

Test Report # 319345 D

Equipment Under Test: BL654 Series BLE Module

Test Date(s): 9/22/2020

Prepared for: Laird Connectivity
Attn: Jonathan Kaye
50 South Main Street, Suite 1100
Akron, OH 44308

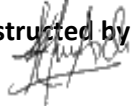
Report Issued by: Khairul Aidi Zainal, Laboratory Manager

Signature:  Date: 12/18/2020

Report Reviewed by: Adam Alger, Quality Manager

Signature:  Date: 12/18/2020

Report Constructed by: Khairul Aidi Zainal, Laboratory Manager

Signature:  Date: 11/28/20

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Laird Connectivity Test Services in Review

The Laird Connectivity, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025:2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein unless otherwise noted



Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers



Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

Company: Laird Connectivity	Page 3 of 16	Name: BL654
Report: TR319345 D		Model: BL654
Job: C-3352		Serial: Engineering Sample

1 TEST REPORT SUMMARY

On **9/22/2020** the Equipment Under Test (EUT), **BL654 series Bluetooth Module**, as provided by **Laird Connectivity** was tested to the following requirement of:

ETSI EN 300 328 V2.2.2

Requirements (Section)	Description	Method (Section)	Compliant
4.3.2.11	Receiver Blocking for wideband data transmission equipment	5.4.11	Yes

Notice:

The results relate only to the item tested as configured and described in this report. Any additional configurations, modes of operation, or modifications made to the equipment under test after the specified test date(s) are at the decision of the client and may not apply to the data seen in this test report.

The decision rule for Pass / Fail assessment to the specification or standard listed in this test report has been agreed upon by the client and laboratory to be as follows:

Measurement Type	Rule
Emissions – Amplitude	0.1 dB below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Laird Connectivity
Contact Person	Jonathan Kaye
Address	50 South Main Street, Suite 1100. Akron, OH 44308

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	BL654 Series Bluetooth Module
Model Number	BL654
Serial Number	Engineering Sample

2.2 Product Description

Bluetooth 5.0 BLE module that comes with options of a 0dBi printed PCB antenna and an RF connector. The antennas associated with the module are listed below:

Manufacturer	Model	Gain (dBi)
Laird	NanoBLue	2
Laird	Flex PIFA	2
Laird	FlexNotch	2
Mag. Layers	EDA-8709-2G4C1-B27-CY	2
Laird	mFlexPIFA	2
Laird	LAIRD NFC	0
Laird	BL-654-SA PCB printed antenna	2
Walsin	RFDPA870900SBAB8G1	2

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 EUT setup information

During test, EUT was supplied with 5VDC via USB. The EUT was in Direct Test mode as defined by BT SIG which comes integrated in the BL654 Normal firmware (29.3.5.0). The Laird BleDtmRfTool v8.0.0 was used on the module to set it in the appropriate test mode.

2.6 Performance criteria

PER (packet error rate) less than or equal to 10%

3 REFERENCES

Publication	Edition	Date
ETSI EN 300 328	V2.2.2	2019-07
ER813002	Rev. 01	2018

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k = 2$.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty \pm
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

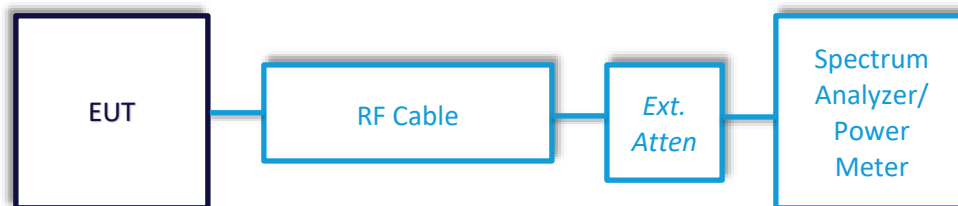
Parameter	ETSI U.C. \pm	U.C. \pm
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted measurements

