SlymBits R2 Series

SBL2100 Hardware Reference

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1. Introduction

SurreyLabs **SlymBits SBL2100** is a single-mode Bluetooth 4.0 Low Energy (BLE) module designed for rapid prototyping and DIY markets. However, because of its very low price, **SBL2100** is also suitable for integrating the latest BLE technology into consumer products.

Based on the award winning Nordic Semiconductor nRF51822 SoC, **SBL2100** combines the exceptionaly low power RF transceiver with an ARM Cortex-M0 MCU, 256KB flash memory, 16k/32kB RAM, and many powerful peripherals in a compact footprint of 13 mm x 20 mm. All these features can be accessed from the 40 standard 2.54 mm pitch I/O pins, which means you can easily integrate **SBL2100** into your applications or develop prototype on a breadboard.

2. Key Features

- Bluetooth v4.0 Low Energy (BLE) single-mode module
- Small footprint: 13 mm x 20 mm
- Ultra-low power consumption
- 32-bit ARM Cortex-M0 processor
- 256kB flash + 32/16kB RAM
- Over-the-Air (OTA) firmware update
- Customizable firmware
- Built-in standard BLE profiles and services
- Flexible and configurable GPIO pins
- 10-bit ADC
- Full set of digital interfaces including: SPI/I2C/UART
- Programmable output power from +4dBm to -20dBm
- On-chip DC/DC buck converter
- Simple ON/OFF global power modes
- Wide supply voltage range (1.8 V to 3.6 V)
- CE, FCC, IC certified

3. Applications

- Power monitoring and management applications
- Mobile phone accessories
- Computer peripherals
- CE remote controls for TV, STB and media systems
- Proximity and security alert tags
- Sports and fitness sensors
- Healthcare and lifestyle sensors
- Game controllers for computers
- Toys and Electronic games
- Industrial control and data-acquisition
- Smart RF tags for tracking and social interaction
- Micro positioning systems
- Intelligent appliances

4. Specifications

RF	
Frequency	2.4GHz ISM (2.40000 – 2.4835GHz)
Output Power	Programmable: +4 to -20dBm in 4dB steps
Antenna	Chip antenna / uFL connector
Range	50m
MCU	
Core	ARM Cortex-M0
Output Power	Programmable: +4 to -20dBm in 4dB steps
RAM	16k / 32k bytes
Flash	256k bytes (optional 4M bytes external SPI Flash)
Peripherals	
GPIO	28 GPIO pins, including 6 analog input pins
SPI	2 SPI master controllers, 1 SPI slave controller
I2C	2 I2C controllers
UART	1 UART controller

5. Block Diagram

The `sbl2100-block-diagram.pdf` file shows the major components in **SBL2100**. See the *Application Interface* section for more information about each block and the module interface.

6. Package Information

6.1. Module Mechanical Outline

Figure 1 shows the module mechanical outline of **SBL2100**, which is 20 x 13 x 2.4 mm.

6.2. Package Marking

SurreyLabs marks devices sold in order to provide device identification and manufacturing traceablility information. The method of presenting the information marked on the device is dependent on the size of the device package and the area available for marking, as well as the nature and specifications of the device.

The information presented here describes the **SBL2100** package marking a customer will observe. Figure 2 shows the package marking of **SBL2100**, and Table 1 shows the marking code (00XXXXBB) definitions.

