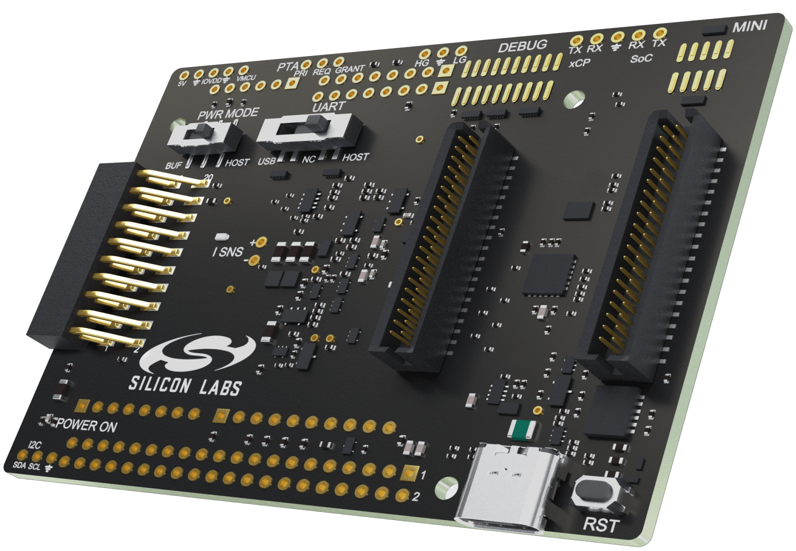
UG569: Adapter Board for Co-processor Expansion Kit User's Guide

The Adapter Board for Co-processor Expansion Kit is an excellent way to explore and evaluate co-processor radio boards with various host devices using either SPI or SDIO interfaces. Examples of host devices are EFM32 or EFR32 devices, Raspberry Pi or other Linux machines with an SDcard interface and STM microcontrollers.

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

The kit comes in three different variants as Si-EB8045A, Si-EB8045B, and Si-EB8045C, 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, such as STM32 Nucleo-64 boards.



ADAPTER BOARD COMMON FEATURES

- Device Interface: Silicon Labs Wireless Radio Boards
- USB port for In System Programming (ISP) of SiWx91x Devices
- Power Source Selector
- 2x analog Current Sense outputs with different gains
- Reset button
- Breakout pads

BRD8045A FEATURES

- Silicon Labs EXP interface for EFM32 or EFR32 Devices Wireless Pro Kit
- EXP-MicroSD Adapter Board (BRD8046A) for other Linux machines (SDIO)
- SiWx917-EB4346A
- Si-EB8045A

BRD8045B FEATURES

- HAT compatible interface for Raspberry Pi
- Si-EB8045B

BRD8045C FEATURES

- Arduino UNO rev 3 compatible Shield interface for boards such as STM32 Nucleo-64
- Si-EB8045C

Table of Contents

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, Raspberry Pi, and some of the most popular open-source platforms like Raspberry Pi, and any other host platform with an Arduino Uno interface like the 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.

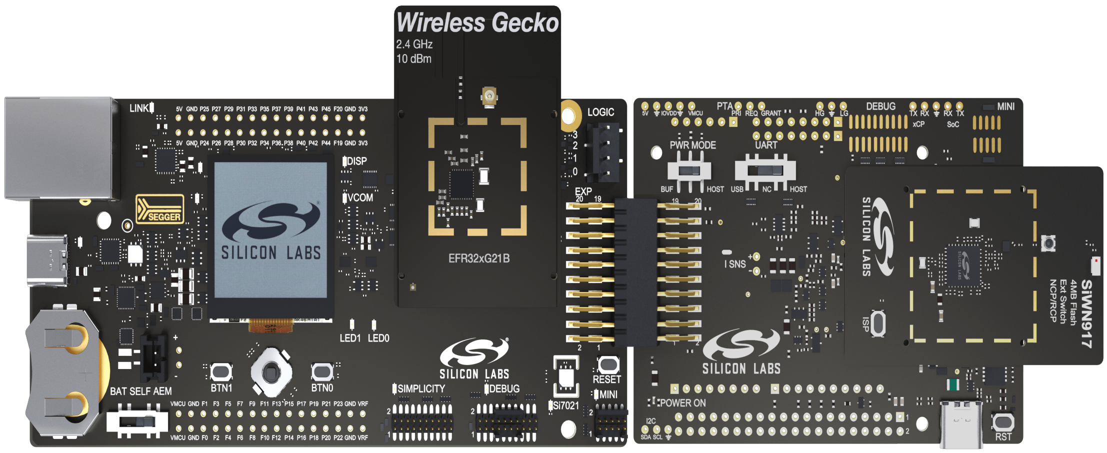


Figure 1.1. Adapter Board (BRD8045A) Connected to a Silicon Labs Wireless Pro Kit Board

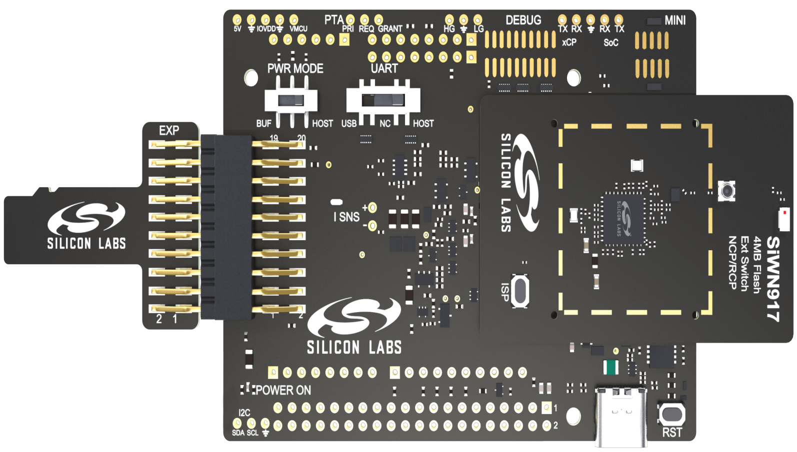


Figure 1.2. Adapter Board (BRD8045A) Connected to a Silicon Labs EXP-MicroSD Adapter Board

