9. NOISE FIGURE

FCC Rules

Test Requirements:

§ 90.219 Use of signal boosters:

(e) (2) The noise figure of a signal booster must not exceed 9 dB in either direction.

ISED Rules

Test Requirements:

RSS-131

6. Equipment standard specifications for zone enhancers working with equipment certified under RSS-119

6.4 Noise

The ERP of noise within the passband should not exceed −43 dBm in a 10 kHz measurement bandwidth.

The ERP of noise in spectrum more than 1 MHz outside of the passband should not exceed −70 dBm in a 10 kHz measurement bandwidth.

The noise figure of a zone enhancer shall not exceed 9 dB in either direction.

Test Procedures:

The EUT was tested using Agilent Application Note 57-1, 'The direct noise measurement method"

1. GAIN measurement

EUT in the maximum gain of the repeater state.

The signal generator was connected to RF input port at a maximum level as determined by the spectrum analyzer was connected to RF output port depending on the circuitry being measured.

EUT GAIN = Output signal level – Input signal level

2. Output Noise level measurement

EUT in the maximum gain of the repeater state.

Without input signal.

Spectrum analyzer was connected to RF output port

Measured to Noise power.

NF=NP-G-BCF-PNAD

NF=NP-G-60+174

NF=NP-G+114

NF=Noise Figure (dB)

NP=Noise power (dBm/MHz)

G=Maximum gain

BCF=Bandwidth Correction Factor=10 log(1 MHz/1 Hz)=60

PNAD=Noise Power Density=-174 dBm/Hz

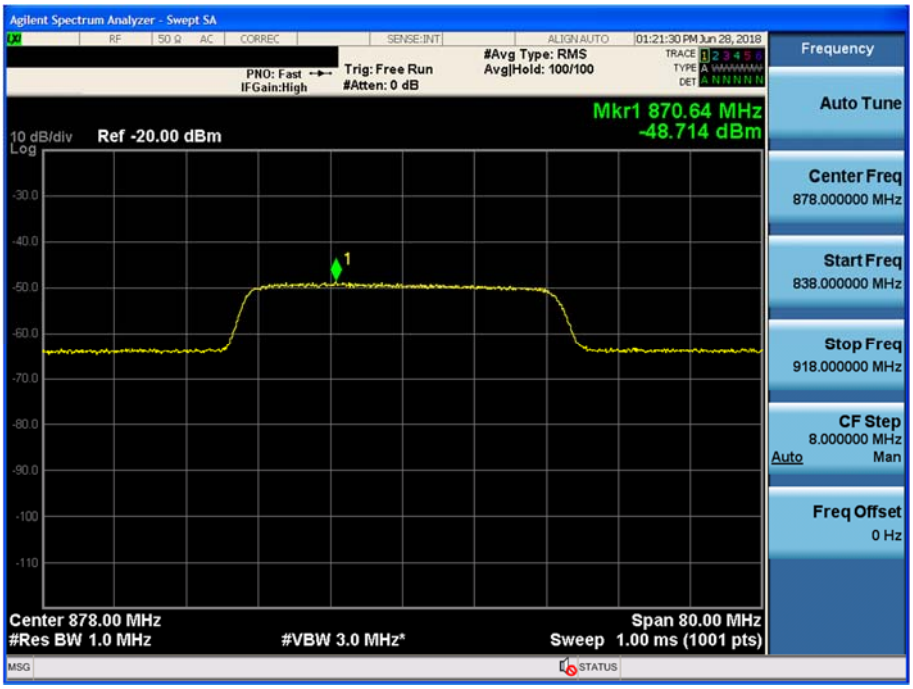
Test Results:

Input Signal	Input Level (dBm)	Maximum Amp Gain
800 IDEN	Without input signal	57

* For reason of filter setting, noise figure is measured at all frequencies of par 22 and part 90 band.

Noise Figure = - 48.714 - 57 + 114 = 8.286 dB

Plot of Noise power



10. SPURIOUS AND HARMONIC EMISSION AT ANTENNA TERMINAL

FCC Rules

Test Requirements:

§ 2.1051 Measurements required: Spurious emissions at antenna terminals:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 22.917 Emission limitations for cellular equipment.

The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.

(c) Alternative out of band emission limit. Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

(d) Interference caused by out of band emissions. If any emission from a transmitter operating in

this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

§ 90.691 Emission mask requirements for EA-based systems

(a) Out-of-band emission requirement shall apply only to the “outer” channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 116 $Log_{10}(f/6.1)$ decibels or 50 + 10 Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + $10Log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

ISED Rules

Test Requirements:

RSS-131

6.5 Equipment standard specifications for zone enhancers working with equipment certified under RSS-119

6.5 Spurious emissions

The spurious emissions of a zone enhancer shall not exceed −13 dBm in any 100 kHz measurement bandwidth.

RSS-132

5. Transmitter Standard Specifications

5.5 Transmitter Unwanted Emissions

Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 $log_{10}p$ (watts).

ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the

power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 $\log_{10}$ p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

Test Procedures:

Measurements were in accordance with the test methods section 3.6 and 4.7 of KDB 935210 D05 v01r02.

3.6.1 General

Refer to the applicable rule part(s) for specified limits on unwanted (out-of-band/out-of-block and spurious) emissions.

Spurious emissions shall be measured using a single test signal sequentially tuned to the low, middle, and high channels or frequencies within each authorized frequency band of operation.

Out-of-band/out-of-block emissions (including intermodulation products) shall be measured under each of the following two stimulus conditions:

a) two adjacent test signals sequentially tuned to the lower and upper frequency band/block edges;

b) a single test signal, sequentially tuned to the lowest and highest frequencies or channels within the frequency band/block under examination.

NOTE—Single-channel boosters that cannot accommodate two simultaneous signals within the passband may be excluded from the test stipulated in step a).

3.6.2 Out-of-band/out-of-block emissions conducted measurements

a) Connect a signal generator to the input of the EUT.

If the signal generator is not capable of generating two modulated carriers simultaneously, then two discrete signal generators can be connected with an appropriate combining network to support this two-signal test.

b) Set the signal generator to produce two AWGN signals as previously described (e.g., 4.1 MHz OBW).

c) Set the center frequencies such that the AWGN signals occupy adjacent channels, as defined by industry standards such as 3GPP or 3GPP2, at the upper edge of the frequency band or block under test.

d) Set the composite power levels such that the input signal is just below the AGC threshold (see 3.2), but not more than 0.5 dB below. The composite power can be measured using the procedures provided in KDB Publication 971168, but it will be necessary to expand the power integration bandwidth so as to include both of the transmit channels. Alternatively, the composite power can be measured using an average power meter as described in KDB Publication 971168.

e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as

necessary.

f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band (typically 1 % of the EBW or 100 kHz or 1 MHz)

g) Set the VBW = 3 × RBW.

h) Set the detector to power averaging (rms) detector.

i) Set the Sweep time = auto-couple.

j) Set the spectrum analyzer start frequency to the upper block edge frequency, and the stop frequency to the upper block edge frequency plus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively.

k) Trace average at least 100 traces in power averaging (rms) mode.

l) Use the marker function to find the maximum power level.

m) Capture the spectrum analyzer trace of the power level for inclusion in the test report.

n) Repeat steps k) to m) with the composite input power level set to 3 dB above the AGC threshold.

o) Reset the frequencies of the input signals to the lower edge of the frequency block or band under test.

p) Reset the spectrum analyzer start frequency to the lower block edge frequency minus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively, and the stop frequency to the lower band or block edge frequency.

q) Repeat steps k) to n).

r) Repeat steps a) to q) with the signal generator configured for a single test signal tuned as close as possible to the block edges.

s) Repeat steps a) to r) with the narrowband test signal.

t) Repeat steps a) to s) for all authorized frequency bands or blocks used by the EUT.

3.6.3 Spurious emissions conducted measurements

a) Connect a signal generator to the input of the EUT.

b) Set the signal generator to produce the broadband test signal as previously described (i.e., 4.1 MHz OBW AWGN).

c) Set the center frequency of the test signal to the lowest available channel within the frequency band or block.

d) Set the EUT input power to a level that is just below the AGC threshold (see 3.2), but not more than 0.5 dB below.

e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.

f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band of operation (e.g., reference bandwidth is typically 100 kHz or 1 MHz).

