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TEST REPORT

Part 20.21

Report Reference No. ..... : **CTL1610114401-WF**

Compiled by: (position+printed name+signature)	Allen Wang (File administrators)	Allen Wang
Tested by: (position+printed name+signature)	Nice Nong (Test Engineer)	Nice Nong
Approved by: (position+printed name+signature)	Tracy Qi (Manager)	Tracy Qi

Product Name ..... :	Mobile Phone Signal Repeater
Model/Type reference ..... :	L2S
List Model(s)..... :	L3S, L4S, L5S
Trade Mark..... :	Longsheng
FCC ID..... :	**2AK8U-L2S**
Applicant's name ..... :	**Shenzhen Longsheng Electronic Technology Co., Ltd**
Address of applicant ..... :	3D Buliding C, No.8 of Shangxue Science & Technology Park East, Jihua Road, Bantian, Longgang District, Shenzhen, China
Test Firm..... :	**Shenzhen CTL Testing Technology Co., Ltd.**
Address of Test Firm ..... :	Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055
Test specification..... :	
Standard ..... :	**FCC CFR Title 47 Part 20.21** **EIA/TIA 603-D: 2010** **KDB 935210 D03**
TRF Originator ..... :	Shenzhen CTL Testing Technology Co., Ltd.
Master TRF..... :	Dated 2011-01
Date of Receipt..... :	Nov. 01, 2016
Date of Test Date..... :	Nov. 02, 2016–Dec. 01, 2016
Data of Issue..... :	Dec. 02, 2016
Result..... :	Pass

TEST REPORT

Test Report No. :	CTL1610114401-WF	Dec. 02, 2016
		Date of issue

Equipment under Test	:	Mobile Phone Signal Repeater
Model /Type	:	L2S
Listed Models	:	L3S, L4S, L5S
Applicant	:	**Shenzhen Longsheng Electronic Technology Co., Ltd**
Address	:	3D Buliding C, No.8 of Shangxue Science & Technology Park East, Jihua Road, Bantian, Longgang District, Shenzhen, China
Manufacturer	:	**Shenzhen Longsheng Electronic Technology Co., Ltd**
Address	:	3D Buliding C, No.8 of Shangxue Science & Technology Park East, Jihua Road, Bantian, Longgang District, Shenzhen, China

Test result	**Pass ***

* In the configuration tested, the EUT complied with the standards specified page 5.

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

** Modified History **

Revisions	Description	Issued Data	Report No.	Remark
Version 1.0	Initial Test Report Release	2016-12-02	CTL1610114401-WF	Tracy Qi

Contents

1 SUMMARY

1.1 TEST STANDARDS

The tests were performed according to following standards:
FCC Part 20.21: COMMERCIAL MOBILE SERVICES, Signal boosters
TIA/EIA 603 D June 2010: Land Mobile FM or PM Communications Equipment Measurement and Performance Standards.
KDB 935210 D03 Signal Booster Measurements v04: PROVIDER-SPECIFIC CONSUMER SIGNAL BOOSTERS COMPLIANCE MEASUREMENTS GUIDANCE

1.2 Test Description

Test Item	Section in CFR 47	Result
Authorized frequency band verification test	20.21(e)(3)	Pass
Maximum power	20.21(e)(8)(i)(D)	Pass
Maximum booster gain computation	20.21(e)(8)(i)(C)(2)	Pass
Inter-modulation	20.21(e)(8)(i)(F)	Pass
Out-of-band emissions	20.21(e)(8)(i)(E)	Pass
Conducted spurious emissions	2.1051; 22.917(a); 24.238(a)	Pass
Noise limits	20.21(e)(8)(i)(A)	Pass
Uplink inactivity	20.21(e)(8)(i)(I)	Pass
Variable booster gain	20.21(e)(8)(i)(C)(1)	Pass
Oscillation Detection	20.21(e)(8)(ii)(A) 20.21(e)(5)	Pass
Oscillation Mitigation	20.21(e)(8)(ii)(A) 20.21(e)(5)	Pass
Radiated Spurious Emission	2.1053	Pass
Occupied bandwidth	2.1049	Pass
Spectrum Block Filtering (This only applies to devices utilizing spectrum block filtering)	20.21(e)(8)(i)(B)	NA

1.3 Test Facility

1.3.1 Address of the test laboratory

Shenzhen CTL Testing Technology Co., Ltd.
Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4 and CISPR 22/EN 55022 requirements.

1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

IC Registration No.: 9618B

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B on November 13, 2013.

FCC-Registration No.: 970318

Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 970318, December 19, 2013.

1.4 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 „Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements “and is documented in the Shenzhen CTL Testing Technology Co., Ltd. Quality system acc. To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CTL laboratory is reported:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.10dB	(1)
Radiated Emission	Above 1GHz	4.32dB	(1)
Conducted Disturbance	0.15~30MHz	3.20dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

2 GENERAL INFORMATION

2.1 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature:	25°C
Relative Humidity:	55 %
Air Pressure:	101 kPa

2.2 General Description of EUT

The EUT is an In-Building bi-directional amplifier for the boosting of cellular phone signals and data communication devices.

Technical specification as follow:

Product Name:	Mobile Phone Signal Repeater
Model/Type reference:	L2S
Rating:	DC 5V from adapter Input:AC100-240V 50/60Hz Output:5V⎓2A
Operation Frequency Band:	Cellular:824-849MHz(Uplink), 869-894MHz(Downlink) Broadband PCS:1850-1910MHz (Uplink),1930-1990MHz (Downlink)
Modulation Type:	GSM, CDMA, EDGE, HSPA, EVDO, LTE
Max.Gain:	Uplink:48dB Downlink:48dB
ACG level:	Uplink:-25dBm Downlink:-55dBm
Max antenna gain:	Uplink:10dBi Downlink:10dBi

Emission Designators:

CDMA	HSPA	LTE	EVDO	EDGE	GSM
F9W	F9W	G7D	F9W	G7W	GXW

2.3 Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
Bilog Antenna	Sunol Sciences Corp.	JB1	A061713	2016/06/02	2017/06/01
Bilog Antenna	Sunol Sciences Corp.	JB1	A061714	2016/06/02	2017/06/01
EMI Test Receiver	R&S	ESCI	103710	2016/06/02	2017/06/01
Spectrum Analyzer	R&S	FSP	1164.4391.38	2016/01/17	2017/01/16
Controller	EM Electronics	Controller EM 1000	N/A	2016/05/21	2017/05/20
Horn Antenna	Sunol Sciences Corp.	DRH-118	A062013	2016/05/19	2017/05/18
Horn Antenna	Sunol Sciences Corp.	DRH-118	A062014	2016/05/19	2017/05/18
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2016/05/19	2017/05/18
Amplifier	Agilent	8349B	3008A02306	2016/05/19	2017/05/18
Amplifier	Agilent	8447D	2944A10176	2016/05/19	2017/05/18
Temperature/Humidity Meter	Gangxing	CTH-608	02	2016/05/20	2017/05/19
Radio Communication Tester	R&S	CMW500	116440	2016/05/22	2017/05/21
High-Pass Filter	K&L	9SH10-2700/ X12750-O/O	N/A	2016/05/20	2017/05/19
High-Pass Filter	K&L	41H10-1375/ U12750-O/O	N/A	2016/05/20	2017/05/19
RF Cable	HUBER+SUHNER	RG214	N/A	2016/05/20	2017/05/19
Climate Chamber	ESPEC	EL-10KA	A20120523	2016/05/20	2017/05/19
SIGNAL GENERATOR	Agilent	E4421B	US40051744	2016/05/20	2017/05/19
Directional Coupler	Agilent	87300B	3116A03638	2016/01/27	2017/01/26
MXG Vector Signal Generator	Agilent	N5182A	MY50142850	2016/01/15	2017/01/14
Power sensor	R&S	NRP-Z21	102638	2016/05/19	2017/05/18

2.4 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: 2AK8U-L2S** filing to comply with of the FCC Part 20 Rules.

2.5 Modifications

No modifications were implemented to meet testing criteria.

3 TEST CONDITIONS AND RESULTS

3.1 Authorized frequency band verification

LIMIT

None

TEST CONFIGURATION

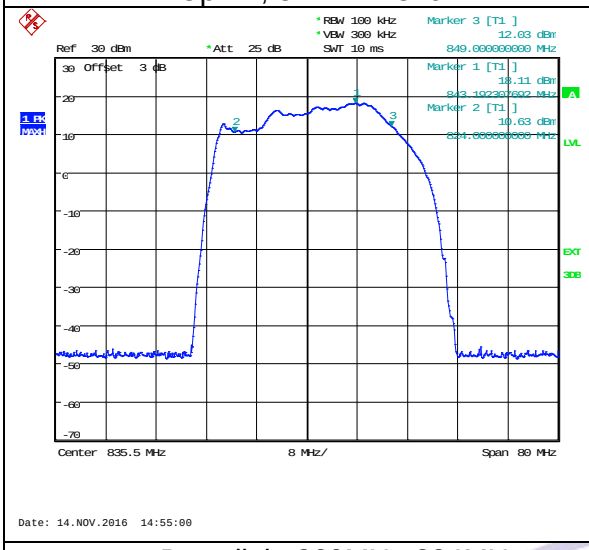
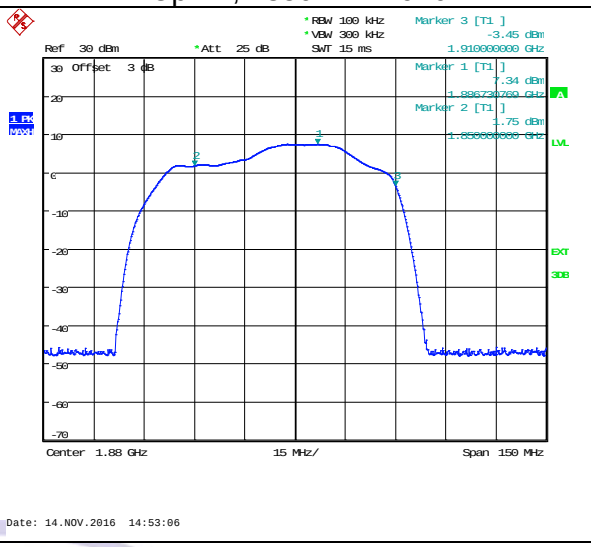
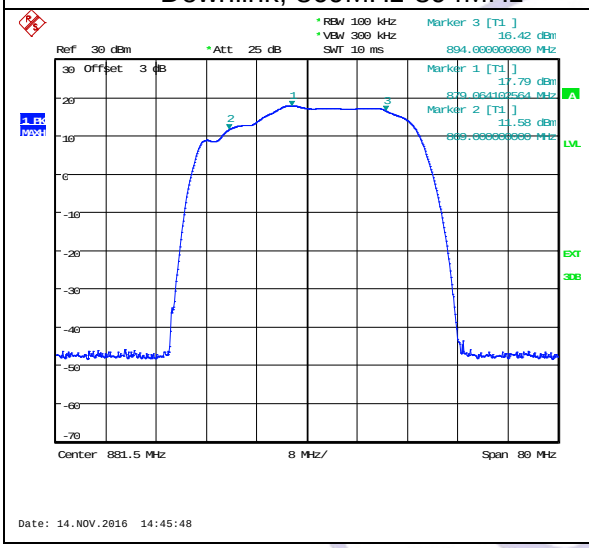
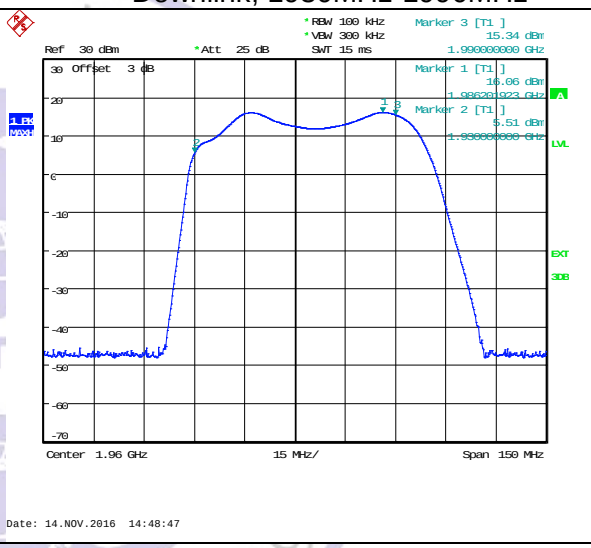
Uplink test configuration

Downlink test configuration

TEST PROCEDURE

a) Connect the EUT to the test equipment either in test mode or normal mode and set the passband of the EUT to the lowest passband frequency of the booster in the CMRS band.
b) Set the spectrum analyzer resolution bandwidth (RBW) for 100 KHz with the video bandwidth (VBW) ≥ 3* 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 5 MHz.
d) Set the signal generator for CW mode and tune to the center frequency of the operational band under test. Alternatively, for signal boosters that implement narrowband rejection protection capability, a 200 KHz or an AWGN signal with a 99% occupied bandwidth (OBW) of 4.1 MHz can be used, as appropriate.
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, then manually reset the EUT (e.g., cycle ac/dc power).
h) Reset the spectrum analyzer span to 2*the width of the CMRS band under test. Adjust the tuned frequency of the signal generator to sweep 2* the width of the CMRS band using the sweep function. The AGC must be deactivated throughout the 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 7.1c) to 7.1j) for all operational uplink and downlink bands with the passband of the booster set to the center of the CMRS band and the highest and lowest passband frequencies of the booster in the CMRS band.

TEST RESULTS

Uplink, 824MHz-849MHz	Uplink, 1850MHz-1910MHz
	
Downlink, 869MHz-894MHz	**Downlink, 1930MHz-1990MHz**
	

3.2 Maximum power

LIMIT

A booster's uplink power must not exceed 1 watt 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.

TEST CONFIGURATION

Uplink test configuration

Downlink test configuration

TEST PROCEDURE

a) Connect the EUT in test mode.
b) Configure the signal generator and spectrum analyzer for operation on the frequency with the highest power level as determined.
c) Set the initial signal generator power to a level far below the AGC threshold level.
d) Slowly increase the signal generator power level until the output signal reaches the AGC threshold level as determined from observation of the signal behavior on the spectrum analyzer (i.e., 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 limiting the output power.
f) Slowly increase the signal generator power to a level just below (and within 0.5 dB of) the AGC threshold without triggering the AGC. Note the signal generator power level as (Pin).
g) Measure the output power (Pout) with the spectrum analyzer as follows.
   1) Set RBW = 100 kHz for AWGN signal type, or 300 kHz for CW or GSM signal type.
   2) Set VBW ≥ 3*RBW.
   3) Select either the BURST POWER or CHANNEL POWER measurement mode, as appropriate for each signal type. For AWGN, the channel power integration bandwidth shall be the 99% OBW of the 4.1 MHz signal.
   4) Select the power averaging (rms) detector.
   5) Affirm that the number of measurement points per sweep ≥ (2*span)/RBW.
   NOTE–This requirement does not apply for BURST power measurement mode.

6) Set sweep time = auto couple, or as necessary (but no less than auto couple value).
7) Trace average at least 100 traces in power averaging (i.e., rms) mode.
8) Record the measured power level Pout, with one set of results for the GSM or CW input stimulus, and another set of results for the AWGN input stimulus.
h) Repeat step 7.2.2g) while increasing the signal generator amplitude in 2 dB steps until the maximum input level indicated in 5.5 is reached. Ensure that the EUT maintains compliance with applicable power limits.
i) Repeat the procedure for each operational uplink and downlink frequency band supported by the booster.

j) Provide tabulated results in the test report.

TEST RESULTS

Mode	Band (MHz)	Signal type	Input level (dBm)	Output level (dBm)	Ant Gain (dBi)	Outside Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
Uplink	824-849	AWGN	-26.5	15.41	10.00	2.06	23.35	≤30
		GSM	-27.8	16.35	10.00	2.06	24.29	
Uplink	1850-1910	AWGN	-26.4	15.33	10.00	2.74	22.59	
		GSM	-26.7	14.29	10.00	2.74	21.55	

Mode	Band (MHz)	Signal type	Input level (dBm)	Output level (dBm)	Ant Gain (dBi)	Inside Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
Downlink	869-894	AWGN	-55.4	-6.75	10.00	1.37	1.88	≤17
		GSM	-56.4	-7.48	10.00	1.37	1.15	
Downlink	1930-1990	AWGN	-56.3	-6.89	10.00	1.99	1.12	
		GSM	-55.8	-7.52	10.00	1.99	0.49	

Calculation: EIRP =Output Power -Cable loss +Antenna gain
Uplink use Extension Cables: ACX100 (30feet)
Downlink use Extension Cables: ACX300 (20feet)

3.3 Maximum booster gain computation

LIMIT

Gain Limit (dB) = 6.5 dB + 20Log (F_{MHz}) while F_{MHz} is the uplink mid-band frequency with the downlink gain limit being equivalent to the paired Uplink band gain limit. The difference between uplink and downlink gain should be ≤ 9dB.

TEST CONFIGURATION

Uplink test configuration

Downlink test configuration

TEST PROCEDURE

a) Connect the EUT in test mode.
b) Configure the signal generator and spectrum analyzer for operation on the frequency with the highest power level as determined.
c) Set the initial signal generator power to a level far below the AGC threshold level.
d) Slowly increase the signal generator power level until the output signal reaches the AGC threshold level as determined from observation of the signal behavior on the spectrum analyzer (i.e., 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 limiting the output power.
f) Slowly increase the signal generator power to a level just below (and within 0.5 dB of) the AGC threshold without triggering the AGC. Note the signal generator power level as (Pin).
g) Measure the output power (Pout) with the spectrum analyzer as follows.
    1) Set RBW = 100 kHz for AWGN signal type, or 300 kHz for CW or GSM signal type.
    2) Set VBW ≥ 3*RBW.
    3) Select either the BURST POWER or CHANNEL POWER measurement mode, as appropriate for each signal type. For AWGN, the channel power integration bandwidth shall be the 99% OBW of the 4.1 MHz signal.
    4) Select the power averaging (rms) detector.
    5) Affirm that the number of measurement points per sweep ≥ (2*span)/RBW. NOTE–This requirement does not apply for BURST power measurement mode.
    6) Set sweep time = auto couple, or as necessary (but no less than auto couple value).
    7) Trace average at least 100 traces in power averaging (i.e., rms) mode.
    8) Record the measured power level Pout, with one set of results for the GSM or CW input stimulus, and another set of results for the AWGN input stimulus.
h) Repeat step g) while increasing the signal generator amplitude in 2 dB steps until the maximum input level is reached. Ensure that the EUT maintains compliance with applicable power limits.
i) Repeat the procedure for each operational uplink and downlink frequency band supported by the booster.
j) Provide tabulated results in the test report.

