

TEST REPORT

Report Number		RAPA14-O-017
Type of Equipment		In-Vehicle Dual Band Booster
Model Name		AVHR-5000N
FCC ID		Q4EA VHR-5000N
Applicant	Name	OPISYS Incorporated
	Logo	 OPISYS, INC.
	Address	511. South Harbor Blvd. Unit P. La Habra, CA. 90631, United States
Manufacturer	Name	Ace Technology Corp.
	Address	24BL 5L, 451-4, Nonhyeon-dong, Namdong-gu, Incheon, 405-849, Korea
Test duration		April 01, 2014 to September 19, 2014
Date of issue		September 19, 2014
Total Page		131 pages (including this page)

SUMMARY

The equipment complies with FCC CFR 47 Part 20.

This test report contains only the results of a single test of the sample supplied for the examination. It is not a general valid assessment of the features of the respective products of the mass-production.

September 22, 2014



Tested by Hyun Soo Lee
Manager
TCL of RAPA

September 22, 2014



Reviewed by Sukil Park
Executive Managing Director
TCL of RAPA

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	April 14, 2014	Hyun Soo Lee	Original Document
2.0	September 19, 2014	Hyun Soo Lee	EUT Specific Revision -DL Gain : 50 dB → 48 dB -UL Gain : 50 dB → 48 dB -DL Output : +10 dBm → +5 dBm

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1. General description of EUT

1.1 Applicant

- Company name : OPISYS Incorporated
- Address : 511. South Harbor Blvd. Unit P. La Habra, CA. 90631, United States
- Contact person : Karen KH Koo
- Phone/Fax : 1-714-990-6247./ 1-714-990-6243

1.2 Manufacturer

- Company name : Ace Technology Corp.
- Address : 24BL 5L, 451-4, Nonhyeon-dong, Namdong-gu, Incheon, 405-849, Korea
- Phone / Fax : 82-32-458-1382 / 82-32-458-1646

1.3 Basic description of EUT

- Product name : In-Vehicle Dual Band Booster
- Model name : AVHR-5000N
- Frequency : Celluar Downlink : 869 MHz - 894 MHz
Celluar Uplink : 824 MHz - 849 MHz
PCS Downlink : 1930 MHz - 1990 MHz
PCS Uplink : 1850 MHz - 1910 MHz
- Output power : Downlink : 5 dBm
Uplink : 23 dBm
- Modulation method : GSM(GXW), EDGE(G7W), CDMA(F9W), WCDMA(F9W), LTE(G7D), EVDO(F9W)
- FCC Rule Part(s) : FCC CFR47 Part 20 & 27
- FCC classification : B2W /Wideband Consumer Booster (CMRS)
- Test duration : April 01, 2014 to September 19, 2014
- Date of issue : September 19, 2014
- Place of test : Head office
824, B104, Anyang Megavalley, 799, Gwanyang-dong,
Dongan-gu, Anyang-si, Gyeonggi-do 483-060, Korea

Open area test site

103, Anseok-gil, 138beon-gil, Hwaseong-si, Gyeonggi-Do 445-100, Korea

- Designation and/or Registration status : FCC Designation Number : 608365 (accredited test laboratory by FCC)
FCC Registration Number : 931589 (10 m /3 m OATS)
IC Submission Number : 143881 (10 m / 3 m OATS)
KCC Designation Number : KR0027 (accredited test laboratory by RRA)

1.4 Electrical specification

Items		Cellular	PCS	Remarks		
Operating Frequency	Downlink	869 MHz ~ 894 MHz	1930 MHz ~ 1990 MHz			
	Uplink	824 MHz ~ 849 MHz	1850 MHz ~ 1910 MHz			
Gain	Downlink	48 dB	48 dB			
	Uplink	48 dB	48 dB			
Output Power Level	Downlink	+5 dBm	+5 dBm			
	Uplink	+23 dBm	+23 dBm			
Ripple	Downlink	< 5 dB	< 5 dB			
	Uplink	< 5dB	< 5 dB			
Noise Figure	Downlink	< 5dB	< 5 dB	Frequency Center		
	Uplink	< 5dB	< 5 dB	Frequency Center		
ALC Level	Downlink	+5 dBm \pm 1 dB	+5 dBm \pm 1 dB	@ 1FA		
	Uplink	+23 dBm \pm 1 dB	+23 dBm \pm 1 dB			
Shutdown Level	Downlink	+6 dBm \pm 1 dB	+6 dBm \pm 1 dB	After ALC		
	Uplink	+24 dBm \pm 1 dB	+24 dBm \pm 1dB			
Spurious	Downlink & Uplink	-45 dBc/30 kHz @ \pm 885 KHz		@PCS Signal Source		
		-50 dBc/30 kHz @ \pm 1.98 MHz				
		-45 dBc/30 kHz @ \pm 750 KHz		@Cellular Signal Source		
		-50 dBc/30 kHz @ \pm 1.98 MHz				
VSWR		< 1 : 1.8				
Propagation Delay		< 1 us				
Sleep Mode		On@ < -93 dBm, OFF@ < -92 dBm		Up link		
Frequency Stability		$\leq \pm 0.05$ ppm				
Modulation Type		GSM(GXW), EDGE(G7W), CDMA(F9W), WCDMA(F9W), LTE(G7D),EVDO(F9W)				
GUI Interface		RS-232C				
Isolation Detection Range		40 dB ~ 60 dB				
Only Uplink Shutdown		\geq -40 dBm \pm 1 dB @ downlink Input Signal		For BTS Protection		
Input Voltage		6.0 Vdc / 3. 5A		Cigar Charger 's Vdc		
Power Consumption		6.0 Vdc / 1050 mA		@ No call		

1.5 Mechanical specification

Item	Specifications	Note
Dimensions (L × W × H)	140.5 mm x 123 mm x 34 mm	-
Connector Type (In/Out)	FME-male	-
Enclosure	IP-3X	
Local Alarm Indicator	LED : Operation, Alarm	

1.6 Environmental specification

Item	Specifications	Note
Temperature	-40 °C ~ +50 °C	-
Humidity	10 % ~ 90 %	-

1.7 AC/DC adaptor specification

Item	Specifications	Note
AC input power	90 ~ 264 Vac, 47 ~ 63 Hz	-
Output rated Voltage	+6.0 Vdc / 3.5 A	-
Voltage Current range	0.0 A ~ 3.5 A	-
Operation Temperature	0 °C ~ +40°C	-
Operation humidity	8 % ~ 95 %	-

2. General information of test

2.1 Test standards and results

Applied Standards : FCC CFR47 Part 22H / 24E and IC RSS-131 Issue 2 July 2003			
FCC part	Section	Description of Test	Result
Part 20.21	(e)(3)	Authorized frequency band verification	Pass
Part 20.21	(e)(8)(i)(B) & (D)	Maximum power measurement	Pass
Part 20.21	(e)(8)(i)(B) & (C)(2)	Maximum booster gain computation	Pass
Part 20.21	(e)(8)(i)(F)	Intermodulation product	Pass
Part 20.21	(e)(8)(i)(E)	Out of band emission	Pass
Part 2,22,24	2.1051, 22.917(a) 24.238(a)	Conducted spurious emission	Pass
Part 20.21	(e)(8)(i)(A)(2)(ii)	Noise limit	Pass
Part 20.21	(e)(8)(i)(I)	Uplink inactivity	Pass
Part 20.21	(e)(8)(i)(C)	Variable booster gain	Pass
Part 2	2.1049	Occupied bandwidth	Pass
Part 20.21	(e)(8)(ii)(A)	Oscillation detection	Pass
Part 20.21	2.1053	Radiated spurious emission	Pass
Part 20.21	(e)(8)(i)(B)	Spectrum block filtering	N/A

* This device is not using utilizing spectrum block filtering.

2.2 Description of EUT modification

During the test, there was no mechanical or circuitry modification to improve RF and spurious characteristic, and any RF and spurious suppression device(s) was not added against the device tested.

2.3 Test configuration

• Type of peripheral equipment used

Model	Manufacturer	Description	Connected to	Remark
AVHR-5000N	OPISYS Incorporated	InVehicle Dual Band Booster	-	-
N5182A	Agilent	Signal Generator	EUT	-
N9020A	Agilent	Spectrum Analyzer	EUT	

• Type of cable used

Device from	Device to	Type of Cable	Length (m)	Shielded
EUT	Signal Generator	SMA-Type	1	Y
EUT	Spectrum Analyzer	SMA-Type	3	Y

• Mode of operation during the test

The EUT has maintained normal operation during the test.

3. Measurement data

3.1 Authorized frequency band verification

This test is intended to confirm that the Signal Booster only operates on the CMRS frequency bands authorized for use by the NPS. In addition, this test will identify the frequency at which the maximum gain is realized with each CMRS operational band, which then serves as a basis for subsequent tests.

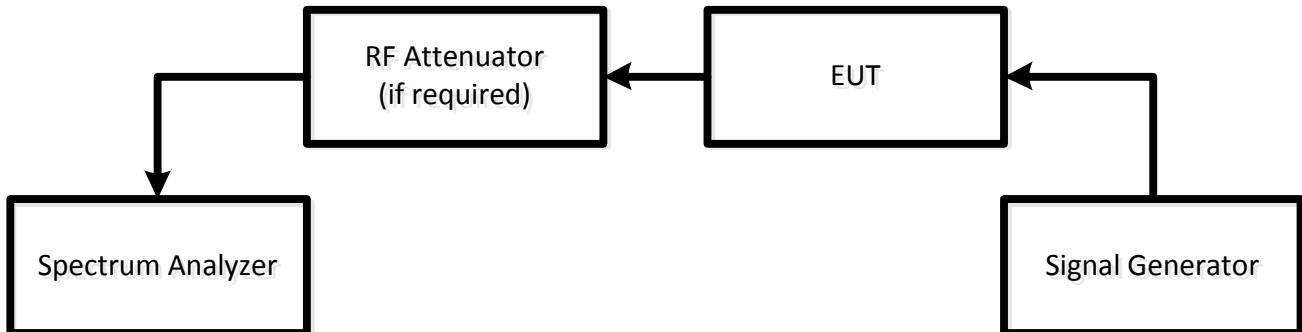
3.1.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(3)

3.1.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.1
 - a) Connect the EUT to the test equipment as shown in **Set-Up**. Begin with the uplink output connected to the spectrum analyzer.
 - b) Set the spectrum analyzer RBW for 100 kHz with the VBW \geq 3X the RBW using a PEAK detector with the MAX HOLD function.
 - c) Set the center frequency of the spectrum analyzer to the center of the operational band under test with a span of 1 MHz.
 - d) Set the signal generator for CW mode and tune to the center frequency of the operational band under test.
 - e) Set the initial signal generator power to a level that is at least 6 dB below the AGC level specified by the manufacturer.
 - f) Slowly increase the signal generator power level until the output signal reaches the AGC operational level.
 - g) Reduce the signal generator power to a level that is 3 dB below the level noted above and manually reset the EUT.
 - h) Reset the spectrum analyzer span to 2 times the CMRS band under test. Adjust the tuned frequency of the signal generator to sweep 2 times the CMRS band using the sweep function. Note: The AGC must not be activated throughout entire sweep.
 - i) Using three markers identify the CMRS band edges and the frequency with the highest power. Ensure that the values of all markers are visible on the display of the spectrum analyzer (e.g., marker table set to on).
 - j) Capture the spectrum analyzer trace for inclusion in the test report.
 - k) Repeat steps c) to j) for all operational uplink and downlink bands.

3.1.3 Set-Up



3.1.4 Test equipment list

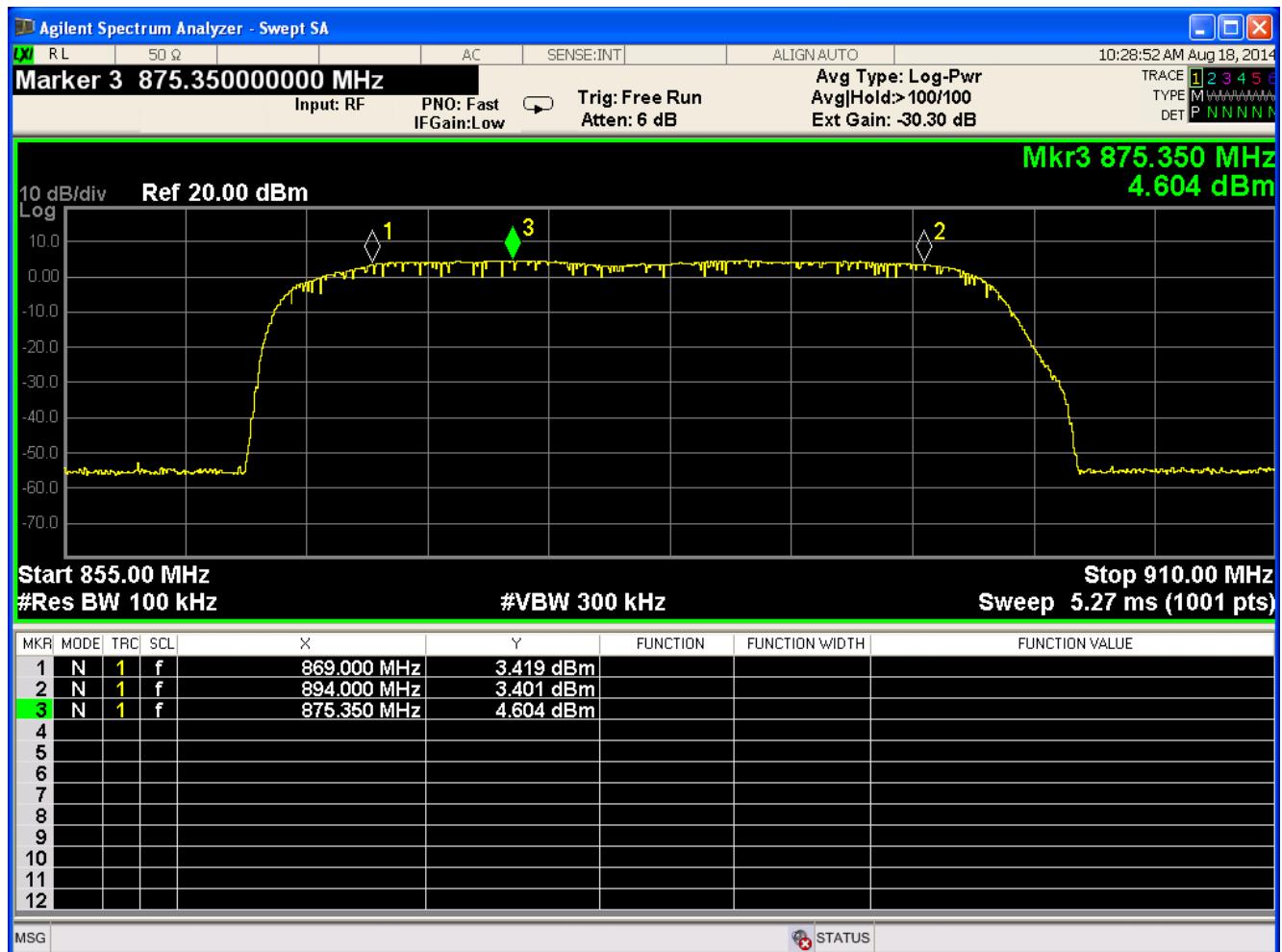
Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.1.5 Test condition

- Test place: Shield Room
- Test environment: 21.5 °C, 51 % R.H.

3.1.6 Test results

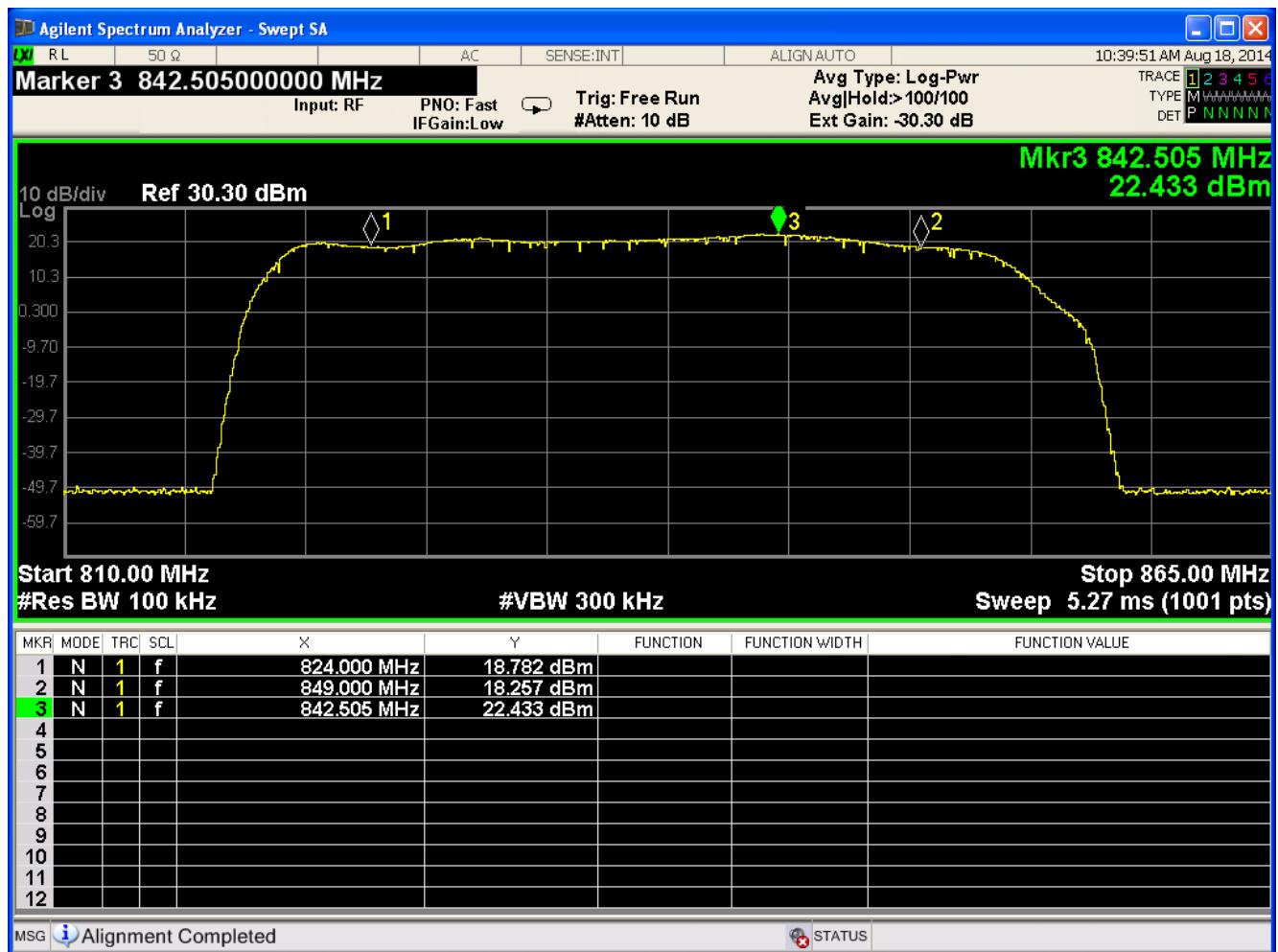
- Cellular / Down link



RBW : 100 kHz
VBW : 300 kHz
Detector mode : Peak
Trace mode : Max hold

Frequency of lower edge : 869.0 MHz
Frequency of upper edge : 894.0 MHz
Frequency of highest power : 875.35 MHz

- Cellular / Up link



RBW : 100 kHz

VBW : 300 kHz

Detector mode : Peak

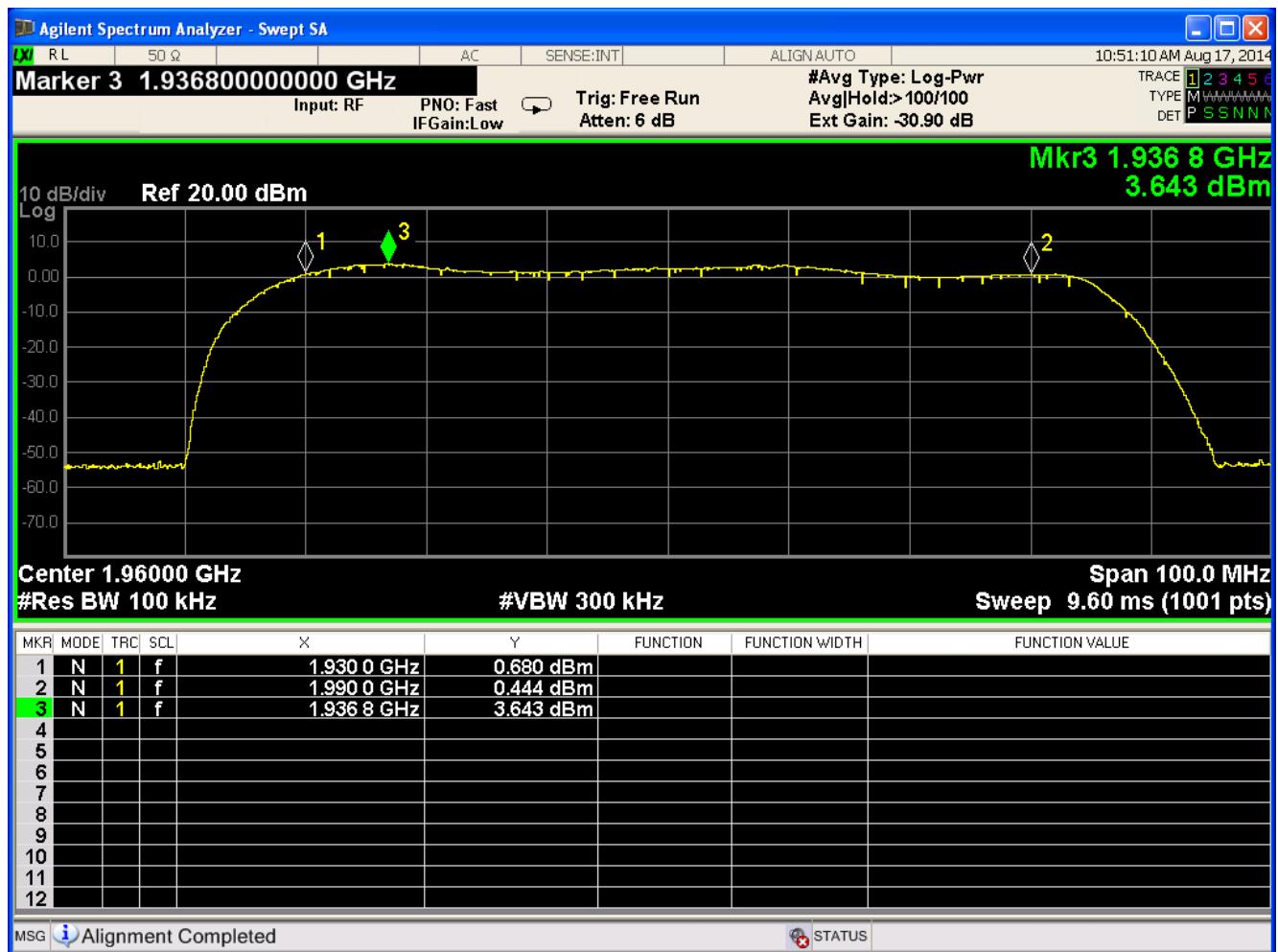
Trace mode : Max hold

Frequency of lower edge : 824.0 MHz

Frequency of upper edge : 849.0 MHz

Frequency of highest power : 842.505 MHz

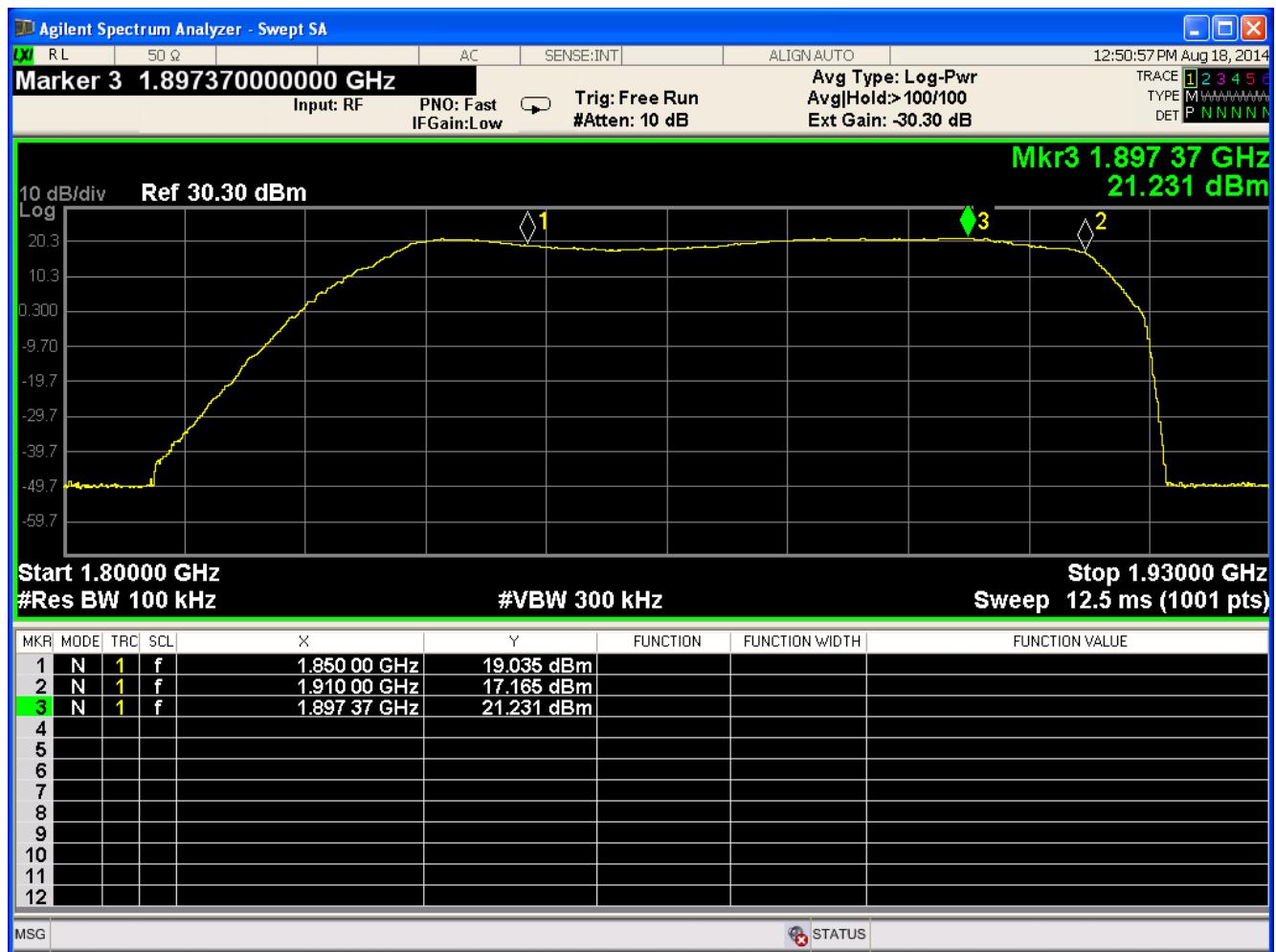
- PCS / Down link



RBW : 100 kHz
VBW : 300 kHz
Detector mode : Peak
Trace mode : Max hold

Frequency of lower edge : 1930.0 MHz
Frequency of upper edge : 1990.0 MHz
Frequency of highest power : 1936.8 MHz

- PCS/ Up link



RBW : 100 kHz

VBW : 300 kHz

Detector mode : Peak

Trace mode : Max hold

Frequency of lower edge : 1850.0 MHz

Frequency of upper edge : 1910.0 MHz

Frequency of highest power : 1897.37 MHz

3.2 Maximum power measurement

3.2.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(B)
- FCC Part 20.21 (e)(8)(i)(D)

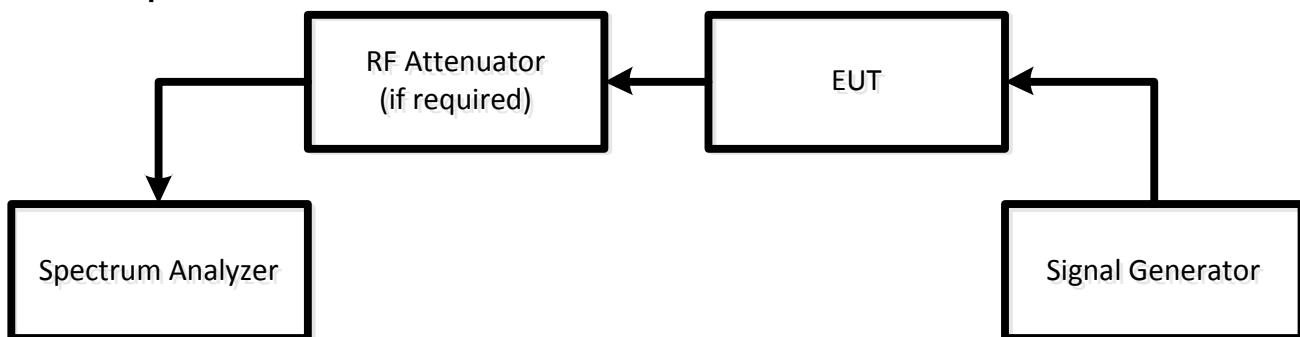
3.2.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.2
 - a) Connect the EUT to the test equipment as shown in **Set-Up**. Begin with the uplink output (donor port) connected to the spectrum analyzer.
 - b) Configure the signal generator and spectrum analyzer for operation on the frequency determined in **Frequency Band** with the highest power level, but with the center frequency of the signal no closer than 2.5 MHz from the band edge. The spectrum analyzer span shall be set to at least 10 MHz.
 - c) Set the initial signal generator power to a level well below that which causes AGC control.
 - d) Slowly increase the signal generator power level until the output signal reaches the AGC operational limit (from observation of signal behavior on the spectrum analyzer; e.g., no further increase in output power as input power is increased).
 - e) Reduce power sufficiently on the signal generator to ensure that the AGC is not controlling the power output.
 - f) Slowly increase the signal generator power to a level just below (within 0.5 dB of) the AGC limit without triggering the AGC. Note the signal generator power level as (P_{in}).
 - g) Measure the output power (P_{out}) with the spectrum analyzer as follows.
 - h) Set RBW = 100 kHz for AWGN signal type and 300 kHz for CW or GSM signal type
 - i) Set VBW \geq 3X RBW
 - j) Select either the BURST POWER or CHANNEL POWER measurement tool, as required for each signal type. The channel power integration bandwidth shall be 99% occupied bandwidth (4.1 MHz).
 - k) Select the RMS (power averaging) detector.
 - l) Ensure that the number of measurement points per sweep \geq (2 x span)/RBW (Note: This requirement does not apply for BURST power measurement mode).
 - m) Set sweep time = auto couple, or as necessary (but no less than auto couple value).
 - n) Trace average at least 100 traces in power averaging (i.e., RMS) mode.
 - o) Record the measured power level as P_{out} with one set of results for the GSM or CW input stimulus and another set of results for the AWGN input stimulus.
 - p) Repeat the procedure for each operational uplink and downlink frequency band supported by the booster.

3.2.3 Limit

- Uplink : Upper / 1 W (30 dBm),
- Downlink : Upper / 50 mW (17 dBm)

3.2.4 Set-Up



3.2.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.2.6 Test condition

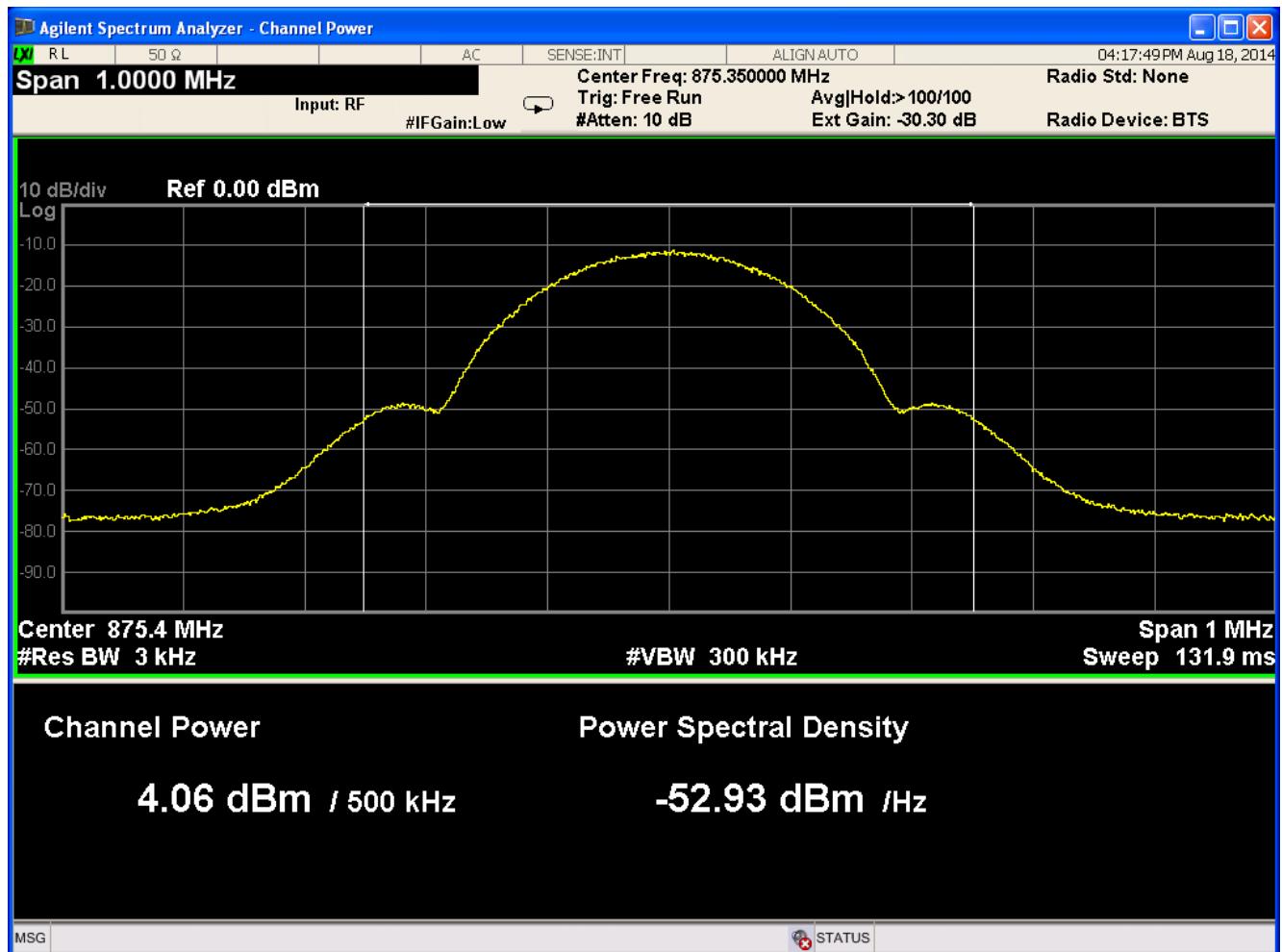
- Test place: Shield Room
- Test environment: 21 °C, 50 % R.H.

3.2.7 Test results

Band	Link	Frequency [MHz]	Signal Type	Input Level [dBm]	Output Level [dBm]	Limit [dBm]
Celluar	Down Link	875.35	GSM	-43.00	4.06	Less than +17.0
			AWGN	-43.00	3.93	
			CDMA	-43.00	4.10	
	Up Link	842.50	GSM	-25.00	21.97	Between +17.0 and +30.0
			AWGN	-25.00	21.71	
			CDMA	-25.00	21.70	
PCS	Down Link	1936.80	GSM	-43.00	3.78	Less than +17.0
			AWGN	-43.00	3.52	
			CDMA	-43.00	3.66	
	Up Link	1897.37	GSM	-25.00	21.64	Between +17.0 and +30.0
			AWGN	-25.00	22.01	
			CDMA	-25.00	21.87	

3.2.7 Test results

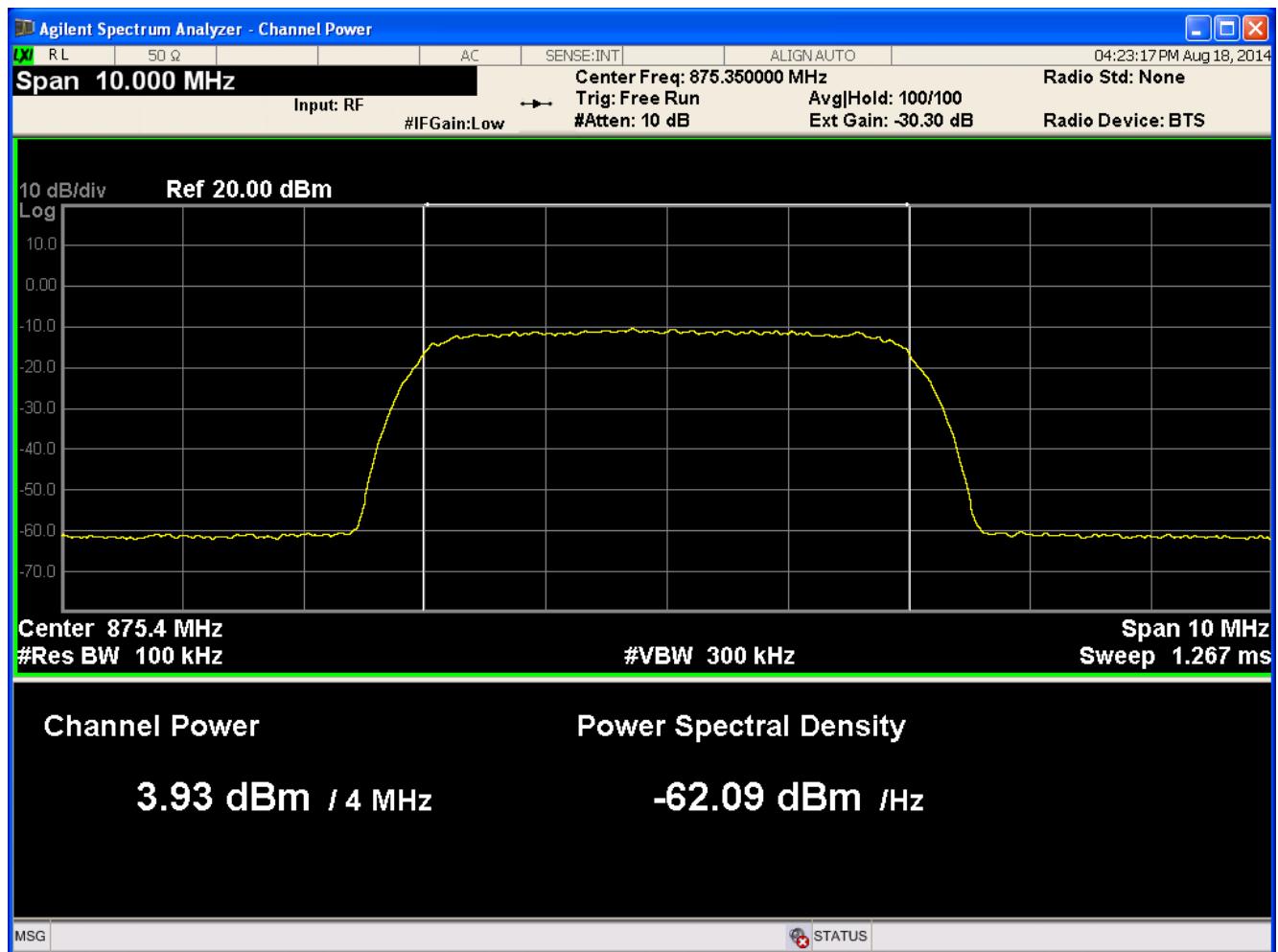
- Cellular / Down link / GSM signal



RBW : 3 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 875.35 MHz
Channel power : 4.06 dBm
Antenna gain : 2.00 dBi
Cable loss : 0.00 dB
EIRP : 6.06 dBm
Limit : 17.00 dBm

- Cellular / Down link / AWGN signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 875.35 MHz

Channel power : 3.93 dBm

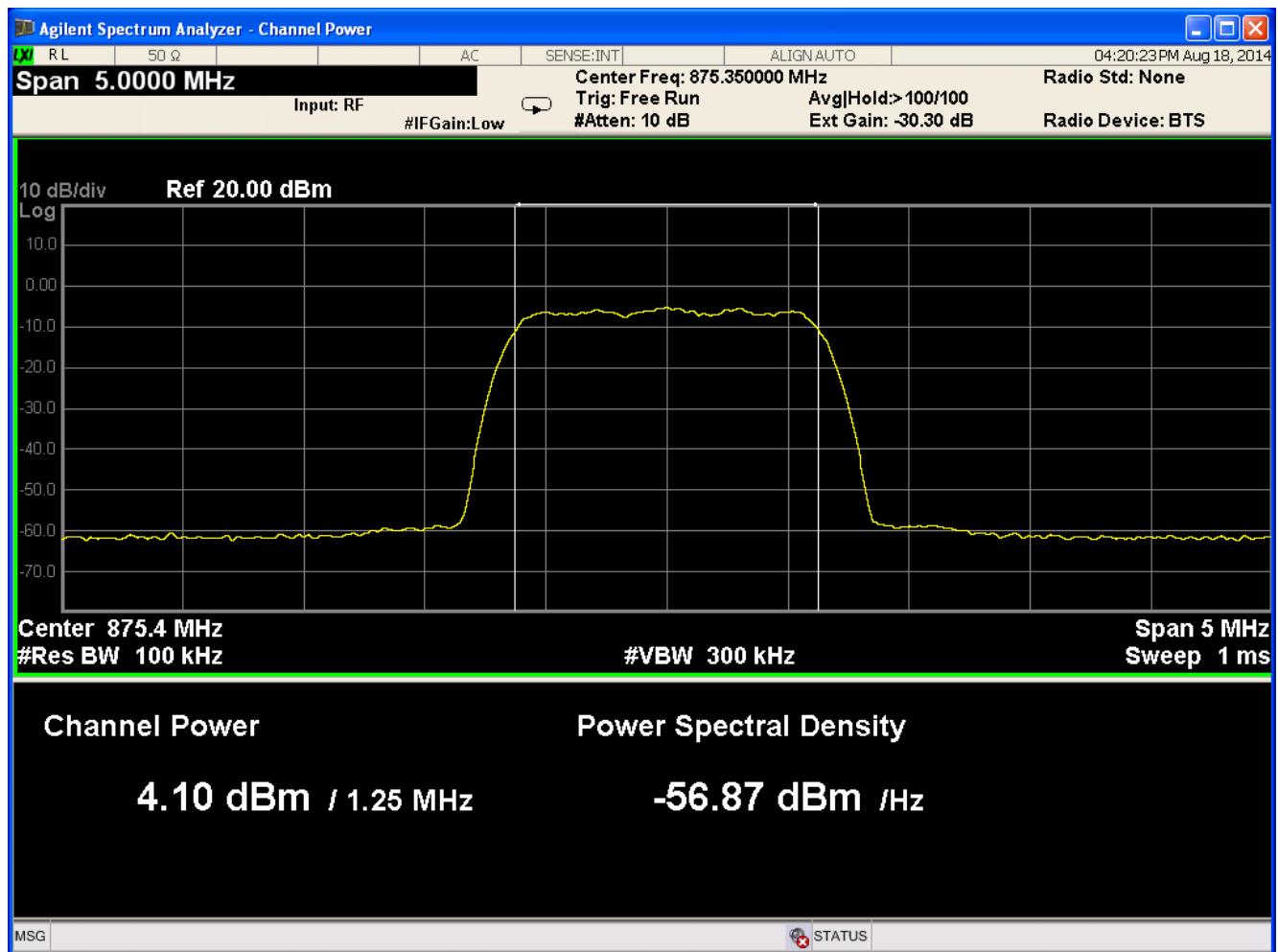
Antenna gain : 2.00 dBi

Cable loss : 0.00 dB

EIRP : 5.93 dBm

Limit : 17.00 dBm

- Cellular / Down link / CDMA signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 875.35 MHz

