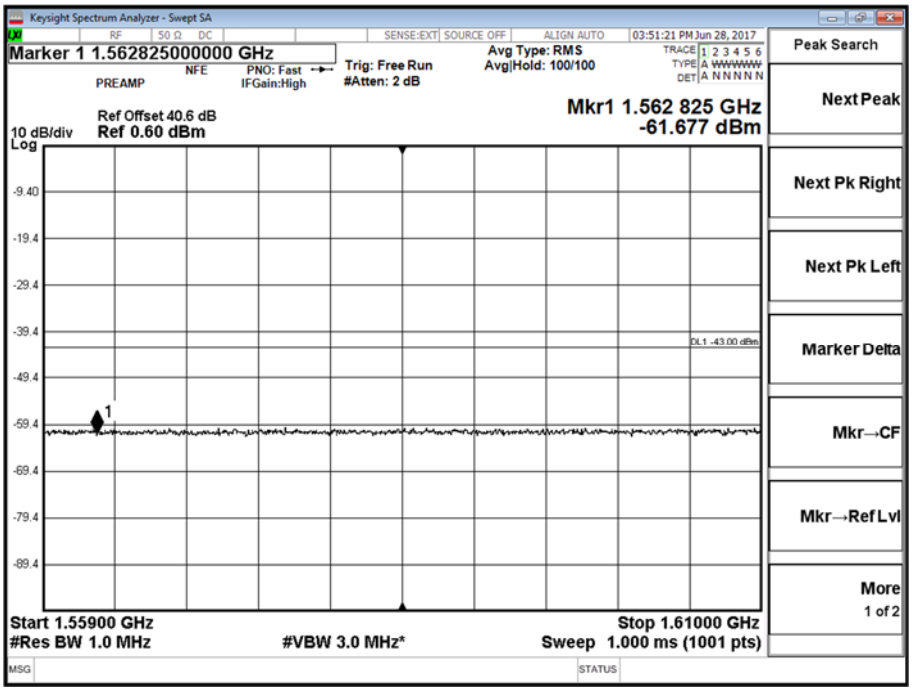
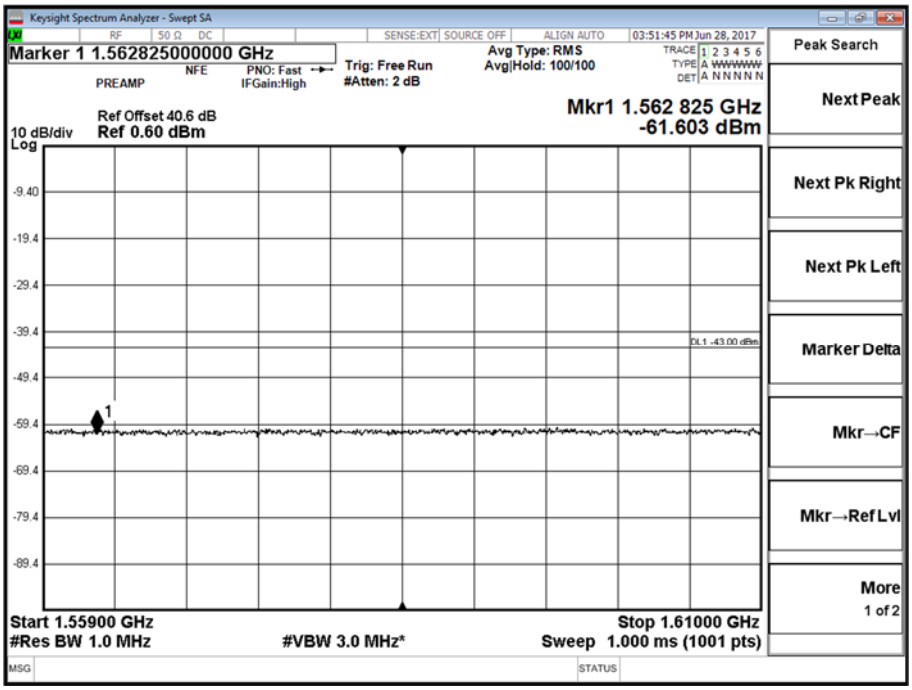
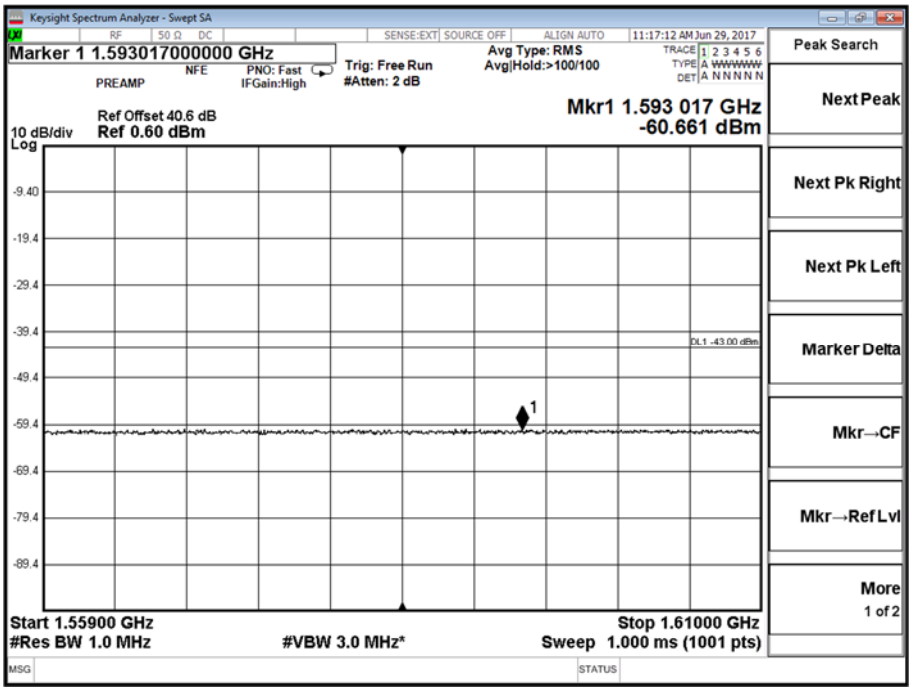
Antenna A - LTE Modulation 16QAM - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



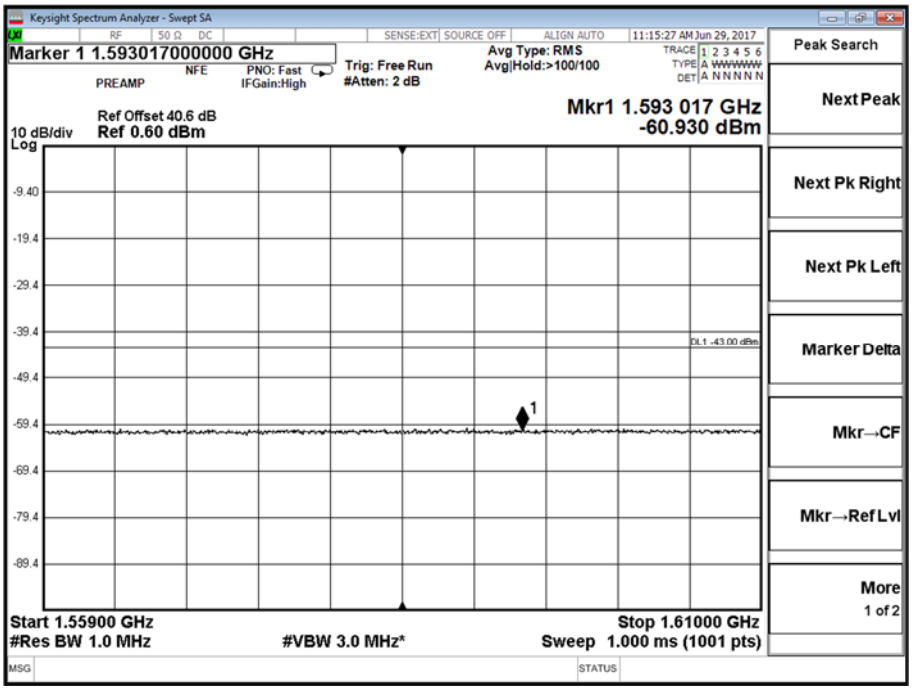
Antenna A - LTE Modulation 64QAM - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



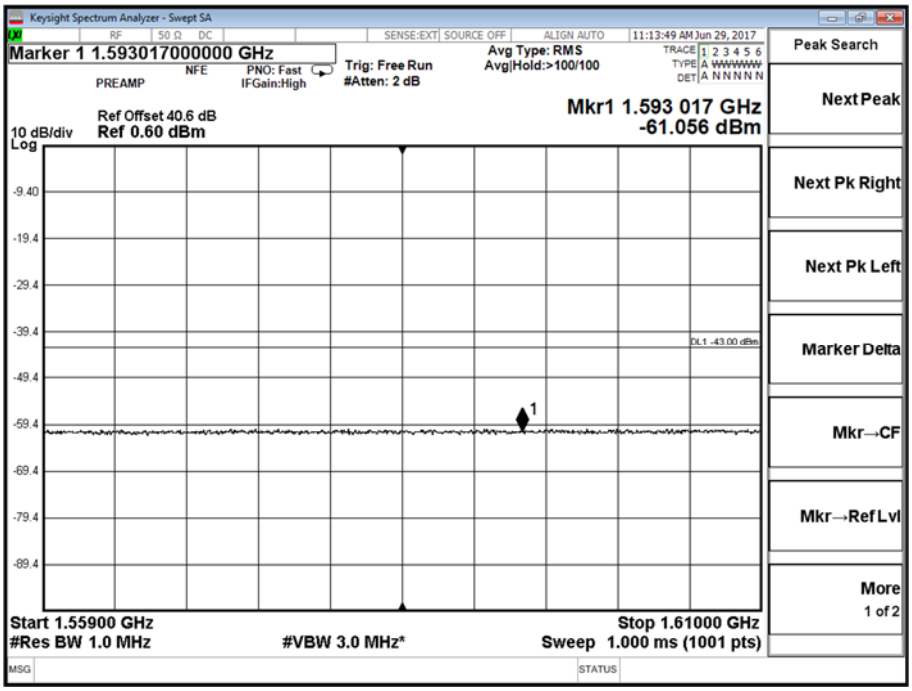
Antenna B - LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Range 1559 to 1610.5 MHz



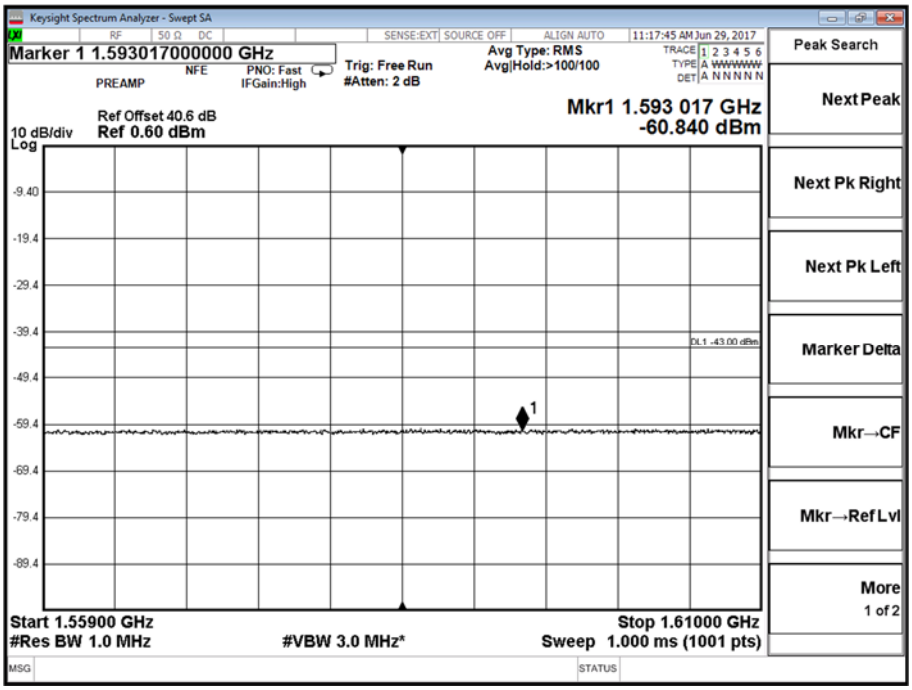
Antenna B - LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



