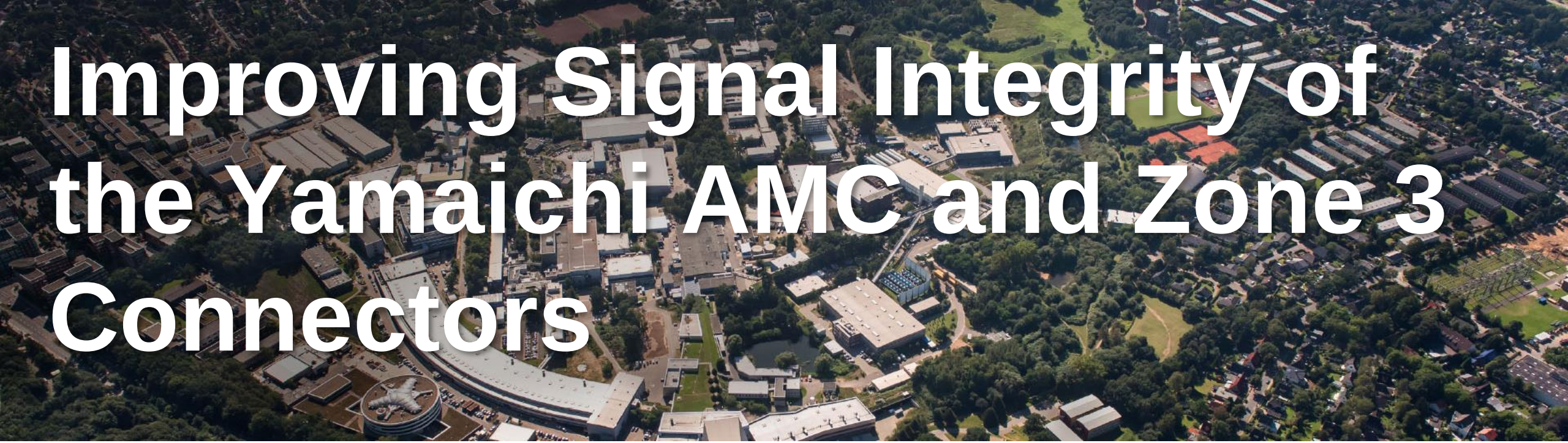


Improving Signal Integrity of the Yamaichi AMC and Zone 3 Connectors

Michael Fenner, DESY Hamburg

13th MicroTCA Workshop for Industry and Research

11th of December 2024

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

Agenda

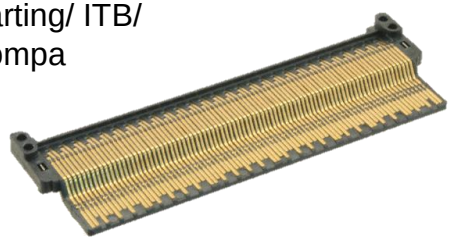
1. Improving Signal Integrity of the Yamaichi AMC Connector
2. Improving Signal Integrity over Zone 3

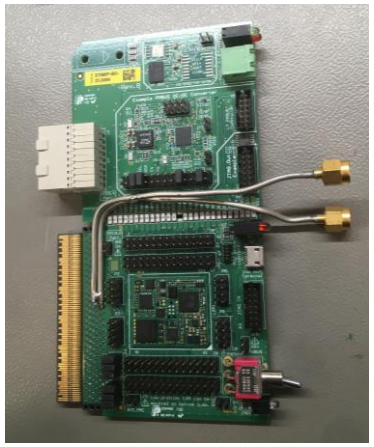
Improving Signal Integrity of the Yamaichi AMC Connector

Addressing possible Obsolescence and better Signal Integrity

A short recap from 2023

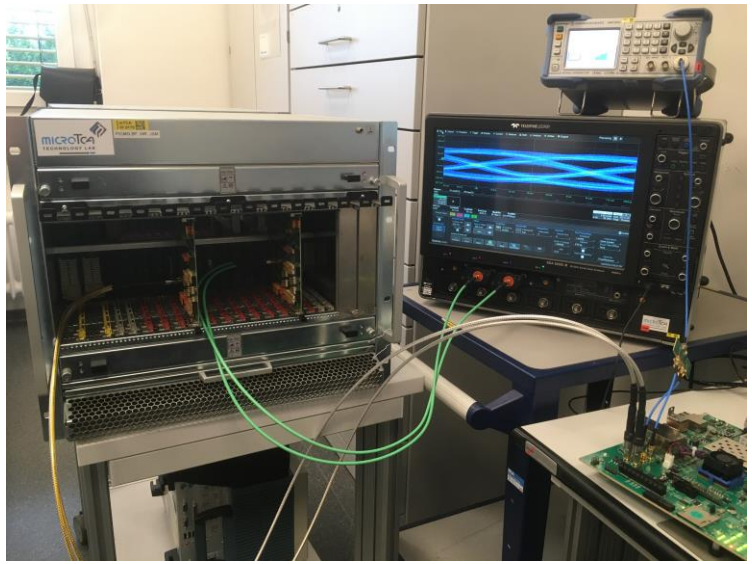
Harting/ ITB/
Rompa





- Replacing the AMC connector is delicate
- Has huge influence on board performance

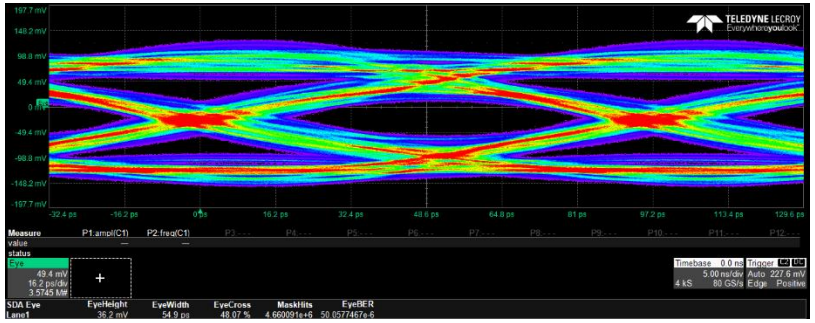
Yamaichi
CN084

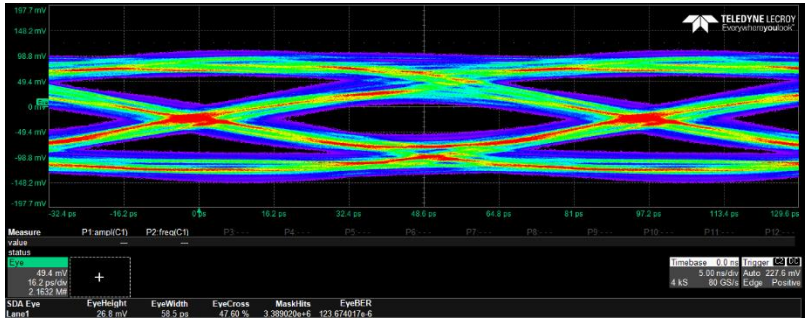


- We made a Test board with the new connector
- We have measured both connectors

10G Eye Test Results

Results from 2023





Harting/ ITB/ Rompa results:

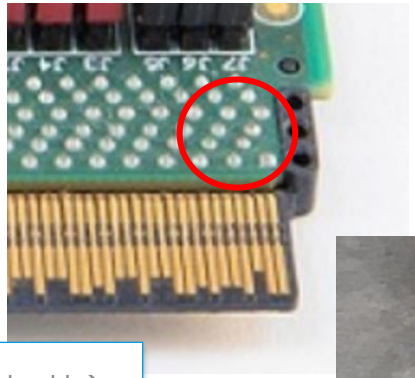
- 36.2mV eye height
- 54.9ps eye width

Yamaichi results:

