



Compliance Testing, LLC
Previously Flom Test Lab
EMI, EMC, RF Testing Experts Since 1963

toll-free: (866) 311-3268
fax: (480) 926-3598
<http://www.ComplianceTesting.com>
info@ComplianceTesting.com

Test Report

Prepared for: Bird Technologies

Model: DDLxxx

Description: Low Power Indoor Cellular Remote Unit

Serial Number: N/A

FCC ID: V5DDL0001

To

FCC Part 20

Date of Issue: August 30, 2016

On the behalf of the applicant:

Bird Technologies
30303 Aurora Road
Cleveland, OH 44139

Attention of:

Tim O'Brien, Technical Product Manager
Ph: (440)519-2194
E-Mail: tobrien@bird-technologies.com

Prepared By
Compliance Testing, LLC
1724 S. Nevada Way
Mesa, AZ 85204
(480) 926-3100 phone / (480) 926-3598 fax
www.compliancetesting.com
Project No: p1680003



Alex Macon
Project Test Engineer

This report may not be reproduced, except in full, without written permission from Compliance Testing
All results contained herein relate only to the sample tested



Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	August 11, 2016	Alex Macon	Original Document
2.0	August 30, 2016	Alex Macon	Updated frequency band on page 7 and removed unnecessary note from page 17



Table of Contents

<u>Description</u>	<u>Page</u>
Standard Test Conditions and Engineering Practices	6
Test Result Summary	8
Mean Output Power and Amplifier gain	8
AGC Threshold	9
Out-Of-Band Rejection	10
Input-Versus-Output Signal Comparison	11
Mean Output and Amplifier Gain	12
Out-Of-Band/Block Emission (Dual Carrier)	13
Out-Of-Band/Block Emission (Single Carrier)	14
Conducted Spurious Emissions	15
Radiated Spurious Emissions	16
Test Equipment Utilized	17



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.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.

Testing Certificate Number: **2152.01**



FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A



The Applicant has been cautioned as to the following:

15.21: Information to the User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a): Special Accessories

Equipment marketed to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer, without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.



Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, KDB 935210 D05 Indus Booster Basic Measurements v01 and FCC Part 2, Part 20.21, Part 22, Part 24, 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 (°C)	Humidity (%)	Pressure (mbar)
24.7 – 25.9	27.8 – 31.5	963.5 – 970.4

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

Model: DDLxxx

Description: Low Power Indoor Cellular Remote User

Firmware: N/A

Software: N/A

Serial Number: N/A

Additional Information: N/A

EUT Operation during Tests

Note: the UL is directly connected to a base station and therefore does not radiate.

The EUT was setup in an end to end configuration. Signals were injected into the head end unit and measured from the remote unit.

AGC Threshold

Several tests reference the AGC Threshold level.

The AGC Threshold was measured as follows:

- Connect a signal generator to the input of the EUT.
- Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- Use a CW signal.
- While monitoring the output of the EUT, increase the input level until the output stops increasing or drops a few 10th's of a dB.
- This is the AGC threshold level of the EUT.
- When the procedure calls out to set the RF Input to just below the AGC Threshold, The AGC Threshold is measured using the procedure listed above, and then the RF Input is backed off 0.2 dB below this threshold level.



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)				
Downlink	728 - 756	869 - 894	1930 - 1995	2110 - 2180	
Modulation Type	GSM, CDMA, EDGE, HSPA, EVDO, LTE				

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

Accessories: None

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	
KDB 935210 D05	Out-Of-Band/Block Emissions Conducted	Pass	
2.1051 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: Alex Macon

Test Date: 8/3/16

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
742	-30.4	-30.64
881.5	-31.8	-31.5
1962.5	-29.6	-30.6
2145	-34.2	-33.6



Out-Of-Band Rejection

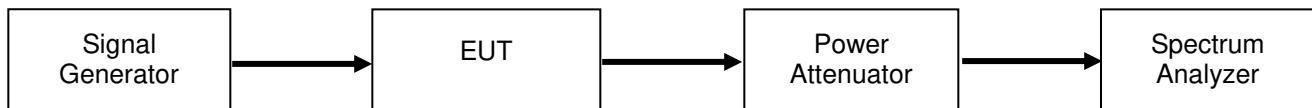
Engineer: Alex Macon

Test Date: 8/3/16

Test Procedure

The EUT was connected to a spectrum analyzer through a 30 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.

