USB-PD

Autor:
Data de publicació: 12-04-2018

USB power standards

SpecificationCurrentVoltagePower (max)

Low-power device
100 mA
5 V
0.50 W

Low-power SuperSpeed (USB 3.0) device
150 mA
5 V
0.75 W

High-power device
500 mA[a]
5 V
2.5 W

High-power SuperSpeed (USB 3.0) device
900 mA[b]
5 V
4.5 W

Battery Charging (BC) 1.2
1.5 A
5 V
7.5 W

Type-C
1.5 A
5 V
7.5 W

3 A
5 V
15 W

Power Delivery 2.0 Micro-USB
3 A
20 V
60 W

Power Delivery 2.0 Type-A/B/C[c]
5 A
20 V
100 W

Jump up^ Up to five unit loads; with non-SuperSpeed devices, one unit load is 100 mA.
Jump up^ Up to six unit loads; with SuperSpeed devices, one unit load is 150 mA.
Jump up^ Requires active PD 5 A cable.

USB supplies power at 5 V ± 5% to power USB downstream devices. To allows for voltage drops, the voltage at the hub port is specified in the range 5.00+0.25
?0.60 V by USB 2.0, and 5.00+0.25
?0.55 V[91]by USB 3.0. Devices' configuration and low-power functions must operate down to 4.40 V at the hub port by USB 2.0 and that devices' configuration, low-power, and high-power functions must operate down to 4.00 V at the device port by USB 3.0.

The limit to device power draw is stated in terms of a unit load, which is 100 mA or 150 mA for SuperSpeed devices. Low-power devices may draw at most 1 unit load, and all devices must act as low-power devices before they are configured. High-power devices draw at most 5 unit loads (500 mA) or 6 unit loads (900 mA) for SuperSpeed devices. A high-powered device must be configured, and may only draw as much power as specified in its configuration.[92][93][94][95] I.e., the maximum power may not be available.

A bus-powered hub is a high-power device providing low-power ports. It draws 1 unit load for the hub controller and 1 unit load for each of at most 4 ports. The hub may also have some non-removable functions in place of ports. A self-powered hub is a device that provides high-power ports. Optionally, the hub controller may draw power for its operation as a low-power device, but all high-power ports draw from the hub's self-power.

Where devices (for example, high-speed disk drives) require more power than a high-power device can draw,[96] they function erratically, if at all, from bus power of a single port. USB provides for these devices as being self-powered. However, such devices may come with a Y-shaped cable that has two USB plugs (one for power and data, the other for only power), so as to draw power as two devices.[97] Such a cable is non-standard, with the USB compliance specification stating that "use of a 'Y' cable (a cable with two A-plugs) is prohibited on any USB peripheral", meaning that "if a USB peripheral requires more power than allowed by the USB specification to which it is designed, then it must be self-powered."[98]

 USB Battery Charging[edit | edit source]
USB Battery Charging defines a charging port,which may be a charging downstream port (CDP), with data, or a dedicated charging port (DCP) without data. Dedicated charging ports can be found on USB power adapters to run attached devices and battery packs. Charging ports on a host with both kinds will be labelled. [99]

The charging device identifies a charging port by non-data signaling on the D+ and D? terminals. A dedicated charging port places a resistance not exceeding 200 ? across the D+ and D? terminals.[99][100]

Per the base specification, any device attached to an SDP must initially be a low-power device, with high-power mode contingent on later USB configuration by the host. Charging ports, however, can immediately supply between 0.5 and 1.5 A of current. The charging port must not apply current limiting below 0.5 A, and must not shut down below 1.5 A or before the voltage drops to 2 V.[99]

Since these currents are larger than in the original standard, the extra voltage drop in the cable reduces noise margins, causing problems with High Speed signaling. Battery Charging Specification 1.1 specifies that charging devices must dynamically limit bus power current draw during High Speed signaling;[101] 1.2 specifies that charging devices and ports must be designed to tolerate the higher ground voltage difference in High Speed signaling.

