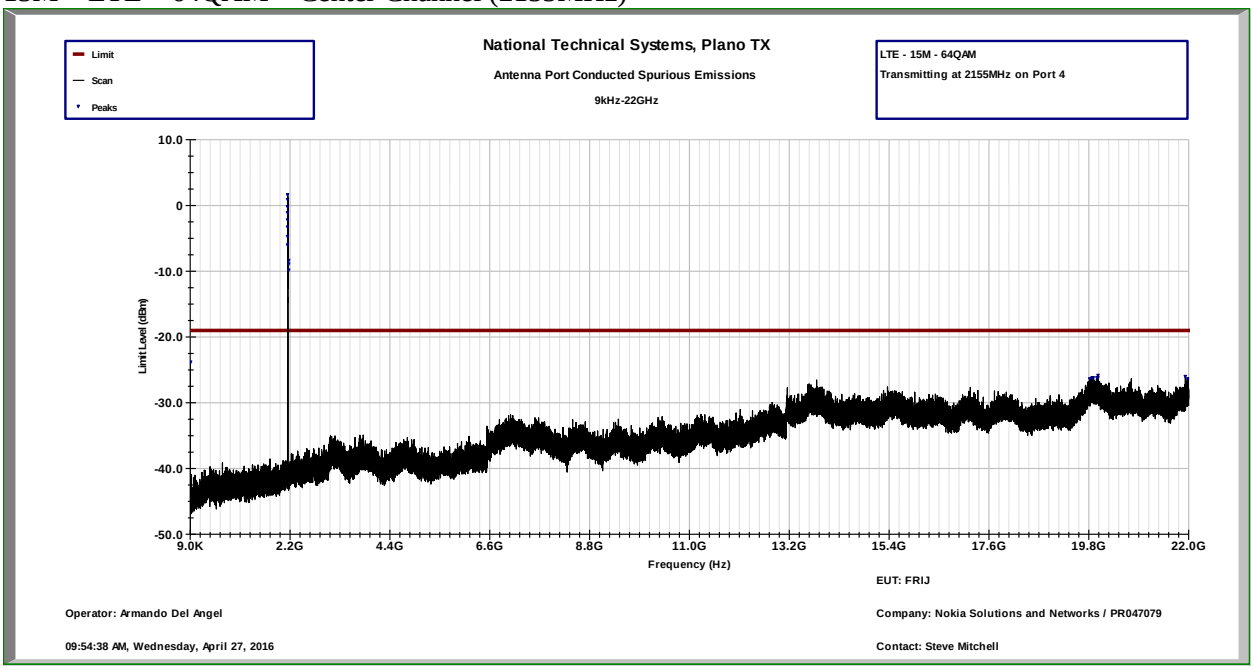
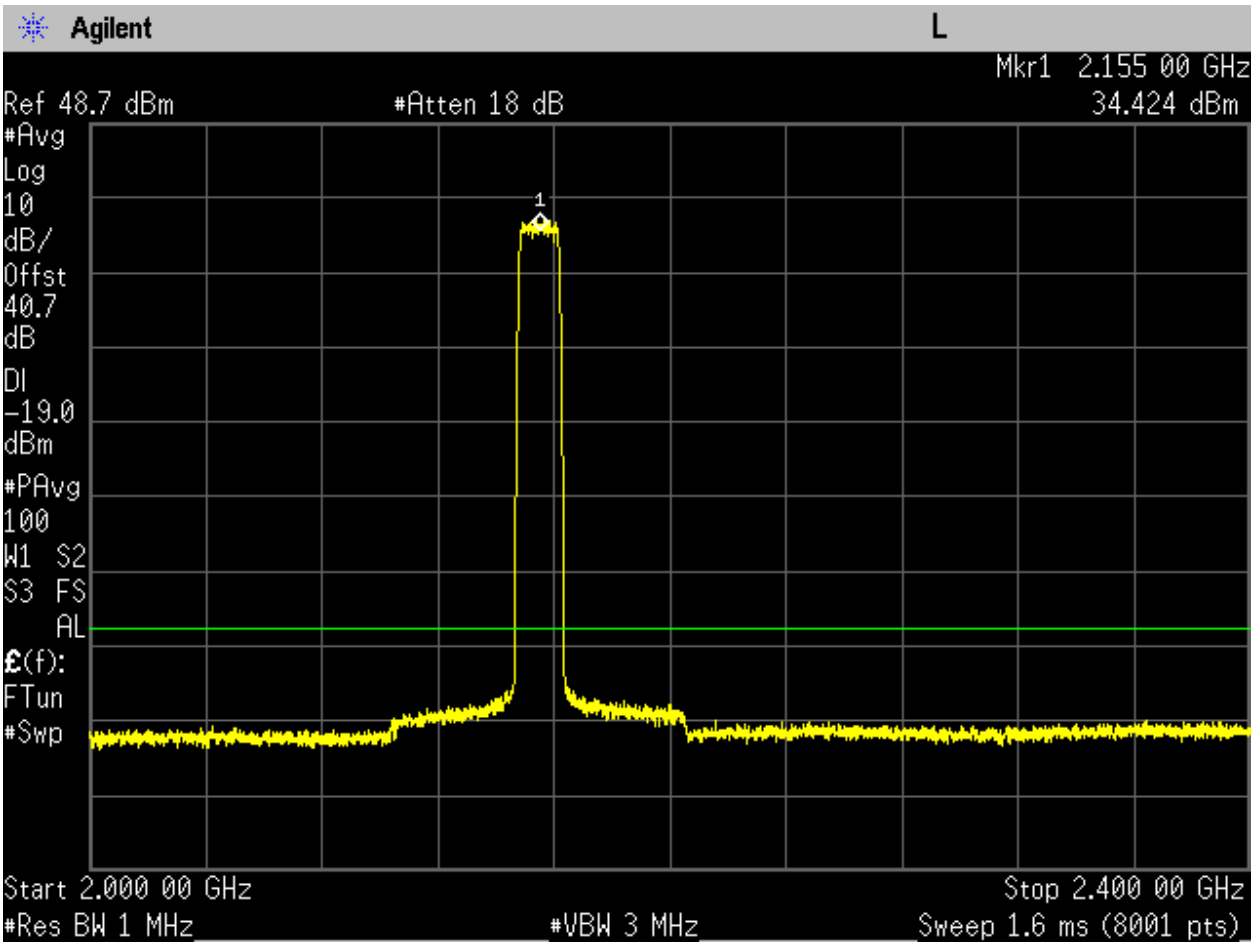
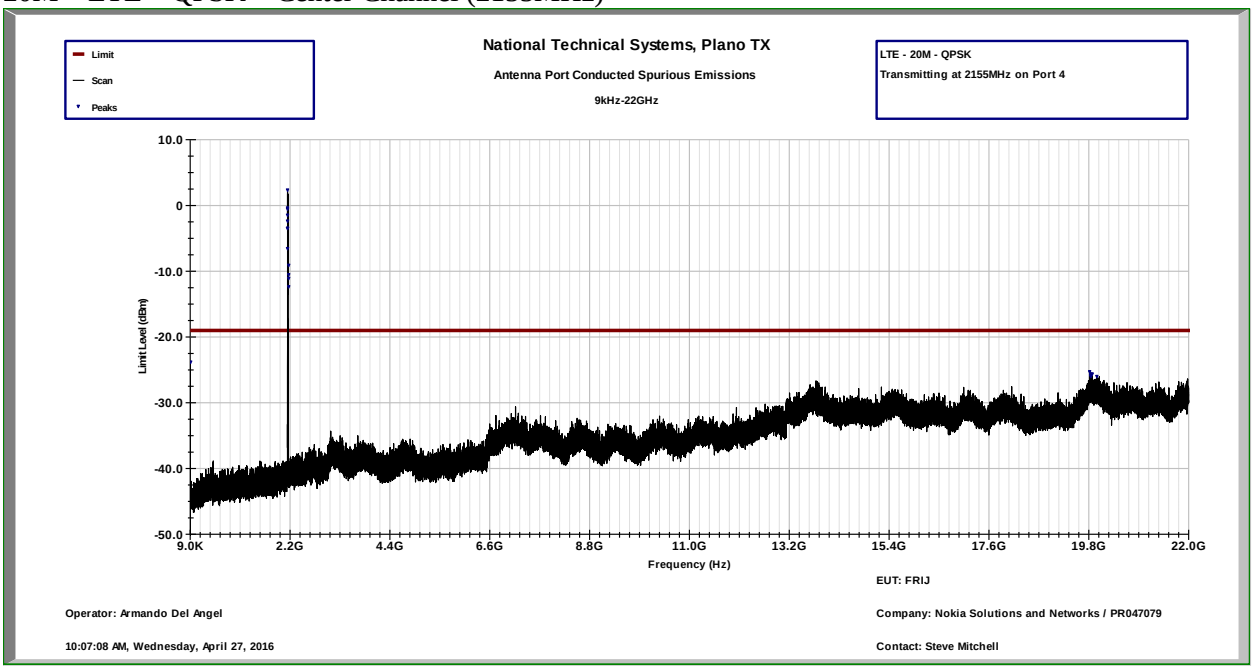
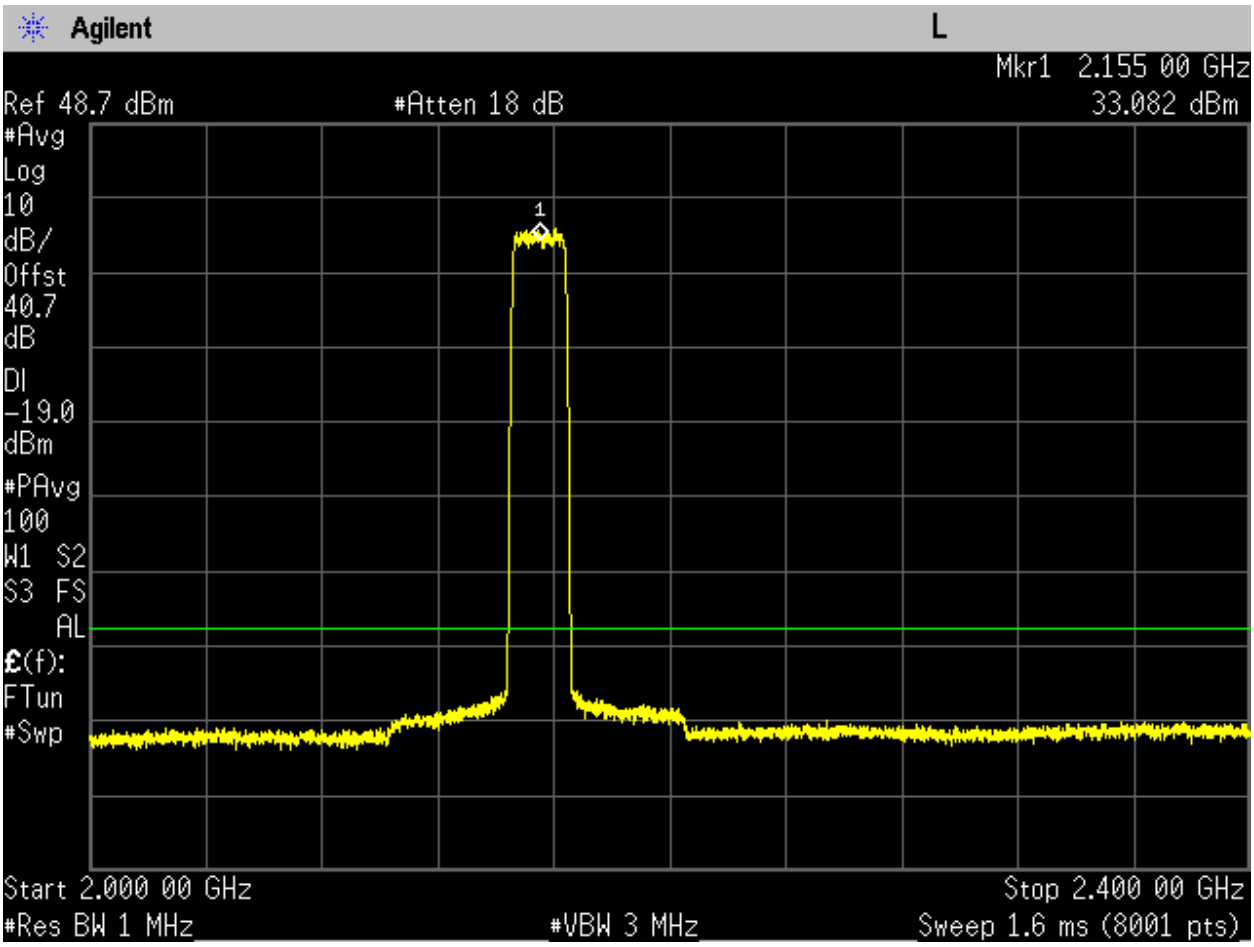
15M – LTE – 64QAM – Center Channel (2155MHz)



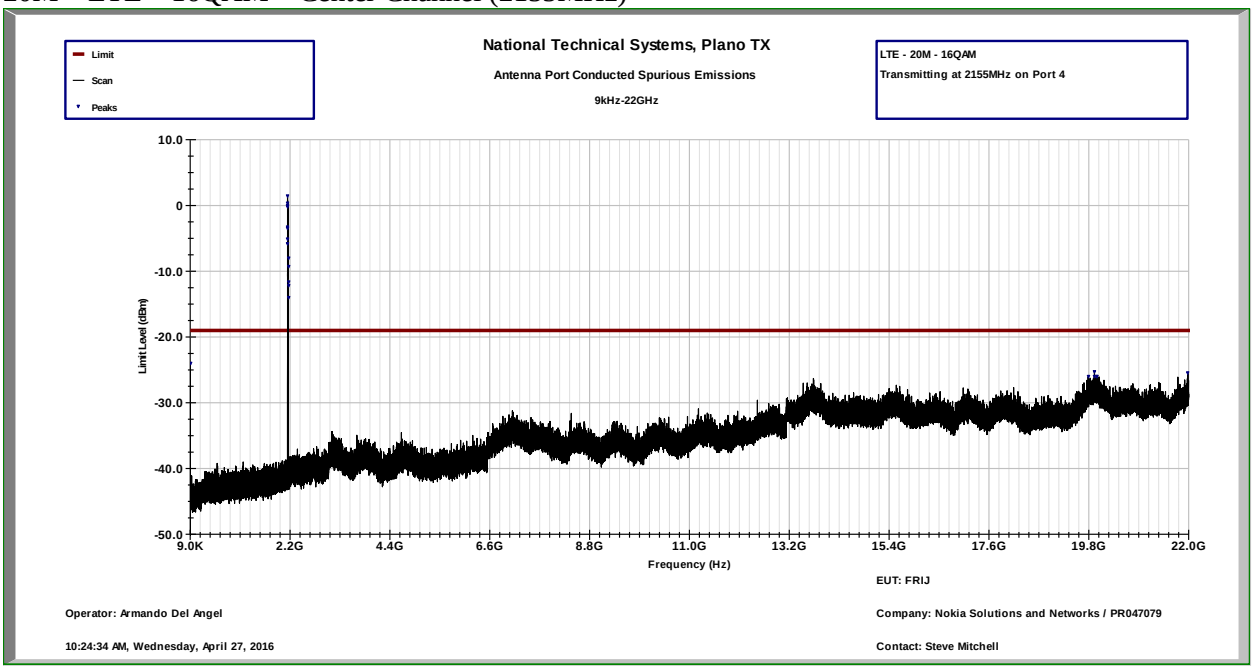


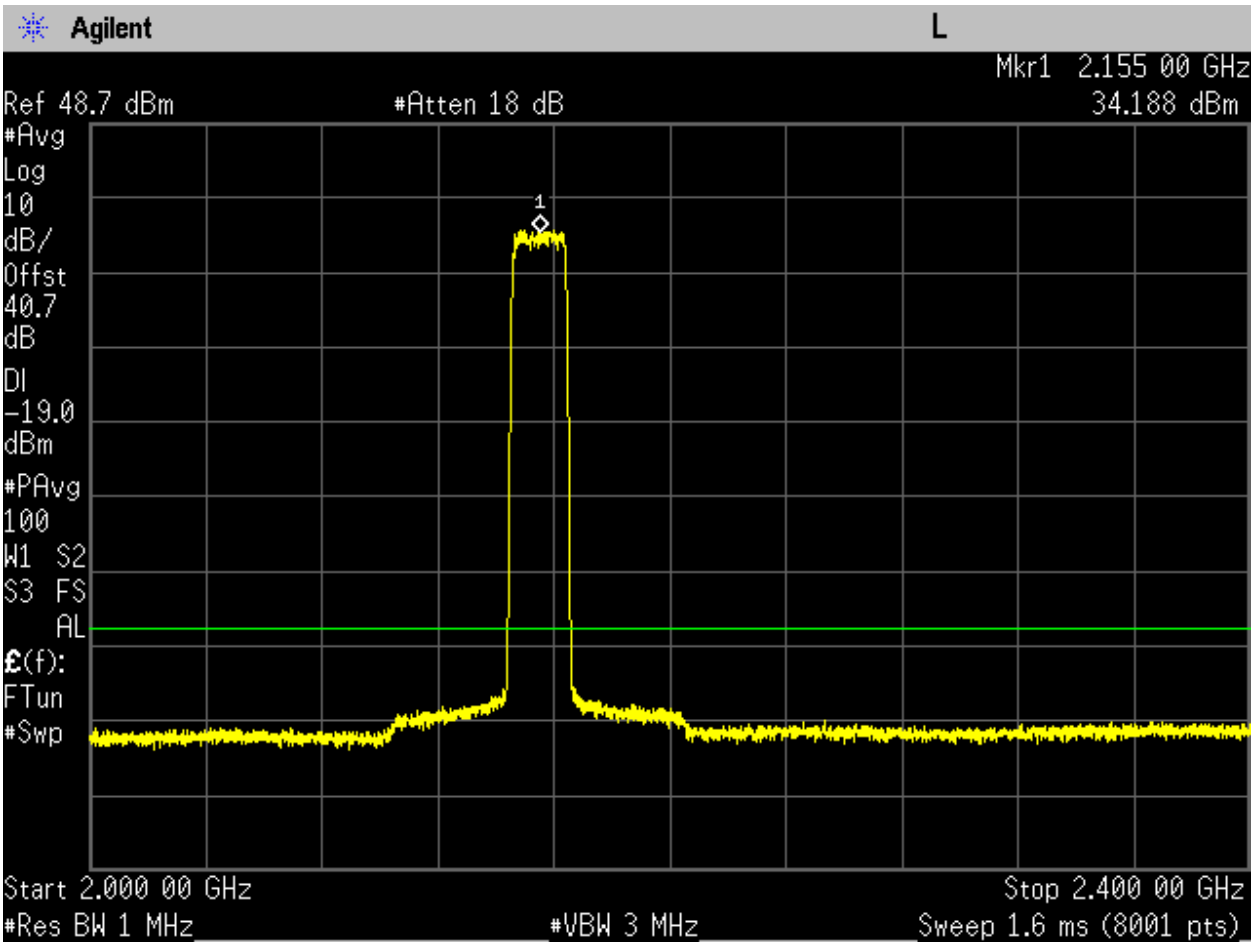
20M – LTE – QPSK – Center Channel (2155MHz)



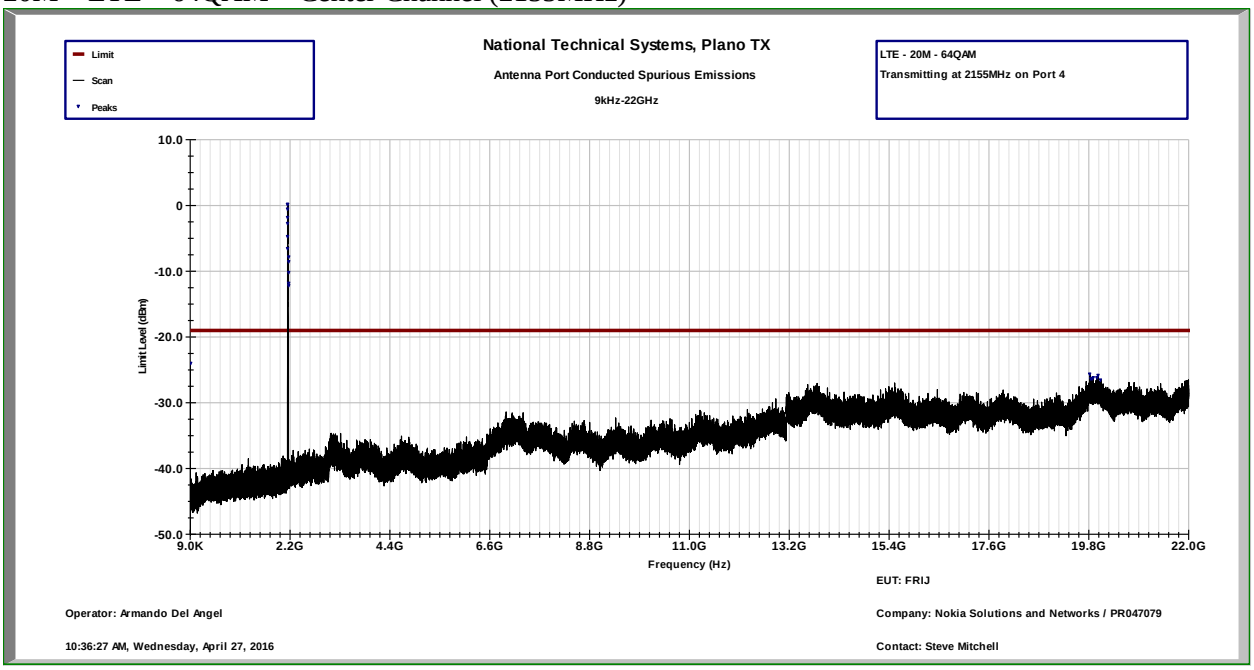


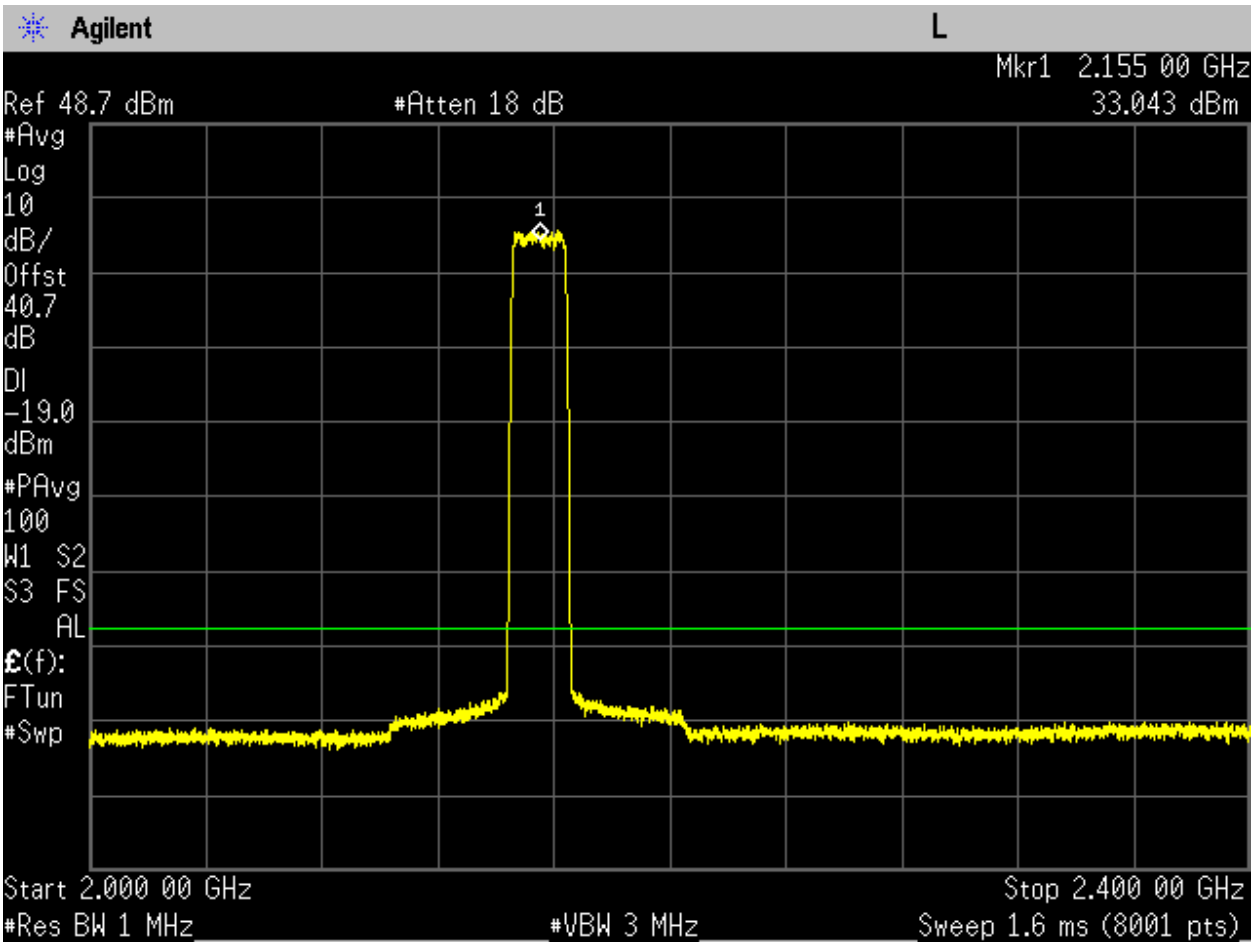
20M – LTE – 16QAM – Center Channel (2155MHz)



