LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 4-25a: Occupied Bandwidth, Band 5 Low Channel, 1.4MHz BW, RB=6

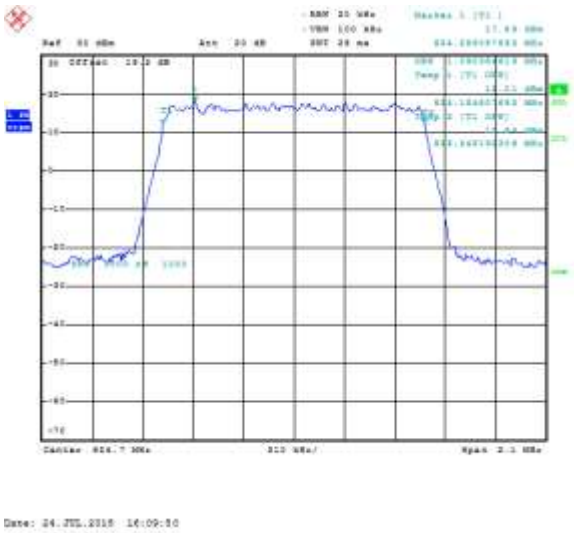


Figure 4-26a: Occupied Bandwidth, Band 5 Middle Channel, 1.4MHz BW, RB=6

Figure 4-27a: Occupied Bandwidth, Band 5 High Channel, 1.4MHz BW, RB=6

LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 4-28a: -26 dBc Bandwidth, Band 5 Low Channel, 10MHz BW, RB=50

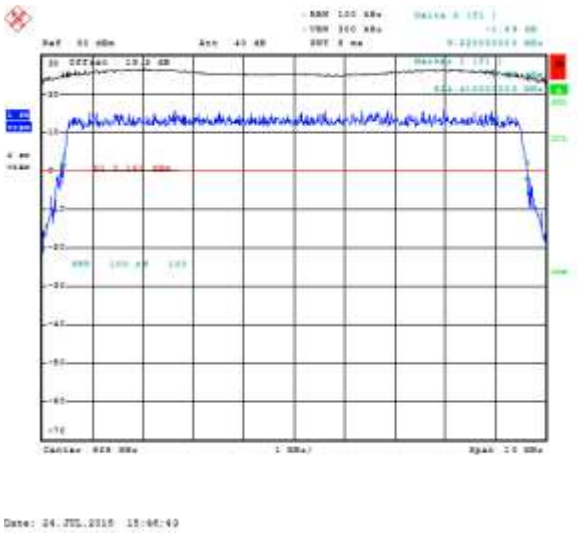


Figure 4-29a: -26 dBc Bandwidth, Band 5 Middle Channel, 10MHz BW, RB=50

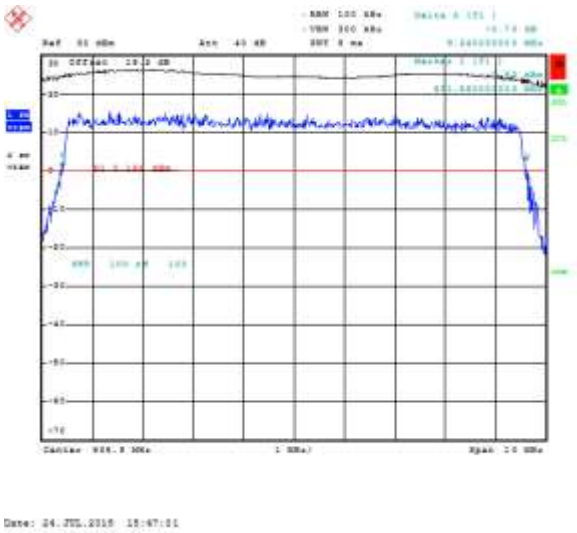


Figure 4-30a: -26 dBc Bandwidth, Band 5 High Channel, 10MHz BW, RB=50

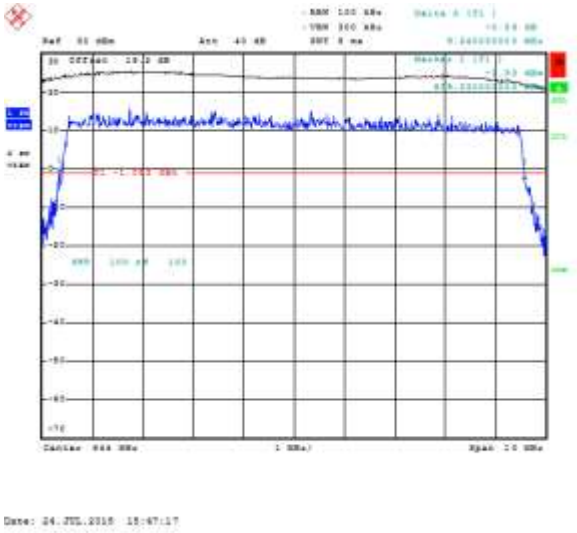
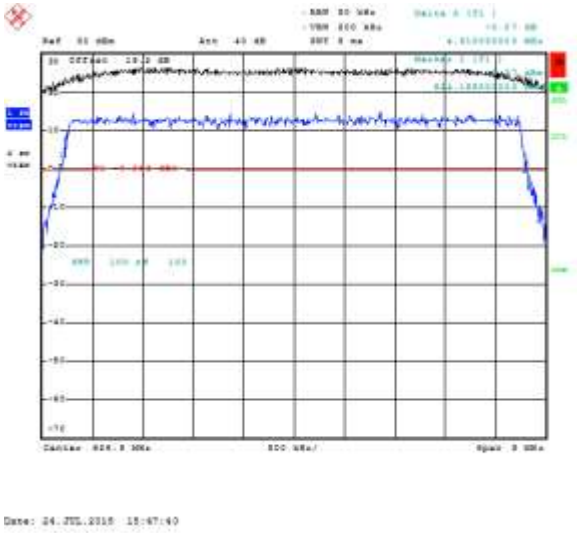


Figure 4-31a: -26 dBc Bandwidth, Band 5 Low Channel, 5MHz BW, RB=25



LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 4-32a: -26 dBc Bandwidth, Band 5 Middle Channel, 5MHz BW, RB=25

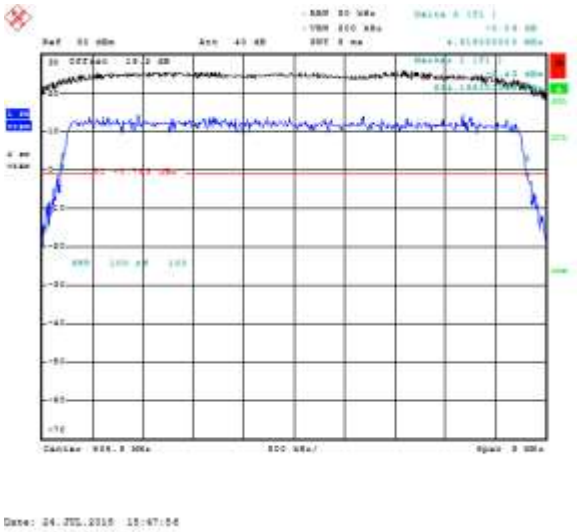


Figure 4-33a: -26 dBc Bandwidth, Band 5 High Channel, 5MHz BW, RB=25

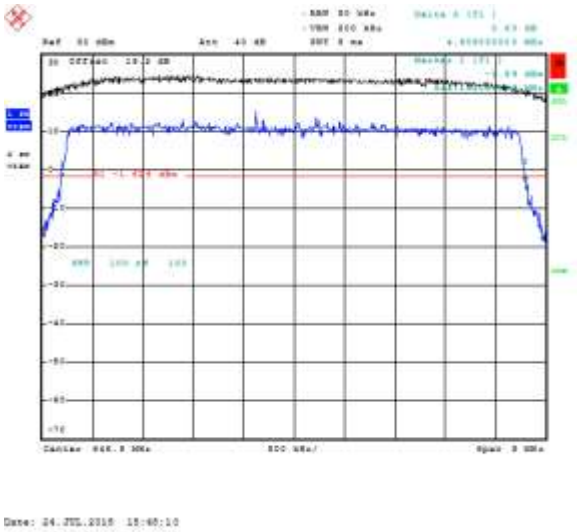


Figure 4-34a: -26 dBc Bandwidth, Band 5 Low Channel, 1.4MHz BW, RB=6

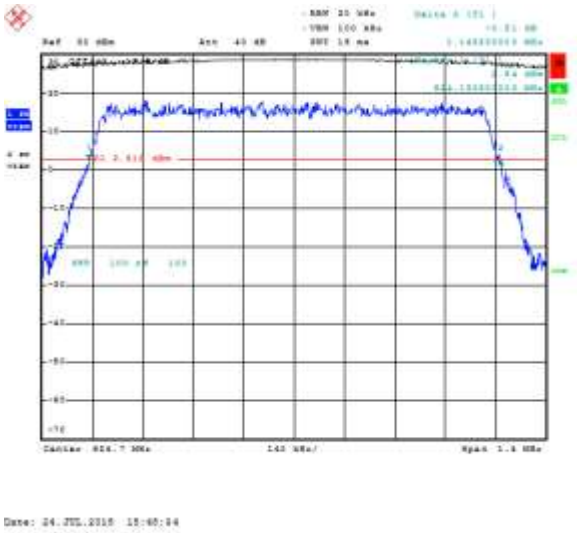
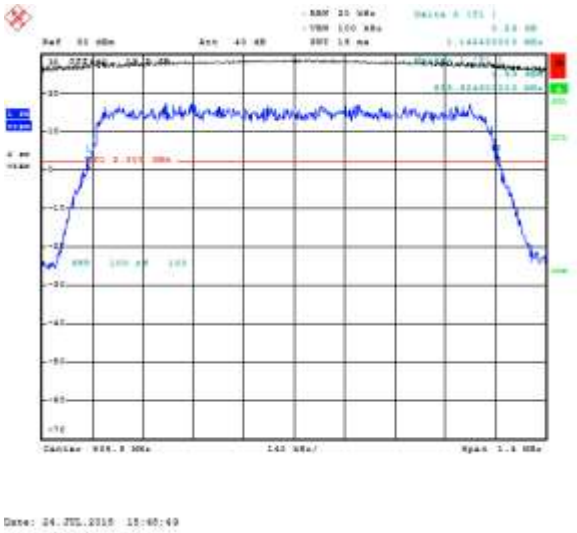


Figure 4-35a: -26 dBc Bandwidth, Band 5 Middle Channel, 1.4MHz BW, RB=6



LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 4-36a: -26 dBc Bandwidth, Band 5 High Channel, 1.4MHz BW, RB=6

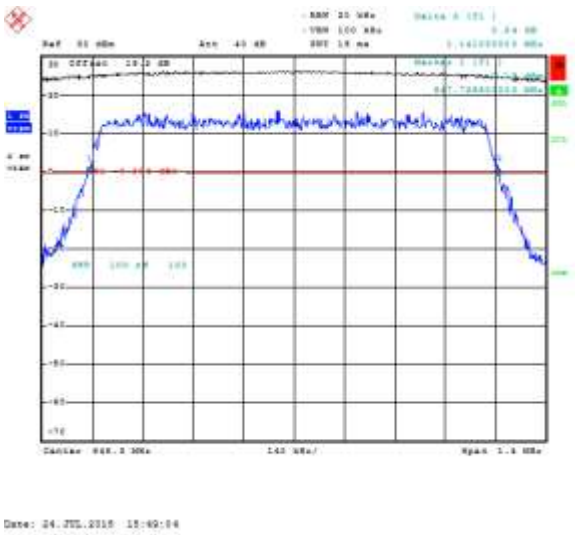


Figure 4-37a: Band 5 Low Channel Mask, 10MHz BW, RB=50

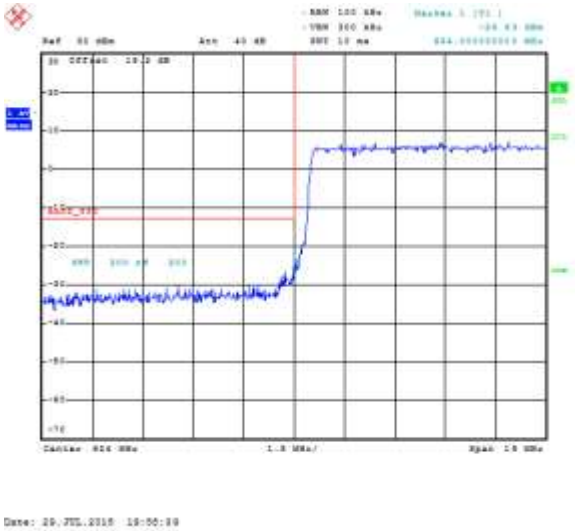
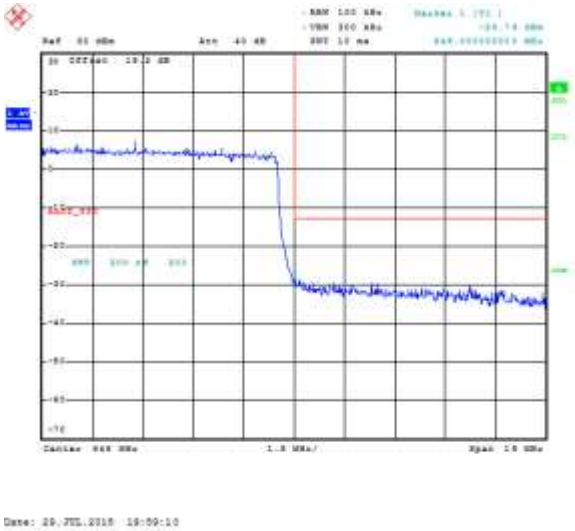


Figure 4-38a: Band 5 High Channel Mask, 10MHz BW, RB=50



LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 4-39a: Band 5 Low Channel Mask, 5MHz BW, RB=25

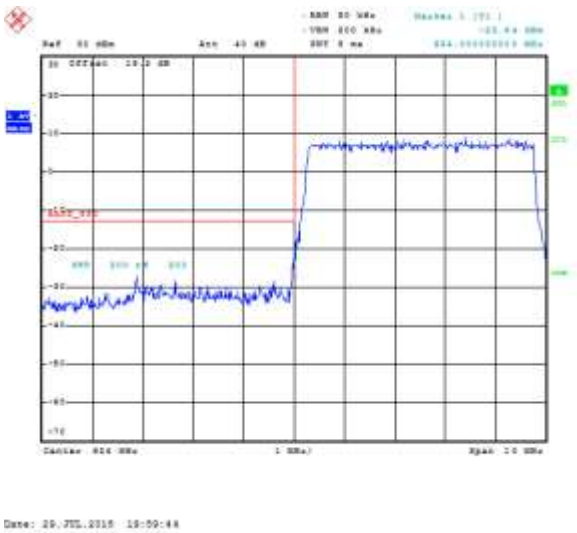


Figure 4-40a: Band 5 High Channel Mask, 5MHz BW, RB=25

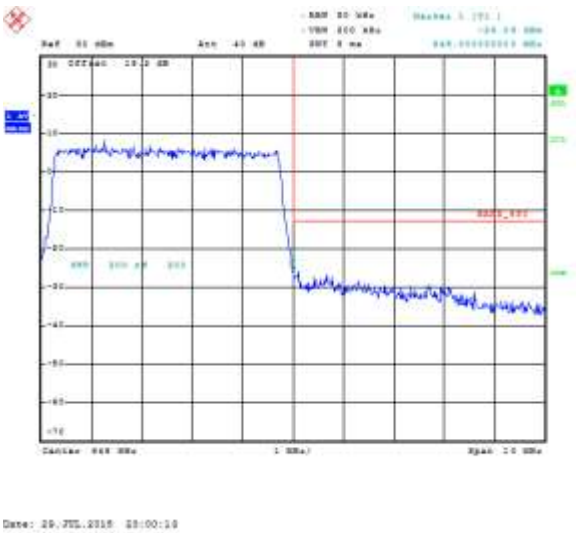


Figure 4-41a: Band 5 Low Channel Mask, 1.4MHz BW, RB=6

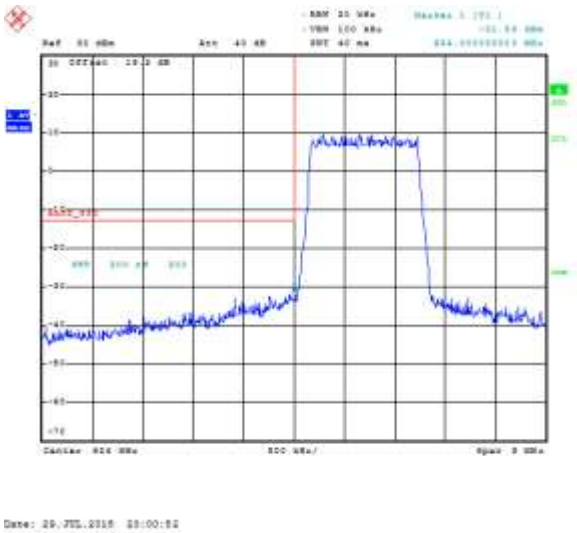
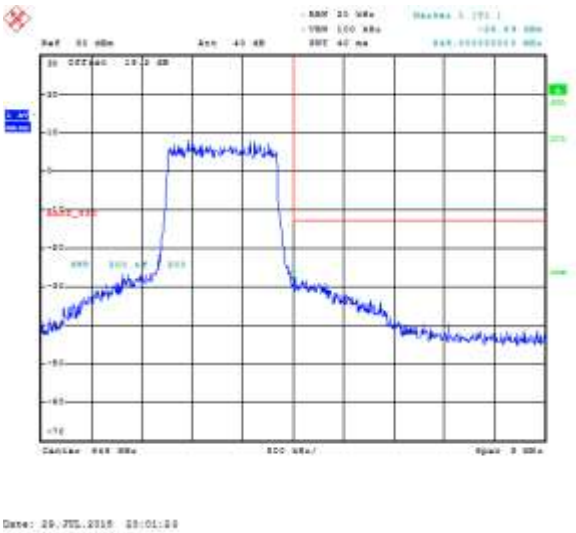


Figure 4-42a: Band 5 High Channel Mask, 1.4MHz BW, RB=6



LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 4-43d: Band 5 Low Channel Mask, 10MHz BW, RB=1

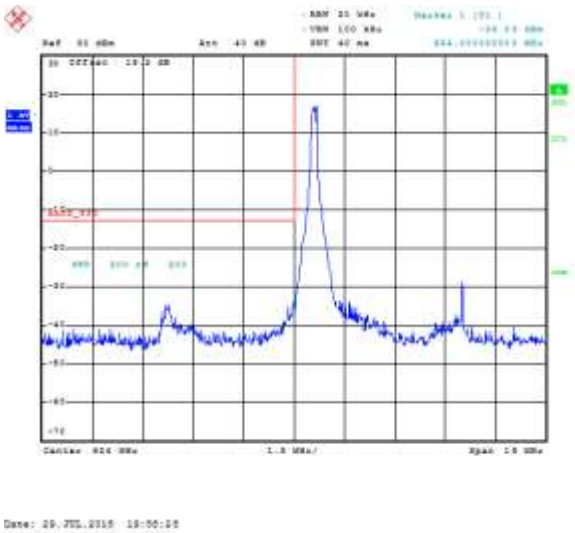
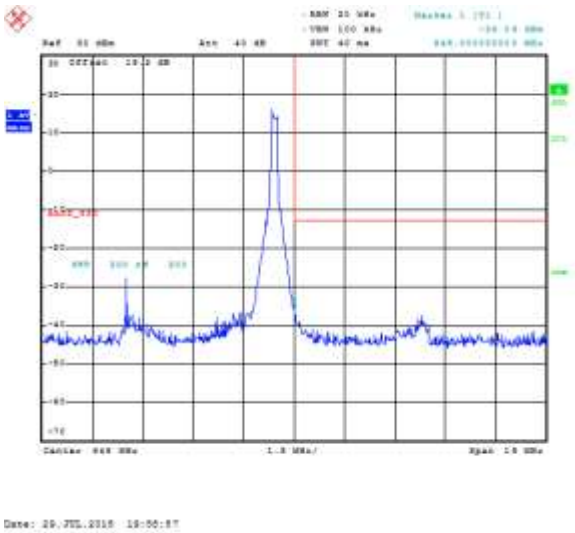


Figure 4-44a: Band 5 High Channel Mask, 10MHz BW, RB=1



LTE Band 5 Conducted RF Emission Test Data cont'd

Figure 3-45a: Occupied Bandwidth, Band 5 Low Channel, 10MHz BW (RB= 50) 16-QAM

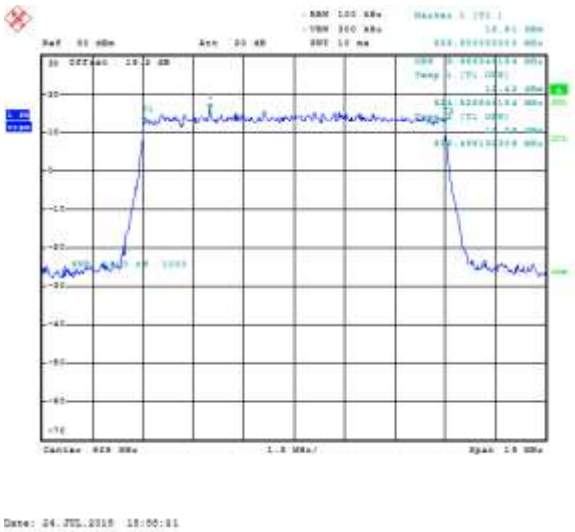


Figure 3-46a: Occupied Bandwidth, Band 5 Mid Channel, 20MHz BW (RB= 50) 16-QAM

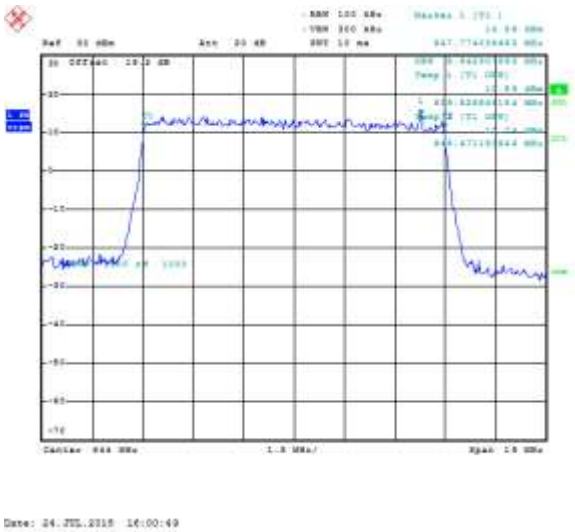
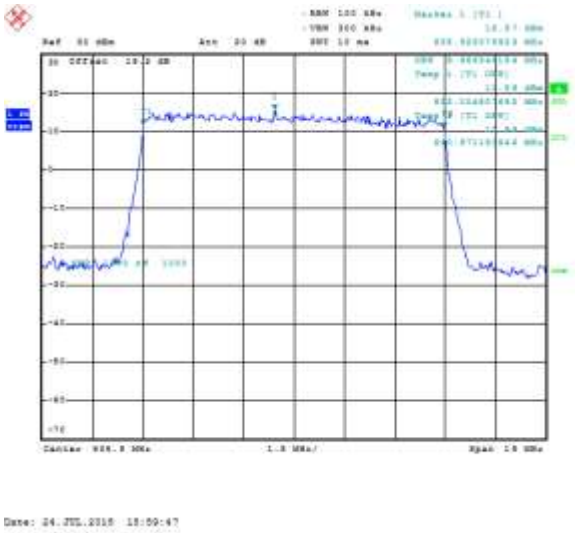
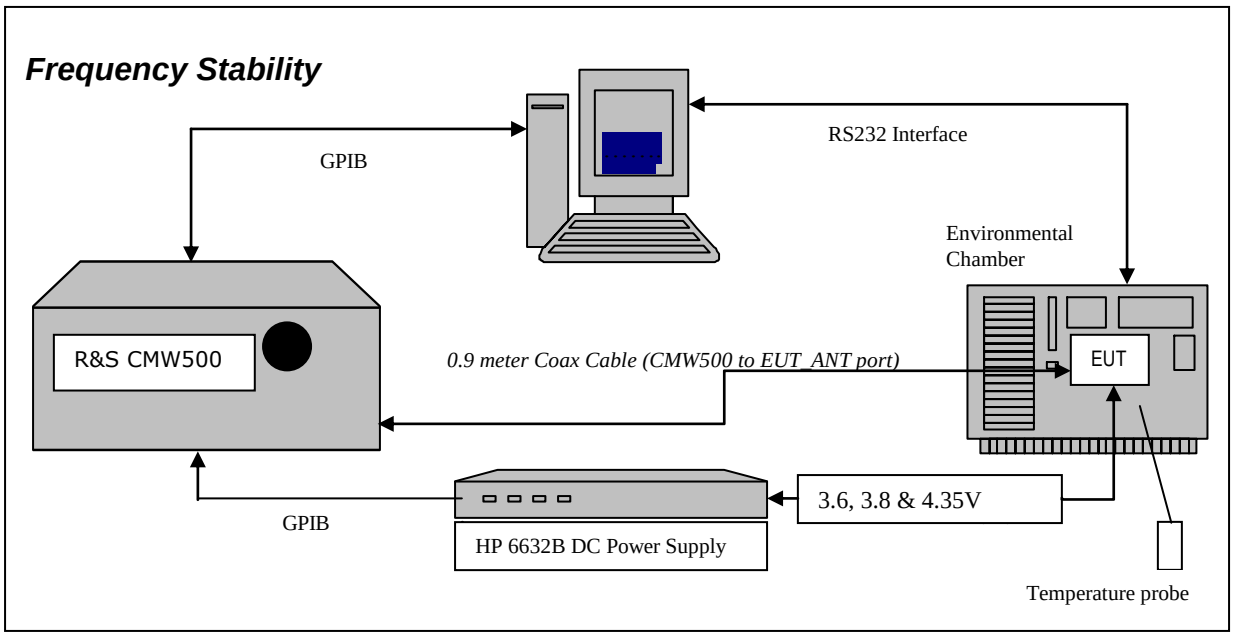


Figure 3-47a: Occupied Bandwidth, Band 5 High Channel, 10MHz BW (RB= 50) 16-QAM



APPENDIX 4B – LTE Band 5 FREQUENCY STABILITY TEST DATA

LTE Band 5 Frequency Stability Test Data



The following measurements were performed by Sijia Li.

CFR 47 Chapter 1 - Federal Communications Commission Rules

Part 2 Required Measurements
2.1055 Frequency Stability - Procedures
(a,b) Frequency Stability - Temperature Variation
(d) Frequency Stability - Voltage Variation

24.236 *Frequency Stability*.
The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

The EUT meets the requirements as stated in CFR 47 chapter 1, Section 27.54, CFR 47 and RSS-139, 6.3 Frequency Stability.
Frequency Stability measurement devices were configured as presented in the block diagram recording frequency, power, data, temperatures, and stepped voltages controlled via a GPIB interface linked to the Environmental chamber, a DC power supply, and the Communications Test Set. A 0.9-metre coax cable was calibrated to characterize the insertion loss for the transmitted frequencies between the RF input/output of the CMW 500 and the EUT antenna port.

Test Setup:

The EUT was placed in the Temperature chamber and connected to CMW 500 outside as shown in the figure above. Dry air was pumped inside the temperature chamber to maintain a backpressure during the test. The EUT was kept in the off condition at all times except when the following measurements were to be made.

The chamber was switched on and the temperature was set to -30°C.
After the chamber stabilized at -30 °C there was a soak period of one hour to alleviate moisture in the chamber, the EUT voltage was enabled.
The system software recorded the frequency, power, and associated measurements.

A Computer system controlled the automated software. This application was given the command of activating all machines intrinsic to the temperature and voltage tests controlling the CMW 500 via the GPIB Bus. The Environmental Chamber was instructed through an RS-232 serial line. The EUT dialogue was passed through a serial connection.

The EUT repetitively transmitted 100 bursts for each set of programmed parameters recording temperature, voltage settings, and systematically selected frequencies. The power supply was cycled from minimum voltage 3.6 volts, 3.8 volts and to 4.35 volts maximum voltage. The frequency error was measured at a maximum output power and recorded by the automated system test software.

The EUT output power and frequency was measured at 3.6 volts, 3.8 volts and 4.35 volts. The transmit frequency was varied in 3 steps consisting of 829.0 MHz, 836.5 MHz and 844.0 MHz each was measured under 10 MHz bandwidth with maximum (50) RBs. This frequency was recorded in MHz and deviation from nominal, in Parts Per Million.

After the initial one-hour soak at the beginning of the tests, a period of thirty minutes soak was initialized between each ascending temperature step, before proceeding to the next measurement test cycle.

Procedure:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

15. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
16. Start test program
17. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
18. Set power supply voltage to 3.6 volts.
19. Set up CMW 500 Radio Communication Tester.
20. Command the CMW 500 to switch to the low channel.
21. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
22. EUT is commanded to Transmit 100 Bursts.
23. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
24. The CMW 500 commands the EUT to change frequency to the middle channel and high channel and repeats steps 7 to 9.
25. Repeat steps 5 to 10 changing the supply voltage to 3.8 Volts
26. Increase temperature by 10°C and soak for 1/2 hour.
27. Repeat steps 4 - 12 for temperatures –30°C to 60°C.
28. Repeat steps 5 to 10 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

The maximum frequency error in the LTE Band 5 measured was **0.0041 PPM**.

LTE Band 5 results: channels 20400, 20525 and 20649 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20450	829.0	3.6	20	1.72	0.0021
20525	836.5	3.6	20	2.17	0.0026
20600	844.0	3.6	20	-1.92	-0.0023

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20450	829.0	3.8	20	3.40	**0.0041**
20525	836.5	3.8	20	1.89	0.0023
20600	844.0	3.8	20	**-2.98**	-0.0035

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20450	829.0	4.35	20	1.97	0.0024
20525	836.5	4.35	20	-2.39	-0.0029
20600	844.0	4.35	20	-2.35	-0.0028

LTE band 5 Results: channel 20400 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20450	829.0	3.6	-30	-3.33	-0.0040
20450	829.0	3.6	-20	-3.91	-0.0047
20450	829.0	3.6	-10	-2.05	-0.0025
20450	829.0	3.6	0	3.36	0.0041
20450	829.0	3.6	10	3.46	0.0042
20450	829.0	3.6	20	1.72	0.0021
20450	829.0	3.6	30	-2.89	-0.0035
20450	829.0	3.6	40	-2.27	-0.0027
20450	829.0	3.6	50	-2.85	-0.0034
20450	829.0	3.6	60	-2.86	-0.0035
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20450	829.0	3.8	-30	-4.48	**-0.0054**
20450	829.0	3.8	-20	3.92	0.0047
20450	829.0	3.8	-10	-3.08	-0.0037
20450	829.0	3.8	0	2.96	0.0036
20450	829.0	3.8	10	-1.16	-0.0014
20450	829.0	3.8	20	3.40	0.0041
20450	829.0	3.8	30	-2.49	-0.0030
20450	829.0	3.8	40	-2.53	-0.0031
20450	829.0	3.8	50	-2.55	-0.0031
20450	829.0	3.8	60	-1.57	-0.0019
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20450	829.0	4.35	-30	-2.80	-0.0034
20450	829.0	4.35	-20	-3.76	-0.0045
20450	829.0	4.35	-10	2.39	0.0029
20450	829.0	4.35	0	3.58	0.0043
20450	829.0	4.35	10	3.82	0.0046
20450	829.0	4.35	20	1.97	0.0024
20450	829.0	4.35	30	-3.75	-0.0045
20450	829.0	4.35	40	-3.45	-0.0042
20450	829.0	4.35	50	1.85	0.0022
20450	829.0	4.35	60	3.45	0.0042

LTE band 5 Results: channel 20525 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20525	836.5	3.6	-30	2.92	0.0035
20525	836.5	3.6	-20	-3.26	-0.0039
20525	836.5	3.6	-10	2.52	0.0030
20525	836.5	3.6	0	2.95	0.0035
20525	836.5	3.6	10	-1.85	-0.0022
20525	836.5	3.6	20	2.17	0.0026
20525	836.5	3.6	30	-3.59	-0.0043
20525	836.5	3.6	40	2.32	0.0028
20525	836.5	3.6	50	-4.06	**-0.0049**
20525	836.5	3.6	60	-3.68	-0.0044
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20525	836.5	3.8	-30	-4.01	-0.0048
20525	836.5	3.8	-20	-2.90	-0.0035
20525	836.5	3.8	-10	3.60	0.0043
20525	836.5	3.8	0	1.92	0.0023
20525	836.5	3.8	10	2.95	0.0035
20525	836.5	3.8	20	1.89	0.0023
20525	836.5	3.8	30	2.07	0.0025
20525	836.5	3.8	40	-3.12	-0.0037
20525	836.5	3.8	50	2.92	0.0035
20525	836.5	3.8	60	-4.02	-0.0048
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20525	836.5	4.35	-30	-2.39	-0.0029
20525	836.5	4.35	-20	-3.19	-0.0038
20525	836.5	4.35	-10	3.50	0.0042
20525	836.5	4.35	0	3.25	0.0039
20525	836.5	4.35	10	3.22	0.0038
20525	836.5	4.35	20	-2.39	-0.0029
20525	836.5	4.35	30	-3.72	-0.0044
20525	836.5	4.35	40	-1.97	-0.0024
20525	836.5	4.35	50	-2.16	-0.0026
20525	836.5	4.35	60	-2.27	-0.0027

LTE band 5 Results: channel 20649 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20600	844.0	3.6	-30	-5.31	**-0.0063**
20600	844.0	3.6	-20	-4.65	-0.0055
20600	844.0	3.6	-10	-3.60	-0.0043
20600	844.0	3.6	0	-2.59	-0.0031
20600	844.0	3.6	10	2.83	0.0034
20600	844.0	3.6	20	-1.92	-0.0023
20600	844.0	3.6	30	-2.60	-0.0031
20600	844.0	3.6	40	-2.89	-0.0034
20600	844.0	3.6	50	-3.68	-0.0044
20600	844.0	3.6	60	-3.83	-0.0045
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20600	844.0	3.8	-30	-5.09	-0.0060
20600	844.0	3.8	-20	-4.16	-0.0049
20600	844.0	3.8	-10	-2.57	-0.0031
20600	844.0	3.8	0	1.96	0.0023
20600	844.0	3.8	10	1.95	0.0023
20600	844.0	3.8	20	-2.98	-0.0035
20600	844.0	3.8	30	-3.92	-0.0046
20600	844.0	3.8	40	-2.90	-0.0034
20600	844.0	3.8	50	2.15	0.0025
20600	844.0	3.8	60	-4.84	-0.0057
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20600	844.0	4.35	-30	-2.76	-0.0033
20600	844.0	4.35	-20	-5.01	-0.0059
20600	844.0	4.35	-10	-4.48	-0.0053
20600	844.0	4.35	0	-2.26	-0.0027
20600	844.0	4.35	10	2.62	0.0031
20600	844.0	4.35	20	-2.35	-0.0028
20600	844.0	4.35	30	-3.50	-0.0042
20600	844.0	4.35	40	-4.22	-0.0050
20600	844.0	4.35	50	-4.08	-0.0048
20600	844.0	4.35	60	-3.76	-0.0045

APPENDIX 4C – LTE Band 5 RADIATED EMISSIONS TEST DATA

Radiated Power Test Data Results

The following measurements were performed by Shiva Kumbham.
Date of Test: August 11, 2015
The environmental tests conditions were: Temperature: 26.0 °C
Relative Humidity: 36.9 %
The BlackBerry® smartphone was standalone horizontal down and LCD Screen pointing to the RX antenna when the turntable is at 0 degree position.
Measurements were performed with QPSK and 16QAM modulations.
Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height.

