



USB Technology Explained

Amphenol

COMMUNICATIONS SOLUTIONS



USB Implementers Forum, Inc. (USB-IF)

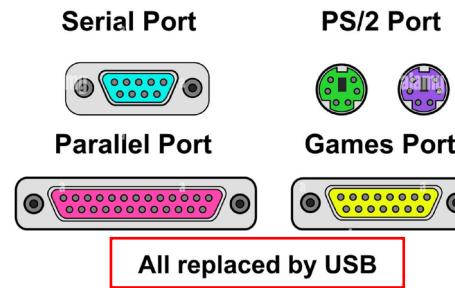
- a non-profit corporation founded by a group of companies (Intel, IBM, HP, Microsoft etc...)
- developed the Universal Serial Bus specification in 1996



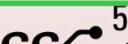
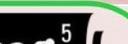
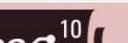
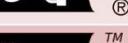
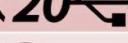
USB Was Designed To Standardize The Connection Of Computer Peripherals

- Replaced Serial and Parallel Ports
- Eliminated The Need For Separate Power Supplies For Devices
- Allows For “Hot Swapping”
- Connect Up To 127 “Devices”
- Allows The Flow Of Information Into AND Out Of A Computer (Host)

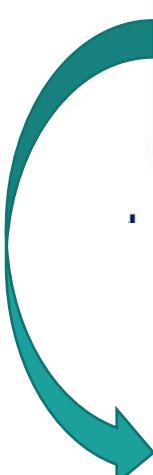
USB
Enabling Connections™



USB Specification Road map

Revision	Issue Date	Brand Name	Bits/sec	Package Logo	Port & Cable Logo	USB-C® Trident Charging Logo
USB 1.0	Jan 1996	Low Speed Full Speed	1.5 Mbps 12 Mbps	CERTIFIED USB		
USB 1.1	Aug 1998	Full Speed With updated	1.5 Mbps 12 Mbps	CERTIFIED USB		
USB 2.0	April 2000	High Speed	480 Mbps	HI-SPEED CERTIFIED USB		
USB 3.0 USB 3.2 Gen 1x1	Nov 12, 2008	SuperSpeed USB 5Gbps	5 Gbps	SUPERSPEED CERTIFIED USB 5 Gbps	 5	 5
USB 3.1 USB 3.2 Gen 2x1	July 26, 2013	SuperSpeed USB 10Gbps	10 Gbps	SUPERSPEED+ CERTIFIED USB 10 Gbps	 10	 10
USB 3.2 USB 3.2 Gen 2x2	Sep 22, 2017	SuperSpeed USB 20Gbps	20 Gbps	SUPERSPEED+ CERTIFIED USB 20 Gbps	 20	 20
USB4 USB4 Gen 2x2	Sep 3, 2019	USB4™ 20Gbps	20 Gbps	CERTIFIED USB20 Gbps	 20™	 20™
USB4 USB4 Gen 3x2	Sep 3, 2019	USB4™ 40Gbps	40 Gbps	CERTIFIED USB40 Gbps	 40™	 40™

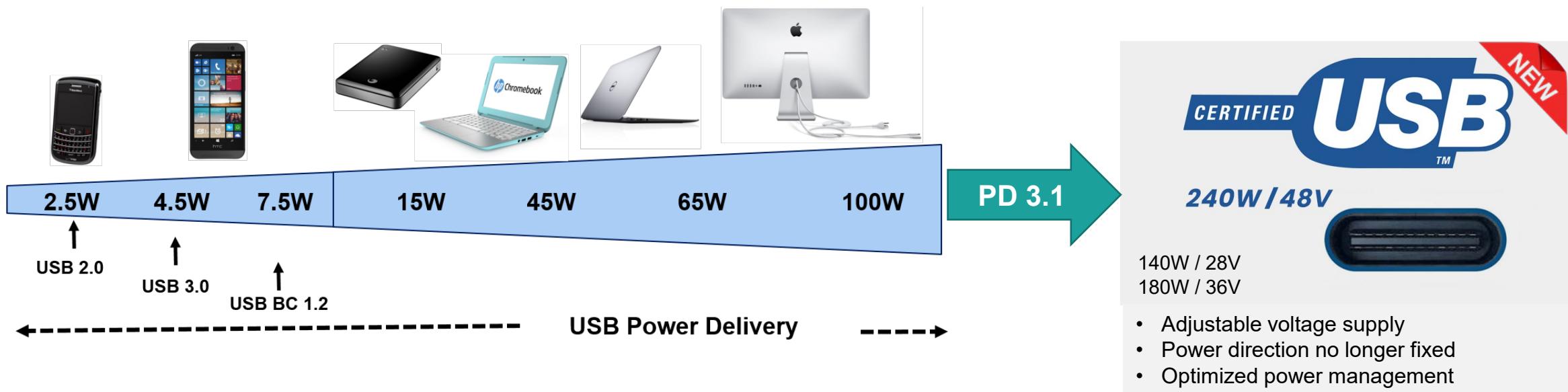
USB 3.x was re-named twice



Original Name	1st time re-name when USB 3.1 (10Gbps) was published	2nd time re-name when USB 3.2 20Gbps was published	Data Speed
USB 3.0	USB 3.1 Gen1	USB 3.2 Gen1	5Gbps
USB 3.1	USB 3.1 Gen2	USB 3.2 Gen2	10Gbps
USB 3.2	USB 3.1 Gen2x2	USB 3.2 Gen2x2	20Gbps

USB has evolved from a data interface capable of supplying limited power to a primary provider of power with a data interface

USB power standards			
Specification	Current	Voltage	Power (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
Multi-lane SuperSpeed (USB 3.2 Gen x2) device	1.5 A ^[c]	5 V	7.5 W
Battery Charging (BC) 1.2	1.5 A	5 V	7.5 W
USB-C	1.5 A	5 V	7.5 W
	3 A	5 V	15 W
Power Delivery 1.0/2.0/3.0 Type-C	5 A ^[d]	20 V	100 W
Power Delivery 3.1 Type-C	5 A ^[d]	48 V ^[e]	240 W



Packaging Logo



Port Logo



USB Type-C® Cable Logos*



packaging, port and cable logo's.....

- **In October 2022**, USB-IF released the USB4® Version 2.0 specification, a major update to enable up to 80 Gbps of data performance over the USB Type-C® cable and connector
- Key characteristics of the updated USB4 solution include:
 - a new physical layer architecture
 - using existing 40 Gbps USB Type-C passive cables and newly-defined 80 Gbps USB Type-C active cables
 - Updates to data and display protocols to better use the increase in available bandwidth
 - USB data architecture updates now enable USB tunneling to exceed 20 Gbps.
 - Updated to align with the latest versions of the DisplayPort and PCIe specifications
 - Backward compatibility with USB4 Version 1.0, USB 3.2, USB 2.0 and Thunderbolt™ 3.

