Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 90 Subpart R
758MHz – 768MHz

FCC ID: **2AOGW610-1003-142**

Model: **Xiphos® Micro Radio Equipment (610-1003-142)**
Product Marketing Name: **Xiphos Micro Radio**

APPLICANT: **Oceus Networks**
5801 Tennyson Parkway, Suite 250
Plano, TX 75024

TEST SITE(S): **National Technical Systems - Plano**
1701 E Plano Pkwy #150
Plano, TX 75074

REPORT DATE: **March 16th 2018**

FINAL TEST DATES: **March 16th 2018**

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	March 17th 2018	(DRAFT) 1st release (Band14 only)	Armando Del Angel
1	March 18th 2018	Corrections per customer comments	Armando Del Angel
2	April 27th 2018	Added missing data for 90.543(e)(2) and (f)	Armando Del Angel

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SCOPE

Tests have been performed on Oceus Networks product Xiphos Micro Radio Model Xiphos® Micro Radio Equipment (610-1003-142), pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission.

- Code of Federal Regulations (CFR) Title 47 Part 2
- CFR Title 47 Part 90 Subpart R

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 C63.4-2014
- ANSI/TIA/EIA-603-D-2010
- TIA-102.CAAA-D-2013

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC requirements.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of Oceus Networks product Xiphos Micro Radio Equipment Model Xiphos and therefore apply only to the tested sample.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, the device requires certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

Testing was performed only on Model Xiphos® Micro Radio Equipment (610-1003-142). No additional models were described or supplied for testing.

STATEMENT OF COMPLIANCE

The tested sample of Oceus Networks product Xiphos Micro Radio Equipment Model 610-1003-142 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 90 Subpart R (Base Stations Operating in 758MHz-768MHz band)

FCC	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics				
§90.531	Frequency range(s)	760.5MHz - 765.5MHz (5M LTE) 758.0MHz - 768.0MHz (10M LTE)	758MHz - 768MHz	Pass
§90.535	Modulation Type	QPSK, 16QAM, 64QAM (5M and 10M for each)	Digital	Pass
§90.542	Output Power	Conducted Output Power (Highest on Port 1) RMS: 37.78Bm EIRP: 39.78dBm[3]	FCC: 1000W ERP	Pass
§2.1051	Peak to Average Ratio	8.28dB highest	13dB	Pass
§2.1049	Emission Bandwidth (99%)	4.852MHz (5M LTE) 8.7881MHz (10M LTE)	Remain in Block	Pass
N/A Informational	Emission Bandwidth (26dB)	4.856MHz (5M LTE) 9.507MHz (10M LTE)	Remain in Block	Pass
Transmitter spurious emissions[1]				
§90.543(e)(3)	At the antenna terminals	< -16.03dBm	-16.03 dBm (per TX chain)	Pass
	Field strength	45.3dBuV/m at 3m Eq. to -49.9dBm EIRP	-13 dBm EIRP	Pass
90.543(e)(2)	Maximum emissions in 769-775 MHz and 799- 805MHz bands	-38.005dBm/6.25kHzRBW	-35dBm per 6.25kHz bandwidth or -38dBm for 2 port MIMO (See Note 2)	Pass
§90.543(f)	Limitations within 1559MHz -1610MHz band	-81.13dBm/MHz	-70 dBW/MHz EIRP (wideband) -80 dBW/MHz EIRP (discrete)	Pass
Other details				
§90.539	Frequency stability	0.0007ppm	1ppm	Pass
§1.1310	RF Exposure	See MPE Report		Pass

Notes

Note 1 – Based on 100kHz RBW. In 100kHz bands immediately outside and adjacent to the frequency block 30kHz RBW has been used.

Note 2: The FCC section 90.543(e)(2) requires an emission limit of -35dBm for any 6.25 kHz bandwidth (i.e.: 65 + 10logP) between frequency bands 769-775 MHz and 799-805 MHz. Adjusting for the two port MIMO requirement the emission limit in these frequency ranges is -38 dBm [i.e.: Limit = -35 dBm/6.25kHz (FCC Limit)– 3dB (2 port MIMO)].

Note 3 – Based on 2dBi Broadband Manpack Antenna

	Emission Designators					
	LTE-QPSK		**LTE-16QAM**		**LTE-64QAM**	
	FCC	**IC**	**FCC**	**IC**	**FCC**	**IC**
5M	4M84F9W	4M38F9W	4M86F9W	4M36F9W	4M89F9W	4M38F9W
10M	9M48F9W	8M76F9W	9M47F9W	8M79F9W	9M51F9W	8M78F9W

Note: FCC based on 26dB emission bandwidth, IC based on 99% emissions bandwidth.

EXTREME CONDITIONS

Frequency stability is determined over extremes of temperature and voltage. The extremes of voltage were 85 to 115 percent of the nominal value.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

MEASUREMENT UNCERTAINTIES

Measurement uncertainties of the test facility based on a 95% confidence level are as follows,

Test	**Uncertainty**
Radio frequency	± 0.2ppm
RF power conducted	±1.2 dB
RF power radiated	±3.3 dB
RF power density conducted	±1.2 dB
Spurious emissions conducted	±1.2 dB
Adjacent channel power	±0.4 dB
Spurious emissions radiated	±4 dB
Temperature	±1°C
Humidity	±1.6 %
Voltage (DC)	±0.2 %
Voltage (AC)	±0.3 %

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The equipment under test (EUT) is an Oceus Networks Xiphos Micro Radio, model Xiphos® Micro Radio Equipment (610-1003-142) which operates over 3 GPP frequency band 14 (BTS Rx: 788 to 798 MHz/BTS Tx: 758 to 768 MHz). The XIPHOS MICRO RADIO has two co-located transmitters with each transmit port supporting 5 watts maximum rated RF output power. The XIPHOS MICRO RADIO can be operated as MIMO or as non-MIMO. Multi-carrier operation is not supported.

The XIPHOS MICRO RADIO supports three downlink modulation types for LTE (QPSK, 16QAM and 64QAM). The XIPHOS MICRO RADIO supports two LTE channel bandwidths (5 MHz and 10 MHz).

The XIPHOS MICRO RADIO has external interfaces including AC power, ground, TX/RX (Ant), Ethernet "B", Ethernet "C", USB port, and GPS. The XIPHOS MICRO RADIO with applicable installation kit may be pole or wall mounted.

The XIPHOS MICRO RADIO LTE channel numbers and frequencies are as follows:

Tested frequencies and EARFCNs for TX measurements

EARFCN Downlink	Frequency [MHz]	Comment
5305	760.5	TX bottom (B) frequency 5 MHz BW configuration
5330	763.0	TX band mid (M) frequency in 10 MHz BW configuration
5355	765.5	TX top (T) frequency in 5 MHz BW configuration

Tested frequencies and EARFCNs for RX measurements

EARFCN	Frequency [MHz]	Comment
23305	790.5	RX band bottom (B) frequency in 5 MHz BW configuration
23355	795.5	RX band bottom (T) frequency in 5 MHz BW configuration

Each corresponding uplink (RX) channel was offset by +18000 from above given downlink EARFCN.

Note: EARFCN are derived according 3GP TS 36.141, table 5.7.3-1.

The sample was received on March 15th, 2018 and tested on March 16th, 2018.The EUT consisted of the following component(s):

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Oceus Networks	Xiphos® Micro Radio Equipment (610-1003-142)	XIPHOS MICRO RADIO	Part#: 610-1003-142 Serial#: XMIC-R14187	FCC ID: 2AOGW610-1003-142

ENCLOSURE

The EUT enclosure is made of heavy duty aluminum and measures approximately 12(W) x 4(D) x 12(H) inches.

AUXILLARY EQUIPMENT

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
N/A	N/A	N/A	N/A	N/A

SUPPORT EQUIPMENT

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Oceus Networks	086479A. X31	Nokia Argon HDMI	RY134602016	N/A
HP	Elite Book 8530w	Laptop PC	2CE918Bk1Q	N/A

EUT INTERFACE PORTS

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

Cable	Type	Shield	Length	Used in Test	Quantity	Termination
AC Power	Power	No	~ 3 m	Yes	1	Power Supply
Earth	Earth	No	~ 1 m	Yes	1	Lab earth ground
TX/RD D	RF	Yes	~ 1 m	Yes	1	50Ω Load
TX/RD M	RF	Yes	~ 1 m	Yes	1	50Ω Load
BH B	Signal	Yes	> 6 m	Yes	1	Laptop
BH C	Signal	Yes	> 6 m	Yes	1	Laptop

The connector layout for XIPHOS MICRO RADIO EQUIPMENT is provided below:

XIPHOS MICRO RADIO EQUIPMENT External Interfaces:

Port:	**Interface:**
Ground	Ground connection
DC Power	Supply power +28 VDC
RF A	TX/RX antenna port A
RF B	TX/RX antenna port B
O&M	Cat 5 port for operations and maintenance computer

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 EUT over the Ethernet port. The laptop is used for changing configuration settings, monitoring tests and controlling the XIPHOS MICRO RADIO EQUIPMENT. The following software versions are used for the XIPHOS MICRO RADIO EQUIPMENT testing:

(1) LabVIEW Software: Version 2012

(2) EUT Firmware: FB_PS_REL_2014_05_374

MODIFICATIONS

No modifications were made to the EUT during testing.

TESTING

GENERAL INFORMATION

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

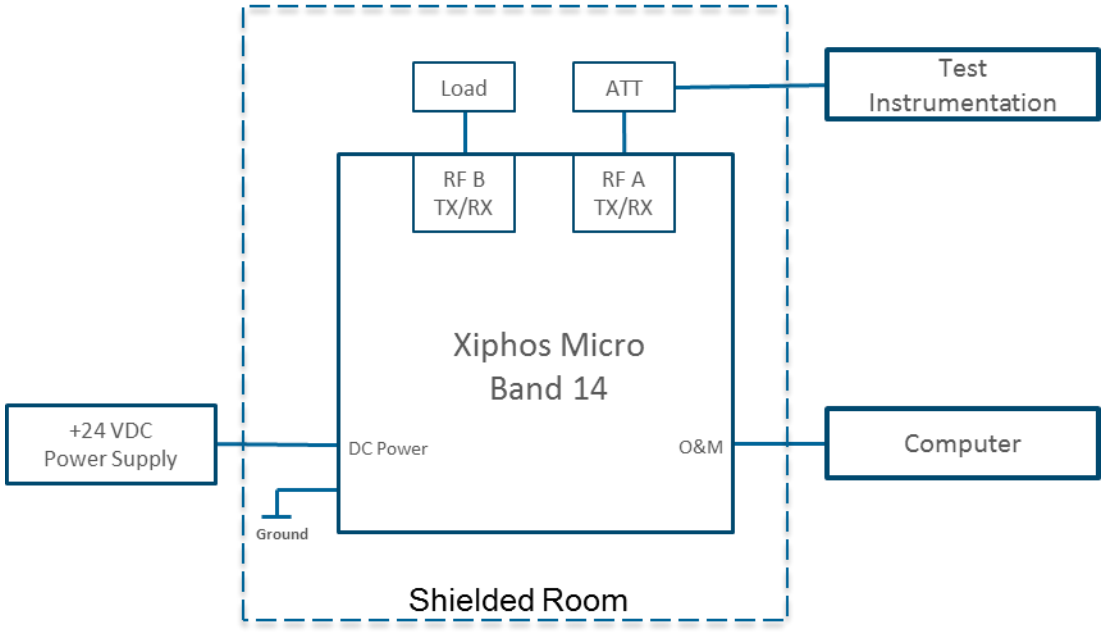
Radiated spurious emissions measurements were taken at the NTS Plano Anechoic Chamber listed below. The sites conform to the requirements of ANSI C63.4-2009 *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range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

Site	Registration Numbers		Location
	FCC	Canada	
Chamber 1	A2LA Accredited Designation Number US1077	IC 4319A	1701 E Plano Pkwy #150 Plano, TX 75074.

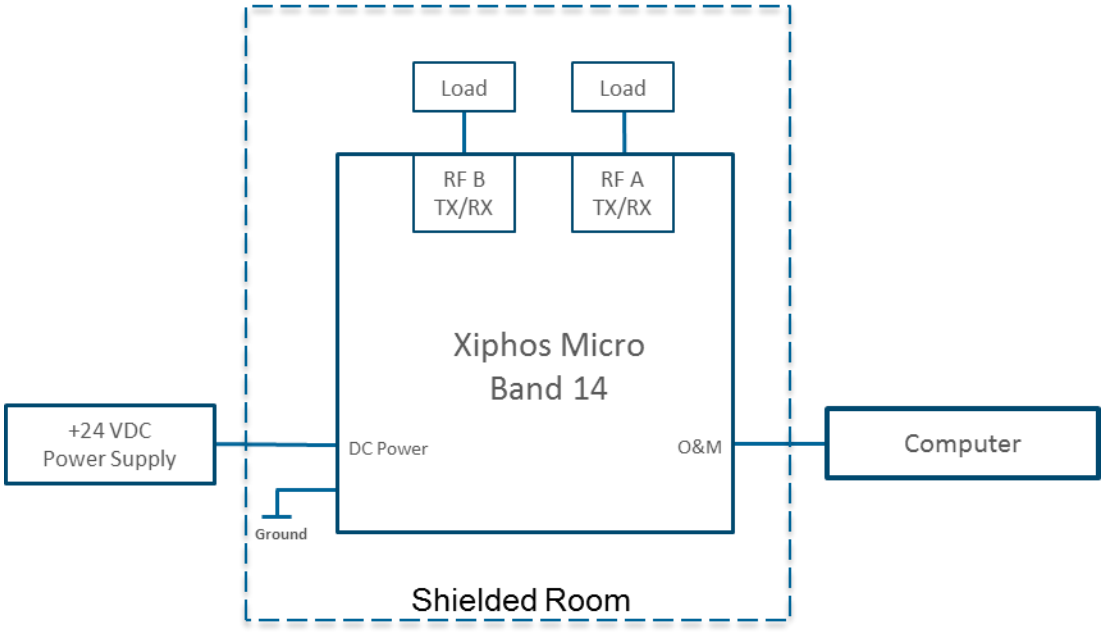
Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

MEASUREMENT PROCEDURES

Output power, emission bandwidth, conducted spurious, conducted bandedge and carrier frequency stability measurements were all performed via a spectrum analyzer connected to the individual RF chains via a 40dB attenuator and an RF cable. The EUT was operating in 2x2 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



Test Configuration for Radiated Measurements

26dB emission bandwidth was measured in accordance with Section 4.1 of FCC KDB 971168 D01 v03.For both measurements Agilent's Benchvue 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 Agilent's Benchvue software tool with settings described in the corresponding sections of the FCC. 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 v03. Agilent's Benchvue 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 v03.

Conducted spurious emissions were captured with TILE6 software which corrected the readings for cable loss and attenuator loss across the 9kHz-8GHz frequency span. Settings of the spectrum analyzer are described in the corresponding test result section.

For frequency stability, the EUT was placed inside a temperature chamber with all support and test equipment located outside of the chamber. Temperature was varied across the specified range in 10 degree increments and EUT was allowed enough time to stabilize at each temperature step. A signal analyzer as detailed in the test equipment section has been used for précised frequency error measurements.

Transmitter radiated spurious emissions measurements were made in accordance with ANSI C63.4-2014 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-D-2010. Both preliminary and final measurements were performed at the same FCC listed test chamber. Preliminary scans were performed with TILE6 software. This software corrected the measurements for antenna factors, cable losses and pre-amplifier gains. Both polarizations of the receiving antenna were scanned from 30MHz to 8GHz with a peak detector (RBW=100kHz, VBW=300kHz, 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 1-8GHz 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.

Test Equipment

NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
E1529P	PSA	Agilent	E4446A	12 Months	4/21/2018
E1260P	PreAmp (1GHz-18GHz)	MITEQ	AFS44-01001800-45-10P-44	12 Months	5/29/2018
E1366P	PreAmp (30MHz-1GHz)	MITEQ	AM-1431-N-1197SC	12 Months	12/28/2018
E1289P	Biconilog Antenna (30MHz-1GHz)	ETS Lindgren	3142C	12 Months	3/26/2018
E1149P	Horn Antenna (1GHz-18GHz)	EMCO	3115	12 Months	12/19/2018
E1447P	RMS Multimeter	Fluke	87V	12 Months	6/14/2018
ENV1035P	Thermometer	Fluke	52 II	12 Months	4/23/2018
ENV1195P	Climatic Chamber	Thermotron	SE-300-2-2	N/A	NCR
E1680P	PreAmp (1GHz-40GHz)	MITEQ		12 Months	10/13/18
WC021208	Horn Antenna (18-40GHz)	ETS Lindgren	3116	12 Months	11/15/18

Appendix A Test Data

RF Output Power

RF output power has been measured in both Peak and RMS Average terms for each transmit chain at the center channel for all modulations and bandwidth modes. Peak to average ratio (PAR) has been calculated as described in Section 5.7.2 of KDB971168 D01 v03 and all results are presented in tabular form below. E-TM1.1 test model used in BW configurations.

		LTE - QPSK			LTE - 16QAM			LTE - 64QAM		
		Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)
Ant 0 Center Channel	5M	45.35	37.33	8.02	45.23	37.14	8.09	45.23	37.14	8.09
	10M	45.46	37.31	8.15	45.48	37.49	7.99	45.29	37.24	8.05
Ant 1 Center Channel	5M	45.45	37.39	8.06	45.34	37.15	8.19	45.4	37.37	8.03
	10M	45.34	37.22	8.12	45.39	37.36	8.03	45.29	37.24	8.05
Combined Center Channel	5M	48.41	40.37	11.68	48.3	40.16	11.77	48.33	40.27	11.7
	10M	48.41	40.28	11.77	48.45	40.44	11.66	48.3	40.25	11.69

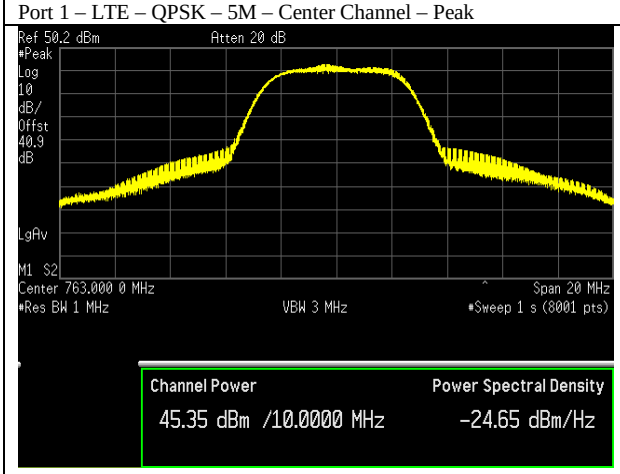
Based on the results above, Port 1 had the highest RMS average power and therefore it was selected for all the remaining antenna port tests on the product.

Subsequently output power levels on lowest and highest channels in only 1 channel bandwidth (5MHz) were tested only at Port 1 and results presented below.

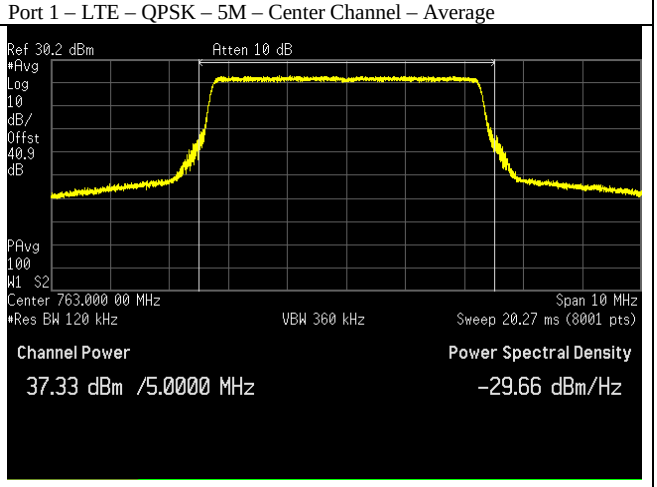
		LTE - QPSK			LTE - 16QAM			LTE - 64QAM		
		Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)
Ant 0 Bottom Channel	5M	45.3	37.32	7.98	45.29	37.32	7.97	45.33	37.28	8.05
	10M	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ant 0 Top Channel	5M	45.3	37.32	7.98	45.29	37.28	8.01	45.33	37.32	8.01
	10M	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

All corresponding plots included on the following pages. Total path loss of 40.9dB (Attenuator Loss: 40dB, RF cable loss: 0.9dB) accounted in via reference level offset to the spectrum analyzer.

