GPIO

General Purpose Input/Output pins on the Raspberry Pi

Overview

This page expands on the technical features of the GPIO pins available on BCM2835 in general. For usage examples, see GPIO usage . When reading this page, reference should be made to the BCM2835 ARM peripherals data sheet, section 6.

GPIO pins can be configured as either general-purpose input, general-purpose output, or as one of up to six special alternate settings, the functions of which are pin-dependent.

There are three GPIO banks on BCM2835.

Each of the three banks has its own VDD input pin. On Raspberry Pi, all GPIO banks are supplied from 3.3V. **Connection of a GPIO to a voltage higher than 3.3V will likely destroy the GPIO block within the SoC.**

A selection of pins from Bank 0 is available on the P1 header on Raspberry Pi.

GPIO pads

The GPIO connections on the BCM2835 package are sometimes referred to in the peripherals data sheet as "pads" — a semiconductor design term meaning 'chip connection to outside world'.

The pads are configurable CMOS push-pull output drivers/input buffers. Register-based control settings are available for:

- Internal pull-up / pull-down enable/disable
- Output drive strength
- Input Schmitt-trigger filtering

Power-on states

All GPIO pins revert to general-purpose inputs on power-on reset. The default pull states are also applied, which are detailed in the alternate function table in the ARM peripherals datasheet. Most GPIOs have a default pull applied.

Interrupts

Each GPIO pin, when configured as a general-purpose input, can be configured as an interrupt source to the ARM. Several interrupt generation sources are configurable:

- Level-sensitive (high/low)
- Rising/falling edge
- Asynchronous rising/falling edge

Level interrupts maintain the interrupt status until the level has been cleared by system software (e.g. by servicing the attached peripheral generating the interrupt).

The normal rising/falling edge detection has a small amount of synchronisation built into the detection. At the system clock frequency, the pin is sampled with the criteria for generation of an interrupt being a stable transition within a three-cycle window, i.e. a record of '1 0 0' or '0 1 1'. Asynchronous detection bypasses this synchronisation to enable the detection of very narrow events.

Alternative functions

Almost all of the GPIO pins have alternative functions. Peripheral blocks internal to BCM2835 can be selected to appear on one or more of a set of GPIO pins, for example the I2C busses can be configured to at least 3 separate locations. Pad control, such as drive strength or Schmitt filtering, still applies when the pin is configured as an alternate function.

Voltage specifications

The following table gives the various voltage specifications for the GPIO pins, it was extracted from the Compute Module datasheet here.

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
V_{IL}	Input Low Voltage	VDD IO = 1.8V	-	-	0.6	V
		VDD IO = 2.7V	-	-	0.8	V
		VDD IO = 3.3V	-	-	0.9	V
V_{IH}	Input high voltage[a]	VDD IO = 1.8V	1.0	-	-	V
		VDD IO = 2.7V	1.3	-	-	V
		VDD IO = 3.3V	1.6	-	-	V
I_{IL}	Input leakage current	TA = +85◦C	-	-	5	µA
C_{IN}	Input capacitance	-	-	5	-	pF
V_{OL}	Output low voltage[b]	VDD IO = 1.8V, IOL = -2mA	-	-	0.2	V
		VDD IO = 2.7V, IOL = -2mA	-	-	0.15	V
		VDD IO = 3.3V, IOL = -2mA	-	-	0.14	V
V_{OH}	Output high voltage[b]	VDD IO = 1.8V, IOH = 2mA	1.6	-	-	V
		VDD IO = 2.7V, IOH = 2mA	2.5	-	-	V
		VDD IO = 3.3V, IOH = 2mA	3.0	-	-	V
I_{OL}	Output low current[c]	VDD IO = 1.8V, VO = 0.4V	12	-	-	mA

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
		VDD IO = 2.7V, VO = 0.4V	17	-	-	mA
		VDD IO = 3.3V, VO = 0.4V	18	-	-	mA
I_{OH}	Output high current[c]	VDD IO = 1.8V, VO = 1.4V	10	-	-	mA
		VDD IO = 2.7V, VO = 2.3V	16	-	-	mA
		VDD IO = 3.3V, VO = 2.3V	17	-	-	mA
R_{PU}	Pullup resistor	-	50	-	65	kΩ
R_{PD}	Pulldown resistor	-	50	-	65	kΩ

[a] Hysteresis enabled

[b] Default drive strength (8mA)

[c] Maximum drive strength (16mA)