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**USB**, short for **Universal Serial Bus**, is an [industry standard](/wiki/Technical_standard) developed in the mid-1990s that defines the cables, connectors and [communications protocols](/wiki/Communications_protocol) used in a [bus](/wiki/Bus_(computing)) for connection, communication, and power supply between [computers](/wiki/Computer) and electronic devices.[[1]](#cite_note-1) It is currently developed by the [USB Implementers Forum](/wiki/USB_Implementers_Forum) (USB IF).

USB was designed to standardize the connection of [computer peripherals](/wiki/Computer_peripheral) (including keyboards, [pointing devices](/wiki/Mouse_(computing)), digital cameras, printers, [portable media players](/wiki/Portable_media_player), [disk drives](/wiki/Disk_drive) and [network adapters](/wiki/Network_interface_controller)) to [personal computers](/wiki/Personal_computer), both to communicate and to supply [electric power](/wiki/Electric_power). It has become commonplace on other devices, such as [smartphones](/wiki/Smartphone), [PDAs](/wiki/Personal_digital_assistant) and [video game consoles](/wiki/Video_game_console).[[2]](#cite_note-2) USB has effectively replaced a variety of earlier interfaces, such as [parallel ports](/wiki/Parallel_port), as well as separate [power chargers](/wiki/Power_charger) for portable devices.

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## Overview[[edit](/index.php?title=(none)&action=edit&section=1)]

In general, there are three basic formats of USB connectors: the default or *standard* format intended for desktop or portable equipment (for example, on USB [flash drives](/wiki/Flash_drives)), the *mini* intended for mobile equipment (now deprecated except the Mini-B, which is used on many cameras), and the thinner *micro* size, for low-profile mobile equipment (most modern mobile phones). Also, there are 5 modes of USB data transfer, in order of increasing bandwidth: Low Speed (from 1.0), Full Speed (from 1.0), High Speed (from 2.0), [SuperSpeed](/wiki/SuperSpeed) (from 3.0), and SuperSpeed+ (from 3.1); modes have differing hardware and cabling requirements. USB devices have some choice of implemented modes, and USB version is not a reliable statement of implemented modes. Modes *are* identified by their names and icons, and the specifications suggests that plugs and receptacles be colour-coded (SuperSpeed is identified by blue).

Unlike other data buses (e.g., Ethernet, HDMI), USB connections are directed, with both upstream and downstream ports emanating from a single host. This applies to electrical power, with only downstream facing ports providing power; this topology was chosen to easily prevent electrical overloads and damaged equipment. Thus, USB cables have different ends: A and B, with different physical connectors for each. Therefore, in general, each different format requires four different connectors: a plug and receptacle for each of the A and B ends. USB cables have the plugs, and the corresponding receptacles are on the computers or electronic devices. In common practice, the A end is usually the standard format, and the B side varies over standard, mini, and micro. The mini and micro formats also provide for [USB On-The-Go](/wiki/USB_On-The-Go) with a hermaphroditic AB receptacle, which accepts either an A or a B plug. On-the-Go allows USB between peers without discarding the directed topology by choosing the host at connection time; it also allows one receptacle to perform double duty in space-constrained applications.

There are cables with A plugs on both ends, which may be valid if the cable includes, for example, a USB host-to-host transfer device with 2 ports, but they could also be non-standard and erroneous and should be used carefully.[[3]](#cite_note-3) Non-obviously, the micro format is the most durable from the point of designed insertion lifetime. The standard and mini connectors were designed for less frequently than daily connections, with a design lifetime of 1,500 insertion-removal cycles.[[4]](#cite_note-4) (Improved Mini-B connectors have reached 5,000-cycle lifetimes.) Micro connectors were designed with frequent charging of portable devices in mind; not only is design lifetime of the connector improved to 10,000 cycles,[[4]](#cite_note-4) but it was also redesigned to place the flexible contacts, which wear out sooner, on the easily replaced cable, while the more durable rigid contacts are located in the receptacles. Likewise, the springy component of the retention mechanism (parts that provide required gripping force) were also moved into plugs on the cable side.[[5]](#cite_note-5)

## History[[edit](/index.php?title=(none)&action=edit&section=2)]

[[File:USB Icon.svg|thumb|left|alt=Large circle is left end of horizontal line. The line forks into three branches ending in circle, triangle and square symbols.|The basic USB *trident* logo[[6]](#cite_note-6) The official USB specification documents also periodically define the term *male* to represent the plug, and *female* to represent the receptacle.[[53]](#cite_note-53)

#### Usability and orientation[[edit](/index.php?title=(none)&action=edit&section=20)]

[thumb|upright|USB extension cable](/wiki/File:Usb_extension_cable.jpg)

