USB 3.1 C Technical Analysis and Design Tips

more than you expect

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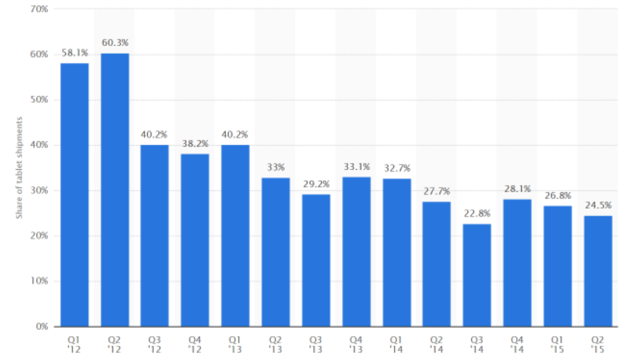
Why Type USB 3.1 & Type C

Market trends for USB (3.1)

- **Telecommunications & entertainment**
  - Smartphones:

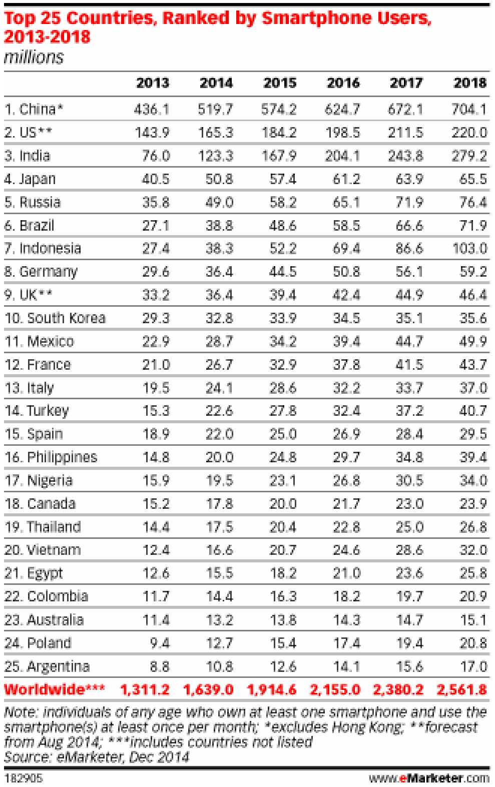
The statistic shows the market share of Apple of global tablet shipments from the first quarter of 2012 to the second quarter of 2015. In the fourth quarter of 2013 Apple's market share was at 33.2 percent.



In Q2 2015, Apple has “only” 24,5% of market share with Iphone with their lightning connector.

Moreover, market will constantly grow:

+ 34% users from 2015 to 2018



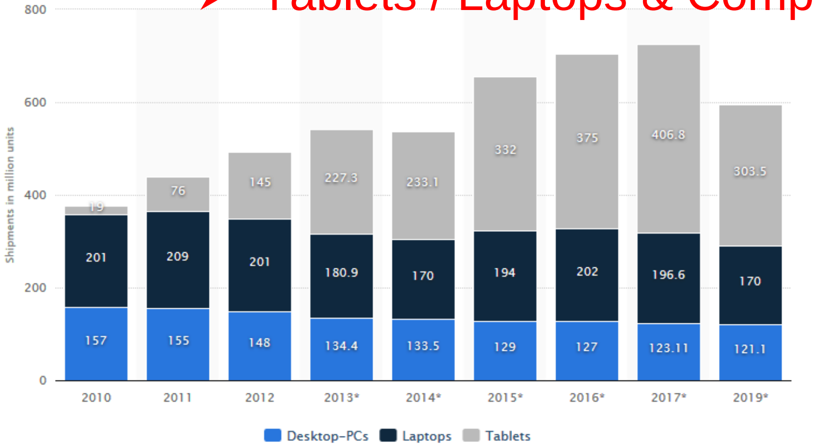
Top 25 Countries, Ranked by Smartphone Users, 2013-2018
millions

	2013	2014	2015	2016	2017	2018
1. China*	436.1	519.7	574.2	624.7	672.1	704.1
2. US**	143.9	165.3	184.2	198.5	211.5	220.0
3. India	76.0	123.3	167.9	204.1	243.8	279.2
4. Japan	40.5	50.8	57.4	61.2	63.9	65.5
5. Russia	35.8	49.0	58.2	65.1	71.9	76.4
6. Brazil	27.1	38.8	48.6	58.5	66.6	71.9
7. Indonesia	27.4	38.3	52.2	69.4	86.6	103.0
8. Germany	29.6	36.4	44.5	50.8	56.1	59.2
9. UK**	33.2	36.4	39.4	42.4	44.9	46.4
10. South Korea	29.3	32.8	33.9	34.5	35.1	35.6
11. Mexico	22.9	28.7	34.2	39.4	44.7	49.9
12. France	21.0	26.7	32.9	37.8	41.5	43.7
13. Italy	19.5	24.1	28.6	32.2	33.7	37.0
14. Turkey	15.3	22.6	27.8	32.4	37.2	40.7
15. Spain	18.9	22.0	25.0	26.9	28.4	29.5
16. Philippines	14.8	20.0	24.8	29.7	34.8	39.4
17. Nigeria	15.9	19.5	23.1	26.8	30.5	34.0
18. Canada	15.2	17.8	20.0	21.7	23.0	23.9
19. Thailand	14.4	17.5	20.4	22.8	25.0	26.8
20. Vietnam	12.4	16.6	20.7	24.6	28.6	32.0
21. Egypt	12.6	15.5	18.2	21.0	23.6	25.8
22. Colombia	11.7	14.4	16.3	18.2	19.7	20.9
23. Australia	11.4	13.2	13.8	14.3	14.7	15.1
24. Poland	9.4	12.7	15.4	17.4	19.4	20.8
25. Argentina	8.8	10.8	12.6	14.1	15.6	17.0
Worldwide***	**1,311.2**	**1,639.0**	**1,914.6**	**2,155.0**	**2,380.2**	**2,561.8**

*Note: individuals of any age who own at least one smartphone and use the smartphone(s) at least once per month; *excludes Hong Kong; **forecast from Aug 2014; ***includes countries not listed*
Source: eMarketer, Dec 2014

182905 www.eMarketer.com

  - Tablets / Laptops & Computers: For 2016 + 2017:
    - Tablets: 782 kk units (+22 %)
    - Laptops: 399 kk units (+ 2 %)
    - Computers: 250 kk units (-5%)



Sources: http://www.emarketer.com & http://www.statista.com

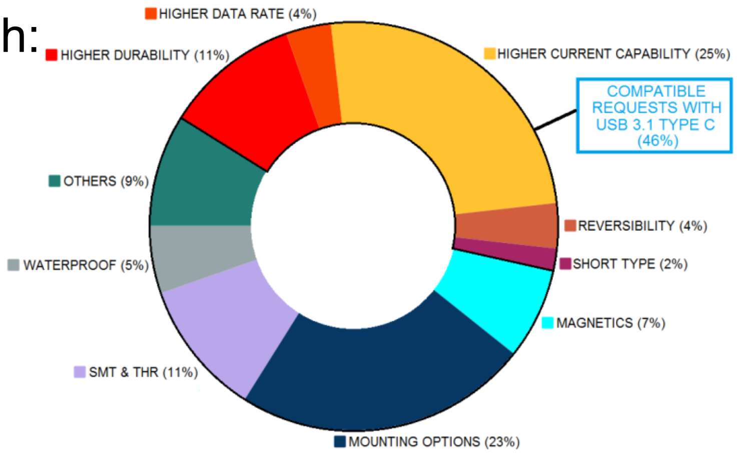
Why Type USB 3.1 & Type C

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:**

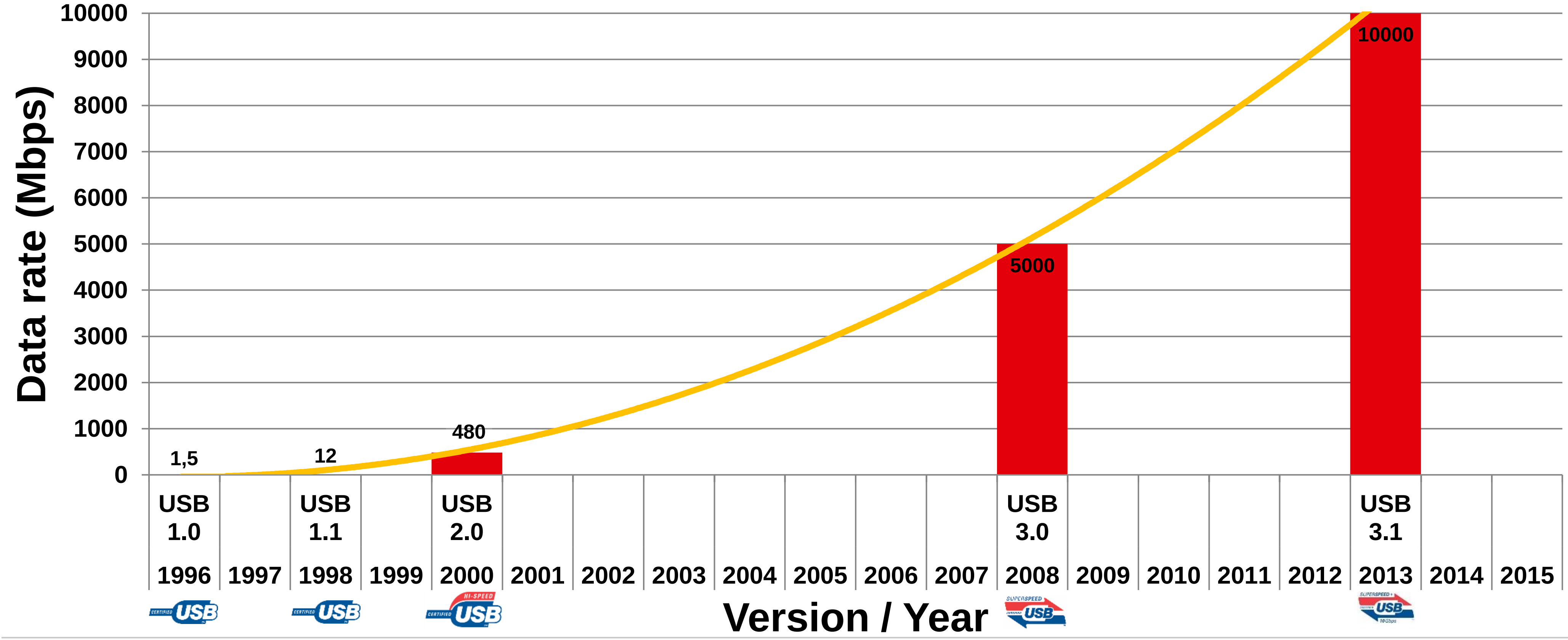
  USB 3.1 Type C fits with customers' expectations with:
  - Higher durability
  - Higher data rate
  - Higher current capability (Power supply)
  - Reversibility feature
  - Short Type (for integrated applications)



Sources: http://www.strategyr.com

A little bit of history – *USB Versions?*

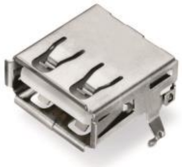
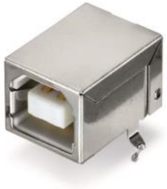
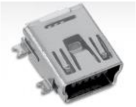
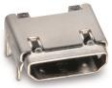
- USB = **Universal Serial Bus**



USB Overview - *USB Versions*

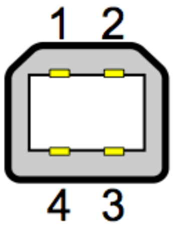
- **USB 1.x – January 1996**
  - Low-speed: 1.5Mbps
  - Full-speed: 12 Mbps
- **USB 1.1 – July 1998**
- **USB 2.0 – April 2000**
  - Full backwards compatibility with USB 1.1
  - Adds high-speed: 480 Mbps
- **USB 3.0 – December 2008**
  - Super-speed: 5 Gbps
  - Backwards-compatible to USB 2.0 standard
- **USB 3.1 – August 2013**
  - Super-speed +: 10 Gbps
  - Backwards-compatible to USB 3.0 standard

A little bit of history – *From 2.0…*

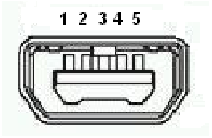
Year/Version	USB 2.0 – 2000
➢ A	
➢ B	
➢ Mini	
➢ Micro	
➢ Data rate	480 Mbps
➢ Power	500mA / 5V

USB 2.0 Overview – *Mini & Micro Types*

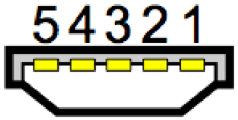
- 5 contacts on Mini and Micro types
- 4 contacts on “Standard” types



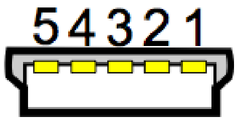
- **WHY?**



Mini-AB



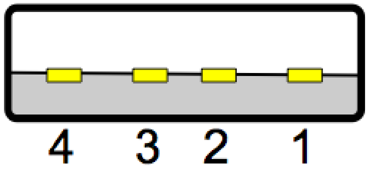
Mini-A

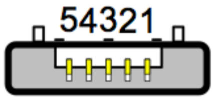


Mini-B

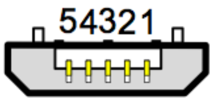
Contact No.	Signal Name	Description
1	VBUS	Power
2	Data-	USB 2.0 Twisted pair
3	Data+	
4	GND	Ground for power return
Shell	Shield	

Contact No.	Signal Name	Description
1	VBUS	Power
2	Data-	USB 2.0 Twisted pair
3	Data+	
4	ID	OTG identification
5	GND	Ground for power return
Shell	Shield	





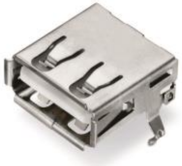
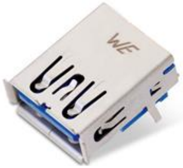
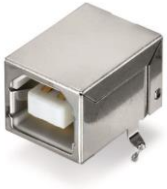
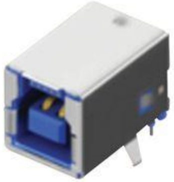
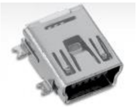
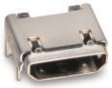
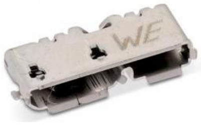
Micro-A



Micro-B

- Cable A to Micro/Mini: loose of 1 wire – information

A little bit of history – …to USB 3.0 …

Year/Version	USB 2.0 – 2000	USB 3.0 – 2008
A		
B		
Mini		✗
Micro		
Data rate	480 Mbps	5000 Mbps
Power	500mA / 5V	900mA / 5V

USB 3.0 Overview - *History / Benchmark*

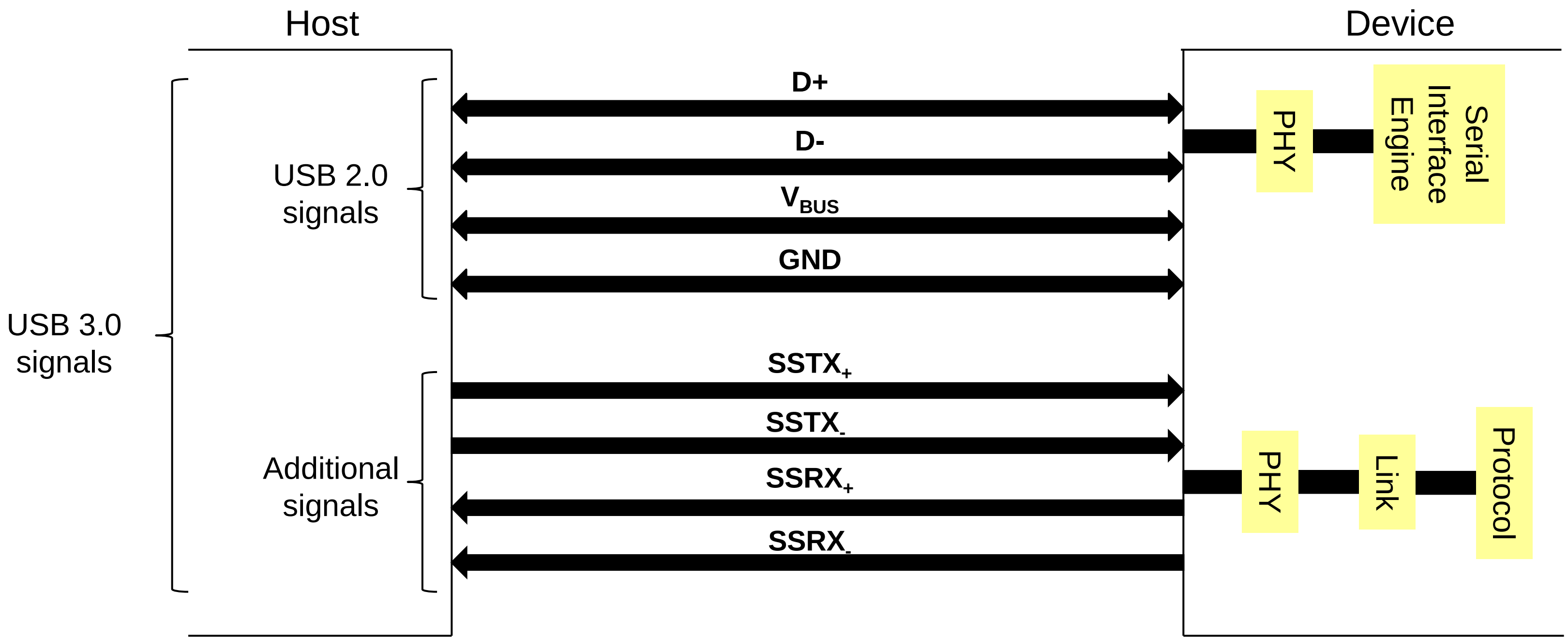
- Based on Microsoft tests: (showed at WinHEC 2008 on Nov 6)

