Laird CONNECTIVITY

LONGER RANGE BLE – ENABLING NEXT GENERATION INDUSTRIAL IOT

Laird Connectivity's new BL653 series enables Industrial OEMs to robustly implement **longer range** BLE applications in the **harshest operating environments**. This series of secure low power, microcontroller modules with multi wireless capabilities is the future of wireless Industrial Internet of Things (IIoT) connectivity.

Powered by **Nordic's nRF52833** silicon, the small form factor BL653 modules and DVKs provide for a secure, robust BLE and **Cortex -M4F** CPU for any OEM's product design. The BL653 provides you with maximum development flexibility with programming options for the **Nordic SDK** or **Zephyr RTOS**, a simple, intuitive **AT command set**, as well as Laird Connectivity's own *smart*BASIC environment.

The BL653 series brings out all nRF52833 hardware features and capabilities including **USB access,** up to **+8 dBm** transmit power up to **5.5V** supply considerations, and **NFC tag (type 2 / 4)** implementation. Complete regulatory certifications enable faster time to market and reduced development risk completes Laird Connectivity's simplification of your next Bluetooth design!

- **Bluetooth v5.1** Bluetooth Low Energy (BLE) plus **NFC**
- **Bluetooth v5.2**- capable
- **802.15.4** radio (non-certified – Thread & ZigBee via Nordic SDK or Thread via Zephyr)
- **Widest range of configurable interfaces**: UART, I2C, SPI, ADC, GPIO, PWM, FREQ, USB, PDM, and NFC
- **Extended** Industrial **Temperature Rating** (-40° to +105 °C)
- **Ultra-small footprint** (15 mm x 10 mm x 2.2 mm)
- BLE Peripheral/Central roles supported
- 2 Mbps and **LE Long Range:** Support for 2 Mbps, 1 Mbps, & 125 kps coded
- Bluetooth 5.1 - Direction finding – **AoA and AoD**
- **Hostless operation** – Internal MCU reduces BOM
- **Powerful Core** Cortex-M4F (512kB Flash, 128 k RAM)
- Built on years of experience with Nordic (BL600 and BL652 Series)
- **Fully featured development kit** everything needed to start BLE development
- **Application design choice:** Leverage Laird Connectivity's *smart*BASIC, simple AT command set, Zephyr RTOS or utilize Nordic SDK directly
- **Nordic nRF52833** – 7x7 QFN with 42 GPIOs utilized.
- Mechanically same form factor as **BL654 Series**

FEATURES AT A GLANCE

NEXT GENERATION OF DIRECTION FINDING
Includes radio capable of Bluetooth v5.1 Direction Finding with AoA and AoD

SOFTWARE FLEXIBILITY AND SPEED TO MARKET
Simple AT Command set or easily write event-driven, automated applications, no toolchain required with s*mart*BASIC. Alternatively utilize either Zephyr RTOS or the Nordic SDK directly – develop application SW your way

TRUE INDUSTRIAL OPERATING RANGE
Designed and certified to the highest industrial temperature range of -40 ºC to +105 ºC for every component utilised.