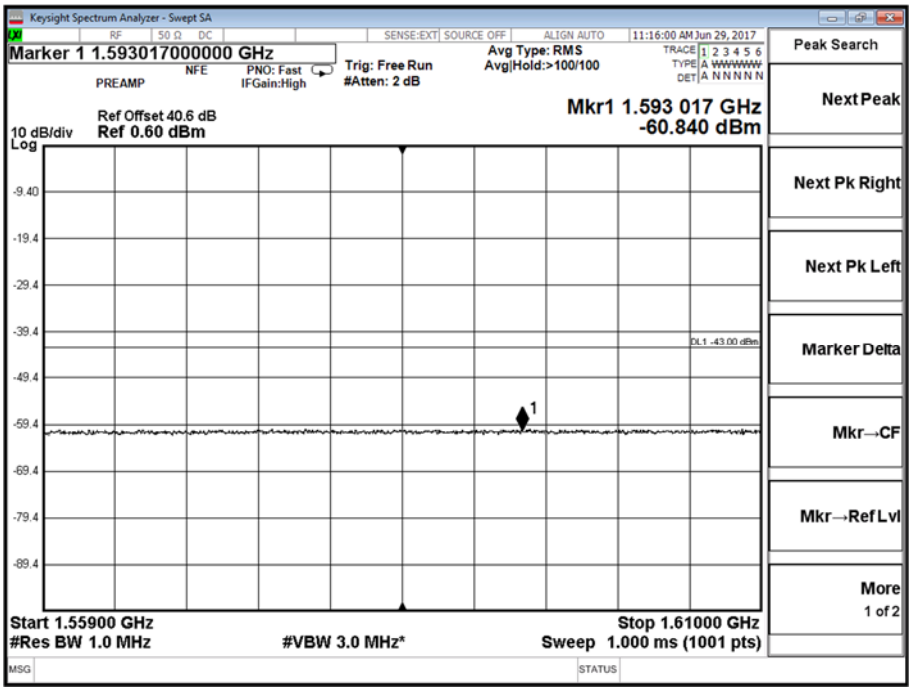
Antenna B - LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Range 1559 to 1610.5 MHz



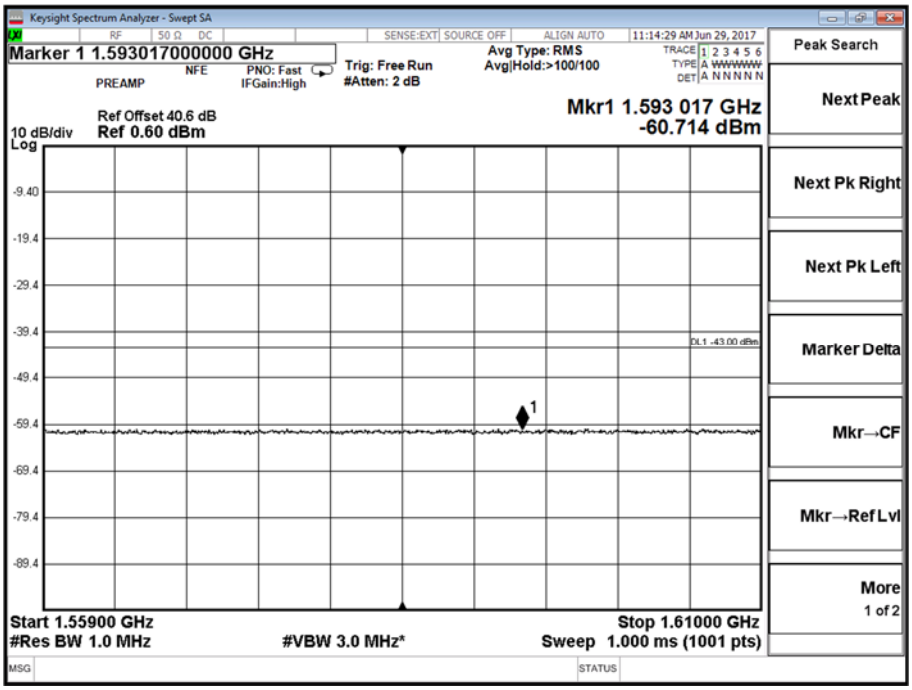
Antenna B - LTE Modulation 16QAM - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Range 1559 to 1610.5 MHz



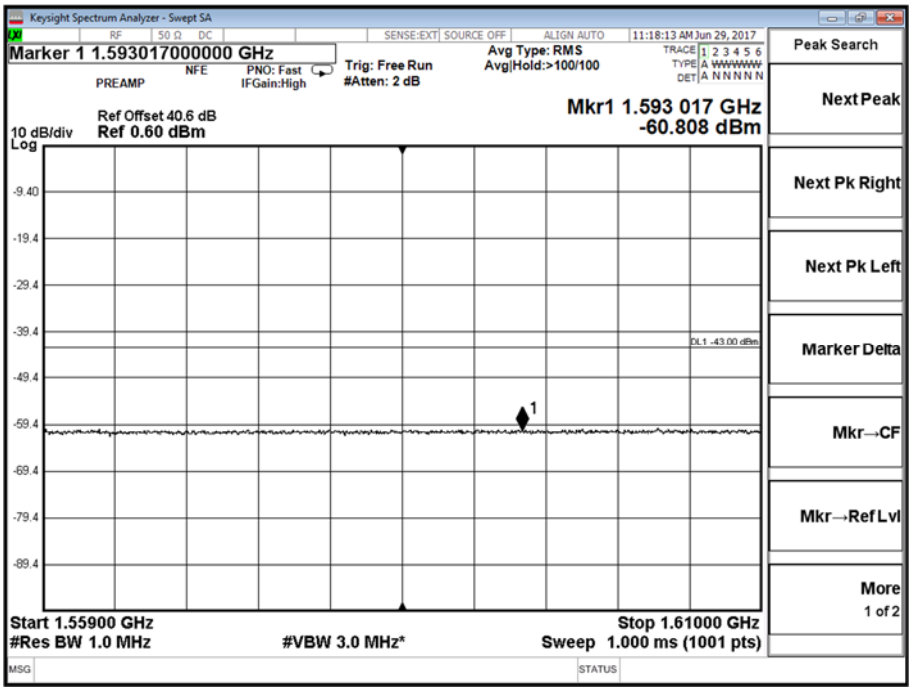
Antenna B - LTE Modulation 16QAM - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



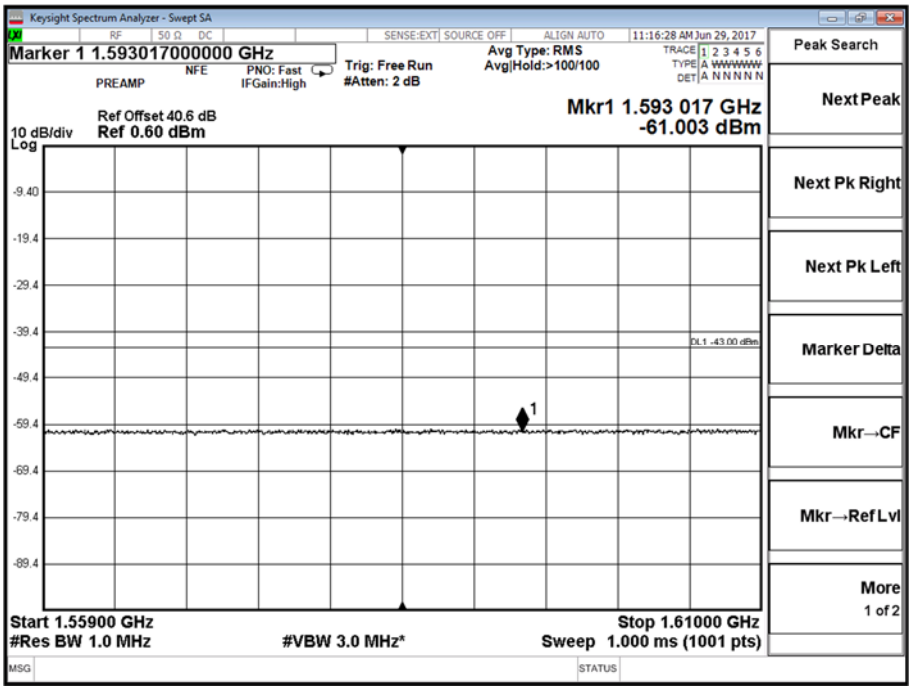
Antenna B - LTE Modulation 16QAM - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Range 1559 to 1610.5 MHz



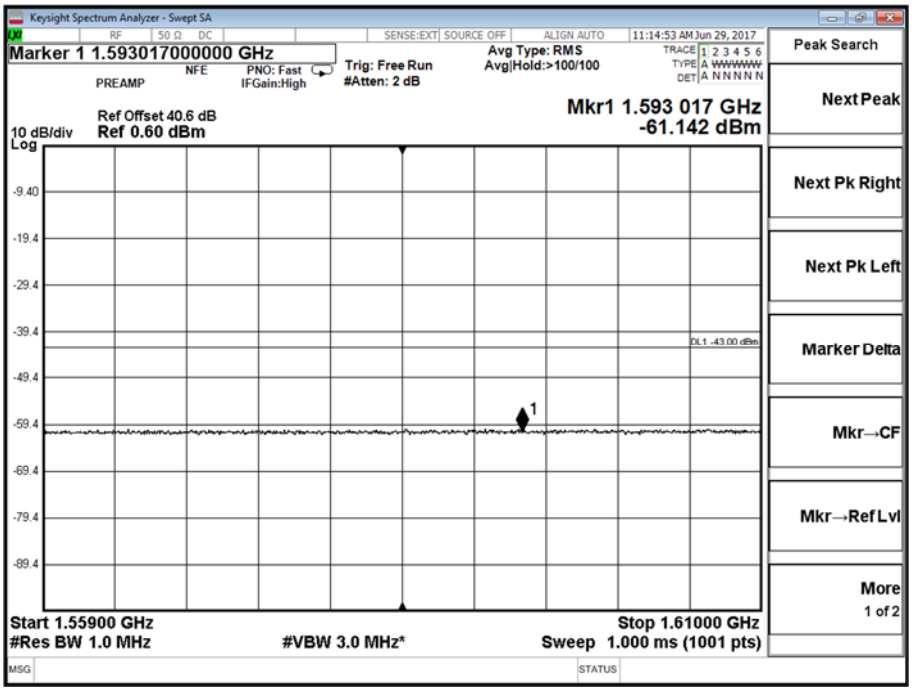
Antenna B - LTE Modulation 64QAM - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Range 1559 to 1610.5 MHz



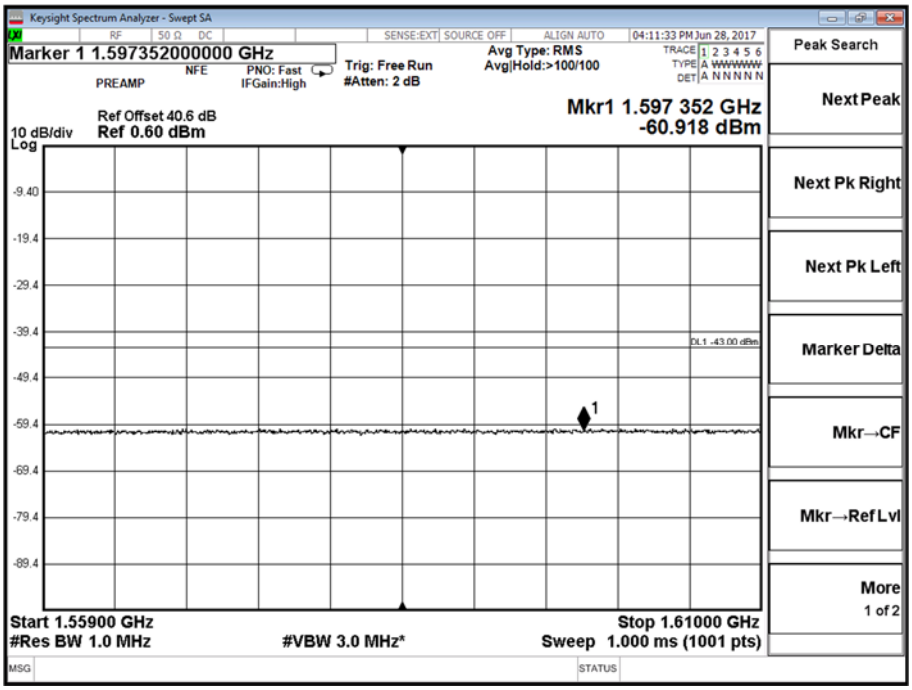
Antenna B - LTE Modulation 64QAM - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



