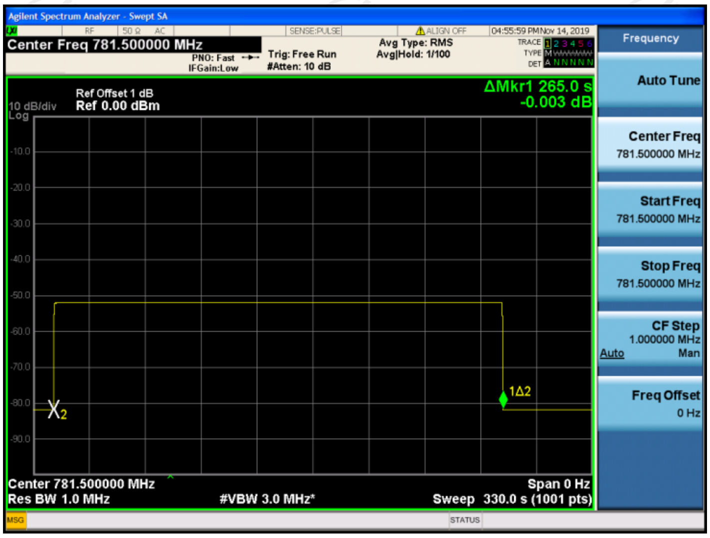
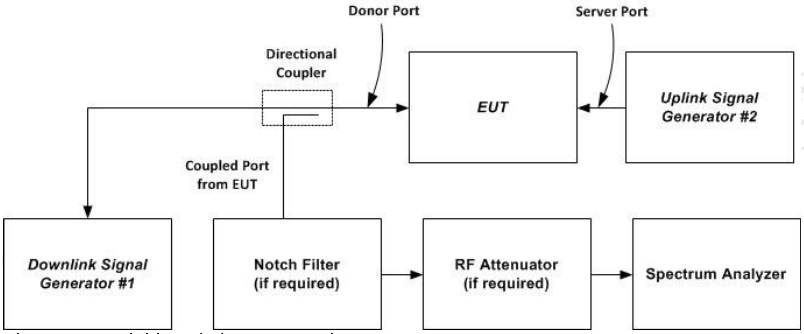
Test Plots


Agilent Spectrum Analyzer - Swept SA
Center Freq 781.500000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 10 dB
Avg Type: RMS
Avg|Hold: 1/100
04:55:59 PM Nov 14, 2019
Ref Offset 1 dB
10 dB/div Ref 0.00 dBm
ΔMkr1 265.0 s
-0.003 dB
Center 781.500000 MHz
Res BW 1.0 MHz
#VBW 3.0 MHz*
Span 0 Hz
Sweep 330.0 s (1001 pts)
Frequency
Auto Tune
Center Freq 781.500000 MHz
Start Freq 781.500000 MHz
Stop Freq 781.500000 MHz
CF Step 1.000000 MHz
Auto Man
Freq Offset 0 Hz

6.8. Variable Booster Gain

6.8.1. Test Specification

Test Requirement:	FCC Part20 Section 120.21(e)(8)(i)(C)(1) FCC Part20 Section 120.21(e)(8)(i)(H)
Test Method:	KDB835210 D03 Signal booster measurements v04r03
Limit:	-34 dB - RSSI + MSCL.
Test Setup:	 Figure 5 – Variable gain instrumentation test setup
Test Procedure:	**Variable gain:** a) Connect the EUT to the test equipment as shown in Figure 5 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 determined from 7.2. 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 of Figure 5), 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. See gain limit in charts in Appendix D for uplink gain requirements. 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 7.9.1b) to 7.9.1k) for all operational uplink bands. **Variable uplink gain timing:** Variable uplink gain timing is to be measured as follows, using the

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	test setup shown in Figure 5. 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 #1 to the lowest level of the RSSI-dependent gain [see 7.9.1k)]. d) Select MAX HOLD and increase the power level of signal generator #1 by 10 dB for mobile boosters, and by 20 dB for fixed indoor boosters. Signal generator #2 remains same, as described in 7.9.1c). e) Confirm that the uplink gain decreases to the specified levels, within 1 second for mobile devices, and within 3 seconds for fixed devices.13 f) Repeat 7.9.2a) to 7.9.2e) for all operational uplink bands.
Test Result:	PASS

6.8.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	E4421B	GB39340839	Jul. 30, 2019	Jul. 29, 2020
Signal Generator	Agilent	N5182A	MY47070282	Sep. 12, 2019	Sep. 11, 2020
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 12, 2019	Sep. 11, 2020
RF Combiner	SUNVNDN	SUD-CS 0800	16230009	Sep. 12, 2019	Sep. 11, 2020
Attenuator	50FP-006-H3	JFW	907763	Sep. 12, 2019	Sep. 11, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.8.3. Test Data

Mobile station coupling loss (MSCL): *the minimum coupling loss (in dB) between the wireless device and the input (server) port of the consumer booster. MSCL must be calculated or measured for each band of operation and provided in compliance test reports. MSCL includes the path loss from the wireless device, and the booster's server antenna gain and cable loss. The wireless device is assumed to be an isotropic (0 dBi) antenna reference. Minimum standoff distances from inside wireless devices to the booster's server antenna must be reasonable and specified by the manufacturer in customer provided installation manuals.*

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MSCL Calculation							
Operation Frequency	Frequency (MHz)	Distance (m)	Path loss (dB)	Indoor Antenna Gain(dBi)	Indoor Cable Loss(dB)	Polarity Loss(dB)	MSCL (dB)
UL776-787	776	2	36.32	6	1.4	3.01	**34.73**

Note: Lp = 20logf + 20logd – 27.5

Polarity loss = 20Log (1/Sin (45deg)) dB = 3.01dB

Variable booster gain							
Operation Frequency	RSSI (dBm)	Input Power (dBm)	Output Power (dBm)	Measured Gain (dB)	MSCL	Limit	Results
UL776-787	-63	-45.8	14.44	60.24	34.73	63.73	PASS
	-62	-45.8	13.38	59.18	34.73	62.73	PASS
	-61	-45.8	12.33	58.13	34.73	61.73	PASS
	-59	-45.8	10.37	56.17	34.73	59.73	PASS
	-57	-45.8	8.35	54.15	34.73	57.73	PASS
	-56	-45.8	6.27	52.07	34.73	56.73	PASS

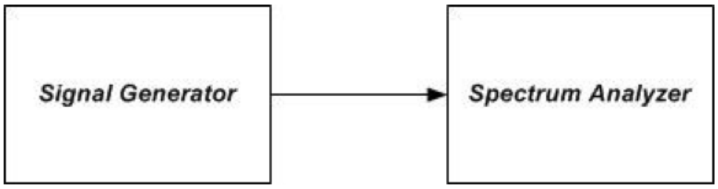
Variable Uplink Gain Timing

Operation Frequency	Measured Sec	Limit Sec	Result
776-787	1.03	3.0	PASS

Variable Uplink Gain Timing Test Plots

6.9. Occupied Bandwidth

6.9.1. Test Specification

Test Requirement:	FCC Part2 Section 2.1049
Test Method:	KDB835210 D03 Signal booster measurements v04r01
Limit:	N/A
Test setup:	 **Figure 6 – Test setup for measuring characteristics of test signals used for subsequent EUT occupied bandwidth testing**
Test Procedure:	a) Connect the test equipment as shown in Figure 6 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 tests of 7.2. 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 7.10c) to 7.10g) 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 7.10c) to 7.10h) for all uplink and downlink operational bands. j) Connect the test equipment as shown in Figure 1, with the uplink output (donor) port connected to the spectrum analyzer, and the server port connected to the signal generator. k) Repeat 7.10c) to 7.10i) with this EUT uplink path test setup. l) Connect the test equipment as shown in Figure 1, with the downlink output (server) port connected to the spectrum analyzer, and the donor port connected to the signal generator. m) Repeat 7.10c) to 7.10i) with this EUT downlink path test setup.
Test results:	PASS

6.9.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Signal Generator	Agilent	N5182A	MY47070282	Sep. 12, 2019	Sep. 11, 2020
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 12, 2019	Sep. 11, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.9.3. Test Data

Operation Band	Signal Type	Input OBW [MHz]	Output OBW [MHz]	Results
UL776-787	GSM	0.245	0.245	PASS
	CDMA	1.240	1.243	PASS
	LTE	4.522	4.547	PASS
DL746-757	GSM	0.246	0.245	PASS
	CDMA	1.243	1.239	PASS
	LTE	4.536	4.501	PASS

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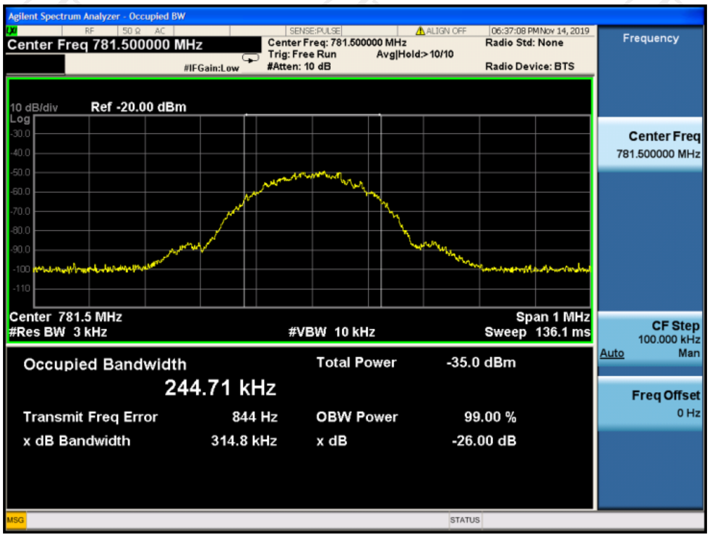
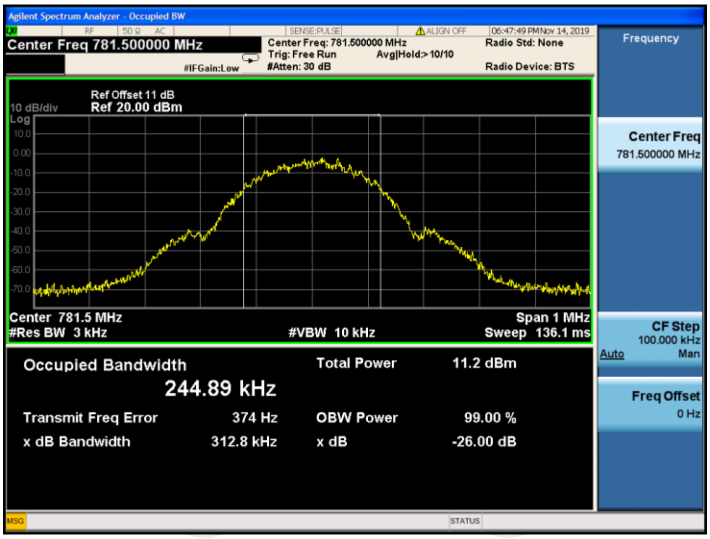
Test Plots