USB Interface and Data Speed Evolution (and re-naming)

USB 1.0

USB 2.0

USB 3.0

3.1 Gen1
3.2 Gen2

USB 3.1

3.2 Gen1
3.2 Gen2

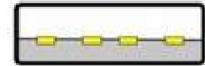
USB 3.2

3.2 Gen 2x2

USB 4

USB 4

USB 4



Type A



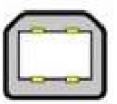
Type B



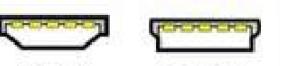
Mini-A



Type A



Type B



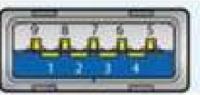
Mini-A

Mini-B



Micro-A

Micro-B



Type A



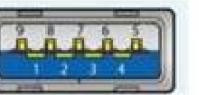
Type B



Mini-B



Micro-B



Type A



Type C



Type B



Type C



Type C



Type C



Type C

12Mbp/s

480Mbp/s

5Gbp/s

10Gbp/s

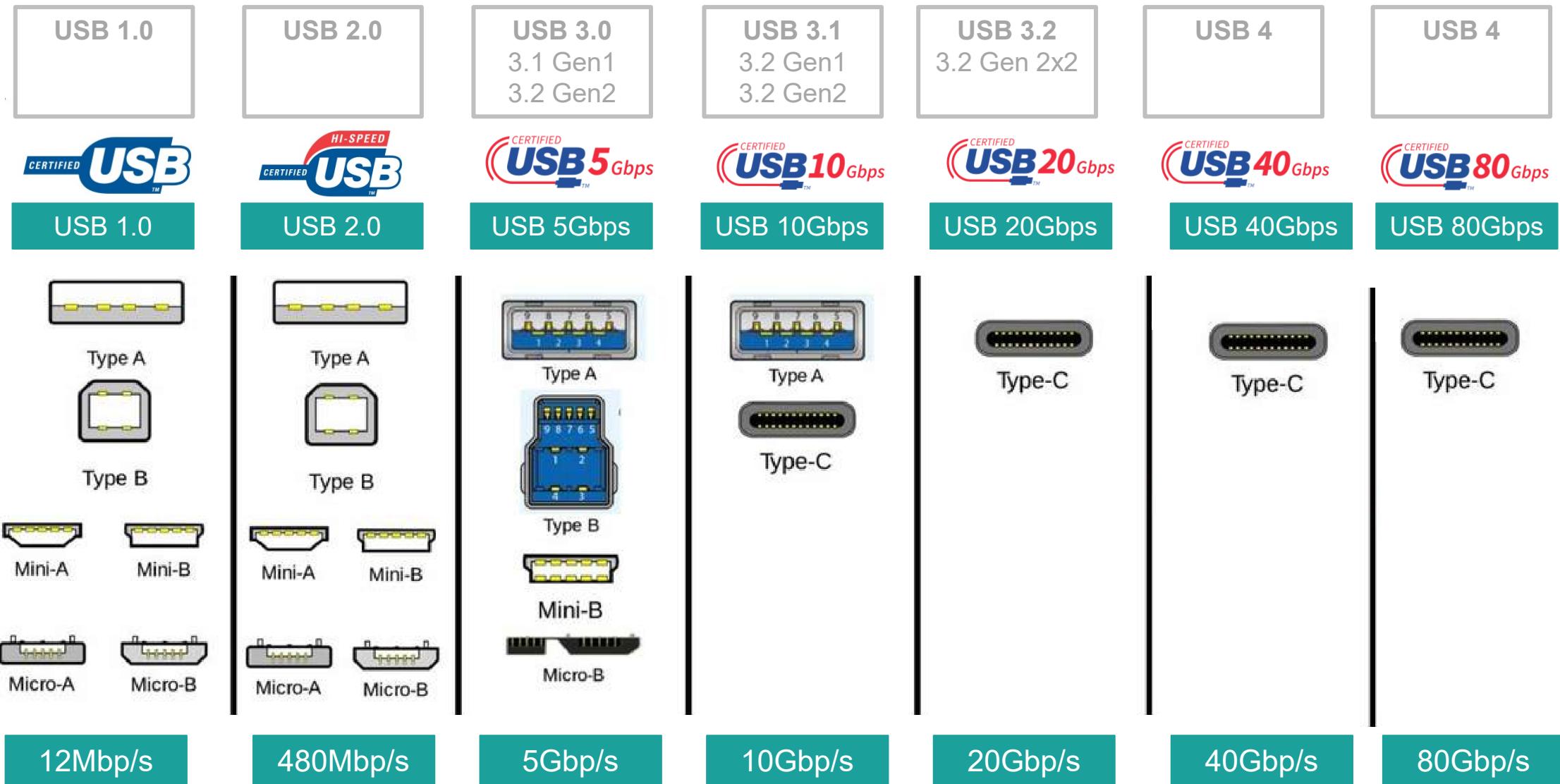
20Gbp/s

20Gbp/s

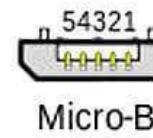
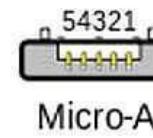
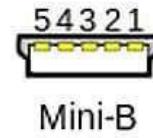
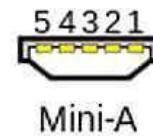
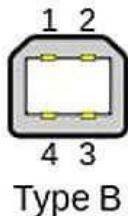
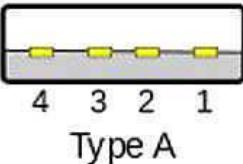
40Gbp/s

80Gbp/s

USB Interface and Data Speed Evolution (and re-naming)



USB 2.0 series



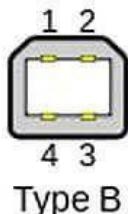
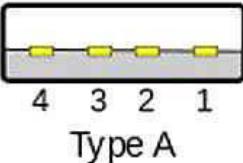
Pin#	Signal name
1	VBUS
2	D-
3	D+
4	GND

Pin#	Signal name
1	GND
2	USB OTG Address bus
3	D+
4	D-
5	VBUS

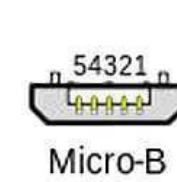
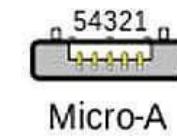
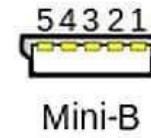
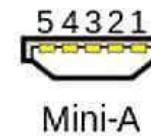


USB On The Go

USB 2.0 series

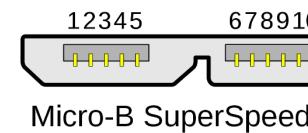
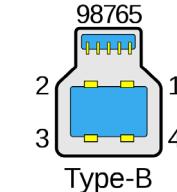
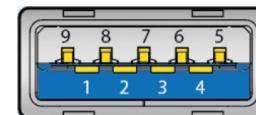