Channel power : 4.10 dBm

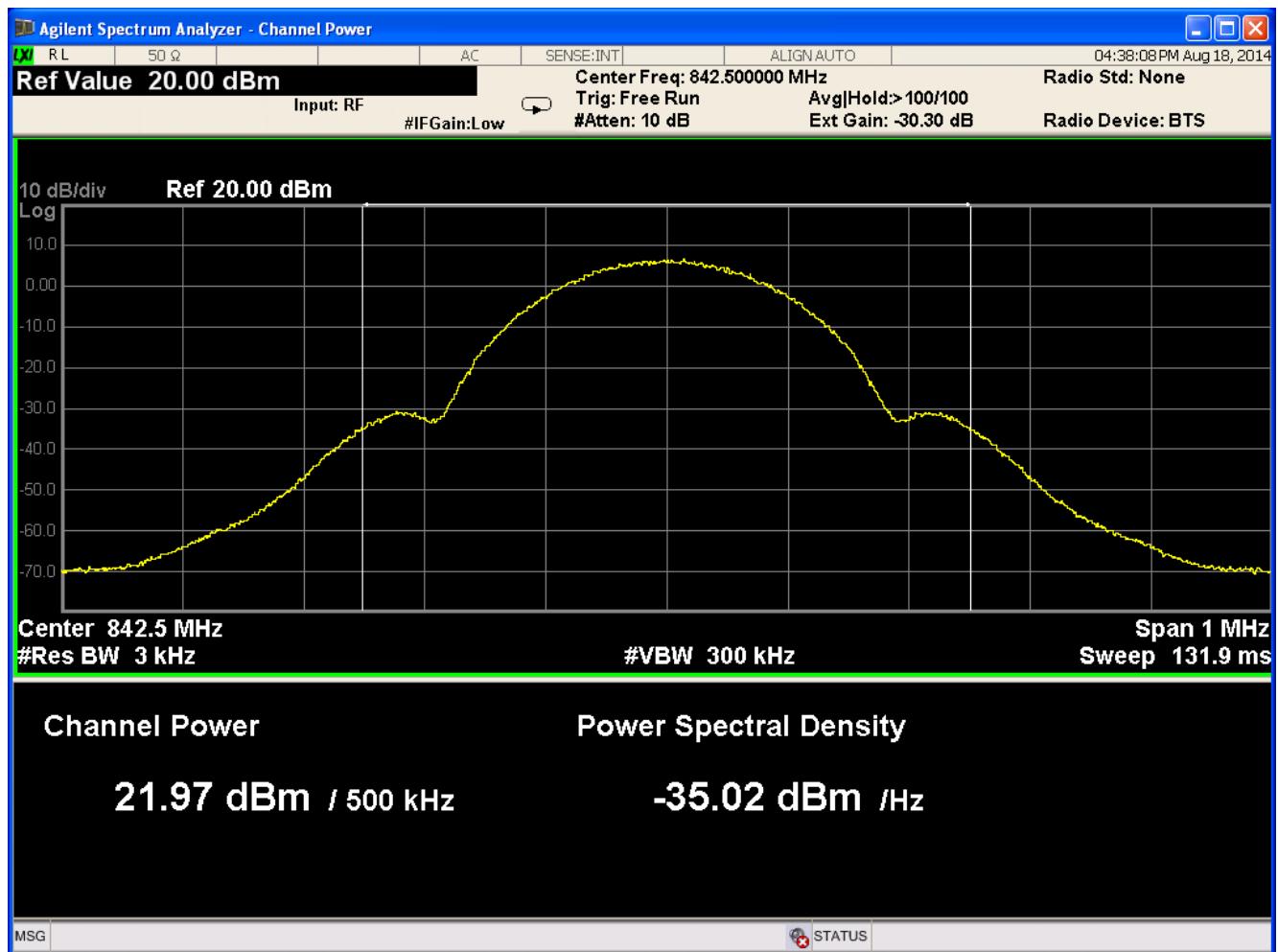
Antenna gain : 2.00 dBi

Cable loss : 0.00 dB

EIRP : 6.10 dBm

Limit : 17.00 dBm

- Cellular / Uplink / GSM signal



RBW : 3 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 842.50 MHz

Channel power : 21.97 dBm

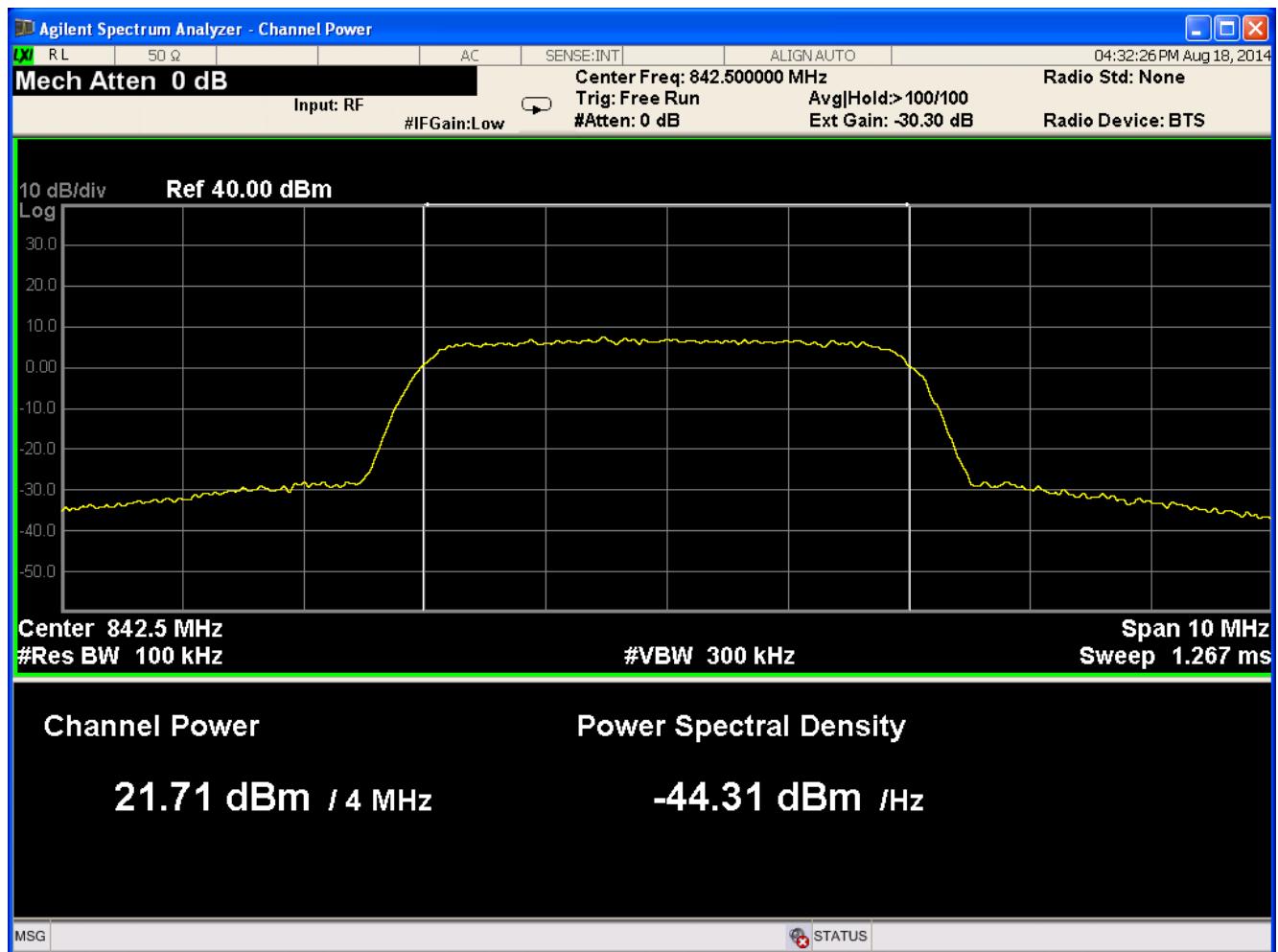
Antenna gain : 5.00 dBi

Cable loss : 0.00 dB

EIRP : 26.97 dBm

Limit : 30.00 dBm

- Celluar/ Uplink / AWGN signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 842.50 MHz

Channel power : 21.71 dBm

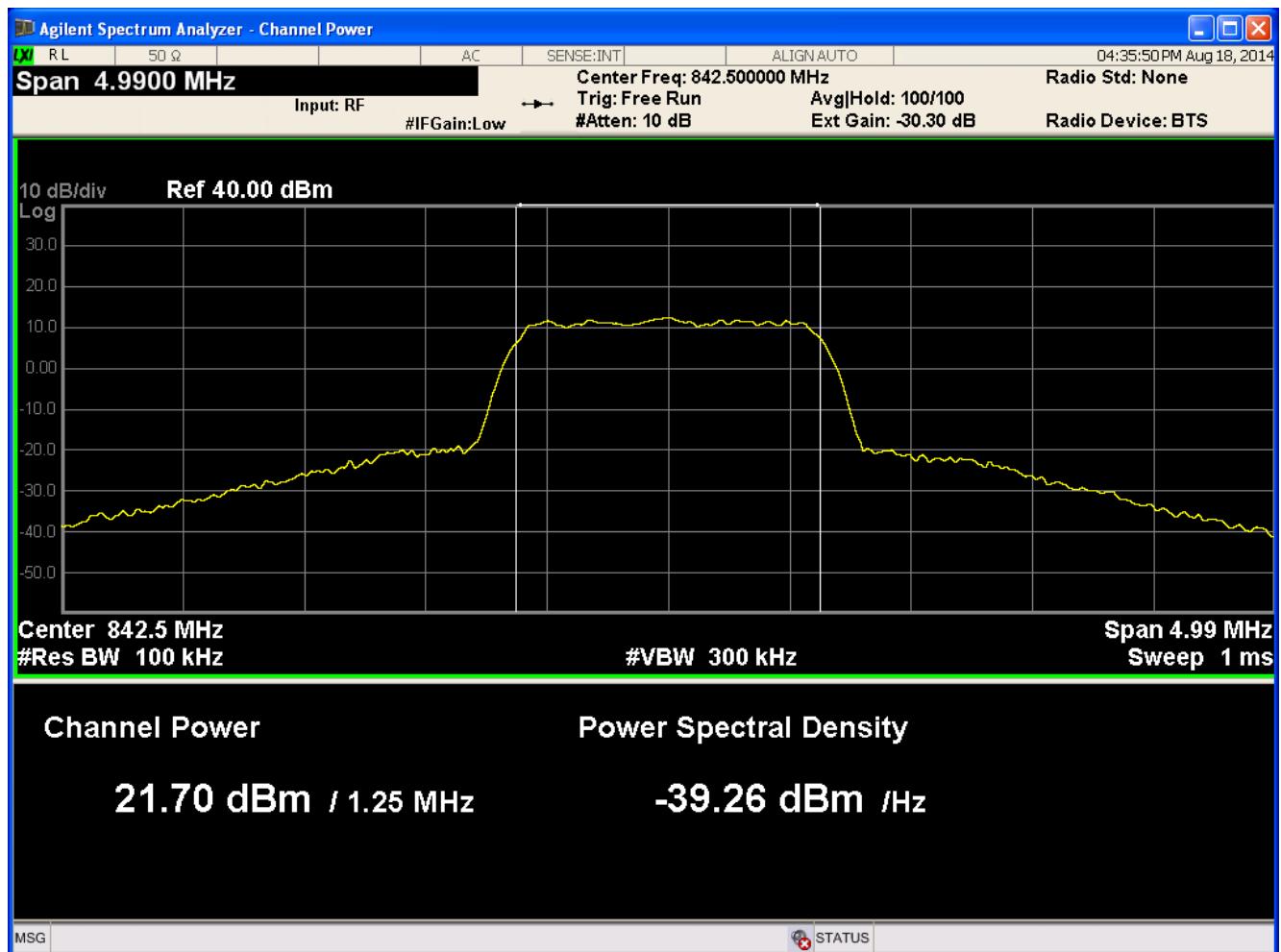
Antenna gain : 5.00 dBi

Cable loss : 0.00 dB

EIRP : 26.71 dBm

Limit : 30.00 dBm

- Cellular / Uplink / CDMA signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 842.50 MHz

Channel power : 21.70 dBm

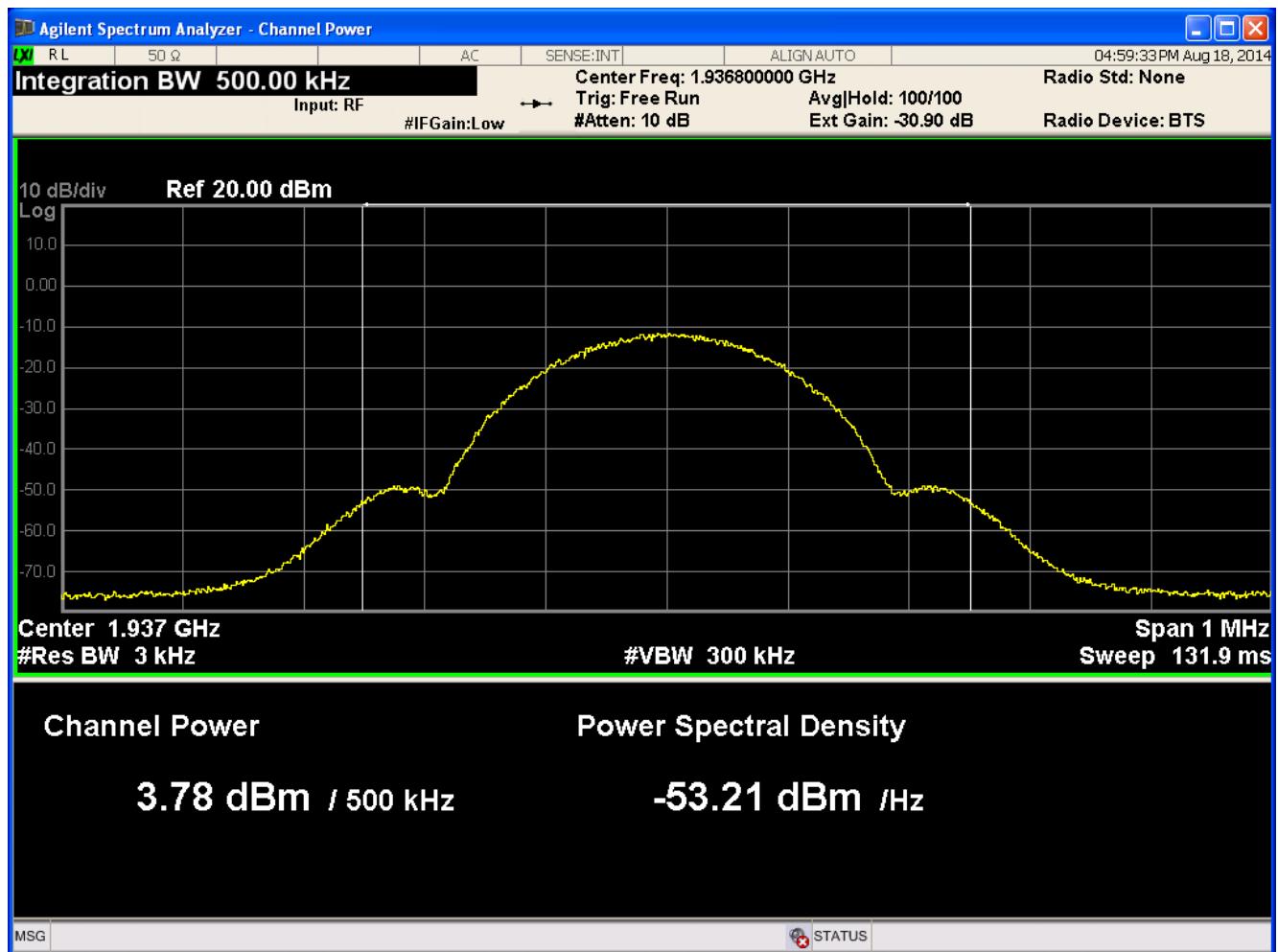
Antenna gain : 5.00 dBi

Cable loss : 0.00 dB

EIRP : 26.70 dBm

Limit : 30.00 dBm

- PCS / Down link / GSM signal



RBW : 3 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1936.8 MHz
Channel power : 3.78 dBm
Antenna gain : 2.00 dBi
Cable loss : 0.00 dB
EIRP : 5.78 dBm

Limit : 17.00 dBm

- PCS/ Down link / AWGN signal

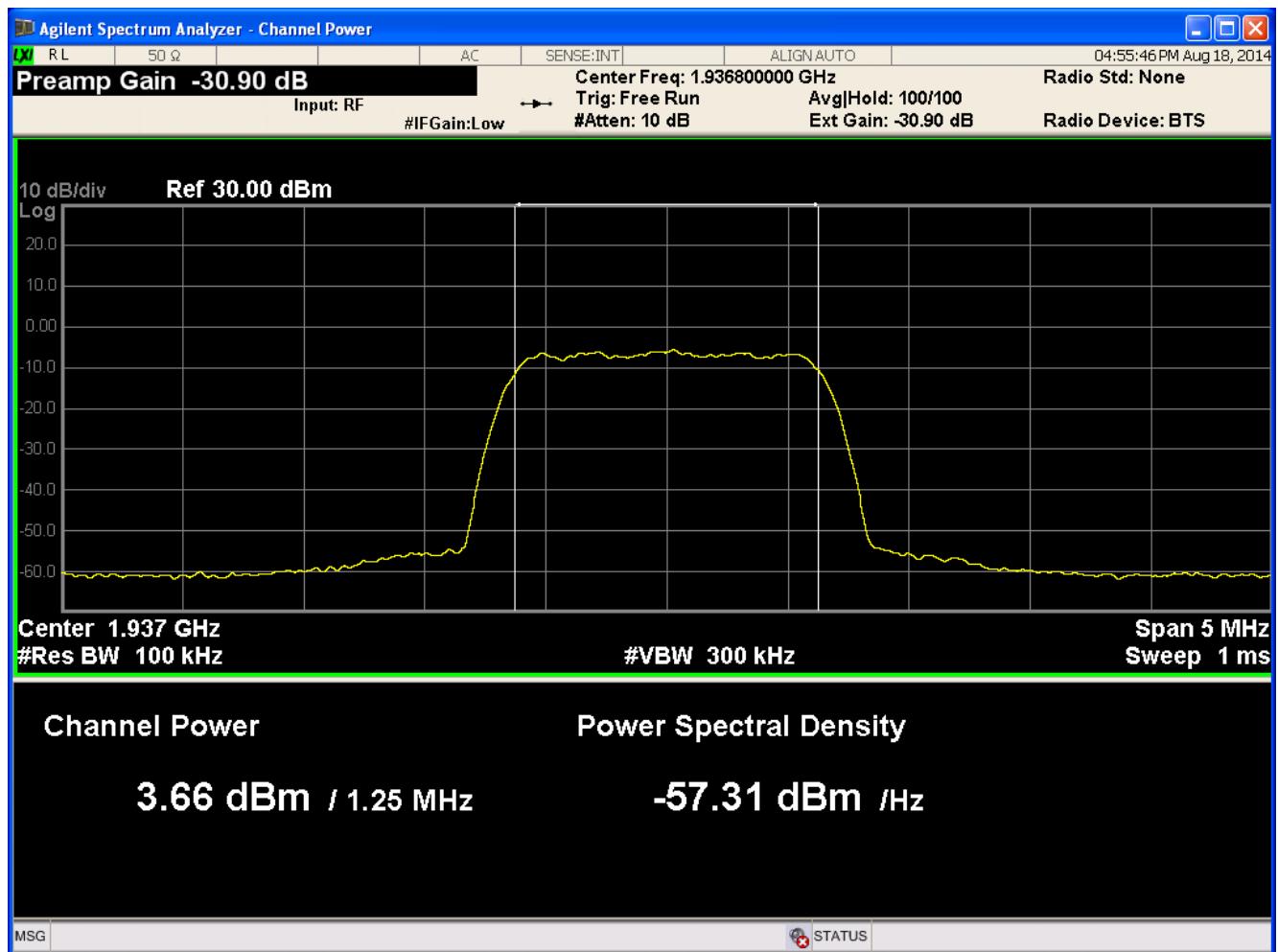


RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1936.8 MHz
Channel power : 3.52 dBm
Antenna gain : 2.00 dBi
Cable loss : 0.00 dB
EIRP : 5.52 dBm

Limit : 17.00 dBm

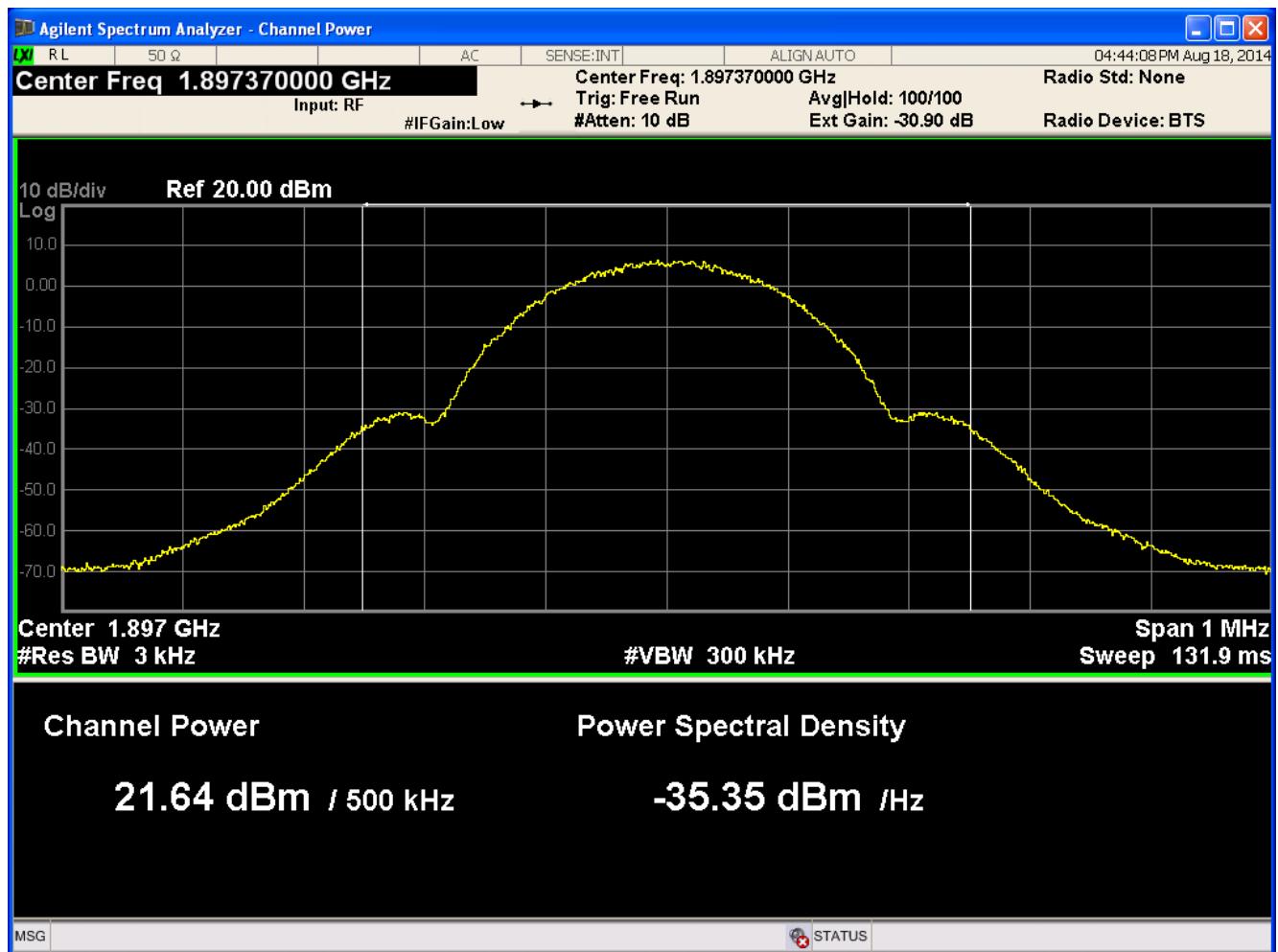
- PCS / Down link / CDMA signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1936.80 MHz
Channel power : 3.66 dBm
Antenna gain : 2.00 dBi
Cable loss : 0.00 dB
EIRP : 5.66 dBm
Limit : 17.00 dBm

- PCS/ Uplink / GSM signal



RBW : 3 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1897.37 MHz
Channel power : 21.64 dBm
Antenna gain : 5.00 dBi
Cable loss : 0.00 dB
EIRP : 26.64 dBm
Limit : 30.00 dBm

- PCS/ Uplink / AWGN signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1897.37 MHz
Channel power : 22.01 dBm
Antenna gain : 5.00 dBi
Cable loss : 0.00 dB
EIRP : 27.01 dBm
Limit : 30.00 dBm

- PCS/ Uplink / CDMA signal



RBW : 100 kHz
VBW : 300 kHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1897.37 MHz
Channel power : 21.87 dBm
Antenna gain : 5.00 dBi
Cable loss : 0.00 dB
EIRP : 26.87 dBm
Limit : 30.00 dBm

3.3 Maximum booster gain computation

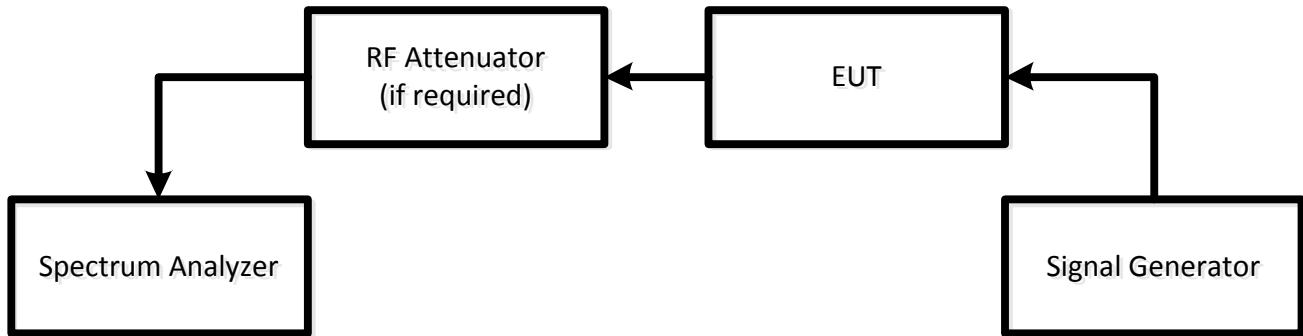
3.3.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(B)
- FCC Part 20.21 (e)(8)(i)(C)(2)

3.3.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.3
 - Compute the maximum gain of the booster as follows to demonstrate compliance to the applicable gain limits as specified.
 - For both the uplink and downlink in each supported frequency band, use each of the P_{out} and P_{in} value pairs for all signal types used in 7.2 in the following equation to determine the maximum gain (G) of the booster: G (dB) = P_{out} (dBm) - P_{in} (dBm).
 - Record the maximum gain of the uplink and downlink paths for each supported frequency band and verify that the each gain value complies with the applicable limit.

3.3.3 Set-Up



3.3.4 Limit

- Mobile Booster maximum gain shall not exceed 50 dB when using an inside antenna.
- The uplink and downlink gain under each condition was verified to be within 9dB of each other.

3.3.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.3.6 Test condition

- Test place: Shield Room
- Test environment: 21 °C, 50 % R.H.

3.3.7 Test results

Band	Link	Frequency [MHz]	Signal Type	Input Level [dBm]	Output Level [dBm]	Gain [dB]	Gain Limit [dB]	Deviation [dB]
Celluar	Down Link	890.819	GSM	-43.0	4.06	47.06	50.0	1.30
			AWGN	-43.0	3.93	46.93		
			CDMA	-43.0	4.10	47.10		
	Up Link	852.656	GSM	-25.0	21.97	46.97	50.0	1.30
			AWGN	-25.0	21.71	46.71		
			CDMA	-25.0	21.70	46.70		
PCS	Down Link	1937.20	GSM	-43.0	3.78	46.78	50.0	1.48
			AWGN	-43.0	3.52	46.52		
			CDMA	-43.0	3.66	46.66		
	Up Link	1879.95	GSM	-25.0	21.64	46.64	50.0	1.48
			AWGN	-25.0	22.01	47.01		
			CDMA	-25.0	21.87	46.78		

3.4 Intermodulation product

3.4.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(F)

3.4.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.4
 - a) Connect the signal booster to the test equipment as shown in **Set-Up**. Begin with the uplink output connected to the spectrum analyzer.
 - b) Set the spectrum analyzer RBW = 3 kHz.
 - c) Set the VBW \geq 3 X the RBW.
 - d) Select the RMS detector.
 - e) Set the spectrum analyzer center frequency to the center of the supported operational band under test.
 - f) Set the span to 5 MHz.
 - g) Configure the two signal generators for CW operation with generator 1 tuned 300 kHz below the operational band center frequency and generator 2 tuned 300 kHz above the operational band center frequency.
 - h) Set the signal generator amplitudes so that the power from each into the RF combiner is equivalent and turn on the RF output.
 - i) Increase the signal generators' amplitudes equally until just before the EUT begins AGC and ensure that all intermodulation products (if any exist), are below the specified limit of -19 dBm.
 - j) Utilize the trace averaging function of the spectrum analyzer and wait for the trace to stabilize. Place a marker at the highest amplitude intermodulation product.
 - k) Record the maximum intermodulation product amplitude level that is observed.
 - l) Capture the spectrum analyzer trace for inclusion in the test report.
 - m) Repeat steps e) to l) for all uplink and downlink operational bands.

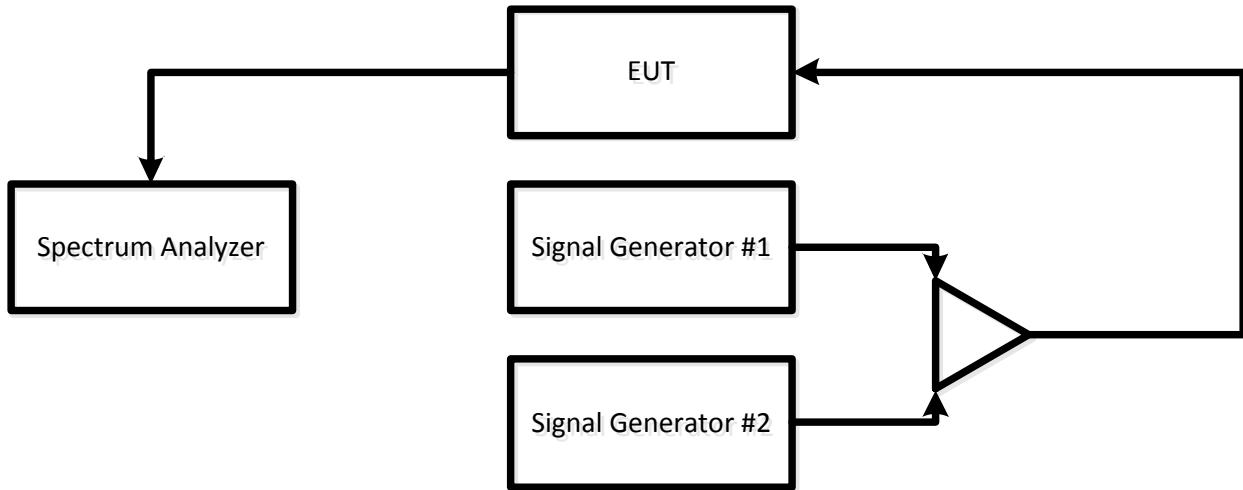
Note: If using a single signal generator with dual outputs, ensure that intermodulation products are not the result of the generator.

- n) Increase the signal generator amplitude in 2 dB steps to 10 dB above the AGC threshold determined in i) to ensure that the EUT maintains compliance with the intermodulation

3.4.3 Limit

- The transmitted intermodulation products of a consumer booster at its uplink and downlink ports shall not exceed the power level of -19 dBm with a 3 kHz measurement bandwidth for the supported bands of operation

3.4.4 Set-Up



3.4.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Signal Generator	E4432B	Agilent
RF Combiner	1506A	Weinschel
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.4.6 Test condition

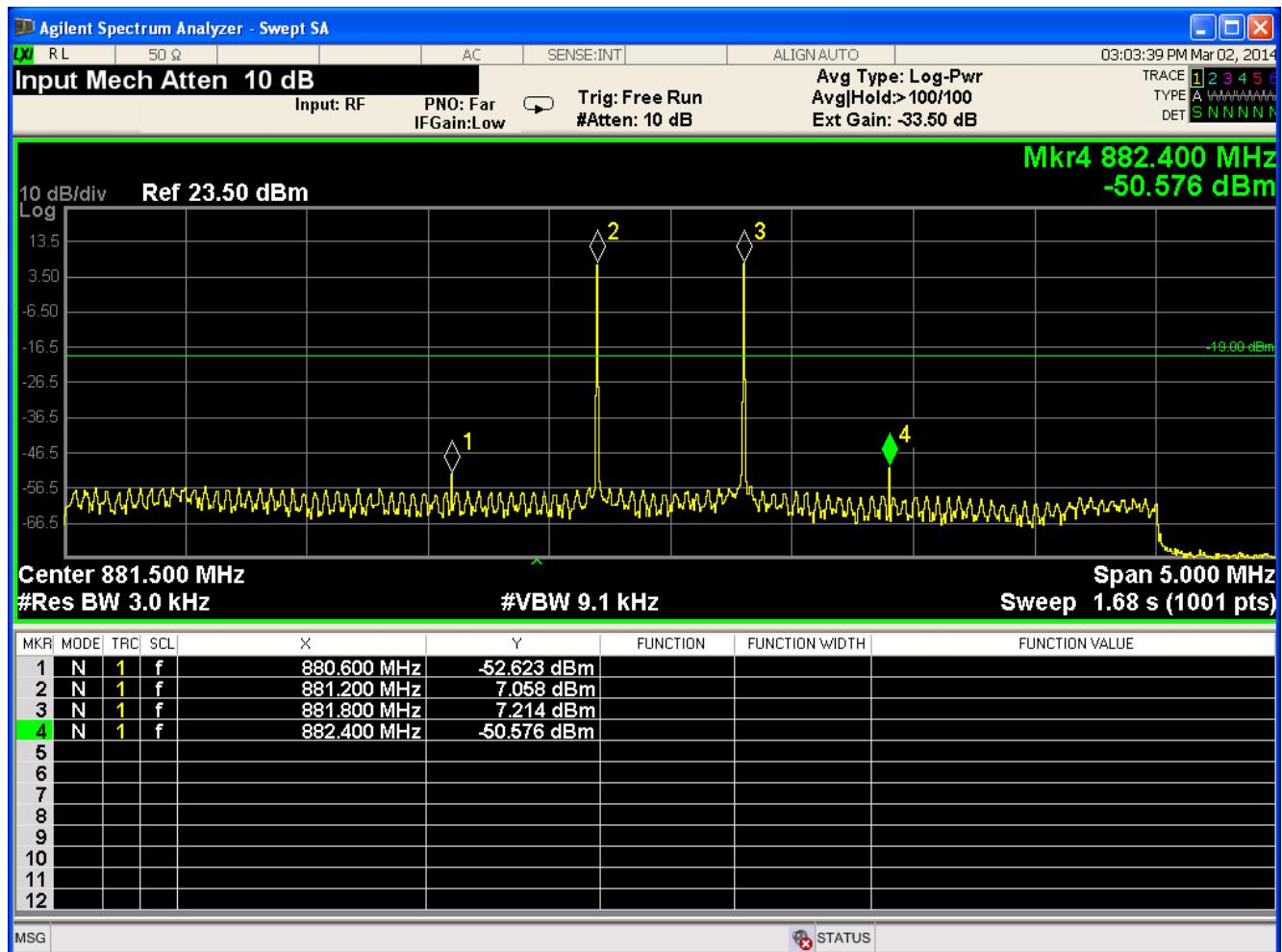
- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.4.7 Test results

Band	Link	Frequency 1 [MHz]	Frequency 2 [MHz]	IMD Level [dBm]	IMD Limit [dB]	Margin [dB]
Celluar	Down Link	881.2	881.8	-50.57	-19.0	31.57
	Up Link	836.2	836.8	-19.86		0.86
PCS	Down Link	1959.7	1960.3	-53.17		34.17
	Up Link	1879.7	1880.3	-20.01		0.99

