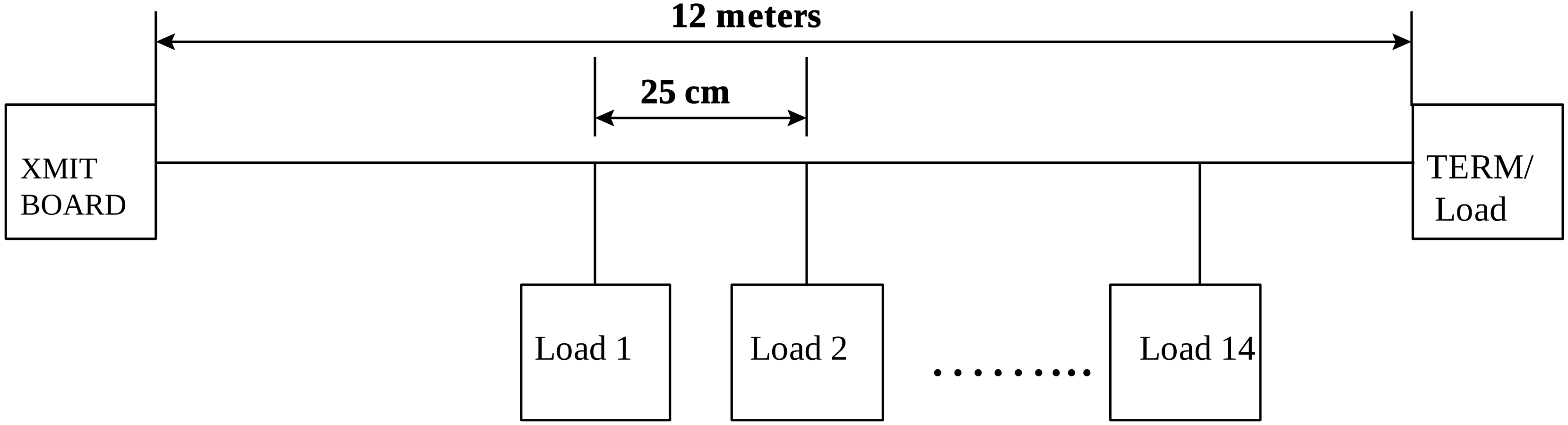
TEST CONFIGUATION



- XMIT board sends Pseudo Random Pattern (run length of 7).
- Load boards are capacitive boards with 22 pf to ground from each side.
- Cable used is Hitachi Twisted Flat Series 23915

HITACHI CABLE #23915

Conductor	30 AVG 7/38 Tinned
Insulation	PVC
Conductor Resistance	0.344 ohms/meter
Capacitance	48.3 pf/meter
Impedance	102 ohms
Propagation Delay	5.07 ns/meter
Skew (max)	0.146 ns/meter

