USB Type-C® Connector Solutions

USB4® & USB PD EPR

Information included herein is current as of the end of Janualy 2023.
Please note that details may have changed by the time this is being viewed.

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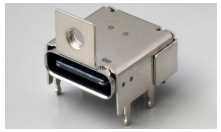
*Thunderbolt™ is a trademark of Intel Corporation.
*USB-IF is a non-profit corporation founded by the group of companies that developed the Universal Serial Bus specification.

What is USB4?

USB Type-C connectors are installed on a wide range of devices, including PCs, smartphones, and gaming devices.
Although USB Type-C is a standard that stipulates the shape (mating face) of the connector, when using a USB Type-C connector, there are various standards (for example, USB 3.2, USB4, and USB-PD) that exist which stipulate such things as the signal type, speed and power to be transmitted.
As you can see in the photo below, the shape of the USB4 connector is similar to previous USB Type-C connectors. We would like to go over what has changed and what improvements have been made.

USB4 Compatible Product Lineup



DX07S024XJ4

DX07S024XA8

DX07S024JAA

DX07B024JAA

DX07BD24JJ4

Receptacle Connectors [Being mass-produced]

SPR 100W Compatible
DX07880B08P***
EPR 240W Compatible
DX07881B10****
Cable Harness [Being prepared for mass-production]

DX07P022FA1
Plug Connector [Being mass-produced]

New Naming Convention

The latest USB version, USB4, removes the space between “USB” and the version number, “4”.
In addition, the decimal point that indicates minor updates to the specifications have been eliminated.
It is believed that these new naming conventions will help to reduce confusion among users.

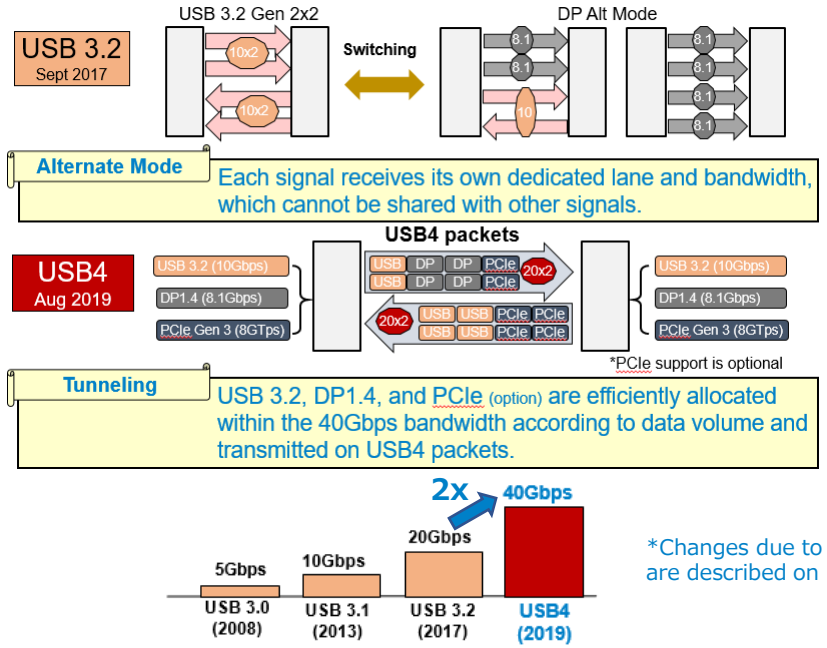
Changes From a User Perspective

Connections using USB Type-C connectors have always had an optional function known as Alternate Mode, which allows transmission of other standards besides USB. What has changed with USB4?
With USB4, the maximum usable bandwidth was expanded to 40Gbps, double that of USB 3.2 Gen 2x2. It now has the ability to dynamically control the allocation of bandwidth within that 40Gbps according to requirements of each signal. That is the concept of tunneling that has been implemented with USB4.
Combining multiple transmission standards into a single interface increases ease of use by customers.
USB 3.2, DisplayPort, and PCIe tunneling is possible depending on the device. Allocation of bandwidth for each signal can also be optimized within the available total bandwidth. This helps to increase transmission efficiency as there is no fixed transmission bandwidth for individual signals that are tunneled.
USB4 is also compatible with USB 3.2 Gen 2 native transmission and Alternate Modes.
Although conventional Alternate Mode can transmit signals other than USB, one protocol will receive its own dedicated signal path and bandwidth which can no longer be changed or reallocated. However, the tunneling feature of USB4 allows for signals other than USB to be carried on USB4 packets on the same transmission path by efficiently allocating bandwidth based on the requirements of each individual signal within the available 40Gbps.