TEST RESULTS

Gain Limit calculation	
Central frequency of uplink band (MHz)	Calculated Limit (dBi)
836.5	64.95
1880	71.98
Central frequency of downlink band (MHz)	Calculated Limit (dBi)
881.5	65.40
1960	72.35
Note: Gain Limit (dB) = 6.5 + 20LogF (MHz)	

Gain test result						
Mode	Band (MHz)	Signal type	Pre AGC Input level (dBm)	Conducted Output level (dBm)	Gain (dB)	Gain limit (dB)
Uplink	824-849	AWGN	-26.5	18.75	45.25	64.95
		GSM	-25.2	21.05	46.25	
	1850-1910	AWGN	-24.7	20.77	45.47	71.98
		GSM	-26.8	16.72	43.52	
Downlink	869-894	AWGN	-56.8	-10.65	46.15	65.40
		GSM	-58.4	-16.15	42.25	
	1930-1990	AWGN	-56.3	-12.74	43.56	72.35
		AWGN	-57.1	-12.28	44.82	

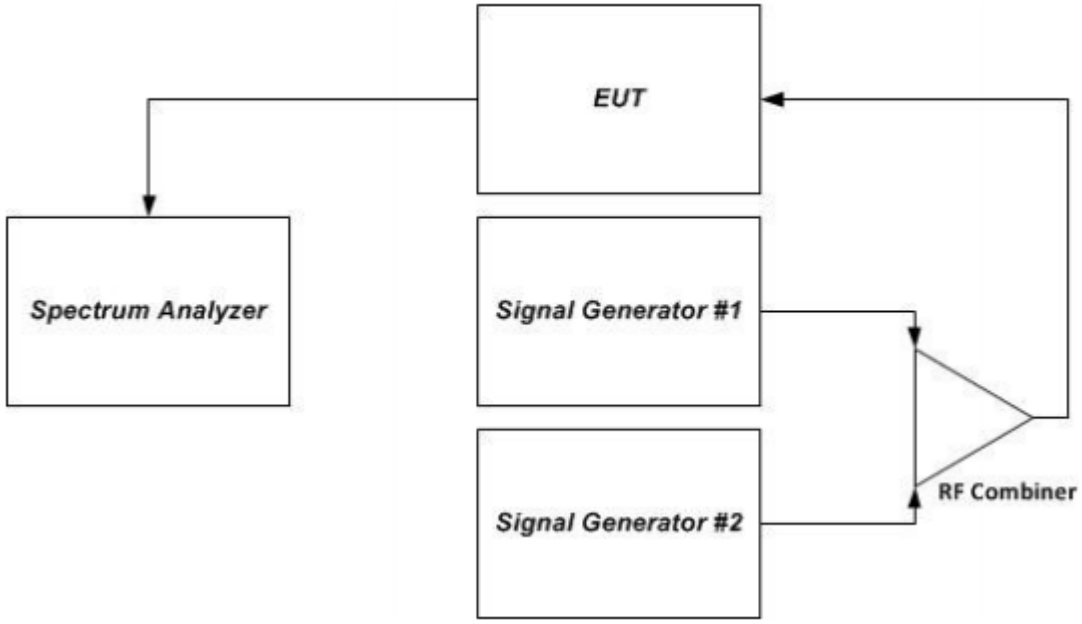
Difference between uplink and downlink gain					
Band (MHz)	Signal type	Uplink Gain (dB)	Downlink Gain (dB)	Difference (dB)	Limit (dB)
824-849	AWGN	45.25	46.15	0.90	+/-9
869-894	GSM	46.25	42.25	-4.00	
1850-1910	AWGN	45.47	43.56	-1.91	
1930-1990	GSM	43.52	44.82	1.30	

3.4 Inter-modulation

LIMIT

Inter-modulation Level ≤ -19dBm

TEST CONFIGURATION



TEST PROCEDURE

a) Begin with the uplink output (donor) port connected to the spectrum analyzer.
b) Set the spectrum analyzer RBW = 3 kHz.
c) Set the VBW ≥ 3* 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 5MHz. Affirm that the number of measurement points per sweep ≥ (2*span)/RBW.
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, then turn on the RF output.
i) Simultaneously increase each signal generators' amplitude equally until just before the EUT begins AGC, then affirm that all intermodulation-product emissions (if any occur) are below the specified limit of −19dBm.
j) Use the trace averaging function of the spectrum analyzer, and wait for the trace to stabilize. Place a marker at the highest amplitude intermodulation-product emission.
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 7.4e) to 7.4l) for all uplink and downlink operational bands.
NOTE–If using a single signal generator with dual outputs, affirm 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, but not exceeding the maximum input level of power test, to affirm that the EUT maintains compliance with the intermodulation limit.

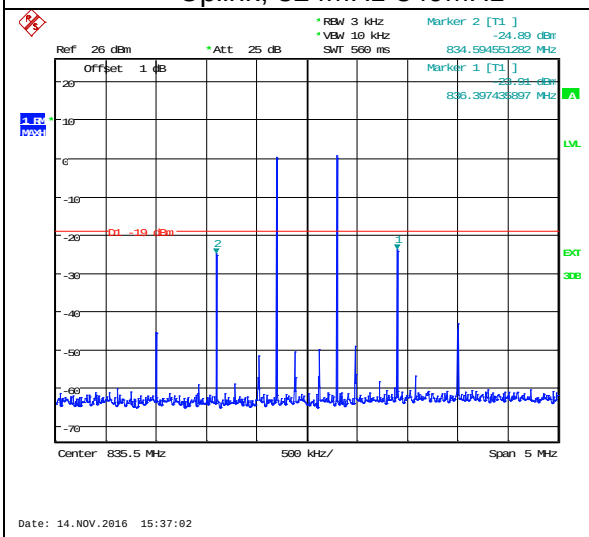
TEST RESULT

AGC Level

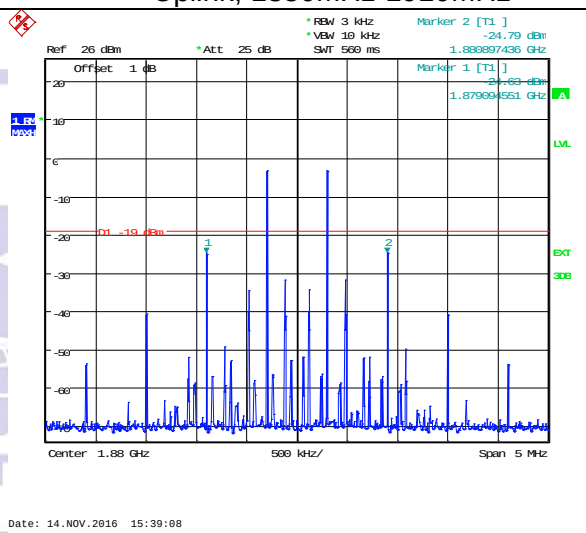
Uplink			
Frequency Band	Intermodulation Level (dBm)	Limit (dBm)	Results
824 – 849 MHz	-22.91	-19	PASS
1850 – 1910 MHz	-24.79	-19	PASS
Downlink			
Frequency Band	Intermodulation Level (dBm)	Limit (dBm)	Results
869 – 894 MHz	-20.28	-19	PASS
1930 – 1900 MHz	-22.58	-19	PASS

AGC Level

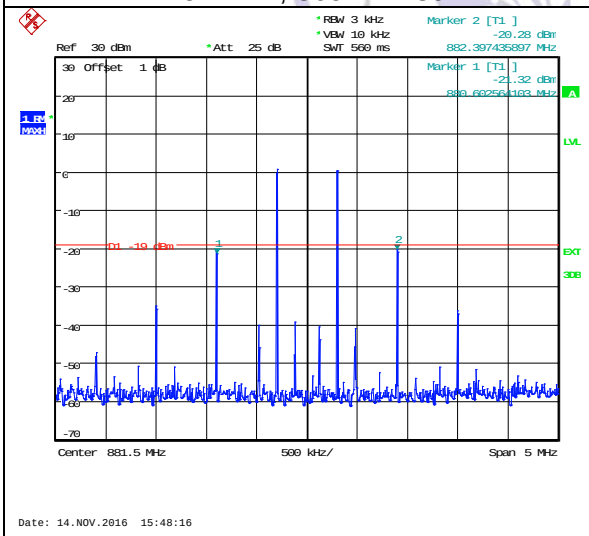
Uplink, 824MHz-849MHz



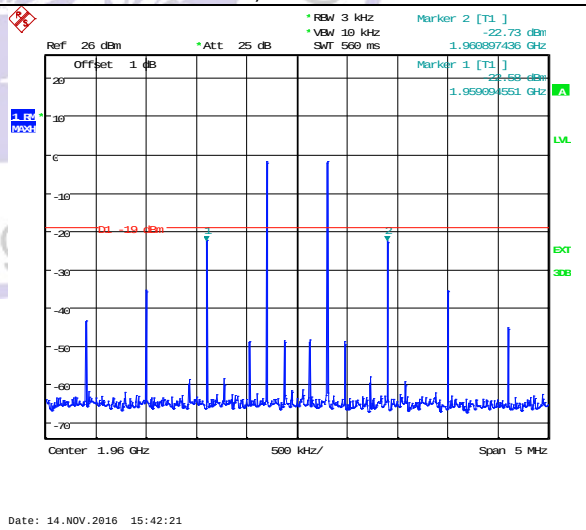
Uplink, 1850MHz-1910MHz



Downlink, 869MHz-894MHz



Downlink, 1930MHz-1990MHz

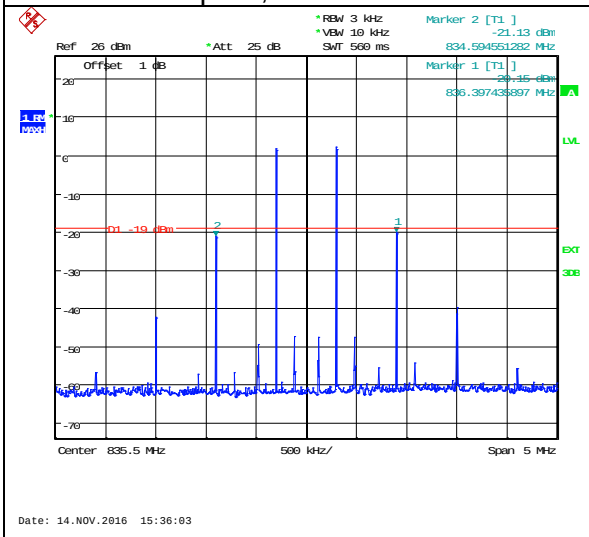


AGC Level + 10dB

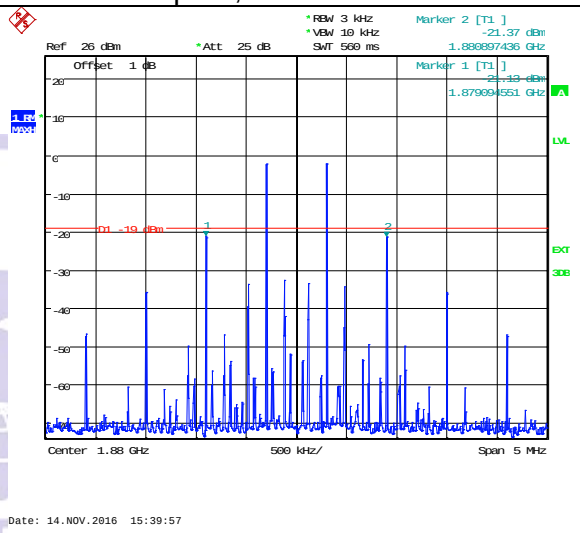
Uplink			
Frequency Band	Intermodulation Level (dBm)	Limit (dBm)	Results
824 – 849 MHz	-20.15	-19	PASS
1850 – 1910 MHz	-21.13	-19	PASS
Downlink			
Frequency Band	Intermodulation Level (dBm)	Limit (dBm)	Results
869 – 894 MHz	-19.85	-19	PASS
1930 – 1900 MHz	-19.64	-19	PASS

AGC Level add 10dB

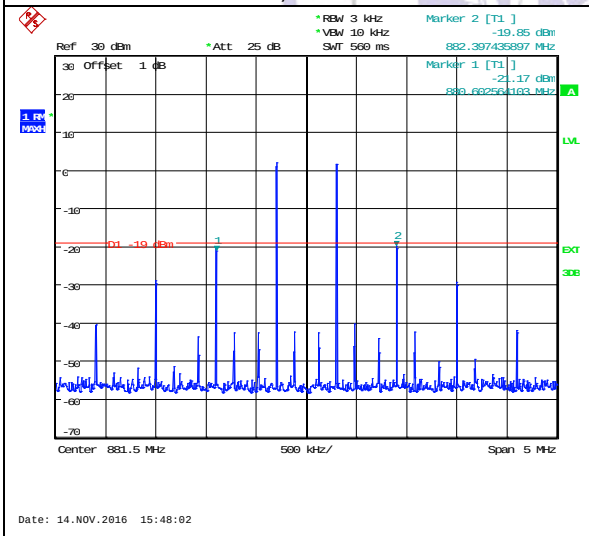
Uplink, 824MHz-849MHz



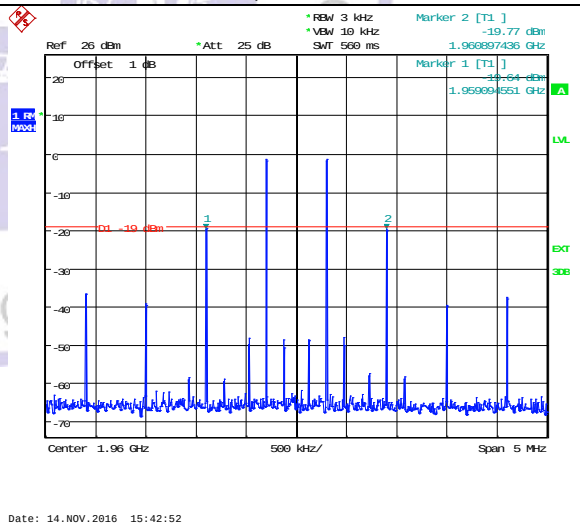
Uplink, 1850MHz-1910MHz



Downlink, 869MHz-894MHz



Downlink, 1930MHz-1990MHz

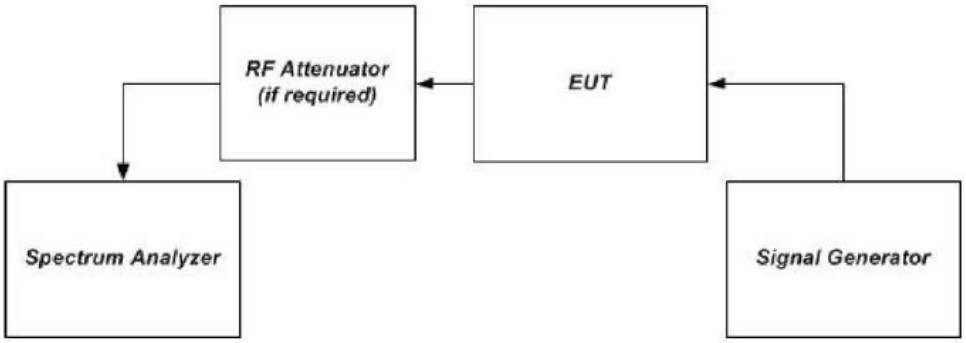


3.5 Out-of-band emissions

LIMIT

Out-of-band Emissions Limit = P1 - 6 - (43+ 10Log (P2)) = -19dBm
P1 = power in dBm
P2 = power in Watts

TEST CONFIGURATION



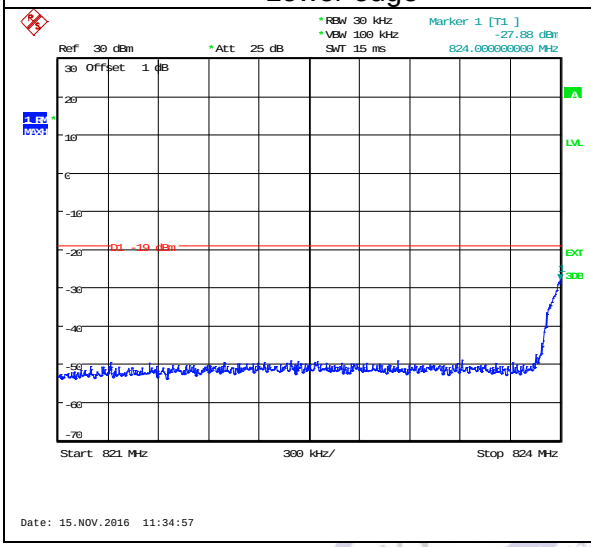
TEST PROCEDURE

a) Begin with the uplink output (donor) port connected to the spectrum analyzer.
b) Configure the signal generator for the appropriate operation for all uplink and downlink bands:
1) GSM: 0.2 MHz from upper and lower band edges.
2) LTE (5 MHz): 2.5 MHz from upper and lower band edges.
3) CDMA: 1.25 MHz from upper and lower band edges, except for cellular band 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 use 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–When using an AWGN test signal, the bandwidth shall be the measured 99% OBW.
c) Set the signal generator amplitude to the maximum power level prior to AGC similar to the power measurement procedures for the appropriate modulations.
d) Set RBW = measurement bandwidth specified in the applicable rule section for the supported frequency band.
e) Set VBW = 3* RBW.
f) Select the power averaging (rms) 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: 300 kHz (when operational frequency is < 1 GHz), or 3 MHz (when operational frequency is ≥ 1 GHz).
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 is reached. Affirm that the EUT maintains compliance with the OOBE limits.
m) Reset the analyzer start frequency to the lower band/block edge frequency minus: 300 kHz (when operational frequency is < 1 GHz), or 3 MHz (when operational frequency is ≥ 1 GHz), and the stop frequency to the lower band/block edge frequency, then repeat i) to l).
n) Repeat b) through m) for each uplink and downlink operational band.

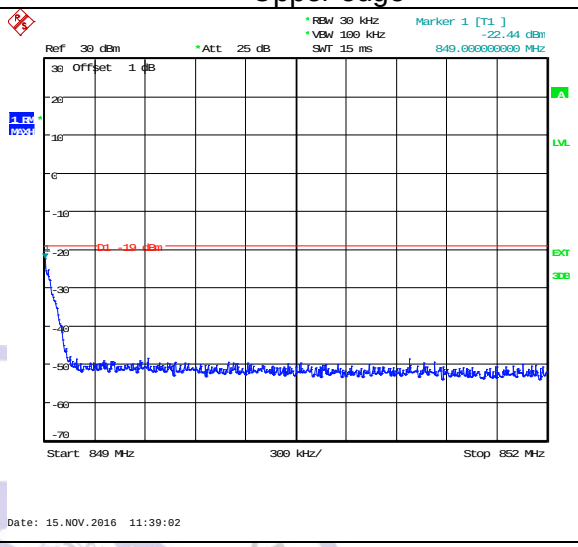
TEST RESULT

GSM Uplink, 824MHz-849MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
824.00	-27.88	-19.00	Pass
849.00	-22.44	-19.00	Pass

Lower edge

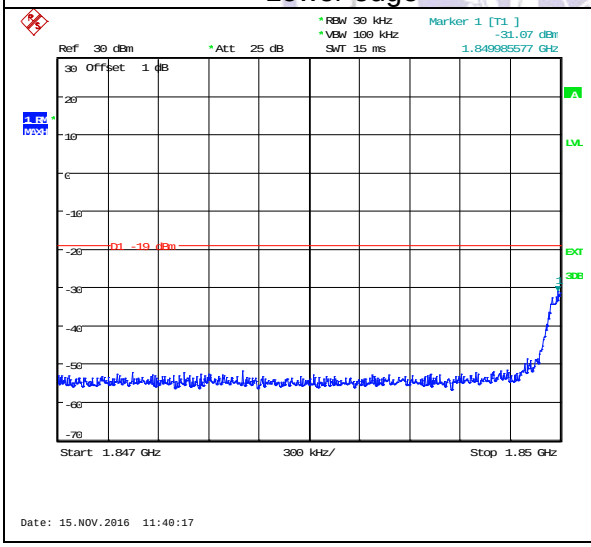


Upper edge

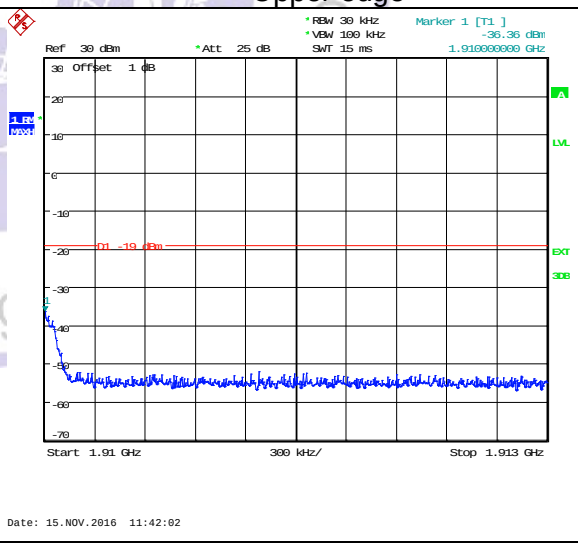


GSM Uplink, 1850MHz-1910MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
1849.9856	-31.07	-19.00	Pass
1910.0000	-36.36	-19.00	Pass