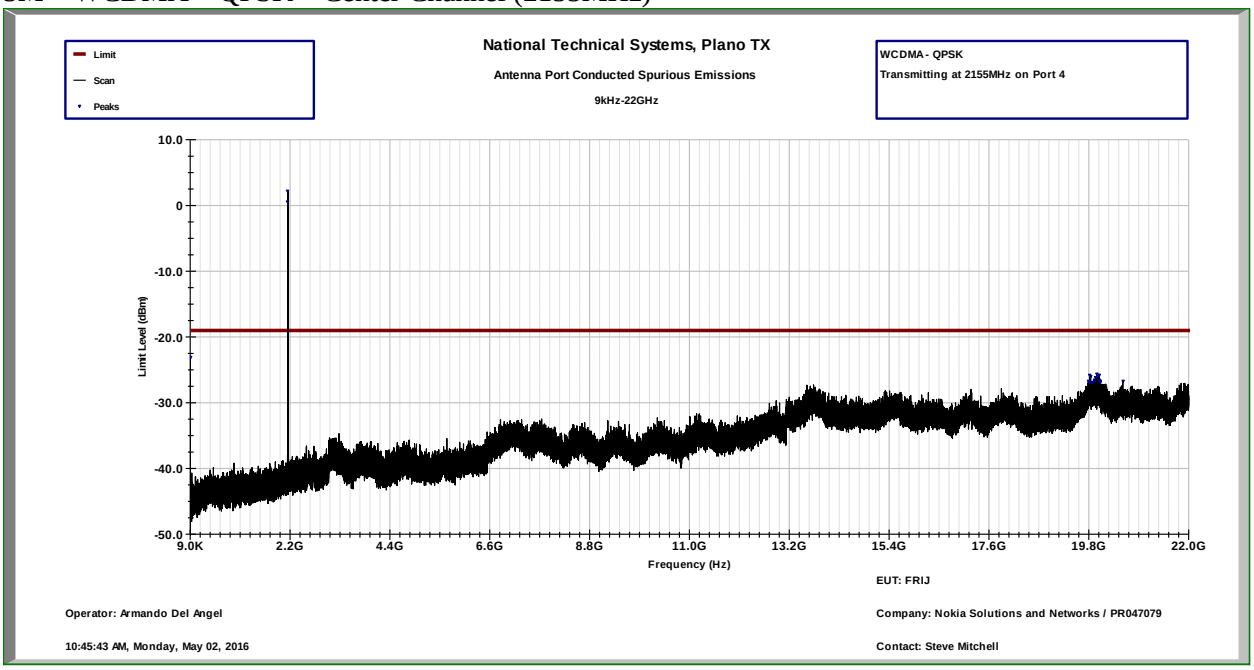


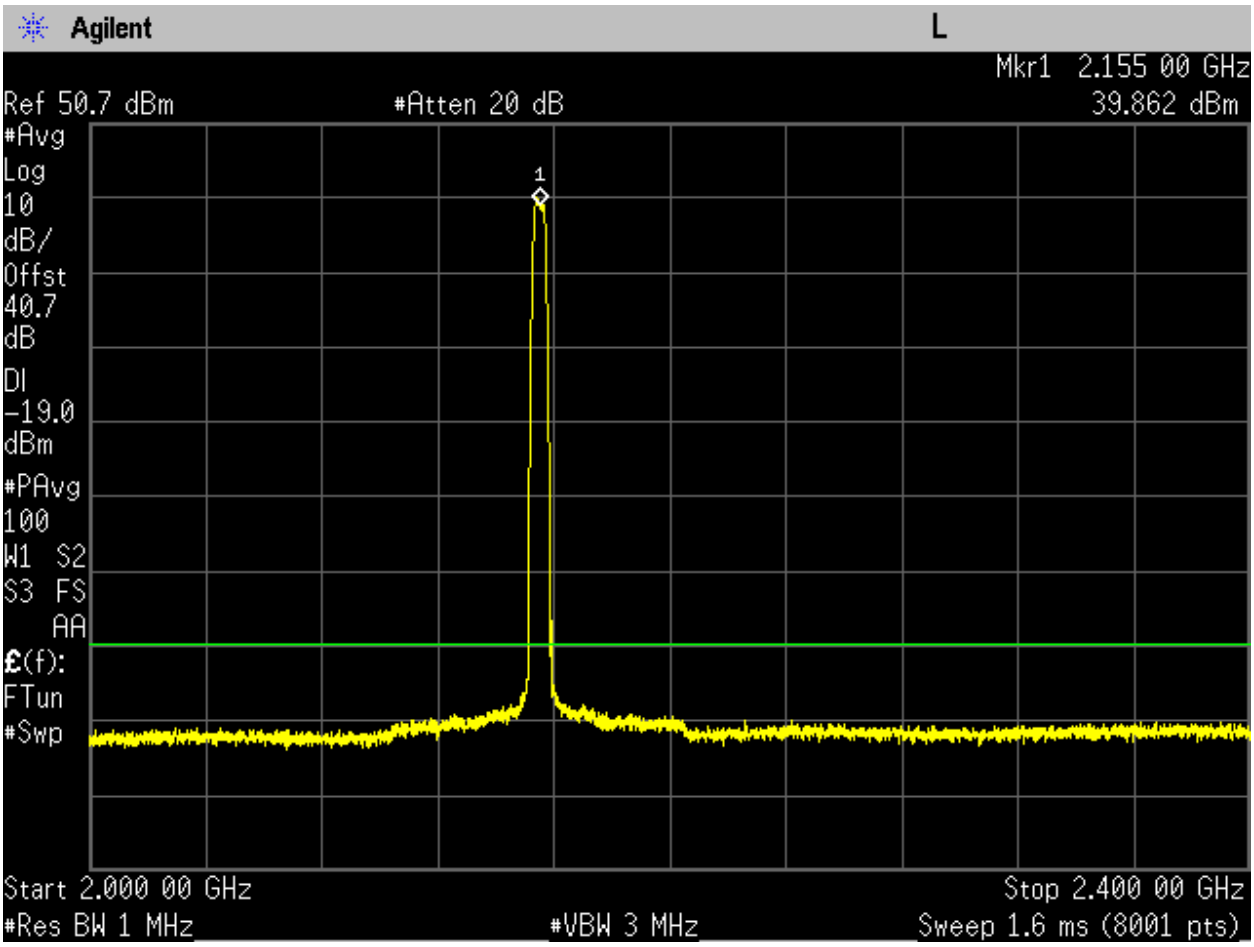
20M – LTE – 64QAM – Center Channel (2155MHz)



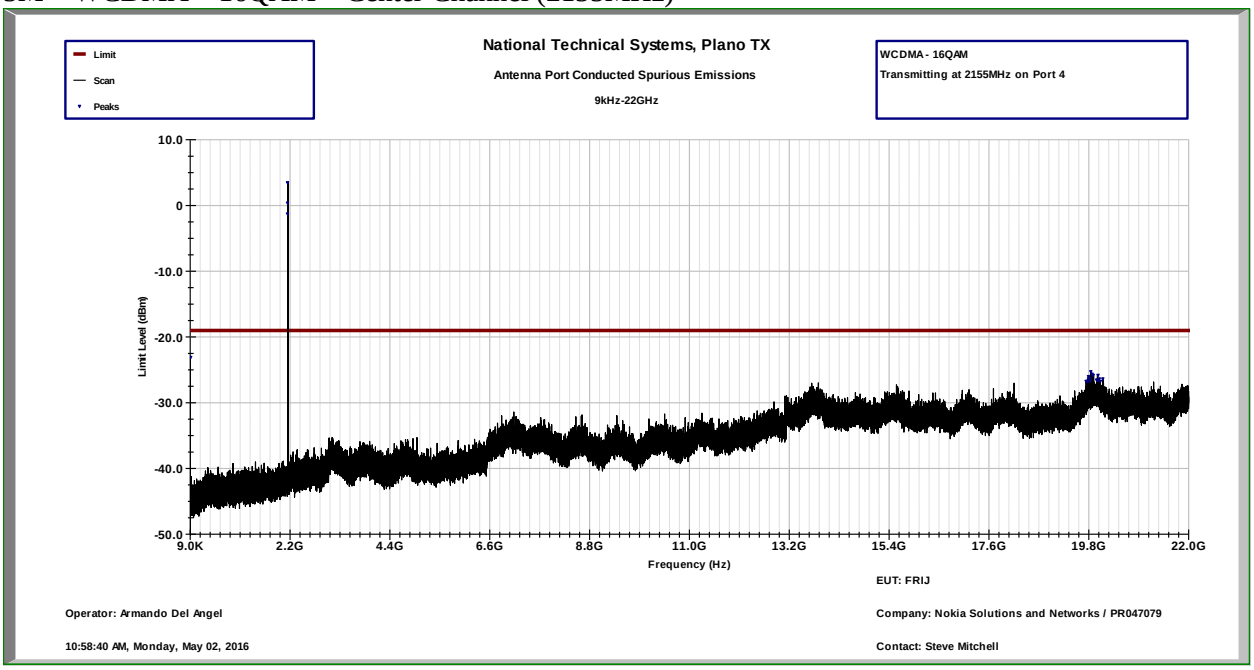


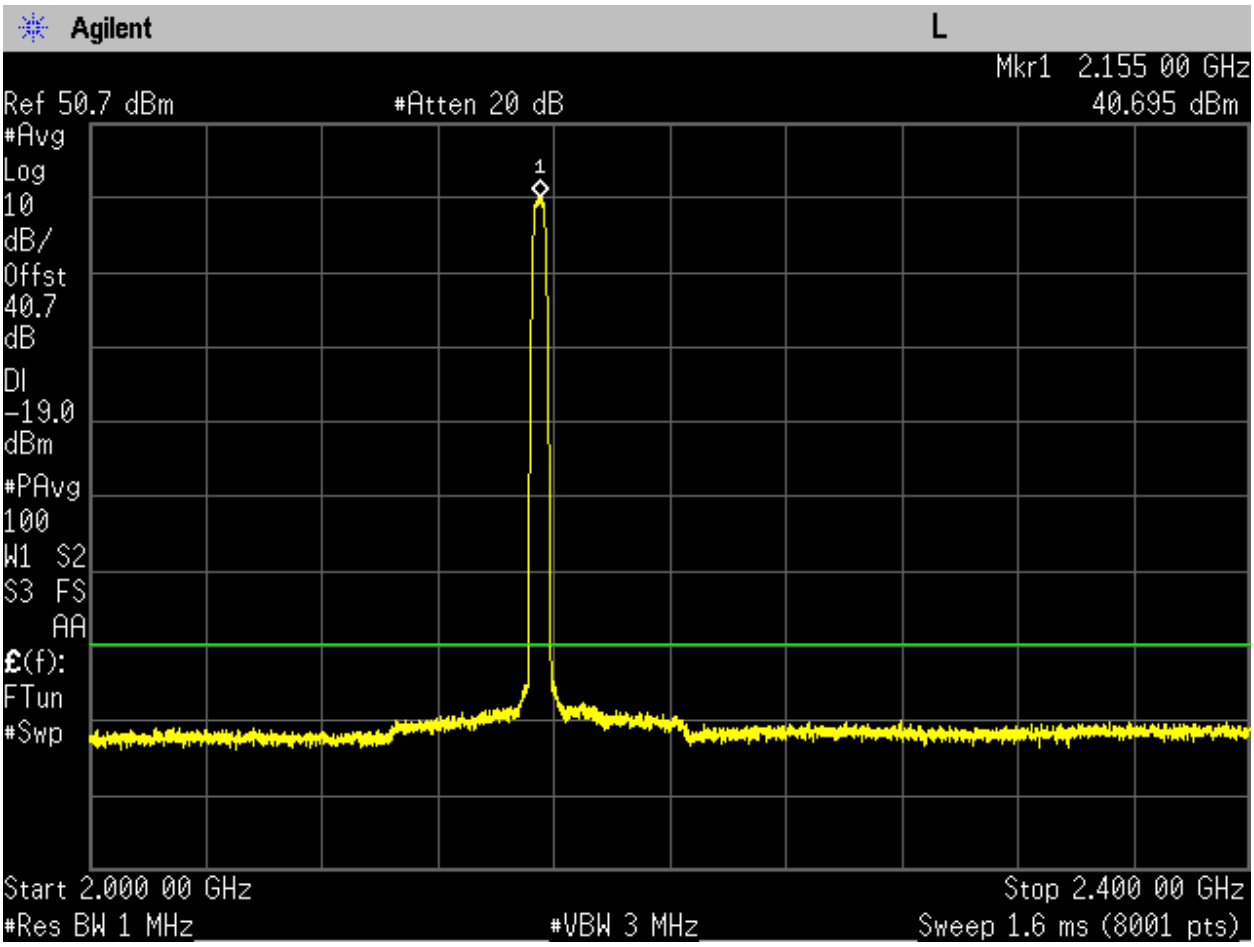
5M – WCDMA – QPSK – Center Channel (2155MHz)



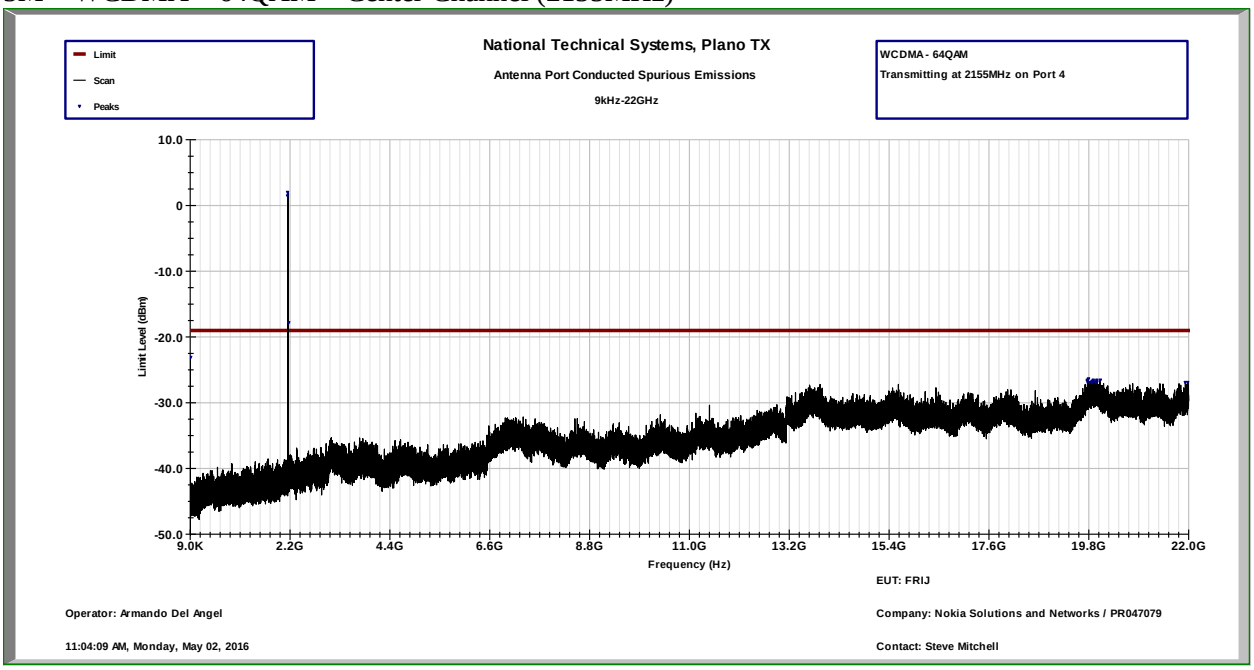


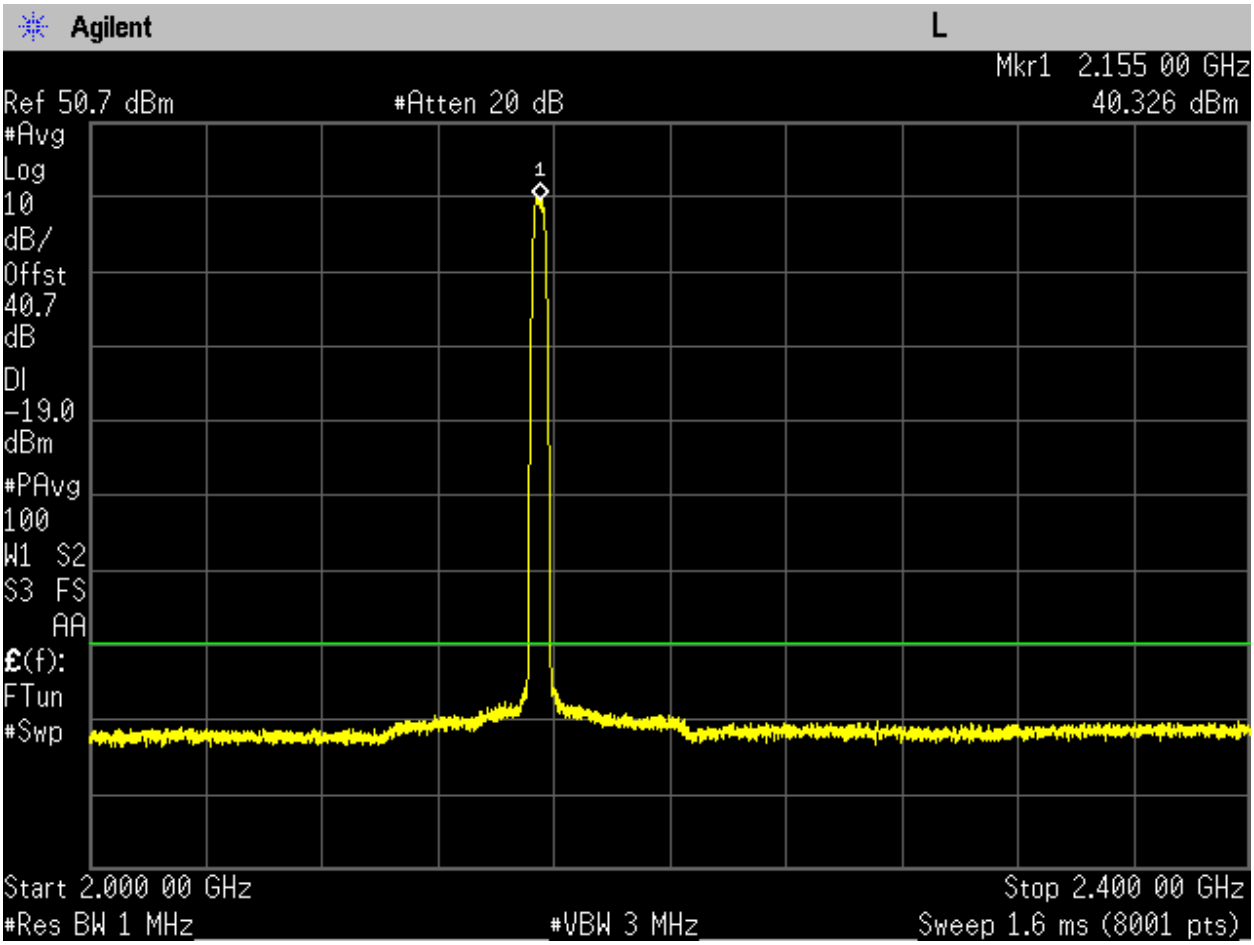
5M – WCDMA – 16QAM – Center Channel (2155MHz)





5M – WCDMA – 64QAM – Center Channel (2155MHz)





Transmitter Radiated Spurious Emissions

Based on antenna port conducted spurious emissions tests results, preliminary scans for radiated spurious emissions were performed in 30MHz – 22GHz frequency range in the following configurations:

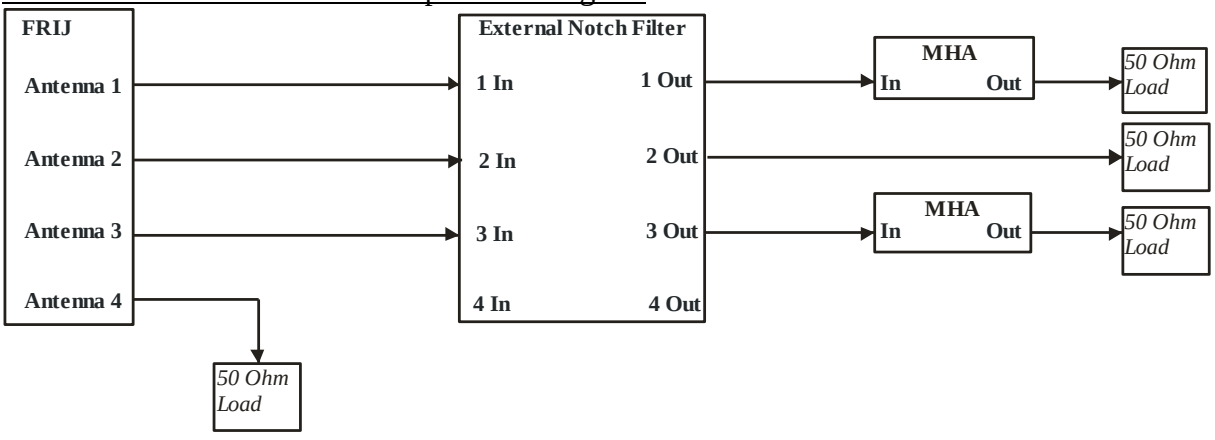
LTE: 5M - QPSK transmitting at Low (2112.5MHz), Notch Filter Top (2192.5MHz), Mid (2155.0, and High (2197.5MHz) channels on antennas 1, 2, 3, and 4 respectively.

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 and unit was transmitting on all of its ports at full power as described above.