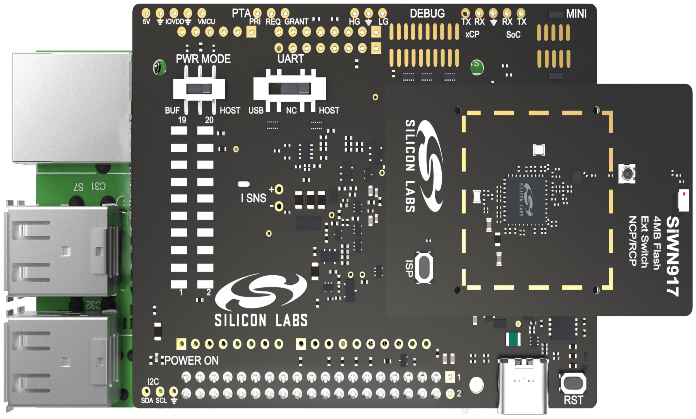


Figure 1.3. Adapter Board (BRD8045B) Connected to a Raspberry Pi

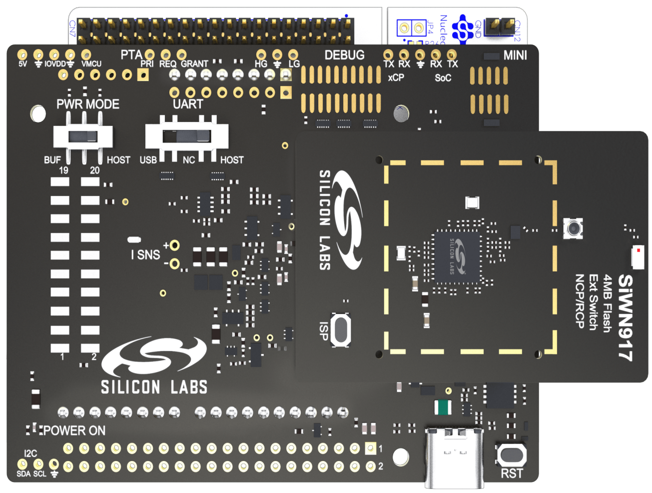


Figure 1.4. Adapter Board (BRD8045C) Connected to a NUCLEO-F411RE

1.1 Ordering Information

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 SiWN917 NCP/RCP Radio Board 1x BRD8045A EXP Adapter Board for Co-processor 1x BRD8046A EXP-MicroSD Adapter Board
Si-EB8045A	EXP Adapter Board for Co-processor Expansion Kit	1x BRD8045A EXP Adapter Board for Co-processor 1x BRD8046A EXP-MicroSD Adapter Board
Si-EB8045B	Raspberry Pi Adapter Board for Co-processor Expansion Kit	1x BRD8045B Raspberry Pi Adapter Board for Co-processor
Si-EB8045C	Shield Adapter Board for Co-processor Expansion Kit	1x BRD8045C Shield Adapter Board for Co-processor

1.2 Prerequisites and Compatibility

Prerequisites

In general, the Si-EB8045x Adapter Board for Co-processor Expansion Kit needs a compatible host board and a Silicon Labs' co-processor radio board to work.

The different variants of Adapter Boards are designed to be interfaced with different types of host boards. Since the Adapter Board either use or replicate the host power supply, a host board always needs to be connected during operation.

Hardware compatibility

The following table gives an overview of the board variants and compatible hardware.

Table 1.2. Hardware Compatibility

Part Number	Compatible Host Boards	Compatible Radio Boards	Peripherals
Si-EB8045A	• Silicon Labs' MCU Starter Kits • Silicon Labs' Wireless Starter Kits • Silicon Labs' Wireless Pro Kits • Si-MB4002A Wireless Pro Kit Mainboard[1]	• SiWx91x co-processor radio boards	• SPI • UART
	• Other hosts with a mini SDIO card slot		• SDIO (through BRD8046A)

Si-EB8045B	• Raspberry Pi 4 Model B or later
	• Raspberry Pi 3 Model B[2]
		• SiWx91x co-processor radio boards
		• EFR32 co-processor radio boards
			• with SiWx91x radio boards:
			  • SDIO
			  • UART
			• with EFR32 radio boards:
			  • SPI

Si-EB8045C	Any host board featuring an Arduino UNO Rev 3 socket, e.g. • STM32F411RE STM Nucleo-64 development kit	• SiWx91x co-processor radio boards	• SPI • UART

Note: 1. The Wireless Pro Kit Mainboard needs to be combined with a radio board (host) to work in this context

Note: 2. using the SDIO interface mapped to the HAT connector of a Raspberry Pi 3 might limit the use of other on-board modules

Any Silicon Labs Starter Kit or Wireless kit will work, however some specific kits might have shared functionality mapped to the EXP header (section EXP Header Pinout). Users are encouraged to check connectivity of SPI INTR and SPI CS before selecting a Starter Kit or a radio board.

Note that while the Si-EB8045B will offer some functionality when used with an EFR32 radio board, connecting the SPI interface to the Raspberry Pi processor throught the HAT interface, the Si-EB8045A and Si-EB8045C will not work with EFR32 radio boards used as NCP.

2. Specifications

2.1 Recommended Operating Conditions

The following table is intended to serve as guideline for a correct use of the Adapter Board for Co-processor Expansion Kit, 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 V[1]	I_D	—	—	1.5	A
Maximum Load Current, V_{VMCU} = 1.8 V[1]	I_D	—	—	0.8	A
Operating Temperature	T_{OP}	0	20	40	˚C
Note: 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}	—	1.5	—	kHz
Output Accuracy	V_{HG}	—	± 22	—	µV
		—	± 0.22	—	µA
Output Offset	V_{HG}	0	30	60	mV
Output Temperature Drift	V_{HG}	—	1.5	—	µV/°C
		—	0.015	—	µA/°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}	—	4800	—	kHz
Output Accuracy	V_{LG}	—	± 0.15	—	µV
		—	± 0.15	—	µA
Output Offset	V_{LG}	0	0.3	0.6	mV
Output Temperature Drift	V_{LG}	—	0.01	—	µV/°C
		—	0.01	—	µA/°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 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 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.

