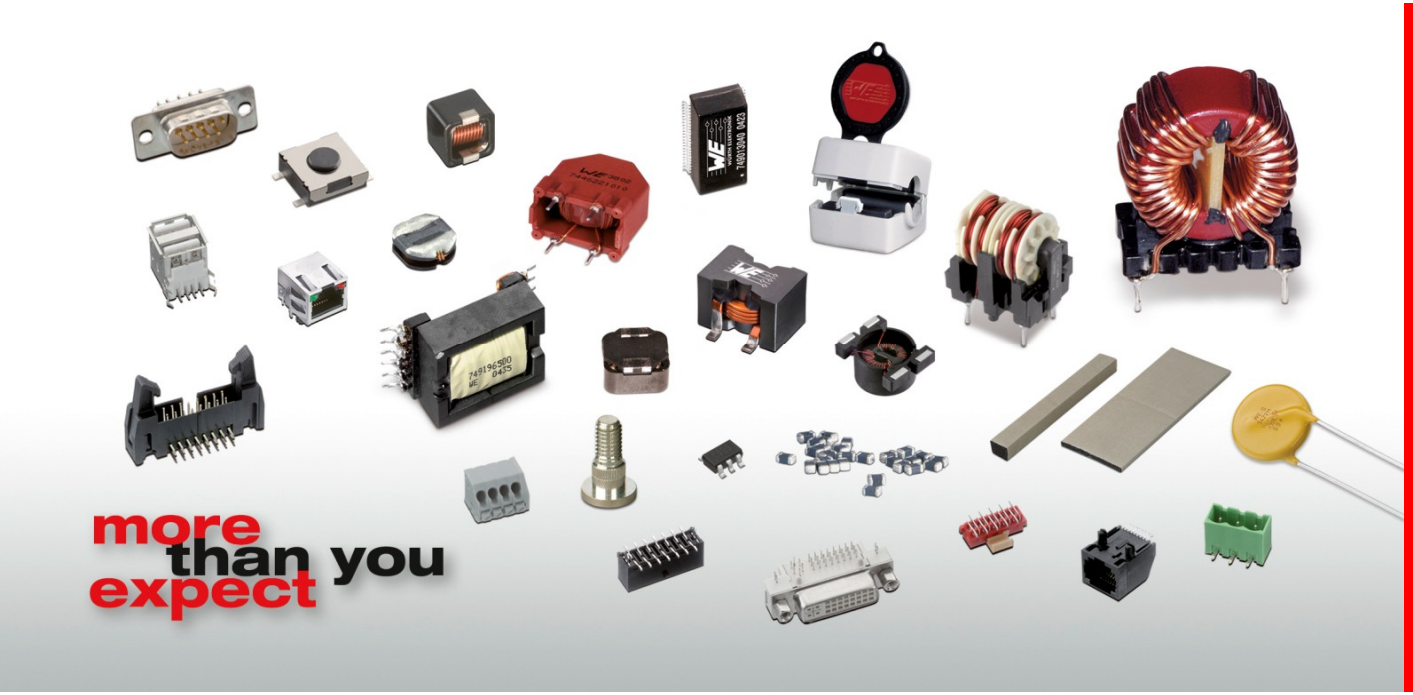
WÜRTH ELEKTRONIK

USB 3.x – a connector for multiple applications



Würth Elektronik
Remco van de Griendt
E-mail: remco.vandegriendt@we-online.com
Tel: +31 6 109 84 436

Table of Content

Why Type USB 3.1 & Type C
Market trends for USB (3.1)

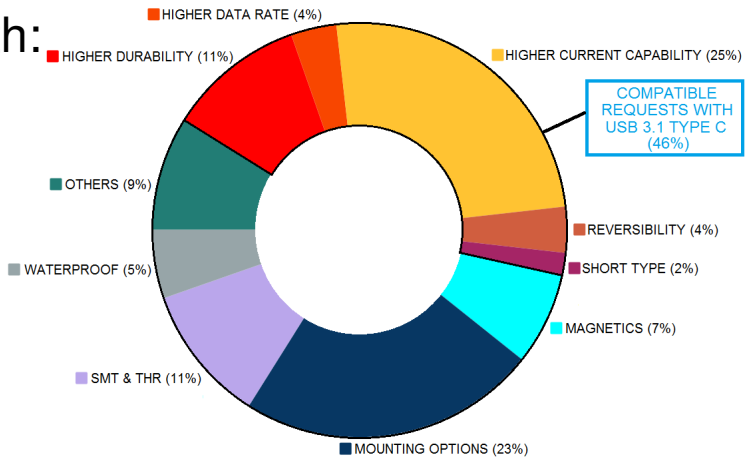
- **Storage / USB Sticks:**
  - Annual shipment of USB sticks could reach 556 kk units in 2020
  - US Biggest market
  - +8% growth is expected for Asia / Pacific area

- **Power supply:**

  USB connectors are more and more often used as power suppliers:
  - Customers are asking for high current connectors (1.8A / 2.1A & 3A)
  - Smartphones, tablets, navigation systems are always requesting more & more power and need to be charged faster

- **Survey on 90 WE customers in America:**

  USB 3.1 Type C fits with customers' expectations with:
  - Higher durability
  - Higher data rate
  - Higher current capability (Power supply)
  - Reversibility feature
  - Short Type (for integrated applications)



Sources: http://www.strategyr.com

A little bit of history – *…to USB 3.1*

Year/Version	USB 2.0 – 2000	USB 3.0 – 2008	USB 3.1 – 2013
➢ A			
➢ B			
➢ Mini		✖	✖
➢ Micro			
➢ **C**			
➢ Data rate	480 Mbps	5000 Mbps	10000 Mbps
➢ Power	500mA / 5V	900mA / 5V	5A / 20V

Specification, Requirements & Performances
Electrical

- Contact resistance
  - V_{BUS} & GND Pins : 30mΩ max
  - Other Pins: 50mΩ max
  - $\Delta_{CONTACT\ RESISTANCE}$: 10mΩ max after mating cycles
- Insulation resistance > 100MΩ
- Dielectric Withstanding Voltage > 100MΩ
- Contact Current & Voltage rating:

Type	A		B		Micro B		C		
	Power Pins	Other Pins	Power Pins	Other Pins	Power Pins	Other Pins	Power Pins		Other Pins
Pin Number	1 & 4	-	1 & 4	-	1 & 5	-	A1,A4,A9 & A12 B1,B4,B9 & B12	A5 & B5	-
Current	1.8 A	0.25 A	1.8 A	0.25 A	1.8 A	0.25 A	1.5 / 5 A	1.25 A	0.25 A
Voltage	5 V								

