

Orange Pi 5 NVMe/SATA SSD Boot Guide

 jamesachambers.com/orange-pi-5-ssd-boot-guide

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Orange Pi 5 NVMe / SSD Boot Guide

The Orange Pi 5 has a nice M.2 NVMe slot but unfortunately most of the official images will not boot if you try to directly image a NVMe drive. Fortunately there is an easy way to get this working that people who frequent the blog will almost certainly have seen before.

We are going to bootstrap the boot process using a SD card and then clone that SD card to our SSD to be used as the root partition. This essentially will let us have our system's root partition on the SSD (much faster).

Let's get started!

Hardware Used

The Orange Pi 5 the latest release from Orange Pi and is the most powerful model yet. It has a 6 core CPU and options from 4GB of RAM all the way up to 32GB of RAM!

Links: [Amazon.com*](#), [AliExpress*](#), [Amazon.ca*](#), [Amazon.co.uk*](#), [Amazon.de*](#), [Amazon.es*](#), [Amazon.fr*](#), [Amazon.it*](#), [Amazon.nl*](#), [Amazon.pl*](#)



Orange Pi 5

The Kioxia (Toshiba) 128GB M.2 2230 PCIe NVMe drive is much shorter than most NVMe drives (full size is 2280). It fits great with single board computers / tablets / other smaller form factors.

Links: [Amazon.com*](#), [Amazon.ca*](#), [Amazon.co.uk*](#), [Amazon.co.jp*](#), [Amazon.com.au*](#), [Amazon.de*](#), [Amazon.es*](#), [Amazon.fr*](#), [Amazon.it*](#), [Amazon.nl*](#), [Amazon.pl*](#), [Amazon.se*](#), [Amazon.sg*](#)



Kioxia 2230 M.2 NVMe Drive

The Geekworm copper heat sink set is designed to fit many different single board computers. It uses thermal conductive adhesive which many "cheap" heat sink kits for SBCs don't have. Eliminates hot spots and reduces throttling. Can be further enhanced by powered cooling over the heat sinks.

Links: [Amazon.com*](#), [Amazon.ca*](#), [Amazon.co.jp*](#), [Amazon.co.uk*](#), [Amazon.de*](#), [Amazon.es*](#), [Amazon.fr*](#), [Amazon.it*](#)



Geekworm Copper Heat Sink Set

The StarTech USB 3.1 to 2.5" SATA adapter is one I have recommended for many years for use with all kinds of devices including the Raspberry Pi, Orange Pi, ODROID, Libre "Renegade" and Tinker Board. It's widely compatible and works with gaming consoles as well.



StarTech 2.5" SATA to
USB 3.1 Adapter

Links: [Amazon.com*](https://www.amazon.com), [Amazon.ca*](https://www.amazon.ca), [Amazon.com.au*](https://www.amazon.com.au),
[Amazon.co.jp*](https://www.amazon.co.jp), [Amazon.co.uk*](https://www.amazon.co.uk), [Amazon.de*](https://www.amazon.de), [Amazon.es*](https://www.amazon.es),
[Amazon.fr*](https://www.amazon.fr), [Amazon.it*](https://www.amazon.it), [Amazon.nl*](https://www.amazon.nl), [Amazon.pl*](https://www.amazon.pl), [Amazon.se*](https://www.amazon.se),
[Amazon.sg*](https://www.amazon.sg)

Note for USB Booting

Important: Only the top blue port of the Orange Pi 5 is fast for using USB storage. You can use a USB-connected SSD.

The bottom port, despite being blue, is USB 2.1.

Keep in mind that if you are using a USB SSD then in the instructions anywhere it says `/dev/nvme0n1` you will need to use `/dev/sda` or whatever drive was assigned when you plug in your drive via USB.

Note for Official Debian / Ubuntu Images (Updated 1/10/2023)

Orange Pi has updated their official images to support directly booting from NVMe. This means that if you are using the official Ubuntu or Debian from [orangepi.org](https://www.orangepi.org) then you can actually write the image directly to the SSD. This is the easiest way to get it going.

You first need to write the image to a SD card and then run:

```
sudo orangepi-config
```

Then choose System->Install->Boot from SPI and install the new updated boot loader to the SPI flash.

