8.3.6 Occupied bandwidth

Description:

Measurement of the occupied bandwidth of the transmitted signal.

Measurement:

Similar to conducted emissions, occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the mid frequencies of the LTE band 4 frequency band. The table below lists the measured 99% power and 26 dB occupied bandwidths. Spectrum analyzer plots are included on the following pages.

Part 27.53 requires a measurement bandwidth of at least 1% of the occupied bandwidth.

Measurement parameters	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	Depends on Channel Bandwidth
Resolution bandwidth:	Depends on Channel Bandwidth
Span:	Depends on Channel Bandwidth
Trace-Mode:	Max Hold

Limits:

FCC	-/-
Occupied Bandwidth	
Spectrum must fall completely in the specified band	

Results:

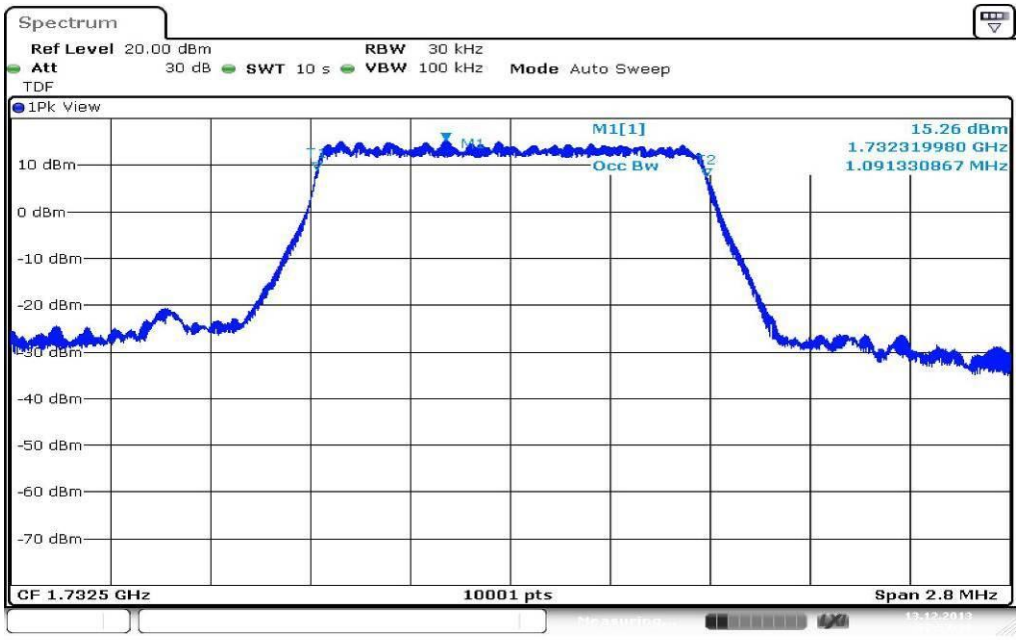
Occupied Bandwidth - QPSK		
Bandwidth [MHz]	**99% OBW (kHz)**	**26 dB bandwidth (kHz)**
1.4	1091	1291
3	2733	3055
5	4502	4983
10	9069	10183
15	13442	14675
20	17938	19630
Measurement uncertainty	± 30 kHz to ± 500 kHz depending on channel bandwidth	

Occupied Bandwidth – 16-QAM		
Bandwidth [MHz]	**99% OBW (kHz)**	**26 dB bandwidth (kHz)**
1.4	1096	1297
3	2727	3054
5	4519	5024
10	9065	10071
15	13430	14723
20	17942	19650
Measurement uncertainty	± 30 kHz to ± 500 kHz depending on channel bandwidth	

