HL7518 Module

Test Report

FOR

FCC Certification

FCC ID: N7NHL7518

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1 Introduction and Purpose

This document provides test data for the HL7518 module for FCC and Industry Canada certifications.

1.1 Revision history

Rev	Date	Author	Summary of changes	ECO #
1.0	May 23, 2014	Markus Myers	First Release	

2 Test Summary

FCC Rule	IC Standards	DESCRIPTION OF TEST	RESULT	PAGE
2.1046	RSS-132, 4.4 RSS-133, 6.4 RSS-139, 4.4	RF Power Output	Complies	5
2.1049	RSS-Gen, 4.6	Occupied Bandwidth	Complies	16
2.1051, 22.917, 24.238, 27.53	RSS-132, 4.5 RSS-133, 6.5	Out of Band Emissions at Antenna Terminals	Complies	45
22.917, 24.238, 27.53	RSS-Gen, 4.6	Block Edge Compliance	Complies	106
2.1055, 22.355, 24.235, 27.54	RSS-132, 4.3 RSS-133, 6.3	Frequency Stability versus Temperature	Complies	122
2.1055, 22.355, 24.235, 27.54	RSS-132, 4.3 RSS-133, 6.3	Frequency Stability versus Voltage	Complies	124
24.232, 27.50		Peak to Average Ratio	Complies	126

3 Description of Equipment under Test

The HL7518 module, referred to as "EUT" hereafter, is a dual-band wireless module operating on the LTE network. The table below shows the supported North American bands for the device.

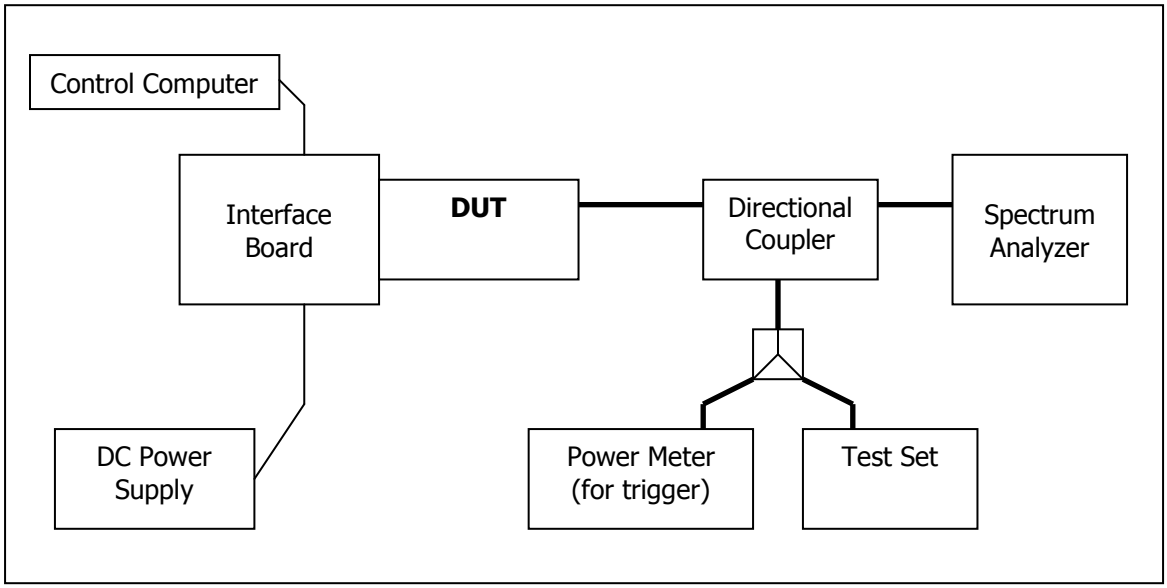
Technology	Band	UL Freq. (MHz)	DL Freq. (MHz)	Max Power
LTE	B4	1710 – 1755	2110 – 2155	23 dBm (+/- 1 dB)
	B13	777 – 787	746 – 756	23 dBm (+/- 1 dB)

4 Compliance Test Equipment List

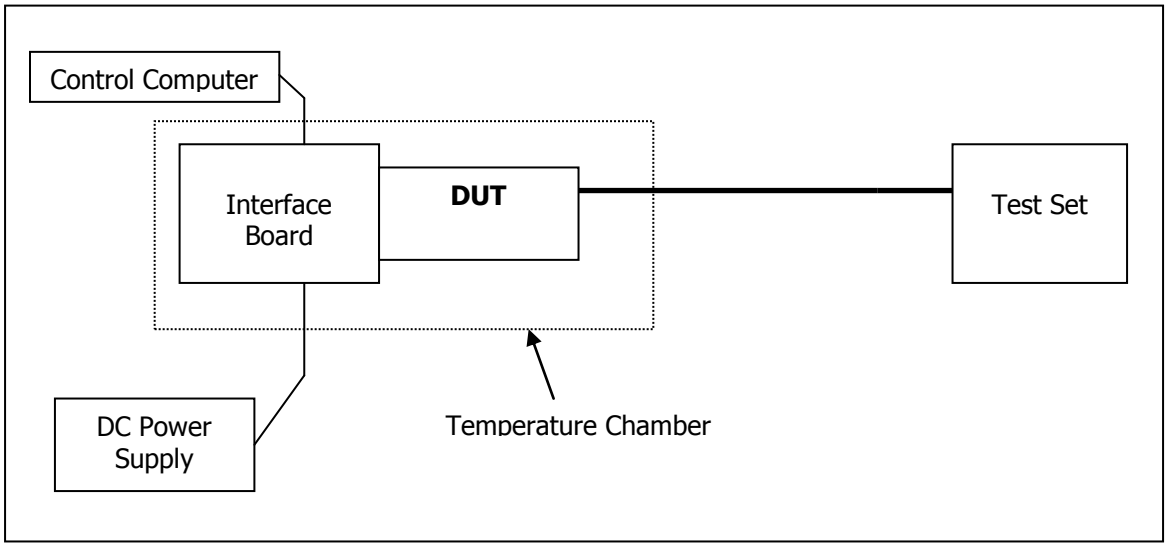
EQUIPMENT	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
Control Computer	TC	Generic PC	100488	N/A
Wireless Test Set	Rohde & Schwarz	CMU200	110521	October 27, 2014
Wireless Test Set	Rohde & Schwarz	CMW500	140914	June 06, 2015
Spectrum Analyzer	Rohde & Schwarz	FSP	100060	October 27, 2014
DC Power Supply	HP	6632A	3530A	N/A
Interface Board	Shop built	ATEMux	N/A	N/A
Directional Coupler	Pasternack	PE2209-10	N/A	N/A

5 Test Setup Block Diagrams

5.1 Test Setup 1



5.2 Test Setup 3



6 RF Power Output

FCC 2.1046

6.1 Test Procedure

The transmitter output was connected to a Rohde & Schwarz CMW500 and configured to operate at maximum power in a call. The maximum power was measured using the LTE power measurement of the CMW500. Refer to Test Setup 1.

6.1.1 LTE Max Power Setup

Configure the CMW500 call box to support all LTE tests in respect to the 3GPP 36.521.

- UE term. Conn: User defined Channels
- Exp. Nominal Power Mode: According to UL Power Control Settings
- RS EPRE: -75.0 dBm/15kHz Full Cell BW Power: -50.2 dBm
- PSS Power Offset = SSS Power Offset = PBCH Power Offset = PCFICH Power Offset = PDCCH Power Offset = 0.0 dB
- PHICH Power Offset = -12 dB
- OCNG ON
- PDSCH Power Offset PA: 0 dB, Power Ratio Index PB: 0 (rhoB/rhoA: 1)
- Active TPC Setup: Max Power
- Security Settings: Authentication OFF, NAS Security OFF, AS Security OFF
- Integrity Algortithm: NULL
- Milenage OFF

- Configure the desired channel, BW, resource block allocation and modulation.
- Connect to test set.
- Set CMW500 TPC Setup to Max Power (Up power control command).
- Measure the power at the HL7518 module antenna connector using the CMW multi evaluation LTE measurement.

6.2 Maximum Transmit Power Test Results

According to 3GPP 36.521, V9.1.0., the output power level for Power Class 3 LTE is to be 23.0dBm ± 2.7dB. The lower limit is shifted down by the MPR amount allowed for certain configurations.

Maximum Power Reduction (MPR) is allowed due to higher order modulation and transmit bandwidth configurations. These MPR levels reduce the lower limit of each output power by the either 1 or 2dB per 3GPP 36.521.

Modulation	Channel bandwidth / Transmission bandwidth configuration [RB]						MPR (dB)
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2

6.2.1 LTE B4 Output Power Results

6.2.1.1 Output Power Results for LTE Band 4, 1.4 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
19957	1710.7	1	0	QPSK	22.86	27.58	0
		1	2	QPSK	22.74	27.48	0
		1	5	QPSK	22.78	27.45	0
		6	0	QPSK	21.71	27.09	1
		1	0	16QAM	21.84	27.51	1
		1	2	16QAM	21.83	27.55	1
		1	5	16QAM	21.82	27.53	1
		6	0	16QAM	20.73	26.88	2
20175	1732.5	1	0	QPSK	22.77	27.55	0
		1	2	QPSK	22.69	27.43	0
		1	5	QPSK	22.73	27.49	0
		6	0	QPSK	21.74	27.37	1
		1	0	16QAM	21.94	27.39	1
		1	2	16QAM	21.88	27.4	1
		1	5	16QAM	21.95	27.4	1
		6	0	16QAM	20.76	27.25	2
20393	1754.3	1	0	QPSK	22.75	27.34	0
		1	2	QPSK	22.63	27.25	0
		1	5	QPSK	22.73	27.26	0
		6	0	QPSK	21.74	27.17	1
		1	0	16QAM	21.83	26.87	1
		1	2	16QAM	21.81	26.84	1
		1	5	16QAM	21.79	26.81	1
		6	0	16QAM	20.81	27.12	2

6.2.1.2 Output Power Results for LTE Band 4, 3 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
19965	1711.5	1	0	QPSK	22.74	27.35	0
		1	7	QPSK	22.8	27.38	0
		1	14	QPSK	22.7	27.4	0
		15	0	QPSK	21.67	27.37	1
		1	0	16QAM	21.73	27.39	1
		1	7	16QAM	21.7	27.36	1
		1	14	16QAM	21.69	27.47	1
		15	0	16QAM	20.78	27.28	2
20175	1732.5	1	0	QPSK	22.73	26.94	0

		1	7	QPSK	22.69	27.49	0
		1	14	QPSK	22.67	27.49	0
		15	0	QPSK	21.66	27.83	1
		1	0	16QAM	21.88	26.83	1
		1	7	16QAM	21.83	27.23	1
		1	14	16QAM	21.87	27.28	1
		15	0	16QAM	20.75	27.31	2
20385	1753.5	1	0	QPSK	22.64	27.09	0
		1	7	QPSK	22.56	26.89	0
		1	14	QPSK	22.56	26.85	0
		15	0	QPSK	21.59	27.16	1
		1	0	16QAM	21.94	27.52	1
		1	7	16QAM	21.91	27.27	1
		1	14	16QAM	21.84	27.53	1
		15	0	16QAM	20.63	27.48	2

6.2.1.3 Output Power Results for LTE Band 4, 5 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
19975	1712.5		0	QPSK	22.75	27.15	0
			12	QPSK	22.76	27.07	0
			24	QPSK	22.63	27.1	0
			0	QPSK	21.65	27.54	1
			0	16QAM	21.81	27.45	1
			12	16QAM	21.83	27.47	1
			24	16QAM	21.7	27.46	1
			0	16QAM	20.65	27.34	2
20175	1732.5	1	0	QPSK	22.71	27.24	0
		1	12	QPSK	22.71	27.77	0
		1	24	QPSK	22.64	27.89	0
		25	0	QPSK	21.7	27.94	1
		1	0	16QAM	22.06	26.98	1
		1	12	16QAM	22.12	27.51	1
		1	24	16QAM	21.99	27.47	1
		25	0	16QAM	20.63	27.91	2
20375	1752.5	1	0	QPSK	22.65	27.18	0
		1	12	QPSK	22.58	26.98	0
		1	24	QPSK	22.58	26.9	0
		25	0	QPSK	21.63	27.52	1

		1	0	16QAM	21.76	27.08	1
		1	12	16QAM	21.67	26.84	1
		1	24	16QAM	21.76	26.85	1
		25	0	16QAM	20.59	27.29	2

6.2.1.4 Output Power Results for LTE Band 4, 10 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
20000	1715	1	0	QPSK	22.96	27.49	0
		1	25	QPSK	22.73	27.35	0
		1	49	QPSK	22.73	27.44	0
		50	0	QPSK	21.78	27.48	1
		1	0	16QAM	22.01	27.44	1
		1	25	16QAM	21.8	27.45	1
		1	49	16QAM	21.79	27.47	1
		50	0	16QAM	20.81	27.32	2
20175	1732.5	1	0	QPSK	22.77	26.98	0
		1	25	QPSK	22.65	27.34	0
		1	49	QPSK	22.56	27.01	0
		50	0	QPSK	21.69	27.35	1
		1	0	16QAM	21.97	26.91	1
		1	25	16QAM	21.74	27.18	1
		1	49	16QAM	21.64	26.93	1
		50	0	16QAM	20.76	27.65	2
20350	1750	1	0	QPSK	22.71	27.38	0
		1	25	QPSK	22.44	27.03	0
		1	49	QPSK	22.44	26.83	0
		50	0	QPSK	21.63	27.25	1
		1	0	16QAM	22.06	27.8	1
		1	25	16QAM	21.77	27.44	1
		1	49	16QAM	21.73	27.18	1
		50	0	16QAM	20.66	27.5	2

6.2.1.5 Output Power Results for LTE Band 4, 15 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
20025	1717.5	1	0	QPSK	23.24	27.59	0
		1	37	QPSK	22.72	27.4	0

		1	74	QPSK	22.79	27.27	0
		75	0	QPSK	21.82	27.77	1
		1	0	16QAM	22.17	27.56	1
		1	37	16QAM	21.76	27.45	1
		1	74	16QAM	21.8	27.31	1
		75	0	16QAM	20.89	27.64	2
20175	1732.5	1	0	QPSK	23.14	27.02	0
		1	37	QPSK	22.74	27.16	0
		1	74	QPSK	22.73	27.05	0
		75	0	QPSK	21.8	27.86	1
		1	0	16QAM	22.1	27.02	1
		1	37	16QAM	21.64	27.21	1
		1	74	16QAM	21.66	27.09	1
		75	0	16QAM	20.79	27.85	2
20325	1747.5	1	0	QPSK	22.83	27.33	0
		1	37	QPSK	22.39	27.05	0
		1	74	QPSK	22.38	26.83	0
		75	0	QPSK	21.65	27.73	1
		1	0	16QAM	22.12	27.7	1
		1	37	16QAM	21.85	27.62	1
		1	74	16QAM	21.67	27.17	1
		75	0	16QAM	20.66	27.69	2

6.2.1.6 Output Power Results for LTE Band 4, 20 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
20050	1720	1	0	QPSK	23.07	27.42	0
		1	50	QPSK	22.62	27.23	0
		1	99	QPSK	22.52	26.91	0
		100	0	QPSK	21.79	27.59	1
		1	0	16QAM	22.42	27.49	1
		1	50	16QAM	22.05	27.37	1
		1	99	16QAM	21.89	27.07	1
		100	0	16QAM	20.8	27.56	2
20175	1732.5	1	0	QPSK	23.08	27.29	0
		1	50	QPSK	22.51	27.46	0
		1	99	QPSK	22.49	27.37	0
		100	0	QPSK	21.77	27.96	1
		1	0	16QAM	22.44	27.21	1

		1	50	16QAM	21.92	27.39	1
		1	99	16QAM	21.89	27.32	1
		100	0	16QAM	20.81	27.72	2
20300	1745	1	0	QPSK	23.02	27.85	0
		1	50	QPSK	22.48	27.4	0
		1	99	QPSK	22.41	26.98	0
		100	0	QPSK	21.66	27.46	1
		1	0	16QAM	21.88	27.66	1
		1	50	16QAM	21.4	27.24	1
		1	99	16QAM	21.3	26.89	1
		100	0	16QAM	20.69	27.51	2

6.2.2 LTE B13 Output Power Results

6.2.2.1 Output Power Results for LTE Band 13, 5 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
23205	779.5	1	0	QPSK	22.85	27.65	0
		1	12	QPSK	22.81	27.13	0
		1	24	QPSK	22.87	26.88	0
		25	0	QPSK	21.93	27.53	1
		1	0	16QAM	21.98	28.29	1
		1	12	16QAM	22.16	27.5	1
		1	24	16QAM	22.04	27.14	1
		25	0	16QAM	20.76	27.51	2
23230	782	1	0	QPSK	22.89	27.48	0
		1	12	QPSK	22.81	26.35	0
		1	24	QPSK	22.7	27.14	0
		25	0	QPSK	21.92	26.74	1
		1	0	16QAM	22.24	27.24	1
		1	12	16QAM	22.27	26.21	1
		1	24	16QAM	22.12	26.99	1
		25	0	16QAM	20.85	26.91	2
23255	784.5	1	0	QPSK	23.04	26.33	0
		1	12	QPSK	22.91	26.94	0
		1	24	QPSK	22.84	27.25	0
		25	0	QPSK	21.99	27.43	1
		1	0	16QAM	21.99	26.25	1

		1	12	16QAM	22.07	26.8	1
		1	24	16QAM	22.04	27.19	1
		25	0	16QAM	20.95	27.36	2

6.2.2.2 Output Power Results for LTE Band 13, 10 MHz Bandwidth

CHANNEL	FREQUENCY (MHz)	NO_RB	RB_START	MODULATION	PWR_AVG	PWR_PK	MPR
23230	782	1	0	QPSK	22.64	27.37	0
		1	25	QPSK	22.6	26.13	0
		1	49	QPSK	22.25	26.98	0
		50	0	QPSK	22.02	27.05	1
		1	0	16QAM	22.02	27.71	1
		1	25	16QAM	21.95	26.36	1
		1	49	16QAM	21.61	27.47	1
		50	0	16QAM	20.99	27.08	2

7 Occupied Bandwidth

FCC 2.1049

7.1 Test Procedure

The transmitter output was connected to a spectrum analyzer through a calibrated coaxial cable and a directional coupler. The occupied bandwidth (defined as the 99% Power Bandwidth) was measured with the spectrum analyzer at mid frequency in each band. The –26dB bandwidth was also measured and recorded. Refer to Test Setup 1.

