
Root On PCIe Connected SATA Drive

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1 Colophon

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2 Introduction

This is a guide to installing Raspberry Pi OS with its root partition on PCIe connected SATA drive. It is not currently possible, and not likely to ever be possible to boot directly from a SATA drive.¹

It is assumed that the reader is familiar with the Linux command line and at least one text editor. Desktop users will need to open a terminal to execute many of the commands in this guide.

The steps outlined in this guide are destructive and may lead to data loss, I cannot and will not accept any liability for any data loss or damage to your hardware.

While aimed at Raspberry Pi OS, much will apply to any Linux distribution.

2.1 What's Not Covered

- OS installation.
- Networking configuration.
- Hardware installation.
- M.2 SATA drives when used with most of the available NVMe HAT[+] and base boards.²
- File systems other than ext4.

2.2 Requirements:

- A Pi model with an exposed PCIe connector: 4B, CM4, Pi 5, or CM5.³
- Raspberry Pi OS Bookworm or Trixie.⁴⁵
- A PCIe HAT[+] or PCIe SATA card (with a suitable adapter to the Pi's PCIe connector)
- A SATA SSD or HDD.
- If using 3.5" drive(s) a 12v supply.
- An internet connection for software updates and installation.
- A Raspberry Pi with a configured and working network connection.
- For a headless⁶ Pi, Raspberry Pi Connect, VNC or ssh enabled.

¹ Sorry, I don't have the link to back that up but it has been stated more than once on the official forum.

² Because they simply won't work.

³ While the CM4 and CM5 expose a PCIe lane the IO board may not.

⁴ Earlier releases require additional steps that out of scope of this guide.

⁵ This should work with later releases too.

⁶ I.E. no monitor, mouse, or keyboard connected.

2.3 Conventions

Text like this indicates input to or output from the command line.

Text like this also refers to full or partial commands but is not generally intended to be entered into the command line as is.

“SD card” refers equally to full size and micro SD cards. IF should also be taken to refer to any boot storage medium in use.

Where “pi” occurs as a username, replace as appropriate.

“server” refers to the NAS, “client” to any device that accesses resources provided by the NAS.

“l-space” is a sample hostname. Replace with the actual hostname of your server.

All non system paths used in this guide follow the Filesystem Hierarchy Standard⁷ though this is not mandatory.

⁷ https://en.wikipedia.org/wiki/Filesystem_Hierarchy_Standard

3 Change Log

2025-12-25

Initial release

4 Prepare The OS

1. If applicable
2. If starting from a fresh OS installation:
 - I. Install Raspberry Pi OS on to bootable media.
 - II. Boot and allow the normal first boot scripts to run.
3. If starting from an existing installation:
 - I. Backup your existing initramfs files.⁸
 - II. If applicable disable the overlayfs root filesystem
 - III. Make sure the boot partition is mounted rw.
 - IV. Optionally back up your entire OS drive.
4. Configure the OS:
 - I. Open `/etc/initramfs-tools/modules` in your preferred text editor. You will need to be root or use `sudo`.
 - II. Add the following to the end of the file

```
libata
libahci
ahci
```
- III. Save and close.
- IV. Regenerate the initramfs:

```
sudo update initramfs
```
- V. Ensure that the new initramfs files have been copied to `/boot/firmware` and that they have the correct names.⁹

5. Reboot and test.

⁸

⁹ Files need to be named the same as the corresponding kernel but without the `.img` suffix. For example `kernel18.img` and `kernel18`

5 Prepare The Target Drive

This assumes you're using the entire drive and that it has not yet been initialised.¹⁰ If using an already partitioned drive some steps can be skipped.

Using a file system other than ext4 may require additional modules in the initramfs.

! Caution: all occurrences of a device node¹¹ are examples only. Always check you're using the correct value for your systems as using the wrong one will destroy your data. !

