

UG379: WF200 Wi-Fi® Expansion Kit

User's Guide

The WF200 Wi-Fi Expansion Kit is an excellent way to explore and evaluate the WF200 Wi-Fi® Transceiver with a Raspberry Pi or an EFM32 MCU for your embedded application.

The WF200 Wi-Fi® Transceiver is an easy to use and easy to interface Wi-Fi Network Co-Processor (NCP). Most of the associated complexity of Wi-Fi and the protocol stack is offloaded to the NCP and allows for easy Wi-Fi integration into any embedded system.

The kit easily integrates and brings Wi-Fi connectivity to a compatible Silicon Labs MCU Starter Kit through the EXP header. The WF200 Wi-Fi Expansion Kit has also been designed after the Raspberry Pi Hardware Attached on Top (HAT) board specification, allowing the WF200 Wi-Fi Expansion Kit to connect to a Raspberry Pi.

WF200 EXPANSION BOARD FEATURES

- EXP connector for interfacing Silicon Labs Starter Kits
- Selectable SPI or SDIO host interface
- Allows board detection and identification
- Raspberry Pi compatible HAT
 - 40-pin header
 - HAT EEPROM for identification

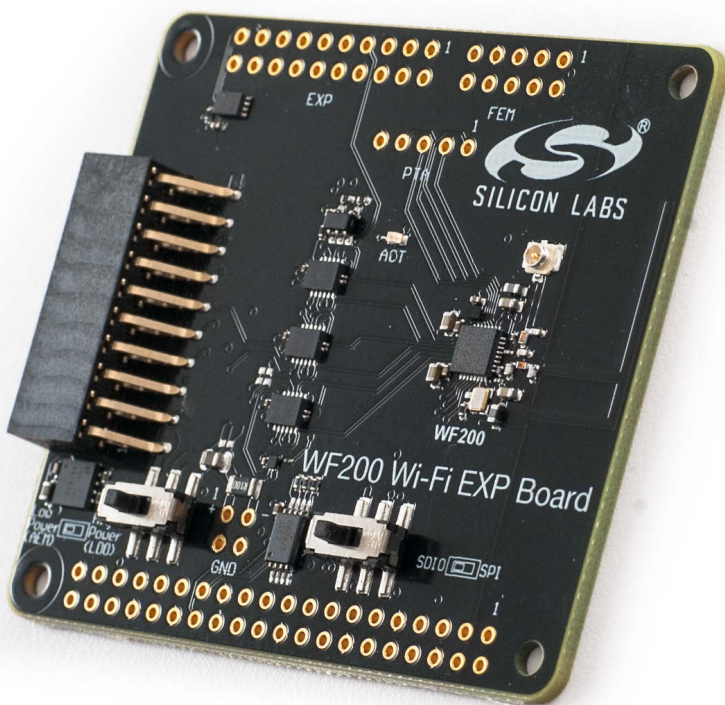


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1. Introduction

This user guide covers the WF200 Wi-Fi Expansion Kit. The kit connects to either a Silicon Labs EFM32 MCU starter kit (STK), a Silicon Labs EFR32 wireless starter kit (WSTK) or a Raspberry Pi equipped with the 40-pin Raspberry Pi hardware-attached-on-top (HAT) connector. SDIO support is available only with selected hosts.

The pictures below shows the kit connected to a Silicon Labs MCU STK through the Expansion Header and a Raspberry Pi 3, respectively.

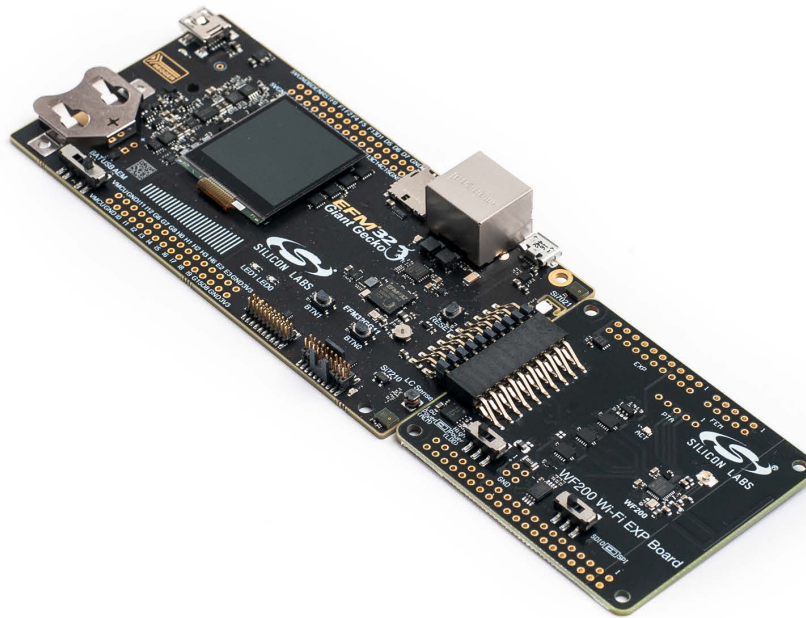


Figure 1.1. WF200 Wi-Fi Expansion Kit Connected to a Silicon Labs EFM32GG11 MCU STK

