

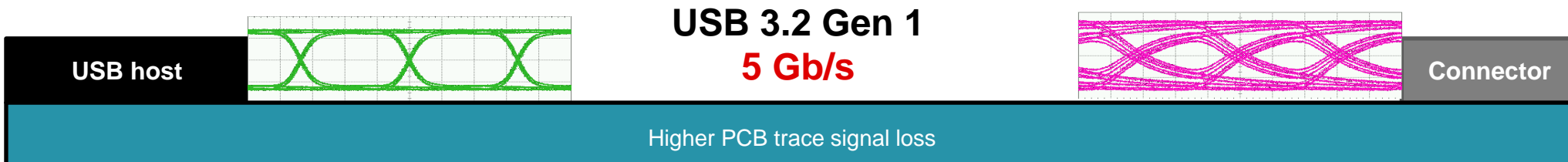
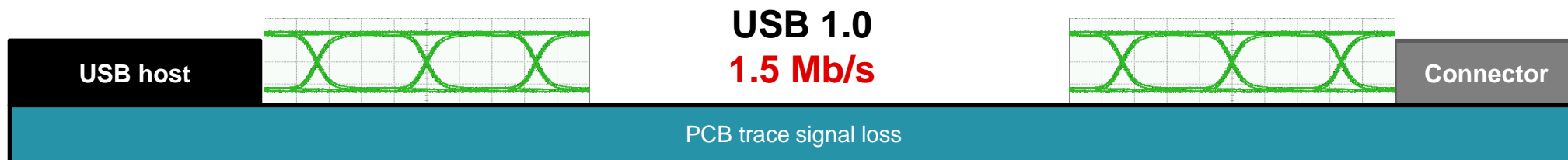
# What is a USB redriver?

TI Precision Labs - USB

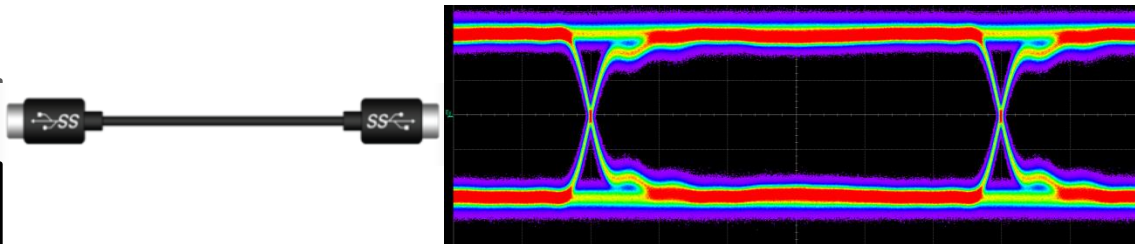
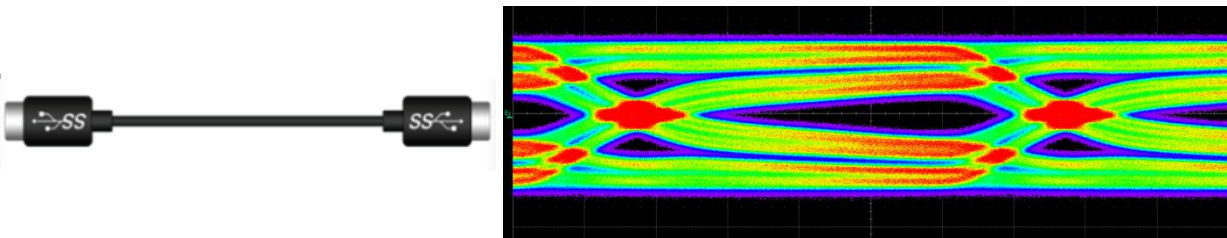
Prepared by Undrea Fields

