BINGHAM

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August 10, 2013

Via E-Mail

Federal Communications Commission
Office of Engineering and Technology
445 12th Street, S.W.
Washington, D.C. 20554
Attn: Mr. Steven Jones

Re: Comments on KDB 935210 DR03; Wideband Consumer Signal Booster Measurement Guidance

Dear Mr. Jones:

On behalf of Nextivity, Inc. ("Nextivity"), please find attached hereto Nextivity's suggested revisions to the above-referenced draft staff publication. Upon review of the staff's draft guidance with respect to the measurement procedures to determine compliance with the Commission's new signal booster rules, and consideration of the practical procedures needed to seek certification, Nextivity has determined that certain revisions should be made to the measurement procedures that apply to provider-specific consumer boosters. Nextivity offers the attached recommended changes as a means to ensure that both wideband and provider-specific signal boosters are subject to comparable test measurement procedures where appropriate and in some cases where provider-specific devices should be subject to different measurement procedures based on the differences in the Commission's Rules. None of the changes that Nextity proposes would require a change in the Commission's Rules.

We appreciate the opportunity to provide input to the Commission staff in this matter. We would appreciate it if you would include the proposed changes in the OET's Knowledge Database on this topic and the forthcoming revisions to the draft guidance document. We are also sending a copy of the attached document to Mr. Art Wall, Chairman of the Wireless Working Group/C63/SC1 for inclusion in upcoming revisions to the draft publications governing signal booster testing.

Please do not hesitate to contact the undersigned with any questions.

Respectfully Submitted,

/electronically signed/
Catherine Wang
Jeffrey R. Strenkowski

Attachment

cc: Art Wall (Wireless Working Group/C63/SC1)
Rashmi Doshi (FCC)
Roger Noel (FCC)
Moslem Sawez (FCC)
Joyce Jones (FCC)
Thomas Struble (FCC)
Tim Harrington (FCC)
Michiel Lotter

Draft For Review

June 14, 2013

Federal Communications Commission
Office of Engineering and Technology
Laboratory Division

Draft Laboratory Division Publications Report

Title: Wideband Consumer Signal Booster Measurement Guidance

Short Title: Consumer Signal Booster Procedure

Reason: Draft measurement procedure to address rulemaking on Consumer Signal Boosters

Publication: 935210 D03

Keyword/Subject: Signal Booster

First Category: Radio Service Rules

Second Category: Certification

Question: What is the Commission guidance for the evaluation of Signal Boosters?

Answer: A recent FCC Report and Order (FCC 13-21) introduces a new regulatory framework for signal boosters, including the introduction of a Network Protection Standard (NPS) that specifies the technical and operational requirements necessary to minimize the potential for interference from signal boosters to wireless networks. These requirements are codified in 47 C.F.R. Part 20.21.

935210 D01 Booster Definitions v01, provides guidance for classifying types of devices and applicable rules for performing compliance measurements on signal boosters operating under 47 CFR §§ 20.21, 90.219, and Parts 22, 24, 27, 90; considerations for some provisions and devices under other rules is also given, e.g., parts 2, 25, 97, 101.

935210 D02 Certification Requirements v01, provides certification requirements for signal boosters that operate under Parts 20, 22, 24, 27 and 90 of the FCC rules.

935210 DR03 Consumer Signal Booster Procedure v01 provides preliminary guidance for demonstrating compliance to the various requirements for Wideband Consumer Signal Boosters as specified in Part 20.21(e), *Consumer Signal Booster Network Protection Standard*. This document represents the current version of an ongoing effort by the C63 Wireless Working Group, RF Booster Task Group to develop applicable measurement guidance. The task group includes representatives from the signal booster manufacturing industry, the compliance testing industry and the FCC. The procedures described here represent draft guidance and as such are still subject to further review, evaluation and update. This draft guidance is being offered now as pre-draft KDB so as to introduce to a wider audience for review and comment. The measurement procedures will be further refined as necessary based on comments received from the public and the C63 working group. Alternative measurement procedures acceptable to the Commission may also be used to prepare data demonstrating compliance to the applicable technical and operational requirements as per Section 2.947(a)(3) of the FCC rules.

Draft For Review OET

In order to continue with the development of the measurement procedures, FCC would like to receive comments on this initial draft within 15 days and we expect that a second draft will be issued based on further comments prior to the final publication of the measurement procedure. We encourage the use of this procedure on actual devices to determine where changes should be made and encourage all parties to provide comments based on experience with applying the test procedures.

Note:

This Draft publication is out for comment for a proposed third attachment to Knowledge Data Base (KDB) publication 935210 as DR03 Consumer Signal Booster Procedure* (pages 3-18).

The current KDB publication 935210, updated on 06/14/2013, includes attachments D01 Booster Definitions** and D02 Certification Requirements**. These ** attachments are final and are not open for comment.

Field Code Changed

Attachment List:

935210 D01 Booster Definitions v01**
935210 D02 Certification Requirements v01**
935210 DR03 Consumer Signal Booster Procedure v01*

Attachment: 935210 DR03 Consumer Signal Booster Procedure v01

Federal Communications Commission
Office of Engineering and Technology
Laboratory Division

DRAFT FOR REVIEW ONLY

WIDEBAND CONSUMER SIGNAL BOOSTER MEASUREMENT GUIDANCE

1. Background and Scope

1.1. This document is limited to the testing of consumer cellular phone signal boosters for wideband, mobile, and provider specific application. Industrial signal boosters and DAS are not covered in this document.

1.2. All boosters contained in this document are subject to the requirements of 47 CFR Subpart 20. This document only provides test procedures, the limits are found in 47 CFR Subpart 20.

1.3. Completely read each procedure prior to beginning any test.

1.4. Cellular phone signals within close proximity to the EUT can have deleterious effects on the results and care should be taken to ensure that the EUT is isolated from any cellular devices during testing.

1.5. All test losses from RF paths must be accounted for either manually or automatically in the measurement results. The specific procedures do not indicate how these factors are to be processed. This is the responsibility of the individual engineer or technician performing the testing based upon the specific capabilities of the selected test equipment being taken into account.

