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Test Report

Prepared for: Wilson Electronics, LLC (weBoost)

Model: 460064

Description: Single Band Industrial Booster

FCC ID: PWO460064

To

FCC Part 20
FCC Part 27

Date of Issue: May 5, 2020

On the behalf of the applicant:	**Wilson Electronics, LLC (weBoost)** **3301 E Deseret Drive** **St. George, UT 84790**
Attention of:	**Sam Judd, Compliance Engineer** **Ph: (435)673-5021** **E-Mail: sjudd@wilsonelectronics.com**

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Project No: p2030006

Greg Corbin
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	May 5, 2020	Greg Corbin	Original Document
2.0	May 13, 2020	Greg Corbin	Added W7D emission designator to table on page 6

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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009)

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

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Testing Certificate Number: **2152.01**

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, KDB 935210 D05 Industrial Booster Basic Measurements v01r04, ANSI C63-26:2015 and FCC Part 2, Part 20.21, Part 27 where appropriate.

Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing.

In accordance with ANSI/TIA 603C, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specify testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Environmental Conditions		
Temp (ºC)	**Humidity (%)**	**Pressure (mbar)**
24.7 – 28.4	29.6 – 35.0	962.3 – 968.7

Measurement results, unless otherwise noted, are worst-case measurements.

EUT Description
Model: 460064
Description: Single Band Industrial Booster
Firmware: N/A
Software: N/A
Serial Number: 430047B0414918280
Highest Clock Frequency: 84 MHz

Additional Information:

The EUT is a bi-directional industrial signal amplifier for the boosting of cellular phone signals and data communication devices.
The signal booster operates in the 600 MHz band using LTE and 5GNR signals.
The nominal gain is 90 dB.
The antenna type and gain are:
Indoor: Panel, 6 dBi
Outdoor: Log Periodic, 6.5 dBi,

EUT Operation during Tests

The EUT is powered by an AC to DC power converter with 120 vac input and 12 vdc output.
The EUT was operated under normal operating conditions.
The EUT has no external manual gain control adjustments.

The signal booster uses the following frequency bands.
The emission designators listed are representative emission designators used by transmitters whose signal is amplified by this booster.

Frequency Band (MHz)	
Uplink	663 - 698
Downlink	617 - 652
Modulation Type	LTE, 5GNR

Emission Designators	
5GNR	**LTE**
G7D, W7D	G7D, W7D

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	AC to DC power supply	EDAC Power Elec.	EA1024P2-120	N/A

Cables: none

Modifications: none

Test Result Summary

Specification	Test Name	Pass, Fail, N/A	Comments
KDB 935210 D05	AGC Threshold	Pass	
KDB 935210 D05	Out-of-Band Rejection	Pass	
KDB 935210 D05	Input-Versus-Output Signal Comparison	Pass	
2.1046 KDB 935210 D05	Mean Output Power and Amplifier gain	Pass	
2.1049 KDB 935210 D05	Out-Of-Band/Block Emissions Conducted	Pass	
2.1051 27.53(g) KDB 935210 D05	Spurious Emissions Conducted	Pass	
KDB 935210 D05	Frequency Stability	N/A	Does not have Frequency translation
2.1053 KDB 935210 D05	Spurious Emissions Radiated	Pass	

AGC Threshold

Engineer: Greg Corbin

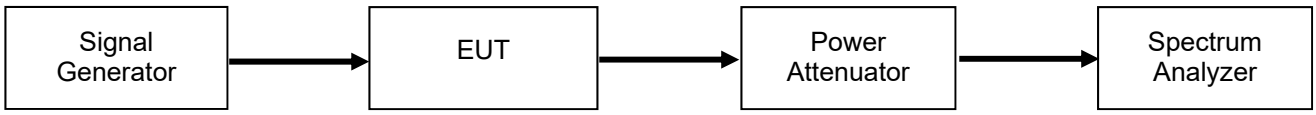
Test Date: 4/30-2020

Test Procedure

A signal generator was connected to the input of the EUT. A spectrum analyzer was connected to the EUT in order to monitor the output power levels. The Signal Generator was configured to produce the necessary broadband and narrow band signals. The input power level was increase in 1 dB increments until the power no longer increased. The input levels were recorded in the table below.