By design, it is difficult to insert a USB plug into its receptacle incorrectly. The USB specification states that the required USB icon must be embossed on the "topside" of the USB plug, which "...provides easy user recognition and facilitates alignment during the mating process." The specification also shows that the "recommended" "Manufacturer's logo" ("engraved" on the diagram but not specified in the text) is on the opposite side of the USB icon. The specification further states, "The USB Icon is also located adjacent to each receptacle. Receptacles should be oriented to allow the icon on the plug to be visible during the mating process." However, the specification does not consider the height of the device compared to the eye level height of the user, so the side of the cable that is "visible" when mated to a computer on a desk can depend on whether the user is standing or kneeling.[[54]](#cite_note-54) While connector interfaces can be designed to allow plugging with either orientation, the original design omitted such functionality to decrease manufacturing costs. Ajay Bhatt, who was involved in the original USB design team, is working on a new design to make the plug insertable either side up.[[55]](#cite_note-55) The new reversible type-C plug is an addition to the [USB 3.1](/wiki/USB 3.1) specification; it is slightly taller but also narrower than, making it comparable to, the Micro-B SuperSpeed connector.[[56]](#cite_note-56) Only moderate force is needed to insert or remove a USB cable. USB cables and small USB devices are held in place by the gripping force from the receptacle (without need of the screws, clips, or thumb-turns other connectors have required).

#### Power-use topology[[edit](/index.php?title=(none)&action=edit&section=21)]

The standard connectors were deliberately intended to enforce the directed [topology](/wiki/Topology) of a USB network: type-A receptacles on host devices that supply power and type-B receptacles on target devices that draw power. This prevents users from accidentally connecting two USB power supplies to each other, which could lead to [short circuits](/wiki/Short_circuit) and dangerously high currents, circuit failures, or even fire. USB does not support cyclic networks and the standard connectors from incompatible USB devices are themselves incompatible.[[3]](#cite_note-3) However, some of this directed topology is lost with the advent of multi-purpose USB connections (such as [USB On-The-Go](/wiki/USB_On-The-Go) in smartphones, and USB-powered Wi-Fi routers), which require A-to-A, B-to-B, and sometimes Y/splitter cables. See the [USB On-The-Go connectors](/wiki/#USB-ON-THE-GO) section below, for a more detailed summary description.

#### Durability[[edit](/index.php?title=(none)&action=edit&section=22)]

The standard connectors were designed to be robust. Because USB is [hot-pluggable](/wiki/Hot-swapping), the connectors would be used more frequently, and perhaps with less care, than other connectors. Many previous connector designs were fragile, specifying embedded component pins or other delicate parts that were vulnerable to bending or breaking. The electrical contacts in a USB connector are protected by an adjacent plastic tongue, and the entire connecting assembly is usually protected by an enclosing metal sheath.[[57]](#cite_note-57) The connector construction always ensures that the external sheath on the plug makes contact with its counterpart in the receptacle before any of the four connectors within make electrical contact. The external metallic sheath is typically connected to system ground, thus dissipating damaging static charges. This enclosure design also provides a degree of protection from electromagnetic interference to the USB signal while it travels through the mated connector pair (the only location when the otherwise [twisted data pair](/wiki/Twisted_pair) travels in parallel). In addition, because of the required sizes of the power and common connections, they are made after the system ground but before the data connections. This type of staged make-break timing allows for electrically safe hot-swapping.[[57]](#cite_note-57) The newer Micro-USB receptacles are designed for a minimum rated lifetime of 10,000 cycles of insertion and removal between the receptacle and plug, compared to 1,500 for the standard USB and 5,000 for the Mini-USB receptacle. Features intended to accomplish include, a locking device was added and the leaf-spring was moved from the jack to the plug, so that the most-stressed part is on the cable side of the connection. This change was made so that the connector on the less expensive cable would bear the most wear instead of the more expensive Micro-USB device.[[5]](#cite_note-5)[[57]](#cite_note-57) However the idea that these changes did in fact make the connector more durable in real world use has been widely disputed, with many contending that they are in fact, much less durable.[[5]](#cite_note-5)

#### Compatibility[[edit](/index.php?title=(none)&action=edit&section=23)]

The USB standard specifies relatively loose tolerances for compliant USB connectors to minimize physical incompatibilities in connectors from different vendors. To address a weakness present in some other connector standards, the USB specification also defines limits to the size of a connecting device in the area around its plug. This was done to prevent a device from blocking adjacent ports due to the size of the cable strain relief mechanism (usually molding integral with the cable outer insulation) at the connector. Compliant devices must either fit within the size restrictions or support a compliant extension cable that does.

In general, USB cables have only plugs on their ends, while hosts and devices have only receptacles. Hosts almost universally have Type-A receptacles, while devices have one or another Type-B variety. Type-A plugs mate only with Type-A receptacles, and the same applies to their Type-B counterparts; they are deliberately physically incompatible. However, an extension to the USB standard specification called [USB On-The-Go](/wiki/USB_On-The-Go) (OTG) allows a single port to act as either a host or a device, which is selectable by the end of the cable that plugs into the receptacle on the OTG-enabled unit. Even after the cable is hooked up and the units are communicating, the two units may "swap" ends under program control. This capability is meant for units such as [PDAs](/wiki/Personal_Digital_Assistant) in which the USB link might connect to a PC's host port as a device in one instance, yet connect as a host itself to a keyboard and mouse device in another instance.

