Clear RF, LLC

TEST REPORT FOR

ClearRF 25db Dual-Band Direct Connect Cellular Amplifier
Model: WRE2710

Tested To The Following Standards:

FCC Part 24E

Report No.: 94772-9

Date of issue: December 23, 2013

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of EMC testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Clear RF, LLC
12825 E Mirabeau Pkwy Ste 104
Spokane Valley, WA 99216

REPRESENTATIVE: Pete Wilhite

REPORT PREPARED BY:

Morgan Tramontin
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 94772

DATE OF EQUIPMENT RECEIPT: September 30, 2013
DATE(S) OF TESTING: September 30 - December 9, 2013

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.

Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
110 Olinda Place
Brea, CA 92823

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.00.14
Immunity	5.00.07

Site Registration & Accreditation Information

Location	CB #	TAIWAN	CANADA	FCC	JAPAN
Brea D	US0060	SL2-IN-E-1146R	3082D-2	100638	A-0147

SUMMARY OF RESULTS

Standard / Specification: FCC Part 24E

Description	Test Procedure/Method	Results
Occupied Bandwidth	2.1049(I)	Pass
Spurious Emissions at Antenna Terminal	Section 24.238(a) / 2.1051	Pass
Field Strength of Spurious Radiation	Section 24.238(a) / 2.1053	Pass

Conditions During Testing

This list is a summary of the conditions noted for or modifications made to the equipment during testing.

Summary of Conditions
None

EQUIPMENT UNDER TEST (EUT)

EQUIPMENT UNDER TEST

ClearRF 25db Dual-Band Direct Connect Cellular Amplifier
Manuf: Clear RF, LLC
Model: WRE2710
Serial: 001

PERIPHERAL DEVICES

The EUT was tested with the following peripheral device(s):

Power Supply
Manuf: DPX
Model: GFP101U-1210
Serial: NA

ESG Vector Signal Generator
Manuf: Agilent
Model: E4433B
Serial: US40052164

FCC PART 24E

This report contains EMC emissions test results under United States Federal Communications Commission (FCC) Transmitter Characteristics for Intentional radiators 47CFR Part 24 Subpart E -Broadband PCS.

2.1049(I) Bandwidth Limitations

Test Conditions / Setup

Test Location: CKC Laboratories • 110 Olinda Place • Brea, CA 92823 • 714-993-6112

Customer:	**Clear RF, LLC**		
Specification:	**Occupied Band Width**		
Work Order #:	**94772**	Date:	10/4/2013
Test Type:	**Conducted Emissions**	Time:	14:40:48
Equipment:	**ClearRF 25db dual-band direct connect cellular amplifier**	Sequence#:	1
Manufacturer:	Clear RF, LLC	Tested By:	E. Wong
Model:	WRE2710		110V 60Hz
S/N:	001		

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T2	AN03430	Attenuator	75A-10-12	9/5/2013	9/5/2015
T3	AN02946	Cable	32022-2-2909K-36TC	7/31/2013	7/31/2015

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
ClearRF 25db dual-band direct connect cellular amplifier*	Clear RF, LLC	WRE2710	001

Support Devices:

Function	Manufacturer	Model #	S/N
Power Supply	DPX	GFP101U-1210	NA
HF Pre Amplifier	HP	830174A	3123A00281
Solid State Amplifier	Comtech	AR178238-30	N1Q4800-1013
ESG Vector Signal Generator	Agilent	E4433B	US40052164

Test Conditions / Notes:

The EUT is placed on the test bench. The Donor port of the Machine to Machine booster is intended to be connected to an antenna and the server port is intended to be connected directly to the antenna port of a cellular modem or cellular handset.

CMRS band.
UL: 824-849MHz, 1850-1915MHz
DL: 869-894MHz, 1930-1995MHz

Evaluation performed at the both Donor and Server antenna port.

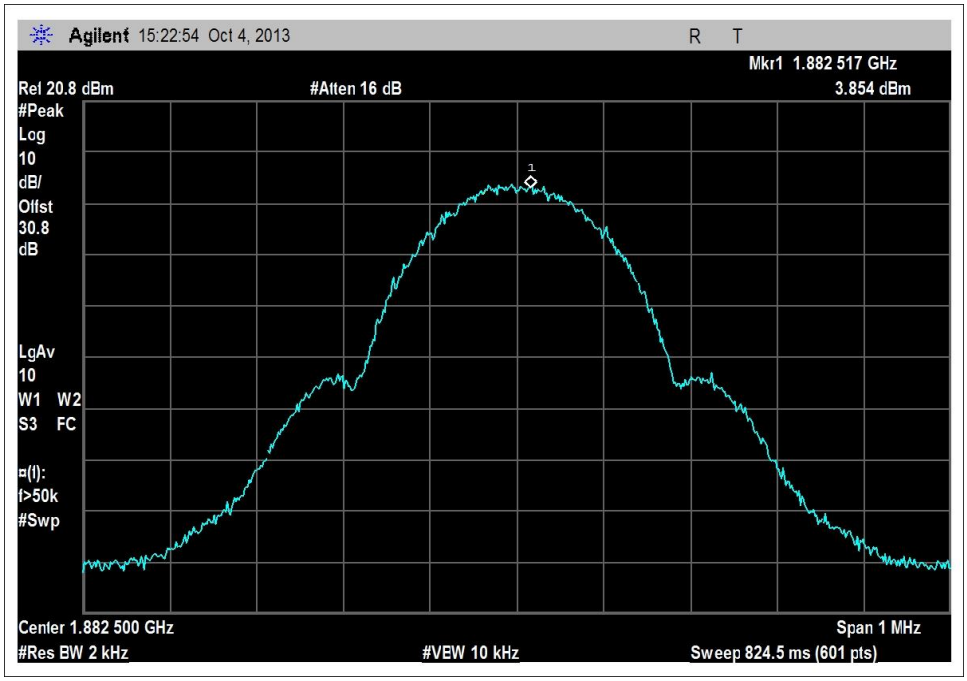
The booster operates in the following frequency band.
UL: 824-849, 1850-1910 MHz
DL: 869-894, 1930-1990 MHz

Evaluation performed IAW 7.10 of the FCC Document 935210 DO3 Wideband Consumer Signal Booster Measurement Guidance DR04-41516.