LTE band 5, 5MHz BW, RB=1, QPSK modulation

								Substitution Method					
EUT				Rx Antenna		Spectrum Analyzer		Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V,H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (dBm)	Corrected Reading (W)	Limit (dBm)	Diff to Limit (dBm)
F0	20425	826.50	5	Horn	V	-41.00	-32.20	V-V	2.62	**20.43**	0.11	38.50	18.07
F0	20425	826.50	5	Horn	H	-32.20		H-H	1.18				
F0	20525	836.50	5	Horn	V	-40.96	-34.25	V-V	1.29	18.98	0.08	38.50	19.52
F0	20525	836.50	5	Horn	H	-34.25		H-H	0.21				
F0	20624	846.40	5	Horn	V	-41.79	-34.38	V-V	1.80	19.55	0.09	38.50	18.95
F0	20624	846.40	5	Horn	H	-34.38		H-H	-0.21				

LTE band 5, 5MHz BW, RB=1, 16-QAM modulation

								Substitution Method					
EUT				Rx Antenna		Spectrum Analyzer		Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V,H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (dBm)	Corrected Reading (W)	Limit (dBm)	Diff to Limit (dBm)
F0	20425	826.50	5	Horn	V	-42.06	-33.05	V-V	1.67	19.48	0.09	38.50	19.02
F0	20425	826.50	5	Horn	H	-33.05		H-H	0.31				
F0	20525	836.50	5	Horn	V	-41.89	-34.19	V-V	1.39	19.08	0.08	38.50	19.42
F0	20525	836.50	5	Horn	H	-34.19		H-H	0.31				
F0	20624	846.40	5	Horn	V	-42.74	-34.22	V-V	1.97	**19.72**	0.09	38.50	18.78

F0	20624	846.40	5	Horn	H	-34.22		H-H	-0.05				

Radiated Emissions Test Data Results cont'd

The following measurements were performed by Savtej Sandhu.

Date of Test: August 10, 2015

The environmental test conditions were: Temperature: 25.8 ºC
Relative Humidity: 33.3 %

The BlackBerry® smartphone was standalone horizontally with LCD facing down and top pointing to the RX antenna when the turntable is at 0 degree position

Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height, and the frequency range scanned was 30MHz – 1GHz.

Measurements were performed in LTE band 5 with QPSK and 16-QAM modulation for 3MHz BW (channel 20415, 20525 and 20634 with RB = 6).

All emissions were at least 25 dB below the limit.

The following measurements were performed by Winston Vernon

Date of Test: August 10-11, 2015

The environmental test conditions were: Temperature: 27.5 ºC
Relative Humidity: 34.3 %

Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height, and a frequency range of 1 GHz to 10 GHz.

The BlackBerry® smartphone was standalone, with horizontally and top pointing to the RX antenna when the turntable is at 0 degree position

Measurements were performed in LTE band 5 with QPSK and 16-QAM modulation for 3MHz BW (channel 20415, 20525 and 20634 with RB = 6).

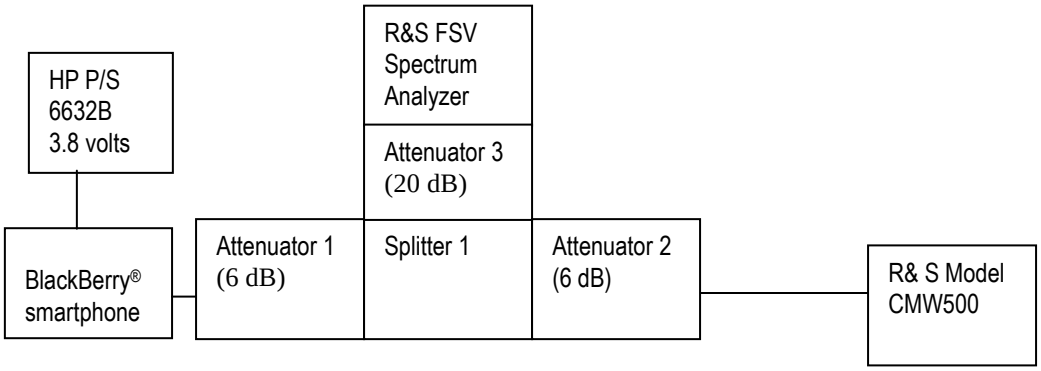
All emissions were at least 25 dB below the limit.

APPENDIX 5A– LTE Band 4 CONDUCTED RF EMISSIONS TEST DATA/PLOTS

LTE Band 4 Conducted RF Emission Test Data

This appendix contains measurement data pertaining to conducted spurious emissions, 99% power bandwidth and the channel mask.

Test Setup Diagram



A reference offset of 31.4 dB was applied to the spectrum analyzer reference level for the attenuators and coaxial cable loss in the test circuit.

UNIT	MANUFACTURER	MODEL	SERIAL NUMBER
Attenuator 1	Mini-Circuits	BW-S6W2+	0647
Attenuator 2	Mini-Circuits	BW-S6W2+	0648
Attenuator 3	Mini-Circuits	BW-S20-2W263+	1234
Splitter 1	Weinschel	1515	MES 92

Date of Test: July 22 – September 3, 2015

The environmental test conditions were: Temperature: 26.3ºC
Relative Humidity: 38.6 %

The following measurements were performed by Sijia Li and Landon Martin.

LTE Band 4 Conducted RF Emission Test Data cont'd

Emission Designator Table

Frequency Range (MHz)	Conducted Output Power (dBm)	Emission Designator	Band	Bandwidth (MHz)	Modulation
1710.7-1754.3	22.57	1M09G7D	LTE B4	1.4	QPSK
1710.7-1754.3	21.92	1M09D7W	LTE B4	1.4	16QAM
1711.5-1753.5	22.95	2M69G7D	LTE B4	3	QPSK
1711.5-1753.5	22.17	2M69D7W	LTE B4	3	16QAM
1712.5-1752.5	23.13	4M49G7D	LTE B4	5	QPSK
1712.5-1752.5	22.17	4M49D7W	LTE B4	5	16QAM
1715-1750	**23.14**	8M96G7D	LTE B4	10	QPSK
1715-1750	22.53	8M96D7W	LTE B4	10	16QAM
1717.5-1747.5	22.92	13M4G7D	LTE B4	15	QPSK
1717.5-1747.5	22.17	13M4D7W	LTE B4	15	16QAM
1720-1745	23.08	17M9G7D	LTE B4	20	QPSK
1720-1745	22.24	18M0D7W	LTE B4	20	16QAM

The conducted spurious emissions – As per 47 CFR 2.1051, 27.53(h), RSS-139, 6.5 were measured from 30 MHz to 20 GHz.

–26 dBc Bandwidth and Occupied Bandwidth (99%)

The modulation spectrum was measured by both methods of 99% power bandwidth and –26 dBc bandwidth For each 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz and 20MHz with Resource Block allocations 100,75,50,25,6 and 3 for LTE band 4,.

QPSK and 16-QAM modulations were applied to each of the bandwidths. Only the worst case measurements are documented in this report.

The resolution bandwidth required for out-of-band emissions in the 1 MHz bands immediately outside and adjacent to the frequency block, was determined to be at least 1% of the emission bandwidth.

The worst case –26dBc bandwidth for LTE band 4 was measured to be 18.9 MHz. Results were derived in a 200 kHz resolution bandwidth.

On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

Test Data for LTE Band 4 selected Frequencies in 20MHz BW (RB = 100)

LTE Band 4 Frequency (MHz)	26dBc Occupied Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	QPSK	16-QAM
1720.0	18.64	17.93	17.93
1732.5	18.6	17.88	17.88
1745.0	**18.9**	17.93	**17.98**

Test Data for LTE Band 4 selected Frequencies in 15MHz BW (RB = 75)

LTE Band 4 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
1717.5	13.41	13.41
1732.5	13.41	13.45
1747.5	13.45	13.41

Test Data for LTE Band 4 selected Frequencies in 10MHz BW (RB = 50)

LTE Band 4 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
1715	8.94	8.94
1732.5	8.97	8.97
1750	8.97	8.94

Test Data for LTE Band 4 selected Frequencies in 5MHz BW (RB = 25)

LTE Band 4 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
1712.5	4.48	4.50
1732.5	4.48	4.47
1752.5	4.50	4.48

Test Data for LTE Band 4 selected Frequencies in 3MHz BW (RB = 15)

LTE Band 4 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
1711.5	2.70	2.69
1732.5	2.70	2.69
1753.5	2.70	2.69

Test Data for LTE Band 4 selected Frequencies in 1.4MHz BW (RB = 6)

LTE Band 4 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
1710.7	1.09	1.08
1732.5	1.10	1.09
1754.3	1.09	1.09

Peak to Average Ratio (PAR)

For each 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz and 20MHz with different number of RBs as per scalable bandwidths for LTE band 4, the peak to average ratio was measured on the low, middle and high channels with QPSK modulation.

On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

The worst case measured was 10.16 dB in 20MHz bandwidth with 50 RBs.

Measurement Plots for LTE Band 4

See Figures 5-1a to 5-18a for the plots of the conducted spurious emissions.

See Figures 5-19a to 5-34a and 5-51a to 5-53a for the plots of 99% Occupied Bandwidth and -26 dBc Bandwidth.

See Figures 5-35a to 5-44a for the plots of the Channel mask.

See Figures 5-45a to 5-50a for the plots of the Peak to Average Ratios.

LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-1a: Band 4, Spurious Conducted Emissions, Low channel, 20MHz BW (RB= 1)

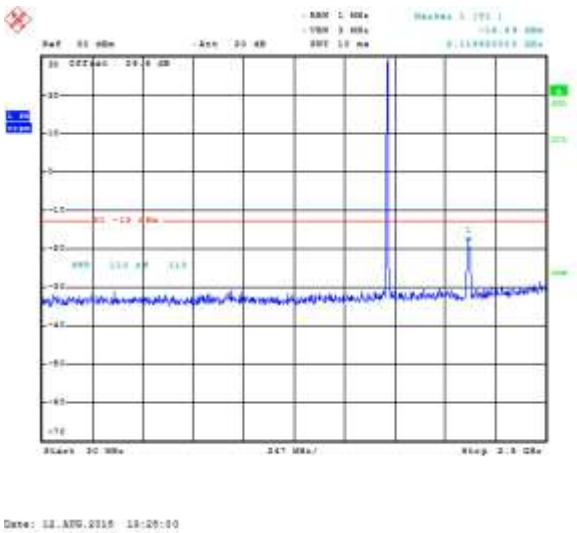


Figure 5-2a: Band 4, Spurious Conducted Emissions, Low channel, 20MHz BW (RB= 1)

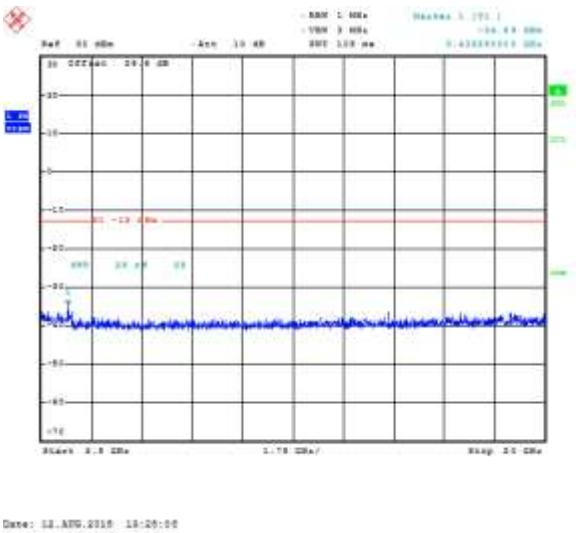


Figure 5-3a: Band 4, Spurious Conducted Emissions, Middle channel, 20MHz BW (RB= 50)

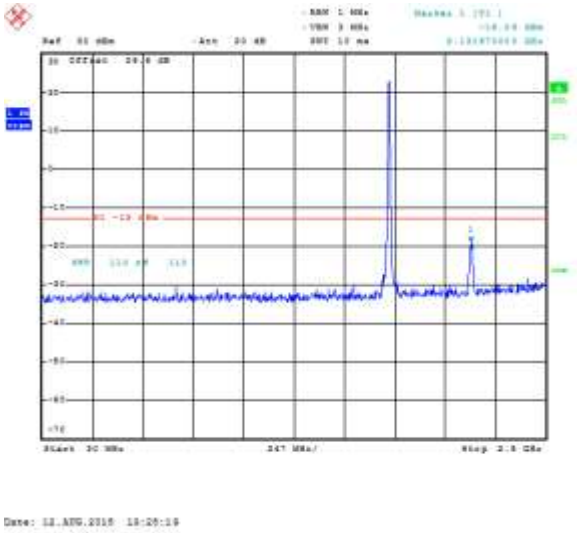
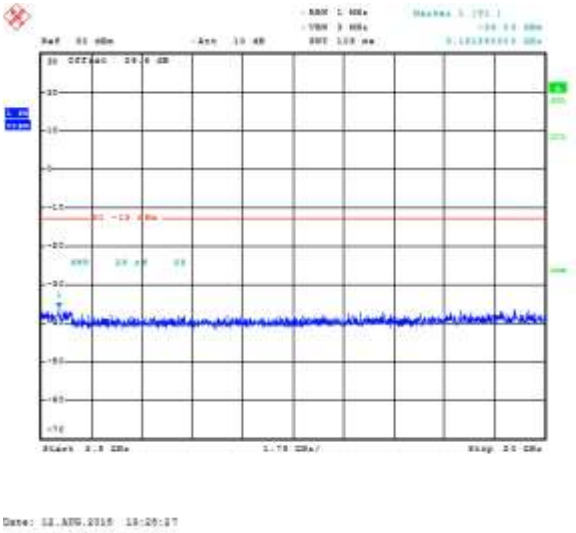


Figure 5-4a: Band 4, Spurious Conducted Emissions, Middle channel, 20MHz BW (RB= 50)



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-5a: Band 4, Spurious Conducted Emissions, High Channel, 20MHz BW (RB= 100)

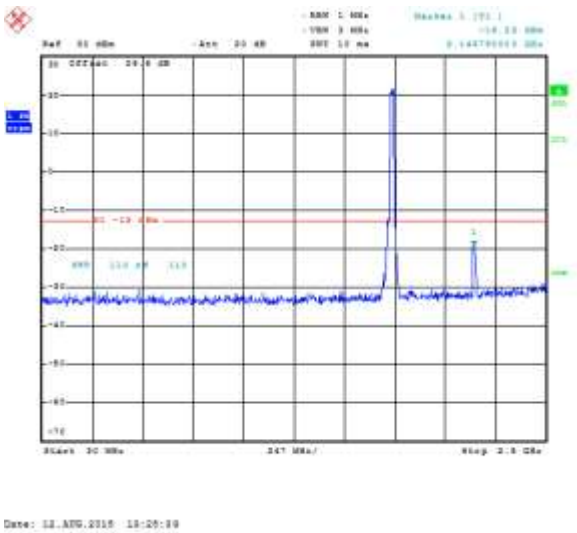


Figure 5-6a: Band 4, Spurious Conducted Emissions, High Channel, 20MHz BW (RB= 100)

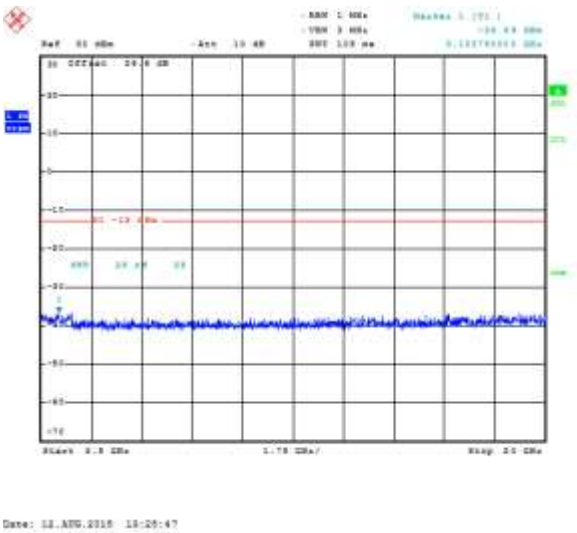


Figure 5-7a: Band 4, Spurious Conducted Emissions, Low channel, 10MHz BW (RB= 1)

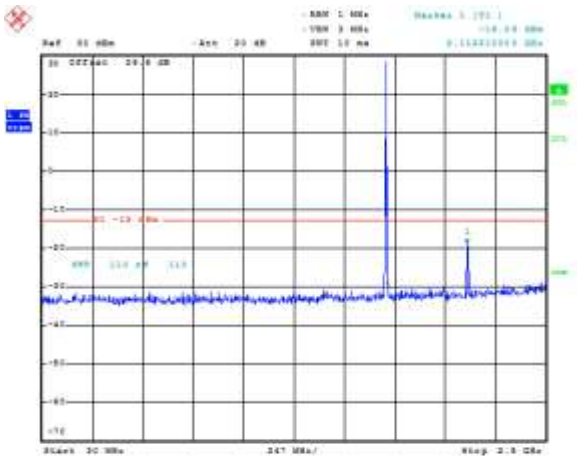
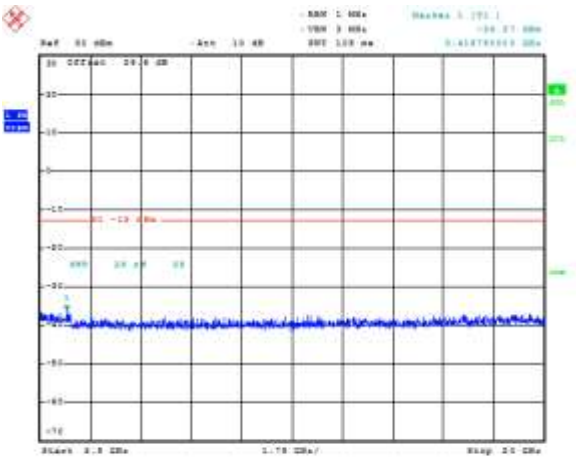


Figure 5-8a: Band 4, Spurious Conducted Emissions, Low channel, 10MHz BW (RB= 1)



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-9a: Band 4, Spurious Conducted Emissions, Middle Channel, 10MHz BW (RB= 25)

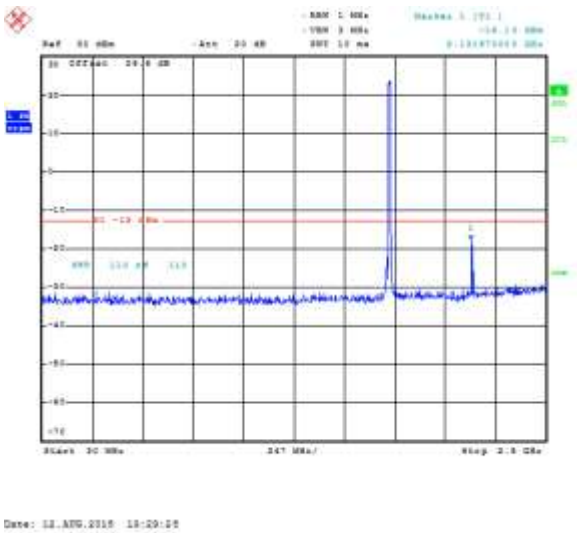


Figure 5-10a: Band 4, Spurious Conducted Emissions, Middle Channel, 10MHz BW (RB= 25)

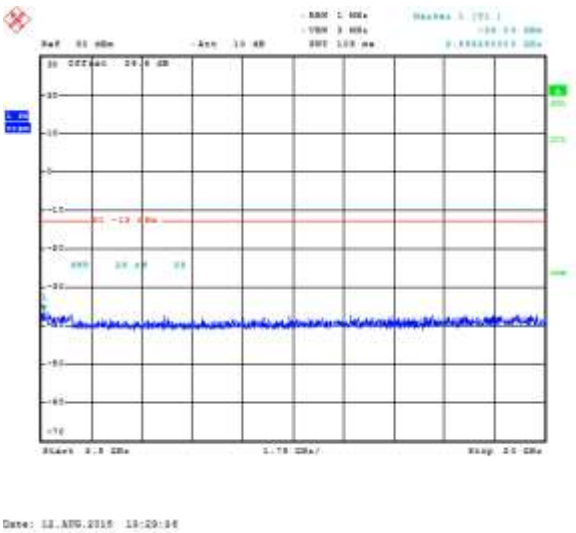


Figure 5-11a: Band 4, Spurious Conducted Emissions, High channel, 10MHz BW (RB= 50)

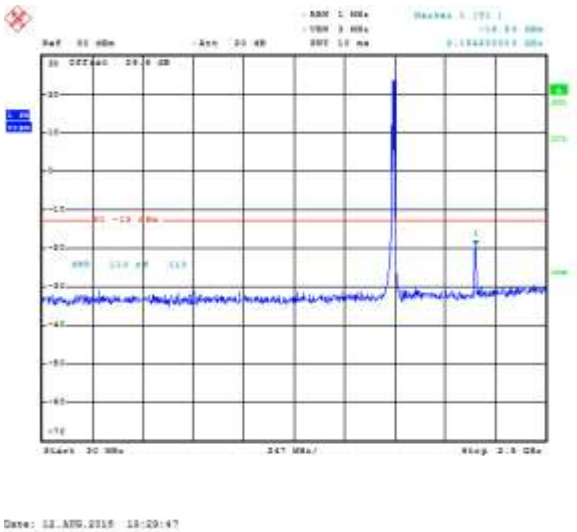
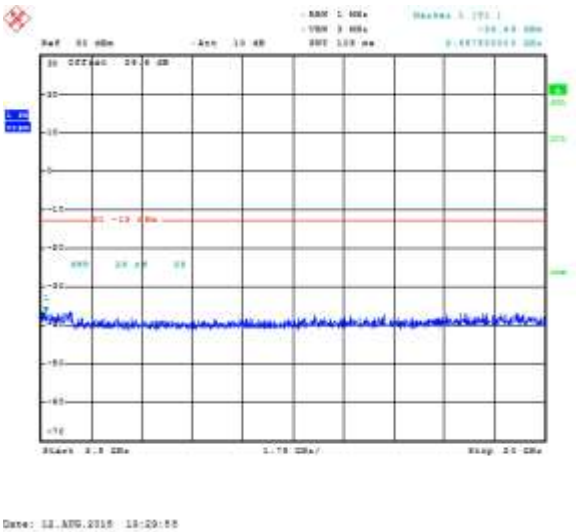


Figure 5-12a: Band 4, Spurious Conducted Emissions, High channel, 10MHz BW (RB= 50)



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-13a: Band 4, Spurious Conducted Emissions, Low Channel, 1.4MHz BW (RB= 1)

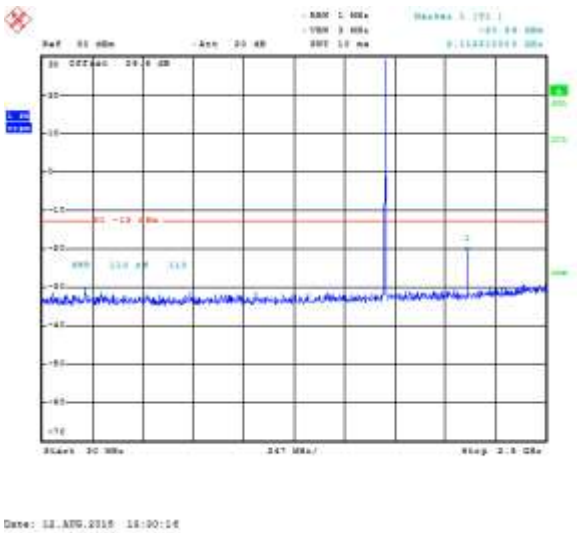


Figure 5-14a: Band 4, Spurious Conducted Emissions, Low Channel, 1.4MHz BW (RB= 1)

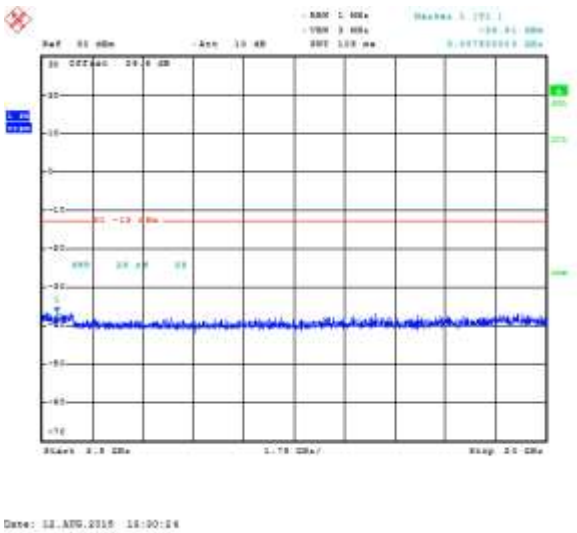


Figure 5-15a: Band 4, Spurious Conducted Emissions, Middle channel, 1.4MHz BW (RB= 3)

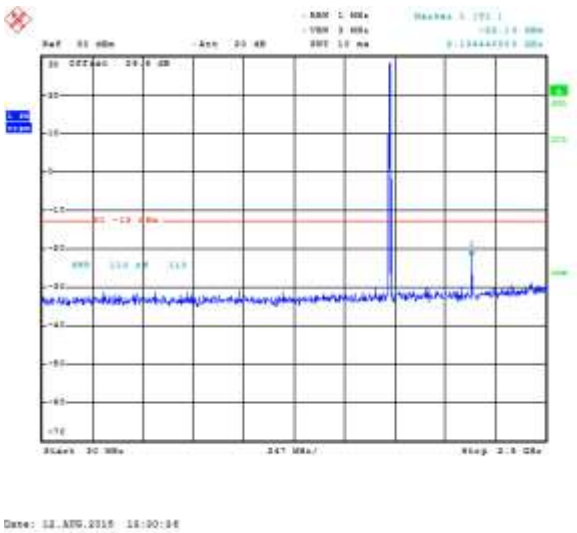
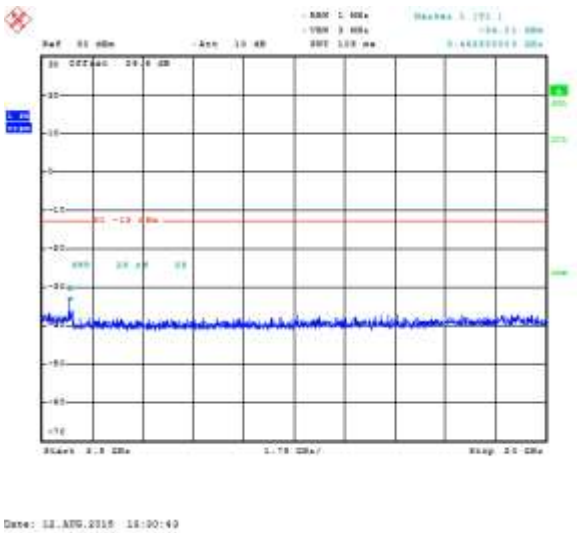


Figure 5-16a: Band 4, Spurious Conducted Emissions, Middle channel, 1.4MHz BW (RB= 3)



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-17a: Band 4, Spurious Conducted Emissions, High channel, 1.4MHz BW (RB= 6)

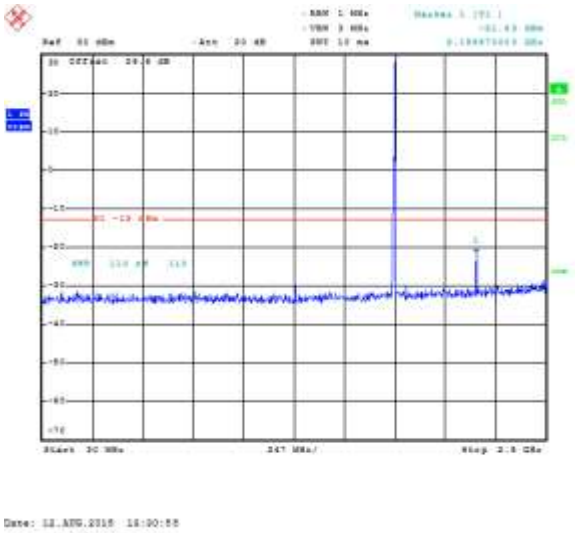
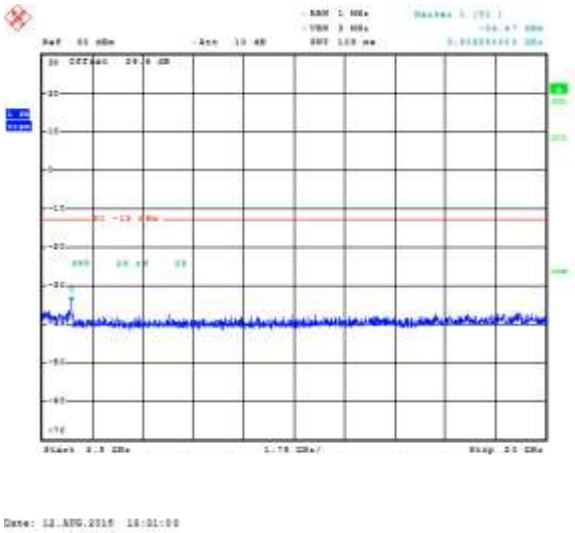


Figure 5-18a: Band 4, Spurious Conducted Emissions, High channel, 1.4MHz BW (RB= 6)



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-19a: Occupied Bandwidth, Band 4 Low Channel, 20MHz BW, RB=100

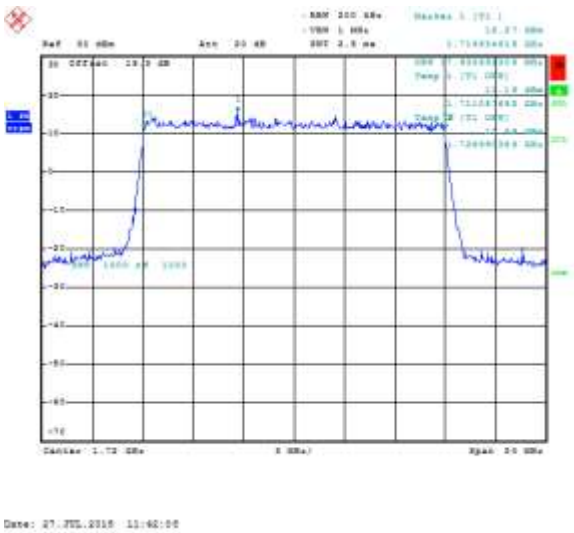


Figure 5-20a: Occupied Bandwidth, Band 4 Middle Channel, 20MHz BW, RB=100

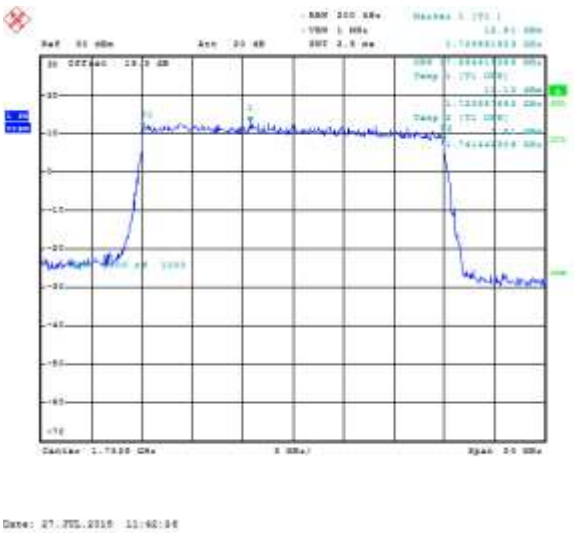
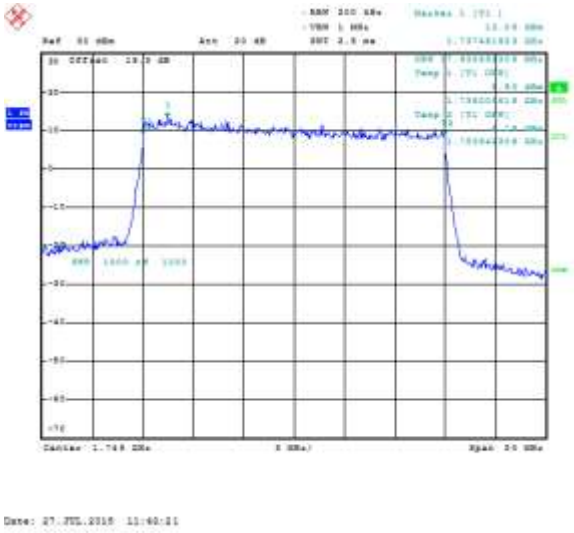


Figure 5-21a: Occupied Bandwidth, Band 4 High Channel, 20MHz BW, RB=100



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-22a: Occupied Bandwidth, Band 4 Low Channel, 10MHz BW, RB=50