Revision 1.2 of the specification was released in 2010. Several changes are made and limits are increased including allowing 1.5 A on charging downstream ports for unconfigured devices, allowing High Speed communication while having a current up to 1.5 A, and allowing a maximum current of 5 A. Also, support is removed for charging port detection via resistive mechanisms.[28]

Before the Battery Charging Specification was defined, there was no standardized way for the portable device to inquire how much current was available. For example, Apple's iPodand iPhone chargers indicate the available current by voltages on the D? and D+ lines. When D+ = D? = 2.0 V, the device may pull up to 500 mA. When D+ = 2.0 V and D? = 2.8 V, the device may pull up to 1 A of current.[102] When D+ = 2.8 V and D? = 2.0 V, the device may pull up to 2 A of current.[103]

Accessory charging adaptors (ACA)[edit | edit source]
Portable devices having an USB On-The-Go port may want to charge and access USB peripheral at the same time, but having only a single port (both due to On-The-Go and space requirement) prevents this. Accessory charging adapters (ACA) are devices that provide portable charging power to an On-The-Go connection between host and peripheral.

ACAs have three ports: the OTG port for the portable device, which is required to have a Micro-A plug on a captive cable; the accessory port, which is required to have a Micro-AB or type-A receptacle; and the charging port, which is required to have a Micro-B receptacle, or type-A plug or charger on a captive cable. The ID pin of the OTG port is not connected within plug as usual, but to the ACA itself, where signals outside the OTG floating and ground states are used for ACA detection and state signaling. The charging port does not pass data, but does use the D± signals for charging port detection. The accessory port acts as any other port. When appropriately signaled by the ACA, the portable device can charge from the bus power as if there were a charging port present; any OTG signals over bus power are instead passed to the portable device via the ID signal. Bus power is also provided to the accessory port from the charging port transparently.[99]

Power Delivery (PD)[edit | edit source]
See also: List of 60W/100W USB chargeable laptops

USB PD rev. 1.0 source profiles[104]

Profile+5 V+12 V+20 V

0
Reserved

1
2.0 A, 10 W[a]
N/A
N/A

2
1.5 A, 18 W

3
3.0 A, 36 W

4
3.0 A, 60 W

5
5.0 A, 60 W
5.0 A, 100 W

Jump up^ Default start-up profile

USB PD rev. 2.0/3.0 source power rules[105][106]

Source output
power (W)Current, at: (A)

+5 V+9 V+15 V+20 V

0.5–15
0.1–3.0
N/A
N/A
N/A

15–27
3.0
(15 W)
1.67–3.0

27–45
3.0
(27 W)
1.8–3.0

45–60
3.0
(45 W)
2.25–3.0

60–100
3.0–5.0

In July 2012, the USB Promoters Group announced the finalization of the USB Power Delivery (PD) Specification (USB PD rev. 1), an extension that specifies using certified PD aware USB cables with standard USB Type-A and Type-B connectors to deliver increased power (more than 7.5 W) to devices with larger power demand. Devices can request higher currents and supply voltages from compliant hosts – up to 2 A at 5 V (for a power consumption of up to 10 W), and optionally up to 3 A or 5 A at either 12 V (36 W or 60 W) or 20 V (60 W or 100 W).[107] In all cases, both host-to-device and device-to-host configurations are supported.[108]

The intent is to permit uniformly charging laptops, tablets, USB-powered disks and similarly higher-power consumer electronics, as a natural extension of existing European and Chinese mobile telephone charging standards. This may also affect the way electric power used for small devices is transmitted and used in both residential and public buildings.[109][110]The standard is designed to coexist with the previous USB Battery Charging specification.[111]

The Power Delivery Specification defines six fixed power profiles for the power sources. PD-aware devices implement a flexible power management scheme by interfacing with the power source through a bidirectional data channel and requesting a certain level of electrical power, variable up to 5 A and 20 V depending on supported profile. The power configuration protocol uses a 24 MHz BFSK-coded transmission channel on the VBUS line.

The USB Power Delivery Specification revision 2.0 (USB PD rev. 2) has been released as part of the USB 3.1 suite.[105][112] It covers the Type-C cable and connector with four power/ground pairs and a separate configuration channel, which now hosts a DC coupled low-frequency BMC-coded data channel that reduces the possibilities for RF interference.[113] Power Delivery protocols have been updated to facilitate Type-C features such as cable ID function, Alternate Mode negotiation, increased VBUS currents, and VCONN-powered accessories.