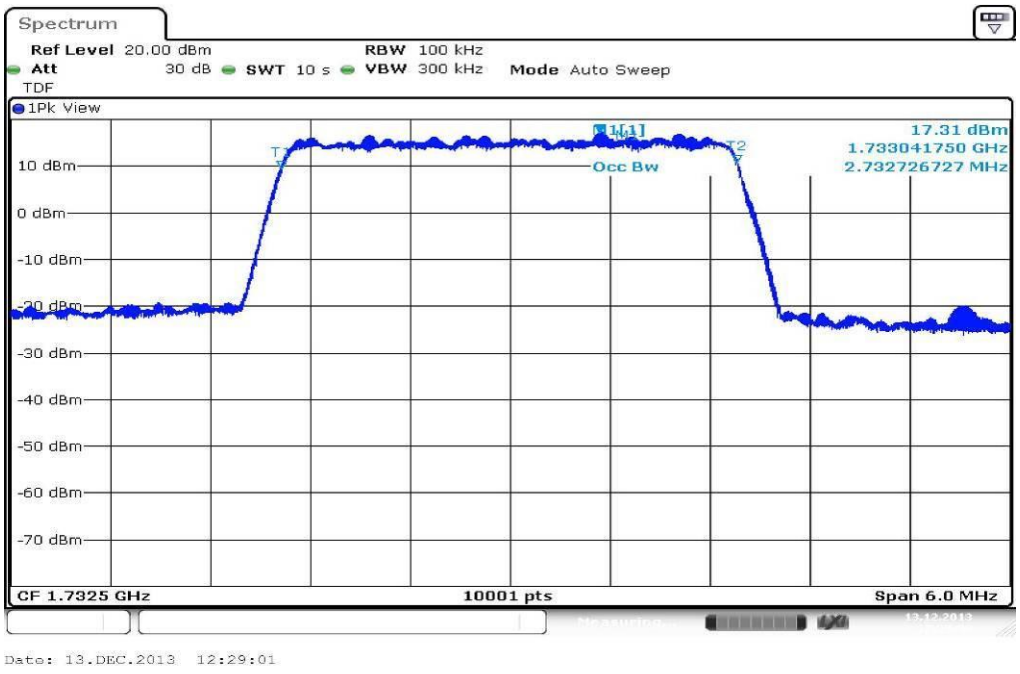
Result: **Passed**

Plots: QPSK

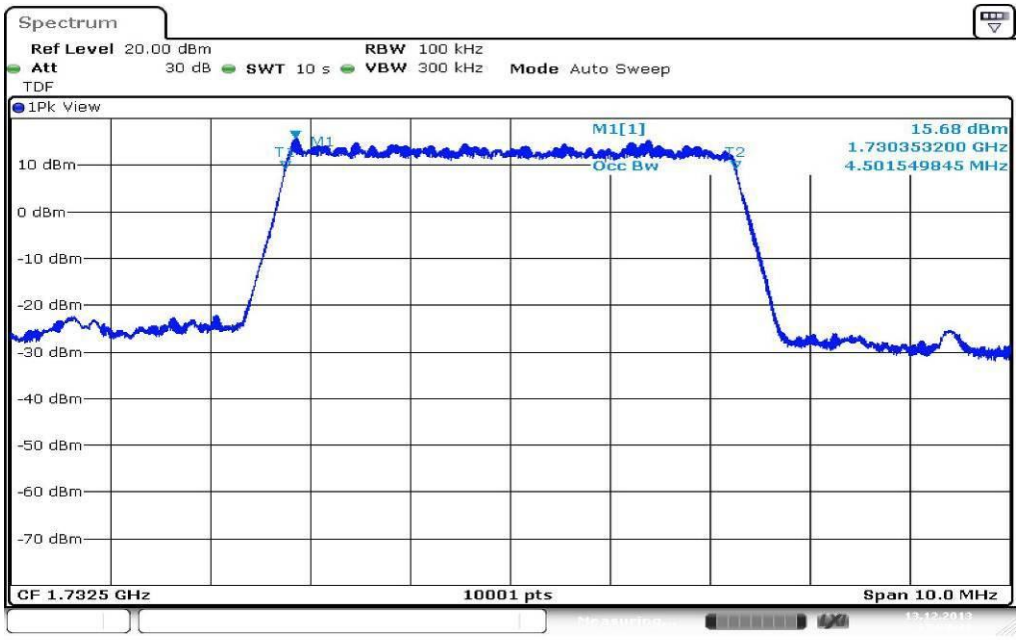
Plot 1: 1.4 MHz, 99% OBW



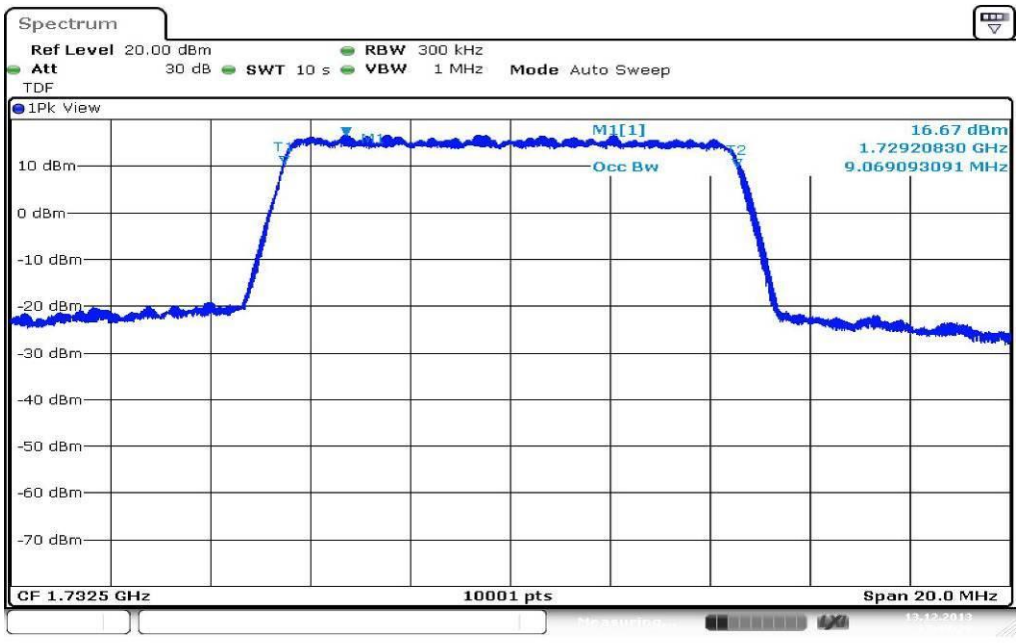
Plot 2: 3 MHz, 99% OBW



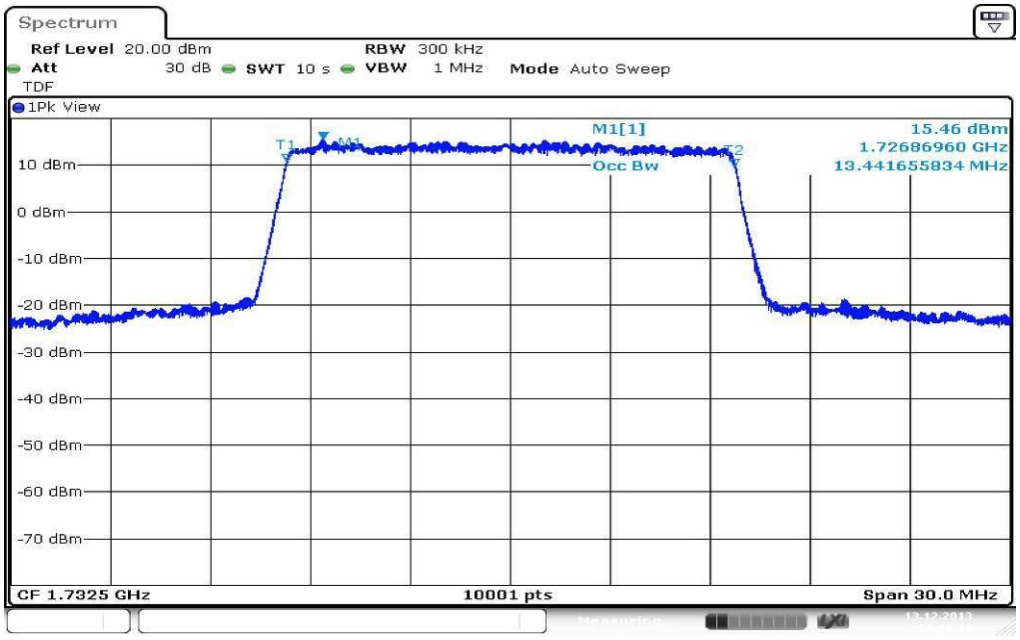
Plot 3: 5 MHz, 99% OBW



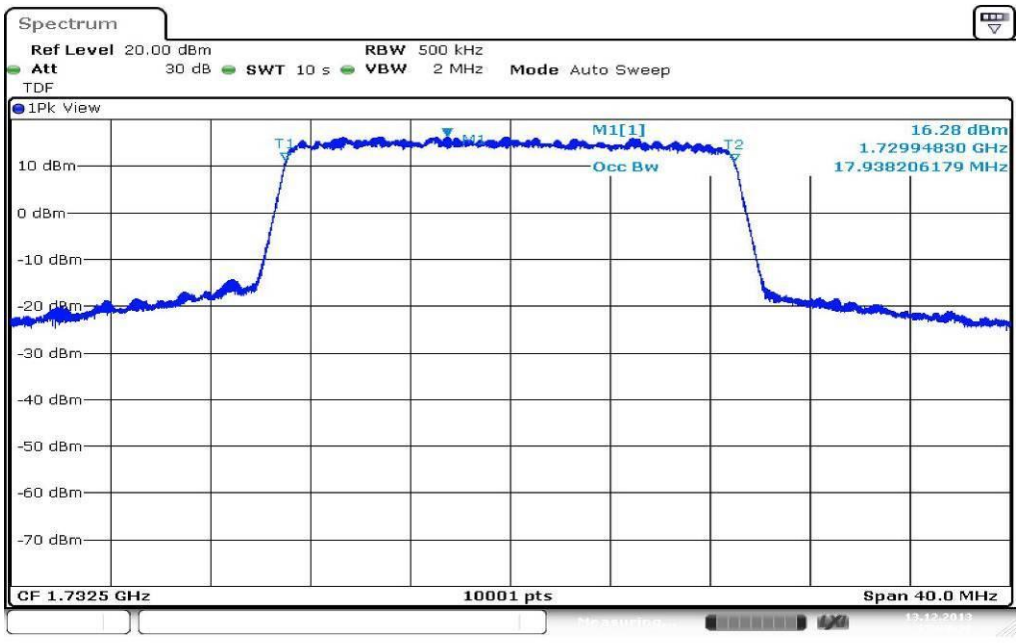
Plot 4: 10 MHz, 99% OBW



Plot 5: 15 MHz, 99% OBW

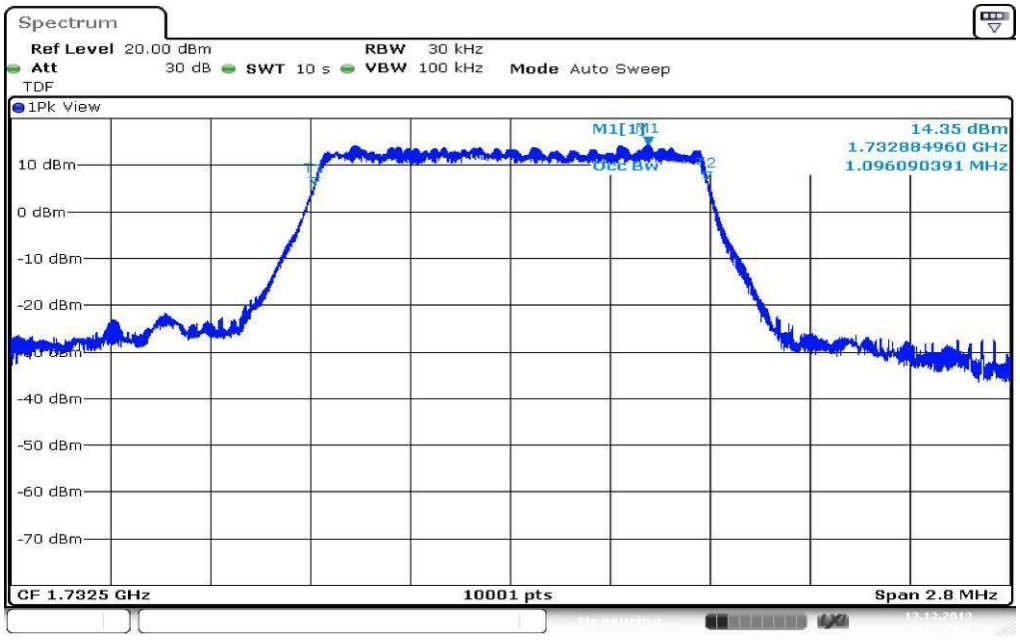


Plot 6: 20 MHz, 99% OBW

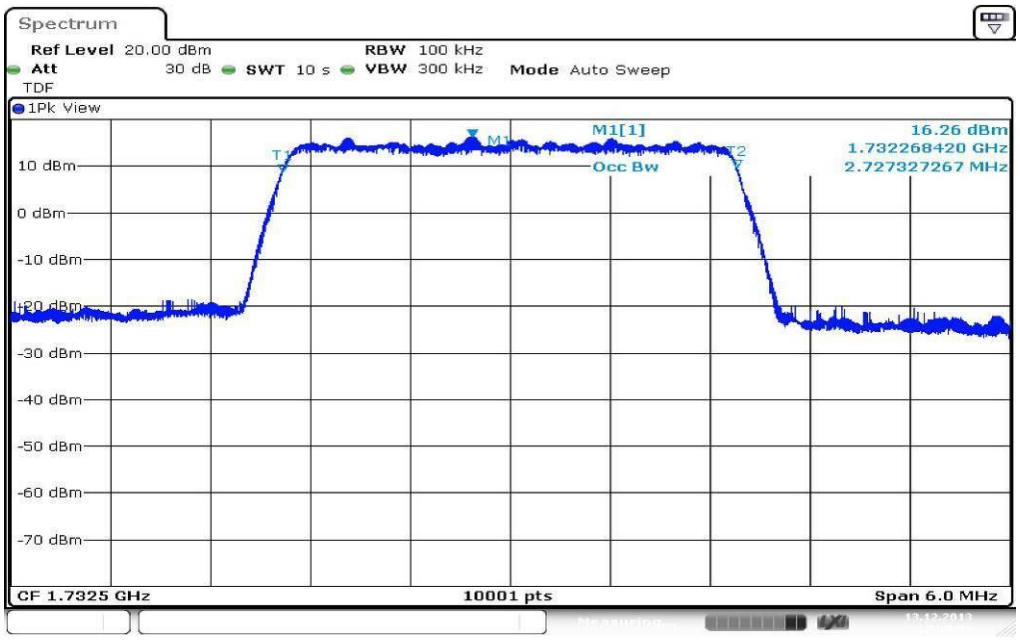


Plots: 16-QAM

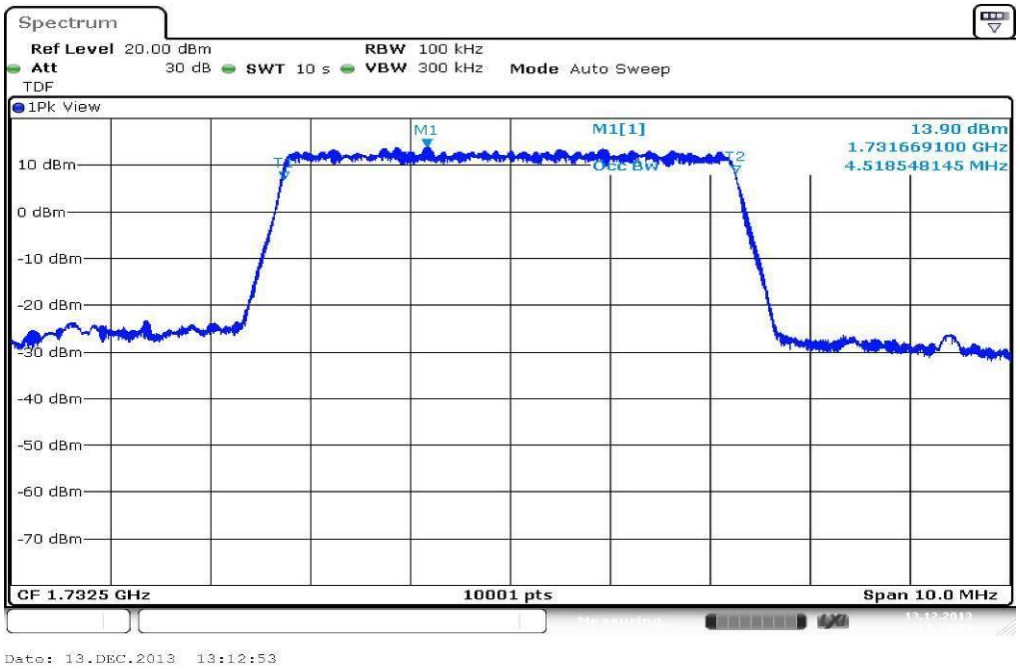
Plot 1: 1.4 MHz, 99% OBW



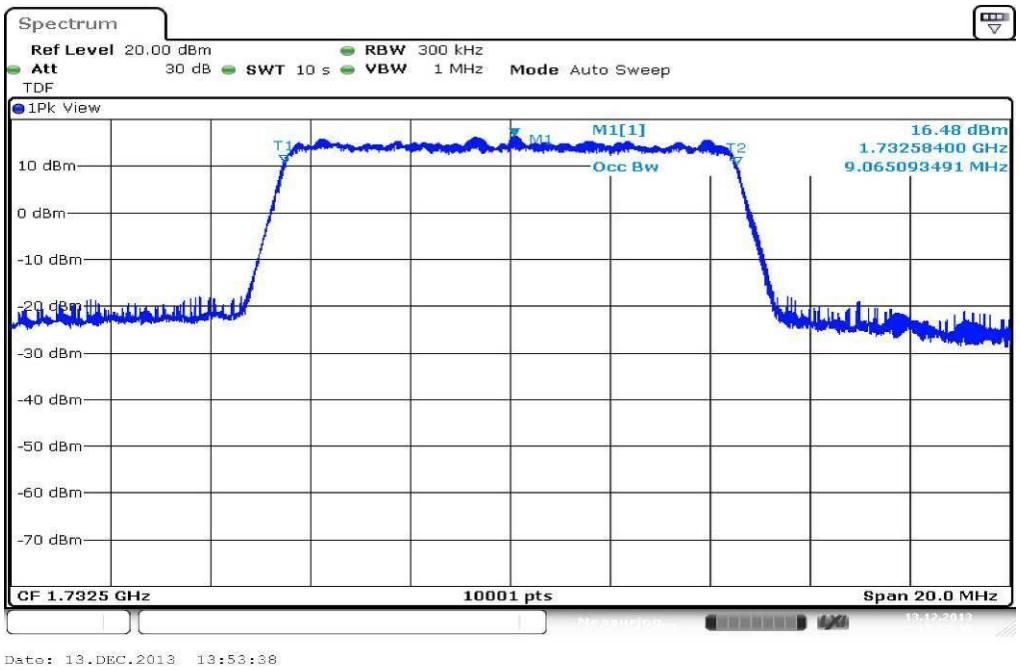
Plot 2: 3 MHz, 99% OBW



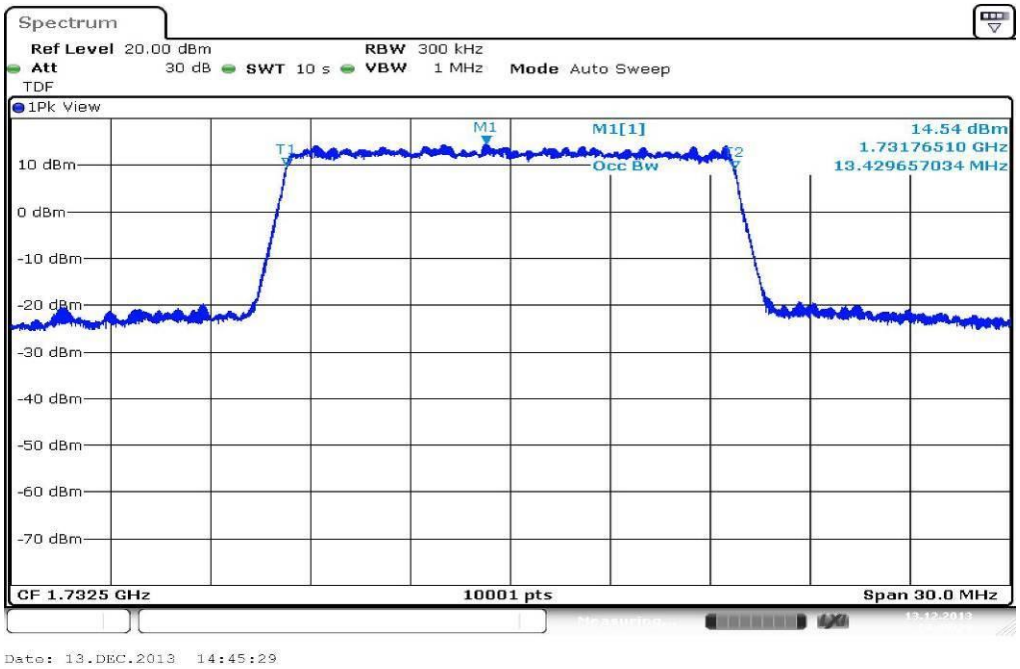
Plot 3: 5 MHz, 99% OBW



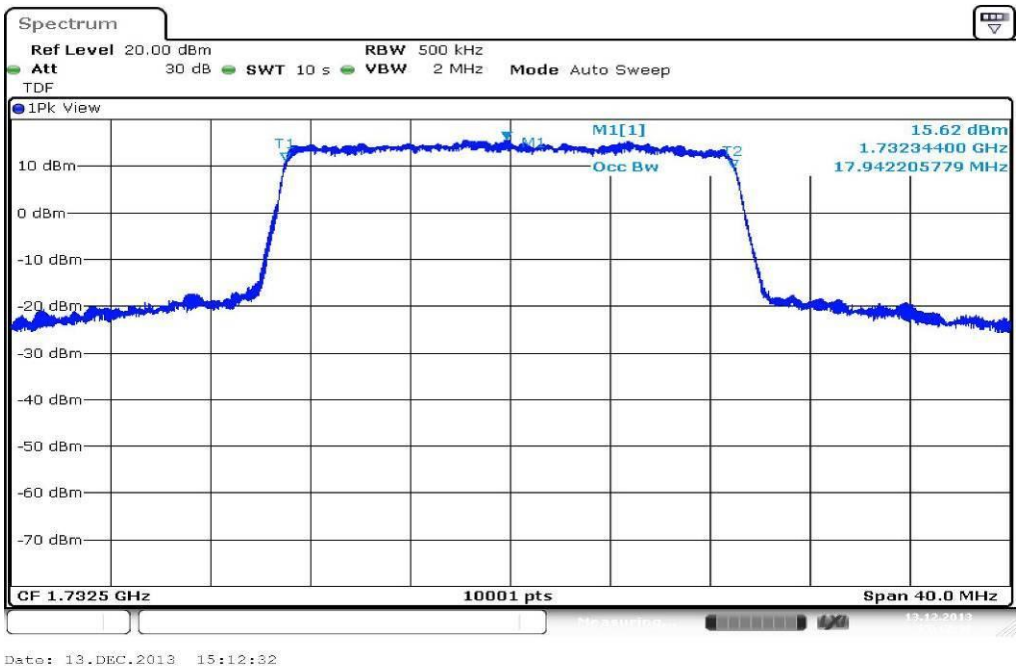
Plot 4: 10 MHz, 99% OBW



Plot 5: 15 MHz, 99% OBW



Plot 6: 20 MHz, 99% OBW



8.4 Results LTE – Band 7

The EUT was set to transmit the maximum power.

8.4.1 RF output power

Description:

This paragraph contains average power, peak output power and EIRP measurements for the mobile station. In all cases, the peak output power is within the required mask (this mask is specified in the JTC standards, TIA PN3389 Vol. 1 Chap 7, and is no FCC requirement).

Measurement:

The mobile was set up for the maximum output power with pseudo random data modulation.

To determine the Peak-To-Average Power Ratio (PAPR) the measurement was performed with the Power Complementary Cumulative Distribution Function (CCDF).

Measurement parameters	
Detector:	Peak and RMS (Power in Burst)
Sweep time:	Auto
Video bandwidth:	Depends on Channel Bandwidth
Resolution bandwidth:	Depends on Channel Bandwidth
Span:	Zero Span
Trace-Mode:	Max Hold

Limits:

FCC	-/-
AVG: 33 dBm	-/-
Max Output Power	
In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.	

Results:

Output Power (conducted)						
Bandwidth (MHz)	**Frequency (MHz)**	**Resource block allocation**	**Average Output Power (dBm) QPSK**	**Peak to Average Ratio (dB)**	**Average Output Power (dBm) 16-QAM**	**Peak to Average Ratio (dB)**
5	2502.5	1 RB low	22.3	3.51	21.7	4.31
		1 RB high	22.7	3.46	22.0	4.27
		50% RB mid	21.6	4.57	20.8	5.49
		100% RB	21.6	4.97	20.7	6.00
	2535	1 RB low	23.1	4.70	22.3	3.80
		1 RB high	23.0	4.60	22.3	3.78
		50% RB mid	21.9	5.85	20.8	4.99
		100% RB	21.8	6.37	20.8	5.37
	2567.5	1 RB low	23.2	3.75	21.8	5.17
		1 RB high	23.0	3.56	21.9	4.70
		50% RB mid	22.1	4.79	21.2	5.78
		100% RB	22.1	5.23	21.2	6.19
10	2505	1 RB low	22.4	4.18	21.8	3.56
		1 RB high	23.3	4.17	22.7	3.56
		50% RB mid	21.9	5.50	21.1	4.62
		100% RB	21.9	5.78	21.0	4.80
	2535	1 RB low	23.0	4.03	21.9	5.26
		1 RB high	23.2	3.61	22.0	4.99
		50% RB mid	22.0	4.99	21.0	5.80
		100% RB	22.0	5.47	21.0	6.49
	2565	1 RB low	23.2	5.47	22.0	4.11
		1 RB high	23.0	4.64	22.0	3.57
		50% RB mid	22.1	5.99	21.1	4.95
		100% RB	22.1	6.48	21.1	5.46
15	2507.5	1 RB low	22.3	3.61	21.7	4.24
		1 RB high	23.6	3.65	23.0	4.29
		50% RB mid	22.2	4.58	21.3	5.56
		100% RB	22.1	5.04	21.3	5.96
	2535	1 RB low	23.2	4.82	22.4	3.93
		1 RB high	23.2	4.54	22.4	3.65
		50% RB mid	22.0	5.97	20.8	4.95
		100% RB	22.1	6.26	21.0	5.28
	2562.5	1 RB low	23.1	4.17	21.9	5.48
		1 RB high	22.9	3.64	21.9	4.66
		50% RB mid	22.0	5.07	21.0	6.08
		100% RB	22.1	5.36	21.0	6.32

20	2510	1 RB low	22.0	4.33	21.4	3.72
		1 RB high	23.3	4.37	22.8	3.76
		50% RB mid	22.0	6.02	20.9	4.89
		100% RB	22.1	6.07	20.9	5.09
	2535	1 RB low	23.0	4.07	22.2	4.98
		1 RB high	23.1	3.64	22.3	4.55
		50% RB mid	22.0	4.91	20.9	5.93
		100% RB	22.0	5.22	20.9	6.22
	2560	1 RB low	22.9	4.85	22.2	4.13
		1 RB high	22.7	4.18	22.3	3.72
		50% RB mid	22.1	6.05	21.1	5.12
		100% RB	22.1	6.21	21.1	4.96
Measurement uncertainty			± 0.5 dB			

The output power radiated is measured with the mode wich have the highest conducted output power.

Output Power (radiated)			
Bandwidth (MHz)	**Frequency (MHz)**	**Average Output Power (dBm) QPSK**	**Average Output Power (dBm) 16-QAM**
5	2502.5	28.2	27.5
	2535	28.1	27.3
	2567.5	28.5	27.2
10	2505	28.8	28.2
	2535	28.2	27.0
	2565	28.5	27.3
15	2507.5	29.1	28.5
	2535	28.2	27.4
	2562.5	28.4	27.2
20	2510	28.8	28.3
	2535	28.1	27.3
	2560	28.2	27.6
Measurement uncertainty		± 3.0 dB	

Result: **Passed**

8.4.2 Frequency stability

Description:

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the mobile station in a “call mode”. This is accomplished with the use of a R&S CMW500 DIGITAL RADIOCOMMUNICATION TESTER.
1. Measure the carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30 C.
3. With the mobile station, powered with V_{nom}, connected to the CMW500 and in a simulated call on channel 1412 (centre channel), measure the carrier frequency. These measurements should be made within two minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +60°C. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with V_{nom}. Vary supply voltage from V_{min} to V_{max}, in 0.1 Volt steps remeasuring carrier frequency at each voltage. Pause at V_{nom} for 1.5 hours unpowered, to allow any self heating to stabilize, before continuing.
6. At all temperature levels hold the temperature to +/- 0.5°C during the measurement procedure.

This measurement was performed with the highest channel bandwidth supported from the EUT on the middle channel

Measurement:

Measurement parameters	
Detector:	Measured with CMW500
Sweep time:	
Video bandwidth:	
Resolution bandwidth:	
Span:	
Trace-Mode:	

Limits:

FCC	-/-
Frequency Stability	
< 2.5 ppm	

Results:

FREQ ERROR versus VOLTAGE

Voltage (V)	Frequency Error (Hz)	Frequency Error (%)	Frequency Error (ppm)
3.3	-8	-0.00000032	-0.0032
3.4	27	0.00000107	0.0107
3.5	-29	-0.00000114	-0.0114
3.6	-23	-0.00000091	-0.0091
3.7	-18	-0.00000071	-0.0071
3.8	10	0.00000039	0.0039
3.9	21	0.00000083	0.0083
4.0	27	0.00000107	0.0107
4.1	25	0.00000099	0.0099
4.2	29	0.00000114	0.0114
4.3	35	0.00000138	0.0138
4.4	16	0.00000063	0.0063

FREQ ERROR versus TEMPERATURE

Temperature (°C)	Frequency Error (Hz)	Frequency Error (%)	Frequency Error (ppm)
-30	15	0.00000059	0.0059
-20	-21	-0.00000083	-0.0083
-10	28	0.00000110	0.0110
± 0	15	0.00000059	0.0059
10	-15	-0.00000059	-0.0059
20	-20	-0.00000079	-0.0079
30	-27	-0.00000107	-0.0107
40	-5	-0.00000020	-0.0020
50	-1	-0.00000004	-0.0004
60	14	0.00000055	0.0055

Result: **Passed**

8.4.3 Spurious emissions radiated

Description:

The following steps outline the procedure used to measure the radiated emissions from the mobile station. The site is constructed in accordance with ANSI C63.4:2009 requirements and is recognized by the FCC to be in compliance for a 3 and a 10 meter site. The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier that can be as high as 2569.3 MHz. This was rounded up to 26 GHz. The resolution bandwidth is set as outlined in Part 27.53. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the LTE band 7.

The final open field emission (here 10m semi-anechoic chamber listed by FCC) test procedure is as follows:

a) The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna.
b) The antenna output was terminated in a 50 ohm load (if possible).
c) A double ridged wave guide antenna was placed on an adjustable height antenna mast 3 meters from the test item for emission measurements.
d) Detected emissions were maximized at each frequency by rotating the test item and adjusting the receive antenna height and polarization. The maximum meter reading was recorded. The radiated emission measurements of the harmonics of the transmit frequency through the 10th harmonic were measured with peak detector and 1 MHz bandwidth. If the harmonic could not be detected above the noise floor, the ambient level was recorded. The equivalent power into a dipole antenna was calculated from the field intensity levels measured at 3 meters.
e) Now each detected emissions were substituted by the substitution method, in accordance with the TIA/EIA 603.

Measurement:

Measurement parameters	
Detector:	Peak
Sweep time:	2 sec.
Video bandwidth:	Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz
Resolution bandwidth:	Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz
Span:	100 MHz Steps
Trace-Mode:	Max Hold

Limits:

FCC	-/-
Spurious Emissions Radiated	
Attenuation ≥ 43 + 10log(P) (P, Power in Watts)	
-13 dBm	

Results:

Radiated emissions measurements were made only at the upper, center, and lower carrier frequencies of the LTE band 7. It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the LTE band 7 into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this.

The final open field radiated levels are presented on the next pages.
All measurements were done in horizontal and vertical polarization; the plots show the worst case.
The plots show only the middle channel with full resource blocks. If spurious were detected, the lowest and highest channel and all supported channel bandwidths were checked, too.

As can be seen from this data, the emissions from the test item were within the specification limit.

QPSK

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	No spurious emissions detected.		No spurious emissions detected.		No spurious emissions detected.
Measurement uncertainty		± 3dB			

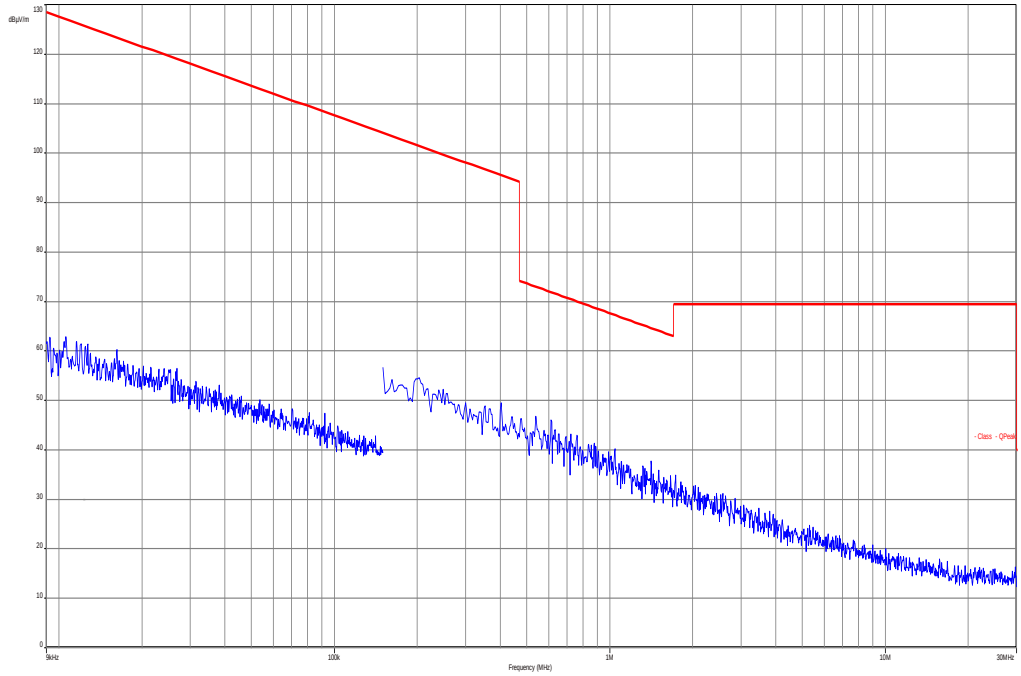
16-QAM

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	No spurious emissions detected.		No spurious emissions detected.		No spurious emissions detected.
Measurement uncertainty		± 3dB			

