SECURE, EXTENDED RANGE BLUETOOTH v5 FOR YOUR IOT DESIGN

Building on Laird's expertise with Nordic from the BL600 and BL652 series comes the most powerful yet - the BL654 PA series! It provides OEMs with the maximum design flexibility and performance. A complete multi-protocol embedded wireless offering with exceptional processing capability, all with extended PA / LNA support for even greater range.

Powered by **Nordic's nRF52840** silicon, the small form factor BL654 PA modules and DVKs provide for a secure, robust BLE and **Cortex -M4F** CPU for any OEM's product design. The BL654 provides you with maximum development flexibility with programming options for the **Nordic SDK**, a simple, intuitive **AT Command Set**, as well as Laird's own *smart*BASIC environment.

The BL654 PA series brings out all nRF52840 hardware features and capabilities including **USB access,** up to **5.5V** supply considerations, and builds in additional TX power capabilities via an **integrated Skyworks PA**. Complete regulatory certifications enable faster time to market and reduced development risk completes Laird's simplification of your next Bluetooth design!

- **Bluetooth v5** Bluetooth Low Energy (BLE) plus **NFC**
- **Widest range of configurable interfaces**: UART, I2C, SPI, ADC, GPIO, PWM, FREQ, USB, and NFC
- Industrial Temp Rating (-40º to +85º C)
- **Ultra-Small footprint** (15mm x 10mm x 2.2mm)
- BLE Peripheral/Central roles with **DTM embedded**
- **2Mbps & LE Long Range:** Support for 2Mbps, 1Mbps, & 125kps coded
- **Hostless operation** – Internal MCU reduces BOM
- **Powerful Core** Cortex-M4F (1Mbit Flash, 256k RAM)
- Built on years of experience with Nordic (BL600 & BL652 Series)
- **Fully featured development kit** everything needed to start BLE development
- **Application Design Choice:** Leverage Laird's *smart*BASIC, simple AT Command Set or utilize Nordic SDK directly.
- **Integrated Power Amplifier:** Upto +18dBM output power (upto +14dBm in LE Coded mode – 125kbps PHY)

FEATURES AT A GLANCE

TRULY HOSTLESS OPERATION FOR AUTOMATED USE CASES
Combine on-module MCU, *smart*BASIC and simultaneous central/peripheral role support for a powerful hostless solution for sensor applications.

SPEED TO MARKET
Easily write event-driven, automated applications, no toolchain required with *smart*BASIC. Or utilize the Nordic SDK directly – design your way

EXTENDED POWER – INCREASED RANGE
Integrated Skyworks PA enables greater TX power capabilities and range – Bluetooth v5 just got even further!

GLOBAL APPROVALS – MAKE YOURSELF AT HOME
Carries several modular FCC, IC, RCM, MIC and Bluetooth SIG approvals.

PERSONAL SUPPORT FROM DESIGN TO MANUFACTURE
Laird's industry-renowned support is passionate about helping you speed your design to market.

APPLICATION AREAS

IoT Devices and Sensors

Beacons and Proximity Applications

Secure Medical Peripherals

Industrial Monitoring

KEY SPECIFICATIONS

CATEGORY	FEATURE	SPECIFICATION	
Wireless Specification	Bluetooth®	v5 – Single-Mode (Peripheral and Central Roles)	
	Frequency	2.402 - 2.480 GHz	
	Transmit Power	+ 18 dBm (maximum). Configurable down to -26 dBm	
		+ 14 dBm (maximum). Configurable down to -26 dBm **(LE CODED PHY mode only)**	
	Receive Sensitivity	-98.5 dBm (typical @ BLE 1 Mpbs)	
		-95 dBm (typical @ BLE 2 Mbps	
		-107 dBm (typical @ BLE 125 kbps)	
	Link Budget	116.5dB (@ BLE I Mbps), 118 db (@ BLE 125kpbs)	
	Antenna Options	PCB Trace antenna or IPEX MHF4 RF Connector	
	Raw Data Rates (Air)	1 Mbps, 2 Mbps, 125kbps	
Host Interface and Peripherals	UART Interface	TX, RX, CTS, RTS. DTR, DSR, DCD, RI possible in *smart*BASIC (GPIO)	
		Default: 115200, N, 8, 1. Configurable from 1200 bps to 1 Mbps	
	USB Interface	2 pins - CDC/Audio/HID & Mass storage virtual interfaces	
	Other	46 multifunction GPIO's that can provide:	
		2 UART (4 GPIO pins each) 8 ADC channels (1 pin each) 2 I2C (2 GPIO pins each) 4 SPI Master (4 GPIO pins including CS each) 1 QSPI (6 GPIO pins)	2 PDM (2 GPIO pins each) 2 I2S (5 GPIO pins) 2 GPIO pins for 32.768kHz crystal 2 GPIO pins for NFC - PWM output on 16 pins - FREQ output on 16 pins
Key BLE Features	Bluetooth Low Energy	- GATT Client & GATT Server – Any Adopted / Custom Services - Central / Peripheral Roles. - Up to 20 BLE connections - BLE Mesh - CODED PHY 2M PHY	- LE Advertising Extensions - LE Secure Connections - Data Packet Length Extensions - LE Privacy v1.2 - LE Ping - vSP – Virtual Serial Port
Programmability Options	*smart*BASIC	On-board BASIC programming language	
	AT Command Set	Simple AT 'Hayes style' command protocol	
	Nordic SDK	Software / Support available from Nordic directly	
FW upgrade		Via UART or JTAG	
Supply Voltage		3.0V – 5.5V	
Power Consumption	Current	Max Peak Radio Current (@ +18dBm TX) – 88mA (DCDC at 3V)	
		Standby Doze – TBC µA	
		Deep Sleep –TBC µA (external signal wake up)	
Physical	Dimensions	22mm x 10mm x 2.2mm	
Environmental	Temp Range	-40°C to +85°C	
Miscellaneous	Lead Free	Lead-free and RoHS compliant	
	Development Kit	Development board and free software tools	
Development Tools	Utilities	UwTerminalX (Multi-platform)	
		Android and iOS applications	
		UART firmware upgrade	
Qualifications	Bluetooth®	Complete Declaration ID	
Regulatory	Approvals	FCC / IC / RCM / Korea	