Specification, Requirements & Performances
Mechanical

- Durability – Mating cycles

	A	B	Micro B	C
Mating cycles	1500 or 5000		10000	
Speed	200 cycles / hour			

- Insertion force

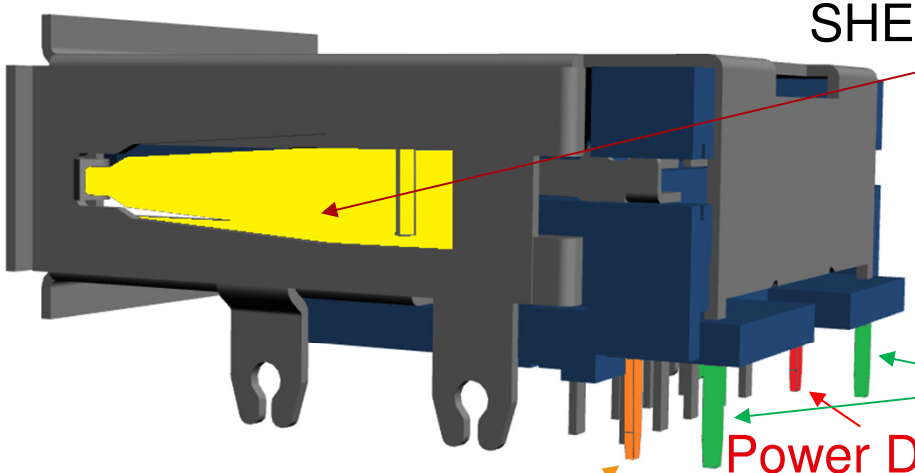
	A	B	Micro B	C
Insertion force	< 35 N	< 35 N	< 35 N	5 N to 8 N
Speed	12.5 mm / min			

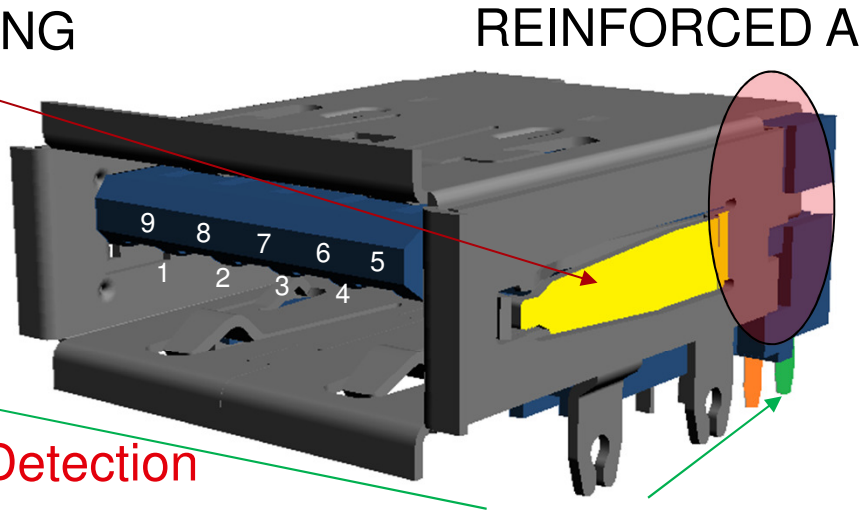
- Extraction force (retention)

	A	B	Micro B	C
Standard mating cycles	1500	1500	10000	10000
Before mating cycles	> 10 N	> 10 N	10 N < Force < 25 N	8 N < Force < 20 N
After 1000 cycles	-	-	-	6 N < Force < 20 N
At max. cycles	> 8 N	> 8 N	8 N < Force < 25 N	6 N < Force < 20 N
Speed	12.5 mm / min			

USB 3.1 Product Overview

PD Type A Receptacle – 632 121 300 001



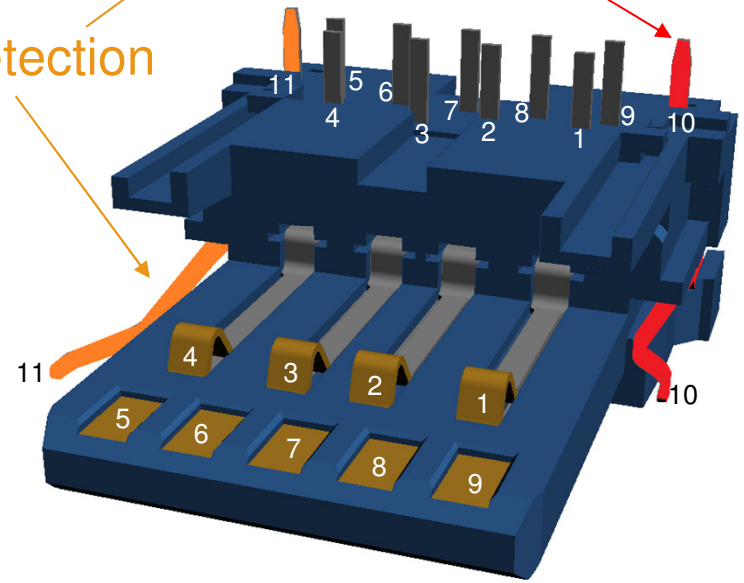


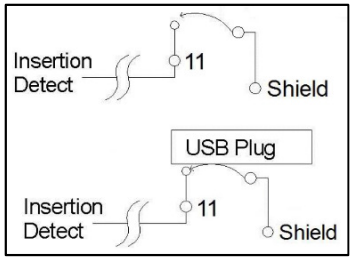
Power Delivery Detection

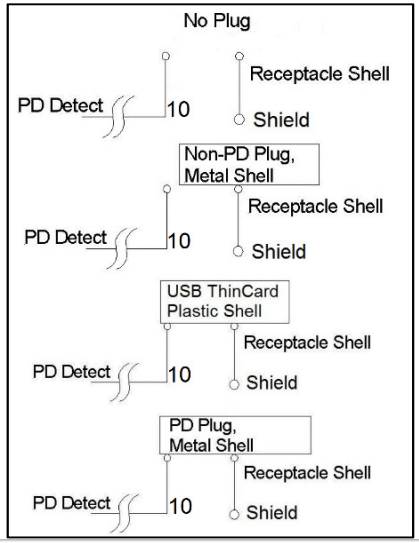
Plug Insertion Detection

Additional EMI DIP Pins

Pin Number	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+
10	PD DETECT
11	INSERTION DETECT