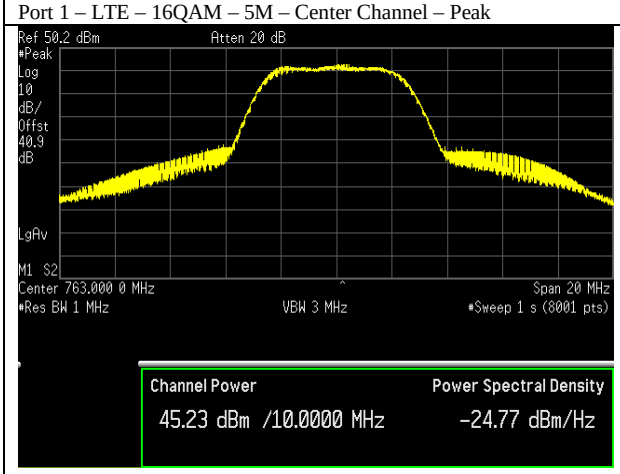
Port 1 – LTE – QPSK – 5M – Center Channel – Peak



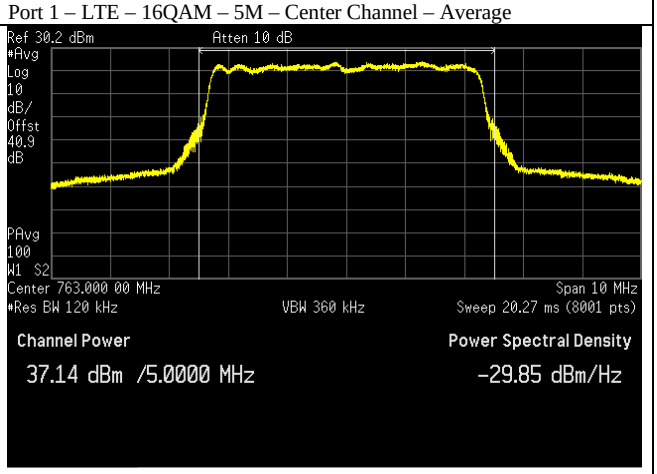
Port 1 – LTE – QPSK – 5M – Center Channel – Average



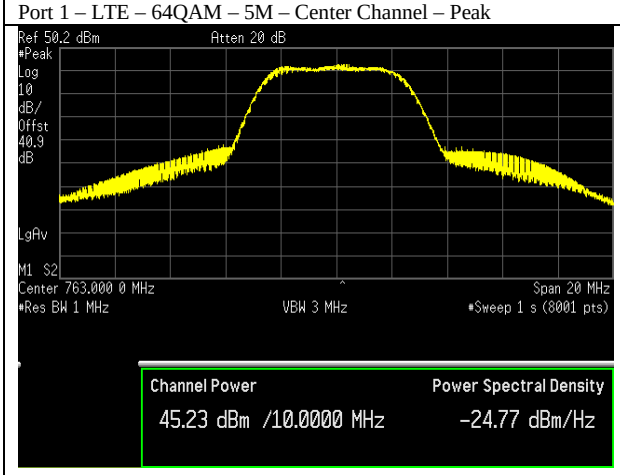
Port 1 – LTE – 16QAM – 5M – Center Channel – Peak



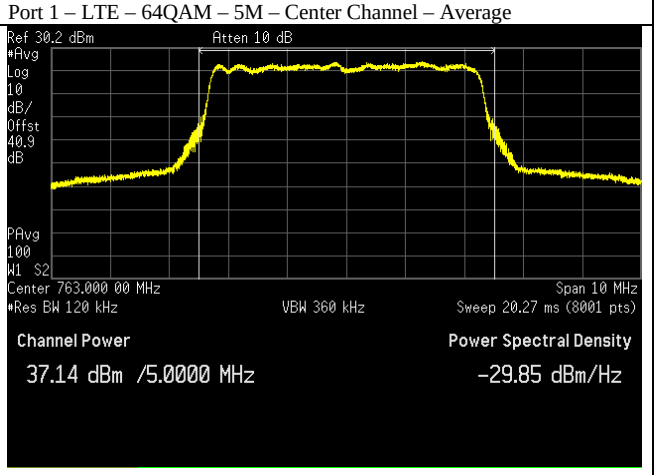
Port 1 – LTE – 16QAM – 5M – Center Channel – Average



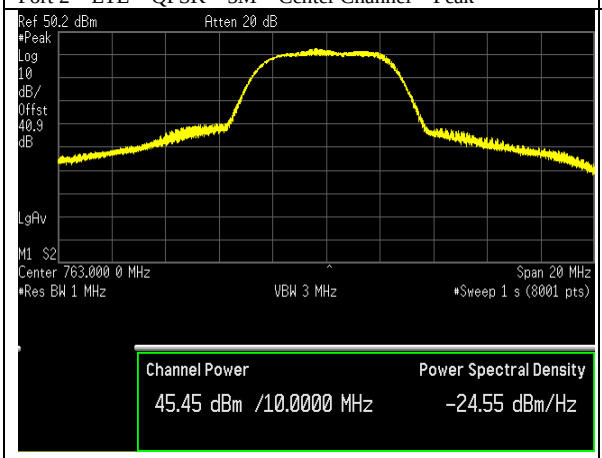
Port 1 – LTE – 64QAM – 5M – Center Channel – Peak



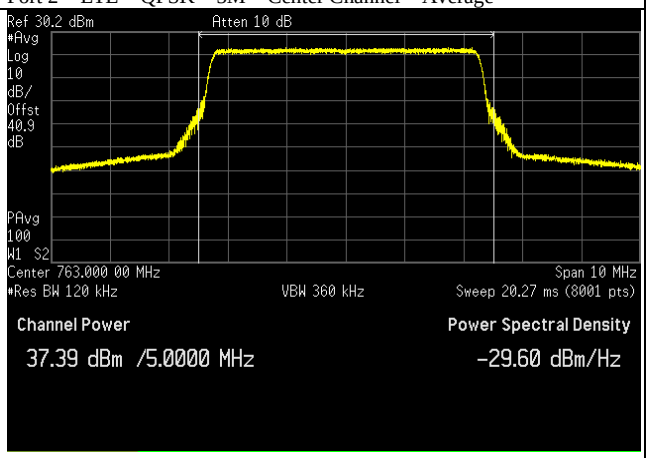
Port 1 – LTE – 64QAM – 5M – Center Channel – Average



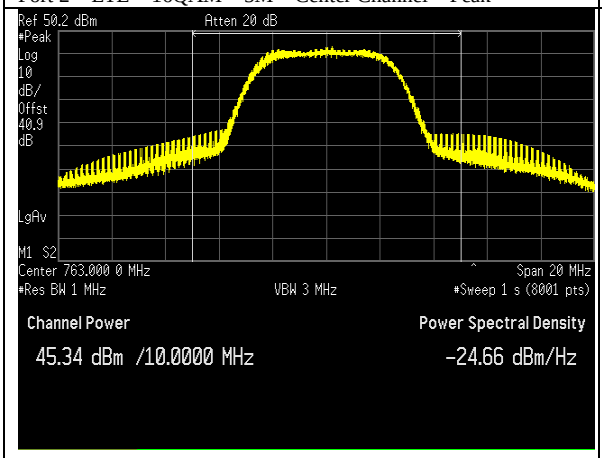
Port 2 – LTE – QPSK – 5M – Center Channel – Peak



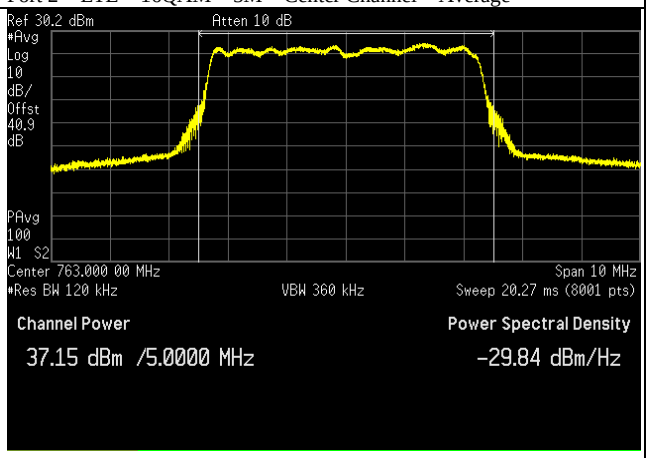
Port 2 – LTE – QPSK – 5M – Center Channel – Average



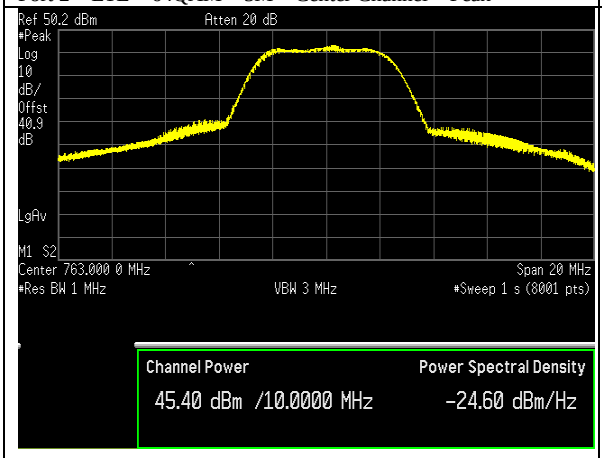
Port 2 – LTE – 16QAM – 5M – Center Channel – Peak



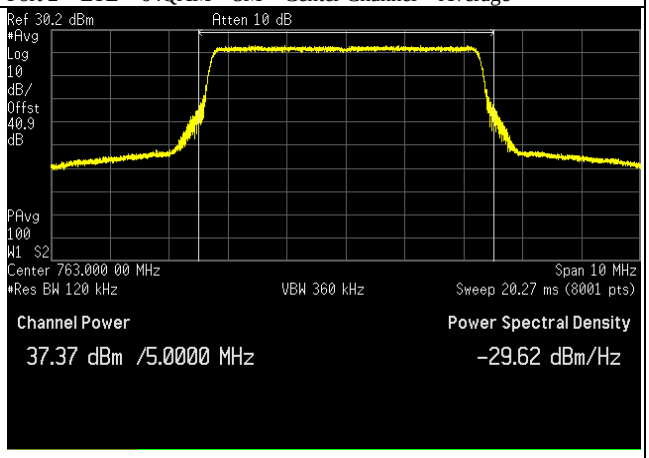
Port 2 – LTE – 16QAM – 5M – Center Channel – Average



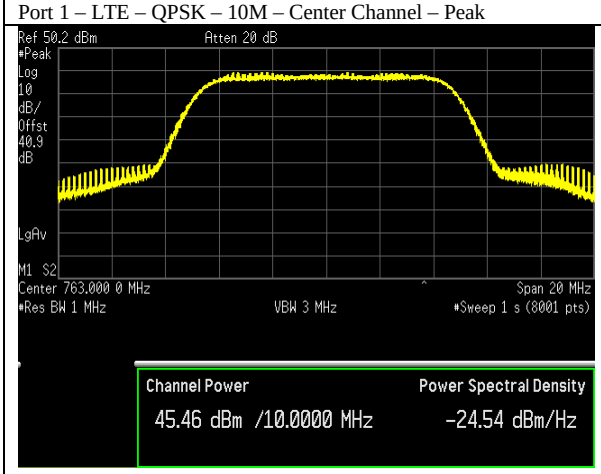
Port 2 – LTE – 64QAM – 5M – Center Channel – Peak



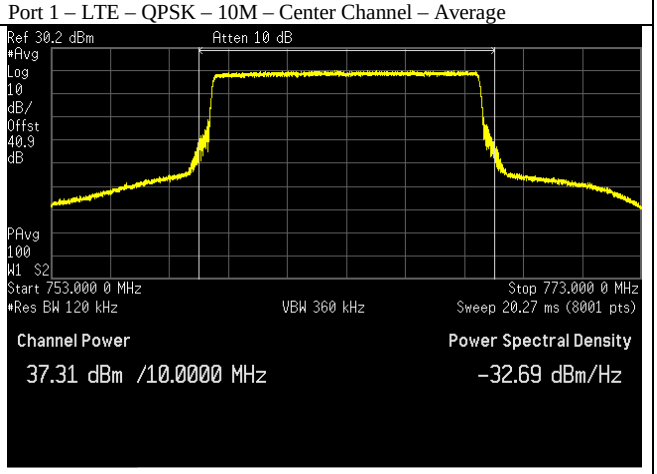
Port 2 – LTE – 64QAM – 5M – Center Channel – Average



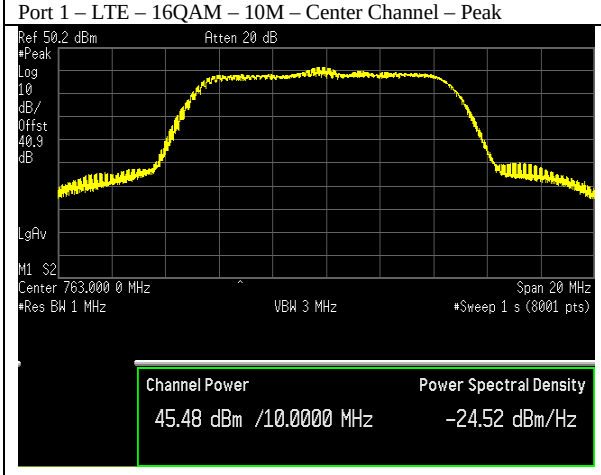
Port 1 – LTE – QPSK – 10M – Center Channel – Peak



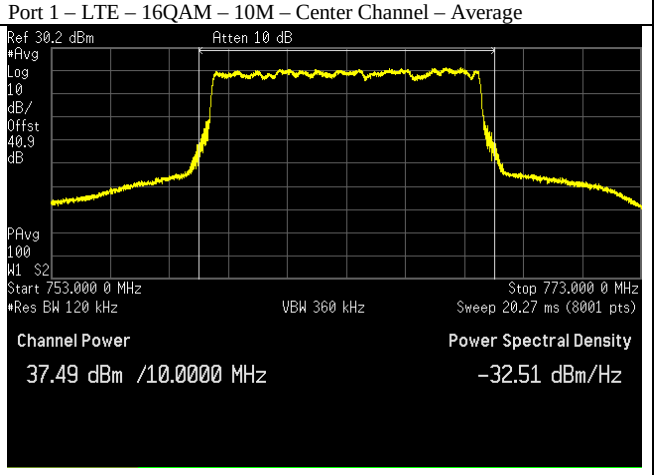
Port 1 – LTE – QPSK – 10M – Center Channel – Average



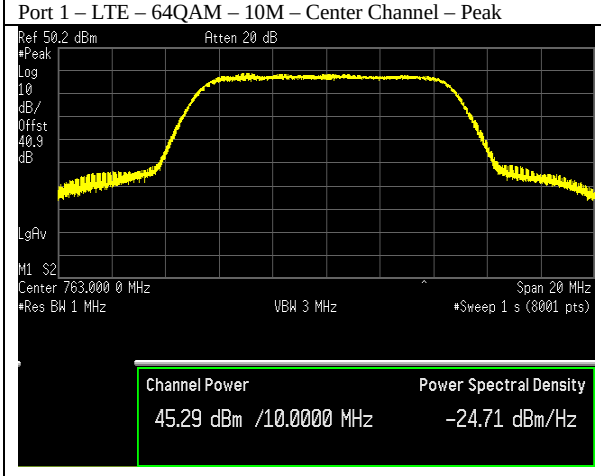
Port 1 – LTE – 16QAM – 10M – Center Channel – Peak



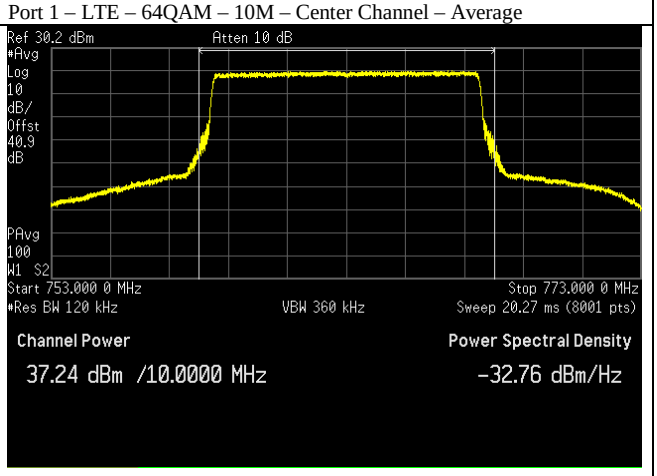
Port 1 – LTE – 16QAM – 10M – Center Channel – Average



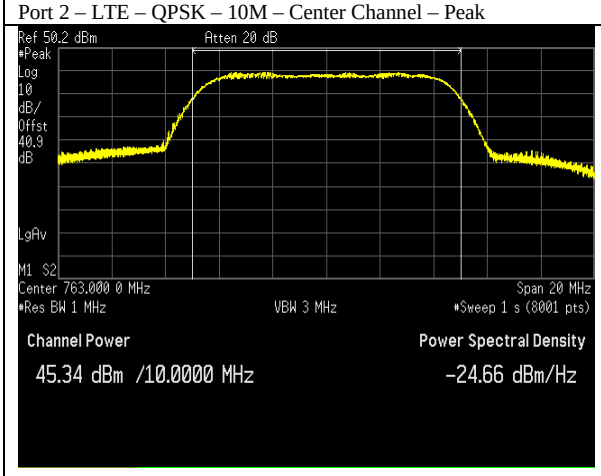
Port 1 – LTE – 64QAM – 10M – Center Channel – Peak



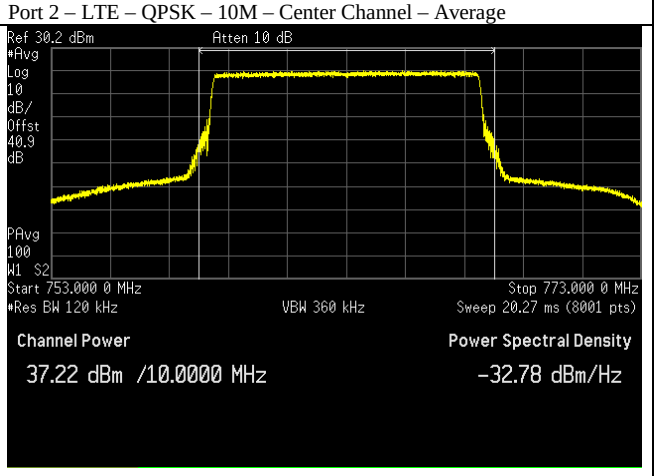
Port 1 – LTE – 64QAM – 10M – Center Channel – Average



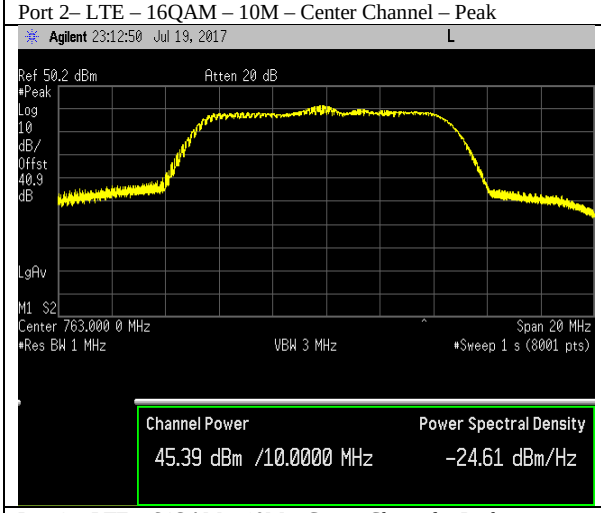
Port 2 – LTE – QPSK – 10M – Center Channel – Peak