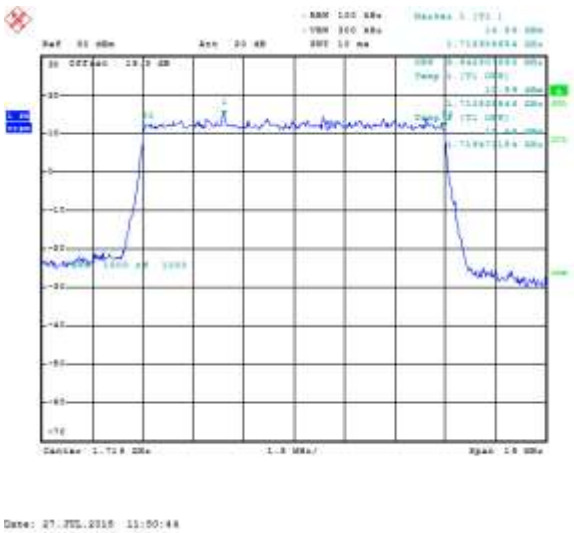


Figure 5-23a: Occupied Bandwidth, Band Middle Channel, 10MHz BW, RB=50

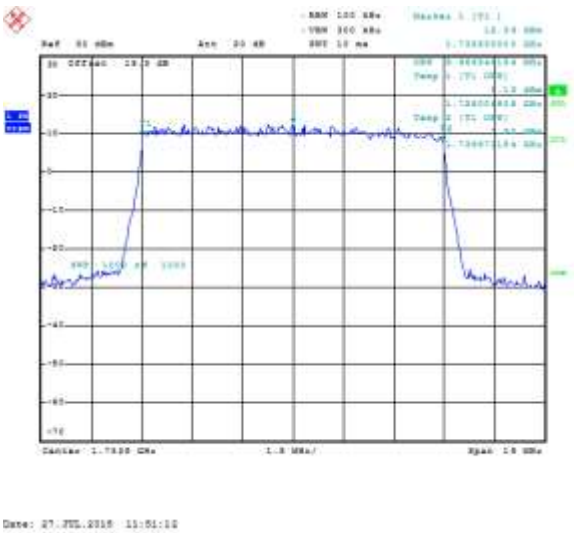
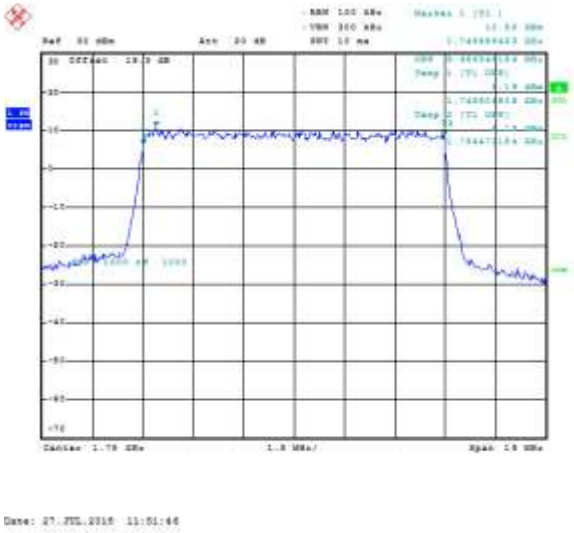


Figure 5-24a: Occupied Bandwidth, Band 4 High Channel, 10MHz BW, RB=50



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-25a: Occupied Bandwidth, Band 4 Low Channel, 1.4MHz BW, RB=6

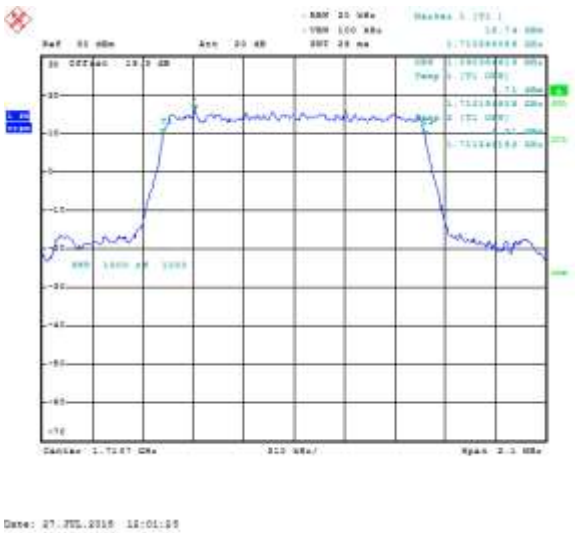


Figure 5-26a: Occupied Bandwidth, Band 4 Middle Channel, 1.4MHz BW, RB=6

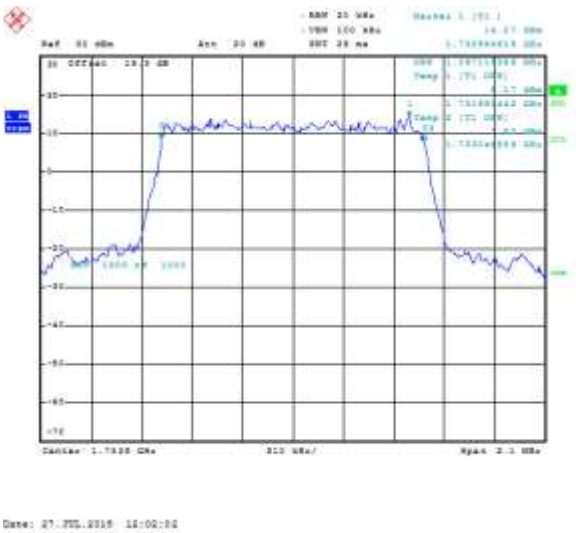
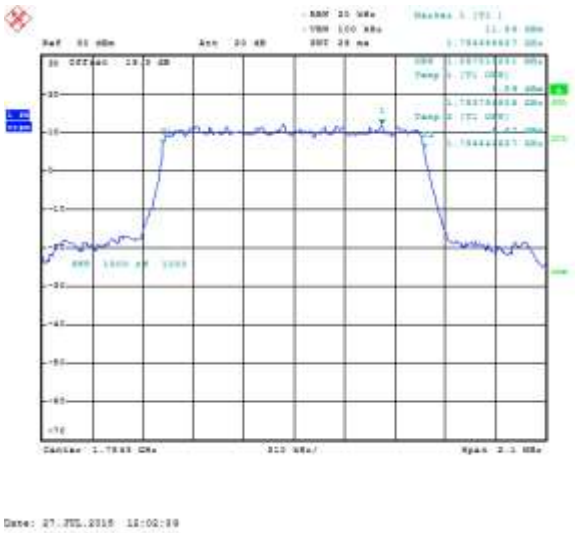


Figure 5-27a: Occupied Bandwidth, Band 4 High Channel, 1.4MHz BW, RB=6



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-28a: -26 dBc Bandwidth, Band 4 Low Channel, 20MHz BW, RB=100

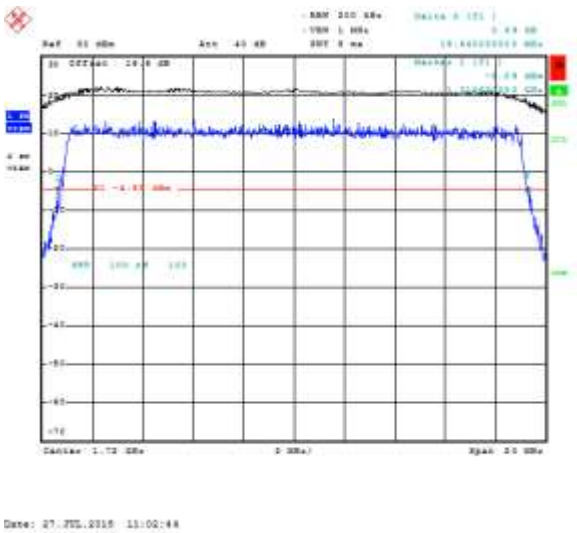


Figure 5-29a: -26 dBc Bandwidth, Band 4 Middle Channel, 20MHz BW, RB=100

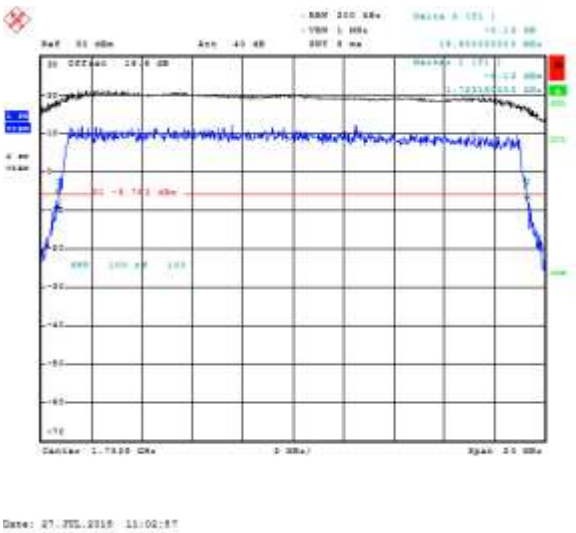


Figure 5-30a: -26 dBc Bandwidth, Band 4 High Channel, 20MHz BW, RB=100

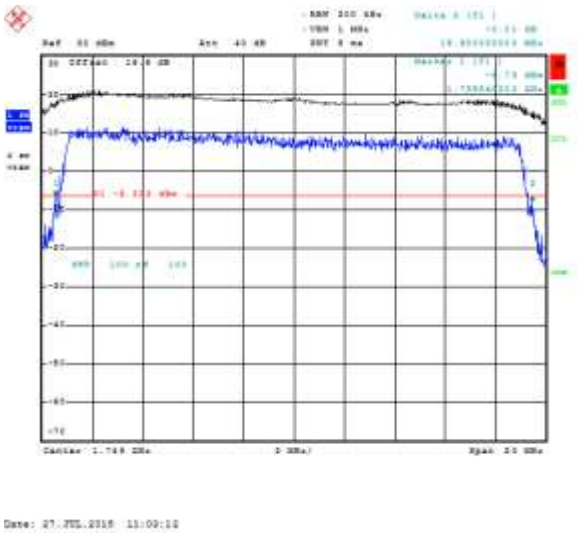
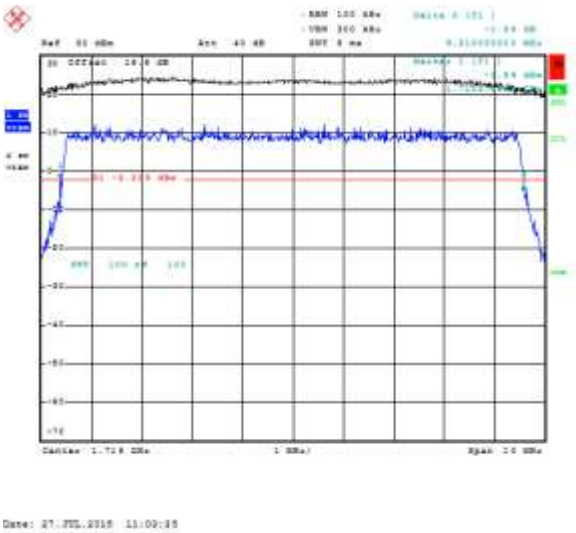


Figure 5-31a: -26 dBc Bandwidth, Band 4 Low Channel, 10MHz BW, RB=50



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-32a: -26 dBc Bandwidth, Band 4 Middle Channel, 10MHz BW, RB=50

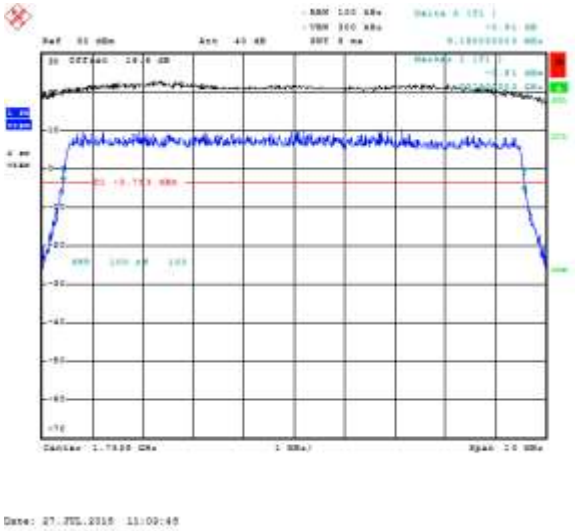


Figure 5-33a: -26 dBc Bandwidth, Band 4 High Channel, 10MHz BW, RB=50

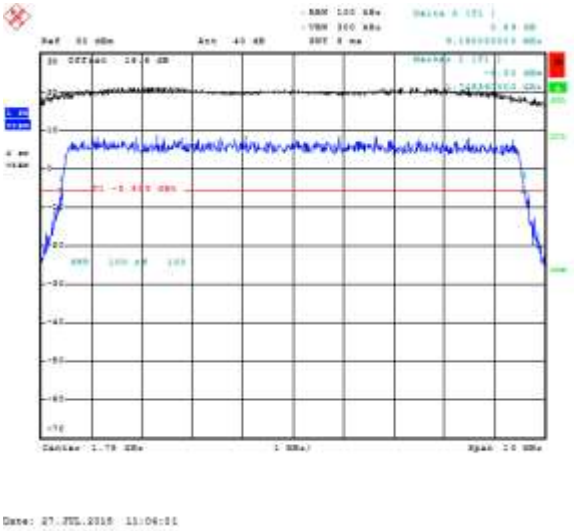


Figure 5-34a: -26 dBc Bandwidth, Band 4 Low Channel, 1.4MHz BW, RB=6

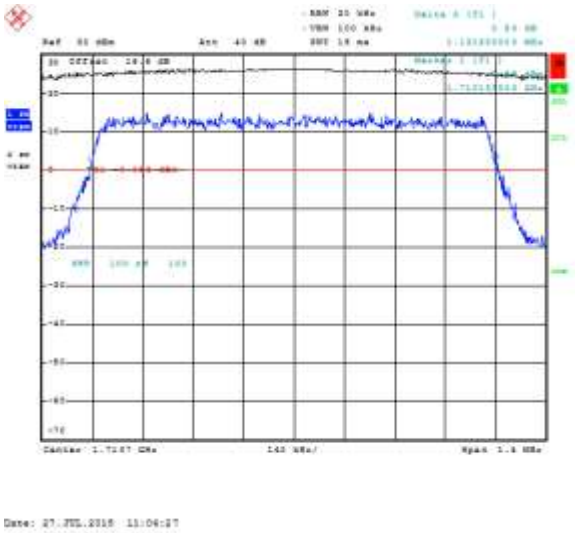
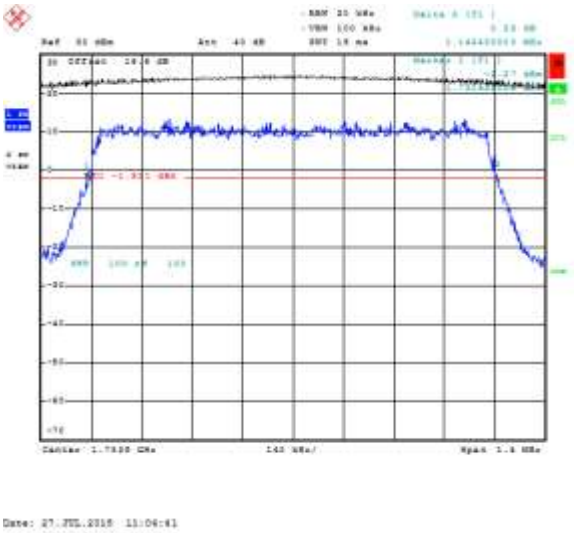


Figure 5-35a: -26 dBc Bandwidth, Band 4 Middle Channel, 1.4MHz BW, RB=6



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-36a: -26 dBc Bandwidth, Band 4 High Channel, 1.4MHz BW, RB=6

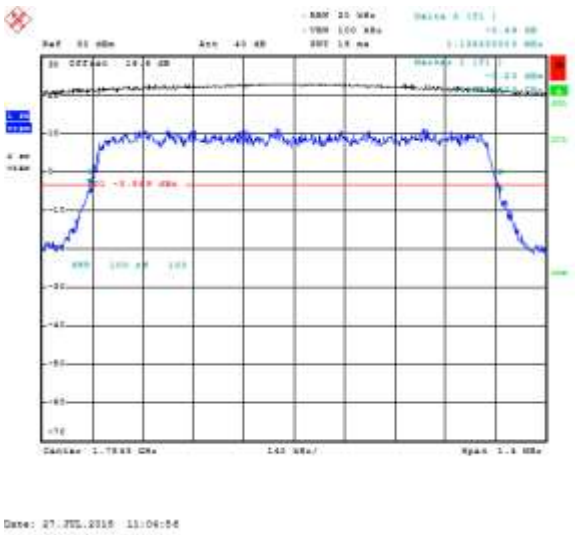


Figure 5-37a: Band 4 Low Channel Mask, 20MHz BW, RB=100

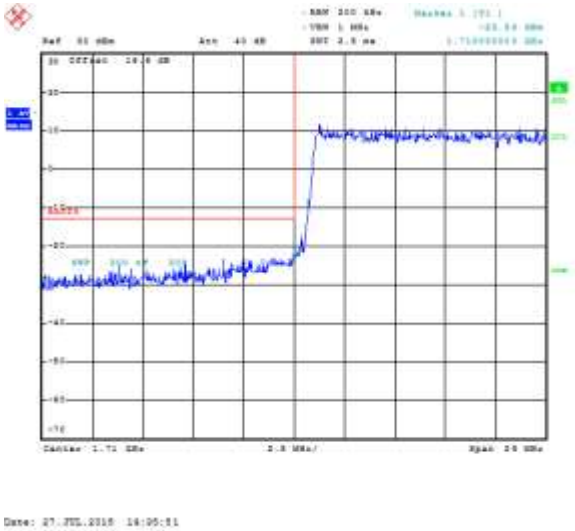
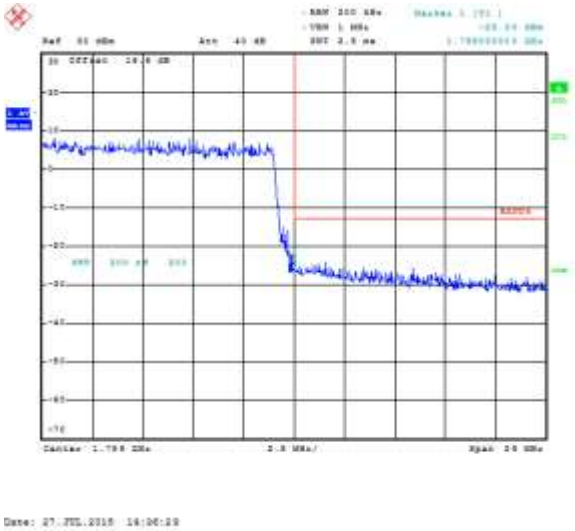


Figure 5-38a: Band 4 High Channel Mask, 20MHz BW, RB=100



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-39a: Band 4 Low Channel Mask, 10MHz BW, RB=50

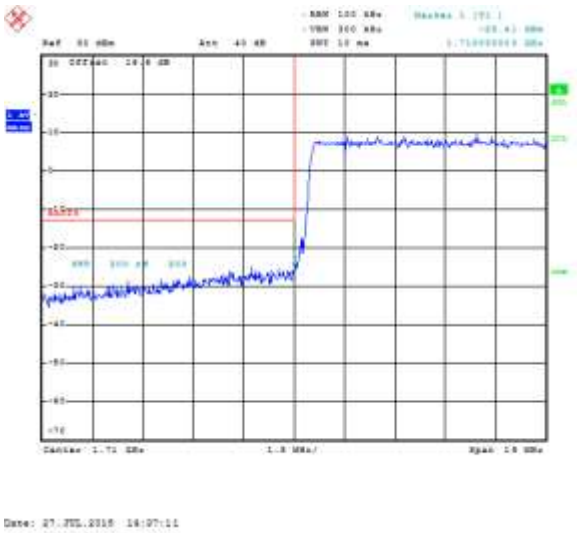


Figure 5-40a: Band 4 High Channel Mask, 10MHz BW, RB=50

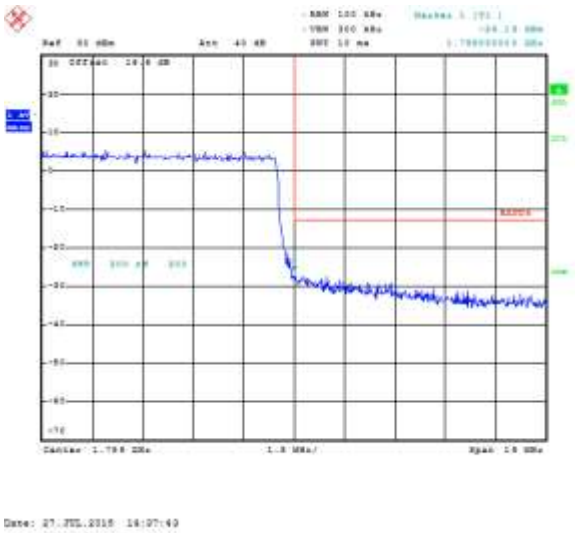


Figure 5-41a: Band 4 Low Channel Mask, 1.4MHz BW, RB=6

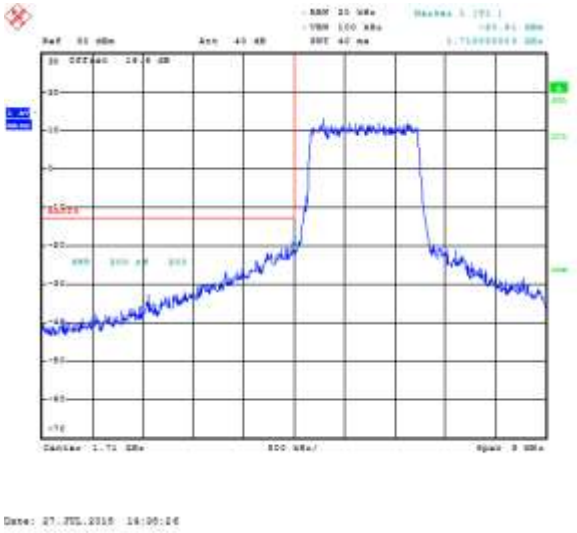
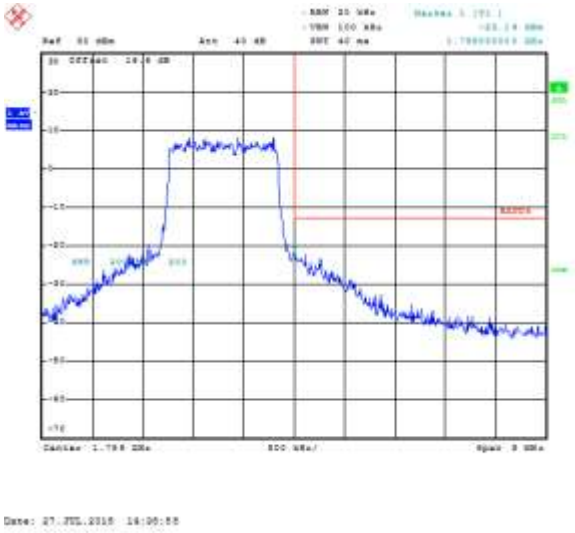


Figure 5-42a: Band 4 High Channel Mask, 1.4MHz BW, RB=6



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-43a: Band 4 Low Channel Mask, 20MHz BW, RB=1

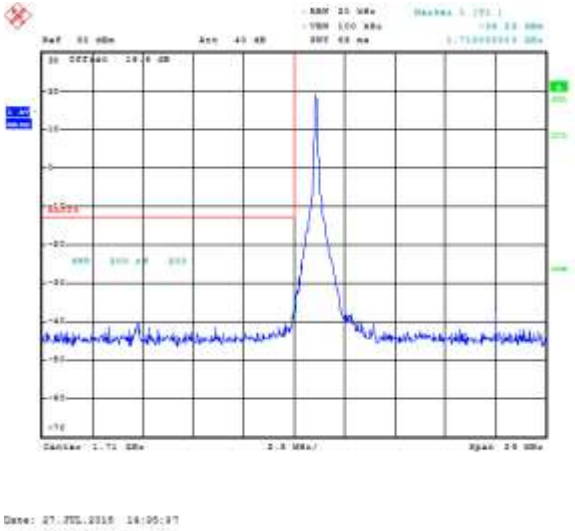


Figure 5-44a: Band 4 High Channel Mask, 20MHz BW, RB=1

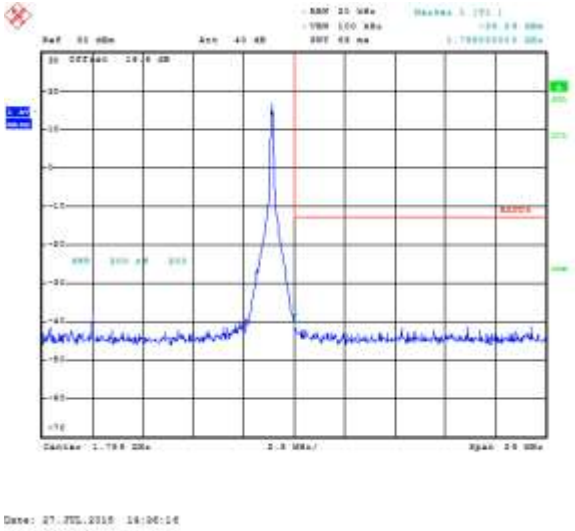


Figure 5-45a: Band 4 Mid Channel PAR, 20MHz BW, RB=50, QPSK

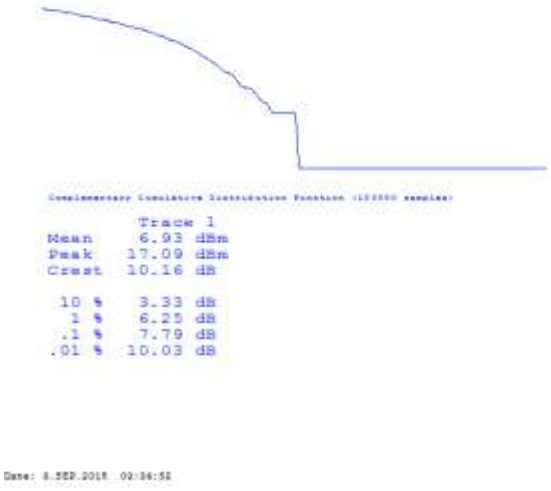
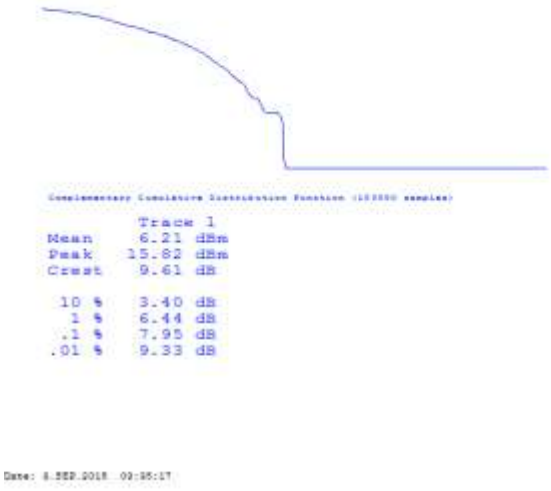


Figure 5-46a: Band 4 Middle Channel Mask, 20MHz BW, RB=100, 16-QAM



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-47a: Band 4 Mid Channel PAR, 10MHz BW, RB=25, QPSK

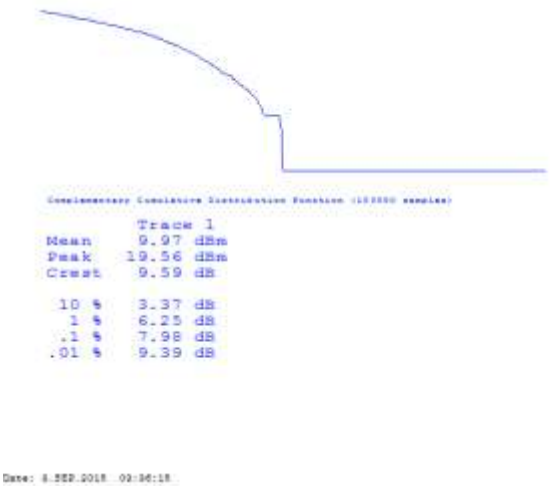


Figure 5-48a: Band 4 Mid Channel PAR, 10MHz BW, RB=50, 16-QAM

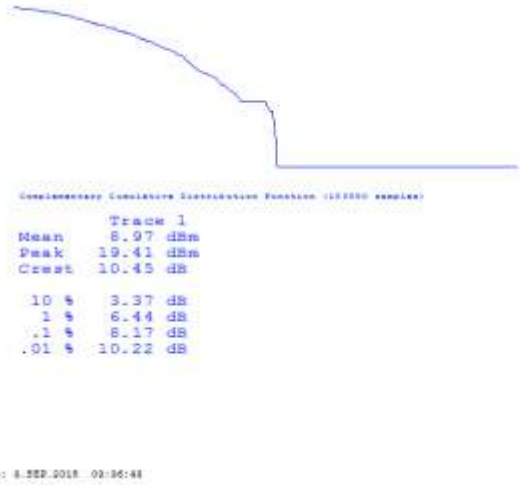


Figure 5-49a: Band 4 Mid Channel PAR, 1.4MHz BW, RB=3, QPSK

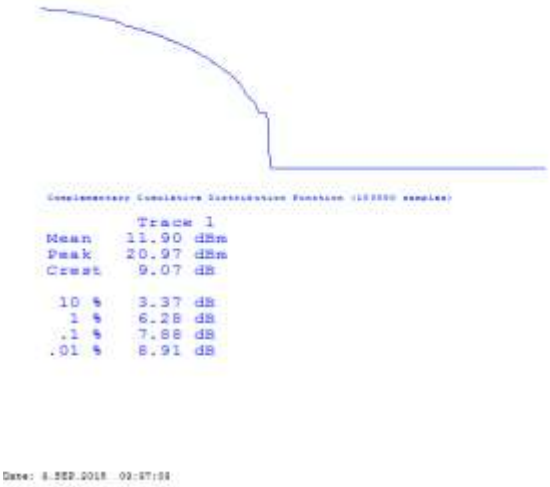
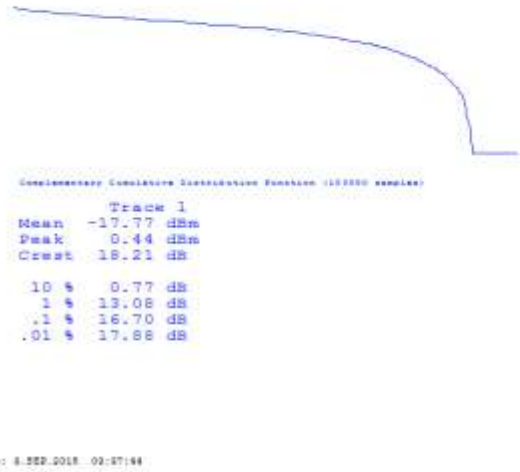


Figure 5-50a: Band 4 Middle Channel Mask, 5MHz BW, RB=6, 16-QAM



LTE Band 4 Conducted RF Emission Test Data cont'd

Figure 5-51a: Occupied Bandwidth, Band 4 Low Channel, 20MHz BW (RB= 100) 16-QAM

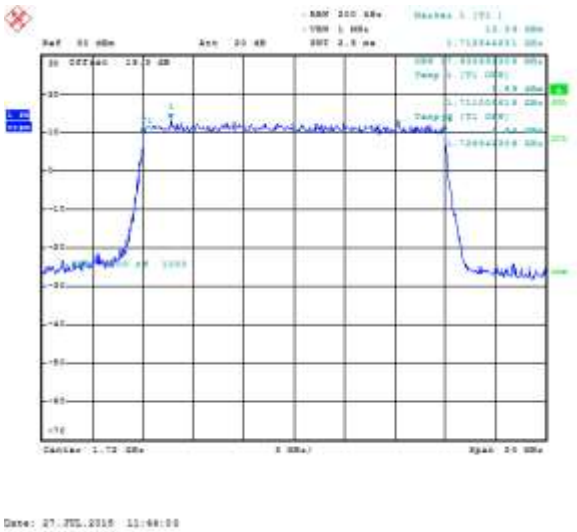


Figure 5-52a: Occupied Bandwidth, Band 4 Mid Channel, 20MHz BW (RB= 100) 16-QAM

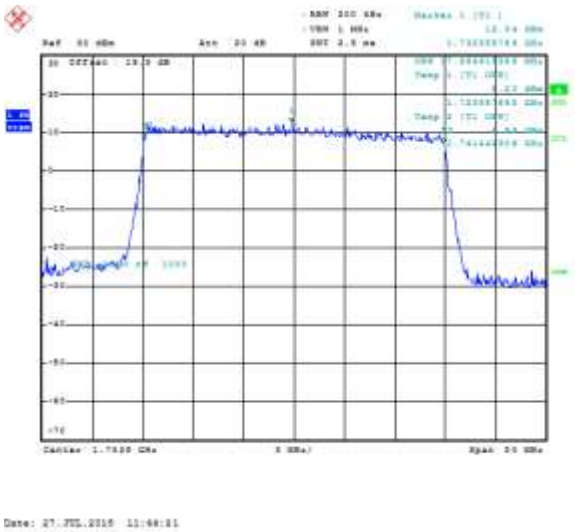
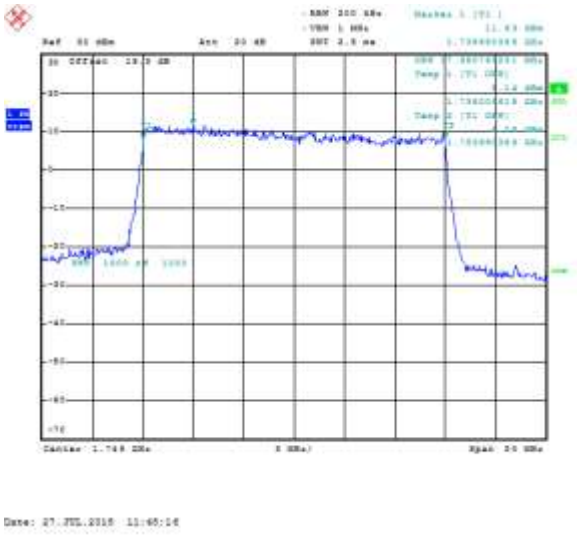
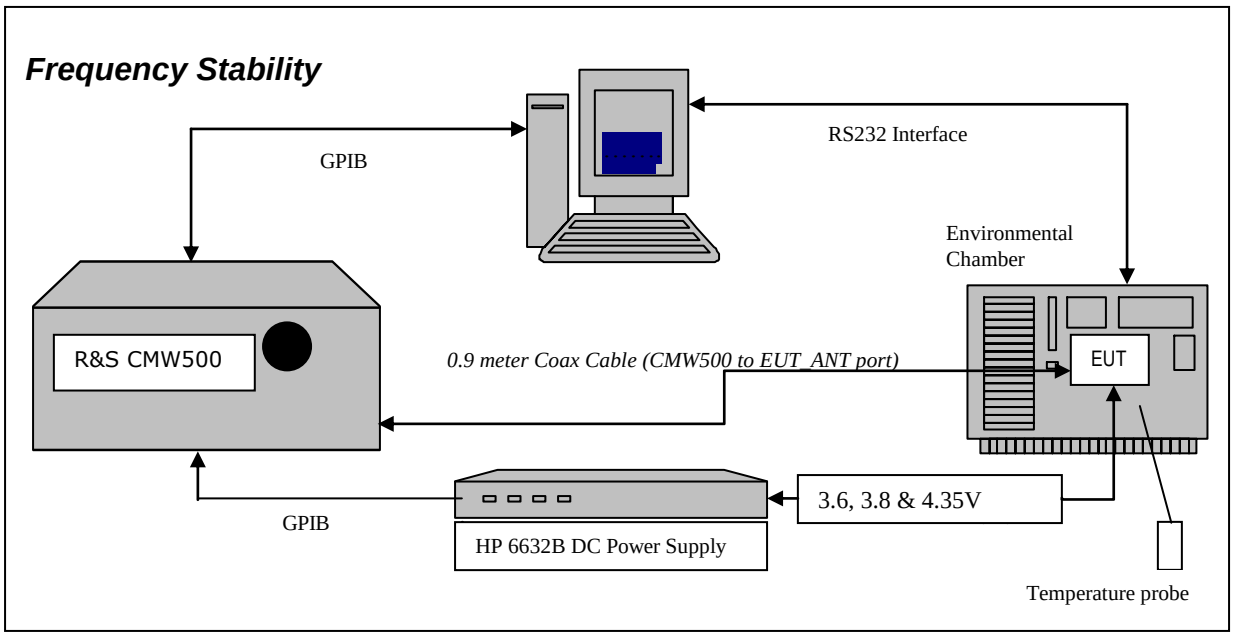


Figure 5-53a: Occupied Bandwidth, Band 4 High Channel, 20MHz BW (RB= 100) 16-QAM



APPENDIX 5B – LTE Band 4 FREQUENCY STABILITY TEST DATA

LTE Band 4 Frequency Stability Test Data



The following measurements were performed by Landon Martin.