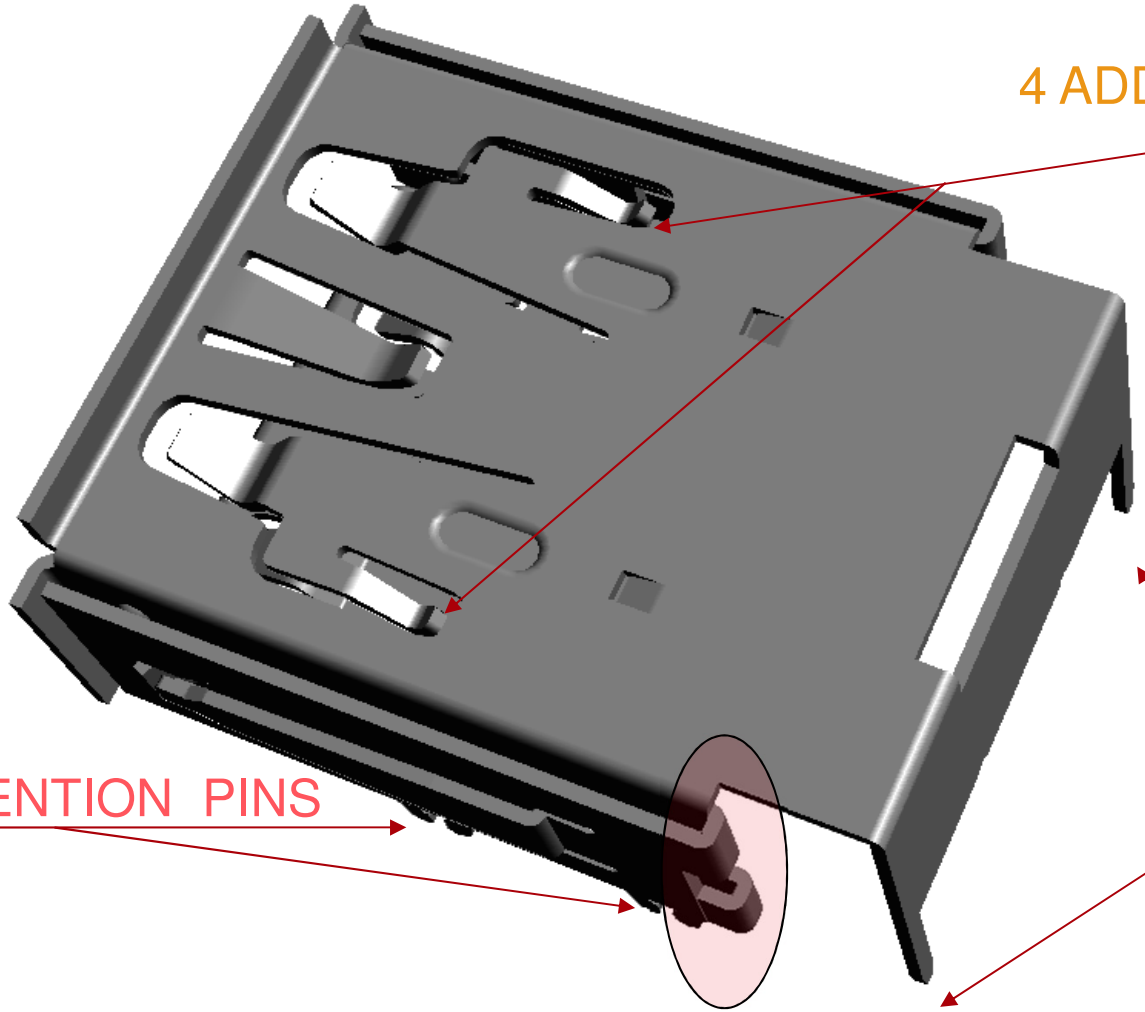






USB 3.1 Product Overview

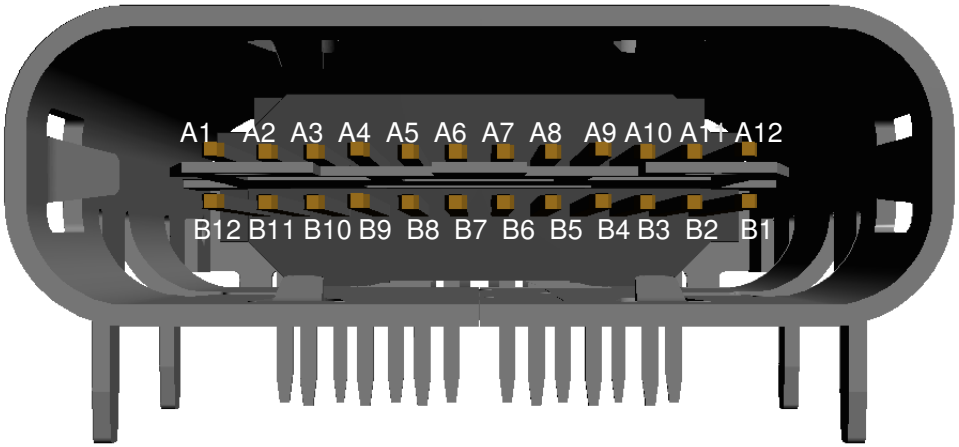
PD Type A Receptacle – 632 121 300 001



PD Type A Receptacle – Conclusion

- Supports Power Delivery with:
  - 5 A
  - 5V / 12V / 20 V
- Improved EMI/RFI Performances of at least 10 dB
  - 4 Additional flanges
  - Improved shielding
  - 2 Additional DIP pins for Ground
- Compatibility with USB 2.0 & USB 3.0
- 5 000 Mating cycles

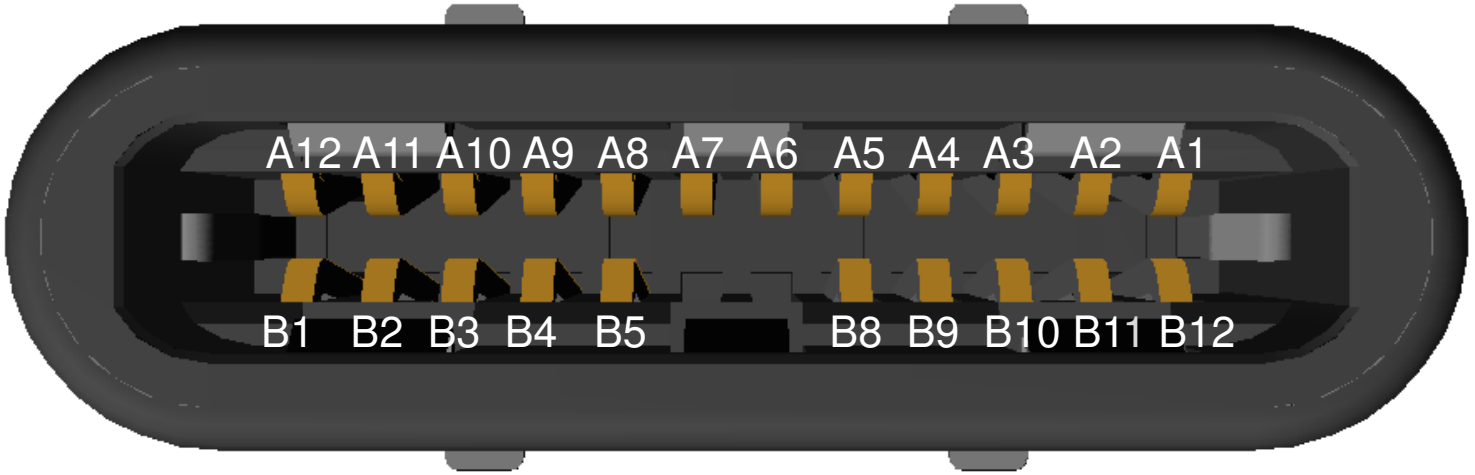
Type C Receptacles – 632 723 x00 011



GND : All pins (4) are connected together
V_{BUS}: All pins (4) are connected together
D : USB 2.0 Data pair
TX : 2 transmission pairs
RX: 2 reception pairs
CC : Configuration Channel : Detection & Power Management + HTD Management
SBU: Side Band use : Alternate modes (other standards

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 Plug – 632 712 000 011



USB 2.0

USB 3.0

USB 3.1

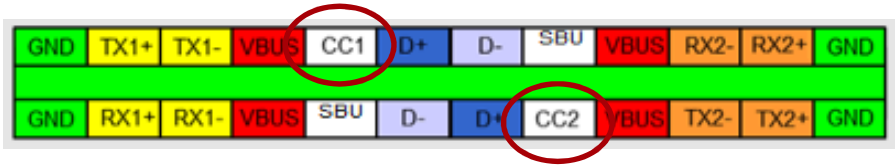
A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2-	V_{BUS}	SBU1	D+	D-	CC1	V_{BUS}	TX1-	TX1+	GND
GND	TX2+	TX2-	V_{BUS}	CC2			SBU2	V_{BUS}	RX1-	RX1+	GND
B1	B2	B3	B4	B5			B8	B9	B10	B11	B12