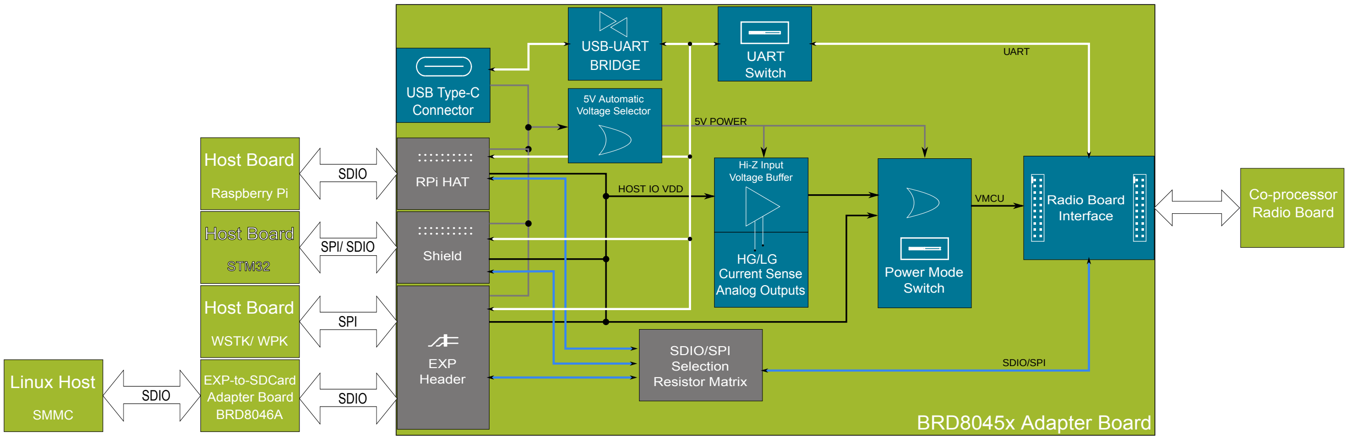


Figure 3.1. Kit Block Diagram

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 SiWx91x 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.

Here is an overview of the signal routed to the host interface, by product variant, relevant to both co-processor and SoC radio boards:

Table 3.1. Overview of Host Connectivity

BRD8045A	BRD8045B	BRD8045C
SPI/SDIO	SDIO	SPI
UART	UART	UART
—	I^2C	I^2C
Low-power Handshake	Low-power Handshake	Low-power Handshake
Reset	Reset	Reset
—	In System Programming (ISP) control	In System Programming (ISP) control
Packet Trafic 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 SiWx91x Wi-Fi co-processor, supporting ISP mode. A slide switch allow users to connect this port either to the host, for remote programming, 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 SiWx91x device family. Users who intend to modify the hardware to remap the UART data lines can find schematic and assembly drawings at silabs.com. Both System on Chip and co-processor UART data lines are always available on four breakout 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 breakout pads.
- HOST – This mode enables the co-processor board to connect to the host's UART peripheral.

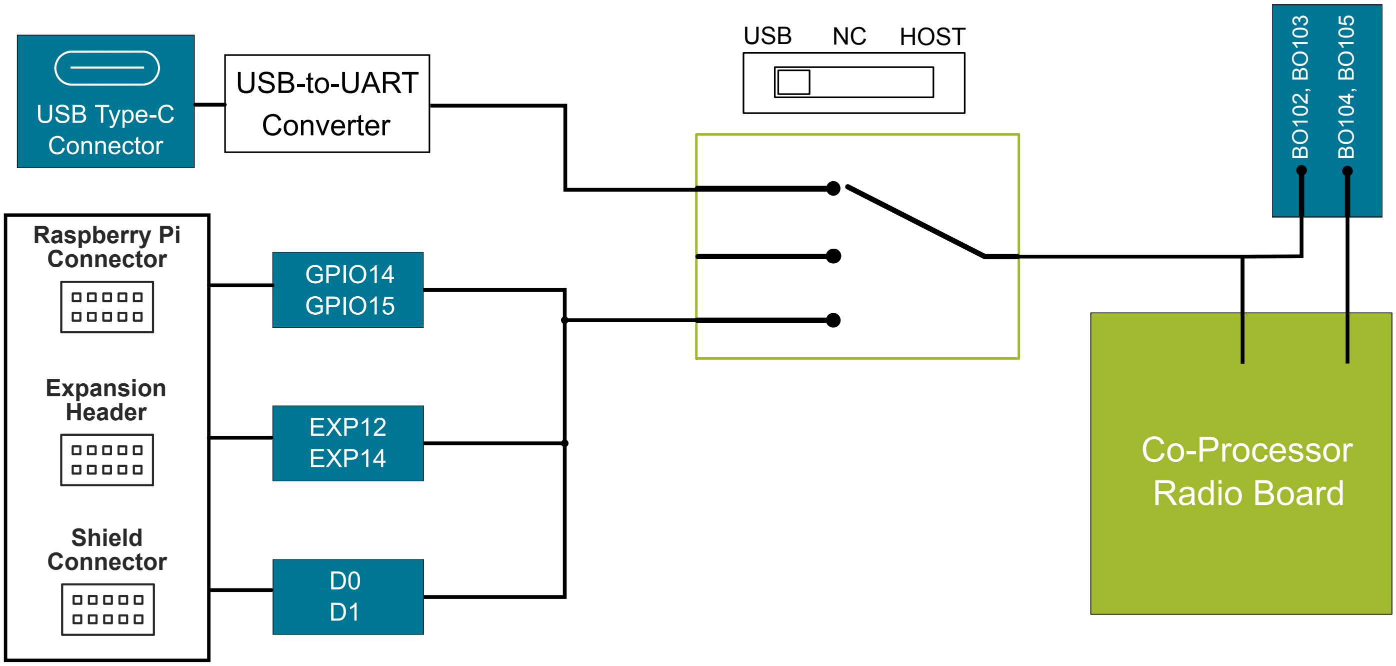


Figure 3.2. UART Slide Switch

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 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 correcly 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:

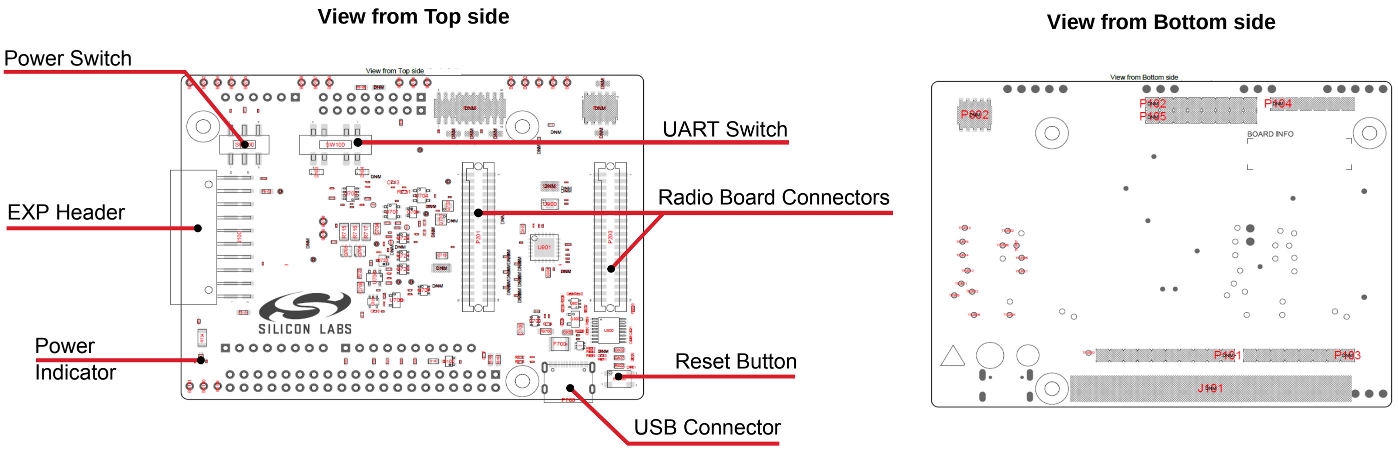


Figure 3.3. BRD8045A Adapter Board Hardware Layout

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.

