

1394b Design Seminar

Taipei, Taiwan



1394b S800 Layout Recommendations

Burke Henehan
Principal Engineer
Symwave



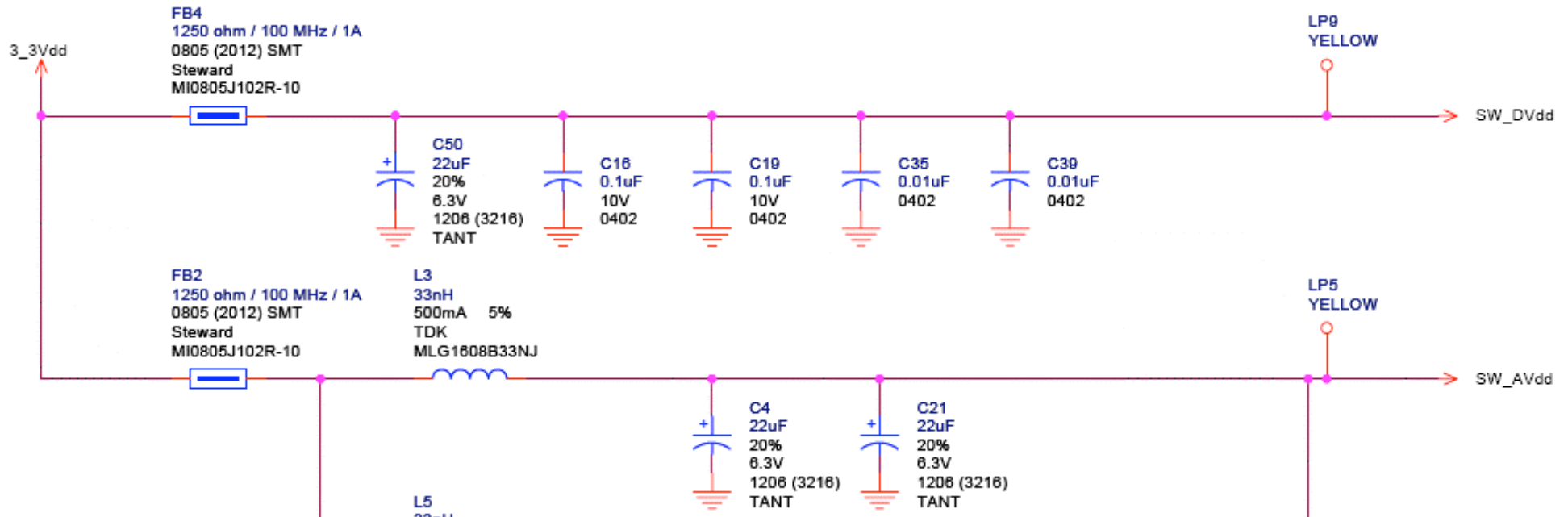
What is better with 1394b

- FASTER - Higher speeds defined to 4 Gbps
- FURTHER - Longer distance cables to 100m per hop
- MORE MEDIA; Enabled by DC-balanced 8B10B encoding, Compatible above the media dependent layer
 - Unshielded Twisted Pair Category 5 (UTP5-100m@100Mbps)
 - Plastic Optical Fiber (POF-50m@200Mbps)
 - Glass Optical Fiber (GOF-100m@3200Mbps)
 - New connector and Shielded Twisted Pair (4.5m@3.2Gbps) cable
 - Easier to implement galvanic Isolation
- MORE EFFICIENT - New asynchronous arbitration (BOSS)
 - Overlapped, pipelined arbitration
- MORE USER FRIENDLY - Loop-free Build allows any cable topology (including redundant connections in loops)
- MORE RESISTANT to ESD – Independent of Bias Level

Agenda

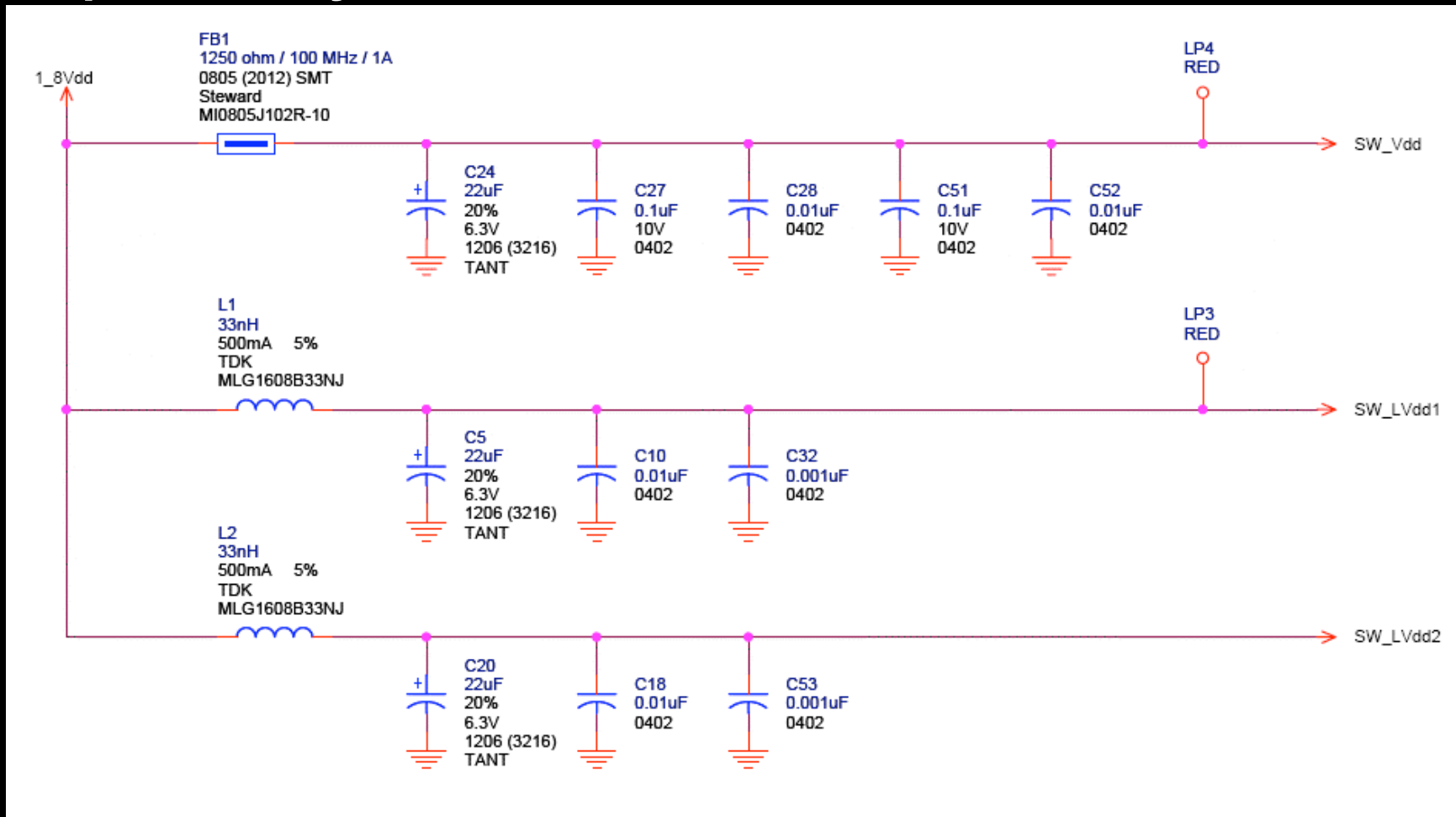
- Schematic Recommendations
- Layout Recommendations
- Verification of Successful Layout