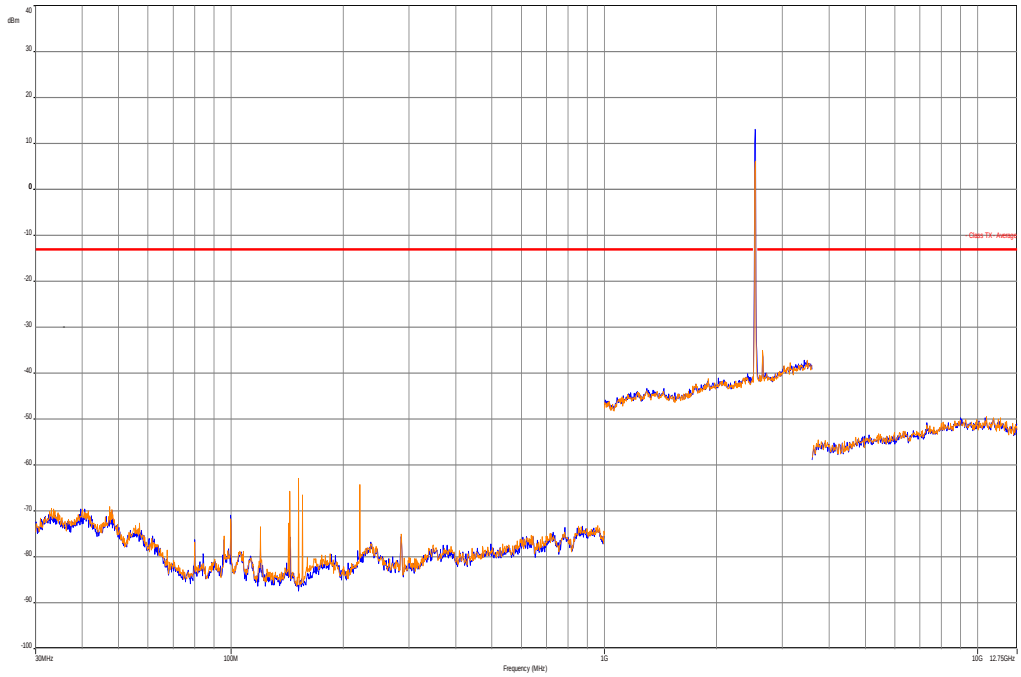
Result: **Passed**

QPSK with 10 MHz channel bandwidth

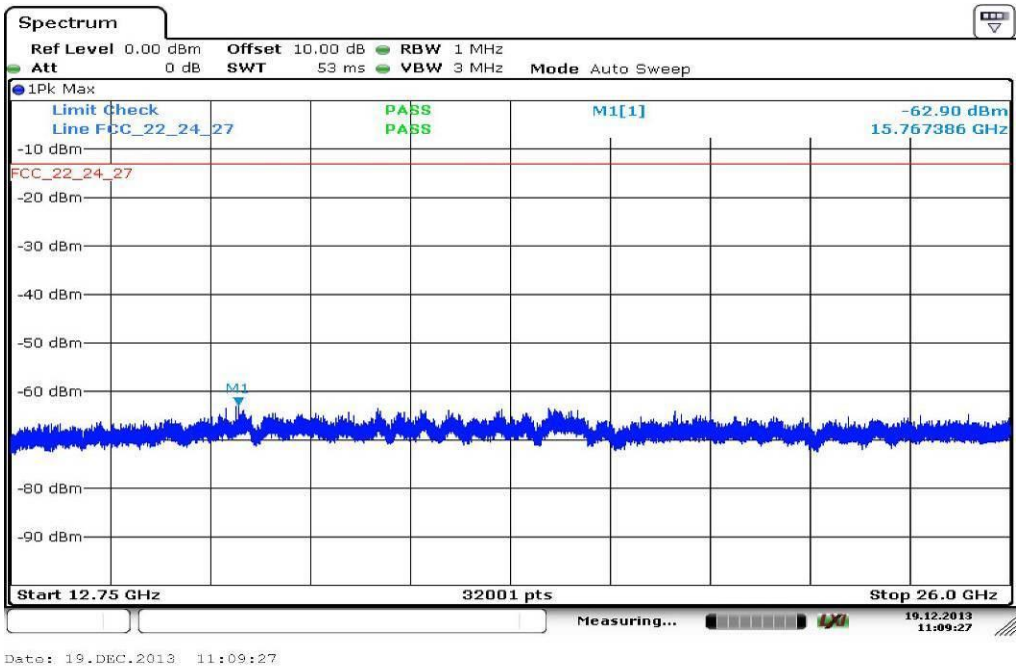
Plot 1: Middle channel, up to 30 MHz



Plot 2: Middle channel, 30 MHz to 12.75 GHz

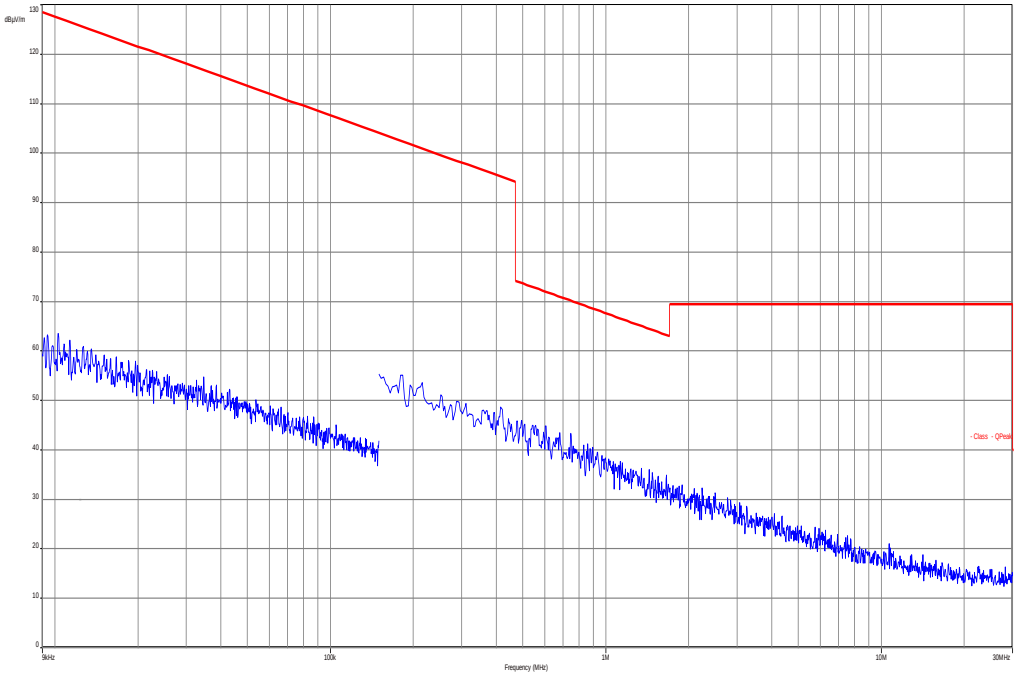


Plot 3: Middle channel, 12 GHz to 26 GHz

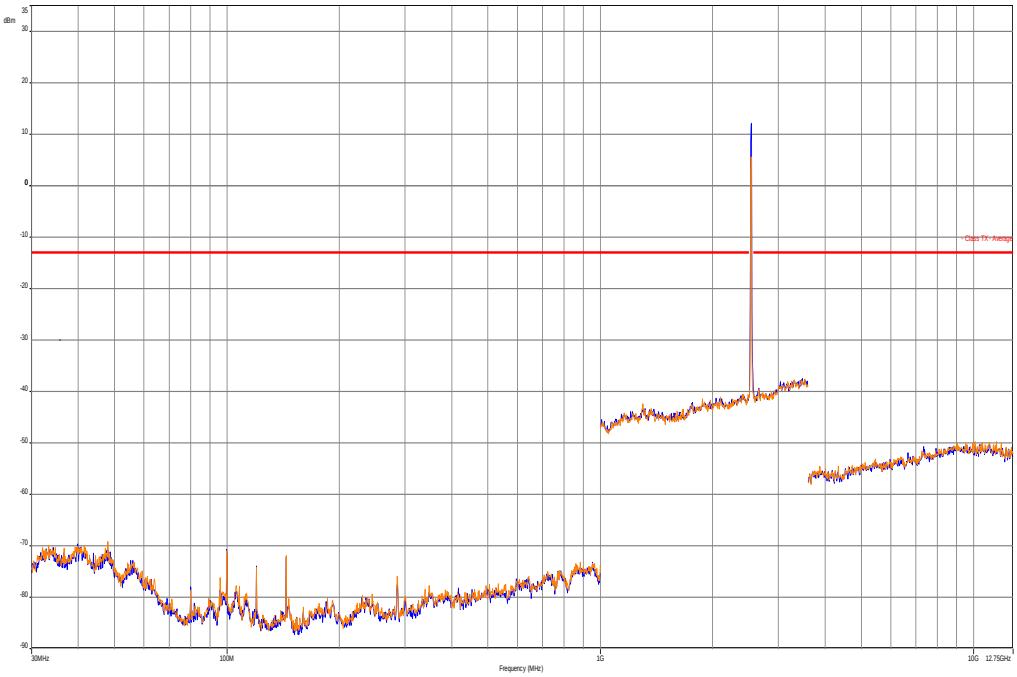


16-QAM with 10 MHz channel bandwidth

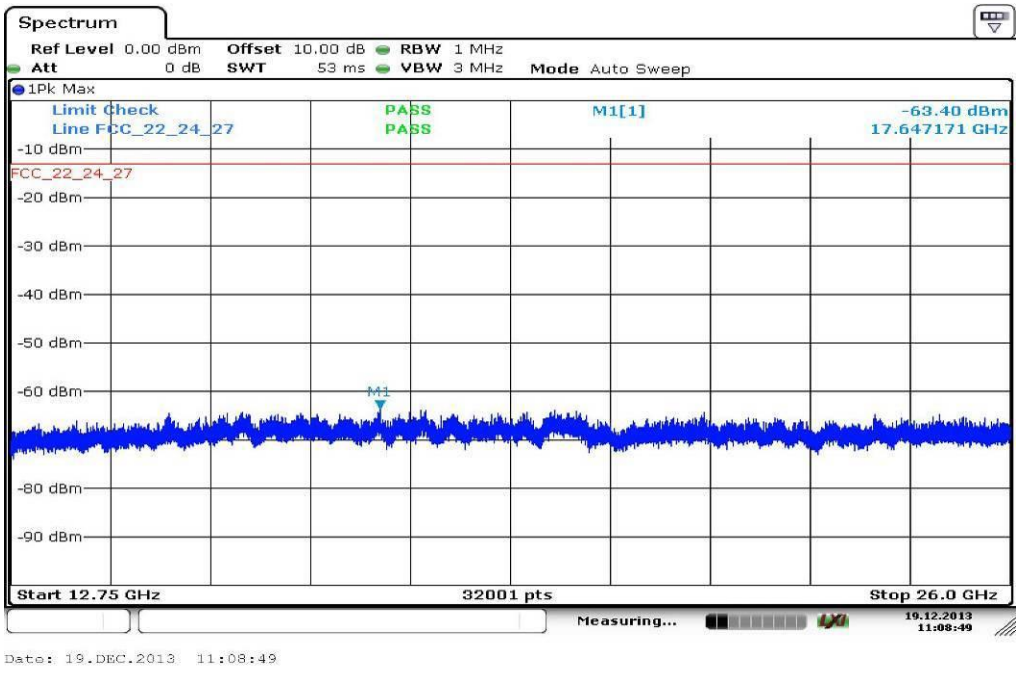
Plot 4: Middle channel, up to 30 MHz



Plot 5: Middle channel, 30 MHz to 12.75 GHz



Plot 6: Middle channel, 12 GHz to 26 GHz



8.4.4 Spurious emissions conducted

Description:

The following steps outline the procedure used to measure the conducted emissions from the mobile station.
1. Determine frequency range for measurements: From CFR 2.1057 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency.
2. Determine mobile station transmits frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.

For the measurement the lowest, middle and highest channel bandwidth was used. If spurious were found the other bandwidths were measured, too.

Measurement:

Measurement parameters	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz
Resolution bandwidth:	Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz
Span:	10 MHz – 25 GHz
Trace-Mode:	Max Hold

Limits:

FCC	-/-
Spurious Emissions Conducted	
Attenuation ≥ 43 + 10log(P) (P, Power in Watts)	
-13 dBm	

Results: for 5 MHz channel bandwidth

QPSK

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

16-QAM

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

Result: **Passed**

Results: for 10 MHz channel bandwidth

QPSK

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

16-QAM

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

Result: **Passed**

Results: for 15 MHz channel bandwidth

QPSK

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

16-QAM

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

Result: **Passed**

Results: **for 20 MHz channel bandwidth**

QPSK

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

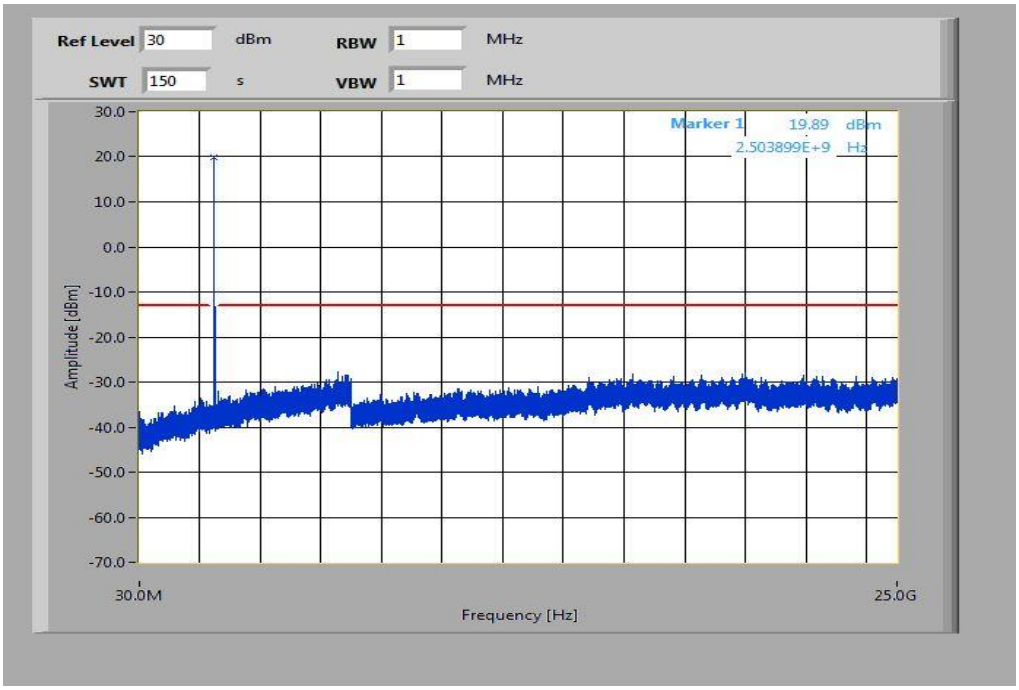
16-QAM

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
	-		-		-
Measurement uncertainty		± 3dB			

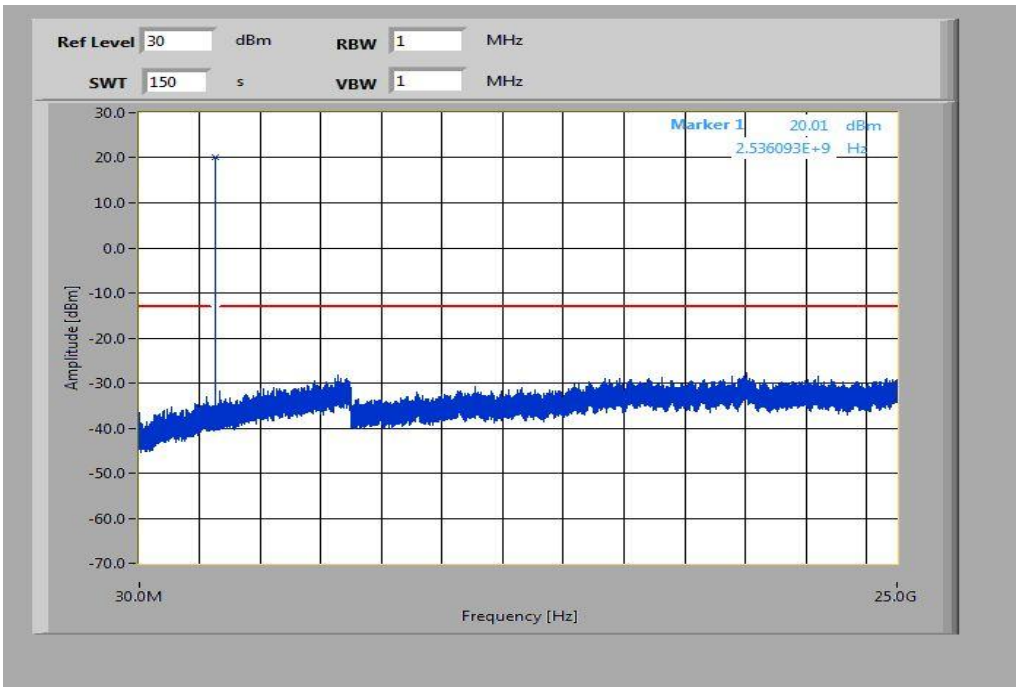
Result: **Passed**

Plots for 5 MHz channel bandwidth, QPSK

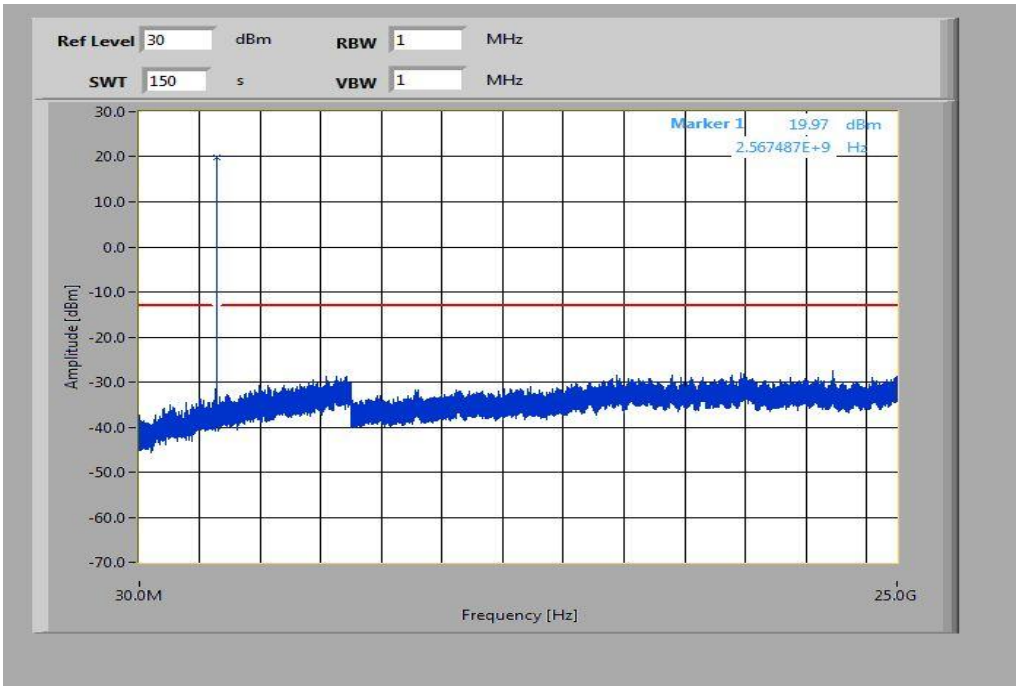
Plot 1: Lowest channel, 10 MHz to 25 GHz



Plot 2: Middle channel, 10 MHz to 25 GHz

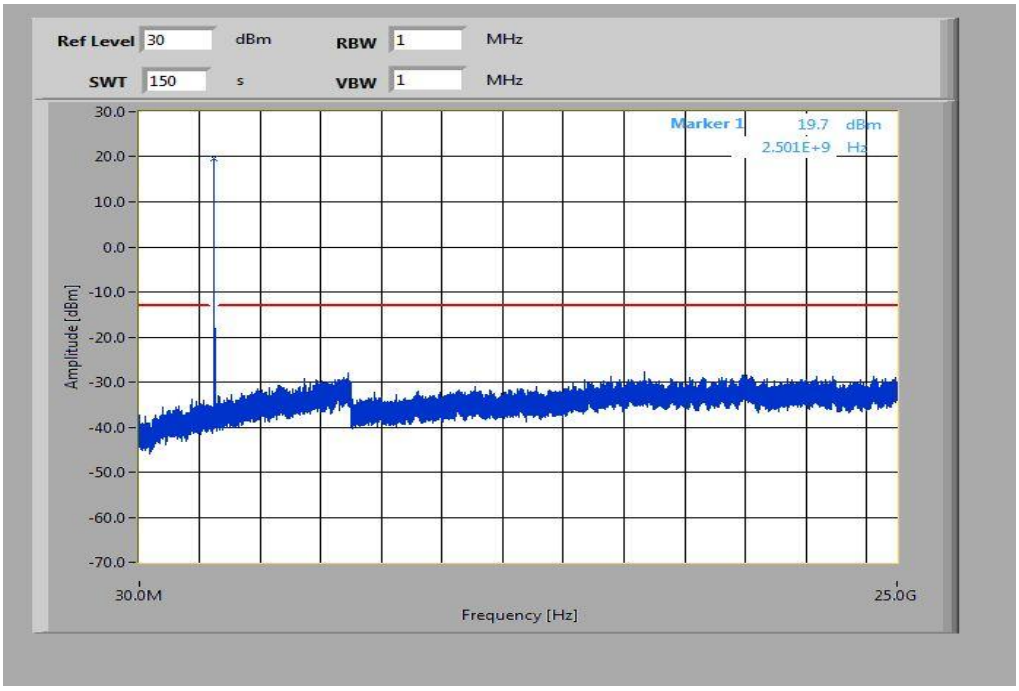


Plot 3: Highest channel, 10 MHz to 25 GHz

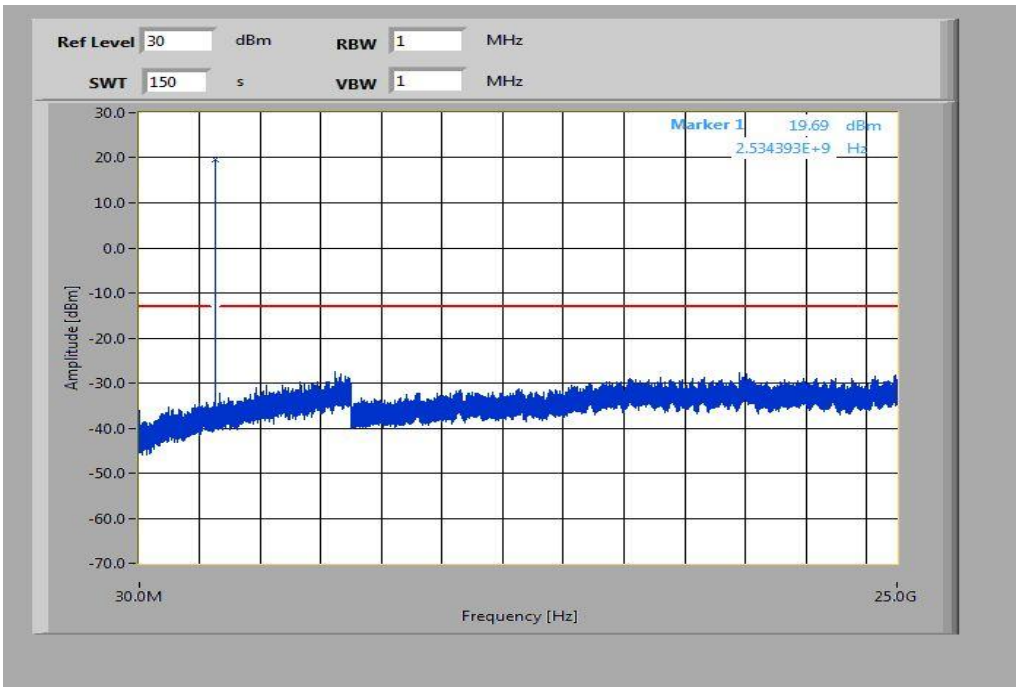


Plots for 5 MHz channel bandwidth, 16-QAM

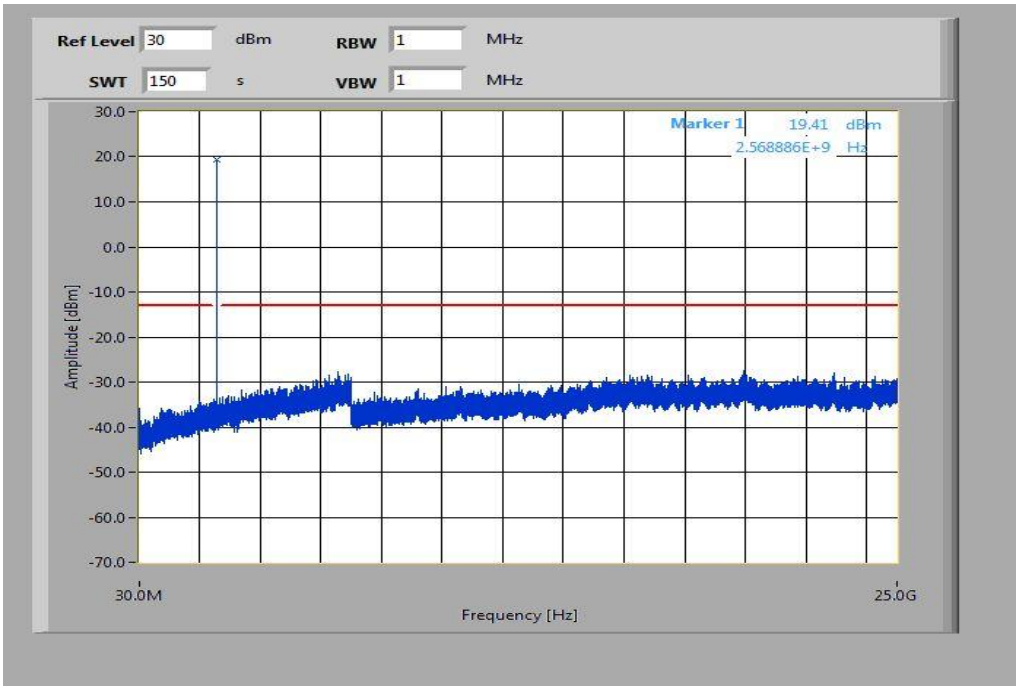
Plot 4: Lowest channel, 10 MHz to 25 GHz



Plot 5: Middle channel, 10 MHz to 25 GHz

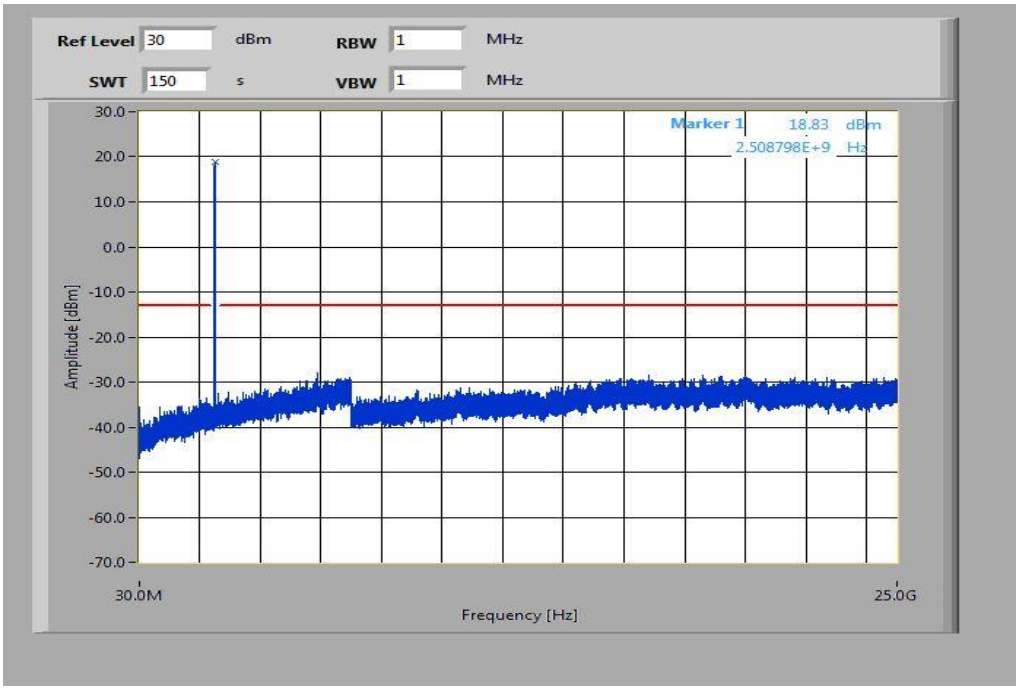


Plot 6: Highest channel, 10 MHz to 25 GHz

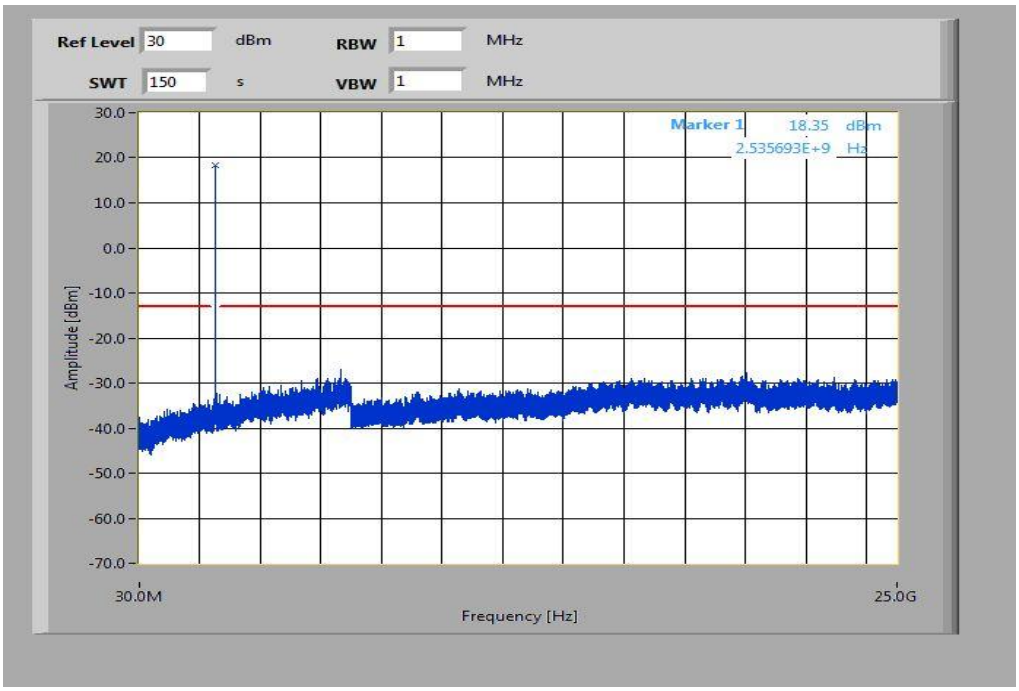


Plots for 10 MHz channel bandwidth, QPSK

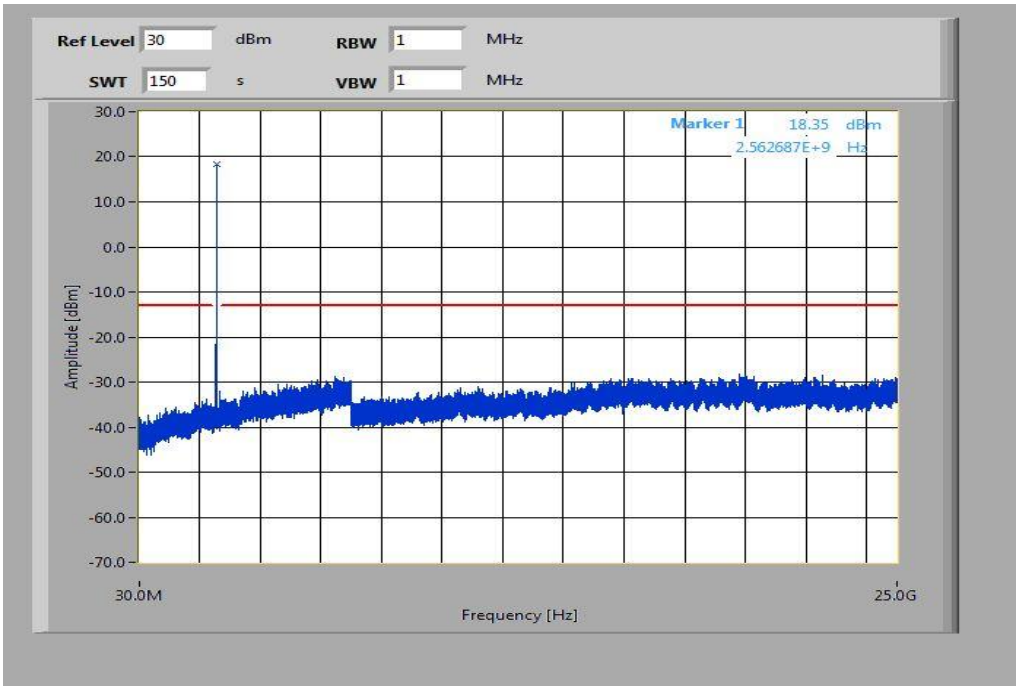
Plot 1: Lowest channel, 10 MHz to 25 GHz