FRIJ Transmit Frequencies used in Radiated Emission Testing

FRIJ Antenna Port	EARFCN	LTE Channel Bandwidth	Modulation Type	Transmit Frequency
1	66461 (Bottom Channel)	5 MHz	QPSK	2112.5 MHz
2	67261 (Notch Filter Top Channel)	5 MHz	QPSK	2192.5 MHz
3	66886 (Middle Channel)	5 MHz	QPSK	2155.0 MHz
4	67311 (Top Channel)	5 MHz	QPSK	2197.5 MHz

FRIJ Radiated Emission RF Setup Block Diagram



30M-10GHz @ 3m Distance

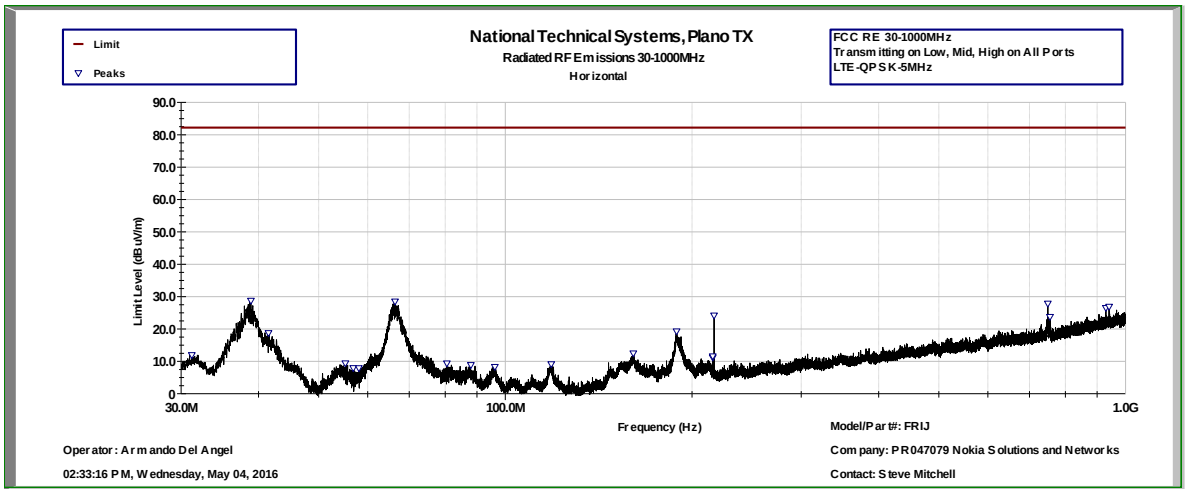
Frequency	Polarity (H/V)	Raw Reading at 3m (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Field Strength at 3m (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)
9988.51	V	45.808	-39.843	38.204	7.211	51.38	82.2	-30.82
9870.34	H	46.361	-39.489	38.072	6.841	51.785	82.2	-30.96
9622.80	H	44.811	-40.308	37.86	6.291	51.475	82.2	-31.255
9223.10	H	42.605	-40.123	37.646	5.973	50.975	82.2	-31.729
4305.17	V	55.691	-41.71	32.111	4.142	50.234	82.2	-31.966
4308.86	H	52.152	-41.718	32.116	4.153	46.702	82.2	-32.004
8823.40	H	43.223	-40.876	37.754	5.988	50.475	82.2	-32.204
8423.70	H	44.908	-41.205	37.259	5.467	49.974	82.2	-32.679
8024.00	H	42.734	-40.504	36.891	5.147	49.474	82.2	-33.154
7624.30	H	42.203	-40.498	36.493	5.285	48.974	82.2	-33.629
7457.75	H	47.617	-40.81	36.563	5.398	48.766	82.2	-33.827
4226.72	V	54.271	-41.773	32.221	3.581	48.299	82.2	-33.901
7224.60	H	45.111	-41.5	36.179	5.739	48.536	82.2	-34.104
6824.90	H	45.125	-41.95	35.396	4.999	48.143	82.2	-34.579
6425.20	H	45.3	-42.124	34.516	5.615	47.749	82.2	-35.053
6025.50	H	47.29	-42.326	34.559	5.408	47.356	82.2	-35.528
6008.01	H	49.74	-42.308	34.52	5.387	47.338	82.2	-35.549
1228.81	V	60.466	-42.2	25.581	2.416	46.261	82.2	-35.939
5625.80	H	45.564	-42.452	34.038	5.22	47.019	82.2	-36.003
5226.10	H	47.106	-42.4	33.839	4.742	46.685	82.2	-36.478
4793.70	V	49.582	-42.006	33.034	4.599	45.208	82.2	-36.992
3831.71	V	49.283	-41.732	32.775	4.17	44.495	82.2	-37.705

10-22GHz @ 1m Distance

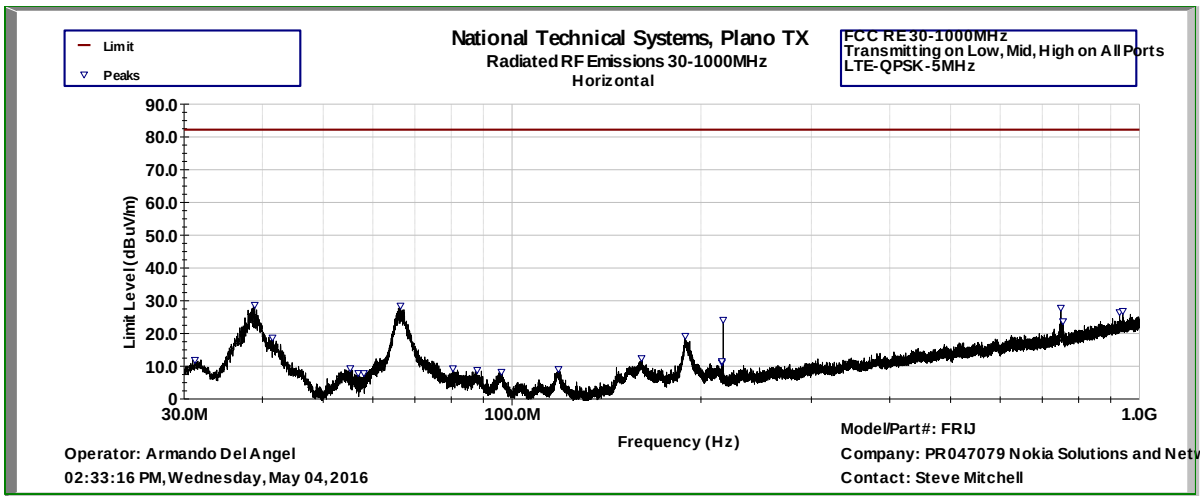
Frequency (GHz)	Polarity (H/V)	Raw Reading at 1m (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Field Strength at 1m (dBuV/m)	Limit at 1m (dBuV/m)	Margin (dB)
17.98	V	46.096	-39.468	45.891	7.121	59.781	91.74	-31.959
17.99	H	45.872	-39.434	45.929	7.126	59.686	91.74	-32.054
17.62	H	43.08	-39.634	43.783	6.932	59.289	91.74	-32.451
17.22	H	41.663	-39.331	41.414	6.694	58.863	91.74	-32.877
16.82	H	42.789	-39.783	39.864	6.828	58.437	91.74	-33.303
16.42	H	43.629	-40.247	38.652	6.697	58.011	91.74	-33.729
16.02	H	45.865	-40.7	38.297	6.543	57.585	91.74	-34.155
15.62	H	45.679	-41.463	38.611	6.421	57.159	91.74	-34.581
15.22	H	44.944	-41.944	40.144	6.532	56.733	91.74	-35.007
14.82	H	45.862	-42.233	41.884	6.55	56.307	91.74	-35.433
14.69	H	49.489	-42.027	42.094	6.616	56.175	91.74	-35.565
14.13	V	49.845	-42.148	41.7	6.543	55.939	91.74	-35.801
14.42	H	44.88	-43.242	41.911	6.674	55.625	91.74	-36.115
14.02	H	45.619	-42.924	41.553	6.272	54.828	91.74	-36.912
13.77	V	49.583	-42.704	41.183	6.386	54.449	91.74	-37.291
13.80	V	49.758	-43.008	41.229	6.464	54.403	91.74	-37.337
13.73	H	49.181	-42.409	41.177	6.309	54.259	91.74	-37.481
13.62	H	44.528	-41.699	41.102	6.127	54.179	91.74	-37.561
13.22	H	46.417	-42.021	40.399	6.066	53.902	91.74	-37.838
13.16	H	49.483	-41.723	40.253	5.829	53.857	91.74	-37.883
13.32	V	49.422	-42.544	40.546	5.883	53.306	91.74	-38.434
12.42	H	44.861	-41.5	39.386	4.93	51.715	91.74	-40.025
12.33	H	48.87	-41.634	39.341	4.894	51.459	91.74	-40.281
12.18	V	49.323	-42.377	39.408	4.832	51.15	91.74	-40.59

Highest noise floor of the measurement instrumentation was more than 20dB below the 82.2dBuV/m at 3m limit and 91.74dBuV/m at 1m (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.

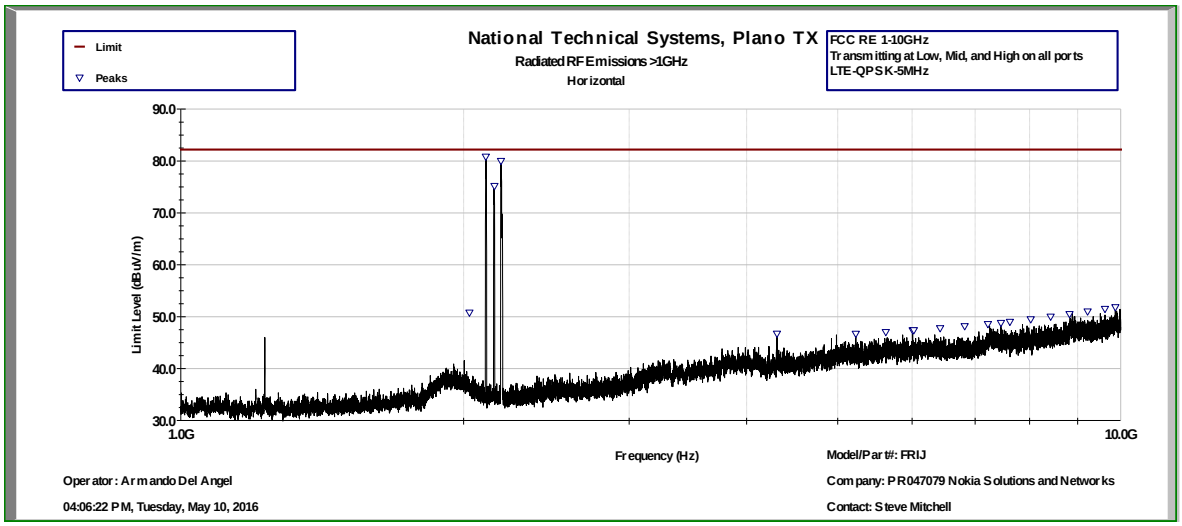
30MHz – 1GHz Peak Prescan at 3m - H



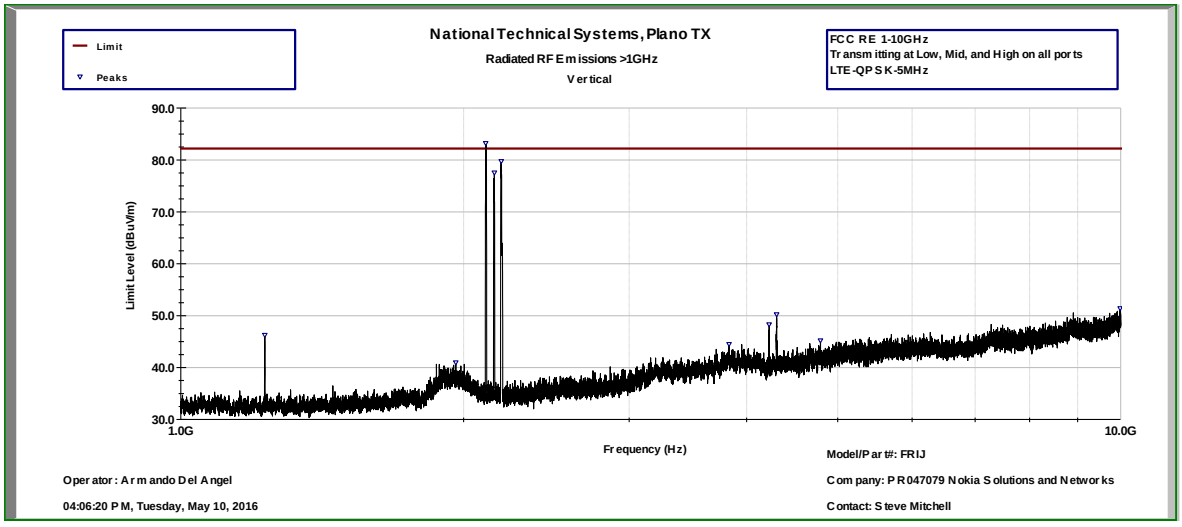
30MHz – 1GHz Peak Prescan at 3m - V



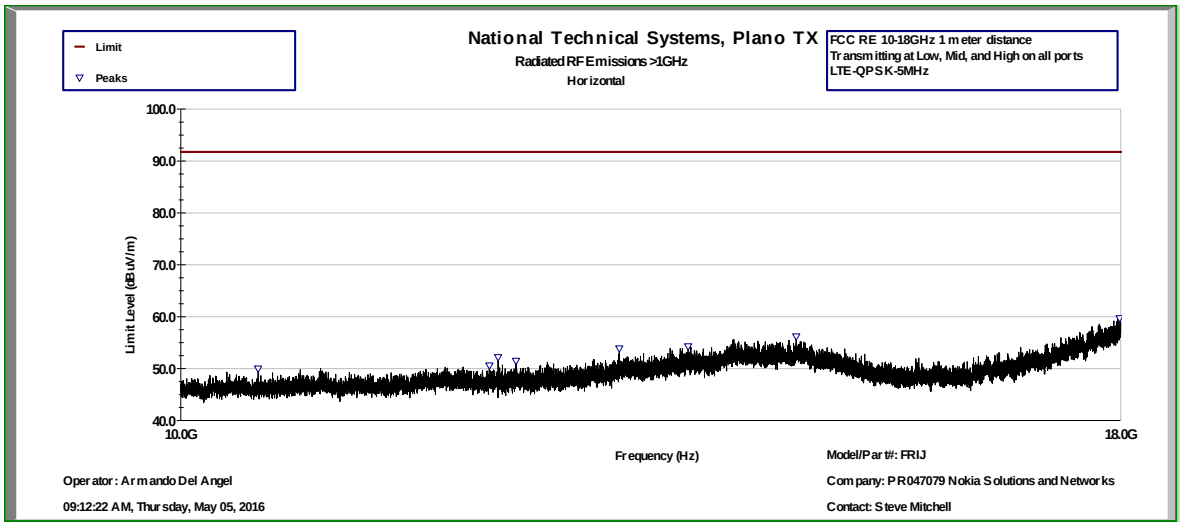
1GHz – 10GHz Peak Prescan at 3m – H



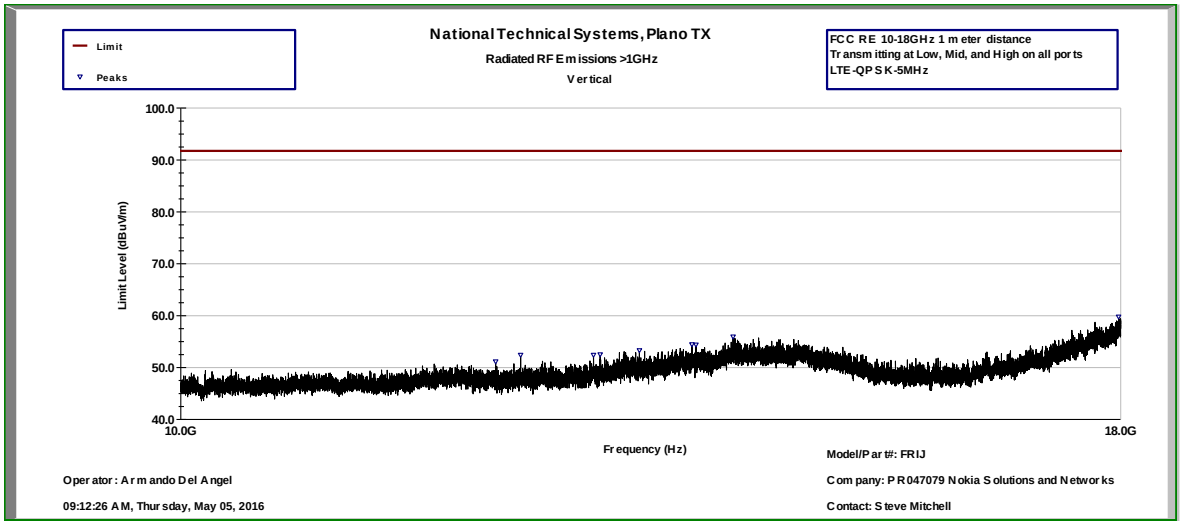
1GHz – 10GHz Peak Prescan at 3m – V



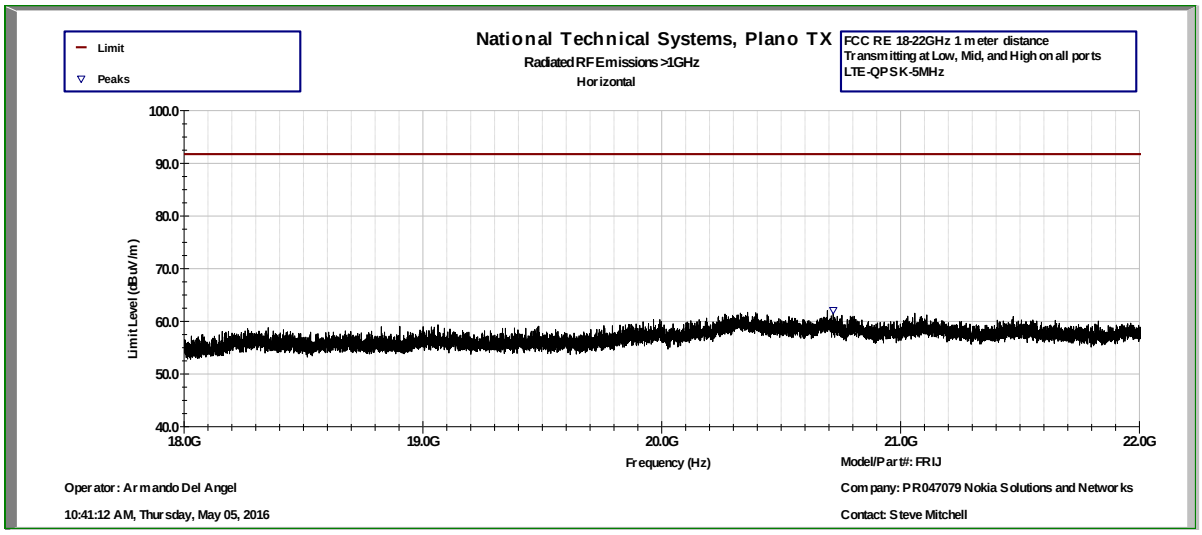
10GHz – 18GHz Peak Prescan at 1m – H



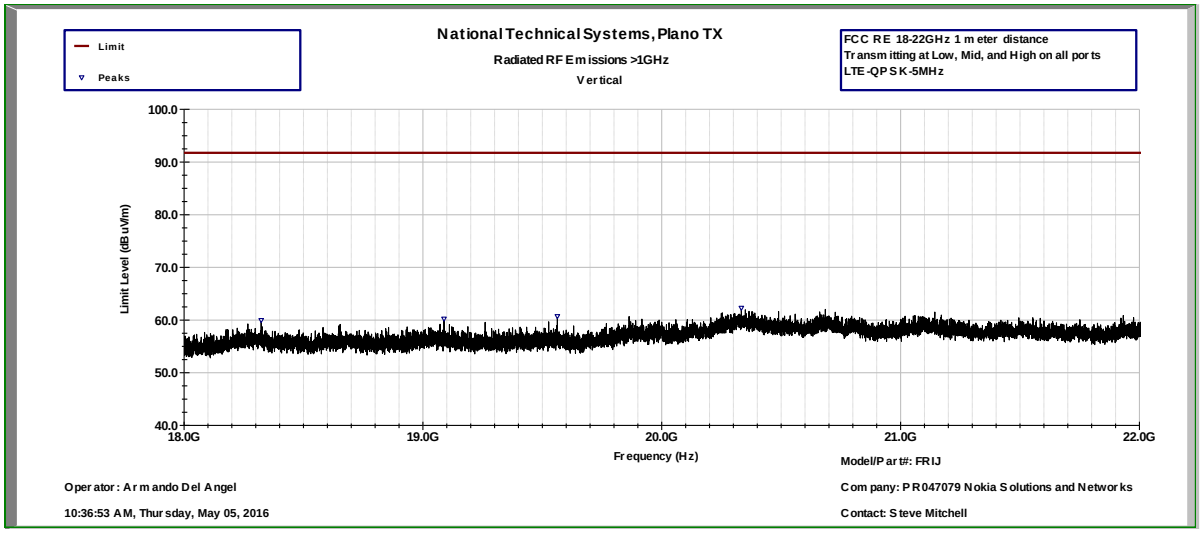
10GHz – 18GHz Peak Prescan at 1m – V



18GHz – 22GHz Peak Prescan at 1m – H



18GHz – 22GHz Peak Prescan at 1m – V



Frequency Stability

In order to demonstrate carrier frequency stability at extreme temperatures and voltages, frequency Bandedge was measured in the following configuration (Worst case from conducted Port Bandedge measurement):

Transmitting in 5MHz-QPSK-LTE mode at Low channel and High Channel on port 4.

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

Amplitude at the bandedges are compared with the limit used during the bandedge measurement (-19.02dBm).

Extreme Voltages

	2110MHz	2200MHz	Limit
20C	**Amplitude (dBm)**	**Amplitude(dBm)**	**dBm**
40.8Vdc	-22.38dBm	-25.99dBm	-19.01dBm
55.2Vdc	-22.78dBm	-27.59dBm	

Extreme Temperatures

48Vdc	2110MHz	2200MHz	Limit
	Amplitude (dBm)	**Amplitude(dBm)**	**dBm**
50C	-21.499dBm	-21.149dBm	-19.01dBm
40C	-21.594dBm	-23.188dBm	
30C	-22.795dBm	-27.9dBm	
20C	-21.646dBm	-25.96dBm	
10C	-22.177dBm	-27.7dBm	
0C	-23.09dBm	-26.62dBm	
-10C	-22.98dBm	-27.613dBm	
-20C	-24.411dBm	-26.92dBm	
-30C	-21.44dBm	-22.837dBm	

Based on the results above, highest amplitude at any bandedge was -21.44dBm, which ensures that the transmitted signal remains in its authorized frequency block at extreme voltages and temperatures.

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

Appendix B Test Data With Notch Filter

(All conducted RF measurements were made at the external notch filter (Filtronics P/N: US-PSD015-F1V1) output port. The notch filter was connected to the FRIJ port 4 (highest power antenna port) via low loss cable.)

