

9. SPURIOUS AND HARMONIC EMISSION AT ANTENNA TERMINAL

FCC Rules

Test Requirement(s):

§ 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.

§ 24.238 Emission limitations for Broadband PCS equipment.

The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications 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 resolution bandwidth of 1 MHz or greater. However, 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 the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz 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.

(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.

Test Procedures: A modulated carrier generated by the signal generator carrier was connected to either the Downlink or Downlink RF port at a maximum level as determined by the spectrum analyzer was connected to either the Downlink or Downlink port depending on the circuitry being

measured.

The spectrum was investigated from 9 kHz to the 26.5 of the carrier.

Test Results: The EUT complies with the requirements of this section. There were no Detectable Spurious emissions for this EUT.

§ 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 $50 + 10 \log_{10}(P)$ 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 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 $43 + 10 \log_{10}(P)$ 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.

*** Note**

Test (a)-(1) was replaced by a band edge test.

Test Procedures:

A modulated carrier generated by the signal generator carrier was connected to either the Uplink or Downlink RF port at a maximum level as determined by the spectrum analyzer was connected to either the Uplink or Downlink port depending on the circuitry being measured.

The spectrum was investigated from 9 kHz to the 26.5 GHz of the carrier.

Test Results:

Input Signal	Input Level (dBm)	Maximum Amp Gain
CDMA CDMA EVDO LTE 5 MHz LTE + CMDA	DL : -65 dBm	DL : 75 dB

1900 MHz band

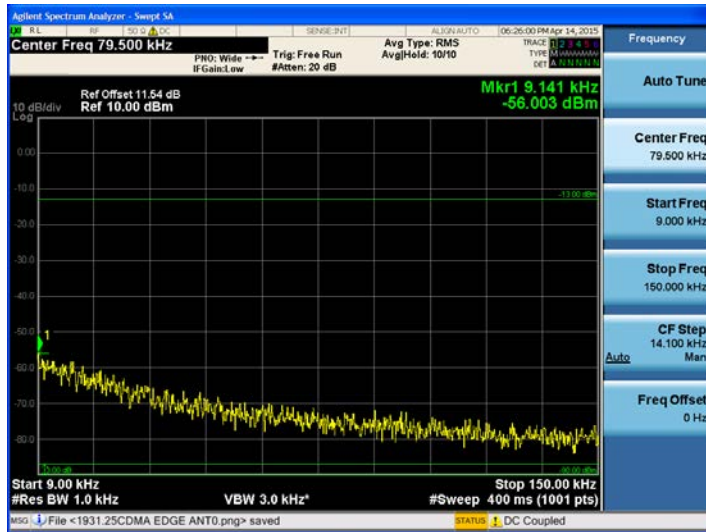
9 kHz ~ 150 kHz

	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	1931.25	-56.00	-13.00
	1962.50	-56.10	-13.00
	1993.75	-53.91	-13.00
CDMA EVDO	1931.25	-56.28	-13.00
	1962.50	-55.92	-13.00
	1993.75	-56.10	-13.00
LTE 5 MHz	1932.50	-55.91	-13.00
	1962.50	-54.56	-13.00
	1992.50	-56.12	-13.00

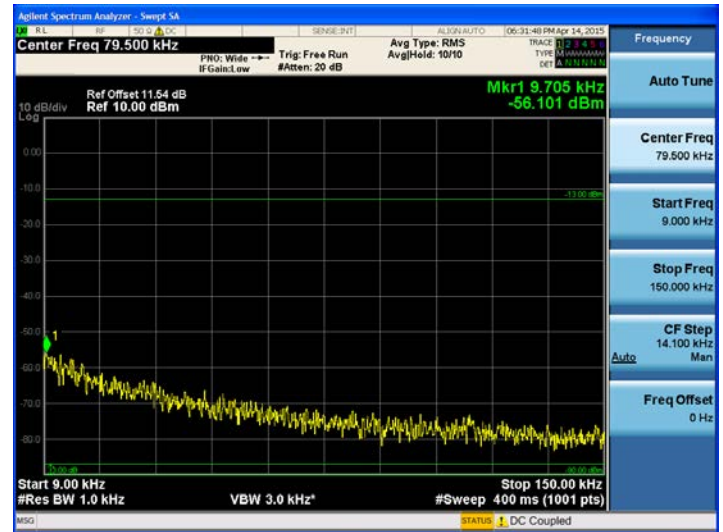
Plots of Spurious Emission 1900 MHz band CDMA Conducted Spurious Emissions (9 kHz – 150 kHz)

TEST Plot for 1900 MHz band CDMA

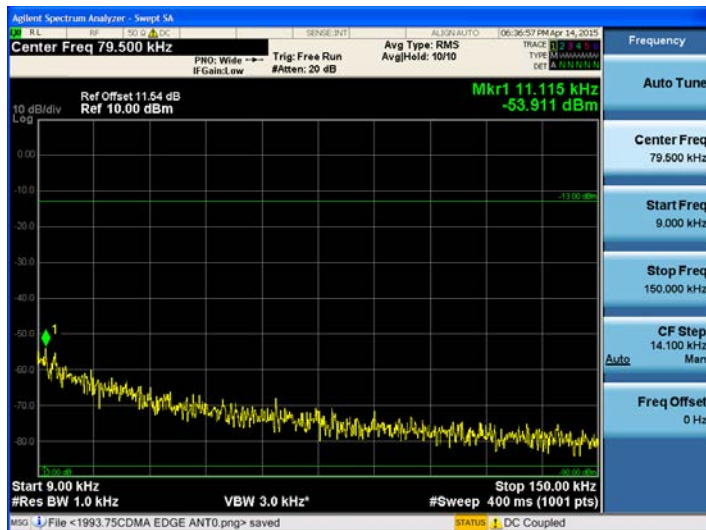
1900 MHz band (9 kHz – 150 kHz) CDMA Low



1900 MHz band (9 kHz – 150 kHz) CDMA Mid



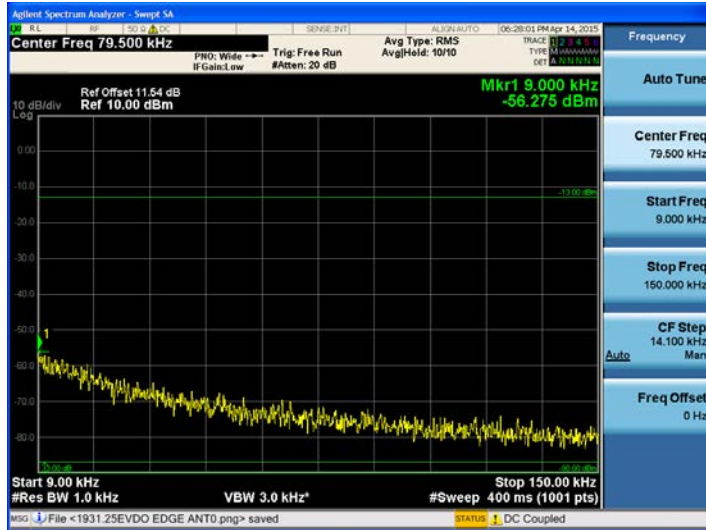
1900 MHz band (9 kHz – 150 kHz) CDMA High



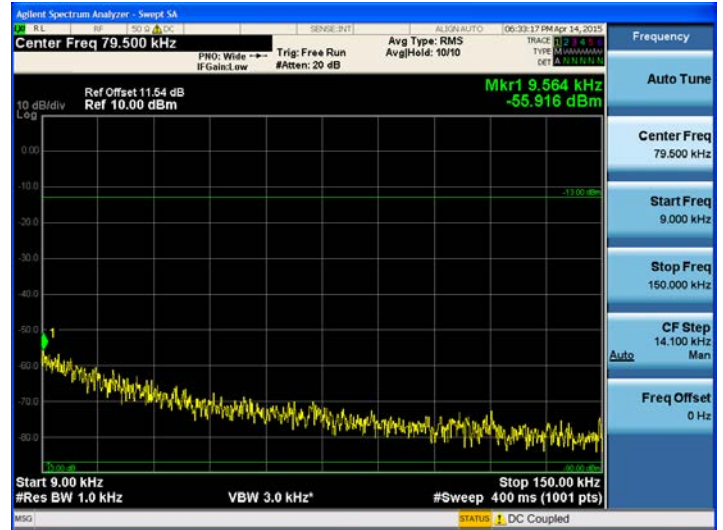
Plots of Spurious Emission 1900 MHz band CDMA EVDO Conducted Spurious Emissions (9 kHz – 150 kHz)

■ TEST Plot for 1900 MHz band CDMA EVDO

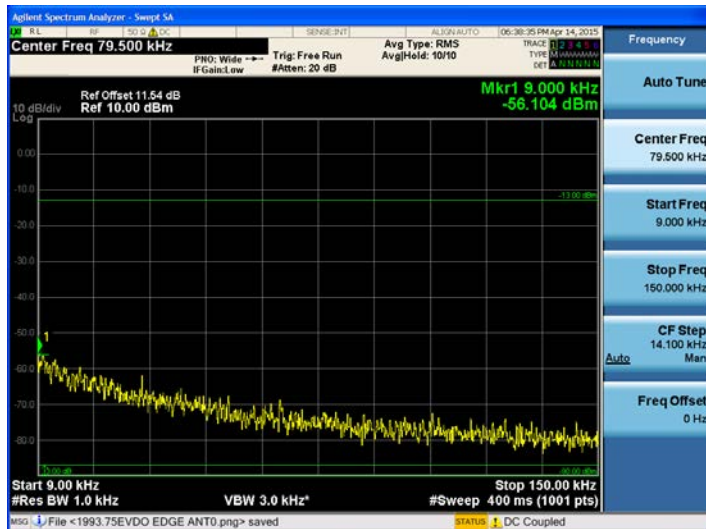
1900 MHz band (9 kHz – 150 kHz) CDMA EVDO Low



1900 MHz band (9 kHz – 150 kHz) CDMA EVDO Mid



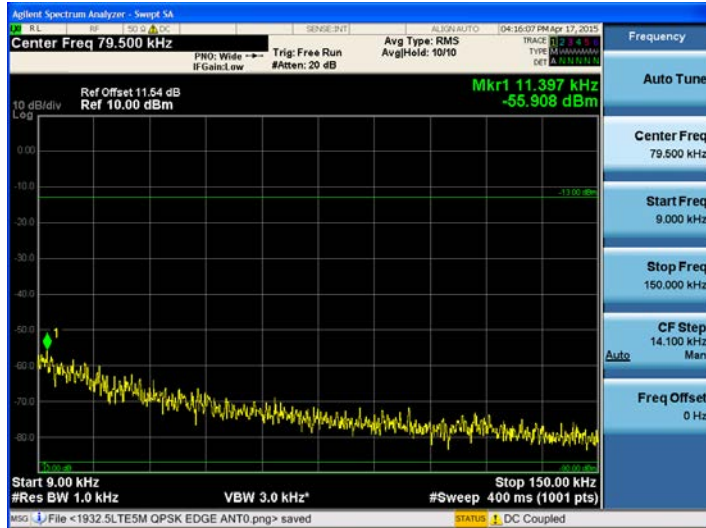
1900 MHz band (9 kHz – 150 kHz) CDMA EVDO High



