

WE MEET @ DIGITAL DAYS



USB-C "FROM LAYOUT TO PRODUCTION"

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WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

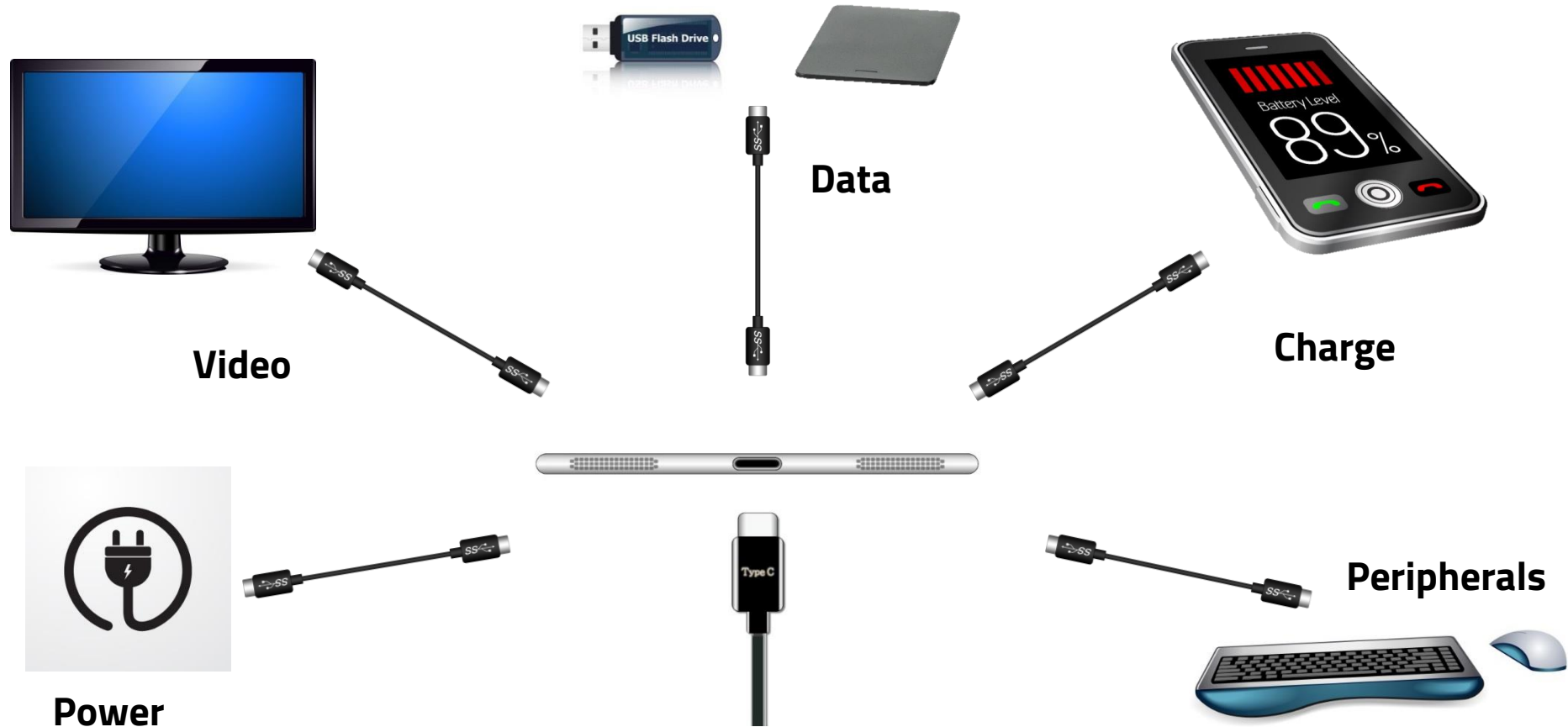
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- USB-C SMT Spacer
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- Possible placement on the PCB
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- Routing tips
- Processability
- Conclusion



USB Type-C for All Connectivity

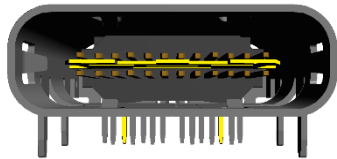
First connector supporting power in both ways



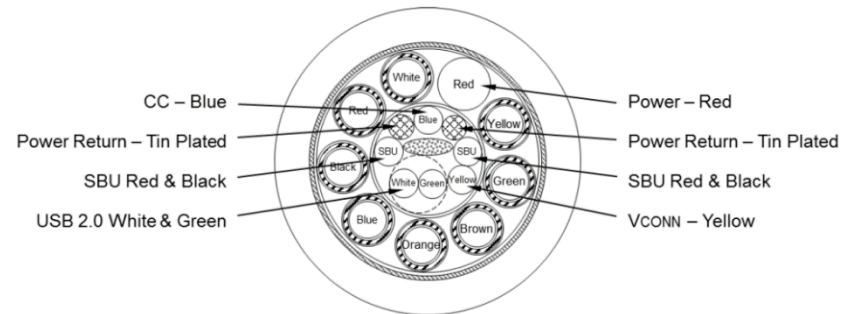
USB 3.1 Product Overview

TYPE C

USB Type-C Receptacle



USB Type-C Cable



OD = 4.8mm

Coax are SS pairs – specific pairs not defined in cable

USB Type-C Plug

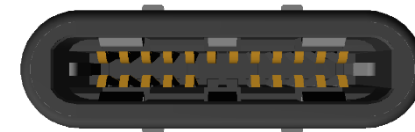


Figure 2-1 USB Type-C Receptacle Interface (Front View)

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1-	VBUS	CC1	D+	D-	SBU1	VBUS	RX2-	RX2+	GND
GND	RX1+	RX1-	VBUS	SBU2	D-	D+	CC2	VBUS	TX2-	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Figure 2-2 USB Full-Featured Type-C Plug Interface (Front View)

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

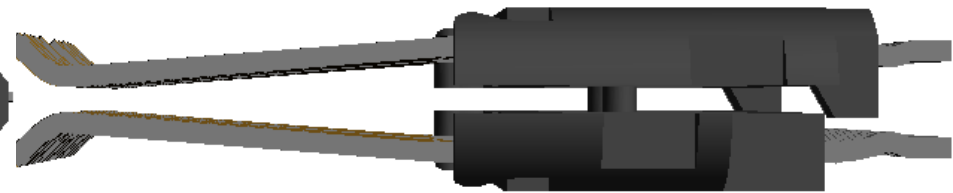
USB 3.1 Product Overview

Type C Plug Design – 632 712 000 011

Receptacle – Side crossed view

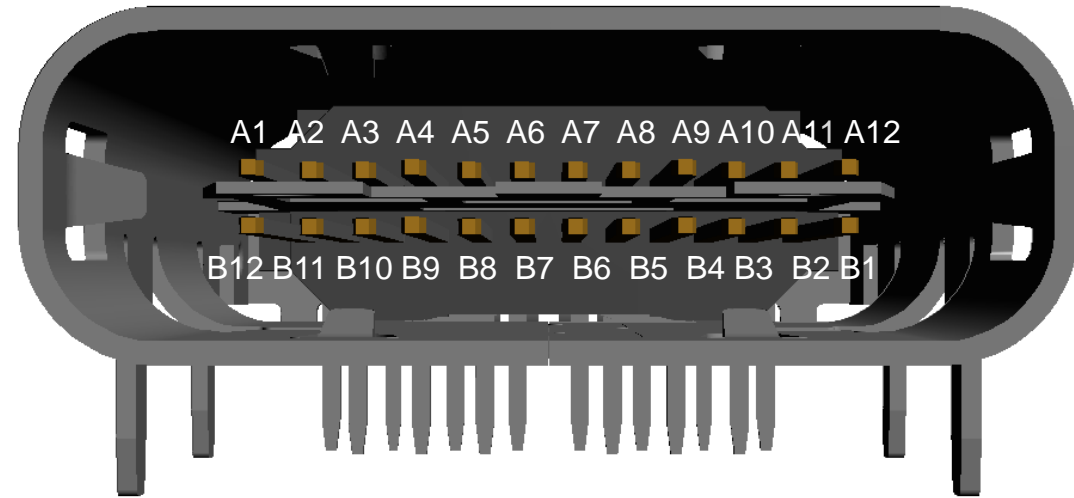
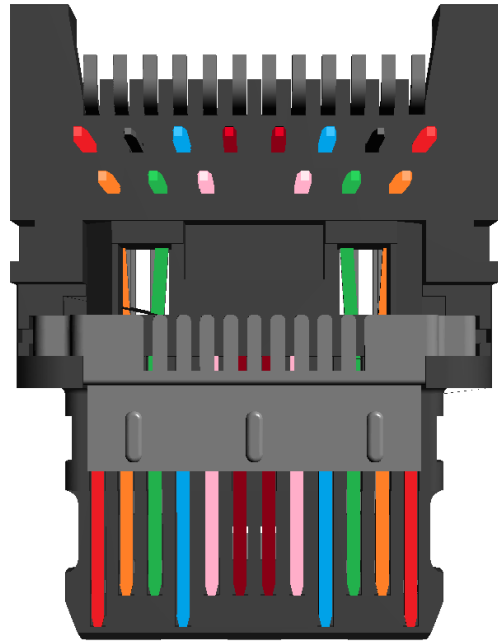


Plug – Side crossed view



USB 3.1 Product Overview

Type C Receptacles Design – 632 723 x00 011



Bottom contacts (B): THT Pins

Top contacts (A) : SMT Pins

- USB 2.0
- USB 3.0
- USB 3.1

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1-	V _{BUS}	CC1	D+	D-	SBU1	V _{BUS}	RX2-	RX2+	GND
GND	RX1+	RX1-	V _{BUS}	SBU2	D-	D+	CC2	V _{BUS}	TX2-	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Type C Receptacles