Plot 2: Middle channel, 10 MHz to 25 GHz

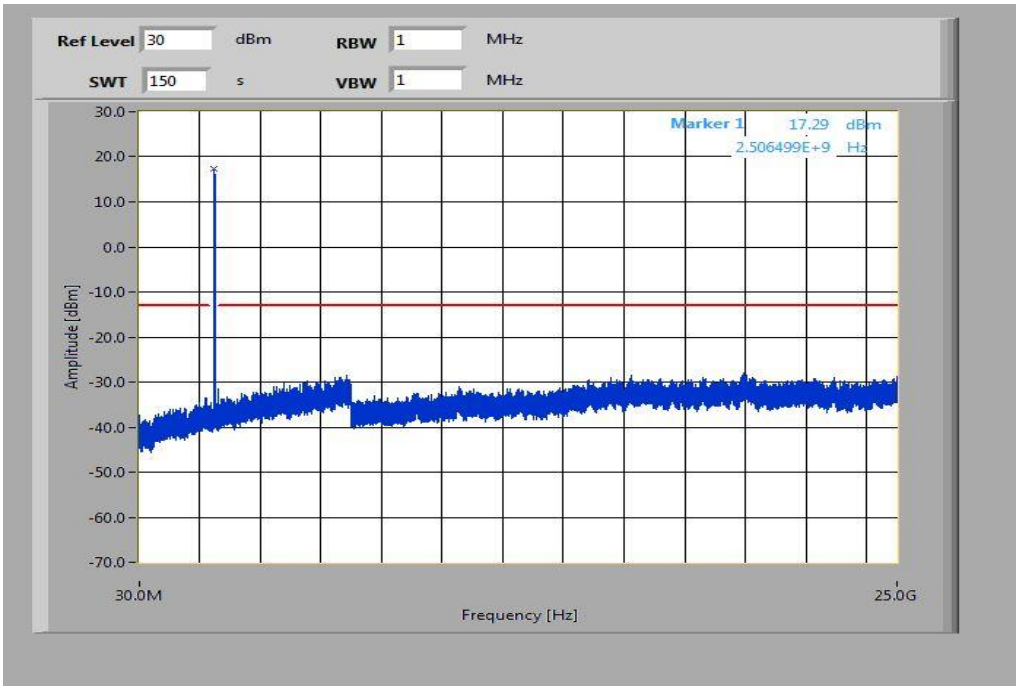


Plot 3: Highest channel, 10 MHz to 25 GHz

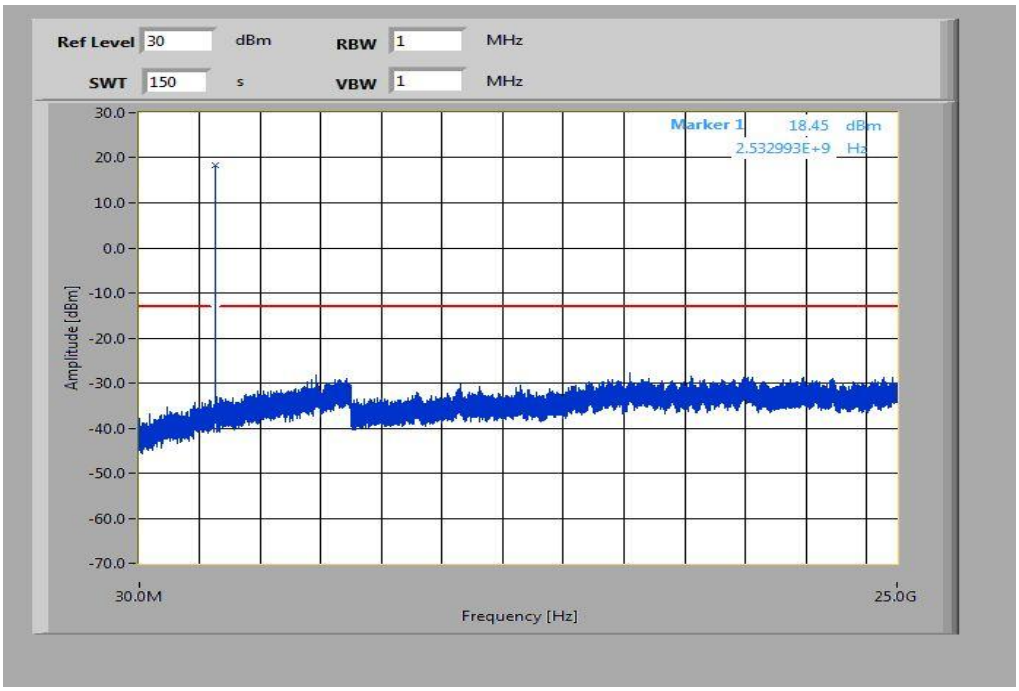


Plots for 10 MHz channel bandwidth, 16-QAM

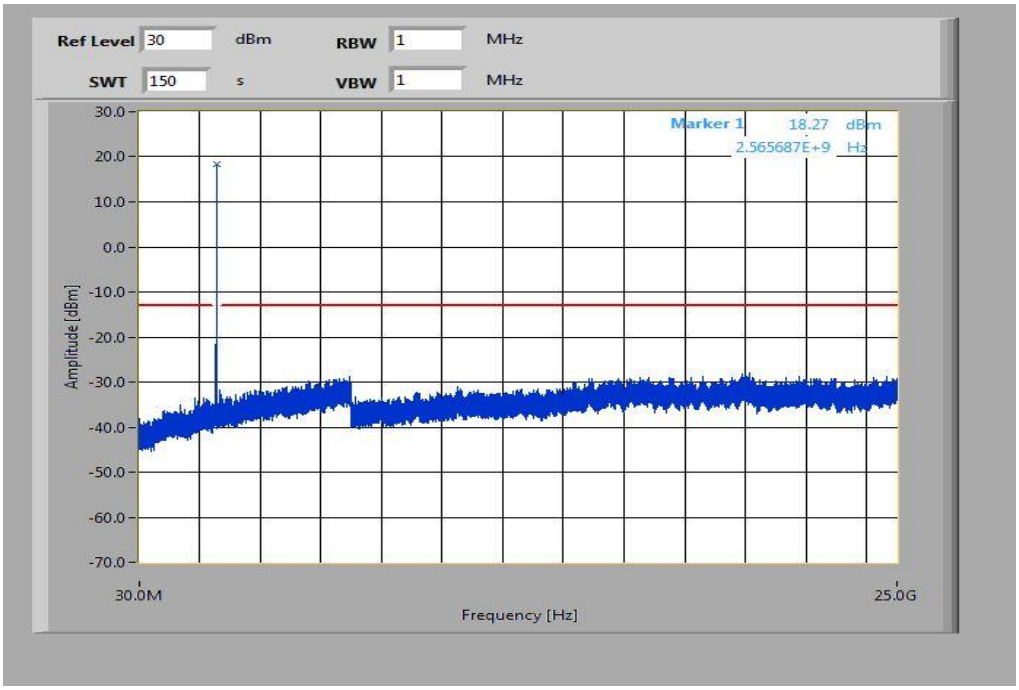
Plot 4: Lowest channel, 10 MHz to 25 GHz



Plot 5: Middle channel, 10 MHz to 25 GHz

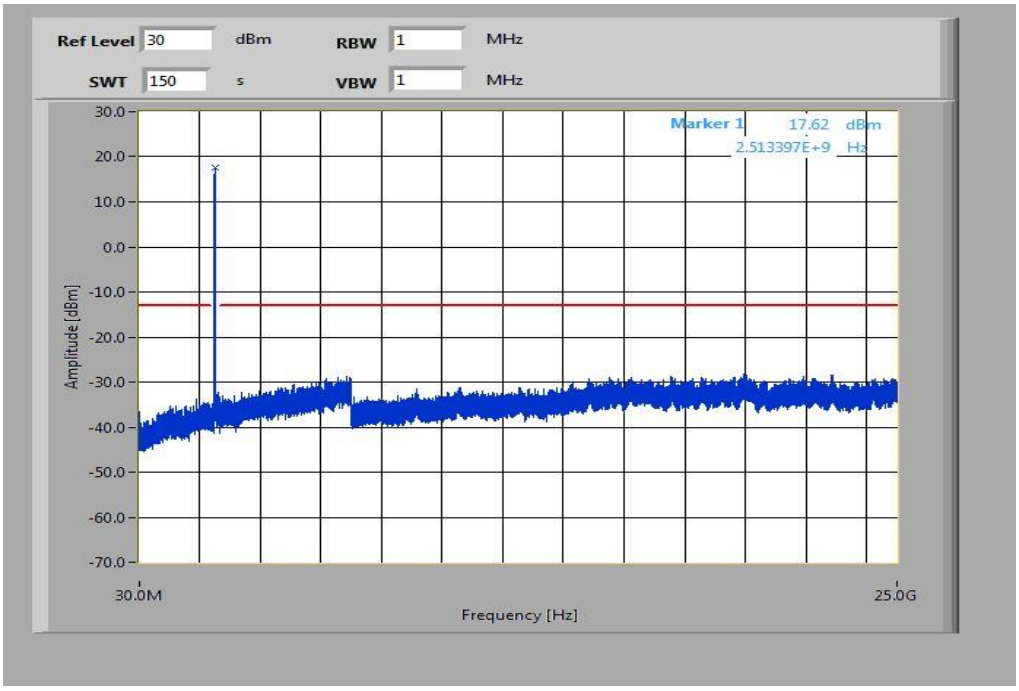


Plot 6: Highest channel, 10 MHz to 25 GHz

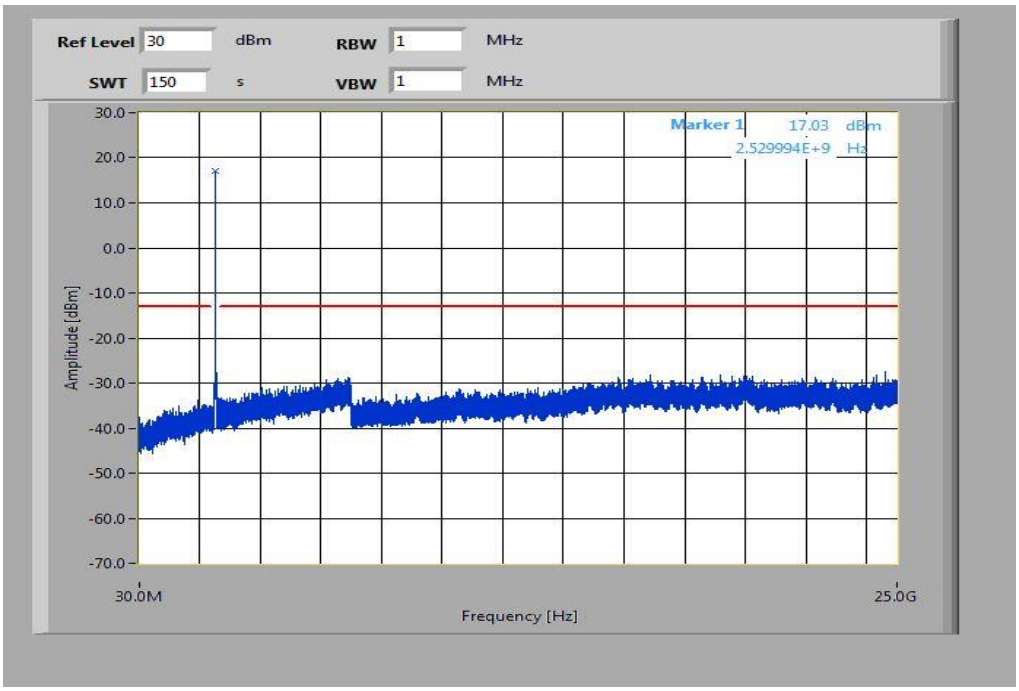


Plots for 15 MHz channel bandwidth, QPSK

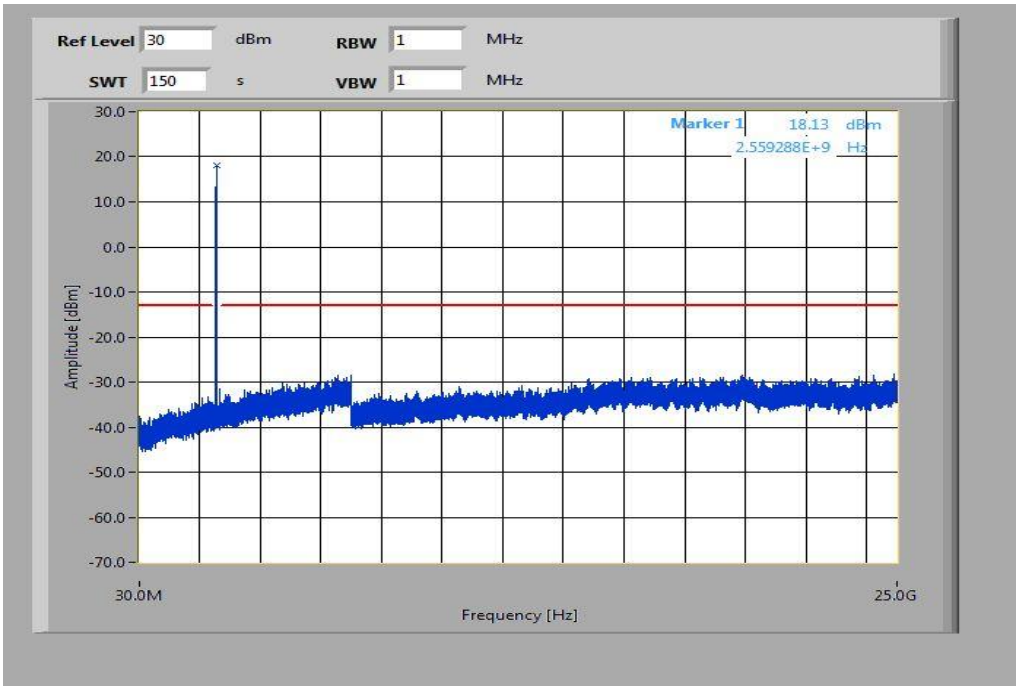
Plot 1: Lowest channel, 10 MHz to 25 GHz



Plot 2: Middle channel, 10 MHz to 25 GHz

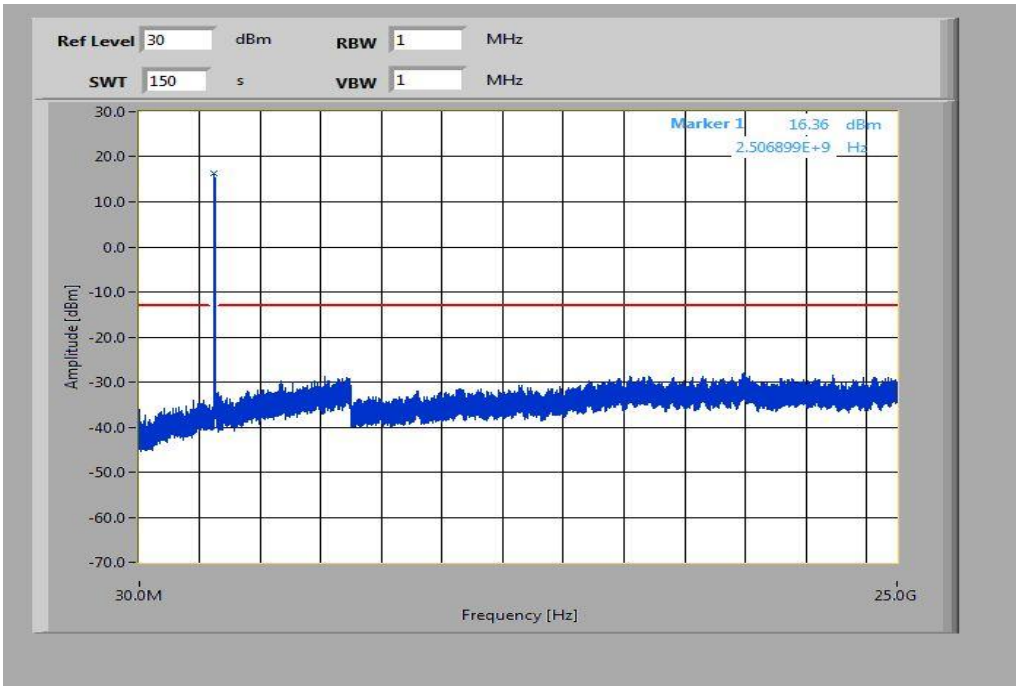


Plot 3: Highest channel, 10 MHz to 25 GHz

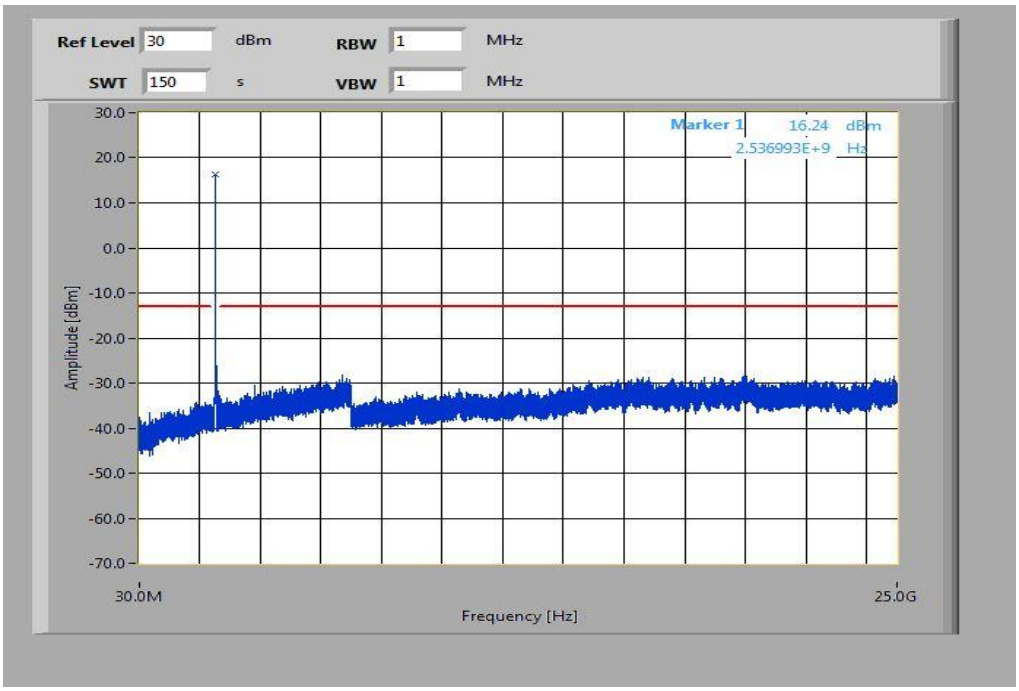


Plots for 15 MHz channel bandwidth, 16-QAM

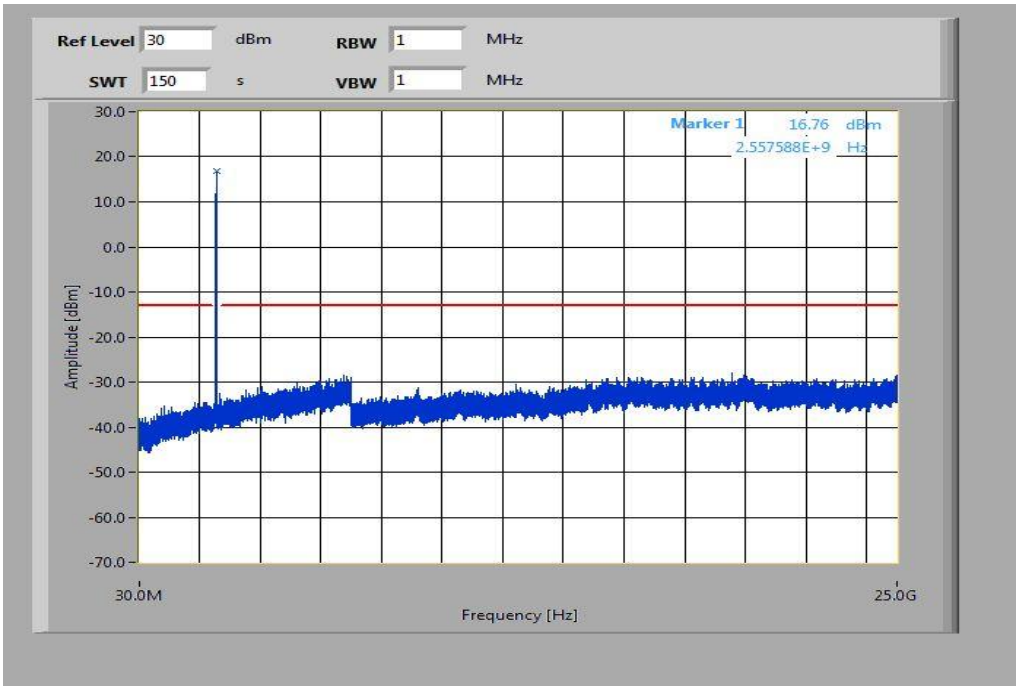
Plot 4: Lowest channel, 10 MHz to 25 GHz