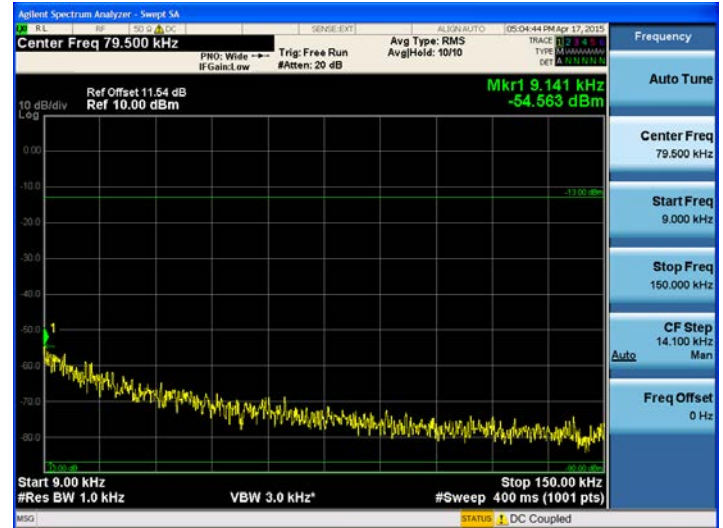
Plots of Spurious Emission 1900 MHz band LTE 5MHz Conducted Spurious Emissions (9 kHz – 150 kHz)

TEST Plot for 1900 MHz band LTE 5MHz

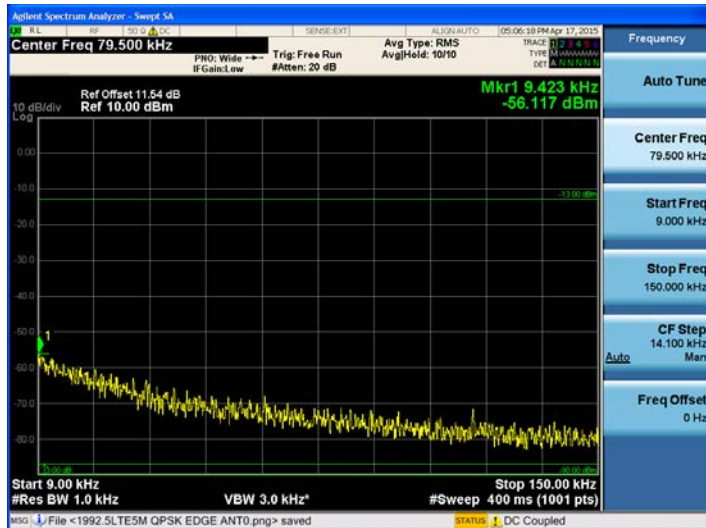
1900 MHz band (9 kHz – 150 kHz) LTE 5MHz Low



1900 MHz band (9 kHz – 150 kHz) LTE 5MHz Mid



1900 MHz band (9 kHz – 150 kHz) LTE 5MHz High



Conducted Spurious Emissions 1900 MHz band

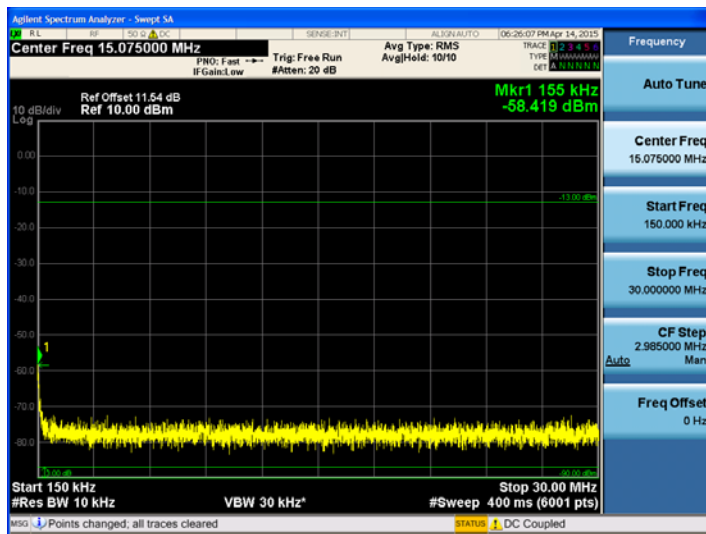
150 kHz ~ 30 MHz

	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	1931.25	-58.42	-13.00
	1962.50	-59.25	-13.00
	1993.75	-60.11	-13.00
CDMA EVDO	1931.25	-59.75	-13.00
	1962.50	-56.72	-13.00
	1993.75	-59.81	-13.00
LTE 5 MHz	1932.50	-55.91	-13.00
	1962.50	-54.56	-13.00
	1992.50	-56.12	-13.00

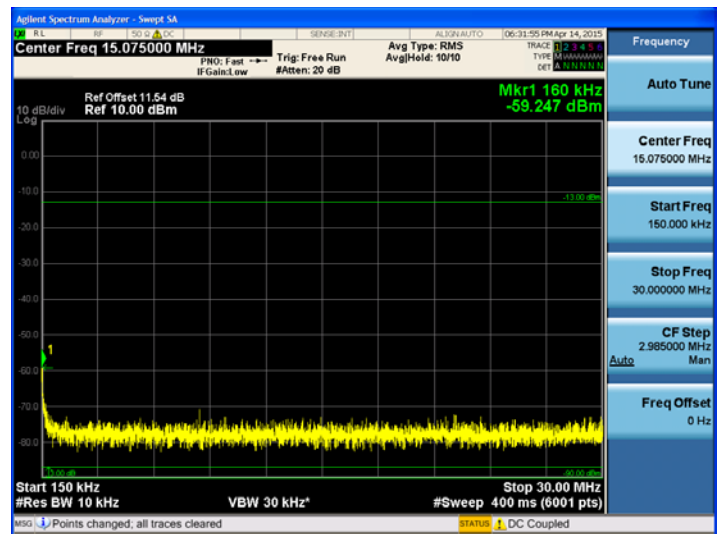
Plots of Spurious Emission 1900 MHz band CDMA Conducted Spurious Emissions (150 kHz – 30 MHz)

TEST Plot for 1900 MHz band CDMA

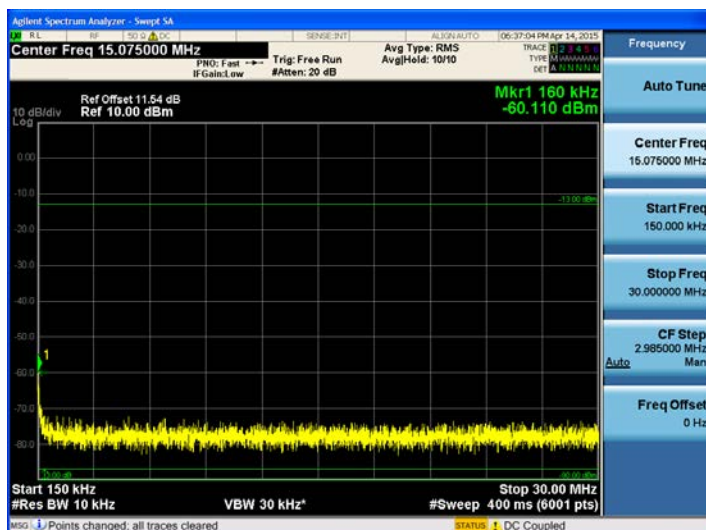
1900 MHz band (150 kHz ~ 30 MHz) CDMA Low



1900 MHz band (150 kHz ~ 30 MHz) CDMA Mid



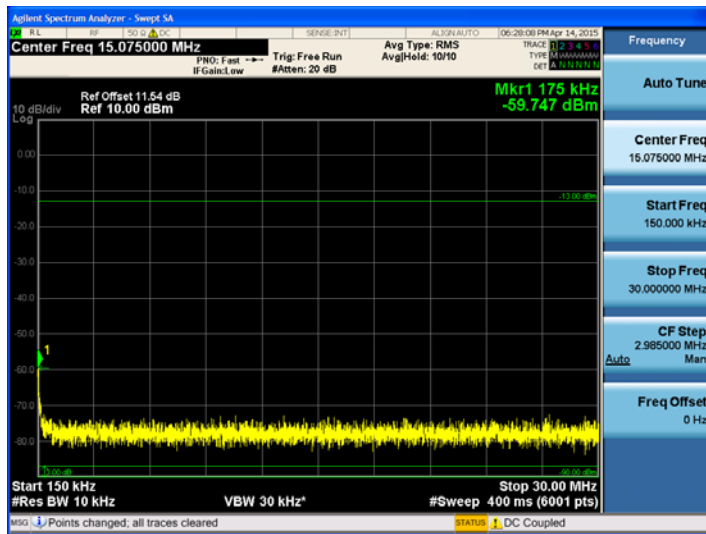
1900 MHz band (150 kHz ~ 30 MHz) CDMA High



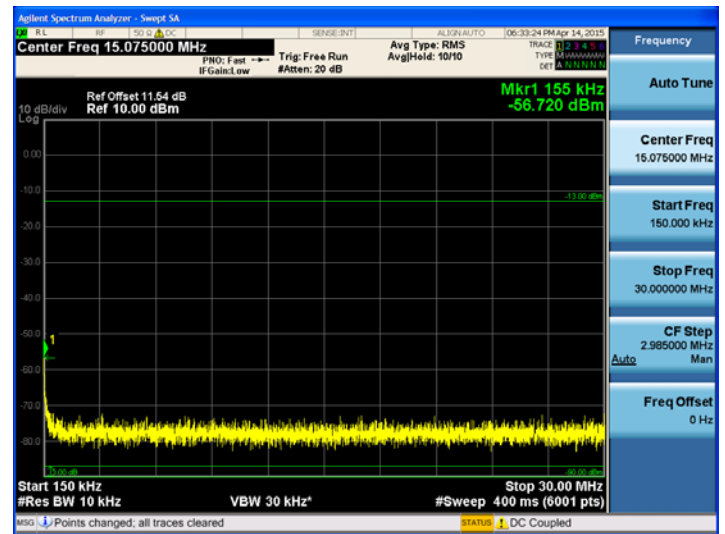
Plots of Spurious Emission 1900 MHz band CDMA EVDO Conducted Spurious Emissions (150 kHz – 30 MHz)

■ TEST Plot for 1900 MHz band CDMA EVDO

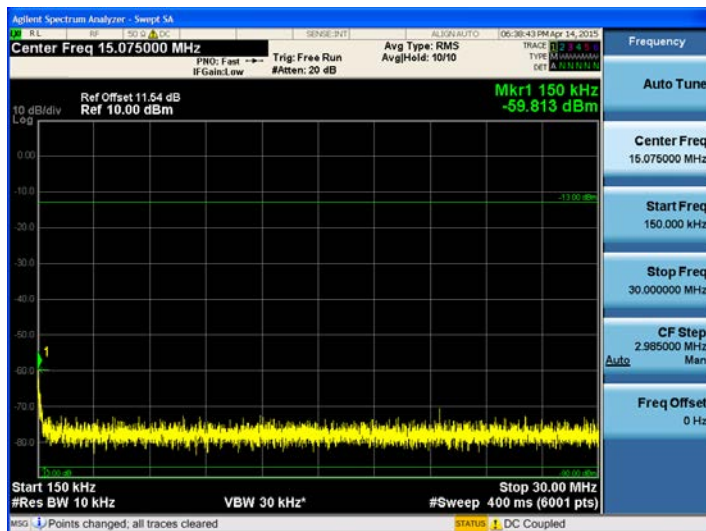
1900 MHz band (150 kHz – 30 MHz) CDMA EVDO Low