- Order code:
 - 632 723 X00 011
- Product features:
 - Material: LCP; black
 - Rated Current: 5 A
 - Rated Voltage: 5 VDC (12VDC/20VDC)
 - Durability: 10 000 cycles
 - Soldering: JEDEC lead free wave and reflow soldering

X	PCB Thickness	Pin length
1	1.00 mm	1.50 mm
3	1.60 mm	1.90 mm



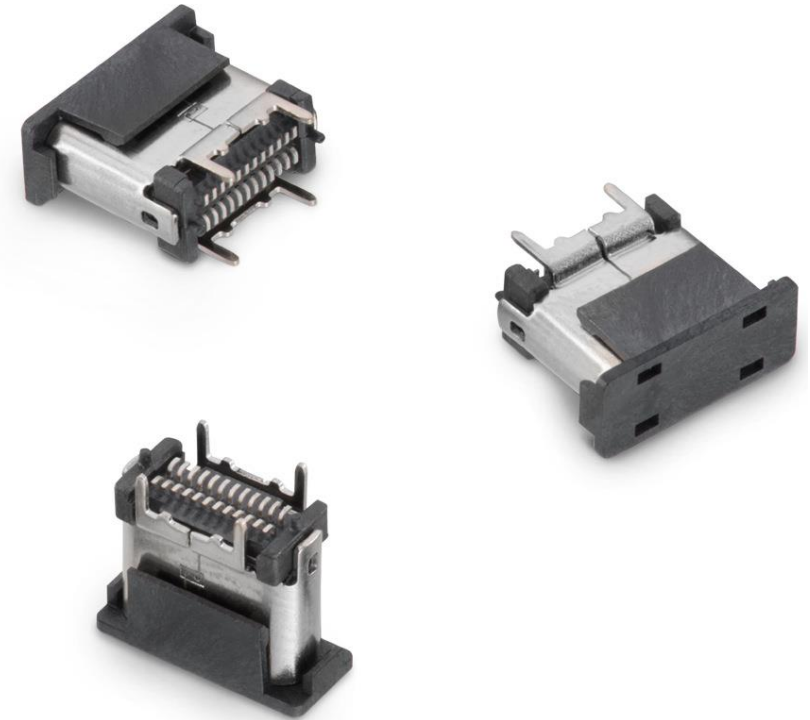
- Order code:
 - 632 723 X30 112

X	PCB Thickness	Pin length
1	1.60 mm	1.60 mm



Typ C – SMT Receptacle

- Order code:
 - 632 722 110 112
- Product features:
 - PCB thickness: 1,20mm
 - Material: LCP; black
 - Rated Current: 5 A
 - Rated Voltage: 5 VDC (12VDC/20VDC)
 - Durability: 10 000 cycles
 - Soldering: JEDEC lead free wave and reflow soldering



Typ C - Plug

- Order code:
 - 632 712 000 011 (22 pol)
 - 632 712 000 112 (24 pol)
- Product features:
 - PCB thickness: 0,80mm
 - Material: LCP; black
 - Rated Current: 5 A
 - Rated Voltage: 5 VDC (12VDC/20VDC)
 - Durability: 10 000 cycles
 - Soldering: JEDEC lead free wave and reflow soldering

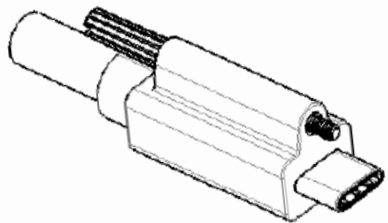
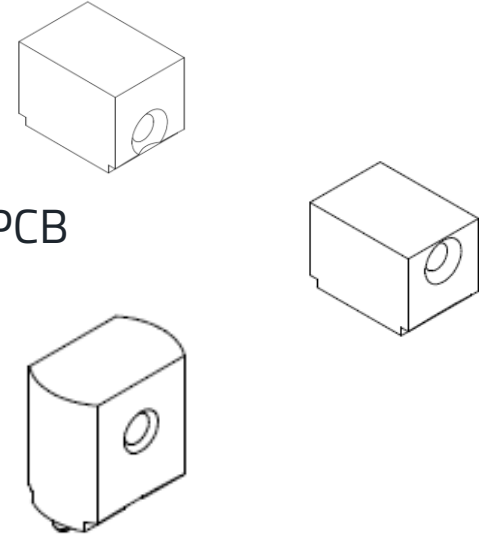


USB-C SMT Spacer

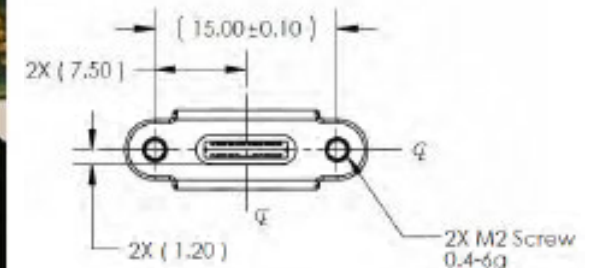
- Order code:

- 7466302 → thread center height 1,58mm for dual screw locking
- 746630200 → thread center height 3,62mm for single screw locking of 1,60mm PCB
- 7466312 → for single screw locking of 1,00mm PCB

- Application examples:**

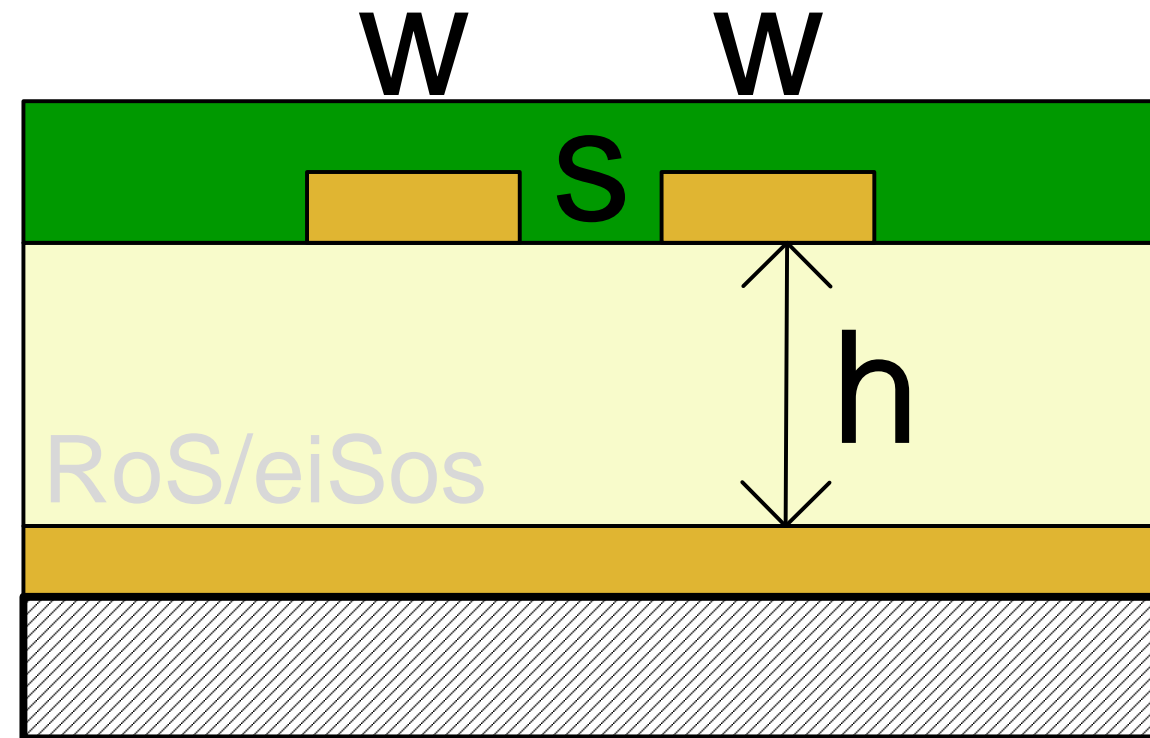


15,00 +/- 0,10mm

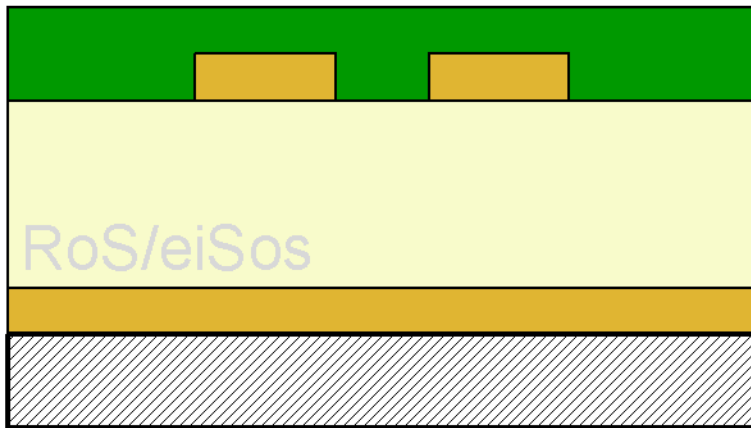


Relationships

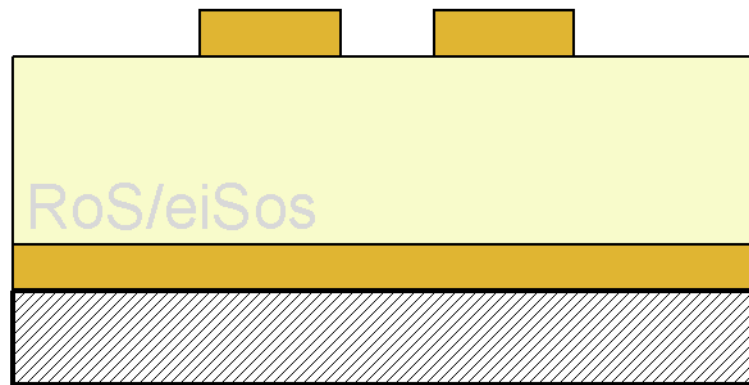
=> $h \uparrow \triangleright Z \uparrow$
=> $w \uparrow \triangleright Z \downarrow$
=> $s \uparrow \triangleright Z \uparrow$



