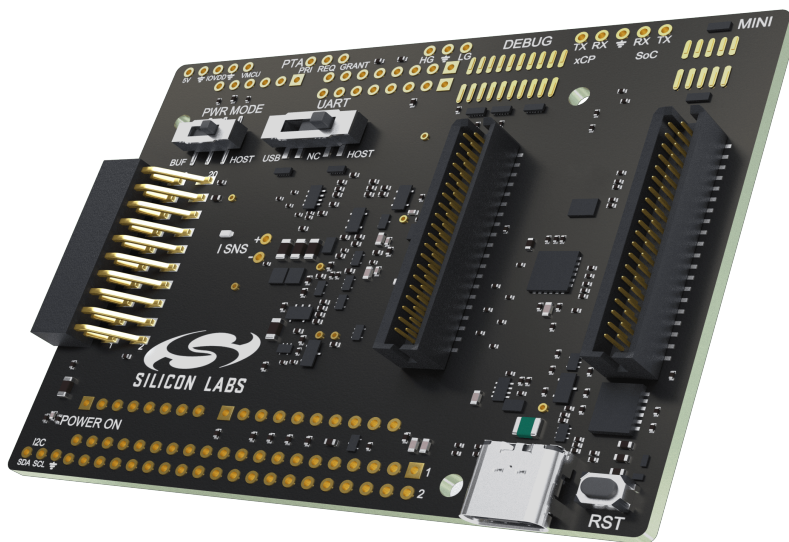


# UG569: Adapter Board for Co-Processor Radio Boards User's Guide

The Adapter Board for Co-Processor Radio Boards is an excellent way to explore and evaluate Co-Processor Radio Boards with various host devices using either SPI or SDIO interfaces. Example of host devices are EFM32 or EFR32 devices, Raspberry Pi or other Linux machines with a Sdcard interface, STM micro-controllers.

When connected to a compatible host board, the Adapter Board puts the Wi-Fi Network or Radio Co-Processor (NCP/RCP) board in direct communication with the host device, securing correct operation while debugging.

The kit comes in three different variants as BRD8045A, BRD8045B and BRD8045C which easily integrate and bring additional wireless connectivity to respectively compatible Silicon Labs Wireless Pro Kit Mainboards through the EXP header, a Raspberry Pi through the HAT interface, and other host boards equipped with an Arduino UNO rev 3 compatible host interface, for example STM32 Nucleo-64 boards.



## ADAPTER BOARD COMMON FEATURES

- Device Interface: Silicon Labs Wireless Radio Boards
- USB port for In System Programming (ISP) of SiWx Devices
- Power Source Selector
- 2x analog Current Sense outputs with different gains
- Reset button
- Break Out pads

## BRD8045A FEATURES

- Silicon Labs EXP interface for EFM32 or EFR32 Devices Wireless Pro Kit
- EXP-to-SDCard Adapter board (BRD8046A) for other Linux machines (SDIO)
- SiWx917-EB4346A

## BRD8045B FEATURES

- HAT compatible interface for Raspberry Pi
- SiWx917-EB4346B

## BRD8045C FEATURES

- Arduino UNO rev 3 compatible Shield interface for e.g. STM32 Nucleo-64 boards
- SiWx917-EB4346C

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**10. Document Revision History . . . . .29**

## 1. Introduction

The Adapter Board is designed to connect the Network/Radio Co-Processors (NCP/RCP) to external hosts, like Silicon Labs EFR and EFM devices, and some of the most popular open-source platforms like Raspberry Pi, Arduino and STM32 Nucleo boards.

Figures 1.1 to 1.4 show the Adapter Board connected to

- a Silicon Labs Wireless Pro Kit Board with EFR host
- an EXP-MicroSD Adapter Board through the Expansion Header
- a Raspberry Pi
- an STM32 NUCLEO-F411RE, respectively.

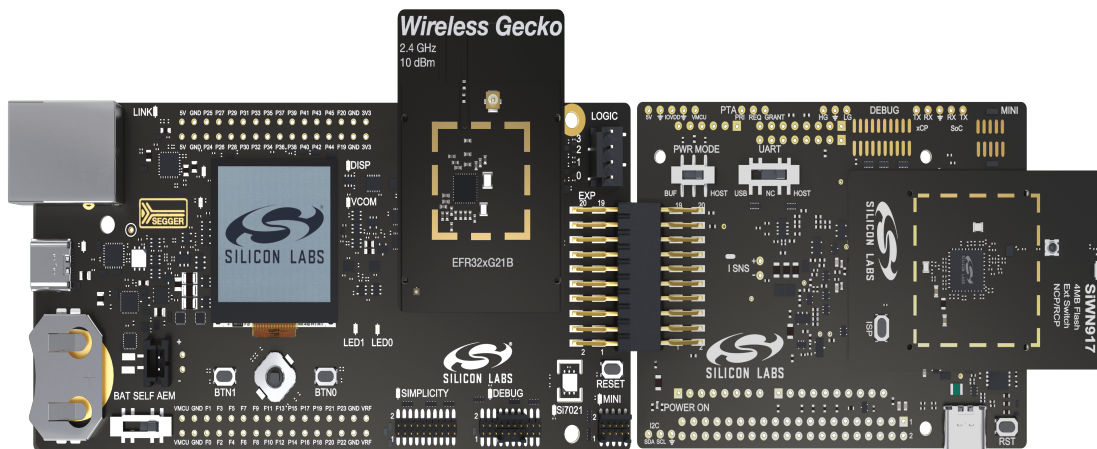


Figure 1.1. Adapter Board (BRD8045A) Connected to a Silicon Labs Wireless Pro Kit Board

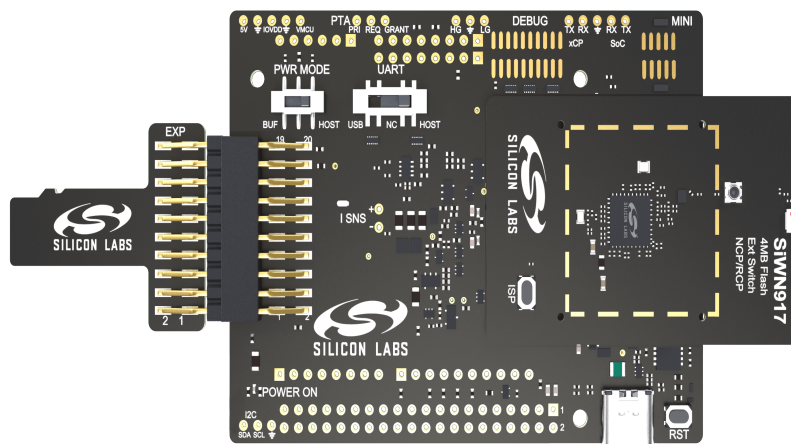


Figure 1.2. Adapter Board (BRD8045A) Connected to a Silicon Labs EXP-MicroSD Adapter Board