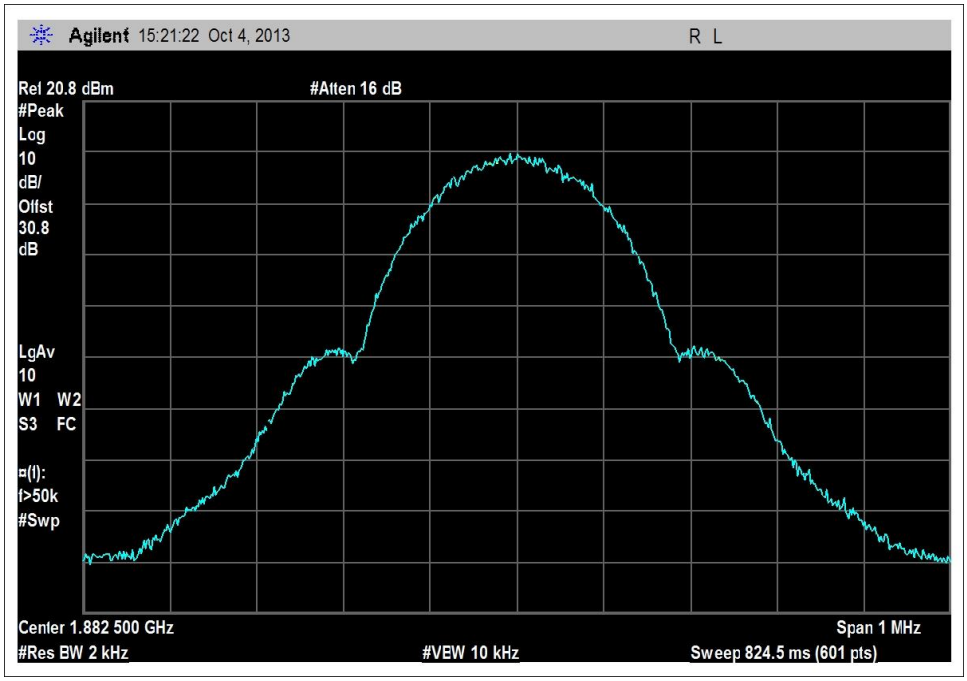
UL measurement , Firmware version : 1.0.16
DL measurement , Firmware version : 1.0.16