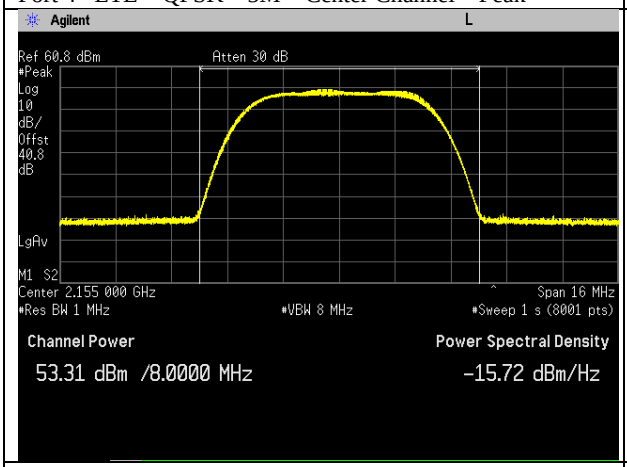
RF Output Power

RF output power has been measured in both Peak and RMS Average terms for each transmit chain at the center channel for all modulations and bandwidth modes. Peak to average ratio (PAR) has been calculated as described in Section 5.7.2 of KDB971168 D01 v02r02 and all results are presented in tabular form below. Based on the results from the measurements performed without the notch filter, Port 4 had the highest RMS average power and therefore it was selected for all the port tests on the product. Measurements made at the external notch filter (Filtronics p/n: US-PSD015-F1V1) output port using FRIJ Ant 4.

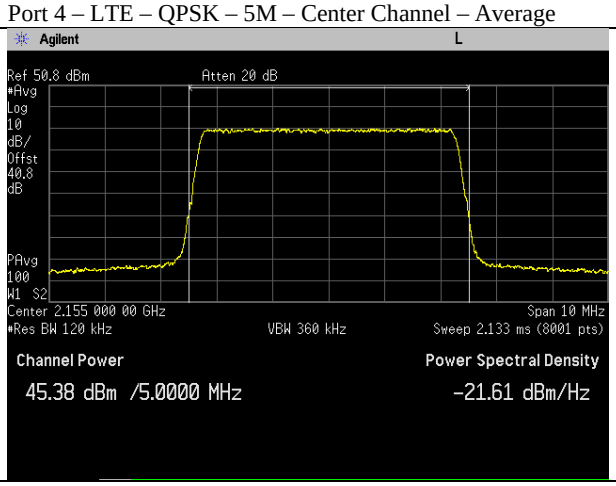
		LTE - QPSK			LTE - 16QAM			LTE - 64QAM		
		Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)	Peak (dBm)	Average (dBm)	PAR (dB)
Port 4 Low Channel	5M	53.49	45.56	7.93	53.43	45.66	7.77	53.51	45.68	7.83
	10M	53.77	45.68	8.09	53.83	45.68	8.15	53.74	45.72	8.02
	15M	53.83	45.76	8.07	53.86	45.78	8.08	53.79	45.68	8.11
	20M	53.8	45.62	8.18	53.81	45.73	8.08	53.87	45.72	8.15
Port 4 Middle Channel	5M	53.31	45.38	7.93	53.24	45.5	7.74	53.42	45.45	7.97
	10M	53.47	45.39	8.08	53.5	45.49	8.01	53.56	45.53	8.03
	15M	53.57	45.38	8.19	53.71	45.51	8.2	53.53	45.5	8.03
	20M	53.62	45.51	8.11	53.61	45.47	8.14	53.6	45.39	8.21
Port 4 Top Channel	5M	53.13	45.33	7.8	53.03	45.27	7.76	53.14	45.23	7.91
	10M	53.45	45.45	8	53.51	45.37	8.14	53.47	45.39	8.08
	15M	53.57	45.48	8.09	53.66	45.55	8.11	53.55	45.54	8.01
	20M	53.66	45.51	8.15	53.7	45.51	8.19	53.6	45.49	8.11

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

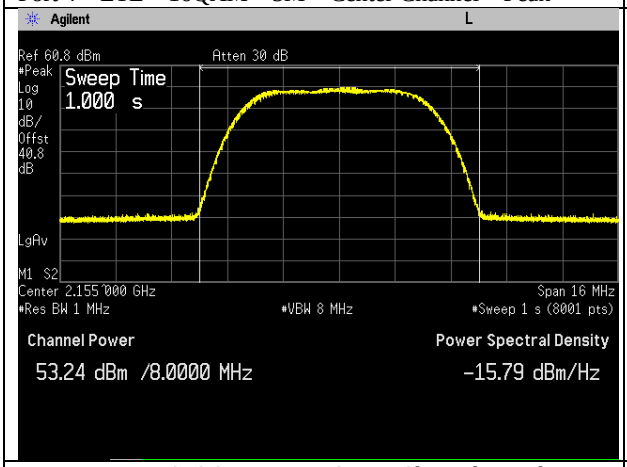
Port 4– LTE – QPSK – 5M – Center Channel – Peak



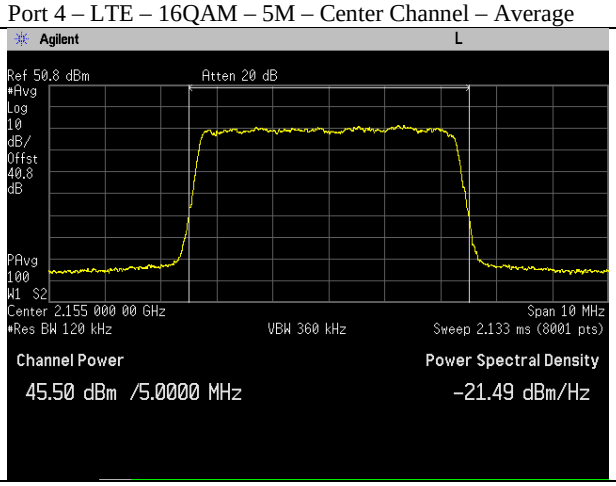
Port 4 – LTE – QPSK – 5M – Center Channel – Average



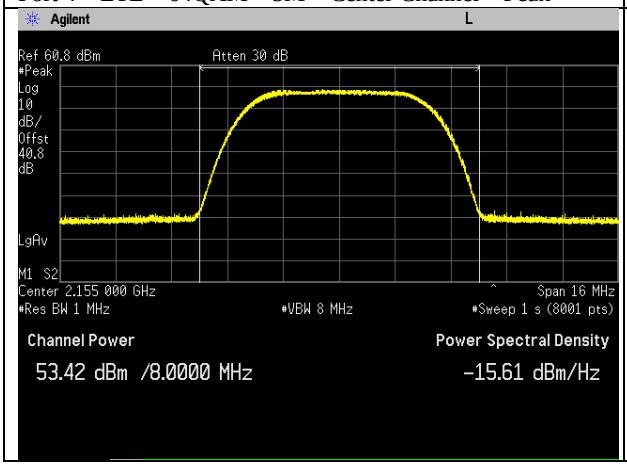
Port 4 – LTE – 16QAM – 5M – Center Channel – Peak



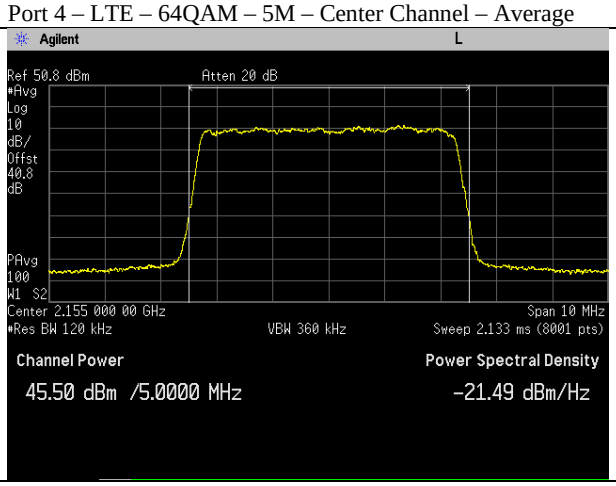
Port 4 – LTE – 16QAM – 5M – Center Channel – Average



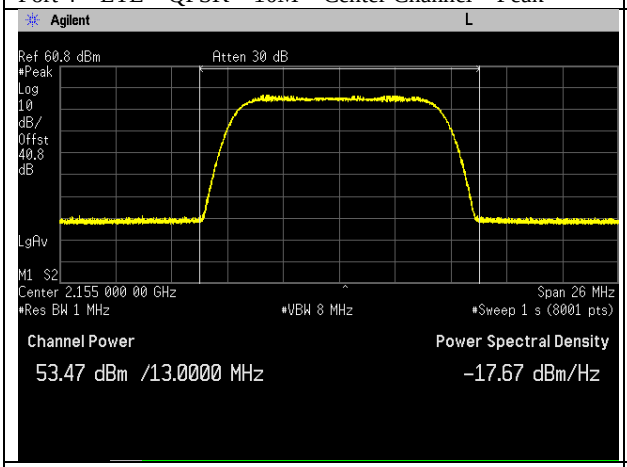
Port 4 – LTE – 64QAM – 5M – Center Channel – Peak



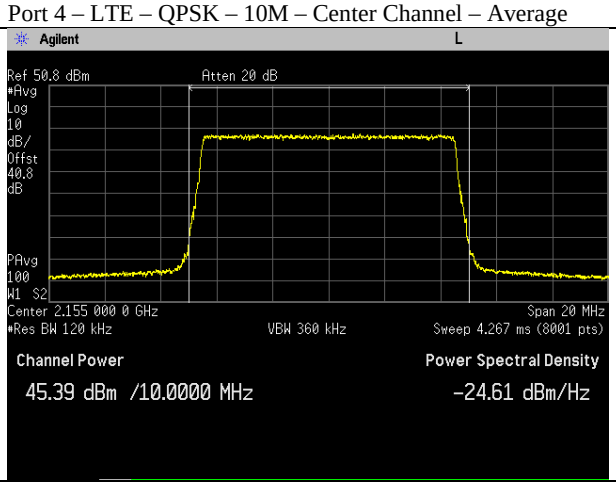
Port 4 – LTE – 64QAM – 5M – Center Channel – Average



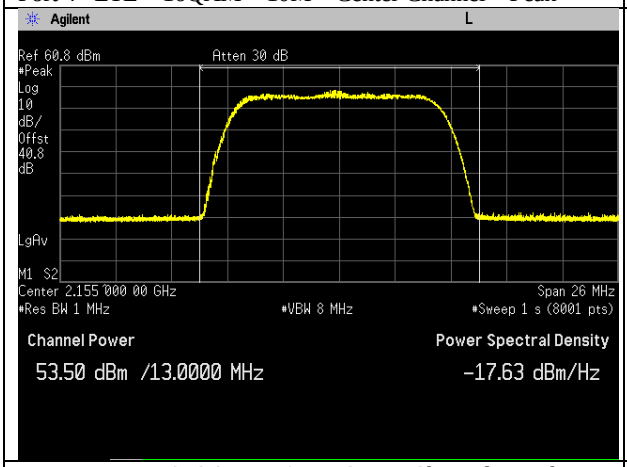
Port 4 – LTE – QPSK – 10M – Center Channel – Peak



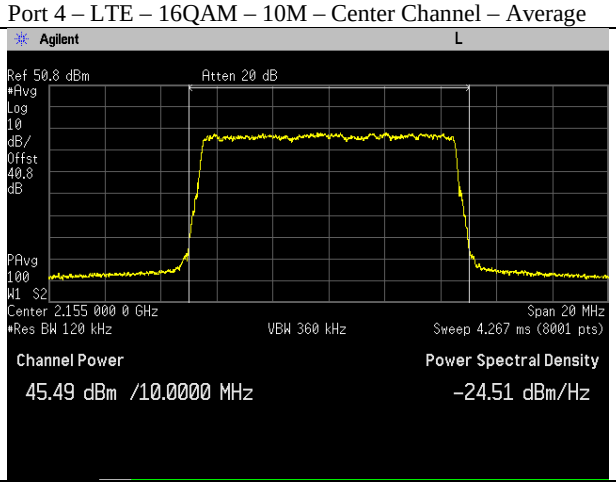
Port 4 – LTE – QPSK – 10M – Center Channel – Average



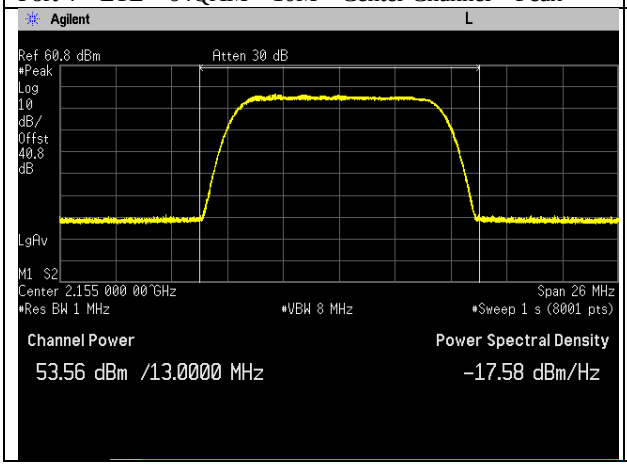
Port 4– LTE – 16QAM – 10M – Center Channel – Peak



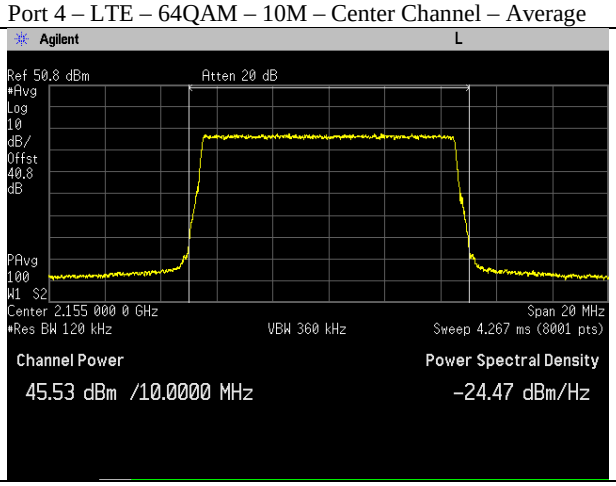
Port 4 – LTE – 16QAM – 10M – Center Channel – Average



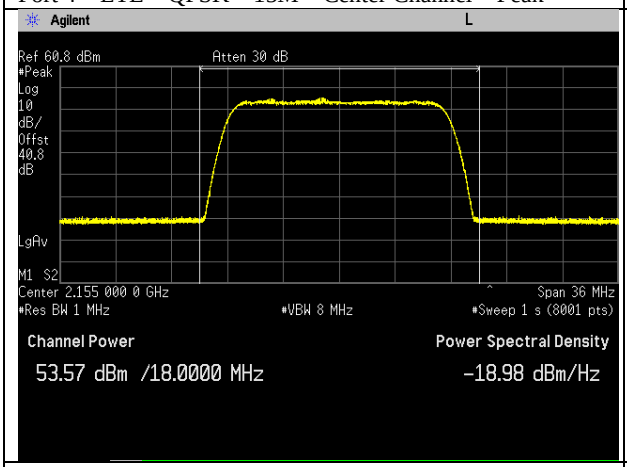
Port 4 – LTE – 64QAM – 10M – Center Channel – Peak



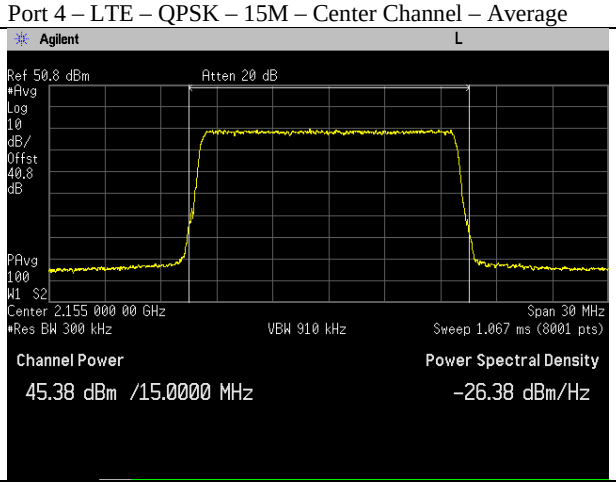
Port 4 – LTE – 64QAM – 10M – Center Channel – Average



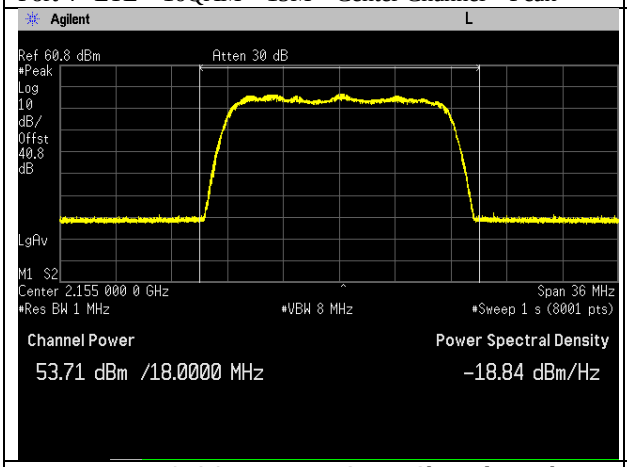
Port 4 – LTE – QPSK – 15M – Center Channel – Peak



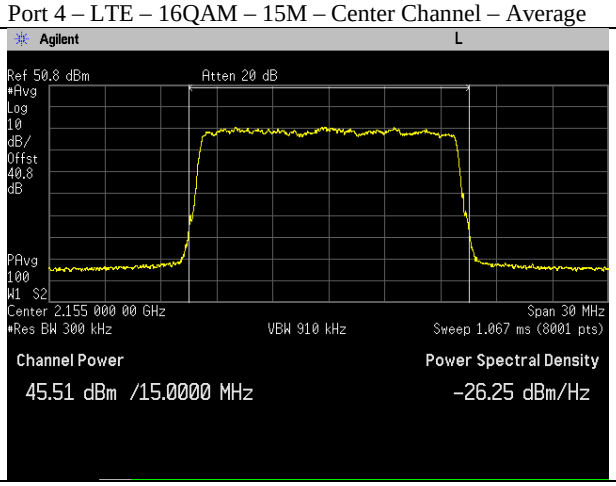
Port 4 – LTE – QPSK – 15M – Center Channel – Average



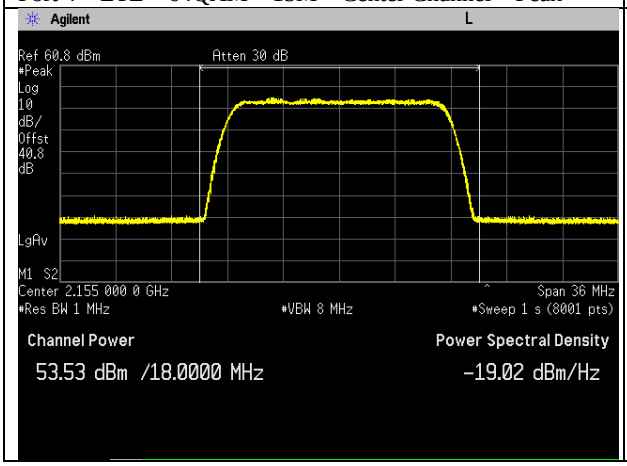
Port 4– LTE – 16QAM – 15M – Center Channel – Peak



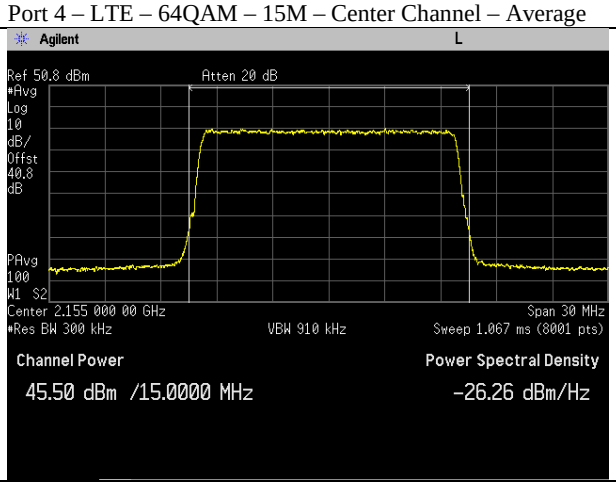
Port 4 – LTE – 16QAM – 15M – Center Channel – Average



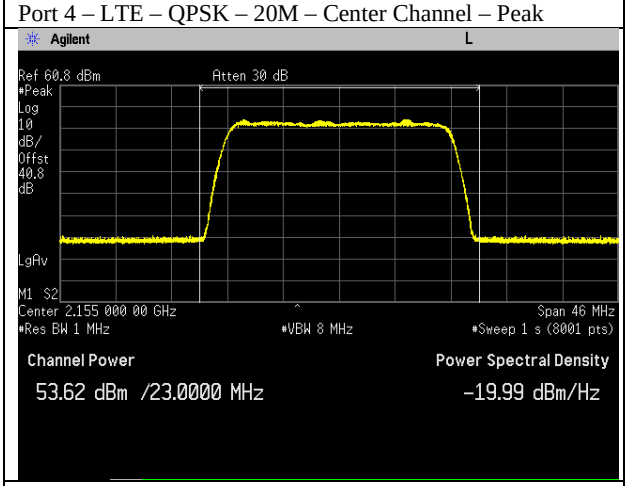
Port 4 – LTE – 64QAM – 15M – Center Channel – Peak



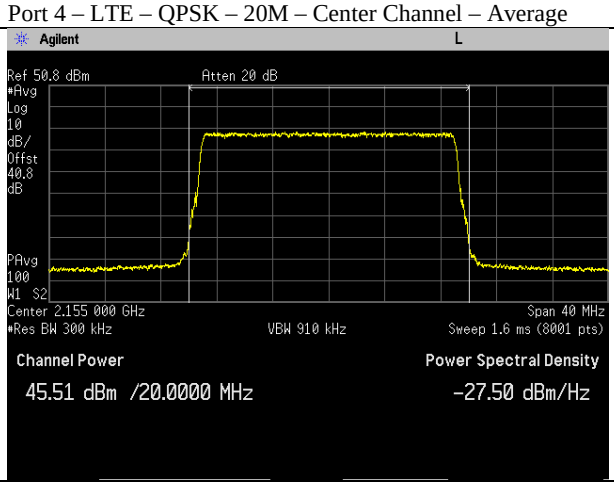
Port 4 – LTE – 64QAM – 15M – Center Channel – Average



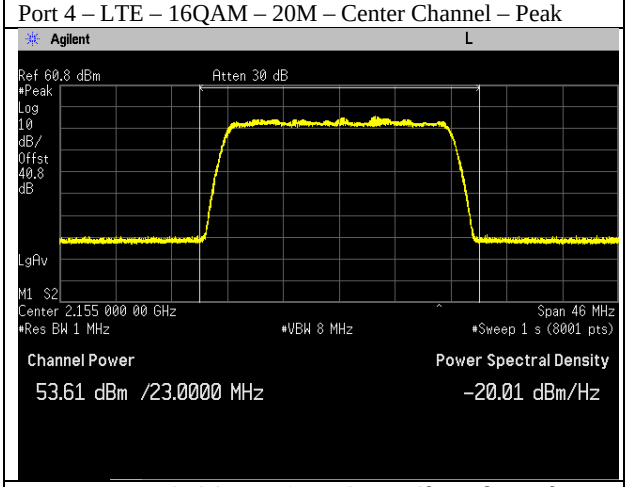
Port 4 – LTE – QPSK – 20M – Center Channel – Peak



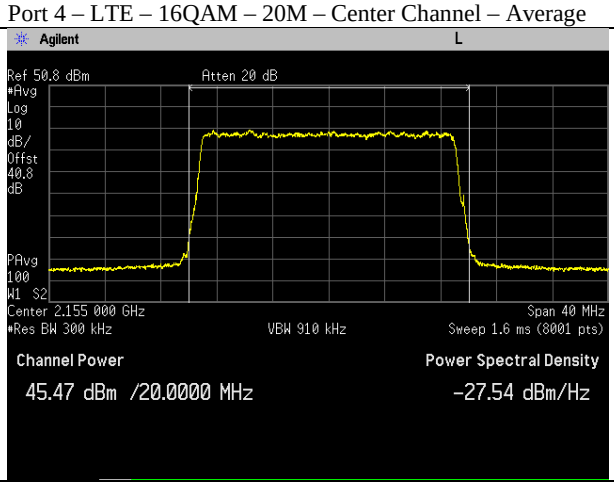
Port 4 – LTE – QPSK – 20M – Center Channel – Average