Transfer of a 25GB Blu-ray movie:
USB 1.1: 9.3 hours
USB 2.0: 13.9 minutes
USB 3.0: 70 seconds

≈ x 40
≈ x 12

USB version	**Data rate**
USB 1.0	1,5 Mbps
USB 1.1	12 Mbps
USB 2.0	480 Mbps
USB 3.0	5 Gbps

USB 3.0 Overview - *Architecture and protocol*


Host
Device
USB 3.0 signals
USB 2.0 signals
Additional signals
D+
D-
V_{BUS}
GND
$SSTX_+$
$SSTX_-$
$SSRX_+$
$SSRX_-$
PHY
Serial Interface Engine
PHY
Link
Protocol

Note: Tx & Rx are defined from the host perspective

USB 3.0 Overview – *Power Management*

With up to 150 mA per unit (+50 % compared to USB 2.0) and up to 6 units together, USB 3.0 can carry up to:

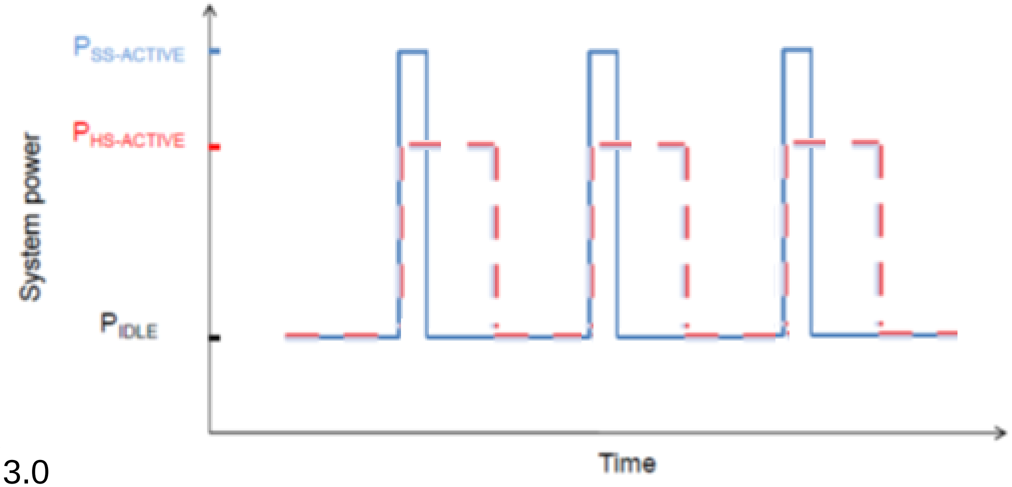
900 mA * 5V = 4,5W = P_{SS_ACTIVE} Vs. 500 mA * 5V = 2,5W = P_{HS_ACTIVE}

This means a total **80% increase compared to USB 2.0**.

$$P_{TOTAL} = PI_{DLE} + (P_{ACTIVE} - PI_{DLE}) * \alpha$$

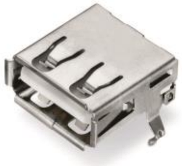
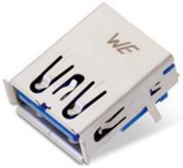
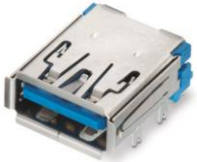
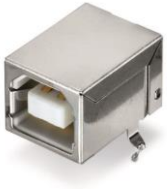
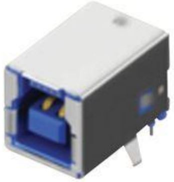
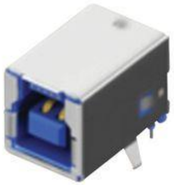
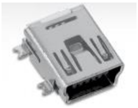
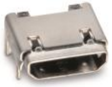
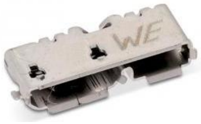
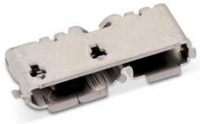
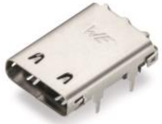
$$P_{TOTAL3} = PI_{DLE} + 1{,}8 * (P_{HS\_ACTIVE} - PIDLE) * \alpha_{3.0}$$

$$P_{TOTAL2} = PI_{DLE} + (P_{HS\_ACTIVE} - PIDLE) * \alpha_{2.0}$$



P_{IDLE} : system power when no data transfer is taking place
$P_{HS\text{-}ACTIVE}$: system power in High Speed (2.0) mode
$P_{SS\text{-}ACTIVE}$: system power in Super Speed (3.0) mode

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 / 5V

Specification, Requirements & Performances
Electrical

- Contact resistance
    - V_{BUS} & GND Pins : 30mΩ max
    - Other Pins: 50mΩ max
    - $\Delta_{\text{CONTACT RESISTANCE}}$: 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

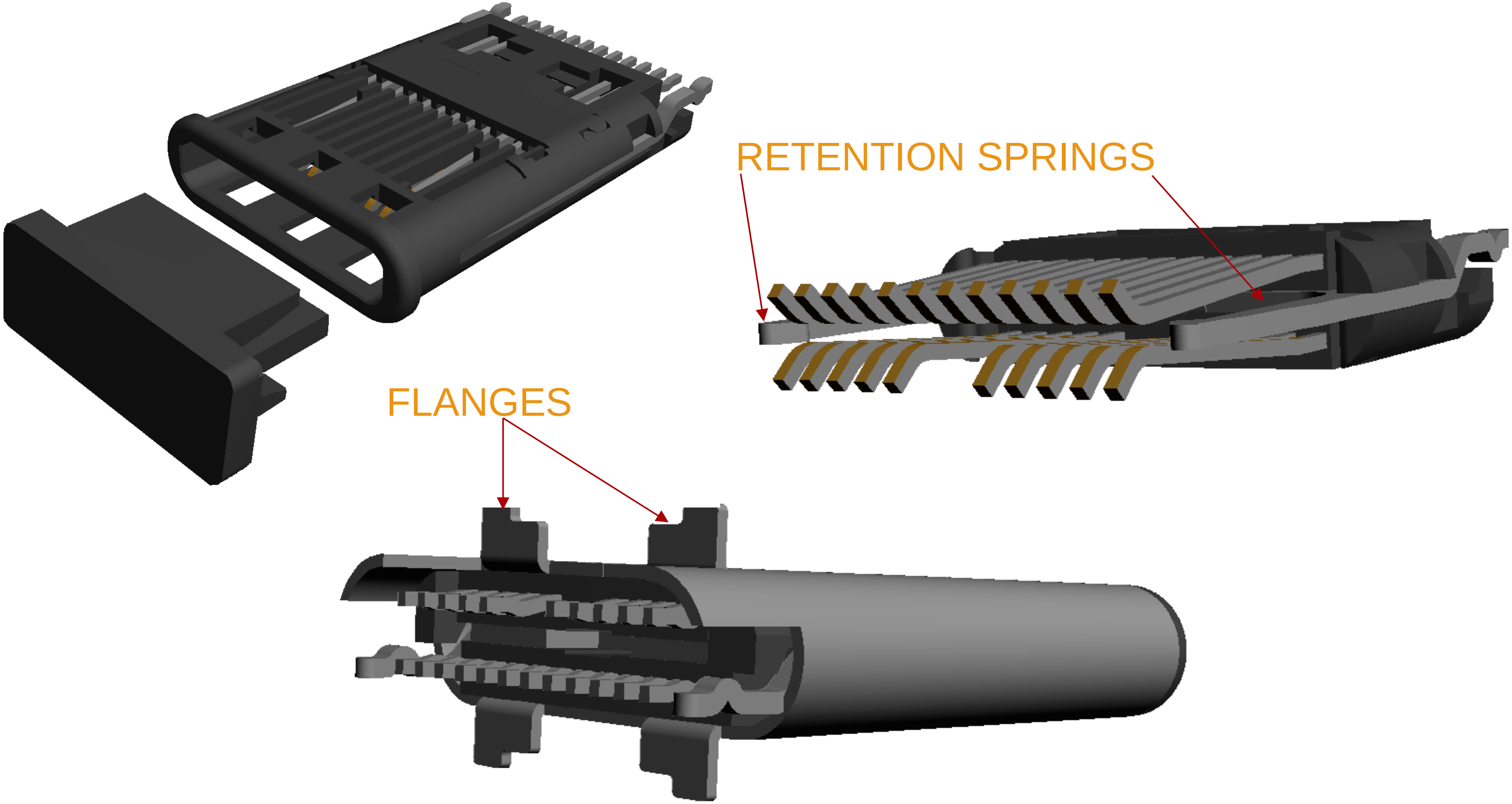
	A	B	Micro B	C
Insertion force	< 35 N	< 35 N	< 35 N	5 N to 8 N
Speed	12.5 mm / min			

- 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

Type C Plug Design – 632 712 000 011


RETENTION SPRINGS
FLANGES

Type C Receptacles

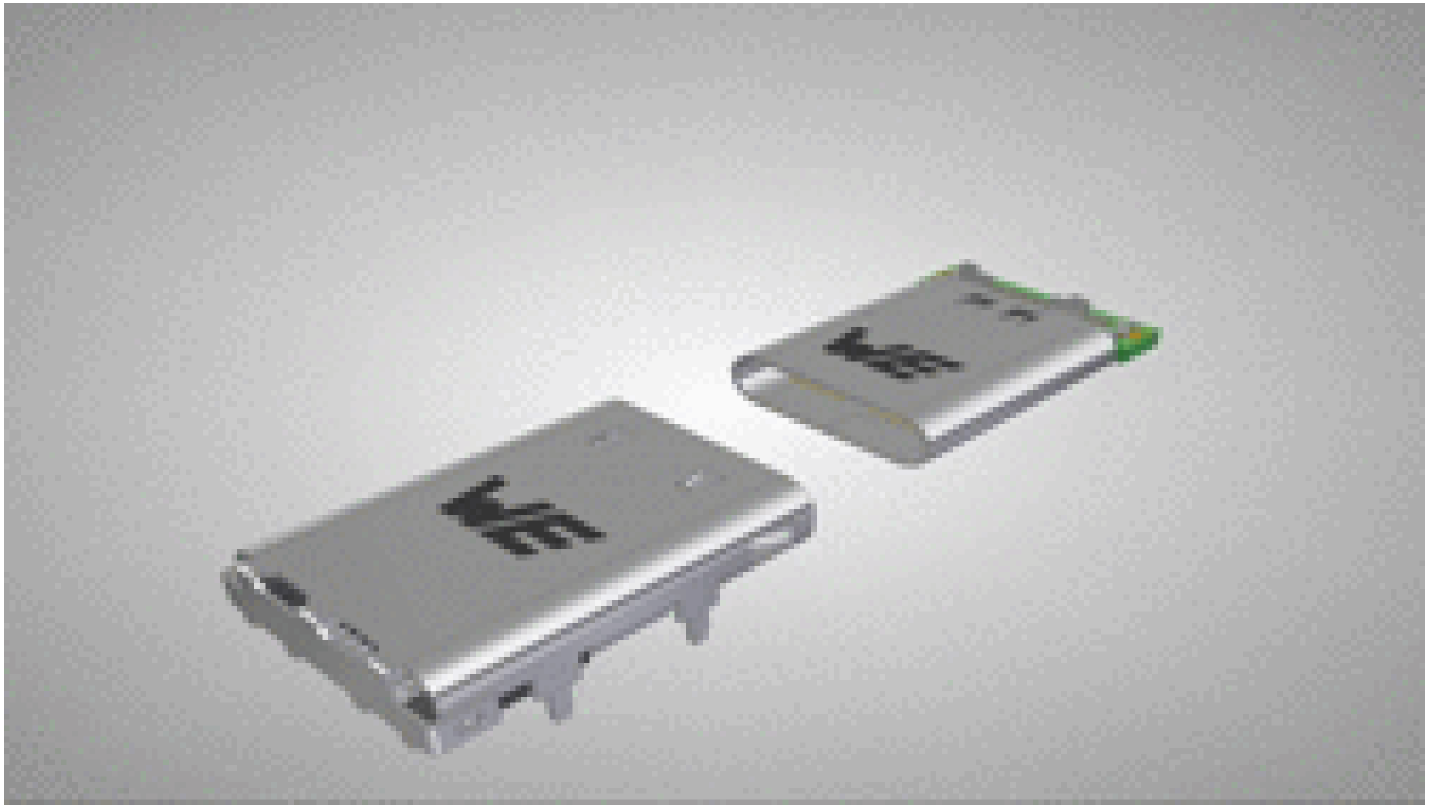
- **Order code:**

  632 723 X00 011

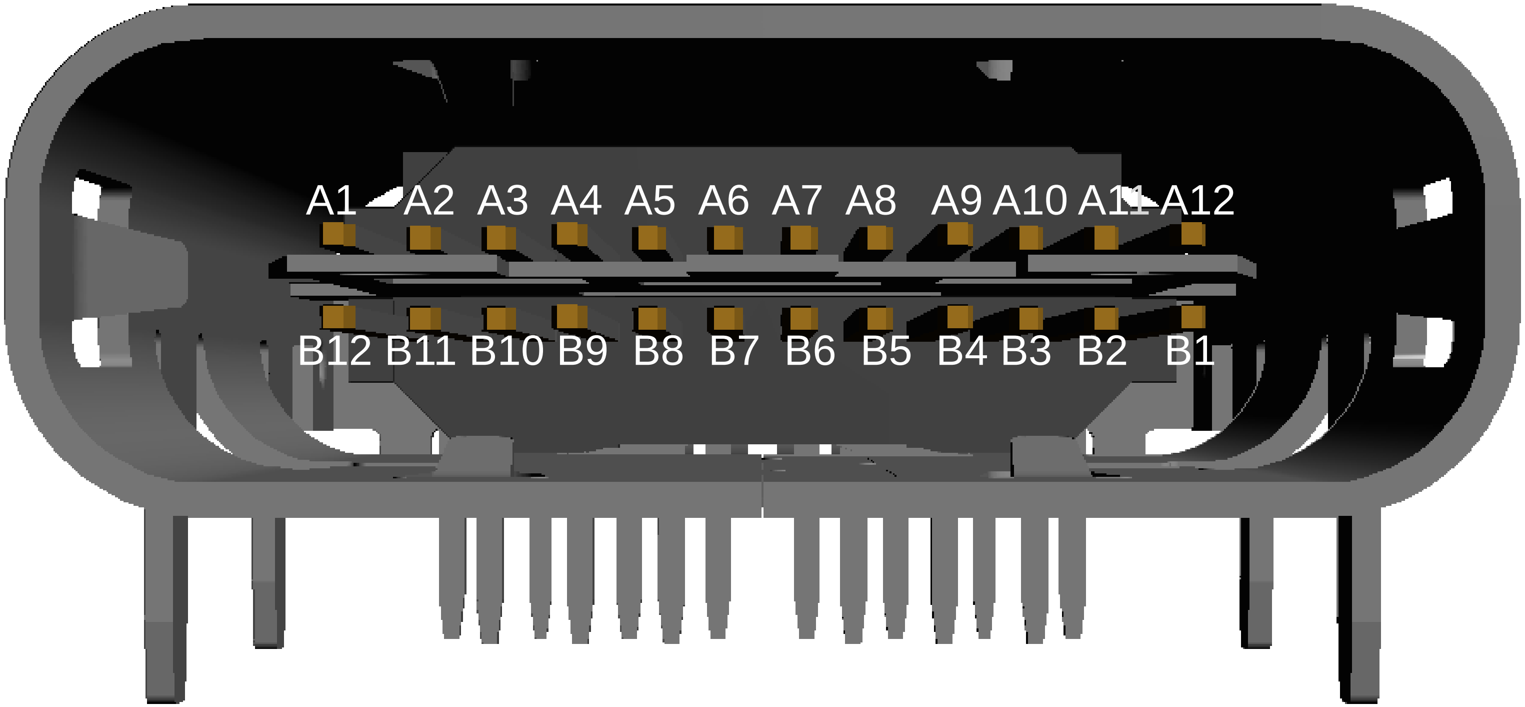
- Product features:
  1. Material: LCP; black
  2. Rated Current: 5 A
  3. Rated Voltage: 5 VDC (12VDC/20VDC)
  4. Durability: 10 000 cycles
  5. Soldering: JEDEC lead free wave and reflow soldering

