

DKBLE
USER GUIDE

Wednesday, 02 December 2020

Version 1.1



VERSION HISTORY

Version	Comment
1.0	First published version
1.1	Renamed "Bluetooth Smart" to "Bluetooth Low Energy" according to the official Bluetooth SIG nomenclature

TABLE OF CONTENTS

1	Design Overview	5
1.1	PIO Connections in the Carriers	7
1.2	Important Notes about the Differences between the Module Carriers	7
1.2.1	Why the External Flash Chip Doesn't Work With BLE121LR Carrier?.....	9
1.2.2	Minimizing the Current Consumption	9
1.3	Sensors, display and USB to UART converter	9
2	Getting Started With DKBLE	10
2.1	Using the On-Board Debugger to Program the Carriers	10
2.2	Using the On-Board Debugger to Program External BLE Devices	11
2.3	Using the Analog Comparator of BLExxx modules	11
3	Measuring Current Consumption	12
4	Schematics and Assembly Drawing	14

1 Design Overview

BLE Development Kit, DKBLE, is targeted for engineers evaluating Bluetooth Low Energy modules BLE112, BLE113 and BLE121LR. DKBLE is platform containing various switchable peripherals for creating and testing several different applications utilizing Bluegiga Bluetooth Low Energy modules. The modules are assembled on a carriers boards and DKBLE contains a header type of interface for plugging in the module carriers. Thus each module can be tested and compared with each other on the same platform. DKBLE contains:

- On-Board debugger
- Switchable powering either from a coin cell battery or USB
- UART interface through USB to UART converter
- USB interface
- programming interface for upgrading the firmware and parameters
- Display connected to SPI
- Accelerometer connected to SPI
- Altimeter connected to I2C
- Potentiometer for ADC input
- Push buttons for 3 PIOs and reset
- All the signals available at test points
- Current measurement points for measuring peak currents of the module, DC current of the module and DC current of the whole board.

The block diagram of DKBLE is shown in the Figure 1. Please, refer to the latest data sheets for information about Bluegiga's *Bluetooth 4.0* single mode modules.

