Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 27 Subpart C& IC RSS-195 ISSUE 2
2345MHz – 2350MHz

FCC ID:	**VBNFRND-01**
IC:	**661W-FRND**
Product Name:	**Flexi Multiradio/Airscale BTS**
Model(s):	**FRND**
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 19th, 2017**
FINAL TEST DATES:	**April 26th – April 28th, 2017**
TOTAL NUMBER OF PAGES:	**40**

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	May 19th, 2017	1st release	Armando Del Angel
1	June 6th, 2017	Added customer comments	Armando Del Angel

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SCOPE

Tests have been performed on Nokia Solutions and Networks product Flexi Multiradio/Airscale BTS Model FRND, 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 4, November 2014
- CFR 47 Part 27 Subpart C
- RSS-195 ISSUE 2, 24 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
KDB 662911D01 v02r01
KDB 971168D01 v02r02

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC and 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 Multiradio/Airscale BTS Model FRND 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. 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 FRND. No additional models were described or supplied for testing.

STATEMENT OF COMPLIANCE

The tested sample of Nokia Solutions and Networks product Flexi Multiradio/Airscale BTS Model FRND 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& IC RSS-195 ISSUE 2 (Base Stations Operating in 2345MHz-2350MHz band)

FCC	IC	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§27.5(a)	RSS-195 ISSUE 2 Section 5.2	Frequency range(s)	2348.5MHz(3M LTE)	2347MHz – 2350.0MHz	Pass
§2.1033(c)(4)	RSS-195 ISSUE 2 Section 5.3	Modulation Type	QPSK, 16QAM, 64QAM, 256QAM (3MHz for each)	Digital	Pass
§27.50(a)(1)(ii)	RSS-195 ISSUE 2 Section 4.1	Output Power	Conducted Output Power (Highest on Port 1) RMS: 36.9dBm Peak: 44.51dBm EIRP will depend on antenna gain (unknown)	2000W EIRP	Pass
N/A Informational	RSS-GEN Section 6.6	Peak to Average Ratio	7.71dB highest	13dB	Pass
§2.1049	RSS-Gen Section 6.6	Emission Bandwidth (99%)	2.7006MHz (3M LTE)	Remain in Block	Pass
27.53(a)(5)	N/A Informational	Emission Bandwidth (26dB)	2.912MHz (3M LTE)	Remain in Block	Pass
Transmitter spurious emissions[1]					
§27.53(a)	RSS-195 ISSUE 2 Section 5.6	At the antenna terminals	< -16.03dBm	-16.03 dBm (per TX chain)	Pass
		Field strength	36.139dBuV/m at 3m Eq. to -59dBm EIRP	-13 dBm EIRP	Pass
Other details					
§27.54	RSS-195 ISSUE 2 Section 5.4	Frequency stability	Low = -38.01dBm High = -37.21dBm	Remain in Block (-16.03dBm)	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		LTE-256QAM	
	FCC	IC	FCC	IC	FCC	IC	FCC	IC
3M	2M91F9W	2M70F9W	2M91F9W	2M70F9W	2M91F9W	2M70F9W	2M91F9W	2M70F9W

Note: FCC based on 26dB emissions 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/Airscale Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model FRND which operates in frequency band BTS Rx: 2315 to 2318MHz/BTS Tx: 2347 to 2350MHz. The FRND has two co-located transmitters with each transmit port supporting 5 watts (average detector) maximum rated RF output power. The FRND can be operated as MIMO or as non-MIMO. The FRND is multi-standard capable (GSM/EDGE/WCDMA/LTE), but for this effort only the LTE-FDD mode is tested. The FRND supports four downlink modulation types for LTE (QPSK, 16QAM, 64QAM and 256QAM). The FRND supports a 3MHz LTE channel bandwidth. The FRND has external interfaces including DC power, ground, Tx/Rx (Ant 1 and Ant 2), Rx (Ant 3 and Ant 4), external alarm (EAC), optical CPRI (OPT) and remote electrical tilt (RET). The RRH with applicable installation kit may be pole or wall mounted.

Following table show channel numbers and frequencies for LTE mode.

	Downlink EARFCN	**Downlink Frequency (MHz)**	**LTE Channel Bandwidth**
			3 MHz
Ant 1, 2	130000	2347.0	Band edge
	……		
	130015	2348.5	Bottom Channel Middle Channel Top Channel
	……		
	130030	2350.0	Band edge

The sample was received on April 25th of 2017 and tested on April 26th - April 28th, 2017. The EUT consisted of the following component(s):

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	FRND	Flexi Multiradio/Airscale BTS RRH	Part#: 473965A.101 Serial#: K9171015916	FCC ID: VBNFRND-01 IC ID: 661W-FRND

ENCLOSURE

The EUT enclosure is made of heavy duty aluminum and measures approximately 308(W) x 130(D) x 512(H) millimeters.

AUXILLARY EQUIPMENT

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Finisar	FTLF8519P3BTL	CPRI SFP Module (Plugs into FRND Opt Port)	Part#: FTLF8519P3BTL Serial#: NVR3DGM	N/A
Nokia	Modified FRND Duplex Filter	2347 to 2350 MHz Carrier Reject/Blocking Filter*	Part#: N/A Serial#: N/A	N/A
*This filter was used in the RF conducted emission testing to reduce measurement instrumentation noise floor levels for the 2320 to 2345MHz frequency range.				

SUPPORT EQUIPMENT

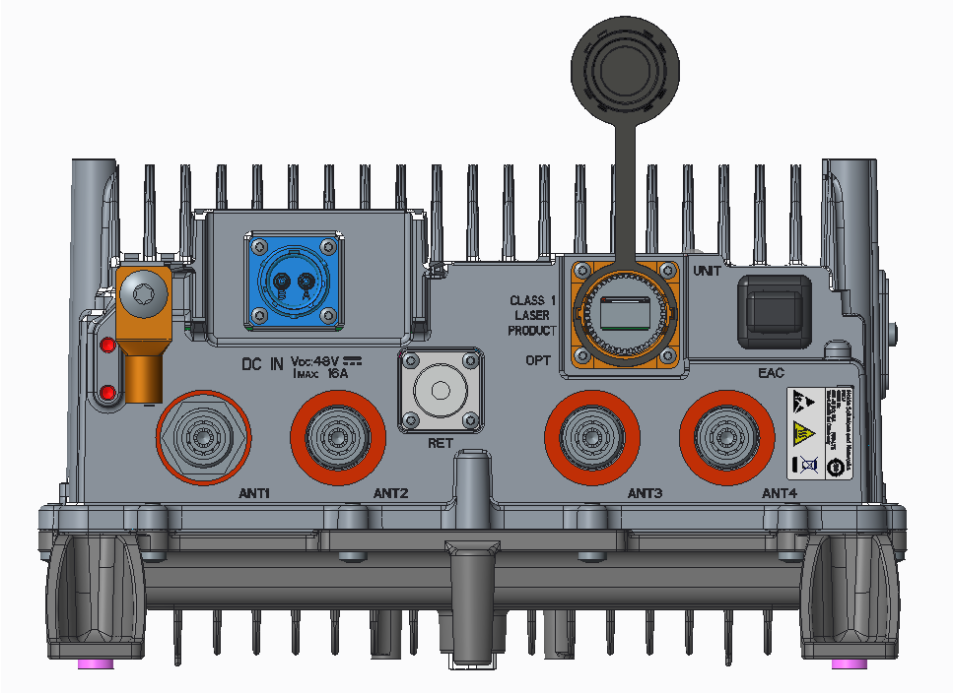
Company	Model	Description	Part Number	FCC ID/IC Number
Nokia Solutions and Networks	FSMF	Flexi System Module	Part#: 472181A.103	N/A
HP	Elite Book 6930p	Laptop PC	N/A	N/A

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
External Alarm	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Remote Electrical Tilt	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Multimode Optical	Optical	No	>6 m	Yes	1	System Module

The connector layout for FRND is provided below:



Name	Qty	Connector Type	Purpose (and Description)
DC In	1	Quick Disconnect	2-pole Power Circular Connector
GND	1	Screw lug (2xM5/1xM8)	Ground
ANT	4	4.3-10	RF signal for Transmitter/Receiver (50 Ohm)
Unit	1	LED	Unit Status LED
LMP	1	Card edge	Local Management/Test Port (Ethernet 10Base-T/100Base-Tx and others, not field accessible)
EAC	1	RJ45	External Alarm Interface (4 alarms)
OPT	1	SFP+ cage	Optical CPRI Interface
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 FRND RRH via the optical (CPRI) interface. The laptop is used for changing configuration settings, monitoring tests and controlling the BTS. The following software versions are used for the FRBI testing:

(1) RRH Unit Software: FRC37.02.R09D

(2) System Module Software: FL17SP_ENB_0000_000419_000000

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.

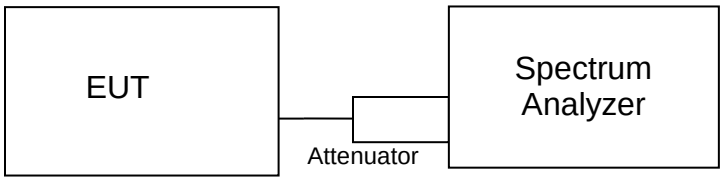
Radiated spurious emissions measurements were taken at the NTS Plano Anechoic Chamber listed below. The sites conform to the requirements of ANSI C63.4-2009 *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range 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 30dB attenuator and an RF cable. The EUT was operating in 2 Port 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 occupied bandwidth built-in function in the spectrum analyzer was used and Keysight Benchvue Software was used to capture the spectrum analyzer screenshots. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Emissions at the band-edges were also captured with Keysight Benchvue Software with settings described in the corresponding sections of the FCC and IC rules. A customer provided filter with a 10 dB attenuator was used to make measurements in the 2320 to 2344MHz and 2344 to 2345MHz frequency ranges. This filter blocks RRH carrier power and allows the measurement instrumentation noise floor to be reduced to needed levels. The test setup insertion loss was characterized in the measurement band and was factored in via reference level offset of the spectrum analyzer. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Peak and average output power measurements were performed in accordance with FCC KDB 971168 D01 v02r02. Measurements were performed with the built in power meter function found in the Spectrum analyzer and the screenshots were captured using Keysight Benchvue Software. Spectrum analyzer settings are shown on their corresponding plots in the 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. Bandedge measurements were performed at the lowest and highest channels to verify that the carrier stayed within the authorized frequency block.

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. For frequencies below 10GHz and a 1m test distance for frequencies above 10GHz. 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 ware 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 double ridged waveguide horn antenna was used for 18-20GHz 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 function.

Test Equipment

NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
E1529P	PSA	Agilent	E4446A	24 Months	4/26/2019
E1009P	PreAmp (1GHz-26.5GHz)	HP	8449B	12 Months	2/14/2018
E1279P	PreAmp (30MHz-1GHz)	MITEQ	AM-1431-N-1179SC	12 Months	9/26/2017
E1524P	Biconilog Antenna (30MHz-1GHz)	ETS Lindgren	3142D	12 Months	12/22/2017
E1019P	Horn Antenna (1GHz-18GHz)	EMCO	3115	12 Months	12/16/2017
E1068P	Horn Antenna (18GHz-40GHz)	EMCO	3116	12 Months	9/27/2017
E1447P	RMS Multimeter	Fluke	87V	12 Months	6/8/2017
ENV1384P	Data Acquisition Switch Unit	Agilent	34970A	12 Months	2/28/2018
ENV1195P	Climatic Chamber	Thermotron	SE-300-2-2	N/A	No Calibration Required

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 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 Results:

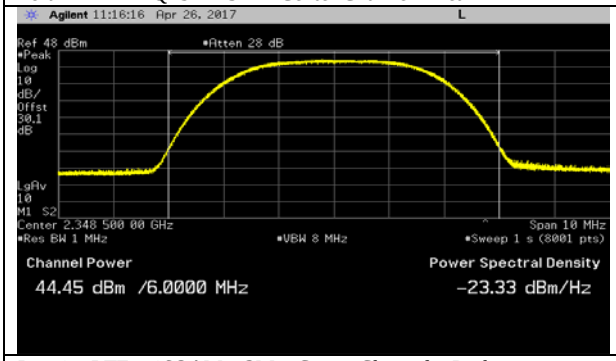
		LTE - QPSK			LTE - 16QAM			LTE - 64QAM			LTE - 256QAM		
		Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)
Port 1 Center Channel	**3M**	44.45	36.85	7.6	44.42	36.83	7.59	44.51	36.9	7.61	44.41	36.87	7.54
Port 2 Center Channel	**3M**	44.45	36.86	7.59	44.42	36.71	7.71	44.5	36.9	7.6	44.4	36.9	7.5
Combined Center	**3M**	47.46	39.87	7.59	47.43	39.78	7.65	47.52	39.91	7.61	47.42	39.9	7.52

The highest measured peak power level was 44.51dBm, the highest measured RMS power level was 36.90dBm, and the largest PAR was 7.71dB.

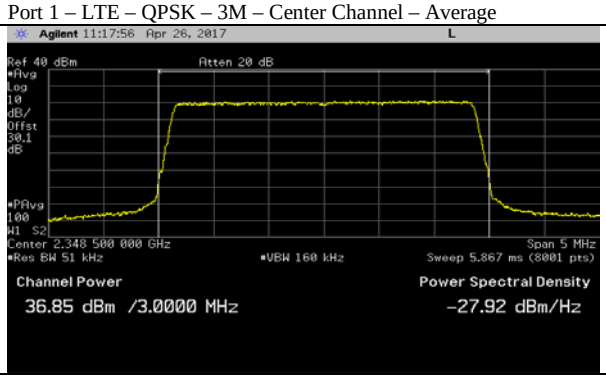
Based on the results above, Port 1 had the highest peak power level and therefore Port 1 was selected for all the remaining LTE mode antenna port tests on the product.

All corresponding plots included on the following pages. Total path loss of 30.1dB (Attenuator Loss and RF cable loss) accounted in via reference level offset to the spectrum analyzer.