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

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

APPLICATION AREAS

Professional Lighting

Direction Finding / AoA / AoD

Secure Medical Peripherals

Industrial IoT Sensors

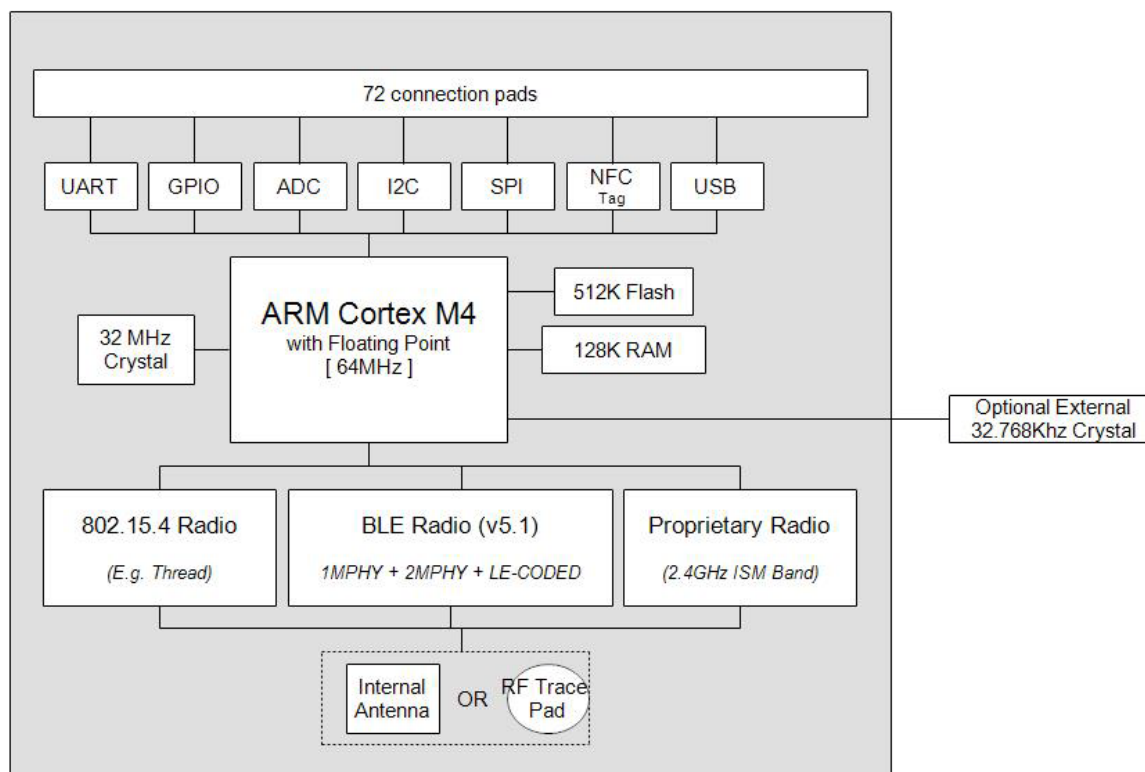Contact Sales -   Americas: +1 262 375 4400   Korea: +82 10 2622 3935
                    Europe: +44 1628 940 ext. 958   Hong Kong: +852 2923 0610

For documentation, software, sample apps and more visit:
http://www.lairdconnect.com/BL653-ble-thread-nfc-modules

KEY SPECIFICATIONS

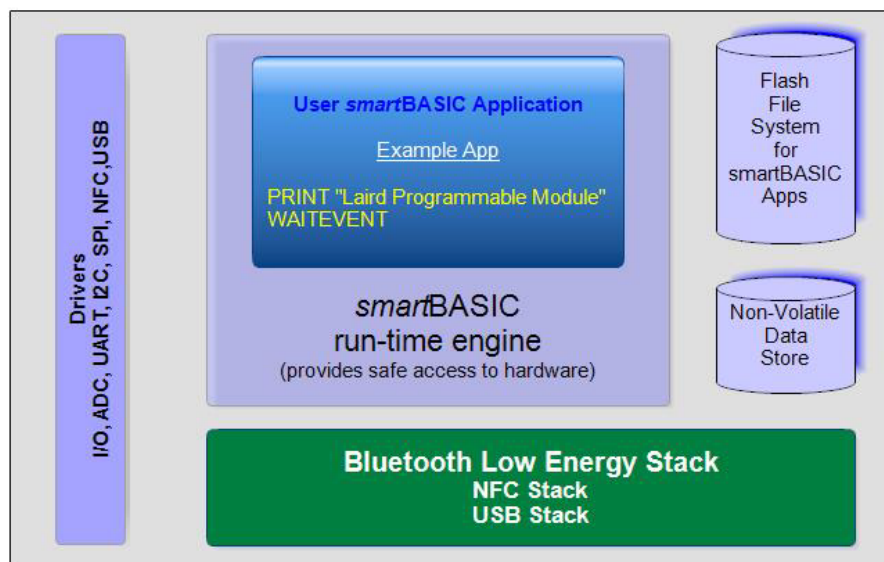| CATEGORY	FEATURE	SPECIFICATION
Wireless Specification	Bluetooth®	v5.1
	802.15.4	Thread and Zigbee support via Nordic SDK
	Frequency	2.402 - 2.480 GHz
	Transmit Power	+ 8 dBm (maximum). Configurable down to -40 dBm
	Receive Sensitivity	-95 dBm (typical @ BLE 1 Mpbs) -103 dBm (typical @ BLE 125 kbps)
	Link Budget	103 dB (@ BLE I Mbps), 111 db (@ BLE 125 kpbs)
	Antenna Options	PCB trace antenna or trace pin for external antennas
	Raw Data Rates (Air)	1 Mbps, 2 Mbps, 125 kbps
Host Interface and Peripherals	UART Interface	TX, RX, CTS, RTS. DTR, DSR, DCD, RI (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	42 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) • 2 PDM (2 GPIO pins each) • 2 I2S (5 GPIO pins) • 2 GPIO pins for 32.768 kHz 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 8 BLE connections (*smart*BASIC) • 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 • Isochronous streams for audio (BT v5.2)
Programmability Options	*smart*BASIC	On-board BASIC event driven programming language
	AT Command Set	Simple AT Hayes-style command protocol
	Nordic SDK	Software/Support available from Nordic directly https://devzone.nordicsemi.com/
	Zephyr RTOS	Software/Support available from https://www.zephyrproject.org/
FW upgrade		Via UART or JTAG
Supply Voltage		1.7V – 5.5V
Power Consumption	Current	Max Peak Radio Current (@ +8 dBm TX) – 14.1 mA (DCDC at 3V)
		Max Peak Radio Current (@ 0 dBm TX) – 4.9 mA (DCDC at 3V)
		Standby Doze – 2.6 µA
		Deep Sleep –0.6 µA (external signal wake-up)
Physical	Dimensions	15 mm x 10 mm x 2.2 mm (modules)
Environmental	Temp Range	-40°C to +105°C
Miscellaneous	Lead Free	Lead-free and RoHS-compliant
	Development Kit	Development board and free software tools
Development Tools	Utilities	UwTerminalX (Multi-platform) Nordic nRFConnect - Android and iOS applications UART firmware upgrade
Qualifications	Bluetooth®	Complete Declaration ID
Regulatory	Approvals	FCC/IC/CE/MIC/RCM - All BL653 Series

