



# Single Mode Bluetooth Low Energy (BLE) Module

Part # BL600-SA, BL600-SC, BL600-ST

## HARDWARE DATA SHEET AND INTEGRATION GUIDE VERSION 0.5



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## BL600-Sx

Single Mode BLE Module

[www.lairdtech.com/wireless](http://www.lairdtech.com/wireless)

## REVISION HISTORY

Revision	Description
Version 0.1	07/02/2013 – first stage internal release
Version 0.2	07/02/13 – includes Mt comments
Version 0.3	15Feb13 –RK initial updates in blue colour. (need to clear it with Nordic how much of the data In their chipset specification we can copy over to our module specification. .
Version 0.4	22Mar13 –RK re-write thoroughly. When reviewed, need to clear it with Nordic how much of the data In their chipset specification we can copy over to our module specification.
Version 0.5	Modify TCB Review Feedback

## CONTENTS

Revision History .....	2
Contents .....	3
1 Overview and Key Features.....	4
2 Specification summary .....	5
3 Hardware Specifications .....	7
4 Power Consumption .....	11
5 Functional Description .....	15
5.1 Power management (includes brown-out and power on reset) .....	15
5.2 Clocks .....	15
5.3 Memory for <i>smart</i> BASIC application code .....	16
5.4 RF .....	16
5.5 UART Interface .....	16
5.6 SPI Bus .....	17
5.7 I2C Interface .....	17
5.8 General Purpose I/O and ADC .....	18
6 HW integration guide .....	20
6.1 Circuit Components Required on Host PCB .....	20
6.2 BL600-Sx General PCB Layout on Host PCB .....	20
6.3 BL600-SA Layout on Host PCB .....	20
6.4 BL600-ST Layout on Host PCB .....	21
7 Tools For development of applications .....	22
8 Application Note for Surface Mount Modules .....	23
8.1 Introduction .....	23
8.2 Shipping .....	23
8.3 Reflow Parameters .....	24
9 FCC and IC Regulatory Statments .....	25
10 Japan (MIC) Regulatory .....	29
11 CE Regulatory .....	29
12 EU DECLARATIONS OF CONFORMITY .....	30
13 Mechanical Details .....	32
14 ORDERING INFORMATION .....	33
15 Bluetooth SIG Approvals .....	34
15.1 End Product Listings (EPLs) .....	34

## 1 OVERVIEW AND KEY FEATURES

Every BL600 Series module is designed to enable OEMs to add single-mode Bluetooth Low Energy (BLE) to small, portable, power –conscious devices. The BL600 modules are enabled with Laird’s *smartBASIC*, an event-driven programming language that enables OEMs to make their BLE product development quicker, and simpler, significantly reducing time to market. *SmartBASIC* enables customers to develop a complete embedded application inside the compact BL600 hardware, connecting to a wide array of external sensors via its I2C, SPI, UART, ADC or GPIO interfaces.

Based on the world-leading Nordic Semiconductor nRF51822 chipset, the BL600 modules provide ultra-low power consumption with outstanding wireless range via 4dBm of transmit power. A broad range of BLE profiles including Temperature and Heart Rate are available and *smartBASIC* provides the ideal mechanism to support any BLE profile development of your choice.

### Features & Benefits



- Bluetooth v4.0 - Single Mode
- External or Internal Antennas
- *smartBASIC* programming language
- Full Bluetooth EPL
- Compact Footprint
- Class 2 output - 4dBm
- UART, GPIO, ADC, I2C and SPI interfaces
- Fast Time to Market
- FCC, CE, IC certified and other regulatory certifications on request
- No external components needed

### Application Areas

- Medical devices
- Wellness devices
- iOS ‘accessories’
- Fitness sensors
- Location Awareness
- Home automation
-

## 2 SPECIFICATION SUMMARY

### 2.1 Specification summary

Table 1: Detailed specifications

Categories	Feature	Implementation
Wireless Specification	Bluetooth®	V4.0 – Single Mode Slave (in base FW v1.1.50.0)
	Frequency	2.402 - 2.480 GHz
	Max Transmit Power	4dBm into integrated antenna 4dBm into IPEX antenna connector
	Min Transmit Power	-20dBm (in 4dB steps with <i>smartBASIC</i> command)
	TX Whisper Mode1 Transmit Power	-30dBm (min) with <i>smartBASIC</i> command
	TX Whisper Mode2 Transmit Power	-55dBm (min) with <i>smartBASIC</i> command
	Receive Sensitivity	Better than -91 dBm (typical)
	Link Budget	95 dB (@ 1 Mbps)
	Range	Up to 150 m in free space
	TX Whisper Modes	Range reduction (NFC like) feature with TX Whisper Modes with <i>smartBASIC</i> command
	Raw Data Rates	Up to 1Mbps (over the air)
Host Interface	TOTAL	28 x Multifunction I/O lines
	UART	TX, RX, CTS, RTS DCD, RI, DTR, DSR, CTS, RTS (Note1) Default 9600, n,8, 1 From 1,200 to 115,200bps
	GPIO	Up to 28 lines
	ADC	6 lines Up to 10 bit resolution
	I2C	2 lines
	SPI	3 lines (Note 2)
Profiles	Services supported (base FW v1.1.50.0)	Heart Rate Service Health Thermometer Service Battery Alert Service Blood Pressure Service Device Information Service Immediate Alert Service IOPT (Interoperability) Link Loss Service

Categories	Feature	Implementation	
		Transmit Power Service	
<b>Control Protocols</b>	Any	User defined via <i>smartBASIC</i>	
	Firmware Upgrade	Base Firmware Upgrade via JTAG interface on DVK-BL600. In Future FW, through UART	
	<i>smartBASIC</i> App Code upgrade	Via UART	
Supply Voltage	Supply	2.1 – 3.6 V – internal DCDC converter 1.8 – 3.6 V – internal LDO	
<b>Power Consumption</b>	Active Modes (Tx pwr 4dBm)	Advertising	TBD mA peak TBD uA Avg
		Connected Mode	TBD mA peak TBD uA Avg
	Ultra Low Power Modes	Standby Doze ( ) Deep Sleep (no RAM retention) (*1),current silicon 1uA.	3.5 uA 400 nA(*1)
<b>Antenna Options</b>	Internal	Multilayer ceramic – BL600-SA	
	External	Connection via IPEX MH4 – BL6000-SC Trace Pads – BL600-ST	
<b>Physical</b>	Dimensions	19 mm x 12.5 mm x 3 mm	
	Weight	<1 gram	
<b>Environmental</b>	Operating	-25 °C to +75 °C	
	Storage	-40 °C to +85 °C	
<b>Miscellaneous</b>	Lead Free	Lead-free and RoHS compliant	
	Warranty	1 Year	
<b>Development Tools</b>	Development Kit	Development Kit DVK-BL600-Sx and Free Software Tools	
<b>Approvals</b>	Bluetooth®	End Product Listing (EPL)	
	FCC / IC / CE / MIC	All BL600 Series	