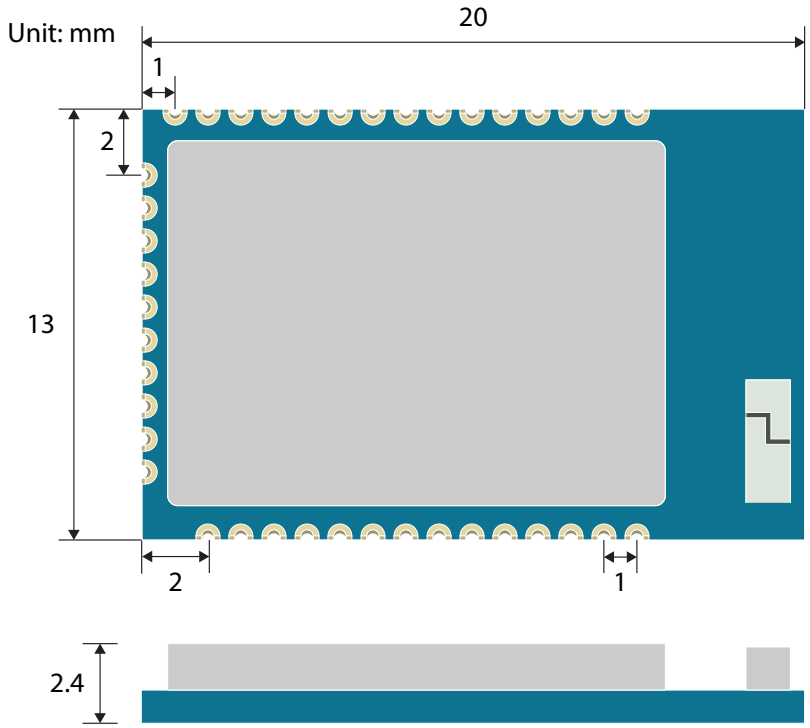

Figure 1: SBL2100 Module Mechanical Outline

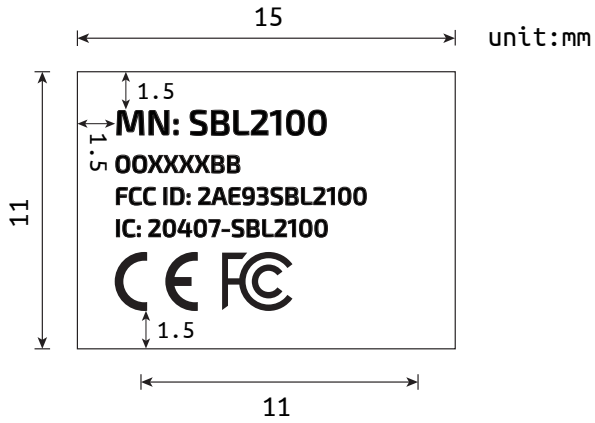

Figure 2: SBL2100 Module Package Marking

Table 1: SBL2100 Marking Code Definition

Code	Name	Description
00	Assembly plant code	The first digit is country code; the second digit is plant code.
XXXX	Date code	The first two digits are year code; the last two digits are six-week period code.
BB	Processing code	The two-digit ID is used to identify the processing method used for the batch.

6.3. Pin Description

In Table 2, you can see all the **SBL2100** pin numbers, names, functions, and descriptions. For more information on pin assignment, see the "Pin assignments and functions" section in *nRF51822 Product Specification*.

