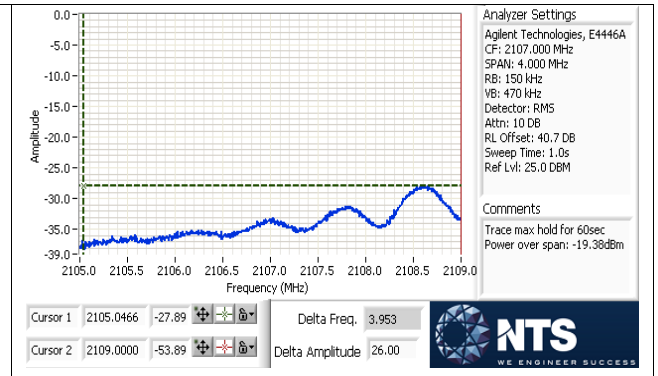


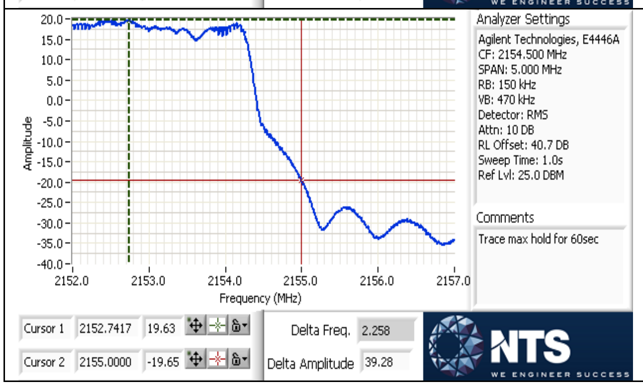
Chain D – 15M – QPSK

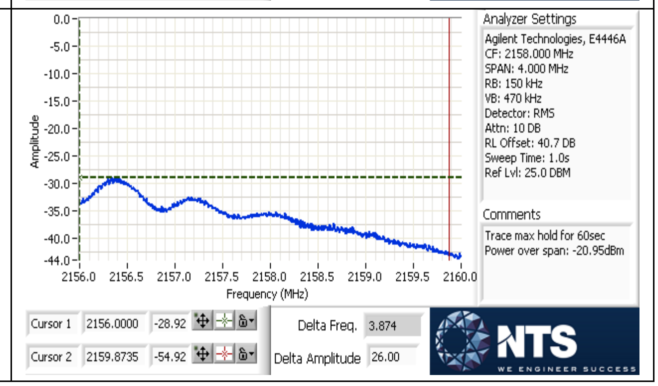


Chain D – 15M – 16QAM

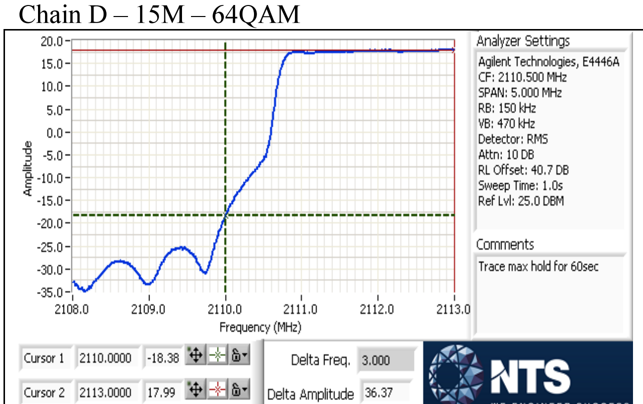


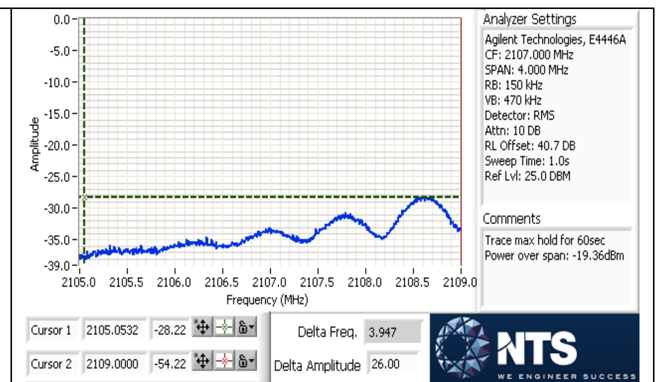


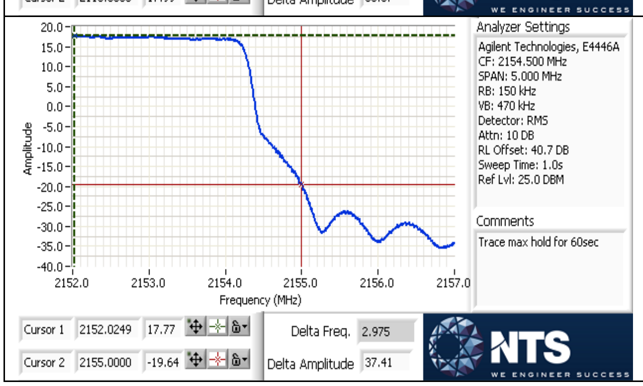


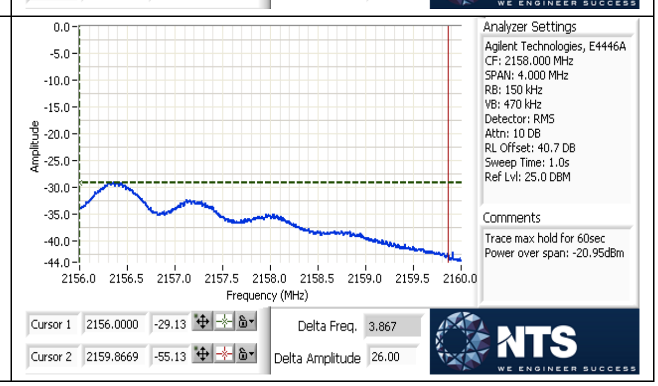