3.4.8 Test results

- Cellular/ Down link



Input frequency : 881.2 MHz & 881.8 MHz

RBW : 3 kHz

VBW : 9.1 kHz

Span : 5 MHz

Detector mode : RMS

Trace mode : Max hold

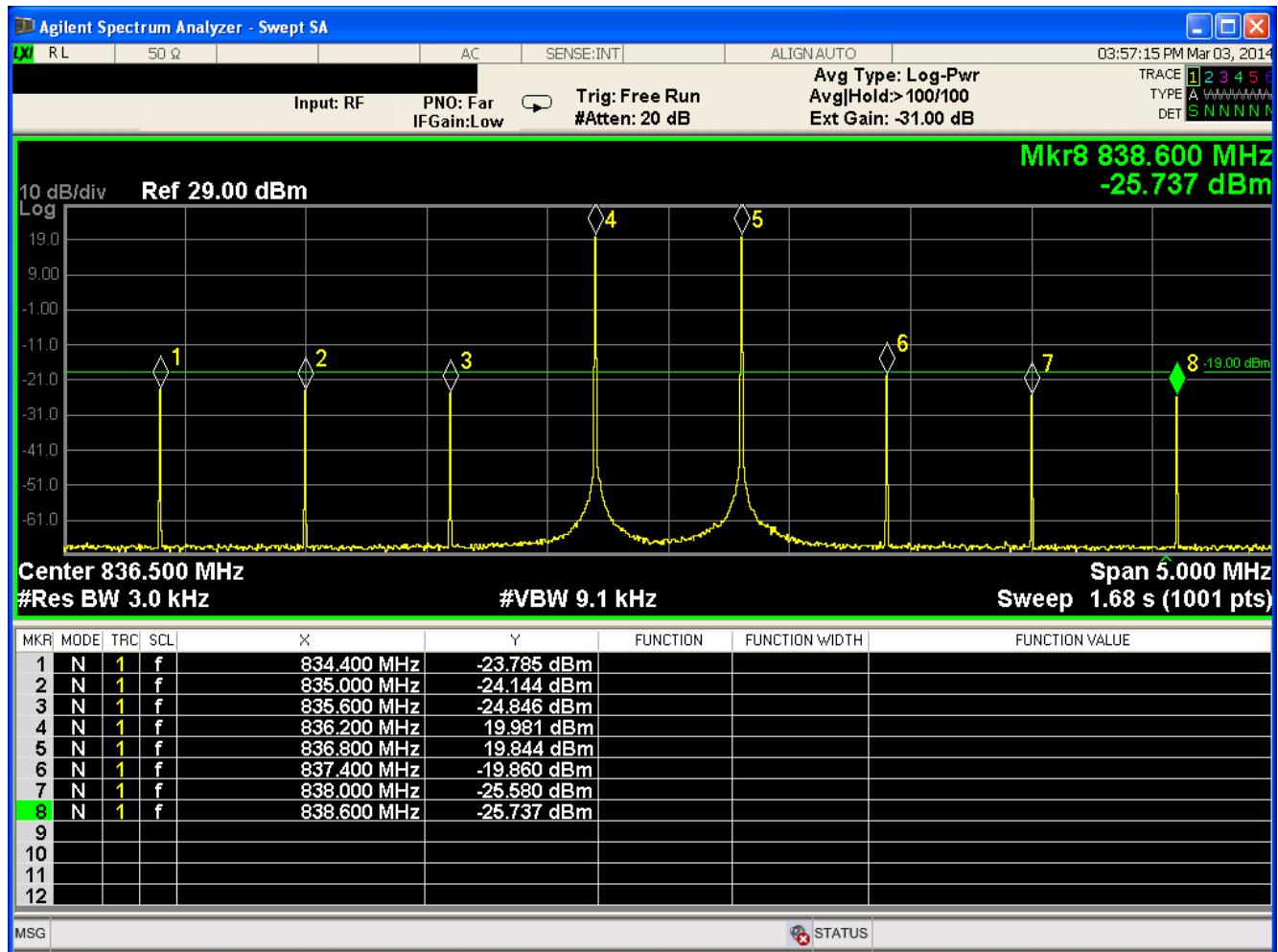
Frequency of highest IMD : 882.4 MHz

Level of highest IMD : -50.57 dBm

Limit : -19.00 dBm

Margin : 31.57 dB

- Cellular/ Up link



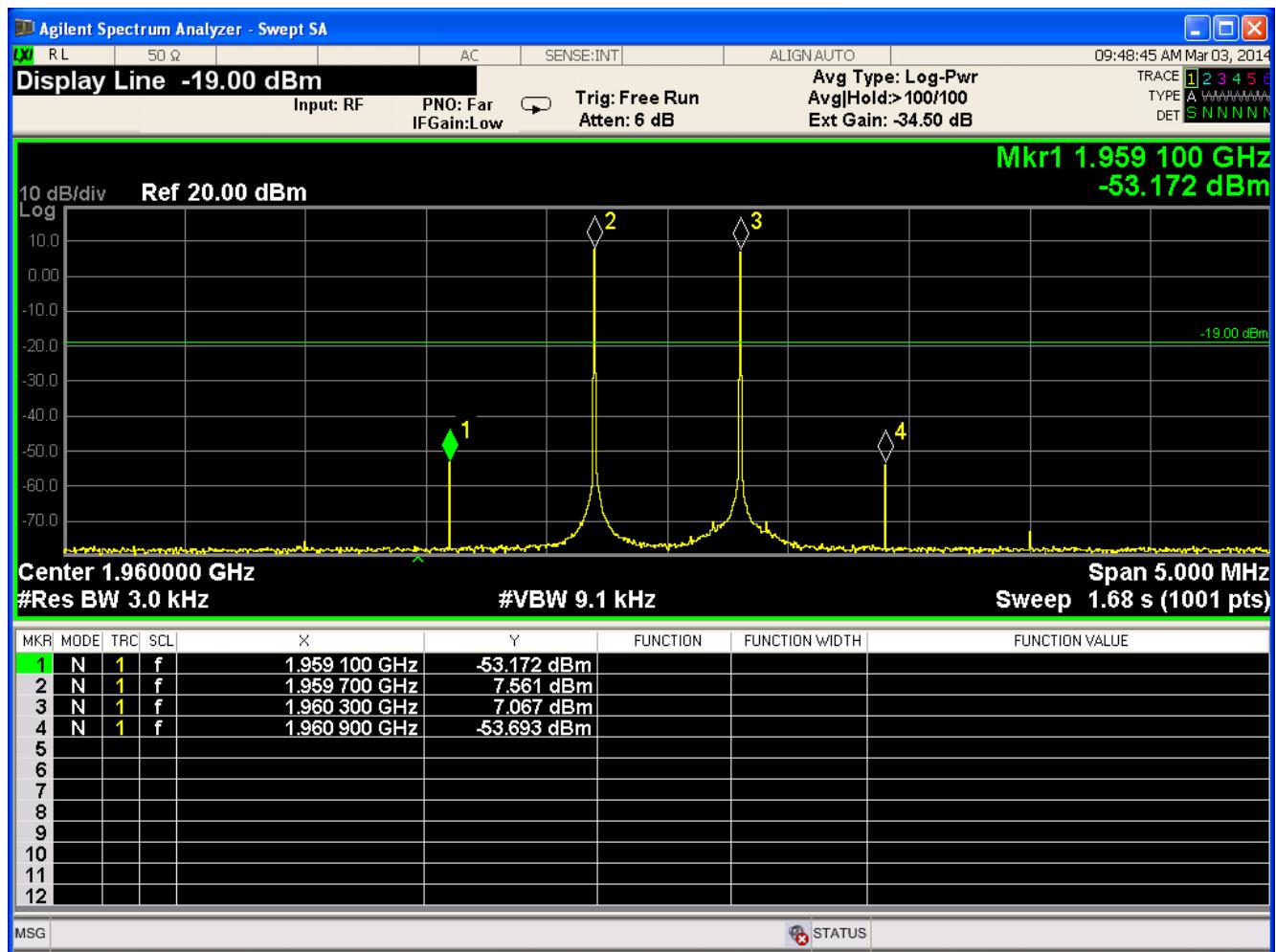
Input frequency : 836.2 MHz & 836.8 MHz

RBW : 3 kHz
VBW : 9.1 kHz
Span : 5 MHz
Detector mode : RMS
Trace mode : Max hold

Frequency of highest IMD : 837.49 MHz
Level of highest IMD : -19.86 dBm

Limit : -19.00 dBm
Margin : 0.86 dB

- PCS/ Down link



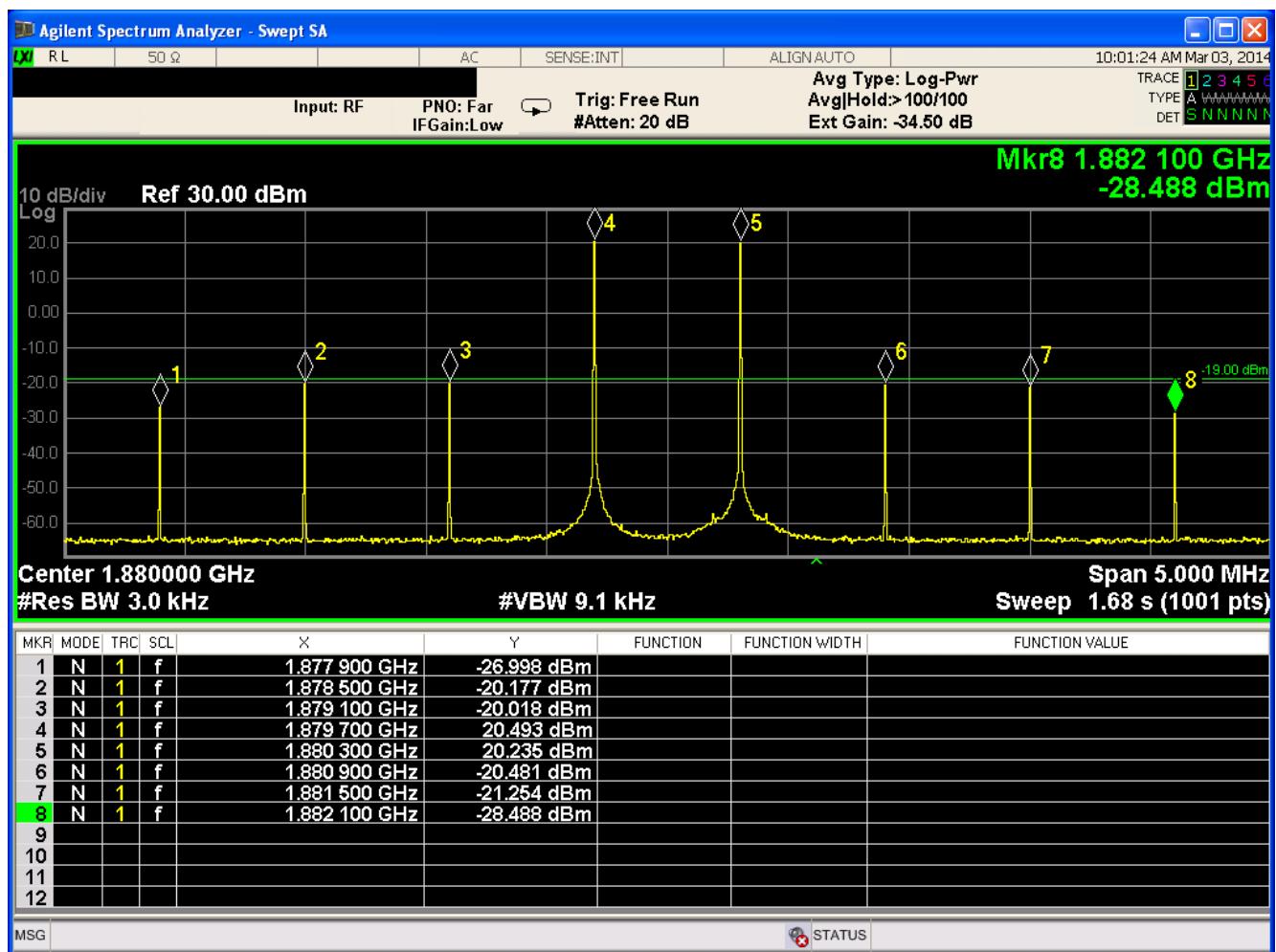
Input frequency : 1959.7 MHz & 1960.3 MHz

RBW : 3 kHz
VBW : 9.1 kHz
Span : 5 MHz
Detector mode : RMS
Trace mode : Max hold

Frequency of highest IMD : 1959.1 MHz
Level of highest IMD : -53.17 dBm

Limit : -19.00 dBm
Margin : 34.17 dB

- PCS/ Up link



Input frequency : 1879.7 MHz & 1880.3 MHz

RBW : 3 kHz
VBW : 9.1 kHz
Span : 5 MHz
Detector mode : RMS
Trace mode : Max hold

Frequency of highest IMD : 1879.1 MHz
Level of highest IMD : -20.01 dBm

Limit : -19.00 dBm
Margin : 0.99 dB

3.5 Out of band emission

3.5.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(E)

3.5.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.5
 - a) Connect the EUT to the test equipment as shown in **Set-Up**. Begin with the uplink output connected to the spectrum analyzer.
 - b) Configure the signal generator for the appropriate operation for all uplink and downlink bands:
 - i) GSM: 0.2 MHz from upper and lower band edge
 - ii) LTE (5 MHz): 2.5 MHz from upper and lower band edge
 - iii) CDMA: 1.25 MHz from upper and lower band edge, except for cellular as follows (only the upper and lower frequencies need to be tested): 824.88 MHz, 845.73 MHz, 836.52 MHz, 848.10 MHz, 869.88 MHz, 890.73 MHz, 881.52 MHz, 893.10 MHz.

Note 1: Alternative test modulation types:

- CDMA (alternative 1.25 MHz AWGN)
- LTE 5 MHz (alternative W-CDMA or 4.1 MHz AWGN)

Note 2: For LTE, the signal generator should utilize the uplink and downlink signal types for these modulations in uplink and downlink tests, respectively. LTE shall use 5 MHz signal 25 resource blocks transmitting.

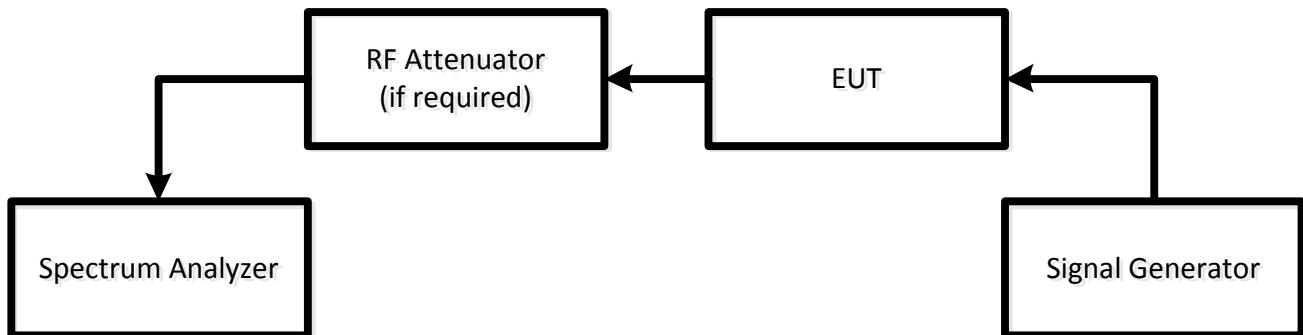
Note 3: AWGN is the measured 99% occupied bandwidth.

- c) Set the signal generator amplitude to the maximum power level prior to AGC similar to the procedures in method of **Maximum power** d) to f) of power measurement procedure for appropriate modulations.
- d) Set RBW = measurement bandwidth specified in the applicable rule section for the supported frequency band.
- e) Set VBW = 3 X RBW.
- f) Select the RMS (power averaging) detector.
- g) Sweep time = auto-couple.
- h) Set the analyzer start frequency to the upper band/block edge frequency and the stop frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, per applicable rule part.
- i) Trace average at least 100 traces in power averaging (i.e., RMS) mode.
- j) Use peak marker function to find the maximum power level.
- k) Capture the spectrum analyzer trace of the power level for inclusion in the test report.
- l) Increase the signal generator amplitude in 2 dB steps until the maximum input level indicated in 5.4 is reached. Ensure that the EUT maintains compliance with the OOB limits.
- m) Reset the analyzer start frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as per applicable rule part, and the stop frequency to the lower band/block edge frequency and repeat steps j) to l).
- n) Repeat steps b) through m) for each uplink and downlink operational band.

3.5.3 Limit

- Booster out of band emissions (OOBE) shall be at least 6 dB below the FCC's mobile emission limits for the supported bands of operation.
- Out of band emissions limit = $6 + (43 + 10 \log (P)) = -19 \text{ dBm}$

3.5.4 Set-Up



3.5.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.5.6 Test condition

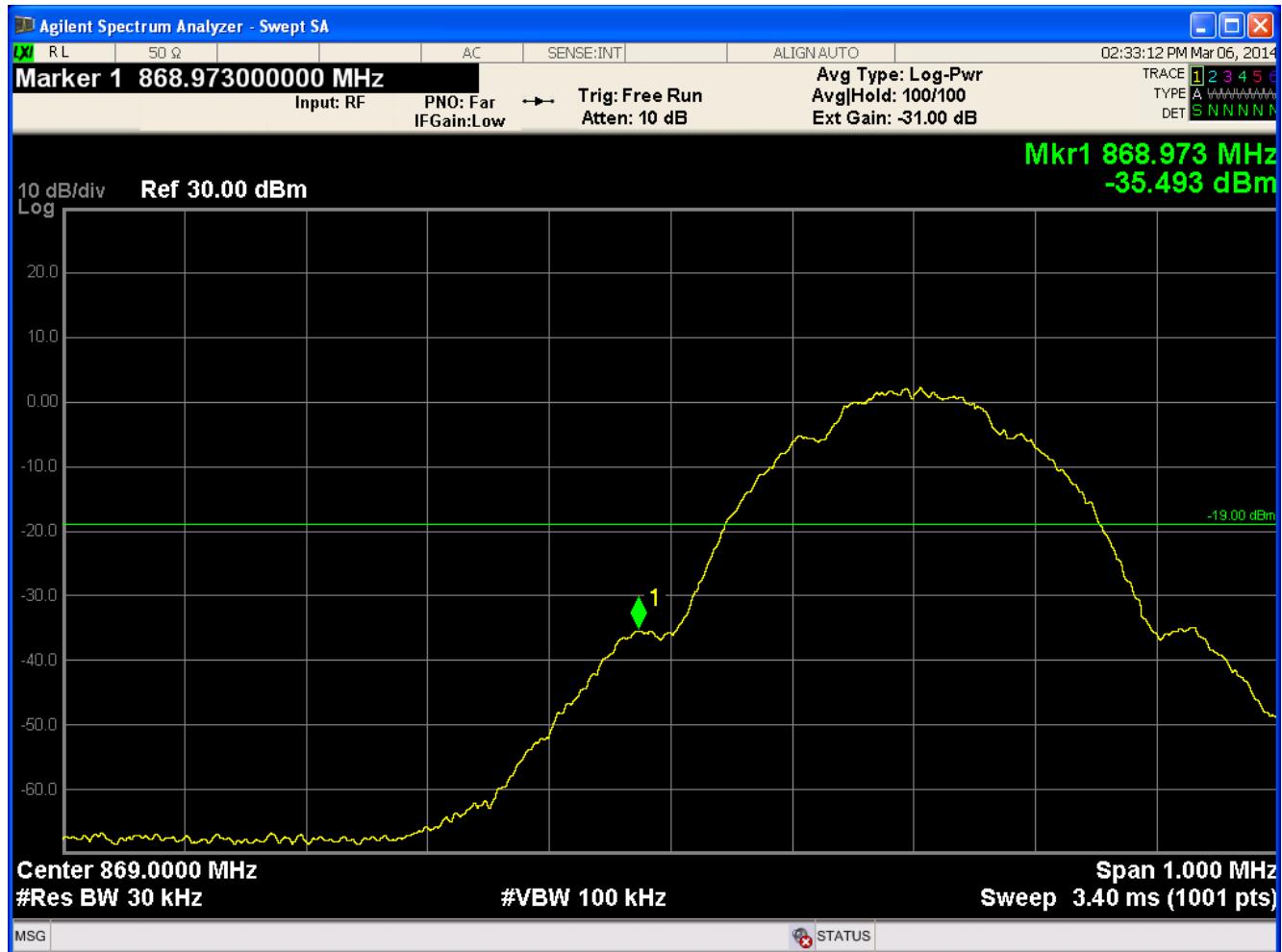
- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.5.7 Test results

Band	Link	Signal Type	Operation Frequency [MHz]	Emission Frequency [MHz]	Emission Level [dBm]	Emission Limit [dB]	Margin [dB]
Celluar	Down Link	GSM	869.20	868.97	-35.49	-19.0	16.49
		AWGN	871.50	869.00	-57.25		38.25
		CDMA	869.88	869.00	-52.79		33.79
			881.52	869.00	-71.14		52.14
		GSM	893.80	894.02	-35.02		16.02
		AWGN	891.50	894.00	-60.74		41.74
		CDMA	890.73	894.00	-71.74		52.74
			893.10	894.00	-54.49		35.49
	Up Link	GSM	824.20	823.98	-22.00		3.00
		AWGN	826.50	824.00	-31.78		12.78
		CDMA	824.88	824.00	-27.51		8.51
			836.52	824.00	-57.71		38.71
		GSM	848.80	849.02	-21.92		2.92
		AWGN	846.50	849.00	-30.98		11.98
		CDMA	845.73	849.00	-52.52		33.52
			848.10	849.00	-25.18		6.18
PCS	Down Link	GSM	1930.20	1929.97	-35.54	-19.0	16.54
		AWGN	1932.50	1930.00	-57.61		38.61
		CDMA	1931.25	1930.00	-53.08		34.08
		GSM	1989.80	1990.02	-35.81		16.81
		AWGN	1987.50	1990.00	-58.52		39.52
		CDMA	1988.75	1990.00	-54.26		35.26
	Up Link	GSM	1850.20	1849.98	-21.07		2.07
		AWGN	1852.50	1850.00	-25.12		6.12
		CDMA	1851.25	1850.00	-22.29		3.29
		GSM	1909.80	1910.02	-22.37		3.37
		AWGN	1907.50	1910.00	-25.64		6.64
		CDMA	1908.75	1910.00	-25.62		6.62

3.5.8 Test results

- Cellular/ Down link / Lower side / GSM

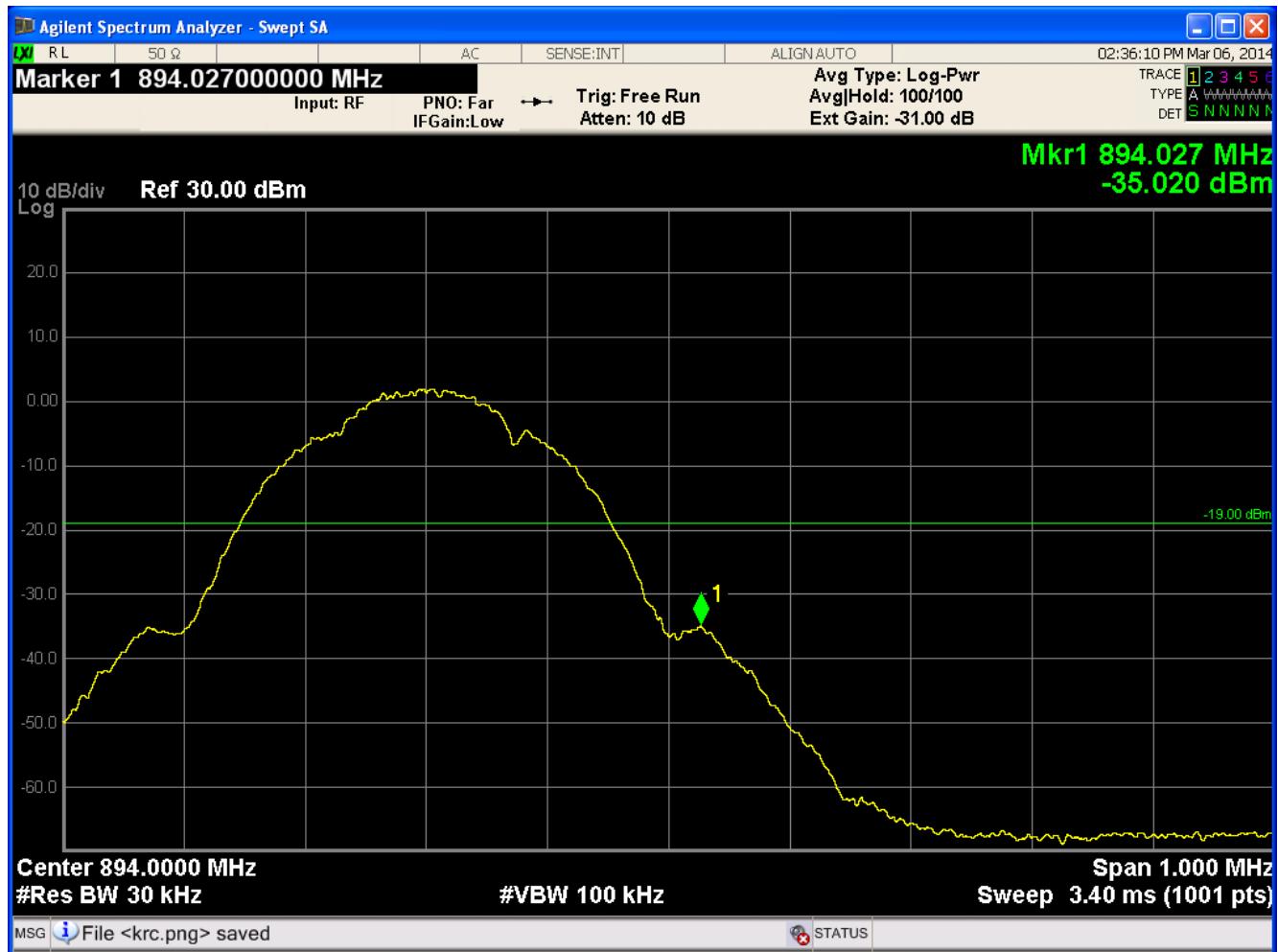


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 869.2 MHz
RF power : 10.10 dBm

Emission frequency : 868.97 MHz
Emission power : -35.49 dBm

Limit : -19.0 dBm
Margin : 16.49 dB

- Celluar/ Down link / Upper side / GSM

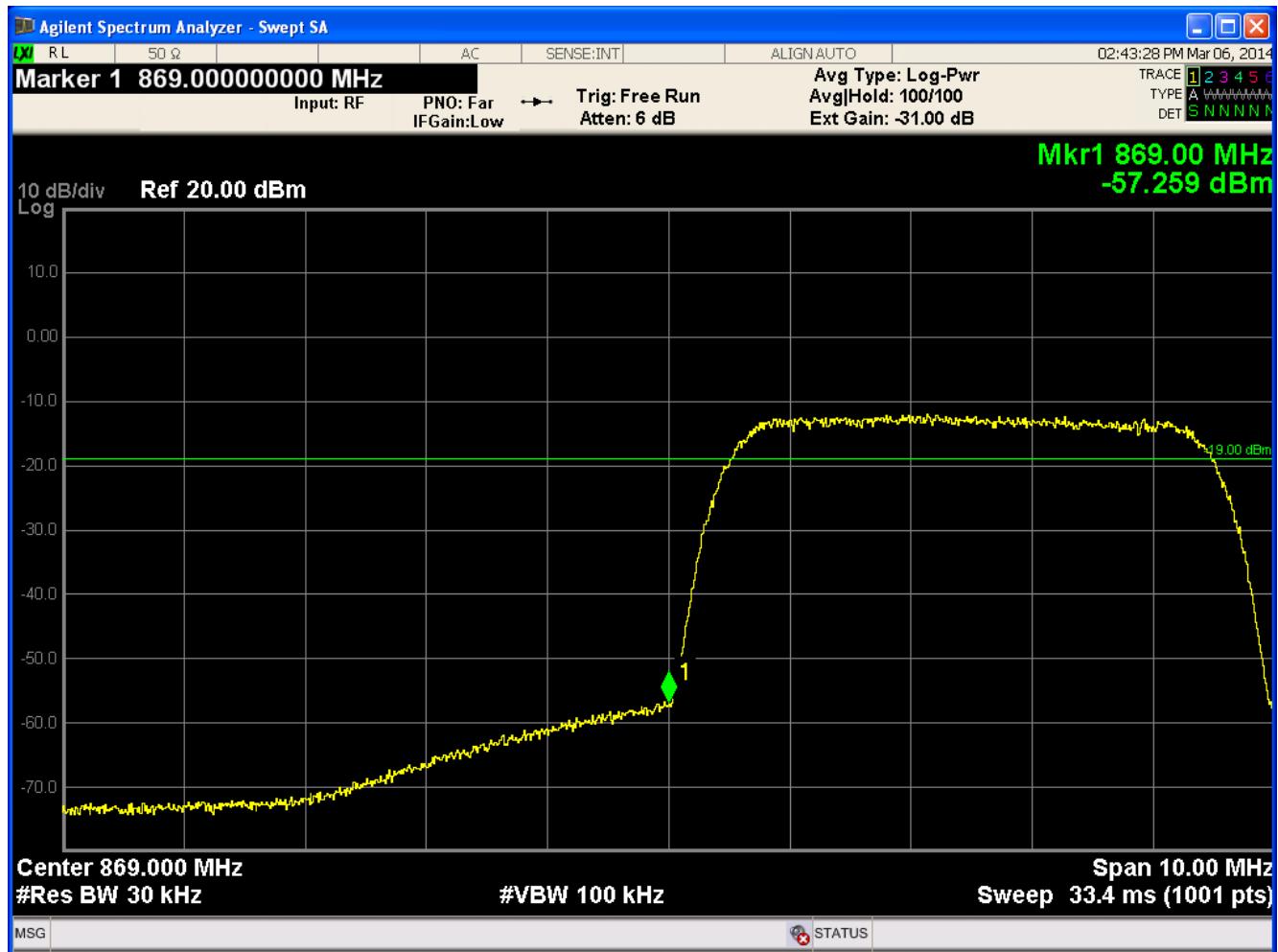


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 893.8 MHz
RF power : 9.99 dBm

Emission frequency : 894.02 MHz
Emission power : -35.02 dBm

Limit : -19.0 dBm
Margin : 16.02 dB

- Cellular/ Down link / Lower side / AWGN



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 871.5 MHz
RF power : 10.01 dBm

Emission frequency : 869.0 MHz
Emission power : -57.25 dBm

Limit : -19.0 dBm
Margin : 38.25 dB

- Cellular/ Down link / Upper side / AWGN

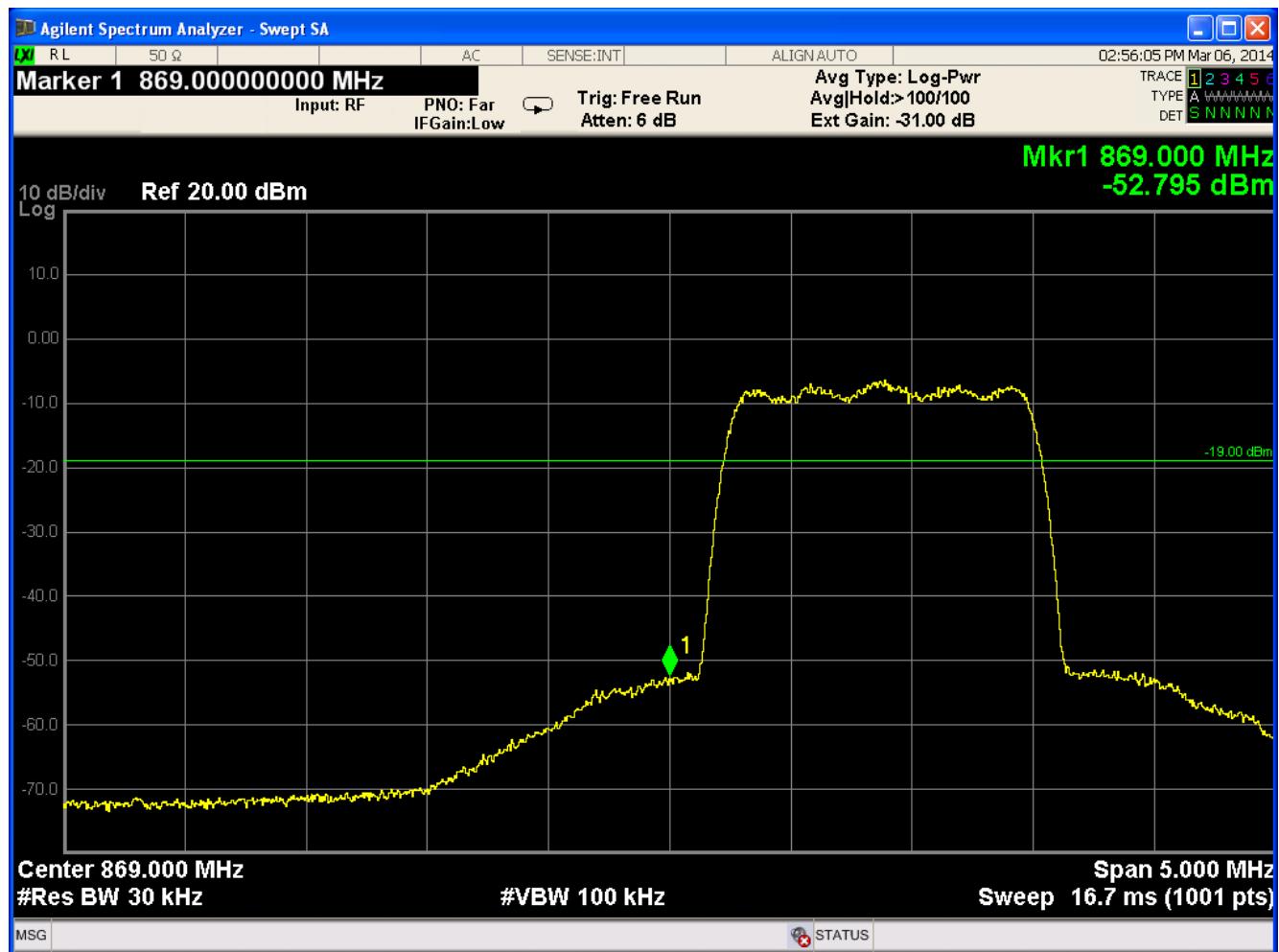


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 891.5 MHz
RF power : 9.99 dBm

Emission frequency : 894.0 MHz
Emission power : -60.74 dBm

Limit : -19.0 dBm
Margin : 41.74 dB

- Celluar/ Down link / Lower side / CDMA 869.88 MHz



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 869.88 MHz
RF power : 10.00 dBm

Emission frequency : 869.0 MHz
Emission power : -52.79 dBm

Limit : -19.0 dBm
Margin : 33.79 dB

- Celluar/ Down link / Lower side / CDMA 881.52 MHz

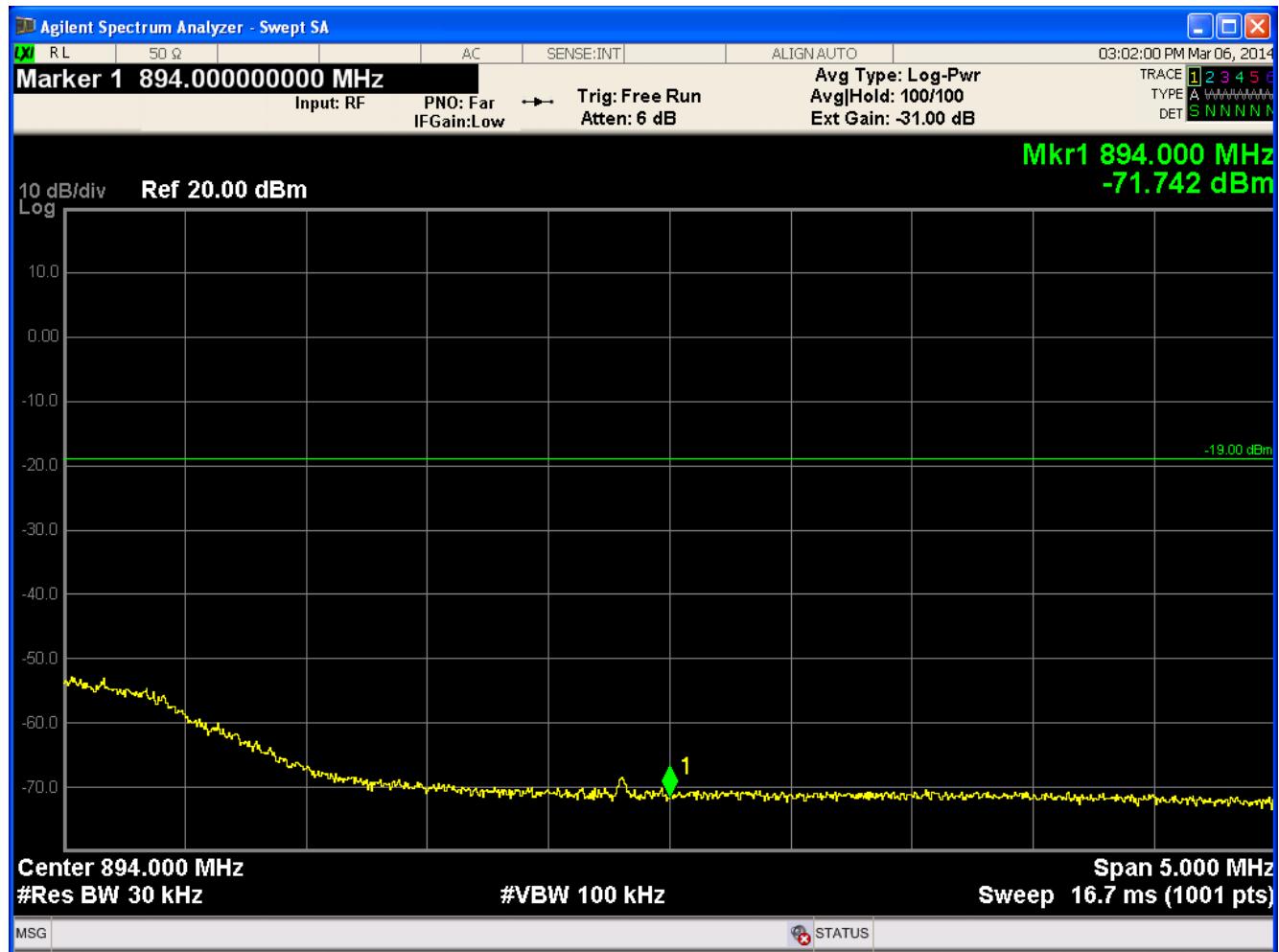


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 881.52 MHz
RF power : 10.00 dBm

Emission frequency : 869.0 MHz
Emission power : -71.14 dBm

Limit : -19.0 dBm
Margin : 52.14 dB

- Cellular/ Down link / Upper side / CDMA / 890.73 MHz

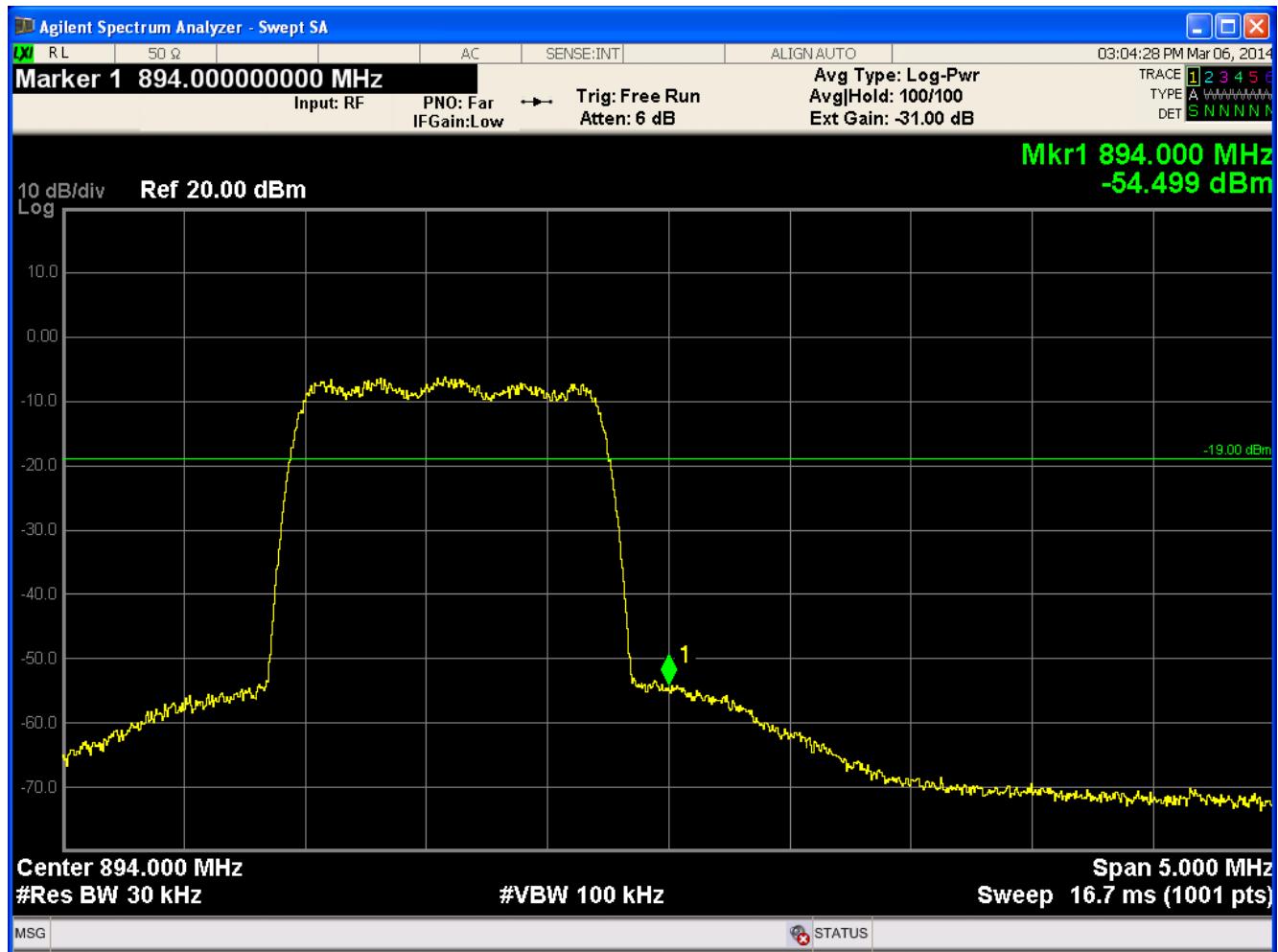


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 890.73 MHz
RF power : 10.30 dBm

Emission frequency : 894.0 MHz
Emission power : -71.74 dBm

Limit : -19.0 dBm
Margin : 52.74 dB

- Cellular/ Down link / Upper side / CDMA / 893.10 MHz

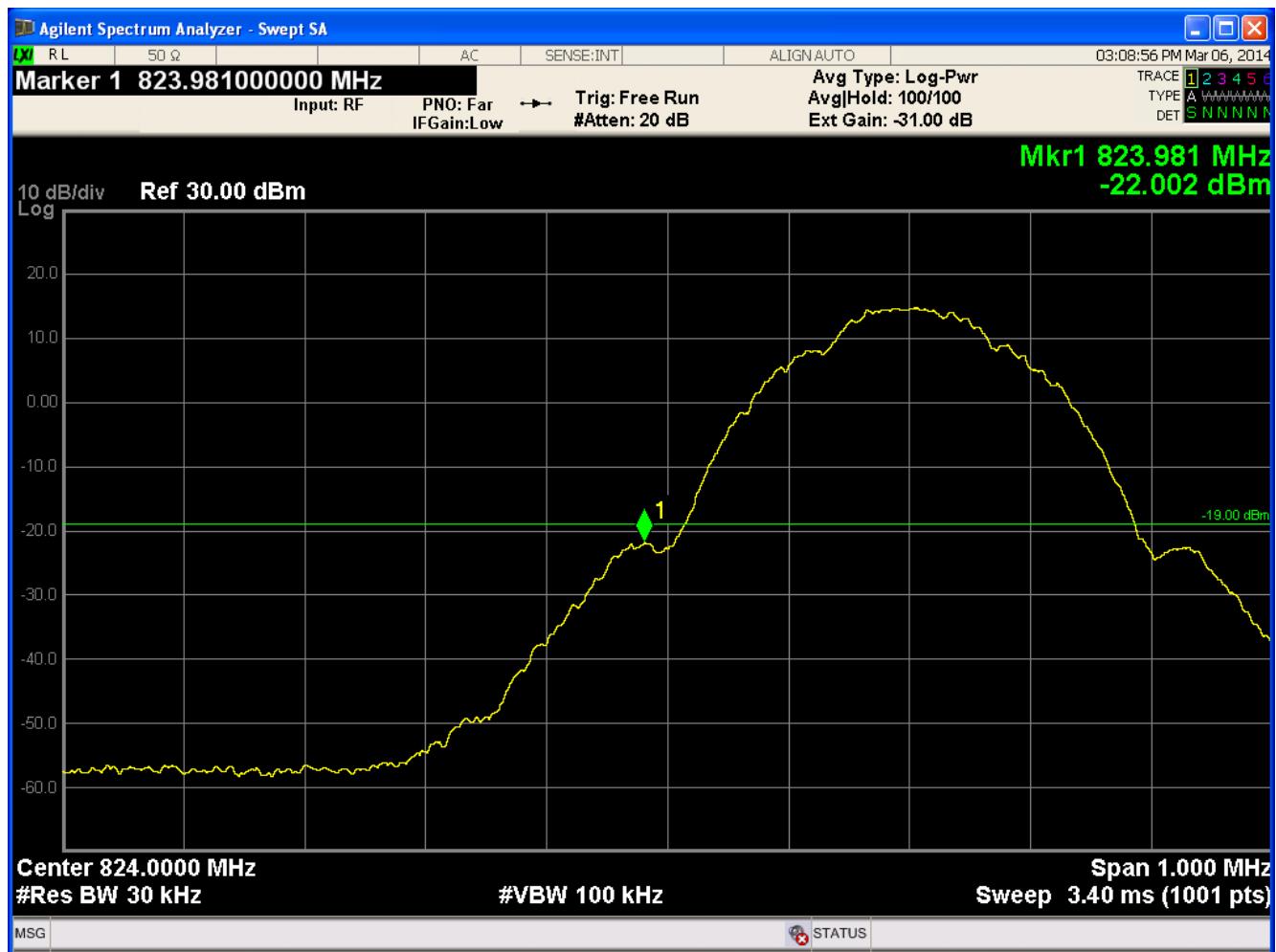


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 893.10 MHz
RF power : 10.20 dBm