CFR 47 Chapter 1 - Federal Communications Commission Rules

Part 2 Required Measurements
2.1055 Frequency Stability - Procedures
(a,b) Frequency Stability - Temperature Variation
(d) Frequency Stability - Voltage Variation

The EUT meets the requirements as stated in CFR 47 chapter 1, Section 27.54, CFR 47 and RSS-139, 6.3 Frequency Stability.
Frequency Stability measurement devices were configured as presented in the block diagram recording frequency, power, data, temperatures, and stepped voltages controlled via a GPIB interface linked to the Environmental chamber, a DC power supply, and the Communications Test Set. A 0.9-metre coax cable was calibrated to characterize the insertion loss for the transmitted frequencies between the RF input/output of the CMW 500 and the EUT antenna port.

Test Setup:

The EUT was placed in the Temperature chamber and connected to CMW 500 outside as shown in the figure above. Dry air was pumped inside the temperature chamber to maintain a backpressure during the test. The EUT was kept in the off condition at all times except when the following measurements were to be made.

The chamber was switched on and the temperature was set to -30°C.
After the chamber stabilized at -30 °C there was a soak period of one hour to alleviate moisture in the chamber, the EUT voltage was enabled.
The system software recorded the frequency, power, and associated measurements.

A Computer system controlled the automated software. This application was given the command of activating all machines intrinsic to the temperature and voltage tests controlling the CMW 500 via the GPIB Bus. The Environmental Chamber was instructed through an RS-232 serial line. The EUT dialogue was passed through a serial connection.

The EUT repetitively transmitted 100 bursts for each set of programmed parameters recording temperature, voltage settings, and systematically selected frequencies. The power supply was cycled from minimum voltage 3.6 volts, to 3.8 volts and to 4.35 volts maximum voltage. The frequency error was measured at a maximum output power and recorded by the automated system test software.

The EUT output power and frequency was measured at 3.6 volts, 3.8 volts and 4.35 volts. The transmit frequency was varied in 3 steps consisting of 1720.0 MHz, 1732.5 MHz and 1745.0 MHz each was measured under 20 MHz bandwidth with maximum (100) RBs. This frequency was recorded in MHz and deviation from nominal, in Parts Per Million.

After the initial one-hour soak at the beginning of the tests, a period of thirty minutes soak was initialized between each ascending temperature step, before proceeding to the next measurement test cycle.

Procedure:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

29. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
30. Start test program
31. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
32. Set power supply voltage to 3.6 volts.
33. Set up CMW 500 Radio Communication Tester.
34. Command the CMW 500 to switch to the low channel.
35. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
36. EUT is commanded to Transmit 100 Bursts.
37. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
38. The CMW 500 commands the EUT to change frequency to the middle channel and high channel and repeats steps 7 to 9.
39. Repeat steps 5 to 10 changing the supply voltage to 3.8 Volts
40. Increase temperature by 10°C and soak for 1/2 hour.
41. Repeat steps 4 - 12 for temperatures –30°C to 60°C.
42. Repeat steps 5 to 10 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

The maximum frequency error in the LTE band 4 measured was **0.0043 PPM**.

LTE Band 4 results: channels 20050, 20175 and 20300 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20050	1720.0	3.6	20	6.04	0.0035
20175	1732.5	3.6	20	6.35	0.0037
20300	1745.0	3.6	20	-4.33	-0.0025

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20050	1720.0	3.8	20	4.86	0.0028
20175	1732.5	3.8	20	5.12	0.0030
20300	1745.0	3.8	20	-5.36	-0.0031

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20050	1720.0	4.35	20	7.32	**0.0043**
20175	1732.5	4.35	20	5.21	0.0030
20300	1745.0	4.35	20	-5.04	-0.0029

LTE band 4 Results: channel 20050 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20050	1720.0	3.6	-30	5.55	0.0032
20050	1720.0	3.6	-20	5.94	0.0035
20050	1720.0	3.6	-10	5.99	0.0035
20050	1720.0	3.6	0	7.28	0.0042
20050	1720.0	3.6	10	6.24	0.0036
20050	1720.0	3.6	20	6.04	0.0035
20050	1720.0	3.6	30	5.39	0.0031
20050	1720.0	3.6	40	2.99	0.0017
20050	1720.0	3.6	50	5.08	0.0030
20050	1720.0	3.6	60	5.38	0.0031
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20050	1720.0	3.8	-30	4.05	0.0024
20050	1720.0	3.8	-20	7.12	0.0041
20050	1720.0	3.8	-10	4.75	0.0028
20050	1720.0	3.8	0	4.72	0.0027
20050	1720.0	3.8	10	5.95	0.0035
20050	1720.0	3.8	20	4.86	0.0028
20050	1720.0	3.8	30	5.79	0.0034
20050	1720.0	3.8	40	6.64	0.0039
20050	1720.0	3.8	50	7.77	0.0045
20050	1720.0	3.8	60	5.92	0.0034
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20050	1720.0	4.35	-30	5.87	0.0034
20050	1720.0	4.35	-20	4.63	0.0027
20050	1720.0	4.35	-10	5.34	0.0031
20050	1720.0	4.35	0	3.95	0.0023
20050	1720.0	4.35	10	5.26	0.0031
20050	1720.0	4.35	20	7.32	0.0043
20050	1720.0	4.35	30	4.75	0.0028
20050	1720.0	4.35	40	6.11	0.0036
20050	1720.0	4.35	50	8.10	**0.0047**
20050	1720.0	4.35	60	3.92	0.0023

LTE band 4 Results: channel 20175 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20175	1732.5	3.6	-30	7.22	**0.0042**
20175	1732.5	3.6	-20	4.92	0.0028
20175	1732.5	3.6	-10	4.68	0.0027
20175	1732.5	3.6	0	6.79	0.0039
20175	1732.5	3.6	10	4.39	0.0025
20175	1732.5	3.6	20	6.35	0.0037
20175	1732.5	3.6	30	3.75	0.0022
20175	1732.5	3.6	40	5.49	0.0032
20175	1732.5	3.6	50	-4.22	-0.0024
20175	1732.5	3.6	60	4.02	0.0023
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20175	1732.5	3.8	-30	-3.58	-0.0021
20175	1732.5	3.8	-20	4.33	0.0025
20175	1732.5	3.8	-10	4.59	0.0027
20175	1732.5	3.8	0	4.82	0.0028
20175	1732.5	3.8	10	4.71	0.0027
20175	1732.5	3.8	20	5.12	0.0030
20175	1732.5	3.8	30	-5.58	-0.0032
20175	1732.5	3.8	40	4.36	0.0025
20175	1732.5	3.8	50	-4.05	-0.0023
20175	1732.5	3.8	60	4.19	0.0024
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20175	1732.5	4.35	-30	4.73	0.0027
20175	1732.5	4.35	-20	3.83	0.0022
20175	1732.5	4.35	-10	4.49	0.0026
20175	1732.5	4.35	0	5.21	0.0030
20175	1732.5	4.35	10	3.09	0.0018
20175	1732.5	4.35	20	5.21	0.0030
20175	1732.5	4.35	30	4.95	0.0029
20175	1732.5	4.35	40	-3.91	-0.0023
20175	1732.5	4.35	50	-3.02	-0.0017
20175	1732.5	4.35	60	4.72	0.0027

LTE band 4 Results: channel 20300 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
20300	1745.0	3.6	-30	-5.85	-0.0034
20300	1745.0	3.6	-20	-4.26	-0.0024
20300	1745.0	3.6	-10	-4.79	-0.0027
20300	1745.0	3.6	0	3.26	0.0019
20300	1745.0	3.6	10	-3.73	-0.0021
20300	1745.0	3.6	20	-4.33	-0.0025
20300	1745.0	3.6	30	-5.68	-0.0033
20300	1745.0	3.6	40	-4.21	-0.0024
20300	1745.0	3.6	50	-7.24	-0.0041
20300	1745.0	3.6	60	-6.29	-0.0036
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20300	1745.0	3.8	-30	-6.29	-0.0036
20300	1745.0	3.8	-20	-4.81	-0.0028
20300	1745.0	3.8	-10	3.66	0.0021
20300	1745.0	3.8	0	-2.78	-0.0016
20300	1745.0	3.8	10	-4.68	-0.0027
20300	1745.0	3.8	20	-5.36	-0.0031
20300	1745.0	3.8	30	-5.46	-0.0031
20300	1745.0	3.8	40	-6.47	-0.0037
20300	1745.0	3.8	50	-4.45	-0.0025
20300	1745.0	3.8	60	-5.82	-0.0033
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
20300	1745.0	4.35	-30	-6.14	-0.0035
20300	1745.0	4.35	-20	-5.68	-0.0033
20300	1745.0	4.35	-10	-2.78	-0.0016
20300	1745.0	4.35	0	-2.78	-0.0016
20300	1745.0	4.35	10	-3.46	-0.0020
20300	1745.0	4.35	20	-5.04	-0.0029
20300	1745.0	4.35	30	-5.51	-0.0032
20300	1745.0	4.35	40	-4.86	-0.0028
20300	1745.0	4.35	50	-4.46	-0.0026
20300	1745.0	4.35	60	-7.71	**-0.0044**

APPENDIX 5C – LTE Band 4 RADIATED EMISSIONS TEST DATA

Radiated Power Test Data Results

The following measurements were performed by Savtej Sandhu.
Date of Test: July 23, 2015
The environmental tests conditions were: Temperature: 24.1 °C
Relative Humidity: 34.2 %
The BlackBerry® smartphone was standalone, side button pointing down with the LCD facing to the RX antenna when the turntable is at 0 degree position.
Measurements were performed with QPSK and 16QAM modulations. The smallest test margins are reported below.
Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height.

LTE band 4, 10MHz BW, RB=1, QPSK modulation

								Substitution Method					
EUT				Rx Antenna		Spectrum Analyzer		Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBuV)	Max (V,H) (dBuV)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Isotropic Radiator) (dBm)	(W)	Limit (dBm)	Diff to Limit (dB)
F0	20000	1715.00	4	Horn	V	-21.34	-21.34	V-V	-13.41	25.78	0.38	30.00	4.22
F0	20000	1715.00	4	Horn	H	-23.07		H-H	-12.86				
F0	20175	1732.50	4	Horn	V	-21.74	-21.74	V-V	-13.50	**25.94**	0.39	30.00	4.06
F0	20175	1732.50	4	Horn	H	-23.31		H-H	-12.85				
F0	20349	1749.90	4	Horn	V	-22.25	-22.25	V-V	-13.43	25.79	0.38	30.00	4.21
F0	20349	1749.90	4	Horn	H	-22.70		H-H	-12.81				

LTE band 4, 10MHz BW, RB=1, 16-QAM modulation

								Substitution Method					
EUT				Rx Antenna		Spectrum Analyzer		Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBuV)	Max (V,H) (dBuV)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Isotropic Radiator) (dBm)	(W)	Limit (dBm)	Diff to Limit (dB)
F0	20000	1715.00	4	Horn	V	-21.99	-21.99	V-V	-14.01	**25.11**	0.32	30.00	4.89
F0	20000	1715.00	4	Horn	H	-23.98		H-H	-13.53				
F0	20175	1732.50	4	Horn	V	-22.71	-22.71	V-V	-14.53	24.95	0.31	30.00	5.05
F0	20175	1732.50	4	Horn	H	-23.95		H-H	-13.84				
F0	20349	1749.90	4	Horn	V	-23.19	-23.19	V-V	-14.50	24.89	0.31	30.00	5.11
F0	20349	1749.90	4	Horn	H	-23.75		H-H	-13.71				

Radiated Emissions Test Data Results cont'd

The following measurements were performed by Savtej Sandhu.

Date of Test: July 22, 2015

The environmental test conditions were: Temperature: 24.8 ºC
Relative Humidity: 34.6 %

The BlackBerry® smartphone was standalone, side button point up with LCD facing to the RX antenna when the turntable is at 0 degree position

Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height, and the frequency range scanned was 30MHz – 1GHz.

Measurements were performed in LTE band 4 with QPSK and 16-QAM modulations for 5MHz BW (channel 19975, 20175 and 20374 with RB = 1).

All emissions were at least 25.0 dB below the limit.

The following measurements were performed by Masud Attayi and Xing Fang.

Date of Test: July 22 and 23, 2015

The environmental test conditions were: Temperature: 26.6 ºC
Relative Humidity: 30.2 %

Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height, and a frequency range of 1 GHz to 20 GHz.

The BlackBerry® smartphone was standalone, side button point up with LCD facing to the RX antenna when the turntable is at 0 degree position

Measurements were performed in LTE band 4 with QPSK and 16-QAM modulations for 5MHz BW (channel 19975, 20175 and 20374 with RB = 1).

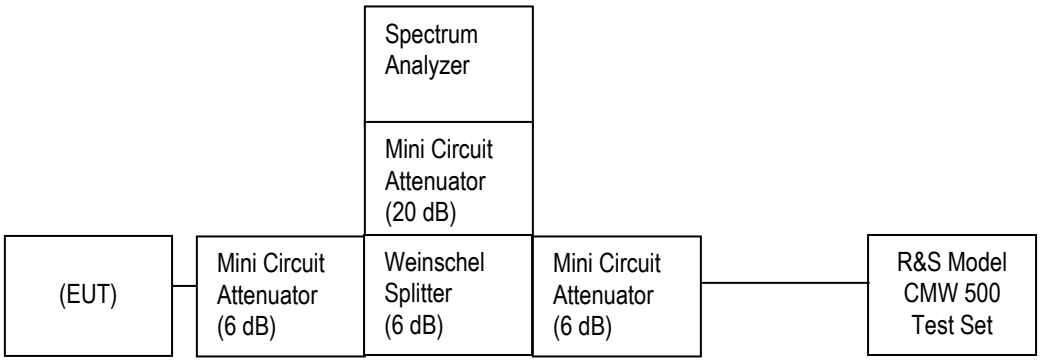
All emissions were at least 25.0 dB below the limit.

APPENDIX 6A– LTE Band 12 CONDUCTED RF EMISSIONS TEST DATA/PLOTS

LTE Band 12 Conducted RF Emission Test Data

This appendix contains measurement data pertaining to conducted spurious emissions, 99% power bandwidth and the channel mask.

Test Setup Diagram



Date of Test: July 27 – September 3, 2015

The environmental test conditions were: Temperature: 22.7 – 23.6 ºC
Relative Humidity: 38.7 – 61.2 %

The following measurements were performed by Sijia Li and Landon Martin.

LTE Band 12 Conducted RF Emission Test Data cont'd

Emission Designator Table

Frequency Range (MHz)	Conducted Output Power (dBm)	Emission Designator	Band	Bandwidth (MHz)	Modulation
701.5-713.5	**22.74**	4M50G7D	LTE B12	5	QPSK
701.5-713.5	22.45	4M48D7W	LTE B12	5	16QAM
704.0-711.0	22.72	8M97G7D	LTE B12	10	QPSK
704.0-711.0	22.55	8M94D7W	LTE B12	10	16QAM

The conducted spurious emissions – As per 47 CFR 2.1051, 27.53(g), RSS-130, 4.6 were measured from 30 MHz to 20 GHz.

–26 dBc Bandwidth and Occupied Bandwidth (99%)
the modulation spectrum was measured by both methods of 99% power bandwidth and –26 dBc bandwidth for each 5MHz and 10MHz with different number of RBs for LTE Band 12.

QPSK and 16-QAM modulations were applied to each of the bandwidths. Only the worst case measurements are documented in this report.
A minimum RB condition was also measured (RB = 1).
The resolution bandwidth required for out-of-band emissions in the 1 MHz bands immediately outside and adjacent to the frequency block, was determined to be at least 1% of the emission bandwidth.

The worst case –26dBc bandwidth for LTE Band 12 was measured to be 9.22 MHz. Results were derived in a 100 kHz resolution bandwidth.
On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

26dbc Test Data for LTE Band 12 selected Frequencies in 10MHz BW (RB = 50)

LTE Band 12 Frequency (MHz)	26dBc Occupied Bandwidth (MHz)
707.5	**9.22**

26 dbc Test Data for LTE Band 12 selected Frequencies in 5MHz BW (RB = 25)

LTE Band 12 Frequency (MHz)	26dBc Occupied Bandwidth (MHz)
704	4.635
707.5	4.64
711	4.615

Test Data for LTE Band 12 selected Frequencies in 10MHz BW (RB =50)

LTE Band 17 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
707.5	8.97	8.94

Test Data for LTE Band 12 selected Frequencies in 5MHz BW (RB =25)

LTE Band 17 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
701.5	4.50	4.48
707.5	4.47	4.48
713.5	4.50	4.48

Test Data for LTE Band 12 selected Frequencies in 3MHz BW (RB =15)

LTE Band 17 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
700.5	2.70	2.69
707.5	2.70	2.69
714.5	2.70	2.69

Test Data for LTE Band 12 selected Frequencies in 5MHz BW (RB =6)

LTE Band 17 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
706	1.09	1.08
707.5	1.10	1.09
709	1.09	1.09

Peak to Average Ratio (PAR)

For each 5MHz and 10MHz with Resource Block allocation 50,25 and 15 as per scalable bandwidths for LTE band 12, the peak to average ratio was measured on the low, middle and high channels with QPSK modulation.
On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.
The worst case measured was 9.61 dB on 10MHz bandwidth with Resource Block allocation 25 while transmitting at 707.5MHz.

Measurement Plots for LTE Band 12

See Figures 6-1a to 6-8a for the plots of the conducted spurious emissions.
See Figures 6-9a to 6-16a for the plots of 99% Occupied Bandwidth and -26 dBc Bandwidth.
See Figures 6-17a to 6-21a for the plots of the Channel mask.
See Figures 6-22a for the plots of the Peak to Average Ratio.

LTE Band 12 Conducted RF Emission Test Data cont'd

Figure 3-1a: Band 12, Spurious Conducted Emissions, 10MHz BW (RB= 50)

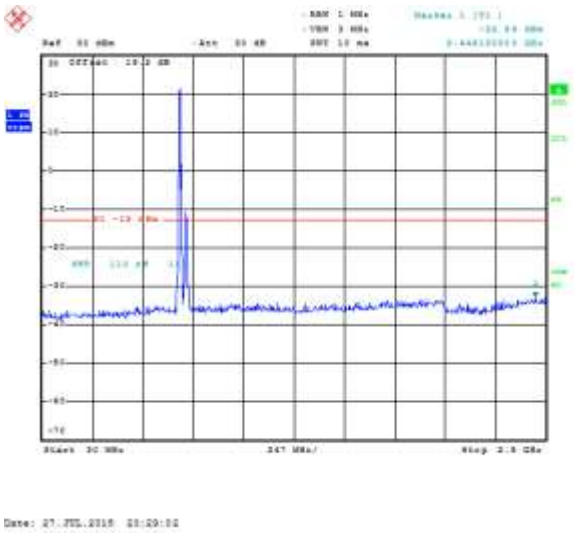


Figure 3-2a: Band 12, Spurious Conducted Emissions, 10MHz BW (RB= 50)

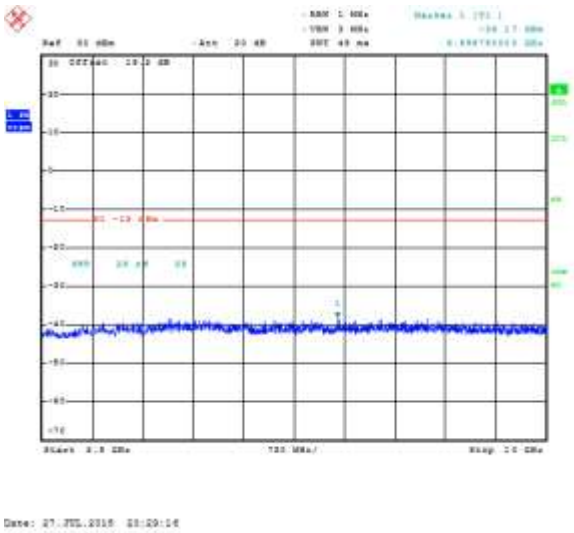


Figure 3-3a: Band 12, Spurious Conducted Emissions, Low channel, 5MHz BW (RB= 1)

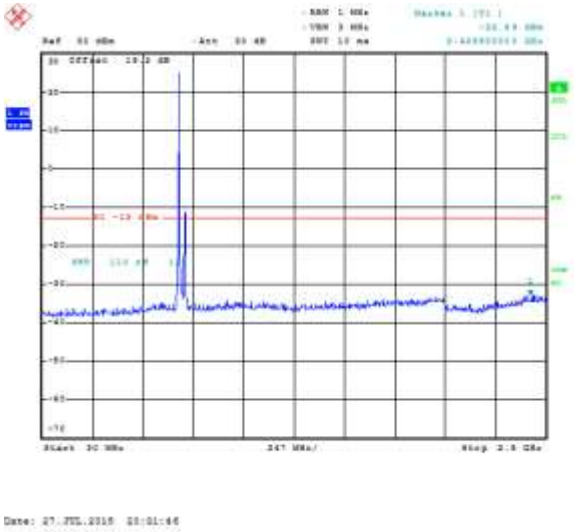
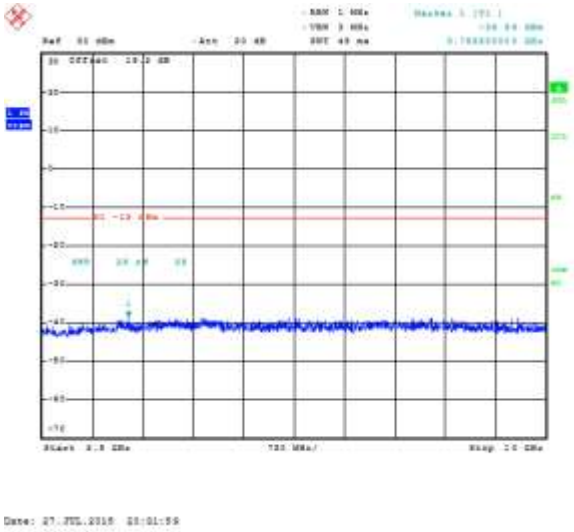


Figure 3-4a: Band 12, Spurious Conducted Emissions, Low channel, 5MHz BW (RB= 1)



LTE Band 12 Conducted RF Emission Test Data cont'd

Figure 3-5a: Band 12, Spurious Conducted Emissions, Middle Channel, 5MHz BW (RB= 25)

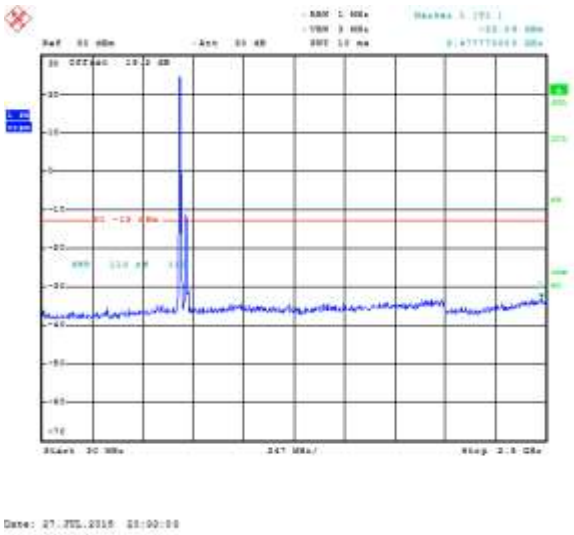


Figure 3-6a: Band 12, Spurious Conducted Emissions, High Channel, 5MHz BW (RB= 25)

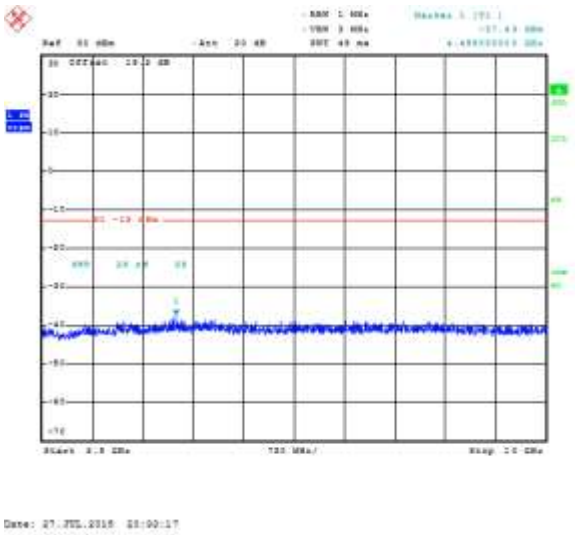


Figure 3-7a: Band 12, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)

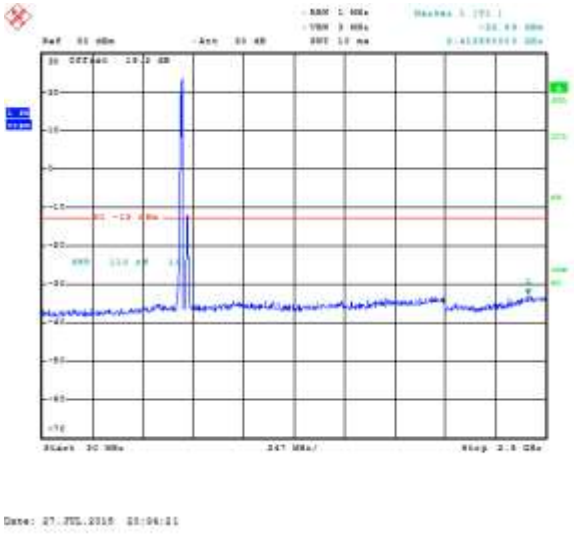
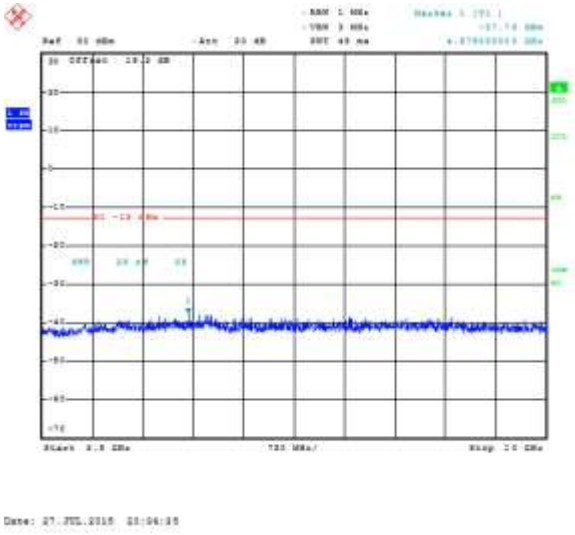


Figure 3-8a: Band 12, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)



LTE Band 12 Conducted RF Emission Test Data cont'd

Figure 3-9a: Occupied Bandwidth, Band 12 10MHz BW, RB=50

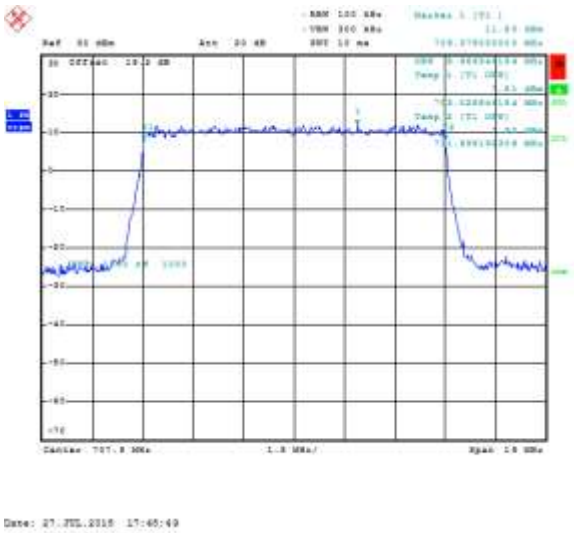


Figure 3-10a: Occupied Bandwidth, Band 5 Low Channel, 5MHz BW, RB=25

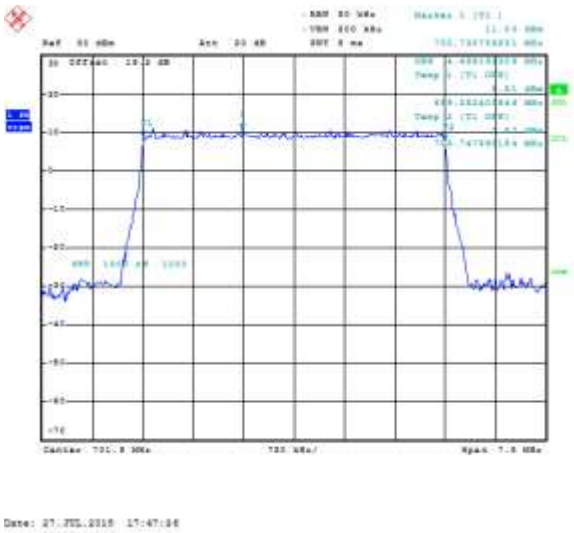


Figure 3-11a: Occupied Bandwidth, Band 5 Middle Channel, 5MHz BW, RB=25

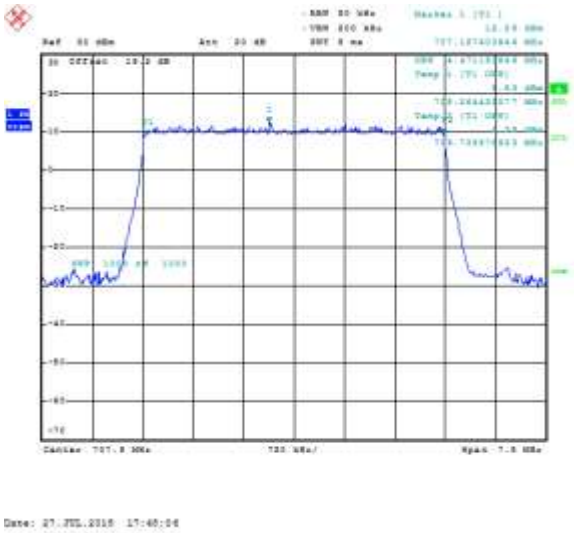
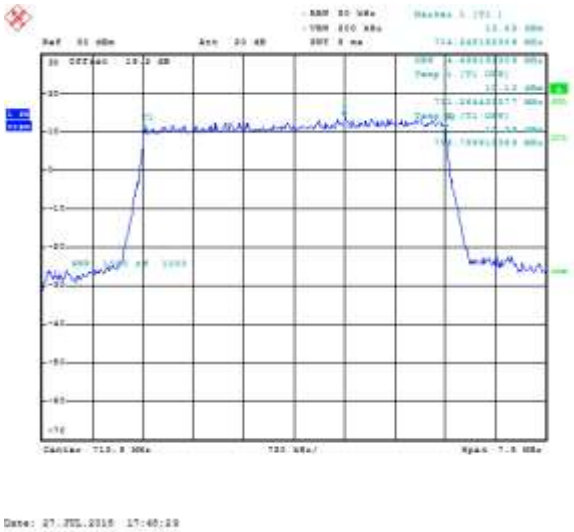


