DKBLE

USER GUIDE

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Version 1.0

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VERSION HISTORY

Version	Comment
1.0	First published version

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1 Design Overview

BLE Development Kit, DKBLE, is targeted for engineers evaluating Bluetooth Smart modules BLE112, BLE113 and BLE121LR. DKBLE is platform containing various switchable peripherals for creating and testing several different applications utilizing Bluegiga Bluetooth Smart 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.

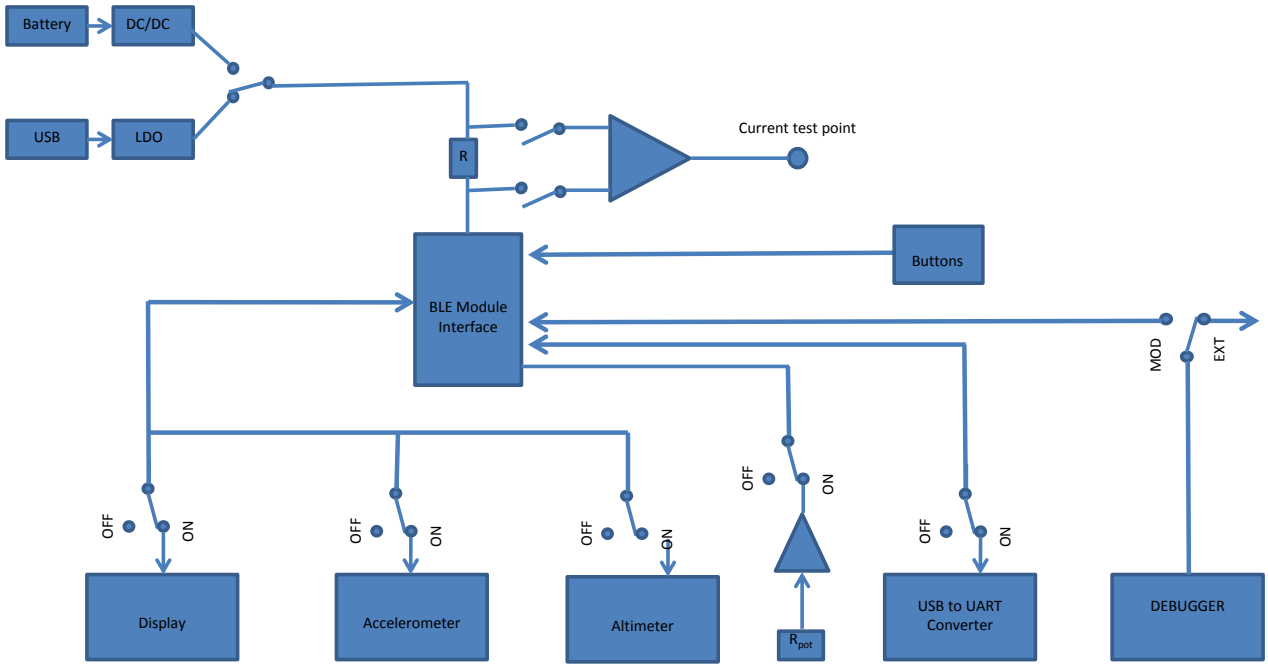


Figure 1: Block diagram of DKBLE

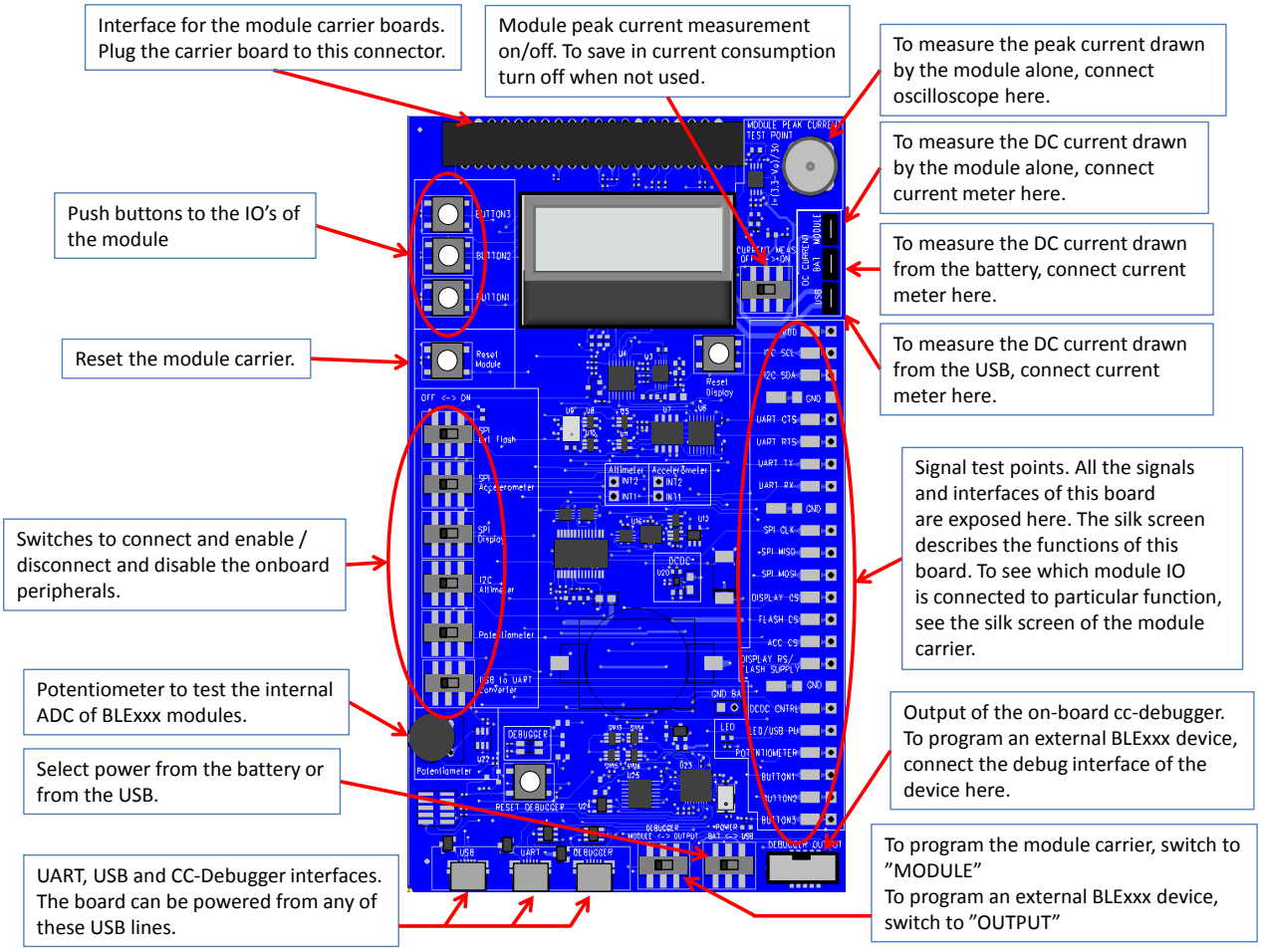


Figure 2: DKBLE interfaces

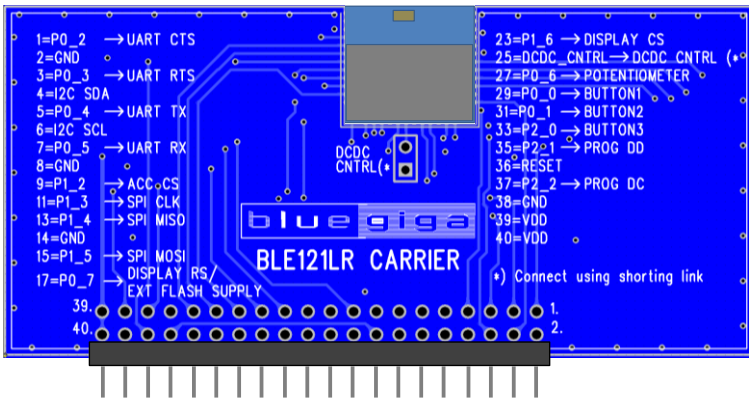


Figure 3: BLE121LR module carrier

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).

