

USB Type-C® Connectors

Essential Knowledge Guide #1



How to specify an appropriately featured and priced USB Type-C® connector for your application





Over 30 years of innovation in connectivity

As a member of the Aloco Group, GCT is an established manufacturer of world class connector and cable assembly solutions.

Companies the world over trust our extensive range of solutions to enable connectivity within their designs. Our drive for product innovation has helped our customers stay at the forefront of their industries.

www.gct.co

Universal Serial Bus

Designed as a universal connection for computer peripherals back in the 1990s, the Universal Serial Bus (USB) promised a user friendly, hot pluggable, self-configuring standard to replace a growing list of proprietary solutions.

In the intervening years, however, there have been more than a dozen different plug configurations - to accommodate varying power and data requirements - so it could be argued that the 'universal' element of the name hasn't exactly held true.

The good news is that the latest version has been designed to satisfy the vast majority of user needs in a single, plug/socket configuration – the USB Type-C.

Not only is it faster and more powerful, it is also fully reversible so it can't be plugged in the wrong way, like previous versions. Without doubt this makes it much more user-friendly and better for users but, in its fully-featured 24 pin versions, it can be over engineered for many applications.

The aim of this guide is to help provide the essential knowledge that can help you select a USB Type-C that is best suited to your application in terms functionality and, just as importantly, price point.

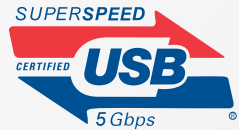


USB Type-C® Evolution

First proposed in 2013, USB Type-C® was developed to be compact, reversible and deliver significant increases in data speed and power delivery.

The original specification delivered speeds of 5Gbps with the Gen2 rated at 10Gbps. The latest version for fully specified USB Type-C at 10Mbps is USB3.2

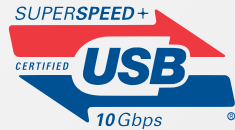
Gen2 delivering performance that allows download of a 4K movie in around 16 seconds compared to over 5 minutes via USB2.0.



USB3.2 Gen 1

Power (max.)	100W
Current (max.)	5A
Voltage (max.)	20V
Data speed (max.)	5Gbps

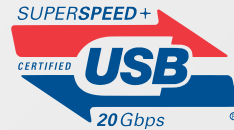
2013



USB3.2 Gen 2

Power (max.)	100W
Current (max.)	5A
Voltage (max.)	20V
Data speed (max.)	10Gbps

2017



USB3.2 Gen 2x2

Power (max.)	100W
Current (max.)	5A
Voltage (max.)	20V
Data speed (max.)	20Gbps



USB4

Power (max.)	240W
Current (max.)	5A
Voltage (max.)	48V
Data speed (max.)	20Gbps

2019



USB4

Power (max.)	240W
Current (max.)	5A
Voltage (max.)	48V
Data speed (max.)	40Gbps

Do you need all that speed and all that power?

If you do, then USB Type-C® in 24-pin format is ideal for you, and GCT has many options for you to choose from. If you don't, then there are further options you should consider.

GCT has developed two ranges of connectors with reduced functionality for applications that require USB2.0

specification (16 pin) or I/O charging only (6 pin) while still offering the benefits of the USB Type-C® format.

These ranges have been developed specifically to reduce the unit price for customers who want the features of USB Type-C® but don't need - and don't want to pay for - all the features.