1900 MHz band (150 kHz – 30 MHz) CDMA EVDO Mid



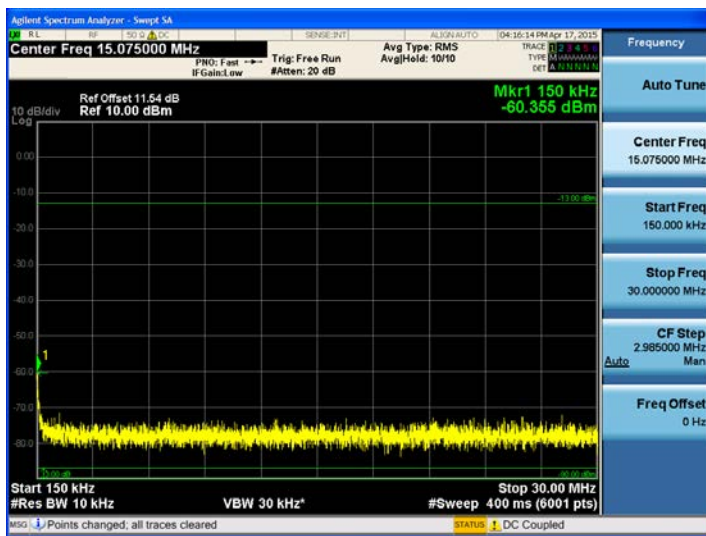
1900 MHz band (150 kHz – 30 MHz) CDMA EVDO High



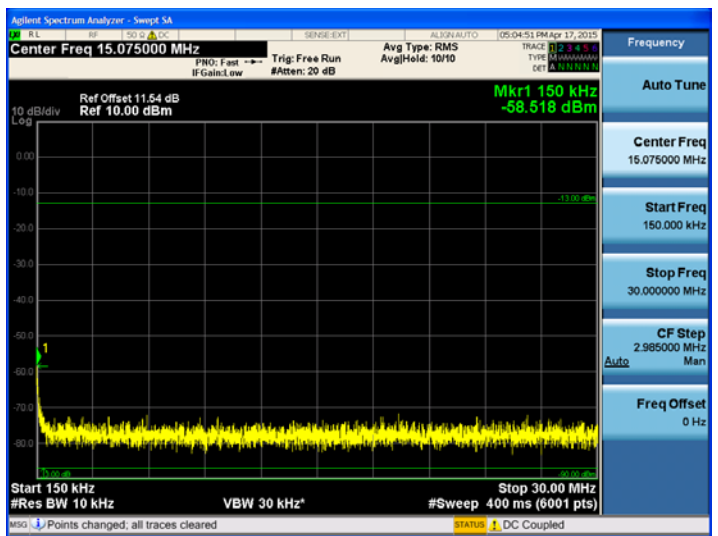
Plots of Spurious Emission 1900 MHz band LTE 5MHz Conducted Spurious Emissions (150 kHz – 30 MHz)

TEST Plot for 1900 MHz band LTE 5MHz

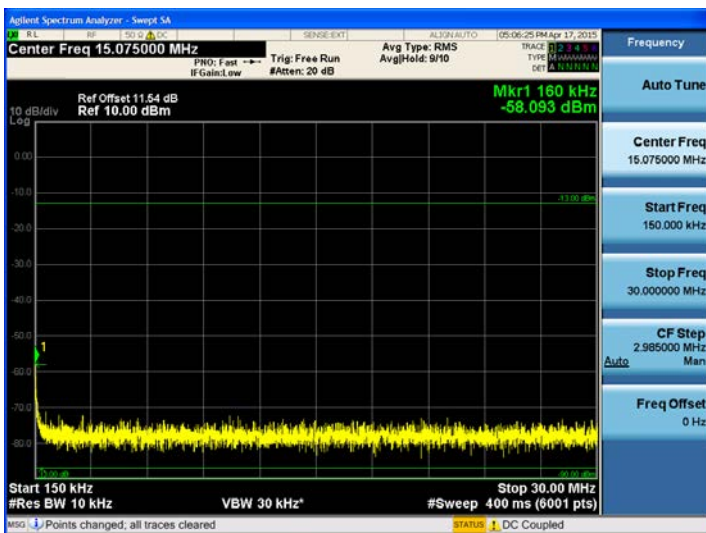
1900 MHz band (150 kHz – 30 MHz) LTE 5MHz Low



1900 MHz band (150 kHz – 30 MHz) LTE 5MHz Mid



1900 MHz band (150 kHz – 30 MHz) LTE 5MHz High



Conducted Spurious Emissions 1900 MHz band

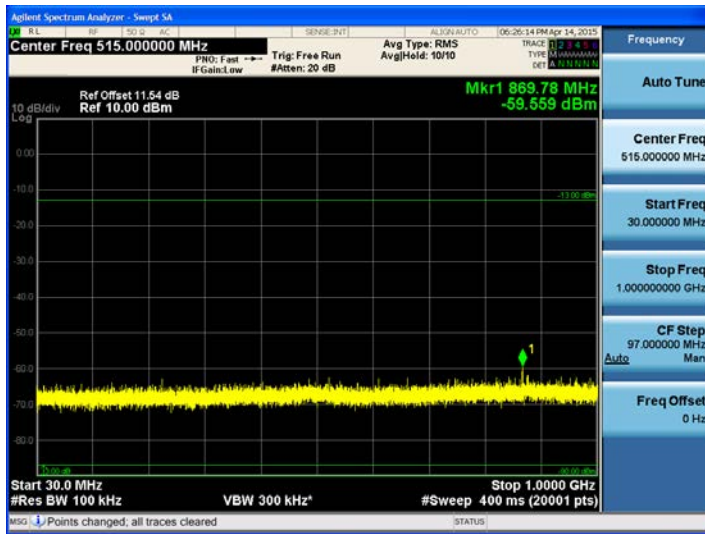
30 MHz ~ 1 GHz

	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	1931.25	-59.56	-13.00
	1962.50	-60.76	-13.00
	1993.75	-60.67	-13.00
CDMA EVDO	1931.25	-60.19	-13.00
	1962.50	-61.92	-13.00
	1993.75	-60.28	-13.00
LTE 5 MHz	1932.50	-60.61	-13.00
	1962.50	-61.12	-13.00
	1992.50	-58.74	-13.00

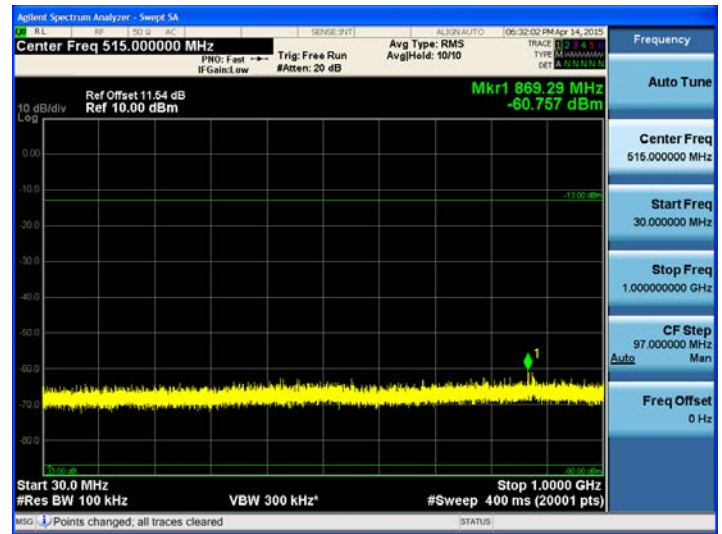
Plots of Spurious Emission 1900 MHz band CDMA Conducted Spurious Emissions (30 MHz- 1 GHz)

■ TEST Plot for 1900 MHz band CDMA

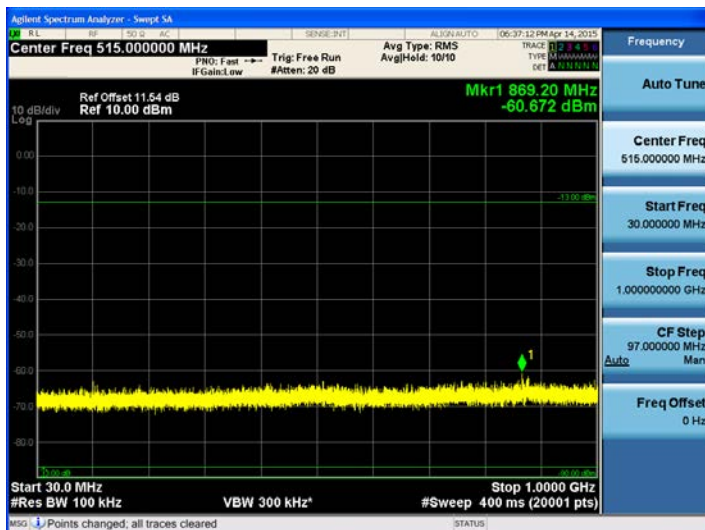
1900 MHz band (30 MHz- 1 GHz) CDMA Low



1900 MHz band (30 MHz- 1 GHz)CDMA Mid



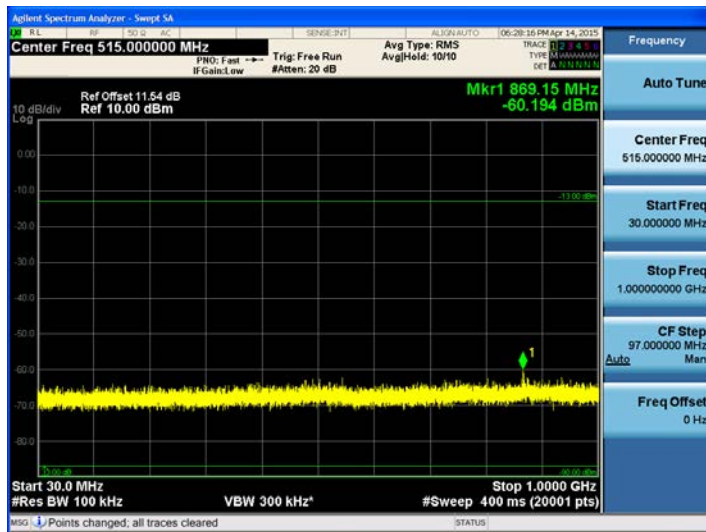
1900 MHz band (30 MHz- 1 GHz) CDMA High



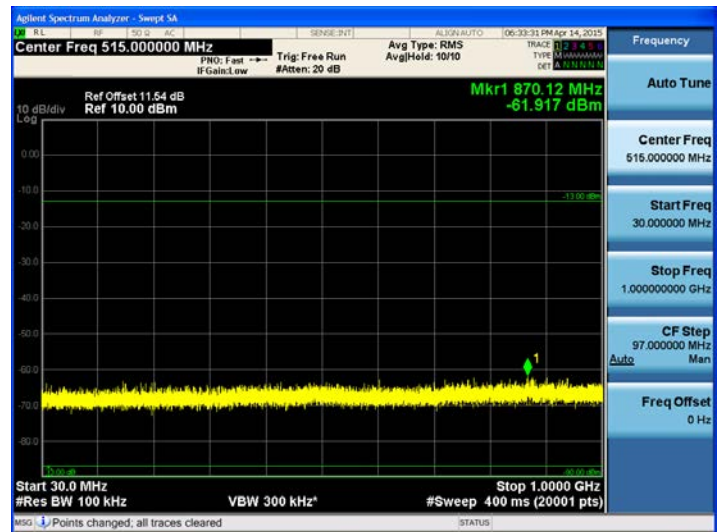
Plots of Spurious Emission 1900 MHz band CDMA EVDO Conducted Spurious Emissions (30 MHz- 1 GHz)