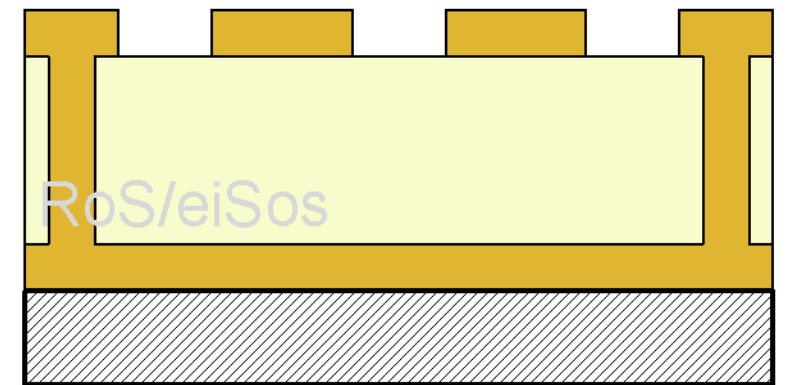
Differential builds – Microstrip



Edge-coupled

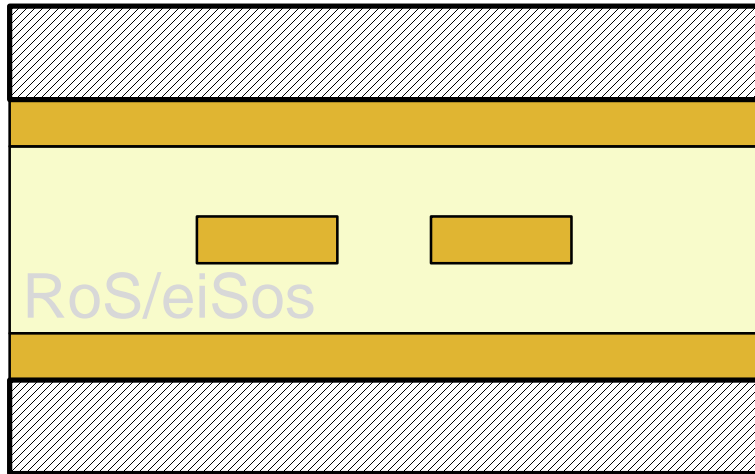


**Edge-coupled
with coating**

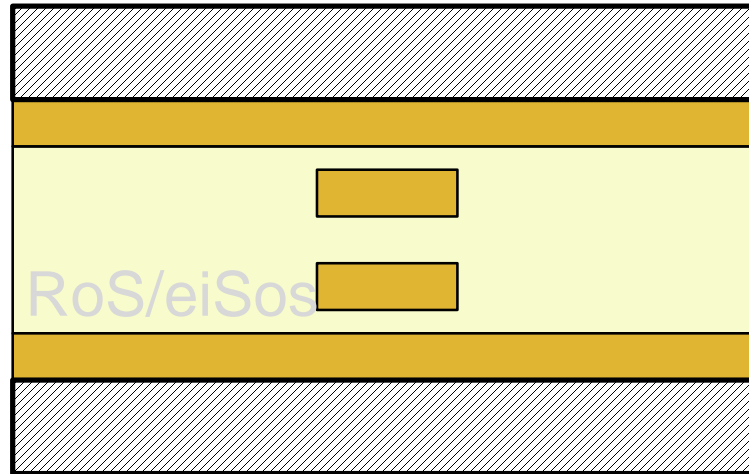


**Grounded coplanar
waveguide**

Differential builds – Stripline



Edge-coupled

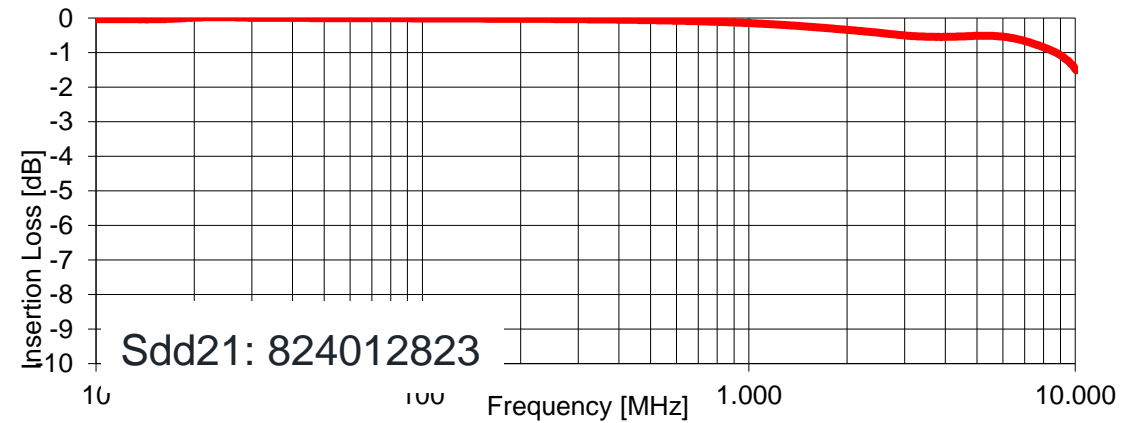
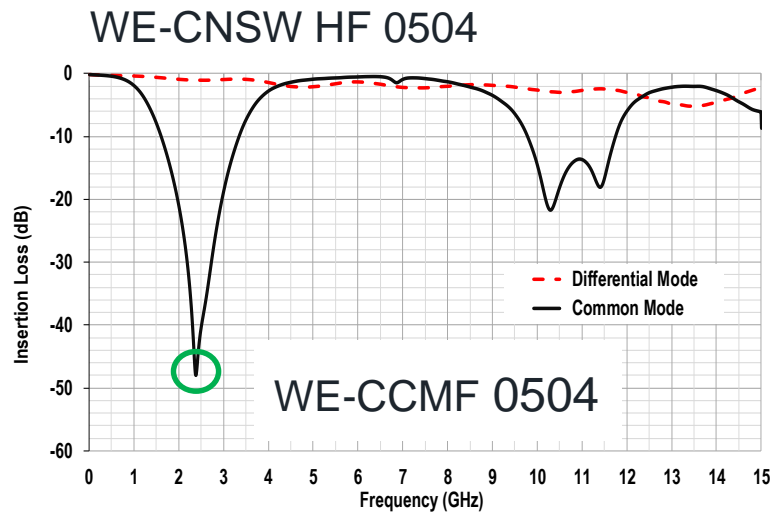
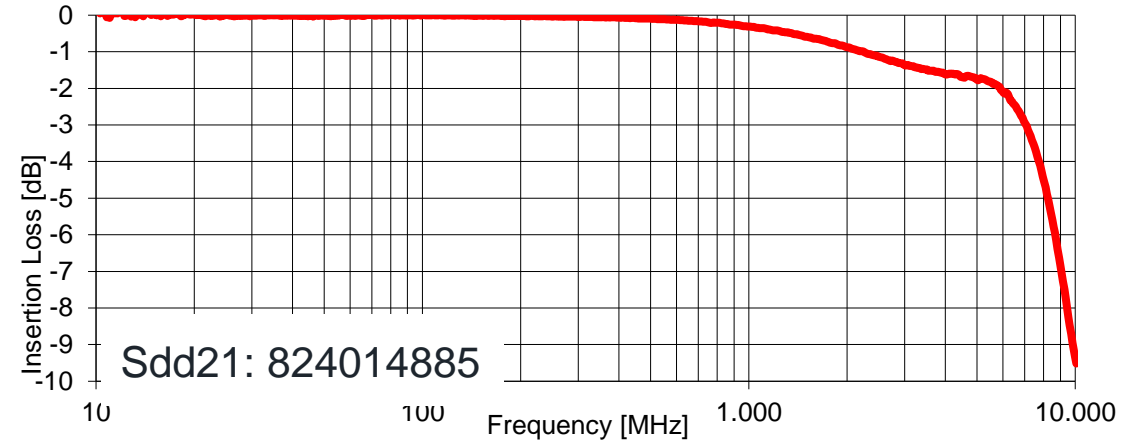


Broadside-coupled

Conclusion

- Several possibilities to get the right impedance together with a lot of parameters are varying
- To reach acceptable results it is important to talk to the pcb-manufacturer about possible layerstacks and materials before the design starts
- For an exact calculation of impedance a lot of parameters take effects. To get precise results use softwaretools (2D/3D-Solver).