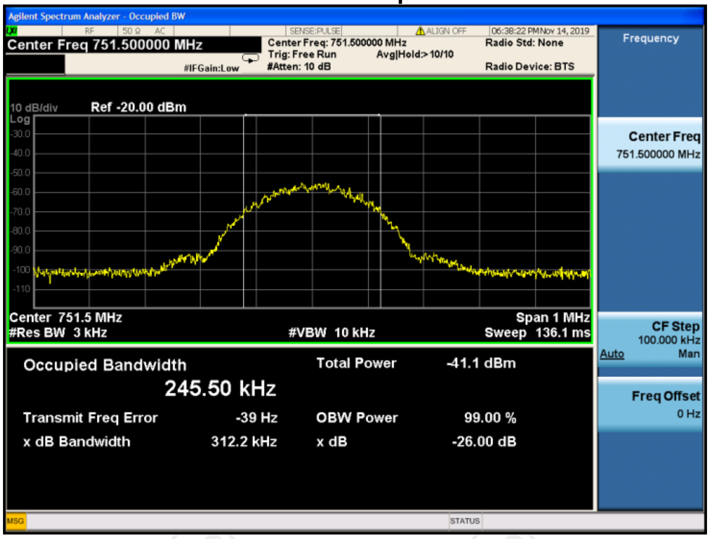
GSM UL Input



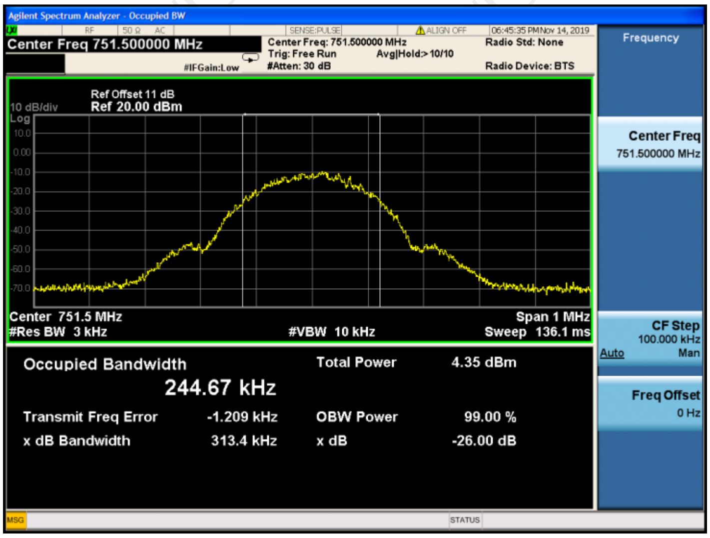
GSM UL output



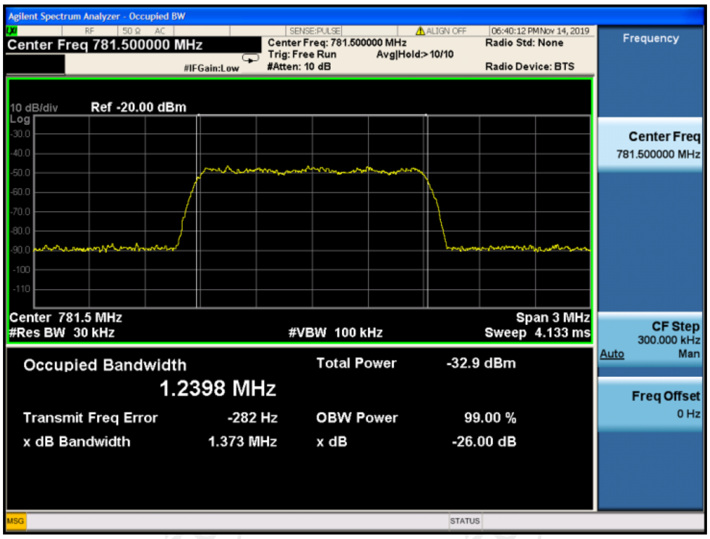
GSM DL Input



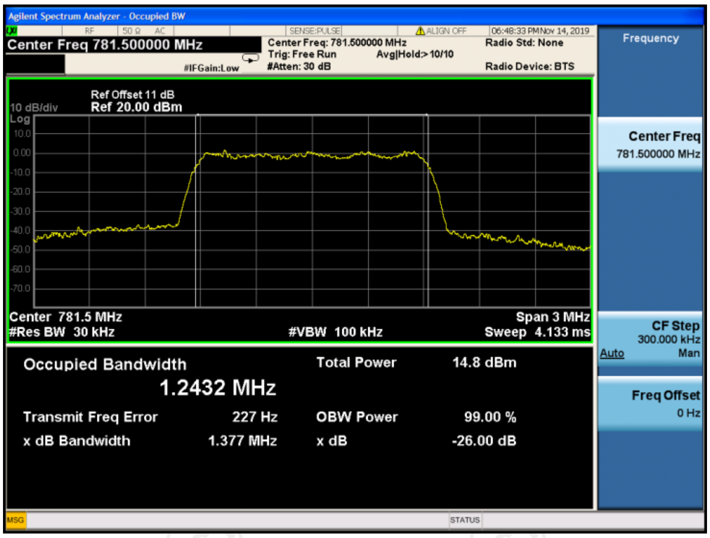
GSM DL Output



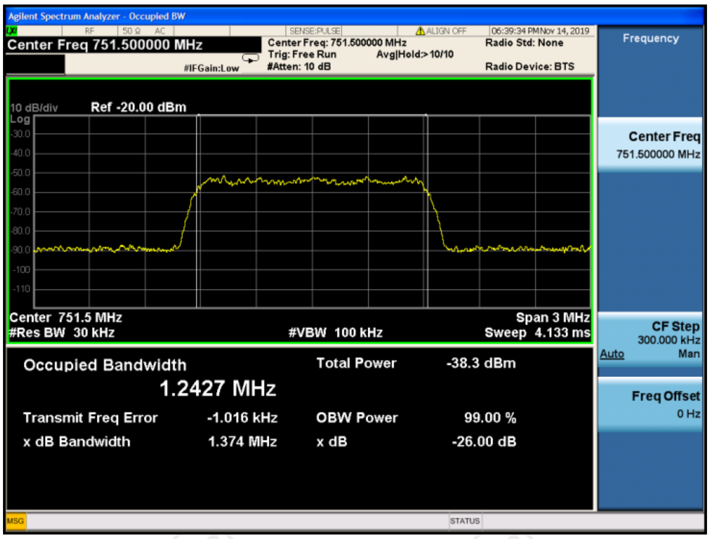
CDMA UL Input



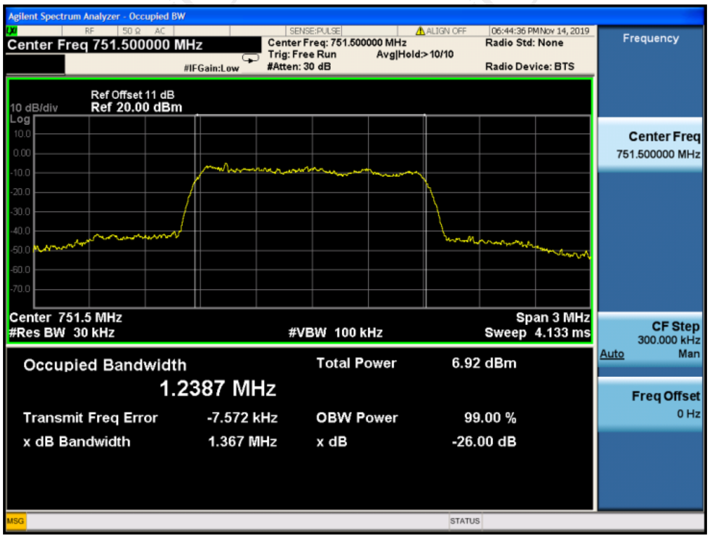
CDMA UL output



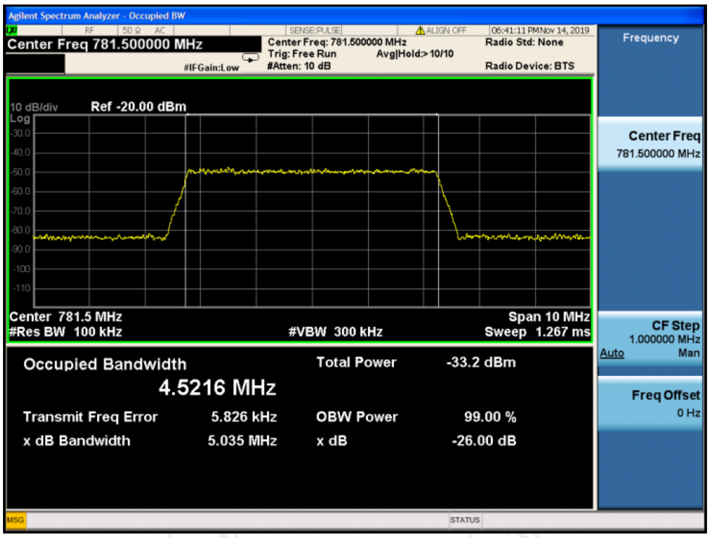
CDMA DL Input



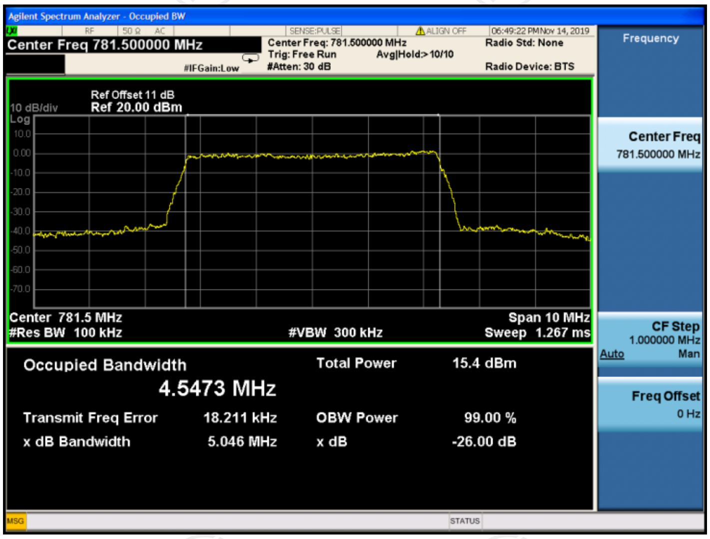
CDMA DL Output



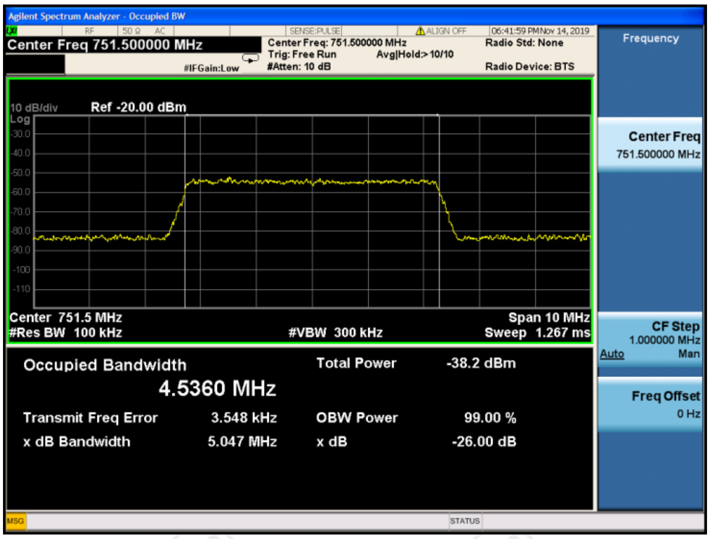
LTE UL Input



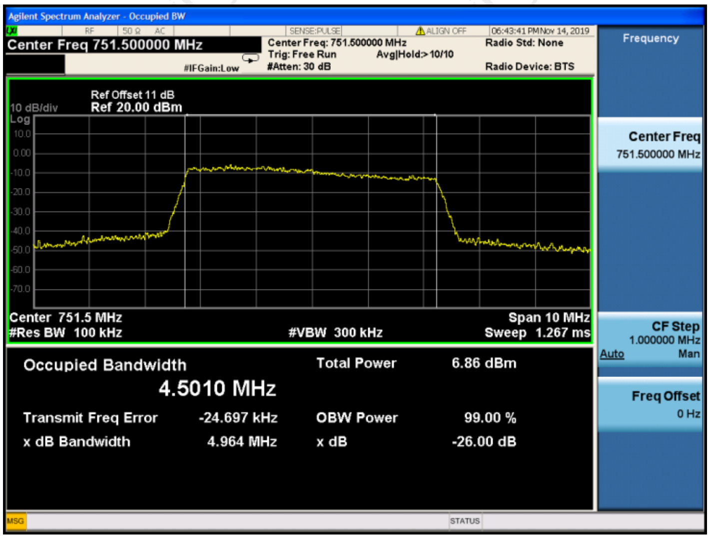
LTE UL output



LTE DL Input



LTE DL Output

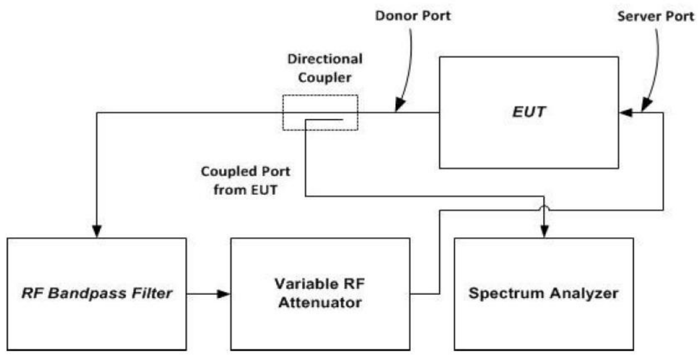


6.10. Oscillation Detection and Mitigation

6.10.1. Test Specification

Test Requirement:	FCC Part20 Section 20.21(e)(8)(iii)(A)
Test Method:	KDB835210 D03 Signal booster measurements v04r01
Limit:	Reference to test data bellow

Test setup:



NOTE—This figure shows the test setup for uplink bands transmission path tests; i.e., signal flow is out from the donor port into the directional coupler. For downlink bands transmission path tests, the feedback signal flow path direction and equipment connections shall be reversed, i.e., signal flow is out from the server port into the directional coupler, and signal flow is into the donor port from the variable RF attenuator.

Figure 7 – Oscillation detection (7.11.2) test setup

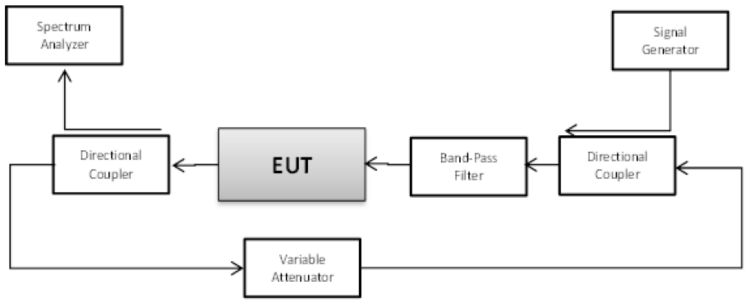


Figure 8 – Oscillation mitigation/shutdown test setup

Test Procedure:

Oscillation restart tests

a) Connect the normal-operating mode EUT to the test equipment as shown in Figure 7 beginning with the spectrum analyzer on the uplink output (donor) port. Confirm 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) 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 > 3xRBW

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 7.11.2c) 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 frequency 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 7.11.2d). 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 7.11.2f) 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 7.11.2b) to 7.11.2k) 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 7.11.2i). q) When the sweep is complete, place cursors between the first two oscillation detections, and save the Test Plots 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 7.11.2m) to 7.11.2q) for all operational uplink and downlink bands. **Test procedure for measuring oscillation mitigation or shutdown** a) Connect the normal-operating mode EUT 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: 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 (see 7.3), 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 7.11.3f2), does not exceed by 12.0 dB the minimal output level measured in 7.11.3f)4). Record the measurement results of 7.11.3f2) and 7.11.3f4) in tabular format for inclusion in the test report. 6) The procedure of 7.11.3f1) to 7.11.3.f5) allows the spectrum analyzer trace to stabilize, and verification of shutdown or oscillation level measurement must occur within 300 seconds.14 g) Decrease the variable attenuator in 1 dB steps, and repeat step 7.11.3f) 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 (see 7.3). h) Repeat 7.11.3a) to 7.11.3g) for all operational uplink and downlink bands.
Test results:	PASS

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6.10.2. Test Instruments

Equipment	Manufacturer	Model	S/N	Calibration Date	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 12, 2019	Sep. 11, 2020
Attenuation	AF115A-09-34	JFW	907763	Sep. 12, 2019	Sep. 11, 2020
RF Combiner	SUNVNDN	SUD-CS0800	16230009	Sep. 12, 2019	Sep. 11, 2020
AN03468	Band Pass Filter	4CS10-781.5/E12.2-O/O	N/A	Sep. 12, 2019	Sep. 11, 2020
AN03469	Band Pass Filter	4CS10-751.5/E12-O/O	N/A	Sep. 12, 2019	Sep. 11, 2020
AN02475	1 dB step Attenuator	8494B	N/A	Sep. 12, 2019	Sep. 11, 2020
AN03429	10dB step Attenuator	8496B	N/A	Sep. 12, 2019	Sep. 11, 2020
ANC00082	RF Coupler	722-10-1.500V	N/A	Sep. 12, 2019	Sep. 11, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

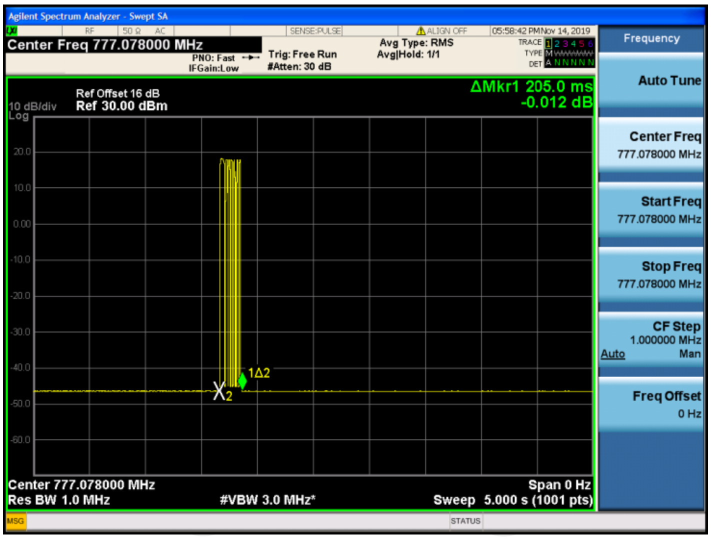
6.10.3. Test Data

Test results of detection time			
Operation Frequency	Detection Time (s)	Limit (s)	Result
UL776-787	0.205	0.300	PASS
DL746-757	0.800	1.000	PASS

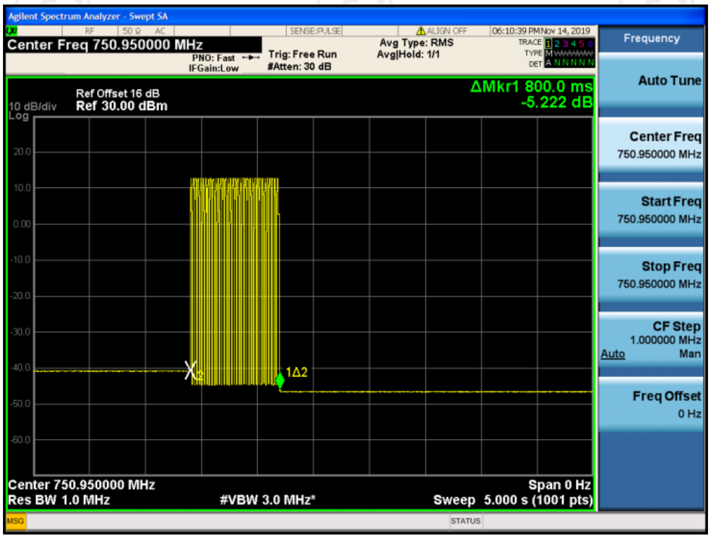
Test results of detection time					
Operation Frequency	Restarting Time(s)	Limit (s)	Restarting Counts	Limit	Result
UL776-787	82.50	60	1	5	PASS
DL746-757	85.80	60	1	5	PASS