Schematic – Filter Analog Power Rail

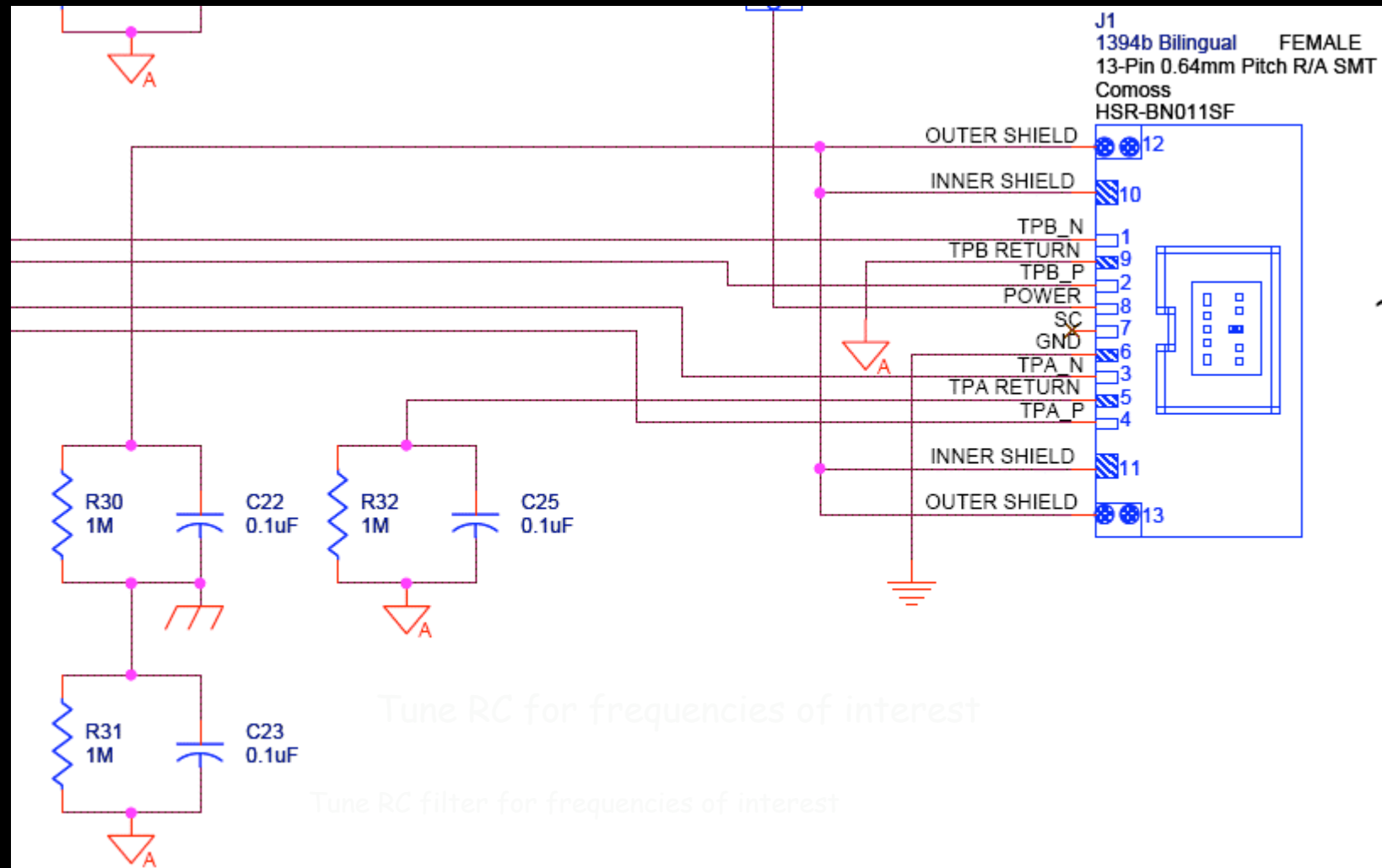


Ferrite for high frequency filtering.
Inductor for lower frequency filtering
If use both, put ferrite on noise "input" side, side where noise coming from.

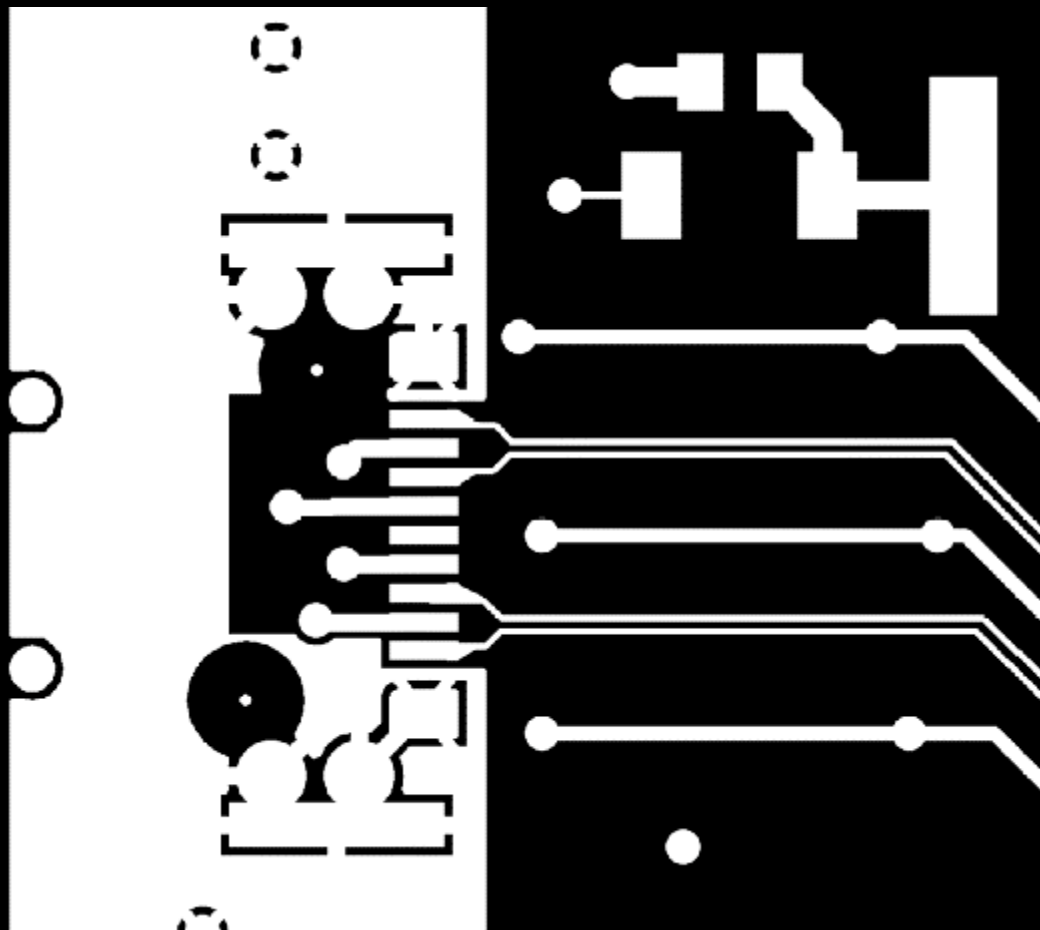
For more Margin Filter PLL power Separately



Schematic Recommendations for EMI/ESD - Channel to Chassis GND



Layout of Chassis GND & Connector



Layout of Twisted Pair Lines

a) Minimize Disruptions

to

Twisted pair lines:

b) 110 Ohm Controlled Impedance

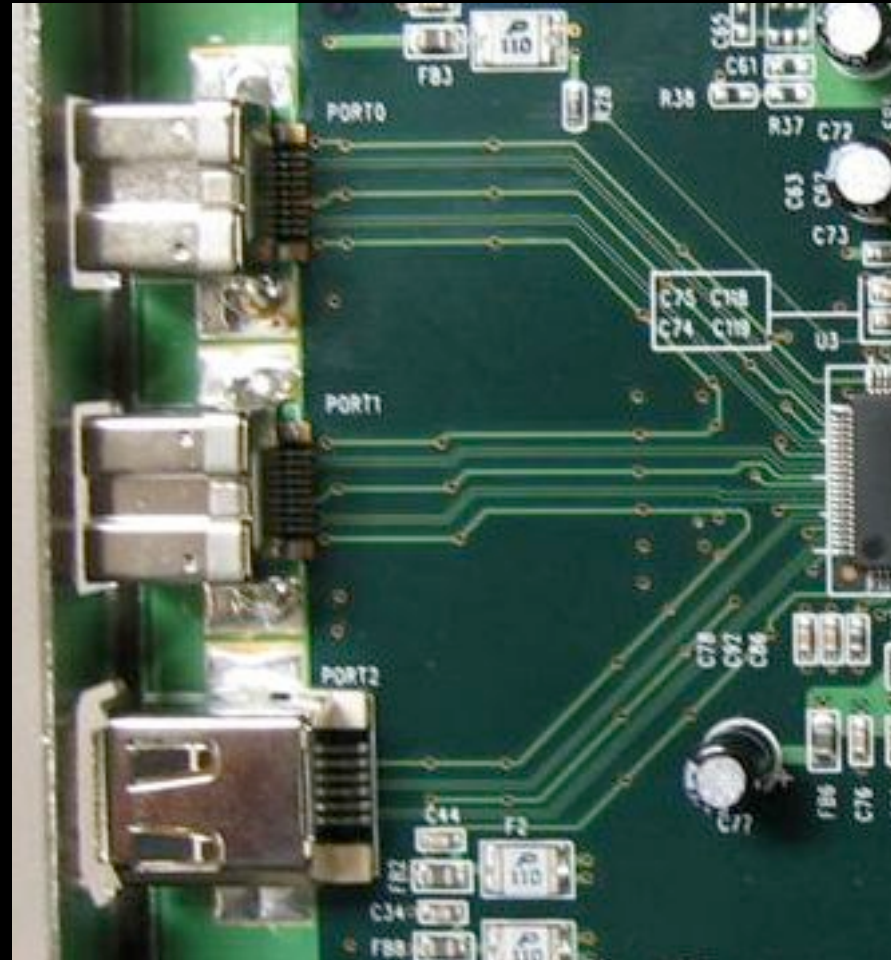
c) No vias

e) Minimum turns

f) Maximize intra-pair coupling (close together)

g) Minimize intra-pair skew (length difference)