Spectrum Analyzer settings
Power Channel integration
RBW = 1-5% of EBW
Video BW = 3x RBW

Test Setup



Downlink

Tuned Frequency (MHz)	AGC Threshold (dBm)	
	AWGN	GSM
634.5	-59.0	-61.6

Uplink

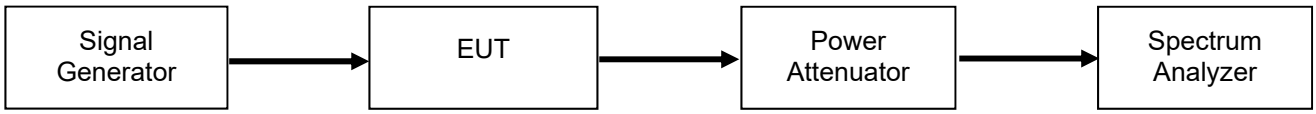
Tuned Frequency (MHz)	AGC Threshold (dBm)	
	AWGN	GSM
680.5	-59.9	-62.4

Out-Of-Band Rejection
Engineer: Greg Corbin
Test Date: 4/30/2020

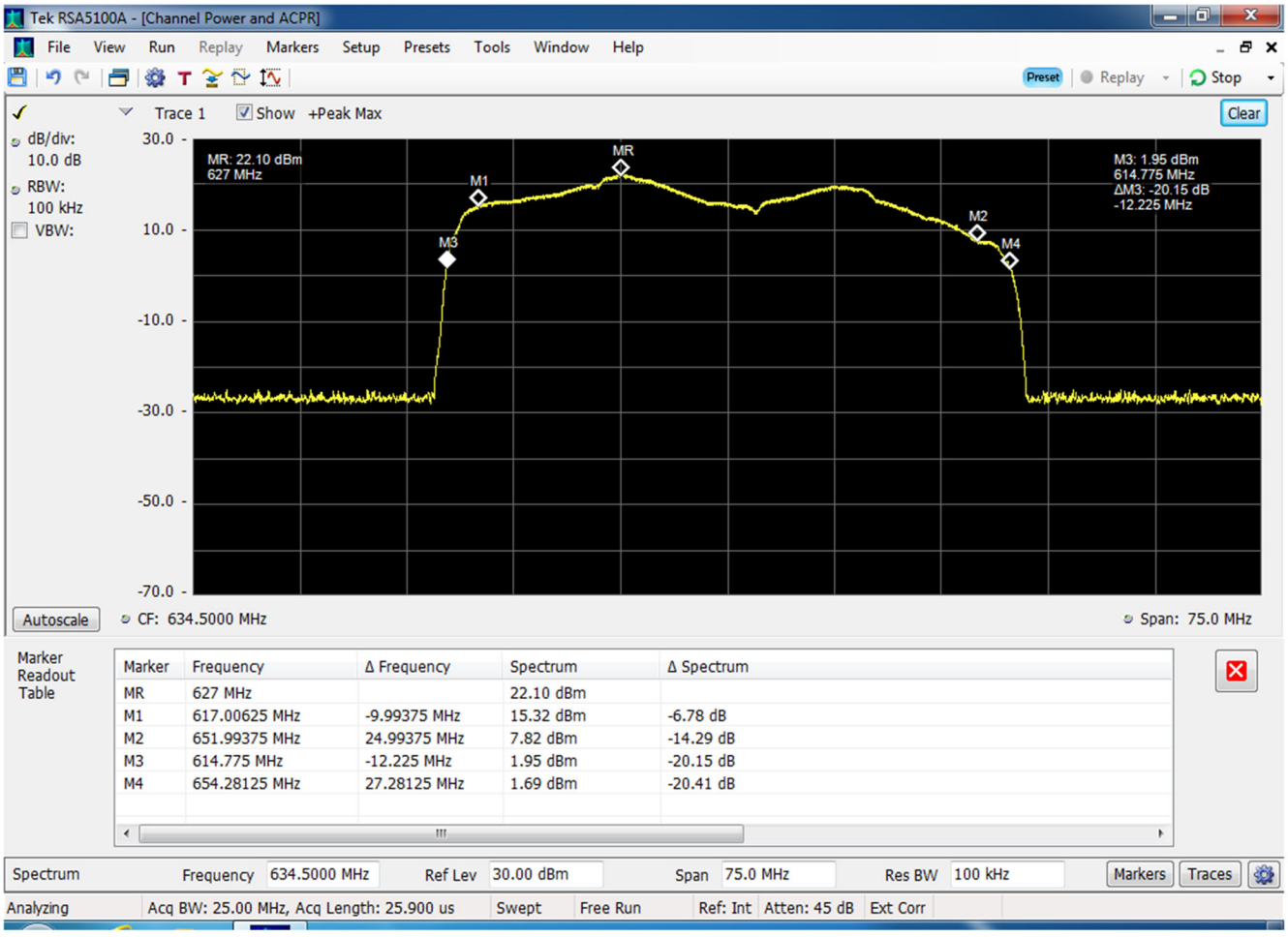
Test Procedure

The EUT was connected to a spectrum analyzer through a 20 dB power attenuator. A signal generator was utilized to produce a swept CW signal with the RF input level set to 3 dB below the AGC Threshold level. The Uplink and Downlink filter response and the -20 dB bandwidth were measured. The marker table function of the spectrum analyzer was used to show the peak amplitude in the passband and the -20 dB bandwidth of the pass band filter.
RBW = 100 kHz
Video BW = 3x RBW