Presented by Nicholas Malone

# Signal integrity problem at higher data rates

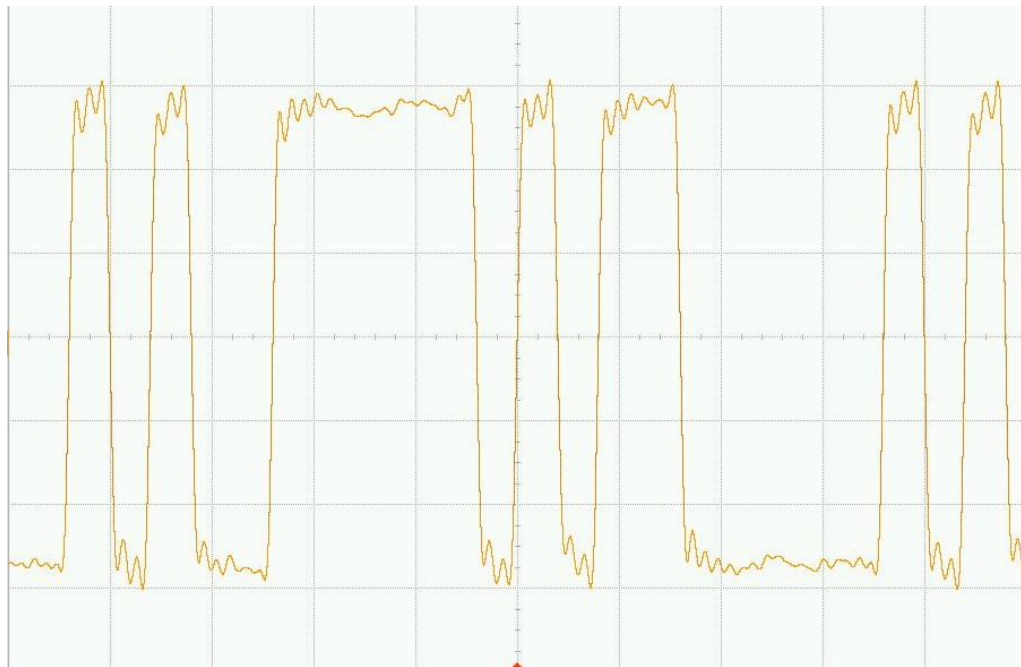


# How does a USB redriver help?

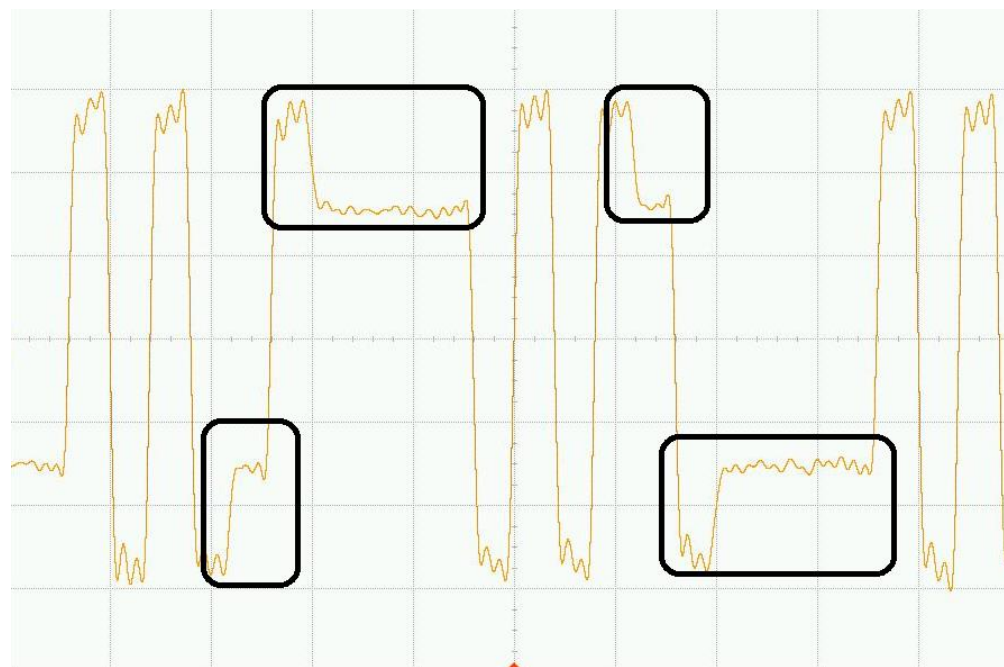


# Transmitter equalization

Waveform without de-emphasis



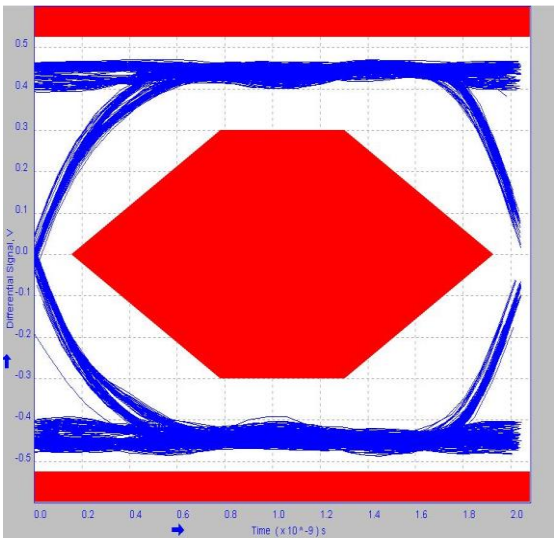
Waveform with de-emphasis



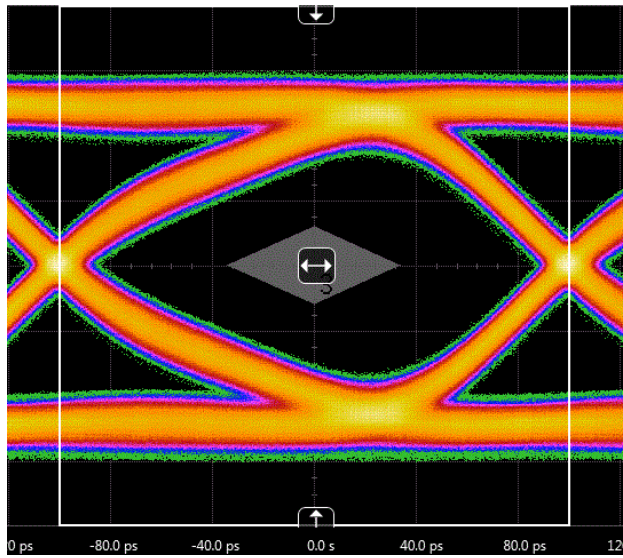