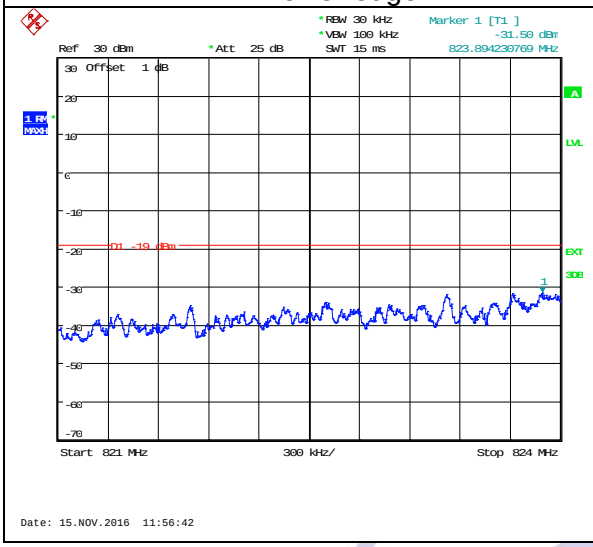
Lower edge

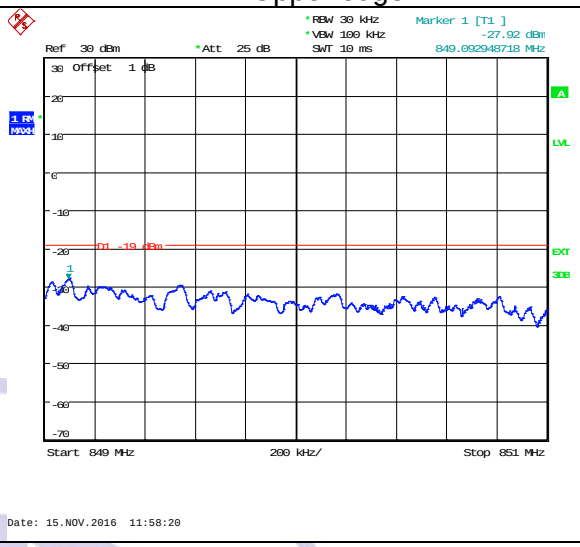


Upper edge

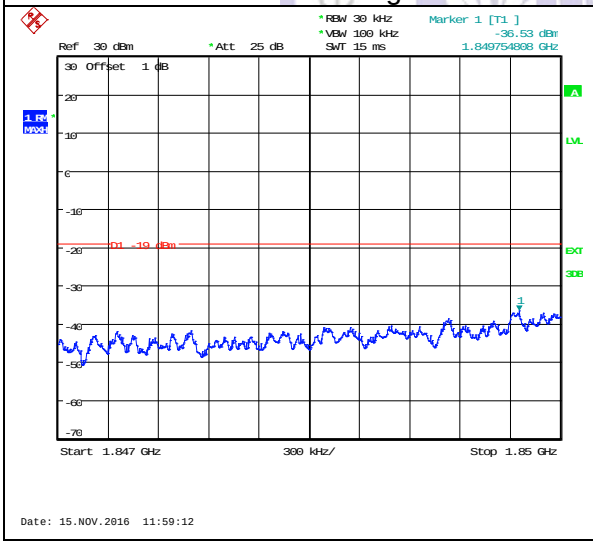


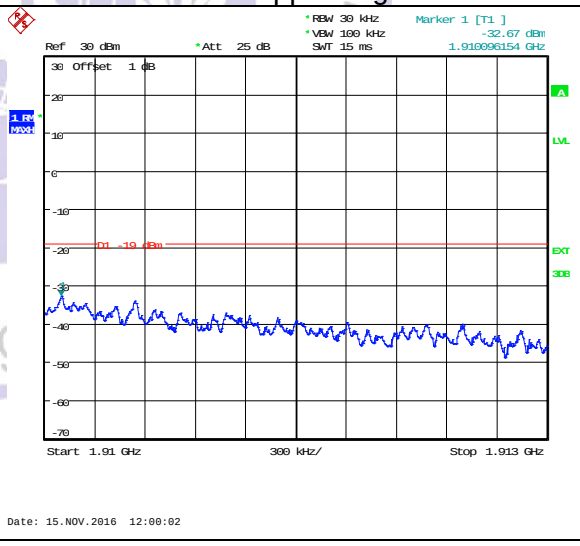
WCDMA/ LTE Uplink, 824MHz-849MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
823.8942	-31.50	-19.00	Pass
849.0929	-27.92	-19.00	Pass
Lower edge		Upper edge	



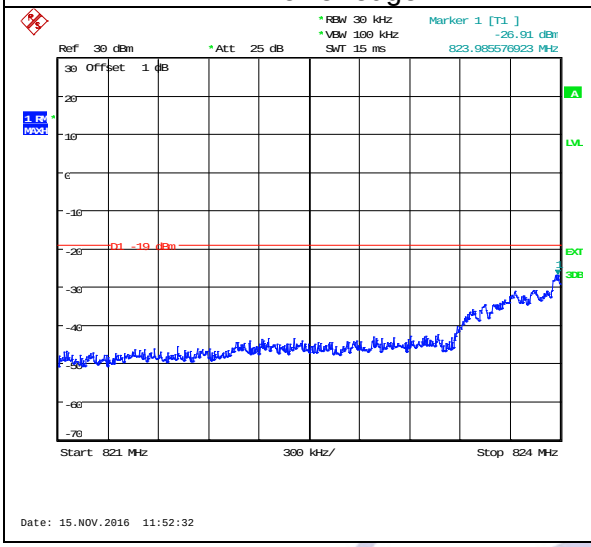


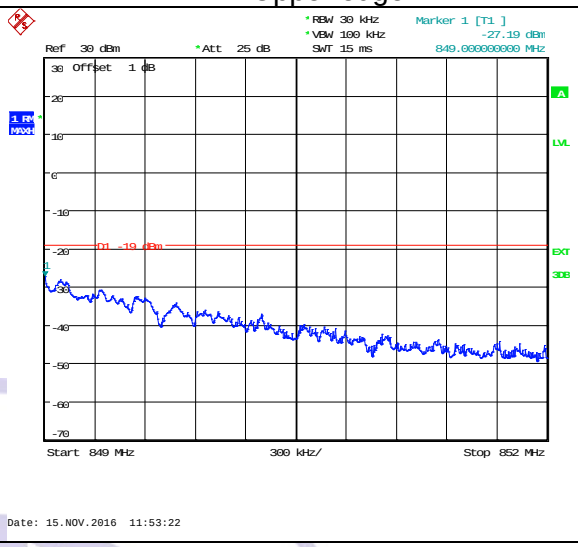
WCDMA/ LTE Uplink, 1850MHz-1910MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
1849.7548	-36.53	-19.00	Pass
1910.0962	-32.67	-19.00	Pass
Lower edge		Upper edge	



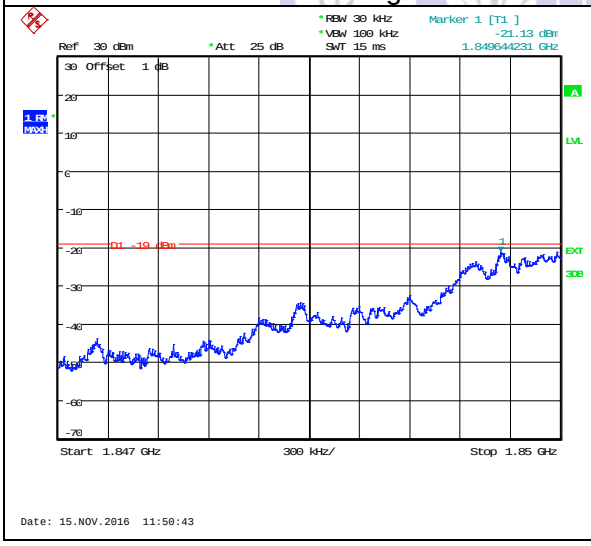


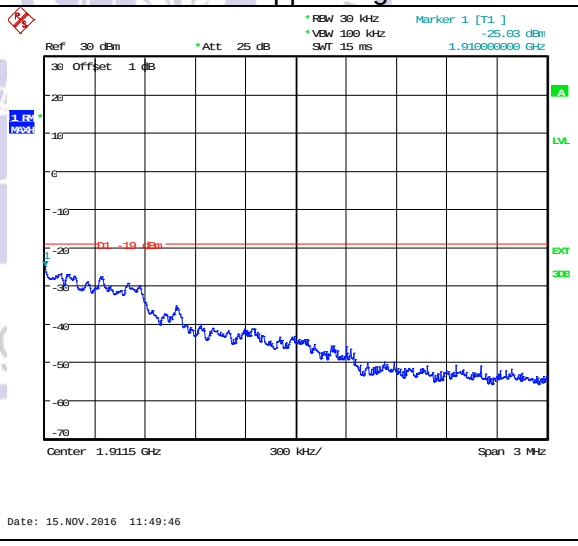
CDMA Uplink, 824MHz-849MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
823.9856	-26.91	-19.00	Pass
849.0000	-27.19	-19.00	Pass
Lower edge		Upper edge	



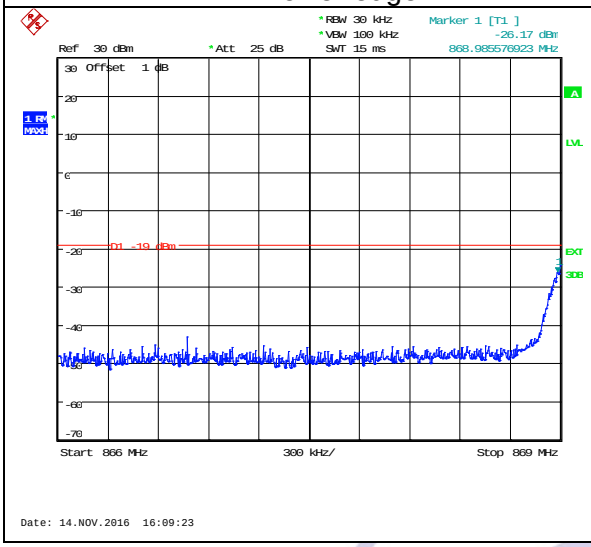


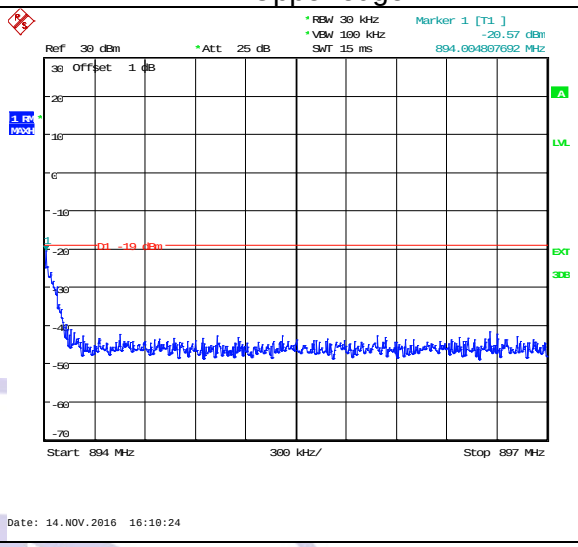
CDMA Uplink, 1850MHz-1910MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
1849.6442	-21.13	-19.00	Pass
1910.0000	-25.03	-19.00	Pass
Lower edge		Upper edge	



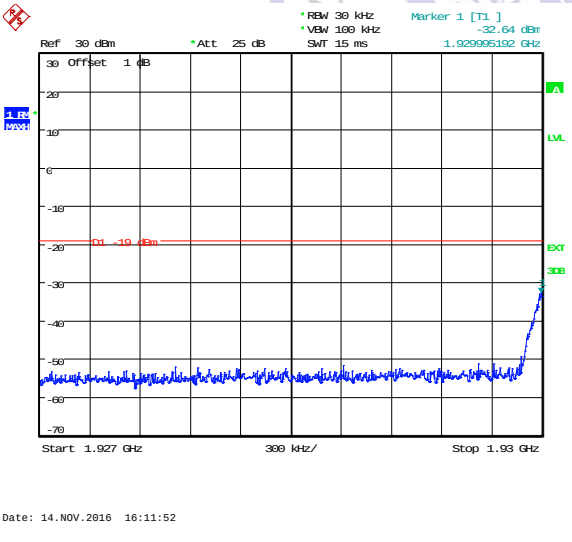


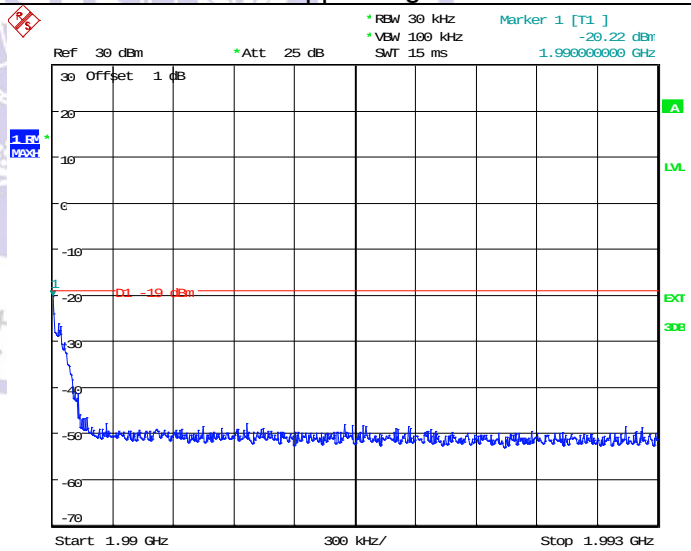
GSM Downlink, 869MHz-894MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
868.9856	-26.17	-19.00	Pass
894.0048	-20.57	-19.00	Pass
Lower edge		Upper edge	



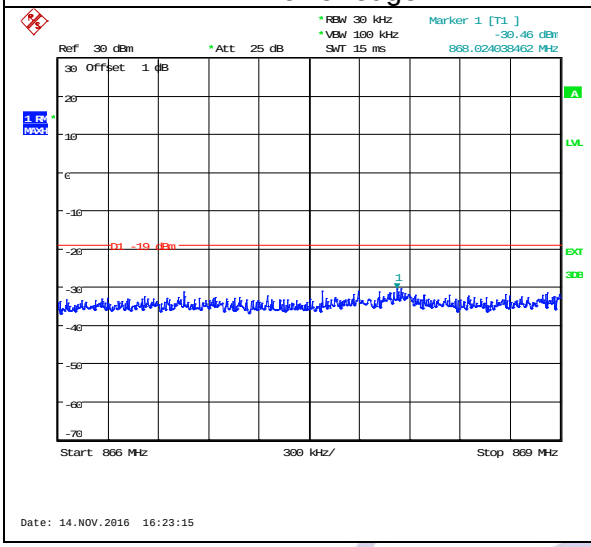


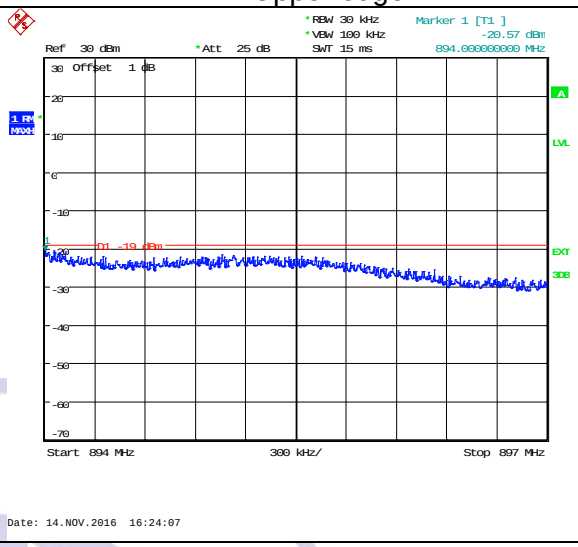
GSM Downlink, 1930MHz-1990MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
1829.9952	-31.07	-19.00	Pass
1990.0000	-20.22	-19.00	Pass
Lower edge		Upper edge	



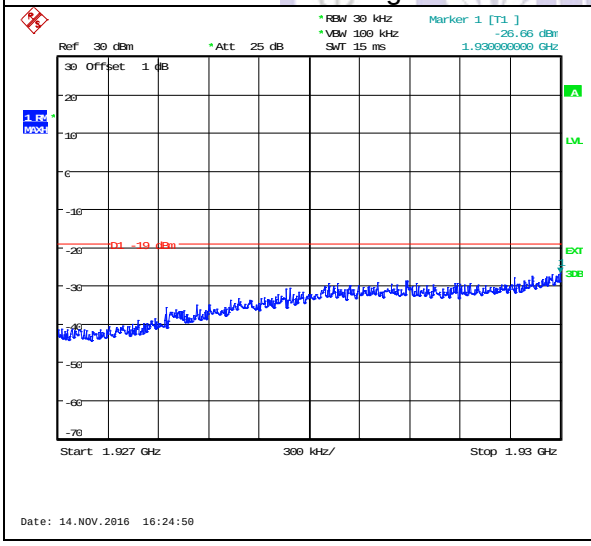


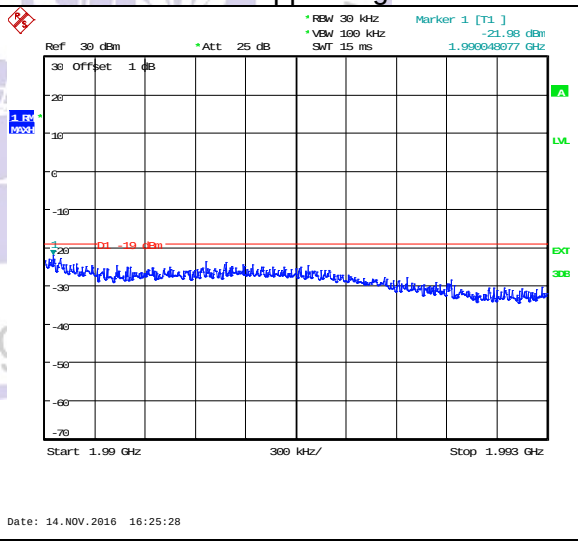
WCDMA/ LTE Downlink, 869MHz-894MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
868.0240	-30.46	-19.00	Pass
894.0000	-20.57	-19.00	Pass
Lower edge		Upper edge	



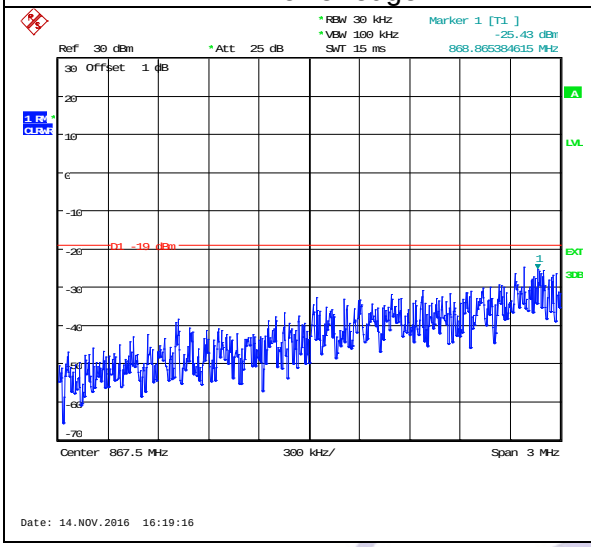


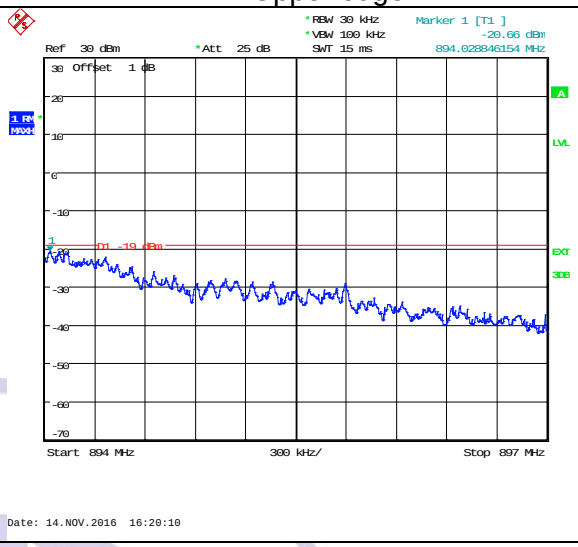
WCDMA/ LTE Downlink, 1930MHz-1990MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
1930.0000	-26.66	-19.00	Pass
1990.0481	-21.99	-19.00	Pass
Lower edge		Upper edge	



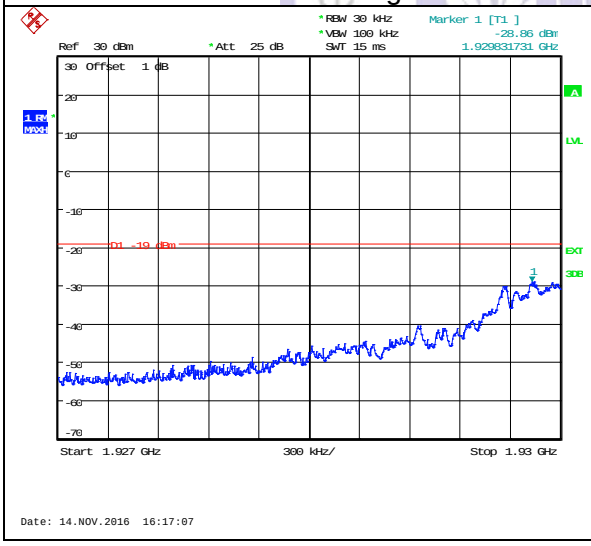


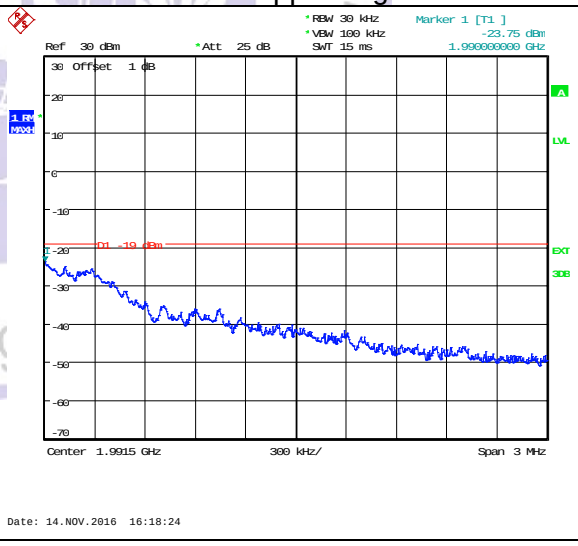
CDMA Downlink, 869MHz-894MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
868.8654	-25.43	-19.00	Pass
849.0288	-20.66	-19.00	Pass
Lower edge		Upper edge	