Componentselection

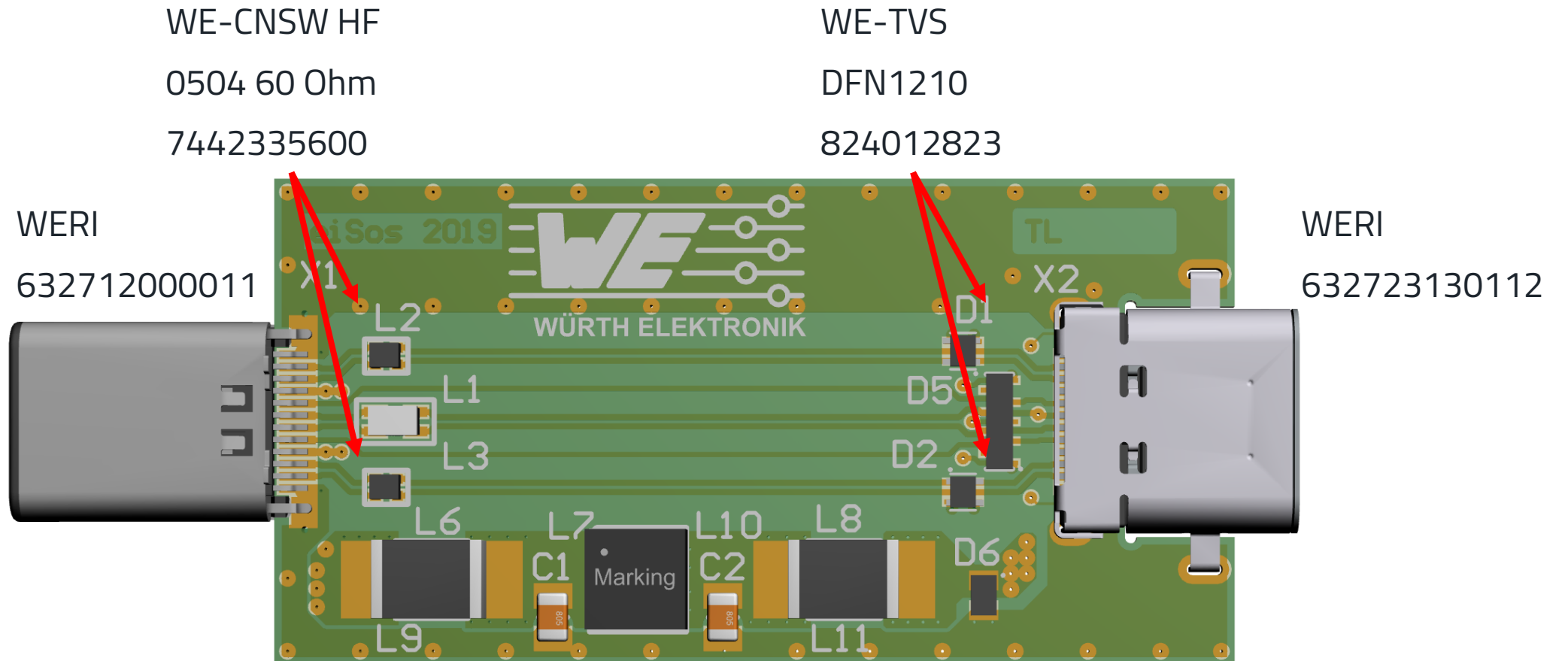


Type-C filter board and -bags

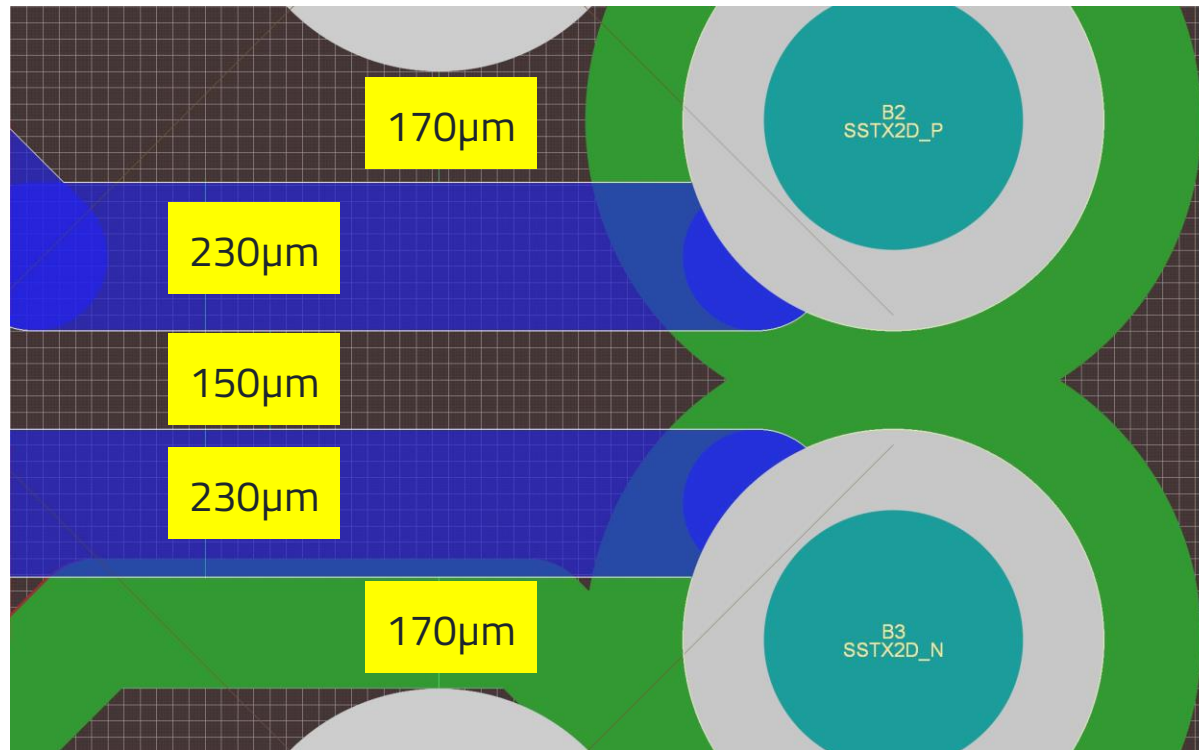
- Stick with 60W PD: 82931060
- Sample bag with all components for 60W: 82931061

- Stick with 100W PD: 82931100
- Sample bag with all components for 100W: 82931101

Type-C filterboard – overview

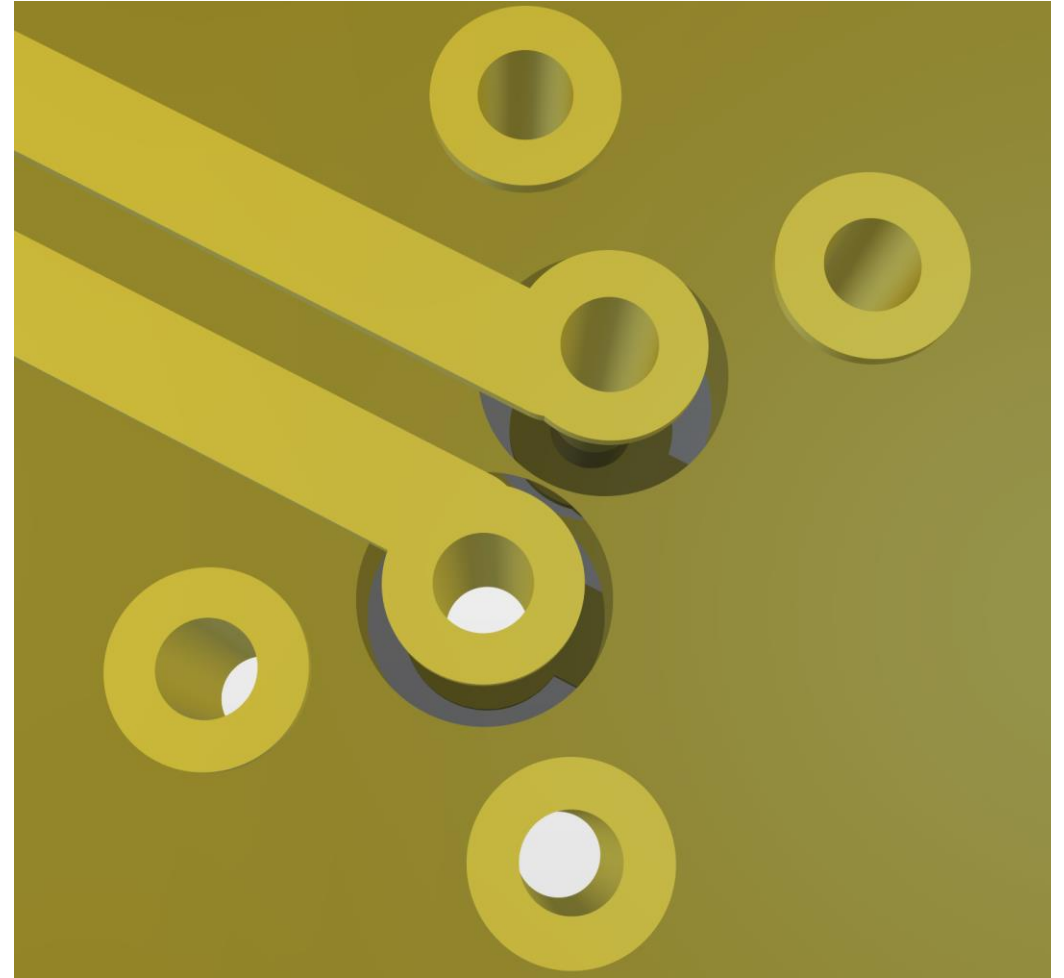
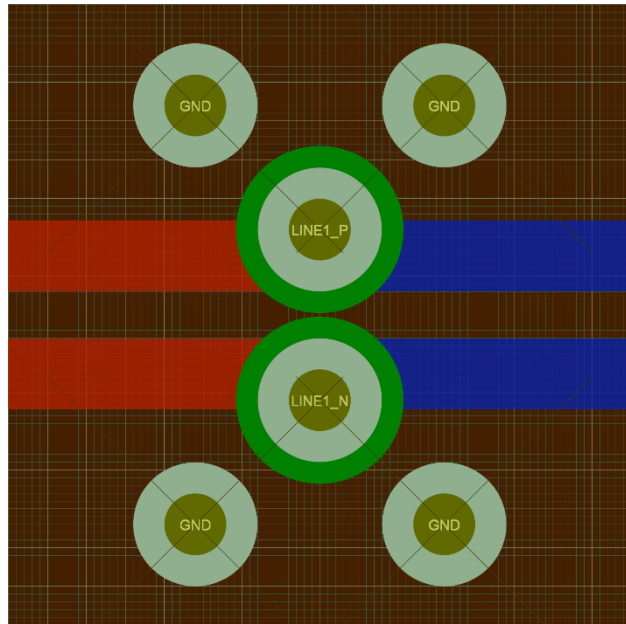