Test Setup



Refer to Annex A for Authorized Frequency Band plots.



Input-Versus-Output Signal Comparison

Engineer: Alex Macon

Test Date: 8/3/16

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 $\geq 3 \times$ RBW

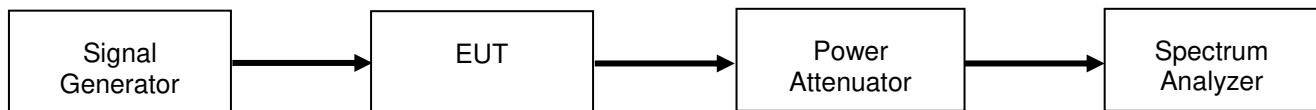
Positive Peak Detector

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 B for Input vs Output plots.



Mean Output and Amplifier Gain

Engineer: Alex Macon

Test Date: 8/3/16

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 increased 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.

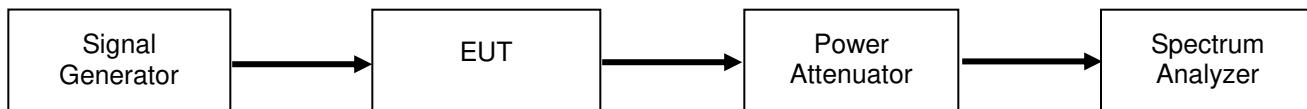
Spectrum Analyzer settings

Channel Power integration was used

RBW = 1-5% of EBW

Video BW = 3x RBW

Test Setup



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)
728 - 756	747.08	-30.84	27.09	57.93	27.72
869 - 894	889.88	-31.7	26.5	58.2	26.47
1930 - 1995	1988.45	-30.8	27.38	58.18	26.16
2110 - 2180	2162.6	-33.8	26.71	60.51	26.64

AWGN

Frequency Range (MHz)	Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)	(Input Power +3dB) Output Power (dBm)
728 - 756	747.08	-30.24	27.23	57.47	27.56
869 - 894	889.88	-32.0	26.29	58.29	26.69
1930 - 1995	1988.45	-29.8	27.81	57.61	26.13
2110 - 2180	2162.6	-34.4	26.44	60.84	26.61



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

Engineer: Alex Macon

Test Date: 8/3/16

Test Procedure

A signal generator to the input of the EUT which was configured to produce two modulated AWGN carriers simultaneously. The center frequencies used were determined by the 3GPP standards and set to the lowest band edge and then to the highest band edge of each applicable 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 = $3 \times$ RBW

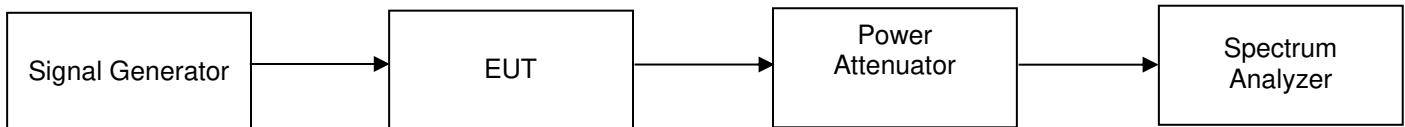
Average power detector

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 or 3 MHz for frequencies below and above 1 GHz, respectively. The traces were captured and recorded. The input level was increased by 3dB and recorded again. This was repeated for all carriers being used with the EUT. The stop frequency was then set to the lower block edge and the start frequency set to 300 kHz or 3 MHz for frequencies below and above 1 GHz respectively. This was repeated for all carriers being used with the EUT. This was applied to all bands being used with the EUT.

Test Setup



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



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

Engineer: Alex Macon

Test Date: 8/3/16

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 = $3 \times$ RBW.

