

HCT CO., LTD.

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CERTIFICATE OF COMPLIANCE (ERM EVALUATION)**Manufacture: GS Instruments Co., Ltd.**

1385-14, Juan-Dong, Nam-Ku, Incheon, 402-200, Korea

Date of Issue: April 16, 2009**Test Report No.: HCT-RF09-0416****Test Site: HCT CO., LTD.****FCC ID**

:

U88-GRS-825DM-BC**APPLICANT**

:

GS Instruments Co., Ltd.**EUT Type:** Repeater**MODEL:** GRS-825DM-BC**Frequency Ranges:** Uplink : 835 – 849 MHz (Cellular)

Downlink : 880 – 894 MHz (Cellular)

RF Output Power: Downlink : 25.0 dBm (Cellular)

Uplink : 25.0 dBm (Cellular)

FCC Rules Part(s): Title 47 of CFR, Part 22 Subpart H (Cellular)**IC Rule Part(s):** RSS-129, RSS-GEN**Engineering Statement:**

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 22 Subpart H of the FCC Rules under normal use and maintenance.

Chang Seok Choi

Report prepared by
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1. CLIENT INFORMATION

The EUT has been tested by request of

Company	GS Instruments Co., Ltd
Contact Point	1385-14, Juan-Dong, Nam-Ku, Incheon, 402-200, Korea

- **EUT Type:** Repeater
- **MODEL :** GRS-825DM-BC
- **Frequency Ranges:** Uplink: 835 – 849 MHz (Cellular)
Downlink: 880 – 894 MHz (Cellular)
- **RF Output Power:** Uplink: 25.0 dBm (Cellular)
Downlink: 25.0 dBm (Cellular)
- **FCC Rules Part(s):** Title 47 of CFR, Part 22 Subpart H (Cellular)
- **IC Rules Part(s):** RSS-129, RSS-GEN
- **Emission Designators:** F9W
- **Modulation :** QPSK
- **Place of Tests:** HCT Co., Ltd. (IC Recognition no.: IC 5944A)

2. TEST SPECIFICATIONS

2.1 Standards

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance With **Part 22 Subpart H, Part 24 Subpart E.**

Description	Reference (FCC)	Reference (IC)	Results
RF Power Output	§2.1046 §22.913	RSS-GEN, Section 4.8 RSS-129, Section 9.1	Compliant
Modulation Characteristics	§2.1047	RSS-129, Section 6.1 and 6.2	N/A
Occupied Bandwidth	§2.1049	RSS-129, Section 6.3 RSS-GEN, Section 4.6.1	Compliant
Spurious Emissions at Antenna Terminals	§2.1051 §22.917	RSS-129, Section 8.1.1 RSS-GEN, Section 4.9	Compliant
Radiated Spurious Emissions	§2.1053 §22.917	RSS-129, Section 8.1.1 RSS-GEN, Section 4.9	Compliant
Frequency Stability	§2.1055 §22.355	RSS-129, Section 9.2.1 RSS-GEN, Section 4.7	Compliant
Receiver Spurious	-	RSS-129, Section 10 RSS-GEN, Section 4.10	Compliant

3. STANDARDS ENVIRONMENTAL TEST CONDITIONS

Temperature :	+ 15 °C to + 35 °C
Relative humidity:	30 % to 60 %
Air pressure	860 mbar to 1060 mbar

4. TEST EQUIPMENT

Manufacturer	Model / Equipment	Cal Interval	Calibration Due	Serial No.
Agilent	E4438C /Signal Generator	Annual	12/15/2009	MY42082646
Agilent	E4416A /Power Meter	Annual	01/21/2010	GB41291412
WEINSCHEL	67-30-33/ATTENUATOR	Annual	02/03/2010	BR0530
Agilent	E7405A /EMC Analyzer	Annual	12/10/2009	US40240290
Schwarzbeck	VULB 9160/ TRILOG Antenna	Annual	04/20/2009	9160-3150
HD	MA240/ Antenna Position Tower	N/A	N/A	556
EMCO	1050/ Turn Table	N/A	N/A	114
HD GmbH	HD 100/ Controller	N/A	N/A	13
HD GmbH	KMS 560/ SlideBar	N/A	N/A	12
MITEQ	AMF-60-0010 1800-35-20P	Annual	01/15/2010	1200937
Schwarzbeck	BBHA 9120D/ Horn Antenna	Annual	05/02/2009	147
Schwarzbeck	BBHA 9120D/ Horn Antenna	Annual	05/02/2009	296
Schwarzbeck	BBHA9170/SHF-EHF Horn Antenna	Annual	05/02/2009	BBHA9170342
Agilent	N9020A/Signal Analyzer	Annual	02/19/2010	US46220219

5. RF OUTPUT POWER

5.1 Test Procedure

Test Requirements:

§ 2.1046 Measurements required: RF power output:

§ 2.1046 (a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

§ 2.1046 (b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters, the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and as applicable in § 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

§ 2.1046 (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

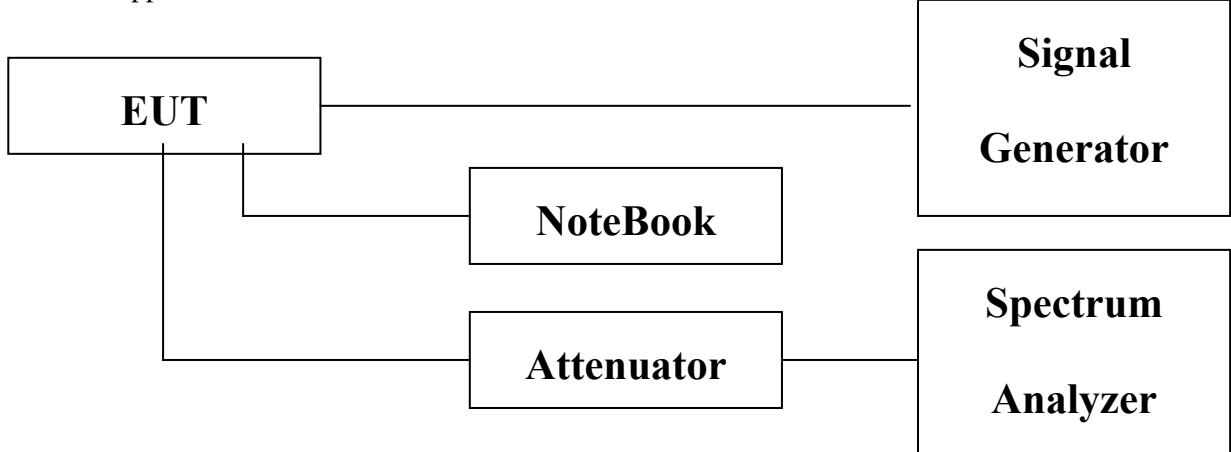
§ 22.913 Effective radiated power limits.

The effective radiated power (ERP) of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(a) Maximum ERP. In general, the effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts.

Test Procedures:

As required by 47 CFR 2.1046, RF power output measurements were made at the RF output terminals using an attenuator and spectrum analyzer or power meter. This test was performed in all applicable modulations.

**Block Diagram 1. RF Power Output Test Setup**

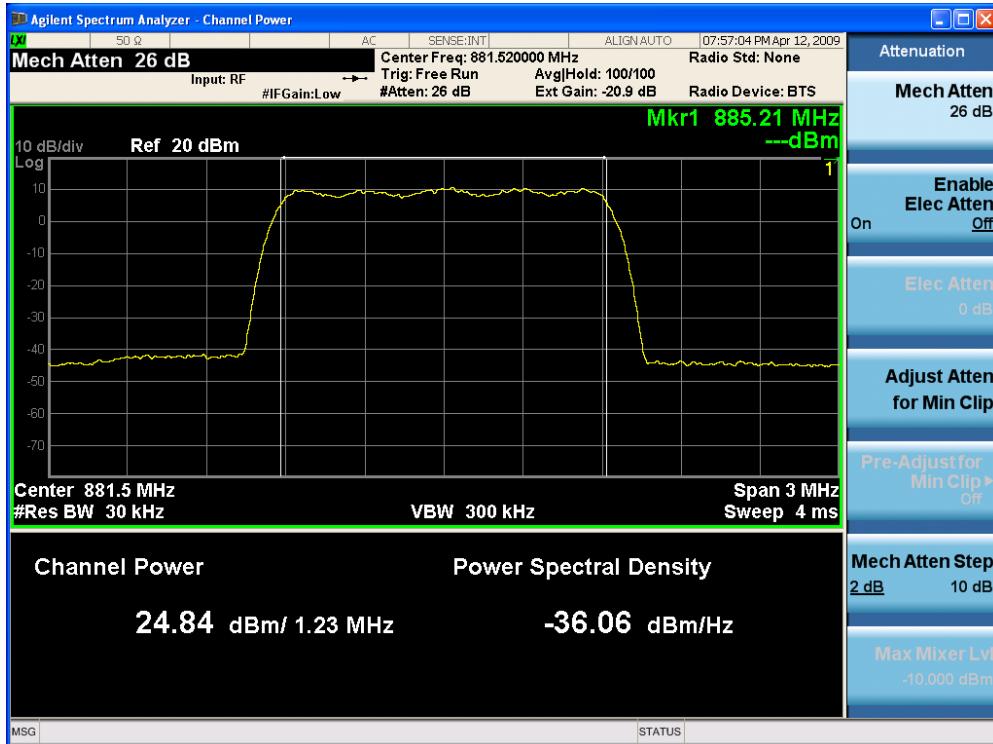
5.2 Test Results

(Cellular)

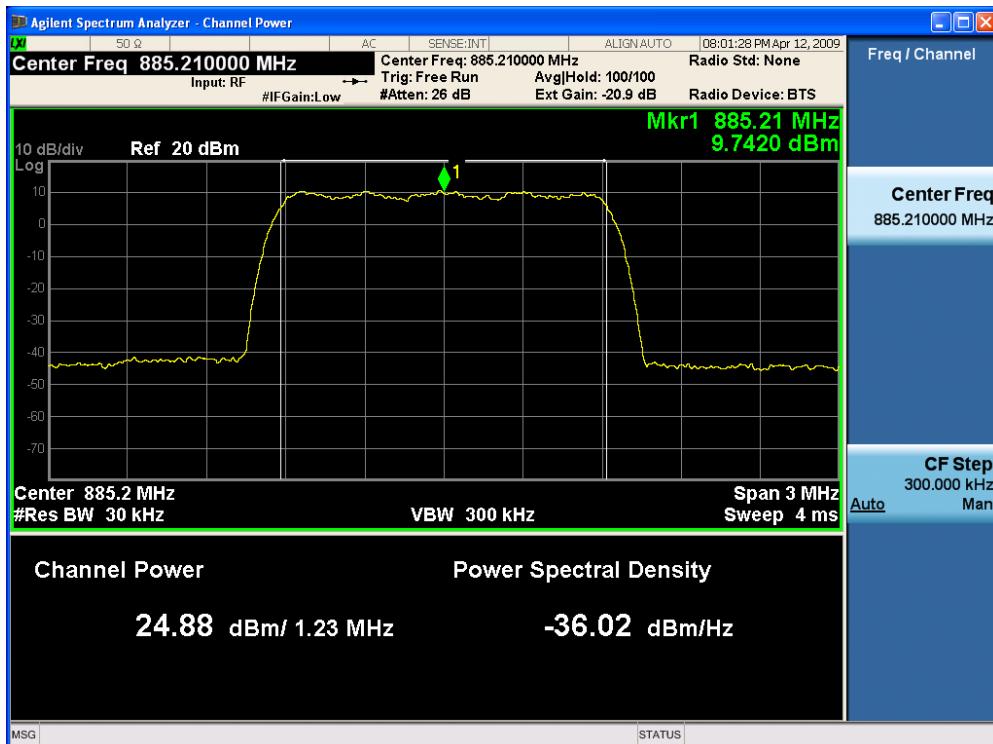
CARRIER CHANNEL	DLINK		UPLINK	
	Frequency (MHz)	Measured Power (dBm)	Frequency (MHz)	Measured Power (dBm)
Low	881.52	24.84	836.52	24.90
Mid	885.21	24.88	840.21	25.10
High	892.75	25.08	847.75	24.90

INPUT SIGNAL	DLINK	UPLINK
Source	Real-time CDMA Forward	Real-time CDMA Reverse
Power Level	-54.1 dBm	-55.3 dBm
Amplitude offset	-20.9 dB	-20.9dB