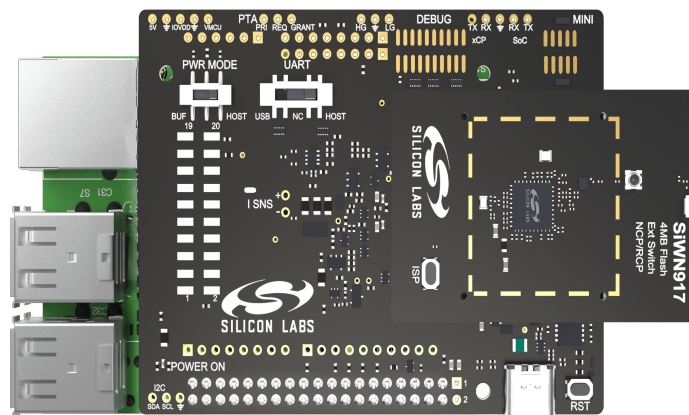


Figure 1.3. Adapter Board (BRD8045B) Connected to a Raspberry Pi

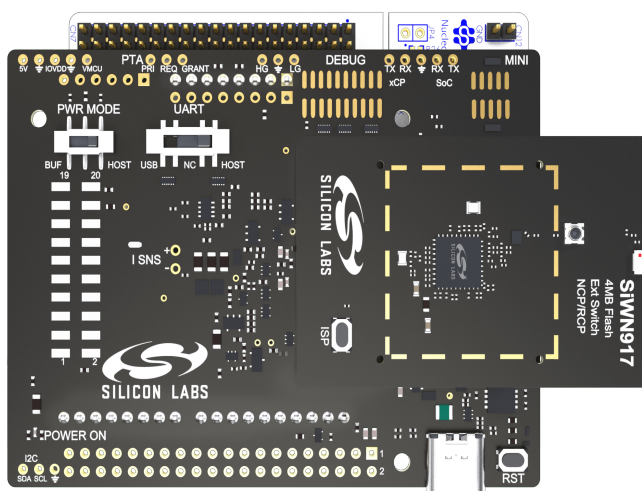


Figure 1.4. Adapter Board (BRD8045C) Connected to a NUCLEO-F411RE

## 1.1 Ordering Information

BRD8045x can be ordered with SiWx917-EB4346x Wi-Fi 6 and Bluetooth LE Co-Processor Kit.

**Table 1.1. Ordering Information**

Part Number	Description	Contents
SiWx917-EB4346A	SiWx917 Wi-Fi 6 and Bluetooth LE Co-Processor EXP Expansion Kit	1x BRD4346A SiWx917 Wi-Fi 6 and Bluetooth LE Co-Processor Radio Board 1x BRD8045A Adapter Board for Co-Processors 1x BRD8046A EXP-to-SDCard Adapter board
SiWx917-EB4346B	SiWx917 Wi-Fi 6 and Bluetooth LE Co-Processor Raspberry Pi Expansion Kit	1x BRD4346A SiWx917 Wi-Fi 6 and Bluetooth LE Co-Processor Radio Board 1x BRD8045B Adapter Board for Co-Processors
SiWx917-EB4346C	SiWx917 Wi-Fi 6 and Bluetooth LE Co-Processor Shield Expansion Kit	1x BRD4346A SiWx917 Wi-Fi 6 and Bluetooth LE Co-Processor Radio Board 1x BRD8045C Adapter Board for Co-Processors

## 2. Specifications

### 2.1 Recommended Operating Conditions

The following table is intended to serve as guideline for a correct use of Adapter Board, indicating typical operating conditions and some design limits.

**Table 2.1. Recommended Operating Conditions**

Parameter	Symbol	Min	Typ	Max	Unit
USB Supply Input Voltage	$V_{USB}$	4.4	5.0	5.25	V
Host Supply Voltage	$V_{IO\_VDD}$	1.8	-	3.6	V
Maximum Load Current, $V_{VMCU} = 3.3\text{ V}^1$	$I_D$	-	-	1.5	A
Maximum Load Current, $V_{VMCU} = 1.8\text{ V}^1$	$I_D$	-	-	0.8	A
Operating Temperature	$T_{OP}$	0	20	40	°C
<b>Note:</b> 1. Current availability varies linearly with the Voltage supplied at $V_{VMCU}$					

### 2.2 Operating Characteristics

The following table is intended for typical performance figures of the Adapter Board.

**Table 2.2. Current Sense High Gain Operating Characteristics**

Parameter	Symbol	Min	Typ	Max	Unit
Gain	$G_{HG}$	-	101	-	V/A
Output Bandwidth	$BW_{HG}$	-	1	-	kHz
Output Accuracy	$V_{HG}$	-	$\pm 300$	-	$\mu\text{V}$
		-	2	-	%
Output Offset	$V_{HG}$	0	30	60	mV
Output Temperature Drift	$V_{HG}$	-	300	-	$\mu\text{V}/^\circ\text{C}$

**Table 2.3. Current Sense Low Gain Operating Characteristics**

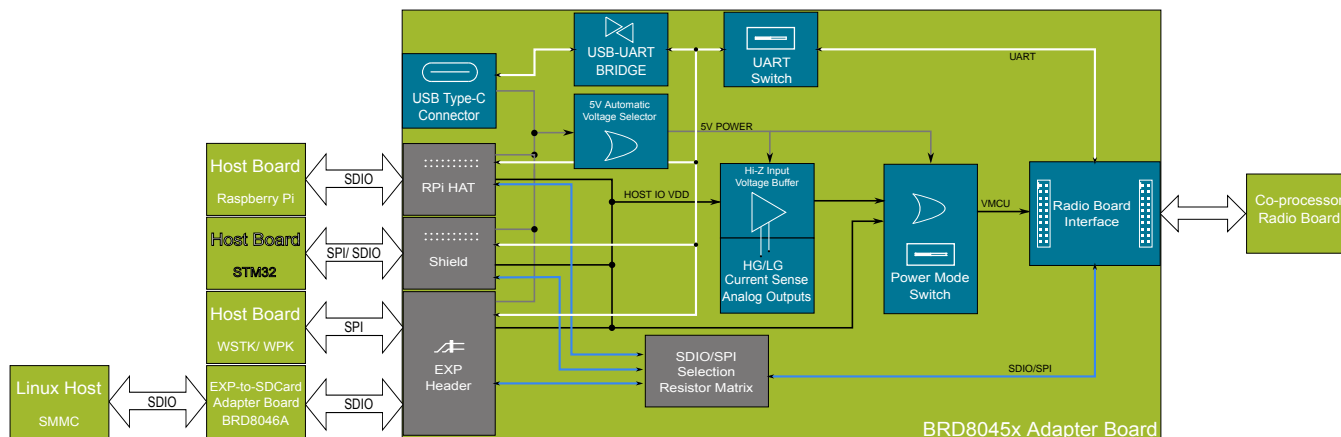
Parameter	Symbol	Min	Typ	Max	Unit
Gain	$G_{LG}$	-	1	-	V/A
Output Bandwidth	$BW_{LG}$	-	500	-	kHz
Output Accuracy	$V_{LG}$	-	$\pm 10$	-	$\mu\text{V}$
		-	2	-	%
Output Offset	$V_{LG}$	0	0.3	0.6	mV
Output Temperature Drift	$V_{LG}$	-	3	-	$\mu\text{V}/^\circ\text{C}$

### 3. Hardware Overview

The following section provides an overview of the Adapter Board hardware. While power architecture and device interface, i.e. the interface toward the Co-Processor Radio Boards are common to all three BRD8045x variants, the host interface differs, based on the type of host board related to the specific part number. See table in section 1.1 [Ordering Information](#) to learn more about the available variants and part numbers. From a high level perspective, all host interfaces feature a high speed communication port, either SPI or SDIO, to exchange wireless data packages, remote reset, and a specific set of signals, depending on the characteristic of the host board interface. Connector pinout details are treated in a dedicate chapter 4. [Connectors](#).

#### 3.1 Block Diagram

An overview of the Adapter Board is shown in the figure below. The common features are represented in blue blocks, while the different interfaces, mutually exclusive, are represented in grey blocks. SPI/SDIO lines are represented in blue, UART lines in white, while host and device power domains with black lines and board power with grey lines.



**Figure 3.1. Kit Block Diagram**

#### 3.2 Communication and Signal Mapping to Host Interfaces

The BRD8045x Adapter Board exposes the device's various communication ports on the host interfaces. While asynchronous communication lines and other single end signals are physically routed to more than one interface on the printed circuit board, when used with a SiWx917 Wi-Fi Co-processors, the SPI/SDIO signals from the Co-processor are routed through a resistor matrix, determining the further path to a specific host interface. This user guide illustrates how the different variants are configured as they come from the factory. Still, it is possible to solder or desolder components to change the original configuration to customize connectivity. Users who intend to modify the hardware for other use case scenarios than these that are supported by the orderable kits can find schematic and assembly drawings at [silabs.com](http://silabs.com).