TEST Plot for 1900 MHz band CDMA EVDO

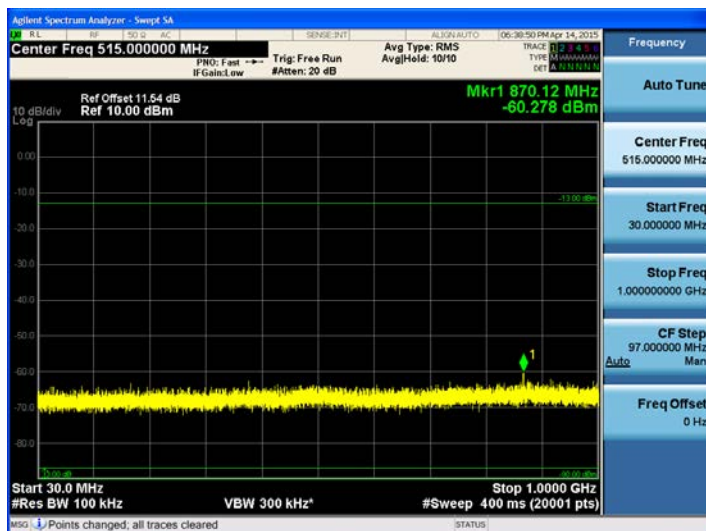
1900 MHz band (30 MHz- 1 GHz) CDMA EVDO Low



1900 MHz band (30 MHz- 1 GHz) CDMA EVDO Mid



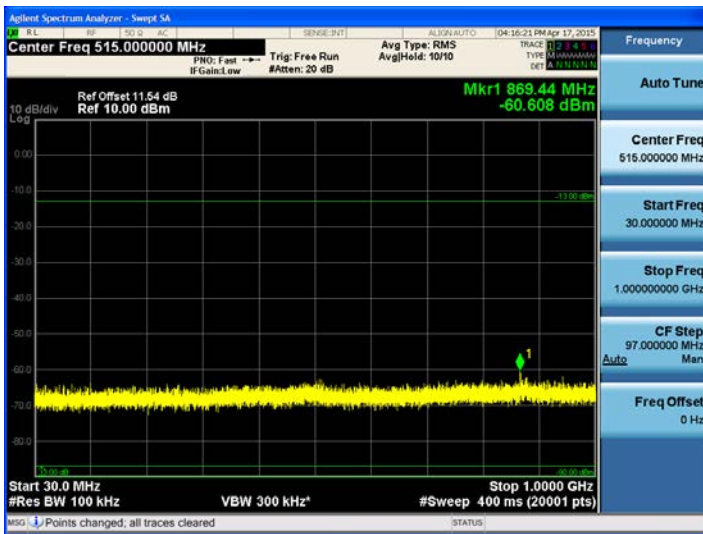
1900 MHz band (30 MHz- 1 GHz) CDMA EVDO High



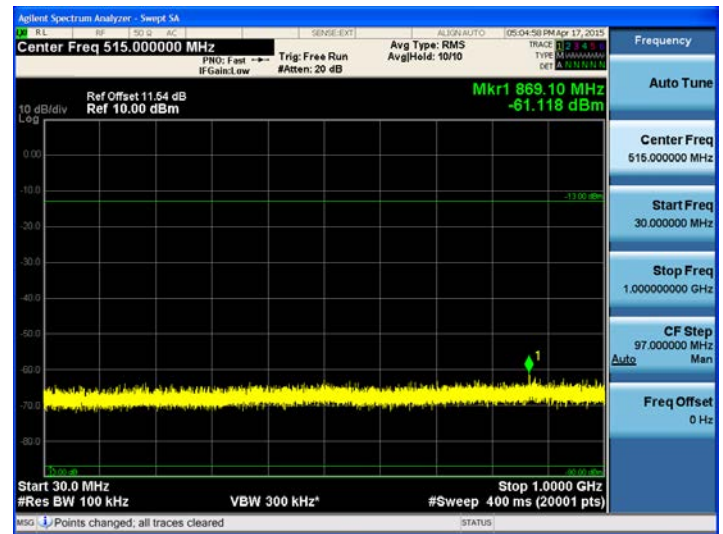
Plots of Spurious Emission 1900 MHz band LTE 5MHz Conducted Spurious Emissions (30 MHz- 1 GHz)

TEST Plot for 1900 MHz band LTE 5MHz

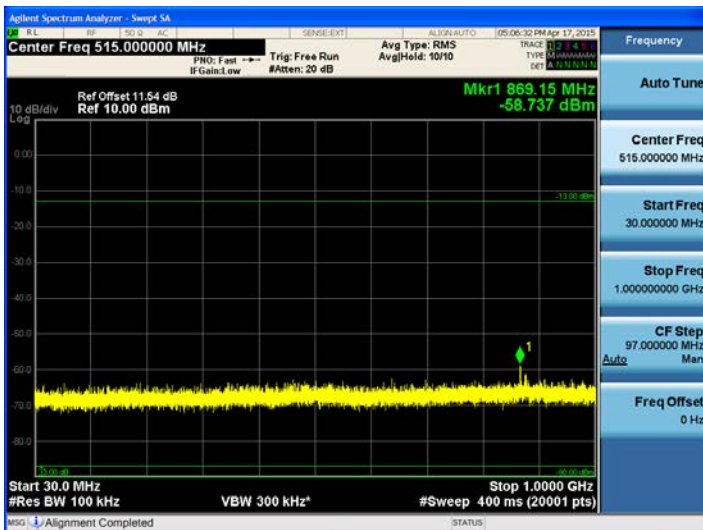
1900 MHz band (30 MHz- 1 GHz) LTE 5MHz Low



1900 MHz band (30 MHz- 1 GHz) LTE 5MHz Mid



1900 MHz band (30 MHz- 1 GHz) LTE 5MHz High



Conducted Spurious Emissions 1900 MHz band

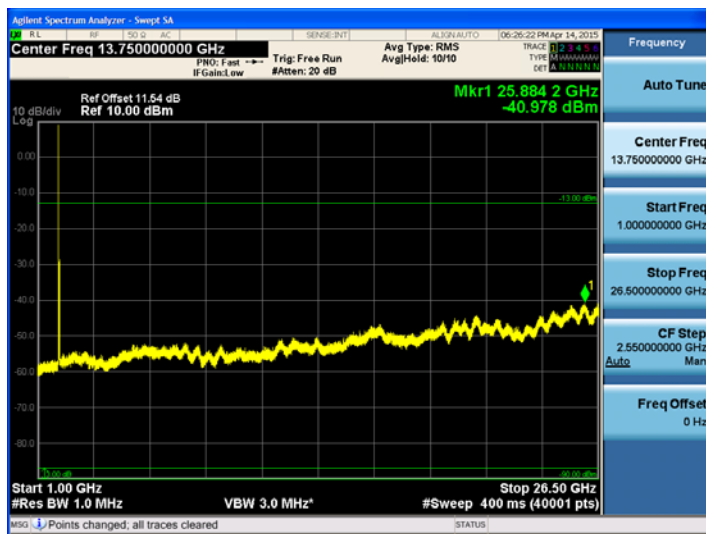
1 GHz ~ 26.5 GHz

	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	1931.25	-40.98	-13.00
	1962.50	-40.97	-13.00
	1993.75	-40.12	-13.00
CDMA EVDO	1931.25	-41.08	-13.00
	1962.50	-40.38	-13.00
	1993.75	-40.65	-13.00
LTE 5 MHz	1932.50	-40.90	-13.00
	1962.50	-40.40	-13.00
	1992.50	-40.29	-13.00

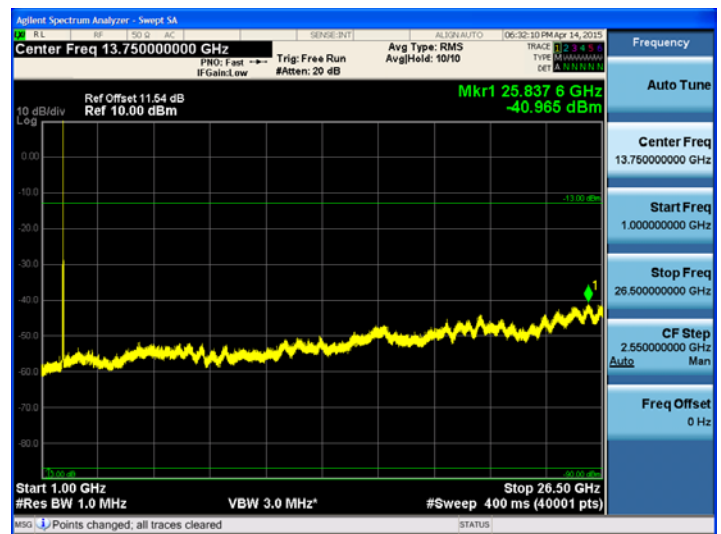
Plots of Spurious Emission 1900 MHz band CDMA Conducted Spurious Emissions (1 GHz – 26.5 GHz)

TEST Plot for 1900 MHz band CDMA

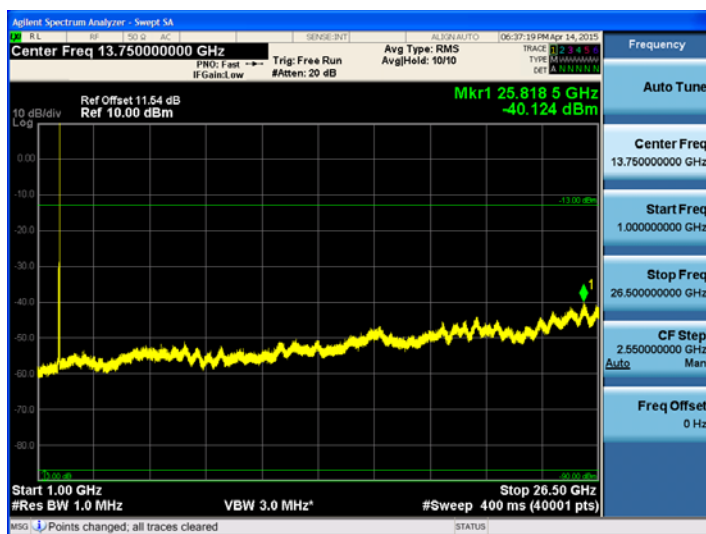
1900 MHz band (1 GHz – 26.5 GHz) CDMA Low



1900 MHz band (1 GHz – 26.5 GHz) CDMA Mid



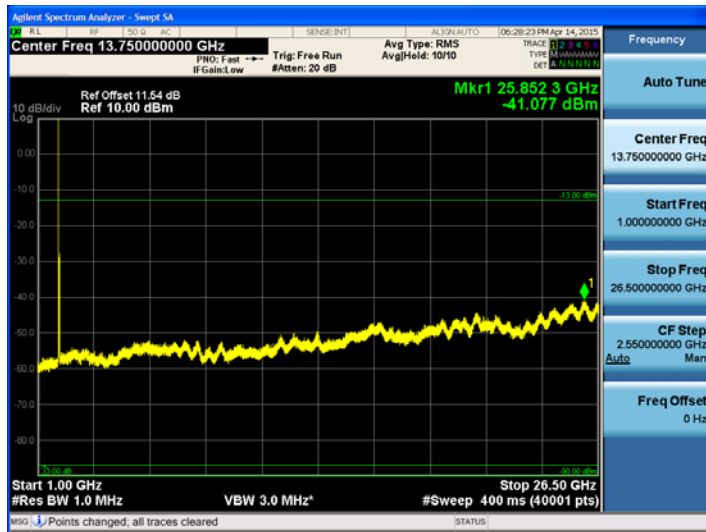
1900 MHz band (1 GHz – 26.5 GHz) CDMA High