**Note1:** DSR, DTR, RI, and DCD can be implemented in *smartBASIC*.

**Note 2:** SPI CS is controlled from *smartBASIC* application allowing multi-dropping.

### 3 HARDWARE SPECIFICATIONS

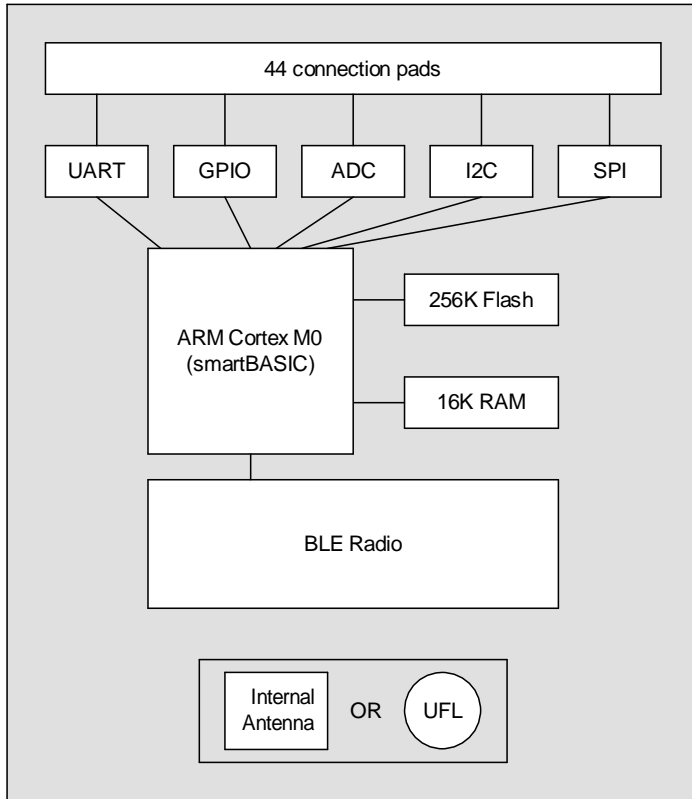


Figure 3: Functional Block Diagram

#### 3.1 SW Block diagram

TBD

#### 3.2 3.1 Pin Definitions

Table 2: Pin definitions

Pin No	Pin Designation	Default Function	Alternate Function	Default Direction	Notes	Comment
1	GND					
2	SIO_1	DIO	AIN	IN	1,2,3,4,5	8,9,10 bit resolution, Voltage scaling
3	GND					
4	SIO_2	DIO	AIN	IN	1,2,3,4,5	8,9,10 bit resolution, Voltage scaling
5	SIO_3	DIO	AIN	IN	1,2,3,4,5	8,9,10 bit resolution, Voltage scaling
6	SIO_4	DIO	AIN	IN	1,2,3,4,5	8,9,10 bit resolution, Voltage

**BL600-Sx**

## Single Mode BLE Module

Pin No	Pin Designation	Default Function	Alternate Function	Default Direction	Notes	Comment
						scaling
7	SIO_5	DIO	AIN	IN	1,2,3,4,5	8,9,10 bit resolution, Voltage scaling
8	SIO_6	DIO	AIN	IN	1,2,3,4,5	8,9,10 bit resolution, Voltage scaling
9	SIO_7	DIO		IN	1,2	
10	VCC					
11	GND					
12	SIO_8	DIO	I2C SDA	IN	1,2,4,5,6	I2COPEN() in smartBASIC selects I2C function
13	SIO_9	DIO	I2C SCL	IN	1,2,4,5,6	
14	SIO_10	DIO	SPI MOSI	IN	1,2,4,5,6	SPIOPEN() in smartBASIC selects SPI function, MOSI and CLK will be outputs
15	SIO_11	DIO	SPI MISO	IN	1,2,4,5,6	
16	SIO_12	DIO	SPI CLK	IN	1,2,4,5,6	when in SPI master mode
17	GND					
18	SIO_13	DIO		IN	1,2	
19	SIO_14	DIO		IN	1,2	
20	SIO_15	DIO		IN	1,2	Laird Devkit : Buzzer output
21	SIO_16	DIO		IN	1,2	Laird Devkit : Button 0 input
22	nRESET			IN		System Reset (Active low)
23	NC					DO NOT CONNECT
24	SIO_17	DIO		IN	1,2	Laird Devkit : Button 1 input
25	SIO_18	DIO		IN	1,2	Laird Devkit : LED 0
26	SIO_19	DIO		IN	1,2	Laird Devkit : LED 1
27	SIO_20	NC				Reserved for future use
28	GND					
29	GND					
30	RF_ANT					
31	GND					
32	SIO_21	UART TX	DIO	OUT	1,2,4,6,7	UARTCLOSE() selects DIO functionality and
33	SIO_22	UART RX	DIO	IN	1,2,4,6,7	UARTOPEN() selects uart
34	SIO_23	UART RTS	DIO	OUT	1,2,4,6,7	comms behaviour
35	SIO_24	UART CTS	DIO	IN	1,2,4,6,7	
36	SIO_25	DIO		IN	1,2	Laird Devkit : UART_DTR via CON12
37	GND					
38	SIO_26	NC				Reserved for future use. Do NOT connect
39	SIO_27	NC				
40	SIO_28	nAutoRUN		IN	In ONLY	Laird Devkit: UART_DSR via CON12



## BL600-Sx

### Single Mode BLE Module

Pin No	Pin Designation	Default Function	Alternate Function	Default Direction	Notes	Comment
41	SIO_29	DIO		IN	1,2	Laird Devkit : UART_DCD via CON12
42	SIO_30	DIO		IN	1,2	Laird Devkit : UART_RI via CON12
43	GND					
44	SIO_0	DIO		IN	1,2	

- Notes:**
1. Secondary function is selectable in *smartBASIC* BASIC application
  2. DIO = Digital Input or Output
  3. AIN = Analog Input
  4. DIO or AIN functionality is selected using the `GpioSetFunc()` function in *smartBASIC*
  5. AIN configuration selected using `GpioSetFunc()` function
  6. I2C, UART, SPI controlled by `xxxOPEN()` functions in *smartBASIC*
  7. SIO\_21 to SIO\_24 are DIO by default when \$autorun\$ app runs on power up.

SIO lines can be configured through *smartBASIC* to be either inputs or outputs with weak or strong pull-ups or pull-downs.

At reset, all SIO lines are configured as the defaults shown above. In other words, BL600 module shipped from production the loaded base FW, all the SIO pins (with "default function" of "DIO" are inputs).

UART\_RX, UART\_TX, UART\_CTS are all 3.3 v level logic. For example, when RX and TX are idle they will be sitting at 3.3V. Conversely for handshaking pins CTS and RTS at 0v is treated as an assertion.

Pin 40 (nAutoRUN) is an input, with active low logic. In the development kit (DVK-BL600-sx) it is connected so that the state is driven by the host's DTR output line.

## 3.3 Electrical Specifications

### 3.3.1 Absolute Maximum ratings

Absolute maximum ratings for supply voltage and voltages on digital and analogue pins of the Module are listed below; exceeding these values will cause permanent damage.

Parameter	Min	Max	Unit
Voltage at VCC pin	-0.3	+3.6	V
Voltage at GND pin		0	V
Voltage at SIO pin	-0.3	VCC+0.3	V
Storage temperature	-40	+85	°C

### 3.3.2 Recommended Operating Parameters

#### 3.3.2.1 Power Supply

Parameter	Min	Typ	Max	Unit
VCC	1.8	3	3.6	V
VCC (with internal DCDC enabled)	2.1	3	3.6	V
VCC rise time (0 to 1.8V) Note1			60	mS
Operating Temperature Range	-25	25	+75	°C

**Note:** The on-chip power-on reset circuitry may not work properly for rise times outside the noted interval.

#### 3.3.2.2 Signal Levels for Interface, SIO

Parameter	Min	Typ	Max	Unit
VIH Input high voltage	0.7VCC		VCC	V
VIL Input low voltage	VSS		3.6	V
VOH Output high voltage (std. drive, 0.5mA) (high-drive, 5mA)	VCC-0.3		VCC	V
Note2	VCC-0.3		VCC	V
VOL Output low voltage (std. drive, 0.5mA) (high-drive, 5mA)	VSS		0.3	V
	VSS		0.3	V

**Note:** Maximum number of pins with 5mA high drive is 3.

#### 3.3.2.3 ADC specification

Parameter	Min	Typ	Max	Unit
ADC Internal reference voltage	-1.5%	1.2V	+1.5%	%
ADC pin input internal selectable scaling		1/1 1/3 2/3		scaling
ADC input pin voltage maximum (w.r.t scaling)	Checking with	NORDIC	1.2 VCC/3 VCC(2/3)	V
1/1				
1/3				
2/3				
Time required to convert single sample in 10bit mode (see note)		68		Us
Time required to convert single sample in 9bit mode		36		us
Time required to convert single sample in 8bit mode		20		us

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**Note:** Current production FW (v1.1.50.0) allows only 10bit mode.