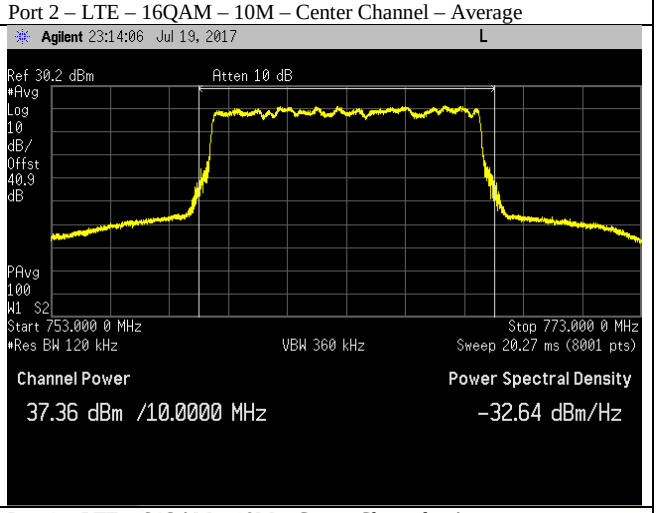
Port 2 – LTE – QPSK – 10M – Center Channel – Average



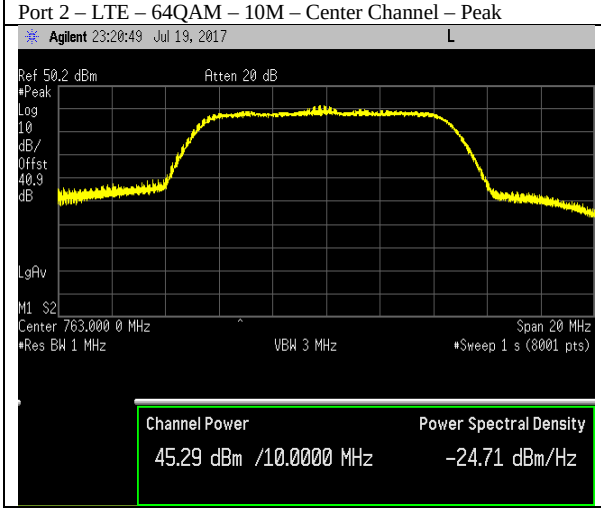
Port 2– LTE – 16QAM – 10M – Center Channel – Peak



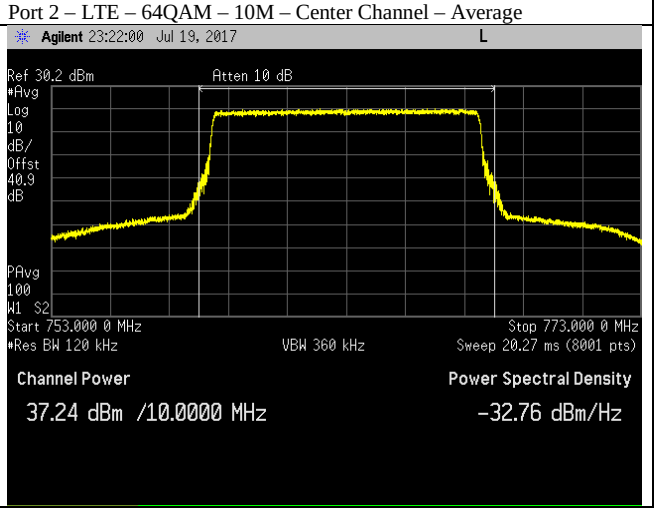
Port 2 – LTE – 16QAM – 10M – Center Channel – Average



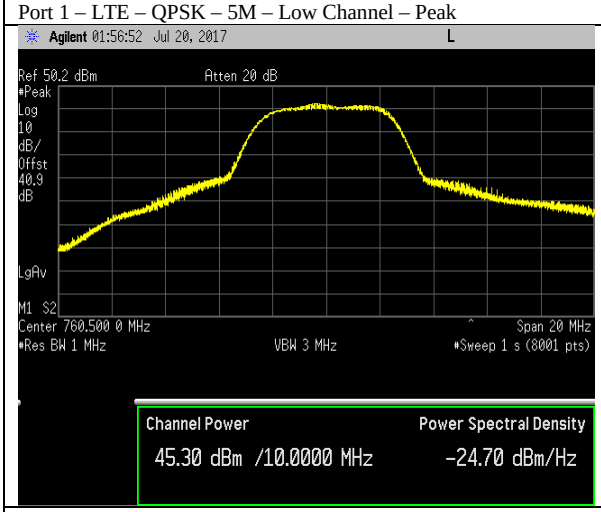
Port 2 – LTE – 64QAM – 10M – Center Channel – Peak



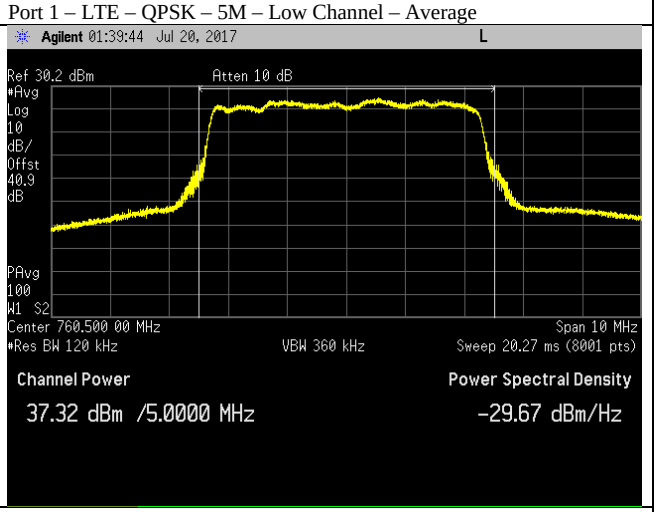
Port 2 – LTE – 64QAM – 10M – Center Channel – Average



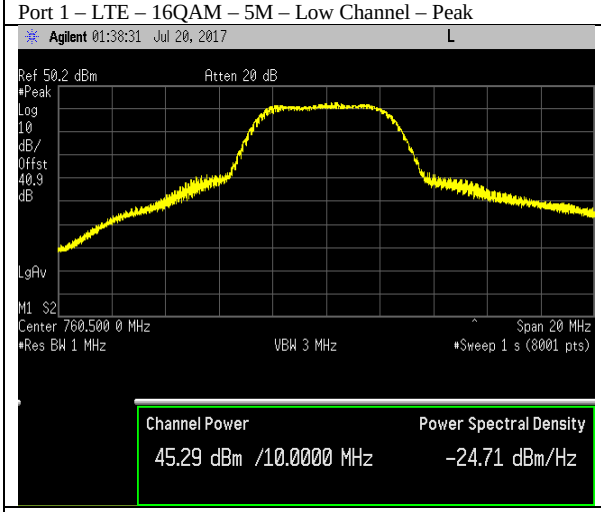
Port 1 – LTE – QPSK – 5M – Low Channel – Peak



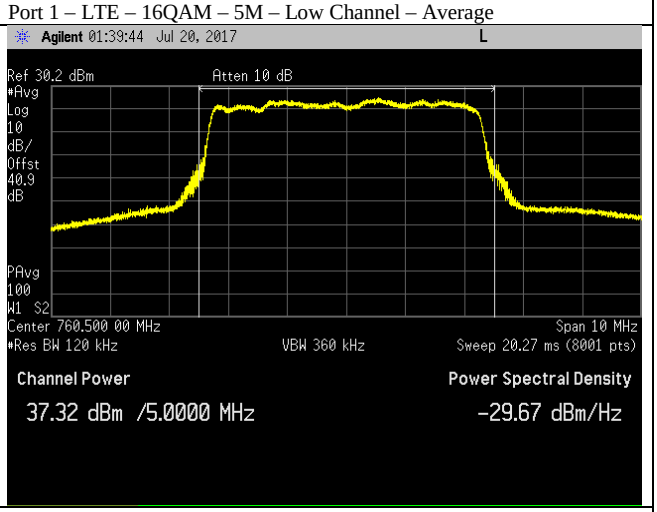
Port 1 – LTE – QPSK – 5M – Low Channel – Average



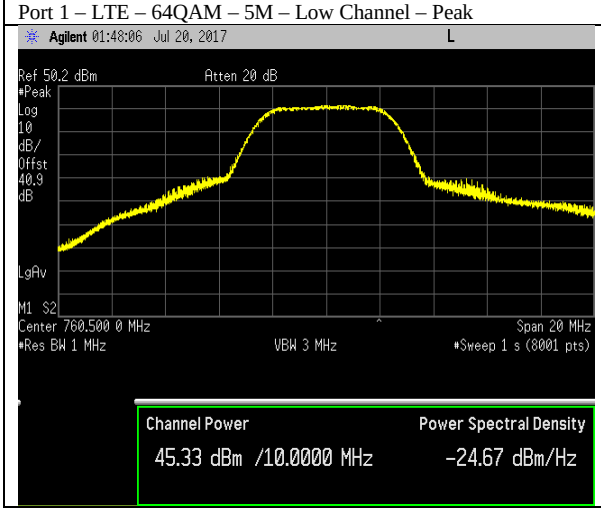
Port 1 – LTE – 16QAM – 5M – Low Channel – Peak



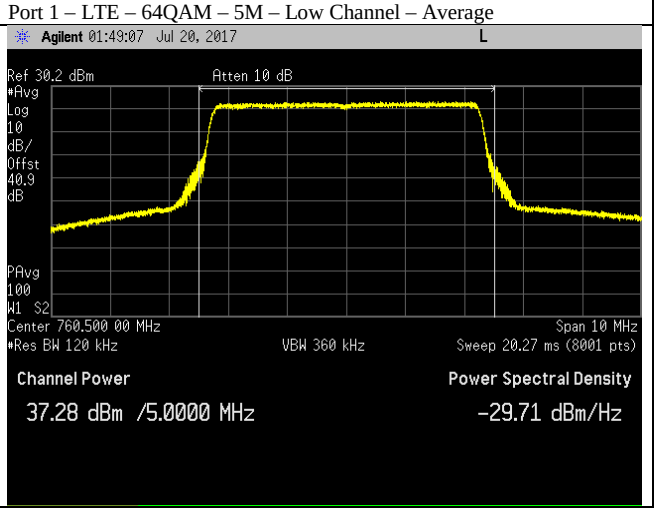
Port 1 – LTE – 16QAM – 5M – Low Channel – Average



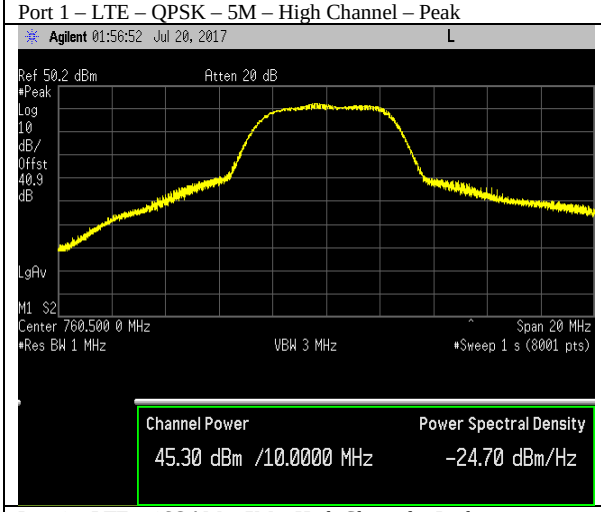
Port 1 – LTE – 64QAM – 5M – Low Channel – Peak



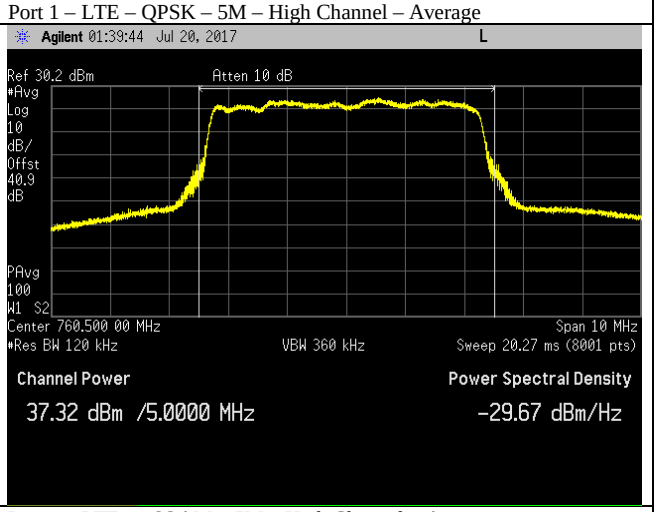
Port 1 – LTE – 64QAM – 5M – Low Channel – Average



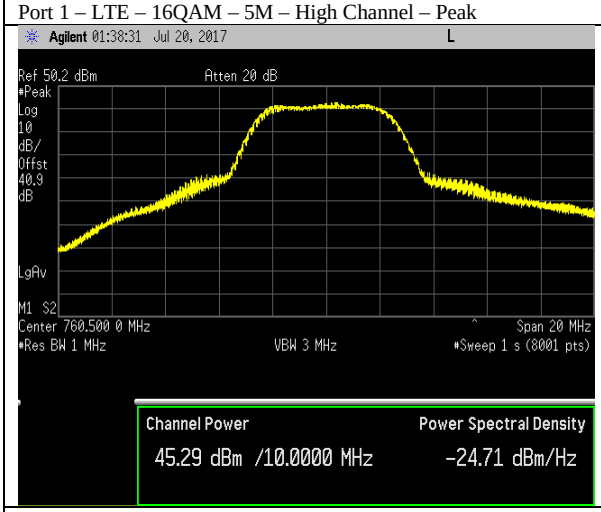
Port 1 – LTE – QPSK – 5M – High Channel – Peak



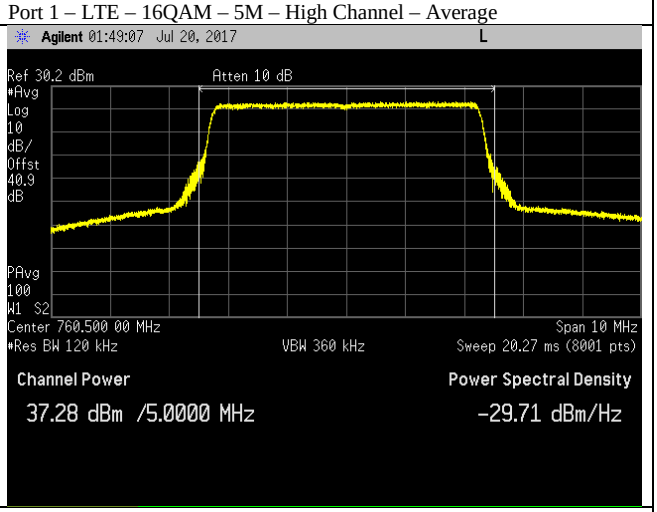
Port 1 – LTE – QPSK – 5M – High Channel – Average



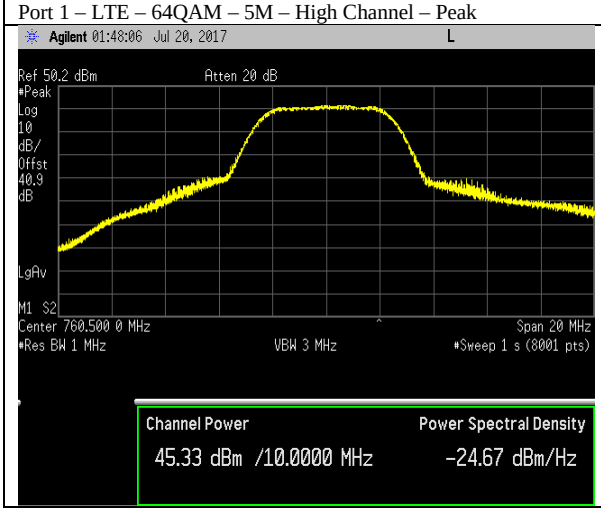
Port 1 – LTE – 16QAM – 5M – High Channel – Peak



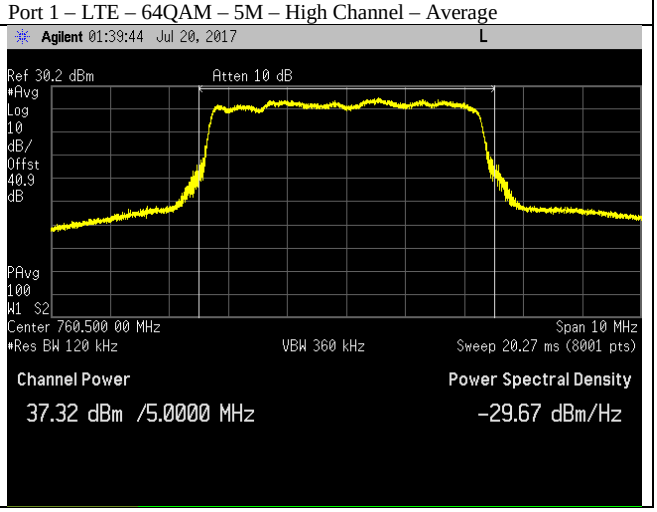
Port 1 – LTE – 16QAM – 5M – High Channel – Average



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



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



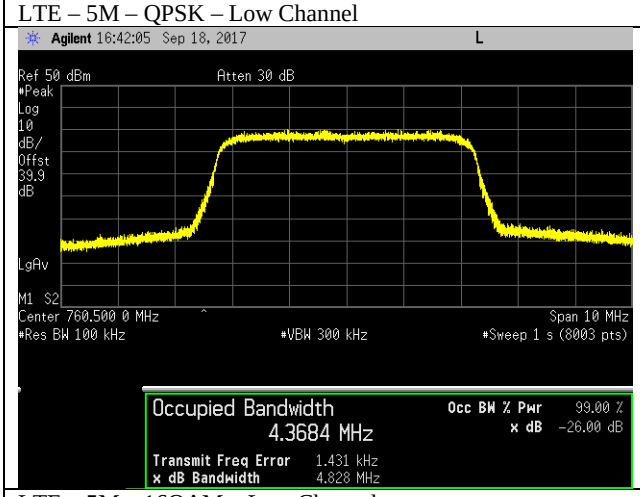
Emission Bandwidths (26dB and 99%)

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

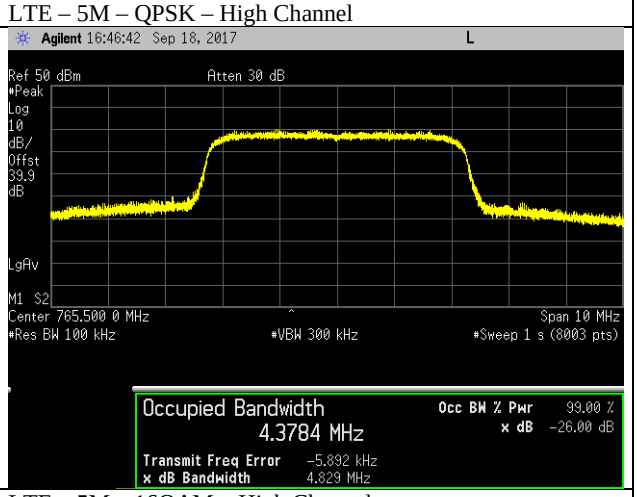
	LTE - QPSK						LTE - 16QAM						LTE - 64QAM					
	Low		Mid		High		Low		Mid		High		Low		Mid		High	
	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)
5M	4.828	4.3684	4.845	4.3796	4.829	4.3784	4.829	4.3608	4.824	4.3464	4.79	4.3396	4.856	4.3766	4.886	4.3727	4.852	4.3777
10M			9.476	8.764					9.473	8.7881					9.507	8.7797		

Corresponding plots included on the following pages.