CDMA Downlink, 1930MHz-1990MHz			
Max Measurement Results		Limit (dBm)	Verdict
Frequency (MHz)	Values (dBm)		
1929.8317	-28.86	-19.00	Pass
1990.0000	-23.75	-19.00	Pass
Lower edge		Upper edge	



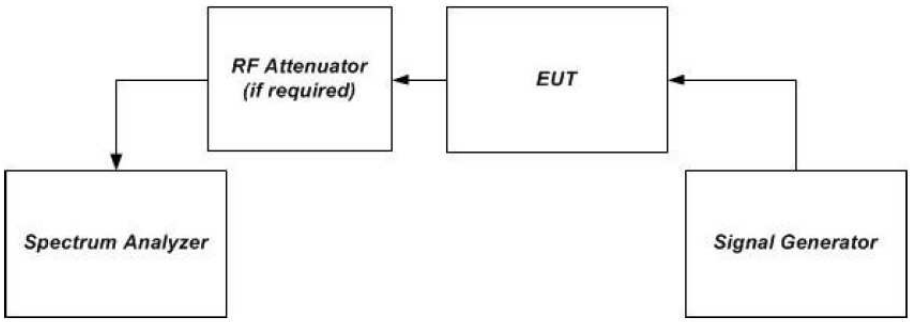


3.6 Conducted spurious emissions

LIMIT

Out-of-band Emissions Limit = P1 - (43+ 10Log (P2)) = -13dBm
P1 = power in dBm
P2 = power in Watts

TEST CONFIGURATION

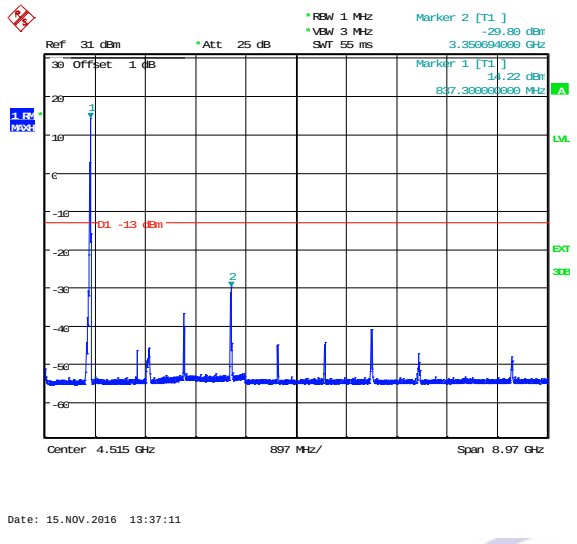
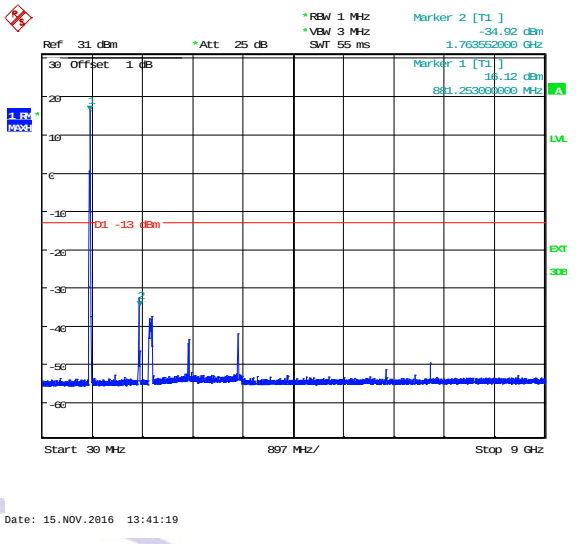
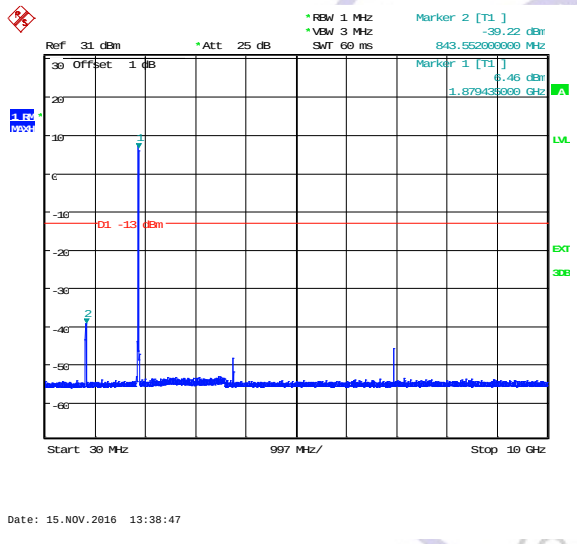
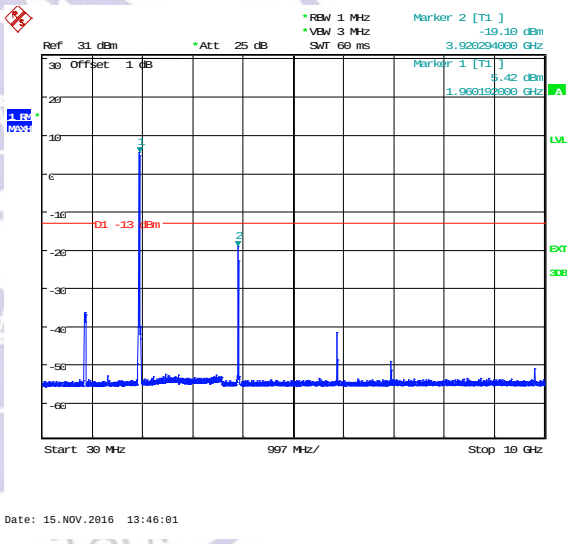
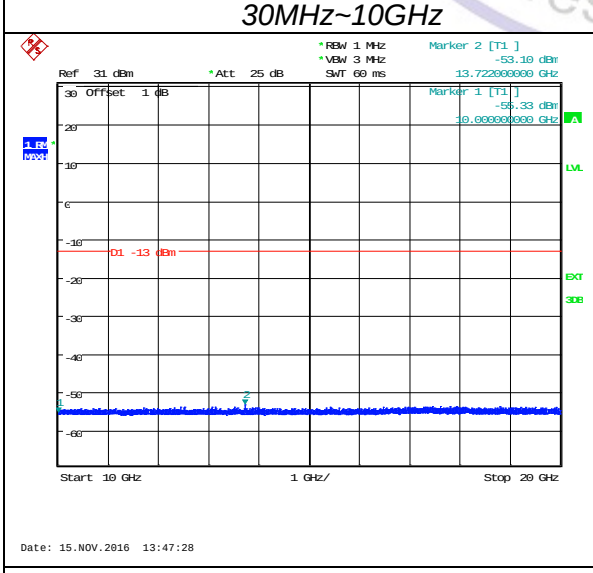
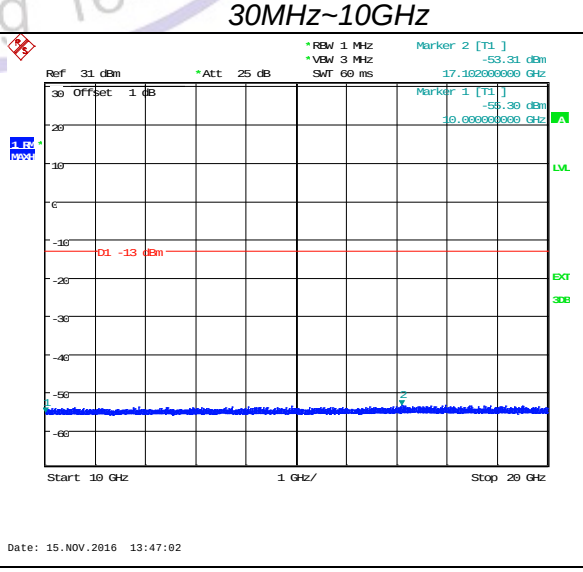


TEST PROCEDURE

a) Begin with the uplink output (donor) port connected to the spectrum analyzer.
b) Configure the signal generator for AWGN with a 99% OBW of 4.1 MHz, 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.
d) Turn on the signal generator RF output and measure the spurious emission power levels with an appropriate measuring instrument as follows.
   1) Set RBW = measurement bandwidth specified in the applicable rule section for the operational frequency band under consideration (see Appendix 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 (EBW)] to enhance measurement accuracy, but the result must then be integrated over the specified measurement bandwidth.
   2) Set VBW = 3*RBW.
   3) Select the power averaging (rms) detector. (See above note regarding the use of a peak detector for preliminary measurements.)
   4) Sweep time = auto-couple.
   5) 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*span/RBW), which may require that the measurement range defined by the preceding start and stop frequencies be subdivided, depending on the available number of measurement points of the spectrum analyzer. Trace average at least 10 traces in power averaging (i.e., rms) mode.
   6) Sweep time = auto-couple.
   7) 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.
   8) 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*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.
   9) 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.

e) Repeat b) through d) for each supported frequency band of operation.

TEST RESULT

Uplink 836.6MHz	Downlink 881.5MHz
	
30MHz~10GHz	30MHz~10GHz
Uplink 1880MHz	Downlink 1960MHz
	
30MHz~10GHz	30MHz~10GHz
	
10GHz ~20GHz	10GHz~20GHz

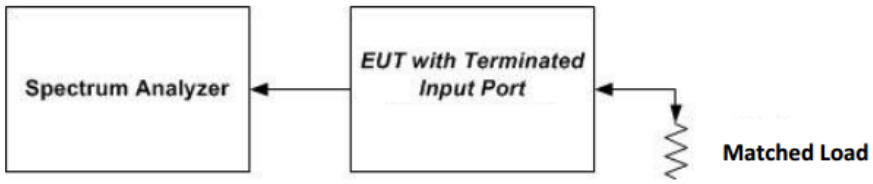
3.7 Noise limits

LIMIT

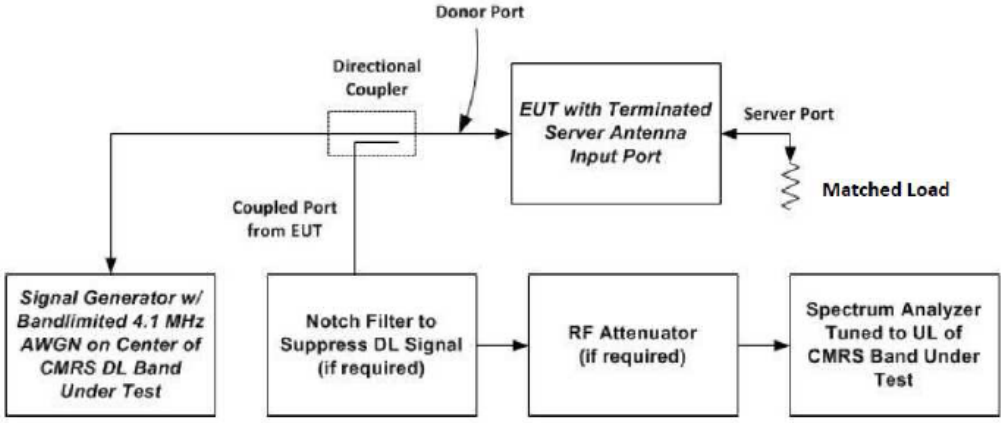
Noise Power = -102.5 + LOG10 (Band Center Frequency)*20
Variable Noise of uplink mode = -103dBm/MHz - RSSI

TEST CONFIGURATION

Noise limit



Uplink noise power measurement in the presence of a downlink signal



TEST PROCEDURE

Maximum transmitter noise power level

a) Connect the EUT to the test equipment as shown in 'Noise limit'. Begin with the uplink output (donor) port connected to the spectrum analyzer. When measuring downlink noise, connect the downlink output (server) port to the spectrum analyzer.
b) Set the spectrum analyzer RBW to 1 MHz with the VBW ≥ 3*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 ≥ 2*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 b) to f) for all operational uplink and downlink bands.
h) Connect the EUT to the test equipment as shown in 'Uplink noise power measurement in the presence of a downlink signal' for uplink noise power measurement in the presence a downlink signal. Affirm the coupled path of the RF coupler is connected to the spectrum analyzer.
i) Configure the signal generator for AWGN operation with a 99% OBW of 4.1MHz.
j) Set the spectrum analyzer RBW for 1 MHz, VBW ≥ 3*RBW, with a power averaging (rms) 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 ≥ 2*the CMRS band. This shall include all spectrum blocks in the particular CMRS band under test.
l) 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.
m) Measure the maximum transmitter noise power level while varying the downlink signal generator output level from −90 dBm to −20 dBm, as measured at the input port (i.e., downlink signal level at the booster donor port node of 'Uplink noise power measurement in the presence of a downlink signal', in 1 dB steps inside the RSSI-dependent region, and in 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.

n) Repeat h) through m) for all operational uplink bands.

Variable uplink noise timing

Variable uplink noise timing is to be measured as follows, using the test setup shown in 'Uplink noise power measurement in the presence of a downlink signal'.

a) Set the spectrum analyzer to the uplink frequency to be measured.
b) Set the span to 0 Hz, with a sweep time of 10 seconds.
c) Set the power level of signal generator to the lowest level of the RSSI-dependent noise.
d) Select MAX HOLD and increase the power level of signal generator by 10 dB for mobile boosters, and 20 dB for fixed boosters.
e) Confirm that the uplink noise decreases to the specified level within 1 second for mobile devices, and within 3 seconds for fixed devices.
f) Repeat a) to e) for all operational uplink bands.
g) Include plots and summary table in test report.

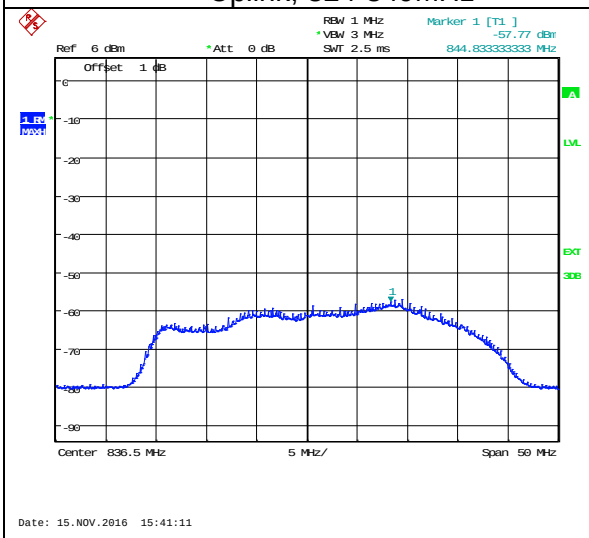
Noise Power limit calculation		
Band (MHz)	Central Frequency of Band (MHz)	Calculated Limit
824-849	836.5	-44.05
869-894	881.5	-43.60
1850-1910	1880.0	-37.02
1930-1990	1960.0	-36.65
Note: Calculated Limit = -102.5 + LOG10(Band Center Frequency)*20		

Lowest RSSI value of RSSI dependent Zone calculation	
Band (MHz)	Calculated Lowest RSSI value (dBm)
824-849	-58.95
1850-1910	-65.98
Note: Calculated Lowest RSSI value = -103 - Noise Power limit of above table	

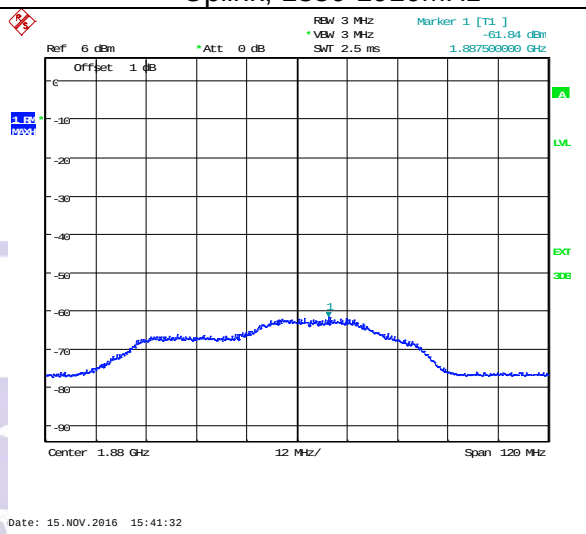
TEST RESULT

Noise Power Test Result				
Mode	Band (MHz)	Max reading (dBm)	Limit (dBm)	Margin (dB)
Uplink	824-849	-57.77	-44.05	13.72
Uplink	1850-1910	-61.84	-37.02	24.82
Downlink	869-894	-55.13	-43.60	11.53
Downlink	1930-1990	-54.29	-36.65	17.64

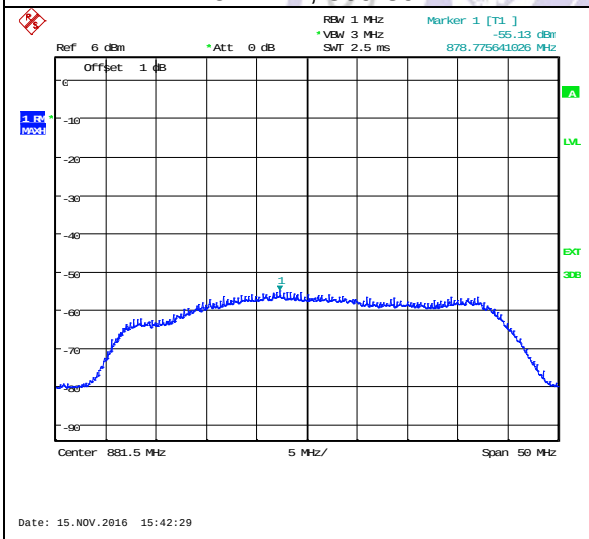
Uplink, 824-849MHz



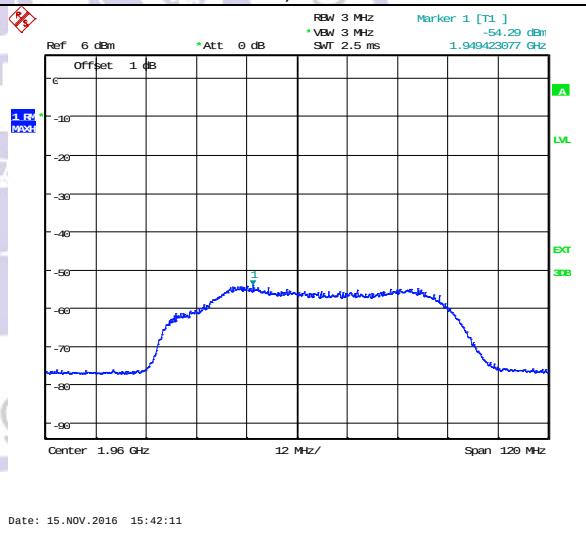
Uplink, 1850-1910MHz



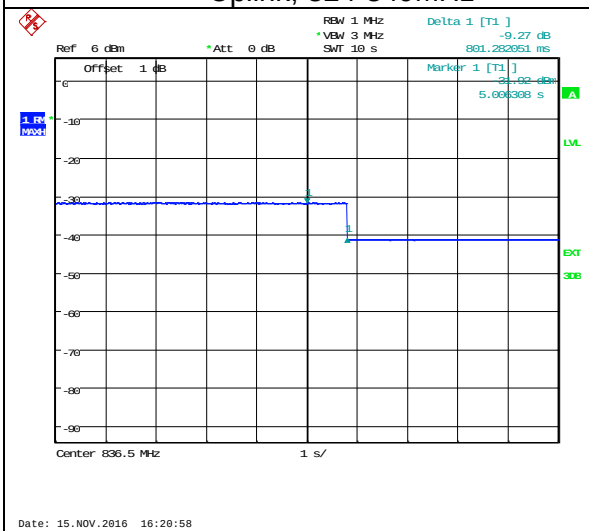
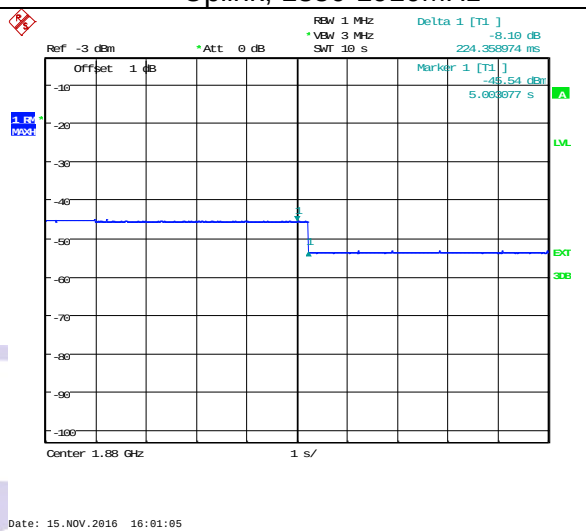
Downlink, 869-894MHz