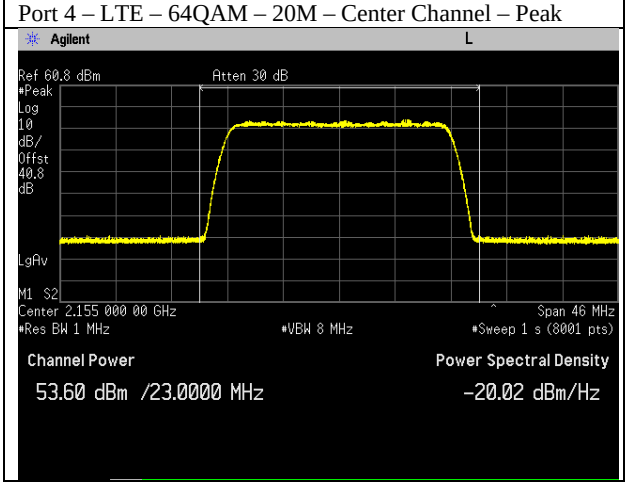
Port 4 – LTE – 16QAM – 20M – Center Channel – Peak



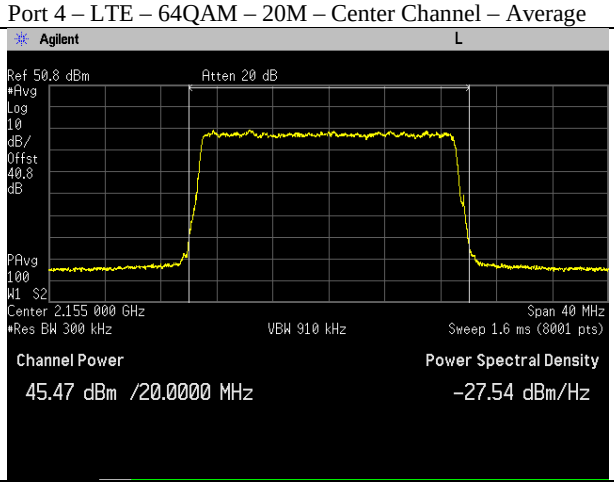
Port 4 – LTE – 16QAM – 20M – Center Channel – Average



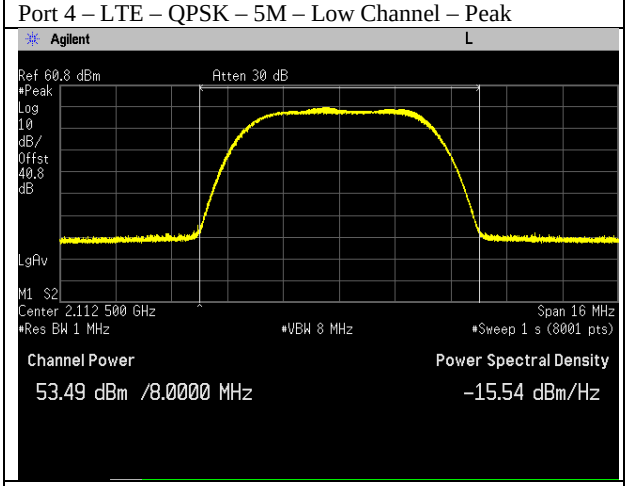
Port 4 – LTE – 64QAM – 20M – Center Channel – Peak



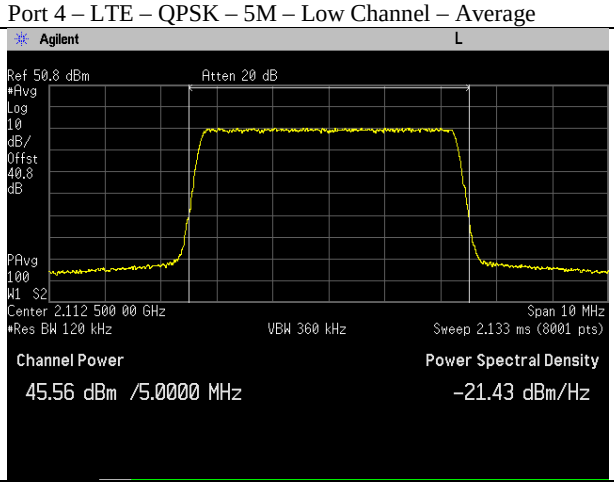
Port 4 – LTE – 64QAM – 20M – Center Channel – Average



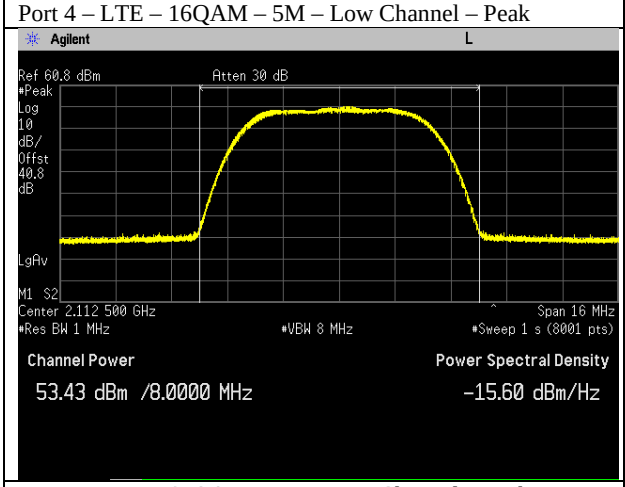
Port 4 – LTE – QPSK – 5M – Low Channel – Peak



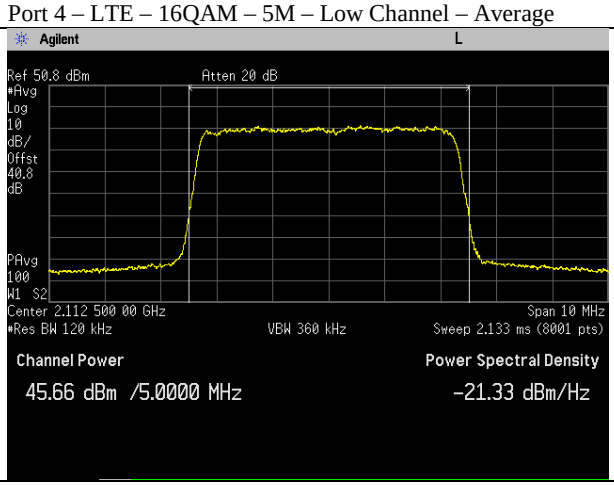
Port 4 – LTE – QPSK – 5M – Low Channel – Average



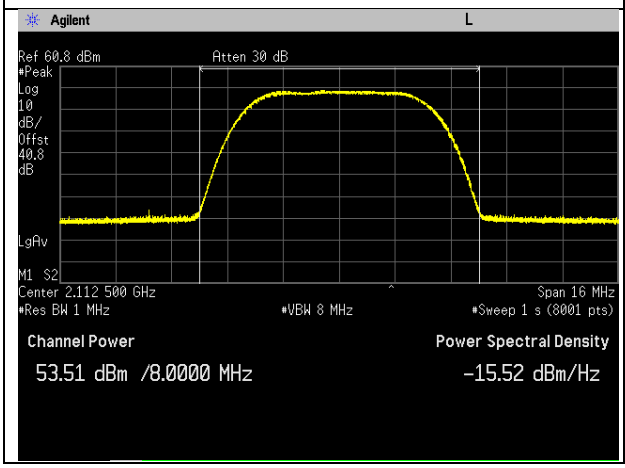
Port 4 – LTE – 16QAM – 5M – Low Channel – Peak



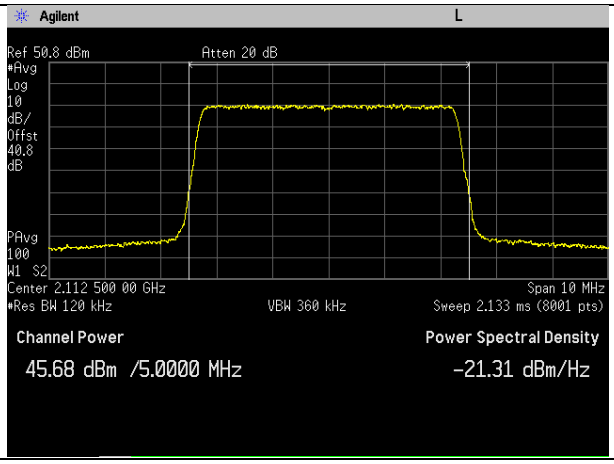
Port 4 – LTE – 16QAM – 5M – Low Channel – Average



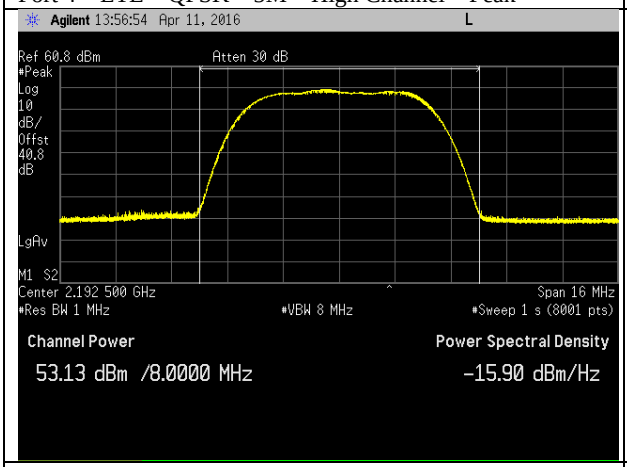
Port 4 – LTE – 64QAM – 5M – Low Channel – Peak



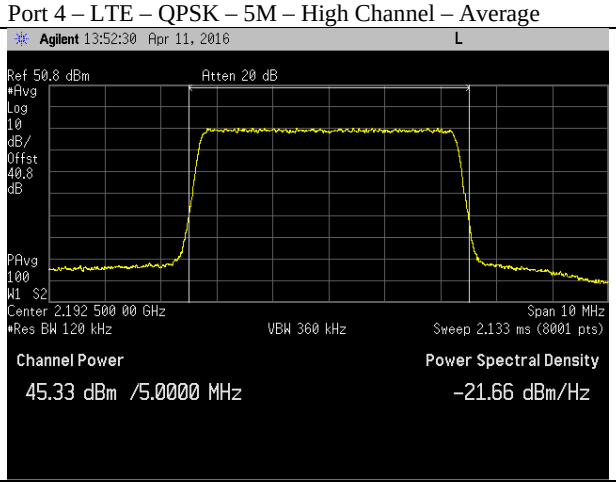
Port 4 – LTE – 64QAM – 5M – Low Channel – Average



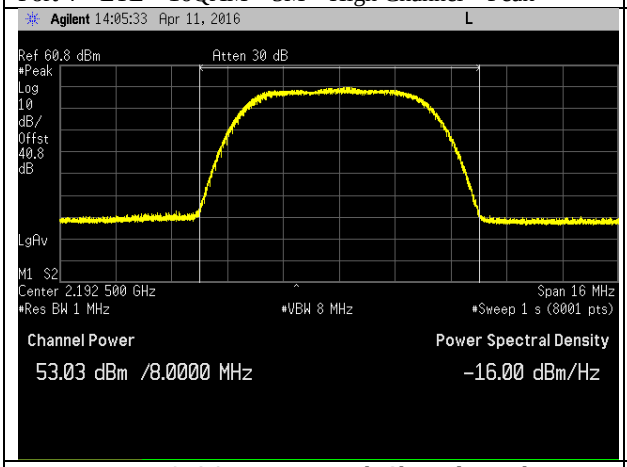
Port 4 – LTE – QPSK – 5M – High Channel – Peak



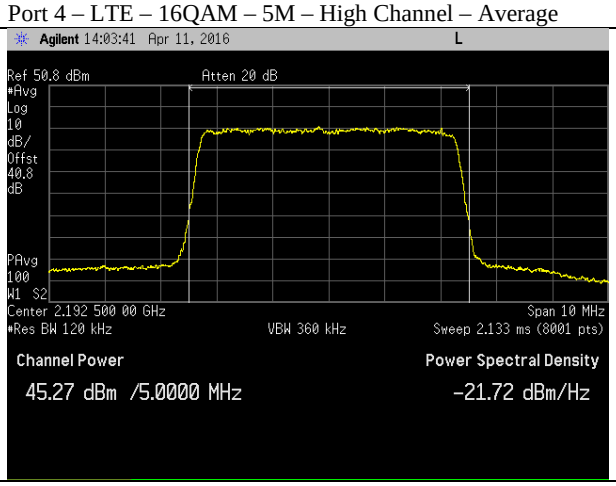
Port 4 – LTE – QPSK – 5M – High Channel – Average



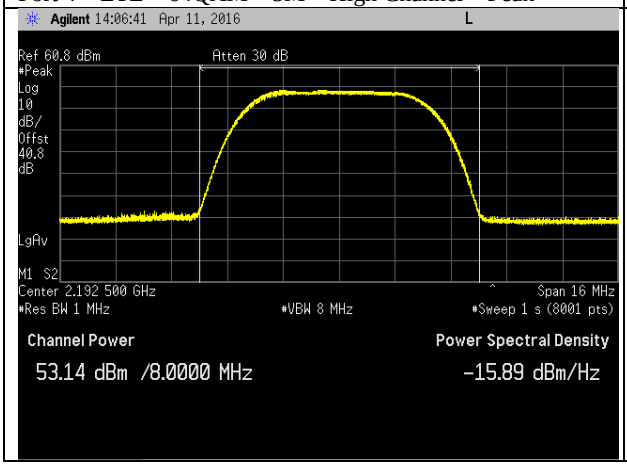
Port 4 – LTE – 16QAM – 5M – High Channel – Peak



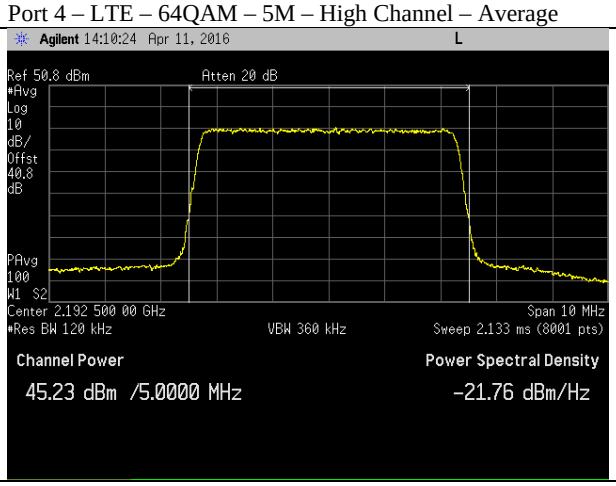
Port 4 – LTE – 16QAM – 5M – High Channel – Average



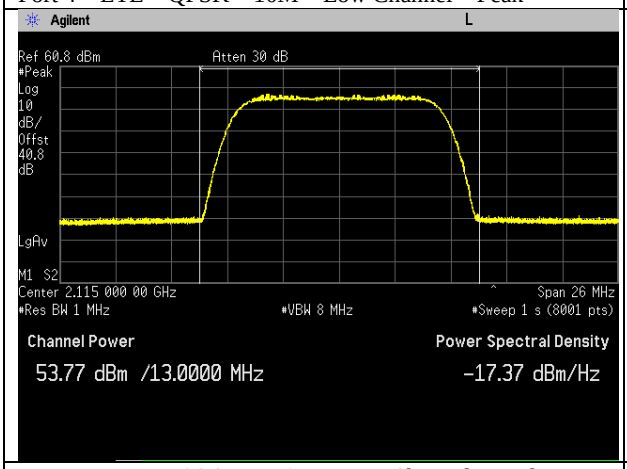
Port 4 – LTE – 64QAM – 5M – High Channel – Peak



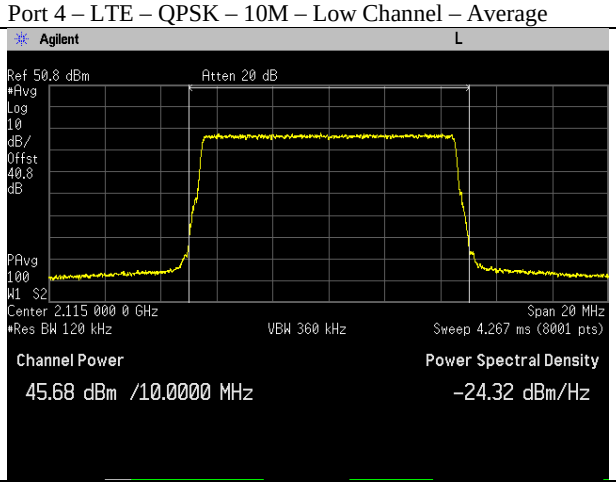
Port 4 – LTE – 64QAM – 5M – High Channel – Average



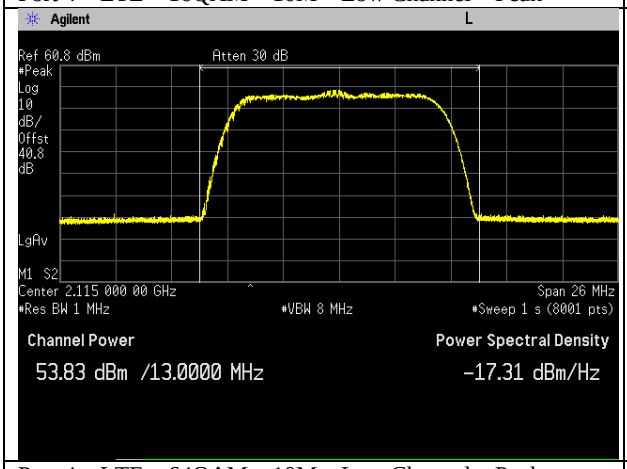
Port 4 – LTE – QPSK – 10M – Low Channel – Peak



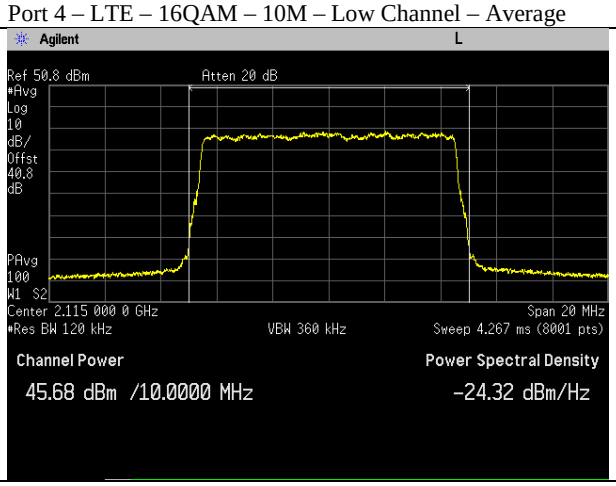
Port 4 – LTE – QPSK – 10M – Low Channel – Average



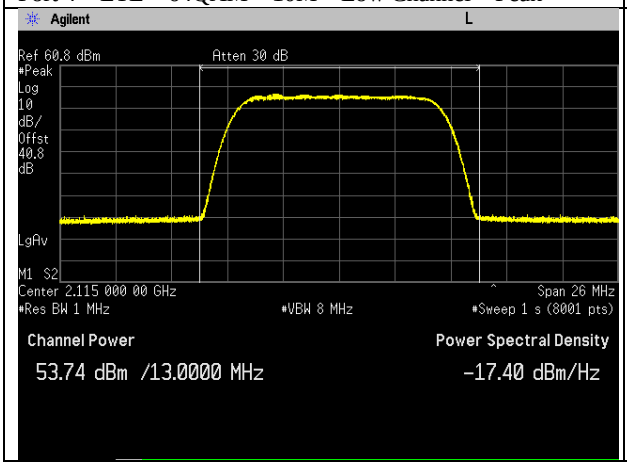
Port 4 – LTE – 16QAM – 10M – Low Channel – Peak



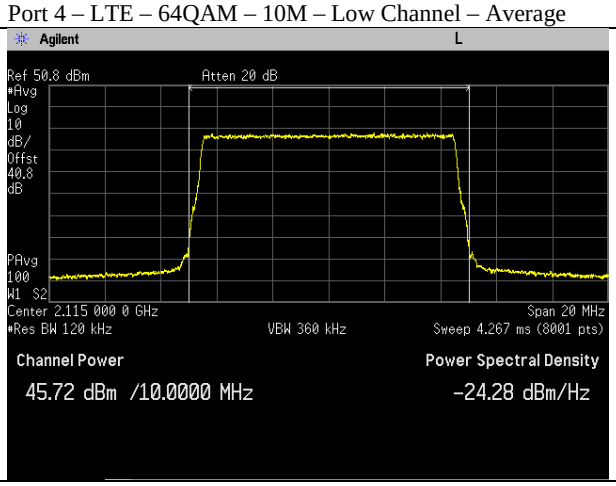
Port 4 – LTE – 16QAM – 10M – Low Channel – Average



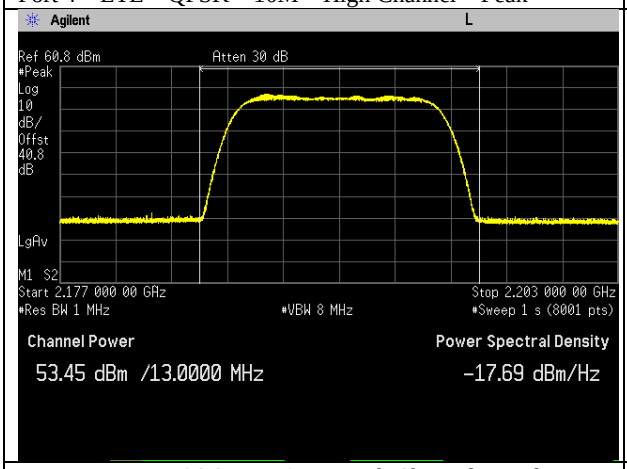
Port 4 – LTE – 64QAM – 10M – Low Channel – Peak



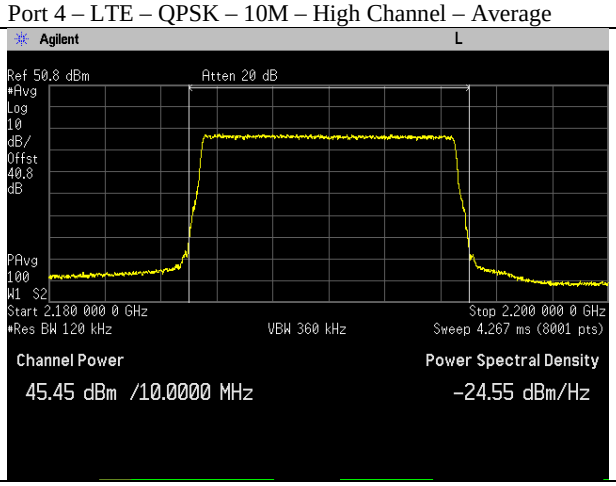
Port 4 – LTE – 64QAM – 10M – Low Channel – Average



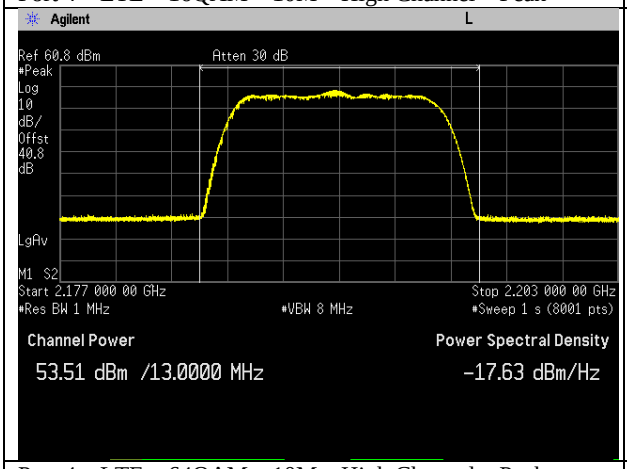
Port 4 – LTE – QPSK – 10M – High Channel – Peak