For full specifications on BL653 modules, please see the appropriate datasheet.

PART #	DESCRIPTION
453-00039R	BLE module (Nordic nRF52833) – Integrated antenna (Tape/Reel)
453-00041R	BLE module (Nordic nRF52833) – Trace pin (Tape/Reel)
453-00039C	BLE module (Nordic nRF52833) – Integrated antenna (Cut Tape)
453-00041C	BLE module (Nordic nRF52833) – Trace pin (Cut Tape)
453-00039-K1	Development kit for Bluetooth + 802.15.4 + NFC module – Integrated antenna
453-00041-K1	Development kit for Bluetooth + 802.15.4 + NFC module – Trace pin (external antenna)

HARDWARE BLOCK DIAGRAM

72 connection pads

| UART | GPIO | ADC | I2C | SPI | NFC Tag | USB |

ARM Cortex M4 with Floating Point [64MHz]

32 MHz Crystal

512K Flash

128K RAM

Optional External 32.768Khz Crystal

802.15.4 Radio (E.g. Thread)

BLE Radio (v5.1) 1MPHY + 2MPHY + LE-CODED

Proprietary Radio (2.4GHz ISM Band)

Internal Antenna OR RF Trace Pad

SOFTWARE DIAGRAM

Drivers
I/O, ADC, UART, I2C, SPI, NFC,USB

User smartBASIC Application

Example App

PRINT "Laird Programmable Module" WAITEVENT

*smart*BASIC run-time engine (provides safe access to hardware)

Flash File System for smartBASIC Apps

Non-Volatile Data Store

Bluetooth Low Energy Stack
NFC Stack
USB Stack

FEDERAL COMMUNICATION COMMISSION INTERFERENCE 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:

Radiation Exposure Statement:

The product comply with the US portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

Country Code selection feature to be disabled for products marketed to the US/CANADA.

INDUSTRY CANADA STATEMENT

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

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

As long as 1 condition above is met, further <u>transmitter</u> 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 <u>can not be met</u> (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID <u>can not</u> 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.

End Product Labeling

The final end product must be labeled in a visible area with the following: "Contains FCC ID: SQGBL653.

Manual Information to the End User

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.

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-BL654)* 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.

Le présent émetteur radio *(IC: 3147A-BL654)* 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.

Manufacturer	Model	Laird Part Number	Type	Connector	2400-2500MHz	2400-2480MHz
Laird	NanoBlue	EBL2400A1-10MH4L	PCB Dipole	IPEX MHF4	2dBi	
Laird	FlexPIFA	001-0022	PCB Dipole	IPEX MHF4		2dBi
Mag.Layers	EDA-8709-2G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2dBi	
Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4		2dBI
Laird	Laird NFC	0600-00061	NFC	N/A		
Laird	BL653-SA PCB printed antenna	NA	Printed PCB	N/A	1.28dBi	

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Europe: +44 1628 940 ext. 958 Hong Kong: +852 2923 0610

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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.

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 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.

End Product Labeling

The final end product must be labeled in a visible area with the following: "Contains IC:3147A-BL653.

Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 3147A-BL653.

Manual Information To the End User

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.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.