1.6. All test equipment is assumed to be calibrated in accordance to the specifics of the laboratories' accreditation requirements. All equipment not subject to certification will be verified prior to use ensuring accurate testing and test results. It is assumed that individuals who are utilizing this document are proficient in the operation of the necessary test equipment.

1.7. The test report generated from the associated test procedures in conjunction with the documentation required for FCC certification will provide a complete package for the standard TCB review process which in totality verifies compliance with CFR 47 Subpart 20.

2. **Terms and Definitions** (This section will be expanded)

2.1. **Wideband Consumer Signal Booster**

2.2. **Provider Specific Consumer Signal Booster**

2.3. **Received Signal Strength Indication (RSSI)** is the downlink composite received signal power in dBm, referenced to the Consumer Booster's donor antenna port, for all CMRS base stations' signals received within the band of operation.

2.4. **Mobile Station Coupling Loss (MSCL)** is the minimum inside 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.

2.5. **Transmitter Noise Power Level**

2.6. **Uplink Saturation levels per device type**

2.6.1. **Direct Connect**; 27 dBm

2.6.2. **Direct Contact Coupling (e.g., cradle-type);** 23 dBm

2.6.3. **Mobile using inside antennas**; 10 dB

2.6.4. **Fixed using an inside antenna**; 0 dBm

2.7. **Downlink Saturation all modes of operation**; – 20 dBm

2.8. **Acronyms**

2.8.1. AGC – Automatic Gain Control

2.8.2. EUT – Equipment Under Control

2.8.3. OATS – Open Area Test Site

3. **Test equipment requirements** (List of specifications for instrumentation to be expanded)

3.1. **Spectrum / Signal Analyzer or EMI receiver**

3.1.1. Frequency range of operation 9 kHz to 10 times the highest operational frequency

3.1.2. Absolute amplitude accuracy 0.4 dB

3.1.3. Frequency Stability ±1 x 10–8

3.1.4. Peak and RMS Average detection

3.1.5. Phase noise ≤ –90 dBc/Hz

3.2. **Signal Generator(s) (two signal paths required)**

3.2.1. 100 kHz – 3GHz operational frequency range

3.2.2. GSM, CDMA, WCDMA modulation types with a PBRS pattern generator(standard pseudo-random pattern)

3.2.3. Output power 20 dBm to -130 dBm

3.2.4. SSB phase noise –135 dBc /Hz Offset?

3.2.5. Wideband noise –153 dBc

3.3. **RF combining network**

3.3.1. Dual Path Resistive network

3.3.2. Operational greater than 3 GHz

3.4. **RF Step attenuator**

3.4.1. Linear step attenuator from 0-70 dB in 10 dB steps

3.4.2. Linear step attenuator from 0 10 dB in 1 dB steps

3.4.3. Linear step attenuator from 0-1 dB in 0.1 dB steps

3.5. **RF Crystal Detector**

3.5.1. Minimum Operating Frequency 500 MHz - 3000 MHz

3.6. **Digital Storage Oscilloscope**

3.6.1. 100 MHz bandwidth (minimum)

3.6.2. 2.5 GS/s Sample Rate

3.6.3. 5 Mega-sample Record Length

3.6.4. Time base Range 1 ns to 1000 s

3.7. **Cables and adapters**

3.7.1. Standard RF cables and adapters with a frequency range and power level matching the equipment under test.

3.8. **RF Directional Coupler**

3.8.1. Frequency Range 500 MHz – 3000 MHz

3.8.2. 10 dB Coupling Loss (minimum)

3.8.3. 1 Watt power handling capability

3.9. **RF Band-pass Filters**

3.9.1. Frequency Range(s) as separate complete bands

3.9.1.1. 698 - 716 MHz

3.9.1.2. 728 - 746 MHz

3.9.1.3. 746 - 757 MHz

3.9.1.4. 776 - 787 MHz

3.9.1.5. 824 - 849 MHz

3.9.1.6. 869 - 894 MHz

3.9.1.7. 1710 - 1755 MHz

3.9.1.8. 1850 - 1915 MHz

3.9.1.9. 1930 - 1995 MHz

3.9.1.10. 2110 - 2155 MHz

3.9.1.11. 1 Watt power handling capability

3.10. **RF Tunable Notch Filters**

3.10.1. Frequency Range(s) tunable across the entire frequency range either as a single device or multiple filters

3.10.1.1. 698 - 716 MHz

3.10.1.2. 728 - 746 MHz

3.10.1.3. 746 - 757 MHz

3.10.1.4. 776 - 787 MHz

3.10.1.5. 824 - 849 MHz

3.10.1.6. 869 - 894 MHz

3.10.1.7. 1710 - 1755 MHz

3.10.1.8. 1850 - 1915 MHz

3.10.1.9. 1930 - 1995 MHz

3.10.1.10. 2110 - 2155 MHz

3.10.2. 1 Watt power handling capability

4. Consumer wideband booster test procedures

Prior to performing any test or measurement ensure all cable, attenuator, or additional system losses as well as any required external amplification are accounted for in the measurement as per test equipment manufacturer recommendations or standard industry practices as necessary. This is applicable to any and all tests carried out under these procedures.

4.1. Out of Band ~~Rejection~~ Gain Limits test procedure[1]

Comment [ML1]: This change is proposed to align test procedure name with §20.21(e)(9)(i)(E)

Field Code Changed

4.1.1. Connect the EUT to the test equipment as shown in figure 1. Begin with the uplink output connected to the spectrum analyzer.

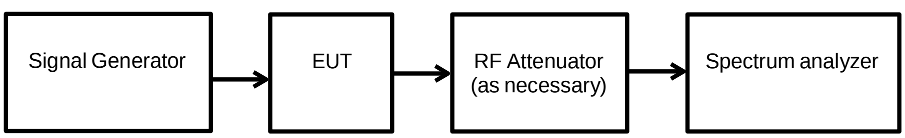

Figure 1

4.1.2. Set the spectrum analyzer RBW for 100 kHz with the VBW ≥3X the RBW using a PEAK detector with the MAX HOLD function.

4.1.3. Set the center frequency of the spectrum analyzer to the center of the operational band under test with the span approximately 2X the operational band.