Plots of Spurious Emission 1900 MHz band CDMA EVDO Conducted Spurious Emissions (1 GHz – 26.5 GHz)

TEST Plot for 1900 MHz band CDMA EVDO

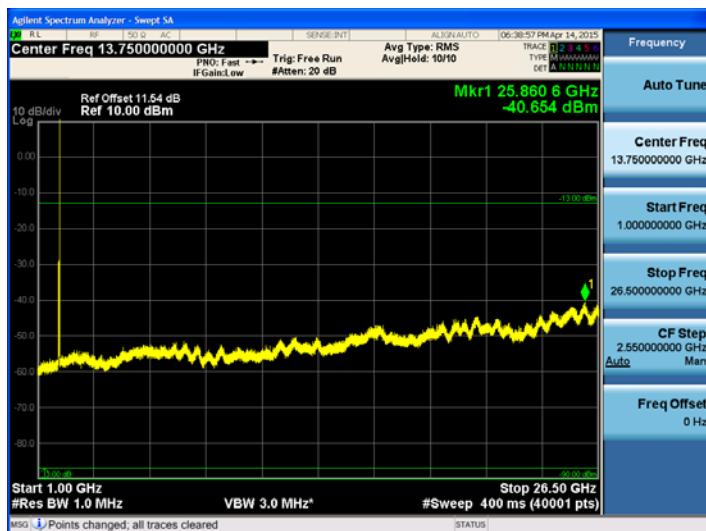
1900 MHz band (1 GHz – 26.5 GHz) CDMA EVDO Low



1900 MHz band (1 GHz – 26.5 GHz) CDMA EVDO Mid



1900 MHz band (1 GHz – 26.5 GHz) CDMA EVDO High



Plots of Spurious Emission 1900 MHz band LTE 5MHz Conducted Spurious Emissions (1 GHz – 26.5 GHz)

TEST Plot for 1900 MHz band LTE 5MHz

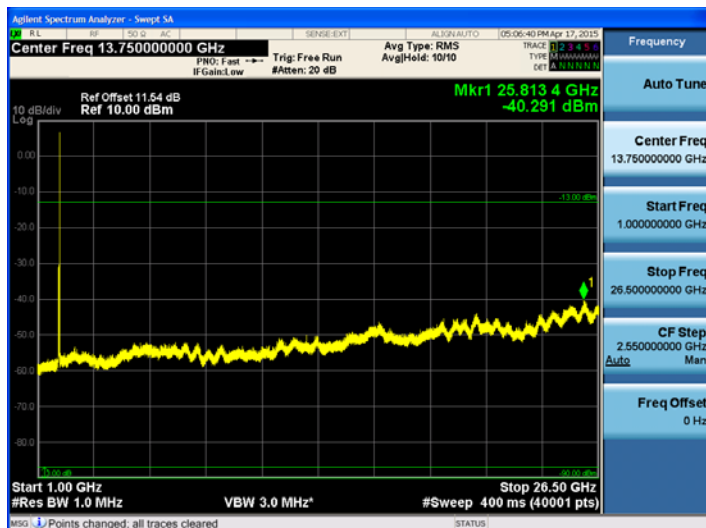
1900 MHz band (1 GHz – 26.5 GHz) LTE 5MHz Low



1900 MHz band (1 GHz – 26.5 GHz) LTE 5MHz Mid



1900 MHz band (1 GHz – 26.5 GHz) LTE 5MHz High

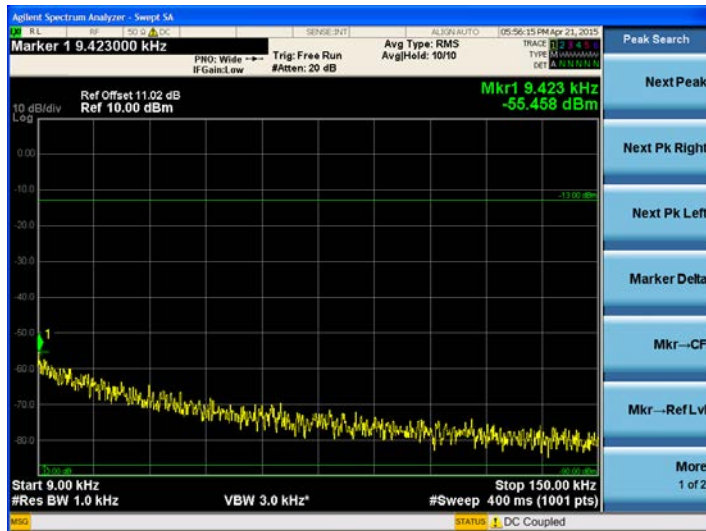


800 MHz band Conducted Spurious Emissions
9 kHz ~ 150 kHz

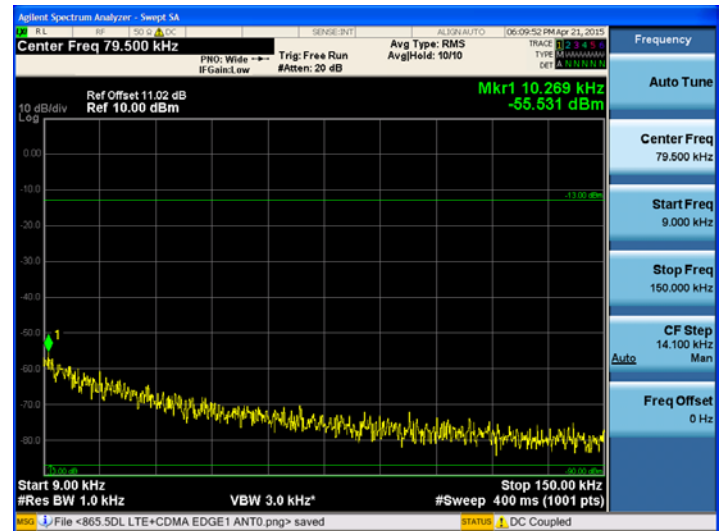
	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	863.00	-55.46	-13.00
CDMA+LTE 5MHz	865.50	-55.53	-13.00
LTE 5 MHz	866.50	-55.04	-13.00

Plots of Spurious Emission 800 MHz band
Conducted Spurious Emissions (9 kHz – 150 kHz)

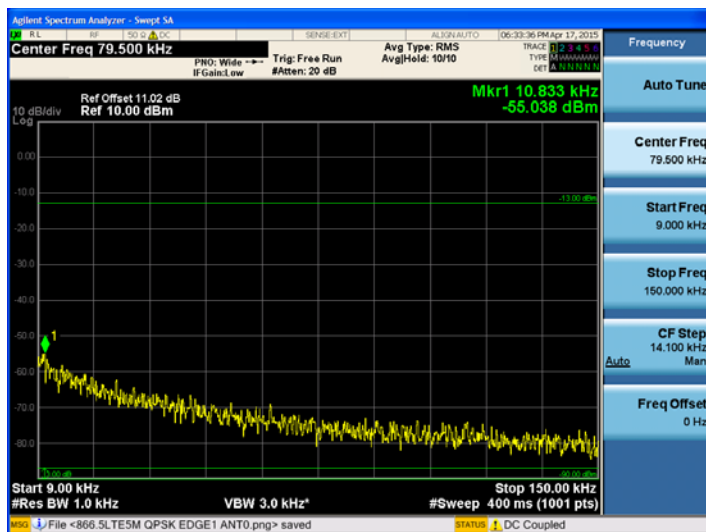
800 MHz band (9 kHz – 150 kHz) CDMA



800 MHz band (9 kHz – 150 kHz) CDMA+LTE 5MHz



800 MHz band (9 kHz – 150 kHz) LTE 5MHz



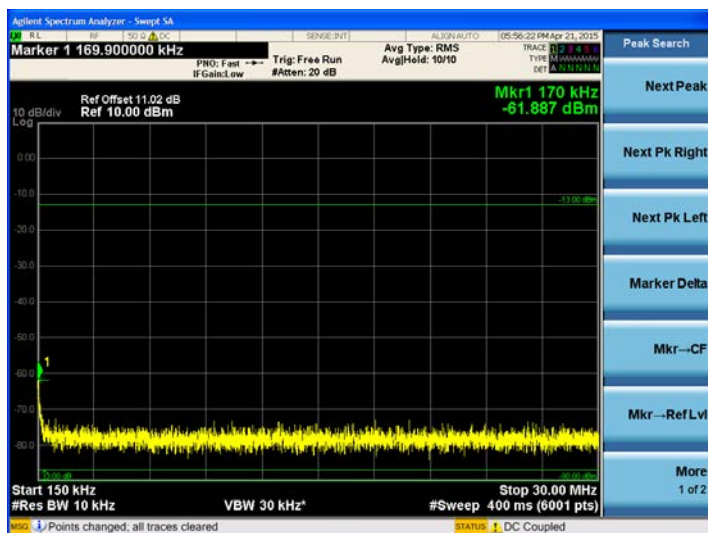
800 MHz band Conducted Spurious Emissions

150 kHz ~ 30 MHz

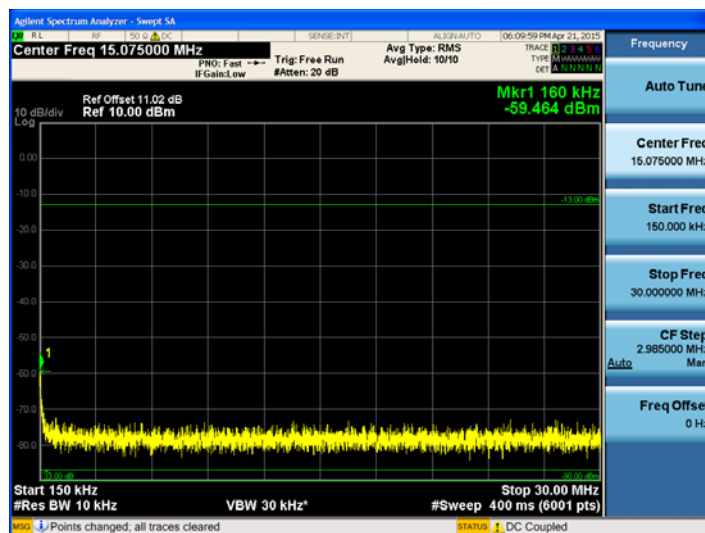
	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	863.00	-61.89	-13.00
CDMA+LTE 5MHz	865.50	-59.46	-13.00
LTE 5 MHz	866.50	-60.71	-13.00

Plots of Spurious Emission 800 MHz band Conducted Spurious Emissions (150 kHz – 30 MHz)

