# FCC RF TEST REPORT

*Issued to*

**Nanjing New-Channel Technical Co., Ltd**

*For*

**GSM/CDMA mini Repeater**

| | | |
|---|---|---|
| Model Name | : | NC-CG850-SB |
| FCC ID | : | 2AAJA-CGSB850 |
| Standard | : | 47 CFR Part 22 Subpart H |
| | | 47 CFR Part 20.21 |
| | | 47 CFR Part 2 |
| Test date | : | Nov.3,2014 to Sep.8,2015 |
| Issue date | : | Sep.8,2015 |

*by*

**Shanghai MORLAB Communication Technology Co., Ltd.**

*Tested by* Wu Hongtei *Approved by* Gu Yejiang *Review by* Mu Wenping

CTIA Authorized Test Lab LAB CODE 20081223-00 IEEE 1725 OTA | OFTA 電訊管理局 | ilac-MRA | TAF Testing Laboratory 2030 | GCF Official Observer of Global Certification Forum | Bluetooth BQTF | FCC Reg. No.741109

# DIRECTORY

## Change History

| Issue | Date | Reason for change |
|---|---|---|
| 1.0 | Nov.5, 2014 | First edition |
| 2.0 | Feb.12,2015 | Second edition |
| 3.0 | Sep.8,2015 | Third edtion |
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# 1. General Information

## 1.1 Applicant

Nanjing New-Channel Technical Co., Ltd
No.114-3 Guanghua Road, Nanjing, China, 210007

## 1.2 Manufacturer

Nanjing Top-Link Radio Science & Technology Co., Ltd
#3 JunNongRoad ,Qinhuai District, Nanjing, China, 210007

## 1.3 Description of EUT

| | |
|---|---|
| EUT Type.....: | GSM/CDMA mini Repeater |
| Model Name .....: | NC-CG850-SB |
| Hardware Version .....: | XBD-216 |
| Software Version.....: | R 2.3.1 |
| Operating Band.....: | NC-CG850-SB<br>Uplink: 824 - 849 MHz<br>Downlink: 869 - 894 MHz |
| Operating Frequency .....: | NC-CG850-SB:<br>GSM 850MHz<br>Uplink: 824.20 - 848.80 MHz<br>Downlink: 869.20 - 893.80MHz<br>CDMA Cellular<br>Uplink: 824.80 - 848.20 MHz<br>Downlink: 869.80 - 893.20MHz |
| Emission Designator.....: | GXW(GSM), F9W(CDMA) |
| Ancillary Equipments .....: | Adapter<br>Mode Name.: XFS-0502000<br>Rated Input: AC 110/240V, 50/60Hz<br>Rated Output: DC 5V, 2A<br>Manufacturer: SHENZHEN SUNFENG ELECTRONICS CO., LTD<br>A3 Building, Xuxingda Industrial Park, Zhoushi Rd, Shiyan Town, Baoan, Shenzhen |

*Note: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.*

# 2. Facilities and Accreditations

## 2.1 Test Facility

Shanghai Morlab Communications Technology Co., Ltd. Morlab Laboratory is a third party testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6644. A 9*6*6(m) fully anechoic chamber was used for the radiated spurious emissions test.

## 2.2 Environmental Conditions

Ambient temperature: 20~25°C
Relative humidity: 40~60%
Atmosphere pressure: 96kPa

## 2.3 List of Equipments Used

| Description | Manufacturer | Model | Serial No. | Cal. Date | Cal. Due |
|---|---|---|---|---|---|
| System Simulator | Agilent | E5515C | GB46040102 | 2015.2.25 | 1year |
| Spectrum Analyzer | Rohde&Schwarz | FSU26 | 200880 | 2015.2.25 | 1year |
| EMI Test Receiver | Rohde&Schwarz | ESCI7 | 100787 | 2015.2.25 | 1year |
| Directional Coupler | Narda | 4242-10 | 00164 | (n.a.) | (n.a.) |
| Power Splitter | Mini-Circuits | ZFRSC-183-S+ | 765001016 | (n.a.) | (n.a.) |
| Variable Attenuator | Feiyang Microwave | 1~30dB | (n.a.) | (n.a.) | (n.a.) |
| Attenuator 1 | Resnet | 10dB | (n.a.) | (n.a.) | (n.a.) |
| Attenuator 2 | Agilent | 30dB | (n.a.) | (n.a.) | (n.a.) |
| Full-AnechoicChamber | Albatross | 9m*6m*6m | (n.a.) | 2014.9.14 | 2year |
| Trilogy Antenna | Schwarzbeck | VULB 9613 | 9613-274 | 2014.9.25 | 1year |
| Horn Antenna | Schwarzbeck | BBHA 9120C | 9120C-384 | 2014.9.22 | 1year |
| Singal Generator | Agilent | E4433B | MY43350266 | 2015.2.25 | 1year |
| Signal Generator | Agilent | E4433B | MY43360267 | 2015.2.24 | 1year |
| Signal Generator | Agilent | E8247C | US43320423 | 2015.2.25 | 1year |
| 3dB NF | / | LHHT-0016C-1 | LN09070001 | (n.a.) | (n.a.) |
| Band Pass Filter | Wainwright | WDCGV10+10-1850-1910/ 1930-1990-75 | (n.a.) | (n.a.) | (n.a.) |
| Band Pass Filter | Wainwright | WDCGV10+10-824-849/ 869-894-75 | (n.a.) | (n.a.) | (n.a.) |

*NOTE:Equipments listed above have been calibrated and are in the period of validation.*

# 3. Test Standards and Results

The objective of the report is to perform testing according to 47 CFR Part 20.21, Part 22 for the EUT FCC ID Certification, following FCC 935210 D03 signal booster measurements v03:

| No. | Identity | Document Title |
|---|---|---|
| 1 | 47 CFR Part 20.21 | Wideband Consumer Signal Boosters. |
| 2 | 47 CFR Part 22 | Public Mobile Services |
| 3 | 47 CFR Part 2 | |

Test detailed items/section required by FCC rules& IC rules and results are as below:

| No. | FCC rules & Description | Measurements | Result |
|---|---|---|---|
| 1 | § 20.21(e)(3) Frequency Bands<br>§ 20.21(a)(4) Self-monitoring | 7.1 Authorized frequency band verification test | PASS |
| 2 | § 20.21(e)(8)(i)(A)(2)(i) Noise Limits<br>§ 20.21(e)(8)(i)(H) Transmit Power Off Mode | 7.7 Noise limits test procedure | PASS |
| 3 | § 20.21(e)(8)(i)(B) Bidirectional Capability<br>§ 20.21(e)(3) Frequency Bands | 7.13 Spectrum block filtering test procedure | N/A |
| 4 | § 20.21(e)(8)(i)(C)(1) Booster Gain Limits<br>§ 20.21(e)(8)(i)(H) Transmit Power Off Mode | 7.9 Variable booster gain test procedure | PASS |
| 5 | § 20.21(e)(8)(i)(C)(2)(i) Booster Gain Limits<br>§ 20.21(e)(8)(i)(B) Bidirectional Capability | 7.3 Maximum booster gain computation | PASS |
| 6 | § 20.21(e)(8)(i)(D) Power Limits<br>§ 20.21(e)(8)(i)(B) Bidirectional Capability | 7.2 Maximum power measurement test procedure | PASS |
| 7 | § 20.21(e)(8)(i)(E) Out of Band Emission Limits | 7.5 Out-of-band emissions test procedure | PASS |
| 8 | § 20.21(e)(8)(i)(F) Intermodulation Limits | 7.4 Intermodulation product test procedure | PASS |
| 9 | § 20.21(e)(8)(i)(G) Booster Antenna Kitting | Note 1 | PASS |
| 10 | § 20.21(e)(8)(i)(H) Transmit Power Off Mode | Note 2 | PASS |
| 11 | § 20.21(e)(8)(i)(I) Uplink Inactivity | 7.8 Uplink inactivity test procedure | PASS |
| 12 | § 20.21(e)(8)(ii)(A) Anti-Oscillation | 7.11.2 Oscillation restart tests<br>7.11.3 Test procedure for measuring oscillation mitigation or shutdown | PASS |
| 13 | § 20.21(e)(8)(ii)(B) Gain Control | Note 3 | PASS |
| 14 | § 2.1049 Measurements required: Occupied bandwidth | 7.10 Occupied bandwidth test procedure | PASS |
| 15 | § 2.1051 Measurements required: Spurious emissions at antenna terminals | 7.6 Conducted spurious emissions test procedure | PASS |
| 16 | § 2.1053 Measurements required: Field strength of spurious radiation | 7.12 Radiated spurious emissions test procedure | PASS |

*Note:*

*1) Generic testing requirements are not established; rather technical documentation is used describing all antennas, cables, and/or coupling devices that may be used with a consumer booster and how those meet the requirements.*

*2) There is no specific test for this functionality but it is instead addressed through a combination of the variable noise, variable gain, and oscillation detection tests.*

*3) Conformance to the requirement to include AGC circuitry is verified in 7.1 and 7.2*

# 4. Antenna

Customer declare that Donor (Outdoor) antenna Gain=10dB, service (Indoor) antenna Gain=5dB,

## Outdoor Antenna

| | |
|---|---|
| Frequency Range | 824-2500Mhz |
| Gain | 10dBi |
| Beamwidth | H：90/60° E：70/55° |
| VSWR | ≤1.5 |
| Polarization | Vertical or horizon |
| Max power | 100W |
| Nominal Impedance | 50Ω |
| Connector | SMA |
| Measurement | 295x215x65 mm |
| Weight | 1 KG |
| Rated Wind Velocity | 60m/s |
| Mounting Mast Diameter | Φ40-Φ50mm |

## Indoor Antenna

| | |
|---|---|
| Frequency Range | 824-894MHz |
| Gain | 5.0dbi |
| VSWR | <1.5 |
| Polarization | horizon |
| Nominal Impedance | 50Ω |
| Max power | 50W |
| Connector | SMA |
| Measurement | Ø14X210mm |
| Weight | 19g |
| operating temperature | -30°C~+60°C |

MSCL calculation:

LP = 20logf + 20logd – 27.5

where:

LP = basic free space path loss,

f = frequency in MHz,

d = separation distance in meters.

The customer booster service was fixed in the wall, in this case, f=836MHz, d=1m,

Coupling Loss= service antenna gain-LP=-25.94,

MSCL=25.94

# 5. Test Result

## 5.1 Authorized frequency band verification

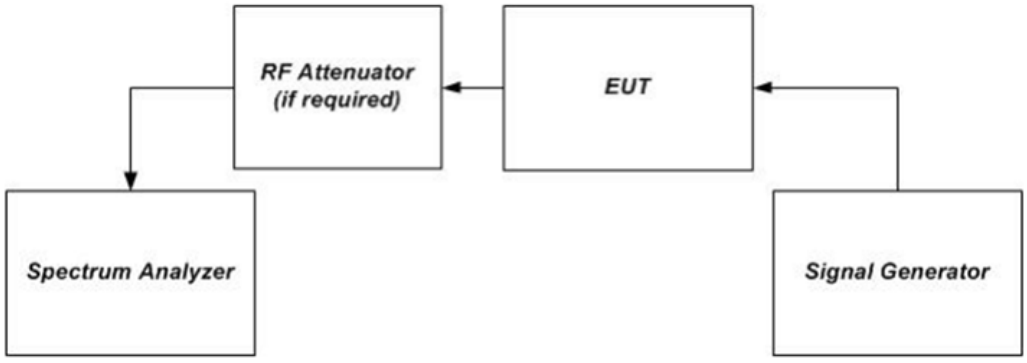
### 5.1.1 Requirement

According to FCC § 20.21(e)(3) Frequency Bands § 20.21(a)(4) Self-monitoring, The subscriber operates the Consumer Signal Booster on frequencies used for the provision of subscriber-based services under parts 22 (Cellular), Consumer Signal Boosters must be designed and manufactured such that they only operate on the frequencies used for the provision of subscriber-based services under parts 22 (Cellular)

### 5.1.2 Test Procedures

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 ≥ 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.

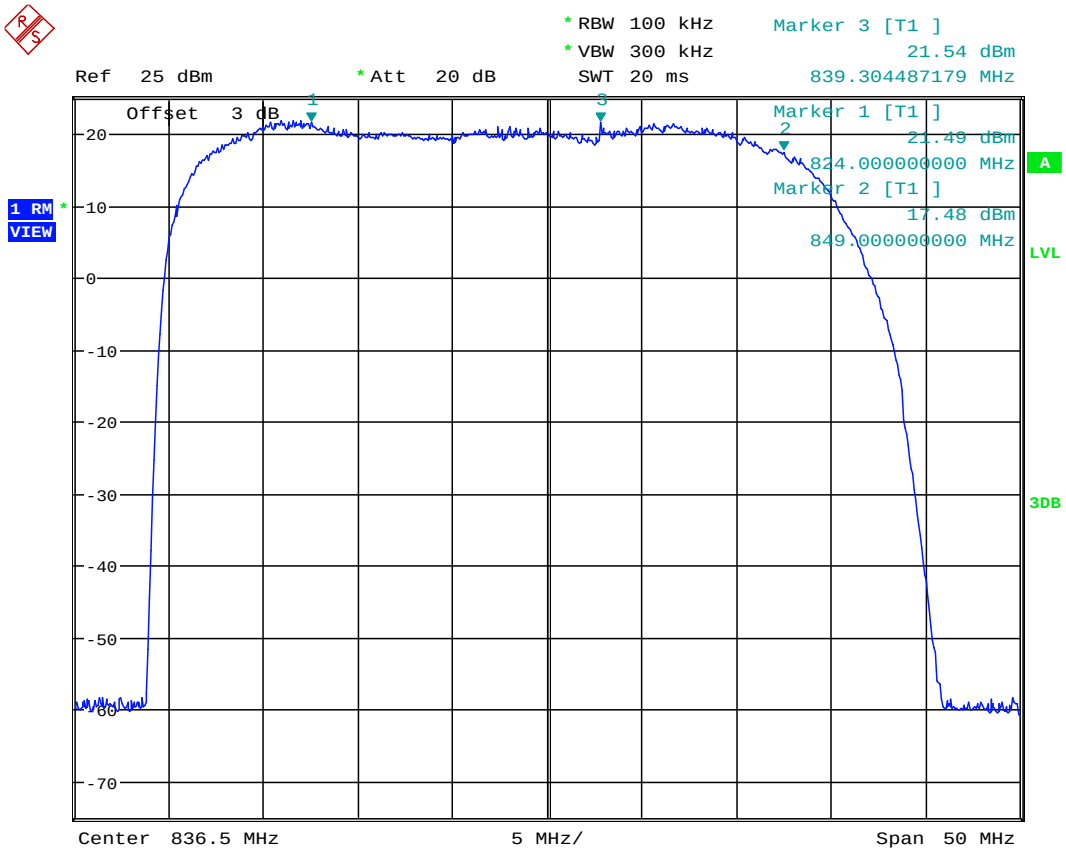
### 5.1.3 Setup



## 5.1.4 Test Result

| | Input Power (dBm) | Max Output Power in CMRS (dBm) | Min Output Power in CMRS (dBm) | Rippe (dB) |
|---|---|---|---|---|
| Uplink | -35 | 21.54 | 17.48 | 4.06 |
| Downlink | -48 | 9.95 | 8.04 | 1.91 |

## 5.1.5 Test Plot

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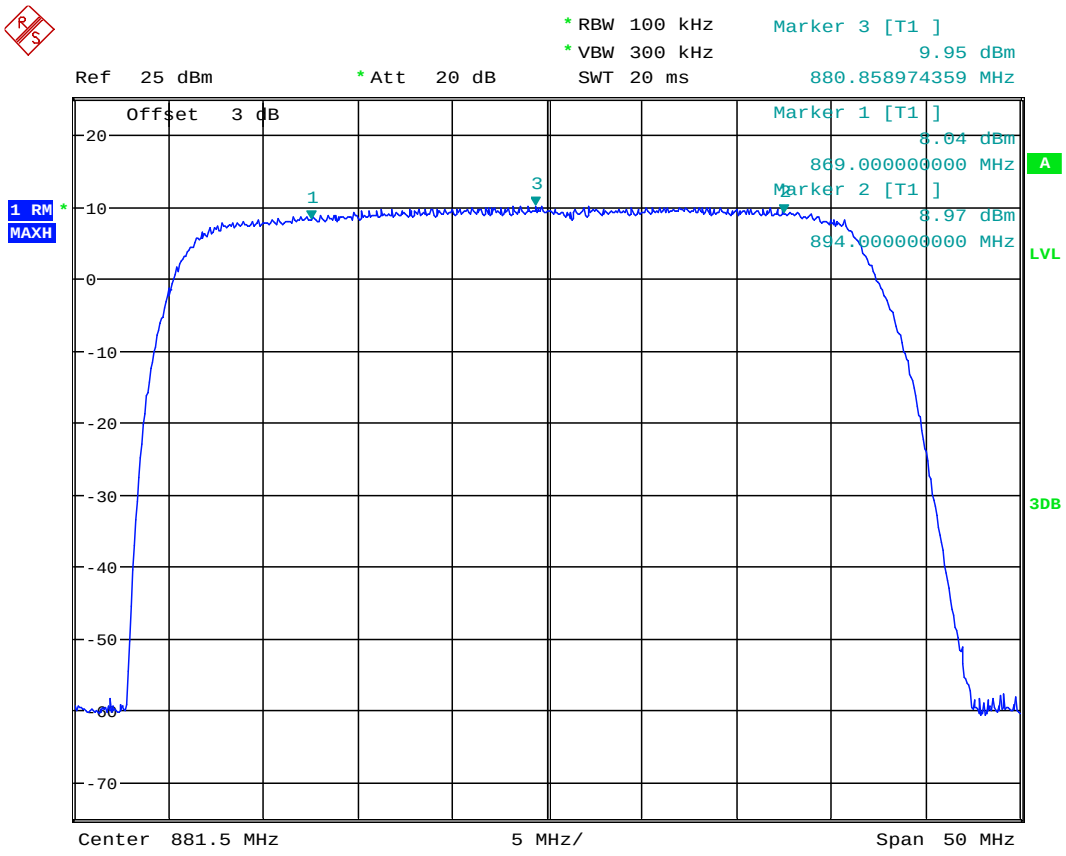
Uplink mode




Downlink mode

## Conclusion:Pass

## 5.2 Maximum power measurement

### 5.2.1 Definition

The procedure of this subclause shall be used to demonstrate compliance to the signal booster power limits and requirements as specified in FCC § 20.21(e)(8)(i)(D) and 20.21(e)(8)(i)(B) for wideband consumer signal boosters.

§ 20.21(e)(8)(i)(D) Power Limits. A booster's uplink power must not exceed 1 watt (30 dBm) composite conducted power and equivalent isotropic radiated power (EIRP) for each band of operation. Composite downlink power shall not exceed 0.05 watt (17 dBm) conducted and EIRP for each band of operation. Compliance with power limits will use instrumentation calibrated in terms of RMS equivalent voltage.

20.21(e)(8)(i)(B)Bidirectional Capability. Consumer Boosters must be able to provide equivalent uplink and downlink gain and conducted uplink power output that is at least 0.05 watts (17 dBm).

### 5.2.2 Test Procedures

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 (Pin).

g) Measure the output power (Pout) 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 ≥ 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 ≥ (2 x span)/RBW (Note: This requirement does not apply for BURST power measurement mode).

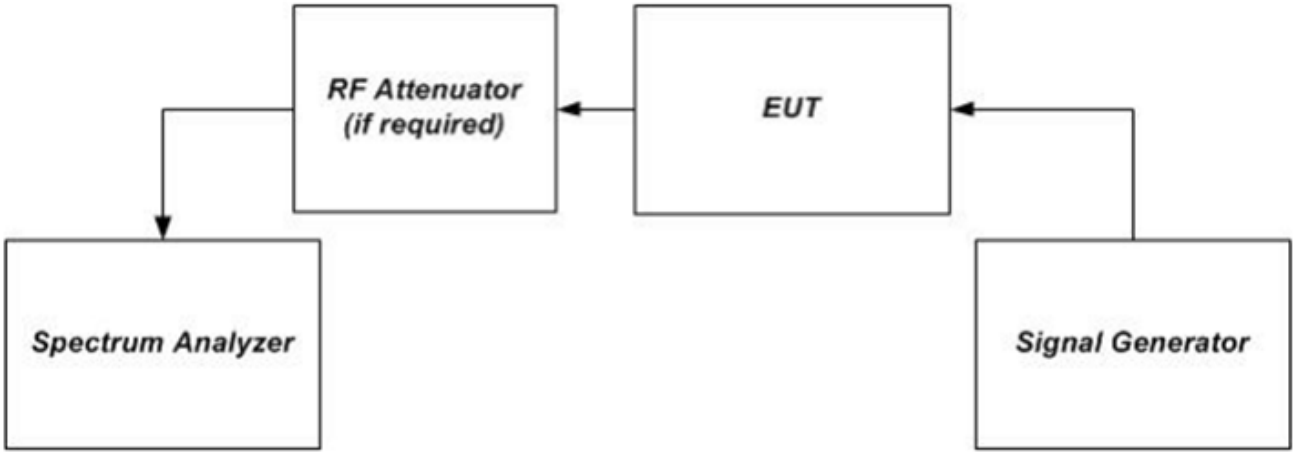
m) Set sweep time = auto couple, or as necessary (but no less than auto couple value).

n) Trace average at least 100 traces in power averaging (i.e., RMS) mode.

o) Record the measured power level as Pout 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.