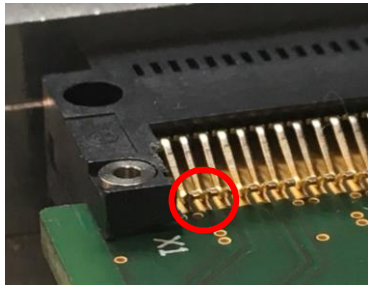
- 26.8mV eye height
- 58.5ps eye width

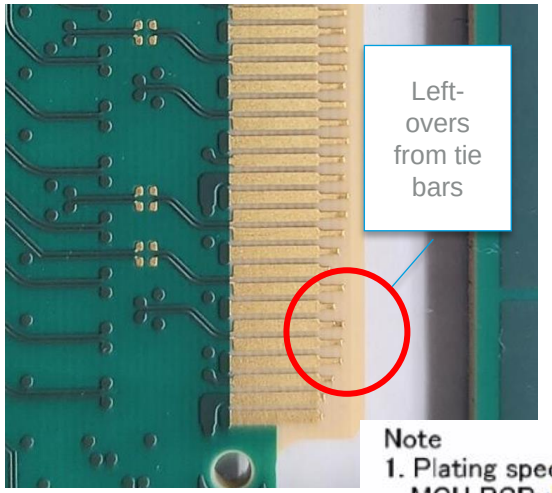
Similar results (Longer FR4 traces on test board)
TX pre-emphasis settings active (identical settings on both eye diagrams)

→ The Yamaichi connector should be way better, but is not…
→ We had issues to apply hard gold plating as required

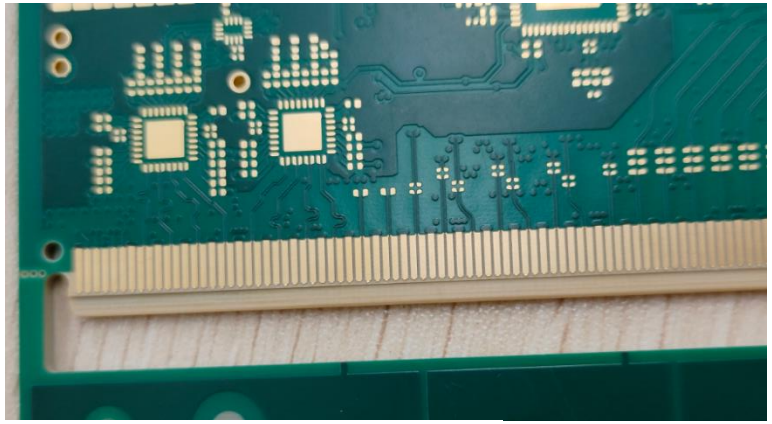


No hard gold → perfect pads

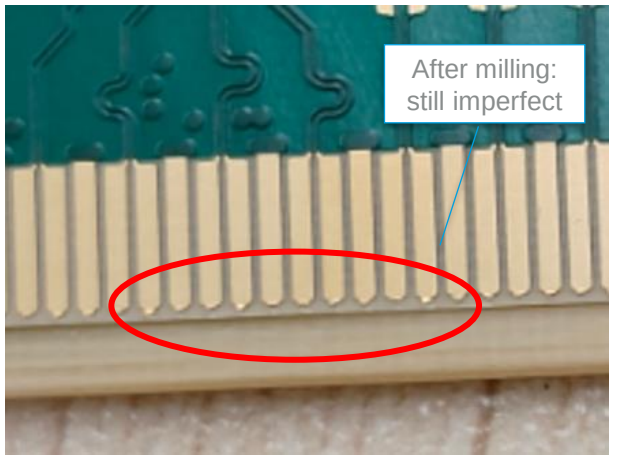




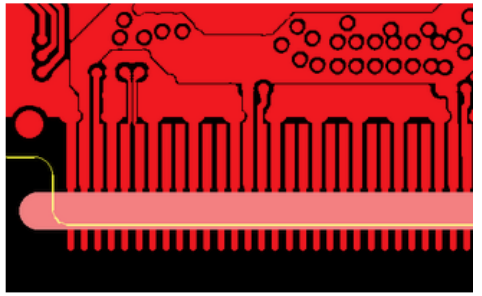
Left-overs from tie bars



Note
1. Plating specification on the PCB pads
MCH PCB : Au 0.30 μ m MIN. over Ni 1.27 μ mMIN.



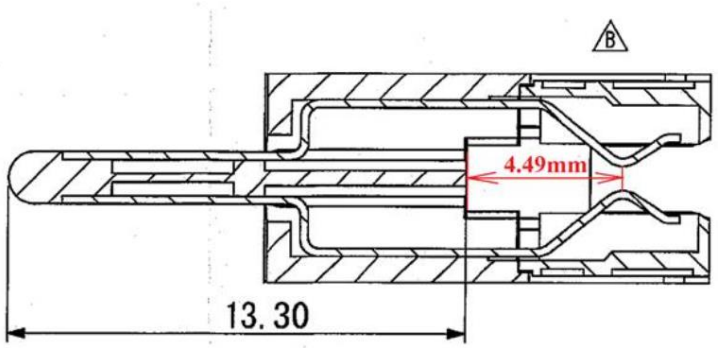
After milling: still imperfect



Courtesy of LeitOn GmbH

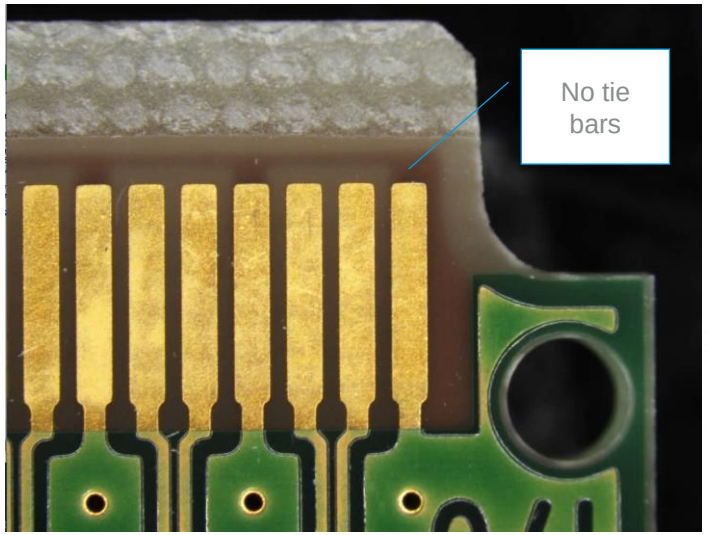
How to improve the Connector Layout?