4.1.4. Set the signal generator for CW mode or AWGN mode[1] at the frequency for the center of the operational band.

4.1.5. Set the initial signal generator power to achieve a passband output ~~a~~ level at least 6 dB below the AGC limit specified by the manufacturer.

[1] Broadband AWGN signal can be used when a booster will not operate with only a CW input

[1] For Out-of-Band rejection see: TBD

4.1.6. Slowly increase the signal generator power level until the passband output signal reaches the AGC operational limit (as determined either from manufacturer specification or from observation of signal behavior on the spectrum analyzer).

4.1.7. Reduce the signal generator power to a level that is 3 dB below the level noted above and manually reset the EUT.

4.1.8. Slowly increase the signal generator power to a level just below (within 0.5 dB of) the AGC limit without triggering the AGC

4.1.9. When using a CW tone, ~~Adjust~~ adjust the tuned frequency of the signal generator to sweep 2 times the pass band using the sweep function.

4.1.10. Using three markers identify the operational band edges and the frequency with the highest power.

4.1.11. Capture the spectrum analyzer trace for inclusion in the test report.

4.1.12. Repeat steps 4.1.3 to 4.1.11 for all operational uplink and downlink bands.

4.2. Maximum power measurement test procedure[2]

Field Code Changed

The following procedures shall be used to demonstrate compliance to the signal booster power limits and requirements.

The frequency with the highest power in each operation band as determined in section 4.1 is to be measured discretely under the following procedure utilizing the following emission and power detector types independently.

Create a pulsed CW or AWGN with 99% Occupied Bandwidth of 5MHz with a pulse width of 570 µS and a duty cycle of 12.5% utilizing a burst power measurement function of the spectrum analyzer.

AWGN with a 99% Occupied Bandwidth of 5 MHz using a channel power measurement tool of a spectrum analyzer.

All modes of operation must be verified to maintain operation at the saturation levels per device type as defined in section 2.6 and 2.7.

4.2.1. Connect the EUT to the test equipment as shown in figure 1. Begin with the uplink output connected to the spectrum analyzer.

4.2.2. Configure the signal generator for operation with to the frequency determined in section 4.1, no closer than 2.5 MHz within the band edge with a span at least 10 MHz.

4.2.3. Set the initial signal generator power to a level at least 6 dB below the AGC limit specified by the manufacturer.

4.2.4. Slowly increase the signal generator power level until the output signal reaches the AGC operational limit (as determined either from manufacturer specification or from observation of signal behavior on the spectrum analyzer).

4.2.5. Reduce the signal generator power to a level that is 3 dB below the level noted above and manually reset the EUT.

4.2.6. Slowly increase the signal generator power to a level just below (within 0.5 dB of) the AGC limit without triggering the AGC. Note the signal generator power level as (Pin).

[2] For Maximum Power Measurement see 47 CFR 2.1046 and §20.21(e)(8)(i)(D) and §20.21€(9)(i)(D).

4.2.7. Measure the output power (Pout) with the spectrum analyzer as follows.

4.2.8. Set RBW = 100 kHz.

4.2.9. Set VBW ≥ 300 kHz.

4.2.10. Select either the BURST POWER or CHANNEL POWER measurement tool as required for each signal type.

4.2.11. Select the RMS (power averaging) detector.

4.2.12. Ensure that the number of measurement points per sweep ≥ (2 x span)/RBW.

4.2.13. Sweep time = auto couple or as necessary.

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

4.2.15. Record the measured power level as POUT.

4.2.16. Repeat the procedure for each operational uplink and downlink frequency band supported by the booster.

4.3. Maximum Gain Computation[3]

Field Code Changed

4.3.1. Compute the maximum gain of the booster as follows to demonstrate compliance to the applicable gain limits specified in.

4.3.2. For both the uplink and downlink in each supported frequency band, use each of the POUT and PIN value pairs determined in 4.2 in the following equation to determine the maximum gain (G) of the booster:

G (dB) = POUT(dBm) - PIN(dBm).

4.3.3. Record the maximum gain of the uplink and downlink paths for each supported frequency band and verify that the each gain value complies with the applicable limit.

Note: Ensure that AGC has not been activated.

Note: Ensure that the signal generator output power is verified using the same spectrum analyzer settings as used when measuring the booster output power.

4.4. Intermodulation product test procedure[4]

Field Code Changed

The following procedures shall be used to demonstrate compliance to the signal booster intermodulation limits and requirements.

4.4.1. Connect the signal booster to the test equipment as shown in figure 2. Begin with the uplink output connected to the spectrum analyzer.

4.4.2. Set the spectrum analyzer RBW = 3 kHz.

4.4.3. Set the VBW ≥ 3 X the RBW.

4.4.4. Select the RMS detector.

4.4.5. Set the spectrum analyzer center frequency to the center of the supported operational band under test.

[3] For maximum gain see 47 CFR §20.21(e)(8)(i)(C)(2).

[4] For intermodulation products see 47 CFR §20.21(e)(8)(i)(F).

4.4.6. Adjust the span to 5 MHz

4.4.7. 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.

4.4.8. Set the signal generator amplitudes so that the power from each into the RF combiner is equivalent and turn on the RF output.

4.4.9. Increase the signal generators' amplitudes equally until just before the EUT begins AGC and ensure the intermodulation products, if any, are below -19 dBm.

4.4.10. Utilize the MAX HOLD function of the spectrum analyzer and wait for the trace to stabilize. Place a marker at the highest amplitude intermodulation product.

4.4.11. Record the maximum intermodulation product amplitude observed.

4.4.12. Capture the spectrum analyzer trace for inclusion in the test report.

4.4.13. Repeat steps 4.4.5 to 4.4.11 for all uplink and downlink operational bands.

Note: If using a single signal generator ensure that inter-modulation products are not the result of the generator.