Test environment conditions: 24°C, 30% Relative Humidity:100kPa

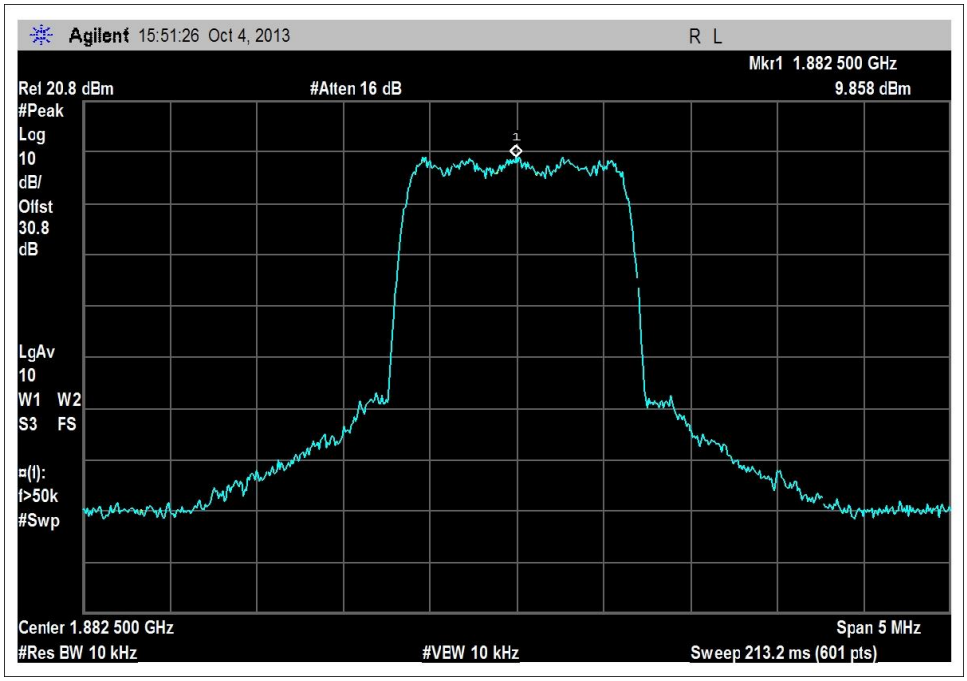
Test Data



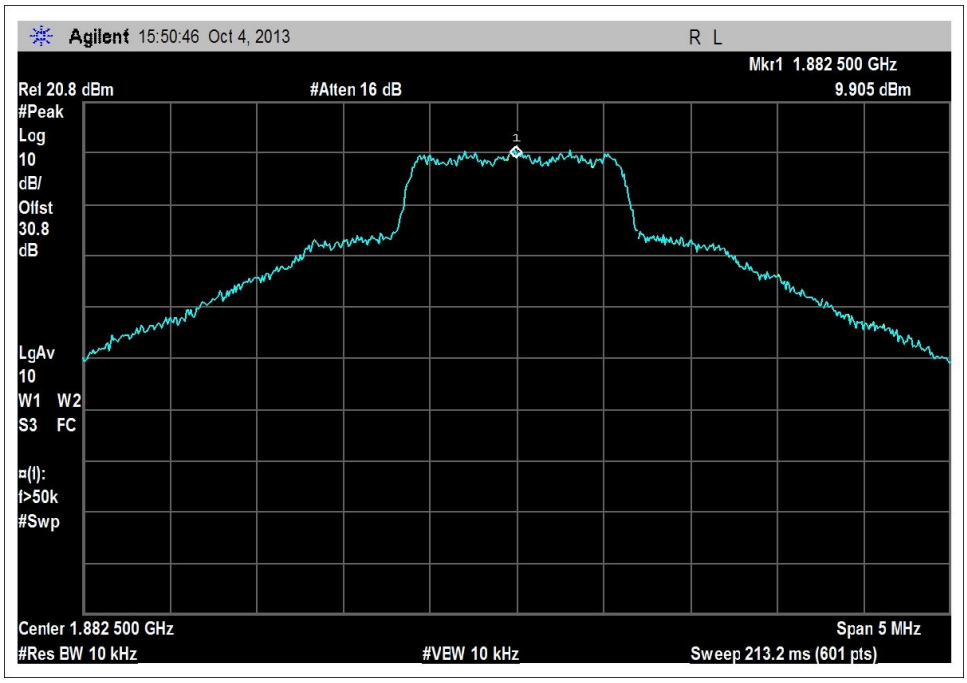
1850 - 1910MHz UL, GSM - Input



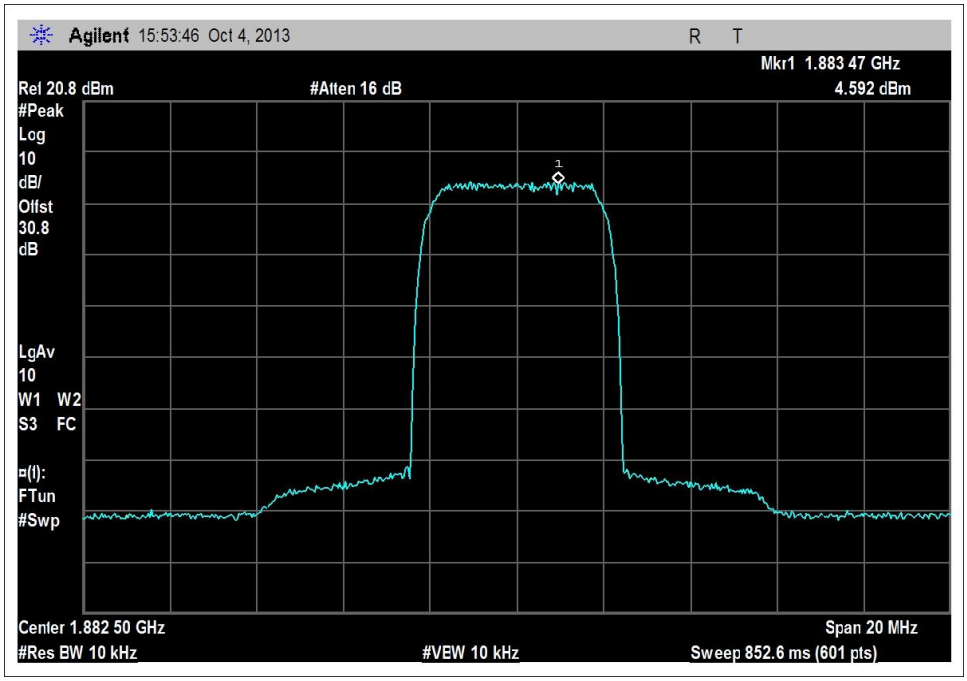
1850 - 1910MHz UL, GSM - Output



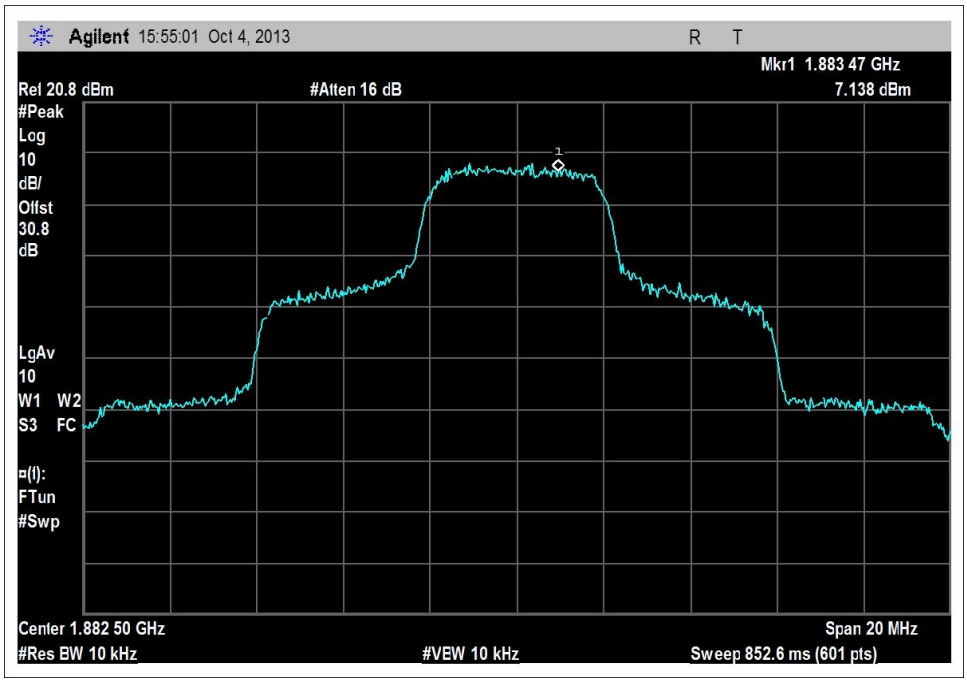
1850 - 1910MHz UL, CDMA - Input



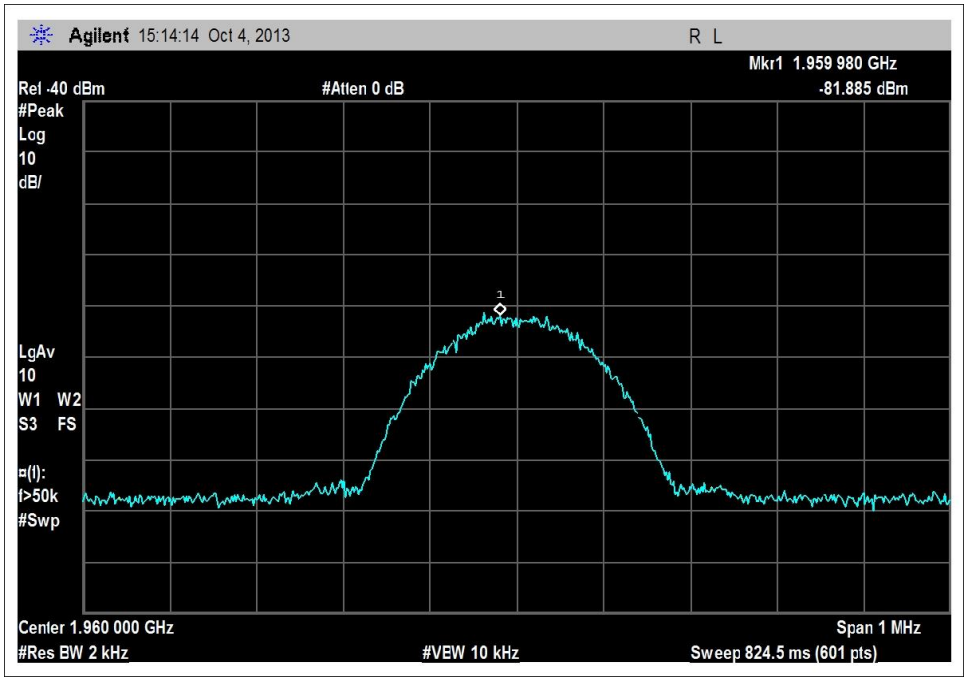
1850 - 1910MHz UL, CDMA - Output



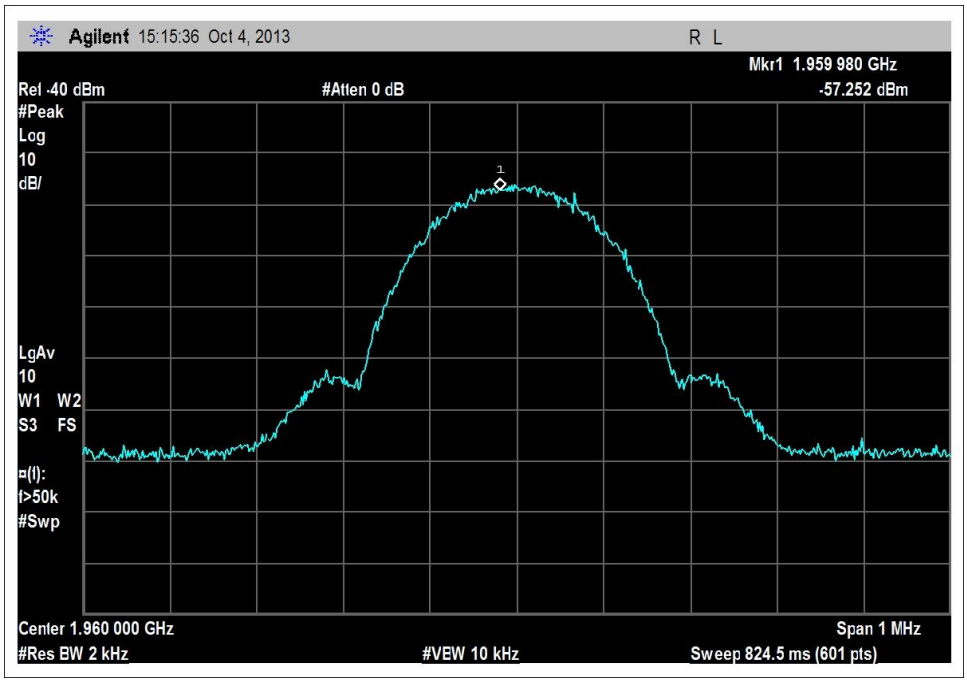
1850 - 1910MHz UL, WCDMA - Input



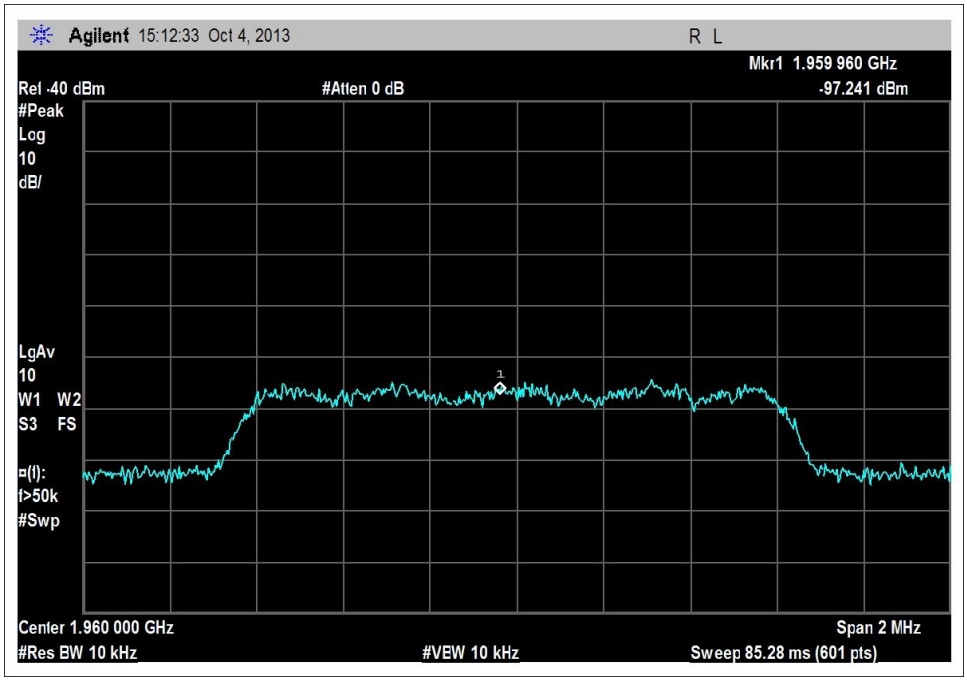
1850 - 1910MHz UL, WCDMA - Output



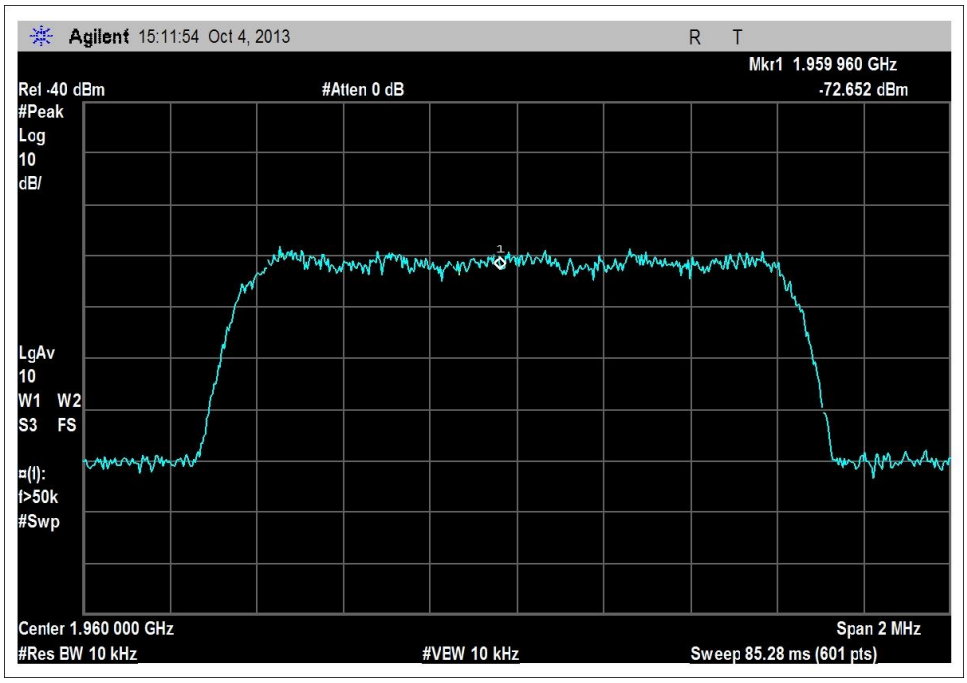
1930 - 1990MHz DL, GSM - Input



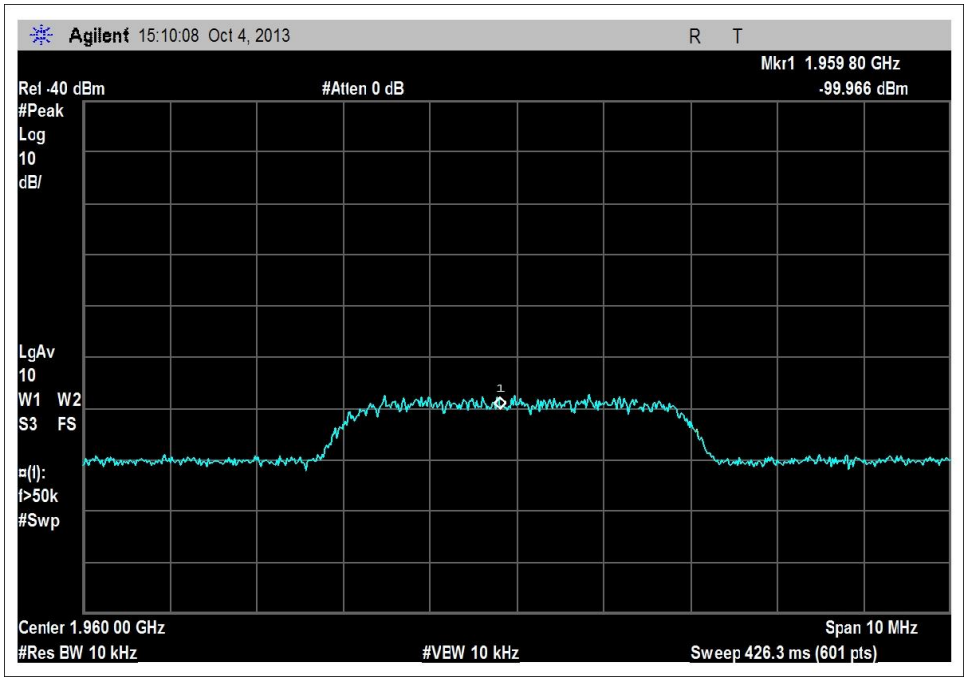
1930 - 1990MHz DL, GSM - Output



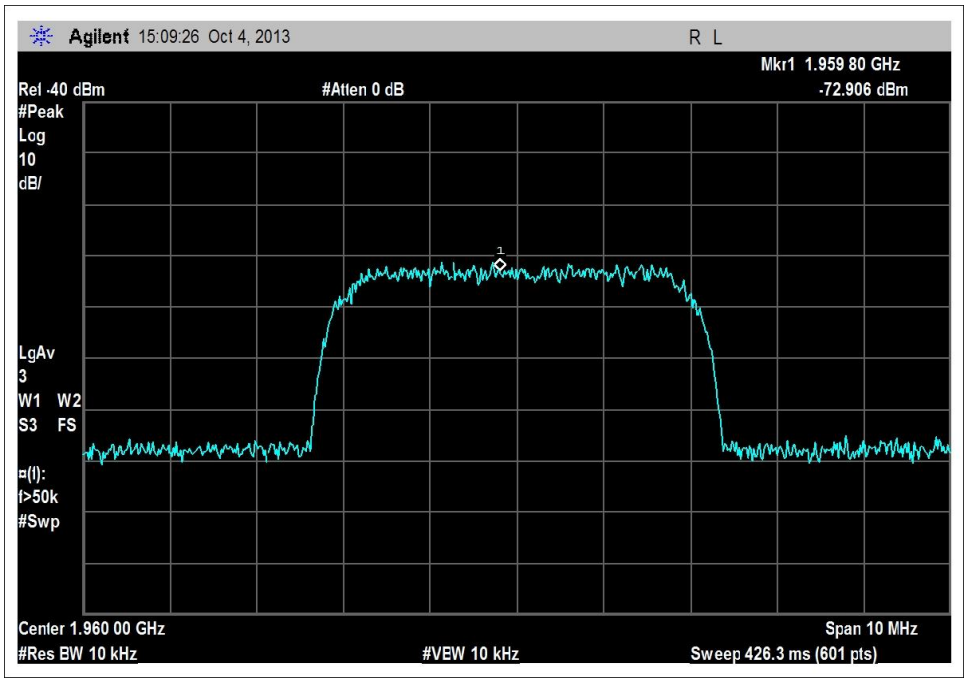
1930 - 1990MHz DL, CDMA - Input



1930 - 1990MHz DL, CDMA - Output

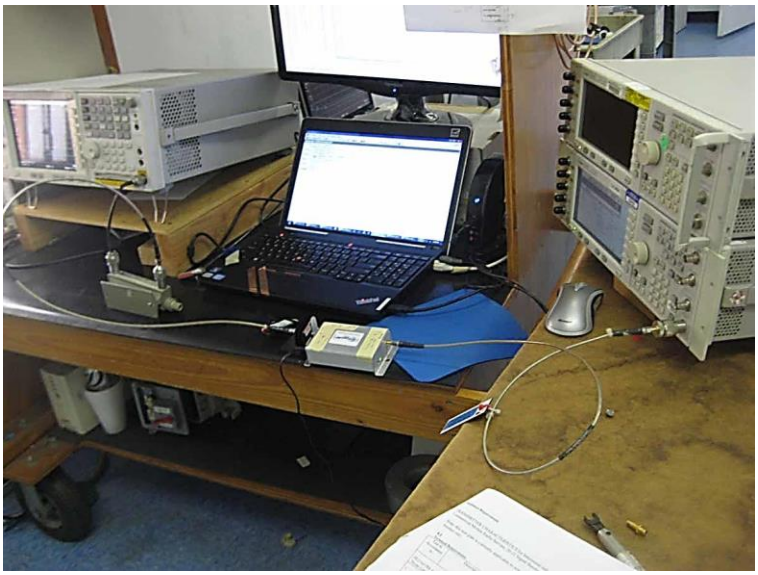


1930 - 1990MHz DL, WCDMA - Input



1930 - 1990MHz DL, WCDMA - Output

Test Setup Photos