7.2 Test Results

Occupied Bandwidth was only measured at maximum resource block allocation and at center of band for each supported LTE BW.

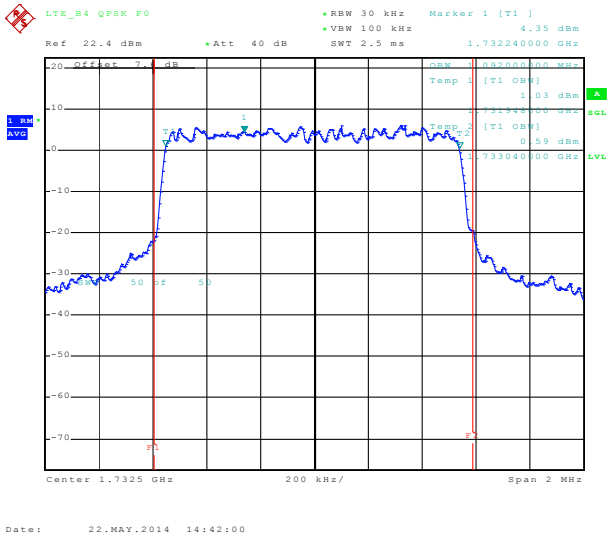
7.2.1 LTE Summary Results

Mode		Band	BW (MHz)	No. RB	RB Offset	Frequency (MHz)	Channel	99% Occupied Bandwidth (MHz)	-26dBc Occupied Bandwidth (MHz)	Corresponding Plot number
LTE	QPSK	B4	1.4	6	0	1732.5	20175	1.088	1.248	7.2.2.1
			3	15				2.724	2.952	7.2.2.2
			5	25				4.48	4.76	7.2.2.3
			10	50				9.04	9.96	7.2.2.4
			15	75				13.44	14.52	7.2.2.5

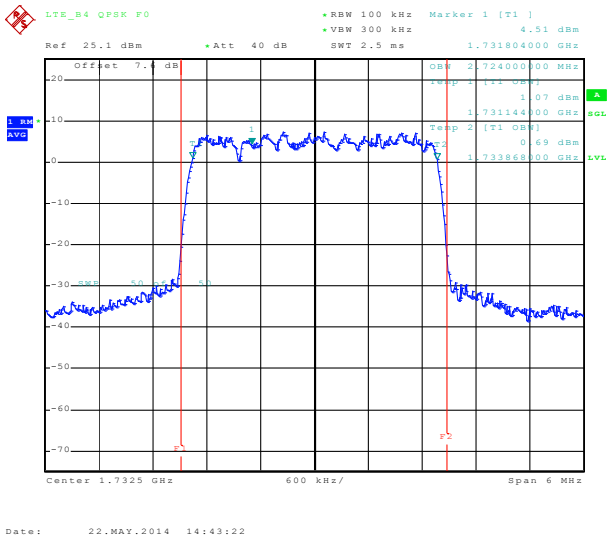
			20	100				17.84	18.96	7.2.2.6
		B13	5	25	0	782	23230	4.5	4.78	7.2.2.7
			10	50				9.08	10	7.2.2.8
	16-QAM	B4	1.4	6	0	1732.5	20175	1.088	1.18	7.2.2.9
			3	15				2.736	2.976	7.2.2.10
			5	25				4.48	4.76	7.2.2.11
			10	50				9.04	10	7.2.2.12
			15	75				13.44	14.4	7.2.2.13
			20	100				17.92	19.04	7.2.2.14
		B13	5	25	0	782	23230	4.52	4.76	7.2.2.15
			10	50				9.08	9.96	7.2.2.16

7.2.2 LTE Test Plots

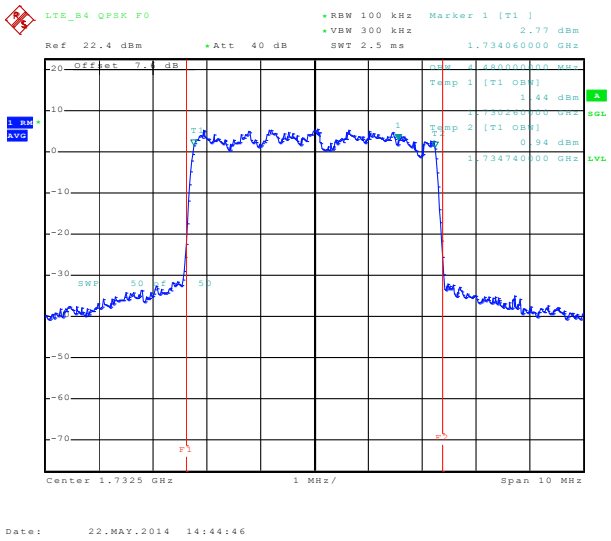
7.2.2.1 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=1.4MHz RB=6 RB Offset=0 QPSK 99% BW



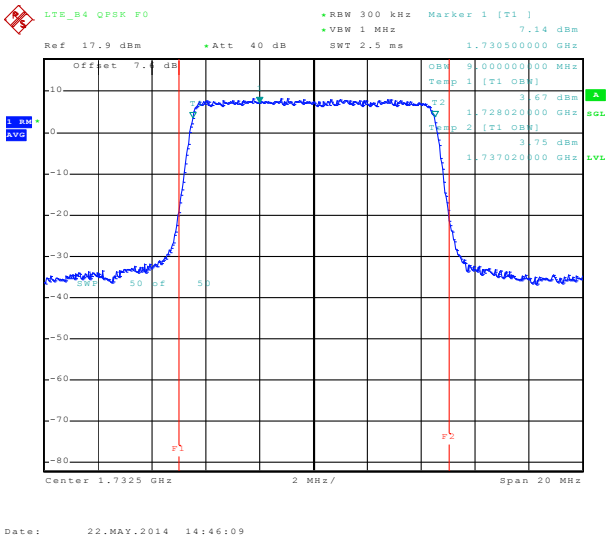
7.2.2.2 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=3MHz RB=15 RB Offset=0 QPSK 99% BW



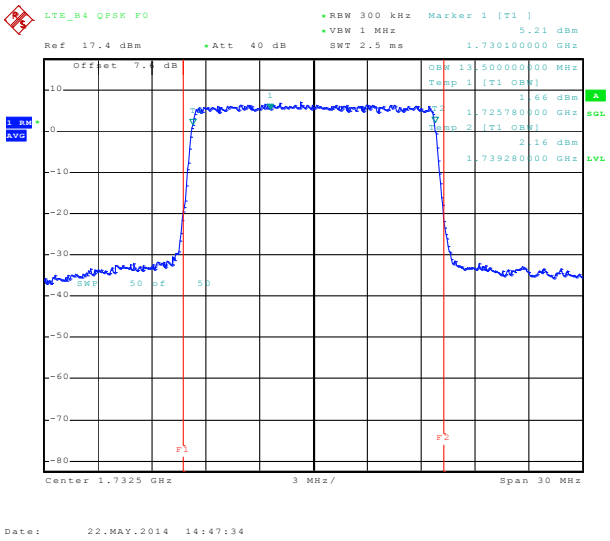
7.2.2.3 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=5MHz RB=25 RB Offset=0 QPSK 99% BW



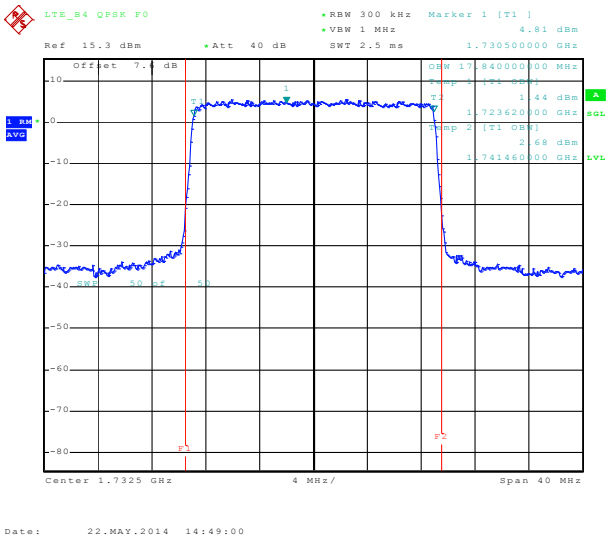
7.2.2.4 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=10MHz RB=50 RB Offset=0 QPSK 99% BW



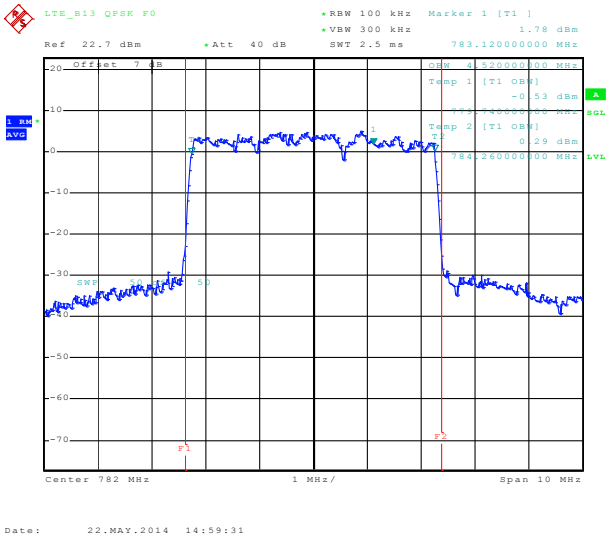
7.2.2.5 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=15MHz RB=75 RB Offset=0 QPSK 99% BW



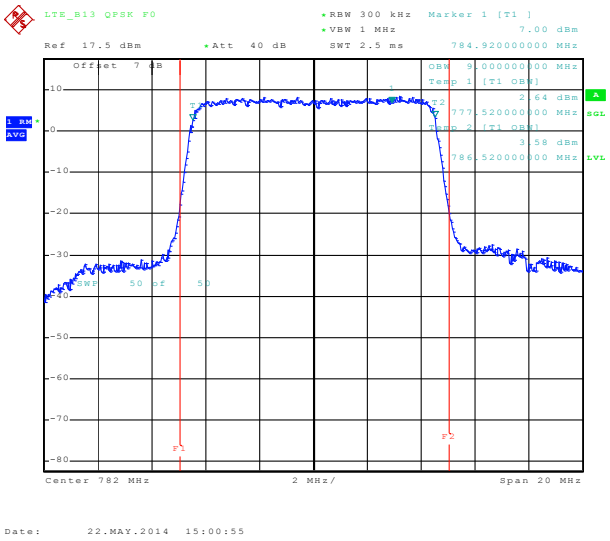
7.2.2.6 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=20MHz RB=100 RB Offset=0 QPSK 99% BW



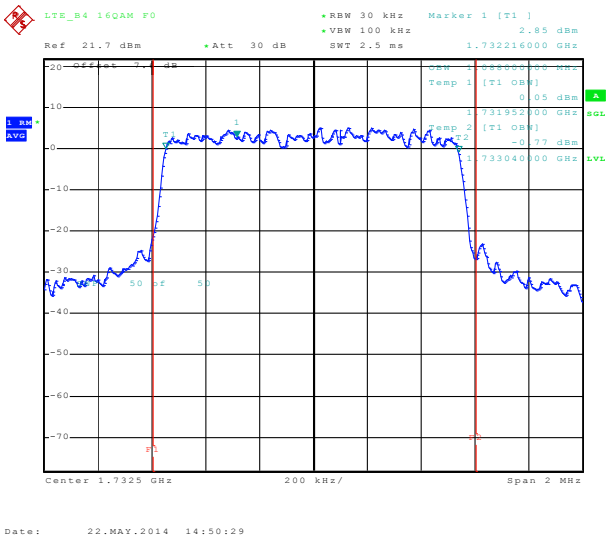
7.2.2.7 LTE Occupied Bandwidth, Band13 mid channel (23230) BW=5MHz RB=25 RB Offset=0 QPSK 99% BW



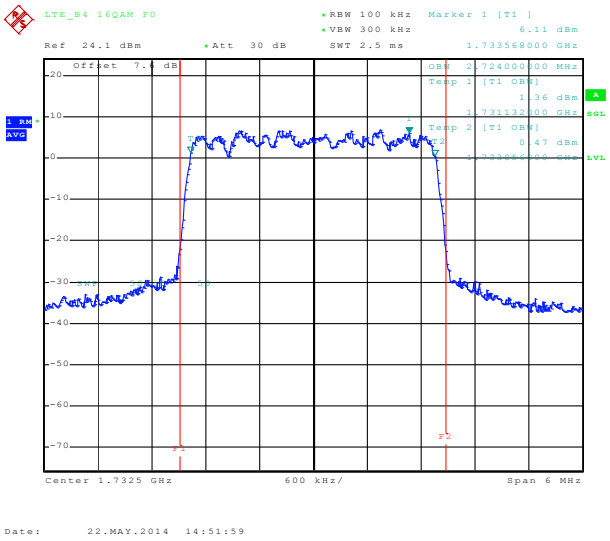
7.2.2.8 LTE Occupied Bandwidth, Band13 mid channel (23230) BW=10MHz RB=50 RB Offset=0 QPSK 99% BW



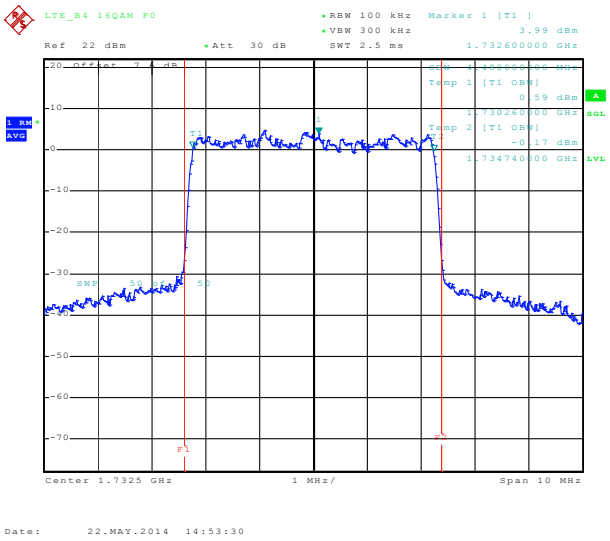
7.2.2.9 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=1.4MHz RB=6 RB Offset=0 16-QAM 99% BW



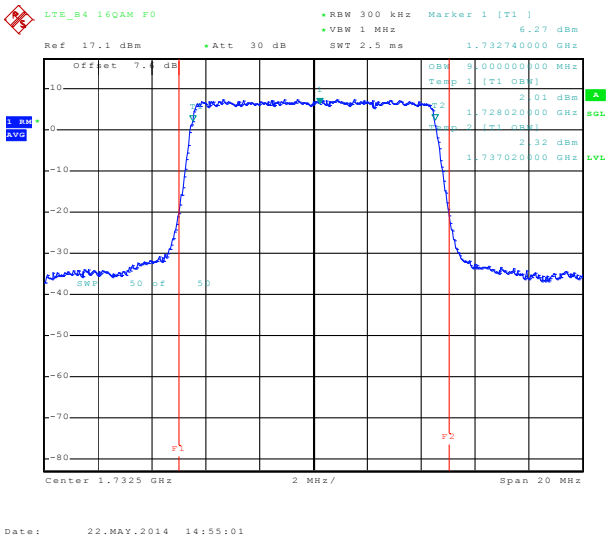
7.2.2.10 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=3MHz RB=15 RB Offset=0 16-QAM 99% BW



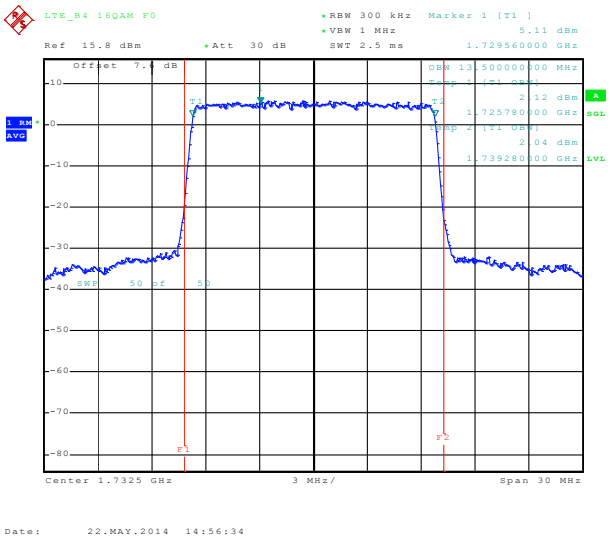
7.2.2.11 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=5MHz RB=25 RB Offset=0 16-QAM 99% BW