##### USB 3.0 connectors[[edit](/index.php?title=(none)&action=edit&section=24)]

[Template:See also](/wiki/Template:See_also)

Standard-A and type-A plugs and receptacles are designed to interoperate. Standard-B plugs and receptacles are somewhat larger than type-B; thus, type-B plugs can fit into standard-B receptacles, while the opposite is not possible.

### Connector types[[edit](/index.php?title=(none)&action=edit&section=25)]

[thumb|400px|Various USB connectors along a centimeter ruler for scale. From left to right:](/wiki/File:Usb_connectors.JPG) [Template:Hlist](/wiki/Template:Hlist)[Template:Noteslist](/wiki/Template:Noteslist)

There are several types of USB connector, including some that have been added while the specification progressed. The original USB specification detailed standard-A and standard-B plugs and receptacles; the B connector was necessary so that cabling could be plug ended at both ends and still prevent users from connecting one computer receptacle to another. The first engineering change notice to the USB 2.0 specification added Mini-B plugs and receptacles.

The data pins in the standard plugs are actually recessed in the plug compared to the outside power pins. This permits the power pins to connect first, preventing data errors by allowing the device to power up first and then establish the data connection. Also, some devices operate in different modes depending on whether the data connection is made.

To reliably enable a charge-only feature, modern USB accessory peripherals now include charging cables that provide power connections to the host port but no data connections, and both home and vehicle charging docks are available that supply power from a converter device and do not include a host device and data pins, allowing any capable USB device to charge or operate from a standard USB cable.

In a charge-only cable, the data wires are shorted at the device end. These wires are usually green and white. If these wires are left as-is, the device will often reject the charger as unsuitable.

#### Standard connectors[[edit](/index.php?title=(none)&action=edit&section=26)]

[thumb|Pin configuration of the type-A and type-B USB connectors, viewed from the mating end of plugs](/wiki/File:USB.svg)

The type-A plug has an elongated rectangular cross-section, inserts into a type-A receptacle on a *downstream port* on a USB host or hub, and carries both power and data. Captive cables on USB devices, such as keyboards or mice, will be terminated with a type-A plug.

A type-B plug has a near square cross-section with the top exterior corners beveled. As part of a removable cable, it inserts into an *upstream port* on a device, such as a printer. On some devices, the type-B receptacle has no data connections, being used solely for accepting power from the upstream device. This two-connector-type scheme (A/B) prevents a user from accidentally creating an [electrical loop](/wiki/Ground_loop_(electricity)).[[58]](#cite_note-58) The spring contacts in the connectors eventually relax and wear out with repeated cycles of plugging and unplugging. The lifetime of a type-A plug is approximately 1,500 connect/disconnect cycles.[[59]](#cite_note-59) [Template:Anchor](/wiki/Template:Anchor) The maximum allowed cross-section of the *overmold boot* (which is part of the connector used for its handling) is 16 by 8 mm for the standard-A plug type, while for the type-B it is 11.5 by 10.5 mm.[[60]](#cite_note-60)[Template:Clear](/wiki/Template:Clear)

#### {{Anchor|MINI|MICRO}}Mini and micro connectors[[edit](/index.php?title=(none)&action=edit&section=27)]

[Template:Multiple image](/wiki/Template:Multiple_image)

Various connectors have been used for smaller devices such as [digital cameras](/wiki/Digital_camera), [smartphones](/wiki/Smartphone), and [tablet computers](/wiki/Tablet_computer). These include the [now-deprecated](/wiki/Deprecation)<ref name=depmini>[Template:Cite press release](/wiki/Template:Cite_press_release)</ref> (i.e. de-certified but standardized) Mini-A and Mini-AB connectors; Mini-B connectors are still supported, but are not On-The-Go-compliant.[[61]](#cite_note-61) The Mini-B USB connector was standard for transferring data to and from the early smartphones and PDAs. Both Mini-A and Mini-B plugs are approximately 3 by 7 mm; the Mini-A connector and the Mini-AB receptacle connector were deprecated on 23 May 2007.[[62]](#cite_note-62) The Micro-USB connector was announced by the [USB-IF](/wiki/USB_Implementers_Forum) on 4 January 2007.[[4]](#cite_note-4)[[63]](#cite_note-63) Micro-USB plugs have a similar width to Mini-USB, but approximately half the thickness, enabling their integration into thinner portable devices. The Micro-A connector is 6.85 by 1.8 [mm](/wiki/Millimeter) with a maximum overmold boot size of 11.7 by 8.5 mm, while the Micro-B connector is 6.85 by 1.8 mm with a maximum overmold size of 10.6 by 8.5 mm.<ref name = microspec>[Template:Cite web](/wiki/Template:Cite_web)</ref>