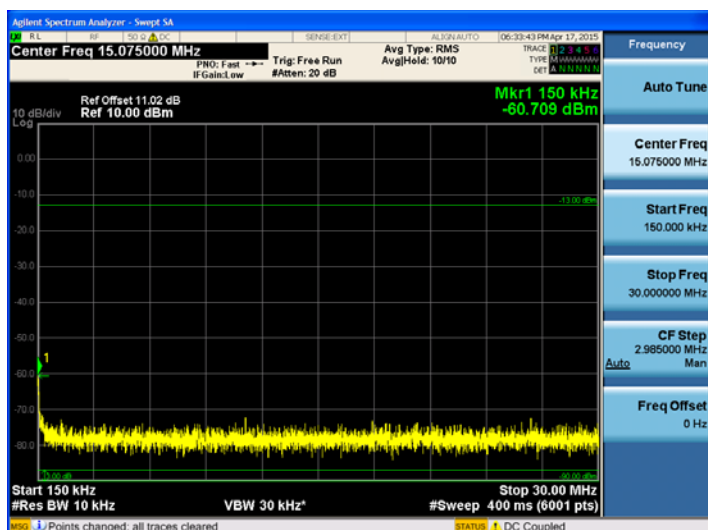
800 MHz band (150 kHz – 30 MHz) CDMA



800 MHz band (150 kHz – 30 MHz) CDMA+LTE 5MHz



800 MHz band (150 kHz – 30 MHz) LTE 5MHz



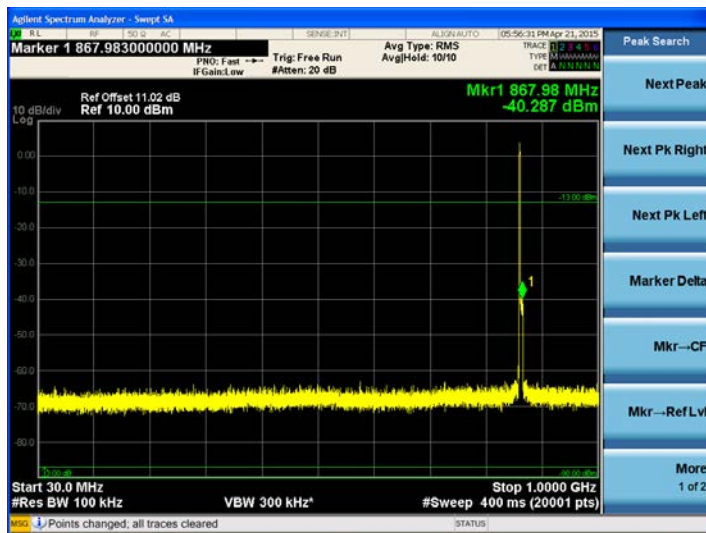
800 MHz band Conducted Spurious Emissions

30 MHz ~ 1 GHz

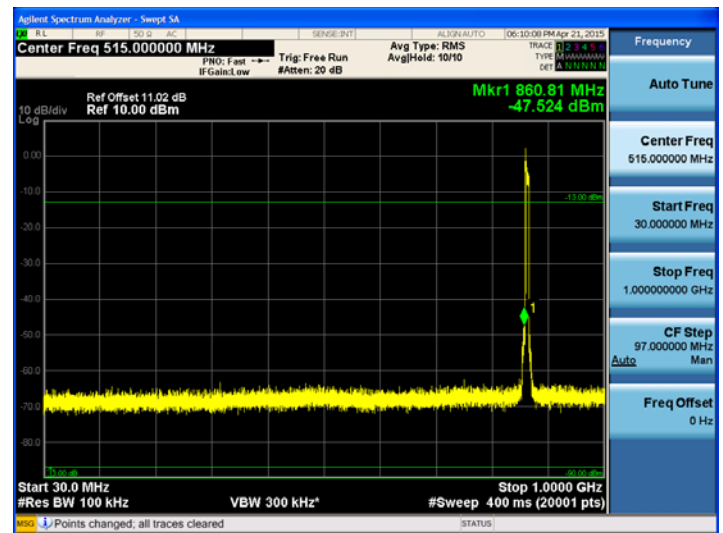
	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	863.00	-40.29	-13.00
CDMA+LTE 5MHz	865.50	-47.52	-13.00
LTE 5 MHz	866.50	-41.40	-13.00

Plots of Spurious Emission 800 MHz band Conducted Spurious Emissions (30 MHz – 1 GHz)

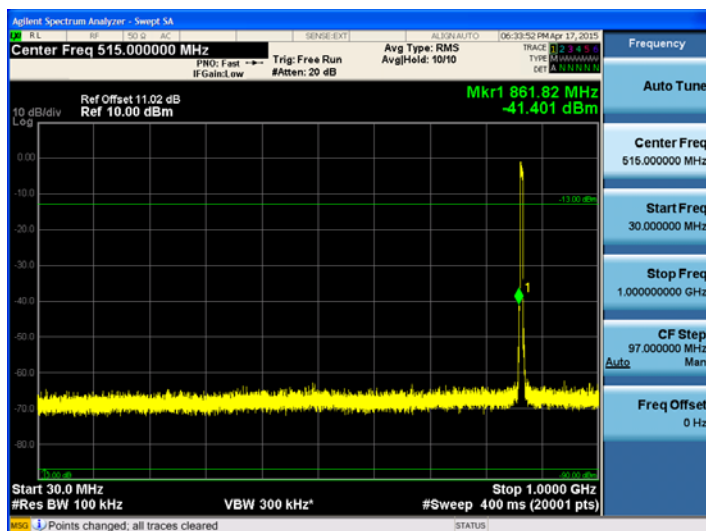
800 MHz band (30 MHz – 1 GHz) CDMA



800 MHz band (30 MHz – 1 GHz) CDMA+LTE 5MHz



800 MHz band (30 MHz – 1 GHz) LTE 5MHz



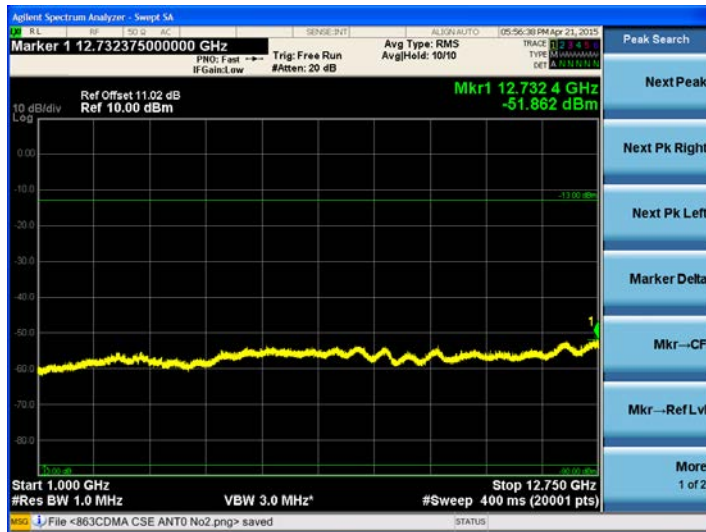
800 MHz band Conducted Spurious Emissions

1 GHz ~ 12.75 GHz

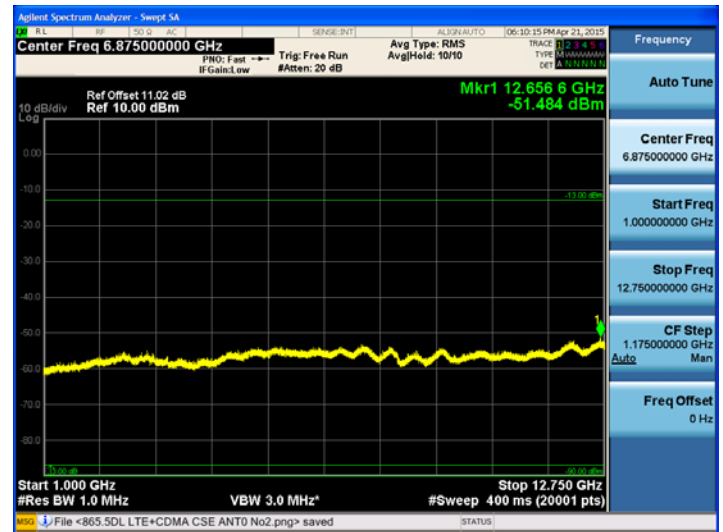
	Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)
CDMA	863.00	-51.86	-13.00
CDMA+LTE 5MHz	865.50	-51.48	-13.00
LTE 5 MHz	866.50	-51.77	-13.00

Plots of Spurious Emission 800 MHz band Conducted Spurious Emissions (1 GHz – 12.75 GHz)

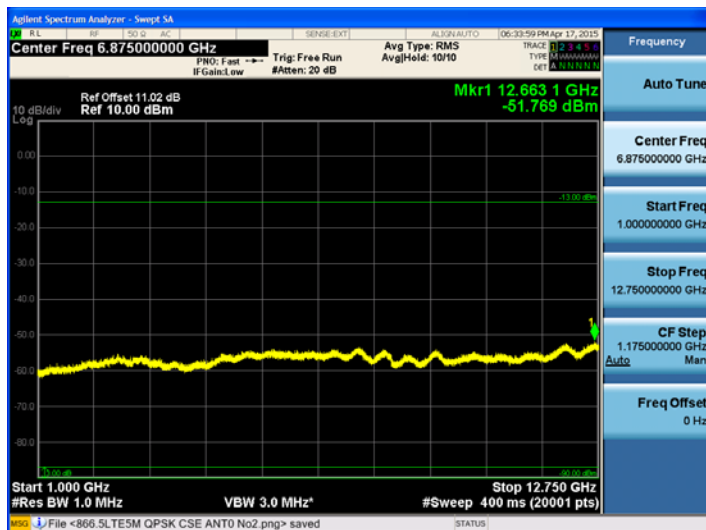
800 MHz band (1 GHz – 12.75 GHz) CDMA



800 MHz band (1 GHz – 12.75 GHz) CDMA+LTE 5MHz



800 MHz band (1 GHz – 12.75 GHz) LTE 5MHz



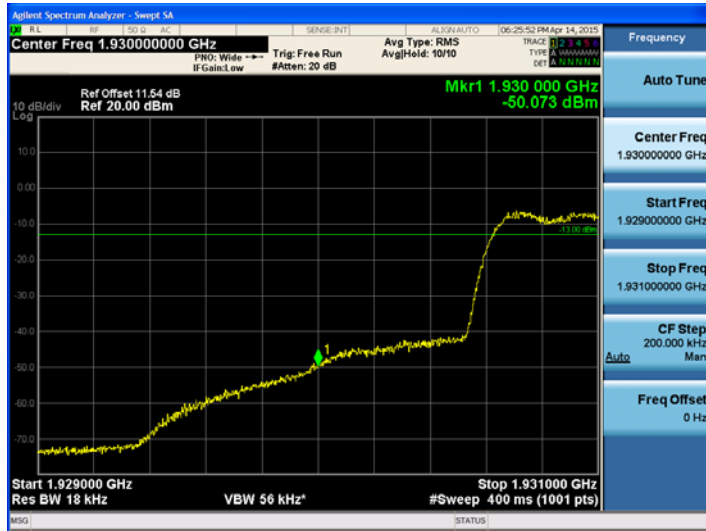
1900 MHz band Edge

		Frequency (MHz)	Band edge (dBm)	Limit (dBm)
CDMA	Low	1931.25	-50.07	-13.00
	High	1993.75	-48.56	-13.00
CDMA EVDO	Low	1931.25	-52.15	-13.00
	High	1993.75	-47.46	-13.00
LTE 5 MHz	Low	1932.50	-46.66	-13.00
	High	1992.50	-43.70	-13.00