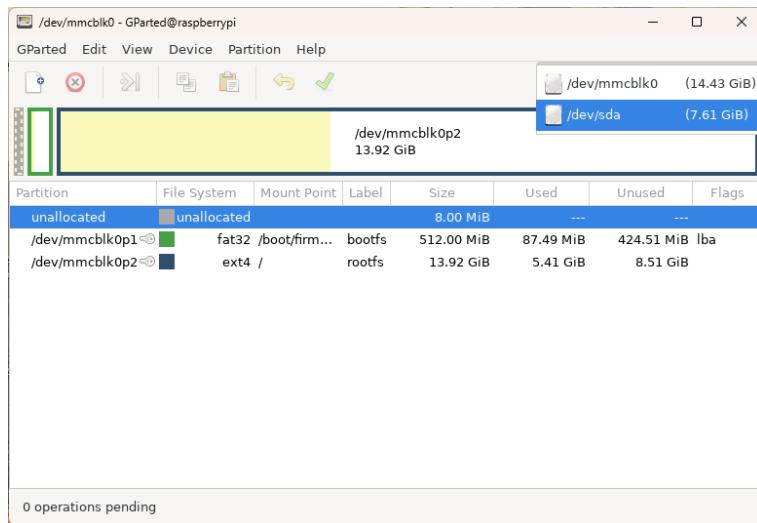
¹⁰ Or that you want to replace all existing partitions and data on it.

¹¹ E.G. /dev/sda

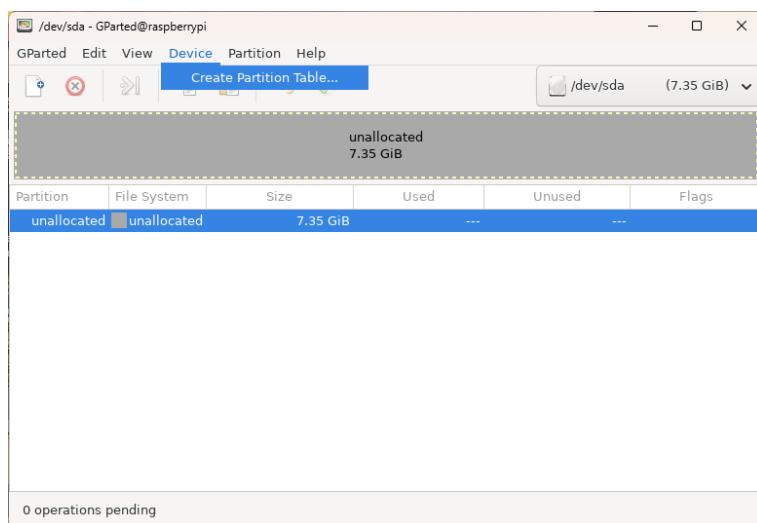
5.1 Desktop

The command line procedure can also be used.

1. Open gparted.
2. Select your target drive from the drop down menu.



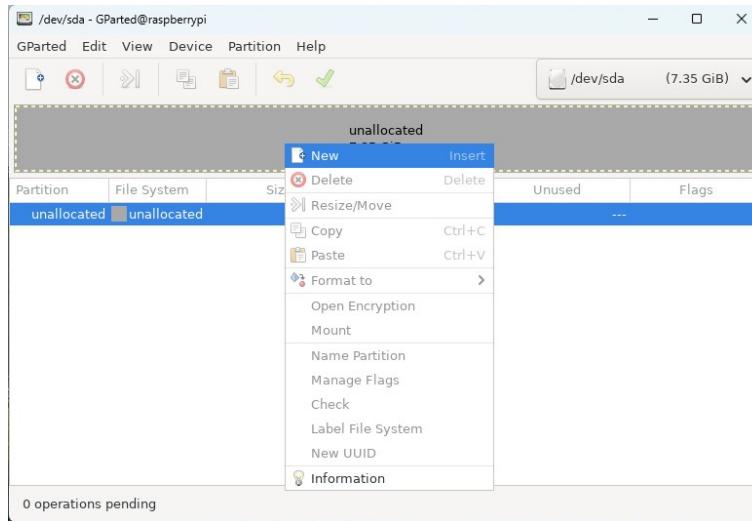
3. Open the Device menu
4. Select Create Partition Table