Figure 3-12a: Occupied Bandwidth, Band 5 High Channel, 5MHz BW, RB=25



LTE Band 12 Conducted RF Emission Test Data cont'd

Figure 3-13a: -26 dBc Bandwidth, Band 12 Middle Channel, 10MHz BW, RB=50

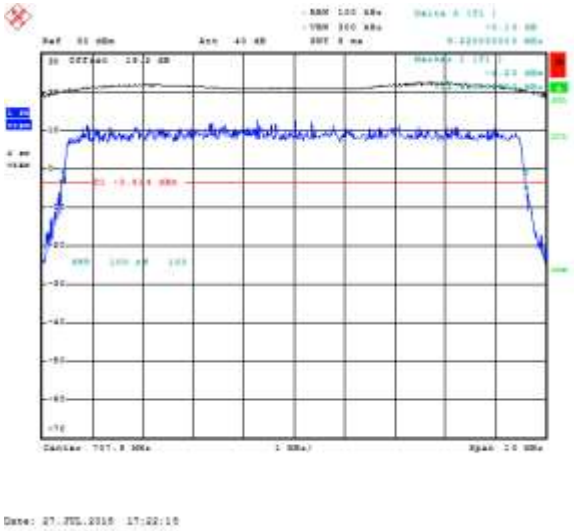


Figure 3-14a: -26 dBc Bandwidth, Band 12 Low Channel, 5MHz BW, RB=25

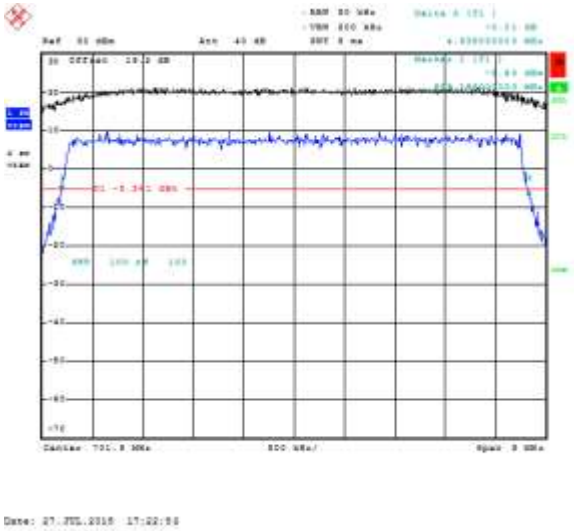


Figure 3-15a: -26 dBc Bandwidth, Band 12 Middle Channel, 5MHz BW, RB=25

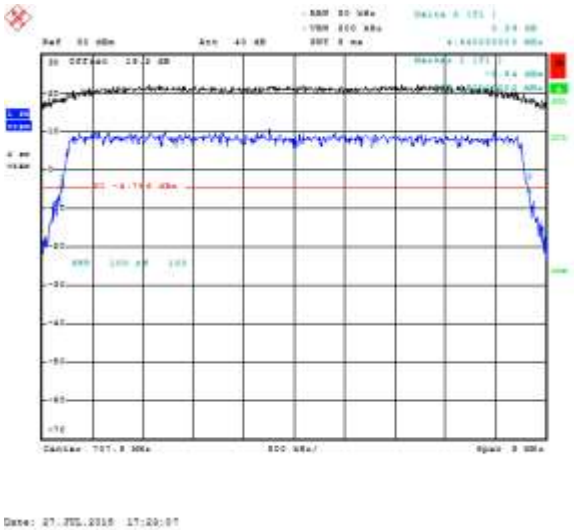
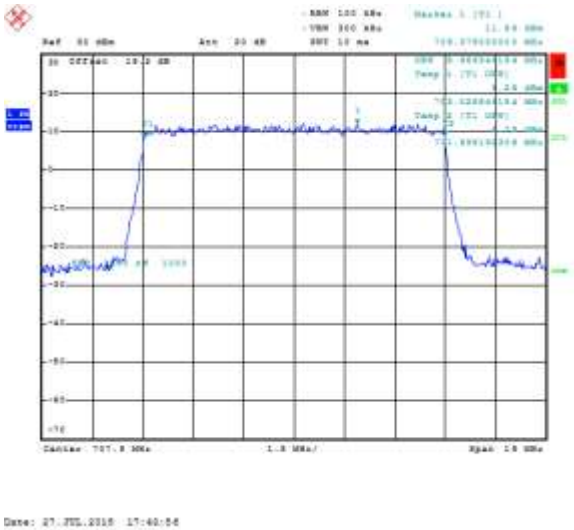


Figure 3-16a: -26 dBc Bandwidth, Band 12 High Channel, 5MHz BW, RB=25



LTE Band 12 Conducted RF Emission Test Data cont'd

Figure 3-17a: Band 12 Channel Mask, 10MHz BW, RB=50

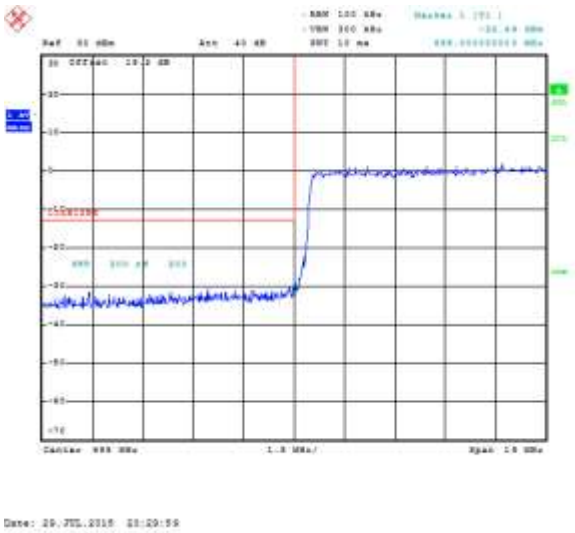


Figure 3-17a: Band 12 Channel Mask, 10MHz BW, RB=50

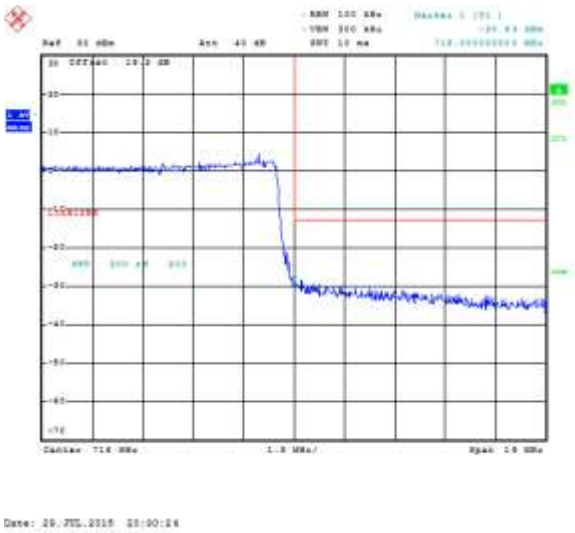


Figure 3-18a: Band 12 Low Channel Mask, 5MHz BW, RB=1

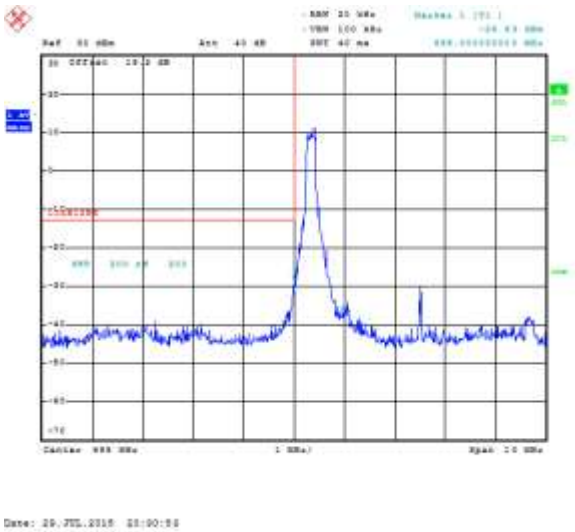
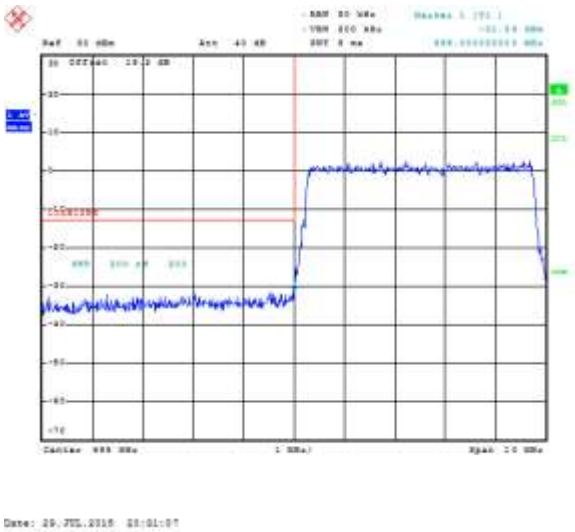


Figure 3-19a: Band 12 Low Channel Mask, 5MHz BW, RB=25



LTE Band 12 Conducted RF Emission Test Data cont'd

Figure 3-20a: Band 12 High Channel Mask, 5MHz BW, RB=1

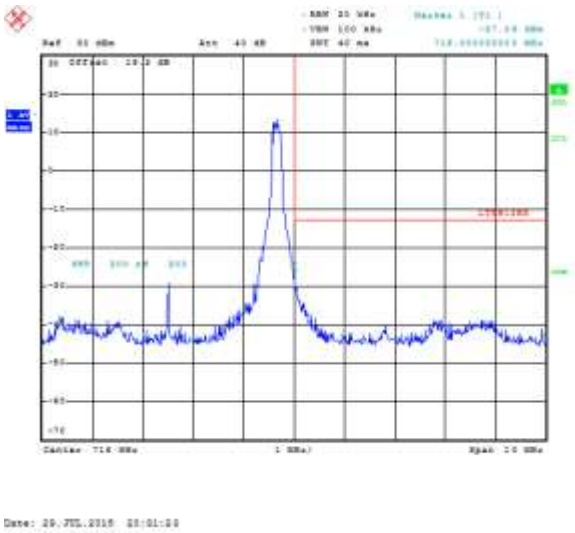


Figure 3-21a: Band 12 High Channel Mask, 5MHz BW, RB=25

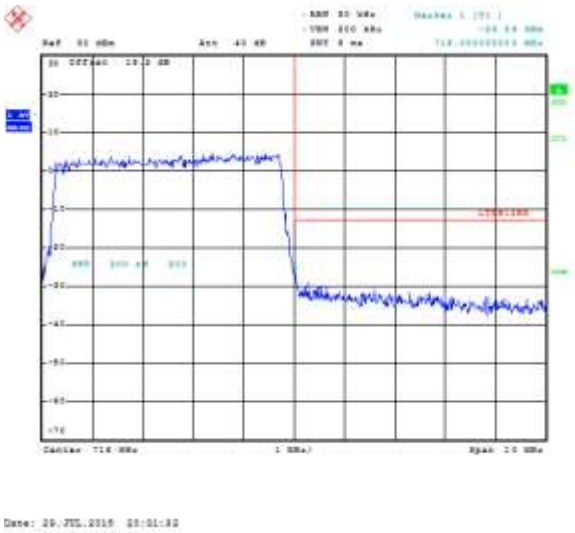
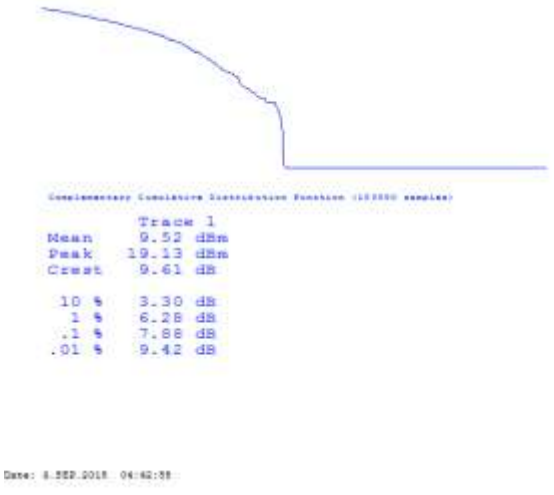
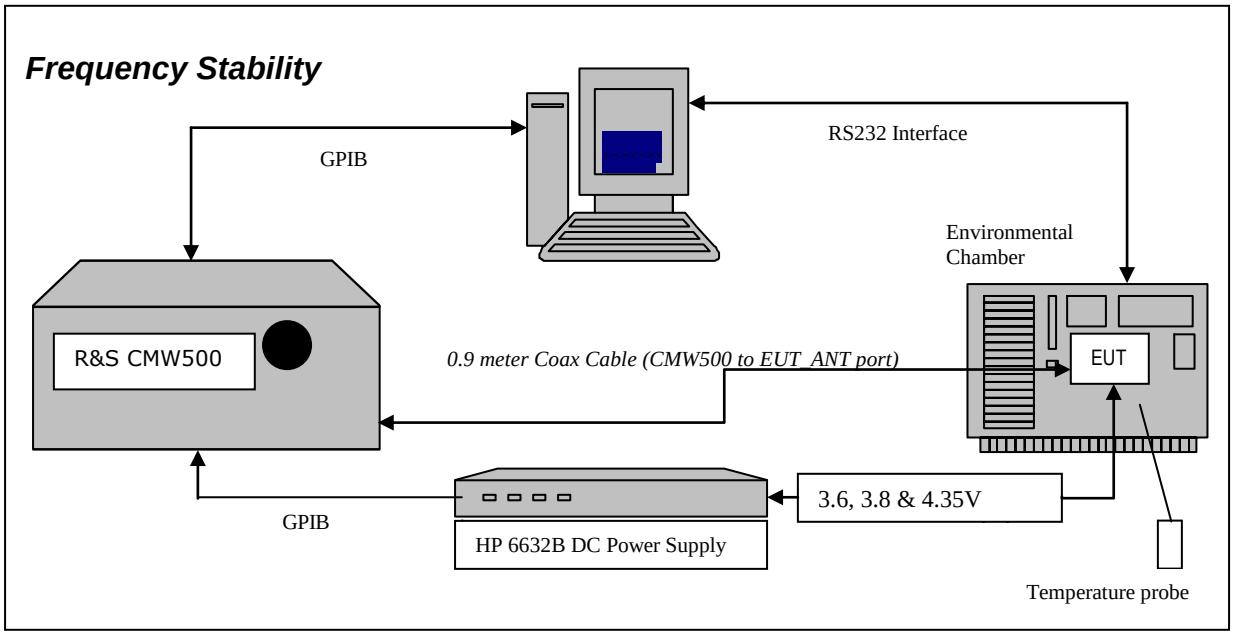


Figure 3-22a: Band 12 PAR, 10MHz BW, RB=25



APPENDIX 6B – LTE Band 12 FREQUENCY STABILITY TEST DATA

LTE Band 12 Frequency Stability Test Data



The following measurements were performed by Sijia Li.

CFR 47 Chapter 1 - Federal Communications Commission Rules

Part 2 Required Measurements
2.1055 Frequency Stability - Procedures
(a,b) Frequency Stability - Temperature Variation
(d) Frequency Stability - Voltage Variation

The EUT meets the requirements as stated in CFR 47 chapter 1, Section 27.54, Frequency Stability.
Frequency Stability measurement devices were configured as presented in the block diagram recording frequency, power, data, temperatures, and stepped voltages controlled via a GPIB interface linked to the Environmental chamber, a DC power supply, and the Communications Test Set. A 0.9-metre coax cable was calibrated to characterize the insertion loss for the transmitted frequencies between the RF input/output of the CMW 500 and the EUT antenna port.

Test Setup:

The EUT was placed in the Temperature chamber and connected to CMW 500 outside as shown in the figure above. Dry air was pumped inside the temperature chamber to maintain a backpressure during the test. The EUT was kept in the off condition at all times except when the following measurements were to be made.

The chamber was switched on and the temperature was set to -30°C.
After the chamber stabilized at -30 °C there was a soak period of one hour to alleviate moisture in the chamber, the EUT voltage was enabled.
The system software recorded the frequency, power, and associated measurements.

A Computer system controlled the automated software. This application was given the command of activating all machines intrinsic to the temperature and voltage tests controlling the CMW 500 via the GPIB Bus. The Environmental Chamber was instructed through an RS-232 serial line. The EUT dialogue was passed through a serial connection.

The EUT repetitively transmitted 100 bursts for each set of programmed parameters recording temperature, voltage settings, and systematically selected frequencies. The power supply was cycled from minimum voltage 3.6 volts, 3.8 volts and to 4.35 volts maximum voltage. The frequency error was measured at a maximum output power and recorded by the automated system test software.

The EUT output power and frequency was measured at 3.6 volts, 3.8 volts and 4.35 volts. The transmit frequency was measured on 782MHz for 10MHz bandwidth with maximum (50) RB. The transmit frequency was varied in 3 steps consisting of 779.5 MHz, 782.0 MHz and 784.5 MHz each was measured under 5 MHz bandwidth with maximum (25) RBs. This frequency was recorded in MHz and deviation from nominal, in Parts Per Million.

After the initial one-hour soak at the beginning of the tests, a period of thirty minutes soak was initialized between each ascending temperature step, before proceeding to the next measurement test cycle.

Procedure:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

43. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
44. Start test program
45. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
46. Set power supply voltage to 3.6 volts.
47. Set up CMW 500 Radio Communication Tester.
48. Command the CMW 500 to switch to the low channel.
49. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
50. EUT is commanded to Transmit 100 Bursts.
51. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
52. The CMW 500 commands the EUT to change frequency to the middle channel and high channel and repeats steps 7 to 9.
53. Repeat steps 5 to 10 changing the supply voltage to 3.8 Volts
54. Increase temperature by 10°C and soak for 1/2 hour.
55. Repeat steps 4 - 12 for temperatures –30°C to 60°C.
56. Repeat steps 5 to 10 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

The maximum frequency error in the LTE Band 12 measured was **0.0058 PPM**.

Date of test: April 25, 2015

LTE Band 12 results (10MHz Bandwidth): channels 23060, 23095 and 23129 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23060	704	3.6	20	-3.09	-0.0044
23095	707.5	3.6	20	3.85	0.0054
23129	710.9	3.6	20	3.85	0.0054

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23060	704	3.8	20	3.68	0.0052
23095	707.5	3.8	20	4.09	**0.0058**
23129	710.9	3.8	20	3.30	0.0046

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23060	704	4.35	20	3.45	0.0049
23095	707.5	4.35	20	3.86	0.0055
23129	710.9	4.35	20	3.78	0.0053

LTE Band 12 Results (10MHz Bandwidth): channel 23060 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23060	704	3.6	-30	-2.37	-0.0034
23060	704	3.6	-20	2.52	0.0036
23060	704	3.6	-10	3.45	0.0049
23060	704	3.6	0	4.68	0.0066
23060	704	3.6	10	2.69	0.0038
23060	704	3.6	20	-3.09	-0.0044
23060	704	3.6	30	3.63	0.0052
23060	704	3.6	40	-3.82	-0.0054
23060	704	3.6	50	-3.81	-0.0054
23060	704	3.6	60	-3.03	-0.0043

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23060	704	3.8	-30	1.97	0.0028
23060	704	3.8	-20	3.46	0.0049
23060	704	3.8	-10	3.39	0.0048
23060	704	3.8	0	1.65	0.0023
23060	704	3.8	10	-2.90	-0.0041
23060	704	3.8	20	3.68	0.0052
23060	704	3.8	30	2.57	0.0037
23060	704	3.8	40	-2.53	-0.0036
23060	704	3.8	50	-2.22	-0.0031
23060	704	3.8	60	-2.88	-0.0041

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23060	704	4.35	-30	-2.99	-0.0042
23060	704	4.35	-20	-2.79	-0.0040
23060	704	4.35	-10	2.99	0.0042
23060	704	4.35	0	1.66	0.0024
23060	704	4.35	10	-2.22	-0.0031
23060	704	4.35	20	3.45	0.0049
23060	704	4.35	30	-5.18	**-0.0074**
23060	704	4.35	40	-3.05	-0.0043
23060	704	4.35	50	2.06	0.0029
23060	704	4.35	60	3.25	0.0046

LTE Band 12 Results(5MHz Bandwidth): channel 23095 @ maximum transmitted power (cont'd)

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23095	707.5	3.6	-30	3.58	0.0051
23095	707.5	3.6	-20	3.73	0.0053
23095	707.5	3.6	-10	3.13	0.0044
23095	707.5	3.6	0	1.92	0.0027
23095	707.5	3.6	10	3.65	0.0052
23095	707.5	3.6	20	3.85	0.0054
23095	707.5	3.6	30	2.93	0.0041
23095	707.5	3.6	40	-4.11	-0.0058
23095	707.5	3.6	50	-3.08	-0.0043
23095	707.5	3.6	60	-3.60	-0.0051

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23095	707.5	3.8	-30	2.23	0.0032
23095	707.5	3.8	-20	-2.55	-0.0036
23095	707.5	3.8	-10	3.42	0.0048
23095	707.5	3.8	0	3.10	0.0044
23095	707.5	3.8	10	-2.57	-0.0036
23095	707.5	3.8	20	4.09	0.0058
23095	707.5	3.8	30	2.63	0.0037
23095	707.5	3.8	40	-3.30	-0.0047
23095	707.5	3.8	50	1.90	0.0027
23095	707.5	3.8	60	-3.39	-0.0048

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23095	707.5	4.35	-30	-4.28	-0.0060
23095	707.5	4.35	-20	-2.80	-0.0040
23095	707.5	4.35	-10	2.00	0.0028
23095	707.5	4.35	0	5.01	**0.0071**
23095	707.5	4.35	10	-2.52	-0.0036
23095	707.5	4.35	20	3.86	0.0055
23095	707.5	4.35	30	2.79	0.0039
23095	707.5	4.35	40	-4.03	-0.0057
23095	707.5	4.35	50	-3.22	-0.0045
23095	707.5	4.35	60	1.97	0.0028

LTE Band 12 Results(5MHz Bandwidth): channel 23129 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23129	710.9	3.6	-30	3.83	0.0054
23129	710.9	3.6	-20	3.81	0.0054
23129	710.9	3.6	-10	3.46	0.0049
23129	710.9	3.6	0	-2.20	-0.0031
23129	710.9	3.6	10	3.56	0.0050
23129	710.9	3.6	20	3.85	0.0054
23129	710.9	3.6	30	2.46	0.0035
23129	710.9	3.6	40	-3.09	-0.0043
23129	710.9	3.6	50	-2.13	-0.0030
23129	710.9	3.6	60	-3.35	-0.0047

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23129	710.9	3.8	-30	2.16	0.0030
23129	710.9	3.8	-20	-3.91	-0.0055
23129	710.9	3.8	-10	3.00	0.0042
23129	710.9	3.8	0	-1.69	-0.0024
23129	710.9	3.8	10	-2.92	-0.0041
23129	710.9	3.8	20	3.30	0.0046
23129	710.9	3.8	30	-3.00	-0.0042
23129	710.9	3.8	40	-2.99	-0.0042
23129	710.9	3.8	50	1.80	0.0025
23129	710.9	3.8	60	-2.96	-0.0042

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23129	710.9	4.35	-30	-3.25	-0.0046
23129	710.9	4.35	-20	-2.39	-0.0034
23129	710.9	4.35	-10	2.83	0.0040
23129	710.9	4.35	0	4.61	**0.0065**
23129	710.9	4.35	10	3.56	0.0050
23129	710.9	4.35	20	3.78	0.0053
23129	710.9	4.35	30	2.02	0.0028
23129	710.9	4.35	40	3.75	0.0053
23129	710.9	4.35	50	-2.76	-0.0039
23129	710.9	4.35	60	-2.70	-0.0038

Procedure for IC:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

1. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
2. Start test program
3. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
4. Set power supply voltage to 3.6 volts.
5. Set up CMW 500 Radio Communication Tester.
6. Command the CMW 500 to switch to the low channel.
7. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
8. EUT is commanded to Transmit 100 Bursts.
9. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
10. Using a resolution bandwidth equal to that permitted within the 1MHz band immediately outside the channel edge, reference points will be selected at the unwanted emission levels which comply with the attenuation 43 + 10 log10 p, for the type of device under test, on the emission mask of the lowest and highest channels, and the frequency at these points shall be recorded as fL and fH respectively.
11. The frequency stability is calculated by fL minus the frequency offset (frequency error measured in step 9) and fH plus the frequency offset shall be within the frequency range that the equipment is designed to operate (2.5 to 2.57 GHz).
12. The CMW 500 commands the EUT to change frequency to the high channel and repeats steps 7 to 11.
13. Repeat steps 5 to 12 changing the supply voltage to 3.8 Volts
14. Increase temperature to 20 and 50°C and soak for 1/2 hour.
15. Repeat steps 4 - 14 for temperatures –30°C to 60°C.
16. Repeat steps 5 to 15 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

Date of test: Sept 2, 2015.

IC RSS – 130, 4.3 LTE Band 12 Frequency Stability.

LTE Band 12 10MHz Bandwidth results: channels 23060, & 23129 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Band 12 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23060	704	3.6	20	-2.489	700.585	N/A	700.585	N/A
23129	710.9	3.6	20	-3.576	N/A	713.980	N/A	713.980

Traffic Channel Number	LTE Band 12 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23060	704	3.8	20	-2.074	700.585	N/A	700.585	N/A
23129	710.9	3.8	20	2.661	N/A	714.205	N/A	714.205

Traffic Channel Number	LTE Band 12 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23060	704	4.35	20	-3.204	700.705	N/A	700.705	N/A
23129	710.9	4.35	20	-3.018	N/A	714.340	N/A	714.340

LTE Band 12 10MHz Bandwidth results: channels 23060, & 23129 @ -30 and +60°C maximum transmitted power

Traffic Channel Number	LTE Band 12 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23060	704	3.6	-30	2.346	700.615	N/A	700.615	N/A
23129	710.9	3.6	-30	-2.460	N/A	711.055	N/A	711.055
23060	704	3.8	-30	2.632	700.600	N/A	700.600	N/A
23129	710.9	3.8	-30	3.390	N/A	713.710	N/A	713.710
23060	704	4.35	-30	2.918	700.600	N/A	700.600	N/A
23129	710.9	4.35	-30	-2.832	N/A	711.760	N/A	711.760
23060	704	3.6	60	-3.076	700.600	N/A	700.600	N/A
23129	710.9	3.6	60	2.317	N/A	714.340	N/A	714.340
23060	704	3.8	60	-3.004	700.600	N/A	700.600	N/A
23129	710.9	3.8	60	-2.875	N/A	714.325	N/A	714.325
23060	704	4.35	60	2.146	700.570	N/A	700.570	N/A
23129	710.9	4.35	60	-2.460	N/A	714.265	N/A	714.265

APPENDIX 6C – LTE Band 12 RADIATED EMISSIONS TEST DATA

Radiated Power Test Data Results

The following measurements were performed by Shiva Kumbham.
Date of Test: August 11, 2015
The environmental tests conditions were: Temperature: 25.5 °C
Relative Humidity: 35.6 %

The BlackBerry® smartphone was standalone, with horizontal top pointing up the RX antenna when the turntable is at 0 degree position.
Measurements were performed with QPSK and 16QAM modulations. The smallest test margins are reported below.
Test Distance was 3.0 meters with the RX antenna height scans between 3-4 meters height.

LTE Band 12, 5MHz BW, RB=1, QPSK modulation

EUT				Rx Antenna		Spectrum Analyzer		Substitution Method / Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V,H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Dipole) (dBm)	(W)	Limit (dBm)	Diff. To Limit (dB)
F0	23035	701.50	13	Dipole	V	-45.71	-30.66	V-V	1.94	20.23	0.11	35.00	14.77
F0	23035	701.50	13	Dipole	H	-30.66		H-H	-0.54				
F0	23095	707.50	13	Dipole	V	-45.24	-29.38	V-V	3.16	21.48	0.14	35.00	13.52
F0	23095	707.50	13	Dipole	H	-29.38		H-H	0.60				
F0	23154	713.40	13	Dipole	V	-45.39	-29.22	V-V	3.91	**22.17**	0.16	35.00	12.83
F0	23154	713.40	13	Dipole	H	-29.22		H-H	0.97				

LTE Band 12, 5MHz BW, RB=1, 16QAM modulation

EUT				Rx Antenna		Spectrum Analyzer		Substitution Method / Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V,H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Dipole) (dBm)	(W)	Limit (dBm)	Diff. To Limit (dB)
F0	23060	704.00	13	Dipole	V	-45.99	-30.80	V-V	1.56	19.85	0.10	35.00	15.15
F0	23060	704.00	13	Dipole	H	-30.80		H-H	-0.80				
F0	23095	707.50	13	Dipole	V	-45.53	-30.25	V-V	2.23	20.55	0.11	35.00	14.45
F0	23095	707.50	13	Dipole	H	-30.25		H-H	-0.28				
F0	23129	710.90	13	Dipole	V	-45.86	-30.06	V-V	2.88	**21.14**	0.13	35.00	13.86
F0	23129	710.90	13	Dipole	H	-30.06		H-H	0.01				

Radiated Emissions Test Data Results cont'd

The following measurements were performed by Savtej Sandhu.

Date of Test: August 10, 2015

The environmental test conditions were: Temperature: 26.8 ºC
Relative Humidity: 33.2 %

The BlackBerry® smartphone was standalone, with horizontal pointing up and top facing the RX antenna when the turntable is at 0 degree position.

Test Distance was 3.0 meters with the RX antenna height scans between 3-4 meters height, and the frequency range scanned was 30MHz – 1GHz.

Measurements were performed in LTE Band 12 with 5MHz BW (channel 23060, 23095 and 23129 with RB = 1) with QPSK modulation. and 10MHz BW (channel 23060, 23095 and 23129 with RB = 1), with 16-QAM modulation.

All emissions had test margins greater than 25.0 dB.

The following measurements were performed by Xing Fang and Winston Vernon.

Date of Test: August 10-11, 2015

The environmental test conditions were: Temperature: 27.9 ºC
Relative Humidity: 39.7 %

Test Distance was 3.0 meters with the RX antenna height scans between 3-4 meters height, and a frequency range of 1 GHz to 10 GHz.

The BlackBerry® smartphone was standalone, horizontal with top facing to the RX antenna when the turntable is at 0 degree position

Measurements were performed in LTE Band 12 with 5MHz BW (channel 23060, 23095 and 23129 with RB = 1) with QPSK modulation. and 10MHz BW (channel 23060, 23095 and 23129 with RB = 1), with 16-QAM modulation.

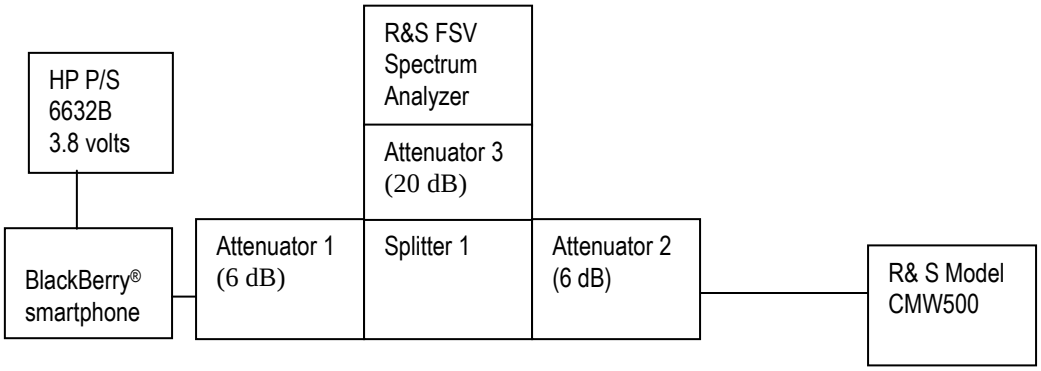
All emissions had test margins greater than 25.0 dB.

APPENDIX 7A– LTE Band 17 CONDUCTED RF EMISSIONS TEST DATA/PLOTS

LTE Band 17 Conducted RF Emission Test Data

This appendix contains measurement data pertaining to conducted spurious emissions, 99% power bandwidth and the channel mask.

Test Setup Diagram



A reference offset of 31.4 dB was applied to the spectrum analyzer reference level for the attenuators and coaxial cable loss in the test circuit.

UNIT	MANUFACTURER	MODEL	SERIAL NUMBER
Attenuator 1	Mini-Circuits	BW-S6W2+	0647
Attenuator 2	Mini-Circuits	BW-S6W2+	0648
Attenuator 3	Mini-Circuits	BW-S20-2W263+	1234
Splitter 1	Weinschel	1515	MES 92

Date of Test: July 27 to September 3, 2015.

The environmental test conditions were: Temperature: 21.9 – 24.3ºC
Relative Humidity: 38.7 – 61.60%

The following measurements were performed by Sijia Li and Landon Martin.

LTE Band 17 Conducted RF Emission Test Data cont'd

Emission Designator Table

Frequency Range (MHz)	Conducted Output Power (dBm)	Emission Designator	Band	Bandwidth (MHz)	Modulation
706.5-713.5	22.69	4M49G7D	LTE B17	5	QPSK
706.5-713.5	21.79	4M48D7W	LTE B17	5	16QAM
709-711	22.78	8M97G7D	LTE B17	10	QPSK
709-711	22.56	8M99D7W	LTE B17	10	16QAM

The conducted spurious emissions – As per 47 CFR 2.1051, 27.53(g), RSS-130, 4.6 were measured from 30 MHz to 20 GHz.

–26 dBc Bandwidth and Occupied Bandwidth (99%)

the modulation spectrum was measured by both methods of 99% power bandwidth and –26 dBc bandwidth for each 5MHz and 10MHz with Resource Block allocations 50 and 25 for LTE band 17.

QPSK and 16-QAM modulations were applied to each of the bandwidths. Only the worst case measurements are documented in this report.

The resolution bandwidth required for out-of-band emissions in the 1 MHz bands immediately outside and adjacent to the frequency block, was determined to be at least 1% of the emission bandwidth.

The worst case –26dBc bandwidth for LTE band 17 was measured to be 9.26MHz. Results were derived in a 100 kHz resolution bandwidth.

On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

Test Data for LTE Band 17 selected Frequencies in 10MHz BW (RB = 50)

LTE Band 17 Frequency (MHz)	26dBc Occupied Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	QPSK	16-QAM
709.0	9.2	8.966	8.966
710.0	9.2	8.966	8.966
711.0	**9.26**	8.966	**8.990**

Test Data for LTE Band 17 selected Frequencies in 5MHz BW (RB = 25)

LTE Band 17 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
706.5	4.495	4.483
710	4.483	4.483
713.5	4.495	4.483

Peak to Average Ratio (PAR)

For each 5MHz and 10MHz with Resource Block allocations 50,25 and 15 as per scalable bandwidths for LTE band 17, the peak to average ratio was measured on the low, middle and high channels with QPSK modulation.

On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

The worst case measured was 8.05 dB on in 10MHz bandwidth with Resource Block allocation 25.

Measurement Plots for LTE Band 17

See Figures 7-1a to 7-12a for the plots of the conducted spurious emissions.

See Figures 7-19a to 7-24a and 7-37a to 7-39a for the plots of 99% Occupied Bandwidth and -26 dBc Bandwidth.

See Figures 7-25a to 7-32a for the plots of the Channel mask.