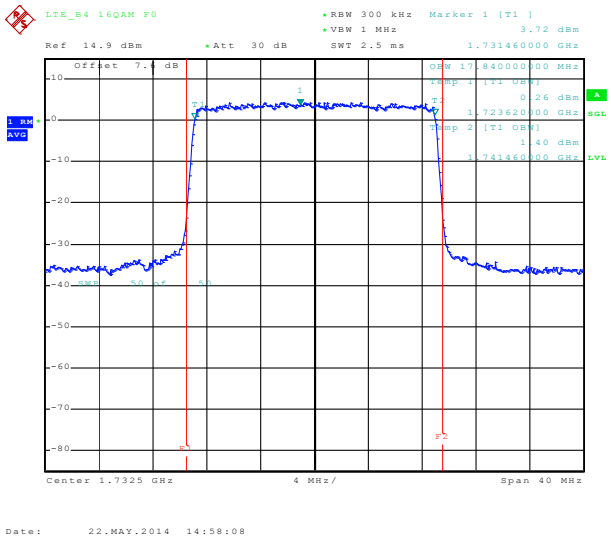
7.2.2.12 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=10MHz RB=50 RB Offset=0 16-QAM 99% BW



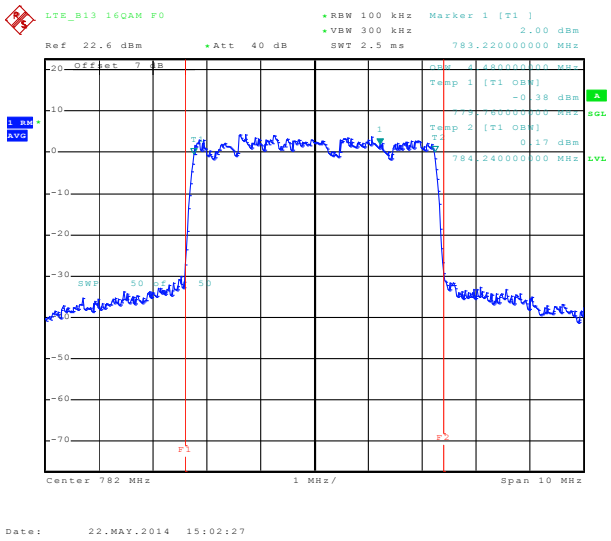
7.2.2.13 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=15MHz RB=75 RB Offset=0 16-QAM 99% BW



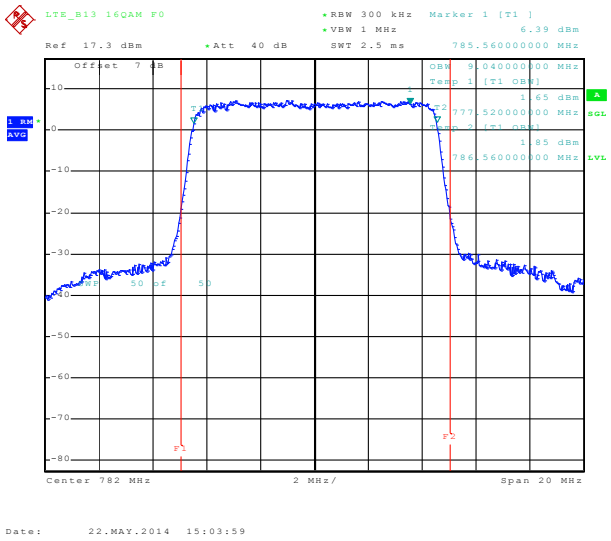
7.2.2.14 LTE Occupied Bandwidth, Band4 mid channel (20175) BW=20MHz RB=100 RB Offset=0 16-QAM 99% BW



7.2.2.15 LTE Occupied Bandwidth, Band13 mid channel (23230) BW=5MHz RB=25 RB Offset=0 16-QAM 99% BW



7.2.2.16 LTE Occupied Bandwidth, Band13 mid channel (23230) BW=10MHz RB=50 RB Offset=0 16-QAM 99% BW



8 Out of Band Emissions at Antenna Terminals

FCC 2.1051, 22.917, 24.238(a), 27.53(h)(m)

Out of Band Emissions:
The mean power of emissions must be attenuated below the mean power of the unmodulated carrier (P) on any frequency outside the frequency band by at least
(43 + 10 log P) dB. The out of band emission limit translates to a worst case absolute limit of -13dBm in this case.

8.1 Test Procedure

The RF output of the transmitter was connected to a spectrum analyzer through a calibrated coaxial cable. Sufficient scans were taken to show the out-of-band emissions, if any, up to 10th harmonic. The EUT was scanned for spurious emissions from 1MHz to 20GHz with sufficient bandwidth and video resolution. Data plots are included. Multiple sweeps were recorded in maximum hold mode using a peak detector to ensure that the worst-case emissions were captured. Refer to Test Setup 2.

8.2 Test Results

Refer to the following plots.

Mode		Band	BW (MHz)	No. RB	RB Offset	Frequency (MHz)	Channel	Corresponding Plot number
LTE	QPSK	B4	1.4	1	3	1732.5	20175	8.2.1.1 -8.2.1.3
			3		7			8.2.1.4 -8.2.1.6

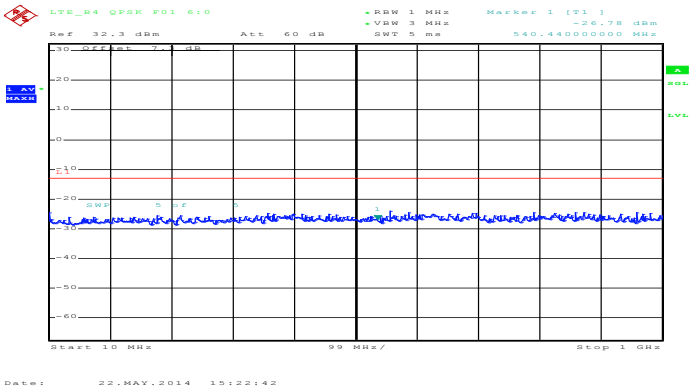
			5		12			8.2.1.7 -8.2.1.9
			10		25			8.2.1.10 -8.2.1.12
			15		32			8.2.1.13 -8.2.1.15
			20		50			8.2.1.16 -8.2.1.18
		B13	5	1	12	782	23230	8.2.1.19 -8.2.1.20
			10		25			8.2.1.21 -8.2.1.22

The plots below show that the conducted emission limits requirements are met.

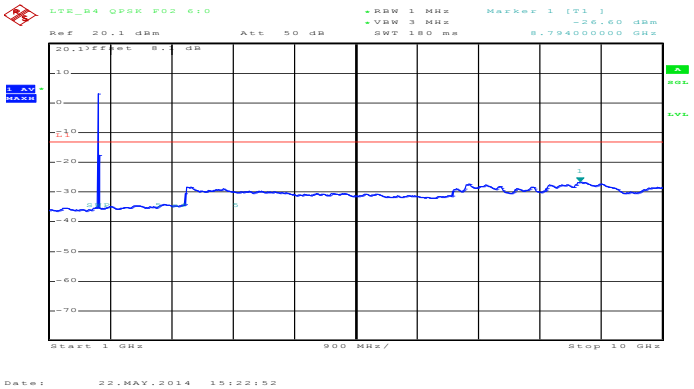
8.2.1 LTE Test Plots

LTE B4

8.2.1.1 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 1.4MHz BW, 1RB, RB Offset 3, QPSK, 30MHz to 1 GHz

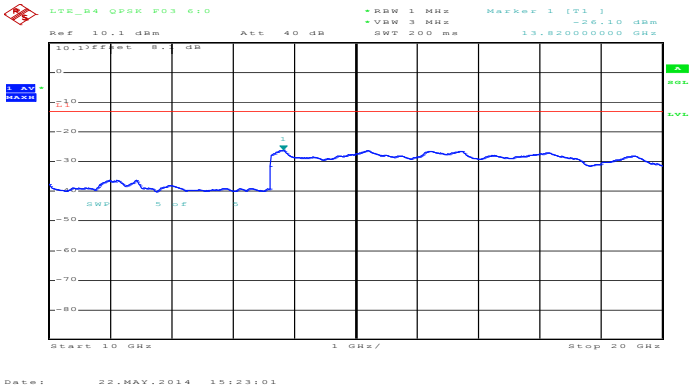


8.2.1.2 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 1.4MHz BW, 1RB, RB Offset 3, QPSK, 1 GHz to 10 GHz

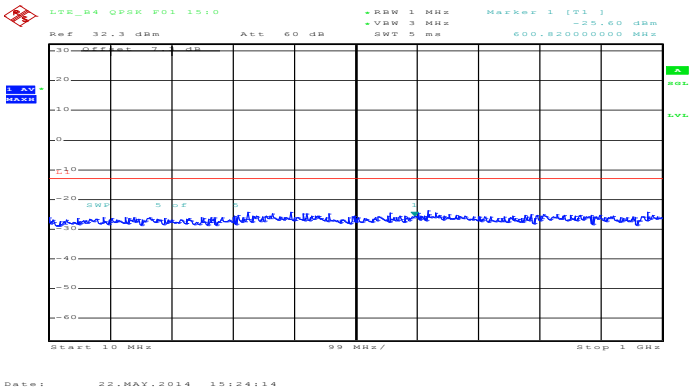


Note: The strong emission shown in each case is the carrier signal.

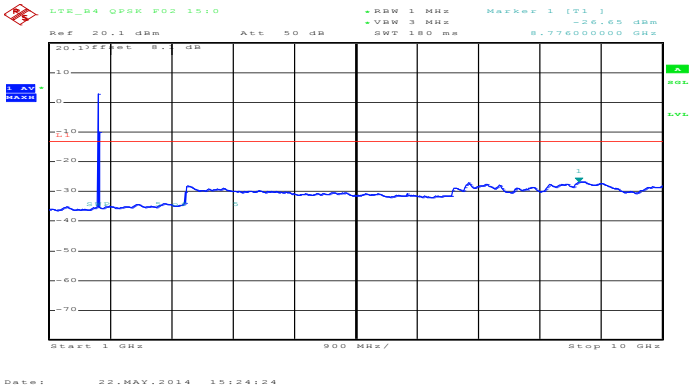
8.2.1.3 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 1.4MHz BW, 1RB, RB Offset 3, QPSK, 10 GHz to 20 GHz



8.2.1.4 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 3MHz BW, 1RB, RB Offset 7, QPSK, 30MHz to 1 GHz

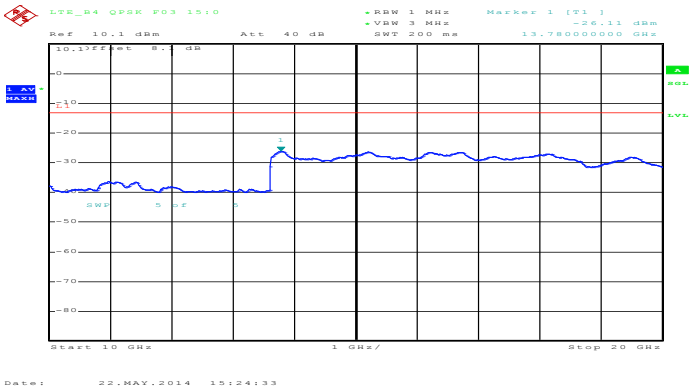


8.2.1.5 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 3MHz BW, 1RB, RB Offset 7, QPSK, 1 GHz to 10 GHz

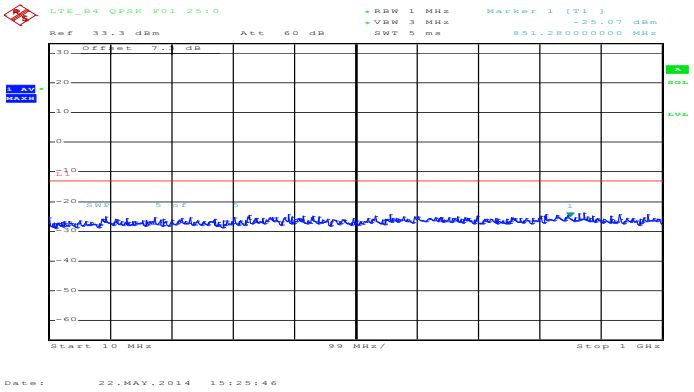


Note: The strong emission shown in each case is the carrier signal.

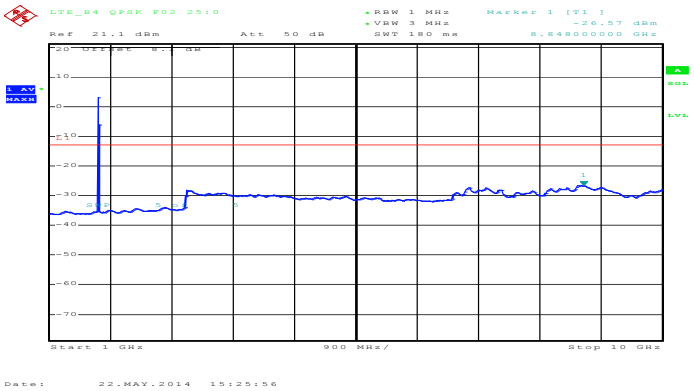
8.2.1.6 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 3MHz BW, 1RB, RB Offset 7, QPSK, 10 GHz to 20 GHz



8.2.1.7 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 5MHz BW, 1RB, RB Offset 12, QPSK, 30MHz to 1 GHz

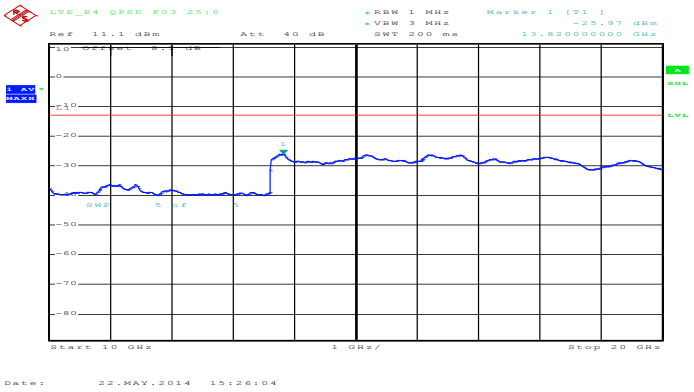


8.2.1.8 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 5MHz BW, 1RB, RB Offset 12, QPSK, 1 GHz to 10 GHz

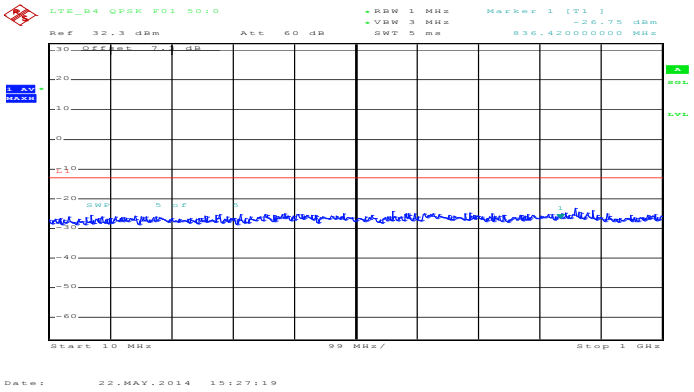


Note: The strong emission shown in each case is the carrier signal.

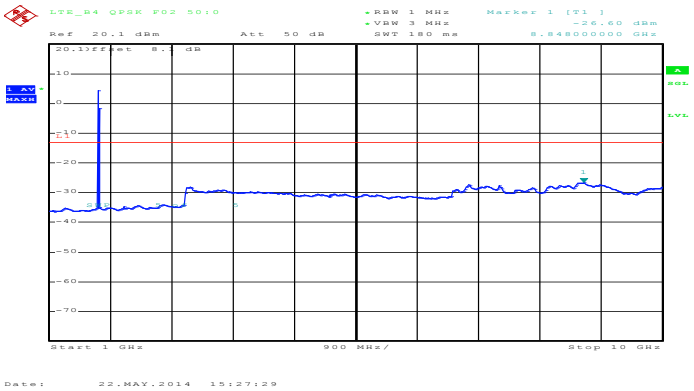
8.2.1.9 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 5MHz BW, 1RB, RB Offset 12, QPSK, 10 GHz to 20 GHz



8.2.1.10 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 10MHz BW, 1RB, RB Offset 25, QPSK, 30MHz to 1 GHz

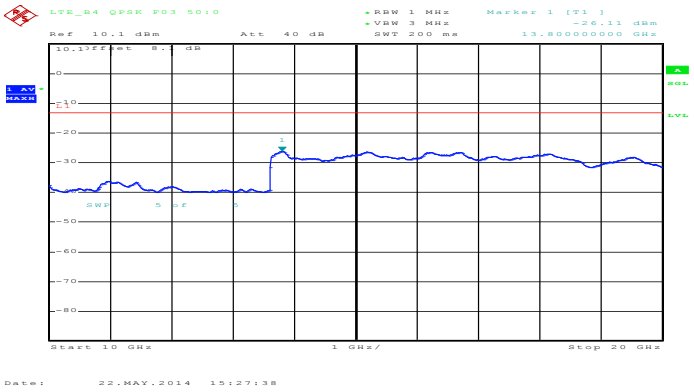


8.2.1.11 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 10MHz BW, 1RB, RB Offset 25, QPSK, 1 GHz to 10 GHz

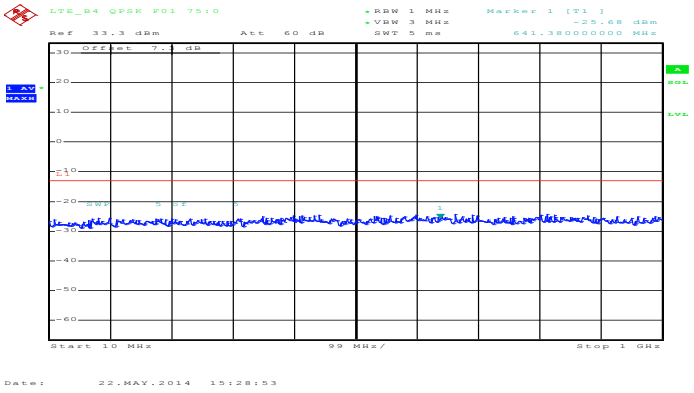


Note: The strong emission shown in each case is the carrier signal.