Type-C Filterboard – PCB stackup



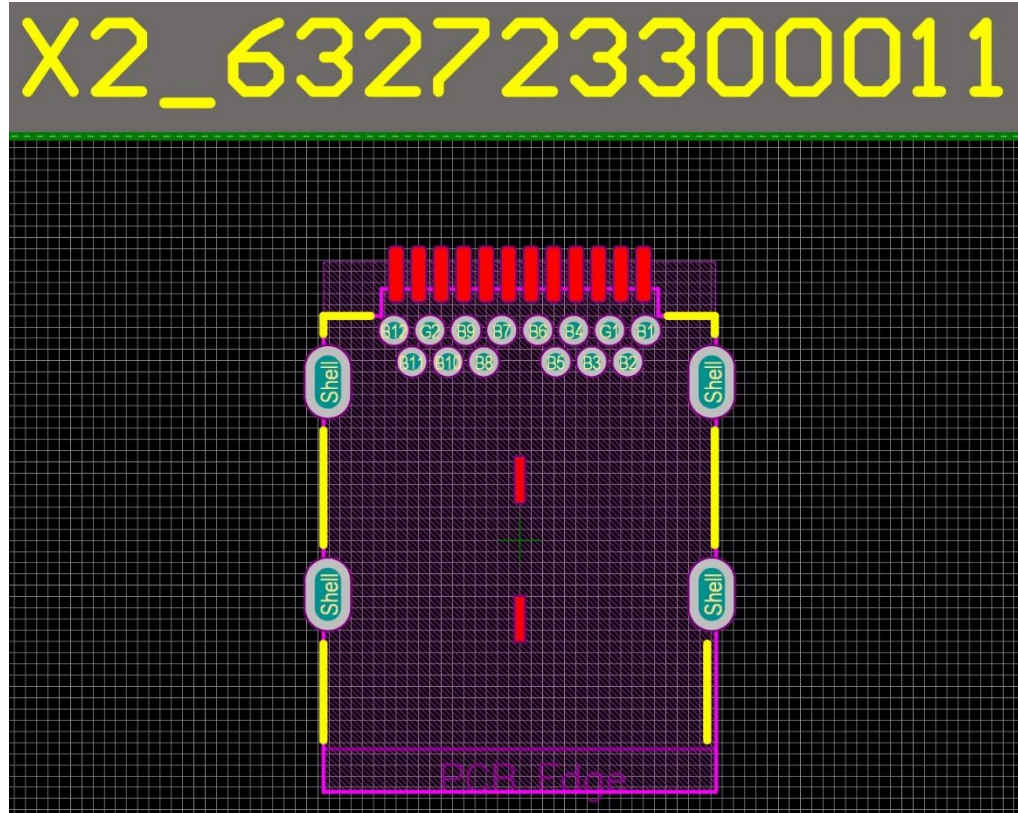
	Thickness (mm)	Dielectric Material	Dielectric Constant
Material	0.03	Solder Resist	3.5
	0.04		
	0.17	FR-4 1080 2116 ...	4
	0.033		
	0.25	FR-4	4.1
	0.033		
	0.17	FR-4 1080 2116 ...	4
	0.04		
Material	0.03	Solder Resist	3.5

Type-C Filterboard – Designrules

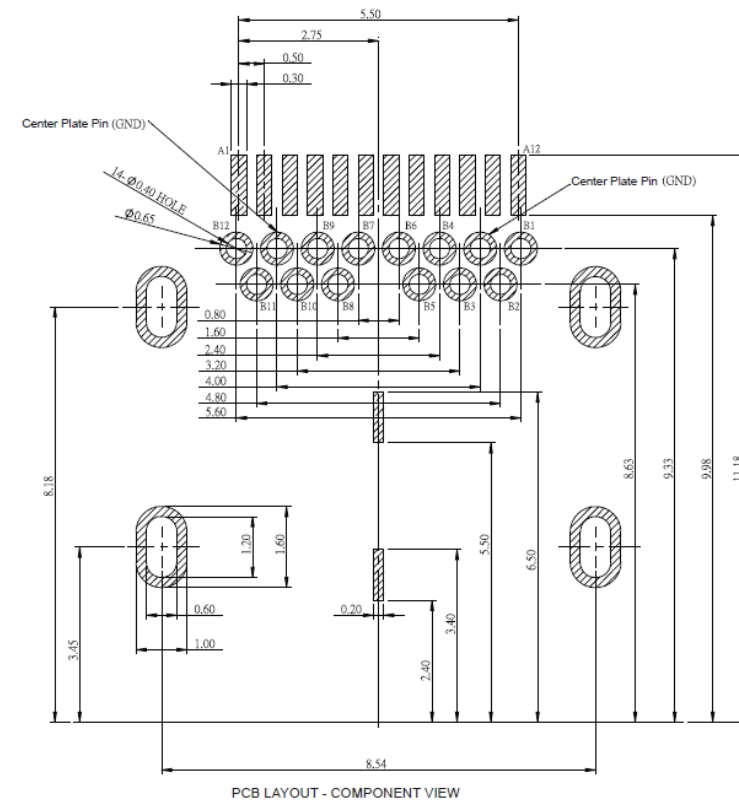


Layout PCB – horizontal USB-C 3.1

Footprint



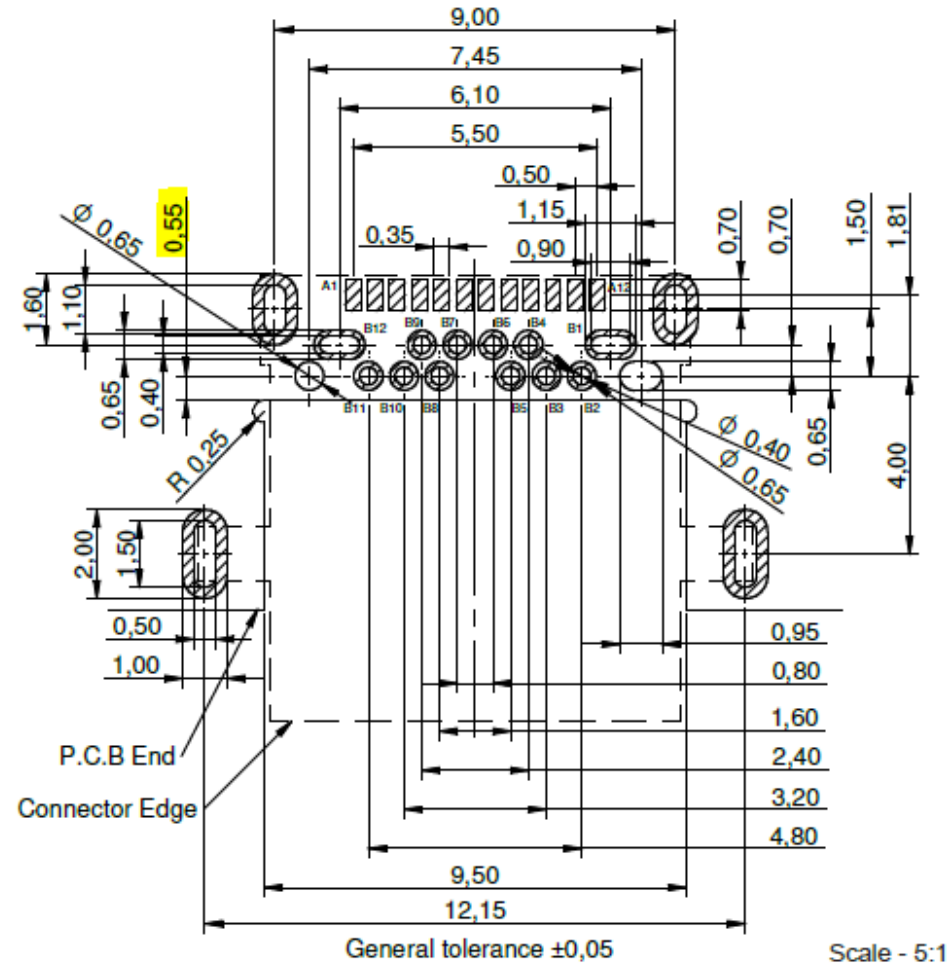
PCB Layout



Layout PCB – mid mount

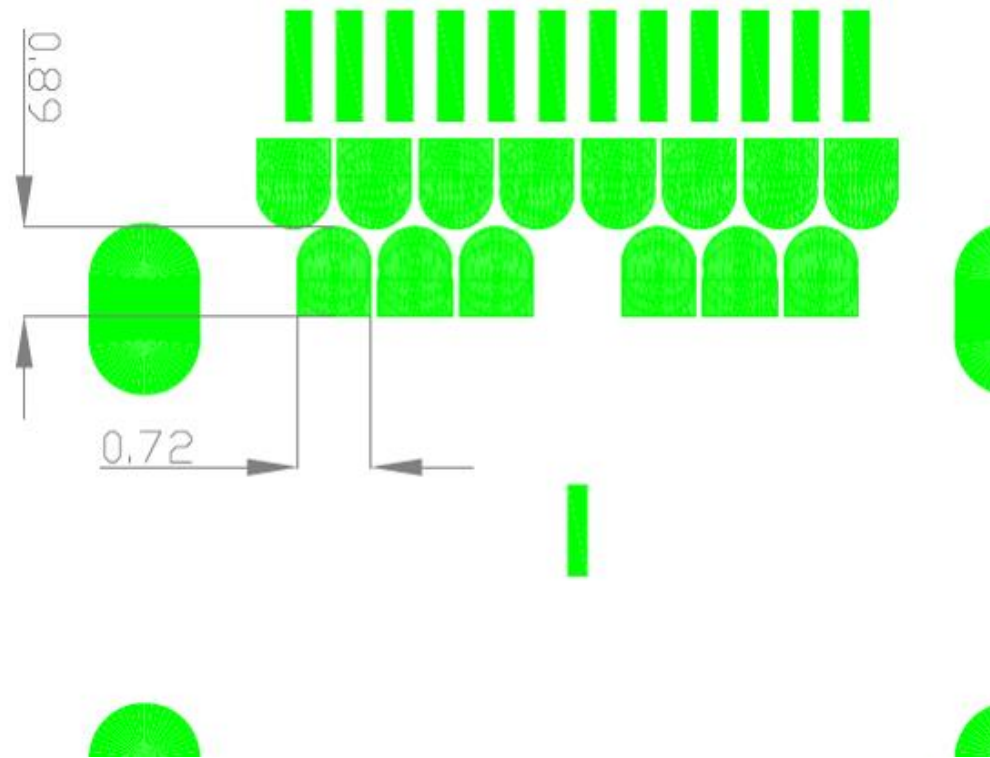
Attention: distance from center of PIN to the top edge of the milling track.