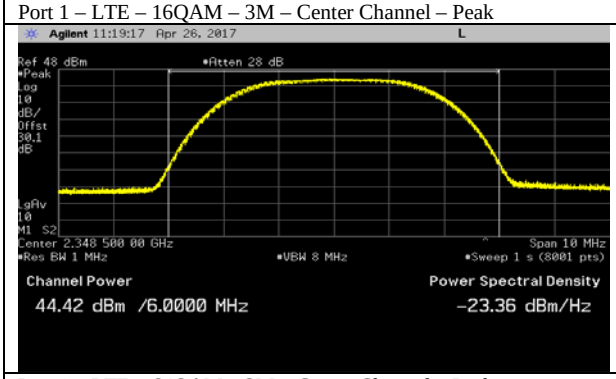
Port 1 – LTE – QPSK – 3M – Center Channel – Peak



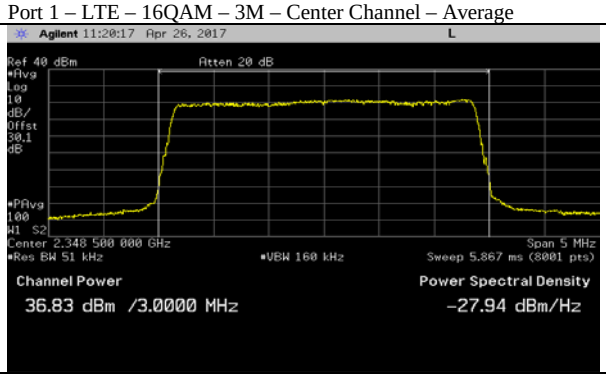
Port 1 – LTE – QPSK – 3M – Center Channel – Average



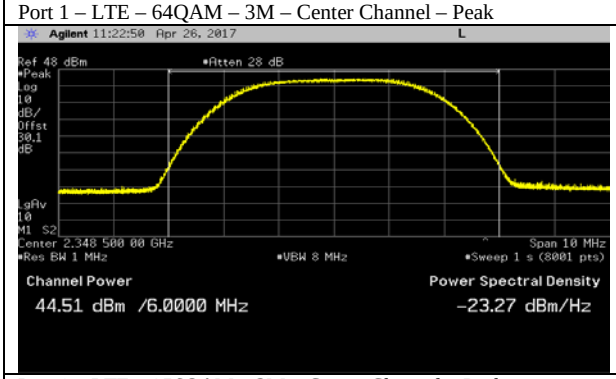
Port 1 – LTE – 16QAM – 3M – Center Channel – Peak



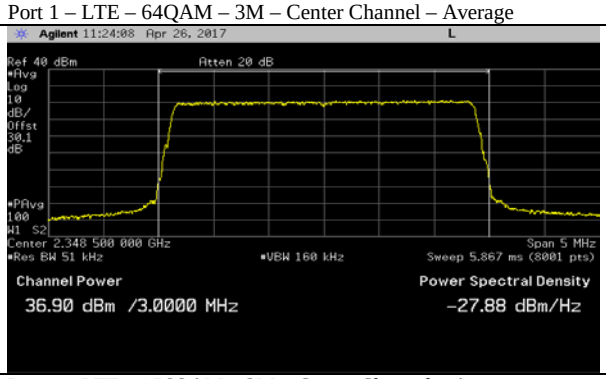
Port 1 – LTE – 16QAM – 3M – Center Channel – Average



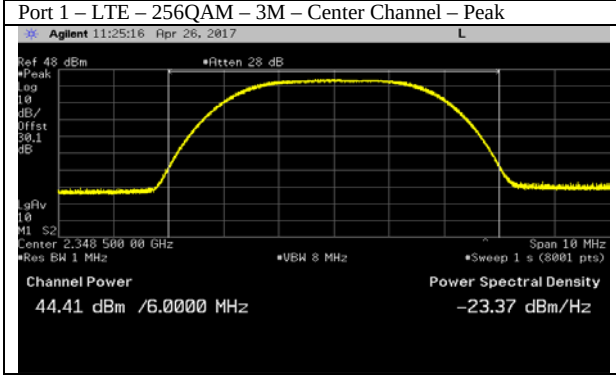
Port 1 – LTE – 64QAM – 3M – Center Channel – Peak



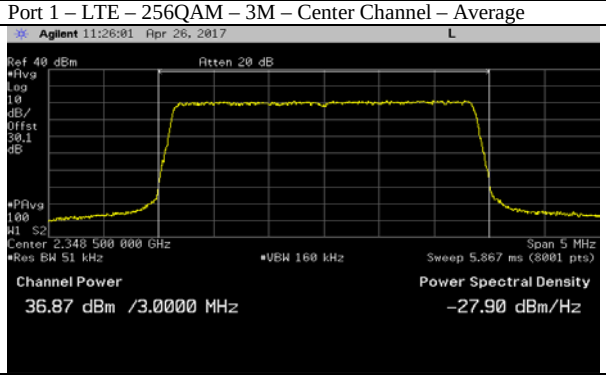
Port 1 – LTE – 64QAM – 3M – Center Channel – Average



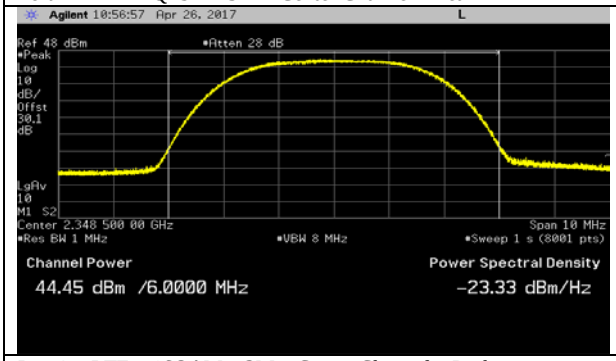
Port 1 – LTE – 256QAM – 3M – Center Channel – Peak



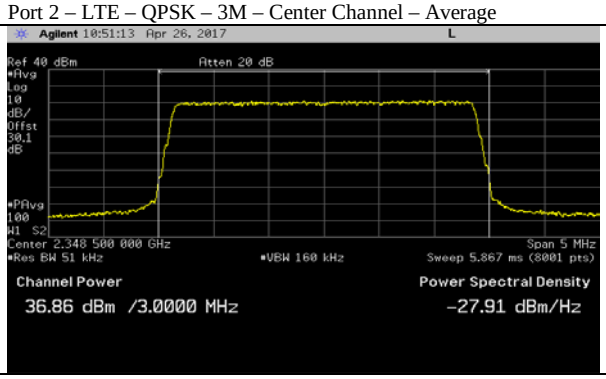
Port 1 – LTE – 256QAM – 3M – Center Channel – Average



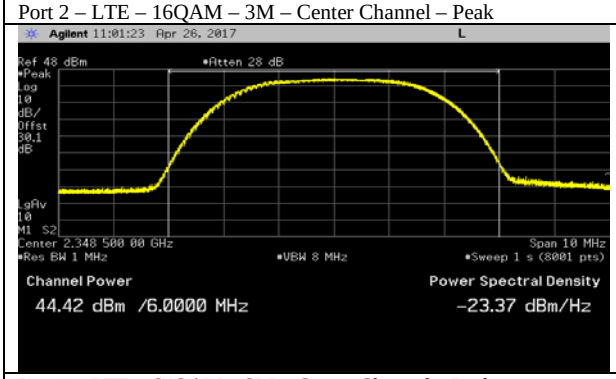
Port 2 – LTE – QPSK – 3M – Center Channel – Peak



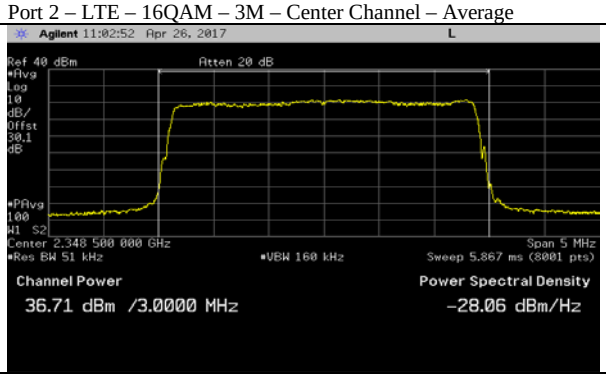
Port 2 – LTE – QPSK – 3M – Center Channel – Average



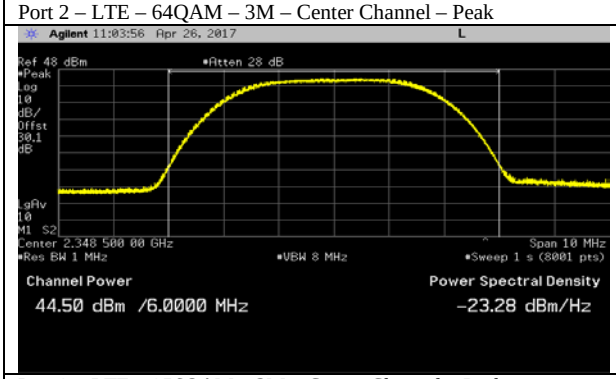
Port 2 – LTE – 16QAM – 3M – Center Channel – Peak



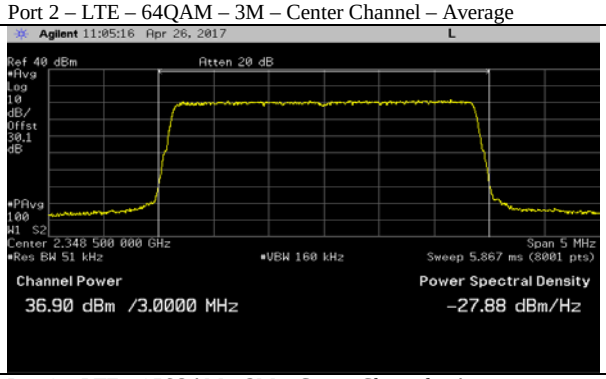
Port 2 – LTE – 16QAM – 3M – Center Channel – Average



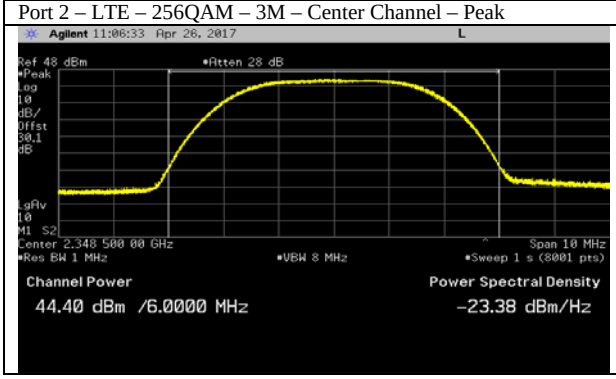
Port 2 – LTE – 64QAM – 3M – Center Channel – Peak



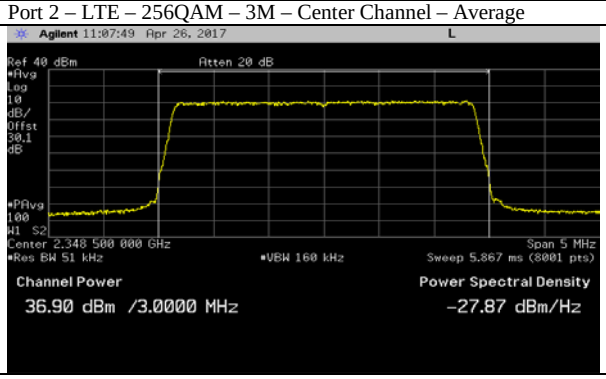
Port 2 – LTE – 64QAM – 3M – Center Channel – Average



Port 2 – LTE – 256QAM – 3M – Center Channel – Peak



Port 2 – LTE – 256QAM – 3M – Center Channel – Average



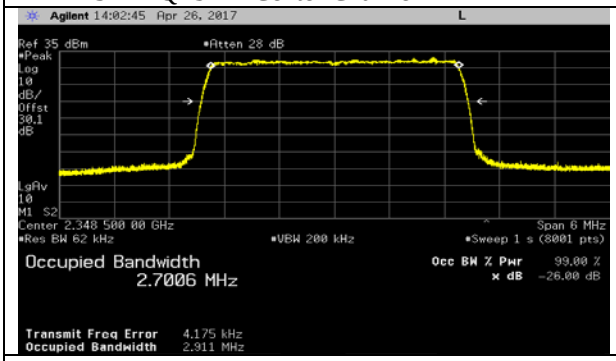
Emission Bandwidths (26dB and 99%)

Emissions bandwidths were measured on bottom and top channels for all modulations and bandwidth modes on Port 1 and results presented below.

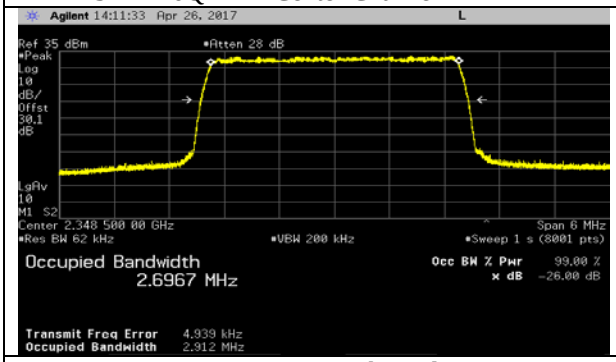
	LTE - QPSK		LTE - 16QAM		LTE - 64QAM		LTE - 256QAM	
	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)
3M	2.911	2.7006	2.912	2.6967	2.912	2.6975	2.911	2.6958

Corresponding plots included on the following pages.