Pin#	Signal name
1	VBUS
2	D-
3	D+
4	GND



Pin#	Signal name
1	GND
2	USB OTG Address bus
3	D+
4	D-
5	VBUS

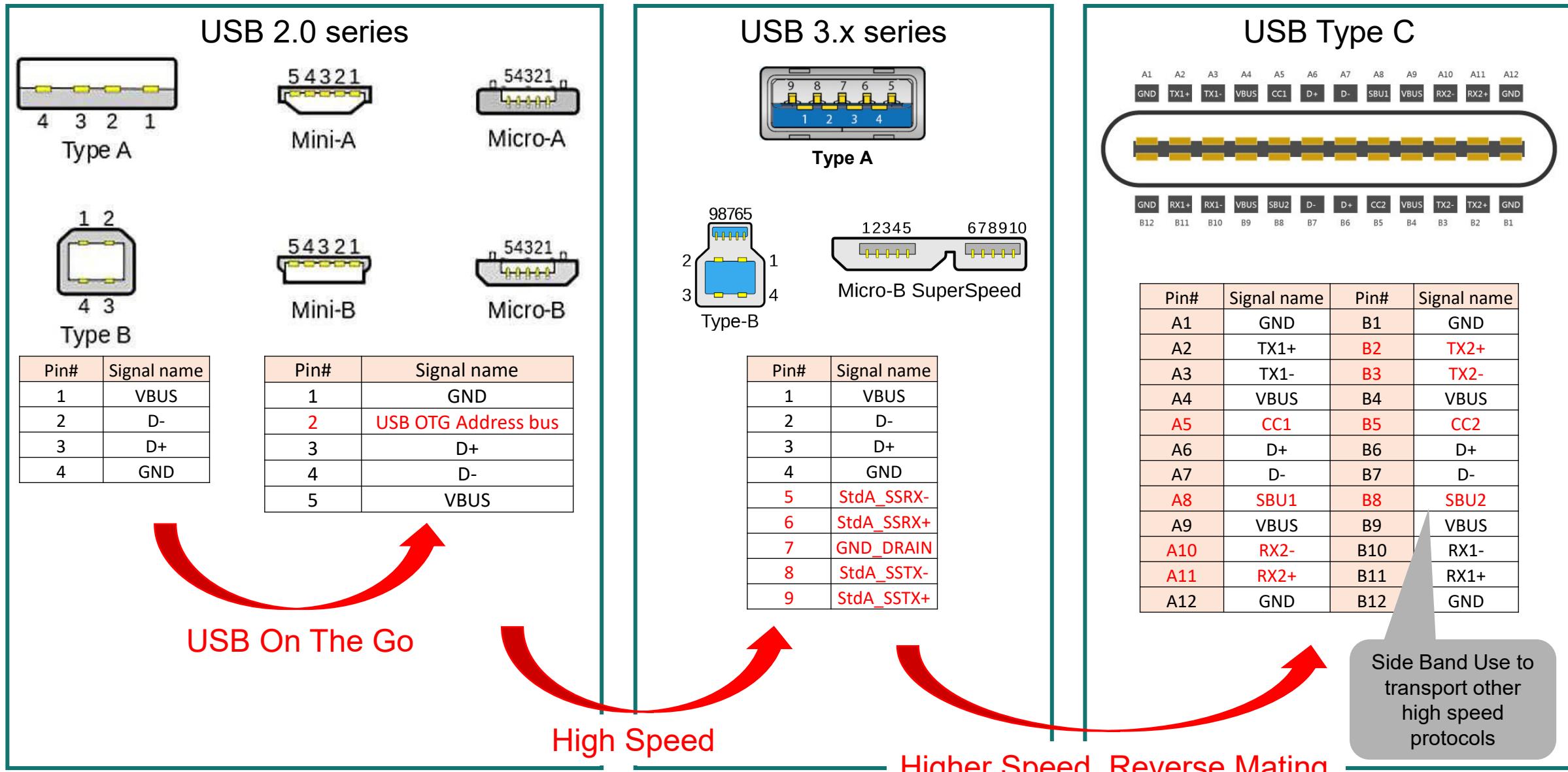
USB 5Gbps series

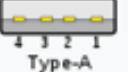
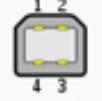
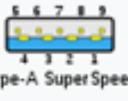
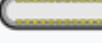
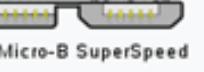
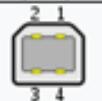
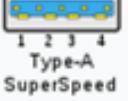
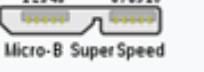


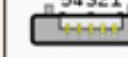
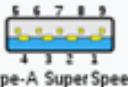
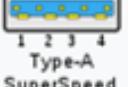
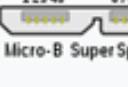
Pin#	Signal name
1	VBUS
2	D-
3	D+
4	GND
5	StdA_SSRX-
6	StdA_SSRX+
7	GND_DRAIN
8	StdA_SSTX-
9	StdA_SSTX+

USB On The Go

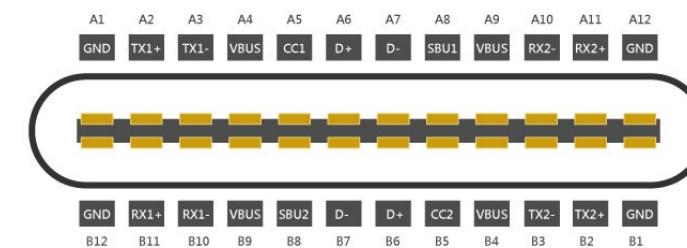
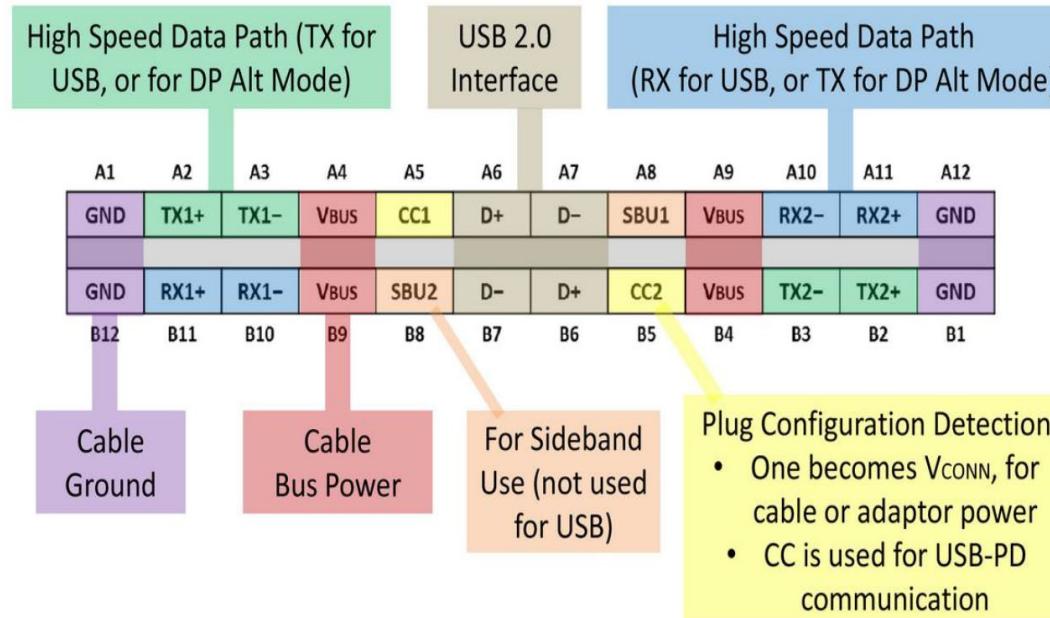
High Speed