Here is an overview of the signal routed to the host interface, by product variant:

**Table 3.1. Overview of Host Connectivity**

BRD8045A	BRD8045B	BRD8045C
SPI/SDIO	SDIO	SPI
UART	UART	UART
-	I <sup>2</sup> C	I <sup>2</sup> C
Low Power Hand Shake	Low Power Hand Shake	Low Power Hand Shake
Reset	Reset	Reset
-	In System Programming (ISP) control	In System Programming (ISP) control
Packet Traffic Arbitration (PTA)	-	-

The BRD8045B Adapter Board for Raspberry Pi also supports SPI communication with Silicon Labs Multiprotocol Systems on Chip of the EFR32 device family.



### 3.2.1 UART and USB connections

As the BRD8045x Adapter Board for Co-Processor Radio Boards comes from the factory, the UART data lines are mapped to a particular UART port of the SiWx917 Wi-Fi Co-processor, supporting ISP mode. A slide switch allow users to connect this port either to the host, for remote programming <sup>1</sup>, or to the on-board UART-USB bridge, to connect a PC and load the Co-processor firmware using a terminal.

None of the orderable variants support UART connections with other EFR32 devices, however shunt resistors are provided to remap the UART port in hardware, so that the UART can be repurposed for EFR32 devices or other Systems on Chip of the SiWx917 device family. Users who intend to modify the hardware to remap the UART data lines can find schematic and assembly drawings at [silabs.com](http://silabs.com). Both System on Chip and Co-processor UART data lines are always available on four break out pads, divided in two clusters by a ground (GND) pad in the middle, respectively BO104-BO105 (RX/TX SoC) and BO102-BO103 (RX/TX NCP or RCP).

Summarized, the Adapter Board for Co-Processors Radio Boards allow the user to switch between the following three modes:

- USB – This is the factory default mode wherein UART peripheral is connected to the UART-USB bridge.
- NC – This mode allows the user to disconnect the UART data lines completely. In this mode, we can still interface with an external UART device by means of break out pads.
- HOST – This mode enables the co-processor board to connect to the host's UART peripheral.

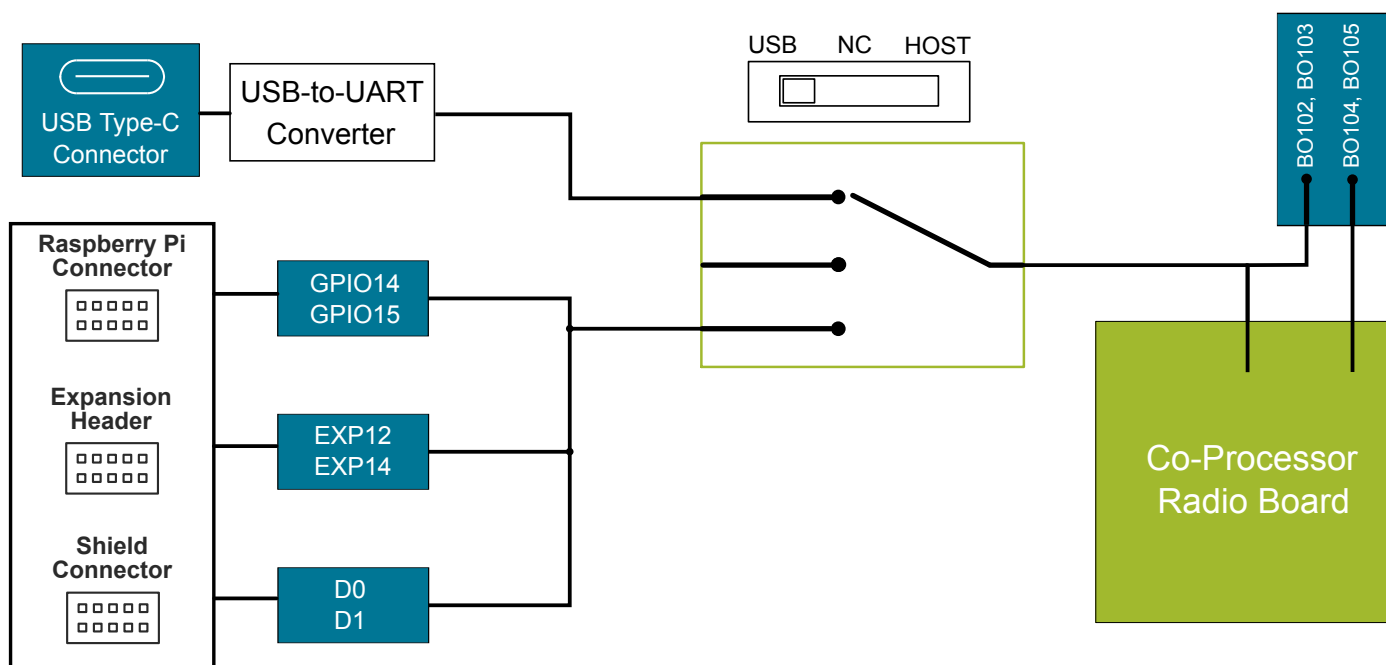


Figure 3.2. UART Slide Switch

**Note:** 1. Remote ISP line is only with BRD8045B and BRD8045C host interfaces.

### 3.2.2 Reset Button

The RESET button can be used to reset the target device on the Radio Board (active low).

When connecting an STM32 Nucleo-64 board to the BRD8045C Adapter Board, the on-board reset circuit resets both the host and device chip at the same time when the button is pressed, but it still allows the host resetting the device remotely without resetting itself.

### 3.3 Power Supply and Current Sense Outputs

This section provides an overview of the hardware architecture of the BRD8045x Adapter Board. More details about power modes and usage are given in chapter 5. [Power Supply](#), examples and procedures for measuring currents with Adapter Board are given in chapter 6. [Current Measurements](#).

The Adapter Board needs 5V power to operate correctly. This power rail is used to power analog circuits, e.g. voltage buffers and power switches. The 5V power is provided either through the host interface or the USB connector. A power multiplexer automatically selects the available power rail, prioritizing the USB power if both the host board and USB cable are providing power at the same time and the USB voltage is within the range specified in table in [2.1 Recommended Operating Conditions](#).

A power switch is available for the user to select power mode. Power modes determines how the Co-processor (Device) is powered once the board is correctly being supplied. The electromechanical switch does not carry power itself, but it controls power transistors that close the current paths. To operate, these transistors need the 5V rail. More details about power modes are given in section [5.2 Device Power Options](#).