Made according to Data Sheet



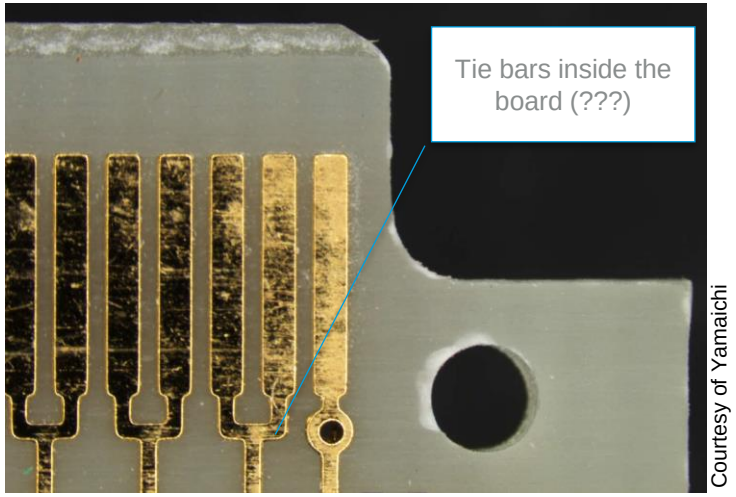
Courtesy of Andreas Grüttner, Struck

Picture from Yamaichi (verification board):
Datasheet design, but no hard gold



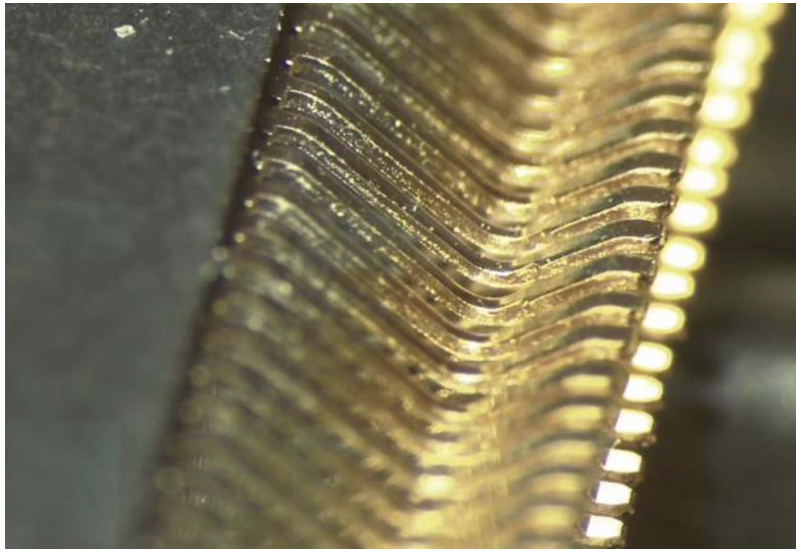
Courtesy of Yamaichi

Picture from Yamaichi (verification board):
Datasheet design with hard gold plating

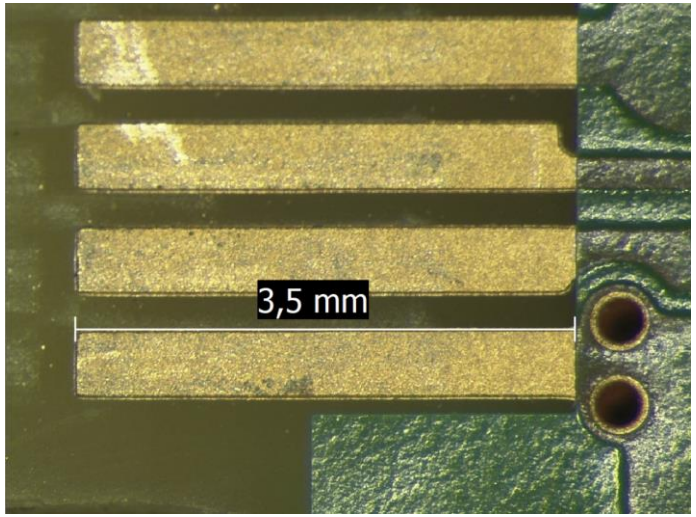


Courtesy of Yamaichi

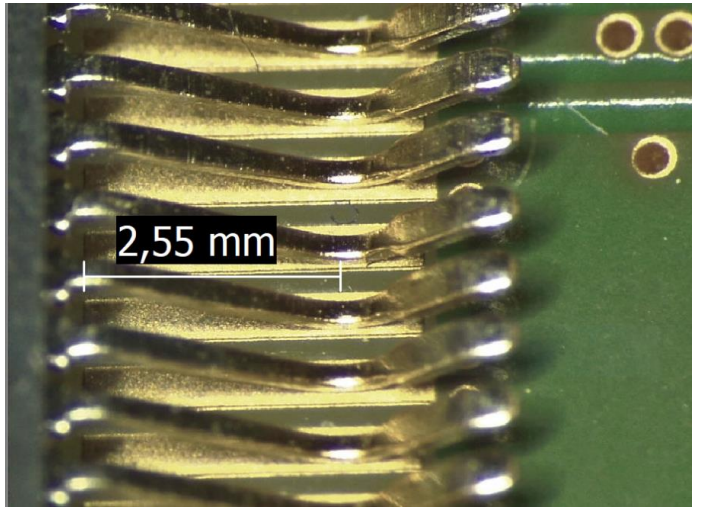
Shape of the Contact Fingers



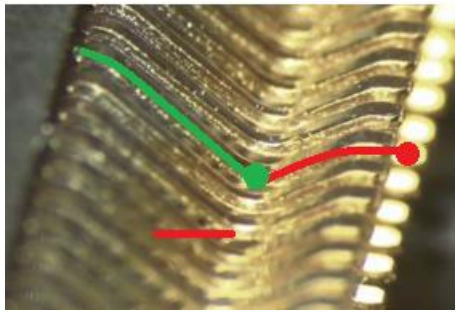
Shape of the Pads

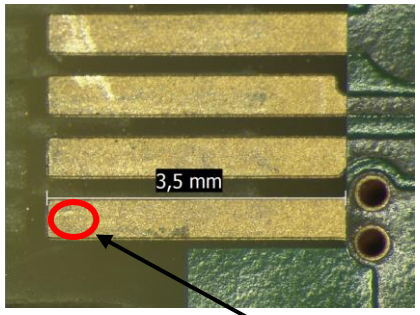


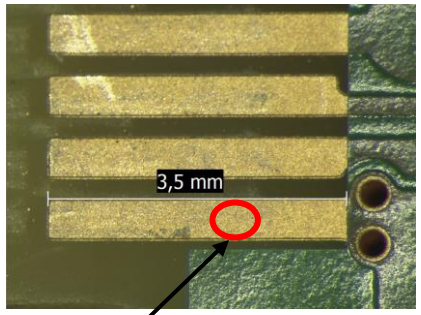
Touching Point → We have a stub of 2.55mm