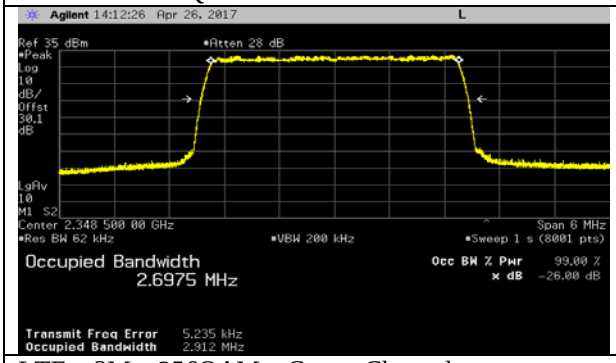
LTE – 3M – QPSK – Center Channel



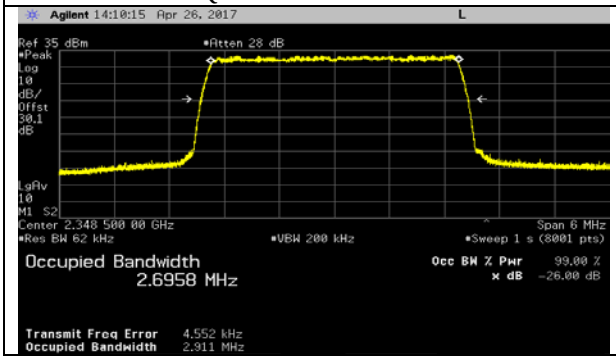
LTE – 3M – 16QAM – Center Channel



LTE – 3M – 64QAM – Center Channel



LTE – 3M – 256QAM – Center Channel



Antenna Port Conducted Bandedge

The RF conducted bandedge measurements were performed over the 2200MHz to 2395MHz frequency range. The emission limits in this frequency range are defined in FCC 27.53a1 and RSS-195 ISSUE 2 paragraph 5.6. The limits are reduced by 10log(2) for 2 port MIMO operation as required by FCC KDB 662911D01 v02r01. The limits are as follows:

Frequency (MHz)	**Limit (dBm) for two port MIMO**	
Less than 2200	-16	
2200 to 2285	-48	
2285 to 2287.5	-45	
2287.5 to 2300	-43	
2300 to 2305	-16	
2305 to 2320	-16	
2320 to 2345	-48	
2345 to 2360	-16	
2360 to 2362.5	-16	
2362.5 to 2365	-28	
2365 to 2367.5	-43	
2367.5 to 2370	-45	
2370 to 2395	-48	
Greater than 2395	-16	

Measurement Limits

All tests were performed on port 1 with the FRND operating at maximum power. The FRND was (may only be) operated with a LTE channel bandwidth of 3MHz at a frequency of 2348.5MHz. Four LTE modulation types (QPSK, 16QAM, 64QAM and 256QAM) were tested.
All measurements were performed with a spectrum analyzer using a peak detector with sweep average over 50 sweeps (per guidance from TCB). To reduce the number of frequency ranges, the measurement range was expanded in some cases but the worst-case limit was used over this frequency range. The spectrum analyzer parameters for the different frequency ranges are provided below.

Frequency Range (MHz)	RBW	VBW	Number of Data Points	Detector	Sweep Time	Averages	Offset (Note 1)
2200 to 2320	≥1MHz	≥3MHz	8000	Peak	Auto	50 Sweeps	30.1dB
2320 to 2344 (Note 2)	≥1MHz	≥3MHz	8000	Peak	Auto	50 Sweeps	15.7dB
2344 to 2345 (Note 2 & 3)	≥30kHz	≥90kHz	8000	Peak	Auto	50 Sweeps	13.9dB
2345 to 2346 (Note 3)	≥30kHz	≥90kHz	8000	Peak	Auto	50 Sweeps	30.1dB
2346 to 2351 Band Edge	≥30kHz	≥90kHz	8000	Peak	Auto	50 Sweeps	30.1dB
2351 to 2352 (Note 3)	≥30kHz	≥90kHz	8000	Peak	Auto	50 Sweeps	30.1dB
2352 to 2362.5	≥1MHz	≥3MHz	8000	Peak	Auto	50 Sweeps	30.1dB
2362.5 to 2395	≥1MHz	≥3MHz	8000	Peak	Auto	50 Sweeps	30.1dB

Note 1: The total measurement RF path loss of the test setup (attenuators, test cables and carrier blocking filter) is accounted for by the spectrum analyzer reference level offset.
Note 2: A carrier blocking filter was required in this frequency range (2320 to 2345 MHz) to reduce the measurement instrument noise floor.
Note 3: Power integrated over 1MHz.

Results Summary:

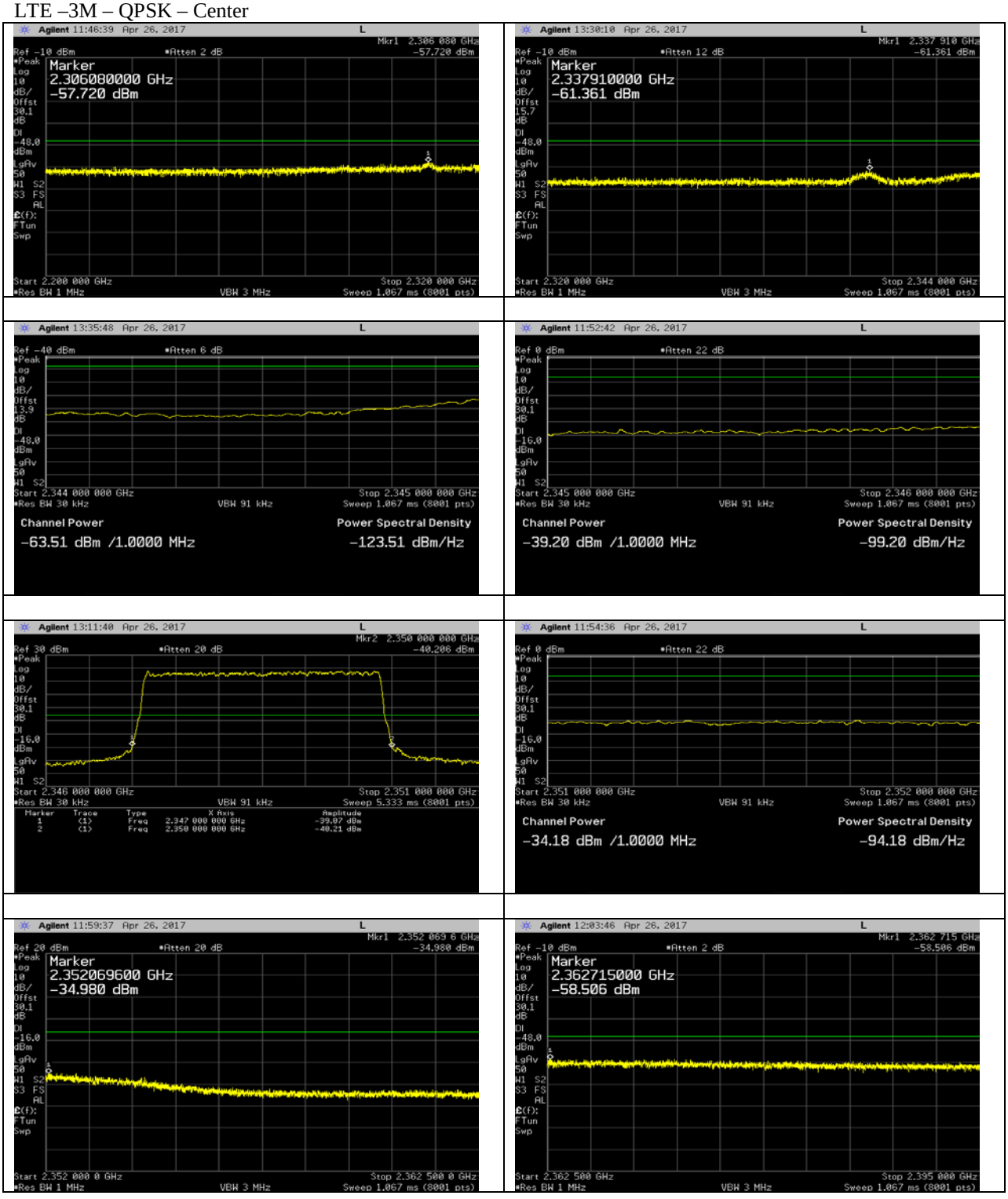
Frequency Range	Measurement Limit	LTE Modulation Type			
		QPSK	16QAM	64QAM	256QAM
2200 to 2320 MHz	-48dBm	-57.720dBm	-57.225dBm	-57.453dBm	-57.133dBm
2320 to 2344 MHz	-48dBm	-61.361dBm	-61.638dBm	-61.9dBm	-60.374dBm
2344 to 2345 MHz	-48dBm	-63.51dBm	-64.11dBm	-63.7dBm	-63.9dBm
2345 to 2346 MHz	-16dBm	-39.2dBm	-39.09dBm	-39.16dBm	-38.98dBm
2346 to 2347 MHz Lower Bandedge	-16dBm	-39.07dBm	-40.9dBm	-39.62dBm	-42.73dBm
2350 to 2351 MHz Upper Bandedge	-16dBm	-40.21dBm	-37.99dBm	-38.71dBm	-37.48dBm
2351 to 2352 MHz	-16dBm	-34.18dBm	-33.36dBm	-34.32dBm	-34.21dBm
2352 to 2362.5 MHz	-16dBm	-34.98dBm	-34.918dBm	-34.157dBm	-35.073dBm
2362.5 to 2395 MHz	-48dBm	-58.506dBm	-58.336dBm	-58.1dBm	-58.608dBm

RF Conducted Bandedge Emission Measurement Summary

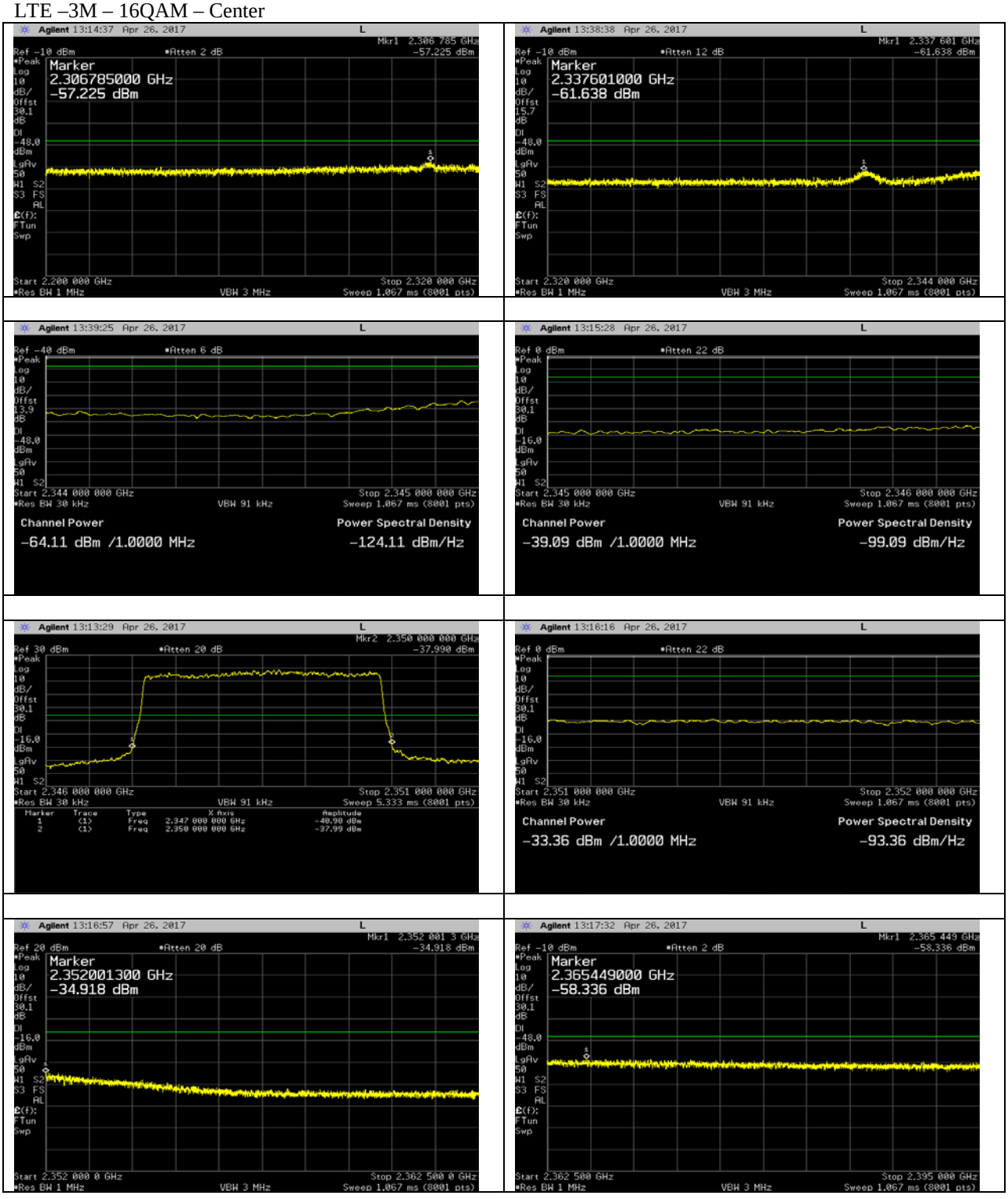
In the 1MHz bands immediately outside and adjacent to the frequency blocks the RBW was reduced to 1% of the emission bandwidth. In the 2344 to 2345MHz, 2345 to 2346MHz, and 2351 to 2352MHz frequency ranges, the RBW was again reduced to 1% of the emission bandwidth and the power was integrated over 1MHz. A notch filter supplied by the customer was characterized for insertion loss and used to measure emissions in the 2320 to 2345MHz frequency range to reduce measurement instrumentation noise floor. For all measurements, the insertion losses are accounted for by the spectrum analyzer offset as shown on the corresponding plots on the following pages. The display line on the plots reflect the required limit.

All corresponding plots are included on the following pages.