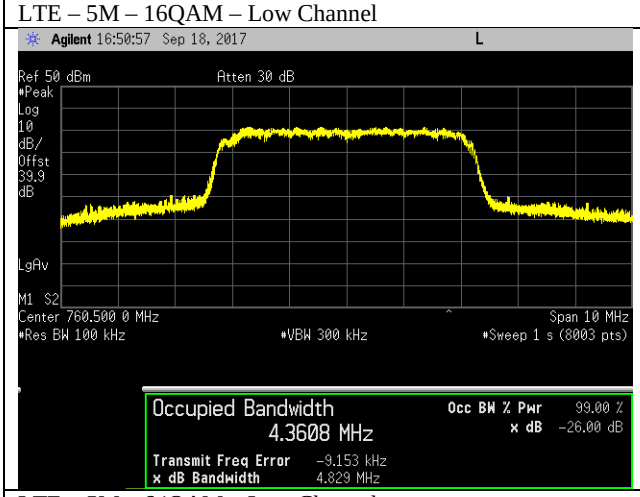
LTE – 5M – QPSK – Low Channel



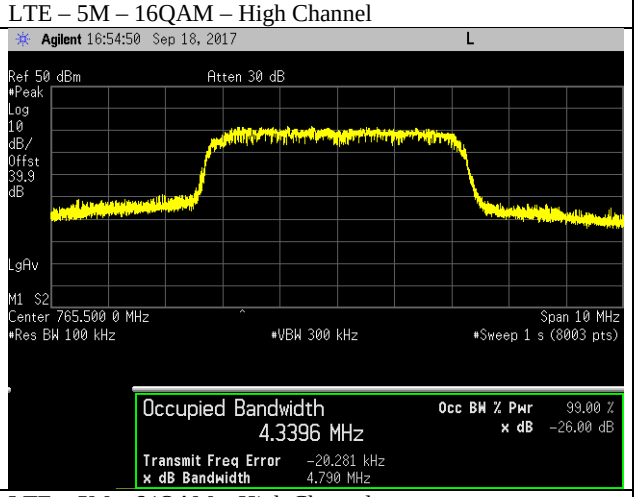
LTE – 5M – QPSK – High Channel



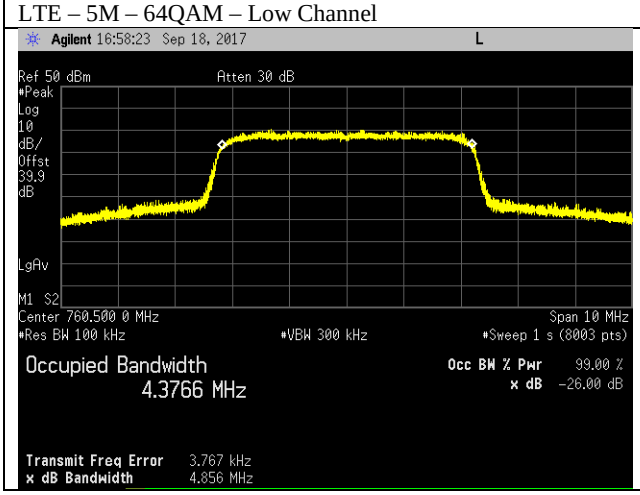
LTE – 5M – 16QAM – Low Channel



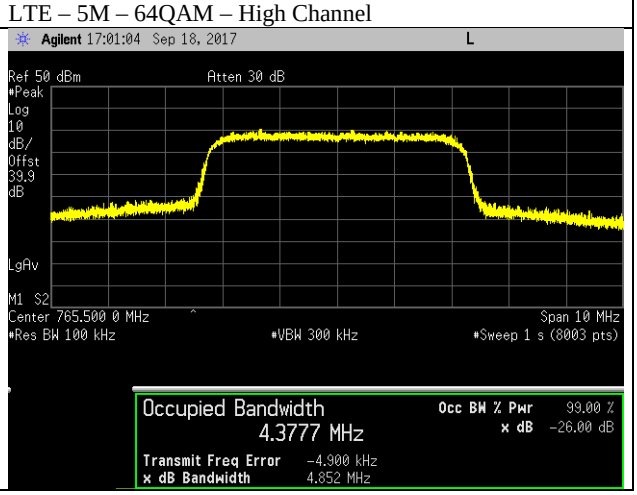
LTE – 5M – 16QAM – High Channel



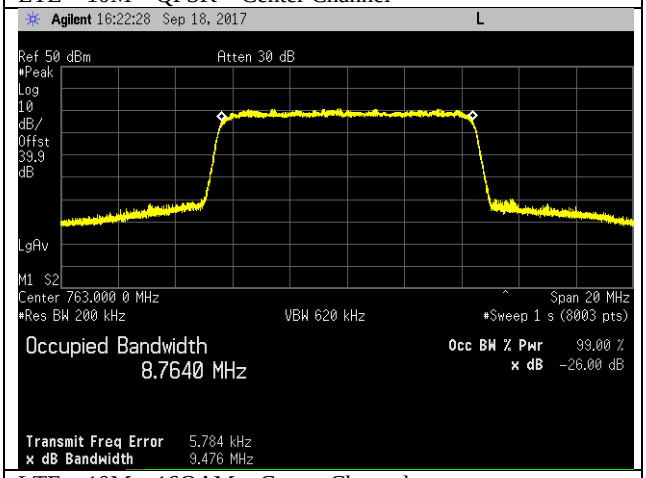
LTE – 5M – 64QAM – Low Channel



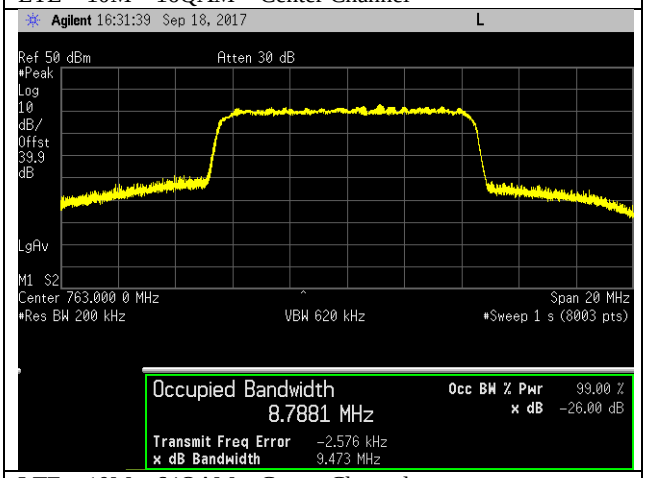
LTE – 5M – 64QAM – High Channel



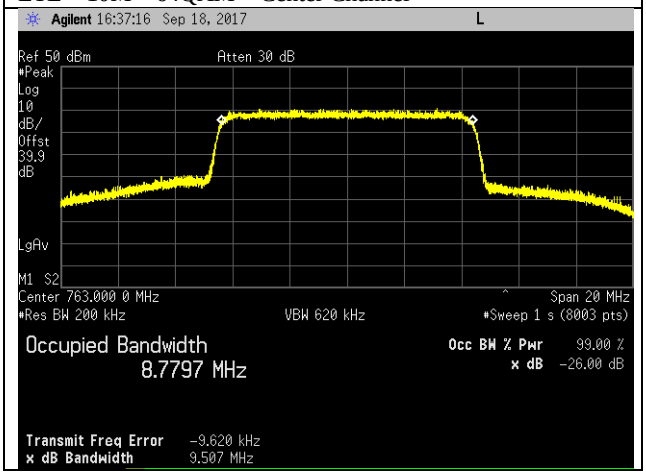
LTE – 10M – QPSK – Center Channel



LTE – 10M – 16QAM – Center Channel



LTE – 10M – 64QAM – Center Channel



Antenna Port Conducted Bandedge

Limits below reflect reduction by 10*log(2) per FCC KDB 662911D01 v02r01 due to 2x2 MIMO operation.

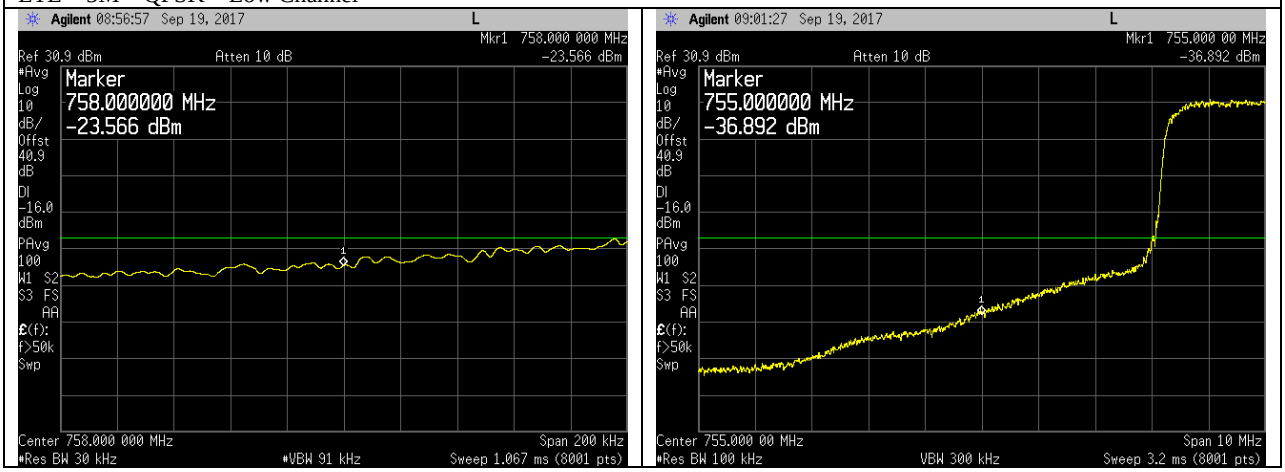
In 10MHz mode there is only once channel to which we tested the low and high bandedge. In 5MHz channel bandwidth mode, we used the low and high channels to test their respective bandedges.

Results summary:

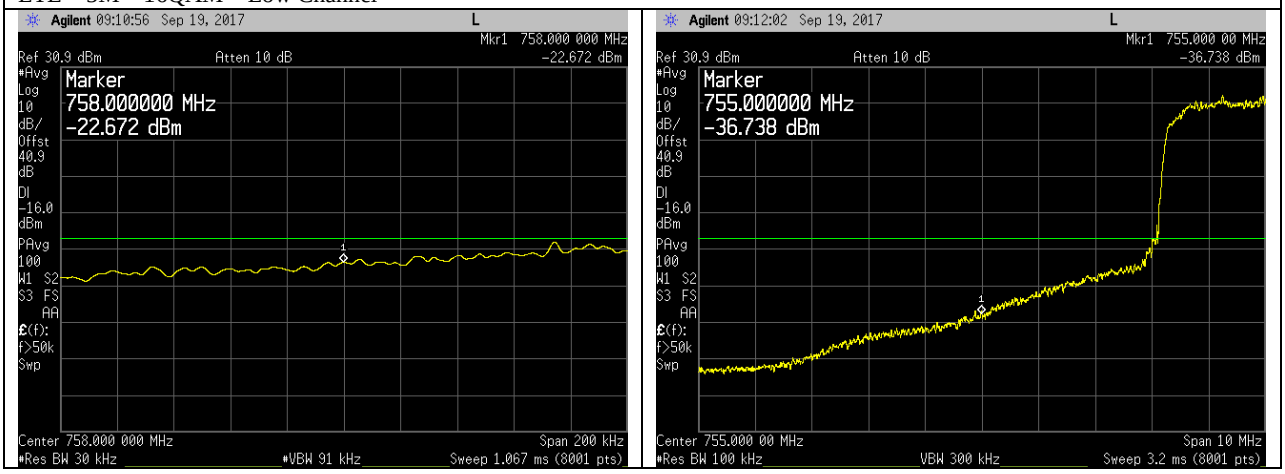
	LTE - QPSK		LTE - 16QAM		LTE - 64QAM	
	Low	High	Low	High	Low	High
	Power (dBm)	Power (dBm)	Power (dBm)	Power (dBm)	Power (dBm)	Power (dBm)
5M	-23.566	-22.934	-22.672	-21.434	-22.385	-22.243
10M	-30.363	-31.521	-30.755	-31.28	-30.657	-31.478

Measurements were performed at Port 1 in RMS average mode over 100 traces. In 4MHz bands immediately outside and adjacent to the frequency blocks, RBW was reduced to 1% of the emission bandwidth. For all measurements insertion losses were factored in via reference level offset to the spectrum analyzer and settings are shown on corresponding plots on the following pages.