pin_{power only}

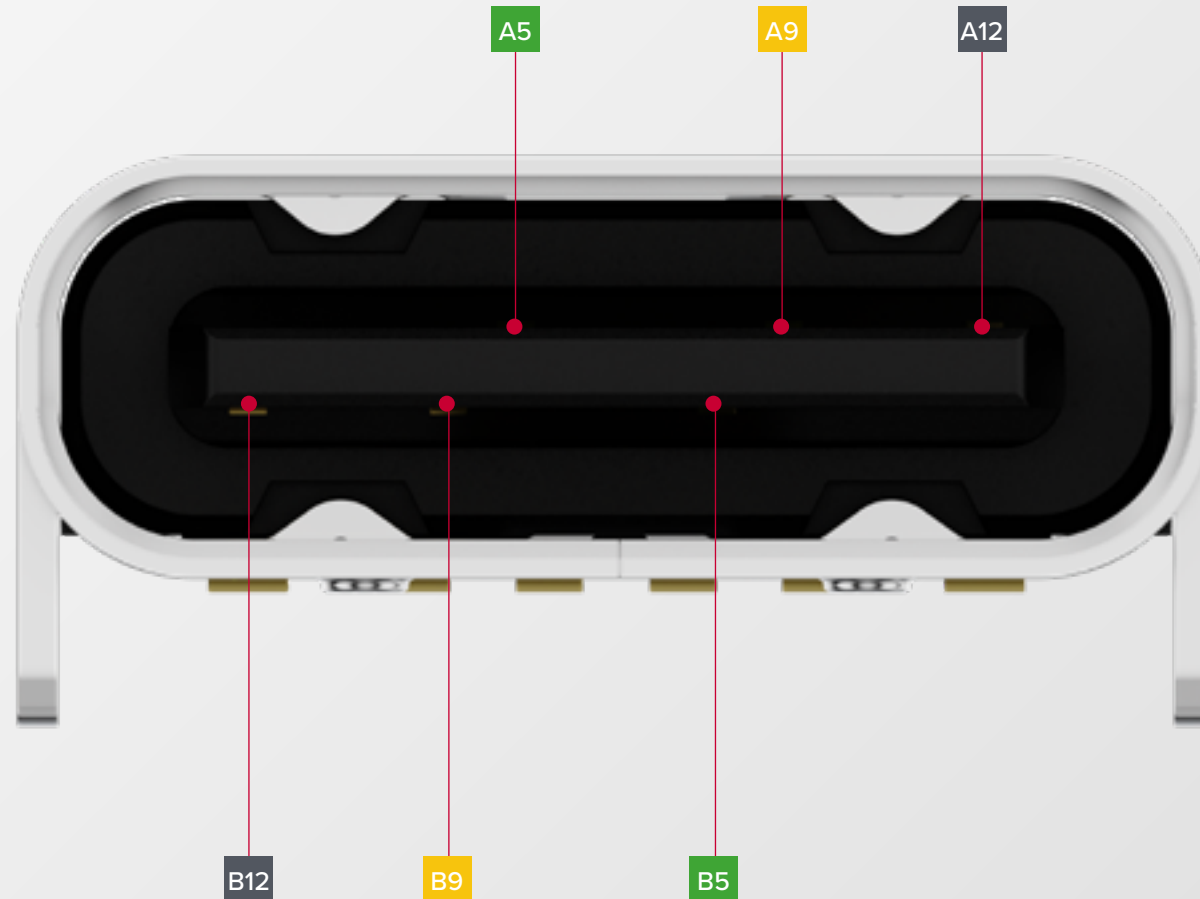
Series developed for applications requiring charging only. The lowest cost USB Type-C format connector. Ideal replacement for applications currently using micro-USB or DC sockets.



Rated at up to 60W (3A @ 20V max)

6pin

Pin	Signal	Mating Sequence
-	-	-
-	-	-
-	-	-
-	-	-
A5	CC1	Second
-	-	-
-	-	-
-	-	-
A9	VBUS	First
-	-	-
-	-	-
A12	GND	First
SHELL	GROUND	



Pin	Signal	Mating Sequence
B12	GND	First
-	-	-
-	-	-
B9	VBUS	First
-	-	-
-	-	-
-	-	-
B5	CC2	Second
-	-	-
-	-	-
-	-	-
-	-	-
SHELL	GROUND	

- Ground
- Configuration channels
- Bus Power

Reversible and fully compatible with all USB Type-C cable assemblies

pin

power and data

Series developed for applications requiring USB2.0 specification.