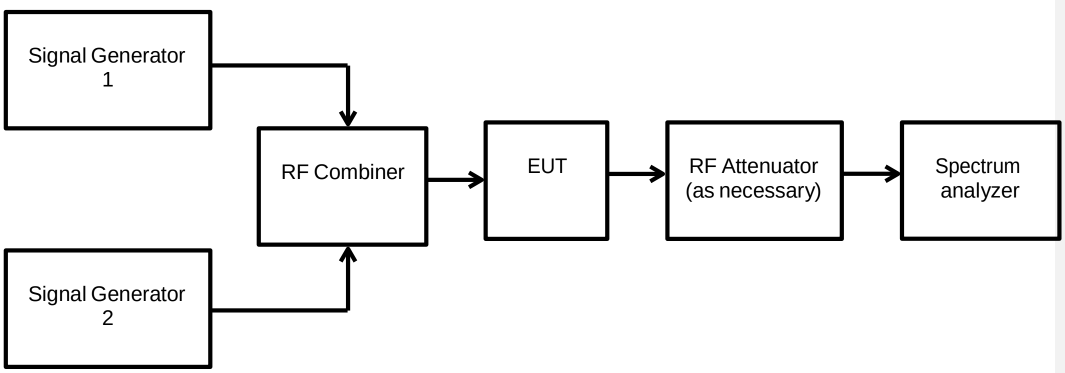

Figure 2

4.5. **Out-of-band emissions test procedure**[5]

Field Code Changed

The following procedures shall be used to demonstrate compliance to the signal booster out-of-band emission power limits and requirements. Note that an out-of-band emission (OOBE) is defined by §2.1 as any "emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions". Within the context of this measurement guidance, the occupied (99%) bandwidth (OBW), the emission bandwidth referenced to the -26 dB points (EBW), and the necessary bandwidth are considered to be equivalent.

[5] For OOBE emissions see 47 CFR 2.1051and §20.21(e)(8)(i)(E).

Tested with the following modulation types if supported[2]:

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

Note 1: For CDMA and LTE, the signal generator should utilize the uplink and downlink signal types for these modulations in uplink and downlink tests, respectively.
Note 2: LTE 5 MHz signal shall use 25 resource blocks. Bandwidth for AWGN are referenced to occupied bandwidth.

4.5.1. Connect the EUT to the test equipment as shown in figure 1. Begin with the uplink output connected to the spectrum analyzer.

4.5.2. Configure the signal generator for the appropriate operation for all uplink and downlink bands:

4.5.2.1. GSM: 0.2 MHz from upper and lower band edge

4.5.2.2. LTE: 2.5 MHz from upper and lower band edge

4.5.2.3. CDMA: 1.25 MHz from upper and lower band edge, except for cellular as follows:

4.5.2.3.1. 824.88 MHz

4.5.2.3.2. 845.73 MHz

4.5.2.3.3. 836.52 MHz

4.5.2.3.4. 848.10 MHz

4.5.2.3.5. 869.88 MHz

4.5.2.3.6. 890.73 MHz

4.5.2.3.7. 881.52 MHz

4.5.2.3.8. 893.10 MHz

4.5.3. Set the signal generator amplitude to the maximum power level prior to AGC similar to the procedures in 4.2.4 to 4.2.6 of power measurement procedure for appropriate modulations.

4.5.4. Turn signal generator RF output on and measure the out-of-band emission power levels (below and above the operational band) with an appropriate spectrum analyzer as follows.

4.5.5. Set RBW = measurement bandwidth specified in applicable rule section for the supported frequency band (e.g., 22.917(b), 24.238(b), 27.53(h)(1), etc.).

4.5.6. Set VBW = 3 X RBW.

4.5.7. Select the RMS (power averaging) detector.

4.5.8. Sweep time = auto-couple.

4.5.9. Set the analyzer start frequency to the upper band/block edge frequency and the stop frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, per applicable rule part.

[2] Certain boosters will not relay with unsupported technologies as input signals

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

4.5.11. Use peak marker function to find the maximum power level.

4.5.12. Record the measured power level and verify compliance to the applicable limit.

4.5.13. Increase the signal generator amplitude to the saturation level indicated in 2.6 and 2.7.

4.5.14. Reset the analyzer start frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as per applicable rule part, and the stop frequency to the lower band/block edge frequency and repeat steps 4.5.10-4.5.12.

4.5.15. Repeat steps 4.5.2 through 4.5.14 for each uplink and downlink operational band.

4.6. Conducted spurious emissions test procedure[6]

Field Code Changed

The following procedures shall be used to demonstrate compliance to the applicable conducted spurious emissions limits.

4.6.1. Connect the EUT to the test equipment as shown in Figure 2. Begin with the uplink output connected to the spectrum analyzer.

4.6.2. Configure the signal generator for AWGN with an emissions bandwidth of 5 MHz operation with a center frequency corresponding to the center of the operational band under test and with a bandwidth representative of the bandwidth of the uplink or downlink signal.

4.6.3. Set the signal generator amplitude to the level determined in the power measurement procedure in 4.2.

4.6.4. Turn signal generator RF output on and measure the spurious emission power levels (from 9 kHz to 10 times the highest frequency of the fundamental emission) with an appropriate spectrum analyzer as follows.

4.6.5. Set RBW = measurement bandwidth specified in the applicable rule section for the operational frequency band under consideration (e.g., 22.917(b), 24.238(b), 27.53(h)(1), etc.). Note that many of the individual rule sections permit the use of a narrower RBW (typically ≥ 1% of the EBW) to enhance measurement accuracy, but the result must then be integrated over the specified measurement bandwidth (see applicable rule section for additional guidance).

4.6.6. Set VBW = 3 X RBW.

4.6.7. Select the RMS (power averaging) detector.

4.6.8. Sweep time = auto-couple.

4.6.9. Set the analyzer start frequency to 9 kHz and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part. Note that the number of measurement points in each sweep must be ≥ (2 x span/RBW) which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer trace average at least 100 traces in power averaging (i.e., RMS) mode.

4.6.10. Use the peak marker function to identify the [6] highest amplitude levels over the each measured frequency range and record.

[6] For conducted spurious emissions see 47 CFR 2.1051. The applicable limits are the mobile emission limits specified in the individual rule parts for each supported band of operation (e.g., 47 CFR 22.917, 24.238, 27.53, etc.)