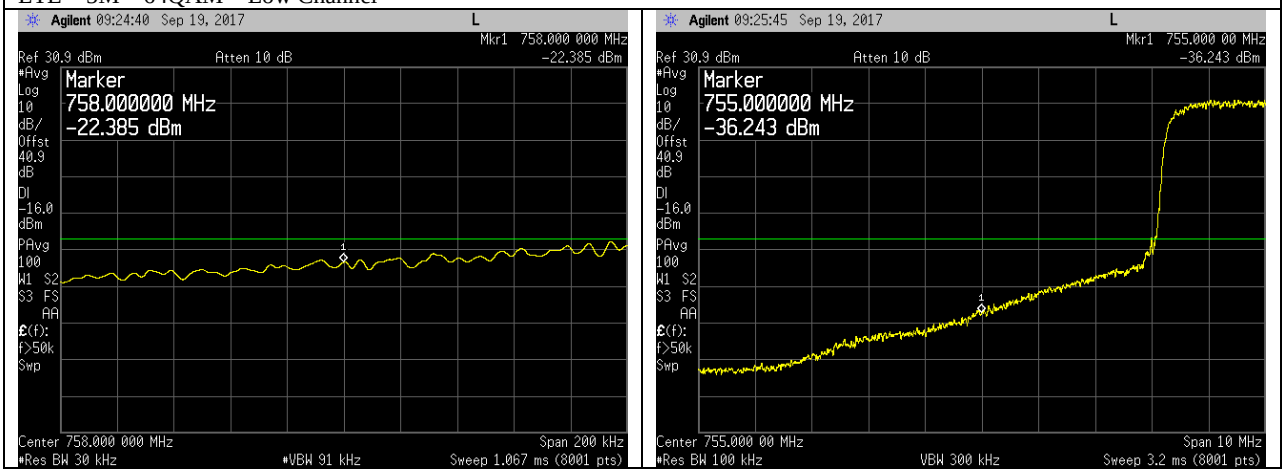
LTE – 5M – QPSK – Low Channel



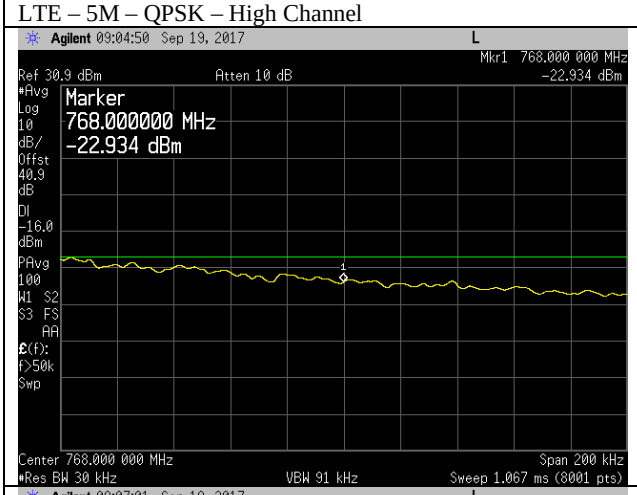
LTE – 5M – 16QAM – Low Channel

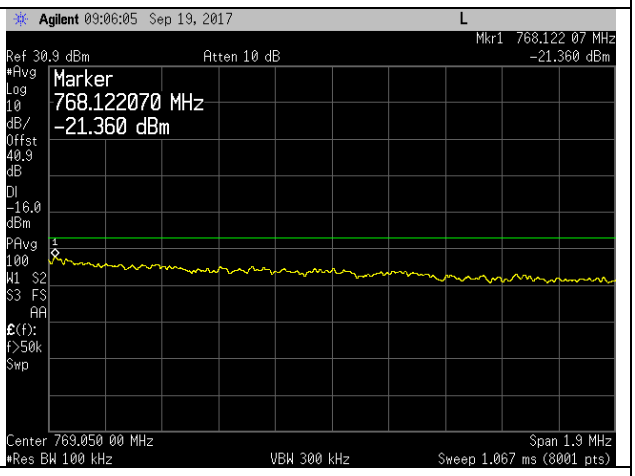


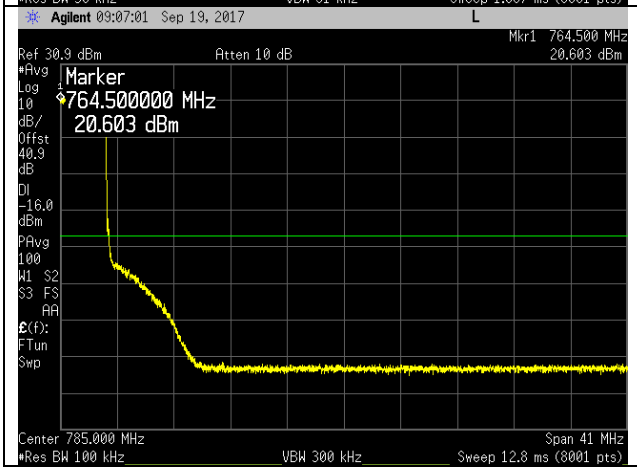
LTE – 5M – 64QAM – Low Channel



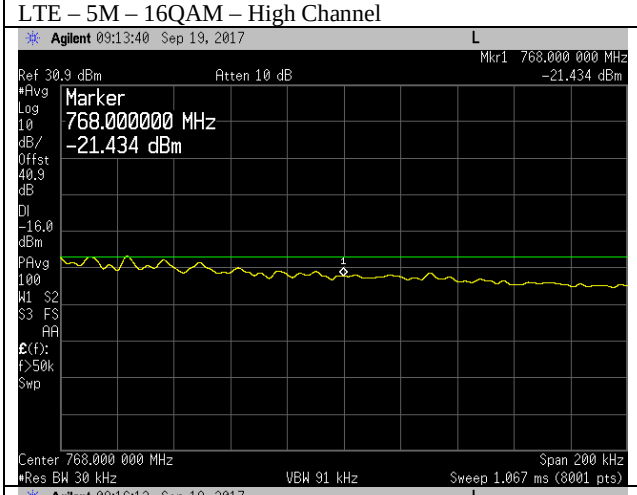
LTE – 5M – QPSK – High Channel

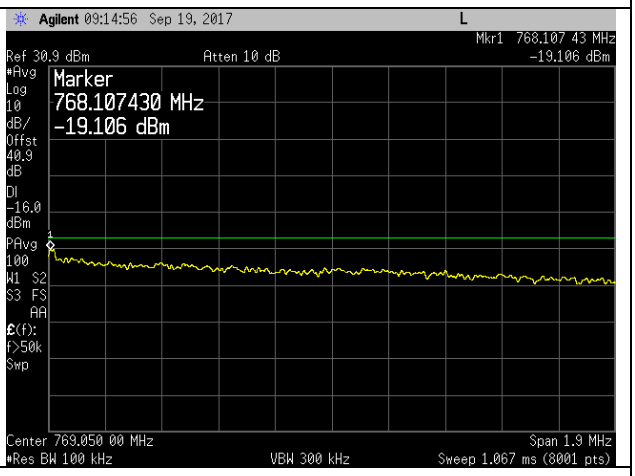


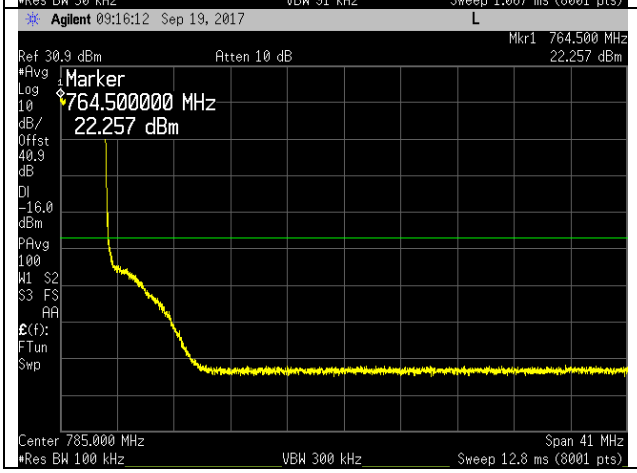




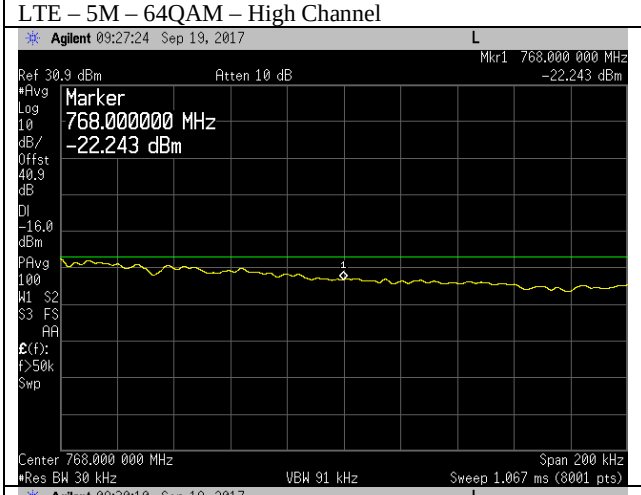
LTE – 5M – 16QAM – High Channel

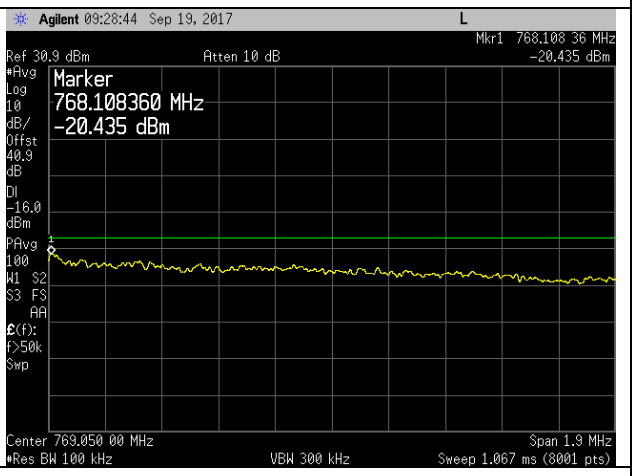


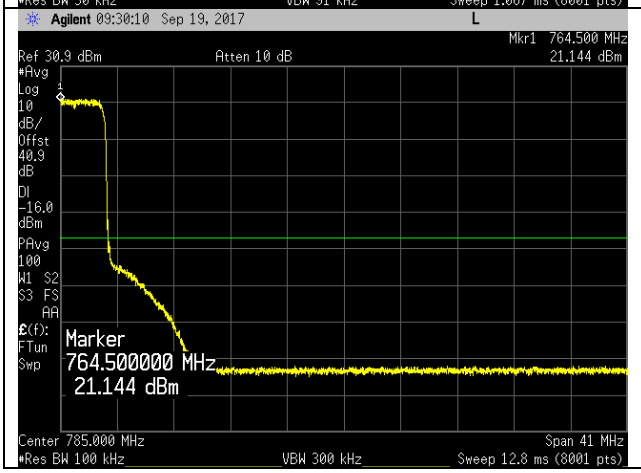




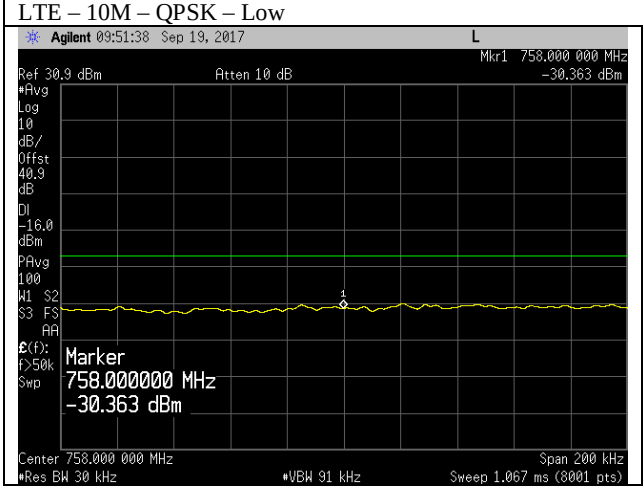
LTE – 5M – 64QAM – High Channel

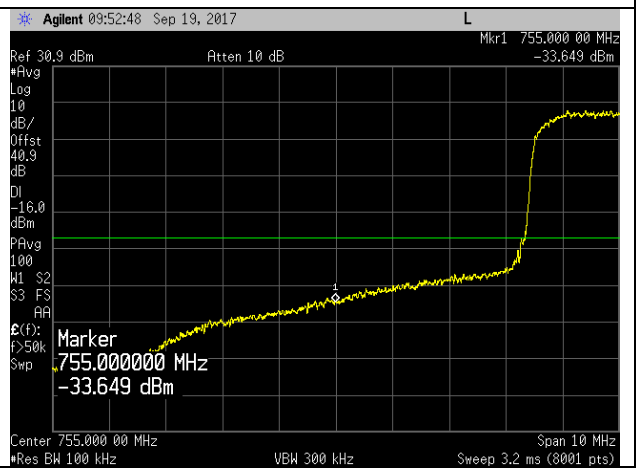




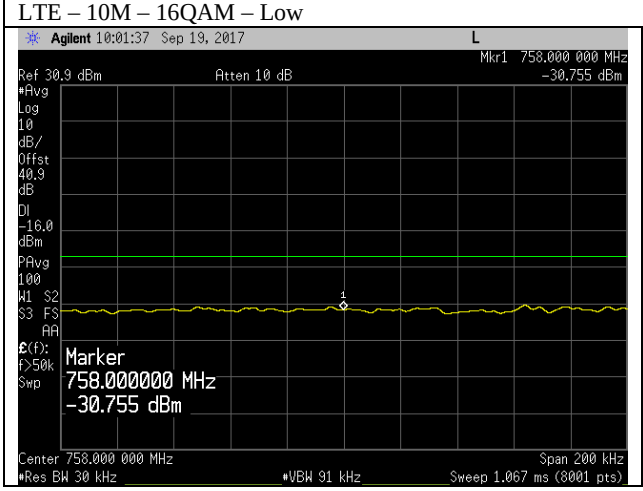


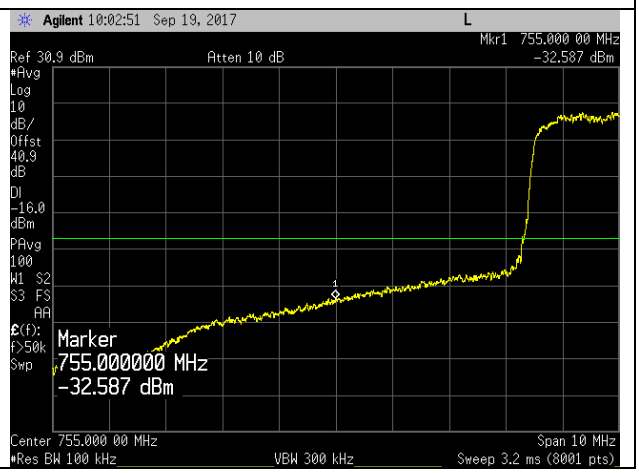
LTE – 10M – QPSK – Low



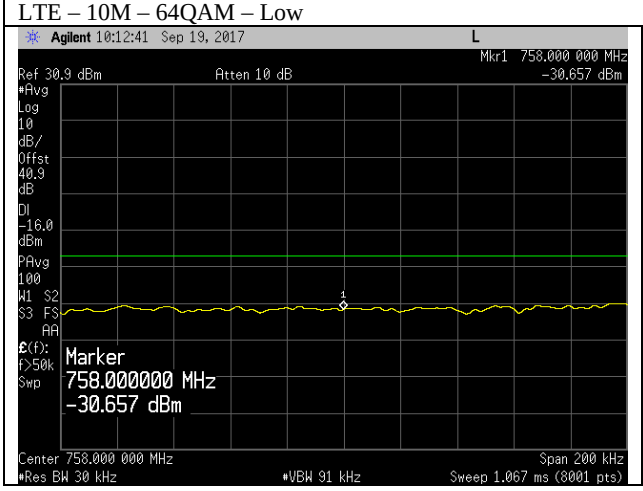


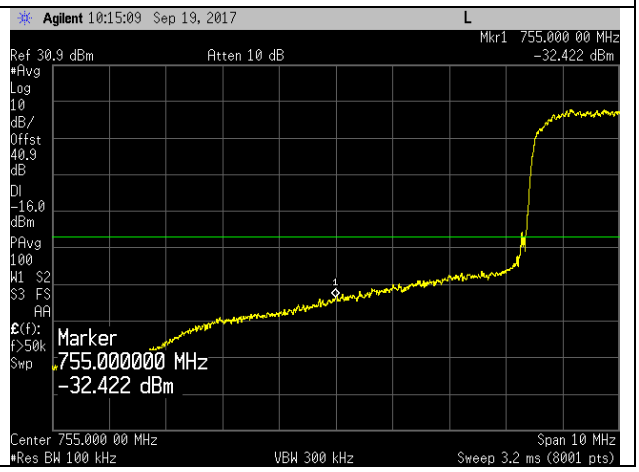
LTE – 10M – 16QAM – Low



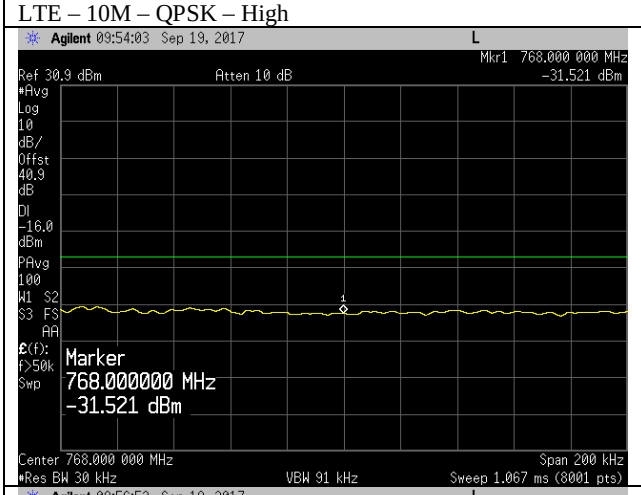


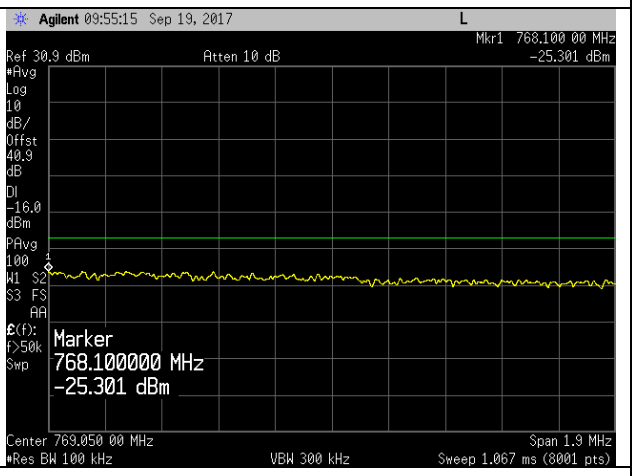
LTE – 10M – 64QAM – Low

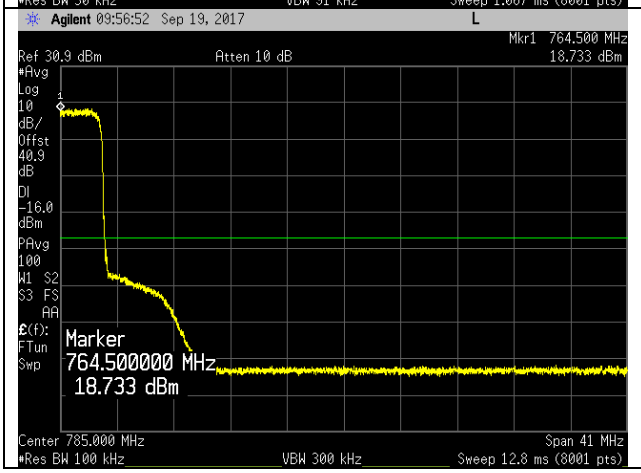




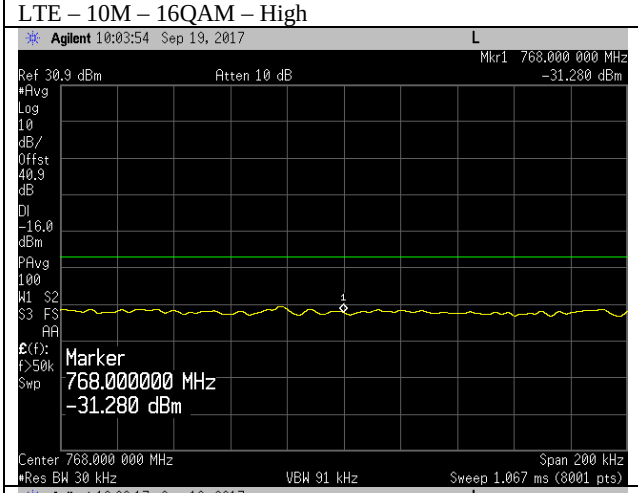
LTE – 10M – QPSK – High

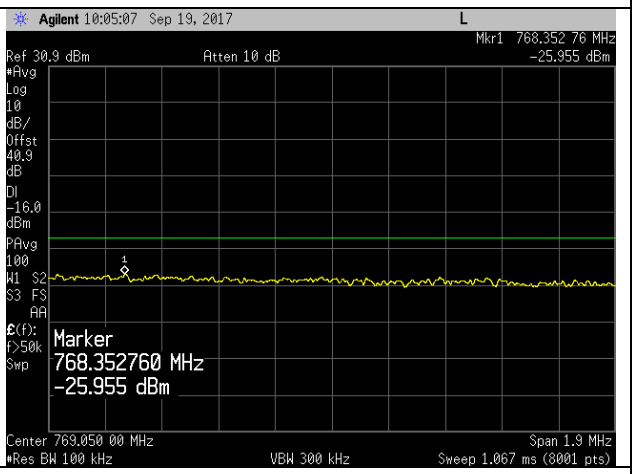


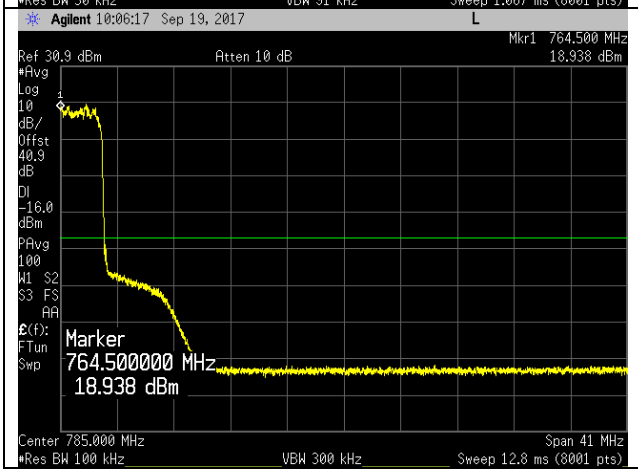




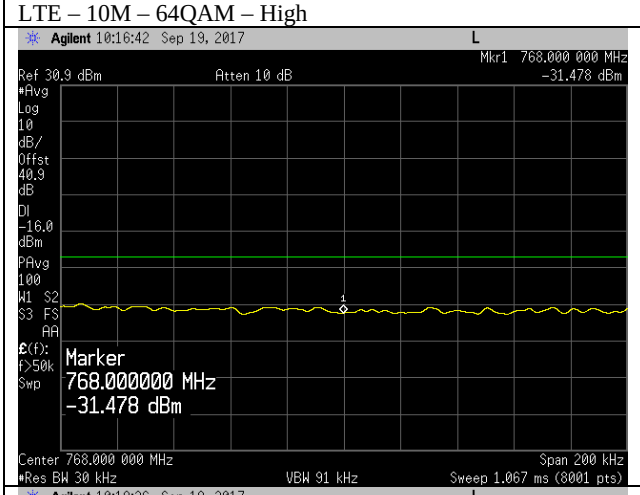
LTE – 10M – 16QAM – High

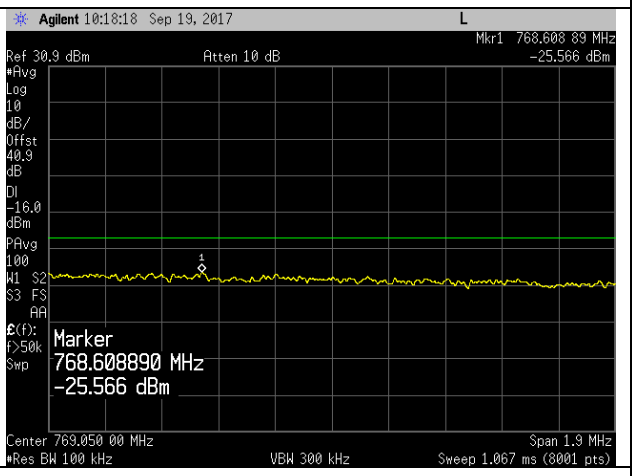


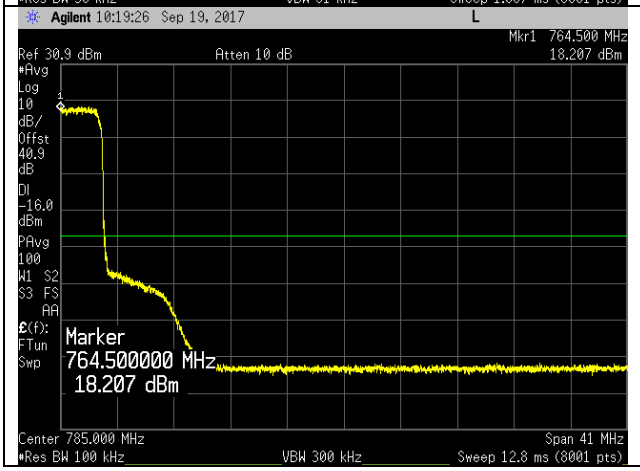




LTE – 10M – 64QAM – High







Transmitter Antenna Port Conducted Spurious Emissions

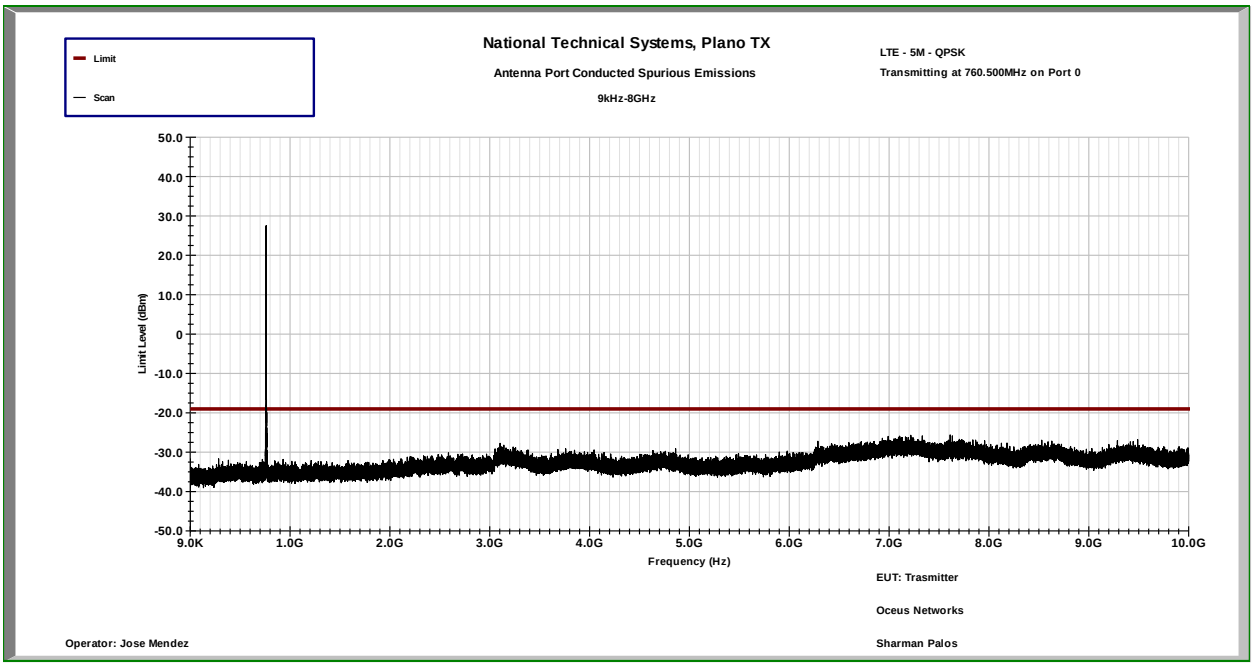
Tests performed at Port 1 on center channel for all modulations and bandwidth modes. Due to 2x2 MIMO operation, limit is -16.01dBm (-13dBm – 10*log(2)) per FCC KDB 662911D01 v02r01.