FCC 24.238(a) / FCC 2.1051 Spurious Emissions at Antenna Terminal

LIMIT LINE FOR SPURIOUS CONDUCTED EMISSION

REQUIRED ATTENUATION = 43+10 LOG P DB

Limit line (dBuV) = V_{dBuv} - Attenuation

$$V_{dBuV} = 20 \; Log \frac{V}{1 \; x \; 10^{-6}}$$

$$= 20 \left(Log \; V - Log \; 1 \; x \; 10^{-6} \right)$$

$$= 20 \; Log \; V - 20 \; Log \; 1 \; x \; 10^{-6}$$

$$= 20 \; Log \; V - 20 \left(-6 \right)$$

$$= 20 \; Log \; V + 120$$

$$Attenuation = 43 + 10 \; Log \; P$$

$$= 43 + 10 \; Log \frac{V^2}{R}$$

$$= 43 + 10 \left(Log \; V^2 - Log \; R \right)$$

$$= 43 + 10 \left(2 \; Log \; V - Log \; R \right)$$

$$= 43 + 20 \; Log \; V - 10 \; Log \; R$$

Limit line = V_{dBuv} - Attenuation

= 20 Log V + 120 – (43 + 20 Log V – 10Log R)

= 20 Log V + 120 – 43 – 20 Log V + 10Log R

= 20 Log V + 120 – 43 – 20 Log V + 10Log R

= 120 – 43 + 10 Log 50 Note : R = 50 Ω

= 120 –43 + 16.897

= 94 dBuV at any power level

Test Data Sheets

Customer:	**Clear RF, LLC**		
Specification:	**47 CFR Â§24.238 Spurious Emissions**		