Test Test Plotss of detection time

UL

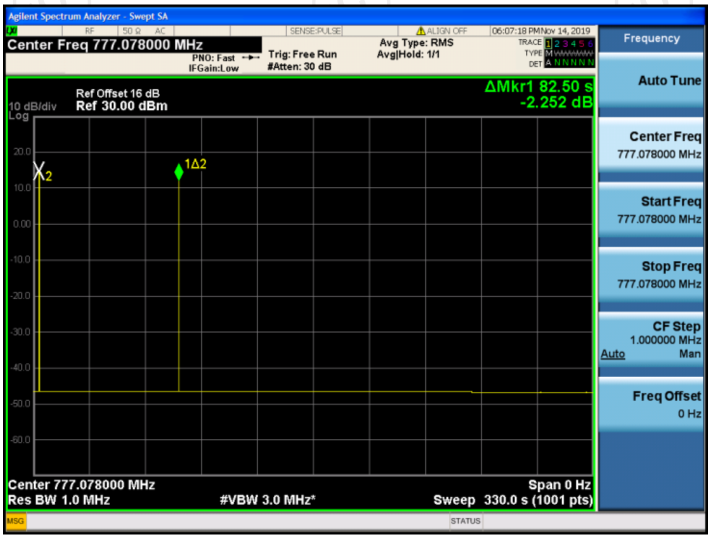


DL

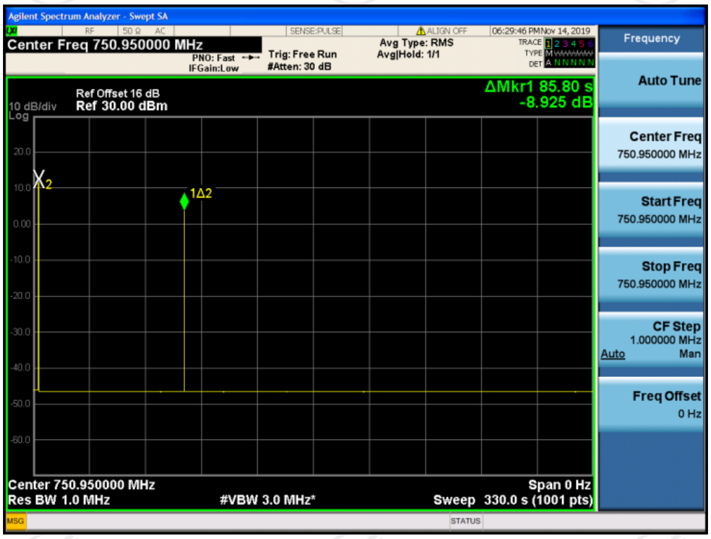


Test Test Plotss of restarting time

UL



DL



Test results of Mitigation or Shutdown

Frequency	Uplink(776-787MHz)								
Signal Type	AWGN								
Isolation	Peak Oscillations		Minimal Level		Delta Value	Limit	Time to Mitigate Oscillation	Mitigation Time Limit	Result
	Freq.	Level	Freq.	Level					
dB	MHz	dBm	MHz	dBm	dB	dB	sec	sec	
+5	777.08	-56.43	781.22	-63.42	6.99	<12	264	300	Pass
+4	777.08	-55.24	781.22	-63.47	8.23	<12	247	300	Pass
+3	777.08	-53.86	781.22	-63.28	9.42	<12	215	300	Pass
+2	777.08	-50.24	781.22	-62.89	12.65	<12	236	300	Pass
+1	777.08	-46.42	781.22	-63.14	16.72	<12	196	300	Pass
0	777.08	-40.58	781.22	-63.17	22.59	<12	215	300	Pass
-1	777.08	-32.36	781.22	-62.45	30.09	<12	175	300	Pass
-2	EUT Shutdown								

Frequency	Downlink(746-757MHz)								
Signal Type	AWGN								
Isolation	Peak Oscillations		Minimal Level		Delta Value	Limit	Time to Mitigate Oscillation	Mitigation Time Limit	Result
	Freq.	Level	Freq.	Level					
dB	MHz	dBm	MHz	dBm	dB	dB	sec	sec	
+5	750.95	-60.74	753.42	-66.34	5.6	<12	224	300	Pass
+4	750.95	-58.56	753.42	-66.42	7.86	<12	196	300	Pass
+3	750.95	-55.14	753.42	-66.73	11.59	<12	204	300	Pass
+2	750.95	-51.39	753.42	-66.25	14.86	<12	186	300	Pass
+1	750.95	-45.36	753.42	-66.22	20.86	<12	125	300	Pass
0	EUT Shutdown								

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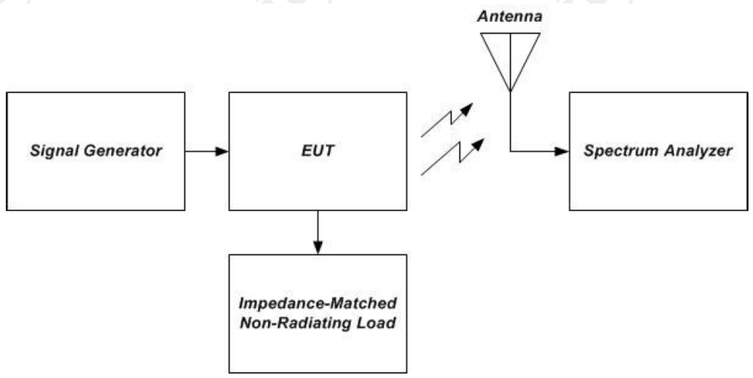
7. Radiation Spurious Emission

7.1.1. Test Specification

Test Requirement:	FCC Part2 Section 2.1053
Test Method:	KDB835210 D03 Signal booster measurements v04r01
Limit:	-13dBm
Test setup:	 Figure 10 – Radiated spurious emissions test and instrumentation setup
Test Procedure:	a) Place the EUT on an OATS or semi-anechoic chamber turntable 3 m from the receiving antenna.15 b) Connect the EUT to the test equipment as shown in Figure 10 beginning with the uplink output (donor) port. c) Set the signal generator to produce a CW signal with the frequency set to the center of the operational band under test, and the power level set at PIN as determined from measurement results per 7.2. d) Measure the radiated spurious emissions from the EUT from the lowest to the highest frequencies as specified in § 2.1057. Maximize the radiated emissions by using the procedures described in ANSI C63.4. e) Capture the peak emissions Test Plotss using a peak detector with Max-Hold for inclusion in the test report. Tabular data is acceptable in lieu of spectrum analyzer Test Plotss. f) Repeat 7.12c) through 7.12e) for all uplink and downlink operational bands.
Test results:	PASS

7.1.2. Test Instruments

Radiated Emission				
Name	**Model No.**	**Manufacturer**	**Date of Cal.**	**Due Date**
EMI Test Receiver	ESIB7	R&S	Jul. 30, 2019	Jul. 29, 2020
Spectrum Analyzer	FSQ40	R&S	Sep. 12, 2019	Sep. 11, 2020
Amplifier	8447D	HP	Sep. 09, 2019	Sep. 08, 2020
Amplifier	EM30265	EM Electronics Corporation CO.,LTD	Sep. 09, 2019	Sep. 08, 2020
Broadband Antenna	VULB9163	Schwarzbeck	Sep. 07, 2019	Sep. 06, 2020
Horn Antenna	BBHA 9120D	Schwarzbeck	Sep. 07, 2019	Sep. 06, 2020
Coaxial Cable	RE-high-02	TCT	Sep. 09, 2019	Sep. 08, 2020
Coaxial Cable	RE-high-04	TCT	Sep. 09, 2019	Sep. 08, 2020
Loop antenna	ZN30900A	ZHINAN	Sep. 12, 2019	Sep. 11, 2020
Signal Generator	N5182A	Agilent	Sep. 12, 2019	Sep. 11, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