# USB transmitter compliance testing

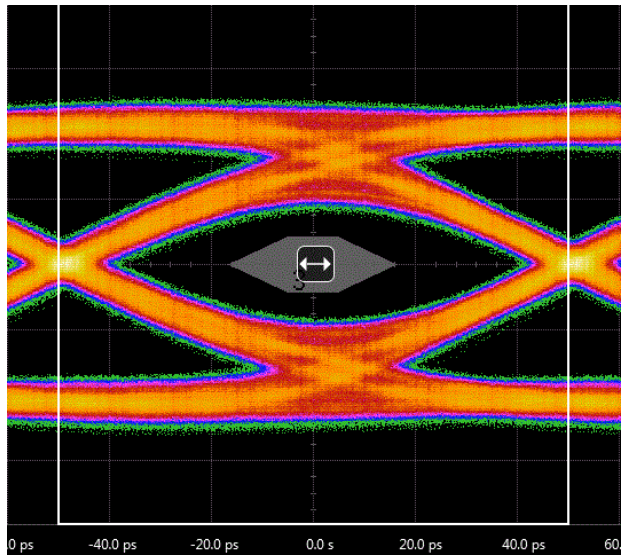
USB 2.0 - 480Mb/s



USB 3.2 Gen 1 - 5Gb/s

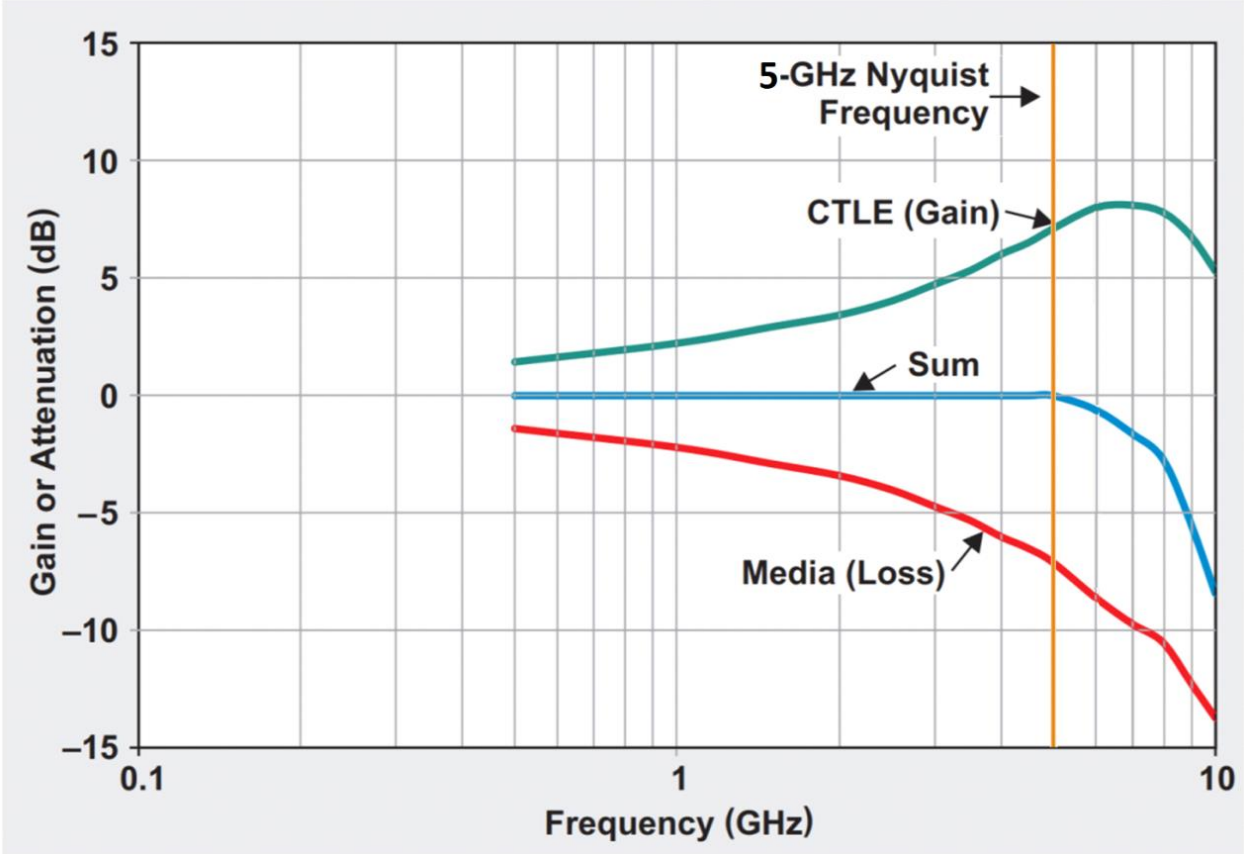


USB 3.2 Gen 2 - 10Gb/s



# Receiver equalization

## Signal loss and CTLE gain



# USB-IF reference CTLE

USB3.2 Gen 1  
reference CTLE equation

$$H(s) = \frac{A_{dc} \omega_{p1} \omega_{p2}}{\omega_z} \cdot \frac{s + \omega_z}{(s + \omega_{p1})(s + \omega_{p2})}$$

where  $A_{dc}$  is the DC gain

$\omega_z = 2\pi f_z$  is the zero frequency

$\omega_{p1} = 2\pi f_{p1}$  is the first pole frequency

$\omega_{p2} = 2\pi f_{p2}$  is the second pole frequency

USB3.2 Gen 2  
reference CTLE equation

$$H(s) = A_{ac} \omega_{p2} \frac{s + \frac{A_{dc}}{A_{ac}} \omega_{p1}}{(s + \omega_{p1})(s + \omega_{p2})}$$