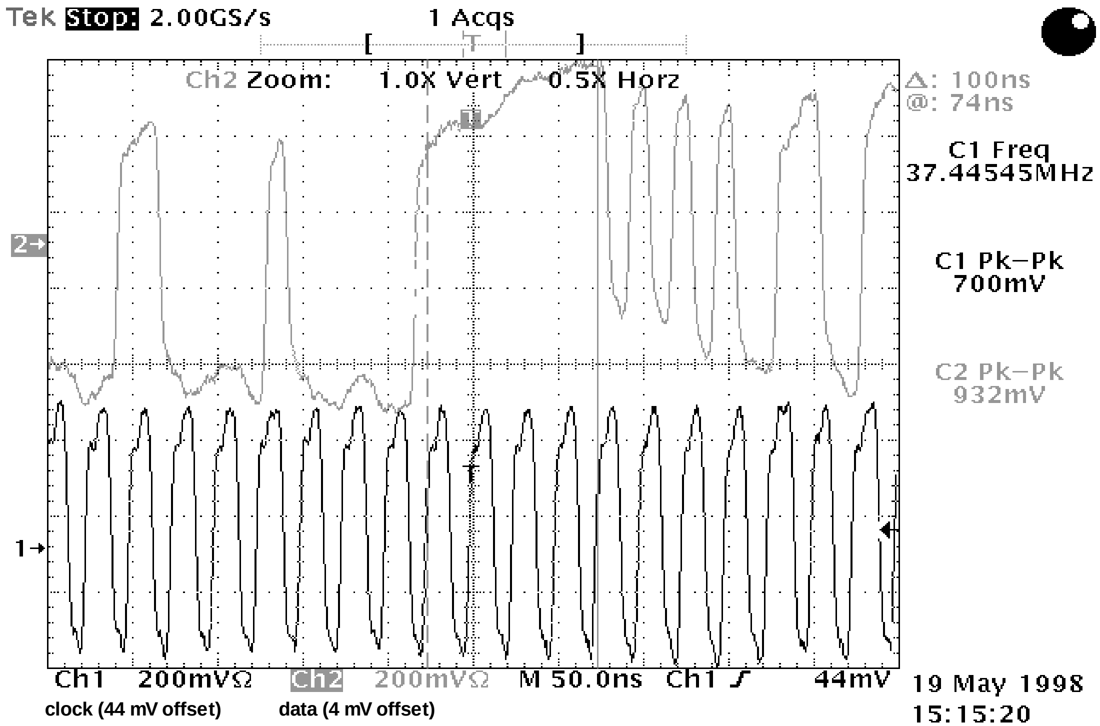
Tests run with two drive levels.

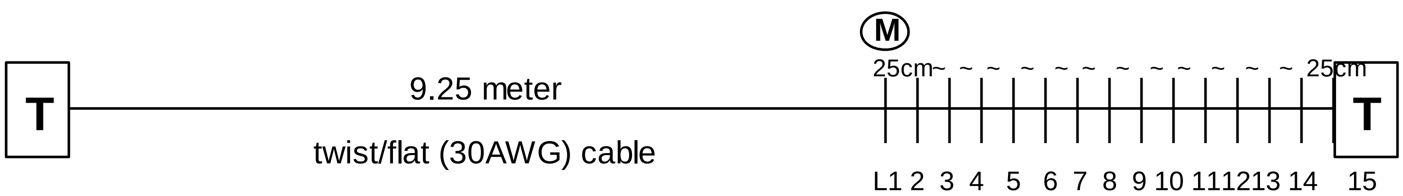
- **Low drive level board output 250 mv**
- **High level drive board output 575 mv peak**

Measured at all load points.

Trigger point varied plus/minus 60 mv.

Will show only several representative points.





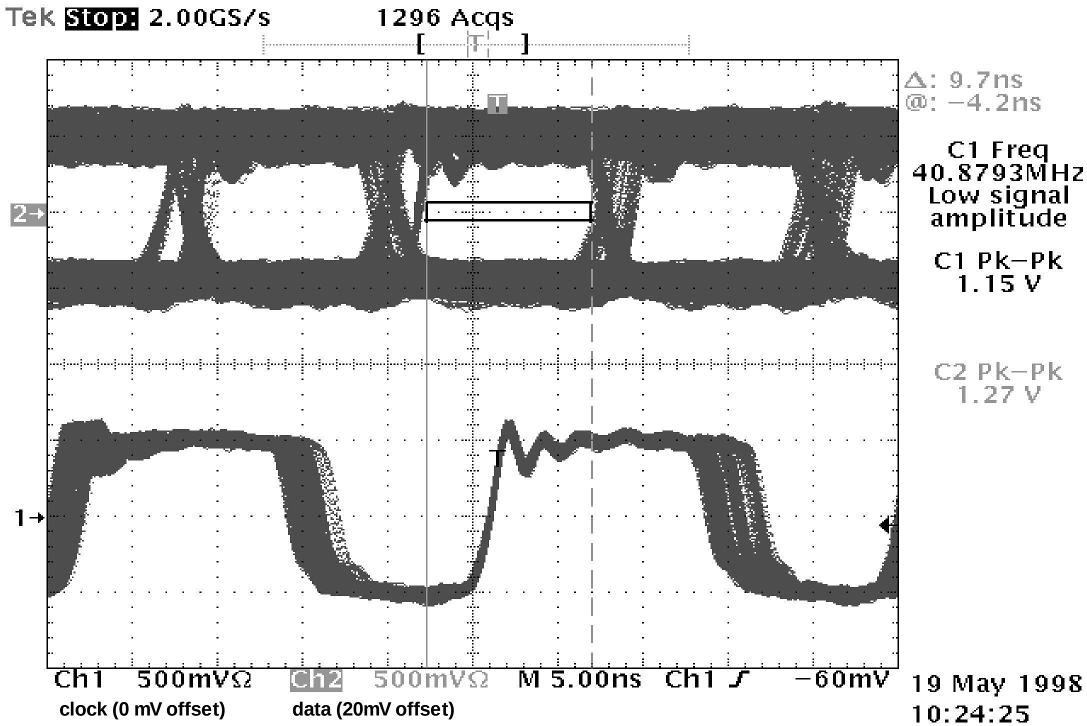
"Pseudo-random data for 12 meter twist/flat cable and 15 loads"