Configuration Channel

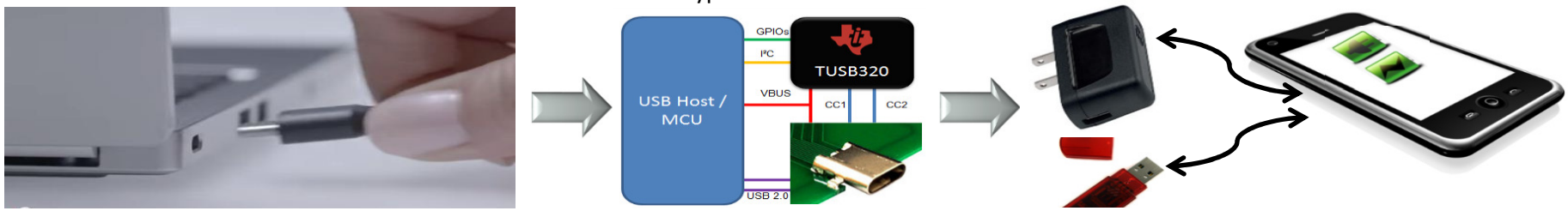
Providing the flexibility of Type-C

Functionally the Configuration Channel (CC) is used to serve the following purposes:

- **Detect connect of USB ports,**
- **Resolve cable orientation and twist connections to establish USB data bus routing**
- **Establish DFP (sink) and UFP (source) roles between two connected ports**
- **Discover and configure power: USB Type-C current modes or USB Power Delivery**
- **Discovery and configuration of optional Alternate and Accessory modes**



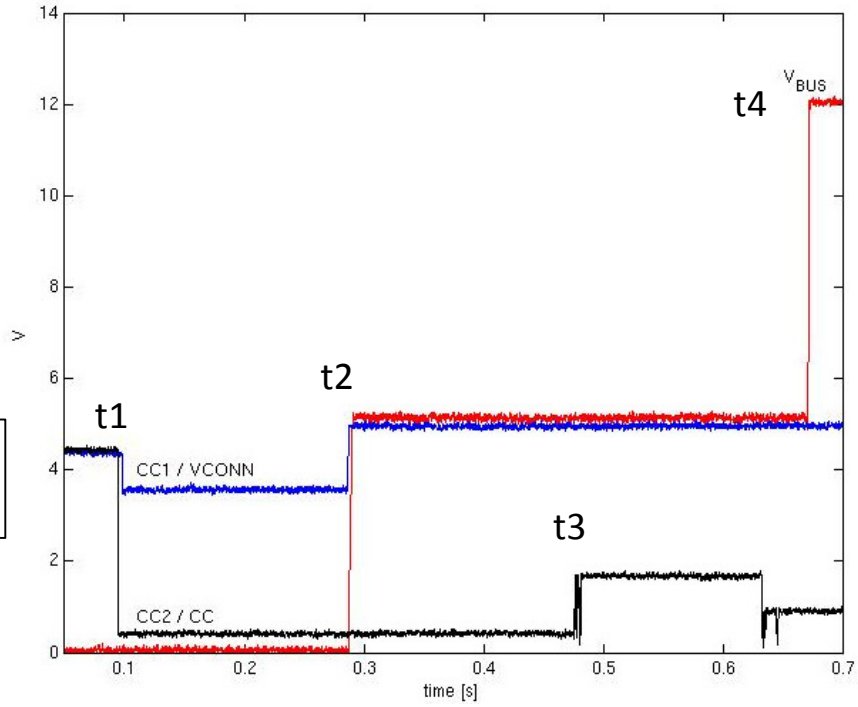
Typical CC flow for DFP to UFP configuration:



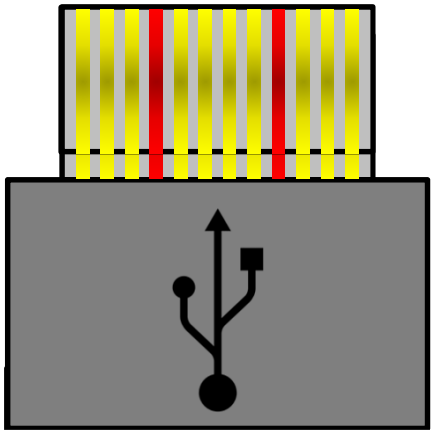
Detect valid connection | Establish USB power method | Configure as a DFP or UFP

Typical Behavior upon Attachment

- **The CC2 / CC line shows the voltages on the configuration channel between the sink and a source that applies VCONN to the cable.**
- **t1: the cable is attached.**
- **t2: the source confirms a valid sink is attached, then applies 5V to VBUS and VCONN.**
- **t3: USB Type-C 3A advertisement begins & USB PD messaging begins on CC line**
- **t4: VBUS voltage is increased to negotiated level.**



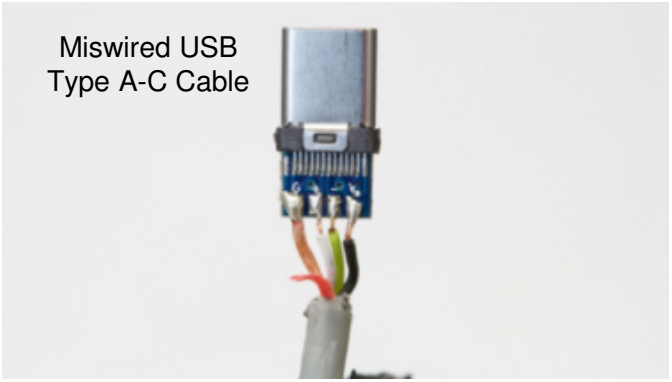
Potential Failure: Noncompliant Cables

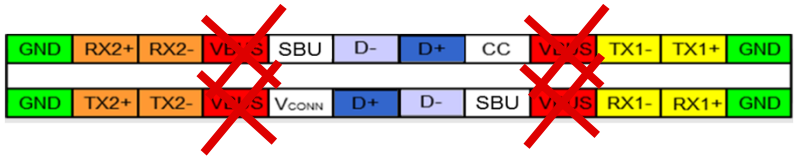


- Even if your system is not using USB PD (you are charging at 5V, 500mA), there are non-compliant cables that output 20V without PD negotiation
- If your system is not designed to handle 20V, then there would be a failure

•In a survey of USB Type-C cables available on Amazon, **28% of cables were not compliant to USB-IF specification.** (*Google Engineer Benson Leung: 20/71 cables out of specification*)

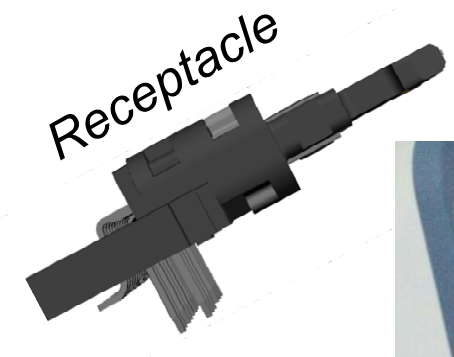
•Despite Amazon's ban there is still a risk of end user's purchasing non-compliant USB Type-C cables from cable manufacturers