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

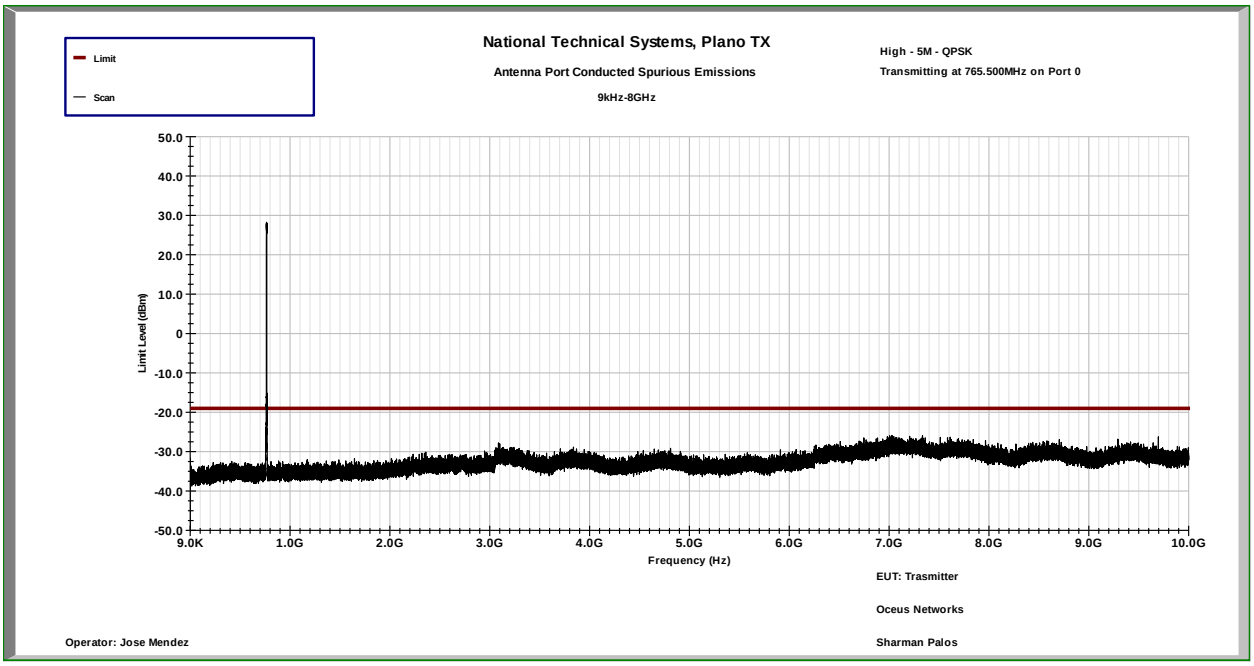
Frequency Range	**RBW**	**VBW**	**Number of data points**	**Divided into**	**Detector**	**Sweep Time**	**Max hold over**
9kHz-150kHz	1kHz	3kHz	8000	1 segment	Peak	Auto	50 sweeps
150kHz-1.5MHz	100kHz	300kHz	8000	1 segments	Peak	Auto	50 sweeps
1.5MHz-5GHz	1MHz	3MHz	8000	3 segments	Peak	Auto	50 sweeps
5GHz-10GHz	1MHz	3MHz	8000	10 segments	Peak	Auto	50 sweeps

Corresponding plots are included on the following pages.

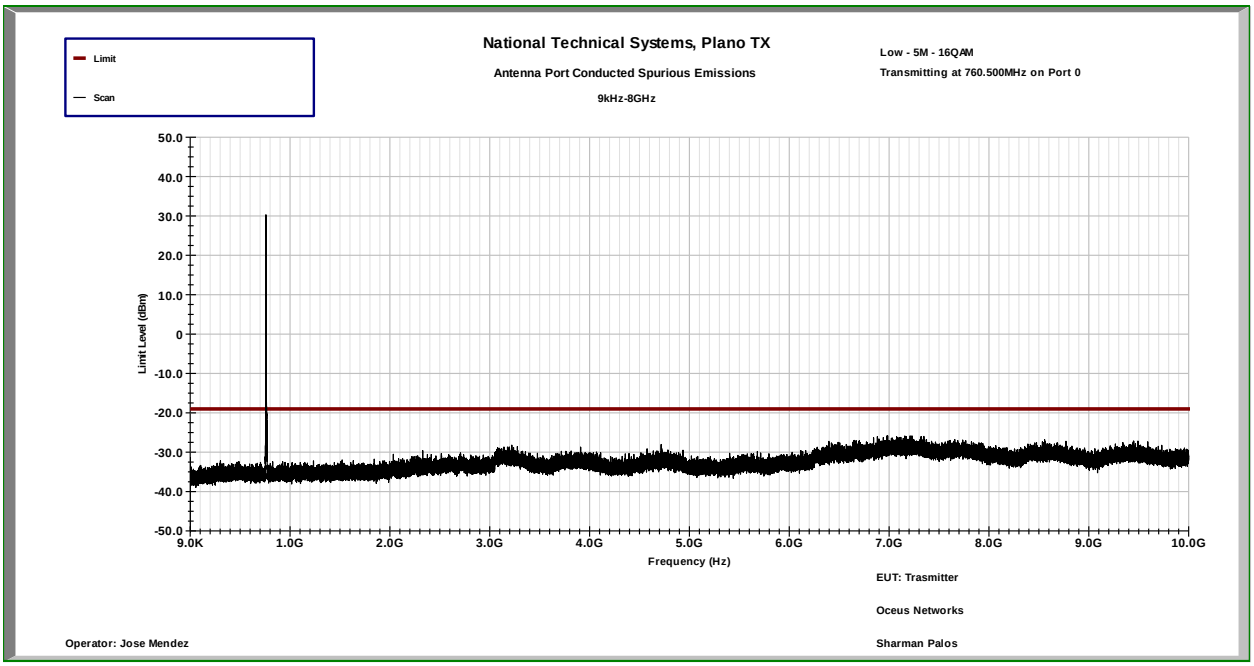
5M – LTE – QPSK – Low Channel



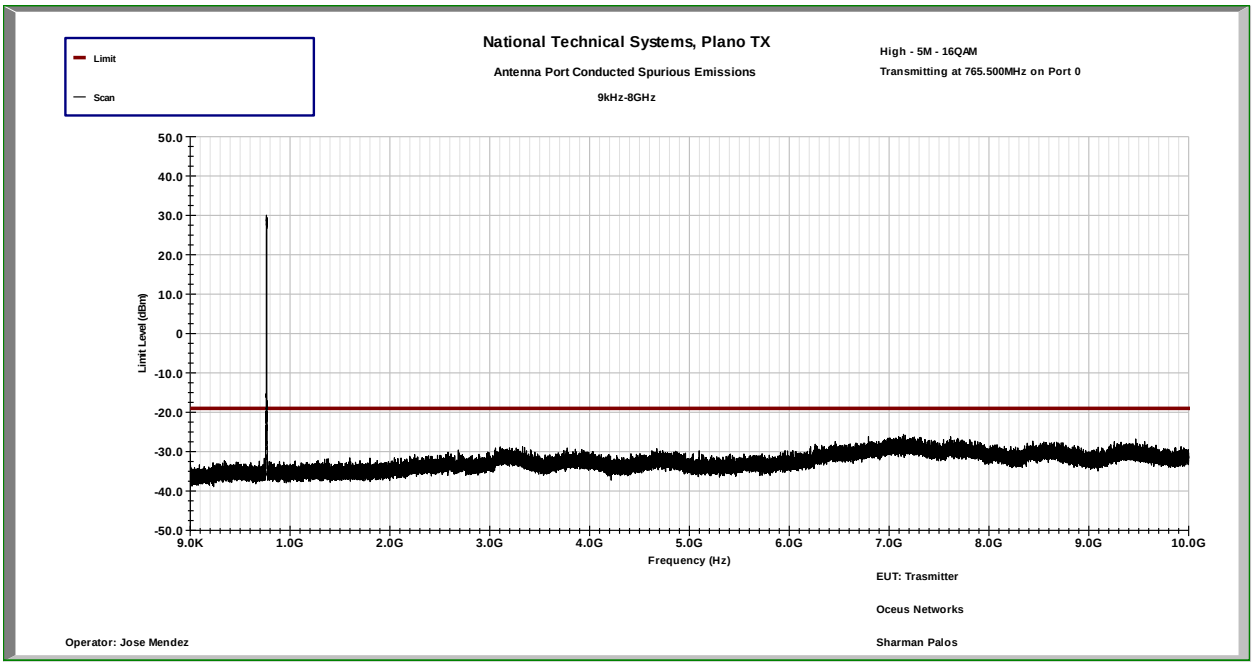
5M – LTE – QPSK – High Channel



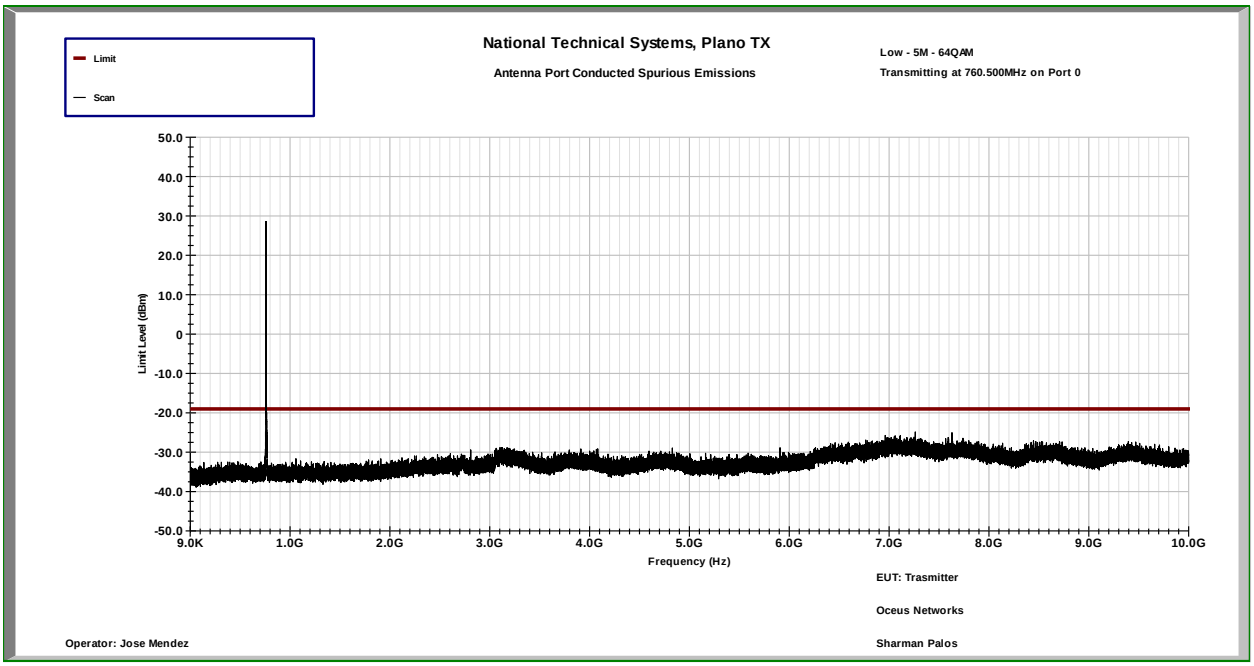
5M – LTE – 16QAM – Low Channel



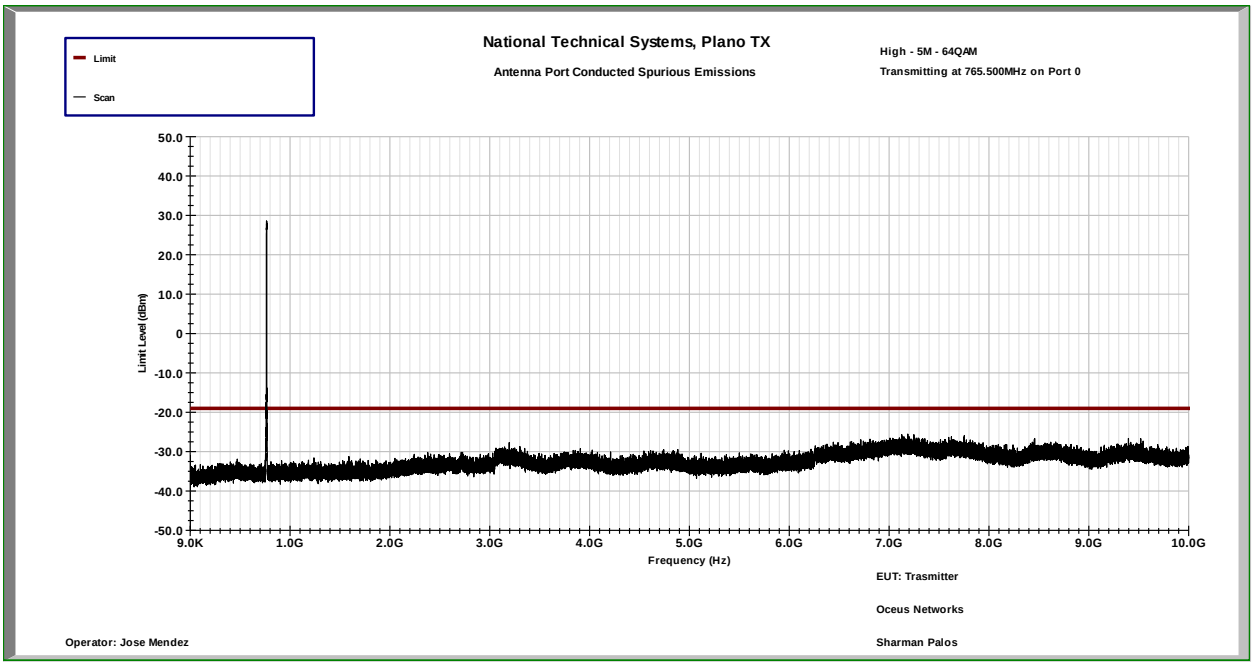
5M – LTE – 16QAM – High Channel



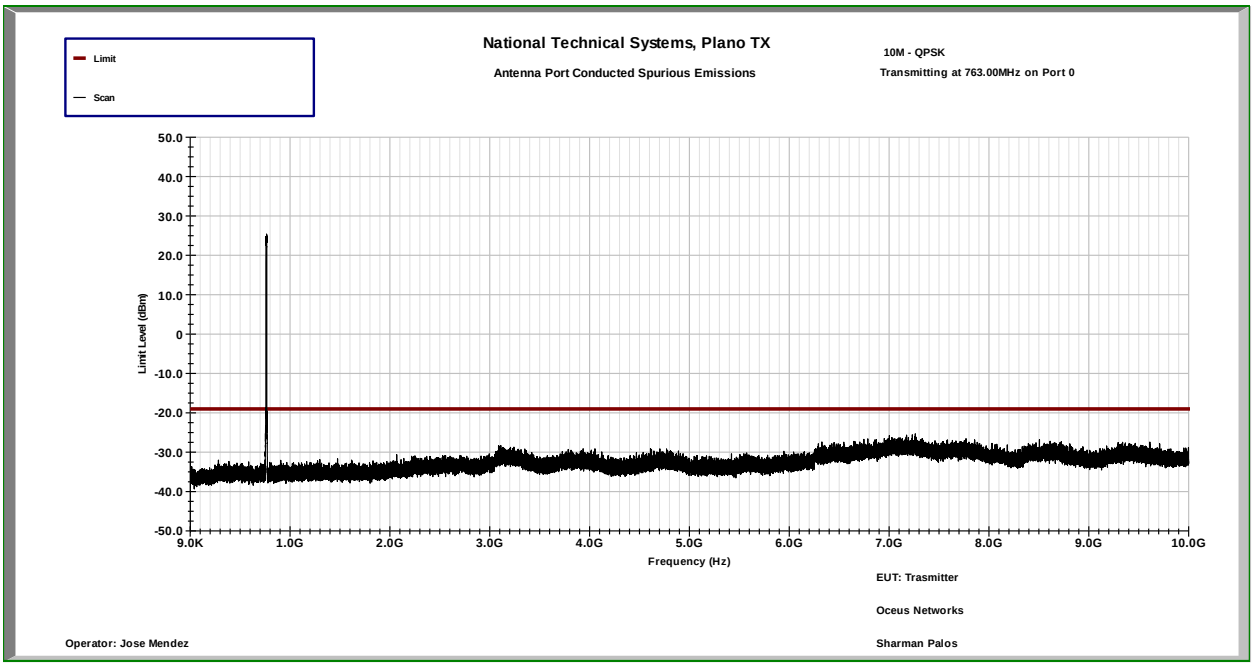
5M – LTE – 64QAM – Low Channel



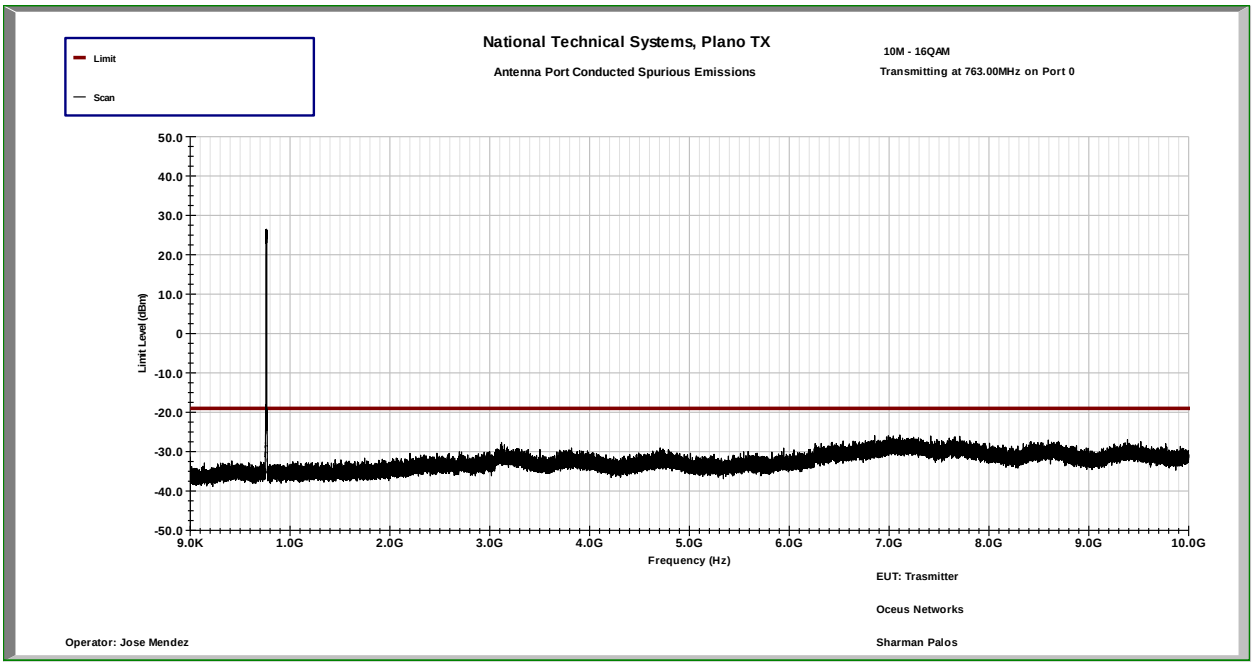
5M – LTE – 64QAM – High Channel



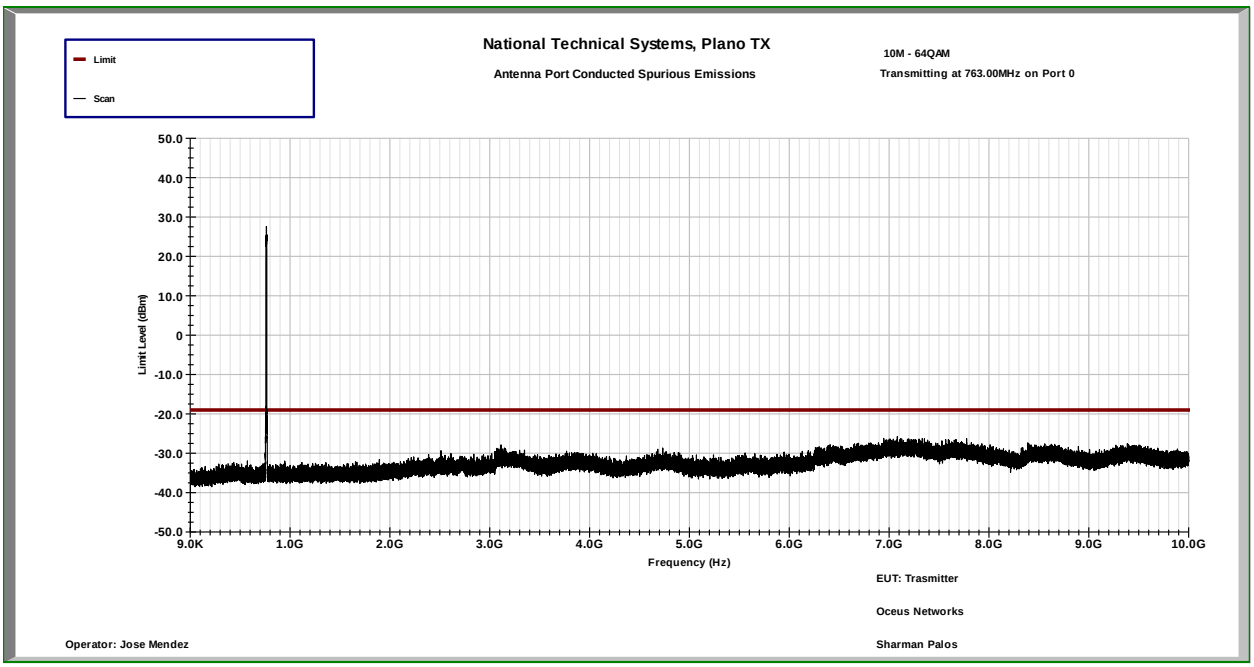
10M – LTE – QPSK – Center Channel (763MHz)



10M – LTE – 16QAM – Center Channel (763MHz)



10M – LTE – 64QAM – Center Channel (763MHz)



The FCC section 90.543(e)(2) requires an emission limit of -35dBm for any 6.25 kHz bandwidth (i.e.: 65 + 10logP) between frequency bands 769-775 MHz and 799-805 MHz.
Adjusting for the two port MIMO requirement the emission limit in these frequency ranges is -38 dBm [i.e.: Limit = -35 dBm/6.25kHz (FCC Limit) – 3dB (2 port MIMO)].