Downlink, 1930-1990MHz



Uplink Noise Timing Test Result				
Mode	Band (MHz)	Max reading (s)	Limit (s)	Margin (s)
Uplink	824-849	0.80	3	2.20
Uplink	1850-1910	0.22	3	2.78

Uplink, 824-849MHz	Uplink, 1850-1910MHz
	

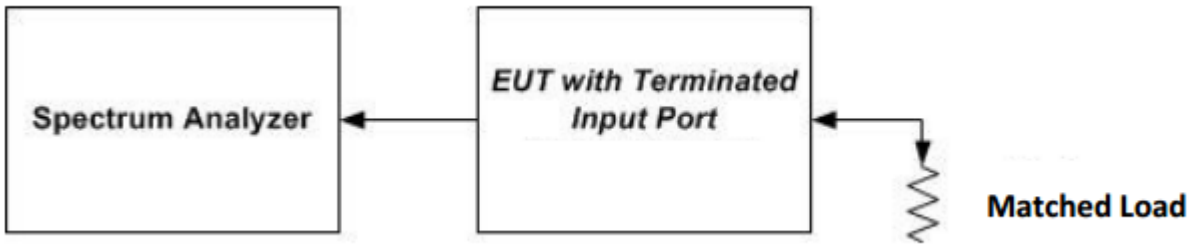
Variable Uplink Noise Limit Test Result					
Mode	Band (MHz)	RSSI (dBm)	Measured Noise (dBm)	Limit (dBm)	Margin (dB)
Uplink	824-849	-90	-56.54	-44.05	12.49
		-80	-55.41	-44.05	11.36
		-70	-57.85	-44.05	13.80
		-40	-65.25	-63.00	2.25
		-35	-69.52	-69.00	0.52
		-34	-70.14	-70.00	0.14
	1850-1910	-80	-66.25	-37.02	29.23
		-70	-67.52	-37.02	30.50
		-60	-65.25	-43.00	22.25
		-50	-66.54	-53.00	13.54
		-36	-75.14	-67.00	8.14
		-34	-76.87	-70.00	6.87

3.8 Uplink inactivity

LIMIT

The EUT was powered on and the time for the uplink to return to an inactive state was measured using the DELTA MARKER method to ensure that it was less than 300 seconds

TEST CONFIGURATION



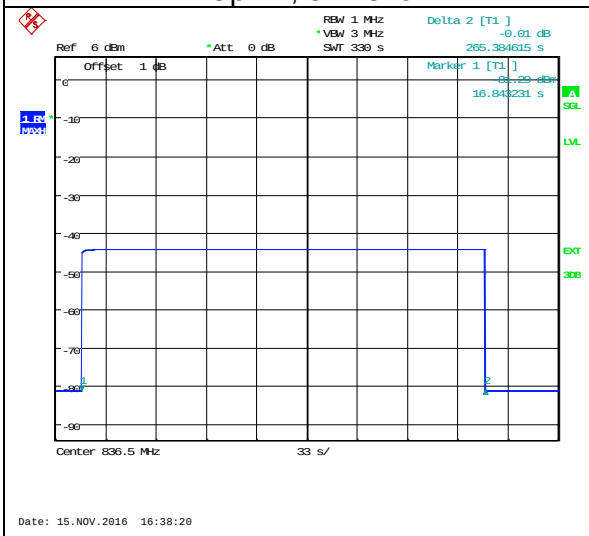
TEST PROCEDURE

a) Connect the EUT to the test equipment with the uplink output (donor) port connected to the spectrum analyzer.
NOTE–Some signal boosters will require a signal generator input because they will not operate unless a signal is received at the input terminals. If this is the case for the setup connecting a signal generator at the server port, then cycle the RF output of the signal generator to simulate this function.
b) Select the power averaging (rms) detector.
c) Set the spectrum analyzer RBW for 1 MHz with the VBW ≥ 3*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) After the full spectrum analyzer trace is complete, place a MARKER on the leading edge of the pulse, then use the DELTA MARKER METHOD to measure the time until the uplink becomes inactive.
i) Affirm that the noise level 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 f).
l) Repeat d) through k) for all operational uplink bands.

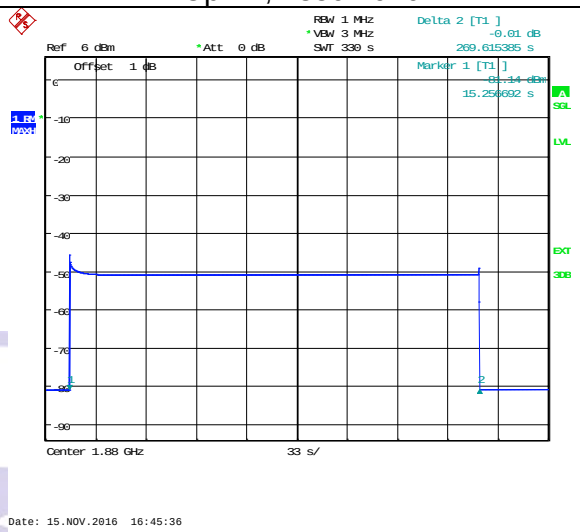
TEST RESULT

Mode	Band (MHz)	Measured Time (s)	Limit (s)	Margin (s)
Uplink	824-849	265.38	300	34.62
	1850-1910	269.62	300	30.38

Uplink, 824-849MHz



Uplink, 1850-1910MHz

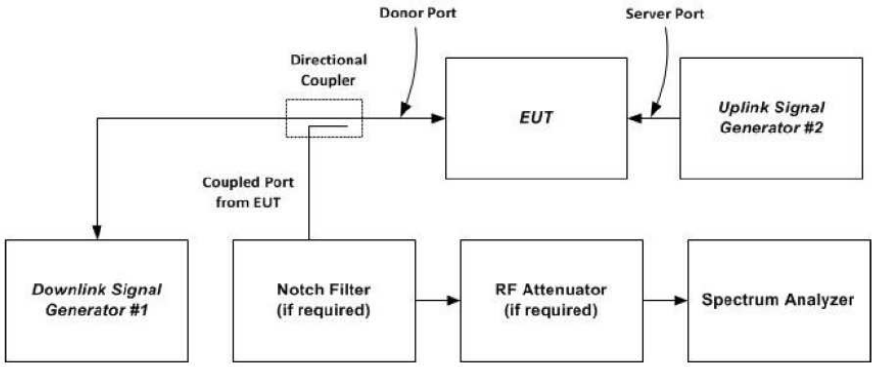


3.9 Variable booster gain

LIMIT

Variable Gain = -34 dB - RSSI + MSCL

TEST CONFIGURATION



TEST PROCEDURE

a) Connect the EUT to the test equipment with the uplink output (donor) port connected to signal generator #1. Affirm that the coupled path of the RF coupler is connected to the spectrum analyzer.
b) Configure downlink signal generator #1 for AWGN operation with a 99% OBW 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 that is 5 dB below the AGC level. 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 mode.
g) Select the power averaging (rms) detector.
h) Affirm that the number of measurement points per sweep ≥ (2*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 output to a level from −90 dBm to −20 dBm, as measured at the input port (i.e., downlink signal level at the booster donor port node, in 1 dB steps inside the RSSI-dependent region, and 10 dB steps outside the RSSI-dependent region. Report the six values closest to the limit, including at least two points from within the RSSI-dependent region of operation. Additionally, document that the EUT provides equivalent uplink and downlink gain, and when operating in shutoff mode that the uplink and downlink gain is within the transmit power off mode gain limits.
l) Repeat b) to k) for all operational uplink bands.

Fixed Gain Limit calculation		
Band (MHz)	Central Frequency of Band (MHz)	Calculated Limit
824-849	836.5	64.95
1850-1910	1880.0	71.98
Note: Gain Limit (dB) = 6.5 + 20Log(F_{MHz})		

Booster Gain Limits Calculation
Note: *Booster Gain Limits* = −34 dB - RSSI + MSCL.

TEST RESULT

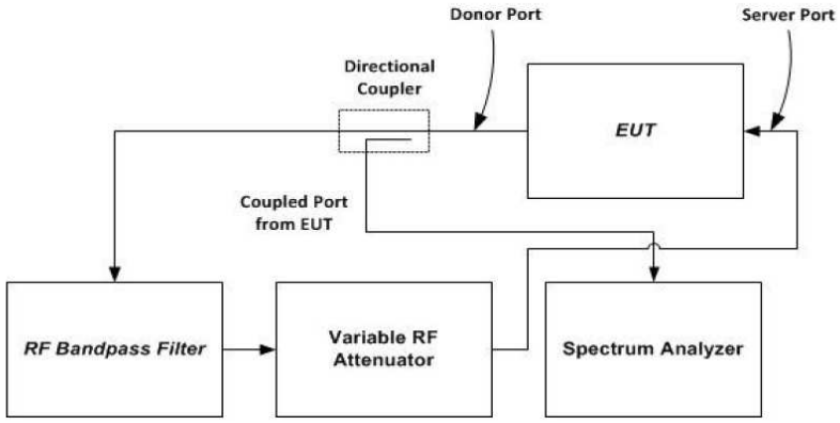
Mode	Band (MHz)	MSCL (dBm)	RSSI (dBm)	Gain reading (dB)	Gain Limit (dB)	Margin (dB)
Uplink	824-849	29.03	-61	43.43	56.03	12.60
		29.03	-60	42.20	55.03	12.83
		29.03	-57	39.72	52.03	12.31
		29.03	-56	38.29	51.03	12.74
		29.03	-55	36.55	50.03	13.48
		29.03	-44	Shutdown	39.03	Shutdown
		29.03	-41	Shutdown	36.03	Shutdown
		29.03	-39	Shutdown	34.03	Shutdown
	1850-1910	36.74	-63	47.46	65.74	18.28
		36.74	-62	46.06	64.74	18.68
		36.74	-61	45.27	63.74	18.47
		36.74	-60	44.87	62.74	17.87
		36.74	-59	43.21	61.74	18.53
		36.74	-36	Shutdown	38.74	Shutdown

3.10 Oscillation Detection

LIMIT

The EUT uplink and downlink were tested to ensure that the presence of oscillation was detected and that the EUT output turned off within 300ms for the Uplink and 1s for the Downlink and remained off for 1 minute. A EUT with test software was utilized to ensure that the EUT only had a maximum of 5 attempts at restart from oscillation before permanently shutting off.

TEST CONFIGURATION



TEST PROCEDURE

a) Connect the normal-operating mode EUT to the test equipment beginning with the spectrum analyzer on the uplink output (donor) port. Confirm that the RF coupled path is connected to the spectrum analyzer.
b) Spectrum analyzer settings:
   1) Center frequency at the center of the band under test
   2) Span equal or slightly exceeding the width of the band under test
   3) Continuous sweep, max-hold
   4) RBW=1 MHz, VBW > 3RBW
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, increase the attenuation by 10 dB, then reset the EUT (e.g., cycle ac/dc power).
d) Repeat c) twice to ensure that the center of the signal created by the booster remains within 250 kHz of the spectrum analyzer display center frequency. If the frequency of the signal is unstable, confirm that the spectrum analyzer display is centered between the frequencies extremes observed. If the signal is wider than 1 MHz, ensure that the spectrum analyzer display is centered on the signal by increasing the RBW. Reset the EUT (e.g., cycle ac/dc power) after each oscillation event, if necessary. Set the spectrum analyzer sweep trigger level to just below the peak amplitude of the displayed EUT oscillation signal.
e) Set the spectrum analyzer to zero-span, with a sweep time of 5 seconds, and single-sweep with max-hold. The spectrum analyzer sweep trigger level in this and the subsequent steps shall be the level identified in d).
f) Decrease the variable attenuator until the spectrum analyzer sweep is triggered, increase the attenuation by 10 dB, then reset the EUT (e.g., cycle ac/dc power).
g) Reset the zero-span trigger of the spectrum analyzer, then repeat f) twice to ensure that the spectrum analyzer is reliably triggered, resetting the EUT (e.g., cycle ac/dc power) after each oscillation event if necessary.
h) Reset the zero-span sweep trigger of the spectrum analyzer, and reset the EUT (e.g., cycle ac/dc power).
i) Force the EUT into oscillation by reducing the attenuation.
j) Use the marker function of the spectrum analyzer to measure the time from the onset 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 sweep time may be adjusted to improve the time

resolution of these cursors.

k) Capture the spectrum analyzer zero-span trace for inclusion in the test report. Report the power level associated with the oscillation separately if it can't be displayed on the trace.

l) Repeat b) to k) for all operational uplink and downlink bands.

m) Set the spectrum analyzer zero-span sweep time for longer than 60 seconds, then measure the restart time for each operational uplink and downlink band.

n) Replace the normal-operating mode EUT with the EUT that supports an anti-oscillation test mode.

o) Set the spectrum analyzer zero-span time for a minimum of 120 seconds, and a single sweep.

p) Manually trigger the spectrum analyzer zero-span sweep, and manually force the booster into oscillation as described in i).

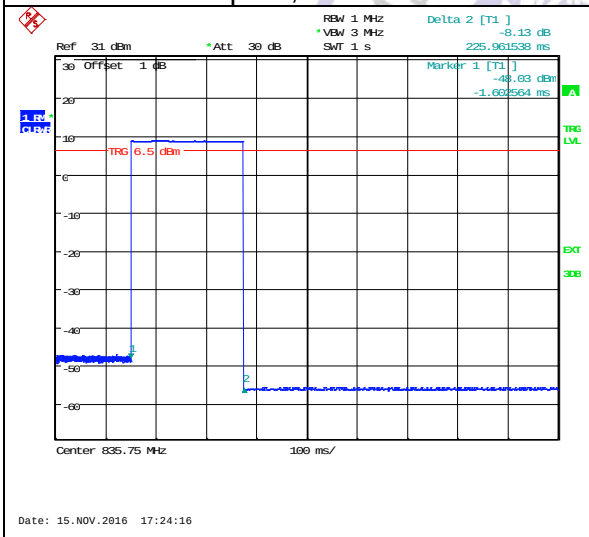
q) When the sweep is complete, place cursors between the first two oscillation detections, and save the plot for inclusion in the test report. The time between restarts must match the manufacturer's timing for the test mode, and there shall be no more than 5 restarts.

r) Repeat m) to q) for all operational uplink and downlink bands.

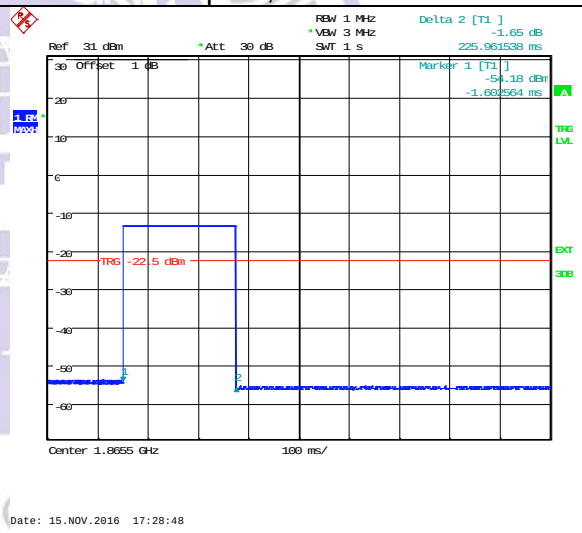
TEST RESULT

Mode	Band (MHz)	Measured Time (ms)	Limit (ms)	Margin (ms)
Uplink	824-849	225.96	300	74.04
	1850-1910	225.96	300	74.04
Downlink	869-894	177.88	1000	822.12
	1930-1990	161.86	1000	838.14

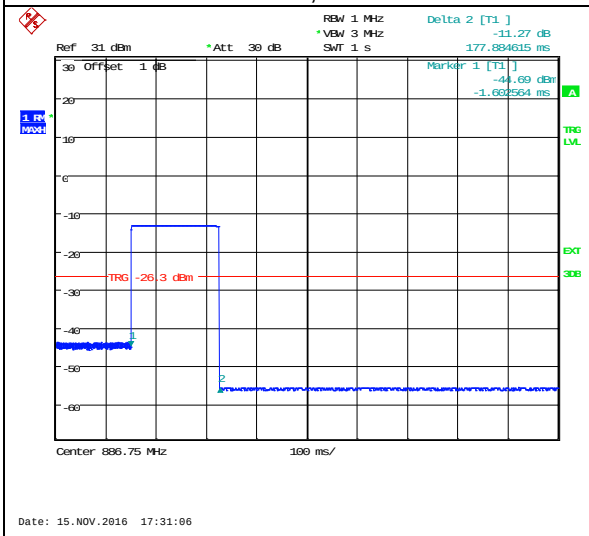
Uplink, 824-849MHz



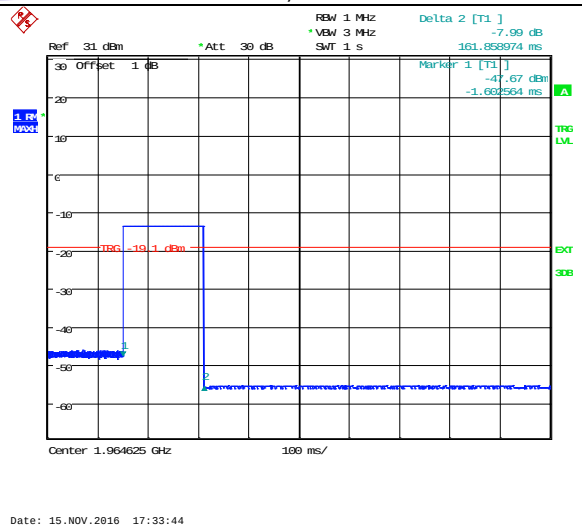
Uplink, 1850-1910MHz



Downlink, 869-894MHz



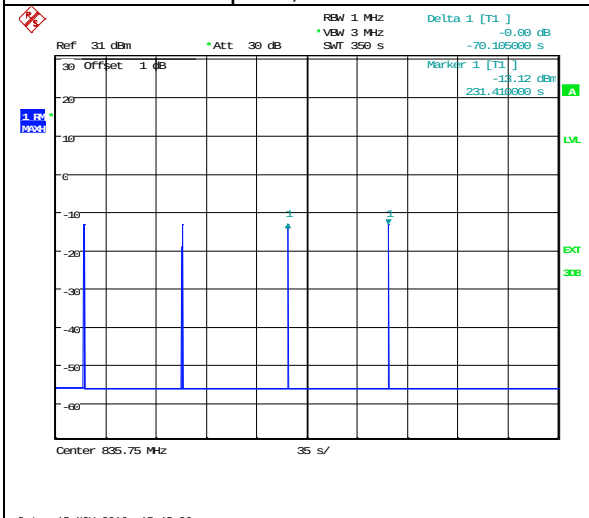
Downlink, 1930-1990MHz



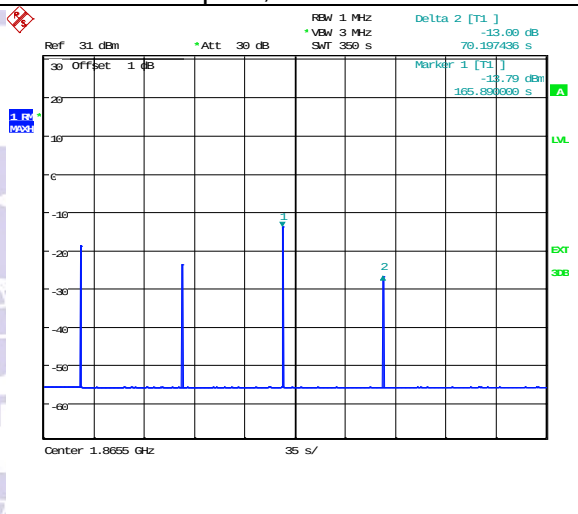
Restart Time				
Mode	Band (MHz)	Measured Time (s)	Limit (s)	Margin (s)
Uplink	824-849	70.03	≥60	10.03
	1850-1910	70.20	≥60	10.2
Downlink	869-894	70.03	≥60	10.03
	1930-1990	69.68	≥60	9.68