Emission frequency : 894.0 MHz
Emission power : -54.49 dBm

Limit : -19.0 dBm
Margin : 35.49 dB

- Celluar/ Up link / Lower side / GSM



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 824.2 MHz
RF power : 23.10 dBm

Emission frequency : 823.98 MHz
Emission power : -22.0 dBm

Limit : -19.0 dBm
Margin : 3.0 dB

- Celluar/ Up link / Upper side / GSM

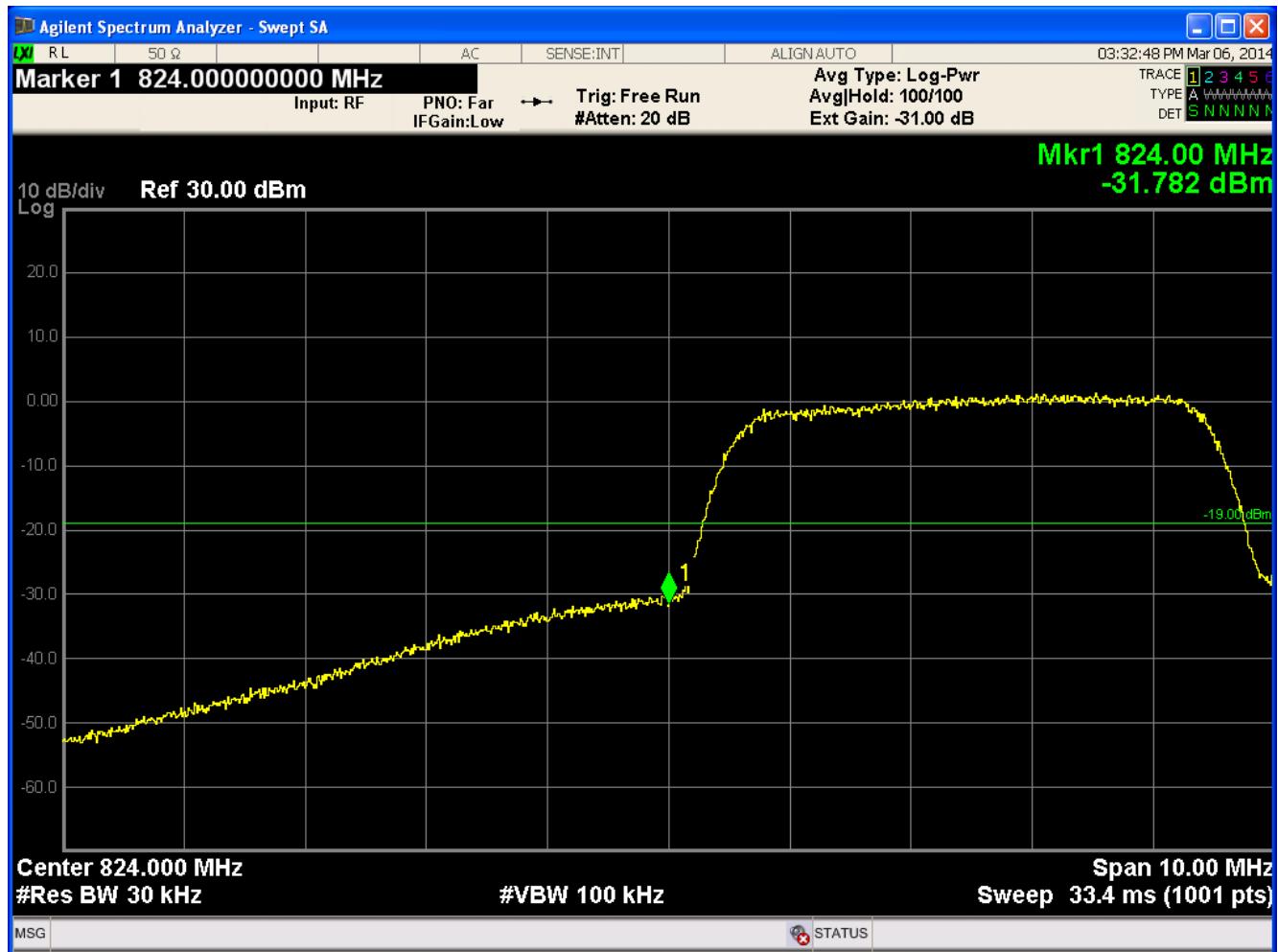


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 848.8 MHz
RF power : 22.9 dBm

Emission frequency : 849.02 MHz
Emission power : -21.92 dBm

Limit : -19.0 dBm
Margin : 2.92 dB

- Celluar/ Up link / Lower side / AWGN



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 826.5 MHz
RF power : 22.9 dBm

Emission frequency : 824.0 MHz
Emission power : -31.78 dBm

Limit : -19.0 dBm
Margin : 12.78 dB

- Celluar/ Up link / Upper side / AWGN

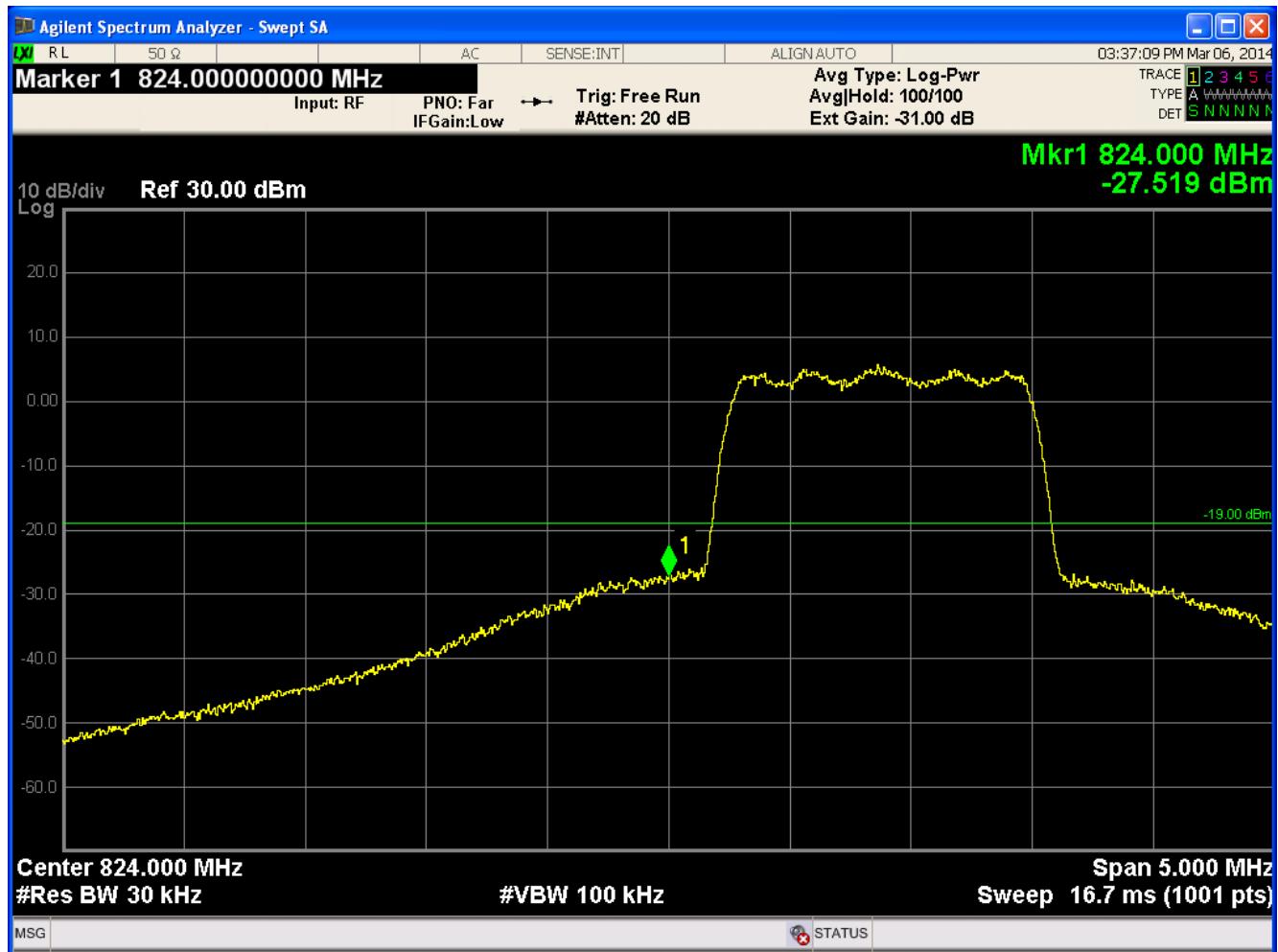


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 846.5 MHz
RF power : 22.9 dBm

Emission frequency : 849.0 MHz
Emission power : -30.98 dBm

Limit : -19.0 dBm
Margin : 11.98 dB

- Celluar/ Up link / Lower side / CDMA / 824.88 MHz

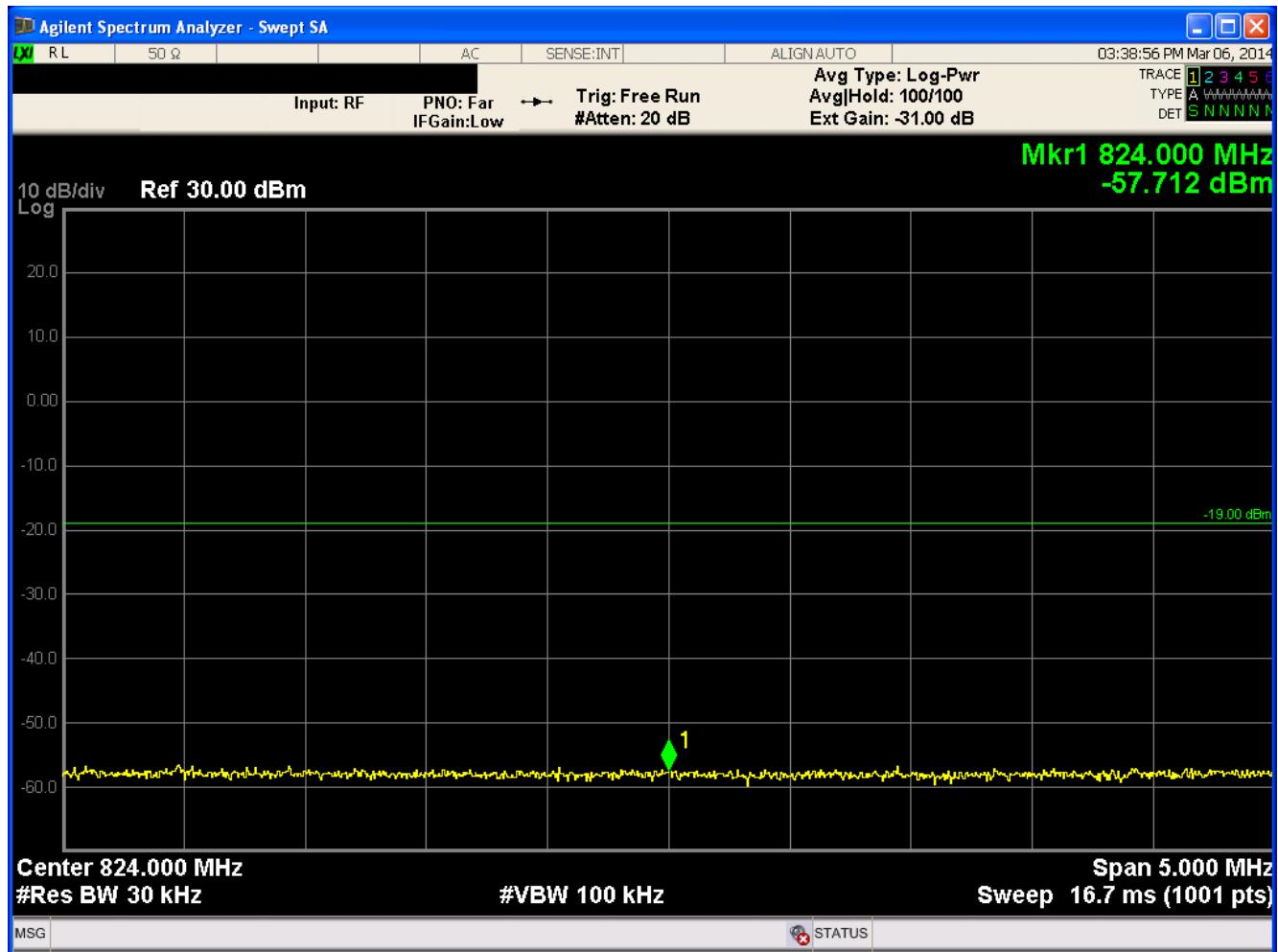


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 824.88 MHz
RF power : 23.10 dBm

Emission frequency : 824.0 MHz
Emission power : -27.51 dBm

Limit : -19.0 dBm
Margin : 8.51 dB

- Celluar/ Up link / Lower side / CDMA / 836.52 MHz



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 836.52 MHz
RF power : 22.9 dBm

Emission frequency : 824.0 MHz
Emission power : -57.71 dBm

Limit : -19.0 dBm
Margin : 38.71 dB

- Celluar/ Up link / Upper side / CDMA / 845.73 MHz



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 845.73 MHz
RF power : 23.00 dBm

Emission frequency : 849.0 MHz
Emission power : -52.52 dBm

Limit : -19.0 dBm
Margin : 33.52 dB

- Celluar/ Up link / Upper side / CDMA / 848.10 MHz

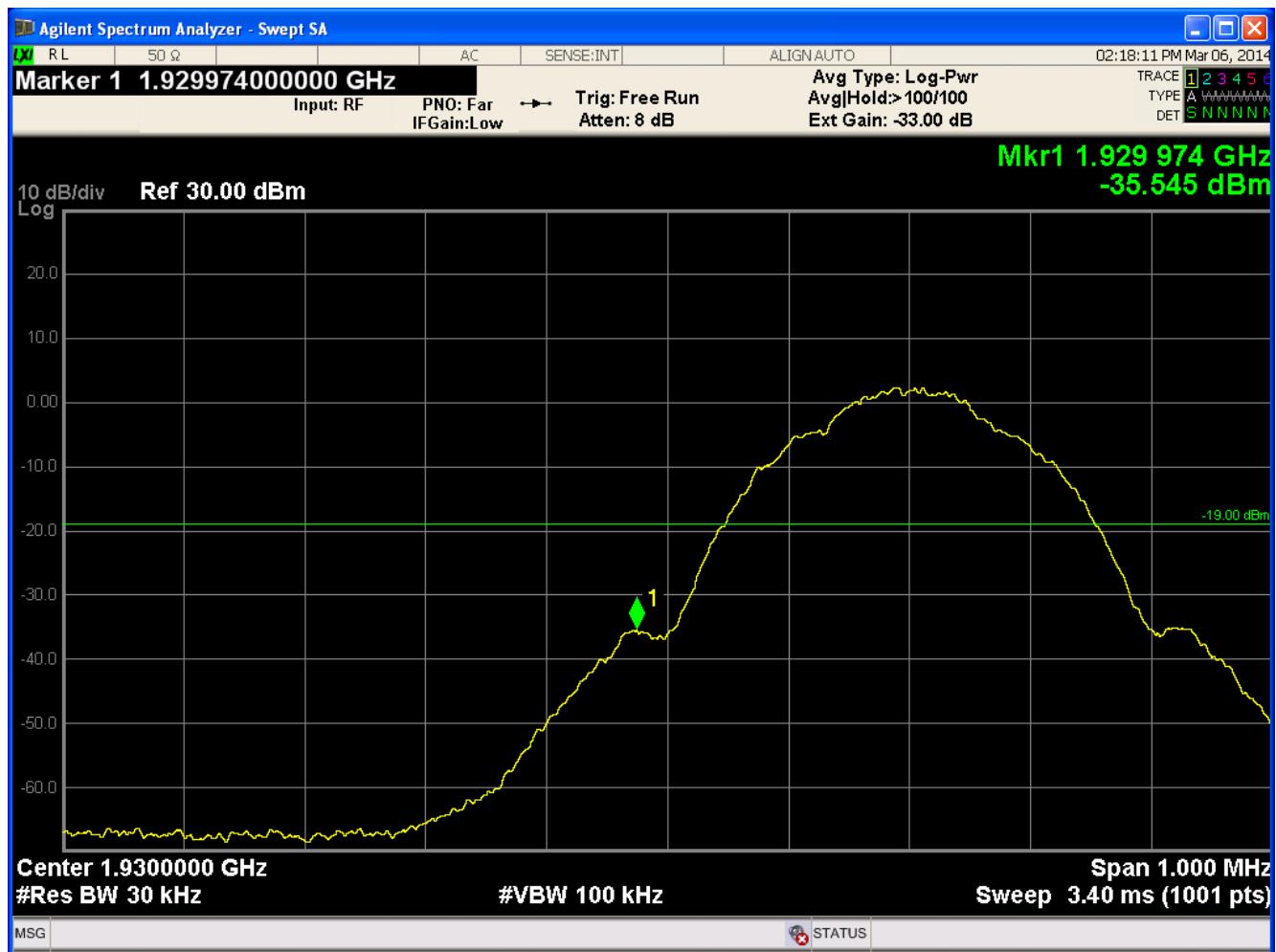


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 848.10 MHz
RF power : 23.0 dBm

Emission frequency : 849.0 MHz
Emission power : -25.18 dBm

Limit : -19.0 dBm
Margin : 6.18 dB

- PCS/ Down link / Lower side / GSM



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1930.2 MHz
RF power : 10.10 dBm

Emission frequency : 1929.97 MHz
Emission power : -35.54 dBm

Limit : -19.0 dBm
Margin : 16.54 dB

- PCS/ Down link / Upper side / GSM

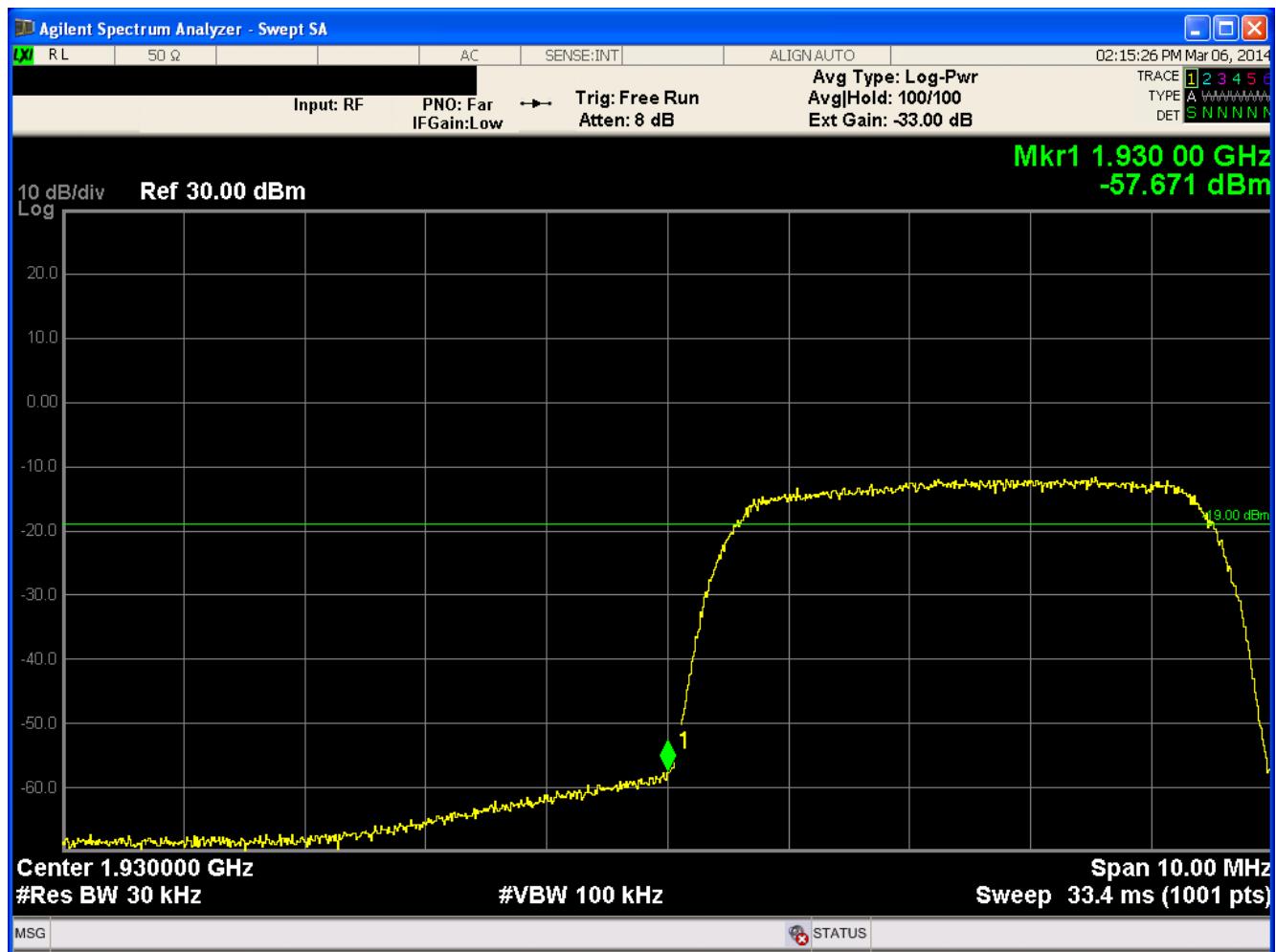


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1989.8 MHz
RF power : 10.02 dBm

Emission frequency : 1990.02 MHz
Emission power : -35.81 dBm

Limit : -19.0 dBm
Margin : 16.81 dB

- PCS/ Down link / Lower side / AWGN

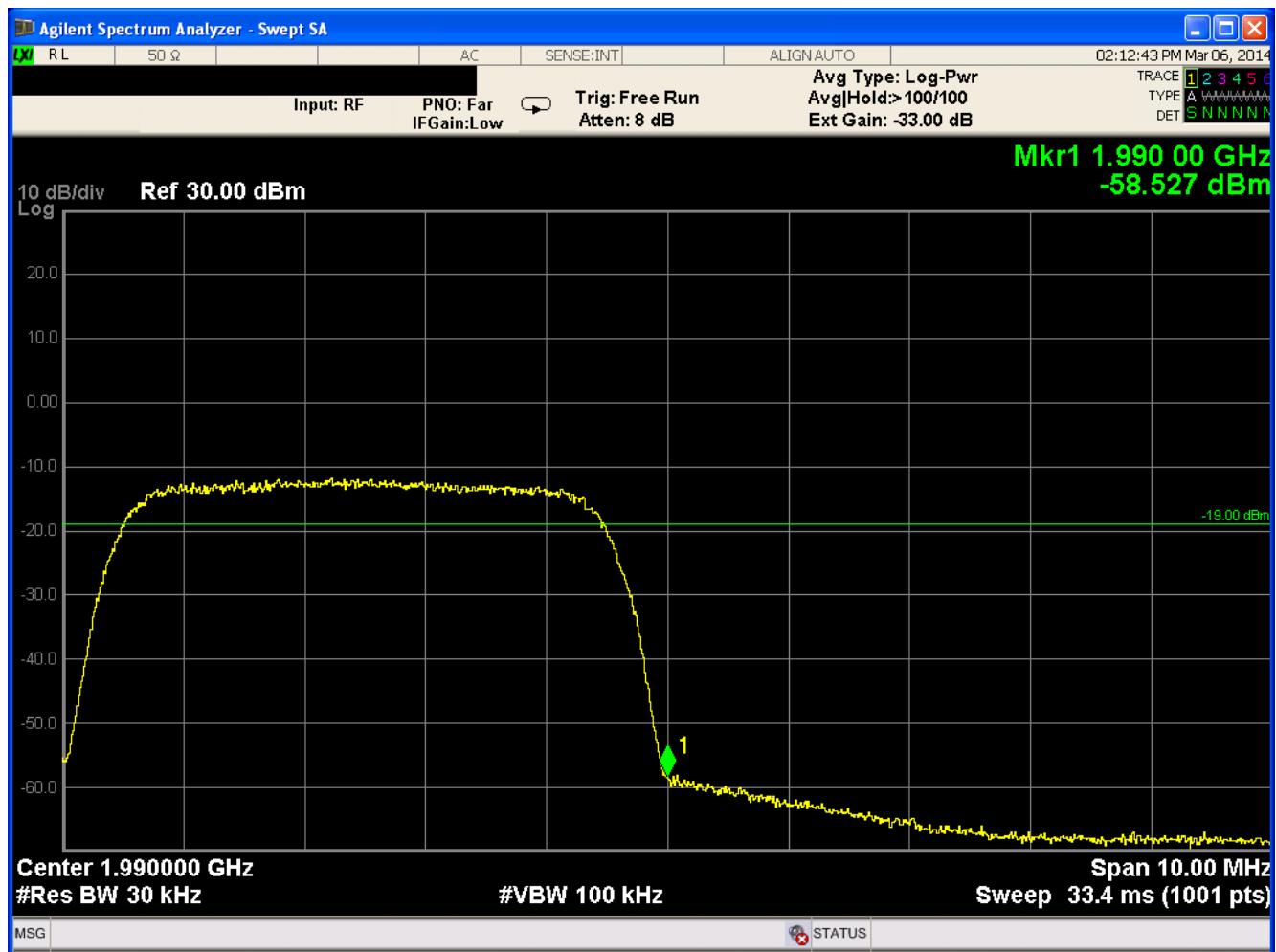


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1932.5 MHz
RF power : 10.10 dBm

Emission frequency : 1930.0 MHz
Emission power : -57.61 dBm

Limit : -19.0 dBm
Margin : 38.61 dB

- PCS/ Down link / Upper side / AWGN

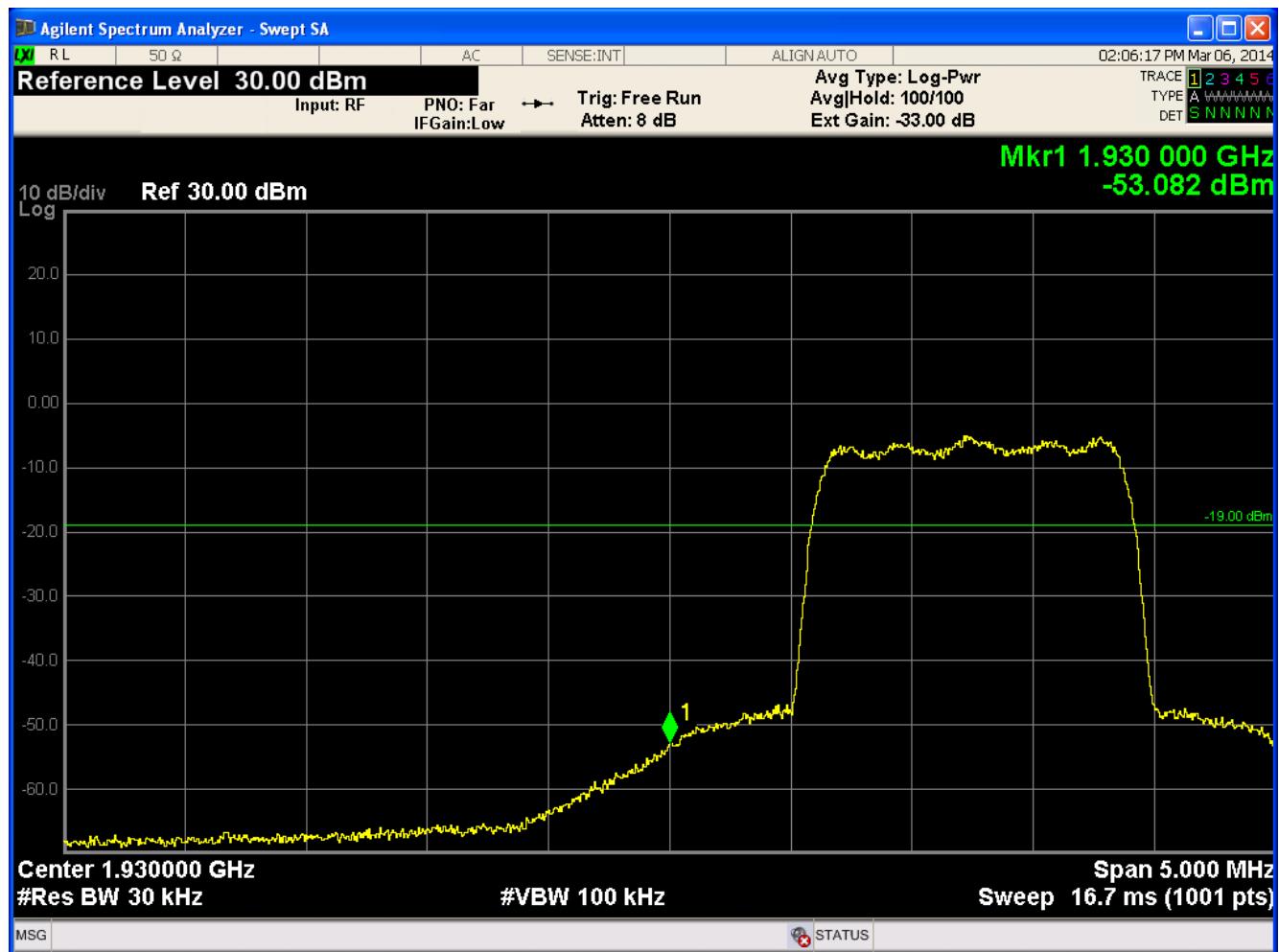


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1987.5 MHz
RF power : 10.02 dBm

Emission frequency : 1990.0 MHz
Emission power : -58.52 dBm

Limit : -19.0 dBm
Margin : 39.52 dB

- PCS/ Down link / Lower side / CDMA

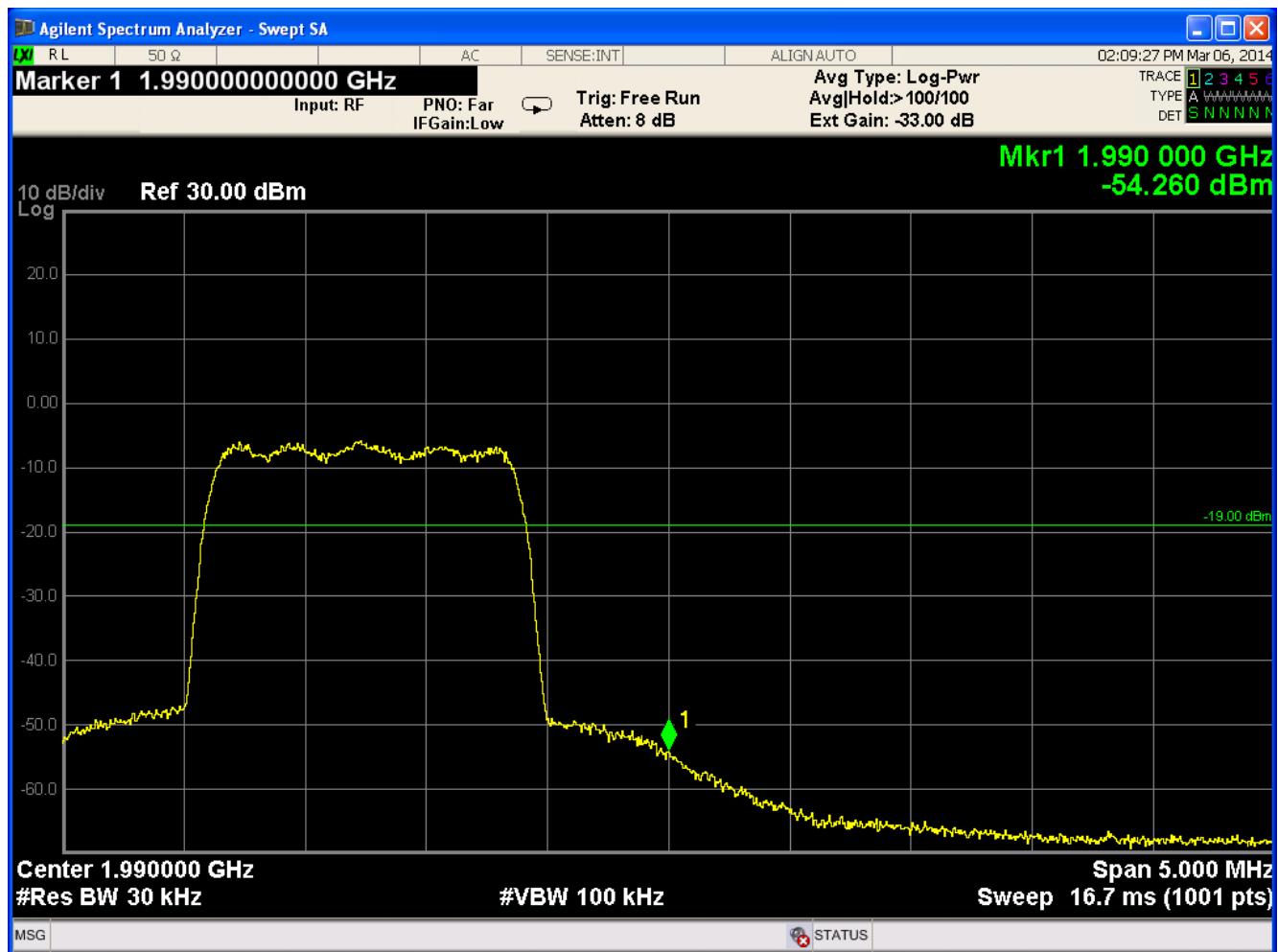


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1931.25 MHz
RF power : 10.1 dBm

Emission frequency : 1930.0 MHz
Emission power : -53.08 dBm

Limit : -19.0 dBm
Margin : 34.08 dB

- PCS/ Down link / Upper side / CDMA

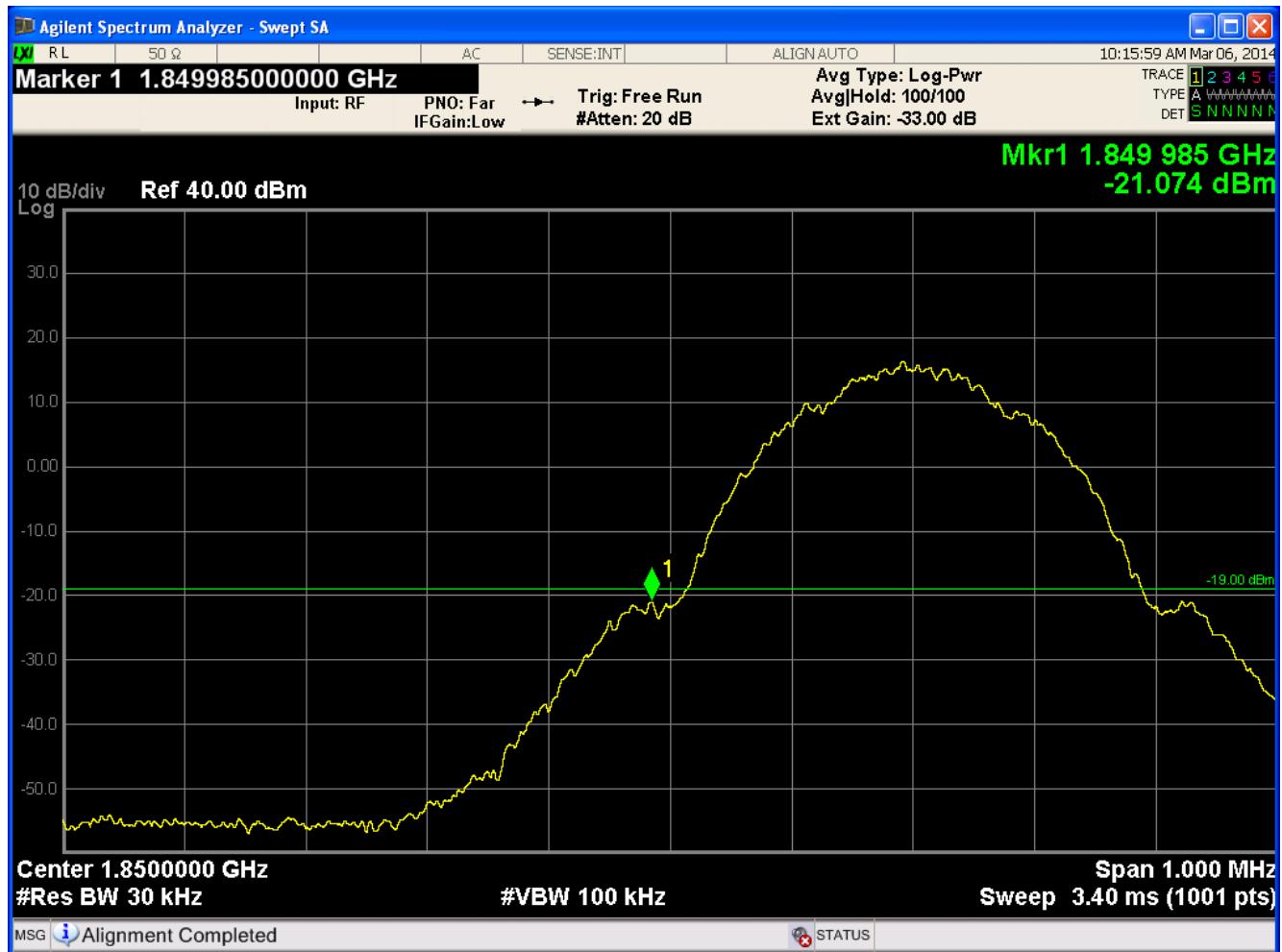


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1988.75 MHz
RF power : 9.9 dBm

Emission frequency : 1990.0 MHz
Emission power : -54.26 dBm

Limit : -19.0 dBm
Margin : 35.26 dB

- PCS/ Up link / Lower side / GSM

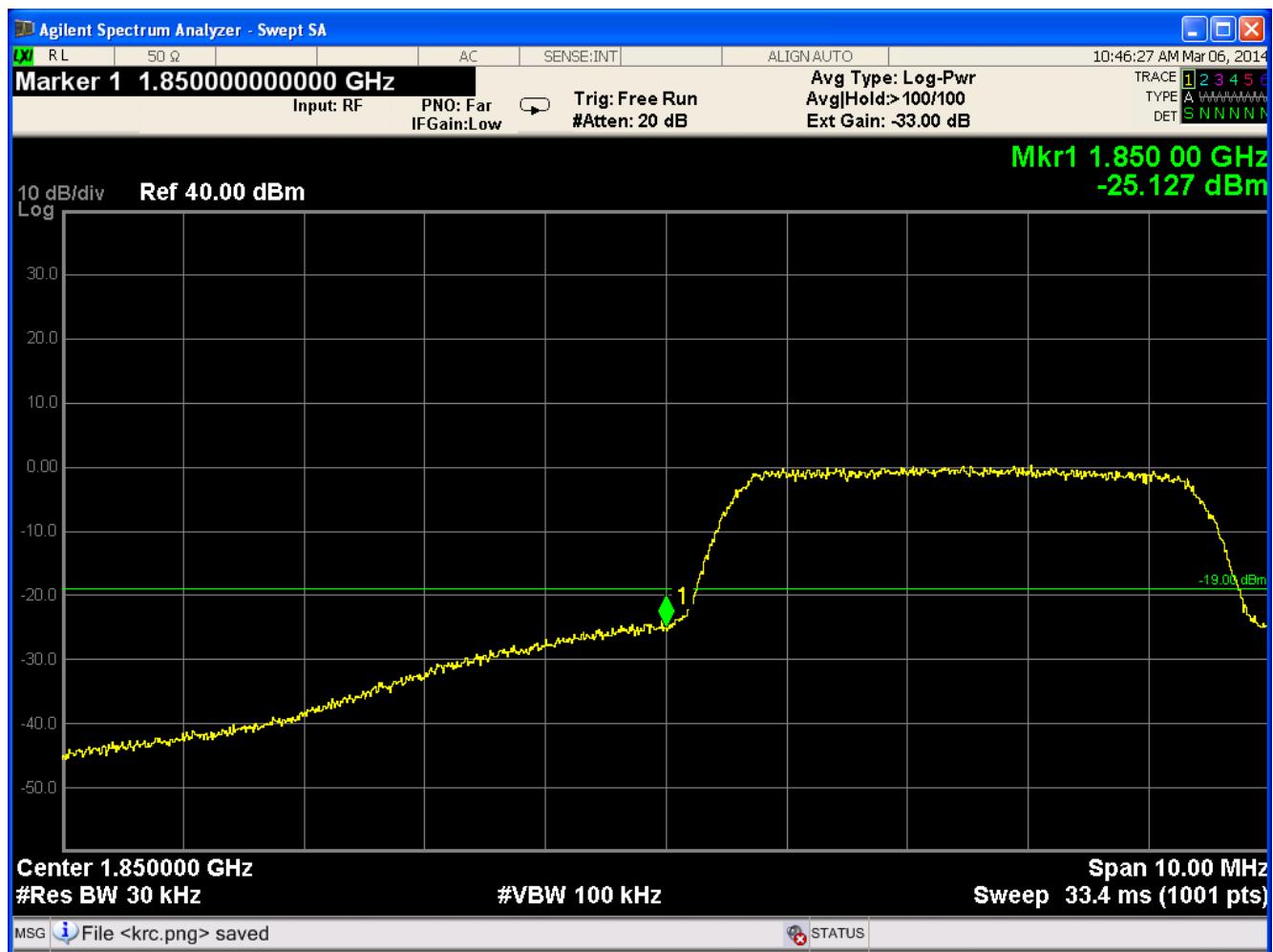


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1850.2 MHz
RF power : 23.0 dBm