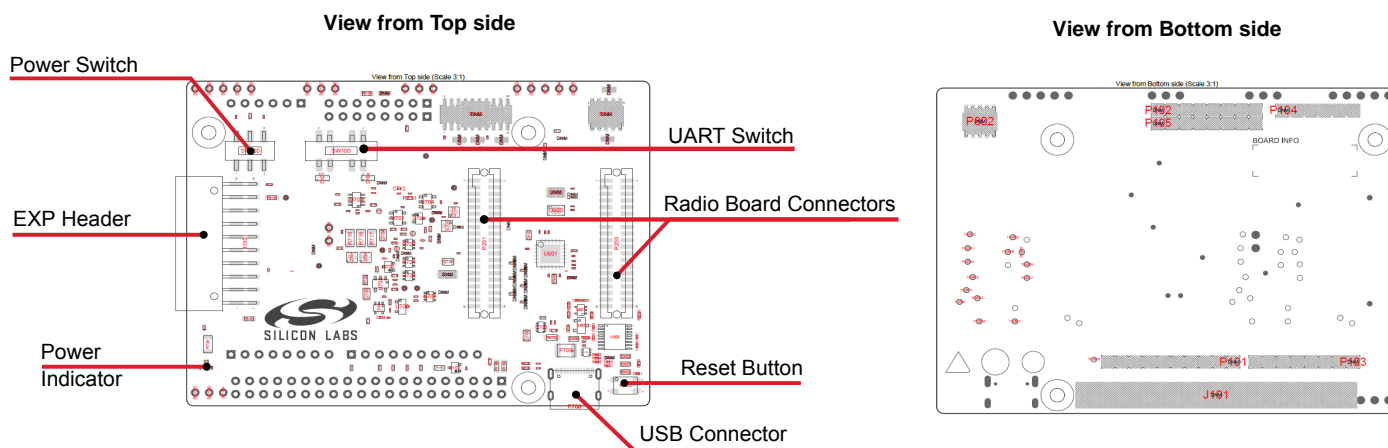
The on-board buffer circuit always tracks the host voltage. When connected, its output provides power to the Co-processor and two analog outputs with different gains to track the current consumption of the Co-processor. More details about the on-board current sense outputs and their usage are provided in section [6.1 Analog Outputs](#).

### 3.4 Hardware Layout

The physical implementations of the different BRD8045x Adapter Boards are shown below. Dashed areas indicate not mounted components.

#### 3.4.1 Hardware Layout of BRD8045A

BRD8045A Adapter Board has components on top side only:



**Figure 3.3. BRD8045A Adapter Board Hardware Layout**

### 3.4.2 Hardware Layout of BRD8045B

BRD8045B Adapter Board is designed to be mounted on top of a Raspberry Pi using the HAT connector (bottom view). There are M2.5 mounting holes to secure the board to the Raspberri Pi host by optional spacers.

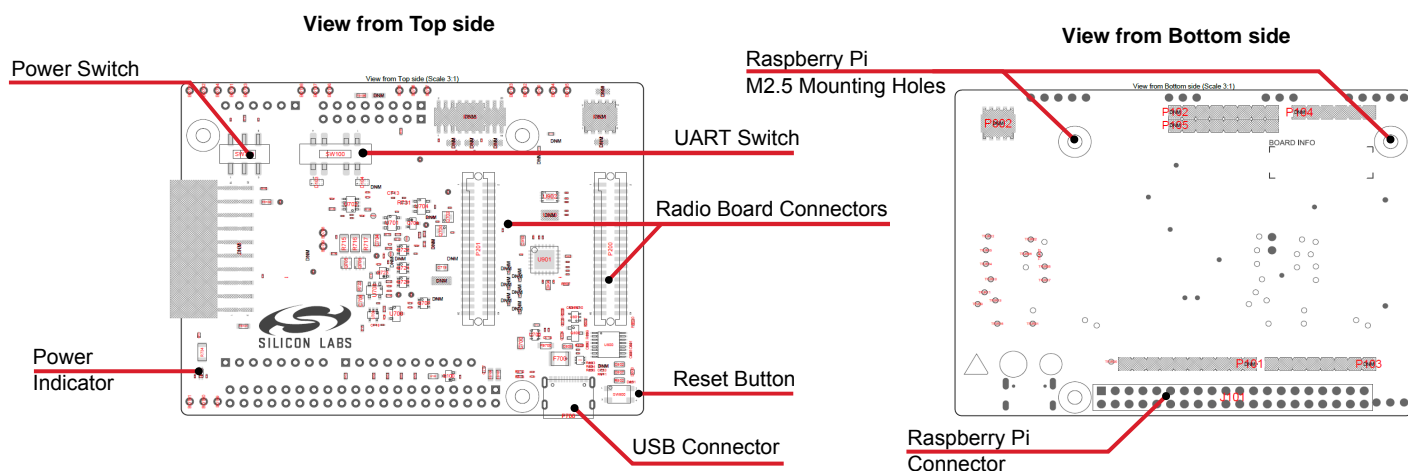


Figure 3.4. BRD8045B Adapter Board Hardware Layout

### 3.4.3 Hardware Layout of BRD8045C

BRD8045C Adapter Board is designed to be mounted on top of a host board featuring an Arduino UNO rev 3 compatible socket, for example STM Nucleo-64 boards, using four pin headers (bottom view).

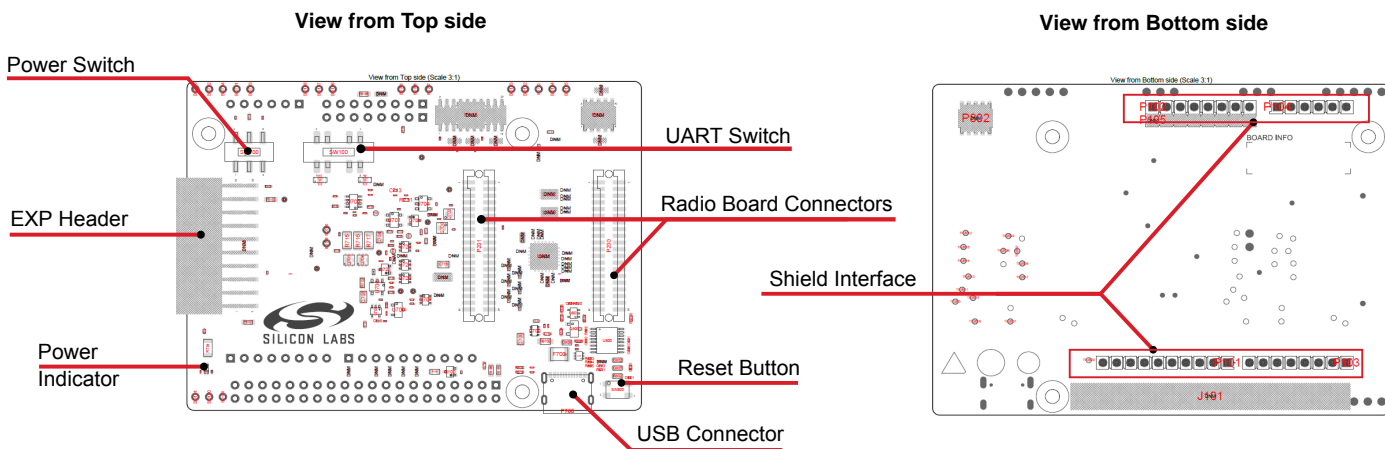


Figure 3.5. BRD8045C Adapter Board Hardware Layout

## 4. Connectors

This chapter gives an overview of the Adapter Board for Co-Processor Radio Boards connectivity.

### 4.1 USB Type-C Connector

The USB Type-C connector is located on the bottom right corner of the board and can be used to provide auxiliary power, or to access In System Programming (ISP) mode.

### 4.2 EXP Header

A right-angle female 20-pin EXP header is provided to connect to a Wireless Pro Kit, as shown in Figure 1.1. The EXP header on the Wireless Pro Kit follows a pinout which ensures that commonly used power nets and peripherals would interface properly when they use communication protocols like SPI and UART. Moreover, a few signals that are specific to SiWx917 Wi-Fi Co-processors, like PTA, Low Power Hand Shake Sleep/Wake Up and RESET are also available on the expansion header. For detailed information regarding the pinout to the expansion header on a specific Wireless Pro Kit, consult the accompanying user's guide.

Alternatively, when connected through a BRD8046A EXP-MicroSD Adapter Board, the EXP header exposes the SDIO peripheral to a Linux machine equipped with a SDcard reader, as shown in Figure 1.2. Such connection does not provide power, hence a USB Type-C cable must be attached to provide power to the board.

The figure below shows how the SiWx917 Wi-Fi Co-processor peripherals are mapped to the EXP header.