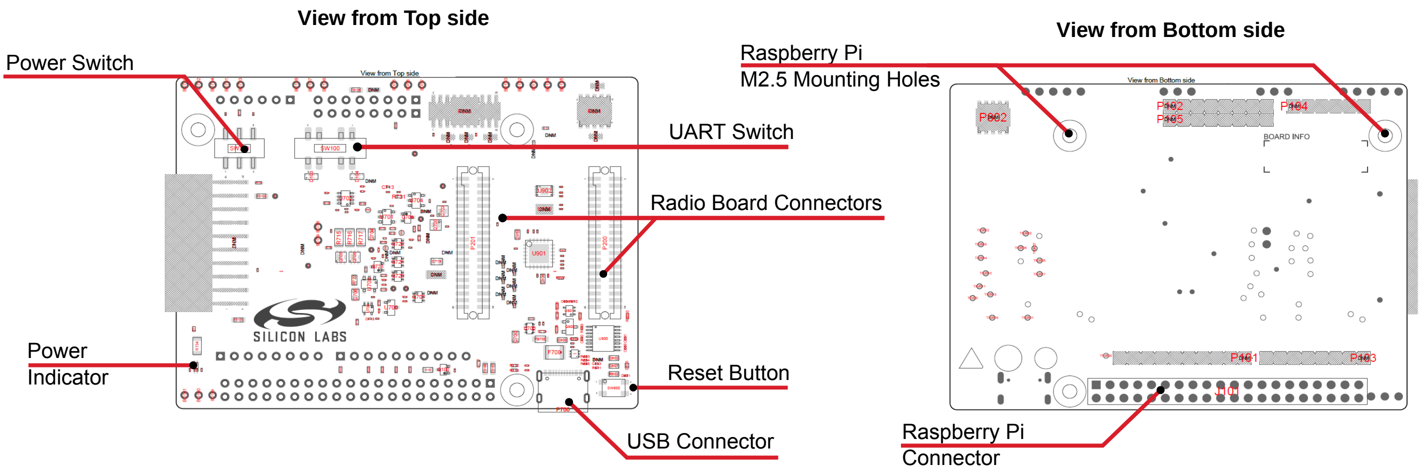


Figure 3.4. BRD8045B Adapter Board Hardware Layout

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).

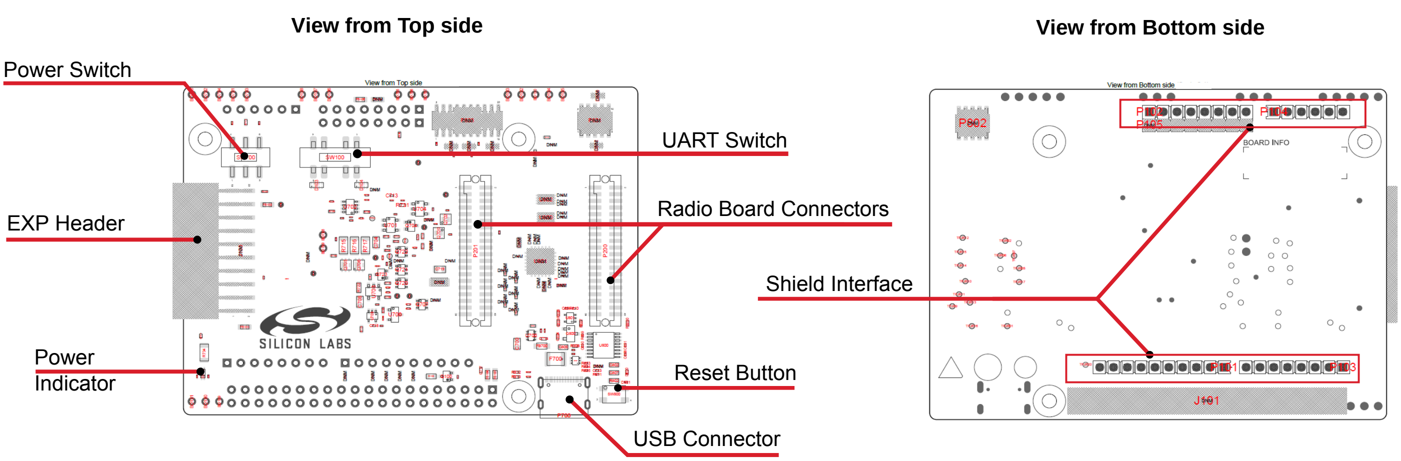


Figure 3.5. BRD8045C Adapter Board Hardware Layout

4. Connectors

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

4.1 Radio Board Connectors

Co-processor radio boards are attached to the headers located at the right side of the Adapter Board, as shown in the figures in section 1. Introduction, with the antenna pointing outward and to the right.

4.2 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 and access the UART peripheral over a built-in USB bridge, typically used to download firmware to co-processors.

4.3 EXP Header

A right-angle, female, 20-pin EXP header is provided to connect to a Wireless Pro Kit, as shown in the figure below. The EXP header on the Wireless Pro Kit follows a pinout which ensures that commonly used power nets and peripherals interface properly when they use communication protocols like SPI and UART. Moreover, a few signals that are specific to SiWx91x Wi-Fi co-processors, like PTA, Low-power Handshake 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 an SDcard reader, as shown in Figure 1.2 Adapter Board (BRD8045A) Connected to a Silicon Labs EXP-MicroSD Adapter Board on page 4. Such connection does not provide power, so a USB Type-C cable must be attached to provide power to the board.

The figure below shows how the SiWx91x Wi-Fi co-processor peripherals are mapped to the EXP header.