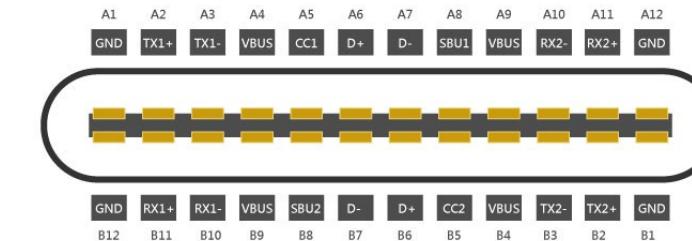
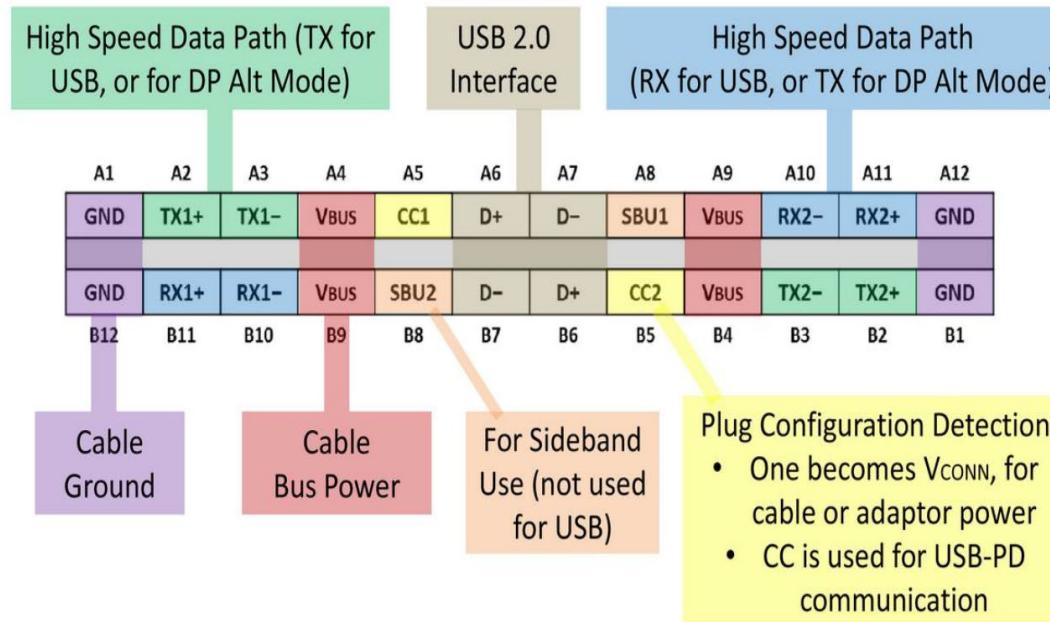
Revision		Type-A	Type-B	Type-C	Mini-A	Mini-B	Mini-AB	Micro-A	Micro-B	Micro-AB
Plug	2	 4 3 2 1 Type-A	 1 2 4 3 Type-B	Not existed	 54321 Mini-A	 54321 Mini-B	Not existed	 54321 Micro-A	 54321 Micro-B	Not existed
	3.2	 5 6 7 8 9 Type-A SuperSpeed	 1 2 4 3 5 6 7 8 9 Type-B SuperSpeed			Deprecated	Deprecated	Deprecated	 10 98 76 54321 Micro-B SuperSpeed	Deprecated
Receptacle	2	 1 2 3 4 Type-A	 2 1 3 4 Type-B	Not existed	 12345 Mini-A	 12345 Mini-B	 12345 Mini-AB	Not existed	 12345 Micro-B	 12 345 Micro-AB
	3.2	 9 8 7 6 5 Type-A SuperSpeed	 2 1 3 4 9 8 7 6 5 Type-B SuperSpeed		Deprecated	Deprecated	Deprecated		 12345 678910 Micro-B SuperSpeed	Deprecated
Application		PC	Scanner Printer	Laptop PC tablet	Portable Device		Universal interface for microA,& B only	Cell phone Tablet		Universal interface for microA,& B only

Revision		Type-A	Type-B	Type-C	Mini-A	Mini-B	Mini-AB	Micro-A	Micro-B	Micro-AB		
Plug	2	 4 3 2 1 Type-A	 1 2 4 3 Type-B	Not existed	 54321 Mini-A	 54321 Mini-B	Not existed	 54321 Micro-A	 54321 Micro-B	Not existed		
	3.2	 5 6 7 8 9 Type-A SuperSpeed	 1 2 4 3 Type-B SuperSpeed		Deprecated	Deprecated		Deprecated	 10 9876 54321 Micro-B SuperSpeed	Deprecated		
Receptacle	2	 1 2 3 4 Type-A	 2 1 3 4 Type-B	Not existed	 12345 Mini-A	 12345 Mini-B	 12345 Mini-AB	Not existed	 12345 Micro-B	 12345 Micro-AB		
	3.2	 9 8 7 6 5 Type-A SuperSpeed	 2 1 3 4 Type-B SuperSpeed		Deprecated	Deprecated	Deprecated		 12345 678910 Micro-B SuperSpeed	Deprecated		
Application		PC	Scanner Printer	Laptop PC tablet	Portable Device		Universal interface for microA,& B only	Cell phone Tablet	Universal interface for microA,& B only			
					mature			growth				
					decline			mature				
					decline							

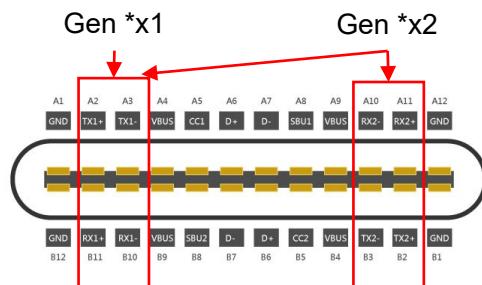
USB Type C Pinout



USB Type C Pinout – 4 Main Versions

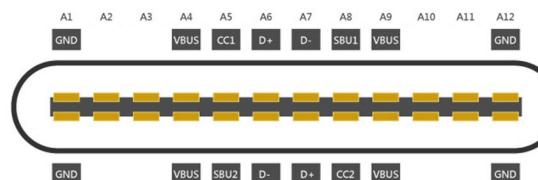


24 positions



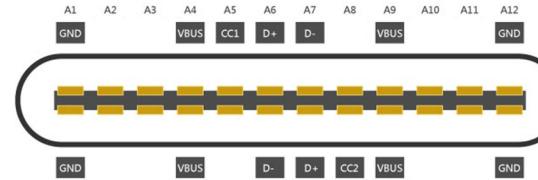
USB 80Gb/s
Full capability of USB-C

16 positions



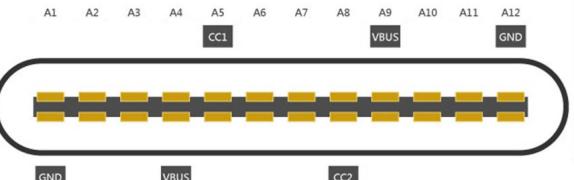
USB 2.0
4 pairs of high speed differential signal pins removed