See Figures 7-33a to 7-36a for the plots of the Peak to Average Ratio.

LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-1a: Band 17, Spurious Conducted Emissions, Low channel, 10MHz BW (RB= 1)

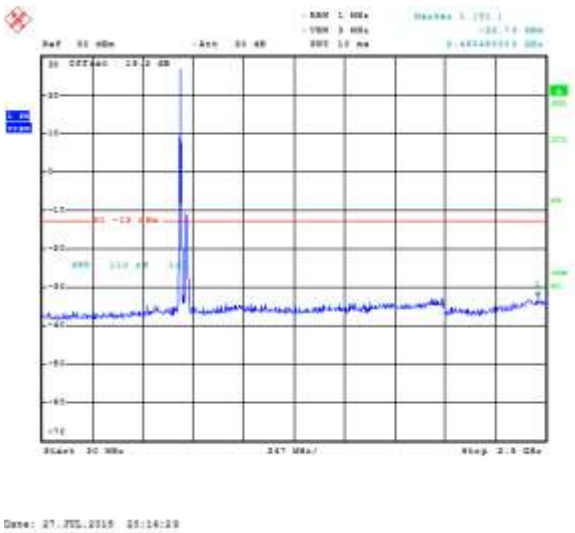


Figure 6-2a: Band 17, Spurious Conducted Emissions, Low channel, 10MHz BW (RB= 1)

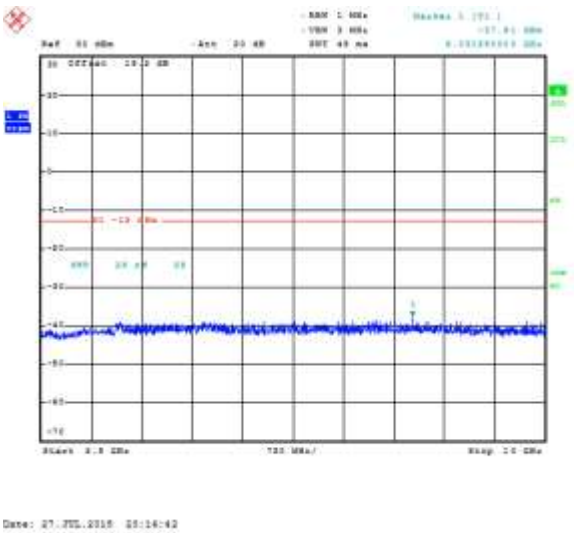


Figure 6-3a: Band 17, Spurious Conducted Emissions, Middle channel, 10MHz BW (RB= 25)

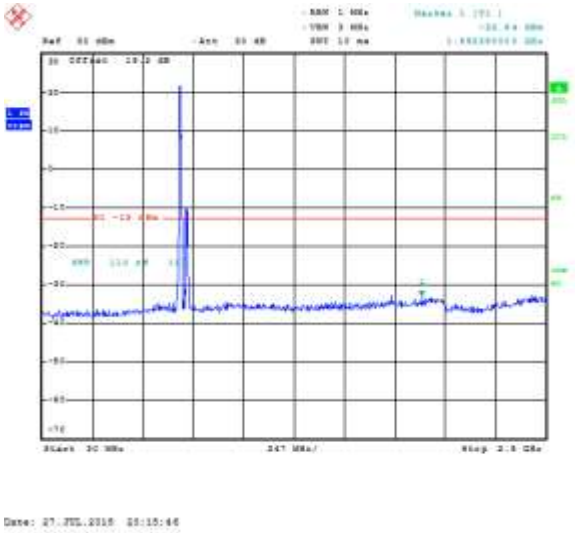
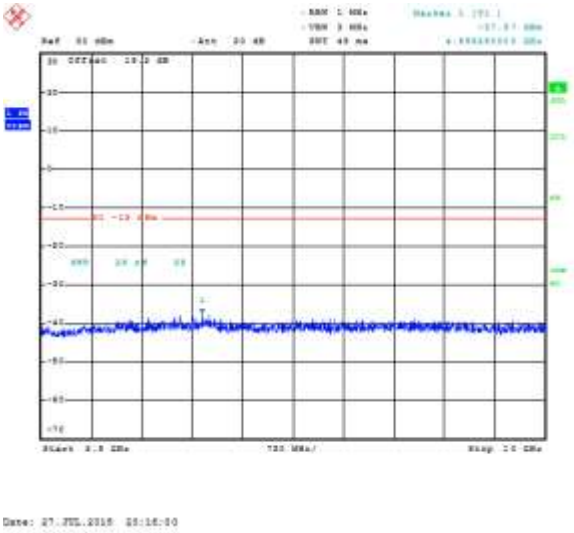


Figure 6-4a: Band 17, Spurious Conducted Emissions, Middle channel, 10MHz BW (RB= 25)



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-5a: Band 17, Spurious Conducted Emissions, High Channel, 10MHz BW (RB= 50)

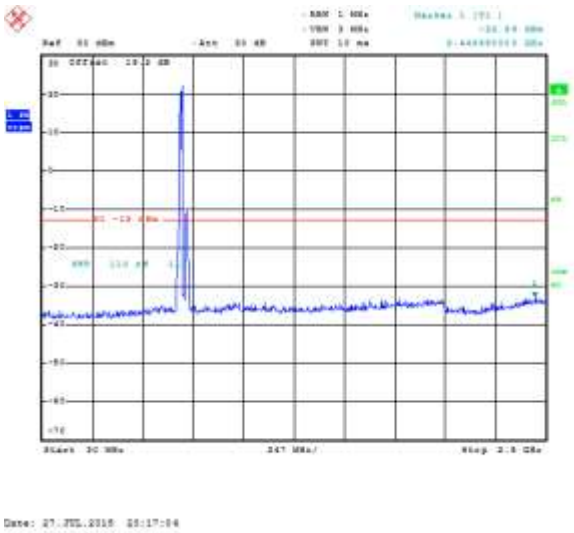


Figure 6-6a: Band 17, Spurious Conducted Emissions, High Channel, 10MHz BW (RB= 50)

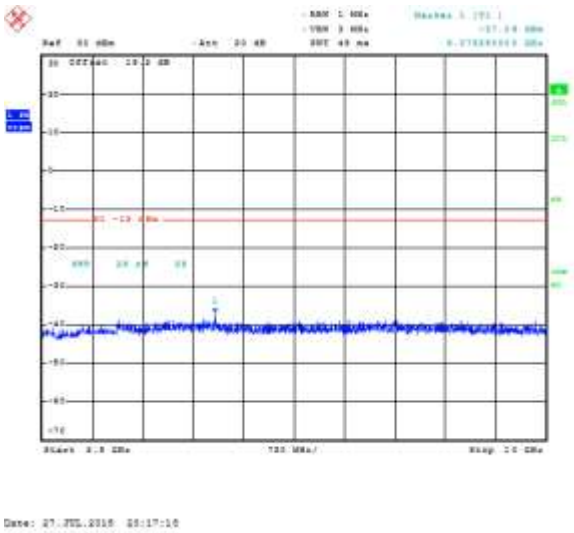


Figure 6-7a: Band 17, Spurious Conducted Emissions, Low channel, 5MHz BW (RB= 1)

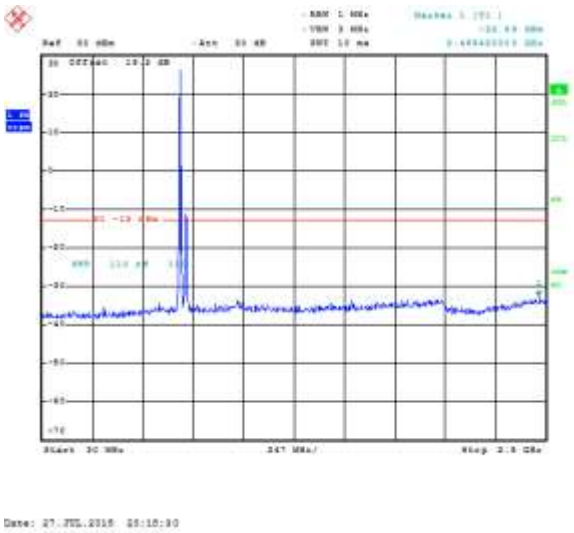
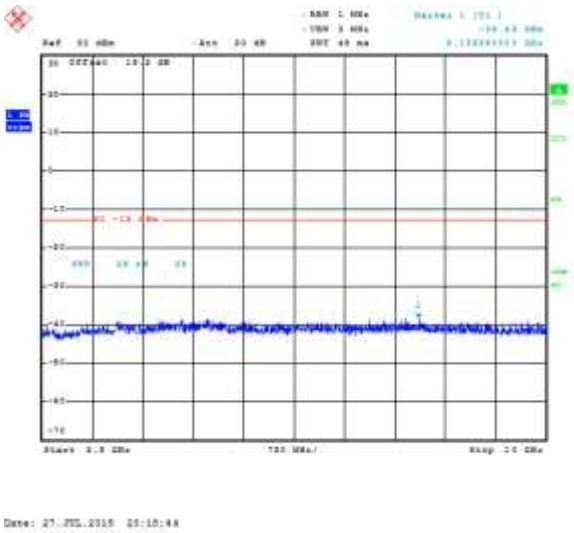


Figure 6-8a: Band 17, Spurious Conducted Emissions, Low channel, 5MHz BW (RB= 1)



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-9a: Band 17, Spurious Conducted Emissions, Middle Channel, 5MHz BW (RB= 15)

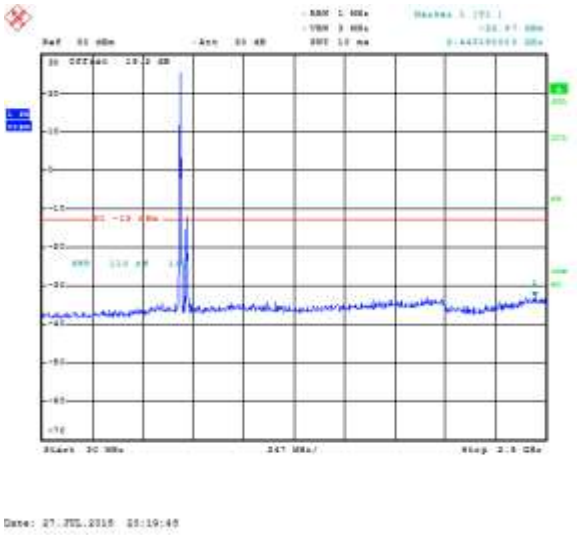


Figure 6-10a: Band 17, Spurious Conducted Emissions, High Channel, 5MHz BW (RB= 15)

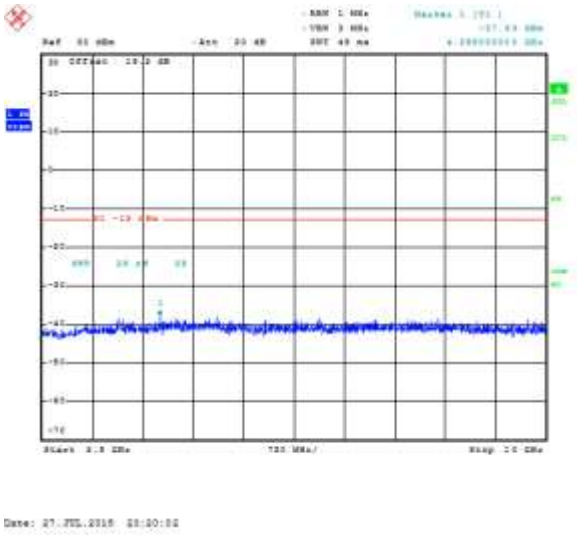


Figure 6-11a: Band 17, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)

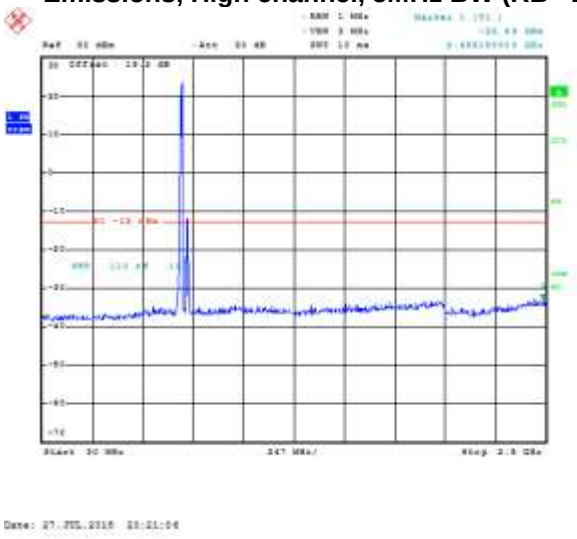
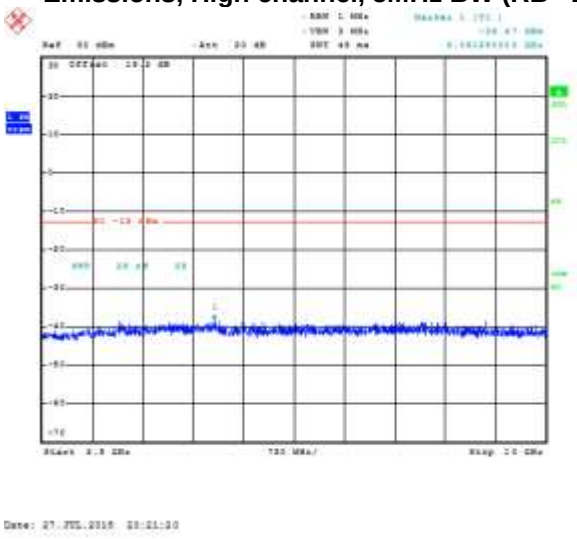


Figure 6-12a: Band 17, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-13a: Occupied Bandwidth, Band 17 Low Channel, 10MHz BW, RB=50

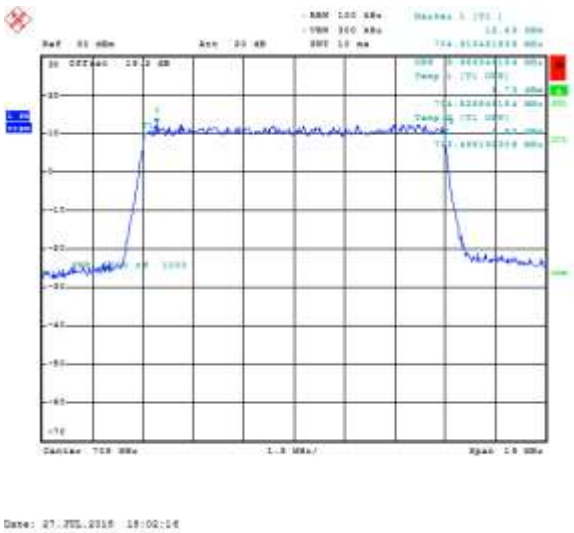


Figure 6-14a: Occupied Bandwidth, Band 17 Middle Channel, 10MHz BW, RB=50

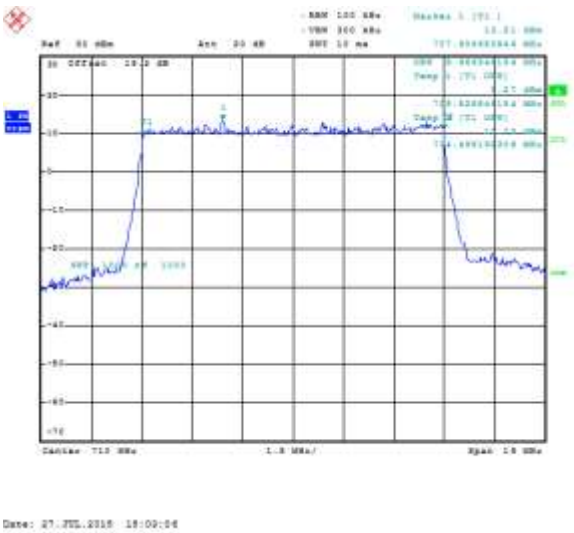
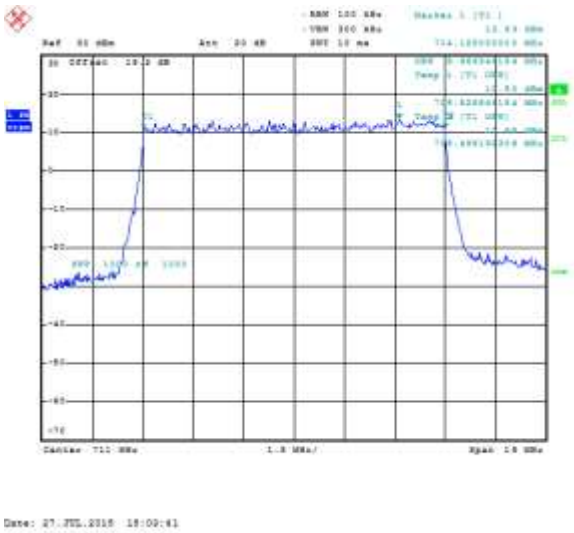


Figure 6-15a: Occupied Bandwidth, Band 17 High Channel, 10MHz BW, RB=50



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-16a: Occupied Bandwidth, Band 5 Low Channel, 5MHz BW, RB=50

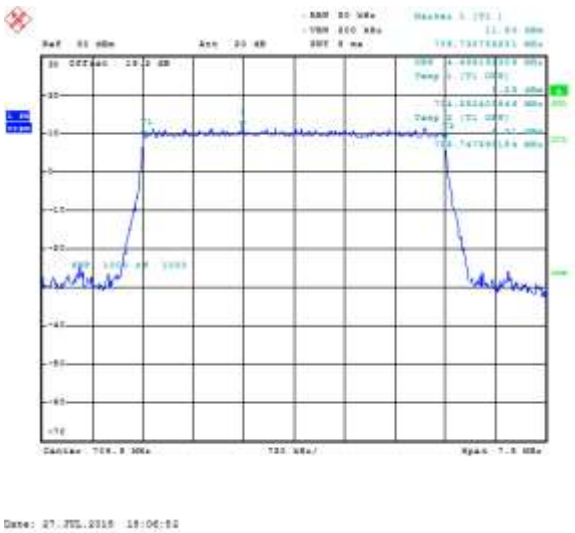


Figure 6-17a: Occupied Bandwidth, Band 5 Middle Channel, 5MHz BW, RB=50

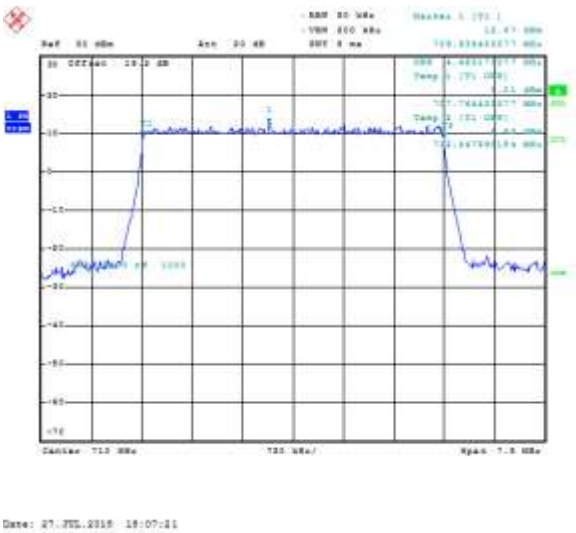
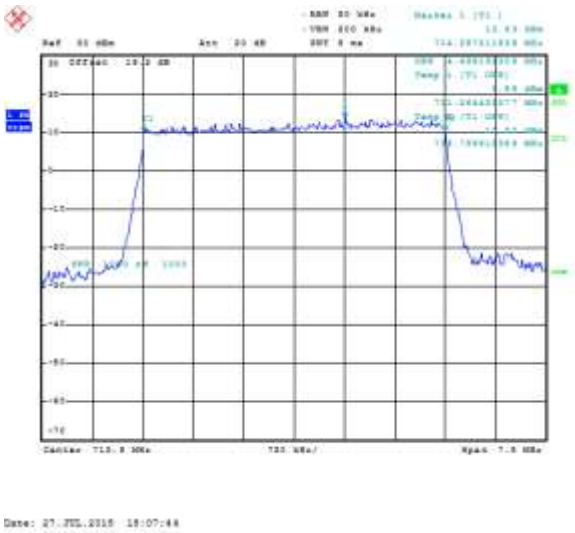


Figure 6-18a: Occupied Bandwidth, Band 5 High Channel, 5MHz BW, RB=50



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-19a: -26 dBc Bandwidth, Band 17 Low Channel, 10MHz BW, RB=50

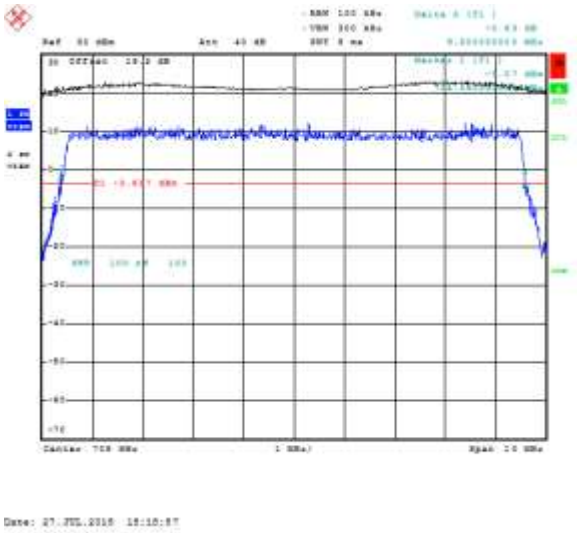


Figure 6-20a: -26 dBc Bandwidth, Band 17 Middle Channel, 10MHz BW, RB=50

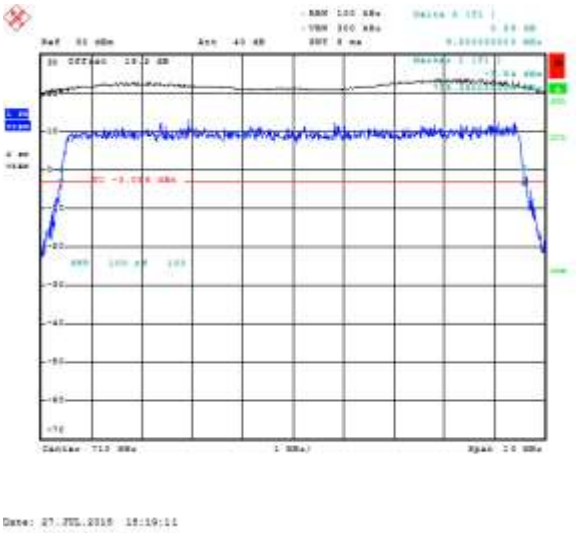


Figure 6-21a: -26 dBc Bandwidth, Band 17 High Channel, 10MHz BW, RB=50

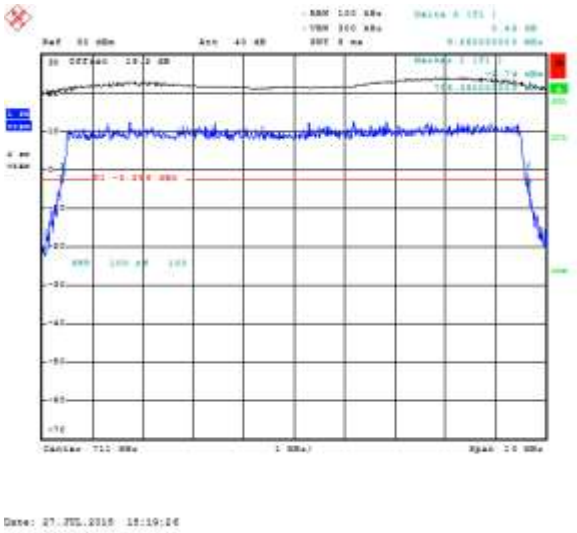
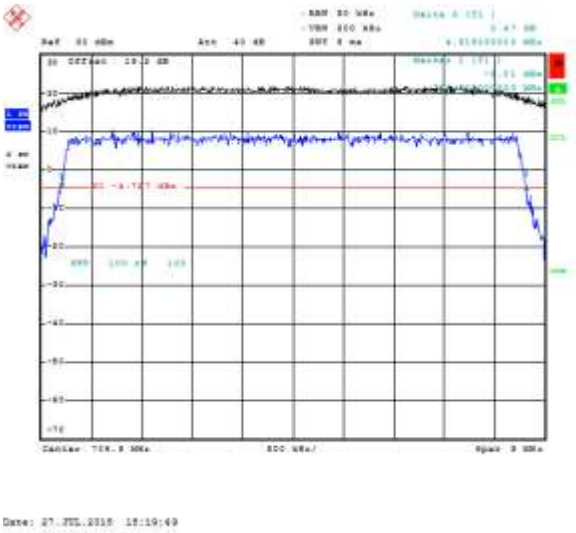


Figure 6-22a: -26 dBc Bandwidth, Band 17 Low Channel, 5MHz BW, RB=25



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-23a: -26 dBc Bandwidth, Band 17 Middle Channel, 5MHz BW, RB=25

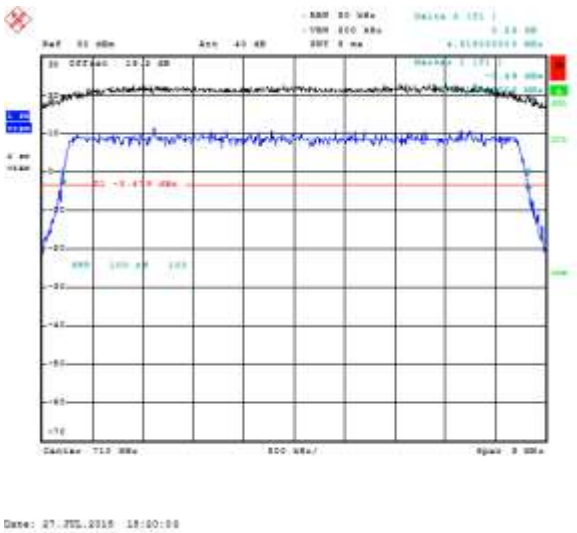


Figure 6-24a: -26 dBc Bandwidth, Band 17 High Channel, 5MHz BW, RB=25

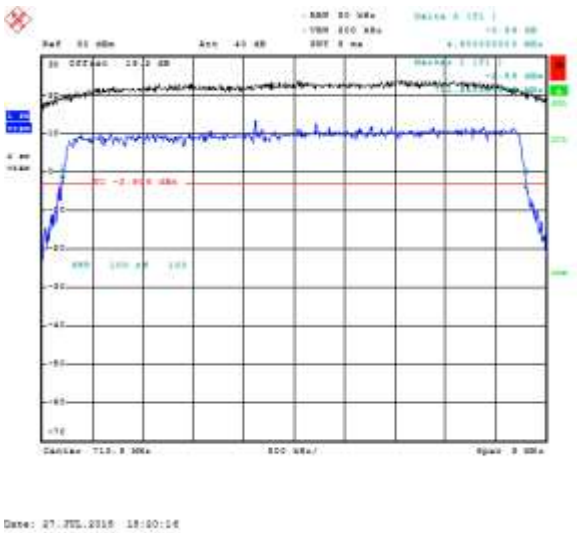


Figure 6-25a: Band 17 Low Channel Mask, 10MHz BW, RB=50

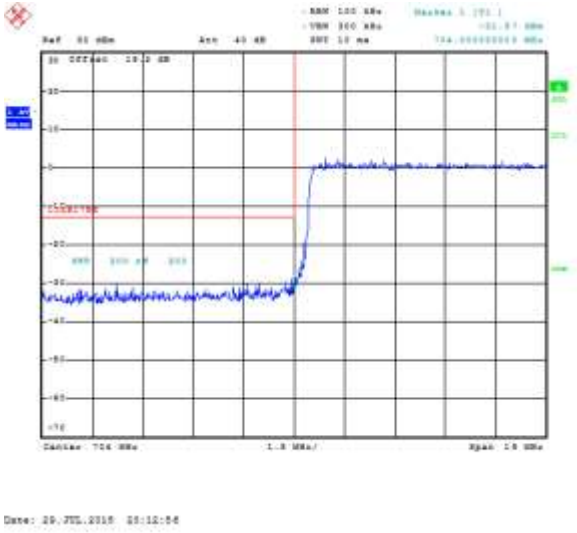
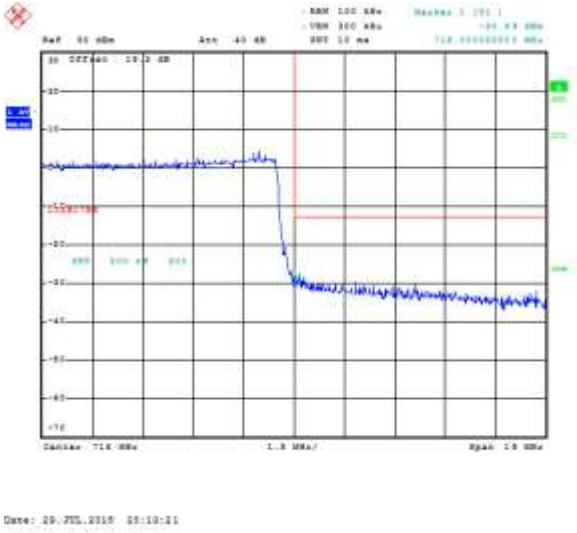


Figure 6-26a: Band 17 High Channel Mask, 10MHz BW, RB=50



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-27a: Band 17 Low Channel Mask, 10MHz BW, RB=1

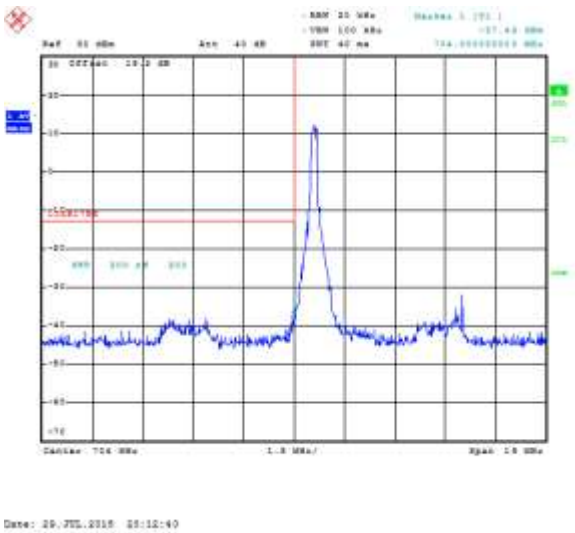


Figure 6-28a: Band 17 High Channel Mask,10MHz BW, RB=1

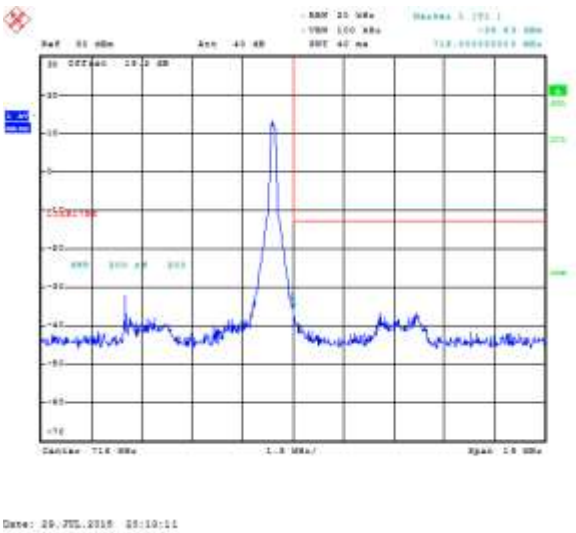


Figure 6-29a: Band 17 Low Channel Mask, 5MHz BW, RB=25

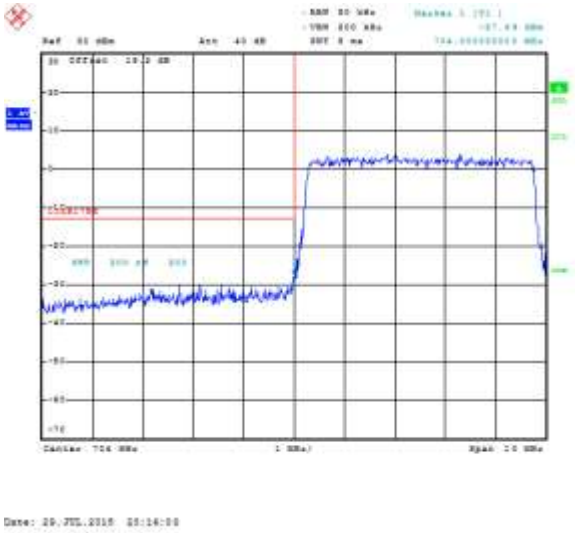
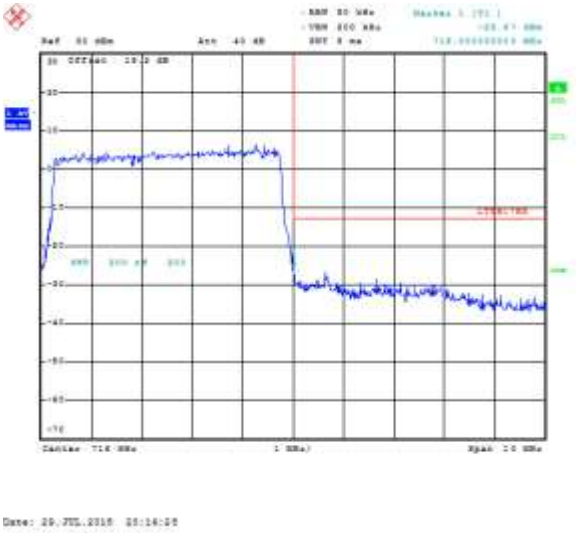


Figure 6-30a: Band 17 High Channel Mask, 5MHz BW, RB=25



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-31a: Band 17 Low Channel Mask, 5MHz BW, RB=1