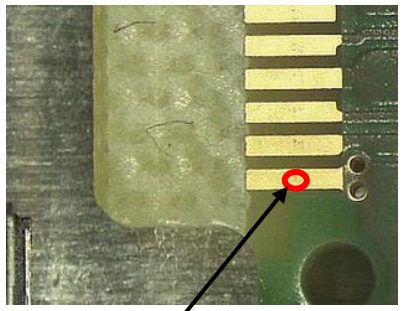


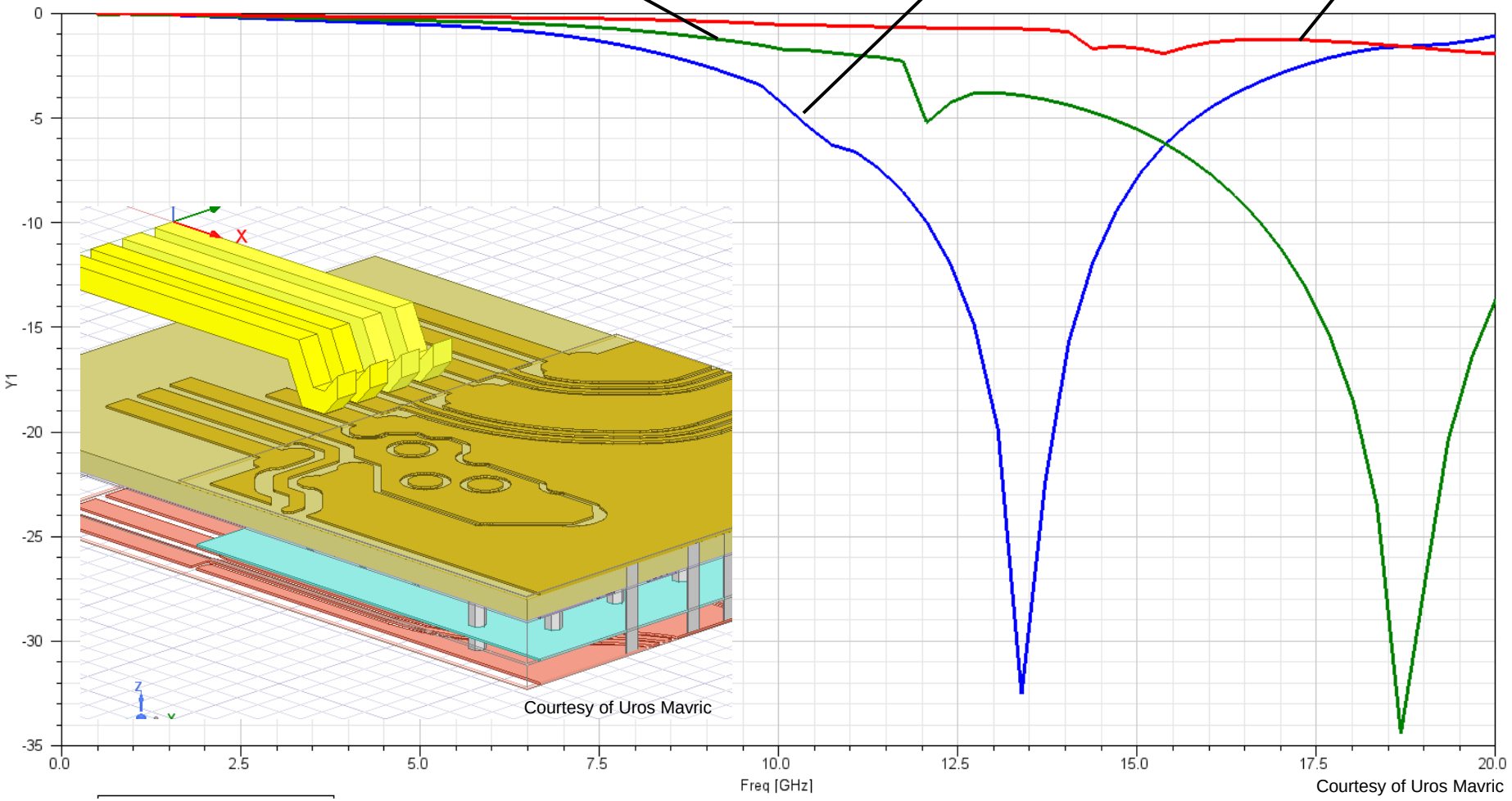
Simulation











- Various options simulated with Ansys SIwave

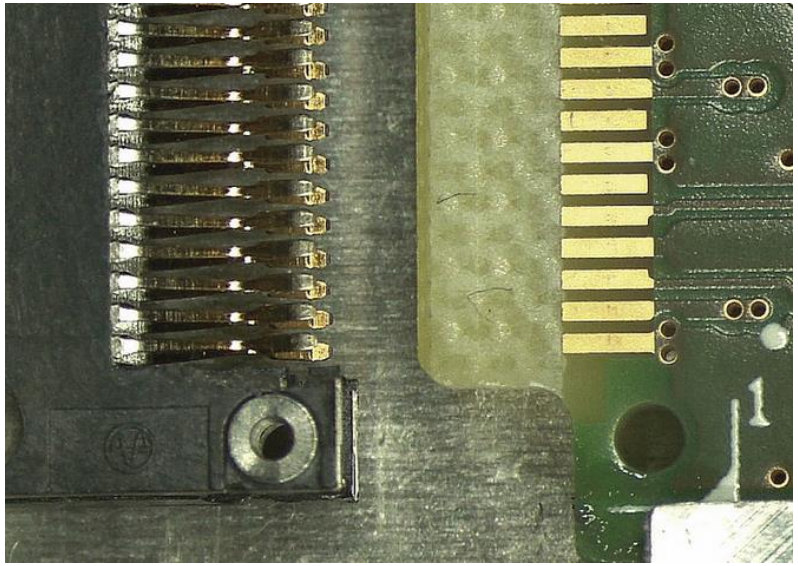
Taken into account

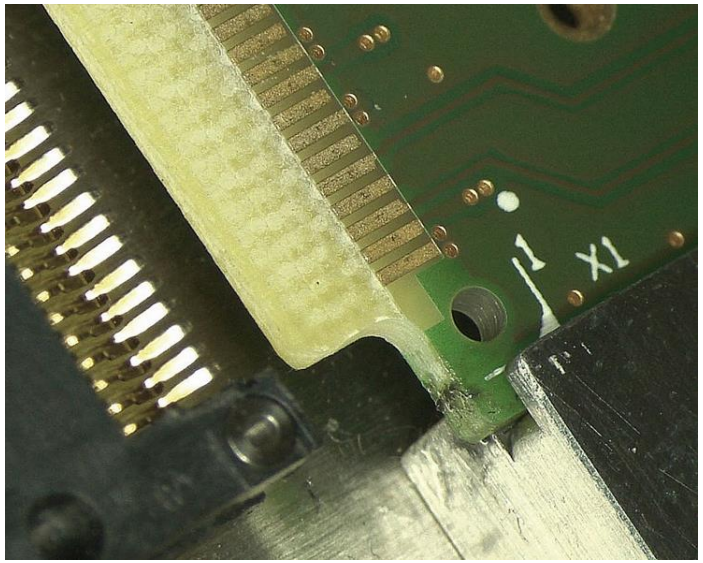
- SI considerations
- Mechanical considerations

Optimum result:

- Same pad width
- Same right end of the pad
- Pad only 2mm long
- 1.5mm cut back from the front face