Tunneling Concept

-Doubles conventional maximum bandwidth and allows tunneling of different protocols-

The image below shows the Alternate Mode and tunneling concepts.



Compatible with Tunneling of Multiple Protocols

The following table shows devices with USB ports and compatibility rules for USB transmission standards

Devices With USB Ports	USB 3.2	DisplayPort	PCIe
USB4 Host (Computer)	Required	Required	Optional
USB4 Device (Peripheral)	Optional	Optional	Optional
USB4 Hub/Dock	Required	Required	Required

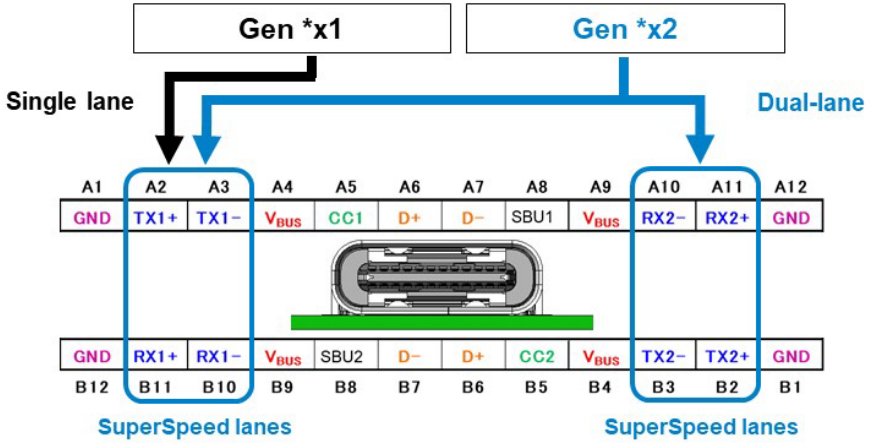
*Changes due to the USB4 Version 2.0 specification announced by USB-IF on October 18, 2022 are described on page 6 of this document.

There are two speed levels defined for USB4: USB4 20Gbps and USB4 40Gbps.
Although these are sometimes marked as Gen 2 and Gen 3, respectively, **the new brand names will show only the data rate to reduce user confusion.**
As with USB 3.2, USB4 achieves double the data rate of a single lane interface by using the two SuperSpeed lanes available within USB Type-C connectors.

New Marketing Names

Revision	New Brand Name	Data Rate	Lanes
USB 3.2 Gen 1x1	SuperSpeed USB 5Gbps	5Gbps	Single
USB 3.2 Gen 2x1	SuperSpeed USB 10Gbps	10Gbps	Single
USB 3.2 Gen 2x2	SuperSpeed USB 20Gbps	20Gbps	Dual
USB4 Gen 2x2	**USB4 20Gbps**	20Gbps	Dual
USB4 Gen 3x2	**USB4 40Gbps**	40Gbps	Dual
※ USB4 Gen 4x2	**USB4 80Gbps**	80Gbps	Dual

Single Lane and Dual Lane Comparison



Changes to Connectors and Harnesses

Backward compatibility is assured by using the same USB Type-C connectors as previous generations.
However, vendors must use connectors and harnesses that have been improved to meet the new USB4 requirements for signal quality.
The receptacle connectors used for USB4 40Gbps devices now have a mandatory signal integrity requirement that must be met during certification tests.
Although signal integrity has always been a mandatory test item, receptacle connectors used to be certified as part of the final device, such as the computer, harness, or docking station.
While the receptacle connector is a short part of the entire USB signal transmission path, which also includes the board traces and harness, there is a possibility that it could become a major cause of unwanted signal reflection or crosstalk. Properly designed and precisely manufactured products are vital to prevent the receptacle connector from becoming a bottleneck for the entire USB signal transmission path. As such, using a certified receptacle connector assures peace of mind.
Because the requirement for USB4 40Gbps-certified harnesses are far stricter than previous versions, the maximum length for a passive harness has been shortened to 0.8m. However, we are developing active harnesses that will allow for longer cable lengths by incorporating equalizers and amplification functions.