The thinner micro connectors are intended to replace the mini connectors in new devices including [smartphones](/wiki/Smartphone), [personal digital assistants](/wiki/Personal_digital_assistant), and cameras.[[64]](#cite_note-64) While some of the devices and cables still use the older mini variant, the newer micro connectors are widely adopted, and [Template:As of](/wiki/Template:As_of) they are the most widely used.[Template:Citation needed](/wiki/Template:Citation_needed)

The micro plug design is rated for at least 10,000 connect-disconnect cycles, which is more than the mini plug design.[[4]](#cite_note-4)[[65]](#cite_note-65) The micro connector is also designed to reduce the mechanical wear on the device; instead the easier-to-replace cable is designed to bear the mechanical wear of connection and disconnection. The *Universal Serial Bus Micro-USB Cables and Connectors Specification* details the mechanical characteristics of Micro-A [plugs](/wiki/Plug_(connector)), Micro-AB receptacles (which accept both Micro-A and Micro-B plugs), and Micro-B plugs and receptacles,[[65]](#cite_note-65) along with a standard-A receptacle to Micro-A plug adapter.

The cellular phone carrier group [Open Mobile Terminal Platform](/wiki/Open_Mobile_Terminal_Platform) (OMTP) in 2007 endorsed Micro-USB as the standard connector for data and power on mobile devices[[66]](#cite_note-66) On 22 October 2009 the [International Telecommunication Union](/wiki/International_Telecommunication_Union) (ITU) announced that it had embraced Micro-USB as the *Universal Charging Solution* its "energy-efficient one-charger-fits-all new mobile phone solution," and added: "Based on the Micro-USB interface, UCS chargers also include a 4-star or higher efficiency rating[Template:Mdashbup](/wiki/Template:Mdashb) to three times more energy-efficient than an unrated charger."[[67]](#cite_note-67) The European Standardisation Bodies [CEN](/wiki/European_Committee_for_Standardization), [CENELEC](/wiki/European_Committee_for_Electrotechnical_Standardization) and [ETSI](/wiki/ETSI) (independent of the OMTP/GSMA proposal) defined a [common External Power Supply](/wiki/Common_External_Power_Supply) (EPS) for use with smartphones sold in the EU based on Micro-USB.[[68]](#cite_note-68) 14 of the world's largest mobile phone manufacturers signed the EU's common EPS Memorandum of Understanding (MoU).[[69]](#cite_note-69)[[70]](#cite_note-70) [Apple](/wiki/Apple_Inc.), one of the original MoU signers, makes Micro-USB adapters available – as permitted in the Common EPS MoU – for its [iPhones](/wiki/IPhone) equipped with Apple's proprietary [30-pin dock connector](/wiki/30-pin_dock_connector) or (later) [Lightning connector](/wiki/Lightning_connector).[[71]](#cite_note-71)[[72]](#cite_note-72)

#### {{anchor|USB-ON-THE-GO}}USB On-The-Go connectors[[edit](/index.php?title=(none)&action=edit&section=28)]

[Template:Main article](/wiki/Template:Main_article)

All current [USB On-The-Go](/wiki/USB_On-The-Go) (OTG) devices are required to have one, and only one, USB connector: a Micro-AB receptacle. Non-OTG compliant devices are not allowed to use the Micro-AB receptacle, due to power supply shorting hazards on the VBUS line. The Micro-AB receptacle is capable of accepting both Micro-A and Micro-B plugs, attached to any of the legal cables and adapters as defined in revision 1.01 of the Micro-USB specification. Prior to the development of Micro-USB, USB On-The-Go devices were required to use Mini-AB receptacles to perform the equivalent job.

To enable Type-AB receptacles to distinguish which end of a cable is plugged in, mini and micro plugs have an "ID" pin in addition to the four contacts found in standard-size USB connectors. This ID pin is connected to GND in Type-A plugs, and left unconnected in Type-B plugs. Typically, a [pull-up resistor](/wiki/Pull-up_resistor) in the device is used to detect the presence or absence of an ID connection.

The OTG device with the A-plug inserted is called the A-device and is responsible for powering the USB interface when required and by default assumes the role of host. The OTG device with the B-plug inserted is called the B-device and by default assumes the role of peripheral. An OTG device with no plug inserted defaults to acting as a B-device. If an application on the B-device requires the role of host, then the Host Negotiation Protocol (HNP) is used to temporarily transfer the host role to the B-device.