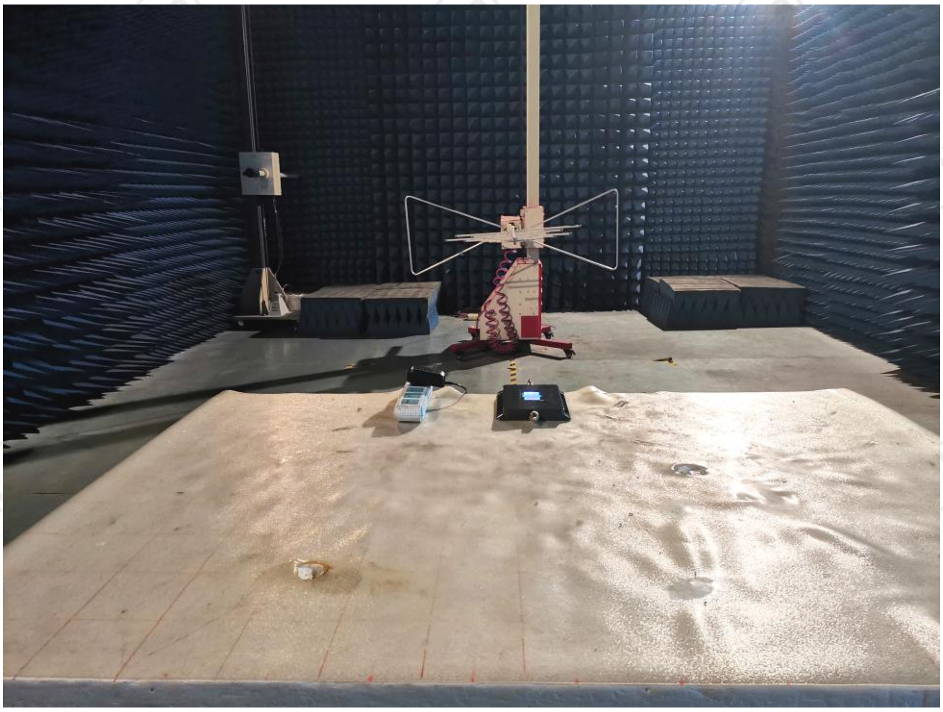
7.1.1. Test data

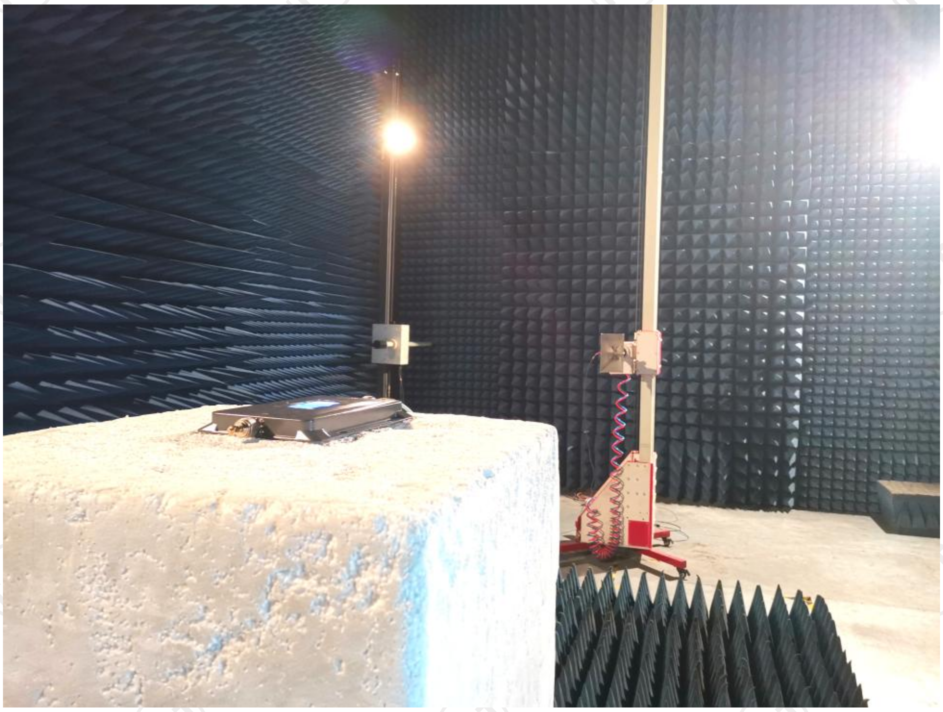
Frequency [MHz]	Antenna polarity [H/V]	Level [dBm]	Limit [dBm]	Margin [dB]
Uplink				
85.36	V	-42.51	-13.00	29.51
110.95	H	-45.93		32.93
1563.00	V	-49.27		36.27
1563.00	H	-48.65		35.65
--	--	--		--
Downlink				
86.42	V	-43.81	-13.00	30.81
111.57	H	-44.36		31.36
1503.00	V	-50.59		37.59
1503.00	H	-52.84		39.84
--	--	--		--