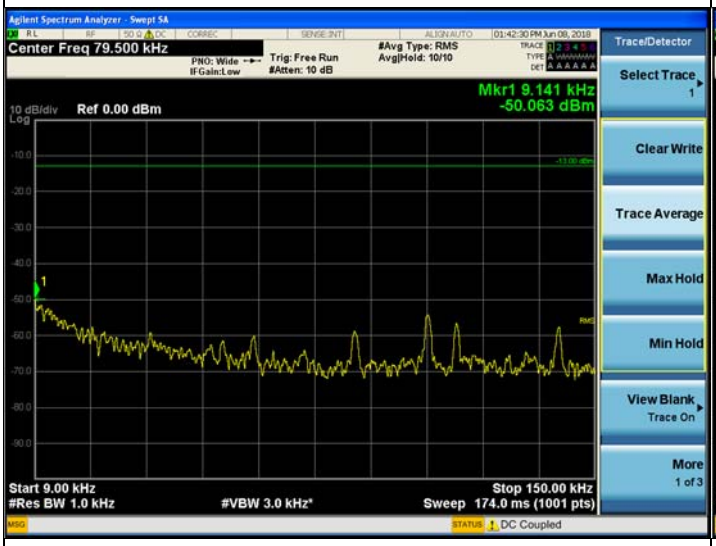
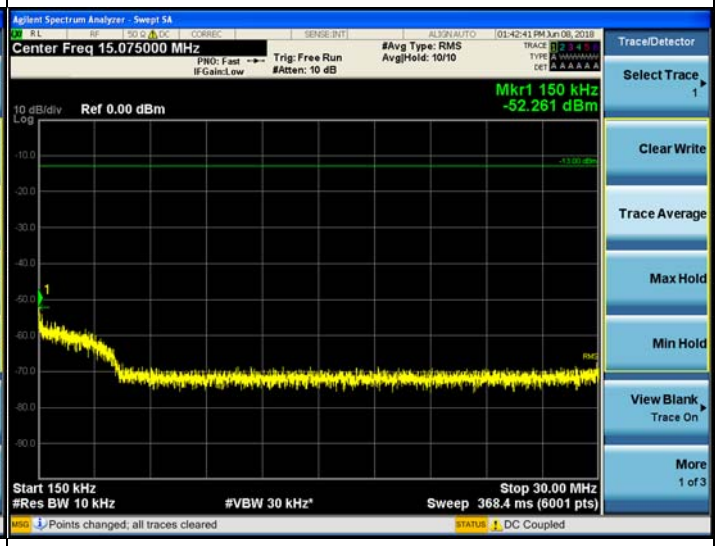
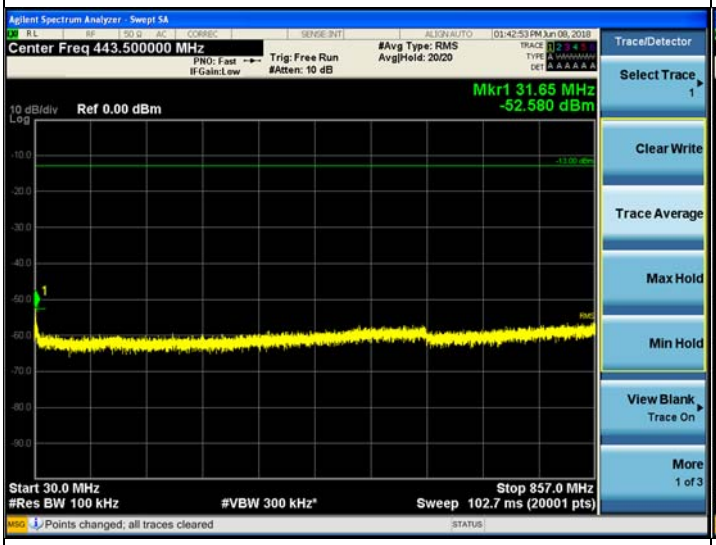
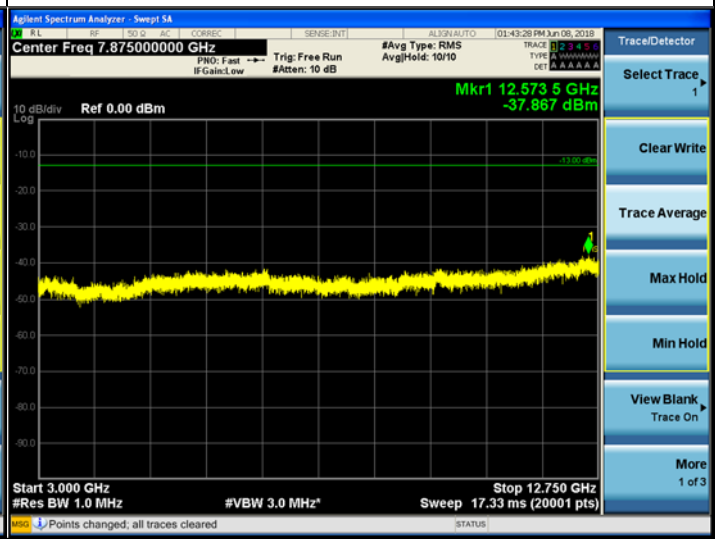
g) Set the VBW ≥ 3 × RBW.

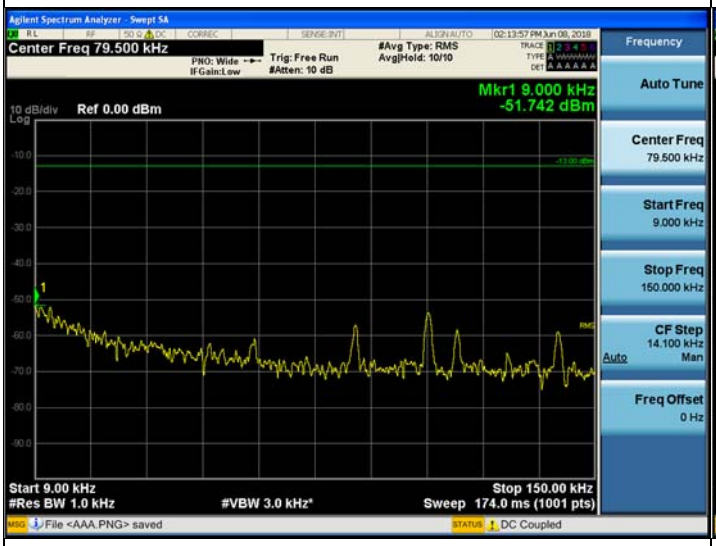
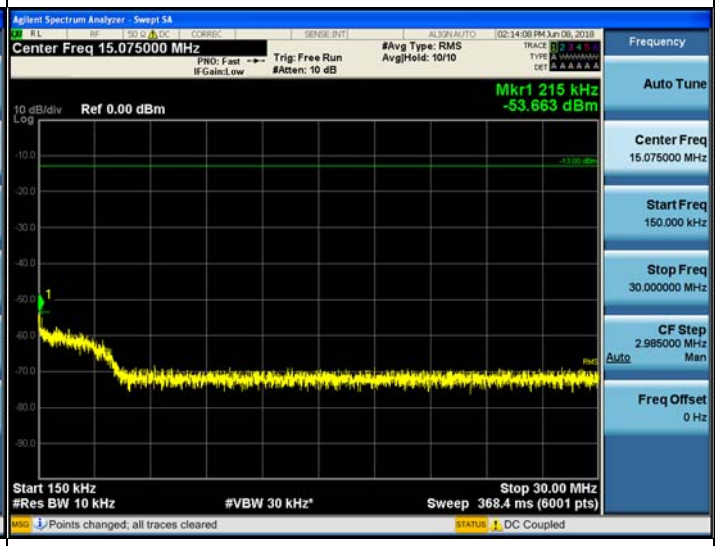
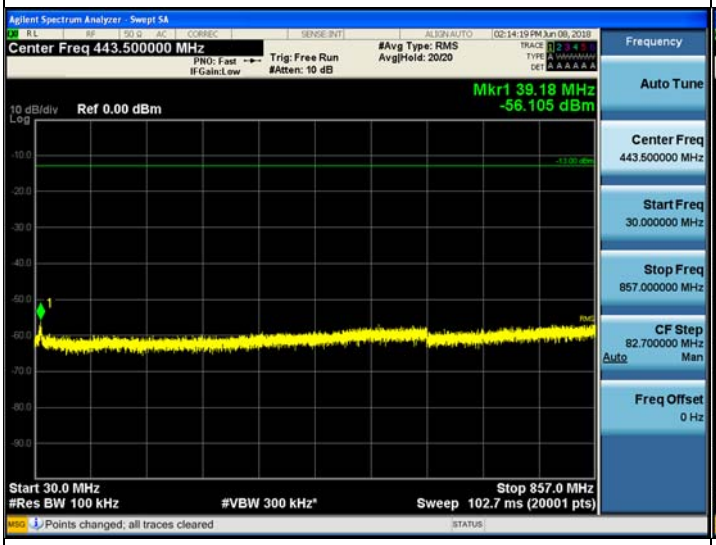
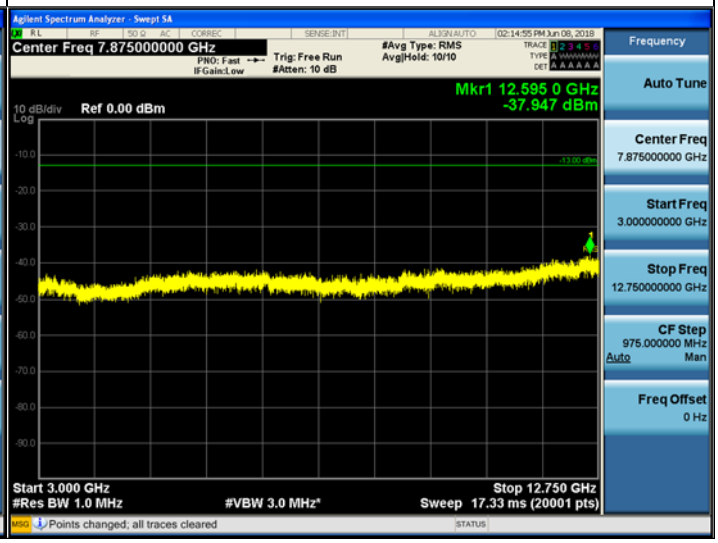
h) Set the Sweep time = auto-couple.
i) Set the spectrum analyzer start frequency to the lowest RF signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part.
The number of measurement points in each sweep must be ≥ (2 × span/RBW), which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.2
j) Select the power averaging (rms) detector function.
k) Trace average at least 10 traces in power averaging (rms) mode.
l) Use the peak marker function to identify the highest amplitude level over each measured frequency range. Record the frequency and amplitude and capture a plot for inclusion in the test report.
m) Reset the spectrum analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the spectrum analyzer stop frequency to 10 times the highest frequency of the fundamental emission (see § 2.1057). The number of measurement points in each sweep must be ≥ (2 × span/RBW), which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.
n) Trace average at least 10 traces in power averaging (rms) mode.
o) Use the peak marker function to identify the highest amplitude level over each of the measured frequency ranges. Record the frequency and amplitude and capture a plot for inclusion in the test report; also provide tabular data, if required.
p) Repeat steps i) to o) with the input test signals firstly tuned to a middle band/block frequency/channel, and then tuned to a high band/block frequency/channel.
q) Repeat steps b) to p) with the narrowband test signal.
r) Repeat steps b) to q) for all authorized frequency bands/blocks used by the EUT.