Distance from center pin to center milling Track is $0.55\text{mm} + \text{the radius of the Cutter } (0.25\text{mm})$ equal to **0.80mm**.

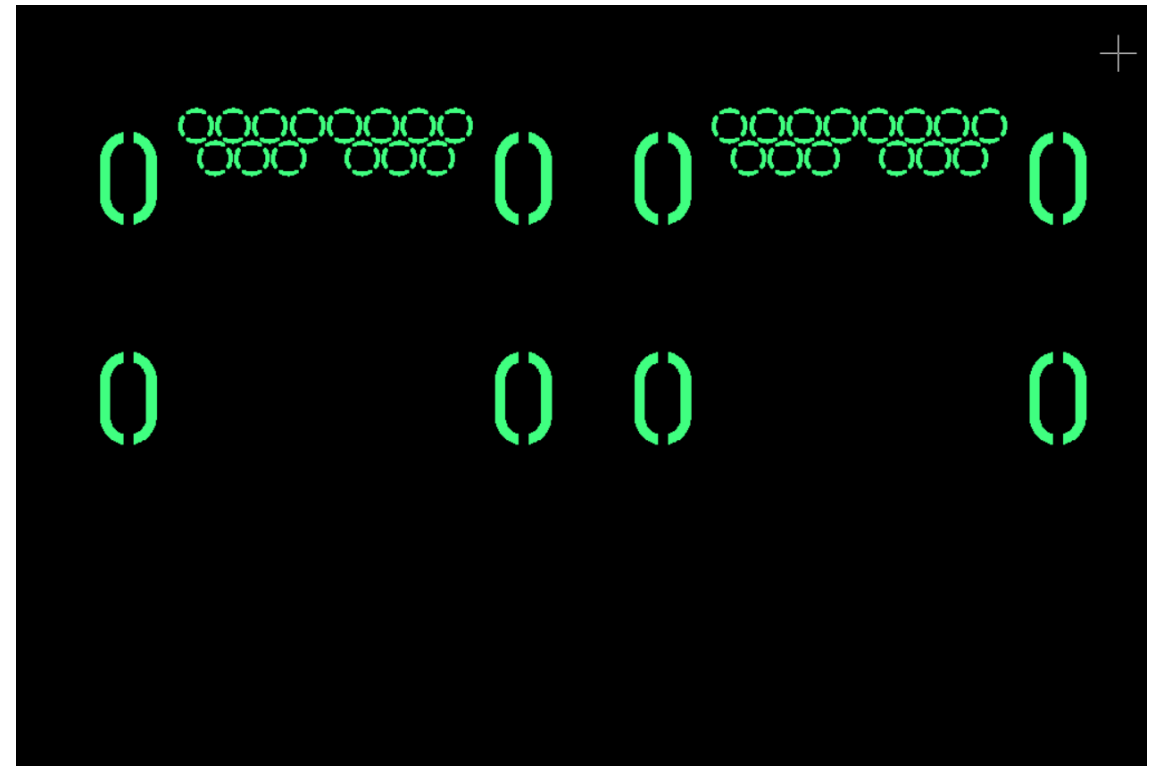


Stencil Receptacle

Top View



Bottom View



Aspect and Area ratio

- **Definition:** The aspect ratio is the width of the aperture divided by stencil thickness. It is generally accepted that an aspect ratio of 1,7 or greater should achieve acceptable solder paste transfer.

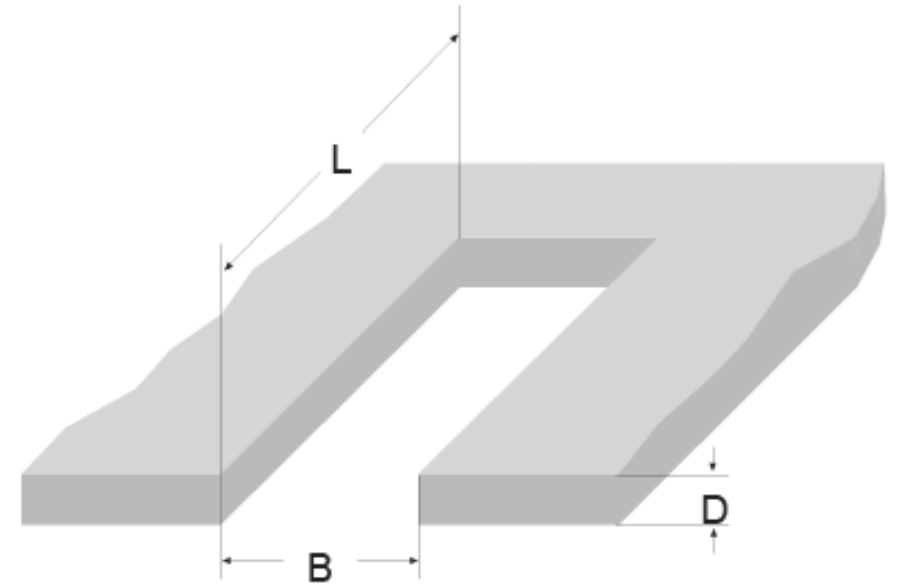
- **Aspect ratio** = $\frac{\text{Aperture-width}}{\text{Stencil-thickness}} = \frac{B}{D} > 1,7$

example: $\frac{0,72\text{mm}}{0,12\text{mm}} = 6$; $\frac{0,72\text{mm}}{0,10\text{mm}} = 7,2$

- **Definition:** The area ratio of a stencil aperture is the area of the aperture open.

- **Area ratio** = $\frac{\text{Aperture-area}}{\text{Aperture-wall surface}} = \frac{L \times B}{2 \times (L+B) \times D} > 0,8$

example: $\frac{0,85\text{mm} \times 0,72\text{mm}}{2 \times (0,85\text{mm} + 0,72\text{mm}) \times 0,12\text{mm}} = \frac{0,612\text{mm}^2}{0,377\text{mm}^2} = 1,6$



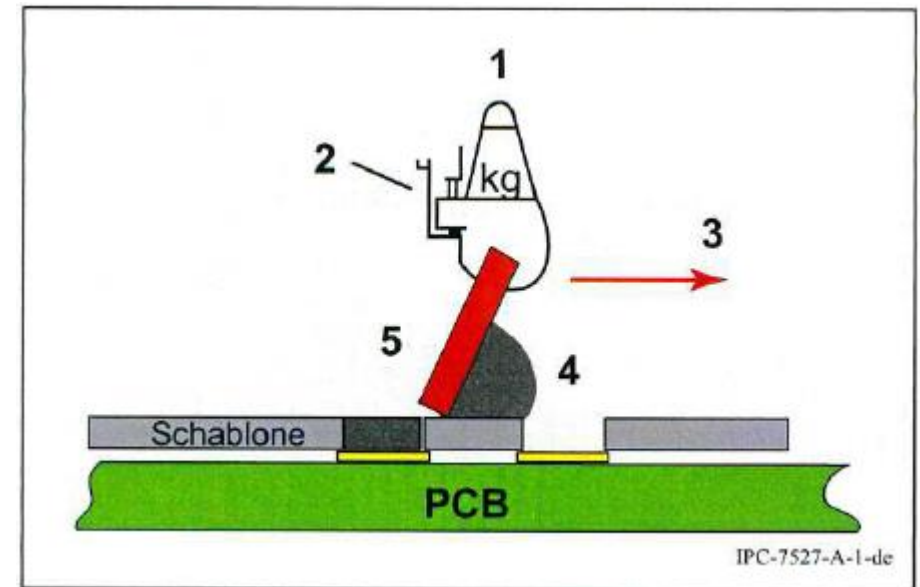
Exemplary production process

- grain size: Typ 5

Class	not bigger than	min. 80% between
Typ 3	50 µm	45 – 25 µm
Typ 4	40 µm	38 – 20 µm
Typ 5	30 µm	25 – 10 µm
Typ 6	20 µm	15 – 5 µm

- Squeegee cycles: 2 cycles
- Squeegee speed: 20mm/s
- Squeegee force: min. 70N (~7kg)
- Squeegee angle: 45°

- 1: Squeegee force
- 2: Squeegee fixture
- 3: Printing direction
- 4: Squeegee angle
- 5: Squeegee

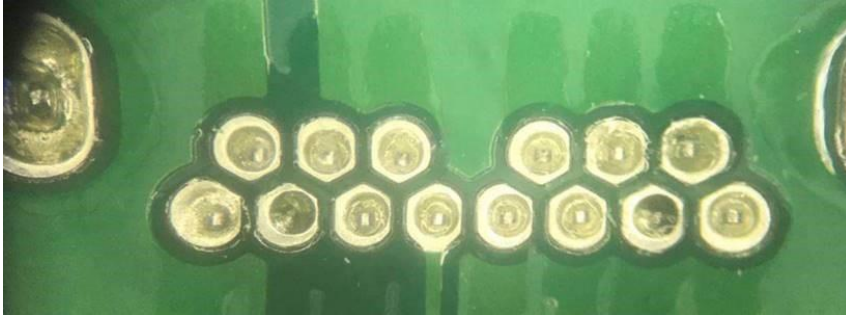


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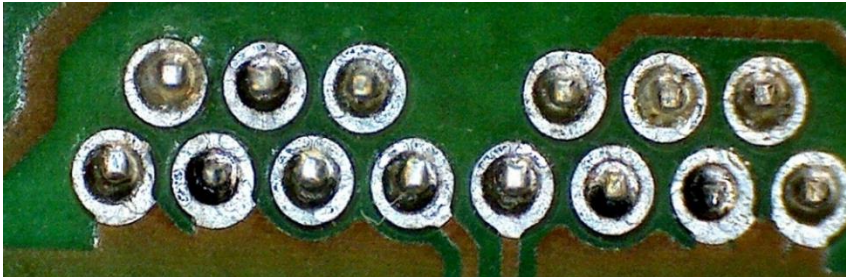
Exemplary production process