Emission frequency : 1849.98 MHz
Emission power : -21.07 dBm

Limit : -19.0 dBm
Margin : 2.07 dB

- PCS/ Up link / Lower side / AWGN

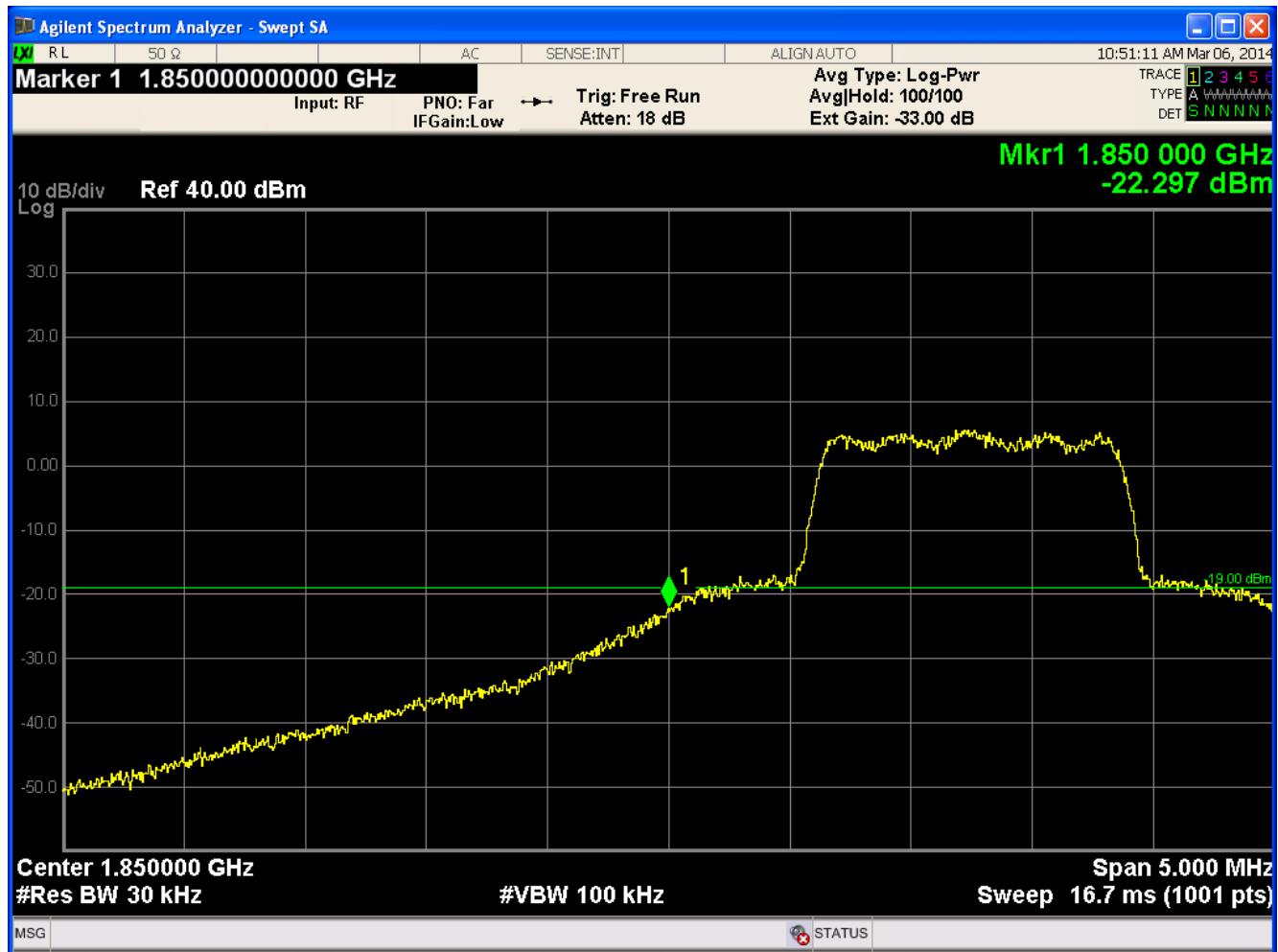


RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1852.5 MHz
RF power : 23.0 dBm

Emission frequency : 1850.0 MHz
Emission power : -25.12 dBm

Limit : -19.0 dBm
Margin : 6.12 dB

- PCS/ Up link / Lower side / CDMA



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1851.25 MHz
RF power : 22.0 dBm

Emission frequency : 1850.0 MHz
Emission power : -22.29 dBm

Limit : -19.0 dBm
Margin : 3.29 dB

- PCS/ Up link / Upper side / GSM



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1909.8 MHz
RF power : 23.01 dBm

Emission frequency : 1910.02 MHz
Emission power : -22.37 dBm

Limit : -19.0 dBm
Margin : 3.37 dB

- PCS/ Up link / Upper side / AWGN



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1907.5 MHz
RF power : 22.8 dBm

Emission frequency : 1910.0 MHz
Emission power : -25.64 dBm

Limit : -19.0 dBm
Margin : 6.64 dB

- PCS/ Up link / Upper side / CDMA



RBW : 30 kHz
VBW : 100 kHz
Detector mode : RMS
Trace mode : 100 trace averaging
Operation frequency : 1908.75 MHz
RF power : 23.01 dBm

Emission frequency : 1910.0 MHz
Emission power : -25.62 dBm

Limit : -19.0 dBm
Margin : 6.62 dB

3.6 Conducted spurious emission

3.6.1 Specification

- FCC Part 22.917(a)
- FCC Part 24.238(a)
- § 2.1051 Spurious emission at antenna terminals

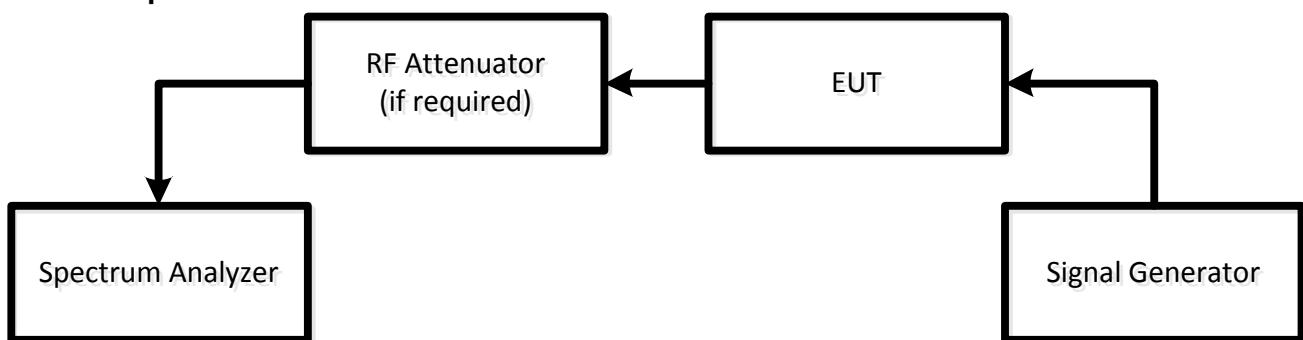
3.6.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.6
 - a) Connect the EUT to the test equipment as shown in **Set-Up**. Begin with the uplink output connected to the spectrum analyzer.
 - b) Configure the signal generator for AWGN with a 99% occupied bandwidth of 4.1 MHz operation with a center frequency corresponding to the center of the CMRS band under test.
 - c) Set the signal generator amplitude to the level determined in the power measurement procedure in **Maximum power**.
 - d) Turn on the signal generator RF output and measure the spurious emission power levels with an appropriate measurement instrument as follows.
 - e) Set RBW = measurement bandwidth specified in the applicable rule section for the operational frequency band under consideration (see Annex A for relevant cross-references). Note that many of the individual rule sections permit the use of a narrower RBW (typically $\geq 1\%$ of the emission bandwidth) to enhance measurement accuracy, but the result must then be integrated over the specified measurement bandwidth.
 - f) Set VBW = 3 X RBW.
 - g) Select the power averaging (RMS) detector. (See above note regarding the use of a peak detector for preliminary measurements.)
 - h) Sweep time = auto-couple.
 - i) Set the analyzer start frequency to the lowest radio frequency 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. Note that the number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$ which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer. Trace average at least 10 traces in power averaging (i.e., RMS) mode.
 - j) 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.
 - k) Reset the 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 analyzer stop frequency to 10 times the highest frequency of the fundamental emission. Note that the number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$ which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.
 - l) 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.
 - m) Repeat steps b) through l) for each supported frequency band of operation.

3.6.3 Limit

- §2.1051, FCC Part 22.917(a), FCC Part 24.238(a)
Conducted emissions limit = -13 dBm
- Emissions limit = $P1 - (43 + 10 \log (P2)) = -13 \text{ dBm}$
 $P1 = \text{Power in dBm}$
 $P2 = \text{Power in Watts}$
- Booster out of band emissions (OOBE) shall be at least 6 dB below the FCC's mobile emission limits
Booster's emission limit = Mobile emission limit – 6 dB = -19 dBm

3.6.4 Set-Up



3.6.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.6.6 Test condition

- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.6.7 Test result

- Spurious emission – 10 MHz to 20 GHz

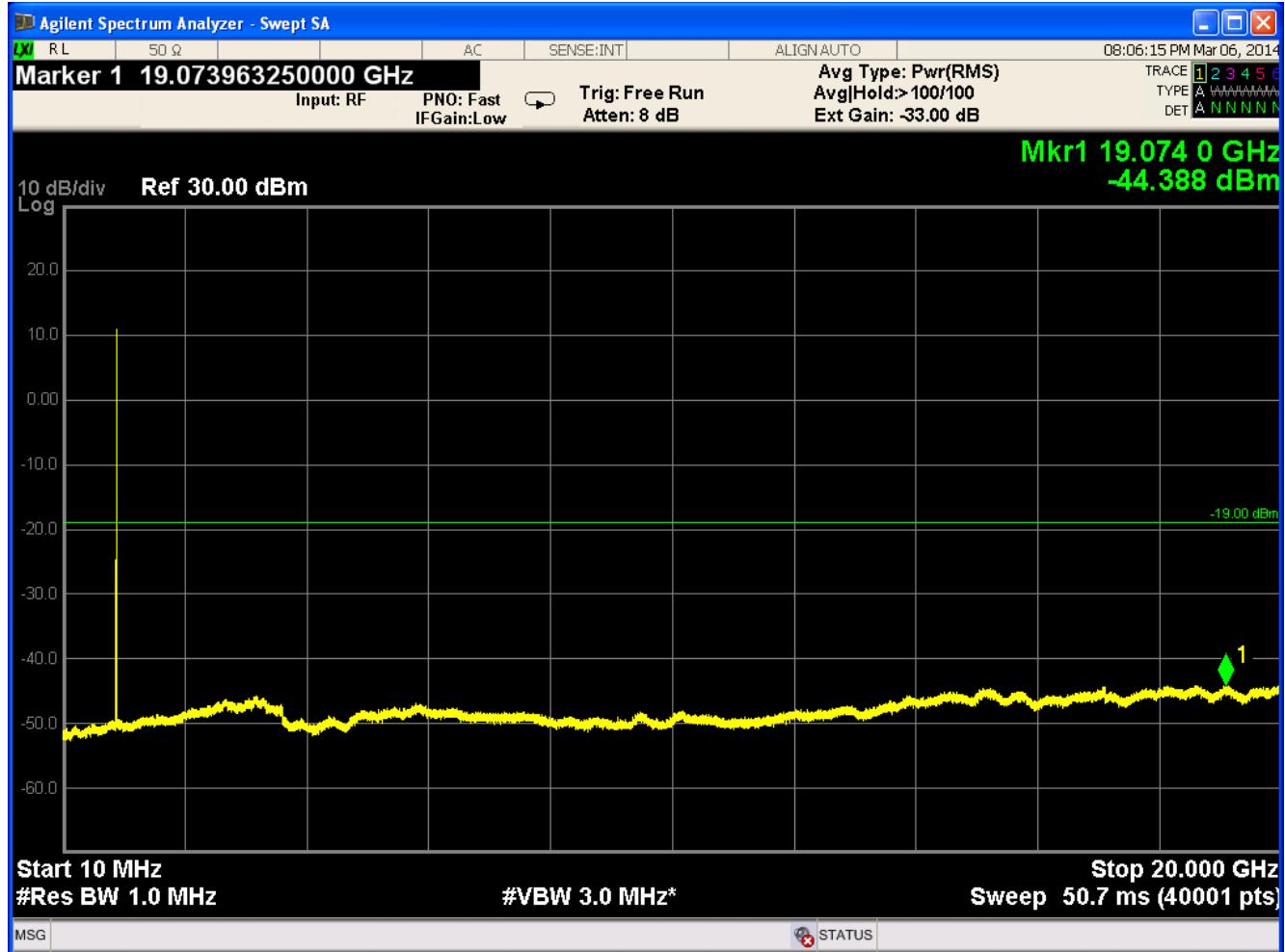
Band	Link	Operation frequency [MHz]	Frequency range of spurious emission [MHz]	Level of spurious emission [dBm]	RBW [MHz]	Limit [dBm]
Celluar	Down Link	881.5	10 to 20 000	-	1	-19.0
	Up Link	836.5		-23.63	1	
PCS	Down Link	1960.0	10 to 20 000	-	1	-19.0
	Up Link	1880.0		-37.88	1	

※ Bandwidth correction factor = $10\log(10/6.25) = 2.0$ dB

※ All other emissions level is below 20 dB to limit.

3.3.8 Plots of spurious emissions

- Cellular/ Down link / 10 MHz to 20 GHz

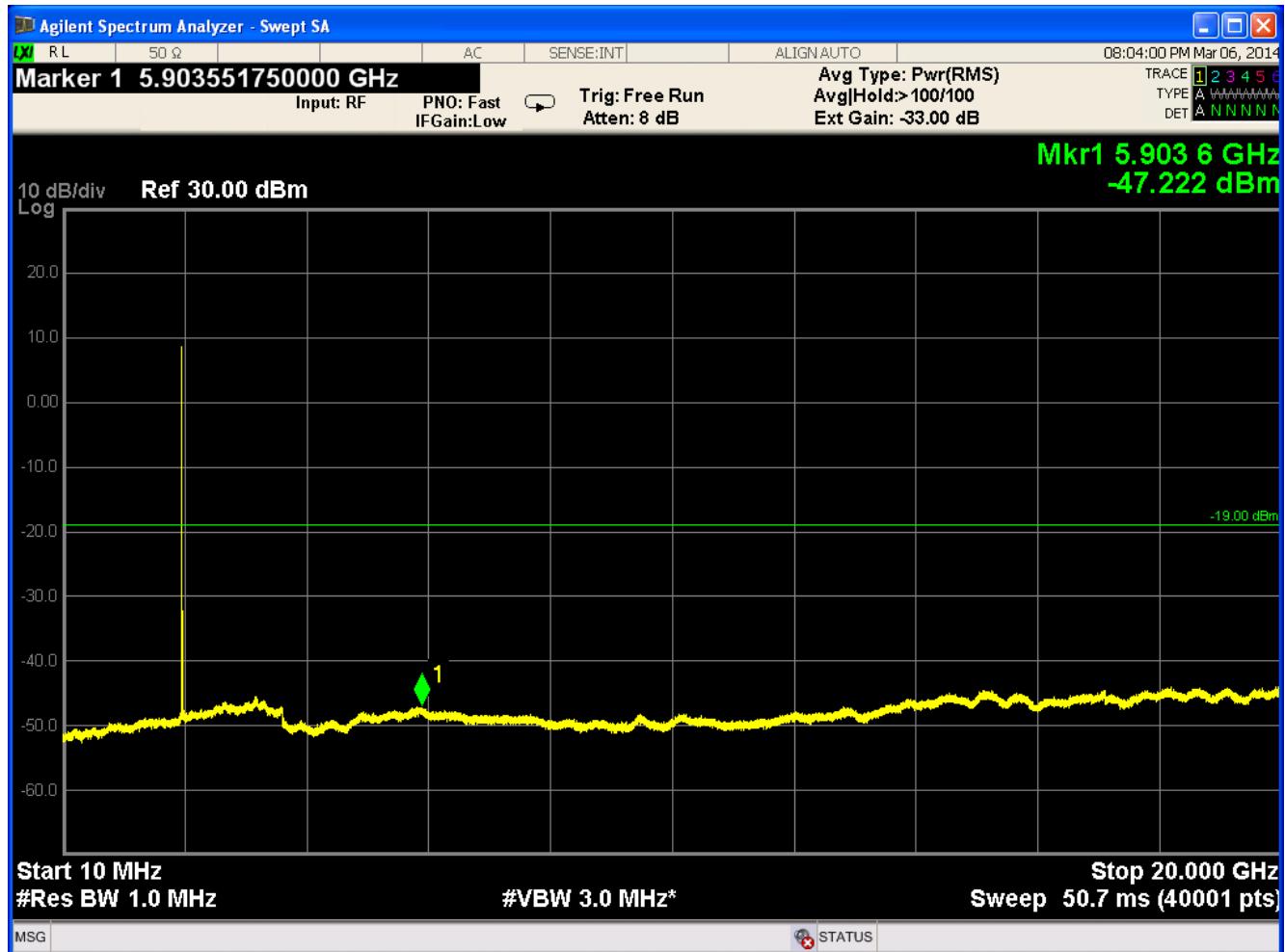


Operating frequency : 881.5 MHz
RBW : 1 MHz
VBW : 3 MHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 20 GHz

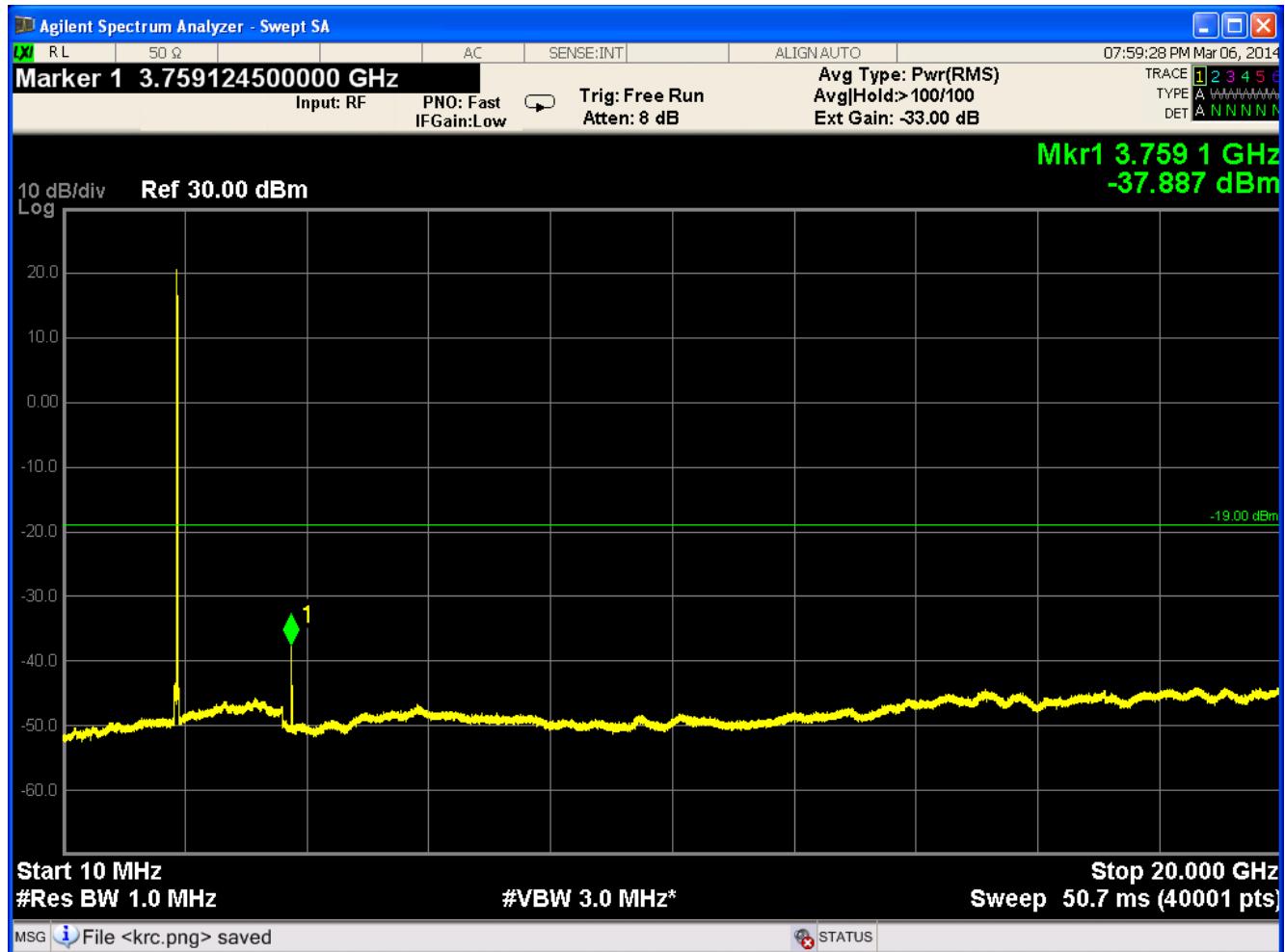
Emission : Not found

• Cellular/ Up link / 10 MHz to 20 GHz


Operating frequency : 836.5 MHz
RBW : 1 MHz
VBW : 3 MHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 20 GHz
Emission : -23.63 dBm

• PCS/ Down link / 10 MHz to 20 GHz


Operating frequency : 1960 MHz
RBW : 1 MHz
VBW : 3 MHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 20 GHz
Emission : Not found

• PCS/ Up link / 10 MHz to 20 GHz


Operating frequency : 1880 MHz
RBW : 1 MHz
VBW : 3 MHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 20 GHz
Emission : -37.88 dBm

3.7 Noise limit

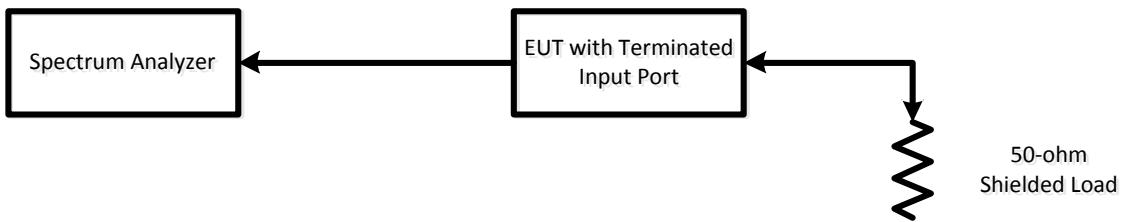
3.7.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(A)

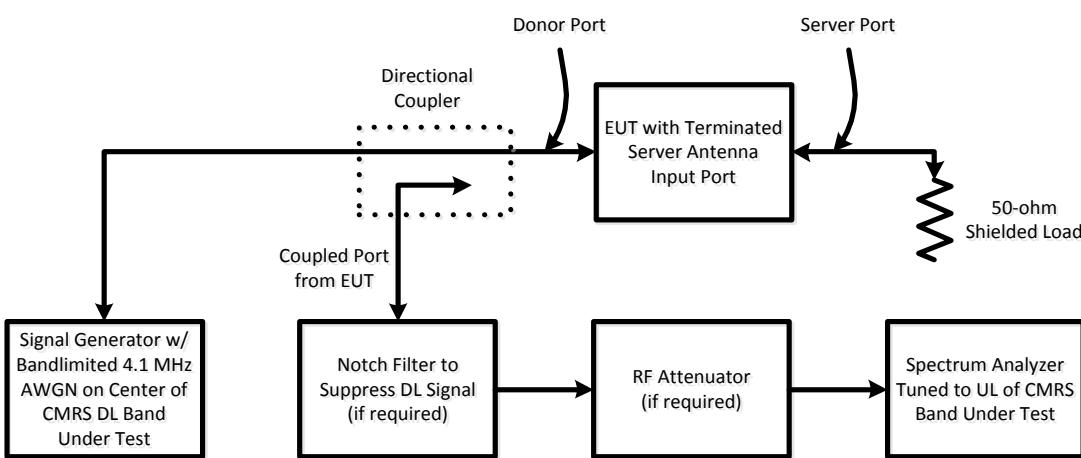
3.7.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.7
 - a) Connect the EUT to the test equipment as shown in **Set-Up 1**. Begin with the uplink output connected to the spectrum analyzer.
 - b) Set the spectrum analyzer RBW to 1 MHz with the VBW \geq 3X RBW
 - c) Select the power averaging (RMS) detector and trace average over at least 100 traces.
 - d) Set the center frequency of the spectrum analyzer to the center of the CMRS band under test with the span \geq 2X the CMRS band.
 - e) Measure the maximum transmitter noise power level.
 - f) Save the spectrum analyzer plot as necessary for inclusion in the final test report.
 - g) Repeat steps b) to f) for all operational uplink and downlink bands.
 - h) Connect the EUT to the test equipment as shown in **Set-Up 2** for uplink and **Set-Up 3** for downlink. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.
 - i) Configure the signal generator for 4.1 MHz AWGN operation for uplink test and 200 kHz 99% OBW AWGN for downlink test.
 - j) Set the spectrum analyzer RBW for 1 MHz with the VBW \geq 3X the RBW with an RMS AVERAGE detector with at least 100 trace averages.
 - k) Set the center frequency of the spectrum analyzer to the center of the CMRS band under test with the span \geq 2X the CMRS band. This shall include all spectrum blocks in the particular CMRS band under test (see Annex A). For uplink noise measurements, set the spectrum analyzer center frequency for the uplink band under test and tune the signal generator to the center of the paired downlink band. For downlink noise measurements, set the spectrum analyzer to the center of the downlink band and tune the signal generator to the upper or lower band-edge of the same band, ensuring that the maximum noise power is being measured.
 - l) Measure the maximum transmitter noise power level when varying the downlink signal generator level from -90 dBm to -20 dBm in 1 dB steps within the RSSI dependent region and 10 dB steps outside the RSSI dependent region, report the six values closest to the limit with at least two points within the RSSI dependent region of the limit.
 - m) Repeat g) through l) for all operational uplink and downlink bands.
 - n) Variable uplink noise timing is to be measured as follows.
 - o) Set the spectrum analyzer to the uplink frequency to be measured.
 - p) Set the span to 0 Hz with a sweep time of 10 seconds.
 - q) Set the power level of the signal generator to the lowest level of the RSSI dependent noise.
 - r) Select MAX HOLD and increase the power level of the signal generator by 10 dB for mobile boosters and 20 dB for fixed boosters.
 - s) Ensure that the uplink noise decreases to the specified level within 1 second for mobile devices and 3 seconds for fixed devices.
 - t) Repeat n) to s) for all operational uplink and downlink bands

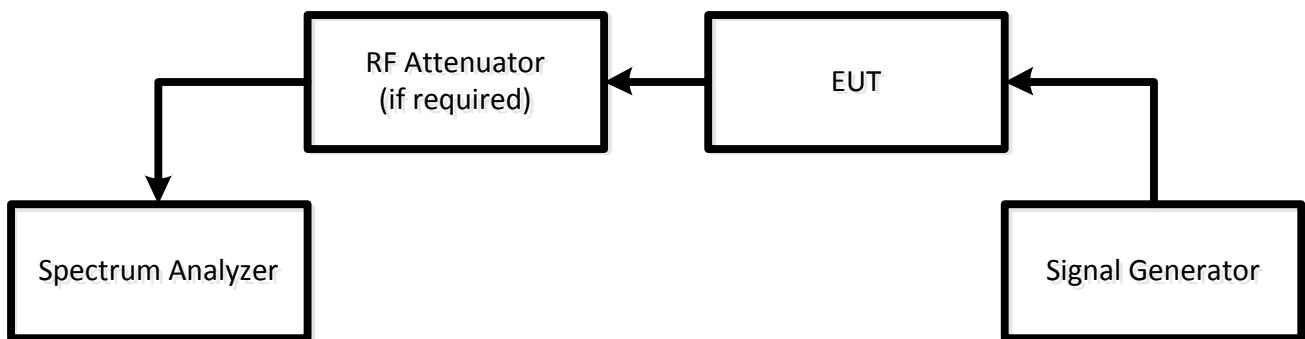
3.7.3 Set-Up 1 (Noise limit instrumentation setup)



3.7.4 Set-Up 2 (Test setup for uplink noise power measurement in the presence of a downlink signal)



3.7.5 Set-Up 3 (Test setup for downlink noise power measurement in the presence of a downlink signal)



3.7.6 Limit

- §20.21(e)(8)(i)(A)(1), The transmitted noise power in dBm/MHz of consumer boosters at their uplink and downlink ports shall not exceed -103 dBm/MHz—RSSI.
- §20.21(e)(8)(i)(A)(2)(ii), Mobile booster maximum noise power shall not exceed -59 dBm/MHz.

3.7.7 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.7.8 Test condition

- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.7.9 Test results of noise limit

Band	Link	Noise Level [dBm]	Noise Level Limit [dBm/MHz]	Margin [dB]
Celluar	Down Link	-61.2	-59.0	2.2
	Up Link	-61.5	-59.0	2.5
PCS	Down Link	61.2	-59.0	2.2
	Up Link	-62.2	-59.0	3.2

3.7.10 Test results of variable downlink noise limit

Band	RSSI [dBm]	Noise Level [dBm]	Noise Level Limit [dBm/MHz]	Margin [dB]
Celluar	-80.0	-62.7	-59.0	3.7
	-70.0	-62.4	-59.0	3.4
	-60.0	-62.5	-59.0	3.5
	-50.0	-62.9	-59.0	3.9
	-43.0	-62.2	-59.0	3.2
	-42.0	-63.4	-60.0	3.4
	-41.0	-64.2	-61.0	3.2
	-40.0	-65.2	-62.0	3.2
	-34.0	-69.9	-69.0	0.9
	-33.0	-77.3	-70.0	7.3
PCS	-80.0	-62.4	-59.0	3.4
	-70.0	-62.4	-59.0	3.4
	-60.0	-62.5	-59.0	3.5
	-50.0	-62.3	-59.0	3.3
	-43.0	-62.1	-59.0	3.1
	-42.0	-63.0	-60.0	3.0
	-41.0	-63.9	-61.0	2.9
	-40.0	-64.8	-62.0	2.8
	-34.0	-69.4	-69.0	0.4
	-33.0	-80.5	-70.0	10.5

3.7.11 Test results of variable uplink noise limit

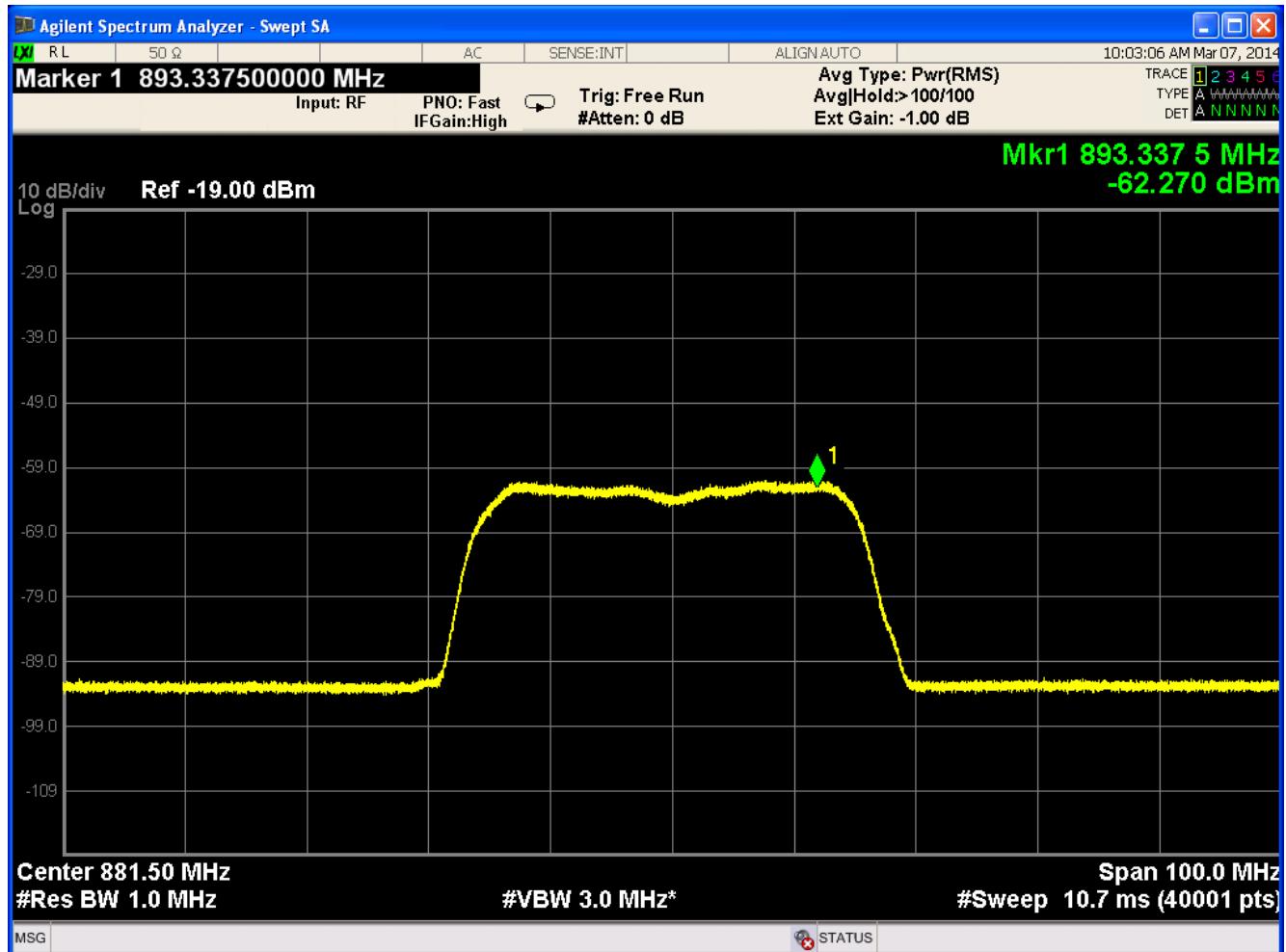
Band	RSSI [dBm]	Noise Level [dBm]	Noise Level Limit [dBm/MHz]	Margin [dB]
Celluar	-70.0	-61.6	-59.0	2.6
	-60.0	-61.7	-59.0	2.7
	-50.0	-61.8	-59.0	2.8
	-44.0	-61.3	-59.0	2.3
	-43.0	-61.5	-59.0	2.5
	-42.0	-82.1	-60.0	22.1
	-41.0	-82.3	-61.0	21.3
	-40.0	-82.6	-62.0	20.6
	-33.0	-82.3	-70.0	12.3
	-23.0	-82.8	-70.0	12.8
PCS	-70.0	-62.5	-59.0	3.5
	-60.0	-62.4	-59.0	3.4
	-50.0	-62.6	-59.0	3.6
	-44.0	-62.0	-59.0	3.0
	-43.0	-62.2	-59.0	3.2
	-42.0	-81.2	-60.0	21.1
	-41.0	-81.9	-61.0	20.9
	-40.0	-81.7	-62.0	19.7
	-33.0	-81.8	-70.0	11.8
	-23.0	-81.4	-70.0	11.4

3.7.12 Test results of variable decrease noise timing

Band	Link	Noise Timing [s]	Limit [s]	Result
Celluar	Down Link	0.8	3.0	Pass
	Up Link	0.8	3.0	Pass
PCS	Down Link	0.7	3.0	Pass
	Up Link	0.7	3.0	Pass

3.7.12 Test results

- Cellular/ Down link



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 893.33 MHz
Noise level : -62.27 dBm

Limit : -59.00 dBm
Margin : 3.27 dB

- Cellular/ Up link



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 846.30 MHz
Noise level : -61.50 dBm

Limit : -59.00 dBm
Margin : 2.5 dB

- PCS/ Down link



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1950.96 MHz
Noise level : -65.62 dBm

Limit : -59.00 dBm
Margin : 6.62 dB

- PCS/ Up link



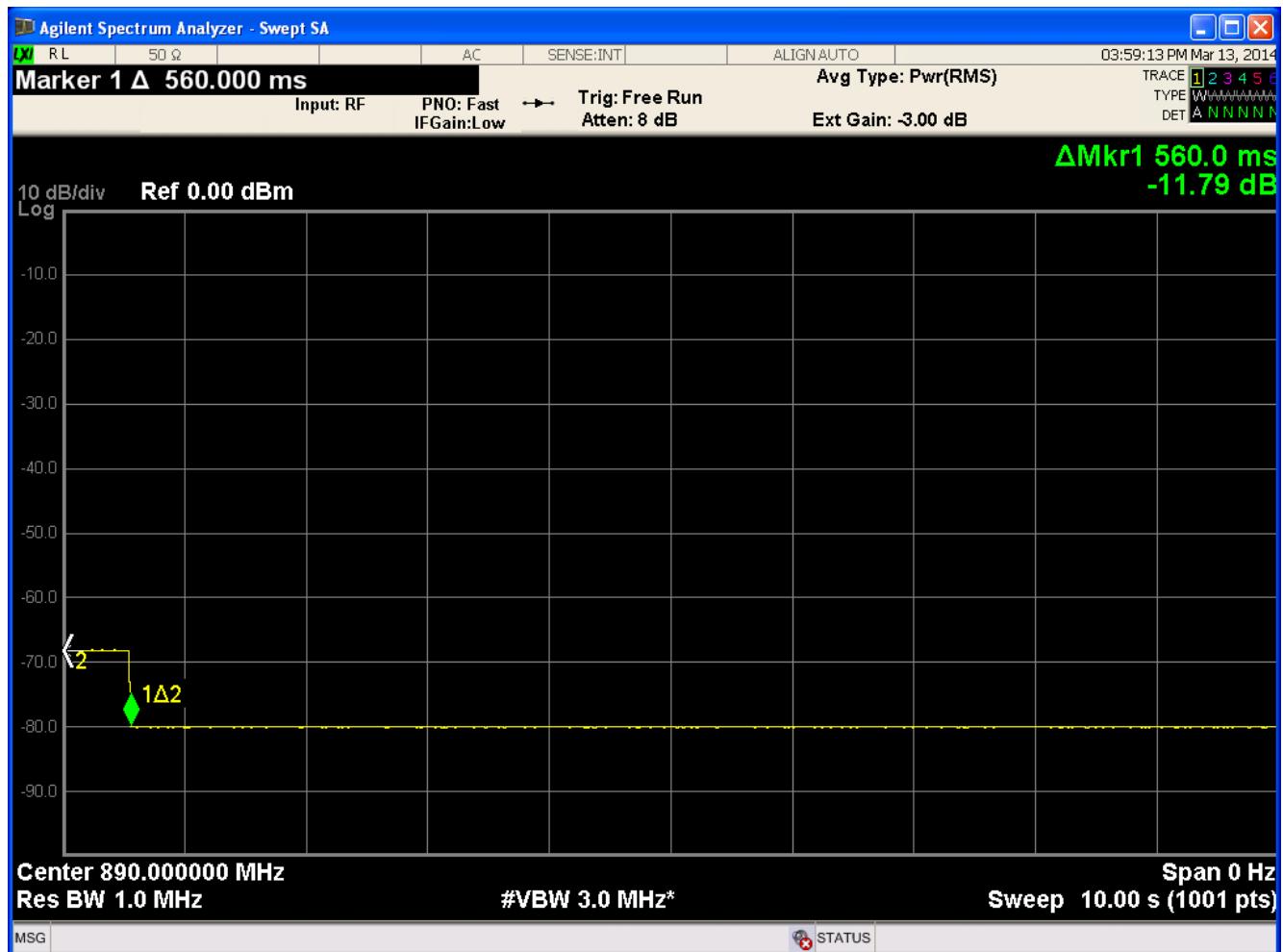
RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : 100 trace averaging

Frequency of highest power in band : 1878.51 MHz
Noise level : -62.23 dBm

Limit : -59.00 dBm
Margin : 3.23 dB

3.9.3 Test results of decrease timing

- Cellular/ Down link

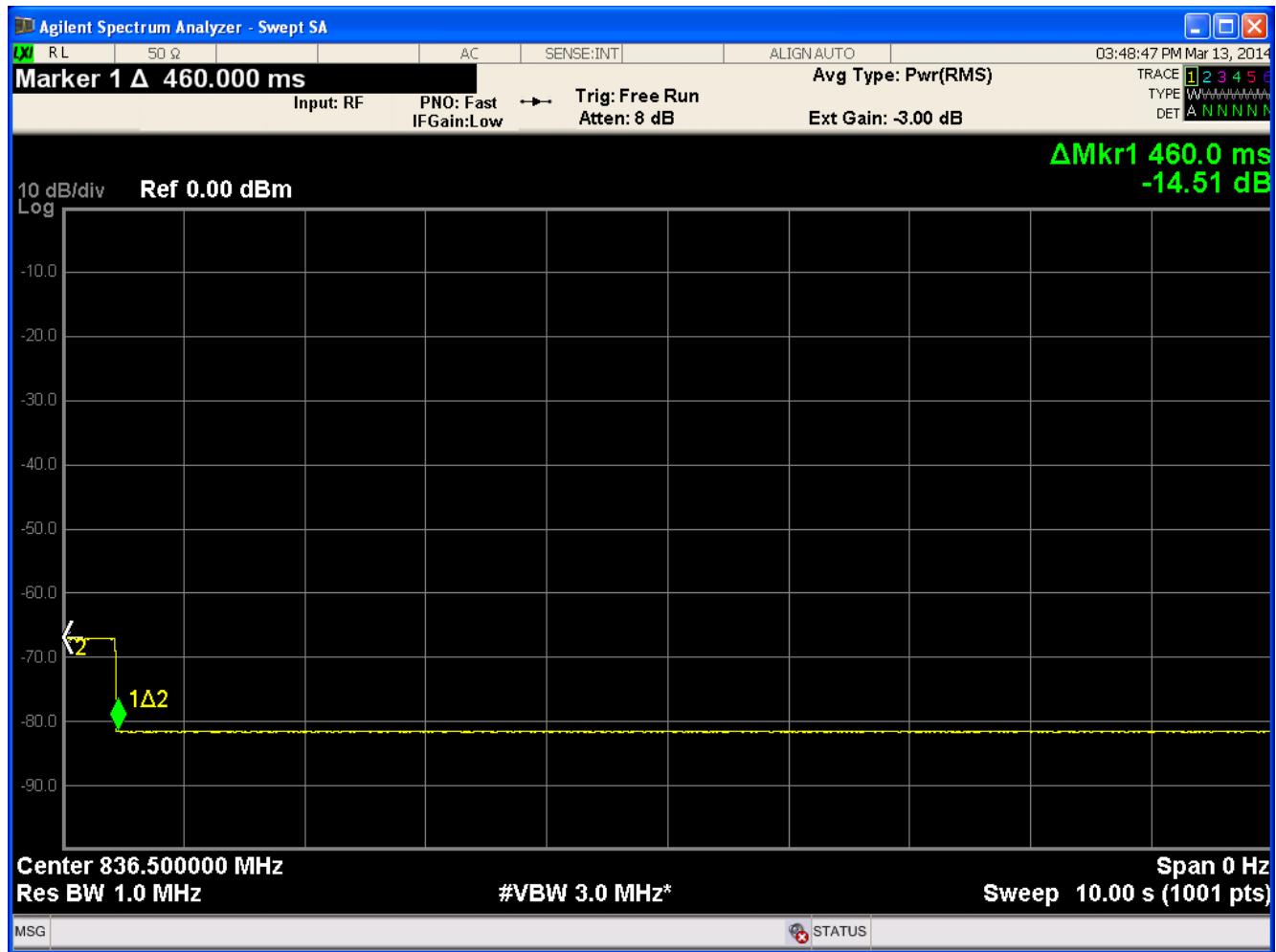


Frequency : 890.000 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.560 s

Limit of timing : 3 s (Fixed device)