Notes:

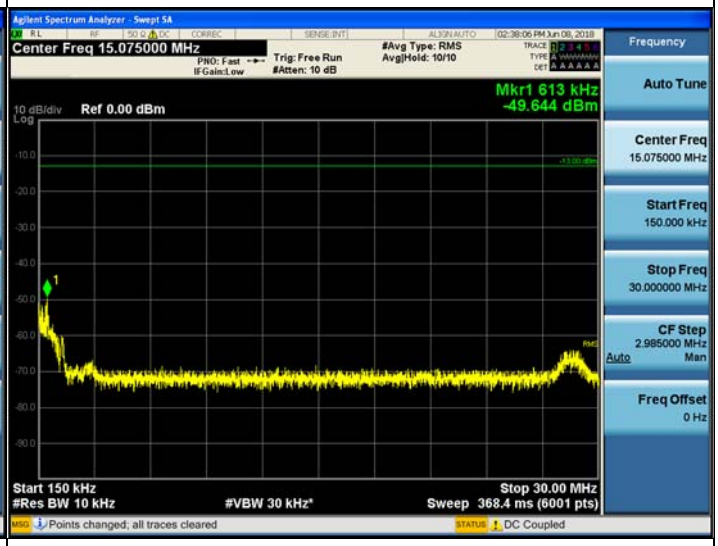
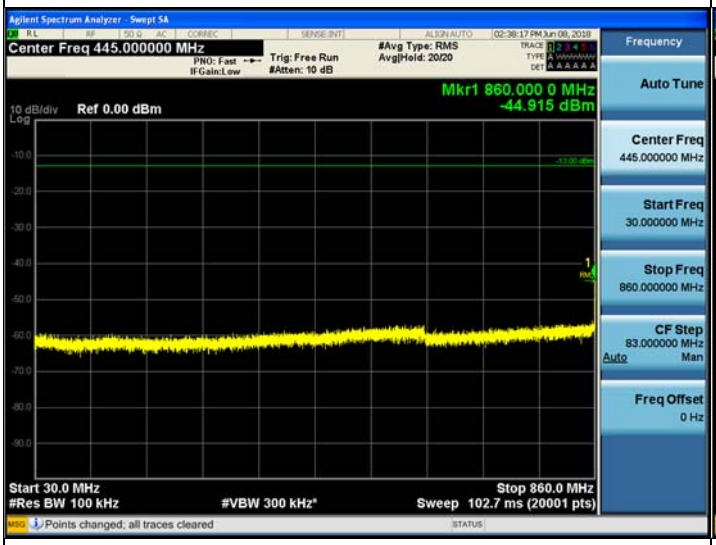
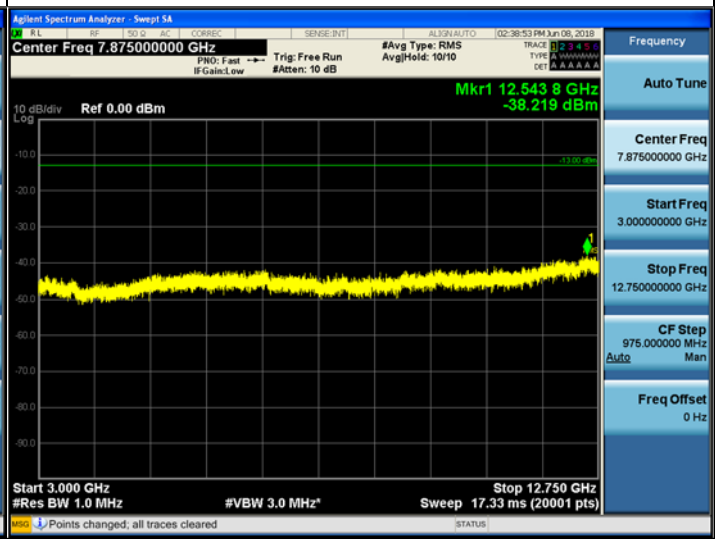
1. In 9 KHz-150 KHz and 150 KHz-30 MHz bands, RBW was reduced to 1% and 10% of the reference bandwidth for measuring unwanted emission level(typically, 100KHz if the authorized frequency band is below 1GHz) and power was integrated.(1% = +20 dB, 10% = +10 dB)
2. The test condition of §90.691(a)(2) can be applied because the EUT provides filters above 37.5 kHz such as CDMA, WCDMA(850CEL band), and LTE. And its limit (43 + 10Log10(P)) is included in spurious emissions and band edge.

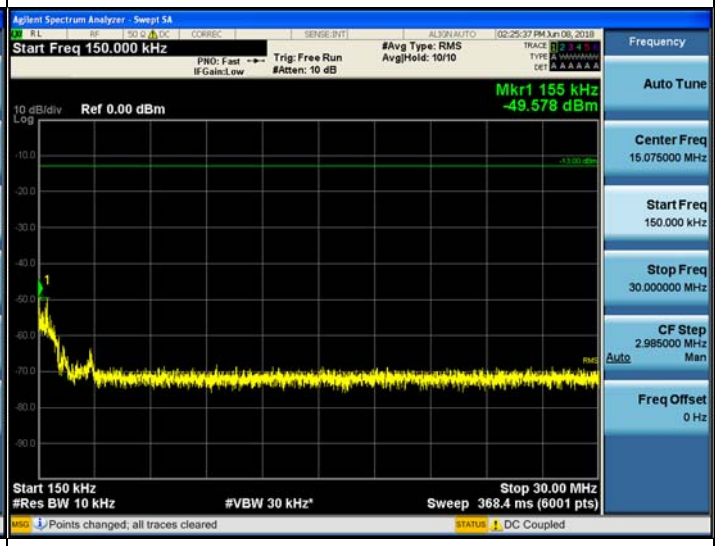
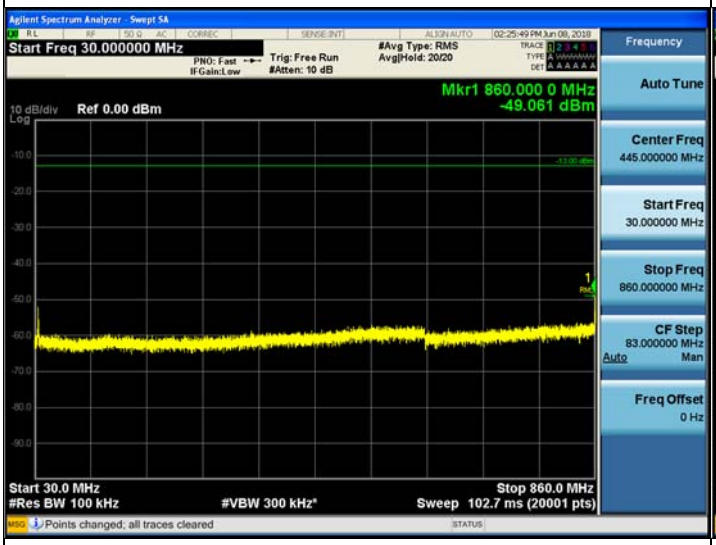
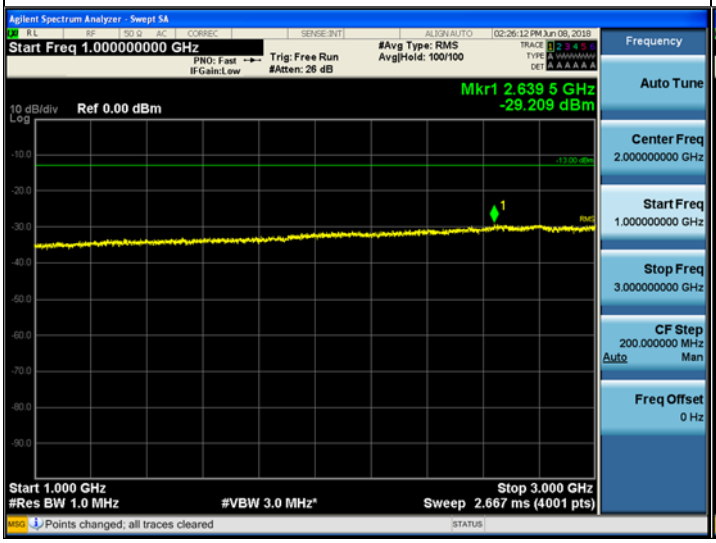
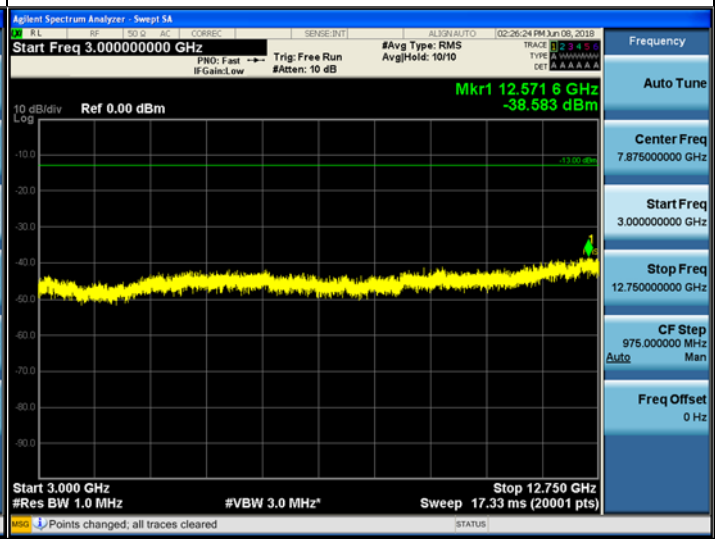
Plots of Unwanted Conducted Emissions for LTE 5 MHz_800 IDEN Band

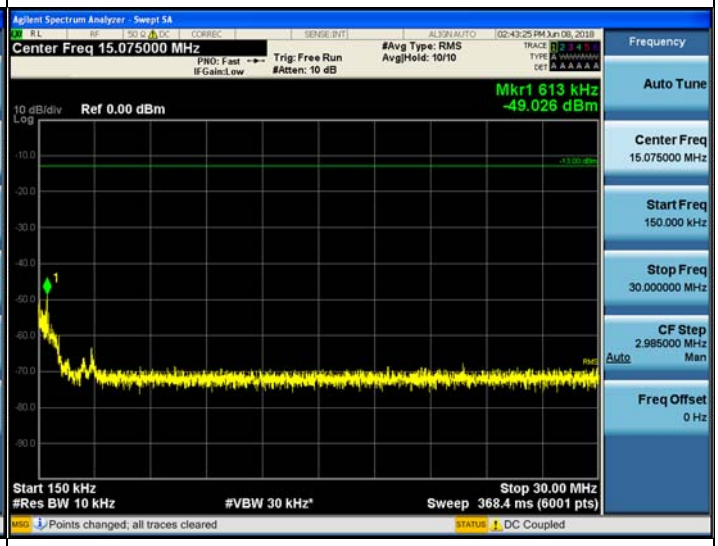
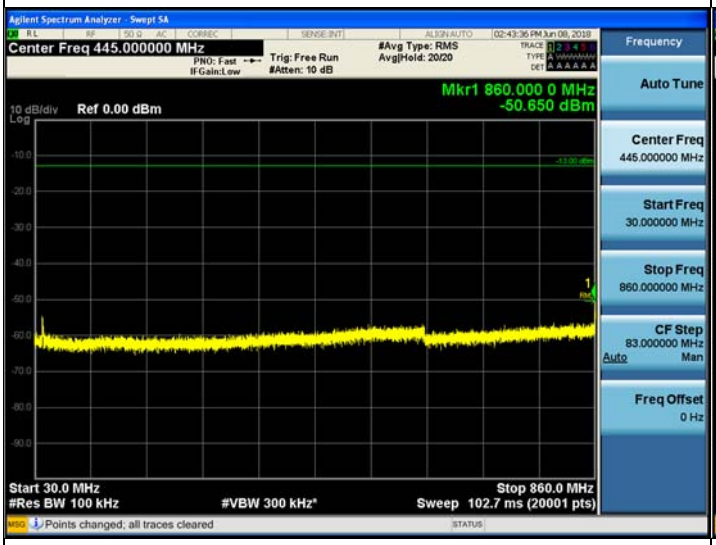
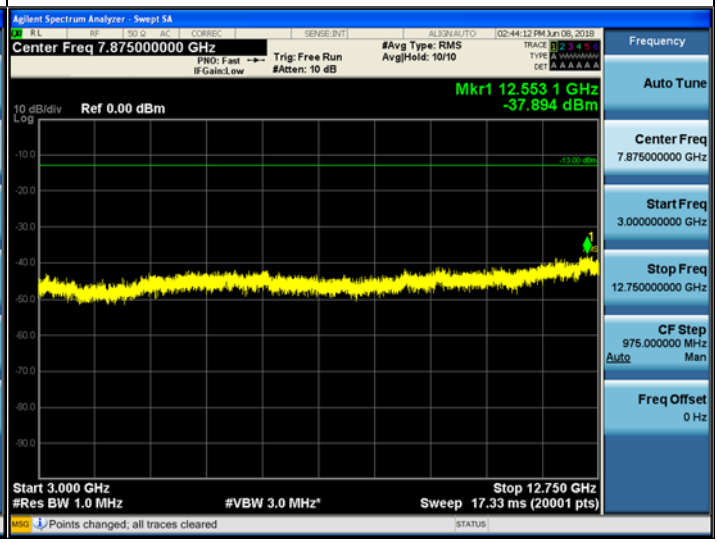
Low Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 857 MHz	874 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

High Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 857 MHz	874 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

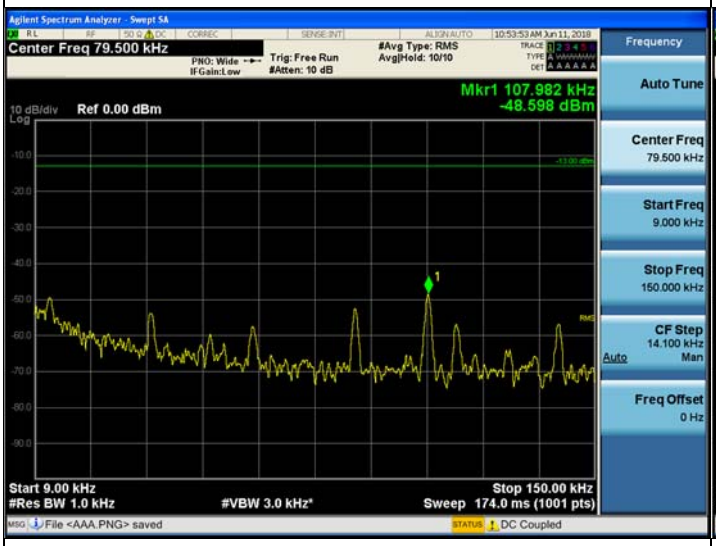
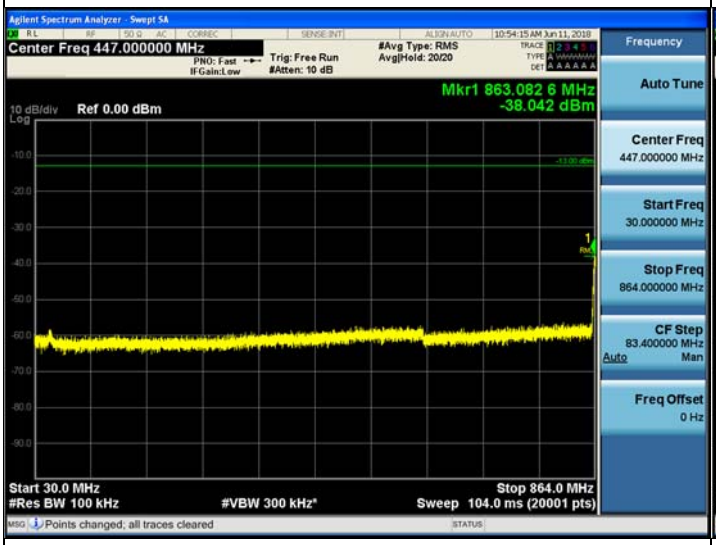
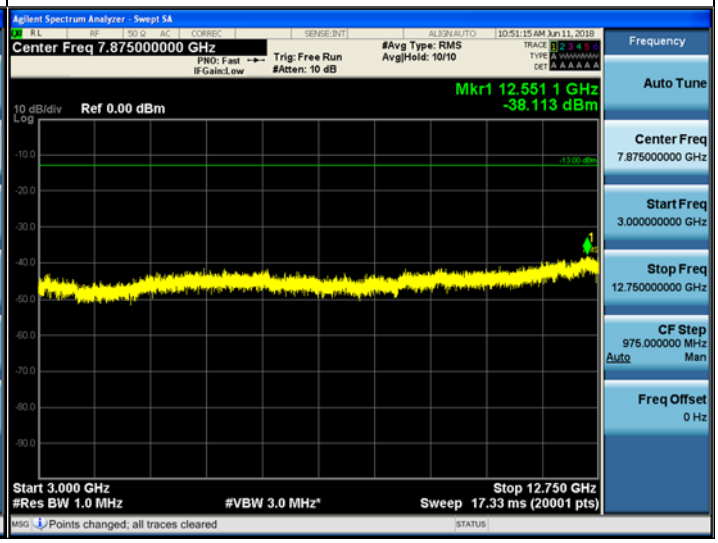
Plot of Unwanted Conducted Emissions for CDMA_800 IDEN Band

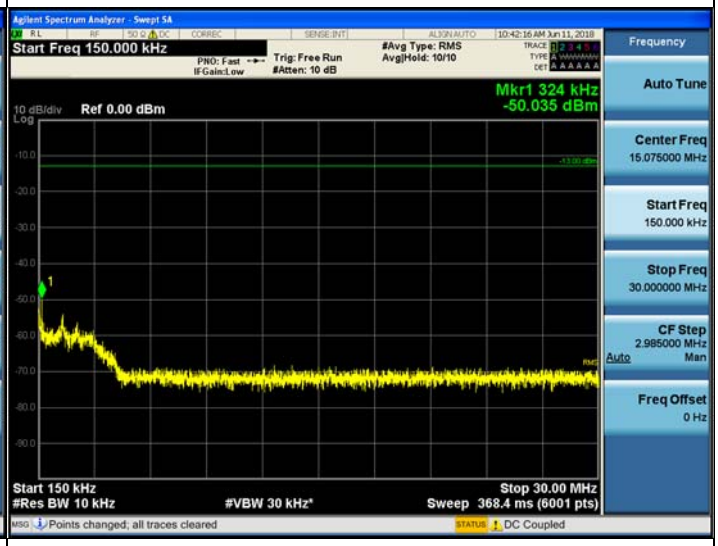
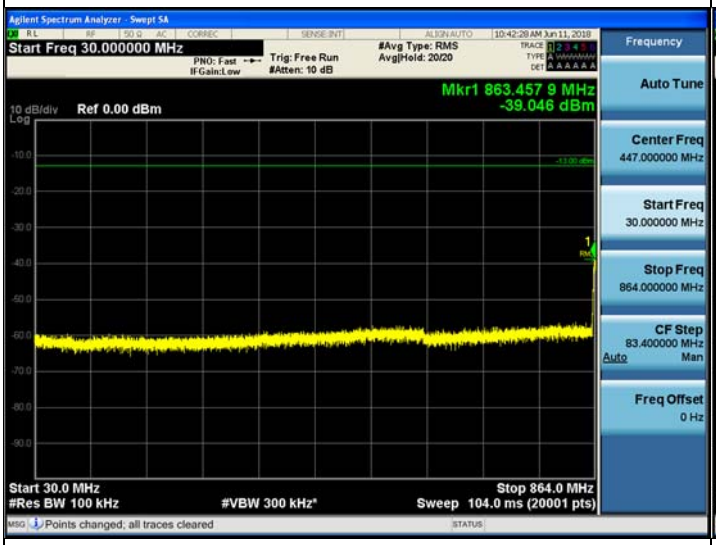
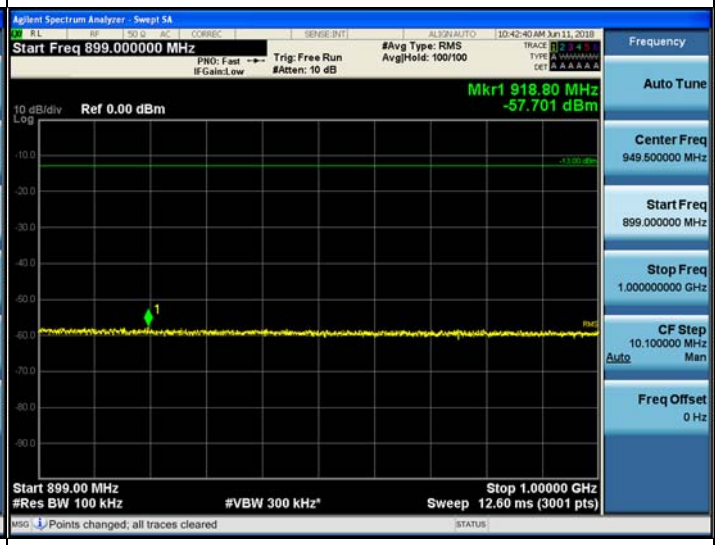
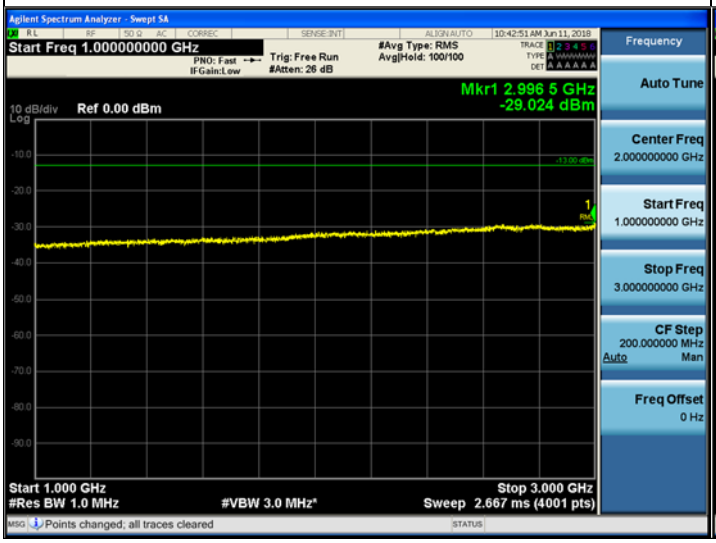
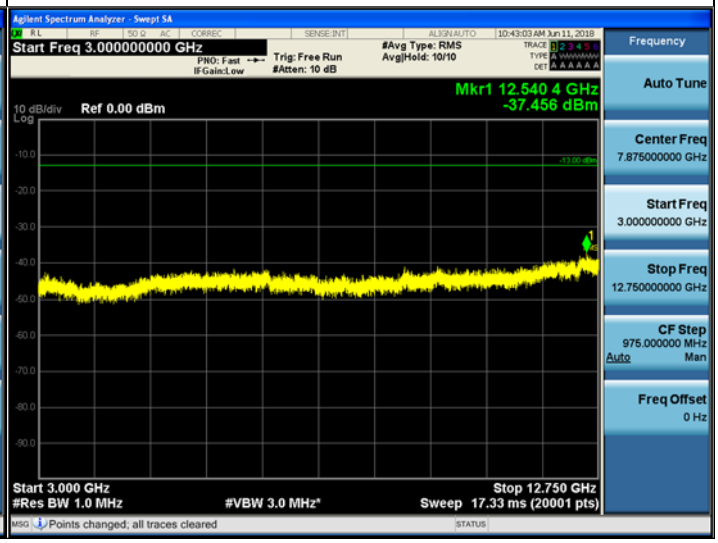
Low Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 860 MHz	871 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