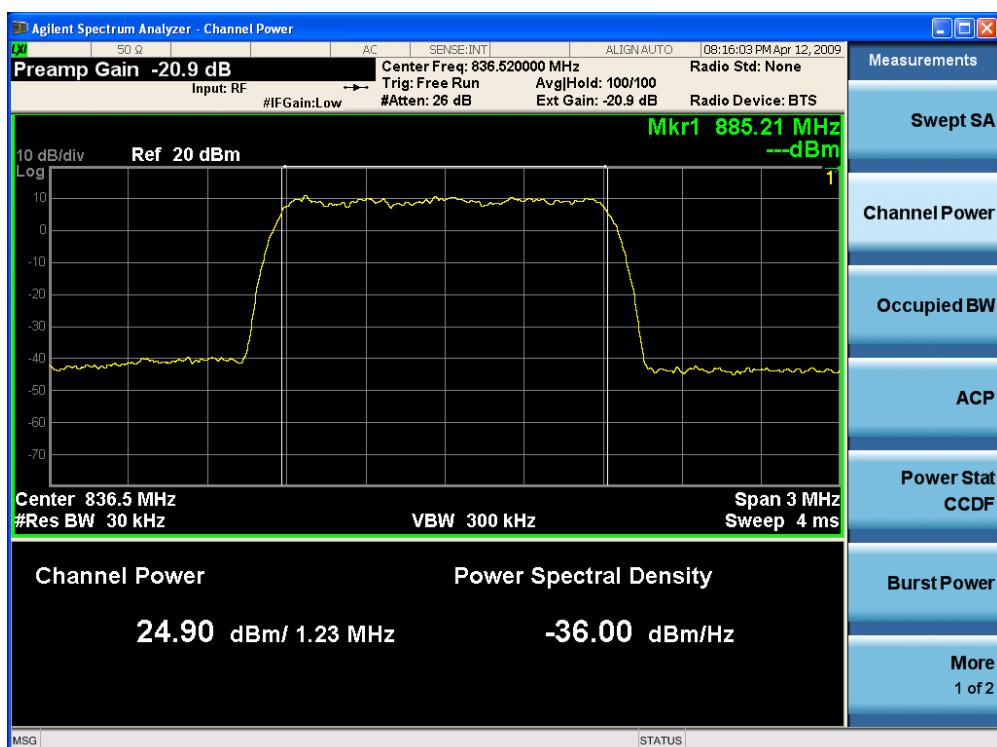
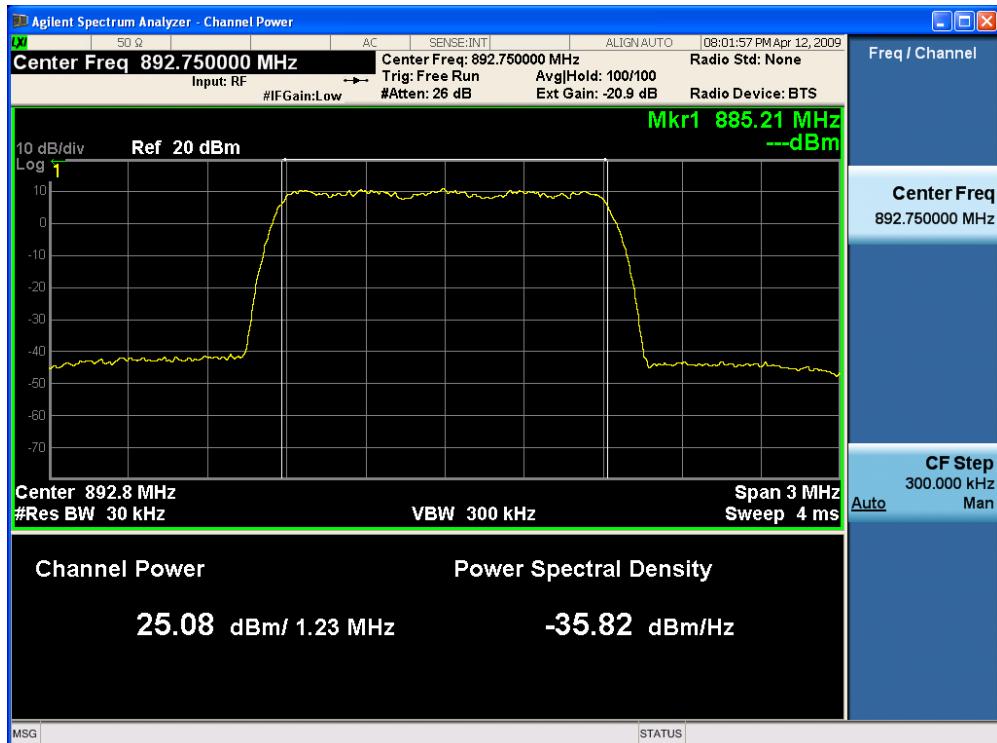
Plots of RF Output Power



Downlink Low CH (Cellular)



Downlink Middle CH (Cellular)





Uplink Middle CH (Cellular)



Uplink High CH (Cellular)

6. OCCUPIED BANDWIDTH

6.1 Test Procedure

Test Requirement(s): § 2.1049 Measurements required: Occupied bandwidth:

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of § 2.1049 (a) through (i) as applicable.

Test Procedures: As required by 47 CFR 2.1049, *occupied bandwidth measurements* were made with a Spectrum Analyzer connected to the RF ports for both Uplink and Downlink

The modulation characteristics of signal generator's carrier was measured first at a maximum RF level prescribed by the OEM. The signal generator was then connected to either the Uplink or Downlink input at the appropriate RF level. The resulting modulated signal through the EUT was measured and compared against the original signal.

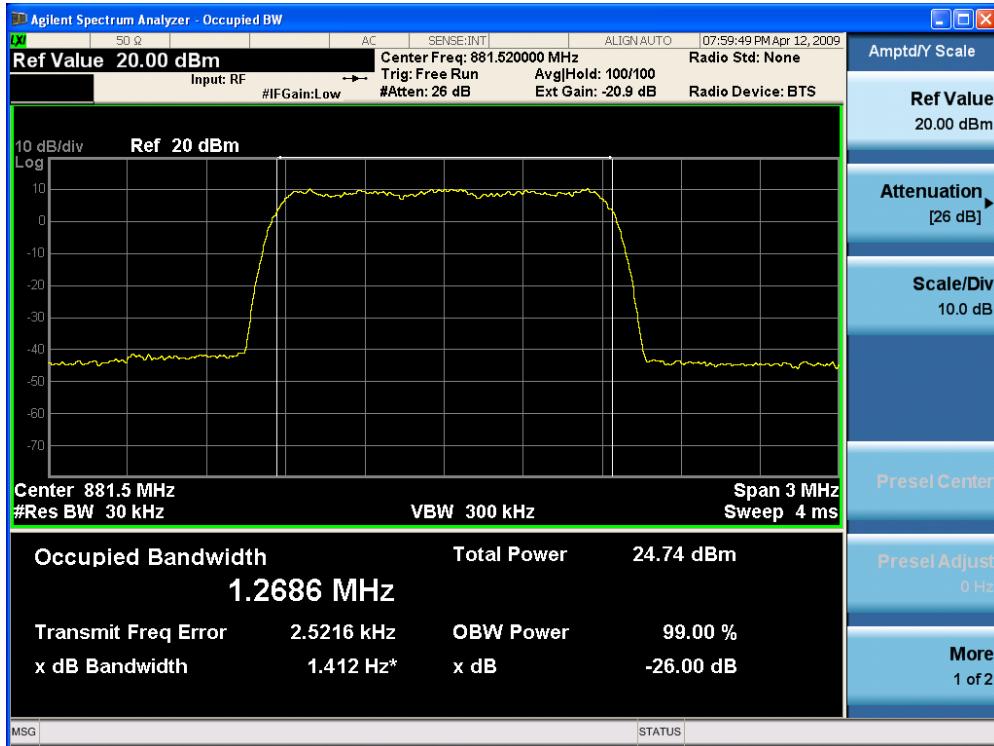
Test Results: The EUT complies with the requirements of this section.

(Cellular)

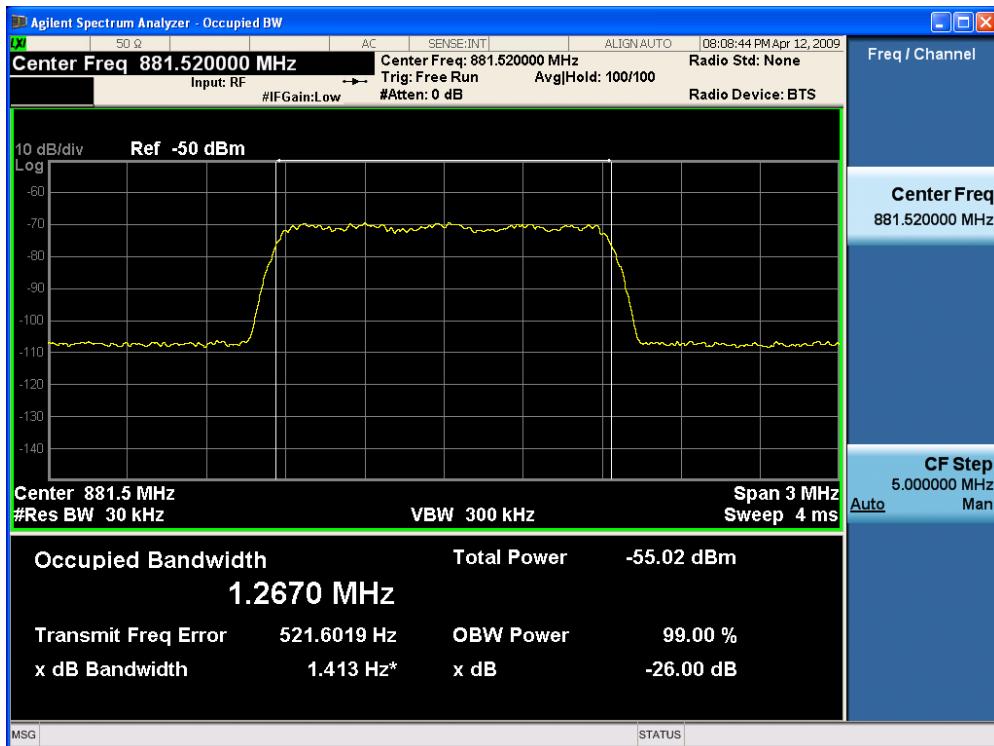
CARRIER CHANNEL	DLINK			UPLINK		
	Frequency (MHz)	Occupied Bandwidth (MHz)		Frequency (MHz)	Occupied Bandwidth (dBm)	
Low	881.52	Out	1.2686	836.52	Out	1.2635
		In	1.2670		In	1.2650
Mid	885.21	Out	1.2645	840.21	Out	1.2631
		In	1.2679		In	1.2664
High	892.75	Out	1.2649	847.75	Out	1.2663
		In	1.2655		In	1.2668

INPUT SIGNAL	DLINK	UPLINK
Source	Real-time CDMA Forward	Real-time CDMA Reverse
Power Level	- 54.1 dBm	- 55.3 dBm
Amplitude offset	- 20.9 dB	- 20.9 dB