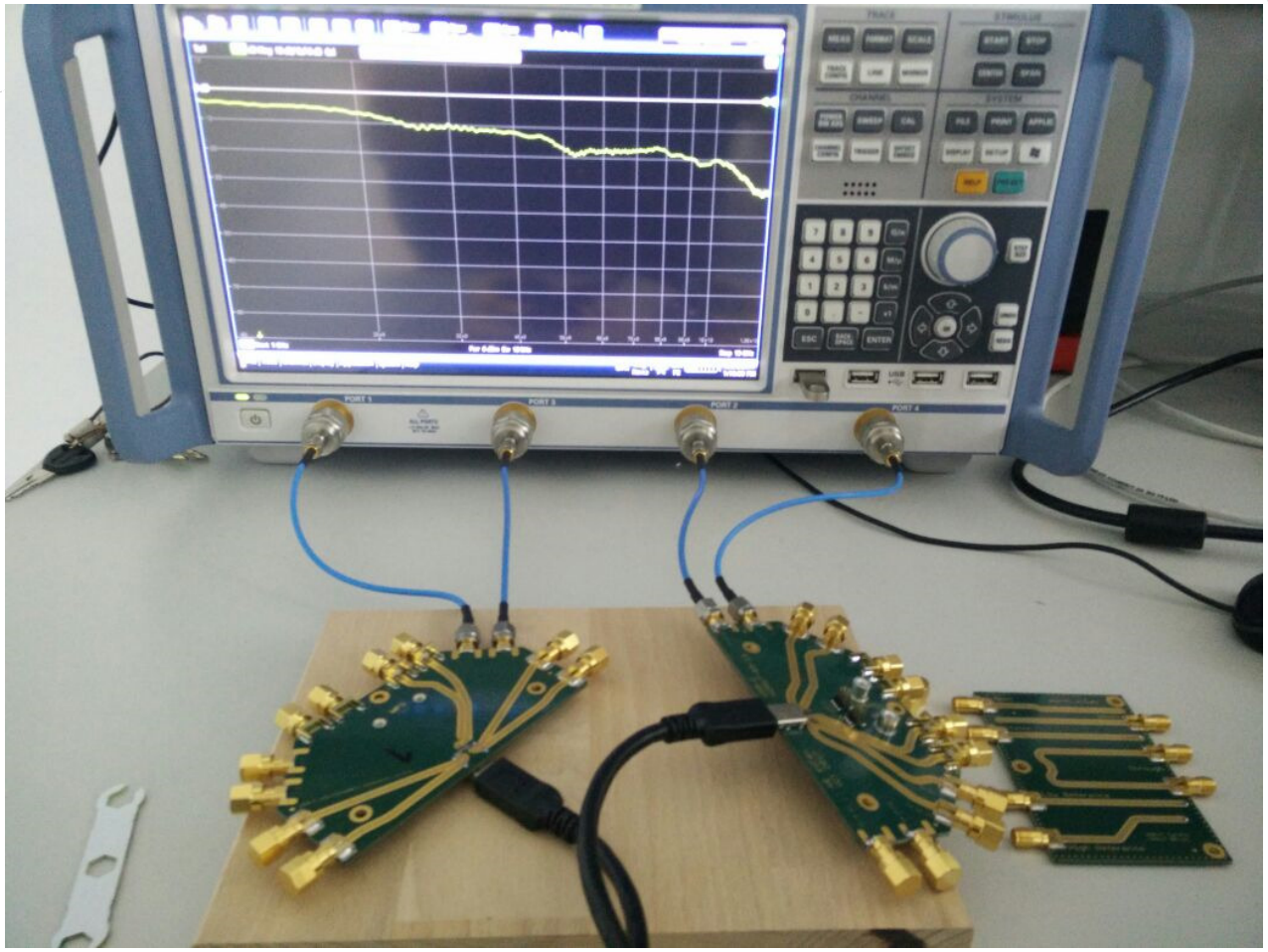




Specification, Requirements & Performances

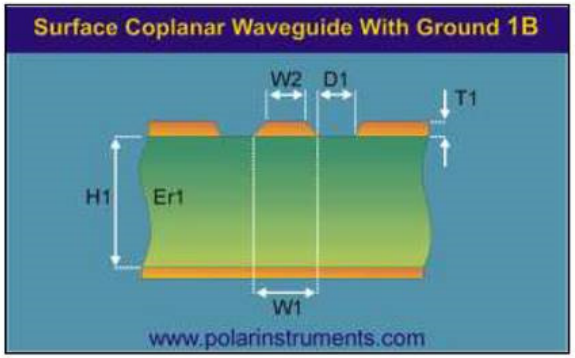
RF behavior





Specification, Requirements & Performances
RF behavior

Polar Si8000 Controlled Impedance Quick Solver



			Toleranz	Minimum	Maximum
Substrat 1 Dicke	H1	322,0000 +/-	0,0000	322,0000	322,0000
Substrat 1 Dielektrikum	Er1	4,6000 +/-	0,0000	4,6000	4,6000
Untere Leiterbreite	W1	450,0000 +/-	0,0000	450,0000	450,0000
Obere Leiterbreite	W2	420,0000 +/-	0,0000	420,0000	420,0000
Separation Massestreifen	D1	225,0000 +/-	0,0000	225,0000	225,0000
Leiterbahndicke	T1	50,0000 +/-	0,0000	50,0000	50,0000
Impedanz	Zo	50,13	------	0,00	0,00
Laufzeit (ps/m)	D	5725,350	------	0,000	0,000
Induktivität (nH/m)	L	287,010	------	0,000	0,000
Kapazität (pF/m)	C	114,211	------	0,000	0,000

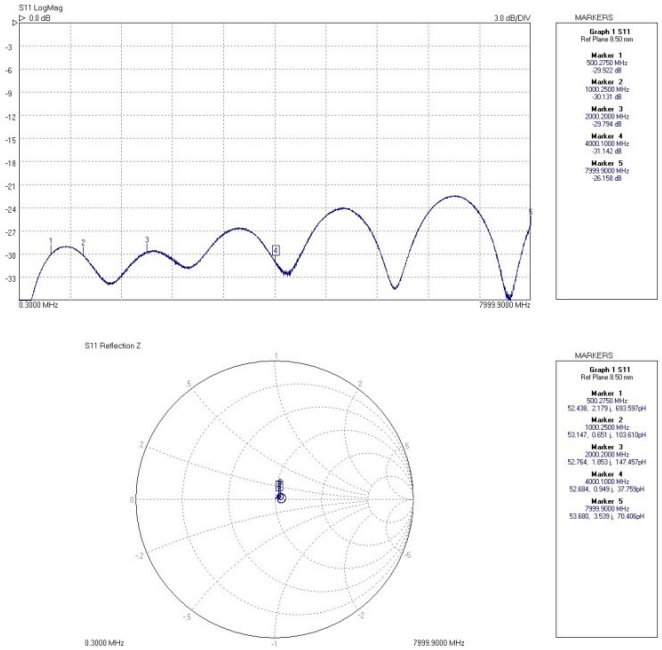
Calibration board

The mirostrip conductor has to be like Würth Elektronik suggests.