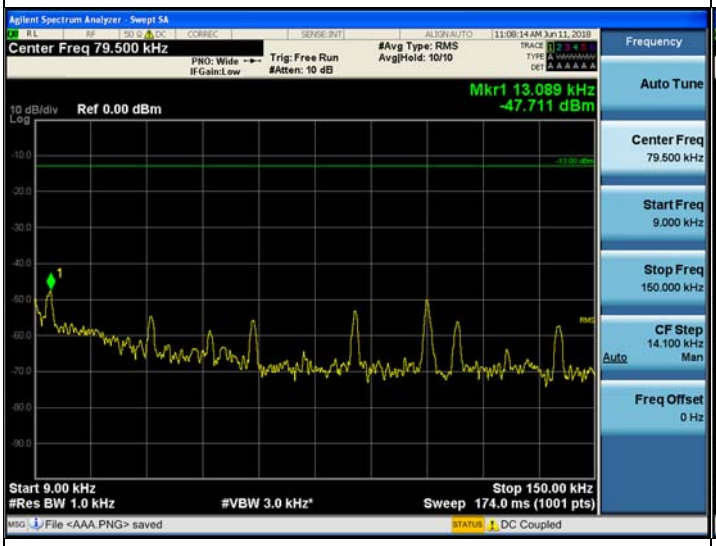
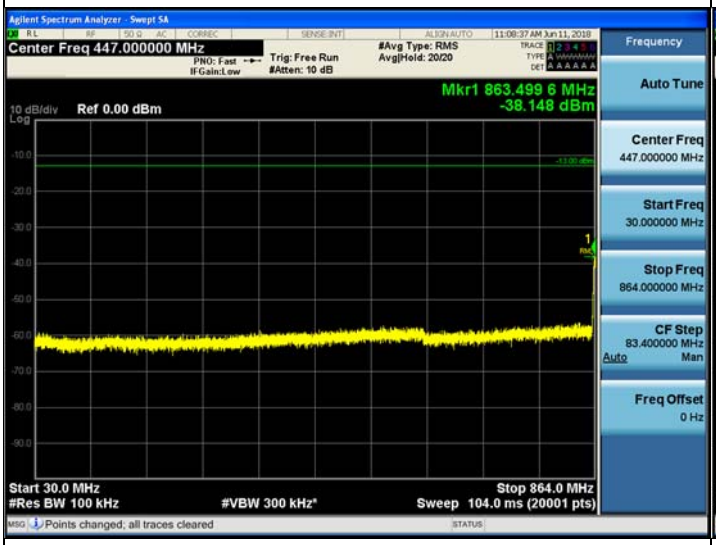
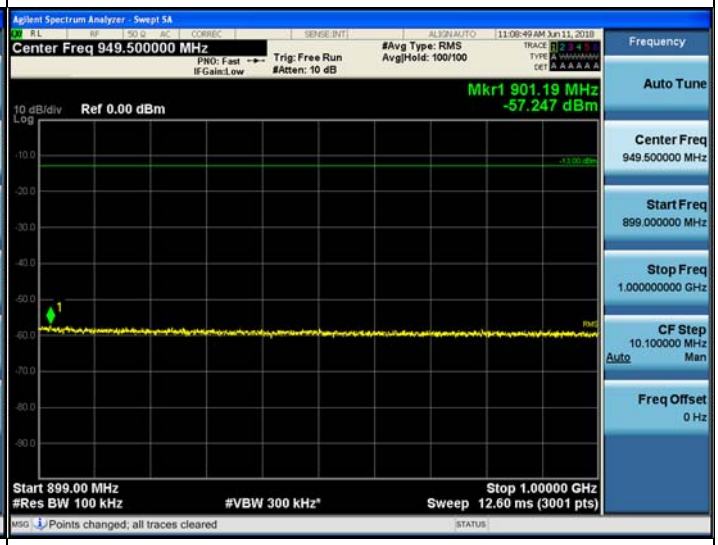
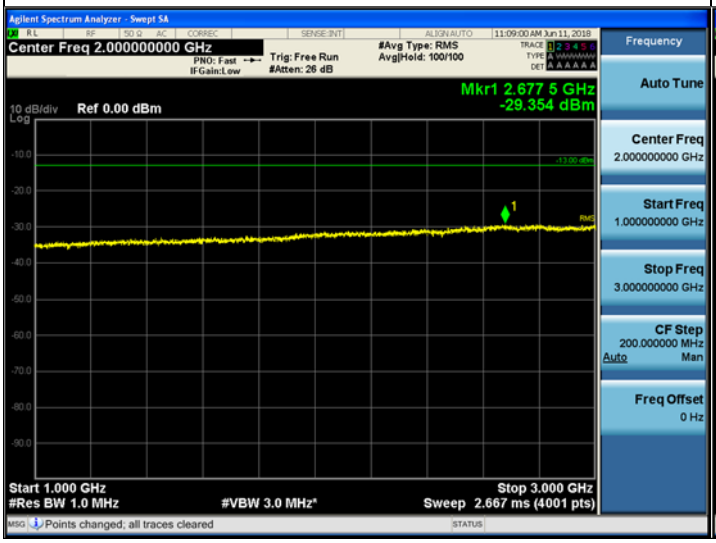
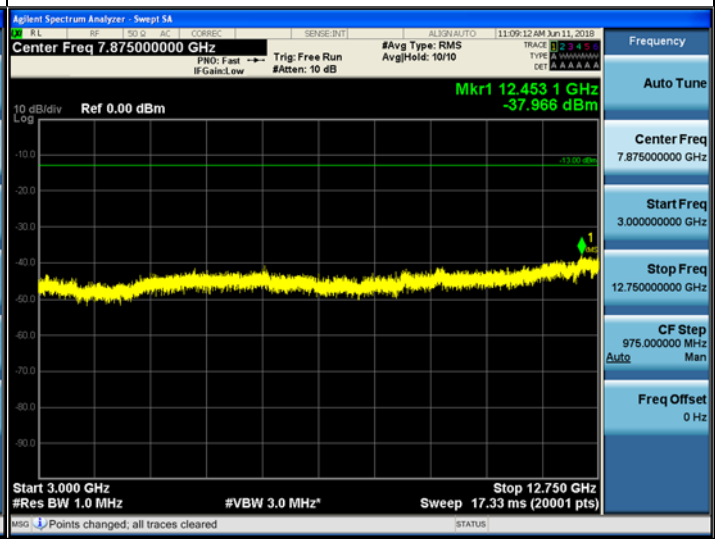
Middle Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 860 MHz	871 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

High Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 860 MHz	871 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

Plots of Unwanted Conducted Emissions for LTE 5 MHz_850 CEL Band

Low Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 864 MHz	899 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

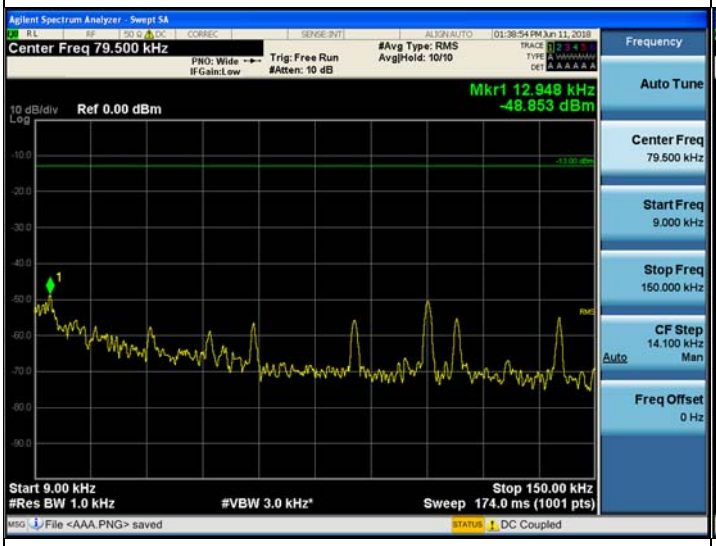
Middle Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 864 MHz	899 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

High Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 864 MHz	899 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