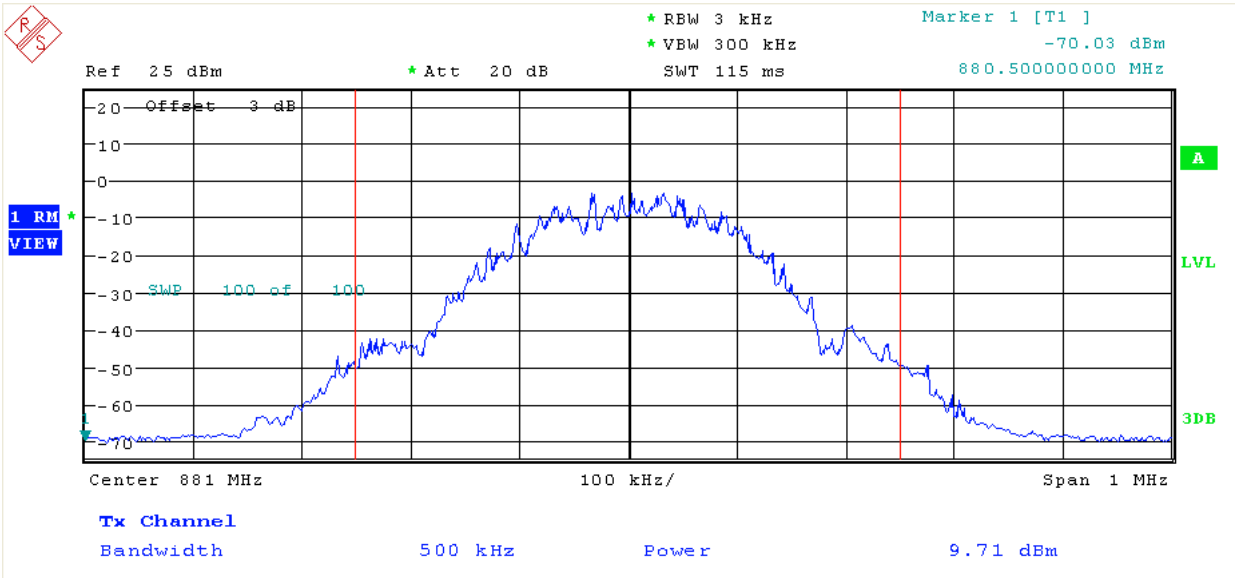
## 5.2.3 Setup



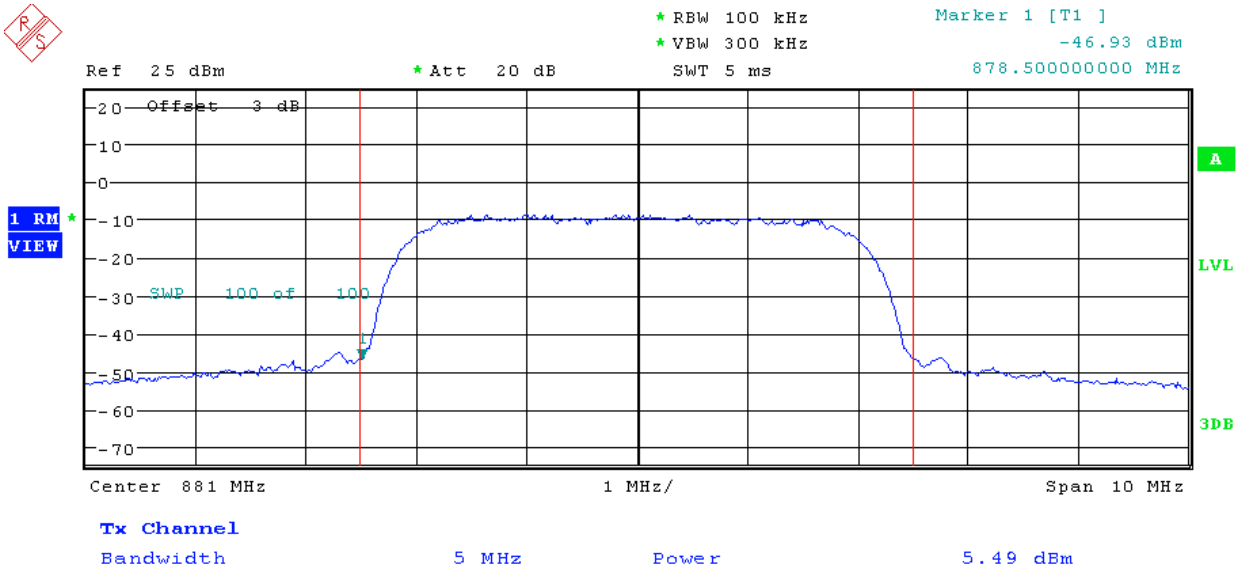

## 5.2.4 Test Results

| Band | Link | Frequency (MHz) | Signal Type | Input Level (dBm) | Output Level (dBm) | EIRP (dBm) | Limit (dBm) | Refer to Plot | Verdict |
|---|---|---|---|---|---|---|---|---|---|
| Cellular | Down Link | 881.00 | GSM | -49.00 | 9.71 | 14.71 | Less than +17.0 | Plot A | Pass |
| | | 881.00 | AWGN | -51.00 | 5.49 | 10.49 | | Plot B | Pass |
| | | 881.00 | CDMA | -53.00 | 6.04 | 11.04 | | Plot C | Pass |
| | Up Link | 839.00 | GSM | -35.00 | 19.13 | 29.13 | Between +17.0 and +30.0 | Plot D | Pass |
| | | 839.00 | AWGN | -38.00 | 19.92 | 29.92 | | Plot E | Pass |
| | | 839.00 | CDMA | -36.00 | 19.64 | 29.64 | | Plot F | Pass |

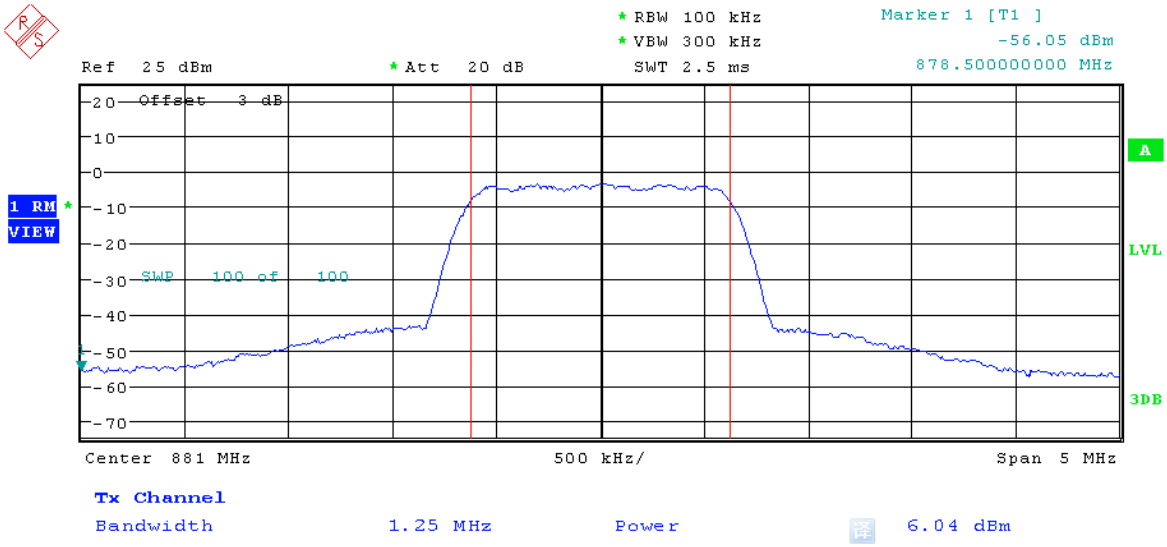
## 5.2.5 Test Plot



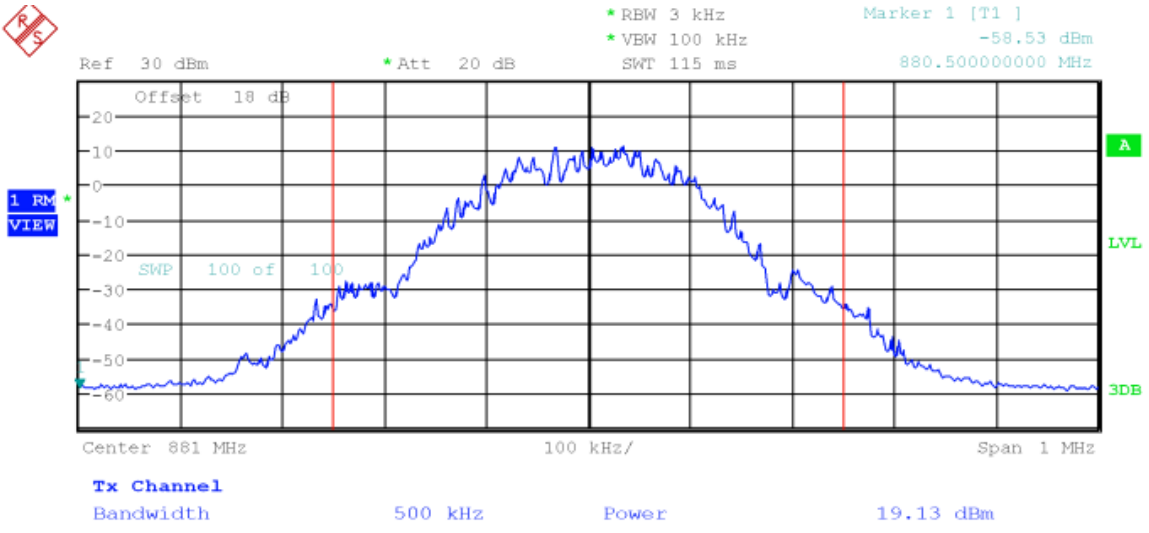

Plot A Downlink / 881.00MHz / GSM



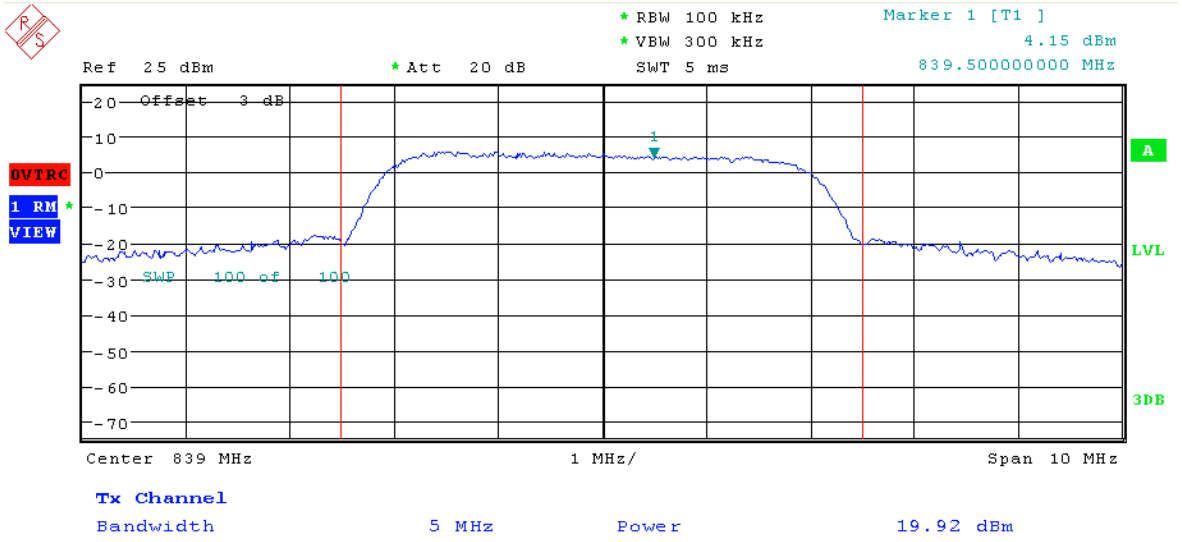

Plot B Downlink / 881.00MHz / AWGN



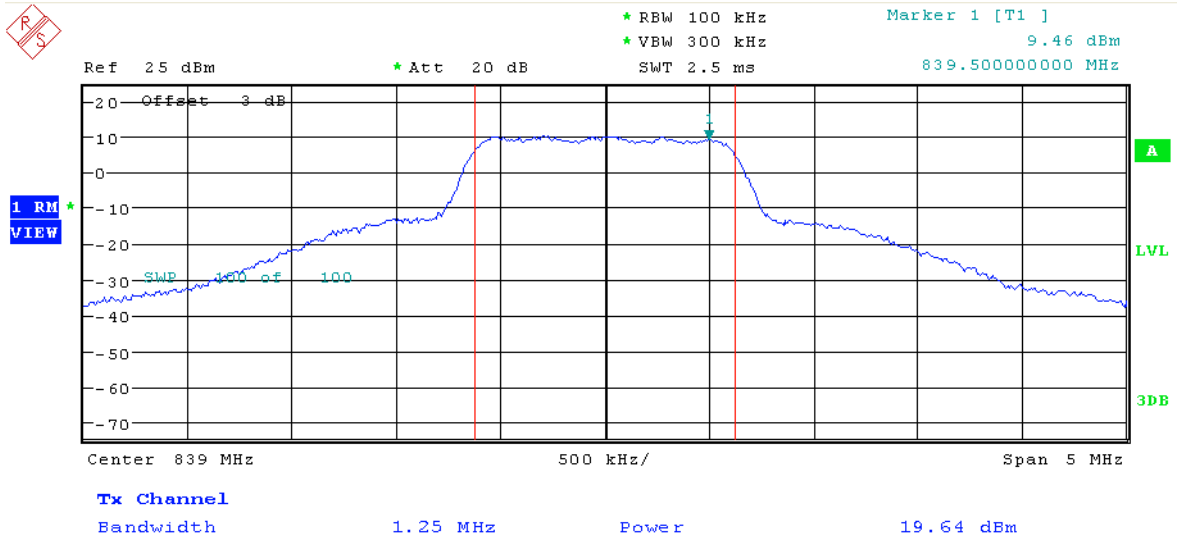

Plot C Downlink / 881.00MHz / CDMA




Plot D Uplink / 839.00MHz / GSM




Plot E Uplink / 839.00MHz / AWGN




Plot F Uplink / 839.00MHz / CDMA

## Conclusion:Pass

## 5.3 Maximum booster gain

### 5.3.1 Requirement

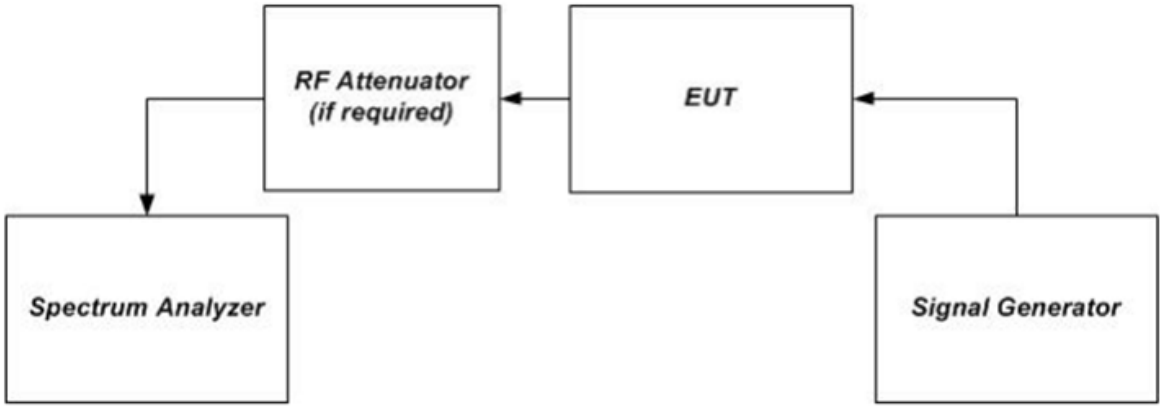
According Rule paragraph(s): § 20.21(e)(8)(i)(C)(2)(i) Booster Gain Limits (maximum gain); § 20.21(e)(8)(i)(B) Bidirectional Capability (equivalent uplink and downlink gain), requires that wideband consumer signal boosters be able to provide equivalent uplink and downlink gain (within 9 dB)

§ 20.21(e)(8)(i)(C)(2)(i)The uplink and downlink maximum gain of a Consumer Booster referenced to its input and output ports shall not exceed the following limits: Fixed Booster maximum gain shall not exceed 6.5 dB + 20 Log10 (Frequency), in this case Uplink F=824MHz, the limit is 64.82dB, Downlink F=869MHz, the limit is 65.28dB.

### 5.3.2 Test Description

This test based on the results obtained from5.2. G=Pout(dBm)-Pin(dBm)

### 5.3.3 Setup




### 5.3.4 Test Procedures

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 Pout and Pin 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) = Pout(dBm) − Pin(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.

### 5.3.5 Test Results

Please refer to the following plots.

| Band | Link | Frequency (MHz) | Signal Type | Input Level (dBm) | Output Level (dBm) | Gain (dB) | Gain Limit (dB) | Verdict |
|---|---|---|---|---|---|---|---|---|
| Cellular | Down Link | 881.00 | GSM | -49.00 | 9.71 | 58.71 | 64.82 | Pass |
| | | 881.00 | AWGN | -51.00 | 5.49 | 57.49 | | Pass |
| | | 881.00 | CDMA | -53.00 | 6.04 | 59.04 | | Pass |
| | Up Link | 839.00 | GSM | -35.00 | 19.13 | 54.13 | 65.28 | Pass |
| | | 839.00 | AWGN | -38.00 | 19.92 | 57.92 | | Pass |
| | | 839.00 | CDMA | -36.00 | 19.64 | 55.64 | | Pass |

**Conclusion: Pass**

## 5.4 Intermodulation product

### 5.4.1 Requirement

AccordingRule paragraph(s): § 20.21(e)(8)(i)(F) Intermodulation Limits.

The transmitted intermodulation products of a consumer booster at its uplink and downlink ports shall not exceed the power level of −19 dBm for the supported bands of operation. Compliance with intermodulation limits will use boosters operating at maximum gain and maximum rated output power, with two continuous wave (CW) input signals spaced 600 kHz apart and centered in the pass band of the booster, and with a 3kHz measurement bandwidth.

### 5.4.2 Test Procedures

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 ≥ 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.

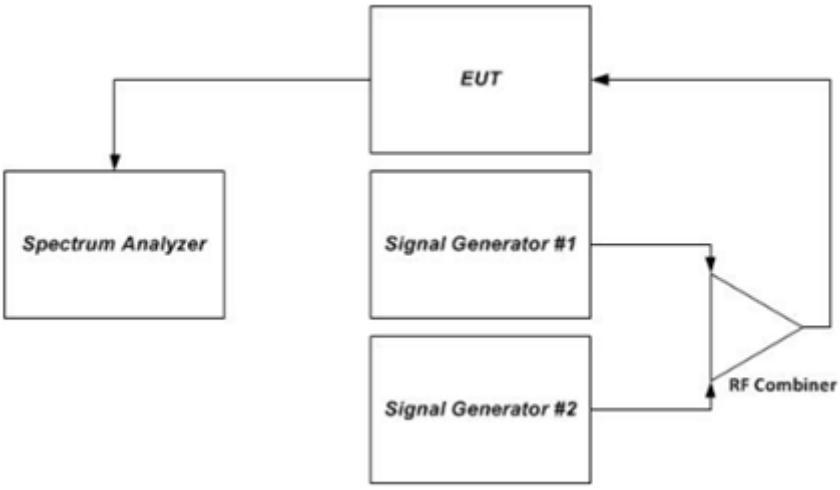
l) Capture the spectrum analyzer trace for inclusion in the test report.

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

### 5.4.3 Setup

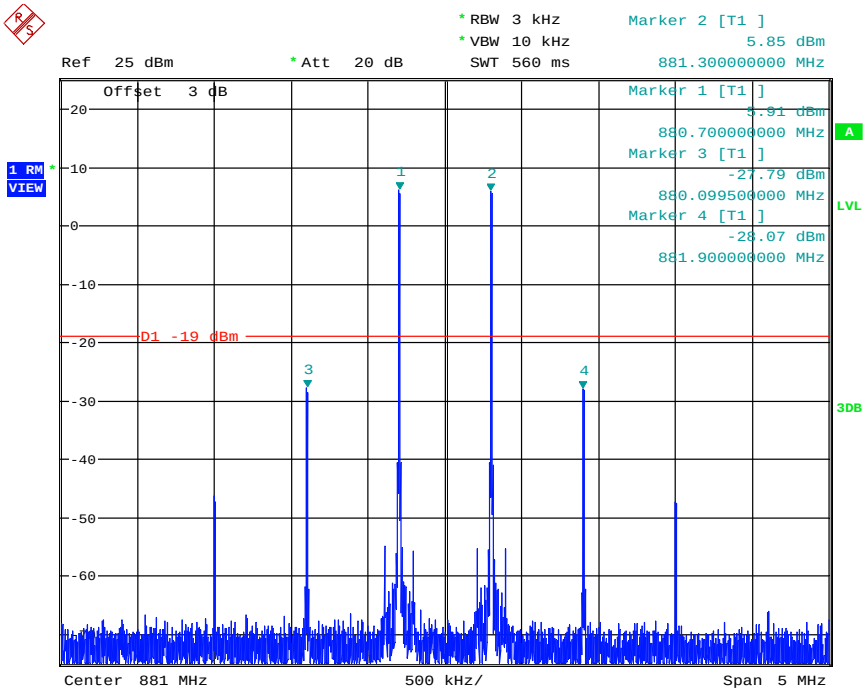



## 5.4.4 Test Results

Please refer to the following plots.

| Band | Link | Frequency 1 (MHz) | Frequency 2 (MHz) | IMD Level (dBm) | IMD Limit (dBm) | Verdict |
|---|---|---|---|---|---|---|
| Cellular | Down Link | 881.3 | 880.7 | -27.79 | -19.0 | Pass |
| | Up Link | 836.3 | 835.7 | -23.11 | | Pass |

## 5.4.5 Test Plot

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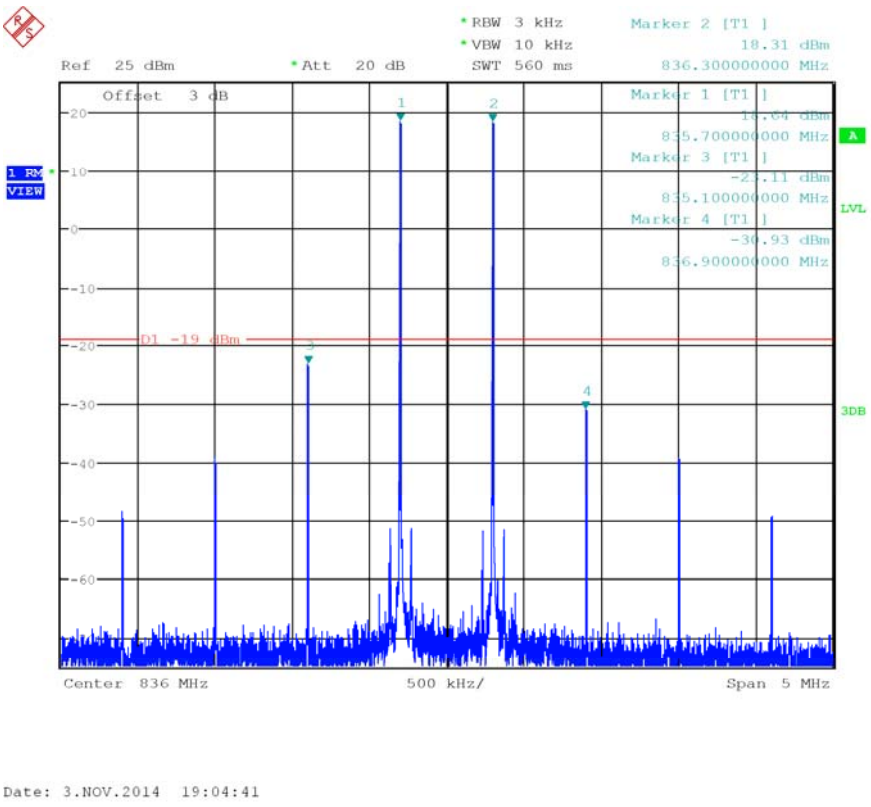
Down Link




Up Link

## Conclusion: Pass

## 5.5 Out-of-band emissions test

### 5.5.1 Requirement

According to Rule paragraph(s): § 20.21(e)(8)(i)(E) Out of Band Emission Limits.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.

### 5.5.2 Limit

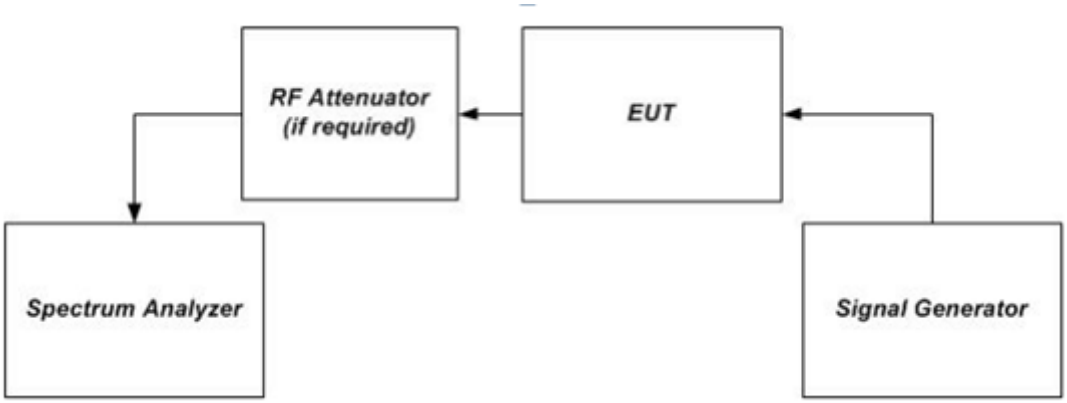
According toFCCsection22.917(a) and FCCsection24.238(a), the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43+10*log(P)dB. This calculated to be -13dBm.
So the limit is -13dBm-6dB=-19dBm

### 5.5.3 Test Procedures

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 OOBE 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.