4.6.11. Reset the analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the analyzer stop frequency to 10 times the highest frequency of the fundamental emission. Note that the number of measurement points in each sweep must be ≥ (2 x span/RBW) which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

4.6.12. Use the peak marker function to identify the [6] highest amplitude levels over the each measured frequency range and record.

4.6.13. Identify the [6] highest amplitude data points from among the accumulated set of data points recorded for each measurement range.

4.6.14. Repeat steps 4.6.2 through 4.6.13 for each supported frequency band of operation.

4.7. **Noise limits test procedure for Wideband Consumer Boosters**[7]

Field Code Changed

4.7.1. Connect the EUT to the test equipment as shown in figure 3. Begin with the uplink output connected to the spectrum analyzer.

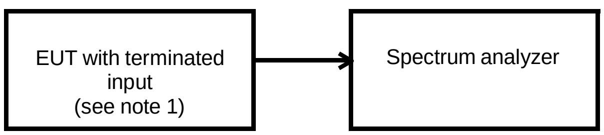

Figure 3

4.7.2. Set the spectrum analyzer RBW of 1 MHz with the VBW ≥3X the RBW with an RMS AVERAGE detector with 100 trace averages.

4.7.3. Set the center frequency of the spectrum analyzer to the center of the operational band under test with the span ≥ 2X the operational band.

4.7.4. Measure the maximum Transmitter Noise Power Level.

4.7.5. Save the spectrum analyzer plot as necessary for inclusion in the final test report.

4.7.6. Repeat steps 4.7.2 to 4.7.5 for all operational uplink and downlink bands.

4.7.7. Connect the EUT to the test equipment as shown in figure 4 for uplink and figure 5 for downlink. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.

[7] For noise limits see 47 CFR (20.21(e)(8)(i)(A)(1), 20.21(e)(9)(i)(A)(~~1~~2), 20.21(e)(8)(i)(C)(1))

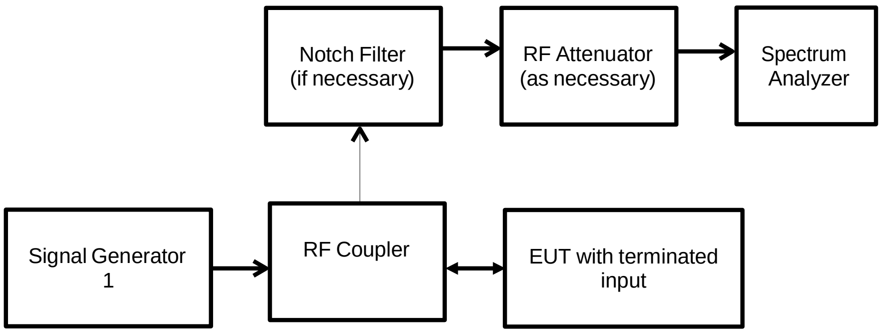

Figure 4

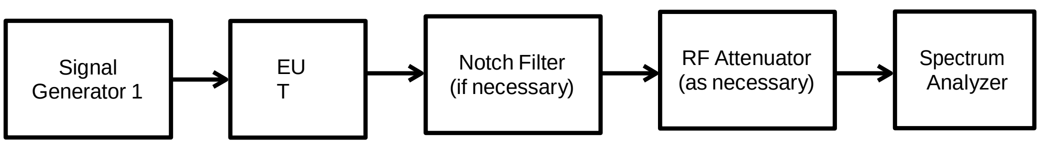

Figure 5

4.7.8. Configure the signal generator for CW operation for downlink test and AWGN (5 MHz) operation for uplink test.
4.7.9. Set the spectrum analyzer RBW for 1 MHz with the VBW ≥3X the RBW with an RMS AVERAGE detector with 100 trace averages.
4.7.10. Set the center frequency of the spectrum analyzer to the center of the operational band under test with the span ≥ 2X the operational band.
4.7.11. Measure the maximum Transmitter Noise Power Level when varying the downlink signal generator level from -90 to -10 dBm in 1 dB steps, report the six values closest to the limit with at least 2 points within the RSSI dependent region of the limit.
4.7.12. Variable Uplink noise timing is to be measured as follows.
4.7.13. Set the spectrum analyzer to the uplink frequency to be measured.
4.7.14. Set the span to 0 Hz with a sweep time of 10 seconds.
4.7.15. Set the power level of signal generator 1 to the lowest level of the RSSI dependent noise.
4.7.16. Select MAX HOLD and increase the power level of signal generator 1 by 20 dB.
4.7.17. Ensure that the Uplink noise decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.

Note: Some signal boosters will require a signal generator input as they will not operate unless a signal is received at the input terminals. If this is the case connect a signal generator and cycle the RF output to simulate this function.

4.8. **Noise limits test procedure for Provider Specific Consumer Boosters**[7]

4.8.1. Connect the EUT to the test equipment as shown in figure 3. Begin with the downlink output connected to the spectrum analyzer.

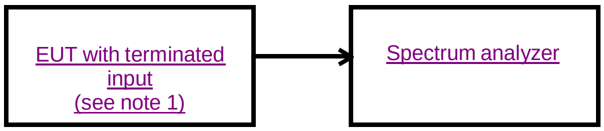

Figure 3

4.8.2. Set the spectrum analyzer RBW of 1 MHz with the VBW ≥3X the RBW with an RMS AVERAGE detector with 100 trace averages.

4.8.3. Set the center frequency of the spectrum analyzer to the center of the operational band under test with the span ≥ 2X the operational band.

4.8.4. Set the EUT to have a passband in the center of the operational band under test.

4.8.5. Measure the maximum Transmitter Noise Power Level outside of the passband of the Provider Specific Signal Booster.

4.8.6. Save the spectrum analyzer plot as necessary for inclusion in the final test report.

4.8.6. Repeat steps 4.8.2 to 4.8.5 for all operational downlink bands.

4.8.7. Connect the EUT to the test equipment as shown in figure 4 for uplink and figure 5 for downlink. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.