This did not work at launch but is working now. **It is now possible to simply write the official images directly to NVMe and boot with it after updating the boot loader!** The following instructions will still be useful for other operating systems or operating systems that do not support booting directly from NVMe.

Note for Armbian (Added 1/20/2023)

Armbian has a similar install utility as `orangepi-config`. For Armbian you will use:

```
sudo armbian-config
```

Then choose System->Install->Boot from eMMC and install the new updated boot loader to the SPI flash.

You should also install the system to Armbian using this method. The instructions in the rest of the article are meant for operating systems that will not boot natively from NVMe. It uses a SD card as the boot loader to essentially let you boot anything (even ones not designed to boot directly from NVMe).

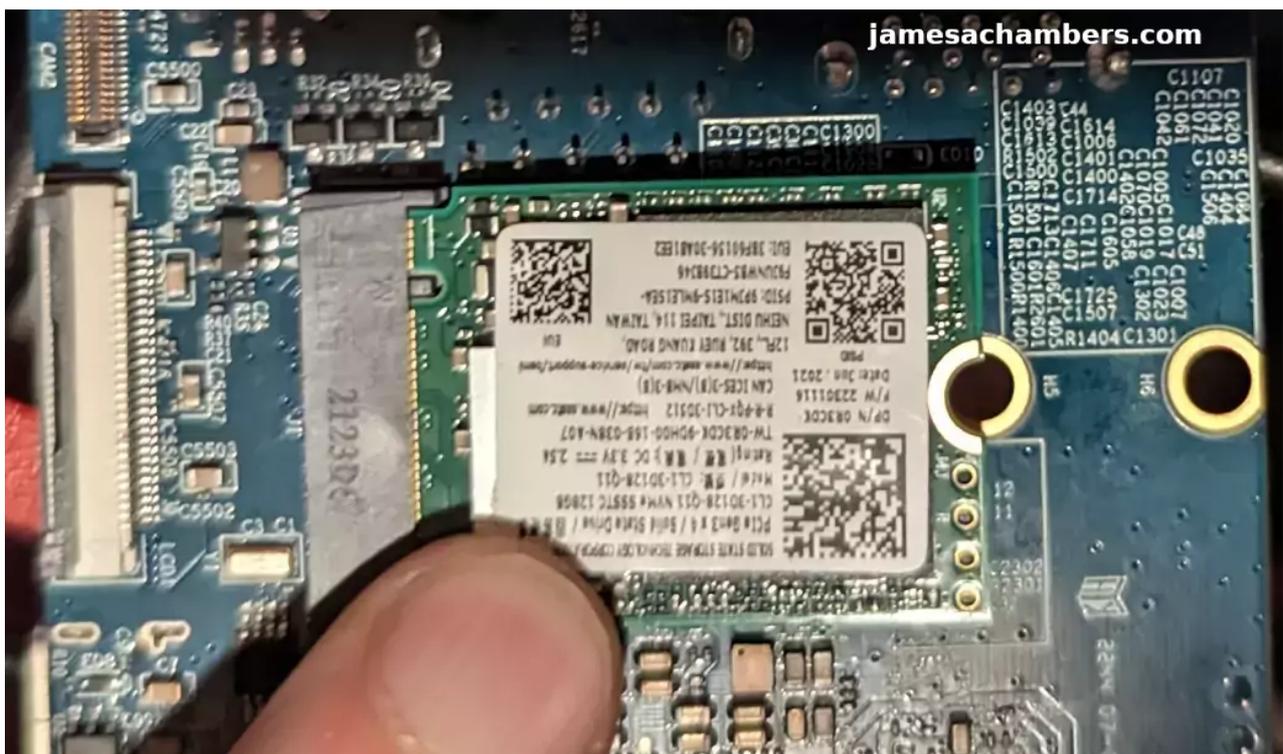
Supported SSD Sizes (Updated 1/26/2023)

Important: There is also a type of M.2 drive called a M.2 SATA drive. This is an older type of drive that most of you won't have but some of you will. This type of drive is supported by the Orange Pi 5 but you have to add a special overlay (overlays=ssd-sata). If your NVMe drive shows up as /dev/sda instead of /dev/nvme0n1 then you have a M.2 SATA SSD. If you have a M.2 SATA drive follow [this excellent guide by u/jng98908 on reddit](#).