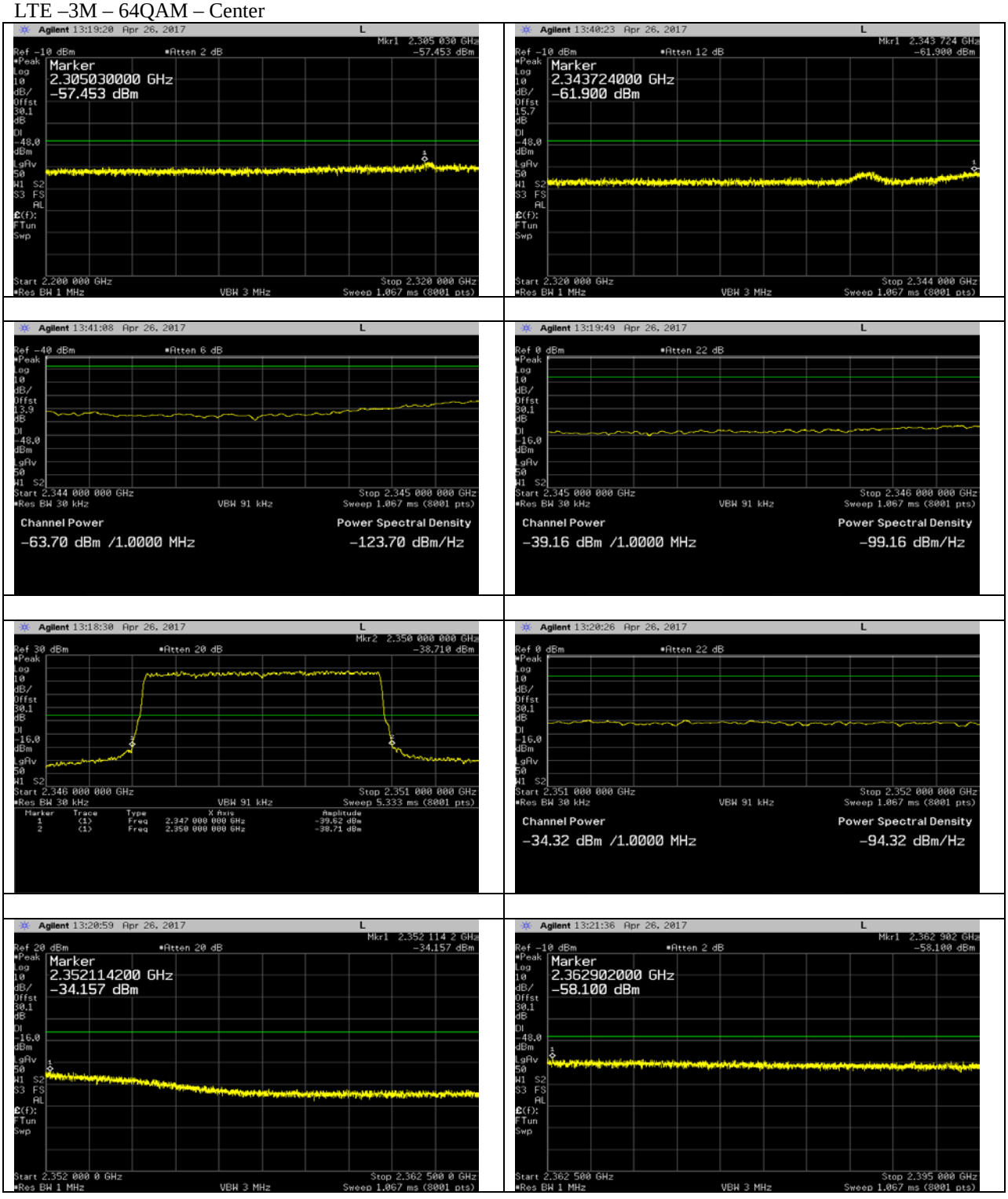
LTE –3M – QPSK – Center



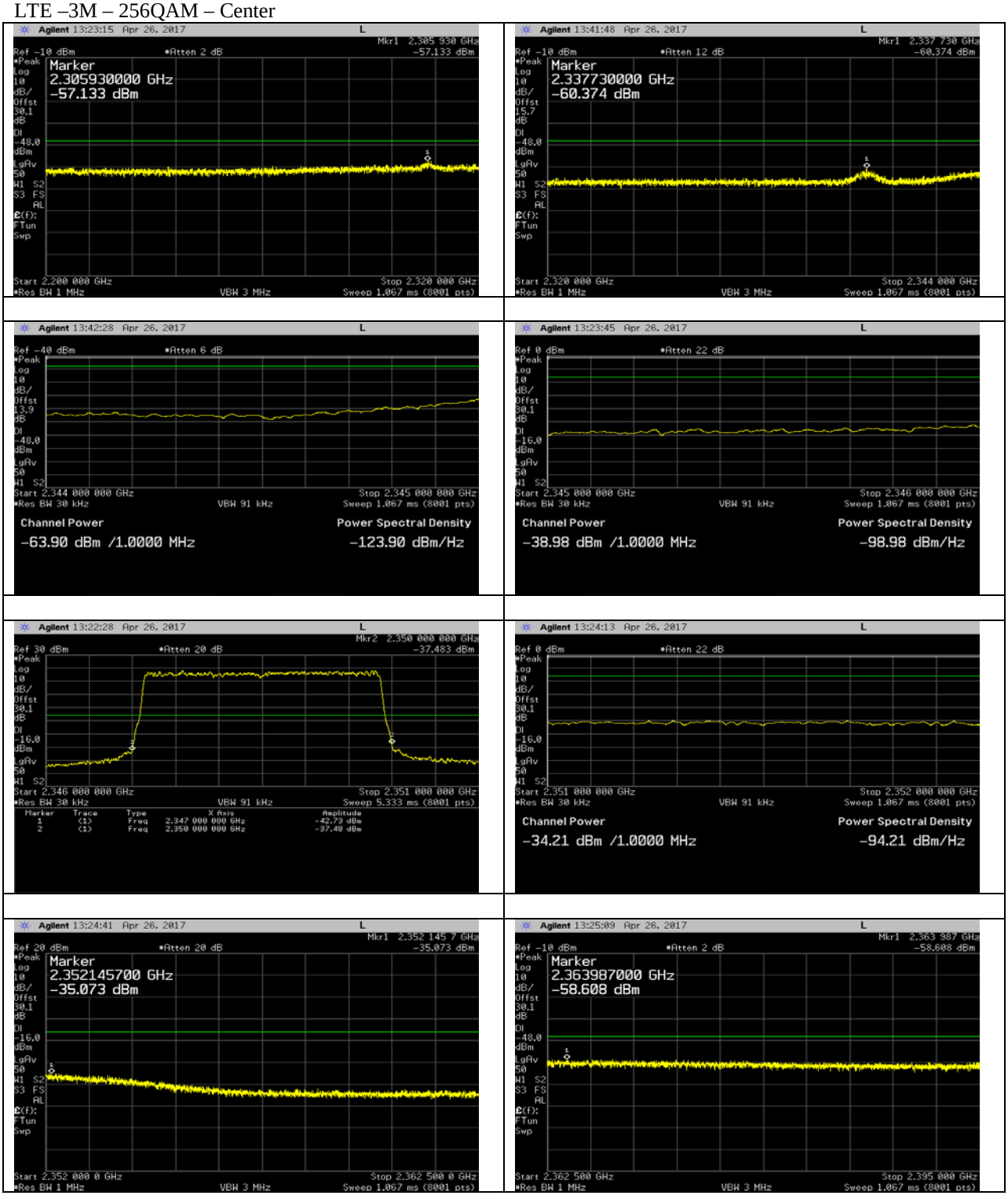
LTE –3M – 16QAM – Center



LTE –3M – 64QAM – Center



LTE –3M – 256QAM – Center



Transmitter Antenna Port Conducted Spurious Emissions

Tests performed at Port 4 on center channel for all modulations and bandwidth modes. Due to 2 Port MIMO operation, limit is -16.03dBm (-13dBm – 10*log(4)) per FCC KDB 662911D01 v02r01.

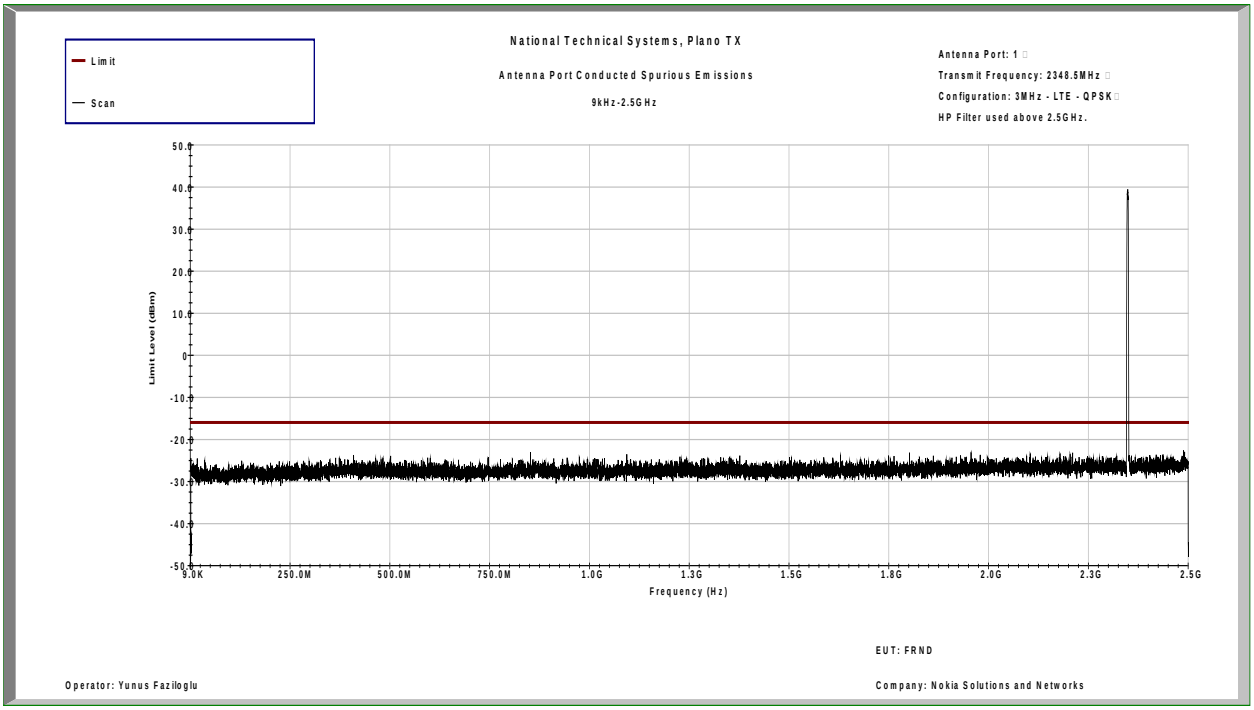
TILE 6 measurement software was used during testing. A high-pass filter was used above 2.5GHz to block the fundamental and reduce the instrumentation noise floor. Except for the fundamental, all the readings were at noise floor.

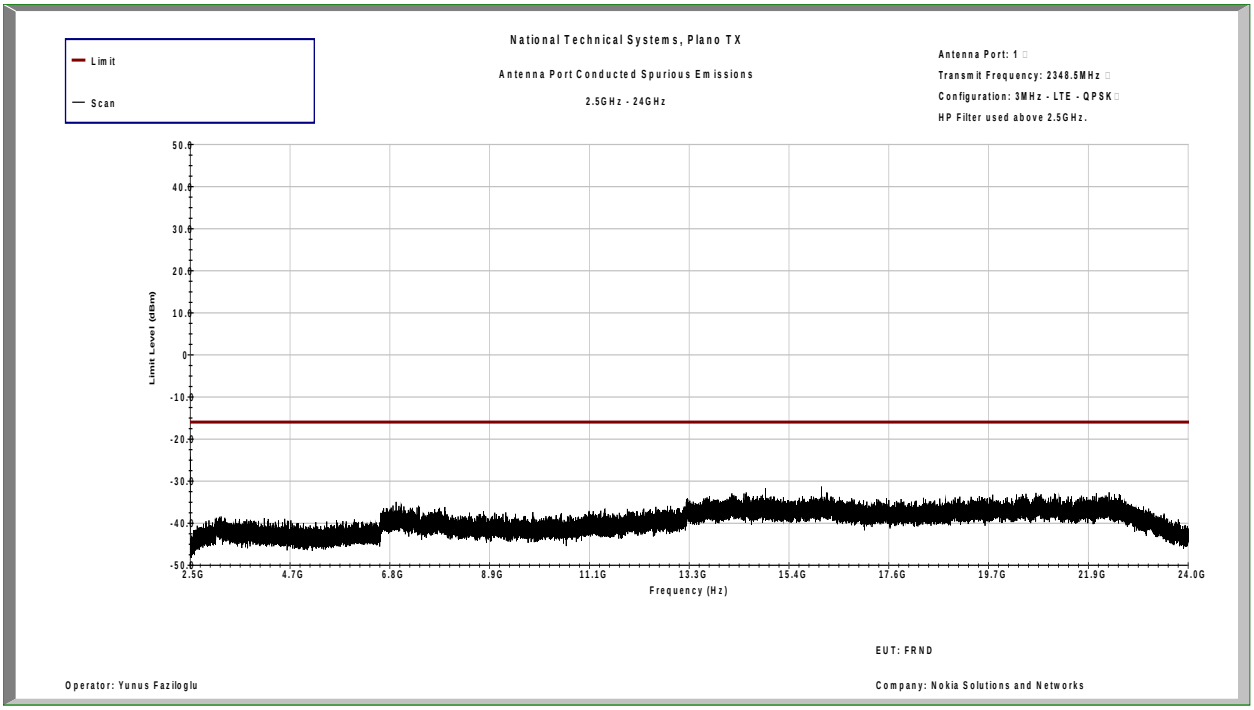
Measurements taken with the following settings:

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-24GHz	1MHz	3MHz	8000	10 segments	Peak	Auto	50 sweeps