- Cellular/ Up link

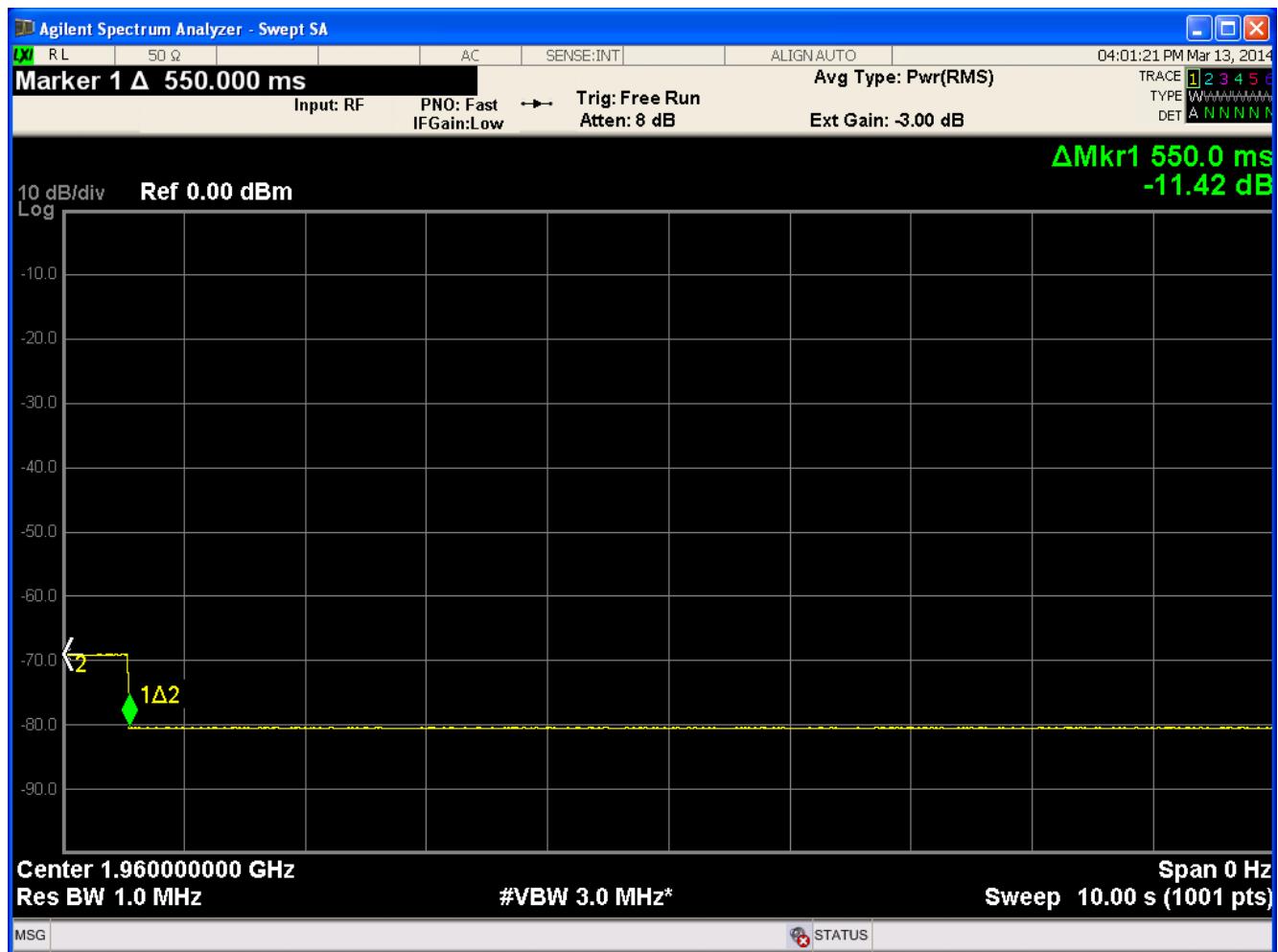


Frequency : 836.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.460 s

Limit of timing : 3 s (Fixed device)

- PCS/ Down link

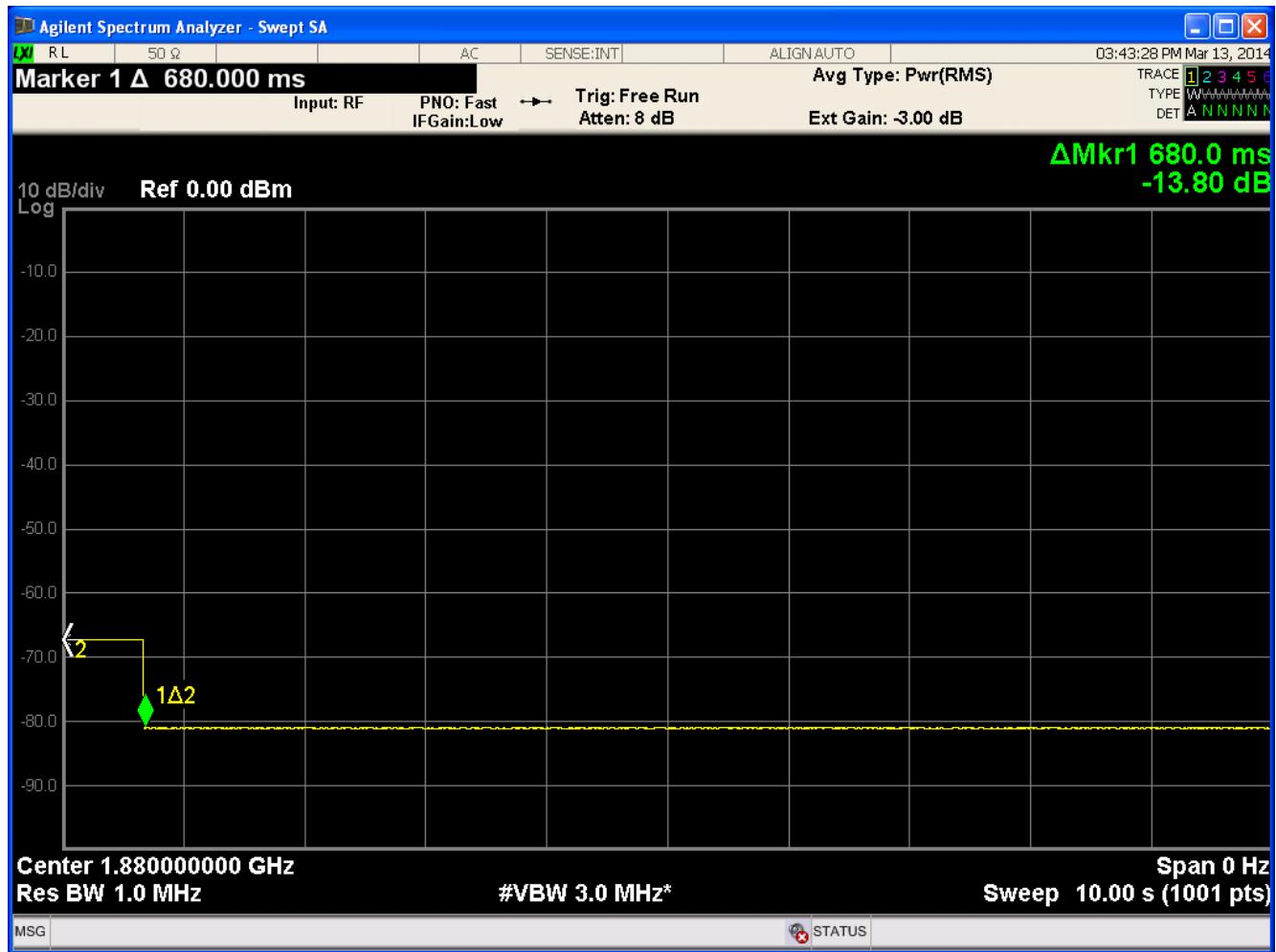


Frequency : 1960.000 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.550 s

Limit of timing : 3 s (Fixed device)

- PCS/ Up link



Frequency : 1880.000 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.680 s

Limit of timing : 3 s (Fixed device)

3.8 Uplink inactivity

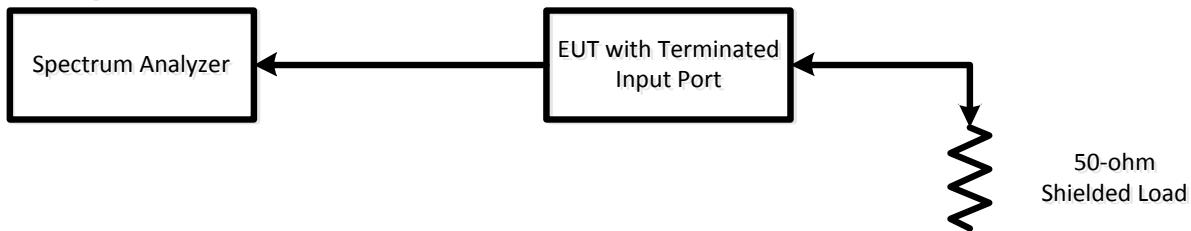
3.8.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(l)

3.8.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.8
 - Connect the EUT to the test equipment as shown in **Set-Up** with the uplink output connected to the spectrum analyzer.
 - Select the RMS power averaging detector.
 - Set the spectrum analyzer RBW for 1 MHz with the VBW \geq 3X RBW.
 - Set the center frequency of the spectrum analyzer to the center of the uplink operational band.
 - Set the span for 0 Hz with a single sweep time for a minimum of 330 seconds.
 - Start to capture a new trace using MAX HOLD.
 - After approximately 15 seconds turn on the EUT power.
 - Once the full spectrum analyzer trace is complete place a MARKER on the leading edge of the pulse and use the DELTA MARKER METHOD to measure the time until the uplink was squelched.
 - Ensure the noise level for the squelched signal is below the uplink inactivity noise power limit, as specified by the rules.
 - Capture the plot for inclusion in the test report.
 - Measure noise using procedures in a) to e).
 - Repeat steps c) to k) for all operational uplink bands.

3.8.3 Set-Up



3.8.4 Limit

- §20.21(e), When a consumer booster is not serving an active device connection after 5 minutes the uplink noise power shall not exceed -70 dBm/MHz.

3.8.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Spectrum Analyzer	N9020A	Agilent

3.8.6 Test condition

- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.8.7 Test results

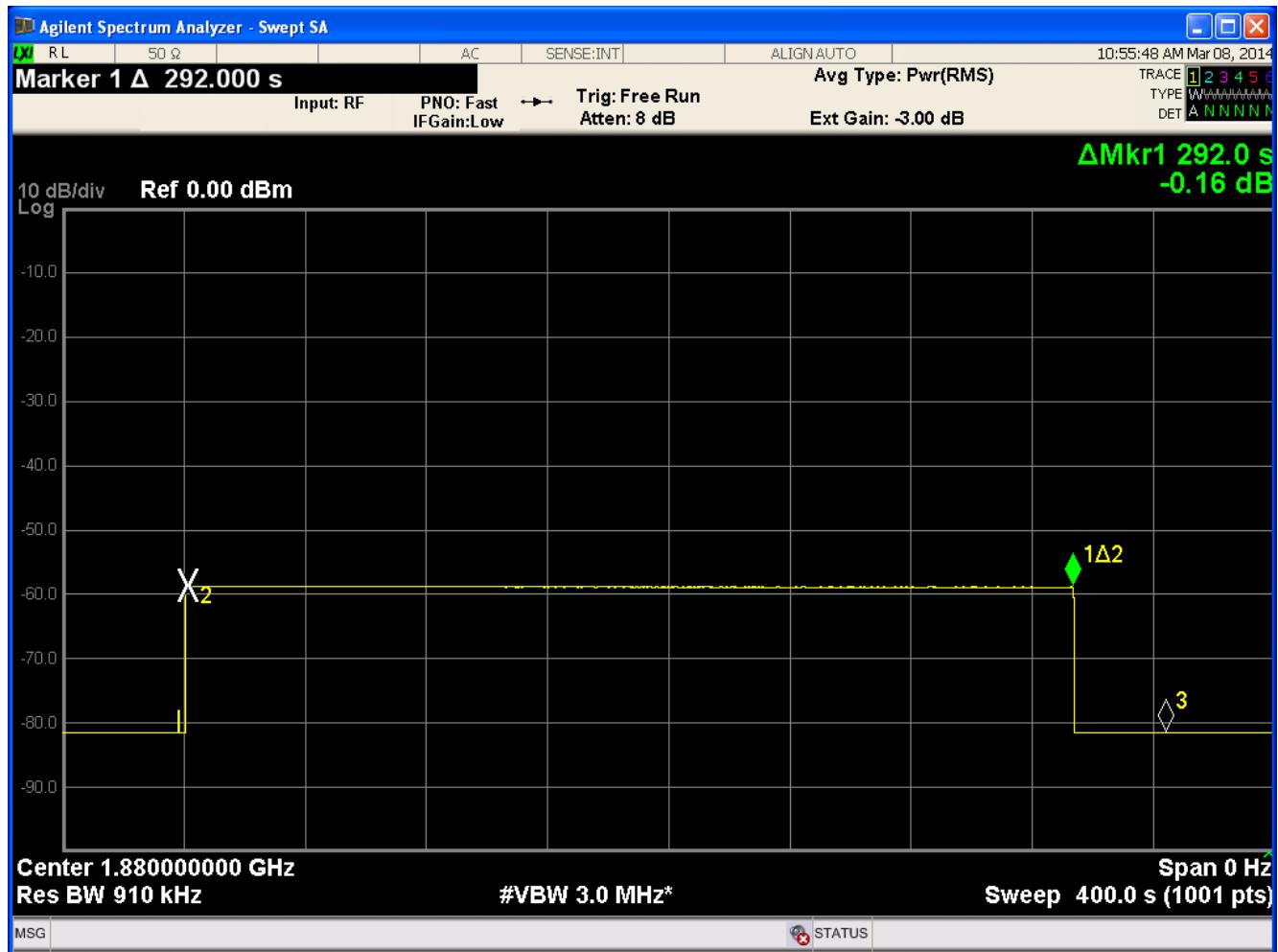
Band	Link	Inactive Time [s]	Limit [s]	Inactive Level [dBm]
Celluar	Up Link	292.0	300.0	-82.04
PCS	Up Link	292.0	300.0	-81.56

3.8.7 Test results

- Cellular/ Up link



- PCS/ Up link



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : Normal

Inactivity timing : 292.0 s
Noise level at inactivity : -81.56 dBm/MHz

Limit of timing : More than 300 s
Limit of noise level at inactivity : -70.0 dBm/MHz

3.9 Variable booster gain

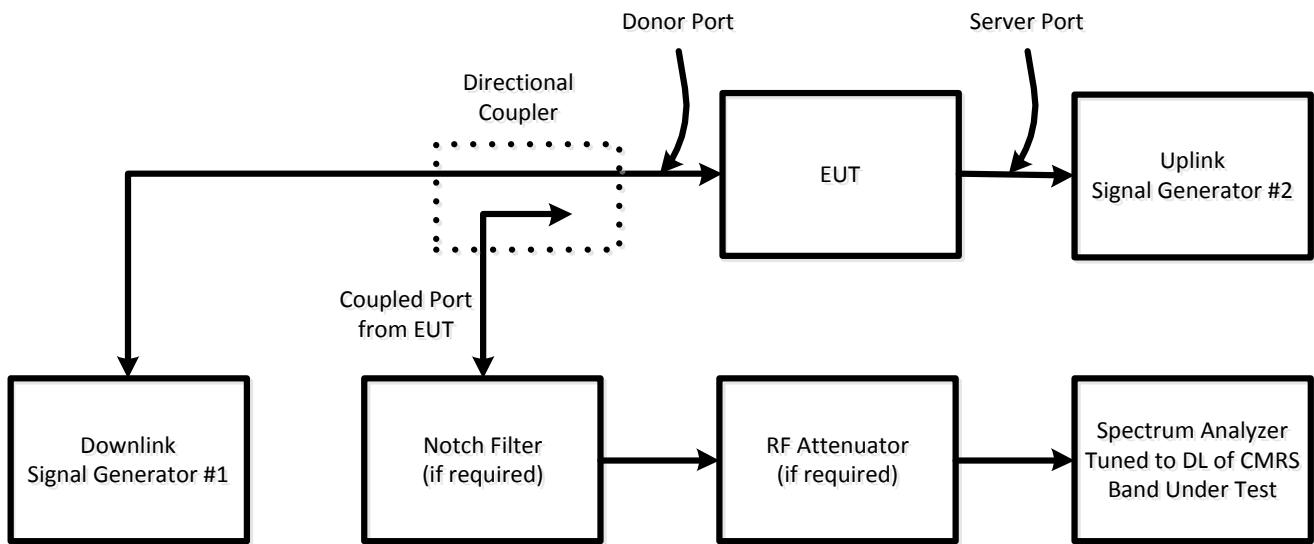
3.9.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(i)(C)

3.9.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.9
 - a) Connect the EUT to the test equipment as shown in **Set-Up** with the uplink output connected to signal generator 1. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.
 - b) Configure downlink signal generator 1 for AWGN operation with an 99% occupied bandwidth of 4.1 MHz tuned to the center of the operational band.
 - c) Set the power level and frequency of signal generator 2 to a value 5 dB below the AGC level determined from **Maximum power**. The signal type is AWGN with a 99% OBW of 4.1 MHz.
 - d) Set RBW = 100 kHz.
 - e) Set VBW \geq 300 kHz.
 - f) Select the CHANNEL POWER measurement tool.
 - g) Select the RMS (power averaging) detector.
 - h) Ensure that the number of measurement points per sweep \geq (2 X span)/RBW.
 - i) Sweep time = auto couple or as necessary (but no less than auto couple value).
 - j) Trace average at least 10 traces in power averaging (i.e., RMS) mode.
 - k) Measure the maximum channel power and compute maximum gain when varying the signal generator 1 to a level from -90 dBm to -20 dBm in 1 dB steps within the RSSI dependent region and 10 dB steps outside the RSSI dependent region and report the six values closest to the limit, including at least two points from within the RSSI dependent region of operation. See gain limit charts in Annex D.
 - l) Repeat c) to k) for all operational uplink bands.
 - m) Variable Uplink gain timing is to be measured as follows.
 - n) Set the spectrum analyzer to the uplink frequency to be measured.
 - o) Set the span to 0 Hz with a sweep time of 10 seconds.
 - p) Set the power level of signal generator 1 to the lowest level of the RSSI dependent gain.
 - q) Select MAX HOLD and increase the power level of signal generator 1 by 10 dB for mobile booster and 20 dB for fixed indoor boosters. Signal generator 2 remains same, as described in c).
 - r) Ensure that the uplink gain decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.
 - s) Repeat m) to r) for all operational uplink bands.

3.9.3 Set-Up



3.9.4 Limit

- §20.21(e), The uplink gain in dB of a consumer booster referenced to its input and output ports shall not exceed -34 dB - RSSI + MSCL.

3.9.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.9.6 Test condition

- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.9.7 Test results of variable gain

- Uplink max gain = 48 dB - RSSI + MSCL
- RSSI = Downlink output power - Downlink gain
- MSCL (distance of between uplink input port and mobile station is 1 meter)

$$\begin{aligned}
 L_{fs} &= 32.45 + 20 \log(d \text{ km}) + 20 \log(f \text{ MHz}) & [\text{free space path loss model : CCIR}] \\
 &= 32.45 + 20 \log(0.001) + 20 \log(881.5) & [31.35 \text{ dB : Cellular}] \\
 &= 32.45 + 20 \log(0.001) + 20 \log(1960) & [38.29 \text{ dB : PCS}]
 \end{aligned}$$

$$\text{MSCL} = L_{fs} - \text{Antenna gain} + \text{Cable loss}$$

$$\begin{aligned}
 &= 31.35 - 2 + 0.0 & [29 \text{ dB : Cellular}] \\
 &= 38.29 - 2 + 0.0 & [36 \text{ dB : PCS}]
 \end{aligned}$$

Band	RSSI [dBm]	MSCL [dB]	Gain Limit [dB]	Input Power [dBm]	Output Power [dBm]	DL Gain [dB]	Margin [dB]
Celluar	-35.0	29	30	-35.0	3.9	38.9	8.9
	-36.0		31	-36.0	3.9	39.9	8.9
	-37.0		32	-37.0	3.7	40.7	8.7
	-38.0		33	-38.0	3.8	41.8	8.8
	-39.0		34	-39.0	3.7	42.7	8.7
	-40.0		35	-40.0	3.8	43.8	8.8
	-43.0		38	-43.0	3.7	46.7	8.7
	-50.0		45	-50.0	-3.0	46.7	1.7
	-51.0		46	-53.0	-4.0	46.8	0.8
PCS	-35.0	36	37	-35.0	3.8	38.8	1.8
	-36.0		38	-36.0	3.7	39.3	1.3
	-37.0		39	-37.0	3.9	40.9	1.9
	-38.0		40	-38.0	4.0	42.0	2.0
	-39.0		41	-39.0	3.9	42.9	1.9
	-40.0		42	-40.0	3.9	43.9	1.9
	-43.0		45	-43.0	3.9	46.0	1.0
	-44.0		46	-44.0	2.9	46.9	0.9
	-45.0		47	-45.0	2.2	47.2	0.2

3.10 Occupied bandwidth

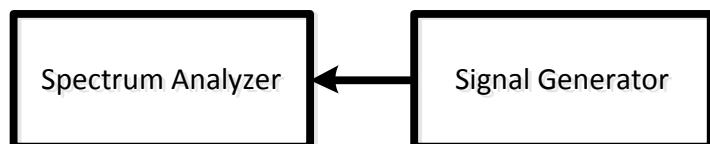
3.10.1 Specification

- FCC Rules Part 2 Section 2.1049

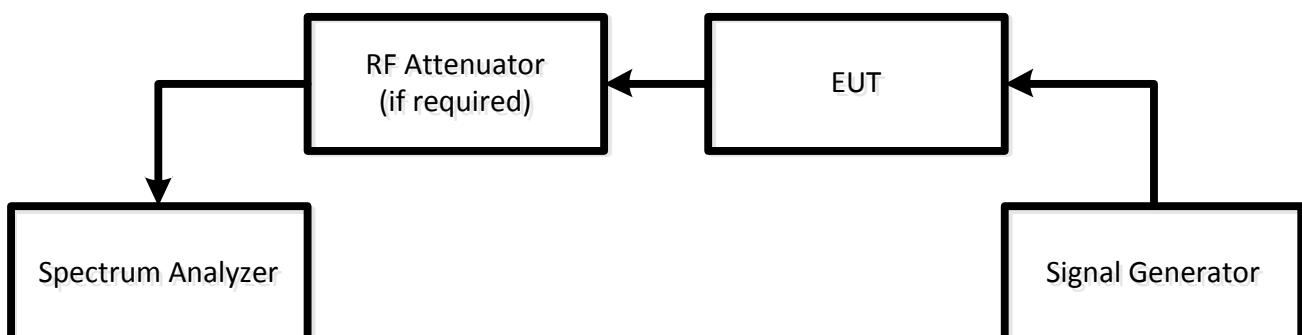
3.10.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.10
 - Connect the test equipment as shown in **Set-Up 1** to measure the characteristics of the test signals produced by the signal generator.
 - Set VBW to $\geq 3X$ RBW
 - Set the center frequency of the spectrum analyzer to the center of the operational band. The span will be adjusted for each modulation type and occupied bandwidth as necessary for accurately viewing the signals.
 - Set the signal generator for power level to match the values obtained in **Maximum power**.
 - Set the signal generator modulation type for GSM with a PRBS pattern and allow the trace on the signal generator to stabilize adjusting the span as necessary.
 - Set the spectrum analyzer RBW for 1% to 5% of the emissions bandwidth.
 - Capture the spectrum analyzer trace for inclusion in the test report.
 - Repeat steps c) to g) for CDMA and W-CDMA modulation adjusting the span as necessary for all uplink and downlink operational bands. (AWGN or LTE may be used in place of W-CDMA, as an option.)
 - Connect the test equipment as shown in **Set-Up 2**. Begin with the uplink output connected to the spectrum analyzer
 - Repeat steps c) to h) in this new configuration.

3.10.3 Set-Up 1 (Instrumentation)



3.10.3 Set-Up 2 (Occupied bandwidth)



3.10.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.10.5 Test condition

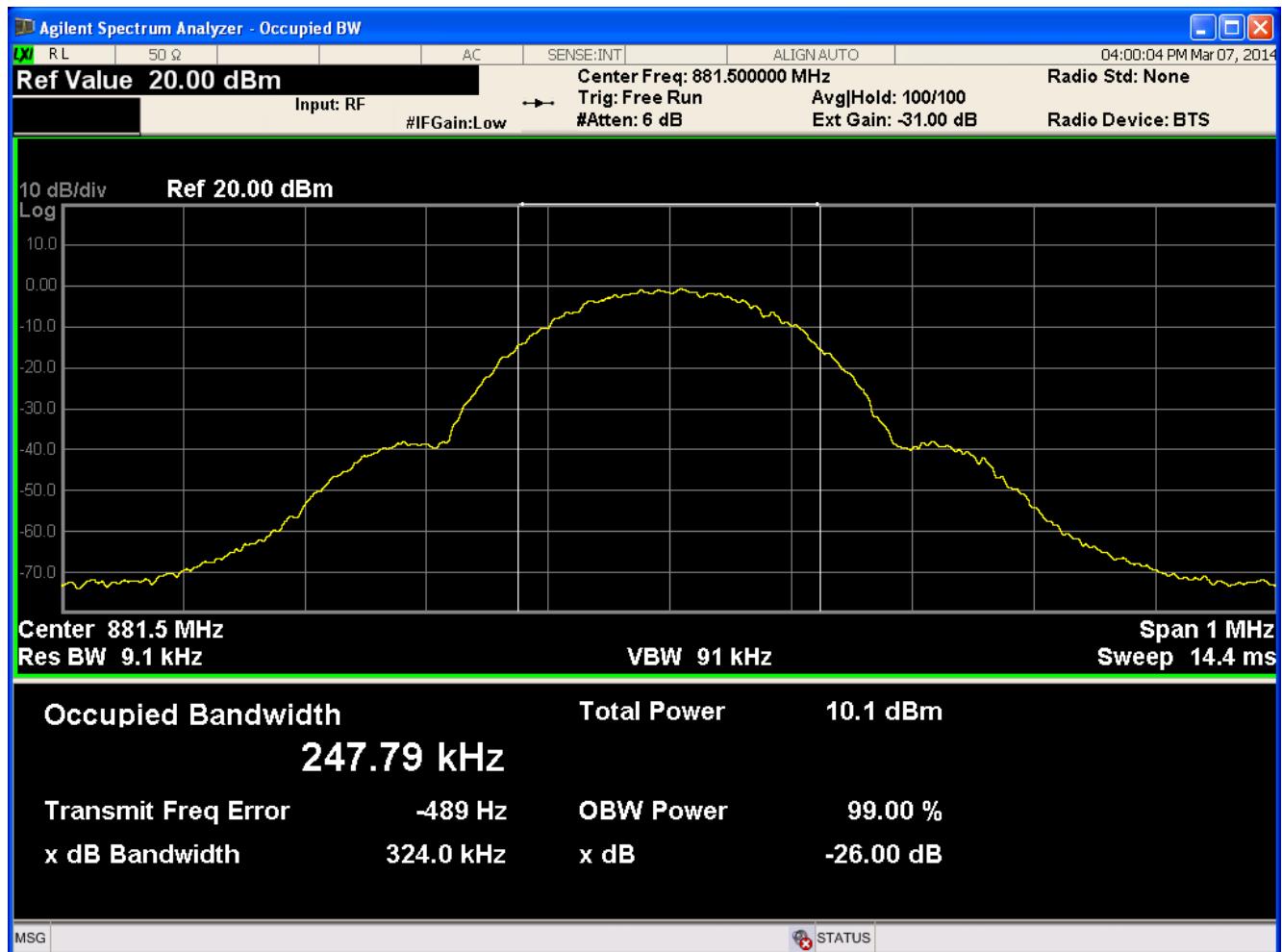
- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.10.6 Test result

Band	Link	Signal Type	Frequency [MHz]	Input OBW [MHz]	Output OBW [MHz]	26 dB Bandwidth [MHz]
Celluar	Down Link	GSM	881.5	0.249	0.247	0.324
		AWGN	881.5	4.088	4.036	4.617
		CDMA	881.5	1.270	1.271	1.429
	Up Link	GSM	836.5	0.245	0.248	0.321
		AWGN	836.5	4.099	4.077	4.776
		CDMA	836.5	1.269	1.294	1.917
PCS	Down Link	GSM	1960.0	0.247	0.248	0.323
		AWGN	1960.0	4.101	4.050	4.616
		CDMA	1960.0	1.253	1.269	1.429
	Up Link	GSM	1880.0	0.243	0.249	0.323
		AWGN	1880.0	4.101	4.065	4.743
		CDMA	1880.0	1.255	1.288	1.966

3.2.7 Plots of occupied bandwidth

- Celluar/ Down Link / 881.5 MHz / GSM



Input signal

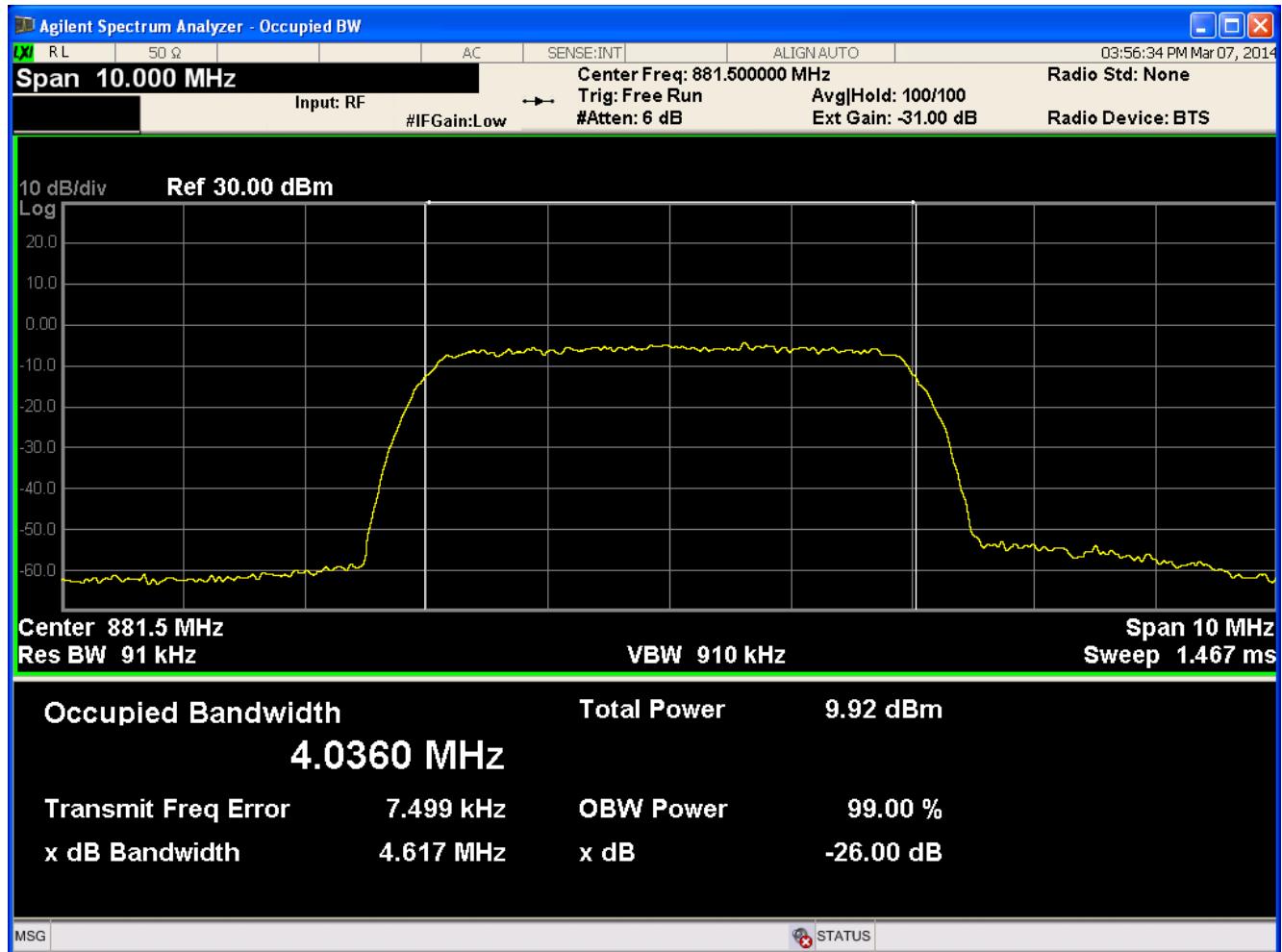
Frequency : 881.500 MHz
99% bandwidth : 0.249 MHz
26 dB bandwidth : 0.323 MHz

Output signal

Span : 1 MHz
RBW : 9.1 kHz
VBW : 91 kHz

99% bandwidth : 0.247 MHz
26 dB bandwidth : 0.324 MHz

- Celluar/ Down Link / 881.5 MHz / AWGN



Input signal

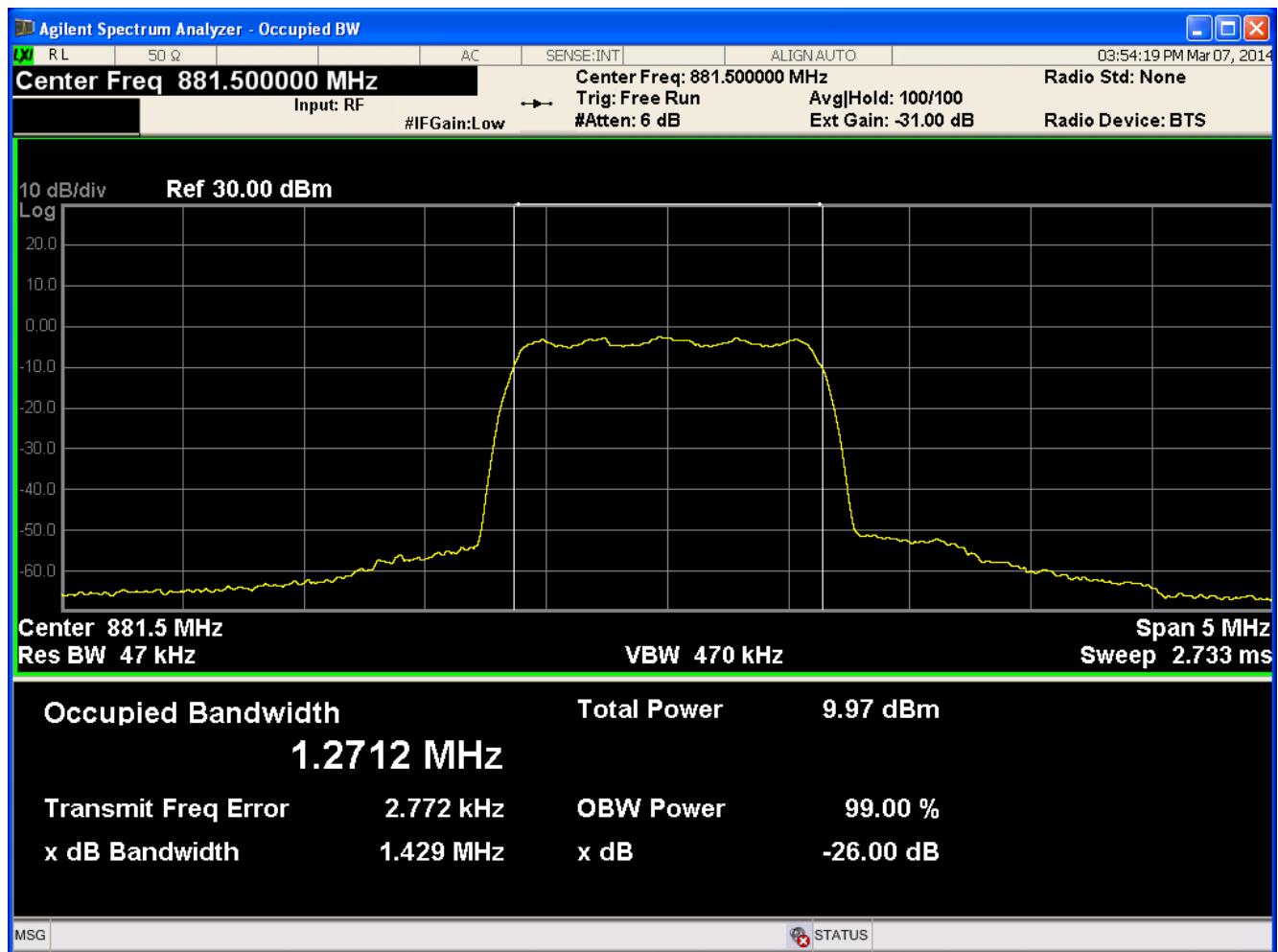
Frequency : 881.500 MHz
99% bandwidth : 4.088 MHz
26 dB bandwidth : 4.693 MHz

Output signal

Span : 10 MHz
RBW : 91 kHz
VBW : 910 kHz

99% bandwidth : 4.036 MHz
26 dB bandwidth : 4.617 MHz

- Celluar/ Down Link / 881.5 MHz / CDMA



Input signal

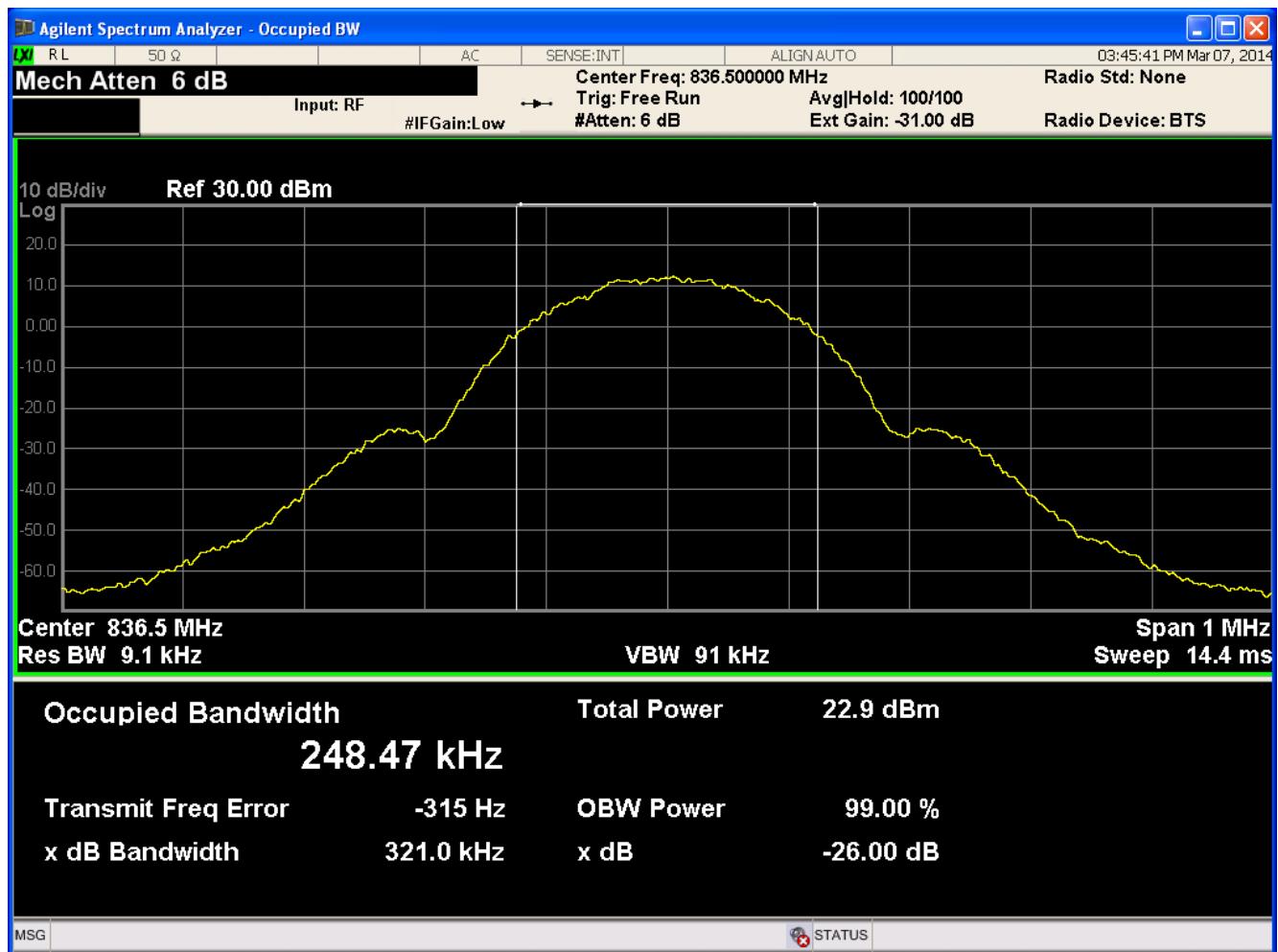
Frequency : 881.500 MHz
99% bandwidth : 1.270 MHz
26 dB bandwidth : 1.451 MHz