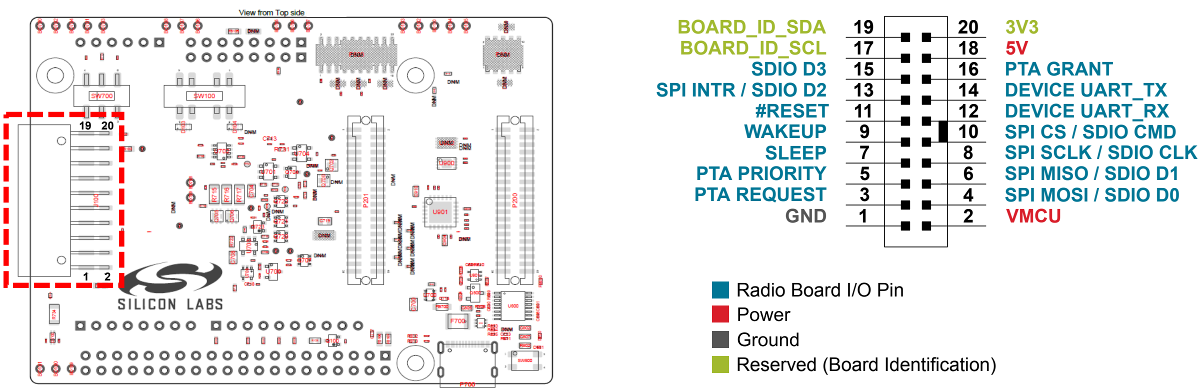


Figure 4.1. Expansion Header

4.3.1 EXP Header Pinout

The table below shows which pins and functions of a SiWx91x co-processor are mapped to the EXP header. Note that some pins are shared between the EXP header and other functions on the Wireless Pro Kit mainboard. For a complete description of Silicon Labs' EXP header and shared functions, users are encouraged to consult UG573: Si-MB4002A Wireless Pro Kit Mainboard User's Guide.

Table 4.1. EXP Header Pinout

Pin	EXP Standard Functions	Co-processor Default Function	Description
20	3V3	—	Reserved. Board identification
18	5V	HOST 5V	WPK USB power, supplies the on-board voltage buffer
16	I2C SDA	PTA GRANT	Packet Trafic Arbitration, Grant
14	UART RX	DEVICE UART TX	co-processor TX / Host RX
12	UART TX	DEVICE UART RX	co-processor RX / Host TX
10	SPI CS	SPI CS / SDIO CMD	Typical usage is SPI with Silicon Labs' EFR32 hosts, or SDIO for other hosts[1]
8	SPI CLK	SPI CLK / SDIO CLK	Typical usage is SPI with Silicon Labs' EFR32 hosts, or SDIO for other hosts[1]
6	SPI MISO	SPI MISO / SDIO D1	Typical usage is SPI with Silicon Labs' EFR32 hosts, or SDIO for other hosts[1]
4	SPI MOSI	SPI MOSI / SDIO D0	Typical usage is SPI with Silicon Labs' EFR32 hosts, or SDIO for other hosts[1]
2	VMCU	HOST IOVDD	Host power rail
19	BOARD ID SDA	—	Reserved. Board identification
17	BOARD ID SCL	—	Reserved. Board identification
15	I2C SCL	SDIO D3	For use with EXP-MicroSD Adapter Board (BRD8046A)
13	GPIO	SPI INTR / SDIO D2	Typical usage is SPI with Silicon Labs' EFR32 hosts, or SDIO for other hosts[1]
11	GPIO	#RESET	Device reset, active low
9	GPIO	WAKEUP	Low-power Handshake, Wakeup
7	GPIO	SLEEP	Low-power Handshake, Sleep
5	GPIO	PTA PRIORITY	Packet Trafic Arbitration, Priority
3	GPIO	PTA REQUEST	Packet Trafic Arbitration, Request
1	GND	GND	Ground

Note:

1. SPI signals are mapped to a subset of the same pins that are used for SDIO in SiWx917 chips. When the BRD8045A EXP Adapter Board for Co-processor is used with a Wireless Pro Kit, the EFR32 host controller will connect to the co-processor through the SPI peripheral mapped to the EXP connector on the WPK mainboard. When the Adapter Board is used with the BRD8046A EXP-MicroSD Adapter Board (included), and is connected to an SD card slot of a generic host, the host will connect to the co-processor through a SDIO peripheral available on the SD card slot.

4.4 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 SiWx91x Wi-Fi co-processor peripherals are mapped to the Raspberry Pi Connector.

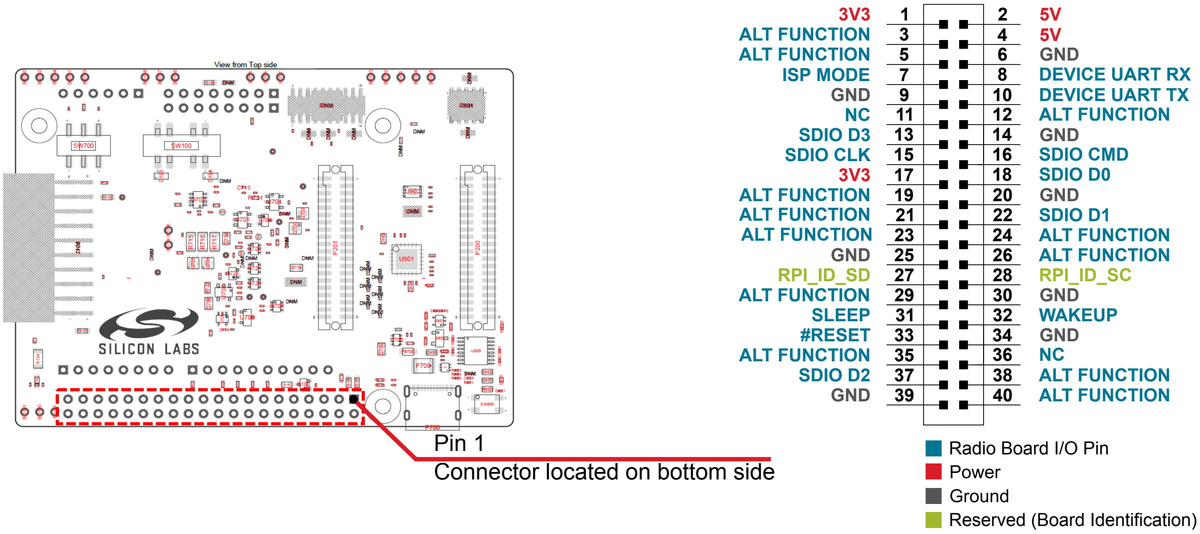


Figure 4.2. Raspberry Pi Connector (HAT)