Chain D – 15M – 64QAM

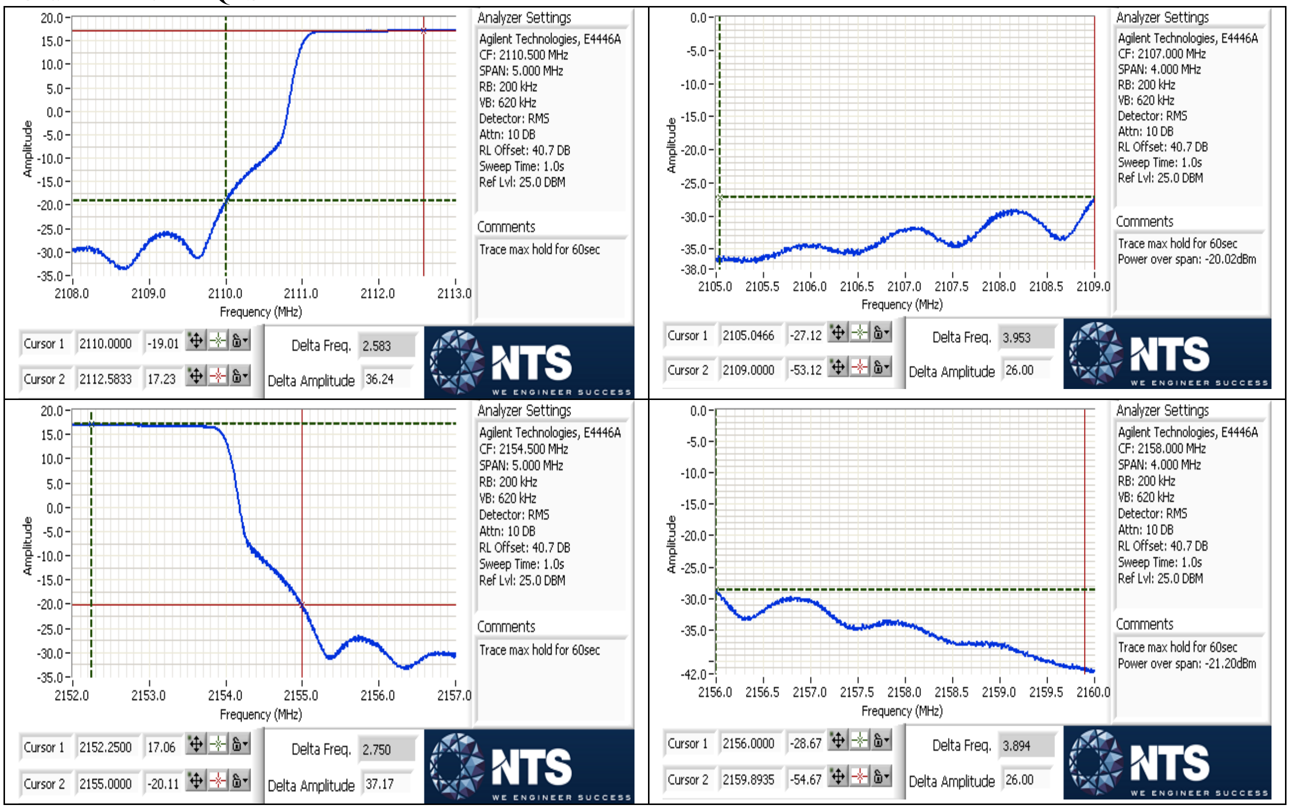




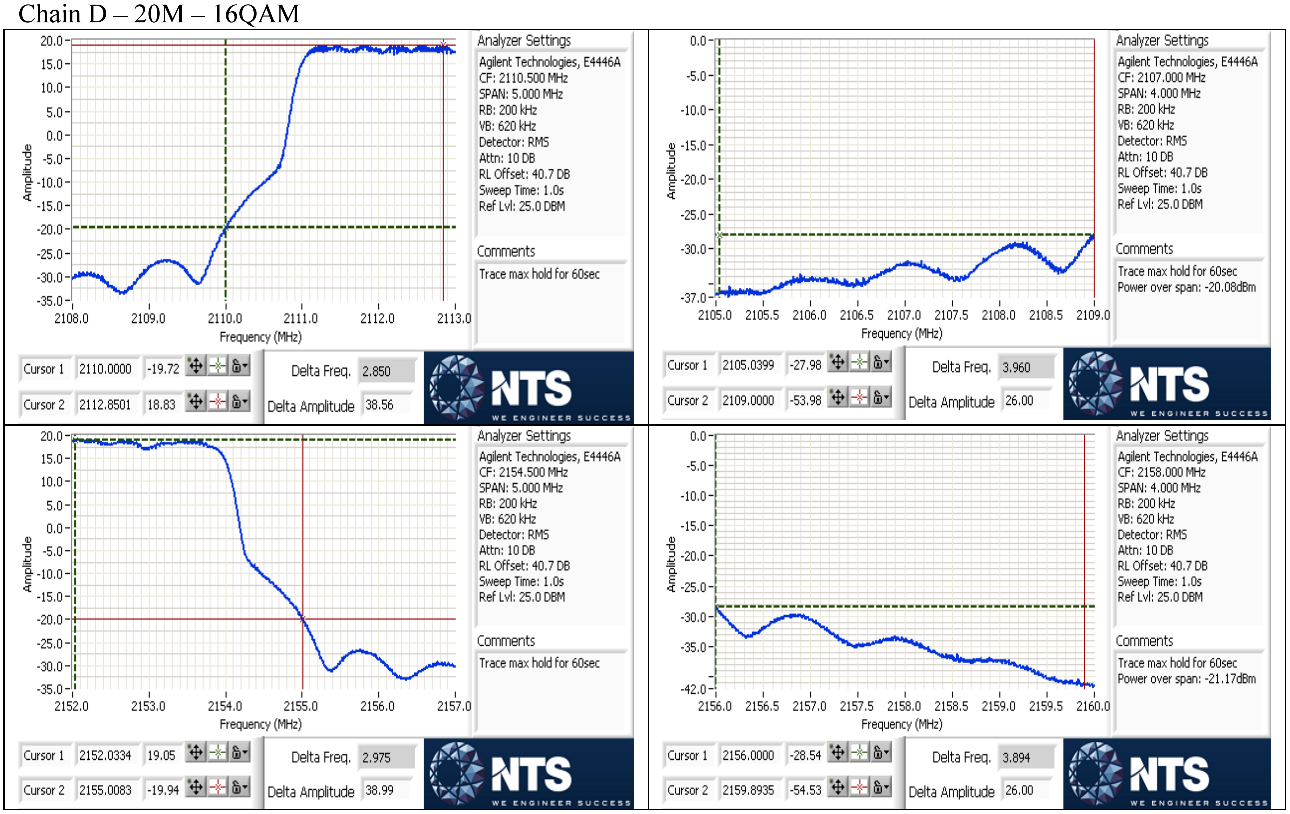




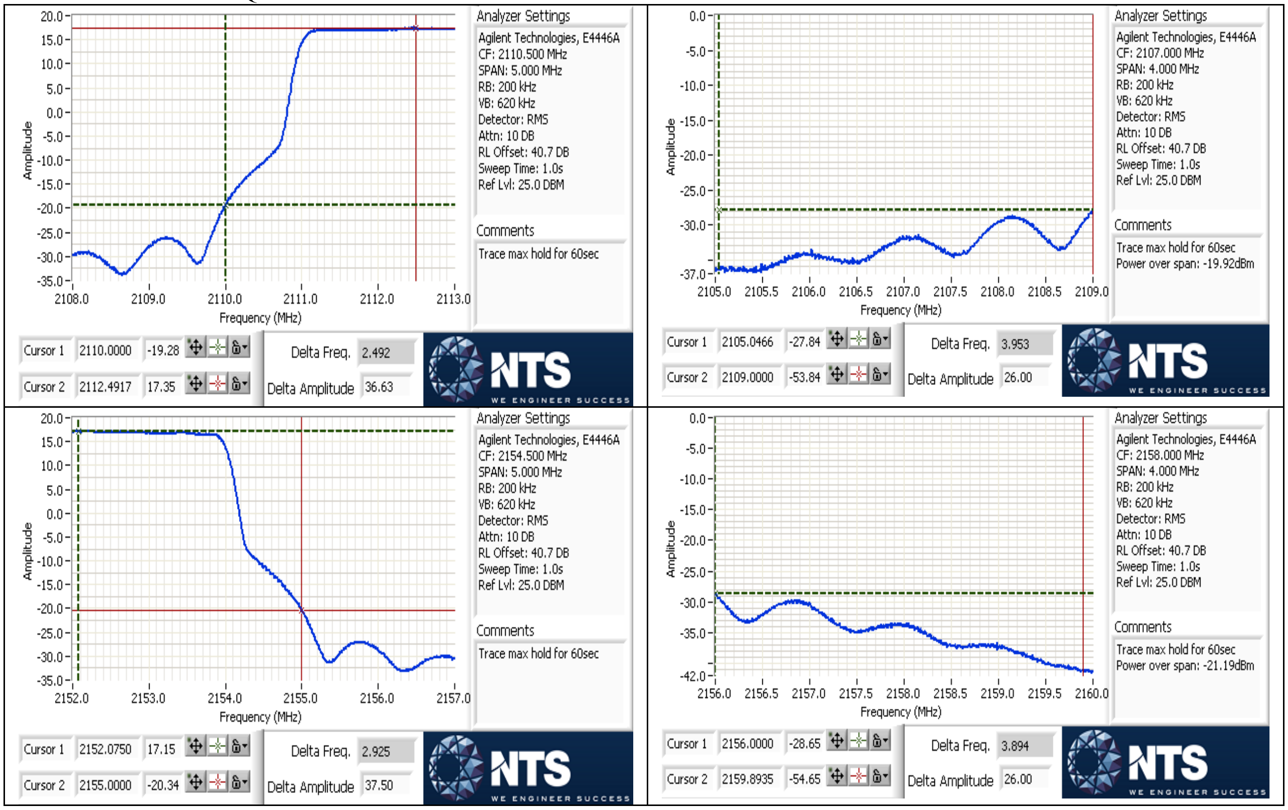
Chain D – 20M – QPSK



Chain D – 20M – 16QAM



Chain D – 20M – 64QAM

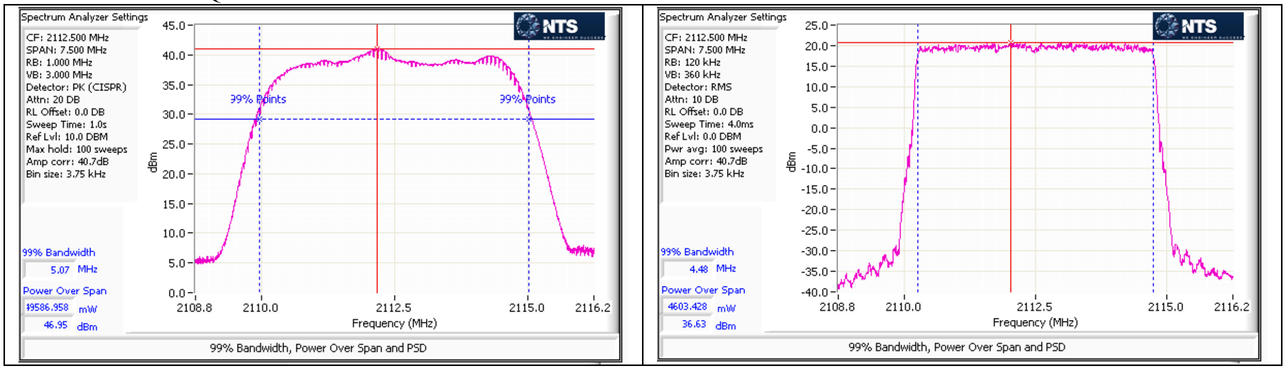


RF Output Power (FCC 2.1046 & 27.50(d), RSS 139 Section 6.4)