(trigger at center of clock)

Note: T is resistive termination

= 110 ohm

High Drive



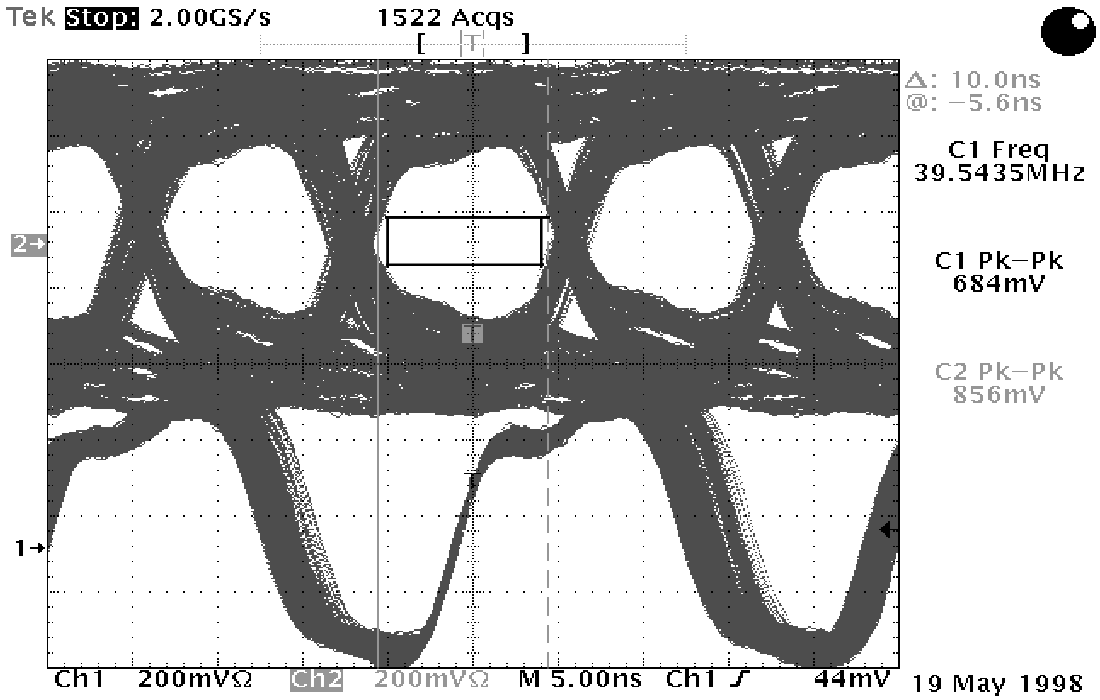
“Eye pattern for 12 meter twist/flat cable and 15 loads”

