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Raspberry Pi Power Limitations

Asked 5 years, 3 months ago Active 2 months ago Viewed 103k times



There are very many, often contradictory, claims about the power requirements and limitations of the Pi.

77



What are the exact requirements?



power-supply usb-power

43



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asked Jul 23 '16 at 6:28

DON'T [Milliways](#)

PANIC **51k** 25 84 168

Which PI? Pi 4 or 3 or what? – [Sohan Arafat](#) Oct 22 '19 at 8:17

-
- 2 @SohanArafat Considering the question was asked over 3 years ago, I think it would be safe to assume that it's not regarding the Pi 4. That said, doesn't hurt to specify. – [amitchone](#) Jan 16 '20 at 13:37
-

2 Answers

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Power requirements of the Pi

96

The Foundation has [recommendations](#) for various models which range from 700mA to 3.0A.



These are quite generous, and all models will operate on a decent 1A supply - I can run my Pi3 with WiFi/keyboard/mouse/HDMI from an Apple 5W supply. Extra current may be required by USB peripherals and the recommended supplies make allowance for these.



Power sources SHOULD provide $5 \pm 0.25V$ and often list a current rating. This is the MAXIMUM current that can be safely drawn without causing the output to drop below its rated voltage. (Of course, very many supplies do not actually meet their published ratings, including many sold by Pi retailers. I have tested a number of PSU (with a dummy load) and have yet to find one which actually delivers the rated voltage at the rated current, except for the Apple 5W iPad Power Adapter.)

Many users worry that that they may "supply too much power" by using a higher rated supply. The Pi will only draw as much current as it requires and can not use more than 2.5A (Pi3) or 2A (Pi2/B+) as this is limited by a fuse, so there is no benefit in a higher rated supply. (Earlier models had a smaller polyfuse - probably 1.1A.)

The newer Pi(3/2/B+) have a voltage monitor chip (APX803) which triggers at **$4.63 \pm 0.07V$** . The Pi3B+, Pi3A+, Pi4B uses a MxL7704 PMIC chip to manage power, which has the same nominal trigger point. (MxL7704 Data Sheet says Voltage rising >4.59 $4.63 < 4.7$ Voltage falling >4.52 $4.57 < 4.65$.) This controls the **Red Power LED**.

The MxL7704 PMIC Data states Input voltage range: 4.0V to 5.5V.

If the **Red Power LED** is not illuminated this means the supply voltage is inadequate. (The newer Pi have a well engineered power circuit, and may continue to function even if the input voltage is below spec; the same may not be true of peripherals). The GUI had an rainbow indicator (replaced by a **lightning bolt**) which comes up in the top right if the voltage is inadequate. This has a 3 second timer, and may display even if the LED appears to be lit.

NOTE the **Red Power LED** on the Pi3B+, Pi3A+, Pi4B only functions if the SD Card/USB key has up to date firmware because it is controlled by software - it is meaningless otherwise.

You should be wary of cheap USB supplies. Many of these have very poor voltage regulation.

Many modern smartphones are designed to draw more current than the normal USB 500mA max. Phone manufacturers often supply higher current chargers, either by non-standard means or by adopting the new USB Charger spec, which permits higher currents,

unreliable) This does **NOT** mean you need a higher current/amp(sic) rating. It is extremely unlikely your supply cannot supply the current - it just cannot supply the required current while maintaining the required voltage.

No matter how good your Power Supply if you use **poor quality cables** to connect to the Pi you will have problems. Many (the majority?) of μ USB cables are designed to carry data, and have very thin wiring. This makes the cables thin, light and inexpensive but they are unsuitable for power. To remain in spec there should be less than 0.25V drop which corresponds to loop resistance of 0.25Ω @ 1A. Cables designed for charging smartphones are probably the best bet, and always use the shortest possible cable.

Unfortunately there appears to be no source of quality cables with guaranteed specifications (I have been forced to make my own). *I have been unable to source Micro USB plugs in small quantities, but have found many sellers on eBay offering Micro USB 5 Pin Male Plug T Port Socket . You need to supply your own strain relief, but coupled with 23/011mm speaker cable (suitable up to 1.5m) these provide a good connection. I couple with one of the 5V Switch Power Supply Driver Adapter For LED Strip to power several Pi.*

How much current can be drawn from the USB ports?

The Pi(3/2/B+) USB Current are supplied through a Current-Limited Power Switch (AP2553?) (U13), although this is not shown on the published schematics.

[Maximum total USB peripheral current draw](#) states the max USB current for Pi(2/B+ or later) is 1200mA. Earlier models claim 500mA.

~~The default for 2/B+ is 600mA which can be doubled by setting `max_usb_current=1` in `/boot/config.txt` . On recent *Raspberry Pi OS* this is set to 1200mA.~~

The USB hub on the B models does not appear to be compliant to the USB specification and does not limit current. Individual ports can supply in excess of 500 mA independent of negotiation, subject to the overall maximum limit and adequate power supply.

How much current can the 3.3V pin on the expansion header supply?

The Pi 3.3V rail is widely assumed to provide 50mA, but this is not officially documented for recent Pi models. The original Pi has an on-board linear regulator which was limited, but the B+ and later have a switch mode regulator which can supply more. The regulator chip (which supplies both 3.3V and 1.8V) is rated at 1A. The MxL7704 PMIC used in the Pi3B+, Pi3A+ and Pi4 is rated at 1.5A.