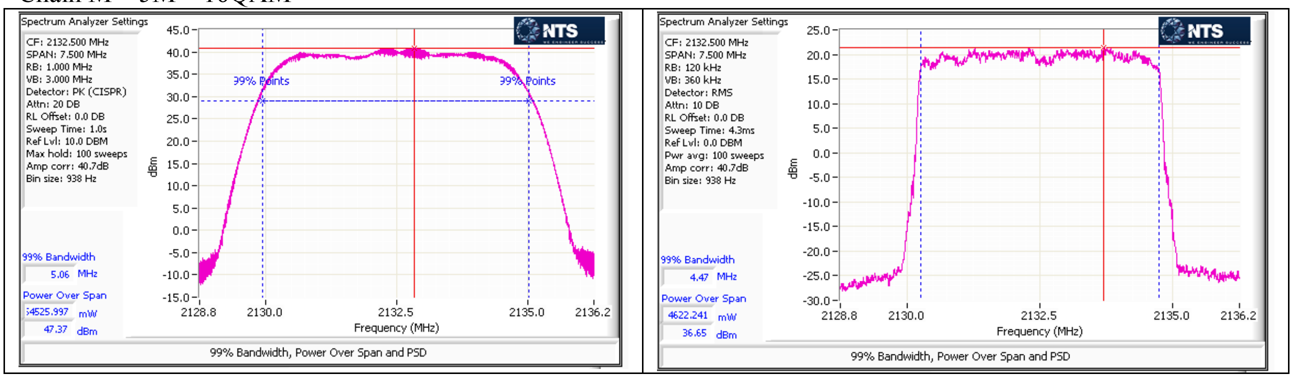
RF output power has been measured in both Peak and RMS Average terms for each transmit chain. Peak to average ratio (PAR) has been calculated as described in Section 5.7.2 of KDB971168 D01 v02r01 and all results are presented in tabular form below. Highest PAR found (10.98dB) is less than its 13dB maximum limit.
Attenuator Loss: 40dB, RF cable loss: 0.7dB

Peak Power - RMS Power - Peak to Average Ratio											
			QPSK			16QAM			64QAM		
			Low	Center	High	Low	Center	High	Low	Center	High
Chain M	5M	Peak (dBm)	46.95	46.7	46.39	47.28	47.37	46.18	46.46	46.59	46.16
		RMS (dBm)	36.63	36.63	36.39	36.51	36.65	35.57	36.51	36.64	36.32
		PAR (dB)	10.32	10.07	10	10.77	10.72	10.61	9.95	9.95	9.84
	10M	Peak (dBm)	47.52	46.9	46.75	47.84	47.55	47.35	46.15	46.78	46.59
		RMS (dBm)	36.81	36.85	36.7	36.86	36.86	36.67	36.8	36.85	36.69
		PAR (dB)	10.71	10.05	10.05	10.98	10.69	10.68	9.35	9.93	9.9
	15M	Peak (dBm)	46.95	46.89	46.7	47.95	47.85	47.54	47	46.91	46.72
		RMS (dBm)	36.98	36.87	36.75	36.98	36.89	36.8	36.95	36.9	36.8
		PAR (dB)	9.97	10.02	9.95	10.97	10.96	10.74	10.05	10.01	9.92
	20M	Peak (dBm)	46.96	46.97	47.06	47.82	47.77	47.82	46.89	46.93	46.96
		RMS (dBm)	36.82	36.93	36.89	36.87	36.88	36.9	36.82	36.88	36.89
		PAR (dB)	10.14	10.04	10.17	10.95	10.89	10.92	10.07	10.05	10.07
Chain D	5M	Peak (dBm)	46.67	46.43	46.39	47.04	47.07	46.66	46.32	46.33	46.11
		RMS (dBm)	36.46	36.47	36.38	36.44	36.4	36.2	36.42	36.48	36.36
		PAR (dB)	10.21	9.96	10.01	10.6	10.67	10.46	9.9	9.85	9.75
	10M	Peak (dBm)	46.3	46.59	46.05	46.91	47.21	46.62	46.15	46.52	45.85
		RMS (dBm)	36.09	36.52	35.94	36.14	36.53	36.04	36.09	36.46	35.95
		PAR (dB)	10.21	10.07	10.11	10.77	10.68	10.58	10.06	10.06	9.9
	15M	Peak (dBm)	46.77	46.6	46.77	47.67	47.55	47.75	46.81	46.71	46.79
		RMS (dBm)	36.78	36.72	36.83	36.76	36.69	36.78	36.77	36.74	36.79
		PAR (dB)	9.99	9.88	9.94	10.91	10.86	10.97	10.04	9.97	10
	20M	Peak (dBm)	46.74	46.65	46.65	47.5	47.48	47.39	46.61	46.63	46.56
		RMS (dBm)	36.5	36.51	36.45	36.52	36.57	36.47	36.52	36.55	36.52
		PAR (dB)	10.24	10.14	10.2	10.98	10.91	10.92	10.09	10.08	10.04
TOTAL	5M	Peak (dBm)	49.82	49.58	49.4	50.17	50.23	49.44	49.4	49.47	49.15
		RMS (dBm)	39.56	39.56	39.4	39.49	39.54	38.91	39.48	39.57	39.35
		PAR (dB)	10.26	10.02	10	10.68	10.69	10.53	9.92	9.9	9.8
	10M	Peak (dBm)	49.96	49.76	49.42	50.41	50.39	50.01	49.16	49.66	49.25
		RMS (dBm)	39.48	39.7	39.35	39.53	39.71	39.38	39.47	39.67	39.35
		PAR (dB)	10.48	10.06	10.07	10.88	10.68	10.63	9.69	9.99	9.9
	15M	Peak (dBm)	49.87	49.76	49.75	50.82	50.71	50.66	49.92	49.82	49.77
		RMS (dBm)	39.89	39.81	39.8	39.88	39.8	39.8	39.87	39.83	39.81
		PAR (dB)	9.98	9.95	9.95	10.94	10.91	10.86	10.05	9.99	9.96
	20M	Peak (dBm)	49.86	49.82	49.87	50.67	50.64	50.62	49.76	49.79	49.77
		RMS (dBm)	39.67	39.74	39.69	39.71	39.74	39.7	39.68	39.73	39.72
		PAR (dB)	10.19	10.08	10.18	10.96	10.9	10.92	10.08	10.06	10.05