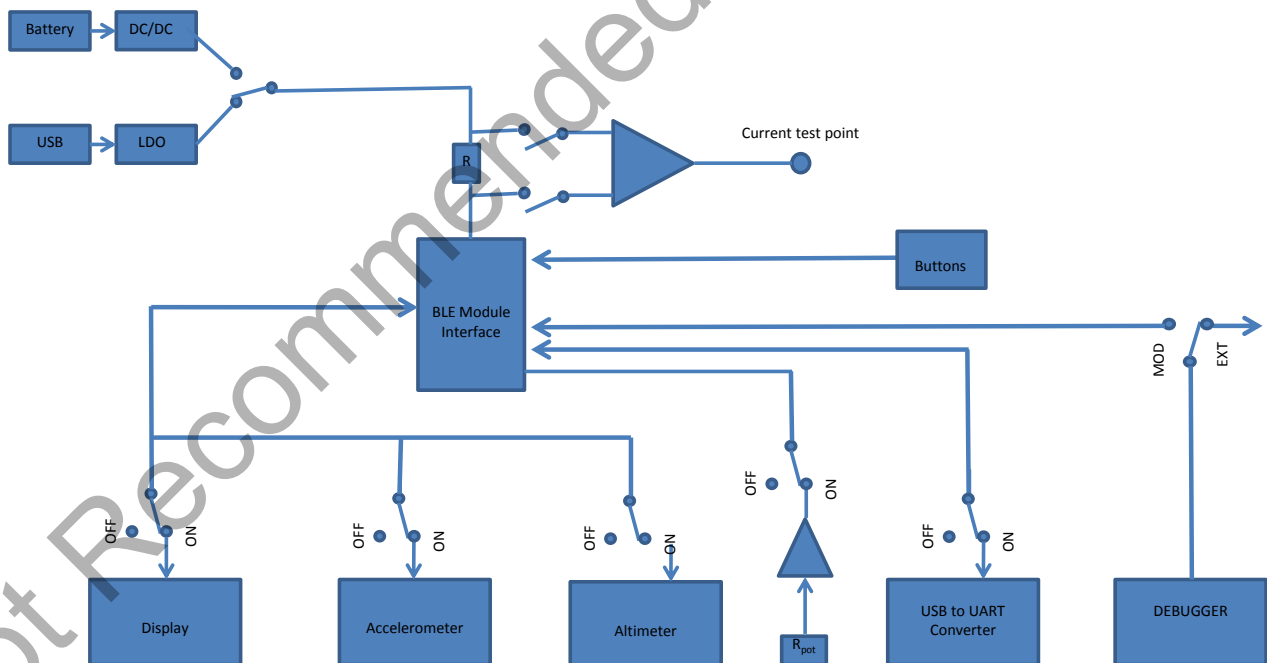


Figure 1: Block diagram of DKBLE

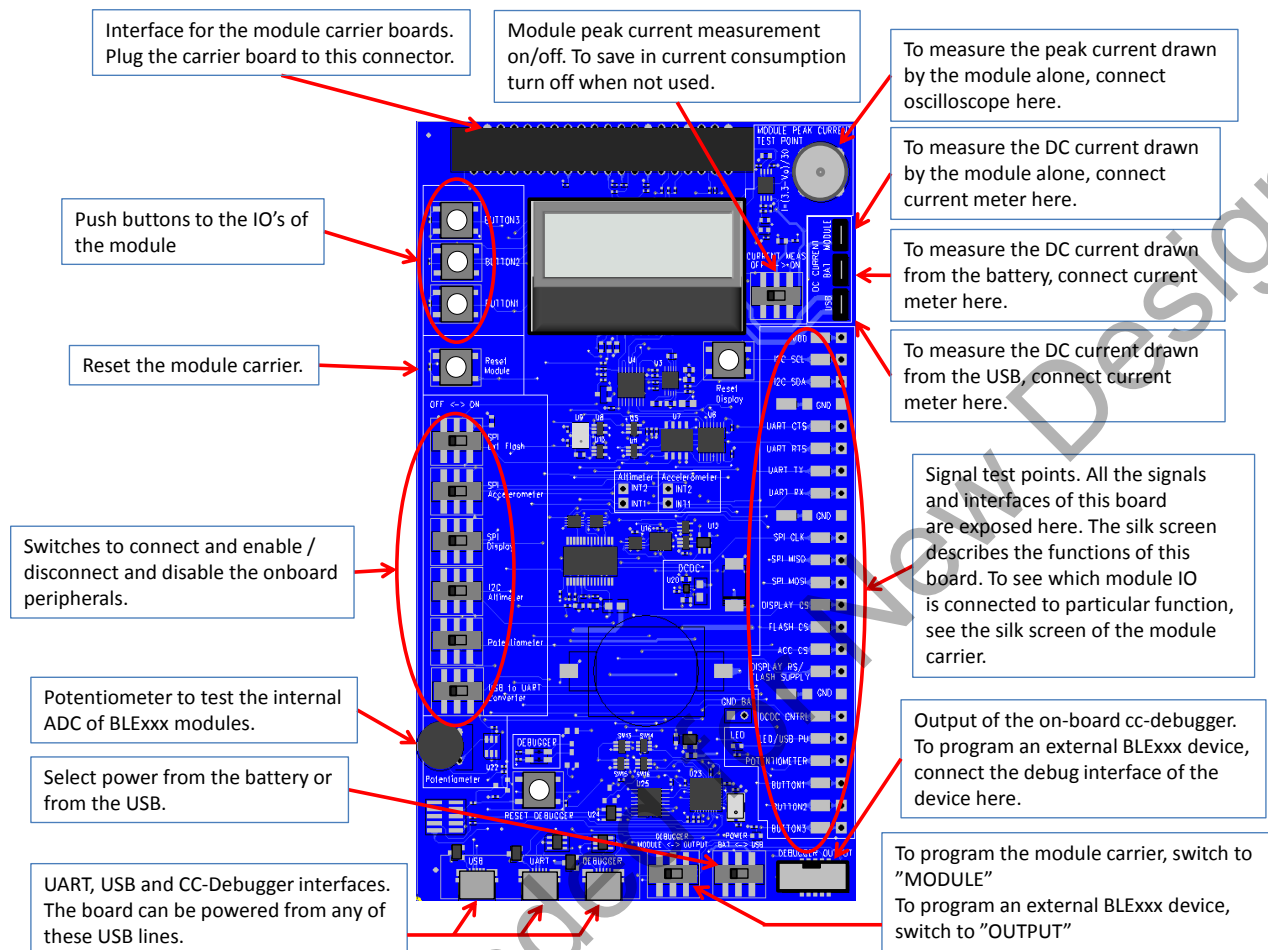


Figure 2: DKBLE interfaces

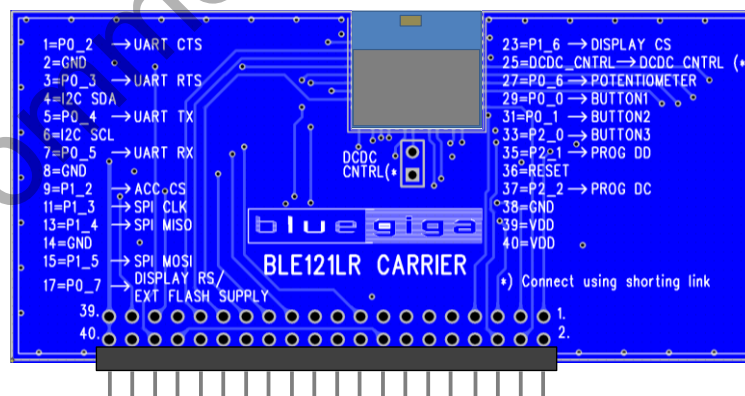


Figure 3: BLE121LR module carrier

1.1 PIO Connections in the Carriers

FUNCTION	BLE112	BLE113	BLE121LR
UART CTS		P0_2	
UART RTS		P0_3	
UART TX		P0_4	
UART RX		P0_5	
SPI CLK		P1_3	
SPI MISO		P1_4	
SPI MOSI		P1_5	
DISPLAY CS		P1_6	
FLASH CS	P0_7		- (pulled down in the carrier)
ACCELEROMETER CS		P1_2	
DISPLAY RS / FLASH SUPPLY	P1_1		P0_7
DCDC CNTRL	P1_7		DCDC_CNTRL (*)
LED / USB PU	P1_0		-
POTENTIOMETER		P0_6	
BUTTON1		P0_0	
BUTTON2		P0_1	
BUTTON3		P2_0	

*) Connect using a shorting link in the carrier

Table 1: PIO connections in the carriers

1.2 Important Notes about the Differences between the Module Carriers

In BLE121LR the PIOs P1_0 and P1_1 are reserved for the internal front end control of the module. Also P1_7 is reserved for this purpose and in case of BLE121LR it can only be used as an output controlling the external DCDC. Thus in BLE121LR P1_7 is named as DCDC CNTRL.

The important differences between the carriers are shown in the Figure 4 (BLE112 and BLE113 carriers) and Figure 5 (BLE121LR carrier).