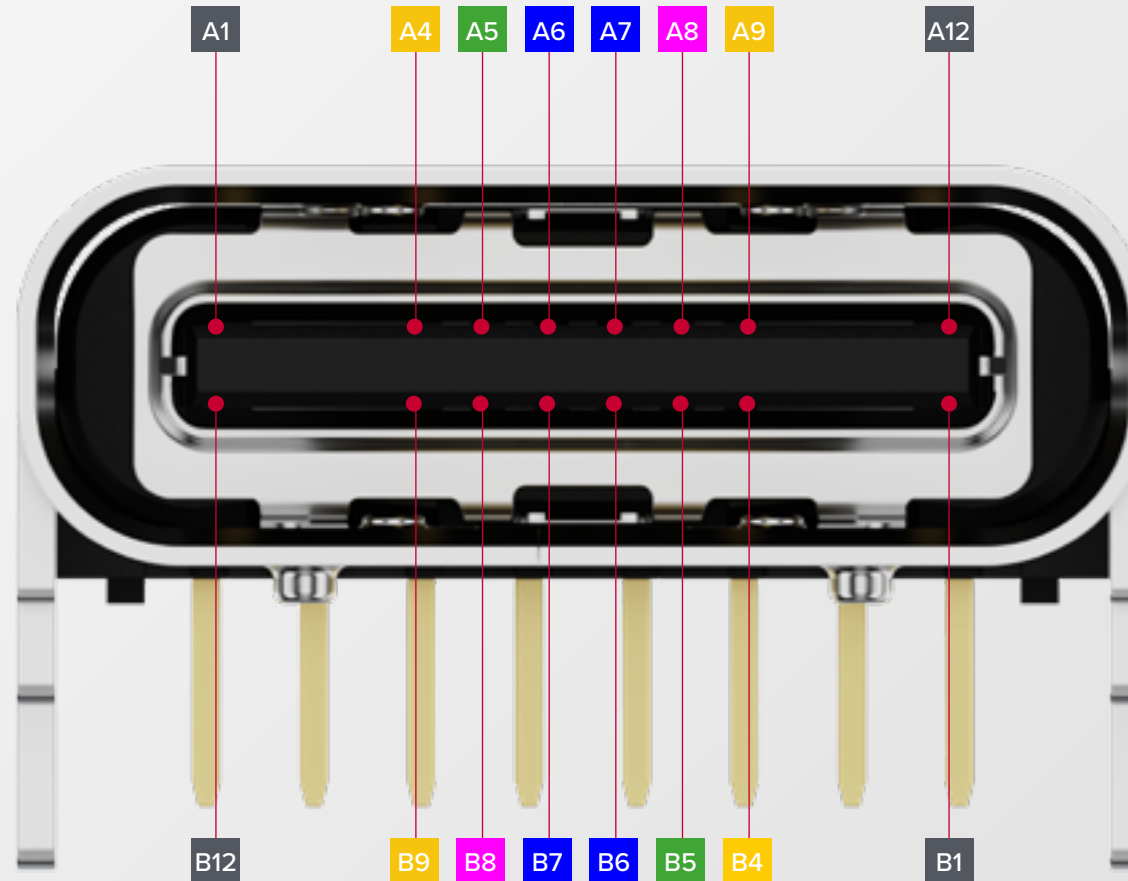
Value engineered against 24 pin. Ideal replacement for applications currently using micro-USB connectors.



Rated at up to 100W (5A @ 20V max)

16pin

Pin	Signal	Mating Sequence
A1	GND	First
-	-	-
-	-	-
A4	VBUS	First
A5	CC1	Second
A6	Dp1	Second
A7	Dn1	Second
A8	SBU1	Second
A9	VBUS	First
-	-	-
-	-	-
A12	GND	First
SHELL GROUND		



Pin	Signal	Mating Sequence
B12	GND	First
-	-	-
-	-	-
B9	VBUS	First
B8	SBU2	Second
B7	Dn2	Second
B6	Dp2	Second
B5	CC2	Second
B4	VBUS	First
-	-	-
-	-	-
B1	GND	First
SHELL GROUND		

- Ground
- Configuration channels
- Sideband Use
- USB 2.0 differential pairs
- Bus Power

Reversible and fully compatible with all USB Type-C cable assemblies

pin

power and data+

Series developed for applications requiring USB3.2 Gen2.