14 positions



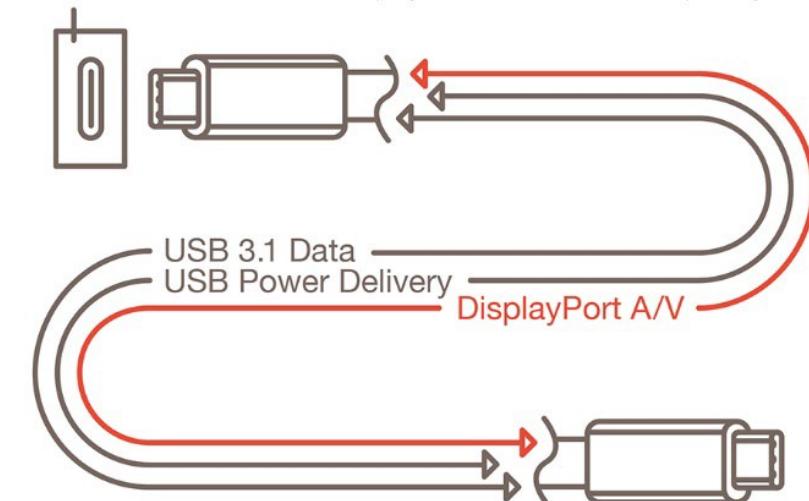
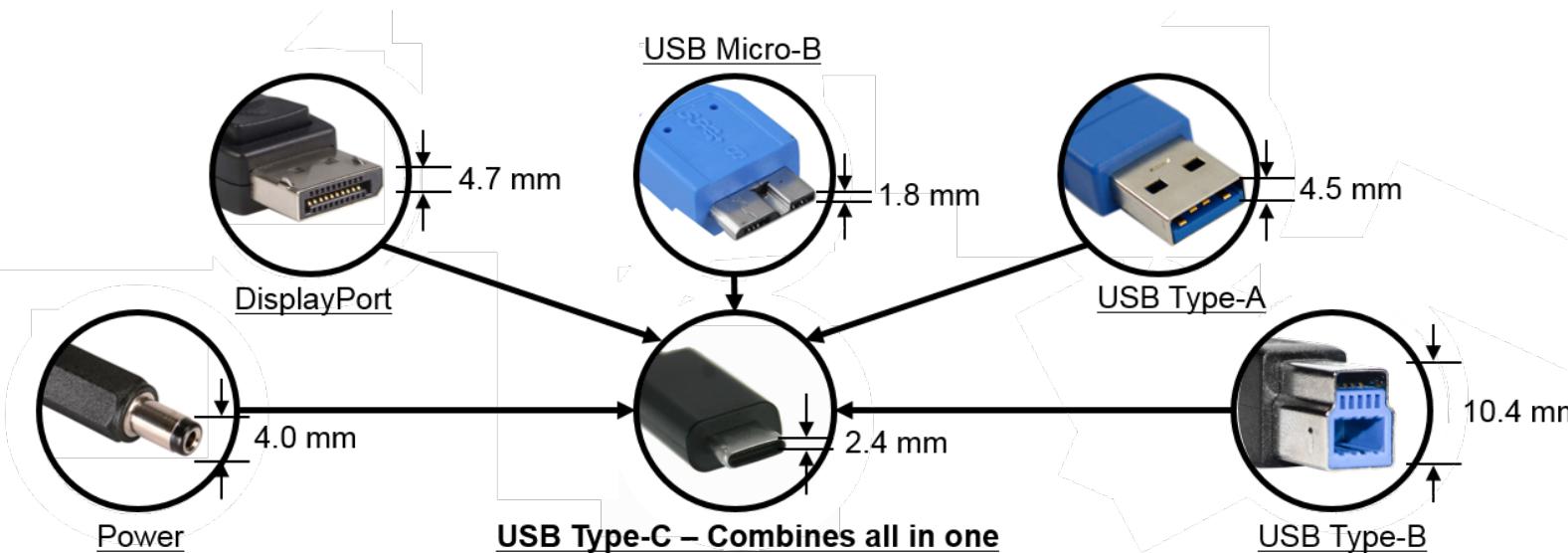
USB 2.0
If alternate mode is not needed