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[7] For noise limits see 47 CFR (20.21(e)(8)(i)(A)(1), 20.21(e)(9)(i)(A)(2), 20.21(e)(8)(i)(C)(1))

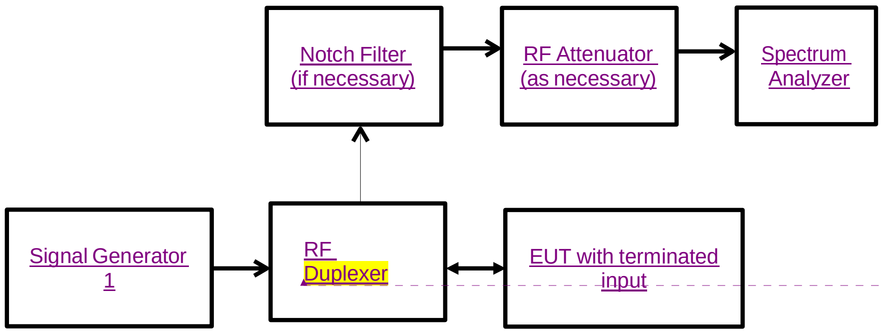

Figure 4

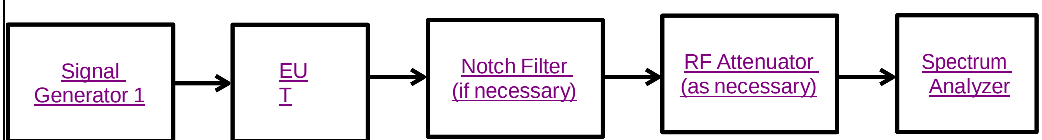

Figure 5

4.8.8. Configure the signal generator for CW operation for downlink test and AWGN (5 MHz) operation for uplink test.

4.8.9. Set the spectrum analyzer RBW for 1 MHz with the VBW ≥3X the RBW with an RMS AVERAGE detector with 100 trace averages.

4.8.10. Set the center frequency of the spectrum analyzer to the center of the operational band under test with the span ≥ 2X the operational band.

4.8.11. Set the EUT to have a passband in the center of the operational band under test.

4.8.12. Measure the maximum Transmitter Noise Power Level outside of the passband of the signal booster when varying the downlink signal generator level from -90 to -30 dBm in 1 dB steps, report the six values closest to the limit with at least 2 points within the RSSI dependent region of the limit.

4.8.13. Variable Uplink noise timing is to be measured as follows.

4.8.14. Set the spectrum analyzer to the uplink frequency to be measured.

4.8.15. Set the span to 0 Hz with a sweep time of 10 seconds.

4.8.16. Set the power level of signal generator 1 to the lowest level of the RSSI dependent noise.

4.8.17. Select MAX HOLD and increase the power level of signal generator 1 by 20 dB.

4.8.18. Ensure that the Uplink noise decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.

Note: Some signal boosters will require a signal generator input as they will not operate unless a signal is received at the input terminals. If this is the case connect a signal generator and cycle the

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RF output to simulate this function.

~~4.8.~~4.9. **Uplink inactivity test procedure**[8]

~~4.8.1.~~4.9.1. Connect the EUT to the test equipment as shown in figure 5~~3~~ with the uplink output connected to the spectrum analyzer.

~~4.8.2.~~4.9.2. Set the spectrum analyzer RBW for 1 MHz with the VBW ≥ 3X RBW.

~~4.8.3.~~4.9.3. Set the center frequency of the spectrum analyzer to the center of the ~~operational~~ pass band under test.

~~4.8.4.~~4.9.4. Set the span for 0 Hz and the sweep time for a minimum of 330 seconds.

4.9.5. Start to capture a new trace using MAX~~-~~HOLD.

~~4.8.5.~~4.9.6. ~~4.8.6.~~After approximately 15 seconds turn off~~n~~ the ~~EUT~~ signal generator ~~power~~output.

~~4.8.7.~~ 4.9.7 Once the full spectrum analyzer trace is complete place a MARKER on the leading edge of the pulse and use the DELTA MARKER METHOD to measure the time until the uplink was squelched.

~~4.8.8.~~ 4.9.8 Ensure the noise level for the squelched signal is below the uplink inactivity noise power limit, as specified by the rules.

~~4.8.9.~~ 4.9.9 Capture the plot for inclusion in the test report.

~~4.8.10.~~ 4.9.10 Repeat steps 4.9~~8~~.3 to 4.9~~8~~.9 for all operational uplink bands.

~~Note: Some signal boosters will require a signal generator input as they will not operate unless a signal is received at the input terminals. If this is the case connect a signal generator and cycle the RF output to simulate this function.~~

~~4.9.~~4.10. **Variable gain test procedure – method 1 (Wideband and Provider Specific boosters not specifically measuring BSCL)**[9]

~~4.9.1.~~4.10.1. Connect the EUT to the test equipment as shown in figure 6 with the uplink output connected to signal generator 1. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.

[8] For uplink inactivity see 47 CFR (20.21(e)(8)(i)(I), 20.21(e)(9)(i)(J)).

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[9] For variable gain see 47 CFR (21(e)(8)(i)(C)(1)).

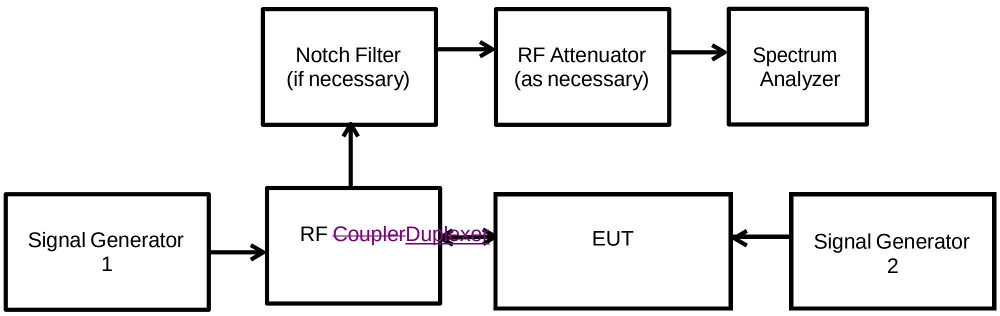

Figure 6

~~4.9.2.~~4.10.2. Configure both signal generators for AWGN operation with an 99% occupied bandwidth of 5 MHz tuned to the center of the operational band.