Plot 5: Middle channel, 10 MHz to 25 GHz

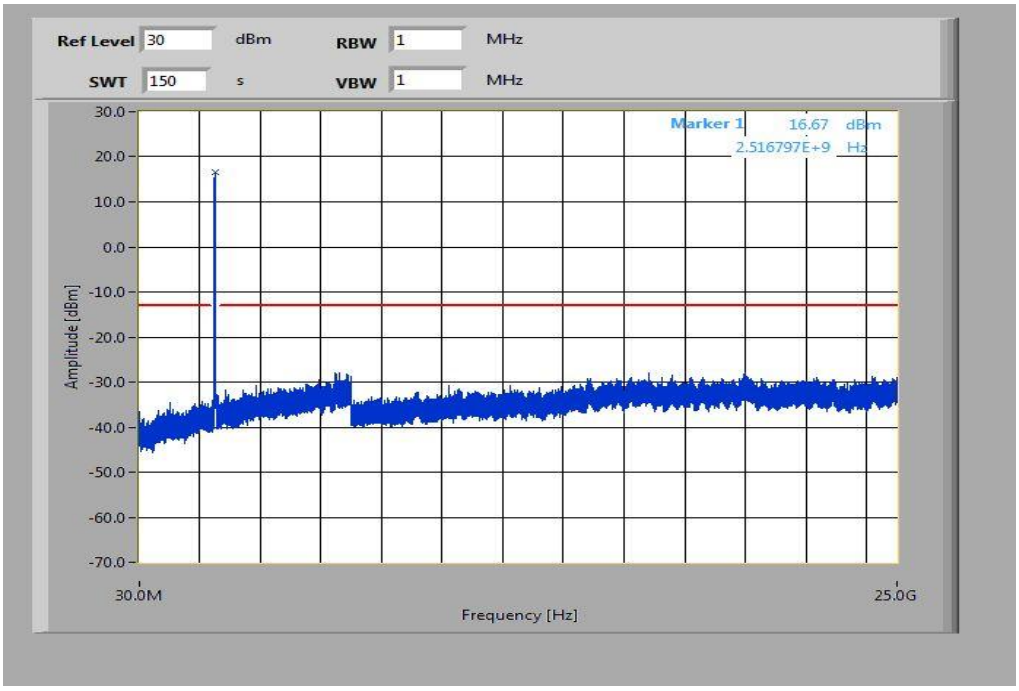


Plot 6: Highest channel, 10 MHz to 25 GHz

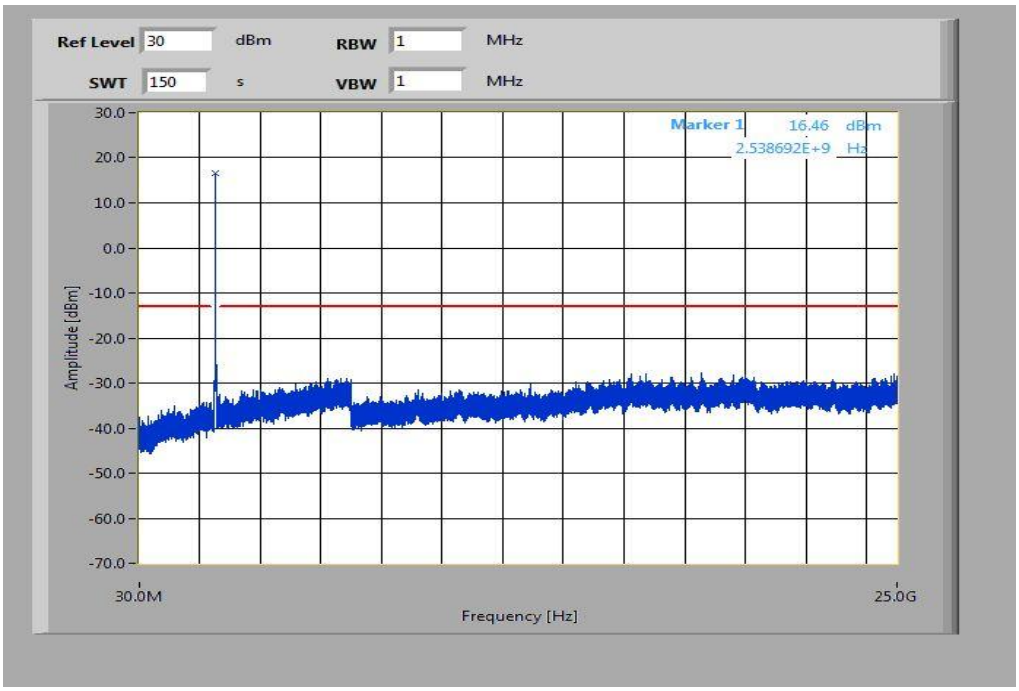


Plots for 20 MHz channel bandwidth, QPSK

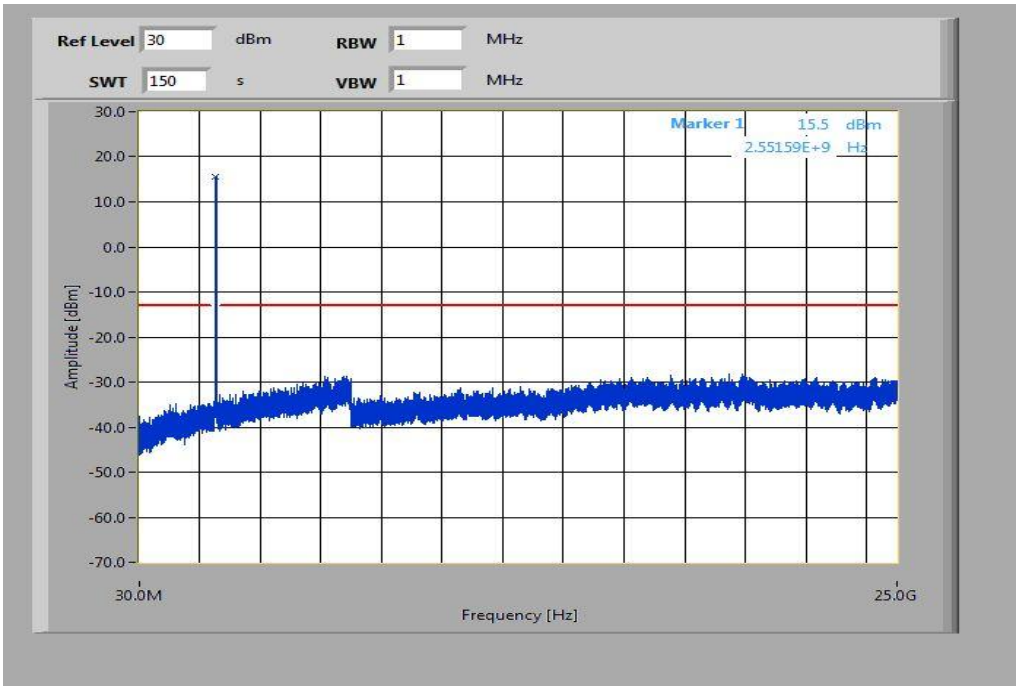
Plot 1: Lowest channel, 10 MHz to 25 GHz



Plot 2: Middle channel, 10 MHz to 25 GHz

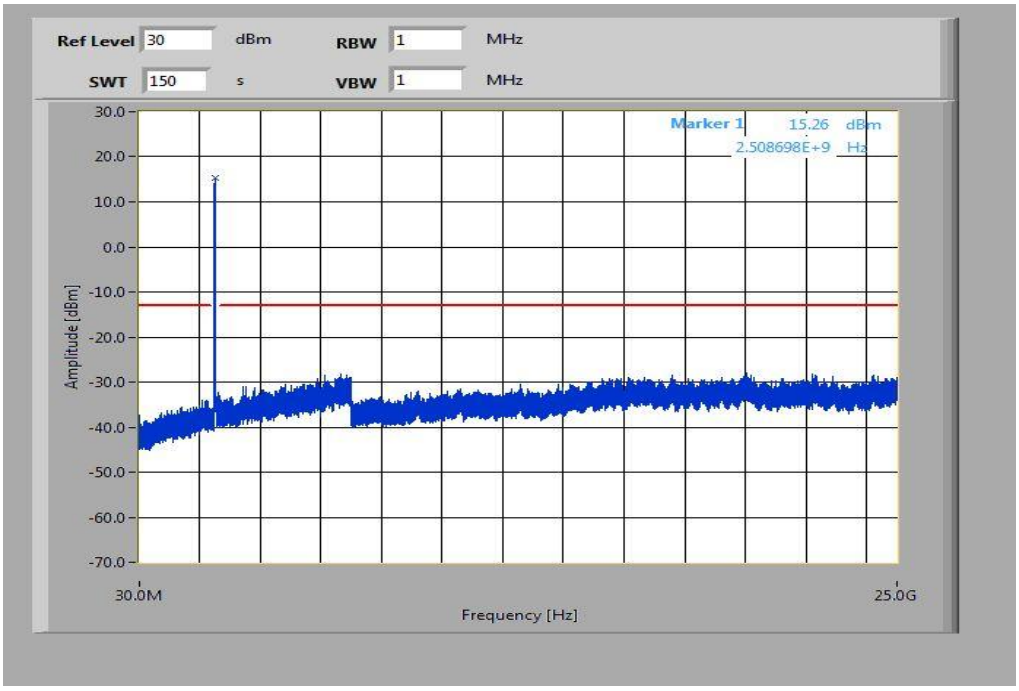


Plot 3: Highest channel, 10 MHz to 25 GHz

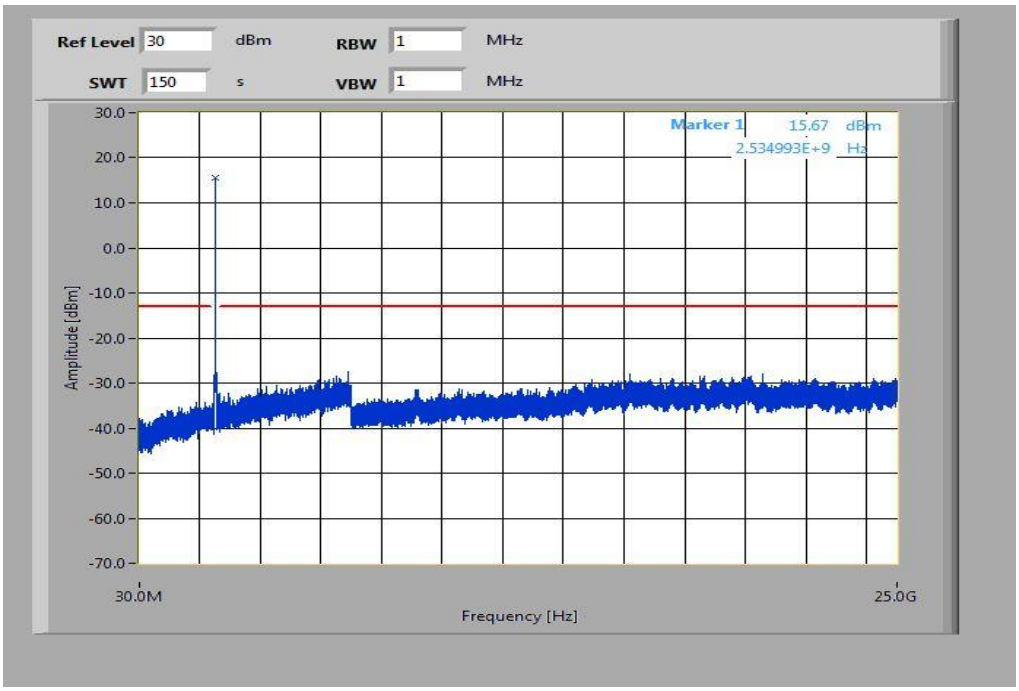


Plots for 20 MHz channel bandwidth, 16-QAM

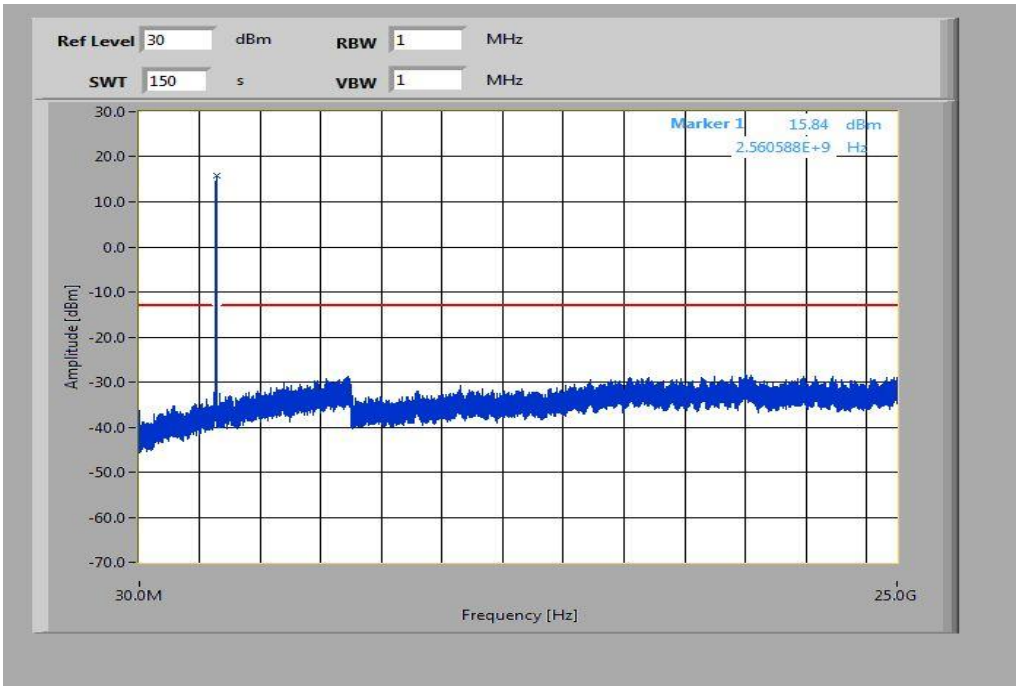
Plot 4: Lowest channel, 10 MHz to 25 GHz



Plot 5: Middle channel, 10 MHz to 25 GHz



Plot 6: Highest channel, 10 MHz to 25 GHz



8.4.5 Block edge compliance

Description:

The spectrum at the band edges must comply with the spurious emissions limits.

For the measurement the lowest, middle and highest channel bandwidth was used. If spurious were found the other bandwidths were measured, too.

Measurement:

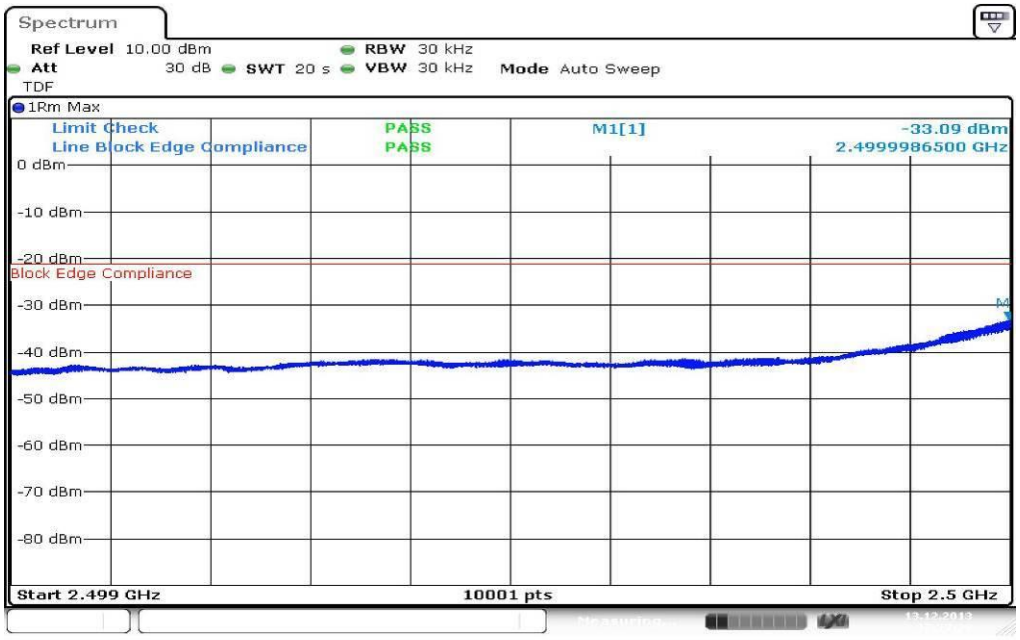
Measurement parameters	
Detector:	RMS
Sweep time:	20 sec.
Video bandwidth:	30 kHz
Resolution bandwidth:	30 kHz
Span:	1 MHz
Trace-Mode:	Max Hold

Limits:

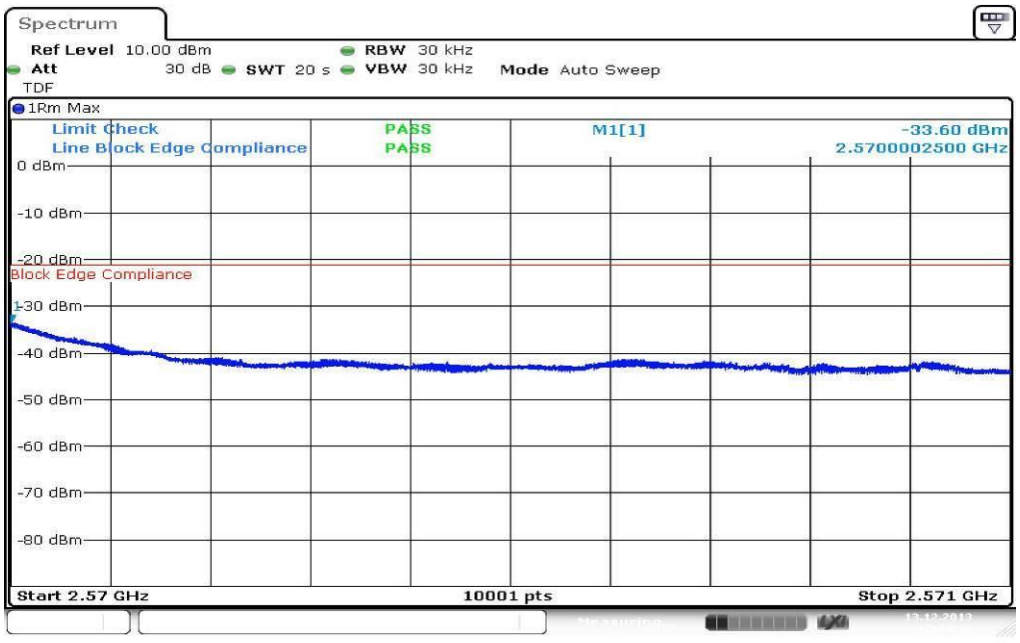
FCC	-/-
Block Edge Compliance	
Part 27.53 specifies that “the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.” However, in publication number 890810, The FCC Office of Engineering and Technology specified the following correction to the limits when a resolution bandwidth smaller than 1% of the emission bandwidth is used: “An alternative is to add an additional correction factor of 10 Log (RBW1/ RBW2) to the 43 +10 log(P) limit. RBW1 is the narrower measurement resolution bandwidth and RBW2 is either the 1% emissions bandwidth or 1 MHz.” When using a 30 kHz bandwidth, this yields a -8.239 adjustment to the limit [10 log(30kHz/50kHz) = -8.239]. When this adjustment is applied to the limit, the limit becomes -21.24.	
-21.24 dBm	

Results: **5 MHz channel bandwidth**

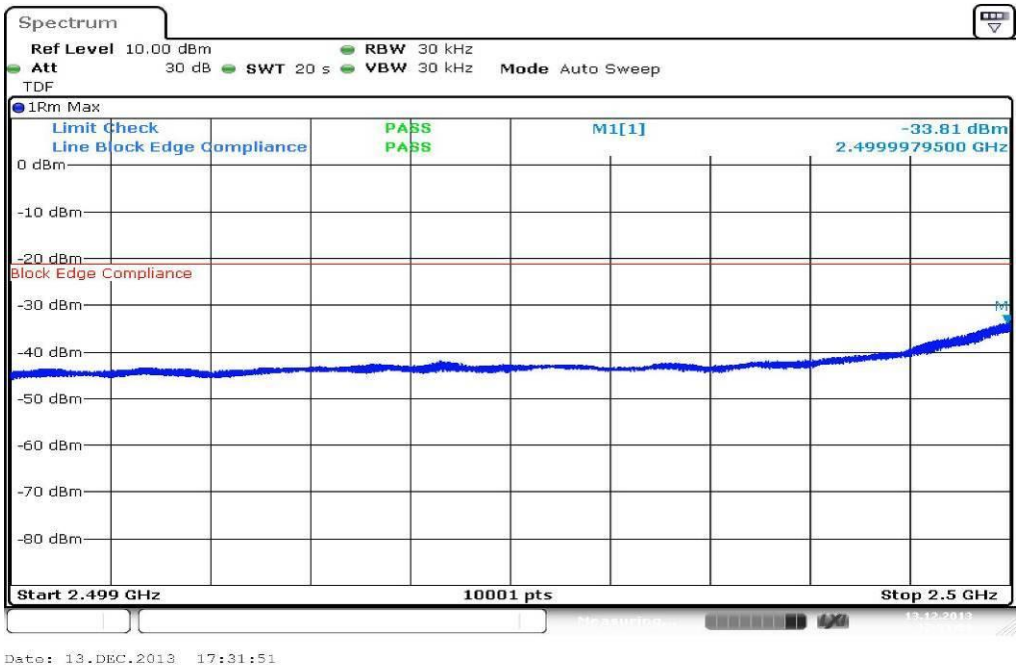
Plot 1: Lowest channel, QPSK modulation



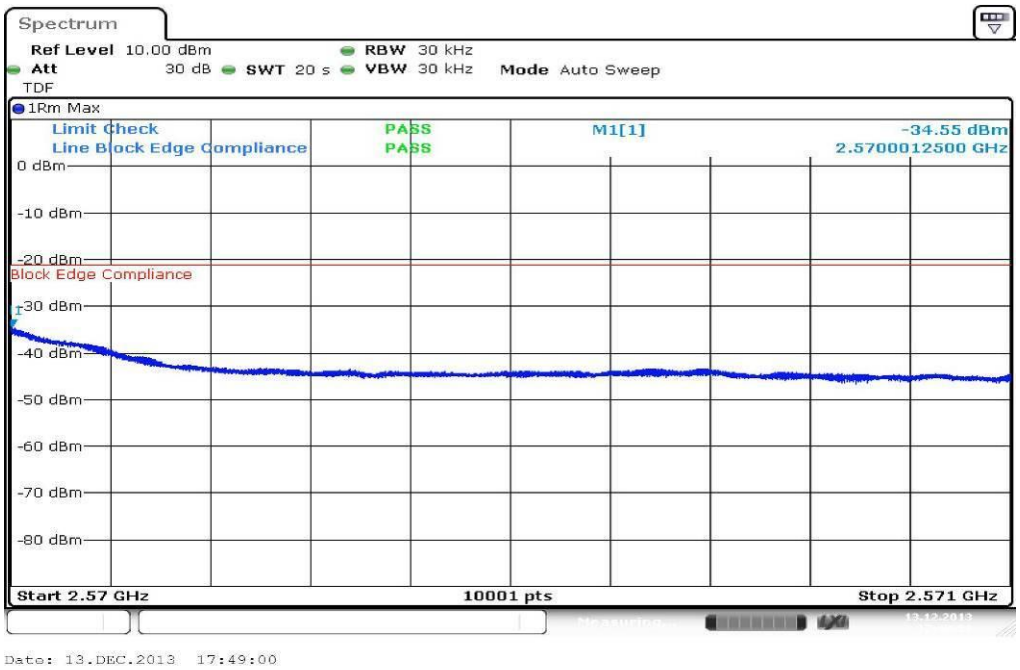
Plot 2: Highest channel, QPSK modulation