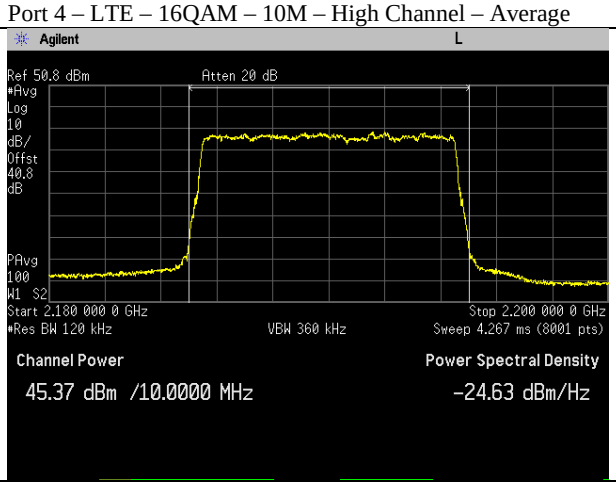
Port 4 – LTE – QPSK – 10M – High Channel – Average



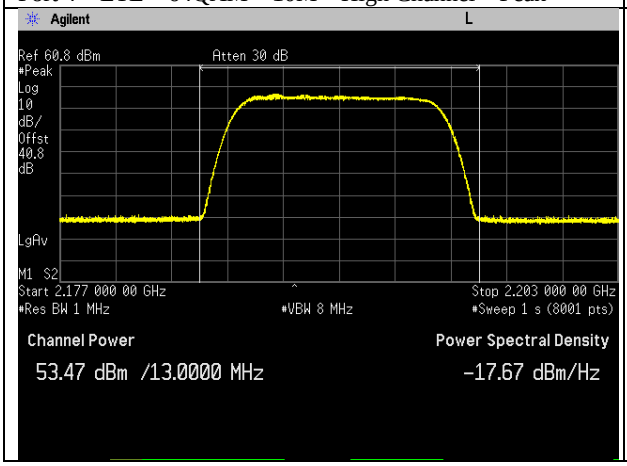
Port 4 – LTE – 16QAM – 10M – High Channel – Peak



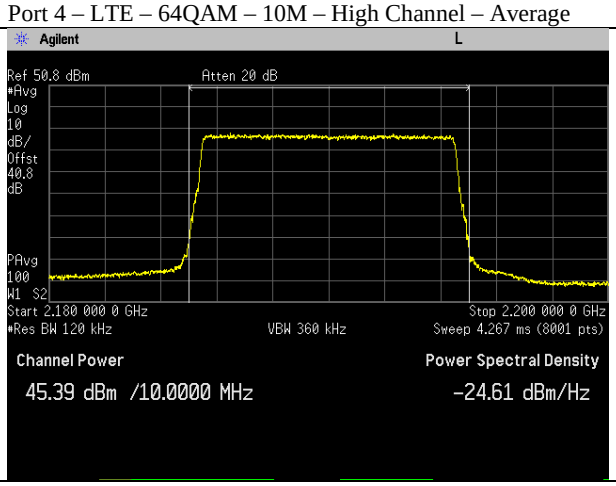
Port 4 – LTE – 16QAM – 10M – High Channel – Average



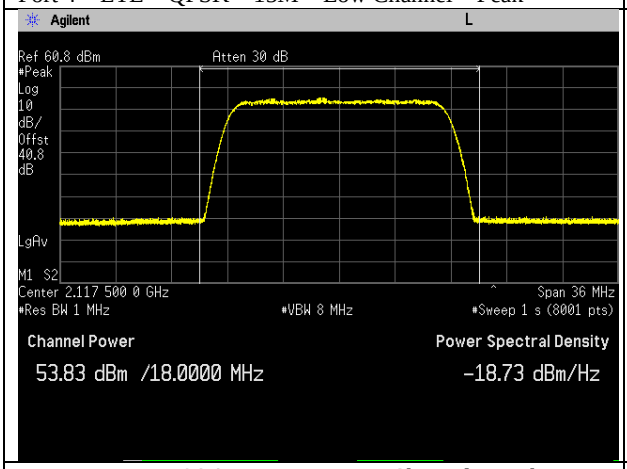
Port 4 – LTE – 64QAM – 10M – High Channel – Peak



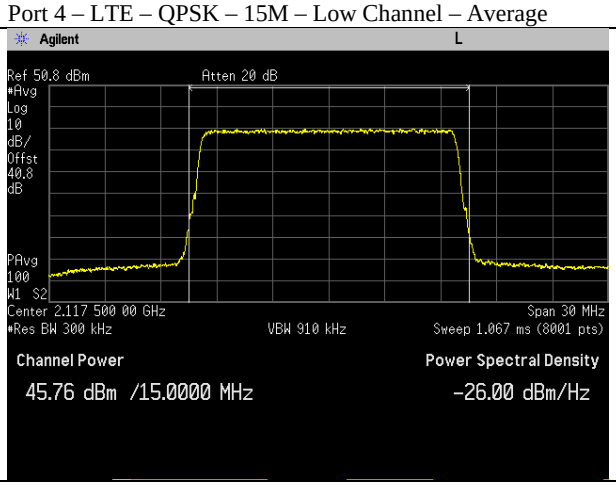
Port 4 – LTE – 64QAM – 10M – High Channel – Average



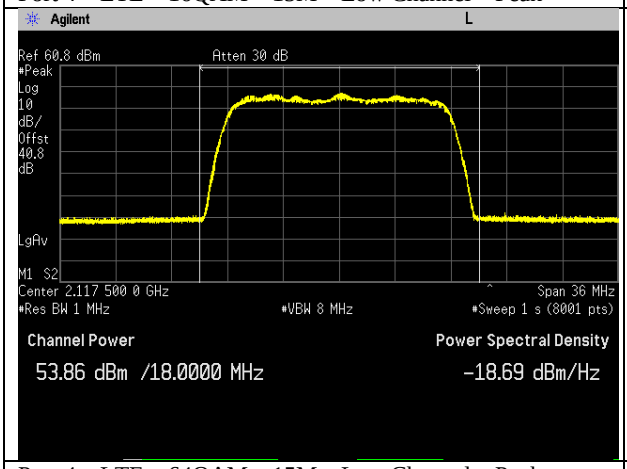
Port 4 – LTE – QPSK – 15M – Low Channel – Peak



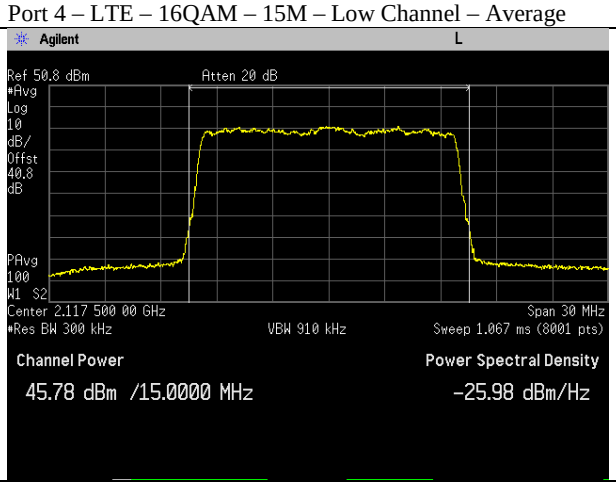
Port 4 – LTE – QPSK – 15M – Low Channel – Average



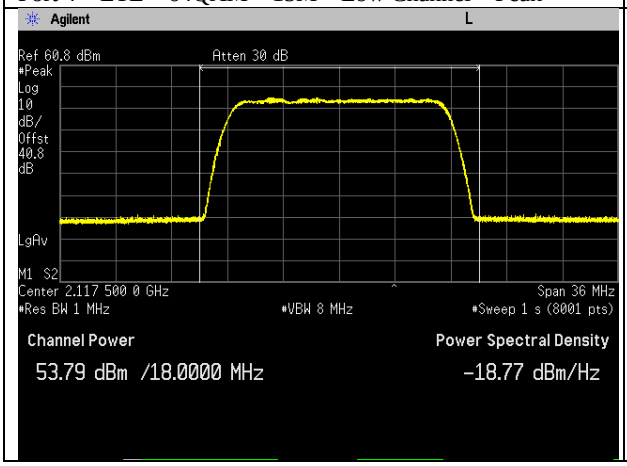
Port 4 – LTE – 16QAM – 15M – Low Channel – Peak



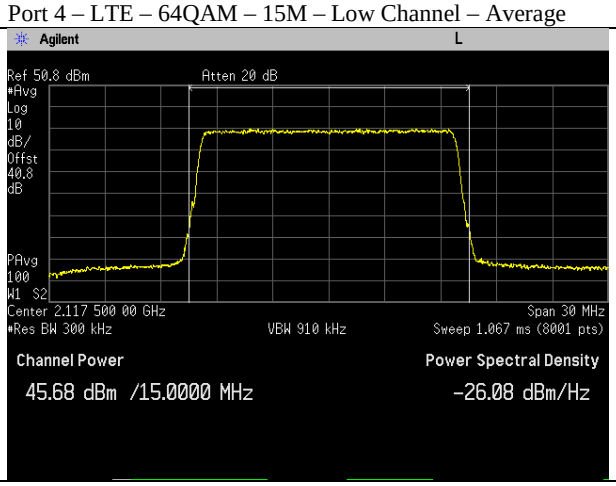
Port 4 – LTE – 16QAM – 15M – Low Channel – Average



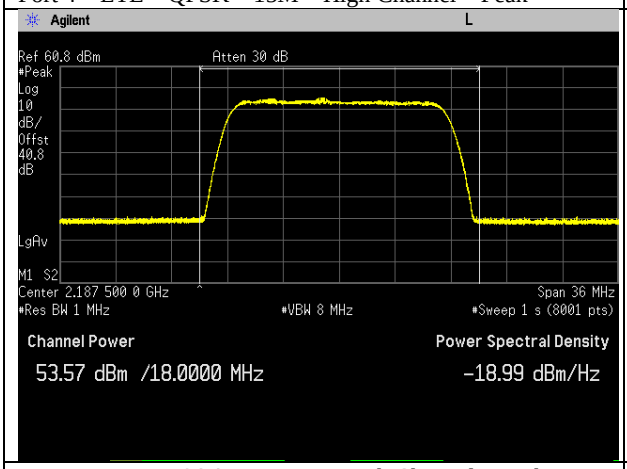
Port 4 – LTE – 64QAM – 15M – Low Channel – Peak



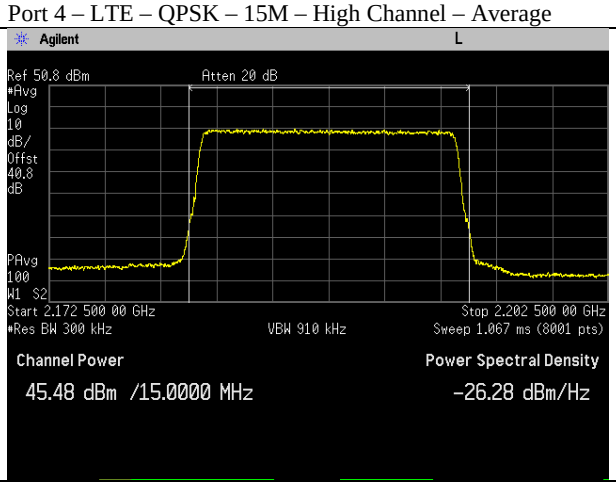
Port 4 – LTE – 64QAM – 15M – Low Channel – Average



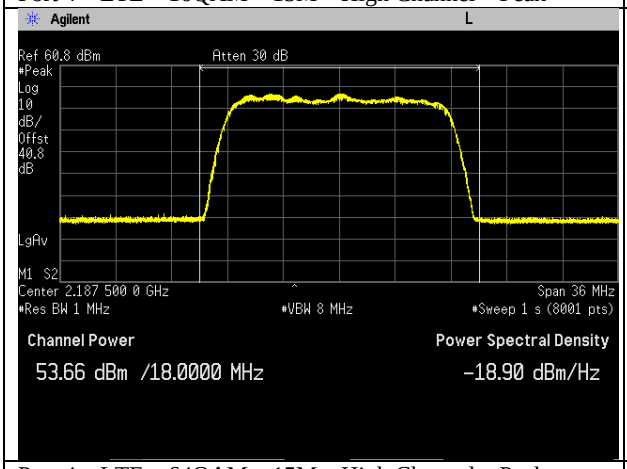
Port 4 – LTE – QPSK – 15M – High Channel – Peak



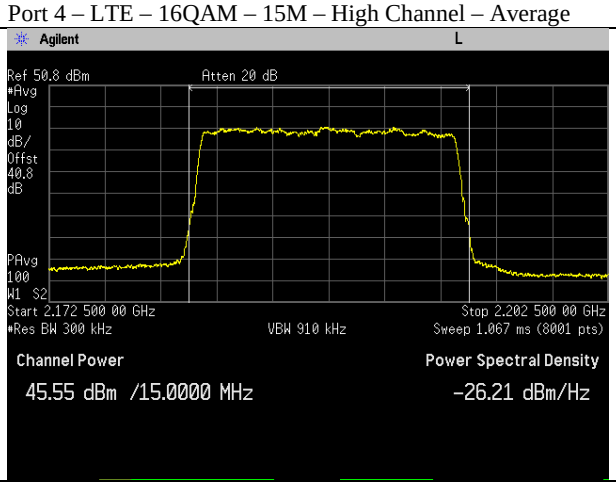
Port 4 – LTE – QPSK – 15M – High Channel – Average



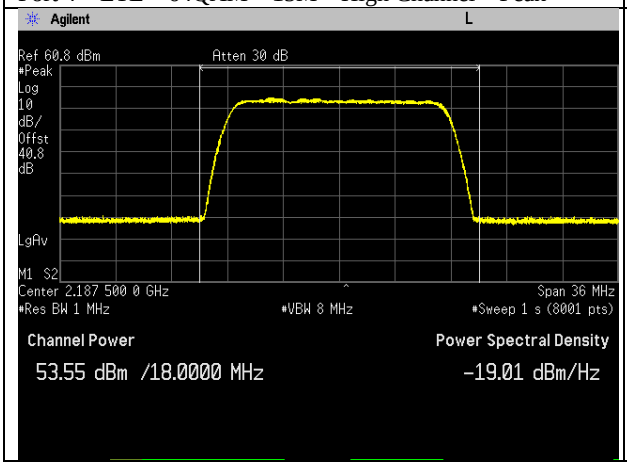
Port 4 – LTE – 16QAM – 15M – High Channel – Peak



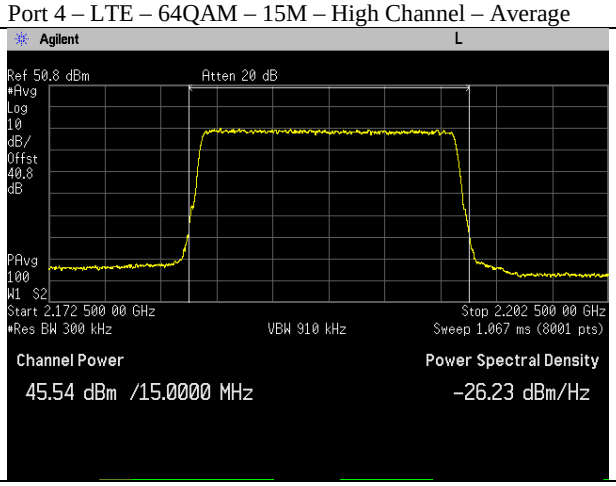
Port 4 – LTE – 16QAM – 15M – High Channel – Average



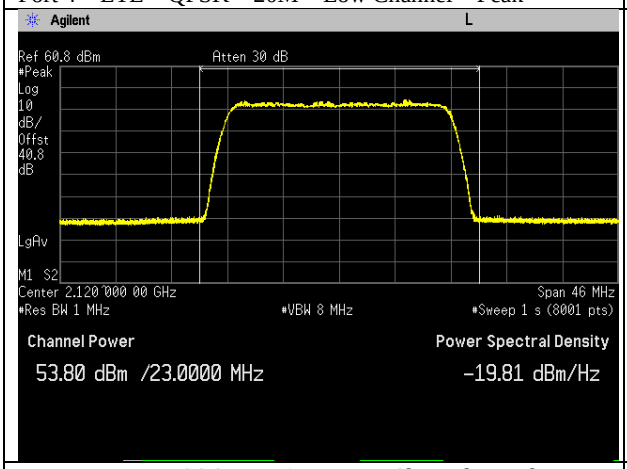
Port 4 – LTE – 64QAM – 15M – High Channel – Peak



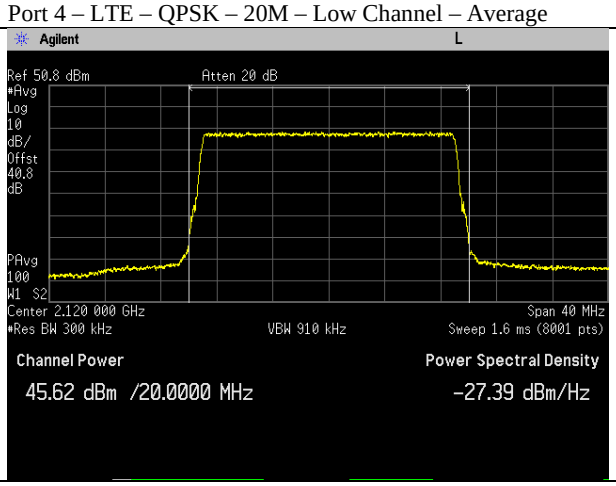
Port 4 – LTE – 64QAM – 15M – High Channel – Average



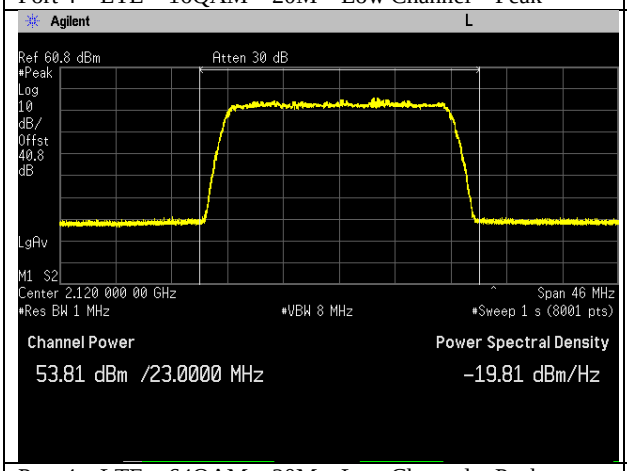
Port 4 – LTE – QPSK – 20M – Low Channel – Peak



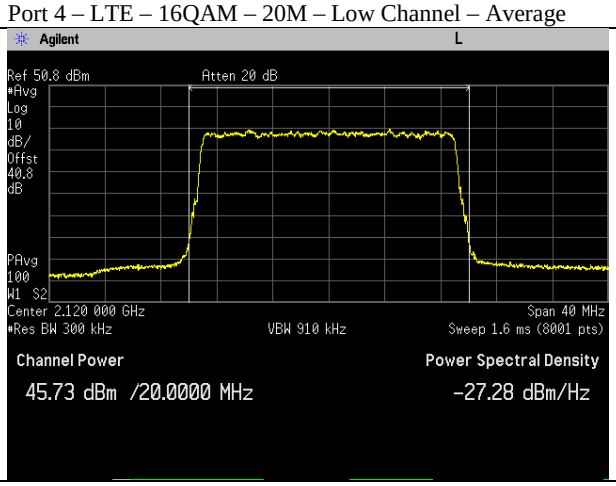
Port 4 – LTE – QPSK – 20M – Low Channel – Average



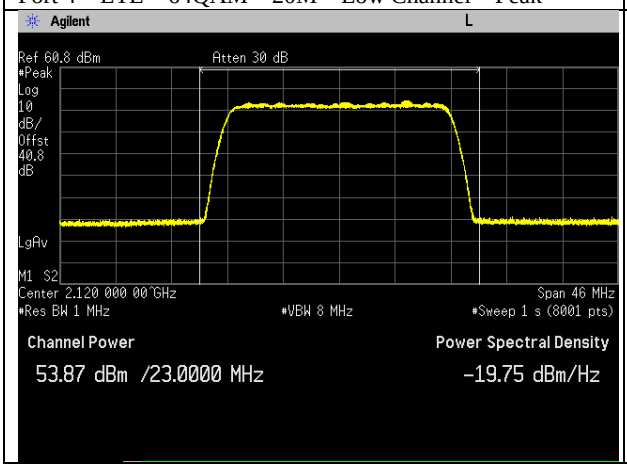
Port 4 – LTE – 16QAM – 20M – Low Channel – Peak



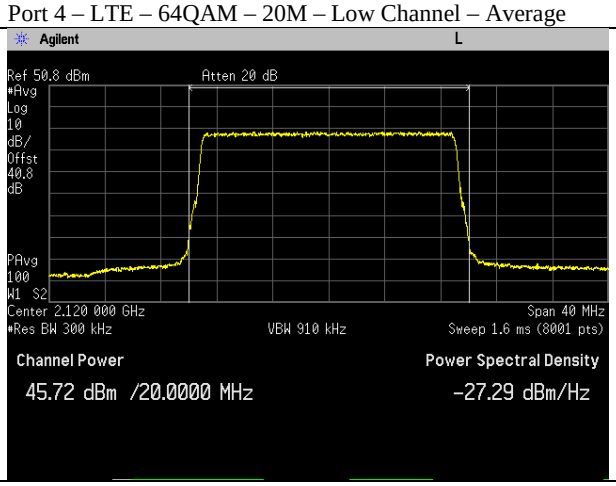
Port 4 – LTE – 16QAM – 20M – Low Channel – Average



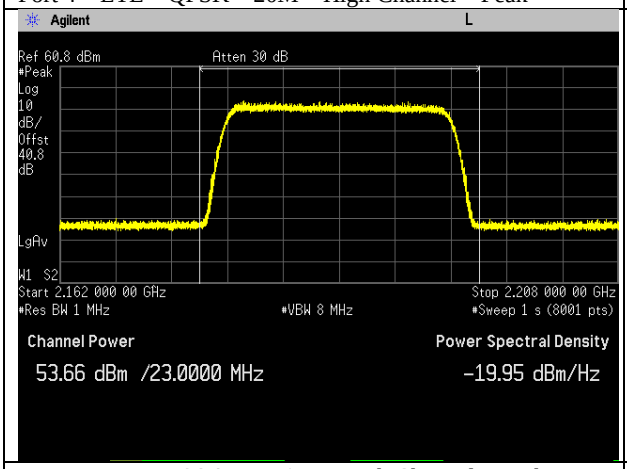
Port 4 – LTE – 64QAM – 20M – Low Channel – Peak