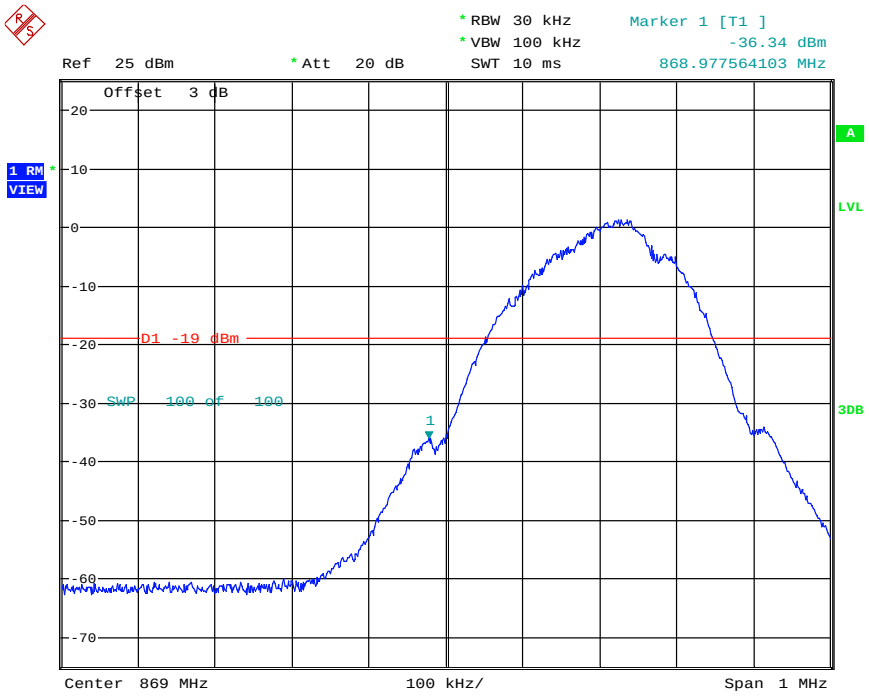
### 5.5.4 Setup



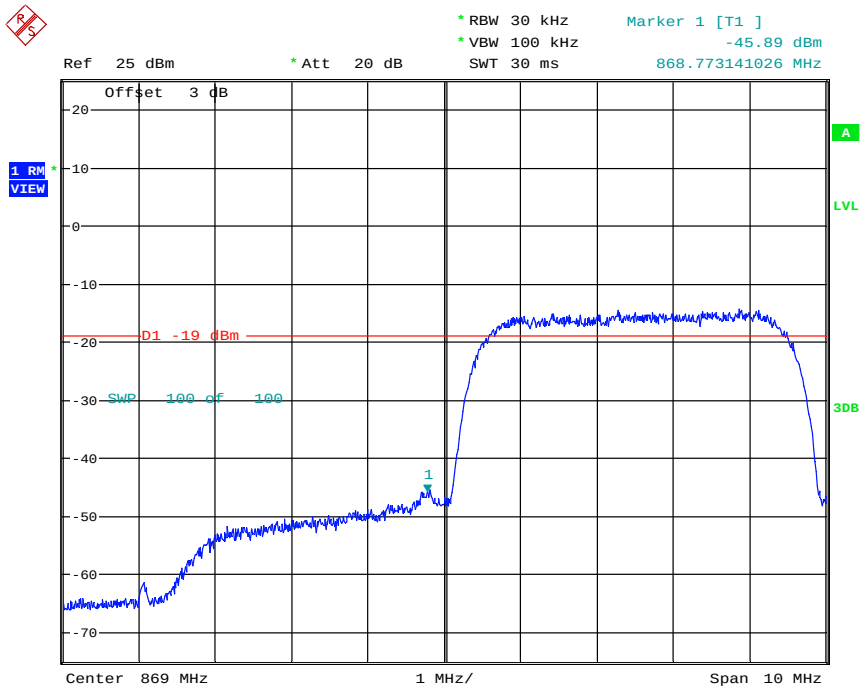

### 5.5.5 Test Results

| Band | Link | Signal Type | Operation Frequency (MHz) | Emission Frequency (MHz) | Emission Level (dBm) | Emission Limit (dB) | Refer to Plot | Verdict |
|---|---|---|---|---|---|---|---|---|
| Cellular | Down Link | GSM | 869.20 | 868.98 | -36.34 | -19.0 | Plot A1 | Pass |
| | | AWGN | 871.50 | 868.77 | -45.89 | | Plot A2 | Pass |
| | | CDMA | 869.88 | 868.97 | -51.79 | | Plot A3 | Pass |
| | | | 881.52 | 866.58 | -63.63 | | Plot A4 | Pass |
| | | GSM | 893.80 | 894.02 | -37.37 | | Plot A5 | Pass |
| | | AWGN | 891.50 | 894.24 | -54.33 | | Plot A6 | Pass |
| | | CDMA | 890.73 | 895.37 | -64.33 | | Plot A7 | Pass |
| | | | 893.10 | 894.10 | -43.47 | | Plot A8 | Pass |
| | Up Link | GSM | 824.20 | 823.98 | -22.82 | | Plot B1 | Pass |
| | | AWGN | 826.50 | 823.79 | -31.85 | | Plot B2 | Pass |
| | | CDMA | 824.88 | 824.00 | -31.53 | | Plot B3 | Pass |
| | | | 836.52 | 824.00 | -69.10 | | Plot B4 | Pass |
| | | GSM | 848.80 | 849.02 | -22.45 | | Plot B5 | Pass |
| | | AWGN | 846.50 | 849.24 | -35.15 | | Plot B6 | Pass |
| | | CDMA | 845.73 | 850.38 | -60.13 | | Plot B7 | Pass |
| | | | 848.10 | 849.19 | -47.71 | | Plot B8 | Pass |

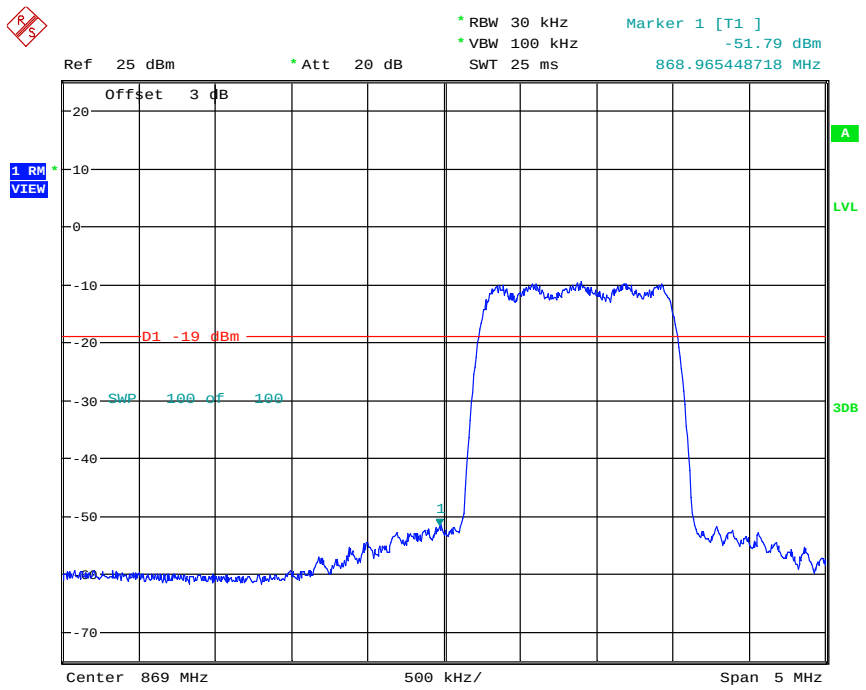
## 5.5.6 Test Plot




Plot A1 Downlink / GSM / 869.2MHz




Plot A2 Downlink / AWGN / 871.5MHz

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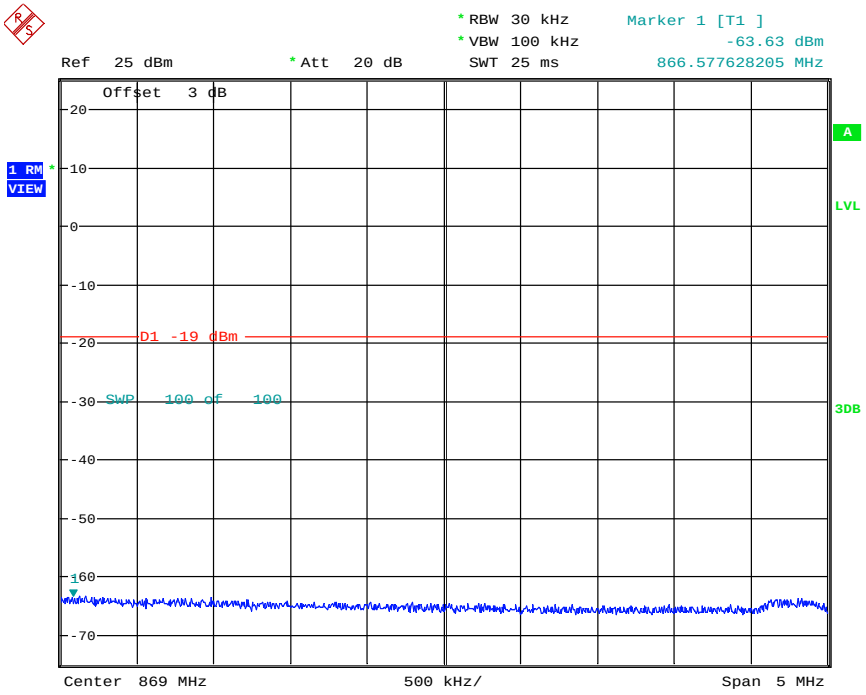
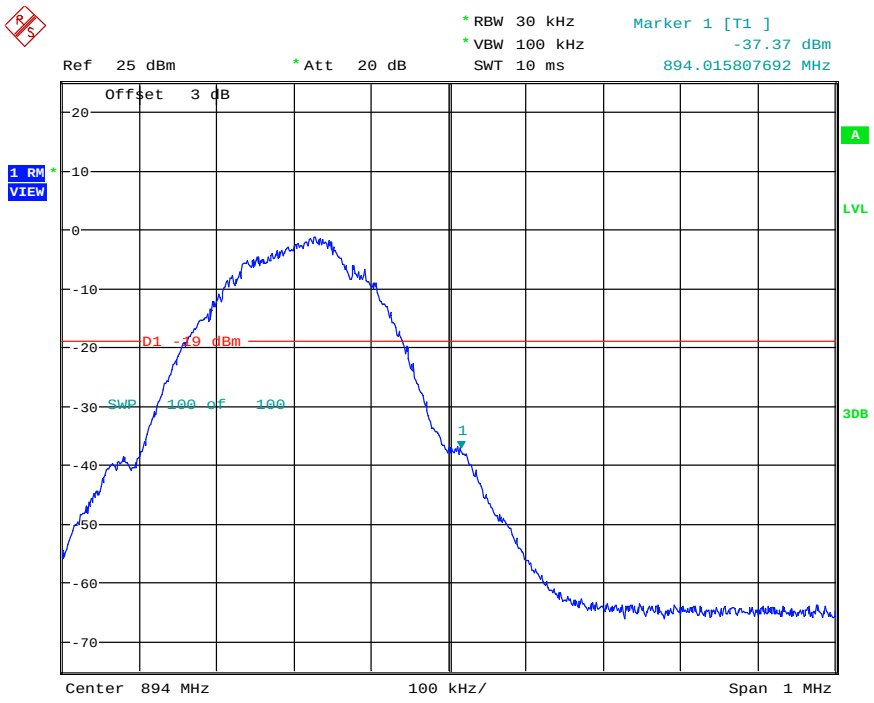
Plot A3 Downlink / CDMA / 869.88MHz