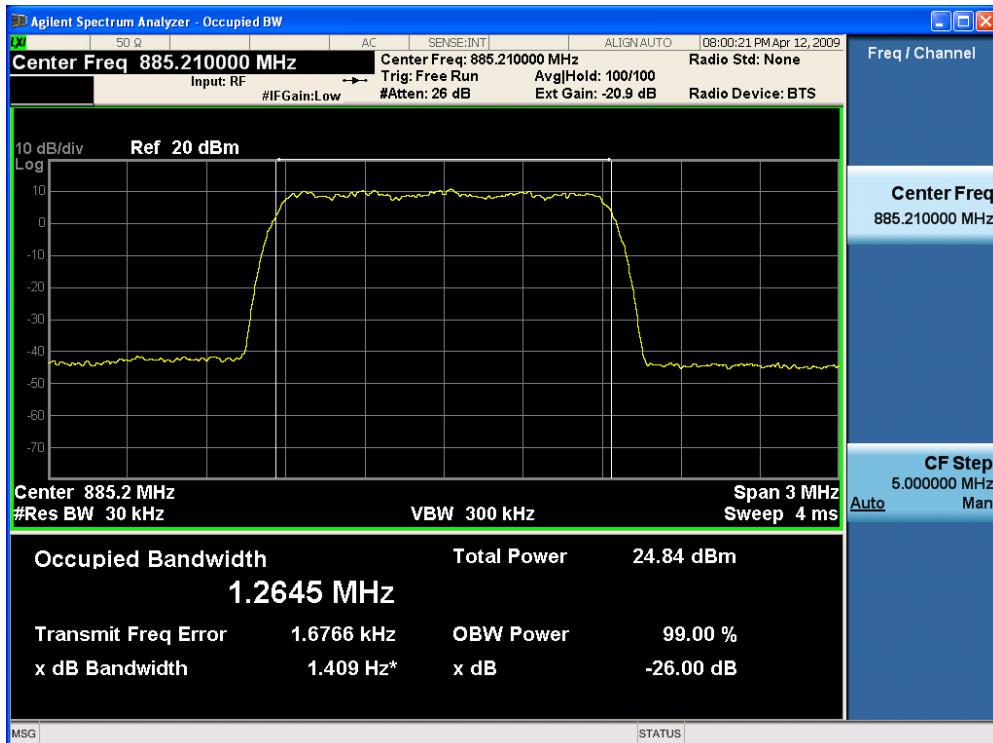
Plots of Occupied Bandwidth



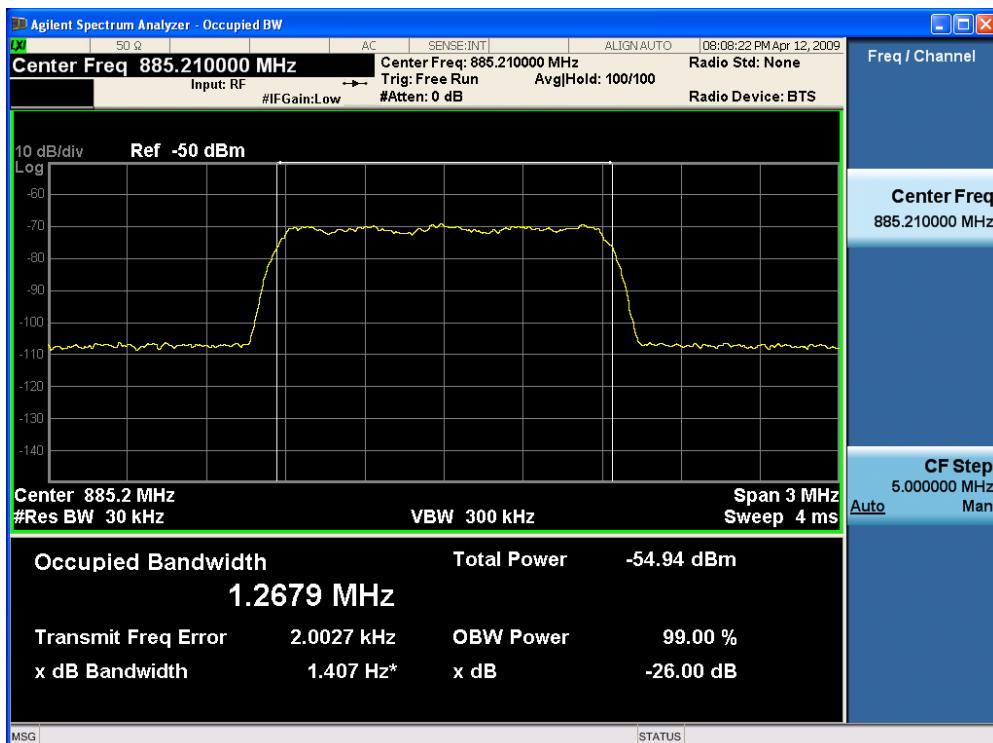
Downlink Low CH (Cellular) Input Signal



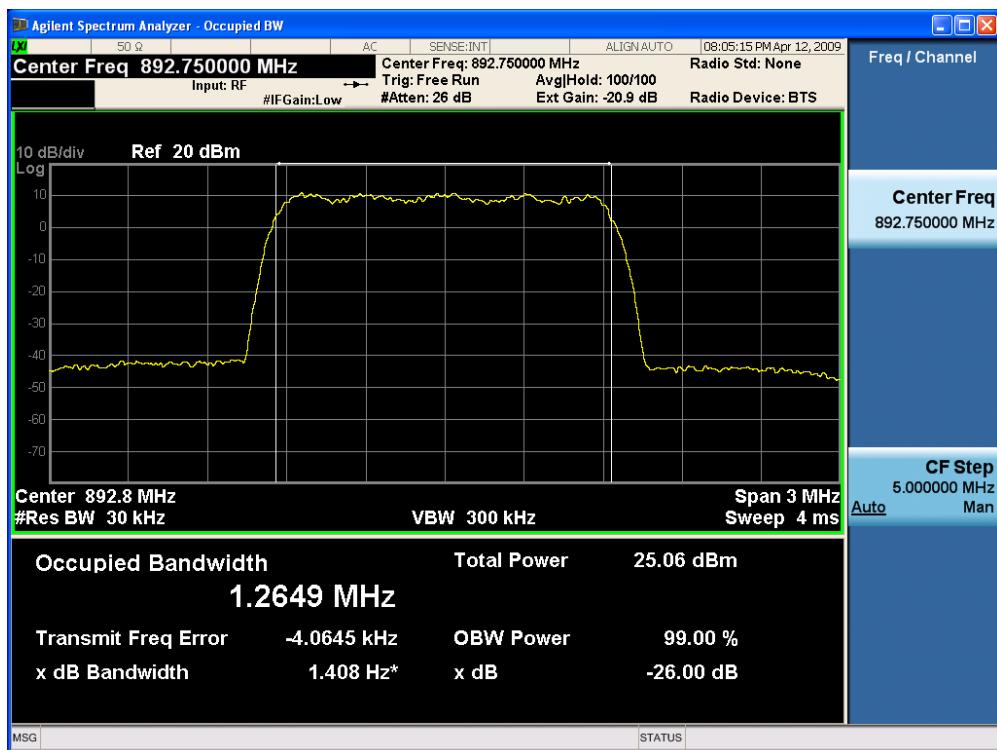
Downlink Low CH (Cellular) Output Signal



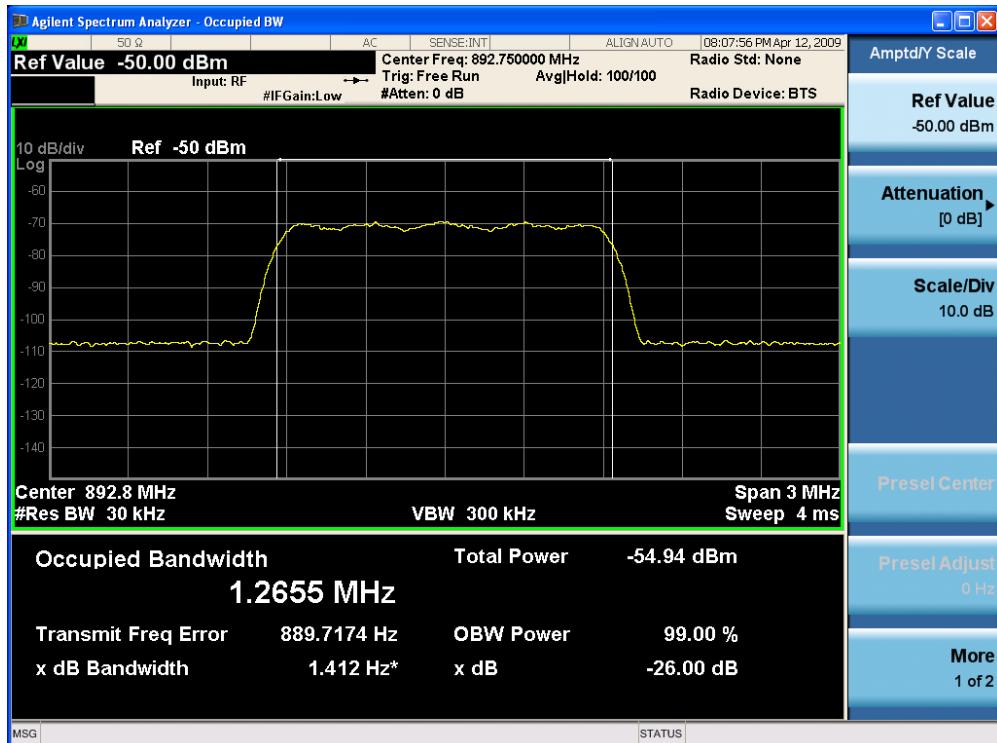
Downlink Mid CH (Cellular) Input Signal



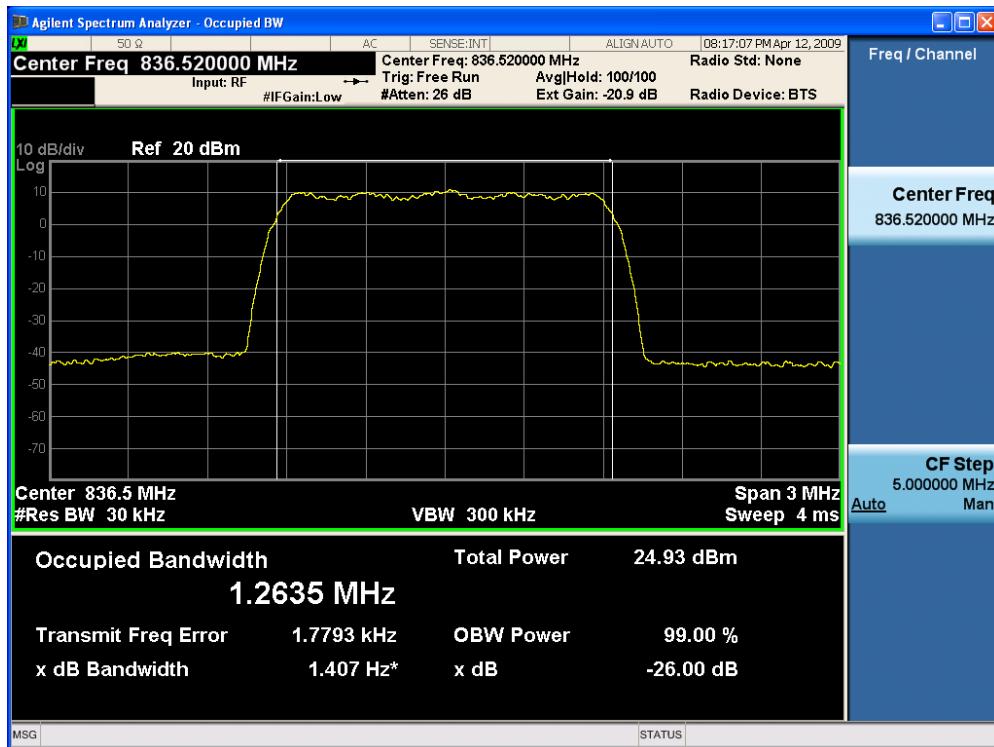
Downlink Mid CH (Cellular) Output Signal



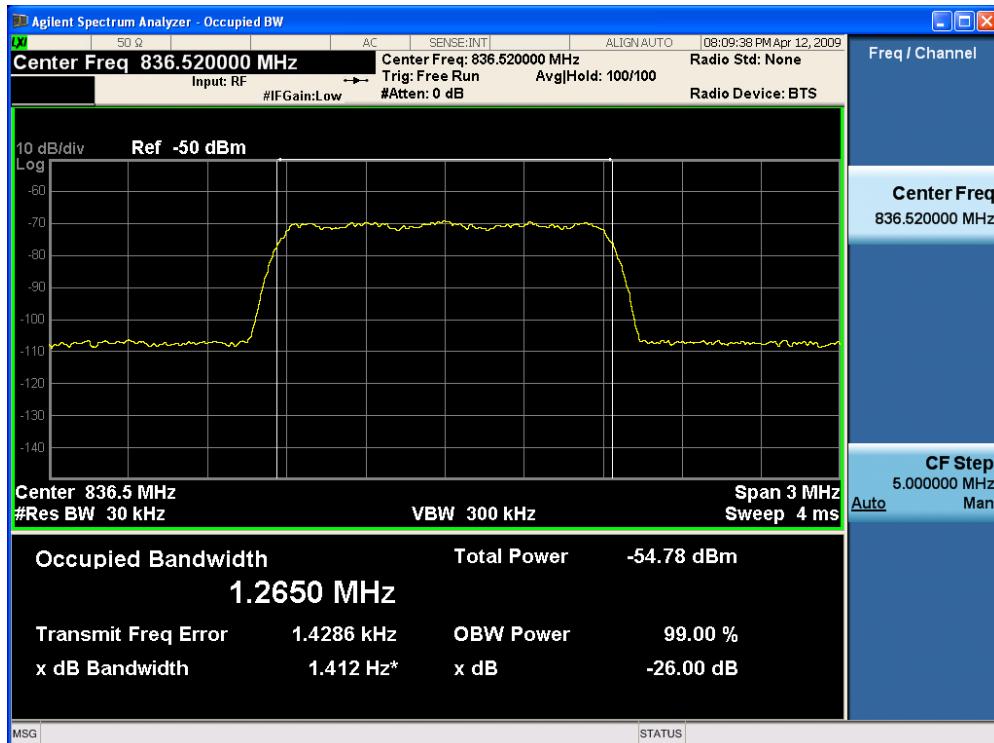
Downlink High CH (Cellular) Input Signal