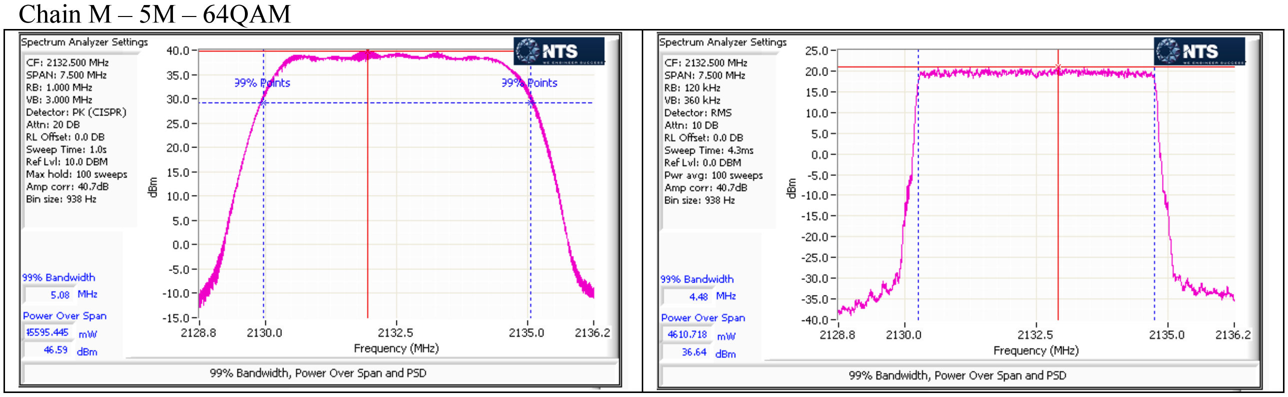
Chain M – 5M – QPSK



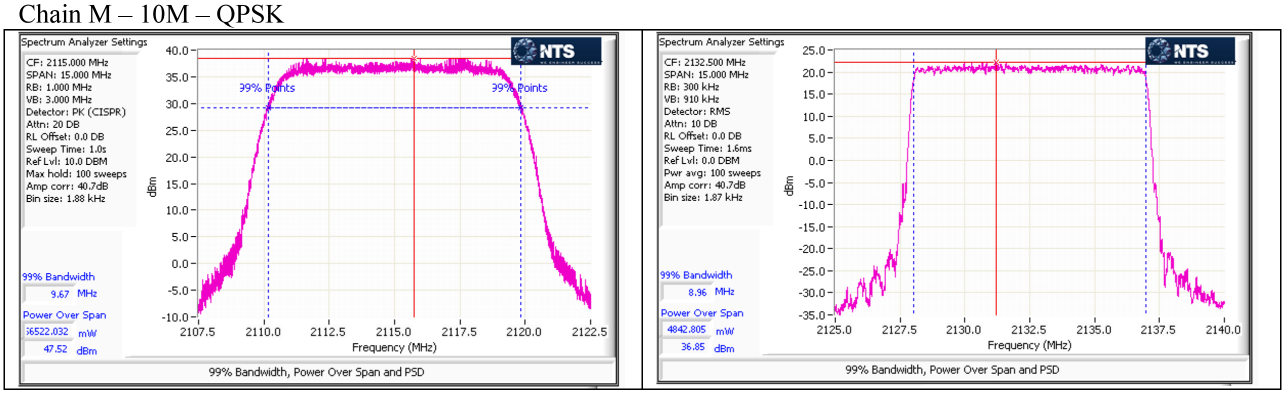
Chain M – 5M – 16QAM



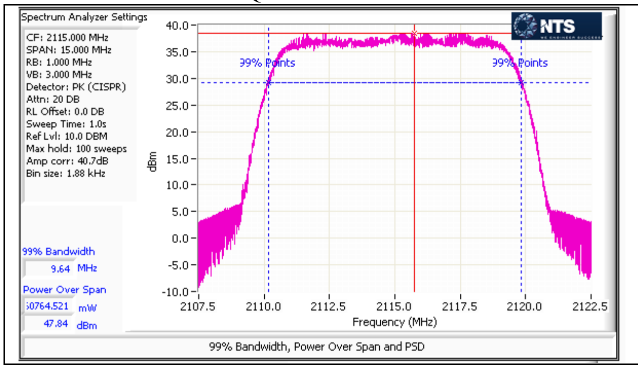
Chain M – 5M – 64QAM

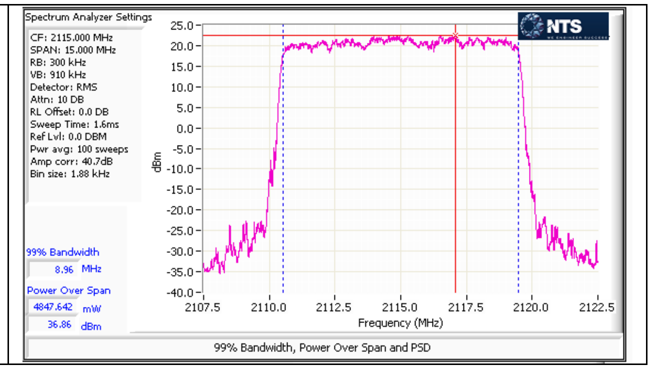


Chain M – 10M – QPSK

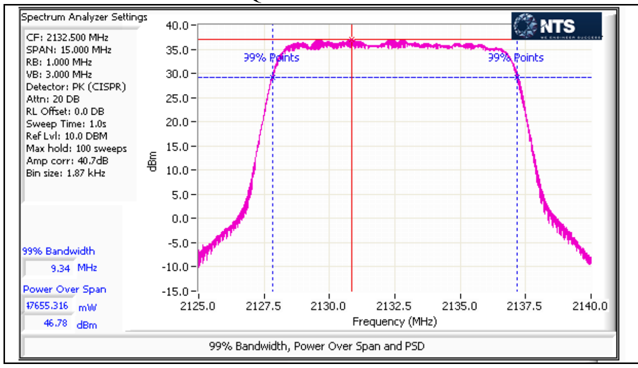


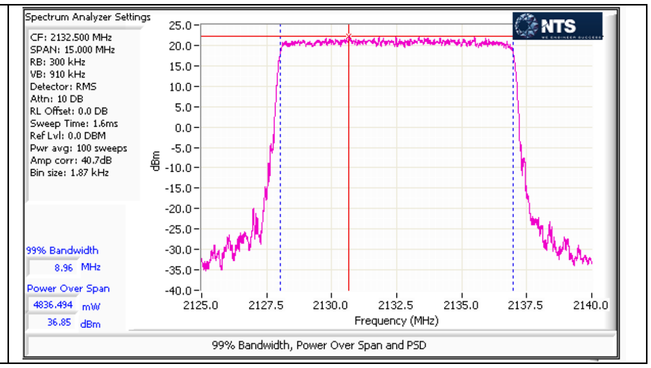
Chain M – 10M – 16QAM



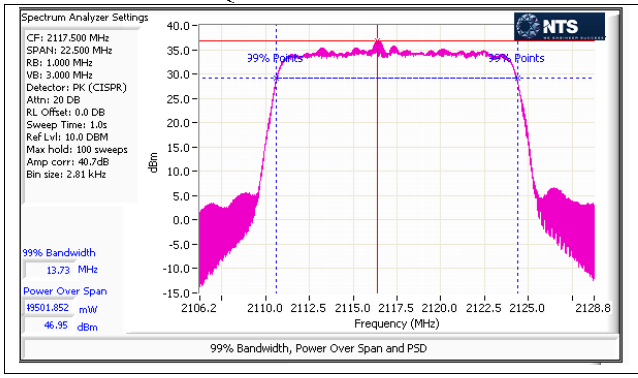


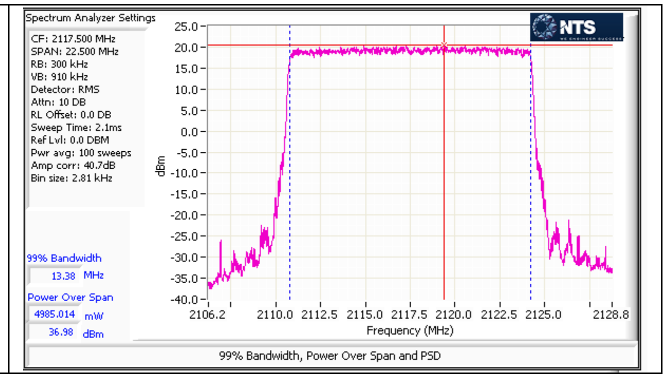
Chain M – 10M – 64QAM



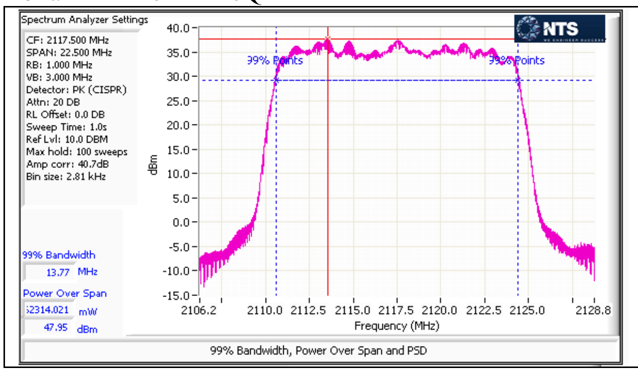


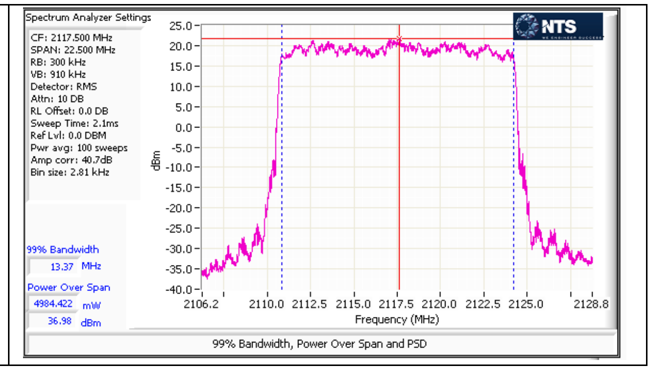
Chain M – 15M – QPSK



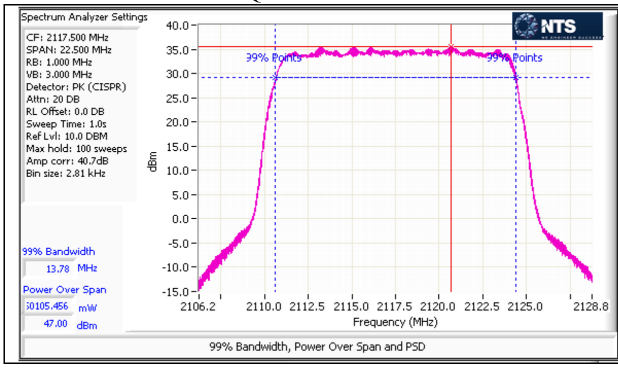


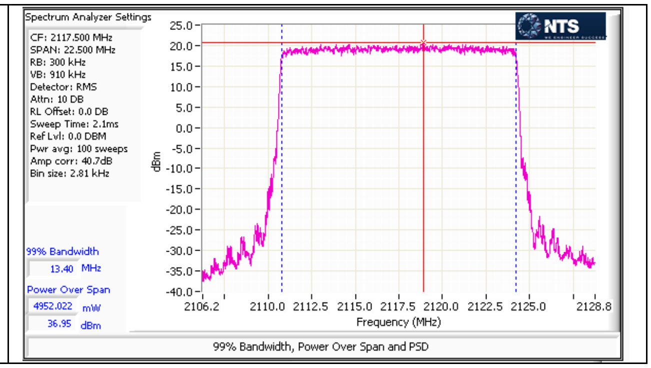
Chain M – 15M – 16QAM



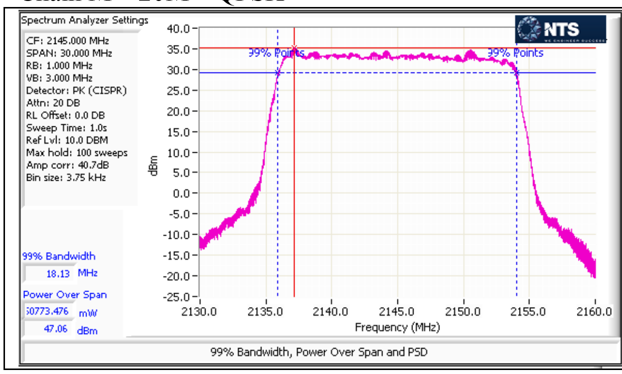


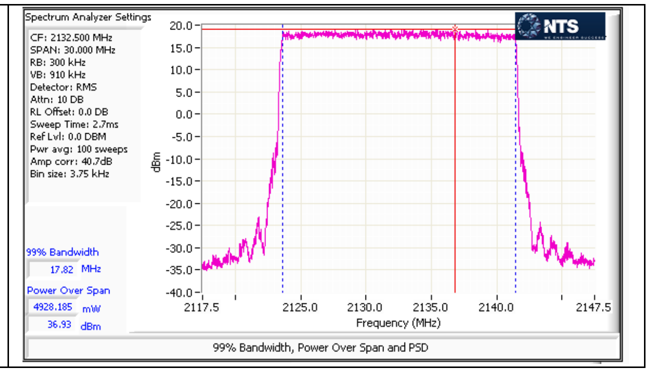
Chain M – 15M – 64QAM



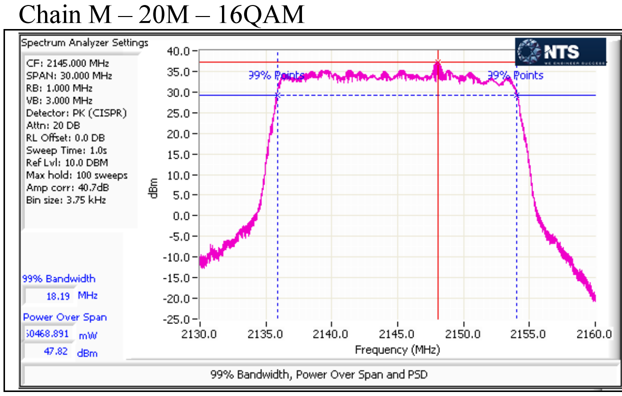


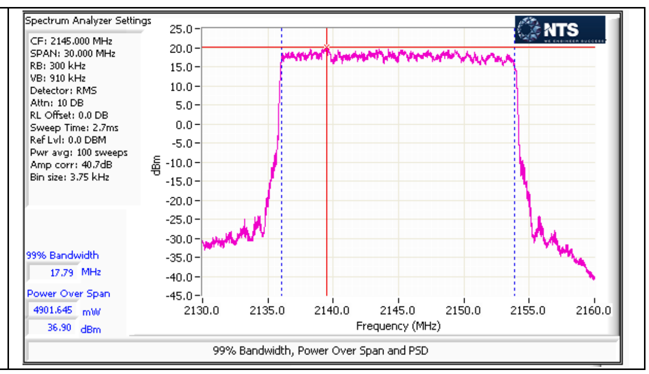
Chain M – 20M – QPSK



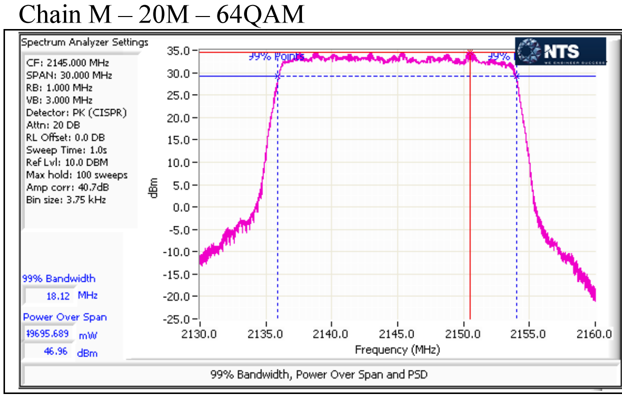