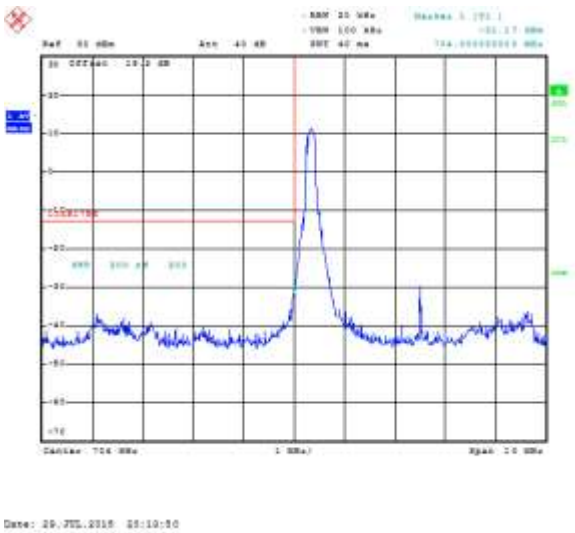


Figure 6-32a: Band 17 High Channel Mask, 5MHz BW, RB=1

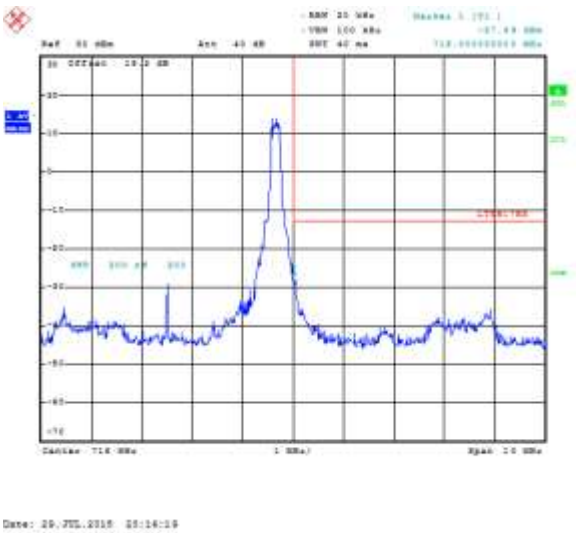


Figure 6-33a: Band 17 Mid Channel PAR, 10MHz BW, RB=25

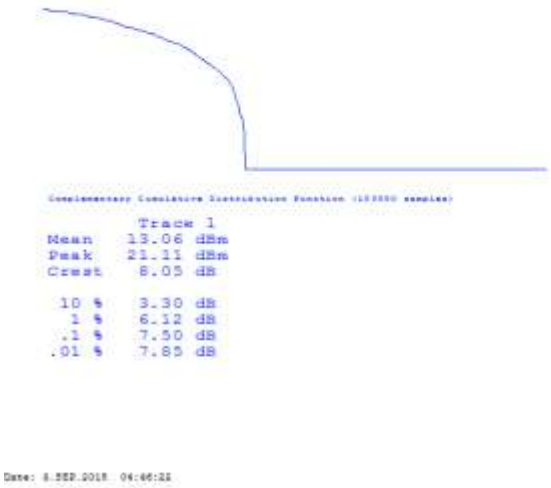
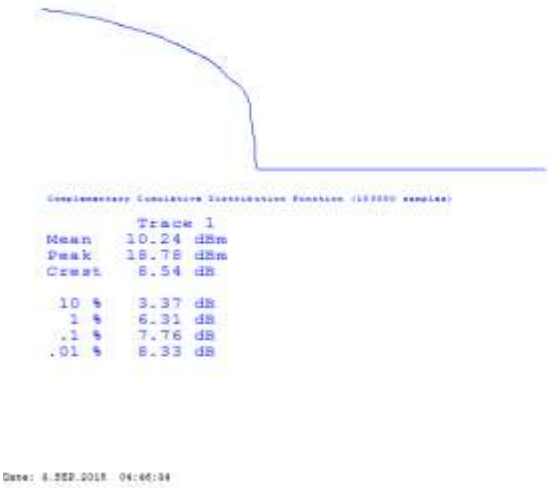


Figure 6-34a: Band 17 Middle Channel PAR, 10MHz BW, RB=50



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-35a: Band 17 Mid Channel PAR, 5MHz BW, RB=15

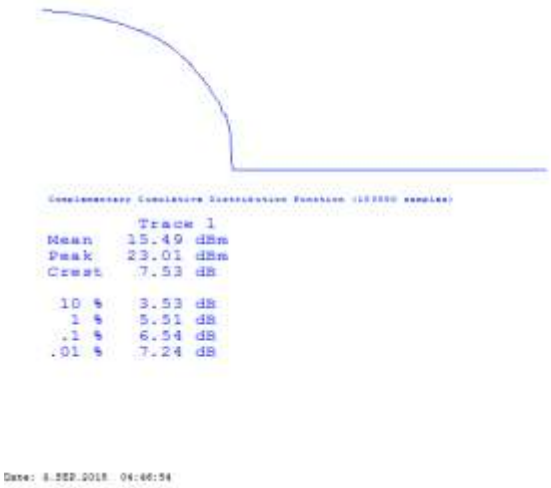
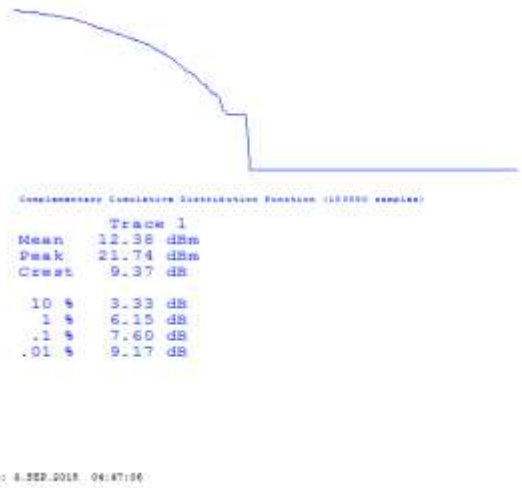


Figure 6-36a: Band 17 Mid Channel PAR, 5MHz BW, RB=25



LTE Band 17 Conducted RF Emission Test Data cont'd

Figure 6-37a: Occupied Bandwidth, Band 17 Low Channel, 10MHz BW (RB= 50) 16-QAM

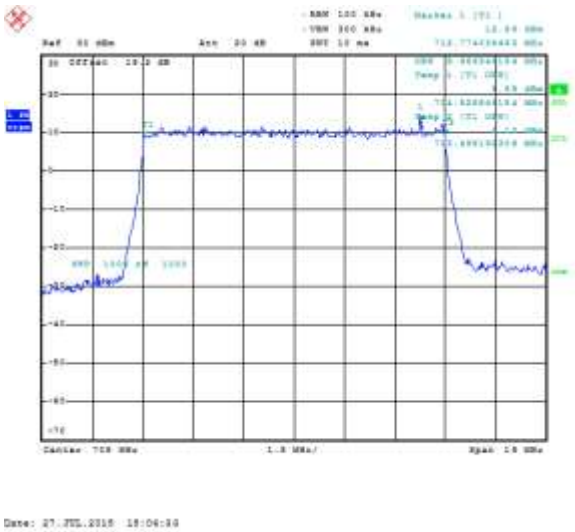


Figure 6-38a: Occupied Bandwidth, Band 17 Mid Channel, 10MHz BW (RB= 50) 16-QAM

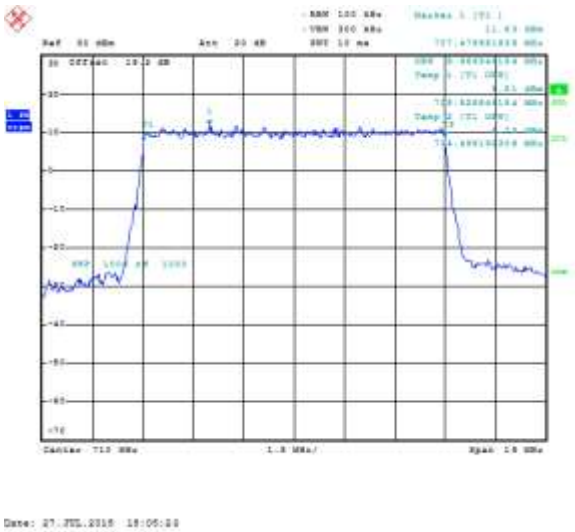
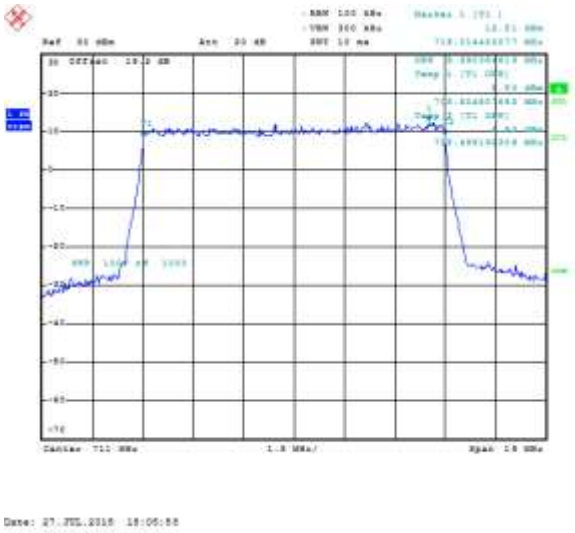
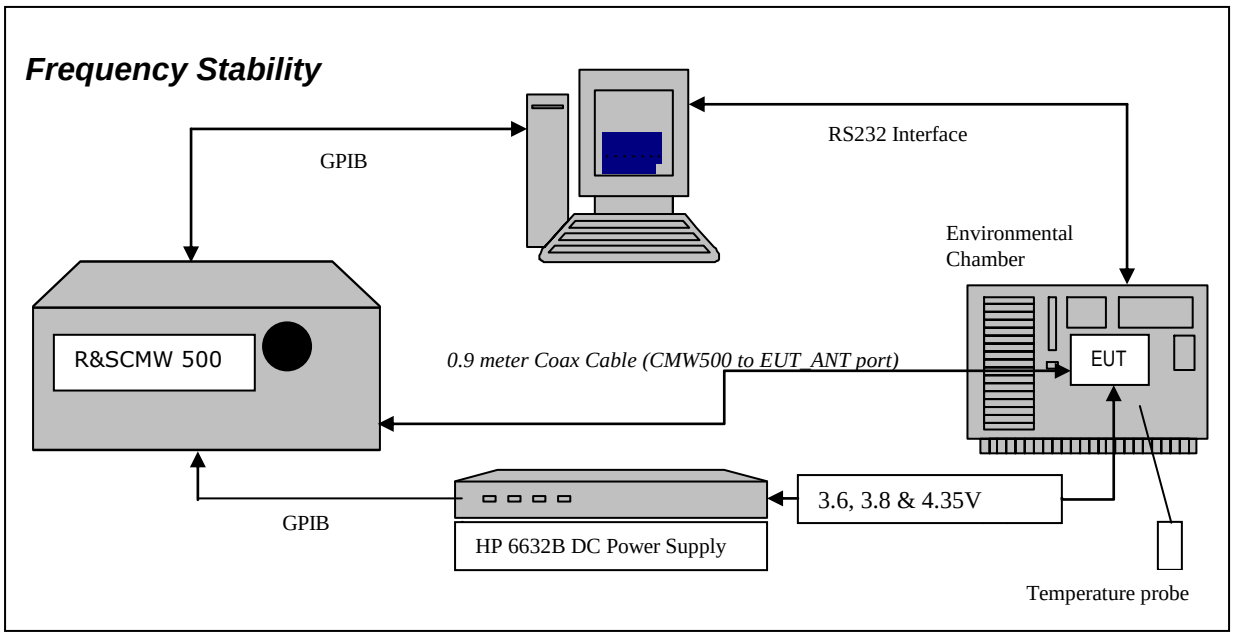


Figure 6-39a: Occupied Bandwidth, Band 17 High Channel, 10MHz BW (RB= 50) 16-QAM



APPENDIX 7B – LTE Band 17 FREQUENCY STABILITY TEST DATA

LTE Band 17 Frequency Stability Test Data



The following measurements were performed by Sijia Li.

CFR 47 Chapter 1 - Federal Communications Commission Rules

Part 2 Required Measurements
2.1055 Frequency Stability - Procedures
(a,b) Frequency Stability - Temperature Variation
(d) Frequency Stability - Voltage Variation

The EUT meets the requirements as stated in CFR 47 chapter 1, Section 27.54, CFR 47 and RSS-139, 6.3 Frequency Stability.
Frequency Stability measurement devices were configured as presented in the block diagram recording frequency, power, data, temperatures, and stepped voltages controlled via a GPIB interface linked to the Environmental chamber, a DC power supply, and the Communications Test Set. A 0.9-metre coax cable was calibrated to characterize the insertion loss for the transmitted frequencies between the RF input/output of the CMW 500 and the EUT antenna port.

Test Setup:

The EUT was placed in the Temperature chamber and connected to CMW 500 outside as shown in the figure above. Dry air was pumped inside the temperature chamber to maintain a backpressure during the test. The EUT was kept in the off condition at all times except when the following measurements were to be made.

The chamber was switched on and the temperature was set to -30°C.
After the chamber stabilized at -30 °C there was a soak period of one hour to alleviate moisture in the chamber, the EUT voltage was enabled.
The system software recorded the frequency, power, and associated measurements.

A Computer system controlled the automated software. This application was given the command of activating all machines intrinsic to the temperature and voltage tests controlling the CMW 500 via the GPIB Bus. The Environmental Chamber was instructed through an RS-232 serial line. The EUT dialogue was passed through a serial connection.

The EUT repetitively transmitted 100 bursts for each set of programmed parameters recording temperature, voltage settings, and systematically selected frequencies. The power supply was cycled from minimum voltage 3.6 volts, to 3.8 volts and to 4.35 volts maximum voltage. The frequency error was measured at a maximum output power and recorded by the automated system test software.

The EUT output power and frequency was measured at 3.6 volts, 3.8 volts and 4.35 volts. The transmit frequency was varied in 3 steps consisting of 709.0 MHz, 710.0 MHz and 711.0 MHz each was measured under 10 MHz bandwidth with maximum (50) RBs. This frequency was recorded in MHz and deviation from nominal, in Parts Per Million.

After the initial one-hour soak at the beginning of the tests, a period of thirty minutes soak was initialized between each ascending temperature step, before proceeding to the next measurement test cycle.

Procedure:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

57. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
58. Start test program
59. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
60. Set power supply voltage to 3.6 volts.
61. Set up CMW 500 Radio Communication Tester.
62. Command the CMW 500 to switch to the low channel.
63. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
64. EUT is commanded to Transmit 100 Bursts.
65. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
66. The CMW 500 commands the EUT to change frequency to the middle channel and high channel and repeats steps 7 to 9.
67. Repeat steps 5 to 10 changing the supply voltage to 3.8 Volts
68. Increase temperature by 10°C and soak for 1/2 hour.
69. Repeat steps 4 - 12 for temperatures –30°C to 60°C.
70. Repeat steps 5 to 10 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

The maximum frequency error in the LTE band 17 measured was **-0.0045 PPM**.

LTE Band 17 results: channels 23780, 23790 and 23800 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23780	709.0	3.6	20	2.33	0.0033
23790	710.0	3.6	20	-1.90	-0.0027
23800	711.0	3.6	20	-3.18	**-0.0045**

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23780	709.0	3.8	20	1.80	0.0025
23790	710.0	3.8	20	2.70	0.0038
23800	711.0	3.8	20	-2.93	-0.0041

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23780	709.0	4.35	20	2.09	0.0029
23790	710.0	4.35	20	2.43	0.0034
23800	711.0	4.35	20	-2.23	-0.0031

LTE band 17 Results: channel 23780 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23780	709.0	3.6	-30	-2.33	-0.0033
23780	709.0	3.6	-20	2.72	0.0038
23780	709.0	3.6	-10	-2.53	-0.0036
23780	709.0	3.6	0	3.20	0.0045
23780	709.0	3.6	10	-1.44	-0.0020
23780	709.0	3.6	20	2.33	0.0033
23780	709.0	3.6	30	-2.62	-0.0037
23780	709.0	3.6	40	-2.82	-0.0040
23780	709.0	3.6	50	-2.88	-0.0041
23780	709.0	3.6	60	-2.06	-0.0029
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
23780	709.0	3.8	-30	-2.25	-0.0032
23780	709.0	3.8	-20	-2.70	-0.0038
23780	709.0	3.8	-10	2.43	0.0034
23780	709.0	3.8	0	3.25	0.0046
23780	709.0	3.8	10	1.65	0.0023
23780	709.0	3.8	20	1.80	0.0025
23780	709.0	3.8	30	-3.33	-0.0047
23780	709.0	3.8	40	-2.07	-0.0029
23780	709.0	3.8	50	-3.10	-0.0044
23780	709.0	3.8	60	-2.98	-0.0042
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
23780	709.0	4.35	-30	3.18	0.0045
23780	709.0	4.35	-20	-2.06	-0.0029
23780	709.0	4.35	-10	-1.90	-0.0027
23780	709.0	4.35	0	3.76	**0.0053**
23780	709.0	4.35	10	2.66	0.0038
23780	709.0	4.35	20	2.09	0.0029
23780	709.0	4.35	30	-3.76	**-0.0053**
23780	709.0	4.35	40	2.55	0.0036
23780	709.0	4.35	50	-2.62	-0.0037
23780	709.0	4.35	60	2.17	0.0031

LTE band 17 Results: channel 23790 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23790	710.0	3.6	-30	-2.70	-0.0038
23790	710.0	3.6	-20	-1.90	-0.0027
23790	710.0	3.6	-10	-2.29	-0.0032
23790	710.0	3.6	0	3.56	**0.0050**
23790	710.0	3.6	10	2.56	0.0036
23790	710.0	3.6	20	-1.90	-0.0027
23790	710.0	3.6	30	1.24	0.0018
23790	710.0	3.6	40	-2.85	-0.0040
23790	710.0	3.6	50	1.63	0.0023
23790	710.0	3.6	60	2.57	0.0036
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
23790	710.0	3.8	-30	-1.50	-0.0021
23790	710.0	3.8	-20	3.45	0.0049
23790	710.0	3.8	-10	1.93	0.0027
23790	710.0	3.8	0	2.89	0.0041
23790	710.0	3.8	10	-2.15	-0.0030
23790	710.0	3.8	20	2.70	0.0038
23790	710.0	3.8	30	-2.63	-0.0037
23790	710.0	3.8	40	2.27	0.0032
23790	710.0	3.8	50	-2.60	-0.0037
23790	710.0	3.8	60	-2.99	-0.0042
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
23790	710.0	4.35	-30	-2.33	-0.0033
23790	710.0	4.35	-20	-1.86	-0.0026
23790	710.0	4.35	-10	2.19	0.0031
23790	710.0	4.35	0	-2.53	-0.0036
23790	710.0	4.35	10	1.60	0.0023
23790	710.0	4.35	20	2.43	0.0034
23790	710.0	4.35	30	-2.47	-0.0035
23790	710.0	4.35	40	-2.03	-0.0029
23790	710.0	4.35	50	-2.96	-0.0042
23790	710.0	4.35	60	1.36	0.0019

LTE band 17 Results: channel 23800 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
23800	711.0	3.6	-30	-4.49	-0.0063
23800	711.0	3.6	-20	-4.41	-0.0062
23800	711.0	3.6	-10	2.03	0.0029
23800	711.0	3.6	0	-2.98	-0.0042
23800	711.0	3.6	10	-3.16	-0.0044
23800	711.0	3.6	20	-3.18	-0.0045
23800	711.0	3.6	30	-5.49	**-0.0077**
23800	711.0	3.6	40	-1.49	-0.0021
23800	711.0	3.6	50	-4.88	-0.0069
23800	711.0	3.6	60	-3.03	-0.0043
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
23800	711.0	3.8	-30	-3.93	-0.0055
23800	711.0	3.8	-20	-3.38	-0.0047
23800	711.0	3.8	-10	2.05	0.0029
23800	711.0	3.8	0	-3.12	-0.0044
23800	711.0	3.8	10	-1.97	-0.0028
23800	711.0	3.8	20	-2.93	-0.0041
23800	711.0	3.8	30	-2.99	-0.0042
23800	711.0	3.8	40	-4.06	-0.0057
23800	711.0	3.8	50	-3.65	-0.0051
23800	711.0	3.8	60	-3.79	-0.0053
Traffic Channel Number	**Frequency (MHz)**	**Voltage (Volts)**	**Temperature (Celsius)**	**Frequency Error (Hz)**	**PPM**
23800	711.0	4.35	-30	-2.76	-0.0039
23800	711.0	4.35	-20	-3.63	-0.0051
23800	711.0	4.35	-10	-2.12	-0.0030
23800	711.0	4.35	0	-2.92	-0.0041
23800	711.0	4.35	10	-1.93	-0.0027
23800	711.0	4.35	20	-2.23	-0.0031
23800	711.0	4.35	30	-3.02	-0.0042
23800	711.0	4.35	40	-3.22	-0.0045
23800	711.0	4.35	50	-5.19	-0.0073
23800	711.0	4.35	60	2.10	0.0030

Procedure for IC:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

1. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
2. Start test program
3. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
4. Set power supply voltage to 3.6 volts.
5. Set up CMW 500 Radio Communication Tester.
6. Command the CMW 500 to switch to the low channel.
7. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
8. EUT is commanded to Transmit 100 Bursts.
9. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
10. Using a resolution bandwidth equal to that permitted within the 1MHz band immediately outside the channel edge, reference points will be selected at the unwanted emission levels which comply with the attenuation 43 + 10 log10 p, for the type of device under test, on the emission mask of the lowest and highest channels, and the frequency at these points shall be recorded as fL and fH respectively.
11. The frequency stability is calculated by fL minus the frequency offset (frequency error measured in step 9) and fH plus the frequency offset shall be within the frequency range that the equipment is designed to operate (2.5 to 2.57 GHz).
12. The CMW 500 commands the EUT to change frequency to the high channel and repeats steps 7 to 11.
13. Repeat steps 5 to 12 changing the supply voltage to 3.8 Volts
14. Increase temperature to 20 and 50°C and soak for 1/2 hour.
15. Repeat steps 4 - 14 for temperatures –30°C to 60°C.
16. Repeat steps 5 to 15 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

Date of test: September 2, 2015.

IC RSS – 130, 4.3 LTE Band 17 Frequency Stability.

LTE Band 17 10MHz Bandwidth results: channels 23780, & 23800 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Band 17 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23780	709.0	3.6	20	-1.90258	704.405	N/A	704.405	N/A
23800	711.0	3.6	20	-2.446175	N/A	715.565	N/A	715.565

Traffic Channel Number	LTE Band 17 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23780	709.0	3.8	20	3.733635	704.42	N/A	704.42	N/A
23800	711.0	3.8	20	-1.945496	N/A	715.58	N/A	715.58

Traffic Channel Number	LTE Band 17 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23780	709.0	4.35	20	-2.717972	704.405	N/A	704.405	N/A
23800	711.0	4.35	20	-1.373291	N/A	715.565	N/A	715.565

LTE Band 17 10MHz Bandwidth results: channels 23780, & 23800 @ -30 and +60°C maximum transmitted power

Traffic Channel Number	LTE Band 17 Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	fL (MHz)	fH (MHz)	fL-Freq Offset (MHz)	fH+Freq Offset (MHz)
23780	709.0	3.6	-30	-3.347397	704.42	N/A	704.42	N/A
23800	711.0	3.6	-30	-4.320145	N/A	715.565	N/A	715.565
23780	709.0	3.8	-30	-3.318787	704.42	N/A	704.42	N/A
23800	711.0	3.8	-30	-3.962517	N/A	715.565	N/A	715.565
23780	709.0	4.35	-30	-2.474785	704.435	N/A	704.435	N/A
23800	711.0	4.35	-30	-4.205704	N/A	715.565	N/A	715.565
23780	709.0	3.6	60	-2.989769	704.405	N/A	704.405	N/A
23800	711.0	3.6	60	-3.232956	N/A	715.565	N/A	715.565
23780	709.0	3.8	60	-1.730919	704.435	N/A	704.435	N/A
23800	711.0	3.8	60	-3.876686	N/A	715.58	N/A	715.58
23780	709.0	4.35	60	-2.717972	704.435	N/A	704.435	N/A
23800	711.0	4.35	60	-4.177094	N/A	715.565	N/A	715.565

APPENDIX 7C – LTE Band 17 RADIATED EMISSIONS TEST DATA

Radiated Power Test Data Results

Date of Test: August 7, 2015
The following measurements were performed by Shiva Kumbham.
The environmental tests conditions were: Temperature: 27.0 °C
Relative Humidity: 37 %

The BlackBerry® smartphone was standalone, vertically with LCD facing the RX antenna when the turntable is at 0 degree position.
Measurements were performed with QPSK and 16QAM modulations. The smallest test margins are reported below.
Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height.

LTE band 17, 5MHz BW, RB=1, QPSK modulation

EUT				Rx Antenna		Spectrum Analyzer		Substitution Method / Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V,H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Dipole) (dBm)	(W)	Limit (dBm)	Diff. To Limit (dB)
F0	23780	709.00	17	Dipole	V	-45.77	-30.93	V-V	2.26	20.55	0.11	35.00	14.45
F0	23780	709.00	17	Dipole	H	-30.93		H-H	-1.53				
F0	23790	710.00	17	Dipole	V	-46.00	-30.96	V-V	2.38	**20.70**	0.12	35.00	14.30
F0	23790	710.00	17	Dipole	H	-30.96		H-H	-1.51				
F0	23799	710.90	17	Dipole	V	-46.30	-31.13	V-V	2.30	20.56	0.11	35.00	14.44
F0	23799	710.90	17	Dipole	H	-31.13		H-H	-1.68				

LTE band 17, 5MHz BW, RB=1, 16-QAM modulation

EUT				Rx Antenna		Spectrum Analyzer		Substitution Method / Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V,H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Dipole) (dBm)	(W)	Limit (dBm)	Diff. To Limit (dB)
F0	23780	709.00	17	Dipole	V	-46.68	-31.67	V-V	1.51	**19.80**	0.10	35.00	15.20
F0	23780	709.00	17	Dipole	H	-31.67		H-H	-2.26				
F0	23790	710.00	17	Dipole	V	-46.99	-32.10	V-V	1.26	19.58	0.09	35.00	15.42
F0	23790	710.00	17	Dipole	H	-32.10		H-H	-2.61				
F0	23799	710.90	17	Dipole	V	-47.02	-31.97	V-V	1.49	19.75	0.09	35.00	15.25
F0	23799	710.90	17	Dipole	H	-31.97		H-H	-2.50				

Radiated Emissions Test Data Results cont'd

The following measurements were performed by Imran Kanji.

Date of Test: August 10, 2015

The environmental test conditions were: Temperature: 26.2 ºC
Relative Humidity: 32.4 %

The BlackBerry® smartphone was standalone, vertically with LCD facing the RX antenna when the turntable is at 0 degree position.

Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height, and the frequency range scanned was 30MHz – 1GHz.

Measurements were performed in LTE band 17 with QPSK and 16-QAM modulations for 10MHz BW (channel 23780, 23790, 23800 with RB = 1).

All emissions were at least 25.0 dB below the limit.

The following measurements were performed by Kevin Guo

Date of Test: August 10-11, 2015

The environmental test conditions were: Temperature: 27.7 ºC
Relative Humidity: 40 %

Test Distance was 3.0 meters with the RX antenna height scans between 1-4 meters height, and a frequency range of 1 GHz to 10 GHz.

The BlackBerry® smartphone was standalone, horizontally with LCD facing up and the top pointing to the RX antenna when the turntable is at 0 degree position

Measurements were performed in LTE band 17 with QPSK and 16-QAM modulations for 10MHz BW (channel 23780, 23790, 23800 with RB = 1).

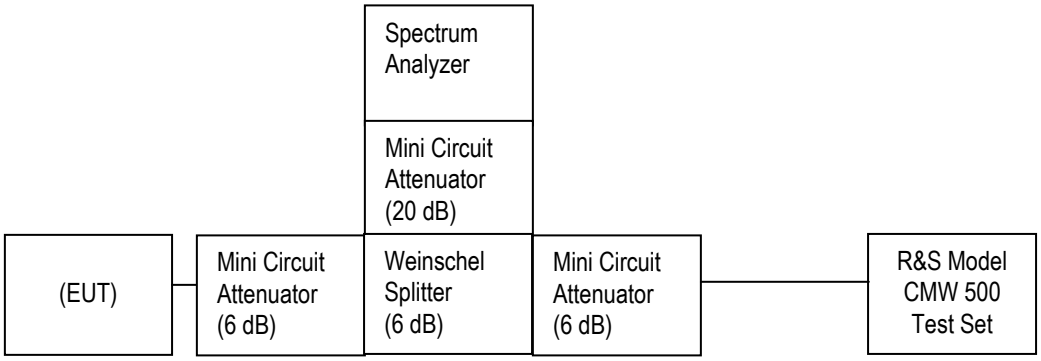
All emissions were at least 25.0 dB below the limit.

APPENDIX 8A– LTE Band 30 CONDUCTED RF EMISSIONS TEST DATA/PLOTS

LTE Band 30 Conducted RF Emission Test Data

This appendix contains measurement data pertaining to conducted spurious emissions, 99% power bandwidth and the channel mask.

Test Setup Diagram



Date of Test: July 27 – September 21, 2015

The environmental test conditions were: Temperature: 22.7 – 23.6 ºC
Relative Humidity: 38.7 – 61.2 %

The following measurements were performed by Kevin Guo and Landon Martin.

LTE Band 30 Conducted RF Emission Test Data cont'd

Emission Designator Table

Frequency Rane (MHz)	Conducted Output Power (dBm)	Emission Designator	Band	Bandwidth (MHz)	Modulation
2307.5-2312.5	**24.57**	4M48G7D	LTE B30	5	QPSK
2307.5-2312.5	23.54	4M48D7W	LTE B30	5	16QAM
2310-2310	24.56	8M94G7D	LTE B30	10	QPSK
2310-2310	24.36	8M94D7W	LTE B30	10	16QAM

The conducted spurious emissions – As per 47 CFR 2.1051, 27.53(a)(4), RSS-195, 5.6 were measured from 30 MHz to 20 GHz.

–26 dBc Bandwidth and Occupied Bandwidth (99%)
the modulation spectrum was measured by both methods of 99% power bandwidth and –26 dBc bandwidth for each 5MHz and 10MHz with different number of RBs for LTE Band 30.

QPSK and 16-QAM modulations were applied to each of the bandwidths. Only the worst case measurements are documented in this report. A minimum RB condition was also measured (RB = 1). The resolution bandwidth required for out-of-band emissions in the 1 MHz bands immediately outside and adjacent to the frequency block, was determined to be at least 1% of the emission bandwidth.

The worst case –26dBc bandwidth for LTE Band 30 was measured to be 9.15 MHz. Results were derived in a 100 kHz resolution bandwidth.
On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

26dbc Test Data for LTE Band 30 selected Frequencies in 10MHz BW (RB = 50)

LTE Band 30 Frequency (MHz)	26dBc Occupied Bandwidth (MHz)
2310	**9.15**

26 dbc Test Data for LTE Band 30 selected Frequencies in 5MHz BW (RB = 25)

LTE Band 30 Frequency (MHz)	26dBc Occupied Bandwidth (MHz)
2307.5	4.625
2310	4.63
2312.5	4.66

Test Data for LTE Band 30 selected Frequencies in 10MHz BW (RB = 25)

LTE Band 30 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
2310	8.94	8.92

Test Data for LTE Band 30 selected Frequencies in 5MHz BW (RB = 25)

LTE Band 17 Frequency (MHz)	99% Occupied Bandwidth (MHz)	
	QPSK	16-QAM
2307.5	4.48	4.48
2310	4.47	4.48
2312.5	4.48	4.47

Peak to Average Ratio (PAR)

For each 5MHz and 10MHz with Resource Block allocation 50,25 and 15 as per scalable bandwidths for LTE Band 30, the peak to average ratio was measured on the low, middle and high channels with QPSK modulation.

On any frequency outside the frequency block and outside the adjacent 1 MHz bands, a resolution bandwidth of at least 1 MHz was applied.

The worst case measured was 9.61 dB on 10MHz bandwidth with Resource Block allocation 25 while transmitting at 707.5MHz.

Measurement Plots for LTE Band 30

See Figures 8-1a to 8-8a for the plots of the conducted spurious emissions.

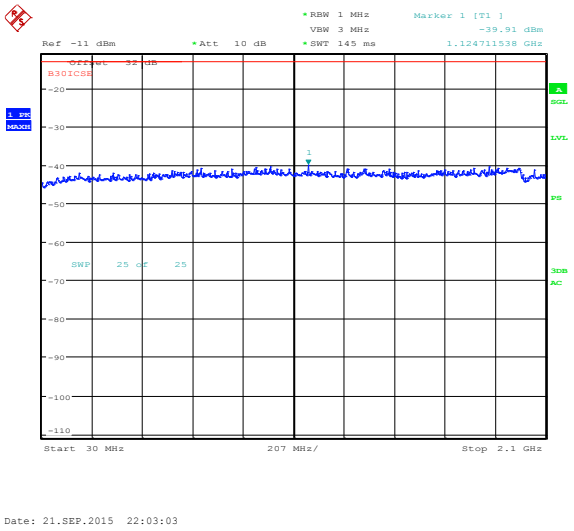
See Figures 8-9a to 8-16a for the plots of 99% Occupied Bandwidth and -26 dBc Bandwidth.

See Figures 8-17a to 8-21a for the plots of the Channel mask.

See Figures 8-22a for the plots of the Peak to Average Ratio.