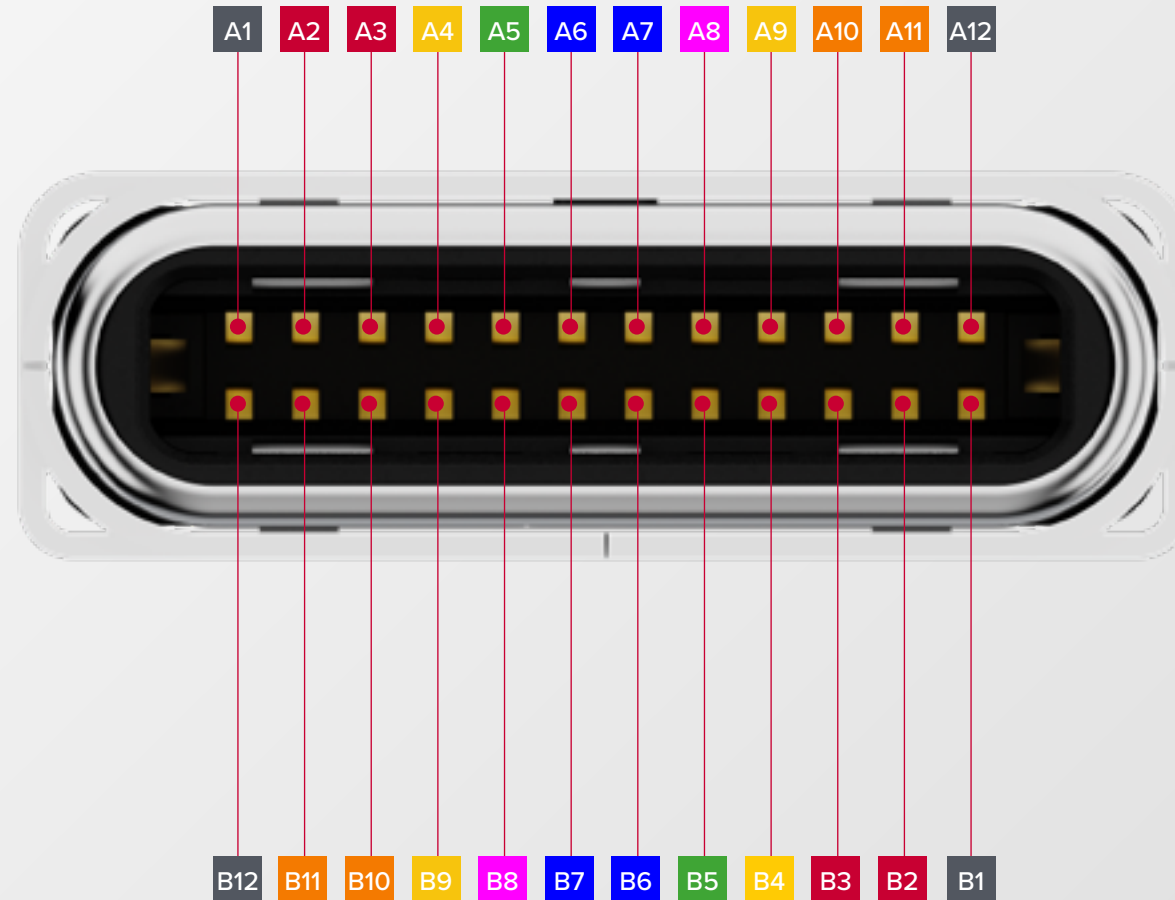
Ideal connector for applications requiring very high data and power rates.



Rated at up to 100W (5A @ 20V max)

24pin

Pin	Signal	Mating Sequence
A1	GND	First
A2	TXp1	Second
A3	TXn1	Second
A4	VBUS	First
A5	CC1	Second
A6	Dp1	Second
A7	Dn1	Second
A8	SBU1	Second
A9	VBUS	First
A10	RXn2	Second
A11	RXp2	Second
A12	GND	First
SHELL GROUND		



Pin	Signal	Mating Sequence
B12	GND	First
B11	RXp1	Second
B10	RXn1	Second
B9	VBUS	First
B8	SBU2	Second
B7	Dn2	Second
B6	Dp2	Second
B5	CC2	Second
B4	VBUS	First
B3	TXn2	Second
B2	TXp2	Second
B1	GND	First
SHELL GROUND		

- Ground
- High speed data path 1
- Configuration channels
- Sideband Use
- USB 2.0 differential pairs
- Bus Power
- High speed data path 2

Reversible and fully compatible with all USB Type-C cable assemblies

Orientation, gender and PCB position

PCB Mount Position



Mid mount

This is where the connector sits in a cut out in the PCB. The advantage of this mounting style is a reduced profile.



Top mount

This is where the component sits on the surface of the PCB.



Edge mount

This is where the connector is fitted to the edge of the PCB. Edge mount connectors are often also mid mount.

Orientation



Vertical

Part is placed on the PCB at a 90° angle.



Horizontal

Part is placed in the same plane as the PCB.

Gender



Plug/Male

Usually part of a cable assembly, however plugs can also be PCB mounted in applications such as docking stations.



Socket/Receptacle/Female

Generally placed within equipment.



Mid-mount offset

The offset is the measurement from the underside of the mid-mount connector shell to the top side of the PCB. This allows the connector to be positioned in a suitable alignment for the application.