Specification, Requirements & Performances
RF behavior

Calibrationboard

The adjustment of the line:



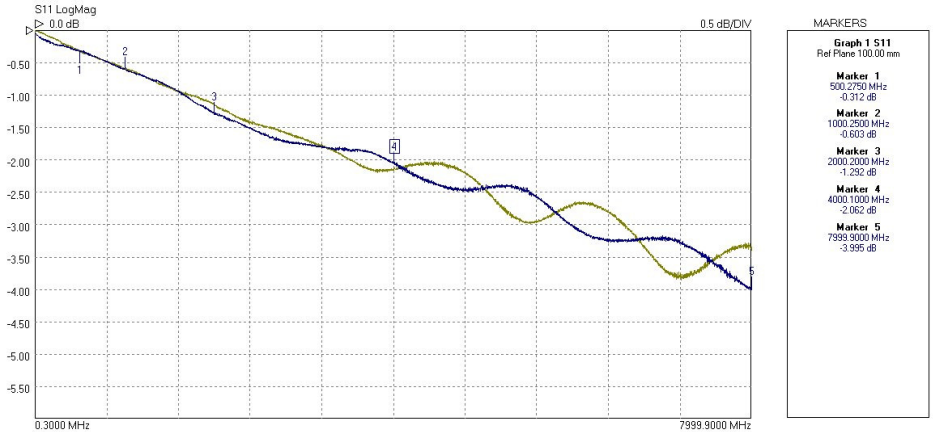
This corresponds to a line impedance of approximately 53 Ω.

Specification, Requirements & Performances

RF behavior

Calibrationboard

Insertion loss (refelction loss open / short)



As expected, open and short show a counter-image.

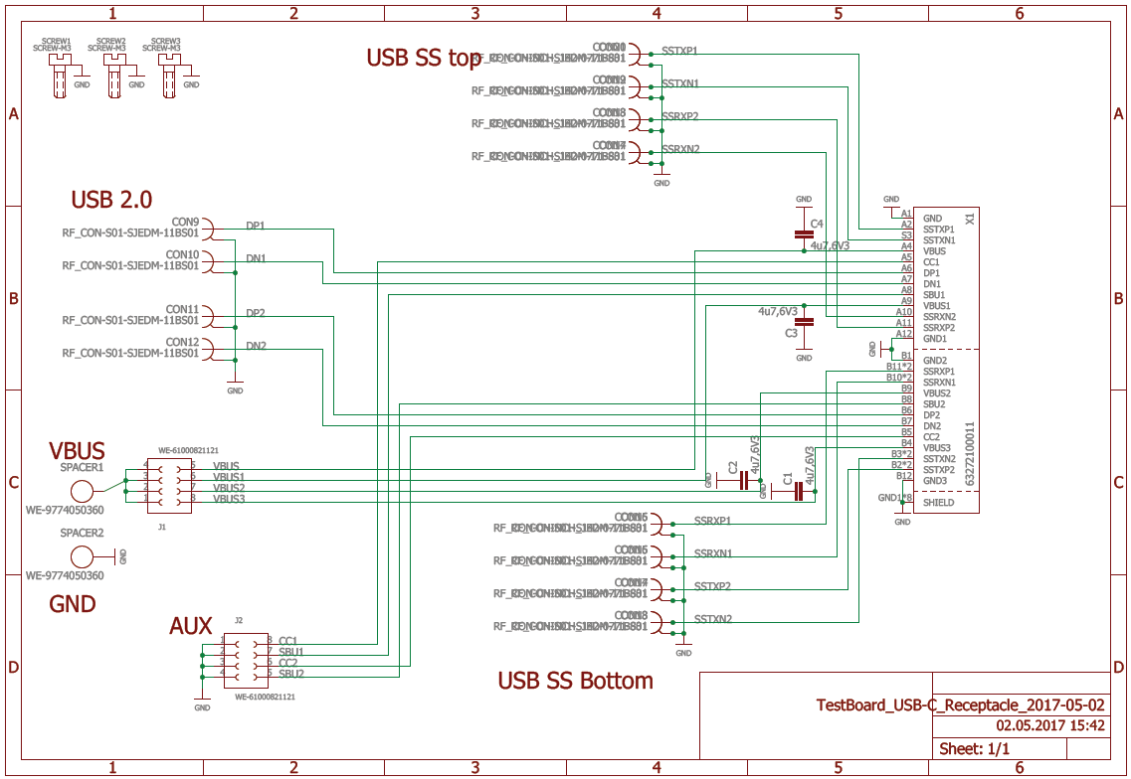
The real attenuation is half the value since the wave is attenuated on the return path.

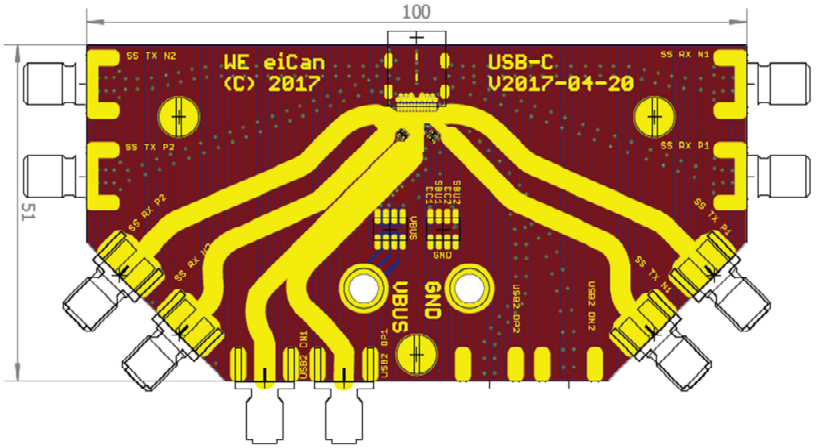
1.5	dB / m at 0.5 GHz
3	dB / m at 1 GHz
6	dB / m at 2 GHz
10.5	dB / m at 4 GHz
19	dB / m at 8 GHz

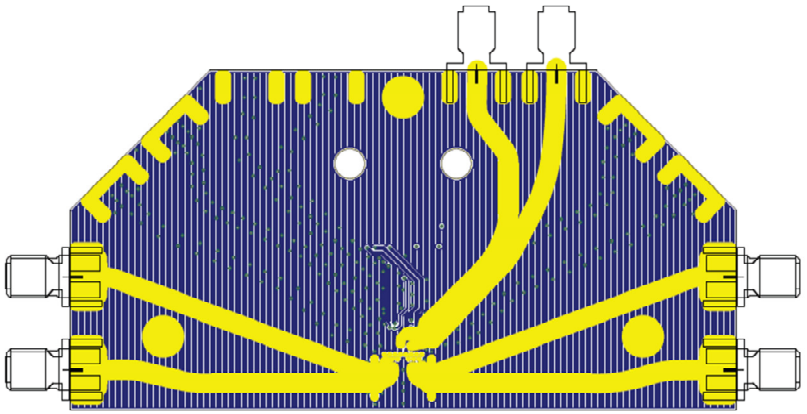
Specification, Requirements & Performances