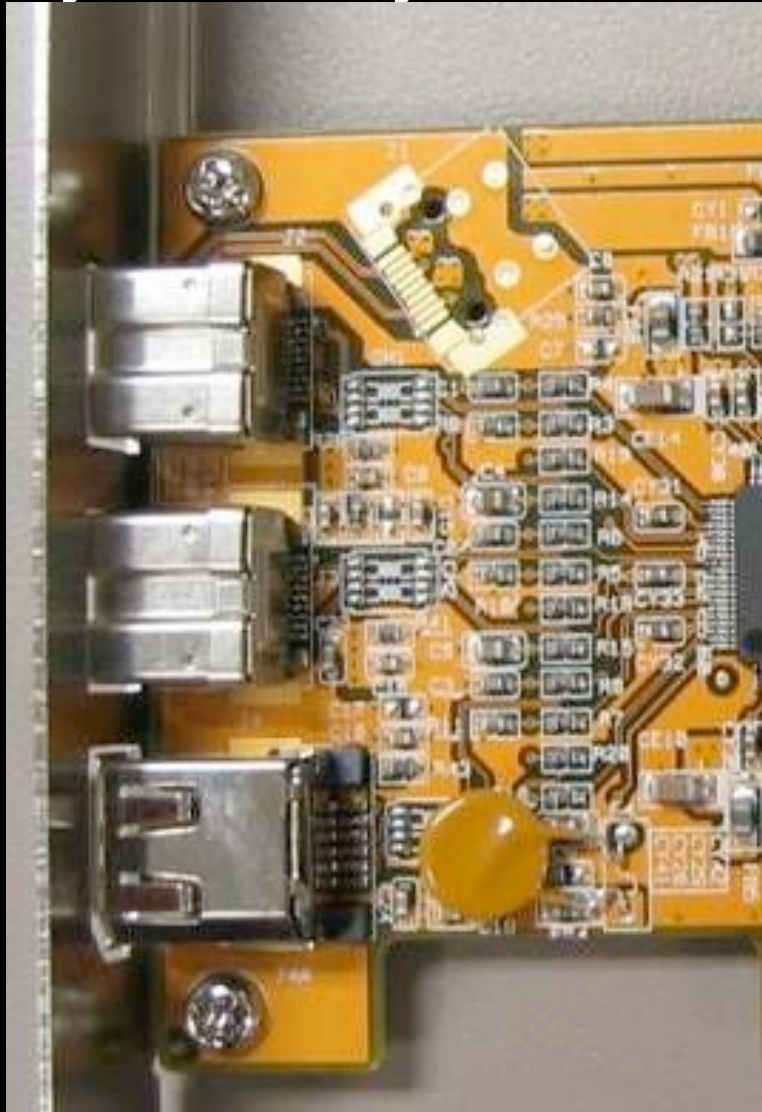
d) Minimum length



Locate Termination Network as Close as Possible to the Physical Layer Terminals

Minimize Stub lengths

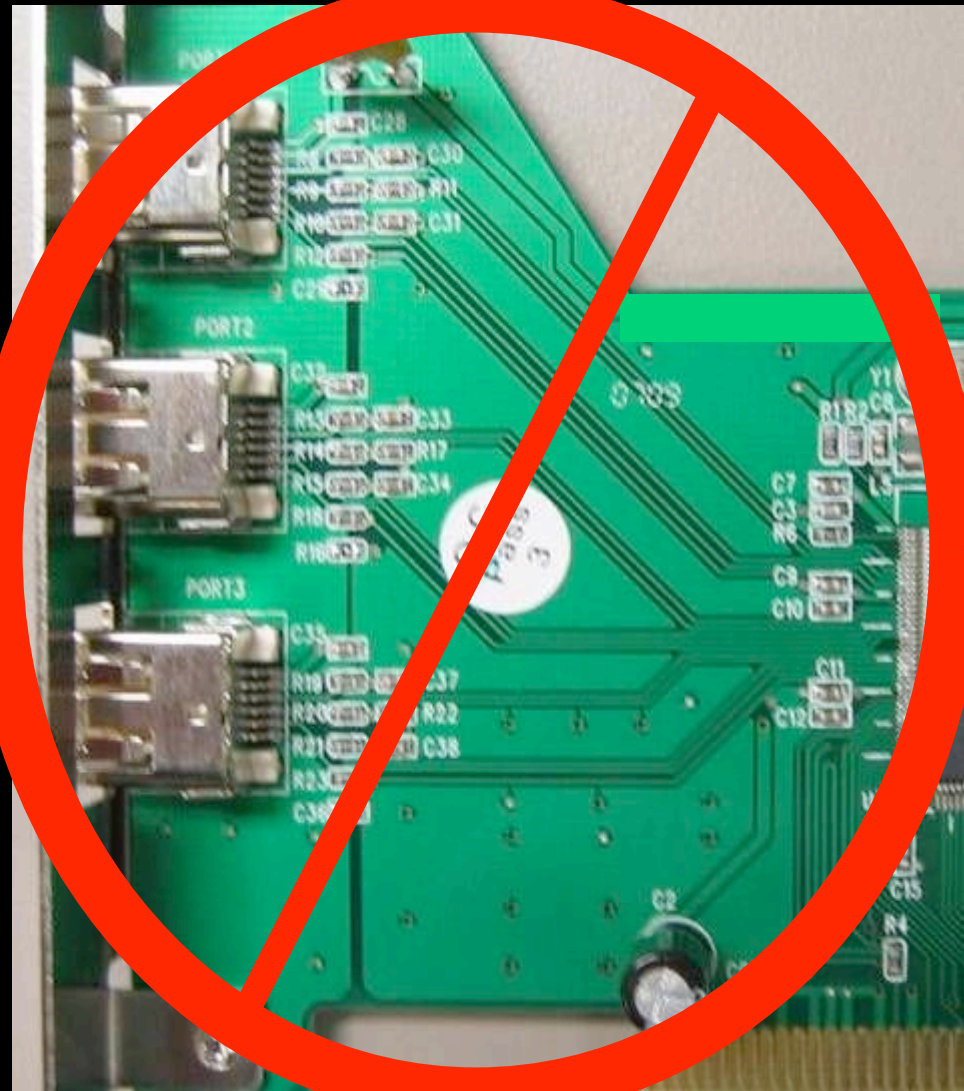
Example of a good Implementation with All components on one Side of PCB



Example of a Bad Implementation

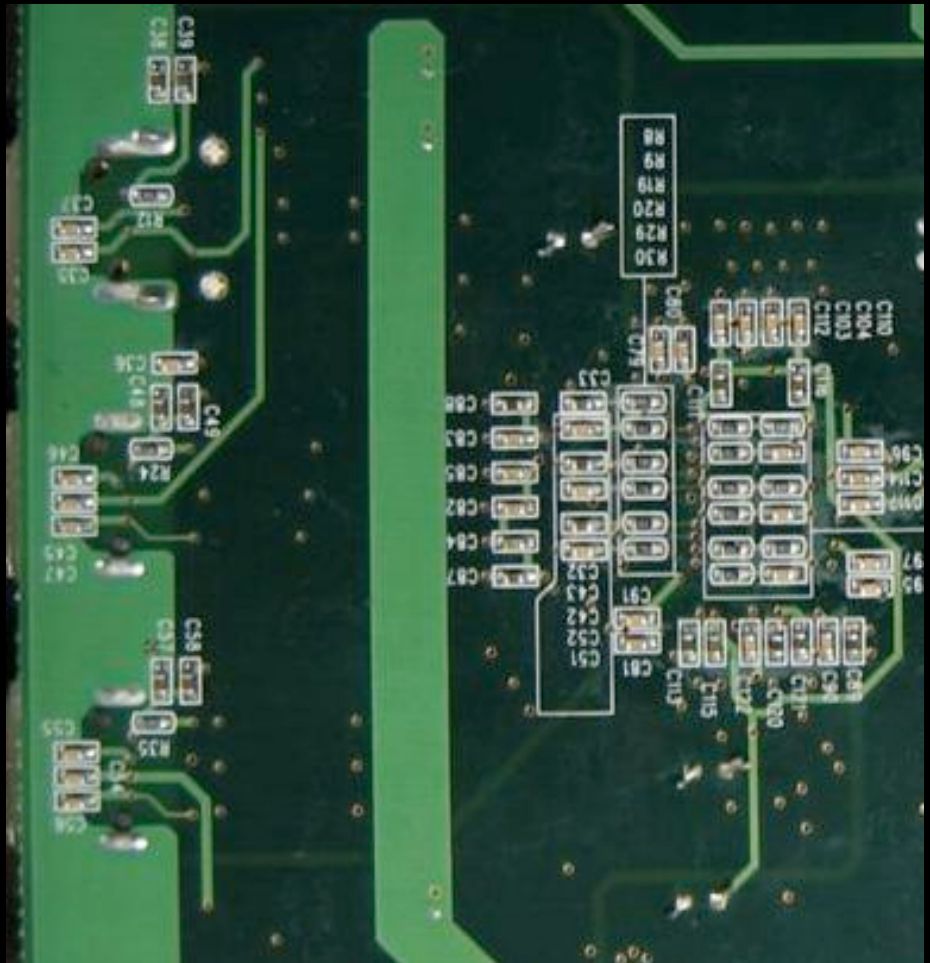
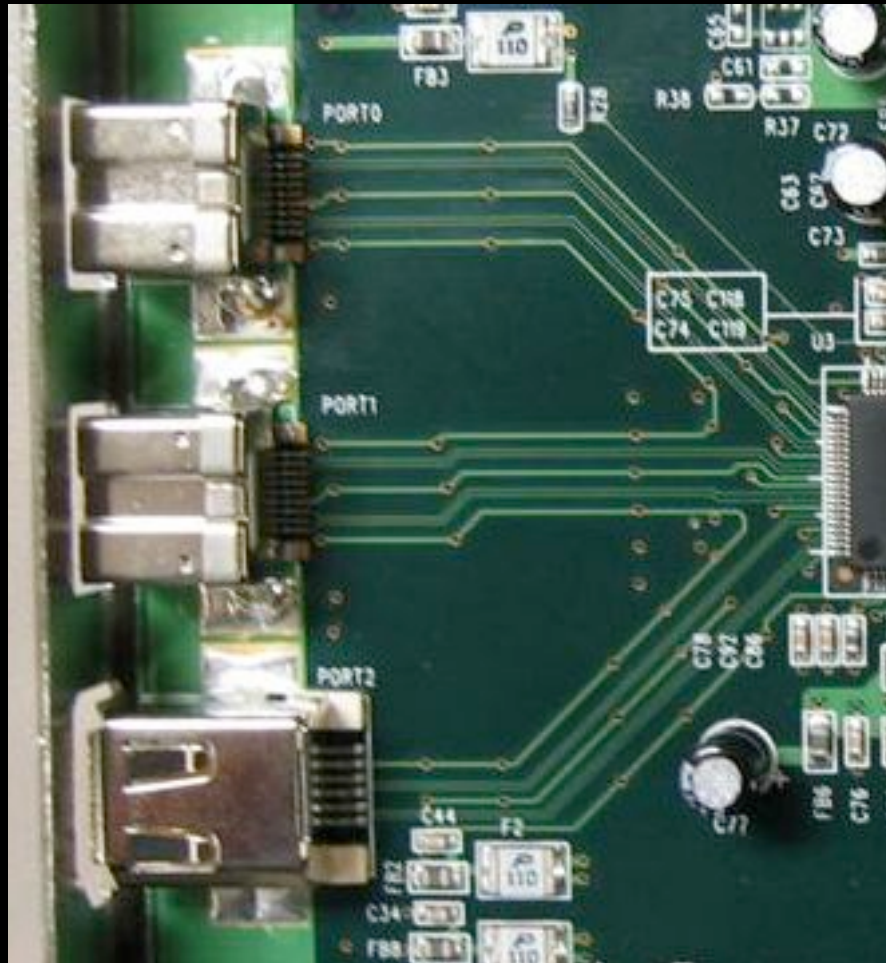
Termination network next to Connector is Poor layout.