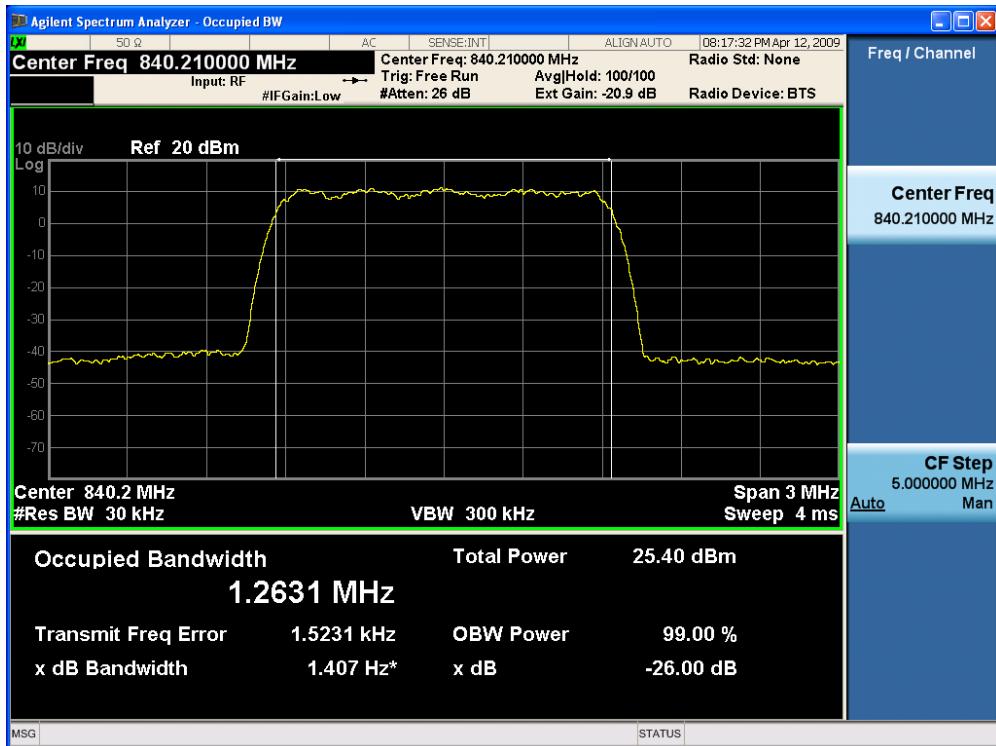
Downlink High CH (Cellular) Output Signal



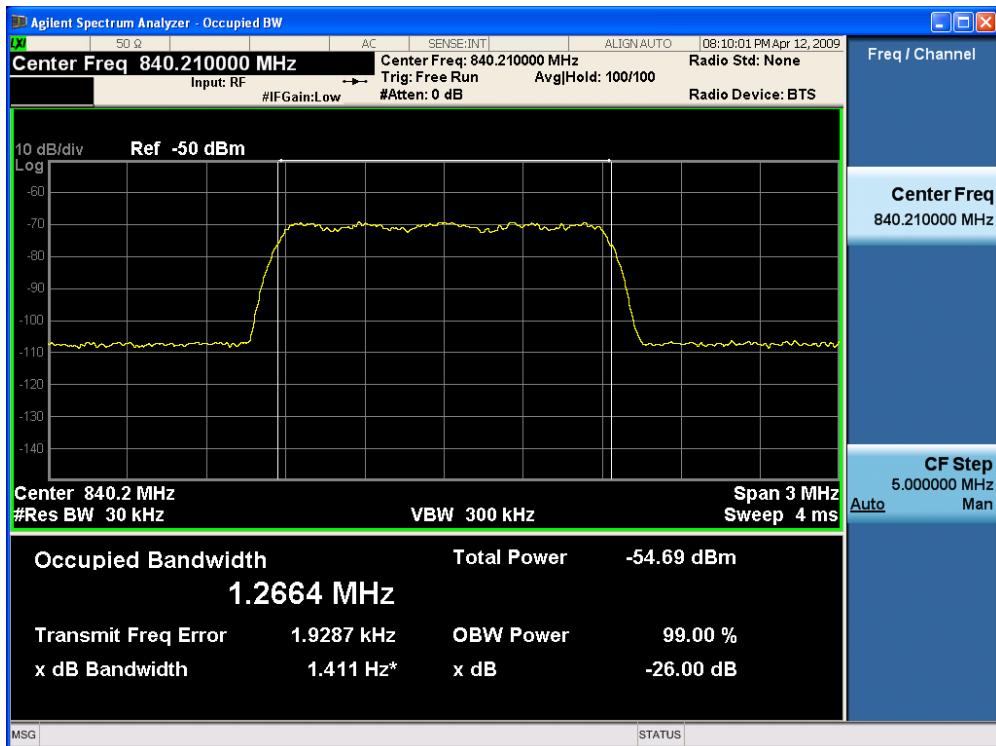
Uplink Low CH (Cellular) Input Signal



Uplink Low CH (Cellular) Output Signal



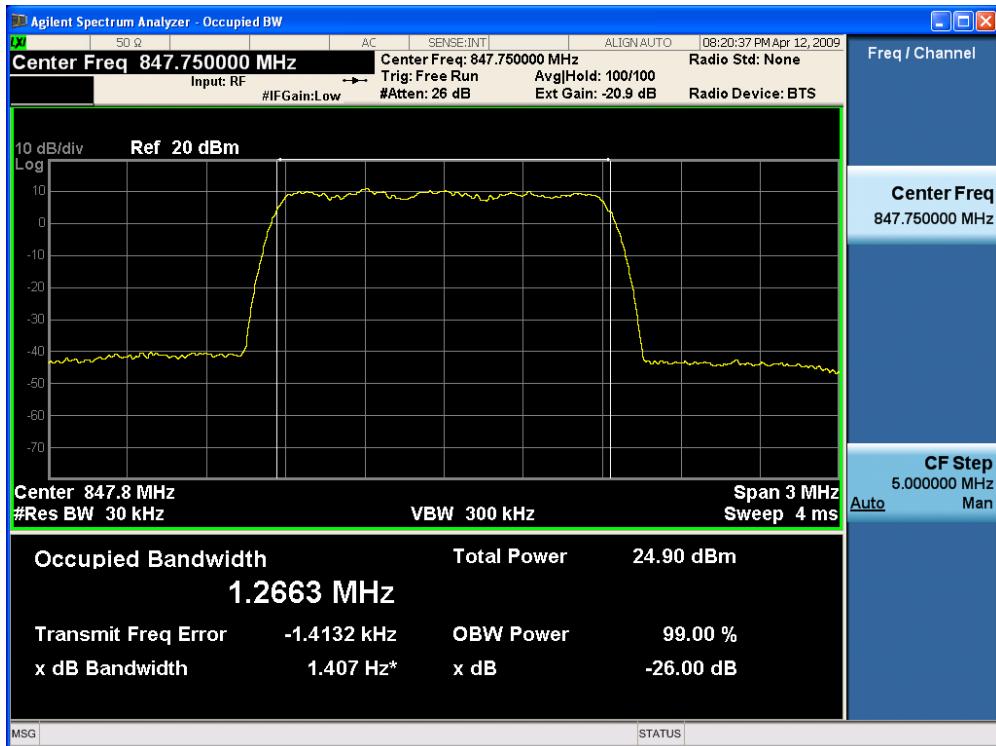
Uplink Mid CH (Cellular) Input Signal



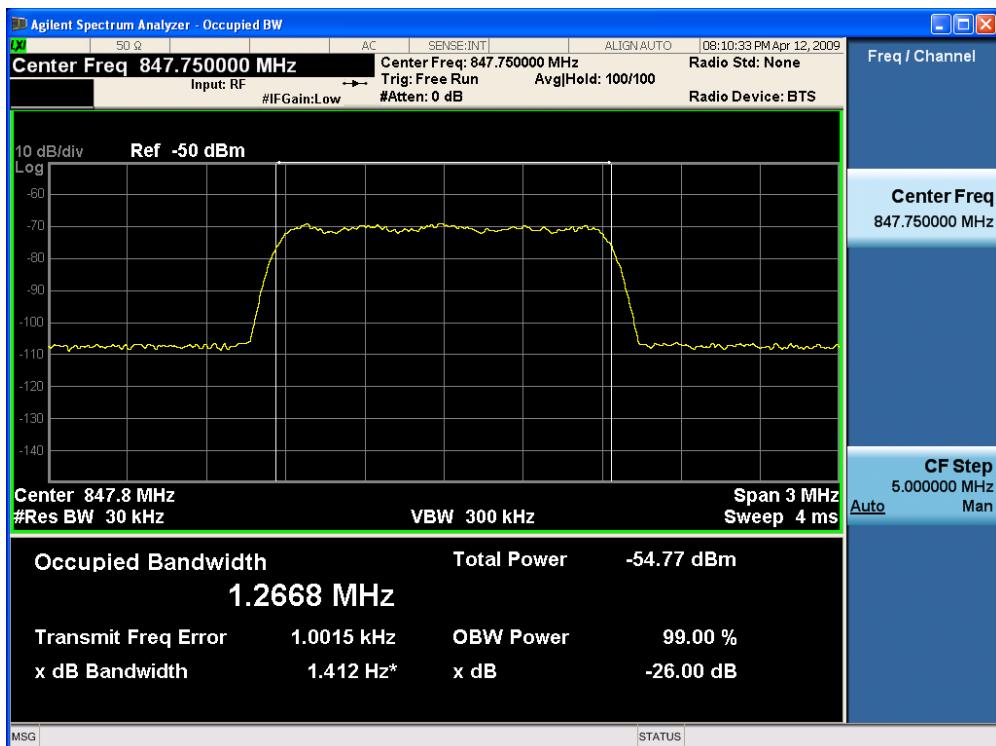
Uplink Mid CH (Cellular) Output Signal

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Uplink High CH (Cellular) Input Signal



Uplink High CH (Cellular) Output Signal

7. SPURIOUS AND HARMONIC EMISSION AT ANTENNA TERMINAL

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.

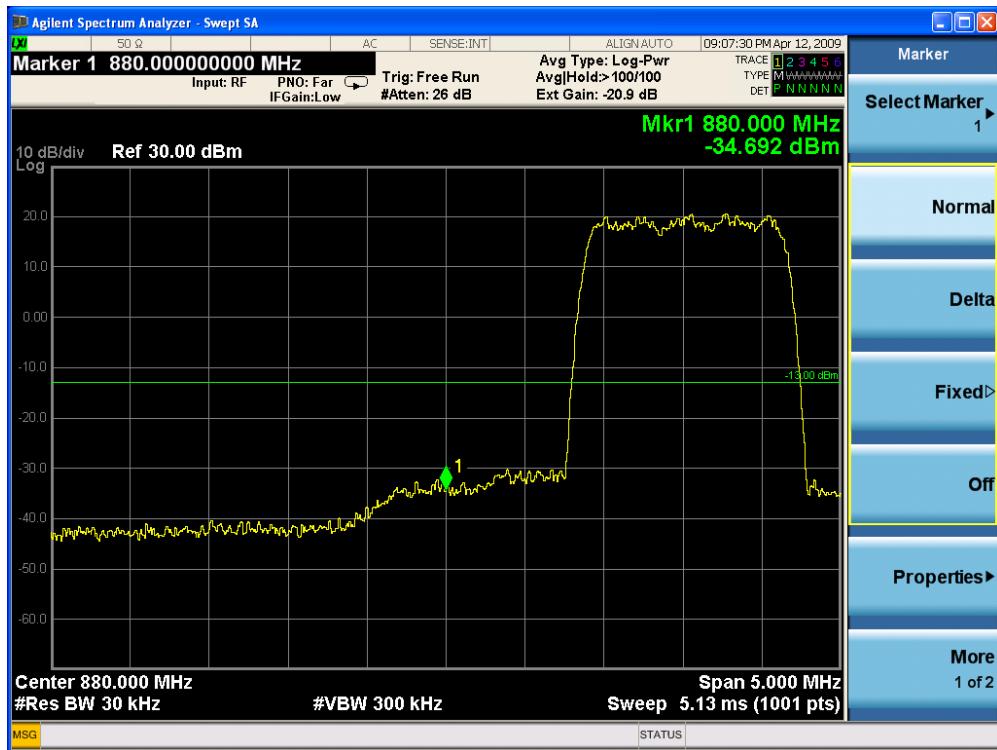
§ 22.917 Emission limitations for cellular equipment: The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

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 OEM A spectrum analyzer was connected to either the Uplink or Downlink port depending on the circuitry being measured. The spectrum was investigated from 30 MHz to the 26.5 GHz of the carrier.