~~4.9.3.~~4.10.3. Set the power level and frequency of signal generator 2 to a value below the AGC level from section 4.2

~~4.9.4.~~4.10.4. Set RBW = 100 kHz.

~~4.9.5.~~4.10.5. Set VBW ≥ 300 kHz.

4.10.6. Select the CHANNEL POWER

measurement tool.-

~~4.9.6.~~4.10.7. ~~4.9.7.~~Select the RMS (power averaging)

detector.

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~~4.9.8.~~4.10.8 Ensure that the number of measurement points per sweep ≥ (2 x span)/RBW.

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~~4.9.9~~ 4.10.9 .Sweep time = auto couple or as necessary.

~~4.9.10.~~ 4.10.10 Trace average at least 100 traces in power averaging (i.e., RMS) mode.

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~~4.9.11.~~ 4.10.11 Measure the maximum channel power and compute maximum gain when varying the signal generator 1 to a level from -90 to -10 dBm in 1 dB steps and report the six values closest to the limit with at least two points in the RSSI dependent region of the limit.

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~~4.9.12.~~ 4.10.12 Variable Uplink gain timing is to be measured as follows.

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~~4.9.13.~~ 4.10.13 Set the spectrum analyzer to the uplink frequency to be measured.

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~~4.9.14.~~ 4.10.14 Set the span to 0 Hz with a sweep time of 10 seconds.

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~~4.9.15.~~ 4.10.15 Set the power level of signal generator 1 to the lowest level of the RSSI dependent gain.

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~~4.9.16.~~ 4.10.16 Select MAX HOLD and increase the power level of signal generator 1 by 20 dB.

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[10] For occupied bandwidth see 47 CFR (2.1049).

4.10.17 Ensure that the Uplink gain decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.

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[10] For occupied bandwidth see 47 CFR (2.1049).

4.11. Variable gain test procedure – method 2 (Provider Specific boosters not specifically measuring BSCL)[9]

4.11.1. Connect the EUT to the test equipment as shown in figure 6 with the uplink output connected to signal generator 1. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.

4.11.2. Configure signal generator 1 for the transmission of a valid base station signal of the standard being tested (e.g. WCDMA or LTE) and set the broadcasted base station power to a known value (A). Configure signal generator 2 for AWGN operation with an 99% occupied bandwidth of 5 MHz tuned to the center of the operational band.

4.11.3. Set the power level and frequency of signal generator 2 to a value below the AGC level from section 4.2

4.11.4. Set RBW = 100 kHz.

4.11.5. Set VBW ≥ 300 kHz.

4.11.6. Select the CHANNEL POWER measurement tool.

4.11.7. Select the RMS (power averaging) detector.

4.11.8. Ensure that the number of measurement points per sweep ≥ (2 x span)/RBW. 4.9.9. Sweep time = auto couple or as necessary.

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

4.11.10. Measure the maximum channel power and compute maximum gain when varying the signal generator 1 to a level from -90 to -10 dBm in 1 dB steps and report the six values closest to the limit with at least two points in the RPCH dependent region of the limit.

4.11.11 Variable Uplink gain timing is to be measured as follows.

4.11.12 Set the spectrum analyzer to the uplink frequency to be measured.

4.11.13 Set the span to 0 Hz with a sweep time of 10 seconds.

4.11.14 Set the power level of signal generator 1 to the lowest level of the RSSI dependent gain.

[10] For occupied bandwidth see 47 CFR (2.1049).

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4.11.15 Select MAX HOLD and increase the power level of signal generator 1 by 20 dB.

4.11.16 Ensure that the Uplink gain decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.

~~4.9.17.~~

~~4.10.~~4.12. **Occupied bandwidth test procedure**[10]

~~4.10.1.~~4.12.1. Connect the test equipment as shown in figure 7.

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[10] For occupied bandwidth see 47 CFR (2.1049).

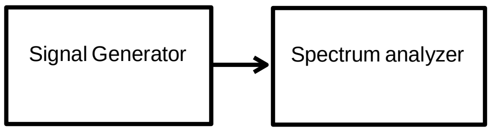

Figure 7

~~4.10.2.~~4.12.2. Set the spectrum analyzer RBW for 1% to 5% of the emissions bandwidth.

~~4.10.3.~~4.12.3. Set VBW to ≥ 3X RBW

~~4.10.4.~~4.12.4. Set the center frequency of the spectrum analyzer to the center of the operational band.

The span will be adjusted for each modulation type and occupied bandwidth as necessary for accurately viewing the signals.

~~4.10.5.~~4.12.5. Set the signal generator for power level to match the values obtained in section 4.2.

~~4.10.6.~~4.12.6. Set the signal generator modulation type for GSM, if supported in the case of Provider Specific Consumer Boosters, with a PBRS pattern and allow the trace on the signal generator to stabilize adjusting the span as necessary.

~~4.10.7.~~4.12.7. Capture the spectrum analyzer trace for inclusion in the test report.

~~4.10.8.~~4.12.8. Repeat steps 4.12~~0~~.4 – 4.12~~0~~.7 for all supported technologies (LTE, CDMA and WCDMA modulation) adjusting the span as necessary for all uplink and downlink operational bands.

~~4.10.9.~~4.12.9. Connect the test equipment as shown in figure 1. Begin with the uplink output connected to the spectrum analyzer

~~4.10.10.~~4.12.10. Repeat steps 4.12~~0~~.4 – 4.12~~0~~.7 in this new configuration.

~~4.11.~~4.13. Oscillation detection test procedure[11]

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For completion of this section two devices will be permitted, one in the normal operating mode and a second which contains a test mode that can disable the uplink inactivity squelching and or a reduction of the time between restarts to 5 seconds. This will greatly decrease the test time required.

~~4.11.1.~~4.13.1. Connect the EUT set for normal operation to the test equipment as shown in figure 8 beginning with the RF detector on the uplink output side of the RF path. Ensure that the RF coupled path is connected to the RF detector.