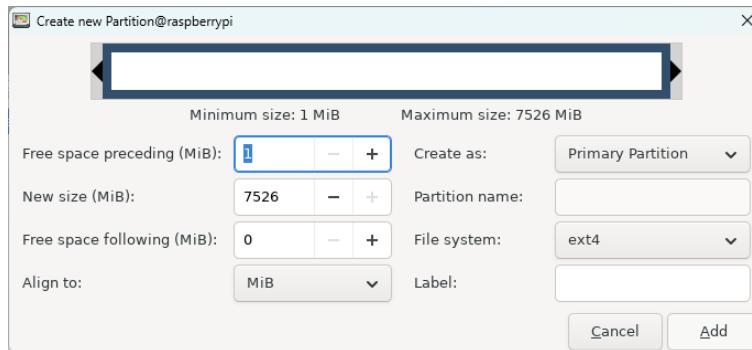
-
5. Select partition table type. Drives over 2TB capacity should use gpt. Drives 2TB and under should use gpt or msdos.



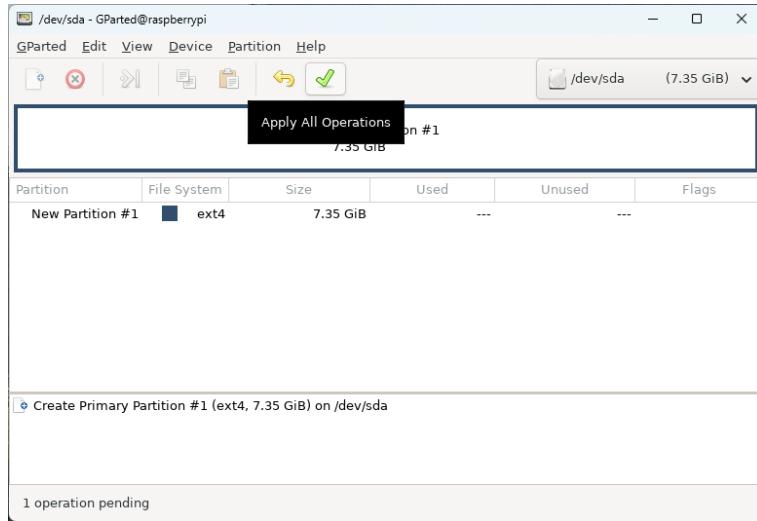
6. Click “Apply”
7. Right click the “unallocated” bar and select New



8. Adjust settings if required (but leave “File system” as ext4) and click “Add”



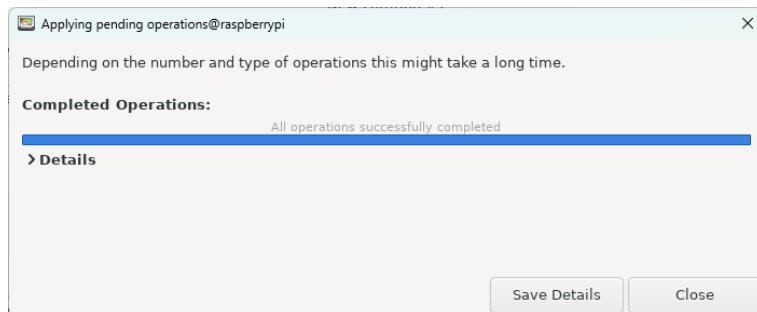
9. Click the green tick icon



10. Click “Apply”



11. Click “Close”



12. Close gparted

5.2 Command Line

1. Find the device node¹² of the drive:

```
lsblk
```

2. Start fdisk using the device node:

```
sudo fdisk /dev/sda
```

3. Create a new partition table. Drives over 2TB capacity should use gpt. Drives 2TB and under should use msdos.

For msdos:

```
o
```

For gpt:

```
g
```

4. Create a new partition:

```
n
```

5. Accept default answers to prompts.

6. Preview changes

```
p
```

7. If all looks correct write changes to disc:

```
w
```

8. Format the partition:

```
sudo mkfs.ext4 /dev/sda1
```

¹² The item in /dev that refers to the physical disc.

6 Copy The Root Partition's Contents

Desktop users will need to open a terminal.

1. Mount the target partition on /mnt:

```
sudo mount /dev/sda1 /mnt
```

Desktop users may first need to eject/unmount the partition.