You can use either a 2230 or a 2242 size NVMe drive.

There are actually holes for mounting hardware at both places.

Using a 2230 size NVMe drive looks like this:



Orange Pi 5 with 2230 NVMe drive mounted

It's totally fine to use a larger one but they will be hanging off the edge of the board. As you can see I do not have the mounts installed on my board. I just leave the 2230 drive in the port like this but it is on my to-do list to find some mounts for the M.2 drive for this board.

SD card boot loader – Preparing SD Card

First you should have a completely working installation on a SD card of the OS that you would like to use. I used the official Debian desktop image for this guide (recommended) so if your partitions are different it may be your flavor of Linux and need slightly altered instructions.

If you have an already working installation you want to move to your SSD you can use this as well most likely.

Note that some operating systems like Armbian will require you to manually go in and modify files on the “boot” partition. If you stick with the official images you should be able to follow the guide as-is but note that some operating systems may have text files (or even files that need to be recompiled with mkimage like for Armbian) for this method to work.

You should completely update first with:

```
sudo apt update && sudo apt full-upgrade
```

Preparing SSD

First we are going to completely remove all partitions from the drive so it's completely blank. Your drive should typically be /dev/nvme0n1:

```
sudo gdisk /dev/nvme0n1
```

Now remove all partitions from the device. If you press “p” it will print out the partitions. You can then use “d” to delete them.

Here's an example on mine:

```
root@orangepi5:~# sudo gdisk
GPT fdisk (gdisk) version 1.0.6
```

Partition table scan:

```
  MBR: protective
  BSD: not present
  APM: not present
  GPT: present
```

Found valid GPT with protective MBR; using GPT.

Command (? for help): p

```
Disk /dev/nvme0n1: 250069680 sectors, 119.2 GiB
Sector size (logical/physical): 512/512 bytes
Disk identifier (GUID): E3017ECA-4571-4F62-A39F-4BA2A4323BD8
Partition table holds up to 128 entries
Main partition table begins at sector 2 and ends at sector 33
First usable sector is 34, last usable sector is 250069646
Partitions will be aligned on 64-sector boundaries
Total free space is 8350 sectors (4.1 MiB)
```

Number	Start (sector)	End (sector)	Size	Code	Name
1	64	8063	3.9 MiB	0700	loader1
2	16384	24575	4.0 MiB	0700	loader2
3	24576	32767	4.0 MiB	0700	trust
4	32768	1081343	512.0 MiB	EF00	boot
5	1081344	250069646	118.7 GiB	8300	rootfs

Command (? for help): d

Keep pressing d until all the partitions are deleted. Once they are gone use the 'w' command to write your changes.

Cloning Installation to SSD

We're now ready to clone your installation to the SSD. We can now copy your drive to the SSD with the following command:

```
cat /dev/mmcb1k1 > /dev/nvme0n1
```

Wait for the operation to complete (there won't be any output but you will have a cursor again and be able to type new commands). Remember that you are copying an entire drive from one to another basically with that one command.

Mine took about 30-45 minutes (although I was using a 64GB SD card and the larger SD card you use the longer it will take to copy the whole drive).

If you are having any trouble with permissions try becoming "root" first with:

```
sudo su
```

Now try running the command again and as the superuser you should not encounter any permission errors.

Change SD card's rootfs UUID

We need to change our SD card's UUID so that it doesn't try to boot from that partition. We can set it to a random one with the following command:

```
sudo tune2fs -U random /dev/mmcblk1p2
```

If you get an error with the previous command regarding csums try the following command instead:

```
sudo tune2fs -O metadata_csum_seed -U random /dev/mmcblk1p2
```

