

TEST REPORT

Report Number		RAPA14-O-055
Type of Equipment		Dual Band Repeater
Model Name		USHR-700L
FCC ID		Q4EUSHR-700L
Applicant	Name	OPISYS Incorporated
	Logo	 OPISYS, INC.
	Address	511 S. Harbor Blvd, Unit P. La Habra, CA. 90631, USA
Manufacturer	Name	Ace Technology Corp.
	Address	24BL 5L, 451-4, Nonhyeon-dong, Namdong-gu, Incheon, 405-849, Korea
Test duration		July 01, 2013 to November 14, 2014
Date of issue		November 24, 2014
Total Page		110 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.

November 24, 2014



Tested by Hyun Soo Lee
Manager

November 24, 2014



Reviewed by Sukil Park
Executive Managing Director

Test Report Revision History

Revision	Date	Revised By	Reason for revision
1.0	March 19, 2014	Chang Young Choi	Original Document
2.0	November 14, 2014	Hyun Soo Lee	EUT Specification Revision -DL Gain : 62 dB → 61 dB -UL Gain : 63 dB → 60 dB -DL Output : +17 dBm → +2 dBm
3.0	November 24, 2014	Hyun Soo Lee	RF EXPORSURE Revision

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1. General description of EUT

1.1 Applicant

- Company name : OPISYS Incorporated
- Address : 511 S. Harbor Blvd, Unit P. La Habra, CA. 90631, USA
- Contact person : Karen KH Koo
- Phone/Fax : 562-448-3102 / 562-448-3105

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 : Dual Band Repeater
- Model name : USHR-700L
- Frequency : Band 12 Downlink : 728 MHz - 746 MHz
Band 12 Uplink : 698 MHz - 716 MHz
Band 13 Downlink : 746 MHz - 757 MHz
Band 13 Uplink : 776 MHz - 787 MHz
- Output power : Downlink : +2 dBm
Uplink : +22 dBm
- Emission Designators : GSM(GXW), EDGE(G7W), CDMA(F9W), WCDMA(F9W), EVDO(F9W)
LTE(G7D)
- FCC Rule Part(s) : FCC CFR47 Part 20
- FCC classification : B2W/Wideband Consumer Booster (CMRS)
- Test duration : July 01, 2013 to November 14, 2014
- Date of issue : November 14, 2014
- Place of test : Head office

#101 & B104 Anyang Megavalley, 268, Hagui-ro, Dongan-gu,
Anyang-si, Gyeonggi-do, 431-767, Korea

Open area test site

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

(FCC Registration Number : 931589)

(IC Company address code : 9355B)

(RRA Designation Number : KR0027)

1.4 Electrical specification

Item		Specifications	Note
Frequency Range	DL	728 ~ 746 MHz	BAND12
	UL	698 ~ 716 MHz	
	DL	746 ~ 757 MHz	BAND13
	UL	776 ~ 787 MHz	
Input Power limit	DL	-45 dBm ~ -59 dBm	BAND12
	UL	-13 dBm ~ -38 dBm	
	DL	-45 dBm ~ -59 dBm	BAND13
	UL	-13 dBm ~ -38 dBm	
Output Power	DL	+2 dBm (Conducted)	LTE DL 5 MHz 25RB
	UL	+22 dBm (Conducted)	LTE UL 5 MHz 25RB
	DL	+2 dBm (Conducted)	LTE DL 5 MHz 25RB
	UL	+22 dBm (Conducted)	LTE UL 5 MHz 25RB
Gain	DL	47 ~ 61 dB (± 1.0 dB)	BAND12
	UL	No Interlocking	
		On Interlocking	
	DL	47 ~ 61 dB (± 1.0 dB)	BAND13
	UL	No Interlocking	
		On Interlocking	
Ripple	DL / UL	< 4 dB	BAND12
	DL / UL	< 4 dB	BAND13
Noise Figure	DL / UL	< 6.0 dB / < 6.0 dB	BAND12 Max Gain
	DL / UL	< 6.0 dB / < 6.0 dB	BAND13 Max Gain
Noise Power Limit	DL	< -70 dBm/MHz	On shutdown
	UL	< -70 dBm/MHz	On shutdown & sleep mode
	DL / UL	< -45.5 dBm/MHz @Max Gain	BAND12
	DL / UL	< -44.6 dBm/MHz @Max Gain	BAND13
Propagation Delay		< 3 us	
VSWR		$\leq 1.8 : 1$	
ALC Setting Level	DL (Upper Value)	+2 dBm $\pm$ 1.0 dB	- ALC, SD, OSC functional operation is completely separate BAND12 and BAND13.
	Window Size(Lower Offset)	0 ~ 10 dB	
	UL (Upper Value)	+22 dBm $\pm$ 1.0 dB	
	Window Size(Lower Offset)	0 ~ 10 dB	
ALC Range	DL / UL	≥ 14 dB / ≥ 25	BAND12
	DL / UL	≥ 14 dB / ≥ 25	BAND13

Item		Specifications	Note
Uplink AGC With DL	Setting Offset	-68dBm -> max gain 60dB -45 dBm -> max gain 37 dB	
Shutdown Level	DL	-44 dBm	
	UL	-13 dBm	
OSC Level	DL	DL detects OSC under 1 sec.	
	UL	UL detects OSC under 0.3 sec	
Uplink In-activity	UL	On@ < -90 dBm, OFF@ < -92 dBm	
Gain Control Range	ALC DL	0 ~ 13 dB / 1 dB step @ Band12	- be controlled GUI or Dip Switch - Total Atten control Range : 0 ~ 25 dB / 1 dB Step (DL and UL are the same)
	ALC UL	0 ~ 25 dB / 1 dB step @ Band13	
	DIP S/W DL	0 ~ 25 dB / 1 dB Step	
	DIP S/W UL	0 ~ 25 dB / 1 dB Step	
Gain Control Deviation		< $\pm$ 0.9 dB	
EVM		< 7%	No Feedback
ACLR ($\pm$ 10MHz)	DL	$\geq$ 32 dB	LTE DL 5MHz 25RB
	UL	$\geq$ 32 dB	LTE UL 5MHz 25RB
Isolation checking Range		47 ~ 75 dB / BAND12	Detecting deviation: < $\pm$ 2.0 dB
		47 ~ 75 dB / BAND13	
In band Spurious (Operating band unwanted emissions)		Category A	3GPP TS 36.106
Out Band Spurious		< -13 dBm / 1 kHz RBW	9 kHz ~ 150 kHz
		< -13 dBm / 10 kHz RBW	150 kHz ~ 30 MHz
		< -13 dBm / 100 kHz RBW	30 MHz ~ 1 GHz
		< -13 dBm / 1 MHz RBW	1 GHz ~ 12.75 GHz
3rd IMD Level		< -19 dBm	
Frequency Stability		$\leq$ $\pm$ 0.01 ppm	
GUI Interface		RS-232C	
Alarm & Status	Display	PWR	- Normal: Green - Power turn off: Off
		BAND12	- Normal: Green - Over Power Shutdown: RED - Checking SD: Green Blinking per 1 sec cycle - Checking OSC Algorithm : RED Blinking per 1sec cycle - Sleep Mode: Green Blinking per 5 sec cycle - ISO SD : RED Blinking per 5 sec cycle
		BAND13	- Normal: Green - Over Power Shutdown: RED - Checking SD: Green Blinking per 1 sec cycle - OSC SD Algorithm : RED Blinking per 1sec cycle - Sleep Mode: Green Blinking per 5 sec cycle - ISO SD : RED Blinking per 5 sec cycle

Item	Specifications	Note
Power Consumption	< 15 W	
Operating Power	AC/DC Adapter(AC110 V or AC220 V)	
RF Connector	N-type Female	

1.5 Mechanical specification

Item	Specifications	Note
Dimensions (L × W × H)	151 mm x 191 mm x 35 mm	-
Weight	< 2 Kg	-

1.6 Environmental specification

Item	Specifications	Note
Temperature	-30 °C ~ 55 °C	-
Relative Humidity	10 % ~ 95 %	-

1.7 AC/DC adaptor specification

Item	Specifications	Note
AC input power	90 Vac ~ 264 Vac, 47 Hz ~ 63 Hz	-
Output rated Voltage	+5.5 Vdc / 1.3 A	-
Voltage Current range	2.5 A ~ 0.0 A	-
Operation Temperature	-30 °C ~ +55 °C	-
Operation humidity	10 %~ 90 %	-

2. General information of test

2.1 Test standards and results

Applied Standards : FCC CFR47 Part 20			
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 Part 20.27	2.1051 27.53	Conducted spurious emission	Pass
Part 20.21	(e)(8)(i)(A)	Noise limit	Pass
Part 20.21	(e)(8)(i)(J)	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 2	2.1053	Radiated spurious emission	Pass
Part 20.21	(e)(8)(i)(B)	Spectrum block filtering	N/A

* This device is not using 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
USHR-700L	OPISYS Incorporated	Dual Band Repeater	-	-
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	N-Type	3	Y
EUT	Attenuator	N-Type	1	Y
Attenuator	Spectrum Analyzer	N-Type	1	Y

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.

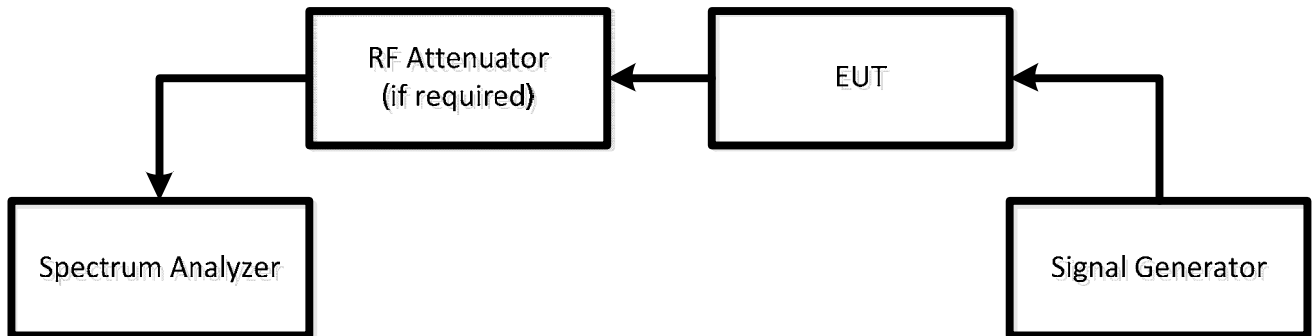
3.1.1 Specification

- FCC 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

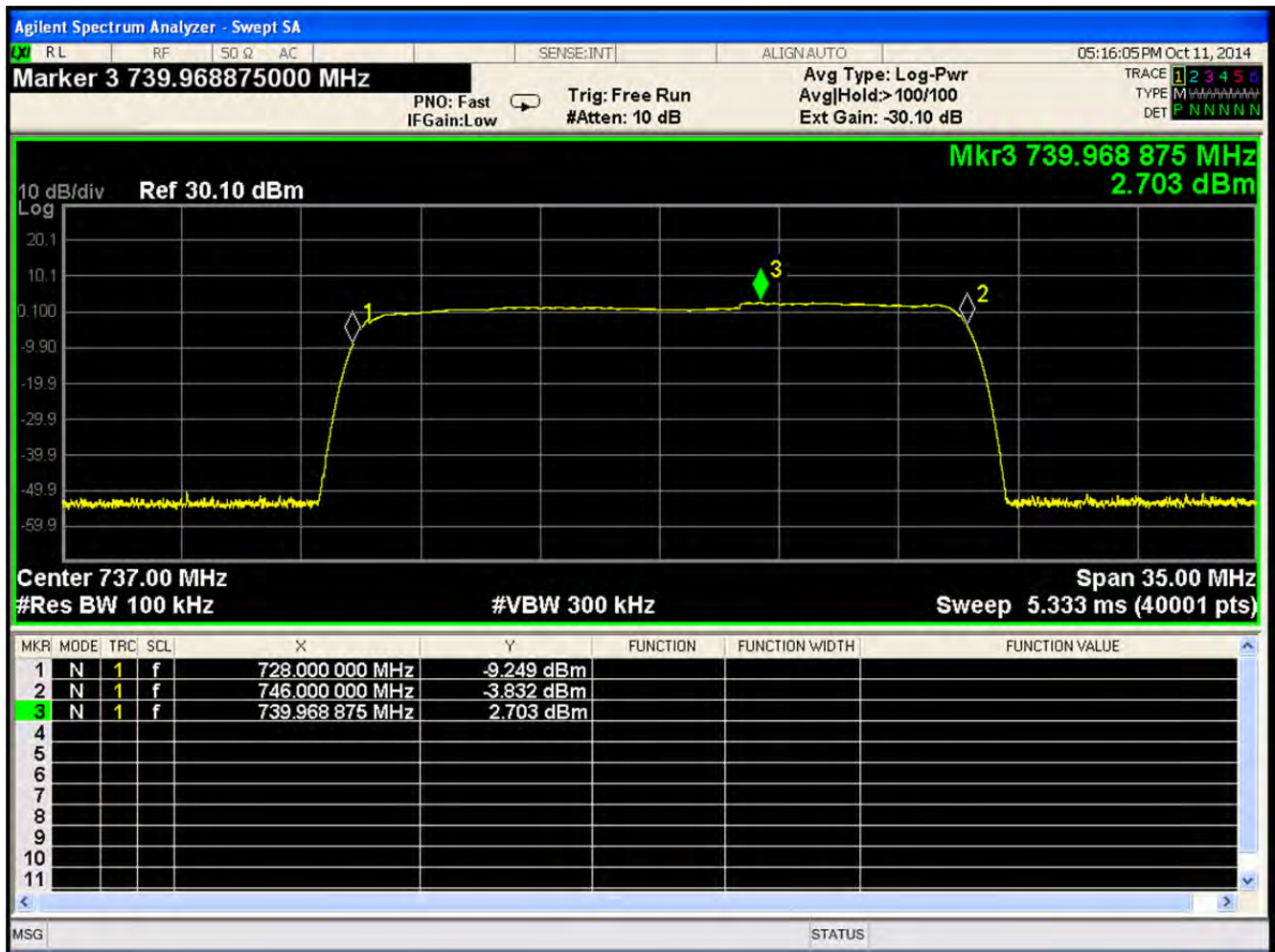
Equipment	Model Name	Manufacturer
EUT	USHR-700L	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.1.5 Test condition

- Test place : Shield Room
- Test environment : 24.2 °C, 51 % R.H.

3.1.6 Test plots

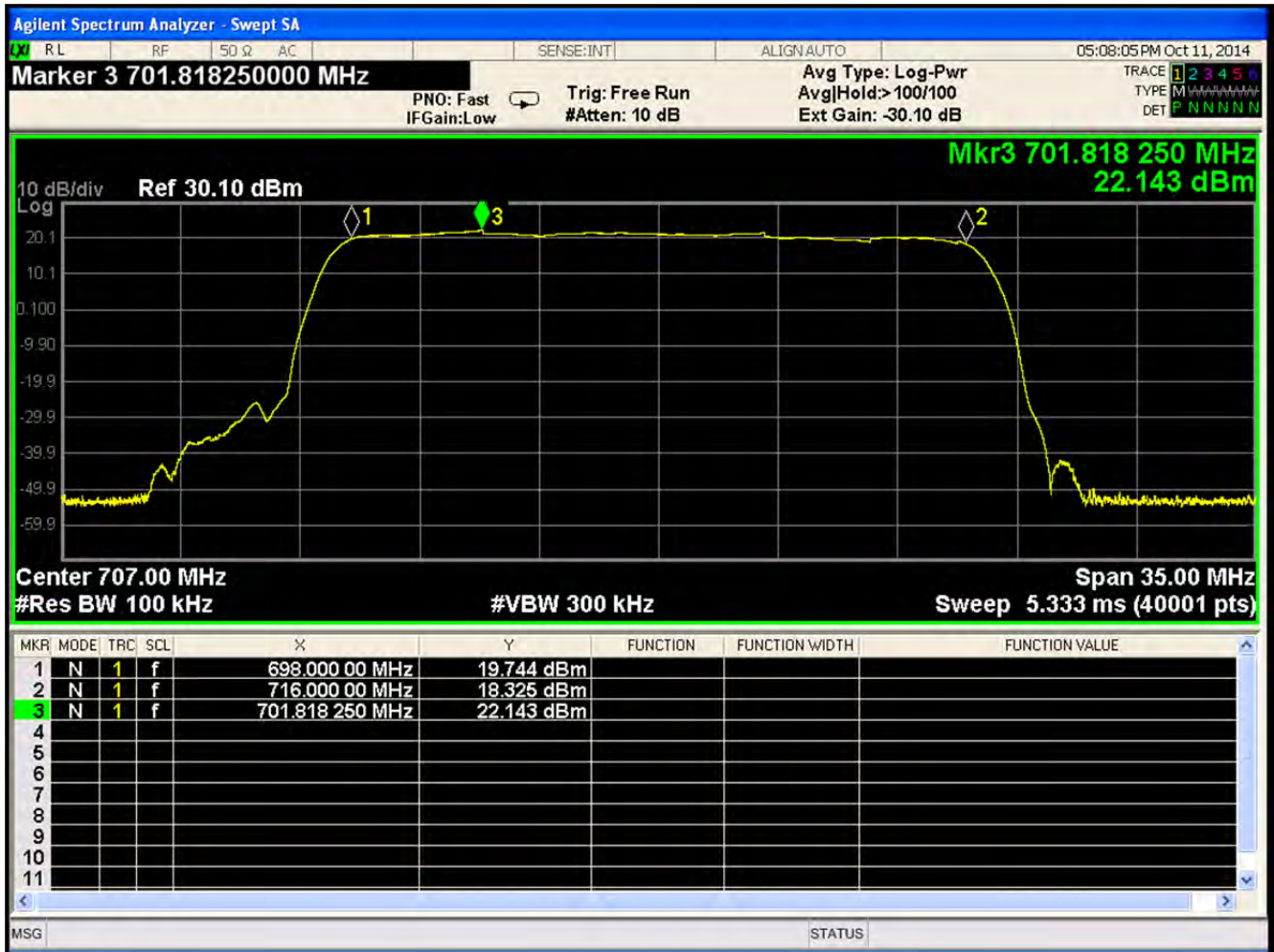
- Band 12 / Down link



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

Frequency of lower edge : 728.000 MHz
Frequency of upper edge : 746.000 MHz
Frequency of highest power : 739.968 MHz

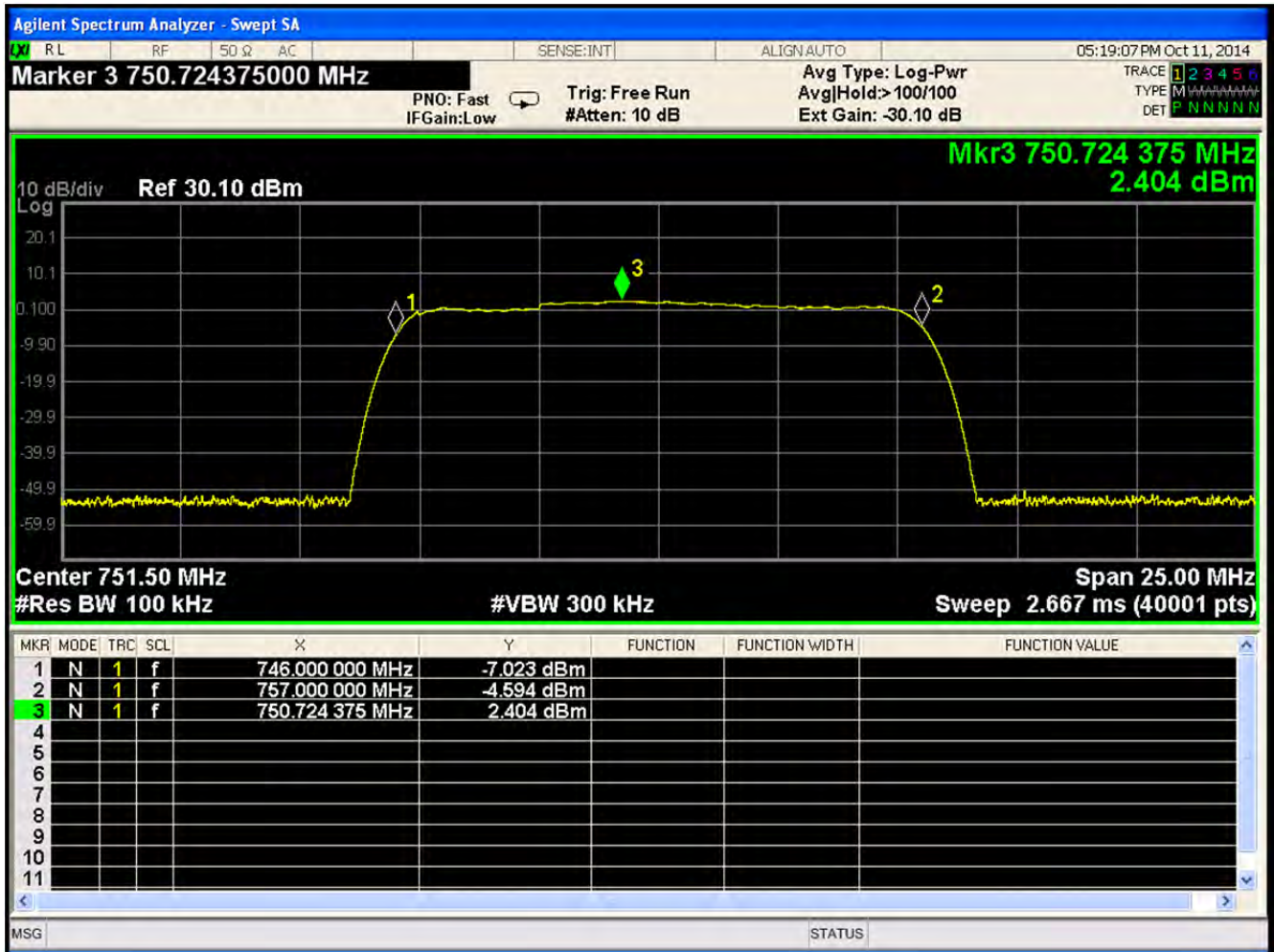
• Band 12 / Up link



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

Frequency of lower edge : 698.000 MHz
Frequency of upper edge : 716.000 MHz
Frequency of highest power : 701.818 MHz

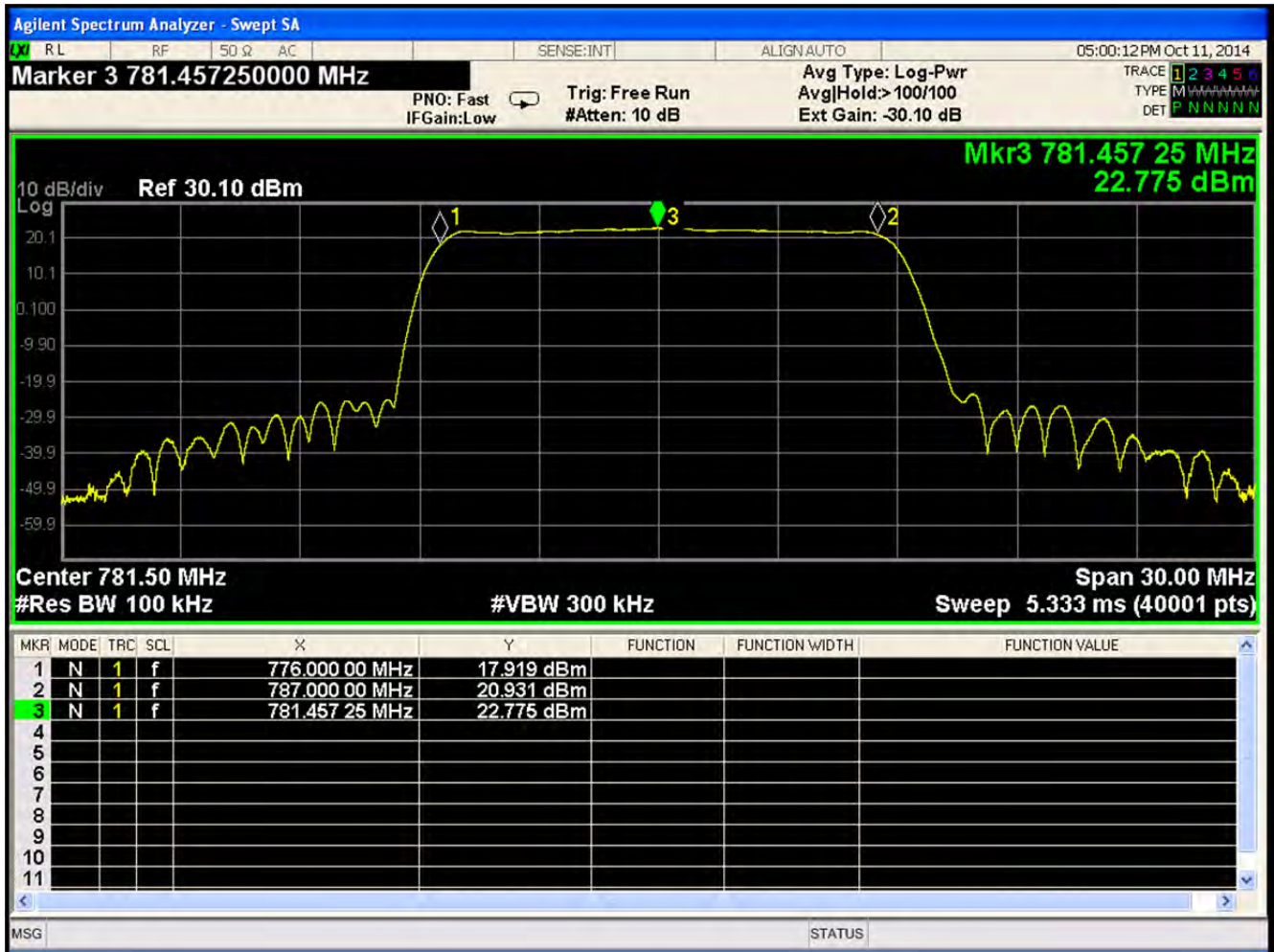
• Band 13 / Down link



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

Frequency of lower edge : 746.000 MHz
Frequency of upper edge : 757.000 MHz
Frequency of highest power : 750.724 MHz

• Band 13 / Up link



RBW : 100 kHz

VBW : 300 kHz

Detector mode : Peak

Trace mode : Max hold

Frequency of lower edge : 776.000 MHz

Frequency of upper edge : 787.000 MHz

Frequency of highest power : 781.457 MHz

3.2 Maximum power measurement

3.2.1 Specification

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

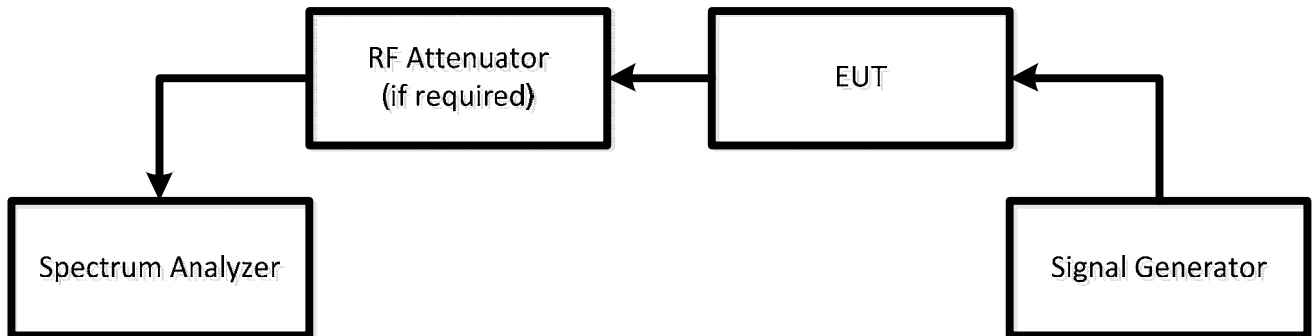
3.2.2 Measurement method

- 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 $\geq (2 \times \text{span})/\text{RBW}$ (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), Lower / 50 mW (17 dBm)
- Downlink : Upper / 50 mW (17 dBm)

3.2.4 Set-Up



3.2.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	USHR-700L	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Signal Generator	N5182A	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.2.6 Test condition

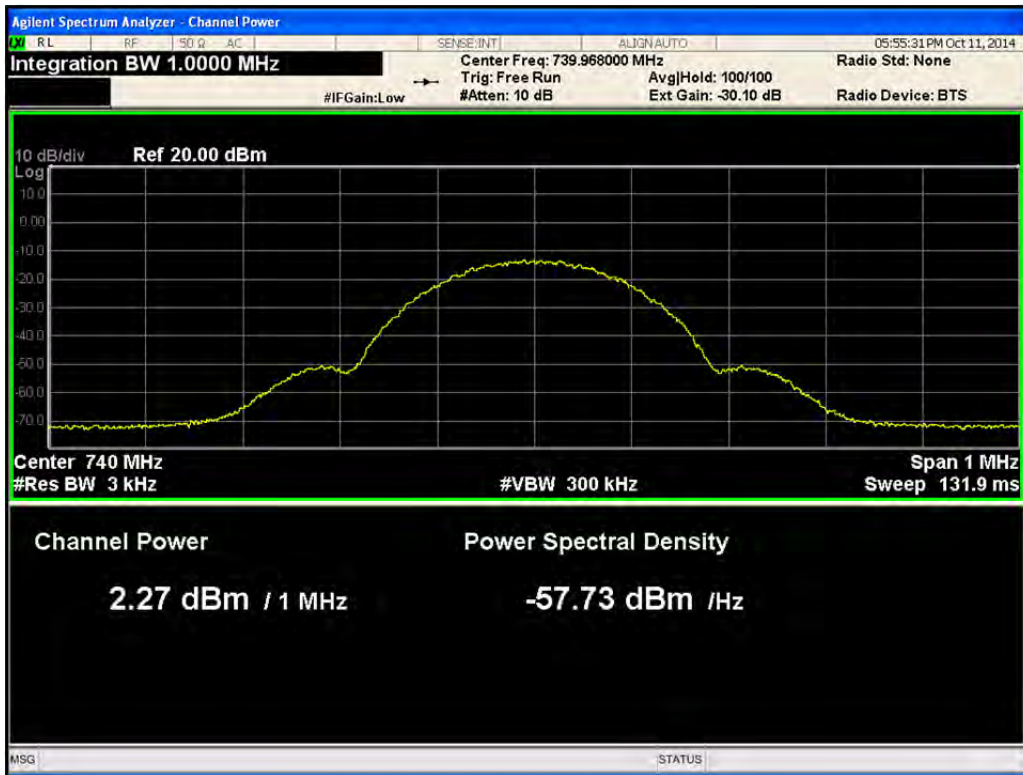
- Test place : Shield Room
- Test environment : 24.2 °C, 51 % R.H.