Output signal

Span : 5 MHz
RBW : 47 kHz
VBW : 470 kHz

99% bandwidth : 1.271 MHz
26 dB bandwidth : 1.429 MHz

- Cellular/ Up Link / 836.5 MHz / GSM



Input signal

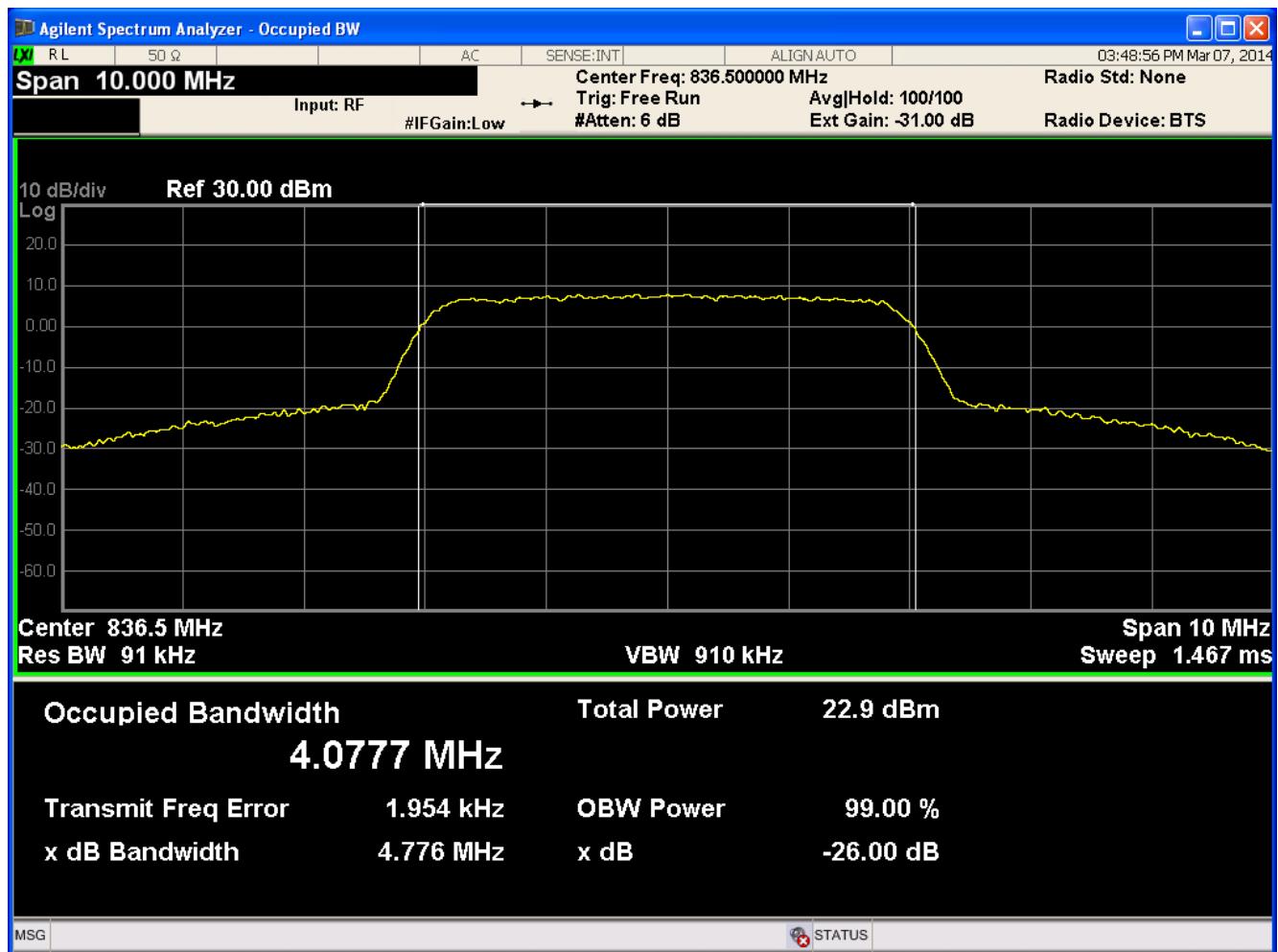
Frequency : 836.500 MHz
99% bandwidth : 0.245 MHz
26 dB bandwidth : 0.320 MHz

Output signal

Span : 1 MHz
RBW : 9.1 kHz
VBW : 91 kHz

99% bandwidth : 0.248 MHz
26 dB bandwidth : 0.321 MHz

- Celluar/ Up Link / 836.5 MHz / AWGN



Input signal

Frequency : 836.500 MHz
99% bandwidth : 4.099 MHz
26 dB bandwidth : 4.676 MHz

Output signal

Span : 10 MHz
RBW : 91 kHz
VBW : 910 kHz

99% bandwidth : 4.077 MHz
26 dB bandwidth : 4.776 MHz

- Celluar/ Up Link / 836.5 MHz / CDMA



Input signal

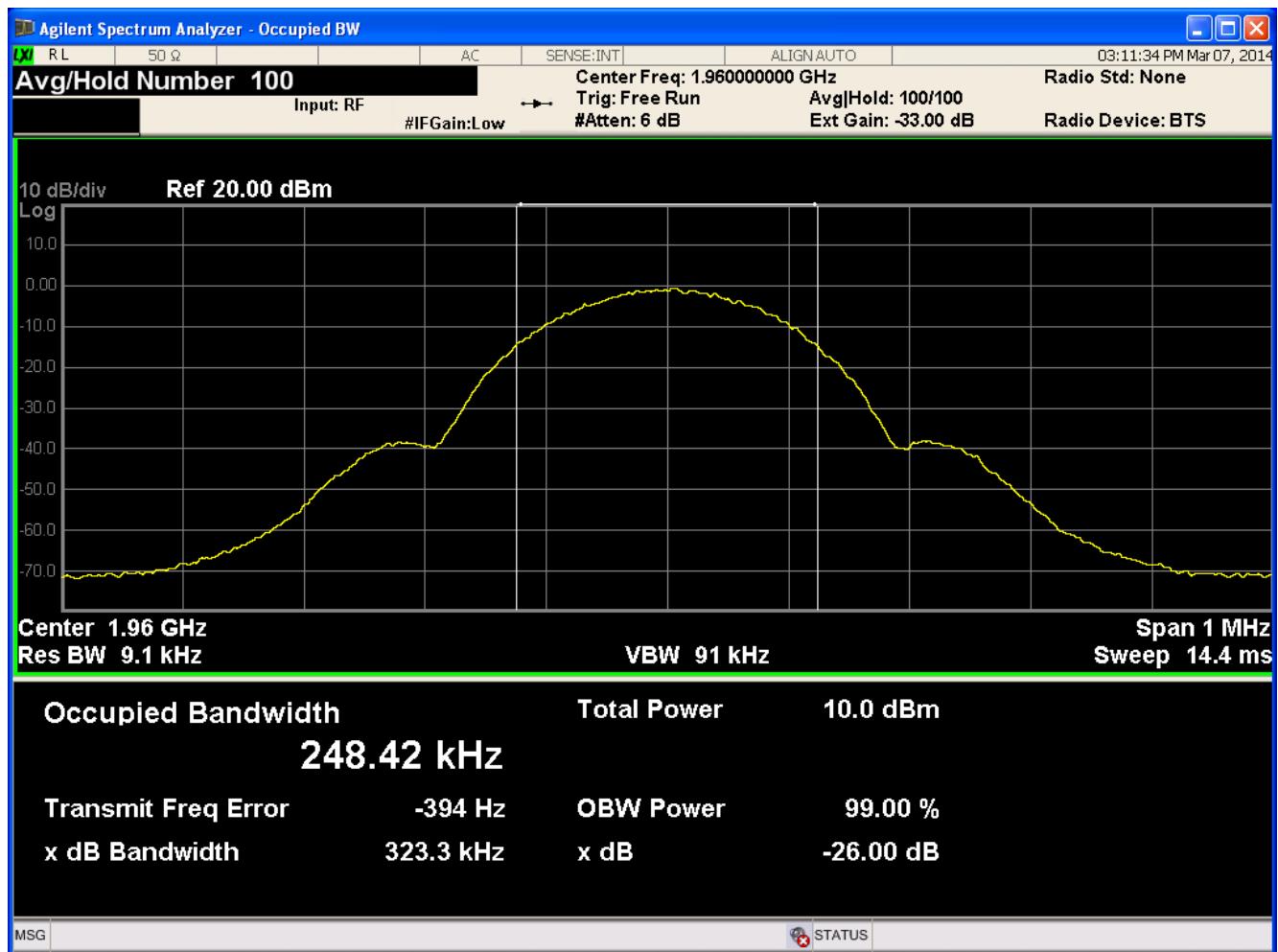
Frequency : 836.500 MHz
99% bandwidth : 1.269 MHz
26 dB bandwidth : 1.846 MHz

Output signal

Span : 5 MHz
RBW : 47 kHz
VBW : 470 kHz

99% bandwidth : 1.294 MHz
26 dB bandwidth : 1.917 MHz

- PCS / Down Link / 1960 MHz / GSM



Input signal

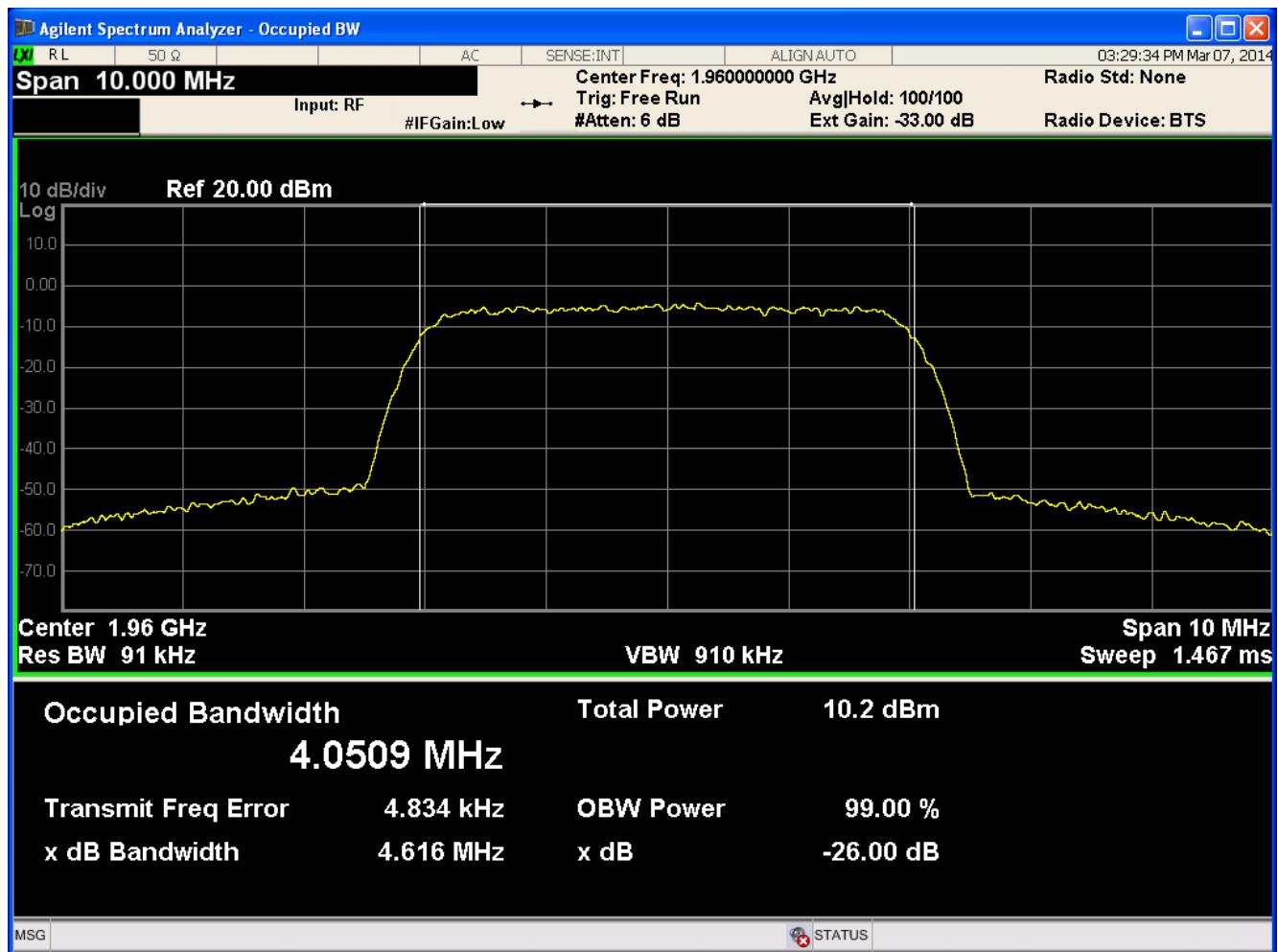
Frequency : 1960.000 MHz
99% bandwidth : 0.249 MHz
26 dB bandwidth : 0.325 MHz

Output signal

Span : 1 MHz
RBW : 9.1 kHz
VBW : 91 kHz

99% bandwidth : 0.248 MHz
26 dB bandwidth : 0.323 MHz

- PCS / Down Link / 1960 MHz / AWGN



Input signal

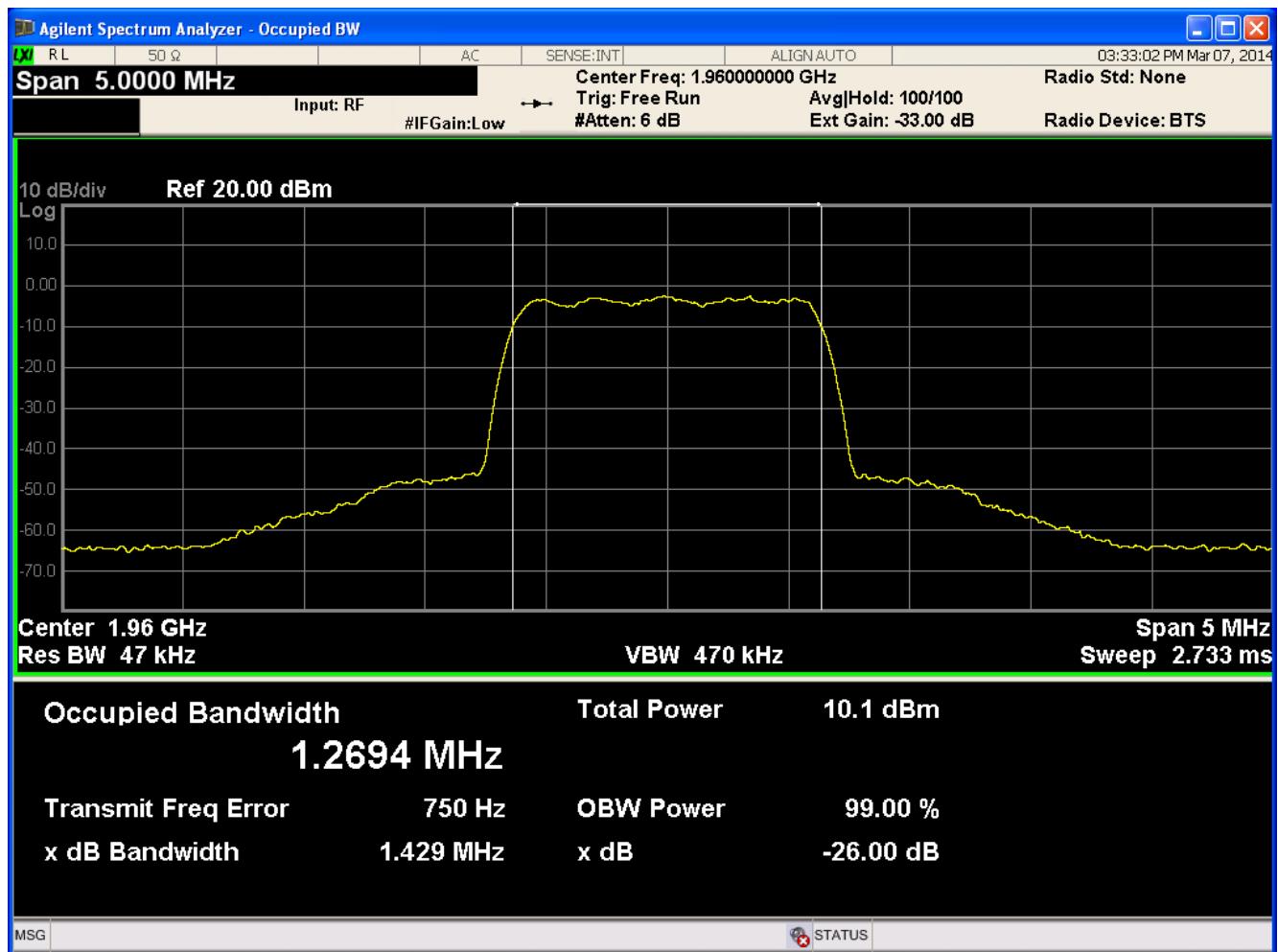
Frequency : 1960.000 MHz
99% bandwidth : 4.101 MHz
26 dB bandwidth : 4.610 MHz

Output signal

Span : 3 MHz
 RBW : 91 kHz
VBW : 910 kHz

99% bandwidth : 4.050 MHz
26 dB bandwidth : 4.616 MHz

- PCS / Down Link / 1960 MHz / CDMA



Input signal

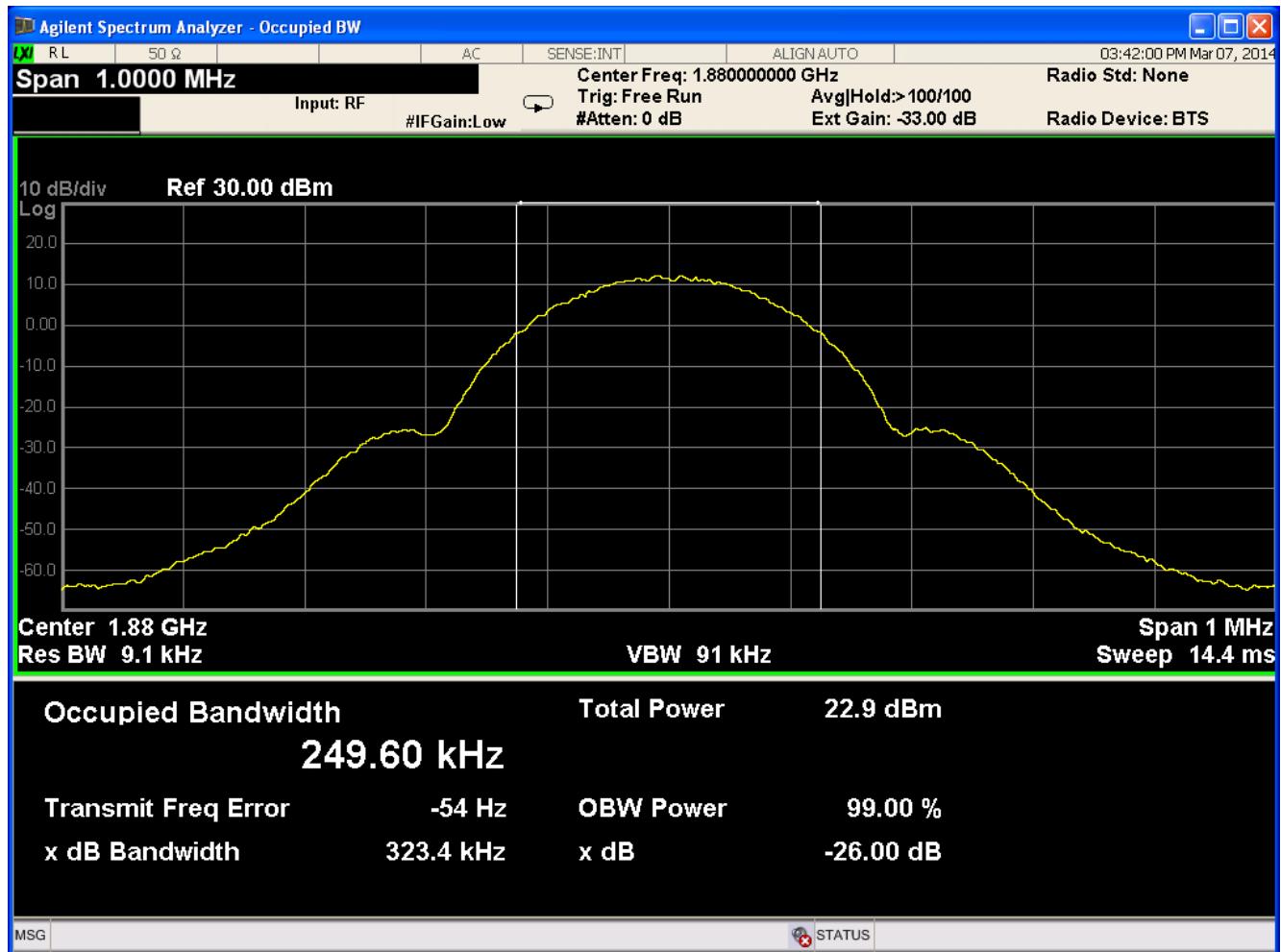
Frequency : 1960.000 MHz
99% bandwidth : 1.253 MHz
26 dB bandwidth : 1.420 MHz

Output signal

Span : 5 MHz
RBW : 47 kHz
VBW : 470 kHz

99% bandwidth : 1.269 MHz
26 dB bandwidth : 1.429 MHz

- PCS / Up Link / 1880 MHz / GSM



Input signal

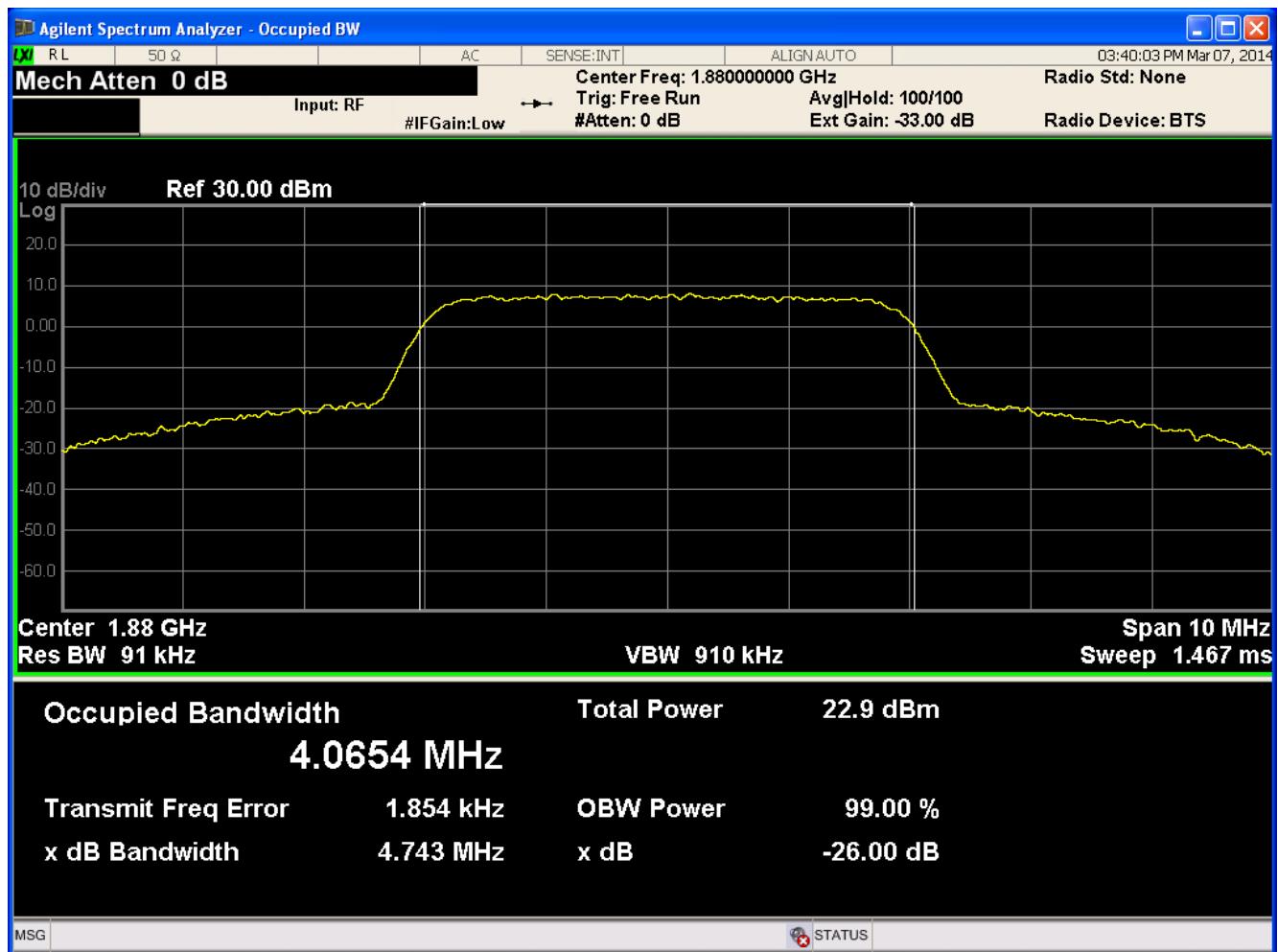
Frequency : 1880.000 MHz
99% bandwidth : 0.243 MHz
26 dB bandwidth : 0.325 MHz

Output signal

Span : 1 MHz
RBW : 9.1 kHz
VBW : 91 kHz

99% bandwidth : 0.249 MHz
26 dB bandwidth : 0.323 MHz

- PCS / Up Link / 1880 MHz / AWGN



Input signal

Frequency : 1880.000 MHz
99% bandwidth : 4.101 MHz
26 dB bandwidth : 4.657 MHz

Output signal

Span : 10 MHz
RBW : 91 kHz
VBW : 910 kHz

99% bandwidth : 4.065 MHz
26 dB bandwidth : 4.743 MHz

- PCS / Up Link / 1880 MHz / CDMA



Input signal

Frequency : 1880.000 MHz
99% bandwidth : 1.257 MHz
26 dB bandwidth : 1.890 MHz

Output signal

Span : 5 MHz
RBW : 47 kHz
VBW : 470 kHz

99% bandwidth : 1.288 MHz
26 dB bandwidth : 1.966 MHz

3.11 Oscillation detection

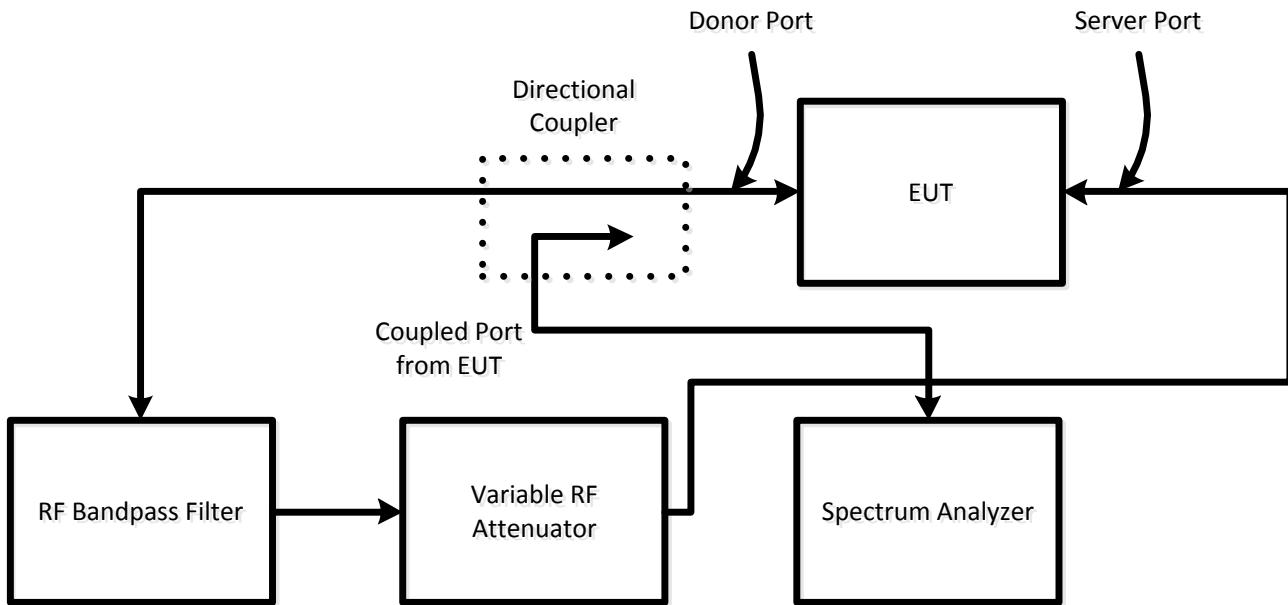
3.11.1 Specification

- FCC 13-21
- FCC Part 20.21 (e)(8)(ii)(A)

3.11.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.11
 - a) Connect the EUT set for normal operation to the test equipment as shown in **Set-Up** beginning with the spectrum analyzer on the uplink output side of the RF path. Ensure that the RF coupled path is connected to the spectrum analyzer.
Note: The band pass filter shall provide sufficient out-of-band rejection to prevent oscillations from occurring in bands not under test.
 - b) Set the spectrum analyzer's center frequency to the center of the band under test. Set the spectrum analyzer's span to equal or slightly exceed the width of the band under test. Set the spectrum analyzer for a continuous sweep, max-hold. Set the spectrum analyzer's RBW to at least 1 MHz and the VBW to > 3 times RBW.
 - c) Decrease the variable attenuator until the spectrum analyzer displays a signal within the band under test. Using a marker, identify the approximate center frequency of this signal on the max-hold display, then increase the attenuation by 10 dB. Reset the EUT.
 - d) Repeat step c) twice to ensure that the center of the signal created by the booster remains within 250 kHz of the spectrum analyzer's center frequency. If the frequency of the signal is unstable, ensure that the spectrum analyzer is centered between the frequency extremes observed. If the signal is wider than 1 MHz, ensure that the spectrum analyzer is centered on the signal by increasing the resolution bandwidth. Reset the EUT after each oscillation event if necessary. Set the spectrum analyzer's sweep trigger level such that it's just below the peak amplitude of the displayed oscillation signal from the EUT.
 - e) Set the spectrum analyzer to zero-span with a sweep time of 5 seconds, single-sweep with max-hold. The spectrum analyzer's sweep trigger level in this and subsequent steps shall be the level identified in step d).
 - f) Decrease the variable attenuator until the spectrum analyzer's sweep is triggered, then increase the attenuation 10 dB. Reset the EUT.
 - g) Reset the zero-span trigger of the spectrum analyzer and repeat step f) twice to ensure that the spectrum analyzer is reliably triggered, resetting the EUT after each oscillation event if necessary.
 - h) Reset the zero-span sweep trigger of the spectrum analyzer and reset the EUT with a power cycle.
 - i) Force the EUT to oscillate by reducing the attenuation.
 - j) Use the Marker function of the spectrum analyzer to measure the time from the on-set of oscillation until the EUT turns off by setting Marker 1 on the leading edge of the oscillation signal and Marker 2 on the trailing edge. The spectrum analyzer's sweep time may be altered to improve the time resolution of these cursors.
 - k) Capture the spectrum analyzer's zero-span trace for inclusion in the test report.
 - l) Repeat steps b) to k) for all operational uplink and downlink bands.
 - m) Set the spectrum analyzer's zero-span sweep time for longer than 1 minute and measure the restart time for each operational uplink and downlink band.
 - n) Replace the normal operating EUT for the EUT set-up to support an anti-oscillation test mode.
 - o) Set the spectrum analyzer's zero-span time for a minimum of 120 seconds and a single sweep.
 - p) Manually trigger the spectrum analyzer's zero-span sweep and manually force the booster into oscillation as in step i).
 - q) When the sweep is complete place cursors between the first two oscillation detections and save the plot for inclusion in the test report. The time between restarts must match the manufacturer's timing for the test mode and there can be no more than 5 restarts.
 - r) Repeat steps m) to q) for all operational uplink and downlink bands.

3.11.3 Set-Up



3.11.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Directional Coupler	11667A	Agilent
Spectrum Analyzer	E4432B	Agilent
Attenuator	66-30-33	Weinschel

3.11.5 Test condition

- Test place: Shield Room
- Test environment: 23 °C, 53 % R.H.

3.11.6 Test results of detection time

Band	Link	Detection Time [S]	Limit [S]	Result
Celluar	Down Link	0.396	1.000	Pass
	Up Link	0.190	0.300	Pass
PCS	Down Link	0.444	1.000	Pass
	Up Link	0.148	0.300	Pass

3.5.7 Test results of restarting time

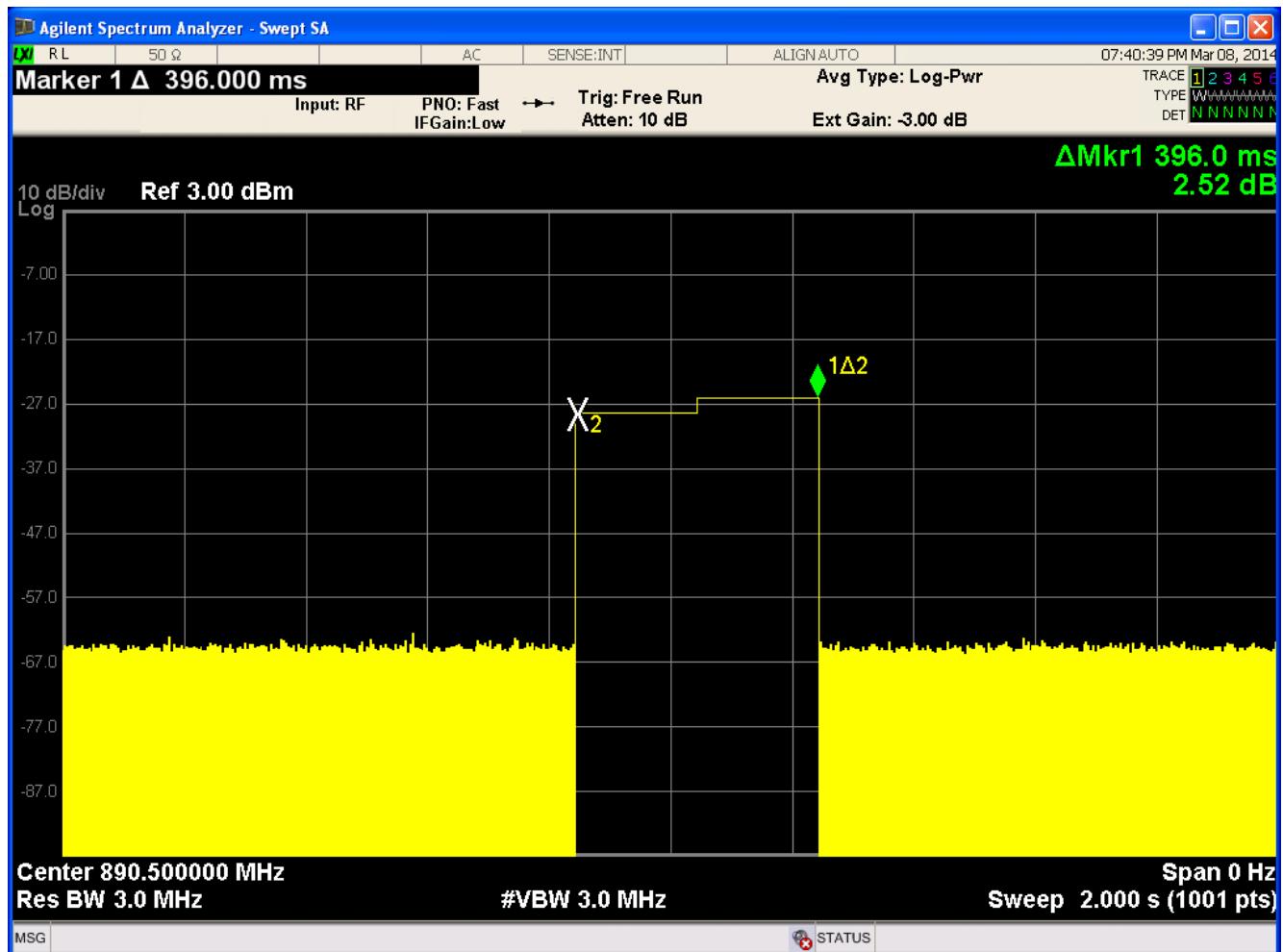
Band	Link	Restarting Time [S]	Limit [S]	Result
Celluar	Down Link	66.0	≥ 60.0	Pass
	Up Link	66.0	≥ 60.0	Pass
PCS	Down Link	65.5	≥ 60.0	Pass
	Up Link	66.0	≥ 60.0	Pass

3.5.8 Test results of restarting count

Band	Link	Restarting Count	Limit	Result
Celluar	Down Link	5	≤ 5	Pass
	Up Link	5	≤ 5	Pass
PCS	Down Link	5	≤ 5	Pass
	Up Link	5	≤ 5	Pass