Plots of Bandedge 1900 MHz band CDMA & CDMA EVDO

■ TEST Plot for 1900 MHz Bandedge

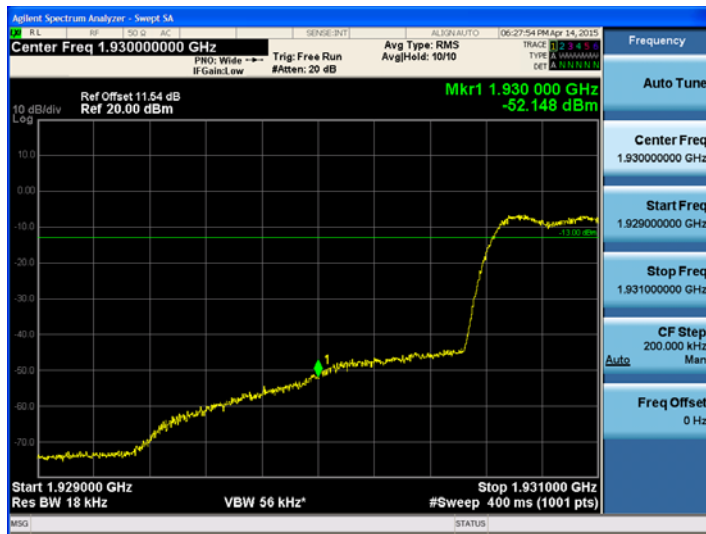
1900 MHz band Bandedge CDMA Low



1900 MHz band Bandedge CDMA High



1900 MHz band Bandedge CDMA EVDO Low



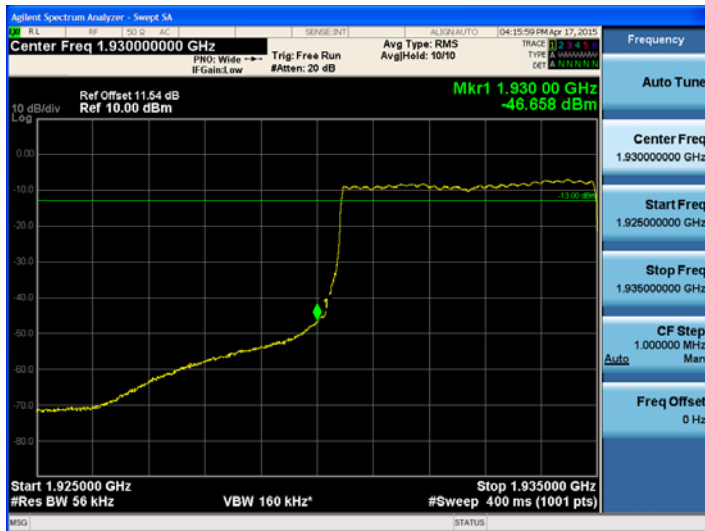
1900 MHz band Bandedge CDMA EVDO High



Plots of Bandedge 1900 MHz band LTE 5MHz

■ TEST Plot for 1900 MHz Bandedge

1900 MHz band Bandedge LTE 5MHz Low



1900 MHz band Bandedge LTE 5MHz High



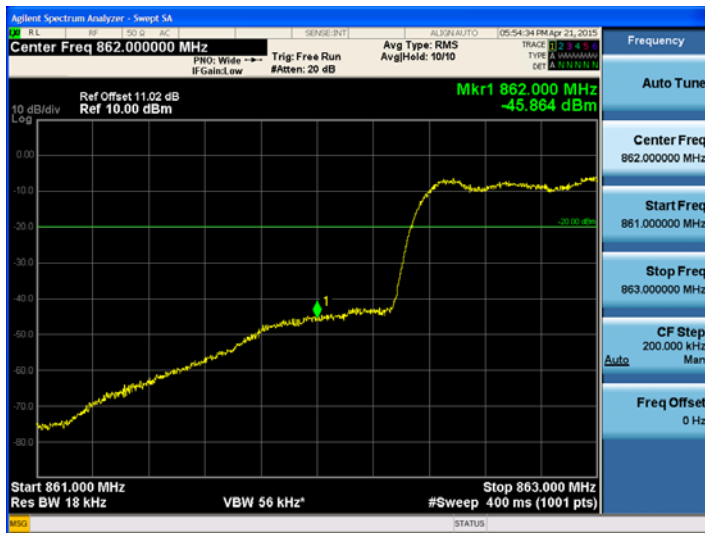
800 MHz band Edge

	Frequency (MHz)	Band edge (dBm)	Limit (dBm)
CDMA	863.00	-56.24	-20.00
LTE + CDMA	865.50	-46.25	-20.00
LTE 5 MHz	866.50	-50.99	-20.00

Plots of Bandedge 800 MHz band CDMA & CDMA +LTE 5MHz

TEST Plot for 800 MHz Bandedge

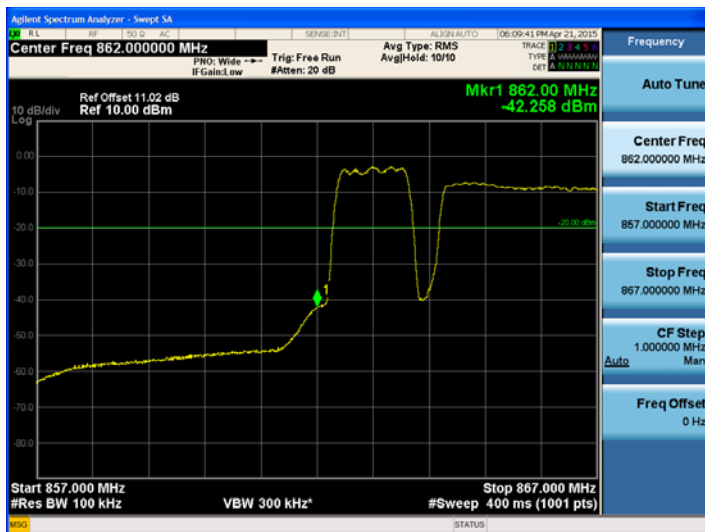
800 MHz band Bandedge CDMA



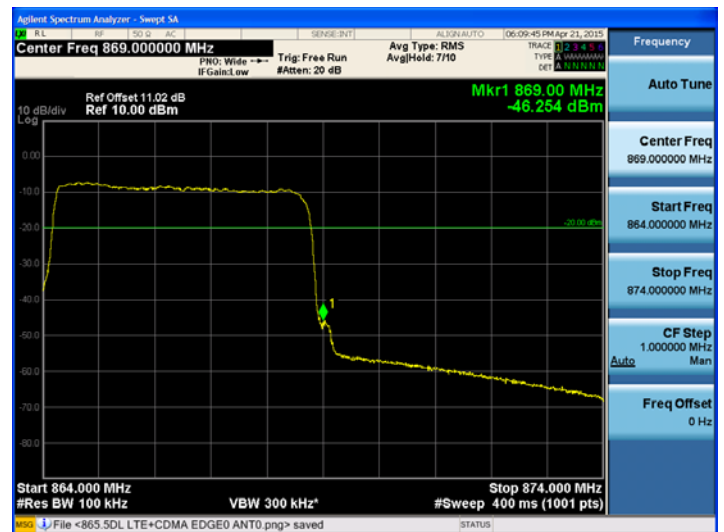
800 MHz band Bandedge CDMA



800 MHz band Bandedge CDMA+LTE 5MHz



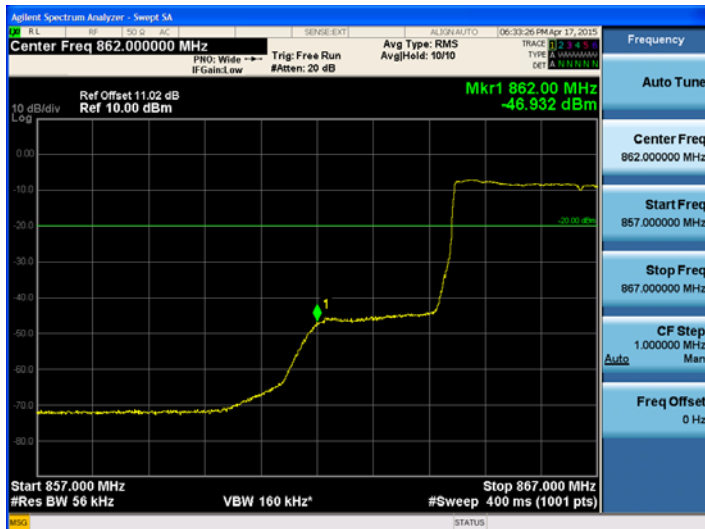
800 MHz band Bandedge CDMA+LTE 5MHz



Plots of Bandedge 800 MHz band LTE 5MHz

■ TEST Plot for 800 MHz Bandedge

800 MHz band Bandedge LTE 5MHz



800 MHz band Bandedge LTE 5MHz

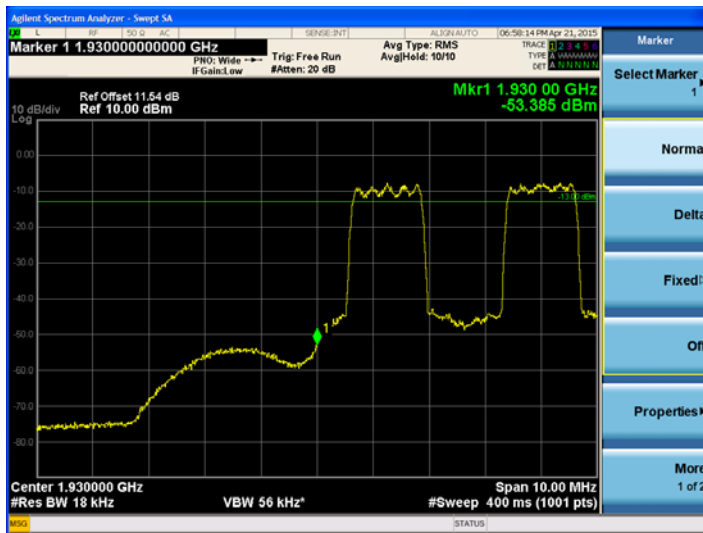


1900 MHz Intermodulation

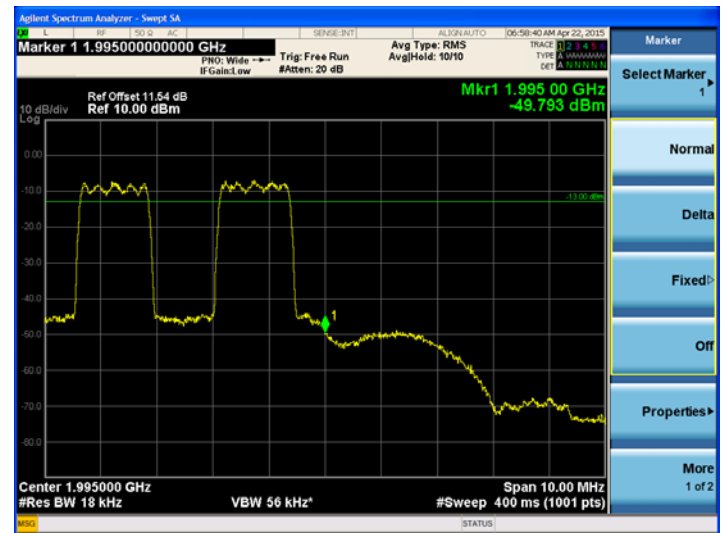
		Frequency (MHz)	Measured Level (dBm)	Limit (dBm)
CDMA	Low	1931.25	-53.39	-20.00
	High	1993.75	-49.79	-20.00
CDMA EVDO	Low	1931.25	-53.92	-20.00
	High	1993.75	-50.35	-20.00

TEST Plot for 1900 MHz Intermodulation Spurious Emissions

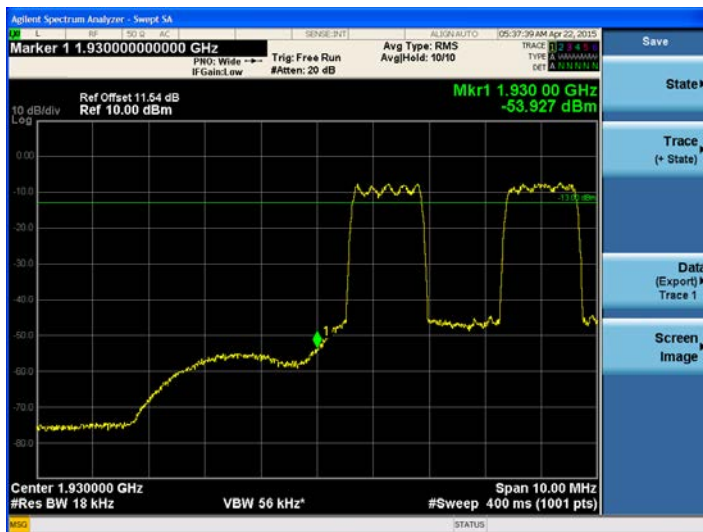
1900 MHz band Intermodulation CDMA Low



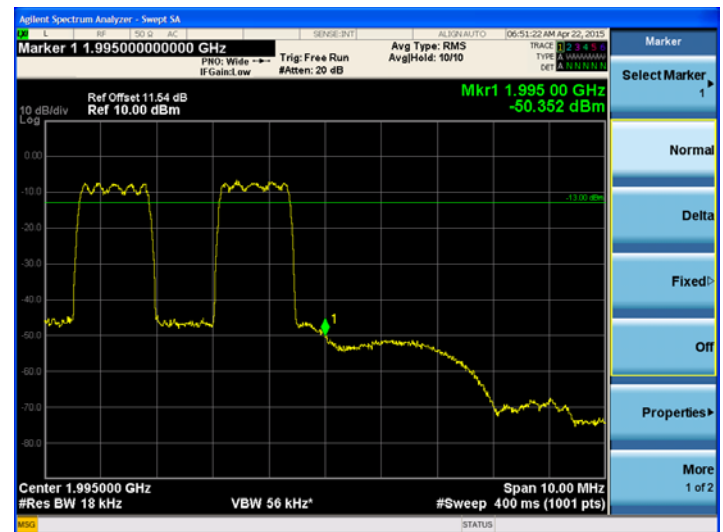
1900 MHz band Intermodulation CDMA High



1900 MHz band Intermodulation CDMA EVDO Low



1900 MHz band Intermodulation CDMA EVDO High



[LTE]

* Were omitted test Because the device amplifies only one selected channel.

10. RADIATED SPURIOUS EMISSIONS

Test Requirement(s): § 2.1053 Measurements required: Field strength of spurious radiation.

§ 2.1053 (a) Measurements shall be made to detect spurious emissions that may be Radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

§ 2.1053 (b): The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to The transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

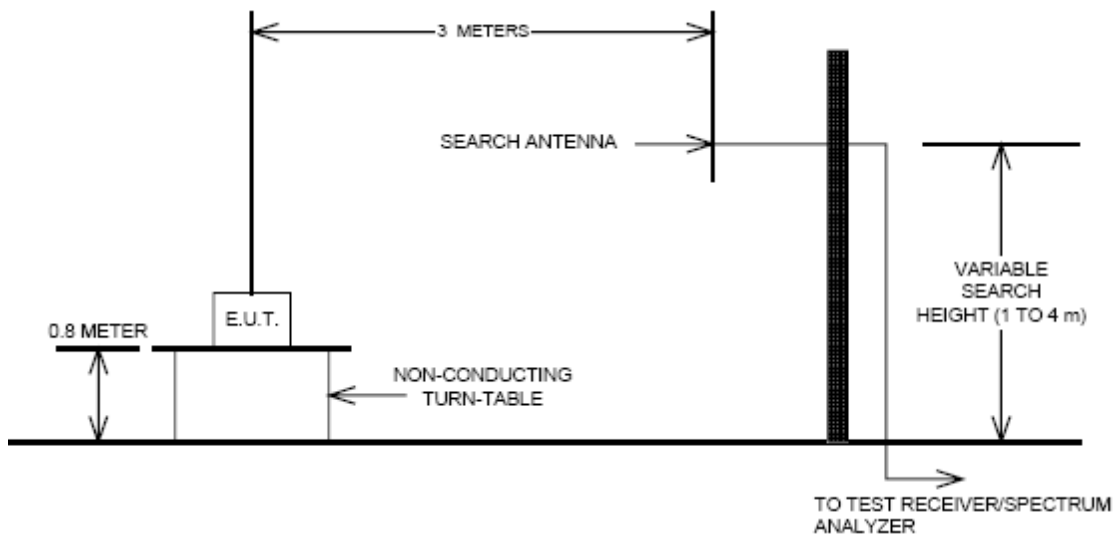
Test Procedures: As required by 47 CFR 2.1053, *field strength of radiated spurious measurements* were made in accordance with the procedures of ANSI/TIA-603-C-2004 "Land Mobile FM or PM Communications Equipment Measurement and Performance Standards".

Radiated emission measurements were performed inside a 3 meter semi-anechoic chamber.

The EUT was set at a distance of 3m from the receiving antenna. The EUT's RF ports were terminated to 50ohm load. The EUT was set to transmit at the low, mid and high channels of the transmitter frequency range at its maximum power level. The EUT was

rotated about 360 and the receiving antenna scanned from 1-3m in order to capture the maximum emission. A calibrated antenna source was positioned in place of the EUT and the previously recorded signal was duplicated. The maximum EIRP of the emission was calculated by adding the forward power to the calibrated source plus its appropriate gain value. These steps were carried out with the receiving antenna in both vertical and horizontal polarization. Harmonic emissions up to the 10th or 40 GHz, whichever was the lesser, were investigated.

Radiated Spurious Emissions Test Setup



Test Result:

Note.

Input signal is the CW signal.

Harmonics were not found.

[800 MHz band]

Test Frequency	Freq.(MHz)	<u>Measured</u> <u>Level</u> [dBuV/m]	<u>SigGen</u> <u>Level</u> [dBm]	Ant. Gain (dBd)	C.L	Pol.	ERP (dBm)	Margin (dB)
862.4	No Peak Found							
865.5								
868.6								

[1900 MHz band]

Test Frequency	Freq.(MHz)	<u>Measured</u> <u>Level</u> [dBuV/m]	<u>SigGen</u> <u>Level</u> [dBm]	Ant. Gain (dBi)	C.L	Pol.	EIRP (dBm)	Margin (dB)
1930.4	No Peak Found							
1962.5								
1994.6								

11. FREQUENCY STABILITY OVER TEMPERATURE AND VOLTAGE VARIATIONS

FCC Rules

Test Requirement(s): §2.1055(a)(1), § 90.213

Test Procedures:

As required by 47 CFR 2.1055, *Frequency Stability measurements* were made at the RF output terminals using a Spectrum Analyzer.

The EUT was placed in the Environmental Chamber.

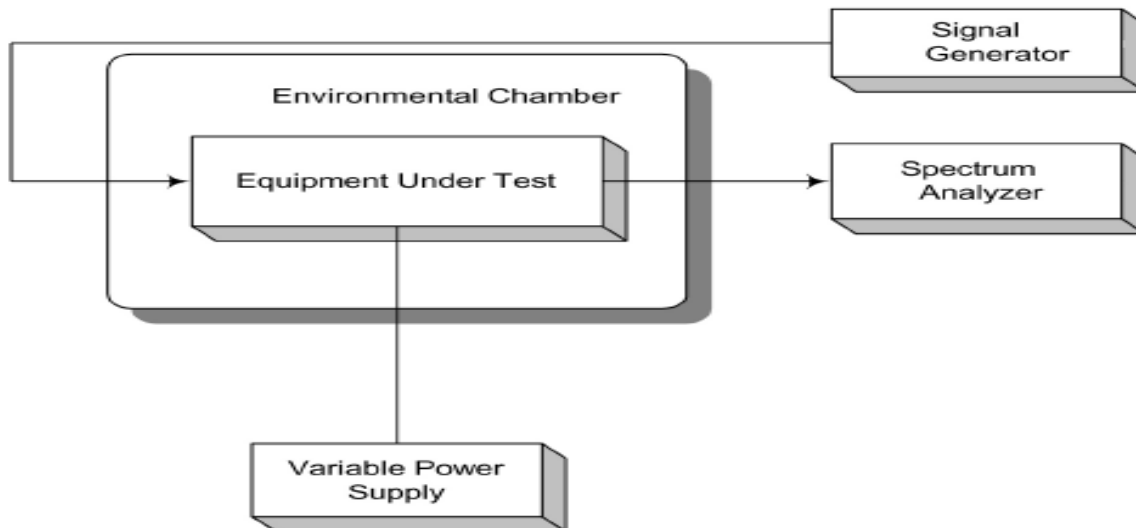
A CW signal was injected into the EUT at the appropriate RF level. The frequency counter option on the Spectrum Analyzer was used to measure frequency deviations.

The frequency drift was investigated for every 10 °C increment until the unit is stabilized then recorded the reading in tabular format with the temperature range of -30 to 50 °C.

Voltage supplied to EUT is 120 Vac reference temperature was done at 20°C.

The voltage was varied by $\pm 15\%$ of nominal

Test Setup:



Test Results:

The E.U.T was found in compliance for Frequency Stability and Voltage Test

Frequency Stability and Voltage Test Results

Reference: 120 Vac at 20°C **Freq.** =1962.5000 MHz

Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (Hz)	ppm
100%	+20(Ref)	1962500000. 0	0.0	0.0	0.0
	-30	1962500000. 0	0.0	0.0	0.0
	-20	1962500000. 0	0.0	0.0	0.0
	-10	1962500000. 0	0.0	0.0	0.0
	0	1962500000. 0	0.0	0.0	0.0
	+10	1962500000. 0	0.0	0.0	0.0
	+30	1962500000. 0	0.0	0.0	0.0
	+40	1962500000. 0	0.0	0.0	0.0
	+50	1962500000. 0	0.0	0.0	0.0
115%	+20	1962500000. 0	0.0	0.0	0.0
85%	+20	1962500000. 0	0.0	0.0	0.0

[1900 MHz band Downlink]

Reference: 120 Vac at 20°C **Freq.** = 865.5000 MHz

Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (Hz)	ppm
100%	+20(Ref)	865500000. 0	0.0	0.0	0.0
	-30	865500000. 0	0.0	0.0	0.0
	-20	865500000. 0	0.0	0.0	0.0
	-10	865500000. 0	0.0	0.0	0.0
	0	865500000. 0	0.0	0.0	0.0
	+10	865500000. 0	0.0	0.0	0.0
	+30	865500000. 0	0.0	0.0	0.0
	+40	865500000. 0	0.0	0.0	0.0
	+50	865500000. 0	0.0	0.0	0.0
115%	+20	865500000. 0	0.0	0.0	0.0
85%	+20	865500000. 0	0.0	0.0	0.0

[800 MHz band Downlink]