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

Type C Receptacles – 632 723 x00 011



Type C Receptacles – 632 723 x00 011


A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12
B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 B1

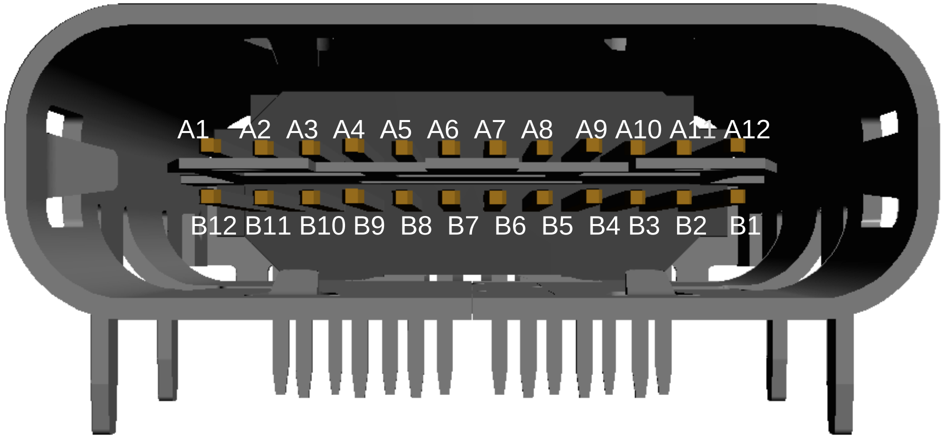
🟥 USB 2.0

🟦 USB 3.0

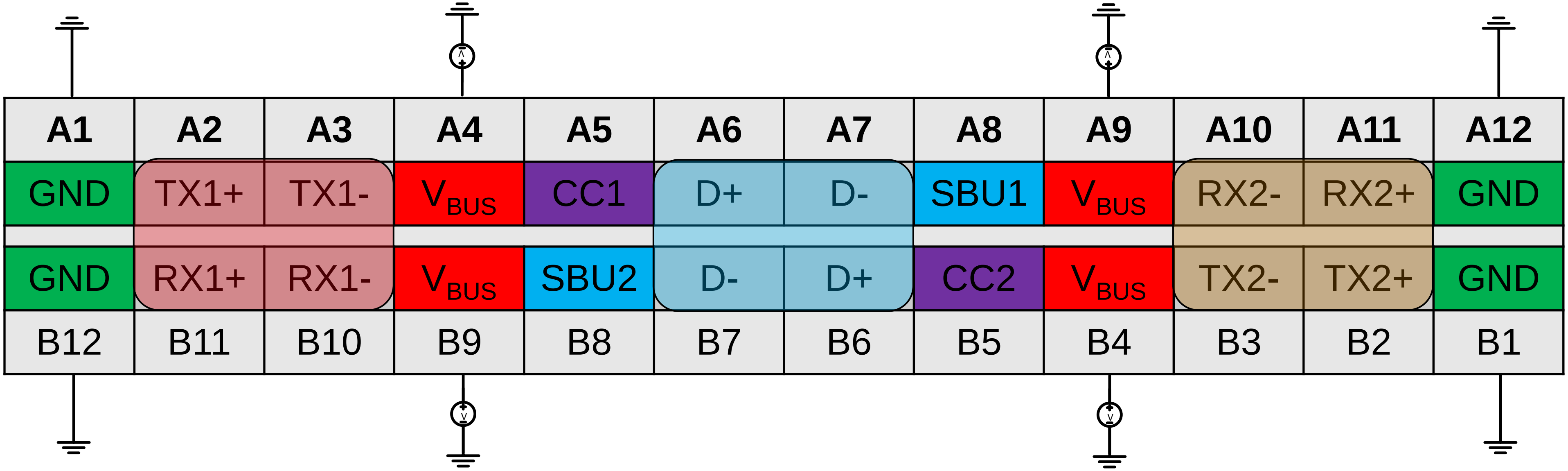
🟩 USB 3.1

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 – 632 723 x00 011


A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12
B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 B1

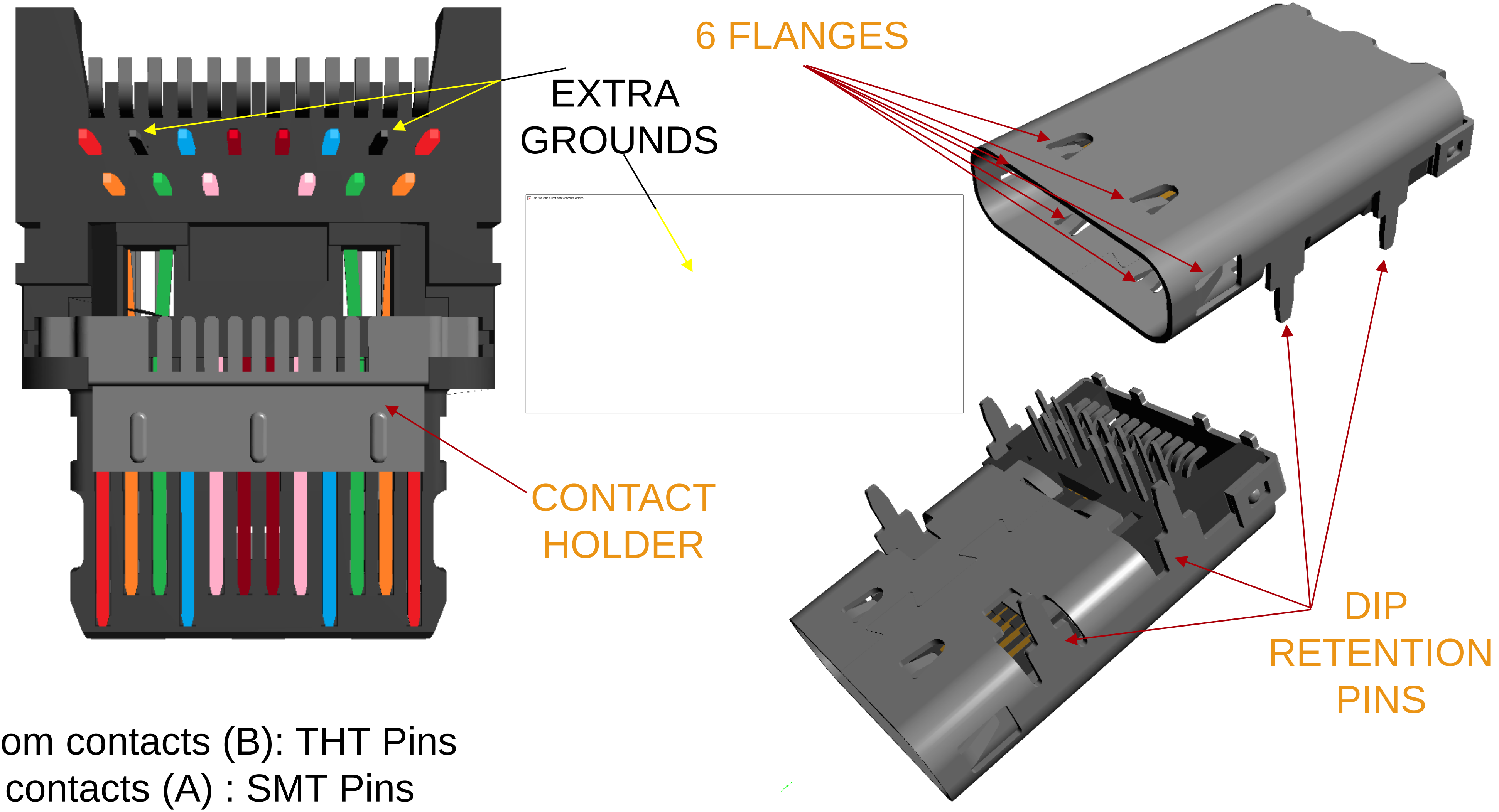
GND :	All pins (4) are connected together
V_{BUS}:	All pins (4) are connected together
D :	USB 2.0 Data pair
TX :	2 transmission pairs
RX:	2 reception pairs
CC :	Configuration Channel : Detection & Power Management + HTD Management
SBU:	Side Band use : Alternate modes (other standards



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

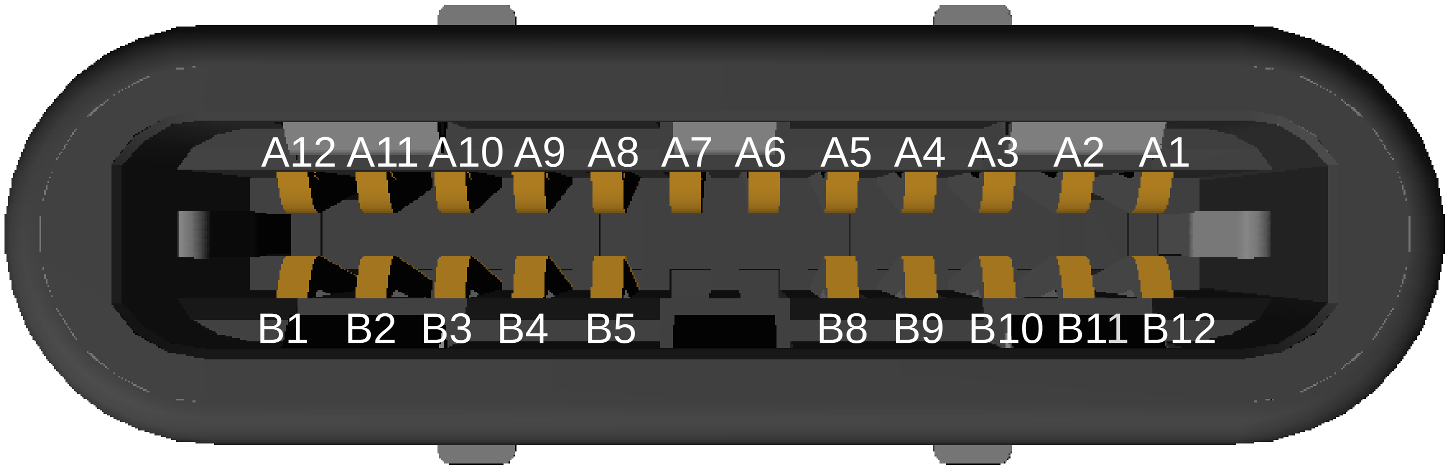
USB 3.1 Product Overview

Type C Receptacles Design – 632 723 x00 011


6 FLANGES
EXTRA GROUNDS
CONTACT HOLDER
DIP RETENTION PINS

Bottom contacts (B): THT Pins
Top contacts (A) : SMT Pins

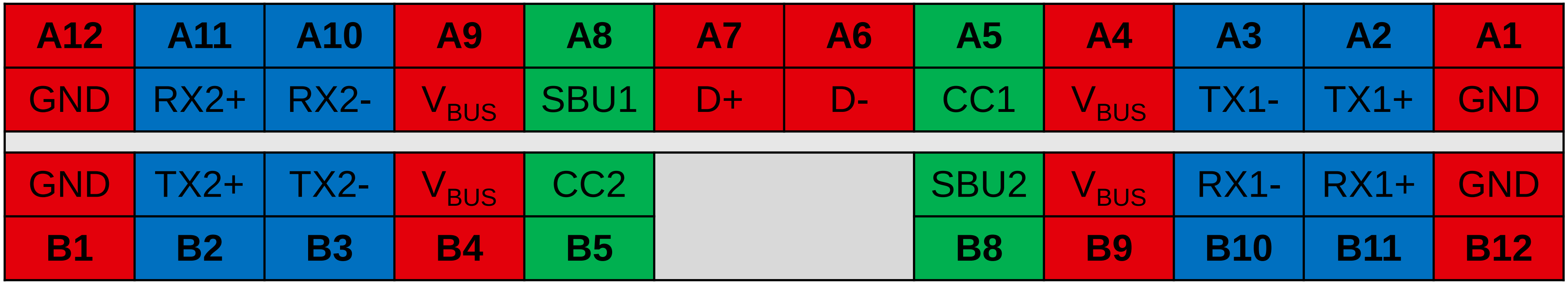
Type C Plug – 632 712 000 011


A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1
B1 B2 B3 B4 B5 B8 B9 B10 B11 B12

🟥 USB 2.0

🟦 USB 3.0

🟩 USB 3.1



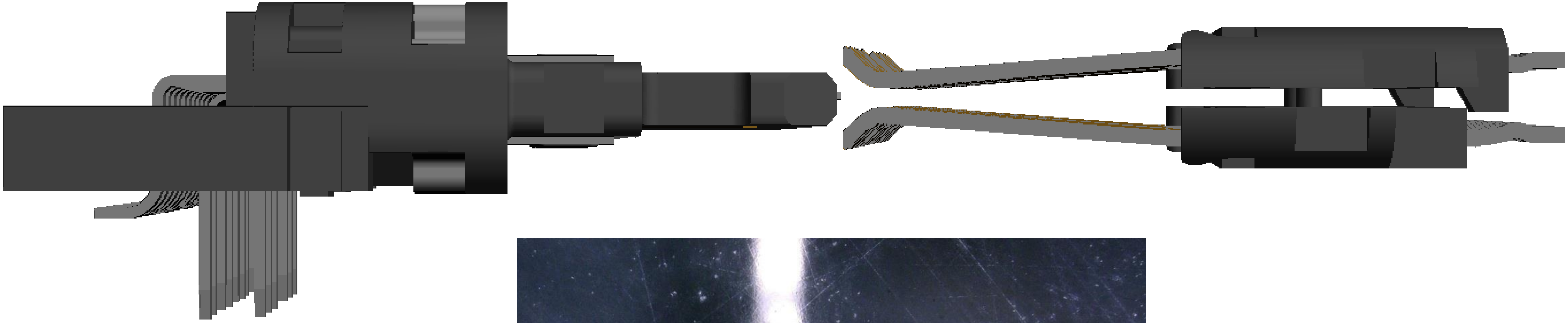
A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2-	V_{BUS}	SBU1	D+	D-	CC1	V_{BUS}	TX1-	TX1+	GND
GND	TX2+	TX2-	V_{BUS}	CC2			SBU2	V_{BUS}	RX1-	RX1+	GND
B1	**B2**	**B3**	**B4**	**B5**			**B8**	**B9**	**B10**	**B11**	**B12**