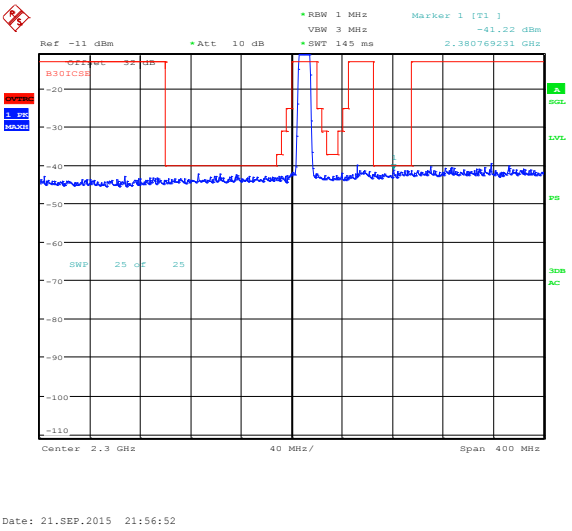
LTE Band 30 Conducted RF Emission Test Data cont'd

Figure 3-1a: Band 30, Spurious Conducted Emissions, 10MHz BW (RB= 50)



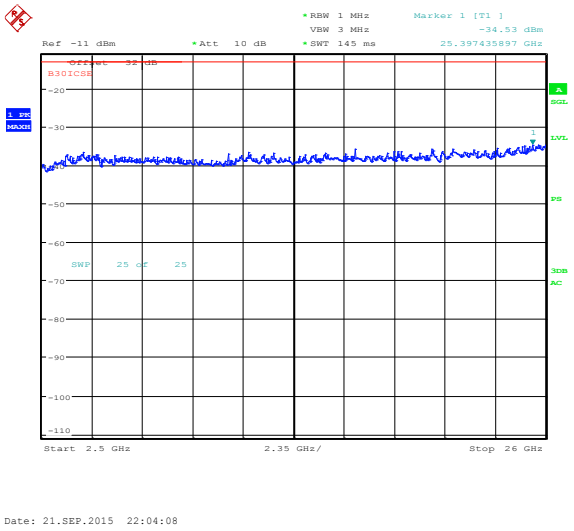
Date: 21.SEP.2015 22:03:03

Figure 3-2a: Band 30, Spurious Conducted Emissions, 10MHz BW (RB= 50)



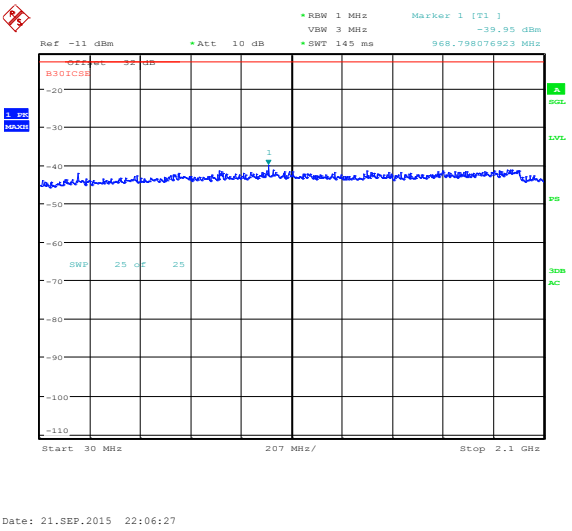
Date: 21.SEP.2015 21:56:52

Figure 3-3a: Band 30, Spurious Conducted Emissions, 10MHz BW (RB= 50)



Date: 21.SEP.2015 22:04:08

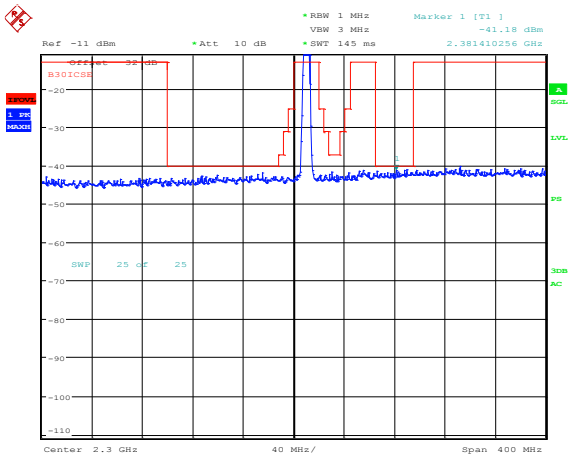
Figure 3-4a: Band 30, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)



Date: 21.SEP.2015 22:06:27

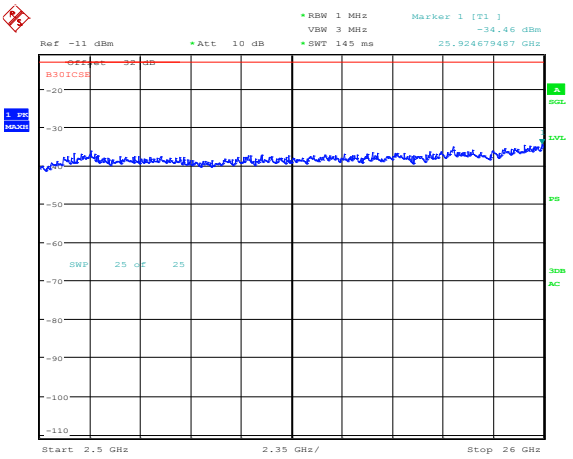
LTE Band 30 Conducted RF Emission Test Data cont'd

Figure 3-5a: Band 30, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)



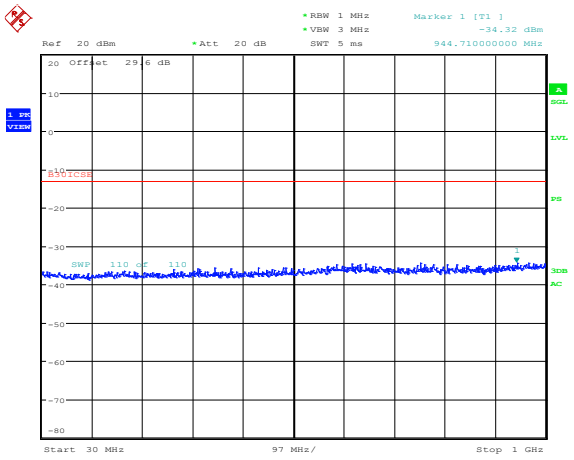
Date: 21.SEP.2015 21:59:24

Figure 3-6a: Band 30, Spurious Conducted Emissions, High channel, 5MHz BW (RB= 25)



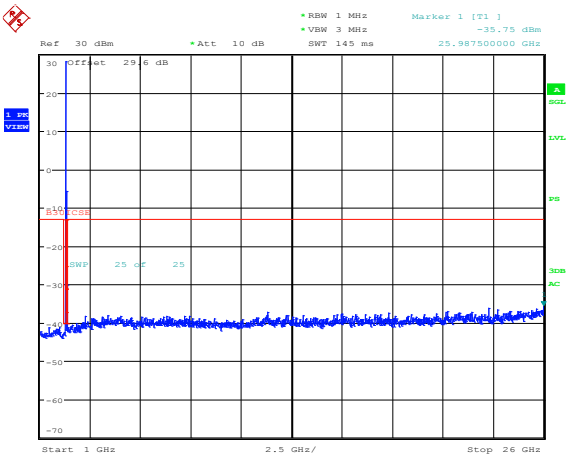
Date: 21.SEP.2015 22:05:08

Figure 3-7a: Band 30, Spurious Conducted Emissions, Low channel, 5MHz BW (RB= 1)



Date: 21.SEP.2015 19:41:26

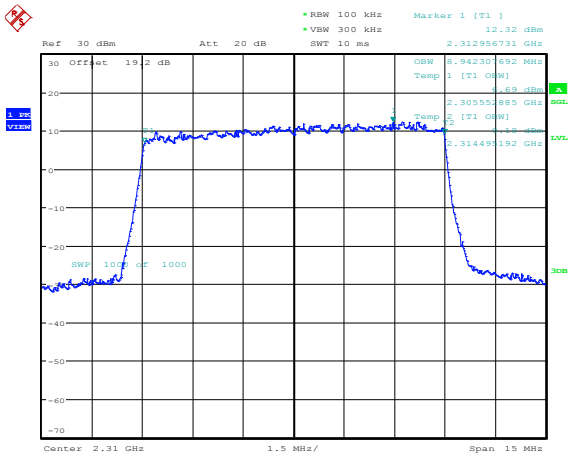
Figure 3-8a: Band 30, Spurious Conducted Emissions, Low channel, 5MHz BW (RB= 1)



Date: 21.SEP.2015 19:41:50

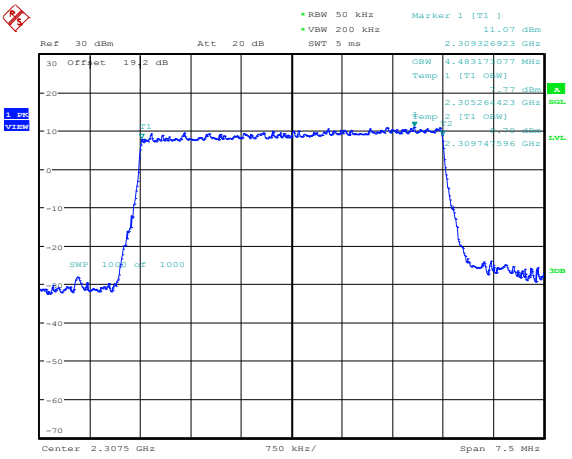
LTE Band 30 Conducted RF Emission Test Data cont'd

Figure 3-9a: Occupied Bandwidth, Band 30 10MHz BW, RB=50



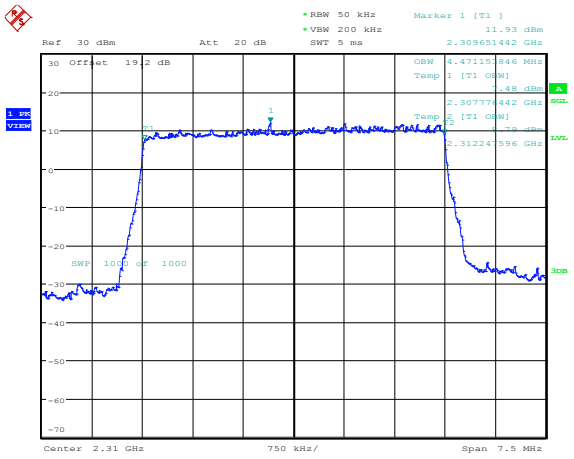
Date: 28.JUL.2015 09:59:29

Figure 3-10a: Occupied Bandwidth, Band 5 Low Channel, 5MHz BW, RB=25



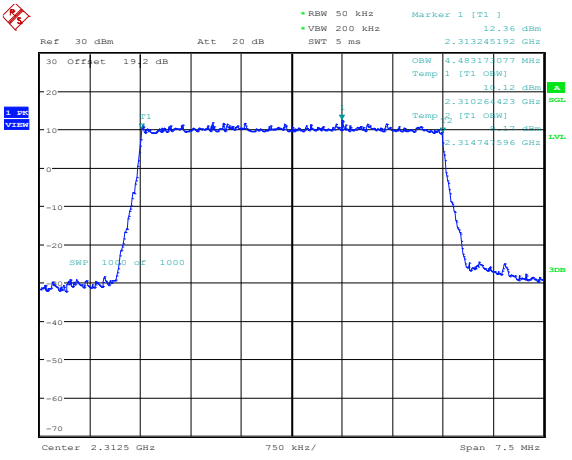
Date: 28.JUL.2015 10:03:51

Figure 3-11a: Occupied Bandwidth, Band 5 Middle Channel, 5MHz BW, RB=25



Date: 28.JUL.2015 10:04:36

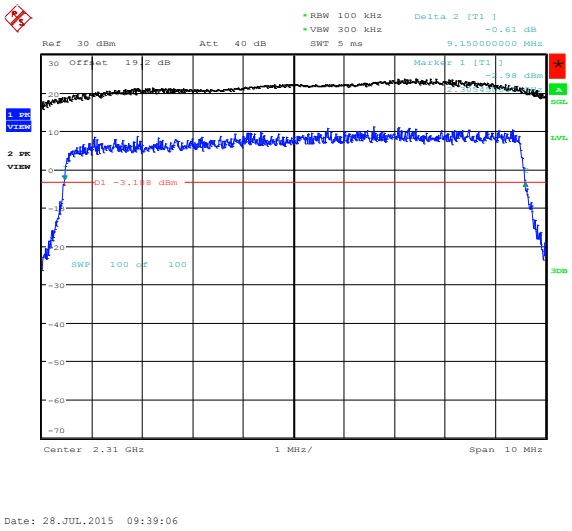
Figure 3-12a: Occupied Bandwidth, Band 5 High Channel, 5MHz BW, RB=25



Date: 28.JUL.2015 10:05:16

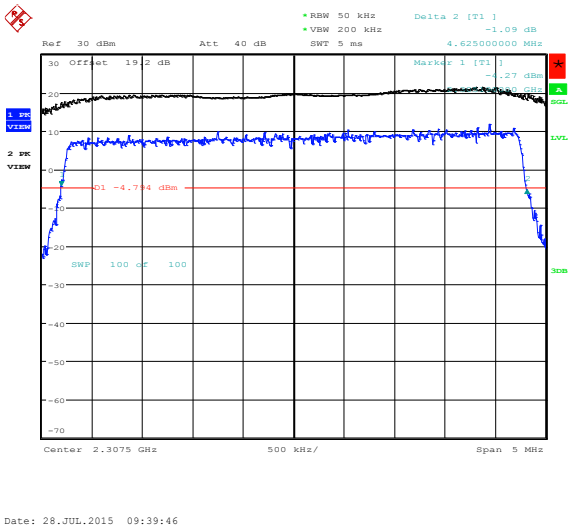
LTE Band 30 Conducted RF Emission Test Data cont'd

Figure 3-13a: -26 dBc Bandwidth, Band 30 Middle Channel, 10MHz BW, RB=50



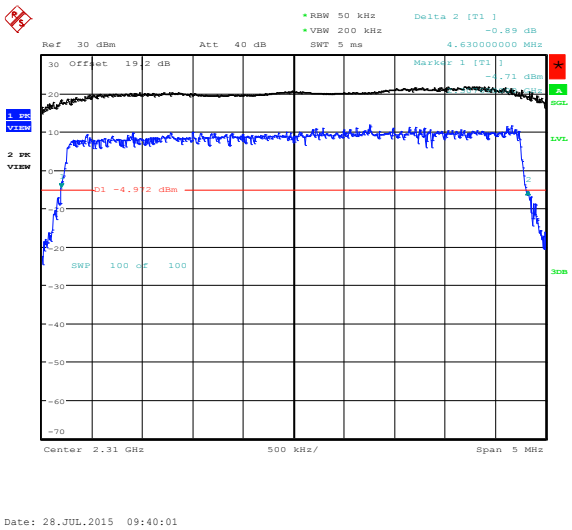
Date: 28.JUL.2015 09:39:06

Figure 3-14a: -26 dBc Bandwidth, Band 30 Low Channel, 5MHz BW, RB=25



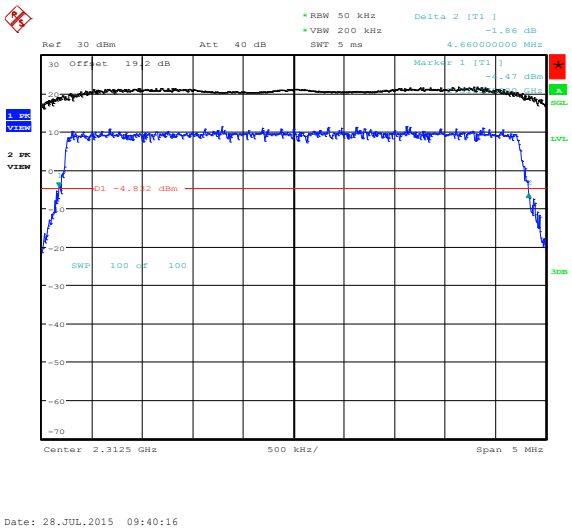
Date: 28.JUL.2015 09:39:46

Figure 3-15a: -26 dBc Bandwidth, Band 30 Middle Channel, 5MHz BW, RB=25



Date: 28.JUL.2015 09:40:01

Figure 3-16a: -26 dBc Bandwidth, Band 30 High Channel, 5MHz BW, RB=25



Date: 28.JUL.2015 09:40:16

LTE Band 30 Conducted RF Emission Test Data cont'd

Figure 3-17a: Band 30 Channel Mask, 10MHz BW, RB=50

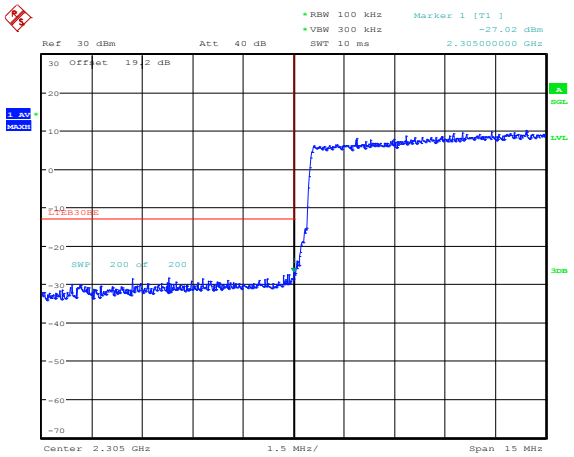


Figure 3-17a: Band 30 Channel Mask, 10MHz BW, RB=50

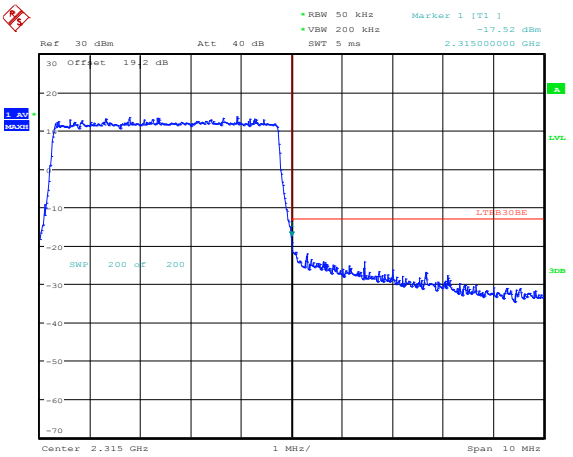


Figure 3-18a: Band 30 Low Channel Mask, 5MHz BW, RB=1

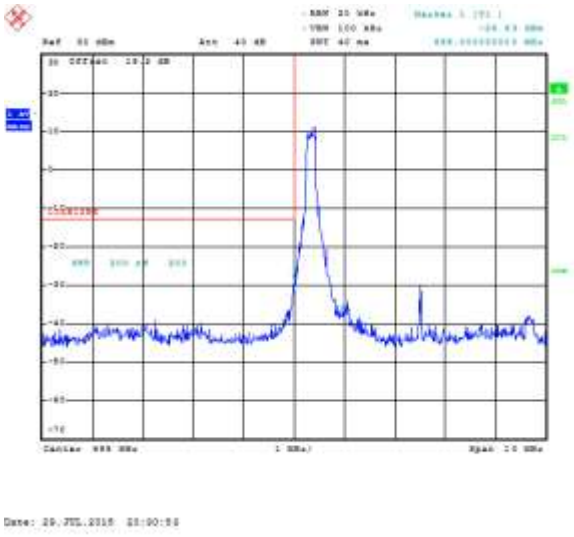
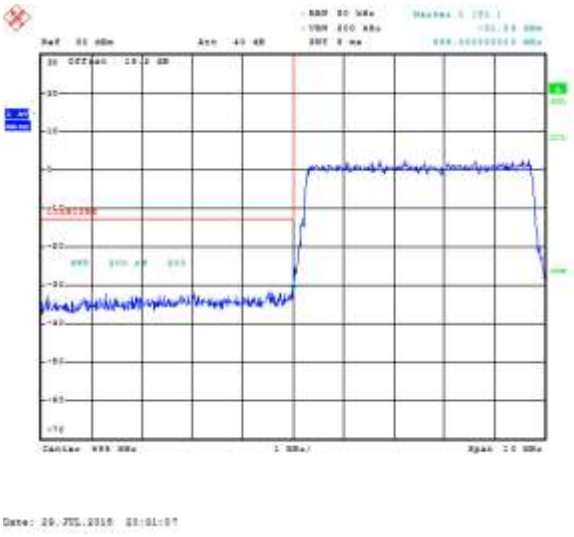


Figure 3-19a: Band 30 Low Channel Mask, 5MHz BW, RB=25



LTE Band 30 Conducted RF Emission Test Data cont'd

Figure 3-20a: Band 30 High Channel Mask, 5MHz BW, RB=1

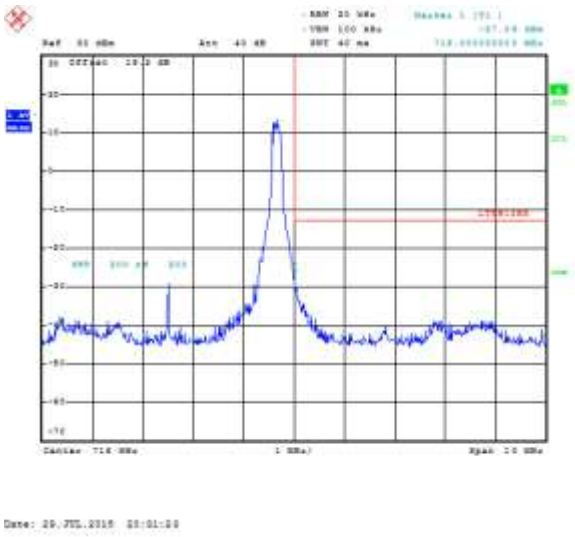


Figure 3-21a: Band 30 High Channel Mask, 5MHz BW, RB=25

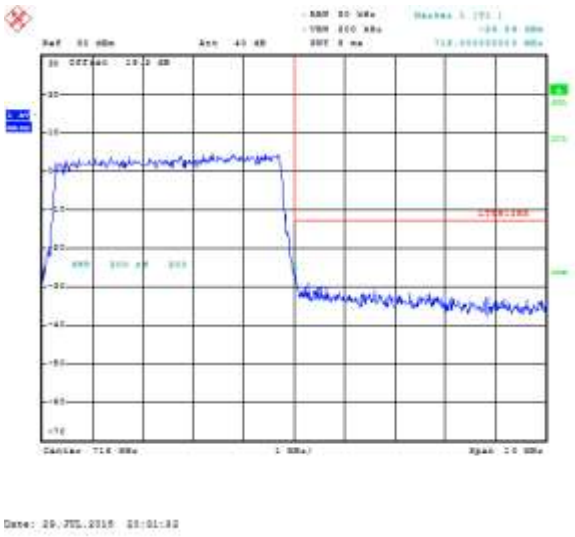
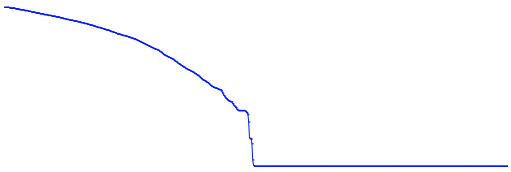


Figure 3-22a: Band 30 PAR, 10MHz BW, RB=25



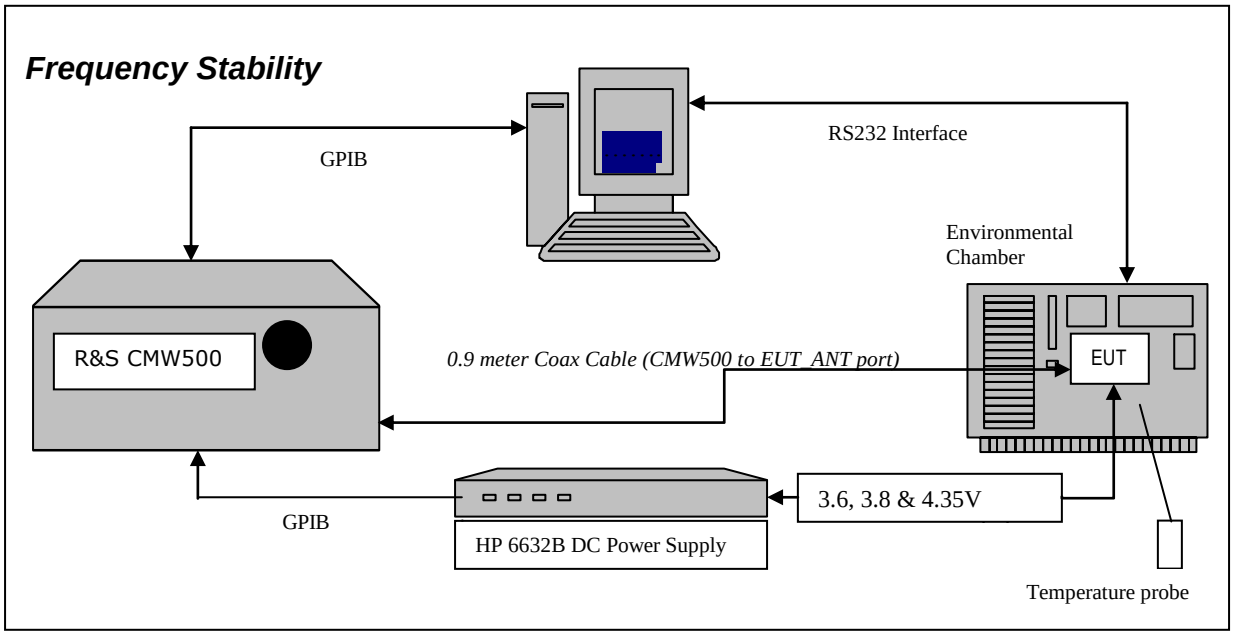
Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	13.32 dBm
Peak	23.22 dBm
Crest	9.90 dB
10 %	3.33 dB
1 %	6.25 dB
.1 %	8.01 dB
.01 %	9.55 dB

Date: 3.SEP.2015 03:17:20

APPENDIX 8B – LTE Band 30 FREQUENCY STABILITY TEST DATA

LTE Band 30 Frequency Stability Test Data



The following measurements were performed by Sijia Li.

CFR 47 Chapter 1 - Federal Communications Commission Rules

Part 2 Required Measurements
2.1055 Frequency Stability - Procedures
(a,b) Frequency Stability - Temperature Variation
(d) Frequency Stability - Voltage Variation

The EUT meets the requirements as stated in CFR 47 chapter 1, Section 27.54, Frequency Stability.
Frequency Stability measurement devices were configured as presented in the block diagram recording frequency, power, data, temperatures, and stepped voltages controlled via a GPIB interface linked to the Environmental chamber, a DC power supply, and the Communications Test Set. A 0.9-metre coax cable was calibrated to characterize the insertion loss for the transmitted frequencies between the RF input/output of the CMW 500 and the EUT antenna port.

Test Setup:

The EUT was placed in the Temperature chamber and connected to CMW 500 outside as shown in the figure above. Dry air was pumped inside the temperature chamber to maintain a backpressure during the test. The EUT was kept in the off condition at all times except when the following measurements were to be made.

The chamber was switched on and the temperature was set to -30°C.
After the chamber stabilized at -30 °C there was a soak period of one hour to alleviate moisture in the chamber, the EUT voltage was enabled.
The system software recorded the frequency, power, and associated measurements.

A Computer system controlled the automated software. This application was given the command of activating all machines intrinsic to the temperature and voltage tests controlling the CMW 500 via the GPIB Bus. The Environmental Chamber was instructed through an RS-232 serial line. The EUT dialogue was passed through a serial connection.

The EUT repetitively transmitted 100 bursts for each set of programmed parameters recording temperature, voltage settings, and systematically selected frequencies. The power supply was cycled from minimum voltage 3.6 volts, 3.8 volts and to 4.35 volts maximum voltage. The frequency error was measured at a maximum output power and recorded by the automated system test software.

The EUT output power and frequency was measured at 3.6 volts, 3.8 volts and 4.35 volts. The transmit frequency was measured on 782MHz for 10MHz bandwidth with maximum (50) RB. The transmit frequency was varied in 3 steps consisting of 779.5 MHz, 782.0 MHz and 784.5 MHz each was measured under 5 MHz bandwidth with maximum (25) RBs. This frequency was recorded in MHz and deviation from nominal, in Parts Per Million.

After the initial one-hour soak at the beginning of the tests, a period of thirty minutes soak was initialized between each ascending temperature step, before proceeding to the next measurement test cycle.

Procedure:

The test system software for commencing the Frequency Stability Tests carried through the following cycle.

71. Switch on the HP 6632B power supply; CMW 500 Communications test Set, and Environmental Chamber.
72. Start test program
73. Set the Temperature to –30°C and maintain a period of one- hour soak time, with the EUT supply voltage disabled.
74. Set power supply voltage to 3.6 volts.
75. Set up CMW 500 Radio Communication Tester.
76. Command the CMW 500 to switch to the low channel.
77. Enable the voltage to the EUT, and connect a link to the CMW 500 test set.
78. EUT is commanded to Transmit 100 Bursts.
79. Software logs the following data from the CMW 500, power supply and temperature chamber: Traffic Channel Number, Traffic Channel Frequency, Power Level, Chamber Temperature, Supply Voltage, Power and Frequency Error.
80. The CMW 500 commands the EUT to change frequency to the middle channel and high channel and repeats steps 7 to 9.
81. Repeat steps 5 to 10 changing the supply voltage to 3.8 Volts
82. Increase temperature by 10°C and soak for 1/2 hour.
83. Repeat steps 4 - 12 for temperatures –30°C to 60°C.
84. Repeat steps 5 to 10 changing the supply voltage to 4.35 volts

Procedure 5 to 10 was repeated at room temperature (20°C) with the power supply voltage set to 3.6, 3.8 and 4.35 volts

The maximum frequency error in the LTE Band 30 measured was **0.0093 PPM**.

Date of test: August 25, 2015

LTE Band 30 results (10MHz Bandwidth): channels 27710 @ 20°C maximum transmitted power

Traffic Channel Number	LTE Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
27710	2310.00	3.6	20	-4.79	-0.0021
27710	2310.00	3.8	20	-5.75	-0.0025
27710	2310.00	4.35	20	-7.08	-0.0031

LTE Band 30 Results (10MHz Bandwidth): channel 27710 @ maximum transmitted power

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
27710	704	3.6	-30	-8.23	-0.0036
27710	704	3.6	-20	-5.49	-0.0024
27710	704	3.6	-10	-6.04	-0.0026
27710	704	3.6	0	-7.52	-0.0033
27710	704	3.6	10	-5.89	-0.0026
27710	704	3.6	20	-4.79	-0.0021
27710	704	3.6	30	-6.34	-0.0027
27710	704	3.6	40	-8.45	-0.0037
27710	704	3.6	50	-8.51	-0.0037
27710	704	3.6	60	-7.28	-0.0032

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
27710	704	3.8	-30	21.59	**0.0093**
27710	704	3.8	-20	-6.28	-0.0027
27710	704	3.8	-10	-5.05	-0.0022
27710	704	3.8	0	-6.19	-0.0027
27710	704	3.8	10	-7.32	-0.0032
27710	704	3.8	20	-5.75	-0.0025
27710	704	3.8	30	-6.98	-0.0030
27710	704	3.8	40	-8.41	-0.0036
27710	704	3.8	50	-6.41	-0.0028
27710	704	3.8	60	-7.80	-0.0034

Traffic Channel Number	Frequency (MHz)	Voltage (Volts)	Temperature (Celsius)	Frequency Error (Hz)	PPM
27710	704	4.35	-30	-5.85	-0.0025
27710	704	4.35	-20	-7.38	-0.0032
27710	704	4.35	-10	-4.98	-0.0022
27710	704	4.35	0	-5.75	-0.0025
27710	704	4.35	10	-5.19	-0.0022
27710	704	4.35	20	-7.08	-0.0031
27710	704	4.35	30	-7.77	-0.0034
27710	704	4.35	40	-6.98	-0.0030
27710	704	4.35	50	-7.65	-0.0033
27710	704	4.35	60	-7.67	-0.0033

APPENDIX 8C – LTE Band 30 RADIATED EMISSIONS TEST DATA

Radiated Power Test Data Results

The following measurements were performed by Shiva Kumbham.
Date of Test: August 7, 2015
The environmental tests conditions were: Temperature: 25.5 °C
Relative Humidity: 35.6 %

The BlackBerry® smartphone was standalone, with horizontal top pointing up the RX antenna when the turntable is at 0 degree position.
Measurements were performed with QPSK and 16QAM modulations. The smallest test margins are reported below.
Test Distance was 3.0 meters with the RX antenna height scans between 3-4 meters height.

LTE Band 30, 5MHz BW, RB=1, QPSK modulation

EUT				Rx Antenna		Spectrum Analyzer		Substitution Method Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V, H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Dipole) (dBm)	(W)	Limit (dBm)	Diff. To Limit (dB)
F0	23035	2307.50	30	Horn	V	-31.97	-28.94	V-V	-10.99	23.46	0.22	24.00	0.54
F0	23035	2307.50	30	Horn	H	-28.94		H-H	-12.37				
F0	23095	2310.00	30	Horn	V	-31.65	-28.91	V-V	-10.95	23.36	0.22	24.00	0.64
F0	23095	2310.00	30	Horn	H	-28.91		H-H	-12.35				
F0	23154	2312.40	30	Horn	V	-31.47	-28.76	V-V	-10.70	**23.52**	0.22	24.00	0.48
F0	23154	2312.40	30	Horn	H	-28.76		H-H	-11.82				

LTE Band 30, 10MHz BW, RB=1, 16QAM modulation

EUT				Rx Antenna		Spectrum Analyzer		Substitution Method Tracking Generator					
Type	Ch	Frequency (MHz)	Band	Type	Pol.	Reading (dBm)	Max (V, H) (dBm)	Pol. Tx-Rx	Reading (dBm)	Corrected Reading (relative to Dipole) (dBm)	(W)	Limit (dBm)	Diff. To Limit (dB)
F0	27710	2310.00	30	Horn	V	-30.23	-29.28	V-V	-11.36	22.95	0.20	24.00	1.05
F0	27710	2310.00	30	Horn	H	-29.28		H-H	-12.72				

Radiated Emissions Test Data Results cont'd

The following measurements were performed by Savtej Sandhu.

Date of Test: August 10, 2015

The environmental test conditions were: Temperature: 26.8 ºC
Relative Humidity: 33.2 %

The BlackBerry® smartphone was standalone, with horizontal pointing up and top facing the RX antenna when the turntable is at 0 degree position.

Test Distance was 3.0 meters with the RX antenna height scans between 3-4 meters height, and the frequency range scanned was 30MHz – 1GHz.

Measurements were performed in LTE Band 30 with 5MHz BW (channel 27710, 23095 and 23129 with RB = 1) with QPSK modulation. and 10MHz BW (channel 27710, 23095 and 23129 with RB = 1), with 16-QAM modulation.

All emissions had test margins greater than 25.0 dB.

The following measurements were performed by Xing Fang and Winston Vernon.

Date of Test: August 10-11 and September 21, 2015

The environmental test conditions were: Temperature: 27.9 ºC
Relative Humidity: 39.7 %

Test Distance was 3.0 meters with the RX antenna height scans between 3-4 meters height, and a frequency range of 1 GHz to 10 GHz.

The BlackBerry® smartphone was standalone, horizontal with top facing to the RX antenna when the turntable is at 0 degree position

Measurements were performed in LTE Band 30 with 5MHz BW (channel 27710, 23095 and 23129 with RB = 1) with QPSK modulation. and 10MHz BW (channel 27710, 23095 and 23129 with RB = 1), with 16-QAM modulation.

All emissions had test margins greater than 25.0 dB.