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

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

Plots of BAND EDGE



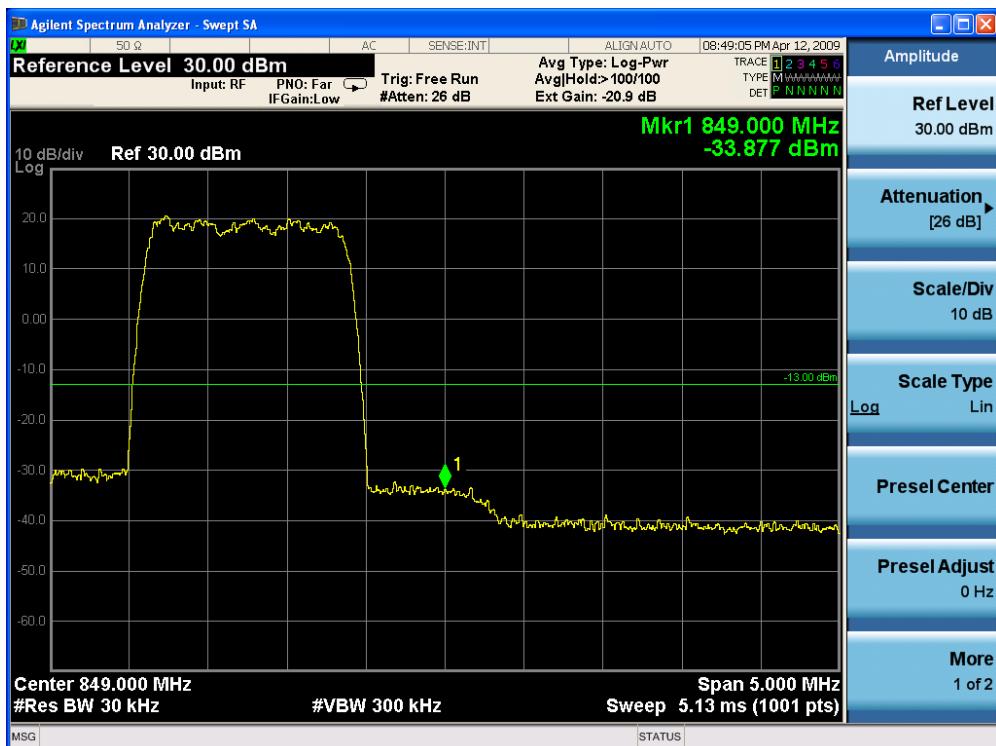
(Downlink Low CH)



(Downlink High CH)

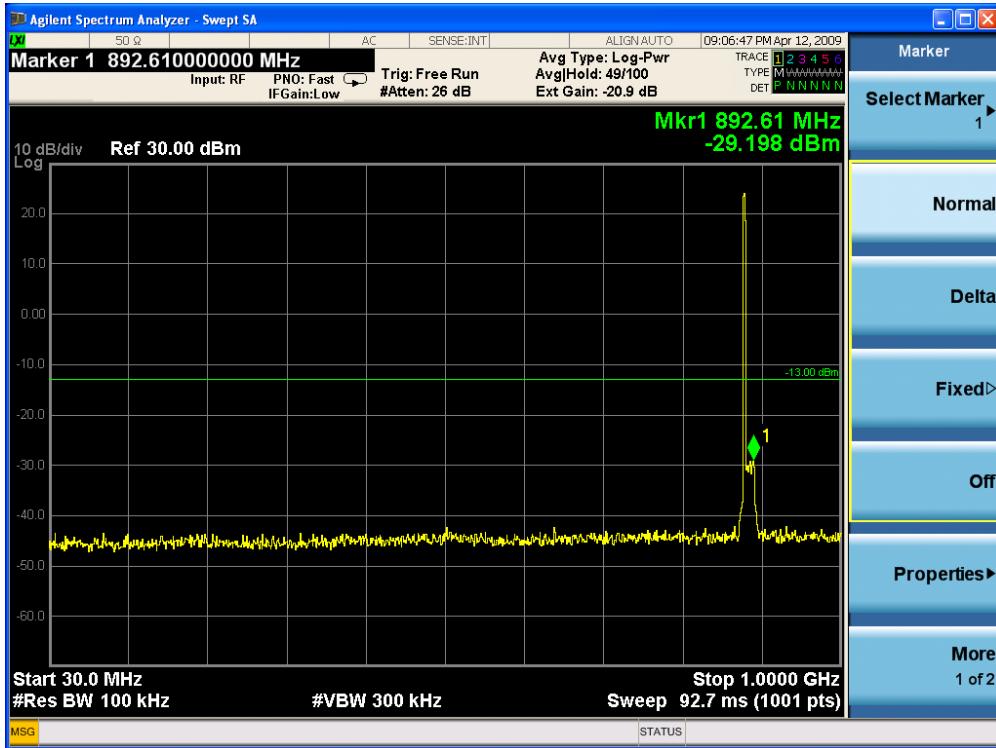


(Uplink Low CH)

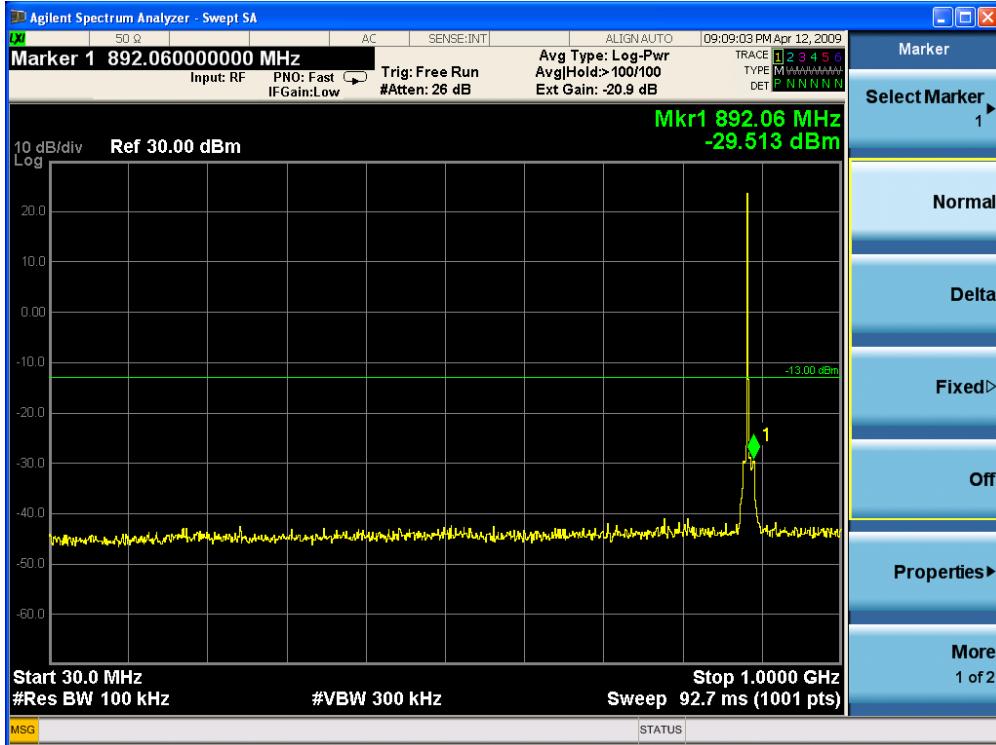


(Uplink High CH)

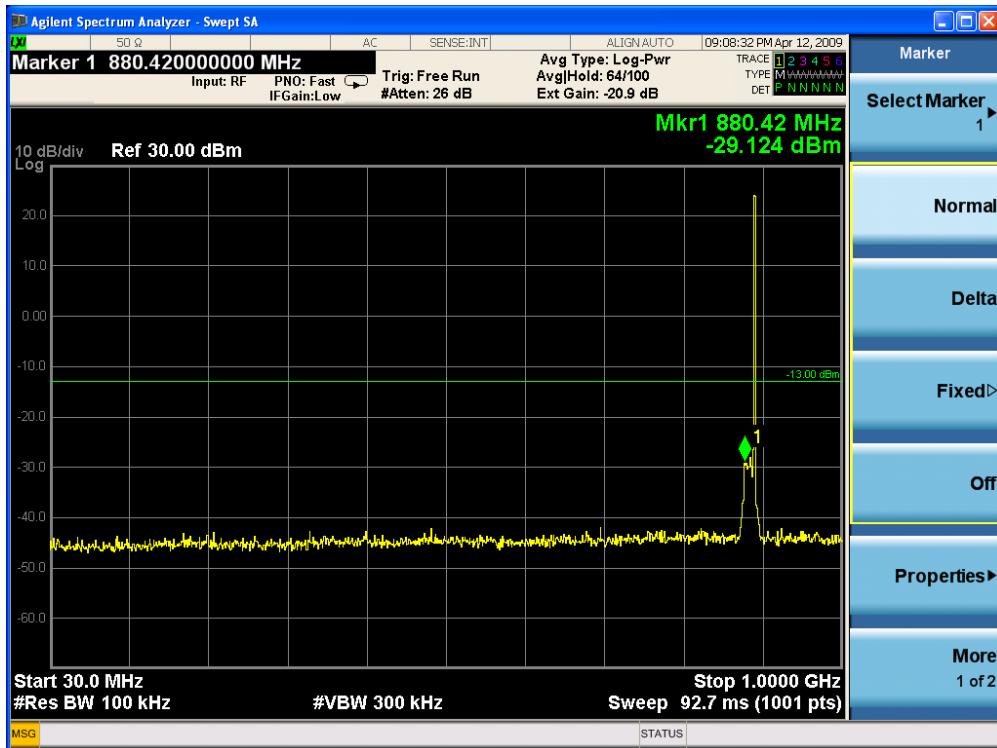
Plots of Spurious Emission



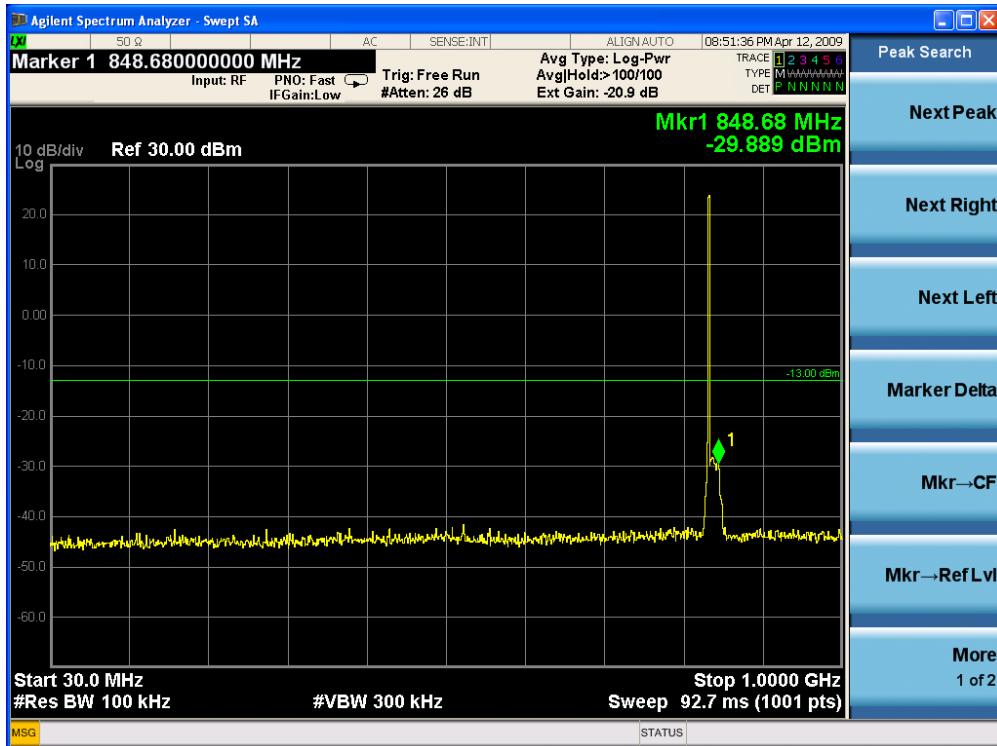
Conducted Spurious Emissions Downlink Low CH (30 MHz – 1 GHz-Cellular)