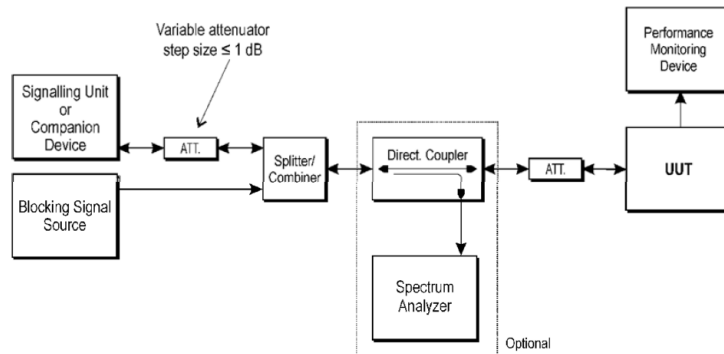
Description of Measurement	<p>The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter.</p> <p>The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.</p>
Example Calculations	<p>Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm)</p> <p>Margin (dB) = Limit (dBm) – Corrected Reading (dBm)</p>

Block Diagram



5.1.1 Receiver Blocking

Block Diagram



Limits:

For equipment that supports a PER or FER test to be performed, the minimum performance criteria shall be a PER or FER less than or equal to 10%

For equipment that does not support a PER or a FER test to be performed, the minimum performance criterion shall be no loss of the wireless transmission function needed for the intended use of the equipment.

Test Parameters

Receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 10 \text{ dB})$ or $(-74 \text{ dBm} + 10 \text{ dB})$ whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
<p>NOTE 1: OCBW is in Hz.</p> <p>NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 26 \text{ dB}$ where P_{\min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.</p> <p>NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.</p>			

Instrumentation



Date : 10-Jul-2020

Test : Receiver Blocking

Job : C-3352

PE : Zach Wilson

Customer : Laird Connectivity

Quote : 319345

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration
2	EE 960086	Generator - Signal	Rohde & Sch.	SMB100A	1406.600K03	7/15/2020	7/15/2021	Active Calibration
3	EE 960094	RF Splitter/Combiner	mini-circuits	ZFSC-2-10G	SF441900526	6/7/2018	6/7/2021	Active Verification
4	CC 000817C	Digital Communication test set	Litepoint	lqxel-M	IQM600169	5/8/2019	5/8/2021	Active Calibration

Data

Operator	Anthony Smith	QA	Aidi Zainal
Temperature (°C)	21.7	R.H. %	51
Test Date	9/22/2020	Location	Conducted RF
Requirement	ETSI 300 328 V2.2.2; 4.3.2.11	Method	ETSI 300 328 V2.2.2; 5.4.11

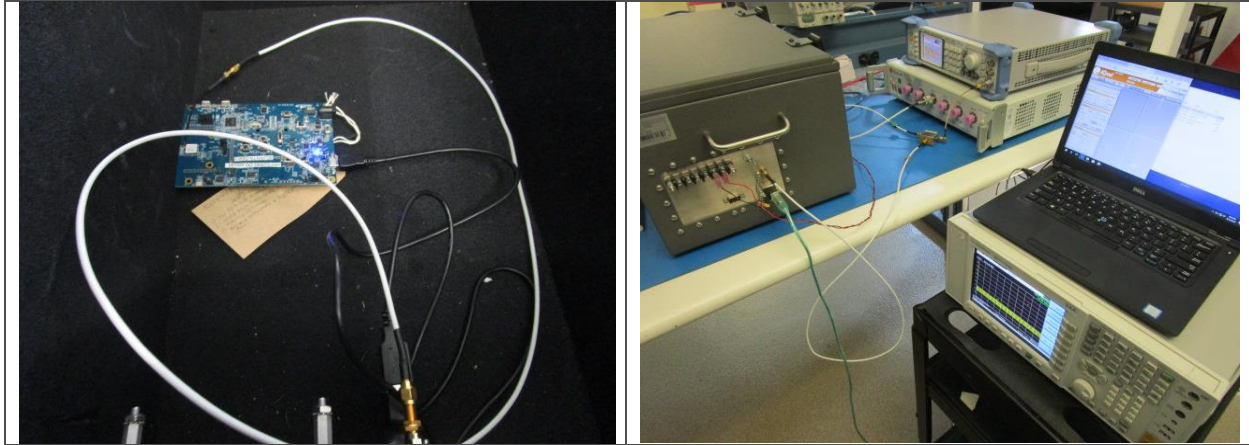
EUT Parameters

OBW (MHz)	1.05 ^{Note 1}	EUT supply voltage	5.0VDC (via USB)
Channel tested	2402MHz, 2480MHz	Antenna Gain (dBi)	2.0
Test configuration (Radiated/Conducted)	Conducted	Max EIRP	9.34 ^{Note 1}
Receiver Category	2	EUT mode	Single channel Receive