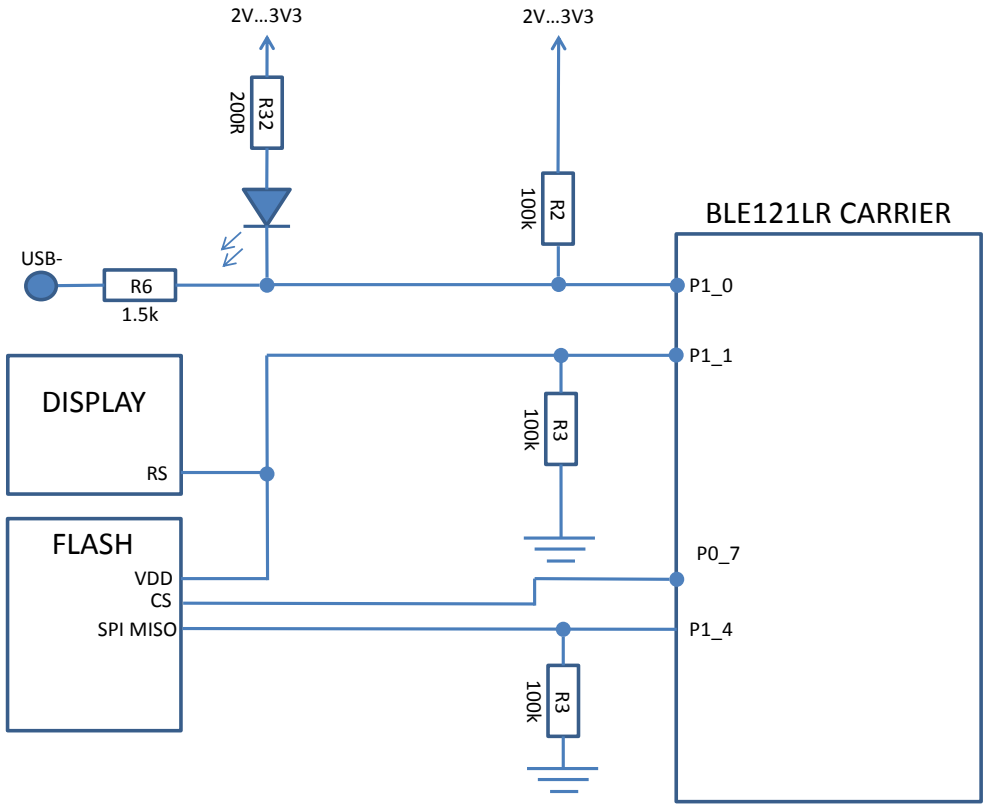


Figure 4: Connections in BLE112 and BLE113 Carriers

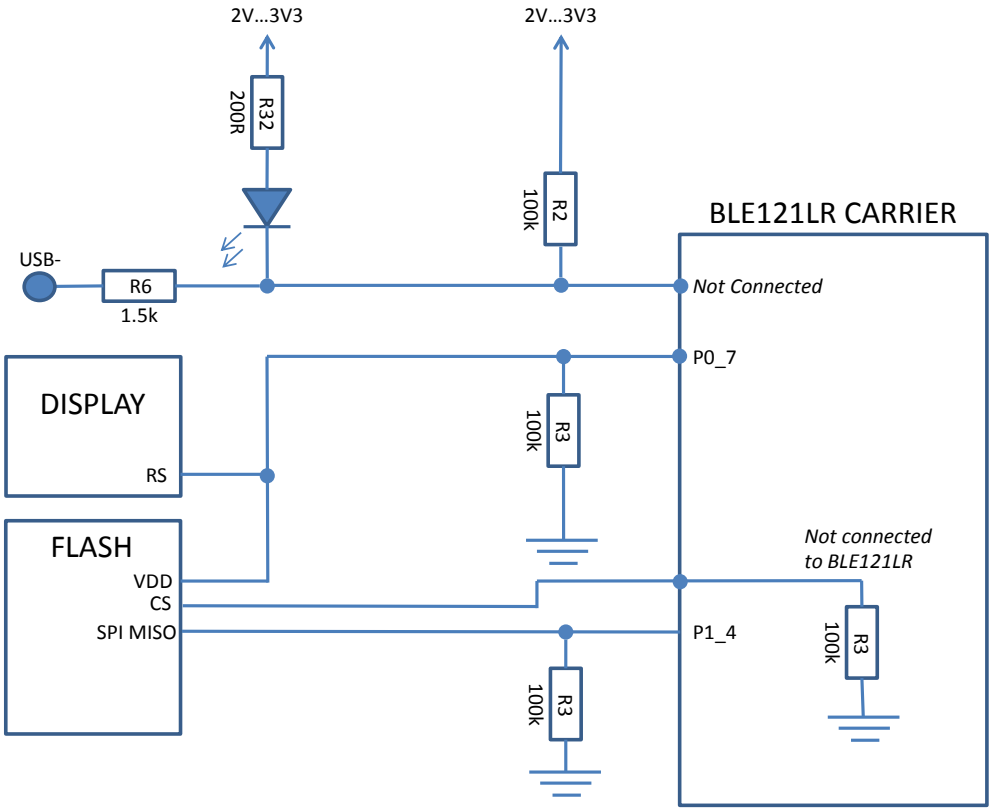


Figure 5: Connections in the BLE121LR Carrier

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 Smart Software and SDK***

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

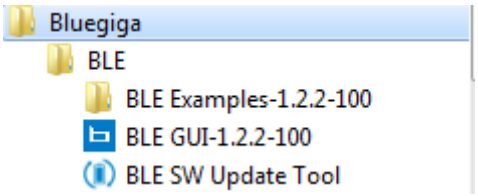


Figure 6: Bluegiga tools and examples in the Windows start menu

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).