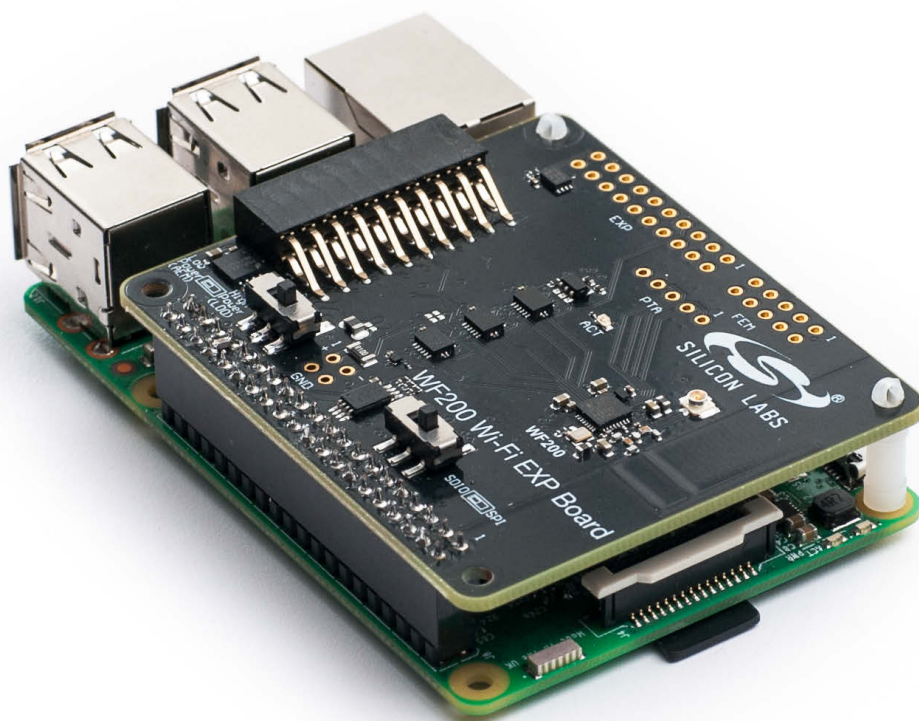


Figure 1.2. WF200 Wi-Fi Expansion Kit Connected to a Raspberry Pi and Secured With Nylon Standoffs

Note: Do **not** connect the kit to both a Silicon Labs MCU STK and a Raspberry Pi at the same time.

2. Hardware Overview

2.1 Hardware Layout

The layout of the WF200 Wi-Fi Expansion Kit is shown in the figure below.