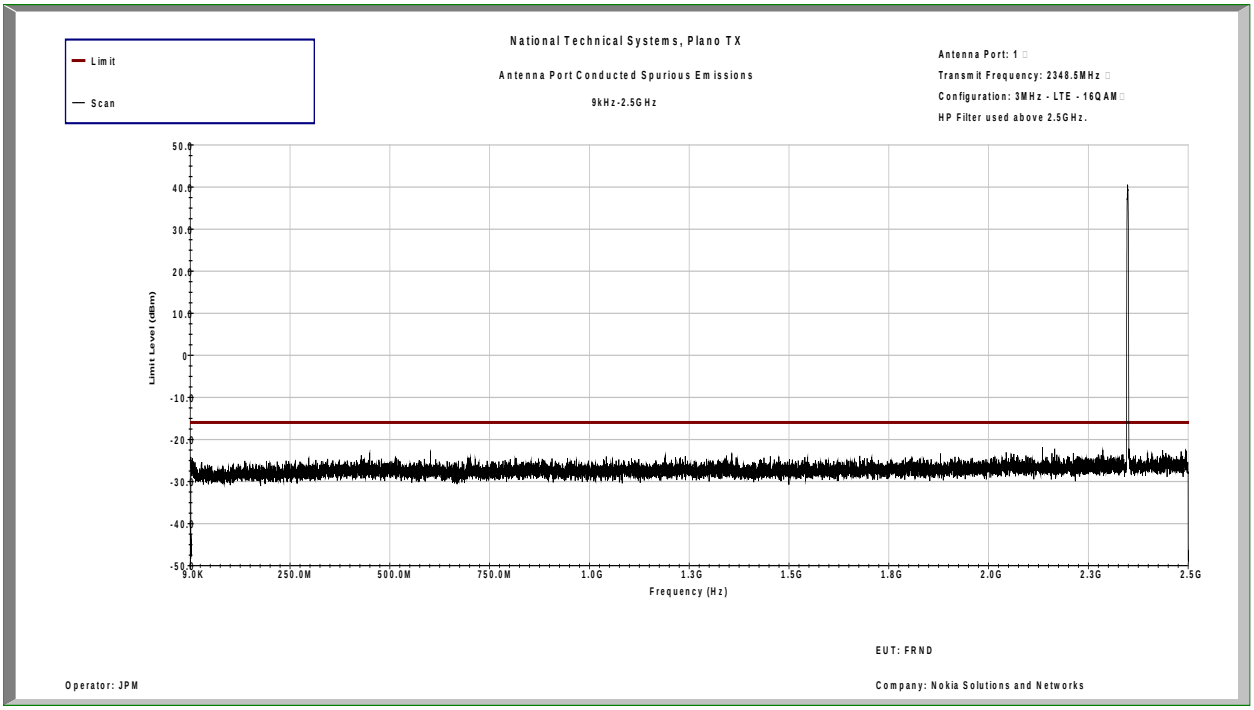
Corresponding plots are included on the following pages.

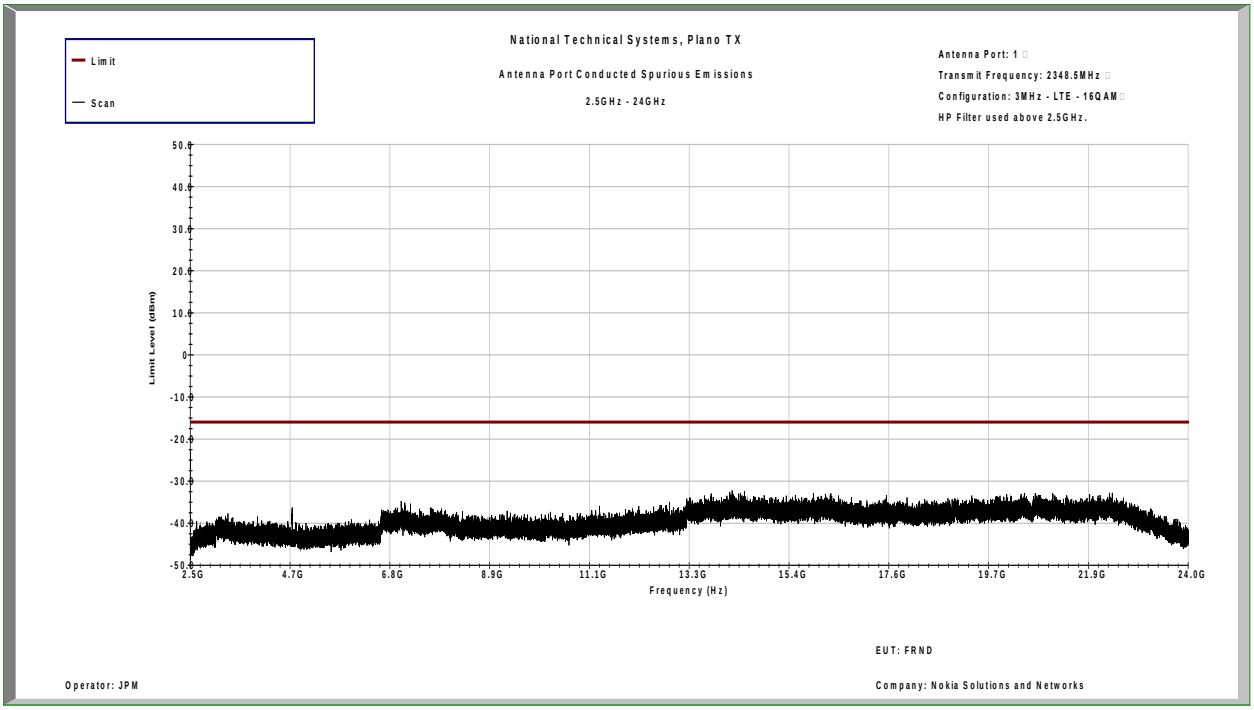
LTE – QPSK – 3M


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
9kHz-2.5GHz
Antenna Port: 1
Transmit Frequency: 2348.5MHz
Configuration: 3MHz - LTE - QPSK
HP Filter used above 2.5GHz.
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: FRND
Operator: Yunus Faziloglu
Company: Nokia Solutions and Networks

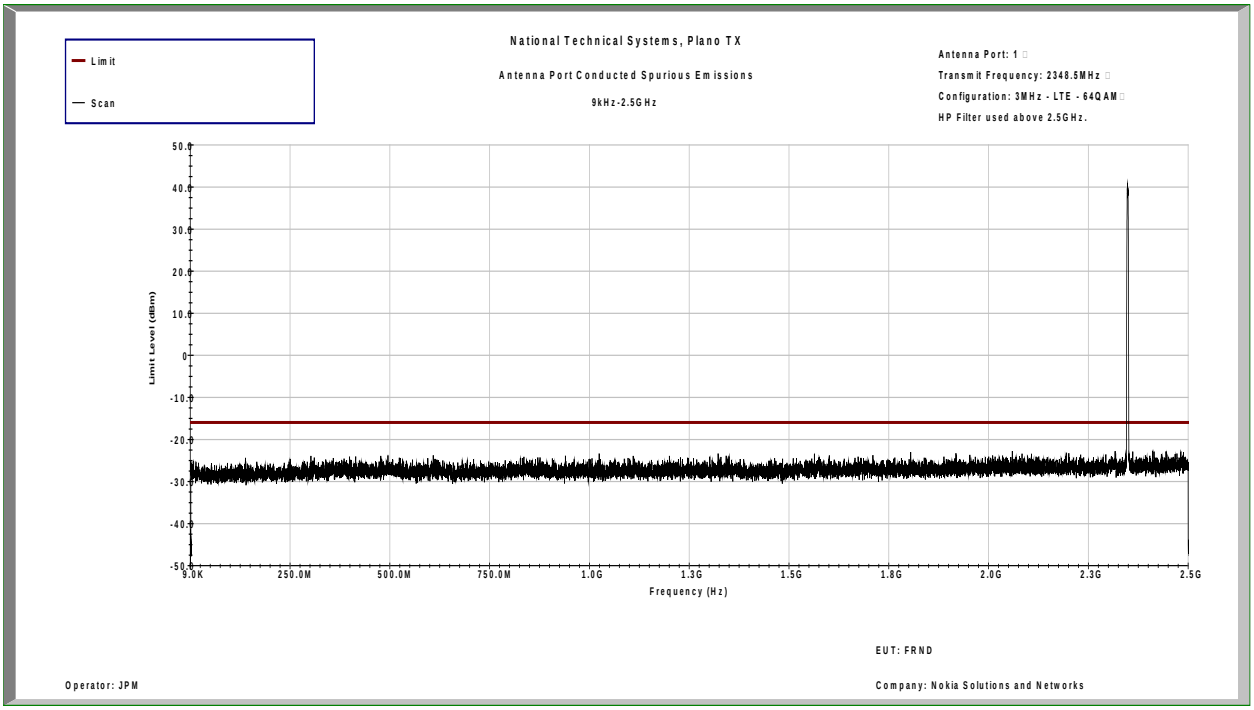

National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
2.5GHz - 24GHz
Antenna Port: 1
Transmit Frequency: 2348.5MHz
Configuration: 3MHz - LTE - QPSK
HP Filter used above 2.5GHz.
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
2.5G
4.7G
6.8G
8.9G
11.1G
13.3G
15.4G
17.6G
19.7G
21.9G
24.0G
Frequency (Hz)
EUT: FRND
Operator: Yunus Faziloglu
Company: Nokia Solutions and Networks

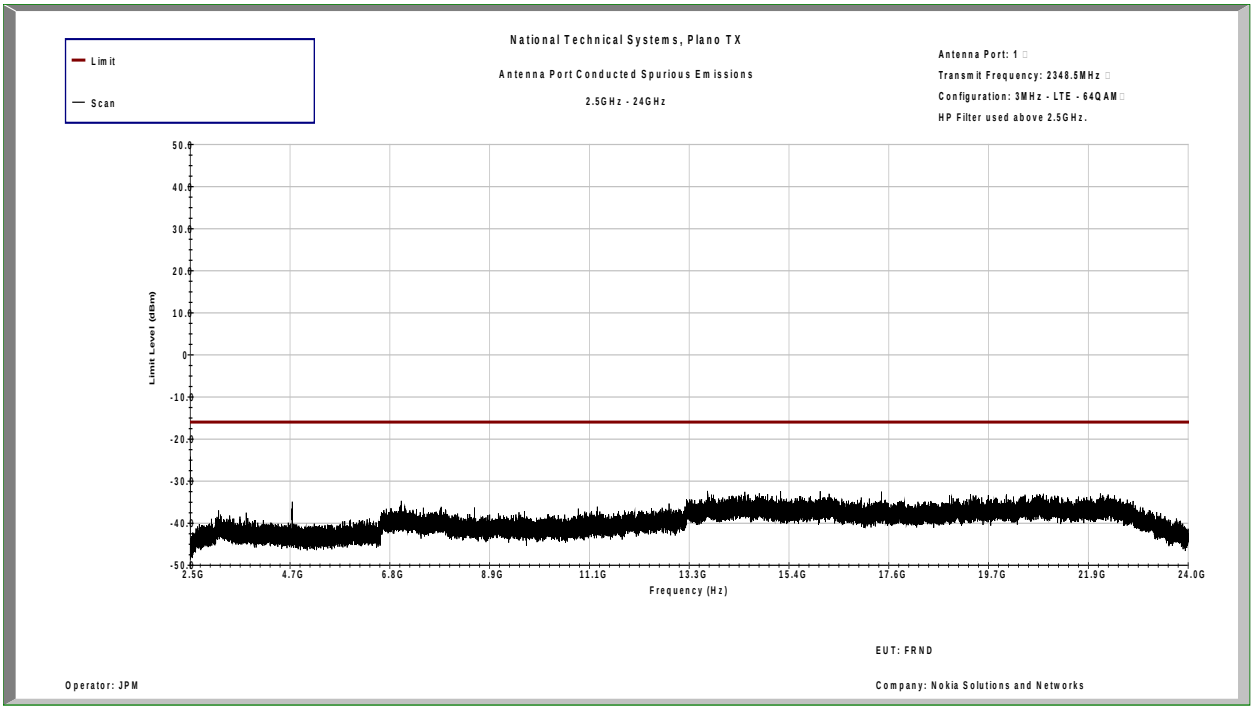
LTE – 16QAM – 3M


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
9kHz-2.5GHz
Antenna Port: 1
Transmit Frequency: 2348.5MHz
Configuration: 3MHz - LTE - 16QAM
HP Filter used above 2.5GHz.
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: FRND
Operator: JPM
Company: Nokia Solutions and Networks

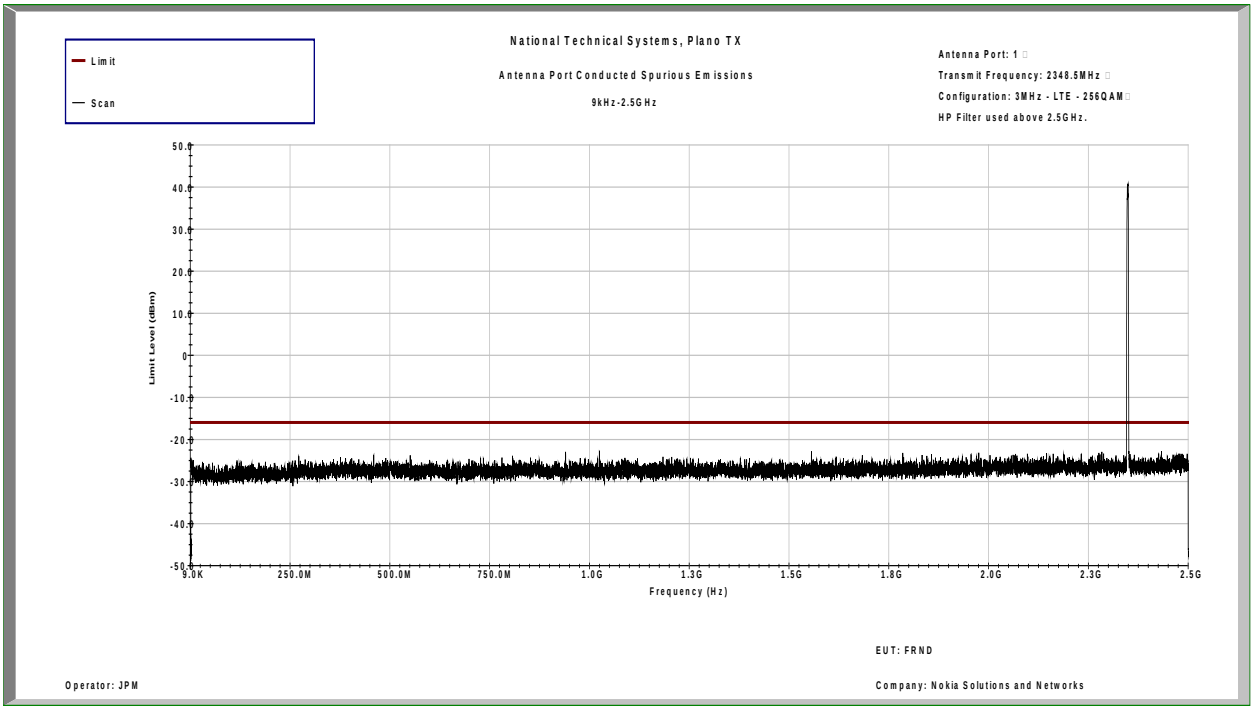

National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
2.5GHz - 24GHz
Antenna Port: 1
Transmit Frequency: 2348.5MHz
Configuration: 3MHz - LTE - 16QAM
HP Filter used above 2.5GHz.
Limit
Scan
Limit Level (dBm)
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
2.5G
4.7G
6.8G
8.9G
11.1G
13.3G
15.4G
17.6G
19.7G
21.9G
24.0G
Frequency (Hz)
EUT: FRND
Operator: JPM
Company: Nokia Solutions and Networks