Restart Count				
Mode	Band (MHz)	Restarts	Limit	Margin
Uplink	824-849	4	≤5	1
	1850-1910	4	≤5	1
Downlink	869-894	4	≤5	1
	1930-1990	4	≤5	1

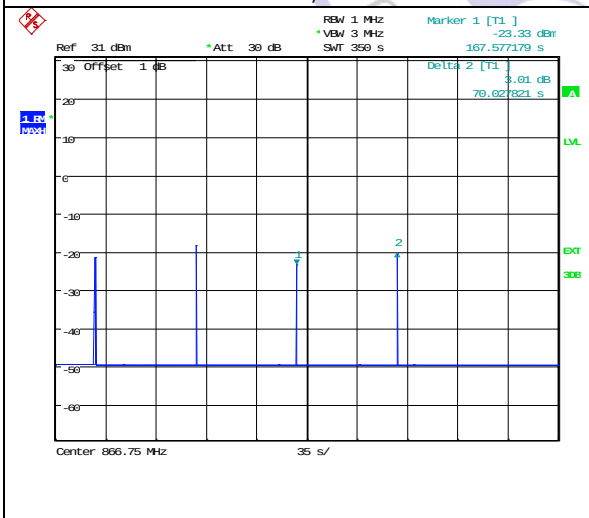
Uplink, 824-849MHz



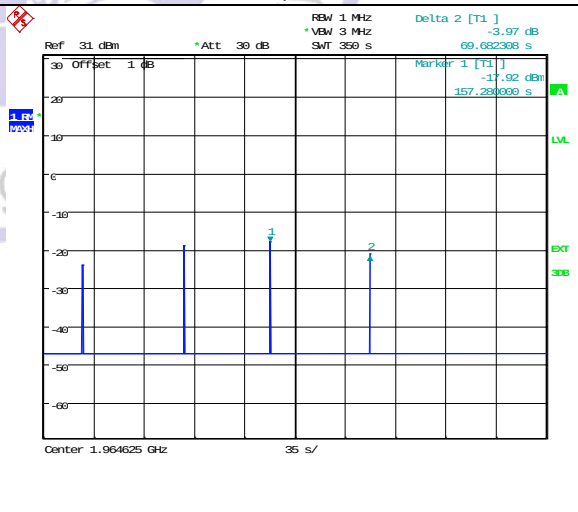
Uplink, 1850-1910MHz



Downlink, 869-894MHz



Downlink, 1930-1990MHz

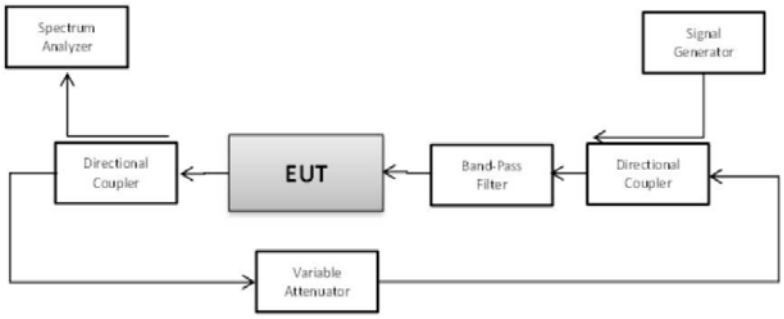


3.11 Oscillation Mitigation

LIMIT

For oscillations that exceeded the 12 dB limit, the time required for the booster to mitigate the oscillation to less than 12dB was recorded. If the booster mitigated the oscillation within the 300s time limit, the time required to mitigate the oscillation was recorded along with the final level of the oscillation after mitigation.

TEST CONFIGURATION



TEST PROCEDURE

a) Connect the normal-operating mode EUT to the test equipment as shown.
b) Set the spectrum analyzer center frequency to the center of band under test, and use the following settings:
   1) RBW=30 kHz, VBW ≥ 3 × RBW,
   2) power averaging (rms) detector,
   3) trace averages ≥ 100,
   4) span ≥ 120% of operational band under test,
   5) number of sweep points ≥ 2 × Span/RBW.
c) Configure the signal generator for AWGN operation with a 99% OBW 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 signal at the output port of the booster is 30 dB less than the maximum power of the booster for the band under test. Affirm 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.

1) Boosters with operating spectrum passbands of 10 MHz or less may use a CW signal source at the band edge rather than AWGN.
2) For device passbands greater than 10 MHz, standard CMRS signal sources (i.e., CDMA, W-CDMA, LTE) may be used instead of AWGN at the band edge.

d) Set the variable attenuator to a high attenuation setting such that the booster will operate at maximum gain when powered on. Reset the the EUT (e.g., cycle ac/dc power). Allow the EUT to complete its boot-up process, to reach full operational gain, and to stabilize its operation.
e) Set the variable attenuator such that the insertion loss for the center of the band under test (isolation) between the booster donor port and server port 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, i.e., to mitigate the oscillations. If the booster does 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 center frequency to the frequency with the highest oscillation signal 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 measured in f2), does not exceed by 12.0 dB the minimal output level measured in f4). Record the measurement results of f2) and f4) in tabular format for inclusion in the test report.
6) The procedure of f1) to f5) allows the spectrum analyzer trace to stabilize, and verification of shutdown or oscillation level measurement must occur within 300s.

g) Decrease the variable attenuator in 1 dB steps, and repeat step f) for each 1 dB step. Continue testing to the level when the insertion loss for the center of band under test (isolation) between the booster donor port and server port is 5 dB lower than the maximum gain.
h) Repeat a) to g) for all operational uplink and downlink bands.

TEST RESULT

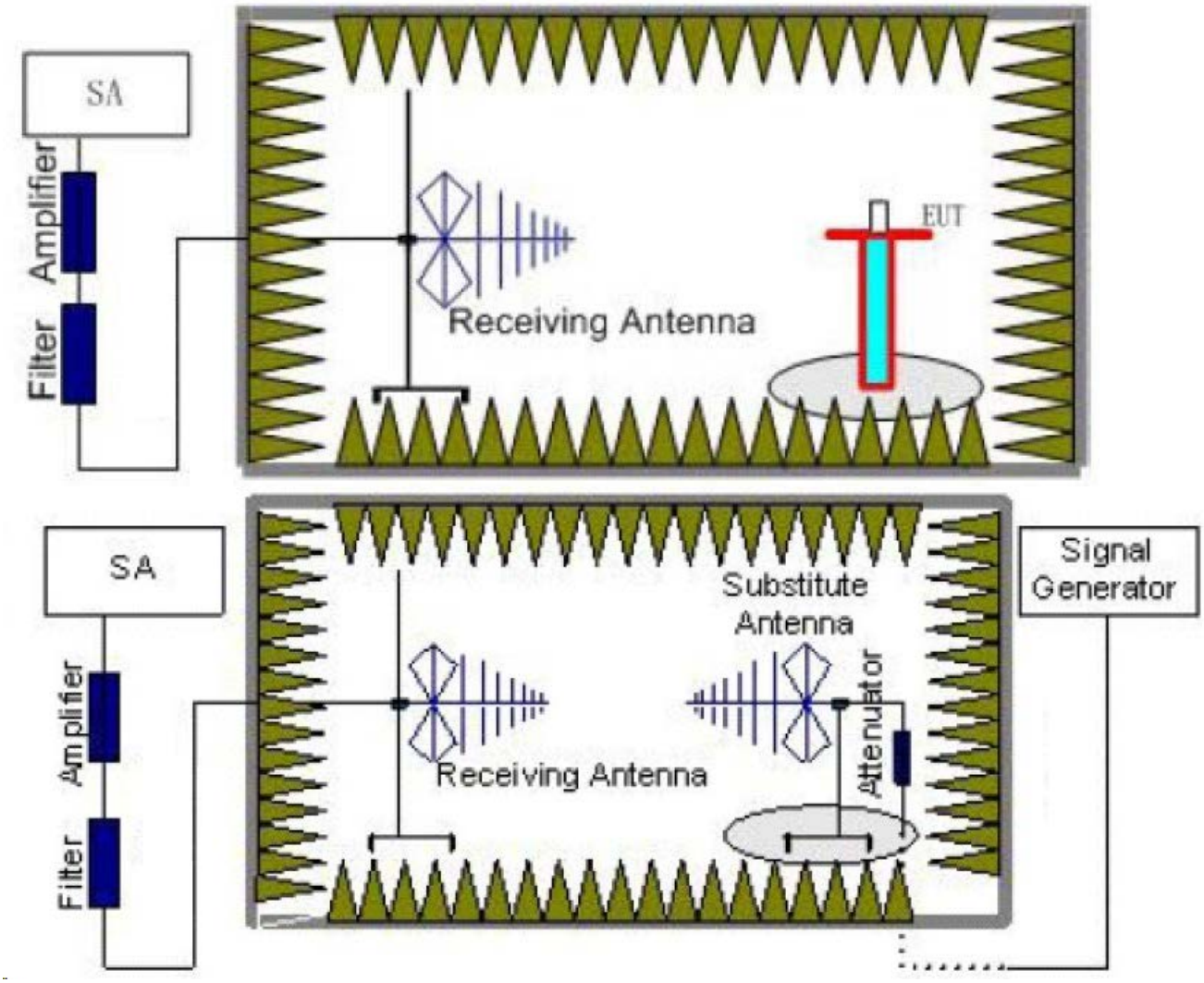
Mode	Band (MHz)	Variable Attenuator (dB)	Time to shutdown (s)	Shutdown Limit (s)	Oscillation difference (dB)	Oscillation Limit (dB)
Uplink	824-849	+5	27	300	/	/
		+4	/	/	/	/
		+3	/	/	/	/
		+2	/	/	/	/
		+1	/	/	/	/
	1850-1910	+5	10	300	/	/
		+4	/	/	/	/
		+3	/	/	/	/
		+2	/	/	/	/
		+1	/	/	/	/
Downlink	869-894	+5	12	300	/	/
		+4	/	/	/	/
		+3	/	/	/	/
		+2	/	/	/	/
		+1	/	/	/	/
	1930-1990	+5	31	300	/	/
		+4	/	/	/	/
		+3	/	/	/	/
		+2	/	/	/	/
		+1	/	/	/	/

3.12 Radiated Spurious Emission

LIMIT

Radiated Spurious Emissions Limit = P1 – (43+ 10Log (P2)) = -13dBm
P1 = power in dBm
P2 = power in Watts

TEST CONFIGURATION



TEST PROCEDURE

a. EUT was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna. A receiving antenna was placed on the antenna mast 3 meters from the EUT for emission measurements. The height of receiving antenna is 1.0m. Detected emissions were maximized at each frequency by rotating the EUT through 360° and adjusting the receiving antenna polarization. The radiated emission measurements of all test transmit frequencies were measured with peak detector.
b. A log-periodic antenna or double-ridged waveguide horn antenna shall be substituted in place of the EUT. The log-periodic antenna will be driven by a signal generator and the level will be adjusted till the same power value on the spectrum analyzer or receiver. The level of the spurious emissions can be calculated through the level of the signal generator, cable loss, the gain of the substitution antenna and the reading of the spectrum analyzer or receiver.
c. The EUT is then put into continuously transmitting mode at its maximum power level during the test. Set Test Receiver or Spectrum 100 KHz below 1GHz and 1MHz above 1GHz, Sweep from 30MHz to the 10^{th} harmonic of the fundamental frequency; and recorded the level of the concerned spurious emission point as (P_r).

d. The EUT then replaced by a substitution antenna. In the chamber, an substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF Signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power (PMea) is applied to the input of the substitution antenna, and adjust the level of the signal generator output until the value of the receiver reach the previously recorded (Pr). The power of signal source (PMea) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.
The measurement results are obtained as described below:

$$Power_{(EIRP)} = P_{Mea} - P_{cl} + G_a$$

Where;
P_{Mea} is the recorded signal generator level
P_{cl} is the cable loss connect between instruments
G_a Substitution Antenna Gain

e. This value is EIRP since the measurement is calibrated using an antenna of known gain (2.15 dBi) and known input power.
f. ERP can be calculated from EIRP by subtracting the gain of the dipole, ERP = EIRP -2.15dBi.
g. Test site anechoic chamber refer to ANSI C63.4:2014.

TEST RESULT

Uplink:

Frequency (MHz)	P_{Mea} (dBm)	P_{cl} (dB)	Diatance	G_a Antenna Gain(dB)	Peak EIRP (dBm)	Limit (dBm)	Margin (dB)	Polarization
Celluar Band, Test Frequency 836.5MHz								
1673.00	-34.71	3.14	3.00	9.61	-28.24	-13.00	15.24	H
2509.50	-44.43	3.59	3.00	10.77	-37.25	-13.00	24.25	H
1673.00	-32.73	3.14	3.00	9.61	-26.26	-13.00	13.26	V
2509.50	-40.36	3.59	3.00	10.77	-33.18	-13.00	20.18	V
PCS Band, Test Frequency 1880MHz								
3760.00	-39.11	4.38	3.00	12.34	-31.15	-13.00	18.15	H
5640.00	-47.83	5.01	3.00	13.58	-39.26	-13.00	26.26	H
3760.00	-36.22	4.38	3.00	12.34	-28.26	-13.00	15.26	V
5640.00	-47.01	5.01	3.00	13.58	-38.44	-13.00	25.44	V

Downlink:

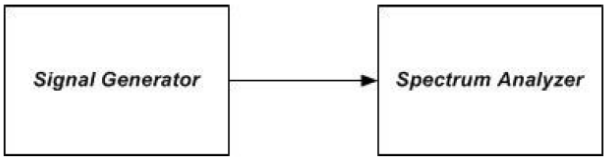
Frequency (MHz)	P_{Mea} (dBm)	P_{cl} (dB)	Diatance	G_a Antenna Gain(dB)	Peak EIRP (dBm)	Limit (dBm)	Margin (dB)	Polarization
Celluar Band, Test Frequency 881.5MHz								
1763.00	-38.57	3.45	3.00	9.77	-32.25	-13.00	19.25	H
2644.50	-45.41	3.98	3.00	10.98	-38.41	-13.00	25.41	H
1763.00	-34.58	3.45	3.00	9.77	-28.26	-13.00	15.26	V
2644.50	-41.74	3.98	3.00	10.98	-34.74	-13.00	21.74	V
PCS Band, Test Frequency 1960MHz								
3920.00	-37.52	4.66	3.00	12.65	-29.53	-13.00	16.53	H
5880.00	-47.98	5.27	3.00	14.11	-39.14	-13.00	26.14	H
3920.00	-36.86	4.66	3.00	12.65	-28.87	-13.00	15.87	V
5880.00	-46.34	5.27	3.00	14.11	-37.50	-13.00	24.50	V

3.13 Occupied bandwidth

LIMIT

For each modulation type, the input and output signal was measured and plotted to ensure that the signals were similar.

TEST CONFIGURATION



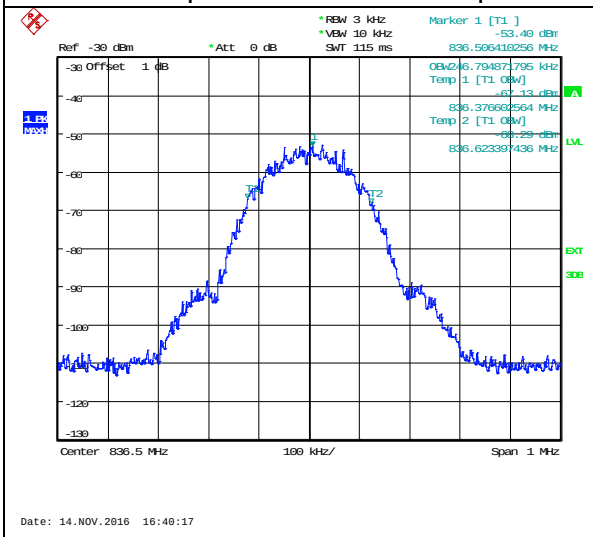
TEST PROCEDURE

a) Connect the test equipment as shown to firstly measure the characteristics of the test signals produced by the signal generator.
b) Set VBW ≥ 3*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 OBW as necessary for accurately viewing the signals
d) Set the signal generator for power level to match the values obtained from the test.
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 EBW.
g) Capture the spectrum analyzer trace for inclusion in the test report.
h) Repeat c) to g) for CDMA and W-CDMA modulation, adjusting the span as necessary. AWGN or LTE may be used in place of W-CDMA, as an option.
i) Repeat c) to h) for all uplink and downlink operational bands.
j) Connect the test equipment as shown, with the uplink output (donor) port connected to the spectrum analyzer, and the server port connected to the signal generator.
k) Repeat c) to i) with this EUT uplink path test setup.
l) Connect the test equipment as shown, with the downlink output (server) port connected to the spectrum analyzer, and the donor port connected to the signal generator.
m) Repeat c) to i) with this EUT downlink path test setup.

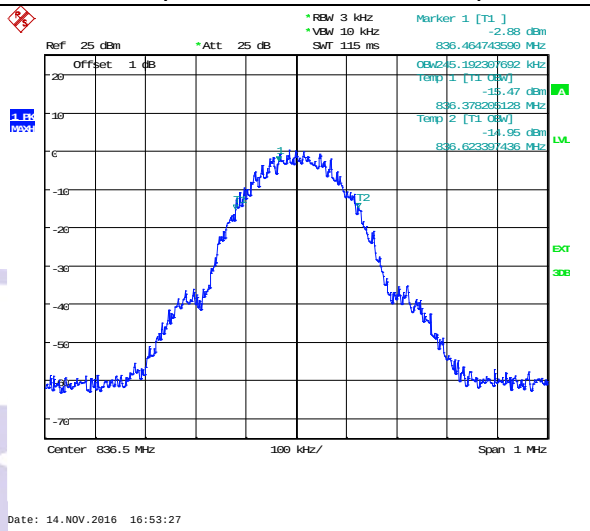
TEST RESULT

Signal Type	Mode	Band (MHz)	Input OB (KHz)	Output OB (KHz)
GSM	Uplink	824-849	246.79	245.19
		1850-1910	246.79	250.00
	Downlink	869-894	245.19	246.79
		1930-1990	245.19	248.40

