What is a USB Type-C Connector?

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The USB connector has three interfaces with different appearances, namely Type-A, Type-B, and Type-C. A Type-C connector has a much smaller volume than Type-A and Type-B and is the latest USB interface appearance standard. Also, Type-C is an interface type that can be applied to both PCs (master devices) and external devices (slave devices, such as mobile phones).

USB Type-C: Explained!

Catalog

I What are Type-C connectors?

USB Type-C connector is a connector of an industry standard for **transmitting data and power** on a single cable. The USB-C connector was developed by the USB Implementers Forum. In 2014, USB Type-C was launched. It was first applied to the Nokia N1 tablet at the end of the year, and then to the Google Chromebook Pixel in early 2015, but the time that it is well-known to the public is the popularity of Apple's Macbook.


USB Type-C connector

In recent years, the Type-C connector has attracted much attention because of its characteristics: fast, strong, and small. Now more and more products begin to use Type-C connectors, and in the future, Type-C will also dominate the interface.

II Pin definition

To understand the principle of USB Type-C, we must first understand its PN definition. Type-C port has 4 pairs of TX/RX splitter, 2 pairs of USBD+/D-, a pair of SBU. 2 CC, and there are 4 VBUS and 4 ground wires.
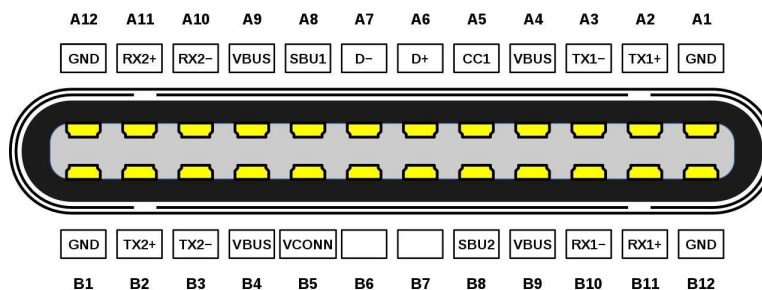
USB Type-C plug outlet end
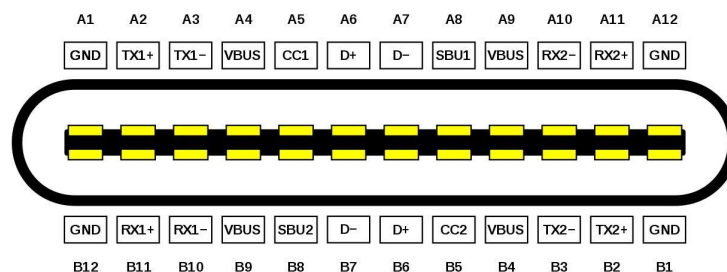
USB Type-C socket end

If the receiving end only needs DP signals and does not need USB 3.1 signals, then DP can use all 4 pairs of TX/RX differential lines for output, so as to achieve up to 4 lanes of DP output, providing a total output bandwidth of up to 32.4Gbps (each lane can output 8.IGbps), easily realize 5Kx3K 60 frame video, even up to 8K×4K 60 frame video (4:2:0 data). This mode is the DP

only mode. Besides, to be compatible with USB2.0, Type-C also retains USBD+/D- signals for USB 2.0 devices. So USB2.0 or even USB 1.0 devices only need to use the Type-C interface, and they can also support front and back insertion. It is worth mentioning that the use of USBD+/D- with the DP only mode above can achieve the DP+USB2.0 mode. DP occupies 4 pairs of TX/RX differential lines, and USB only uses D+/D-. Normally, the USB2.0 differential signal will only be connected to one side because the USB Type-C Plug does not have B6 and B7. USB3.1 only uses 2 pairs of TX/RX differential lines as data lines. Connect TX1/RX1 during forwarding insertion and TX2/RX2 during reverse insertion. It can be seen that in any case, there will be 2 pairs of differential lines that are not used. The DP alternate mode is to load the DP signal on these two pairs of "excessive" differential lines so that USB 3.1+DP can work simultaneously.

The Type-C connector also provides 2 CC lines and 2 SBU lines. The CC line is mainly used for the communication of the Power Delivery module (hereinafter referred to as PD). The CC line is first used to determine the direction of device insertion. If it is a positive insertion, the host uses CC1 to communicate with the device. Reverse insertion uses CC2, and you can see that the CC uses the single-wire protocol. When the DP function is enabled, the SBU line turns into the AUX_P/AUX_N differential line in the DP protocol whose polarity can be modified according to the positive and negative insertion directions). It is responsible for the transmission equipment. DPCD, EDID, and other key information.

Ⅲ Main features USB Type-C

1 Power Supply

The USB Type-C interface's default 5V power supply is backward compatible with the previous USB interface. Not only that, but the new USB Type-C interface also contains 4 pins dedicated to power and ground, respectively. "USB Power Delivery Specification" enables the USB Type-C interface to support up to 20V voltage and 5A current.