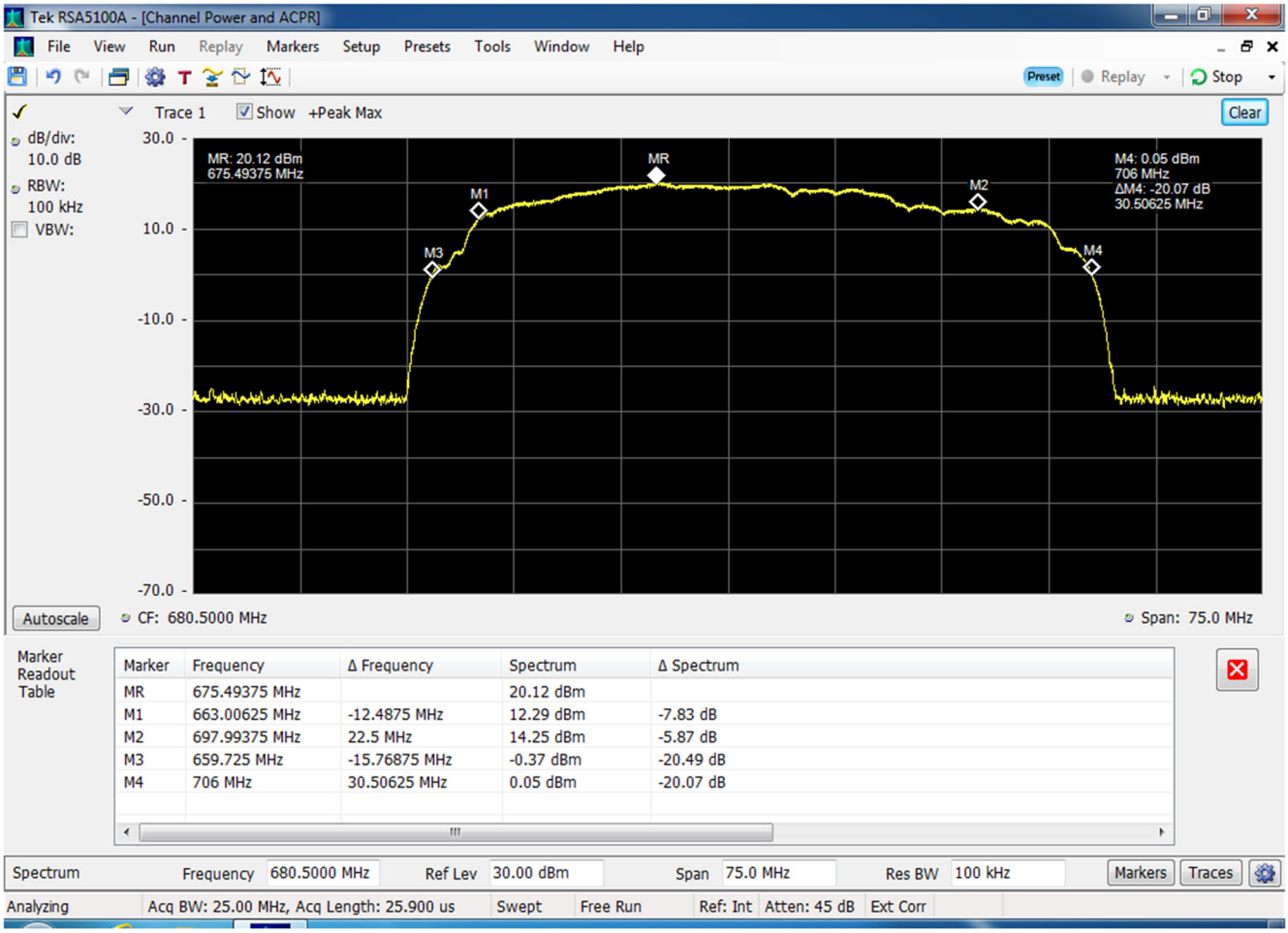
Test Setup



Out of Band Rejection_DL_617 - 652 MHz



Out of Band Rejection _UL_663 - 698 MHz



Input-Versus-Output Signal Comparison

Engineer: Greg Corbin

Test Date: 5/4/2020

Test Procedure

A signal generator was connected to the input of the EUT and was configured to transmit an AWGN signal. The amplitude was set to be just below the AGC threshold level but not more than 0.5 dB.

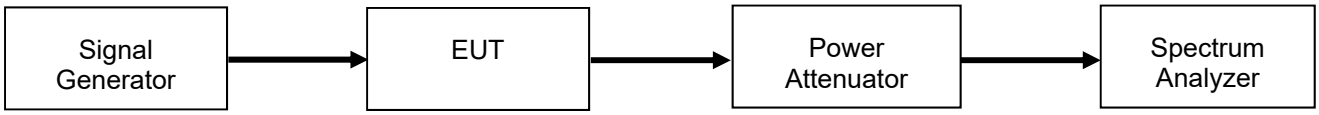
Spectrum analyzer setting:

Span 2 times to 5 times the EBW or alternatively the OBW.
Frequency set to the center frequency of the operational band under test.
RBW to 1% to 5 % of the anticipated OBW
VBW ≥ 3 × RBW
Reference Level 10 log (OBW / RBW) below the reference level
Positive Peak Detector
Max Hold

The -26dB bandwidth was compared between the input and the output of the EUT. All passbands applicable to the EUT were investigated. The input level was then increased by 3 dB above and the comparison repeated.