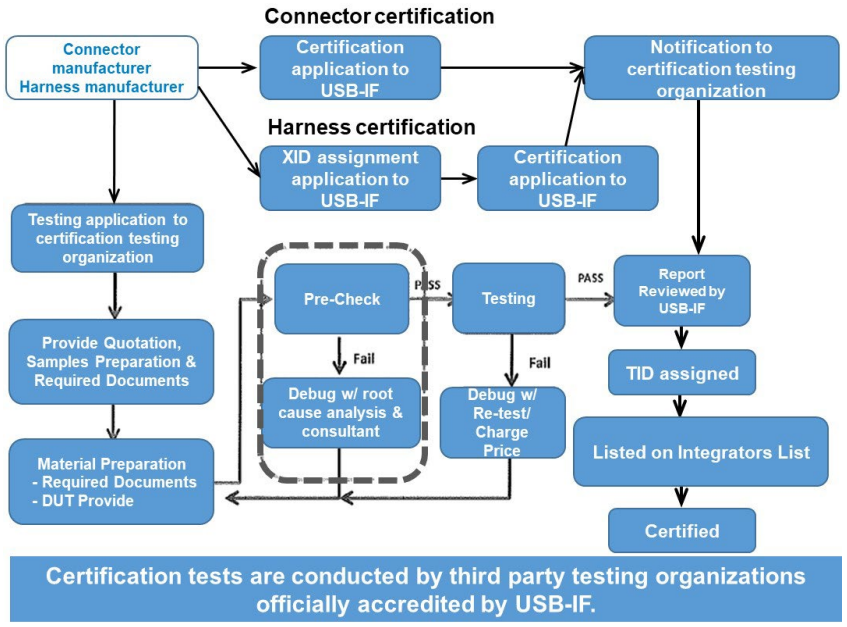
*Changes due to the USB4 Version 2.0 specification announced by USB-IF on October 18, 2022 are described on page 6 of this document.

JAE's USB4 Certified Products

As a global leader in interconnect technology, JAE was an active contributor in the USB-IF working group tasked with creating the new specifications.
The following is an introduction to the receptacle connectors, cable harnesses, and plug connectors (not applicable for certification) that are certified for the latest USB4 standard.
Before we introduce our products, let us briefly explain the USB certification process and test items.

Certification Process

USB-IF has established a certification program to confirm compliance with the standard. Products that have passed tests by certified third party testing facilities are listed on the Integrators List on the USB-IF website and are granted the right to use the various USB logos.



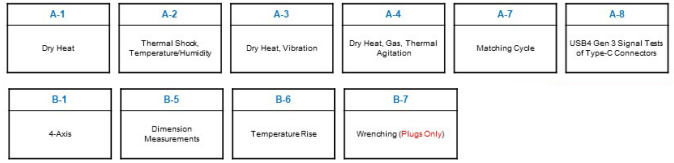
XID/TID: a number assigned as an ID during certification tests

Certification Test Items

■Receptacle Connector and Plug Connector

The single tests are B-5: Dimension Measurements and B-6: Temperature Rise, and the majority are sequential combined tests.

*B-7 is only conducted for plug connectors.



■Cable Harness Certification

Harnesses must use certified connectors and **pass the required SI tests (tests according to signal characteristic requirements).**

*B-1, B-4, and B-5 are not sequential tests.

USB4® Version 2.0 Specifications Overview

The main features of the USB4® Version 2.0 specification announced by the USB-IF on October 18, 2022 are described in ① to ⑥ below.
Of these features, ①, ④, and ⑤ are a little difficult to understand, and supplementary explanations are also provided, so please check them as well.