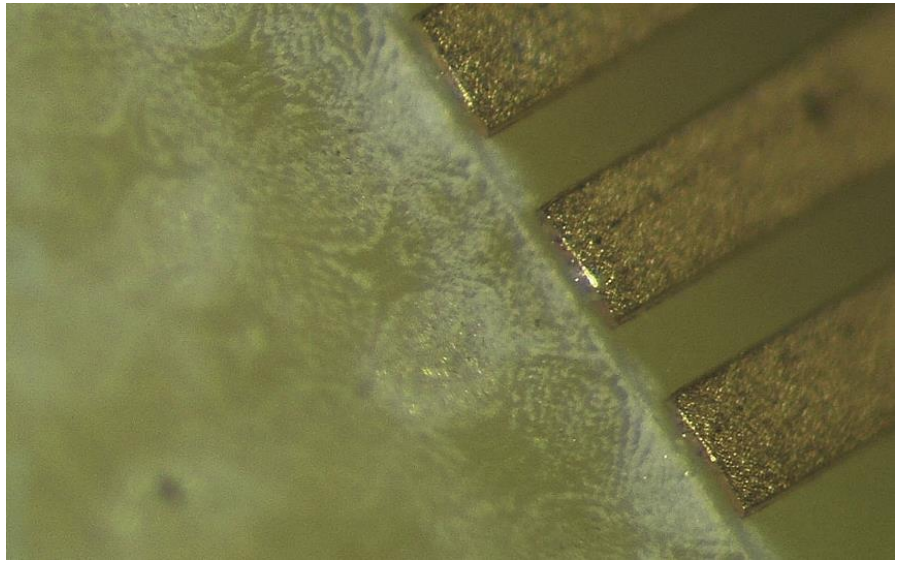
Prototype with improved pads

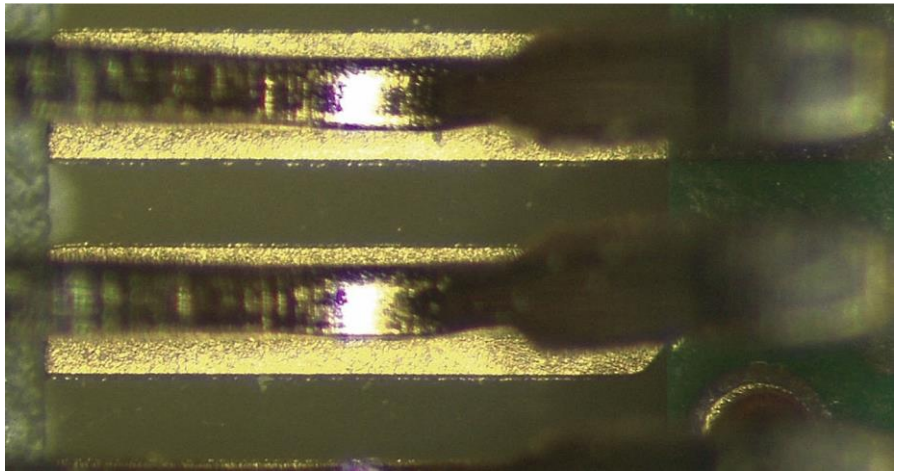




- Hard gold plating
- -1mm and +1mm tolerance on right and left side of the touching point
- Z-Axis milling by 0.1mm to cut tie bars along the front face of the connectors

- Perfect alignment
- Perfect machining
- shallow step of only 0.1mm
- Made at Leiton GmbH (a low-cost pool manufacturer); produced in Germany



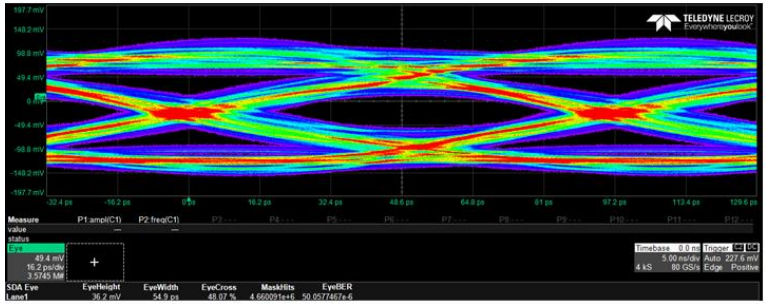


Results

Eye height improvement: +103%

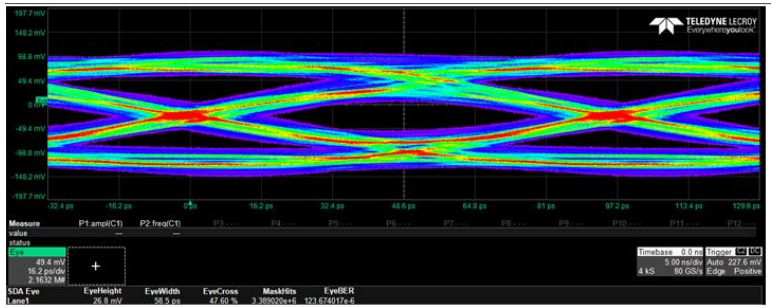
RX Pattern	TX Pre-Cursor	TX Post-Cursor	TX Diff Swing
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)

Harting/ ITB/ Rompa
- Eye Height: 36.2mV
- Eye Width: 54.9ps



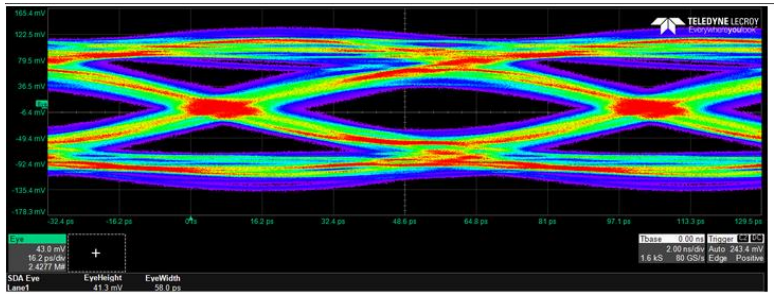
RX Pattern	TX Pre-Cursor	TX Post-Cursor	TX Diff Swing
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)

Yamaichi, original footprint, same settings
- Eye Height: 26.8mV
- Eye Width: 58.2ps



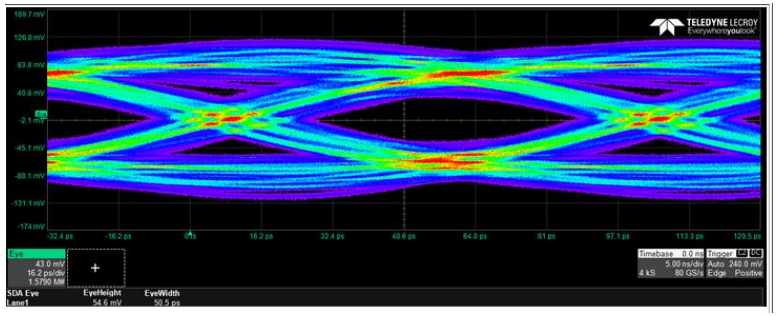
RX Pattern	TX Pre-Cursor	TX Post-Cursor	TX Diff Swing
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)
PRBS 7-bit	1.67 dB (00111)	6.94 dB (10110)	1000 mV (11110)

Yamaichi, new footprint, same settings
- Eye Height: 41,3mV (**+54%**)
- Eye Width: 58.0ps