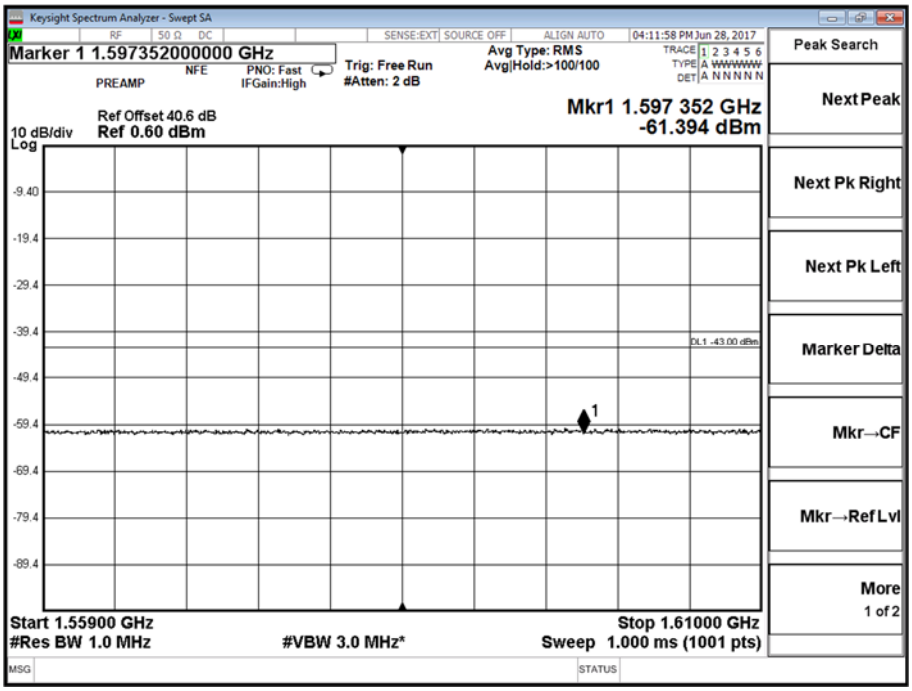
Antenna B - LTE Modulation 64QAM - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Range 1559 to 1610.5 MHz



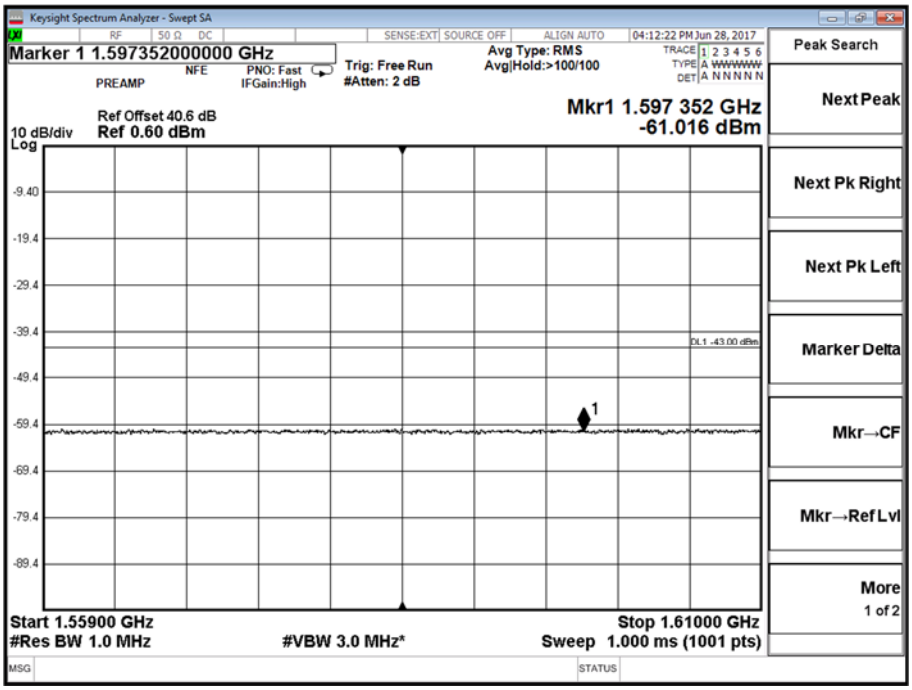
Antenna B - LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



Antenna B - LTE Modulation 16QAM - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



Antenna B - LTE Modulation 64QAM - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Range 1559 to 1610.5 MHz



Limit	-40 dBm -43 dBm (2 port MIMO)

2.5 FREQUENCY STABILITY

2.5.1 Specification Reference

FCC CFR 47 Part 2, Clause 2.1055
FCC CFR 47 Part 90, Clause 90.539(d)

2.5.2 Date of Test and Modification State

30 June 2017, 11 July 2017 - Modification State 0, 1

2.5.3 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.4 Environmental Conditions

Ambient Temperature	22.9°C
Relative Humidity	48.3%

2.5.5 Test Method

All measurements were made in accordance with FCC KDB 971168 D01.

The EUT was setup in a Climatic Chamber and connected to a Vector Signal Analyser via attenuators. The temperature was varied over the range -30˚C to +50˚C in 10˚C steps. At each temperature interval, the EUT was left to stabilise. After this period of time, the maximum Frequency Error was measured and recorded on the Middle channel.

For LTE, testing was performed using a 10 MHz channel bandwidth with QPSK modulation.

As no limits were described for the downlink band, the limits defined in 90.539(d) were used. The limit is the most stringent from Fixed and Mobile operation, thus covering both modes.

2.5.6 Test Results

Configuration 1

Maximum Output Power 30 dBm

Temperature	Voltage	Frequency Error (Hz)
		Channel Position M
-30°C	120.0 V AC 60 Hz	EUT inoperative*
-20°C	120.0 V AC 60 Hz	125.1**
-10°C	120.0 V AC 60 Hz	10.29
0°C	120.0 V AC 60 Hz	13.96
+10°C	120.0 V AC 60 Hz	7.72
+20°C	120.0 V AC 60 Hz	6.74
+20°C	120.0 V AC 60 Hz	6.73
+20°C	120.0 V AC 60 Hz	7.01
+30°C	120.0 V AC 60 Hz	8.92
+40°C	120.0 V AC 60 Hz	-7.55
+50°C	120.0 V AC 60 Hz	-6.98
+20°C	12.0 V DC	-11.00
+20°C	13.8 V DC	-12.22
+20°C	10.2 V DC	-11.19
+20°C	24.0 V DC	-12.33
+20°C	27.6 V DC	-12.33
+20°C	20.4 V DC	-11.51

Remarks

* Whilst the EUT was operational at -30 °C, the EUT did not transmit.
** Modification State 1

Limit	±1.0 ppm or ±763 Hz

2.6 MODULATION CHARACTERISTICS

2.6.1 Specification Reference

FCC CFR 47 Part 2, Clause 2.1047

2.6.2 Date of Test and Modification State

30 June 2017 - Modification State 0

2.6.3 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.4 Environmental Conditions

Ambient Temperature	21.4°C
Relative Humidity	52.1%

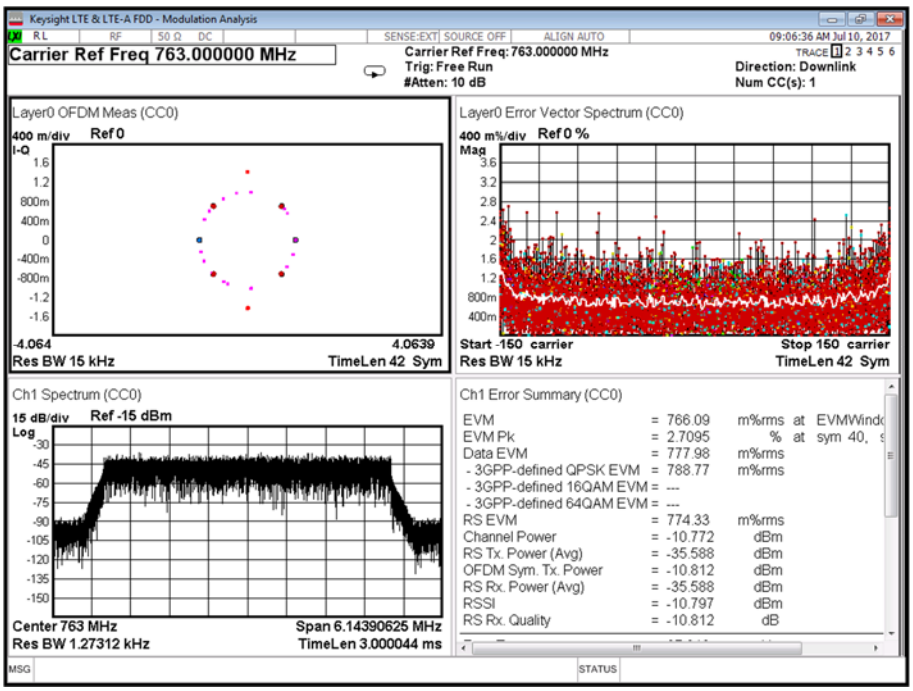
2.6.5 Test Method

All measurements were made in accordance with FCC KDB 971168 D01.

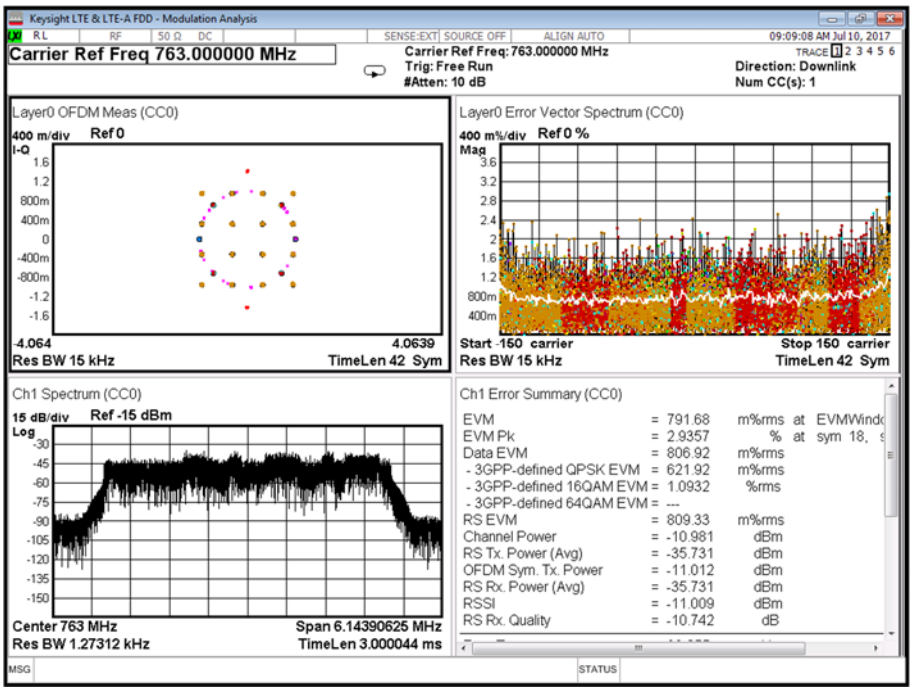
2.6.6 Test Results

Configuration 1

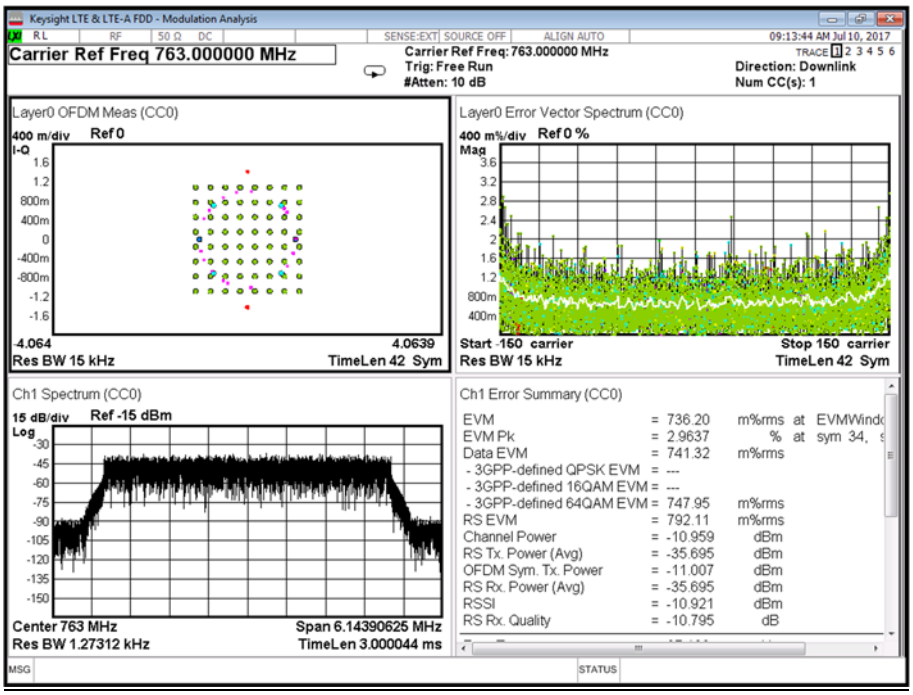
<u>LTE - QPSK – 5 MHz</u>



LTE – 16QAM – 5 MHz



LTE – 64QAM – 5 MHz



2.7 TRANSMITTER RADIATED SPURIOUS EMISSIONS

2.7.1 Specification Reference

FCC CFR 47 Part 90, Clause 90.543(e)(1)(2)(3)

2.7.2 Date of Test and Modification State

02 July 2017, 03 July 2017 - Modification State 0

2.7.3 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.7.4 Environmental Conditions

Ambient Temperature	22.5°C
Relative Humidity	55.2%

2.7.5 Test Method

All measurements were made in accordance with FCC KDB 971168 D01 Clause 7.