Plots of Unwanted Conducted Emissions for LTE 10 MHz_850 CEL Band

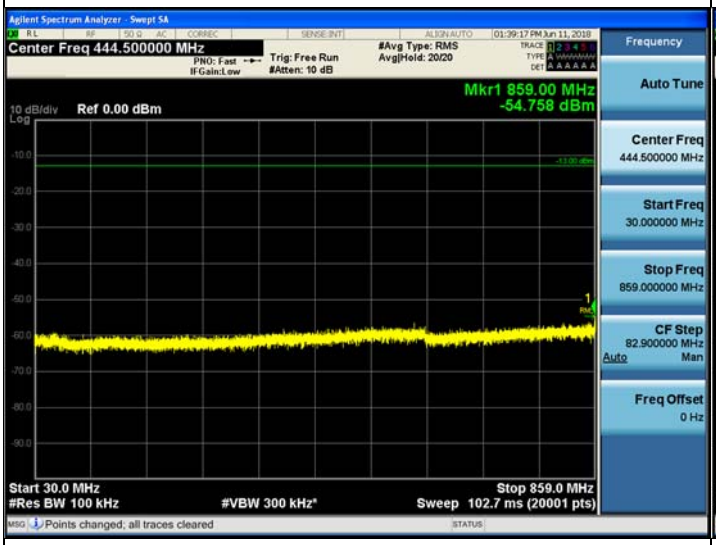
Low Channel

9 kHz ~ 150 kHz

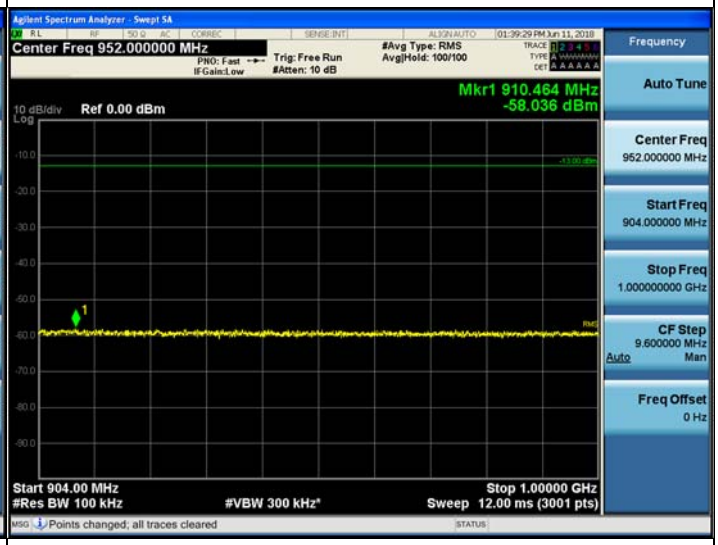


150 kHz ~ 30 MHz

30 MHz ~ 859 MHz

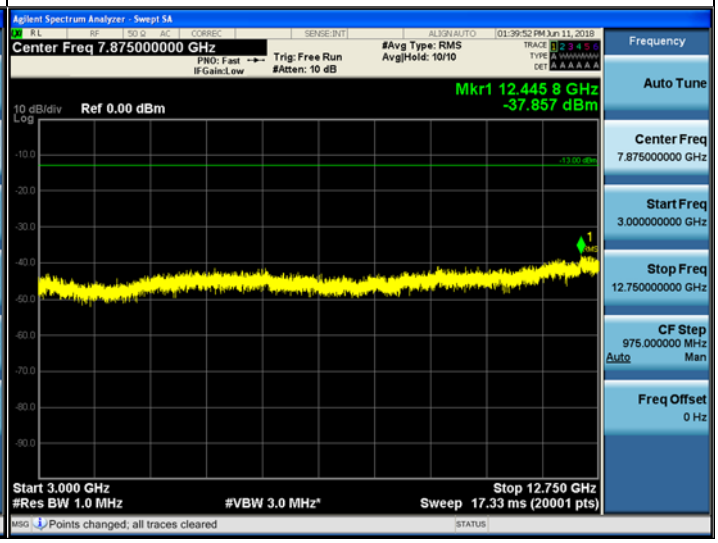


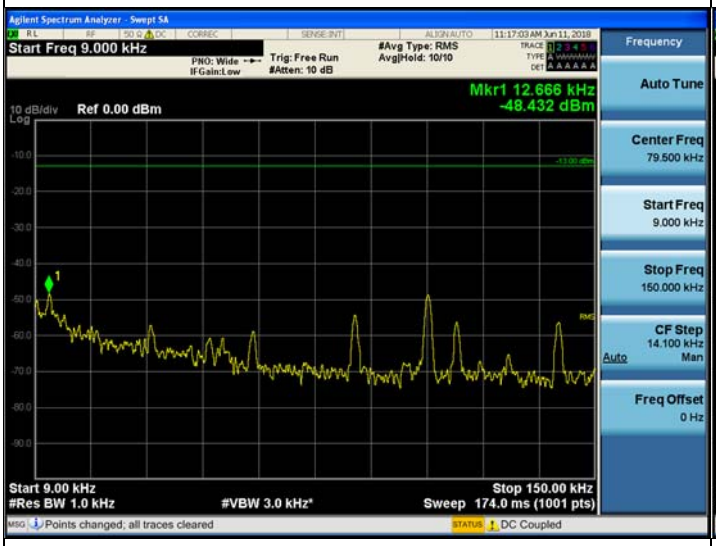
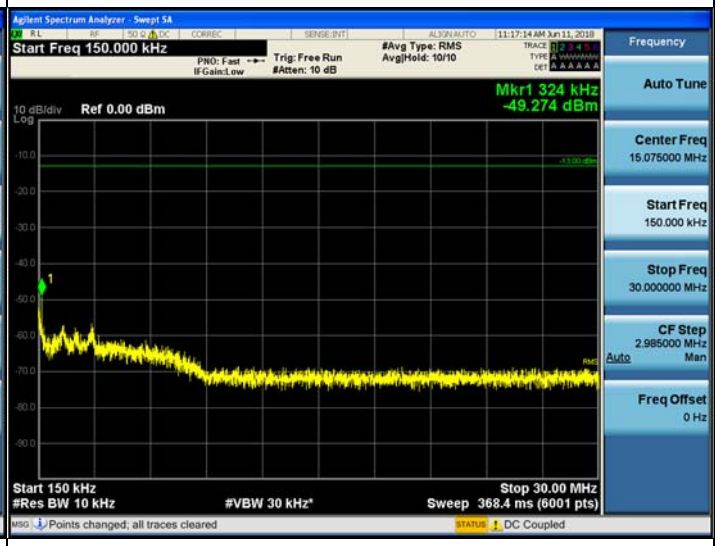
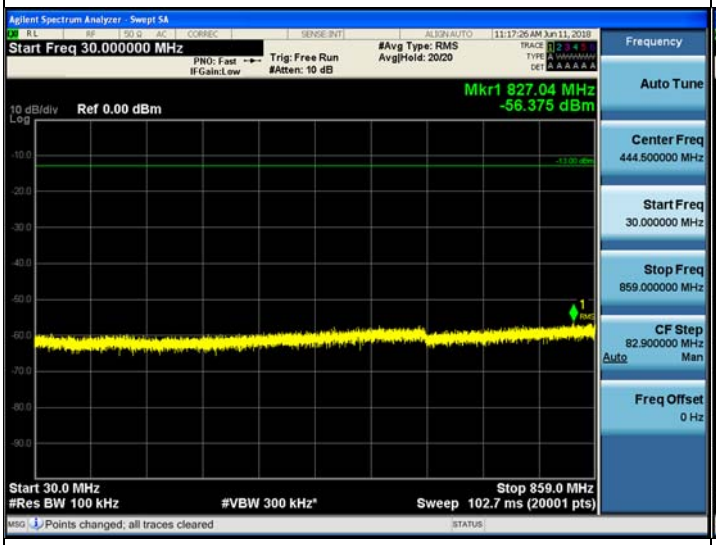
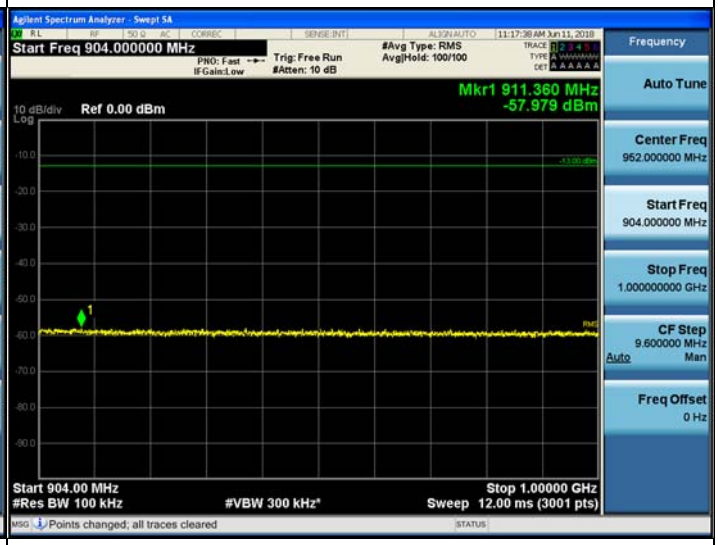
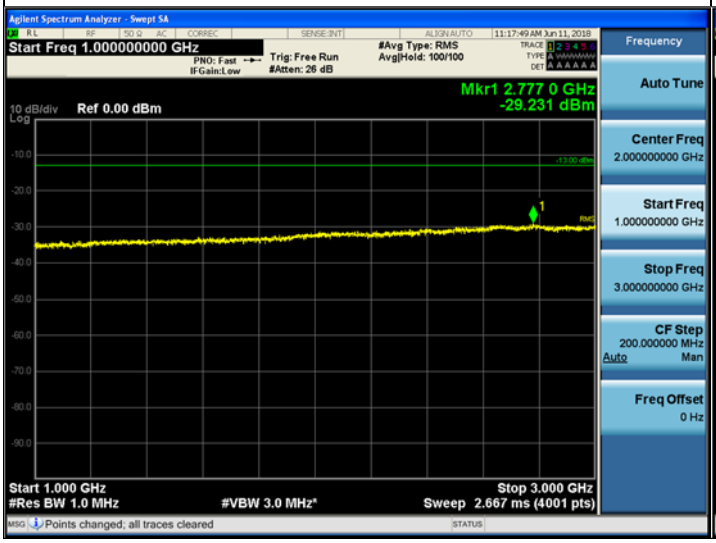
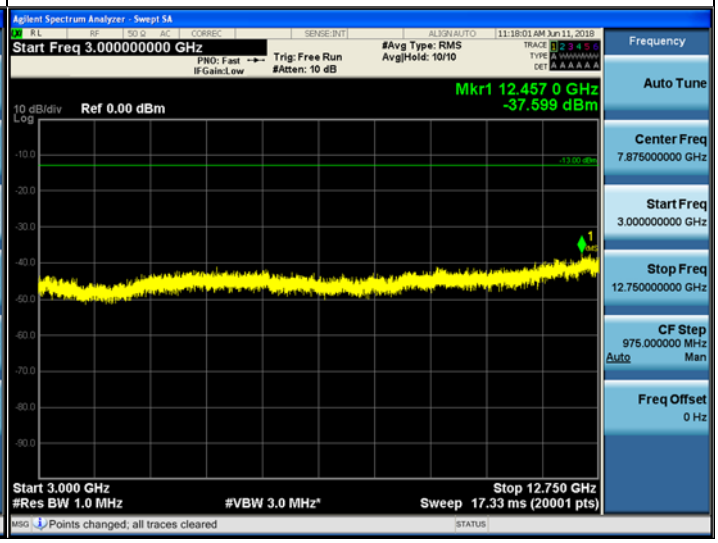
904 MHz ~ 1 GHz