3.2.7 Test results

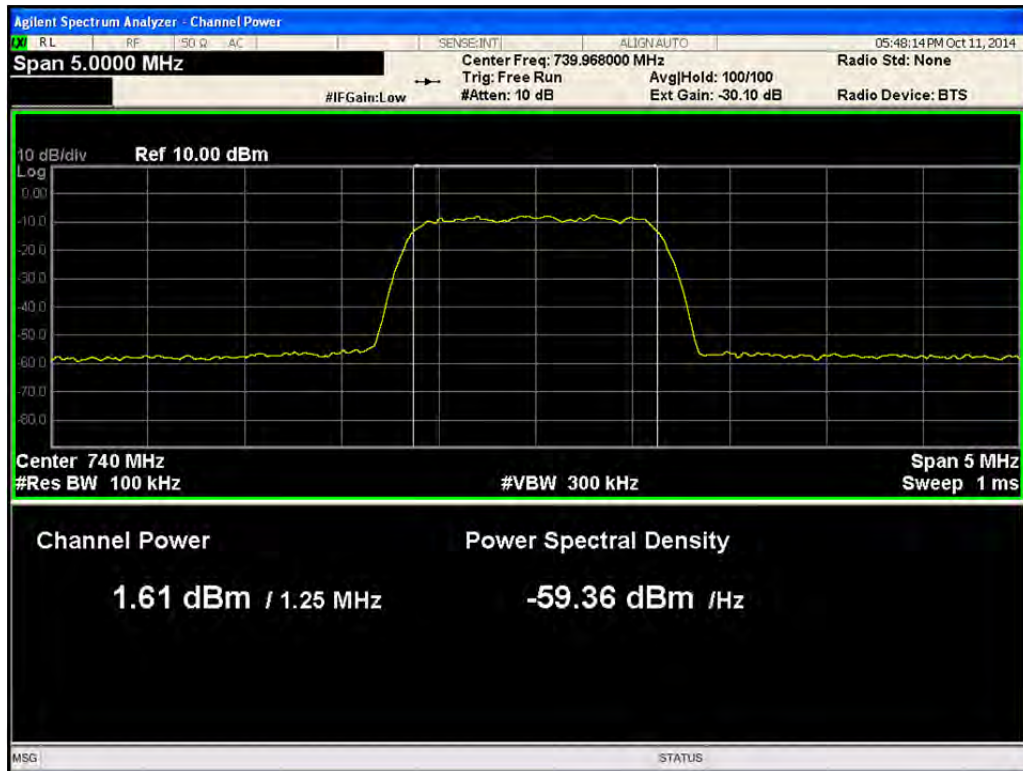
Band	Link	Frequency [MHz]	Signal Type	Input Level [dBm]	Output Level [dBm]	Limit [dB]
Band 12	Down Link	739.968	GSM	-59.0	2.27	Less than +17.0
			CDMA	-59.0	1.61	
			AWGN	-59.0	1.67	
			LTE	-59.0	2.00	
	Up Link	701.818	GSM	-38.0	21.30	Between +17.0 and +30.0
			CDMA	-38.0	21.17	
			AWGN	-38.0	21.01	
			LTE	-38.0	21.70	
Band 13	Down Link	750.724	GSM	-59.0	1.73	Less than +17.0
			CDMA	-59.0	1.58	
			AWGN	-59.0	1.56	
			LTE	-59.0	1.66	
	Up Link	781.457	GSM	-38.0	22.16	Between +17.0 and +30.0
			CDMA	-38.0	21.89	
			AWGN	-38.0	21.84	
			LTE	-38.0	22.23	