RF behavior

Testboard

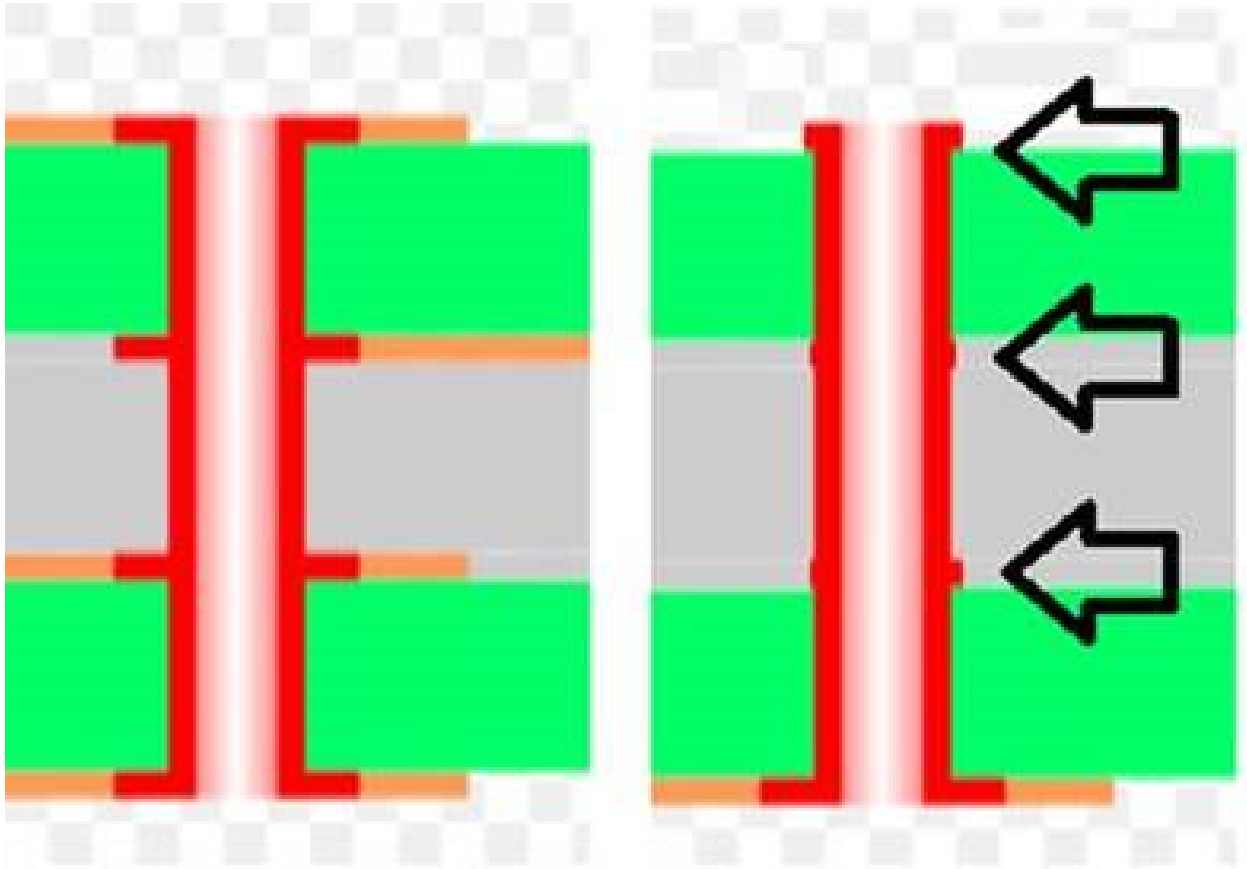






Specification, Requirements & Performances

RF behavior



Testboard

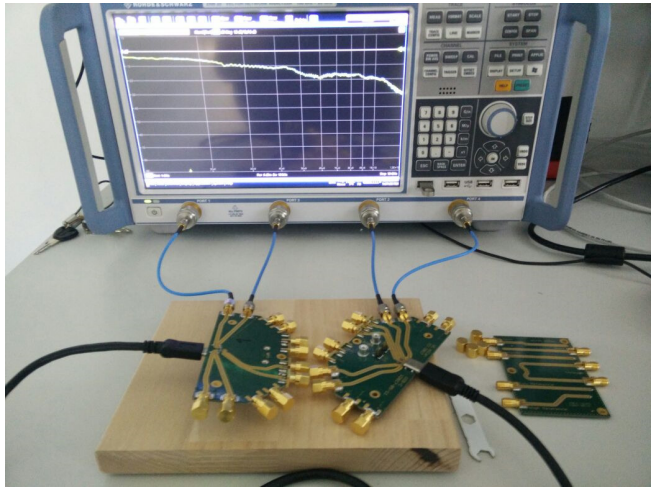
VIA preperation:

Without rest ring is important to avoid capacitive and inductive effects between the layers.

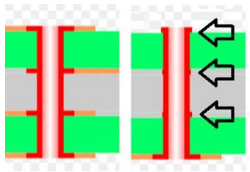
Specification, Requirements & Performances

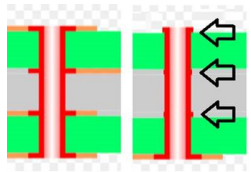
RF behavior

VIA
USB-C (Hybrid mount 623723300011)
USB-C Plug

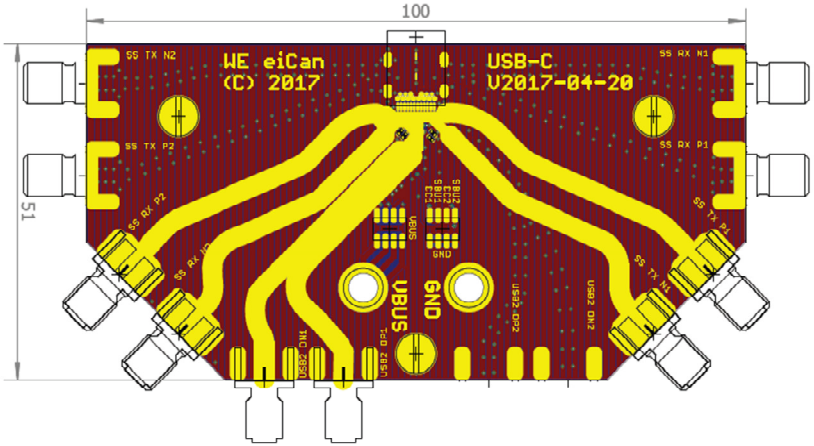


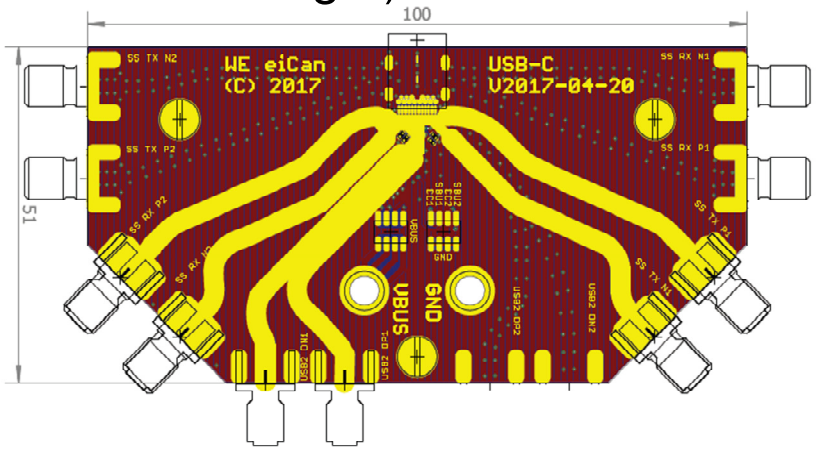
VIA
USB-C (Hybrid mount 623723300011)
USB-C Plug