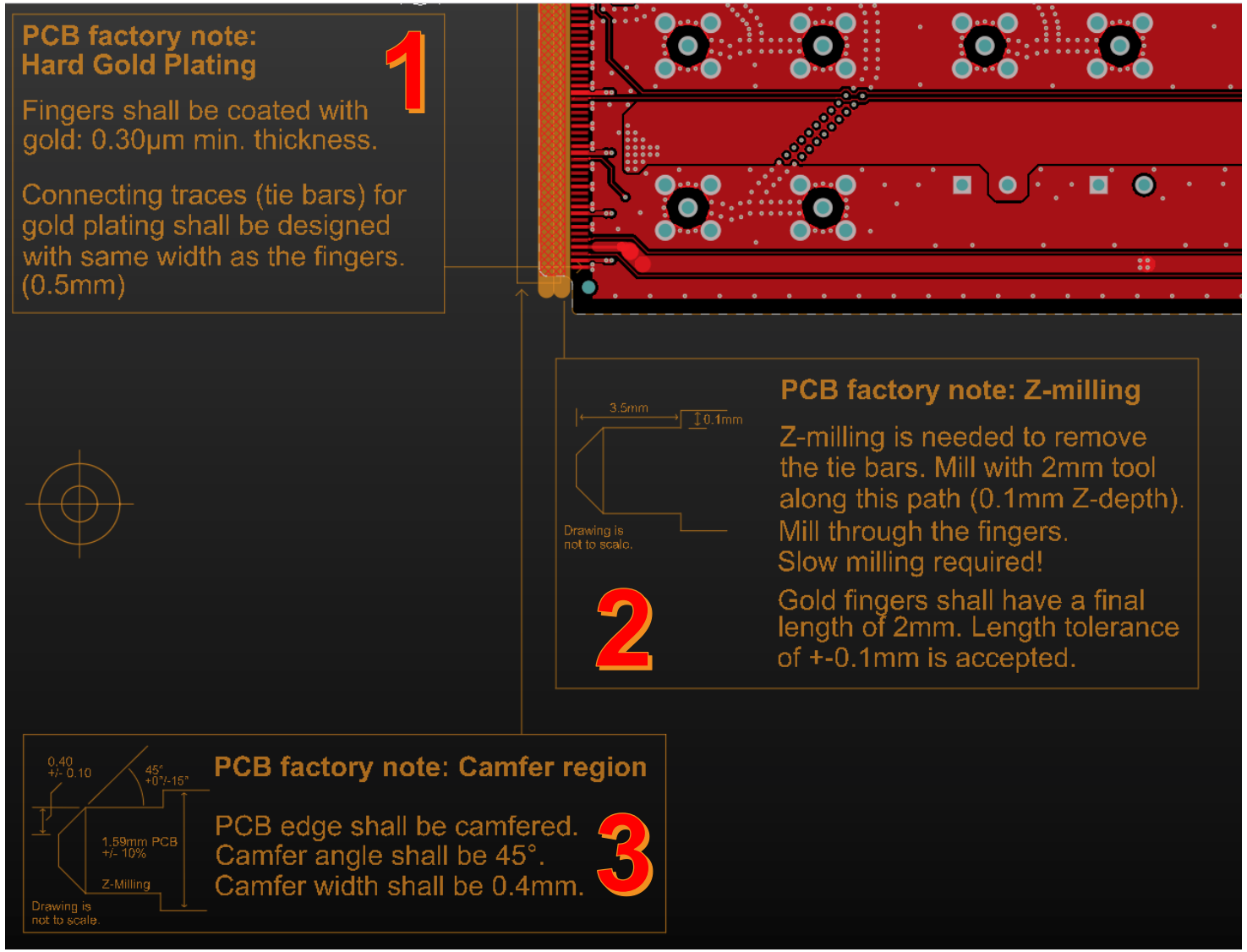


RX Pattern	TX Pre-Cursor	TX Post-Cursor	TX Diff Swing
PRBS 7-bit	1.94 dB (01000)	7.96 dB (11000)	1000 mV (11110)
PRBS 7-bit	1.94 dB (01000)	7.96 dB (11000)	1000 mV (11110)
PRBS 7-bit	1.94 dB (01000)	7.96 dB (11000)	1000 mV (11110)
PRBS 7-bit	1.94 dB (01000)	7.96 dB (11000)	1000 mV (11110)
PRBS 7-bit	1.94 dB (01000)	7.96 dB (11000)	1000 mV (11110)

Yamaichi, new footprint, optimized settings
- Eye Height: 54,6mV (**+103%**)
- Eye Width: 50.0ps



Cookbook recipe:



- The picture shows how to advise the PCB factory to produce edge connector as we have simulated and verified in hardware.
  1. Hard Gold plating with optimal tie bars
  2. Z-Axis Milling
  3. Camfer Region (from Yamaichi Datasheet)

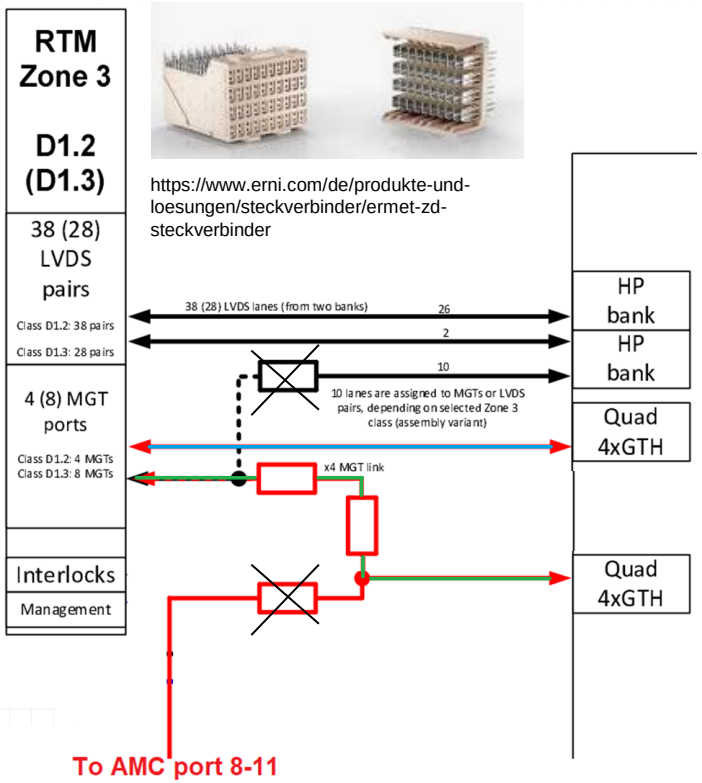
DMMC-BoB: Contact us to get the Gerber files.

Part of AMC Template: Contact us to get the Altium files.

Contact us to get the mounting tool mechanical design files.

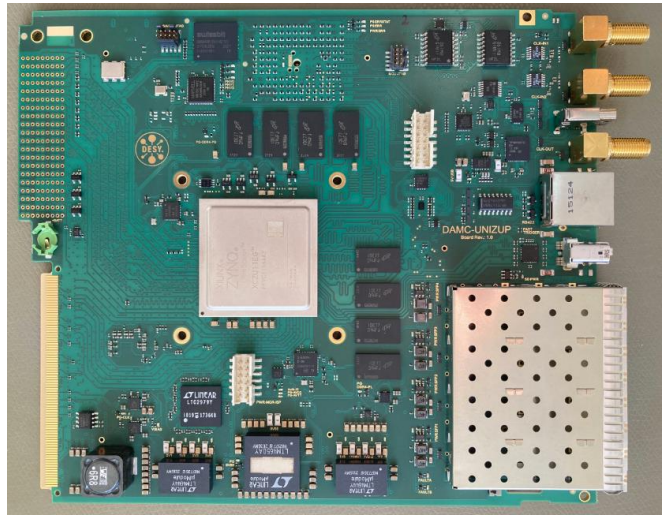
Improving Signal Integrity over Zone 3

DAMC-UNIZUP Challenge



https://www.erni.com/de/produkte-und-loesungen/steckverbinder/ermet-zd-steckverbinder

- DAMC-UNIZUP is very flexible
- Normally used as RTM D1.2 (LVDS operation)
- We wanted to build RTM with 8 SFP+ channels (D1.3)
- Ermet ZD rated for 5 Gbps only
- But 10Gbps desired…