① **Supports 80Gbps with PAM3 signal encoding**
② **80Gbps operation is possible with existing USB4 Gen3 (40Gbps) standard receptacles, passive cables, and newly-defined active cables**
③ **Supports DisplayPort™ 2.1 and PCI Express® 4.0**
④ **USB 3.2 by tunneling will be enable 20Gbps communication**
⑤ **Asymmetric mode (3 TX / 1 RX) allows configuration of 120 Gbps transmission/40 Gbps reception**
⑥ **Retains compatibility with all previous versions of USB**

① What is PAM3 signal encoding?

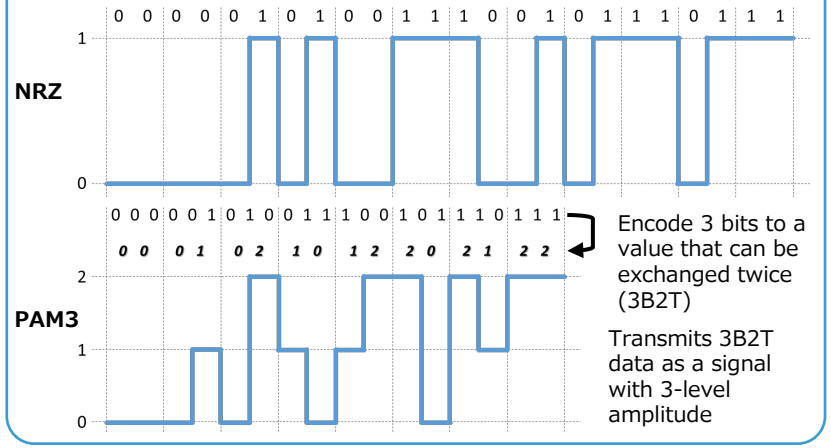
PAM (Pulse Amplitude Modulation) is a method of transmitting digital signals depending on the amplitude (voltage) of the signal.In particular, the method of transmitting 1 bit (binary values of 1 and 0) is called NRZ (Non Return to Zero).PAM3 means that three values are transmitted depending on the voltage level.Compared to transmitting binary data per hour, ternary data can be sent 1.5 times as much data, so speed can be increased without increasing the frequency.However, since the voltage difference is small, it is necessary to consider that data transmission may become difficult due to the effects of noise, etc. if appropriate measures are not taken.

④ What is USB 3.2 by tunneling will be enable 20Gbps communication?

With the advent of USB4 Version 2.0, the transmission rate of 10Gbps was improved to 20Gbps with conventional USB4.Please refer to page 13 of this document for an explanation of the concept of tunneling.

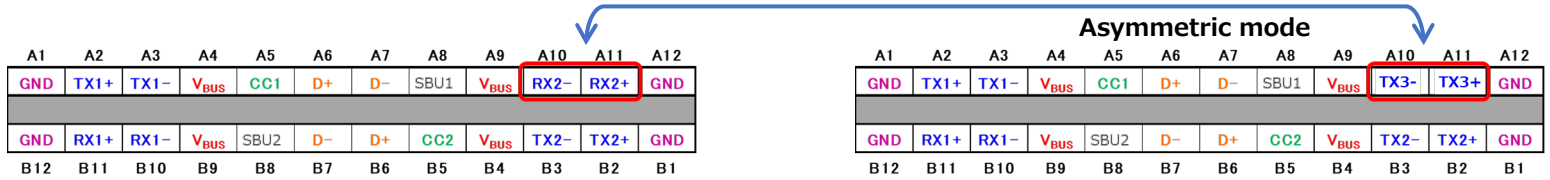
NRZ and PAM3

For example, when transmitting data 000001010011100101110111



⑤ What is Asymmetric mode (3 TX / 1 RX) allows configuration of 120 Gbps transmission/40 Gbps reception?

