



Updating Raspberry Pi firmware

Colophon

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Document version history

Release	Date	Description
1	24 May 2021	Initial release
2	27 April 2022	Copy edit, public release
3	24 Mar 2026	Update adding bootloader section

Scope of document

This document applies to the following Raspberry Pi products:

Single Board Computers / SBCs

Pi Zero			Pi Zero 2		Pi 1				Pi 2	Pi 3			Pi 4	Pi 5
-	W	H	W	WH	A	B	A+	B+	B	A+	B	B+	B	-
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Compute Modules

CM0	CM1	CM3	CM3+	CM4	CM4S	CM5
✓	✓	✓	✓	✓	✓	✓

Keyboard Computers

Pi 400	Pi 500	Pi 500+
✓	✓	✓

Introduction

In some circumstances, it may be necessary to update the VideoCore firmware in a Raspberry Pi operating system (OS) image without going through the normal upgrade process. This white paper documents how to use the standard upgrade process and explains how to bypass that process if it is unsuitable.

What is firmware?

Firmware is specialised, low-level software that controls the core functions of a device. You can think of it as the software that starts the device up, then acts as the bridge between its hardware and its higher-level operating systems. In Raspberry Pi's case, this is usually the Linux-based Raspberry Pi OS.

The firmware on Raspberry Pi devices, up to and including the Raspberry Pi 4 Model B series, is split between the [bootloader](#) and the `start.elf` file. The bootloader passes control over to `start.elf` once the hardware has been initialised, and `start.elf` then runs the OS. There is no `start.elf` on Raspberry Pi 5 – just a flash-based bootloader that handles startup and passes control over to the OS.

Note

Over the years, Raspberry Pi has removed more and more code from the firmware and handed its functionality over to the OS itself. For example, the 3D system, CODECs, and display controls all used to be handled by the firmware in `start.elf`, but their functionality has since been integrated into Raspberry Pi OS, making the code open source. Raspberry Pi 5 requires very little firmware support, as almost all of its functionality is handled by the OS, leaving just some low-level temperature control and cryptographic support.

Why you might need new firmware

As time goes on, the firmware on your Raspberry Pi devices will need to be upgraded. Possible reasons for an upgrade include:

- Bug fixes
- Support for new processors (e.g. moving from Raspberry Pi 3 Model B to Raspberry Pi 4 Model B)
- Support for new memory chips
- Support for new revisions of the printed circuit board (PCB)

It's not possible to make the firmware forward compatible, i.e. able to cope with future changes to the hardware; however, every effort is made to ensure the firmware is backward compatible, and the latest version should always work on older products without causing any regressions.

For example, there are numerous revisions of the Raspberry Pi 4 Model B PCB, the latest of which requires the most recent firmware to work correctly. This is in part due to some changes in the power management chips on the PCB, which require a different startup sequence. If you use third-party products based on Raspberry Pi 4 Model Bs, you may find that a batch of devices belongs to a newer revision, and that your standard distribution with older firmware no longer works correctly.

The standard upgrade process

There are standard commands you can use in Raspberry Pi OS (and many third-party OS distributions) to upgrade the system and its firmware. Raspberry Pi Ltd recommends using these wherever possible.

To upgrade the Linux kernel and all of the Raspberry Pi-specific firmware to the latest release version, use the following commands:

```
</> Code
sudo apt update
sudo apt full-upgrade
```

Note that this process will not upgrade between major OS versions. While it is possible to implement a full upgrade between major versions in place, Raspberry Pi Ltd does not recommend doing so — this is not a tested procedure, due to the huge number of changes involved. In this case, we recommend starting afresh by installing the latest OS on a new SD card using Raspberry Pi Imager. You will need to reinstall all of the required software in any new installation.

Updating only the firmware

Updating your device using the standard procedure may not be possible at times; for example, you may have a customised distribution with no update facilities, or one that cannot be upgraded without causing further issues. In these circumstances, and possibly others not mentioned here, you will need to update the firmware files in the distribution manually.

You can download the firmware files from the following location: <https://github.com/raspberrypi/firmware/archive/refs/heads/stable.zip>

This zip file contains a number of items, but the ones we are interested in at this stage are located in the `boot` folder. The firmware files are named in the format `start.elf`, and their associated support files are named `fixup.dat`.

The basic principle is to copy the required `start` and `fixup` files from this zip file and replace those of the same name in the destination OS image. The exact process will depend on how the OS has been set up, but the following gives an example of how it should be done for a Raspberry Pi OS image:

- Extract or open the zip file so that you can access the required files
- Open the `boot` folder in the destination OS image (this can be on an SD card or a disk-based copy)
- Determine which `start.elf` and `fixup.dat` files are present in the destination OS image
- Copy those files from the zip file to the destination OS image

The image should now be ready to use on the latest Raspberry Pi Ltd hardware.

Bootloader updates

All Raspberry Pi devices have second-stage bootloader firmware that is loaded and run by the first-stage, ROM-based bootloader. The primary purpose of the bootloaders is to load the operating system from different storage media, e.g. SD or USB. On boards prior to Raspberry Pi 4 Model B, the second-stage bootloader is a file on the SD card called `bootcode.bin`.

On the following devices, the bootloader is stored in the on-board EEPROM:

- Raspberry Pi 4 Model B
- Raspberry Pi Compute Module 4
- Raspberry Pi Compute Module 4 SODIMM
- Raspberry Pi 400
- Raspberry Pi 5
- Raspberry Pi Compute Module 5
- Raspberry Pi 500
- Raspberry Pi 500+

Tip

The bootloaders on these devices are programmed into the EEPROM during manufacture. Changes to the bootloaders are rare, and usually only occur when there has been a hardware change or a major new feature is being released (e.g. [Network Install](#)).

When using Raspberry Pi OS, the bootloader is updated — irrespective of device type — via the standard `apt` update process described above, which always installs the latest factory-default firmware. Alternatively, a manual `apt` command, `sudo rpi-eeprom-update -a`, can be used to run the update.

Warning

The preprogrammed factory firmware should be regarded as the minimum supported version for the board on which it is installed. You should not install a bootloader older than the factory default, as the device may no longer boot. If an older bootloader has been incorrectly installed, the resulting non-booting board can usually be recovered using the instructions in the next section.

Using Raspberry Pi Imager to update an EEPROM-based bootloader

It's possible to update the bootloader manually without booting the device to Raspberry Pi OS. You may need to do this if, for some reason, the bootloader has been corrupted, though this is incredibly rare.

1. Open Raspberry Pi Imager on your computer (download it [here](#), if required).
2. Select your device, then click 'Next'.
3. On the 'OS' tab, select 'Misc utility images' and then 'Bootloader'.
4. Select the appropriate option for your board (e.g. SD card boot for Raspberry Pi 4/5) and click 'Next'.
5. Insert an SD card, select it in the 'Storage' tab, and click 'Next'.
6. If all of the settings are correct, click 'Write'.
7. Once the write is complete, insert the SD card into your Raspberry Pi and power it on.
8. Wait for the green LED to start blinking rapidly. If a display has been connected via HDMI, the screen will also turn green, indicating that the update has been successful. If the screen goes red, it means the update has not been completed.

Contact Details for more information

Please contact applications@raspberrypi.com if you have any queries about this whitepaper.

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