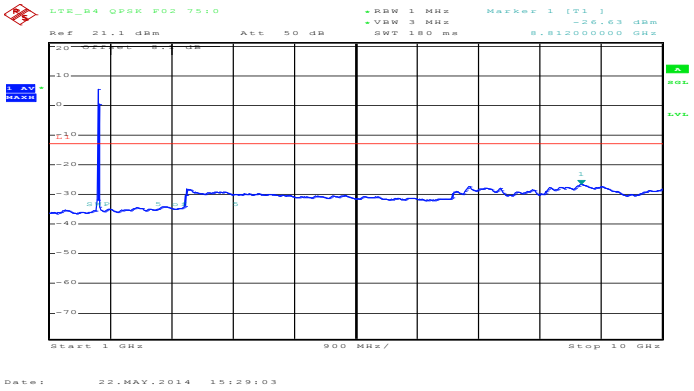
8.2.1.12 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 10MHz BW, 1RB, RB Offset 25, QPSK, 10 GHz to 20 GHz



8.2.1.13 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 15MHz BW, 1RB, RB Offset 32, QPSK, 30MHz to 1 GHz

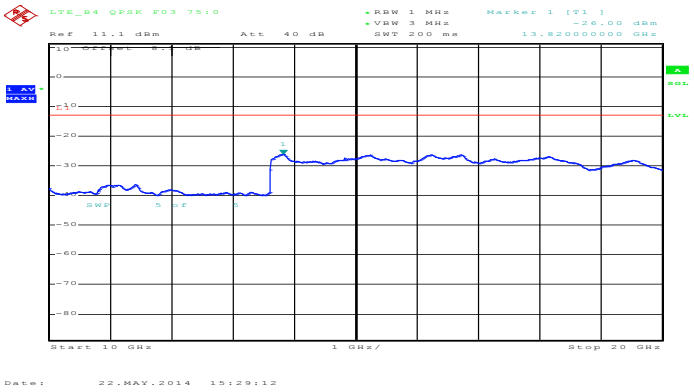


8.2.1.14 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 15MHz BW, 1RB, RB Offset 32, QPSK, 1 GHz to 10 GHz

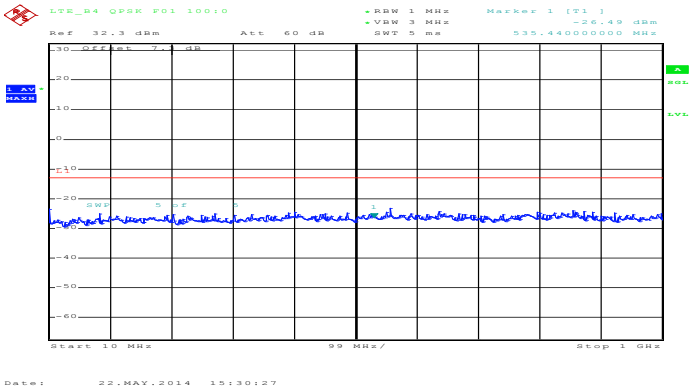


Note: The strong emission shown in each case is the carrier signal.

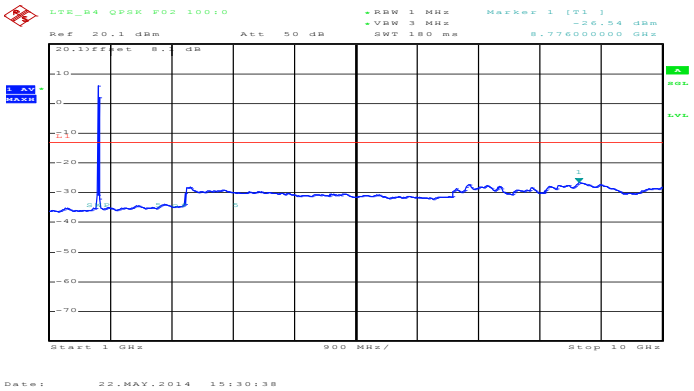
8.2.1.15 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 15MHz BW, 1RB, RB Offset 32, QPSK, 10 GHz to 20 GHz



8.2.1.16 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 20MHz BW, 1RB, RB Offset 50, QPSK, 30MHz to 1 GHz

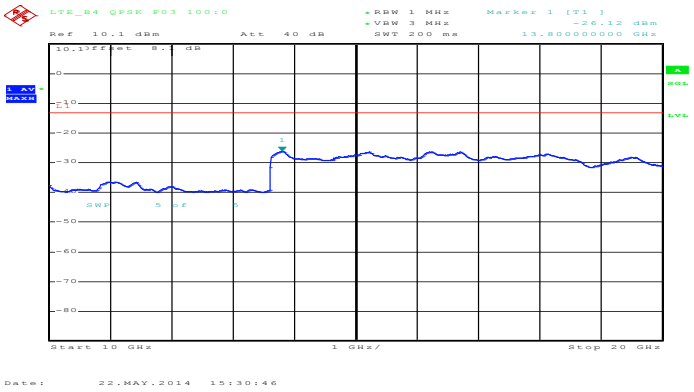


8.2.1.17 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 20MHz BW, 1RB, RB Offset 50, QPSK, 1 GHz to 10 GHz



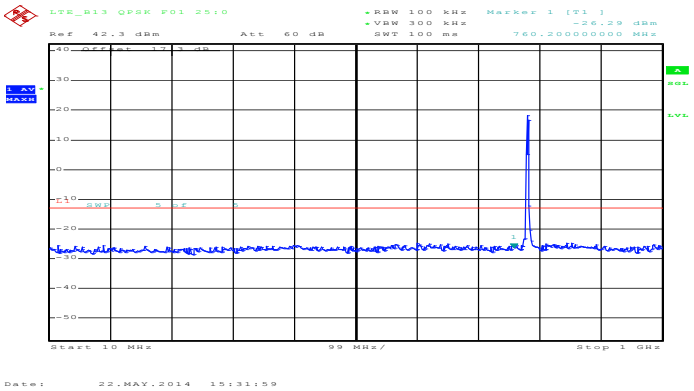
Note: The strong emission shown in each case is the carrier signal.

8.2.1.18 Out of Band Emissions at Antenna Terminals LTE B4, Mid channel, 1732.5 MHz, 20MHz BW, 1RB, RB Offset 50, QPSK, 10 GHz to 20 GHz



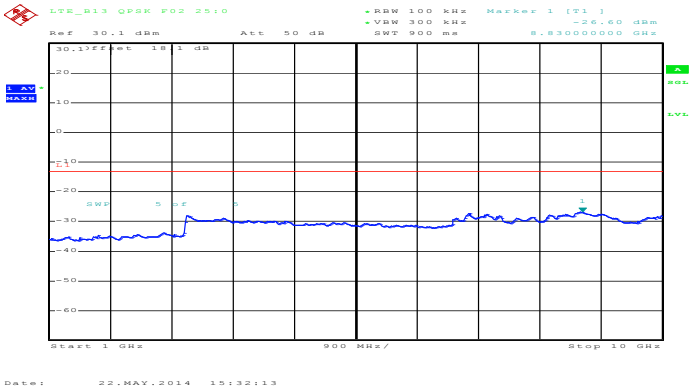
LTE B13

8.2.1.19 Out of Band Emissions at Antenna Terminals LTE B13, Mid channel, 782.0 MHz, 5MHz BW, 1RB, RB Offset 12, QPSK, 30MHz to 1 GHz

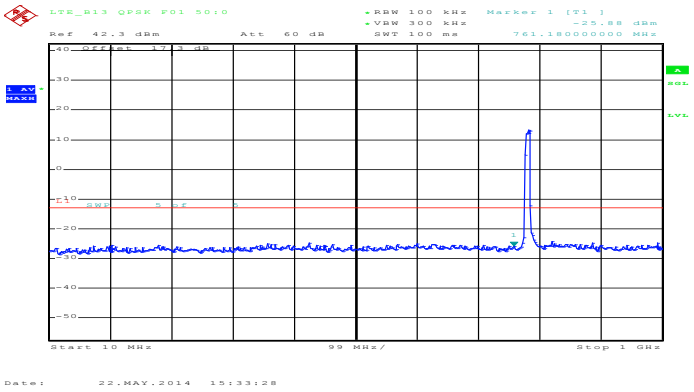


Note: The strong emission shown in each case is the carrier signal.

8.2.1.20 Out of Band Emissions at Antenna Terminals LTE B13, Mid channel, 782.0 MHz, 5MHz BW, 1RB, RB Offset 12, QPSK, 1 GHz to 10 GHz

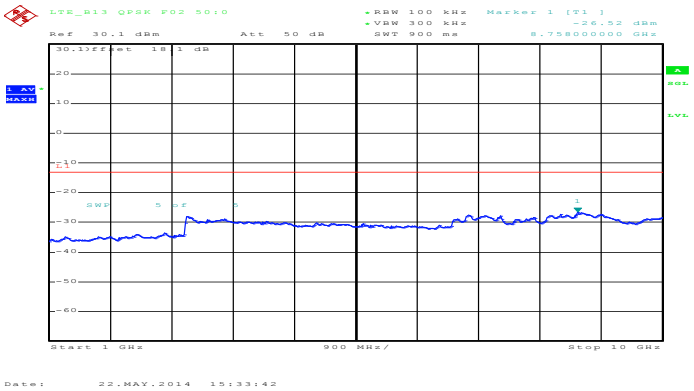


8.2.1.21 Out of Band Emissions at Antenna Terminals LTE B13, Mid channel, 782.0 MHz, 10MHz BW, 1RB, RB Offset 25, QPSK, 30MHz to 1 GHz



Note: The strong emission shown in each case is the carrier signal.

8.2.1.22 Out of Band Emissions at Antenna Terminals LTE B13, Mid channel, 782.0 MHz, 10MHz BW, 1RB, RB Offset 25, QPSK, 1 GHz to 10 GHz



9 Block Edge Compliance

FCC Part 2.1051, 22.917, 24.238(a), 27.53(h)(m)

9.1 Test Procedure

The transmitter output was connected to a Rohde & Schwarz CMW500, through a coaxial RF cable and a directional coupler, and configured to operate at maximum power. The block edge emissions were measured at the required operating frequencies in each band on the Spectrum Analyzer. Refer to Test Setup 1.

The resolution bandwidth was set to at least 1% of the emission bandwidth (where applicable). The power was scaled accordingly:

Power offset = 10*log(FCC_RBW/Measurement_RBW)

9.2 Test Results

Mode		Band	BW (MHz)	No. RB	RB Offset	Frequency (MHz)	Channel	Corresponding Plot number
LTE	QPSK	B4	1.4	1	0	1712.5	19975	9.2.1.1
				6	0			
				1	5	1752.5	20375	
				6	0			
		B4	5	1	0	1712.5	19975	9.2.1.2
				15	0			
				1	14	1752.5	20375	
				15	0			
		B4	5	1	0	1712.5	19975	9.2.1.3
				25	0			
				1	24	1752.5	20375	
				25	0			
		B4	10	1	0	1715	20000	9.2.1.4
				50	0			
				1	49	1750	20350	
				50	0			
		B4	15	1	0	1717.5	20025	9.2.1.5
				75	0			
				1	74	1747.5	20325	
				75	0			
		B4	20	1	0	1720	20050	9.2.1.6
				100	0			
				1	99	1745	20300	
				100	0			
		B13	5	1	0	779.5	23205	9.2.1.7
				25	0			
				1	24	784.5	23255	
				25	0			
		B13	10	1	0	782	23230	9.2.1.8
				50	0			
				1	49	782	23230	
				50	0			
LTE	16-QAM	B4	1.4	1	0	1712.5	19975	9.2.1.9
				6	0			

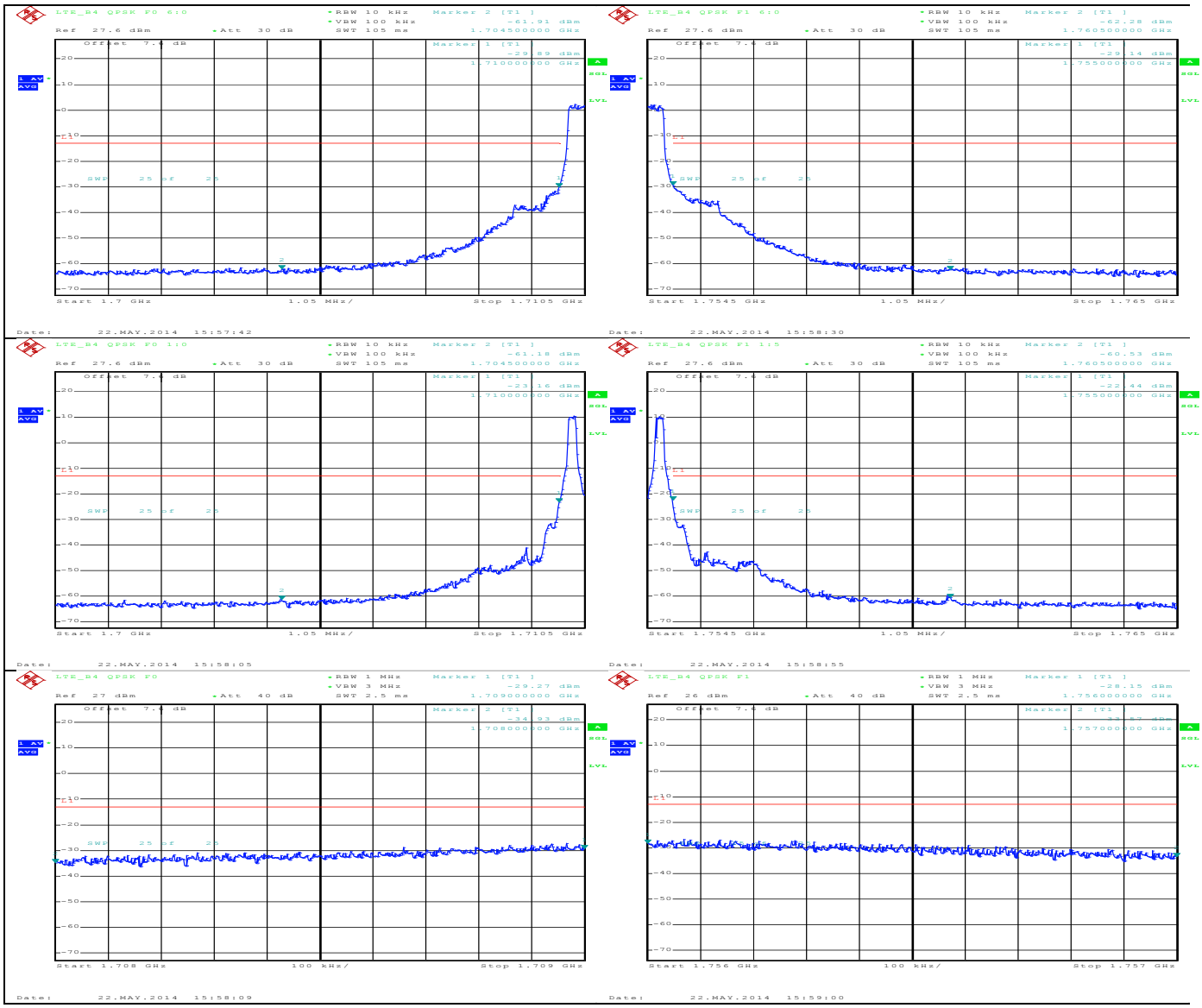
				1	5	1752.5	20375	
				6	0			
		B4	5	1	0	1712.5	19975	9.2.1.10
				15	0			
				1	14	1752.5	20375	
				15	0			
		B4	5	1	0	1712.5	19975	9.2.1.11
				25	0			
				1	24	1752.5	20375	
				25	0			
		B4	10	1	0	1715	20000	9.2.1.12
				50	0			
				1	49	1750	20350	
				50	0			
		B4	15	1	0	1717.5	20025	9.2.1.13
				75	0			
				1	74	1747.5	20325	
				75	0			
		B4	20	1	0	1720	20050	9.2.1.14
				100	0			
				1	99	1745	20300	
				100	0			
		B13	5	1	0	779.5	23205	9.2.1.15
				25	0			
				1	24	784.5	23255	
				25	0			
		B13	10	1	0	782	23230	9.2.1.16
				50	0			
				1	49	782	23230	
				50	0			