- less the current required by the Pi itself ([~750mA for Pi3](#), although this will increase for heavy use),
- less USB peripheral current,
- less Camera Module (~250mA if fitted),
- less HDMI port (~50mA),
- less Display (if fitted),
- less 3.3V current supplied to external devices (including GPIO).

Can the Pi be powered through the expansion header?

There are many good reasons to power through the expansion connector e.g using battery supply or powering multiple Pi from a single supply. There is no risk if you apply proper engineering practices. Indeed the Foundation [Hats Master](#) has recommendations and minimum requirements for such connection.

"It is possible to power the Pi by supplying 5V through the GPIO (sic) header pins 2,4 and GND. The acceptable input voltage range is $5V \pm 5\%$ Implement a duplicate power safety diode ... supply 5V at a minimum of 1.3A ... Under no circumstances should a power source be connected to the 3.3V pins."

NOTE the [Hats Master](#) has been updated for newer models, and includes suggested circuitry.

If you are using a Pi Zero the use of a power safety diode is probably superfluous, as the Zero does not have one, or indeed any protection circuitry.

Technical details

The release of the Pi3B+ has been followed by a description of its [Power Circuitry](#) which includes comments on earlier models. The PEN pin (next to RUN) on the J2 header is connected to the Global Enable on the power module. Pulling this low should reduce Pi current to a couple of mA.

For those interested in understanding the Pi power configuration see the [Raspberry Pi3 Schematic](#). [Schematics](#) for other models are available. This can be a little intimidating,

NOTE On the B+ and Pi2 the "PWR" LED was connected to a GPIO pin as was the APX803 voltage monitor chip. This let the the Pi detect under-voltage OR control the LED.

The MOSFET controlling the Pi3 "PWR" LED is directly connected to the APX803 (which is open drain) so will ALWAYS be off if the voltage is low, but if not it should be possible to pull it low (and turn the LED off) with a [program](#). The latest Raspbian (using kernel 4.9) seems to have restored access to `/sys/class/leds/led1` which can be used to control the PWR LED on the Pi3.

Recent kernels support `vcgencmd get_throttled` bit0 indicates [under-voltage](#)

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edited Aug 22 at 7:35

answered Jul 23 '16 at 6:28

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DON'T [Milliways](#)

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-
- 3 Very minor gripe: in para 4, you've opted for 'there is no benefit in a higher rated supply'. Novice users may experience some mildly alarming toastiness caused by running 2.5A out of a supply rated for 2.5A for extended periods. It might be worth amending to 'there is no benefit *to the Pi* in a higher rated supply'. – [goobering](#) Jan 19 '17 at 12:04
-
- 1 @goobering I don't see your point. I agree that many (most?) supplies fail to meet their published specifications (and I already expressed my cynicism about "specifications"), but the PI will definitely **NOT** deliver more than 2.5A, regardless of the supply. Maybe you want me to say no benefit in a supply which would **actually** deliver more than 2.5A? – [Milliways](#) Jan 19 '17 at 12:19
-
- 7 The benefit is entirely to the power supply, not the Pi - if you run a power supply at its rated maximum for extended periods you're inviting early failure and (usually) relatively high temperatures. The high temps particularly can be a little worrisome. If you over-spec the power supply to leave a little headroom you reduce fatigue and extend its longevity a little. – [goobering](#) Jan 19 '17 at 12:56
-
- 1 @goobering A power supply that is rated for 2.5A, should be able to deliver that for it's rated live. – [Christian](#) Dec 20 '17 at 12:35
-
- 1 @Christian: Maybe... but I see very few that list "rated life" among their specs. Also, if this power



The Raspberry Pi Foundation recommendation has always been 5V plus or minus 0.25V.

5

In practice the Pi works from just over 3.3V to just under 6V. Personally I would limit the voltage to less than 5.8V.



Of course things you connect to the Pi may have a more limited voltage range.

The maximum current draw from the 5V and 3V3 rails depends on the Pi version and how it's powered (if powered via the microUSB all but the Pi Zero have a polyfuse fitted).

If you power via the expansion header use a 5V and ground pin.

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edited Dec 13 '16 at 0:07



Ghanima ♦

15.3k

15

56

109

answered Jul 23 '16 at 17:02



joan

65k

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2 This answer is rather broad and dangerous to anyone who does not know what he does. You might need a higher voltage, yes. But not to drive the Pi! Too high voltage will damage it! You usually need higher voltage to overcome the voltage drop on cheap USB cables to power the Pi. While undervoltage will not damage the Pi itself, it might lead to dropouts and reboots at high load thus damaging the filesystem. – [kwasmich](#) May 12 '17 at 9:13

1 I definitely agree that powering via the GPIO pins is the most reliable but there you have to be extra cautious as you bypass any security measures like fuses. – [kwasmich](#) May 12 '17 at 9:15

1 @kwasmich This answer is to the point. The question was not about fool-proof powering methods, then just buy the official Raspberry Pi power adapter. The Pi has a fuse in the usb connector, but that is not to protect against wrong usb powering, what is the chance on such event, but against short circuit in a usb device or cable that receives power FROM the Pi. Powering via the header pins is not the most reliable, as you noted it is easy to make mistakes there, but it may be the method with the lowest voltage drop. – [Roland](#) May 24 '20 at 9:47