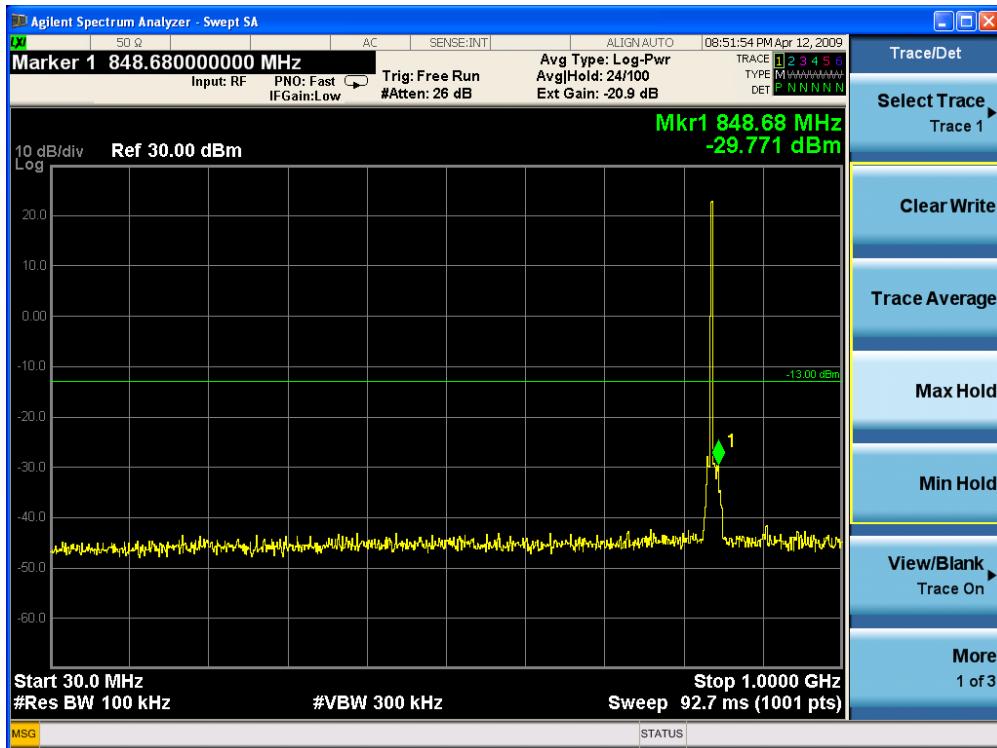
Conducted Spurious Emissions Downlink Mid CH (30 MHz – 1 GHz-Cellular)



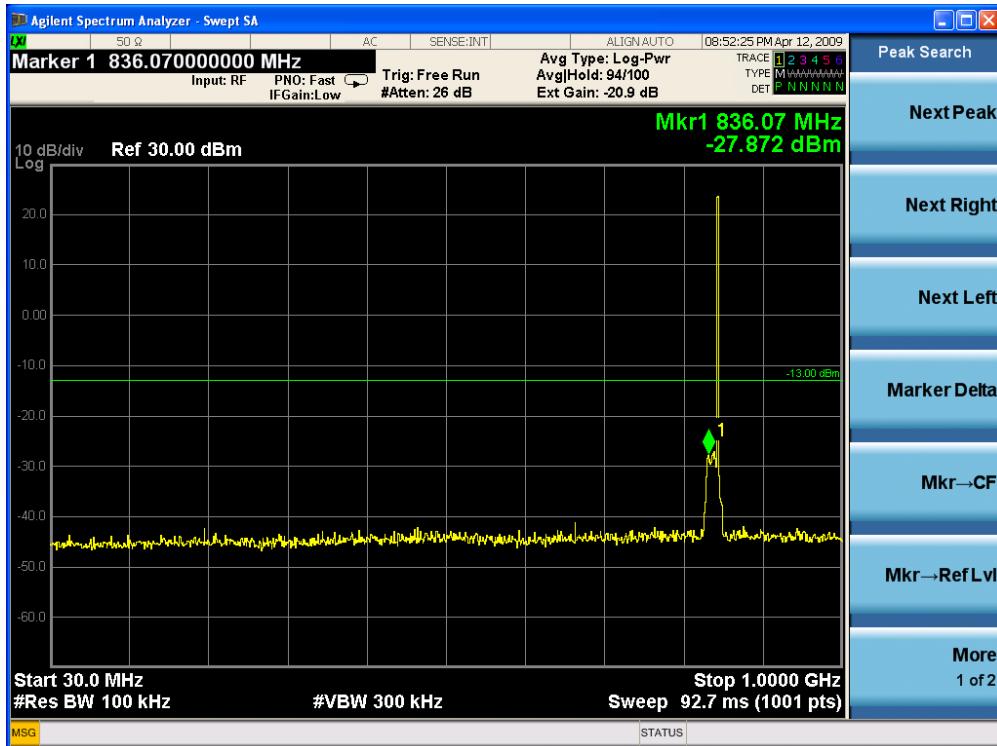
Conducted Spurious Emissions Downlink High CH (30 MHz – 1 GHz-Cellular)



Conducted Spurious Emissions Uplink Low CH (30 MHz – 1 GHz-Cellular)



Conducted Spurious Emissions Uplink Mid CH (30 MHz – 1 GHz-Cellular)



Conducted Spurious Emissions Uplink HighCH (30 MHz – 1 GHz-Cellular)



Conducted Spurious Emissions Downlink Low CH (1 GHz – 26.5 GHz-Cellular)



Conducted Spurious Emissions Downlink Low CH (1 GHz – 26.5 GHz-Cellular)



Conducted Spurious Emissions Downlink High CH (1 GHz – 26.5 GHz-Cellular)



Conducted Spurious Emissions Uplink Low CH (1 GHz – 26.5 GHz-Cellular)

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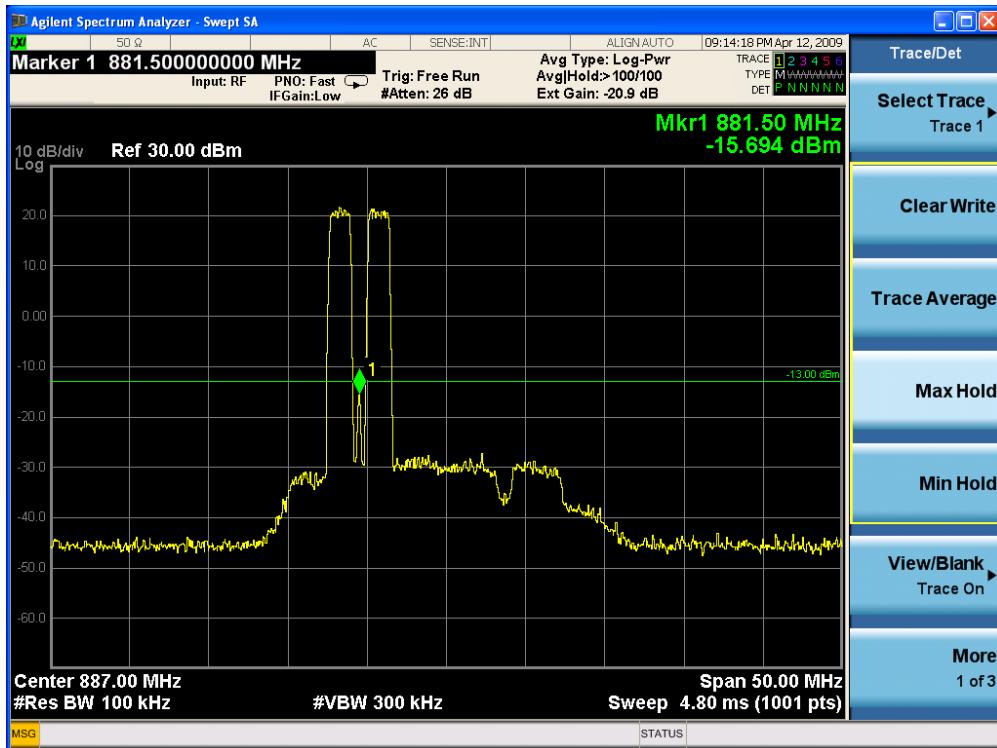


Conducted Spurious Emissions Uplink Mid CH (1 GHz – 26.5 GHz-Cellular)

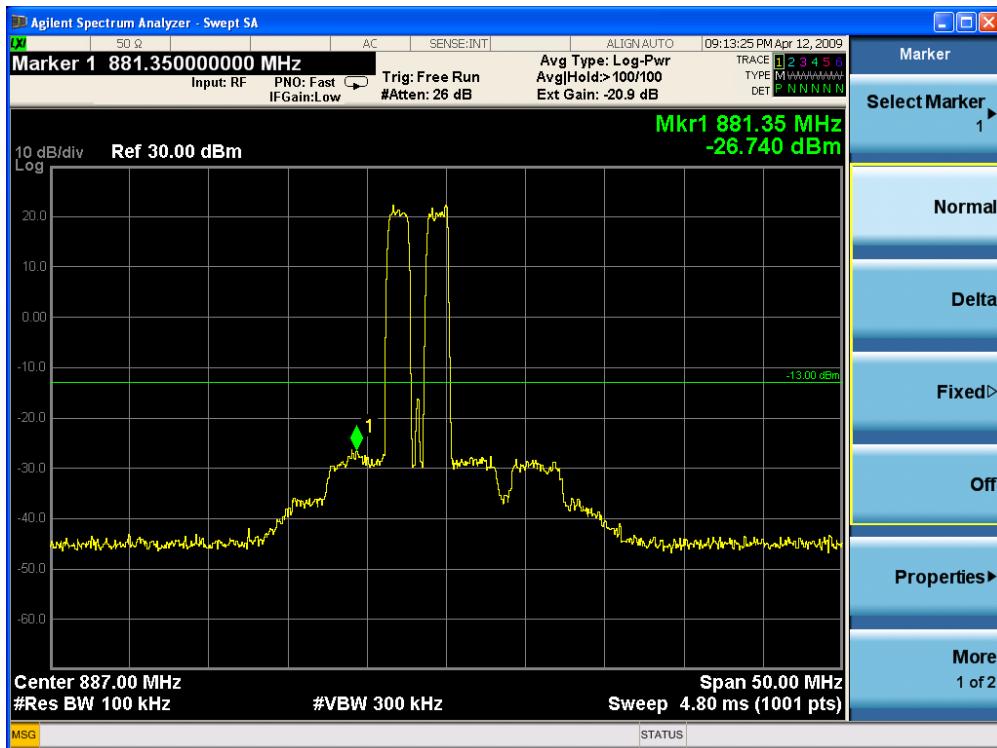


Conducted Spurious Emissions Uplink High CH (1 GHz – 26.5 GHz-Cellular)