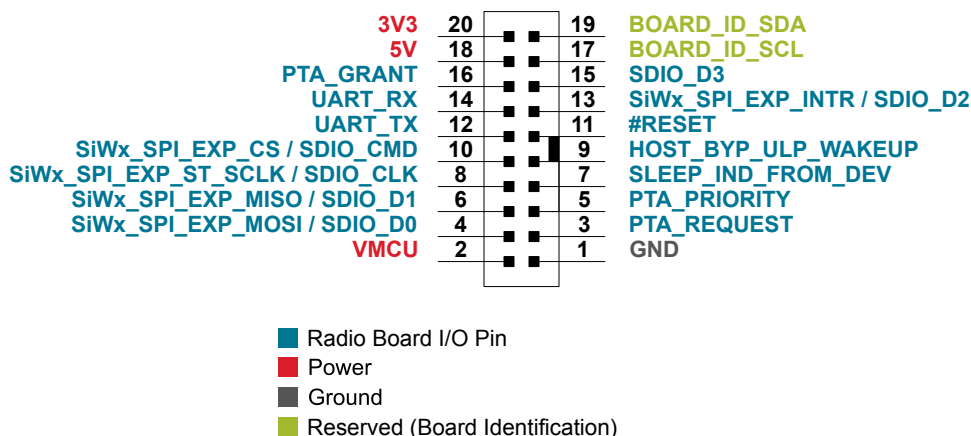


Figure 4.1. Expansion Header

### 4.2.1 EXP Header Pinout

The table below shows the pin assignments of the EXP Header.

**Table 4.1. EXP Header Pinout**

EXP Header	
Pin	Function
20	3V3
18	HOST_5V
16	PTA_GRANT
14	UART_RX
12	UART_TX
10	SPI_CS / SDIO_CMD
8	SPI_SCLK
6	SPI_MISO / SDIO_D1
4	SPI_MOSI / SDIO_D0
2	HOST_IOVDD
19	BOARD_ID_SDA / I2C_SDA
17	BOARD_ID_SCL / I2C_SCL
15	SDIO_D3
13	SPI_INTR / SDIO_D2
11	#RESET
9	WAKEUP
7	SLEEP
5	PTA_PRIORITY
3	PTA_REQUEST
1	GND

### 4.3 Raspberry Pi Connector (HAT)

The Raspberry Pi connector (HAT) is located on the bottom side of the Adapter Board for Co-Processor Radio Boards.

The figure below shows how the SiWx917 Wi-Fi Co-processor peripherals are mapped to the Raspberry Pi Connector.

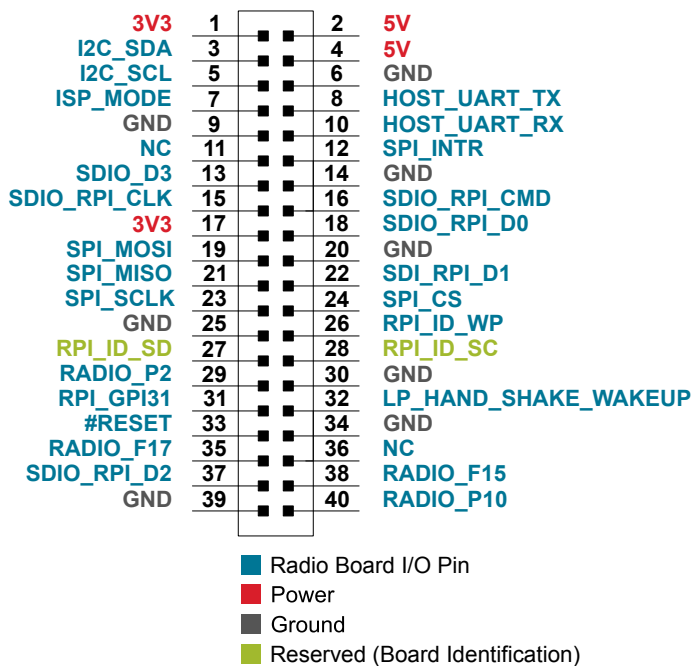


Figure 4.2. Raspberry Pi Connector (HAT)

### 4.3.1 Raspberry Pi Connector (HAT) Pinout

The table below shows the pin assignments of the Raspberry Pi connector, and the port pins and peripheral functions that are available on the Adapter Board.

**Table 4.2. Raspberry Pi Connector (HAT) Pinout**

Raspberry Pi Connector		
Pin(s)	Function	Raspberry Pi Pin
1	3V3	3V3 Power
2	5 V	5V Power
3	I2C_SDA	GPIO 2
4	5 V	5V Power
5	I2C_SCL	GPIO 5
6	GND	GND
7	ISP_MODE	GPIO 4
8	HOST_UART_TX	GPIO 14
9	GND	GND
10	HOST_UART_RX	GPIO 15
11	-	Not Connected
12	SPI_INTR	GPIO 18
13	SDIO_D3	GPIO 27
14	GND	GND
15	SDIO_RPI_CLK	GPIO 22
16	SDIO_RPI_CMD	GPIO 23
17	3V3	3V3 Power
18	SDIO_RPI_D0	GPIO 24
19	SPI_MOSI	GPIO 10
20	GND	GND
21	SPI_MISO	GPIO 9
22	SDIO_RPI_D1	GPIO 25
23	SPI_SCLK	GPIO 11
24	SPI_CS	GPIO 8
25	GND	GND
26	RPI_I2C_WP	GPIO 7
27	I2C_SDA	GPIO 0
28	I2C_SCL	GPIO 1
29	RADIO_P2	GPIO 5
30	GND	GND
31	LP_HAND_SHAKE_SLEEP	GPIO 6
32	LP_HAND_SHAKE_WAKEUP	GPIO 12

Raspberry Pi Connector		
Pin(s)	Function	Raspberry Pi Pin
33	#RESET	GPIO 13
34	GND	GND
35	RADIO_F17	GPIO 19
36	-	Not Connected
37	SDIO_RPI_D2	GPIO 26
38	RADIO_F15	GPIO 20
39	GND	GND
40	RADIO_P10	GPIO 21

#### 4.4 Shield Interface

The Arduino UNO rev 3 compatible Shield interface is a cluster of four pin headers mounted on the bottom side of the Adapter Board for Co-Processor Radio Boards.

The figure below shows how the SiWx917 Wi-Fi Co-processor peripherals are mapped to an Arduino-compatible host board, e.g. a STM Nucleo-64.

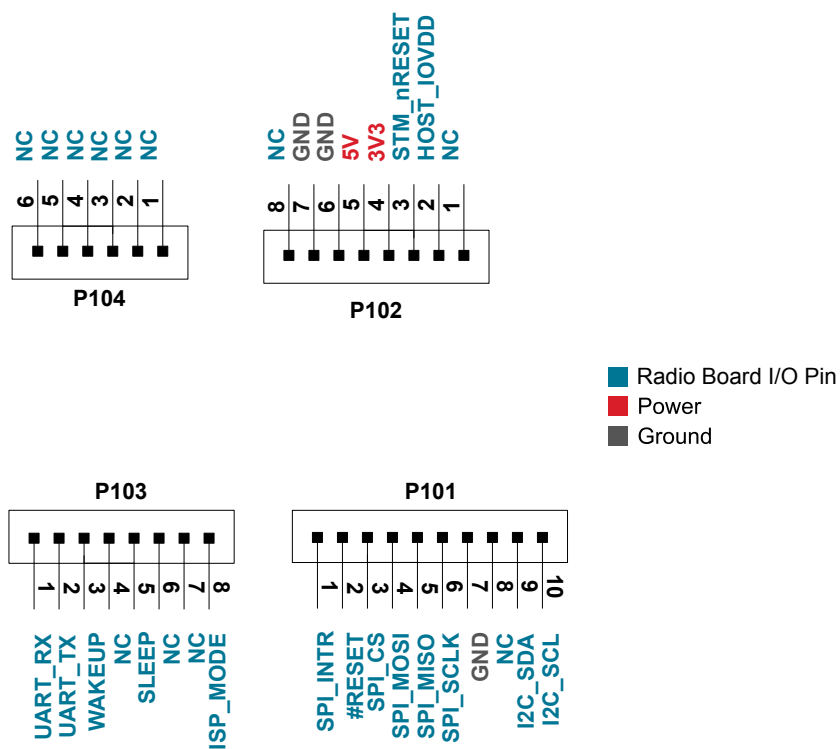


Figure 4.3. Shield Interface

Beyond the connectors described above, the Adapter Board hosts pads to connect a N144 Complimentary SDIO interface, which connects the SDIO peripheral of a Nucleo 144 board, typically a STM32H7 host. An extra connector (P105) must be soldered and six shunt resistors must be moved to divert the signals from SPI/ SDIO peripheral on the Co-processor Radio Board to the SDIO pins. Users who intend to modify the hardware, can find schematic and assembly drawings at [silabs.com](http://silabs.com).