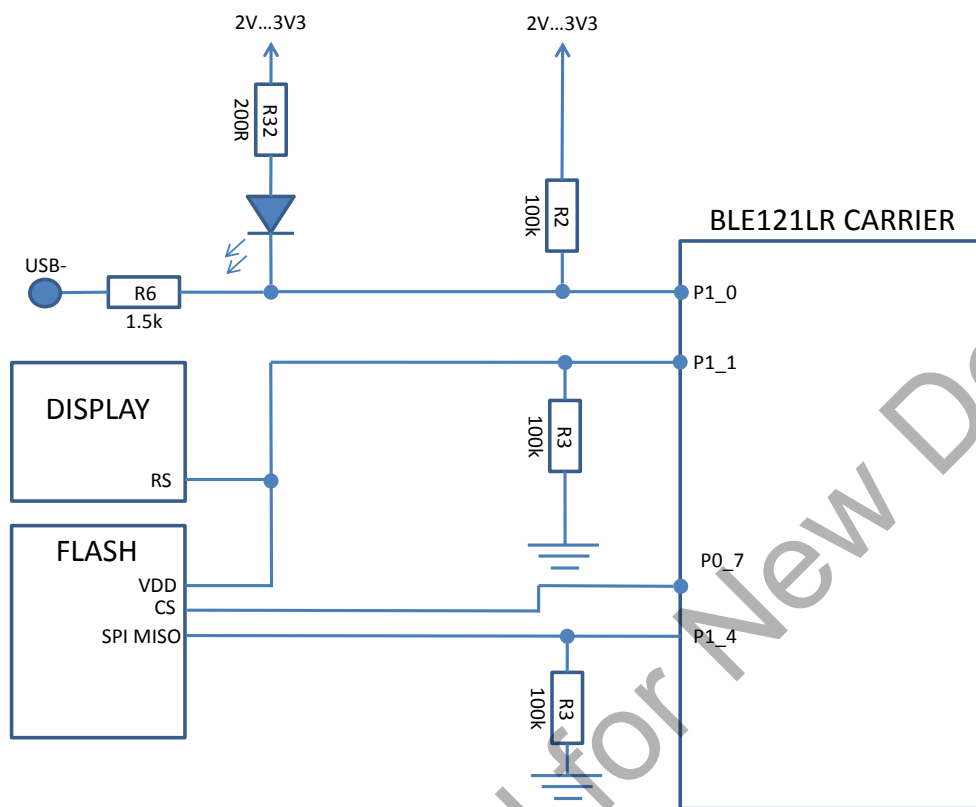


Figure 4: Connections in BLE112 and BLE113 Carriers

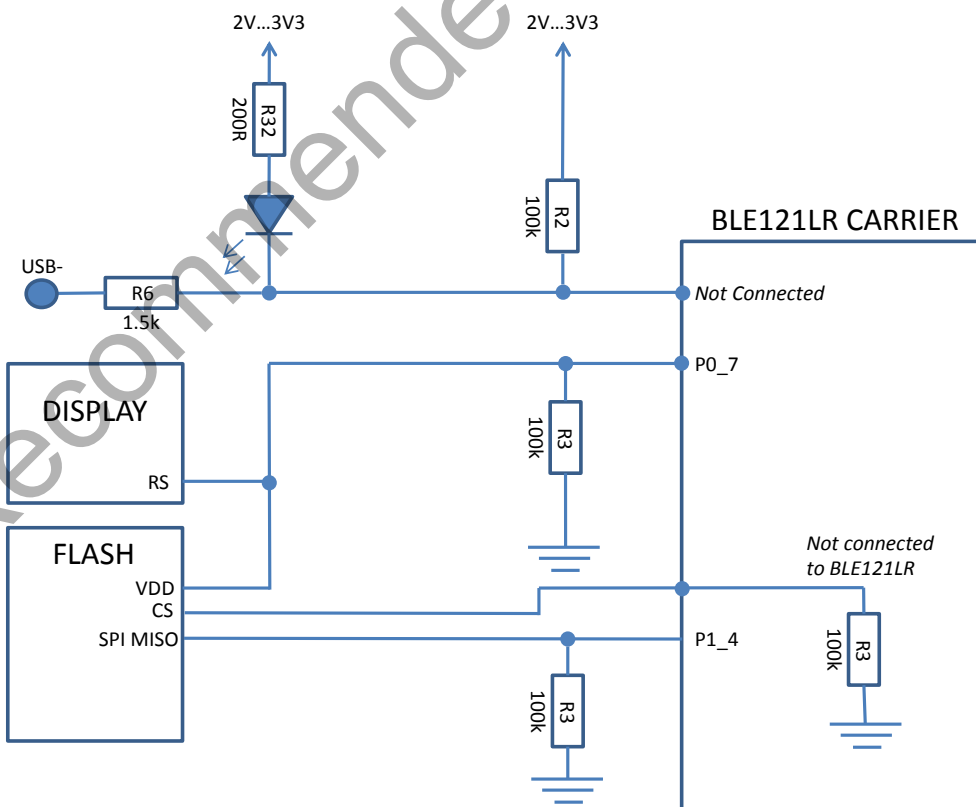


Figure 5: Connections in the BLE121LR Carrier

1.2.1 Why the External Flash Chip Doesn't Work With BLE121LR Carrier?

The external flash chip is powered with one of the IO's of the module. In BLE121LR Carrier the Flash supply is connected to an IO with 4 mA current driving capability where as in BLE112 and BLE113 Carrier it is connected to an IO with 20 mA current driving capability. Thus BLE121LR carrier is not able to power the flash and using the flash with BLE121LR carrier is not possible in DKBLE.

1.2.2 Minimizing the Current Consumption

In all Carriers pin P1_4 is externally pulled down by the pull-down resistor in DKBLE. The purpose of this resistor is to avoid leakage when using the display. Note that any PIO's configured as peripherals do not have internal pull-down or pull-up capability and thus, when left floating, they will require external pull-down resistor.

For this reason port P1 can't be configured to have internal pull-ups (the default setting of the module) but the port P1 must be pulled low in the HW configuration file.

In BLE121LR carrier also pin P0_7 is externally pulled down by the pull-down resistor in DKBLE.

For these reasons both ports P1 and P2 must be pulled low in the HW configuration file.

The PIO used for the display RS (Register Select) signal has an external pull-down resistor in DKBLE (Note that P1_0 and P1_1 require external pull-up or pull-down when configured as input).

For these reasons the PIO used for the RS signal must be driven low when the not writing to the display.

1.3 Sensors, display and USB to UART converter

Device	Manufacturer	Manufacturer Part Number
USB to UART Converter	Prolific	PL2303HX rev.D
Display	Newhaven Display Intl	NHD-C0216CZ-FSW-FBW-3V3
Altimeter	Freescale	MPL3115A2
Accelerometer	Analog Devices	ADXL350BCEZ-RL
External Flash	Winbond	W25X20CLSNIG

Table 2: Sensors, display, external flash and USB to UART converter in DKBLE

2 Getting Started With DKBLE

By default the modules delivered with the DKBLE have demonstration FW which prints the temperature to the display and starts automatically advertising. Several example applications are provided with the SDK package downloadable in the Bluegiga web pages.

To get started with the example applications navigate to

www.bluegiga.com → **Products** → **Bluetooth 4.0 Modules**

Select the module of your choice and then navigate to

Documentation and Software → **Software Releases** → **Bluetooth Low Energy Software and SDK**

Download and install the package. After successful installation the tools can be found from the start menu.

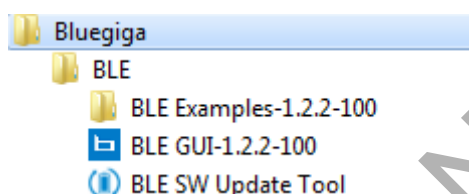


Figure 6: Bluegiga tools and examples in the Windows start menu

2.1 Using the On-Board Debugger to Program the Carriers

To program the module in the carrier, connect the debugger with USB to a PC as shown in the Figure 7. Launch the BLE SW Update Tool. Browse to select the project file for the right module carrier, and then click “update”. After successful programming, the background of the BLE SW Update Tool turns into green (Figure 8).