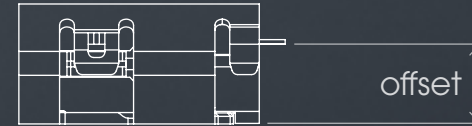


Illustration shows the offset based on the USB4520

USB4500



0.80mm
OFFSET



USB4505



1.00mm
OFFSET



USB4515



1.60mm
OFFSET



USB4510



1.60mm
OFFSET



USB4520



2.10mm
OFFSET

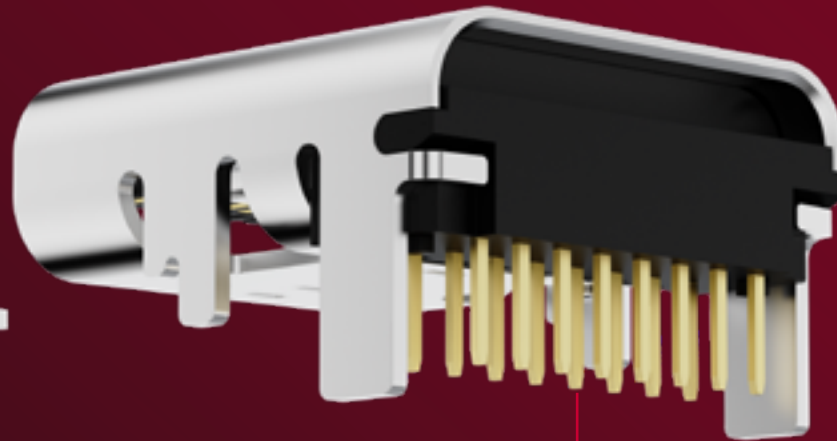


Contact pin type

Parts are available with either through hole (TH), surface mount (SMT) or hybrid combination (TH+SMT).



Surface mount (SMT)



Through hole (TH)



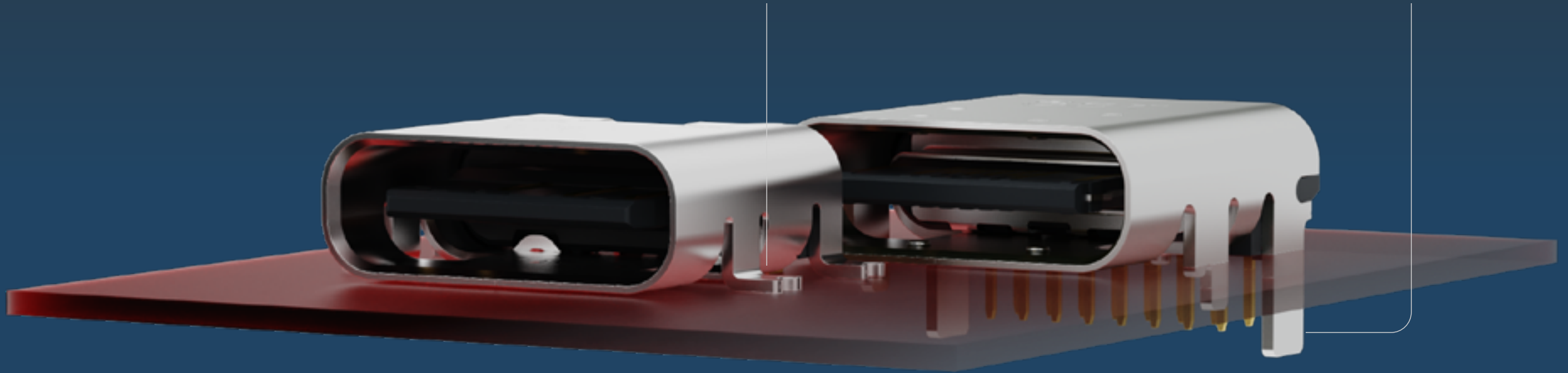
Hybrid combination (TH+SMT)

Shell stake types

A shell stake is a part of the metal shell that is used to make a **robust fixing to the PCB**. The contact pins are relatively small, so shell stakes add additional strength and stability after soldering. Shell stakes can be either through hole (TH) or surface mount (SMT).

Surface mount (SMT)

Through hole (TH)



Note - Parts with TH solder stakes can be soldered using IR reflow process if Pin in Paste technology is used (see solder process)