It Creates Transmission Line Stubs

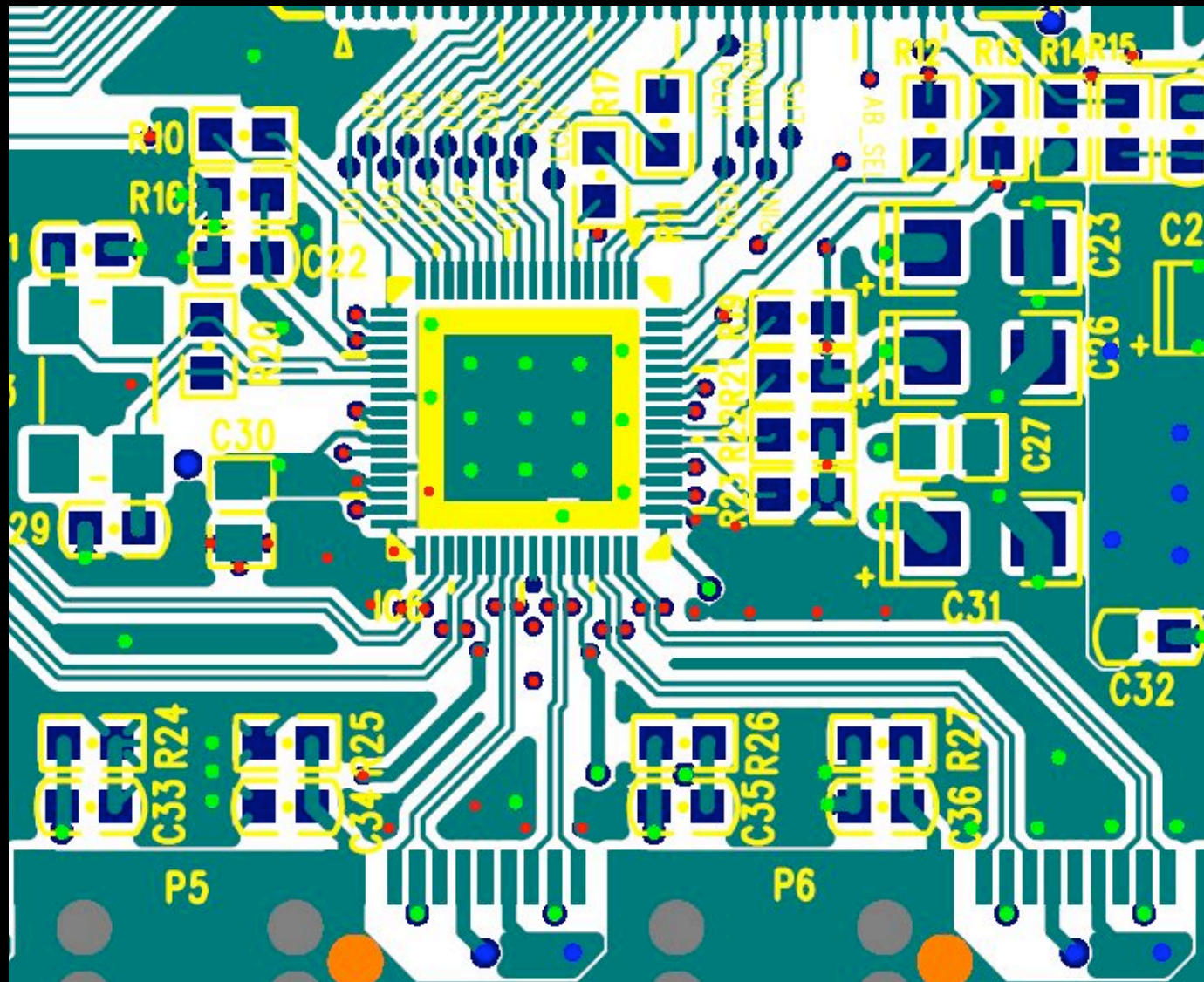


“Fly-by” Termination for More Margin

Minimizes Stubs

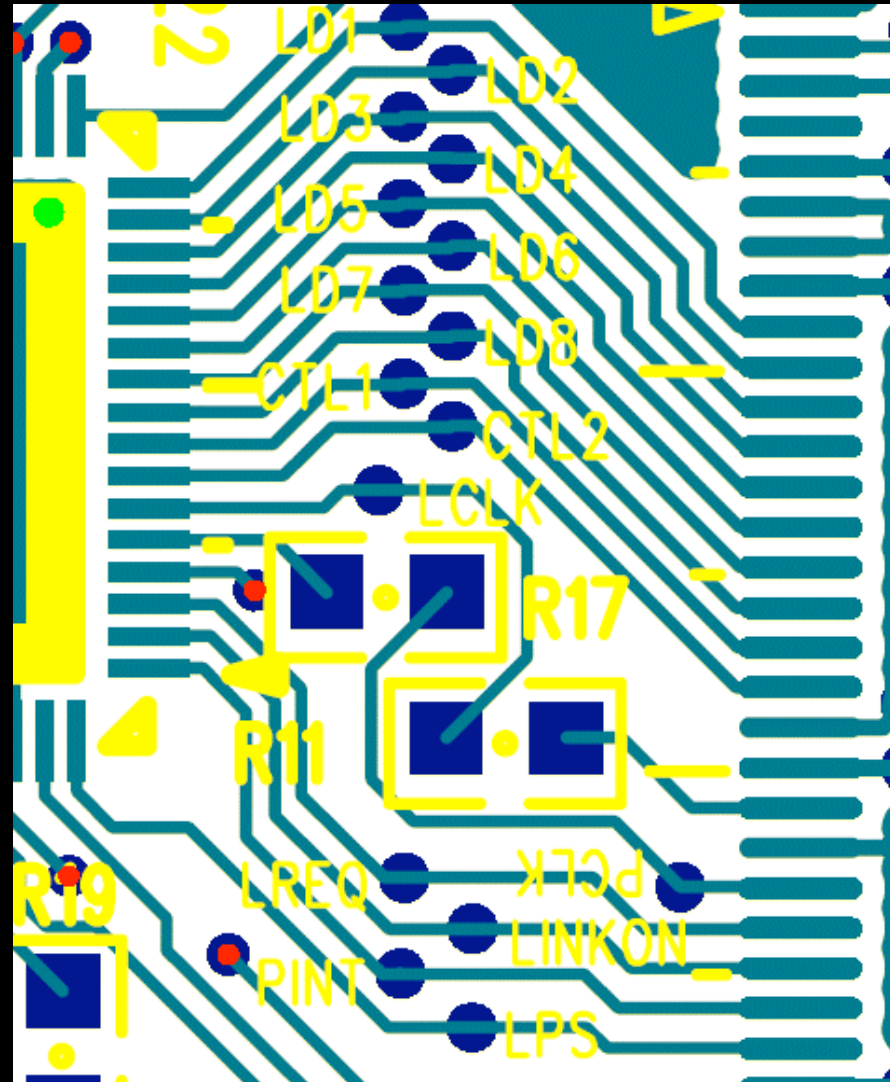


Must Solder Device to Thermal Pad,
with Thermal Vias to GND Plane

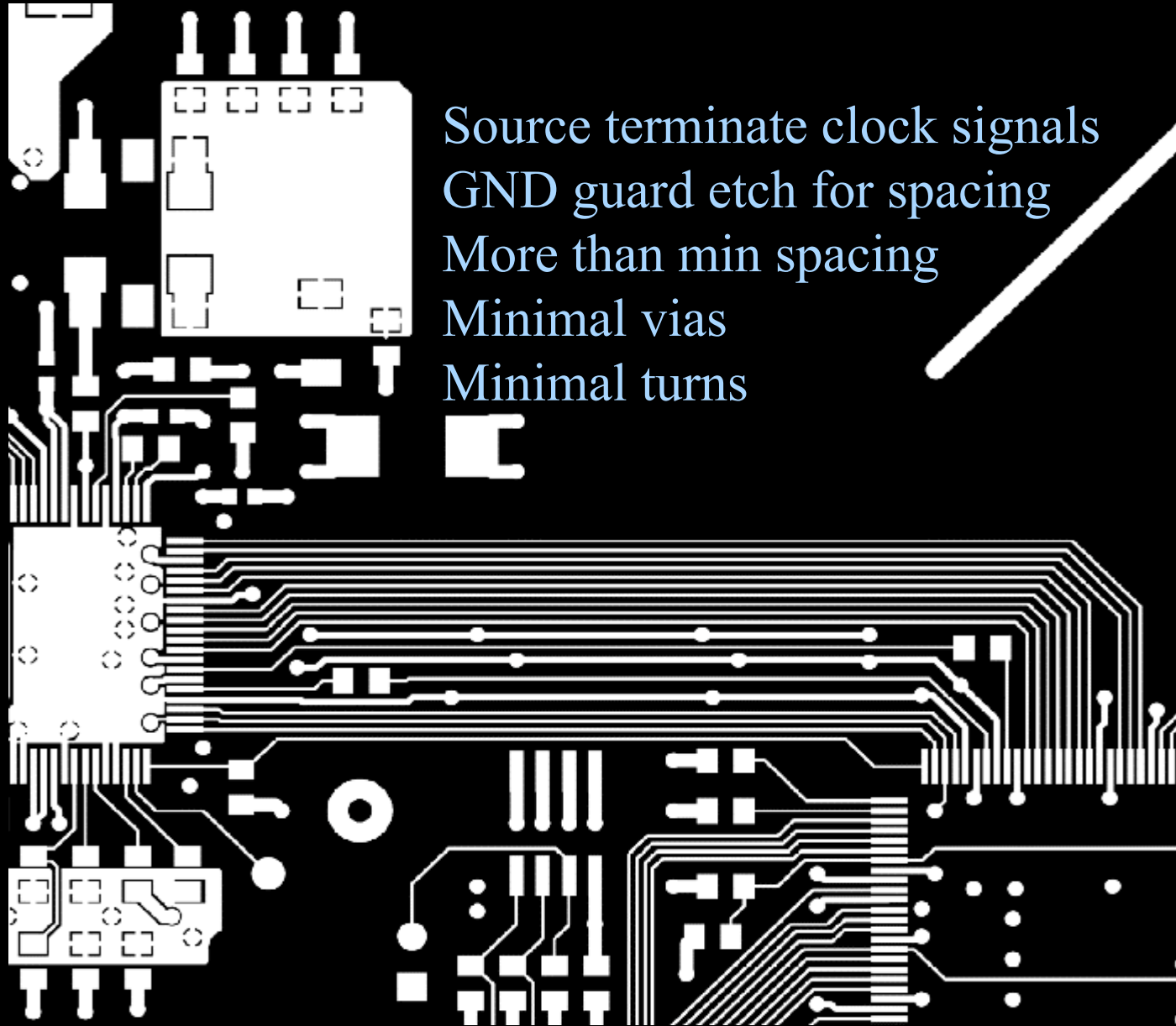


Source Terminate PHY-Link Clock Signals

Source Terminate
PCLK and SCLK
To damp down
Standing waves

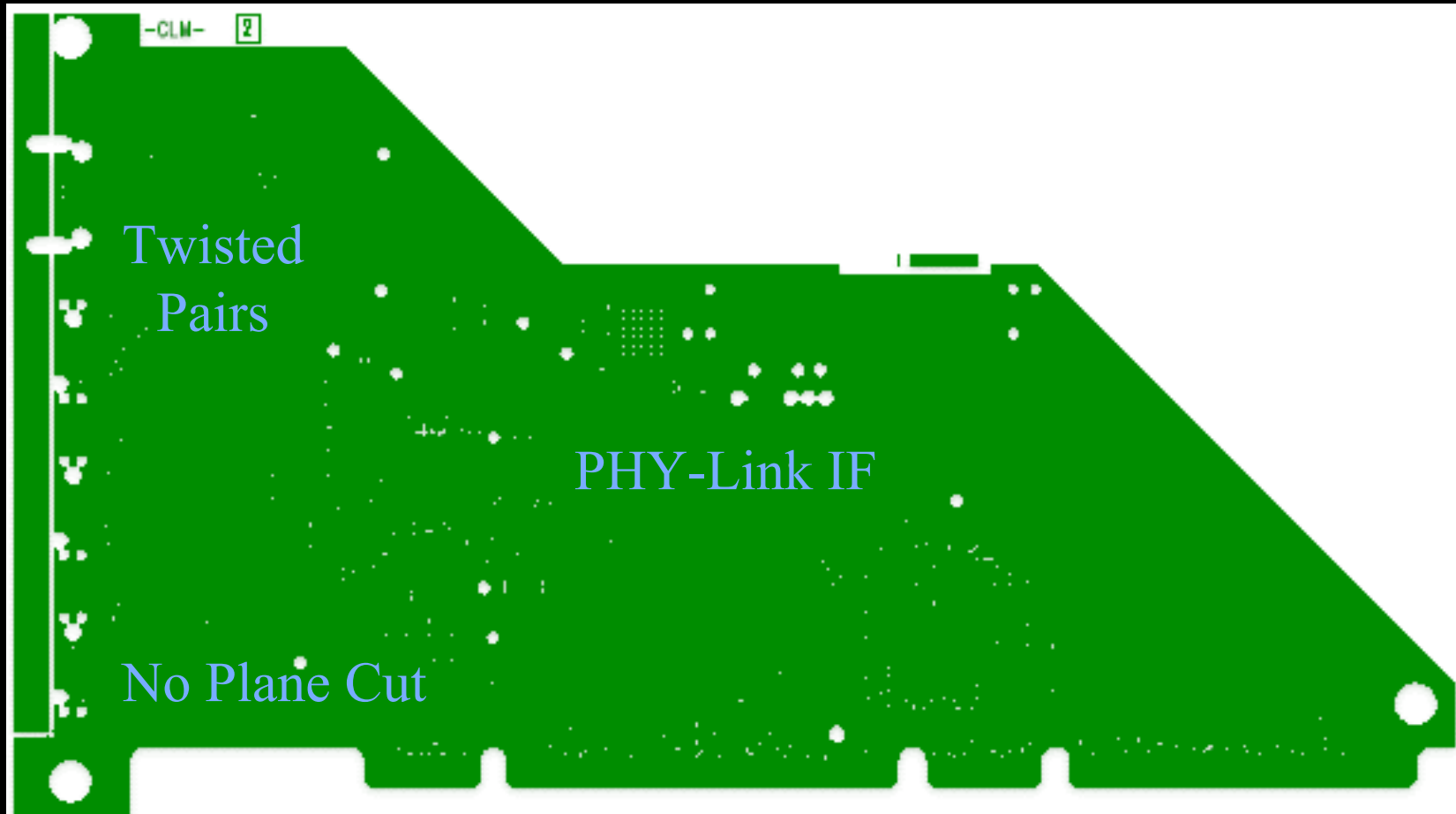


Layout - PHY-Link Interface

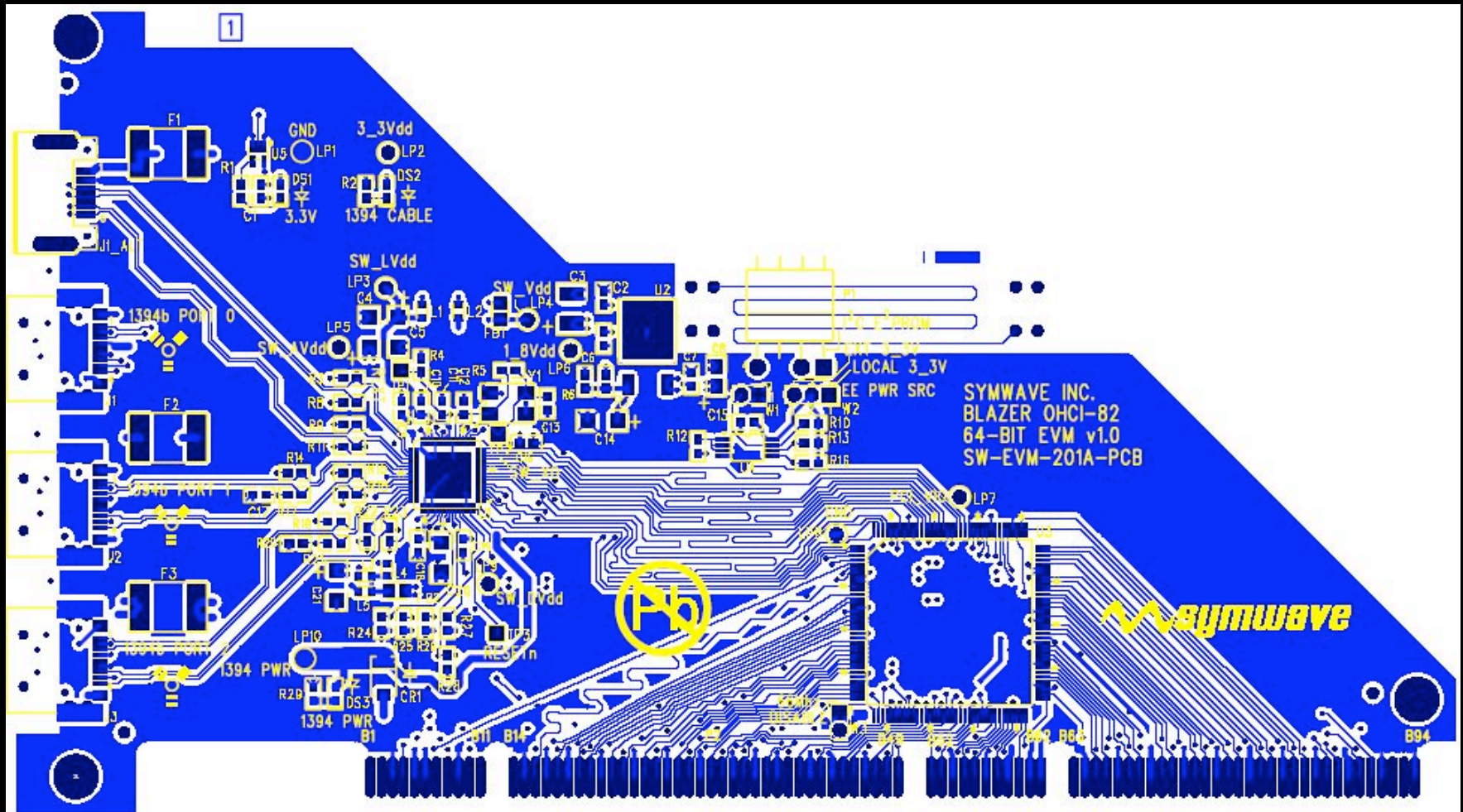


Source terminate clock signals
GND guard etch for spacing
More than min spacing
Minimal vias
Minimal turns

Solid Plane Under High Speed or High Current Signals



Top Layer: Twisted Pairs, PHY-Link-IF



Simulate (Predict) Signal Integrity

- Best results when can simulate signal integrity using simulation tool.
 - Requires expensive tools
 - Requires expertise in layout
 - Requires expertise in simulation tools
 - Requires expertise in simulation models
- If Careful, and can verify Signal Integrity, not required for S400
- If Careful, Lucky, and can verify Signal Integrity, can get by without at S800