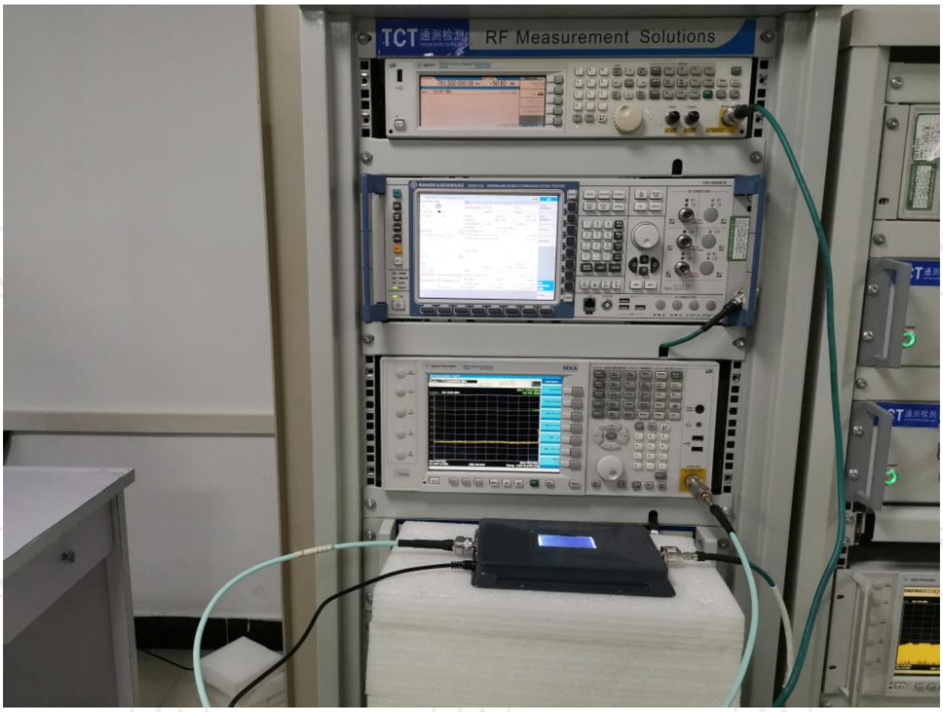
Appendix A: Photographs of Test Setup

Product: cell phone signal booster

Model: SV70





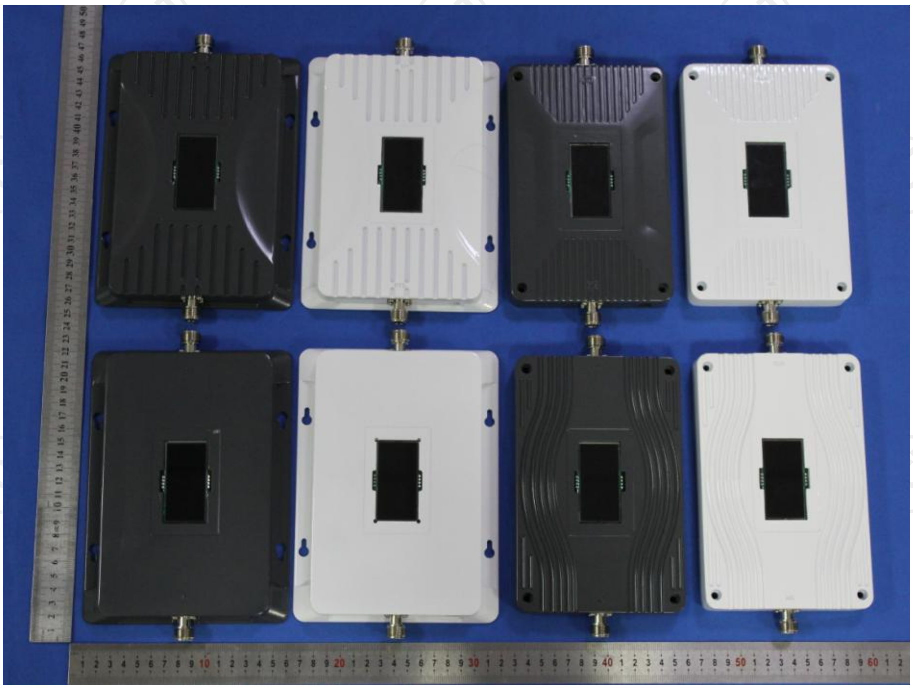

TCT 通测检测
RF Measurement Solutions

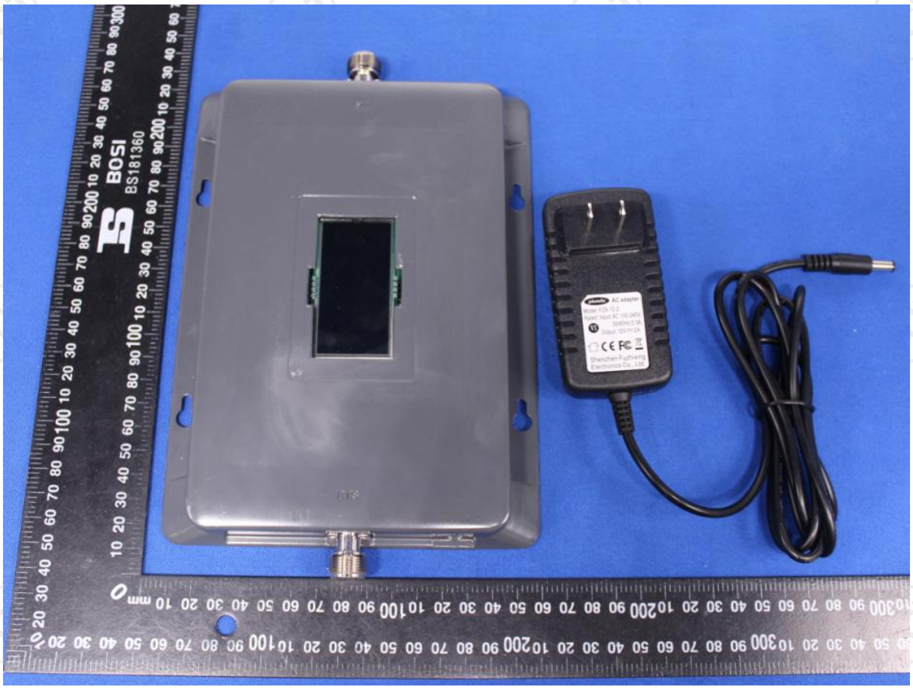
Appendix B: Photographs of EUT

Product: cell phone signal booster

Model: SV70

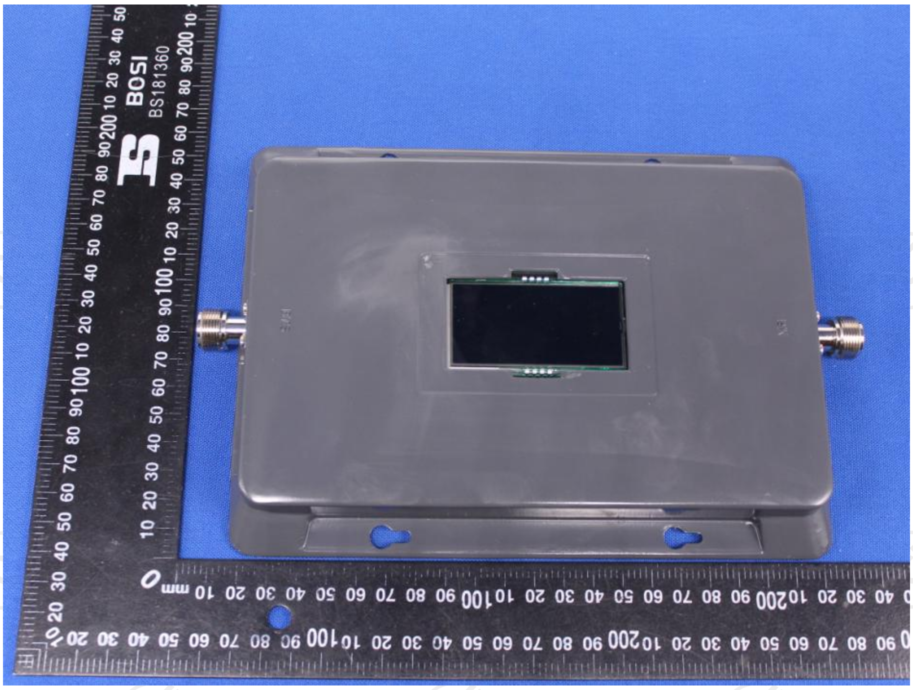
External Photos

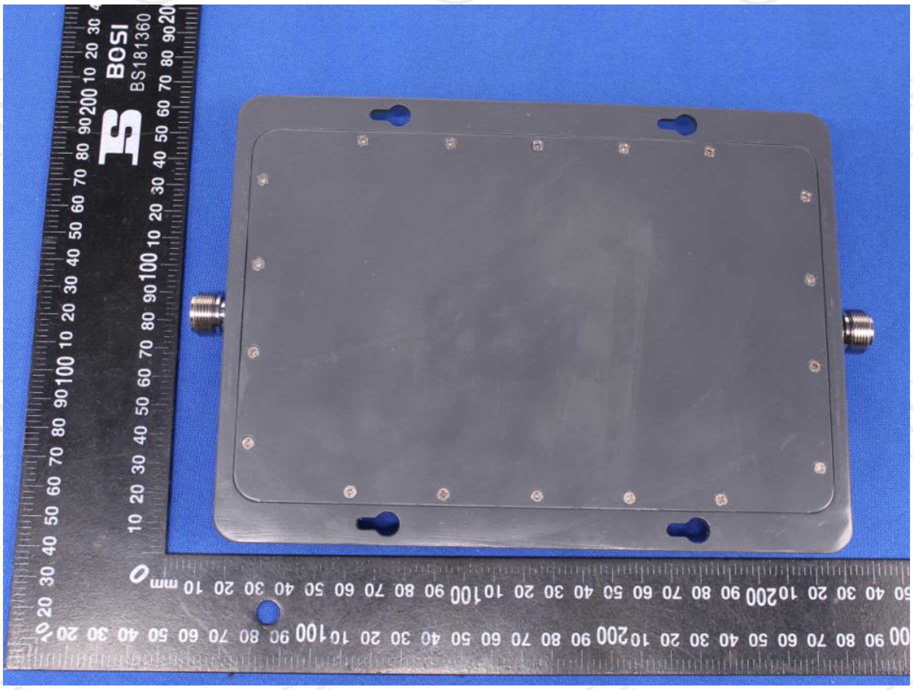




Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com


phonelex AC adapter
Model: FZX-12-2
Rated: Input: AC 100-240V,
50/60Hz,0.3A;
VI
Output: 12V⎓2A
Shenzhen Fuzhixing
Electronics Co., Ltd.


BOSI
BS181360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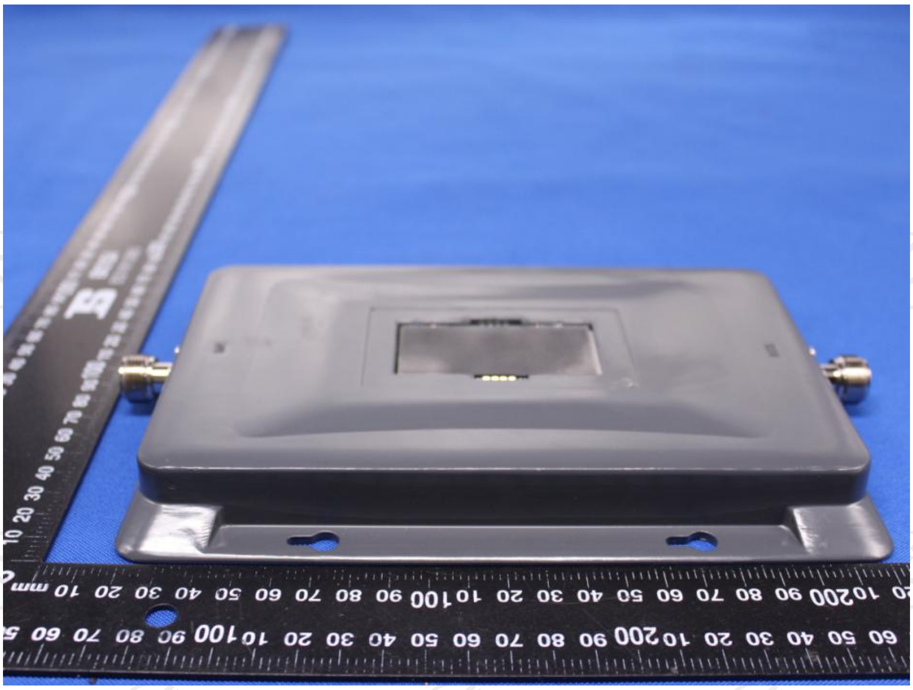
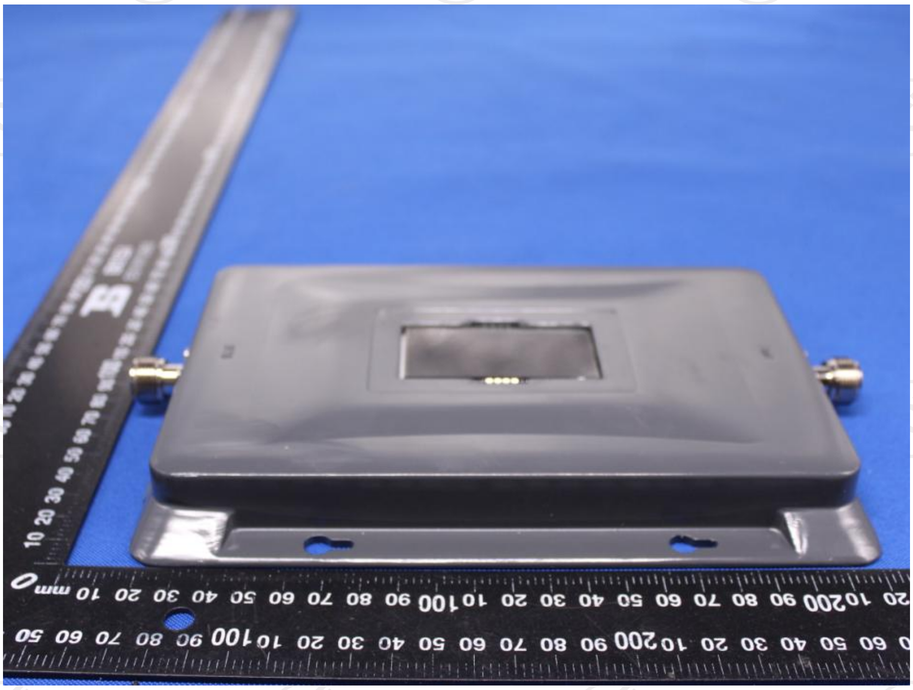
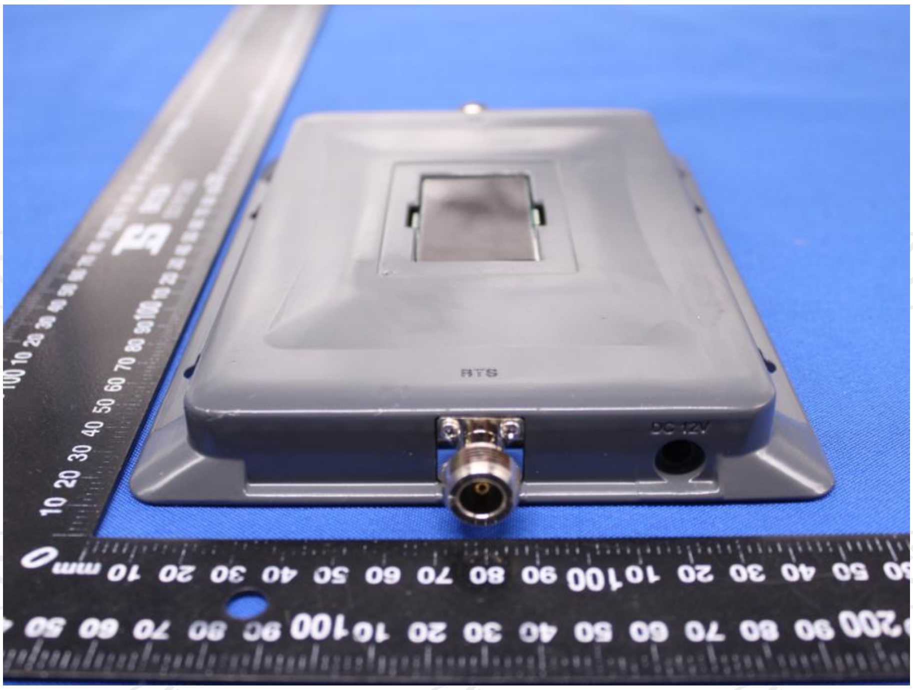
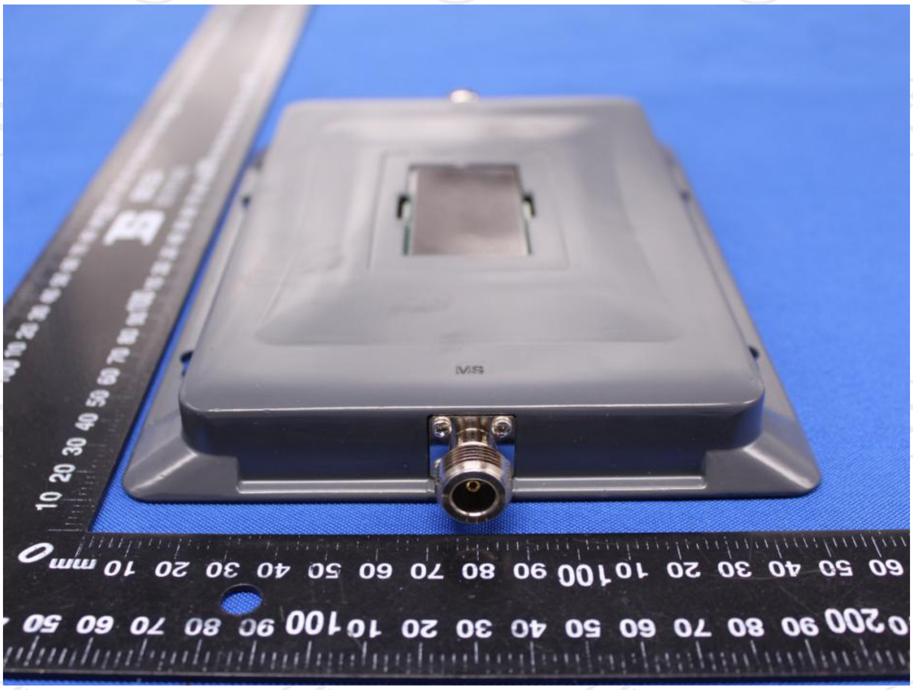
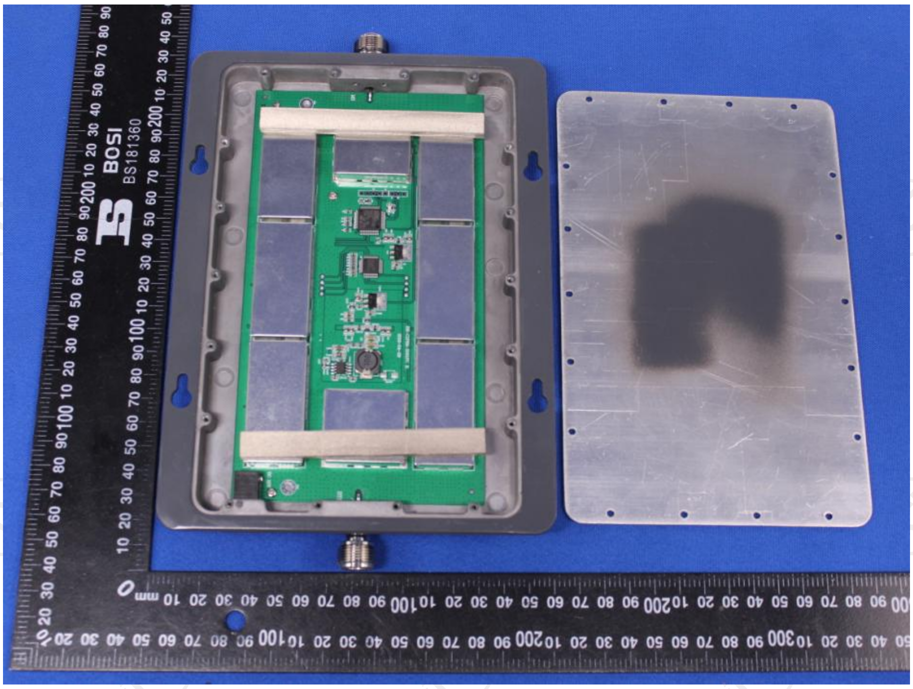