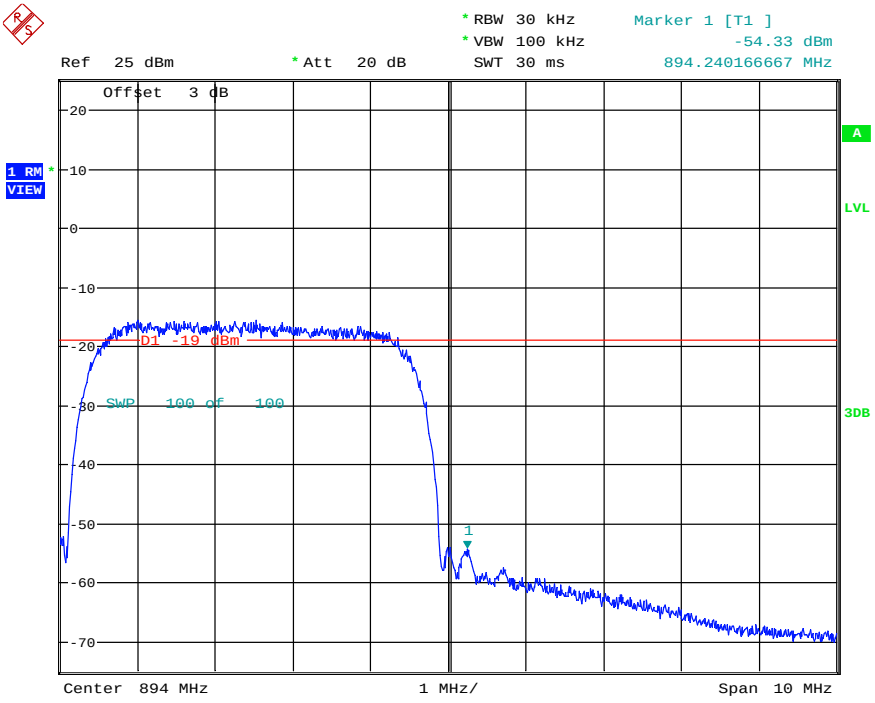



Date: 4.NOV.2014 12:13:51

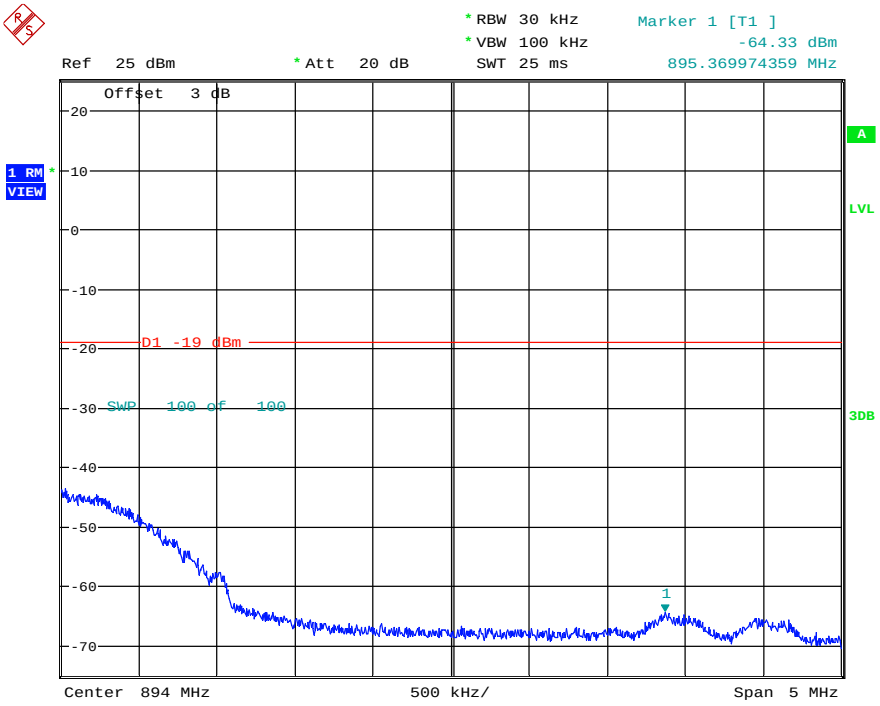
Plot A4 Downlink / CDMA / 881.52MHz



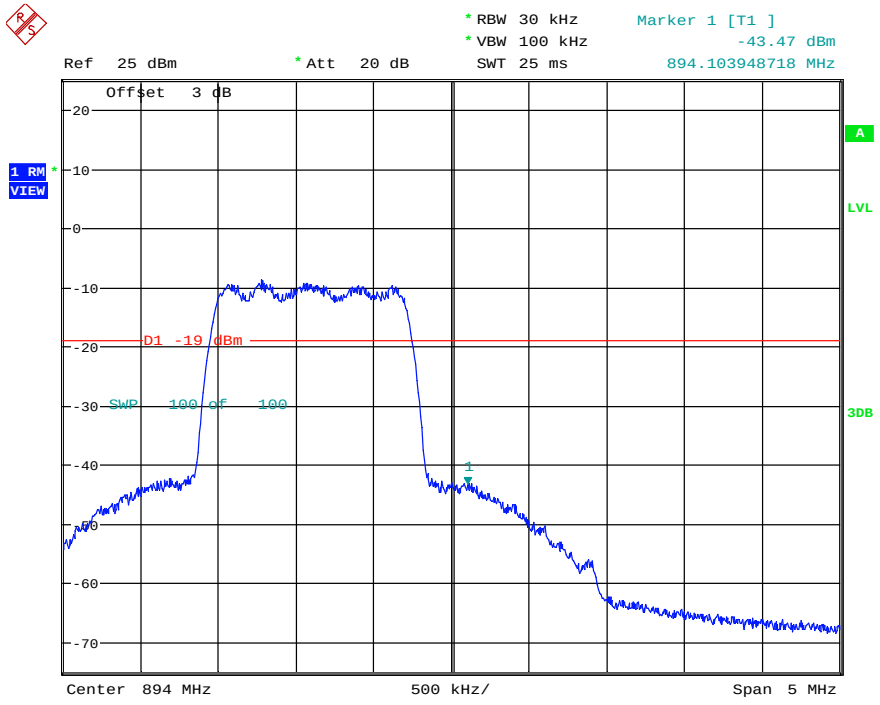

Plot A5 Downlink / GSM / 893.8MHz



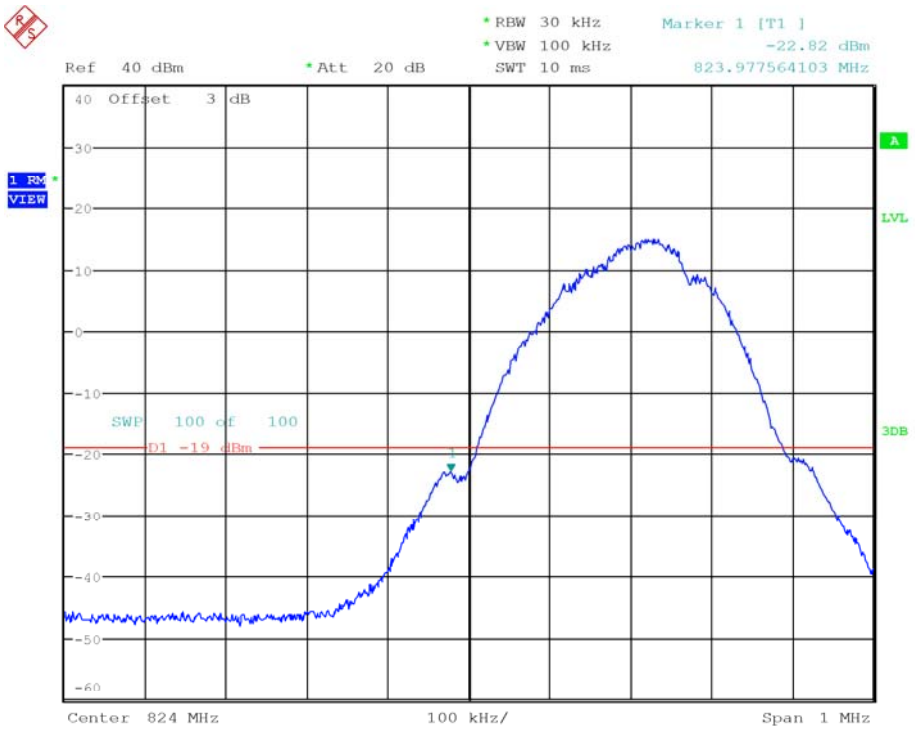

Plot A6 Downlink / AWGN / 891.5MHz



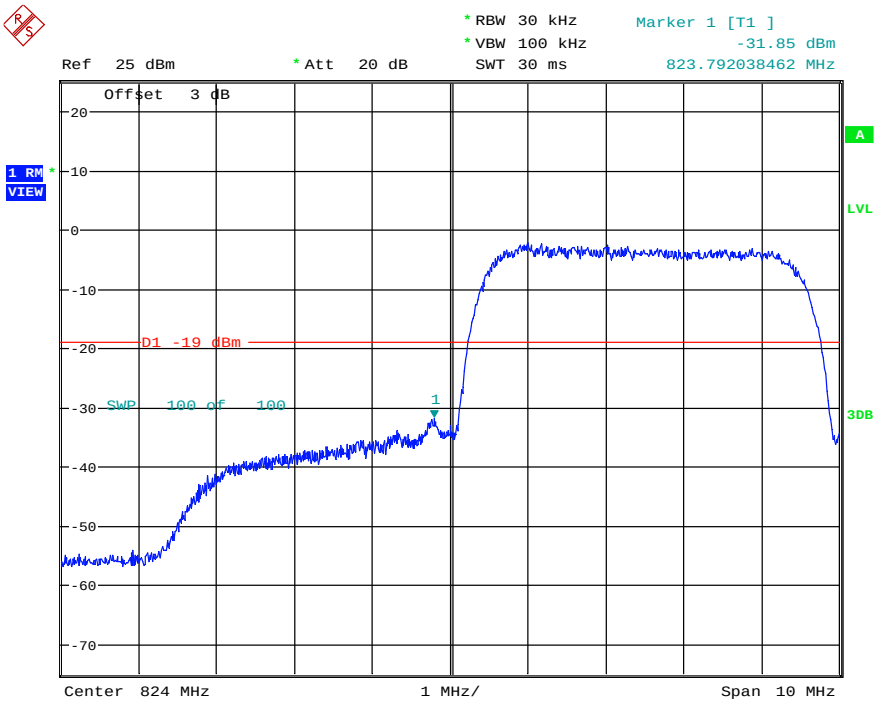

Plot A7 Downlink / CDMA / 890.73MHz



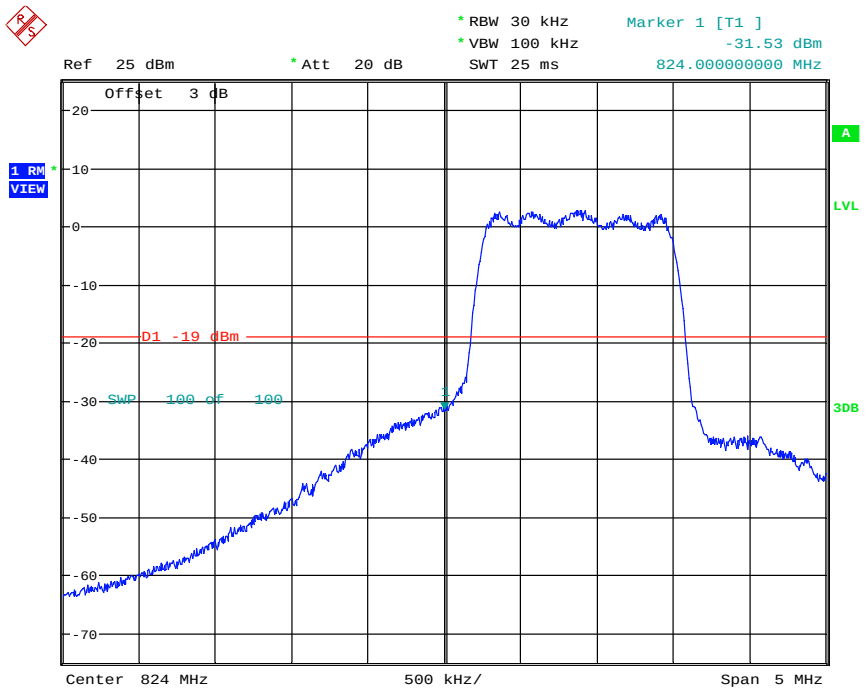

Plot A8 Downlink / CDMA / 893.1MHz



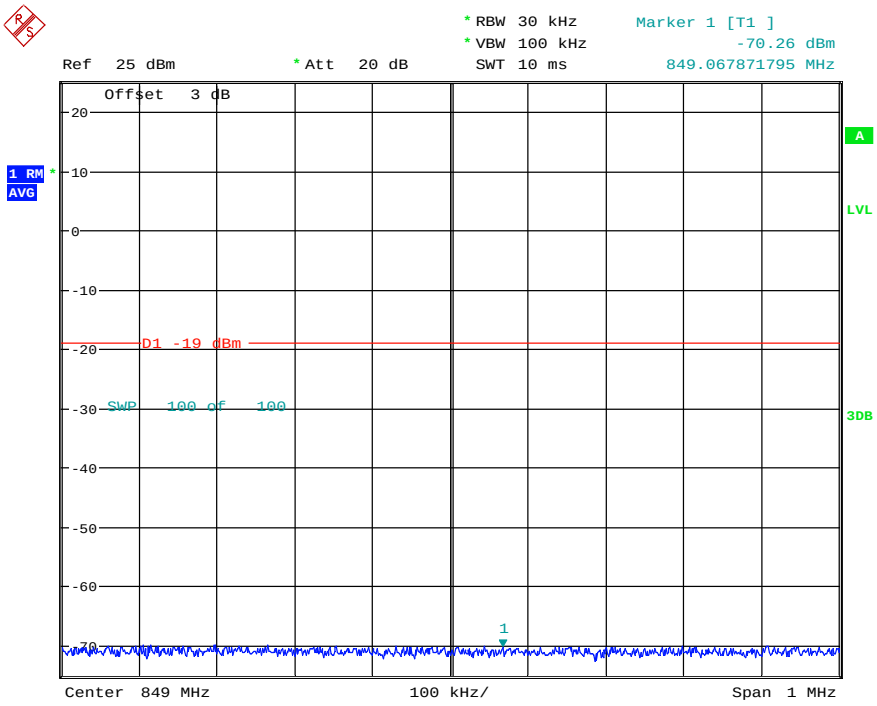

Plot B1 Uplink / GSM / 824.2MHz



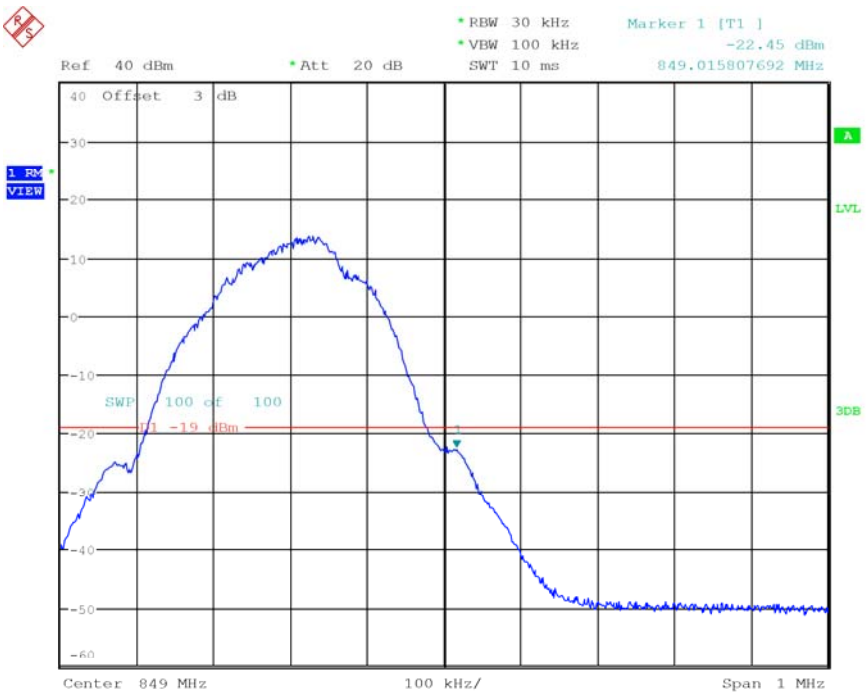

Plot B2 Uplink / AWGN / 826.5MHz




Plot B3 Uplink / CDMA / 824.88MHz

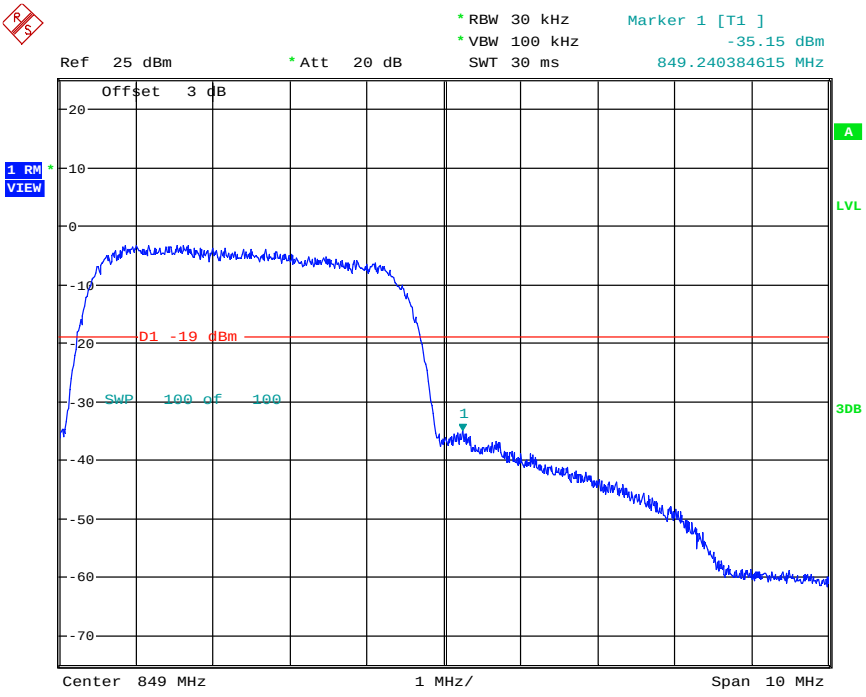



Plot B4 Uplink / CDMA / 836.52MHz



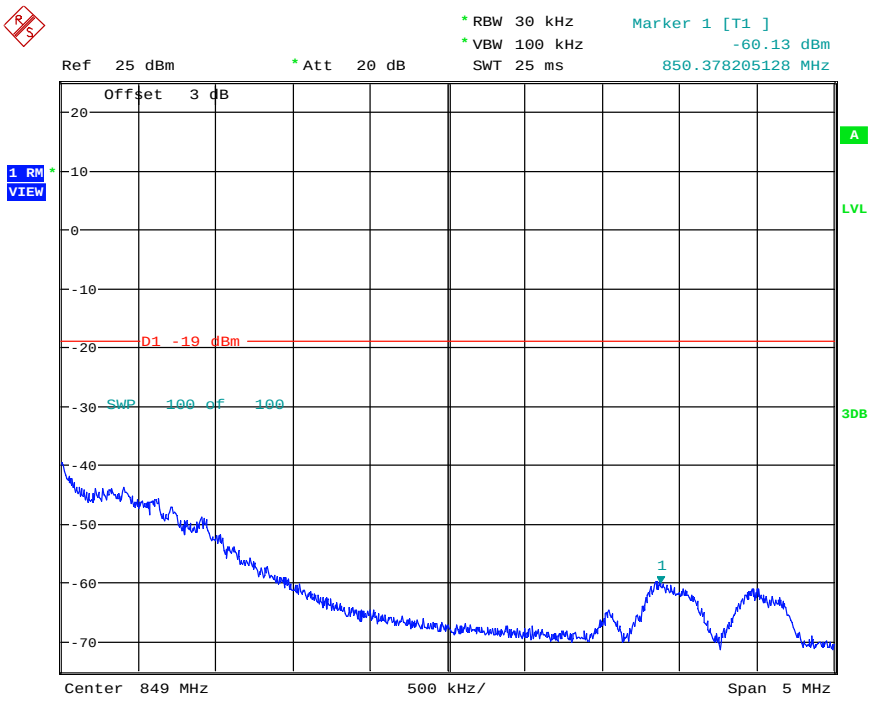

Date: 4.NOV.2014 12:27:53

Plot B5 Uplink / GSM / 848.8MHz

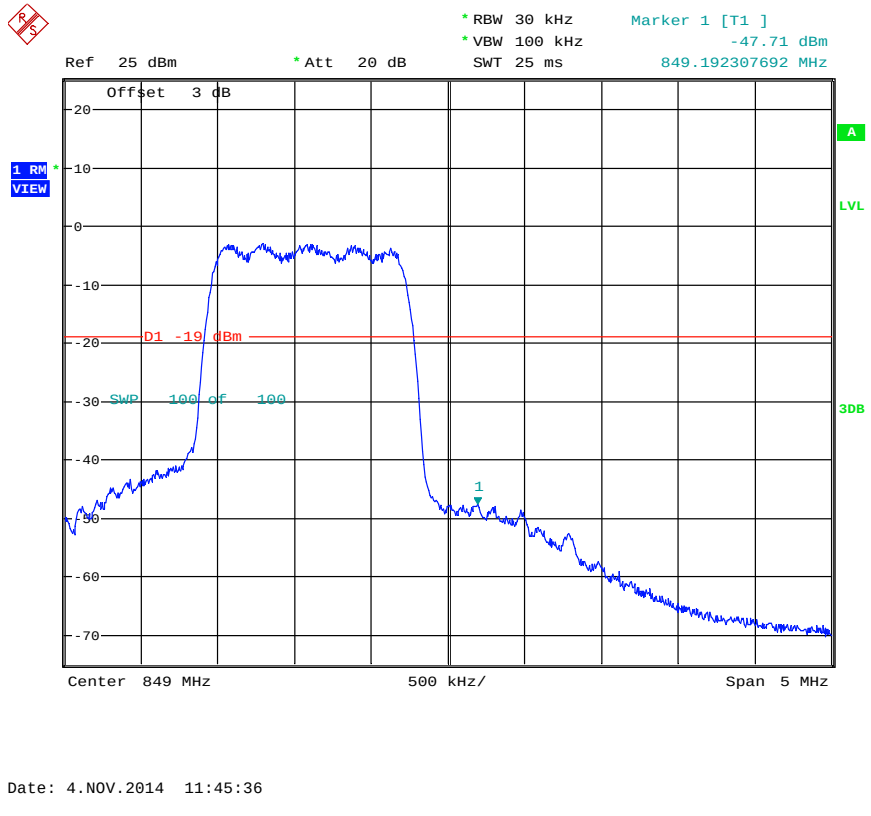



Date: 4.NOV.2014 11:41:46

Plot B6 Uplink / AWGN / 846.5MHz




Plot B7 Uplink / CDMA / 845.73MHz




Plot B8 Uplink / CDMA / 848.7MHz

## Conclusion: Pass

## 5.6 Conduct spurious emissions

### 5.6.1 Requirement

According to Rule paragraph(s): Rule paragraph(s): § 2.1051 Measurements required: Spurious emissions at antenna terminals.

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 dBm
  P1 = Power in dBm
  P2 = 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

### 5.6.2 Test Procedures

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 ≥ 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 ≥ (2 X span/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.

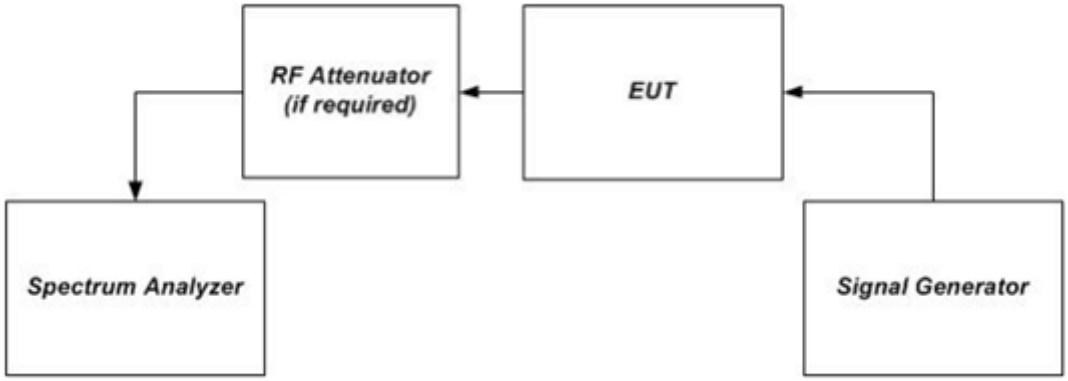
k) Reset the analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the analyzer stop frequency to 10 times the highest frequency of the fundamental emission. Note that the number of measurement points in each sweep

must be ≥ (2 X span/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.

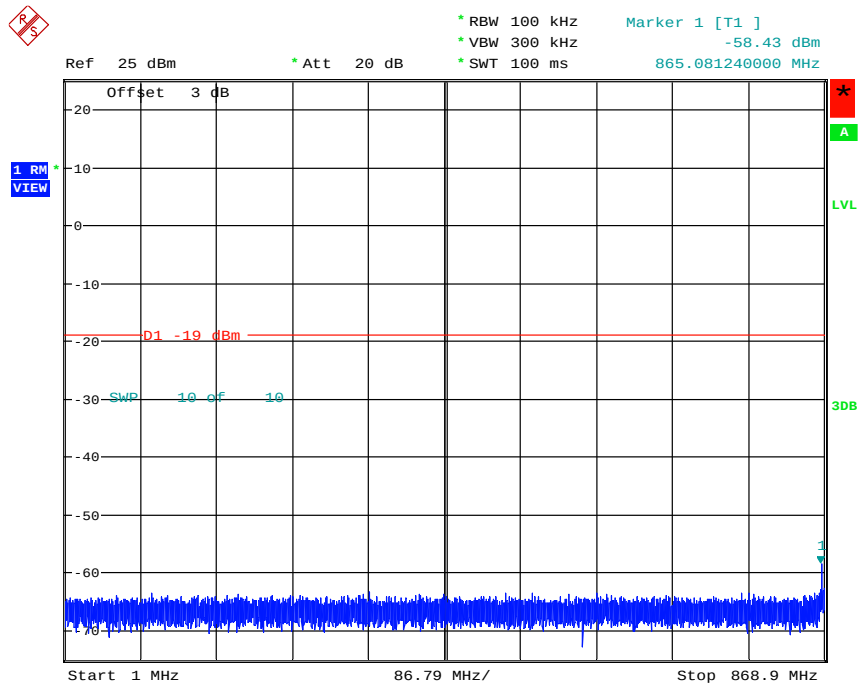
## 5.6.3 Setup




## 5.6.4 Test Results

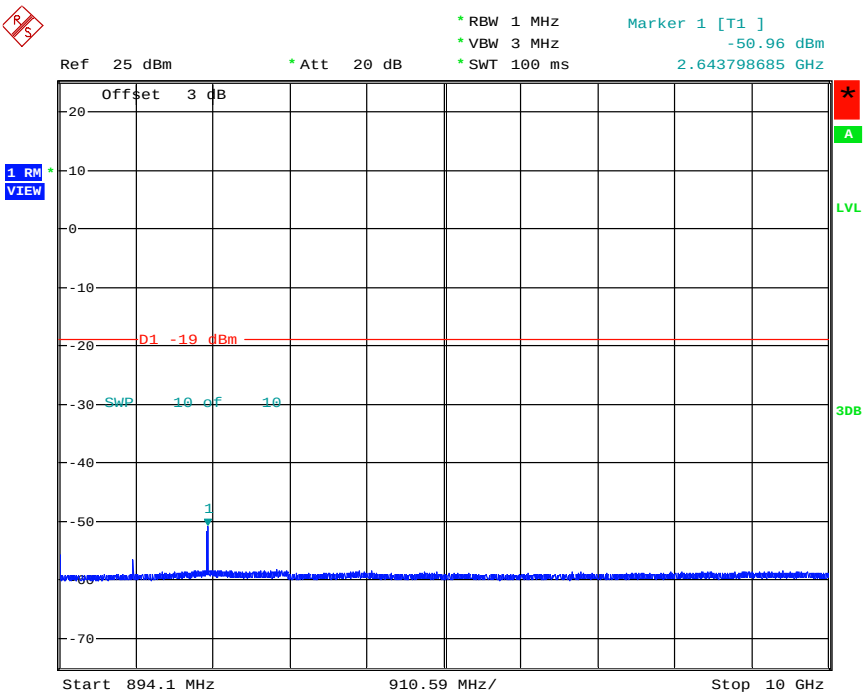
| Band | Link | Frequency (MHz) | Level of spurious emission (dBm) | Limit (dBm) | Plot | Verdict |
|---|---|---|---|---|---|---|
| Cellular | Down Link | 1~868.9 | -58.43 | -19.0 | Plot A | Pass |
| | | 894.1~10000 | -50.96 | | Plot B | Pass |
| | Up Link | 1~823.9 | -63.39 | | Plot C | Pass |
| | | 849.1~10000 | -56.75 | | Plot D | Pass |

## 5.6.5 Test Plot



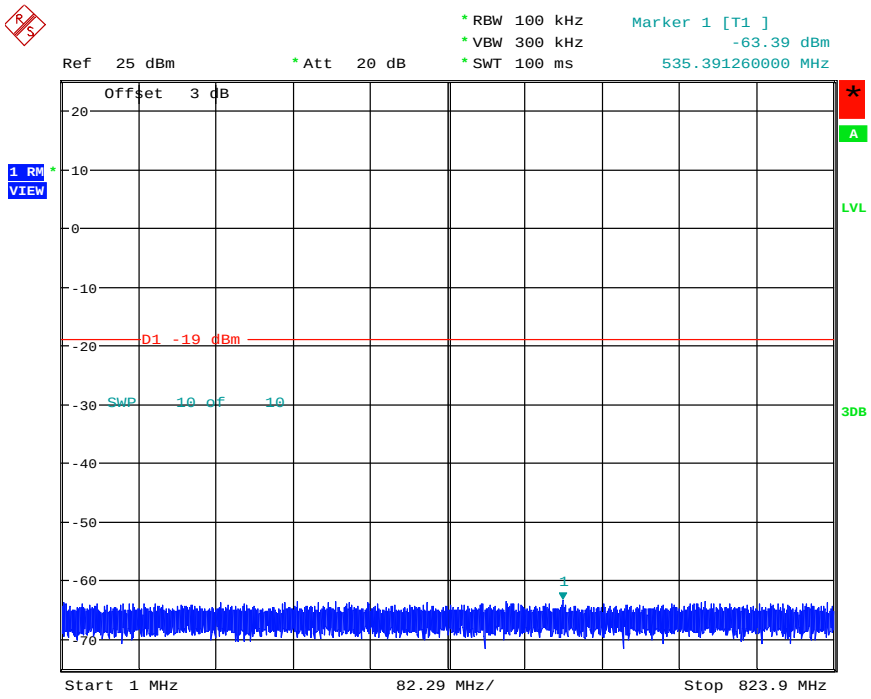

Date: 4.NOV.2014 12:54:20

Plot A Downlink / 1~868.9MHz

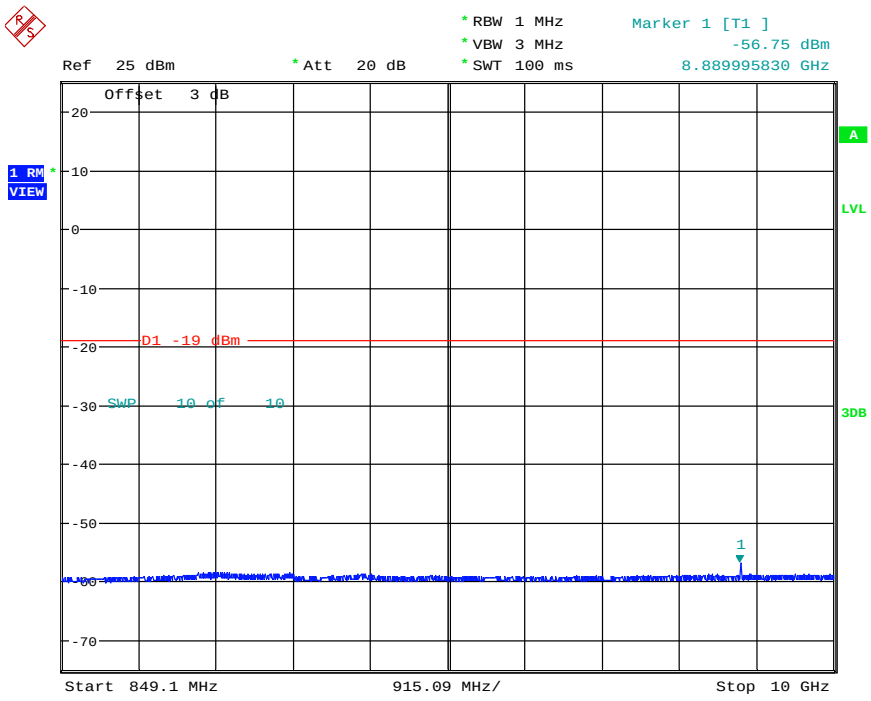



Date: 4.NOV.2014 12:55:48

Plot B Downlink / 894.1~10000MHz




Plot C Uplink / 1~823.9MHz




Plot D Uplink / 849.1~10000MHz

**Conclusion: Pass**

## 5.7 Noise limits

### 5.7.1 Requirement

According to Rule paragraph(s): § 20.21(e)(8)(i)(A)(2)(i) Noise Limits; § 20.21(e)(8)(i)(H) Transmit Power Off Mode (uplink and downlink noise power).

§ 20.21(e)(8)(i)(A)(2)(i) Noise Limits :Fixed booster maximum noise power shall not exceed −102.5 dBm/MHz + 20 Log10(Frequency), where Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz. In this case, limit was -44.18dBm/MHz for uplink and -43.72dBm/MHz for downlink.