9.2.1 LTE Test Plots

LTE B4

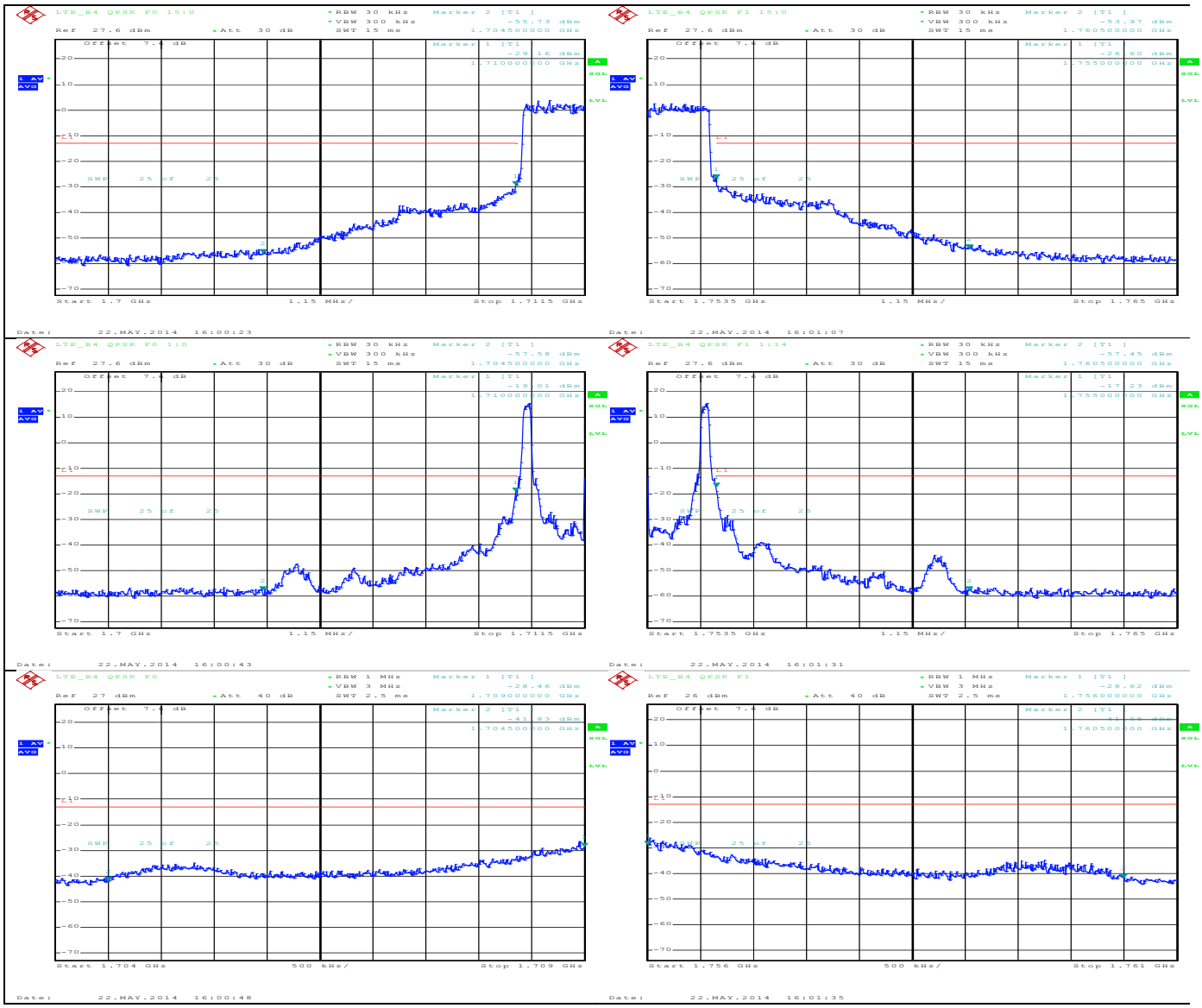
9.2.1.1 LTE; Band4, 1.4 MHz BW, QPSK

Below 1710 MHz	Above 1755 MHz



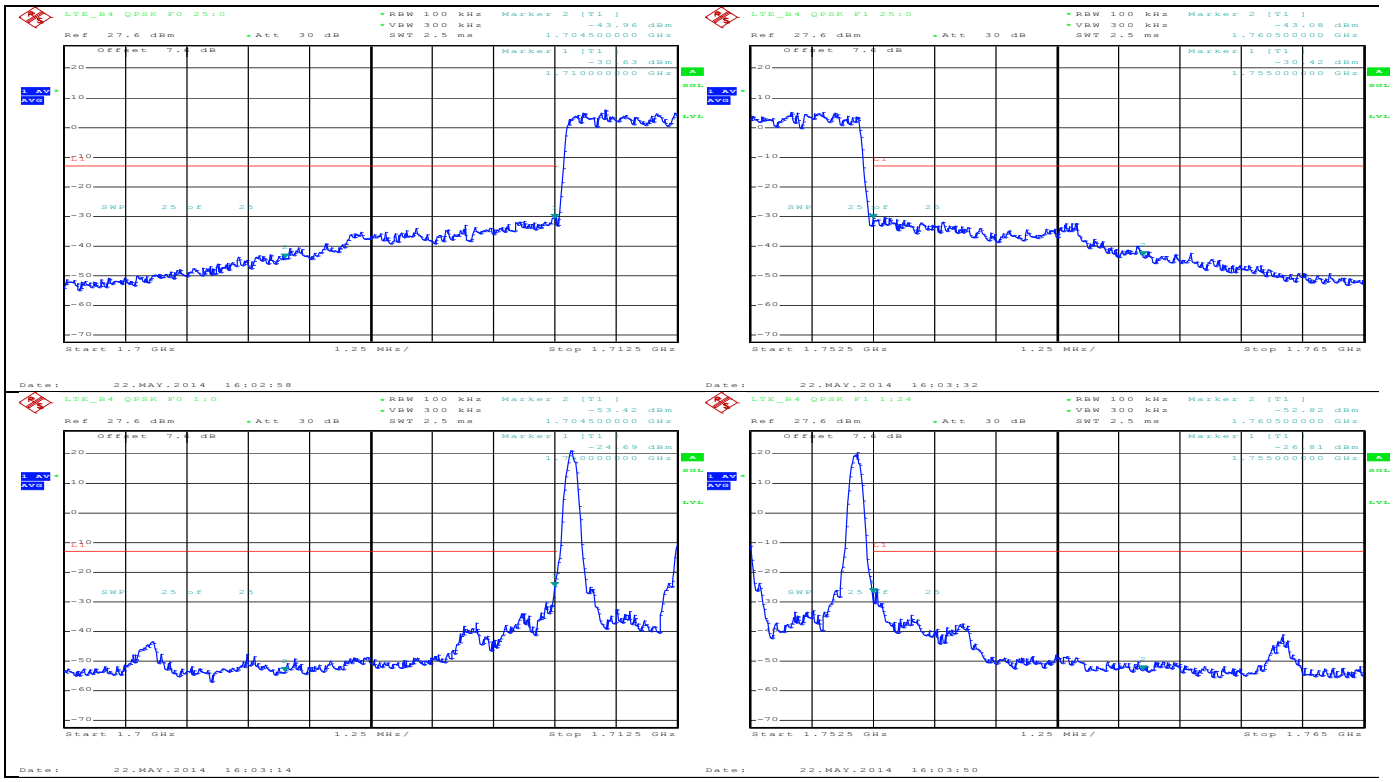
9.2.1.2 LTE; Band4, 3 MHz BW, QPSK

Below 1710 MHz	Above 1755 MHz



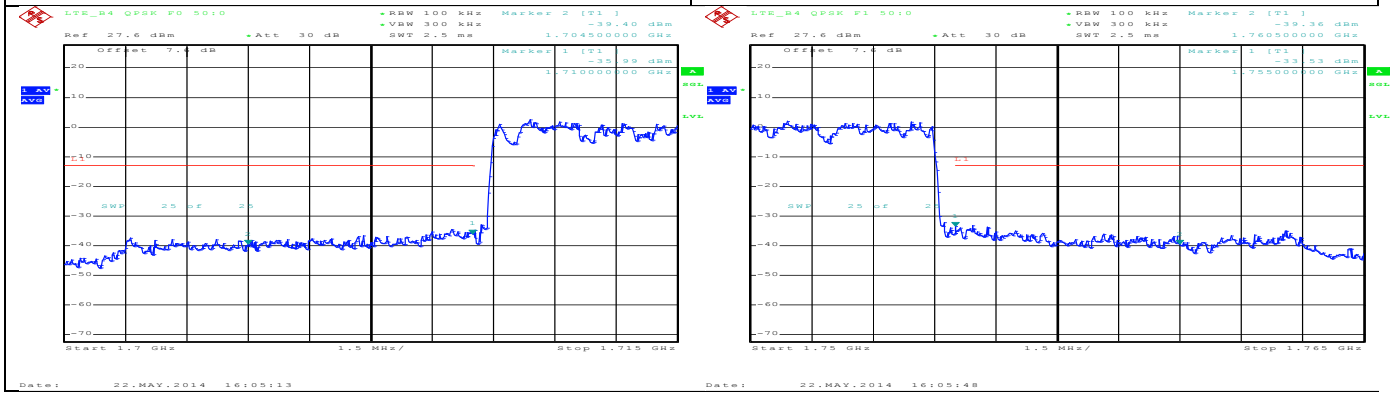
9.2.1.3 LTE; Band4, 5 MHz BW, QPSK

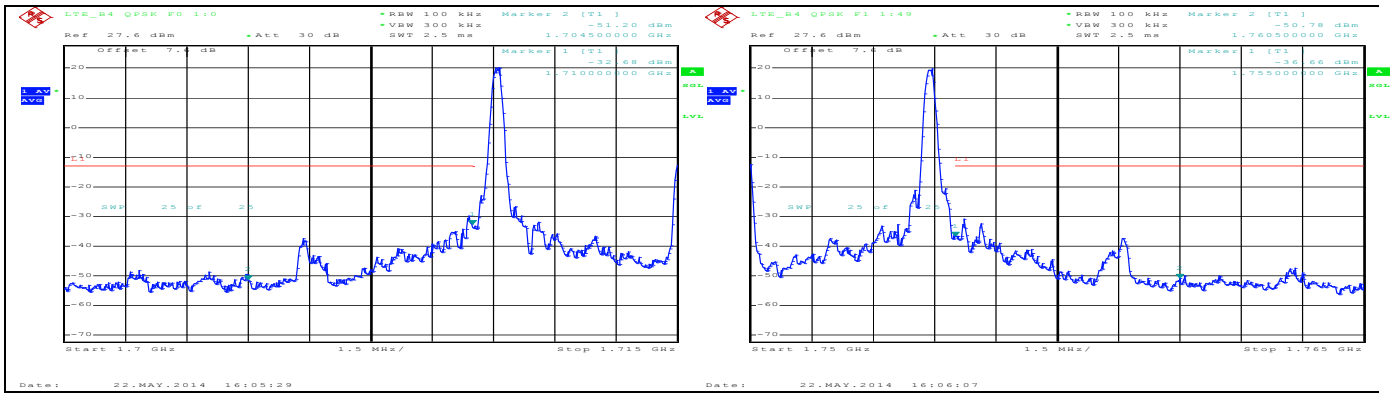
Below 1710 MHz	Above 1755 MHz



9.2.1.4 LTE; Band4, 10 MHz BW, QPSK

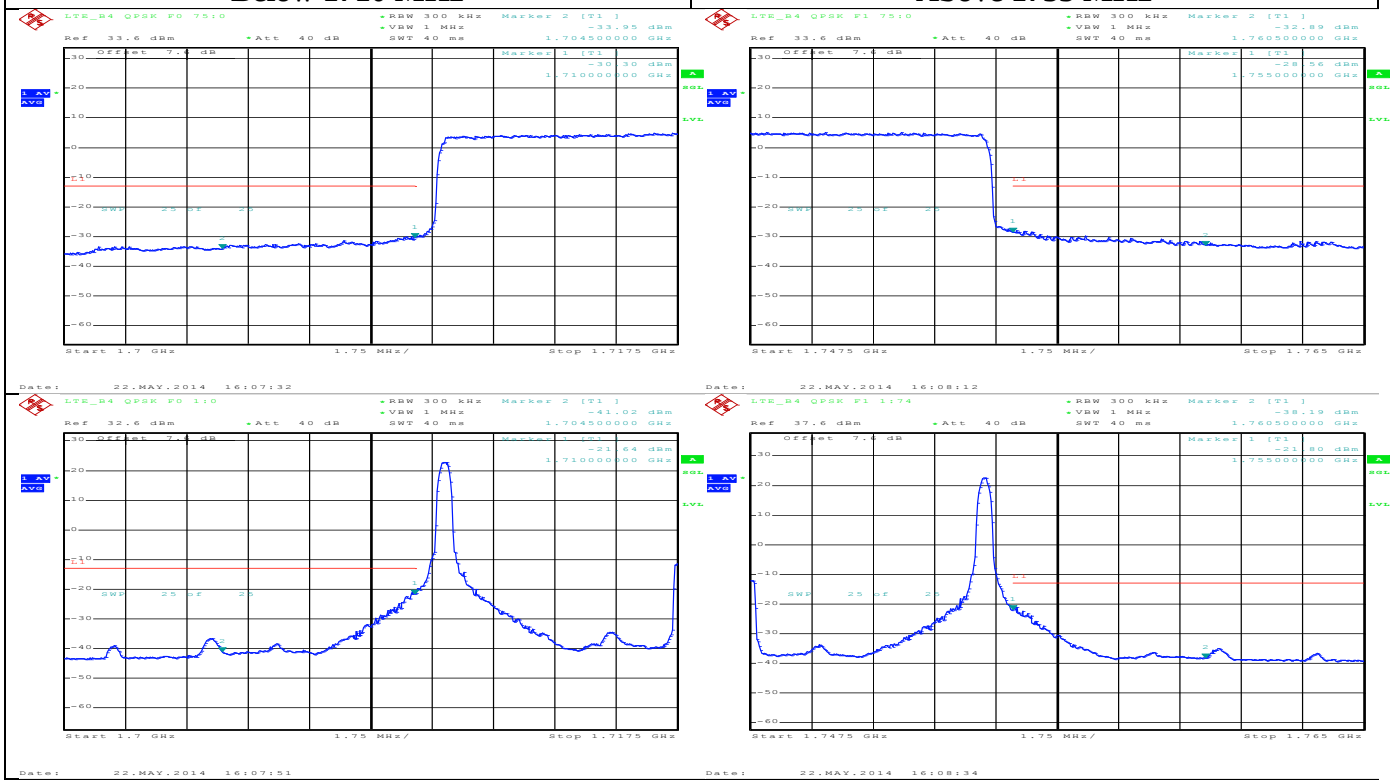
Below 1710 MHz	Above 1755 MHz





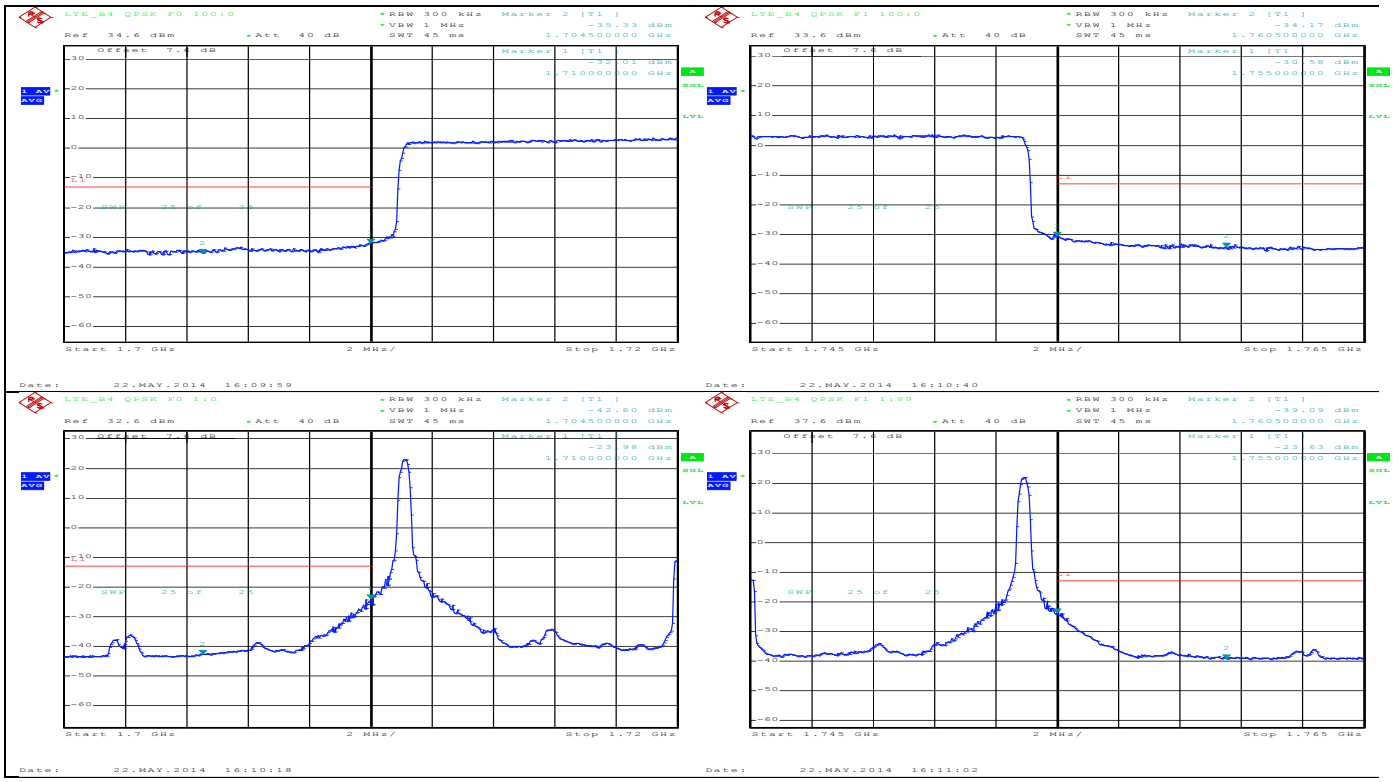
9.2.1.5 LTE; Band4, 15 MHz BW, QPSK

Below 1710 MHz	Above 1755 MHz



9.2.1.6 LTE; Band4, 20 MHz BW, QPSK

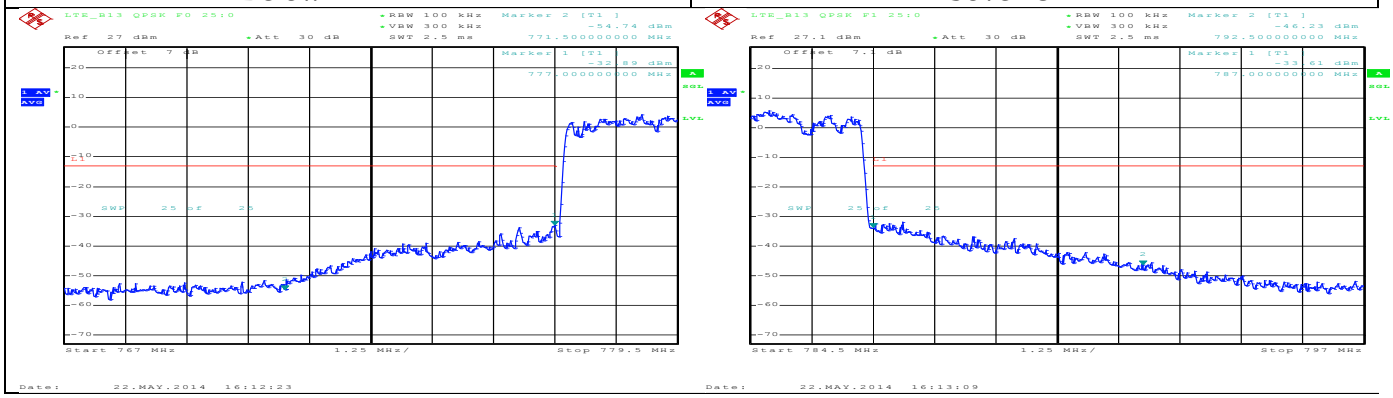
Below 1710 MHz	Above 1755 MHz

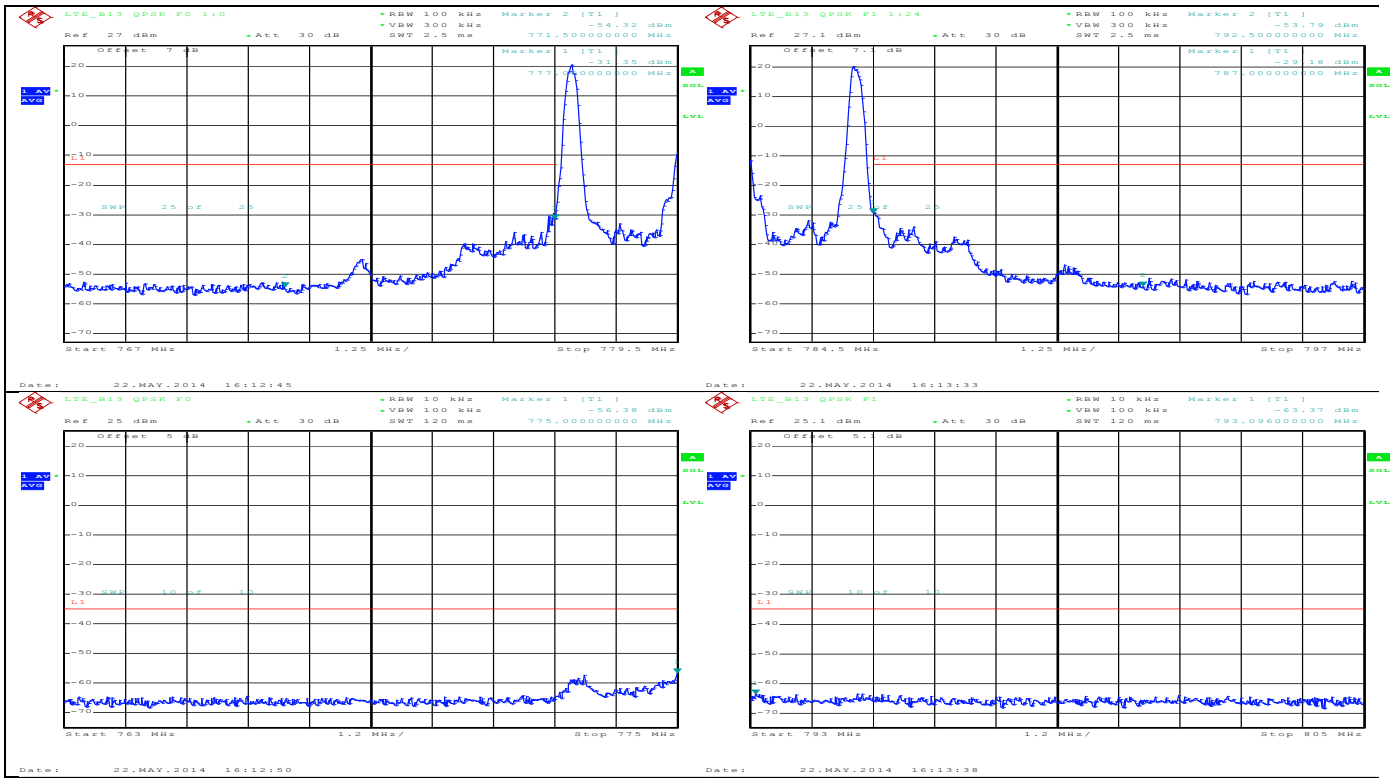


LTE B13

9.2.1.7 LTE; Band13, 5 MHz BW, QPSK

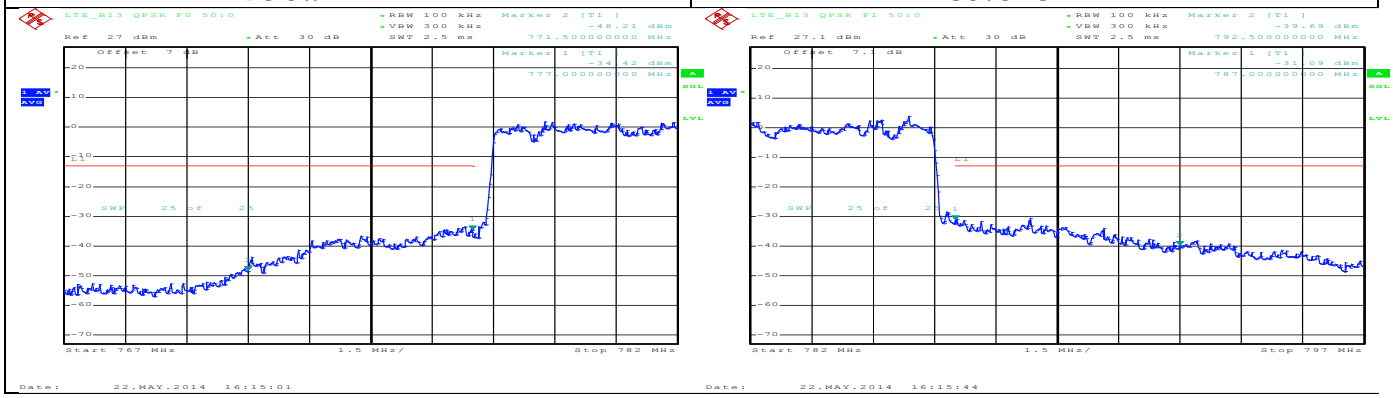
Below 777 MHz	Above 787 MHz

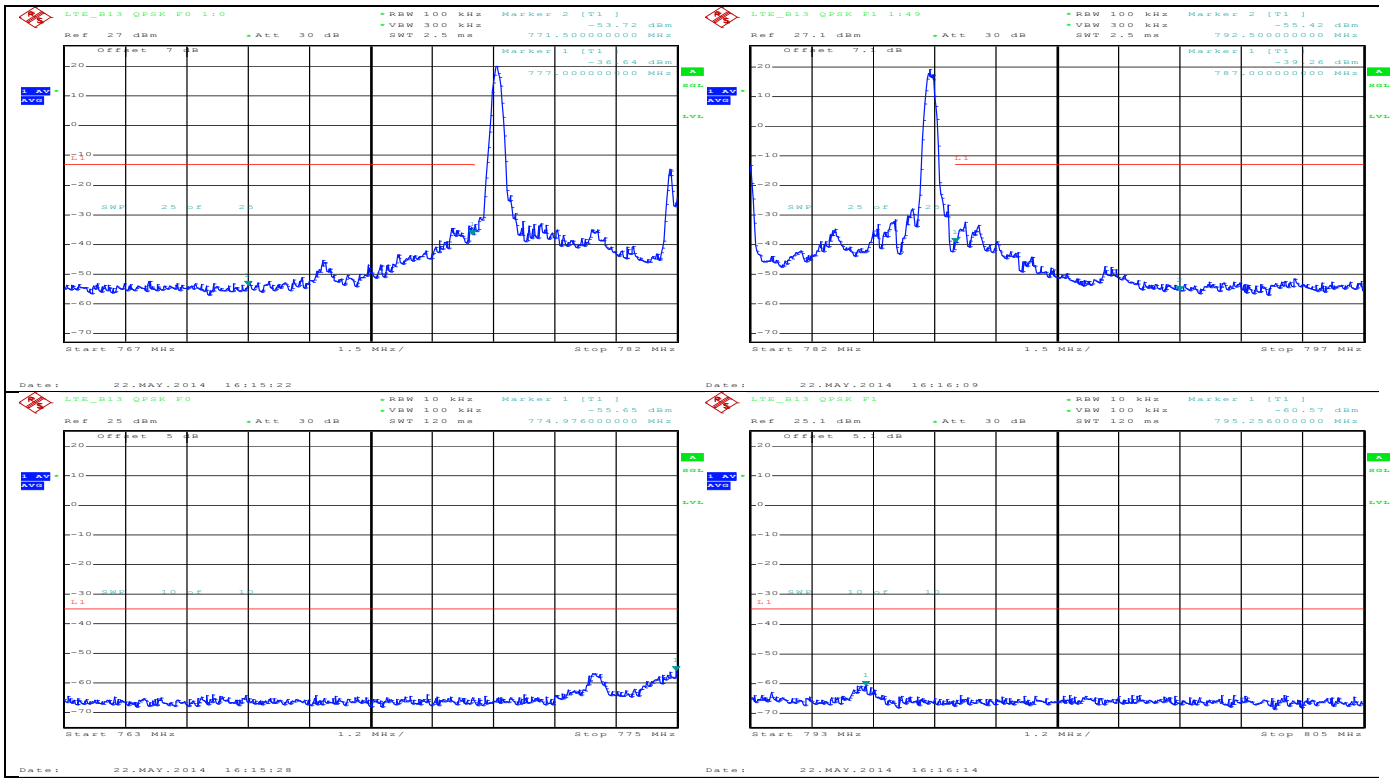




9.2.1.8 LTE; Band13, 10 MHz BW, QPSK

Below 777 MHz	Above 787 MHz

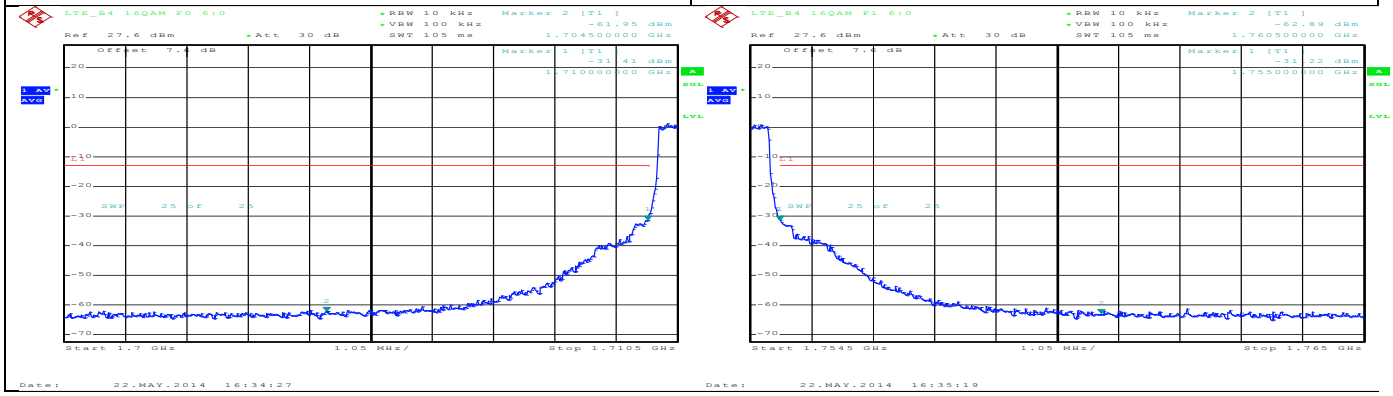


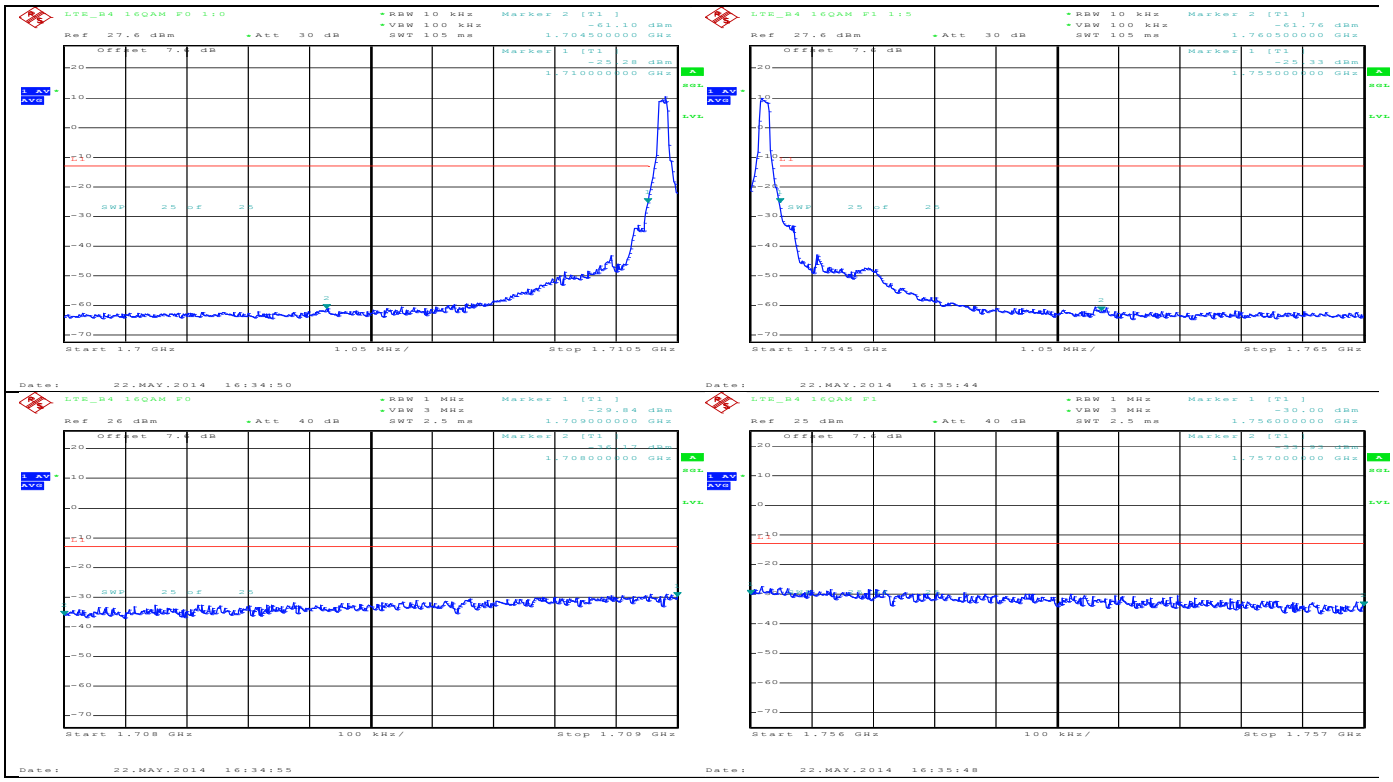


LTE B4

9.2.1.9 LTE; Band4, 1.4 MHz BW, 16-QAM

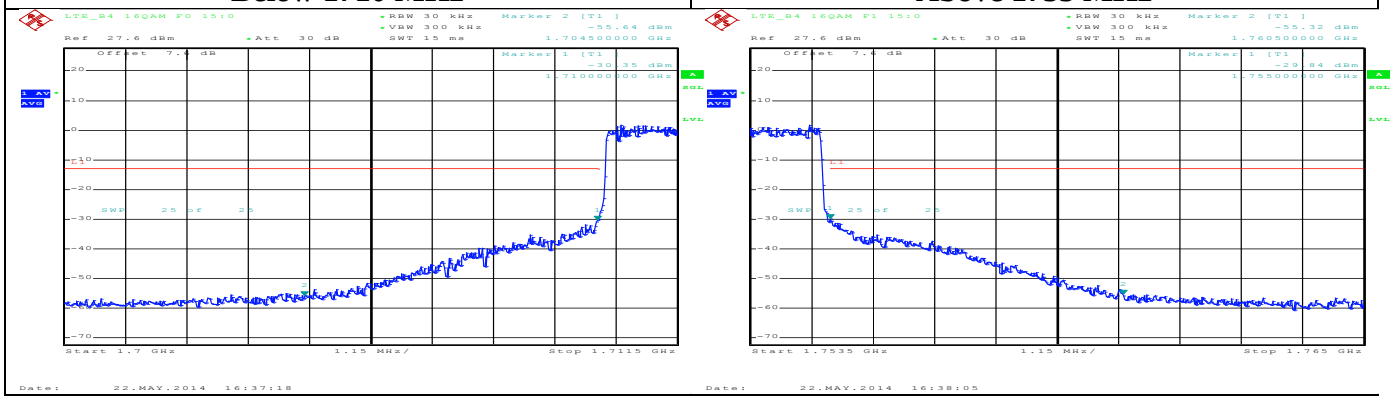
Below 1710 MHz	Above 1755 MHz

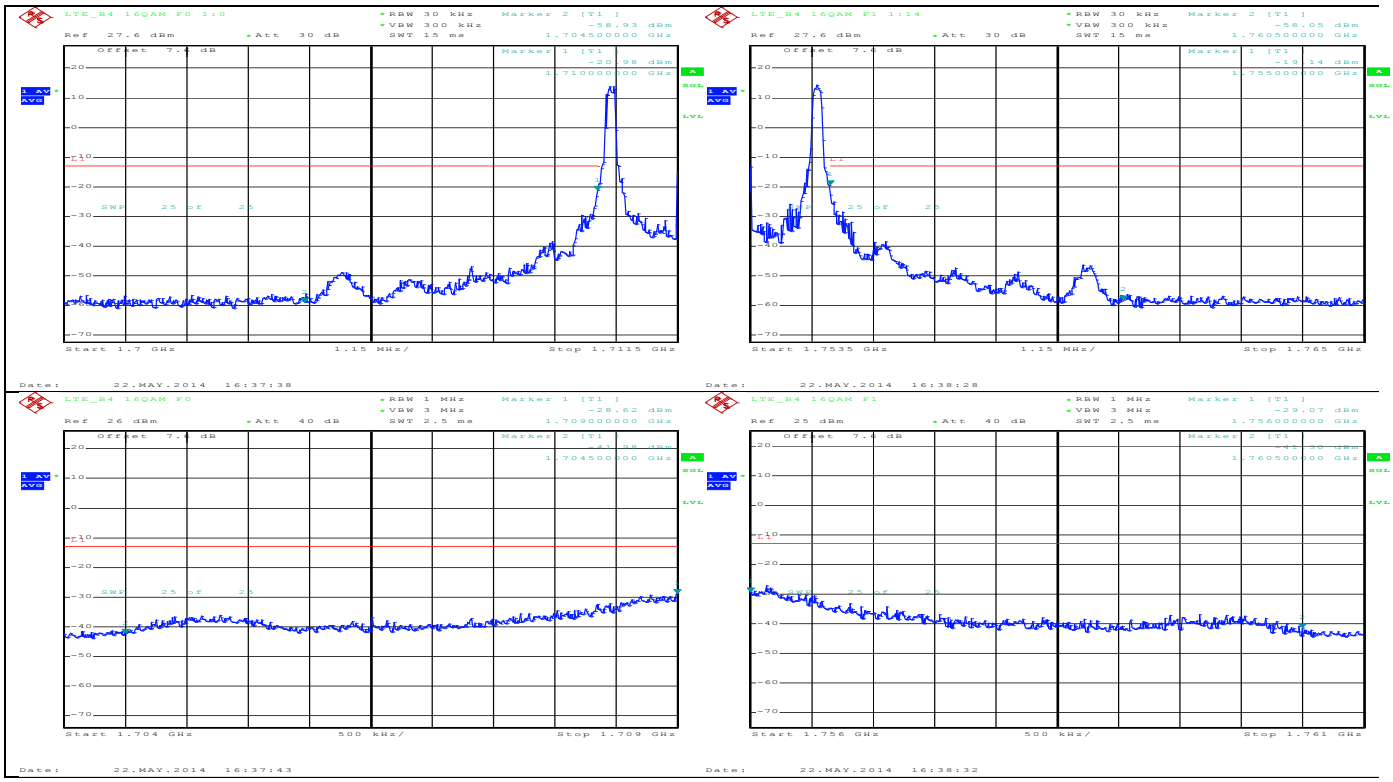




9.2.1.10 LTE; Band4, 3 MHz BW, 16-QAM

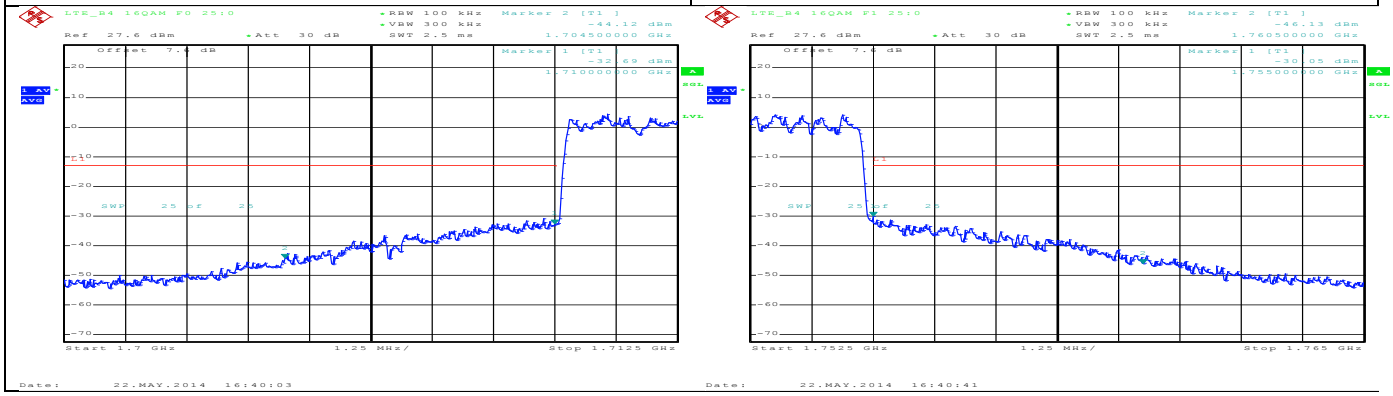
Below 1710 MHz	Above 1755 MHz

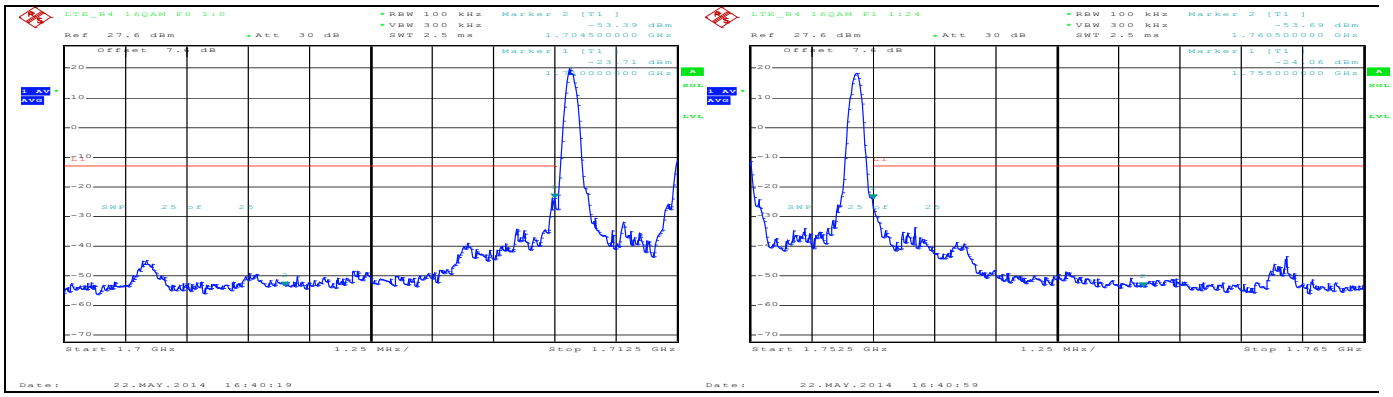




9.2.1.11 LTE; Band4, 5 MHz BW, 16-QAM

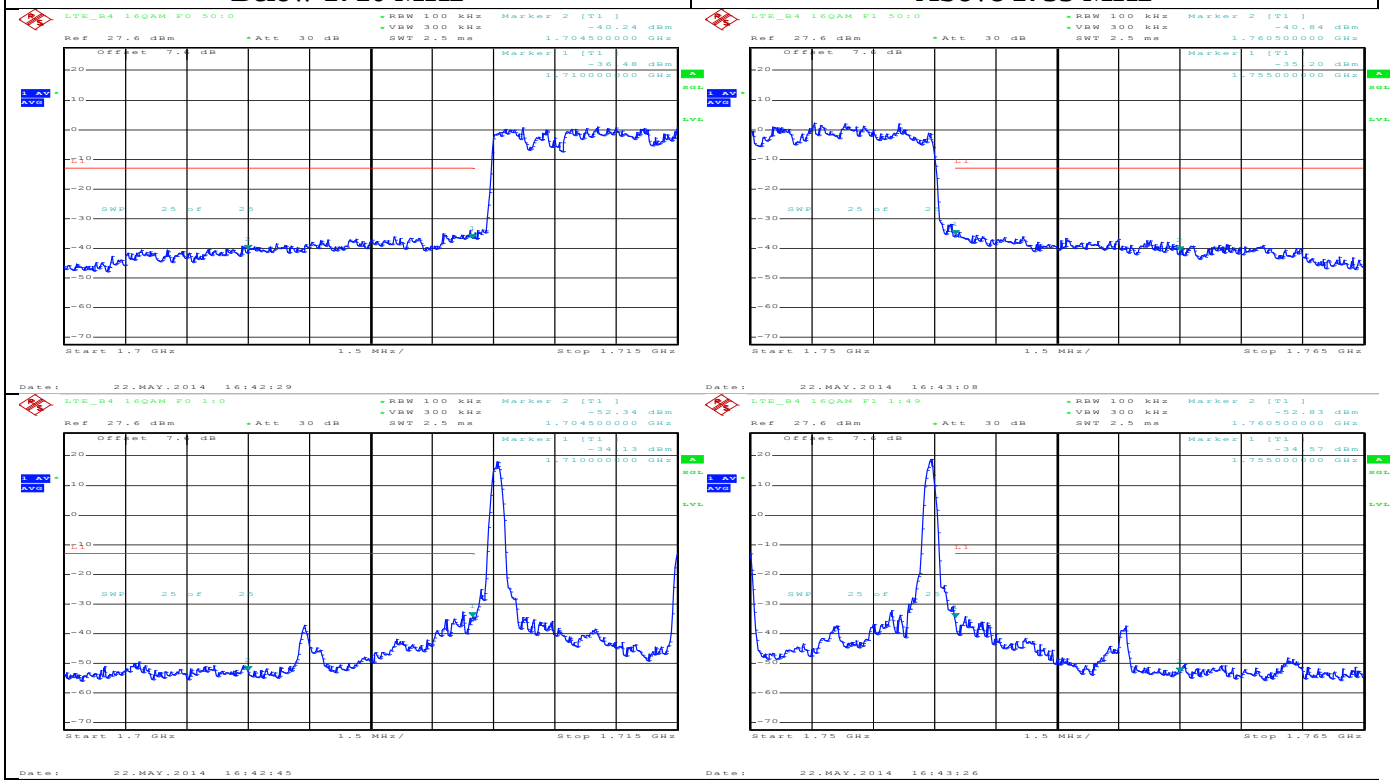
Below 1710 MHz	Above 1755 MHz





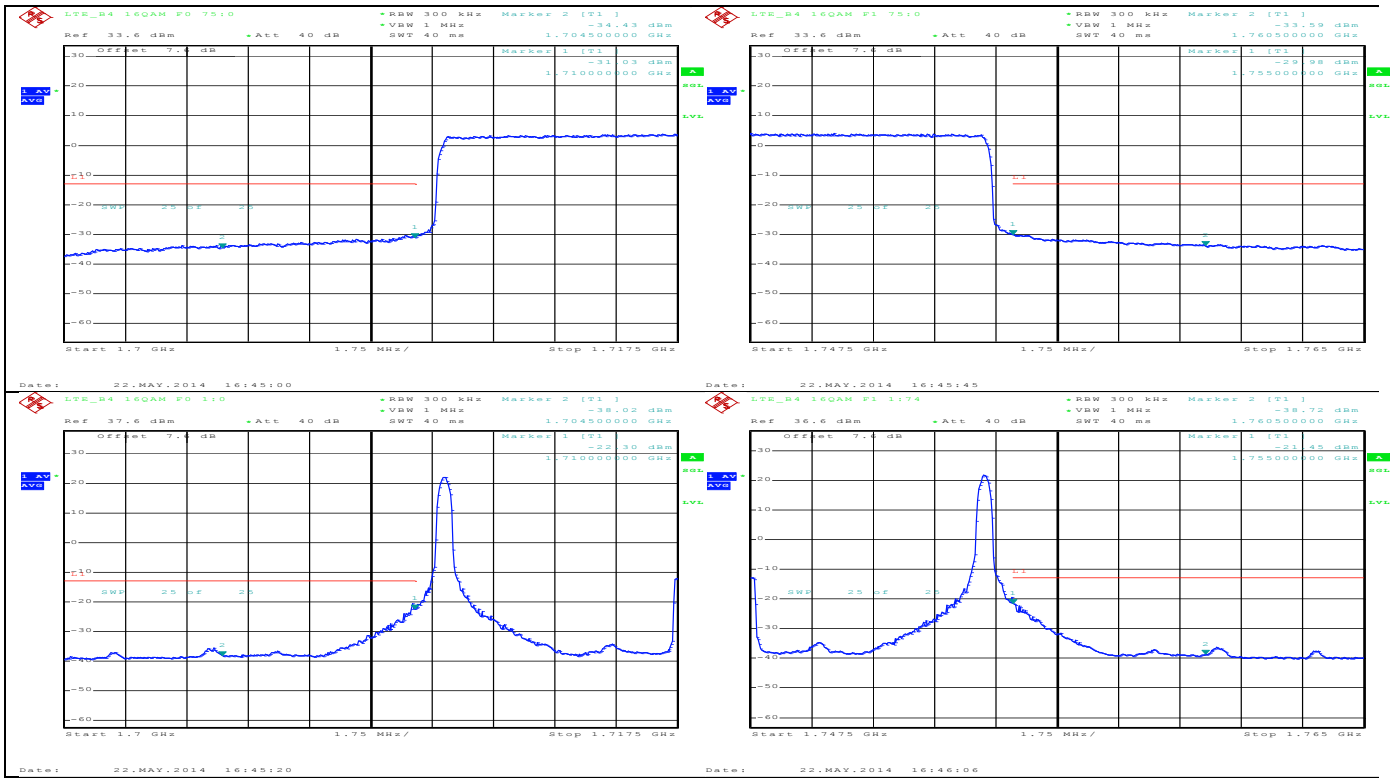
9.2.1.12 LTE; Band4, 10 MHz BW, 16-QAM