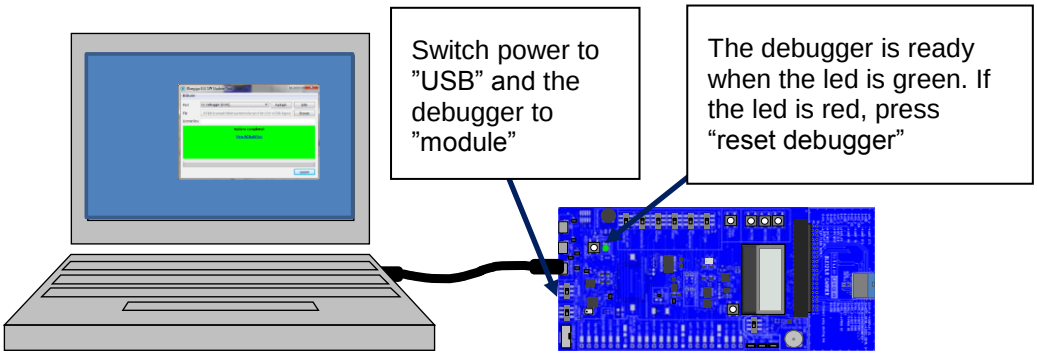


Figure 7: Using the on-board debugger to program the carrier

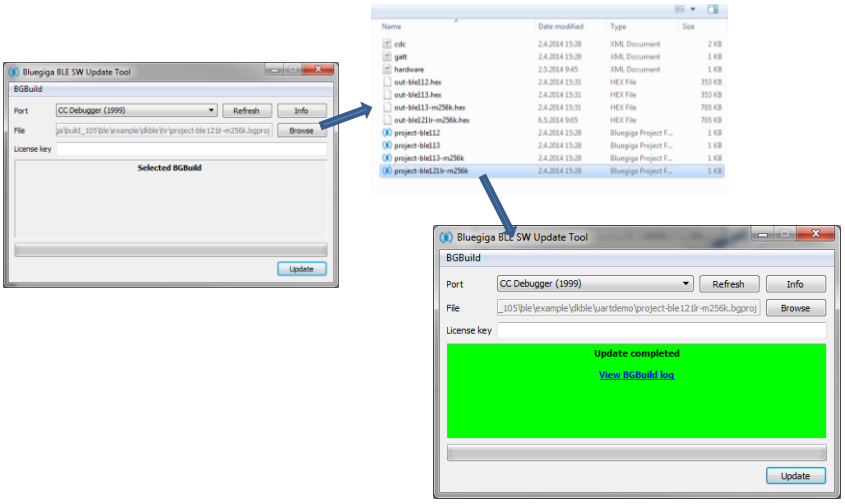


Figure 8: Using the BLE Update Tool

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

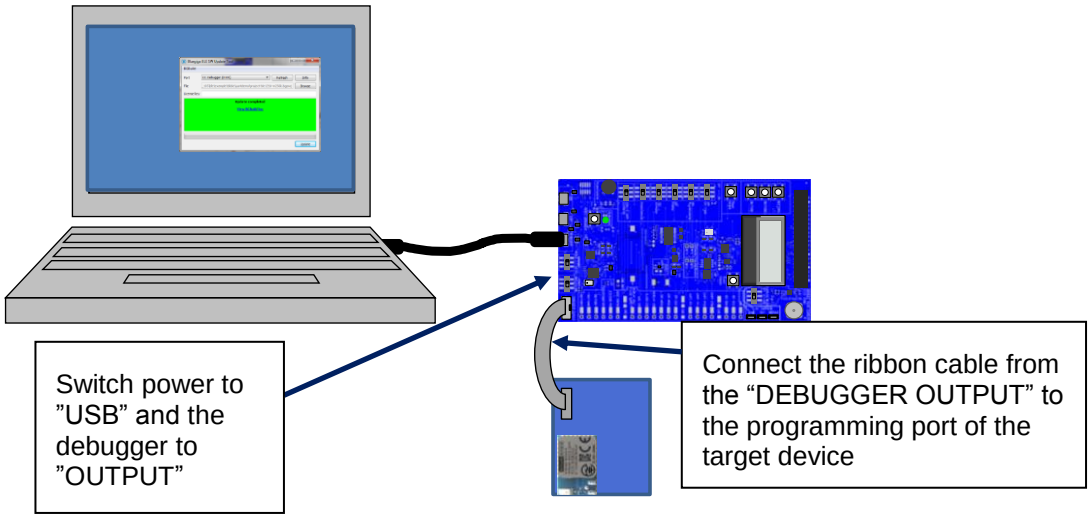


Figure 9: Using the on-board debugger to program external BLE devices

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 Smart Software API Reference for details about the analog comparator configurations.

3 Measuring Current Consumption

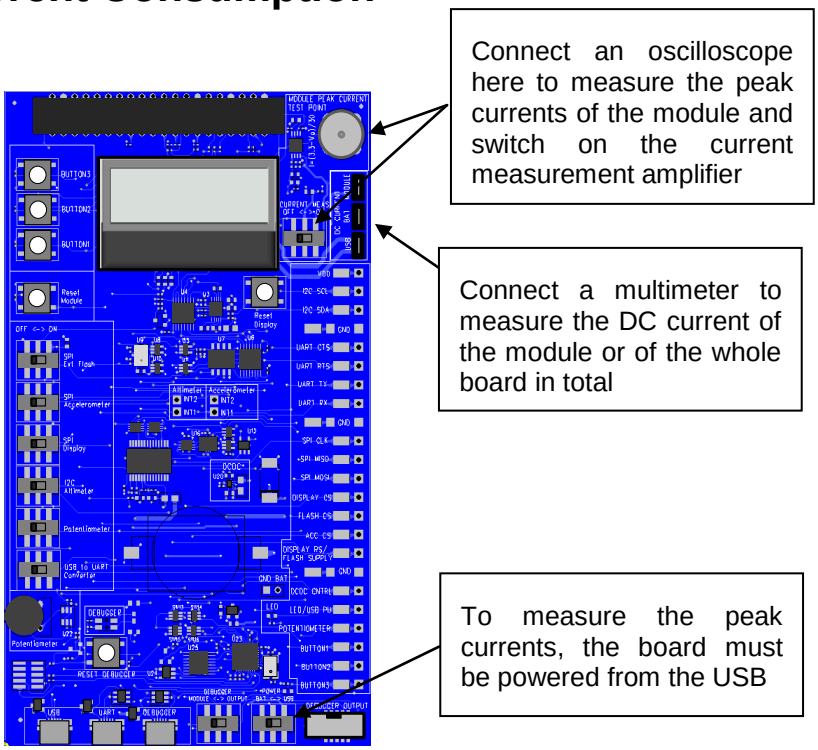


Figure 10: Measuring the current consumption

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

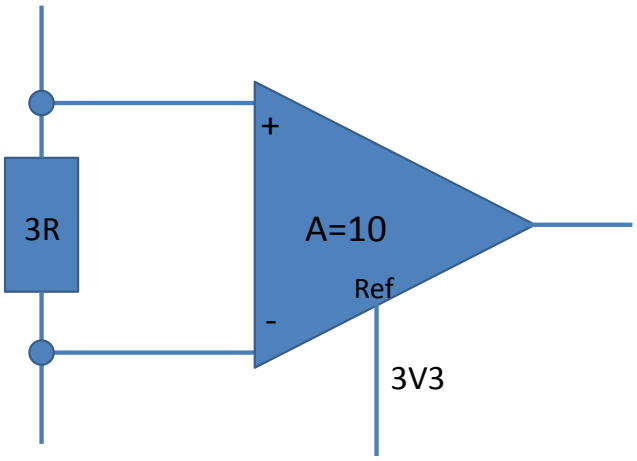


Figure 11: TX current measurement amplifier

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 µs/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