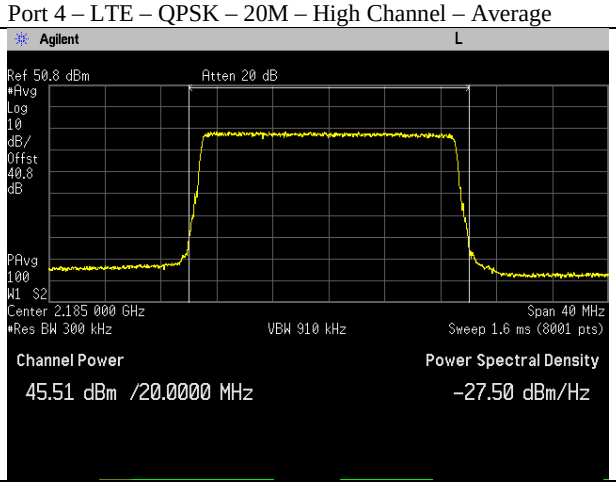
Port 4 – LTE – 64QAM – 20M – Low Channel – Average



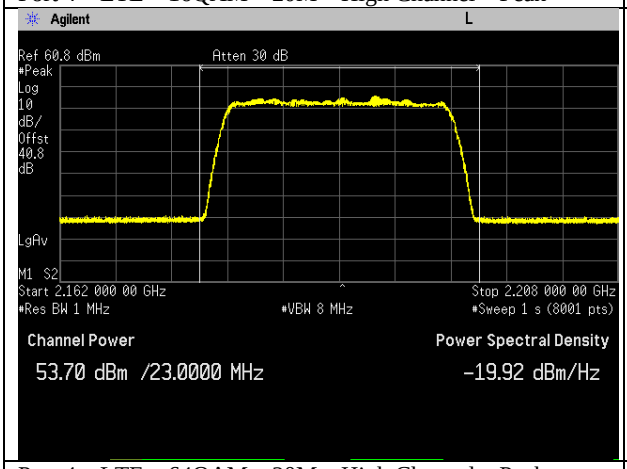
Port 4 – LTE – QPSK – 20M – High Channel – Peak



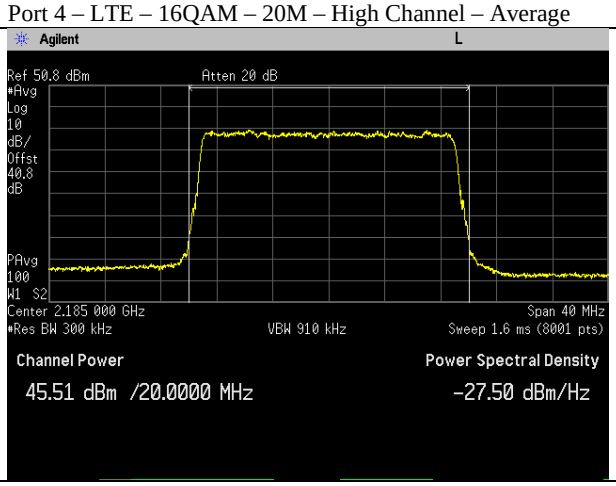
Port 4 – LTE – QPSK – 20M – High Channel – Average



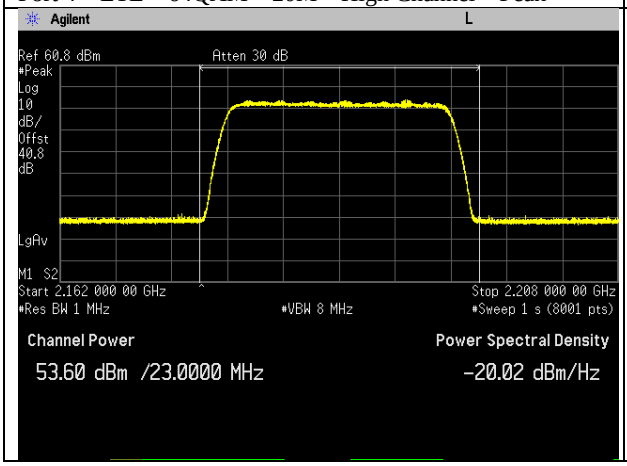
Port 4 – LTE – 16QAM – 20M – High Channel – Peak



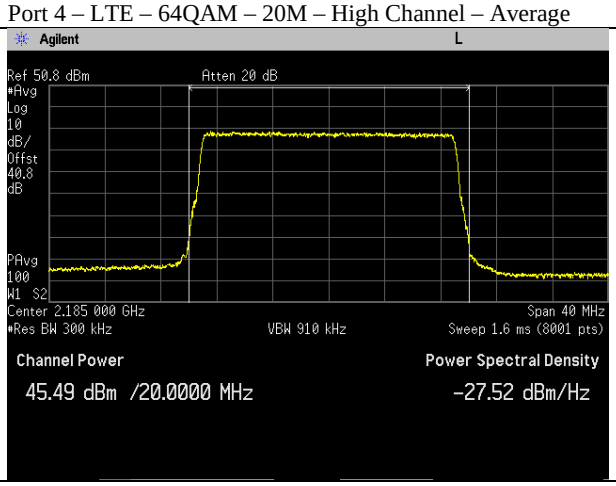
Port 4 – LTE – 16QAM – 20M – High Channel – Average



Port 4 – LTE – 64QAM – 20M – High Channel – Peak



Port 4 – LTE – 64QAM – 20M – High Channel – Average



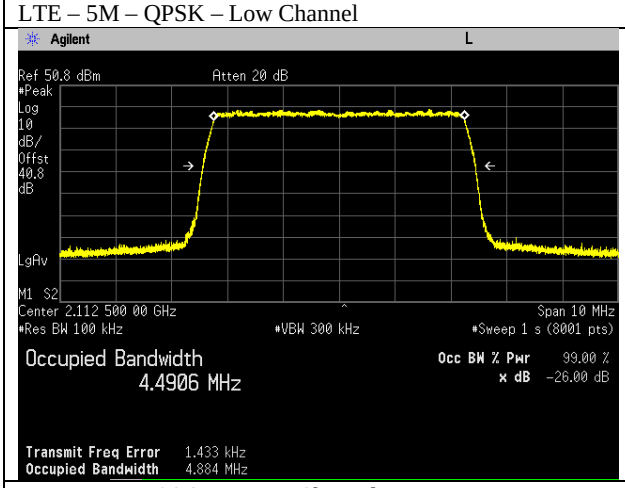
Emission Bandwidths (26dB and 99%)

Emissions bandwidths were measured at the external notch filter (Filtronics p/n: US-PSD015-F1V1) output port using FRIJ Ant 4 on low and high channels in 5MHz, 10MHz, 15MHz, and 20MHz channel bandwidths for all modulations and results presented below.

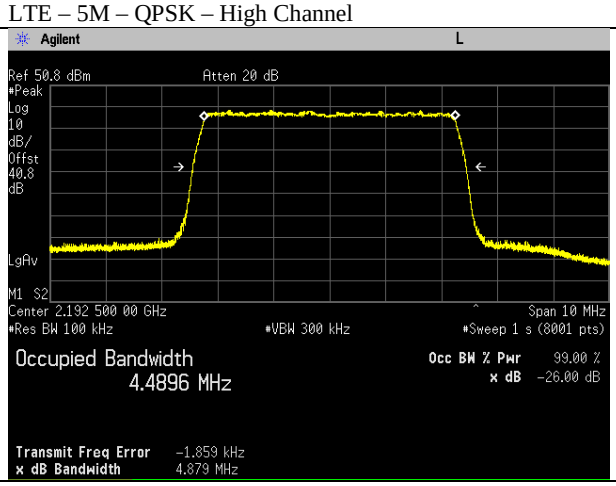
	LTE - QPSK				LTE - 16QAM				LTE - 64QAM			
	Low		High		Low		High		Low		High	
	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)	26dB (MHz)	99% (MHz)
5M	4.884	4.4906	4.879	4.4896	4.854	4.4796	4.862	4.4824	4.881	4.5007	4.88	4.5007
10M	9.732	8.9866	9.72	8.9847	9.714	8.9967	9.718	9.0006	9.751	8.9884	9.765	8.9905
15M	14.579	13.4863	14.567	13.4816	14.52	13.499	14.514	13.4944	14.617	13.4809	14.624	13.4794
20M	19.429	17.9471	19.372	17.9435	19.356	17.9975	19.34	17.9819	19.469	17.956	19.446	17.9429

Corresponding plots included on the following pages.