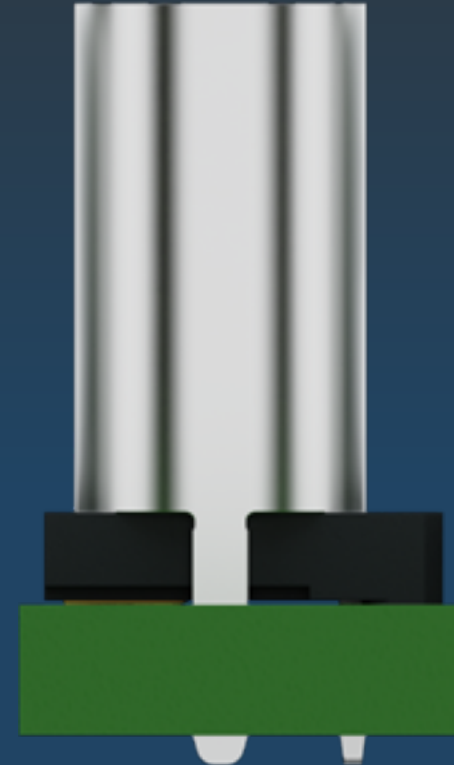
Shell stake lengths

Shell stakes are designed to add strength to the PCB fixing. As PCB thickness is not universal, through hole (TH) shell stakes come in a variety of lengths. Through hole shell stakes are suitable for reflow solder processes, so pin in paste technology can be used if needed.

In this example we have the USB4140 at different shell stakes, 0.70mm, 1.70mm and 2.30mm



0.60mm PCB with a 0.70mm shell stake length



1.60mm PCB with a 1.70mm shell stake length



2.00mm PCB with a 2.30mm shell stake length

Solder Process

All PCB level electronic components need to be soldered to a PCB.

There are 3 methods of doing this:

Hand soldering – Using a good old fashioned soldering iron and solder.

Wave soldering – The circuit board is passed over a pan of molten solder in which a pump produces an upwelling of solder that looks like a standing wave. As the circuit board makes contact with this wave, the components become soldered to the board.

https://en.wikipedia.org/wiki/Wave_soldering

IR reflow soldering – This is a process in which a solder paste (a sticky mixture of powdered solder and flux) is used to temporarily attach electrical components to their contact pads after which the entire assembly is subjected to controlled heat. The solder paste reflows in a molten state, creating permanent solder joints. Heating may be accomplished by passing the assembly through a reflow oven or under an infrared lamp.

https://en.wikipedia.org/wiki/Reflow_soldering

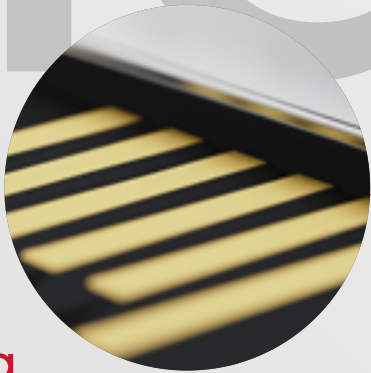
Note - Parts with SMT contacts pins and TH solder stakes can be soldered using IR reflow process if Pin in Paste technology is used.

In the Pin-in-Paste (PIP) process, the solder paste is screen printed into the through holes. After solder application, the component is placed in the holes. The board then undergoes reflow soldering in order to form the solder joint.

Plating

Shell Plating

This refers to the coating of metal that is applied to the connector metal shell. This is usually nickel with 30 - 50 μ " thickness.