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

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

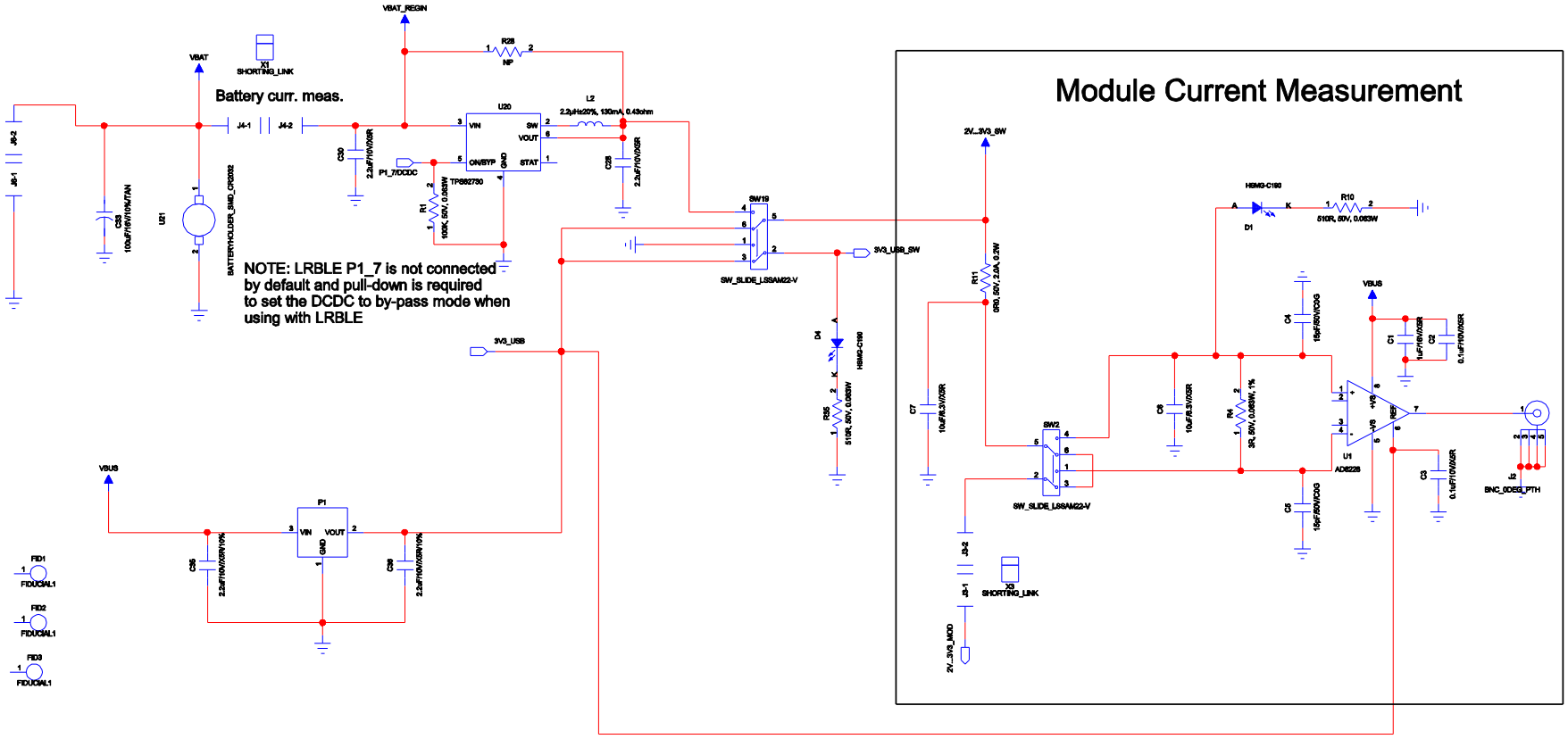


Figure 12: BLE113 Evaluation Board Schematic (1/6)