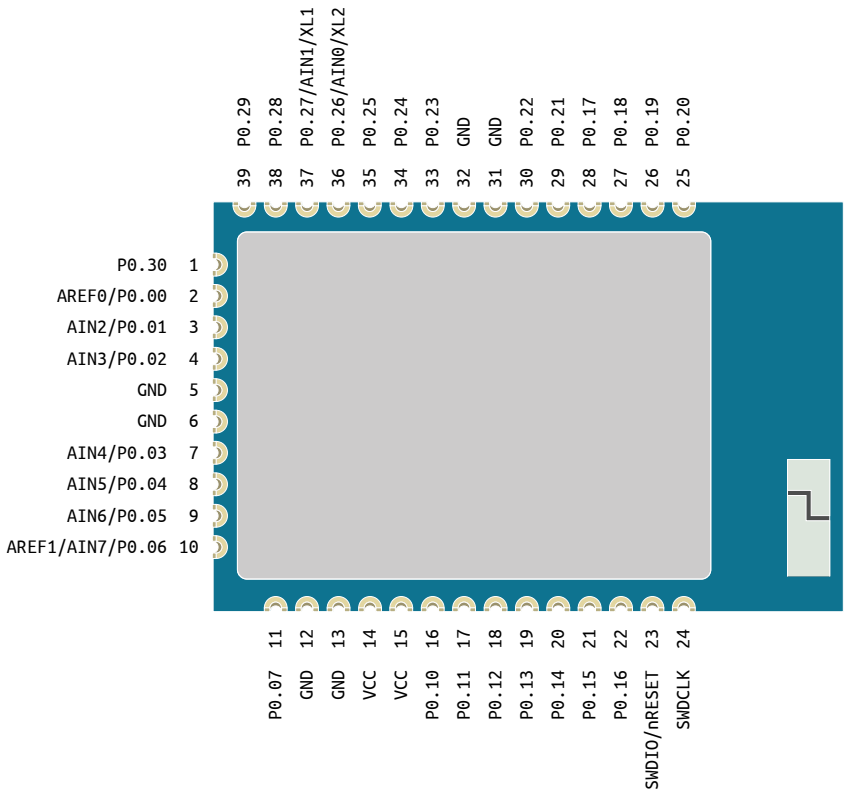

Figure 3: SBL2100 Pin Assignment

Table 2: SBL2100 Pin Definitions

Pin Number	Pin Name	Function	Description
1	P0.30	Digital I/O	General purpose I/O pin
2	P0.00 AREF0	Digital I/O Analog input	General purpose I/O pin ADC/LPCOMP reference input 0
3	P0.01 AIN2	Digital I/O Analog input	General purpose I/O pin ADC/LPCOMP input 2
4	P0.02 AIN3	Digital I/O Analog input	General purpose I/O pin ADC/LPCOMP input 3
5, 6	GND	Power	Ground
7	P0.03 AIN4	Digital I/O Analog input	General purpose I/O pin ADC/LPCOMP input 4
8	P0.04 AIN5	Digital I/O Analog input	General purpose I/O pin ADC/LPCOMP input 5
9	P0.05 AIN6	Digital I/O Analog input	General purpose I/O pin ADC/LPCOMP input 6
10	P0.06 AIN7 AREF1	Digital I/O Analog input Analog input	General purpose I/O pin ADC/LPCOMP input 6 ADC/LPCOMP reference input 1
11	P0.07	Digital I/O	General purpose I/O pin
12, 13	GND	Power	Ground
14, 15	VCC	Power	Power supply
16 to 22	P0.10 to P0.16	Digital I/O	General purpose I/O pin
23	SWDIO nRESET	Digital I/O	System reset (active low) and hardware debug and flash programming I/O
24	SWDCLK	Digital input	Hardware debug and flash programming I/O
25 to 30	P0.17 to P0.22	Digital I/O	General purpose I/O pin
31, 32	GND	Power	Ground
33	P0.23	Digital I/O	General purpose I/O pin
34	P0.24	Digital I/O	General purpose I/O pin
35	P0.25	Digital I/O	General purpose I/O pin
36	P0.26 AIN0 XL2	Digital I/O Analog input Analog output	General purpose I/O pin ADC/LPCOMP input 0 Connection for 32.768 kHz crystal
37	P0.27 AIN1 XL1	Digital I/O Analog input Analog output	General purpose I/O pin ADC/LPCOMP input 1 Connection for 32.768 kHz crystal or external 32.768 kHz clock reference
38	P0.28	Digital I/O	General purpose I/O pin
39	P0.29	Digital I/O	General purpose I/O pin

7. Application Interface

In this section, we will describe how to use the features of **SBL2100** exposed by the 39 1mm pitch pads. The first step is learning how to provide power to the module. Then you will see how to program the module through the SWD (Serial Wire Debug) interface. Finally, we will discuss how to use all kinds of interfaces.

7.1. Power Supply

SBL2100 is designed to be powered by either 3.3V DC or a 3V CR2032 coin cell battery. DC power ranging from 1.8V to 3.6V is acceptable. However, for optimal performance, the power source should be as stable as possible.

The `sbl2100-schematic-power-supply.pdf` file shows the minimalist schematic of using **SBL2100**. In this schematic, you have to program **SBL2100** through the OTA (Over-the-Air) bootloader. For more information about how to download firmware using the OTA bootloader, see *SBL2100 Getting Started Guide*.

If you power **SBL2100** by a CR2032 coin cell battery, it is recommended to place a low-leakage 10uF capacitor in parallel to the battery, so the battery could live longer. For more information about how to maximize CR2032 coin cell battery life, see the white paper, *Coin Cells and Peak Current Draw*, from Texas Instruments.

7.2. Reset

The `nRESET` pin is active low. To reset **SBL2100**, pull the `nRESET` pin low for minimum 100ms.

7.3. Serial Wire Debug Interface

The Serial Wire Debug interface (`SWDIO`, `SWDCLK`) is normally not used in products, because when you want to update firmware in the field, you will use the OTA bootloader and program the new firmware using Bluetooth Smart.

However, you may want to use the SWD interface to program firmware in the mass production process, or debug issues reported by users. In this case, you can connect 10-pin J-Link connector with `SWDIO` and `SWDCLK` like the `sbl2100-schematic-swd.pdf` file shows.

7.4. Low Frequency Clock Interface

Bluetooth Smart protocol stack needs a low frequency clock to handle the protocol timing. If we don't provide an external 32kHz crystal oscillator as the clock source, **SBL2100** will use the internal RC oscillator.