Plot 3: Lowest channel, 16 – QAM modulation

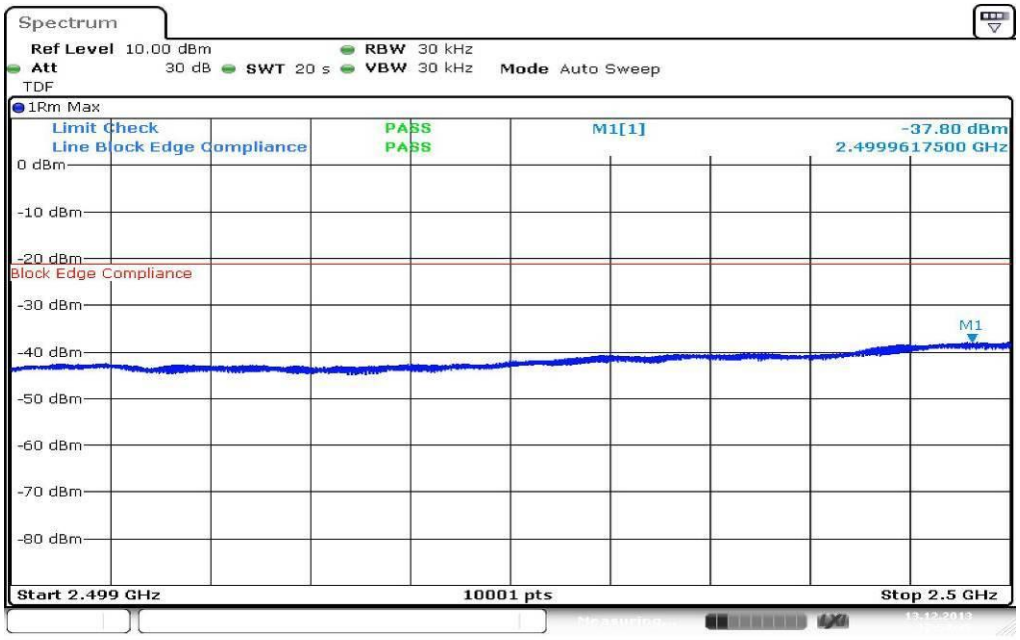


Plot 4: Highest channel, 16 – QAM modulation

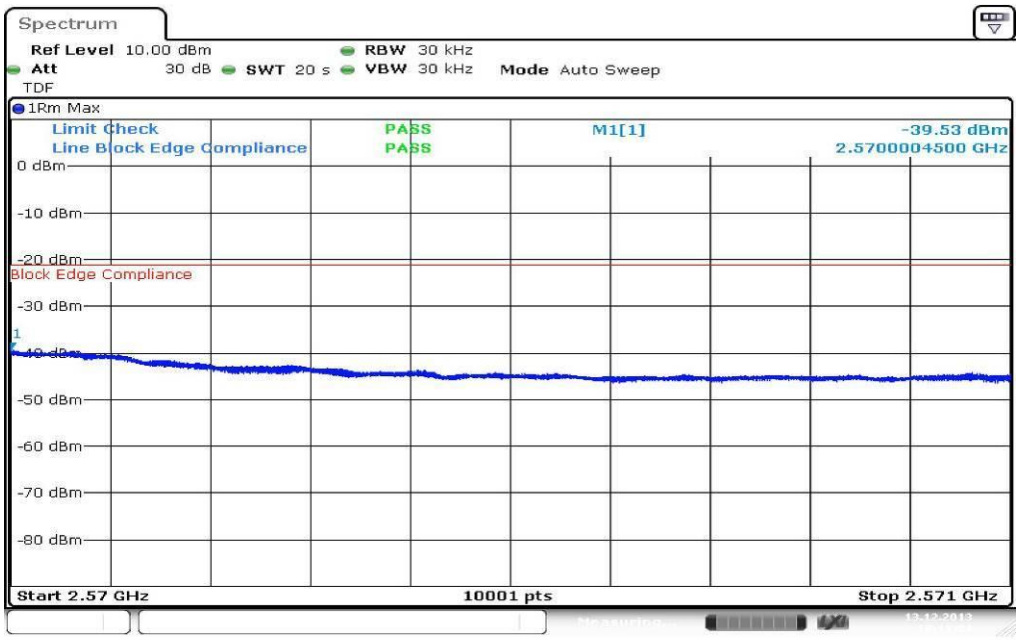


Results: **10 MHz channel bandwidth**

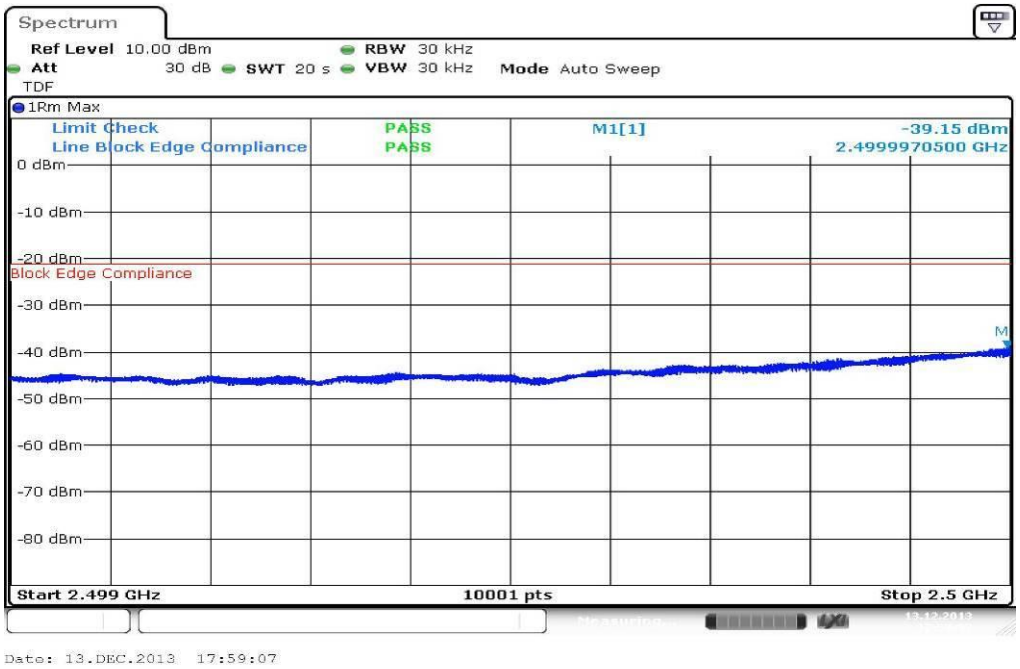
Plot 1: Lowest channel, QPSK modulation



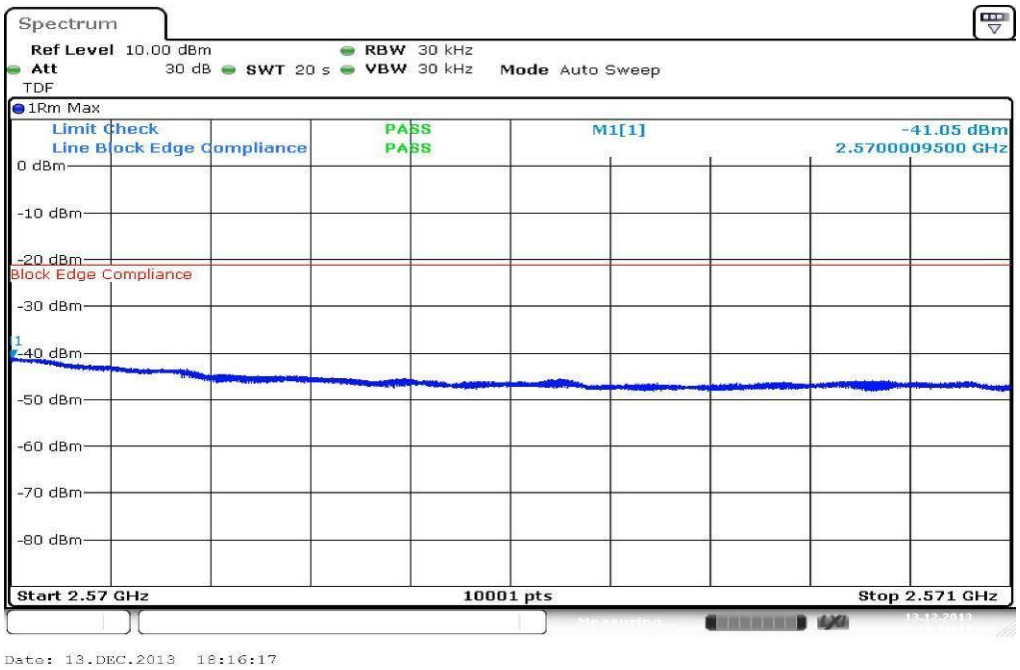
Plot 2: Highest channel, QPSK modulation



Plot 3: Lowest channel, 16 – QAM modulation

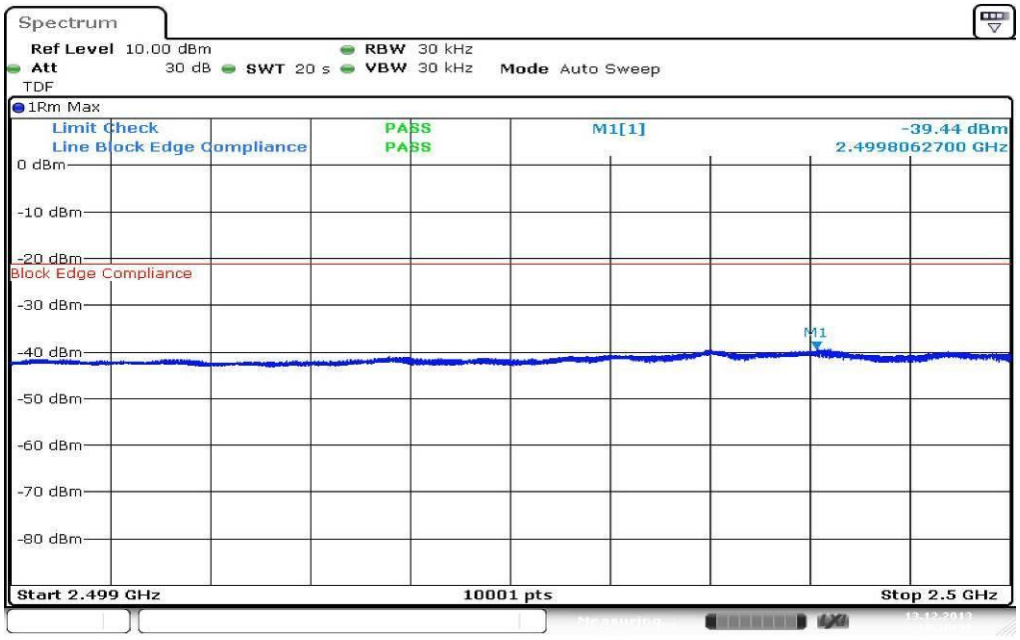


Plot 4: Highest channel, 16 – QAM modulation

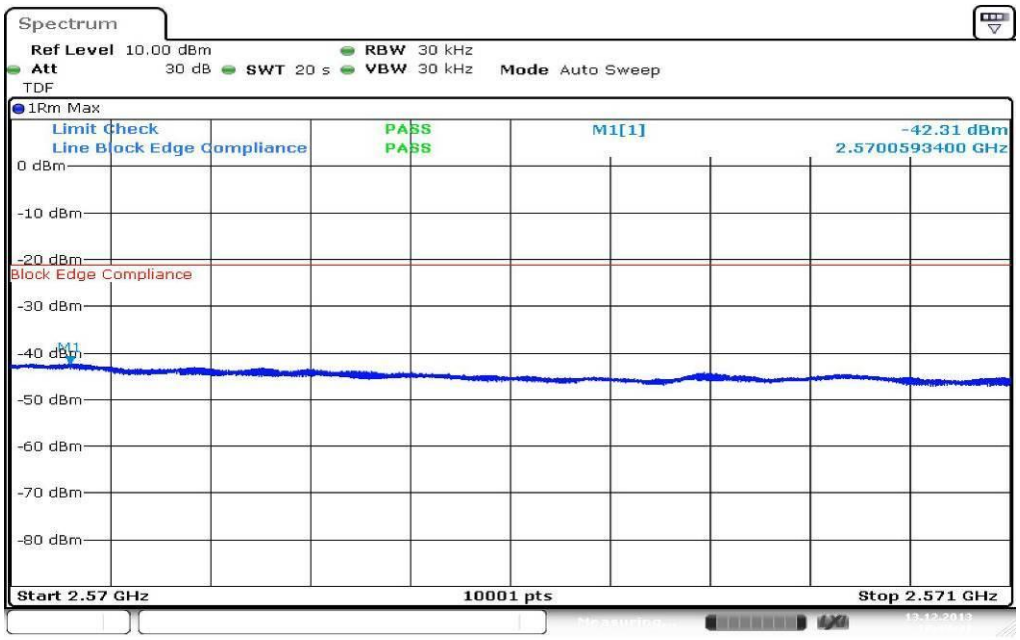


Results: **15 MHz channel bandwidth**

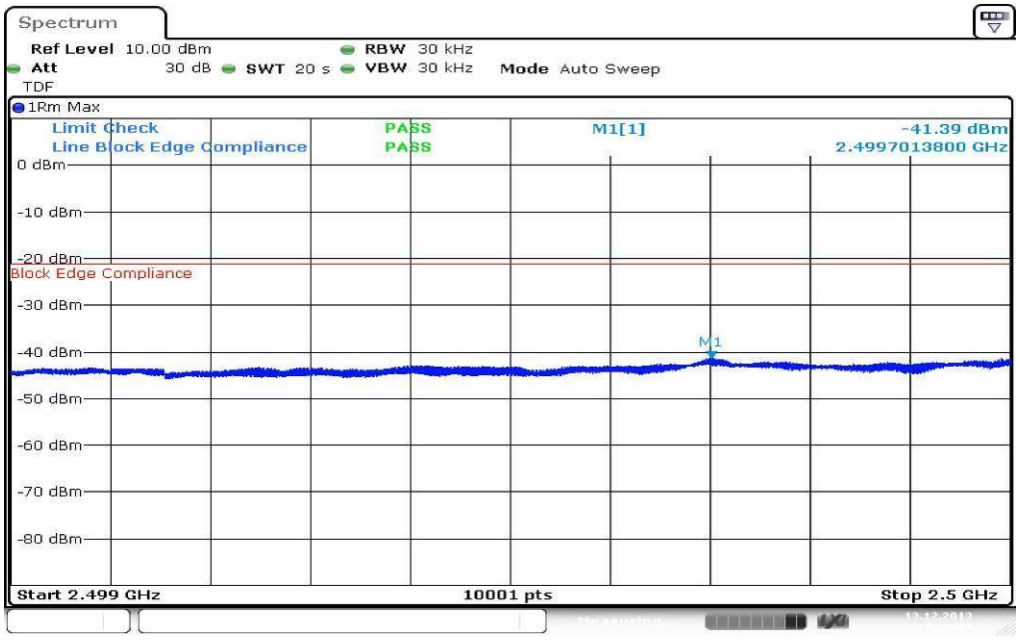
Plot 1: Lowest channel, QPSK modulation



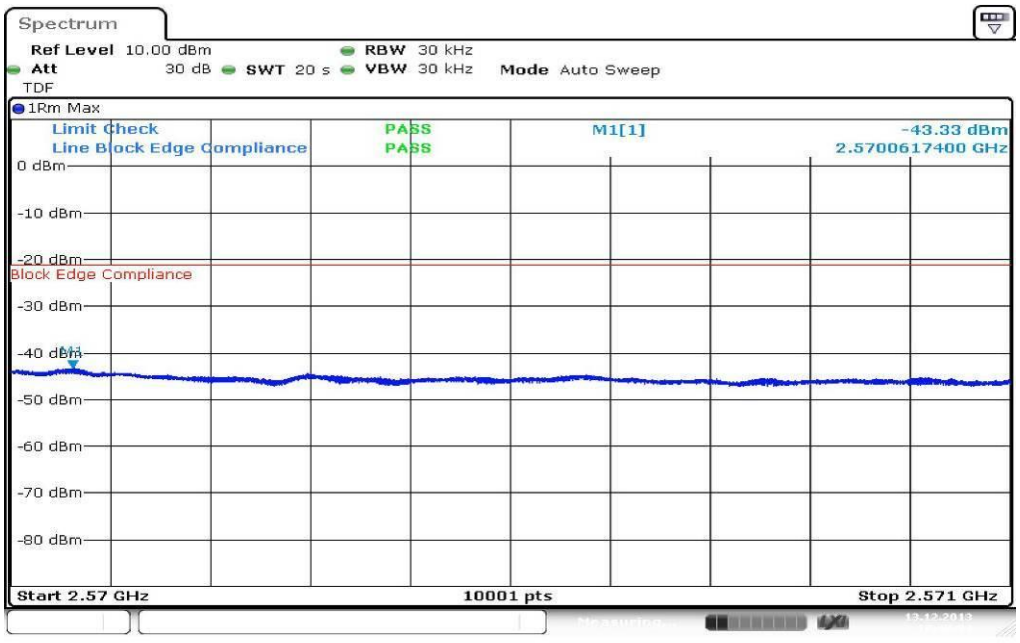
Plot 2: Highest channel, QPSK modulation