4.4.1 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

HAT Pin	Raspberry Pi Pin	Co-processor Default Function	Description
1	3V3 Power	3V3	Raspberry Pi MCU power rail
2	5V Power	5 V	Raspberry Pi USB power, supplies the on-board voltage buffer
3	GPIO 2	—	None. Alt function for SiWG91x SoC: I2C_SDA
4	5V Power	5 V	Raspberry Pi USB power, supplies the on-board voltage buffer
5	GPIO 3	—	Alt function for SiWG91x SoC: I2C_SCL
6	GND	GND	Ground
7	GPIO 4	ISP MODE	Force ISP mode from host
8	GPIO 14	DEVICE UART RX	co-processor UART RX /Raspberry Pi TX
9	GND	GND	Ground
10	GPIO 15	DEVICE UART TX	co-processor UART TX / Raspberry Pi RX
11	GPIO 17	—	Not connected
12	GPIO 18	—	Alt function for EFR32: SPI_INTR
13	GPIO 27	SDIO D3	SDIO data
14	GND	GND	Ground
15	GPIO 22	SDIO CLK	SDIO Clock
16	GPIO 23	SDIO CMD	SDIO Command / Response
17	3V3 Power	3V3	Raspberry Pi MCU power rail
18	GPIO 24	SDIO D0	SDIO data
19	GPIO 10	—	Alt function for EFR32: SPI_MOSI
20	GND	GND	Ground
21	GPIO 9	—	Alt function for EFR32: SPI_MISO
22	GPIO 25	SDIO D1	SDIO data
23	GPIO 11	—	Alt function for EFR32: SPI_SCLK
24	GPIO 8	—	Alt function for EFR32: SPI_CS
25	GND	GND	Ground
26	GPIO 7	—	Alt function for other SoCs: spare GPIO
27	GPIO 0	—	HAT device identification SD
28	GPIO 1	—	HAT device identification SC
29	GPIO 5	—	Alt function for other SoCs: spare GPIO
30	GND	GND	Ground
31	GPIO 6	SLEEP	Low-power Handshake, Sleep

HAT Pin	Raspberry Pi Pin	Co-processor Default Function	Description
32	GPIO 12	WAKEUP	Low-power Handshake, Wakeup
33	GPIO 13	#RESET	Device reset, active low
34	GND	GND	Ground
35	GPIO 19	—	Alt function for other SoCs: spare GPIO
36	GPIO 16	—	Not connected
37	GPIO 26	SDIO D2	SDIO data
38	GPIO 20	—	Alt function for other SoCs: spare GPIO
39	GND	GND	Ground
40	GPIO 21	—	Alt function for other SoCs: spare GPIO

4.5 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 SiWx91x Wi-Fi co-processor peripherals are mapped to an Arduino-compatible host board, such as a STM Nucleo-64 (right). To ease probing, the location of the Shield Interface connectors is shown from the top side, while connectors are located on the bottom side (left).

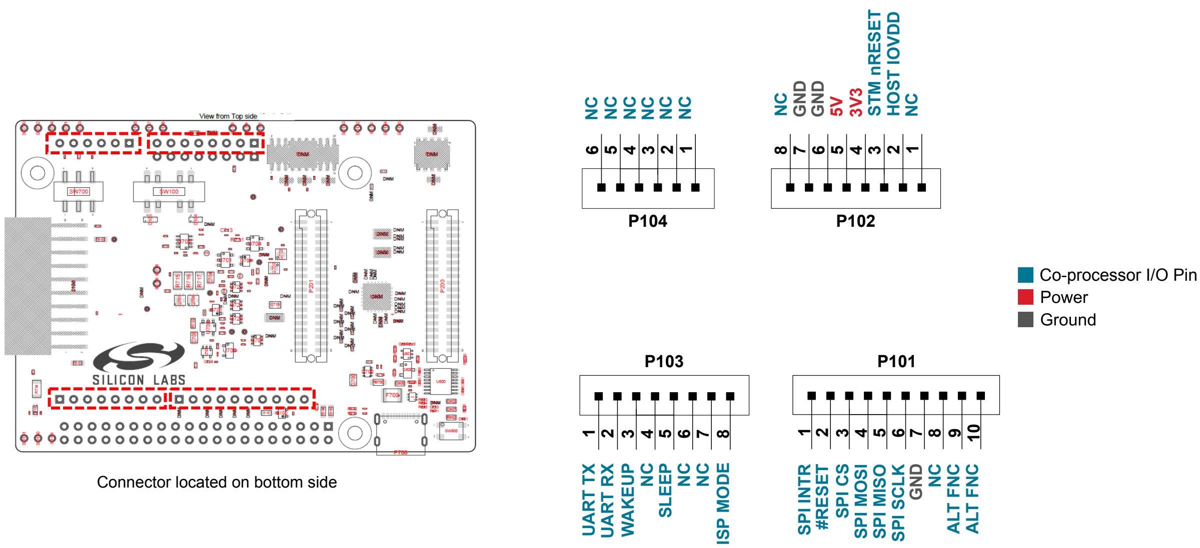


Figure 4.3. Shield Interface

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.

4.5.1 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

P101	STM Nucleo 64	Co-processor Default Function	Description
1	D8	SPI INTR	SPI Interrupt
2	PWM/D9	#RESET	Device reset, active low
3	PWM/CS/D10	SPI CS	SPI Chip Select
4	PWM/MOSI/D11	SPI MOSI	SPI Main Output Secondary Input
5	MISO/D12	SPI MISO	SPI Main Input Secondary Output
6	SCK/D13	SPI SCLK	SPI Clock
7	GND	GND	Ground
8	AVDD	—	Not Connected
9	SDA/D14	—	Alt function for SiWG91x SoC: I2C_SDA
10	SCL/D15	—	Alt function for SiWG91x SoC: I2C_SCL

Table 4.4. Bottom Row (P103) Pinout

P103	STM Nucleo 64	Co-processor Default Function	Description
1	RX/D0	DEVICE UART TX	co-processor UART TX / Host RX
2	TX/D1	DEVICE UART RX	co-processor UART RX / Host TX
3	D2	WAKEUP	Low-power Handshake, Wakeup
4	PWM/D3	—	Not connected
5	D4	SLEEP	Low-power Handshake, Sleep
6	PWM/D5	—	Not connected
7	PWM/D6	—	Not connected
8	D7	ISP MODE	Force ISP mode from host

Table 4.5. Top Row (P102) Pinout

P102	STM Nucleo 64	Co-processor Default Function	Description
1	NC	—	Not connected
2	IOREF	HOST IOVDD	Host IO power rail
3	NRST	STM nRESET	Host reset from on-board Reset Button (SW800), active low.
4	3V3 Power	3V3	Not connected
5	5V Power	5 V	Host USB power, supplies the on-board voltage buffer
6	GND	GND	Ground
7	GND	GND	Ground

P102	STM Nucleo 64	Co-processor Default Function	Description
8	VIN	—	Not connected

Note: In BRD8045C Shield Adapter Board for Co-processor the Reset Button resets both Host and Device.