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## 4 POWER CONSUMPTION

### 4.1 Power Consumption

Parameter	Min	Typ	Max	Unit
<b>Active mode</b> (Advertising or Connection)				
TX only run peak current @TXpwr= +4dBm		16		mA
TX only run peak current @TXpwr= 0dBm		10.5		mA
TX only run peak current @TXpwr= -4dBm		8		mA
TX only run peak current @TXpwr= -8dBm		7		mA
TX only run peak current @TXpwr= -12dBm		6.5		mA
TX only run peak current @TXpwr= -16dBm		6		mA
TX only run peak current @TXpwr= -20dBm		5.5		mA
<b>TX Whisper mode 1</b>				
TX only run peak current @TXpwr= -30dBm		5.5		mA
<b>TX Whisper mode 2</b>				
TX only run peak current @TXpwr= -55dBm		Need to measure		
<b>Active Mode</b>				
RX only current		13		mA
<b>Ultra Low Power Mode1 (note1)</b>				
Standby Doze		3.5		uA
Standby Doze (UART on)		<b>1.33mA to be measured again</b>		
<b>Ultra Low Power Mode2 Note2</b>				
Deep Sleep (no RAM retention)		400		nA
Deep Sleep (8kB RAM retention)		600		nA
Deep Sleep (16kB RAM retention)		800		nA

**Note 1:** In Standby Doze, all functional blocks independently are in IDLE or RUN mode depending on needed functionality. All peripherals that are enabled stay on and may wake the chip again. Depending on active peripherals, current consumption will be from ~2-3  $\mu$ A up to > 1 mA. See individual peripherals current consumption in Table xx on page.

**Note 2:** In Deep Sleep everything is disabled and the only wake-up sources are reset and change on pins on which sense is enabled. The current consumption is ~1000nA to 1200nA (in current Nordic silicon). Current base FW ((v1.1.50.0) allows coming out of

## BL600-Sx

### Single Mode BLE Module

deep sleep through HW reset only. Future FW release will allow coming out from Deep Sleep to Standby Doze through GPIO signal or HW reset.

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## 4.2 Measured waveforms

TBD

Figure xx Typical current consumption profile *during advertising* in slave mode @ Tx pwr +4dBm

Figure X: Typical current consumption profile *during advertising* in slave mode @ Tx pwr -30dBm (TX Whisper Mode1)

Figure X: Typical current consumption profile *during advertising* in slave mode @ Tx pwr -55dBm (TX Whisper Mode2)

Measured waveform

Figure X: Typical current consumption profile *during data connection* in slave mode @ Tx pwr +4dBm (TX Whisper Mode1)

Figure X: Typical current consumption profile *during data connection* in slave mode @ Tx pwr -30dBm (TX Whisper Mode1)

Figure X: Typical current consumption profile *during data connection* in slave mode @ Tx pwr -55dBm (TX Whisper Mode1)

## 4.3 Peripheral block current consumption

The values below are calculated for a typical operating voltage of 3 V.

Table 3: UART Power Consumption

Parameter	Min	Typ	Max	Unit
UART Run current @ 115200 bps		220		uA
UART Run current @ 1200 bps		210		uA
UART Baud rate	1.2		115.2	kbps

Table 4: SPI Power Consumption

Parameter	Min	Typ	Max	Unit
SPI Master Run current @ 125 kbps		180		uA
SPI Master Run current @ 8 Mbps		220		uA
SPI bit rate	0.125		8	Mbps

Table 5: I2C Power Consumption

Parameter	Min	Typ	Max	Unit
I2C Run current @ 100 kbps		380		uA
I2C Run current @ 400 bps		400		uA
I2C Bit rate	100		400	kbps

**Table 6: ADC**

Parameter	Min	Typ	Max	Unit
ADC current during conversion		290		uA

The above current consumption is for the particular peripheral only and to operate that peripheral requires the 16MHz crystal oscillator (clock tree) and internal low voltage LDO which consume a fixed amount of base current (~740uA). Current Nordic silicon this fixed current is bit higher (by ~400uA).

## 5 FUNCTIONAL DESCRIPTION

The BL600 BLE module is a self-contained Bluetooth Low Energy product and requires only power and a user's *smartBASIC* application to implement full BLE functionality. The integrated, high performance antenna combined with the RF and Base-band circuitry provides the Bluetooth wireless link, and any of the SIO lines provide the OEM's chosen interface connection to the sensors. The user's *smartBASIC* application binds the sensors to the BLE wireless functionality.

The variety of hardware interfaces and the *smartBASIC* programming language allow the BL600 module to serve a wide range of wireless applications, whilst reducing overall time to market and the learning curve for developing BLE products.

To provide the widest scope for integration a variety of physical host interfaces / sensors are provided. The major BL600 series module functional blocks described below.

### 5.1 Power management (includes brown-out and power on reset)

Power management features:

- System Standby Doze / Deep Sleep modes,
- Brownout Reset,
- Open /Close Peripherals (UART, SPI, I2C, SIO's and ADC). Peripherals consume current when Open; each peripheral can be individually closed to save power consumption.
- 2-region RAM retention in System Deep Sleep mode
- Enable DCDC on power-up if VCC is >2.1V
- *smartBASIC* command allows the VCC voltage to be read (through the internal ADC)

Features to be included in future firmware:

- Power fail comparator
- Pin wake-up system from Deep sleep

Power supply features:

- Supervisor HW to manage power on reset, brownout (and power fail)
- 1.8V to 3.6V supply range using internal LDO regulator
- 2.1 to 3.6V supply range using internal DCDC convertor
- DCDC operation automatically suspended when only the internal low current LDO is needed.

This feature is useful for applications using battery technologies with higher nominal cell voltages. The reduction in supply voltage level from a high voltage to a low voltage reduces the peak power drain from the battery. Used with a 3 V coin-cell battery, the peak current drawn from the battery is reduced by approximately 30%.

### 5.2 Clocks

The high accuracy (+/-10ppm) 32.768kHz crystal oscillator provides protocol timing and helps with Radio power consumption in the System Standby Doze /Deep sleep modes.by reducing the time that the RX window needs to be open. Standard accuracy clocks tend to have lower accuracy +/-250 ppm.

## BL600-Sx

### Single Mode BLE Module

The high accuracy 16 MHz crystal oscillator helps with Radio operation and also helps reduce power consumption in the Active modes.

## 5.3 Memory for smartBASIC application code

User has approximately 5 Kbytes of data memory available for *smartBASIC* application code. Please consult Laird FAE for more information.