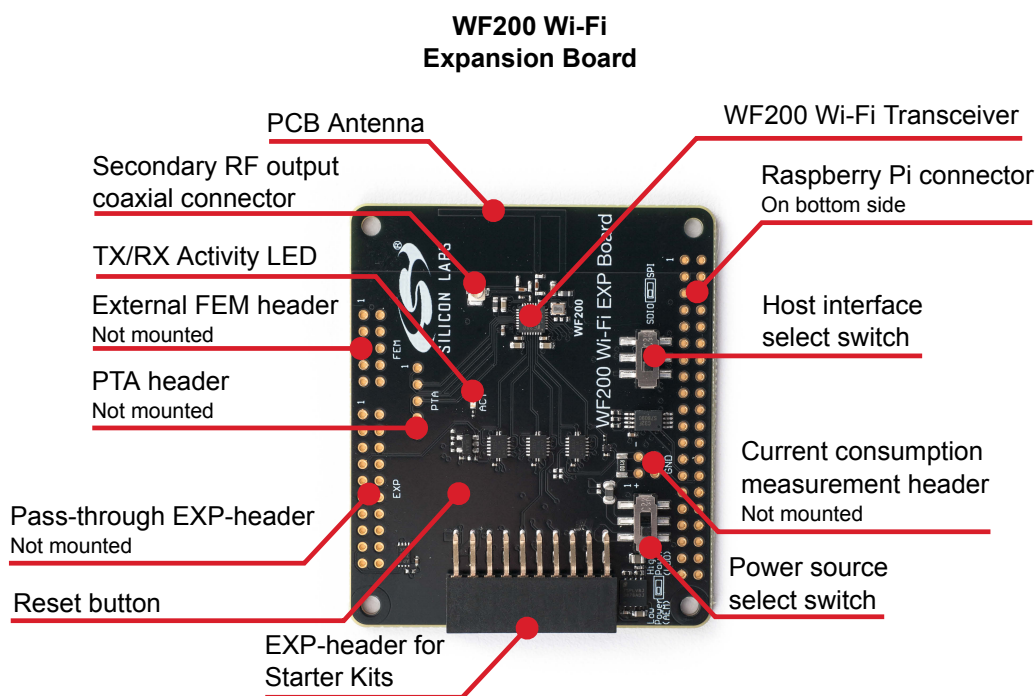


Figure 2.1. WF200 Wi-Fi Expansion Kit Hardware Layout

3. WF200 Wi-Fi NCP Expansion Kit

The WF200 Wi-Fi® Transceiver is a Wi-Fi Network Co-Processor (NCP) transceiver from Silicon Labs.

3.1 Host Interfaces

There are two available host interfaces (HIF) on the WF200 Wi-Fi Expansion Kit: SPI or SDIO. Which interface to use is selected using a slide switch, whose state is sampled during power-on reset or manually issued reset. The slide switch must remain in the same position throughout the duration of the session since it also controls HIF selection multiplexer circuits.

When the WF200 Wi-Fi Expansion Kit is connected to an EFM32/EFR32 starter kit through the EXP header, the state of the HIF selection switch can be read (but not controlled) by the kit mcu through a GPIO pin.

The WF200 Wi-Fi Expansion Kit incorporates a set of multiplexer circuits which allows the user to use the same kit for evaluating the WF200 in both applications requiring SPI or SDIO connectivity to the host. These circuits will normally not be needed in an end-user application since in most cases the interface to use will be fixed.

A simplified circuit diagram showing the host interface multiplexer circuits is shown below. The EXP_HEADER9 signal is connected to pin 9 on the EXP header, while the HIF_OEn output enable signal is controlled by the power-on reset circuit (explained later).