1. Paste print PCB underside (if possible to prepare a solder deposit)
2. Reflow soldering
3. Paste printing PCB top side (pressure control → check the filling quantity of the holes before assembly)
4. Assemble the USB-C connector with placement machines (set the placement parameters so that the paste is not punched out of the hole)
5. Reflow soldering (PCB should go into the oven with the mating face first)
6. AOI inspection

Soldering Examples



Soldering without defects



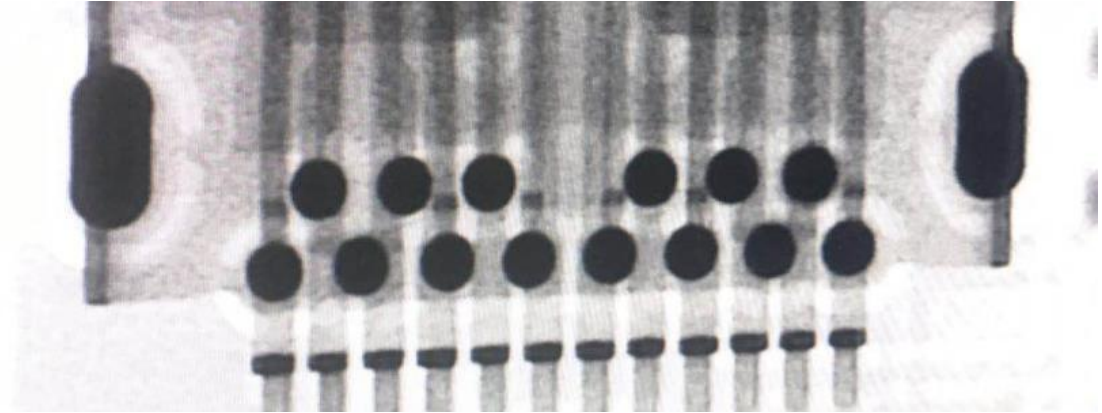
Soldering with defects



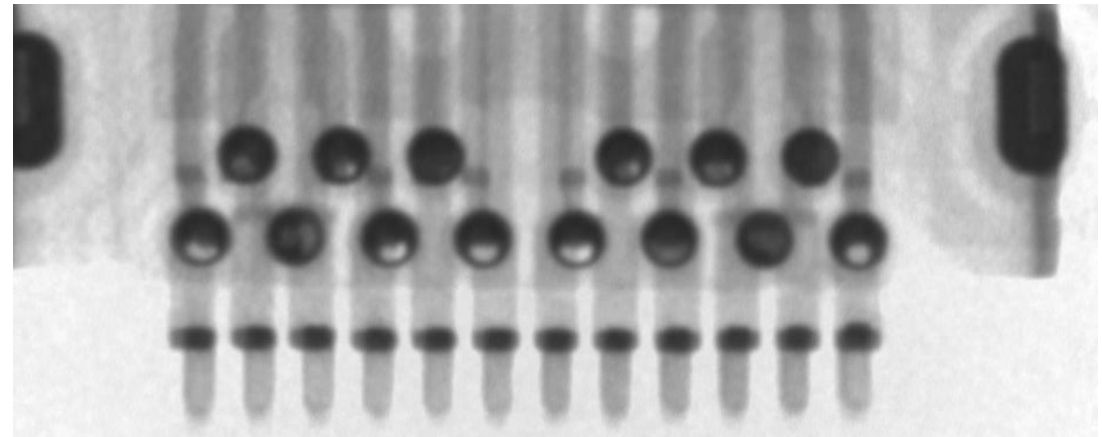
Handsoldering

Soldering inspection via X-Ray

Soldering result without defects

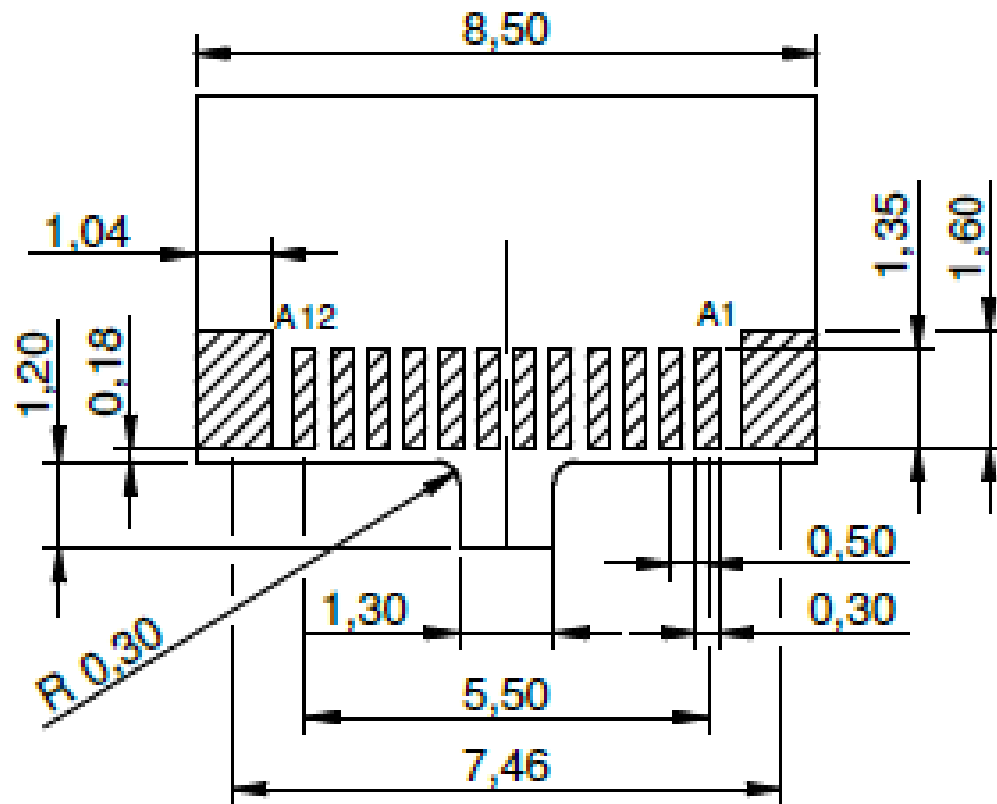


Soldering result with defects

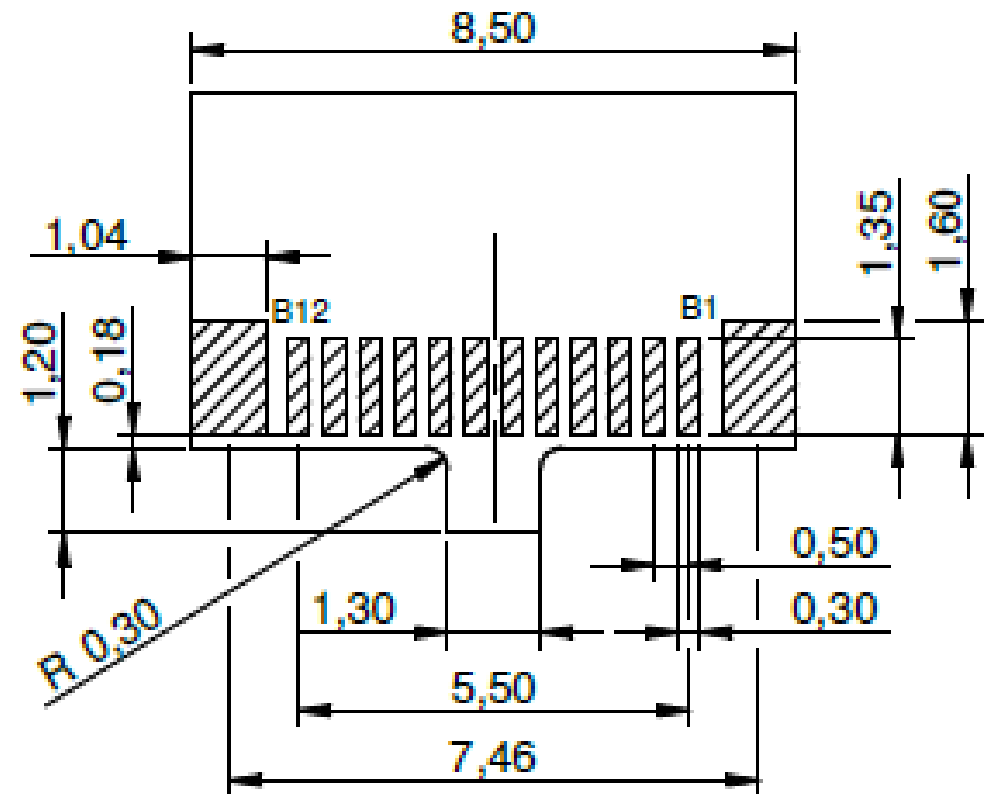


Layout PCB

Top View



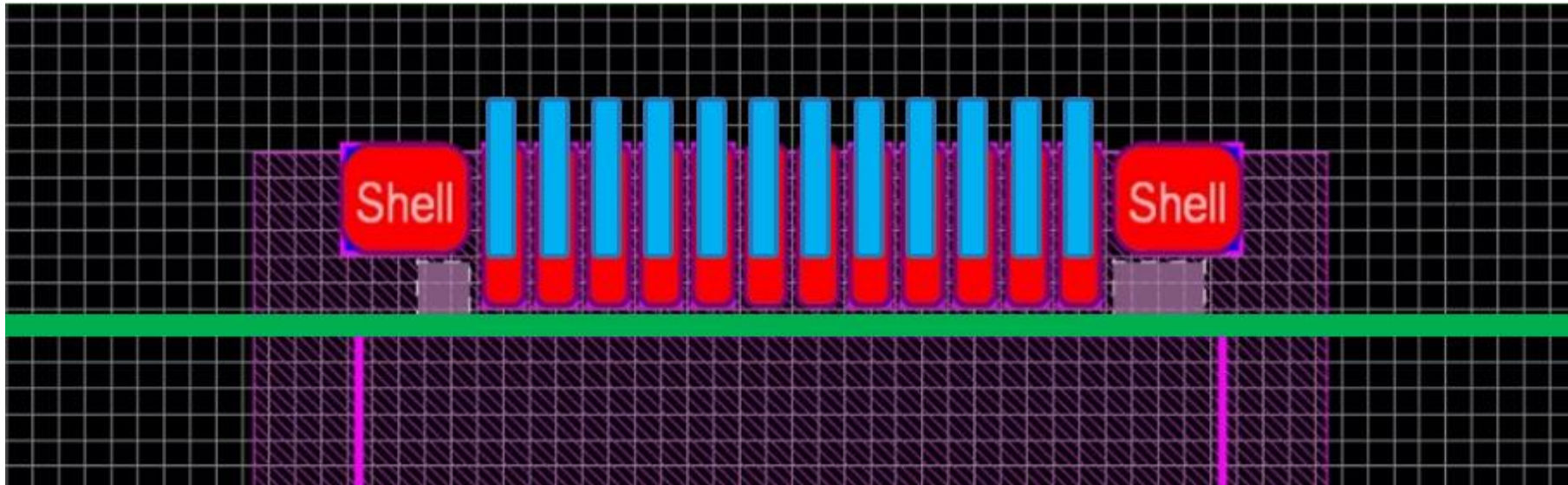
Bottom View



Stencil Plug

Top side:

- reduce the width of the stencil opening to 0,20mm (pad width 0,30mm)
- move the stencil opening 33% up to the pad destination



Bottom side:

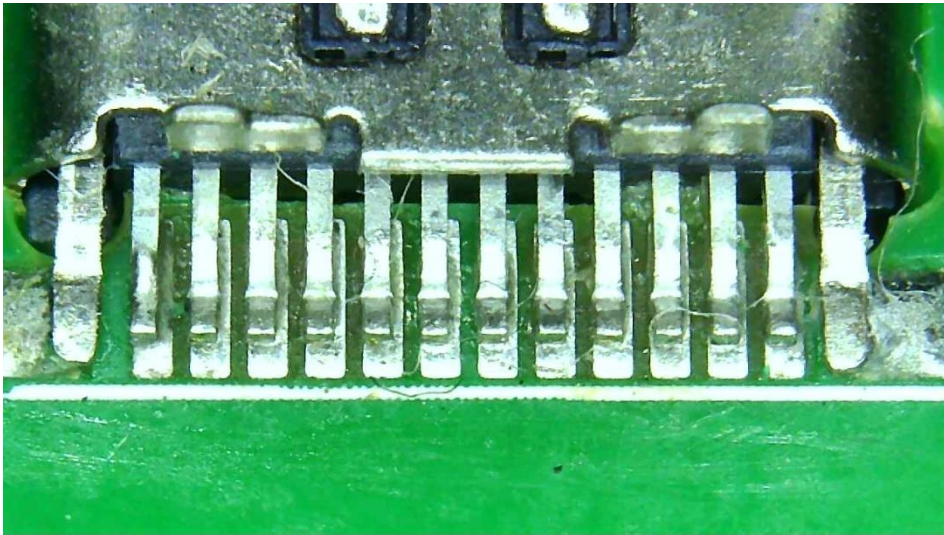
- reduce the stencil opening in relation to the original pad by 4% all around (oblong opening)

Exemplary production process

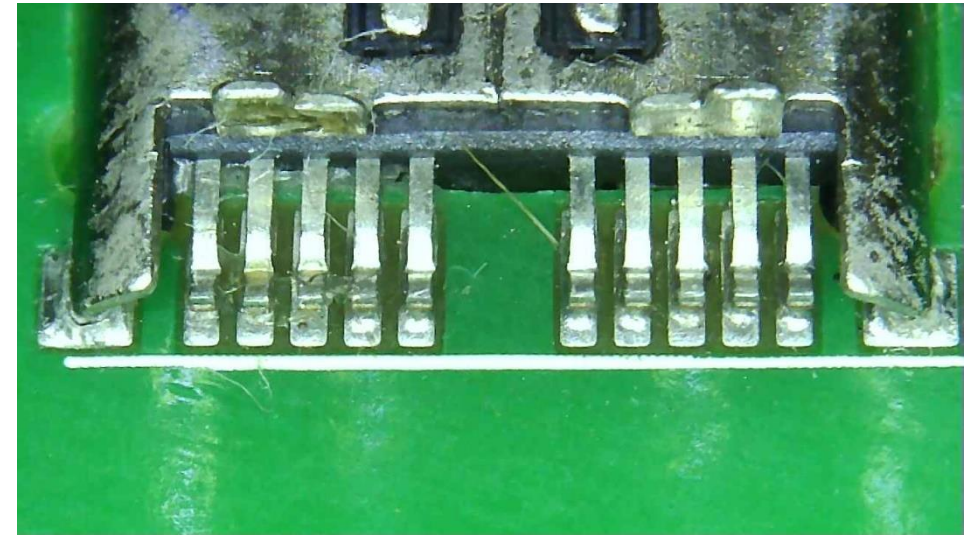
1. Paste printing PCB bottom side (if possible to prepare a solder deposit)
2. Reflow soldering
3. Paste printing PCB top side
4. Assemble USB-C connector with automatic placement machines (automatic or manual assembly, depending on the production equipment)
5. Reflow soldering (PCB should go into the oven with the mating face first)
6. AOI inspection

Soldering Example

Top View



Bottom View



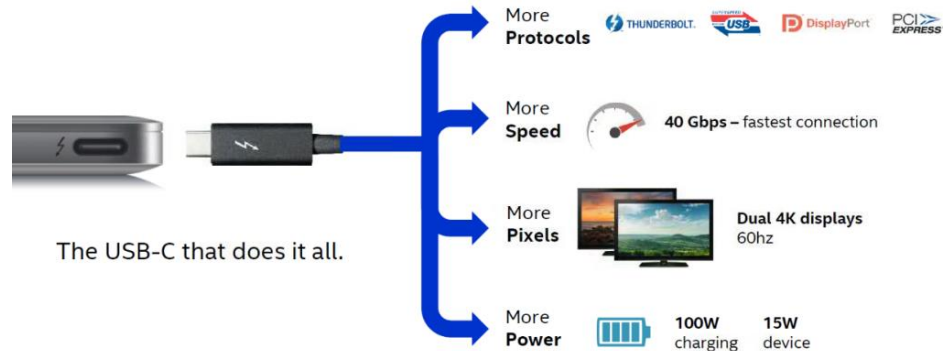
Application Note

Parameter table

2.1. Produktfamilie	2.2. Plug		2.3. Receptacle		