## 5.4 RF

- TX output power of +4dBm programmable to -20 dBm in steps of 4 dB.
  - TX Whisper mode1 -30 dBm
  - TX Whisper mode2 -55 dBm
- Receiver (with integrated channel filters) to achieve maximum sensitivity -93dBm @ 1Mbps BLE
- RF conducted interface available in 3-ways:
  - BL600-SA - RF connected to on-board antenna on BL600-SA
  - BL600-SC -RF connected to on-board IPEX MH4 RF connector on BL600-SC
  - BL600-ST -RF connected to RF pad on BL600-ST
- Antenna options
  - Integrated antenna on BL600-SA
  - External antenna connected with to IPEX MH4 RF connector on BL600-SC
  - External antenna connected to RF pads on BL600-ST

## 5.5 UART Interface

The Universal Asynchronous Receiver/Transmitter offers fast, full-duplex, asynchronous serial communication with built-in flow control support (UART\_CTS, UART\_RTS) in HW up to 1 Mbps baud. Parity checking and generation for the 9th data bit are supported.

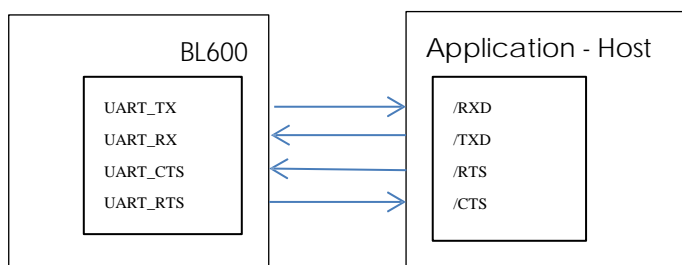
UART\_TX, UART\_RX, UART\_RTS, and UART\_CTS form a conventional asynchronous serial data port with handshaking. The interface is designed to operate correctly when connected to other UART devices such as the 16550A. The signalling levels are nominal 0 V and 3.3 V (tracks VCC) and are inverted with respect to the signalling on an RS232 cable.

Two-way hardware flow control is implemented by UART\_RTS and UART\_CTS. UART\_RTS is an output and UART\_CTS is an input. Both are active low.

These signals operate according to normal industry convention. UART\_RX, UART\_TX, UART\_CTS, UART\_RTS are all 3.3 V level logic (tracks VCC). For example, when RX and TX are idle they sit at 3.3 V. Conversely for handshaking pins CTS, RTS at 0 V is treated as an assertion.

The module communicates with the customer application using the following signals:

- Port /TXD of the application sends data to the module's UART\_RX signal line
- Port /RXD of the application receives data from the module's UART\_TX signal line





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**Note:** The BL600 serial module output is at 3.3V CMOS logic levels (tracks VCC). Level conversion must be added to interface with an RS-232 level compliant interface.

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Some serial implementations link CTS and RTS to remove the need for handshaking. Laird does not recommend linking CTS and RTS other than for testing and prototyping. If these pins are linked and the host sends data at the point that the BL600 deasserts its RTS signal, then there is significant risk that internal receive buffers will overflow, which could lead to an internal processor crash. This will drop the connection and may require a power cycle to reset the module. Laird recommends that the correct CTS/RTS handshaking protocol be adhered to for proper operation.

**Table 7: UART Interface**

Signal Name	Pin No	I/O	Comments
UART_TX	32	O	
UART_RX	33	I	
UART_RTS	34	O	
UART_CTS	35	I	

The UART interface is used to load *smartBASIC* application code.

## 5.6 SPI Bus

The SPI interface is an alternate function on SIO pins, configurable by *smartBASIC*.

The Module is a master device that uses terminals SPI\_MOSI, SPI\_MISO, and SPI\_CLK. SPI\_CSB is implemented using any spare SIO digital output pins to allow for multi-dropping.

The SPI interface enables full duplex synchronous communication between devices. It supports a 3-wire (SPI\_MOSI, SPI\_MISO, SPI\_SCK,) bidirectional bus with fast data transfers to and from multiple slaves. Individual chip select signals will be necessary for each of the slave devices attached to a bus, but control of these is left to the application through use of SIO signals. I/O data is double buffered.

The SPI peripheral supports SPI mode 0, 1, 2, and 3.

Signal Name	Pin No	I/O	Comments
SPI_MOSI	14	O	This interface is an alternate function on each pin, configurable by <i>smartBASIC</i> .
SPI_MISO	15	I	
SPI_CLK	16	O	

## 5.7 I2C Interface

The I2C interface is an alternate function on SIO pins, configurable by *smartBASIC*.

The Two-wire interface can interface a bi-directional wired-AND bus with two lines (SCL, SDA). The interface is capable of clock stretching. Data rates of 100 kbps and 400 kbps are supported.

**Table 8: I2C Interface**

Signal Name	Pin No	I/O	Comments
I2C_SDA	12	I/O	This interface is an alternate function on each pin, configurable by <i>smartBASIC</i> .
I2C_SCL	13	I/O	

## 5.8 General Purpose I/O and ADC

### 5.8.1 GPIO

The 28 SIO pins are configurable by *smartBASIC*. They can be accessed individually. Each has the following user configured features:

- Input/output direction
- Output drive strength (standard drive 0.5mA or high drive 5mA)
- Internal pull up and pull down resistors (13K typical) or no pull-up/down
- Wake-up from high or low level triggers on all pins

The following feature exists in hardware but cannot be configured in the firmware:

- All pins individually can be configured to carry quadrature demodulator signals. This feature may be for customer designing wireless mouse application.

### 5.8.2 ADC

The ADC is an alternate function on SIO pins, configurable by *smartBASIC*.

The BL600 provides access to six-channel 10-bit incremental ADC. This enables sampling up to six external signals through a front end MUX. The ADC has configurable input and reference prescaling and sample resolution (8, 9 and 10bit).

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**Note:** Current base FW (v1.1.50.0) provides access to 10-bit mode resolution only. Future FW will provide access to 8 and 9 bit resolution.

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#### 5.8.2.1 Analog Interface (ADC)

Signal Name	Pin No	I/O	Comments
AIN – Analog Input	2	I	This interface is an alternate function on each pin, configurable by <i>smartBASIC</i>
AIN – Analog Input	4	I	
			Lines are 8, 9, 10 bit resolution with voltage scaling.
AIN – Analog Input	5	I	
AIN – Analog Input	6	I	
AIN – Analog Input	7	I	

### 5.8.3 nRESET pin

Signal Name	Pin No	I/O	Comments
nRESET	22	I	BL600 HW reset (active low)

Add reset signal period after VCC power up.

### 5.8.4 nAutoRUN pin

Signal Name	Pin No	I/O	Comments
nAutoRUN (SIO)	28	I	BL600 HW reset (active low)

## BL600-Sx

Single Mode BLE Module

### 5.8.4.1 Miscellaneous (hidden JTAG)

The BL600 FW consists of 2 pieces:

- BL600 base FW (loaded at production, may be upgraded)
- BL600 *smart*BASIC programming (loaded through UART by customer)

To allow customer the capability to upgrade the BL600 base FW, then in current FW (v1.1.49.15) only allows this via the hidden 2-wire (JTAG) interface.

Signal Name (hidden name)	Pin No	I/O	Comments
nRESET (SWDIO)	22	I/O	
NC (SWDCLK)	23	I	Connect 12 K resistor to GND (for current silicon only???)

Laird can supply JTAG programmer for this. Only requirement is that the customer should use the following JTAG connector on the customers host PCB.

The JTAG connector MPN is as follows:

Reference	Part	Description
JP1 note1	FTSH-105	Header, 1.27mm, SMD, 10-way, FTSH-105-01-L-DV Samtech

**Note 1:** Reference on BL600 development board SCH.

Please refer to the BL600 development board schematic for wiring between BL600 and JTAG connector.