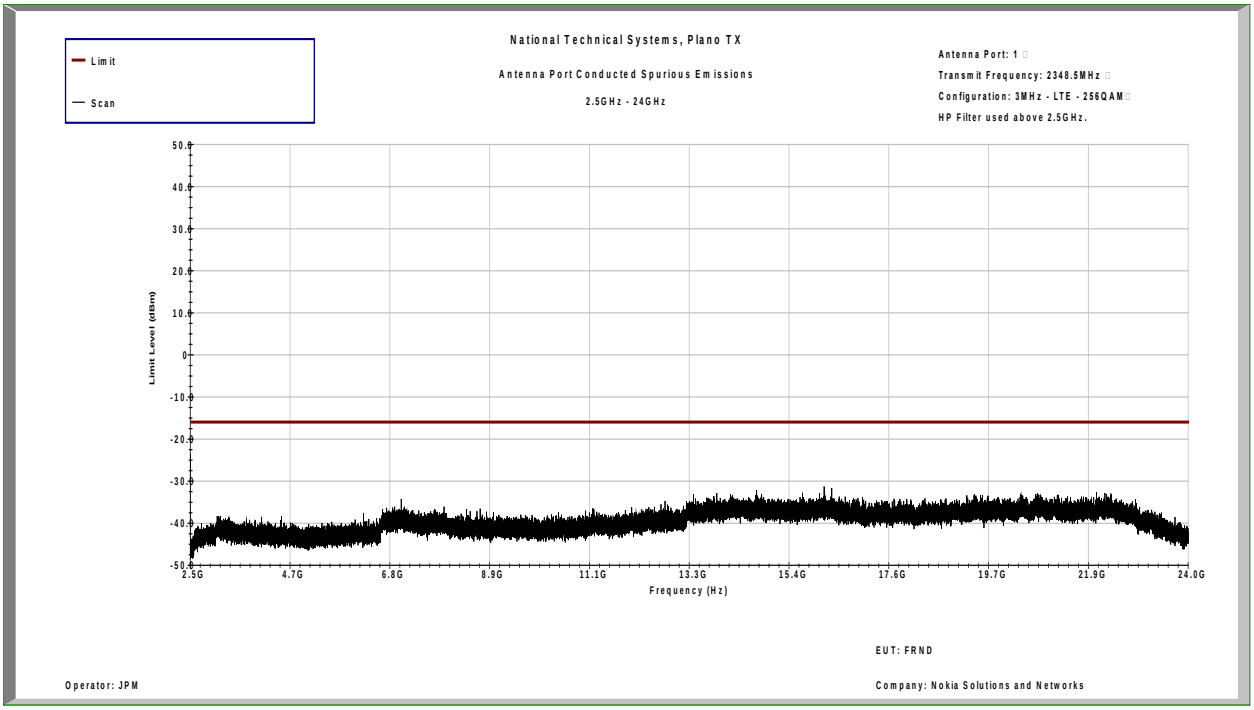
LTE – 64QAM – 3M


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
9kHz-2.5GHz
Antenna Port: 1
Transmit Frequency: 2348.5MHz
Configuration: 3MHz - LTE - 64QAM
HP Filter used above 2.5GHz.
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: FRND
Operator: JPM
Company: Nokia Solutions and Networks


National Technical Systems, Plano TX
Antenna Port Conducted Spurious Emissions
2.5GHz - 24GHz
Antenna Port: 1
Transmit Frequency: 2348.5MHz
Configuration: 3MHz - LTE - 64QAM
HP Filter used above 2.5GHz.
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: FRND
Operator: JPM
Company: Nokia Solutions and Networks

LTE – 256QAM – 3M





Transmitter Radiated Spurious Emissions

Antenna port conducted spurious emissions results for all modulations and channel bandwidth modes produced similar results around instrumentation noise floor. Pre scans have been performed in the 30MHz – 24GHz frequency range when the unit was transmitting on its center channel at maximum power on both ports with QPSK modulation. Final maximized peak radiated emissions were measured in these modes.

During testing all antenna ports of the base station were terminated with 50ohm termination blocks.

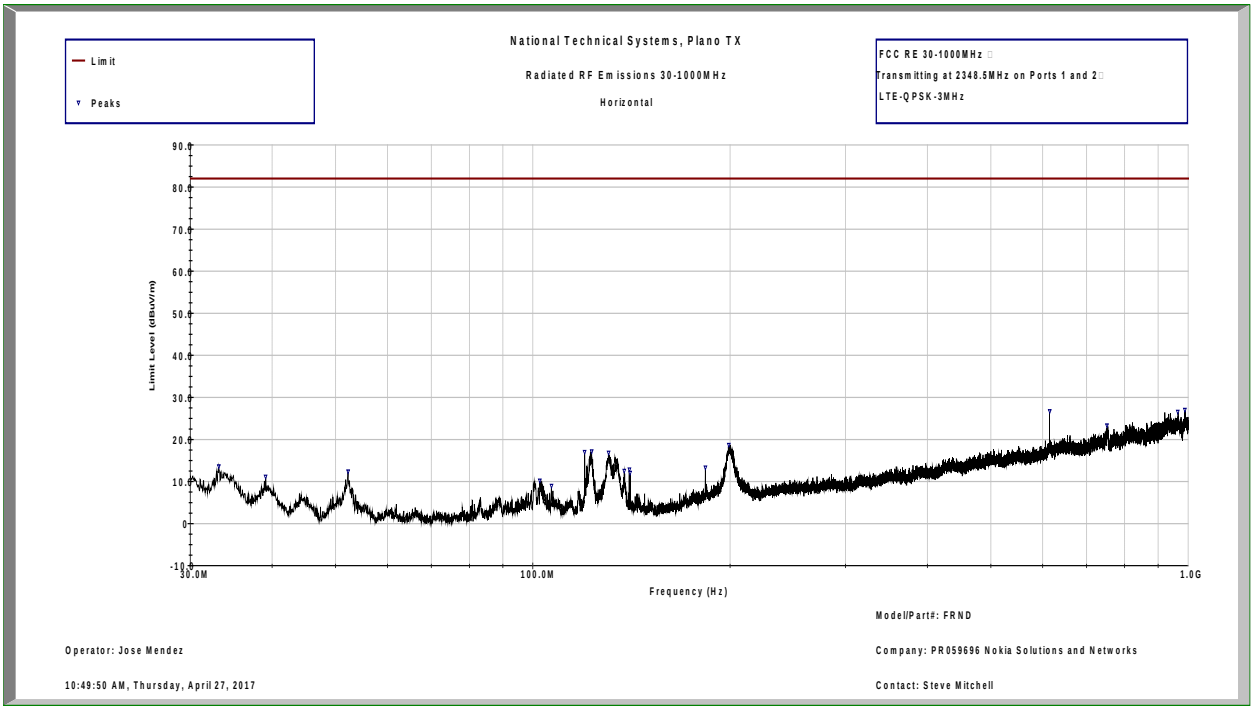
Frequency	Polarity	Peak Raw	Antenna	Pre Amp	Cableloss	Peaks	Limit	Margin	Tower	Turntable
MHz	H/V	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	dB	cm	Degrees
23692.17	V	34.749	45.671	-26.462	10.167	64.125	92.3	-28.175	100	306
20802.18	H	33.299	44.914	-27.843	9.363	59.733	92.3	-32.567	100	306
22544.8	H	27.587	45.881	-26.033	9.951	57.386	92.3	-34.914	100	306
22538.19	V	27.12	45.881	-26.016	9.95	56.934	92.3	-35.366	100	359
23780.88	H	26.166	45.678	-26.751	10.183	55.276	92.3	-37.024	100	306
23458.72	V	25.453	45.707	-26.128	10.124	55.155	92.3	-37.145	100	359
21205.33	V	27.629	44.964	-27.303	9.513	54.802	92.3	-37.498	100	359
22072.18	H	25.587	45.318	-27.323	9.826	53.408	92.3	-38.892	100	306
9070.26	H	30.777	37.561	-31.734	6.773	43.376	82.3	-38.924	100	258
17892.5	V	25.275	47.397	-28.827	8	51.845	92.3	-40.455	100	359
21135.67	H	24.56	44.988	-27.653	9.487	51.383	92.3	-40.917	100	306
20695.52	V	24.468	44.831	-27.933	9.323	50.688	92.3	-41.612	100	359
18969.77	V	22.338	44.886	-27.755	8.92	48.389	92.3	-43.911	100	359
12636.25	V	33.198	38.737	-30.129	6.528	48.333	92.3	-43.967	100	359
9933.82	V	25.895	37.967	-31.189	5.524	38.195	82.3	-44.105	200	214
17858.55	H	21.711	47.155	-28.796	7.933	48.002	92.3	-44.298	200	359
21770.06	H	19.682	44.975	-28.002	9.718	46.373	92.3	-45.927	100	306
1952.4	V	40.6	27.465	-34.466	2.542	36.139	82.3	-46.161	100	359
14656.94	V	25.987	41.822	-30.001	6.982	44.791	92.3	-47.509	100	359
14363.04	H	24.68	42.223	-29.403	7.029	44.529	92.3	-47.771	200	359
12667.74	H	29.015	38.79	-30.085	6.612	44.332	92.3	-47.968	200.1	359
4696.71	V	30.178	32.722	-32.507	3.72	34.112	82.3	-48.188	162	214
11800.54	H	26.636	39.309	-28.95	6.462	43.457	92.3	-48.843	156	359
13285.98	H	24.675	40.076	-28.307	6.826	43.269	92.3	-49.031	200.1	359
9145.26	V	20.587	37.567	-31.67	6.469	32.952	82.3	-49.348	200.1	214
12424.74	V	28.129	38.668	-30.414	6.564	42.947	92.3	-49.353	100	359
3774.29	H	29.217	32.391	-32.375	3.586	32.818	82.3	-49.482	100	258
11747.3	V	23.577	39.265	-28.697	6.442	40.586	92.3	-51.714	100	359
4700.8	H	23.766	32.73	-32.506	3.725	27.715	82.3	-54.585	100	258
14860.38	H	1.798	40.815	-29.716	6.922	19.82	92.3	-72.48	200.1	359

In the 30M-1GHz range emissions recorded were from the unintentional circuitry of the EUT. Harmonics of the fundamental, except for the 2nd harmonic, were below the instrumentation noise floor. All other spurious emissions were below the instrumentation noise floor as well. Testing above 10GHz was performed at a distance of 1m; Limit was adjusted accordingly. The highest spurious emission in the table (other than instrumentation noise floor) is 1952.4MHz at 36.192dBuV/m at 3 meters which equates to an EIRP of -58.99dBm.

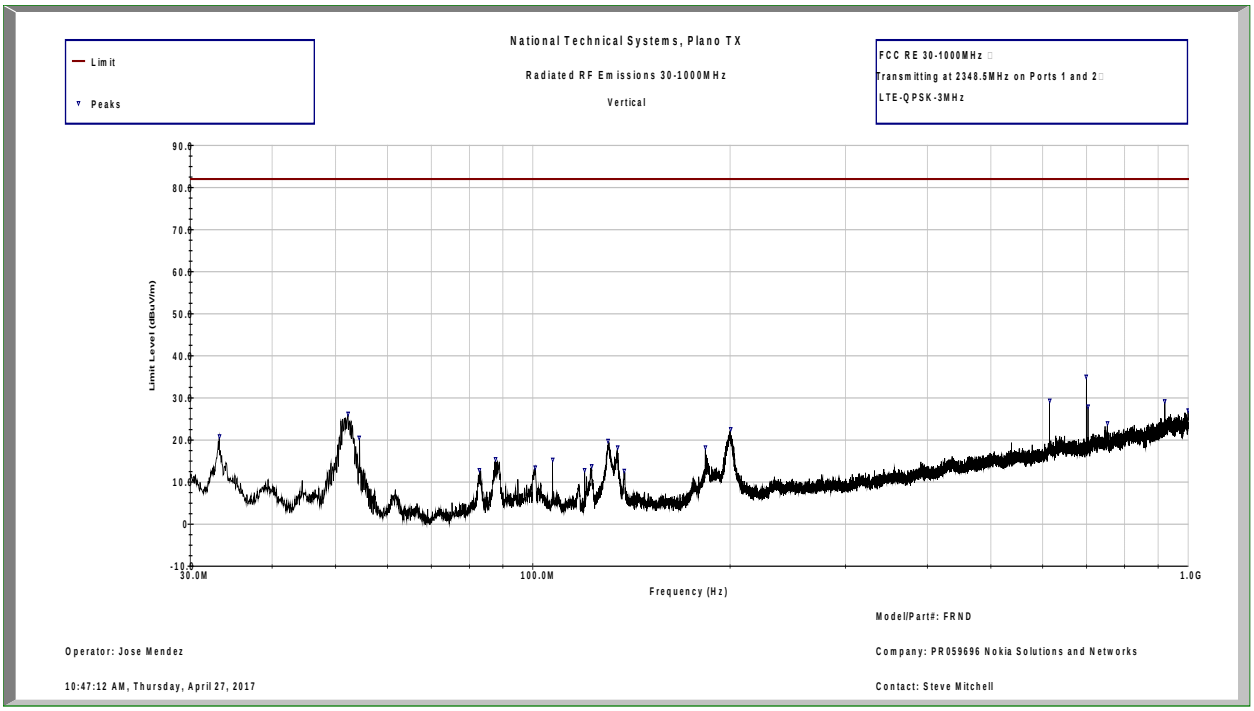
Highest noise floor of the measurement instrumentation was more than 20dB below the 82.2dBuV/m at 3m limit (equivalent to –13dBm EIRP). Since all maximized readings were more than 20dB below the 82.2dBuV/m at 3m limit (equivalent to -13dBm EIRP), substitution

measurements were not performed. TILE software was used for all prescans and plots included on the following pages.