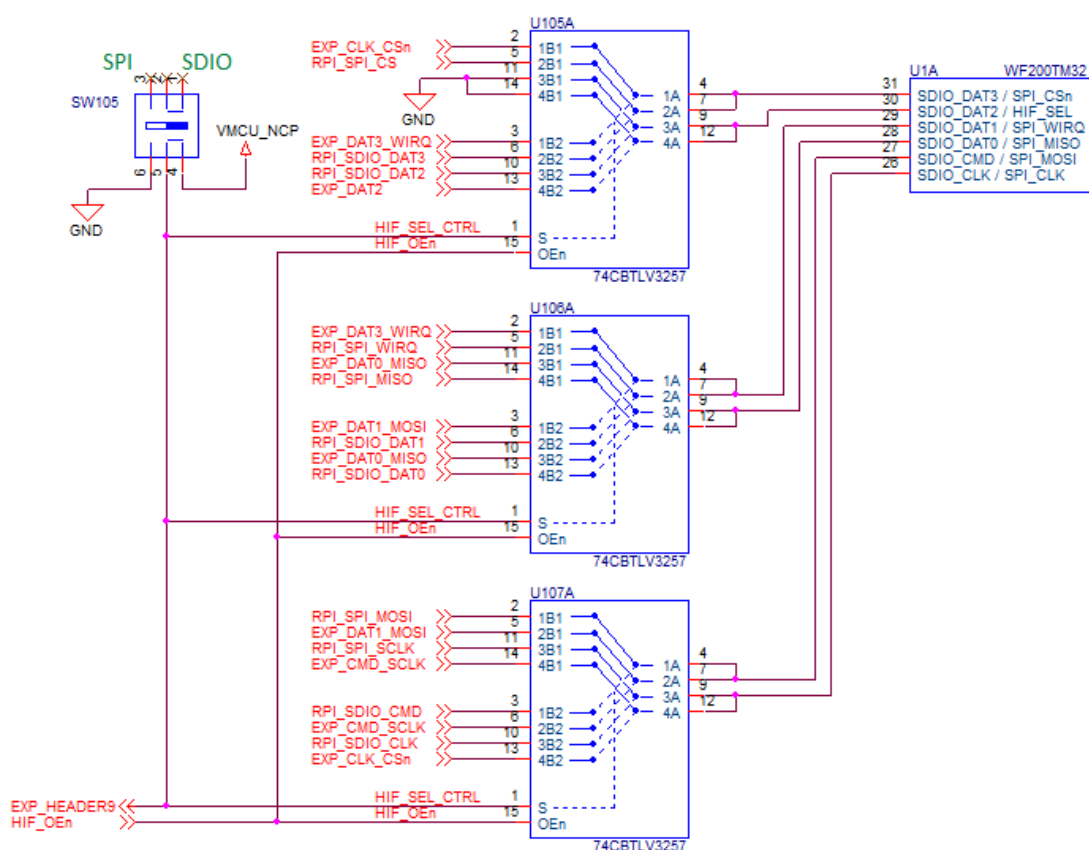


Figure 3.1. Host Interface Multiplexer Circuit

3.2 Power-on and Manual Reset Circuit

To ensure that the state of the host interface selection signal to be sampled correctly at the rising edge of the WF200 RESETn signal, a power-on reset circuit has been added to the WF200 Wi-Fi Expansion Kit. This circuit achieves this by

- Adding a delay of 1ms to the rising edge of the RESETn signal compared to the rising edge of the power supply
- Isolating the host from the WF200 DAT2/HIF_SEL pin during the rising edge of the RESETn signal

The figure below shows the circuit diagram for the power-on and manual reset circuit. Its functionality is as follows:

- NCP_RESETn is the active-low reset signal of the WF200. The WF200 RESETn pin has an internal pull-up of approx. 70 kOhms. The on-board reset button is connected to this signal.
- HIF_SEL_CTRL is the signal from the HIF selection switch
- HIF_OEn is the active-low output enable signal of the HIF multiplexer circuits
- WF200_DAT2_HIF_SEL is the combined SDIO DAT2 signal and HIF selection signal of the WF200
- U114 is an open-drain active low output reset monitor which with the installed capacitor connected to the CD pin keeps NCP_RESETn tied to ground for about 1 ms after VMCU_NCP has exceeded the threshold voltage of 0.9 volts
- U115 is a tri-state output buffer with an active low output enable signal connected to NCP_RESETn which pulls the CD pin of U116 low while NCP_RESETn is low
- U116 is a push-pull active high output reset monitor which drives HIF_OEn high for 1 ms after the output of U115 is disabled
- U109 is a tri-state output buffer with an active high output enable signal which connects the HIF_SEL_CTRL signal to the WF200_DAT2_HIF_SEL signal as long as HIF_OEn is high

The NCP_RESETn signal is available on both the EXP header and the Raspberry Pi connector and can be used for issuing a manual reset sequence by pulling it low for at least 1 ms.

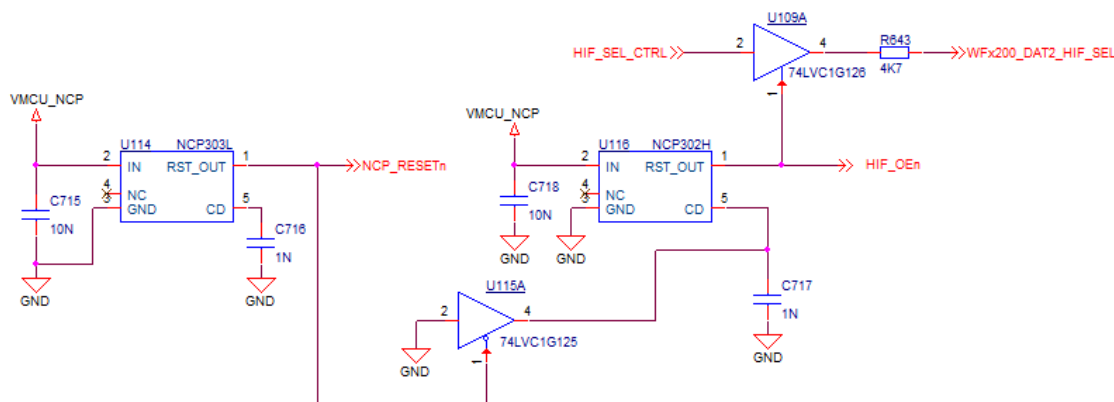


Figure 3.2. Power-on and Manual Reset Circuit Diagram

4. Connectors

This chapter gives an overview of the WF200 Wi-Fi Expansion Kit connectivity and power connections.