OTG devices attached either to a peripheral-only B-device or a standard/embedded host have their role fixed by the cable, since in these scenarios it is only possible to attach the cable one way.[Template:Citation needed](/wiki/Template:Citation_needed)

#### Host and device interface receptacles[[edit](/index.php?title=(none)&action=edit&section=29)]

USB plugs fit one receptacle with notable exceptions for USB On-The-Go "AB" support and the general backwards compatibility of [USB 3.0](/wiki/#Cable_plugs_(USB_3.0)) as shown.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| USB connectors mating matrix (images not to scale) | | | | | | | | | | |
| [**Template:Down-arrow**](/wiki/Template:Down-arrow) **Receptacle** | **Plug** | | | | | | | | | |
| [**x50px**](/wiki/File:USB_Std_A.svg) | [**x50px**](/wiki/File:Connector_USB_3_IMGP6024_wp.jpg) **Type-A SuperSpeed** | [**x70px**](/wiki/File:USB_Std_B.svg) | [**x50px**](/wiki/File:USB-3.0-Stecker_(Typ_B).jpg) **Type-B SuperSpeed** | [**75px**](/wiki/File:USB_Mini_A.svg) | [**75px**](/wiki/File:USB_Mini_B.svg) | [**75px**](/wiki/File:USB_Micro_A.svg) | [**x50px**](/wiki/File:USB_Micro_B.svg) | [**110px**](/wiki/File:USB_3.0_Micro_B_plug.svg) **Micro-B SuperSpeed** | [**75px**](/wiki/File:USB-Type-C.svg) |
| [**x40px**](/wiki/File:USB_Type-A_receptacle.svg) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**x40px**](/wiki/File:USB_3.0_A_Buchse_13.jpg) **Type-A SuperSpeed** | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**x60px**](/wiki/File:USB_Type-B_receptacle.svg) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**x40px**](/wiki/File:USB3_Buchse_Typ_B_IMGP8200_smial_wp.jpg) **Type-B SuperSpeed** | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**60px**](/wiki/File:USB_Mini-A_receptacle.svg) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Depends](/wiki/Template:Depends) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
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| [**60px**](/wiki/File:USB_Micro-AB_receptacle.svg) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**60px**](/wiki/File:USB_Micro_B_receptacle.svg) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**x60px**](/wiki/File:Connector_USB_3_IMGP6017_wp.jpg) **Micro-B SuperSpeed** | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) |
| [**x60px**](/wiki/File:USB-Type-C.svg) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) |

#### Cables and their connectors[[edit](/index.php?title=(none)&action=edit&section=30)]

[thumb|right|USB 3.0 Micro-B plug](/wiki/File:Connector_USB_3_IMGP6033_wp.jpg) [Template:See also](/wiki/Template:See_also)

USB 3.0 introduced new standard and micro-sized Type-A and Type-B plugs and receptacles. The 3.0 receptacles are backward-compatible with the corresponding pre-3.0 plugs. See the Micro-B cable plug photo on the right. The Micro-B 3.0 plug effectively consists of a standard USB 1.x/2.0 Micro-B cable plug, with an additional five-pin plug "stacked" to the side of it. In this way, USB 3.0 Micro-A host connectors can achieve backward compatibility with the USB 1.x/2.0 Micro-B cable plugs.

USB cables exist with various combinations of plugs on each end of the cable, as displayed below. Notes from the section above apply here as well.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| USB cables matrix | | | | | | | | |
| **Plugs, each end** | [**x55px**](/wiki/File:USB_Std_A.svg) | [**x60px**](/wiki/File:USB_Mini_A.svg) | [**x60px**](/wiki/File:USB_Micro_A.svg) | [**x70px**](/wiki/File:USB_Std_B.svg) | [**x60px**](/wiki/File:USB_Mini_B.svg) | [**x60px**](/wiki/File:USB_Micro_B.svg) | [**110px**](/wiki/File:USB_3.0_Micro_B_plug.svg) **Micro-B SuperSpeed** | [**75px**](/wiki/File:USB-Type-C.svg) |
| [**x55px**](/wiki/File:USB_Std_A.svg) | [Template:Yes2](/wiki/Template:Yes2) | [Template:Yes2](/wiki/Template:Yes2) | [Template:Yes2](/wiki/Template:Yes2) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) |
| [**x60px**](/wiki/File:USB_Mini_A.svg) | [Template:Yes2](/wiki/Template:Yes2) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Depends](/wiki/Template:Depends) | [Template:Depends](/wiki/Template:Depends) | [Template:Yes2](/wiki/Template:Yes2) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**x60px**](/wiki/File:USB_Micro_A.svg) | [Template:Yes2](/wiki/Template:Yes2) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes2](/wiki/Template:Yes2) | [Template:Yes2](/wiki/Template:Yes2) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) |
| [**x70px**](/wiki/File:USB_Std_B.svg) | [Template:Yes](/wiki/Template:Yes) | [Template:Depends](/wiki/Template:Depends) | [Template:Yes2](/wiki/Template:Yes2) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) |
| [**x60px**](/wiki/File:USB_Mini_B.svg) | [Template:Yes](/wiki/Template:Yes) | [Template:Depends](/wiki/Template:Depends) | [Template:Yes2](/wiki/Template:Yes2) | [Template:No](/wiki/Template:No) | [Template:Yes2](/wiki/Template:Yes2) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) |
| [**x60px**](/wiki/File:USB_Micro_B.svg) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes2](/wiki/Template:Yes2) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) |
| [**110px**](/wiki/File:USB_3.0_Micro_B_plug.svg) **Micro-B SuperSpeed** | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) |
| [**75px**](/wiki/File:USB-Type-C.svg) | [Template:Yes](/wiki/Template:Yes) | [Template:No](/wiki/Template:No) | [Template:No](/wiki/Template:No) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) | [Template:Yes](/wiki/Template:Yes) |

[Template:Color box](/wiki/Template:Color_box) Non-standard

Existing for specific [proprietary purposes](/wiki/Proprietary_hardware), 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.[[73]](#cite_note-73) Other combinations of connectors are not compliant.[Template:Paragraph breakThere](/wiki/Template:Paragraph_break) do exist A-to-A assemblies, referred to as cables (such as the [Easy Transfer Cable](/wiki/Easy_Transfer_Cable)); however, these have a pair of USB devices in the middle, making them more than just cables.