3.2.8 Test Plots

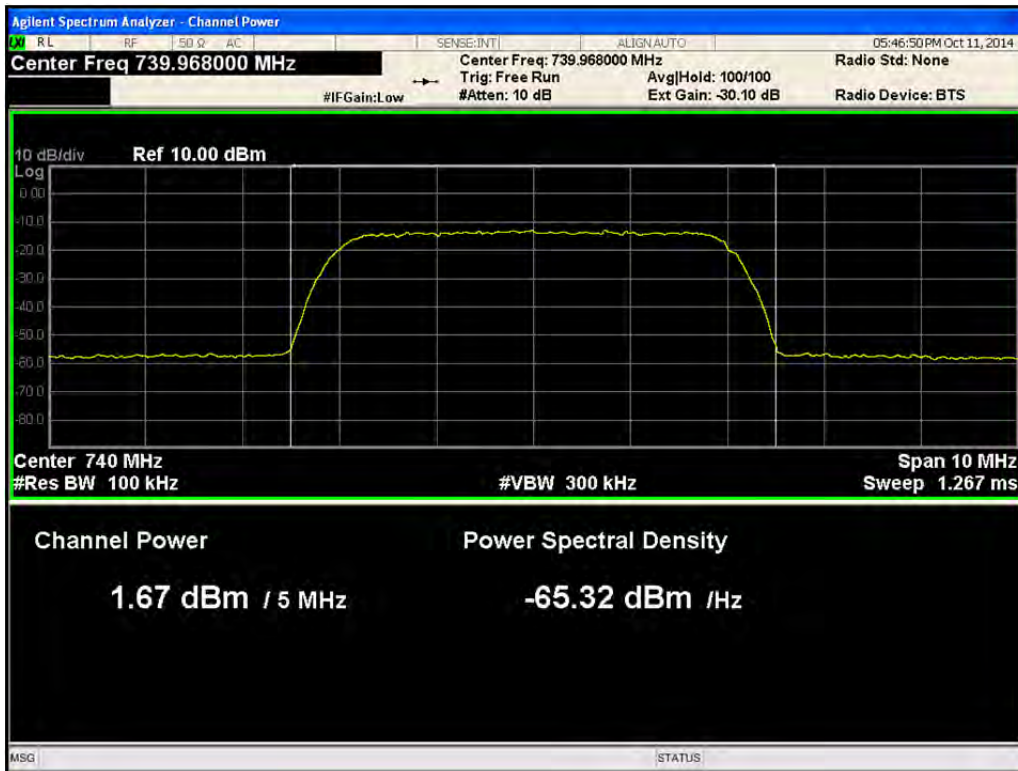
- Band 12 / Downlink / GSM



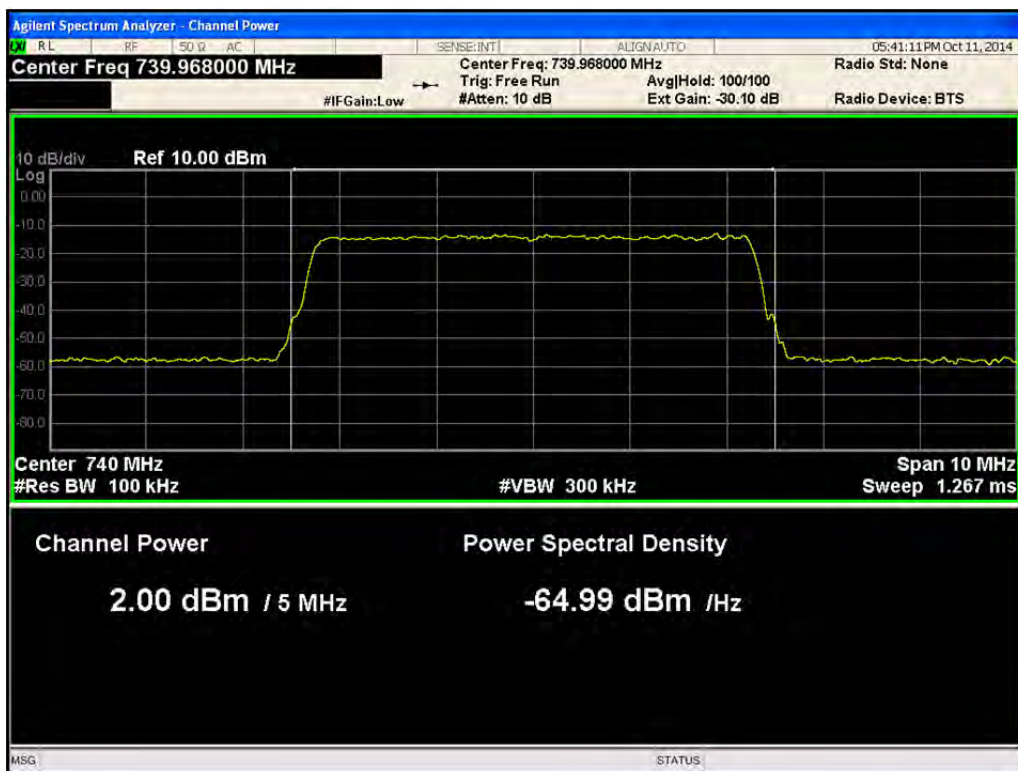
- Band 12 / Downlink / CDMA



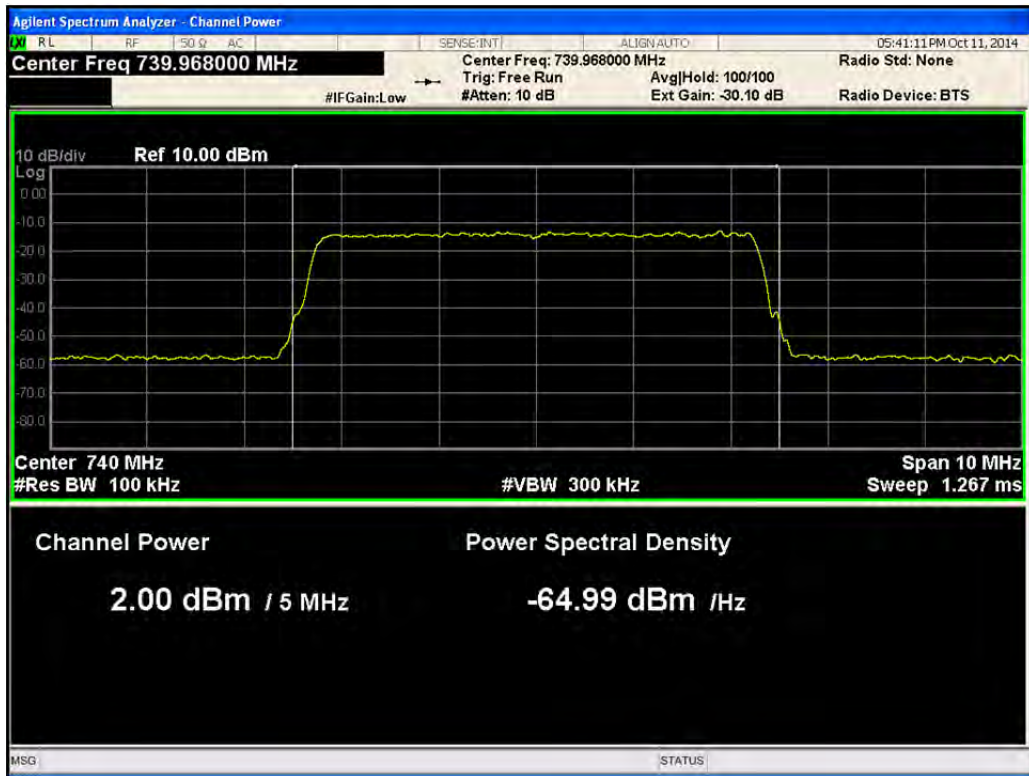
• Band 12 / Downlink / AWGN



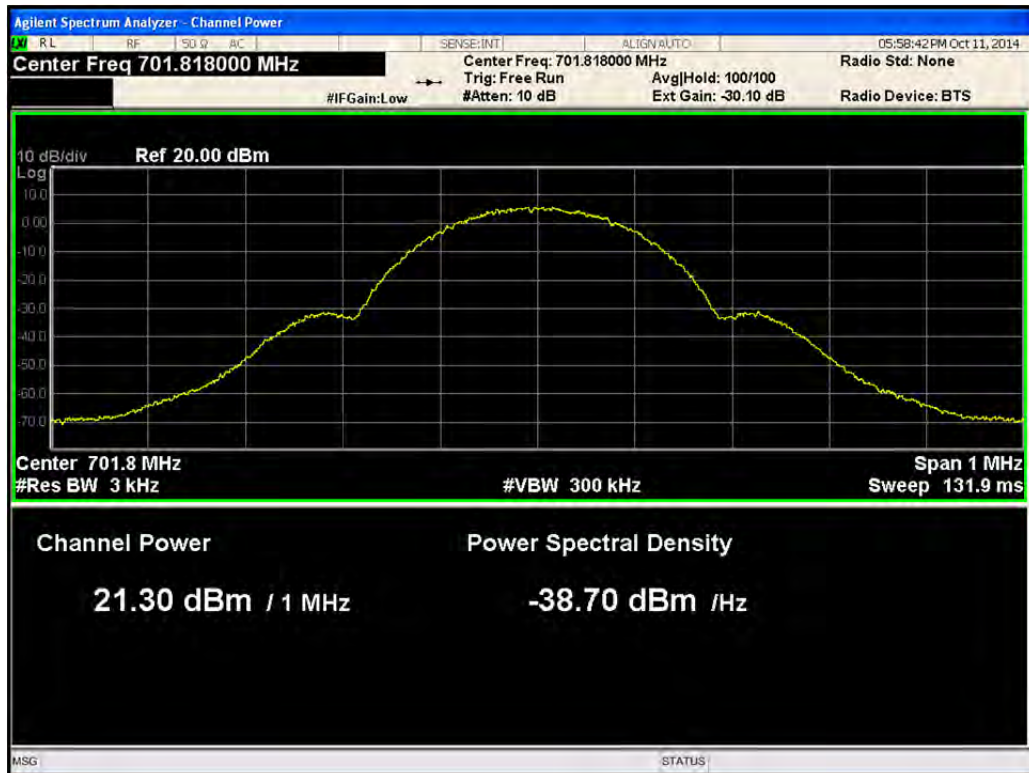
• Band 12 / Downlink / LTE



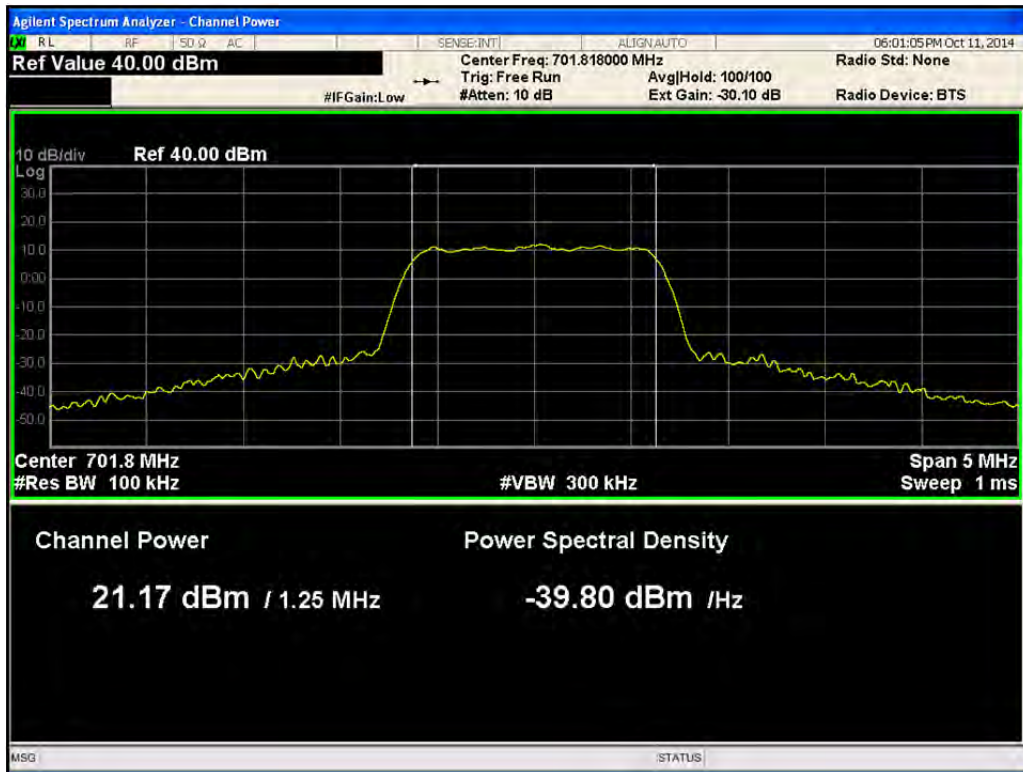
• Band 12 / Downlink / LTE



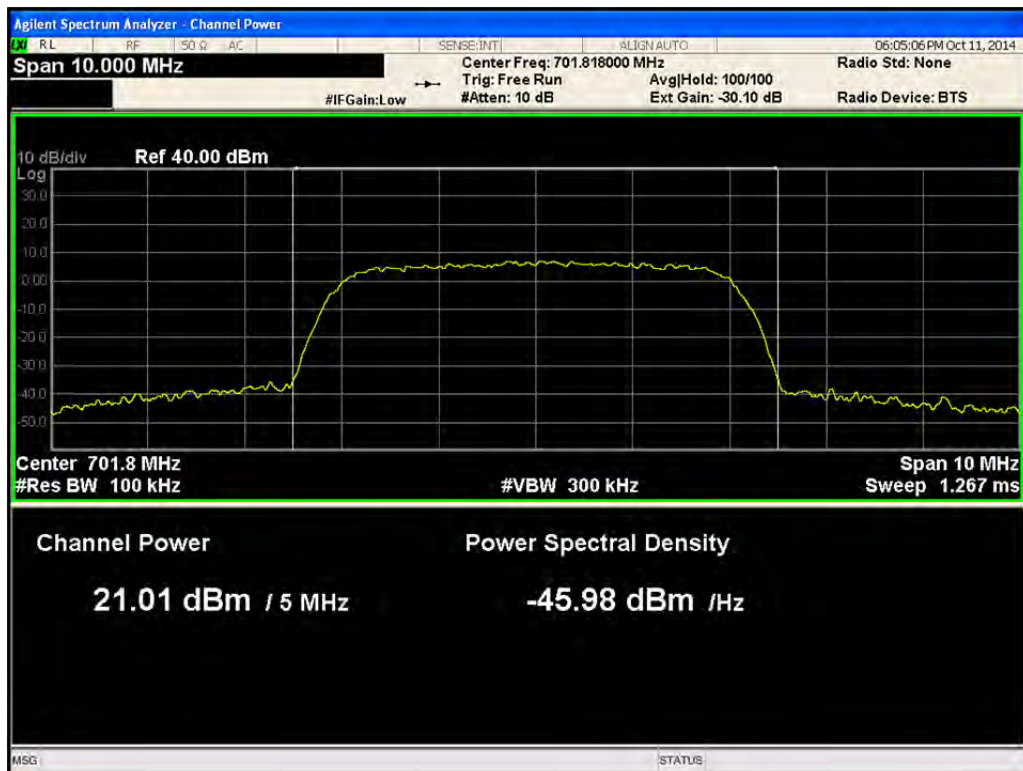
• Band 12 / Uplink / GSM



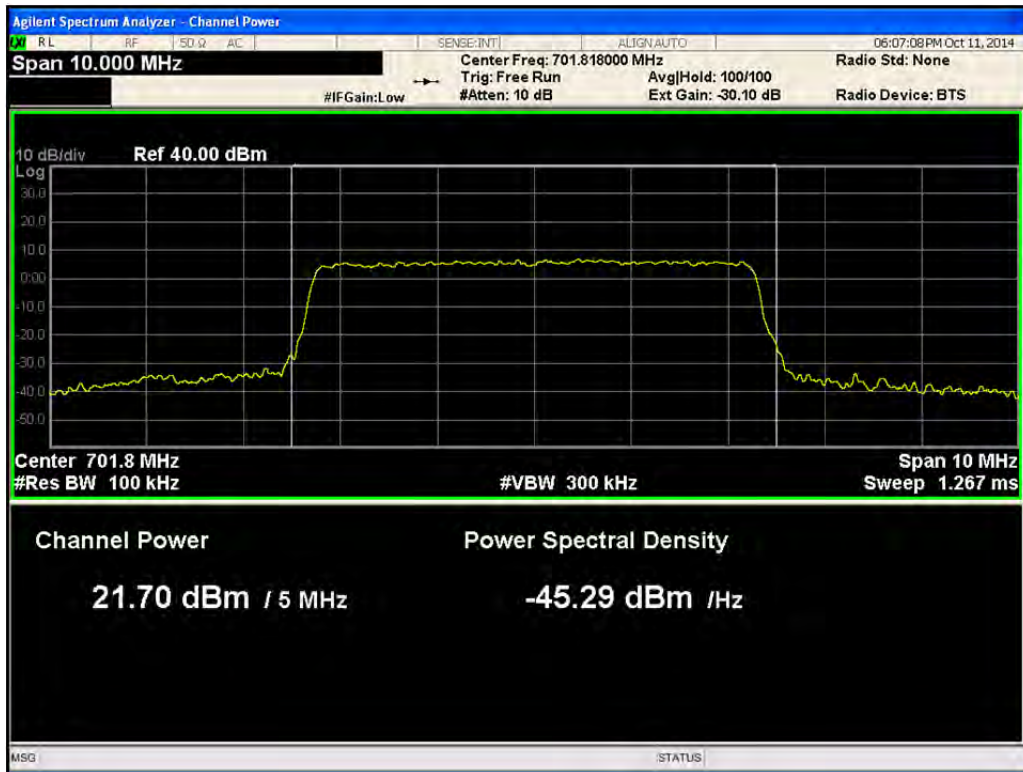
• Band 12 / Uplink / CDMA



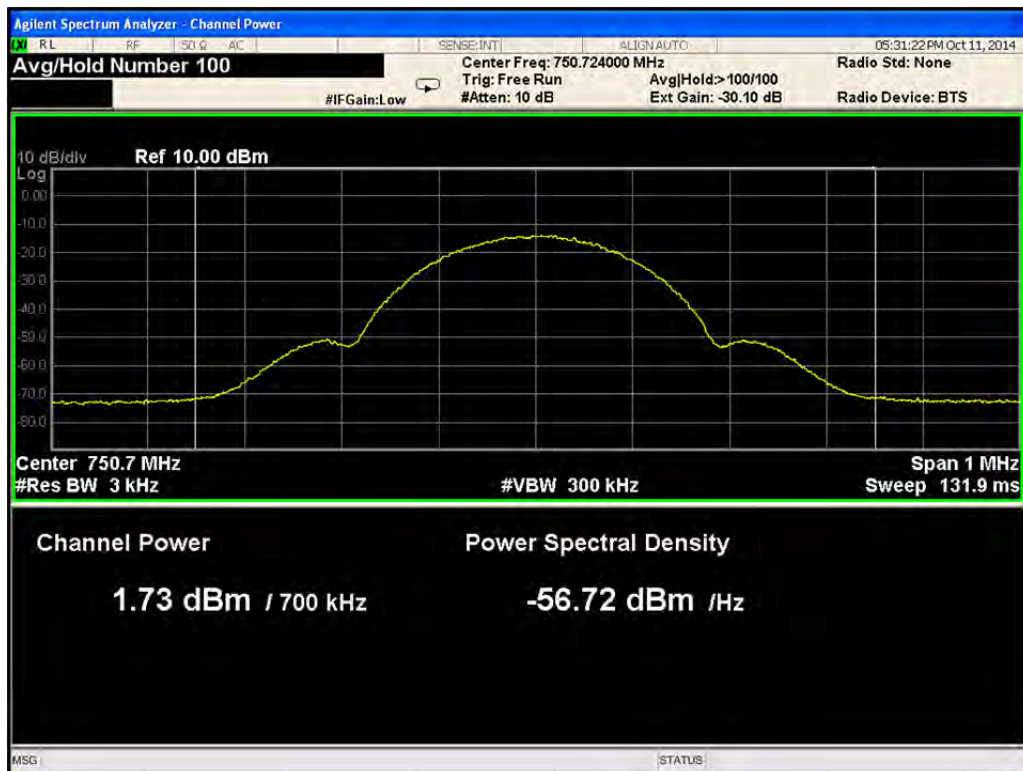
• Band 12 / Uplink / AWGN



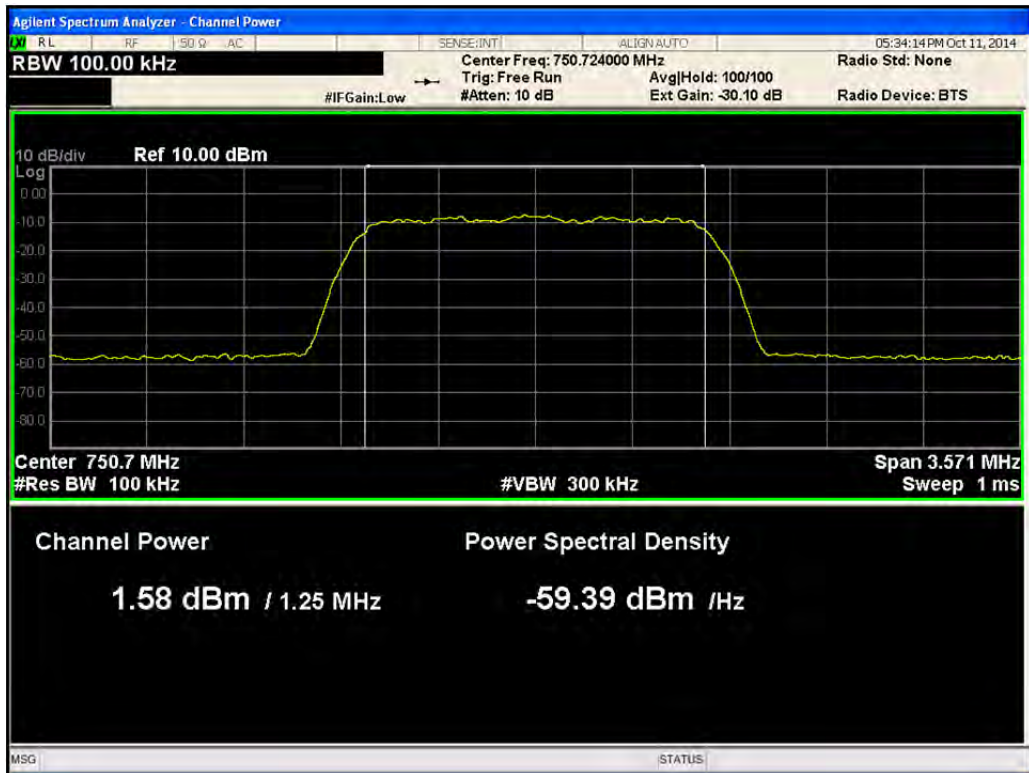
• Band 12 / Uplink / LTE



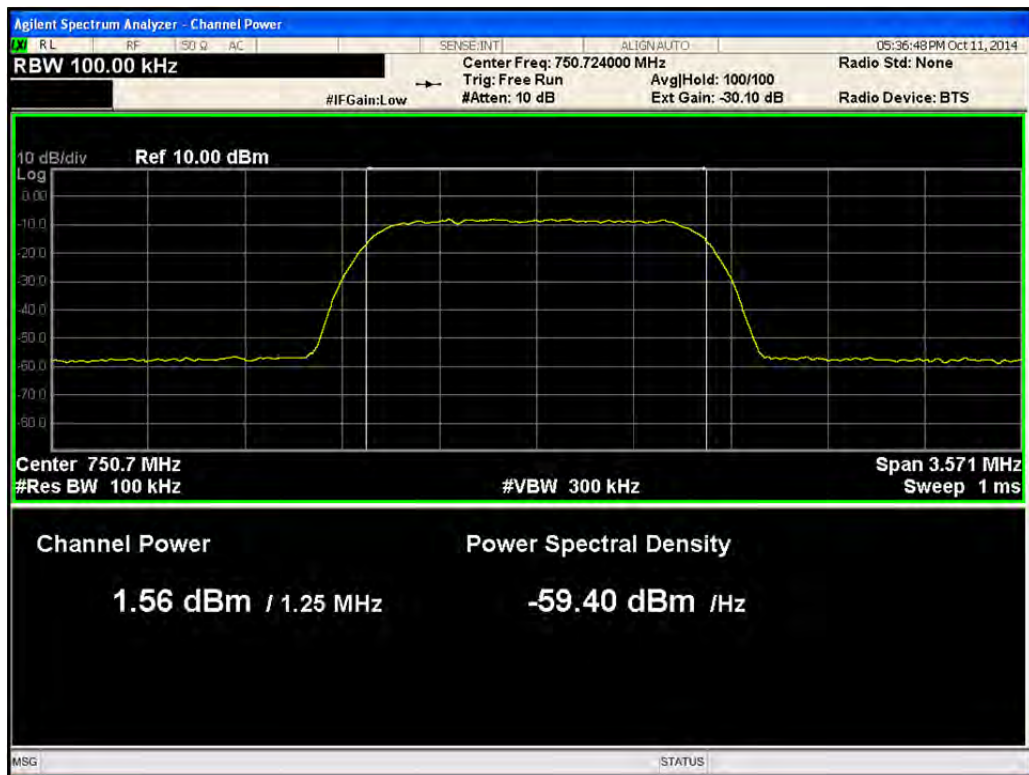
• Band 13 / Downlink / GSM



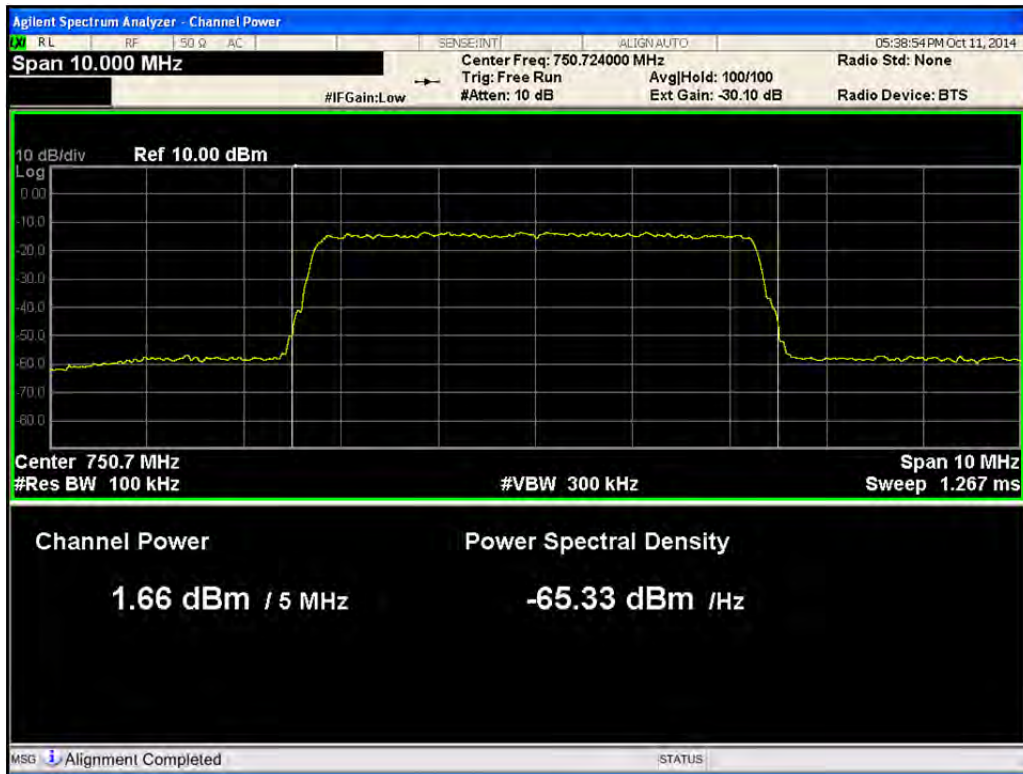
• Band 13 / Downlink / CDMA



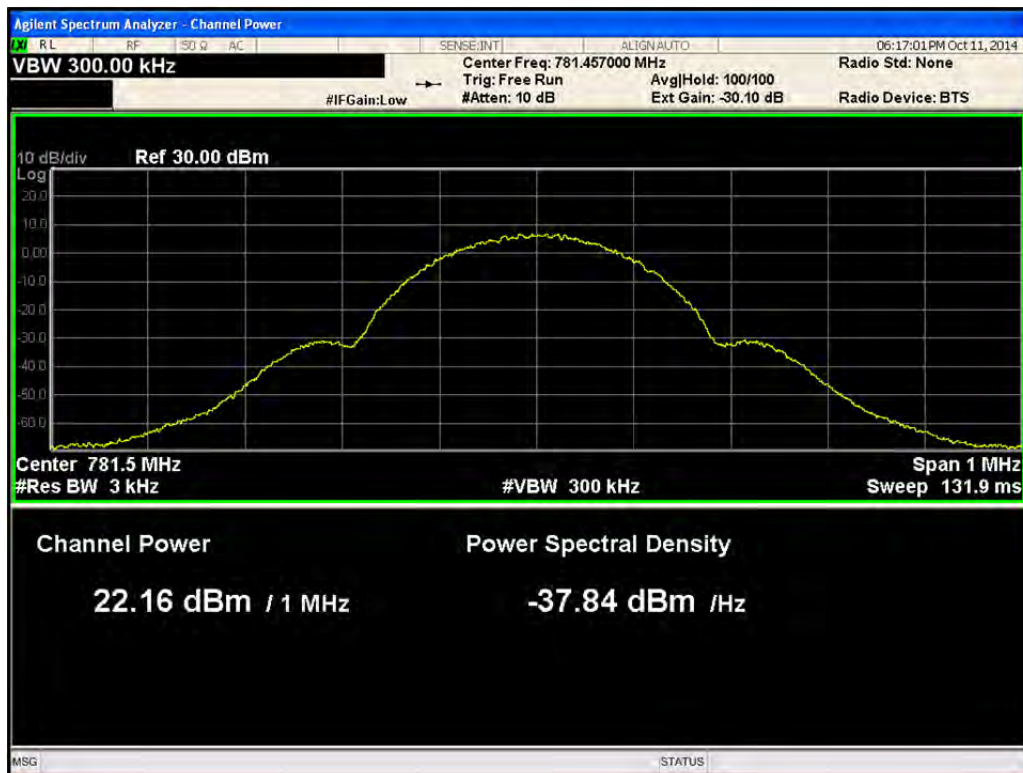
• Band 13 / Down link / AWGN



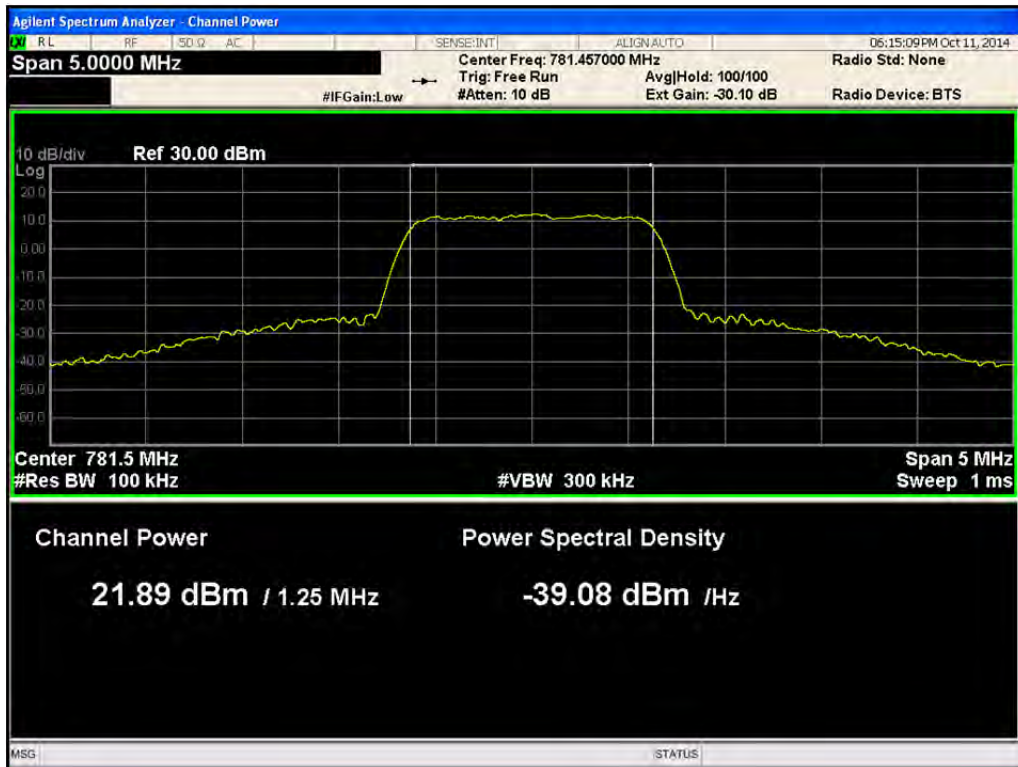
• Band 13 / Downlink / LTE



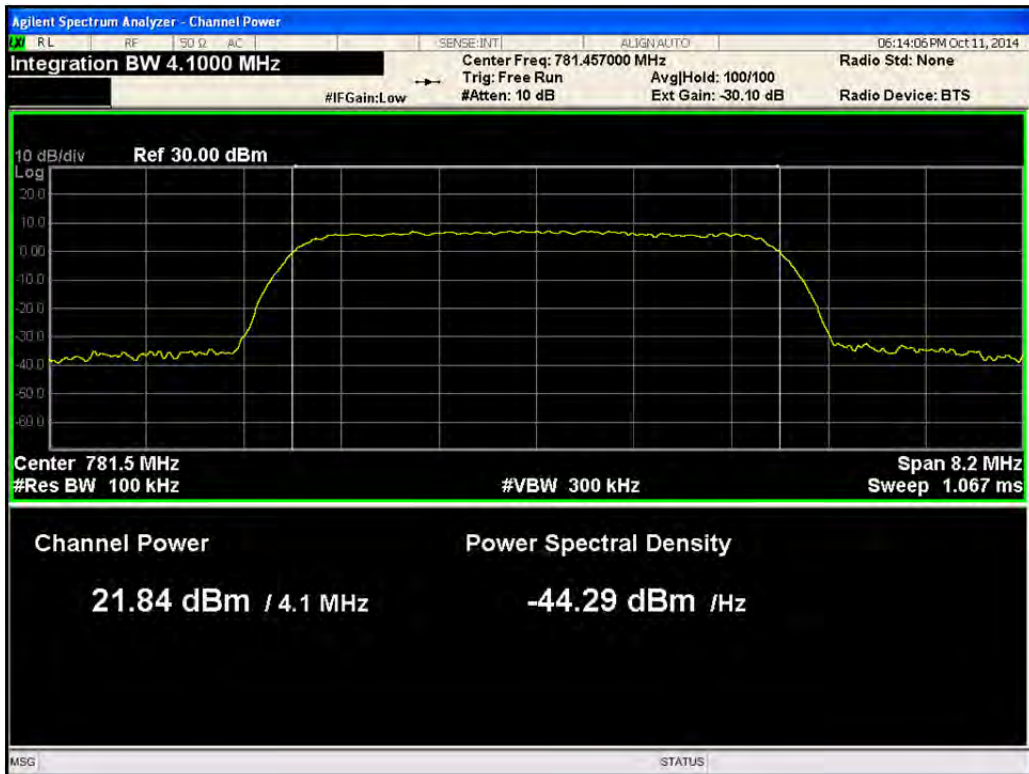
• Band 13 / Uplink / GSM



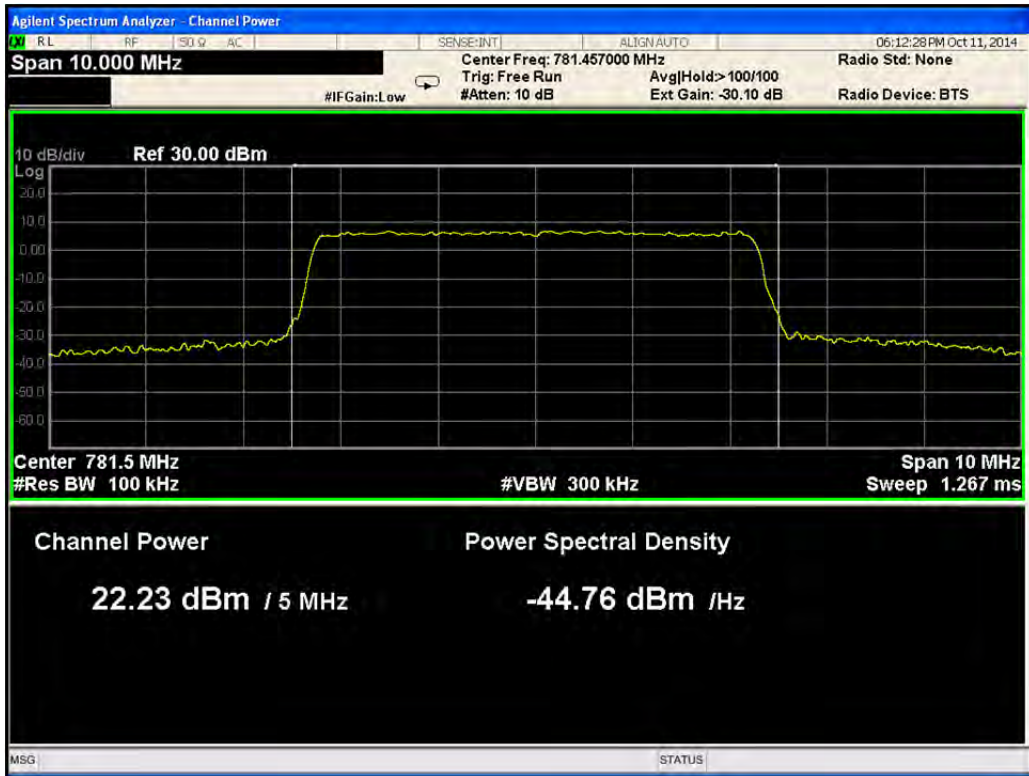
• Band 13 / Uplink / CDMA



• Band 13 / Uplink / AWGN



• Band 13 / Uplink / LTE



3.3 Maximum booster gain computation

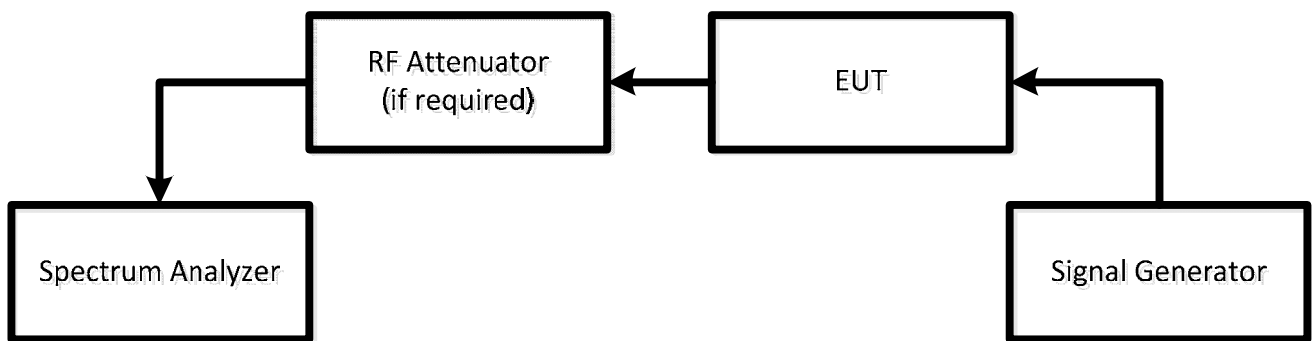
3.3.1 Specification

- 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
- a) Compute the maximum gain of the booster as follows to demonstrate compliance to the applicable gain limits as specified.
- b) 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: $G (dB) = P_{out}(dBm) - P_{in}(dBm)$.
- c) 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

- Maximum gain limit = $6.5 \text{ dB} + 20 \log (F \text{ in MHz})$
- 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	USHR-700L	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.3.6 Test condition

- Test place: Shield Room
- Test environment: 24.2 °C, 51 % 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]
Band 12	Down Link	739.968	GSM	-59.0	+ 2.27	-61.27	62.4	0.1
			CDMA	-59.0	+ 1.61	-60.61		
			AWGN	-59.0	+ 1.67	-60.67		
			LTE	-59.0	+ 2.00	-61.00		
	Up Link	701.818	GSM	-38.0	+ 21.30	-59.30	62.0	
			CDMA	-38.0	+ 21.17	-59.17		
			AWGN	-38.0	+ 21.01	-59.01		
			LTE	-38.0	+ 21.70	-59.70		
Band 13	Down Link	750.724	GSM	-59.0	+ 1.73	-60.73	62.5	0.1
			CDMA	-59.0	+ 1.58	-60.58		
			AWGN	-59.0	+ 1.56	-60.56		
			LTE	-59.0	+ 1.66	-60.66		
	Up Link	781.457	GSM	-38.0	+ 22.16	-60.16	62.8	
			CDMA	-38.0	+ 21.89	-59.89		
			AWGN	-38.0	+ 21.84	-59.84		
			LTE	-38.0	+ 22.23	-60.23		

3.4 Intermodulation product

3.4.1 Specification

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

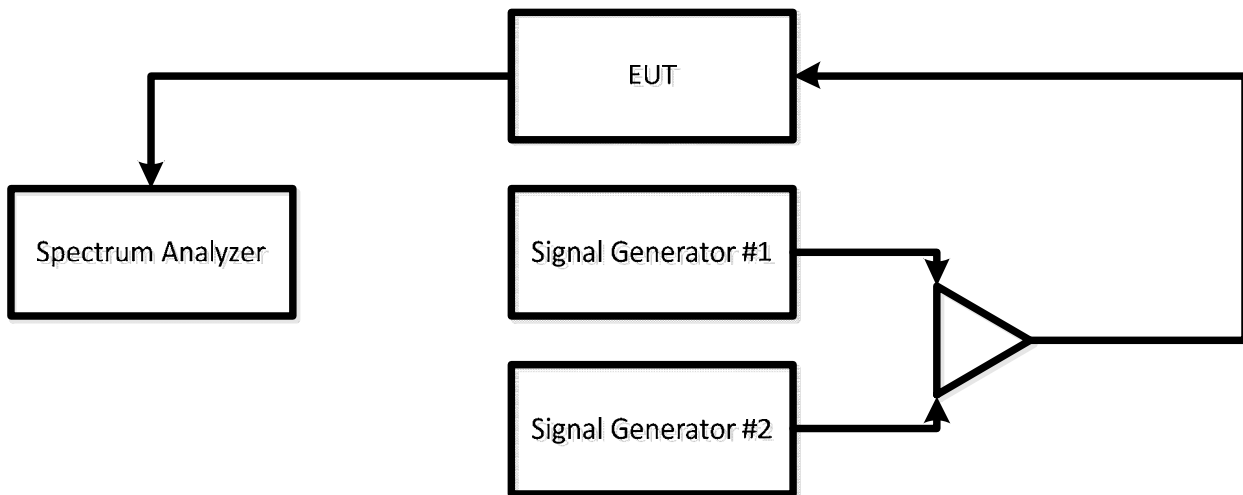
3.4.2 Measurement method

- 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 $\geq 3 \times$ 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	USHR-700L	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

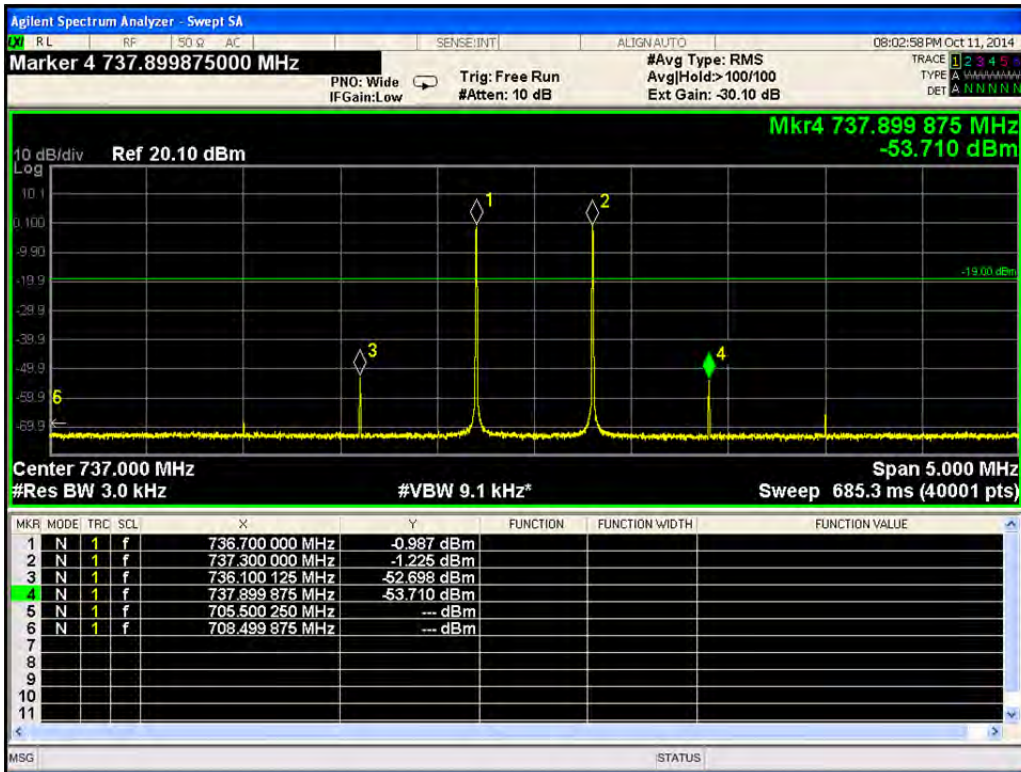
- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.4.7 Test results

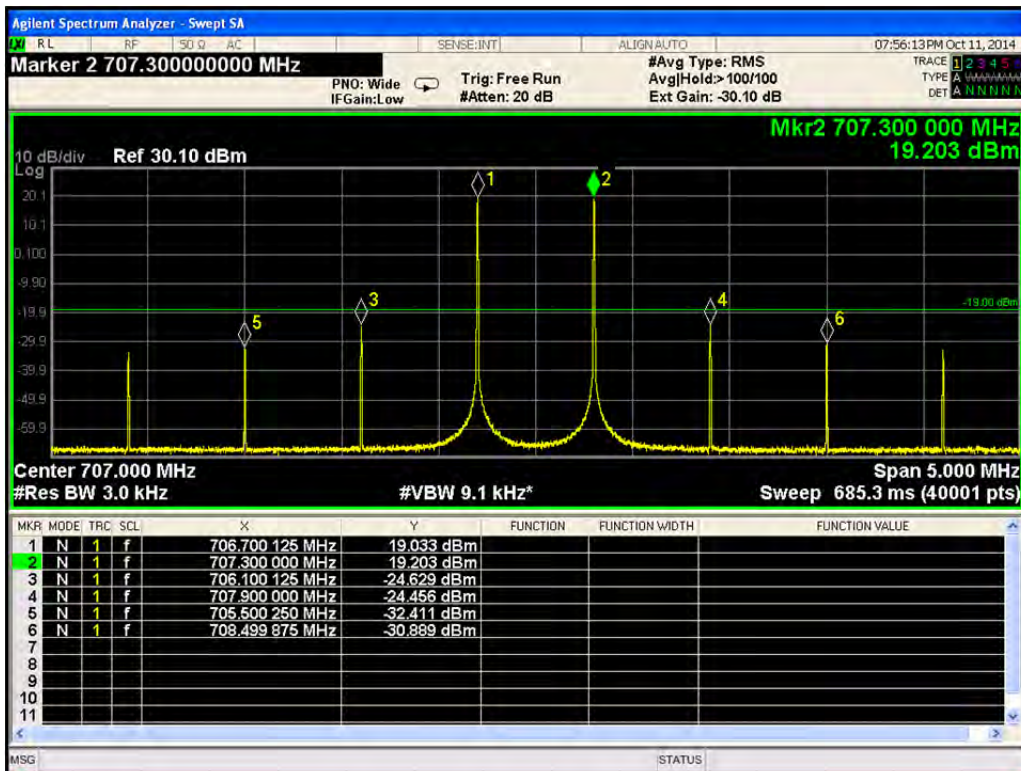
Band	Link	Frequency 1 [MHz]	Frequency 2 [MHz]	IMD Level [dBm]	IMD Limit [dB]	Margin [dB]
Band 12	Down Link	736.7	737.3	-52.69	-19.0	33.69
	Up Link	706.7	707.3	-24.25		5.45
Band 13	Down Link	751.2	751.8	-55.62		36.62
	Up Link	781.2	781.8	-30.54		11.54

3.4.8 Test Plots

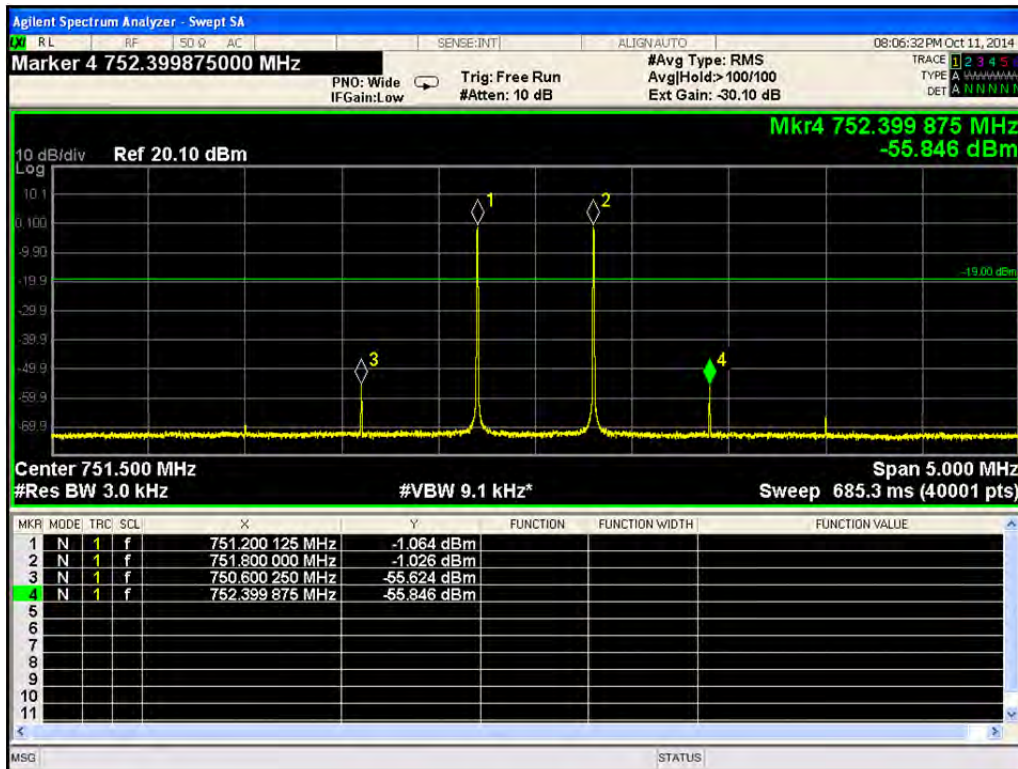
- Band 12 / Downlink



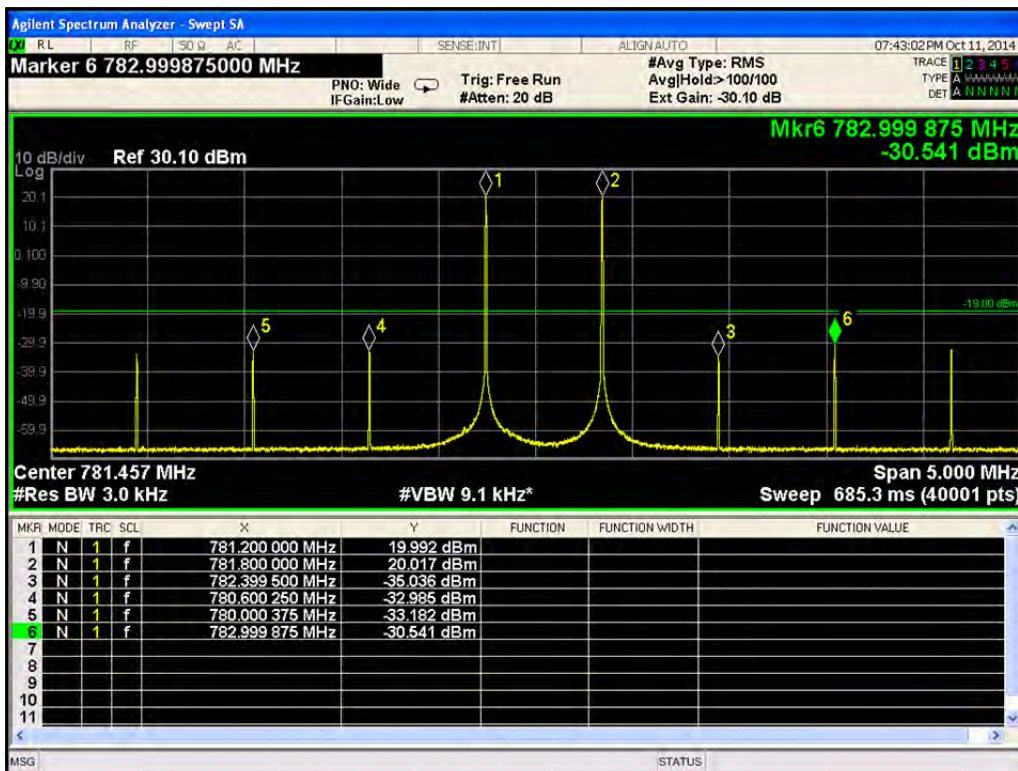
- Band 12 / Uplink



• Band 13 / Downlink



• Band 13 / Uplink



3.5 Out of band emission

3.5.1 Specification

- 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)

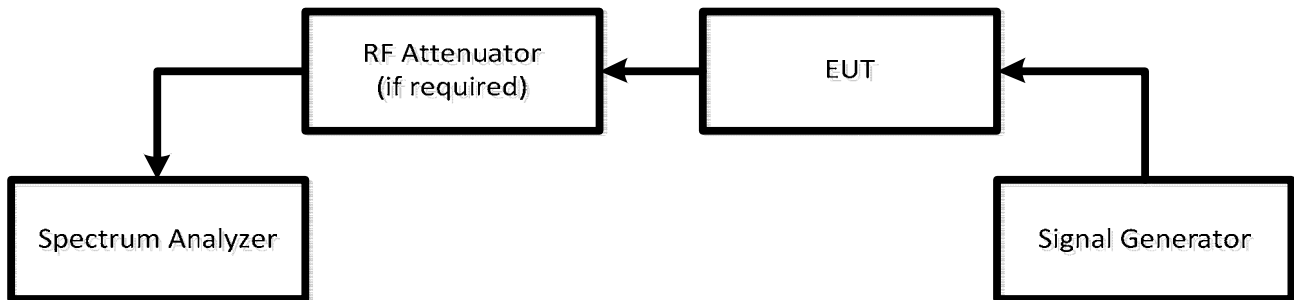
Note 2: For LTE, the signal generator should utilize the uplink and downlink signal types for these modulations in uplink and downlink tests, respectively. LTE shall use 5 MHz signal 25 resource blocks transmitting.

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 = $-6 + (P2 - (43 + 10 \log (P1))) = -19 \text{ dBm}$
- P1 : Output Watt , P2 : Output dBm

3.5.4 Set-Up



3.5.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	USHR-700L	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.5.6 Test condition

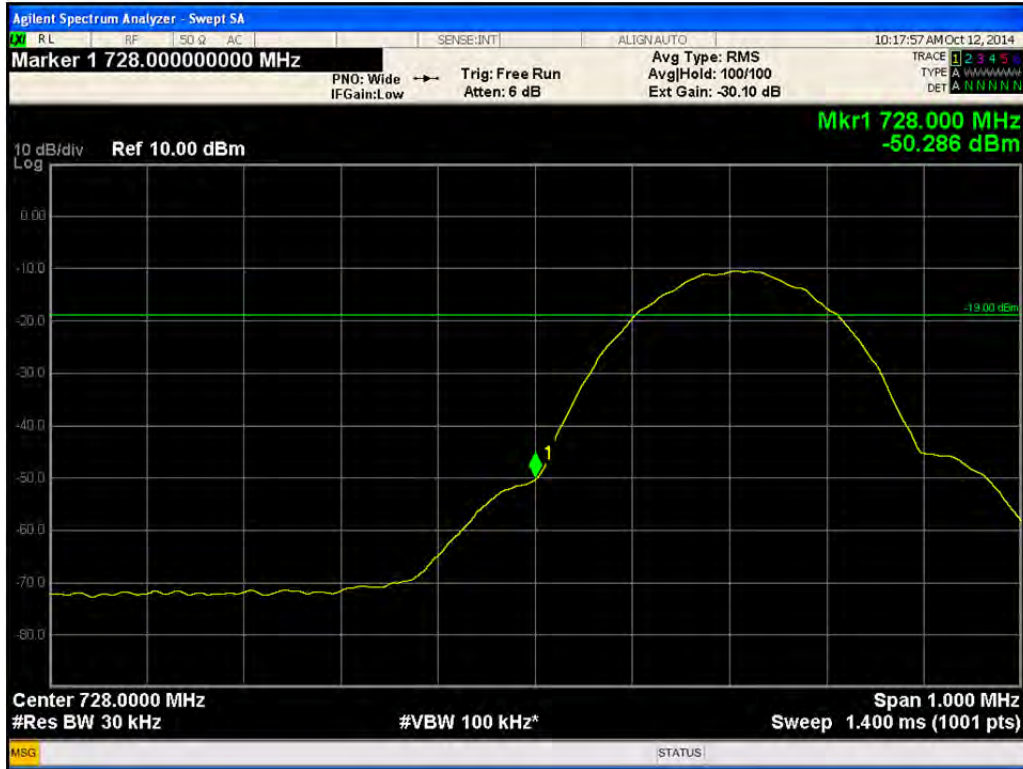
- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.5.7 Test Results

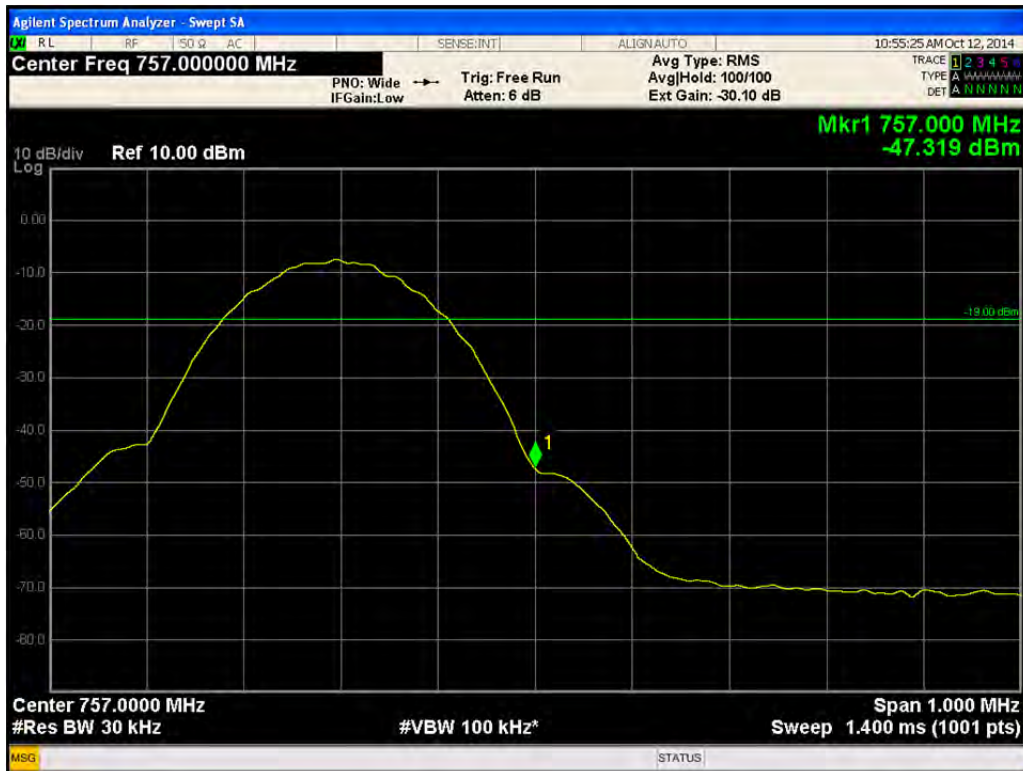
Band	Link	Signal Type	Band Edge	Operation Frequency [MHz]	Emission Level [dBm]	Emission Limit [dB]	Result
Band 12	Down Link	GSM	Lower	728.20	-50.28	-19.0	Pass
			Upper	745.80	-46.44		
		CDMA	Lower	729.25	-69.20		
			Upper	744.75	-66.28		
		AWGN	Lower	730.50	-68.89		
			Upper	743.50	-65.07		
	Up Link	GSM	Lower	698.20	-24.28		
			Upper	715.80	-25.13		
		CDMA	Lower	699.25	-35.25		
			Upper	714.75	-31.79		
Band 13	Down Link	GSM	Lower	746.20	-50.04		
			Upper	756.80	-47.31		
		CDMA	Lower	747.25	-68.77		
			Upper	755.75	-66.14		
		AWGN	Lower	748.50	-66.75		
			Upper	754.50	-65.87		
	Up Link	GSM	Lower	776.20	-25.57		
			Upper	786.80	-21.88		
		CDMA	Lower	777.25	-34.59		
			Upper	787.75	-30.29		
		AWGN	Lower	778.50	-40.36		
			Upper	784.50	-33.70		

3.5.8 Test Plots

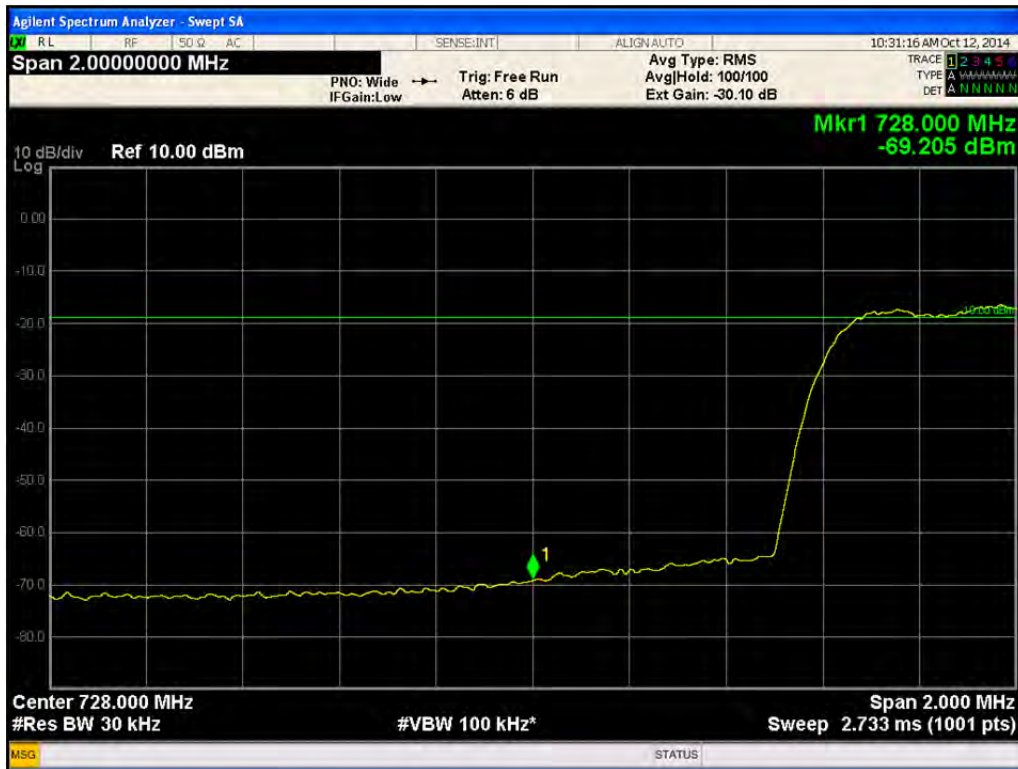
- Band 12 / Downlink / Lower side / GSM



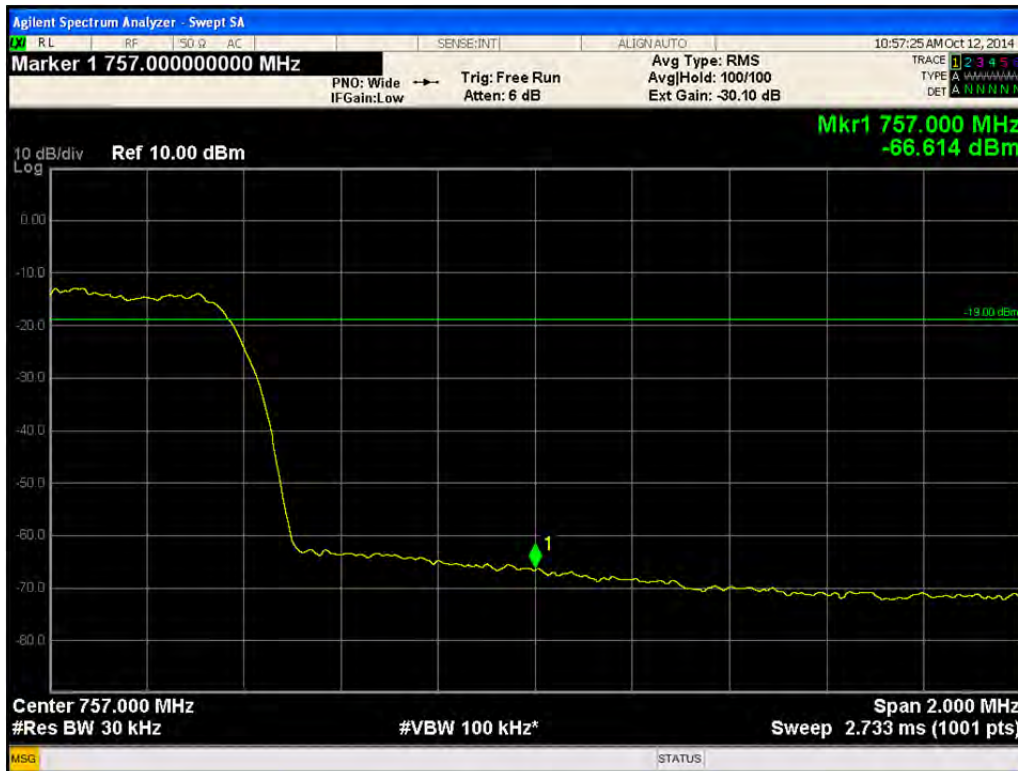
- Band 12 / Downlink / Upper side / GSM



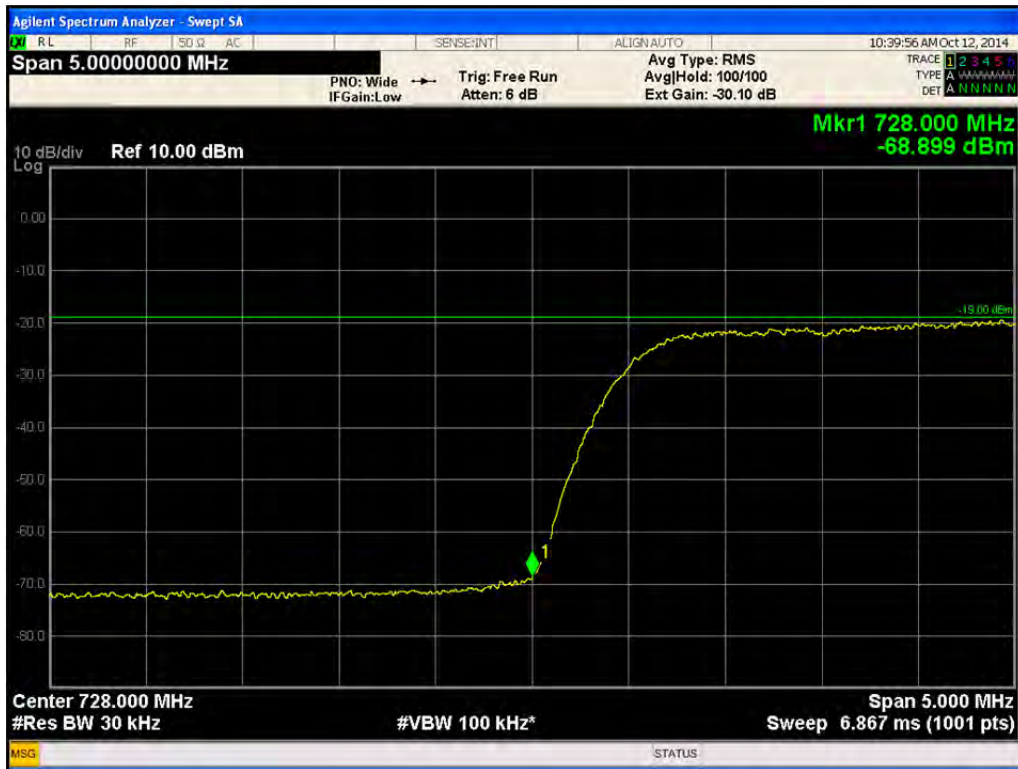
• Band 12 / Downlink / Lower side / CDMA