6 positions

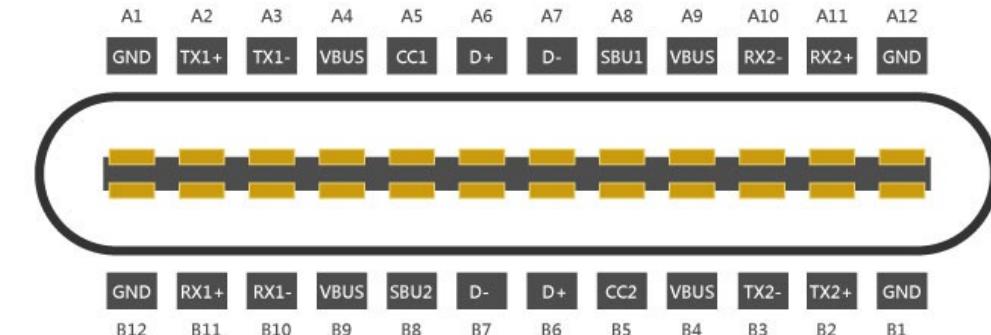


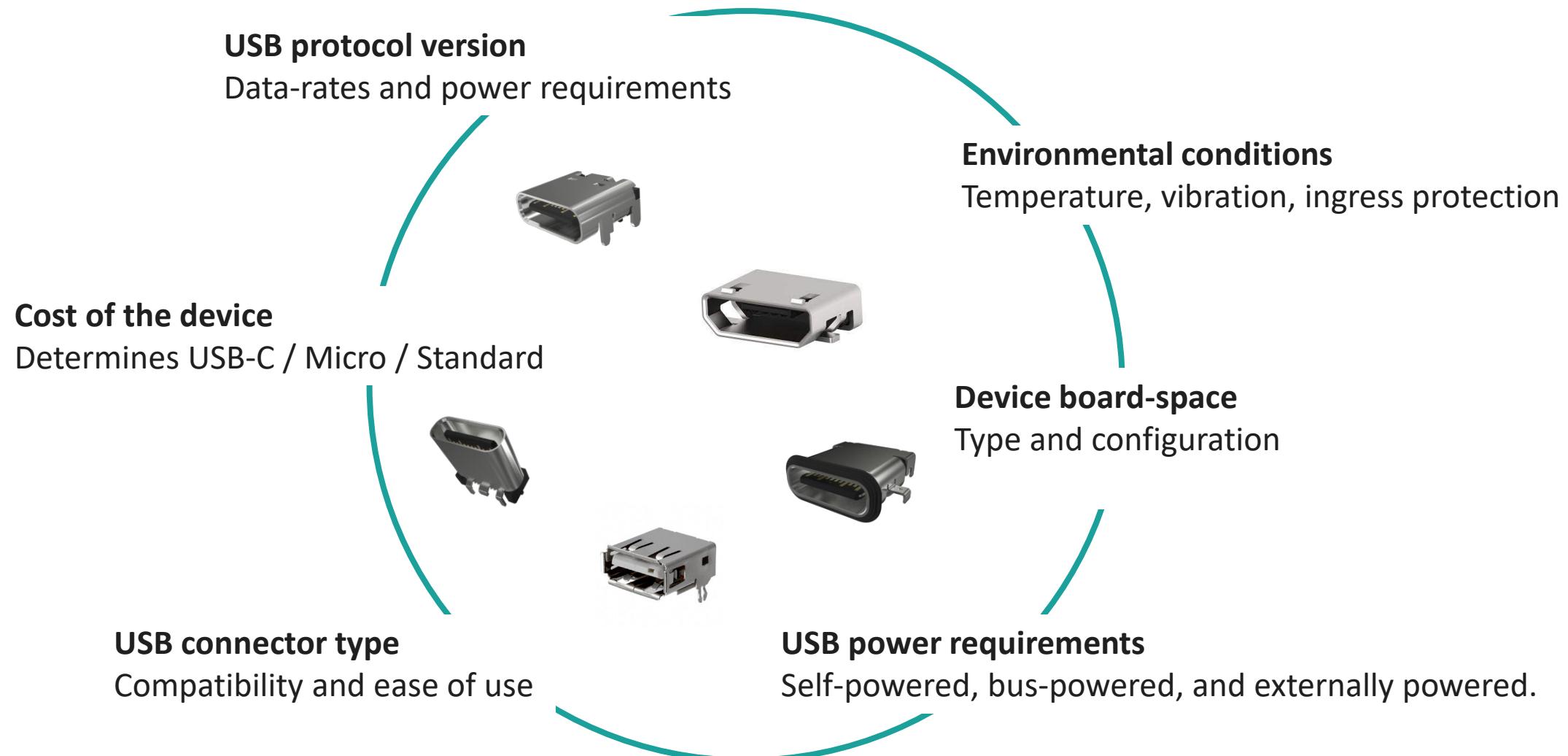
Charging only
No data transmission

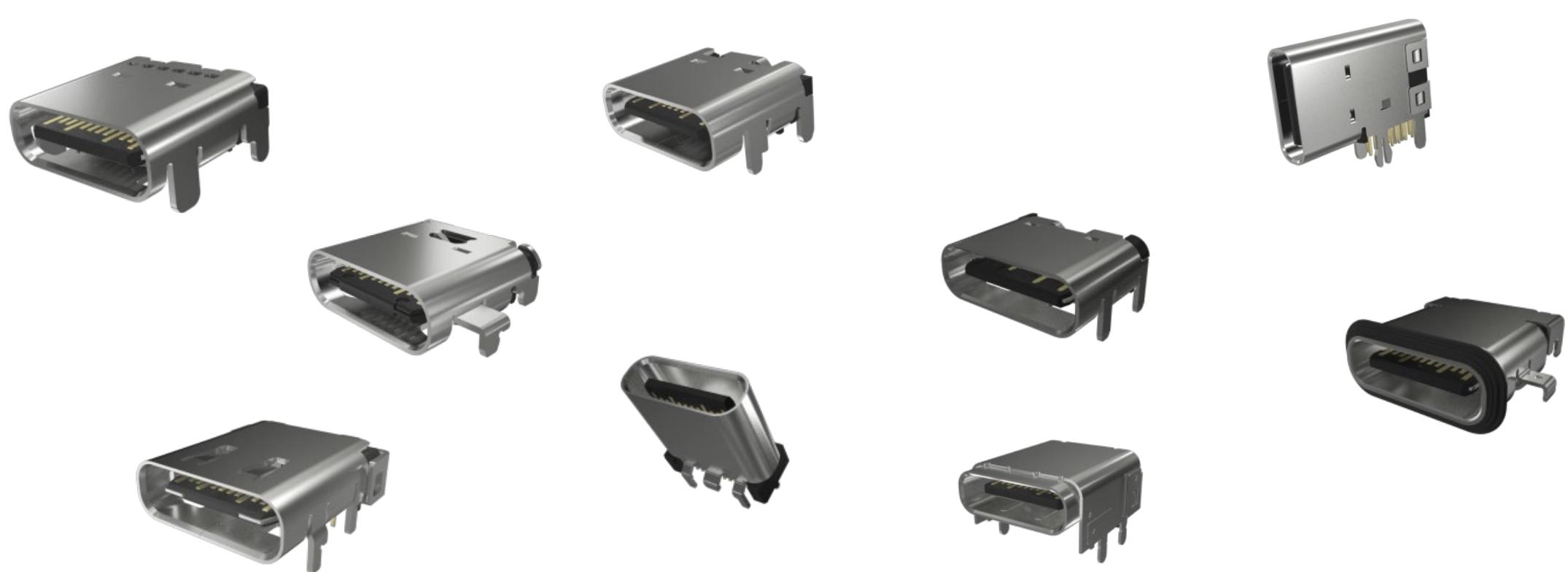
USB C Advantages



- Blind mate / reverse mate
- Up to 5A current rating, support 240W max power delivery
- Data transmission up to 80Gbps.
- Charging interface for various electric products via PD protocol
- Enhanced anti-EMI and RFI mitigation performance
- Optional integrated DisplayPort, HDMI (side band)







.... come in various shapes and configurations...

Features and Benefits of USB Type C - Right Angle

Support 5.0A/100W power delivery and up to 20 Gbps data rates

Enables fast charging and high-speed data transfer

Spring shell friction design

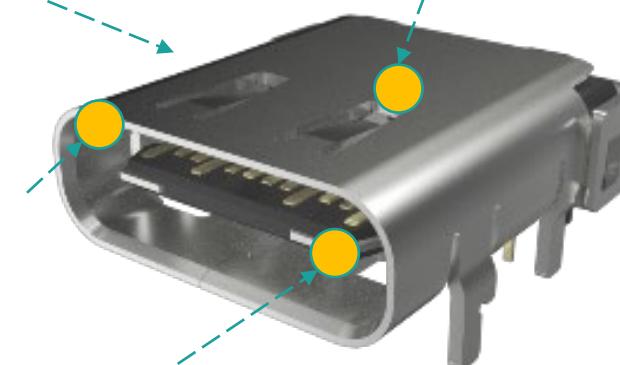
Provides higher un-mating force to prevent unintentional cable release

Soldering pins Hybrid

- Provides higher retention force
- Enables easy inspecting
- Eases supplementary soldering on SMT pins