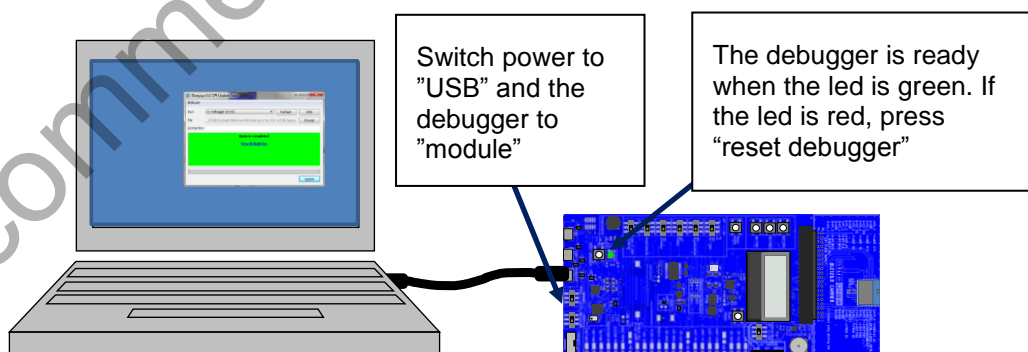


Figure 7: Using the on-board debugger to program the carrier

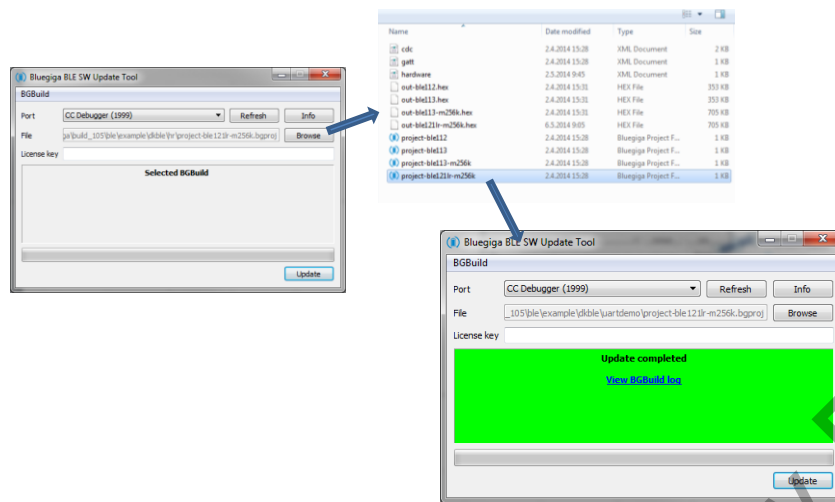


Figure 8: Using the BLE Update Tool

2.2 Using the On-Board Debugger to Program External BLE Devices

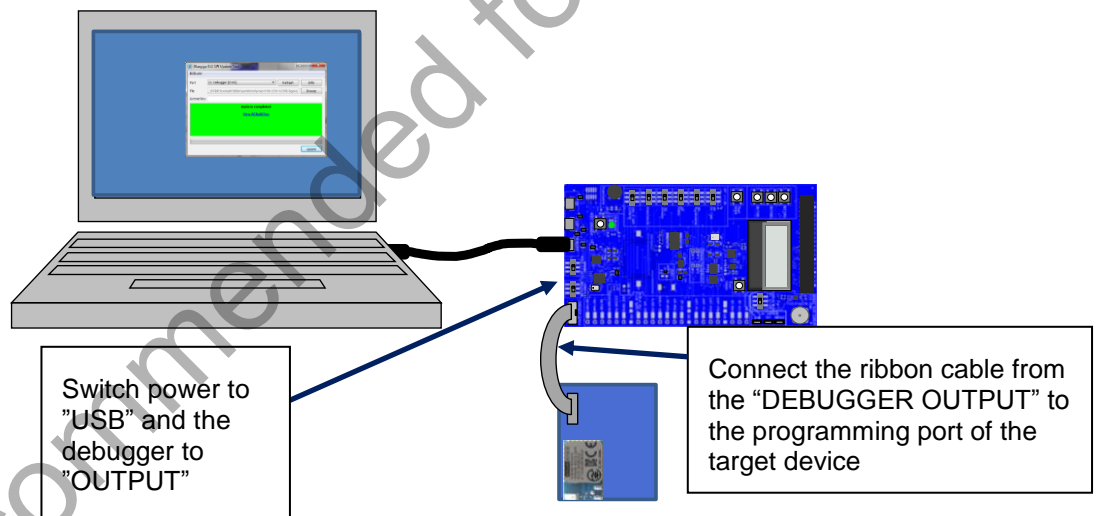


Figure 9: Using the on-board debugger to program external BLE devices

2.3 Using the Analog Comparator of BLExxx modules

The analog comparator of BLE112, BLE113 and BLE121LR is fixed to the pins P0_4 (-) and P0_5 (+). The pins overlap with the UART TX and RX signals in DKBLE. Thus to use the analog comparator the USB to UART converter must be turned off. Refer to Bluetooth Low Energy Software API Reference for details about the analog comparator configurations.