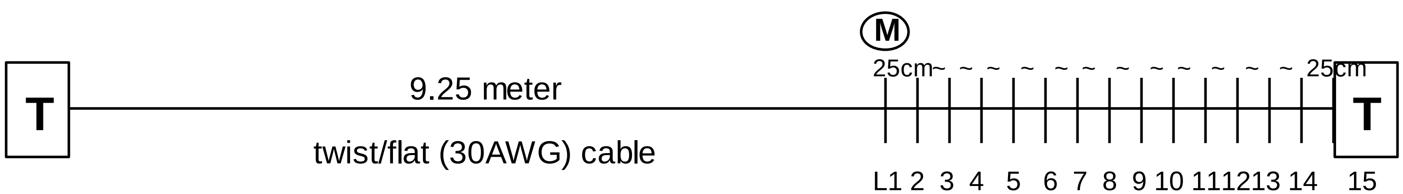
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





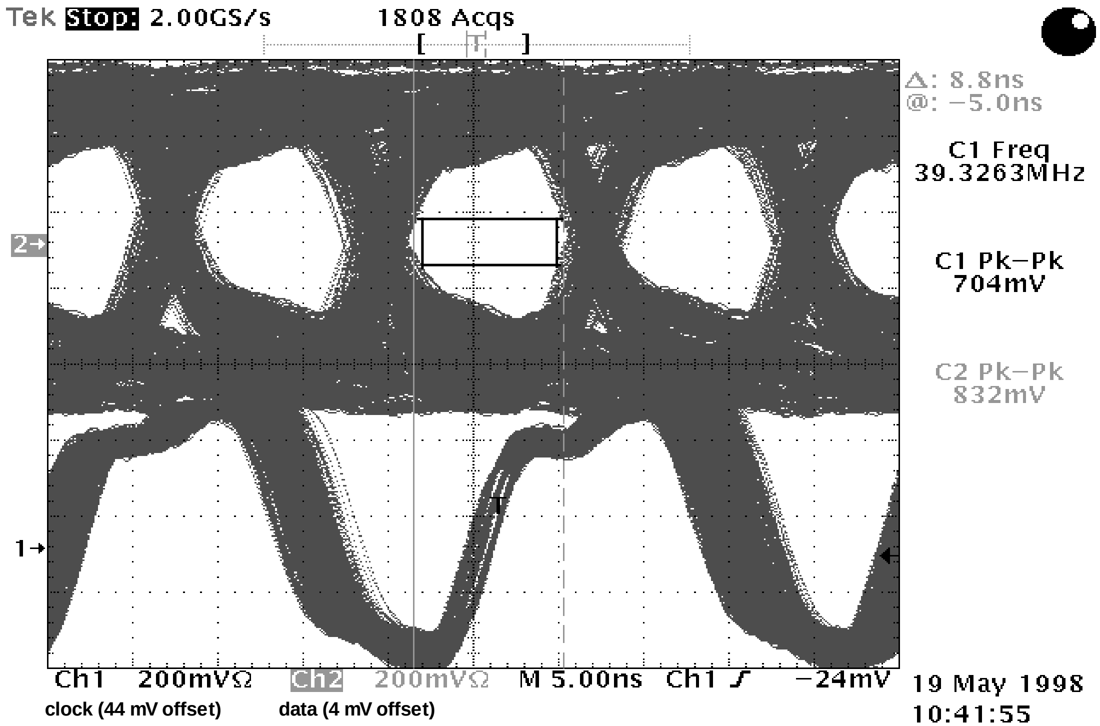
"Eye pattern for 12 meter twist/flat cable and 15 loads"