- I Think Required at S1600 and S3200

Verify Signal Integrity

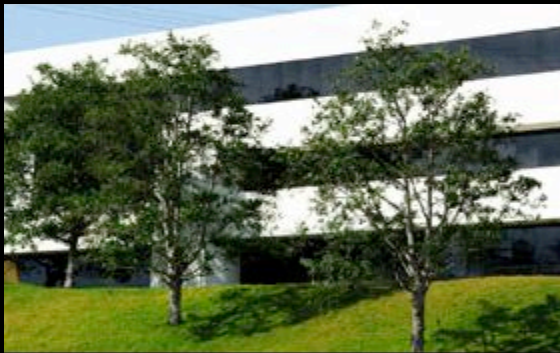
- Verify Signal Integrity Using:
 - Length of Cable can train across
 - Only somewhat useful and only if done in a consistent way
 - Cheapest and easiest
 - Eye Diagrams
 - Useful for comparison but only if done in a consistent way
 - Needs good, but readily available equipment
 - Time Domain Reflectometry (TDR)
 - Very useful to isolate problem locations but only if done in a consistent way
 - Needs high quality expensive HW and SW. Complex
 - Bit Error Rate Testing
 - Primitive test by checking packet error rate, requires SW or Analyzer
 - Less primitive by checking codeword Error register in 1394b PHY, requires SW
 - Robust test requires use of test modes in 1394b PHY & expensive HW
 - All three methods require testing be done in a consistent way
 - Vector Network Analyzer (VNA)
 - Very useful for modeling, extensive information on frequency response of crosstalk, return loss, attenuation, emi, emc
 - Needs high quality very expensive HW and SW. Complex.
 - Only useful if done in a consistent way