3 Measuring Current Consumption

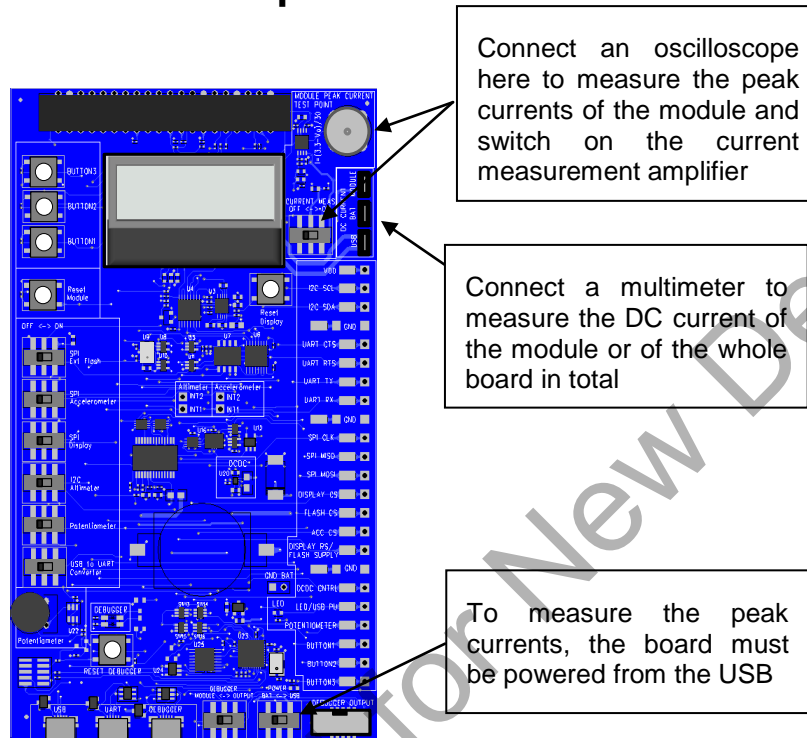


Figure 10: Measuring the current consumption

The peak current consumption of the module is measured over 3 ohm resistor using an instrumentation amplifier with a gain of 10. The instrumentation amplifier is powered from USB 5V line and the DC bias is from the 3V3 LDO. Because the amplifier is powered from the USB VBUS, it can't be used unless USB is connected. If USB is not connected then the instrumentation amplifier must be turned off and by-passed using the switch labeled "CURRENT MEAS OFF<->ON" to avoid excessive leakage current into the input of the amplifier.

NOTE: Peak current measurement is not possible when the external DCDC is used

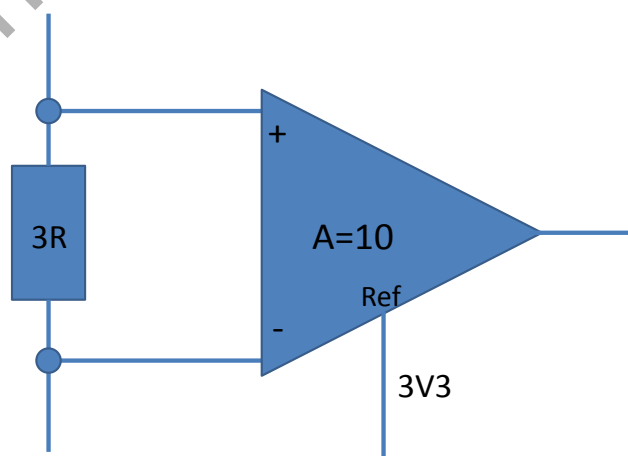


Figure 11: TX current measurement amplifier

To measure the peak TX current consumption of the module, connect a coaxial cable to the BNC connector in the board and to an oscilloscope. Set the oscilloscope

- Coupling: DC
- Vertical scale 500 mV/DIV
- Horizontal scale: 200 μ s/DIV
- Level: 2.5 V
- Offset: -2.0 V
- Trigger: Normal, falling edge

The instrumentation amplifier inverts the signal. The current consumption is calculated by

$$I = \frac{3.3V - V_o}{30\Omega}$$

NOTE: Because of the limited common mode input range of the instrumentation amplifier the peak current can only be measured when powering the module from USB.