[Template:Color box](/wiki/Template:Color_box) [Deprecated](/wiki/Deprecation)

Some 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.[[74]](#cite_note-74)[Template:Paragraph breakNote](/wiki/Template:Paragraph_break): Mini-B is not deprecated, but less and less used since the arrival of Micro-B.

### Pinouts[[edit](/index.php?title=(none)&action=edit&section=31)]

[Template:See also](/wiki/Template:See_also)

USB is a serial bus, using four shielded wires for the USB 2.0 variant: two for power (VBUS and GND), and two for [differential data signals](/wiki/Differential_signalling) (labelled as D+ and D− in [pinouts](/wiki/Pinout)). [Non-Return-to-Zero Inverted](/wiki/Non-Return-to-Zero_Inverted) (NRZI) encoding scheme is used for transferring data, with a sync field to synchronize the host and receiver clocks. D+ and D− signals are transmitted on a [differential pair](/wiki/Differential_pair), providing [half-duplex](/wiki/Half-duplex) data transfers for USB 2.0. 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.[[75]](#cite_note-75) USB 3.0 provides two additional differential pairs (four wires, SSTx+, SSTx−, SSRx+ and SSRx−), providing [full-duplex](/wiki/Full-duplex) data transfers at *SuperSpeed*, which makes it similar to [Serial ATA](/wiki/Serial_ATA) or single-lane [PCI Express](/wiki/PCI_Express).

[thumb|left|**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.](/wiki/File:Types-usb_th1.svg)[[73]](#cite_note-73) [thumb|**Micro-B SuperSpeed plug**](/wiki/File:USB_3.0_Micro_B_plug.PNG) [Template:Ordered list](/wiki/Template:Ordered_list)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type-A and -B pinout | | | | |
| **Pin** | **Name** | **Wire color** | | **Description** |
| 1 | VBUS | style=background:red;color:white| Red, or | Orange | +5 V |
| 2 | D− | style=background:white| White, or | style=background:gold| Gold | Data− |
| 3 | D+ | colspan=2 style=background:green;color:white| Green | Data+ |  |
| 4 | [GND](/wiki/Ground_(electricity)) | style=background:black;color:white| Black, or | style=background:blue;color:white| Blue | Ground |

|  |  |  |  |
| --- | --- | --- | --- |
| Mini/Micro-A and -B pinout | | | |
| **Pin** | **Name** | **Wire color** | **Description** |
| 1 | VBUS | style=background:red;color:white| Red | +5 V |
| 2 | D− | style=background:white| White | Data− |
| 3 | D+ | style=background:green;color:white| Green | Data+ |
| 4 | ID | [Template:N/a](/wiki/Template:N/a) | [On-The-Go](/wiki/#USB-ON-THE-GO) ID distinguishes cable ends:   * "A" plug (host): connected to GND * "B" plug (device): not connected |
| 5 | GND | style=background:black;color:white| Black | Signal ground |

[Template:Clear](/wiki/Template:Clear)

#### Proprietary connectors and formats[[edit](/index.php?title=(none)&action=edit&section=32)]

Manufacturers of personal electronic devices might not include a USB standard connector on their product for technical or marketing reasons.[[76]](#cite_note-76) 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.[[77]](#cite_note-77) <gallery perrow=5 widths=180px heights=140px> Image:Htc extmicrousb port and mhl-hdmi plug.png|[HTC](/wiki/HTC) ExtMicro USB port and connector Image:Popport.jpg|[Nokia](/wiki/Nokia) [Pop-Port](/wiki/Nokia_Pop-Port) connector Image:Lightning to USB Cable.jpg|An [Apple Lightning](/wiki/Lightning_(connector))-to-USB adapter and captive USB cable </gallery>

### Colors[[edit](/index.php?title=(none)&action=edit&section=33)]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Usual USB color-coding | | | | | |
| **Color** | | | | | **Description** |
|  | |  | | Black or white | Type-A or type-B |
|  | | | | Blue (Pantone 300C) | Type-A or type-B, SuperSpeed |
|  | | | | Teal blue | Type-A or type-B, SuperSpeed+ |
|  |  | |  | Yellow, orange or red | Ports only. High-current or [sleep-and-charge](/wiki/#Sleep-and-charge_ports) |

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.[[78]](#cite_note-78)[Template:Clear](/wiki/Template:Clear)

## Cabling[[edit](/index.php?title=(none)&action=edit&section=34)]

[thumb|A USB twisted pair, where the *Data+* and *Data−* conductors are twisted together in a double](/wiki/File:USB_Twisted_Pair.svg) [helix](/wiki/Helix). The wires are enclosed in a further layer of shielding.