Plot 3: Lowest channel, 16 – QAM modulation

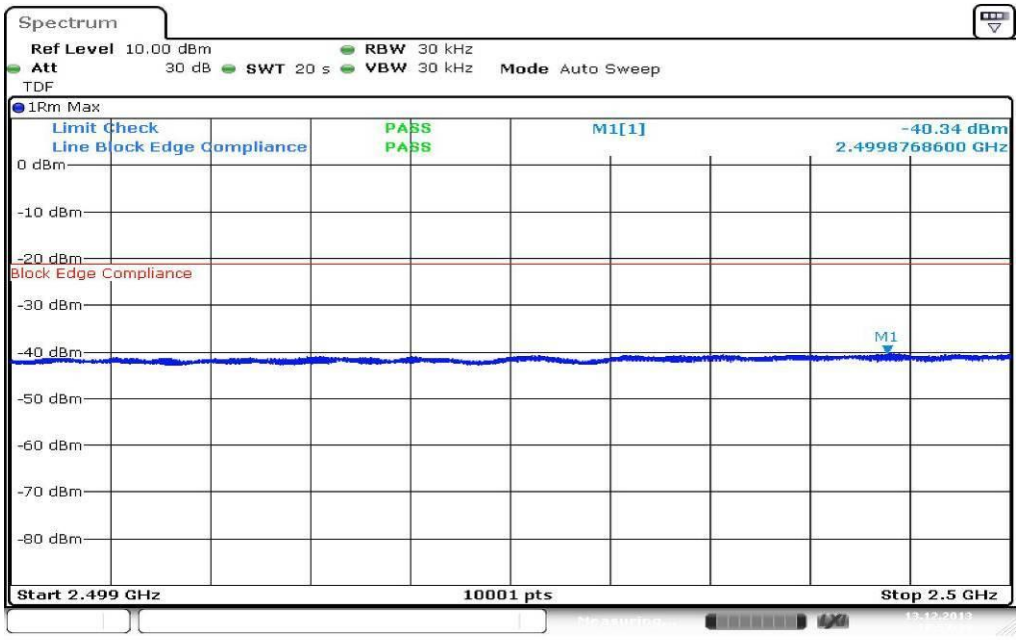


Plot 4: Highest channel, 16 – QAM modulation

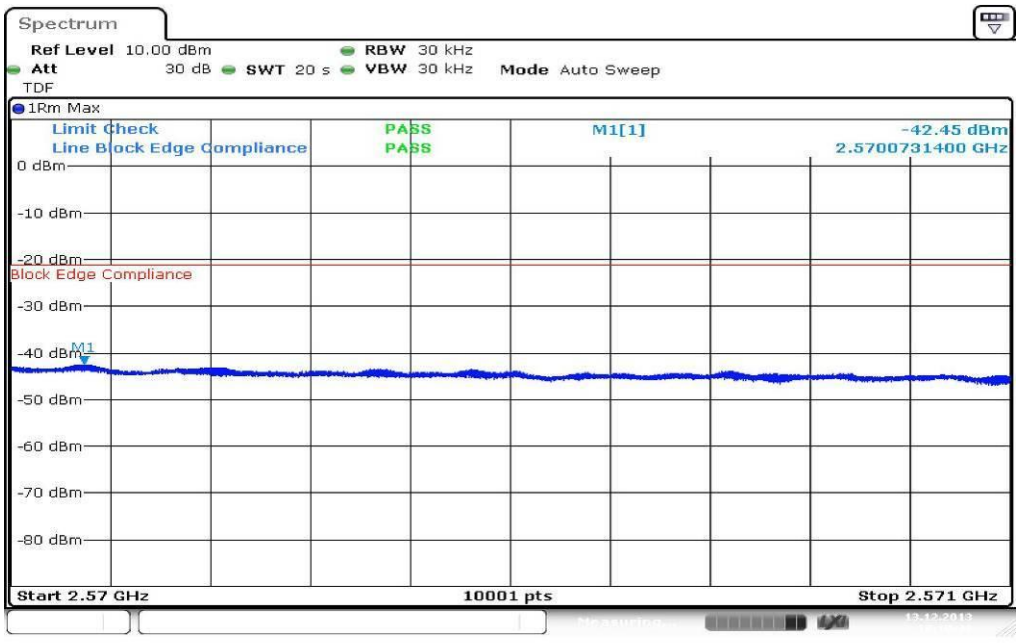


Results: **20 MHz channel bandwidth**

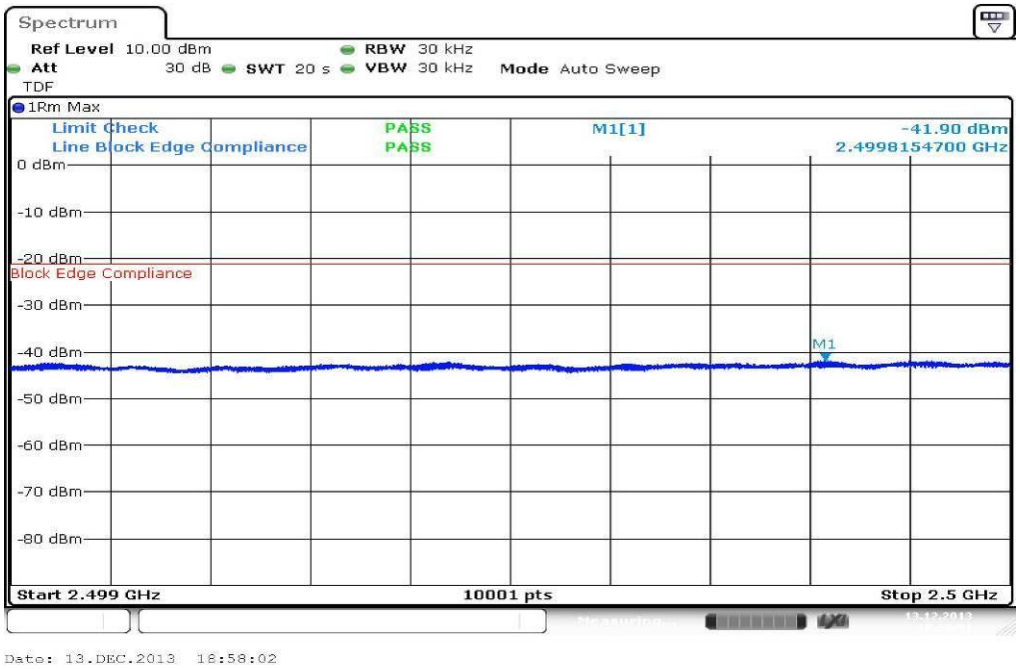
Plot 1: Lowest channel, QPSK modulation



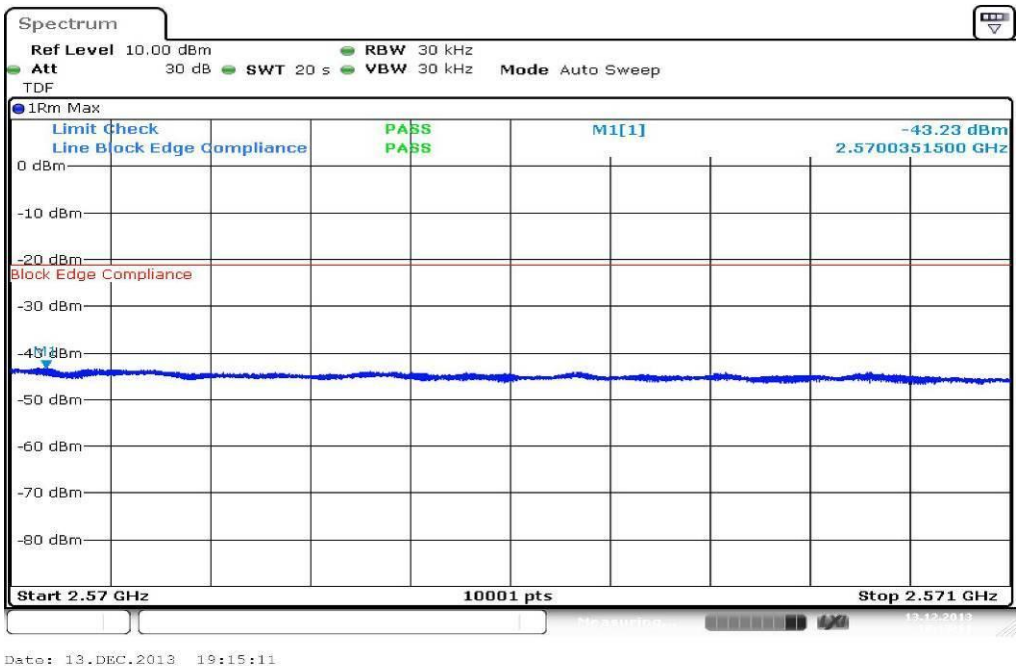
Plot 2: Highest channel, QPSK modulation



Plot 3: Lowest channel, 16 – QAM modulation



Plot 4: Highest channel, 16 – QAM modulation



Result: **Passed**

8.4.6 Occupied bandwidth

Description:

Measurement of the occupied bandwidth of the transmitted signal.

Measurement:

Similar to conducted emissions, occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the mid frequencies of the LTE band 7. The table below lists the measured 99% power occupied bandwidths. Spectrum analyzer plots are included on the following pages.

Part 27.53 requires a measurement bandwidth of at least 1% of the occupied bandwidth.

Measurement parameters	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	Depends on Channel Bandwidth
Resolution bandwidth:	Depends on Channel Bandwidth
Span:	Depends on Channel Bandwidth
Trace-Mode:	Max Hold

Limits:

FCC	-/-
Occupied Bandwidth	
Spectrum must fall completely in the specified band	

Results:

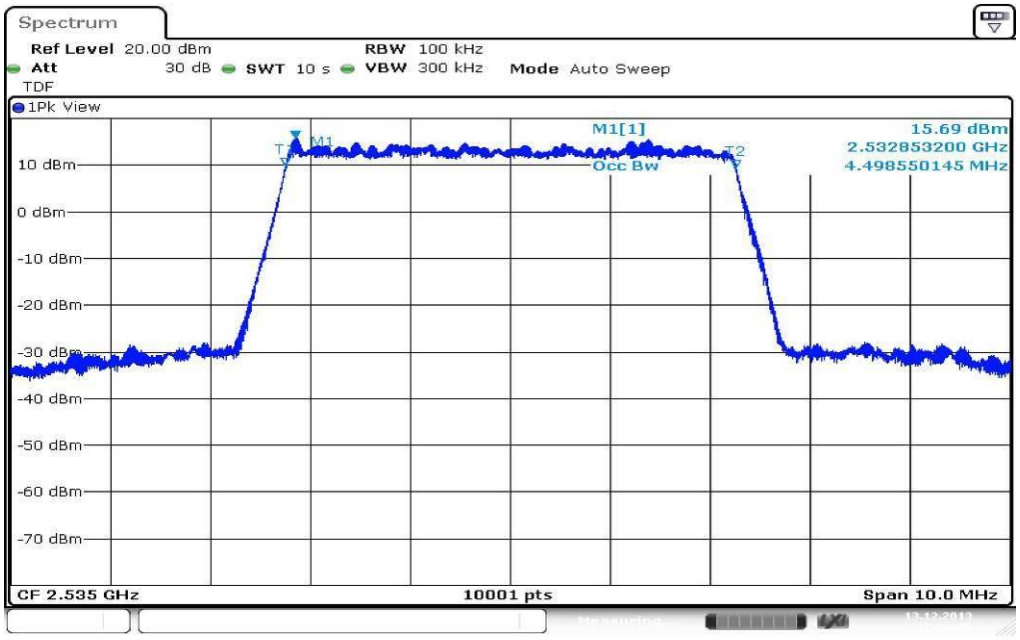
Occupied Bandwidth - QPSK		
Bandwidth [MHz]	**99% OBW (kHz)**	**26 dB bandwidth (kHz)**
5	4499	4994
10	9061	10173
15	13433	14741
20	17934	19645
Measurement uncertainty	± 50 kHz to ± 500 kHz depending on channel bandwidth	

Occupied Bandwidth – 16-QAM		
Bandwidth [MHz]	**99% OBW (kHz)**	**26 dB bandwidth (kHz)**
5	4516	5028
10	9061	10057
15	13424	14669
20	17938	19690
Measurement uncertainty	± 50 kHz to ± 500 kHz depending on channel bandwidth	

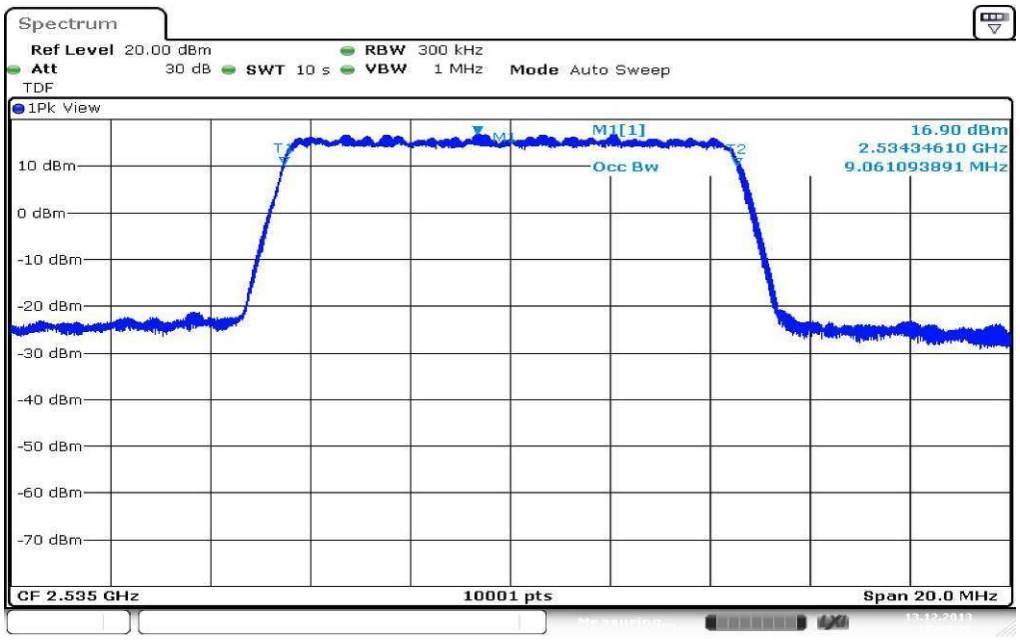
Result: **Passed**

Plots: QPSK

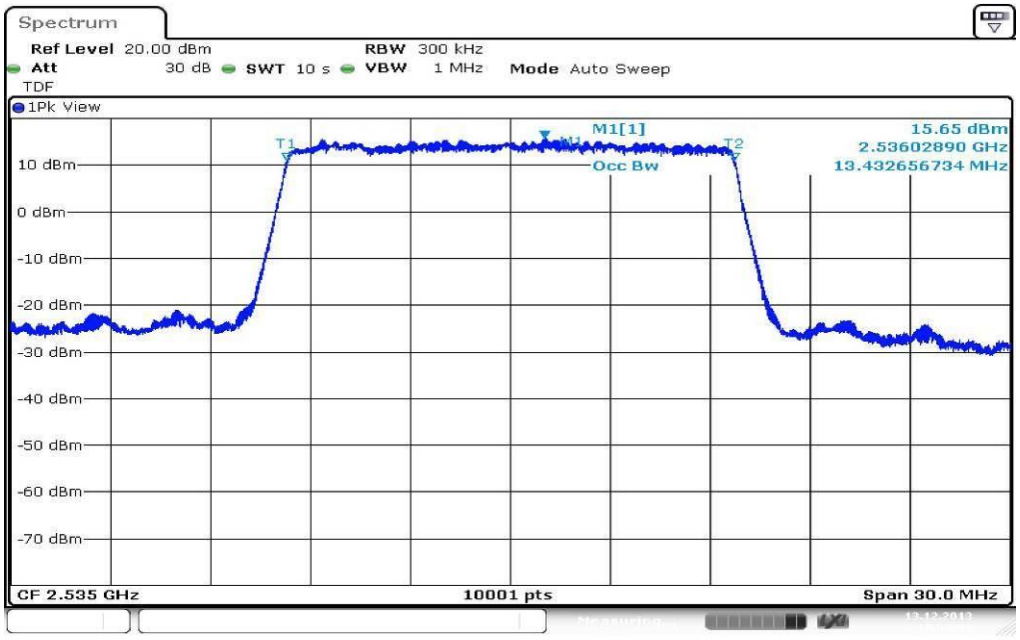
Plot 1: 5 MHz, 99% OBW



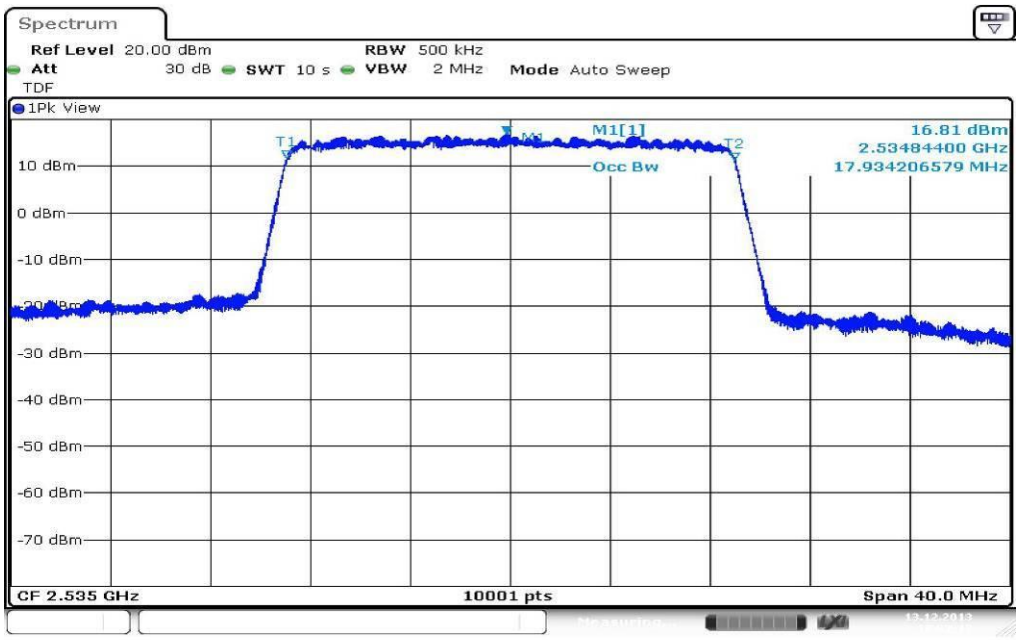
Plot 2: 10 MHz, 99% OBW



Plot 3: 15 MHz, 99% OBW

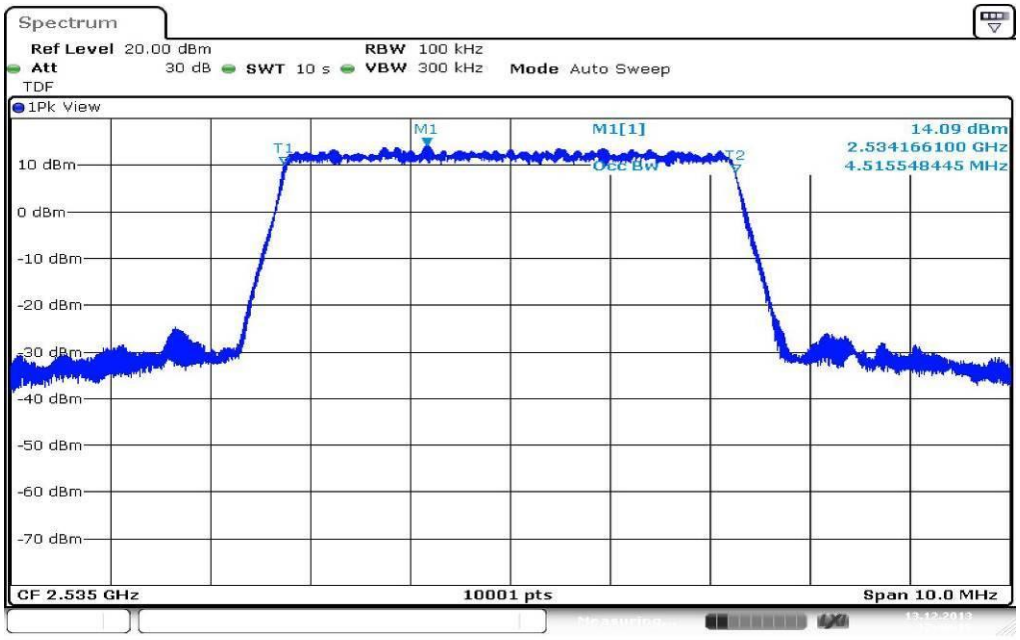


Plot 4: 20 MHz, 99% OBW

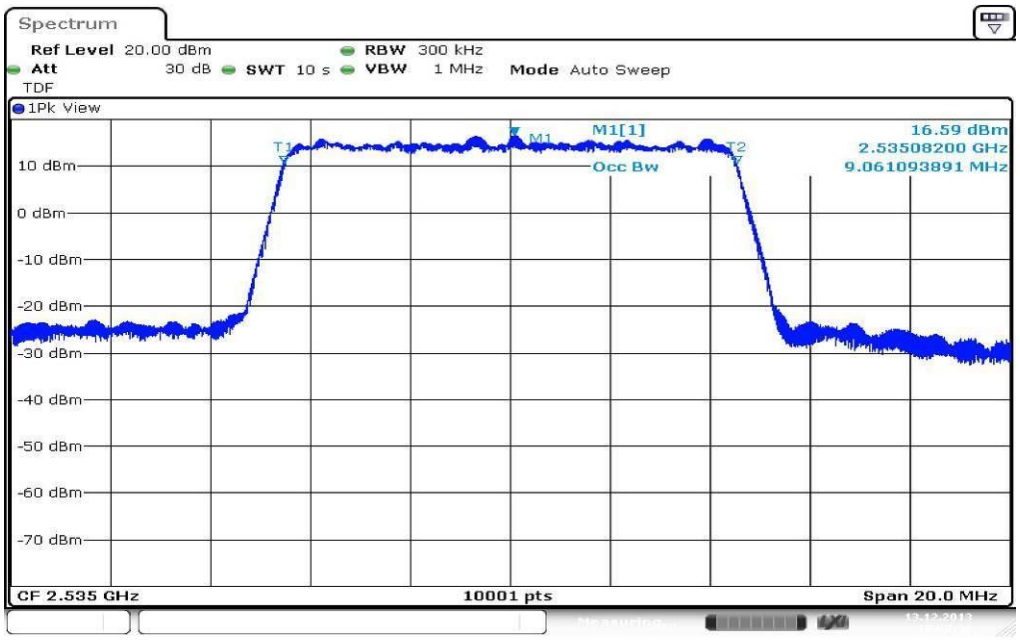


Plots: 16-QAM

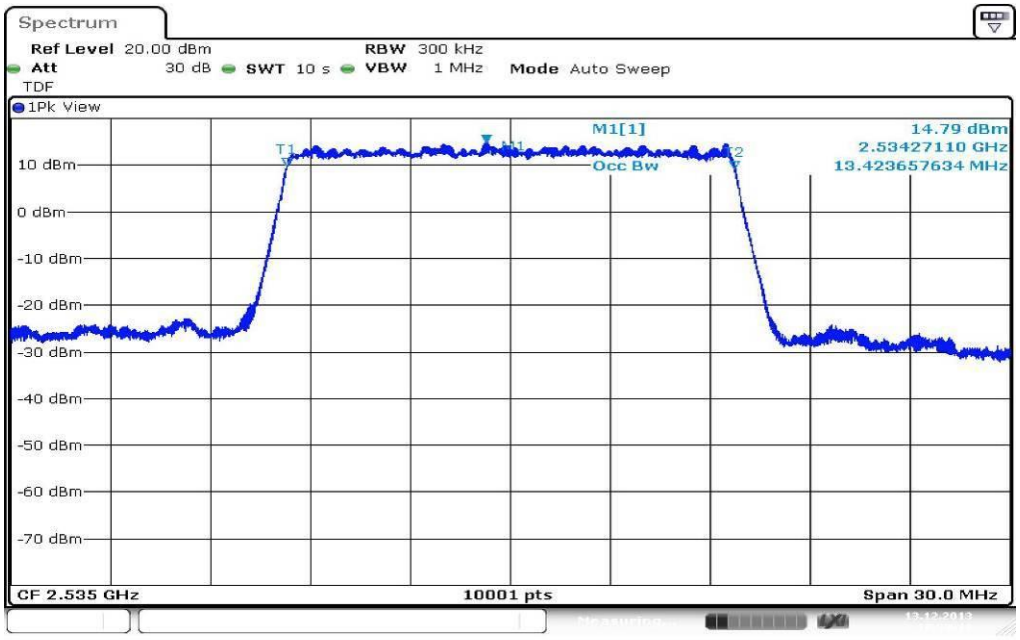
Plot 1: 5 MHz, 99% OBW



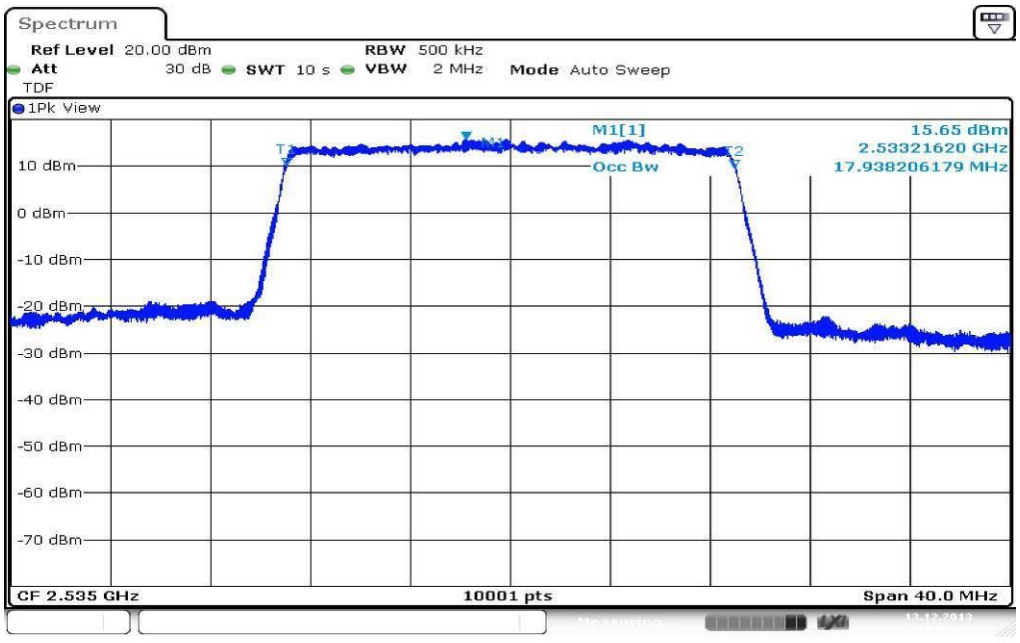
Plot 2: 10 MHz, 99% OBW



Plot 3: 15 MHz, 99% OBW



Plot 4: 20 MHz, 99% OBW



8.5 Results LTE – Band 13

The EUT was set to transmit the maximum power.

8.5.1 RF output power

Description:

This paragraph contains average power, peak output power and EIRP measurements for the mobile station. In all cases, the peak output power is within the required mask (this mask is specified in the JTC standards, TIA PN3389 Vol. 1 Chap 7, and is no FCC requirement).

Measurement:

The mobile was set up for the maximum output power with pseudo random data modulation.

To determine the Peak-To-Average Power Ratio (PAPR) the measurement was performed with the Power Complementary Cumulative Distribution Function (CCDF).

Measurement parameters	
Detector:	Peak and RMS (Power in Burst)
Sweep time:	Auto
Video bandwidth:	Depends on Channel Bandwidth
Resolution bandwidth:	Depends on Channel Bandwidth
Span:	Zero Span
Trace-Mode:	Max Hold

Limits:

FCC	-/-
Nominal Peak Output Power	
+33.00 dBm In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.	