**Note:** Future releases of BL600 base FW (Q3 2013) will support upgrading the BL600 firmware over UART.

### 5.8.5 BL600-SA On-board Antenna characteristics

The BL600-SA on-board chip antenna radiation performance depends on the host PCB layout. Please refer to suggested BL600-SA placement (from the BL600 development board) to allow the on-board antenna to radiate and reduce proximity effects due to nearby host PCB GND copper. Antenna characteristics are those achieved by the BL600-SA placed on the BL600 development board.

## 6 HW INTEGRATION GUIDE

### 6.1 Circuit Components Required on Host PCB

The BL600-series module is easy to integrate requiring no external components on the customer's board.

---

**Note:** In BL600 modules shipped from production with base firmware, all SIO pins (with "default function" of "DIO") are inputs. Remember to change the direction SIO pin (using *smart BASIC*) if that particular pin is wired to a device that expects to be driven by the BL600 SIO pin configured as an output.

---

### 6.2 BL600-Sx General PCB Layout on Host PCB

- Ensure silk screen under module location (refer to land pattern of BL600 development board)
- Use solid GND plane on inner layer (for best EMC and RF performance).
- Place GND vias close to module GND pads as possible.
- Route traces to avoid noise being picked up on VCC supply and SIO (digital) and AIN (analogue) traces.
- Unused PCB area on surface layer can flood with copper but place GND vias regularly to connect copper flood to inner GND plane.

### 6.3 BL600-SA Layout on Host PCB

The BL600-SA has an integrated chip antenna. It is critical to find the best placement of the BL600-SA on the host PCB to allow the antenna to radiate. The following are a few helpful guidelines:

- Ensure there is no copper in the antenna keep-out area on any layers of the host PCB. Keep all mounting hardware and metal clear of the area to allow proper antenna radiation.
- For best antenna performance, place the module on the edge of the host PCB, preferably in the corner with the antenna facing the corner.
- The antenna keep-out area is defined by the BL600 development board which was used for module development and antenna performance evaluation. Keep-out area is shown in [Figure 1](#).

**BL600-Sx**  
Single Mode BLE Module

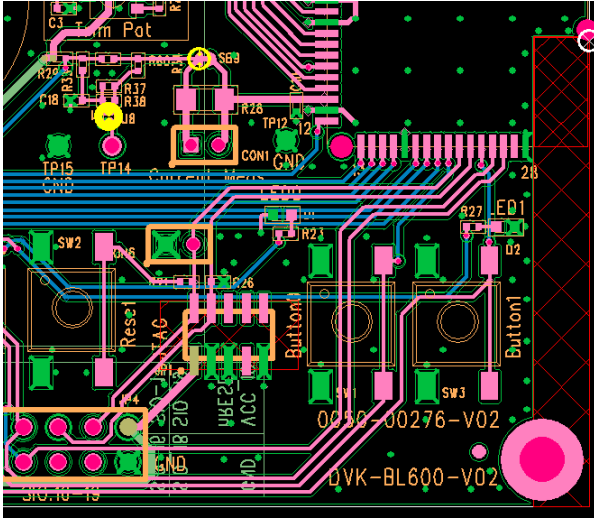


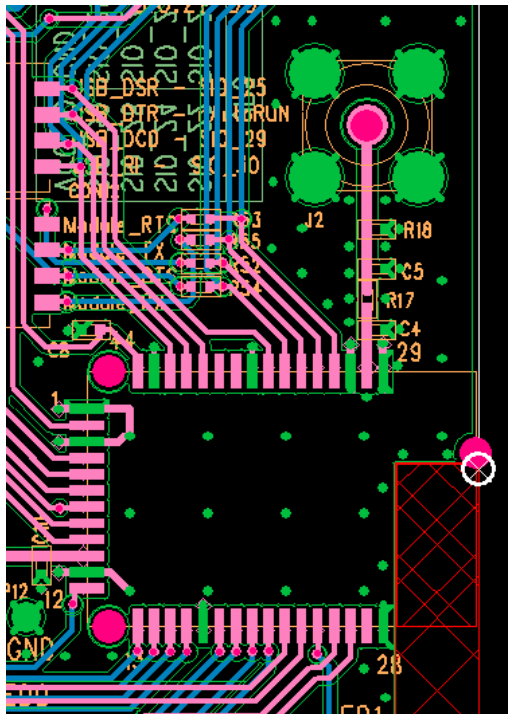
Figure 1: Antenna keep-out area in red under the BL600-SA module.

### 6.4 BL600-ST Layout on Host PCB

The below picture shows the RF trace (implemented as GCPW) from the BL600-ST module RF trace pads (GND, RF\_ANT, GND). Notice the regular spaced GND vias.

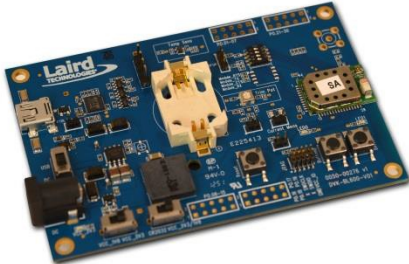
Note: For this device to meet the requirement of a limited module approval. It must be attached to DVK-BL600-ST (Brand: Laird/Model name: DVK-BL600-ST) having a maximum gain of 2.0dBi. Only this type of antenna may be used.

Integration is typically strictly restricted to Grantee himself or dedicated OEM integrators under control of the Grantee.



## 7 TOOLS FOR DEVELOPMENT OF APPLICATIONS

The *smartBASIC* programming language makes BL600 module hardware even easier to integrate. It allows easy development of a complete BLE enabled sensor application. Laird provides the below hardware and software tools.

HW	SW
1 BL600 development board	<i>smartBASIC</i>
	uWterminal

Refer to the BL600 DVK User's Manual for list of accessories provided with development board.

## 8 APPLICATION NOTE FOR SURFACE MOUNT MODULES

### 8.1 Introduction

Laird Technologies surface mount modules are designed to conform to all major manufacturing guidelines. This application note is intended to provide additional guidance beyond the information that is presented in the User Manual. This Application Note is considered a living document and will be updated as new information is presented.

The modules are designed to meet the needs of a number of commercial and industrial applications. They are easy to manufacture and conform to current automated manufacturing processes.

### 8.2 Shipping

Modules are shipped in ESD (Electrostatic Discharge) safe trays that can be loaded into most manufacturers pick and place machines. Layouts of the trays are provided in [Figure 8-1](#).