The D± signals used by low, full, and high speed are carried over a [twisted pair](/wiki/Twisted_pair) (typically, unshielded) to reduce [noise](/wiki/Signal_noise) and [crosstalk](/wiki/Crosstalk_(electronics)). SuperSpeed uses separate transmit and receive [differential pairs](/wiki/Differential_pair), which additionally require shielding (typically, shielded twisted pair but twinax is also mentioned by the specification). Thus, to support SuperSpeed data transmission, cables contain twice as many wires and are thus larger in diameter.[[79]](#cite_note-79) The USB 1.1 standard specifies that a standard cable can have a maximum length of 3 meters with devices operating at full speed (12 Mbit/s), and a maximum length of 5 meters with devices operating at low speed (1.5 Mbit/s).[[80]](#cite_note-80)[[81]](#cite_note-81) USB 2.0 provides for a maximum cable length of 5 meters for devices running at high speed (480 Mbit/s). The primary reason for this limit is the maximum allowed round-trip delay of about 1.5 μs. If USB host commands are unanswered by the USB device within the allowed time, the host considers the command lost. When adding USB device response time, delays from the maximum number of hubs added to the delays from connecting cables, the maximum acceptable delay per cable amounts to 26 ns.[[82]](#cite_note-82) The USB 2.0 specification requires that cable delay be less than 5.2 ns per meter [Template:Nowrap](/wiki/Template:Nowrap), which is close to the maximum achievable transmission speed for standard copper wire).

The USB 3.0 standard does not directly specify a maximum cable length, requiring only that all cables meet an electrical specification: for copper cabling with [AWG](/wiki/American_wire_gauge) 26 wires the maximum practical length is [Template:Convert](/wiki/Template:Convert).[[83]](#cite_note-83)

## {{Anchor|POWER}}Power[[edit](/index.php?title=(none)&action=edit&section=35)]

|  |  |  |  |
| --- | --- | --- | --- |
| USB power standards | | | |
| **Specification** | **Current** | **Voltage** | **Power** |
| Low-power device | 100 mA | 5 V | 0.50 W |
| Low-power SuperSpeed device | 150 mA | 5 V | 0.75 W |
| High-power device | 500 mA[Template:Efn](/wiki/Template:Efn) | 5 V | 2.5 W |
| High-power SuperSpeed device | 900 mA[Template:Efn](/wiki/Template:Efn) | 5 V | 4.5 W |
| Battery Charging (BC) 1.2 | 5 A | 5 V | 25 W |
| Type-C[Template:Efn](/wiki/Template:Efn) | 1.5 A | 5 V | 7.5 W |
| 3 A | 5 V | 15 W |
| Power Delivery micro-format[Template:Efn](/wiki/Template:Efn) | 3 A | 20 V | 60 W |
| Power Delivery standard format or Type-C[Template:EfnTemplate:Efn](/wiki/Template:Efn) | 5 A | 20 V | 100 W |
| [Template:Noteslist](/wiki/Template:Noteslist) | | | |

[thumb|right|Y-shaped USB 3.0 cable; with such a cable, a device can draw power from two USB ports simultaneously](/wiki/File:Y-shaped_USB_3.0_cable.jpg)

USB supplies bus power across V[Template:Sub](/wiki/Template:Sub) and GND at a nominal voltage 5 V ± 5%, at supply, to power USB devices. Power is sourced solely from upstream devices or hosts, and is consumed solely by downstream devices. USB provides for various voltage drops and losses in providing bus power. As such, the voltage at the hub port is specified to be in the range [Template:Val](/wiki/Template:Val) by USB 2.0, and [Template:Val](/wiki/Template:Val)[[84]](#cite_note-84) by USB 3.0. It is specified that 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.

There are limits on the power a device may draw, stated in terms of a *unit load*, which is 100 mA, or 150 mA for SuperSpeed devices. There are low-power and high-power devices. Low-power devices may draw at most 1 unit load, and all devices must act as low-power devices when, starting out as, unconfigured. High-power devices draw at least 1 unit load and 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.[[85]](#cite_note-85)[[86]](#cite_note-86)[[87]](#cite_note-87)[[88]](#cite_note-88) 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 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,[[89]](#cite_note-89) 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 2 USB plugs (1 for power and data, the other for only power), so as to draw power as 2 devices.[[90]](#cite_note-90) 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."[[91]](#cite_note-91)

### {{Anchor|ACA|BCS|62680-3}}USB Battery Charging[[edit](/index.php?title=(none)&action=edit&section=36)]

[thumb|right|A small device that provides voltage and current readouts for devices charged over USB](/wiki/File:USB_voltage_and_current_meter.jpg) [thumb|right|This USB power meter additionally provides a charge readout (in mAh) and data logging](/wiki/File:USB_voltage,_current_and_charge_(mAh)_meter_2.jpg)