For full specifications on BL654 modules, please see the appropriate datasheet.

PART #	DESCRIPTION
453-00021	Bluetooth v5 PA Module – Integrated Antenna (Tape / Reel)
451-00022	Bluetooth v5 PA Module – IPEX MHF4 Antenna Connector (Tape / Reel)
451-00021C	Bluetooth v5 PA Module – Integrated Antenna (Cut Tape)
451-00022C	Bluetooth v5 PA Module – IPEX MHF4 Antenna Connector (Cut Tape)
455-00022	Development Board for Bluetooth v5 PA Module – Integrated Antenna
455-00023	Development Board for Bluetooth v5 PA Module – IPEX MHF4 Antenna Connector

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REGULATORY STATEMENT

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the

following two conditions: (1) This device may not cause harmful interference, and (2)

this device must accept any interference received, including interference that may

cause undesired operation.

IMPORTANT NOTE:

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Integration instructions for host product manufacturers

Applicable FCC rules to module

FCC Part 15.247

Summarize the specific operational use conditions

The module is must be installed in mobile device.

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and

2) The transmitter module may not be co-located with any other transmitter or antenna

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Limited module procedures

Not applicable

Trace antenna designs

Not applicable

RF exposure considerations

20 cm separation distance and co-located issue shall be met as mentioned in "Summarize the specific operational use conditions".

Product manufacturer shall provide below text in end-product manual

"This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body."

Antennas

Ant. No.	Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)	Remarks
1	Laird	NanoBlue	EBL2400A1-10MH4L	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	Connector Type Antenna
3	Laird	2.4GHz Dipole Antenna	001-0001	Dipole	RP-SMA Male	2	Connector Type Antenna
4	Mag.Layers	EDA-8709-2 G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2	Connector Type Antenna
5	Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4	2	Connector Type Antenna
6	Laird	Laird NFC	0600-00061	NFC	N/A	---	Printed PCB Antenna & Connector Type Antenna
7	Laird	BL654 PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

Label and Compliance Information

Product manufacturers need to provide a physical or e-label stating

"Contains FCC ID: SQGBL654PA" with finished product

Information on Test Modes and Additional Testing Requirements

SmartBASIC DTM shall be used to set the module to transmit continuously.

Additional Testing, Part 15 Subpart B Disclaimer

The module is only FCC authorized for the specific rule parts listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference
(2) This device must accept any interference, including interference that may cause undesired operation of the device

Cet appareil contient des émetteurs / récepteurs exempts de licence qui sont conformes au (x) RSS (s) exemptés de licence d'Innovation, Sciences et Développement économique Canada. L'opération est soumise aux deux conditions suivantes:

(1) Cet appareil ne doit pas causer d'interférences
(2) Cet appareil doit accepter toute interférence, y compris les interférences pouvant provoquer un fonctionnement indésirable de l'appareil

This radio transmitter (IC: 3147A-BL654PA) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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Le présent émetteur radio (IC: 3147A-BL654PA) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Ant. No.	Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)	Remarks
1	Laird	NanoBlue	EBL2400A1-10MH4L	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	Connector Type Antenna
3	Laird	2.4GHz Dipole Antenna	001-0001	Dipole	RP-SMA Male	2	Connector Type Antenna
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5	Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4	2	Connector Type Antenna
6	Laird	Laird NFC	0600-00061	NFC	N/A	---	Printed PCB Antenna & Connector Type Antenna
7	Laird	BL654 PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

Radiation Exposure Statement:

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 20cm entre le radiateur et votre corps.

1) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 1 condition above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

1) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

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In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

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