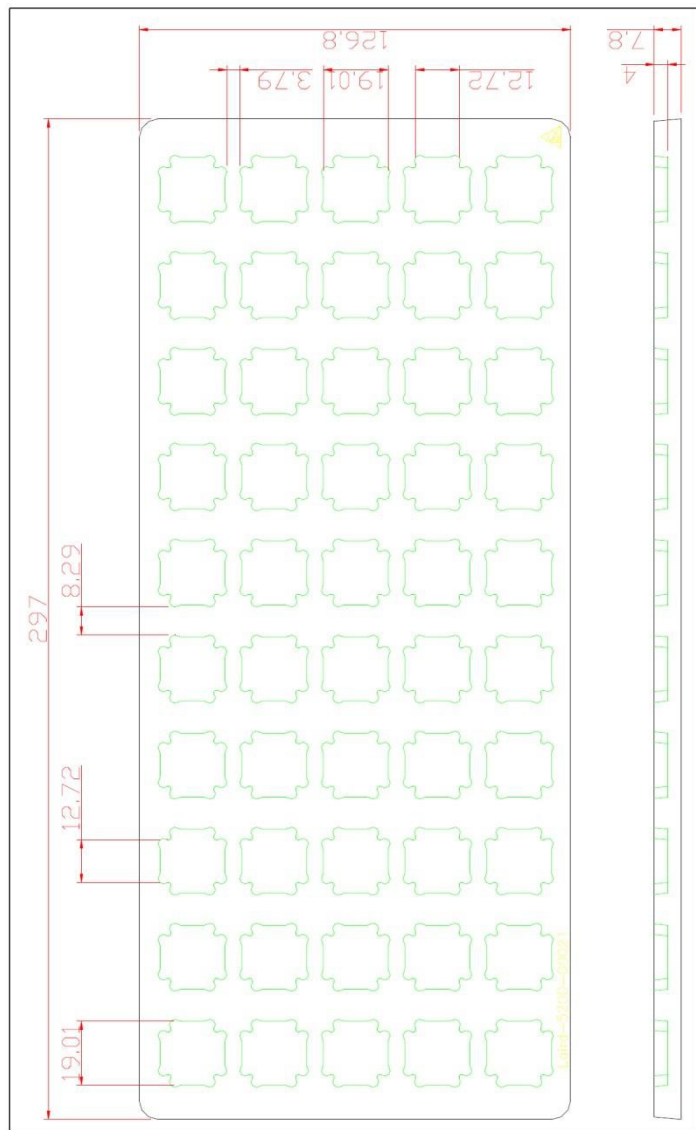


Figure 8-1: BL600 Shipping Tray Details

### 8.3 Reflow Parameters

Laird Technologies surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Laird Technologies' surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

**Important:** During reflow, modules should not be above 260° and not for more than 30 seconds.

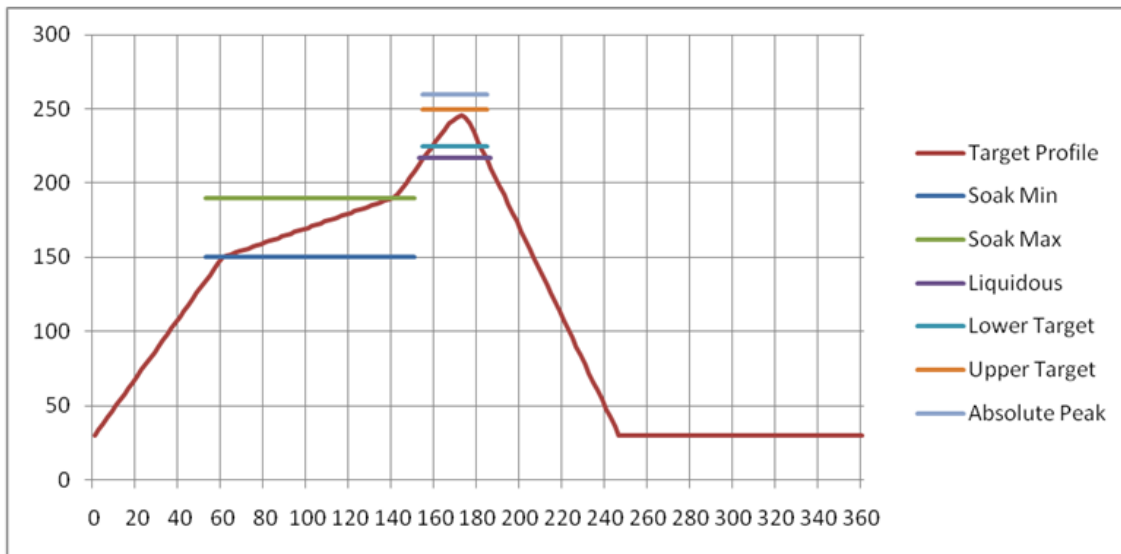


Figure 8-2: Recommended Reflow Temperature

Temperatures should not exceed the minimums or maximums presented in Table 9.

Table 9: Recommended Maximum and minimum temperatures

Specification	Value	Unit
Temperature Inc./Dec. Rate (max)	1~3	°C / Sec
Temperature Decrease rate (goal)	2-4	°C / Sec
Soak Temp Increase rate (goal)	.5 - 1	°C / Sec
Flux Soak Period (Min)	70	Sec
Flux Soak Period (Max)	120	Sec
Flux Soak Temp (Min)	150	°C
Flux Soak Temp (max)	190	°C
Time Above Liquidous (max)	70	Sec
Time Above Liquidous (min)	50	Sec
Time In Target Reflow Range (goal)	30	Sec
Time At Absolute Peak (max)	5	Sec
Liquidous Temperature (SAC305)	218	°C
Lower Target Reflow Temperature	240	°C



**BL600-Sx**  
Single Mode BLE Module

Specification	Value	Unit
Upper Target Reflow Temperature	250	°C
Absolute Peak Temperature	260	°C

## 9 FCC AND IC REGULATORY STATEMENTS

Model	US/FCC	CANADA/IC
BL600-SA	PI4BL600	1931B-BL600
BL600-SC	PI4BL600	1931B-BL600
BL600-ST	PI4BL600T	1931B-BL600T

**Important:** The BL600-ST holds a limited modular approval for the U.S and Canada markets. To ensure regulatory compliance when integrating the BL600-ST into a host device, it is necessary to follow the design implementation requirements in this manual so the BL600-ST modular certification can carry over to the host device. If these requirements cannot be met, the OEM will need to either seek a new FCC/ IC approval for their device or seek a Class 2 Permissive Change through Laird Technologies which adds the new antenna layout to the BL600-St approval. Contact Laird Technologies for further guidance.

The BL600-SA and BL600-SC hold full modular approvals. The OEM must follow the regulatory guidelines and warnings listed below to inherit the modular approval.

PART #	FORM FACTOR	TX OUTPUT	ANTENNA
BL600-SA-XX	Surface Mount	4dBm	Ceramic
BL600-SC-XX	Surface Mount	4dBm	IPEX MHF4
BL600-ST-XX	Surface Mount	4dBm	Trace Pad

\*Last two slots "XX" in Part # are used for production firmware release changes. Can be values 01-99, aa-zz

The BL600 family has been designed to operate with the antennas listed below with a maximum gain of 2.21 dBi. The required antenna impedance is 50 ohms.

Item	Part Number	Mfg.	Type	Gain (dBi)	Model
1	AT5020-E3R0HBANT/LF	ACX	Ceramic	0	BL600-SA
2	EDA-8709-2G4C1-B27-CY	MAG. Layers	Dipole	2.0	BL600-SC
3	PCA-4606-2G4C1-A33-CY	MAG. Layers	Dipole	2.21	BL600-SC
4	EDA-8709-2G4R2-A40-CY	MAG. Layers	Dipole	2.0	BL600-ST

---

**Note:** The OEM is free to choose another vendor’s antenna of like type and equal or lesser gain as an antenna appearing in the table and still maintain compliance. Reference FCC Part 15.204(c)(4) for further information on this topic.

To reduce potential radio interference to other users, the antenna type and gain should be chosen so that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication.

---

## 9.1 Power Exposure Information

### FCC RF Exposure Statement:

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transceiver must not be co-located or operating in conjunction with any other antenna, transmitter, or external amplifiers.

## 9.2 OEM Responsibilities

**WARNING:** The OEM must ensure that FCC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Laird Technology FCC identifier for this product as well as the FCC notice below.

---

**Note:** BL600-SA & BL600-SC Contains FCC ID: PI4BL600; Contains transmitter module IC: 1393-BL600

BL600-ST Contains FCC ID: PI4BL600T; Contains transmitter module IC:1931B-BL600T

The enclosed device complies with Part 15 of the FCC Rules and Industry Canada License Exempt RSS Standard(s). 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

---

Label and text information should be in a size of type large enough to be readily legible, consistent with the dimensions of the equipment and the label. However, the type size for the text is not required to be larger than eight point.