On page 8 of this document, we explained that high-speed data transmission is performed with the “TX” and “RX” terminals using the USB Type-C pin assignment.
The configuration consists of two pairs of "TX" terminals on the transmitting side and two pairs of "RX" terminals on the receiving side. However, in USB4 Version 2.0, by assigning the RX2 terminal to the transmitting side as the TX3 terminal, the configuration of 120 Gbps transmission / 40 Gbps reception. is now possible



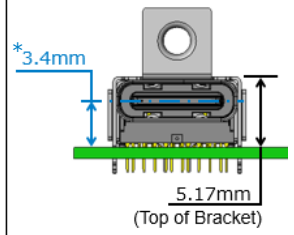
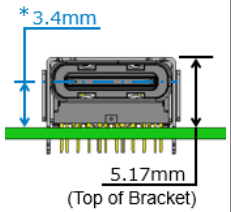
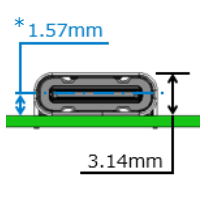
USB4 Certified Receptacle Connector

USB4 and Thunderbolt™ 4 standards certified on-board and mid-mount types

Choose a type that fits the device or board design.

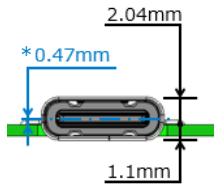
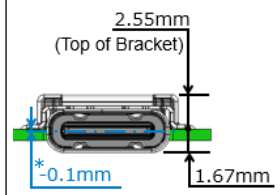
On-board Type

*Indicates the height from the board mounting surface to the center of the connector mating face (center height).

			
Part Number	**DX07S024XJ4**	**DX07S024XA8**	**DX07S024JAA**
TID(Certification Number)	7420	8315	4729

Mid-mount Type

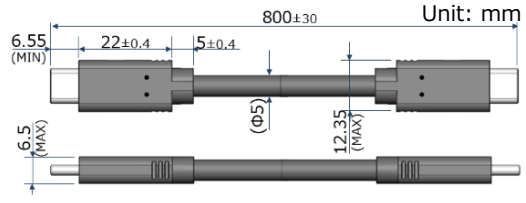
*Indicates the height from the board mounting surface to the center of the connector mating face (center height).

		
Part Number	**DX07B024JAA**	**DX07BD24JJ4**
TID	5067	5362

USB4 Certified Cable Harness

The product has passed certification tests and has acquired a TID number.

Mass production will be considered.

Part Number	**DX07880B08P*****
TID (Certification Number)	**4636**
Cable Length	80cm
Wire Type	Coaxial cable
Rated Current (Maximum power)	5A maximum (100W)
Mold	TPE (black)
Product Shape Dimensions	

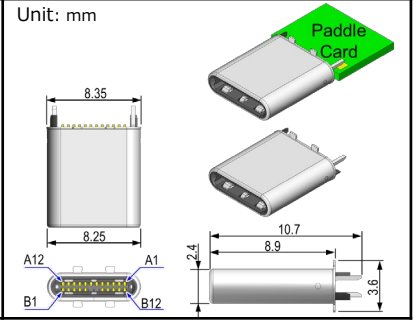
USB4 Plug Connector

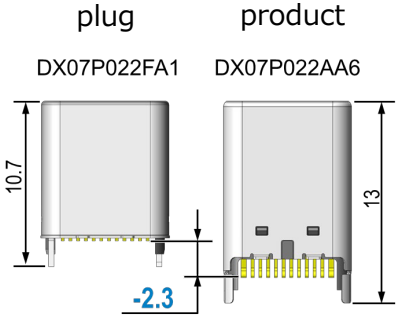
This is the part number and specifications for the plug connector optimized for USB4 cable harnesses. The plug connector is used on both ends of JAE's USB4 passive cable harness. 。

(USB 3.2 Gen 2 certified (TID: 4025). *See below)

By shortening the terminal length by 2.35mm, the plug connector is not only more compact than previous connectors, but it has superior electrical characteristics.

The product has been adopted as the plug connector installed on official test fixtures used for USB4 receptacle connector certification tests (also known as the Golden Plug).

Part Number	**DX07P022FA1**
Product Shape Dimensions	



***Plug connector SI performance is considered as part of the cable harness SI performance and does not receive USB4 connector certification.**

What is USB PD EPR?

