Raspberry Pi Connector for PCIe

A 16-way PCIe FFC Connector Specification

Colophon

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Chapter 1. PCIe connector

The Raspberry Pi 5 is the first Raspberry Pi product to feature a single lane PCI Express (PCIe) connector. This connector is a 16-pin, 0.5mm pitch FFC connector, which is small and low-cost. This document specifies the connector pinout and how to use it if you are developing third-party products.

IMPORTANT

The FFC used must be 50mm or shorter, and must offer controlled impedance. See Chapter 3.

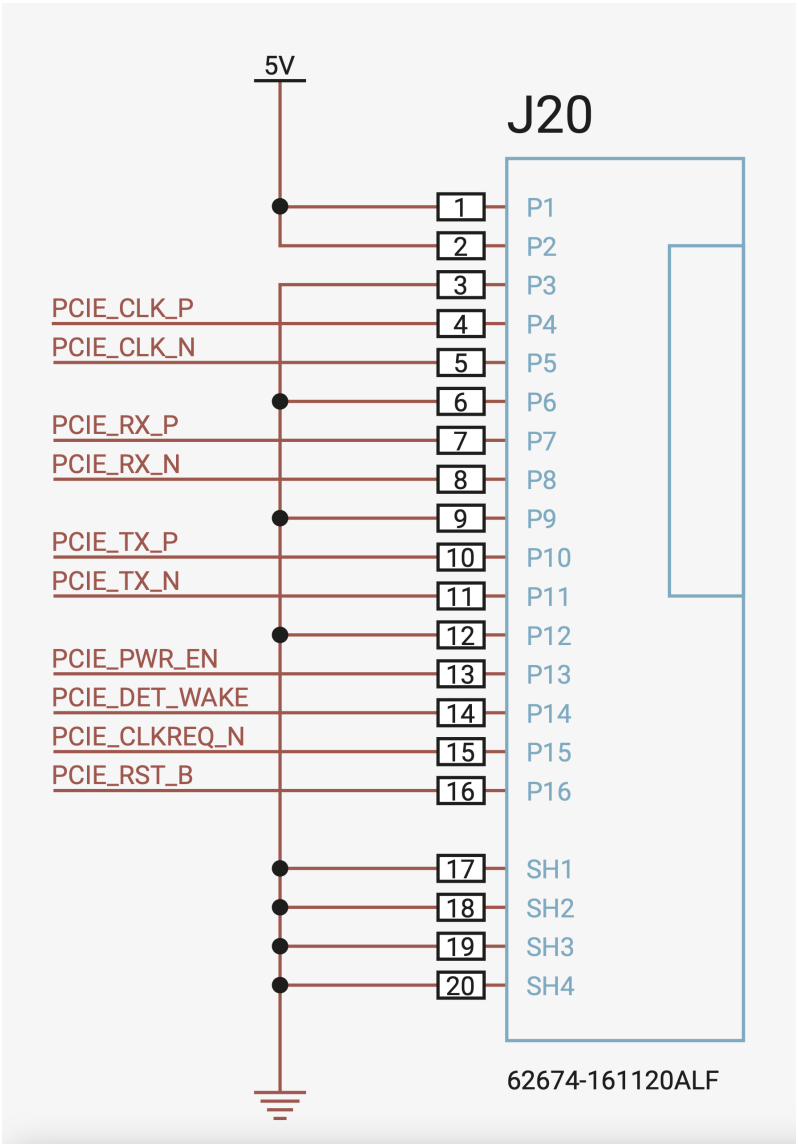


Figure 1. Raspberry Pi 5 16W PCIe FFC Connector Pinout

NOTE

Third-party PCIe accessory or adaptor boards are not necessarily constrained to use the HAT form-factor. For instance, they might be mounted underneath the Raspberry Pi. However, unless they obey the HAT specification these boards should not be referred to as HATs.

1.1. Raspberry Pi 5 power states

OFF

No 5V power connected to the board.

WARM-STANDBY

The Raspberry Pi is halted/off but all of the power rails are still enabled – this is the default mode when doing a 'sudo halt' or soft power-button-off operation.

STANDBY

The Raspberry Pi has the +5V rail powered (so the PMIC is powered), but no other power supplies on the PMIC/board are enabled. Instead, 'sudo halt' or power-button-off can be configured using the EEPROM to enter this mode rather than `WARM-STANDBY`.