**CAUTION:** The OEM should have their device which incorporates the BL600 tested by a qualified test house to verify compliance with FCC Part 15 Subpart B limits for unintentional radiators.

**CAUTION:** Any changes or modifications not expressly approved by Laird Technology could void the user’s authority to operate the equipment.

### FCC Warning:

“THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES AND INDUSTRY CANADA LICENSE-EXEMPT RSS STANDARD(S). OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:

## BL600-Sx

### Single Mode BLE Module

(1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRE OPERATION.

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.

#### For BL600-ST:

FCC Radiation Exposure Statement:

This equipment complies with FCC /IC radiation exposure limits set forth for an uncontrolled environment and is safe for intended operation as described in this manual.

LMA approval for BL600-ST:

This device (BL-600ST) meets the requirement of a limited module approval. It must attached to below host and antenna.

Host information	Brand name : Laird , Model name : DVK-BL600-ST, with a RSMA
Antenna information	Brand name: MAG. LAYERS, Model name: EDA-8709-2G4R2-A40-CY
Antenna connector	RSMA

Integration is typically strictly restricted to Grantee himself or dedicated OEM integrators under control of the Grantee.

#### IMPORTANT NOTE:

Federal Communication Commission (FCC) Radiation Exposure Statement  
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This module is intended for OEM integrator. The OEM integrator is still responsible for the FCC compliance requirement of the end product, which integrates this module.

Under such configuration, the FCC radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

#### USERS MANUAL OF THE END PRODUCT:

The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users' manual: This device complies with Part 15 of 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.

#### LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " BL600-SA & BL600-SC Contains FCC ID: PI4BL600; BL600-ST Contains TX FCC ID: PI4BL600T ". If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must

## BL600-Sx

### Single Mode BLE Module

accept any interference received, including interference that may cause undesired operation.

#### Industry Canada (IC) Warning:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French equivalent is:

Le présent appareil est conforme aux CNR d'Industrie Canada applicable aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### IC Radiation Exposure Statement (BL600-SA, BL600-SC)

This EUT is compliance with SAR for general population/uncontrolled exposure limits in IC RSS-102 and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528.

Déclaration IC d'exposition aux radiations

Ce EUT est conforme avec SAR pour la population générale / limites d'exposition non contrôlée à IC RSS-102 et a été testé en conformité avec les méthodes de mesure et procédures spécifiées dans la norme IEEE 1528.

#### IC Radiation Exposure Statement (BL600-ST)

This equipment complies with IC 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 aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

#### Modular Approval

OEM integrator is still responsible for testing their end product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

#### Approbation modulaire

OEM intégrateur est toujours responsable de tester leur produit final pour les exigences de conformité supplémentaires nécessaires à ce module installé (par exemple, les émissions de périphériques numériques, les exigences de périphériques PC, etc.)

---

#### 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.

## BL600-Sx

Single Mode BLE Module

### **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: "BL600-SA & BL600-SC Contains transmitter module IC: 1931B-BL600"; "BL600-ST Contains transmitter module IC: 1931B-BL600T"

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: " BL600-SA & BL600-SC Contient des IC: 1931B -BL600"; BL600-ST Contient des IC: 1931B -BL600T"

## 10 Japan (MIC) Regulatory

The BL600 is approved for use in the Japanese market. The part numbers listed below hold WW type certification. Refer to **ARIB-STD-T66** for further guidance on OEM's responsibilities.

Model	Certificate Number	Antenna
BL600-SA	204-320049	Ceramic
BL600-SC	204-320050	IPEX MHF4
BL600-ST	204-320048	Trace Pad

### 10.1 Antenna Information

Japan does not allow use with any antennas other than those listed below. Contact a Laird Technologies representative for more information regarding adding antennas.

Item	Part Number	Mfg.	Type	Gain (dBi)	Model
1	AT5020-E3R0HBANT/LF	ACX	Ceramic	0	BL600-SA
2	EDA-8709-2G4C1-B27-CY	MAG. Layers	Dipole	2.0	BL600-SC
3	PCA-4606-2G4C1-A33-CY	MAG. Layers	Dipole	2.21	BL600-SC
4	EDA-8709-2G4R2-A40-CY	MAG. Layers	Dipole	2.0	BL600-ST

## 11 CE Regulatory

The BL600-SA / BL600-SC / BL600-ST have been tested for compliance with relevant standards for the EU market. The BL600-SC and BL600-ST modules were tested with a 2.2 dBi antenna. The OEM can operate the BL600-SC and BL600-ST modules with any other type of antenna but must ensure that the gain does not exceed 2.2 dBi to maintain the Laird Technologies approval.

The OEM should consult with a qualified test house before entering their device into an EU member country to make sure all regulatory requirements have been met for their complete device.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

## 12 EU DECLARATIONS OF CONFORMITY

### 12.1 BL600-SA / BL600-SC

Manufacturer:	Laird
Product:	BL600-SA
EU Directive:	RTTE 1995/5/EC
Conformity Assessment:	Annex IV

**Reference standards used for presumption of conformity:**

Article Number:	Requirement	Reference standard(s):
3.1a	Health and Safety	EN 60950-1:2006
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 V1.8.1 EN 301 489-17 V2.1.1 Emissions: EN55022:2006/A1:2000/A2:2006 (Class B) Immunity: EN61000-4-2:1995/A1:1998/A2:2001 EN61000-4-3:2002/A1:2002
3.2	Means of the efficient use of the radio frequency spectrum	EN 300 328 V1.7.1 (2006-10)

**Declaration:**

We, Laird, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Directive 1995/5/EC, when used for its intended purpose.

Place of Issue:	Laird Saturn House, Mercury Park Wooburn Green HP100HH, United Kingdom tel: +44 (0)1628 858 940 fax: +44 (0)1628 528 382
Date of Issue:	March 2013
Name of Authorized Person:	Andrew Dobbing, Engineering Manager
Signature:	

## 12.2 BL600-ST

Manufacturer:	Laird
Product:	BL600-ST
EU Directive:	RTTE 1995/5/EC
Conformity Assessment:	Annex IV

### Reference standards used for presumption of conformity:

Article Number:	Requirement	Reference standard(s):
3.1a	Health and Safety	EN 60950-1:2006
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 V1.8.1 EN 301 489-17 V2.1.1 Emissions: EN55022:2006/A1:2000/A2:2006(Class B) Immunity: EN61000-4-2:1995/A1:1998/A2:2001 EN61000-4-3:2002/A1:2002
3.2	Means of the efficient use of the radio frequency spectrum	EN 300 328 V1.7.1 (2006-10)

### Declaration:

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Place of Issue:	Laird Saturn House, Mercury Park Wooburn Green HP100HH, United Kingdom tel: +44 (0)1628 858 940 fax: +44 (0)1628 528 382
Date of Issue:	March 2013
Name of Authorized Person:	Andrew Dobbing, Engineering Manager
Signature:	