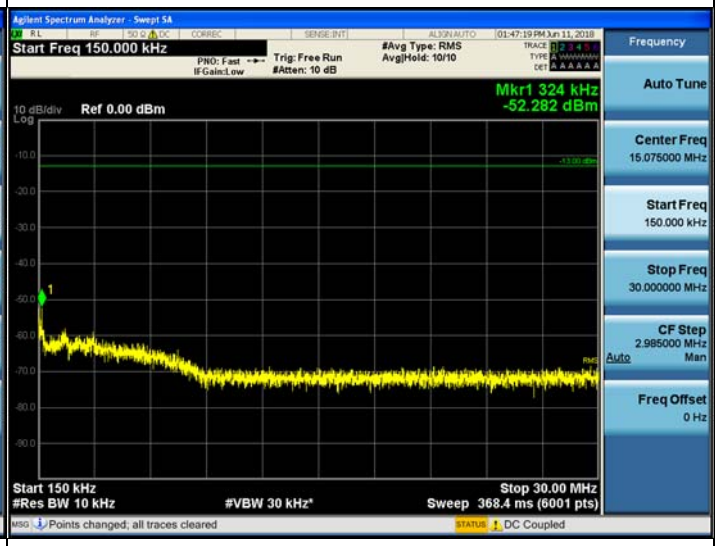
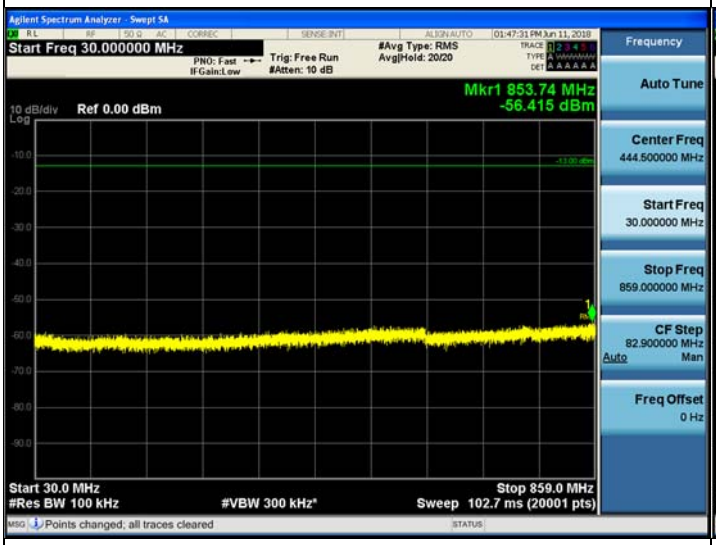
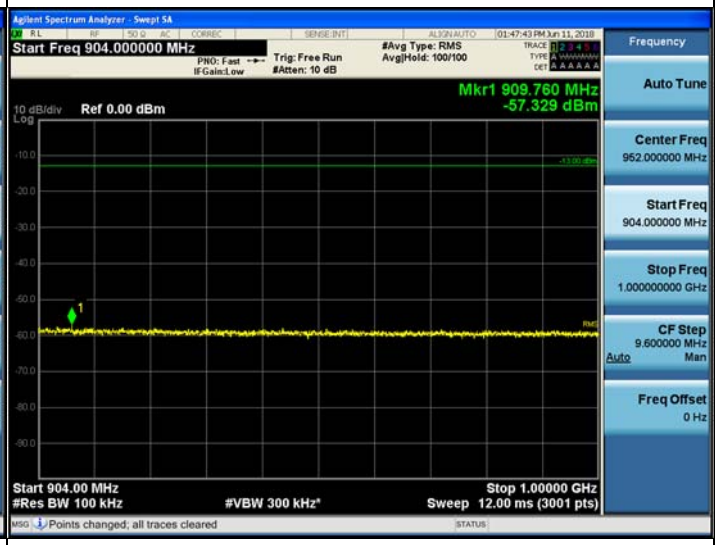
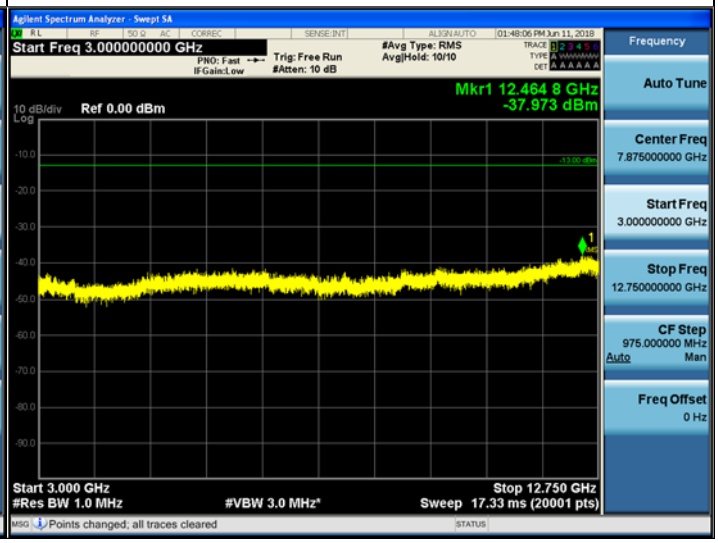


1 GHz ~ 3 GHz

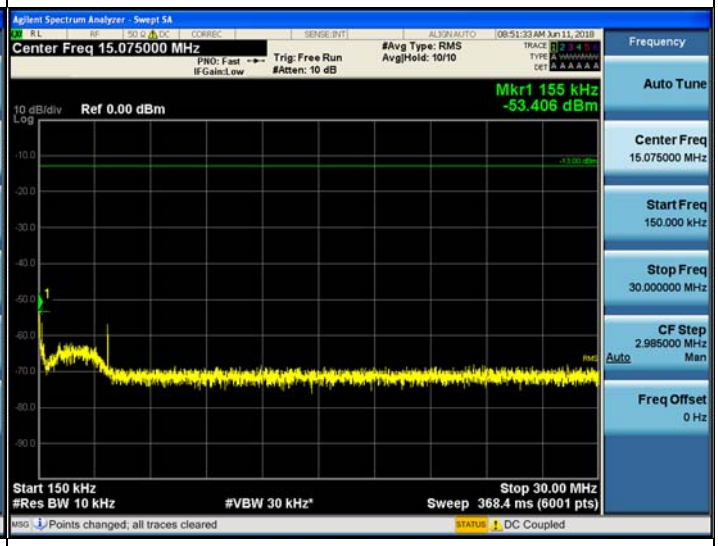
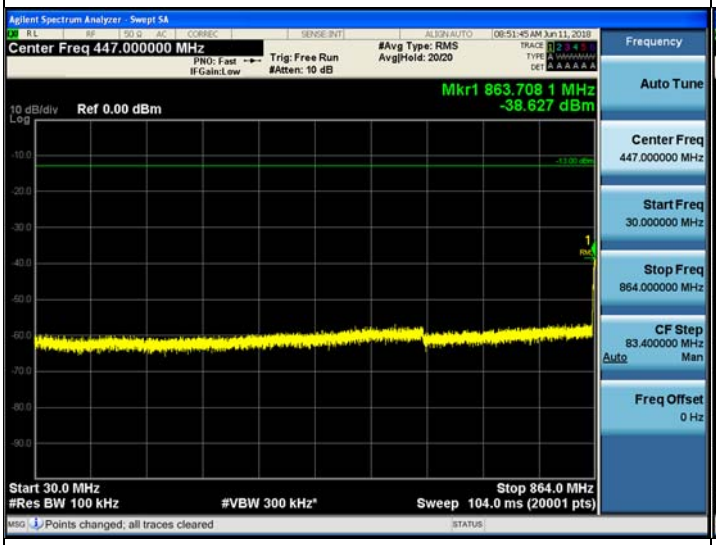
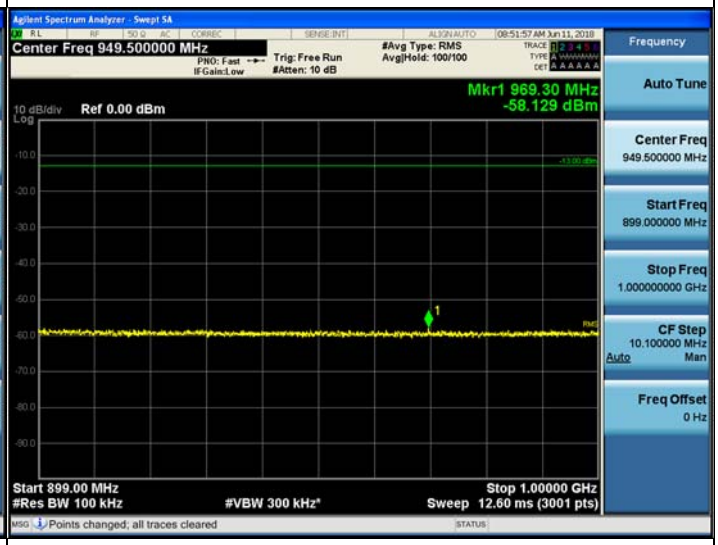
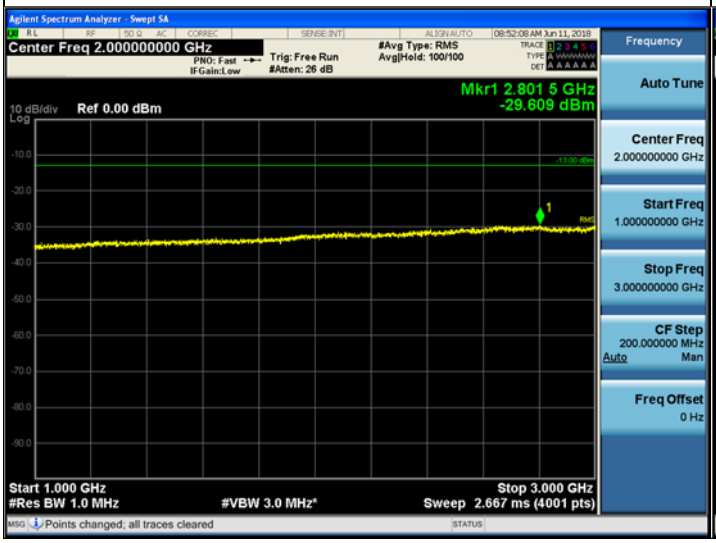
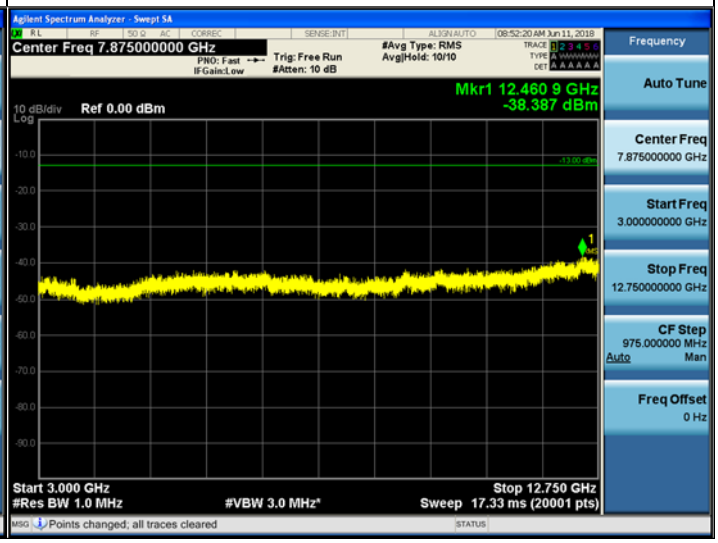
3 GHz ~ 12.75 GHz