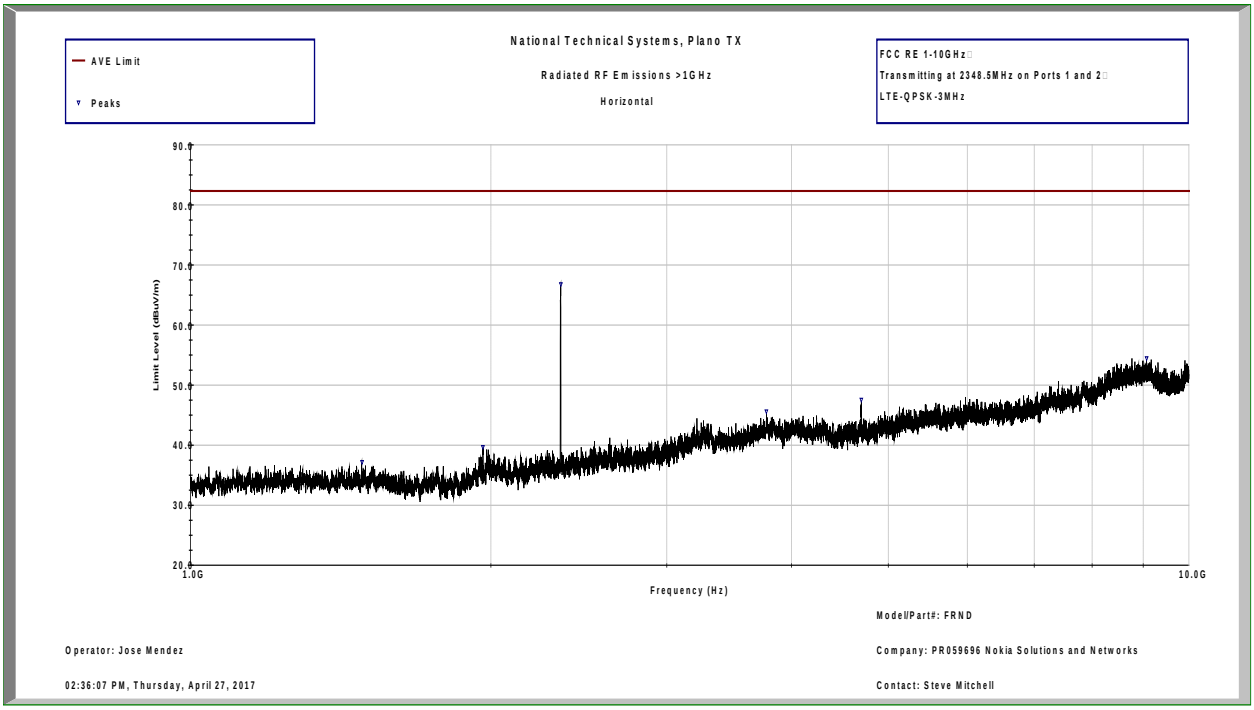
30MHz – 1GHz Peak Prescan at 3m – H



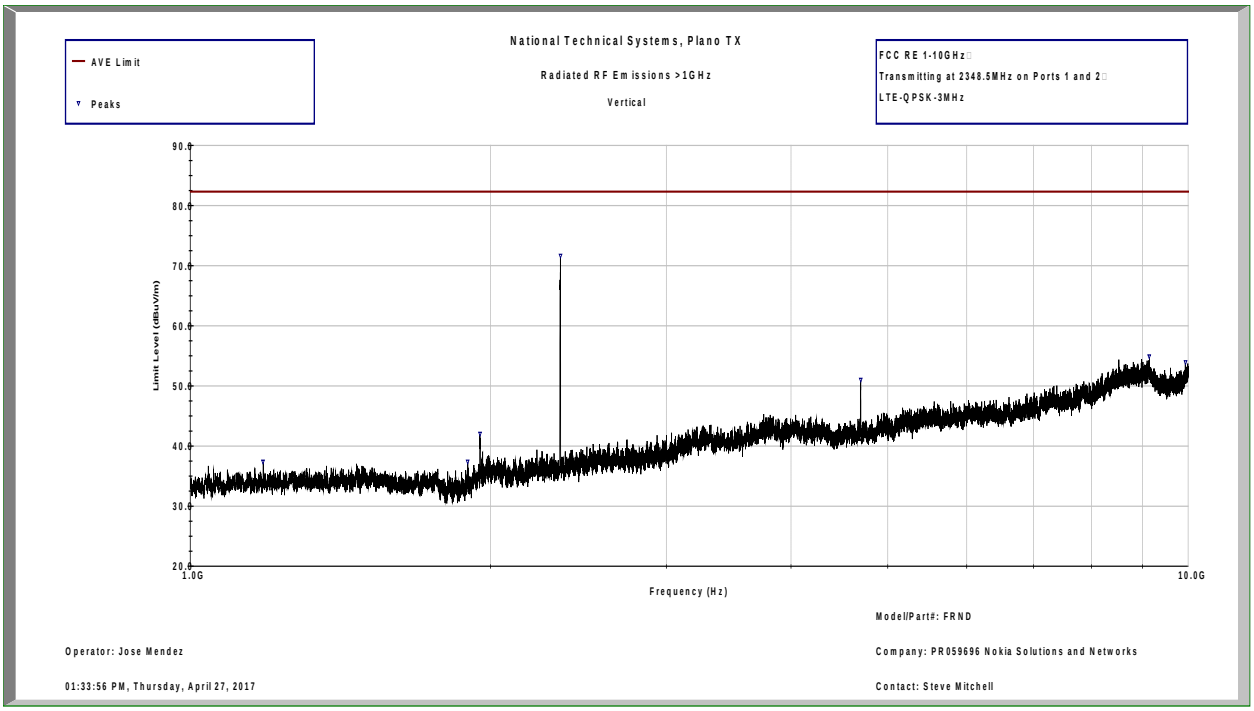
30MHz – 1GHz Peak Prescan at 3m – V



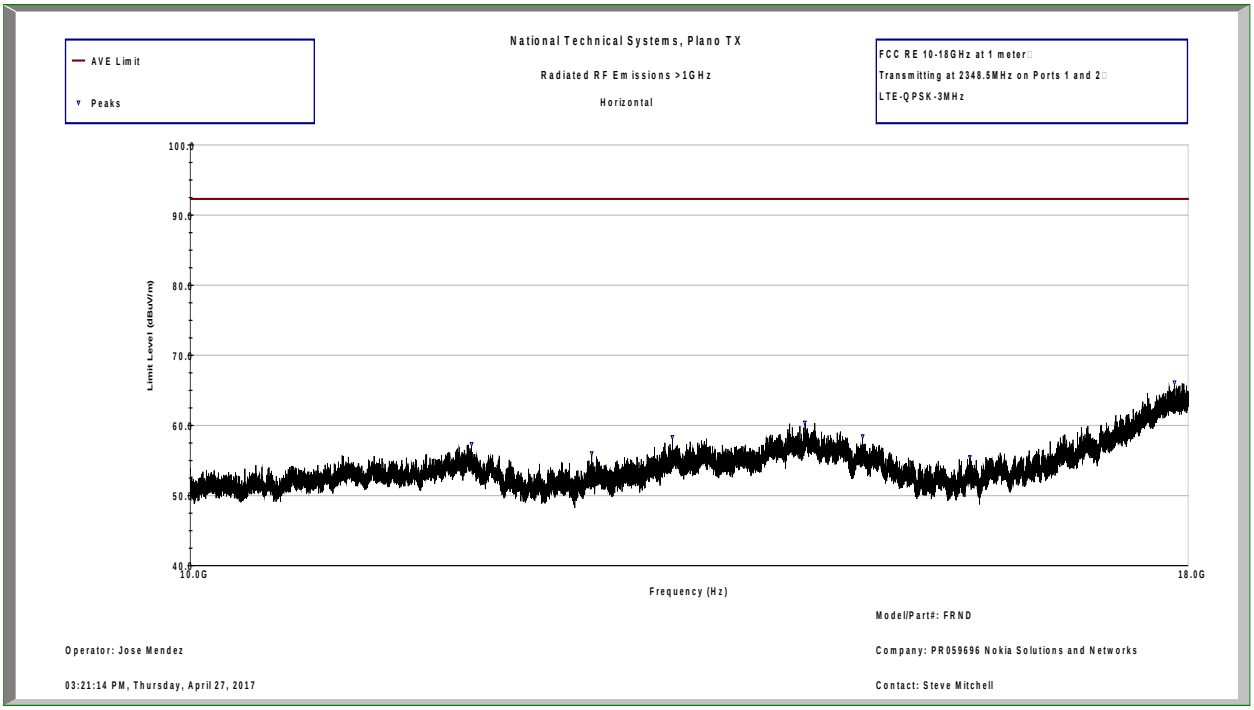
1GHz – 10GHz Peak Prescan at 3m – H



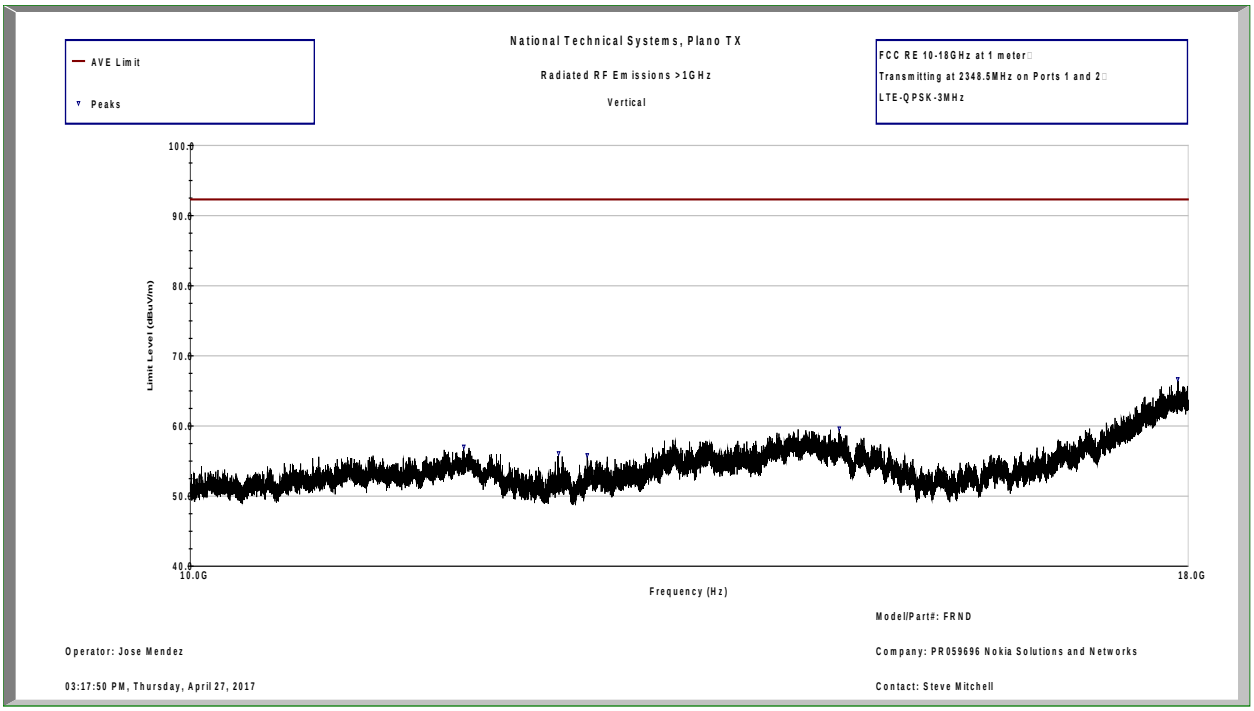
1GHz – 10GHz Peak Prescan at 3m – V



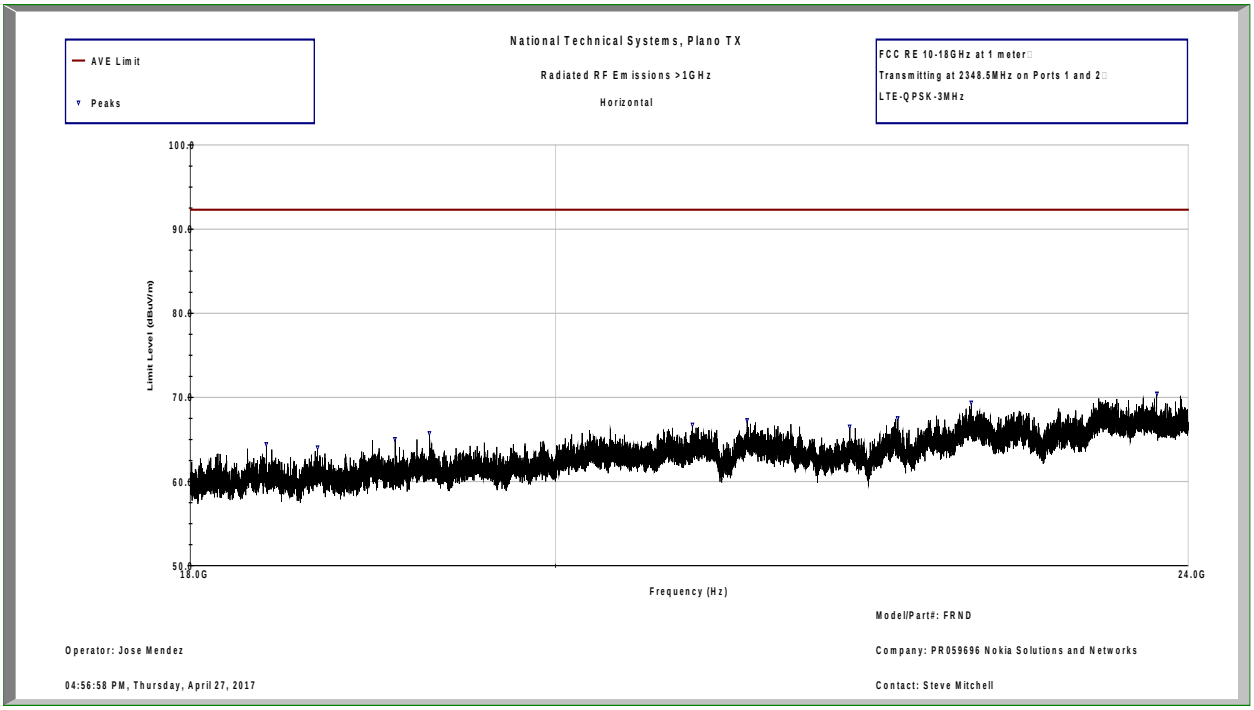
10GHz – 18GHz Peak Prescan at 3m – H



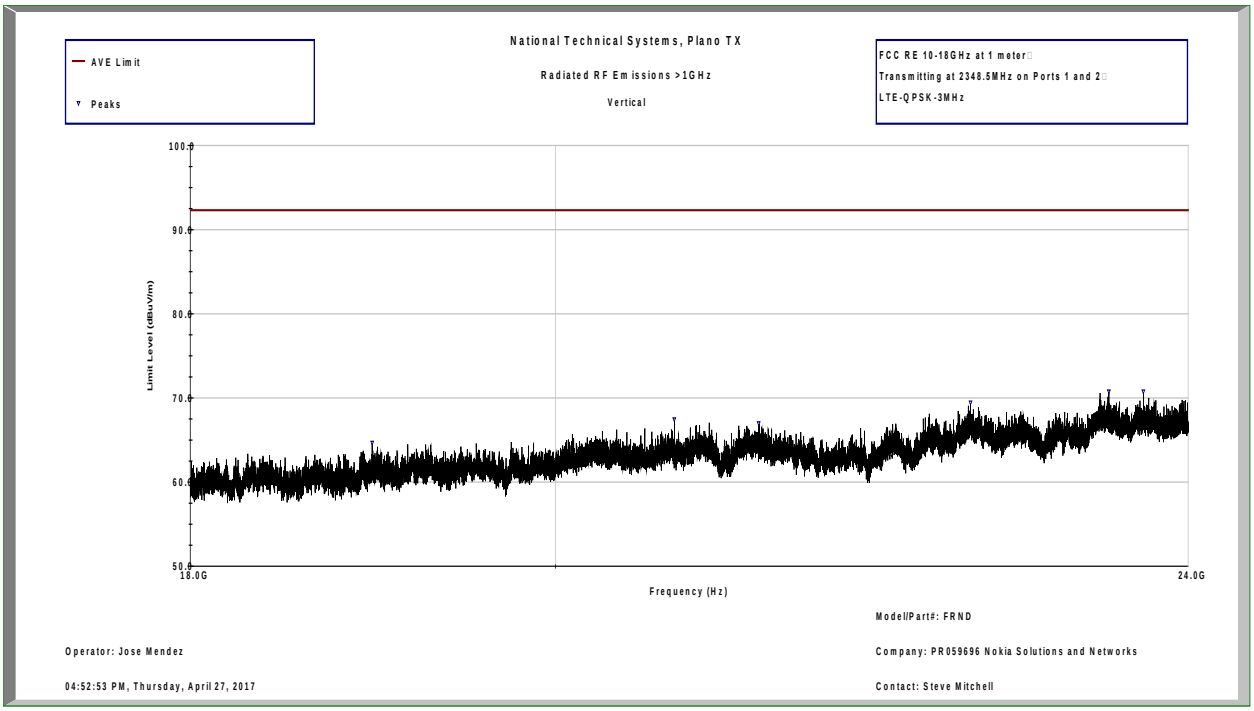
10GHz – 18GHz Peak Prescan at 3m – V



18GHz – 24GHz Peak Prescan at 3m – H



18GHz – 24GHz Peak Prescan at 3m – V



Frequency Stability

In order to demonstrate carrier frequency stability at extreme temperatures and voltages, bandedge compliance was verified at Port 1 on center channel. The FRND was transmitting on port 1 at maximum power using a 3MHz LTE channel bandwidth with QPSK Modulation at 2348.5MHz for all testing.

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

Bandedge reading results are listed below for extreme voltages and temperatures. The limit for compliance is same as the limit applied during previous bandedge tests, i.e. -16.03dBm.

Extreme Voltages