USB Type-C R2.1 and USB PD R3.1 were released on May 25, 2021, and with the introduction of EPR, USB Type-C connectors are now able to support power delivery of up to 240W.
An outline of USB Power Delivery Extended Power Range (USB PD EPR), its advantages, and compatible JAE products are explained below.

First, What Is the USB PD Standard?

These are the standards established by the USB Implementers Forum (USB-IF).

Not only will power supply exceeding the 7.5W (5V/1.5A) supported by USB BC 1.2 (Battery Charging Specification Revision 1.2) become possible using USB Type-C connectors and cables, the cables and connectors will also be used to sync with hosts, exchange host and device roles, and negotiate transmission of non-USB protocols. (Alternate Mode)

Before the advent of the USB PD specification, voltage was restricted to 5V when delivering power using USB ports. With the USB PD standard, higher levels of power delivery have become possible by expanding the voltage range, and with the new EPR standard, that voltage range has been expanded further. With USB PD R3.1 (EPR), maximum power has increased from 100W (20V/5A) to 240W (48V/5A).

The following table shows the list of power supply requirements defined in the USB standard.

Operating Mode	Maximum Voltage	Maximum Current	Maximum Power
USB 2.0	5V	500mA	2.5W
USB 3.2	5V	900mA	4.5W
USB4	5V	1.5A	7.5W
USB BC 1.2	5V	1.5A	7.5W
USB Type-C Current @ 1.5A	5V	1.5A	7.5W
USB Type-C Current @ 3.0A	5V	3A	7.5W
USB PD 3.1	20V	5A	100W
USB PD 3.1 (EPR)	**48V**	**5A**	**240W**

Outline and Advantages of USB PD EPR

■ Outline

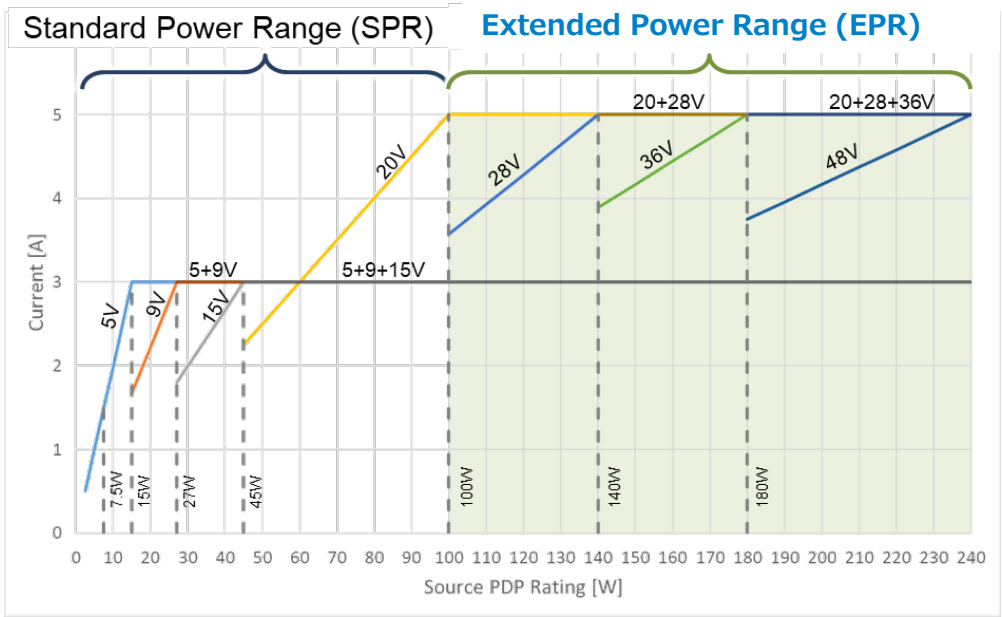
- With the EPR mode active, power can be increased from 100W (20V/5A) to 240W (48V/5A).
- In addition to the existing fixed voltage levels of 5V, 9V, 15V, and 20V, three new fixed voltage levels can now be selected: 28V (>100W), 36V (>140W), and 48V(>180W).
- In adjustable voltage supply (AVS) mode, the voltage can range from a minimum of 15V to one of three maximum voltages (28V, 36V, or 48V) depending on the available power. The device can precisely adjust for an ideal voltage in 100mV/50mA increments. This allows for an increase in charging and thermal efficiency.