§ 20.21(e)(8)(i)(H) Transmit Power Off Mode, When the consumer booster cannot otherwise meet the noise and gain limits defined herein it must operate in “Transmit Power OFF Mode.” In this mode of operation, the uplink and downlink noise power shall not exceed −70 dBm/MHz and uplink gain shall not exceed the lesser of 23 dB or MSCL

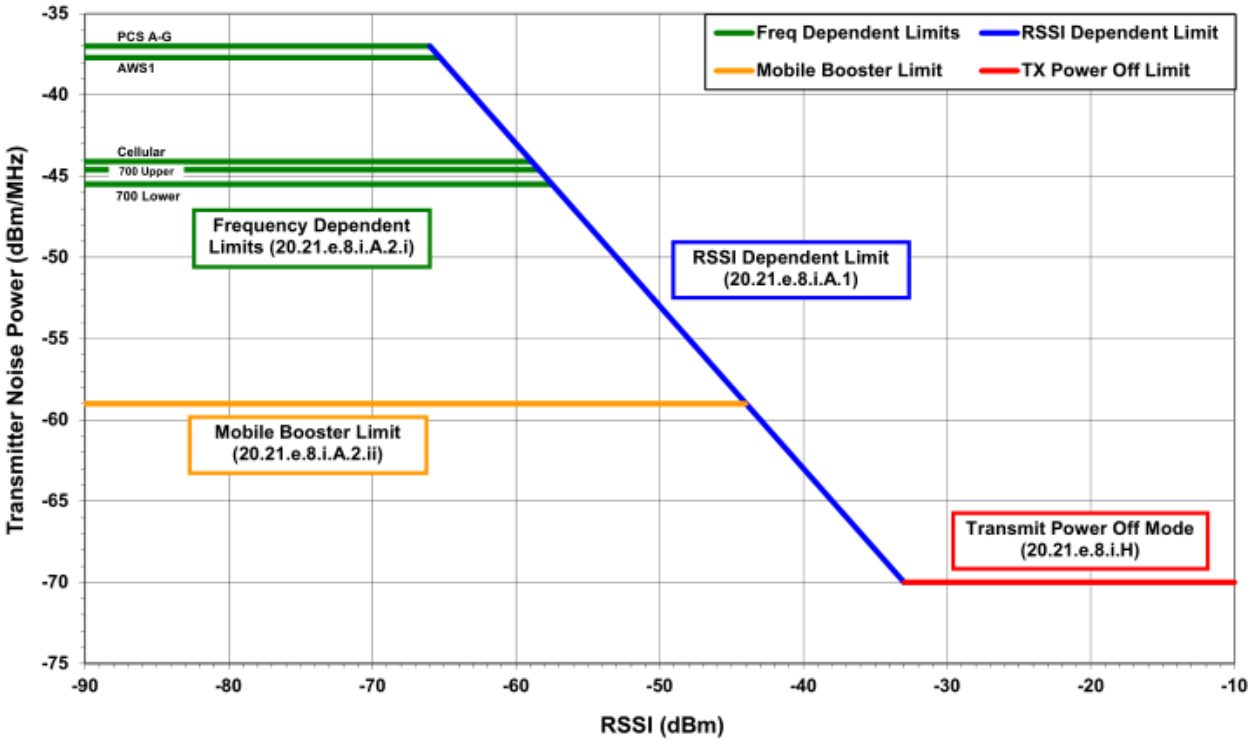



**Figure D1.** Wideband consumer signal booster variable noise limits.

### 5.7.2 Test Procedures

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 ≥ 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 ≥ 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 ≥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 ≥ 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

### 5.7.3 Setup

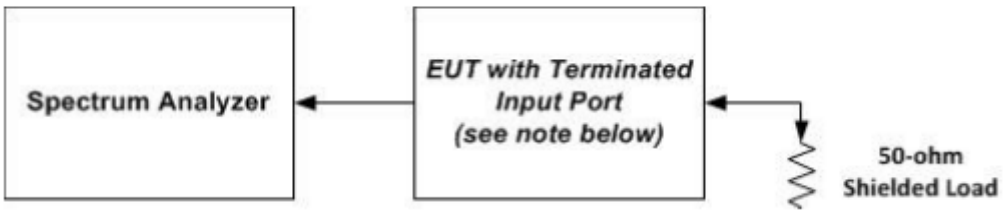



**Figure 3 – Noise limit instrumentation test setup**

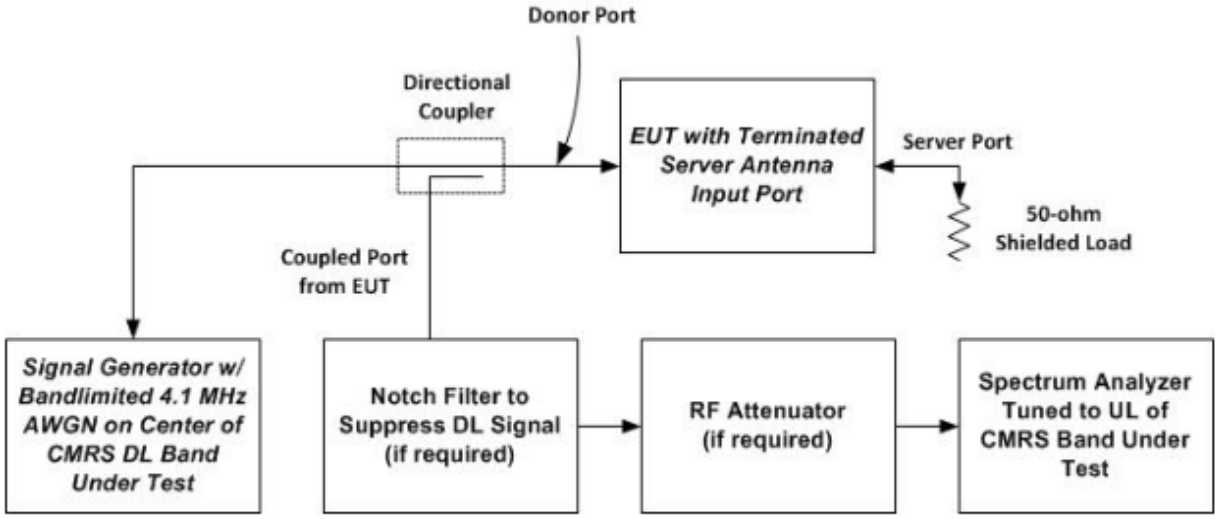



**Figure 4 – Test setup for uplink noise power measurement in the presence of a downlink signal**

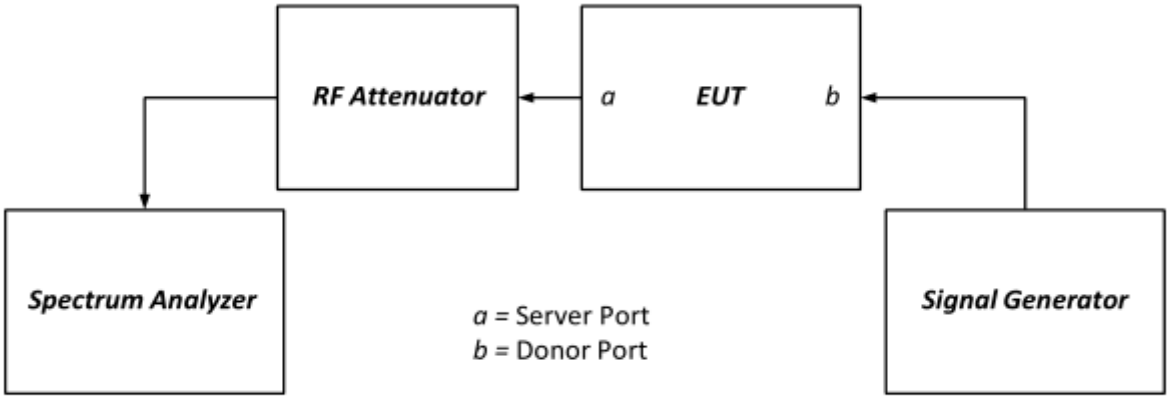
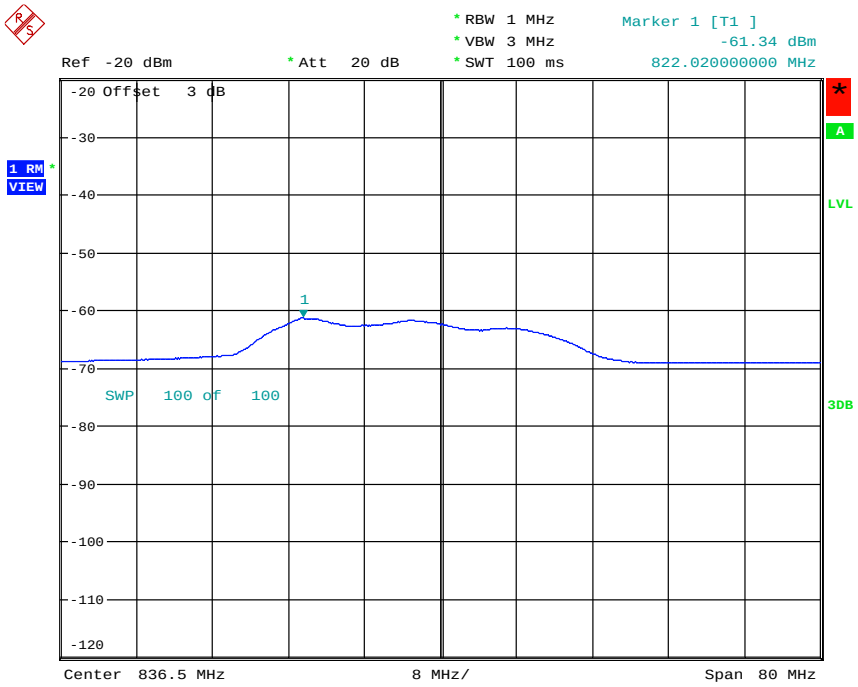



**Figure 5 – Test setup for downlink noise power measurement in the presence of a downlink signal**

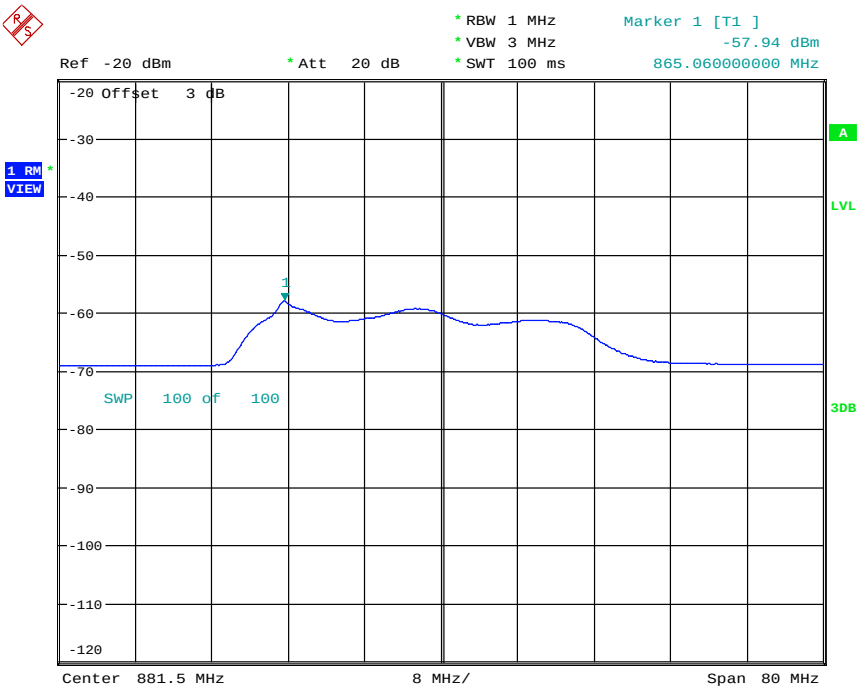
## 5.7.4 Test Results

**Result of noise limit**

| Band | Link | Noise Level (dBm/MHz) | Noise Level Limit (dBm/MHz) | Verdict |
|---|---|---|---|---|
| Cellular | Uplink | -61.34 | -44.18 | Pass |
| | Downlink | -57.94 | -43.72 | Pass |




Plot Uplink Noise




Plot Downlink noise

## Results of variable downlink noise limit

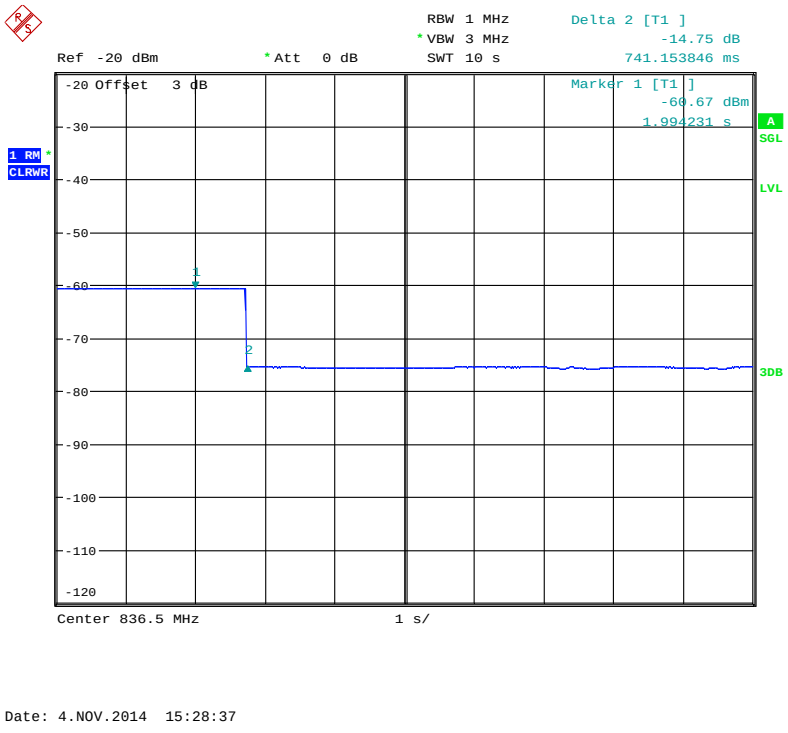
| Band | RSSI | Noise Level (dBm/MHz) | Noise Level Limit (dBm/MHz) | Verdict |
|---|---|---|---|---|
| Cellular | -60 | -58.8 | -44 | Pass |
| | -40 | -67.3 | -63 | Pass |
| | -38 | -70.2 | -65 | Pass |
| | -35 | -70.5 | -68 | Pass |
| | -34 | -71.8 | -69 | Pass |
| | -30 | -75.4 | -70 | Pass |

## Results of variable uplink noise limit

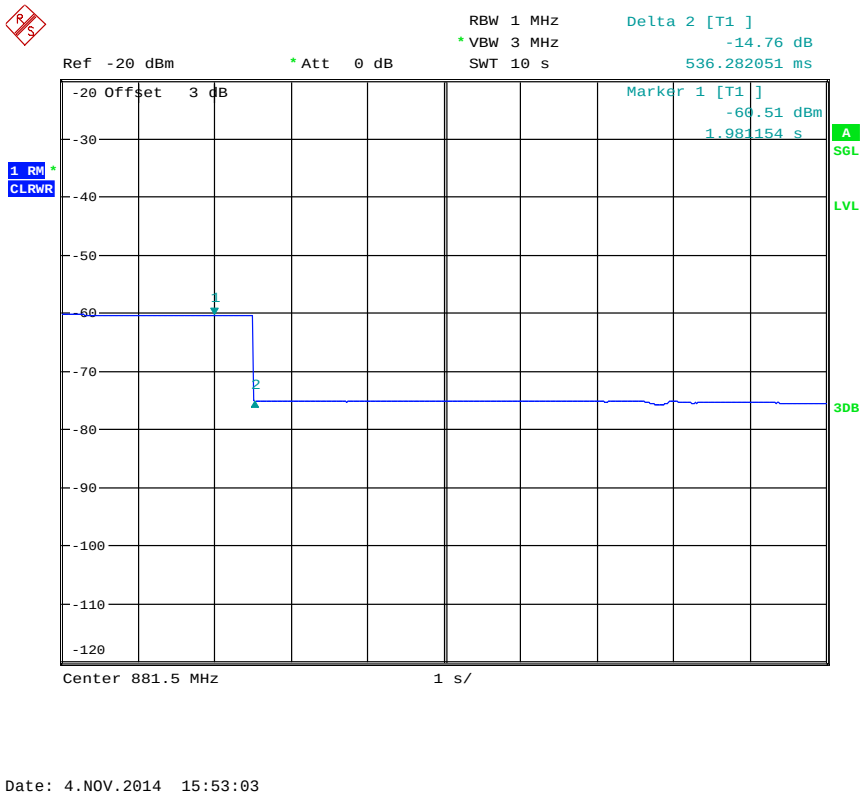
| Band | RSSI | Noise Level (dBm/MHz) | Noise Level Limit (dBm/MHz) | Verdict |
|---|---|---|---|---|
| Cellular | -65 | -61.5 | -44 | Pass |
| | -39 | -66.9 | -64 | Pass |
| | -38 | -67.6 | -65 | Pass |
| | -36 | -70.2 | -67 | Pass |
| | -35 | -70.9 | -68 | Pass |
| | -30 | -74.7 | -70 | Pass |

## Variable uplink noise timing

| Band | Link | Start Time (s) | Noise Timing (s) | Limit (s) | Verdict |
|---|---|---|---|---|---|
| Cellular | Uplink | 1.994 | 0.741 | 3.0 | Pass |
| | Downlink | 1.981 | 0.536 | 3.0 | Pass |




Plot Uplink variable noise




Plot Downlink variable noise

## Conclusion: Pass

## 5.8 Uplink inactivity

### 5.8.1 Requirement and limit

According to Rule paragraph(s): § 20.21(e)(8)(i)(I) Uplink Inactivity.

§ 20.21(e)(8)(i)(I) Uplink Inactivity. When a consumer booster is not serving an active device connection after 5 minutes the uplink noise power shall not exceed −70 dBm/MHz.

### 5.8.2 Test Procedures

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 ≥ 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.

### 5.8.3 Setup

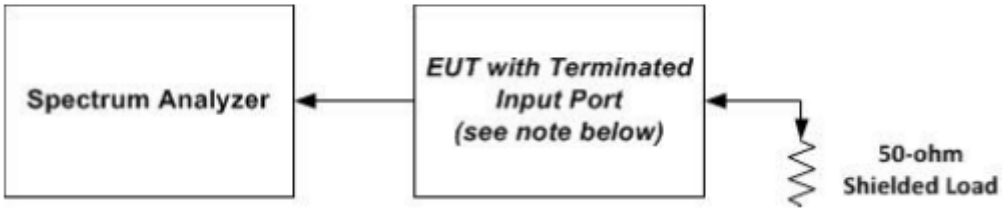
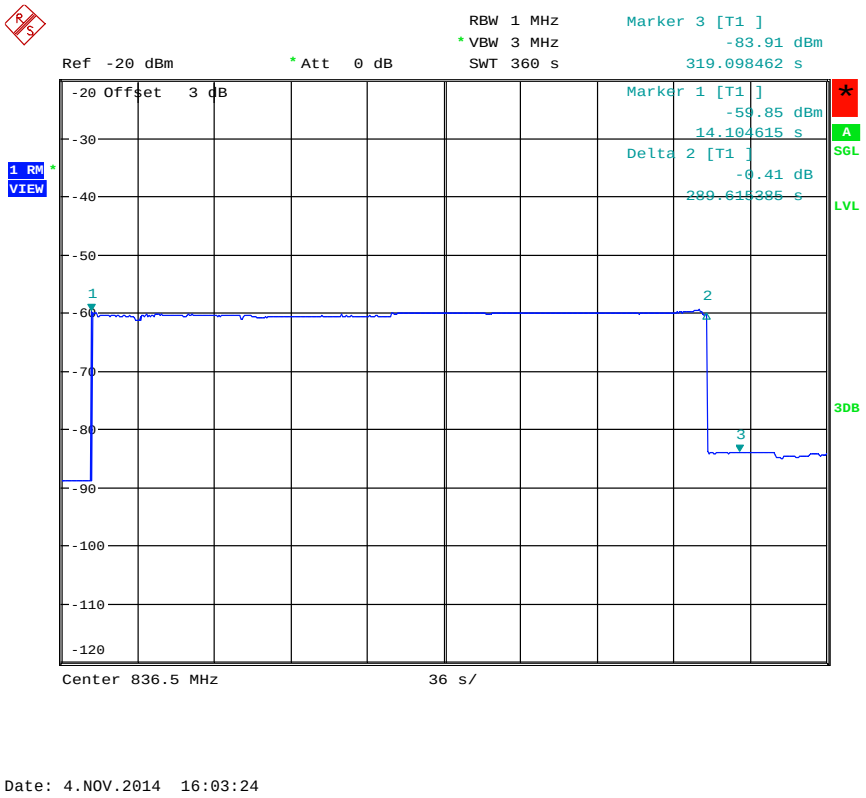



**Figure 3 – Noise limit instrumentation test setup**

### 5.8.4 Test Results

| Band | Link | Inactive Time (s) | Limit (s) | Inactive Level (dBm/MHz) | Limit (dBm/MHz) | Verdict |
|---|---|---|---|---|---|---|
| Cellular | Uplink | 289.6 | 300 | -83.91 | -70.00 | Pass |




Plot Uplink inactive

## Conclusion: Pass

## 5.9 Variable booster gain

### 5.9.1 Requirement

According to Rule paragraph(s): § 20.21(e)(8)(i)(C)(1) Booster Gain Limits (variable gain); § 20.21(e)(8)(i)(H) Transmit Power Off Mode (uplink gain).

§ 20.21(e)(8)(i)(C)(1) Booster Gain Limits The uplink and downlink gain in dB of a frequency selective consumer booster referenced to its input and output ports shall not exceed BSCL−28 dB−(40 dB−MSCL)

§ 20.21(e)(8)(i)(H) Transmit Power Off Mode (uplink gain), When the consumer booster cannot otherwise meet the noise and gain limits defined herein it must operate in “Transmit Power OFF Mode.” In this mode of operation, the uplink and downlink noise power shall not exceed −70 dBm/MHz and uplink gain shall not exceed the lesser of 23 dB or MSCL

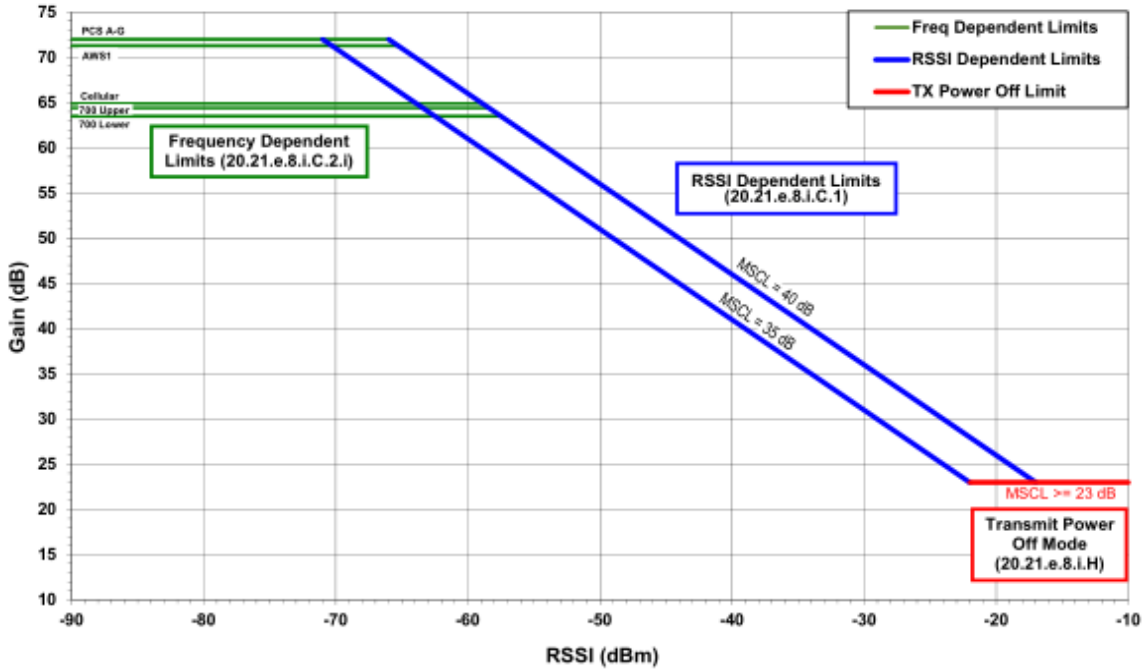



**Figure D2.** Fixed wideband consumer signal booster variable gain limits.

### 5.9.2 Test Procedures

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 ≥ 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 ≥ (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.