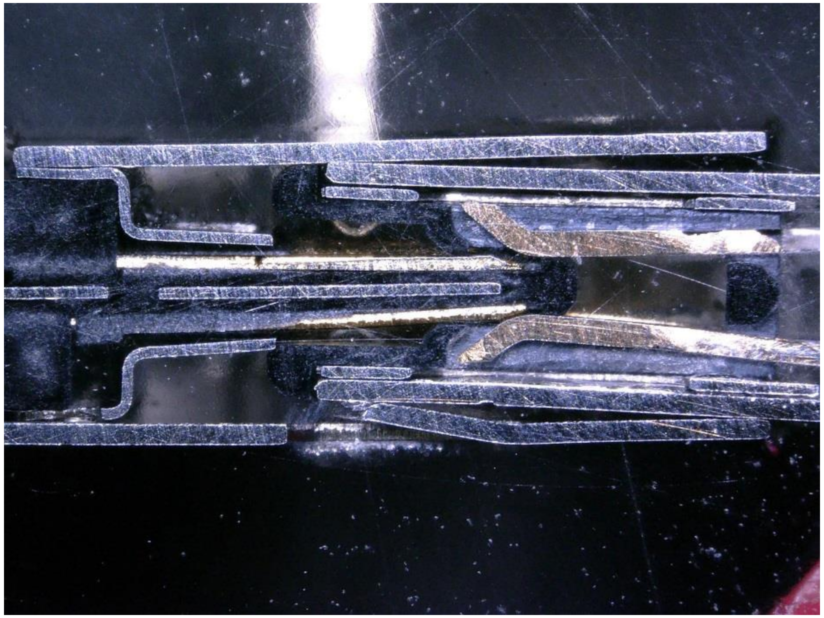
USB 3.1 Product Overview

Type C Plug Design – 632 712 000 011

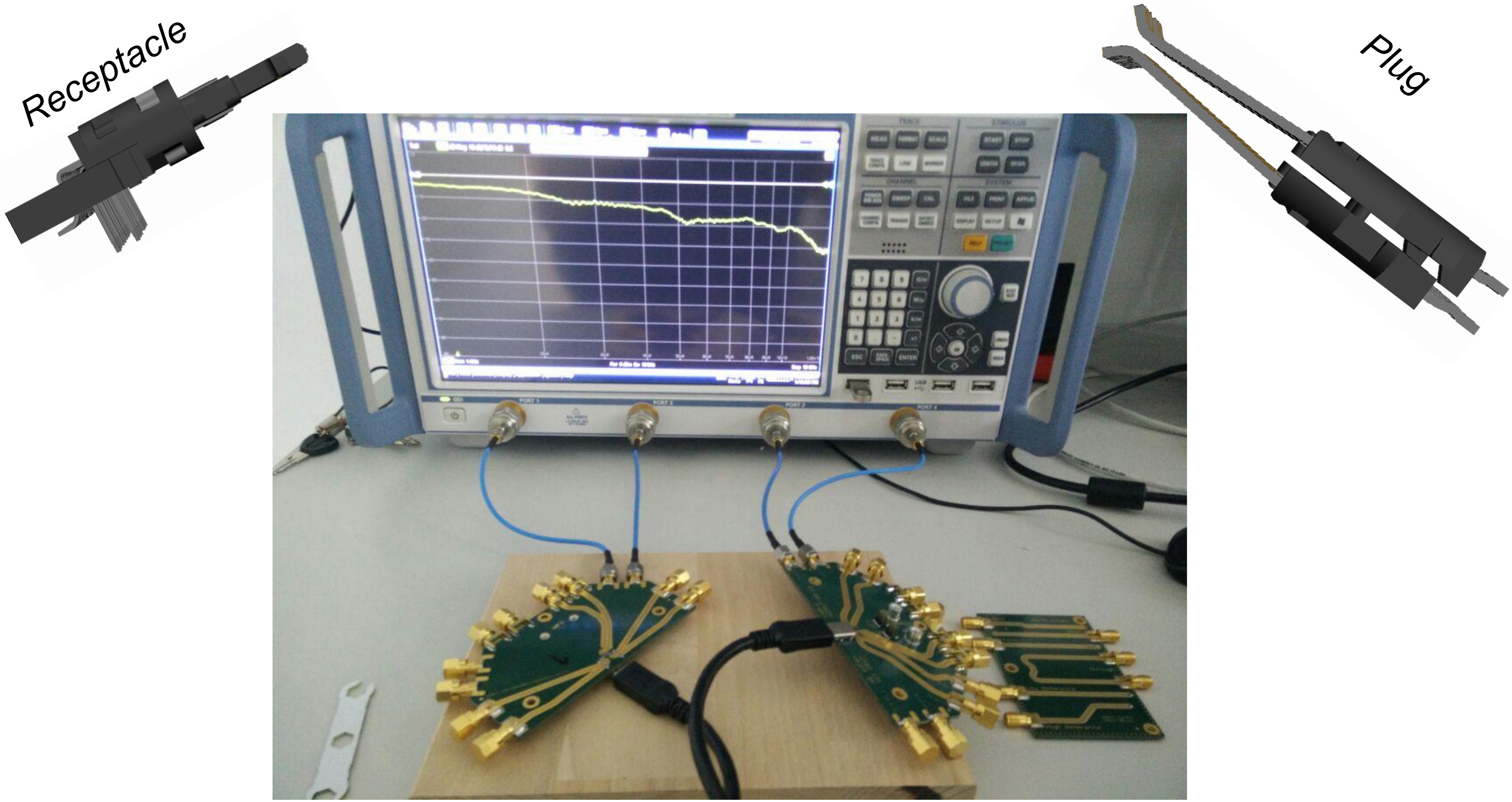
Receptacle – Side crossed view

Plug – Side crossed view



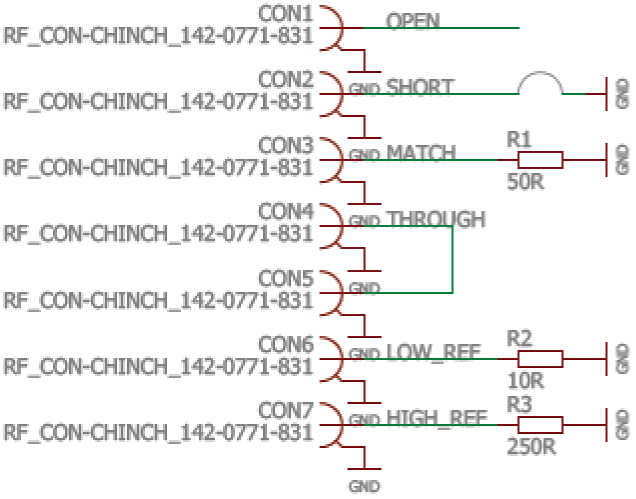


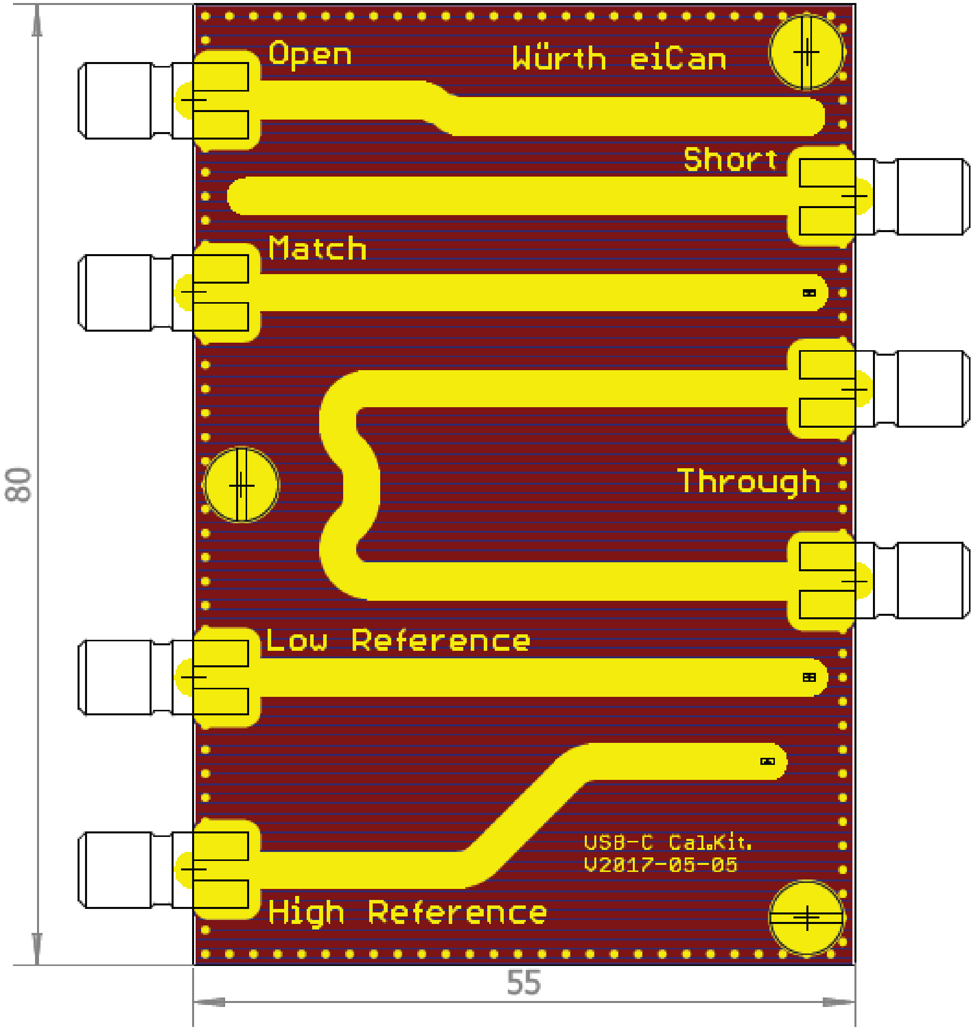
Specification, Requirements & Performances
RF behavior


Receptacle
Plug

Specification, Requirements & Performances

RF behavior

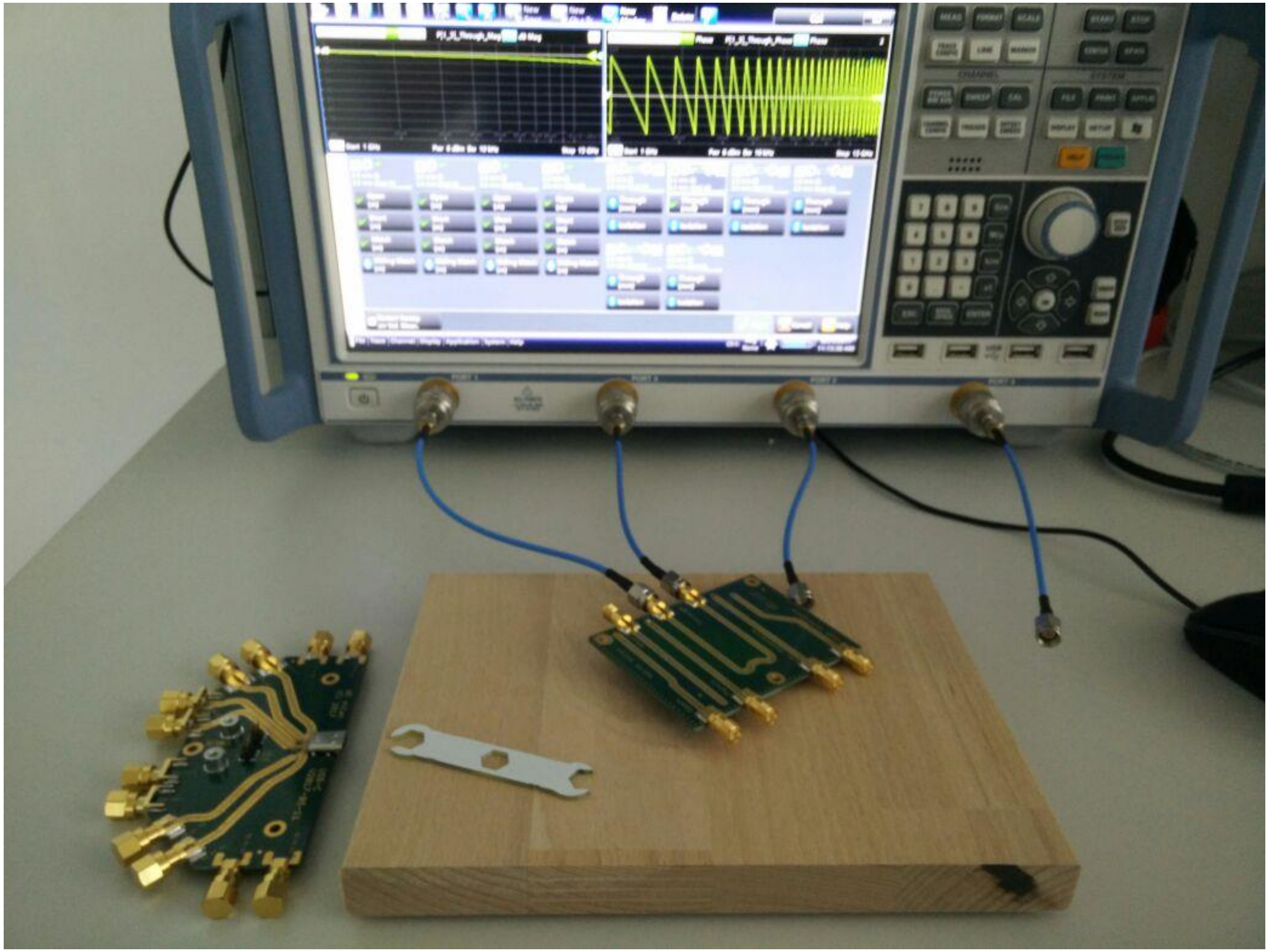

CON1
RF_CON-CHINCH_142-0771-831
OPEN
CON2
RF_CON-CHINCH_142-0771-831
GND SHORT
CON3
RF_CON-CHINCH_142-0771-831
GND MATCH
R1
50R
CON4
RF_CON-CHINCH_142-0771-831
GND THROUGH
CON5
RF_CON-CHINCH_142-0771-831
GND
CON6
RF_CON-CHINCH_142-0771-831
GND LOW_REF
R2
10R
CON7
RF_CON-CHINCH_142-0771-831
GND HIGH_REF
R3
250R
GND


Open
Würth eiCan
Short
Match
Through
Low Reference
USB-C Cal.Kit.
V2017-05-05
High Reference
80
55

Calibration board

Specification, Requirements & Performances

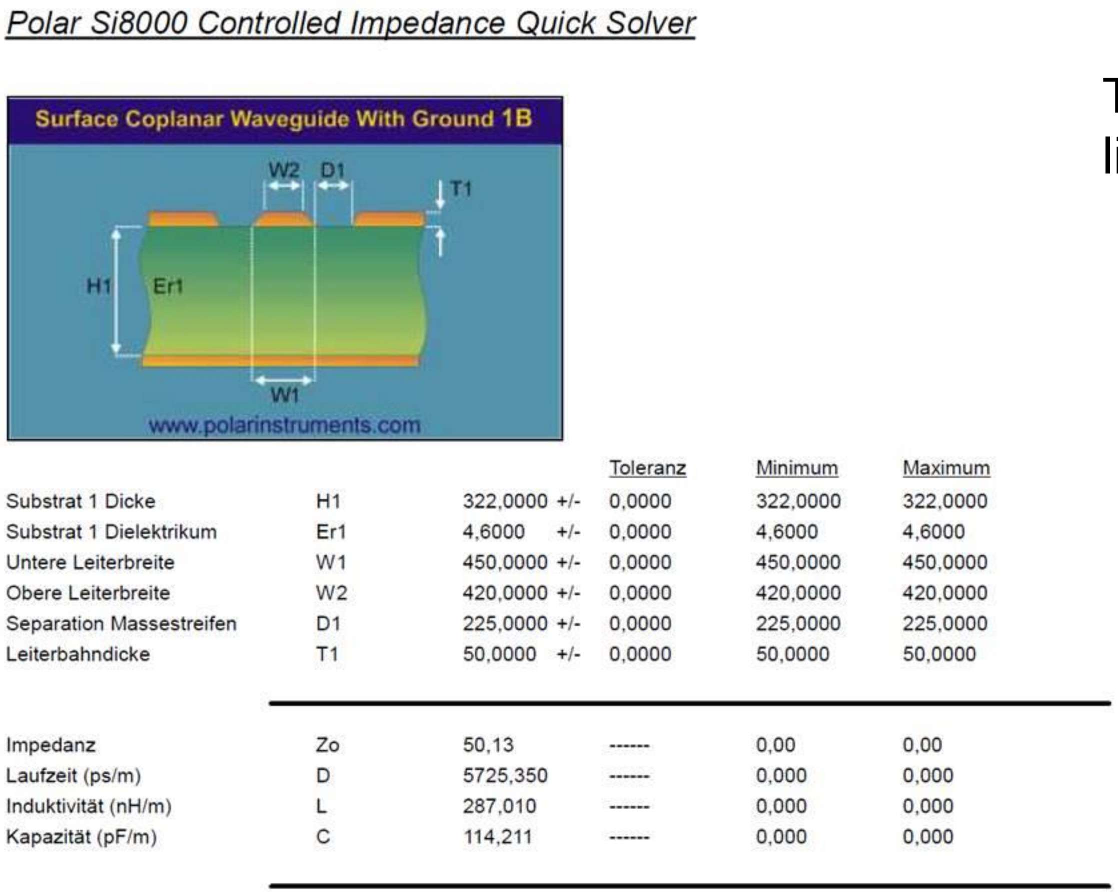
RF behavior



Calibration board

Specification, Requirements & Performances

RF behavior


Surface Coplanar Waveguide With Ground 1B
W2
D1
T1
H1
Er1
W1
www.polarinstruments.com

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

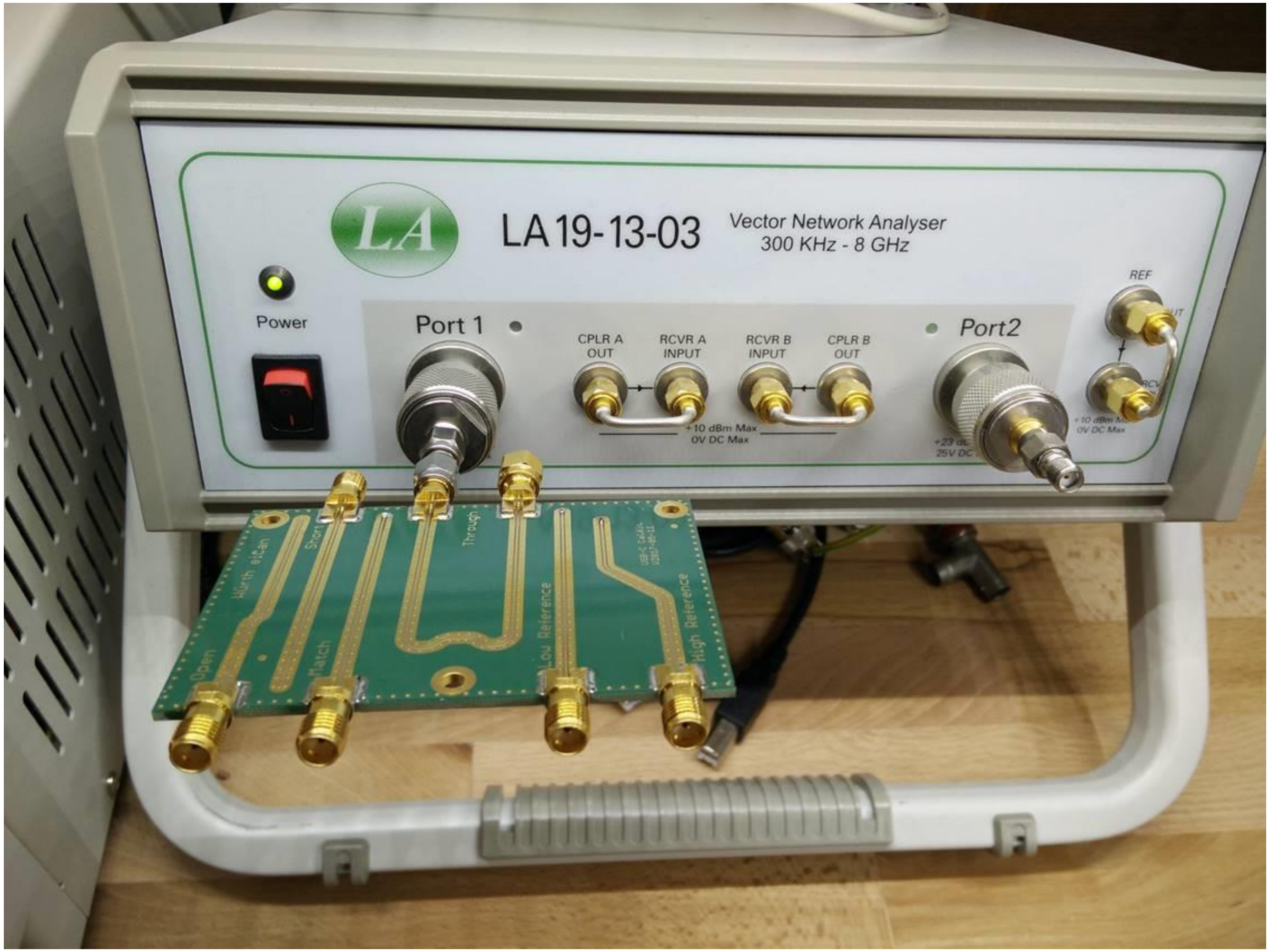
Impedanz	Zo	50,13	------	0,00	0,00
Laufzeit (ps/m)	D	5725,350	------	0,000	0,000
Induktivität (nH/m)	L	287,010	------	0,000	0,000
Kapazität (pF/m)	C	114,211	------	0,000	0,000

Calibration board

The mirostrip conductor has to be like Würth Elektronik suggests.

Specification, Requirements & Performances

RF behavior


LA
LA 19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
CPLR A OUT
RCVR A INPUT
RCVR B INPUT
CPLR B OUT
+10 dBm Max
0V DC Max
Port2
REF
Open
Short
Match
Through
Low Reference
High Reference

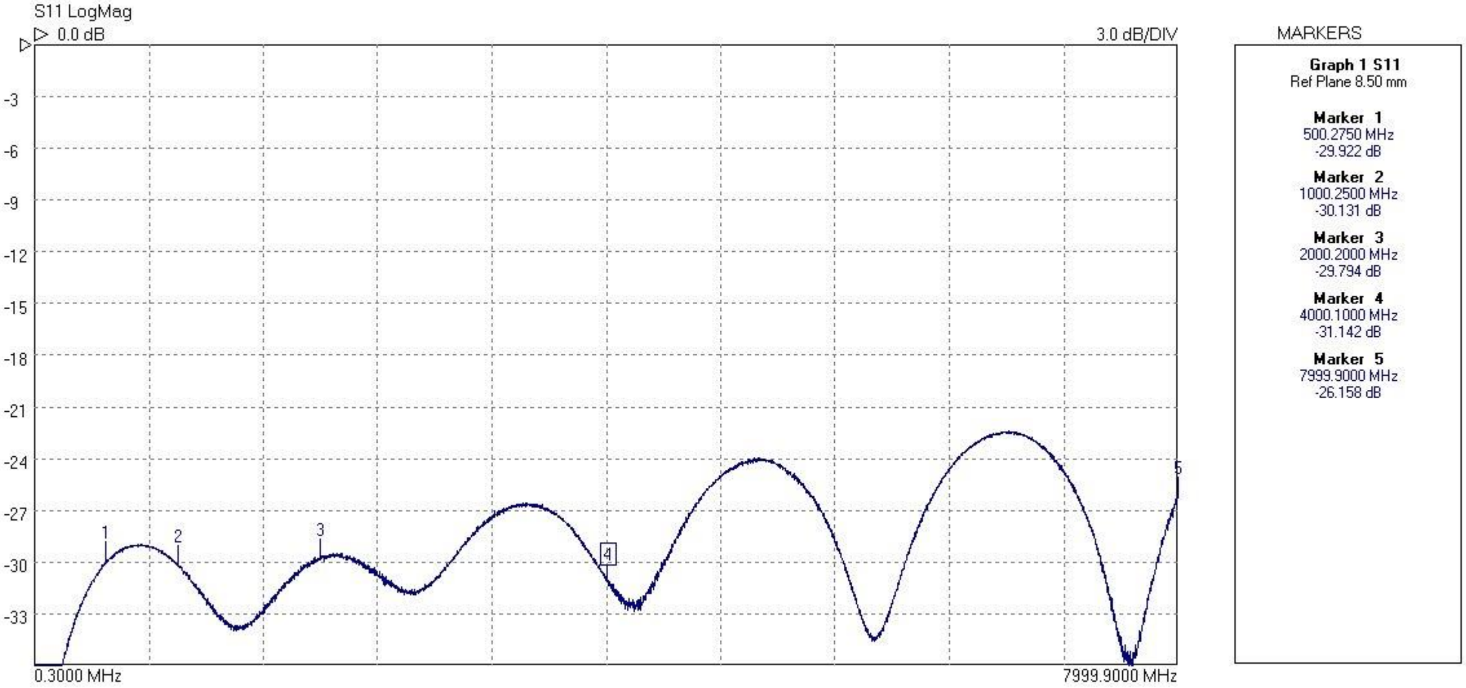
Specification, Requirements & Performances

RF behavior

LA19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2

Calibrationboard

The adjustment of the line:



MARKERS

Graph 1 S11
Ref Plane 8.50 mm

Marker 1
500.2750 MHz
-29.922 dB

Marker 2
1000.2500 MHz
-30.131 dB

Marker 3
2000.2000 MHz
-29.794 dB

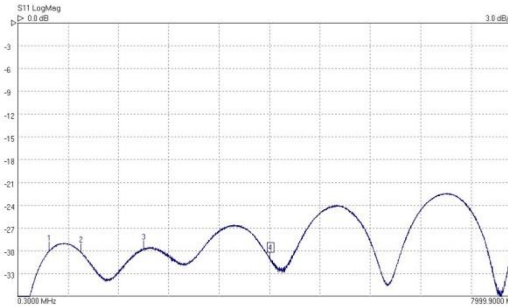
Marker 4
4000.1000 MHz
-31.142 dB

Marker 5
7999.9000 MHz
-26.158 dB

Specification, Requirements & Performances

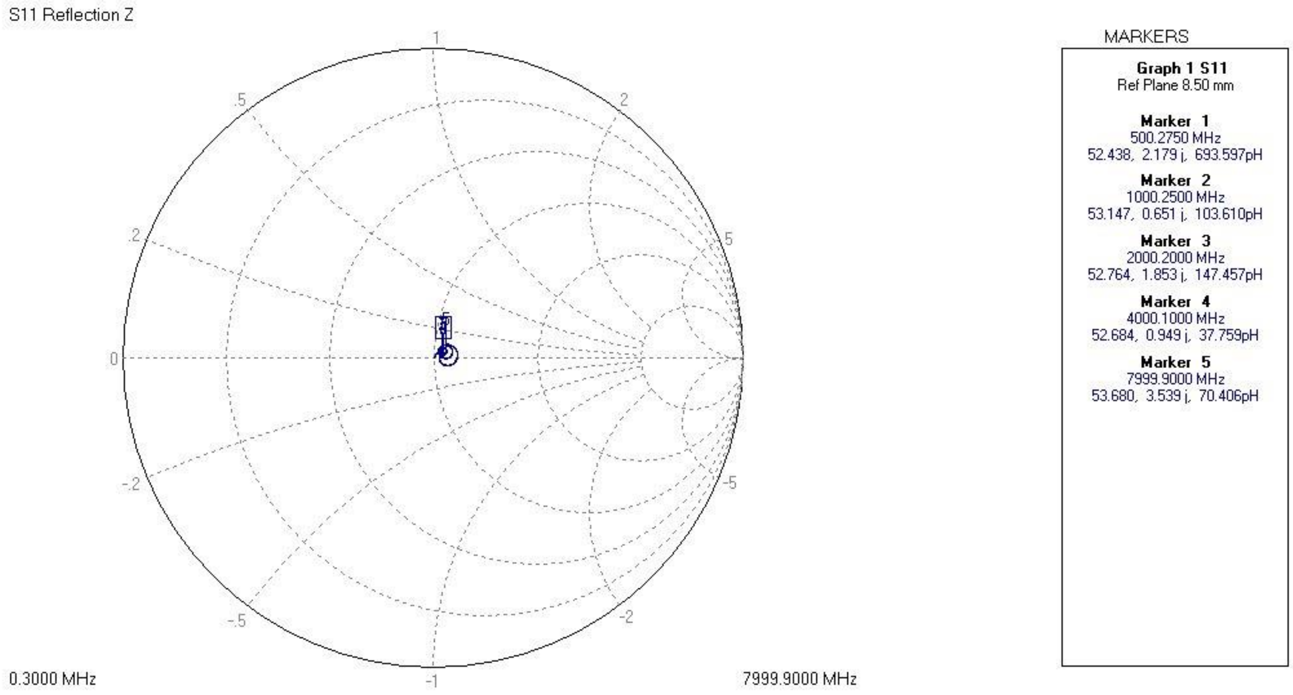
RF behavior

LA 19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2



Calibrationboard

The adjustment of the line:


S11 Reflection Z
1
.5
2
.2
5
0
-.2
-5
-.5
-2
-1
0.3000 MHz
7999.9000 MHz

MARKERS

Graph 1 S11
Ref Plane 8.50 mm

Marker 1
500.2750 MHz
52.438, 2.179 j, 693.597pH

Marker 2
1000.2500 MHz
53.147, 0.651 j, 103.610pH

Marker 3
2000.2000 MHz
52.764, 1.853 j, 147.457pH

Marker 4
4000.1000 MHz
52.684, 0.949 j, 37.759pH

Marker 5
7999.9000 MHz
53.680, 3.539 j, 70.406pH

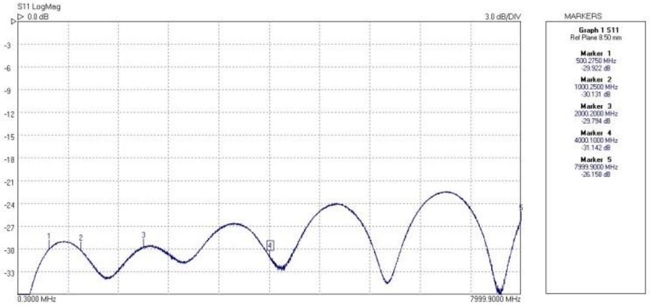
Specification, Requirements & Performances

RF behavior

LA
LA19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2

Calibrationboard

The adjustment of the line:



MARKERS

Graph 1 S11
Ref Plane 8.50 mm

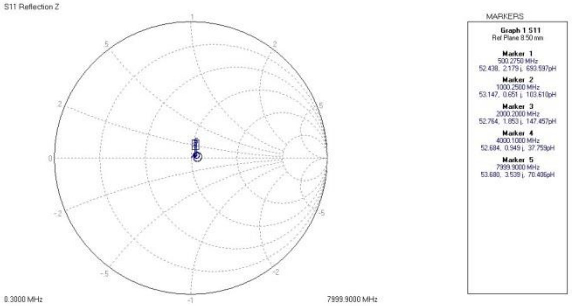
Marker 1
500.2750 MHz
-29.922 dB

Marker 2
1000.2500 MHz
-30.131 dB

Marker 3
2000.2000 MHz
-29.794 dB

Marker 4
4000.1000 MHz
-31.142 dB

Marker 5
7999.9000 MHz
-26.158 dB



MARKERS

Graph 1 S11
Ref Plane 8.50 mm

Marker 1
500.2750 MHz
52.438, 2.179 j, 693.597pH

Marker 2
1000.2500 MHz
53.147, 0.651 j, 103.610pH

Marker 3
2000.2000 MHz
52.764, 1.853 j, 147.457pH

Marker 4
4000.1000 MHz
52.684, 0.949 j, 37.759pH

Marker 5
7999.9000 MHz
53.680, 3.539 j, 70.406pH

This corresponds to a line impedance of approximately 53 Ω.

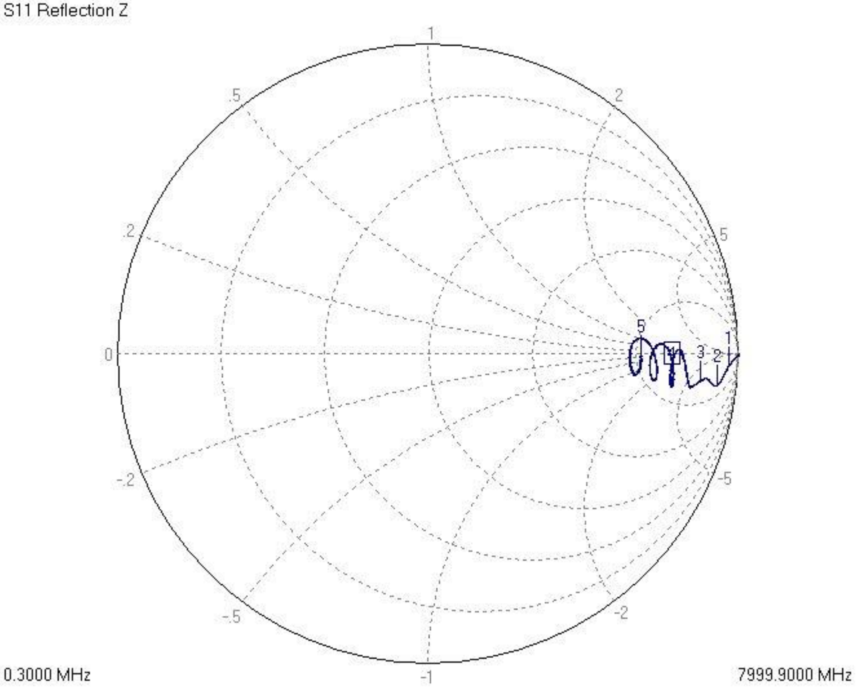
Specification, Requirements & Performances

RF behavior

LA
LA19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2

Calibrationboard

Line length: smith open = 100mm (electrical)


S11 Reflection Z

MARKERS

Graph 1 S11
Ref Plane 100.00 mm

Marker 1
500.2750 MHz
1133.024, -1341.760 j, 0.237pF

Marker 2
1000.2500 MHz
421.432, -665.504 j, 0.239pF

Marker 3
2000.2000 MHz
478.002, -367.583 j, 0.216pF

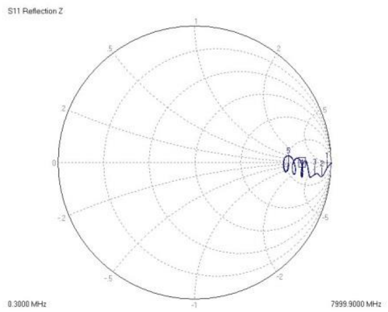
Marker 4
4000.1000 MHz
336.289, -153.940 j, 0.258pF

Marker 5
7999.9000 MHz
263.925, -4.054 j, 4.907pF

Specification, Requirements & Performances

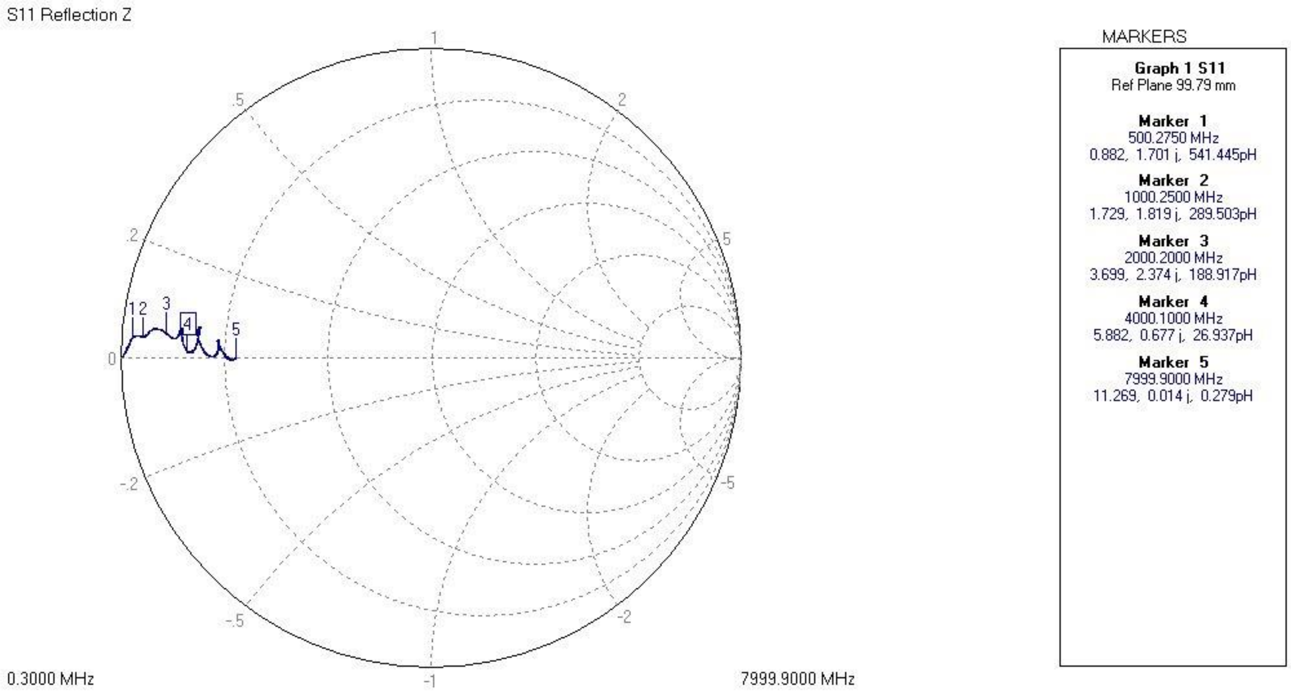
RF behavior

LA 19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2



Calibrationboard

Line length: smith short = 99,79mm (electrical)



Graph 1 S11
Ref Plane 99.79 mm

Marker 1
500.2750 MHz
0.882, 1.701 j, 541.445pH

Marker 2
1000.2500 MHz
1.729, 1.819 j, 289.503pH

Marker 3
2000.2000 MHz
3.699, 2.374 j, 188.917pH

Marker 4
4000.1000 MHz
5.882, 0.677 j, 26.937pH

Marker 5
7999.9000 MHz
11.269, 0.014 j, 0.279pH

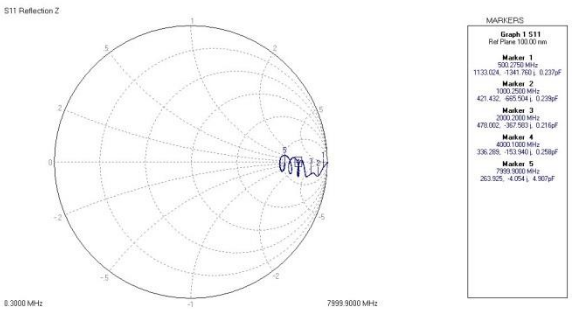
Specification, Requirements & Performances
RF behavior

LA
LA19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2

Calibrationboard

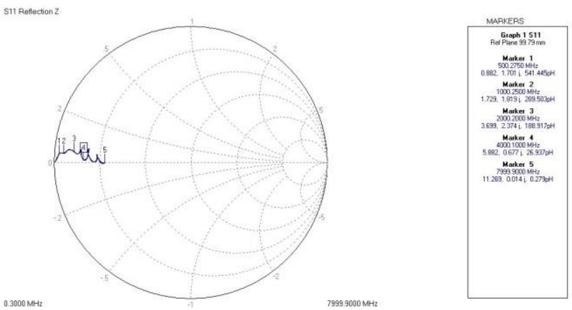
With an SMA plug length of 8.5mm this gives an electrical length of 91.4mm.

With a mechanical length of 51.0 mm, this results in a shortening factor of 0.558 and thus a running time of 5977ps / m (compared to 5725ps / m).



```
Graph 1 S11
Ref Plane 100.00 mm

Marker 1
500.2750 MHz
1133.024, -1341.760 j, 0.237pF
Marker 2
1000.2500 MHz
421.432, -665.504 j, 0.239pF
Marker 3
2000.2000 MHz
478.002, -367.583 j, 0.216pF
Marker 4
4000.1000 MHz
336.289, -153.940 j, 0.258pF
Marker 5
7999.9000 MHz
263.925, -4.054 j, 4.907pF
```



```
Graph 1 S11
Ref Plane 99.79 mm

Marker 1
500.2750 MHz
0.882, 1.701 j, 541.445pH
Marker 2
1000.2500 MHz
1.729, 1.819 j, 289.503pH
Marker 3
2000.2000 MHz
3.699, 2.374 j, 188.917pH
Marker 4
4000.1000 MHz
5.882, 0.677 j, 26.937pH
Marker 5
7999.9000 MHz
11.269, 0.014 j, 0.279pH
```

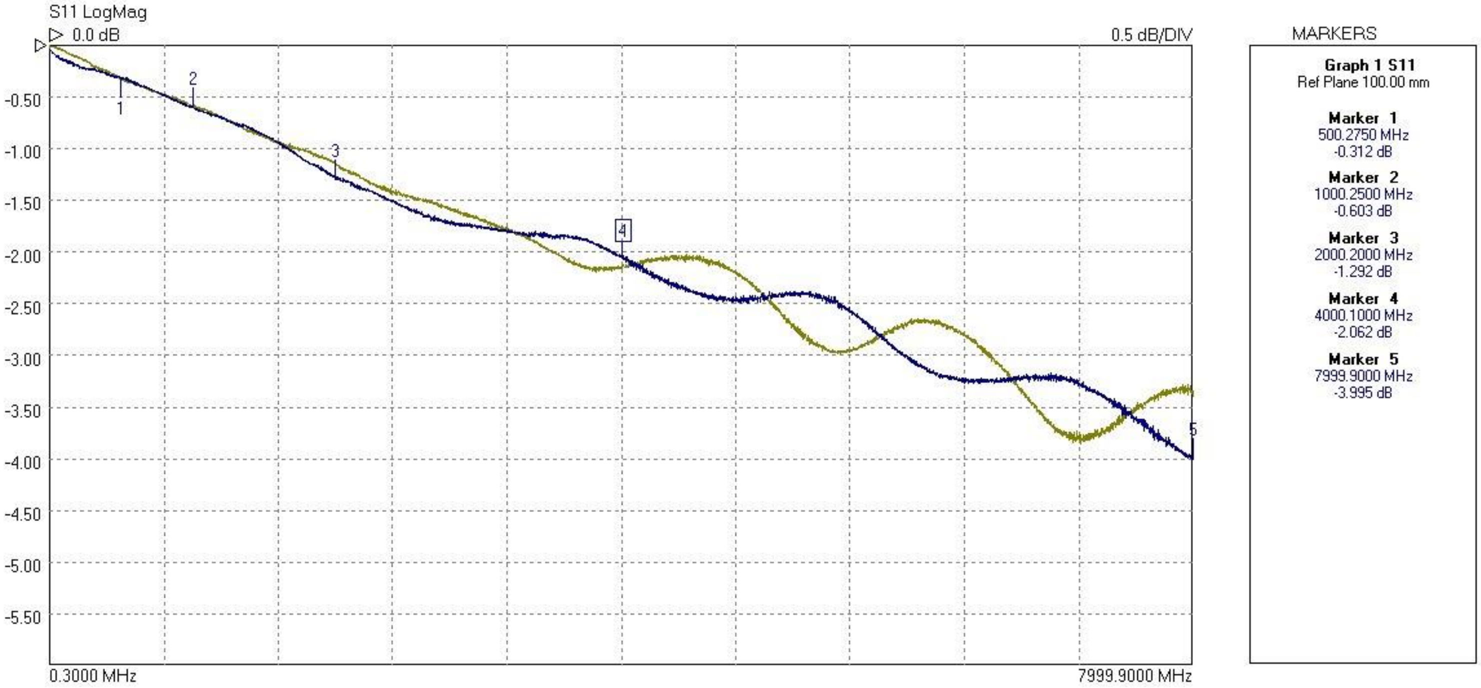
Specification, Requirements & Performances

RF behavior

LA
LA19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2

Calibrationboard

Insertion loss (refelction loss open / short)



Graph 1 S11
Ref Plane 100.00 mm

Marker 1
500.2750 MHz
-0.312 dB

Marker 2
1000.2500 MHz
-0.603 dB

Marker 3
2000.2000 MHz
-1.292 dB

Marker 4
4000.1000 MHz
-2.062 dB

Marker 5
7999.9000 MHz
-3.995 dB

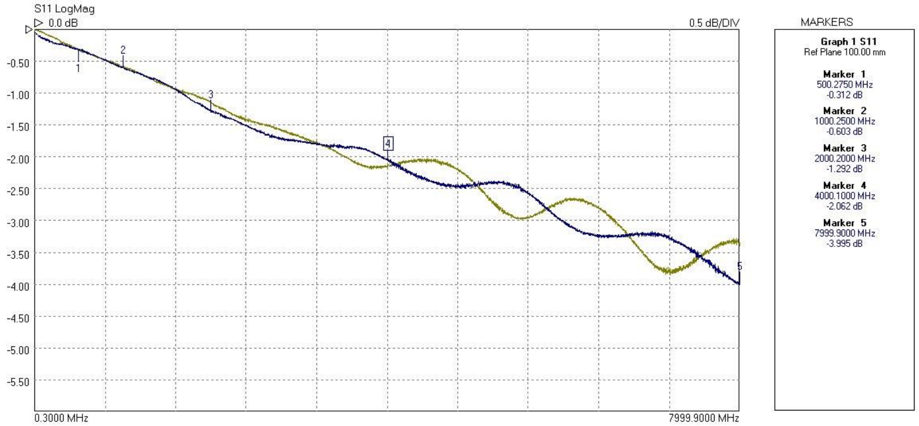
Specification, Requirements & Performances

RF behavior

LA 19-13-03
Vector Network Analyser
300 KHz - 8 GHz
Power
Port 1
Port2

Calibrationboard

Insertion loss (refelction loss open / short)



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

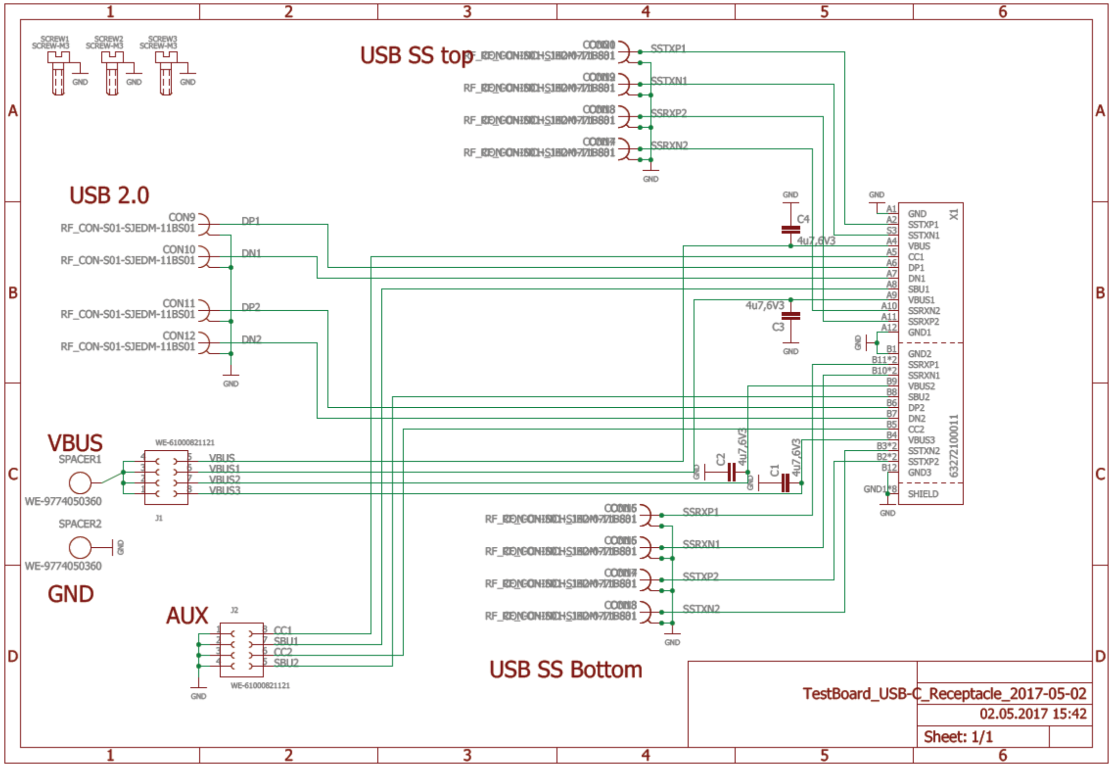
The real attenuation is half the value since the wave is attenuated on the return path.

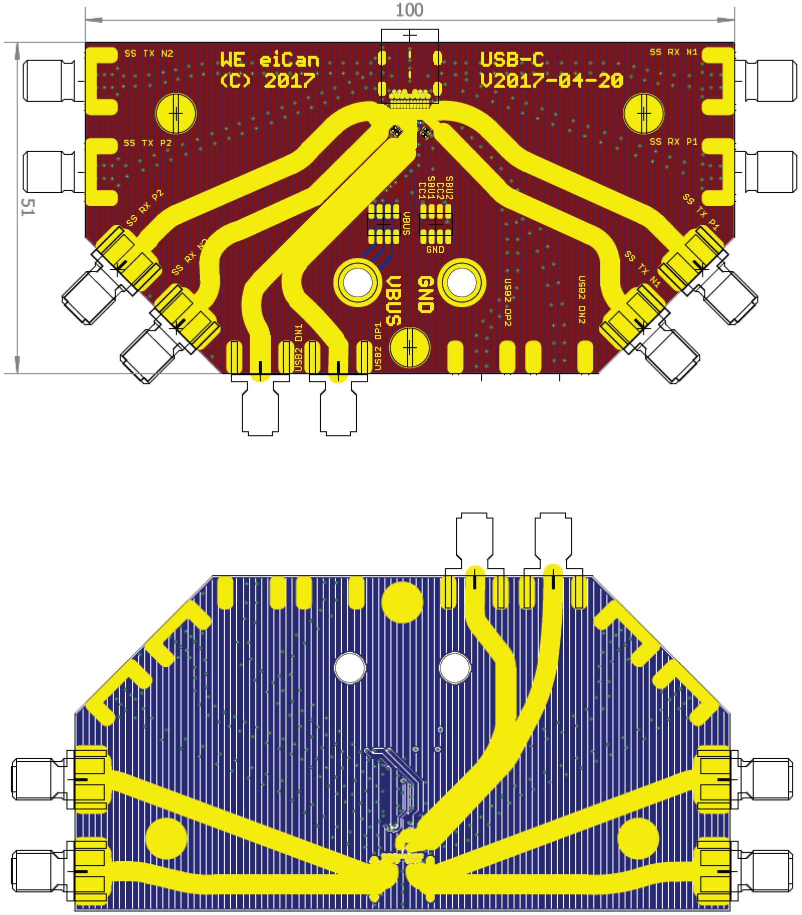
1.5 dB / m at 0.5 GHz
3 dB / m at 1 GHz
6 dB / m at 2 GHz
10.5 dB / m at 4 GHz
19 dB / m at 8 GHz

Specification, Requirements & Performances

RF behavior

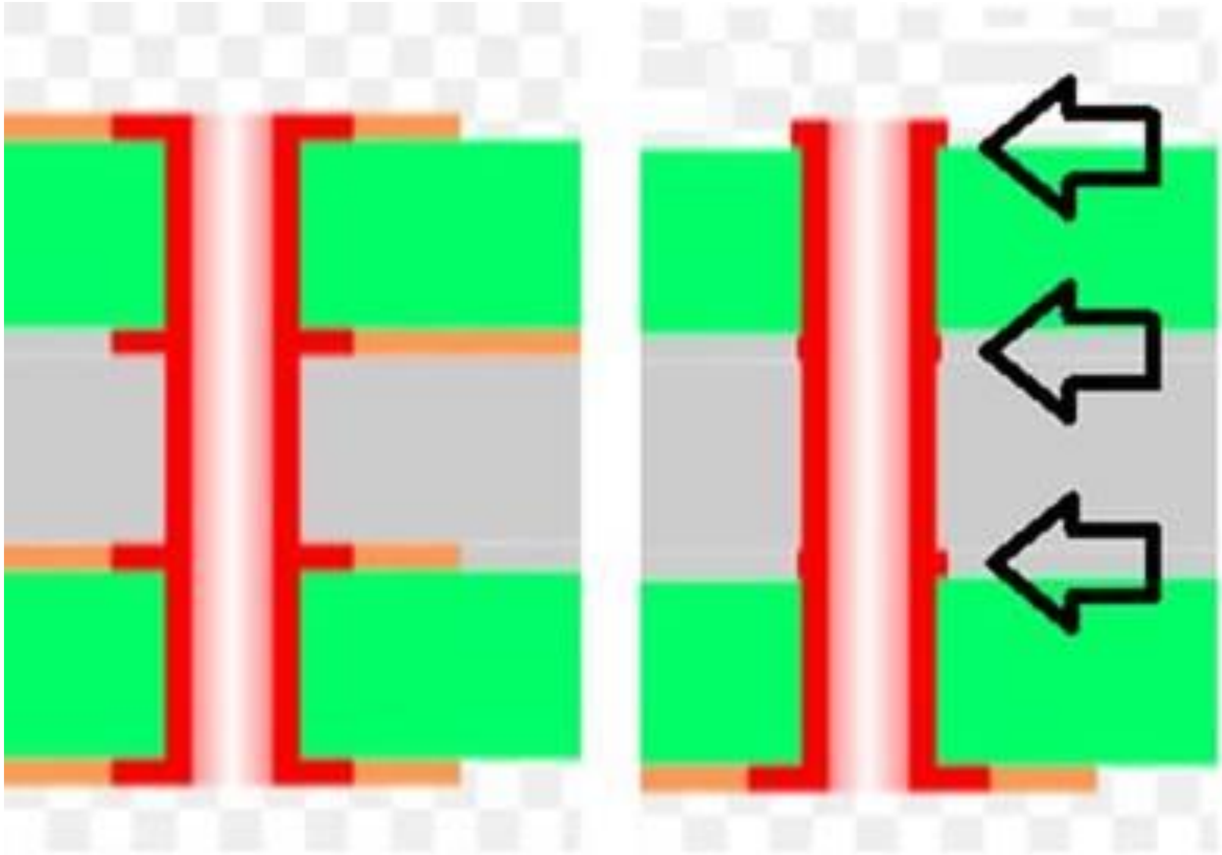
Testboard


USB SS top
USB 2.0
VBUS
GND
AUX
USB SS Bottom
SSTXP1
SSTXN1
SSRXP2
SSRXN2
SSRXP1
SSRXN1
SSTXP2
SSTXN2
DP1
DN1
DP2
DN2
RF_CON-S01-SJEDM-11BS01
SPACER1
SPACER2
WE-9774050360
WE-61000821121
CC1
SBU1
CC2
SBU2
C1
C2
C3
C4
4u7,6V3
632721000011
SHIELD
X1
TestBoard_USB-C_Receptacle_2017-05-02
02.05.2017 15:42
Sheet: 1/1


100
51
WE eiCan
(C) 2017
USB-C
V2017-04-20
SS TX N2
SS TX P2
SS RX P2
SS RX N2
SS RX N1
SS RX P1
SS TX P1
SS TX N1
VBUS
GND
USB2 DN1
USB2 DP1
USB2 DP2
USB2 DN2

Specification, Requirements & Performances

RF behavior



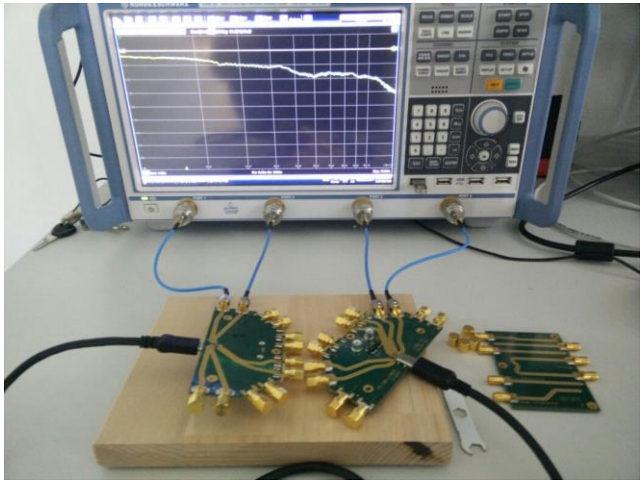
Testboard

VIA preperation:

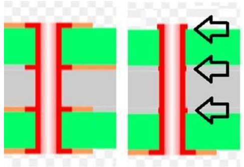
Without rest ring is important to avoid capacitive and inductive effects between the layers.

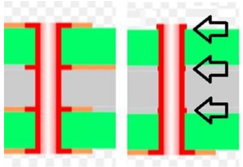
Specification, Requirements & Performances
RF behavior

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

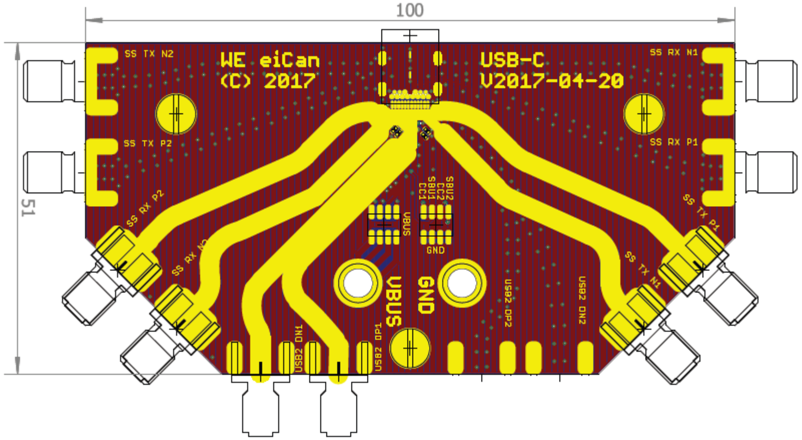


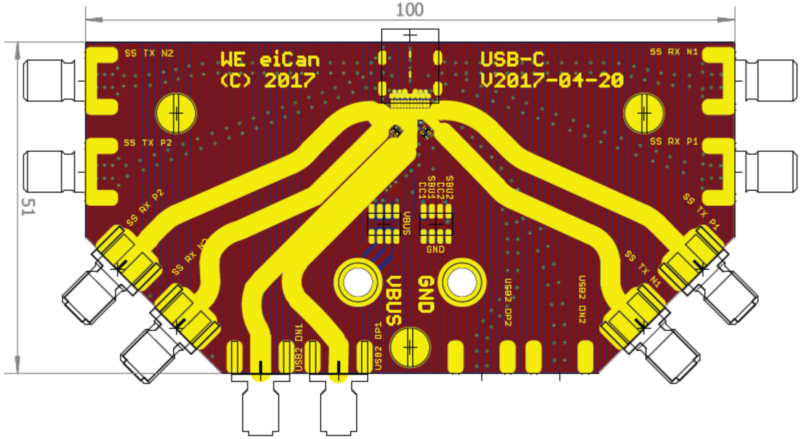
VIA
USB-C (Hybrid mount 623723300011)
USB-C Plug





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

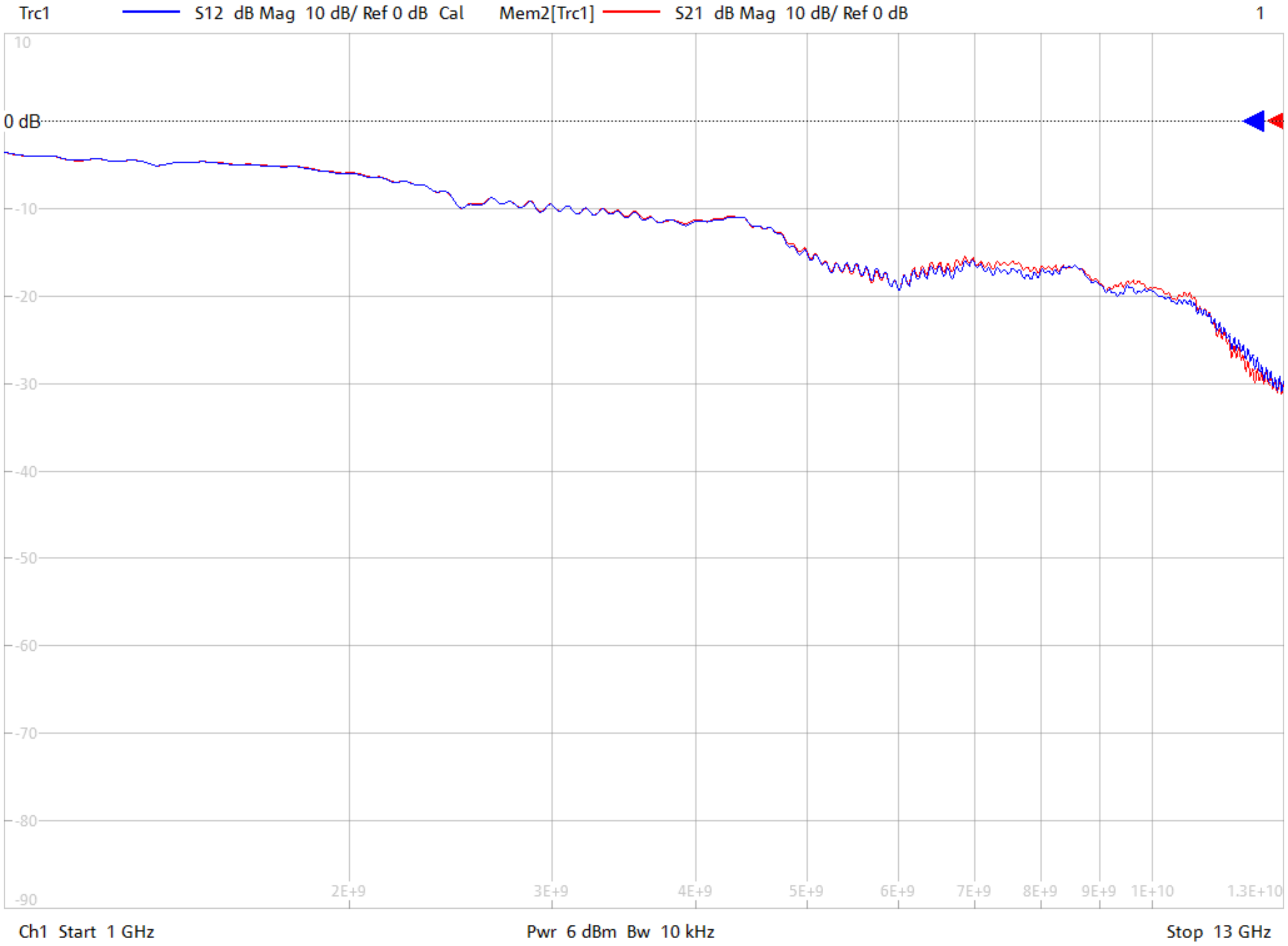

100
51
SS TX N2
WE eiCan
(C) 2017
USB-C
V2017-04-20
SS RX N1
SS TX P2
SS RX P1
SS RX P2
SS RX N2
SS TX P1
SS TX N1
VBUS
GND
USB2 DN1
USB2 DP1
USB2 DP2
USB2 DN2


100
51
SS TX N2
WE eiCan
(C) 2017
USB-C
V2017-04-20
SS RX N1
SS TX P2
SS RX P1
SS RX P2
SS RX N2
SS TX P1
SS TX N1
VBUS
GND
USB2 DN1
USB2 DP1
USB2 DP2
USB2 DN2

Specification, Requirements & Performances

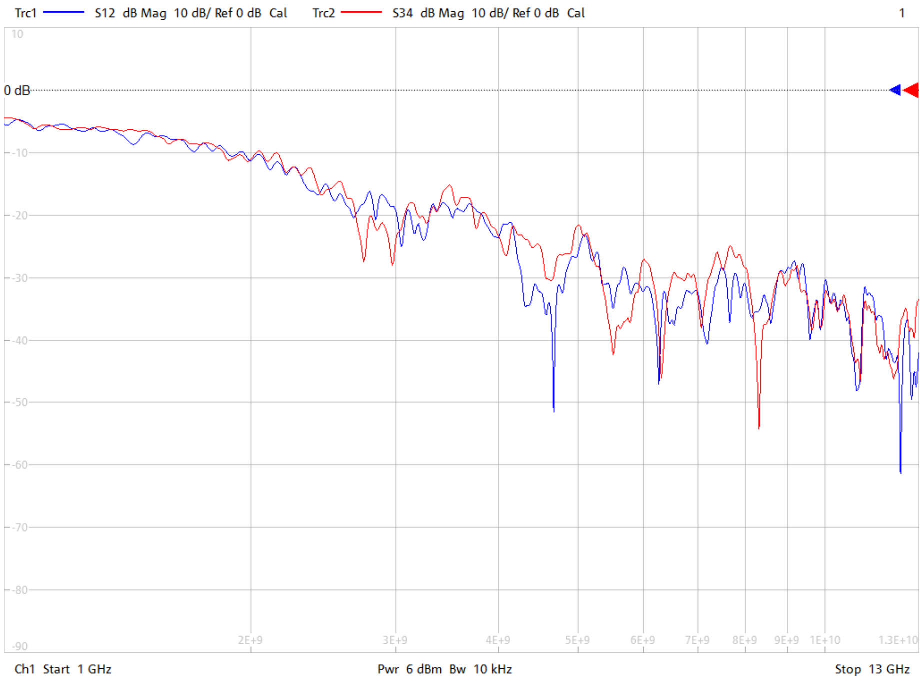
RF behavior

Attenuation:

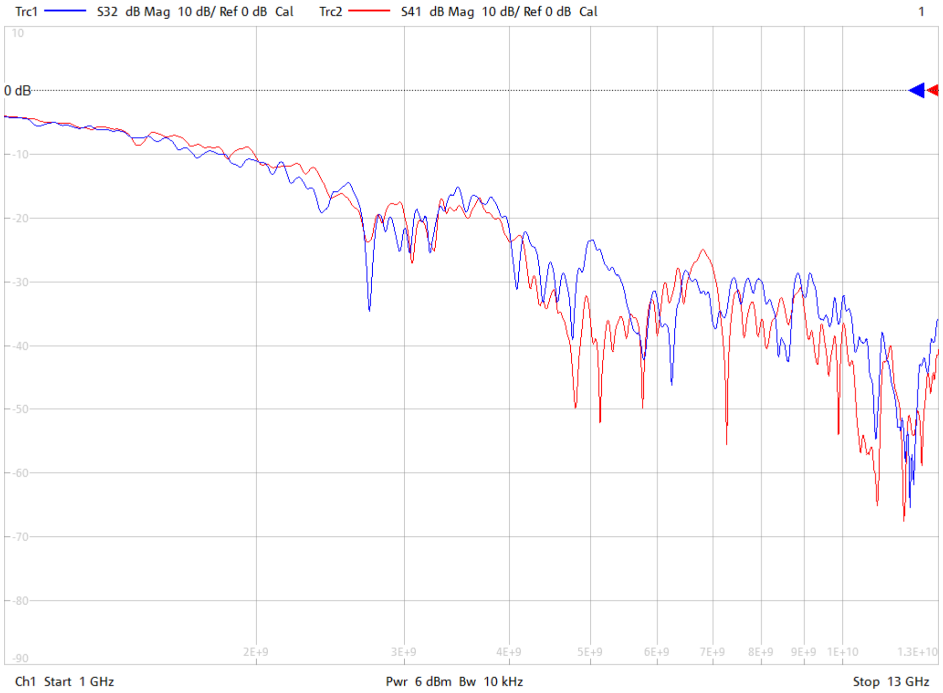


Specification, Requirements & Performances
RF behavior

Attenuation D1 – D1:
(S12 – S34)



Attenuation D2 – D2:
(S32 – S41)

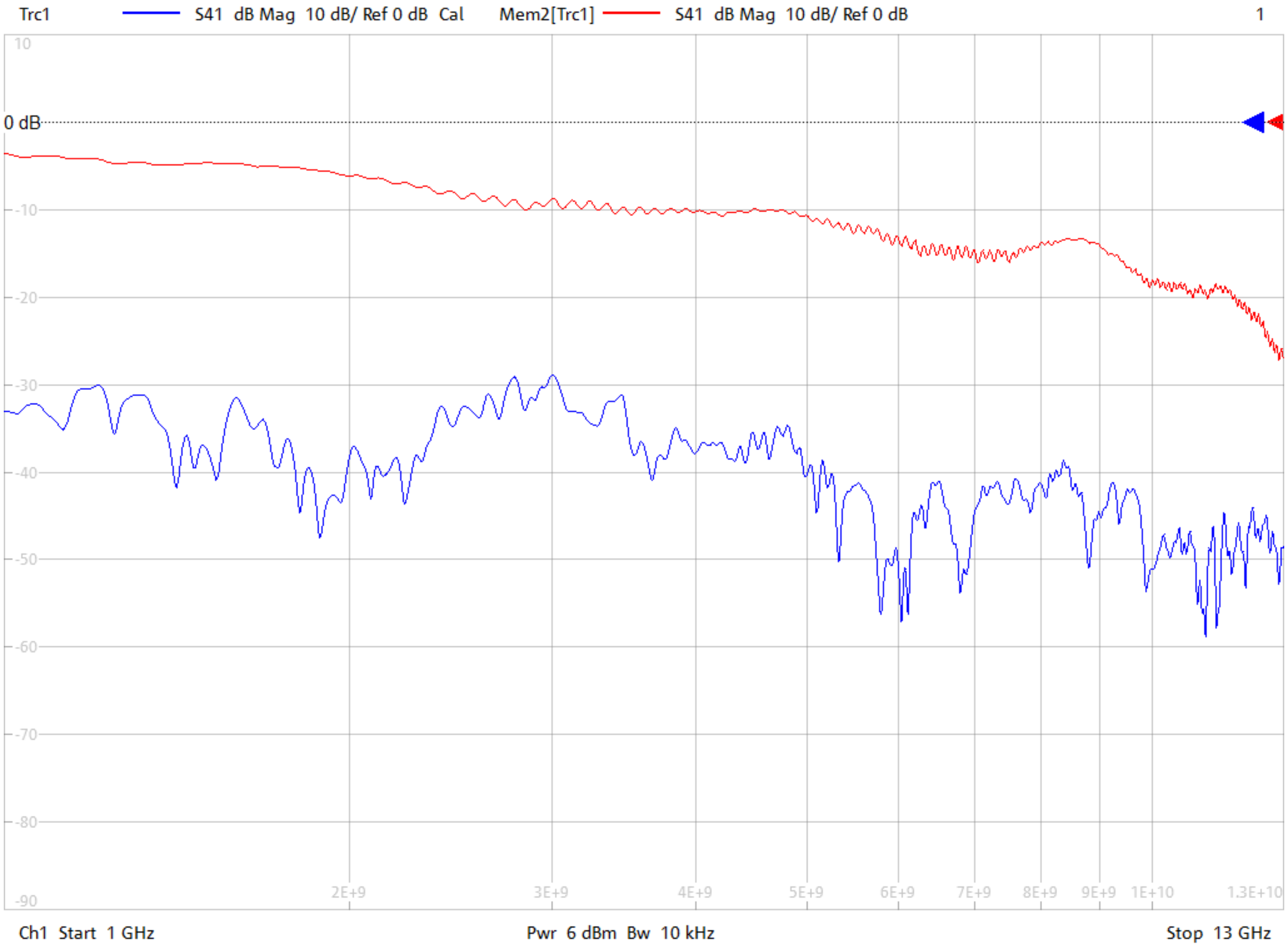


Pairs of datalines are nearly simmilar!

Specification, Requirements & Performances

RF behavior

Attenuation and crosstalk:

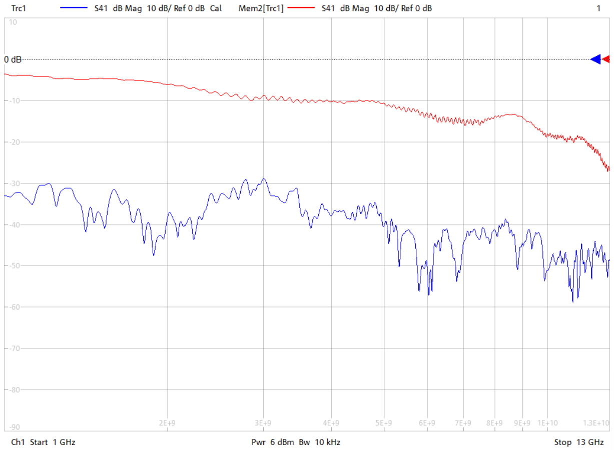


Specification, Requirements & Performances

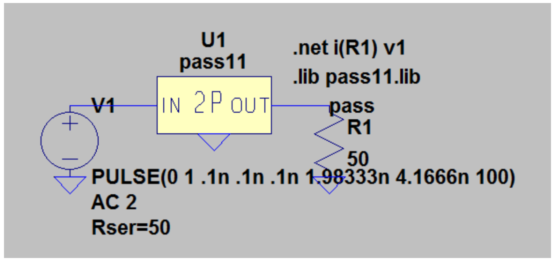
RF behavior

Integration of measurement in LTSpice:

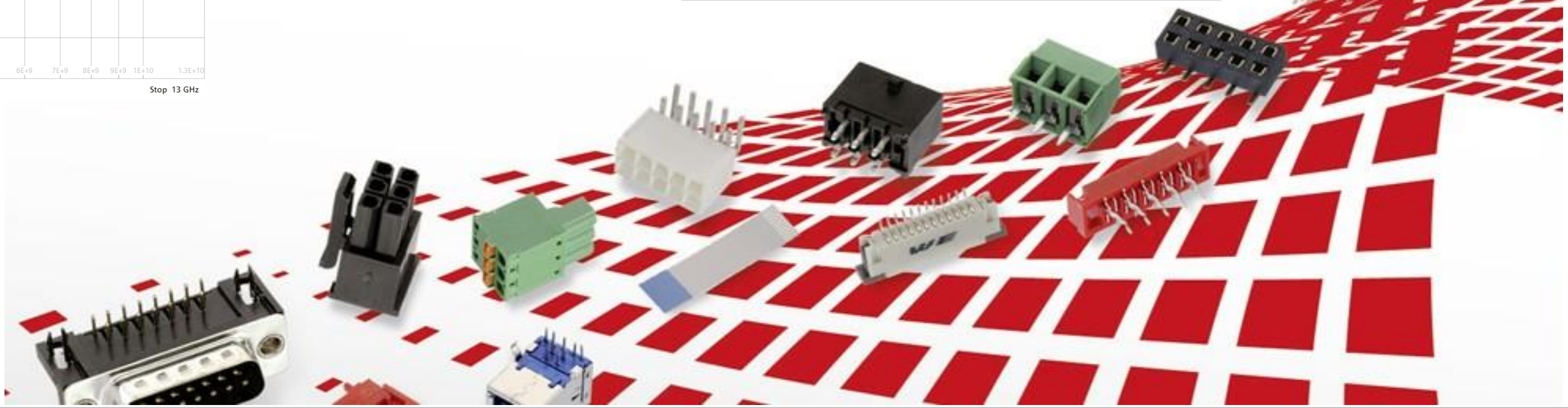
integrating a set of parameter



s2spice


U1
pass11
IN 2P OUT
V1
pass
R1
50
PULSE(0 1 .1n .1n .1n 1.98333n 4.1666n 100)
AC 2
Rser=50

```
.net i(R1) v1
.lib pass11.lib
```



Specification, Requirements & Performances

RF behavior

Integration of measurement data:

WHY ?

- **For many RF-components an LT-Spice model is not available**
- **For nearly every RF-component S-Parameter sets are available**
- **You can find a s2spice-converter at LTSpice-Group**
  http://tech.groups.yahoo.com/group/LTspice/files/%20Tut/S-Parameter/S-Parameter%20to%20SPICE/
- **The S2spice-converter changes S-Parameter sets in touchstone format to LTSpice library data sets**

Advantages of this USB 3.1 c type connector

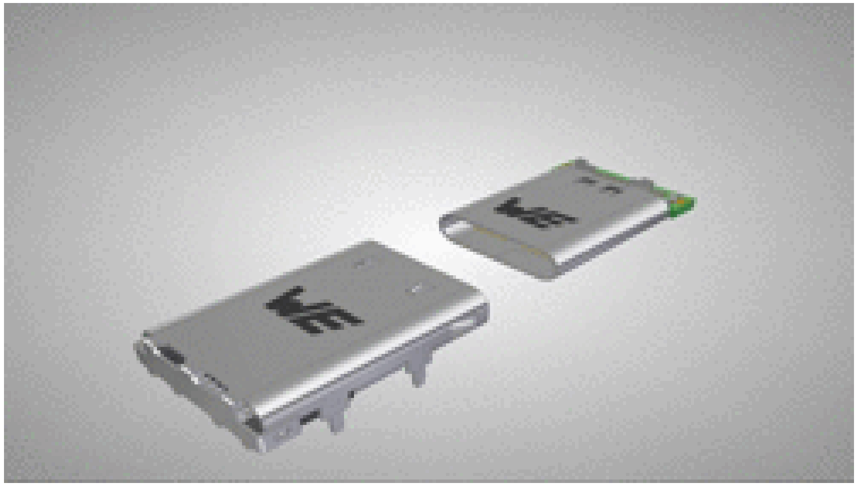
Features

Key features of this new connector:

- Higher durability
- Higher data rate
- Higher current capability (Power supply)
- Reversibility feature
- Short Type (for integrated applications)

Compatibility with different protocols:

HDMI
Thunderbolt…



Advantages of this USB 3.1 C type connector

Features

- How to increase data rate?
  - Improve EMC performances: Shielding change
  - Protocol modification: ≈ 20% additional BandWidth (BW)
    - 5 Gbps for Gen 1 in 8b/10b code
    - 10 Gbps for Gen 2 in 128b/132b code
    - Change of polynomial scrambling / encoding
  - Decrease tolerable Jitter regarding USB 3.0 for maintaining BER at 10^{-12}
    - From 200ps to 100ps on all Tx-Media-Rx chain
    - Including crosstalk & ISI after equalization

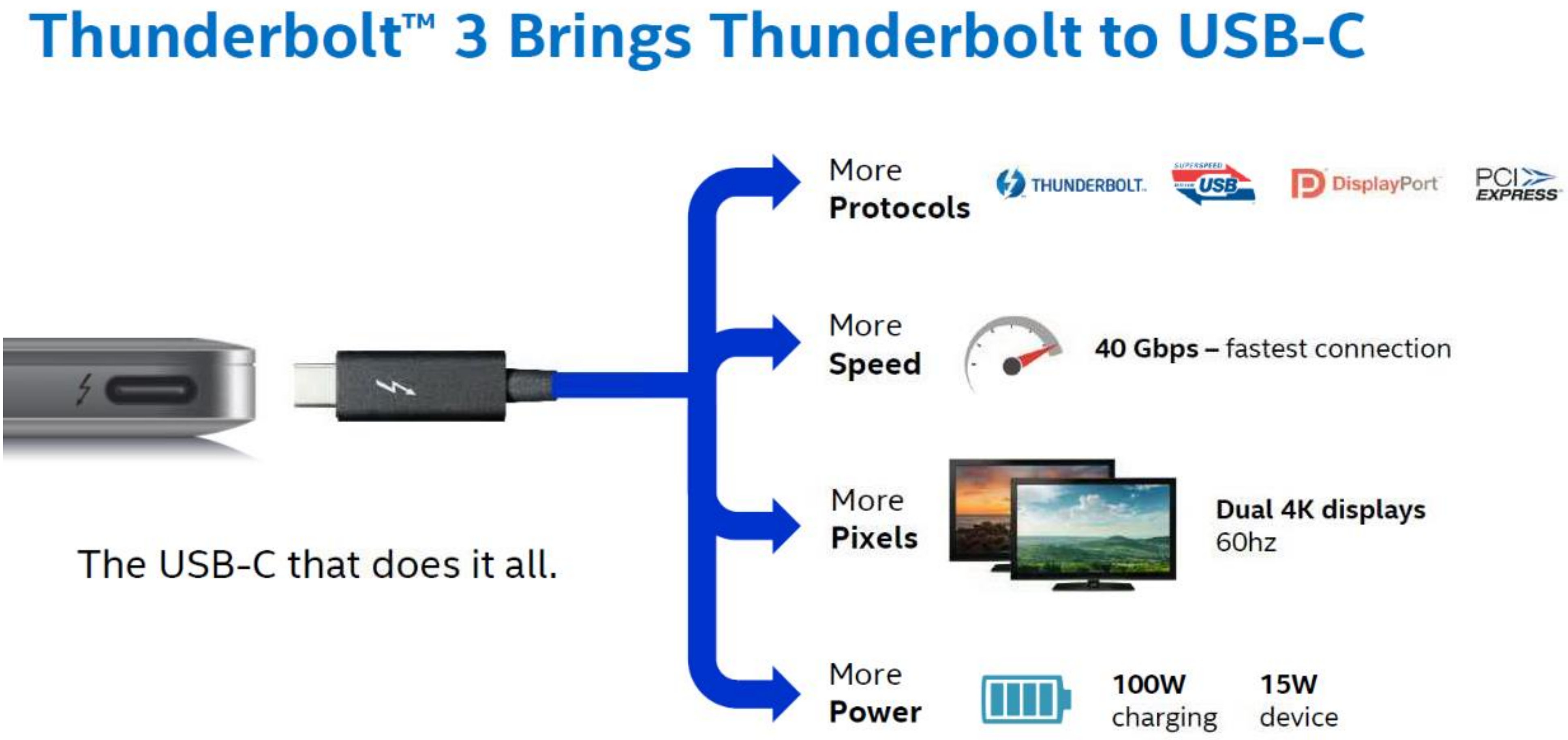
Where to use it ?

Applications for USB (3.1 C type)

- ➢ USB Sticks
- ➢ Adapters
- ➢ Mouse
- ➢ Keyboards
- ➢ Hard drives
- ➢ Printers
- ➢ Video / Camera
- ➢ Mobile phones
- ➢ Set-top Boxes
- ➢ Medical equipment
- ➢ Industrial testers

C.A 8335
QUALISTAR+

Where to use it ?
Applications for USB (3.1 C type)



Thunderbolt™ 3 Brings Thunderbolt to USB-C

The USB-C that does it all.

More **Protocols**

THUNDERBOLT.
SUPERSPEED USB
DisplayPort
PCI EXPRESS

More **Speed**

40 Gbps – fastest connection

More **Pixels**

Dual 4K displays
60hz

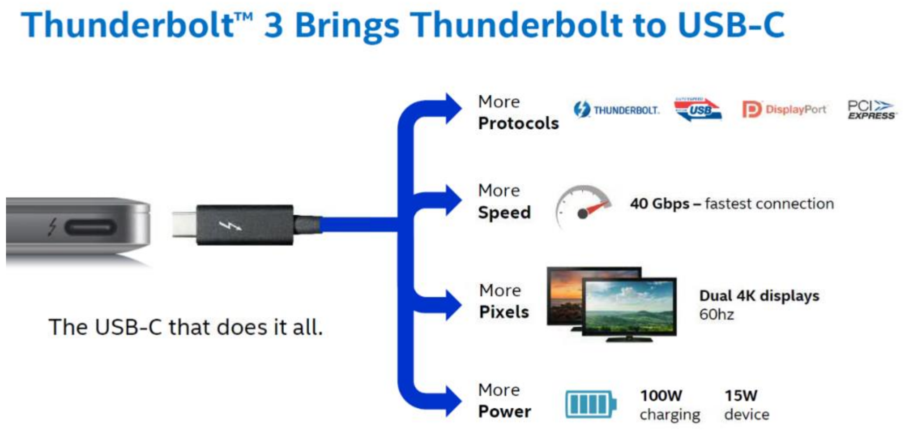
More **Power**

100W charging

15W device

Source: https://www.golem.de/news/ueberblick-wir-entwirren-den-kabelsalat-um-usb-typ-c-1601-118667.html

Conclusion
Applications for USB (3.1 C type)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More Protocols
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The USB-C that does it all.

Source: https://www.golem.de/news/ueberblick-wir-entwirren-den-kabelsalat-um-usb-typ-c-1601-118667.html

Mechanical Performance

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

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)

Electrical Performance

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

Where to use it ?

Applications for USB (3.1 C type)

Where *NOT* to use it ?