The following table is a comparison of the previous USB PD 3.0 and USB PD 3.1 with the addition of EPR.

Operating Mode	Nominal Voltage	Maximum Power *
Extended Power Range (EPR) USB PD (R3.1) Adjustable Voltage Supply (AVS) Fixed Voltages	48V 36V 28V	240W 180W 140W
Standard Power Range (SPR) USB PD (R3.0) Programmable Power Supply (PPS) Fixed Voltages	20V 15V 9V 5V	60W/100W 45W 27W 15W

*Due to connector restrictions, maximum is 5A and 3A for default cables.

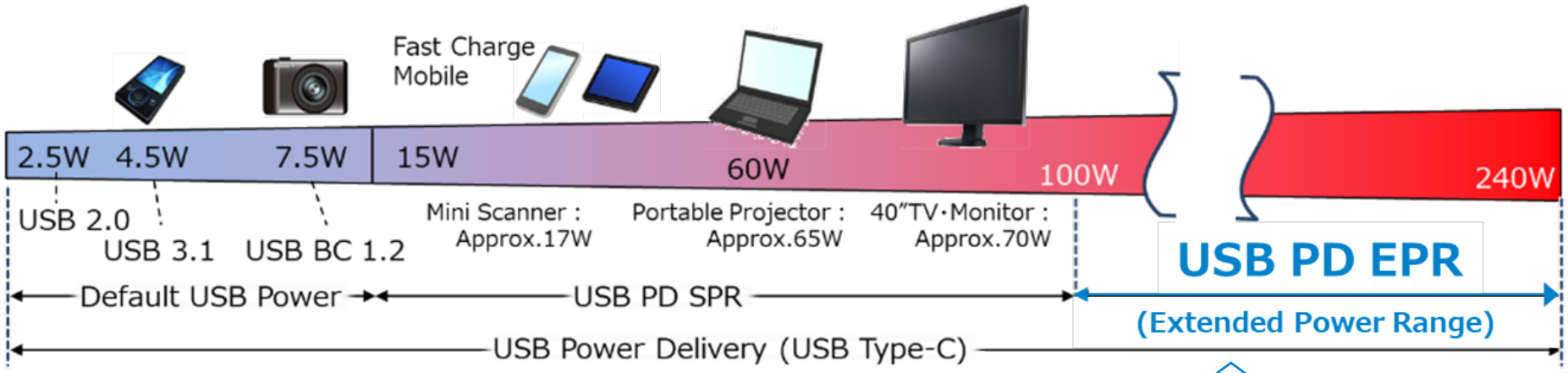
The graph below shows the expanded power range with EPR.



■ Main Advantages

- Higher voltage allows for more power delivery.
- Increase of over 100W compared to previous USB PD specification for a wider range of applications.
- Precise adjustments through AVS to an ideal voltage that increases sync capabilities and thermal efficiency.

Over 100W, Even Wider Range of Applications



・Large laptop PCs and desktop PCs
・Workstations and gaming PCs
・Docking stations and displays
・Other high voltage devices

Requirements for USB Type-C Standard Connectors and Cables

When the USB PD standard was updated to revision 3.1, the USB Type-C standard was also updated to revision 2.1.
The main changes are as follows.

■There are no additional requirements for connectors.

- **USB ports must have the following identification icons.**

■EPR cable requirements have been added to cable assemblies.

- EPR cables must be able to functionally support 50V and 5A operations.
- Cables must support a minimum functional voltage of 53.65V.
- Electrical components in the VBUS path (e.g., bypass condensers) must be rated for at least 63V.
- All EPR cables must be digitally marked and the eMarker must contain EPR-specific information.
- EPR cables should be 50V, 5A compatible.
- **EPR cables must be able to be visually identified with a cable identification icon defined by USB-IF.**

Various Cable Certification Icons

	For Packaging	For Cables/USB Ports	For Combined Data/Power USB4
Certified USB4 40Gbps *	CERTIFIED USB 40Gbps	40Gbps	CERTIFIED USB 40Gbps 240W
Certified USB Type-C 240W Cable *	CERTIFIED USB 240W	240W **	40Gbps 240W **
Certified USB 240W Charging	CERTIFIED USB CHARGER 240W	—	—

The table below shows the changes due to the USB4 Version 2.0 specification announced by the USB-IF on October 18, 2022.