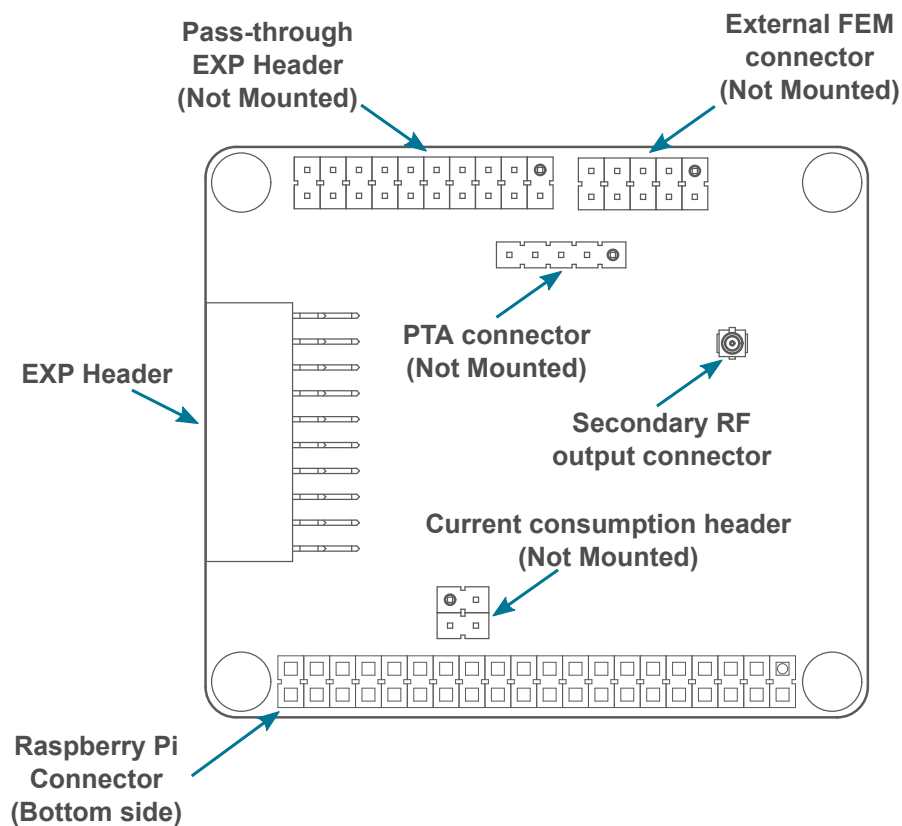


Figure 4.1. WF200 Wi-Fi Expansion Kit Connector Layout

4.1 EXP Header

On the left-hand side of the WF200 Wi-Fi Expansion Kit, a right-angle female 20-pin EXP header is provided to allow connection to one of Silicon Labs' supported Starter Kits. The EXP header on the Starter Kits follows a standard which ensures that commonly used peripherals such as an SPI, a UART, and an I2C bus, are available on fixed locations on the connector. Additionally, the VMCU, 3V3 and 5V power rails are also available on the expansion header. For detailed information regarding the pinout to the expansion header on a specific Starter Kit, consult the accompanying user's guide.

The figure below shows how the WF200 Wi-Fi® Transceiver is connected to the connector and the peripheral functions that are available.

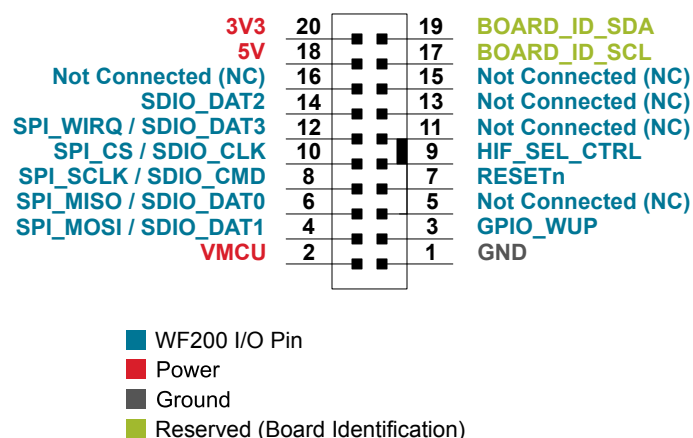


Figure 4.2. Expansion Header

4.1.1 Pass-through EXP Header

The WF200 Wi-Fi Expansion Kit features a footprint for a secondary EXP header. All signals from the EXP header, including those that are not connected to any features on the WF200 Wi-Fi Expansion Kit, are directly tied to the corresponding pins in the footprint, allowing daisy-chaining of additional expansion boards if a connector is soldered in.

