

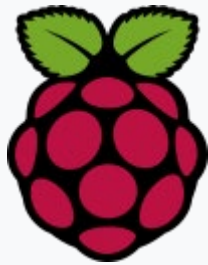
Raspberry Pi

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"RPi" redirects here. For other uses, see [RPI](#). For the dessert, see [Raspberry pie \(food\)](#).

Raspberry Pi



Raspberry Pi 3 Model B+

Also known as RPi

Release date 29 February 2012; 6 years ago

Introductory price US\$35

[Linux](#)

[FreeBSD](#)

[Operating system](#) [NetBSD](#)

[OpenBSD](#)

[Plan 9](#)

	RISC OS
	Windows 10 IoT Core ^[2]
System-on-chip used	Broadcom BCM2837B0
CPU	1.4 GHz 64/32-bit quad-core ARM Cortex-A53
Memory	1 GB LPDDR2 RAM at 900 MHz ^[3]
Storage	MicroSDHC slot
Graphics	Broadcom VideoCore IV 300 MHz/400 MHz
Power	1.5 W (average when idle) to 6.7 W (maximum under stress) ^[4]
Website	raspberrypi.org

The **Raspberry Pi** is a series of small [single-board computers](#) developed in the [United Kingdom](#) by the [Raspberry Pi Foundation](#) to promote teaching of basic [computer science](#) in schools and in [developing countries](#).^{[5][6][7]} The original model became far more popular than anticipated,^[8] selling outside its [target market](#) for uses such as [robotics](#). It does not include peripherals (such as [keyboards](#) and [mice](#)) and [cases](#). However, some accessories have been included in several official and unofficial bundles.^[8]

The organisation behind the Raspberry Pi consists of two arms. The first two models were developed by the [Raspberry Pi Foundation](#). After the Pi Model B was released, the Foundation set up Raspberry Pi Trading, with [Eben Upton](#) as CEO, to develop the third model, the B+. Raspberry Pi Trading is responsible for developing the technology while the Foundation is an educational charity to promote the teaching of basic computer science in schools and in developing countries.

According to the Raspberry Pi Foundation, more than 5 million Raspberry Pis were sold by February 2015, making it the best-selling [British computer](#).^[9] By November 2016 they had sold 11 million units,^{[10][11]} and 12.5m by March 2017, making it the third best-selling "general purpose

computer".^[12] In July 2017, sales reached nearly 15 million.^[13] In March 2018, sales reached 19 million.^[11]

Most Pis are made in a [Sony](#) factory in [Pencoed](#), Wales;^[14] some are made in China or Japan.^[15]



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Generations of released models[\[edit\]](#)



The Raspberry Pi Zero, a US\$5 model first introduced in 2015

Several generations of Raspberry Pis have been released. All models feature a [Broadcom system on a chip](#) (SoC) with an integrated [ARM](#)-compatible [central processing unit](#) (CPU) and [on-chip graphics processing unit](#) (GPU).

Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+; on-board memory ranges from 256 MB to 1 GB RAM. [Secure Digital](#) (SD) cards are used to store the operating system and program memory in either SDHC (early Raspberry Pi's) or MicroSDHC (Later Raspberry Pi's) sizes. The boards have one to four [USB](#) ports. For video output, [HDMI](#) and [composite video](#) are supported, with a standard 3.5 mm [tip-ring-sleeve](#) jack for audio output. Lower-level output is provided by a number of [GPIO](#) pins, which support common protocols like [I²C](#). The B-models have an [8P8C Ethernet](#) port and the Pi 3 and Pi Zero W have on-board [Wi-Fi 802.11n](#) and [Bluetooth](#). Prices range from US\$5 to \$35.

The first generation (**Raspberry Pi 1 Model B**) was released in February 2012, followed by the simpler and cheaper **Model A**. In 2014, the Foundation released a board with an improved design, **Raspberry Pi 1 Model B+**. These boards are approximately credit-card sized and represent the standard *mainline* form-factor. Improved A+ and B+ models were released a year later. A ["Compute Module"](#) was released in April 2014 for [embedded applications](#). The **Raspberry Pi 2**, which added more [random-access memory](#), was released in February 2015.

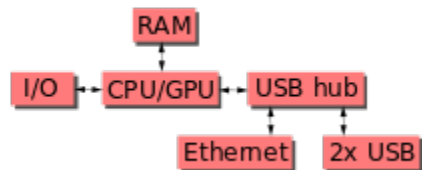
A **Raspberry Pi Zero** with smaller size and reduced [input/output](#) (I/O) and [general-purpose input/output](#) (GPIO) capabilities was released in November 2015 for US\$5. By 2017, it became the newest mainline Raspberry Pi. On 28 February 2017, the **Raspberry Pi Zero W** was launched, a version of the Zero with Wi-Fi and Bluetooth capabilities, for US\$10.^{[\[6\]](#)[\[17\]](#)} On 12 January 2018, the **Raspberry Pi Zero WH** was launched, the same version as the Zero W with pre-soldered GPIO headers.^{[\[18\]](#)}

Raspberry Pi 3 Model B was released in February 2016 with a 64-bit [quad core](#) processor, on-board [WiFi](#), [Bluetooth](#) and USB boot capabilities.^{[\[19\]](#)} On [Pi Day](#) 2018 **model 3B+** appeared with a faster 1.4 GHz processor and a three times faster network based on [gigabit Ethernet](#) (throughput limited to ca. 300 Mbit/s by the internal USB 2.0 connection) or 2.4 / 5 GHz [dual-band](#) Wi-Fi

(100 Mbit / s).^[1] Other options are: [Power over Ethernet](#) (PoE), [USB boot](#) and [network boot](#) (an [SD card](#) is no longer required).