Below 1710 MHz	Above 1755 MHz



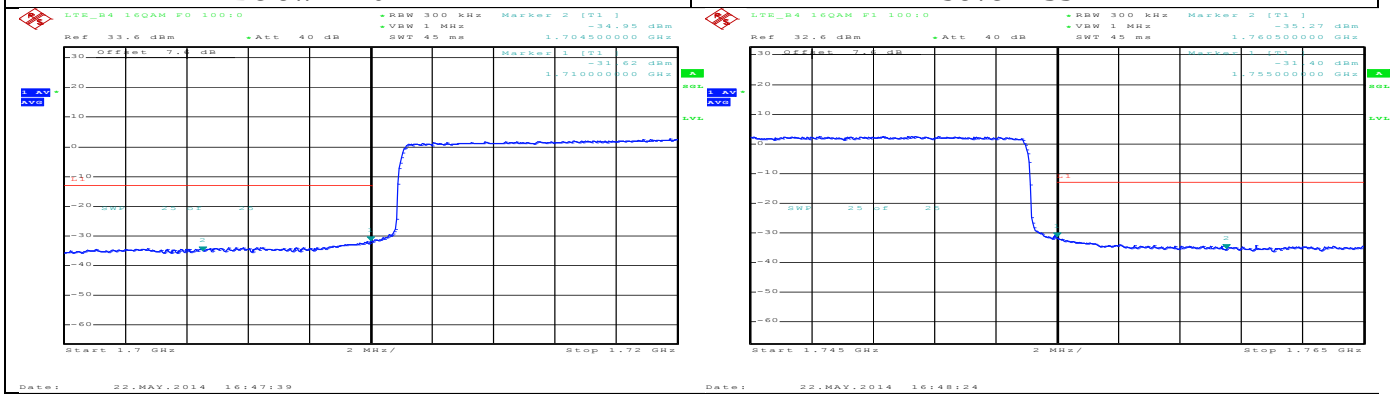
9.2.1.13 LTE; Band4, 15 MHz BW, 16-QAM

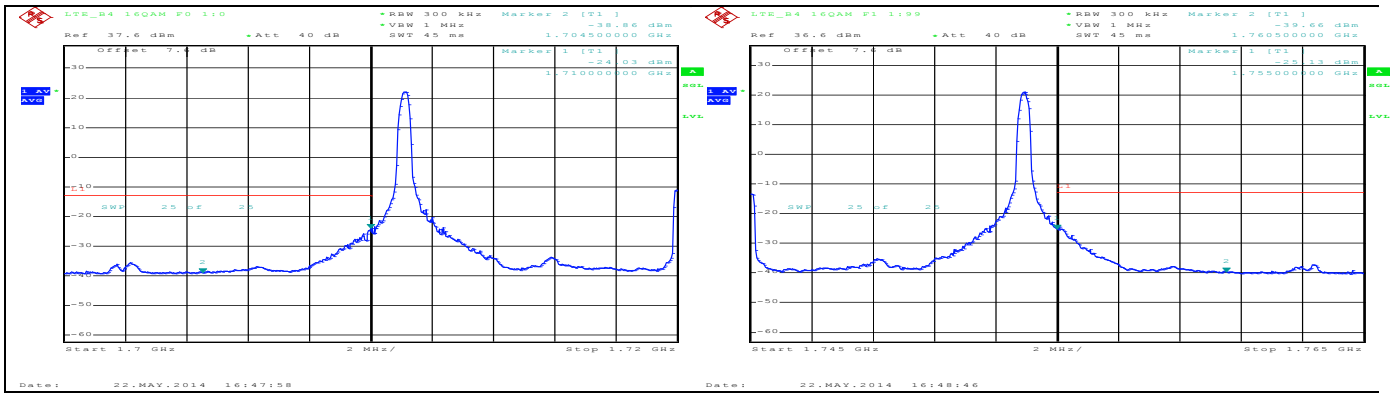
Below 1710 MHz	Above 1755 MHz



9.2.1.14 LTE; Band4, 20 MHz BW, 16-QAM

Below 1710 MHz	Above 1755 MHz

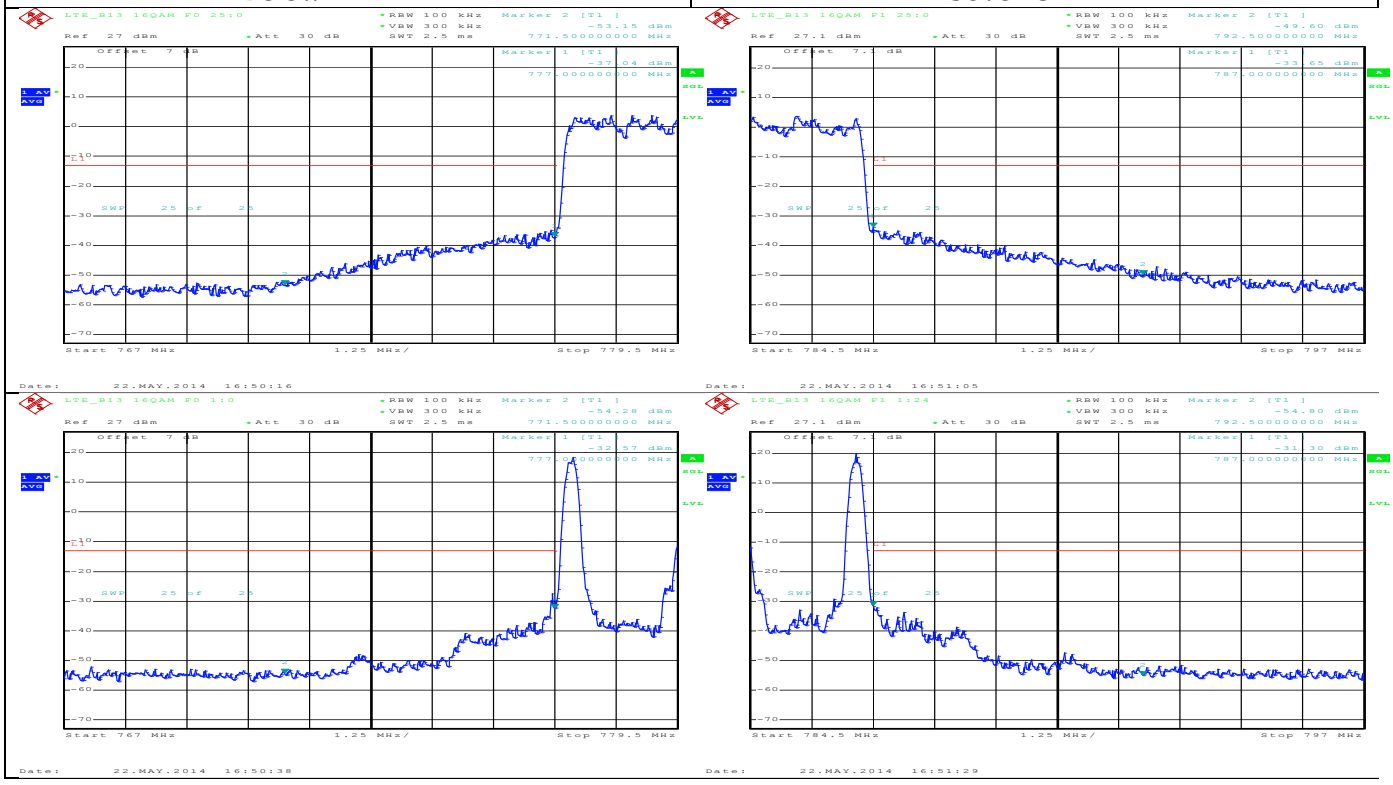


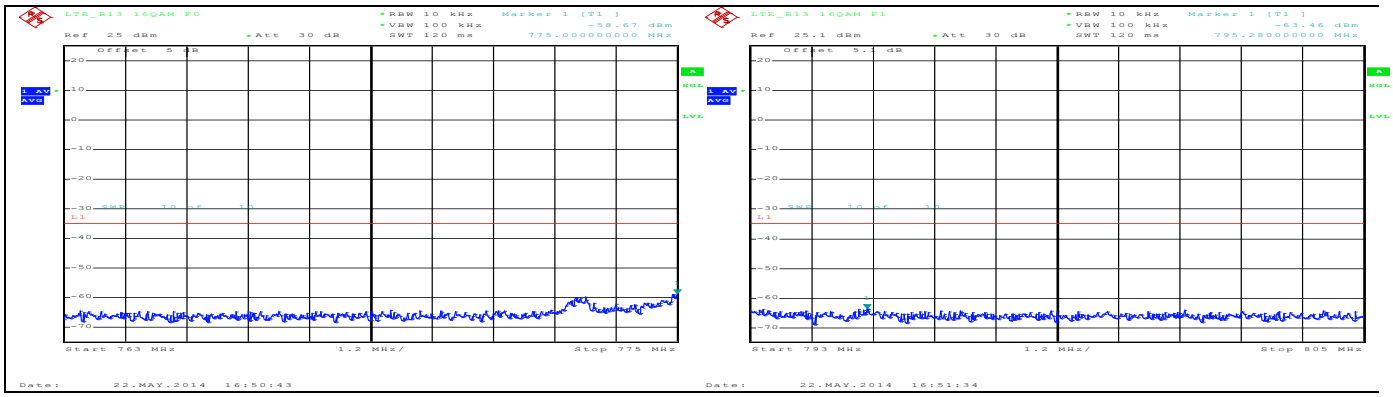


LTE B13

9.2.1.15 LTE; Band13, 5 MHz BW, 16-QAM

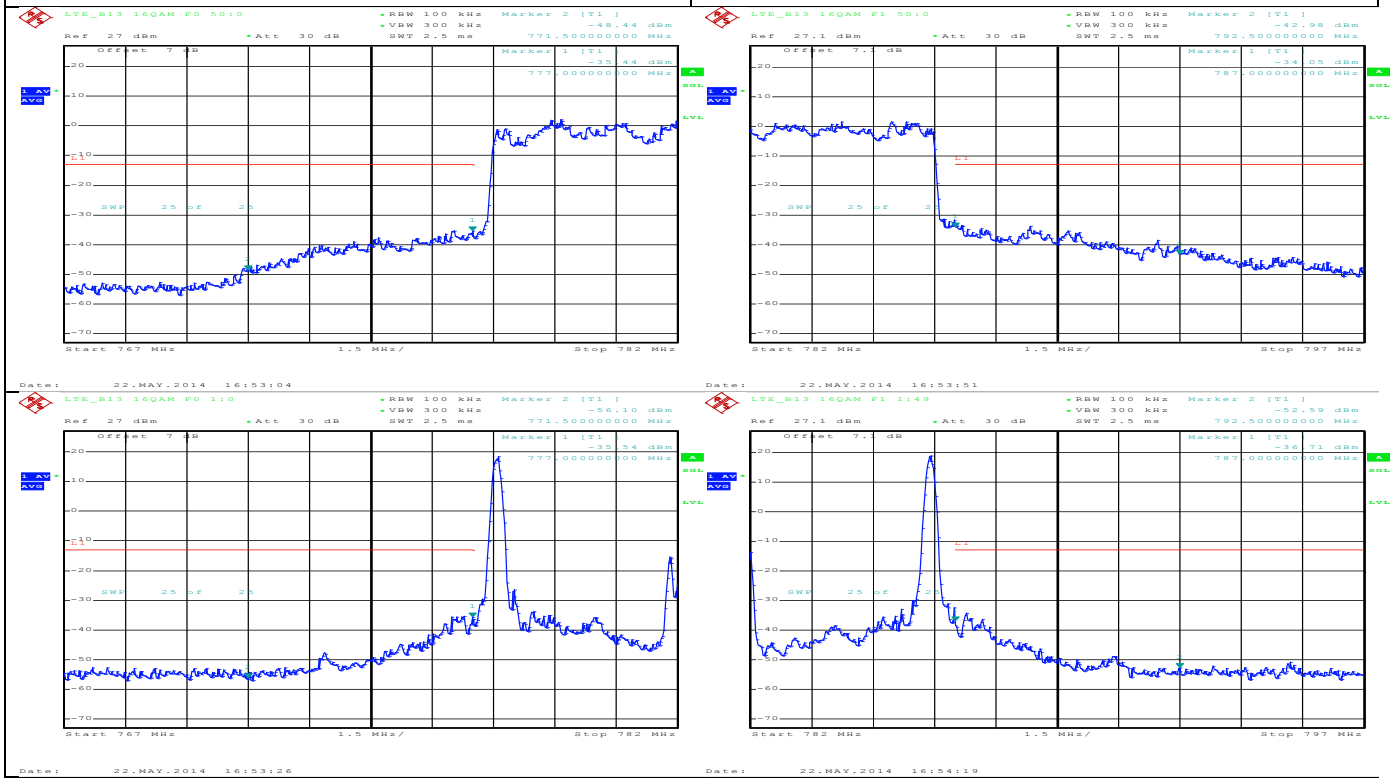
Below 777 MHz	Above 787 MHz

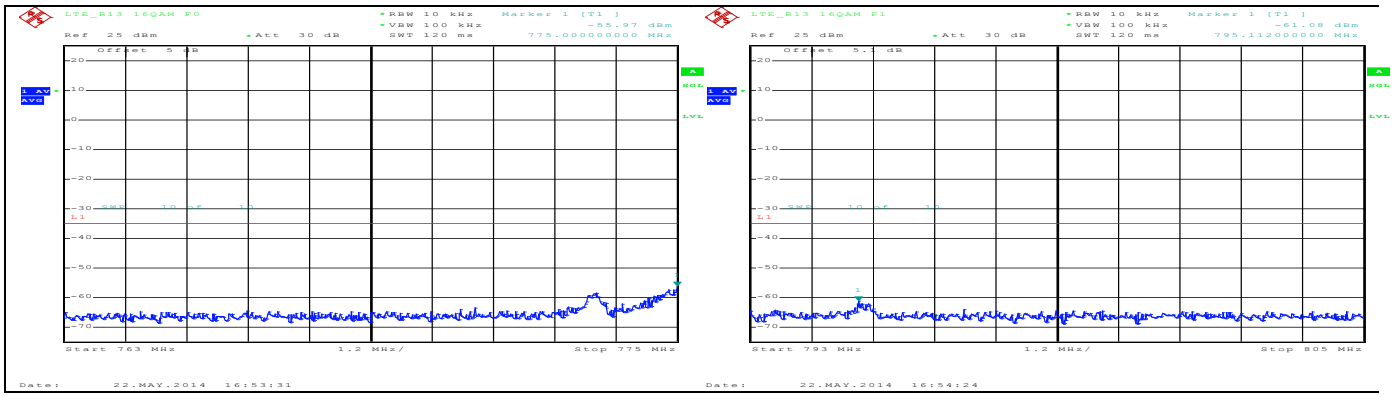




9.2.1.16 LTE; Band13, 10 MHz BW, 16-QAM

Below 777 MHz	Above 787 MHz





10 Frequency Stability versus Temperature

FCC 2.1055, FCC 22.355, FCC 24.235, FCC 27.54

10.1 Summary of Results

The EUT's Frequency Stability versus temperature meets the requirements of less than 2.5ppm when temperature varies from -30°C to +50°C.

10.2 Test Procedure

The EUT was placed inside a temperature chamber. The temperature was set to -30°C and maintained to stabilize. After sufficient soak time, the transmitting frequency error was measured. The temperature was then increased by 10 degrees, maintained to stabilize, and the measurement was repeated. This procedure was repeated until +50°C is reached. Frequency metering included internal averaging of the CMW500 to stabilize the reading. Reference power supply voltage for these tests is 3.8 volts. Refer to Test Setup 2.

10.3 Test Results

Frequency stability is not affected by transmission bandwidth or modulation mode (QPSK, 16-QAM). The measurements below were performed with a 10 MHz transmission bandwidth and QPSK modulation.

10.3.1 LTE Frequency Error over Temperature