Work Order #:	**94772**	Date:	12/3/2013
Test Type:	**Conducted Emissions**	Time:	19:07:51
Equipment:	**ClearRF 25db dual-band direct connect cellular amplifier**	Sequence#:	1
Manufacturer:	Clear RF, LLC	Tested By:	S. Yamamoto
Model:	WRE2710		110V 60Hz
S/N:	001		

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	2/6/2013	2/6/2015
T2	AN03430	Attenuator	75A-10-12	9/5/2013	9/5/2015
T3	AN02945	Cable	32022-2-2909K-36TC	10/30/2013	10/30/2015

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
ClearRF 25db dual-band direct connect cellular amplifier*	Clear RF, LLC	WRE2710	001

Support Devices:

Function	Manufacturer	Model #	S/N
Power Supply	DPX	GFP101U-1210	NA
ESG Vector Signal Generator	Agilent	E4433B	US40052164

Test Conditions / Notes:

The EUT is placed on the test bench. The Donor port of the Machine to Machine booster is intended to be connected to an antenna and the server port is intended to be connected directly to the antenna port of a cellular modem or cellular handset.
Emissions scanned and measured up to within 100kHz (<1GHz) /1MHz (>1GHz) of each UL and DL band edge.

CMRS band.
UL: 1850-1915Hz
DL: 1930-1995MHz

Evaluation performed at the both Donor and Server antenna port.

The booster operates in the following frequency band.
UL: 1850-1910 MHz
DL: 1930-1990 MHz

Conducted Spurious emission performed with the following transmit frequency testing IAW 7.6 of the FCC Document 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516

TX freq and RF input power at the Donor and Server port.
Signal : AWGN 99% Bandwidth 4.1MHz, 1.25MHz, 200kHz

Input freq and power level
UL TX Freq: 1907.95MHz and 1852.05MHz +9.8dBm
DL TX Freq: 1932.05MHz and 1987.95MHz -44.8dBm

Frequency range of measurement = 9 kHz- 20 GHz.
9 kH -150 kHz;RBW=200 Hz,VBW=200 Hz;150 kHz-30 MHz;RBW=9 kHz,VBW=9 kHz;30 MHz-1000 MHz;RBW=120 kHz,VBW=120 kHz,1000 MHz-20000 MHz;RBW=1 MHz,VBW=1 MHz.
Test environment conditions: 22°C, 42% Relative Humidity, 100kPa
Site D