Summary

- Take care with the layout of 1Gbps 1394b
 - Minimize noise to analog circuitry
 - Minimize disruptions to twisted pair lines
 - Solid GND plane underneath
 - Terminate PHY-Link Clock Signals
- 4 or more Layer circuit board
- Verify Signal Integrity on HW

Symwave Quick Facts

- World-class, high performance analog/mixed-signal ICs:
 - Serial PHYs, Analog Front-Ends
- Mixed signal products targeting CE, PC and mobile markets
- Founded in 2001
- Corporate HQ and system architecture in San Diego
- Engineering and production in Southern China
- Global Customer Support organization
- Backed by top-tier Silicon Valley and Asian venture capitalists



San Diego Corporate Headquarters



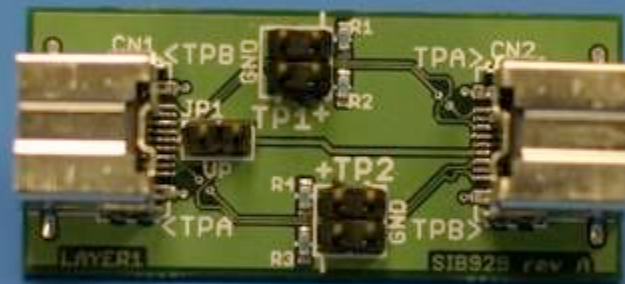
Shenzhen Design Center

Additional Backup Information on HW
Measurement of Signal Integrity &
Connector choices

Measure cable length

- Use same PCB on both ends of cable
- Try .3m to 4.5m cable length
- Verify can train up at maximum speed
- If have SW to read PHY registers, verify number of errors in 1394b PHY error register
- If have SW control, verify Packet error rate