		Temperature (°C)									
Band	Offset	-30	-20	-10	0	10	20	30	40	50	60
B4	Hz	0.27	-0.53	0.37	0.13	1.83	2.63	0.7	2.06	2.46	1.07
	ppm	0.0002	-0.0003	0.0002	0.0001	0.0011	0.0015	0.0004	0.0012	0.0014	0.0006
B13	Hz	-1.1	-3.39	-1.69	-0.99	-0.79	-0.53	-0.21	-1.5	-1.46	-0.86
	ppm	-0.0014	-0.0043	-0.0022	-0.0013	-0.0010	-0.0007	-0.0003	-0.0019	-0.0019	-0.0011

11 Frequency Stability versus Voltage

FCC 2.1055, FCC 22.355, FCC 24.235, FCC 27.54

11.1 Summary of Results

The EUT is specified to operate with a supply voltage varying between 3.2 VDC and 4.4 VDC, having a nominal voltage of 3.7 VDC. It meets the frequency stability limit of less than 2.5ppm when supply voltage varies within the specified limits. Operation above or below these voltage limits is prohibited by firmware in order to prevent improper operation.

11.2 Test Procedure

The EUT was connected to a DC Power Supply and a LTE test set (CMW500) with frequency error measurement capability. The power supply output was adjusted to the test voltage as measured at the input terminals to the device while transmitting. A voltmeter was used to confirm the terminal voltage. The peak frequency error is recorded (worst case). The test voltages are 3.2 volts to 4.4 volts. Refer to Test Setup 2.

11.3 Test Results

11.3.1 LTE Frequency Error over Voltage

		Voltage (V)		
Band	Offset	3.2	3.7	4.4
B4	Hz	-5.71	-3.83	-2.16
	ppm	-0.0033	-0.0022	-0.0012
B13	Hz	-0.84	-0.92	-0.84
	ppm	-0.0011	-0.0012	-0.0011

12 Peak to Average Ratio

FCC 24.232, 27.50(d)

12.1 Summary of Results

The EUT meets the requirement of having a peak to average ratio of less than 13dB.