• Band 12 / Downlink / Upper side / CDMA



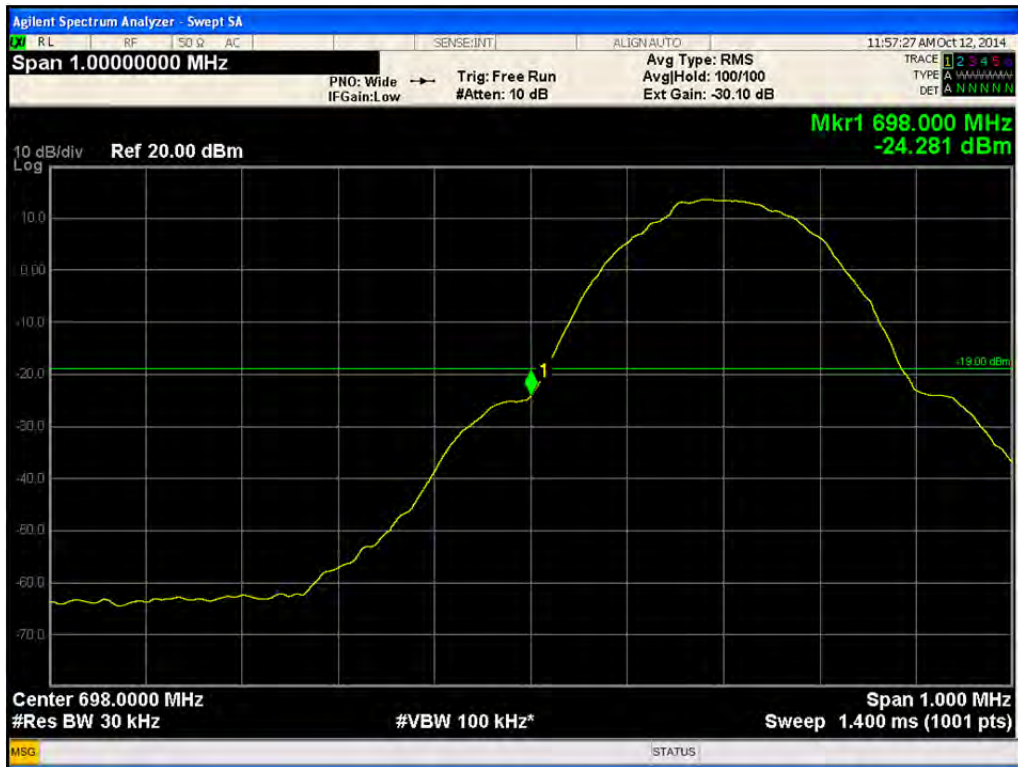
• Band 12 / Downlink / Lower side / AWGN



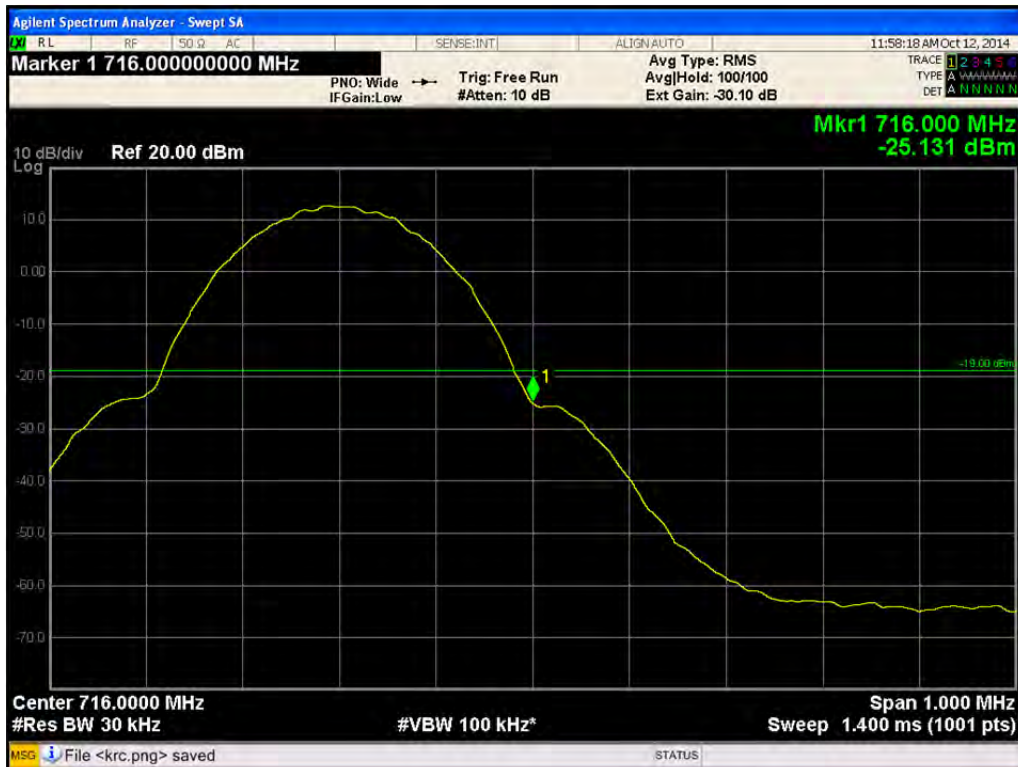
• Band 12 / Downlink / Upper side / AWGN



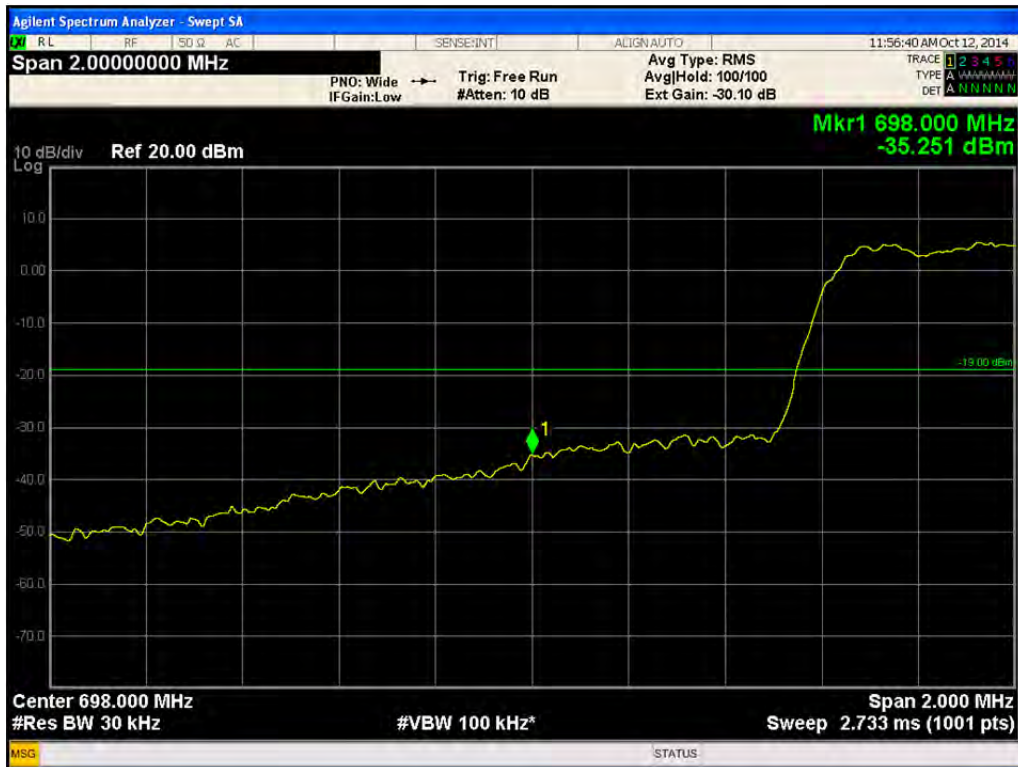
• Band 12 / Uplink / Lower side / GSM



• Band 12 / Uplink / Upper side / GSM



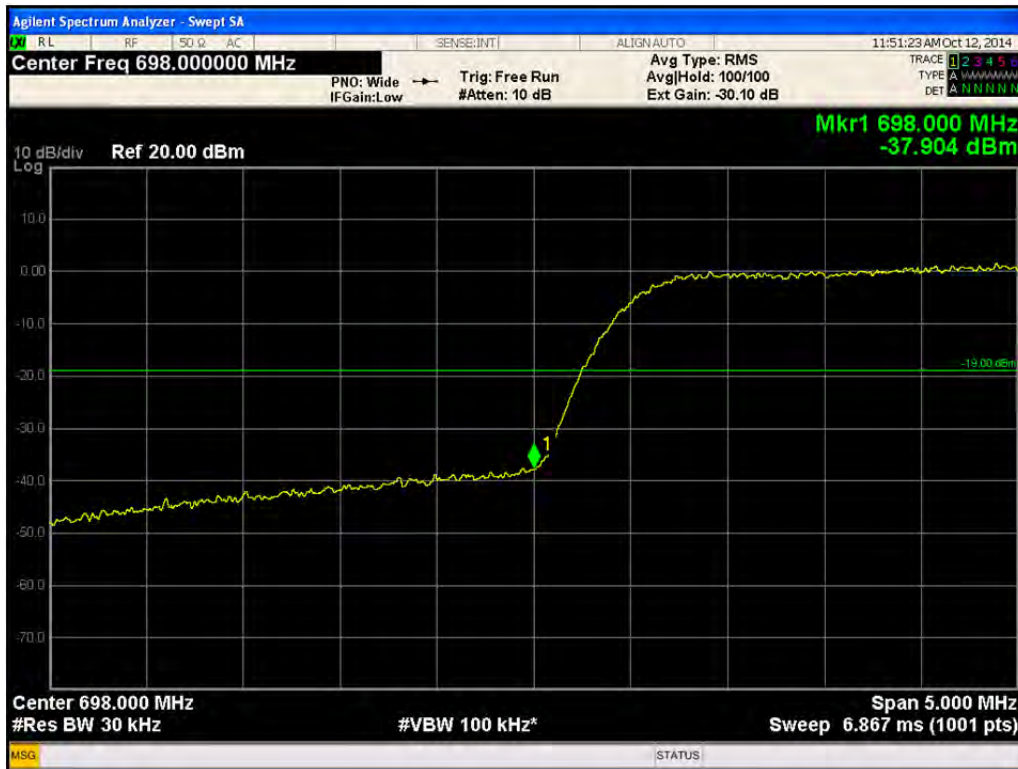
• Band 12 / Uplink / Lower side / CDMA



• Band 12 / Uplink / Upper side / CDMA



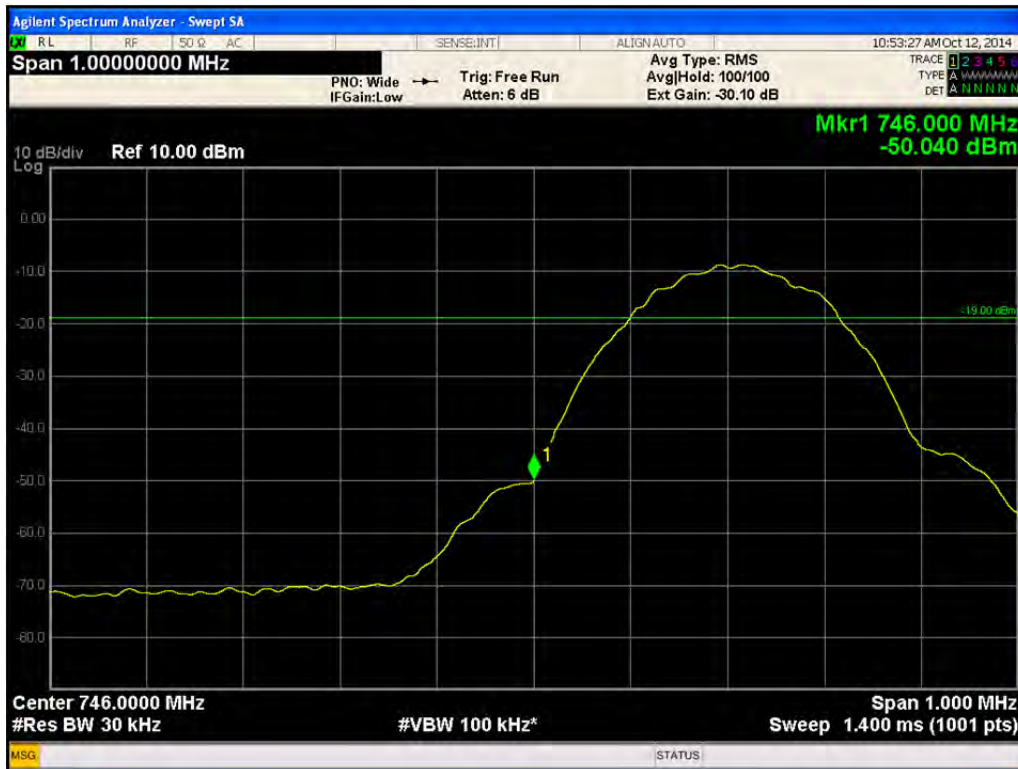
• Band 12 / Uplink / Lower side / AWGN



• Band 12 / Uplink / Upper side / AWGN



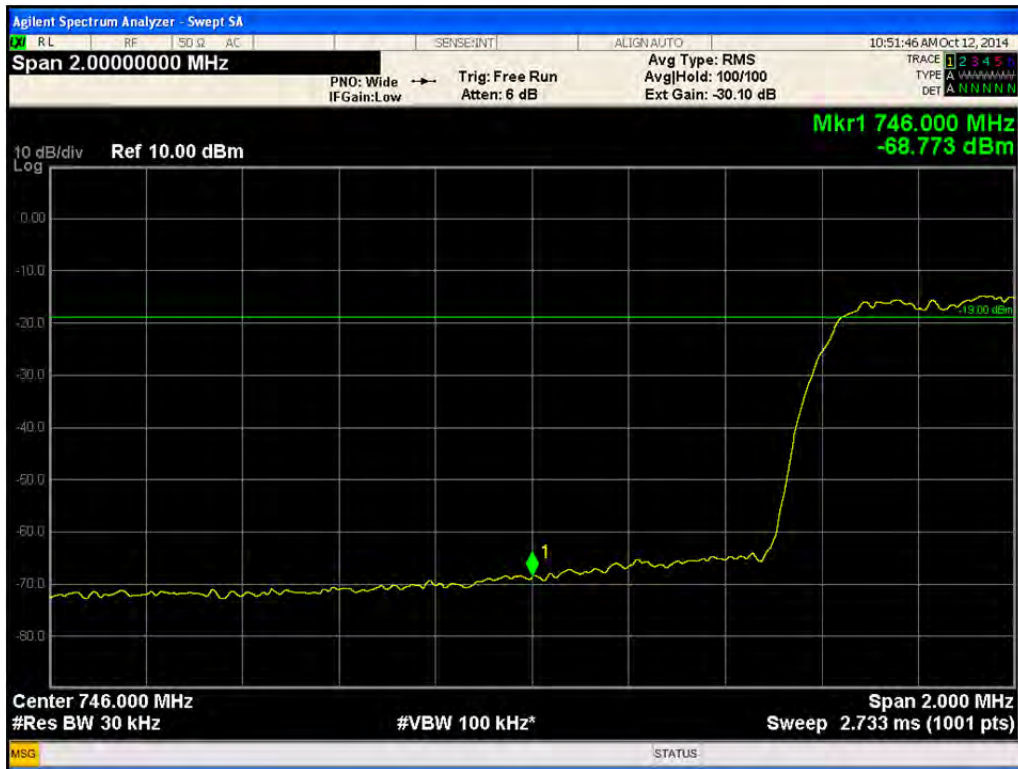
• Band 13 / Downlink / Lower side / GSM



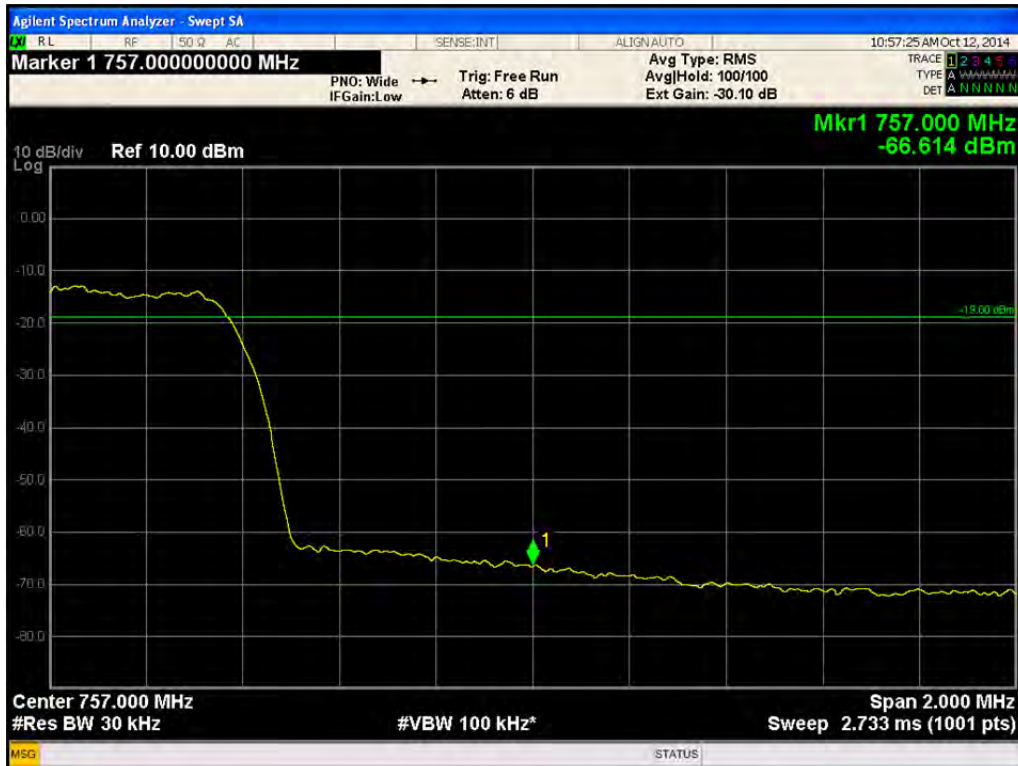
• Band 13 / Downlink / Upper side / GSM



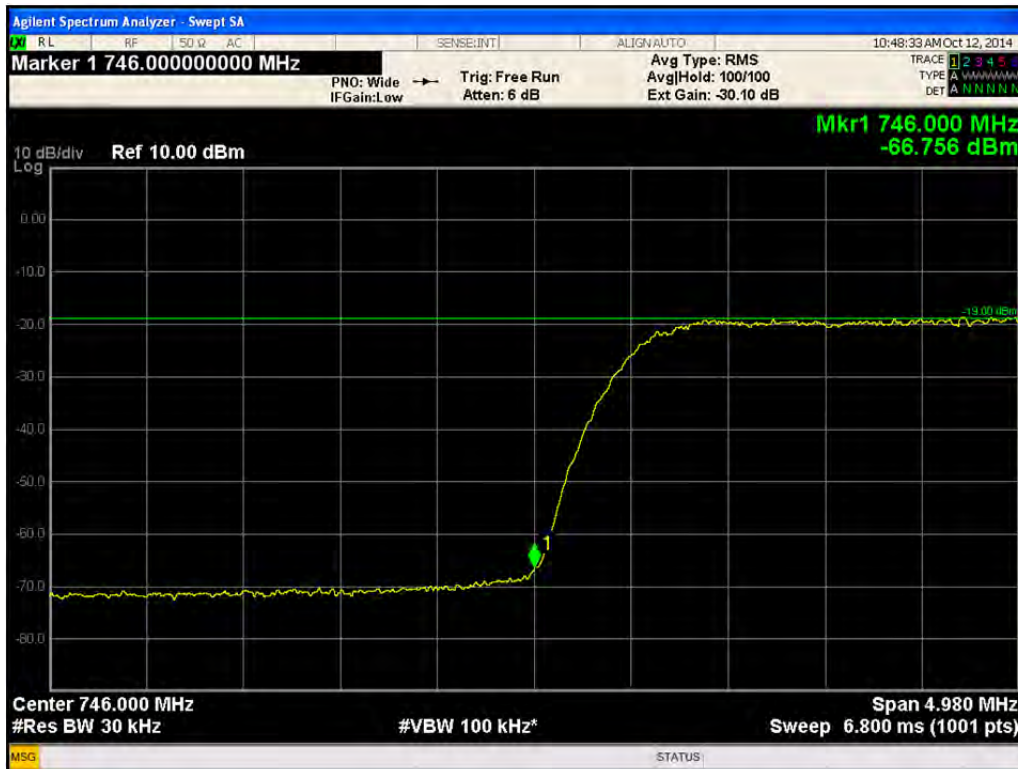
• Band 13 / Downlink / Lower side / CDMA



• Band 13 / Downlink / Upper side / CDMA



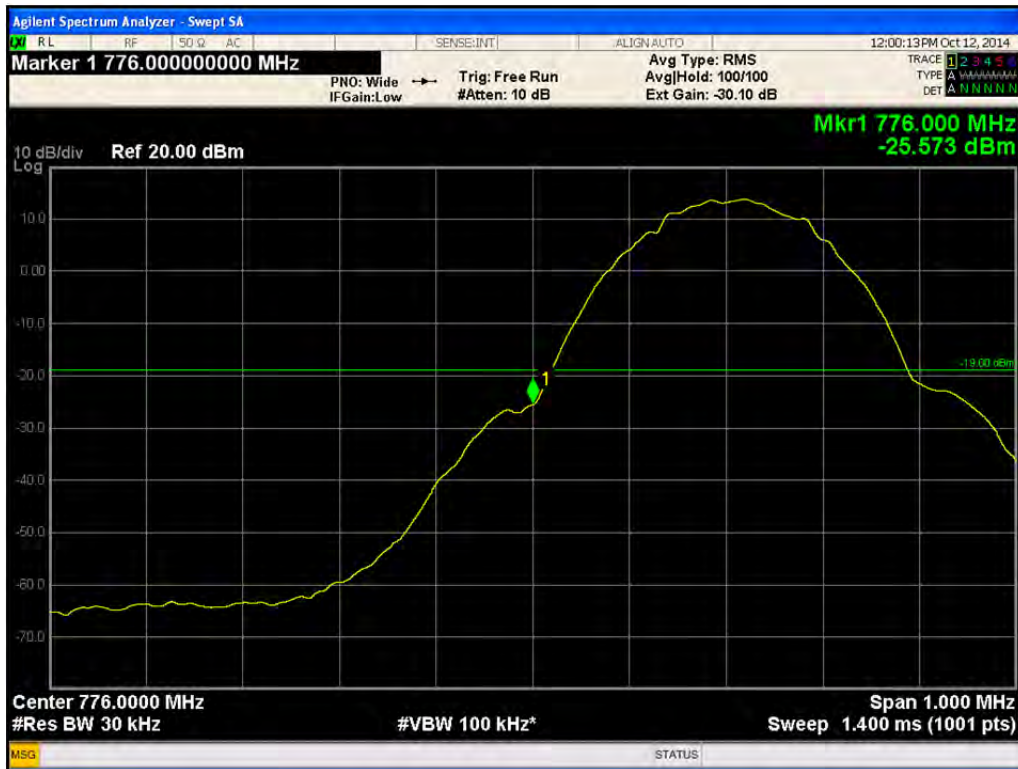
• Band 13 / Downlink / Lower side / AWGN



• Band 13 / Downlink / Upper side / AWGN



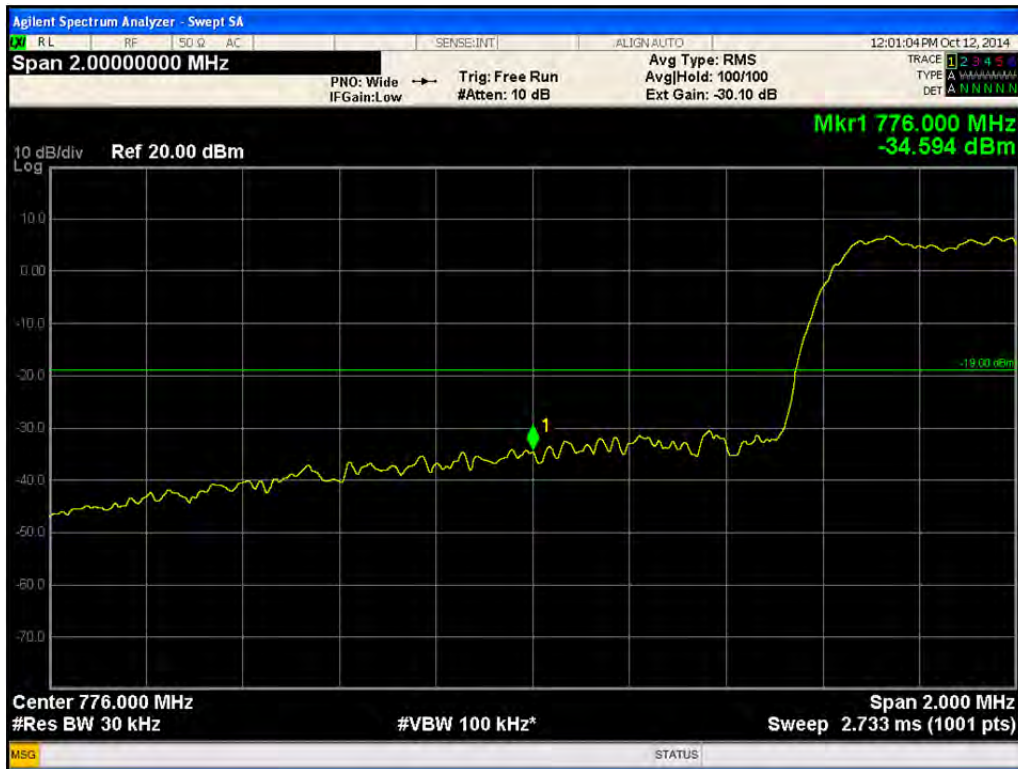
• Band 13 / Uplink / Lower side / GSM



• Band 13 / Uplink / Upper side / GSM



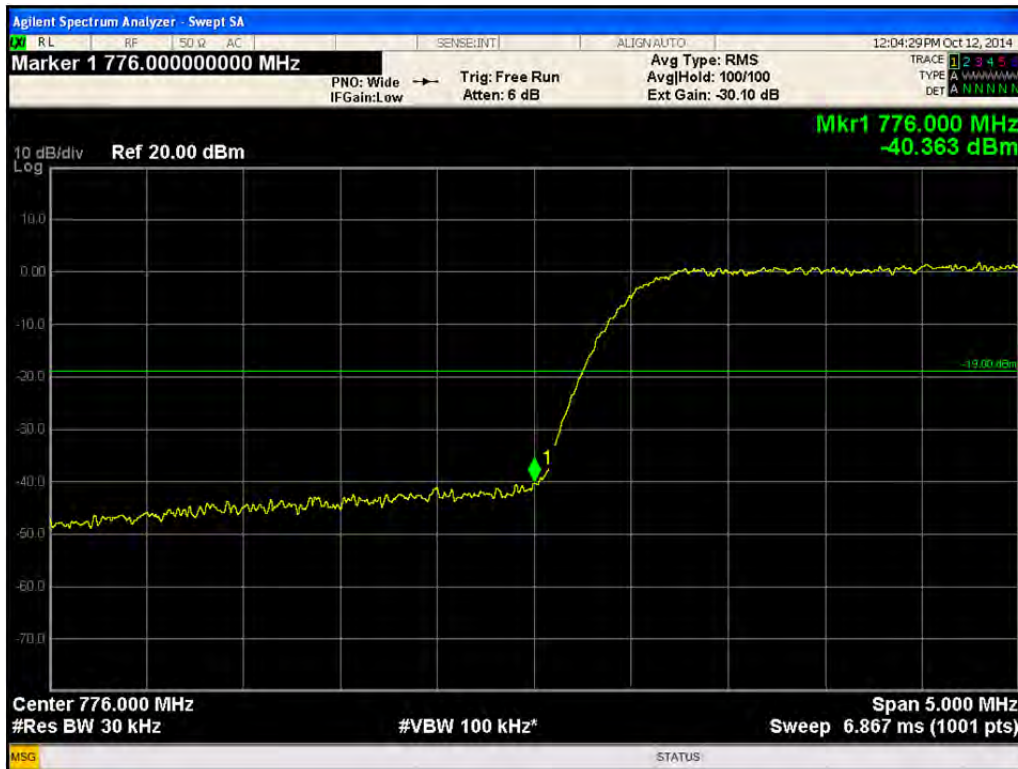
• Band 13 / Uplink / Lower side / CDMA



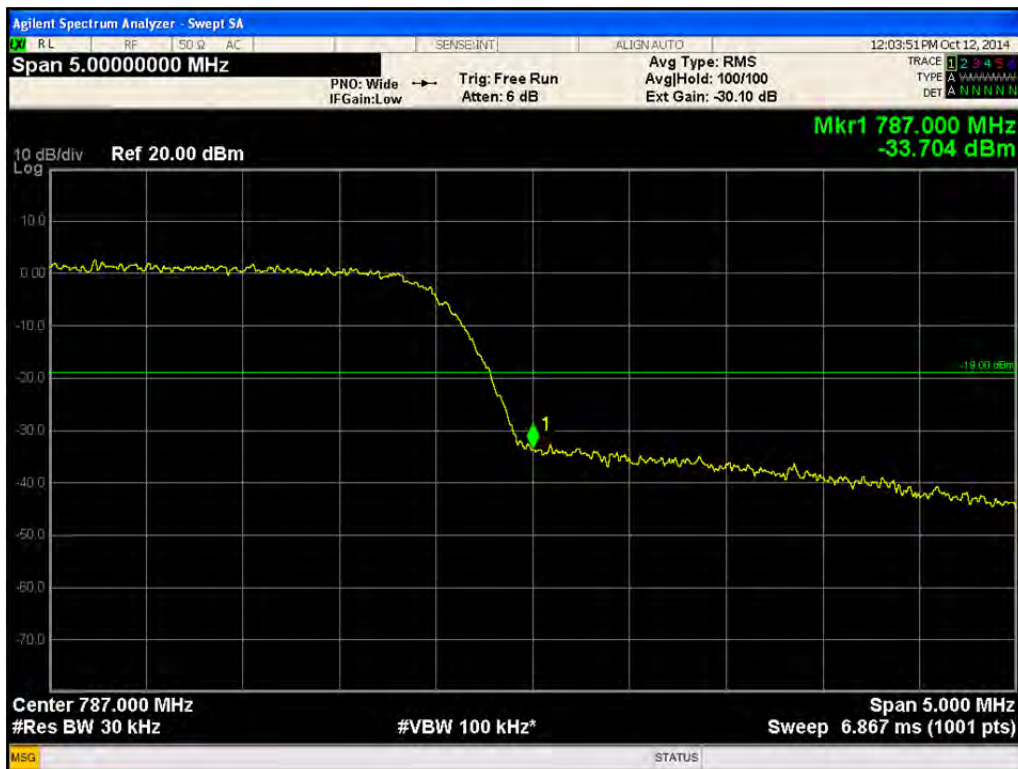
• Band 13 / Uplink / Upper side / CDMA



• Band 13 / Uplink / Lower side / AWGN



• Band 13 / Uplink / Upper side / AWGN



3.6 Conducted spurious emission

3.6.1 Specification

- FCC Rules Part 27 Subpart C, Section 27.53
- FCC Rules Part 2 Section 2.1051

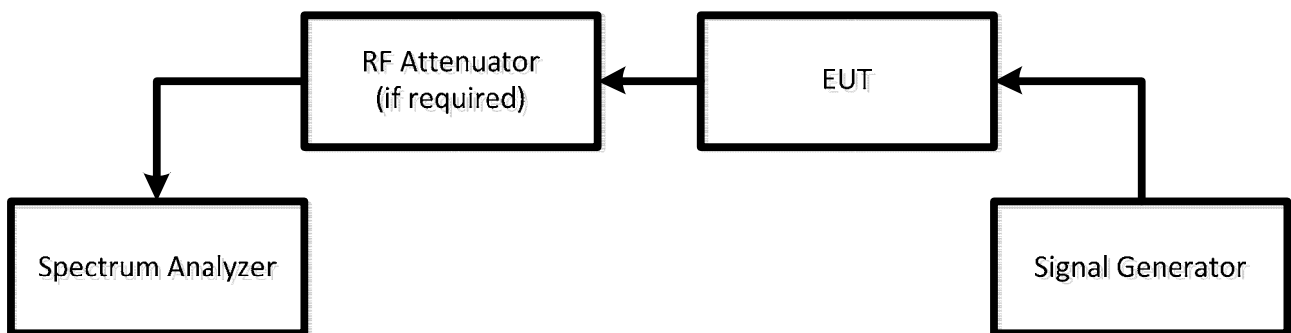
3.6.2 Measurement method

- 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

- §2.1053, Conducted emissions limit = $43 + 10 \log (P) = -13 \text{ dBm}$
- §27.53(c), For operations in the 746-758 MHz band and the 776-788 MHz band
On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than $76 + 10 \log (P) \text{ dB}$ in a 6.25 kHz band segment, for base and fixed stations
- §27.53(e), For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands
Emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth.