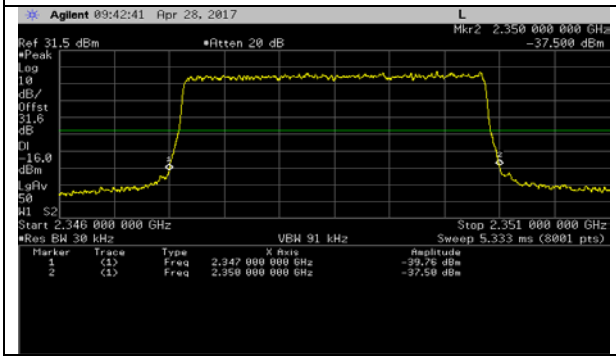
	2347MHz	2350MHz
20C	Amplitude (dBm)	Amplitude (dBm)
40.8VDC	-40.09	-38.33
55.2VDC	-40.79	-39.17

Extreme Temperatures

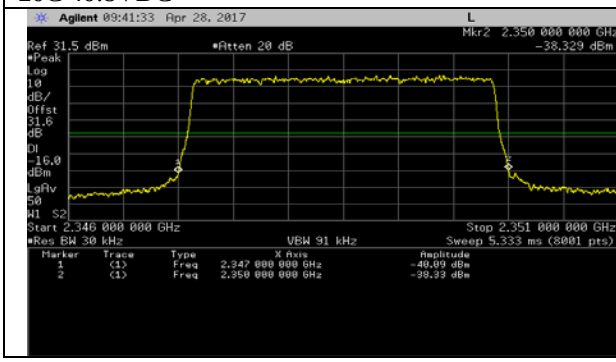
	2347MHz	2350MHz
48VDC	Amplitude (dBm)	Amplitude (dBm)
-30	-41.18	-37.39
-20	-40.05	-38.25
-10	-40.15	-38.17
0	-39.46	-37.97
10	-39.17	-37.88
20	-39.76	-37.5
30	-38.01	-37.21
40	-39.2	-37.56
50	-39.55	-37.57

Results above are deemed sufficient to demonstrate carrier frequency stability.
All corresponding plots are included on the following pages.

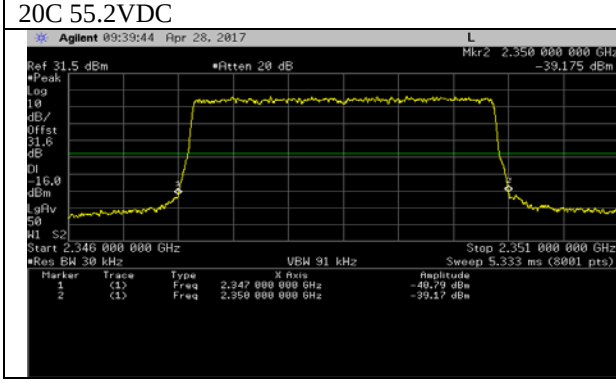
20C 48VDC Center



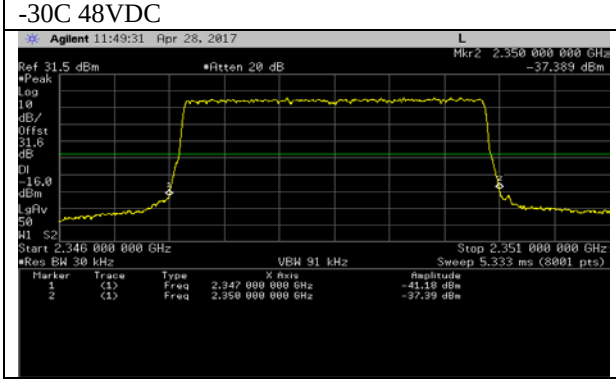
20C 40.8VDC



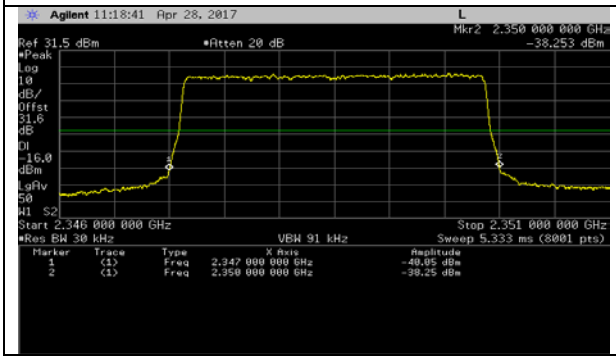
20C 55.2VDC



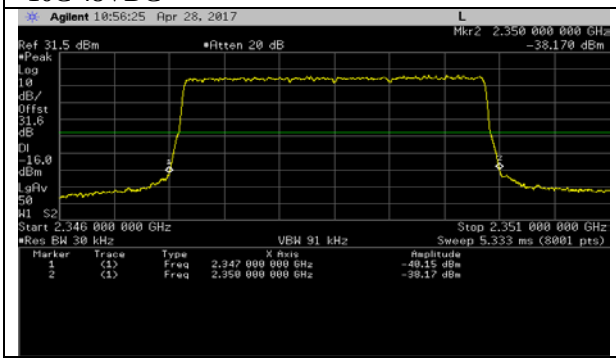
-30C 48VDC



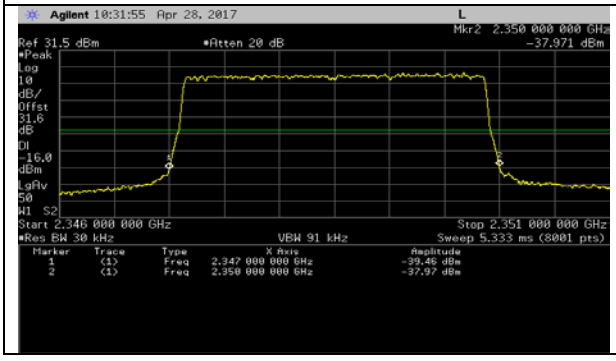
-20C 48VDC



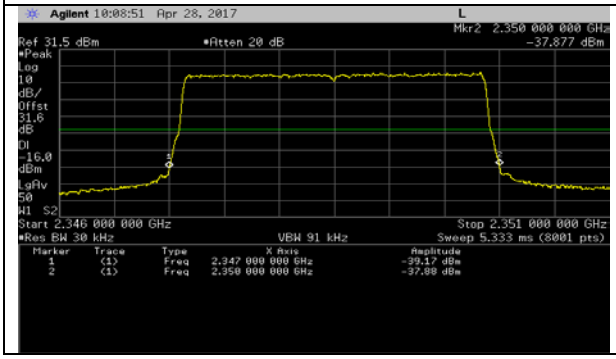
-10C 48VDC



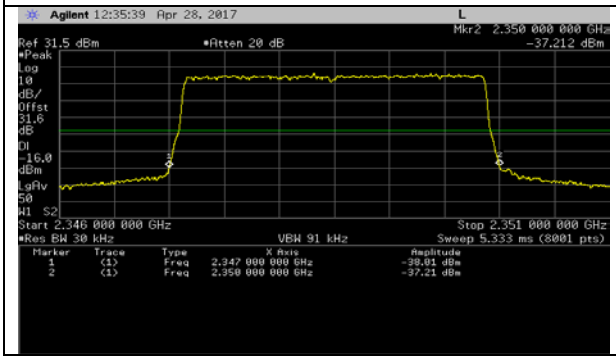
0C 48VDC



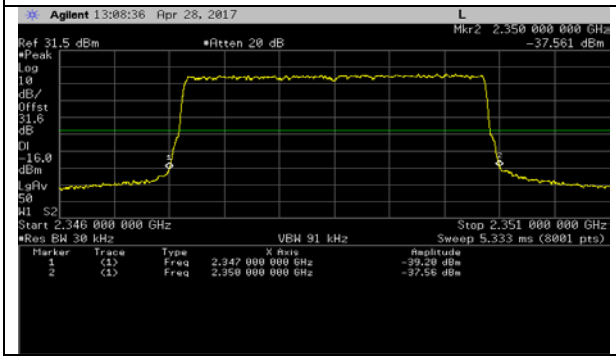
10C 48VDC



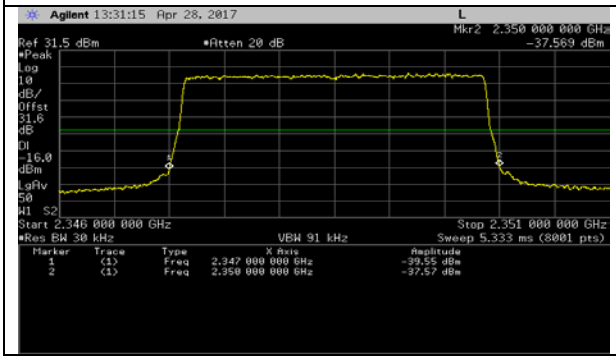
30C 48VDC



40C 48VDC



50C 48VDC



End of Report

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