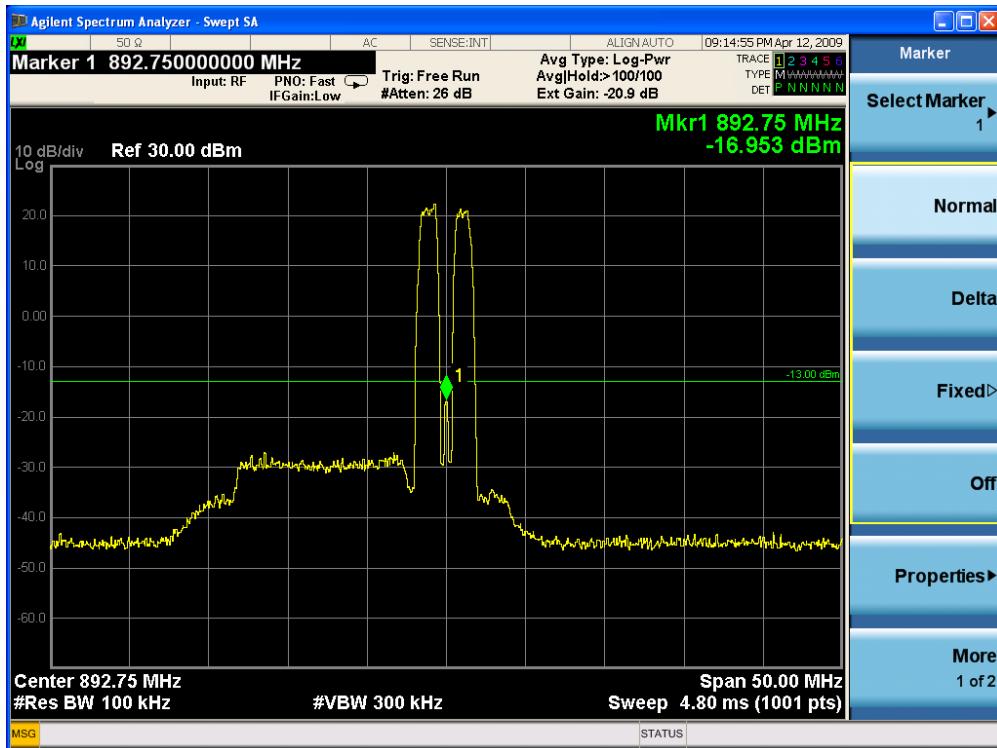
Intermodulation



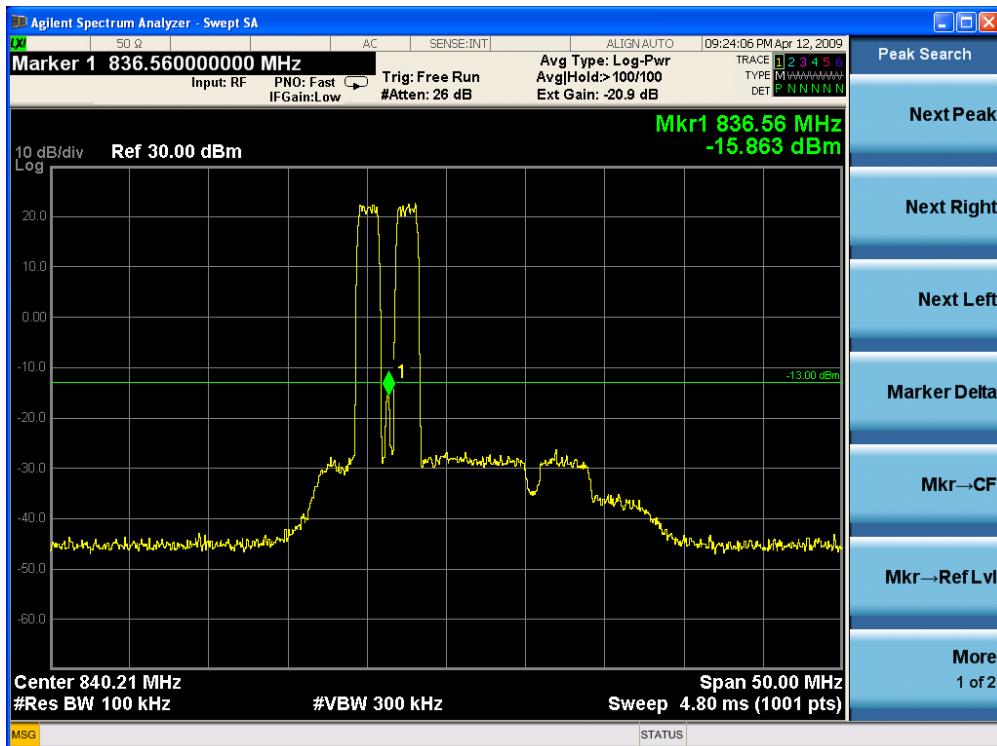
Intermodulation Downlink Low CH (Cellular)



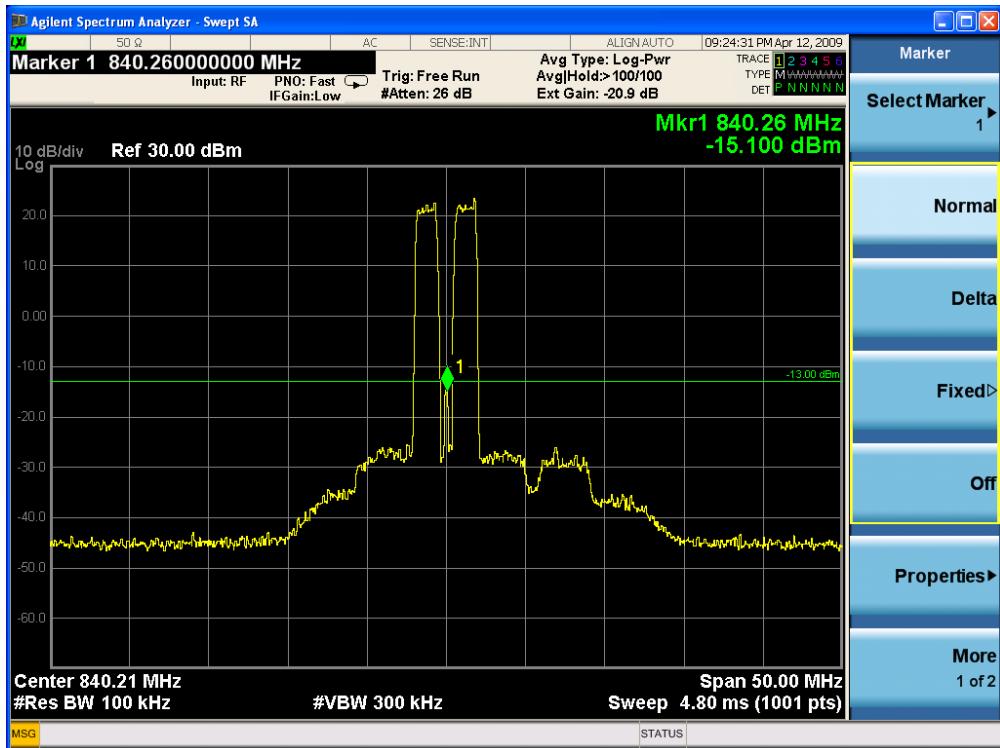
Intermodulation Downlink Mid CH (Cellular)



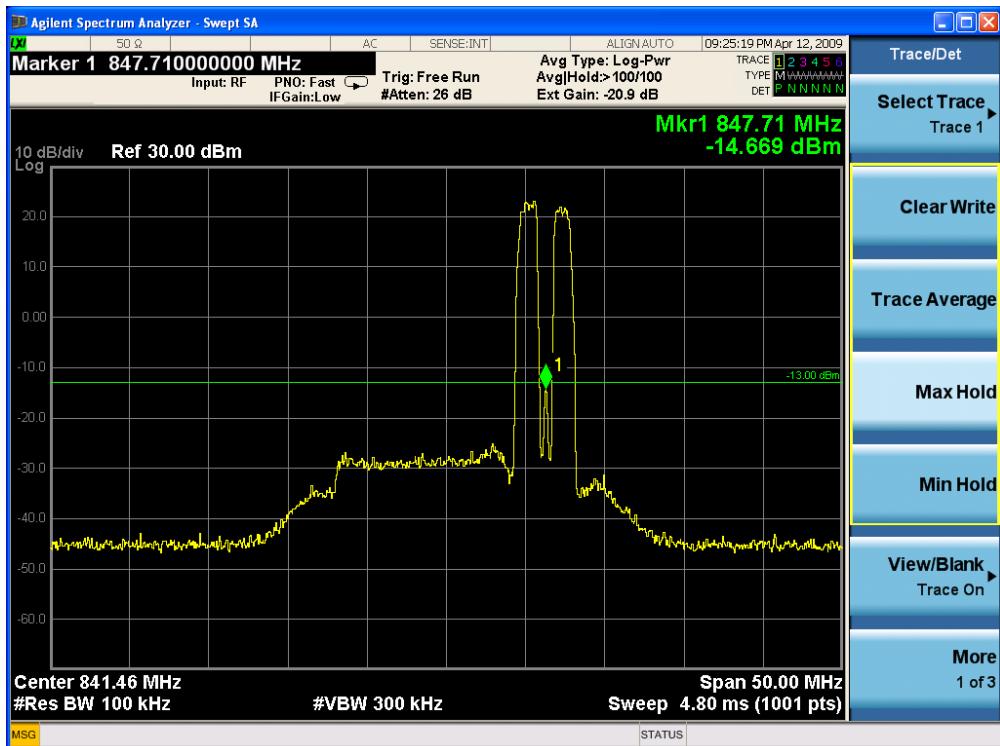
Intermodulation Downlink High CH (Cellular)



Intermodulation Uplink Low CH (Cellular)

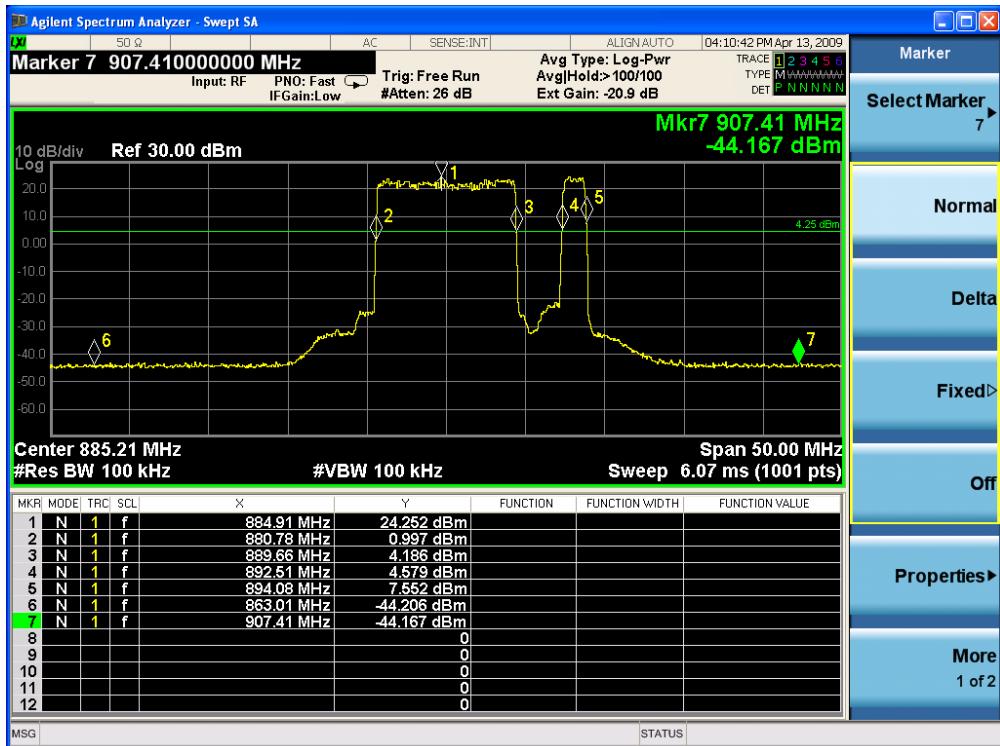


Intermodulation Uplink Mid CH (Cellular)