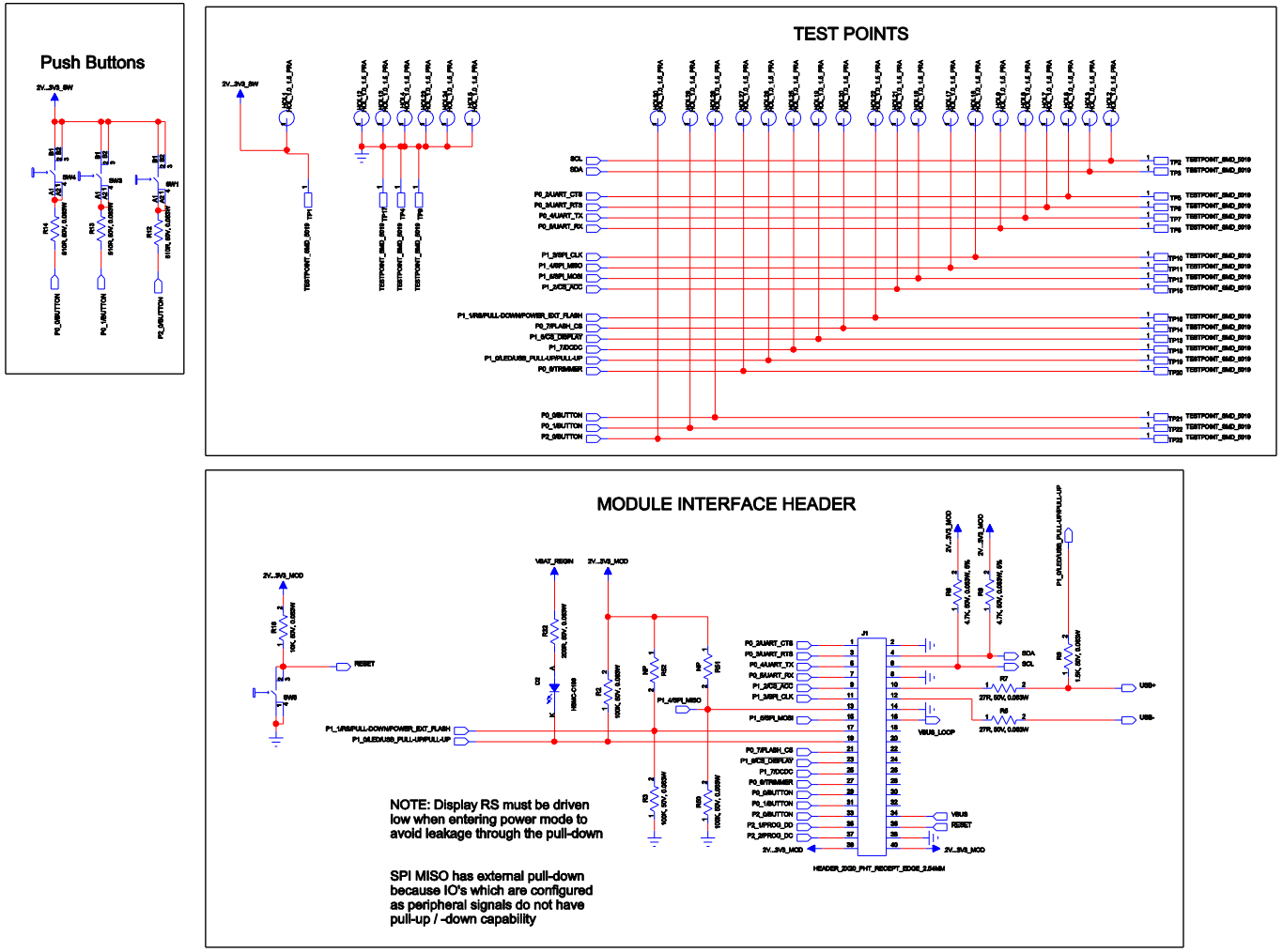


Figure 13: BLE113 Evaluation Board Schematic (2/6)

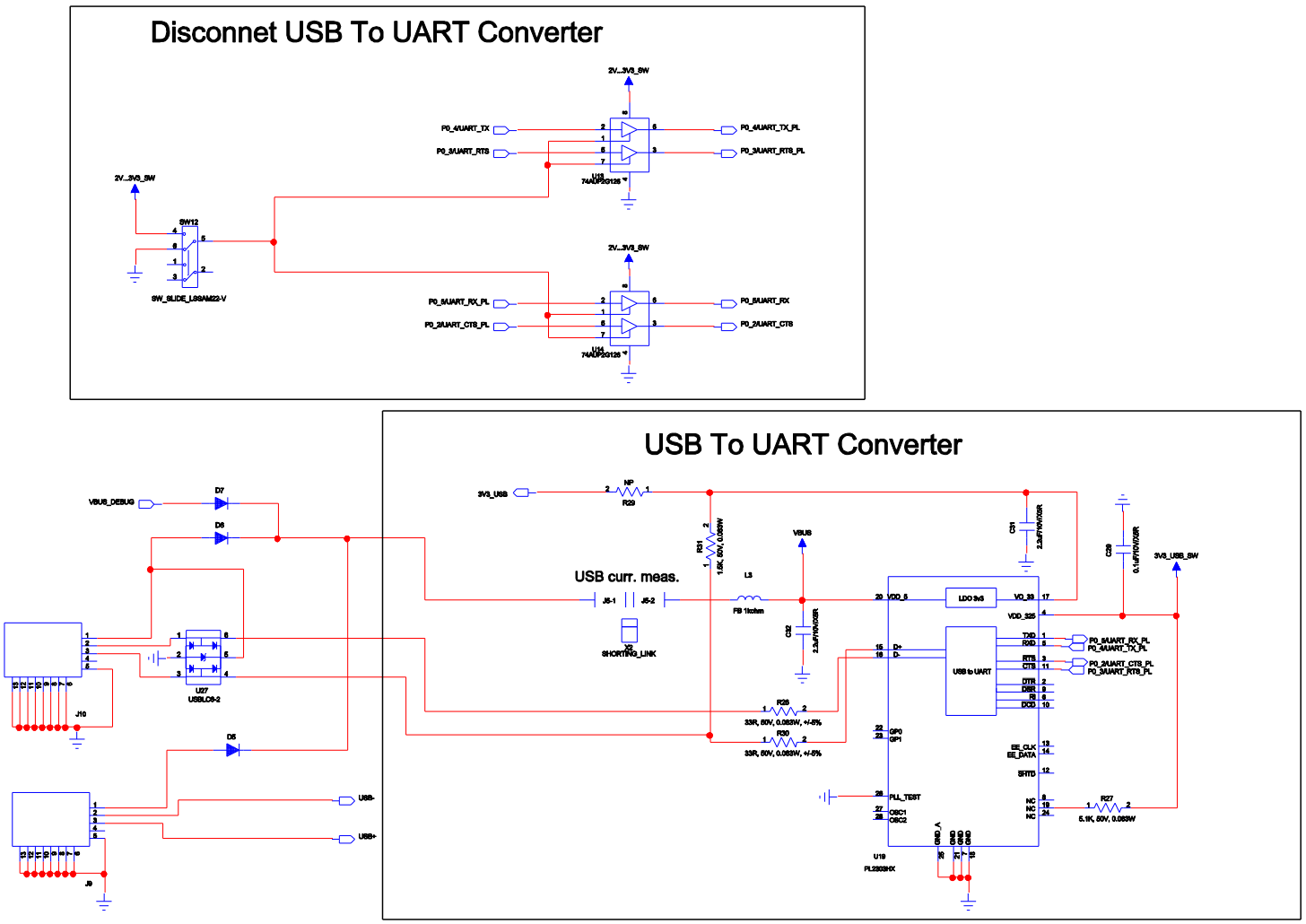


Figure 14: BLE113 Development Board Schematic (3/6)