3.11.9 Test results of detection time

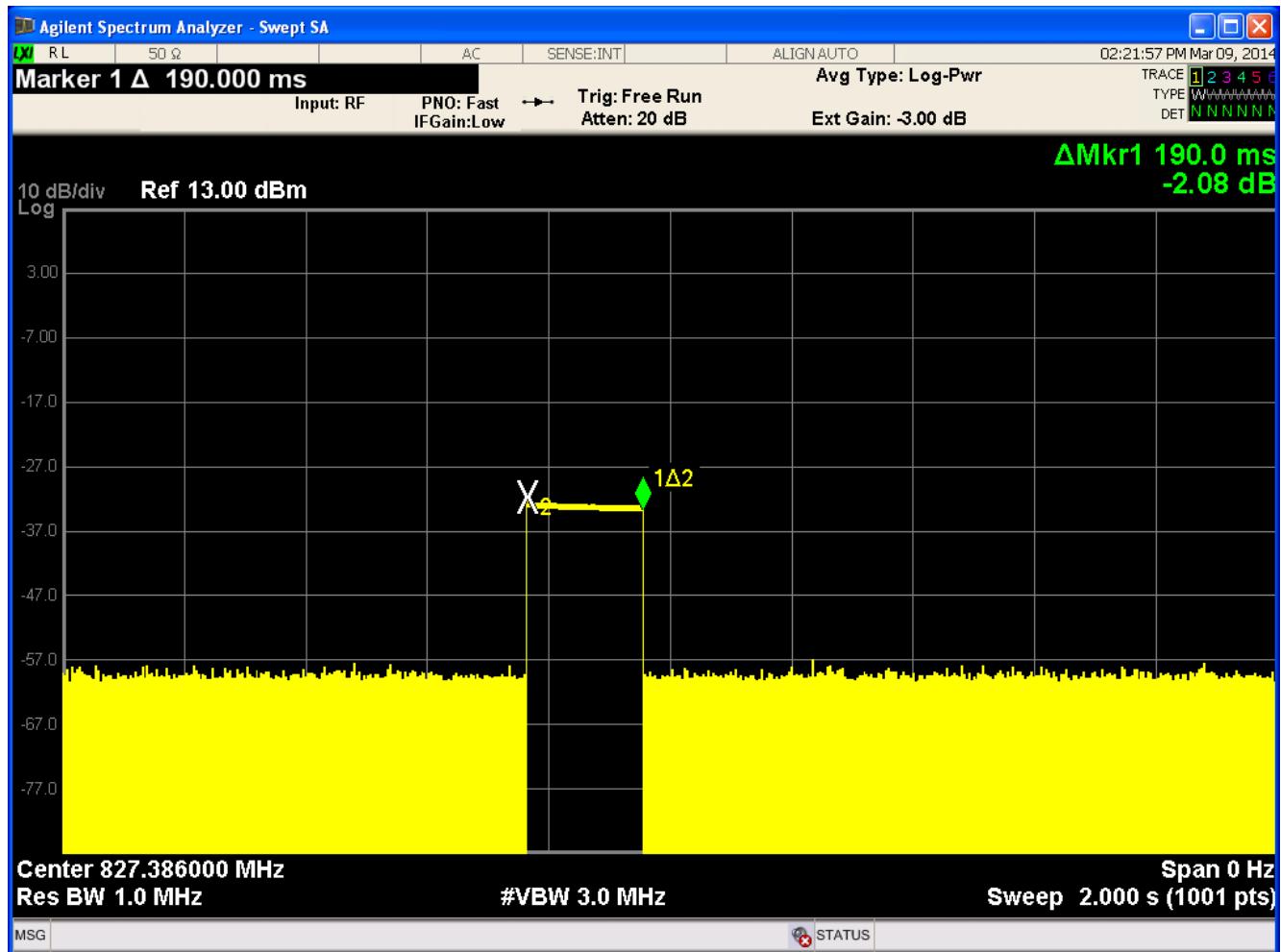
- Cellular/ Down link



Time of oscillation detection and mitigation : 0.396 s

Limit : 1.000 s

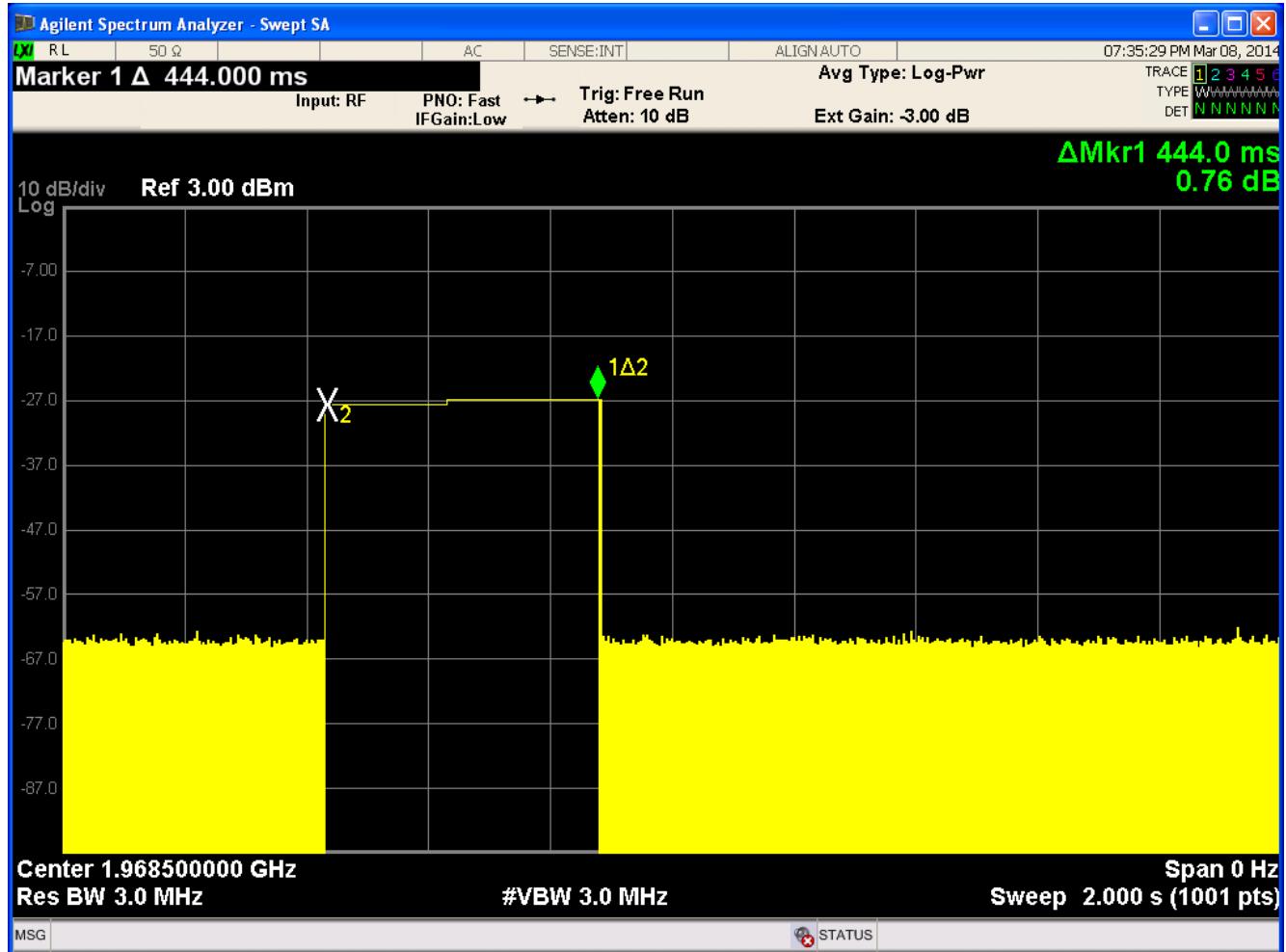
- Cellular/ Up link



Time of oscillation detection and mitigation : 0.190 s

Limit : 0.300 s

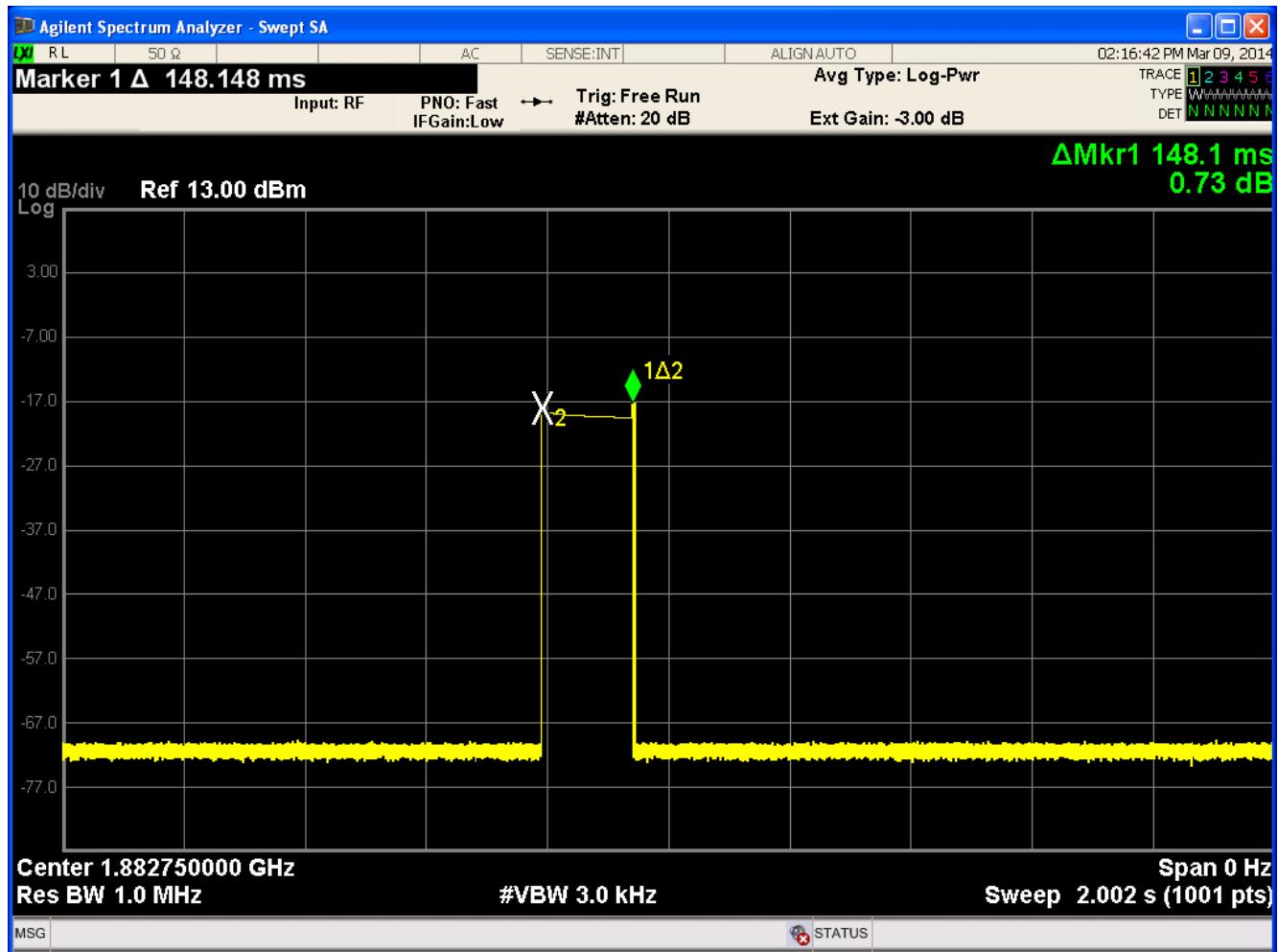
- PCS/ Down link



Time of oscillation detection and mitigation : 0.444 s

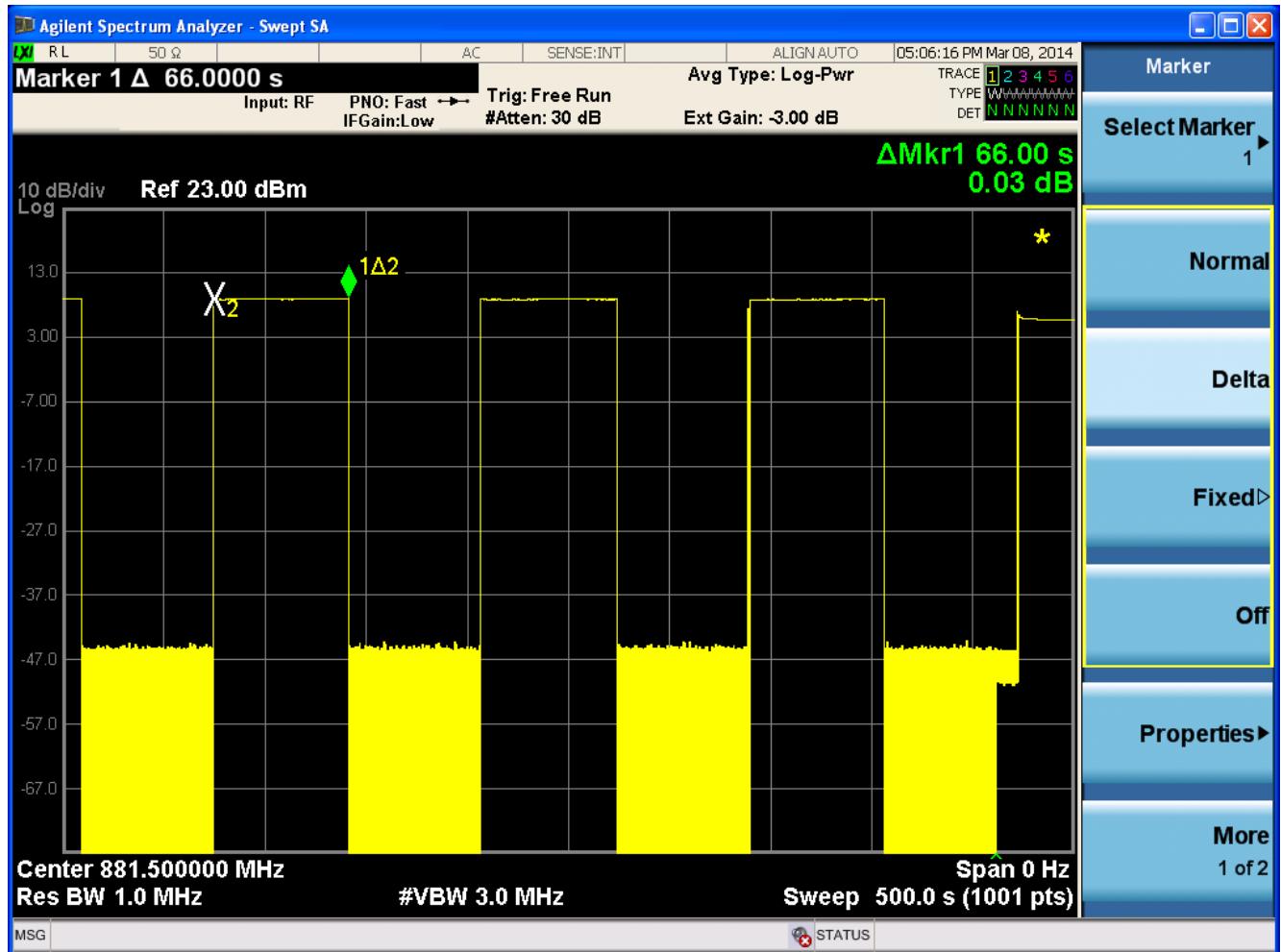
Limit : 1.000 s

- PCS/ Up link



3.11.10 Test results of restarting time

- Cellular/ Down link



Restarting time : 66.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

- Cellular/ Up link



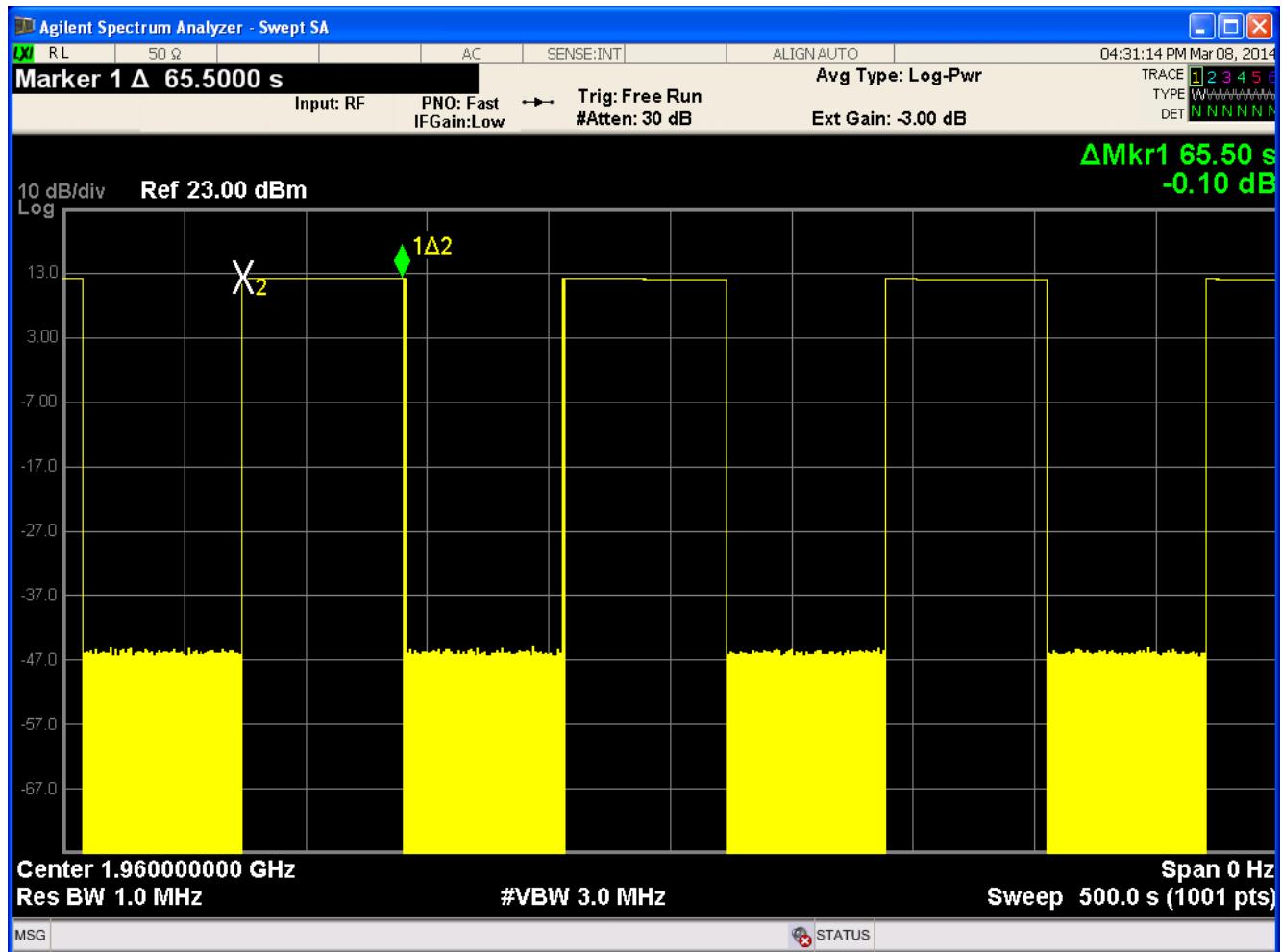
Restarting time : 66.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

- PCS/ Down link



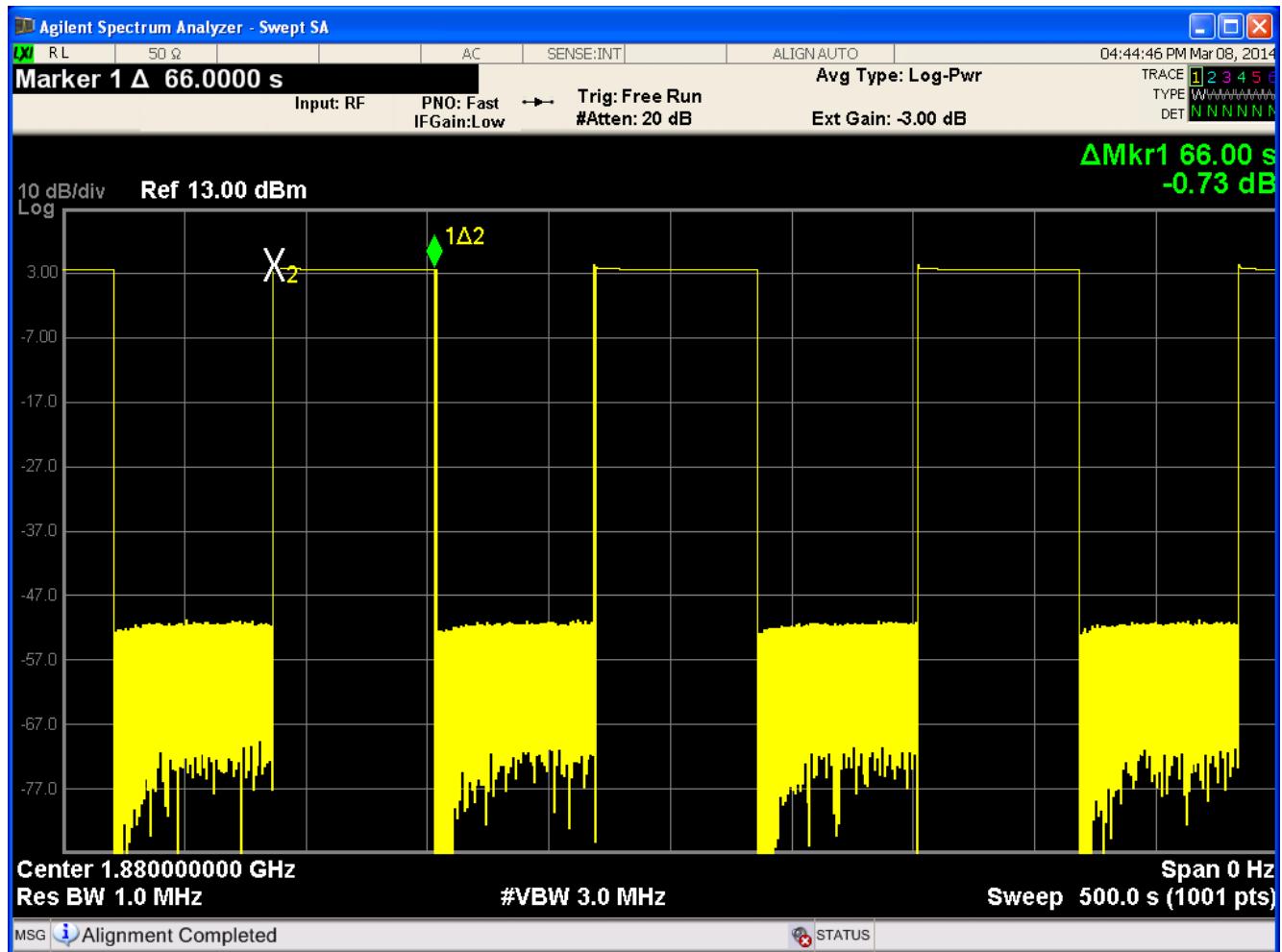
Restarting time : 65.5 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

- PCS/ Up link



Restarting time : 66.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

3.12 Radiated spurious emission

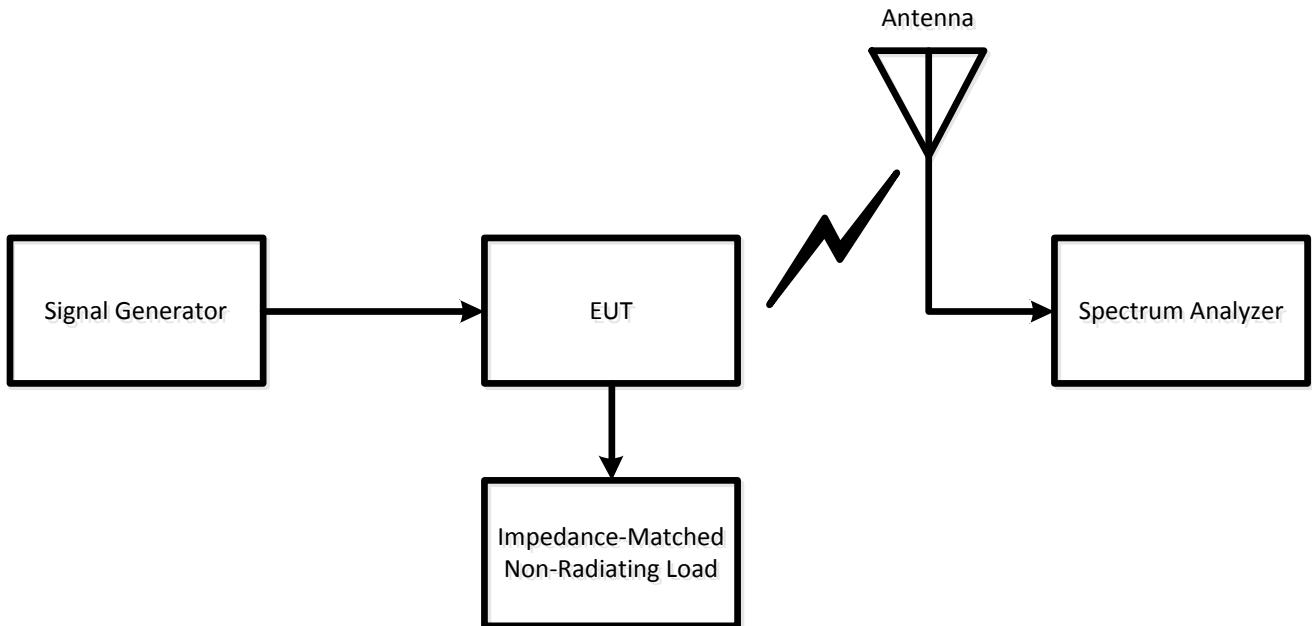
3.12.1 Specification

- FCC Rules Part 2 Section 2.1053

3.12.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.12
 - Place the EUT on an OATS or semi-anechoic chamber turntable 3 m from the receiving antenna.
 - Connect the EUT to the test equipment as shown in **Set-Up** beginning with the uplink output
 - Set the signal generator for the center frequency of the operational band under test with the power level set at P_{IN} from **Maximum power** with CW signal.
 - Measure the radiated spurious emissions from the EUT from lowest to the highest frequencies as specified in § 2.1057. Maximize the radiated emissions by utilizing the procedures described in **Clause 8 of ANSI C63.4-2009**.
 - Capture the peak emissions plots using a peak detector with Max-Hold for inclusion in the test report. Tabular data is acceptable in lieu of spectrum analyzer plots.
 - Repeat steps c) to e) for all operational bands.

3.12.3 Set-Up



3.12.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	AVHR-5000N	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Bi-conical Antenna	VHA9103	Schwarzbeck
Log Periodic Antenna	VULP9118A	Schwarzbeck
Horn Antenna	BBHA-9120D	Schwarzbeck
Pre-Amplifier	SCU-01	R&S
Pre-Amplifier	ESMI-Z7	R&S

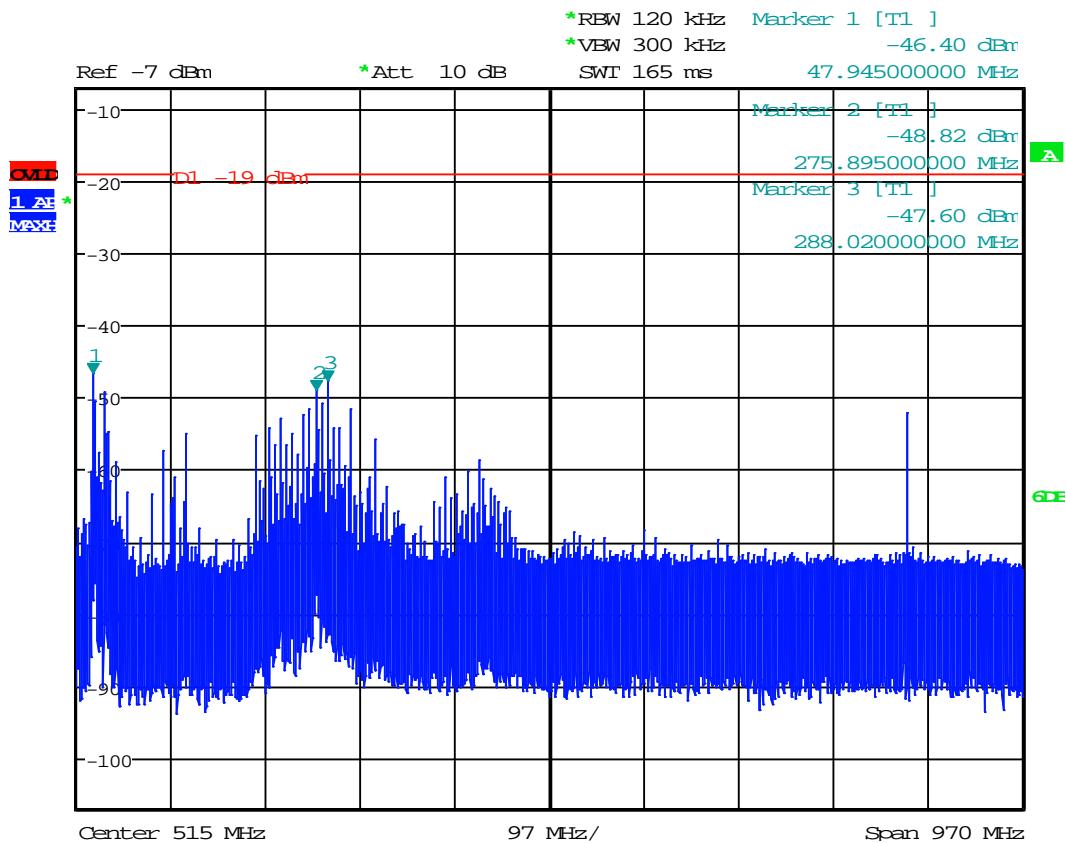
3.12.5 Test condition

- Test place: Shield Room
- Test environment: 25 °C, 61 % R.H.

3.12.6 Test result

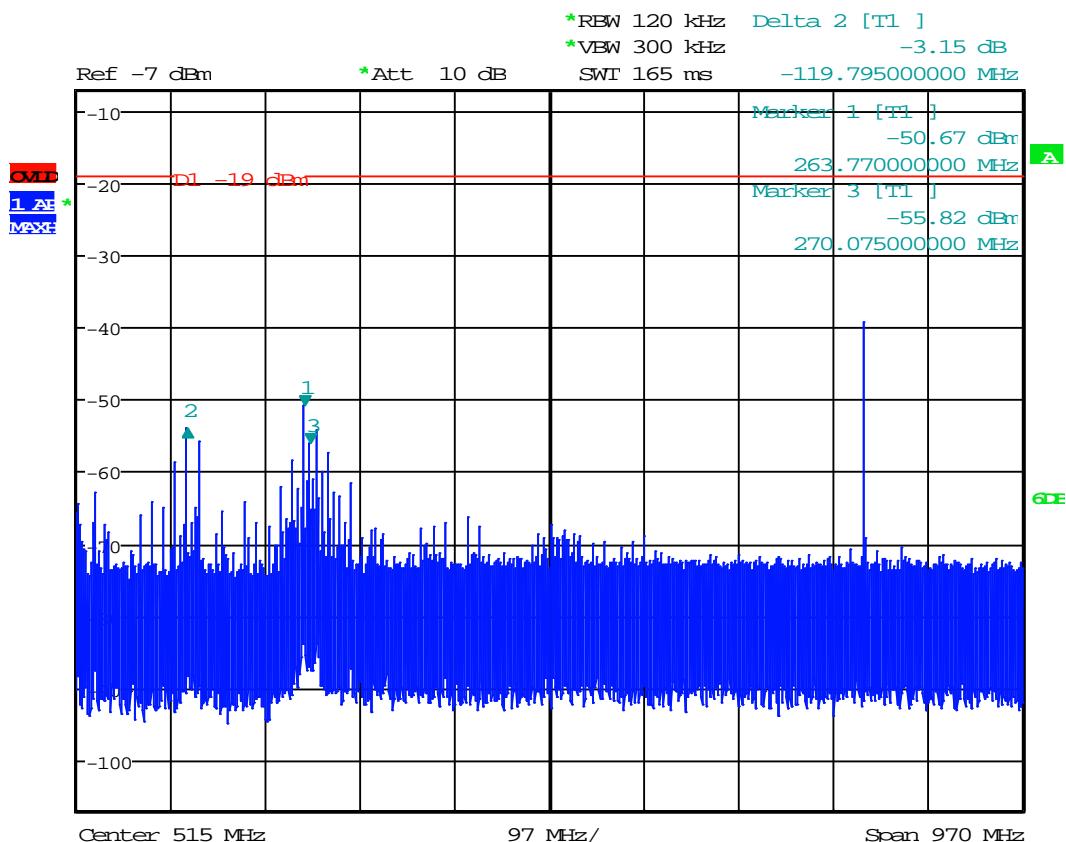
Frequency [MHz]	Reading [dBuV]	Generator Level [dBm]	Antenna polarity [H/V]	Antenna gain [dBd]	Cable loss [dB]	Level [dBm]	Limit [dBm]	Margin [dB]
Celluar / Down link / 881.5 MHz								
47.94	60.68	-40.50	H	8.68	0.49	-46.40	-13.00	33.40
Celluar / Up link / 836.5 MHz								
263.77	56.31	-28.90	V	12.99	1.43	-50.67	-13.00	37.67
PCS / Down link / 1960 MHz								
47.94	61.28	-40.33	H	8.68	0.49	-45.70	-13.00	32.70
PCS / Up link / 1880 MHz								
275.69	62.58	-28.85	V	12.99	1.43	-44.40	-13.00	31.40

- Cellular / Down link



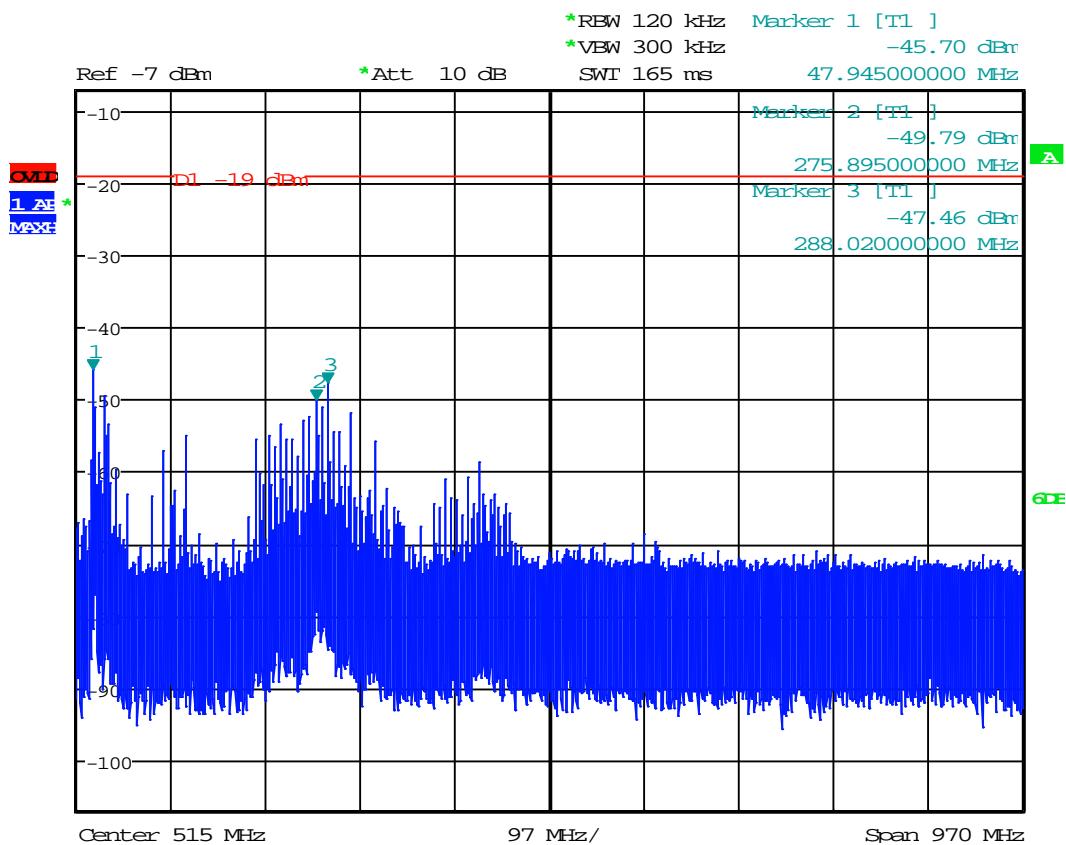
Date: 11.APR.2014 15:58:49

- Cellular / Up link



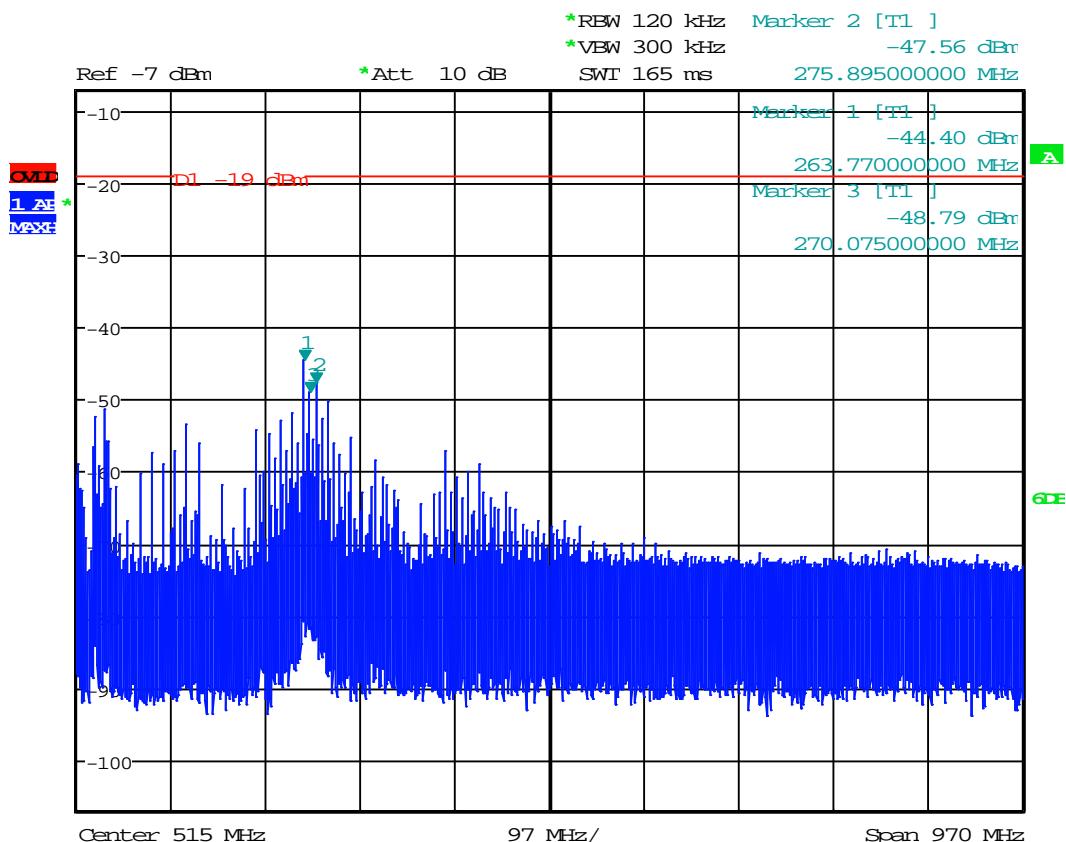
Date: 11.APR.2014 16:10:16

- PCS / Down link



Date: 11.APR.2014 16:02:26

- PCS / Up link



Date: 11.APR.2014 16:06:29

4. RF exposure statement

According to FCC Part1 Section 1.1307, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to FCC Part1 Section 1.1310 and 2.1091 RF exposure is calculated by Friis transmission formula.

Frequency Range [MHz]	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm ²]	Averaging Time [minute]
Limits for General Population/Uncontrolled Exposure				
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

Limits for General Population/Uncontrolled Exposure

Here, f = frequency in MHz

4.1 Friis transmission formula

$$P_d = (P_{out} \times G) / (4\pi r^2)$$

P_d = Power density

P_{out} = power input to antenna

G = power gain

r = distance to the center of radiation of the antenna

4.2 Information of Antenna

The Coaxial Cable is used for RF distribution to the Service Antenna (2 dBi gain) from AVHR-5000N and to the Donnor Antenna (5.5 dBi gain) from AVHR-5000N.

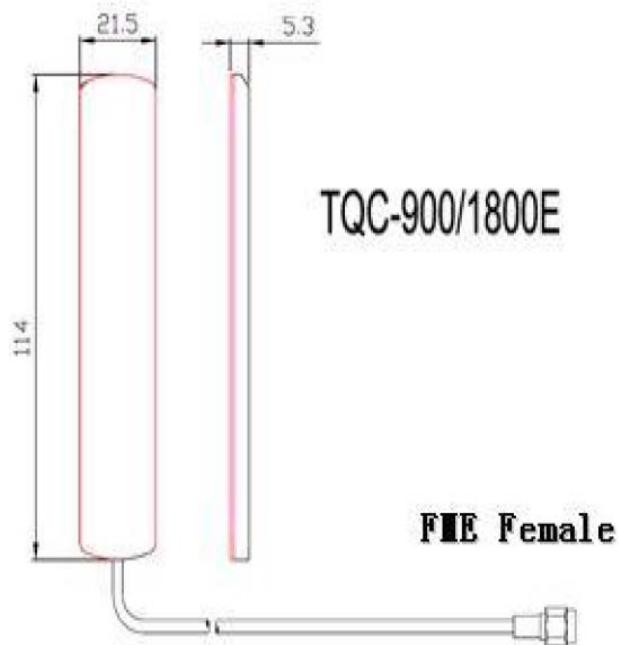
RF cable type is FME which the length is 30 cm and the Loss is 0.2 dB ~ 0.3 dB /1 m

- **Model Name : TQC-900-1800E (Down link antenna)**



Antenna Gain:

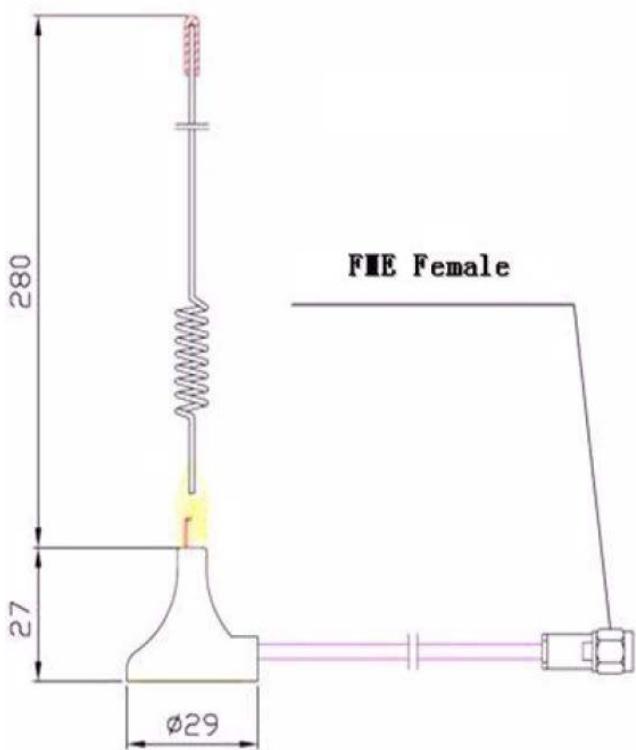
- 890 MHz – 960 MHz : 2 dBi
- 1710 MHz – 1990 MHz : 2 dBi



- Model Name : TQC-900-1800C2 (Up link antenna)

**Antenna Gain:**

- 890 MHz – 960 MHz : 5.0 dBi
- 1710 MHz – 1990 MHz : 5.0 dBi



4.3 Calculation of MPE at 20 cm

Band	Link	Frequency [MHz]	Output power [dBm]	Antenna gain [dBi]	Cable loss [dBi]	EIRP		Power density [mW/cm ²]	Limit [mW/cm ²]
						[dBm]	[mW]		
Celluar	Down	890.819	10.14	3.00	0.00	13.14	20.63	0.004 1016	0.593 879
	Up	842.656	23.01	5.00	0.00	28.01	632.41	0.125 878	0.561 771
PCS	Down	1937.20	10.32	3.00	0.00	13.32	21.47	0.004 275	1.000 000
	Up	1879.95	23.07	5.00	0.00	28.07	641.20	0.127 629	1.000 000

• Celluar

The maximum conducted power is 23.01 dBm; antenna is fix-mounted with a maximum gain and cable loss of 5.0 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The maximum Peak EIRP calculated is 28.01 dBm.

The Power Density can be calculated using the formula

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.

At 0.2 m, $S = 0.125 \text{ mW/cm}^2$, which is below the MPE Limit of 0.562 mW/cm²

• PCS

The maximum conducted power is 23.07 dBm; antenna is fix-mounted with a maximum gain and cable loss of 5.0 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The maximum Peak EIRP calculated is 28.07 dBm.

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.

At 0.2 m, $S = 0.127 \text{ mW/cm}^2$, which is below the MPE Limit of 1.000 mW/cm²

• Celluar + PCS

Power density on up link side for Celluar and PCS are 25.1 % and 14.8 % of the limit, so combined they are still well below 100 % of the limit.

5. Test equipment list

The listing below denotes the test equipment for the test(s).

No.	Equipment	Model	Manufacturer	Serial Number	Calibration Due date
1	Spectrum analyzer	N9020A	Agilent	MY48010456	2015.01.22
2	Signal generator	N5182A	Agilent	MY49060695	2015.01.20
3	Signal generator	E4432B	Agilent	GB38450504	2015.01.21
4	Attenuator	66-30-34	Weinschel	CB0744	2015.01.21
5	RF combiner	1506A	Weinschel	NP154	2015.01.21
6	Biconical antenna	VHA9103	Schwarzbeck	2217	2014.11.29
7	Log-Periodic antenna	VULP9118A	Schwarzbeck	382	2014.11.29
8	Horn antenna	BBHA 9120 D	Schwarzbeck	395	2014.08.07
9	Pre-amplifier	SCU-01	R&S	10020	2015.09.02
10	Pre-amplifier	JS4-00102600-26-5P	MITEQ	383521	2015.01.27
11	Turn table	N/A	Daeil EMC	N/A	N/A
12	Antenna mast	EAM4.5	Daeil EMC	N/A	N/A
13	Controller	DE200	Daeil EMC	AAA69813111	N/A