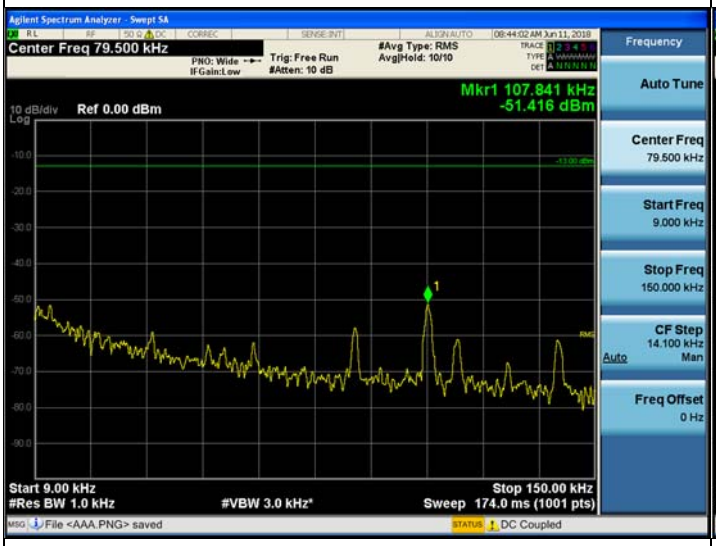
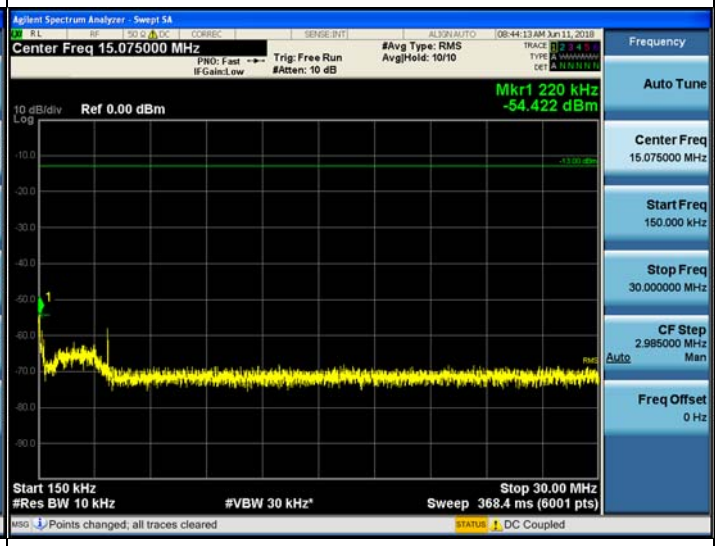
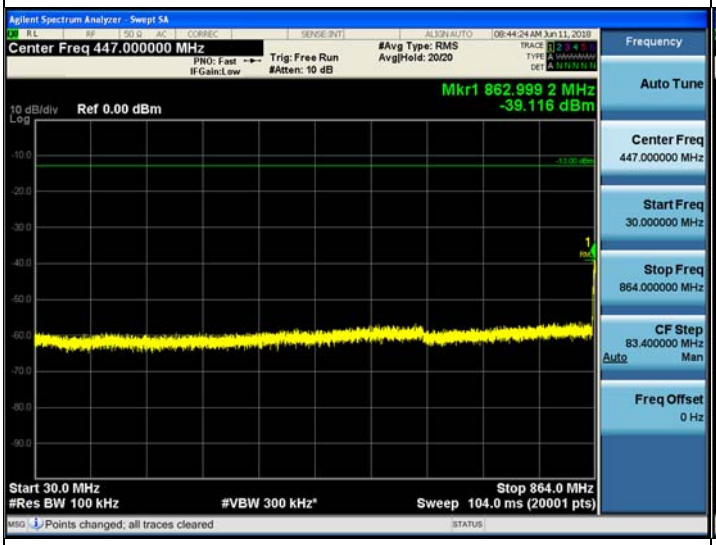
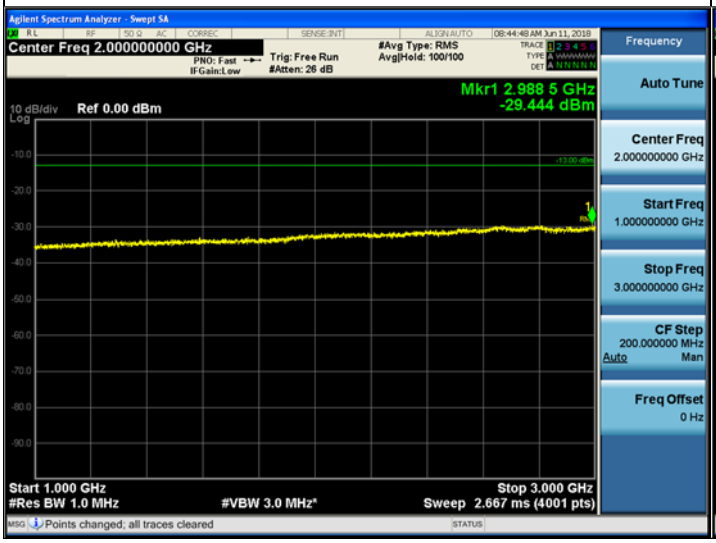
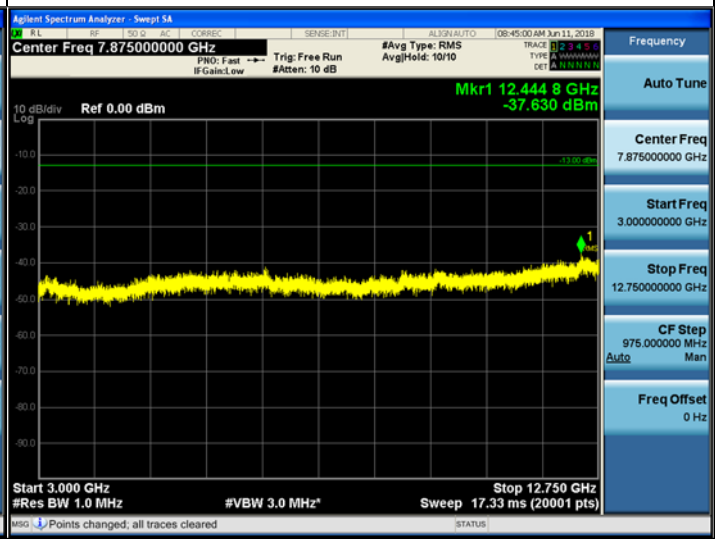


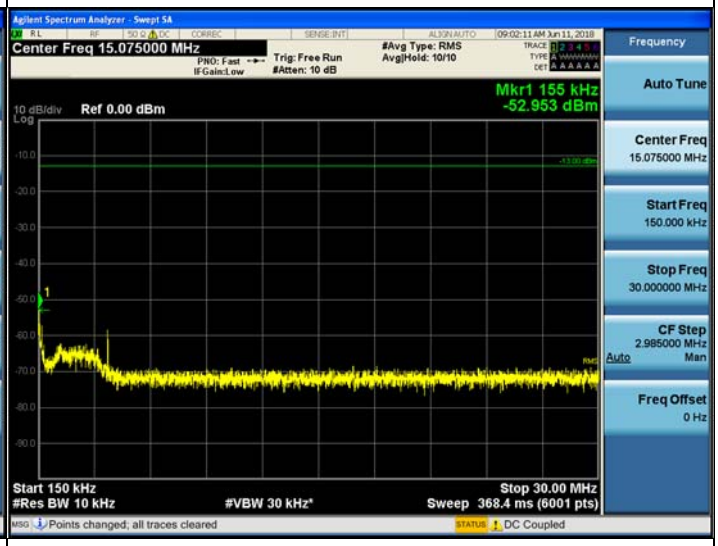
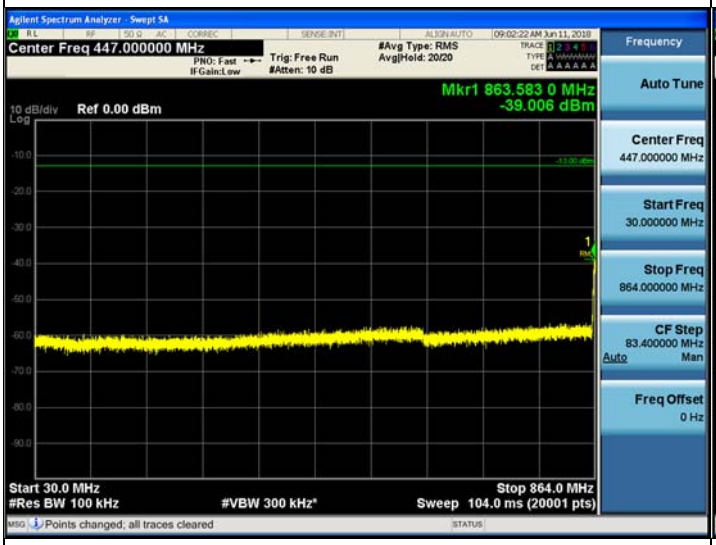
Middle Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 859 MHz	904 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

High Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 859 MHz	904 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

Plots of Unwanted Conducted Emissions for WCDMA_850 CEL Band

Low Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 864 MHz	899 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

Middle Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 864 MHz	899 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz
	

High Channel	
9 kHz ~ 150 kHz	150 kHz ~ 30 MHz
	
30 MHz ~ 864 MHz	899 MHz ~ 1 GHz
	
1 GHz ~ 3 GHz	3 GHz ~ 12.75 GHz