3.6.4 Set-Up



3.6.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	USHR-700L	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: 24.2 °C, 51 % R.H.

3.6.7 Test results

- Spurious emissions

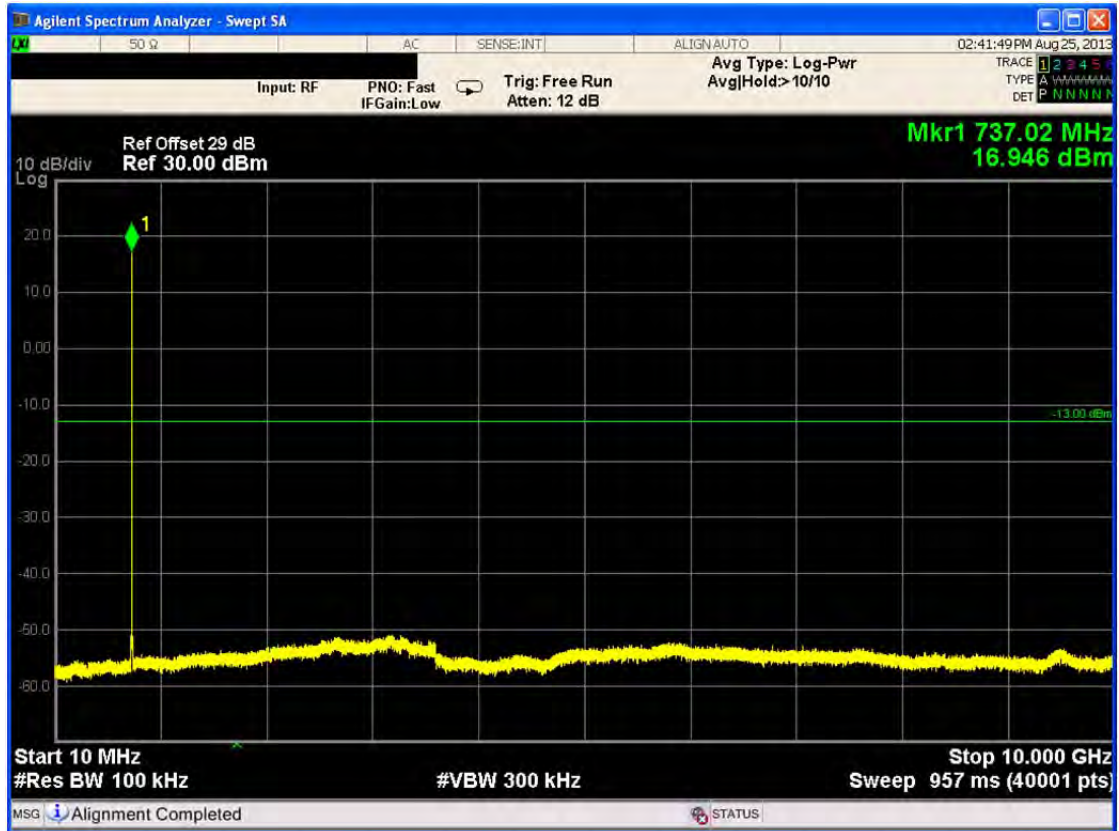
Band	Link	Operation frequency [MHz]	Frequency range of spurious emission [MHz]	Level of spurious emission [dBm]	RBW [kHz]	Limit [dBm]
Band 12	Down Link	737.0	10 to 10 000	-	100	-13.0
	Up Link	707.0		-32.7	100	
Band 13	Down Link	752.0	10 to 10 000	-	100	-13.0
	Up Link	782.0		-50.2	100	
	Down Link	752.0	763 to 775	-	6.25	-46.0
	Up Link	782.0		-	6.25	
	Down Link	752.0	793 to 805	-	6.25	
	Up Link	782.0		-	6.25	
	Down Link	752.0	1 559 to 1 610	-	1 000	-40.0
	Up Link	782.0		-42.1	1 000	

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

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

3.6.8 Plots of spurious emissions

- Band 12 / Downlink / 737 MHz / 10 MHz to 10 GHz



Operating frequency : 737 MHz
RBW : 100 kHz
VBW : 300 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 10 GHz

Emission : Not found

• Band 12 / Uplink / 707 MHz / 10 MHz to 10 GHz



Operating frequency : 707 MHz
RBW : 100 kHz
VBW : 300 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 10 GHz

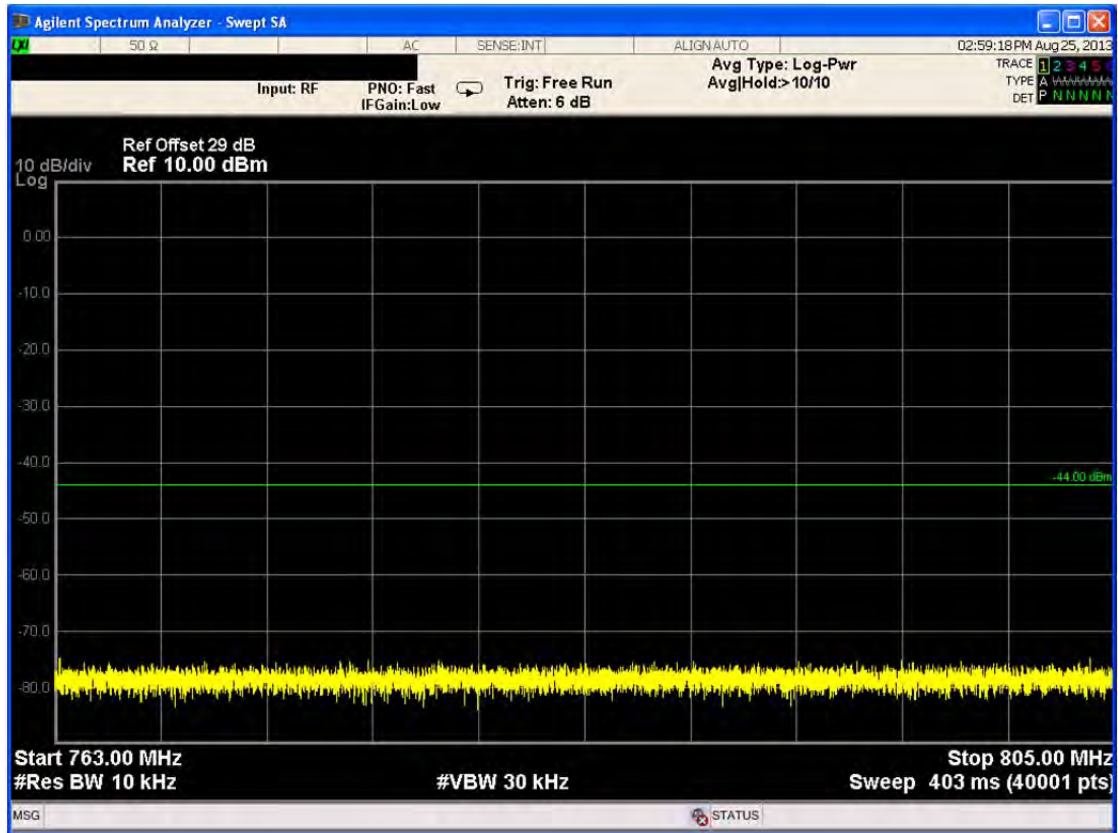
Emission : -32.736 dBm at 1 414 MHz

• Band 13 / Downlink / 752 MHz / 10 MHz to 10 GHz



Operating frequency : 752 MHz
RBW : 100 kHz
VBW : 300 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 10 GHz
Emission : Not found

• Band 13 / Downlink / 752 MHz / 763 MHz to 805 MHz



Operating frequency : 752 MHz
RBW : 10 kHz
VBW : 30 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 763 MHz to 805 MHz
Emission : Not found

※ $76 + 10 \cdot \log(20W/1W) \text{ dB} \Rightarrow -46 \text{ dBm}$ in a 6.25 kHz band segment.

Spurious measured in the plot with a RBW of 10 kHz so the limit is calculated:
 $-46 \text{ dBm} / 6.25 \text{ kHz} + 10 \cdot \log(10 \text{ kHz} / 6.25 \text{ kHz}) = -44 \text{ dBm} / 10 \text{ kHz}$

• Band 13 / Downlink / 752 MHz / 1 559 MHz to 1 610 MHz



Operating frequency : 752 MHz
RBW : 1 MHz
VBW : 3 MHz
Detector mode : Peak
Trace mode : Average
Emission range : 1 559 MHz to 1 610 MHz
Emission : Not found

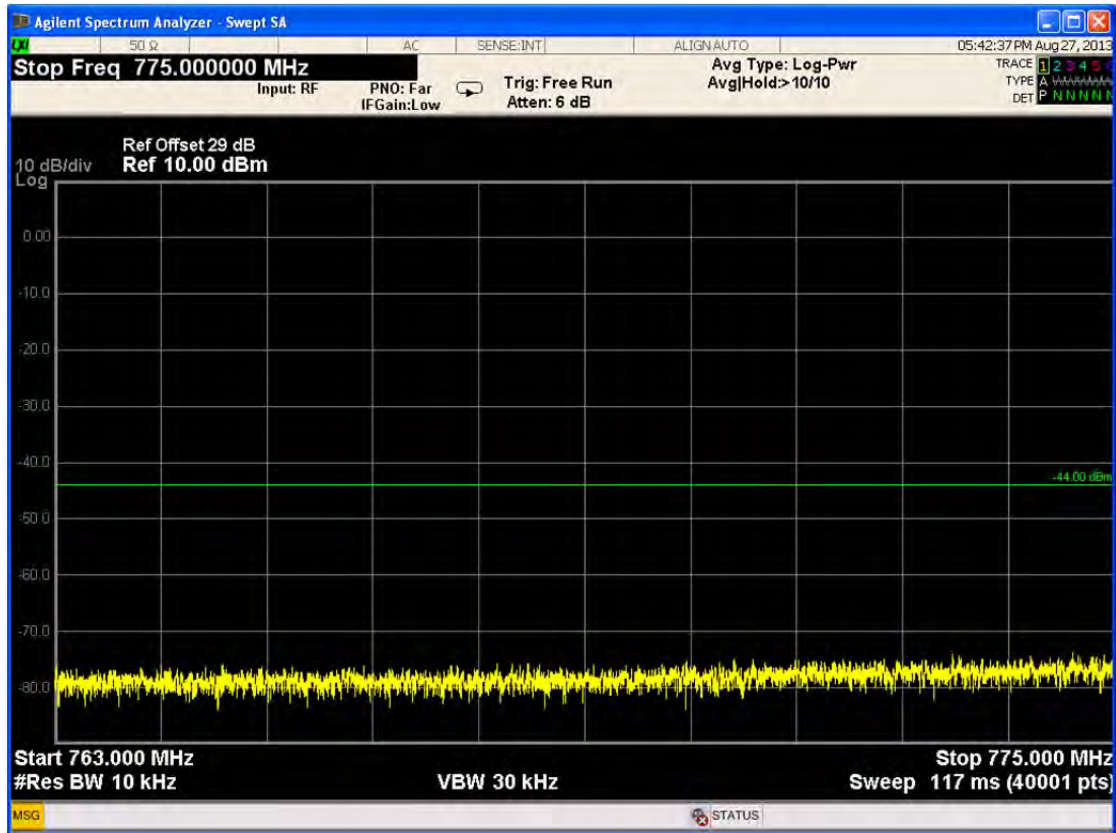
✳ Antenna gain of down link : 4 dBi

• Band 13 / Uplink / 782 MHz / 10 MHz to 10 GHz



Operating frequency : 782 MHz
RBW : 100 kHz
VBW : 300 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 10 MHz to 10 GHz
Emission : -50.188 dBm at 1 504 MHz

• Band 13 / Uplink / 782 MHz / 763 MHz to 775 MHz

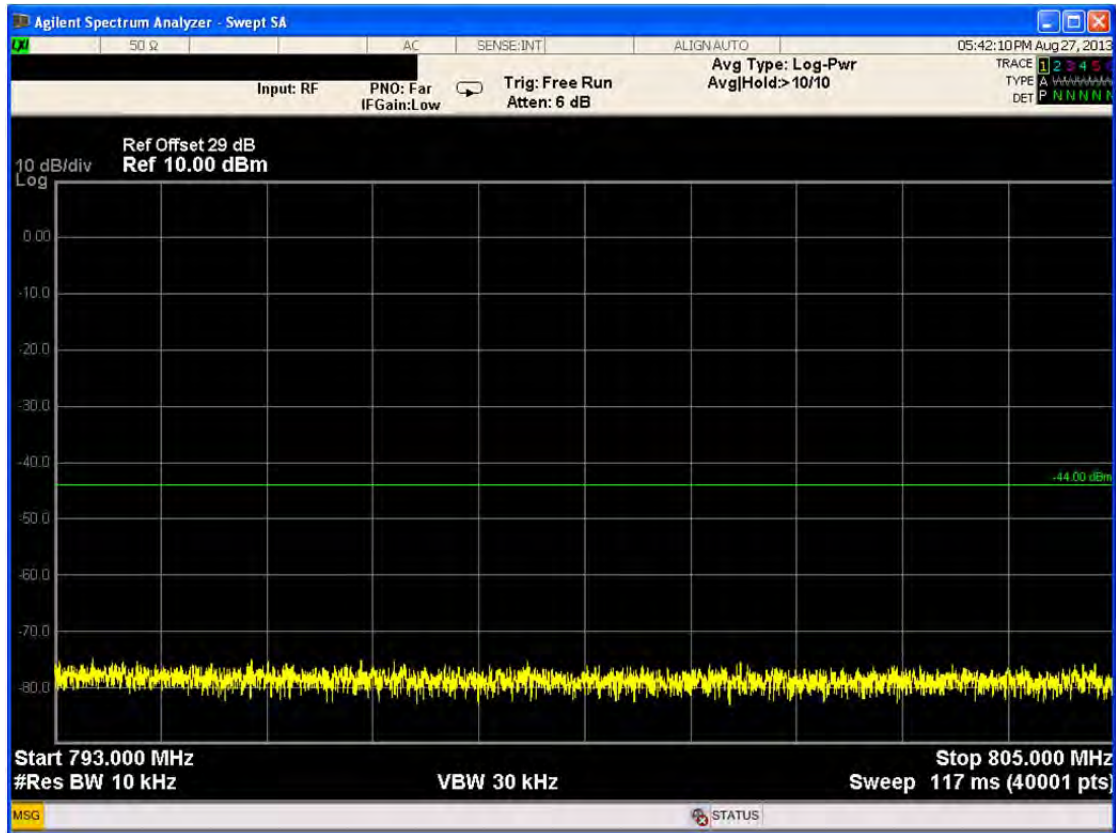


Operating frequency : 782 MHz
RBW : 10 kHz
VBW : 30 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 763 MHz to 775 MHz
Emission : Not found

※ $76 + 10 \cdot \log(20W/1W) \text{ dB} \Rightarrow -46 \text{ dBm}$ in a 6.25 kHz band segment.

Spurious measured in the plot with a RBW of 10 kHz so the limit is calculated:
 $-46 \text{ dBm} / 6,25 \text{ kHz} + 10 \cdot \log(10 \text{ kHz} / 6.25 \text{ kHz}) = -44 \text{ dBm} / 10 \text{ kHz}$

• Band 13 / Uplink / 782 MHz / 793 MHz to 805 MHz

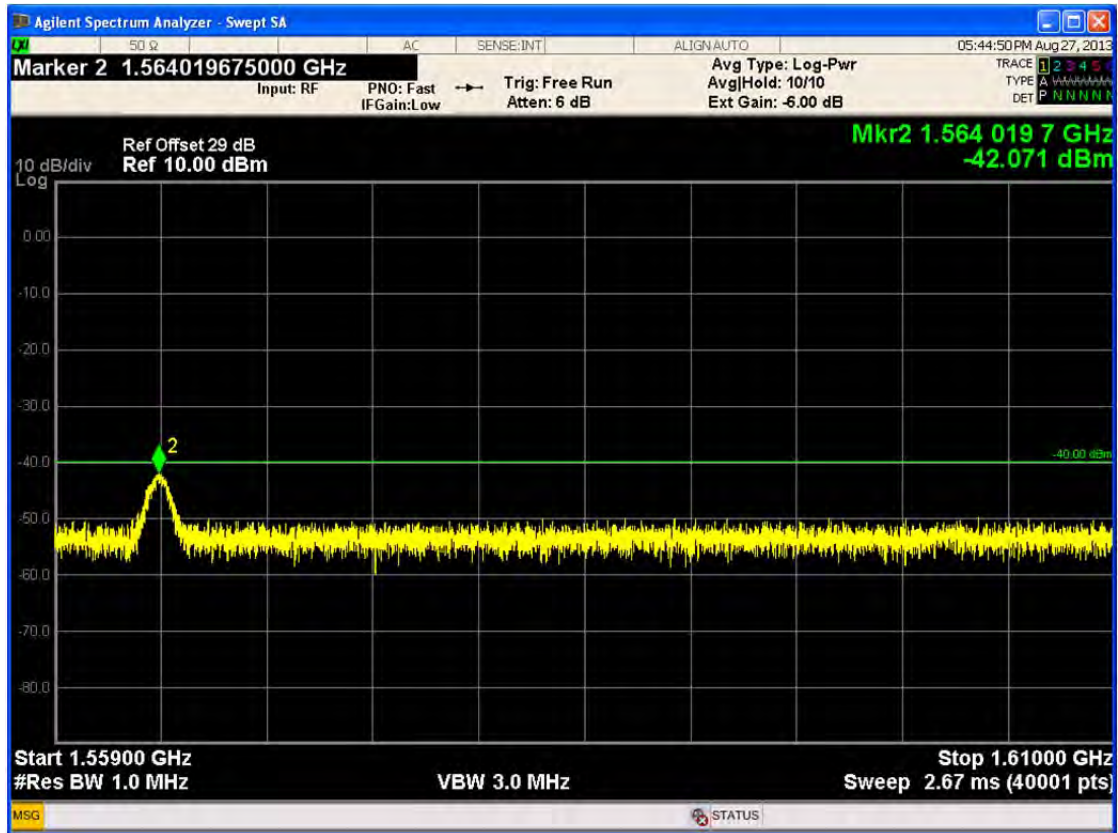


Operating frequency : 782 MHz
RBW : 10 kHz
VBW : 30 kHz
Detector mode : Peak
Trace mode : Average
Emission range : 793 MHz to 805 MHz
Emission : Not found

※ $76 + 10 \cdot \log(20W/1W) \text{ dB} \Rightarrow -46 \text{ dBm}$ in a 6.25 kHz band segment.

Spurious measured in the plot with a RBW of 10 kHz so the limit is calculated:
 $-46 \text{ dBm} / 6,25 \text{ kHz} + 10 \cdot \log(10 \text{ kHz} / 6.25 \text{ kHz}) = -44 \text{ dBm} / 10 \text{ kHz}$

• Band 13 / Uplink / 782 MHz / 1 559 MHz to 1 610 MHz



Operating frequency : 782 MHz
RBW : 1 MHz
VBW : 3 MHz
Detector mode : Peak
Trace mode : Average
Emission range : 1 559 MHz to 1 610 MHz
Emission : -42.071 dBm at 1564 MHz

✳ Antenna gain of down link : 6 dBi

3.7 Noise limit

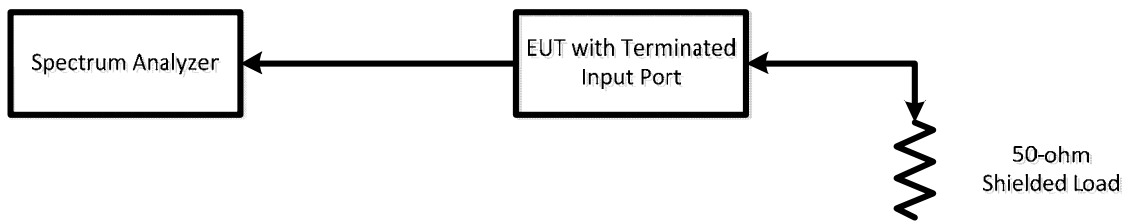
3.7.1 Specification

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

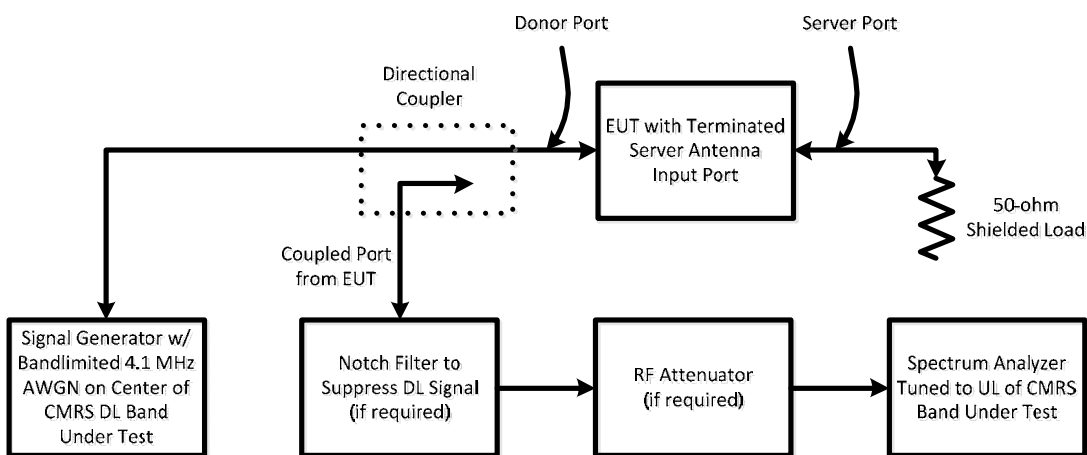
3.7.2 Measurement method

- 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

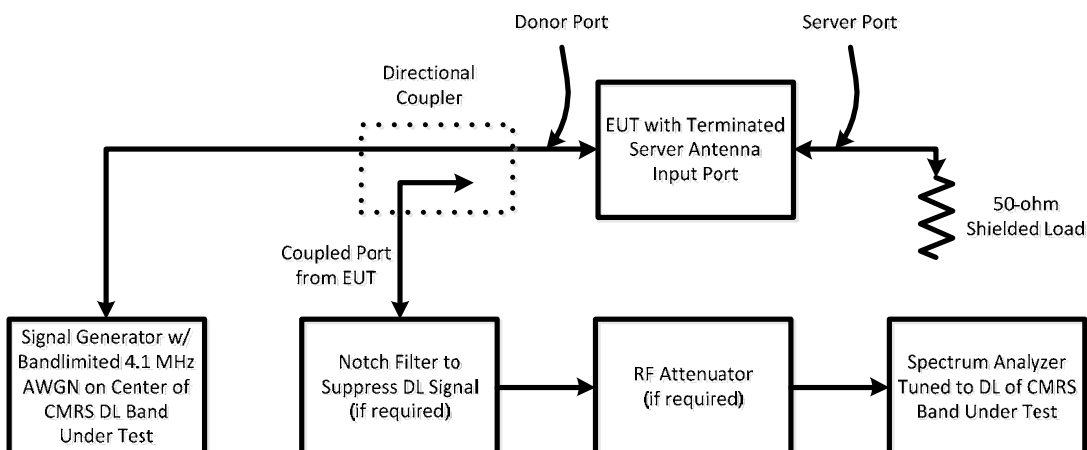
3.7.3 Set-up 1 (Noise limit instrumentation setup)



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 $-103 \text{ dBm/MHz} - \text{RSSI}$.
- §20.21(e)(8)(i)(A)(2)(i), Fixed booster maximum noise power shall not exceed $-102.5 \text{ dBm/MHz} + 20 \log (F)$, where Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz.

3.7.7 Test equipment list

Equipment	Model Name	Manufacturer
EUT	USHR-700L	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Directional Coupler	87300B	Agilent
Attenuator	66-30-33	Weinschel

3.7.8 Test condition

- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.7.9 Test results of noise limit

Band	Link	Noise Level [dBm]	Noise Level Limit [dBm]	Margin [dB]
Band 12	Down Link	-46.20	-45.20	1.00
	Up Link	-50.05	-45.50	4.55
Band 13	Down Link	-47.04	-45.00	2.04
	Up Link	-48.60	-44.60	4.00

3.7.10 Test results of variable downlink noise limit

Band	RSSI [dBm]	Noise Level [dBm]	Noise Level Limit [dBm]	Margin [dB]
Band 12	-70.0	-48.1	-45.2	2.9
	-60.0	-47.9	-45.2	2.7
	-59.0	-48.6	-45.2	3.4
	-55.0	-52.9	-48.0	4.9
	-50.0	-56.4	-53.0	3.4
	-48.0	-58.7	-55.0	3.7
	-46.0	-59.1	-57.0	2.1
	-45.0	-59.8	-58.0	1.8
	-44.0	-72.6	-59.0	13.6
	-43.0	-72.8	-60.0	12.8
	-42.0	-73.1	-61.0	12.1
	-30.0	-73.2	-70.0	3.2
Band 13	-70.0	-48.5	-45.0	3.5
	-60.0	-47.9	-45.0	2.9
	-59.0	-49.4	-45.0	4.4
	-55.0	-52.4	-48.0	4.4
	-50.0	-56.9	-53.0	3.9
	-48.0	-58.2	-55.0	3.2
	-46.0	-59.3	-57.0	2.3
	-45.0	-59.6	-58.0	1.6
	-44.0	-72.1	-59.0	13.1
	-43.0	-72.2	-60.0	12.2
	-42.0	-71.9	-61.0	10.9
	-30.0	-73.8	-70.0	3.8

3.7.11 Test results of variable uplink noise limit

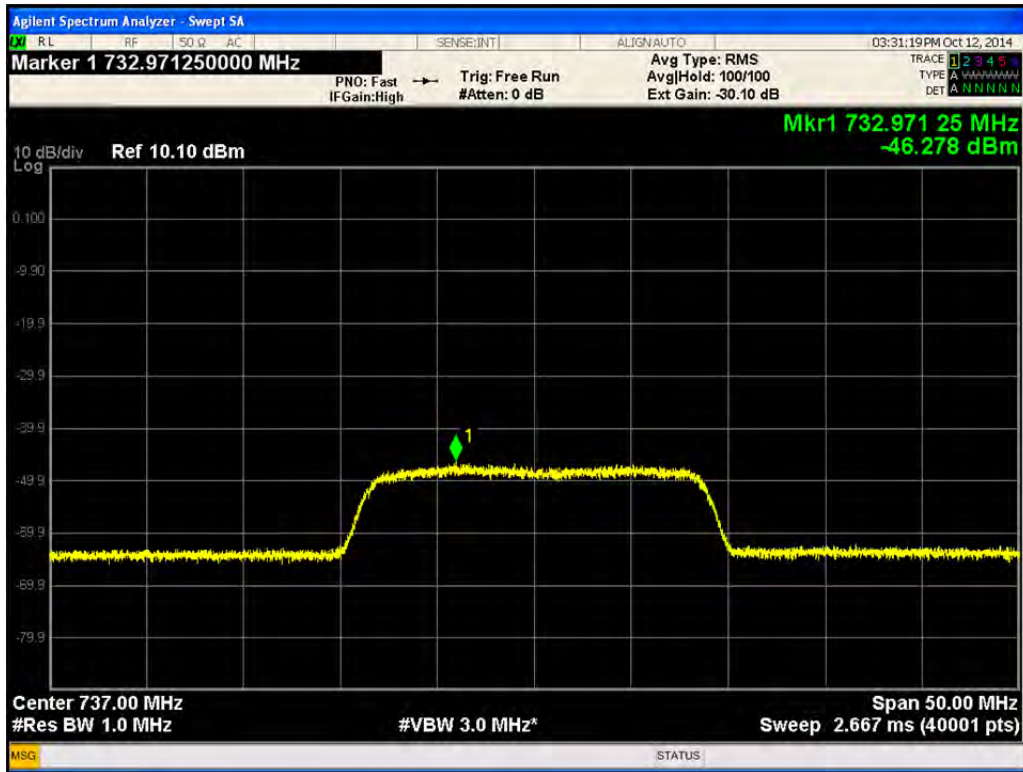
Band	RSSI [dBm]	Noise Level [dBm]	Noise Level Limit [dBm]	Margin [dB]
Band 12	-70.0	-51.2	-45.5	5.7
	-68.0	-51.1	-45.5	5.6
	-60.0	-59.1	-45.5	13.6
	-59.0	-59.8	-45.5	14.3
	-55.0	-62.2	-48.0	14.2
	-50.0	-64.7	-53.0	11.7
	-48.0	-65.5	-55.0	10.5
	-46.0	-65.7	-57.0	8.7
	-45.0	-65.8	-58.0	7.8
	-44.0	-81.7	-59.0	22.7
	-43.0	-81.5	-60.0	21.5
	-42.0	-82.1	-61.0	21.1
	-30.0	-81.0	-70.0	11.0
Band 13	-70.0	-49.9	-44.6	5.0
	-68.0	-50.1	-44.6	5.5
	-60.0	-57.8	-44.6	13.2
	-59.0	-58.3	-44.6	13.7
	-55.0	-61.8	-48.0	13.8
	-50.0	-64.5	-53.0	11.5
	-48.0	-64.9	-55.0	9.9
	-46.0	-65.9	-57.0	8.9
	-45.0	-64.5	-58.0	6.5
	-44.0	-81.5	-59.0	22.5
	-43.0	-81.6	-60.0	21.6
	-42.0	-80.9	-61.0	19.9
	-30.0	-82.3	-70.0	12.3

3.7.12 Test results of variable decrease noise timing

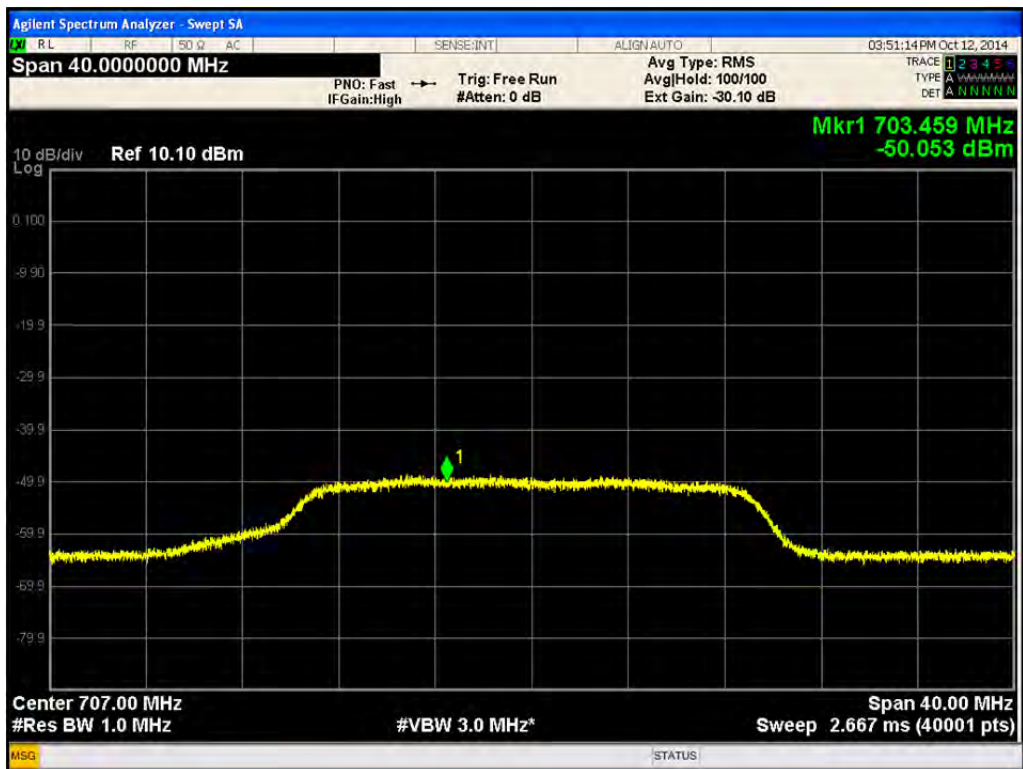
Band	Link	Noise Timing [s]	Limit [s]	Result
Band 12	Down Link	0.8	3.0	Pass
	Up Link	0.8	3.0	Pass
Band 13	Down Link	0.7	3.0	Pass
	Up Link	0.7	3.0	Pass