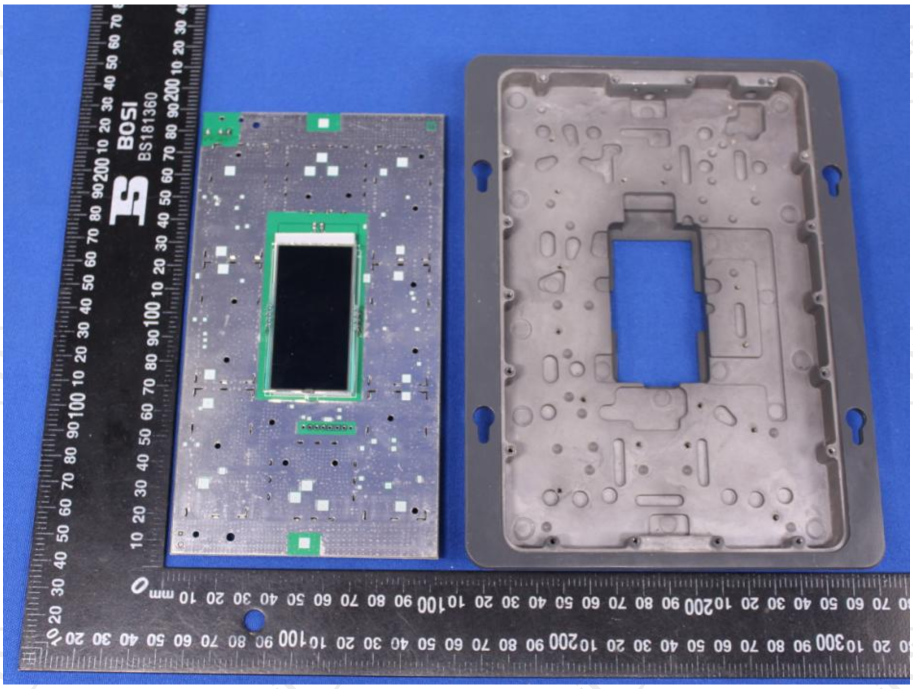


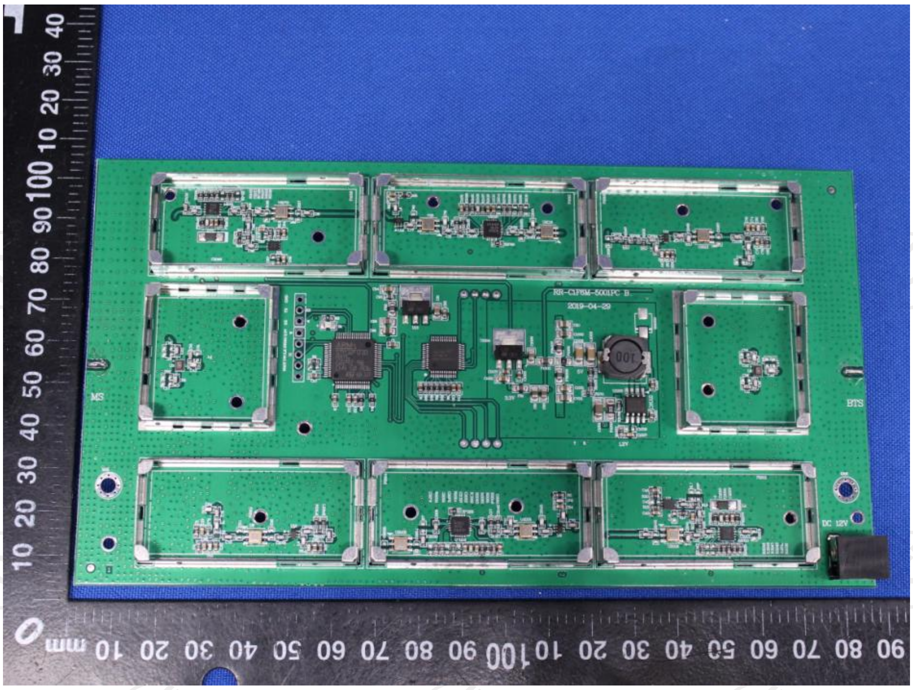

BTS
DC12V

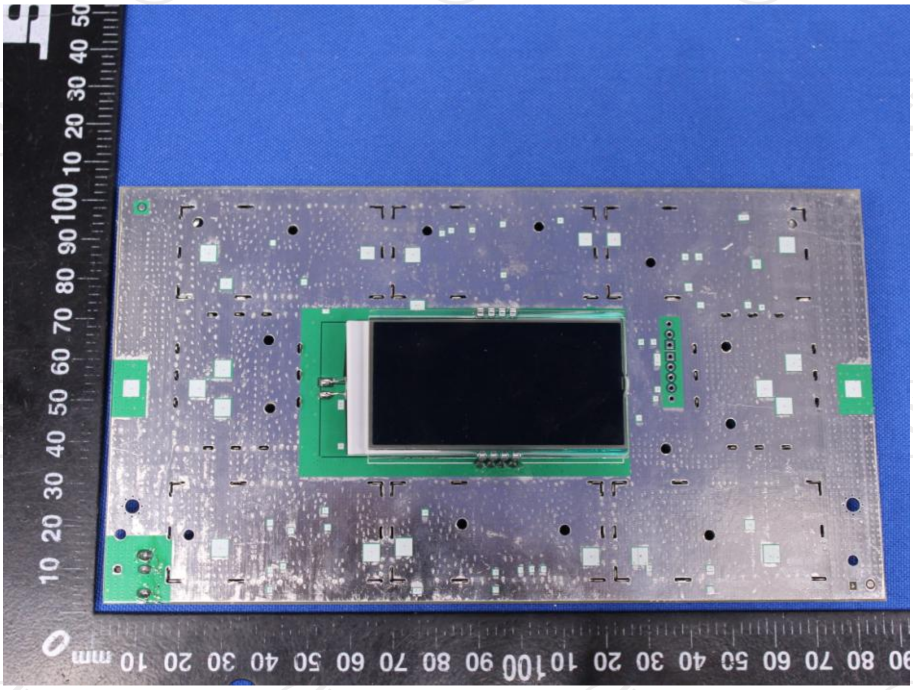

MS

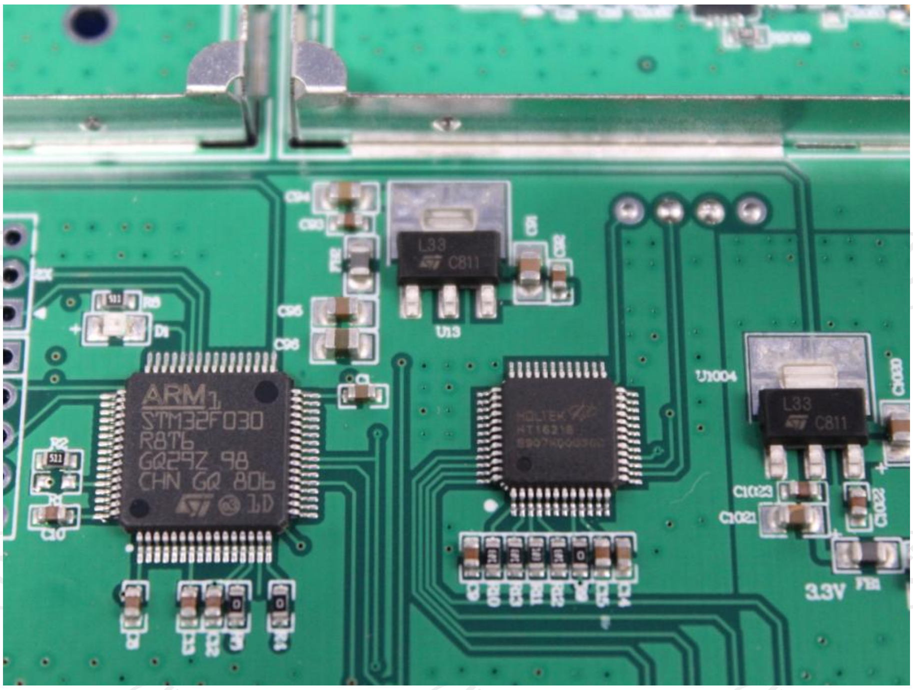
Product: cell phone signal booster
Model: SV70
Internal Photos