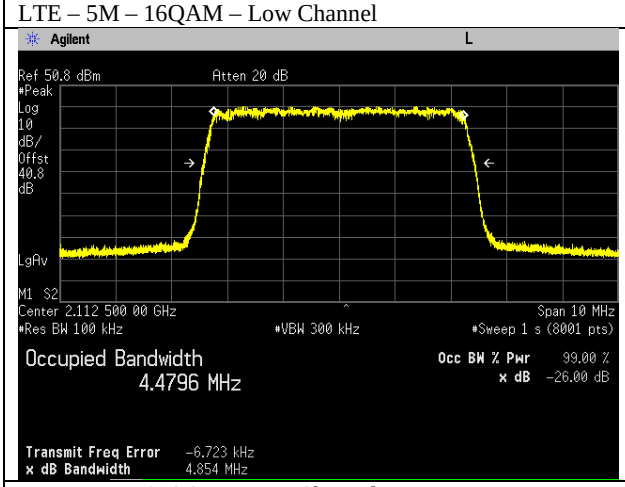
LTE – 5M – QPSK – Low Channel



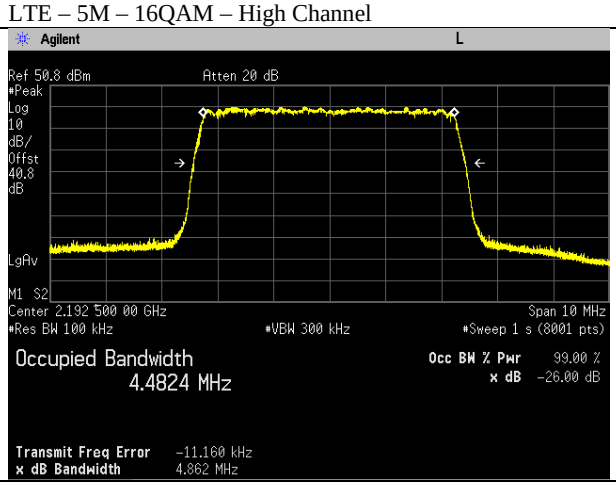
LTE – 5M – QPSK – High Channel



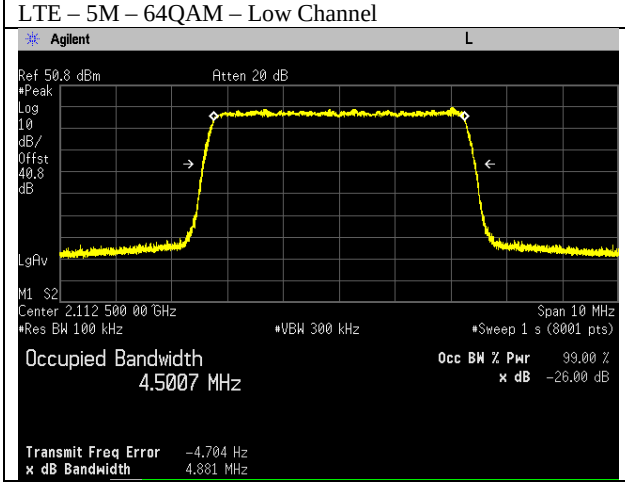
LTE – 5M – 16QAM – Low Channel



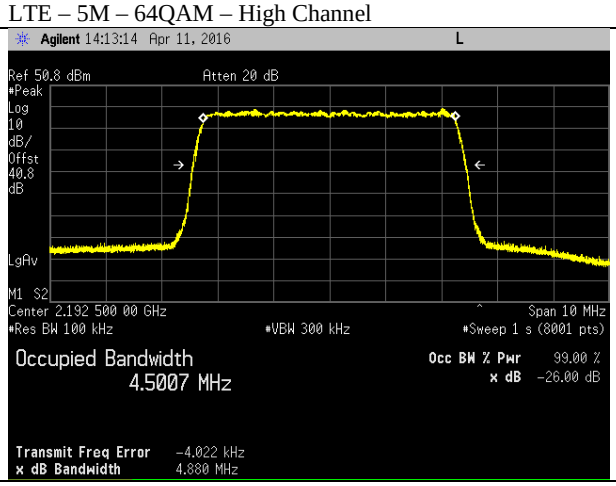
LTE – 5M – 16QAM – High Channel



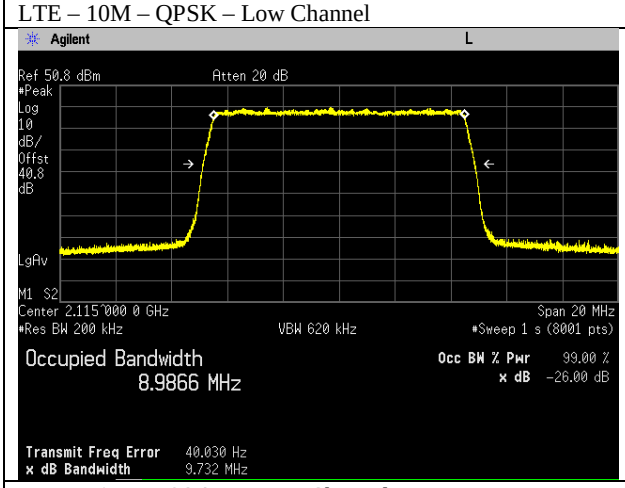
LTE – 5M – 64QAM – Low Channel



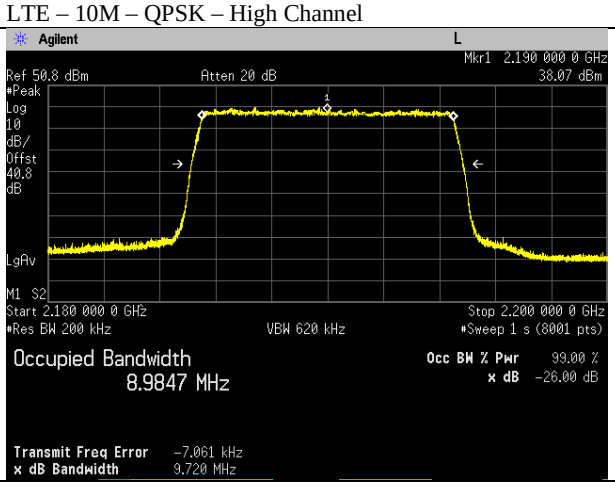
LTE – 5M – 64QAM – High Channel



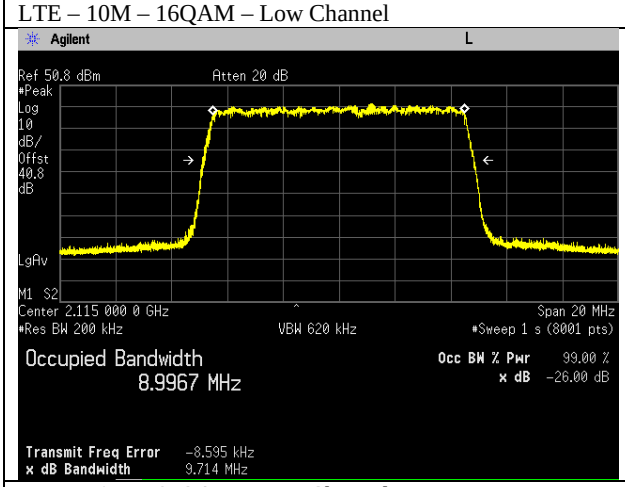
LTE – 10M – QPSK – Low Channel



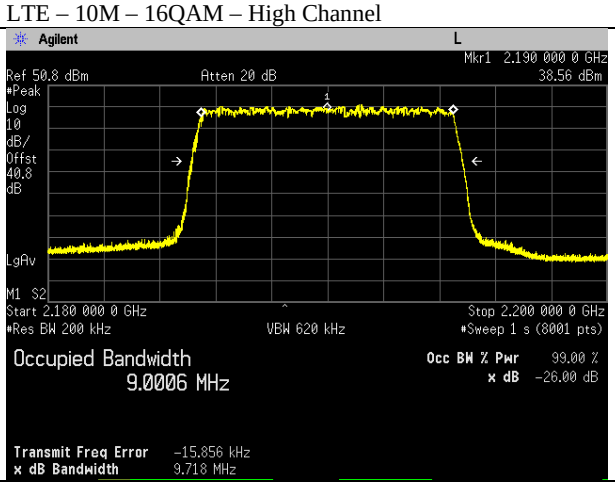
LTE – 10M – QPSK – High Channel



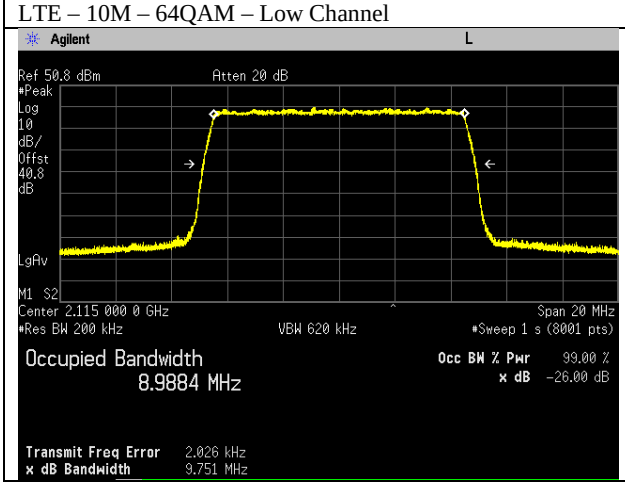
LTE – 10M – 16QAM – Low Channel



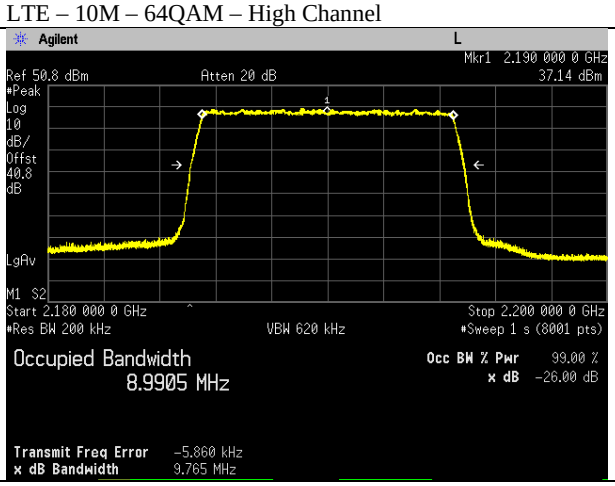
LTE – 10M – 16QAM – High Channel



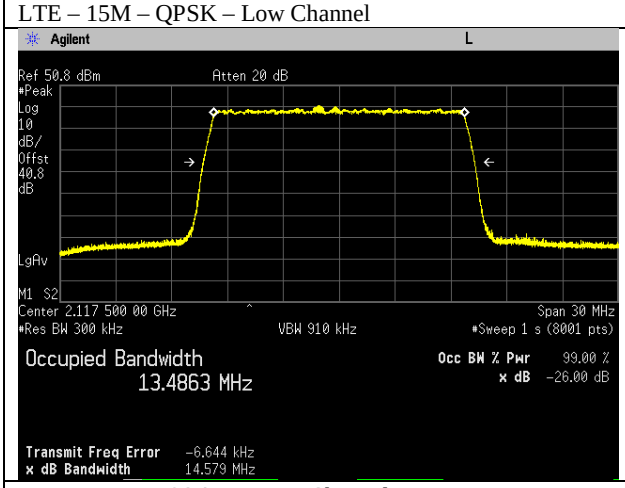
LTE – 10M – 64QAM – Low Channel



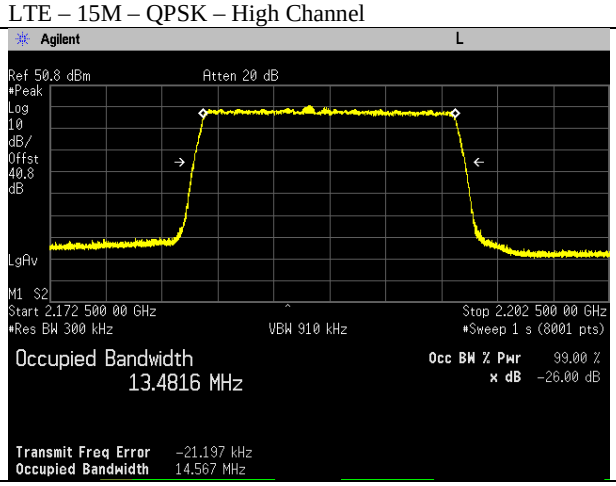
LTE – 10M – 64QAM – High Channel



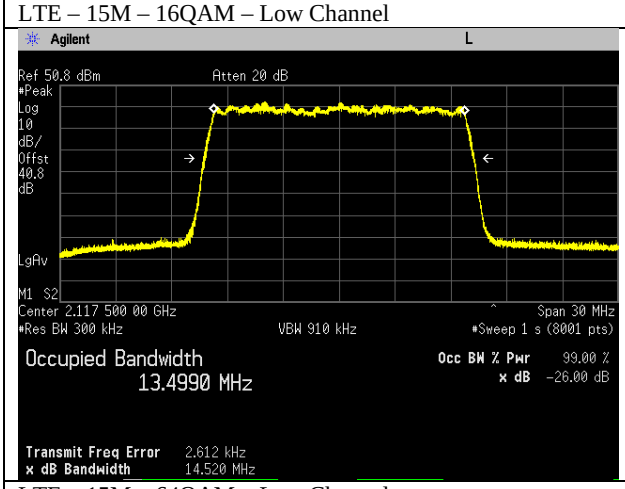
LTE – 15M – QPSK – Low Channel



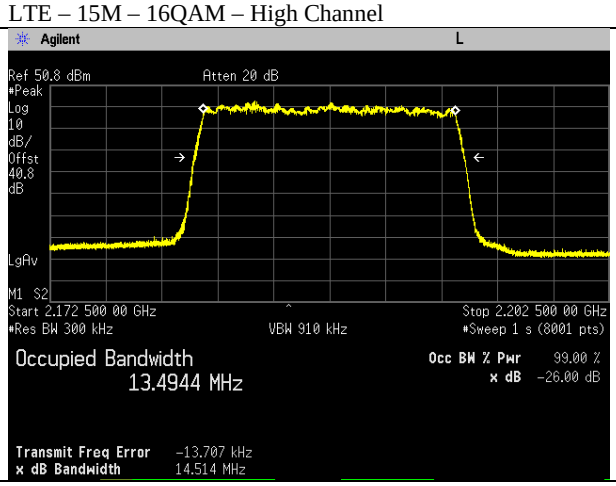
LTE – 15M – QPSK – High Channel



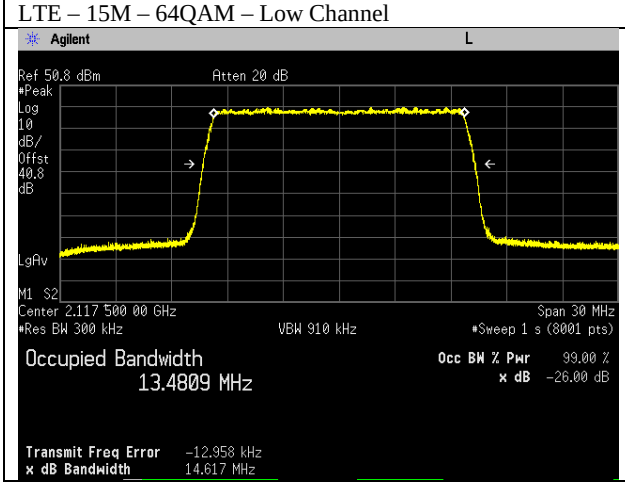
LTE – 15M – 16QAM – Low Channel



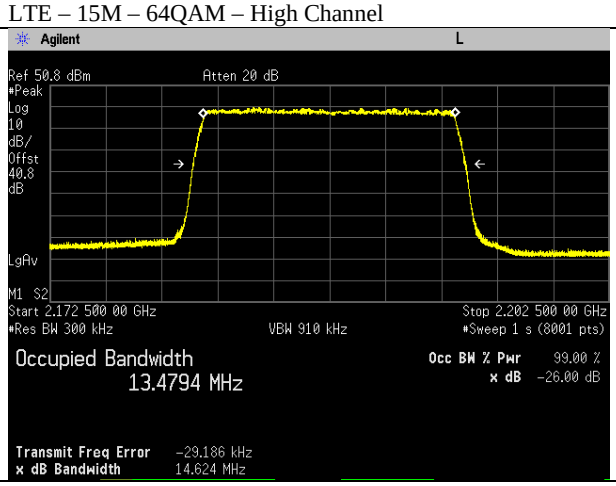
LTE – 15M – 16QAM – High Channel



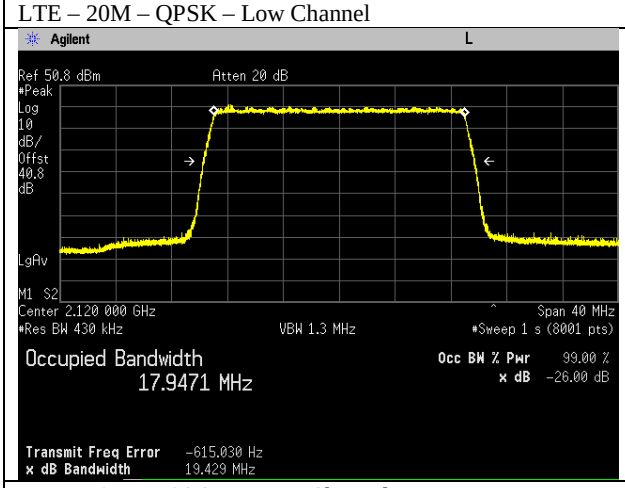
LTE – 15M – 64QAM – Low Channel



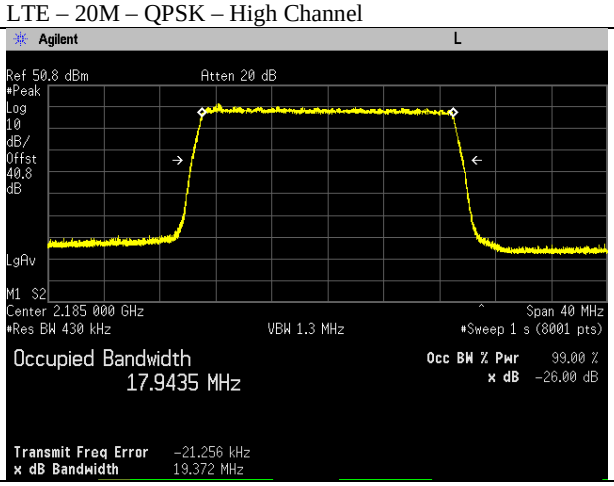
LTE – 15M – 64QAM – High Channel



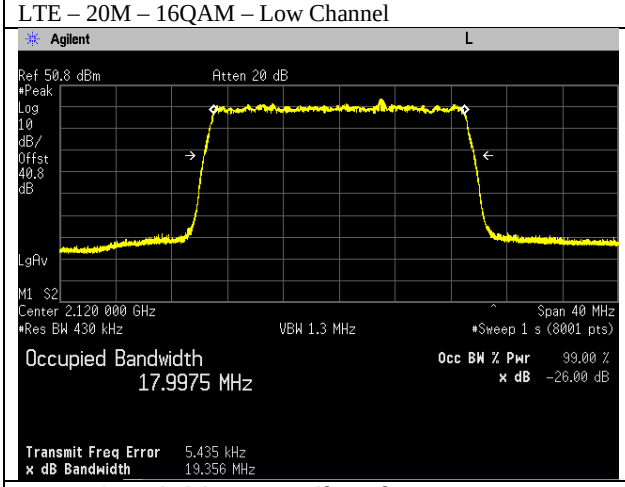
LTE – 20M – QPSK – Low Channel



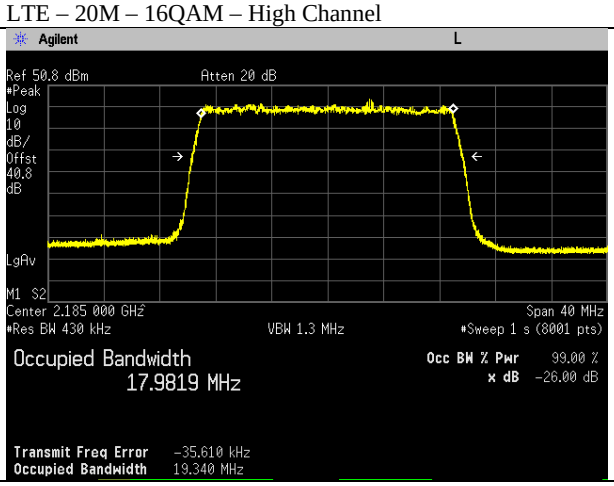
LTE – 20M – QPSK – High Channel



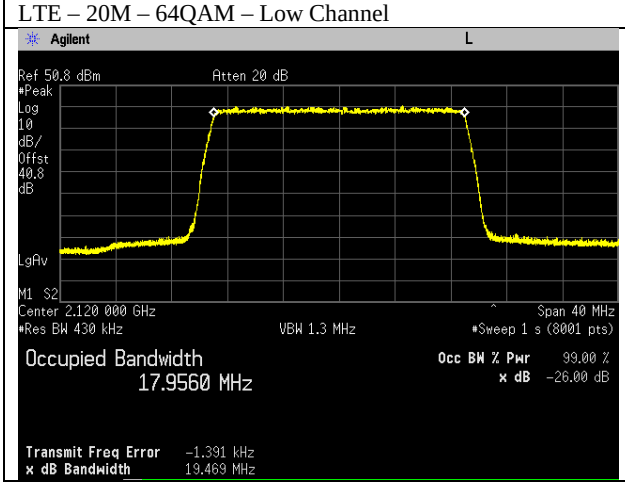
LTE – 20M – 16QAM – Low Channel



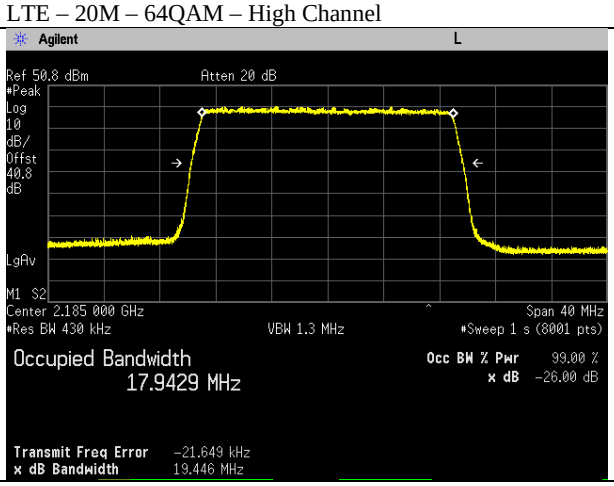
LTE – 20M – 16QAM – High Channel



LTE – 20M – 64QAM – Low Channel



LTE – 20M – 64QAM – High Channel



Antenna Port Conducted Bandedge

Limit is -13dBm and is further reduced by 10*log(4) per FCC KDB 662911D01 v02r01 due to 4x4 MIMO operation, which brings it down to -19.03dBm.

Measurements made at the external notch filter (Filtronics p/n: US-PSD015-F1V1) output port using FRIJ Ant 4 on lowest and highest channels for all modulations and channel bandwidth modes.

Results summary:

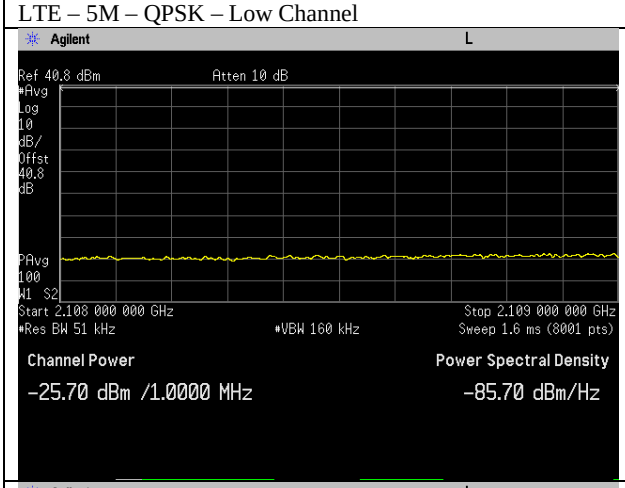
	LTE - QPSK		LTE - 16QAM		LTE - 64QAM	
	Low	High	Low	High	Low	High
5M	-21.522dBm	-30.790dBm	-22.475dBm	-31.126dBm	-22.802dBm	-31.199dBm
10M	-25.320dBm	-31.131dBm	-25.208dBm	-31.945dBm	-24.395dBm	-30.578dBm
15M	-20.554dBm	-31.192dBm	-21.134dBm	-32.618dBm	-22.001dBm	-31.195dBm
20M	-25.682dBm	-30.935dBm	-25.830dBm	-31.263dBm	-25.196dBm	-31.168dBm
5M Dual	-21.601dBm	-31.013dBm	-22.678dBm	-31.054dBm	-22.362dBm	-31.104dBm

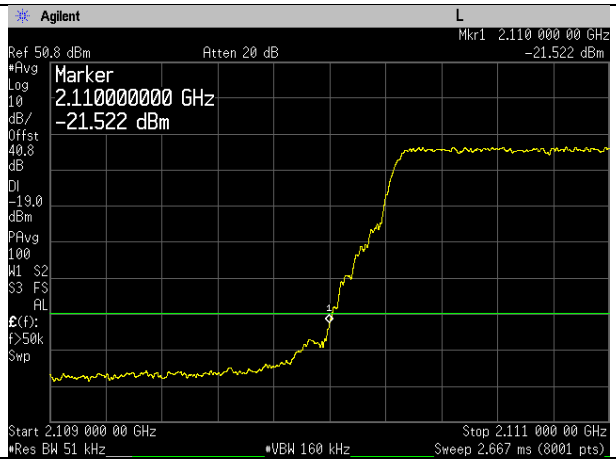
Measurements were performed in RMS average mode with 100kHz RBW and 300kHz VBW over 100 traces. In 1MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 1% of the emission bandwidth has been used. In 1 to 2 MHz frequency range outside lower bandedge (i.e.: 2108-2109 MHz) the RBW was again reduced to 1% of the emission bandwidth and power was integrated (over 1 MHz).

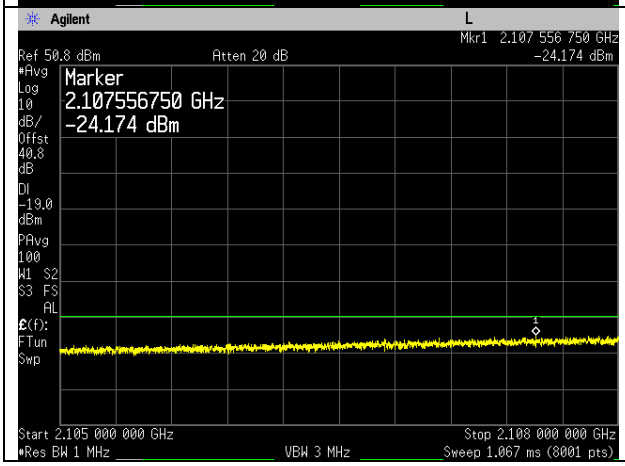
Total path loss of 40.8dB accounted in via reference level offset to the spectrum analyzer.

All corresponding plots are included on the following pages.

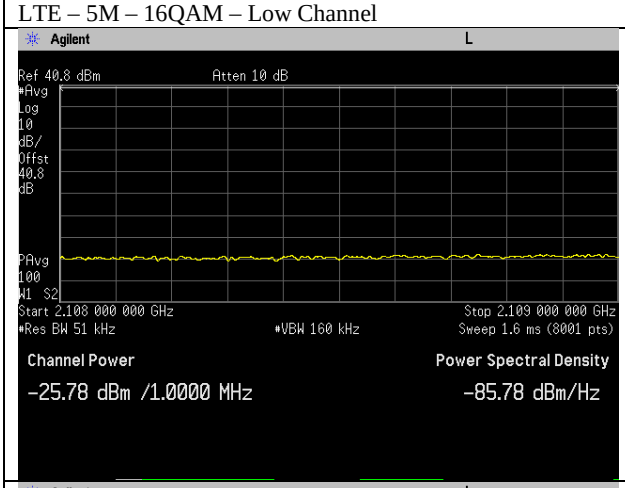
LTE – 5M – QPSK – Low Channel

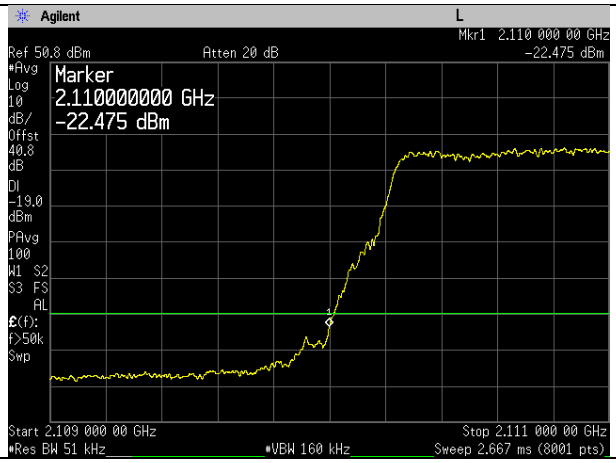


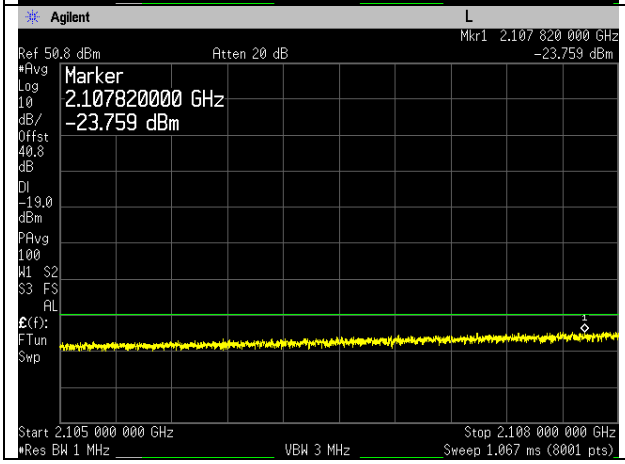




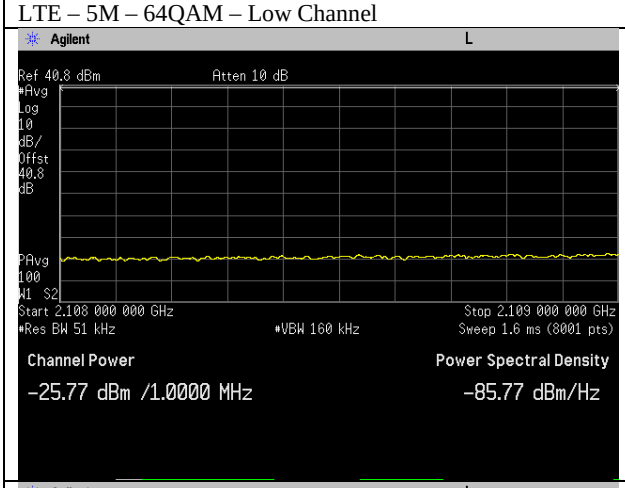
LTE – 5M – 16QAM – Low Channel

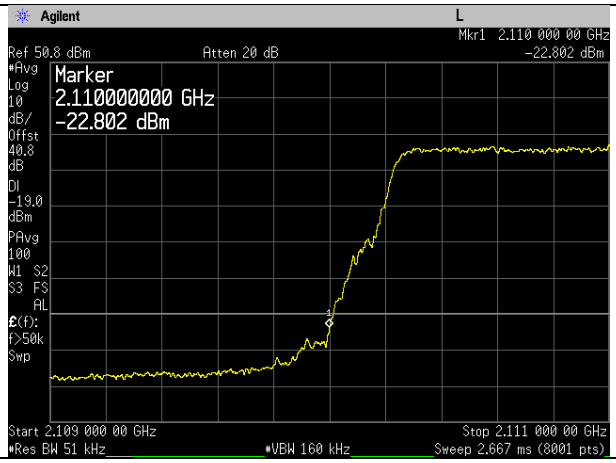


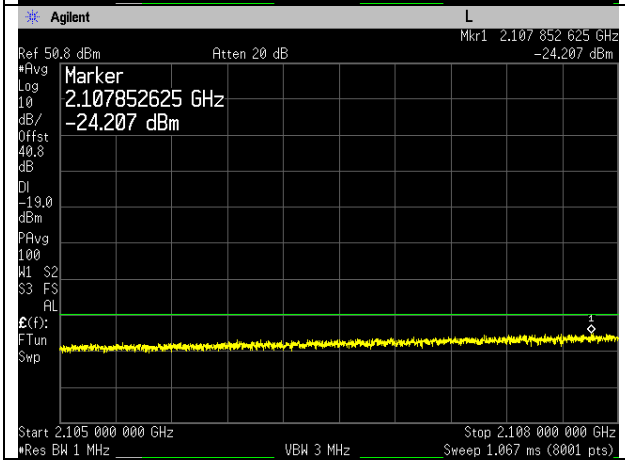


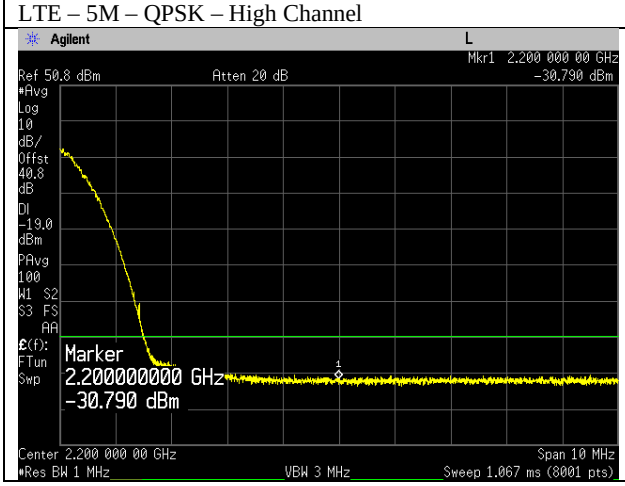


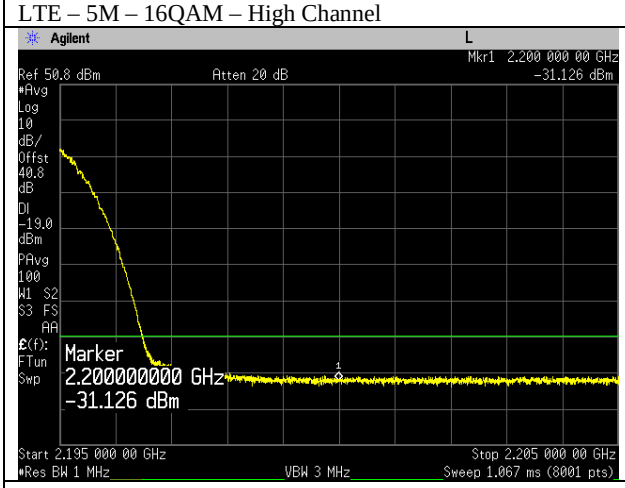
LTE – 5M – 64QAM – Low Channel

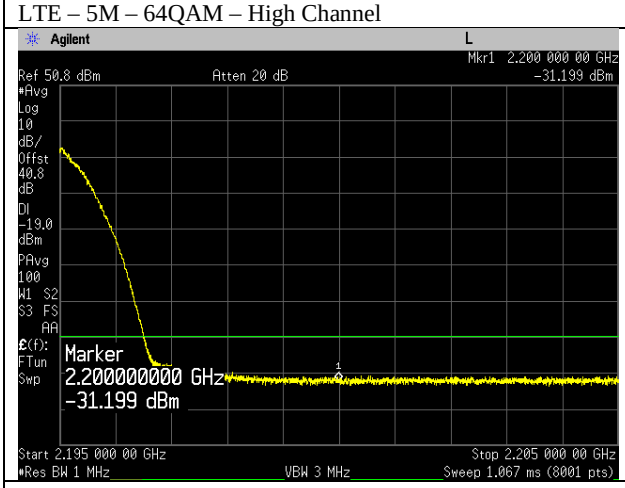




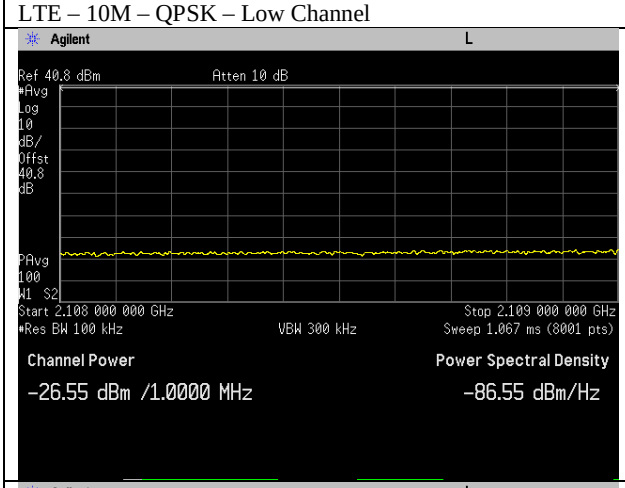


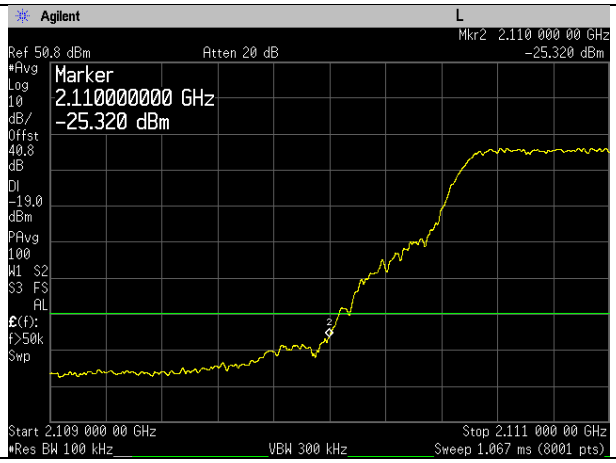
LTE – 5M – QPSK – High Channel	
	

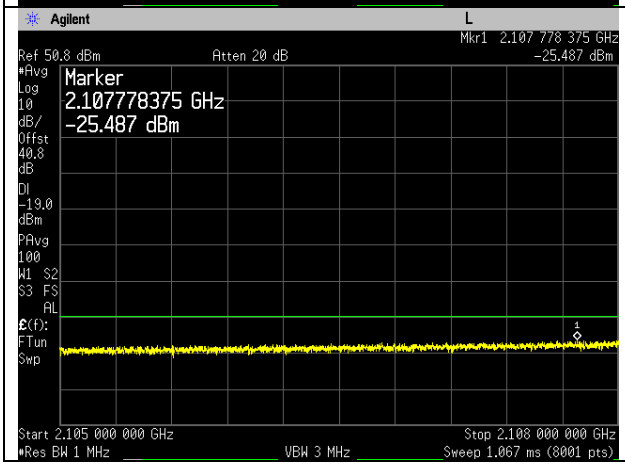
LTE – 5M – 16QAM – High Channel	
	

LTE – 5M – 64QAM – High Channel	
	

LTE – 10M – QPSK – Low Channel







LTE – 10M – 16QAM – Low Channel