This test was repeated for the GSM narrowband signal.

Test Setup



Refer to Annex A for Input vs Output plots.

Mean Output and Amplifier Gain

Engineer: Greg Corbin

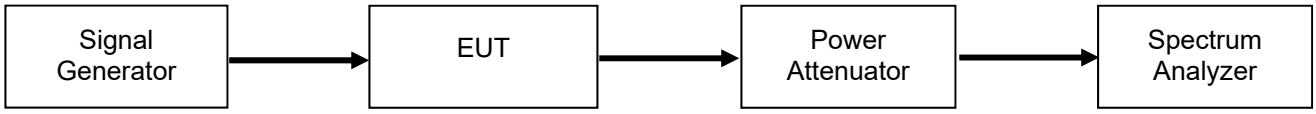
Test Date: 4/30/2020

Test Procedure

A signal generator tuned to the peak signal from the Out of Band Rejection data was connected to the input of the EUT.
A spectrum analyzer was connected to the EUT in order to monitor the output power levels.
The Signal Generator was configured to produce the necessary broadband and narrow band signals.
The input power level was increase in 1 dB increments until the power no longer increased.
The input and output levels were recorded in the table below.
The amplifier gain was determined from the delta between the input and output levels.
The input level was increased 3 dB and the output power was recorded.