However, the internal RC oscillator is not accurate enough, so it needs to be calibrated regularly (for example, every 4000ms). When the internal RC oscillator is calibrated, the 16MHz crystal oscillator must run during the calibration process, which causes an increase in the average current consumption of about 7uA with a 4000ms interval. The internal RC oscillator also uses more current than a crystal, so that total increase will be about 10uA, compared with a 20ppm crystal.

To improve power efficiency, you can use an external 32kHz crystal and connect it to `XL1` and `XL2`. For more information about the external low frequency clock schematic, see *nRF51822 Product Specification*.

7.5. UART Interface

The UART (Universal Asynchronous Receiver/Transmitter) interface supports the following features:

- Asynchronous serial communication
- Full-duplex operation
- Built-in automatic flow control (CTS, RTS)
- High speed communication (up to 1Mbps)
- Parity checking and generation for the 9th data bit

You can use any GPIO pin for each UART interface line (TXD, RXD, CTS, RTS) and they are independently configurable. This enables great flexibility in device pinout and efficient use of board space and signal routing.

7.6. GPIO Interface

SBL2100 supports 29 GPIO pins. Each GPIO pin can be accessed individually with the following user configurable features:

- Input/output direction
- Output drive strength
- Internal pull-up and pull-down resistors
- Wake-up from high or low level triggers on all pins
- Trigger interrupt on all pins
- All pins can be used by the PPI task/event system; the maximum number of pins that can be interfaced through the PPI at the same time is limited by the number of GPIOTE channels
- All pins can be individually configured to carry serial interface or quadrature demodulator signals

7.7. I2C Interface

The I2C interface (also called TWI, Two-Wire Interface) can communicate with a bi-directional wired-AND bus with two lines (SCL, SDA). The protocol makes it possible to interconnect up to 127 individually addressable devices. The interface is capable of clock stretching, supporting data rates of 100 kbps and 400 kbps.

The GPIOs used for each I2C interface line can be chosen from any GPIO on the device and are independently configurable. This enables great flexibility in device pinout and efficient use of board space and signal routing.

SBL2100 supports two I2C masters.

7.8. SPI Interface

The SPI interfaces enable full duplex synchronous communication between devices. They support a three-wire (SCK, MISO, MOSI) bi-directional bus with fast data transfers. The SPI Master can communicate with multiple slaves using individual chip select signals for each of the slave devices attached to a bus. Control of chip select signals is left to the application through use of GPIO signals. SPI Master has double buffered I/O data. The SPI Slave includes EasyDMA for data transfer directly to and from RAM allowing Slave data transfers to occur while the CPU is IDLE.

The GPIOs used for each SPI interface line can be chosen from any GPIO on the device and are independently configurable. This enables great flexibility in device pinout and efficient use of printed circuit board space and signal routing.

SBL2100 supports two SPI masters and one SPI slave.

8. Federal Communication Commission (FCC) Regulatory Statements

SurreyLabs **SBL2100** holds full modular approvals (FCC ID: 2AE93SBL2100). The OEM must follow the regulatory guidelines and warnings listed below to inherit the modular approval.

8.1. Federal Communication Commission (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 transceiver must not be co-located or operating in conjunction with any other antenna, transmitter, or external amplifiers. Further testing / evaluation of the end product will be required if the OEM's device violates any of these requirements.

8.2. Federal Communication Commission (FCC) 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 or more 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 SurreyLabs Technology Inc. could void the user's authority to operate this equipment

FCC 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 SurreyLabs Technology Inc. FCC identifier for this product.

Contains FCC ID: 2AE93SBL2100

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 visible on outside of device:

The enclosed 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.

FCC WARNING

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

9. Industry Canada (IC) Regulatory Statements

SurreyLabs **SBL2100** holds full modular approvals (IC: 20407-SBL2100). The OEM must follow the regulatory guidelines and warnings listed below to inherit the modular approval.

9.1. Industry Canada (IC) Radiation Exposure Statement

This equipment complies with IC RSS-102 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.

IC WARNING

This device complies with Industry Canada's licence-exempt RSSs. 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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables 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.

IMPORTANT NOTE

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.).

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the IC authorization is no longer considered valid and the IC No. cannot 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 IC authorization.

The final end product must be labeled in a visible area with the following:

Contains transmitter module IC: 20407-SBL2100.

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.)

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.

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante:

Contient le module d'émission IC: 20407-SBL2100