As of USB Power Delivery Specification revision 2.0, version 1.2, the six fixed power profiles for power sources have been deprecated.[114] USB PD Power Rules replace power profiles, defining four normative voltage levels at 5 V, 9 V, 15 V, and 20 V. Instead of six fixed profiles, power supplies may support any maximum source output power from 0.5 W to 100 W.

The USB Power Delivery Specification revision 3.0 defines a programmable power supply protocol that allows granular control over VBUS power in 20 mV steps to facilitate constant current or constant voltage charging. Revision 3.0 also adds extended configuration messages, fast role swap, and deprecates the BFSK protocol.[106][115][116]

As of April 2016, there are silicon controllers available from several sources such as TI and Cypress.[117][118] Power supplies bundled with Type-C based laptops from Apple, Google, HP, Dell, and Razer support USB PD.[119] In addition, accessories from third party vendors including Anker,[120] Belkin,[121][122] iVoler,[123] and Innergie[124] support USB PD rev. 2 at multiple voltages. Asus make a PD compliant adapter card, the USB 3.1 UPD Panel.[125]

On 8 January 2018 USB-IF announced "Certified USB Fast Charger" which will certify chargers that use the feature "Programmable Power Supply" (PPS) of the USB Power Delivery 3.0 specification.[126]

Sleep-and-charge ports[edit | edit source]

A yellow USB port denoting sleep-and-charge.

Sleep-and-charge USB ports can be used to charge electronic devices even when the computer is switched off. Normally, when a computer is powered off the USB ports are powered down, preventing phones and other devices from charging. Sleep-and-charge USB ports remain powered even when the computer is off. On laptops, charging devices

from the USB port when it is not being powered from AC drains the laptop battery faster; most laptops have a facility to stop charging if their own battery charge level gets too low.[127] This feature has also been implemented on some laptop docking stations allowing device charging even when no laptop is present.[128]

Sleep-and-charge USB ports may be found colored differently than regular ports, mostly red or yellow,[citation needed] though that is not always the case.

On Dell and Toshiba laptops, the port is marked with the standard USB symbol with an added lightning bolt icon on the right side. Dell calls this feature PowerShare,[129] while Toshiba calls it USB Sleep-and-Charge.[130] On Acer Inc. and Packard Bell laptops, sleep-and-charge USB ports are marked with a non-standard symbol (the letters USB over a drawing of a battery); the feature is simply called Power-off USB.[131] On some laptops such as Dell and Apple MacBook models, it is possible to plug a device in, close the laptop (putting it into sleep mode) and have the device continue to charge.[citation needed]

Mobile device charger standards[edit | edit source]
In China[edit | edit source]
As of 14 June 2007, all new mobile phones applying for a license in China are required to use a USB port as a power port for battery charging.[132][133] This was the first standard to use the convention of shorting D+ and D?.[134]

OMTP/GSMA Universal Charging Solution[edit | edit source]
In September 2007, the Open Mobile Terminal Platform group (a forum of mobile network operators and manufacturers such as Nokia, Samsung, Motorola, Sony Ericsson, and LG) announced that its members had agreed on Micro-USB as the future common connector for mobile devices.[135][136]

The GSM Association (GSMA) followed suit on 17 February 2009,[137][137][138][139][140] and on 22 April 2009, this was further endorsed by the CTIA – The Wireless Association,[141]with the International Telecommunication Union (ITU) announcing on 22 October 2009 that it had also embraced the Universal Charging Solution as its "energy-efficient one-charger-fits-all new mobile phone solution," and added: "Based on the Micro-USB interface, UCS chargers will also include a 4-star or higher efficiency rating—up to three times more energy-efficient than an unrated charger."[142]

EU smartphone power supply standard[edit | edit source]
Main article: Common external power supply

In June 2009, many of the world's largest mobile phone manufacturers signed an EC-sponsored Memorandum of Understanding (MoU), agreeing to make most data-enabled mobile phones marketed in the European Union compatible with a common External Power Supply (common EPS). The EU's common EPS specification (EN 62684:2010) references the USB Battery Charging Specification and is similar to the GSMA/OMTP and Chinese charging solutions.[143][144] In January 2011, the International Electrotechnical Commission (IEC)released its version of the (EU's) common EPS standard as IEC 62684:2011.[145]

Non-standard devices[edit | edit source]

This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (October 2011) (Learn how and when to remove this template message)

Some USB devices require more power than is permitted by the specifications for a single port. This is common for external hard and optical disc drives, and generally for devices with motors or lamps. Such devices can use an external power supply, which is allowed by the standard, or use a dual-input USB cable, one input of which is for power and data

transfer, the other solely for power, which makes the device a non-standard USB device. Some USB ports and external hubs can, in practice, supply more power to USB devices than required by the specification but a standard-compliant device may not depend on this.