The EUT can operate as either a fixed or mobile unit. Therefore, the limit line on the plots below show the most stringent limit as detailed below.

Measurements were only performed using QPSK modulation as this was assessed from the conducted output power results to have the highest output power and therefore was worst case. Both ports were transmitting at maximum power with the ports terminated with 50 Ohm loads.

For the measurement range 30 MHz to 8 GHz, excluding the measurement ranges specified below, the limit line on the plot is representative of -13 dBm (EIRP).

<u>769 – 775 MHz and 799 – 805 MHz – Fixed Stations</u>

76 + 10log(P) = -46 dBm

The limit line on the plots for this measurement range is representative of -46 dBm (EIRP).

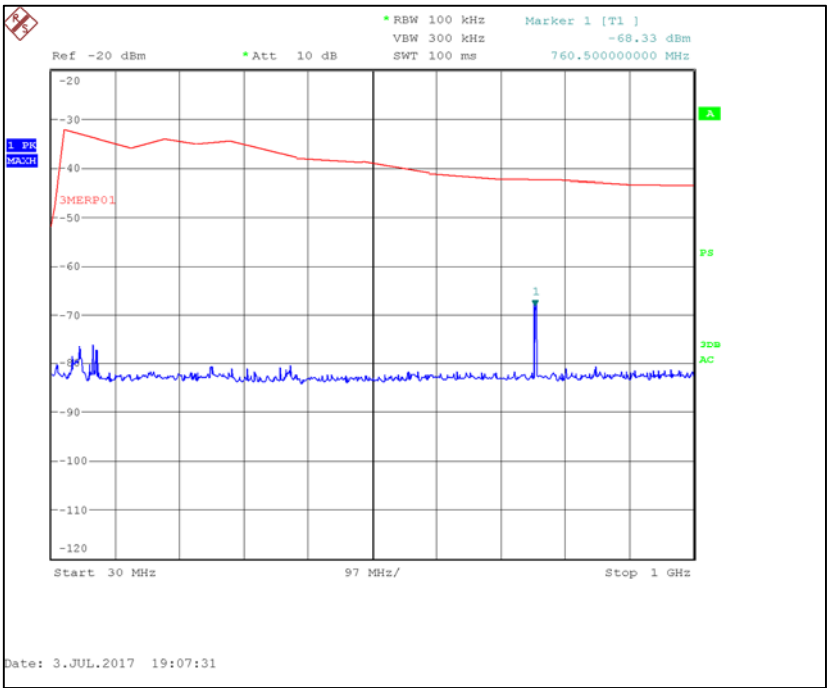
<u>1559 – 1610 MHz</u>

-70 dBW + 30 = -40 dBm (For Broadband Emission Measurements)
-80 dBW + 30 = -50 dBm (For Discrete Emission Measurements)

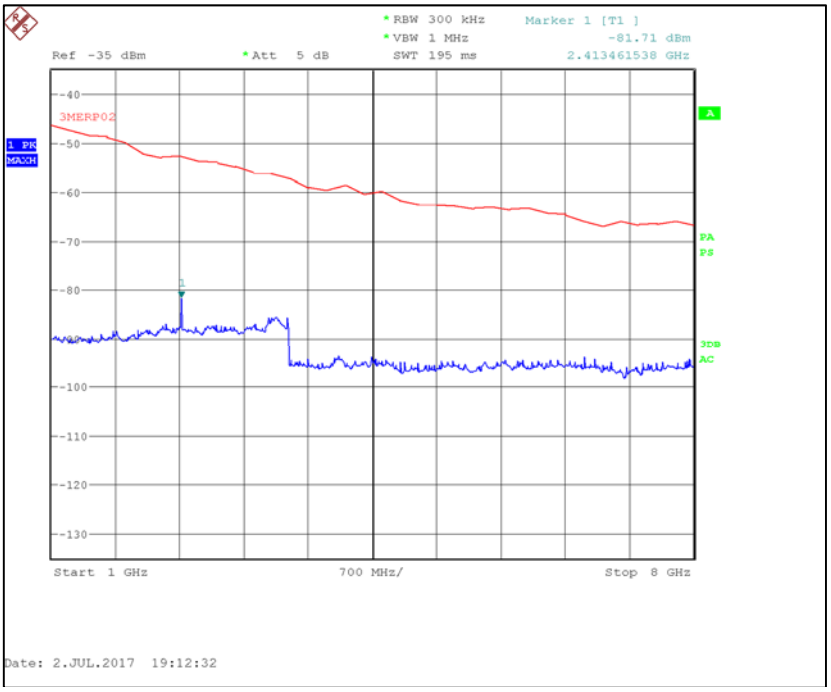
The limit line on the plots for this measurement range is representative of -43 dBm (EIRP).

2.7.6 Test Results

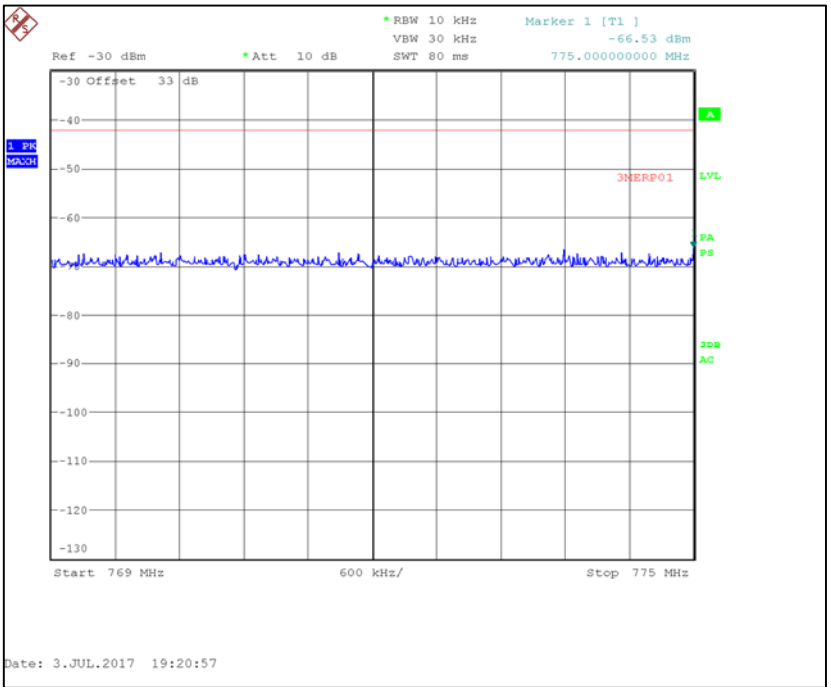
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 30 to 1000 MHz



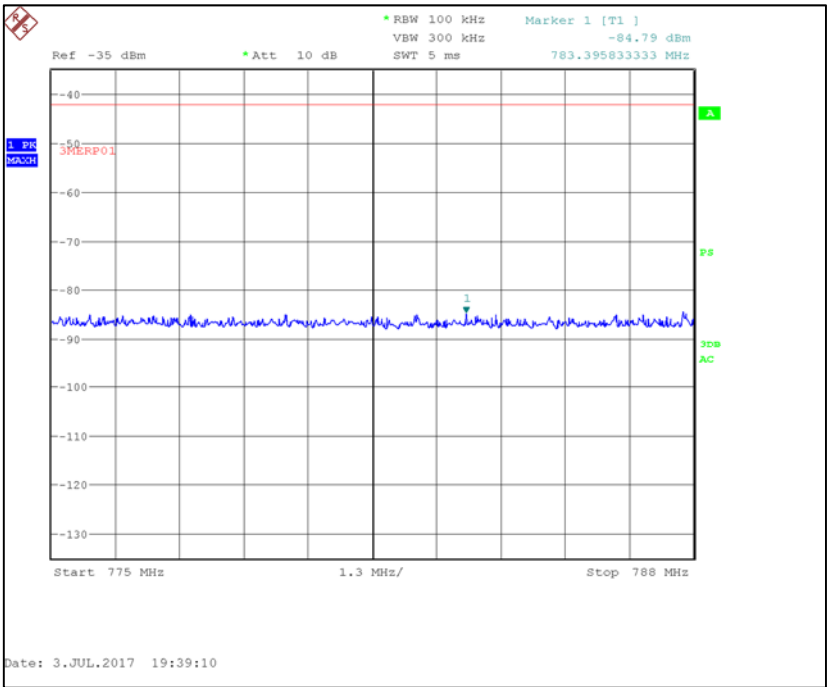
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 1000 to 8000 MHz



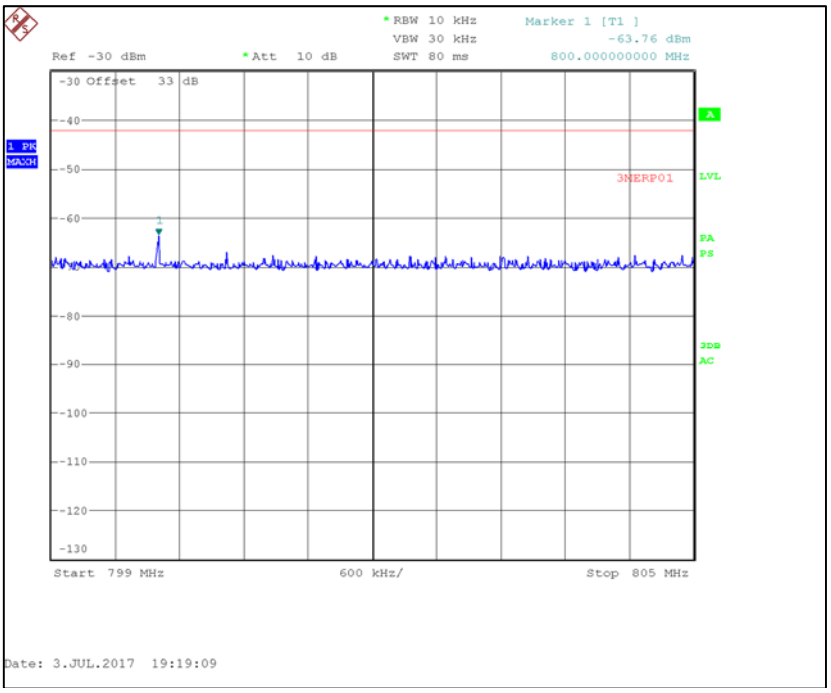
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 769 to 775 MHz