4.1.2 EXP Header Pinout

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

Table 4.1. EXP Header Pinout

EXP Header	
Pin	Function
2	WF200 voltage domain (power switch set to Low Power)
4	SPI_MOSI / SDIO_DAT1
6	SPI_MISO / SDIO_DAT0
8	SPI_SCLK / SDIO_CMD
10	SPI_CS / SDIO_CLK
12	SPI_WIRQ / SDIO_DAT3
14	SDIO_DAT2
16	Not Connected
18	Board 5V supply. Used to supply LDO regulator.
20	Board 3V3 supply. Only used for board identification.
1	Ground
3	GPIO (WF200 WUP)
5	Not Connected
7	GPIO (WF200 RESETn)
9	GPIO (HIF_SEL_CTRL read access)
11	Not Connected
13	Not Connected
15	Not Connected
17	Identification of expansion boards.
19	Identification of expansion boards.

4.2 Raspberry Pi Connector

On the bottom side of the WF200 Wi-Fi Expansion Kit, a dual row, female socket, 0.1" pitch connector is soldered in to allow the WF200 Wi-Fi Expansion Kit to act as a Raspberry Pi Hardware Attached on Top (HAT) board.

The figure below shows how the WF200 Wi-Fi® Transceiver is connected to the connector and the peripheral functions that are available.

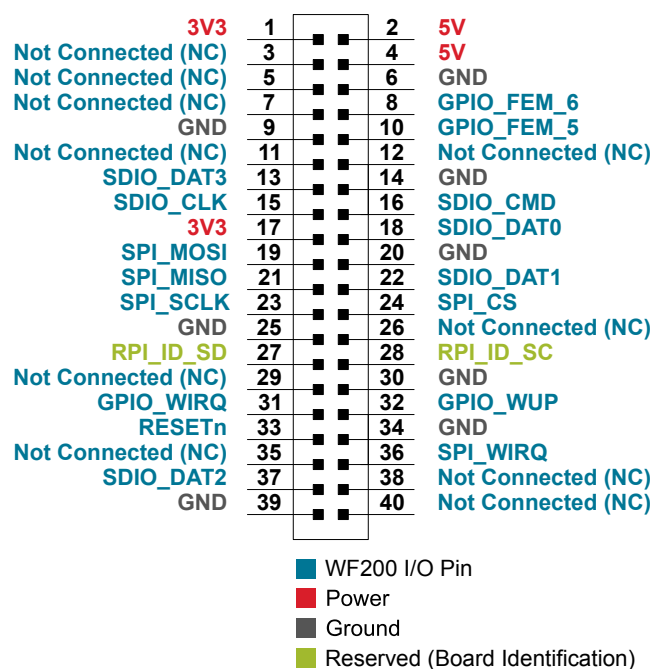


Figure 4.3. Raspberry Pi Connector

4.2.1 Raspberry Pi Connector 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 WF200 Wi-Fi Expansion Kit.

Table 4.2. Raspberry Pi Connector Pinout

Raspberry Pi Connector		
Pin(s)	Function	Raspberry Pi Pin
1	3V3	3v3 Power
2	5V	5v Power
3	-	Not Connected
4	5V	5v Power
5	-	Not Connected
6	GND	Ground
7	-	Not Connected
8	GPIO (WF200 FEM_6)	BCM 14
9	GND	Ground
10	GPIO (WF200 FEM_5)	BCM 15
11	-	Not Connected
12	-	Not Connected
13	SDIO_DAT3	BCM 27
14	GND	Ground
15	SDIO_CLK	BCM 22
16	SDIO_CMD	BCM 23
17	3V3	3v3 Power
18	SDIO_DAT0	BCM 24
19	SPI_MOSI	BCM 10
20	GND	Ground
21	SPI_MISO	BCM 9
22	SDIO_DAT1	BCM 25
23	SPI_SCLK	BCM 11
24	SPI_CS	BCM 8
25	GND	Ground
26	-	Not Connected
27	ID EEPROM SDA	BCM 0
28	ID EEPROM SCL	BCM 1
29	-	Not Connected
30	GND	Ground
31	GPIO (WF200 WIRQ)	BCM 6
32	GPIO (WF200 WUP)	BCM 12

Raspberry Pi Connector		
Pin(s)	Function	Raspberry Pi Pin
33	GPIO (WF200 RESETn)	BCM 13
34	GND	Ground
35	-	Not Connected
36	SPI_WIRQ	BCM 16
37	SDIO_DAT2	BCM 26
38	-	Not Connected
39	GND	Ground
40	-	Not Connected

4.3 External FEM Connector

The WF200 Wi-Fi Expansion Kit features a 2x5-pin 0.1" pitch connector exposing the WF200 Wi-Fi® Transceiver's external front-end module (FEM) interface, which allows the connection of an external FEM board using a ribbon cable.