In addition to limiting the total average power used by the device, the USB specification limits the inrush current (i.e., the current used to charge decoupling and filter capacitors) when the device is first connected. Otherwise, connecting a device could cause problems with the host's internal power. USB devices are also required to automatically enter ultra low-power suspend mode when the USB host is suspended. Nevertheless, many USB host interfaces do not cut off the power supply to USB devices when they are suspended.[146]

Some non-standard USB devices use the 5 V power supply without participating in a proper USB network, which negotiates power draw with the host interface. These are usually called USB decorations.[citation needed] Examples include USB-powered keyboard lights, fans, mug coolers and heaters, battery chargers, miniature vacuum cleaners, and even miniature lava lamps. In most cases, these items contain no digital circuitry, and thus are not standard-compliant USB devices. This may cause problems with some computers, such as drawing too much current and damaging circuitry. Prior to the USB Battery Charging Specification, the USB specification required that devices connect in a low-power mode (100 mA maximum) and communicate their current requirements to the host, which then permits the device to switch into high-power mode.

Some devices, when plugged into charging ports, draw even more power (10 watts at 2.1 amperes) than the Battery Charging Specification allows — The iPad is one such device.[147] Barnes & Noble Nook Color devices also require a special charger that runs at 1.9 amperes.[148]

PoweredUSB[edit | edit source]
Main article: PoweredUSB

PoweredUSB is a proprietary extension that adds four additional pins supplying up to 6 A at 5 V, 12 V, or 24 V. It is commonly used in point of sale systems to power peripherals such as barcode readers, credit card terminals, and printers.

The Micro-USB interface is commonly found on chargers for mobile phones

An AC adaptor with a green USB connector supporting Qualcomm Quick Charge 2.0

Australian and New Zealand power socket with USB charger socket

Y-shaped USB 3.0 cable; with such a cable, a device can draw power from two USB ports simultaneously

A small device that provides voltage and current readouts for devices charged over USB

This USB power meter additionally provides a charge readout (in mAh) and data logging

USB-powered mini fans

USB-powered vacuum cleaner

Host and device interface receptacles[edit | edit source]

USB plugs fit one receptacle with notable exceptions for USB On-The-Go "AB" support and the general backward compatibility of USB 3.0 as shown.

USB connectors mating table (images not to scale)

Receptacle Plug

Yes
Only non-
SuperSpeed
No
No
No
No
No
No
No
No

Type-A SuperSpeed
Only non-
SuperSpeed
Yes
No
No
No
No

No
No
No
No

No
No
Yes
No
No
No
No
No
No
No

Type-B SuperSpeed
No
No
Only non-
SuperSpeed
Yes
No
No
No
No
No
No

No
No
No
No
Deprecated
No
No
No
No
No

No
No
No
No
Deprecated
Deprecated
No
No
No
No

No
No
No
No
No
Yes
No
No
No
No

No
No
No
No
No
No
Yes
Yes
No
No

No
No
No
No
No
No
No
Yes
No
No

Micro-B SuperSpeed
No
No
No
No
No
No
No
Only non-
SuperSpeed
Yes
No

No
No
No
No
No
No

No
No
No
Yes

USB cables table

Plugs, each end
Micro-B SuperSpeed

Non-
standard
Non-
standard
Non-
standard
Yes
Yes
Yes
Yes
Yes

Non-
standard
No
No
Deprecated
Deprecated
Non-
standard
No
No

Non-
standard
No
No
Non-
standard
Non-
standard
Yes
No
No

Yes
Deprecated
Non-

standard
No
No
No
No
Yes

Yes
Deprecated
Non-
standard
No
Non-
standard
No
No
Yes

Yes
Non-
standard
Yes
No
No
No
No
Yes

Micro-B SuperSpeed
Yes
No
No
No
No
No
No
Yes

Yes
No
No
Yes
Yes
Yes
Yes
Yes

Non-standardExisting for specific proprietary purposes, and in most cases not inter-operable with USB-IF compliant equipment. In addition to the above cable assemblies comprising two plugs, an "adapter" cable with a Micro-A plug and a standard-A receptacle is compliant with USB specifications.[64] Other combinations of connectors are not