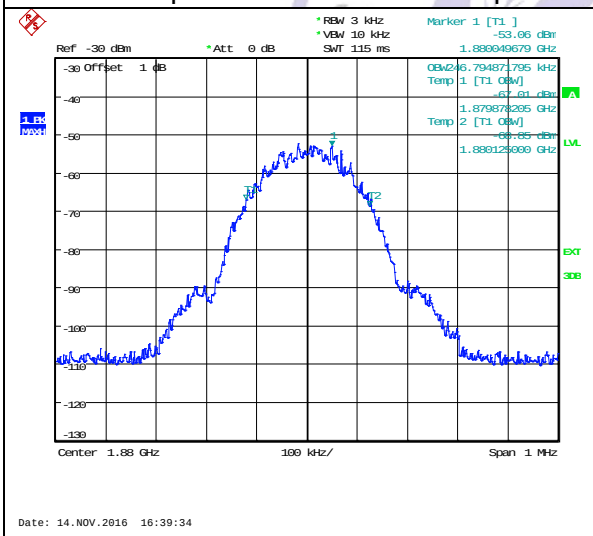
Uplink，824-849MHz Input



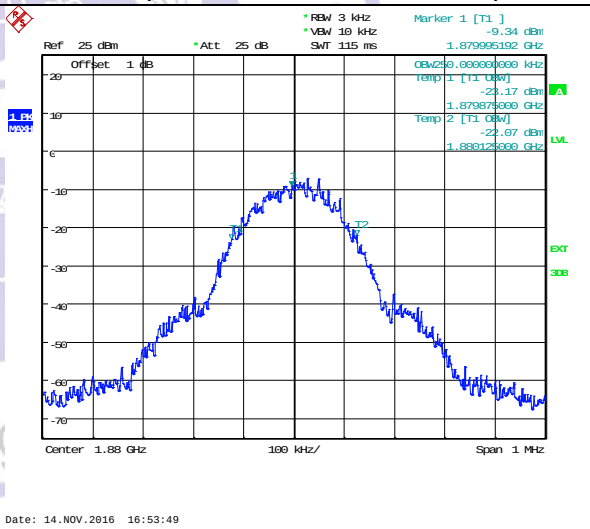
Uplink，824-849MHz Output

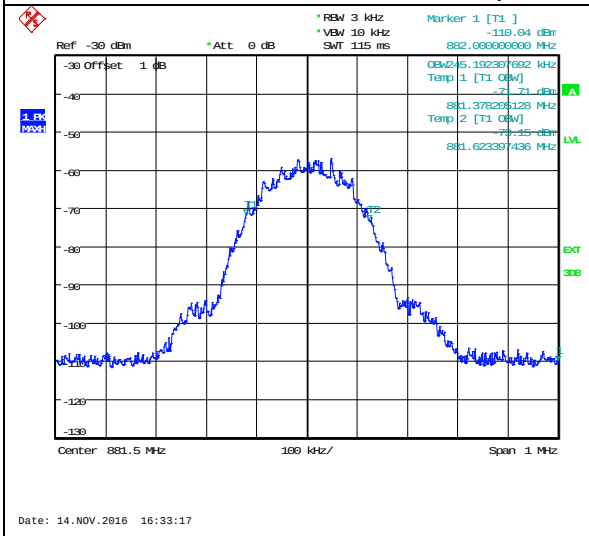
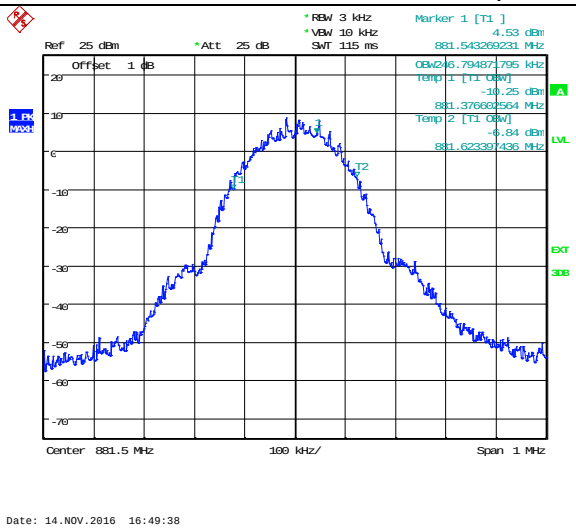
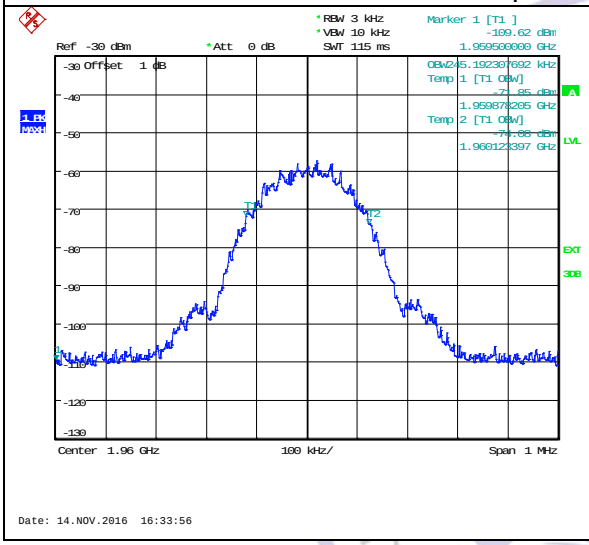
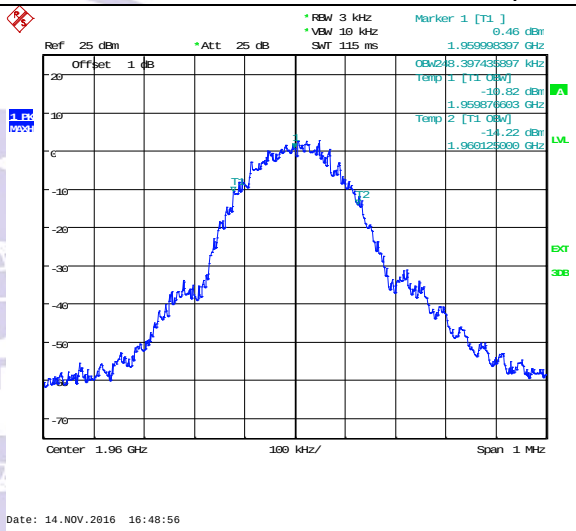


Uplink，1850-1910MHz Input



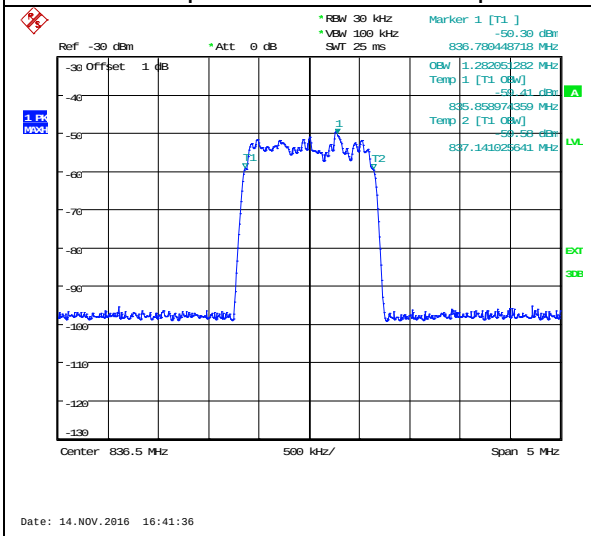
Uplink，1850-1910MHz Output



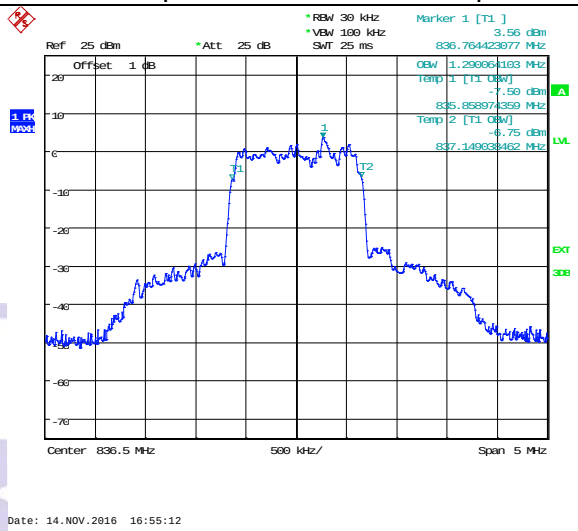
Downlink，869-894MHz Input	Downlink，869-894MHz Output
	
Downlink，1930-1990MHz Input	Downlink，1930-1990MHz Output
	

Signal Type	Mode	Band (MHz)	Input OB (MHz)	Output OB (MHz)
CDMA	Uplink	824-849	1.28	1.29
		1850-1910	1.28	1.29
	Downlink	869-894	1.28	1.32
		1930-1990	1.28	1.39

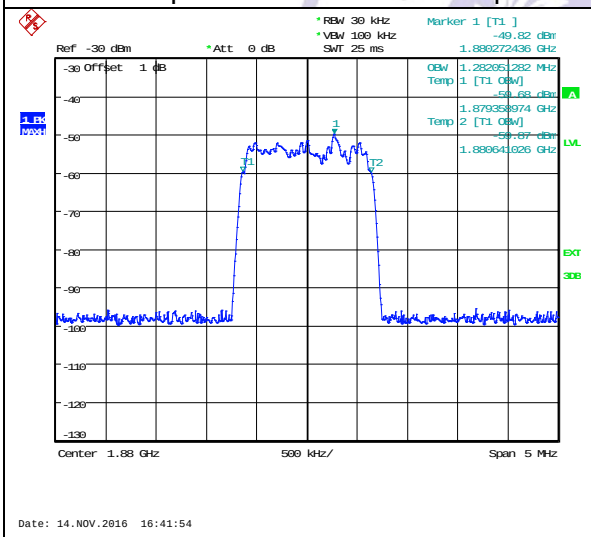
Uplink，824-849MHz Input



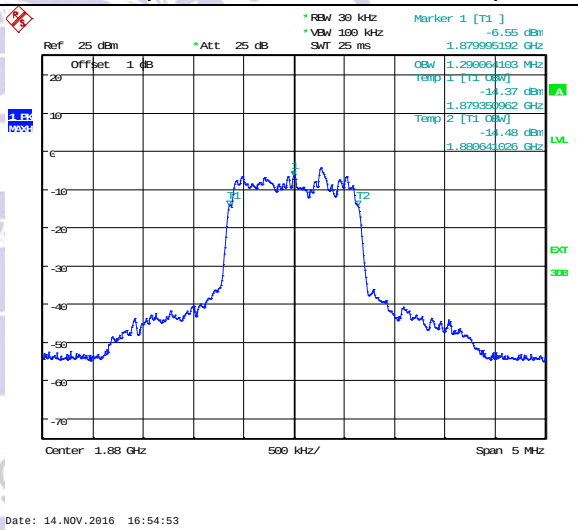
Uplink，824-849MHz Output

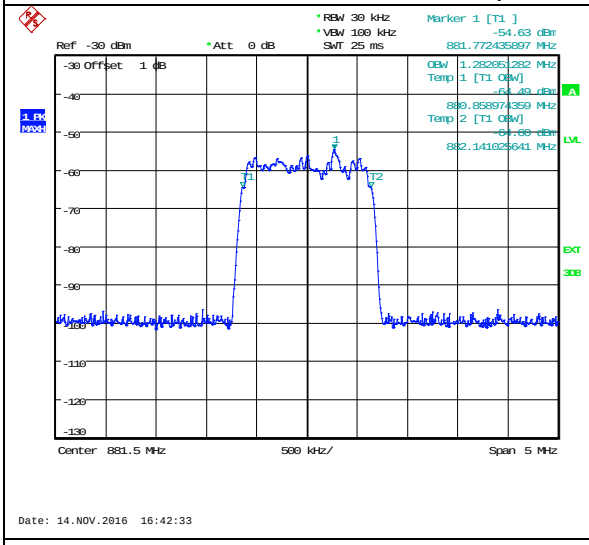
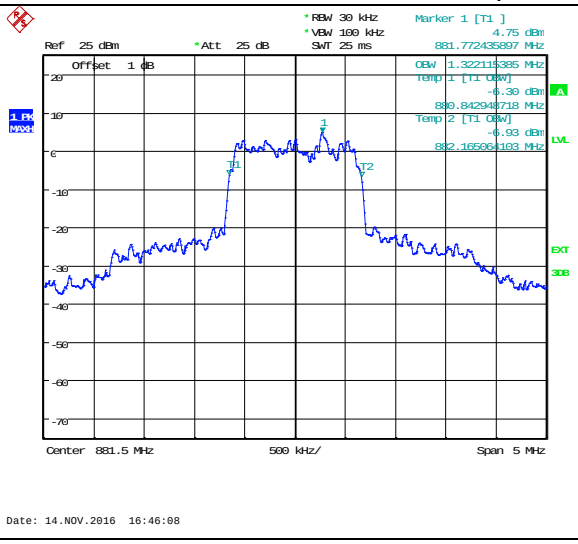
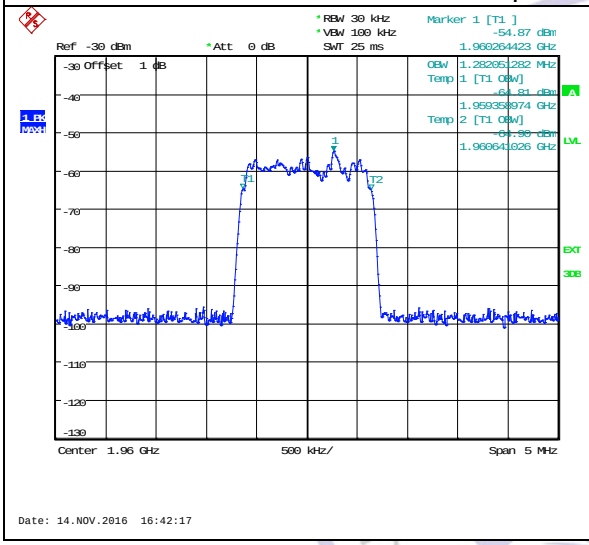
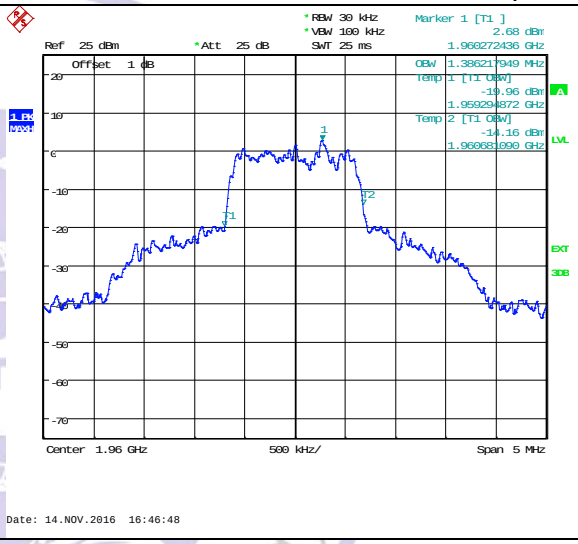


Uplink，1850-1910MHz Input



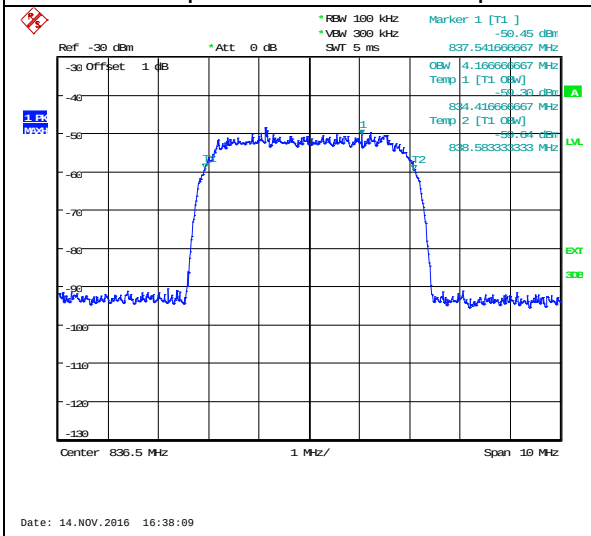
Uplink，1850-1910MHz Output



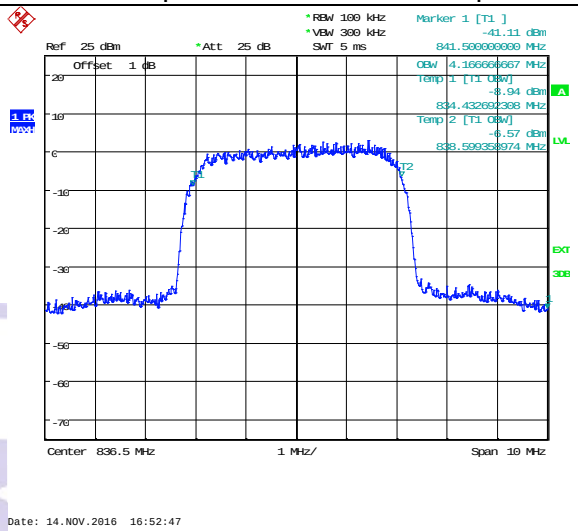
Downlink，869-894MHz Input	Downlink，869-894MHz Output
	
Downlink，1930-1990MHz Input	Downlink，1930-1990MHz Output
	

Signal Type	Mode	Band (MHz)	Input OB (MHz)	Output OB (MHz)
WCDMA/LET	Uplink	824-849	4.17	4.17
		1850-1910	4.18	4.17
	Downlink	869-894	4.18	4.25
		1930-1990	4.18	4.25

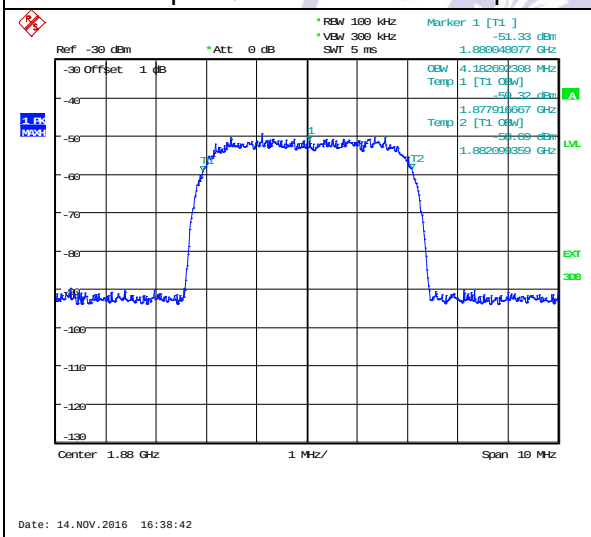
Uplink，824-849MHz Input



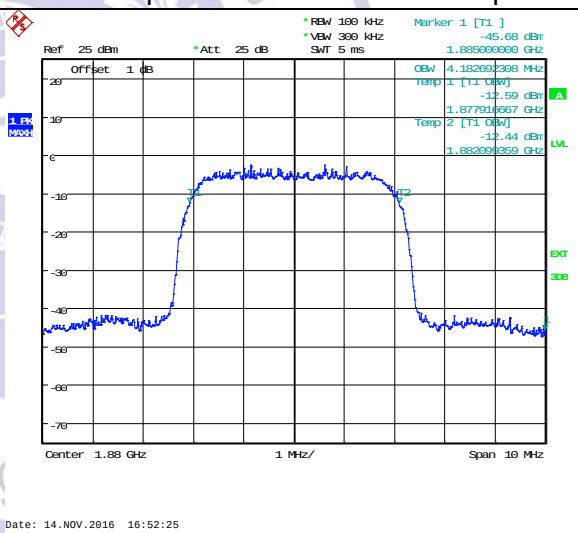
Uplink，824-849MHz Output

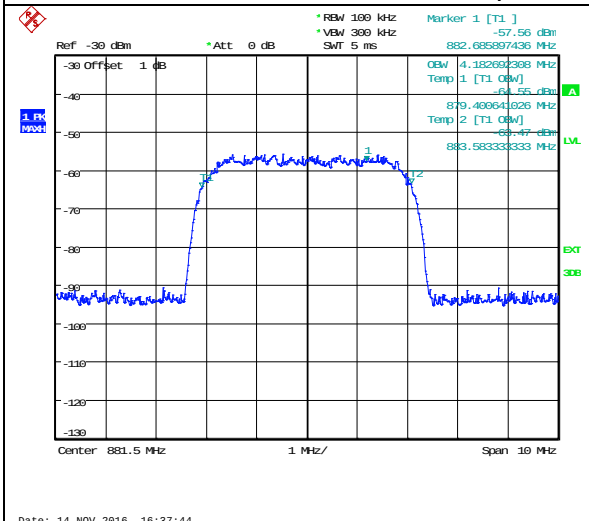
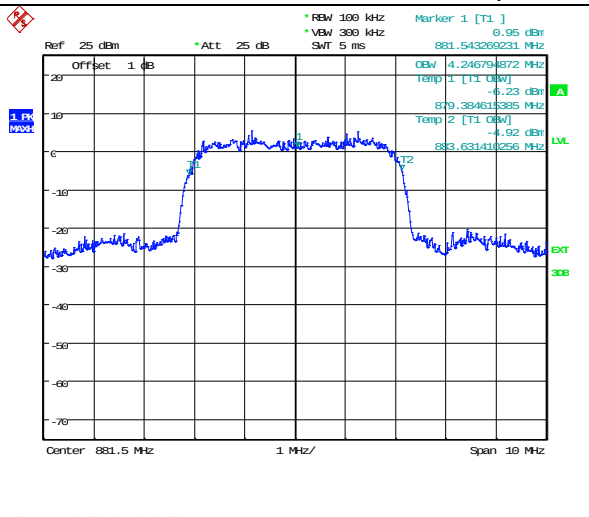
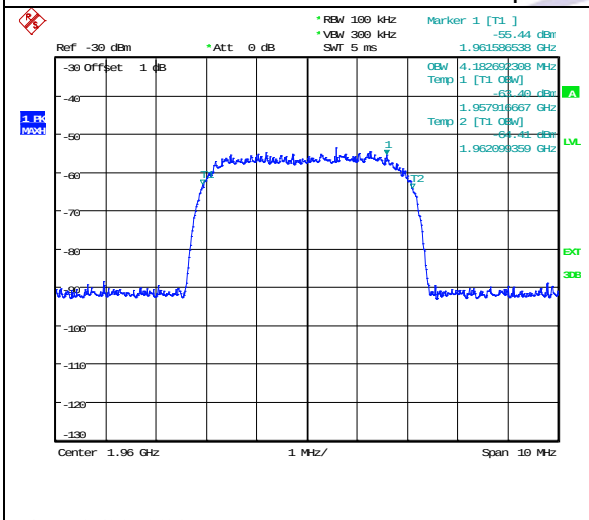
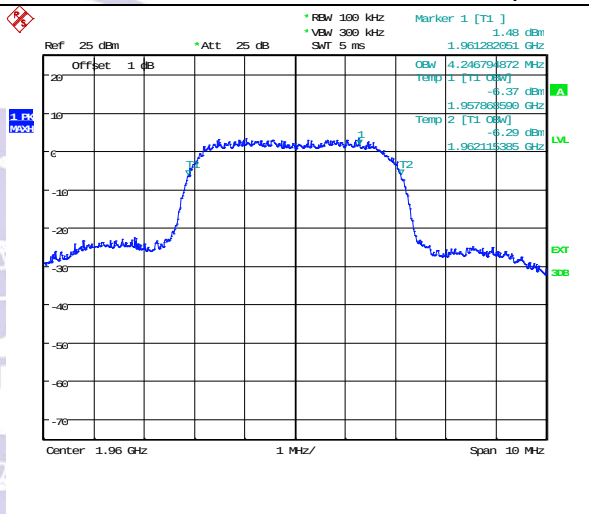