#### 4.4.1 Shield Interface Pinout

The table below shows the pin assignments of the Shield Interface, and the port pins and peripheral functions that are available on the Adapter Board.

**Table 4.3. Bottom Row (P101) Pinout**

Shield Interface		
Pin(s)	Function	Nucleo Shield Pin
1	SPI_INTR	D8
2	#RESET	D9
3	SPI_CS	D10
4	SPI_MOSI	D11
5	SPI_MISO	D12
6	SPI_SCLK	D13
7	GND	Ground
8	-	Not Connected
9	I2C_SDA	D14
10	I2C_SCL	D15

**Table 4.4. Bottom Row (P103) Pinout**

Shield Interface		
Pin(s)	Function	Nucleo Shield Pin
1	UART_RX	D0
2	UART_TX	D1
3	WAKEUP	D2
4	-	Not Connected
5	SLEEP	D4
6	-	Not Connected
7	-	Not Connected
8	ISP_MODE	D7

**Table 4.5. Top Row (P102) Pinout**

Shield Interface		
Pin(s)	Function	Nucleo Shield Pin
1	-	Not Connected
2	HOST_IOVDD	IOREF
3	STM_nRESET	NRST
4	3V3	3V3 Power
5	5 V	5V Power

Shield Interface		
Pin(s)	Function	Nucleo Shield Pin
6	GND	Ground
7	GND	Ground
8	-	Not Connected

**Table 4.6. Top Row (P104) Pinout**

Shield Interface		
Pin(s)	Function	Nucleo Shield Pin
1	-	Not Connected
2	-	Not Connected
3	-	Not Connected
4	-	Not Connected
5	-	Not Connected
6	-	Not Connected

#### 4.5 Breakout Pads

The Breakout Pads are available on the top and bottom edges of the Adapter Board. These have a standard 2.54 mm pitch, and pin headers can be soldered in if required.

The pinout of the connector, as seen from the Co-Processor Radio Boards side, is illustrated in the figure below.

### 4.5.1 Breakout Pads Pinout

Breakout pads are grouped in clusters by function and in most cases positioned at board edges.

#### Power Breakout Pads

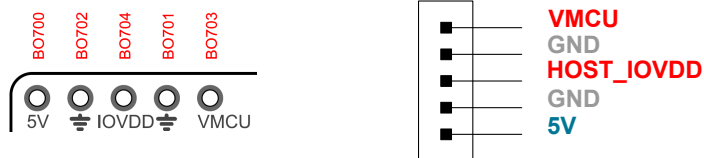


Table 4.7. Power Breakout

Power Breakout		
Pin(s)	Function	Breakout Pads
1	5V	B0700
2	GND	B0702
3	IO_VDD	B0704
4	GND	B0701
5	VMCU	B0703

**Note:** VMCU is for sensing only and no voltage shall ever be applied to this pin.

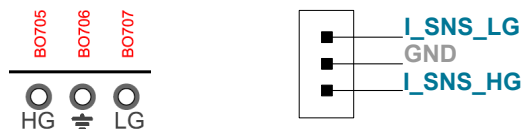
#### PTA Breakout



Table 4.8. PTA Breakout Pads

PTA Breakout		
Pin(s)	Function	Breakout Pads
1	PRE	B0108
2	REQ	B0107
3	GRANT	B0106

### Current Sense Output Breakout Pads



**Table 4.9. Current Sense Output Breakout**

Current Sense Output Breakout		
Pin(s)	Function	Breakout Pads
1	HG	B0705
2	GND	B0706
3	LG	B0707

**Note:** Refer to Section for current consumption.

### UART Breakout Pads

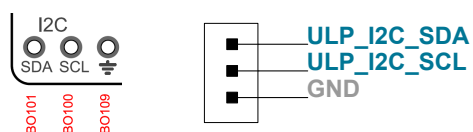


**Table 4.10. UART Breakout**

UART Breakout		
Pin(s)	Function	Breakout Pads
1	UART1_TX	B0103
2	UART1_RX	B0102
3	GND	B0110
4	UART_RX	B0104
5	UART_TX	B0105

**Note:** Breakout pads are directly routed from co processor boards to these pins.

### I2C Breakout Pads

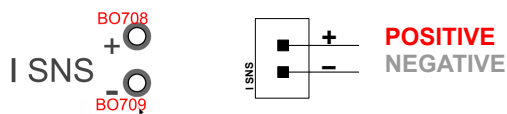


**Table 4.11. I2C Breakout**

I2C Breakout		
Pin(s)	Function	Breakout Pads
1	SDA	B0101
2	SCL	B0100
3	GND	B0109

**Current Sense Breakout Pads**

The Current Sense Breakout pads expose the differential signals positioned far from the board edge, along the current path of the voltage buffer to avoid exposing the circuit to excessive noise.



**Table 4.12. SNS Breakout**

SNS Breakout		
Pin(s)	Function	Breakout Pads
1	Positive	B0708
2	Negative	B0709

## 5. Power Supply

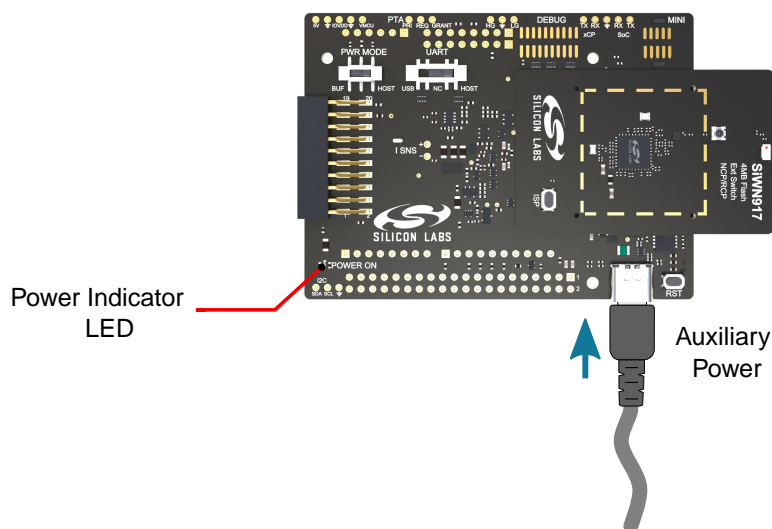
This section covers two important aspects connected to power supply: how to power the Adapter Board and how to power the Co-Processor Radio Boards attached to the Adapter Board.

### 5.1 Board Power Options

The Adapter Board needs a 5V power source to operate correctly.

When the Adapter Board is connected to a compatible Host Board, the 5V power is provided by the host board in a transparent way to the user. When lit, the green light of Power Indicator LED means that the Adapter Board is being powered by the Host Board.