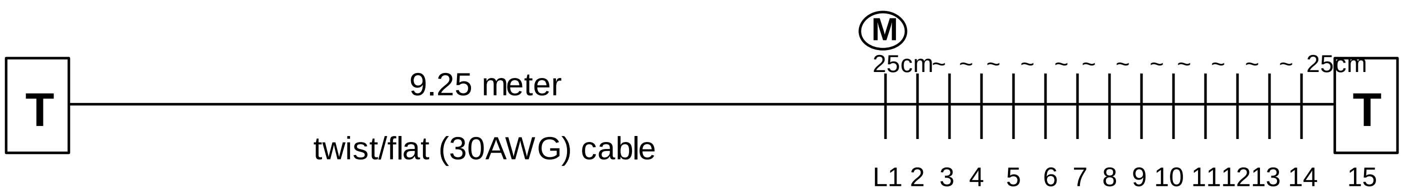
(trigger at center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





"Eye pattern for 12 meter twist/flat cable and 15 loads"

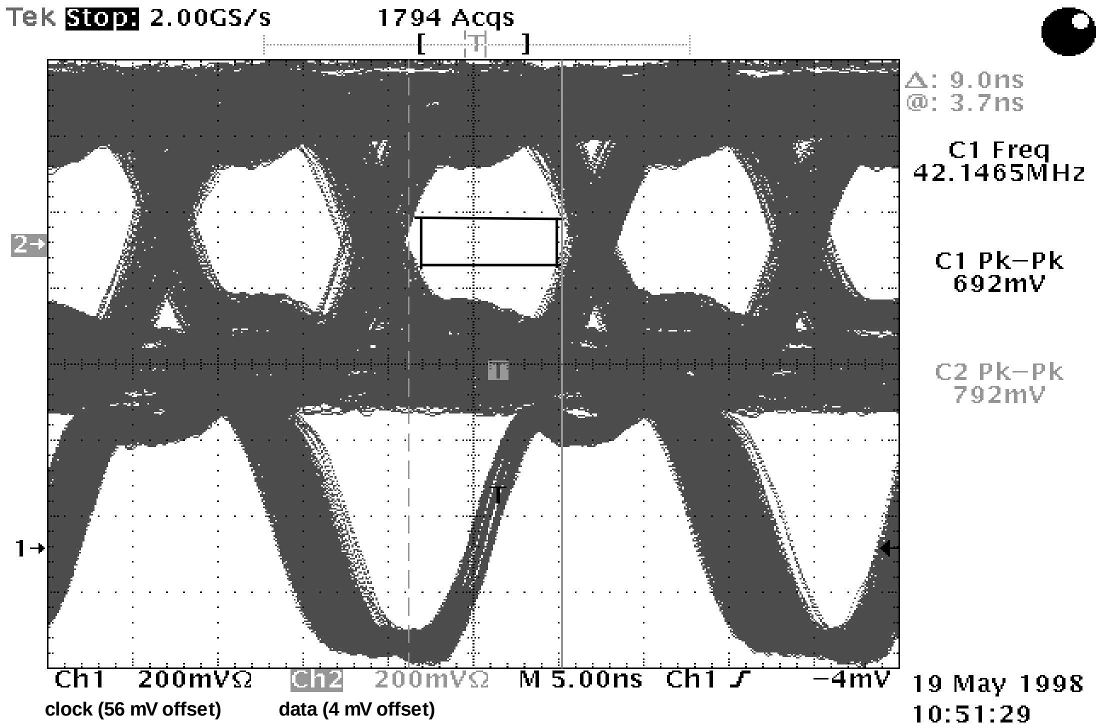
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

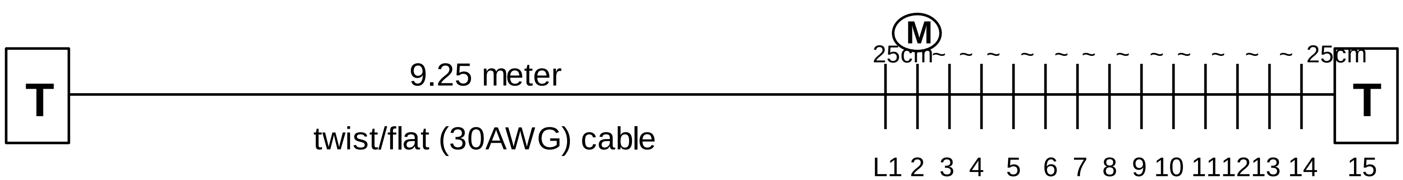
= 110 ohm

adaptec

High Drive



clock (56 mV offset) data (4 mV offset)