The WF200 Wi-Fi Expansion Kit also features a TX/RX Activity indicator LED which is connected to the FEM_5 signal.

The pinout of the connector is illustrated in the figure below.

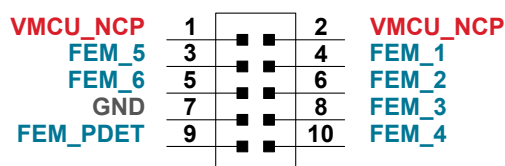


Figure 4.4. External FEM Connector

4.3.1 External FEM Connector Pinout

The pin assignment of the external FEM connector on the board is given in the table below.

Table 4.3. External FEM Connector Pin Descriptions

Pin Number	WFx200 Connection
1	VMCU_NCP
2	VMCU_NCP
3	FEM_6
4	FEM_1
5	FEM_6
6	FEM_2
7	GND
8	FEM_3
9	FEM_PDET
10	FEM_4

4.4 PTA Connector

The WF200's packet transfer arbitration (PTA) interface for managing coexistence in a multi-transceiver application is exposed on a 1x5-pin 0.1" pitch header on the WF200 Wi-Fi Expansion Kit.

The pinout of the connector is illustrated in the figure below.

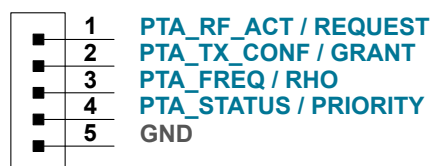


Figure 4.5. PTA Connector

4.4.1 PTA Connector Pinout

The pin assignment of the PTA connector on the board is given in the table below.

Table 4.4. PTA Connector Pin Descriptions

Pin Number	WF200 Connection
1	PTA_RF_ACT / REQUEST
2	PTA_TX_CONF / GRANT
3	PTA_FREQ / RHO
4	PTA_STATUS / PRIORITY
5	GND

4.5 Secondary RF Connector

The WF200's secondary RF output is exposed on the WF200 Wi-Fi Expansion Kit through a Hirose u.FL coaxial connector. Matching components on the board ensure that a 50 ohm characteristic impedance is seen when connecting an external antenna or RF measurement equipment to this connector.

For connecting the secondary RF output to an RF measurement instrument, a u.FL to SMA adapter cable (not included with the kit) can be used. Examples of such adapter cables are the Taoglas CAB.721 (100 mm) or CAB.720 (200 mm) cable assemblies.

4.6 Power Supply

There are two ways to provide power to the kit:

- The kit can be connected to, and powered by, a Silicon Labs MCU STK
- The kit can be connected to, and powered by, a Raspberry Pi

Note: Connecting the WF200 Wi-Fi Expansion Kit to both an EFM32/EFR32 STK and a Raspberry Pi at the same time is not a valid option.

When connected to a Silicon Labs MCU STK, the WF200 Wi-Fi® Transceiver can either be powered by the VMCU rail present on the EXP header or through an LDO regulator on board the WF200 Wi-Fi Expansion Kit. If connected to the VMCU rail of the starter kit, the current consumption of the WF200 Wi-Fi® Transceiver will be included in the starter kit's on-board Advanced Energy Monitor (AEM) measurements. The LDO regulator draws power from the 5V net, and, hence, the power consumption of the WF200 Wi-Fi® Transceiver will not be included in any AEM measurements performed by the MCU STK.

A mechanical power switch on the WF200 Wi-Fi Expansion Kit is used to select between Low Power (AEM) mode and High Power (LDO) mode. When the switch is set to Low Power (AEM) mode, the WF200 Wi-Fi® Transceiver is connected to the VMCU net on the Expansion Header. When the switch is set to High Power (LDO) mode, the WF200 Wi-Fi® Transceiver is connected to the output of the LDO. For applications requiring high power consumption or when the WF200 Wi-Fi Expansion Kit is connected to a Raspberry Pi, the power switch must be set to High Power (LDO) mode.

A 0.1 ohm current sense resistor accompanied by a 2x2-pin 0.1" unpopulated header is provided in order to measure the current consumption of the WF200 Wi-Fi® Transceiver in situations where AEM is not available or when the current consumption exceeds the measurement range of AEM.

The power topology is illustrated in the figure below.