Produktname	WR-COM USB 3.1 Type C Plug Horizontal SMT 0.8 mm	WR-COM USB 3.1 Type C Plug Horizontal 0.8 mm	WR-COM USB 3.1 Type C Receptacle Horizontal THR / SMT	WR-COM USB 3.1 Type C Receptacle Horizontal Mid-Mount THR / SMT 1.6 mm	WR-COM USB 3.1 Type C Receptacle Vertical SMT 1.0 mm
Produktbild					
Artikel-Nr.	632712000011	632712000112	632723100011 632723300011	632723130112	632722110112
Pins	22	24	24	24	24
Leiterplattendicke	0.8 mm	0.8 mm	1.00 / 1.60 mm	1.60 mm	-
Montageart	SMT	SMT	SMT / THR	SMT / THR	SMT
Schablonenparameter					
Schablonenstärke	100 µm	100µm	100 µm	100µm	100 µm
Elektropoliert	ja	ja	ja	ja	ja
Nanobeschichtet	nein	nein	ja	ja	nein
Schablonenempfehlung	Bild 1	Bild 1	Bild 4-7	Bild 4-7	Bild 12
Druckparameter					
Korngröße Lotpaste	4	4	5	5	4
Druckgeschwindigkeit	40 mm/s	40 mm/s	20 mm/s	20 mm/s	40 mm/s
Rakeldruck	50 N	50 N	70 N	70 N	50 N
Rakelwinkel	60-67°	60-67°	45°	45°	60-67°
Rakeltyp	Metall	Metall	Kunststoff	Kunststoff	Metall
Druckzyklen	1	1	2	2	1
zusätzliches Lotdepot	nein	nein	ja	ja	ja
Bestückungsparameter					
Bestückungsgeschwindigkeit	Standard	Standard	Reduziert auf Minimum	Reduziert auf Minimum	Standard
automatische Bestückung	Teil-automatisiert	Teil-automatisiert	ja	ja	ja
Lötparameter					
Lötprofil	IPC/ JEDEC J-STD-020E				
Durchlaufrichtung	-	-	Steckgesicht oder Pins voran	Steckgesicht oder Pins voran	-
Kontrolle der Lötstellen	AOI	AOI	AOI / XRAY	AOI / XRAY	AOI

Conclusion

Thunderbolt™ 3 Brings Thunderbolt to USB-C



RF Behaviour:

- high data rate (over 10GHz)
- EMC / EMI protection
- mix mode is possible
(e.g. USB 2.0 & I²C; USB 2.0 and DC/DC controller)

Mechanical Performance:

- 10.000 mating cycles
- High extraction (retention) force
- Long time reliability
- Time saving (only one type of connector is needed)
- Space saving

Electrical Performance:

- 5V / 12V / 20V
- up to 5A
- PD (up to 100W)