Table 4.6. Top Row (P104) Pinout

P104	STM Nucleo 64	Co-processor Default Function	Description
1	A0	—	Not connected
2	A1	—	Not connected
3	A2	—	Not connected
4	A3	—	Not connected
5	A4	—	Not connected
6	A5	—	Not connected

4.6 Breakout Pads

Breakout pads are through hole pads grouped in clusters by function, mostly positioned at board edges and meant to probe signals and power rails. Breakout pads within a cluster are placed in rows and spaced at 2.54 mm from each other, so pin headers can optionally be soldered if needed.

Locations are the same for all board variants. The following figure gives an overview of the breakout pads by clusters and location.

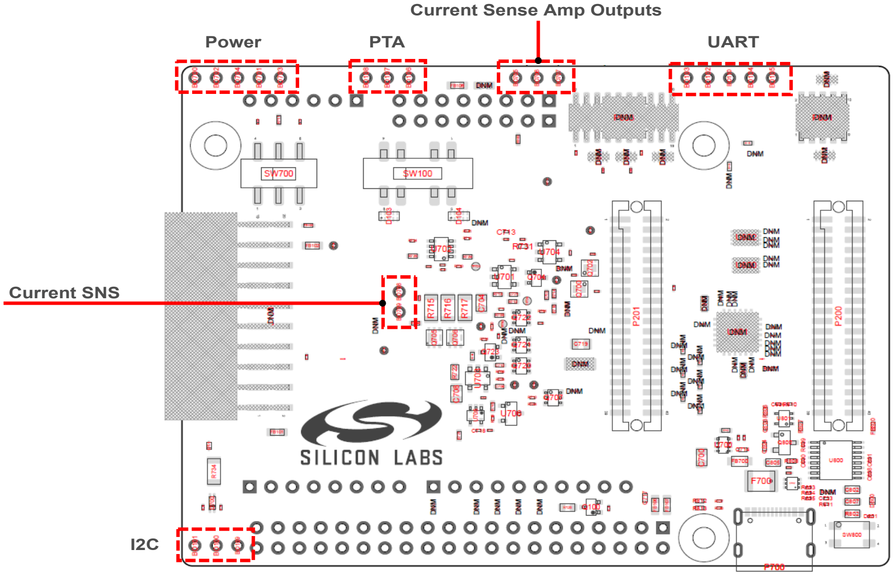


Figure 4.4. Overview of Breakout Pads

4.6.1 Power Breakout Pads

The power breakout pads, located on the top left corner of the board, allows users to probe power rails.

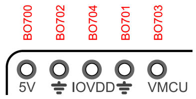


Table 4.7. Power Breakout Pads

Reference Designator	Function	Description
BO700	5V	5V rail, supplies the on-board voltage buffer. Either sourced by the host board or the on-board USB connector if present[1]. See section 5.1 Board Power Options for more details about power modes.
BO702	GND	Ground
BO704	IO_VDD	Host power rail
BO701	GND	Ground
BO703	VMCU[2]	Device (co-processor) power rail. Either sourced by the on-board voltage buffer or the host power rail directly[1]. See section 5.2 Device Power Options for more details about power modes.

Note:

1. More details about the power architecture of the Adapter Board are provided in section Power Supply and Current Sense Outputs.

2. VMCU is for sensing only and no voltage shall ever be applied to this pin. In general, it is not recommended to apply voltage to any of these pads as long as the Adapter Board is connected to a host board.

4.6.2 PTA Breakout Pads

Table 4.8. PTA Breakout Pads

Reference Designator	Function	Description
BO108	PRI	Packet Trafic Arbitration, Priority
BO107	REQ	Packet Trafic Arbitration, Request
BO106	GRANT	Packet Trafic Arbitration, Grant

4.6.3 Current Sense Amplifier Output Breakout Pads

The current sense output breakout pads give the user direct access to probe the on-board current sense amplifier. More details and instructions are provided in section 6.1 Analog Outputs. These two sense outputs can only be used in BUF MODE, i.e., when the on-board voltage buffer supplies current to the device (co-processor).

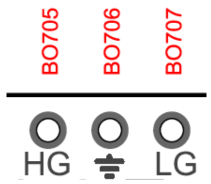


Table 4.9. Current Sense Amplifier Output Breakout Pads

Reference Designator	Function	Description
BO705	HG Analog Output	Current sense amplifier, high gain output
BO706	GND	Ground, reference for current sense amplifier outputs
BO707	LG Analog Output	Current sense amplifier, low gain output

Note: Refer to Section 6.1 Analog Outputs for current measurements using analog outputs.

4.6.4 UART Breakout Pads

While the host interface is only mapped to the ISP UART (co-processors), the UART breakout pads give direct access to both ISP and VCOM UART (SoCs) at the same time.

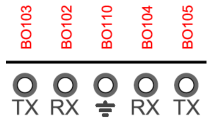


Table 4.10. UART Breakout pads

Reference Designator	Function	Description
BO103	ISP TX (NCP/RCP)	Typically used to access the ISP menu with co-processors
BO102	ISP RX (NCP/RCP)	Typically used to access the ISP menu with co-processors
BO110	GND	Ground, reference for UART signals
BO104	VCOM RX (SoC)	Typically used with SiWG91x EFR32 SoCs, not connected to the host interface by default
BO105	VCOM TX (SoC)	Typically used with SiWG91x EFR32 SoCs, not connected to the host interface by default

4.6.5 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. These two sense nodes can only be used in BUF MODE, i.e., when the on-board voltage buffer supplies current to the device (co-processor). A resistor of 0.5 Ω is connected between the positive and negative nodes.

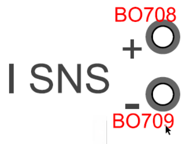


Table 4.11. Current Sense Breakout pads

Reference Designator	Function	Description
BO708	Positive	Connected to the on-board buffer output
BO709	Negative	Connected to the device power rail

4.6.6 I^{2}C Breakout Pads

The I2C breakout pads, can be used to probe signals when SoCs are used instead of co-processors.

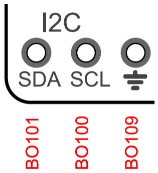


Table 4.12. I^{2}C Breakout Pads

Reference Designator	Function	Description
BO101	SDA	I^{2}C data
BO100	SCL	I^{2}C clock
BO109	GND	Ground, reference for I^{2}C signals

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 substain 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.