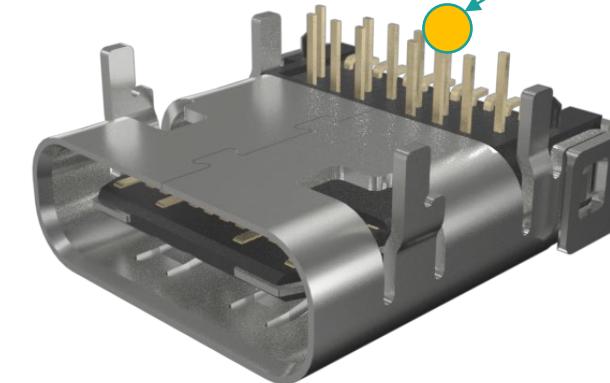
Metal shell

Provides robustness to the connector and better EMI shielding performance



Mid-plate design enhance the tongue strength

Supporting high reliability of 10,000 mating cycles and preventing damage from connector mishandling



Middle mount design

Offers mechanical design flexibility



High rise design (Dual shell)

Provides higher center height 3.4mm (normal type is 1.68mm) to align with other I/O connectors

Vertical type

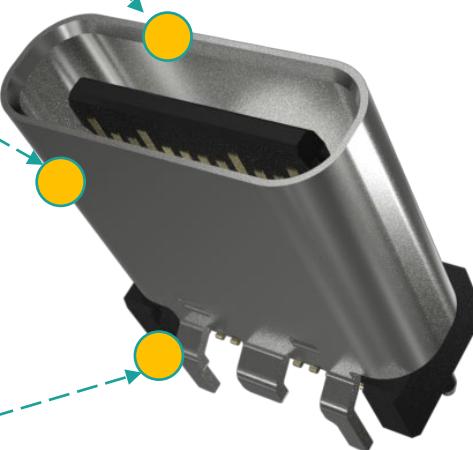
Offers mechanical design flexibility

Upright type

Offers mechanical design flexibility

Flexible height design

Two height options of 9.25&10.4mm to provide customer mechanical design flexibility



Plastic housing holder and shell stopper

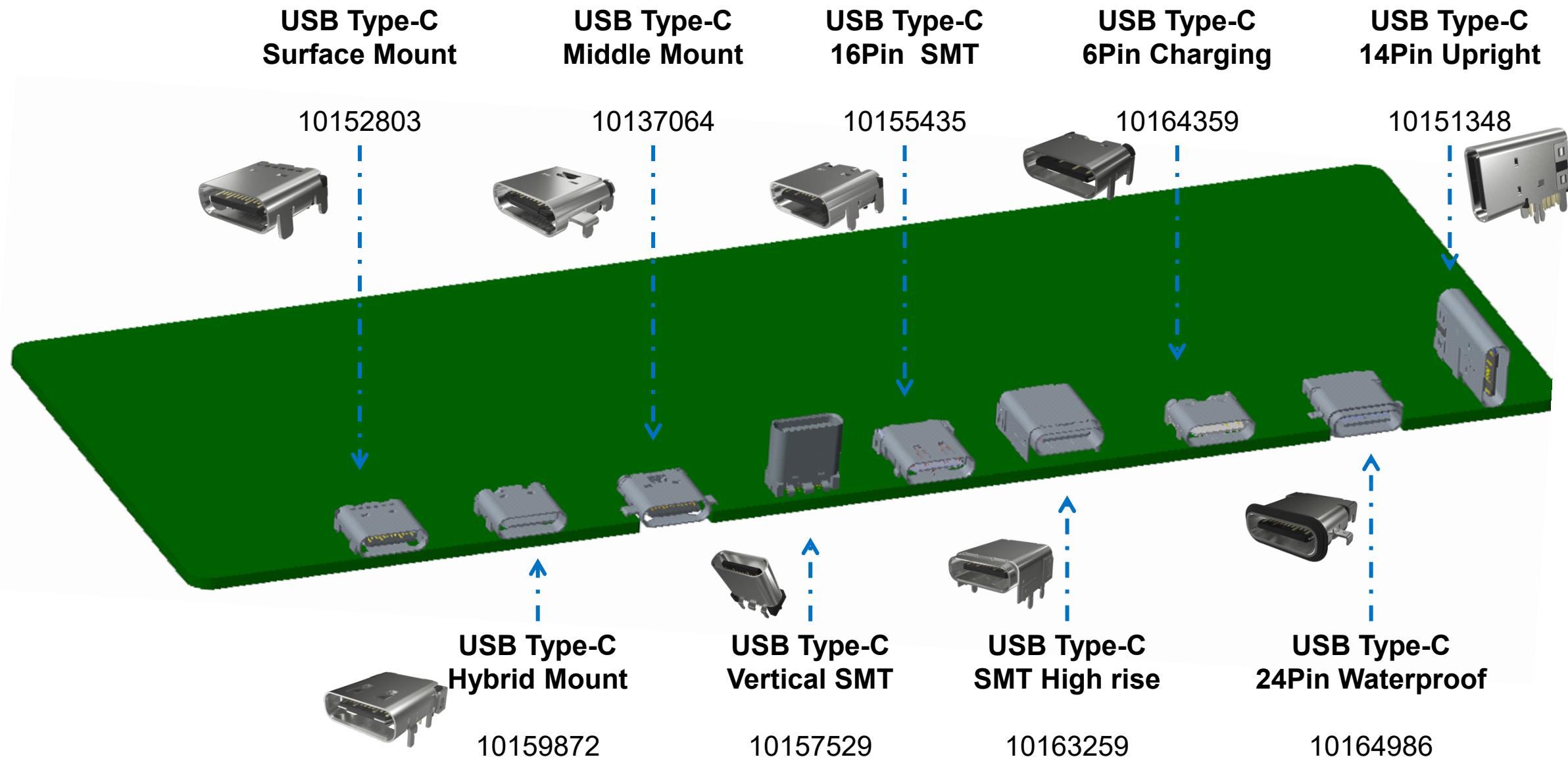
Provide robust design to prevent plug over insertion

Shell peg hook design

Provides retention force during soldering process to avoid uplift

Silicon molded seal ring

Excellent temperature resistance and protection against dust and water ingress (IP67)