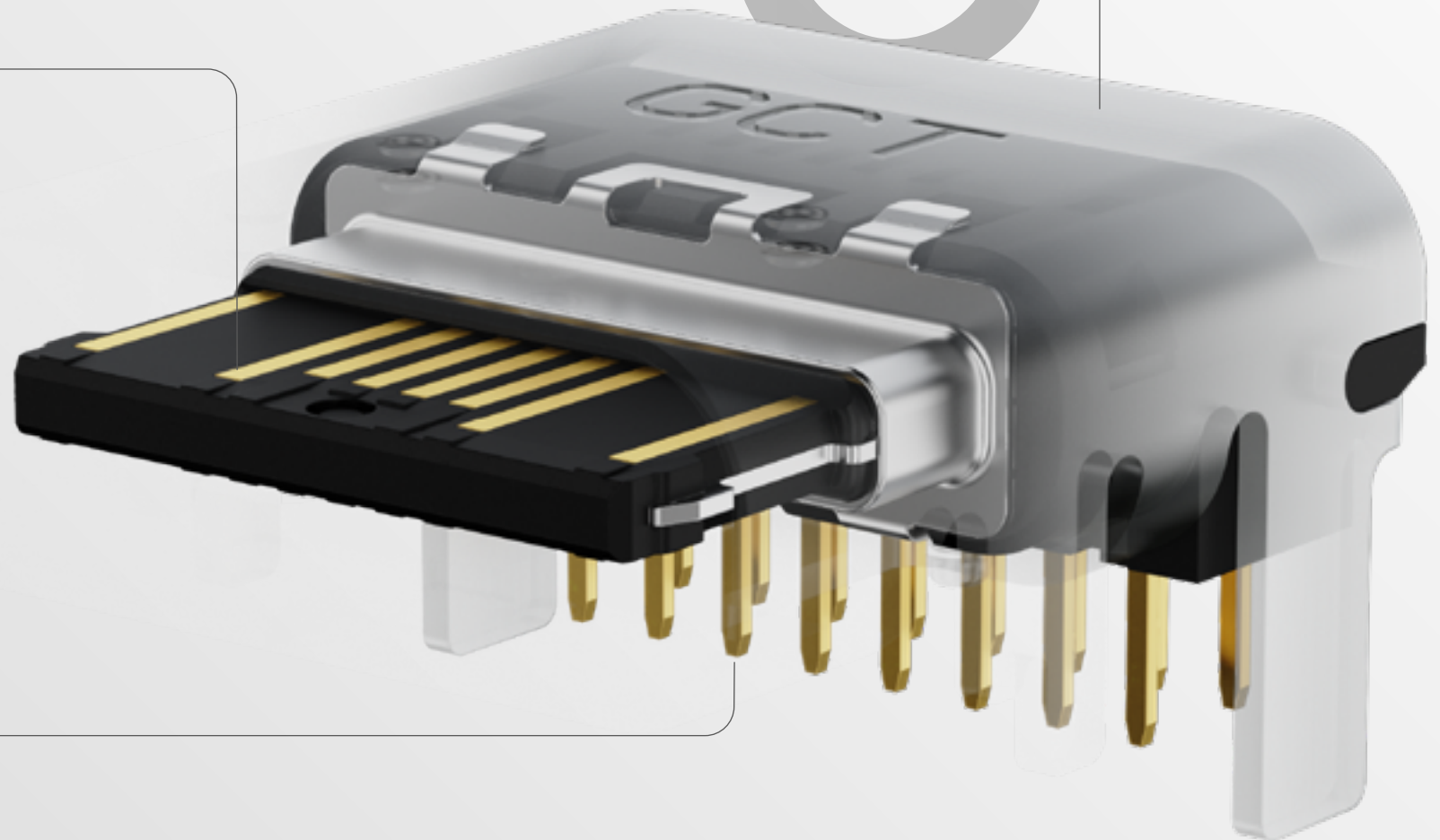


Contact plating

This refers to the coating of metal that is applied to the internal contact pins. This is always gold and can range between gold flash (GF) and 30 μ " thickness. GF is usually between 1 and 3 μ " thick.

Solder tail plating

This refers to the coating of metal that is applied to the PCB solder pins. This is typically tin or gold and can range between gold flash (GF) up to 30 μ " thickness. GF is usually between 1 and 3 μ " thick.



Body length

Body length refers to the total length from the mating face to the rear plate. It does not include the length of the PCB contacts

Profile

Profile refers to the height of the connector above the PCB. Horizontal connectors have a lower profile than vertical types

Shell springs

Unlike earlier USB versions, USB Type-C usually does not have shell springs on either the plug or receptacle.

Retention Latches

For USB Type-C the mating and unmating strength is controlled via side latches in the plug connector (the one that is most commonly on a cable).

Mating cycles

Mating cycles refers to the number of times a connector can be used while still meeting the minimum force specified. All USB Type-C connectors meet 10,000 cycle and some GCT 6 pin parts are rated at 20,000 cycles.



Retention

6pin



USB4125



USB4130



USB4135



USB4140



USB4515

USB Version	Power Only	Power Only	Power Only	Power Only	Power Only
Gender	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle
Number of contacts	6	6	6	6	6
PCB Orientation	Horizontal	Vertical	Horizontal	Vertical	Horizontal
PCB Mount Position	Top	Top	Top	Top	Mid
Shell Stake Type	Thru-hole	Thru-hole	SMT	Thru-hole	Thru-hole
Profile Height	3.16mm	6.50mm	3.16mm	6.50mm	3.16mm
Body Length	6.80mm	6.50mm	6.90mm	6.50mm	6.80mm
PCB Pin Type	SMT	SMT	SMT	SMT	SMT
Mid Mount offset	-	-	-	-	1.60mm
Shell Stake Length 1	1.00mm	1.20mm	-	0.70mm	0.75mm
Shell Stake Length 2	1.90mm	-	-	1.70mm	-
Shell Stake Length 3	-	-	-	2.30mm	-
Contact Plating	Gold Flash	Gold Flash	Gold Flash	Gold Flash	Gold Flash
Current Rating	3A	3A	3A	3A	3A
Mating Cycles	20000	10000	20000	10000	10000