SLEEP

Some rails are off (notably the CPU core), and Linux is in suspend-to-RAM state. Pressing the power button will cause the PMIC to move to the `ACTIVE` state.

ACTIVE

All rails up and everything running (e.g. running desktop Linux).

NOTE

The `SLEEP` state is currently untested and unsupported on Raspberry Pi 5.

Chapter 2. Pinout

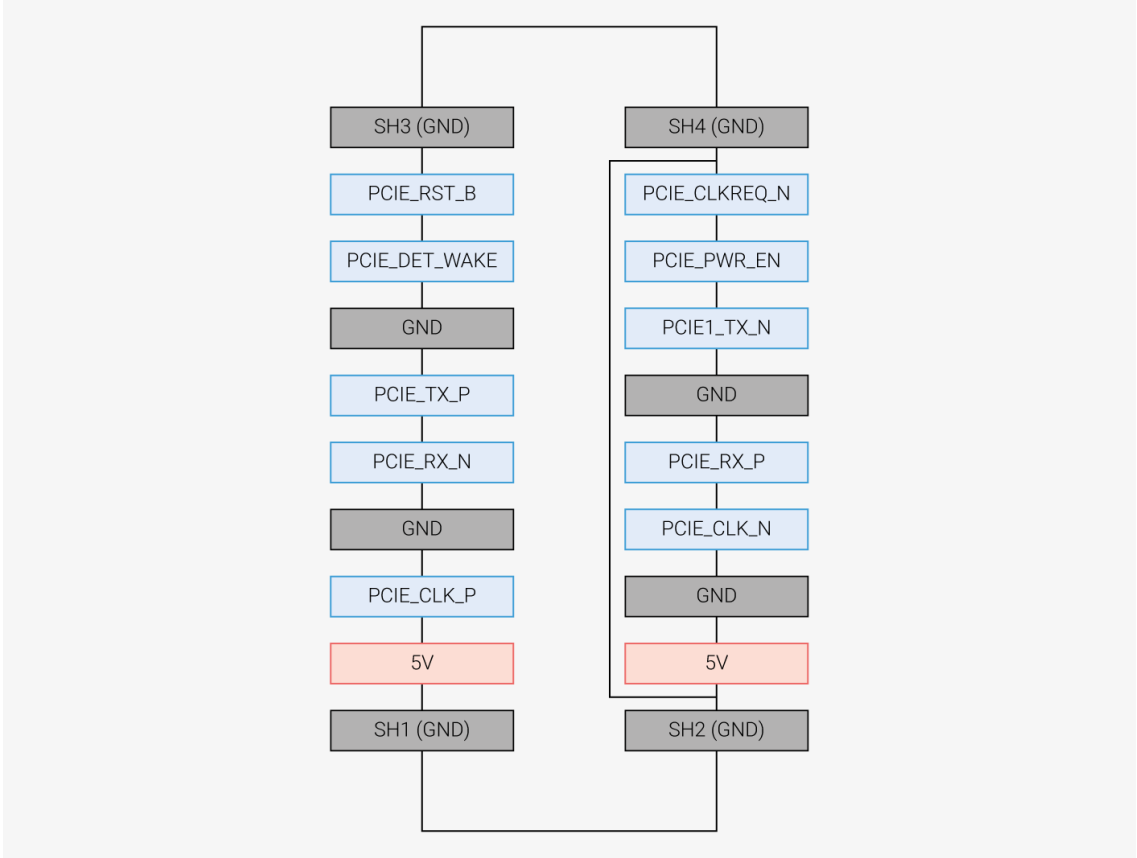
The Raspberry Pi connector for PCIe has 5V power, ground (GND), and standard single-lane PCIe signals.

The pinout for the vertically mounted FPC connector as used on Raspberry Pi 5 is shown in Figure 2.

The connector carries RX and TX pairs, clock pair, reset, and two GPIOs that are used for both board power enable, wakeup and board detect; as well as power and ground. Please see Figure 1 for the schematic symbol and Figure 2 for the PCB layout of the FFC connector on the Raspberry Pi 5 board.

The SH1-SH3 pins of the 16W FFC (J20) shown in Figure 2 are mechanical mounting pins and are not electrically connected even though we tie them to ground on Raspberry Pi 5.

Figure 2. Vertical FFC footprint on Raspberry Pi 5 (FFC contact fingers on RHS)



NOTE

On the Raspberry Pi 5 vertical FFC connector shown, the contact fingers are on the right-hand side. The 16-W FFC connector provides 5V power via pins 1 and 2. These pins are each rated at 500mA (for 1A total current).