For Packaging	For Cables/USB Port	For Combined Data/Power USB4
CERTIFIED USB 80Gbps	80Gbps	80Gbps 240W

*There are certification logos for USB Type-C 60W cables and USB4 20Gbps solutions.
**For use only on certified USB Type-C cables.

■100W USB Type-C to USB Type-C cables are no longer recommended.

- USB-IF recommends that all 5A cables be 240W compatible and has stopped certification of 100W cables on December 22, 2021.

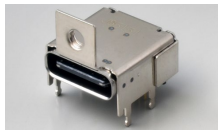
JAE's USB PD EPR Compatible Products

As a global leader in interconnect technology, JAE was an active contributor in the USB-IF working group tasked with creating the new specifications. The following are current compatible JAE products.

Receptacles and Plug Connectors

All products are EPR 240W (5A/48V) compatible.

■ Receptacle connectors
[Being mass-produced]



DX07S024XJ4

DX07S024XA8

DX07S024JAA

DX07B024JAA

DX07BD24JJ4

■ Plug connector
[Being mass-produced]

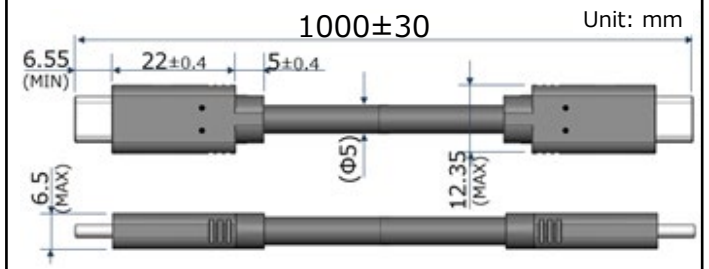
DX07P022FA1

Cable harness

Type-C to Type-C coaxial cable harness (1.0m in length) has acquired USB certification.
(As of the end of June 2022)

■ EPR 240W USB4 Gen 3 compatible cable harnesses

The product has passed certification tests and has acquired a TID number.
Mass production will be considered.

Part Number	DX07881B10******
TID (Certification Number)	**7919**
Cable Length	100cm
Wire Type	Coaxial cable
Rated Current (Maximum Power)	5A maximum (240W)
Mold	TPE (black)
Product Shape Dimensions	

*Product specifications may change.

Related Information

The Latest Information on USB4 Compatible Products are Available from the Following URLs

Page Outline	URL
USB4 On-board Receptacle ・DX07S024XJ4 ・DX07S024XA8 ・DX07S024JAA	https://www.jae.com/en/connectors/series/detail/product/id=66516 https://www.jae.com/en/connectors/series/detail/product/id=96701 https://www.jae.com/en/connectors/series/detail/product/id=95496
USB4 Mid-mount Receptacle ・DX07B024JAA ・DX07BD24JJ4	https://www.jae.com/en/connectors/series/detail/product/id=95495 https://www.jae.com/en/connectors/series/detail/product/id=111874
USB4 Compatible Plug Connector (Golden Plug) ・DX07P022FA1	https://www.jae.com/en/connectors/series/detail/product/id=112712
USB4 Compatible Products Only	https://www.jae.com/en/connector-special/usb4_dx07/
All USB Type-C Compatible Products	https://www.jae.com/en/connector-special/dx07_usb_type-c/
・All Receptacles	https://www.jae.com/en/connectors/series/detail/id=86994
・All Plug Connectors	https://www.jae.com/en/connectors/series/detail/id=86993
・All Cable Harnesses	https://www.jae.com/en/connectors/series/detail/id=86995

Technology to Inspire Innovation

JAE

Please feel free to contact us if you would like to consult with us or have any questions concerning our products.

Contact Us : https://www.jae.com/en/contact/connector_usa/

JAE website : https://www.jae.com/en/