### 5.9.3 Setup

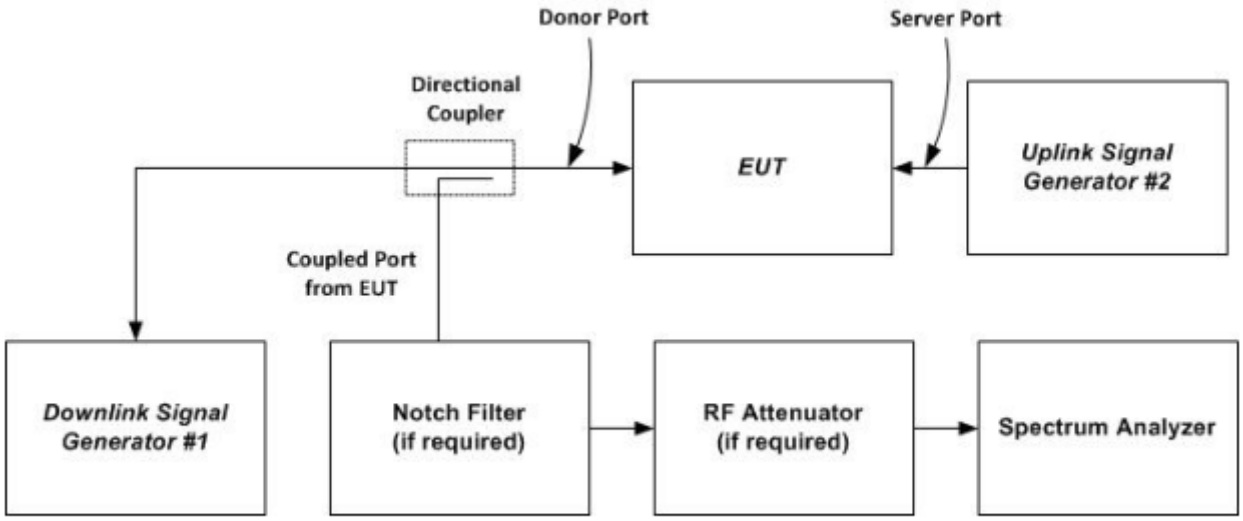



**Figure 6 – Variable gain instrumentation test setup**

### 5.9.4 Test Results

| Band | RSSI (dBm) | MSCL (dB) | Input Power (dBm) | Output Power (dBm) | Uplink Gain (dB) | Gain Limit (dB) | Verdict |
|---|---|---|---|---|---|---|---|
| Cellular | -58.0 | 26 | -43.0 | 4.5 | 47.5 | 50 | Pass |
| | -57.0 | | -43.0 | 3.9 | 46.9 | 49 | Pass |
| | -56.0 | | -43.0 | 2.6 | 45.6 | 48 | Pass |
| | -41.0 | | -43.0 | -11.2 | 31.8 | 33 | Pass |
| | -40.0 | | -43.0 | -12.3 | 30.7 | 32 | Pass |
| | -38.0 | | -43.0 | -15.1 | 27.9 | 30 | Pass |

## 5.10 Occupied bandwidth

### 5.10.1 Requirement

According to Rule paragraph(s): § 2.1049 Measurements required: Occupied bandwidth

This measurement is required to compare the uniformity of the output signal relative to the input signal and to satisfy the requirements of § 2.1049.

### 5.10.2 Test Procedures

a) Connect the test equipment as shown in Set-Up 1 to measure the characteristics of the test signals produced by the signal generator.

b) Set VBW to ≥ 3X RBW

c) 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.

d) Set the signal generator for power level to match the values obtained in Maximum power.

e) 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.

f) Set the spectrum analyzer RBW for 1% to 5% of the emissions bandwidth.

g) Capture the spectrum analyzer trace for inclusion in the test report.

h) 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.)

i) Connect the test equipment as shown in Set-Up 2. Begin with the uplink output connected to the spectrum analyzer

j) Repeat steps c) to h) in this new configuration.

### 5.10.3 Setup

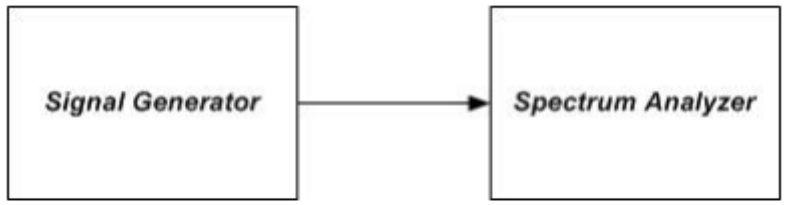
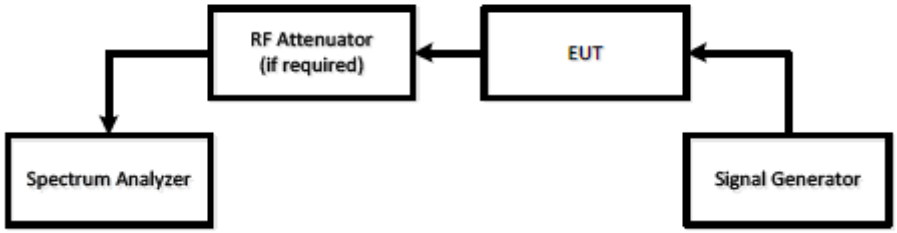


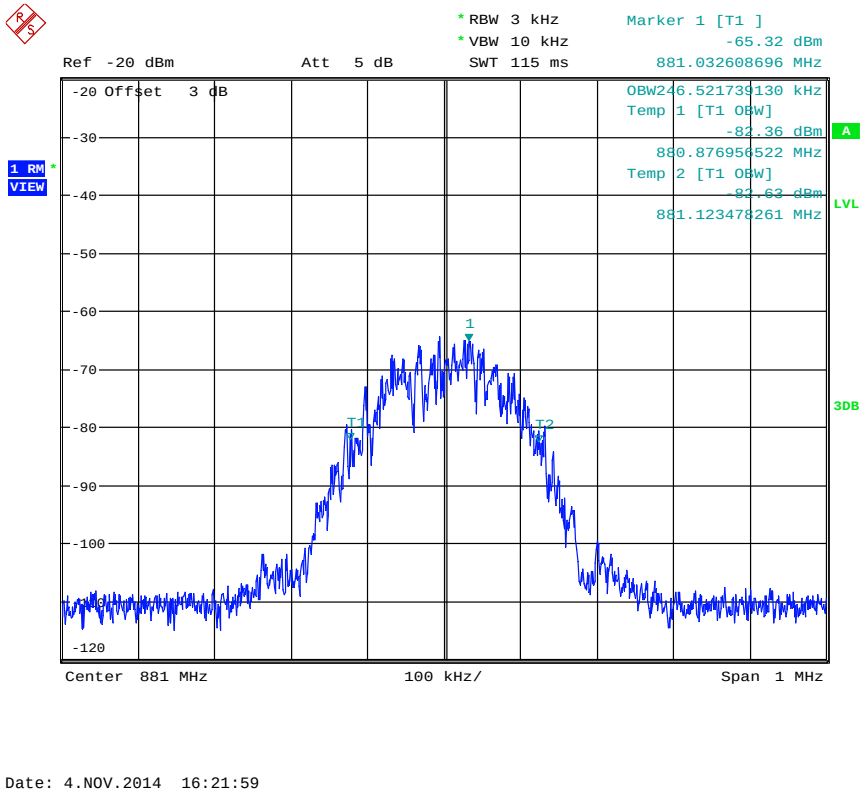

**Figure 7 – Occupied bandwidth instrumentation test setup**



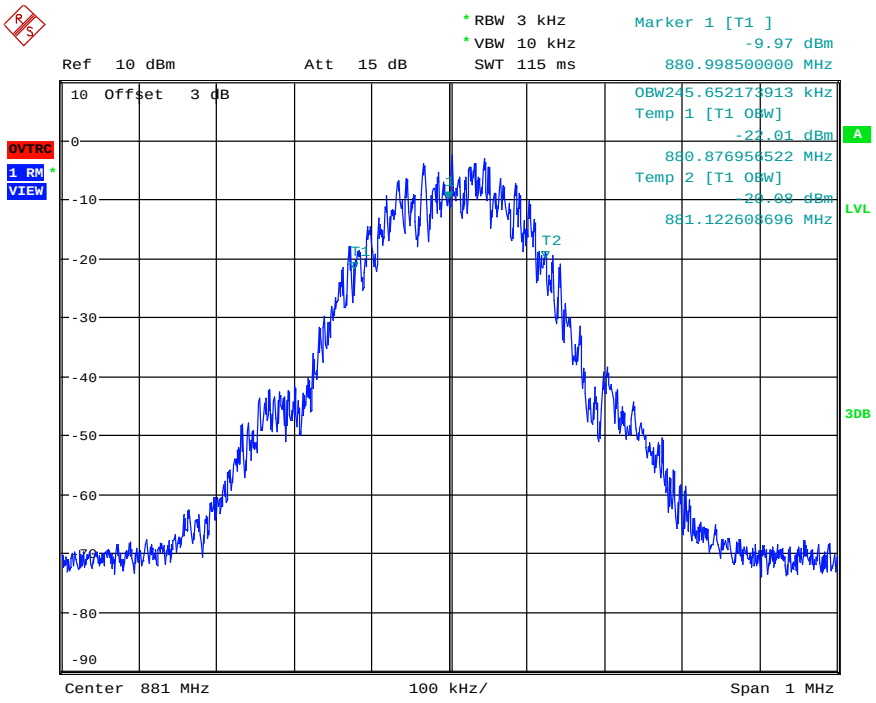
## 5.10.4 Test Results

| Band | Link | Signal Type | Frequency (MHz) | Input OBW (kHz) | Refer to Plot | Output OBW (kHz) | Refer to Plot |
|---|---|---|---|---|---|---|---|
| Cellular | Down Link | GSM | 881.0 | 246.5 | Plot A1 | 245.7 | Plot A2 |
| | | AWGN | 881.0 | 4247.8 | Plot B1 | 4152.2 | Plot B2 |
| | | CDMA | 881.0 | 1280.0 | Plot C1 | 1274.7 | Plot C2 |
| | Up Link | GSM | 836.0 | 244.3 | Plot D1 | 245.2 | Plot D2 |
| | | AWGN | 836.0 | 4191.3 | Plot E1 | 4121.7 | Plot E2 |
| | | CDMA | 836.0 | 1278.3 | Plot F1 | 1271.3 | Plot F2 |