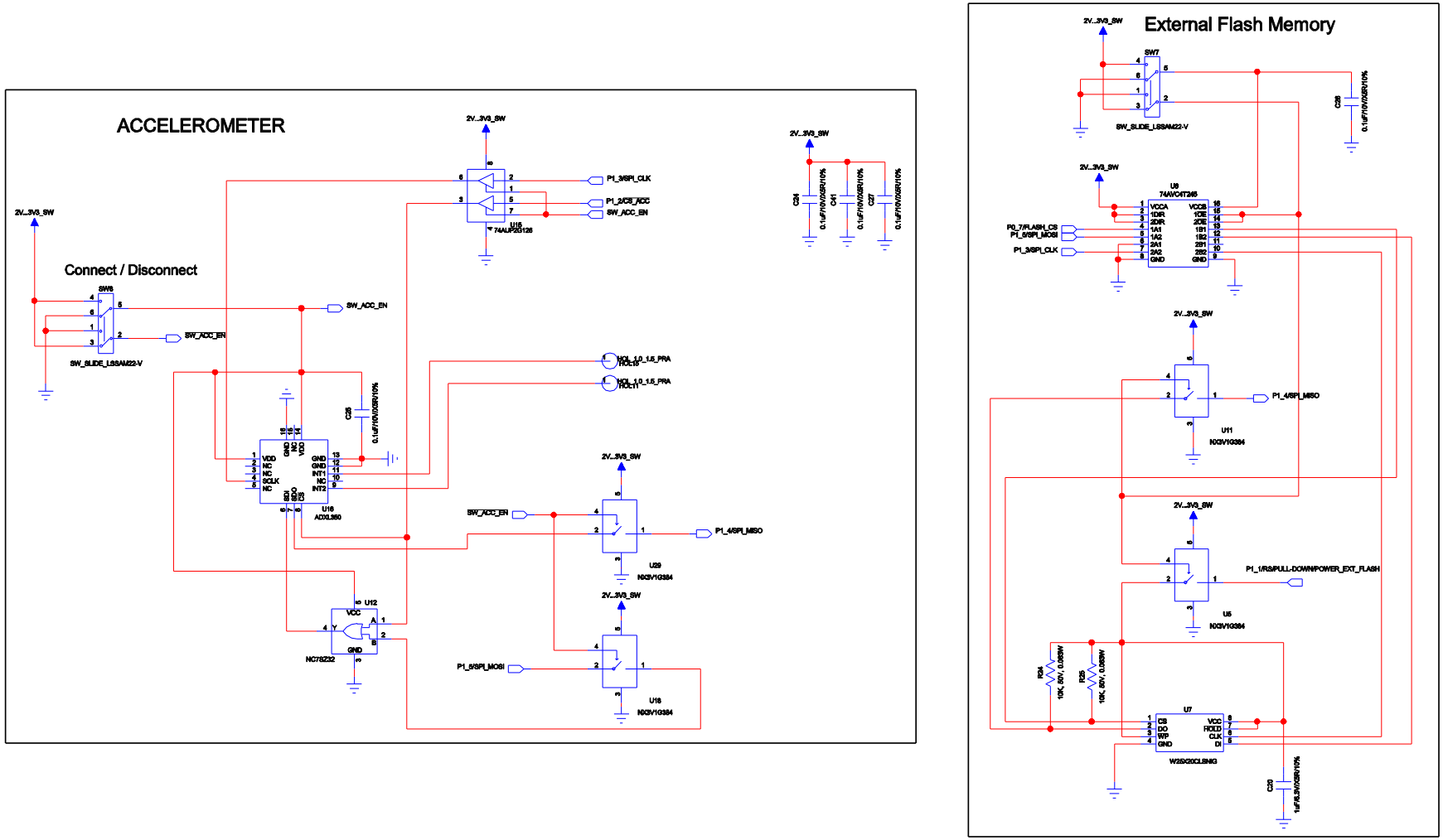
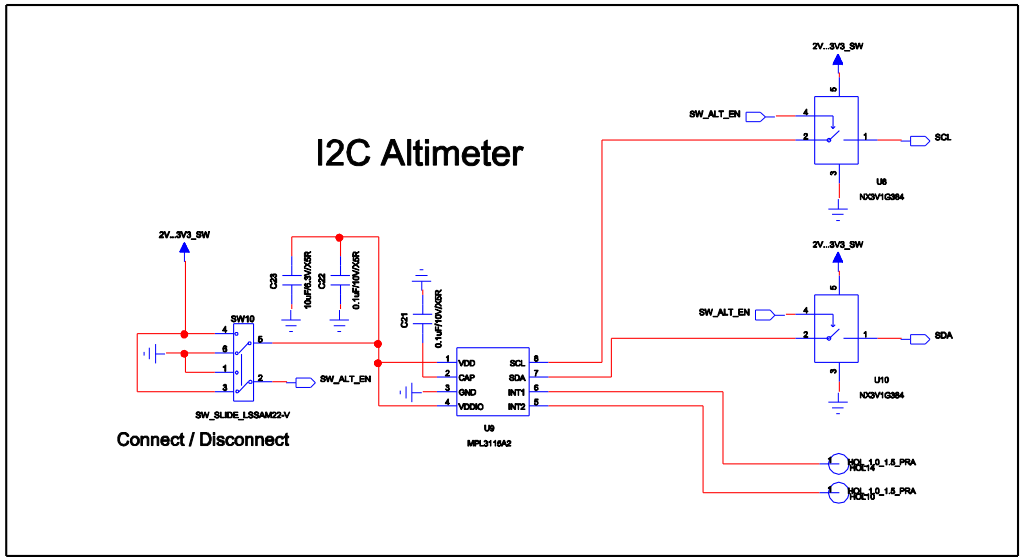