We can verify that it has changed with blkid like this:

```
root@orangepi5:~# sudo blkid
/dev/nvme0n1p1: SEC_TYPE="msdos" LABEL_FATBOOT="opi_boot" LABEL="opi_boot"
UUID="0257-2A31" BLOCK_SIZE="512" TYPE="vfat" PARTLABEL="bootfs"
PARTUUID="0a65713b-d4b4-0642-a3a4-ebc357e507a1"
/dev/nvme0n1p2: LABEL="opi_root" UUID="ae948e48-3646-4f5c-be01-73168e079bc8"
BLOCK_SIZE="4096" TYPE="ext4" PARTUUID="7490e84a-f585-944e-9ce6-f275f067a023"
/dev/mmcblk1p1: SEC_TYPE="msdos" LABEL_FATBOOT="opi_boot" LABEL="opi_boot"
UUID="0257-2A31" BLOCK_SIZE="512" TYPE="vfat" PARTLABEL="bootfs"
PARTUUID="0a65713b-d4b4-0642-a3a4-ebc357e507a1"
/dev/mmcblk1p2: LABEL="opi_root" UUID="37a6ee0a-e61d-470a-9e53-eaf51726942c"
BLOCK_SIZE="4096" TYPE="ext4" PARTUUID="4f32d51c-0523-1248-9bc3-092d1f11c594"
```

Notice that /dev/nvme0n1p2 and /dev/mmcblk1p2 no longer have matching UUIDs. This is exactly what we want.

Change SSD's boot UUID

Next we are going to change the boot partition's UUID on the SSD. This will make it so that the mounted /boot folder inside your operating system actually mounts the SD card (which is your actual boot loader in this configuration).

First make sure you have mtools with:

```
sudo apt install mtools -y
```

Now we can change the UUID with:

```
sudo mlabel -N aaaa1111 -i /dev/nvme0n1p1 ::
```

You can verify these are different using the same sudo blkid command as the previous section.

Run fsck

Before we reboot run fsck on the drive like this:

```
sudo fsck -yf /dev/nvme0n1p2
```

This will prevent you from having to run fsck on the CLI the first time you try to boot.

Reboot and Verify

Now reboot the Orange Pi 5 with:

```
sudo reboot
```

With any luck you should be booted using your SSD! We can verify this with the mount command like this:

```
root@orangepi5:~# mount
/dev/nvme0n1p2 on / type ext4 (rw,noatime,errors=remount-ro,commit=600)
/dev/mmcblk1p1 on /boot type vfat
(rw,relatime,fmask=0022,dmask=0022,codepage=936,iocharset=utf8,shortname=mixed,erro
ro)
/dev/nvme0n1p2 on /var/log.hdd type ext4 (rw,noatime,errors=remount-ro,commit=600)
```

Here we can see that our root partition (/) is indeed on /dev/nvme0n1p2 and not /dev/mmcblkop2. We can also see that my /boot folder is properly mounted is /dev/mmcblkop1 (the SD card which is serving as our boot loader). Success!

Resize NVMe Partition (Added 1/24/2023)

You can use Orange Pi's built in resize application if you are using one of the official operating systems:

```
sudo /usr/lib/orangepi/orangepi-resize-filesystem start
```

Testing Performance

For the guide I used a SSSTC 128GB 2230 M.2 NVMe drive. These are available on Amazon for around \$10-12 (also see [Kioxia 128GB M.2 2230 module*](#)).

You can [verify the performance of your drive on Pi Benchmarks](#) using the following command:

```
sudo curl
https://raw.githubusercontent.com/TheRemote/PiBenchmarks/master/Storage.sh | sudo
bash
```

Here are the results:

Category	Test	Result
HDParm	Disk Read	375.32 MB/s
HDParm	Cached Disk Read	381.15 MB/s
DD	Disk Write	234 MB/s
FIO	4k random read	47080 IOPS (188321 KB/s)
FIO	4k random write	35128 IOPS (140514 KB/s)
IOZone	4k read	75628 KB/s
IOZone	4k write	67285 KB/s
IOZone	4k random read	35874 KB/s
IOZone	4k random write	70620 KB/s

Score: **17,718**

[The full Orange Pi 5 benchmark can be viewed here on Pi Benchmarks.](#)

That is an outstanding score. We are getting NVMe performance. This score actually even beats [my ODROID M1 benchmark.](#)

The Orange Pi 5 is without a doubt a very powerful board and is performing exactly where it should be.

Other Resources

If you are looking for alternative WiFi adapters for the Orange Pi 5 see [my using E-keyed WiFi adapters with the Orange Pi 5.guide here!](#)

I've [written a review for the Orange Pi 5 available here](#)

[All of my single board computer reviews are available here](#)