Quantum
Parametrics
cable test
point card



Packet error rate testing and Codeword error rate testing

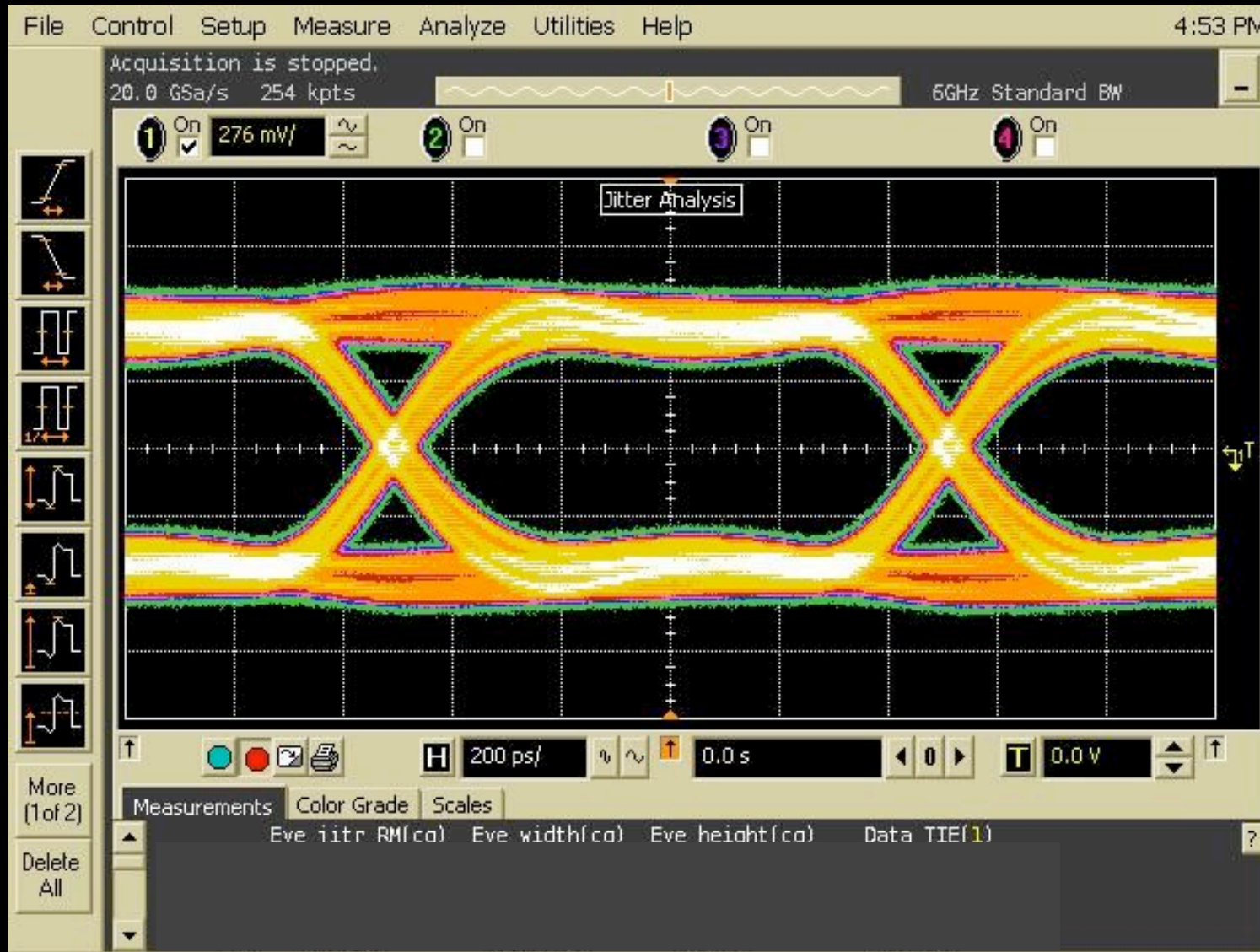
- Requires SW able to send wide variety of packets and verify correct acknowledge received back.
- Must be able to count good acks and bad acks to get rate.
- More useful if can keep track of number of bytes in each good packet and bad packet.

Codeword Error Rate Testing

Read Port Error Register to get # of codeword errors (10 bit 8B10B code)

Port								
Address	Bit							
	0	1	2	3	4	5	6	7
1000	Astat		Bstat		Child	Connected	Receive OK	Disabled
1001	Negotiated_speed			Int_enable	Fault	Standby_Fault	Disable_Scrambler	Beta_mode only_port
1010	DC_Conn	Max_port_speed			LPP	Cable_speed		
1011	Conn_Unreliable				Beta_Mode			
1100	Port_error							
1101						Loop Disable	In_Standby	Hard_Disable
1110								
1111								

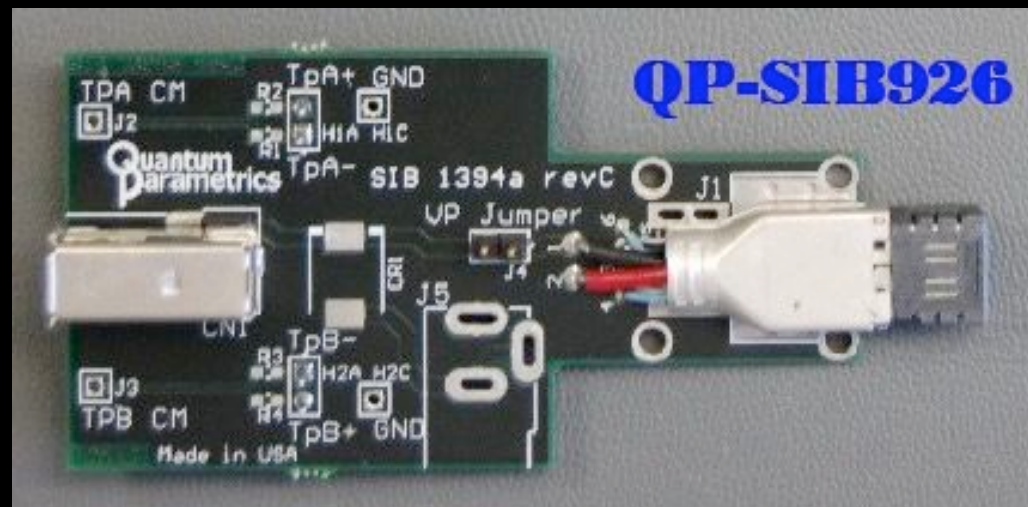
Eye Diagram S800



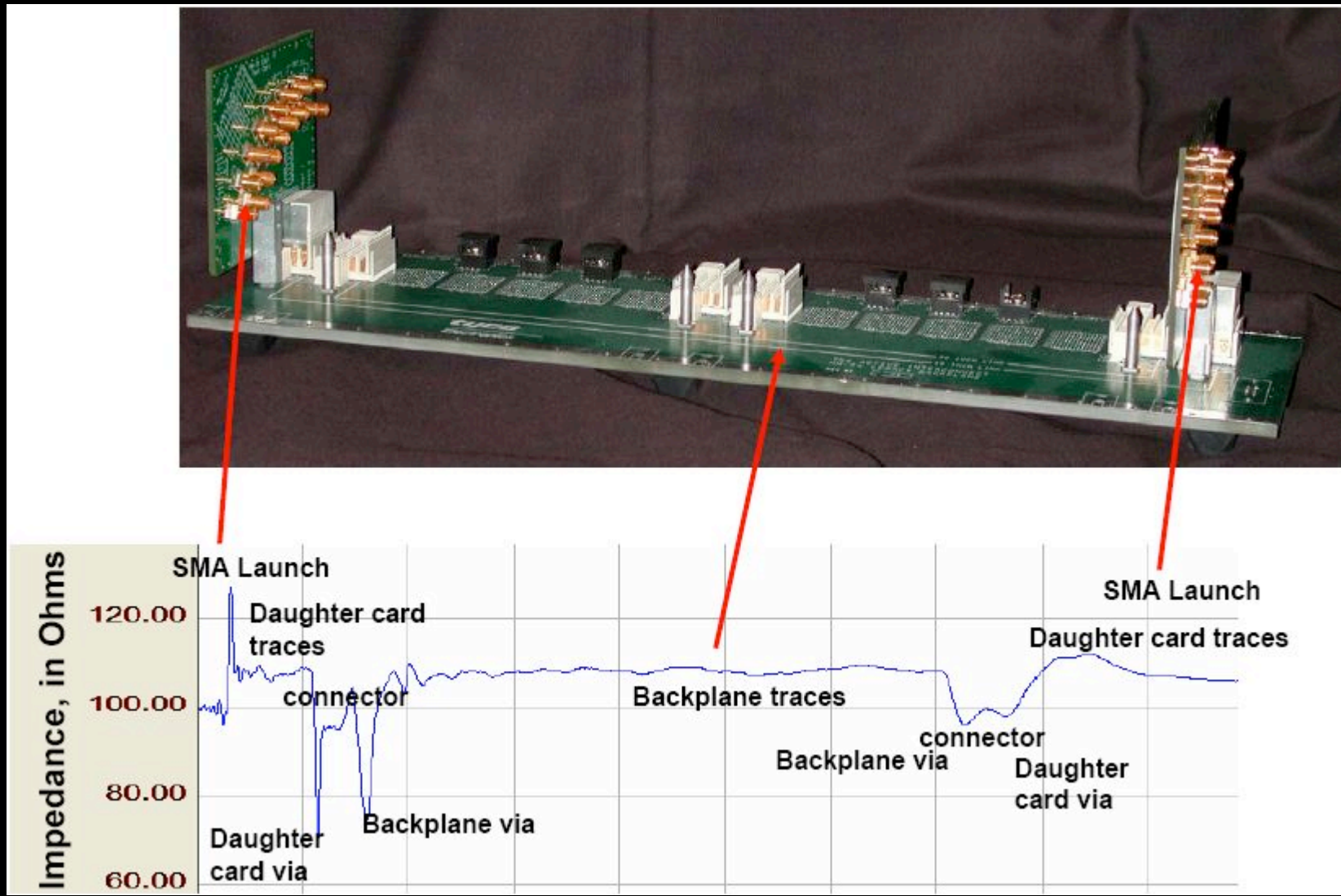
Eye Diagrams

- Highest BW, highest sample rate scope, with highest BW scope probes you can get
- Best quality 1394b cable you have, same best 1394b node on far end for All measurements.
- Make sure are measuring the TPB (transmitting pair) of the unit under test, NOT transmitting pair from far end of cable .