Figure 15: BLE113 Development Board Schematic (4/6)



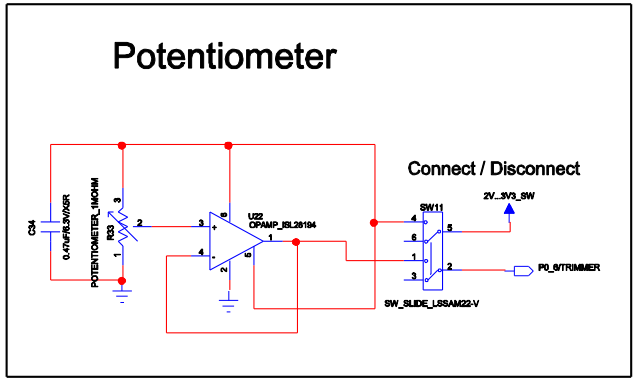


Figure 16: BLE113 Development Board Schematic (5/6)

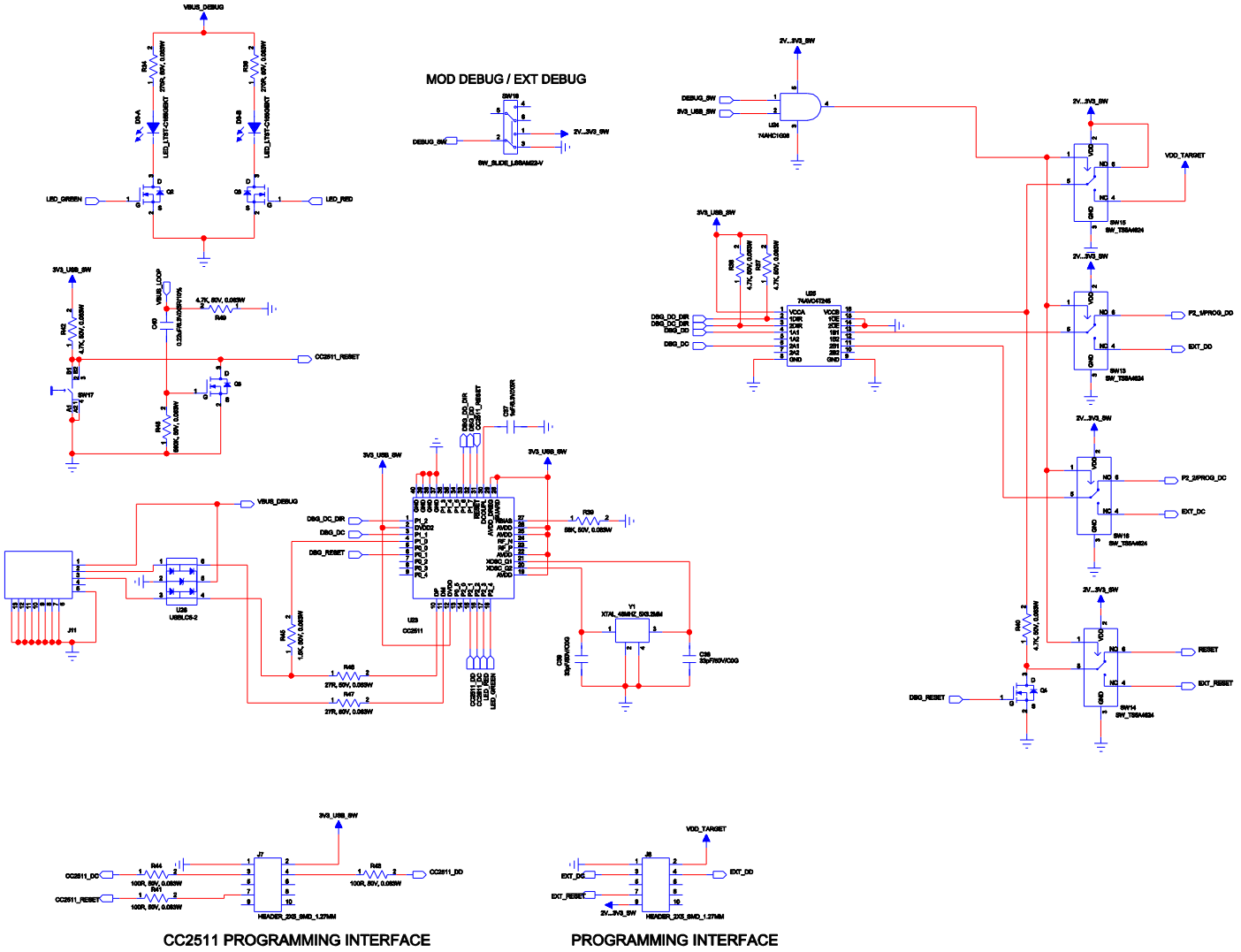


Figure 17: BLE113 Development Board Schematic (6/6)

5 WEEE Compliance

The crossed-out wheeled bin means that within the European Union the product must be taken to separate collection at the product end-of-life. Do not dispose of these products as unsorted municipal waste.

6 Contact Information

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