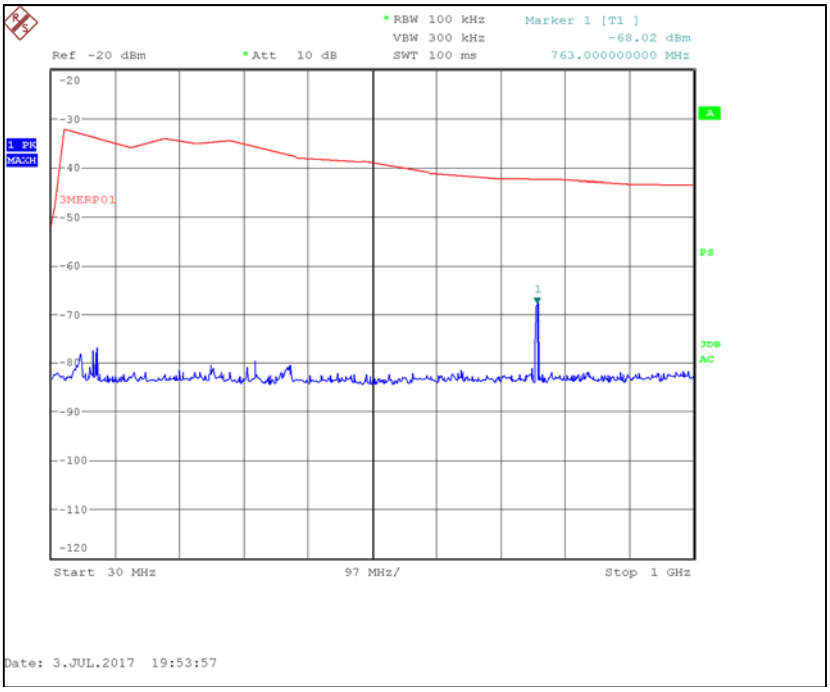
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 775 to 788 MHz



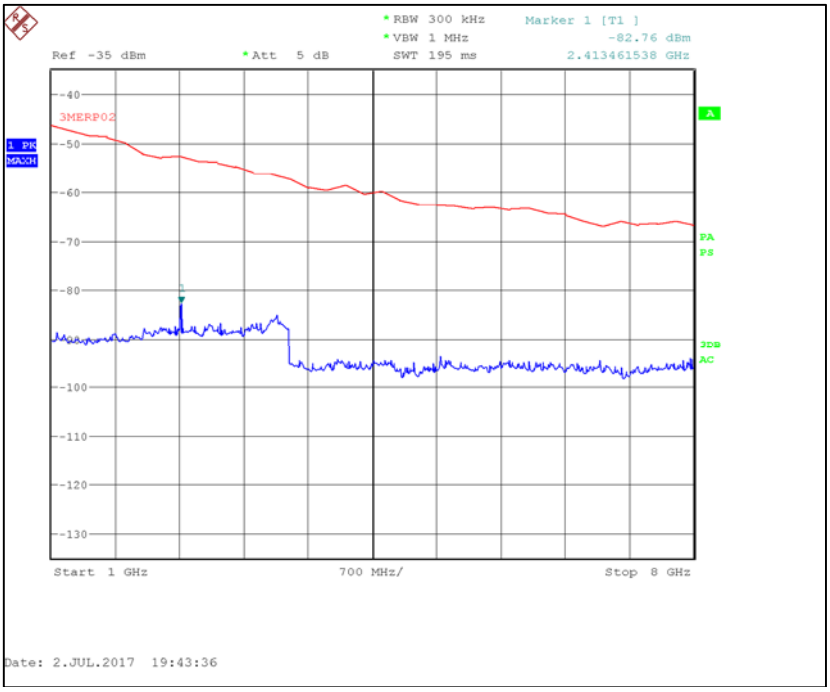
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 799 to 805 MHz



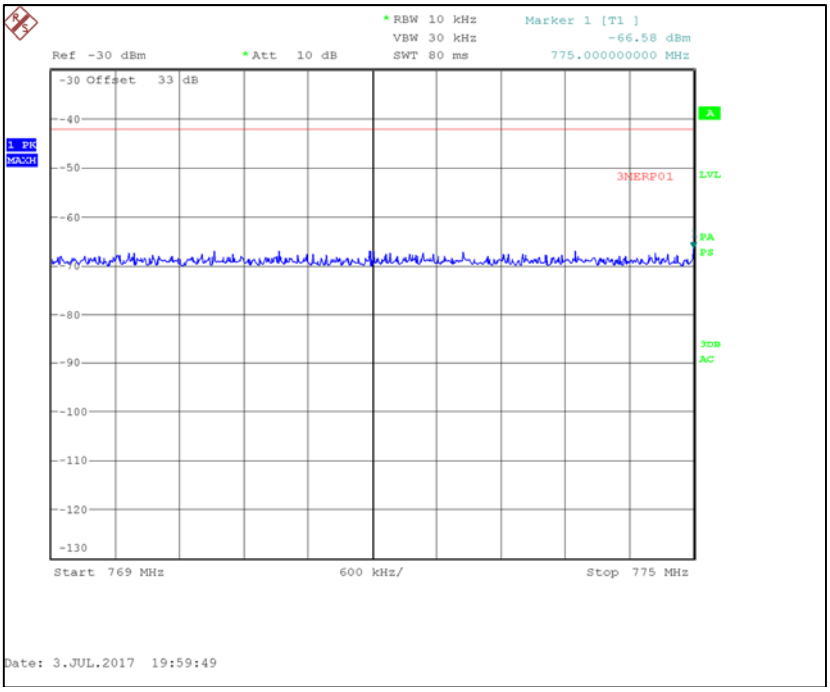
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 30 to 1000 MHz



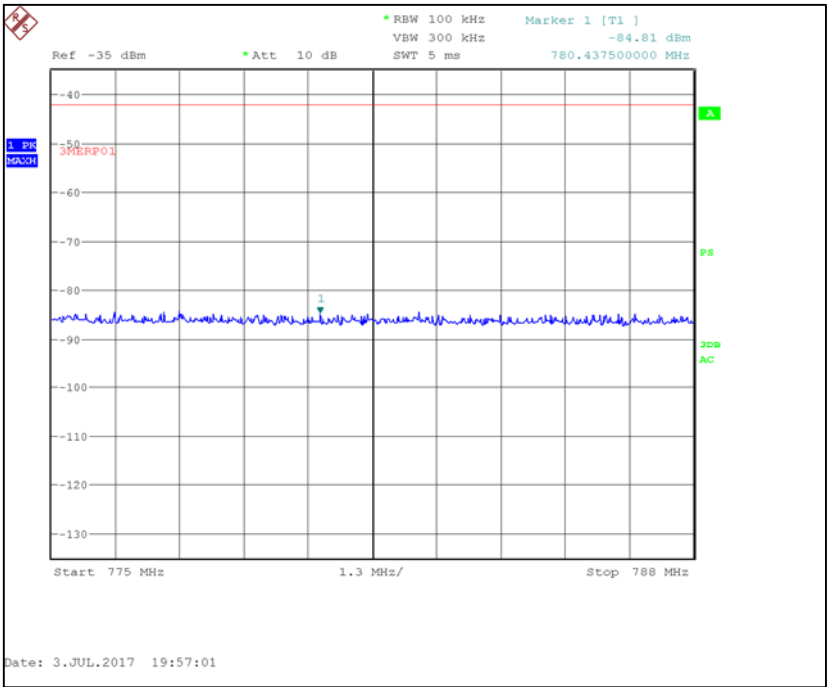
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 1000 to 8000 MHz



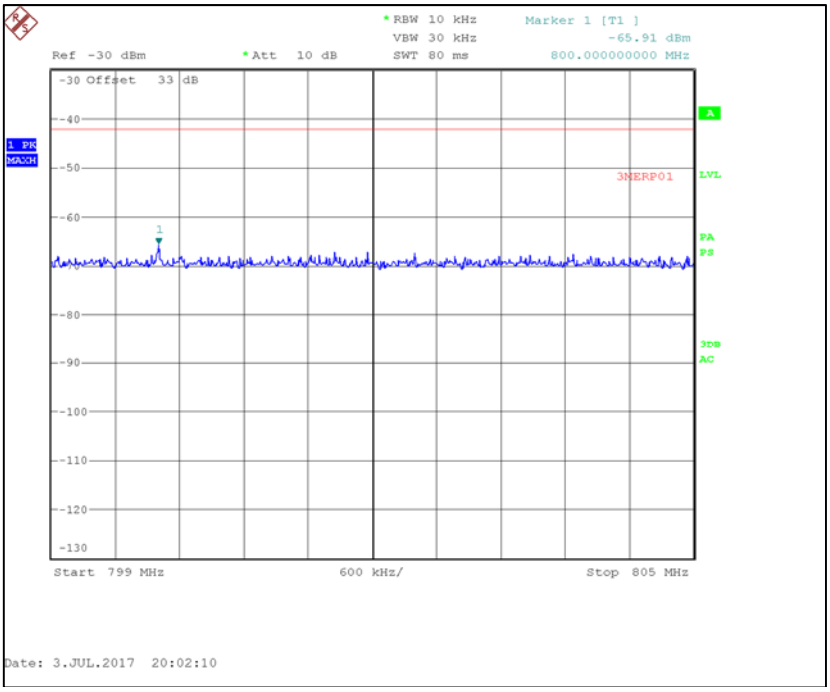
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 769 to 775 MHz



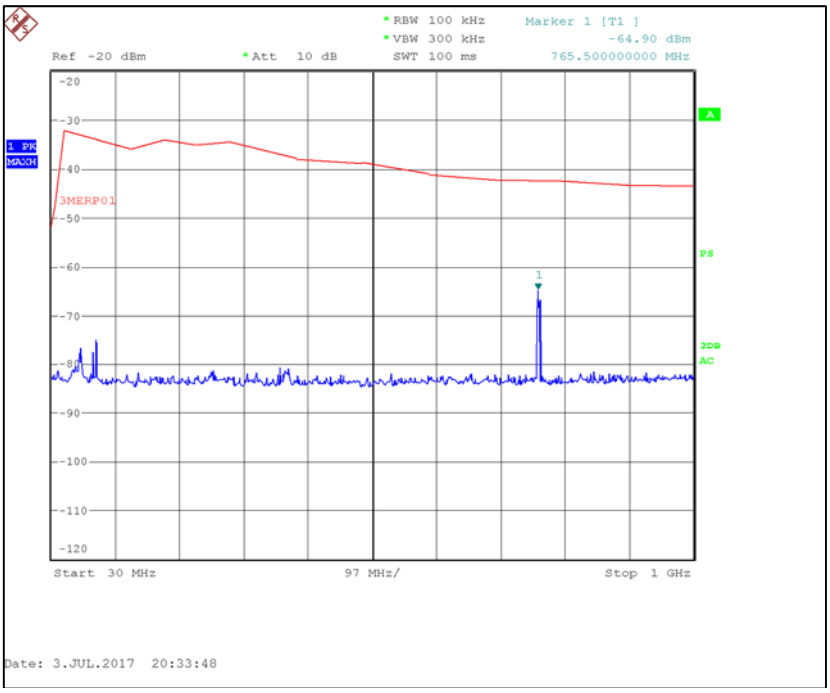
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 775 to 788 MHz



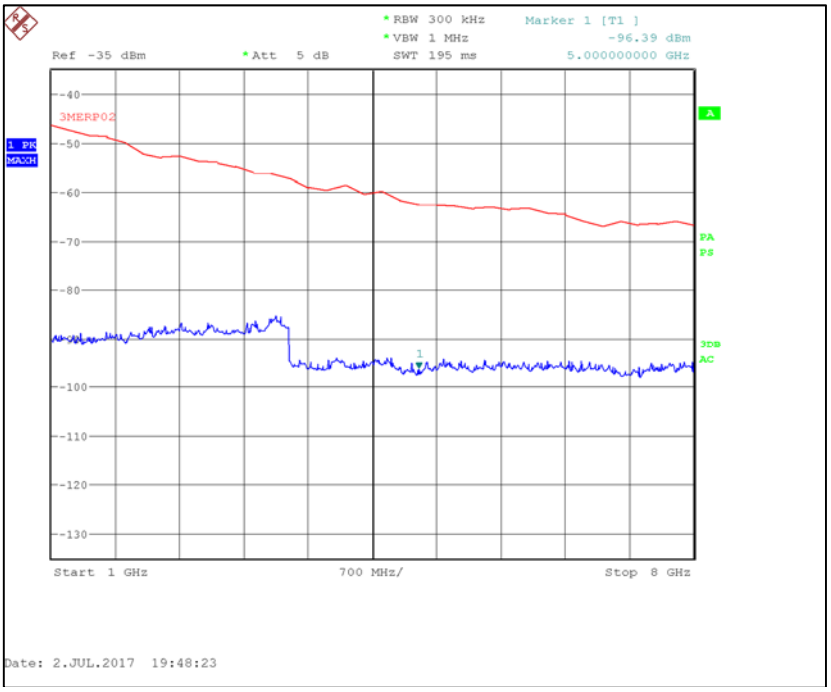
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 799 to 805 MHz