16pin



USB4085

USB4105

USB4110

USB4120

USB4145

USB4500

USB4505

USB4510

USB4520

USB Version	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Gender	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle
Number of contacts	16	16	16	16	16	16	16	16	16
PCB Orientation	Horizontal	Horizontal	Horizontal	Vertical	Vertical	Horizontal	Horizontal	Horizontal	Horizontal
PCB Mount Position	Top	Top	Top	Top	Top	Mid	Mid	Mid	Mid
Shell Stake Type	Thru-hole	Thru-hole	SMT	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole
Profile Height	3.46mm	3.31mm	3.26mm	6.50mm	7.46mm	3.16mm	3.16mm	3.16mm	3.16mm
Body Length	9.17mm	7.53mm	7.35mm	6.50mm	5.90mm	6.50mm	6.50mm	6.50mm	6.50mm
PCB Pin Type	Thru-hole	SMT	SMT	SMT	SMT	SMT	SMT	SMT	SMT
Mid Mount offset	-	-	-	-	-	0.80mm	1.00mm	1.60mm	2.10mm
Shell Stake Length 1	2.10mm	0.60mm	-	0.95mm	0.70mm	0.70mm	0.80mm	0.70mm	0.85mm
Shell Stake Length 2	-	0.95mm	-	-	1.70mm	-	-	-	-
Shell Stake Length 3	-	1.20mm	-	-	2.30mm	-	-	-	-
Contact Plating	Gold Flash	Gold Flash	Gold Flash	3μ" gold	3μ" gold	3μ" gold	3μ" gold	3μ" gold	3μ" gold
Current Rating	5A	5A	5A	5A	5A	5A	5A	5A	5A
Mating Cycles	10000	10000	10000	10000	10000	10000	10000	10000	10000

24pin



USB Version	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2	3.2 GEN2
Gender	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Receptacle	Plug	Plug	Receptacle
Number of contacts	24	24	24	24	24	24	24	24	24	24	24	24
PCB Orientation	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal	Vertical	Horizontal	Vertical	Vertical	Vertical	Horizontal	Vertical
PCB Mount Position	Mid	Top	Top	Mid	Top	Top	Top	Top	Top	Top	Edge	Top
Shell Stake Type	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole	Thru-hole
Profile Height	3.42mm	3.46mm	3.31mm	3.42mm	3.46mm	10.50mm	3.16mm	9.25mm	11.10mm	2.90mm	7.46mm	
Body Length	10.0mm	10.0mm	9.87mm	8.65mm	8.65mm	10.50mm	7.90mm	9.25mm	11.10mm	15.50mm	5.90	
PCB Pin Type	Hybrid	Hybrid	Hybrid	Hybrid	Hybrid	SMT	SMT	SMT	SMT	SMT	SMT	SMT
Mid Mount offset	1.37mm	-	-	1.37mm	-	-	-	-	-	-	-	-
Shell Stake Length 1	0.60mm	1.20mm	1.15mm	0.60mm	1.20mm	1.30mm	0.50mm	1.15mm	1.25mm	0.90mm	0.70mm	
Shell Stake Length 2	-	-	1.40mm	-	-	-	-	-	-	-	-	1.70mm
Shell Stake Length 3	-	-	-	-	-	-	-	-	-	-	-	2.30mm
Contact Plating	30μ" gold	30μ" gold	3μ" gold	30μ" gold	3μ" gold	30μ" gold	3μ" gold	3μ" gold	3μ" gold	Gold Flash	3μ" gold	3μ" gold
Current Rating	5A	5A	5A	5A	5A	5A	5A	5A	5A	5A	5A	5A
Mating Cycles	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000



Globally Connected

London, UK (HQ)

sales@gct-europe.com
+44 (0)1707 321122

Berlin, DE

sales@gct-europe.com
+49 162 301 4214

Boston, MA, USA

sales@gct-americas.com
+1 978 208 1618

San Jose, CA, USA

sales@gct-americas.com
+1 650 448 9660

Atlanta, GA, USA

sales@gct-americas.com
+1 678 524 5817

Hong Kong, HK

sales@gct-apac.com
+852 2578 9030

Singapore, SG

sales@gct-apac.com
+65 8332 2263

New Delhi, IN

sales@gct-apac.com
+91 987 300 8975