Uplink，1850-1910MHz Input

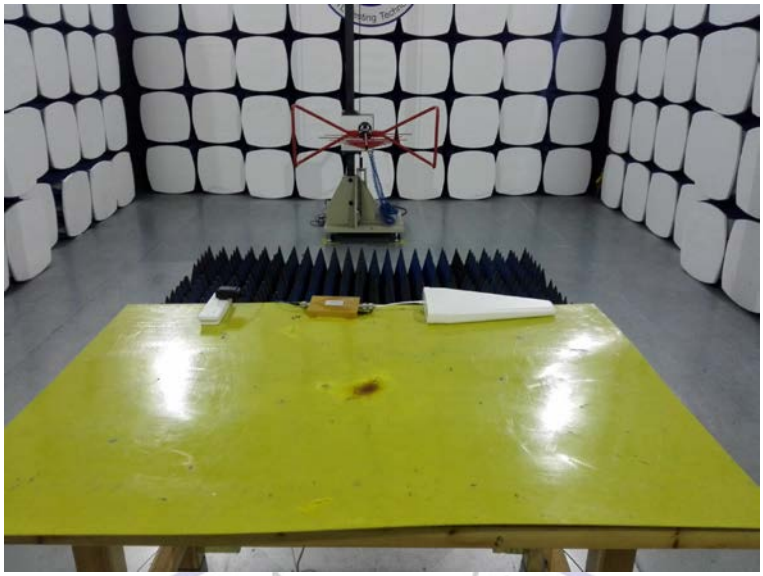


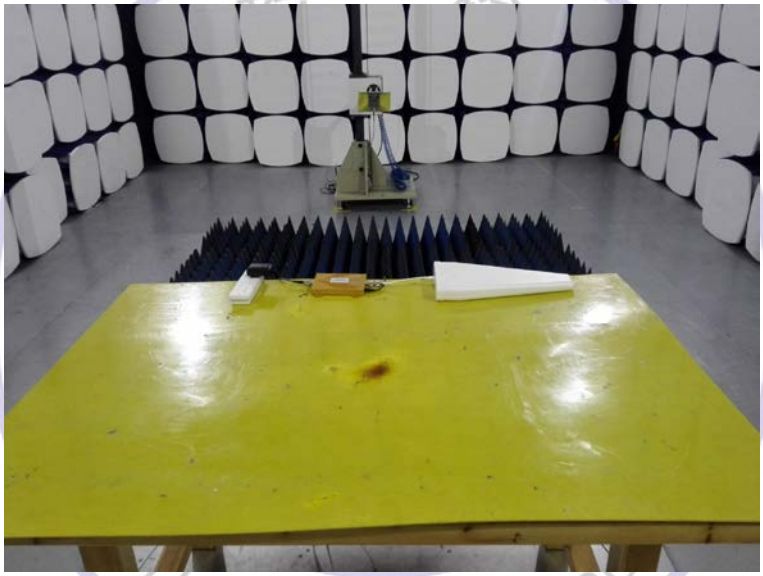
Uplink，1850-1910MHz Output



Downlink，869-894MHz Input	Downlink，869-894MHz Output
	
Downlink，1930-1990MHz Input	Downlink，1930-1990MHz Output
	

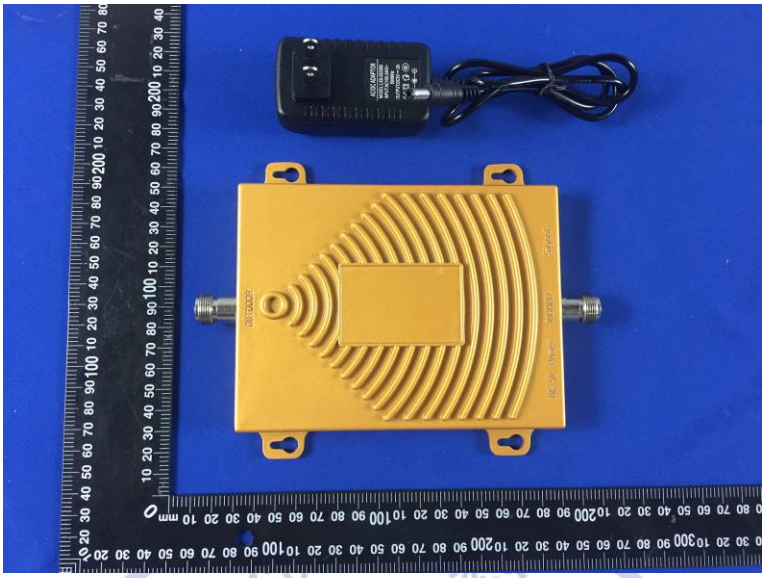
4 Test Setup Photos of the EUT

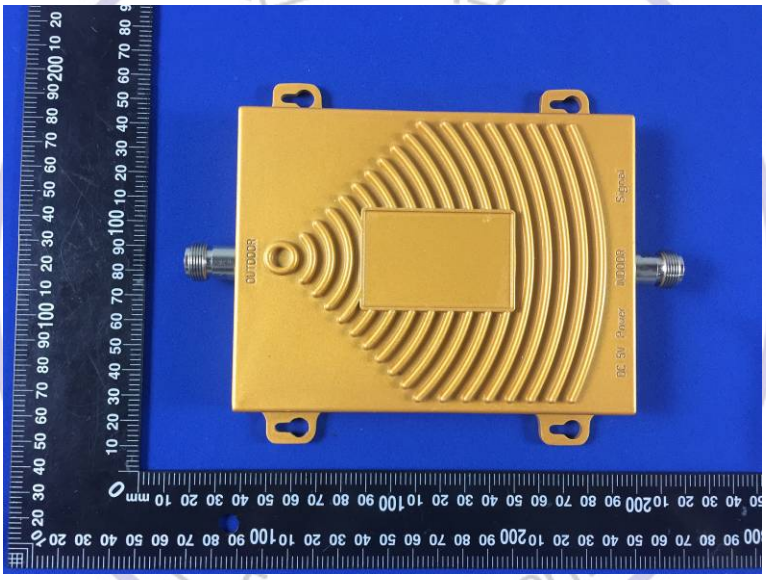


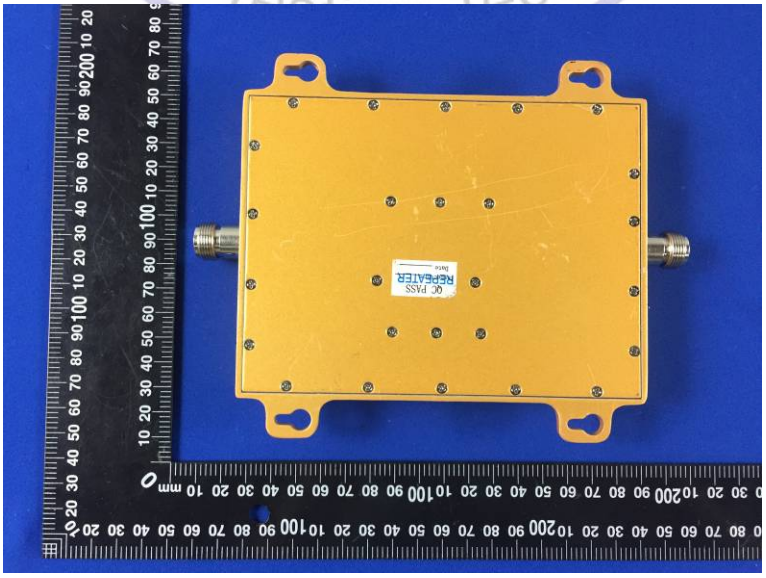


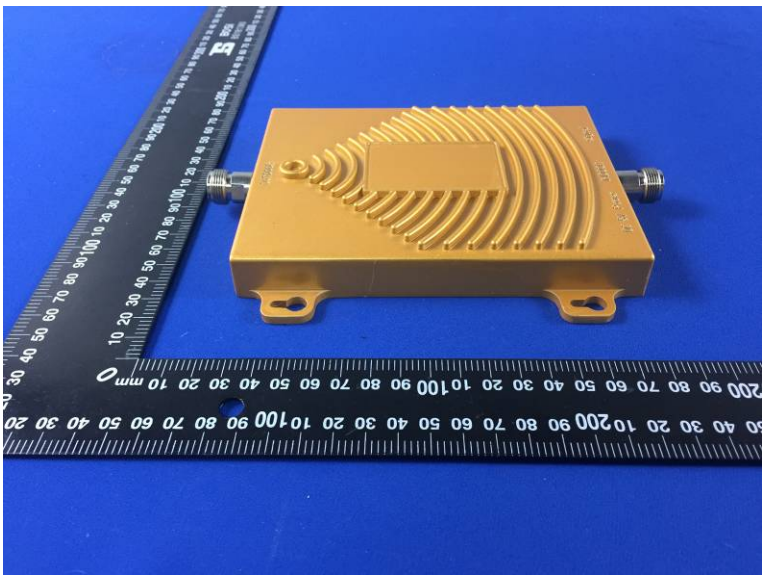
5 External and Internal Photos of the EUT

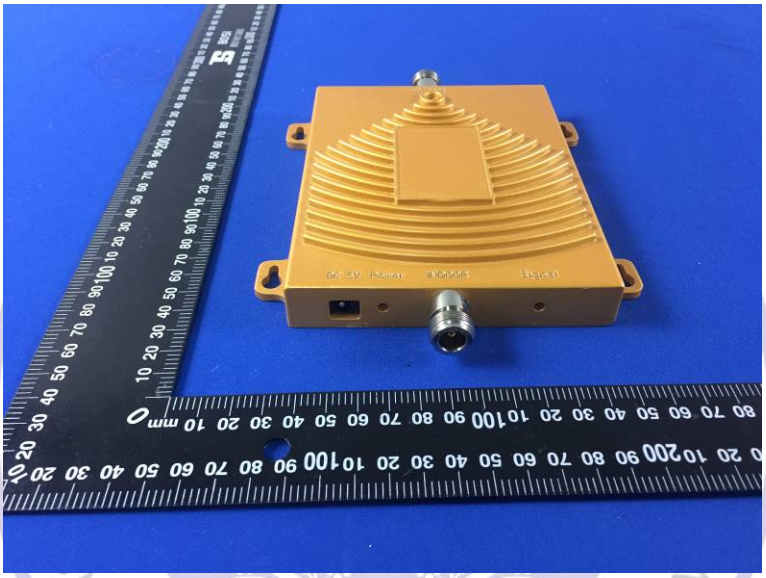
External Photos of EUT

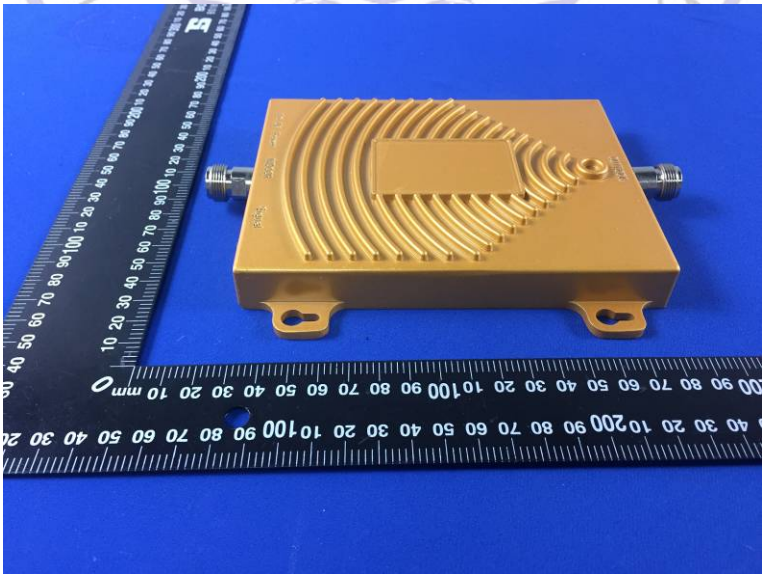


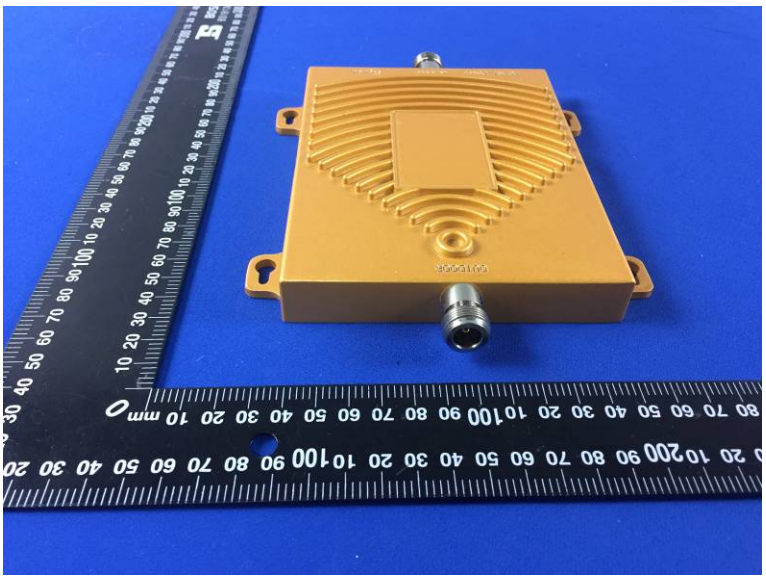




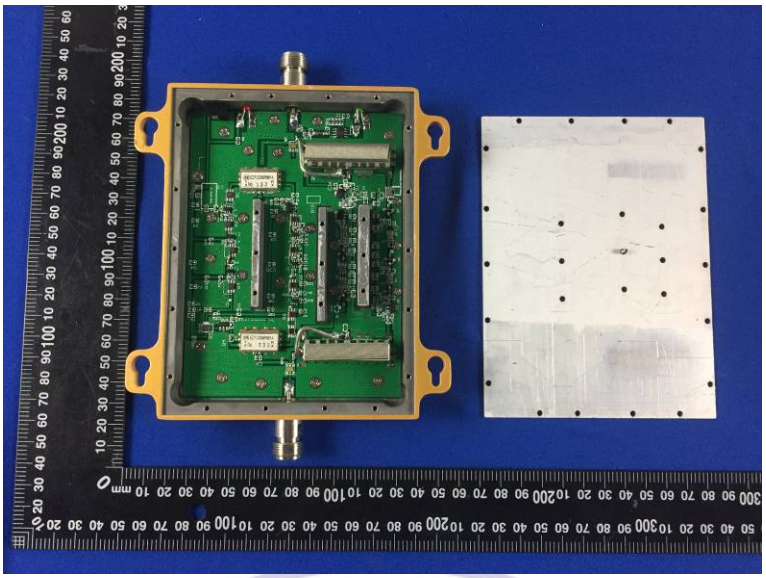


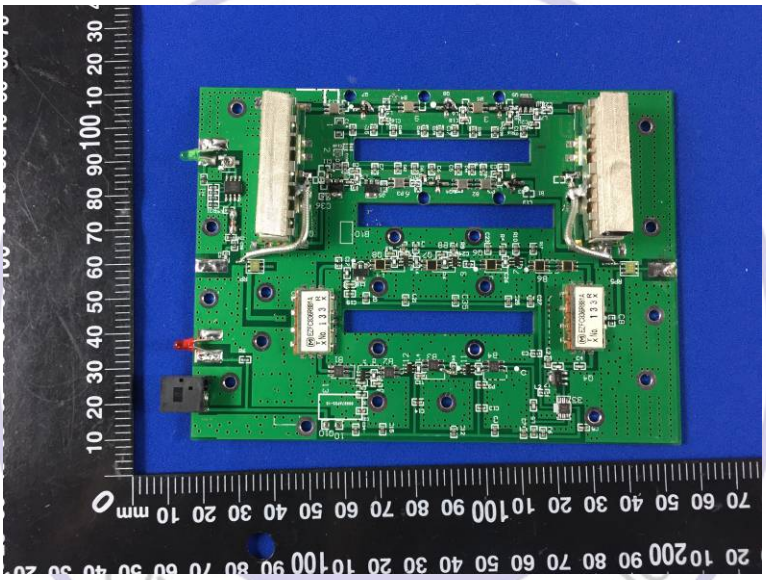


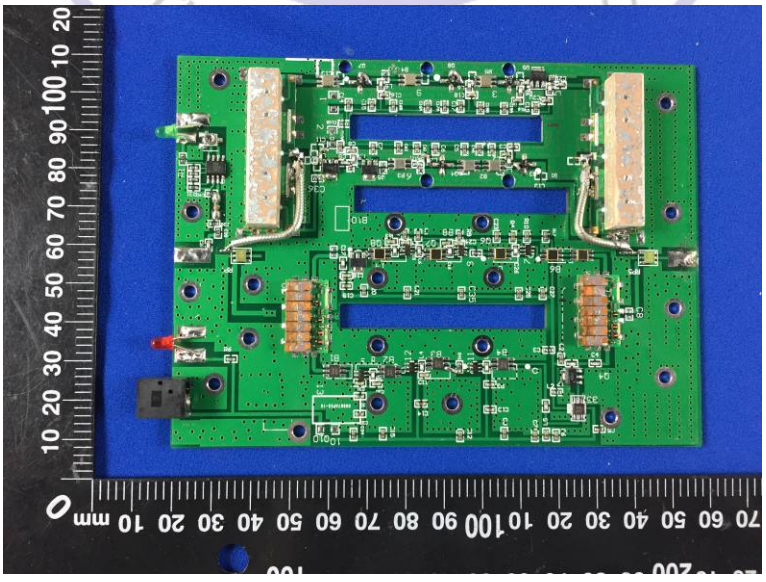


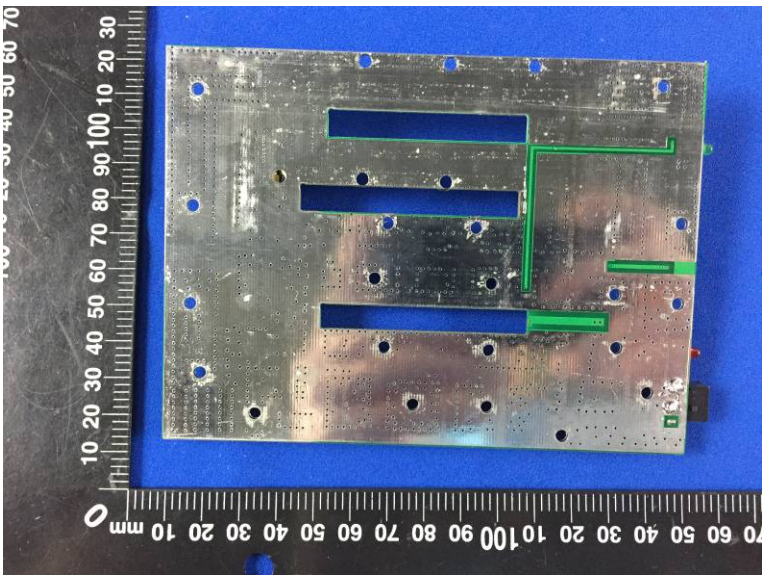


Internal Photos of EUT









********** End of Report **********