2. Copy the files:

```
sudo rsync -avxHAX / /mnt
```

7 Final OS Configuration

Desktop users will need to open a terminal.

1. Find the new root partition's PARTUUID:

```
lsblk -o NAME,MOUNTPOINT,PARTUUID /dev/sda
```

2. Open /mnt/etc/fstab in your preferred text editor. You will need to be root or use sudo.

3. Find the line with a single / in the second field.

4. Replace the value in that line after PARTUUID= with the PARTUUID from above.

5. Save and close.

6. Back up your existing cmdline.txt:

```
sudo cp /boot/firmware/cmdline.txt /boot/firmware/cmdline.bak
```

7. Open /boot/firmware/cmdline.txt in your preferred text editor. You will need to be root or use sudo.

8. Replace the value after root=PARTUUID= with the value from above.

9. Ensure the file's contents are still on a single line.¹³

10. Save and close.

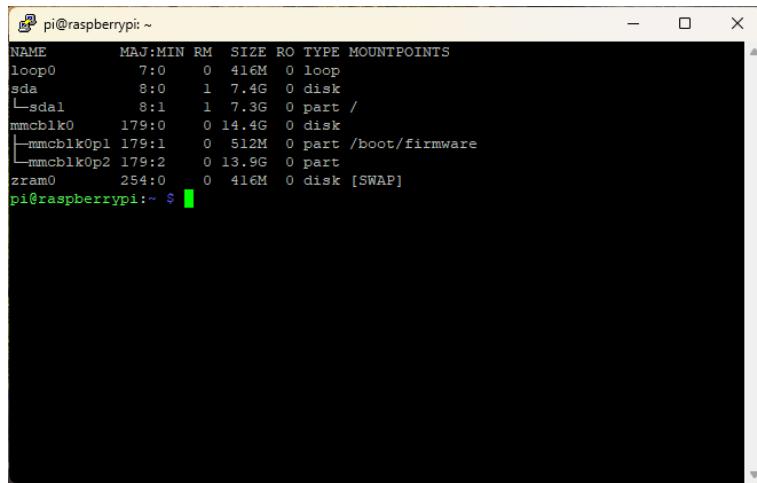
¹³ Word wrap is OK but there must be no line breaks/new lines present.

8 Final Steps

1. Reboot
2. Check the correct partitions are mounted:

```
lsblk
```

The output should be similar to



A terminal window titled "pi@raspberrypi: ~" displaying the output of the "lsblk" command. The output shows the following disk information:

NAME	MAJ:MIN	RM	SIZE	RO	TYPE	MOUNTPOINTS
loop0	7:0	0	416M	0	loop	
sda	8:0	1	7.4G	0	disk	
└─sda1	8:1	1	7.3G	0	part	/
mmcblk0	179:0	0	14.4G	0	disk	
└─mmcblk0p1	179:1	0	512M	0	part	/boot/firmware
└─mmcblk0p2	179:2	0	13.9G	0	part	
zram0	254:0	0	416M	0	disk	[SWAP]

pi@raspberrypi:~ \$

3. Optional step: delete the root partition from your SD card.

9 Troubleshooting

Due to the wide range of potential failures it is not possible to offer detailed or complete advice.

9.1 Pi Fails to Boot

- Check the usual possibilities and causes.¹⁴
- Ensure that the SD card¹⁵ is still present and that it has a valid boot partition.

9.2 Root Partition is Not Mounted

This will manifest in one of two ways: “Recovery mode” with a prompt for the root password¹⁶ or a busybox/initramfs command prompt.

- Ensure the PARTUUID in cmdline.txt is correct.
- Ensure the PARTUUID in the new fstab is correct. You will need a Linux box to check this or restore the backed up cmdline.txt and reboot first.

9.3 The Wrong Root Partition is Mounted

- Ensure the PARTUUID in cmdline.txt is correct.
- Ensure the PARTUUID in the new fstab is correct.

¹⁴ See <https://forums.raspberrypi.com/viewtopic.php?t=5815>

¹⁵ Or other boot media.

¹⁶ By design there is no password for the root user.