Spectrum Analyzer settings
Channel Power integration was used
RBW = 1-5% of EBW
Video BW = 3x RBW

Test Setup



Uplink Output Power and Gain

GSM

Frequency Range (MHz)	Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)	(Input Power +3dB) Output Power (dBm)
663 - 698	675.49	-62.9	22.7	85.6	22.6

AWGN

Frequency Range (MHz)	Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)	(Input Power +3dB) Output Power (dBm)
663 - 698	675.49	-60.8	24.2	85	24

Downlink Output Power and Gain

GSM

Frequency Range (MHz)	Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)	(Input Power +3dB) Output Power (dBm)
617 - 652	627	-63.4	23.3	86.7	23.2

AWGN

Frequency Range (MHz)	Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)	(Input Power +3dB) Output Power (dBm)
617 - 652	627	-61.0	24.5	85.5	24.5

Out-Of-Band/Block Emission (Dual Carrier)

Engineer: Greg Corbin

Test Date: 5/1/2020

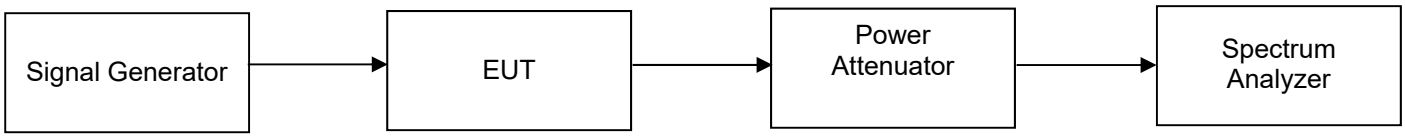
Test Procedure

A signal generator to the input of the EUT which was configured to produce two modulated AWGN carriers simultaneously.
The center frequencies were chosen such that the modulated signal at the band edge remained within the band.
The input power level was set to just below the AGC threshold but not more than 0.5dB.

The spectrum analyzer was set with the following parameters
RBW = 1 % of the emission bandwidth, 100 kHz
VBW = 3 × RBW
Average power detector
Sweep time = auto-couple
Trace average at least 100 traces in power averaging

Start frequency was set to the upper block edge frequency and the stop frequency to the upper block edge frequency plus 300 kHz. The traces were captured and recorded. The input level was increased by 3dB and recorded again. This was repeated for the GSM narrowband signal. The stop frequency was then set to the lower block edge and the start frequency set to 300 kHz. This was repeated for the GSM narrowband signal.

Test Setup



Refer to Annex B for Out of Band/Block emission plots (dual Carrier)

Out-Of-Band/Block Emission (Single Carrier)

Engineer: Greg Corbin

Test Date: 5/1/2020

Test Procedure

A signal generator was connected to the input of the EUT which was configured to produce one modulated AWGN carrier. The center frequencies was set to the lowest available frequency within the band and then to the highest possible frequency in the band. The input power level was set to just below the AGC threshold but not more than 0.5dB.

The spectrum analyzer was set with the following parameters:

RBW = 1 % of the emission bandwidth, 100 kHz, or 1 MHz
VBW = 3 × RBW.
Detector to power averaging (rms)
Sweep time = auto-couple
Number of points ≥ (2 × span/RBW)
Trace average at least 10 traces in power averaging mode

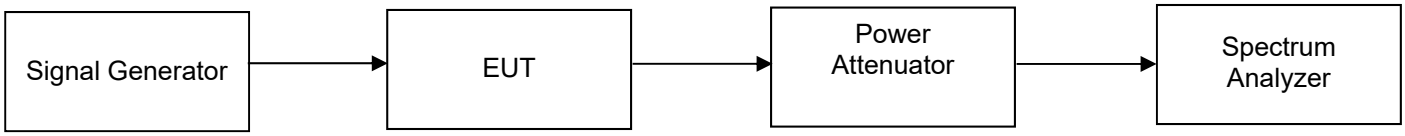
The start frequency was set to the lowest radio frequency signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 300 kHz or 3 MHz, as specified in the applicable rule part.

The start frequency was set to the upper band/block edge frequency plus 300 kHz or 3 MHz, as specified in the applicable rule part and the analyzer stop frequency to 10 times the highest frequency of the fundamental emission

All carriers and bands being used with the EUT were investigated.

The traces were captured and recorded.

Test Setup



Refer to Annex B for Out of Band/Block emission plots (single carrier)

Conducted Spurious Emissions
Engineer: Greg Corbin
Test Date: 5/1/2020

Test Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings were obtained.

The test is performed with a wideband AWGN signal and repeated with a narrowband GSM signal.

The RF input signal level was set to 0.2 dB below the AGC Threshold.
The RBW was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.
The VBW was set to 3 times the RBW.
A peak detector with max hold was used.