Results:

Output Power (conducted)						
Bandwidth (MHz)	**Frequency (MHz)**	**Resource block allocation**	**Average Output Power (dBm) QPSK**	**Peak to Average Ratio (dB)**	**Average Output Power (dBm) 16-QAM**	**Peak to Average Ratio (dB)**
5	779.5	1 RB low	23.7	4.13	22.8	4.79
		1 RB high	23.8	4.68	22.6	4.92
		50% RB mid	22.7	4.92	21.8	5.75
		100% RB	22.7	5.63	21.8	6.58
	782	1 RB low	23.8	4.42	23.0	4.69
		1 RB high	23.6	4.10	23.0	4.23
		50% RB mid	22.7	5.83	21.7	4.99
		100% RB	22.5	6.51	21.7	5.32
	784.5	1 RB low	23.5	4.31	22.4	5.00
		1 RB high	23.9	4.29	22.8	4.82
		50% RB mid	22.7	4.62	21.7	5.54
		100% RB	22.8	5.47	21.8	6.39
10	782.0	1 RB low	23.7	5.44	22.8	4.31
		1 RB high	23.8	4.89	22.6	4.07
		50% RB mid	22.7	5.72	21.5	4.94
		100% RB	22.6	6.04	21.5	5.16
Measurement uncertainty			± 0.5 dB			

The output power radiated is measured with the mode wich have the highest conducted output power.

Output Power (radiated)			
Bandwidth (MHz)	**Frequency (MHz)**	**Average Output Power (dBm) QPSK**	**Average Output Power (dBm) 16-QAM**
5	779.5	21.5	20.5
	782.0	21.1	20.3
	784.5	21.6	20.5
10	782.0	21.5	20.5
Measurement uncertainty		± 3.0 dB	

Result: **Passed**

8.5.2 Frequency stability

Description:

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the mobile station in a “call mode”. This is accomplished with the use of a R&S CMW500 DIGITAL RADIOCOMMUNICATION TESTER.
1. Measure the carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30 C.
3. With the mobile station, powered with V_{nom}, connected to the CMW500 and in a simulated call on channel 1412 (centre channel), measure the carrier frequency. These measurements should be made within two minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +60°C. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with V_{nom}. Vary supply voltage from V_{min} to V_{max}, in 0.1 Volt steps remeasuring carrier frequency at each voltage. Pause at V_{nom} for 1.5 hours unpowered, to allow any self heating to stabilize, before continuing.
6. At all temperature levels hold the temperature to +/- 0.5°C during the measurement procedure.

This measurement was performed with the highest channel bandwidth supported from the EUT on the middle channel

Measurement:

Measurement parameters	
Detector:	Measured with CMW500
Sweep time:	
Video bandwidth:	
Resolution bandwidth:	
Span:	
Trace-Mode:	

Limits:

FCC	-/-
Frequency Stability	
< 2.5 ppm	

Results:

FREQ ERROR versus VOLTAGE

Voltage (V)	Frequency Error (Hz)	Frequency Error (%)	Frequency Error (ppm)
3.3	11	0.00000141	0.0141
3.4	4	0.00000051	0.0051
3.5	-10	-0.00000128	-0.0128
3.6	-4	-0.00000051	-0.0051
3.7	11	0.00000141	0.0141
3.8	4	0.00000051	0.0051
3.9	7	0.00000090	0.0090
4.0	-14	-0.00000179	-0.0179
4.1	5	0.00000064	0.0064
4.2	-12	-0.00000153	-0.0153
4.3	-13	-0.00000166	-0.0166
4.4	4	0.00000051	0.0051

FREQ ERROR versus TEMPERATURE

Temperature (°C)	Frequency Error (Hz)	Frequency Error (%)	Frequency Error (ppm)
-30	-13	-0.00000166	-0.0166
-20	16	0.00000205	0.0205
-10	-9	-0.00000115	-0.0115
± 0	-8	-0.00000102	-0.0102
10	9	0.00000115	0.0115
20	-1	-0.00000013	-0.0013
30	-4	-0.00000051	-0.0051
40	-9	-0.00000115	-0.0115
50	-7	-0.00000090	-0.0090
60	-14	-0.00000179	-0.0179

Additional measurements for RSS-130 (4.3 b)

f_L =777.061 MHz	f_H = 786.952 MHz
f_L – (max freq. error) = 777.061 MHz	f_H + (max freq. error) = 786.952 MHz

Result: **Passed**

8.5.3 Spurious emissions radiated

Description:

The following steps outline the procedure used to measure the radiated emissions from the mobile station. The site is constructed in accordance with ANSI C63.4:2009 requirements and is recognized by the FCC to be in compliance for a 3 and a 10 meter site. The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier that can be as high as 784.5 MHz. This was rounded up to 12 GHz. The resolution bandwidth is set as outlined in Part 27.53. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the LTE band 13.

The final open field emission (here 10m semi-anechoic chamber listed by FCC) test procedure is as follows:

a) The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna.
b) The antenna output was terminated in a 50 ohm load (if possible).
c) A double ridged wave guide antenna was placed on an adjustable height antenna mast 3 meters from the test item for emission measurements.
d) Detected emissions were maximized at each frequency by rotating the test item and adjusting the receive antenna height and polarization. The maximum meter reading was recorded. The radiated emission measurements of the harmonics of the transmit frequency through the 10th harmonic were measured with peak detector and 1 MHz bandwidth. If the harmonic could not be detected above the noise floor, the ambient level was recorded. The equivalent power into a dipole antenna was calculated from the field intensity levels measured at 3 meters.
e) Now each detected emissions were substituted by the substitution method, in accordance with the TIA/EIA 603.

Measurement:

Measurement parameters	
Detector:	Peak
Sweep time:	2 s
Video bandwidth:	Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz
Resolution bandwidth:	Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz
Span:	100 MHz Steps
Trace-Mode:	Max Hold

Limits:

FCC	-/-
Spurious Emissions Radiated	
Attenuation ≥ 43 + 10log(P) (P, Power in Watts)	
-13 dBm	

Results:

Radiated emissions measurements were made only at the upper, center, and lower carrier frequencies of the LTE band 13 (779.5 MHz, 782.0 MHz and 784.5 MHz). It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the LTE band 13 into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this.

The final open field radiated levels are presented on the next pages.
All measurements were done in horizontal and vertical polarization; the plots show the worst case.
The plots show only the middle channel with full resource blocks. If spurious were detected, the lowest and highest channel and all supported channel bandwidths were checked, too.

As can be seen from this data, the emissions from the test item were within the specification limit.

QPSK

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	No spurious emissions detected.		No spurious emissions detected.		No spurious emissions detected.
Measurement uncertainty		± 3dB			

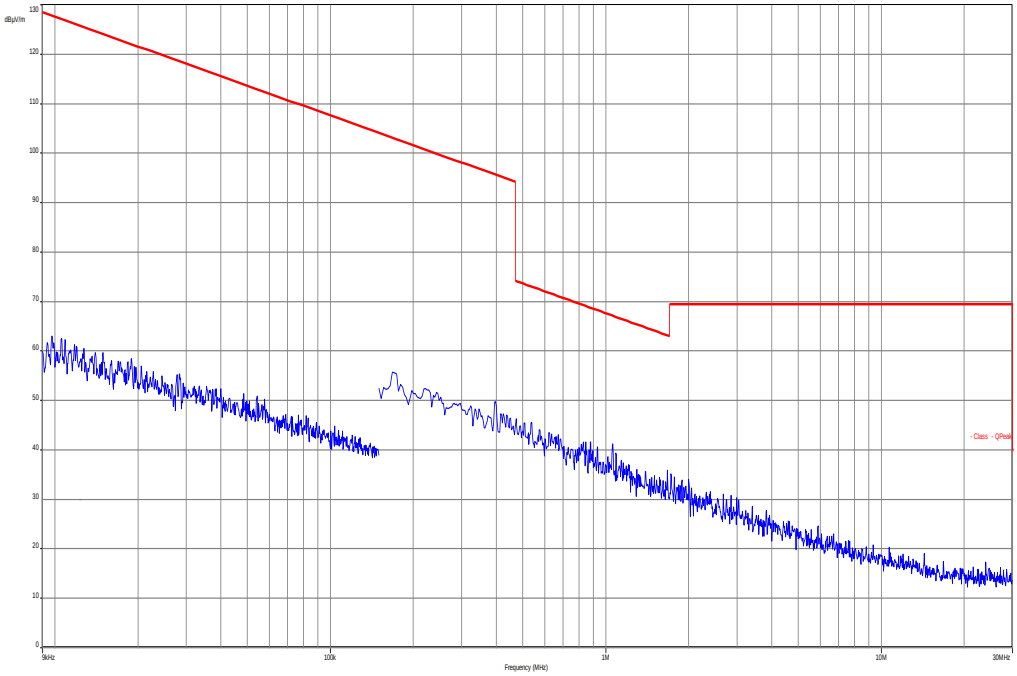
16-QAM

Spurious Emission Level (dBm)					
Lowest channel		**Middle channel**		**Highest channel**	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
	No spurious emissions detected.		No spurious emissions detected.		No spurious emissions detected.
Measurement uncertainty		± 3dB			

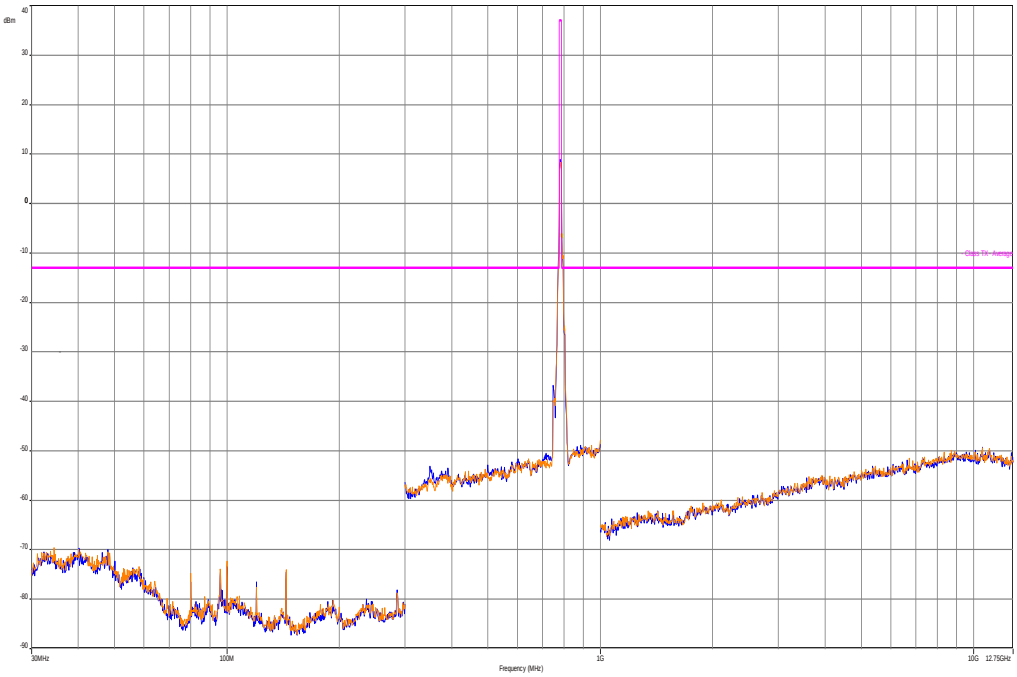
Result: **Passed**

QPSK with 10 MHz channel bandwidth

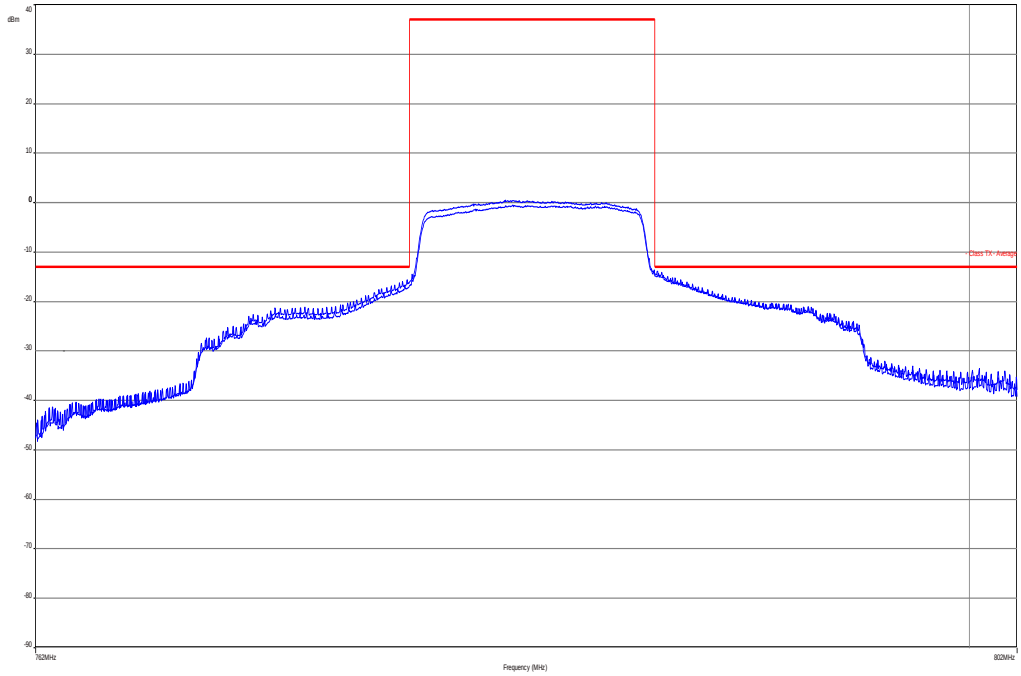
Plot 1: Middle channel, up to 30 MHz



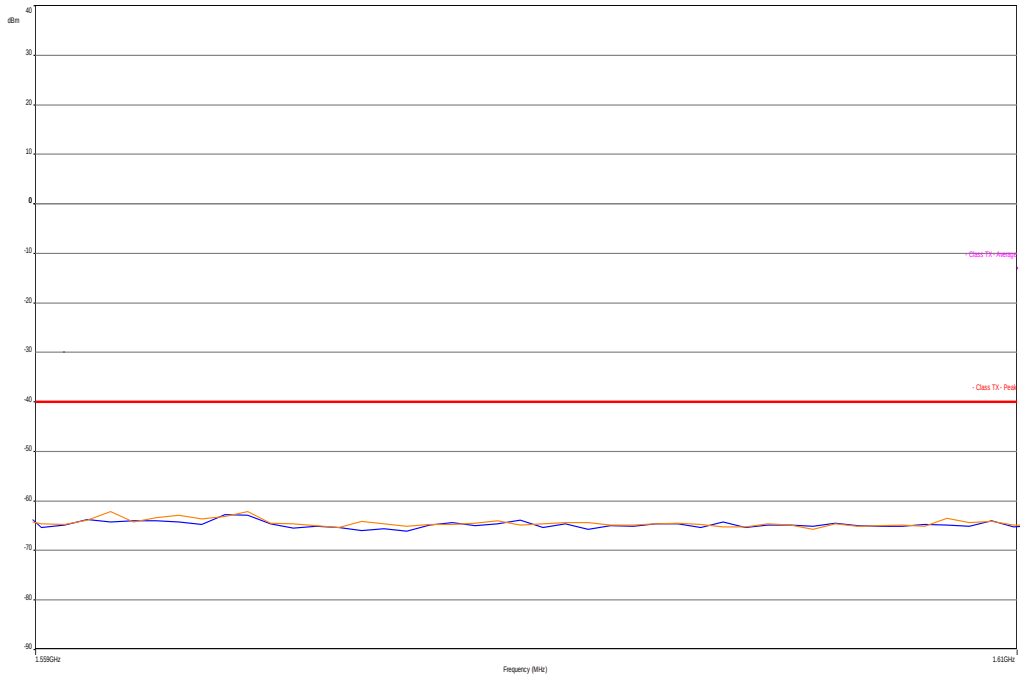
Plot 2: Middle channel, 30 MHz to 12.75 GHz



Plot 3: Middle channel, band zoom, AVG

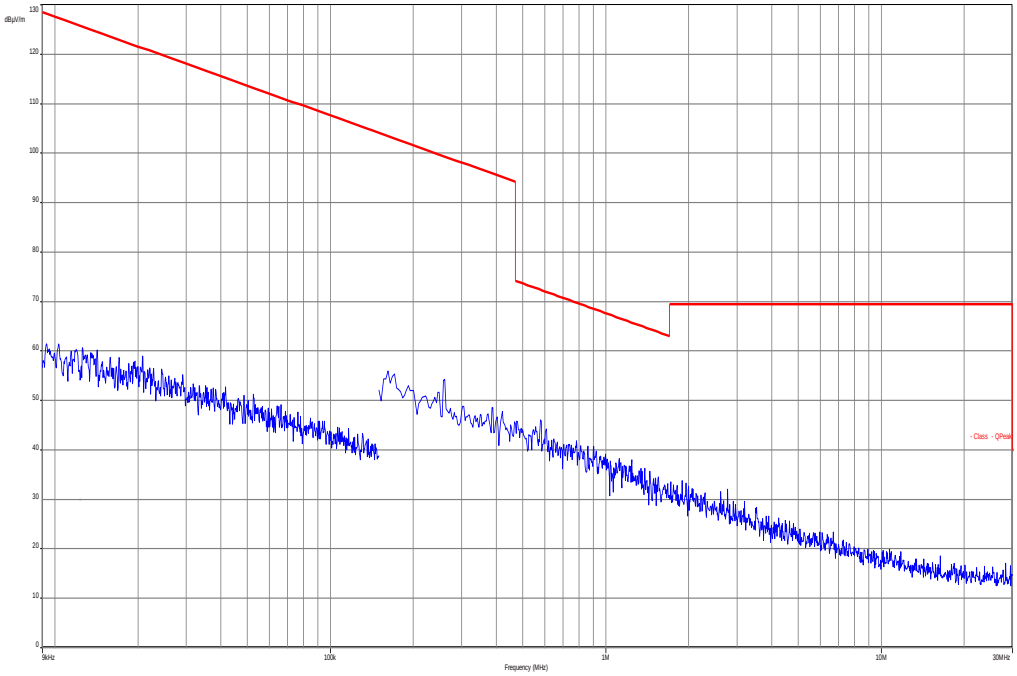


Plot 4: Middle channel, Special band: 1559 MHz to 1610 MHz

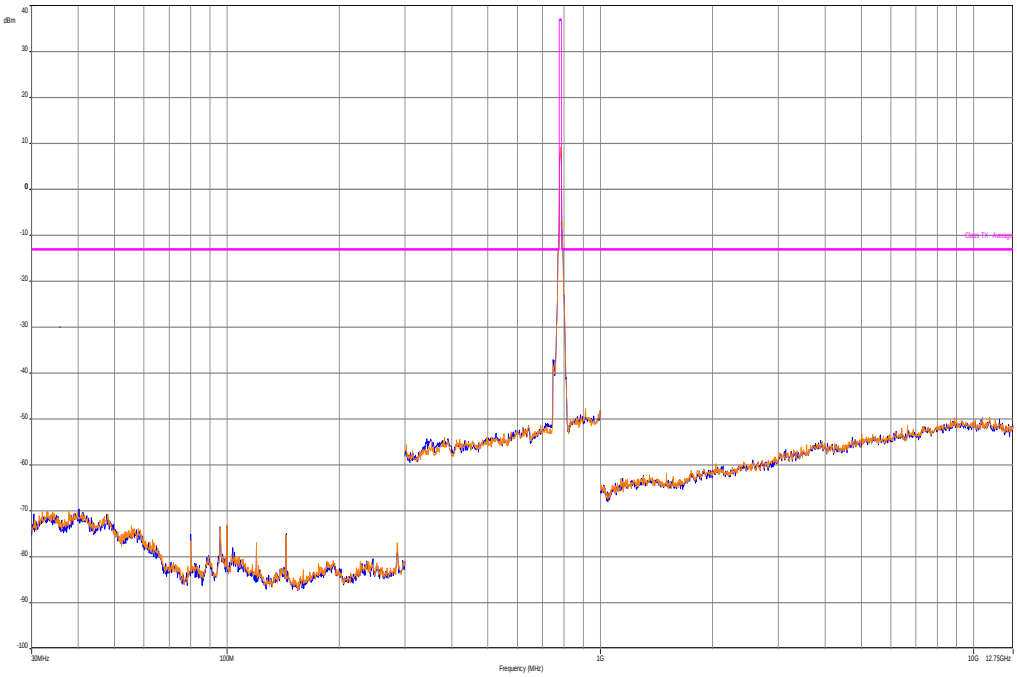


16-QAM with 10 MHz channel bandwidth

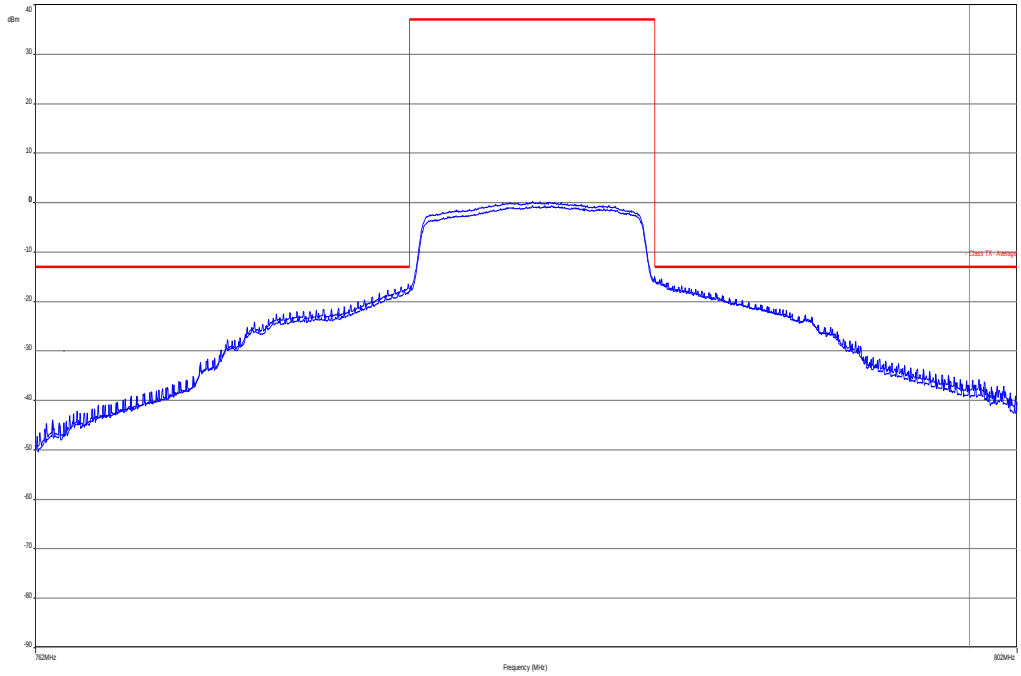
Plot 5: Middle channel, up to 30 MHz



Plot 6: Middle channel, 30 MHz to 12.75 GHz



Plot 7: Middle channel, band zoom, AVG



Plot 8: Middle channel, Special band: 1559 MHz to 1610 MHz