## 5.10.5 Test Plot

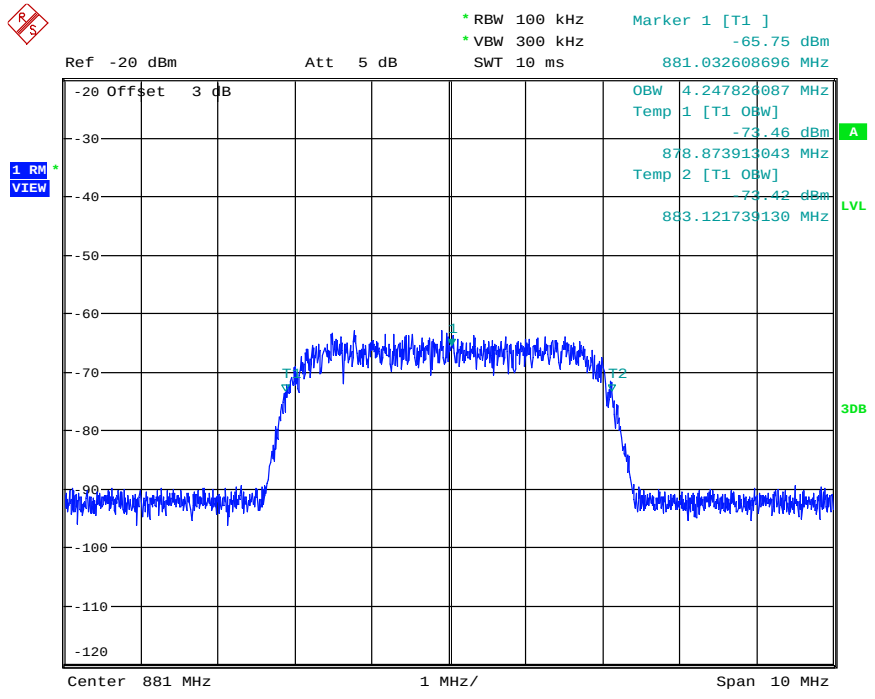



Plot A1 Downlink / GSM / Input



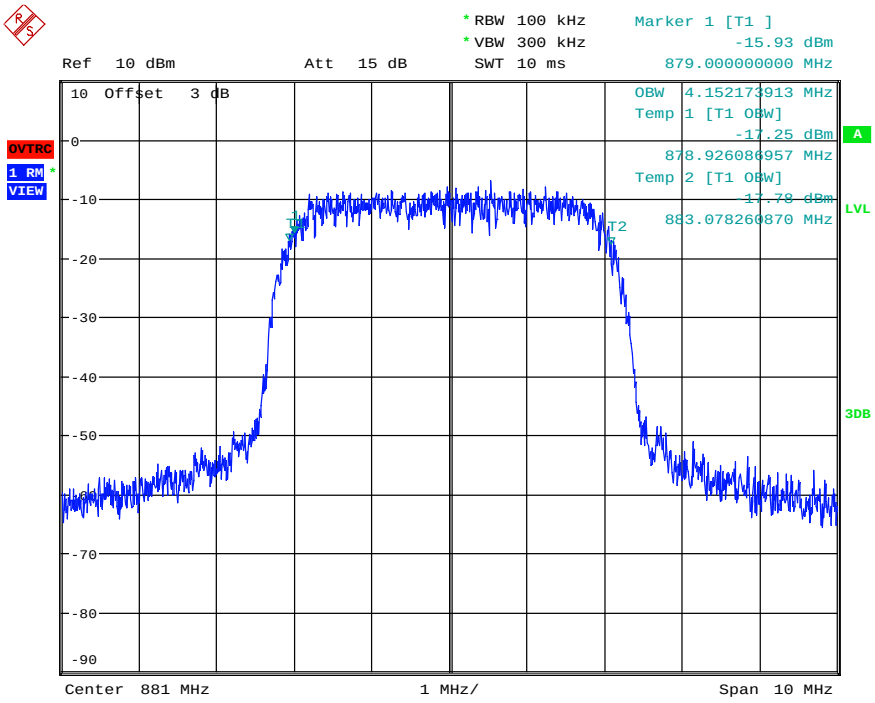

Date: 4.NOV.2014 17:09:39

Plot A2 Downlink / GSM / Output



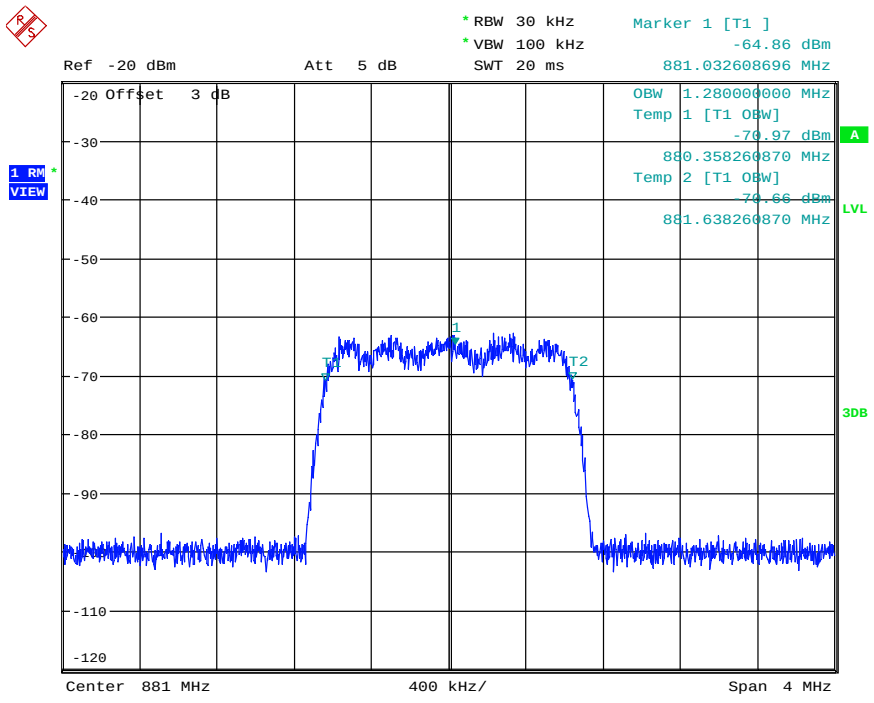

Date: 4.NOV.2014 16:28:42

Plot B1 Downlink / AWGN / Input



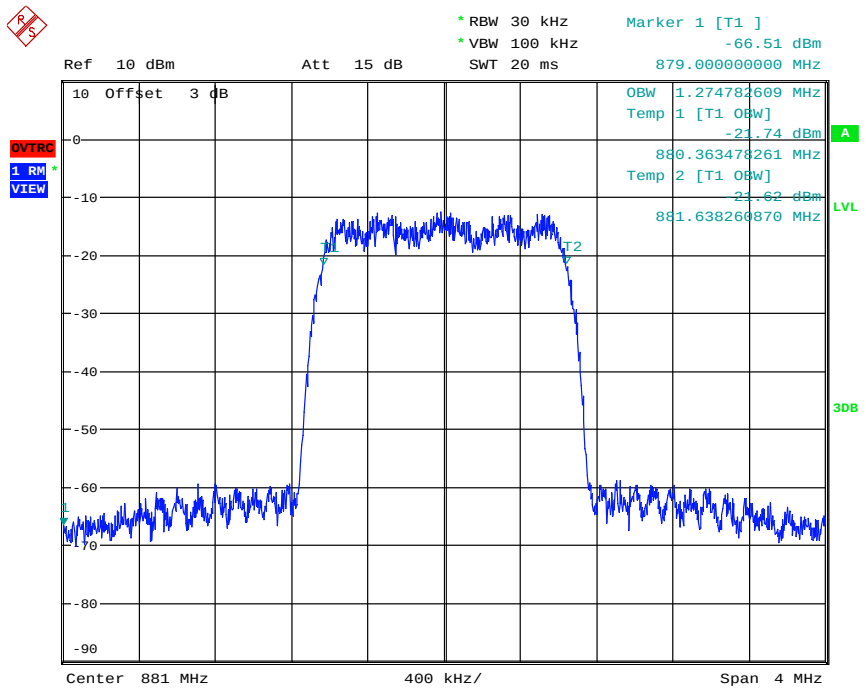

Date: 4.NOV.2014 16:59:39

Plot B2 Downlink / AWGN / Output

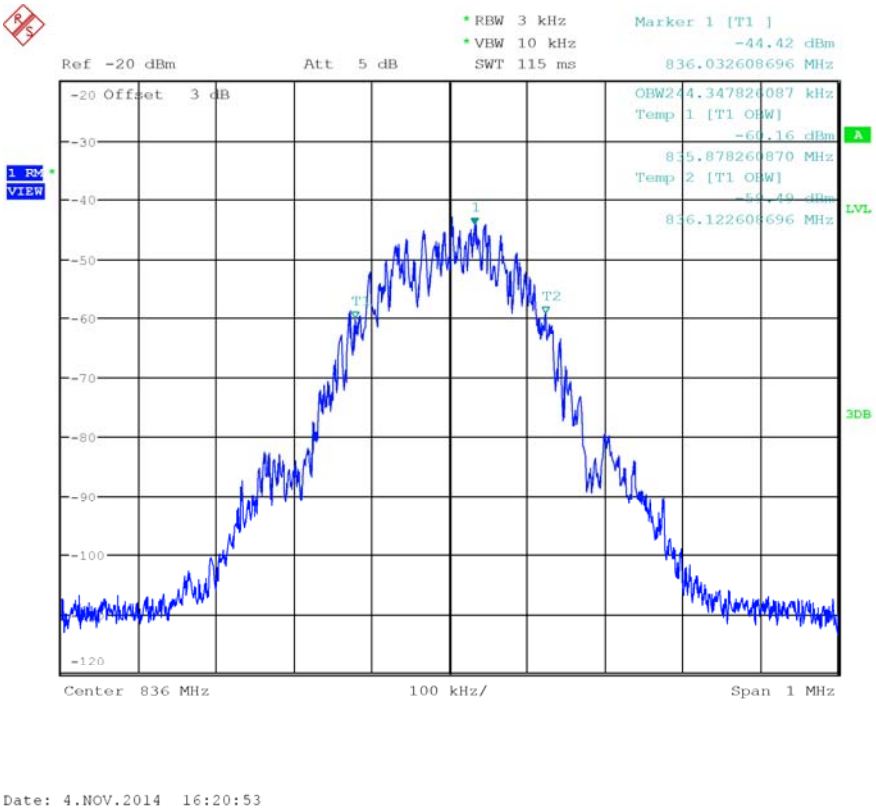



Date: 4.NOV.2014 16:29:58

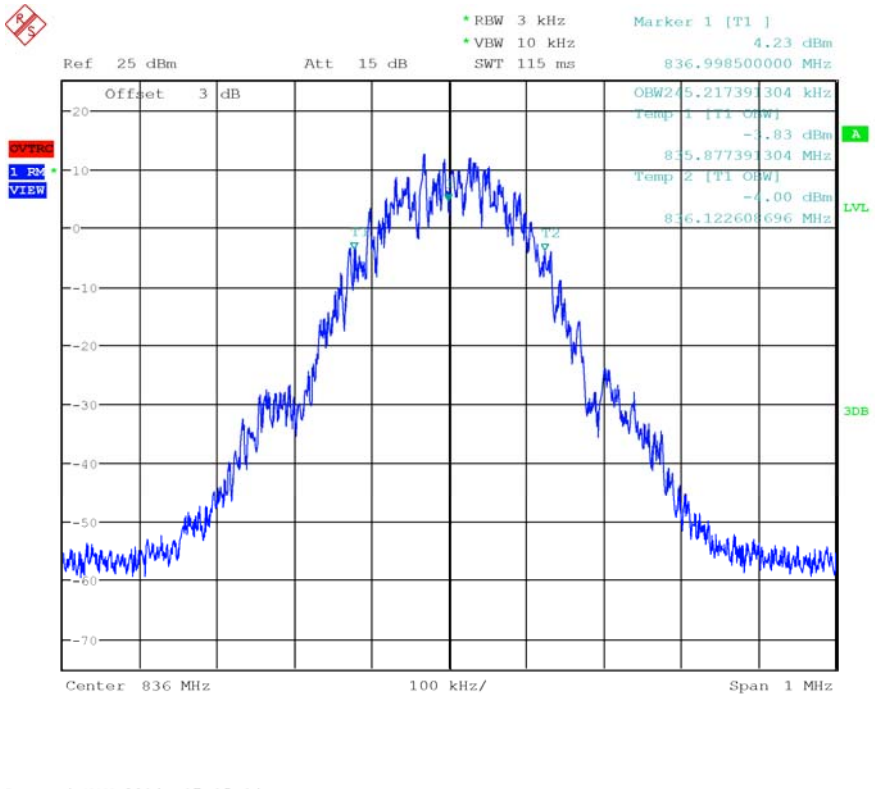
Plot C1 Downlink / CDMA / Input



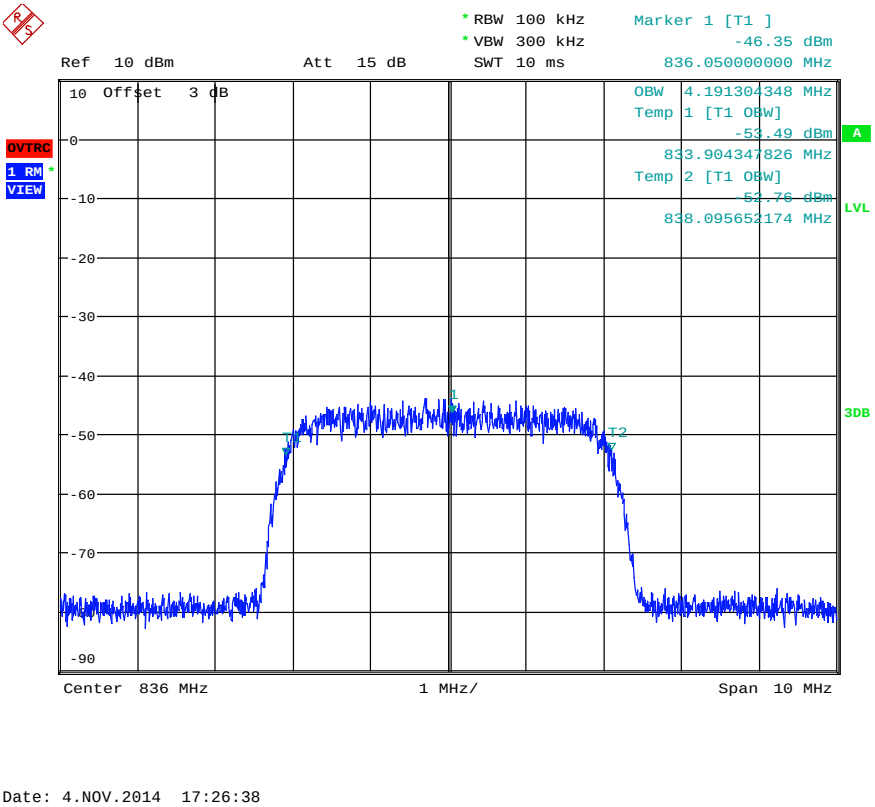

Plot C2 Downlink / CDMA / Output



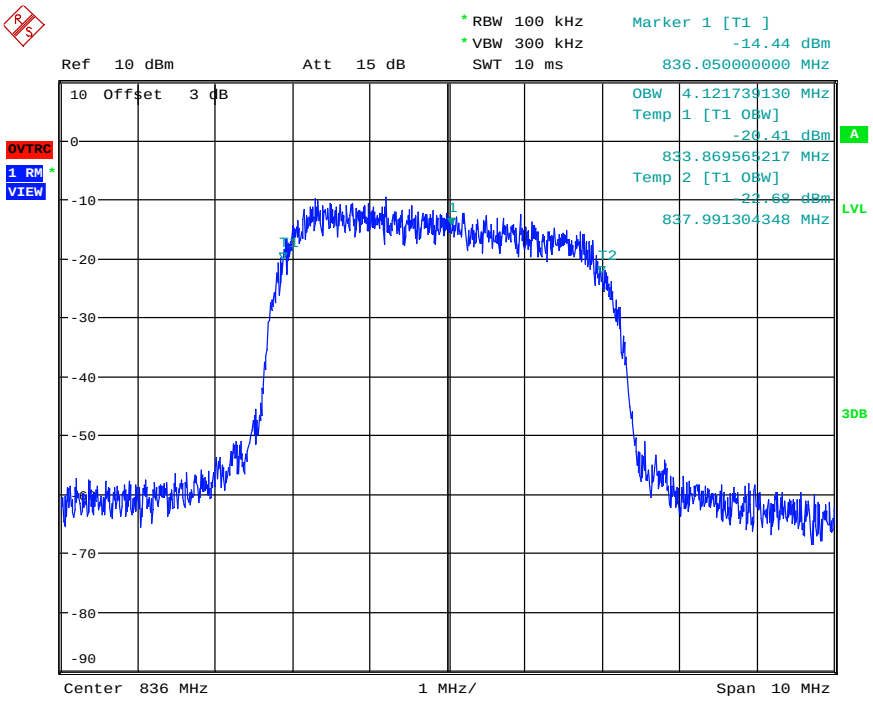

Plot D1 Uplink / GSM / Input




Plot D2 Uplink / GSM / Output

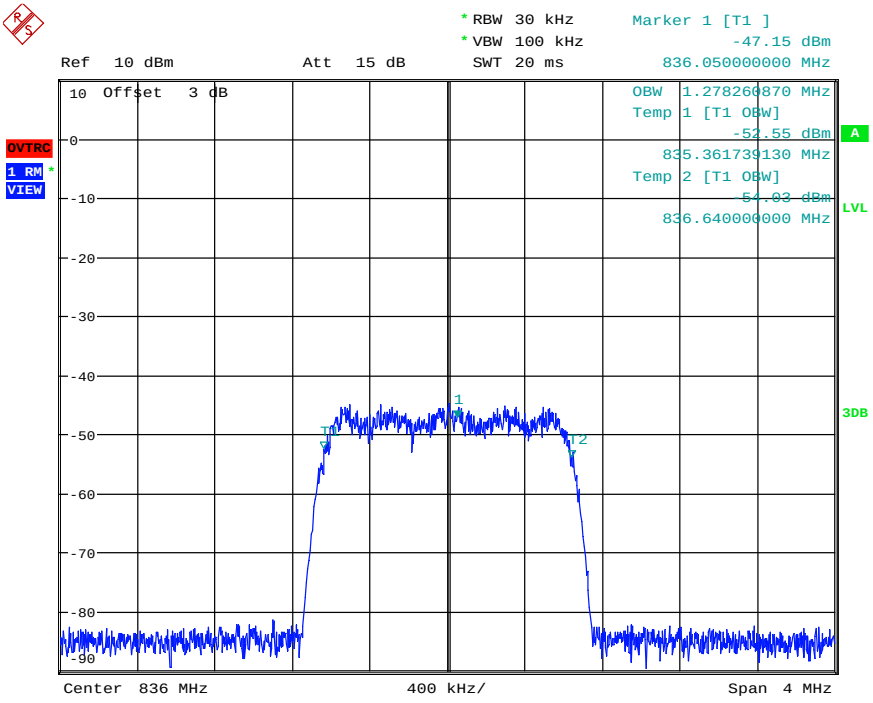



Plot E1 Uplink / AWGN / Input



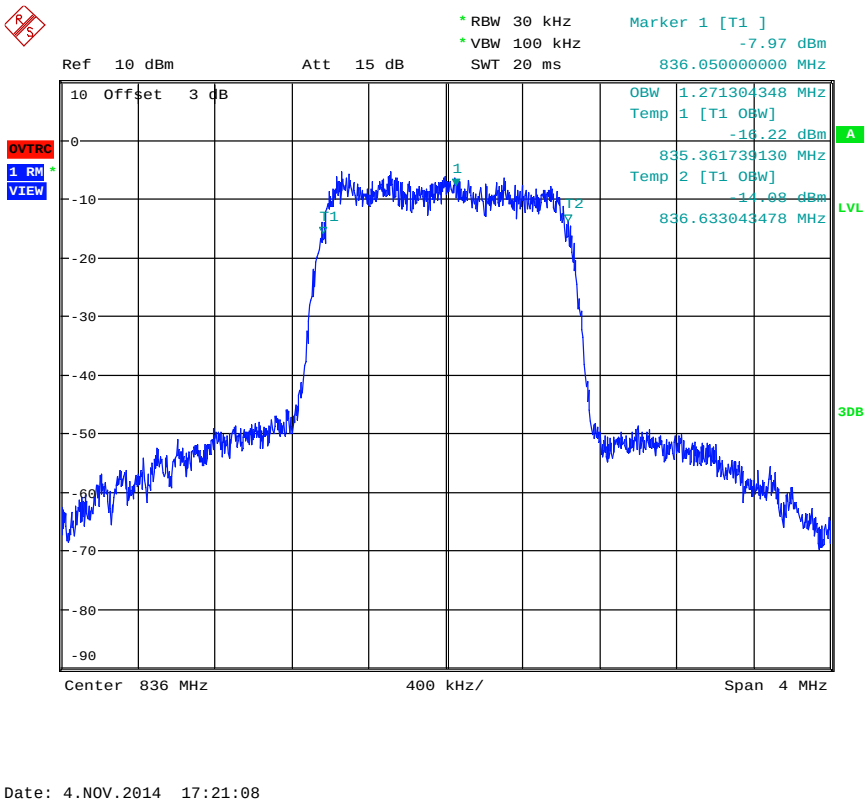

Date: 4.NOV.2014 17:20:17

Plot E2 Uplink / AWGN / Output




Date: 4.NOV.2014 17:25:27

Plot F1 Uplink / CDMA / Input




Plot F2 Uplink / CDMA / Output

## Conclusion: Pass

## 5.11 Oscillation detection

### 5.11.1 Requirement

According to Rule paragraph(s): § 20.21(e)(8)(ii)(A) Anti-Oscillation.

§ 20.21(e)(8)(ii)(A) Anti-Oscillation,Consumer boosters must be able to detect and mitigate (i.e., by automatic gain reduction or shut down), any oscillations in uplink and downlink bands. Oscillation detection and mitigation must occur automatically within 0.3 seconds in the uplink band and within 1 second in the downlink band. In cases where oscillation is detected, the booster must continue mitigation for at least one minute before restarting. After five such restarts, the booster must not resume operation until manually reset.

### 5.11.2 Test Procedures

5.11.2.1 Oscillation restart tests

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.

5.11.2.2 Measuring oscillation mitigation or shutdown

a) Connect the EUT set for normal operation to the test equipment as shown in **Figure 8**.

b) Set the spectrum analyzer center frequency to the center of band under test, and use the following settings: Set RBW=30 kHz, VBW ≥ 3 × RBW, rms detector, trace averages ≥ 100, span ≥ 120% of operational band under test, number of sweep points ≥ 2 × Span/RBW.

*NOTE—For spectrum analyzers with less than the required number of sweep points to measure 120 % of the band under test in one span: Perform pretests with span equal to smaller band segments, such that 120 % of the operational band is captured in multiple tests, using the parameters specified above, record the center frequency of the strongest oscillation level occurring, and affirm this frequency is within the span and band segment used in this test.*

c) Configure signal generator for AWGN operation with 99 % occupied bandwidth of 4.1 MHz tuned to the frequency of 2.5 MHz above the lower edge or below the upper edge of the operating band under test. Adjust the RF output level of the signal generator; such that the measured power level of the AWGN signals at the output port of the booster is 30 dB less than the maximum power of the booster for the band under test. Confirm that the input signal is not obstructing the measurement of the strongest oscillation peak in the band, and is not included within the span in the measurement.

*NOTE—Boosters with spectrum bandwidths of 10 MHz or less may use a CW signal source at the band edge instead of AWGN. Standard CMRS signal sources (i.e., CDMA, WCDMA, LTE) may be used instead of AWGN at the band edge.*

d) Set the variable attenuator with a high attenuation setting such that the booster will operate at maximum gain when powered on. Reset the power on the EUT. Allow the EUT to complete its booting process, reach full operational gain, and stabilize its operation.

e) Set the variable attenuator such that the insertion loss for center of band under test (isolation) between the booster's donor and server ports is 5 dB greater than the maximum gain, as recorded in the maximum gain test procedure, for the band under test.

f) Verify the EUT shuts down, to mitigate the oscillations. For boosters that do not shut down, measure and verify the peak oscillation level as follows.

1) Allow the spectrum analyzer trace to stabilize.

2) Place the marker at the highest oscillation level occurring within the span, and record its output level and frequency.

3) Set the spectrum analyzer's center frequency to the frequency of the highest oscillation level, and reduce the span such that the upper and lower adjacent oscillation peaks are within the span.

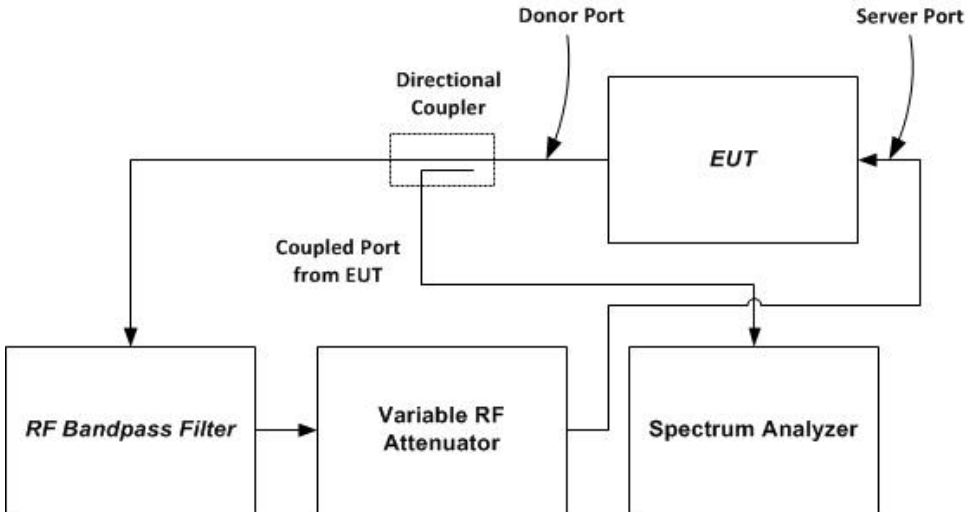
4) Use the Minimum Search Marker function to find the lowest output level that is within the span, and within the operational band under test, and record its output level and frequency.

5) Affirm that the peak oscillation level, as measured in step 2) above, does not exceed the minimal output level, as measured in step 5.11.2.2f)4), by 12.0 dB. Record measurement results of step 5.11.2.2f)2) and step 5.11.2.2f)4) in tabular format for inclusion in the test report.

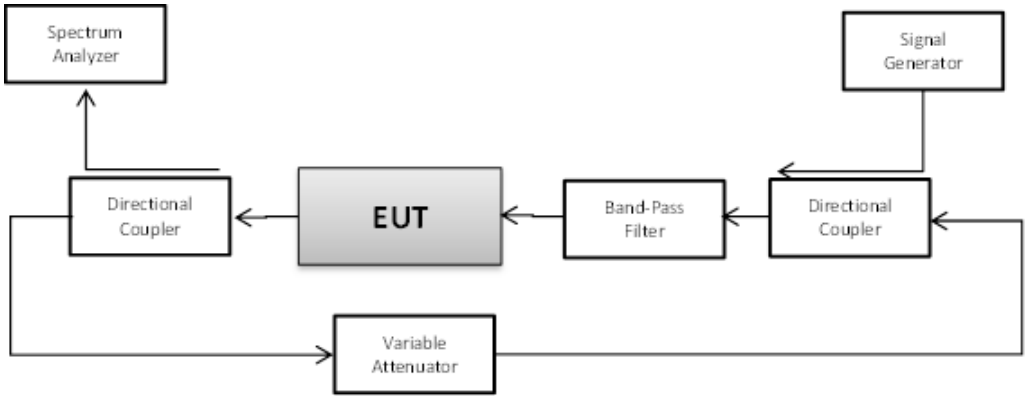
g) Decrease the variable attenuator in 1 dB steps, and repeat step 5.11.2.2f) for each 1 dB step. Continue testing to the level when the insertion loss for center of band under test (isolation) between the booster's donor and server ports is 5 dB lower than the maximum gain.

h) Repeat 5.11.2.2a) to 5.11.2.2g) for all operational uplink and downlink bands.

## 5.11.3 Setup




Oscillation detection instrumentation test setup



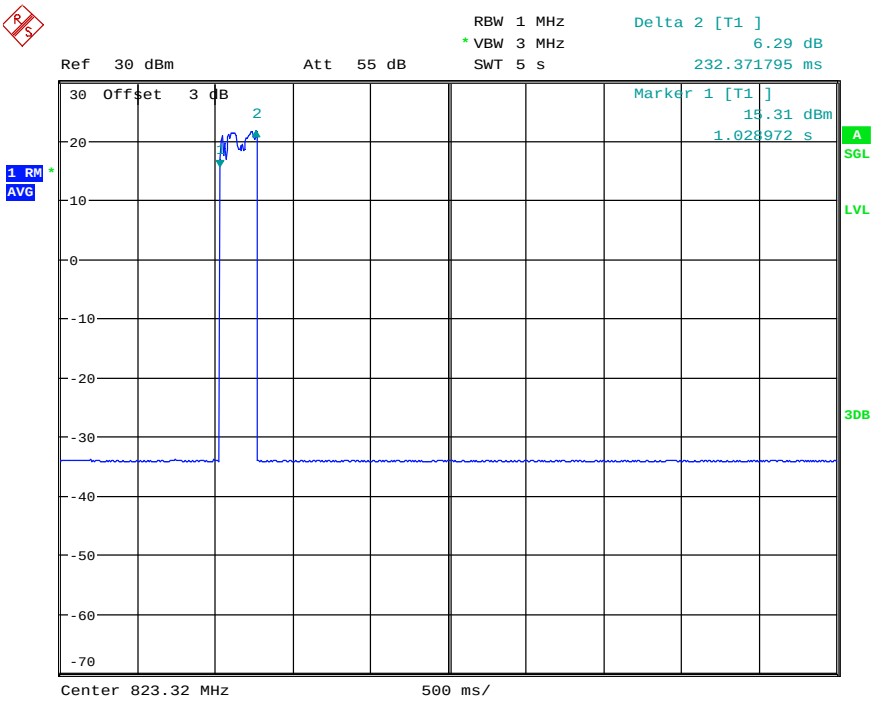

Oscillation mitigation/shutdown test setup

## 5.11.4 Test Results

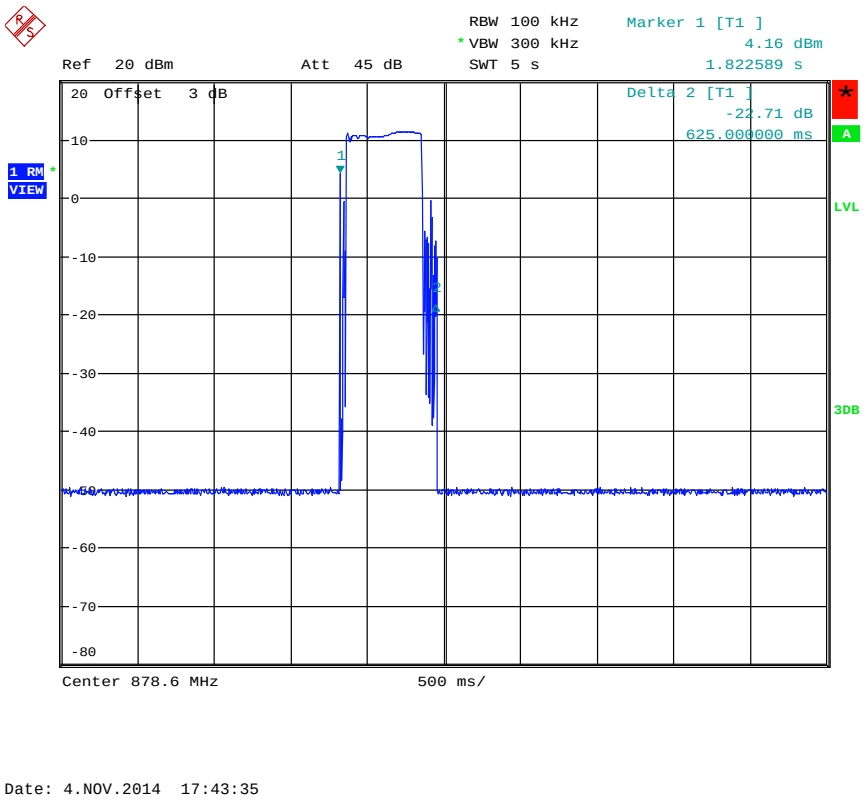
### 5.11.4.1 Oscillation restart tests

Results of detection time

| Band | Link | Detection Time (s) | Limit (s) | Verdict |
|---|---|---|---|---|
| Cellular | Uplink | 0.232 | 0.300 | Pass |
| | Downlink | 0.625 | 1.000 | Pass |




Uplink detection time



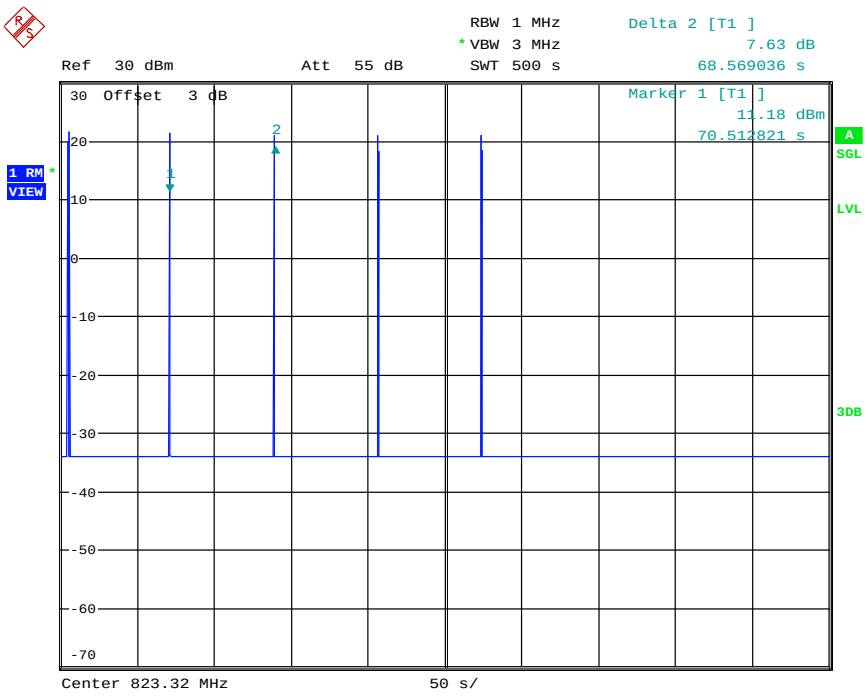

Downlink detection time

Results of restarting time

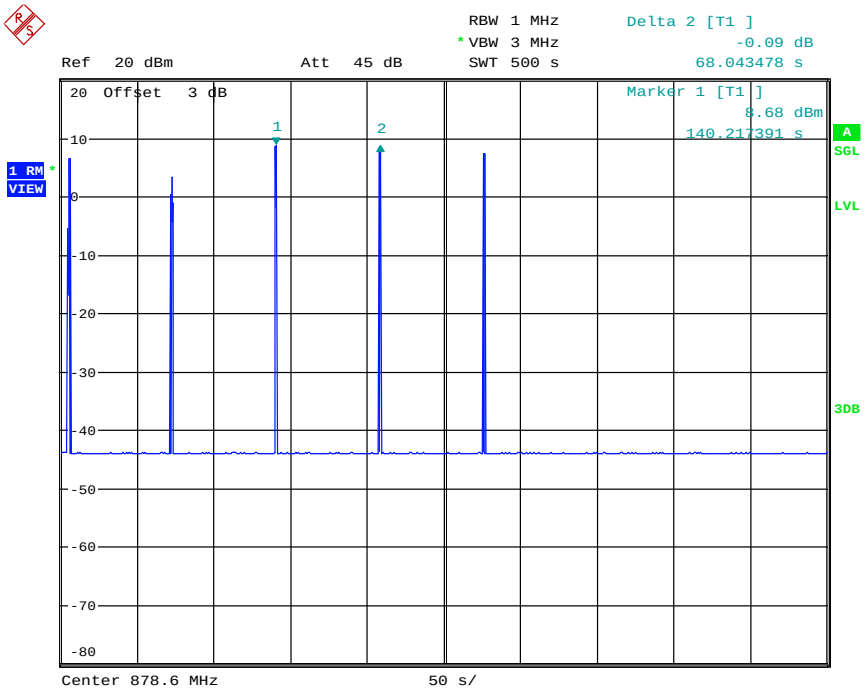
| Band | Link | Restarting Time (s) | Limit (s) | Verdict |
|---|---|---|---|---|
| Cellular | Uplink | 68.57 | ≥ 60.0 | Pass |
| | Downlink | 68.04 | ≥ 60.0 | Pass |