3.7.13 Test plots

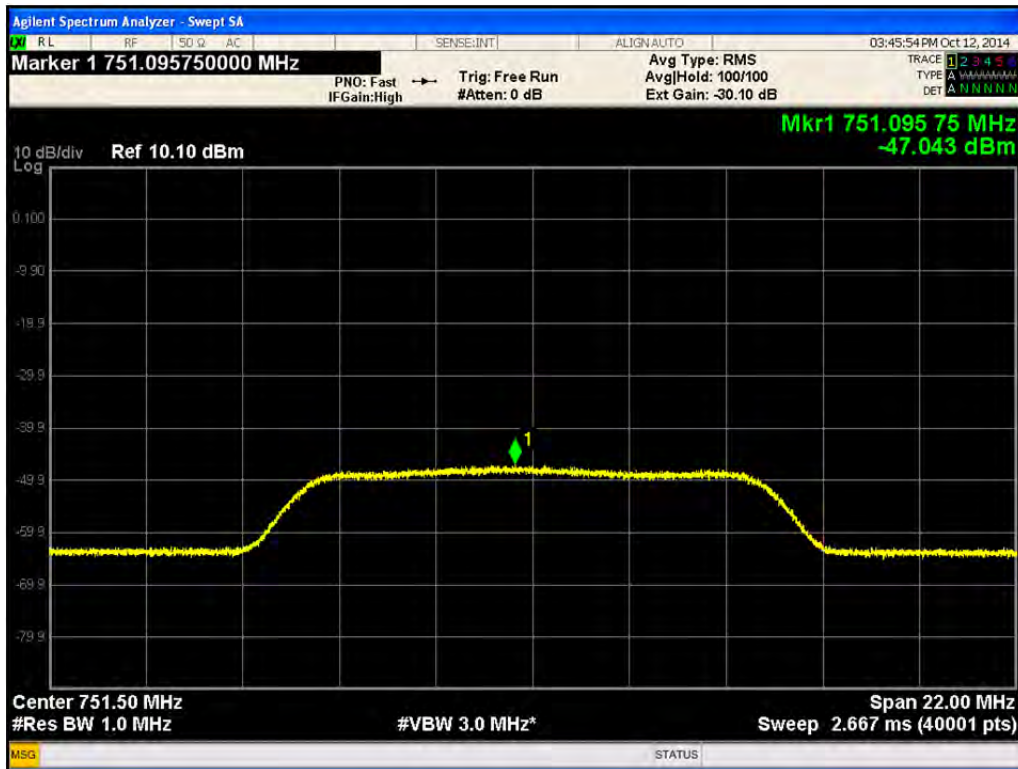
- Band 12 / Downlink



- Band 12 / Uplink



• Band 13 / Downlink

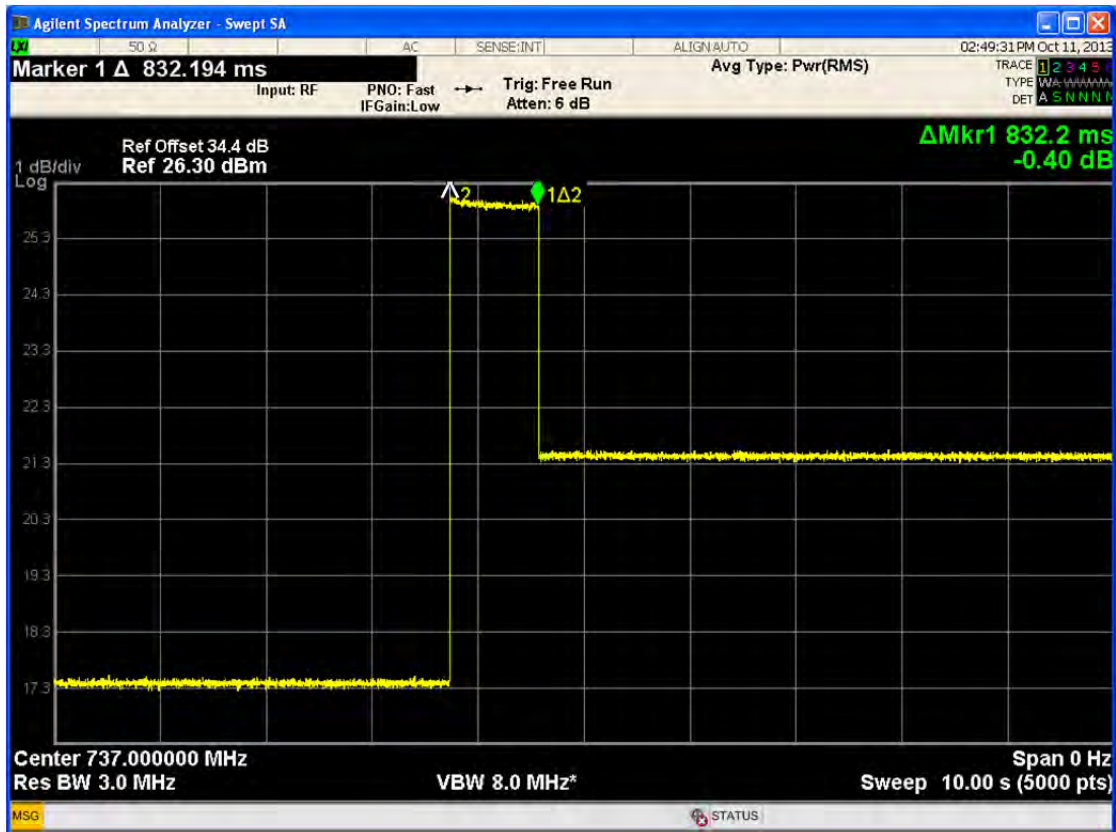


• Band 13 / Uplink



3.7.14 Test plots of decrease timing

- Band 12 / Downlink



Frequency : 737.000 MHz

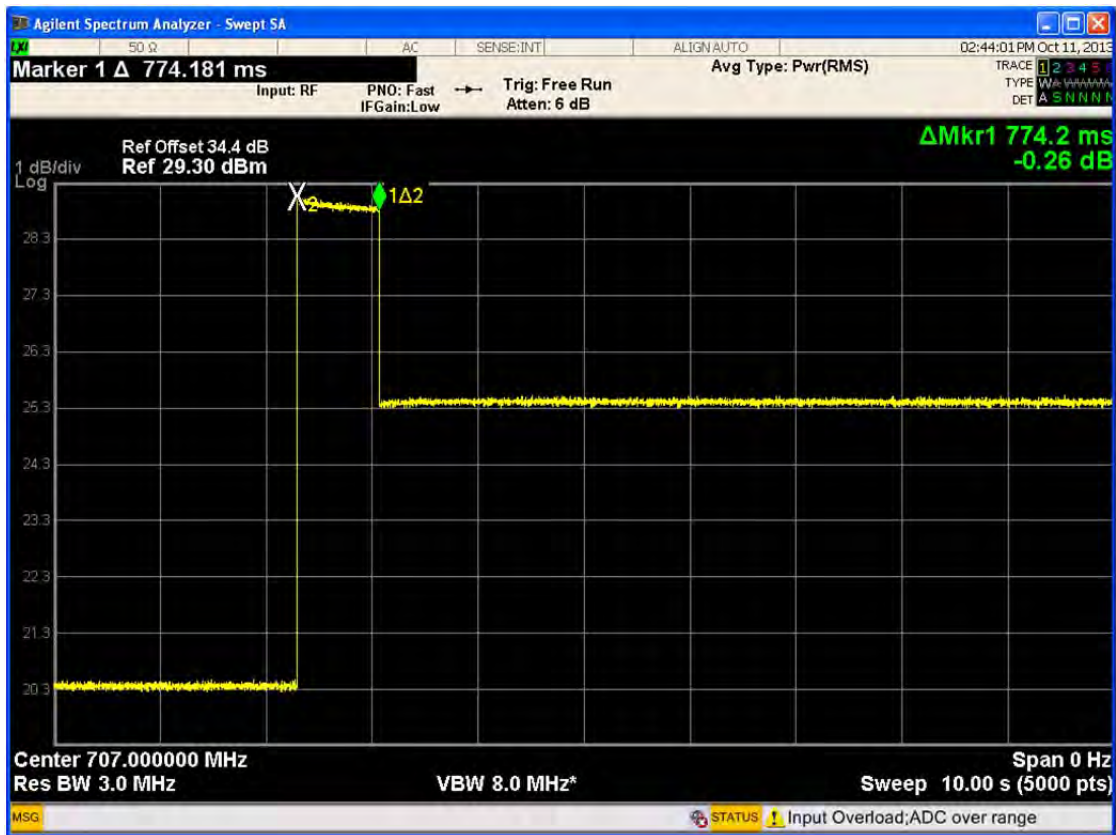
Span : Zero

Sweep time : 10 s

Time of decrease gain : 0.832 s

Limit of timing : 3 s (Fixed device)

• Band 12 / Uplink



Frequency : 707.000 MHz

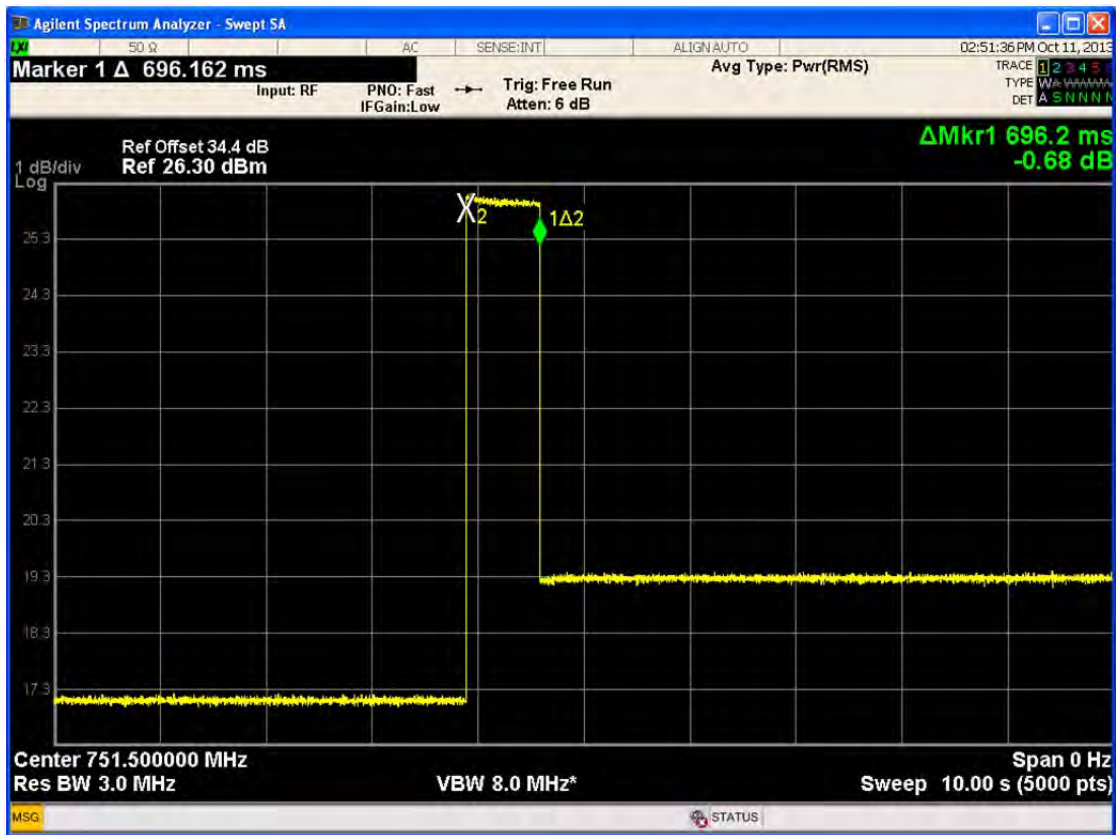
Span : Zero

Sweep time : 10 s

Time of decrease gain : 0.774 s

Limit of timing : 3 s (Fixed device)

• Band 13 / Downlink



Frequency : 751.500 MHz

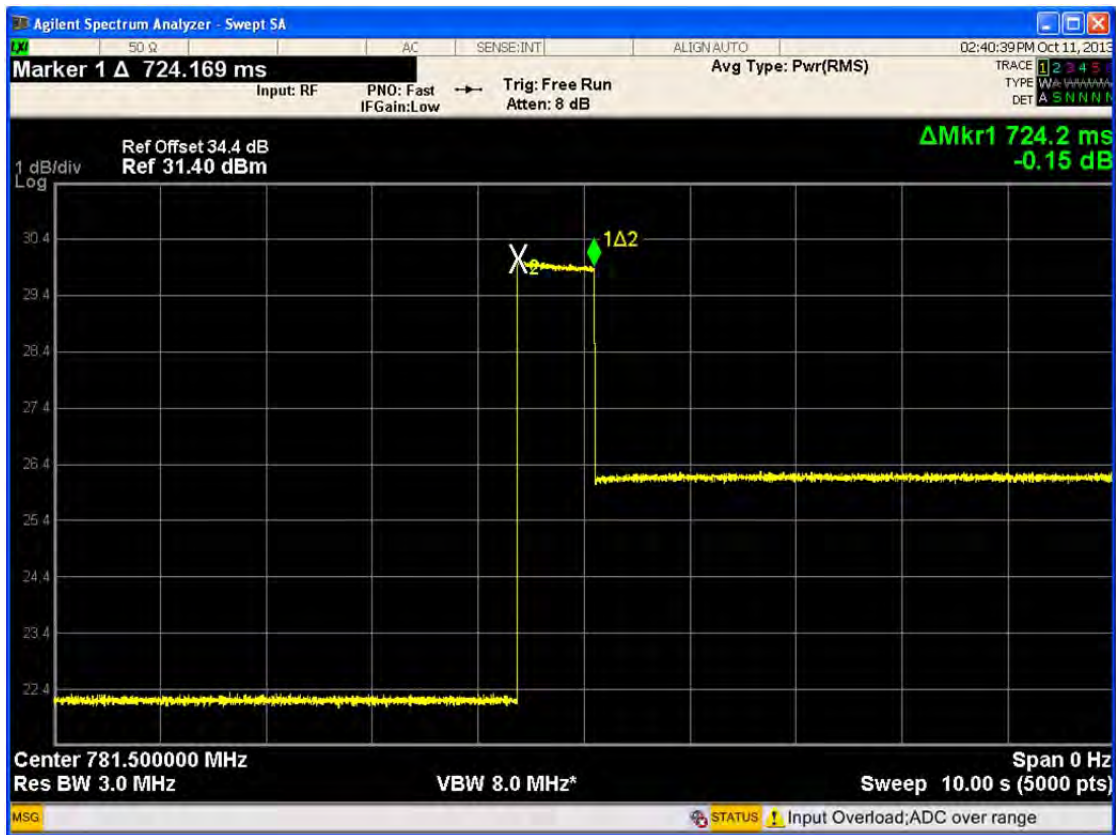
Span : Zero

Sweep time : 10 s

Time of decrease gain : 0.696 s

Limit of timing : 3 s (Fixed device)

• Band 13 / Uplink



Frequency : 781.500 MHz

Span : Zero

Sweep time : 10 s

Time of decrease gain : 0.724 s

Limit of timing : 3 s (Fixed device)

3.8 Uplink inactivity

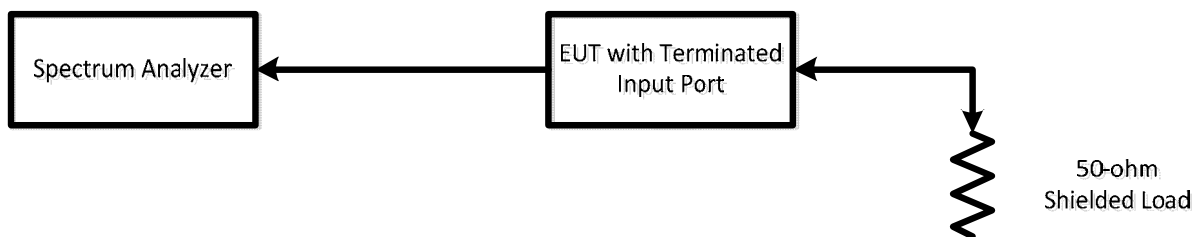
3.8.1 Specification

- FCC Part 20.21 (e)(8)(i)(I)

3.8.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.8
- a) Connect the EUT to the test equipment as shown in **Set-Up** with the uplink output connected to the spectrum analyzer.
- b) Select the RMS power averaging detector.
- c) Set the spectrum analyzer RBW for 1 MHz with the VBW $\geq 3X$ RBW.
- d) Set the center frequency of the spectrum analyzer to the center of the uplink operational band.
- e) Set the span for 0 Hz with a single sweep time for a minimum of 330 seconds.
- f) Start to capture a new trace using MAX HOLD.
- g) After approximately 15 seconds turn on the EUT power.
- h) 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.
- i) Ensure the noise level for the squelched signal is below the uplink inactivity noise power limit, as specified by the rules.
- j) Capture the plot for inclusion in the test report.
- k) Measure noise using procedures in a) to e).
- l) 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	USHR-700L	OPISYS Incorporated
Spectrum Analyzer	N9020A	Agilent

3.8.6 Test condition

- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.8.7 Test results

Band	Link	Inactive Time [s]	Limit [s]	Inactive Level [dBm]
Band 12	Uplink	291.4	300.0	-86.2
Band 13	Uplink	290.7	300.0	-85.3

3.8.8 Test plots

- Band 12 / Uplink



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

Inactivity timing : 291.4 s
Noise level at inactivity : -86.2 dBm/MHz

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

• Band 13 / Uplink



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

Inactivity timing : 290.7 s
Noise level at inactivity : -85.3 dBm/MHz

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

3.9 Variable booster gain

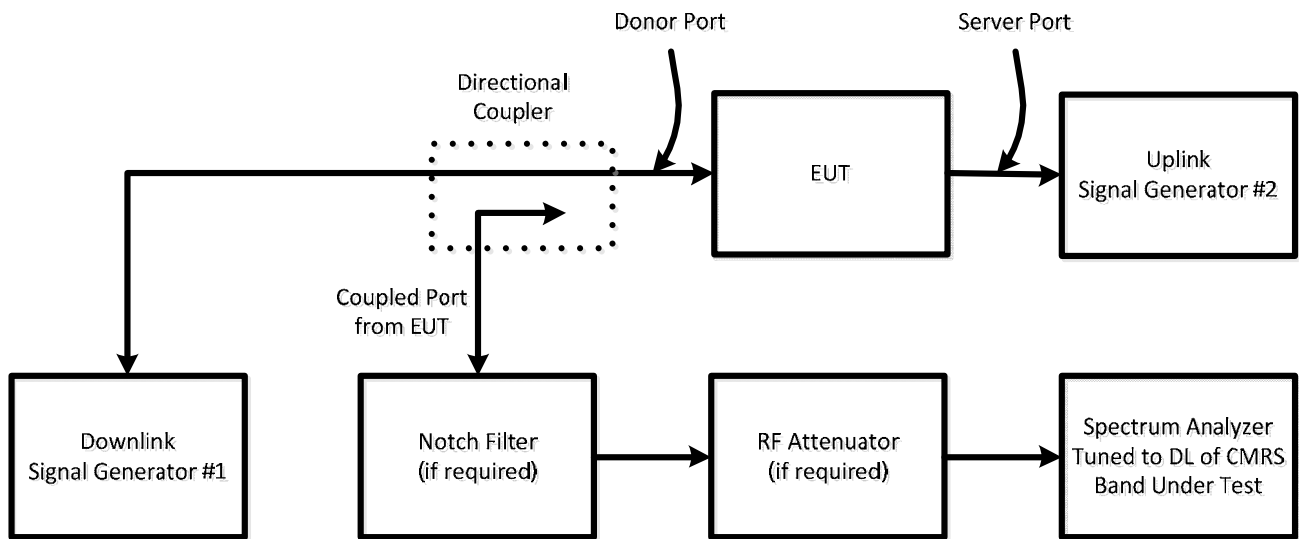
3.9.1 Specification

- FCC 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 $\geq (2 \times \text{span})/\text{RBW}$.
 - 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	USHR-700L	OPISYS Incorporated
Signal Generator	E4432B	Agilent
Signal Generator	N5182A	Agilent
Spectrum Analyzer	N9020A	Agilent
Directional Coupler	87300B	Agilent
Attenuator	66-30-33	Weinschel

3.9.6 Test condition

- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.9.7 Test results of variable gain

- Uplink max gain = -34 dB - RSSI + MSCL
- RSSI = Downlink output power - Downlink gain
- MSCL (distance of between uplink input port and mobile station is 1 meter)

$$L_{fs} = 32.45 + 20 \log (d \text{ km}) + 20 \log (f \text{ MHz})$$

$$= 32.45 + 20 \log (0.001) + 20 \log (698)$$

$$= 32.45 + 20 \log (0.001) + 20 \log (776)$$

[free space path loss model : CCIR]
[29.3dB : Band 12]
[30.3dB : Band 13]

Band	RSSI [dBm]	MSCL [dB]	Gain Limit [dB]	Uplink Input Power [dBm]	Uplink Output Power [dBm]	Uplink Gain [dB]	Margin [dB]
Band 12	-80	29.3	75.3	-38.0	+21.0	59.0	16.3
	-68		63.3	-38.0	+20.0	58.0	5.3
	-60		55.3	-38.0	+11.0	49.0	6.3
	-59		54.3	-38.0	+11.0	49.0	5.3
	-55		50.3	-38.0	+8.0	46.0	4.3
	-50		45.3	-38.0	+2.1	40.1	5.2
	-46		41.3	-38.0	-0.9	37.1	4.2
	-45		40.3	-38.0	-1.9	36.1	4.2
	-44		39.3	-38.0	Shutdown	Shutdown	-
	-43		38.3	-38.0	Shutdown	Shutdown	-
Band 13	-80	30.3	76.3	-38.0	+22.3	60.3	16.0
	-68		64.3	-38.0	+22.3	60.3	4.0
	-60		56.3	-38.0	+14.2	52.2	4.1
	-59		55.3	-38.0	+13.3	51.3	4.0
	-55		51.3	-38.0	+9.3	47.3	4.0
	-50		46.3	-38.0	+4.3	42.3	4.0
	-46		42.3	-38.0	+0.2	38.2	4.1
	-45		41.3	-38.0	-0.6	37.4	3.9
	-44		40.3	-38.0	Shutdown	Shutdown	-
	-43		39.3	-38.0	Shutdown	Shutdown	-

3.10 Occupied bandwidth

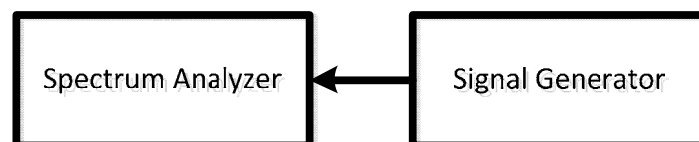
3.10.1 Specification

- FCC Rules Part 2 Section 2.1049

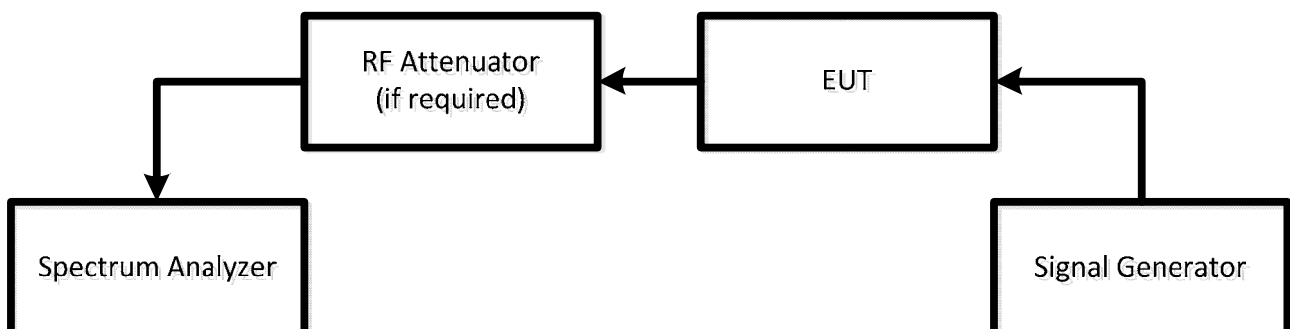
3.10.2 Measurement method

- 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)



3.10.4 Set-up 2 (Occupied bandwidth)



3.10.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	USHR-700L	OPISYS Incorporated
Signal Generator	N5182A	Agilent
Signal Generator	E4432B	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.10.6 Test condition

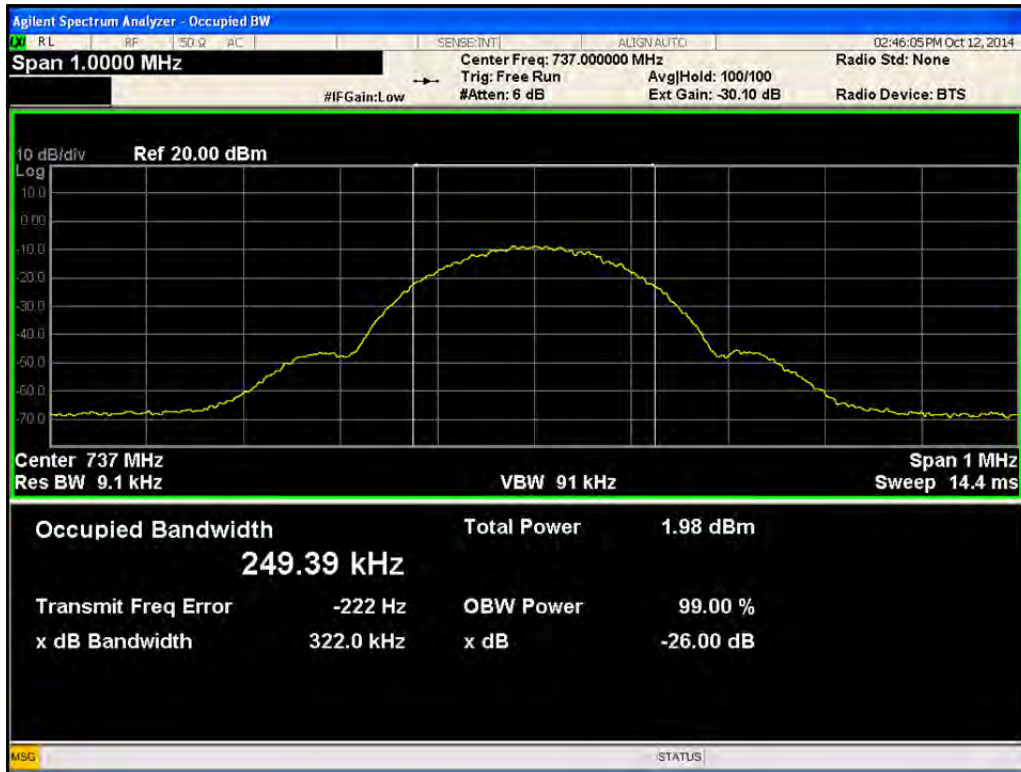
- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.10.7 Test results

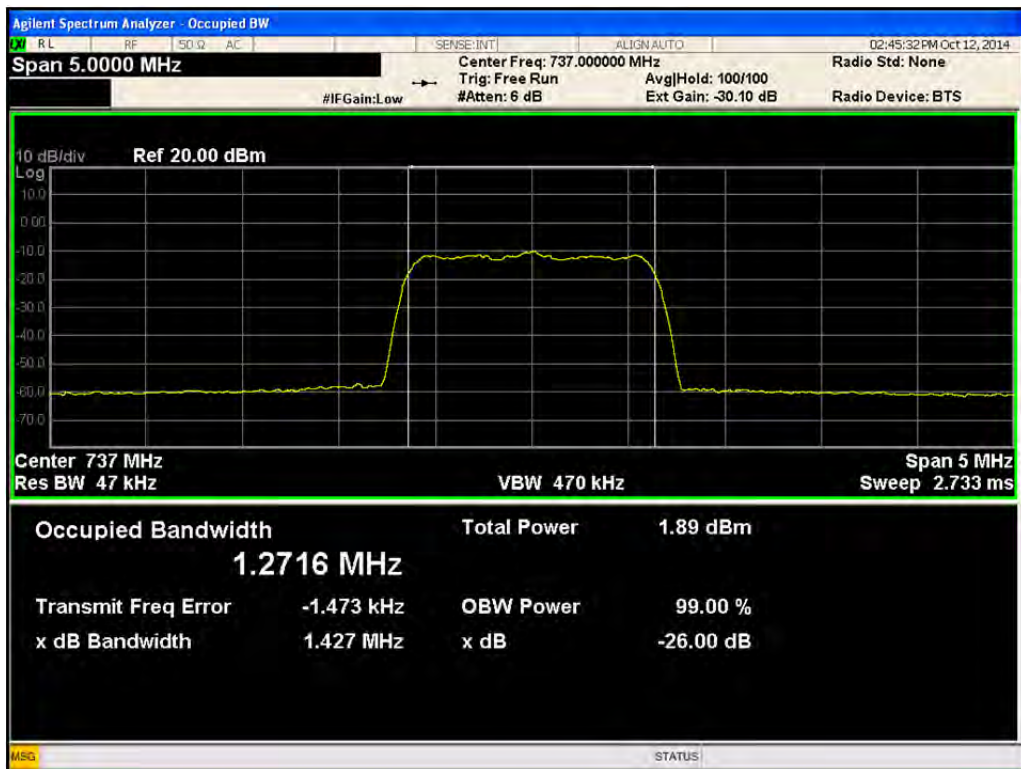
Band	Link	Signal Type	Frequency [MHz]	Input OBW [MHz]	Output OBW [MHz]	26 dB Bandwidth [MHz]
Band 12	Down Link	GSM	737.0	0.249	0.249	0.322
		CDMA	737.0	1.271	1.271	1.427
		AWGN	737.0	4.101	4.106	4.683
		LTE	737.0	4.494	4.502	4.871
	Up Link	GSM	707.0	0.249	0.249	0.322
		CDMA	707.0	1.273	1.305	1.504
		AWGN	707.0	4.099	4.095	4.698
		LTE	707.0	4.493	4.501	4.821
Band 13	Down Link	GSM	751.5	0.249	0.249	0.321
		CDMA	751.5	1.274	1.270	1.428
		AWGN	751.5	4.098	4.084	4.660
		LTE	751.5	4.496	4.488	4.798
	Up Link	GSM	781.5	0.249	0.248	0.320
		CDMA	781.5	1.270	1.272	1.428
		AWGN	781.5	4.102	4.085	4.682
		LTE	781.5	4.494	4.493	4.828