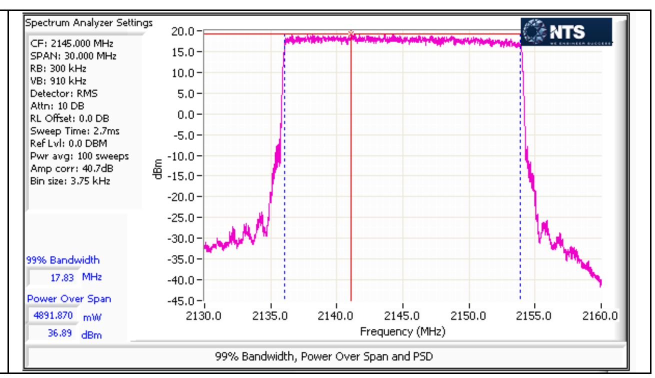
Chain M – 20M – 16QAM



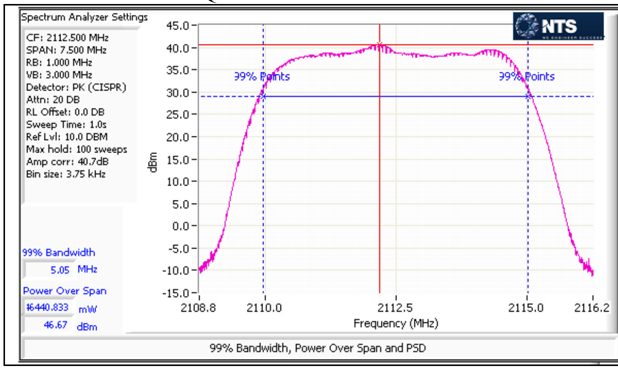


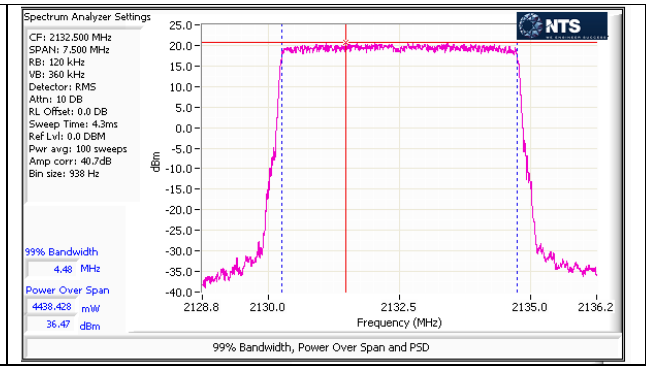
Chain M – 20M – 64QAM



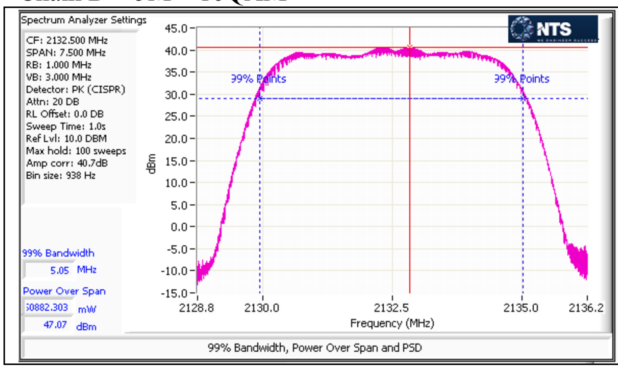


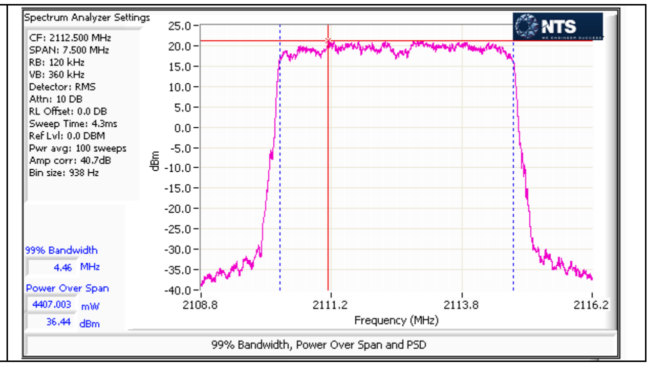
Chain D – 5M – QPSK



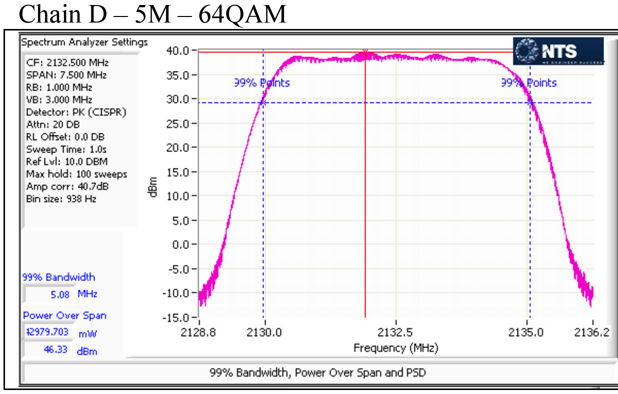


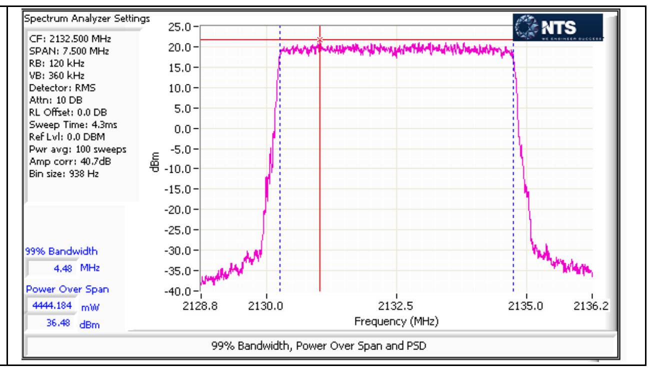
Chain D – 5M – 16QAM



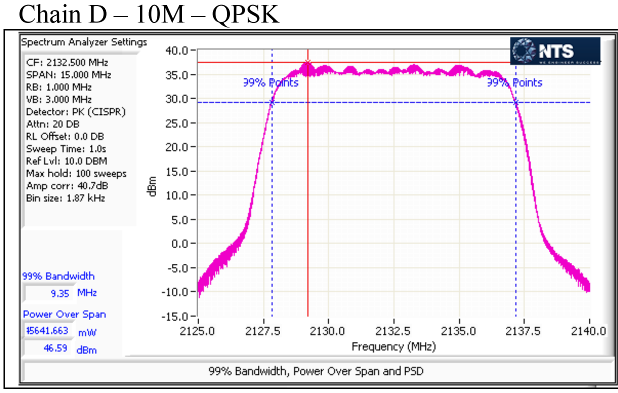


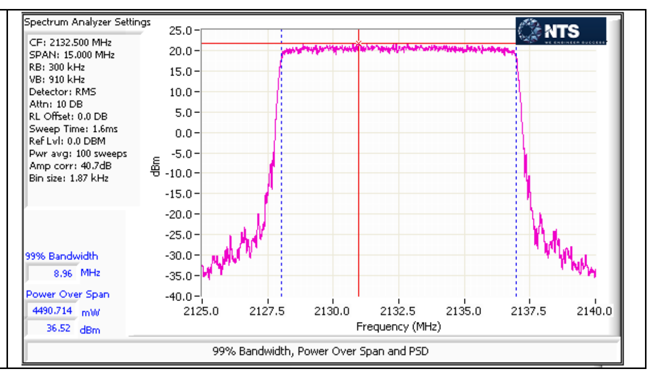
Chain D – 5M – 64QAM



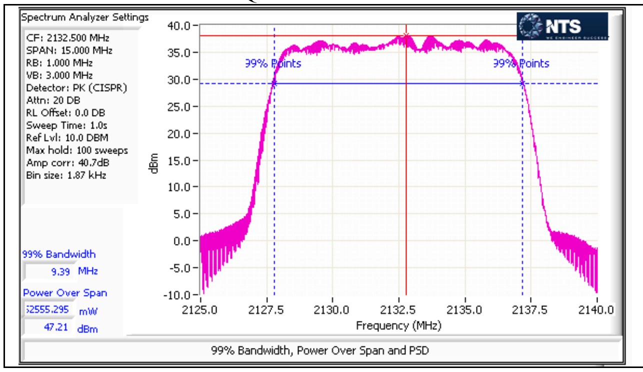


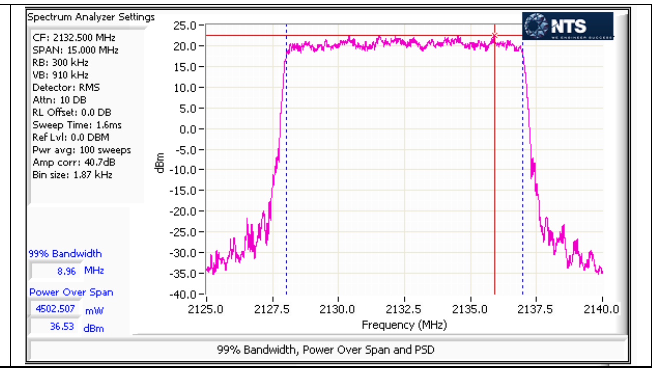
Chain D – 10M – QPSK



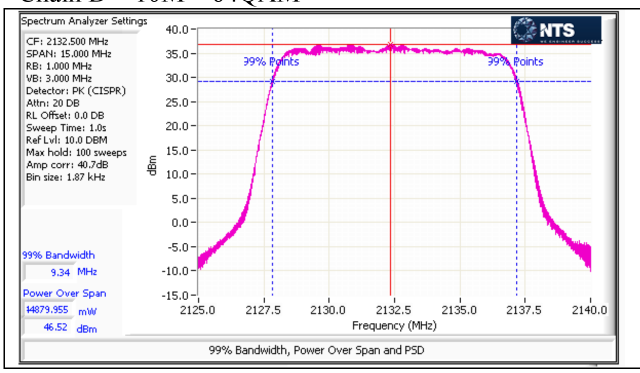


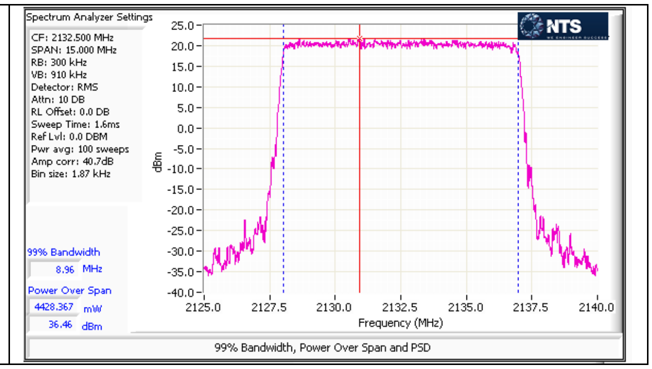
Chain D – 10M – 16QAM



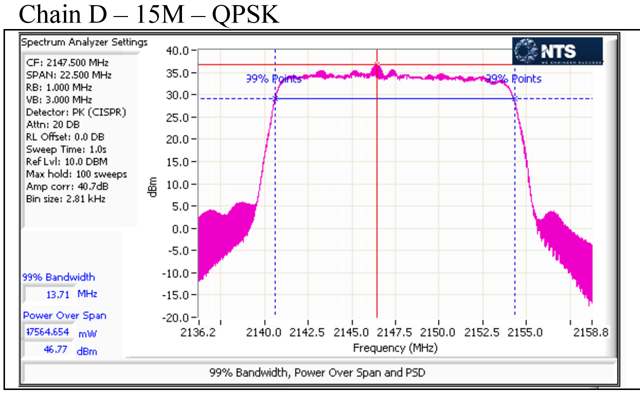


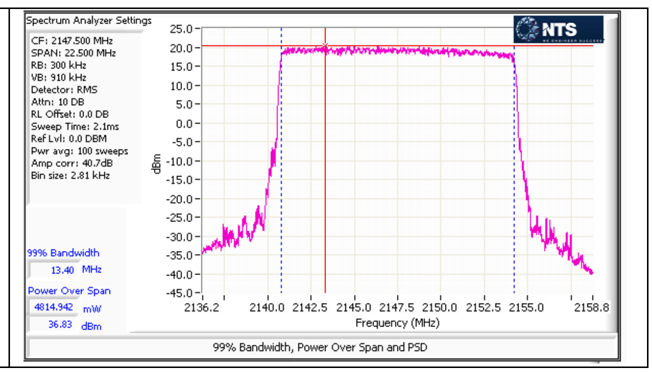
Chain D – 10M – 64QAM



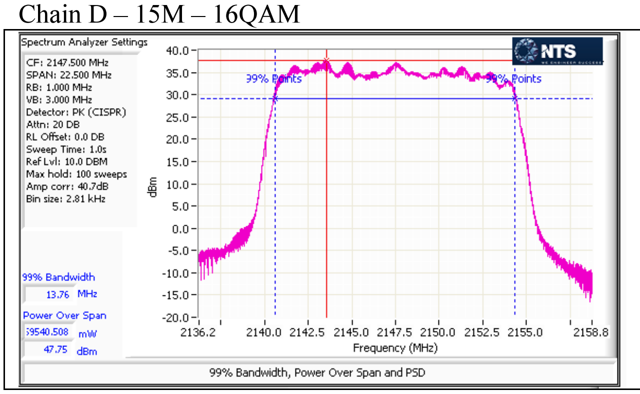


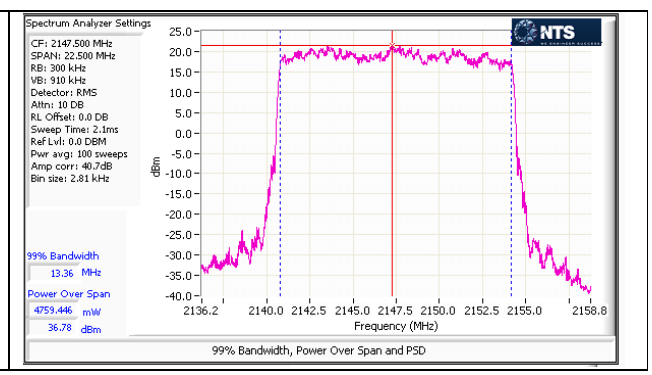
Chain D – 15M – QPSK



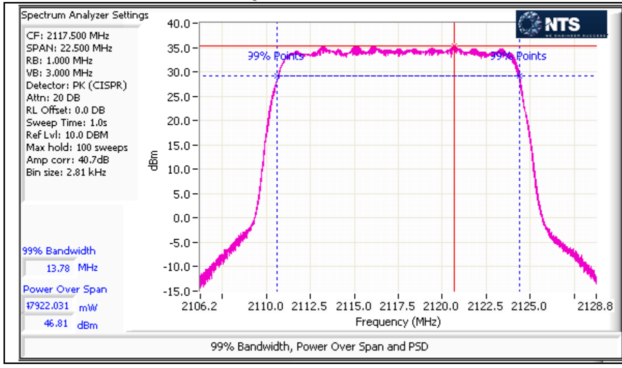