The FCC section 90.543(f) EIRP limit in 1559 to 1610 MHz frequency band is -70dBW/MHz for wideband signals and -80dBW for discrete emissions of bandwidths less than 700Hz. This equates to an EIRP of -40dBm/MHz for wideband emissions and -50dBm/MHz for discrete emissions. Adjusting for two port MIMO (-3dB) the emission limit is -43dBm/MHz for wideband emissions and -53dBm/MHz for discrete emissions.

In 5MHz channel bandwidth mode, low and high channels configurations were tested. In 10MHz channel bandwidth mode, unit can only operate at the center channel.

Measurements were made for three frequency ranges; FR1 at 769MHz to 775MHz, FR2 at 799MHz to 805MHz and FR3 at 1559MHz to 1610MHz.

Results summary:

	LTE - QPSK (dBm)			LTE - 16QAM (dBm)			LTE - 64QAM (dBm)		
	FR1	FR2	FR3	FR1	FR2	FR3	FR1	FR2	FR3
5M	-38.005	-73.745	-81.13	-38.033	-73.366	-82.881	-38.625	-73.566	-81.344
10M	-38.358	-73.442	-81.296	-38.087	-73.383	-83.16	-38.234	-73.449	-81.153

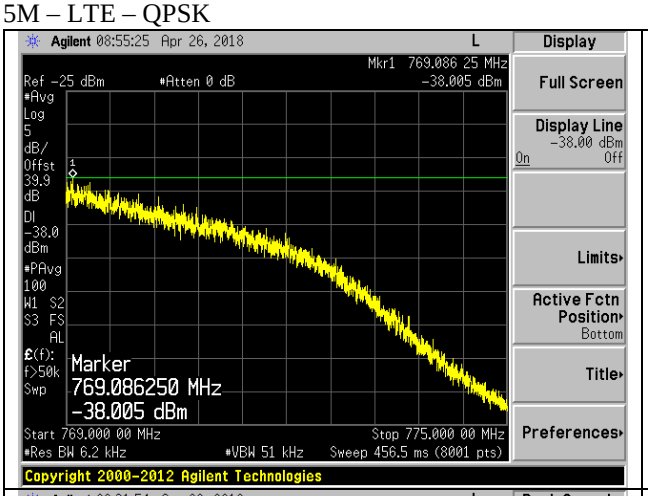
For FR1, the measurements were performed in RMS average mode with 6.25kHz RBW and 51kHz VBW over 100 traces. The total path loss of 39.9 dB was accounted for via reference level offset of the spectrum analyzer.

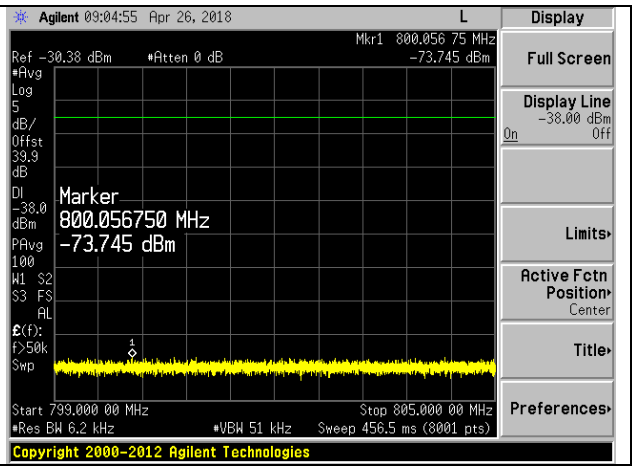
For FR2, the measurements were performed in RMS average mode with 6.25kHz RBW and 51kHz VBW over 100 traces. The total path loss of 39.9 dB was accounted for via reference level offset of the spectrum analyzer.

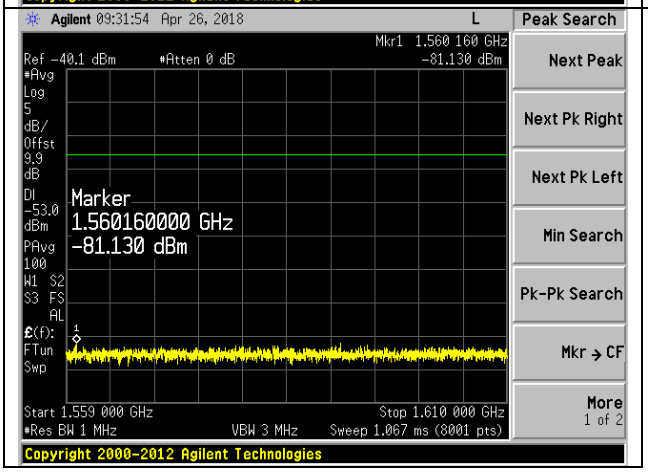
For FR3, the measurements were performed in RMS average mode with 1MHz RBW and 3MHz VBW over 100 traces. In order to reduce instrumentation noise floor a carrier blocking filter with a 10dB attenuator was used. The total path loss of 9.9dB was accounted for via reference level offset of the spectrum analyzer.

All corresponding plots are included on the following pages.

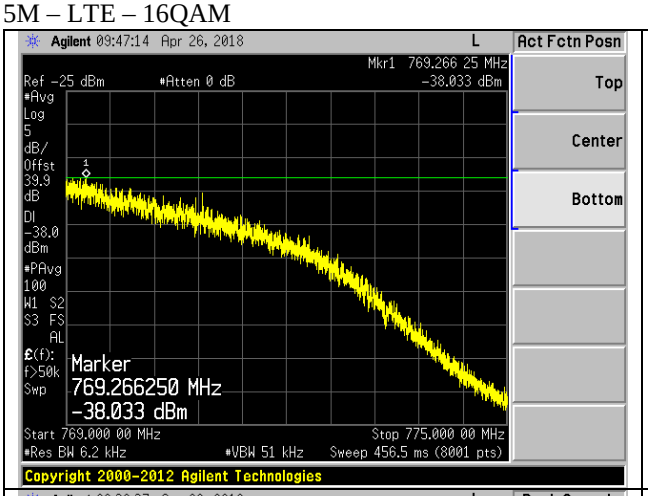
5M – LTE – QPSK

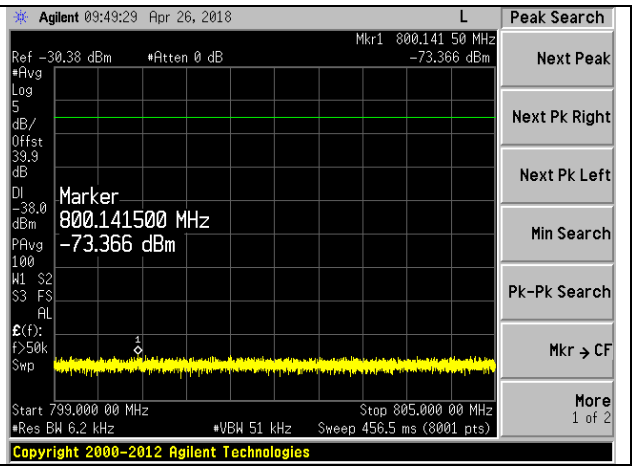

Agilent 08:55:25 Apr 26, 2018
L
Mkr1 769.086 25 MHz
Ref -25 dBm
#Atten 0 dB
-38.005 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Dl
-38.0
dBm
#PAvg
100
W1 S2
S3 FS
AL
£(f):
f>50k
Swp
Marker
769.086250 MHz
-38.005 dBm
Start 769.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Stop 775.000 00 MHz
Sweep 456.5 ms (8001 pts)
Copyright 2000-2012 Agilent Technologies
Display
Full Screen
Display Line
-38.00 dBm
On Off
Limits
Active Fctn
Position
Bottom
Title
Preferences

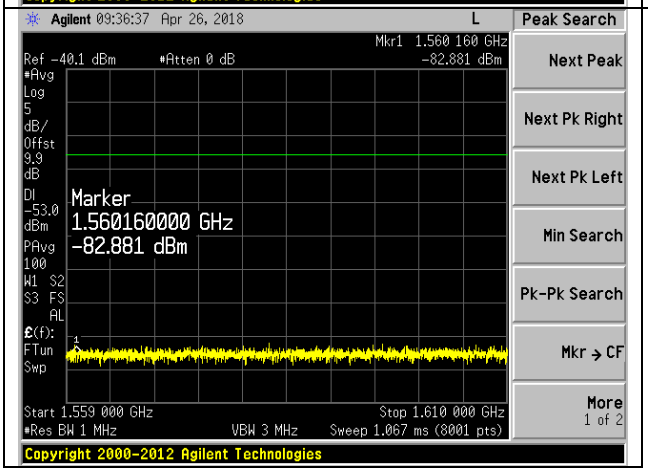

Agilent 09:04:55 Apr 26, 2018
L
Mkr1 800.056 75 MHz
Ref -30.38 dBm
#Atten 0 dB
-73.745 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Dl
-38.0
dBm
PAvg
100
W1 S2
S3 FS
AL
£(f):
f>50k
Swp
Marker
800.056750 MHz
-73.745 dBm
Start 799.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Stop 805.000 00 MHz
Sweep 456.5 ms (8001 pts)
Copyright 2000-2012 Agilent Technologies
Display
Full Screen
Display Line
-38.00 dBm
On Off
Limits
Active Fctn
Position
Center
Title
Preferences


Agilent 09:31:54 Apr 26, 2018
L
Mkr1 1.560 160 GHz
Ref -40.1 dBm
#Atten 0 dB
-81.130 dBm
#Avg
Log
5
dB/
Offst
9.9
dB
Dl
-53.0
dBm
PAvg
100
W1 S2
S3 FS
AL
£(f):
FTun
Swp
Marker
1.560160000 GHz
-81.130 dBm
Start 1.559 000 GHz
#Res BW 1 MHz
VBW 3 MHz
Stop 1.610 000 GHz
Sweep 1.067 ms (8001 pts)
Copyright 2000-2012 Agilent Technologies
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2

5M – LTE – 16QAM


Agilent 09:47:14 Apr 26, 2018
L
Act Fctn Posn
Mkr1 769.266 25 MHz
Ref -25 dBm
#Atten 0 dB
-38.033 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Dl
-38.0
dBm
#PAvg
100
W1 S2
S3 FS
AL
£(f):
f>50k
Swp
Marker
769.266250 MHz
-38.033 dBm
Start 769.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Sweep 456.5 ms (8001 pts)
Stop 775.000 00 MHz
Top
Center
Bottom
Copyright 2000-2012 Agilent Technologies


Agilent 09:49:29 Apr 26, 2018
L
Peak Search
Mkr1 800.141 50 MHz
Ref -30.38 dBm
#Atten 0 dB
-73.366 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Dl
-38.0
dBm
PAvg
100
W1 S2
S3 FS
AL
£(f):
f>50k
Swp
Marker
800.141500 MHz
-73.366 dBm
Start 799.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Sweep 456.5 ms (8001 pts)
Stop 805.000 00 MHz
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Copyright 2000-2012 Agilent Technologies


Agilent 09:36:37 Apr 26, 2018
L
Peak Search
Mkr1 1.560 160 GHz
Ref -40.1 dBm
#Atten 0 dB
-82.881 dBm
#Avg
Log
5
dB/
Offst
9.9
dB
Dl
-53.0
dBm
PAvg
100
W1 S2
S3 FS
AL
£(f):
FTun
Swp
Marker
1.560160000 GHz
-82.881 dBm
Start 1.559 000 GHz
#Res BW 1 MHz
VBW 3 MHz
Sweep 1.067 ms (8001 pts)
Stop 1.610 000 GHz
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
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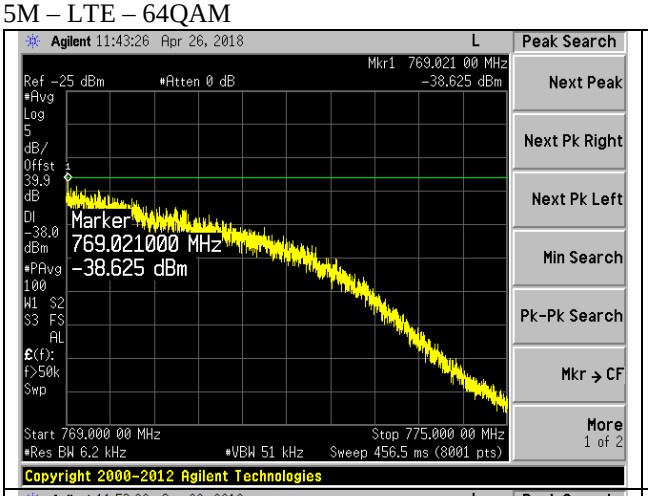
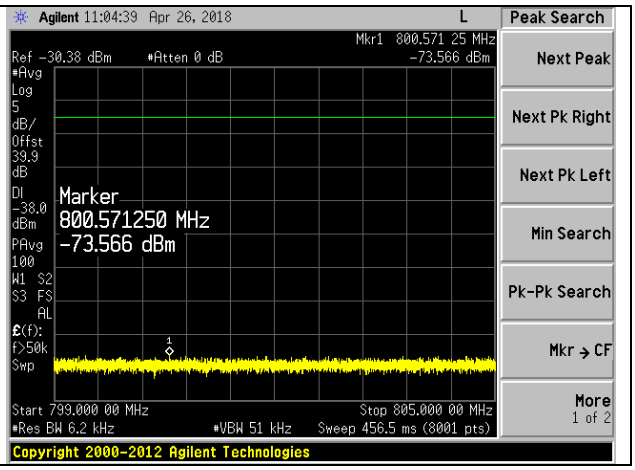
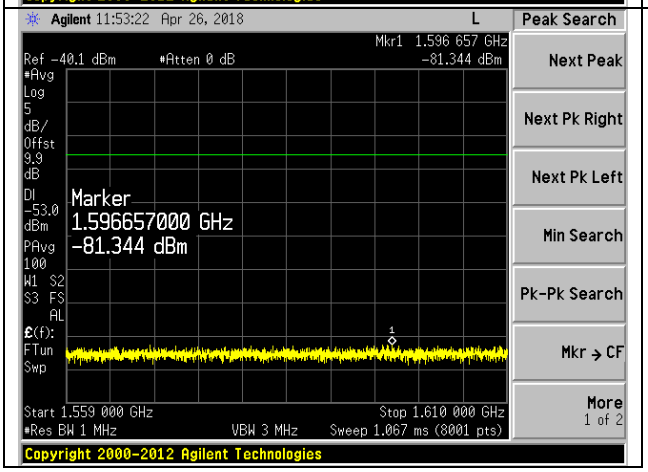
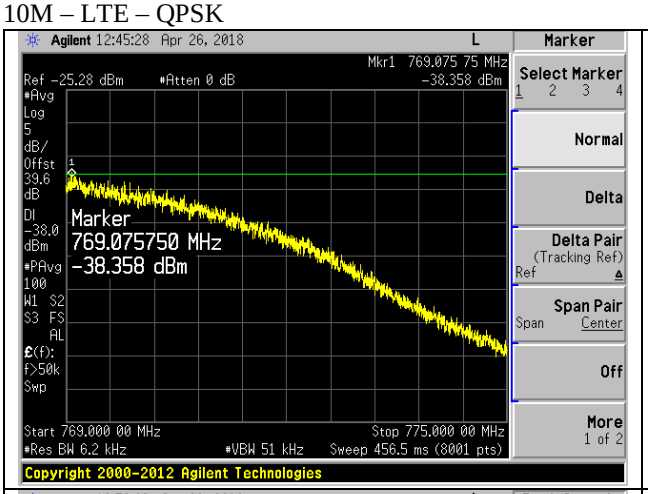
5M – LTE – 64QAM

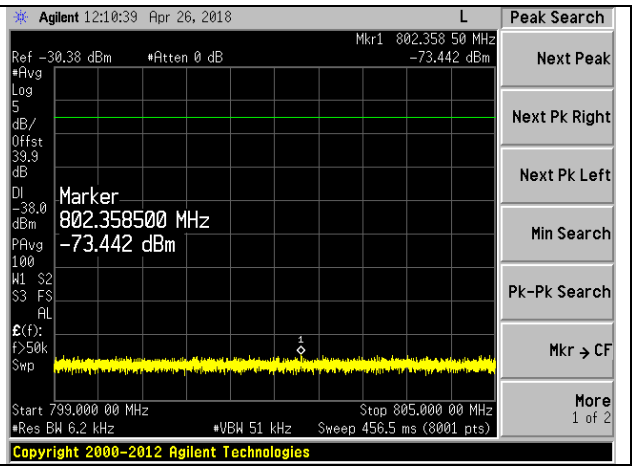

Agilent 11:43:26 Apr 26, 2018
L
Peak Search
Mkr1 769.021 00 MHz
Ref -25 dBm
#Atten 0 dB
-38.625 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Dl
-38.0
dBm
#PAvg
100
W1 S2
S3 FS
AL
£(f):
f>50k
Swp
Marker
769.021000 MHz
-38.625 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 769.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Stop 775.000 00 MHz
Sweep 456.5 ms (8001 pts)
Copyright 2000-2012 Agilent Technologies

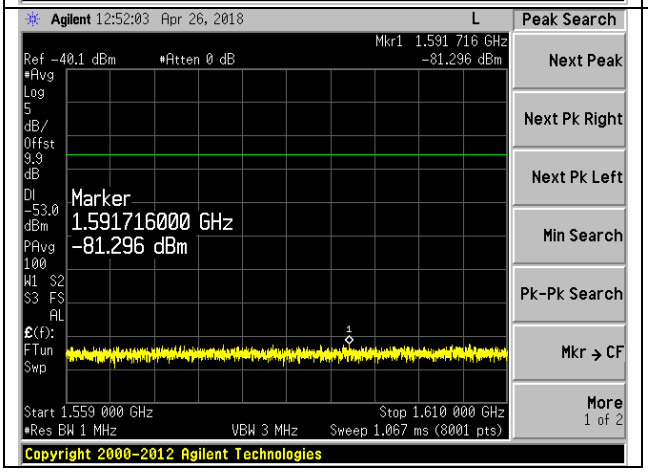

Agilent 11:04:39 Apr 26, 2018
L
Peak Search
Mkr1 800.571 25 MHz
Ref -30.38 dBm
#Atten 0 dB
-73.566 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Dl
-38.0
dBm
PAvg
100
W1 S2
S3 FS
AL
£(f):
f>50k
Swp
Marker
800.571250 MHz
-73.566 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 799.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Stop 805.000 00 MHz
Sweep 456.5 ms (8001 pts)
Copyright 2000-2012 Agilent Technologies