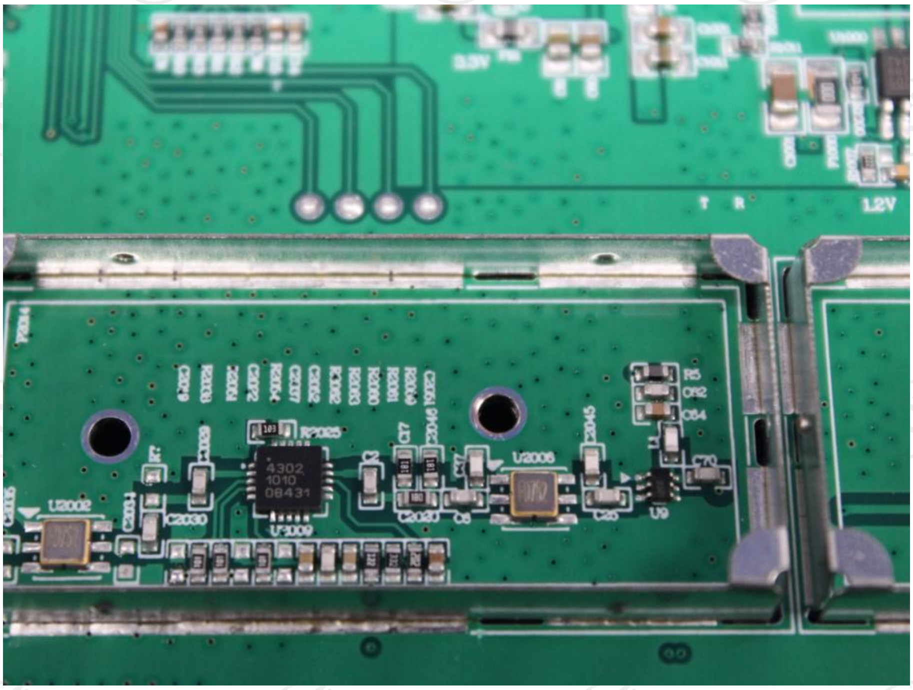


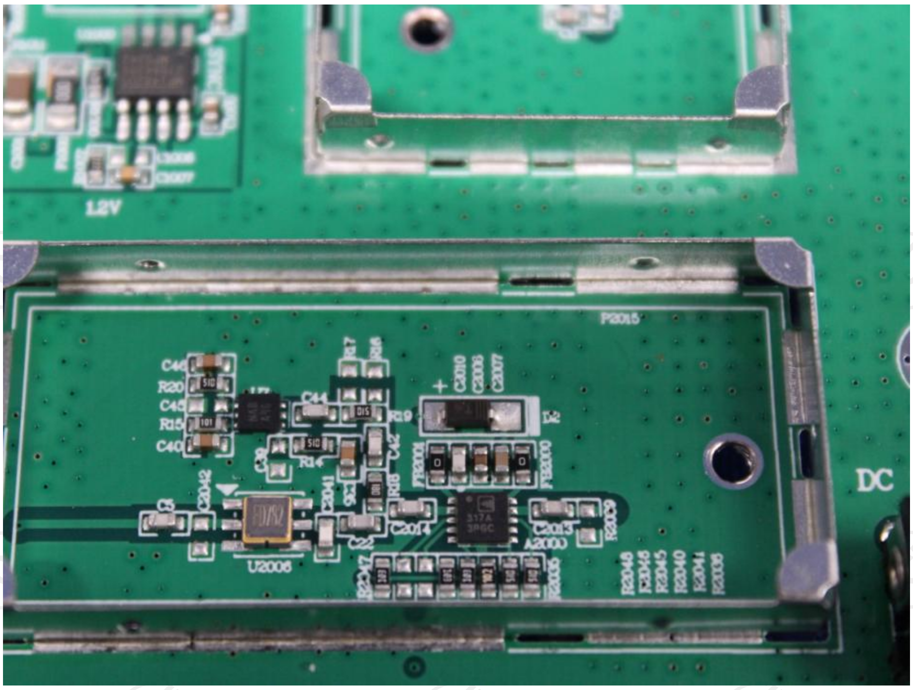


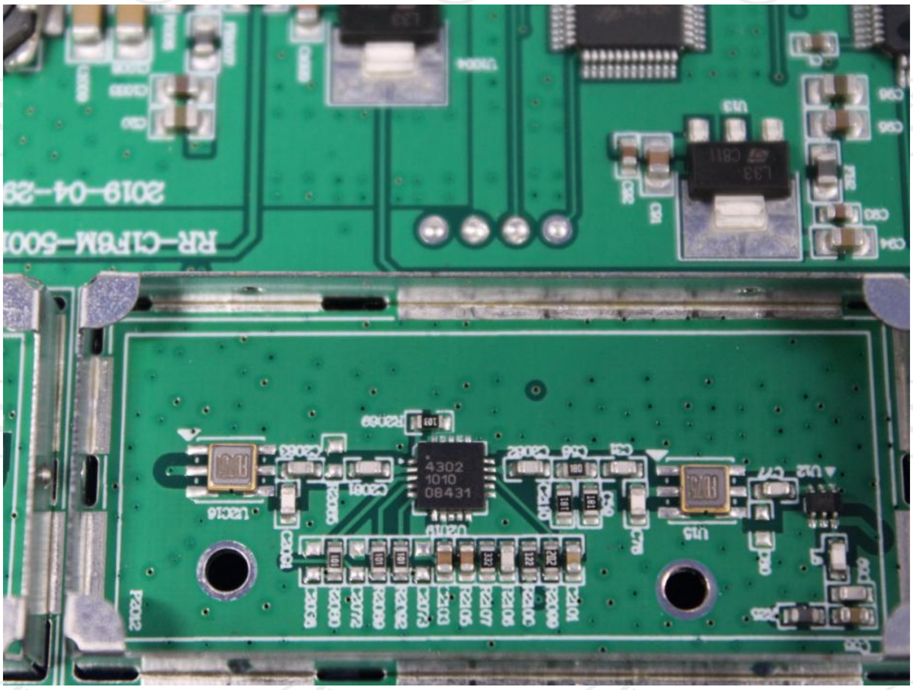


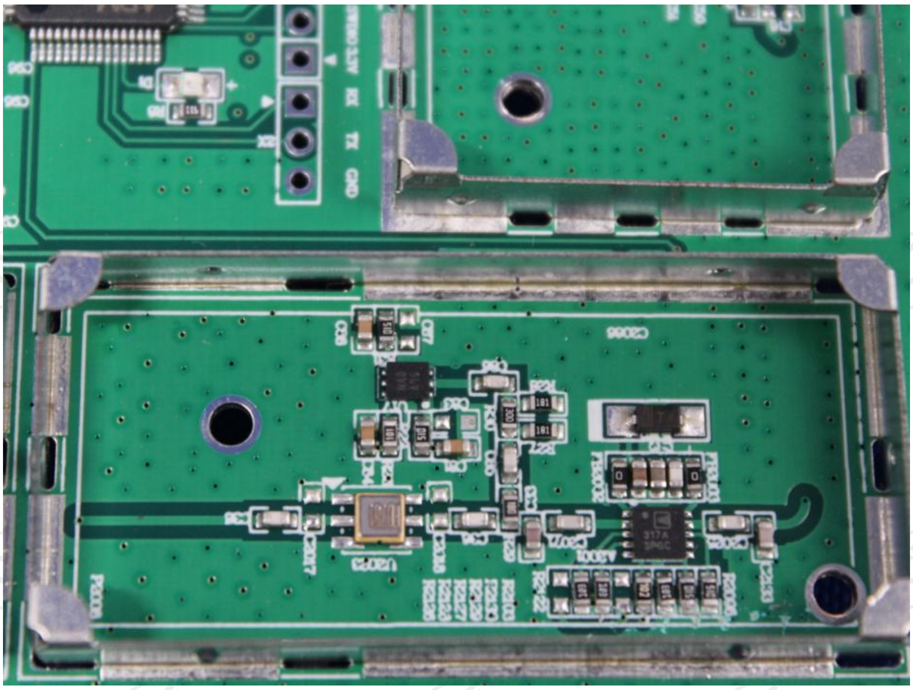


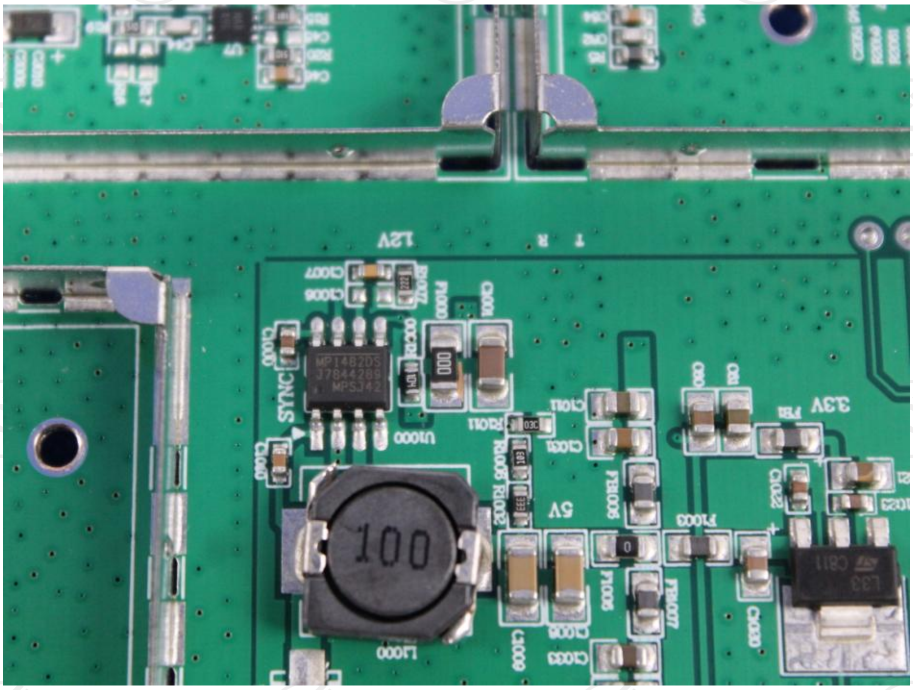

ARM
STM32F030
R8T6
L33
C811
3.3V


3.3V
1.2V
4302
1010
08431
U2002
U2006
U9


12V
P2015
DC
U2006


4302
1010
D8431





********END OF REPORT********