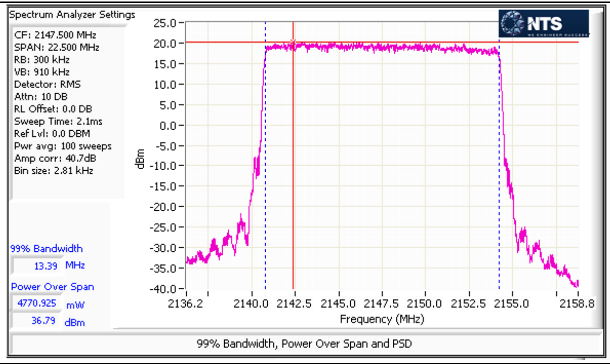
Chain D – 15M – 16QAM



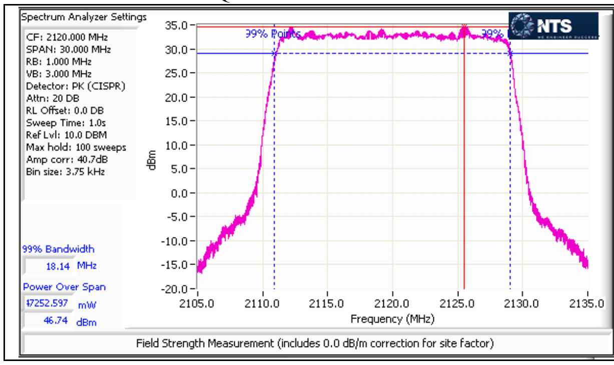


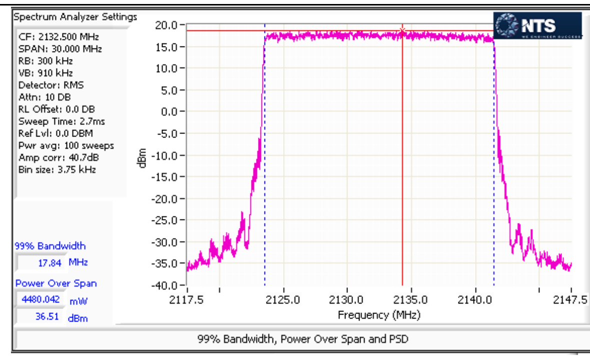
Chain D – 15M – 64QAM



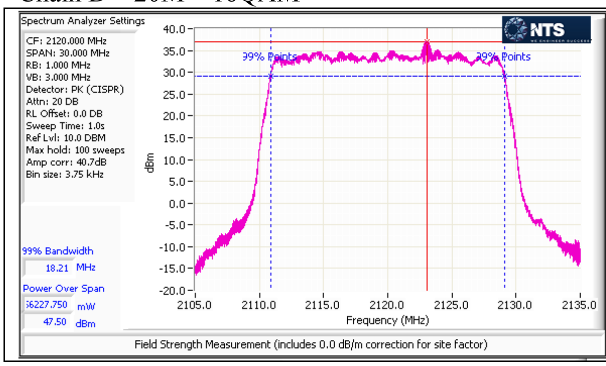


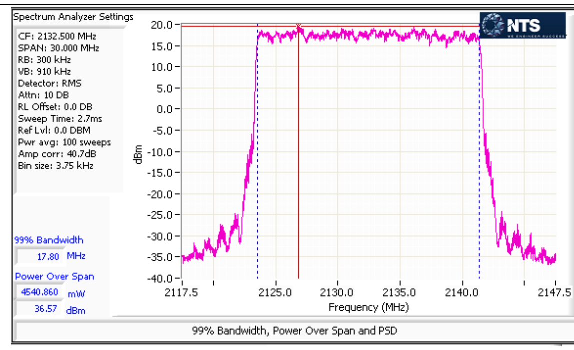
Chain D – 20M – QPSK



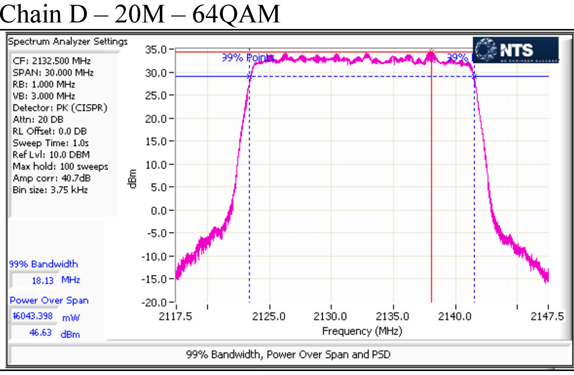


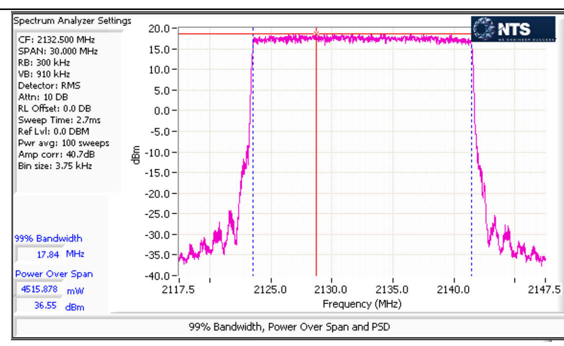
Chain D – 20M – 16QAM





Chain D – 20M – 64QAM





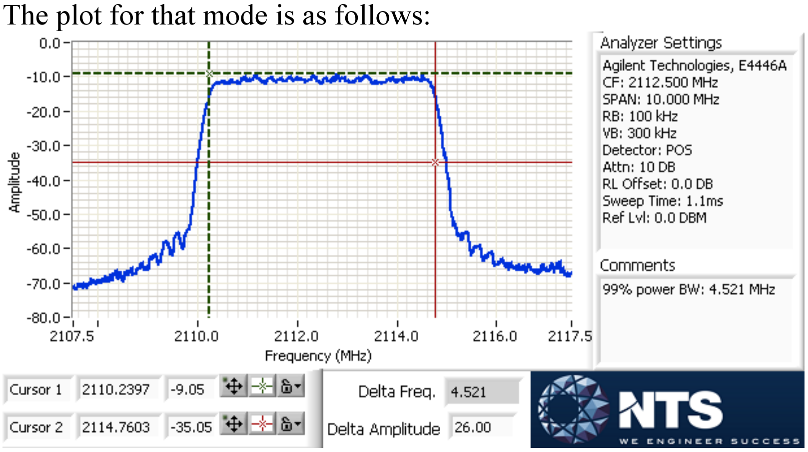
Frequency Stability (FCC 2.1055 & 27.54, RSS 139 Section 6.3)

Tests performed at the center channel (2132.5MHz) of 20M 64QAM mode. Results presented in tabular form below. 10dB bandwidth has been measured at each level to calculate the center frequency of the emission and drifts in Hz are calculated with respect to the reference emission at nominal temperature and voltage.

Frequency Stability										
		-30	-20	-10	0	10	20	30	40	50
Chain M	102V AC	0	2500	0	-2500	0	0	0	-2500	2500