The spectrum analyzer start frequency was set to the lowest RF 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.
A peak marker was placed at the highest amplitude and the trace was recorded.

The spectrum analyzer start frequency was set to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the spectrum analyzer stop frequency to 10 times the highest frequency of the fundamental emission
A peak marker was placed at the highest amplitude and the trace was recorded.

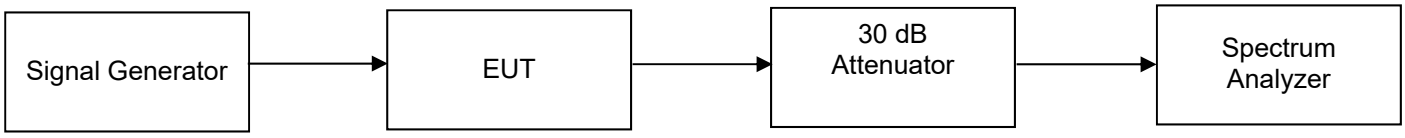
The frequency range from 30 MHz to the 10^{th} harmonic of the passband frequency was observed and plotted.

The test was repeated for the low, middle, high channels within the passband.

The following formula was used for calculating the limits.

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

Test Setup



Refer to Annex C for the Conducted Spurious Emissions Plots

Radiated Spurious Emissions

Engineer: Greg Corbin

Test Date: 5/5/2020

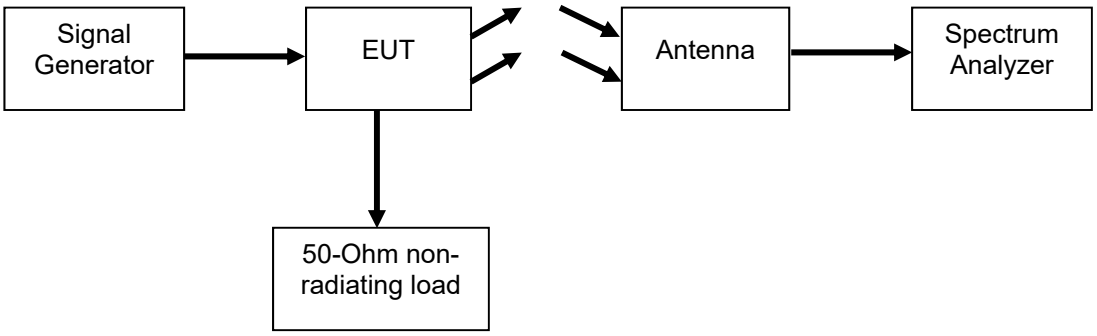
Test Procedure

The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions.
The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure that the signal levels were maximized.
All cable and antenna correction factors were input into the spectrum analyzer ensuring an accurate measurement in ERP/EIRP with the resultant power in dBm.
A signal generator was used to provide a GSM signal at the input to the EUT, with the power level set to just 0.5 dB of the AGC threshold.
The EUT output was terminated into a 50 Ohm non-radiating load.
The EUT was tested the input signal set to the low, mid, high channels within the band.
The radiated spurious emissions were measured from 30 MHz to the 10th harmonic.

The RBW was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.
The VBW was set to 3 times the RBW.

The following formula was used for calculating the limits:
Radiated Spurious Emissions Limit = P1 – (43+ 10Log(P2)) = -13dBm

Test Setup



Refer to Annex D for Radiated Spurious Emission plots

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	6/16/18	6/16/20
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	1/17/19	1/17/21
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	7/10/19	7/10/20
Voltmeter	Fluke	87III	i00319	5/15/19	5/15/20
EMI Analyzer	Agilent	E7405A	i00379	1/21/20	1/21/21
Signal Generator	Rohde & Schwarz	SMU200A	i00405	7/24/19	7/24/20
Spectrum Analyzer	Textronix	RSA5126A	i00424	7/17/19	7/17/20
Signal Generator	Keysight (Agilent)	E4438C	i00457	1/3/2020	1/3/2021
Spectrum Analyzer	Keysight	N9038A	i00552	9/9/19	9/9/20
Signal Generator	Rohde & Schwarz	SMW200A	1743750J (rental)	7/22/19	7/22/22

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT