

DIGITAL WE DAYS

2024



SIGNAL INTEGRITY OF BASE
CONNECTORS

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WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

IMPEDANCE AND S PARAMETERS REMINDER

EM WAVES IMPEDANCE MISMATCH

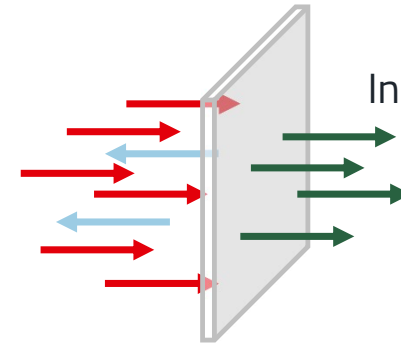


EM WAVES IMPEDANCE MISMATCH

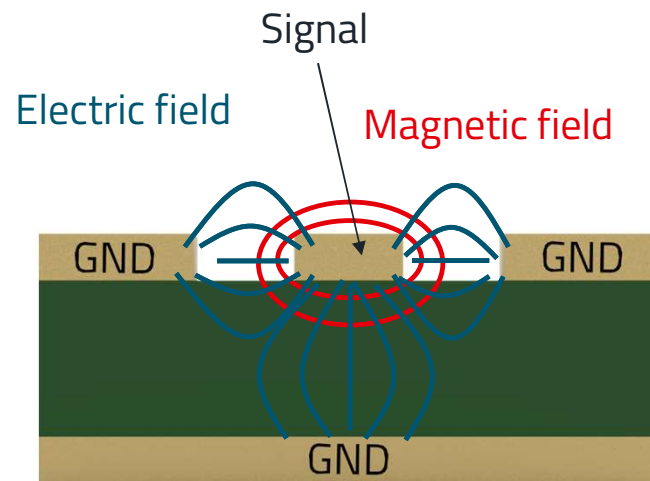
glass = impedance mismatch

Reflection loss – S11

Insertion loss – S21



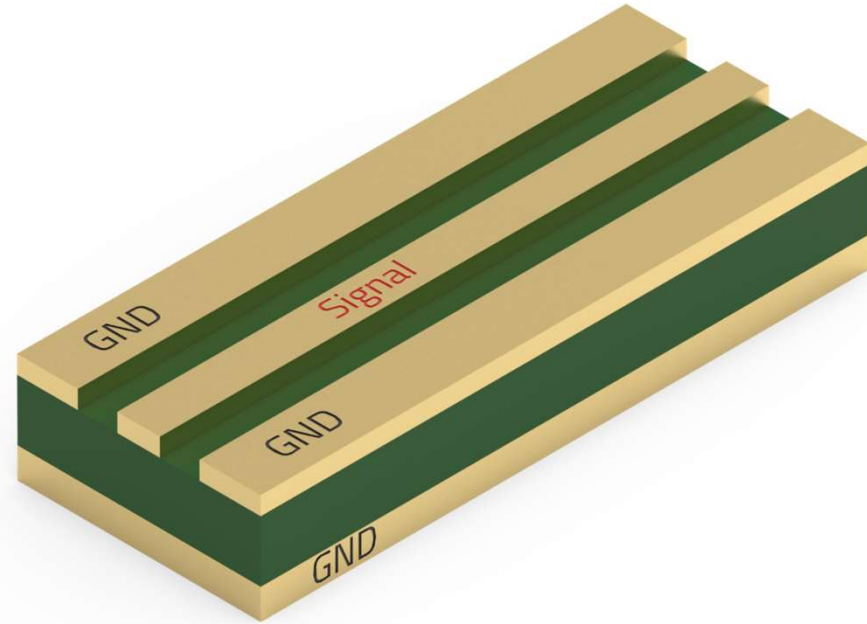
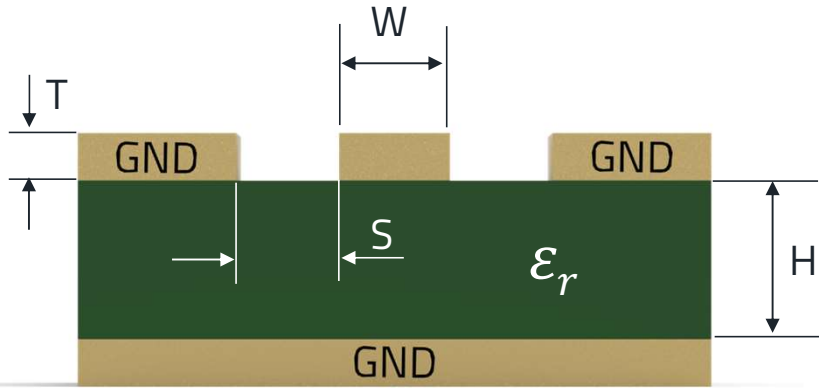
PCB TRANSMISSION LINE



At high frequency

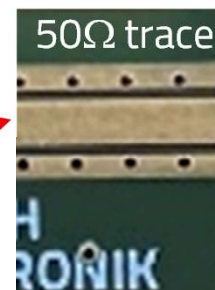
$$Z_c \approx \sqrt{\frac{L}{C}}$$

PCB TRANSMISSION LINE



$$Z_c \approx \sqrt{\frac{L}{C}}$$

Thickness = 35μm
Width = 1.2mm



Clearance = 0.254mm

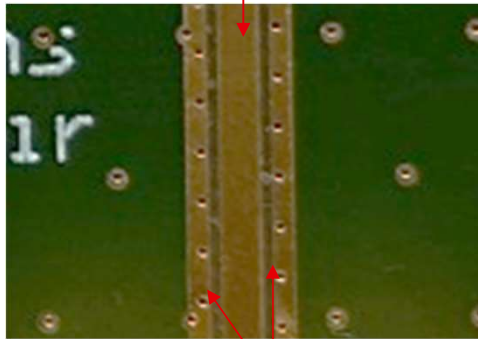
PCB 1.6mm

TEST SET-UP

MEASUREMENT PROCESS

50Ω trace

1.2mm

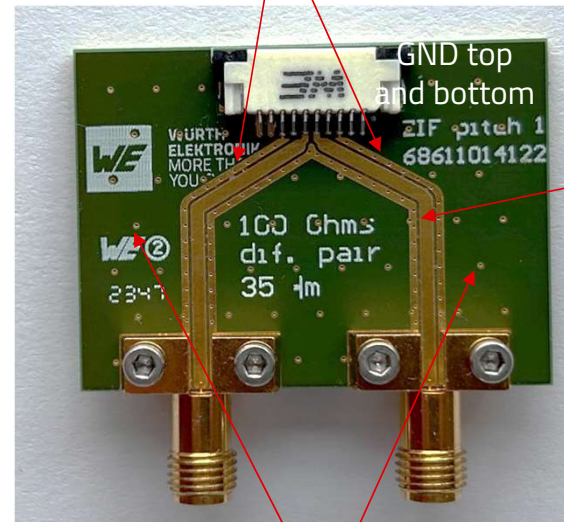


Clearance 0.254mm

PCB 1.6mm
2 layers
35μm

#	Name	Material	Type	Weight	Thickness	Dk
	Top Overlay		Overlay			
	Top Solder	Solder Resist	Solder Mask		0.01016mm	3.5
1	Top Layer		Signal	1oz.	0.03556mm	
	Dielectric 1	FR-4	Dielectric		0.32004mm	4.8
2	Bottom Layer		Signal	1oz.	0.03556mm	
	Bottom Solder	Solder Resist	Solder Mask		0.01016mm	3.5
	Bottom Overlay		Overlay			

Via stitching
Trace shielding



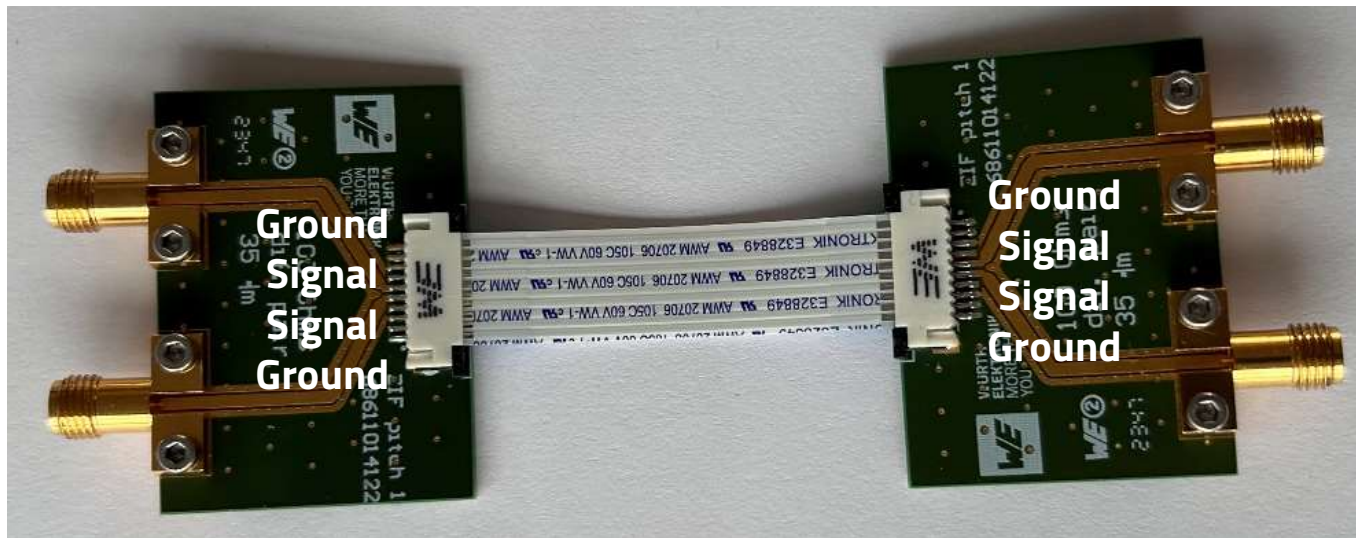
GND top
and bottom

No solder resist – less
permittivity

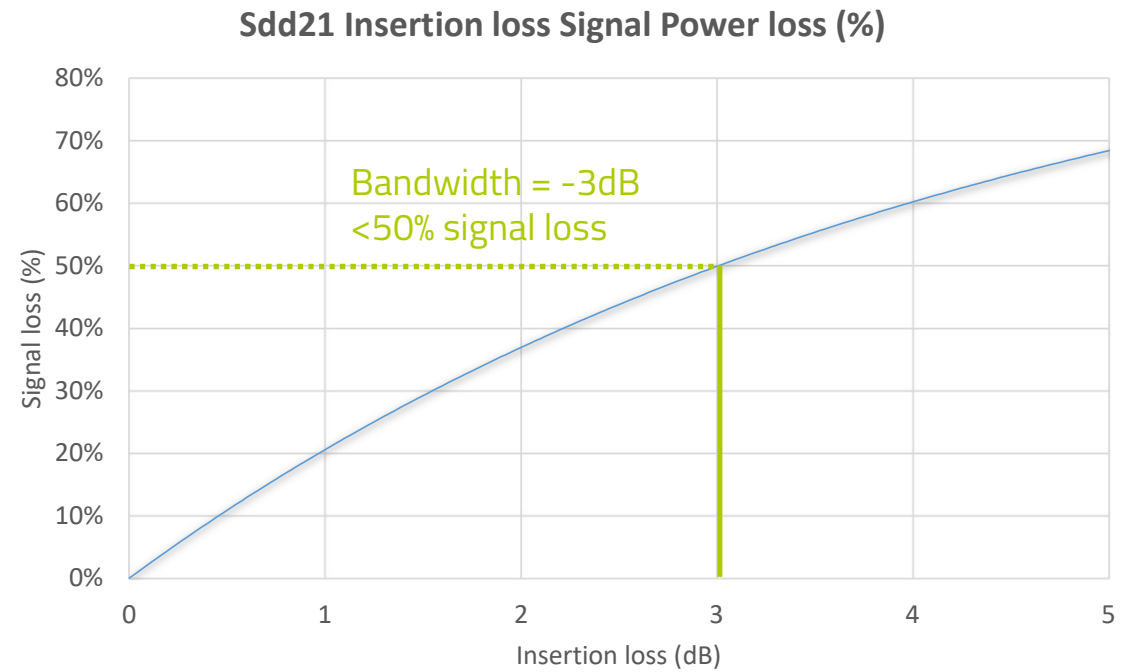
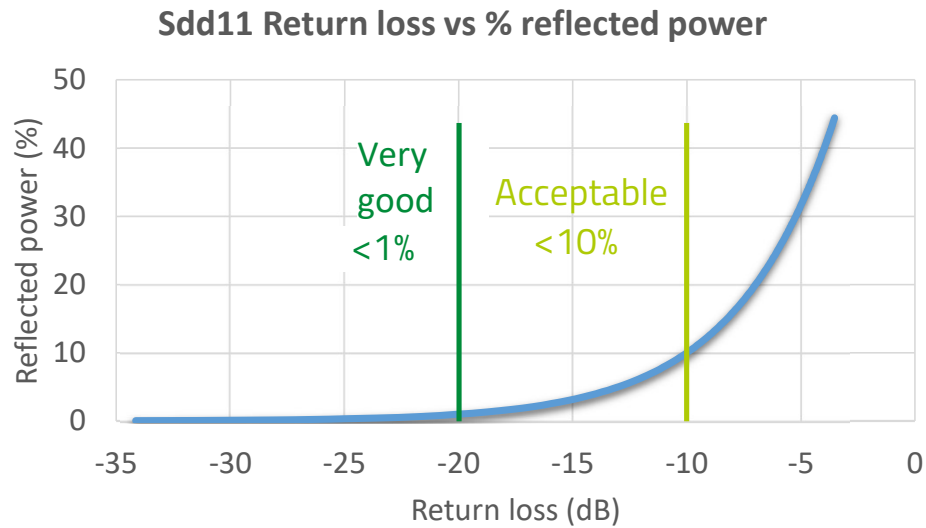
GND top and bottom
global links

MEASUREMENT PROCESS

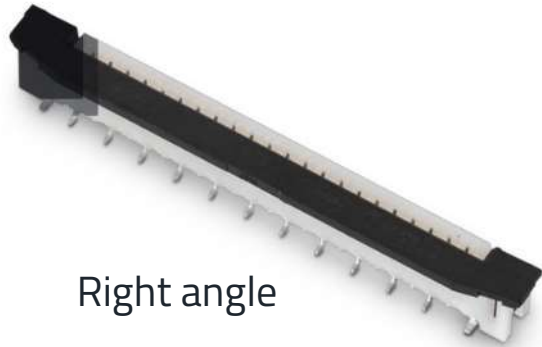
- Differential pair PCB



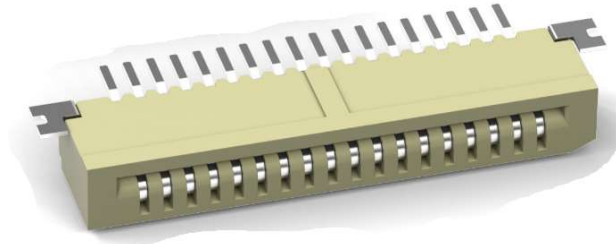
S PARAMETERS REMINDER



ZIF FFC PARAMETERS

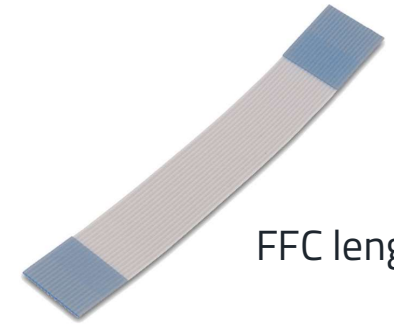


Right angle

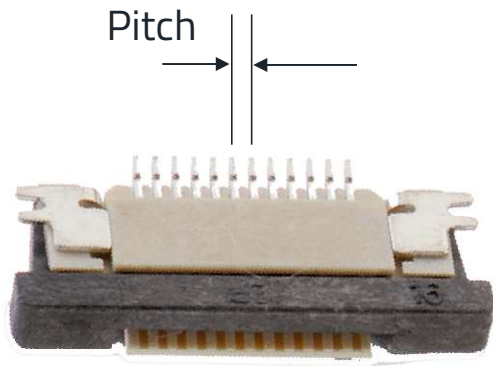


LIF

Tin & gold contact



FFC length



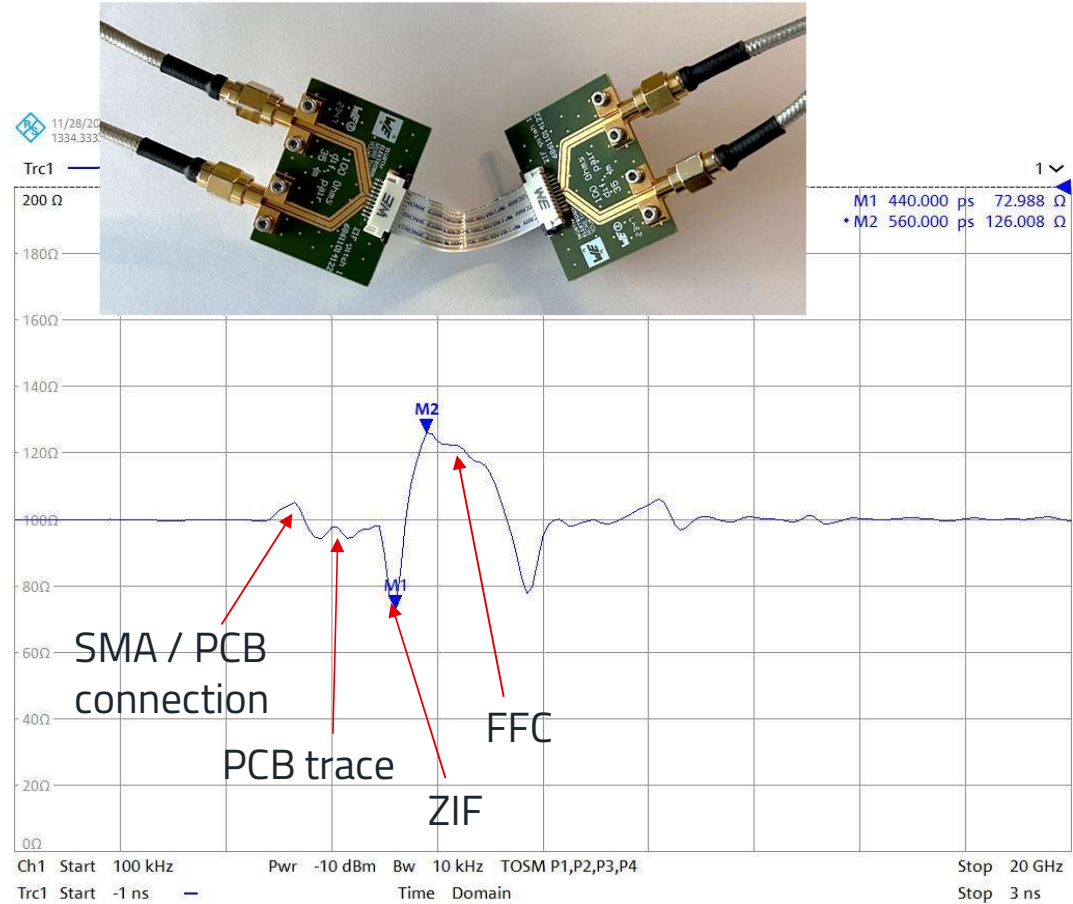
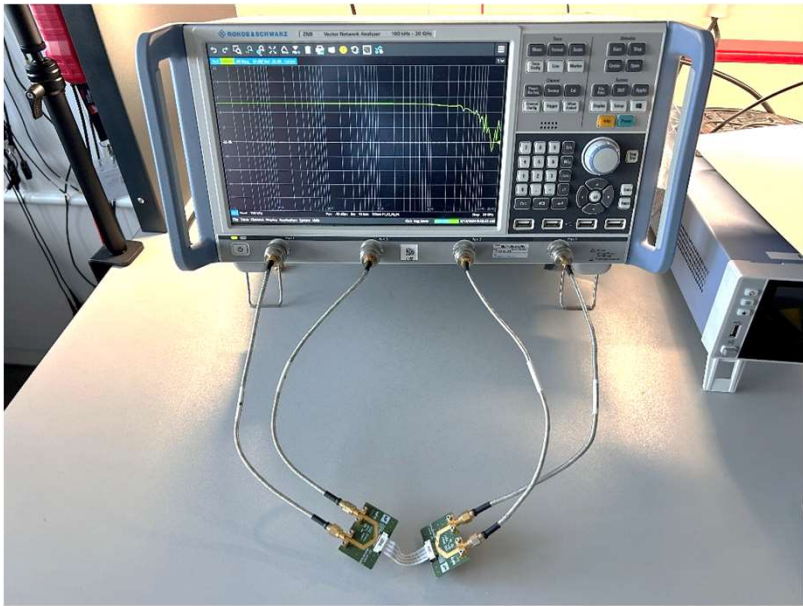
- Characteristic impedance influence parameters:
- Pitch
 - Standard /Right angle
 - Gold / tin
 - FFC length
 - FFC folded or not



FFC folded

PIN HEADER IMPEDANCE

Pin header
Characteristic impedance example

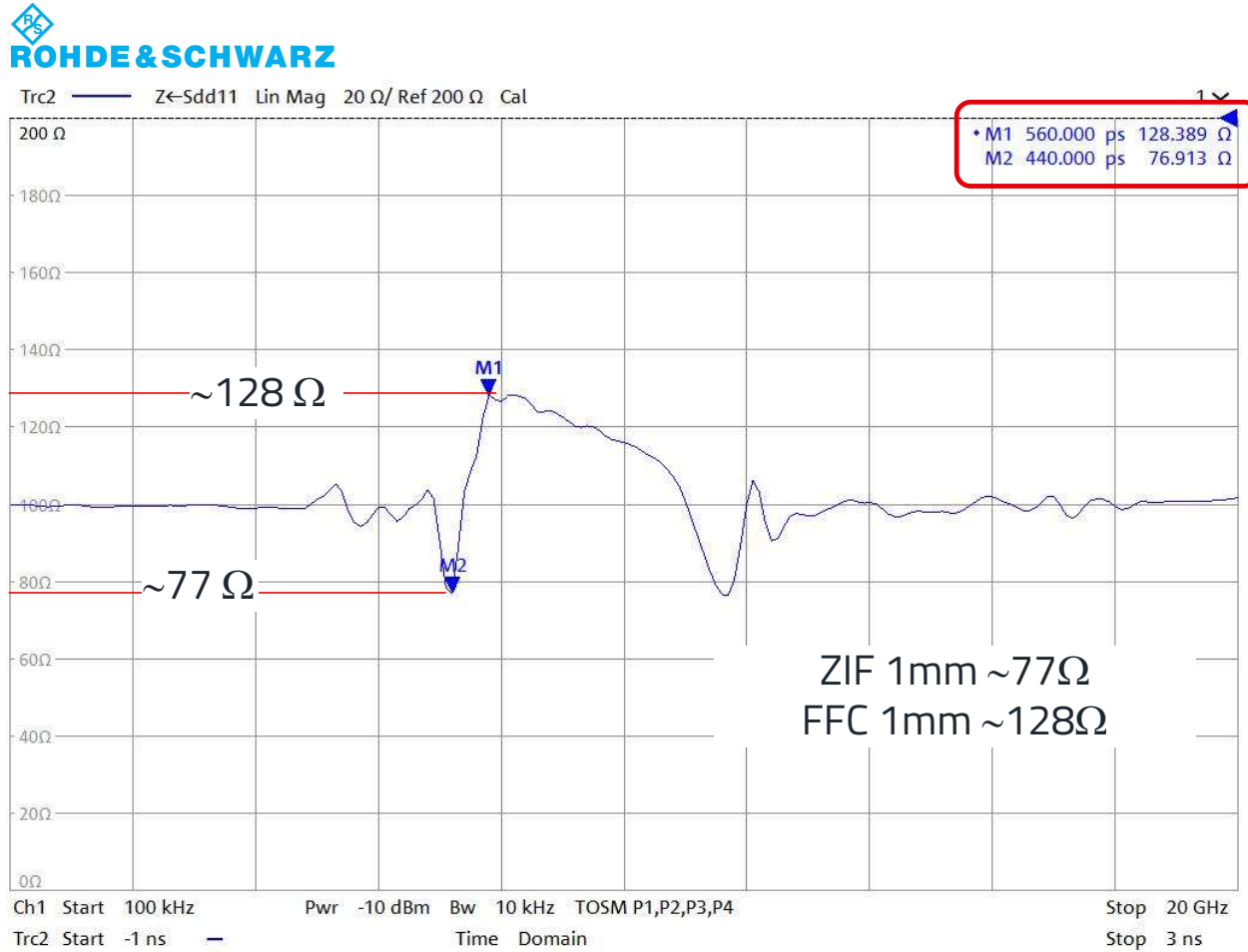


ZIF & LIF FFC



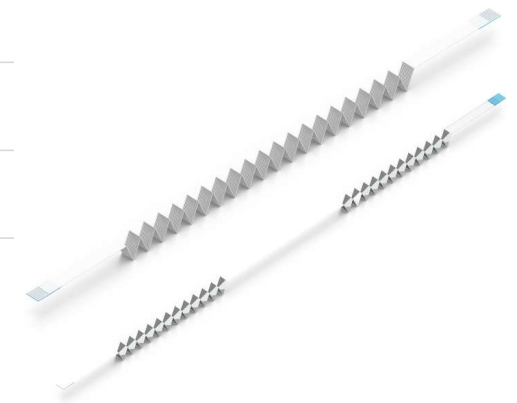
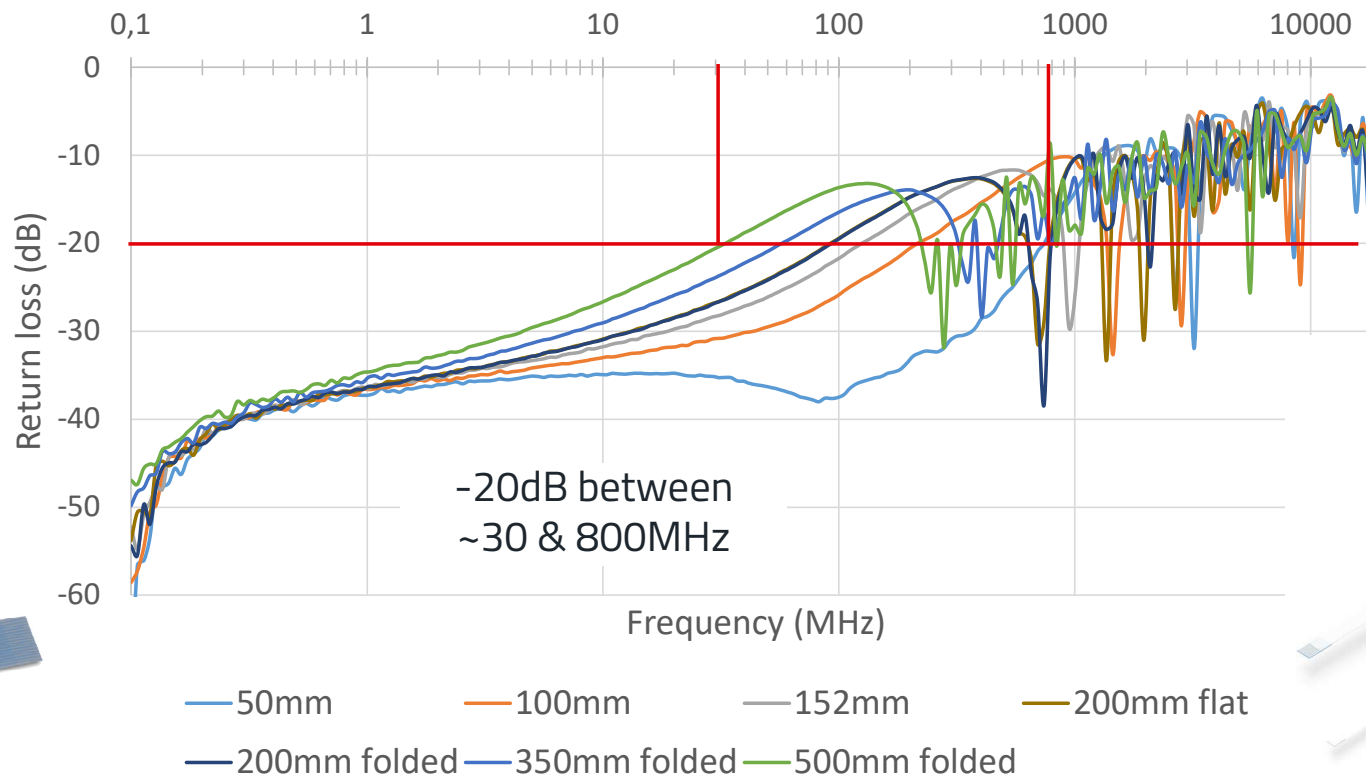
ZIF FFC IMPEDANCE

Pitch 1mm



ZIF FFC LENGTH RETURN LOSS

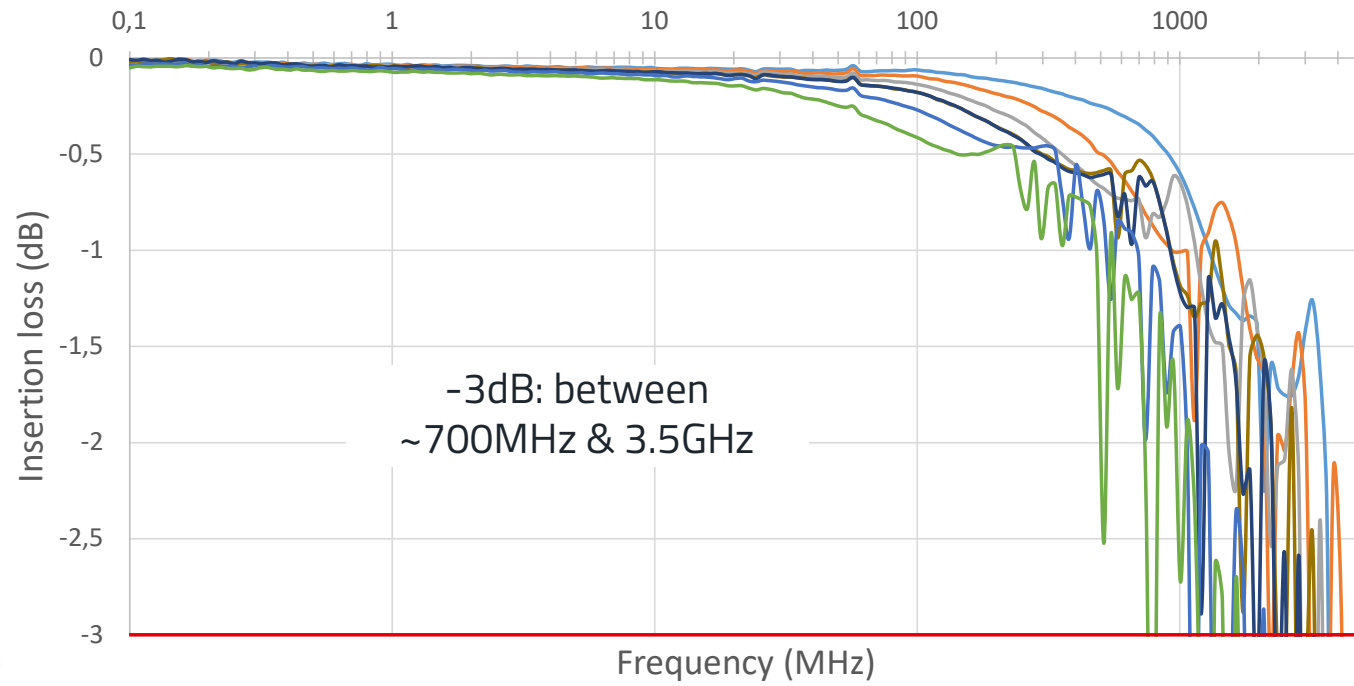
Return loss vs FFC length
ZIF 1mm



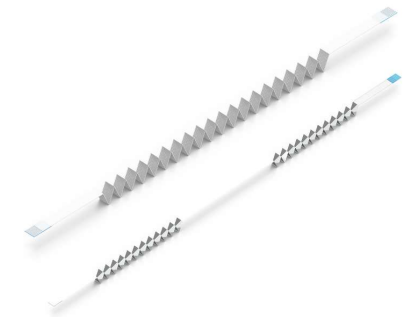
ZIF FFC LENGTH INSERTION LOSS

Insertion loss vs FFC length
ZIF 1mm

FFC length impact is important

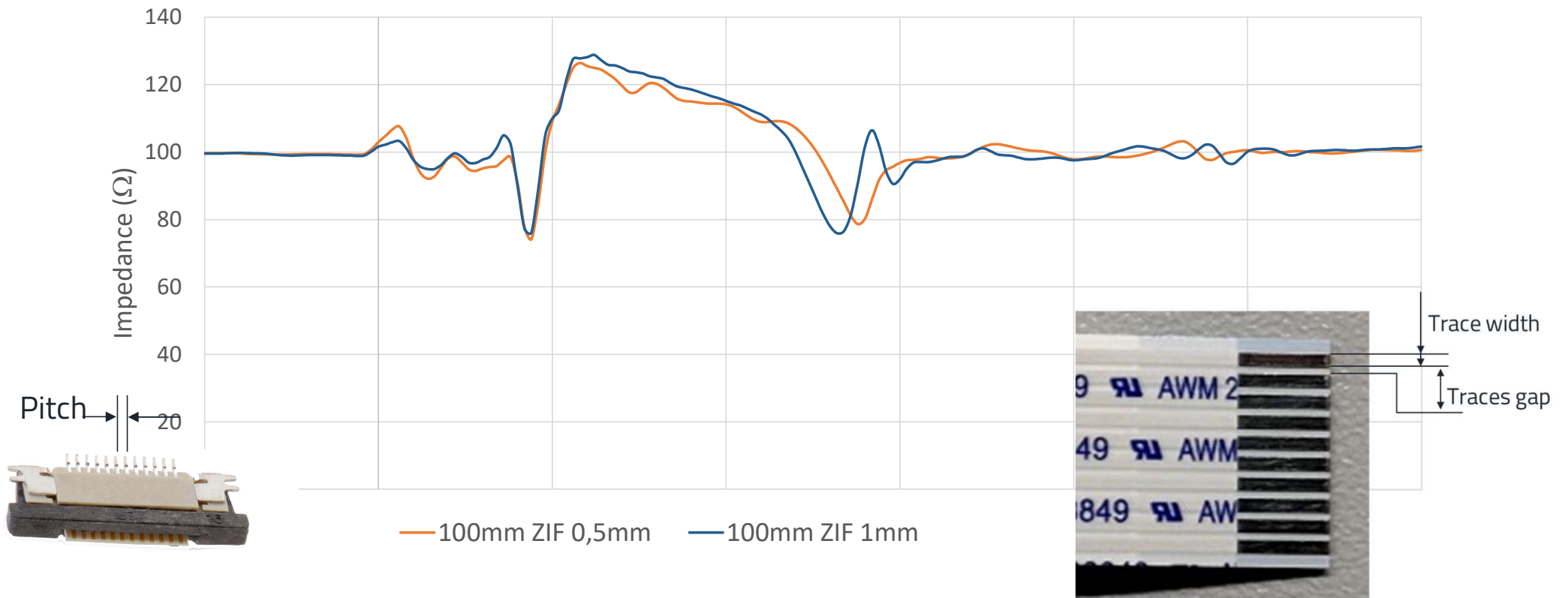


- 50mm
- 100mm
- 152mm
- 200mm flat
- 200mm folded
- 350mm folded
- 500mm folded



ZIF PITCH INFLUENCE

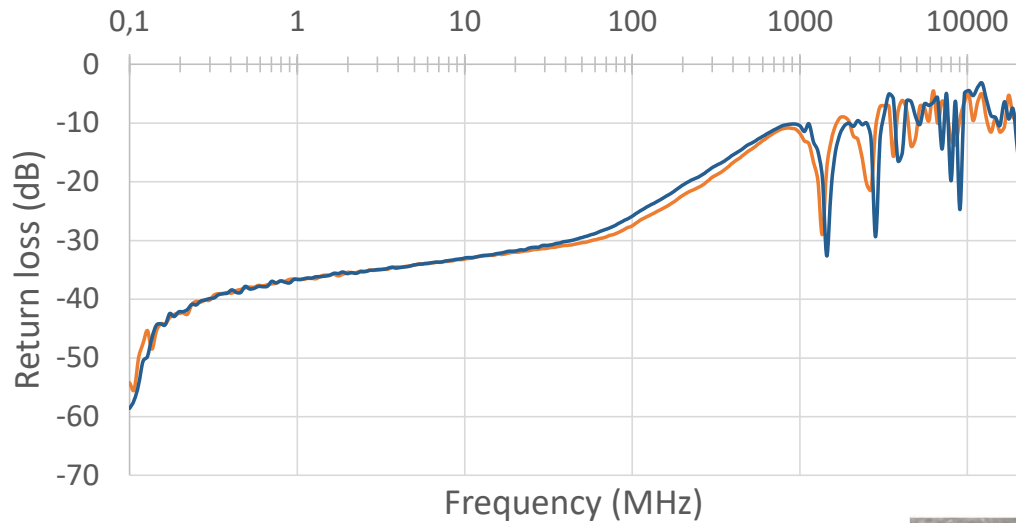
Characteristic impedance vs FFC length
ZIF 0,5mm



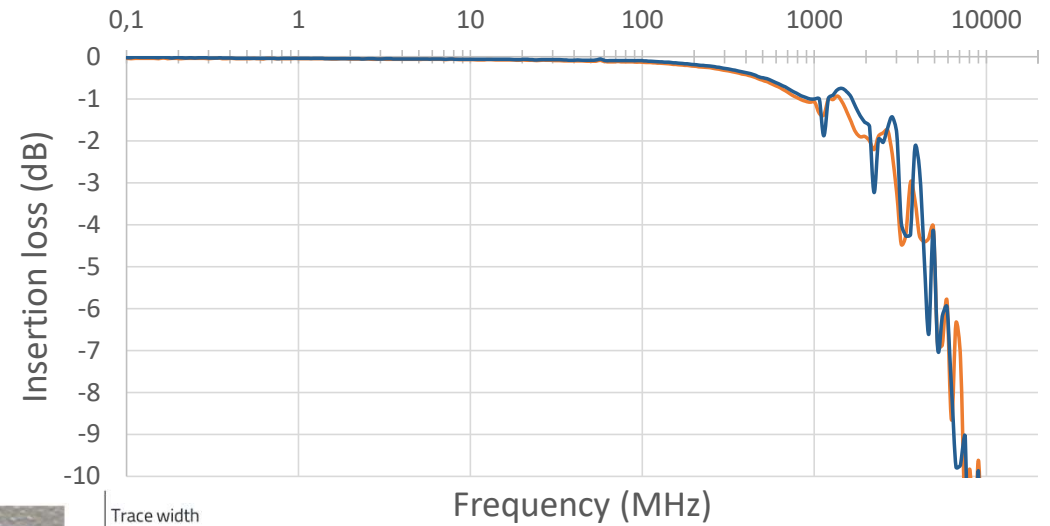
ZIF PITCH INFLUENCE

Pitch of 0,5 and 1mm gives roughly same kind of results

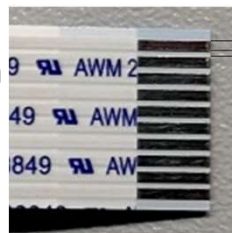
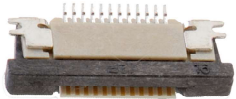
Return loss vs FFC length
ZIF 0,5mm



Insertion loss vs FFC length
ZIF 0,5mm



— 100mm ZIF 0,5mm — 100mm ZIF 1mm



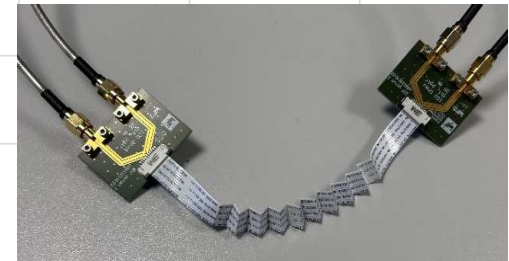
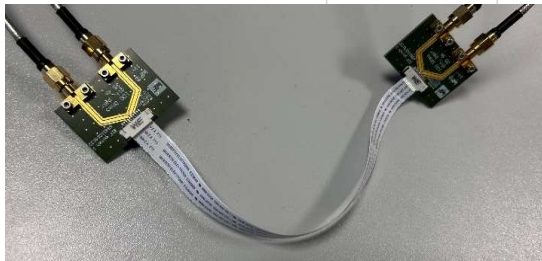
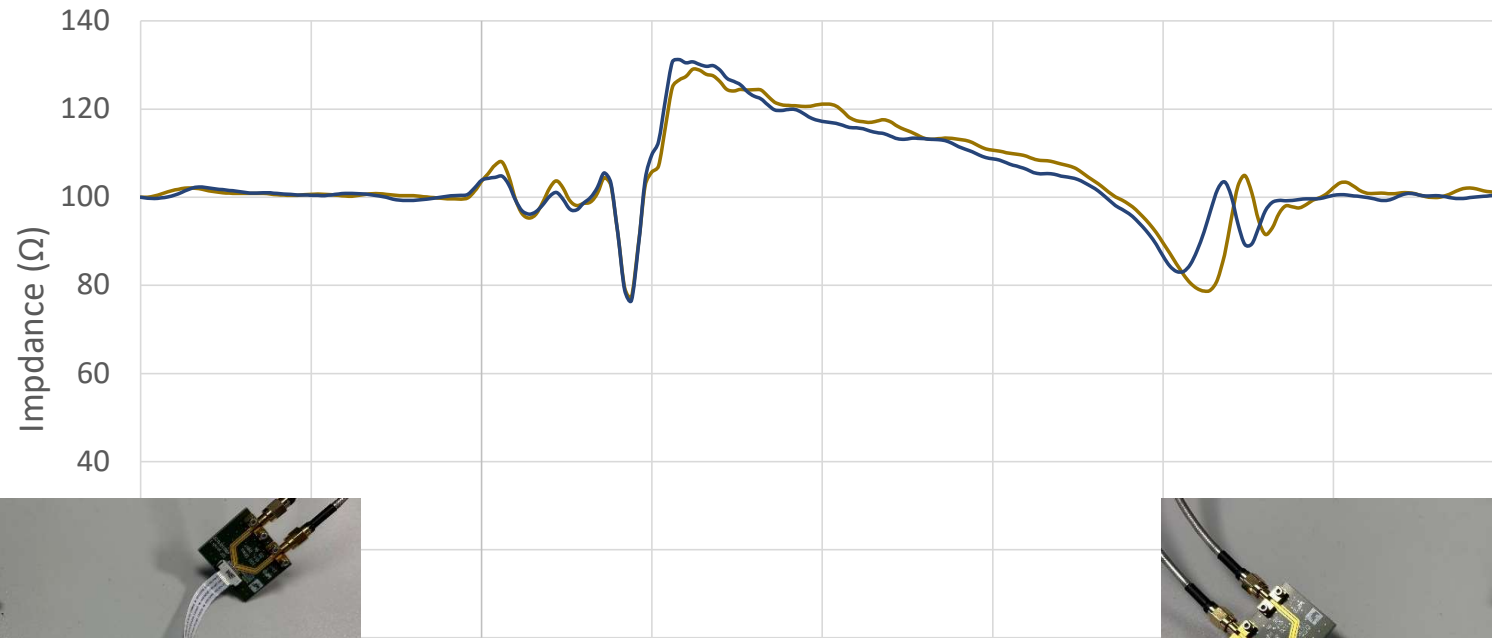
Trace width
Traces gap

— 100mm ZIF 0,5mm — 100mm ZIF 1mm



FLAT FOLDED FFC

Characteristic impedance FFC flat vs folded
ZIF pitch 1mm

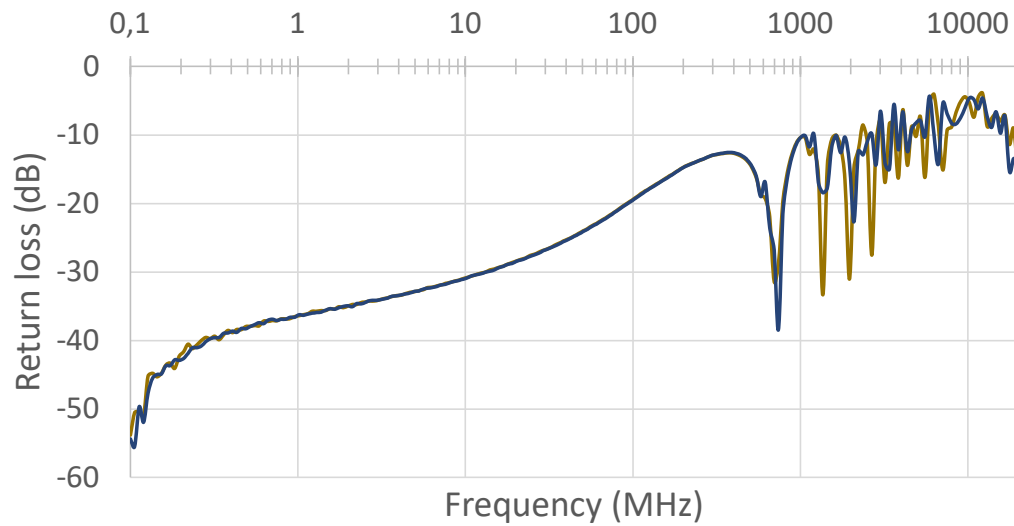


— 200mm flat — 200mm folded

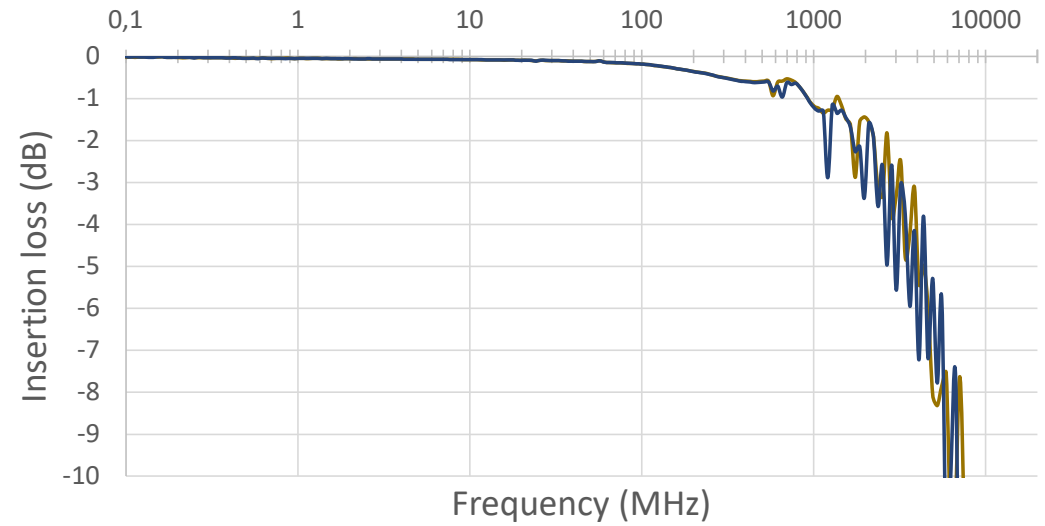
FLAT FOLDED FFC

Folded FFC has no major influence on signal integrity

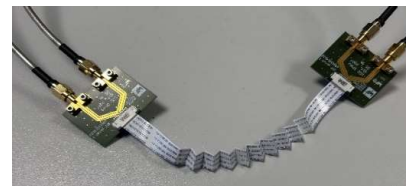
Return loss flat vs folded FFC
ZIF 1mm



Insertion loss vs FFC length
ZIF 1mm



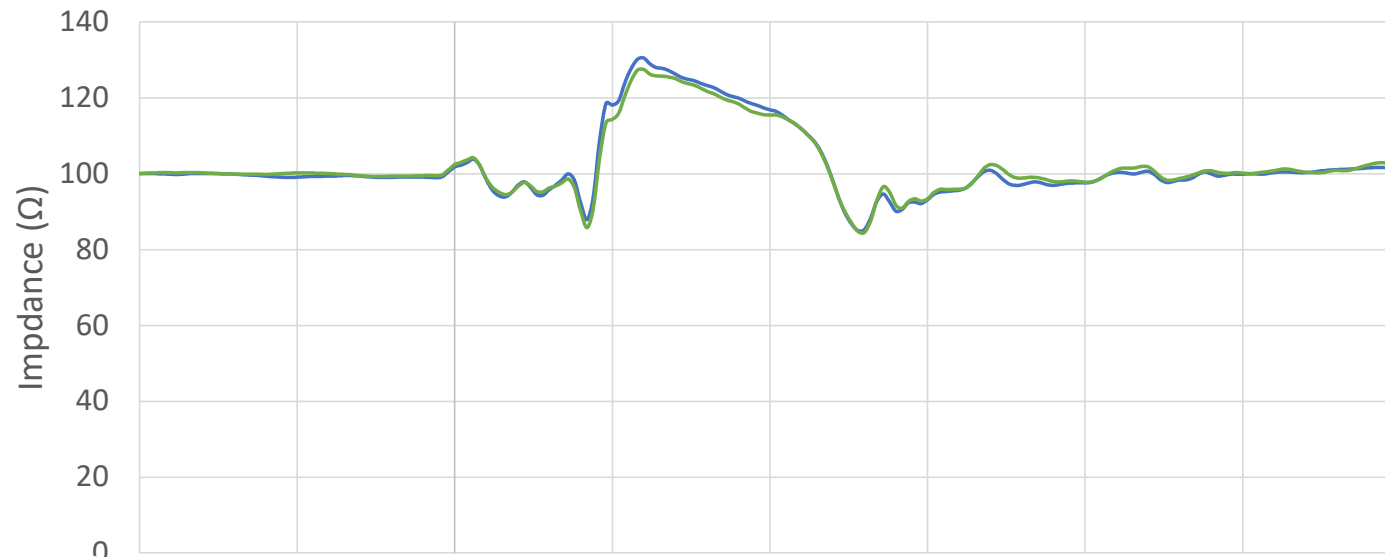
— 200mm flat — 200mm folded



— 200mm flat — 200mm folded

GOLD OR TIN ?

Characteristic impedance gold vs tin
ZIF pitch 1mm FFC 100mm



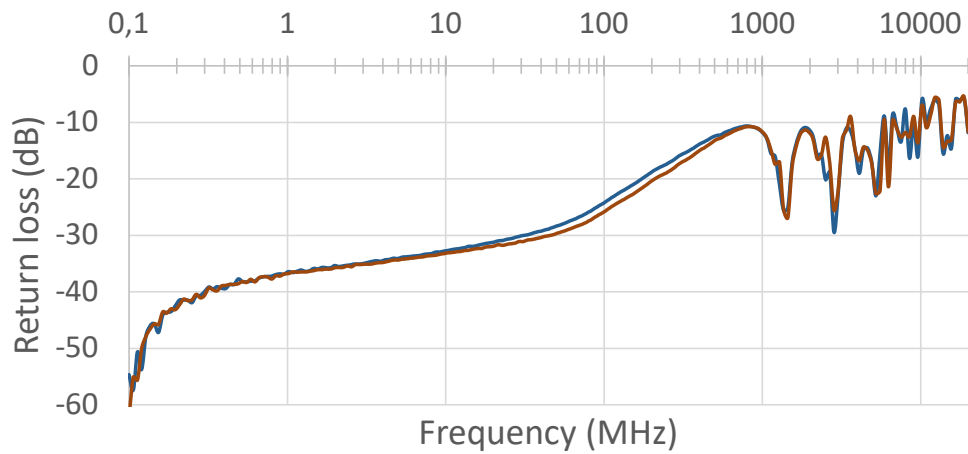
— 100mm ZIF gold FFC gold

— 100mm ZIF tin FFC tin

GOLD OR TIN ?

Gold provides equivalent results as tin

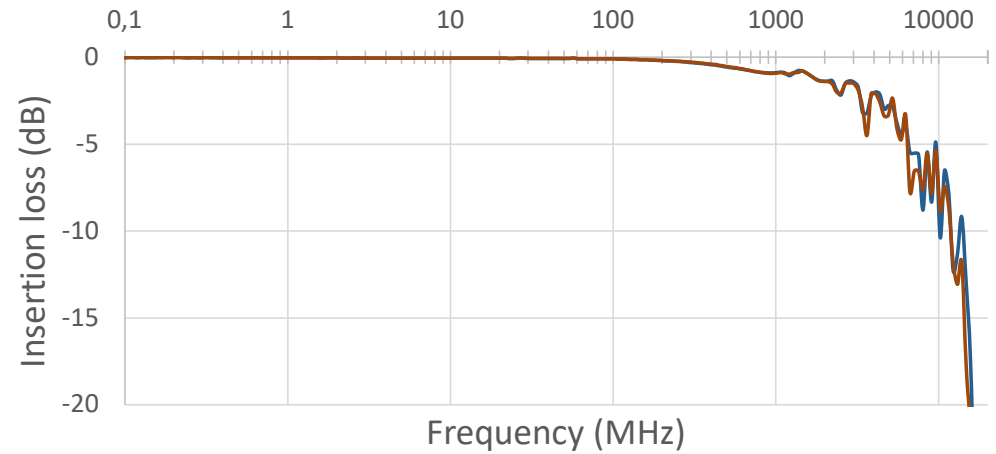
Return loss gold vs tin
ZIF pitch 1mm FFC 100mm



— 100m ZIF gold FFC gold — 100mm ZIF tin FFC tin



Insertion loss gold vs tin
ZIF pitch 1mm FFC 100mm



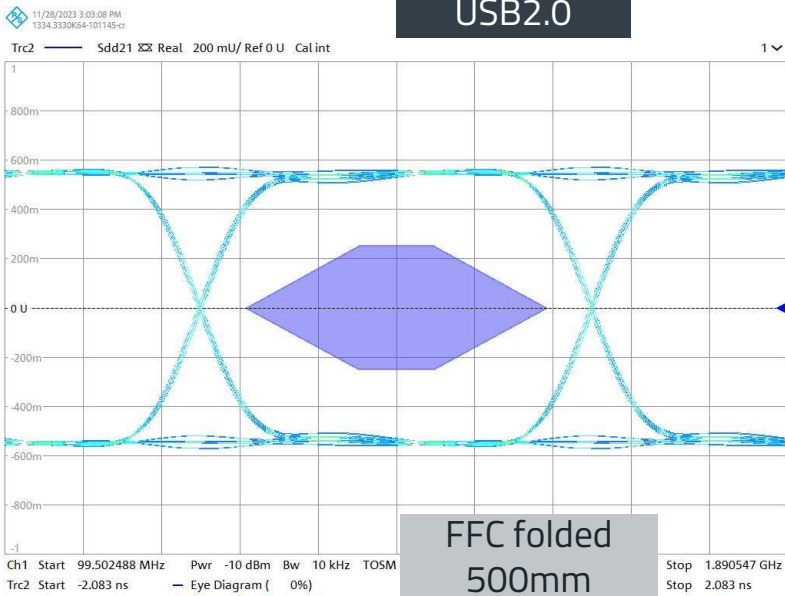
— 100mm ZIF gold FFC gold — 100mm ZIF tin FFC tin

EYE DIAGRAM

EYE DIAGRAMM

ZIF 1 mm

USB2.0

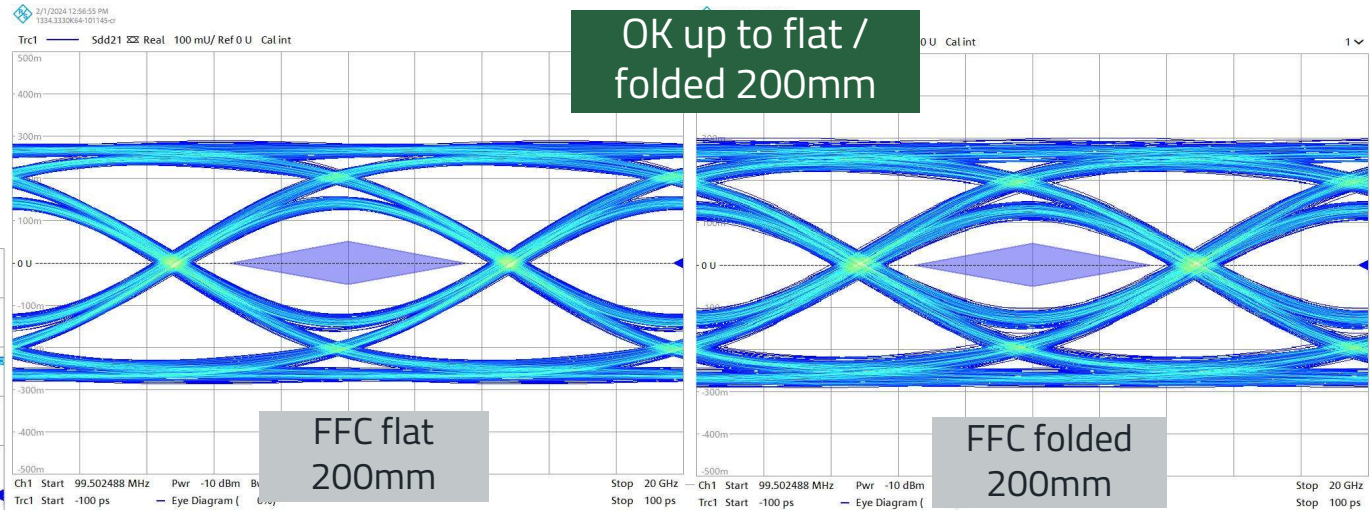


FFC folded 500mm

OK all length

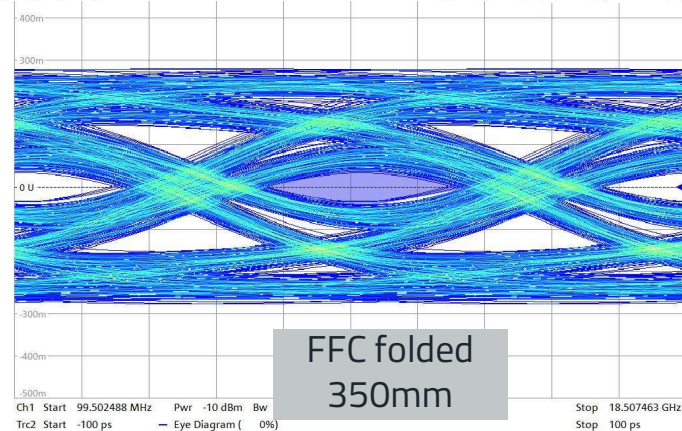
USB3.2 gen 1

OK up to flat / folded 200mm



FFC flat 200mm

FFC folded 200mm

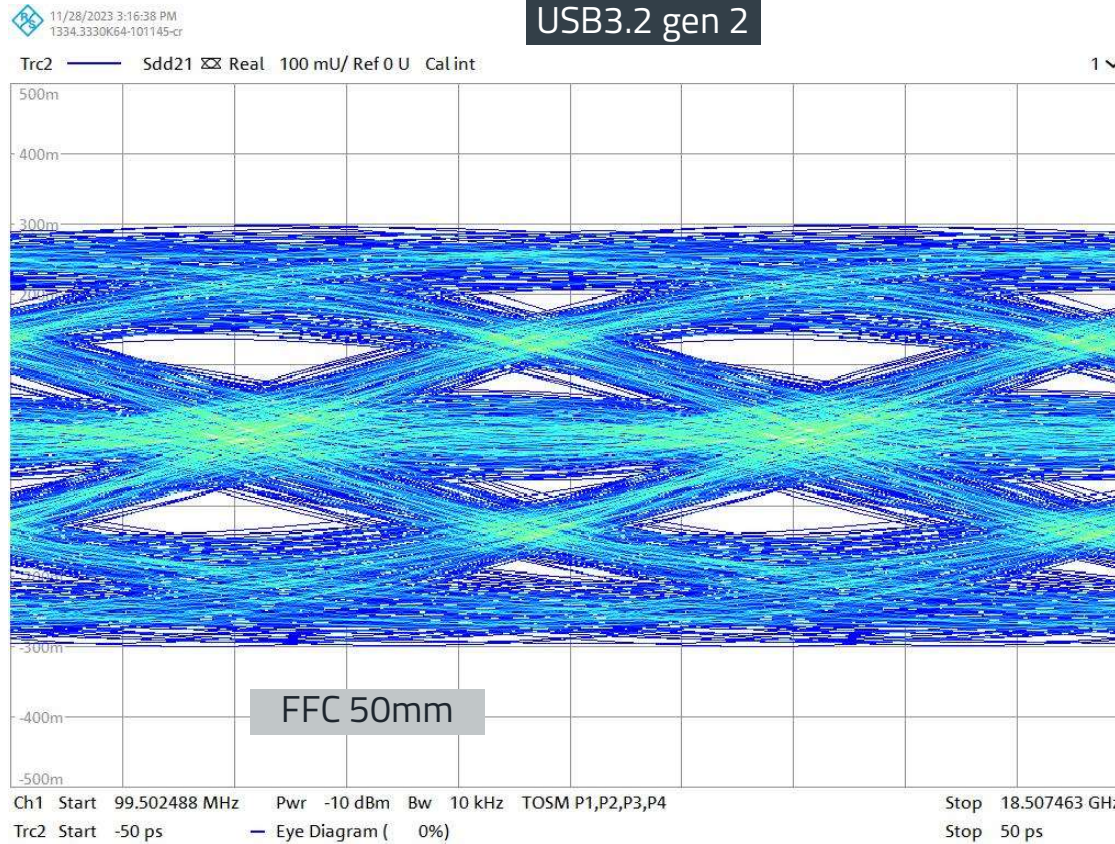


FFC folded 350mm

USB 3.2 gen 1
from 350mm
NOK

EYE DIAGRAMM

ZIF 1 mm



USB3.2 gen 2

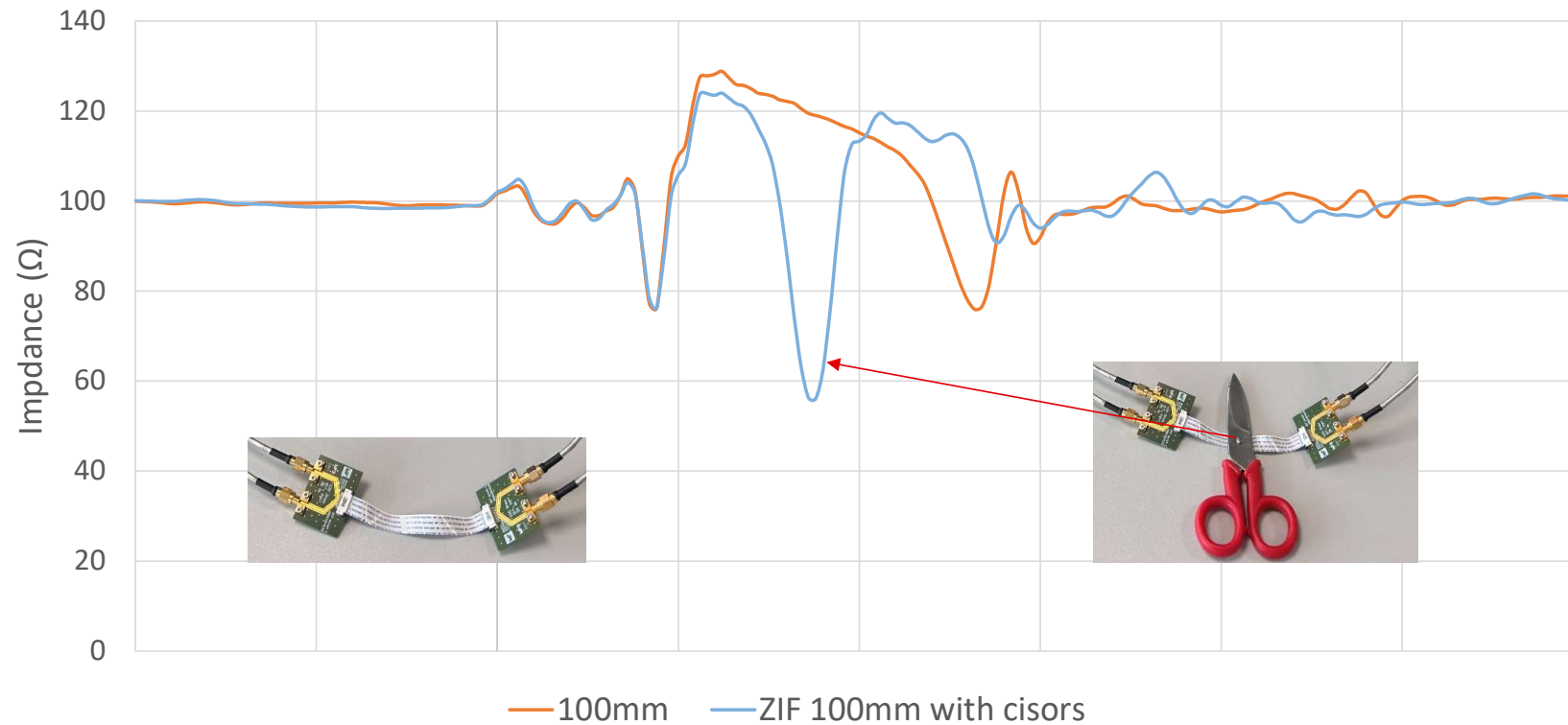
USB 3.2 gen 2
NOK

FUN FACTS



METAL

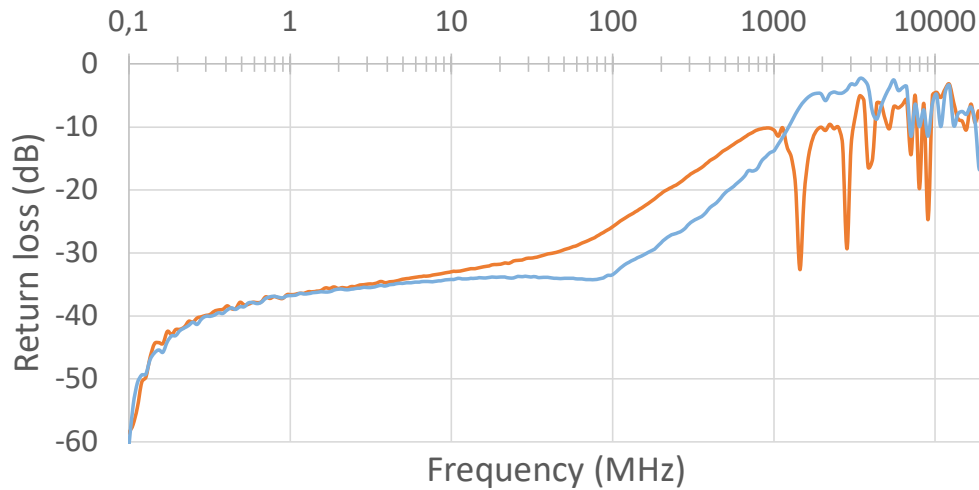
Characteristic impedance vs FFC length
ZIF pitch 1mm



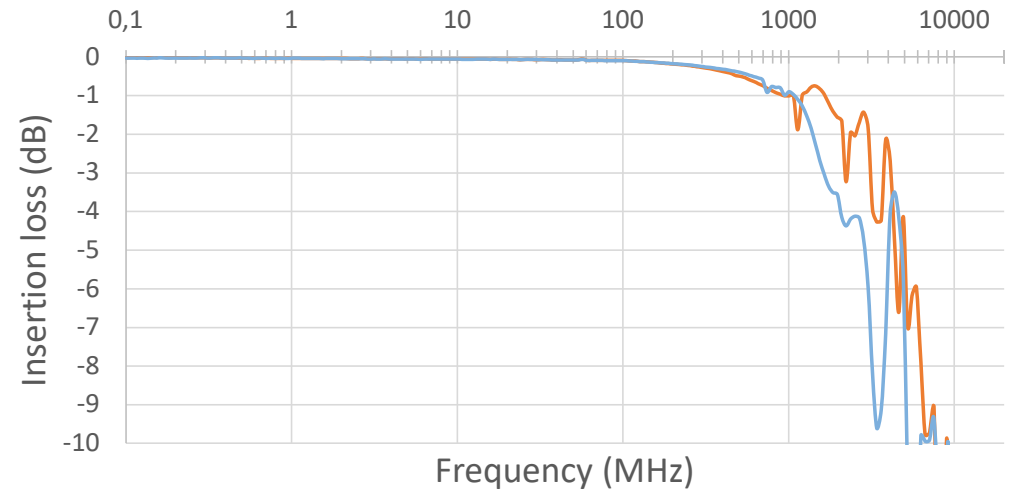
METAL

Steel stuff has a big impact on high frequencies

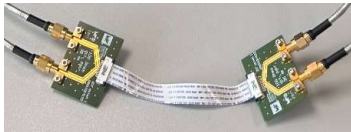
Return loss vs FFC length
ZIF 1mm



Insertion loss vs FFC length
ZIF 1mm



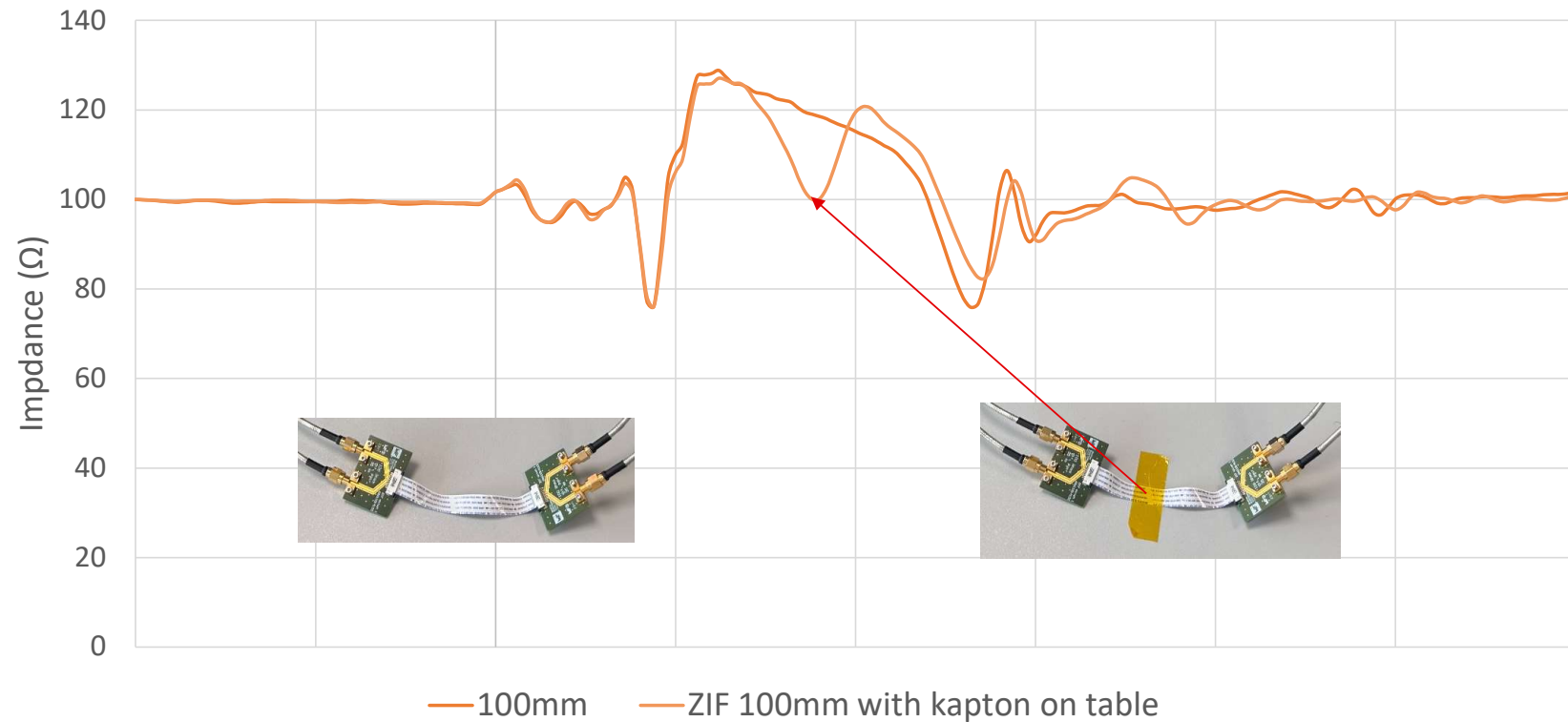
— 100mm — ZIF 100mm with cisors



— 100mm — ZIF 100mm with cisors

KAPTON TAPE ON WOOD TABLE

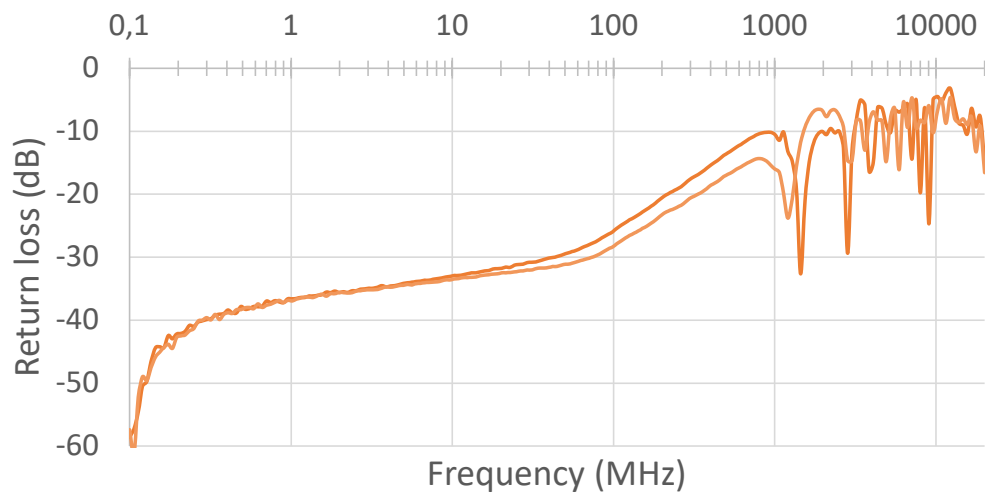
Characteristic impedance vs FFC length
ZIF pitch 1mm



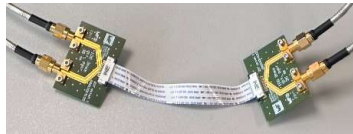
KAPTON TAPE ON WOOD TABLE

No significant impact

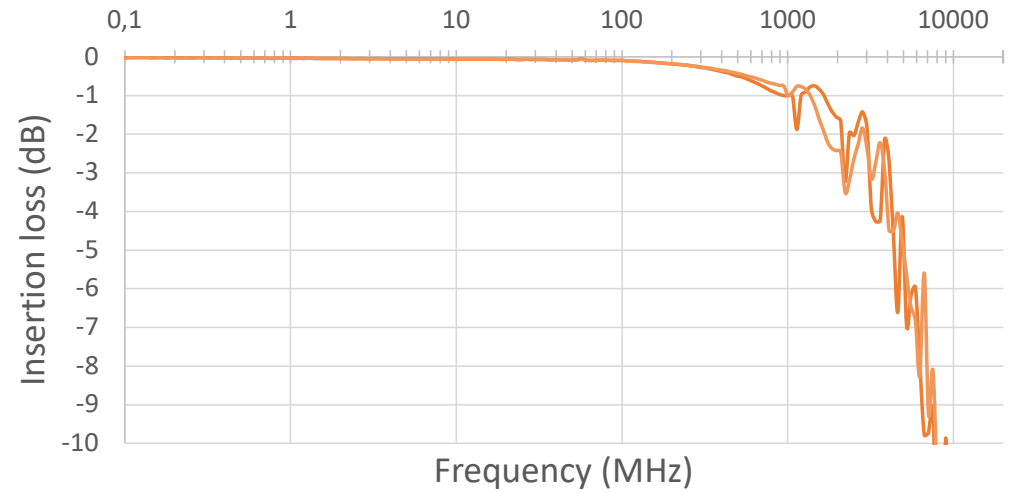
Return loss vs FFC length
ZIF 1mm



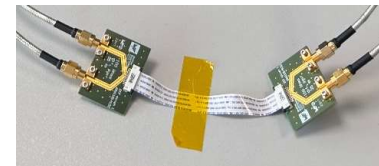
— 100mm — ZIF 100mm with kapton on table



Insertion loss vs FFC length
ZIF 1mm

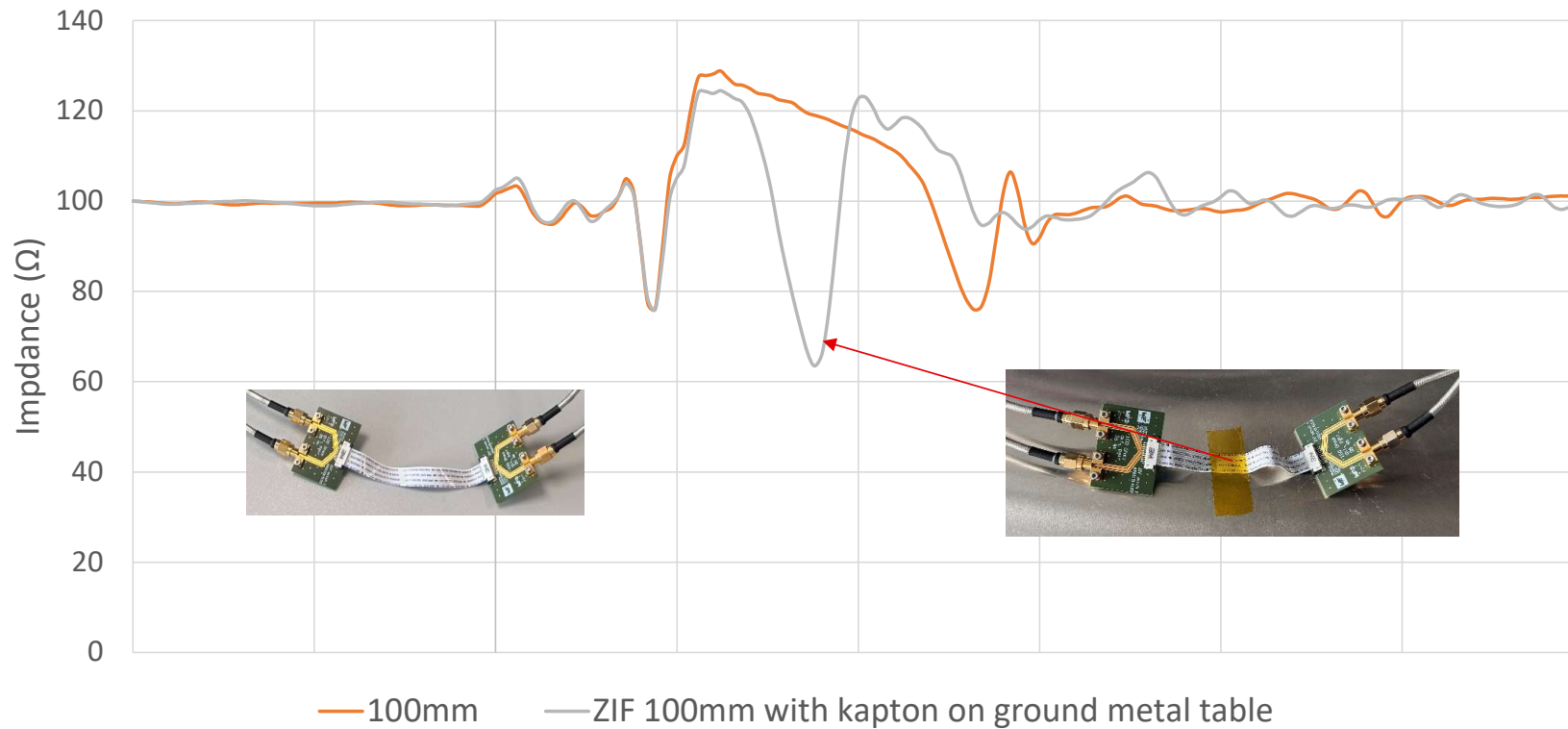


— 100mm — ZIF 100mm with kapton on table



KAPTON TAPE ON GROUND METAL PLATE

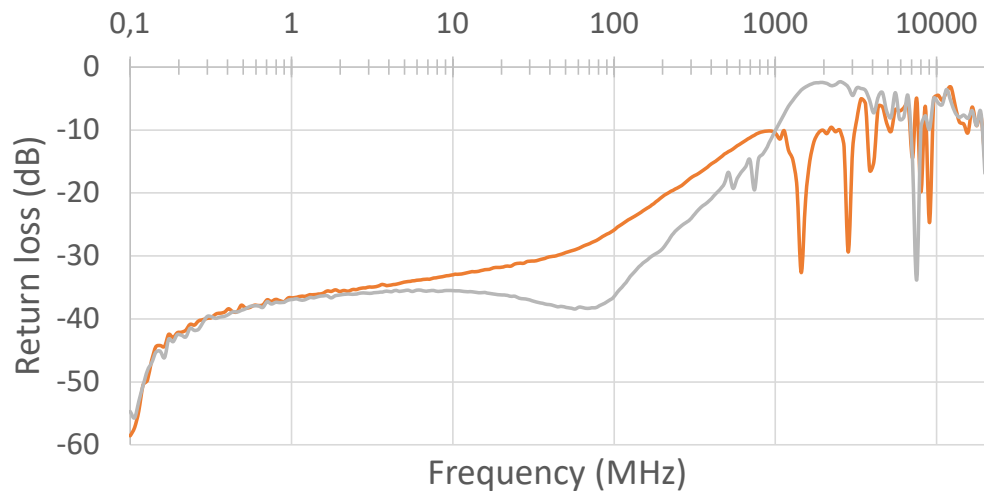
Characteristic impedance vs FFC length
ZIF pitch 1mm



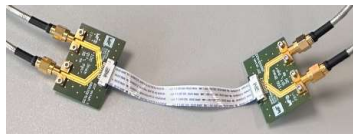
KAPTON TAPE ON GROUND METAL PLATE

Metal plate has a big impact on frequencies above 1GHz

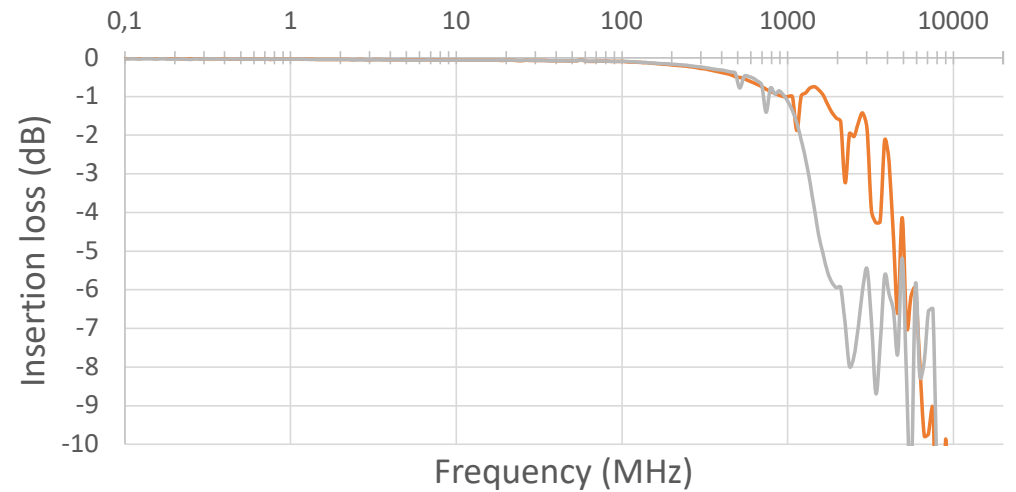
Return loss vs FFC length
ZIF 1mm



— 100mm — ZIF 100mm with kapton on ground metal table



Insertion loss vs FFC length
ZIF 1mm

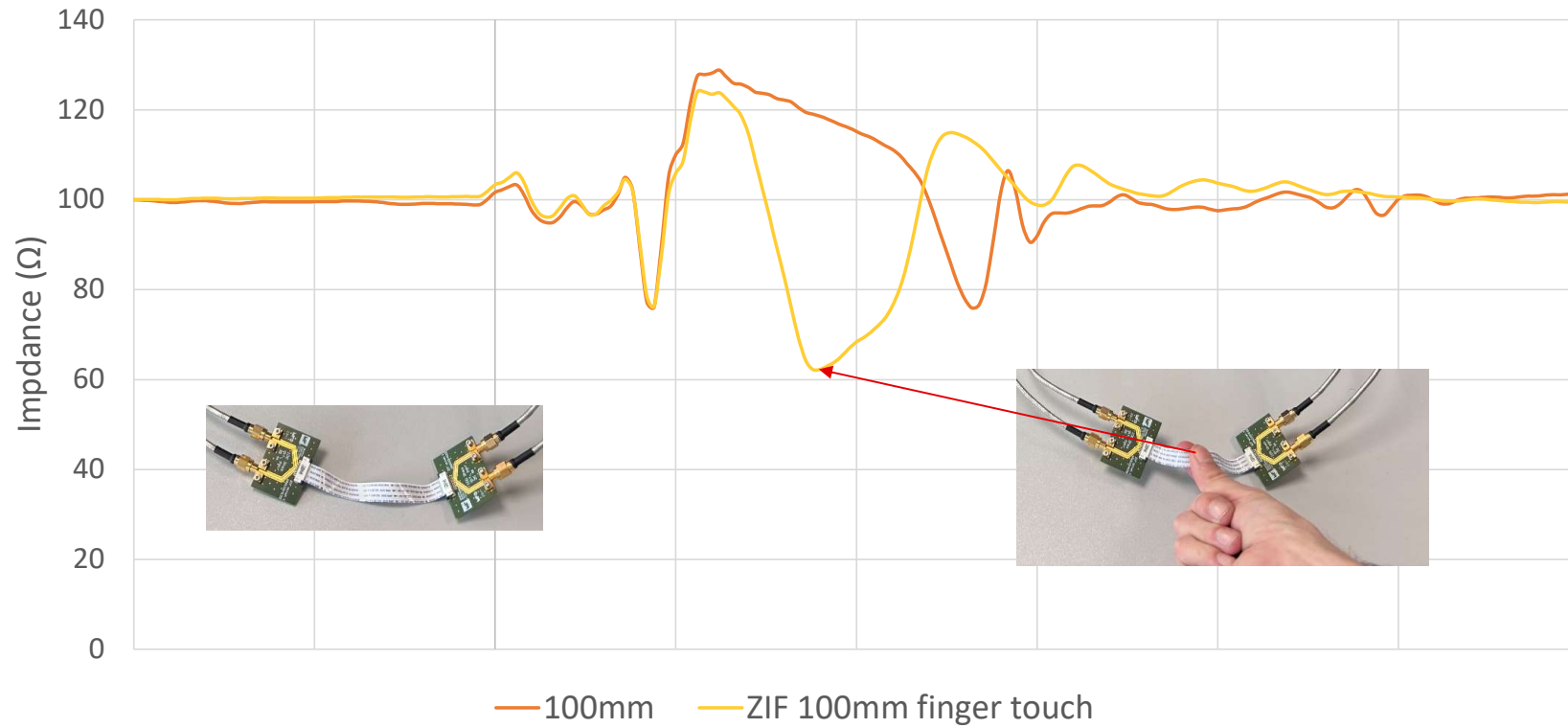


— 100mm — ZIF 100mm with kapton on ground metal table



HAND CONTACT

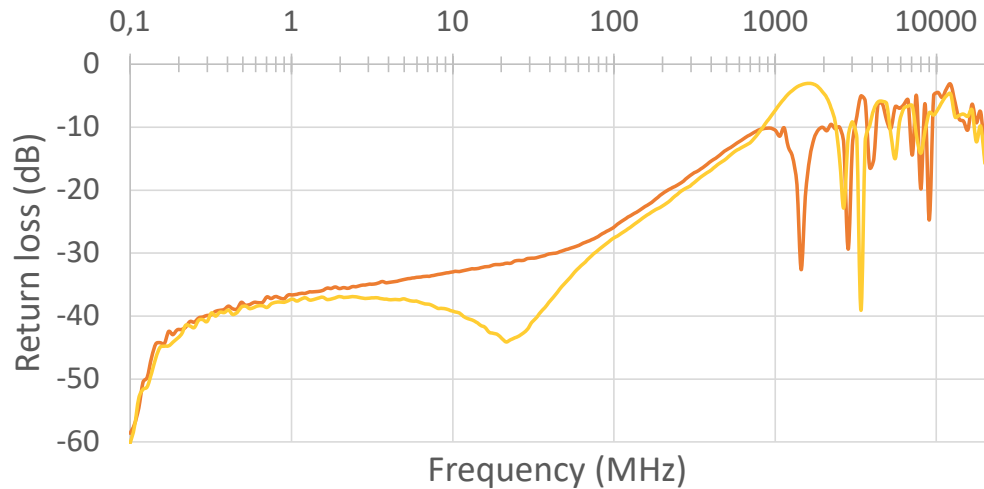
Characteristic impedance vs FFC length
ZIF pitch 1mm



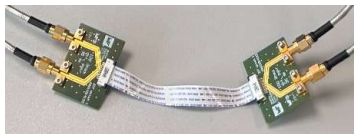
HAND CONTACT

Impact of body contact is significant

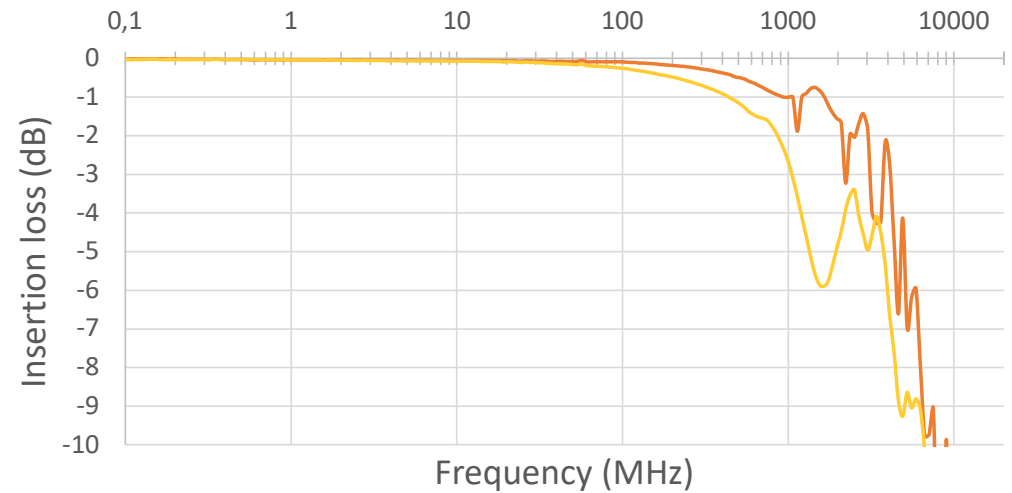
Return loss vs FFC length
ZIF 1mm



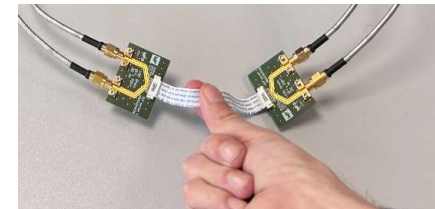
— 100mm — ZIF 100mm finger touch



Insertion loss vs FFC length
ZIF 1mm

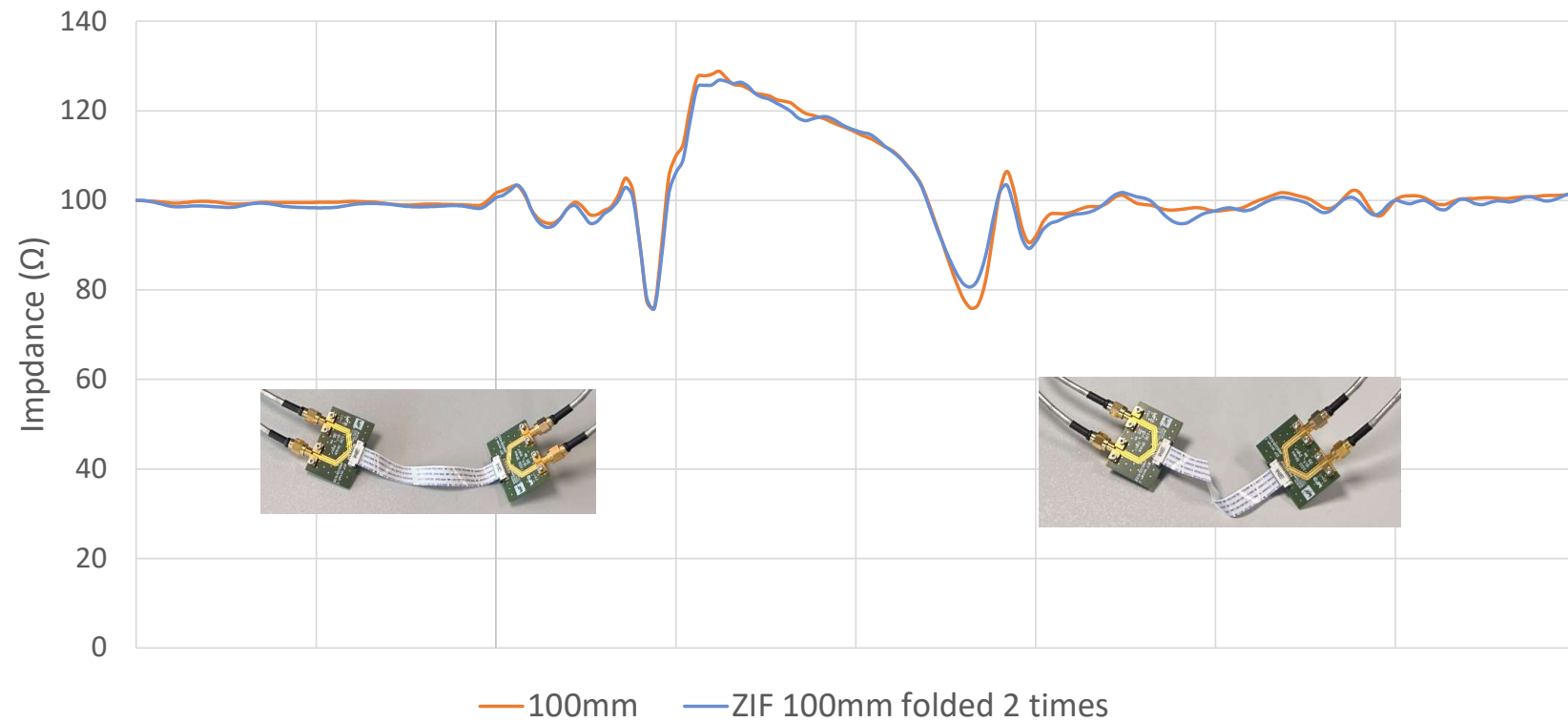


— 100mm — ZIF 100mm finger touch



RANDOMLY FOLDED FFC

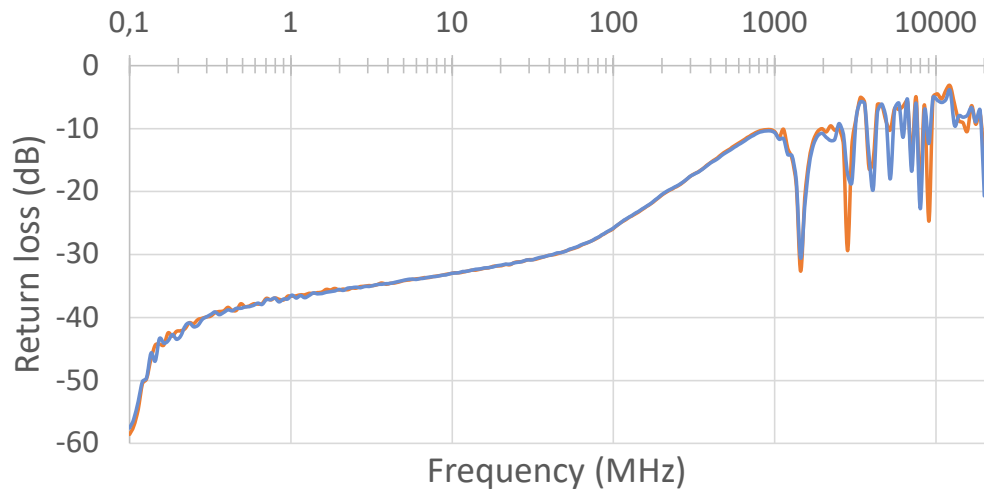
Characteristic impedance vs FFC length
ZIF pitch 1mm



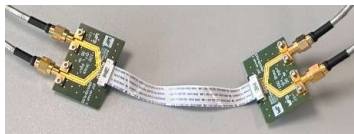
RANDOMLY FOLDED FFC

Bend FFC has no impact

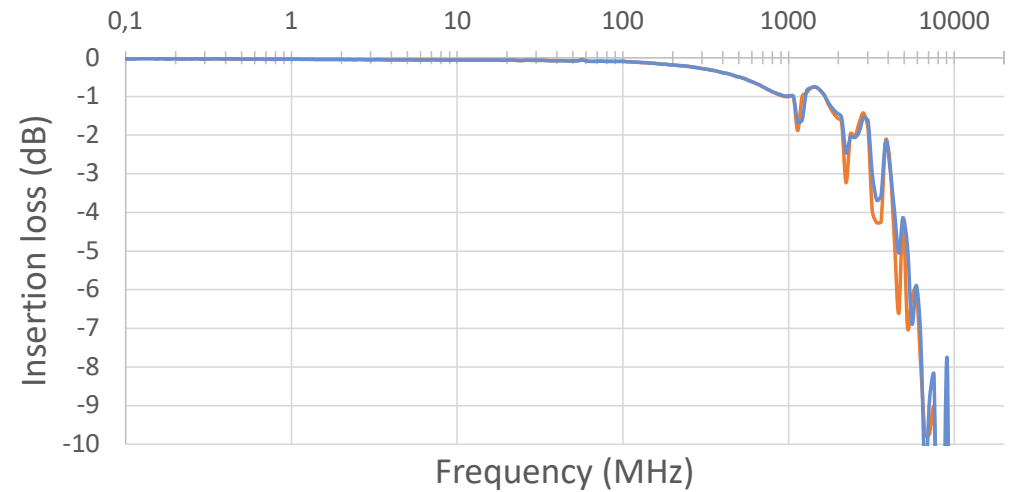
Return loss vs FFC length
ZIF 1mm



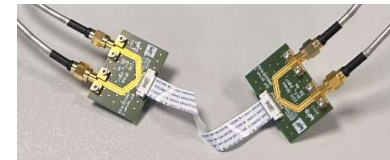
— 100mm — ZIF 100mm folded 2 times



Insertion loss vs FFC length
ZIF 1mm



— 100mm — ZIF 100mm folded 2 times



CONCLUSIONS

- Pitch 0.5mm and 1mm gives good results
- Parameters with **low** sensitive relative impact
 - ZIF and LIF give equivalent results
 - Gold plating (give higher results on contact resistance, mating cycles and durability)
 - ZIF vertical impact low
 - FFC sticked on standard table
 - FFC folded
- Parameters with **significant** impact on signal integrity:
 - FFC sticked on ground metal table
 - FFC in contact with metal part
 - FFC in contact with human body
- Parameters with **high** impact on signal integrity:
 - FFC length
- USB eye diagram
 - USB2.0 is ok
 - USB3.2 gen 1 is very limited
 - USB 3.2 gen 2 is not possible

Questions

& Answers



We are here for you now!
Ask us directly via our chat or via E-Mail.

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