4 Schematics and Assembly Drawing

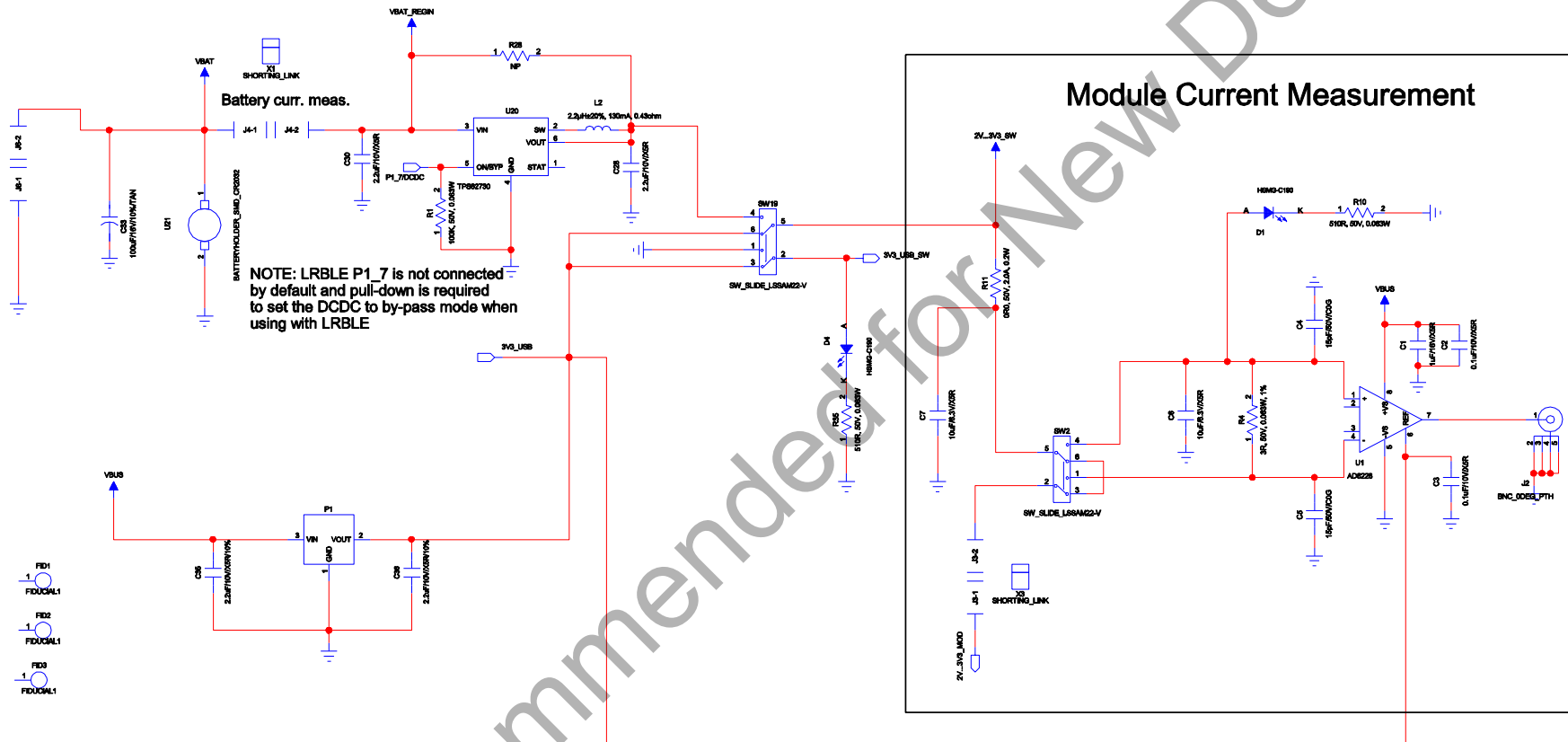




Figure 13: BLE113 Evaluation Board Schematic (2/6)