USB Cable (632910731731)
USB3.1 cable C Male to C Male 100cm length)

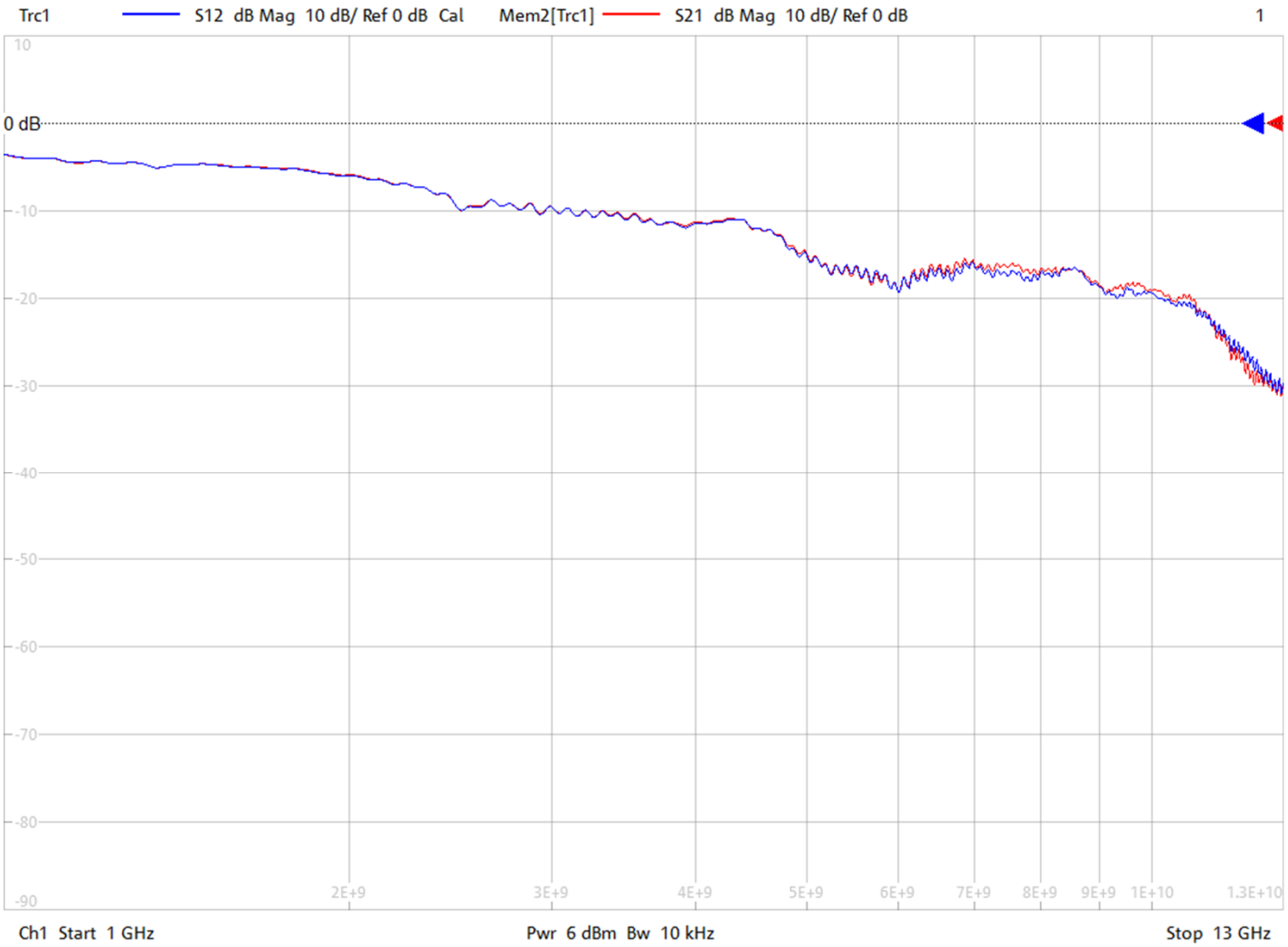




Specification, Requirements & Performances

RF behavior

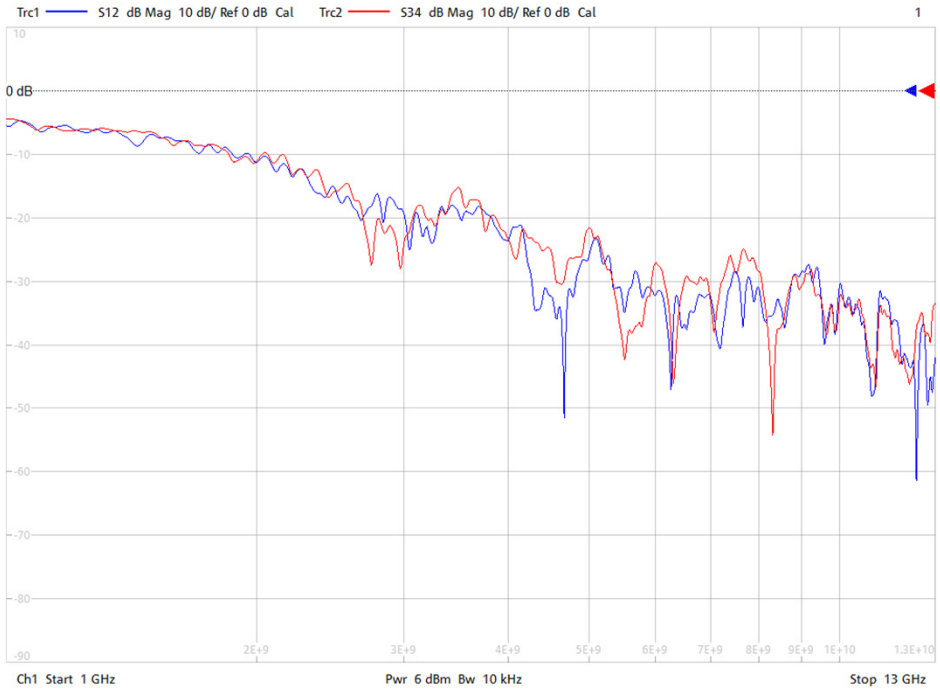
Attenuation:



Specification, Requirements & Performances

RF behavior

Attenuation D1 – D1:
(S12 – S34)



Attenuation D2 – D2:
(S32 – S41)

Pairs of datalines are nearly simmilar!

Thanks for your attention!

Würth Elektronik
Remco van de Griendt
E-mail: remco.vandegriendt@we-online.com
Tel: +31 6 109 84 436