	120V AC	2500	0	0	-7500	-2500	Ref	2500	-2500	0
	138V AC	2500	0	2500	-7500	0	0	0	0	0
Chain D	102V AC	-2500	0	-2500	-2500	2500	-5000	-2500	-5000	-2500
	120V AC	0	-5000	-2500	-2500	-5000	Ref	-5000	-5000	-2500
	138V AC	-2500	-2500	-2500	-2500	-5000	-2500	0	-5000	-5000

Highest drift in Chain M is 7500Hz ~ 3.52ppm
Highest drift in Chain D is 5000Hz ~ 2.34ppm

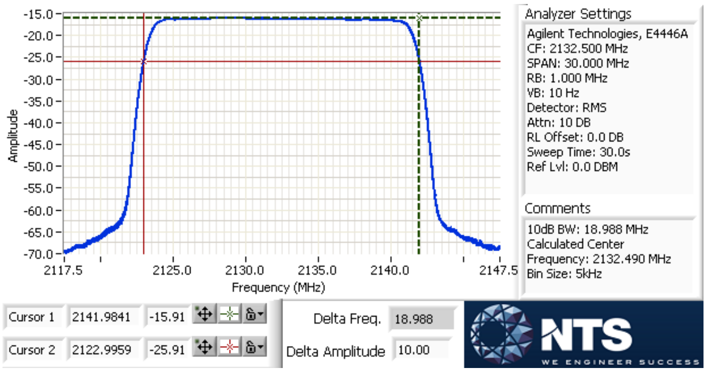
<u>Compliance Justification:</u>
Based on the 99% occupied bandwidth results presented in this report, the ratio of the widest 99% occupied bandwidth to its nominal bandwidth at low and high channels are as follows;
Chain M 5M: 4521/5000 = 0.9042
Chain M 10M: 9031/10000 = 0.9031
Chain M 15M: 13528/15000 = 0.9019
Chain M 20M: 18043/20000 = 0.9022
Chain D 5M: 4518/5000 = 0.9036
Chain D 10M: 9034/10000 = 0.9034
Chain D 15M: 13511/15000 = 0.9007
Chain D 20M: 18033/20000 = 0.9017
The highest ratio appears at Chain M 5M 64QAM Low Channel as 0.9042
The plot for that mode is as follows:



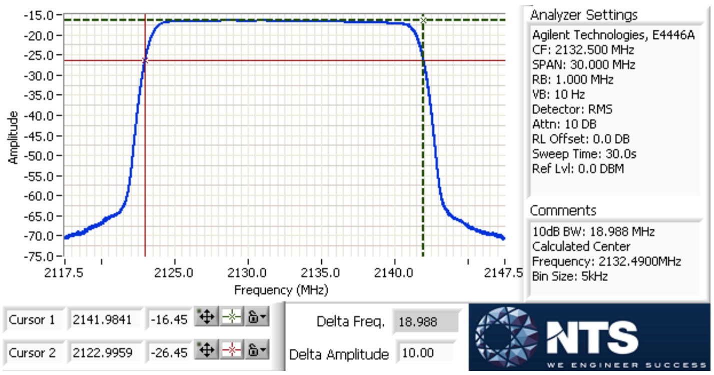
Cursor 1 is located at 2110239700Hz. If this point is shifted by 7500Hz to the left, it would reach 2110232200Hz, which is still above 2110000000Hz block edge. Therefore it can be concluded that with maximum 7500Hz frequency drift all 99% emissions will still remain within the operating frequency block of 2110MHz-2155MHz for all modulations and bandwidths.

In addition, frequency stability results for other channel bandwidth modes and modulations are expected not to differ from the values listed above since all carriers are controlled by the same frequency stabilization circuitry that was subjected to the extreme conditions under this test.

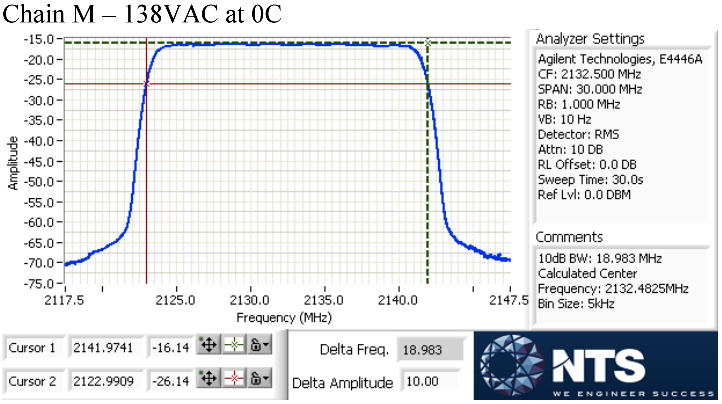
Chain M – 120VAC at 20C



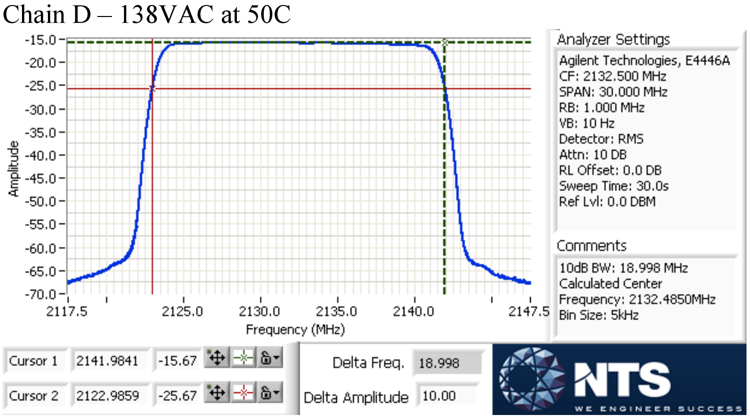
Chain D – 120VAC at 20C



Chain M – 138VAC at 0C



Chain D – 138VAC at 50C



End of Report

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