Note: The band pass filter shall provide sufficient out-of-band rejection to prevent oscillations from occurring in bands not under test.

[11] For oscillator detection see 47 CFR 20.21(e)(8)(ii)(A), 20.21(e)(9)(ii)(A).

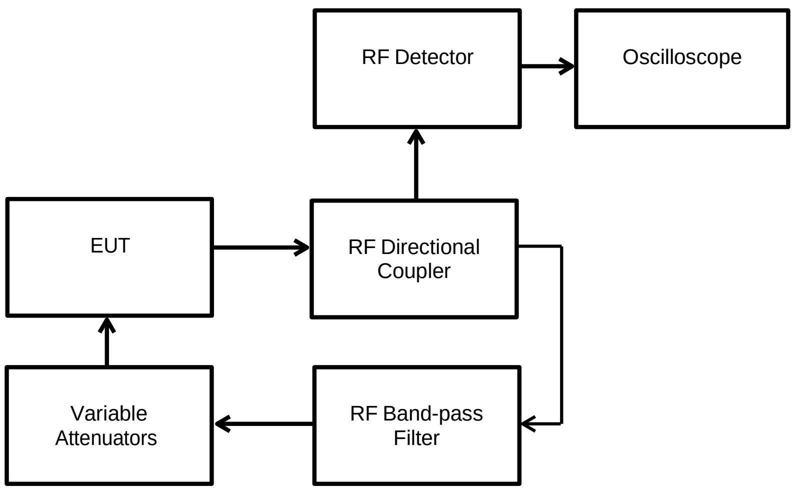

Figure 8

~~4.11.2.~~4.13.2. Set the oscilloscope for a positive edge trigger and single trigger operation.

4.13.3. Sweep the Variable Attenuators from 110dB to 20dB in 10dB steps until the EUT oscillates as shown on the oscilloscope or 20dB is reached.

4.13.4. If 20dB is reached without any oscillation occurring, the test is deemed to be passed.

4.13.5. If the EUt oscillates, continue with the test procedure below.

~~4.11.3.~~4.13.6. Set the attenuation as necessary until the oscilloscope triggers and increase the attenuation level to a point 10 dB above that point.

~~4.11.4.~~4.13.7. Reset the trigger of the oscilloscope and reset the EUT with a power cycle.

~~4.11.5.~~4.13.8. Force the EUT to oscillate this will trigger the oscilloscope.

~~4.11.6.~~4.13.9. Use the CURSOR function of the oscilloscope to measure the time from the detection of oscillation until the EUT turns off by setting CURSOR 1 on the leading edge of the signal and CURSOR 2 on the trailing edge.

~~4.11.7.~~4.13.10. Capture the oscilloscope trace for inclusion in the test report.

~~4.11.8.~~4.13.11. Repeat steps 4.13~~1~~.2 to 4.1~~1~~3.7 for all operational uplink and downlink bands.

~~4.11.9.~~4.13.12. Set the oscilloscope time base for longer than 1 minute and measure the restart time for each operational uplink and downlink band.

~~4.11.10.~~4.13.13. Replace the normal operating EUT for the EUT with the test mode.

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~~4.11.11.~~4.13.14. Set the oscilloscope time base for a minimum 120 seconds with an AUTO Trigger and a single sweep.

4.13.15. Start the Oscilloscope and a manually force the booster into oscillation. ~~4.11.13.~~

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~~4.11.12.~~4.13.16. When the sweep is complete place cursors between the first two

oscillation detections

and save the plot for inclusion in the test report. The time between restarts must match the manufacturer's timing for the test mode and there can be no more than 5 restarts.

4.11.14.Repeat steps 4.11.12 to 4.11.1~~3~~6 for all operational uplink and downlink bands.

Note: in lieu of an oscilloscope and a crystal detector a spectrum analyzer set for 0 span with a center frequency set equal to the center of the operational band can be used.

~~4.12.~~4.14. **Radiated spurious emissions test procedure**[12]

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~~4.12.1.~~4.14.1. Place the EUT on an OATS or Anechoic chamber turntable from the receiving antenna. (refer to general procedures in clause 5 of C63.26)

4.14~~2~~.2. Connect the EUT to the test equipment as shown in figure 9 beginning with the uplink output

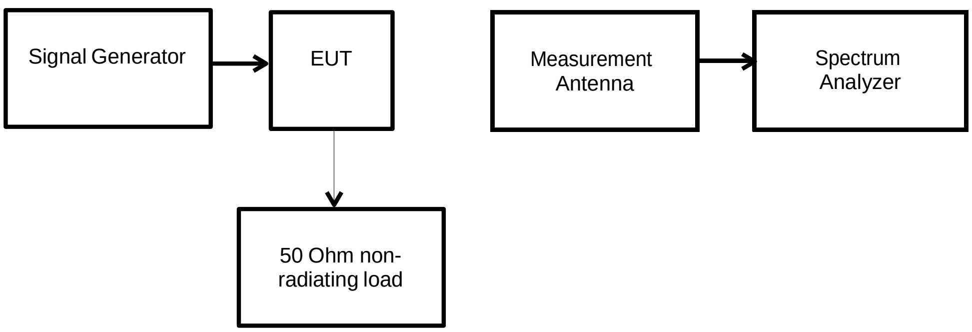

Figure 9

~~4.12.3.~~ 4.14.3 Set the signal generator for the center frequency of the operational band under test with the power level set at PIN from section 3.1 with CDMA Modulation.

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~~4.12.4.~~ 4.14.4 Measure the radiated spurious emissions from the EUT from 9 kHz to the 10th harmonic of the tuned frequency. Ensure any and all signals are at their maximum levels by rotating the turntable and raising the antenna from 1m- - 4m in both the horizontal and vertical axis.

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~~4.12.5.~~ 4.14.5 Capture the peak emissions plots for inclusion in the test report. Tabular data is acceptable in lieu of spectrum analyzer plots.

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~~4.12.6.~~ 4.14.6 Repeat steps 4~~3~~.14~~0~~.3 to 4~~3~~.14~~0~~.5 for all operational bands.

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[12] For spurious emissions see 47 CFR 2.1053.