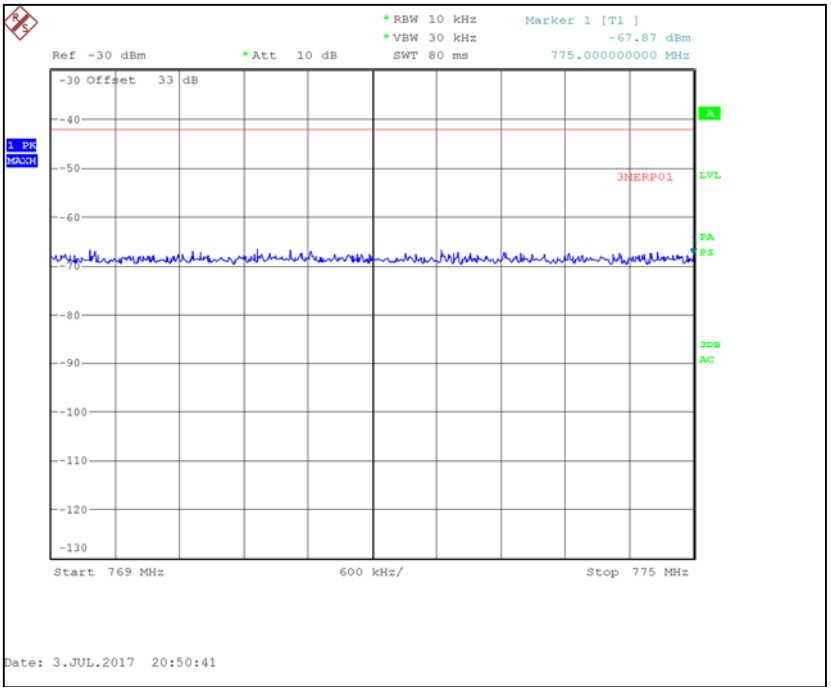
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 30 to 1000 MHz



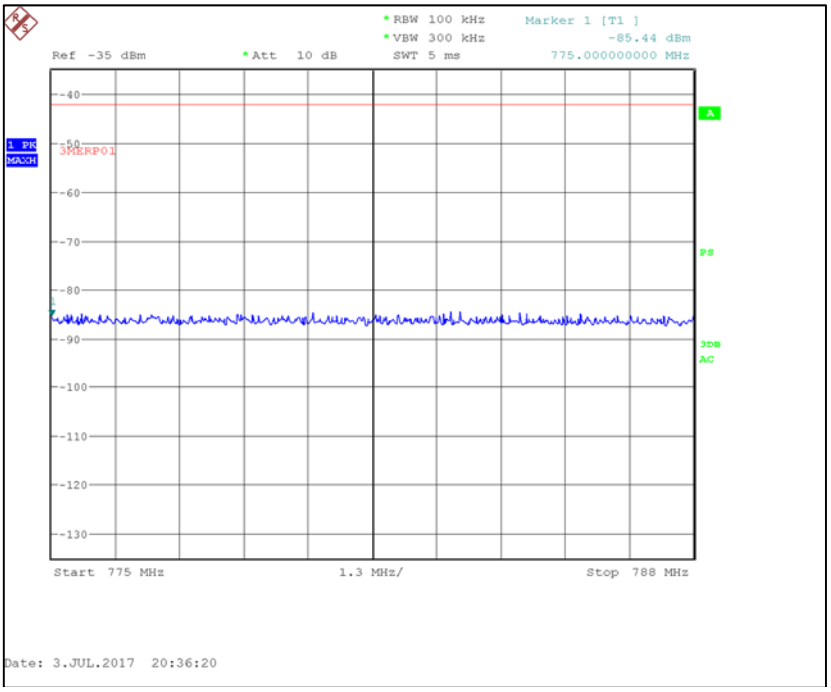
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 1000 to 8000 MHz



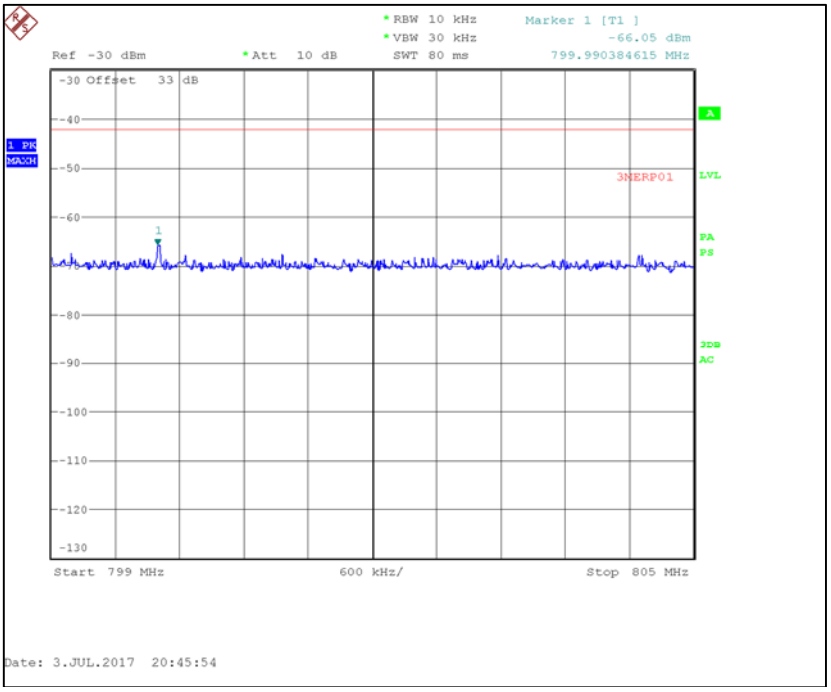
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 769 to 775 MHz



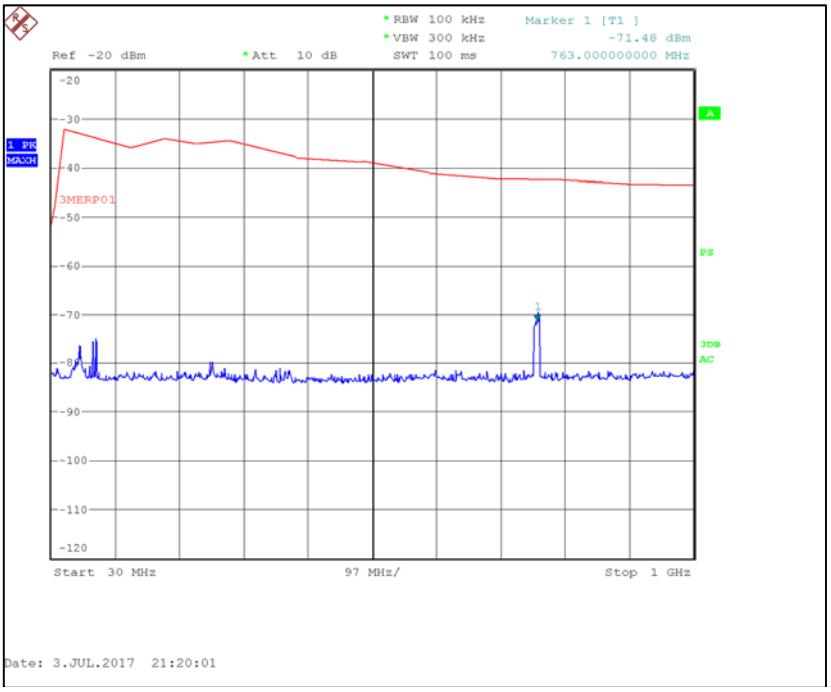
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 775 to 788 MHz



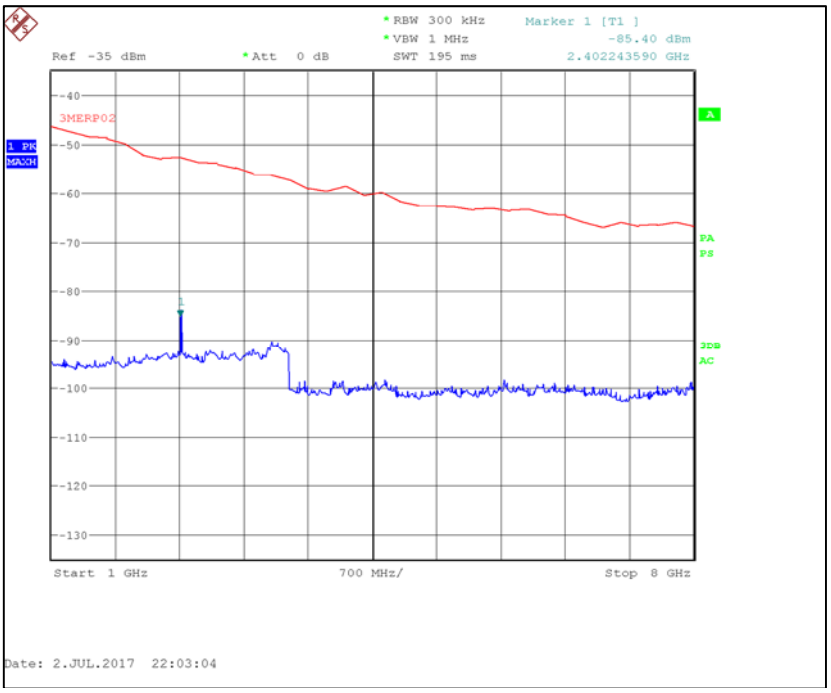
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 799 to 805 MHz



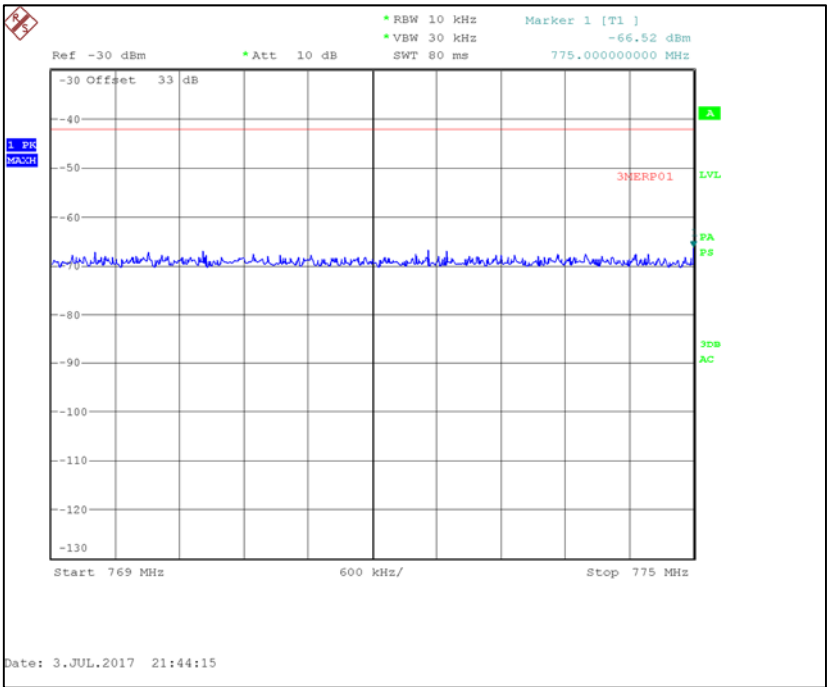
LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Band 1 - Range 30 to 1000 MHz