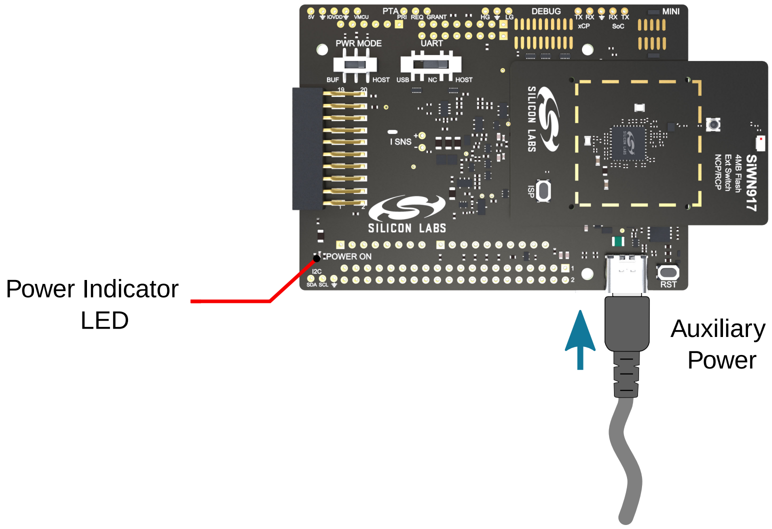


Figure 5.1. Adapter Board Auxiliary Power Connector and Power Indicator

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 differents 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 SiWx91x 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 SiWx91x Device, the Energy Profiler would track the current absorbed by both EFR32 and SiWx91x 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.

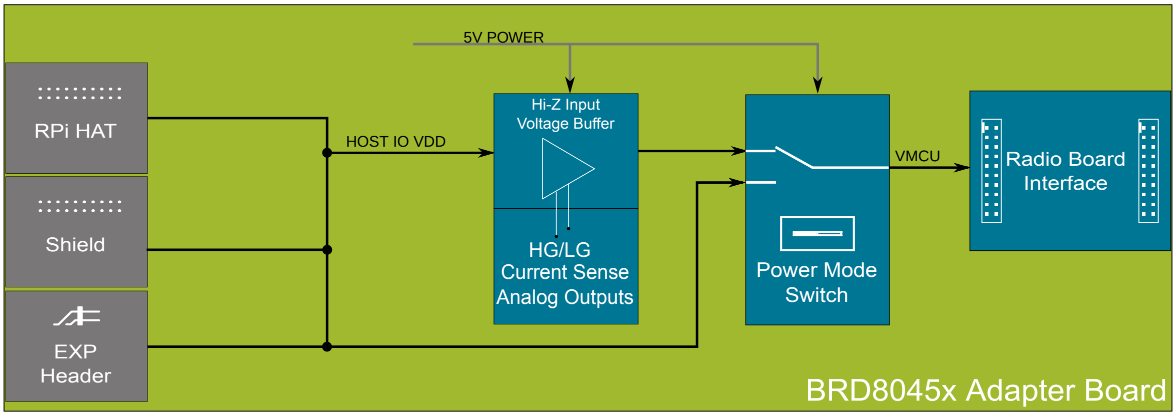


Figure 5.2. Adapter Board Power Topology

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 migth 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 30 mA current[1]
- HG (BO705) High Gain Current Sense outpu with a gain factor of 101 A/V. A read of 30mV corresponds to 297 µA current[1]

Furthermore, an unamplified differential voltage output across a 0.5 Ω 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 MΩ -10 MΩ. These values are common to the majority of commercial digital voltmeters and oscilloscopes. For measuring the differential voltage output at least 10 MΩ 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 magnitute 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 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 breakout pads and their physical location on the board refer to section 4.6 Breakout Pads.

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:

1. 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-process-oronly 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 the figure below, 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.

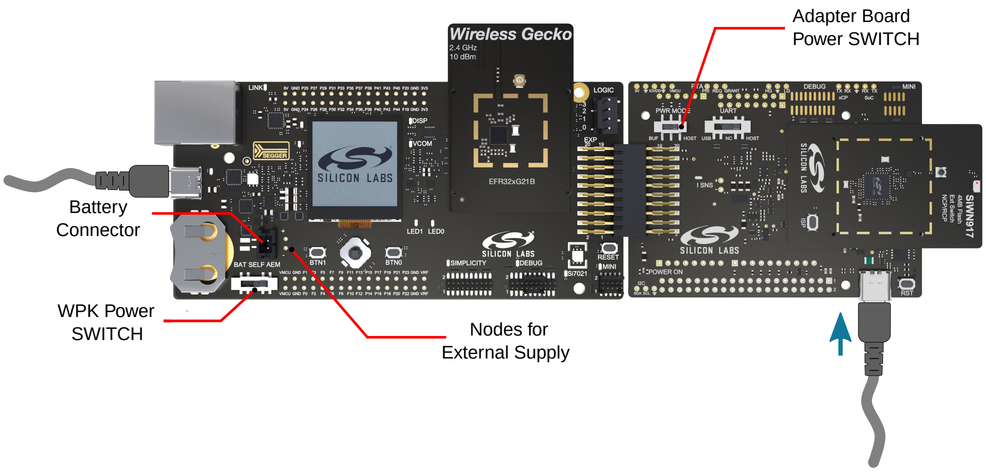


Figure 6.1. Example of current measurement set up with external meter

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 SiWx91x Wi-Fi co-processors

Normally, SiWx91x co-processors enter ISP mode after a reset. Follow the steps below to download the firmware using the on-board USB:

1. The Adapter Board must be connected to a compatible host board.
2. UART switch must be turned on USB mode.
3. 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.
4. RESET button must be shortly pressed.

In this state, after receiving a capital *"U"*, the SiWx91x device will prompt the bootloader menu. Default Baud Rate is 115200 bps. This can be changed once connected through the bootloader menu.

Note that host applications might potentially interfere with firmware upgrade as they might pull the reset line while flashing the co-processor.

To dowload firmware from the Host to the Device over UART interface, the UART switch must be turned on HOST. 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: The host's output pin controlling the co-processor's #DEV_RESET signal must be configured as open drain.

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.

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 Si-EB8045A Revision History

Kit Revision	Released	Description
A01	9 September 2024	Initial release.

9.3 Si-EB8045B Revision History

Kit Revision	Released	Description
A01	9 September 2024	Initial release.

9.4 Si-EB8045C Revision History

Kit Revision	Released	Description
A01	9 September 2024	Initial release.

10. Document Revision History

Revision 1.6

September 2024

- Kit ordering information updated. Prerequisite section added. Performance, Connector and Downloading Firmaware sections updated.

Revision 1.0

December 2023

- Initial document revision.

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