Note:

1. Provided from client supplied test report ER813002

Setup Photos



Company: Laird Connectivity	Page 12 of 16	Name: BL654
Report: TR319345 D		Model: BL654
Job:C-3352		Serial: Engineering Smple

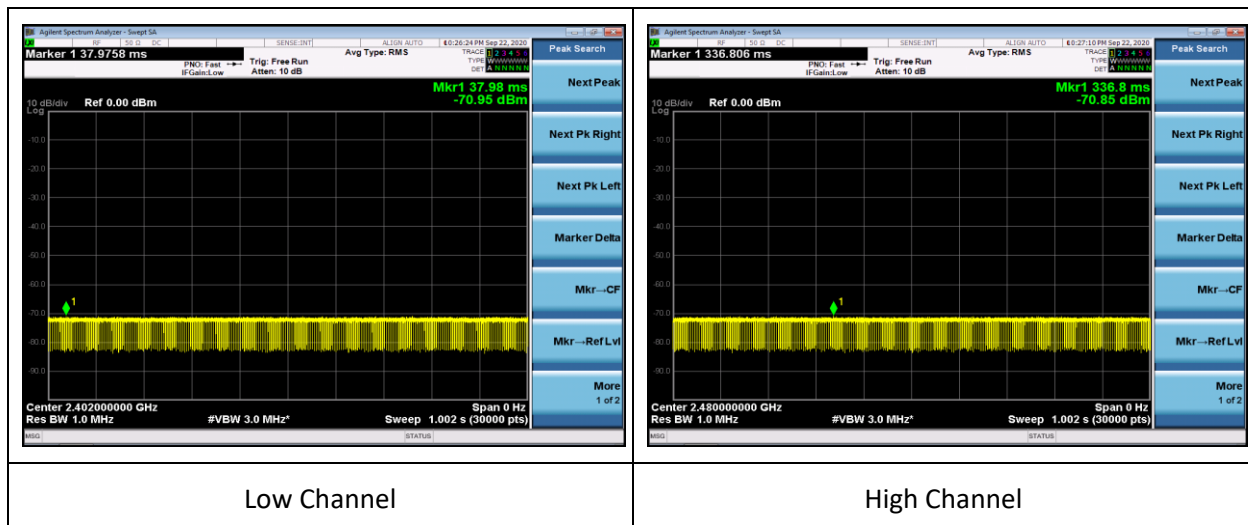
Wanted Mean Signal

Wanted Mean signal = -139 dm + 10 X log(OCBW) + 10dB

OCBW (Hz)	Wanted Signal Mean Power (dBm)
1052000	-68.8

Antenna gain adjusted wanted signal mean power (signal power – G):

Wanted Signal Mean power (dBm)	Antenna Gain	Antenna gain corrected Wanted Signal Mean Power from Companion Device
-68.8	2	-70.8



Blocking Signal Level

Blocking Frequency (MHz)	Blocking Signal Power (dBm)	Antenna Gain (dBi)	Corrected Blocking Level (dBm)
2380.0	-34.0	2.0	-32.0
2504.0	-34.0	2.0	-32.0
2300.0	-34.0	2.0	-32.0
2584.0	-34.0	2.0	-32.0



Test Result

			Blocking Signal Frequency (MHz)				
			2380.0	2504.0	2300.0	2584.0	
Radio Mode	Data Rate	EUT Channel	PER %				Packets
BLE	125kbps	Low	0.00	N/A	0.00	N/A	2000
BLE	125kbps	High	N/A	1.15	N/A	1.10	2000

6 REVISION HISTORY

Version	Date	Notes	Person
0	11/28/20	Draft	Aidi Zainal
1	12/10/20	Final	Aidi Zainal

END OF REPORT