Agilent 11:53:22 Apr 26, 2018
L
Peak Search
Mkr1 1.596 657 GHz
Ref -40.1 dBm
#Atten 0 dB
-81.344 dBm
#Avg
Log
5
dB/
Offst
9.9
dB
Dl
-53.0
dBm
PAvg
100
W1 S2
S3 FS
AL
£(f):
FTun
Swp
Marker
1.596657000 GHz
-81.344 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 1.559 000 GHz
#Res BW 1 MHz
VBW 3 MHz
Stop 1.610 000 GHz
Sweep 1.067 ms (8001 pts)
Copyright 2000-2012 Agilent Technologies

10M – LTE – QPSK


Agilent 12:45:28 Apr 26, 2018
L
Marker
Mkr1 769.075 75 MHz
Ref -25.28 dBm
#Atten 0 dB
-38.358 dBm
#Avg
Log
5
dB/
Offst
39.6
dB
Marker
769.075750 MHz
-38.358 dBm
Start 769.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Stop 775.000 00 MHz
Sweep 456.5 ms (8001 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span
Center
Off
More
1 of 2
Copyright 2000-2012 Agilent Technologies


Agilent 12:10:39 Apr 26, 2018
L
Peak Search
Mkr1 802.358 50 MHz
Ref -30.38 dBm
#Atten 0 dB
-73.442 dBm
#Avg
Log
5
dB/
Offst
39.9
dB
Marker
802.358500 MHz
-73.442 dBm
Start 799.000 00 MHz
#Res BW 6.2 kHz
#VBW 51 kHz
Stop 805.000 00 MHz
Sweep 456.5 ms (8001 pts)
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Copyright 2000-2012 Agilent Technologies


Agilent 12:52:03 Apr 26, 2018
L
Peak Search
Mkr1 1.591 716 GHz
Ref -40.1 dBm
#Atten 0 dB
-81.296 dBm
#Avg
Log
5
dB/
Offst
9.9
dB
Marker
1.591716000 GHz
-81.296 dBm
Start 1.559 000 GHz
#Res BW 1 MHz
VBW 3 MHz
Stop 1.610 000 GHz
Sweep 1.067 ms (8001 pts)
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
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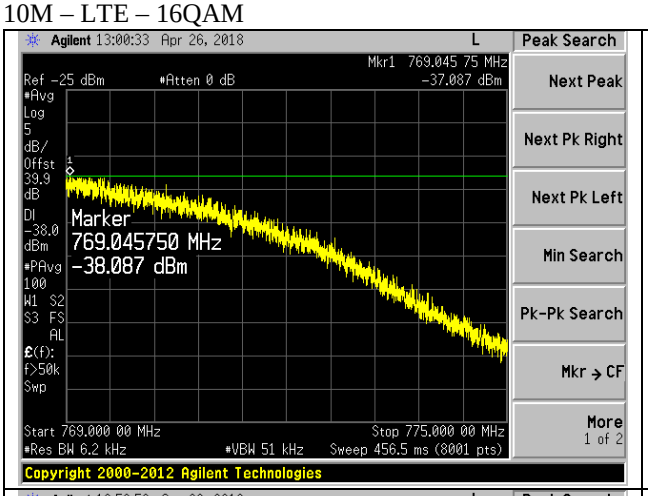
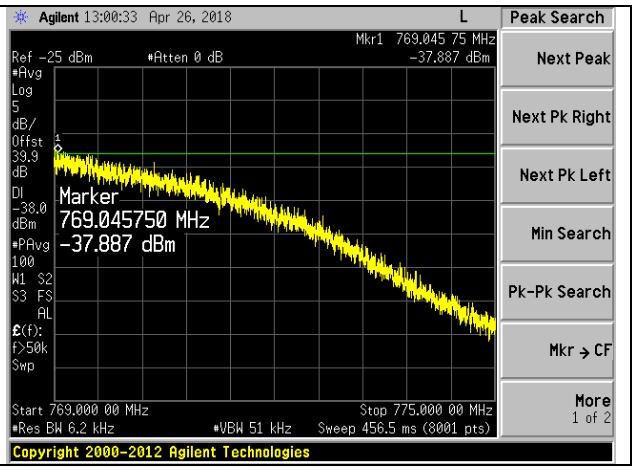
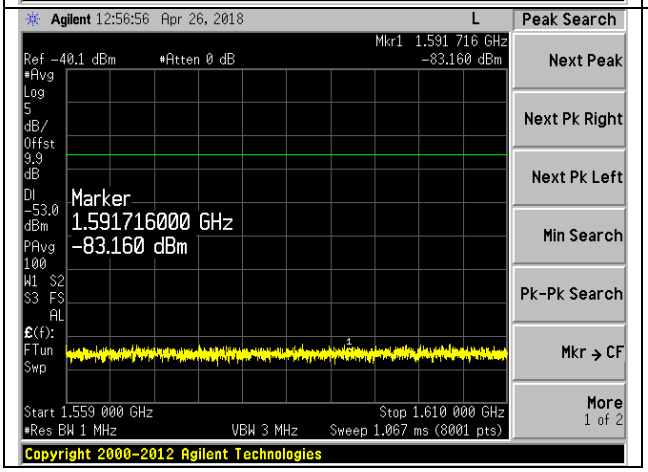
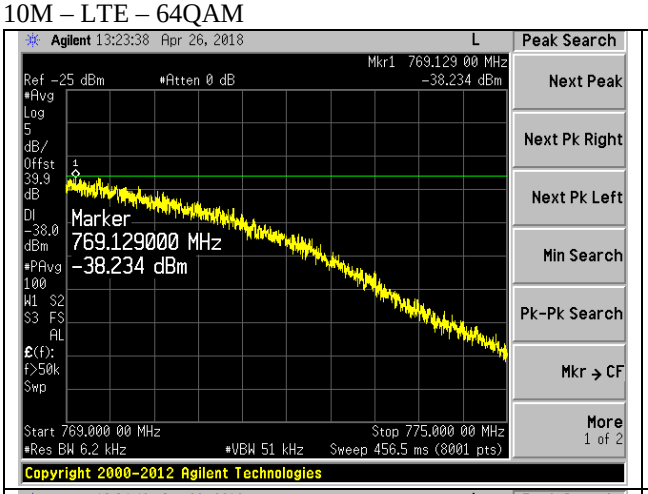
10M – LTE – 16QAM

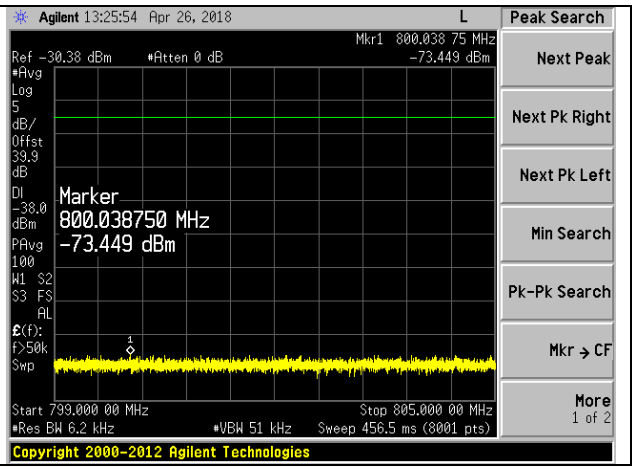


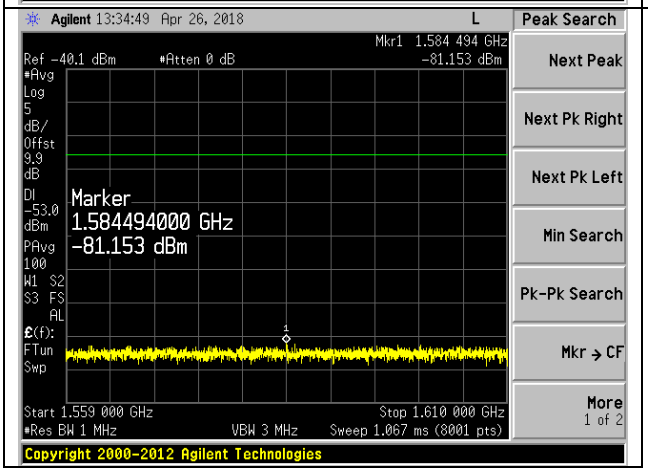




10M – LTE – 64QAM







Transmitter Radiated Spurious Emissions

Antenna port conducted spurious emissions tests produced similar results for all modulations and channel bandwidth modes. Preliminary scans for radiated spurious emissions were performed in 30MHz – 10GHz frequency range in the following configuration:

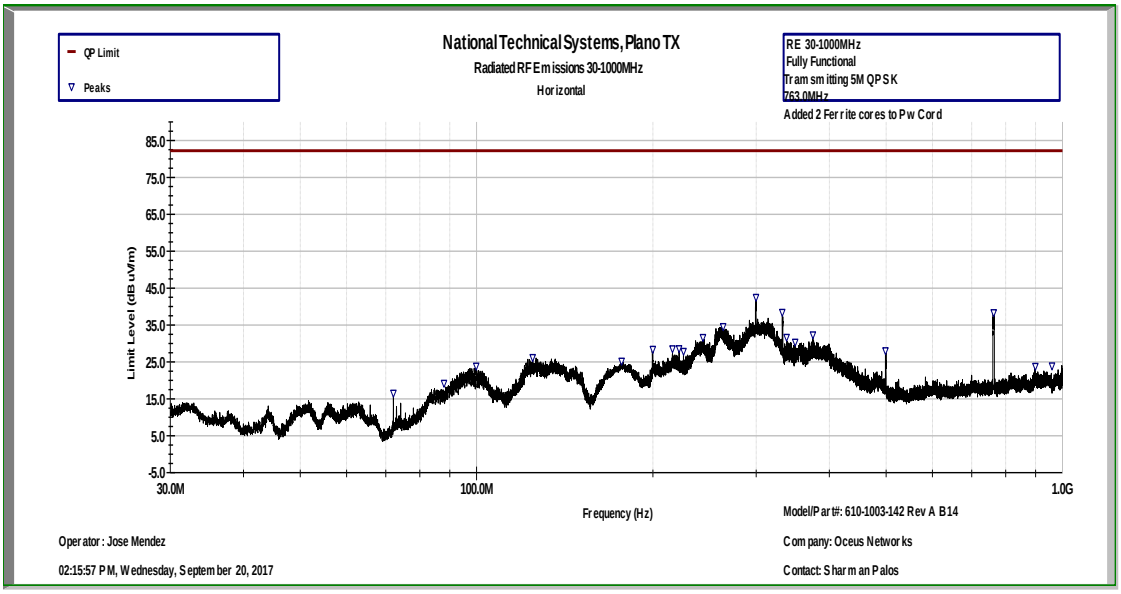
Transmitting in 5MHz-QPSK-LTE mode at center channel (763MHz) on all 2 ports.

Final maximized peak radiated emissions were measured in this mode. Measurement distance was 3m. During testing all 2 antenna ports of the transmitter were terminated with 50ohm termination blocks and unit was transmitting on all of its ports at full power as described above.

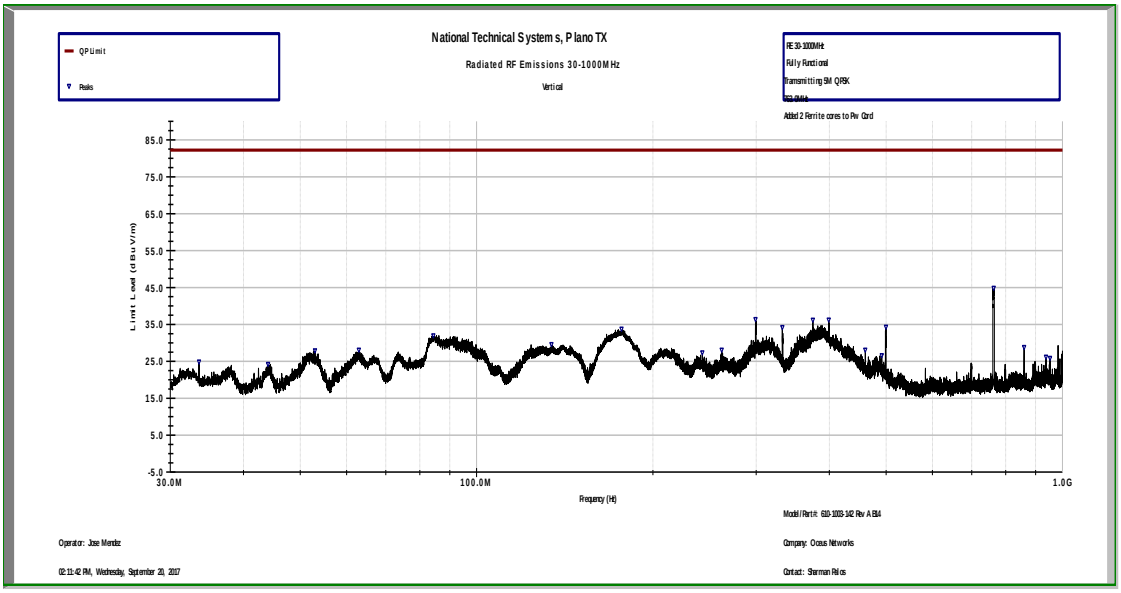
Frequency	Polarity	Raw Peak	Antenna	Cableloss	PreAmp	Peaks	Limit	Margin	Tower	Turntable
GHz	V/H	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	dB	cm	Degrees
9.99036	H	30.472	38.29	1.917	-30.885	39.792	82.2	-42.408	100	1
8.5335	V	26.415	37.376	4.188	-30.803	37.177	82.2	-45.023	100	1
7.8141	V	27.234	36.663	3.107	-31.862	35.142	82.2	-47.058	100	1
7.95485	V	26.919	36.865	3.417	-32.088	35.113	82.2	-47.087	100	1
6.68012	H	28.019	34.929	2.695	-31.682	33.961	82.2	-48.239	100	1
7.79093	H	24.879	36.642	3.054	-31.825	32.751	82.2	-49.449	100	1
8.51724	H	21.452	37.372	4.175	-30.782	32.217	82.2	-49.983	100	1
9.18316	V	21.88	37.69	3.953	-31.638	31.884	82.2	-50.316	100	1
7.36238	H	23.941	36.611	2.383	-31.697	31.24	82.2	-50.96	100	1
5.99909	H	23.502	34.569	1.674	-31.715	28.03	82.2	-54.17	100	1
6.62897	V	21.298	34.804	2.599	-31.638	27.062	82.2	-55.138	221	1
1.95136	V	31.231	27.296	0.149	-34.467	24.207	82.2	-57.993	100	1

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 these levels as well, substitution measurements were not performed. TILE software was used for all preliminary scans and plots included on the following pages.

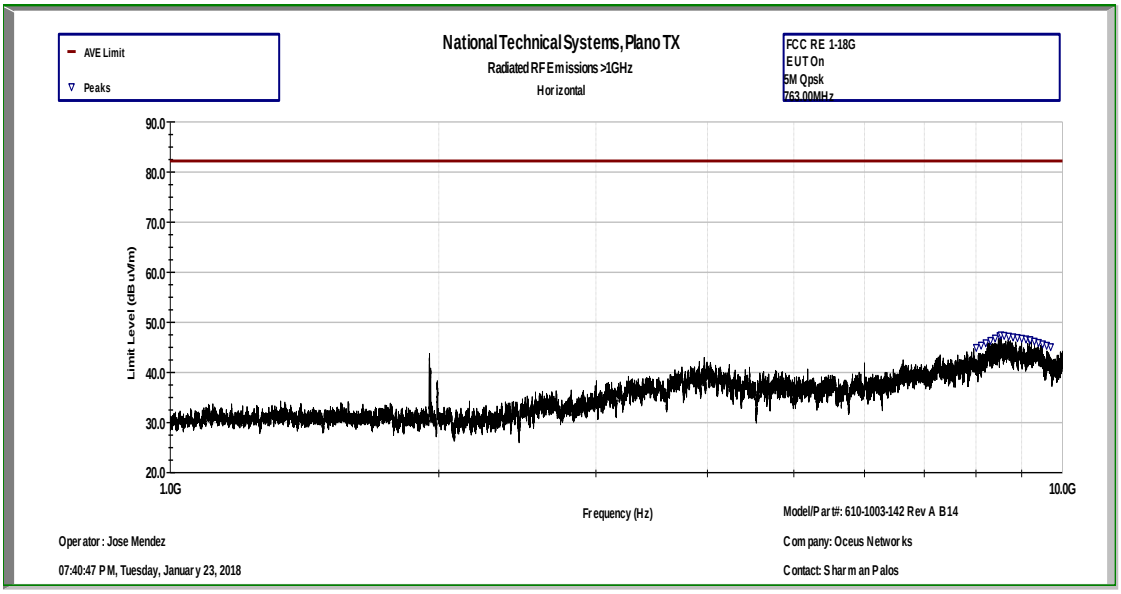
30MHz – 1GHz Peak Prescan at 3m - H



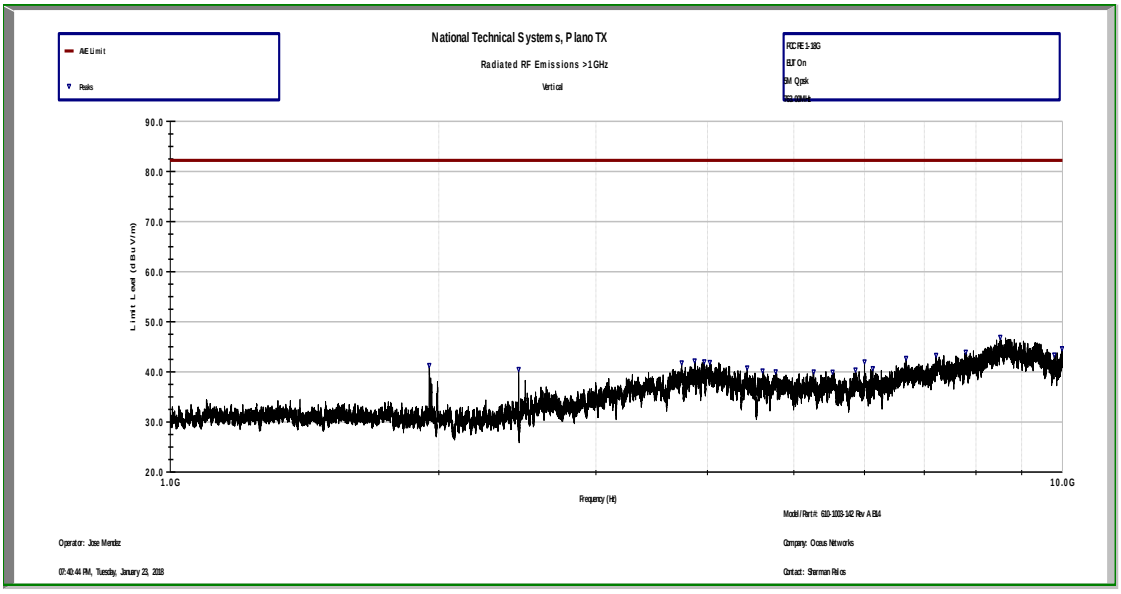
30MHz – 1GHz Peak Prescan at 3m - V



1GHz – 10GHz Peak Prescan at 3m – H



1GHz – 10GHz Peak Prescan at 3m – V



Frequency Stability

Transmitting in 5MHz-QPSK-LTE mode at Mid channel (763MHz)

Nominal operating voltage of the product is declared as 115VAC.

Extreme Voltages

20C	Freq. Error (mHz)
97.75VAC	684
132.25VAC	379

Extreme Temperatures

115VAC	Freq. Error (mHz)
-30	521
-20	325
-10	485
0	627
10	394
20	218
30	328
40	468
50	591

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

End of Report

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