When the Adapter Board is connected to a Host Board which is not capable of providing the necessary amount of power to the Adapter Board, or to a Host connected by means of BRD8046 through an SDcard interface, auxiliary power must be provided to the board by connecting a USB cable to the USB connector on the Adapter Board. The USB power source should be selected so it has enough power to sustain the target application. When lit, the red light of Power Indicator LED means that the Adapter Board is being powered by the auxiliary power input. Whenever a USB cable is connected, the power from the USB interface takes priority over the power from the Host Board, as long as the voltage is greater than 4.4 V.



**Figure 5.1. Adapter Board Auxiliary Power Connector and Power Indicator**

When Power Indicator is not lit, the Adapter Board is not being powered and can not operate.

**Note:** when using a WPK or STK the power switch on the Mainboards must be turned on AEM mode to provide the 5V power to the Adapter Board. To power an EFR or EFM by battery, an auxiliary USB power source should be connected to the Adapter Board first.

## 5.2 Device Power Options

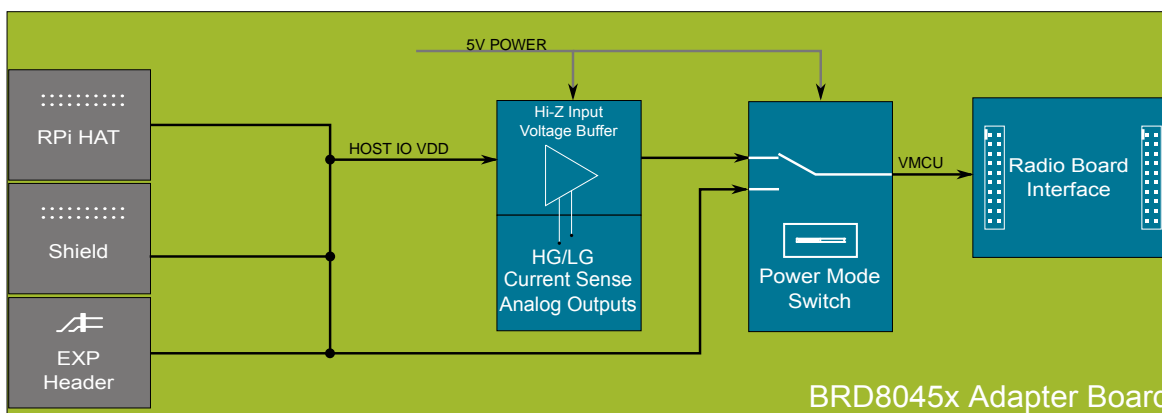
When correctly powered, the Adapter Board interfaces a Host and a Device on different boards and it ensures that the two portions of circuit in communication always operate at the same voltage level. This is important to avoid back-feeding one of the two circuits and to perform correct current measurements.

The power to the target device, typically a SiWN or an EFR32 Co-Processor located on the Radio Board connected to the Adapter Board, is either provided by the Adapter Board or provided by the Host and then routed through the Adapter Board. The selection of the source for the target voltage (VMCU) is operated through the Power Mode Switch on Adapter Board.

The power modes available are:

- **BUF:** a voltage buffer on the Adapter Board senses the Host's voltage and replicates it, sourcing current from the local 5V power net (see board power options). Hence the target device does not draw any current from the Host power domain. In this mode, a built in current sense amplifier provides two analog outputs with different gains which are proportional to the current being drawn by the target device. This mode allows users to measure power consumption for Host and Device separately. This mode is also recommended for high power applications, where the Host voltage rail does not have enough power to ensure correct operation of the device (Co-Processor Radio Boards). Using a Wireless Pro Kit with a Radio Board carrying an EFR32 acting as Host, in this mode the Energy Profiler would only track the current consumed by the EFR32 device and not by the Co-Processor Radio Boards.
- **HOST:** the on board buffer is disengaged, Host and Device power domains are directly connected. This mode allows measuring power consumption of Host and Device together. For example, using a Wireless Pro Kit with a Radio Board carrying an EFR32 acting as Host and a Adapter Board with a Co-Processor Radio Board carrying a SiWN91x Device, the Energy Profiler would track the current absorbed by both EFR32 and SiWN91x Device at the same time.

Default from factory is BUF mode. For both modes, the Adapter Board accepts Host operating with voltages varying between 1.8V and 3.6V.



**Figure 5.2. Adapter Board Power Topology**

## 6. Current Measurements

Measuring current consumption of a Co-processor is in general a more complex task than measuring the consumption of a Microcontroller. While a Microcontroller can be programmed for test purposes, to enter a determinate state (e.g. sleep state) at start up, a Co-processor typically needs a Host that sends specific instructions to operate and enter a determinate state, which one might want to investigate. When measuring consumption currents, it is essential that the Host and the Co-processor communication ports are connected and the signal levels refer to equivalent potentials, i.e. Host and the Co-processor IO ports must operate at equal voltages. If significant differences arise, there will be current flowing through the IO lines, bypassing the power pins of the IC. Back-feeding conditions alter current measurements, producing invalid results. To complicate things further, back-feeding might occur dynamically, e.g. when the Co-processor wakes up and starts sending and receiving, hence pass unnoticed if only checking steady state operation. Accurate current meters use variable resistances to measure currents in different ranges, but they have limited dynamic response and might cause back-feeding when the load level suddenly increases.

The methods described in this section aim to secure correct operation with regard to the respective power domains of Host and Co-processor, avoid them back-feeding one another. Which method to choose depends on the scope of the measurement. While the first method is more appropriate for debugging fast transients and changes of state, the second method produces more accurate average values, useful to estimate sleep currents and battery lifetime.

Before measuring power consumption with the BRD8045x Adapter Board, the user is recommended to read the section [5. Power Supply](#) to become familiar with the power modes and to be able to choose a suitable method to measure current, suitable for the selected power mode.

### 6.1 Analog Outputs

When in BUF mode, the on-board voltage buffer sources current to the Co-processor, securing correct operation, i.e. balance between the Host and Co-processor power domains, under static and dynamic operation. This circuit provides two single-end, uncalibrated analog voltage outputs with different gains, namely:

- LG (BO707) Low Gain Current Sense output with a gain factor of 1 A/V. A read of 30mV corresponds to 30mA current<sup>1</sup>
- HG (BO705) High Gain Current Sense output with a gain factor of 101 A/V. A read of 30mV corresponds to 297  $\mu$ A current<sup>1</sup>

Furthermore, an unamplified differential voltage output across a 0.5  $\Omega$  sense resistor is provided (I\_SNS +/-).

Examples of suitable instruments to measure the single-end voltage outputs digital voltmeters and oscilloscope. Probes must have high impedance, in the range 1 M $\Omega$  -10 M $\Omega$ . These values are common to the majority of commercial digital voltmeters and oscilloscopes. For measuring the differential voltage output at least 10 M $\Omega$  probes are recommended.

- Digital Voltmeters or Multimeters are suitable instruments to measure average currents. To avoid aliasing when using averaging instruments, make sure that the averaging window is at least one order of magnitude larger than the longest period (cycle) implemented in firmware. A digital Voltmeter might be helpful to estimate battery lifetime
- Oscilloscopes have often a lower resolution than the instruments mentioned above, but they are able to track dynamic changes in current patterns. Refer to section [2.2 Operating Characteristics](#) to see the available bandwidth of each of the two single end analog voltage outputs. An oscilloscope might be helpful to debug changes of states

For more details about Break Out pads and their physical location on the board refer to section [4.5.1 Breakout Pads Pinout](#) .

**Zero-current voltage:** the output have a variable offset, addressed in this guide as the Zero-current voltage. The Zero-current voltage varies with manufacturing parameters and operating temperature. To calculate the absolute value of the current consumption the Zero-current voltage must be read first and then subtracted. To read the Zero-current voltage it is sufficient to move the power switch to HOST mode and read the output voltage. To continue reading actual currents, the power mode switch needs to be turned back to BUF mode.