2 Symmetrical connection

The USB Type-C connector is symmetrical, so it can be plugged and unplugged as well as the direction of the cable. The liberation of the plug-in direction solves the main troubles caused by the previous connector. The type of the previous interface indicates the function of the accessory device (Type-A interface is used for the host, and Type-B interface is used for external devices). The USB Type-C interface can be connected to any one of the two ends, and the function is defined by the connected hardware. The interfaces at both ends of the USB Type-C cable are the same, so the plugging and unplugging of the cable are simplified.

3 Bandwidth

USB Type-C supports USB 2.0, USB 3.1 Gen 1 (SuperSpeed USB 5Gbps) and USB 3.1 Gen 2 (SuperSpeed USB 10Gbps) data rates. USB 2.0 and USB 3.1 are defined by separate specifications. SuperSpeed USB differential signal pairs are distributed on both sides of the interface. When inserting the interface in either direction, a set of SuperSpeed USB signal transmission connections are used.

4 Channel configuration

The USB Type-C interface contains 2 channel configuration signal pins (CC1 & CC2) for function negotiation. The above signals determine the direction of interface insertion and are used to negotiate the power supply function, alternate mode, and peripheral mode on the interface.

5 Non-USB signal transmission

The USB Type-C connector supports multiple OEM product customization modes to expand device functions. The figure below shows the USB Type-C pin diagram. Certain pins can be reassigned according to product type. The pins marked in yellow can be reconfigured with a fully functional USB Type-C cable. Also, the pins marked in orange can be reconfigured for Direct Connect Application.

A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2−	VBUS	SBU1	D−	D+	CC	VBUS	TX1−	TX1+	GND
GND	TX2+	TX2−	VBUS	VCONN			SBU2	VBUS	RX1−	RX1+	GND
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12

USB Type-C interface pin diagram

Signal redistribution is achieved through negotiation on the CC channel. The interface can enter two modes, peripheral mode, and alternative mode. To enter peripheral mode, a simple logic test will be performed on the CC channel to determine which peripheral mode is required. To enter alternate mode, Biphase Mark Code (BMC) will be used for two-way communication on the CC channel to set up the link correctly. In this negotiation process, the devices at both ends need to agree on the reallocation of signals before making any changes. All USB Type-C interfaces are required to be able to be used as USB-compatible interfaces in non-alternative mode or non-peripheral mode.

IV Main advantages of Type-C connectors

(1) Slim design. The size of the interface socket is about 8.3mm×2.5mm, which is 1/3 of the size of the standard USB Type-A connector.

(2) Support "positive and negative insertion". The front and back of the Type-C connector are the same, and it supports the "positive and negative insertion" function that can be inserted from both the front and the back. It solves the problem of "USB is always inserted incorrectly" and can withstand 10,000 repeated insertions and removals.

(3) The maximum data transmission speed can reach 10Gbit/sec, which is the standard of USB3.1.

(4) USB Type-C supports USB PD protocol (power transmission protocol), which can deliver up to 100 watts of power and can freely change the direction of power transmission. Therefore, USB Type-C can realize fast charging and bidirectional charging. For example, users can not only charge mobile devices with notebooks but also use other devices or mobile power sources to charge notebooks.

(5) To expand the integration of various transmission specifications, Type-C has developed Alternate Modes, including Displayport for high-speed video transmission, MHL for multimedia transmission of mobile devices, Intel-led high-speed transmission interface Thunderbolt 3, and high-definition video transmission interface such as HDMI.

USB Type-C can transmit audio and video signals, expand to multiple audio and video output interfaces, such as HDMI, DVI, VGA interface. It can even achieve the expansion of 4K resolution. In general, USB Type-C has a slim design, supports positive and negative insertion, and has a faster transfer rate. One line can integrate charging, data transmission, and audio and video transmission functions.

V Type of USB connectors

Here is a brief introduction to the other members of the USB interface family and their practical uses.

1 The relationship between USB Type-C and USB3.1

Many people are now blurring the boundaries between the two words USB3.1 and Type-C, because they appear at similar times, so people mistakenly think they are the same concept, but in fact, they are not.

USB3.1 is the USB transmission standard introduced in 2013 and was developed by the USB-IF Association. At present, there are mainly the following USB standards, and their main difference lies in the transmission speed:

It should be noted here that most people are now confused about USB3.1 Gen1 and USB3.1 Gen2. The biggest difference between them is the transmission rate. The maximum transmission rate of USB3.1 Gen1 can reach a bandwidth of 5Gb/s. The maximum transmission rate of USB3.1 Gen2 can reach the theoretical bandwidth of 10Gb/s. In fact, the so-called USB 3.1 Gen 1 is the original USB 3.0, and USB3.1 Gen2 is the real USB3.1. Since the compatibility solution of the Gen2 standard USB3.1 is not yet mature, and the price is relatively high, most of the manufacturers claiming to support the USB3.1 standard are using USB3.1 Gen1, which is what you know before USB3.0.