Hardware^{[[edit](#)]}

The Raspberry Pi hardware has evolved through several versions that feature variations in [memory](#) capacity and peripheral-device support.



This block diagram describes Model B and B+; Model A, A+, and the Pi Zero are similar, but lack the [Ethernet](#) and [USB](#) hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the [system on a chip](#) (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-port USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a [micro USB](#) (OTG) port.

Processor^{[[edit](#)]}



The Raspberry Pi 2B uses a 32-bit 900 MHz quad-core [ARM Cortex-A7](#) processor.

The [Broadcom](#) BCM2835 SoC used in the first generation Raspberry Pi^[20] includes a 700 [MHz](#) [ARM11](#) 76JZF-S processor, [VideoCore](#) IV [graphics processing unit](#) (GPU),^[21] and RAM. It has a level 1 (L1) [cache](#) of 16 [KB](#) and a level 2 (L2) cache of 128 KB. The [level 2 cache](#) is used primarily by the GPU. The SoC is [stacked](#) underneath the RAM chip, so only its edge is visible. The 1176JZ(F)-S is the same CPU used in the [original iPhone](#),^[22] although at a higher [clock rate](#), and mated with a much faster GPU.

The earlier V1.1 model of the Raspberry Pi 2 used a Broadcom BCM2836 SoC with a 900 MHz [32-bit](#), [quad-core](#) [ARM Cortex-A7](#) processor, with 256 KB shared L2 cache.^[23] The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz [64-bit](#) quad-core [ARM](#)

[Cortex-A53](#) processor,^[24] the same SoC which is used on the Raspberry Pi 3, but [underclocked](#) (by default) to the same 900 MHz CPU clock speed as the V1.1. The BCM2836 SoC is no longer in production as of late 2016.

The Raspberry Pi 3+ uses a Broadcom BCM2837B0 SoC with a 1.4 GHz 64-bit quad-core [ARM Cortex-A53](#) processor, with 512 KB shared L2 cache.^[1]

Performance[\[edit\]](#)

While operating at 700 MHz by default, the first generation Raspberry Pi provided a real-world performance roughly equivalent to 0.041 [GFLOPS](#).^{[25][26]} On the [CPU](#) level the performance is similar to a 300 MHz [Pentium II](#) of 1997–99. The GPU provides 1 [Gpixel](#)/s or 1.5 [Gtexel](#)/s of graphics processing or 24 [GFLOPS](#) of general purpose computing performance. The graphical capabilities of the Raspberry Pi are roughly equivalent to the performance of the [Xbox](#) of 2001.

Raspberry Pi 2 V1.1 included a quad-core [Cortex-A7](#) CPU running at 900 MHz and 1 GB RAM. It was described as 4–6 times more powerful than its predecessor. The GPU was identical to the original.^[23] In parallelised benchmarks, the Raspberry Pi 2 V1.1 could be up to 14 times faster than a Raspberry Pi 1 Model B+.^[27]

The Raspberry Pi 3, with a quad-core [ARM Cortex-A53](#) processor, is described as having ten times the performance of a Raspberry Pi 1.^[28] This was suggested to be highly dependent upon task [threading](#) and [instruction set](#) use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in [parallelised](#) tasks.^[29]

Overclocking[\[edit\]](#)

Most Raspberry Pi [systems-on-chip](#) could be [overclocked](#) to 800 MHz, and some to 1000 MHz. There are reports the Raspberry Pi 2 can be similarly overclocked, in extreme cases, even to 1500 MHz (discarding all safety features and over-voltage limitations). In the [Raspbian Linux distro](#) the overclocking options on [boot](#) can be done by a software command running "sudo raspi-config" without voiding the warranty.^[30] In those cases the Pi automatically shuts the overclocking down if the chip [temperature](#) reaches 85 °C (185 °F), but it is possible to override automatic over-voltage and overclocking settings (voiding the warranty); an appropriately sized [heat sink](#) is needed to protect the chip from serious [overheating](#).

Newer versions of the [firmware](#) contain the option to choose between five overclock ("turbo") presets that when used, attempt to maximise the performance of the SoC without impairing the lifetime of the board. This is done by monitoring the core temperature of the chip and the [CPU load](#), and dynamically adjusting [clock speeds](#) and the [core voltage](#). When the demand is low on the CPU or it is running too hot the performance is [throttled](#), but if the CPU has much to do and the chip's temperature is acceptable, performance is temporarily increased with clock speeds of up to 1 GHz, depending on the individual board and on which of the turbo settings is used.

The seven overclock presets are:

- none; 700 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 [overvolting](#)
- modest; 800 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting,
- medium; 900 MHz ARM, 250 MHz core, 450 MHz SDRAM, 2 overvolting,
- high; 950 MHz ARM, 250 MHz core, 450 MHz SDRAM, 6 overvolting,
- turbo; 1000 MHz ARM, 500 MHz core, 600 MHz SDRAM, 6 overvolting,
- Pi 2; 1000 MHz ARM, 500 MHz core, 500 MHz SDRAM, 2 overvolting,
- Pi 3; 1100 MHz ARM, 550 MHz core, 500 MHz SDRAM, 6 overvolting. In system information the CPU speed will appear as 1200 MHz. When idling, speed lowers to 600 MHz. ^{[30][31]}

In the highest (*turbo*) preset the SDRAM clock was originally 500 MHz, but this was later changed to 600 MHz because 500 MHz sometimes causes SD card corruption. Simultaneously in *high* mode the core clock speed was lowered from 450 to 250 MHz, and in *medium* mode from 333 to 250 MHz.

The Raspberry Pi Zero runs at 1 GHz.

The CPU on the first and second generation Raspberry Pi board did not require cooling, such as a heat sink or [fan](#), even when overclocked, but the Raspberry Pi 3 may generate more heat when overclocked