12.2 Test Procedure

The transmitter output was connected to a Rohde & Schwarz CMW500 through a coaxial RF cable and directional coupler, and configured to operate at maximum power. The peak to average ratio was measured at the required operating frequencies in each band on the Spectrum Analyzer. Refer to Test Setup 1.

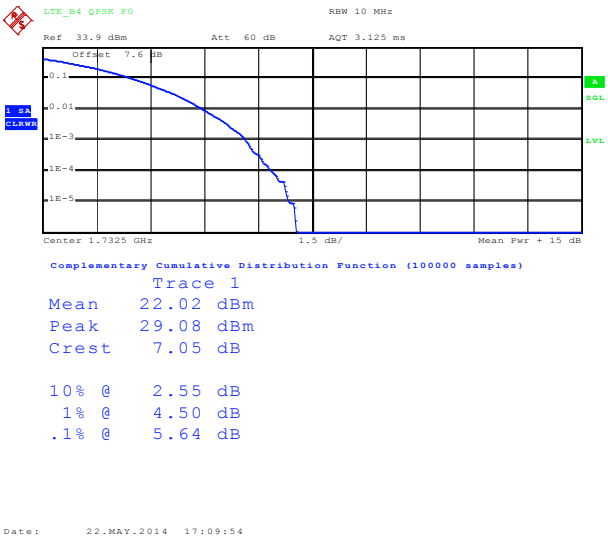
12.3 Test Results

The Peak to Average ration is not bandwidth dependent. The results below were measured with a 10 MHz transmission bandwidth (50 RB).

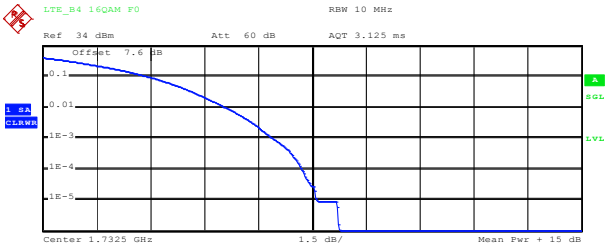
Band	Channel	Frequency (MHz)	Modulation	Plot No.	Peak to Average Ratio
B4	20175	1732.5	QPSK	12.3.1.1	5.64
			16-QAM	12.3.1.2	6.45
B13	23230	782	QPSK	12.3.1.3	5.07
			16-QAM	12.3.1.4	5.94

12.3.1 Test Plots

12.3.1.1 LTE peak to average ratio, QPSK Band4, Mid channel, 1732.5 MHz



12.3.1.2 LTE peak to average ratio, 16-QAM Band4, Mid channel, 1732.5 MHz

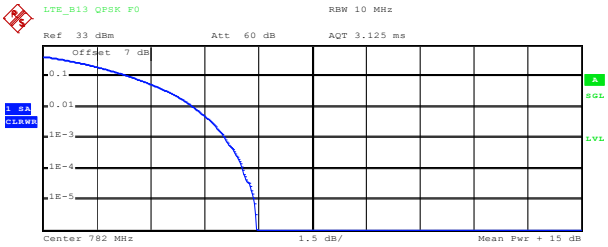


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	21.11 dBm
Peak	29.36 dBm
Crest	8.25 dB
10% @	3.03 dB
1% @	5.13 dB
.1% @	6.45 dB

Date: 22.MAY.2014 17:11:45

12.3.1.3 LTE peak to average ratio, QPSK Band13, Mid channel, 782.0 MHz

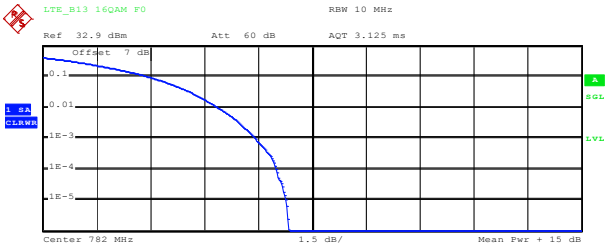


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	21.96 dBm
Peak	27.91 dBm
Crest	5.95 dB
10% @	2.49 dB
1% @	4.23 dB
.1% @	5.07 dB

Date: 22.MAY.2014 17:13:19

12.3.1.4 LTE peak to average ratio, 16-QAM Band13, Mid channel, 782.0 MHz



Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	21.00 dBm
Peak	27.84 dBm
Crest	6.84 dB
10% @	3.03 dB
1% @	4.92 dB
.1% @	5.94 dB

Date: 22.MAY.2014 17:15:09