Through the introduction of USB3.1, we can find that USB3.1 and USB Type-C are two concepts. USB 3.1 is a transmission standard, and USB Type-C is an interface form (type). Therefore, the USB 3.1 standard can support USB Type A, USB Type B (Micro USB), and the latest USB Type-C interface types. The USB Type-C interface can also use USB2.0, USB3.0, USB3.1, and other transmission standards.

2 The relationship between USB Type-C and USB 3.2

USB 3.2 is the latest USB transmission standard launched by the USB-IF organization in September 2017. Officially stated that USB 3.2 is an incremental update, that is, it is supplemented based on USB 3.1 and is an upgraded version of USB 3.1.

USB 3.2 still uses the SuperSpeed US layer data rate and encoding technology. Compared with USB 3.1, the change of USB 3.2 is that it supports the seamless switching between the host device and peripherals between single and dual channels. Using dual-channel technology, the transmission rate can be doubled, and the maximum transmission rate can reach 20Gbps. To speed up the end of the coexistence of multiple USB interface types, USB-IF listed Type-C as the only recommended interface when formulating the USB 3.2 standard.

3 The relationship between USB Type-C and Thunderbolt 3

Thunderbolt is a technology launched by Apple and Intel in deep cooperation. It combines traditional PCIE data transmission technology and DisplayPort display technology. The latest Thunderbolt 3 combines data transmission, video output, and charging into a compact interface. The maximum bandwidth of the interface can reach 40Gb/s, which is 8 times that of USB3.0 and 4 times that of USB3.1. Intel changed the Thunderbolt 3 physical interface from the previous mini DP to USB Type C, further consolidating the long-cherished wish of USB Type C to unify the interfaces of PC and mobile devices.

VI Application of USB Type-C connector

At present, the most widely used application areas of USB Type-C connectors are concentrated on smartphones, tablets, and laptops. In the future, USB Type-C will cover mobile phones, PCs and peripherals, digital headsets, VR/AR, flat-screen TVs, Automotive, pan-IoT terminal, and other fields.

So, what changes will Type-C bring to our daily life?

1 One line integrates charging, data transmission, and audio and video transmission functions, ending the **trouble of multiple wires and multiple interfaces**.

Many people will have such troubles. There are always a bunch of messy wires on the table, and so many interfaces on the display. We often do not know which one to plug. And the interface on the computer is not enough, so you have to unplug the mouse if you plug in a U disk.

The Type-C connector has charging, data transmission, and audio and video transmission functions, so that the power interface, USB interface, DP interface, HDMI interface, VGA interface, etc., can be uniformly carried by a Type-C connector.

In 2015, Apple's new MacBook for the first time used a USB Type-C to carry the power interface, USB interface, DP interface, HDMI interface, and VGA interface on a laptop computer. This is the first time that USB Type-C technology has been used in consumer notebooks.

2 **Improve working efficiency**. In the past, the USB interface had a directional problem, and there was a problem with improper insertion. A slightly larger file would take longer to transfer, but the emergence of Type-C solved the problem and made the process quick. Type-C supports both forward and reverses insertion. Also, it can copy large files at a speed of 10Gbit/sec, greatly improving the working efficiency.

3 **Fast charging**. Now under the USB PD, power transfer protocol, the power supply parameters of Type-C connector can be expanded to an output voltage of 20V, an output current of up to 5A, and a maximum of 100W of power transmission, which can improve charging speed.

Many data transmission interfaces including Type-A are still used by most consumers, and some Macbook users want to expand the use, they must match various conversion lines. But undoubtedly, the Type-C that is popular among many industry giants will become the mainstream in the future.

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Frequently Asked Questions

What devices use USB Type C?

In addition, USB-C is narrow enough that it can fit on phones with no problem. This means that it can be a standard connector for both computers and phones, as well as other devices like game consoles. Some popular devices that use USB-C cables are the Nintendo Switch, MacBook Pro, and Samsung Galaxy line of phones.

What plugs into a USB-C port?

Really, anything that has a Micro USB or USB-A could ultimately get a USB-C port. Devices like wireless mice, keyboards, speakers, and smart home devices, all either currently do, or could in the future, offer USB-C ports, both for power delivery and data transfer.

What is the difference between USB and USB-C?

The USB-A has a much larger physical connector than the Type C, Type C is around the same size as a micro-USB connector. Unlike, Type A, you won't need to try and insert it, flip it over and then flip it over once more just to find the right orientation when trying to make a connection.

Are all USB-C connectors the same?

No, not all USB-C cables are equal. USB-C stands for the shape and type of connector, which is the same for all USB-C cables but not all cables support the same kind of protocols and transfer speeds.

What does USB-C look like?

The USB-C connector looks similar to a micro USB connector at first glance, though it's more oval in shape and slightly thicker to accommodate its best feature: flippability. Like Lightning and MagSafe, the USB-C connector has no up or down orientation.