2.1. PCIe Signals

The PCIe signals are a single lane of PCIe Gen 2, including CLKREQ_N and RST_B sideband signals which operate at 3.3V.

NOTE

Signals can be run at Gen 3 speeds, but this is not officially supported.

2.1.1. PCIE_PWR_EN pin

This pin is a 3.3V output from the Raspberry Pi to a HAT+ or other add-on board, and signals to the HAT+ to power up any supplies. For example, in the instance of the Raspberry Pi M.2 M Key HAT+, this enables the M.2 3.3V power (which is generated from the incoming 5V). Provide a 100K low pull on this pin on any HAT+.

2.1.2. PCIE_DET_WAKE pin

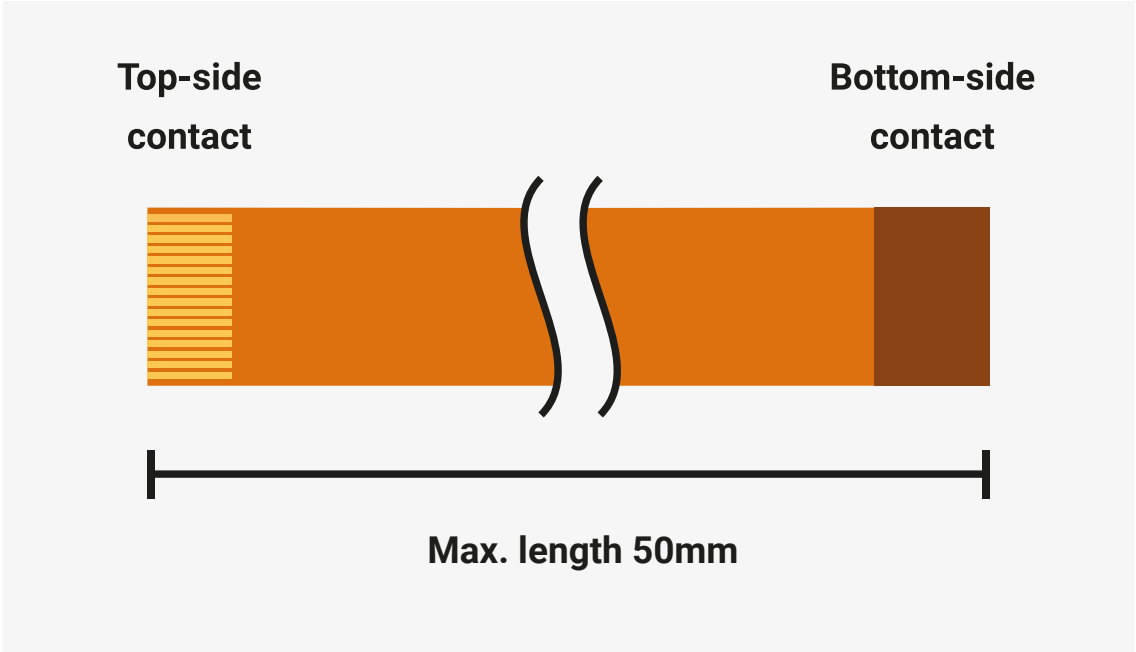
This pin is a 3.3V input to the Raspberry Pi. Pull high to 3.3V either from a resistive divider from 5V (3k6/6k8 giving 2.35k output impedance), or from permanently enabled 3.3V (using a 2.2K resistor). The Raspberry Pi will detect this high pull at boot time, and will automatically probe the PCIe bus.

Use the PCIe `WAKE#` to pull this low.

Chapter 3. FFC

This connector is a 16-pin, 0.5mm pitch FFC connector. The recommended FFC length is 50mm or shorter. The FFC must control the PCIe differential pair impedance to 90R+/- 10% over a continuous ground plane.

Figure 3. The FFC



The FFC **must** be of the opposite-sides-contact type, see Figure 3. As specified, a same-side-contact PCIe FFC would not be reversible; if inserted the wrong way around it would short the Raspberry Pi 5 and/or the accessory board.

Appendix A: Release History

Table 1. Documentation release history

Release	Date	Description
0.7	06 Nov 2023	• Preliminary draft
0.8	16 Nov 2023	• Initial internal release
0.9	01 Dec 2023	• Internal release • Changes to FFC specification
1.0	08 Dec 2023	• Public release
1.1	15 Jan 2024	• Minor updates