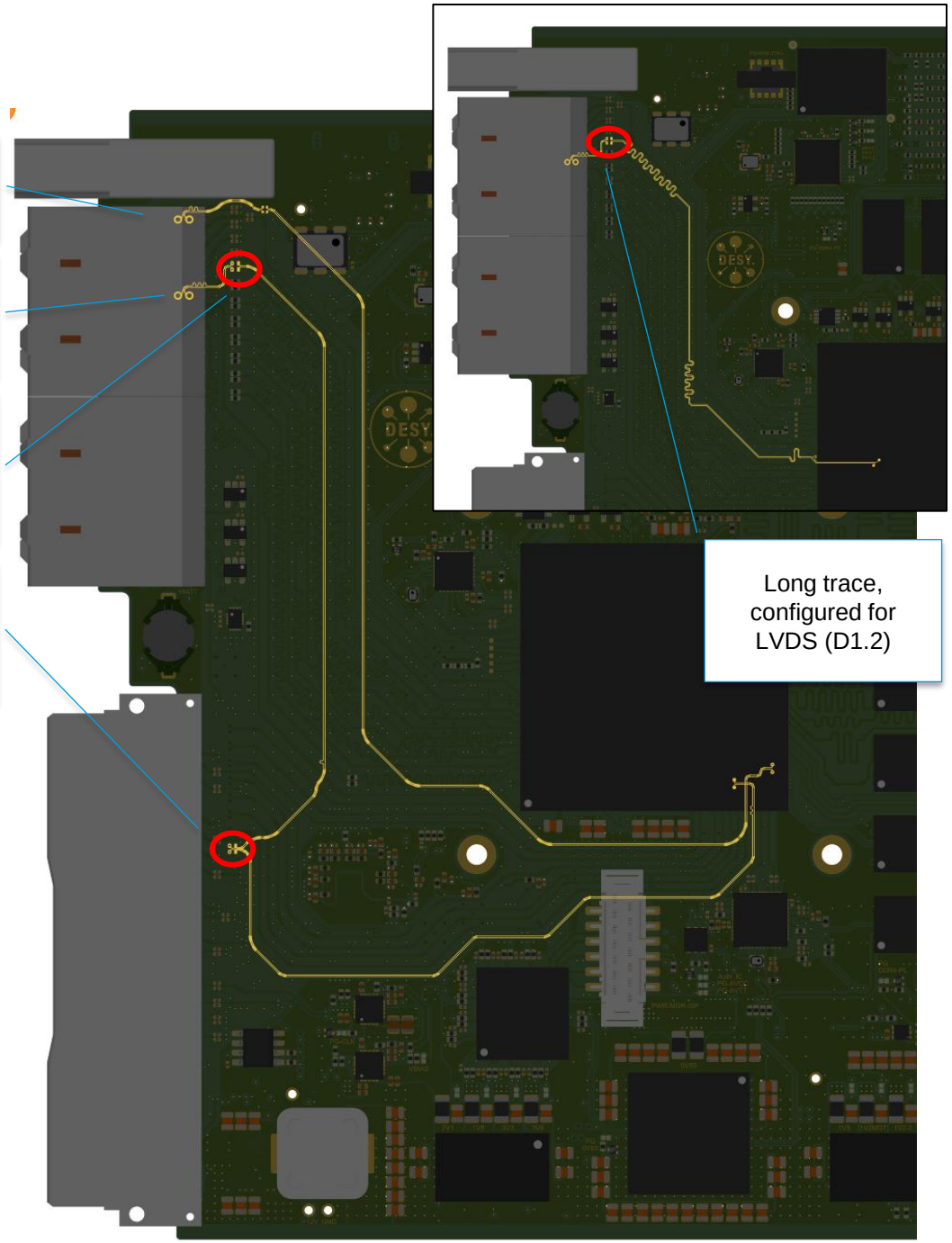
Challenge: 0R Jumper Options

RTM Class D1.2

- 38x LVDS to RTM
- 4 MGTs to RTM
- 8 MGTs to AMC

RTM Class D1.3

- 28x LVDS to RTM
- 8 MGTs to RTM
- 4 MGTs to AMC

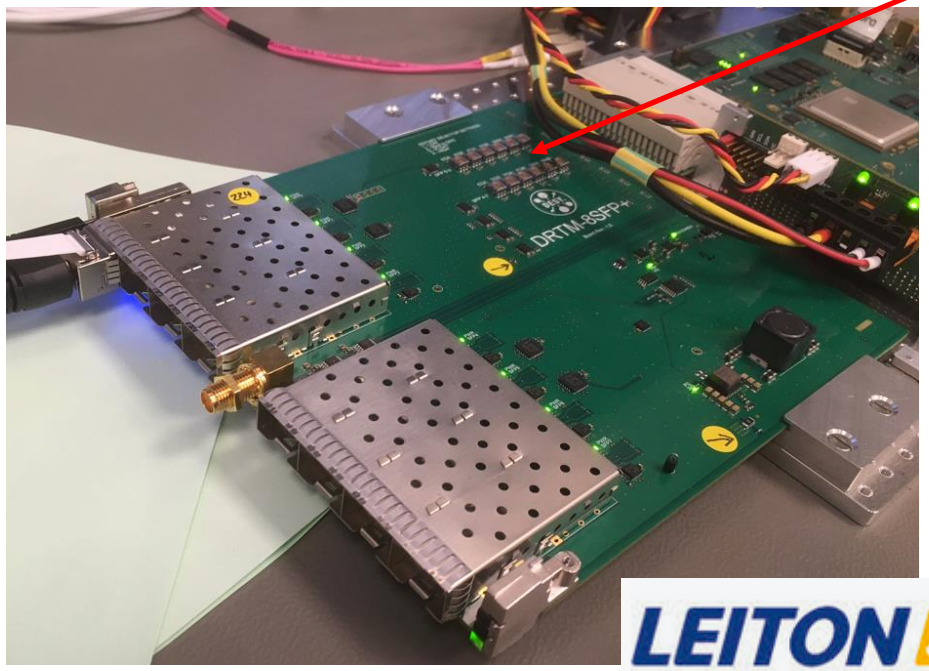


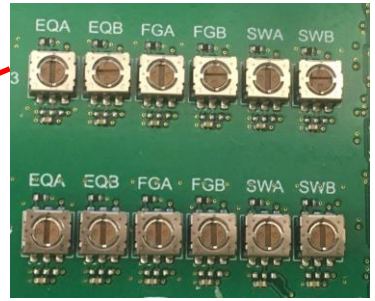
DESY.

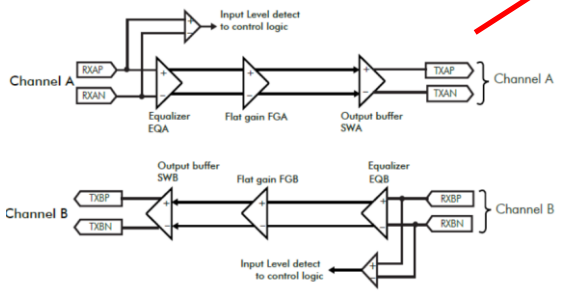
DAMC-8SFP+

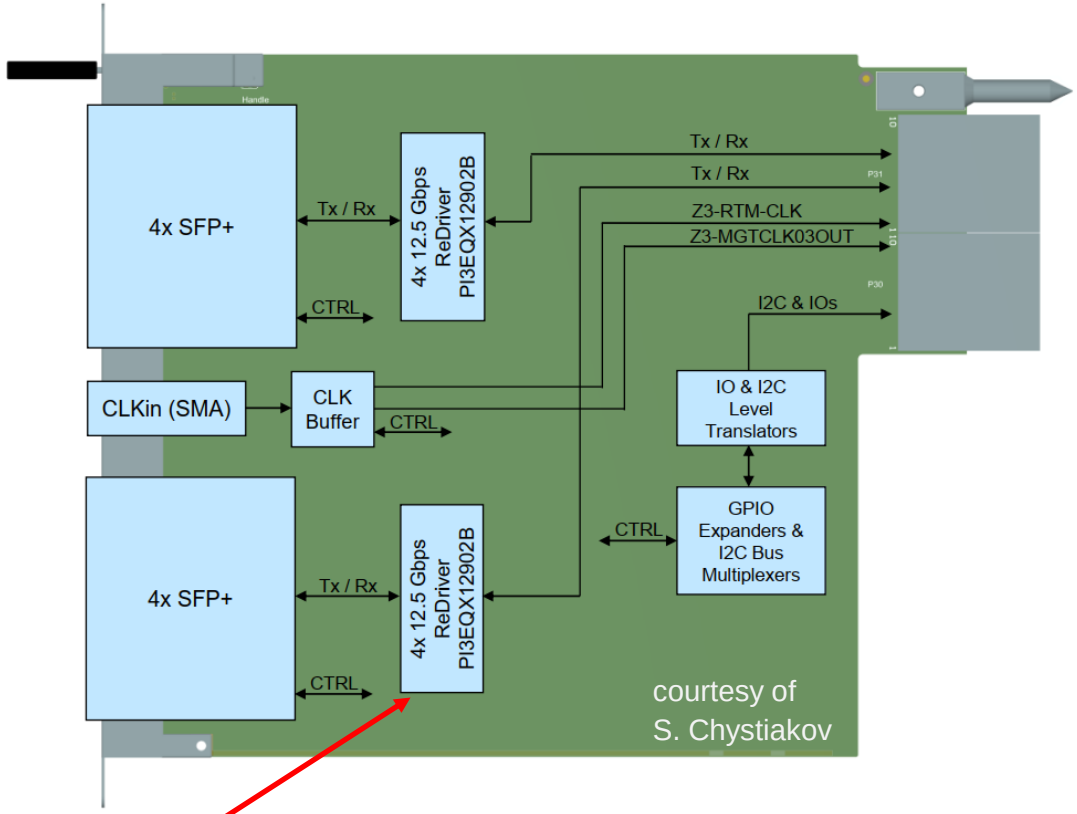
Fan-out of MGT Channels from DAMC-UNIZUP

- We needed to verify UNIZUPs 8 MGTs to RTM
- We designed a 8-SFP+ RTM
- Board works on all other Digital Class AMCs
- Brings 1 to 8 MGTs to RTM **12.5 Gbps**: not trivial
- First use of “analog” equalizer
- Development time: 3 months
- Low-cost circuit board and components
- Manufactured in the “**PCB pool**” from Leiton (Berlin)
- Material: Panasonic R-1566W (Dk=0.010 !!!)







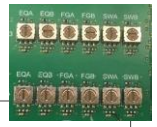


Improving of Signal Integrity by using Equalizers

First use of an analog equalizer for our serial interfaces

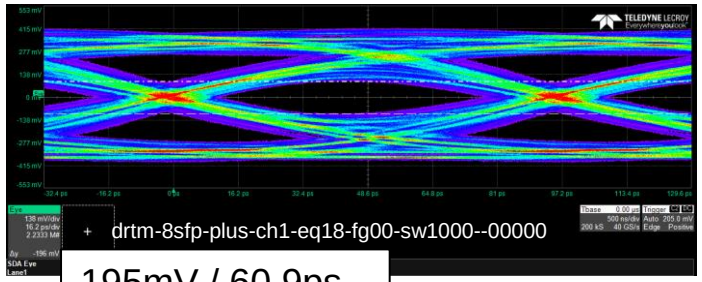
- Super critical RTM MGT routing on DAMC-UNIZUP
- 10.315 Gbps (up to 12.5 Gbps)
- Bad channel:
  - two 0-ohm bridges
  - Erni connector
- “Warning: it doesn’t work” – but it does, *if you do it right*…

PI3EQX12902B: 4 Configurations possible



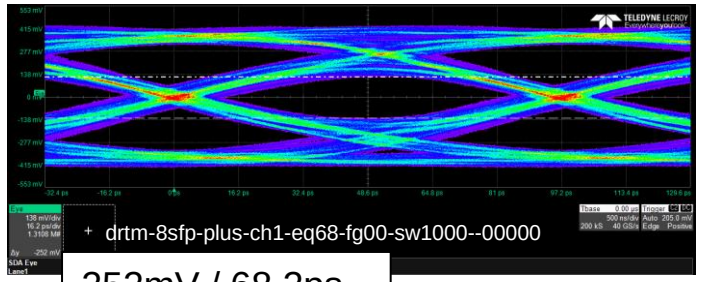
	Equalizer setting (dB)				
	@2.5GHz	@3GHz	@4GHz	@5GHz	@6GHz
1	1.8	2.6	4.5	6.6	8.9
2	3.7	4.7	6.7	9.4	11.7 (Default)
3	5.1	6.3	8.7	11.2	13.5
4	6.8	8.2	10.8	13.2	15.3

Short channel: 5 GHz: +6.6dB



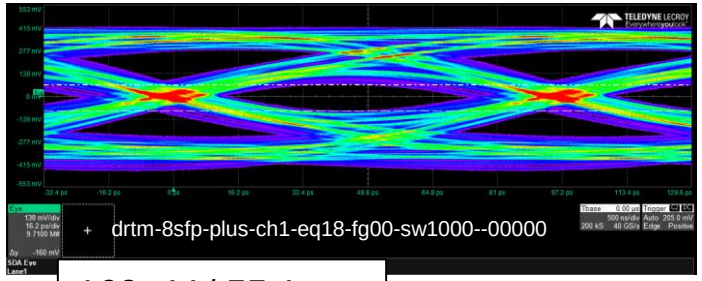
195mV / 60.9ps

Short channel: 5 GHz: +13.2dB



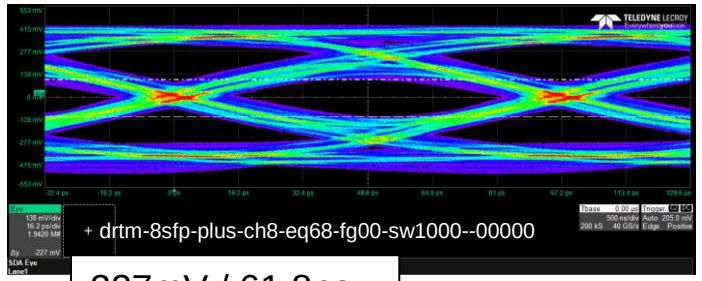
252mV / 68.2ps

Long channel: 5 GHz: +6.6dB



160mV / 55.1ps

Long channel: 5 GHz: +13.2dB

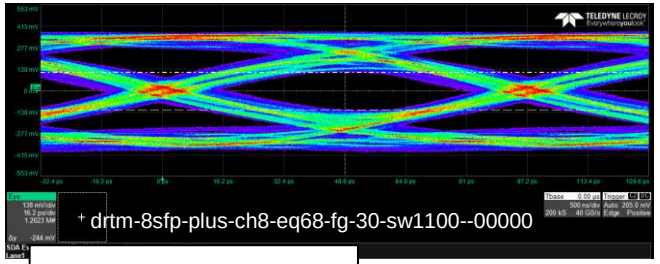


227mV / 61.8ps

Conclusion for DAMC-UNIZUP

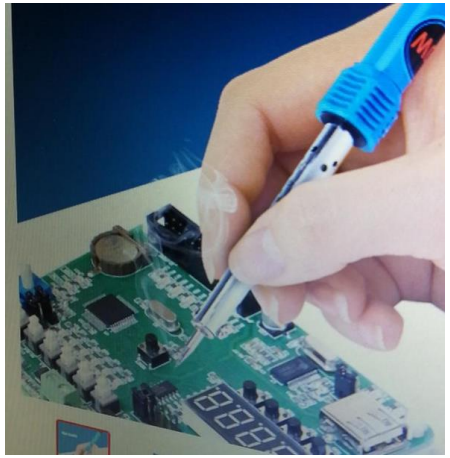
- Even in Minimum equalisation setting (+6.6dB) we achive wide-open eyes (6dB is a lot…)
- Short and long Channels verified
- Tweaking brings more headroom to long channels
- More than enough eye opening at 10 Gbps….
- Class D1.3 verification successful

Long channel: 5 GHz, +13.2dB
1100mV Level, -3.0dB “flat gain”



244mV / 60.3ps

Thank you!



:-) https://www.reddit.com/r/electronics/comments/d62qwi/karen_hold_it_like_you_were_soldering/

Contact

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Backup