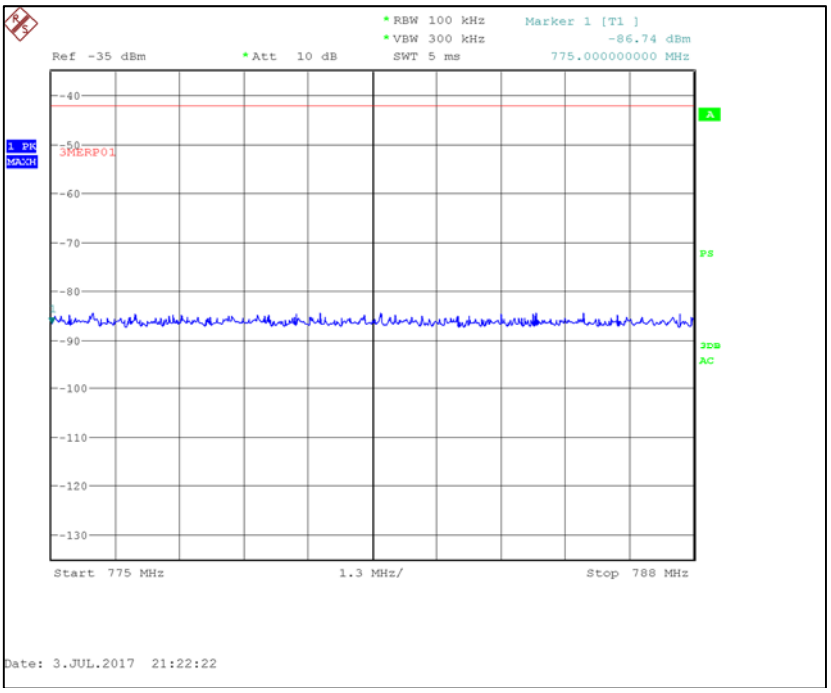
LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Band 1 - Range 1000 to 8000 MHz



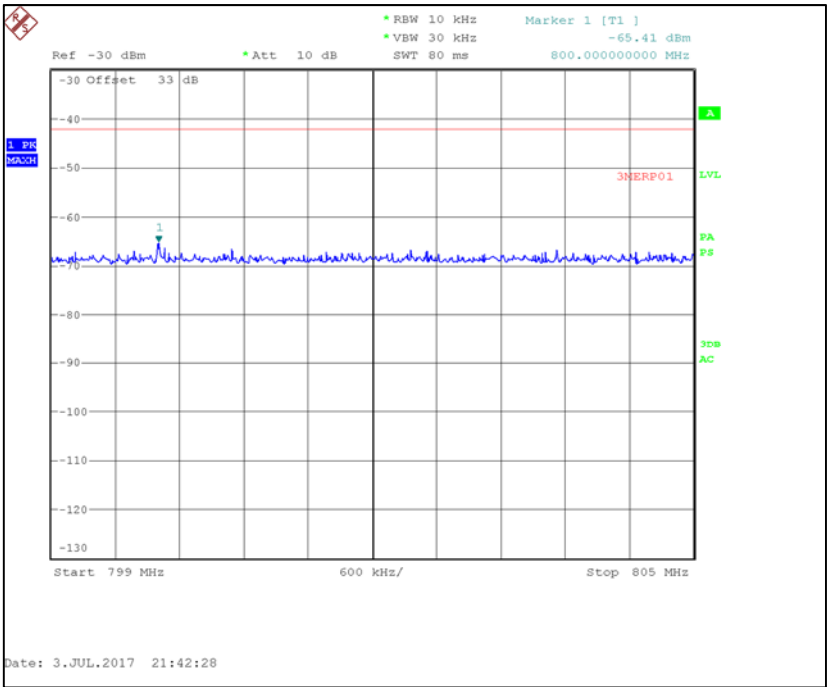
LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Band 1 - Range 769 to 775 MHz



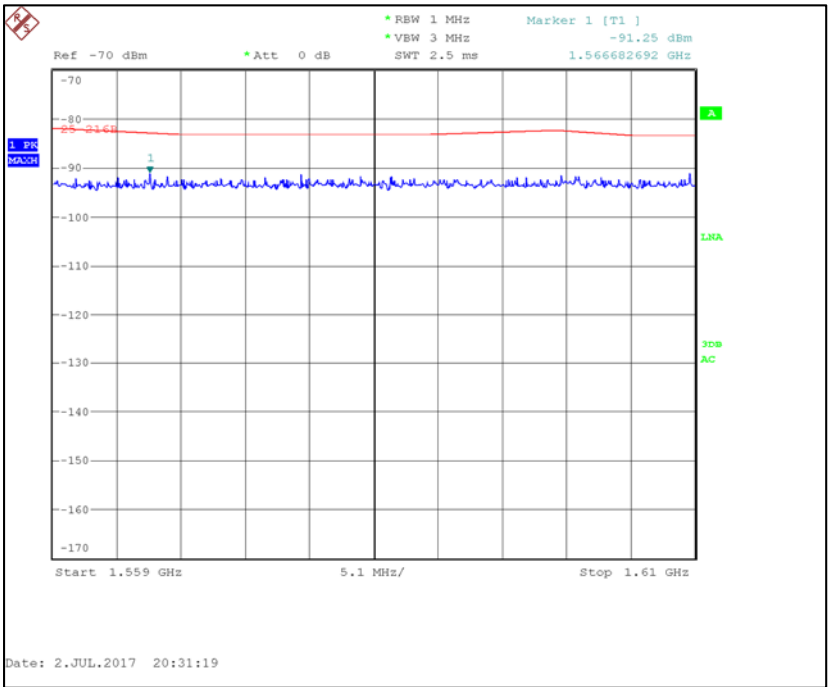
LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Band 1 - Range 775 to 799 MHz



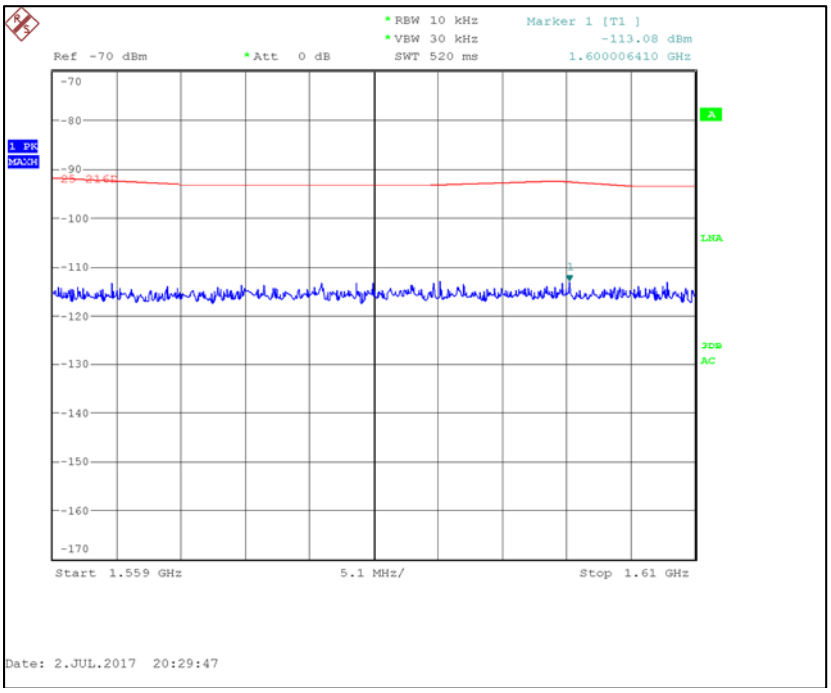
LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Band 1 - Range 799 to 805 MHz



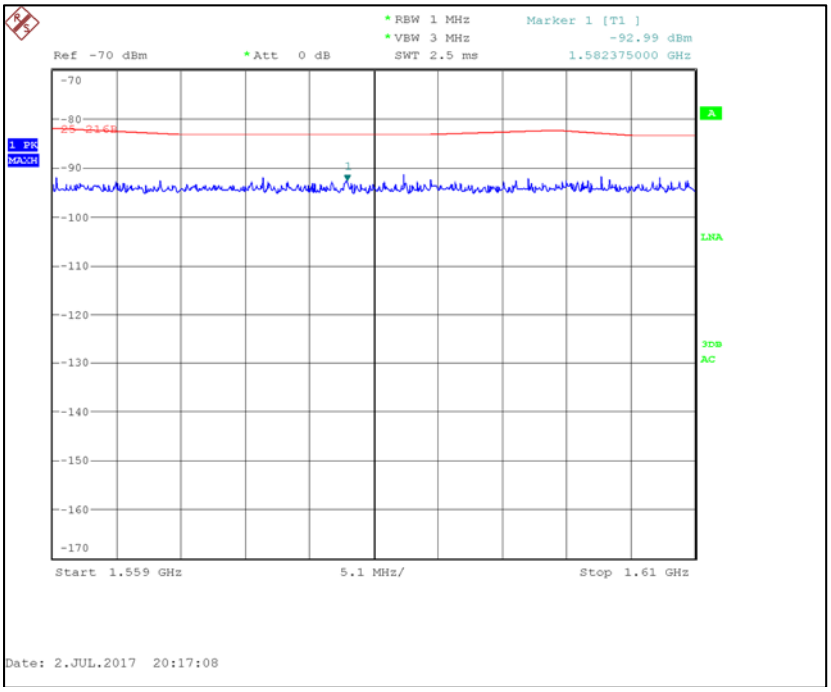
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 1559 to 1610 MHz – Broadband Emission Measurement



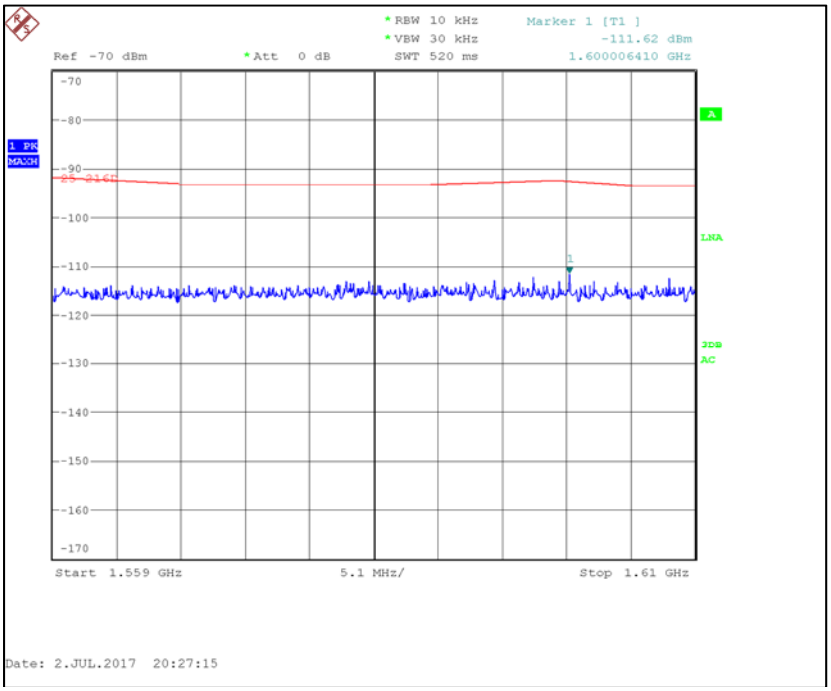
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position B - Band 1 - Range 1559 to 1610 MHz – Discrete Emission Measurement



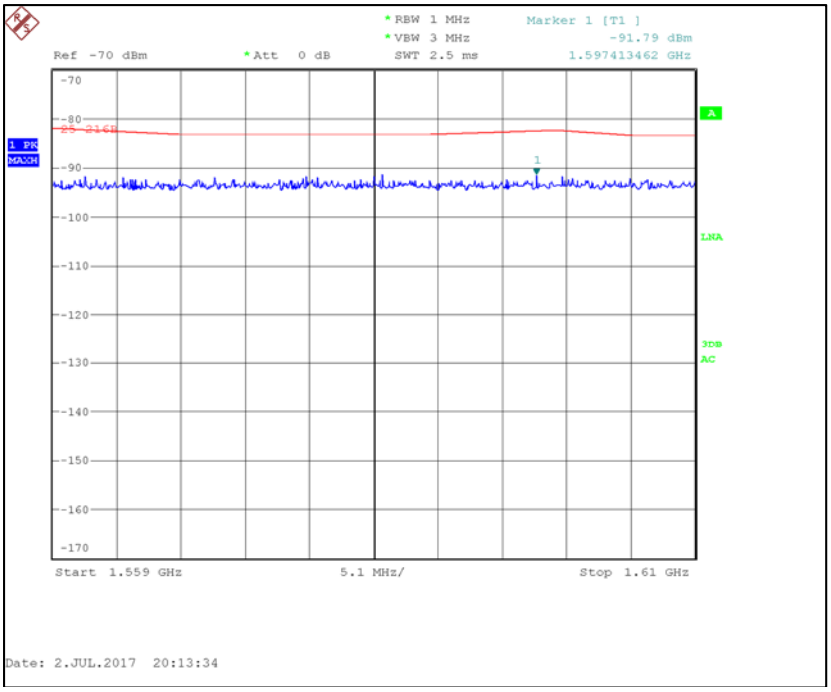
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 1559 to 1610 MHz – Broadband Emission Measurement