For detailed specifications about the current sense outputs refer to section [2.2 Operating Characteristics](#).

Procedure summary for reading average currents with analog outputs:

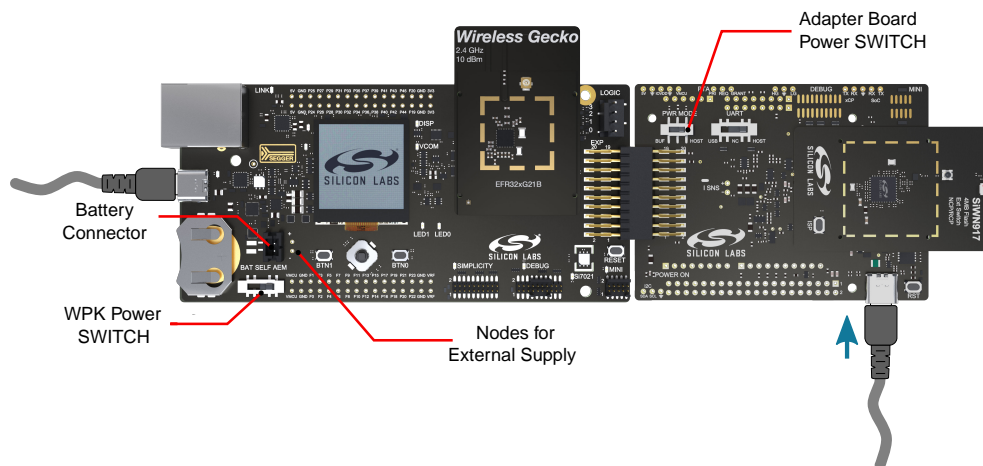
1. Switch to HOST mode and read the Zero-current voltage
2. Switch to BUF mode and read the current consumption. Make sure the averaging window is appropriate for the periodical events imposed by the application code running
3. Subtract the Zero-current voltage found in step 1 to the current read in step 2 to find the actual current consumptions

**Note:** It is important to account for Zero-current voltage when measuring small currents, e.g. sleep currents. However, for larger currents than 50mA the Zero-current voltage will account for less than 1%



## 6.2 Using External Current Meters

When in HOST mode, the current drawn by the Co-processor is tracked along with the current drawn by the Host and other devices on the same power domains. In other words, it is not possible to obtain a direct measure of the current consumption of the Co-processor only using HOST mode, but it might be helpful for deriving an indirect measure. An example of indirect measure, using Studio's Energy Profiler and the set up in Figure 1.1, is switching between HOST mode to measure the total power consumption, and BUF mode to read the EFR32 power consumption. The difference of the two average readings will provide an indirect estimate of the average current. Alternatively, the same method can be used to connect an external meter to the auxiliary Nodes for External supply on the Wireless Pro Kit. In this configuration, the power switch on the Wireless Pro Kit must be turned to BAT mode and auxiliary power connected to the Adapter Board, as shown in the figure below. Refer to AN969 for more details about current measurement with Wireless Gecko Devices.



**Figure 6.1. Example of current measurement set up with external meter**

Procedure summary for reading average currents with external current monitoring tools:

1. Switch to HOST mode and read the total current consumption of Host + Co-processor. Make sure the averaging window is appropriate for the periodical events imposed by the application code running
2. Switch to BUF mode and read the current consumption of the Host alone.
3. Subtract the Host current found in step 1 to the current read in step 2 to estimate the average current consumptions of the Co-processor

**Note:** 2. The above analog voltage outputs of the on-board voltage buffer do not produce any valid output in HOST mode and can not be used for other purposes than reading the Zero-current voltage

## 7. Downloading Firmware to SiWx917 Wi-Fi Co-processors

Co-Processor Radio Boards feature an ISP button for In System Programming, i.e. to load firmware to SiWx devices. For manual activation of the ISP mode, i.e. to let the SiWx device located on the Co-Processor Radio Boards enter ISP mode:

- the Adapter Board must be connected to a compatible host board
- UART switch must be turned on USB mode
- a USB cable must be connected to the USB connector on the Adapter Board, as shown in Figure 6.1 for example, to activate the on-board USB-UART bridge
- both ISP and RESET buttons must be pressed then released in the following sequence:
  - RESET first
  - ISP then

In this state, after receiving a *vertical bar* or *pipe* symbol ( | ), the SiWx device will prompt the ISP menu. Default Baud Rate is 115200 bps. This can be changed once connected through the ISP menu.

To remotely activate the ISP mode <sup>1</sup> from the Host over UART interface, the UART switch must be turned on HOST. The RESET and ISP signals must be pulled low (activated) and released respecting the sequence as described above. If SPI or SDIO interfaces are used to download firmware the UART switch has no relevance. The RESET line is mapped on all host interfaces.

If no USB cable is connected, the USB bridge is deactivated to avoid undesired activity on the UART lines. The USB bridge is powered by the on-board 5V rail and does not draw current from the Device power domain.

**Note:** 1. Remote ISP line is only with BRD8045B and BRD8045C host interfaces.

## 8. Schematics, Assembly Drawings, and BOM

Schematics, assembly drawings, and bill of materials (BOM) are available through Simplicity Studio when the kit documentation package has been installed. They are also available from the kit page on the Silicon Labs website: [silabs.com](https://silabs.com).

## 9. Kit Revision History

The kit revision can be found printed on the kit packaging label, as outlined in the figure below. The revision history given in this section may not list every kit revision. Revisions with minor changes may be omitted.

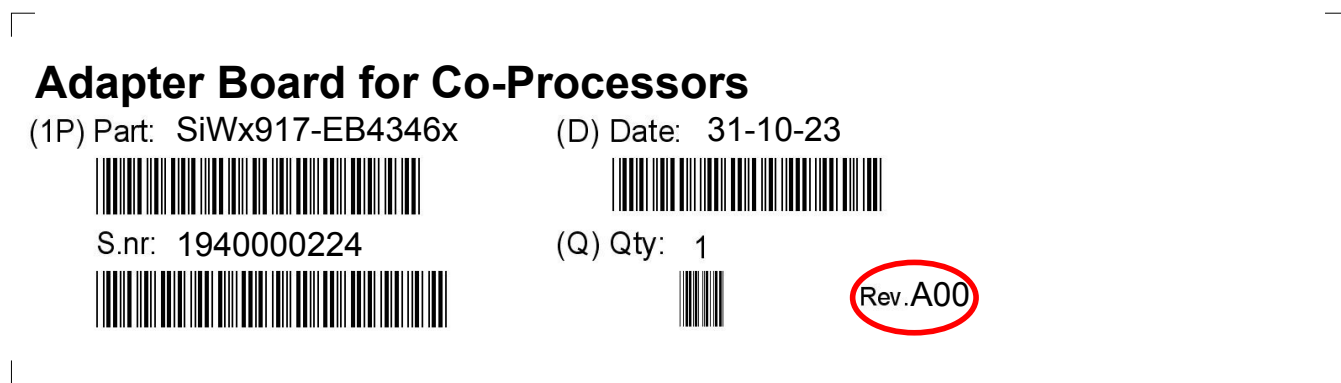


Figure 9.1. Kit Label

### 9.1 SiWx917-EB4346A Revision History

Kit Revision	Released	Description
A00	31 October 2023	Initial release.

### 9.2 SiWx917-EB4346B Revision History

Kit Revision	Released	Description
A00	31 October 2023	Initial release.

### 9.3 SiWx917-EB4346C Revision History

Kit Revision	Released	Description
A00	31 October 2023	Initial release.

## 10. Document Revision History

### Revision 1.0

December 2023

- Initial document revision.

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