Detector to power averaging (rms)

Sweep time = auto-couple

Number of points $\geq (2 \times \text{span}/\text{RBW})$

Trace average at least 10 traces in power averaging mode

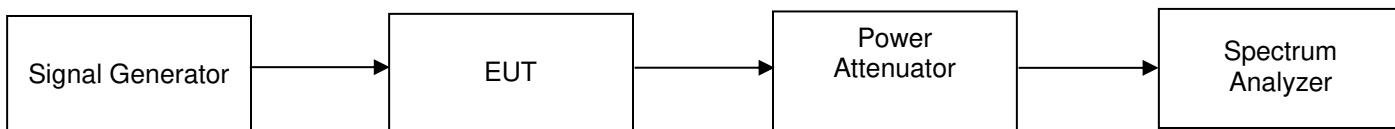
The start frequency was set to the lowest radio frequency signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part.

The 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 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 C for Out of Band/Block emission plots (single carrier)



Conducted Spurious Emissions

Engineer: Alex Macon

Test Date: 8/3/16

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.

An rms power averaging detector was used.

Trace averaging was utilized and the peak marker function 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 9 kHz to the 10th harmonic of the passband frequency was observed and plotted.

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

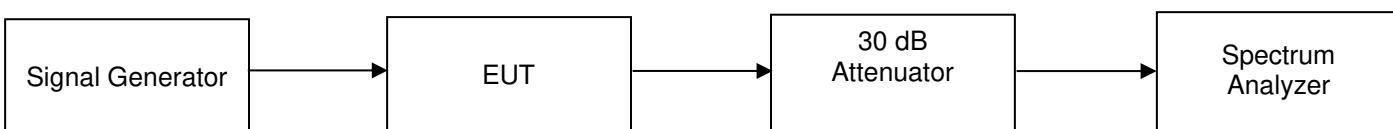
The following formula was used for calculating the limits.

Conducted Spurious Emissions Limit = $P1 - (43 + 10\log(P2)) = -13 \text{ dBm}$

P1 = power in dBm

P2 = power in Watts

Test Setup



Refer to Annex D for the Conducted Spurious Emissions Plots



Radiated Spurious Emissions

Engineer: Alex Macon

Test Date: 8/5/16

Test Procedure

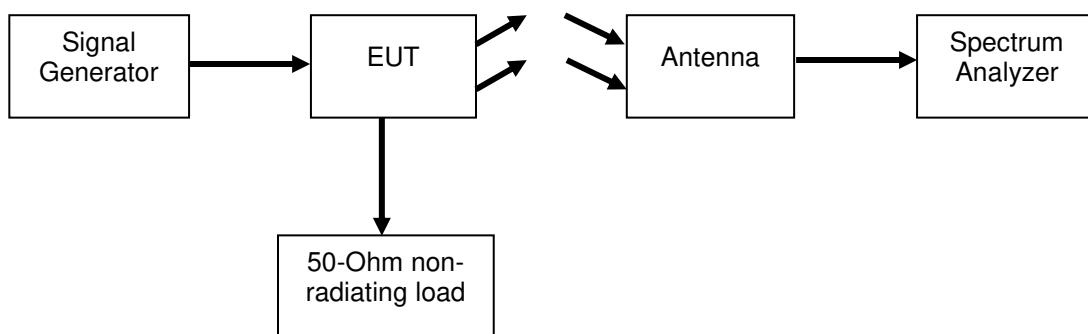
The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation 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 CW signal. The EUT output was terminated into a 50 Ohm non-radiating load.

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:

$$\text{Radiated Spurious Emissions Limit} = P1 - (43 + 10\log(P2)) = -13\text{dBm}$$

Test Setup



Refer to Annex E for Radiated Spurious Emission plots



Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna, Amplified	ARA	DRG-118/A	i00271	6/16/16	6/16/18
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	10/19/15	10/19/17
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	5/26/16	5/26/17
Voltmeter	Fluke	87III	i00319	4/11/16	4/11/19
Spectrum Analyzer	Agilent	E4407B	i00331	9/18/15	9/18/16
Non-radiating load	Termaline	8201	i00334	Verified on: 8/3/16	
Signal Generator	Keysight (Agilent)	E4438C	I00457	9/26/2014	9/26/2016
RF Directional Coupler	Meca	CS06-1.500V	i00412	Verified on: 8/3/16	

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