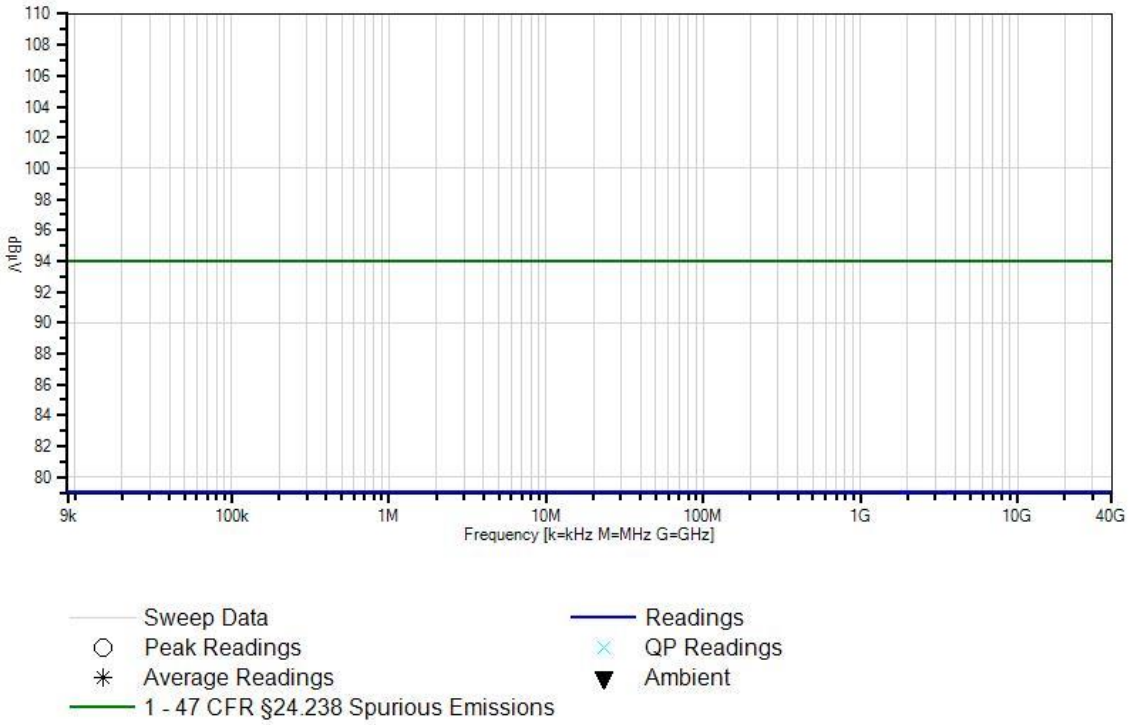
Ext Attn: 0 dB

Measurement Data: Reading listed by margin. Test Lead: Ant Port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	1911.000M	58.6	+0.0	+10.1	+0.7		+0.0	69.4	94.0	-24.6	Ant P
									UL 1850-1910MHz AWGN		
2	1911.825M	57.0	+0.0	+10.1	+0.7		+0.0	67.8	94.0	-26.2	Ant P
									UL 1850-1910MHz AWGN		
3	1912.933M	50.8	+0.0	+10.1	+0.7		+0.0	61.6	94.0	-32.4	Ant P
									UL 1850-1910MHz AWGN		
4	1849.000M	49.6	+0.0	+10.0	+0.7		+0.0	60.3	94.0	-33.7	Ant P
									UL 1850-1910MHz AWGN		
5	1847.250M	45.8	+0.0	+10.0	+0.7		+0.0	56.5	94.0	-37.5	Ant P
									UL 1850-1910MHz AWGN		

6	1845.100M	40.7	+0.0	+10.0	+0.7	+0.0	51.4	94.0	-42.6	Ant P
								UL 1850-1910MHz AWGN		
7	844.700M	40.8	+0.0	+9.9	+0.3	+0.0	51.0	94.0	-43.0	Ant P
								UL 1850-1910MHz AWGN		
8	843.000M	37.1	+0.0	+9.9	+0.3	+0.0	47.3	94.0	-46.7	Ant P
								UL 1850-1910MHz AWGN		
9	3817.580M	32.5	+0.0	+9.6	+0.9	+0.0	43.0	94.0	-51.0	Ant P
								UL 1850-1910MHz AWGN		
10	3705.520M	28.5	+0.0	+9.7	+0.8	+0.0	39.0	94.0	-55.0	Ant P
								UL 1850-1910MHz AWGN		
11	1929.000M	20.5	+0.0	+10.1	+0.7	+0.0	31.3	94.0	-62.7	Ant P
								DL 1930-1990MHz AWGN		
12	1991.000M	20.2	+0.0	+9.9	+0.7	+0.0	30.8	94.0	-63.2	Ant P
								DL 1930-1990MHz AWGN		

CKC Laboratories, Inc. Date: 12/3/2013 Time: 19:07:51 Clear RF, LLC WO#: 94772
47 CFR §24.238 Spurious Emissions Test Lead: Ant Port 110V 60Hz Sequence#: 1 Ext ATTN: 0 dB



Test Setup Photos

FCC 24.238(a) / 2.1053 Field Strength of Spurious Radiation

LIMIT LINE FOR SPURIOUS RADIATED EMISSION

REQUIRED ATTENUATION = 43+10 LOG P (DB)

For radiated spurious emission measured at 3 meter test distance,

Required attenuation = 43+10 Log $P_{t\ at\ 3\ meter}$ dB
Limit line (dBuV) = E_{dBuv} - Attenuation

E_{dBuv} = Measured field strength at 3 meter in dBuV/m

Power Density (Isotropic)

$$P_D = \frac{P_t}{4\pi r^2}$$

P_D = Power Density in Watts /m^2
Pt = Average Transmit Power
r = Test distance

Field Intensity E (V/m)

$$E = \sqrt{P_D \times 377}$$

$$E = \frac{\sqrt{P_t \times 377}}{4\pi r^2}$$

$$E = \sqrt{\frac{P_t \times 30}{r^2}}$$

$$P_t = \left(\frac{E^2 \times r^2}{30}\right)$$

$10 \text{ Log } P_t = 10 \text{ Log } E^2 \text{ (V/m)} + 10 \text{ Log } r^2 - 10 \text{ Log } 30$

$10 \text{ Log } P_t = 20 \text{ Log } E \text{ (V/m)} + 20 \text{ Log } r - 10 \text{ Log } 30$

At 3 meter, r = 3 m

$10 \text{ Log } P_t = 20 \text{ Log } E \text{ (V/m)} + 20 \text{ Log } 3 - 10 \text{ Log } 30$