USB Battery Charging defines a new port type, the *charging port*, as opposed to the *standard downstream port* (SDP) of the base specification. Charging ports are divided into 2 further types: the *charging downstream port* (CDP), which has data signals, and the *dedicated charging port* (DCP), which does not. Dedicated charging ports can be found on USB power adapters that convert utility power or another power source (e.g., a car's electrical system) to run attached devices and battery packs. On a host (such as a laptop computer) with both standard and charging USB ports, the charging ports should be labeled as such.[[92]](#cite_note-92) The charging device identifies the type of port through non-data signalling on the D+ and D− signals immediately after attach. A DCP simply has to place a resistance not exceeding 200 Ω across the D+ and D− signals.[[92]](#cite_note-92)[[93]](#cite_note-93) 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 up to at least 1.5 A. More current may be supplied up to the maximum current of 5 A, but the charging port may apply current limiting, or even shut down. The maximum current is determined by the over-current protection maximum current in the baseline specification. Note that it is specified only that USB connectors are tested to a contact current rating of at least 1.5 A.[[92]](#cite_note-92) These bus power currents being much higher than cables were designed for, though not unsafe, cause a larger voltage between the ends of the ground signal, significantly reducing noise margins causing problems with High Speed signalling. Battery Charging 1.1 specifies that charging devices must dynamically limit bus power current draw during High Speed signalling;[[94]](#cite_note-94) 1.2 simply specifies that charging devices and ports must be designed to tolerate the higher ground voltage difference in High Speed signalling.

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.[[25]](#cite_note-25) 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 [iPod](/wiki/IPod) and [iPhone](/wiki/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.[[95]](#cite_note-95) When D+ = 2.8 V and D− = 2.0 V, the device may pull up to 2 A of current.[[96]](#cite_note-96)

#### Accessory charging adaptors (ACA)[[edit](/index.php?title=(none)&action=edit&section=37)]

Portable devices having an 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 which allow a charging power to be injected into 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 signalling. 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 signalled 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.[[92]](#cite_note-92)

### {{Anchor|PD|PD-R1.0|PD-R1.0V1.1|PD-R1.0V1.2|PD-R2.0V1.0}}USB Power Delivery (UPD)[[edit](/index.php?title=(none)&action=edit&section=38)]

|  |  |  |  |
| --- | --- | --- | --- |
| USB PD rev. 1 source profiles[[97]](#cite_note-97) | | | |
| **Profile** | **+5 V** | **+12 V** | **+20 V** |
| **0** | colspan=3 [Template:N/a](/wiki/Template:N/a) |  |  |
| **1** | 2.0 A, 10 W[Template:Efn](/wiki/Template:Efn) | [Template:No](/wiki/Template:No) | rowspan=3 [Template:No](/wiki/Template:No) |
| **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 |
| [Template:Noteslist](/wiki/Template:Noteslist) | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| USB PD rev. 2 source power rules[[98]](#cite_note-98) | | | | |
| **Source output  power (W)** | **Current, at: (A)** | | | |
| **+5 V** | **+9 V** | **+15 V** | **+20 V** |
| **0.5–15** | 0.1–3.0 | [Template:No](/wiki/Template:No) | rowspan=2 [Template:No](/wiki/Template:No) | rowspan=3 [Template:No](/wiki/Template:No) |
| **15–27** | 3.0  (15 W) | 1.7–3.0 |  |  |
| **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, 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[Template:Snd](/wiki/Template:Snd) 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).[[99]](#cite_note-99) In all cases, both host-to-device and device-to-host configurations are supported.[[100]](#cite_note-100) 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.[[55]](#cite_note-55)[[101]](#cite_note-101) 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](/wiki/BFSK)-coded transmission channel on the VBUS line.

The USB Power Delivery revision 2.0 specification has been released as part of the USB 3.1 suite.[[102]](#cite_note-102) It covers the Type-C cable and connector with four power/ground pairs and a separate configuration channel, which now hosts a [DC coupled](/wiki/DC_coupled) low-frequency [BMC](/wiki/Biphase_mark_code)-coded data channel that reduces the possibilities for [RF interference](/wiki/USB_3.0_RF_interference).[[103]](#cite_note-103) 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 Revision 2.0 Version 1.2, the six fixed power profiles for power sources have been deprecated.[[104]](#cite_note-104) USB PD Power Rules replace power profiles, defining four normative voltage levels at 5V, 9V, 15V, and 20V. Instead of six fixed profiles, power supplies may support any maximum source output power from 0.5W to 100W.[[105]](#cite_note-105) Status of available product: Currently (April, 2016) there are silicon controllers available from several sources (TI, Cypress) [[106]](#cite_note-106)[[107]](#cite_note-107) and several others. Power supplies bundled with Type-C based laptops from Apple, Google, HP, Dell, and Razer support USB PD.[[108]](#cite_note-108)