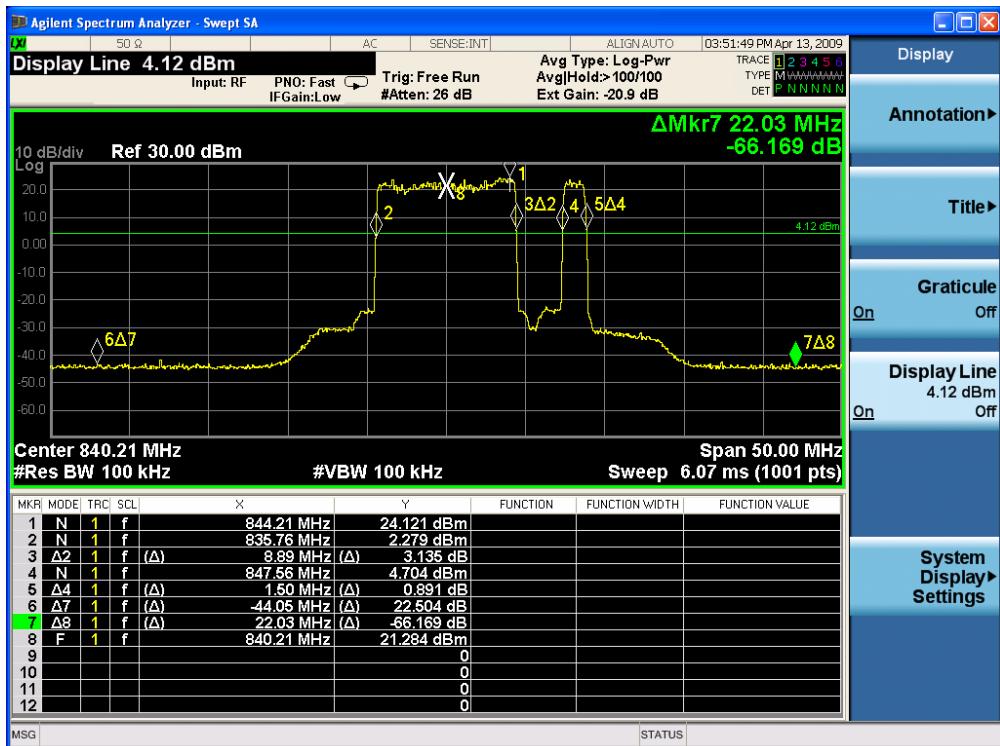


Intermodulation Uplink High CH (Cellular)

Passband Gain and Bandwidth



Passband Gain and Bandwidth Downlink (Cellular: B & B' Band)



Passband Gain and Bandwidth Uplink (Cellular: B & B' Band)

8. 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:

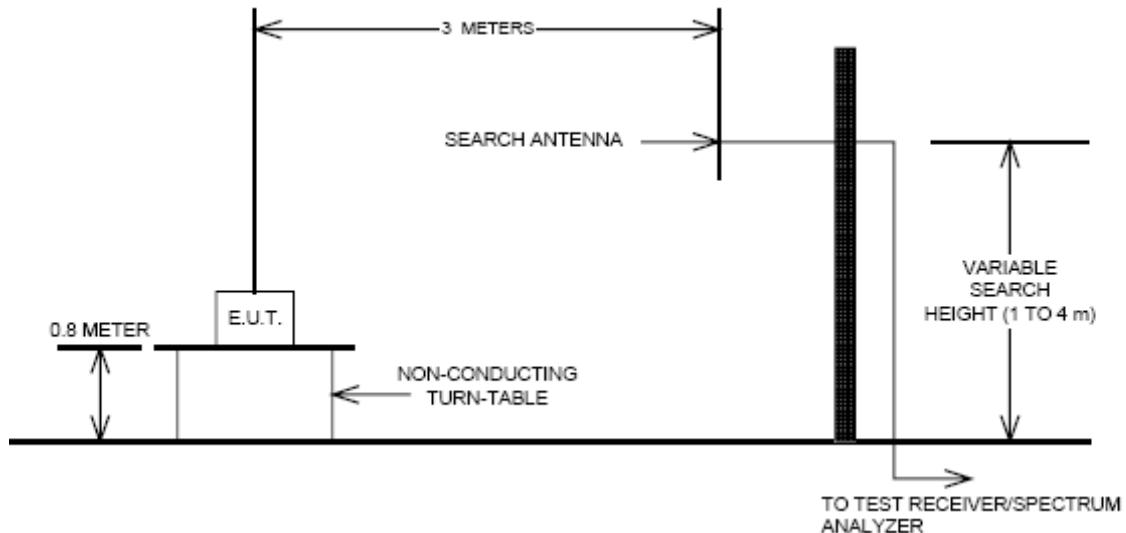
- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types 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 TIA/EIA-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 40GHz, whichever was the lesser, were investigated.

Test Results: There were no emissions detected above the noise floor which was at least 20 dB below the limit.

Radiated Spurious Emissions Test Setup



9. RECEIVER SPURIOUS EMISSIONS

Test Requirement(s):

RSS-129 Section 10, RSS-GEN Section 4.10

Test Procedures:

The receiver shall be operated in the normal receive mode near the mid-point of the band over which the receiver is designed to operate.

Unless otherwise specified in the applicable RSS, the radiated emission measurement is the standard measurement method (with the device's antenna in place) to measure receiver spurious emissions.

Radiated emission measurements are to be performed using a calibrated open-area test site. As an alternative, the conducted measurement method may be used when the antenna is detachable. In such a case, the receiver spurious signal may be measured at the antenna port.

If the receiver is super-regenerative, stabilize it by coupling to it an unmodulated carrier on the receiver frequency (antenna conducted measurement) or by transmitting an unmodulated carrier on the receiver frequency from an antenna in the proximity of the receiver (radiated measurement).

Taking care not to overload the receiver, vary the amplitude and frequency of the stabilizing signal to obtain the highest level of the spurious emissions from the receiver.

For either method, the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tuneable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

For emissions below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector with the same measurement bandwidth as that for CISPR quasi-peak measurements.

Above 1 GHz, measurements shall be performed using an average detector and a resolution bandwidth of 300 kHz to 1 MHz.

Spurious Frequency (MHz)
Field Strength (microvolts/m) at 3 metres

30-88	100
88-216	150
216-960	200
960-1610	500
Above 1610	1000

Test Results: There were no emissions detected above the noise floor

30 MHz ~ 1 GHz

Frequency MHz	Reading dBuV	Ant. Factor dB/m	Cable Loss dB	ANT POL (H/V)	Total dBuV/m	Limit dBuV/m	Margin dB
108.0	22.5	11.53	2.2	V	36.23	46.0	-9.77

Above 1 GHz

Frequency MHz	Reading dBuV	Ant. Factor dB/m	Cable Loss dB	ANT POL (H/V)	Total dBuV/m	Limit dBuV/m	Margin dB
No Peaks Found							

10. FREQUENCY STABILITY OVER TEMPERATURE AND VOLTAGE VARIATIONS

Test Requirement(s):

§2.1055(a)(1) §22.355

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

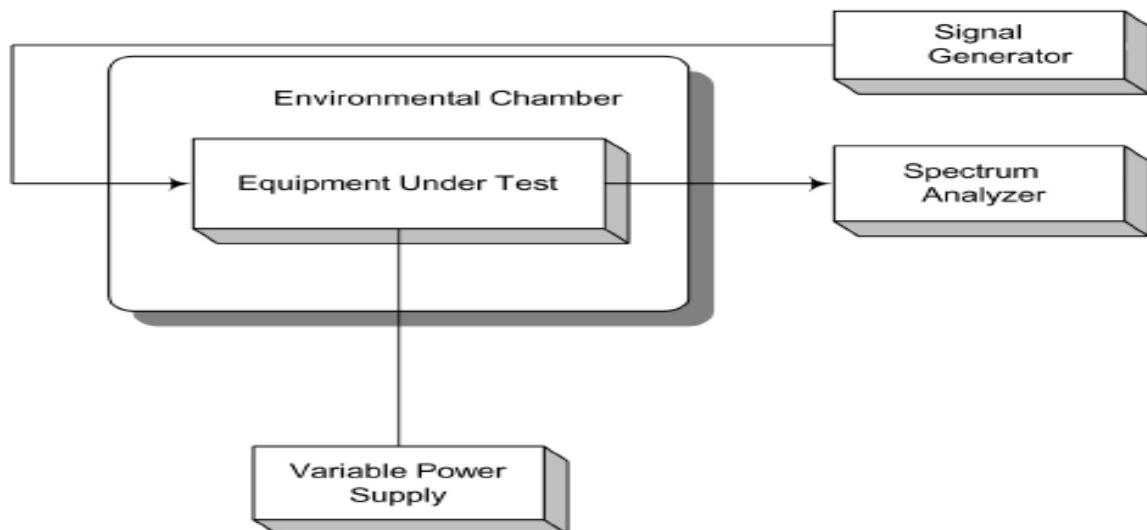
on the Spectrum Analyzer was used to measure frequency deviations.

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 Results:

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

Test Setup:

Frequency Stability and Voltage Test Results

Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	+20(Ref)	885 210 004	4.2	0.0000004999	0.0050
100%	-30	885 210 006	5.63	0.0000006730	0.0067
100%	-20	885 210 005	5.38	0.0000006431	0.0064
100%	-10	885 210 005	5.03	0.0000006013	0.0060
100%	0	885 210 005	4.97	0.0000005941	0.0059
100%	+10	885 210 005	4.65	0.0000005559	0.0056
100%	+20	885 210 005	4.64	0.0000005547	0.0055
100%	+30	885 210 004	4.38	0.0000005236	0.0052
100%	+40	885 210 004	4.07	0.0000004865	0.0049
100%	+50	885 210 005	4.53	0.0000005415	0.0054
115%	+20	885 210 004	3.64	0.0000004351	0.0044
85%	+20	885 210 004	3.61	0.0000004315	0.0043

(Cellular Downlink Mid CH)

Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	+20(Ref)	840 210 003	2.55	0.0000003035	0.0030
100%	-30	840 210 007	7.34	0.0000008774	0.0088
100%	-20	840 210 007	6.53	0.0000007806	0.0078
100%	-10	840 210 006	5.67	0.0000006778	0.0068
100%	0	840 210 005	4.59	0.0000005487	0.0055
100%	+10	840 210 004	4.21	0.0000005033	0.0050
100%	+20	840 210 004	3.87	0.0000004626	0.0046
100%	+30	840 210 003	2.57	0.0000003072	0.0031
100%	+40	840 210 003	3.09	0.0000003694	0.0037
100%	+50	840 210 003	3.21	0.0000003837	0.0038
115%	+20	840 210 003	2.87	0.0000003431	0.0034
85%	+20	840 210 003	2.78	0.0000003323	0.0033

(Cellular Uplink Mid CH)

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11. RF EXPOSURE STATEMENT

1. LIMITS

According to §1.1310 and §2.1091 RF exposure is calculated.

(B) Limits for General Population/Uncontrolled Exposures

Frequency range (MHz)	Electric field Strength (V/m)	Magnetic field Strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
0.3 - 1.34.....	614	1.63	*(100)	30
1.34 - 30.....	824/f	2.19/f	*(180/ f ²)	30
30 - 300.....	27.5	0.073	0.2	30
300 - 1500.....	f/1500	30
1500 - 100.000.....	1.0	30

F = frequency in MHz

* = Plane-wave equivalent power density

2. MAXIMUM PERMISSIBLE EXPOSURE Prediction

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

S = Power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

2-1. Cellular Downlink

Max Peak output Power at antenna input terminal	25.080	dBm
Max Peak output Power at antenna input terminal	322.107	mW
Prediction distance	20.000	cm
Prediction frequency	892.750	MHz
Antenna Gain(typical)	5.000	dBi
Antenna Gain(numeric)	3.162	–
Power density at prediction frequency(S)	0.203	mW/cm ²
MPE limit for uncontrolled exposure at prediction frequency	0.595	mW/cm ²

2-2. Cellular Uplink

Max Peak output Power at antenna input terminal	25.100	dBm
Max Peak output Power at antenna input terminal	323.594	mW
Prediction distance	20.000	cm
Prediction frequency	840.210	MHz
Antenna Gain(typical)	5.000	dBi
Antenna Gain(numeric)	3.162	–
Power density at prediction frequency(S)	0.204	mW/cm ²
MPE limit for uncontrolled exposure at prediction frequency	0.560	mW/cm ²

2-3. Cellular Uplink (Modem)

Max Peak output Power at antenna input terminal	26.000	dBm
Max Peak output Power at antenna input terminal	398.107	mW
Prediction distance	20.000	cm
Prediction frequency	850.000	MHz
Antenna Gain(typical)	5.000	dBi
Antenna Gain(numeric)	3.162	–
Power density at prediction frequency(S)	0.250	mW/cm ²
MPE limit for uncontrolled exposure at prediction frequency	0.567	mW/cm ²

* It use only 850MHz CDMA.

3. RESULTS

The power density level at 20 cm is 0.203 mW/cm², which is below the uncontrolled exposure limit for Cellular band.

The Combined MPE for uplink is 0.80 (0.204/0.560 + 0.250/0.567), which is below the uncontrolled exposure limit for FCC OET 65.

Warning: In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, it must also have a minimum distance of 20 cm from the body during normal operation.