$10 \text{ Log } P_t = 20 \text{ Log } E \text{ (V/m)} + 9.54 - 14.77$

$10 \text{ Log } P_t = 20 \text{ Log } E \text{ (V/m)} - 5.23$

Since 20 Log E (V/m) = 20 Log E (uV/m) –120

$10 \text{ Log } P_t = 20 \text{ Log } E \text{ (uV/m)} - 120 - 5.23$

$10 \text{ Log } P_t = 20 \text{ Log } E \text{ (uV/m)} - 125.23$

Limit line (dBuV) at 3 meter = E_{dBuv} – Attenuation

= $E_{dBuv} - (43 + 10 \text{ Log } P_{t \text{ at 3 meter}})$

= $E_{dBuv} - 43 - 10 \text{ Log } P_{t \text{ at 3 meter}}$

= $E_{dBuv} - 43 - (20 \text{ Log } E \text{ (uV/m)} - 125.23)$

= $E_{dBuv} - 43 - 20 \text{ Log } E \text{ (uV/m)} + 125.23$

= $E_{dBuv} - 20 \text{ Log } E \text{ (uV/m)} + 82.23$

Since 20 Log E (uV/m) = E in dBuV/m

= $\cancel{E_{dBuv}} - \cancel{E_{dBuv}} + 82.23$

Radiated Emission limit $_{3 \text{ meter}}$ = 82.23 dBuV at any power level measured in dBuV

Test Data Sheets

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • 7149936112

Customer: **Clear RF, LLC**
Specification: **47 CFR §24.238 Spurious Emissions**
Work Order #: **94772** Date: 12/9/2013
Test Type: **Radiated Scan** Time: 19:32:57
Equipment: **ClearRF 25db dual-band direct connect cellular amplifier** Sequence#: 2
Manufacturer: Clear RF, LLC Tested By: E. Wong
Model: WRE2710
S/N: 001

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02672	Spectrum Analyzer	E4446A	9/4/2012	9/4/2014
	AN00314	Loop Antenna	6502	6/29/2012	6/29/2014
	AN01995	Biconilog Antenna	CBL6111C	5/16/2012	5/16/2014
	ANP05198	Cable-Amplitude 15 to 45degC (dB)	8268	12/11/2012	12/11/2014
	AN00309	Preamp	8447D	3/29/2012	3/29/2014
	ANP05050	Cable	RG223/U	1/21/2013	1/21/2015
T2	AN00786	Preamp	83017A	6/20/2012	6/20/2014
T3	AN00849	Horn Antenna	3115	4/13/2012	4/13/2014
	AN01413	Horn Antenna-ANSI C63.5 (dB/m)	84125-80008	11/9/2012	11/9/2014
T4	AN03239	Cable	32022-2-29094K-24TC	10/30/2013	10/30/2015
T5	ANP05988	Cable	LDF1-50	3/12/2012	3/12/2014

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
ClearRF 25db dual-band direct connect cellular amplifier*	Clear RF, LLC	WRE2710	001

Support Devices:

Function	Manufacturer	Model #	S/N
Power Supply	DPX	GFP101U-1210	NA
ESG Vector Signal Generator	Agilent	E4433B	US40052164

Test Conditions / Notes:

The EUT is placed Styrofoam table. The Donor port of the Machine to Machine booster is intended to be connected to an antenna and the server port is intended to be connected directly to the antenna port of a cellular modem or cellular handset.

CMRS band.
UL: 1850-1915MHz
DL: 1930-1995MHz

Evaluation performed with the Donor / Server antenna port terminated to a load while the Server /Donor port connected to remotely located signal generator respectively.

The booster operates in the following frequency band.
UL: 1850-1910 MHz
DL: 1930-1990 MHz

Radiated Spurious emission performed with the following transmit frequency testing IAW 7.6 of the FCC Document 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516

TX freq and RF input power at the Donor and Server port.
Signal : CW

Input freq and power level
UL TX Freq: 1880MHz +14.5dBm
DL TX Freq: 1960MHz - 56.8dBm

Frequency range of measurement = 9 kHz- 20 GHz.
9 kH -150 kHz;RBW=200 Hz,VBW=200 Hz;150 kHz-30 MHz;RBW=9 kHz,VBW=9 kHz;30 MHz-1000 MHz;RBW=120 kHz,VBW=120 kHz,1000 MHz-20000 MHz;RBW=1 MHz,VBW=1 MHz.
Test environment conditions: 22C, 42%, 100kPa

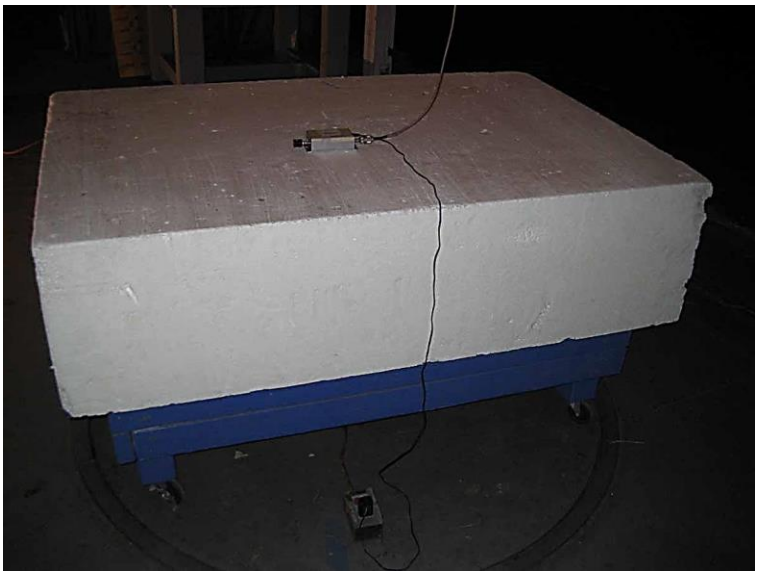
No emission found, recorded reading represents noise floor level at harmonics.

Operating Frequency: UL: 1850-1910 MHz, DL: 1930-1990 MHz

Channels: CW
Highest Measured Output Power: 19.70(dBm) = 0.09 (Watts)
Distance: 3meters
Limit: 43+10Log(P) = 32.54dBc

Freq. (MHz)	Reference Level (dBm)	Antenna Polarity (H/V)	dBc
3,760.00	-53.04242509	Horiz	72.74
5,880.00	-54.24242509	Horiz	73.94

Test Setup Photos



SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

The reported measurement uncertainties are calculated based on the worst case of all laboratory environments from CKC Laboratories, Inc. test sites. Only those parameters which require estimation of measurement uncertainty are reported. The reported worst case measurement uncertainty is less than the maximum values derived in CISPR 16-4-2. Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or carrot ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point the measuring device is set into the linear mode and the scan time is reduced.