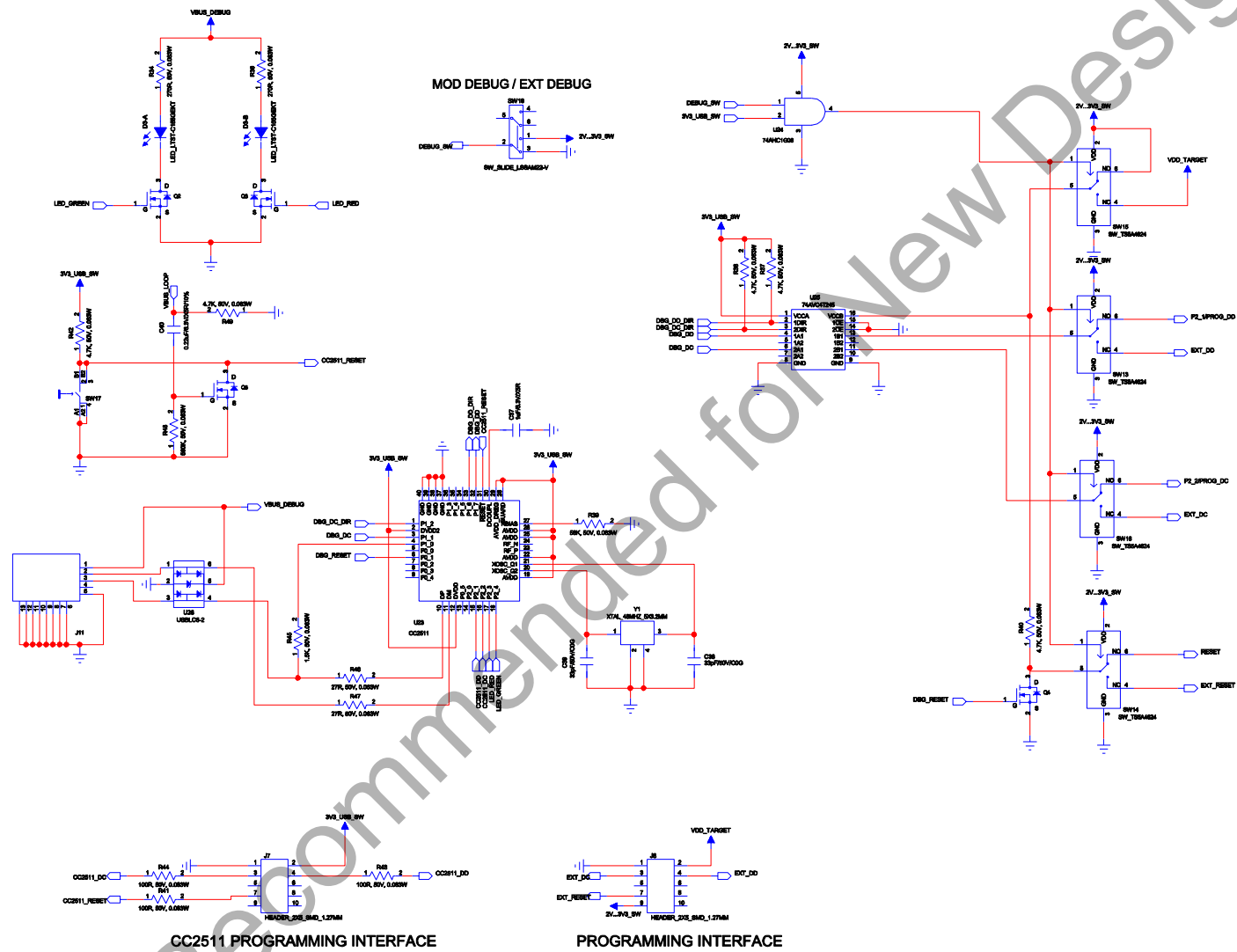


Figure 17: BLE113 Development Board Schematic (6/6)

Simplicity Studio

One-click access to MCU and wireless tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!



IoT Portfolio

www.silabs.com/IoT



SW/HW

www.silabs.com/simplicity



Quality

www.silabs.com/quality



Support & Community

www.silabs.com/community

Disclaimer

Silicon Labs intends to provide customers with the latest, accurate, and in-depth documentation of all peripherals and modules available for system and software implementers using or intending to use the Silicon Labs products. Characterization data, available modules and peripherals, memory sizes and memory addresses refer to each specific device, and "Typical" parameters provided can and do vary in different applications. Application examples described herein are for illustrative purposes only. Silicon Labs reserves the right to make changes without further notice to the product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information. Without prior notification, Silicon Labs may update product firmware during the manufacturing process for security or reliability reasons. Such changes will not alter the specifications or the performance of the product. Silicon Labs shall have no liability for the consequences of use of the information supplied in this document. This document does not imply or expressly grant any license to design or fabricate any integrated circuits. The products are not designed or authorized to be used within any FDA Class III devices, applications for which FDA premarket approval is required, or Life Support Systems without the specific written consent of Silicon Labs. A "Life Support System" is any product or system intended to support or sustain life and/or health, which, if it fails, can be reasonably expected to result in significant personal injury or death. Silicon Labs products are not designed or authorized for military applications. Silicon Labs products shall under no circumstances be used in weapons of mass destruction including (but not limited to) nuclear, biological or chemical weapons, or missiles capable of delivering such weapons. Silicon Labs disclaims all express and implied warranties and shall not be responsible or liable for any injuries or damages related to use of a Silicon Labs product in such unauthorized applications.

Trademark Information

Silicon Laboratories Inc.®, Silicon Laboratories®, Silicon Labs®, SiLabs® and the Silicon Labs logo®, Bluegiga®, Bluegiga Logo®, ClockBuilder®, CMEMS®, DSPLL®, EFM®, EFM32®, EFR®, Ember®, Energy Micro, Energy Micro logo and combinations thereof, "the world's most energy friendly microcontrollers", Ember®, EZLink®, EZRadio®, EZRadioPRO®, Gecko®, Gecko OS, Gecko OS Studio, ISOModem®, Precision32®, ProSLIC®, Simplicity Studio®, SiPHY®, Telegesis, the Telegesis Logo®, USBXpress®, Zentri, the Zentri logo and Zentri DMS, Z-Wave®, and others are trademarks or registered trademarks of Silicon Labs. ARM, CORTEX, Cortex-M3 and THUMB are trademarks or registered trademarks of ARM Holdings. Keil is a registered trademark of ARM Limited. Wi-Fi is a registered trademark of the Wi-Fi Alliance. All other products or brand names mentioned herein are trademarks of their respective holders.



Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

<http://www.silabs.com>