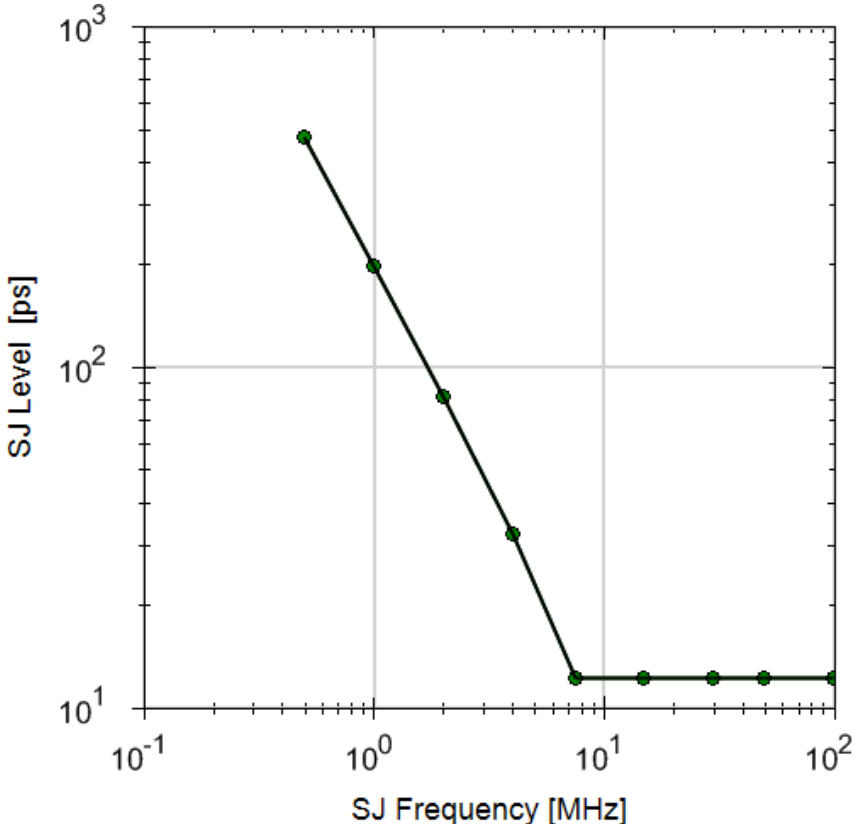
where  $A_{ac}$  is the high frequency peak gain

$A_{dc}$  is the DC gain

$\omega_{p1} = 2\pi f_{p1}$  is the first pole frequency

$\omega_{p2} = 2\pi f_{p2}$  is the second pole frequency

# USB receiver compliance testing



## USB 3.2 Gen 2 Rx JTOL test

Result	SJ Frequency [MHz]	Failed Adjusted SJ [ps]	Passed Adjusted SJ [ps]	Min Spec [ps]	Nominal SJ [ps]	Errors [ ]
pass	100.000		12.17	12.17	17.00	0
pass	50.000		12.17	12.17	17.00	0
pass	30.000		12.17	12.17	17.00	0
pass	15.000		12.17	12.17	17.00	0
pass	7.500		12.17	12.17	17.00	0
pass	4.000		32.17	32.17	37.00	0
pass	2.000		82.17	82.17	87.00	0
pass	1.000		198.17	198.17	203.00	0
pass	0.500		471.17	471.17	476.00	0



# Short quiz



True or false: USB 1.0 data rate is 1.5Mbps.

# Short quiz



True or false: A USB redriver can help a system pass compliance testing.

## Short quiz

**FALSE**

True or false: A USB redriver is not designed to compensate for system ISI.

## Short quiz

**FALSE**

True or false: A USB redriver can only be found on a PC motherboard.



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