Quantum Parametrics
Connector Test Point
Card



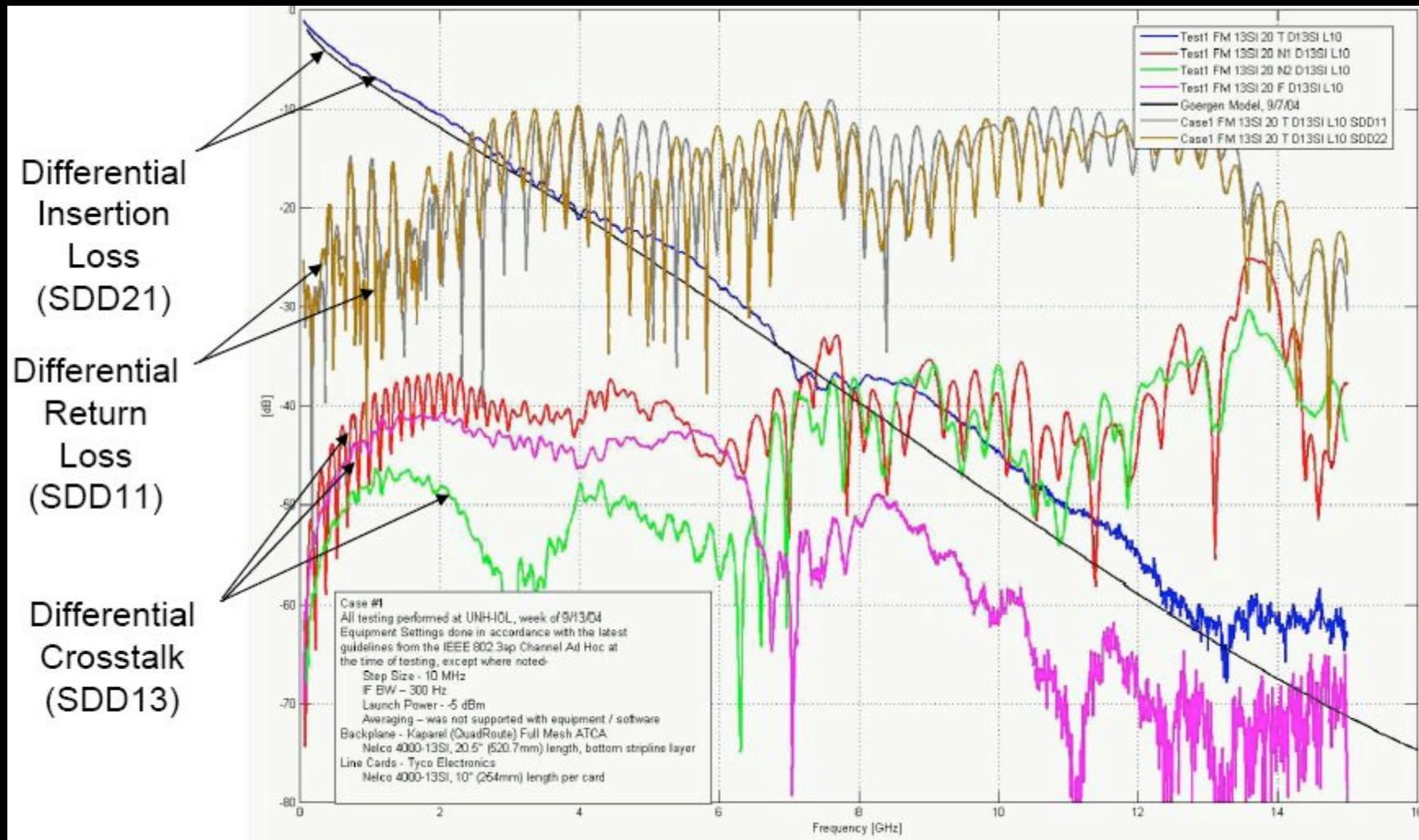
Time Domain Reflectometry (TDR)



Bit Error Rate Testing

- Requires ability to force particular bit pattern through system
 - Therefore usually means a special test mode
- Needs right equipment to force mode, force bit pattern at full speed and verify bit pattern at full speed
 - Parallel BERT, serial BERT, etc.
- Complex

Vector Network Analyzer (VNA) s-parameters



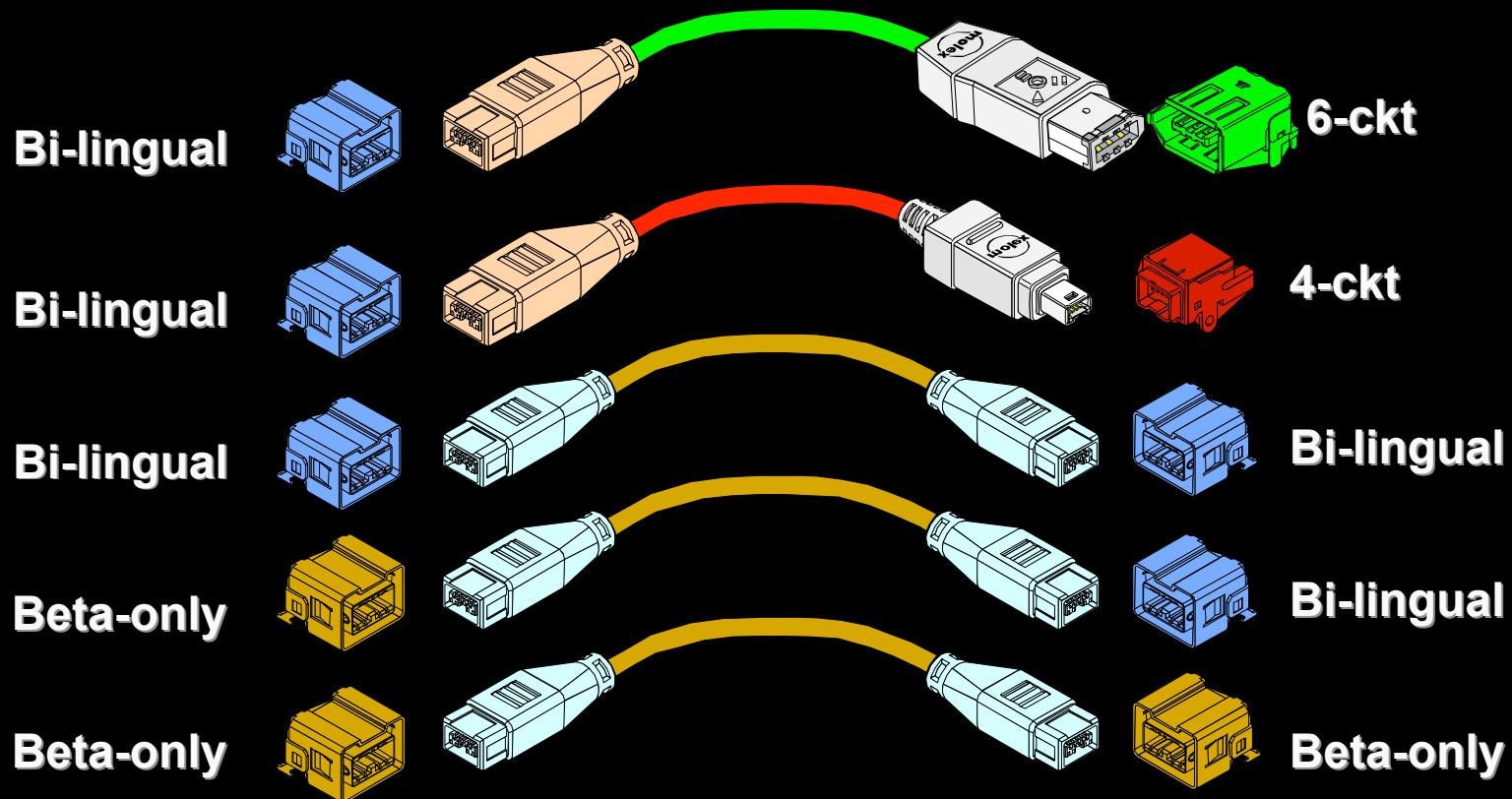
Measurement data courtesy of University of New Hampshire

Which Connector to Use?

- Today Media that supports S800 is limited to:
 - Shielded Twisted Pair 1394b Cables
 - Glass Optical Fiber

3 Cables, 4 Sockets

- Legacy mode cables (prevents 1394a (DS) to 1394b Beta-only connection)
 - Bilingual to 6-ckt 1394a Data-Strobe (carries power)
 - Bilingual to 4-ckt 1394a Data-Strobe (no power)
- 1394b Beta mode cable (also used for bilingual to Beta)



When Should the 1394b Bi-Lingual Connector be Used?

- When want to be able to:
 - Connect at S800+ 1394b speeds
- AND
 - Want to be able to connect to existing 1394a-2000 or 1394-1995 devices using 9-pin to 6-pin or 9-pin to 4-pin cables
- Requires a new cable

When Should the 1394a-2000 Connector be Used?

- When want to be able to connect to existing equipment using existing cables
 - Simplest for Users
- Must force port to be 1394a-only to prevent 1394b signaling from going across a 1394a cable
 - Bi-lingual PHY always attempts to connect as a 1394b PHY first, unless forced to 1394a mode.
 - S800 1394b signaling will encounter more errors when sent across 1394a cables/connectors - Do not put S800 across 1394a connectors and cables

When Should the 1394b Beta-only Connector be Used?

- When want to ONLY use 1394b mode connections.
 - Does not allow connection to any existing 1394a-2000 or 1394-1995 devices
 - Will only be able to connect to other nodes that use either 1394b Beta-only connectors or 1394b Bilingual connectors
- Can only use new Beta to Beta cable