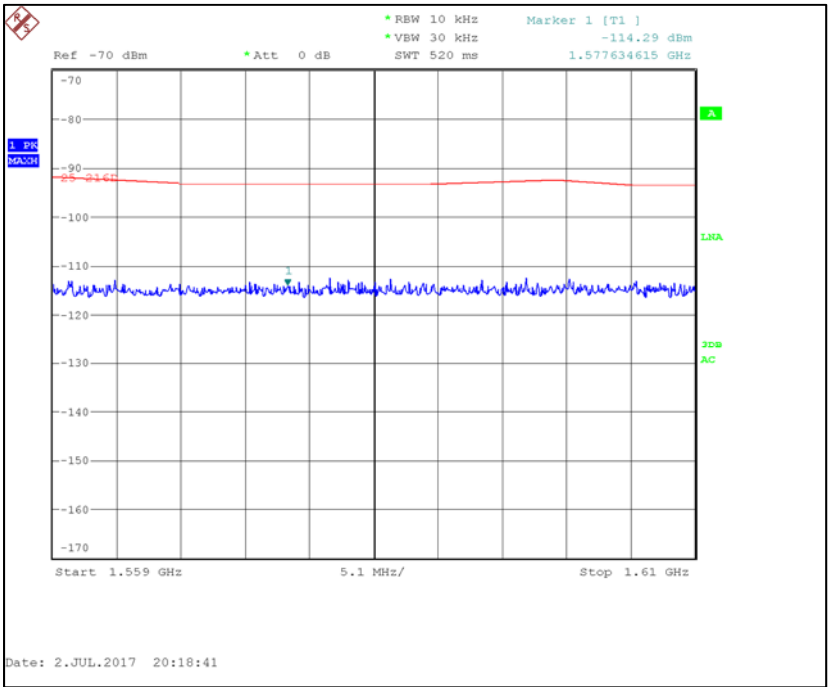
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position M - Band 1 - Range 1559 to 1610 MHz – Discrete Emission Measurement



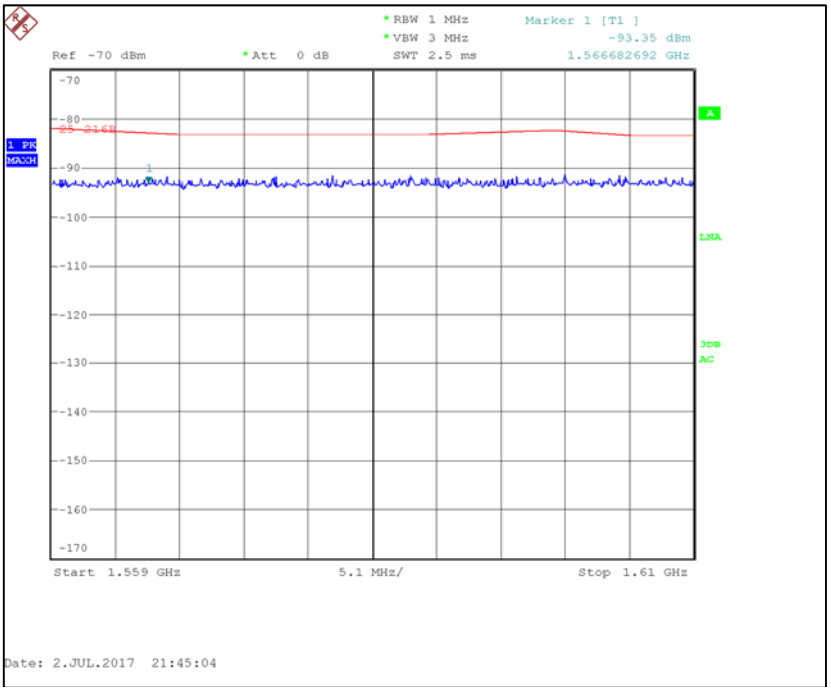
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 1559 to 1610 MHz – Broadband Emission Measurement



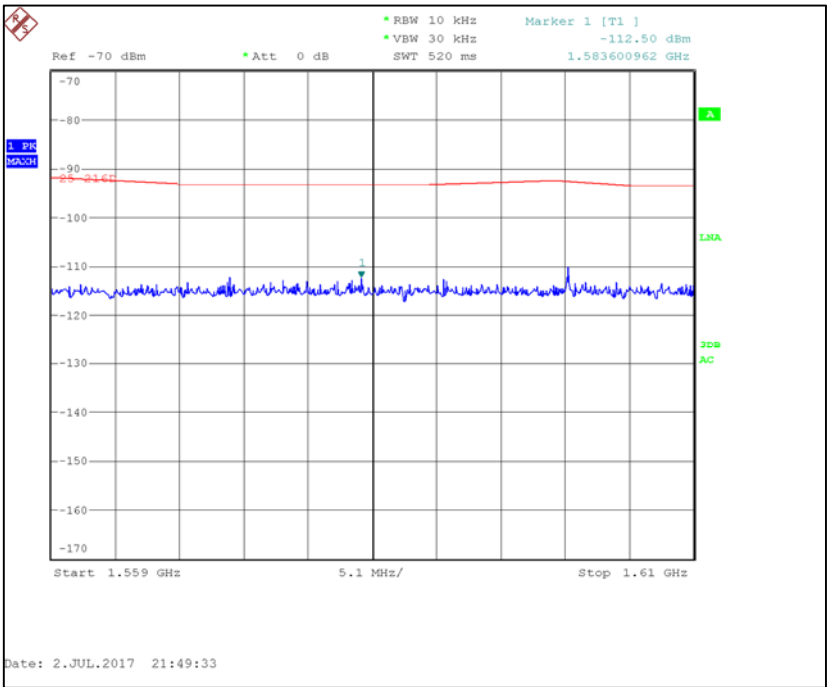
LTE Modulation QPSK - LTE Carrier Bandwidth 5.0 MHz - Channel Position T - Band 1 - Range 1559 to 1610 MHz – Discrete Emission Measurement



LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position B - Band 1 - Range 1559 to 1610 MHz – Broadband Emission Measurement



LTE Modulation QPSK - LTE Carrier Bandwidth 10.0 MHz - Channel Position M - Band 1 - Range 1559 to 1610 MHz – Discrete Emission Measurement



SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Maximum Peak Output Power and Peak to Average Ratio - Conducted					
Power Supply	California Instruments	2001RP	1898	-	O/P Mon
DVM	Iso-tech	IDM101	2419	12	14-Nov-2017
Attenuator	Weinschel	47-10-34	398	12	20-Oct-2017
Attenuator	Aeroflex	47-30-34	3164	-	O/P Mon
Spectrum Analyser	Keysight	N9030A	4654	12	6-Oct-2017
THG	Rotronic	I-1000	3220	12	23-Aug-2017
Network Analyser	Rohde & Schwarz	ZVA40	3548	12	15-Sep-2017
Calibration Kit	Rohde & Schwarz	ZV-Z54	4368	12	8-Sep-2017
Occupied Bandwidth					
Power Supply	California Instruments	2001RP	1898	-	O/P Mon
DVM	Iso-tech	IDM101	2419	12	14-Nov-2017
Attenuator	Weinschel	47-10-34	398	12	20-Oct-2017
Attenuator	Aeroflex	47-30-34	3164	-	O/P Mon
Spectrum Analyser	Keysight	N9030A	4654	12	6-Oct-2017
THG	Rotronic	I-1000	3220	12	23-Aug-2017
Network Analyser	Rohde & Schwarz	ZVA40	3548	12	15-Sep-2017
Calibration Kit	Rohde & Schwarz	ZV-Z54	4368	12	8-Sep-2017
Band Edge					
Power Supply	California Instruments	2001RP	1898	-	O/P Mon
DVM	Iso-tech	IDM101	2419	12	14-Nov-2017
Attenuator	Weinschel	47-10-34	398	12	20-Oct-2017
Attenuator	Aeroflex	47-30-34	3164	-	O/P Mon
Spectrum Analyser	Keysight	N9030A	4654	12	6-Oct-2017
THG	Rotronic	I-1000	3220	12	23-Aug-2017
Network Analyser	Rohde & Schwarz	ZVA40	3548	12	15-Sep-2017
Calibration Kit	Rohde & Schwarz	ZV-Z54	4368	12	8-Sep-2017
Transmitter Spurious Emissions					
Power Supply	California Instruments	2001RP	1898	-	O/P Mon
DVM	Iso-tech	IDM101	2419	12	14-Nov-2017
Attenuator	Weinschel	47-10-34	398	12	20-Oct-2017
Attenuator	Aeroflex	47-30-34	3164	-	O/P Mon
Spectrum Analyser	Keysight	N9030A	4654	12	6-Oct-2017
THG	Rotronic	I-1000	3220	12	23-Aug-2017
Network Analyser	Rohde & Schwarz	ZVA40	3548	12	15-Sep-2017
Calibration Kit	Rohde & Schwarz	ZV-Z54	4368	12	8-Sep-2017
High Pass Filter	Daden Anthony	MH-1500-7SS	2778	12	6-Feb-2018
Modulation Characteristics					
Power Supply	California Instruments	2001RP	1898	-	O/P Mon
DVM	Iso-tech	IDM101	2419	12	14-Nov-2017
Attenuator	Weinschel	47-10-34	398	12	20-Oct-2017

Attenuator	Aeroflex	47-30-34	3164	-	O/P Mon
Spectrum Analyser	Keysight	N9030A	4654	12	6-Oct-2017
THG	Rotronic	I-1000	3220	12	23-Aug-2017
Network Analyser	Rohde & Schwarz	ZVA40	3548	12	15-Sep-2017
Calibration Kit	Rohde & Schwarz	ZV-Z54	4368	12	8-Sep-2017
Frequency Stability					
Power Supply	California Instruments	2001RP	1898	-	O/P Mon
DVM	Iso-tech	IDM101	2419	12	14-Nov-2017
Attenuator	Weinschel	47-10-34	398	12	20-Oct-2017
Attenuator	Aeroflex	47-30-34	3164	-	O/P Mon
Spectrum Analyser	Keysight	N9030A	4654	12	6-Oct-2017
THG	Rotronic	I-1000	3220	12	23-Aug-2017
Network Analyser	Rohde & Schwarz	ZVA40	3548	12	15-Sep-2017
Calibration Kit	Rohde & Schwarz	ZV-Z54	4368	12	8-Sep-2017
Thermometer	Fluke	51	3172	12	16-Nov-2017
Climatic Chamber	Aralab	FitoTerm 300E45	4823	-	O/P Mon
Transmitter Radiated Spurious Emissions					
Antenna (Bilog)	Schaffner	CBL6143	287	24	18-Apr-2018
Screened Room (5)	Rainford	Rainford	1545	36	20-Dec-2017
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Hygromer	Rotronic	A1	2138	12	2-Feb-2018
Cable (N-N, 8m)	Rhophase	NPS-2302-8000-NPS	3248	12	2-May-2018
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017
Tilt Antenna Mast	maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	maturo Gmbh	NCD	3917	-	TU
Cable (Yellow, Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4527	6	4-Nov-2017
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	17-Feb-2018

N/A – Not Applicable
OP MON – Output Monitored with Calibrated Equipment

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:-

Test Discipline	Frequency / Parameter	MU
Conducted Maximum Peak Output Power	30 MHz to 20 GHz Amplitude	± 0.68 dB
Conducted Emissions	30 MHz to 20 GHz Amplitude	± 2.3 dB
Frequency Stability	30 MHz to 2 GHz	± 5.0 Hz
Occupied Bandwidth	5 MHz Bandwidth	± 11.5 kHz
	10 MHz Bandwidth	± 23.09 kHz
Band Edge	30 MHz to 20 GHz Amplitude	± 0.8 dB
Radiated Emissions, Bilog Antenna, AOATS	30MHz to 1GHz Amplitude	5.1dB*
Radiated Emissions, Horn Antenna, AOATS	1GHz to 40GHz Amplitude	6.3dB*
Worst case error for both Time and Frequency measurement 12 parts in 10^6		

* In accordance with CISPR 16-4

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

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