3.10.8 Plots of Occupied bandwidth

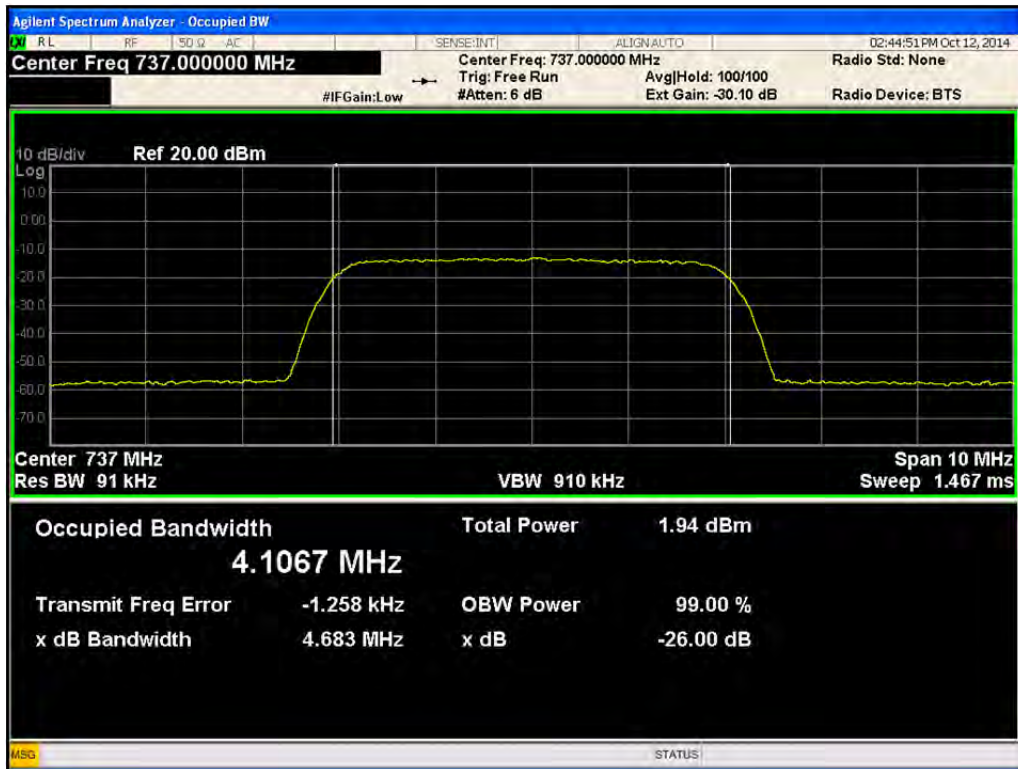
- Band 12 / Downlink / GSM



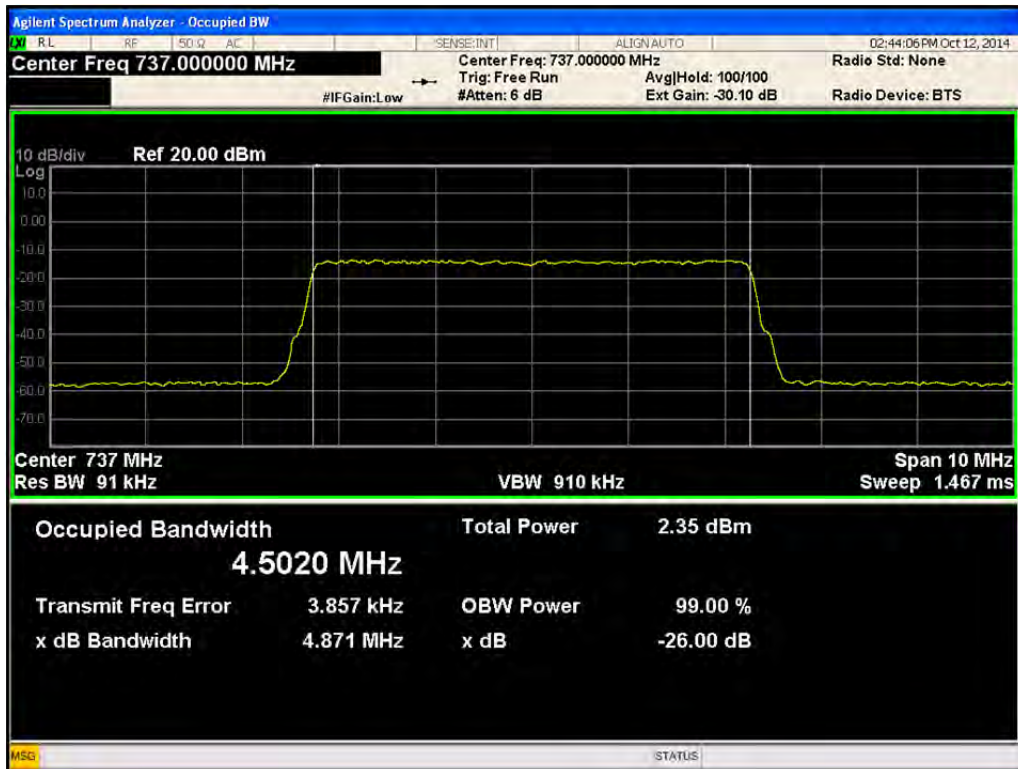
- Band 12 / Downlink / CDMA



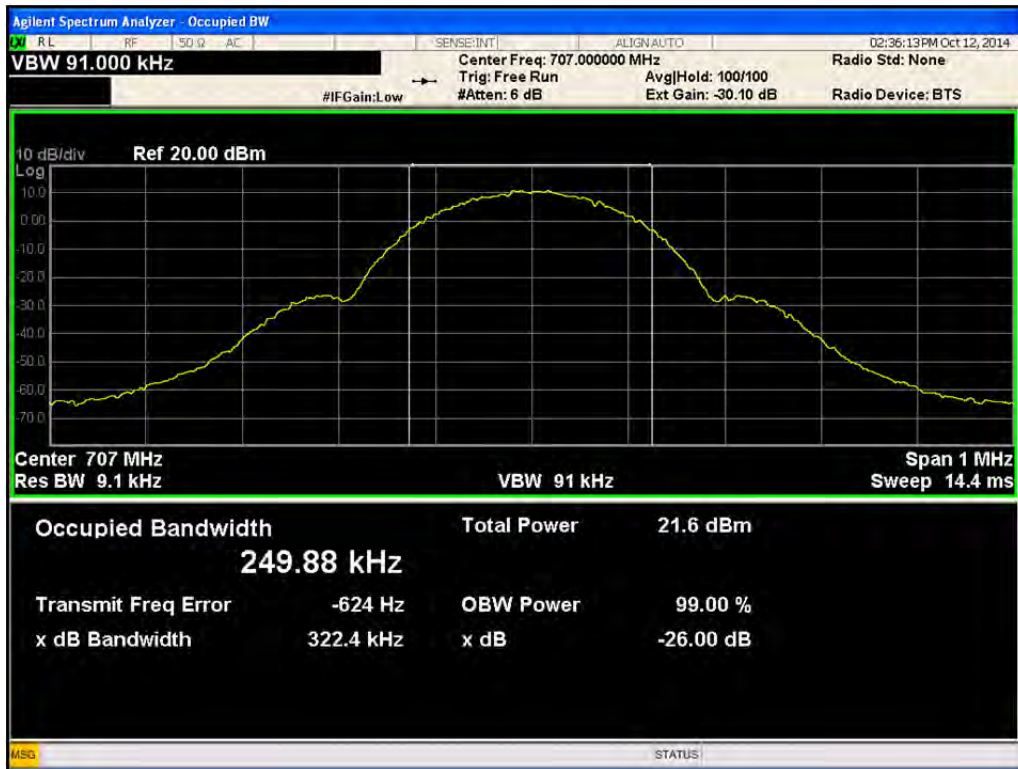
• Band 12 / Downlink / AWGN



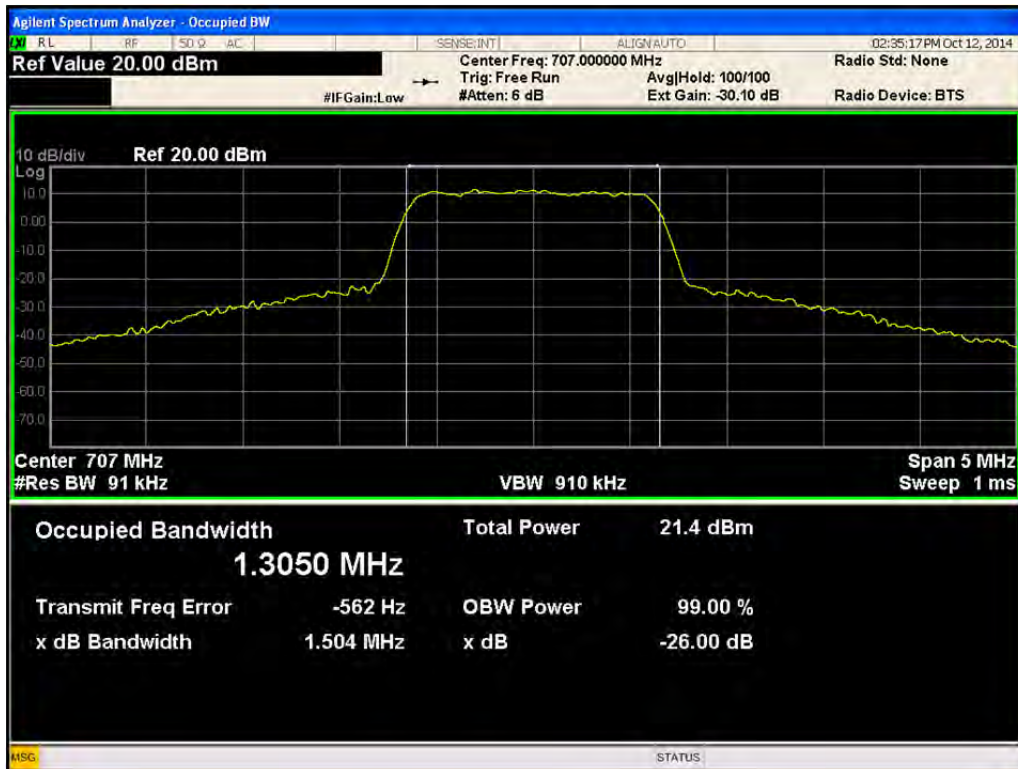
• Band 12 / Down link / LTE



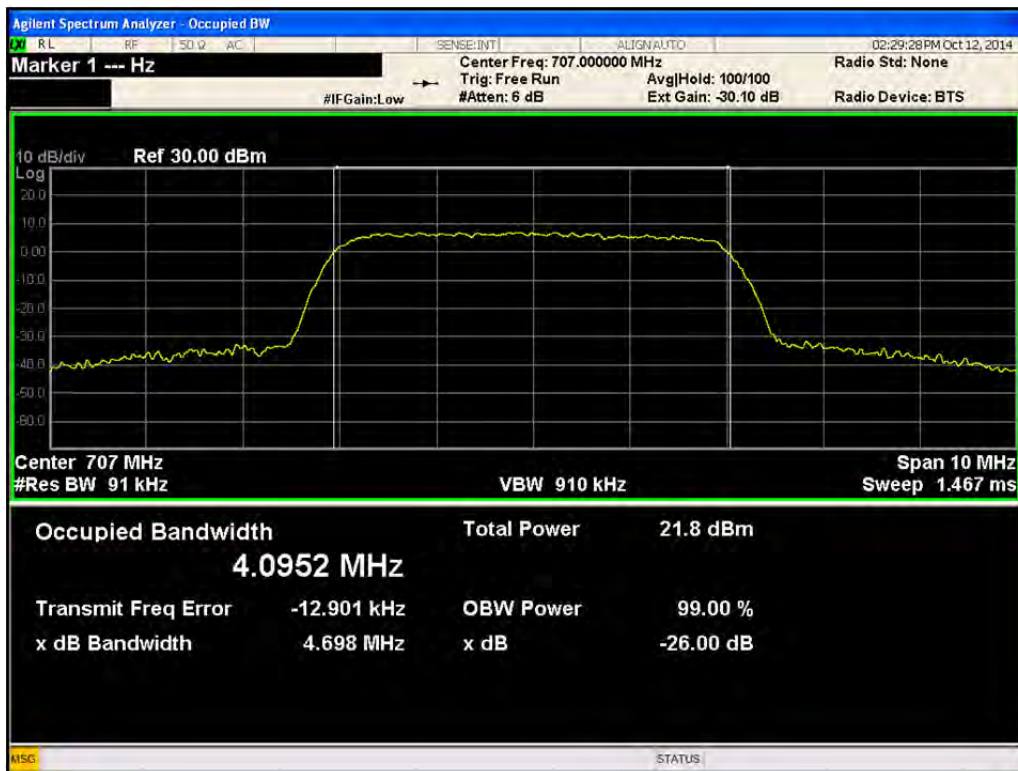
• Band 12 / Uplink / GSM



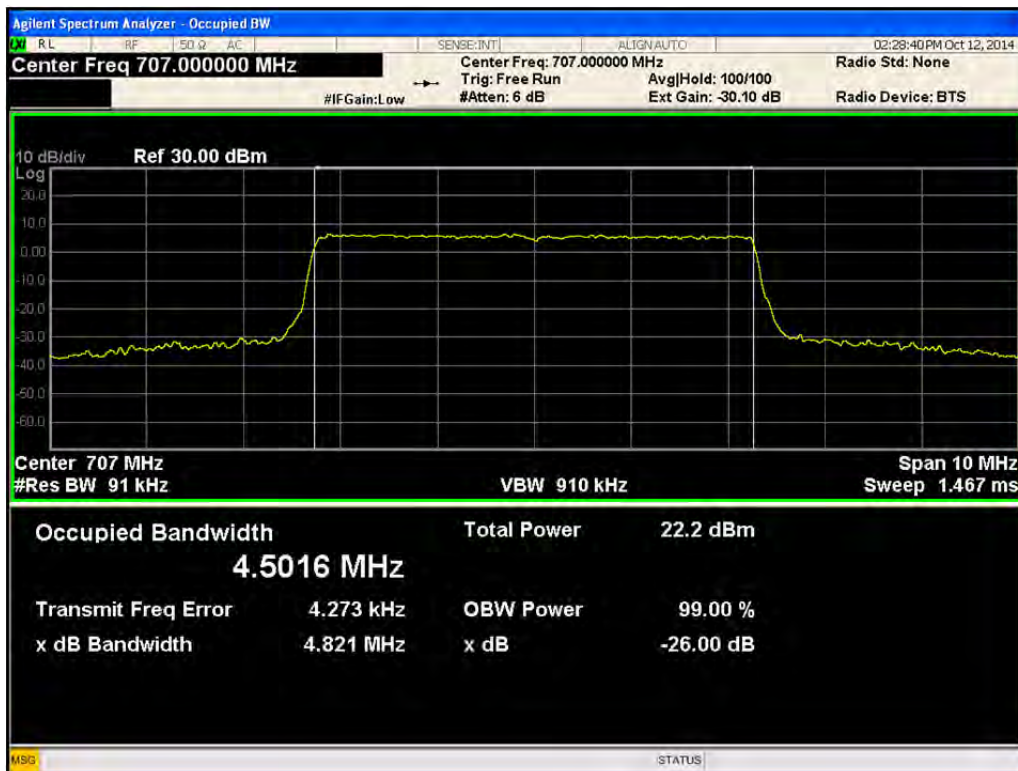
• Band 12 / Uplink / CDMA



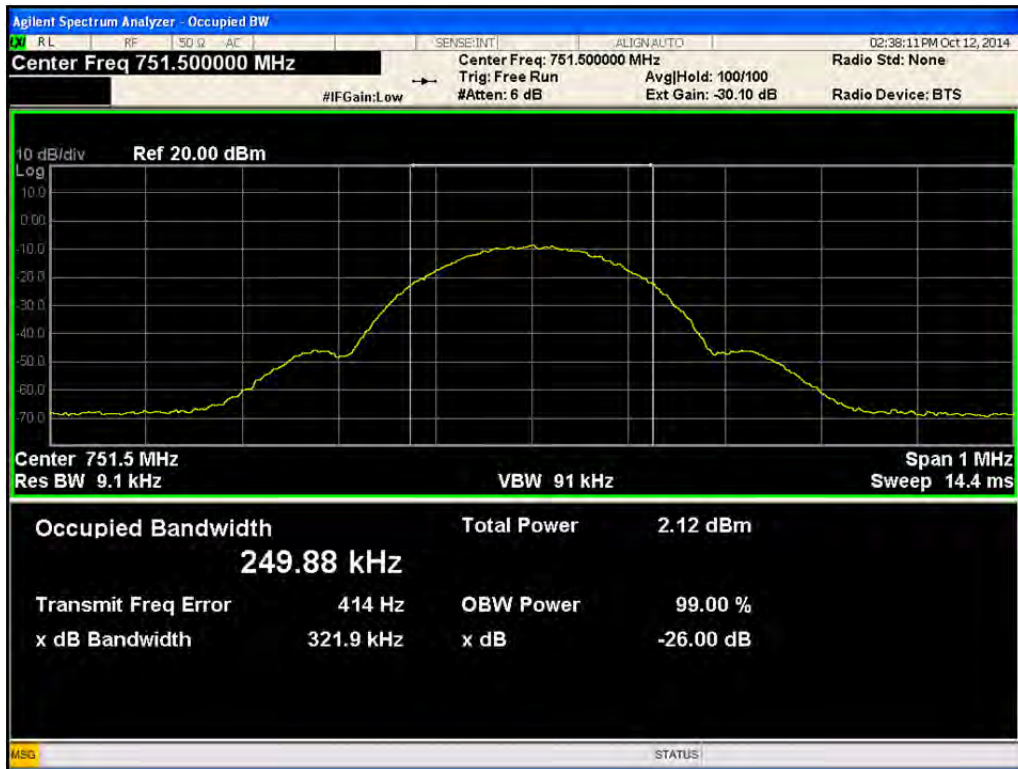
• Band 12 / Uplink / AWGN



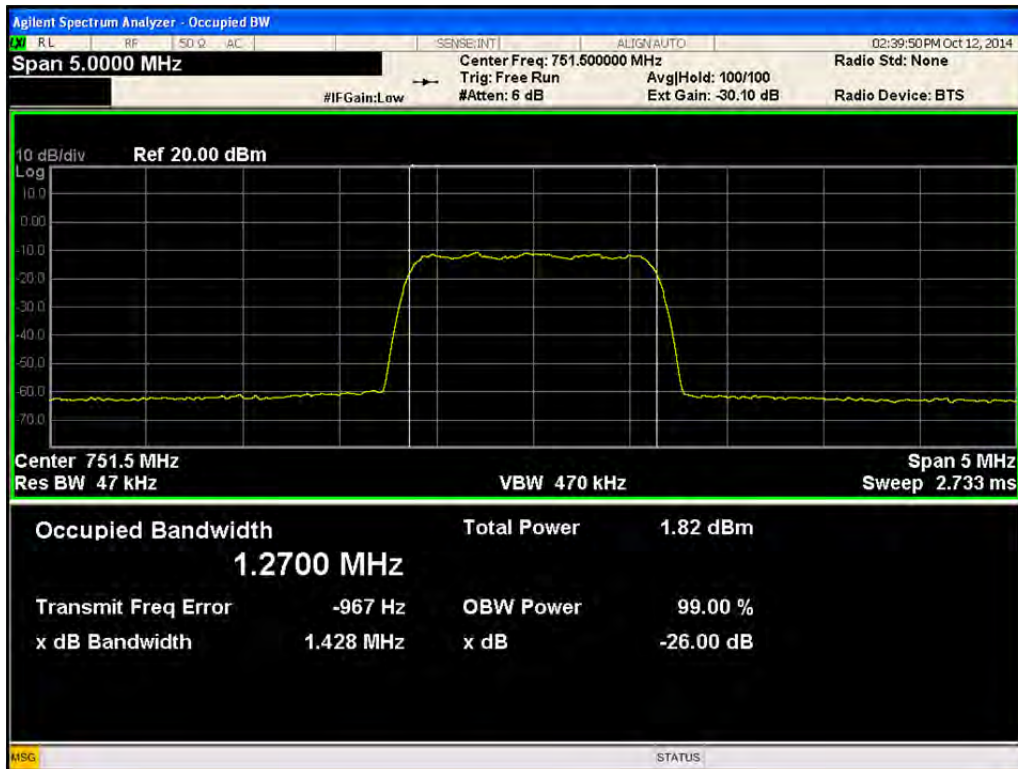
• Band 12 / Uplink / LTE



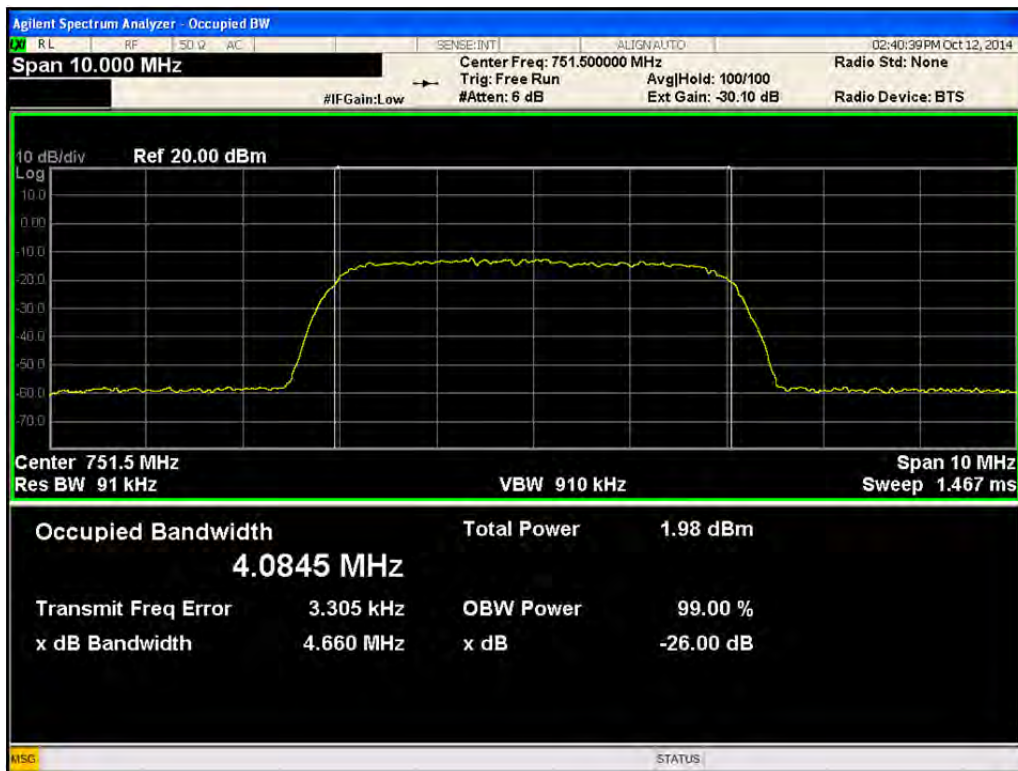
• Band 13 / Downlink / GSM



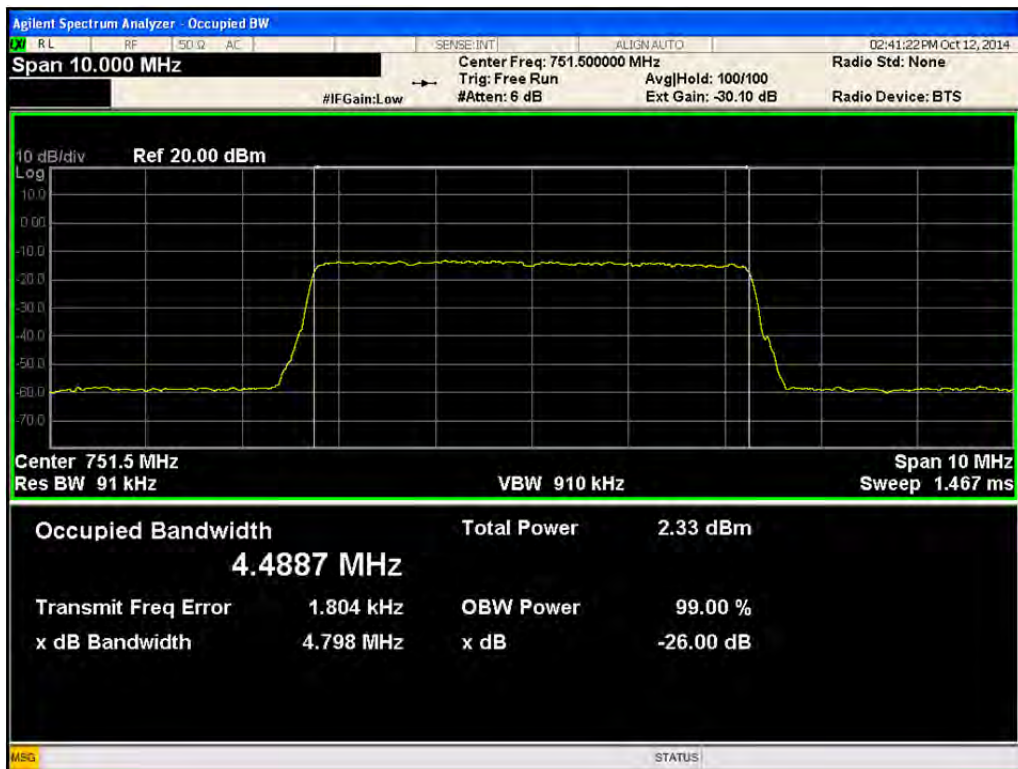
• Band 13 / Downlink / CDMA



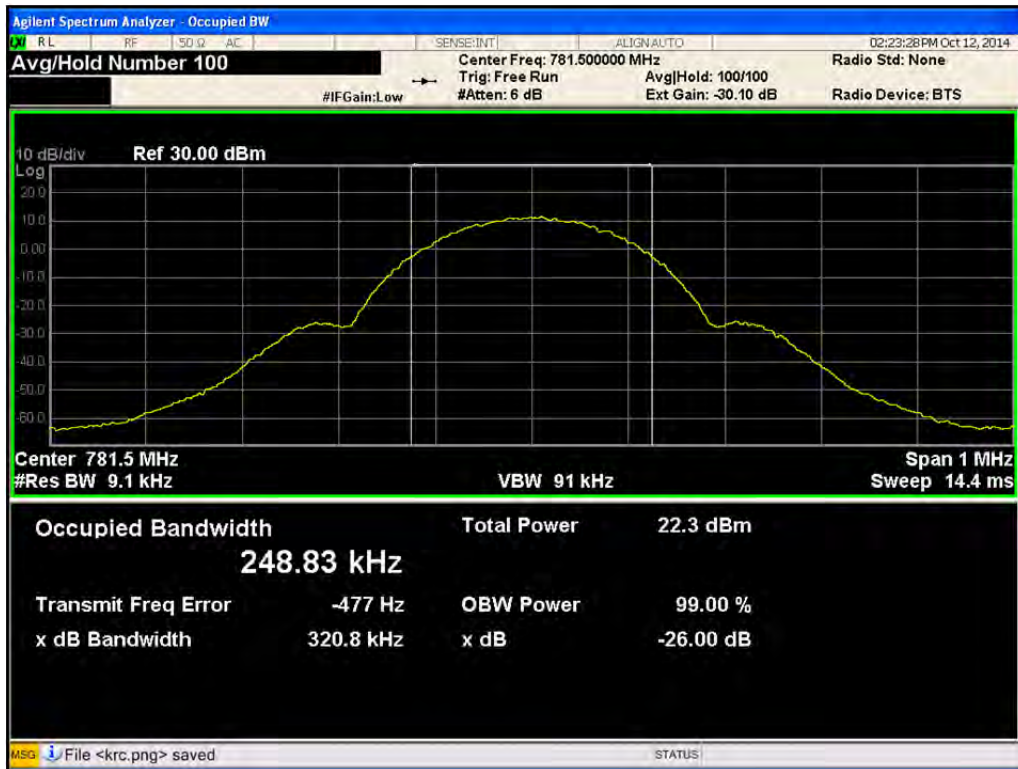
• Band 13 / Downlink / AWGN



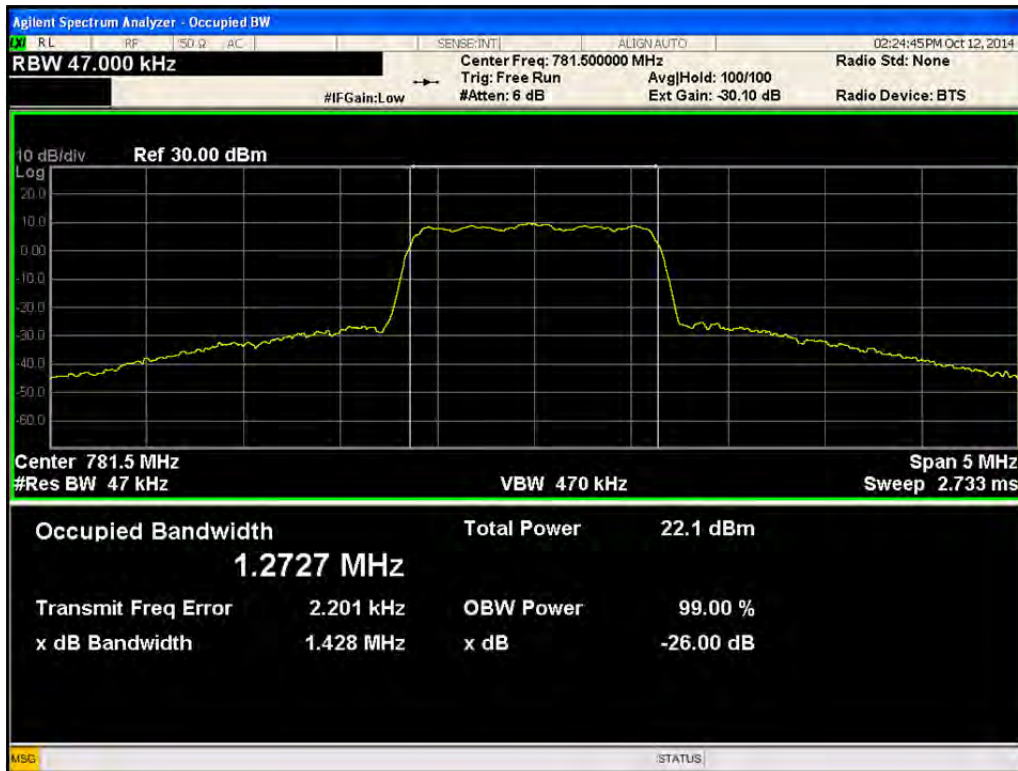
• Band 13 / Down link / LTE



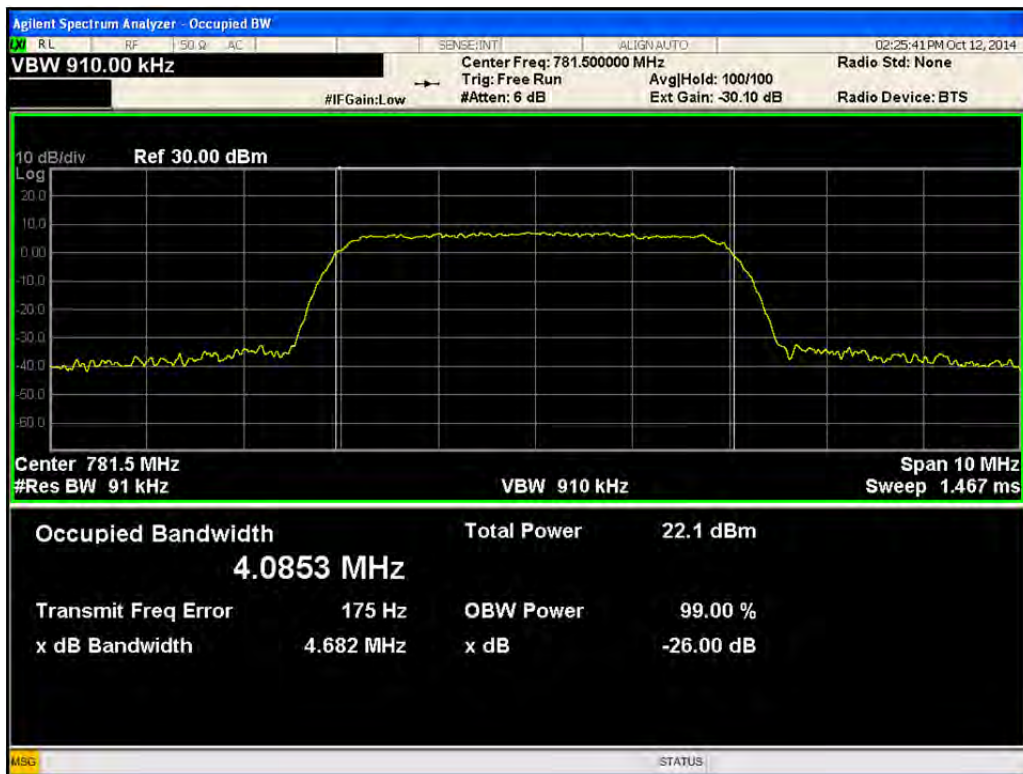
• Band 13 / Uplink / GSM



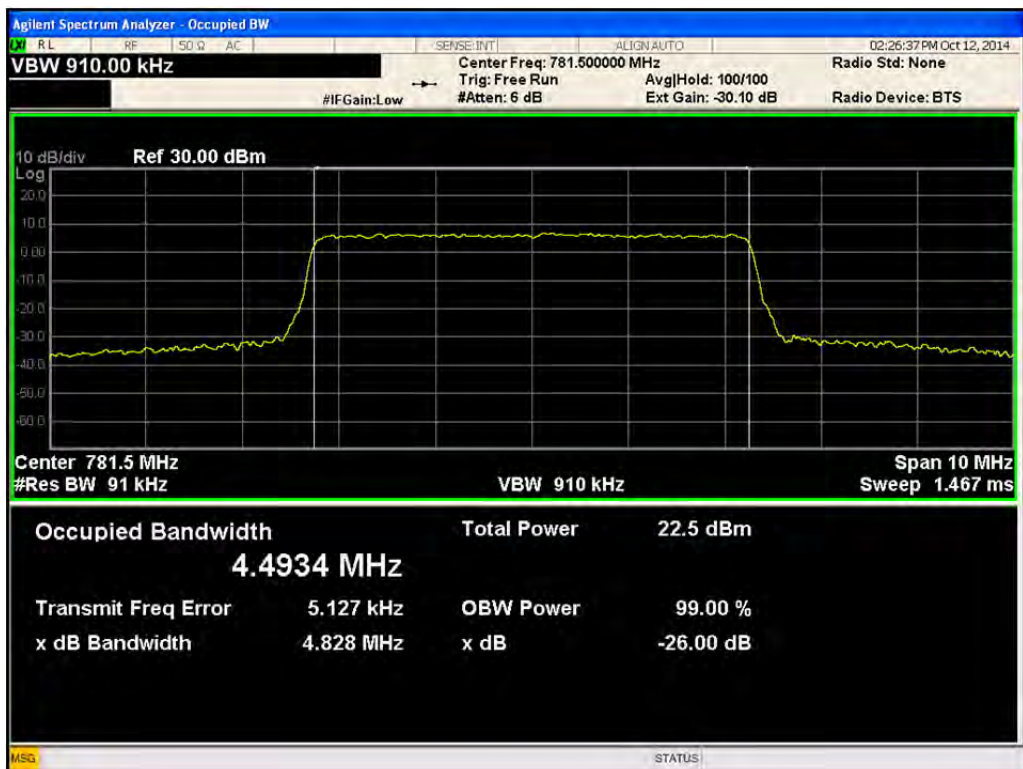
• Band 13 / Uplink / CDMA



• Band 13 / Uplink / AWGN



• Band 13 / Uplink / LTE



3.11 Oscillation detection

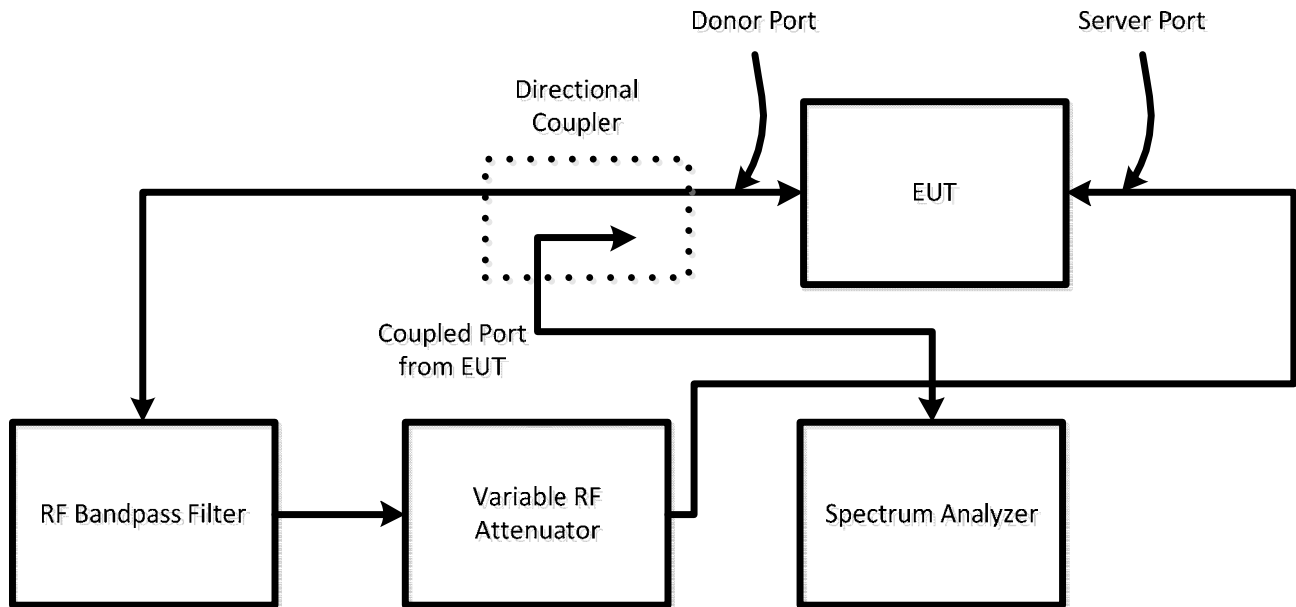
3.11.1 Specification

- 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 a 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	USHR-700L	OPISYS Incorporated
Directional Coupler	11667A	Agilent
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-33	Weinschel

3.11.5 Test condition

- Test place: Shield Room
- Test environment: 24.2 °C, 51 % R.H.