compliant.There do exist A-to-A assemblies, referred to as cables (such as the Easy Transfer Cable); however, these have a pair of USB devices in the middle, making them more than just cables. DeprecatedSome older devices and cables with Mini-A connectors have been certified by USB-IF. The Mini-A connector is obsolete: no new Mini-A connectors and neither Mini-A nor Mini-AB receptacles will be certified.[61]Note: Mini-B is not deprecated, but less and less used since the arrival of Micro-B.

Pinouts[edit | edit source]
See also: USB 3.0 § Pinouts

USB 2.0 uses two wires for power (VBUS and GND), and two for differential serial data signals. Mini and micro connectors have their GND connections moved from pin #4 to pin #5, while their pin #4 serves as an ID pin for the On-The-Go host/client identification.[80]

USB 3.0 provides two additional differential pairs (four wires, SSTx+, SSTx?, SSRx+ and SSRx?), providing full-duplex data transfers at SuperSpeed, which makes it similar to Serial ATA or single-lane PCI Express.

Standard, Mini-, and Micro-USB plugs (not to scale). White areas are empty. The receptacles are pictured with USB logo to the top, looking into the open end; note this means the pin order is mirrored from plug to socket.[64]

Micro-B SuperSpeed plug

Power (VBUS, 5 V)
Data? (D?)
Data+ (D+)
ID (On-The-Go)
GND
SuperSpeed transmit? (SSTx?)
SuperSpeed transmit+ (SSTx+)
GND
SuperSpeed receive? (SSRx?)
SuperSpeed receive+ (SSRx+)

Type-A and -B pinout

PinNameWire color[a]Description

1

VBUS
Red or
Orange
+5 V

2
D?
White or
Gold
Data?

3
D+
Green
Data+

4
GND
Black or
Blue
Ground

Mini/Micro-A and -B pinout

PinNameWire color[a]Description

1
VBUS
Red
+5 V

2
D?
White
Data?

3
D+
Green
Data+

4
ID
No wire
On-The-Go ID distinguishes cable ends:

"A" plug (host): connected to GND
"B" plug (device): not connected

5
GND
Black
Signal ground

^ Jump up to:a b In some sources D+ and D- are erroneously swapped.

Proprietary connectors and formats[edit | edit source]

Manufacturers of personal electronic devices might not include a USB standard connector on their product for technical or marketing reasons.[81] Some manufacturers provide proprietary cables that permit their devices to physically connect to a USB standard port. Full functionality of proprietary ports and cables with USB standard ports is not assured; for example, some devices only use the USB connection for battery charging and do not implement any data transfer functions.[82]

Some manufacturers now offer USB magnetic port adapters; as of 2018 all product are proprietary incompatible designs. Magnetic connectors were developed mainly for mobile phones devices having Micro B, type-C or Apple's Lightning ports. They offer ease of operation and are also intended to protect the mobile device's connector from deteriorating under the mechanical action of connecting and disconnecting.[citation needed]

Colors[edit | edit source]

An orange charge-only USB port on a front panel USB 3.0 switch with card reader.

A blue Standard-A USB connector on a Sagemcom F@ST 3864OP ADSL modem router without USB 3.0 contacts fitted.

Usual USB color-coding

ColorLocationDescription

Black or white

Ports & plugs
Type-A or type-B

Blue (Pantone 300C)
Ports & plugs
Type-A or type-B, SuperSpeed

Teal blue
Ports & plugs
Type-A or type-B, SuperSpeed+

Green
Ports & plugs
Type-A or type-B, Qualcomm Quick Charge[83]

Yellow, orange or red
Ports only
High-current or sleep-and-charge

USB ports and connectors are often color-coded to distinguish their different functions and USB versions. These colors are not part of the USB specification and can vary between manufacturers; for example, USB 3.0 specification mandates appropriate color-coding while it only recommends blue inserts for standard-A USB 3.0 connectors and plugs.[84]