## 13 MECHANICAL DETAILS

### 13.1 Mechanical Details

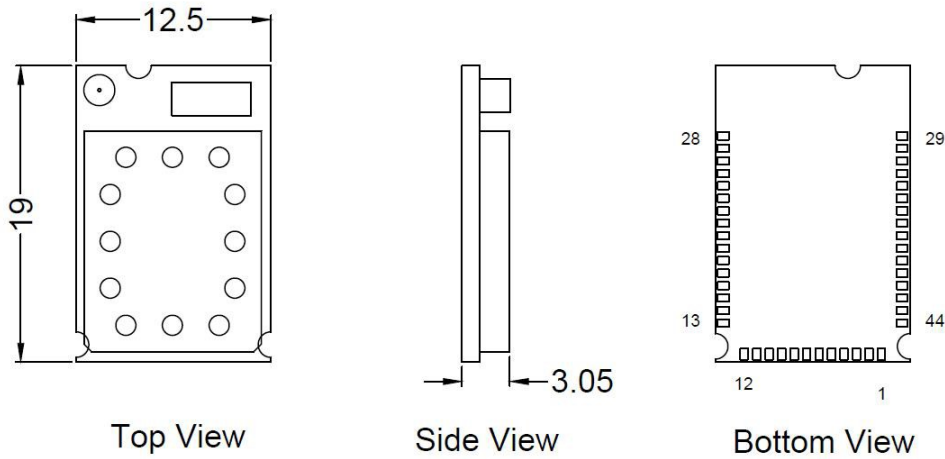
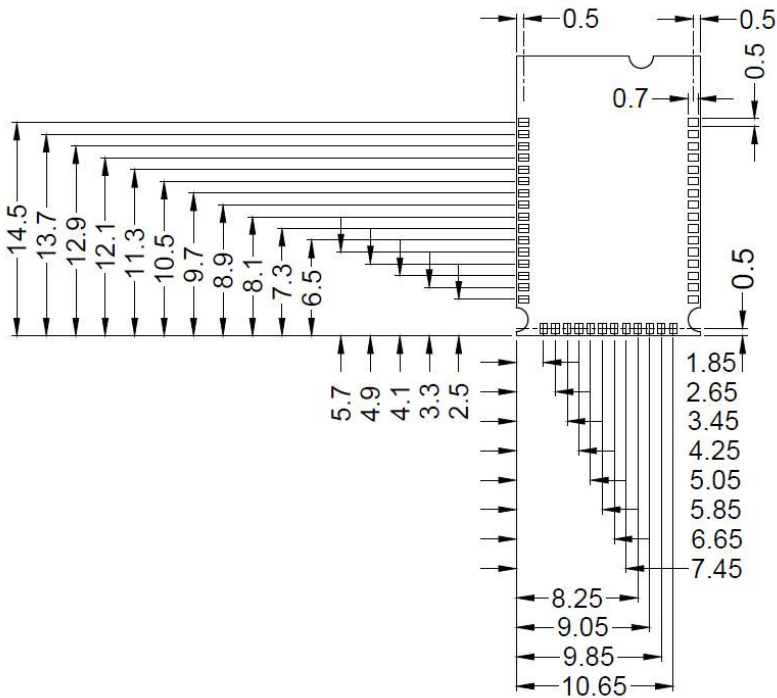


Figure 3: BL600 Mechanical drawings



**Module Keep-Out Area:** An area of 1.5mm around the module should be reserved as a keep-out area. No other components should be placed in this area.

---

## APPLICATION NOTES

1. Ensure there is no copper in the antenna keep out area on any layers of the host PCB. Also keep all mounting hardware or any metal clear of the area to prevent affecting proper antenna radiation.
  2. For best antenna performance, the module should be placed on the edge of the host PCB and preferably in the corner with the antenna facing the corner.
  3. Antenna keep out area definition comes from the module's DVK board which was used for module development and antenna performance evaluation
  4. Ensure no exposed copper under module on host PCB to avoid shorting to test points on underside of the module.
  5. The user may modify the PCB land pattern dimensions based on their experience and / or process capability.
- 

## 14 ORDERING INFORMATION

part number	DESCRIPTION
BL600-SA	Single Mode BLE Module featuring <i>smart</i> BASIC – integrated antenna
BT730-SC	Single Mode BLE Module featuring <i>smart</i> BASIC – IPEX MHF4 connector
BL600-ST	Single Mode BLE Module featuring <i>smart</i> BASIC – Trace Pad
DVK – BL600-SA	Development board with BL600-SA module soldered in place
DVK – BL600-SC	Development board with BL600-SC module soldered in place
DVK – BL600-ST	Development board with BL600-ST module soldered in place

### 14.1 General Comments

This is a preliminary datasheet. Please check with Laird for the latest information before commencing a design. If in doubt, ask.

## 15 BLUETOOTH SIG APPROVALS

### 15.1 End Product Listings (EPLs)

This section covers the procedure for generating a new EPL (End Product Listing), on the Bluetooth SIG website. In the instance of a Bluetooth End Product design, a member can create their own EPL which will have a direct reference to the original Bluetooth End Product QDID.

#### BL600 Original End Product listing

Design Name	Owner	QDID number	Link to listing on the SIG website
BL600 Module	Laird Technologies	B020700	<a href="#">BL600 Module listing</a>

The BL600 Module incorporates the following Bluetooth components from Nordic Semiconductor ASA;

Design Name	Owner	QDID number	Link to listing on the SIG website
nRF51XXX_RF	Nordic Semiconductor ASA	B020553	<a href="#">nRF51XXX_RF</a>
nRF51xxx - S110 link layer	Nordic Semiconductor ASA	B020269	<a href="#">nRF51xxx - S110 link layer listing</a>
nRF51xxx - S110 host	Nordic Semiconductor ASA	B020552	<a href="#">nRF51xxx - S110 host listing</a>

#### Assumptions

This procedure assumes that the member is using the original Bluetooth End Product design with no modifications. The original Bluetooth End Product design includes all the mandatory protocol and profiles layers. You can generate a new EPL (End Product Listing) by using the web interface on the Bluetooth SIG website. [Figure 4](#) shows the basic concept of how an EPL is referenced back to a Bluetooth End Product.



Figure 4: EPL referenced back to BT end product

## BL600-Sx

Single Mode BLE Module

The following link provides an overview of the EPL system:

<https://www.bluetooth.org/technical/qualification/eploverview.htm>

For a detailed procedure of how to make an EPL entry, please refer to the following SIG document;

[https://www.bluetooth.org/docman/handlers/DownloadDoc.ashx?doc\\_id=71880](https://www.bluetooth.org/docman/handlers/DownloadDoc.ashx?doc_id=71880)

---

**Note:** Alternatively the member can choose to have a new QDID for their own End Product Design if they do not want any reference the original QDID listing. However it should be noted that this would incur a listing fee, please refer to FAQ 214 below.

---

### Useful FAQ links

[https://www.bluetooth.org/ticketing/view\\_article.cfm?action=article\\_comment&aid=275](https://www.bluetooth.org/ticketing/view_article.cfm?action=article_comment&aid=275)

[https://www.bluetooth.org/ticketing/view\\_article.cfm?action=article\\_comment&aid=214](https://www.bluetooth.org/ticketing/view_article.cfm?action=article_comment&aid=214)

[https://www.bluetooth.org/ticketing/view\\_article.cfm?action=article\\_comment&aid=112](https://www.bluetooth.org/ticketing/view_article.cfm?action=article_comment&aid=112)

### Additional Assistance

Please contact your local sales representative for further assistance

## BL600-Sx

Single Mode BLE Module



Laird is the world leader in the design and manufacture of customized, performance-critical products for wireless and other advanced electronics applications.

Laird Technologies partners with its customers to find solutions for applications in various industries such as:

- Network Equipment
- Telecommunications
- Data Communications
- Automotive Electronics
- Computers
- Aerospace
- Military
- Medical Equipment
- Consumer Electronics

Laird offers its customers unique product solutions, dedication to research and development, as well as a seamless network of manufacturing and customer support facilities across the globe.

### global solutions: local support™

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#### LWS-UM-BL600-Sx

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