3.11.6 Test results of detection time

Band	Link	Detection Time [S]	Limit [S]	Result
Band 12	Down Link	0.798	1.000	Pass
	Up Link	0.251	0.300	Pass
Band 13	Down Link	0.818	1.000	Pass
	Up Link	0.246	0.300	Pass

3.11.7 Test results of restarting time

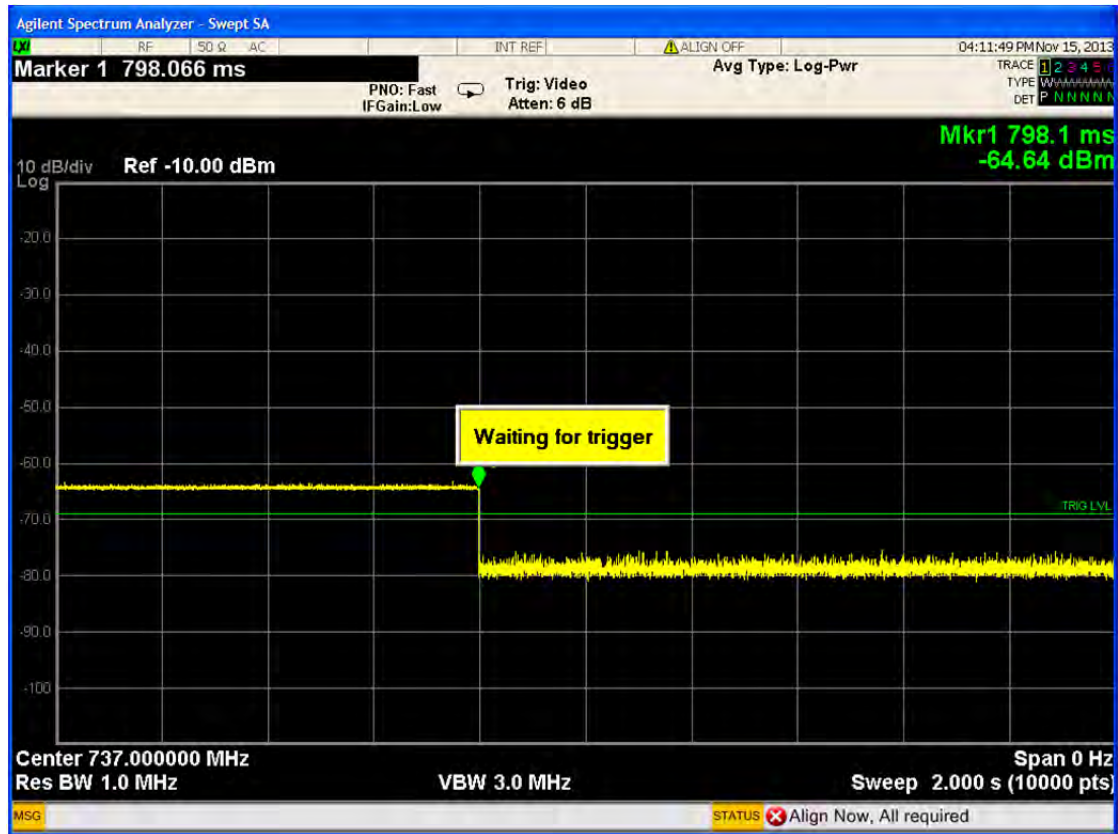
Band	Link	Restarting Time [S]	Limit [S]	Result
Band 12	Down Link	65.0	≥ 60.0	Pass
	Up Link	63.0	≥ 60.0	Pass
Band 13	Down Link	64.0	≥ 60.0	Pass
	Up Link	66.0	≥ 60.0	Pass

3.11.8 Test results of restarting count

Band	Link	Restarting Count	Limit	Result
Band 12	Down Link	5	≤ 5	Pass
	Up Link	5	≤ 5	Pass
Band 13	Down Link	5	≤ 5	Pass
	Up Link	5	≤ 5	Pass

3.11.9 Test plots of detection time

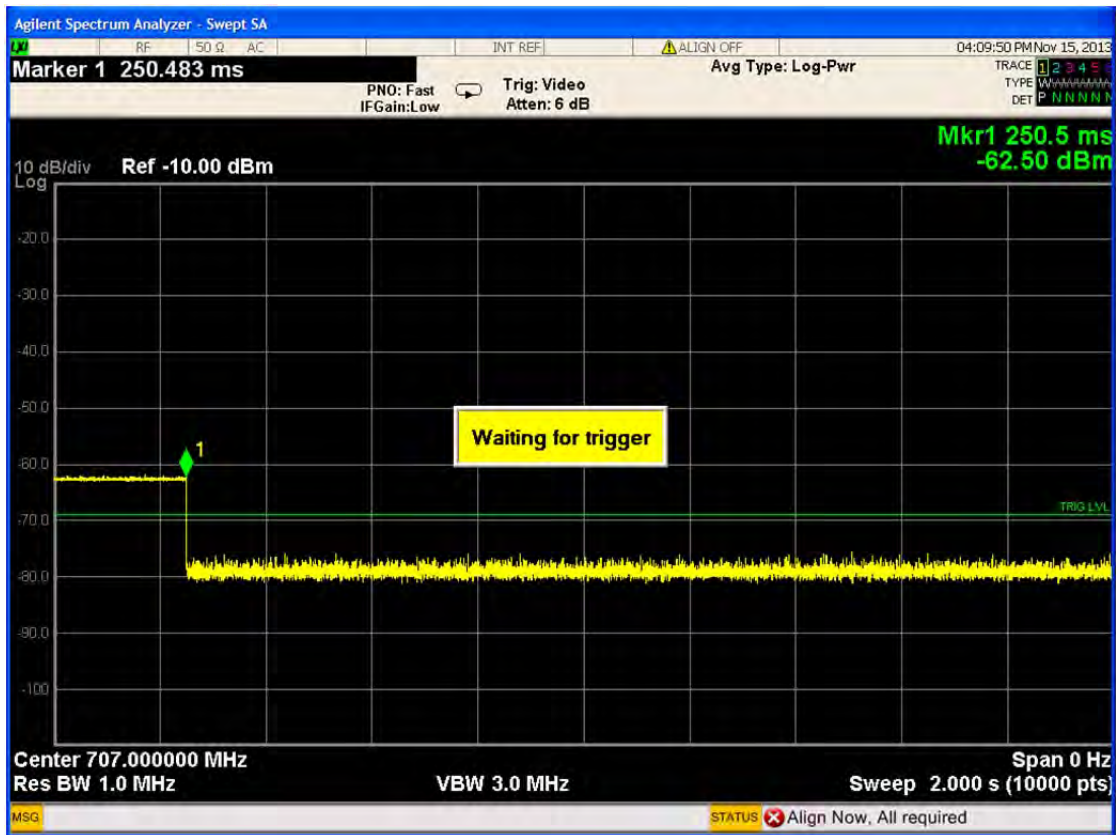
- Band 12 / Downlink



Time of oscillation detection and mitigation : 0.798 s

Limit : 1.000 s

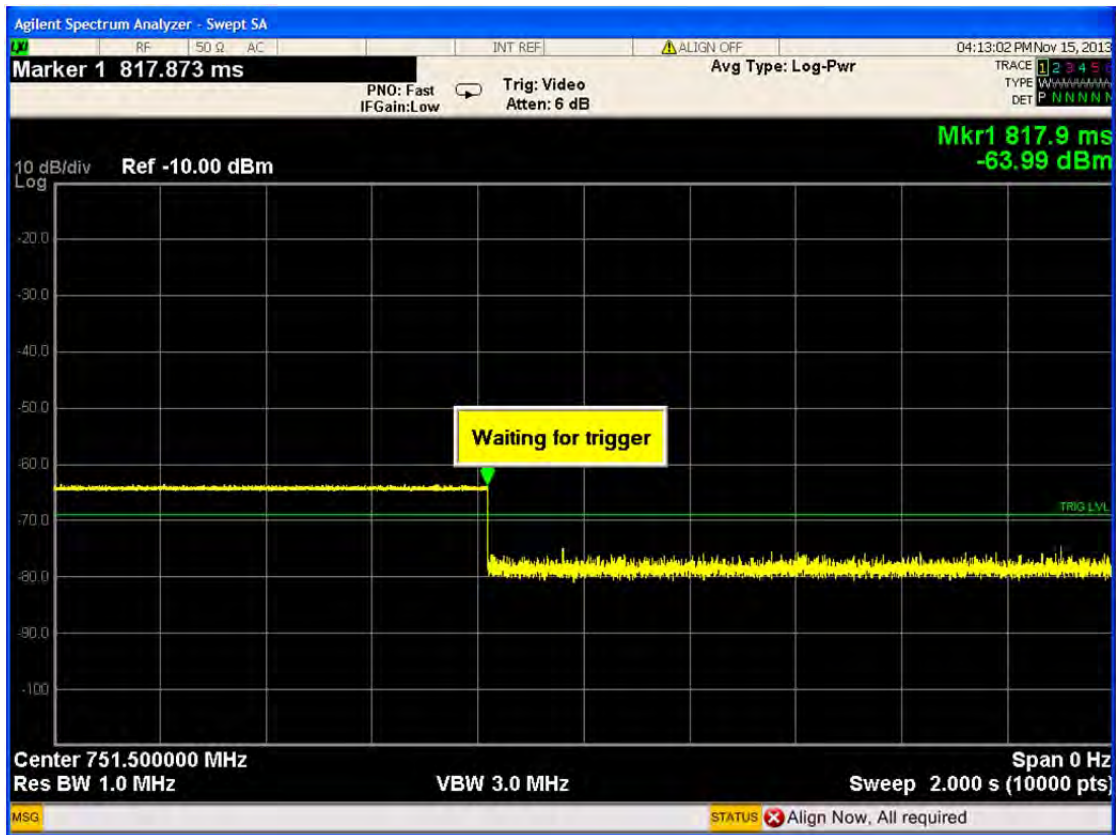
• Band 12 / Uplink



Time of oscillation detection and mitigation : 0.251 s

Limit : 0.300 s

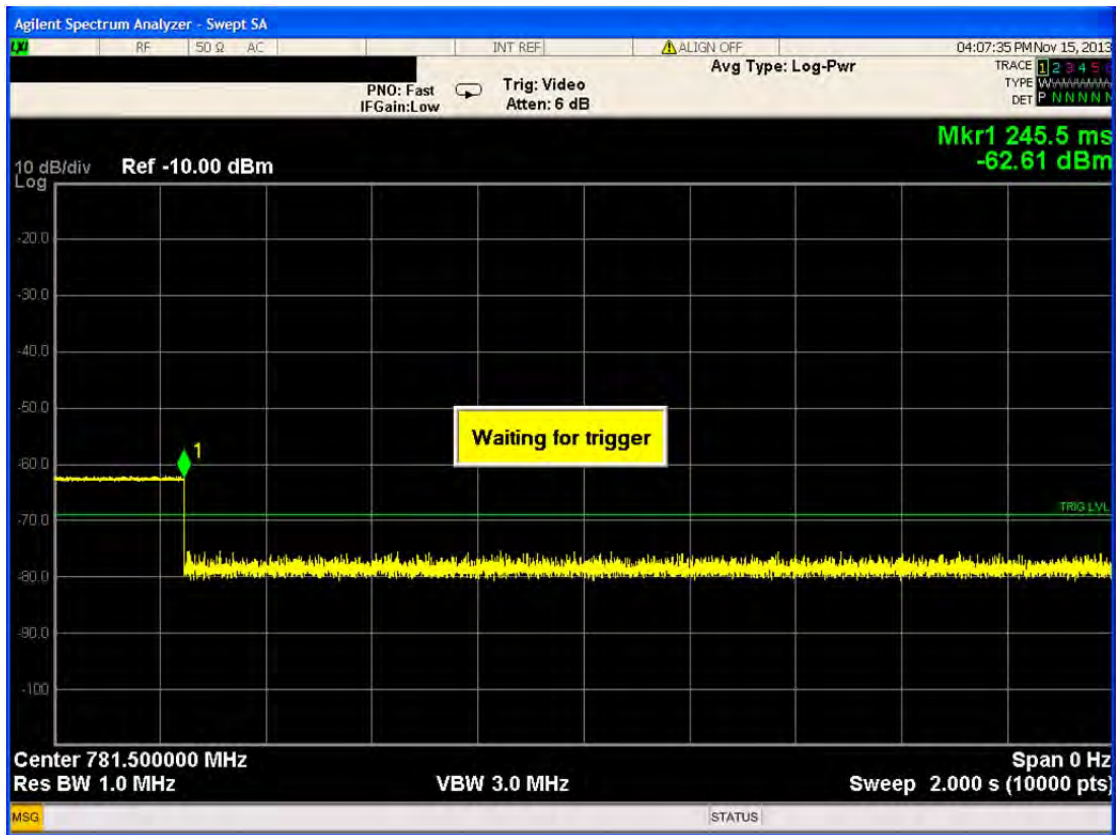
• Band 13 / Downlink



Time of oscillation detection and mitigation : 0.818 s

Limit : 1.000 s

• Band 13 / Uplink

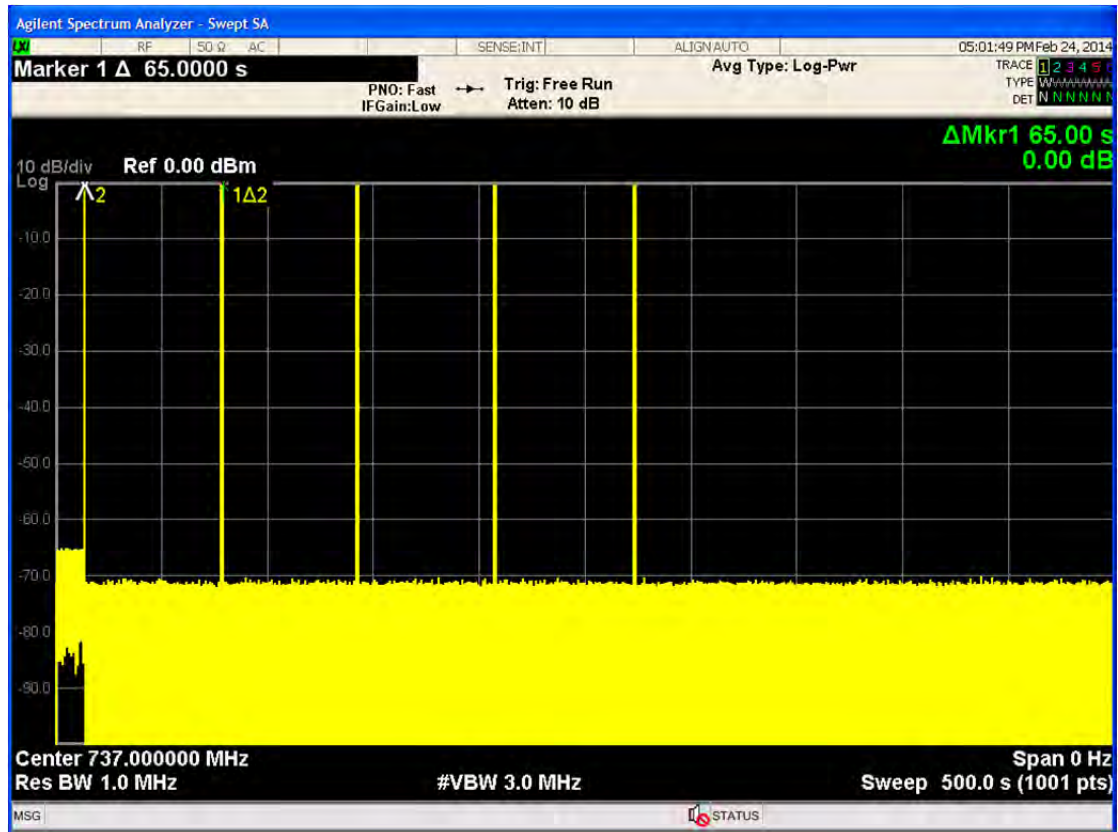


Time of oscillation detection and mitigation : 0.246 s

Limit : 0.300 s

3.11.10 Test plots of restarting time

- Band 12 / Downlink



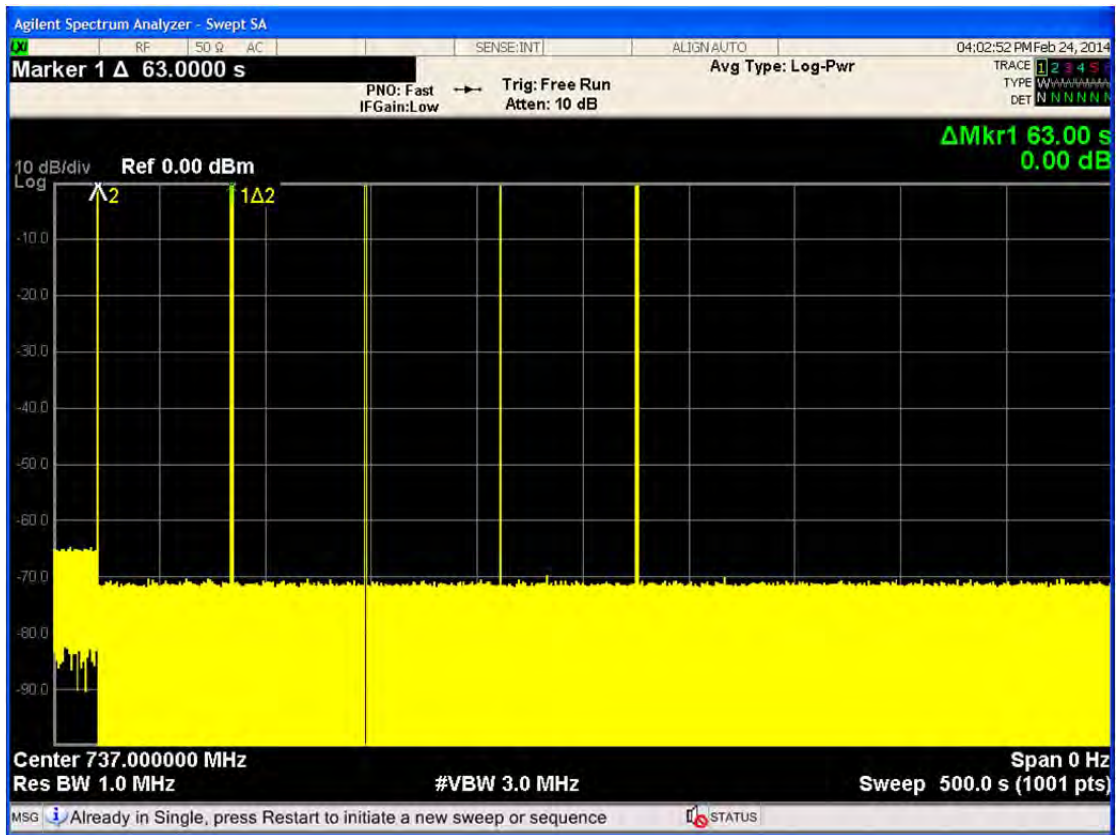
Restarting time : 65.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

• Band 12 / Uplink



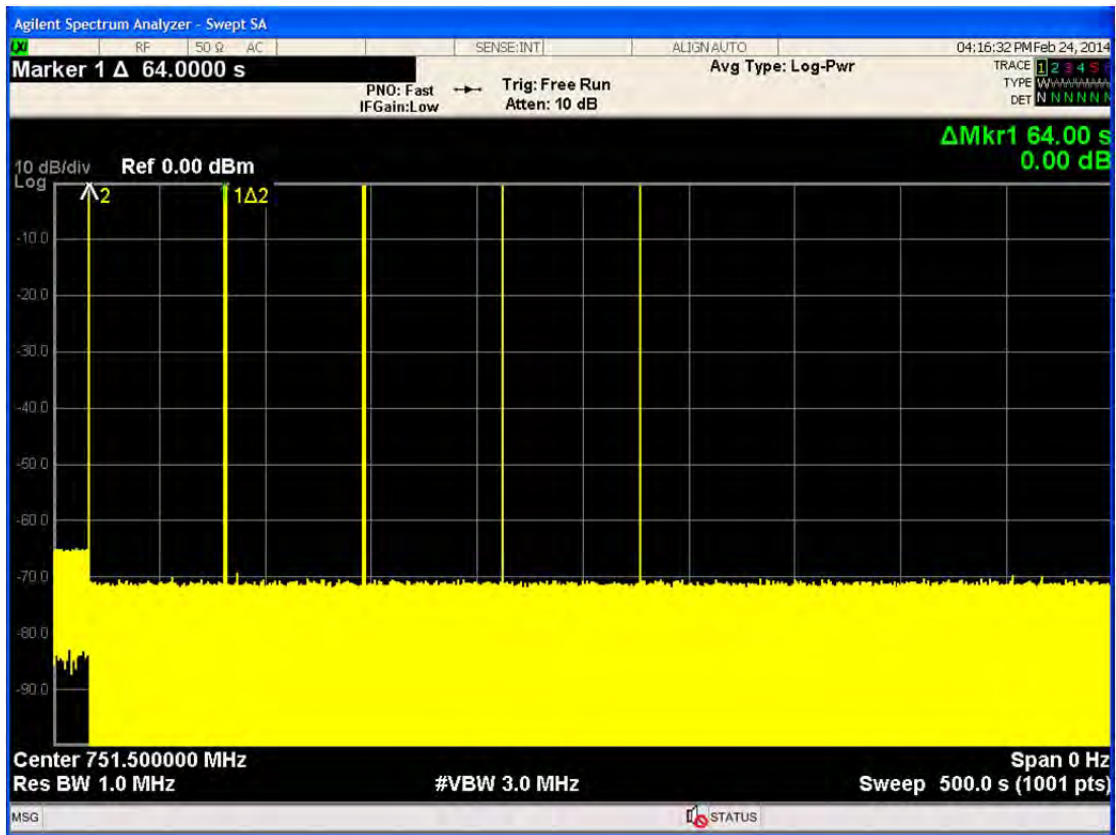
Restarting time : 63.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

• Band 13 / Downlink



Restarting time : 64.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

• Band 13 / Uplink



Restarting time : 66.0 s

Limit : More than 60.0 s

Restarting count : 5 time

Limit : 5 time

3.12 Radiated spurious emission

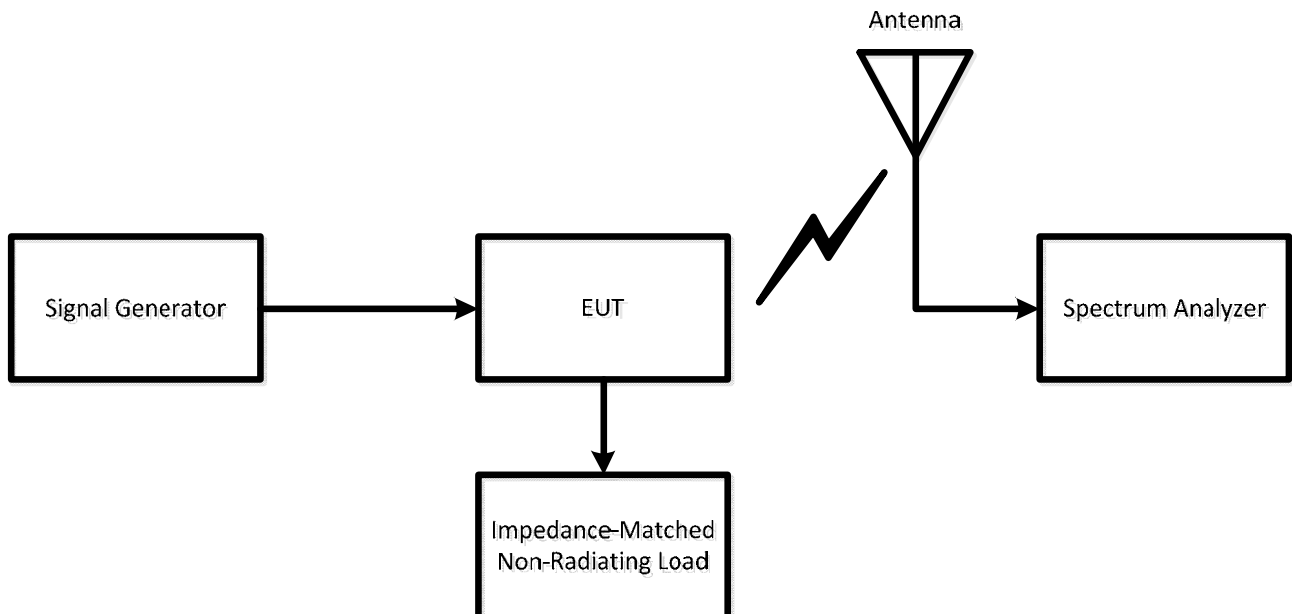
3.12.1 Specification

- FCC Rules Part 2 Section 2.1053

3.12.2 Measurement method

- 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516 §7.12
- a) Place the EUT on an OATS or semi-anechoic chamber turntable 3 m from the receiving antenna.
- b) Connect the EUT to the test equipment as shown in **Set-Up** beginning with the uplink output
- c) 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.
- d) 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**.
- e) 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.
- f) 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	USHR-700L	OPISYS Incorporated
Signal Generator	N5182A	Agilent
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: 27 °C, 51 % 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]
Band 12 / Downlink / 737 MHz								
-	-	-	-	-	-	-	-13.00	-
Band 12 / Uplink / 707 MHz								
-	-	-	-	-	-	-	-13.00	-
Band 13 / Downlink / 752 MHz								
-	-	-	-	-	-	-	-13.00	-
Band 13 / Uplink / 782 MHz								
-	-	-	-	-	-	-	-13.00	-

※ All emissions are under the noise floor level.

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

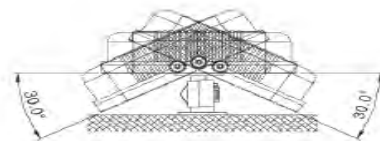
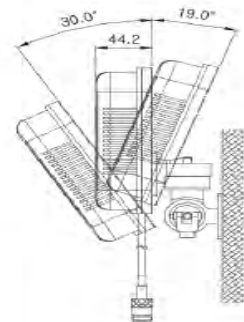
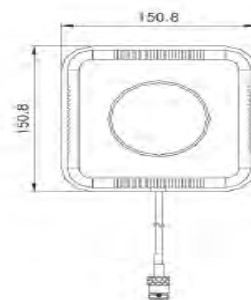
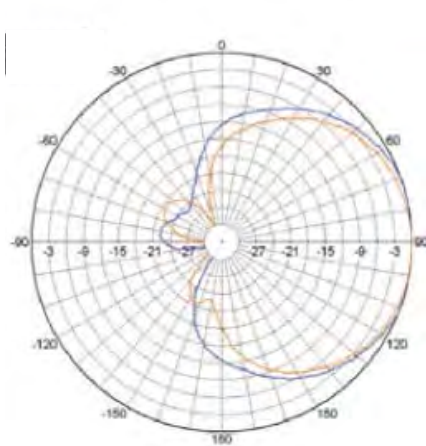
The Coaxial Cable is used for RF distribution to the Service Antenna (8 dBi gain) from USHR-700L and to the Donnor Antenna (9 dBi gain) from USHR-700L.

- **Model Name : PAT-CPWI-L (Service antenna)**



Antenna Gain;

- 698 MHz – 787 MHz : 4 dBi



- **Model Name : TS260771 (Service antenna)**



- **Antenna Gain**
- **698 MHz – 787 MHz : 8 dBi**

- **Model Name : TS250374 (Service antenna)**



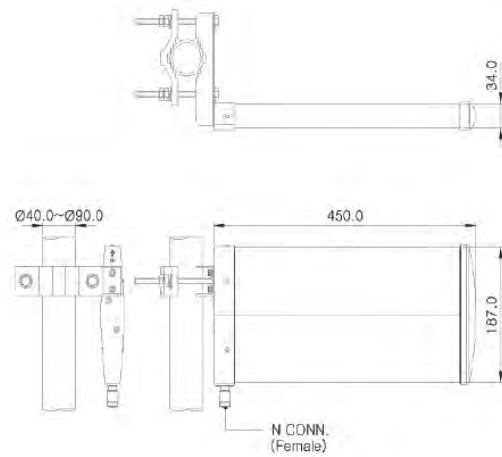
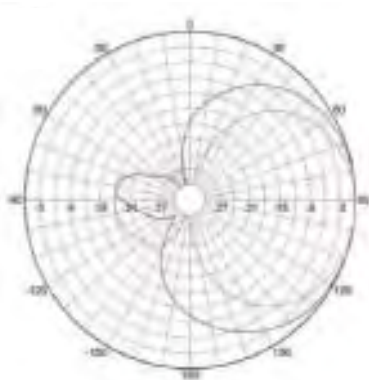
- **Antenna Gain**
- **698 MHz – 787 MHz : 5 dBi**

• **Model Name : ALP-17QD-L (Donor antenna)**



Antenna Gain;

- 698 MHz – 787 MHz : 6 dBi



- **Model Name : TS210471 (Donor antenna)**



Antenna Gain

- **698 MHz – 787 MHz : 4.5 dBi**

- **Model Name : TS220971 (Donor antenna)**



Antenna Gain

- **698 MHz – 787 MHz : 9 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]		
Band 12	Down	739.9	2.27	+8.00	-0.90	9.37	8.64	0.001 721 7	0.493 267
	Up	701.8	21.70	+9.00	-1.80	28.90	776.24	0.154 507 8	0.467 867
Band 13	Down	750.2	1.73	+8.00	-0.90	8.83	7.63	0.001 520 4	0.500 133
	Up	781.4	22.23	+9.00	-1.80	29.43	877.00	0.174 562 3	0.520 933

• Band 12

The maximum conducted power is 21.70 dBm; antenna is fix-mounted with a maximum gain and cable loss of 7.2 dBi gain.

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

The maximum Peak EIRP calculated is 28.90 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, $S = 0.154 \text{ mW/cm}^2$, which is below the MPE Limit of 0.467 mW/cm^2

• Band 13

The maximum conducted power is 22.23 dBm; antenna is fix-mounted with a maximum gain and cable loss of 7.2 dBi gain.

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

The maximum Peak EIRP calculated is 29.43 dBm.

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

At 0.2 m, $S = 0.174 \text{ mW/cm}^2$, which is below the MPE Limit of 0.520 mW/cm^2

• Band 12 + Band 13

Power density on up link side for Band 12 and Band 13 are 9.98 % and 10.38 % 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	2016.08.06
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