USB Type-C Cable Typical product and application

USB 2.0 Type A to C

< 15W Power charging &
480Mbps data transmission



USB3.2 Type C to C

< 100W PD fast charging &
<20Gbps data transmission



USB4/Thunderbolt Type C to C

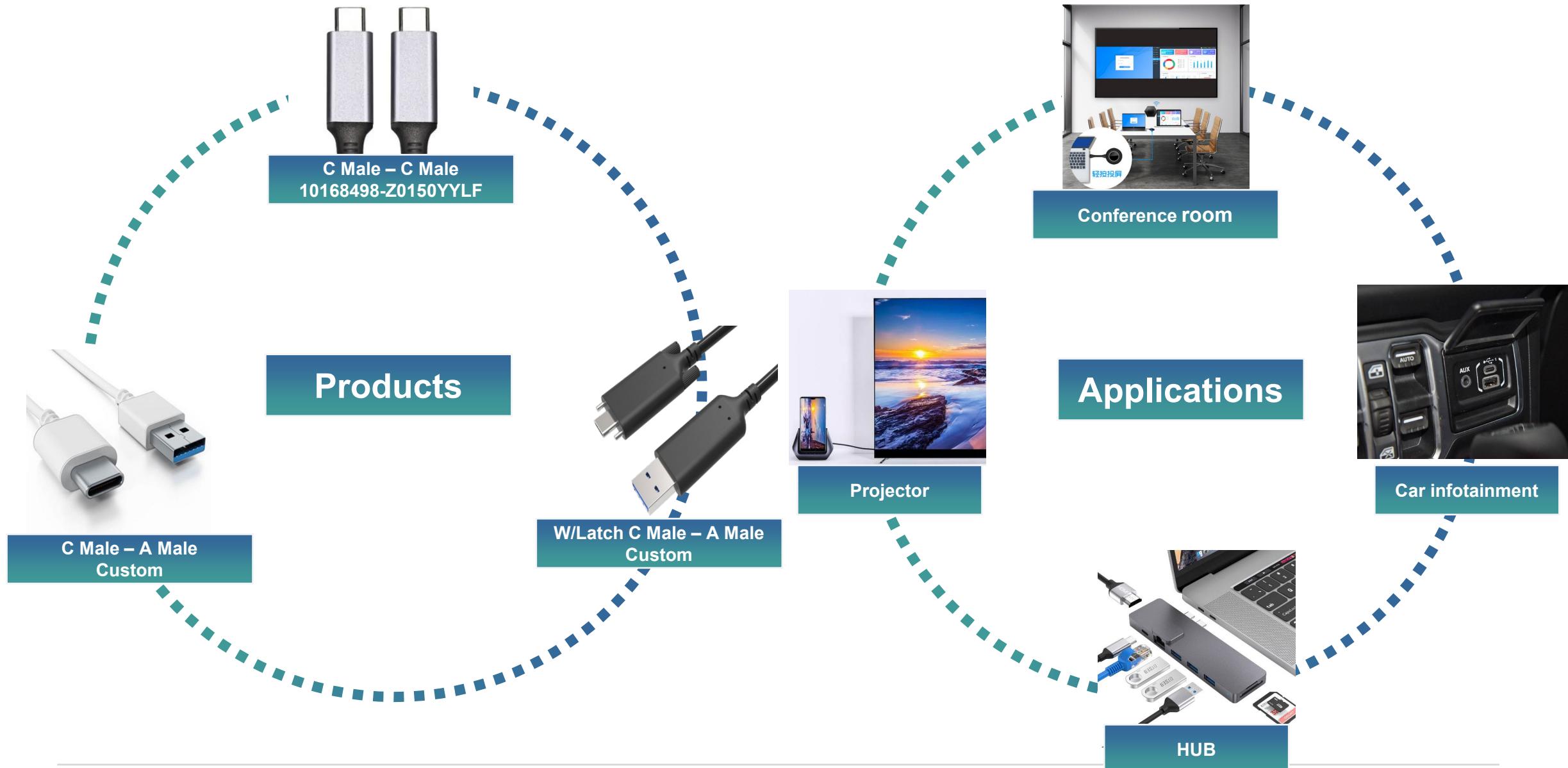
Up to 240W PD fast charging &
Up to 40Gbps data transmission

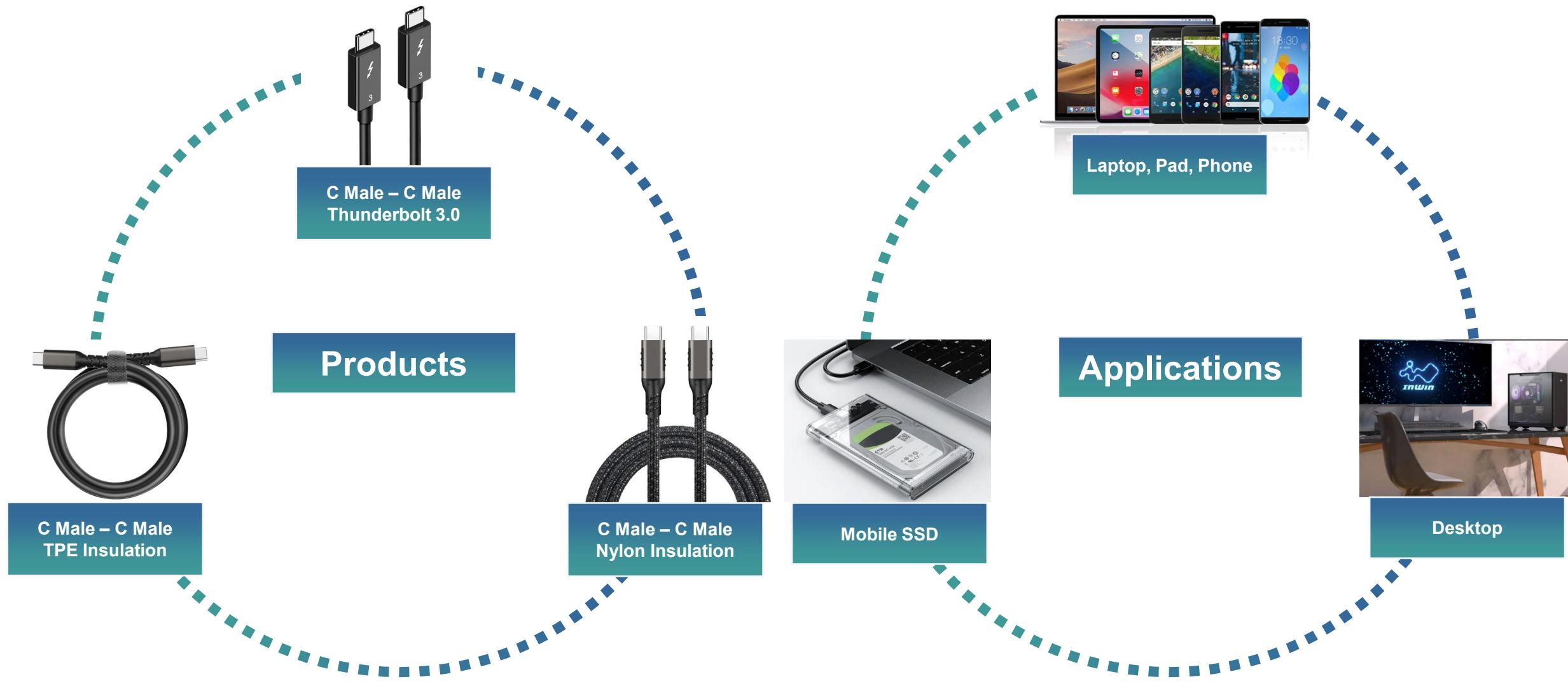


Product and Application - USB 2.0 A to C for Consumer



Product and application – USB 3.2 Gen 1 & 2 5G/10Gbps





Target Applications: Ruggedized Handhelds



Computing



Measurement



Point of Sale



Medical



interface cables



charging cables



Don't forget the cables!!!



Smart Home



AV/VR devices



Drones

.... ANY smaller electronic device requiring a power and/or data connection!!



MOUSER
ELECTRONICS

[More USB Type C info can be found at Mouser's website!](#)

Thank You

Amphenol
COMMUNICATIONS SOLUTIONS