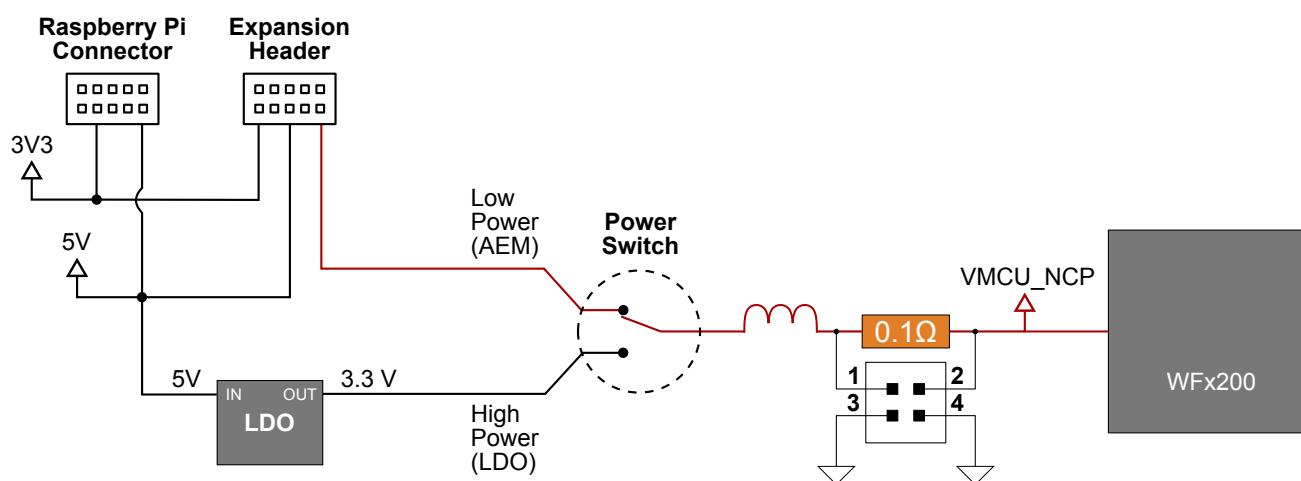


Figure 4.6. WF200 Wi-Fi Expansion Kit Power Topology

5. 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 Silicon Labs website and kit page.

6. Kit Revision History

The kit revision can be found printed on the kit packaging label, as outlined in the figure below.

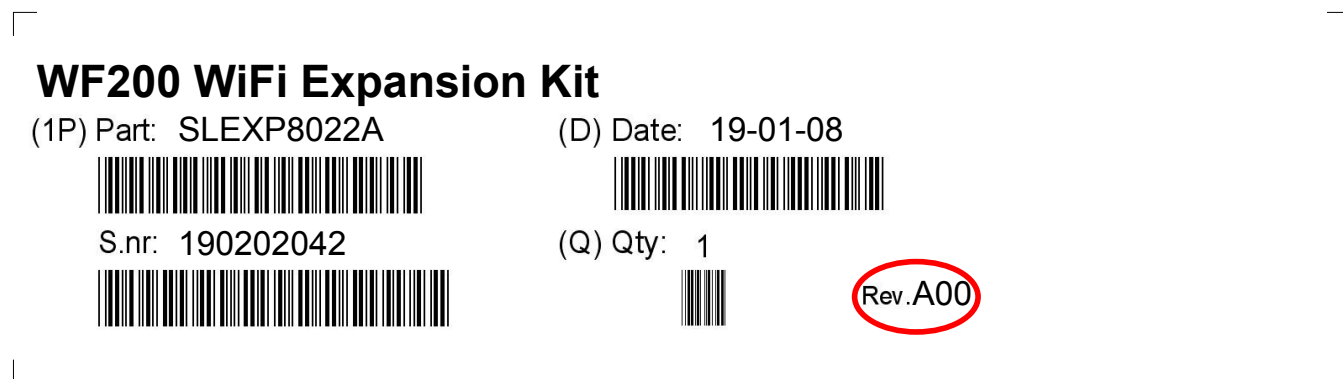


Figure 6.1. Kit Label

6.1 SLEXP8022A Revision History

Kit Revision	Released	Description
A00	2019-01-08	Initial release.

6.2 SLEXP8022B Revision History

Kit Revision	Released	Description
A00	2019-01-08	Initial release.

7. Document Revision History

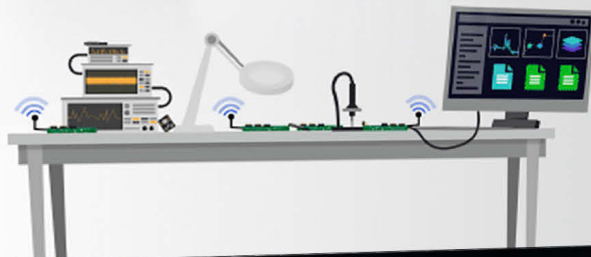
Revision 1.0

2019-01-08

- Initial document revision.

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