Results of restarting count

| Band | Link | Restarting Count | Limit | Verdict |
|---|---|---|---|---|
| Cellular | Uplink | 5 | ≤ 5 | Pass |
| | Downlink | 5 | ≤ 5 | Pass |




Uplink restarting time and count




Downlink restarting time and count

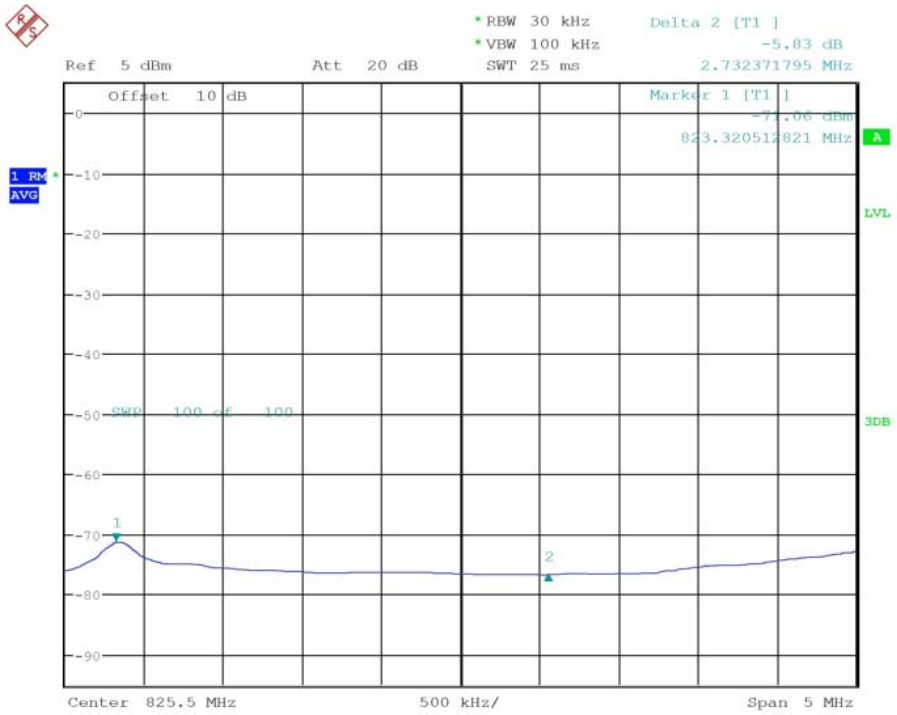
5.11.4.2 Measuring oscillation mitigation or shutdown

| Band | Link | Max Gain (dBi) | Isolation (dB) | Difference (dB) | Limit (dB) | Time prior to shutdown (s) | Refer to Plot |
|---|---|---|---|---|---|---|---|
| Cellular | Uplink | 59.04 | +5 | 5.83 | ≤ 12 | / | Plot A |
| | | | +4 | 8.29 | | / | Plot B |
| | | | +3 | 11.28 | | / | Plot C |
| | | | +2 | * | | 27 | / |
| | | | +1 | * | | 8 | / |
| | | | 0 | ** | | ** | / |
| | | | -1 | ** | | ** | / |
| | | | -2 | ** | | ** | / |
| | | | -3 | ** | | ** | / |
| | | | -4 | ** | | ** | / |
| | | | -5 | ** | | ** | / |
| Cellular | Downlink | 57.92 | +5 | 6.11 | ≤ 12 | / | Plot D |
| | | | +4 | 9.32 | | / | Plot E |
| | | | +3 | 11.00 | | / | Plot F |
| | | | +2 | * | | 39 | / |
| | | | +1 | * | | 11 | / |
| | | | 0 | ** | | ** | / |
| | | | -1 | ** | | ** | / |
| | | | -2 | ** | | ** | / |
| | | | -3 | ** | | ** | / |
| | | | -4 | ** | | ** | / |
| | | | -5 | ** | | ** | / |

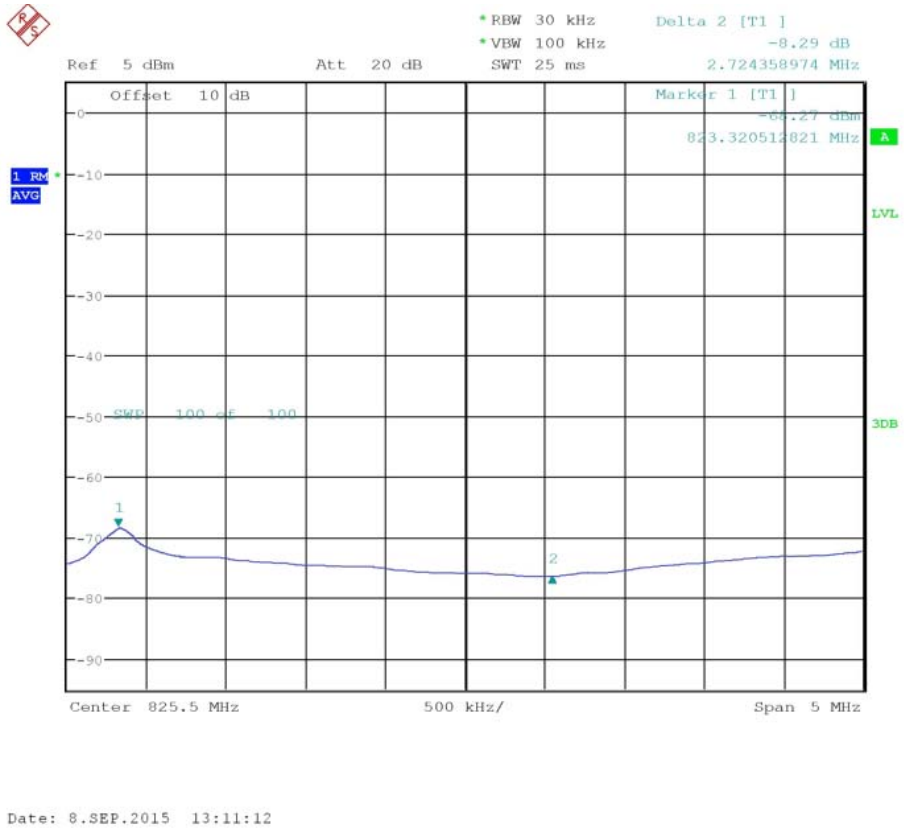
Note:

* The measured difference exceeds the limit for a period of less than 300 second before device mitigates and shutdown.

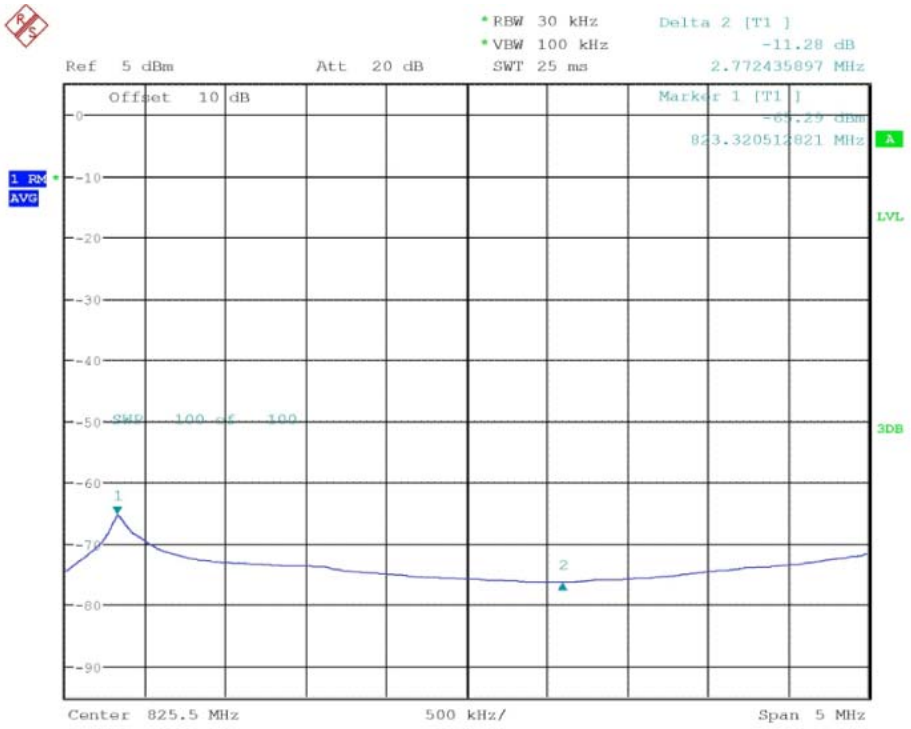
** The device shuts down immediately.


RBW 30 kHz
VBW 100 kHz
SWT 25 ms
Delta 2 [T1 ]
-5.83 dB
2.732371795 MHz
Ref 5 dBm
Att 20 dB
Offset 10 dB
Marker 1 [T1 ]
-71.06 dBm
823.320512821 MHz
1 RM
AVG
A
LVL
3DB
SWP 100 of 100
Center 825.5 MHz
500 kHz/
Span 5 MHz
Date: 8.SEP.2015 13:10:11

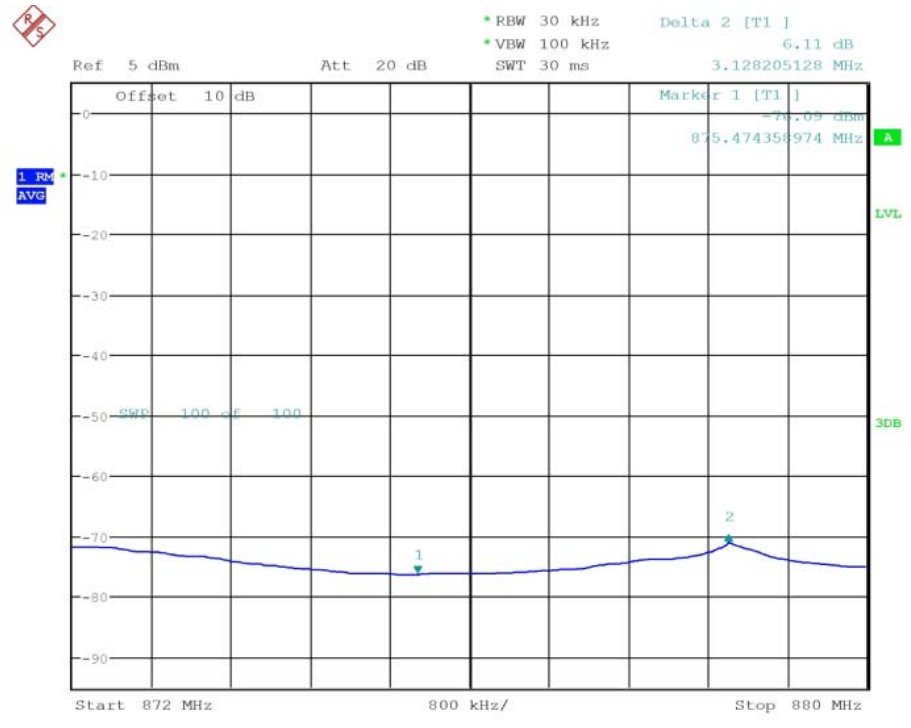
Plot A


RBW 30 kHz
VBW 100 kHz
SWT 25 ms
Delta 2 [T1 ]
-8.29 dB
2.724358974 MHz
Ref 5 dBm
Att 20 dB
Offset 10 dB
Marker 1 [T1 ]
-64.27 dBm
823.320512821 MHz
1 RM
AVG
A
LVL
3DB
SWP 100 of 100
Center 825.5 MHz
500 kHz/
Span 5 MHz
Date: 8.SEP.2015 13:11:12

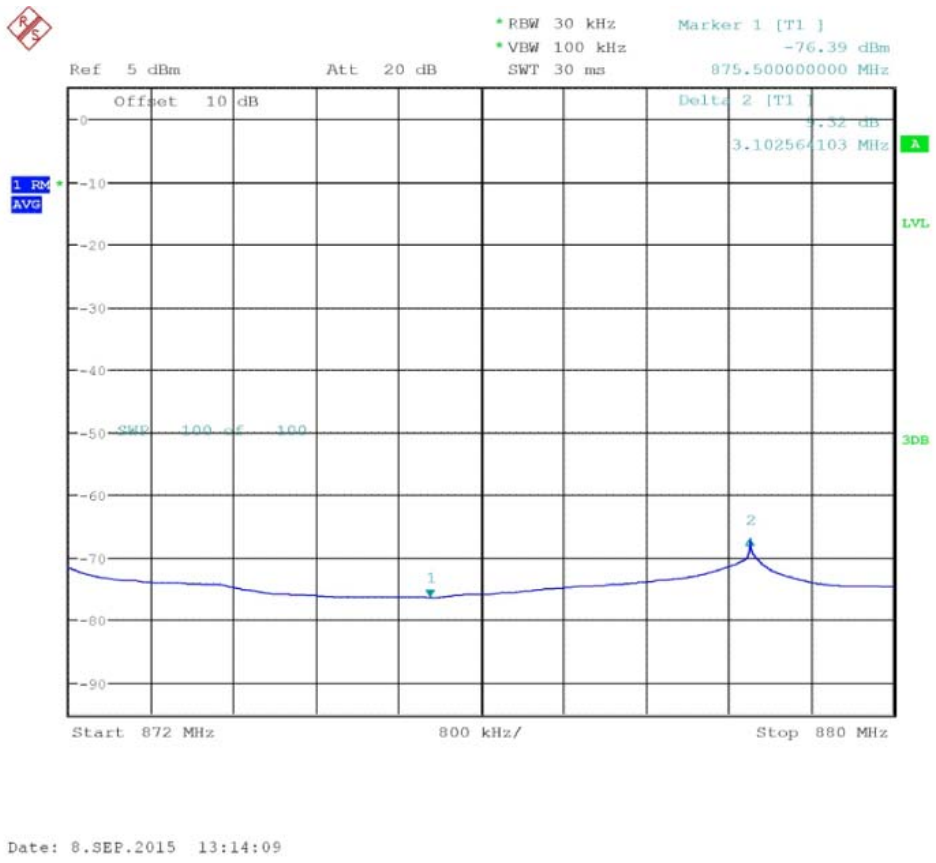
Plot B


RBW 30 kHz
VBW 100 kHz
SWT 25 ms
Delta 2 [T1 ]
-11.28 dB
2.772435897 MHz
Ref 5 dBm
Att 20 dB
Offset 10 dB
Marker 1 [T1 ]
823.320512821 MHz
1 RM
AVG
LVL
3DB
Center 825.5 MHz
500 kHz/
Span 5 MHz
Date: 8.SEP.2015 13:11:34

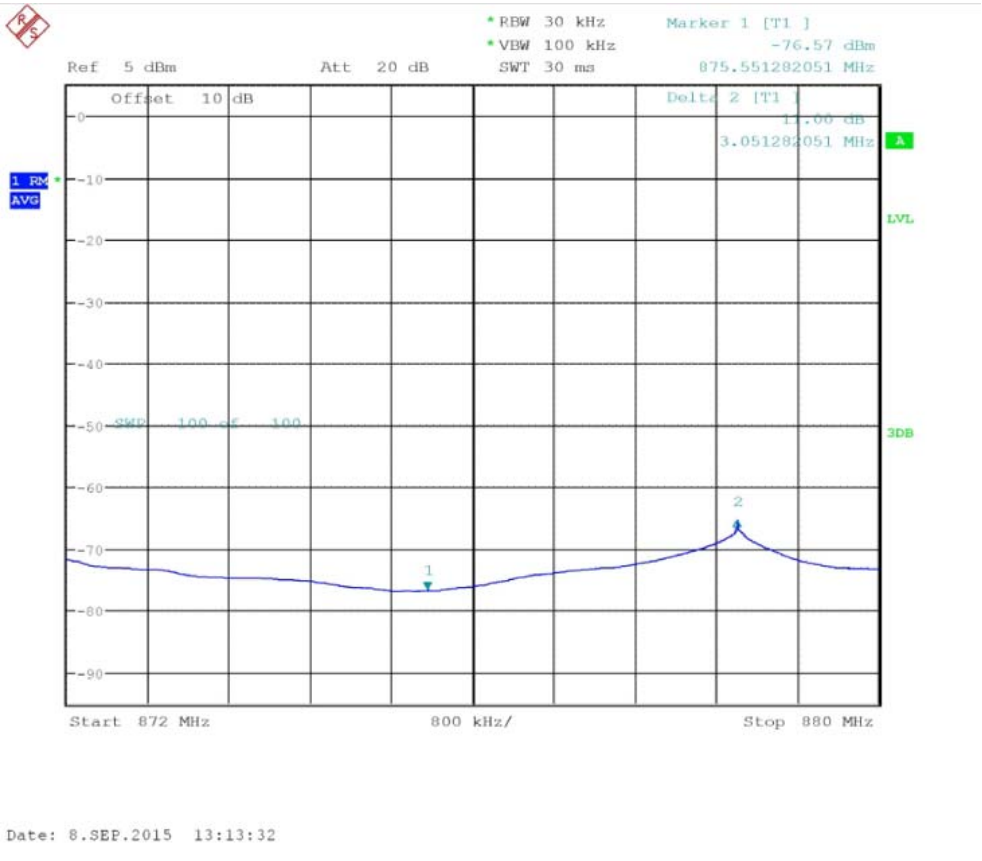
Plot C


RBW 30 kHz
VBW 100 kHz
SWT 30 ms
Delta 2 [T1 ]
6.11 dB
3.128205128 MHz
Ref 5 dBm
Att 20 dB
Offset 10 dB
Marker 1 [T1 ]
875.474358974 MHz
1 RM
AVG
LVL
3DB
Start 872 MHz
800 kHz/
Stop 880 MHz
Date: 8.SEP.2015 13:14:58

Plot D




Plot E




Plot F

## Conclusion: Pass

## 5.12 Radiated spurious emissions

### 5.12.1 Requirement

According to Rule paragraph(s): § 2.1053 Measurements required: Field strength of spurious radiation.

### 5.12.2 Test Procedures

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. The EUT output was terminated into a 50 Ohm non-radiating load.
c) Set the signal generator for the center frequency of the operational band under test with the power level set at PIN 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.

### 5.12.3 Setup

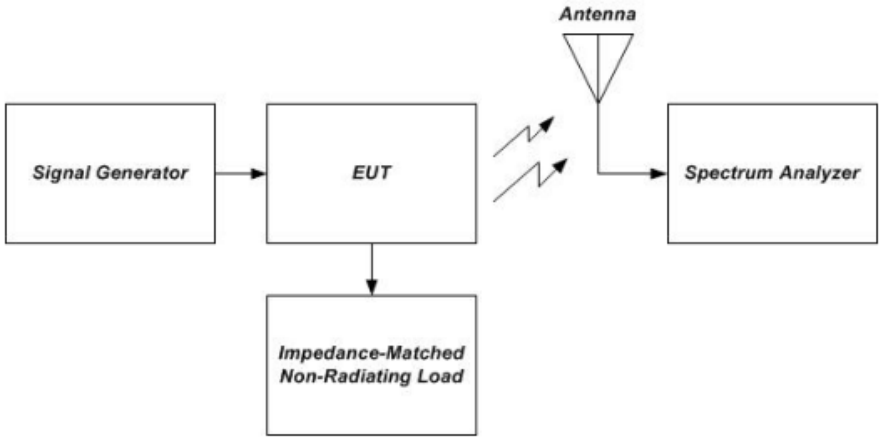



**Figure 9 – Radiated spurious emissions test instrumentation setup**

### 5.12.4 Test Results

| Uplink Spurious Emission (dBm) | | | | |
|---|---|---|---|---|
| Polarization | Frequency (MHz) | Level (dBm) | Limit (dBm) | Verdict |
| V | 42.3 | -42.2 | -13 | Pass |
| V | 903.6 | -51.7 | -13 | Pass |
| V | 1673.0 | -63.3 | -13 | Pass |
| V | 2509.5 | nf | -13 | Pass |
| V | 3346.0 | nf | -13 | Pass |
| H | 47.2 | -49.7 | -13 | Pass |
| H | 157.4 | -54.3 | -13 | Pass |
| H | 1673.0 | -61.8 | -13 | Pass |
| H | 2509.5 | nf | -13 | Pass |
| H | 3346.0 | nf | -13 | Pass |

| Downlink Spurious Emission (dBm) | | | | |
|---|---|---|---|---|
| Polarization | Frequency (MHz) | Level (dBm) | Limit (dBm) | Verdict |
| V | 42.3 | -43.7 | -13 | Pass |
| V | 903.6 | -49.3 | -13 | Pass |
| V | 1763.0 | -59.2 | -13 | Pass |
| V | 2644.5 | nf | -13 | Pass |
| V | 3526.0 | nf | -13 | Pass |
| H | 47.2 | -48.9 | -13 | Pass |
| H | 157.4 | -50.5 | -13 | Pass |
| H | 1763.0 | -63.3 | -13 | Pass |
| H | 2644.5 | nf | -13 | Pass |
| H | 3526.0 | nf | -13 | Pass |

*NOTE:*

*1) the power of the EUT transmitting frequency should be ignored.*

*2) All spurious emission tests were performed in X,Y,Z axis direction, Only the worst axis test condition was recored in this test report.*

*3) 'nf' means that the emission level is too low to read out from the noise floor.*

*4) The spurious emission above 4th harmonic to 10th harmonic is too low to read out from the noise floor.*

## Conclusion: Pass

## 5.13 **Spectrum block filtering**

### 5.13.1 Requirement

According to Rule paragraph(s): § 20.21(e)(8)(i)(B) Bidirectional Capability and § 20.21(e)(3) Frequency Bands

### 5.13.2 Test Result

This device does not support block filtering.

No applicable.

** END OF REPORT **