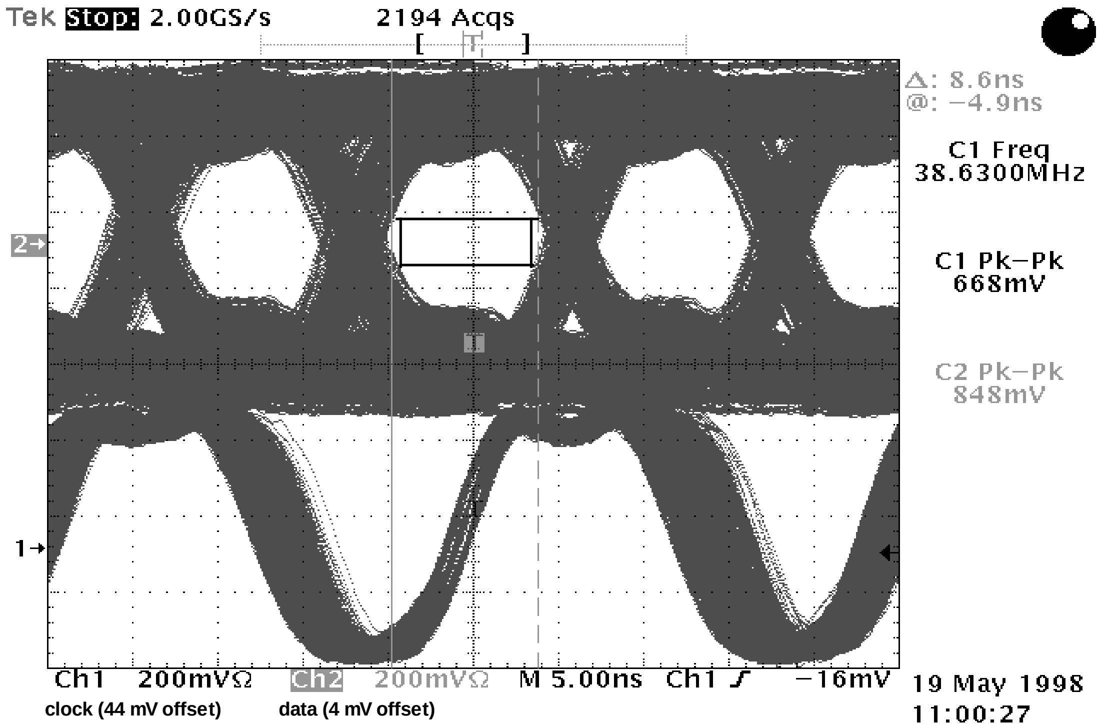
"Eye pattern for 12 meter twist/flat cable and 15 loads"

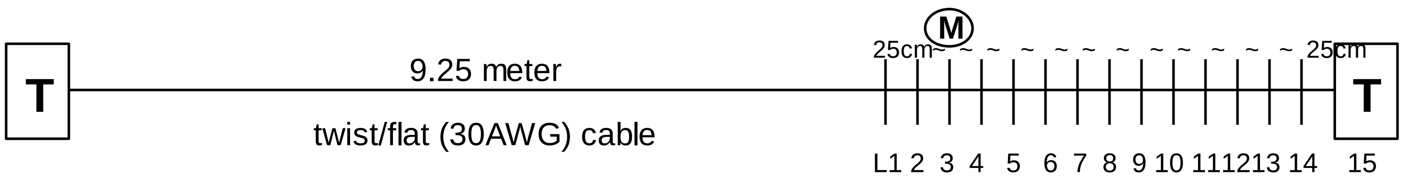
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive



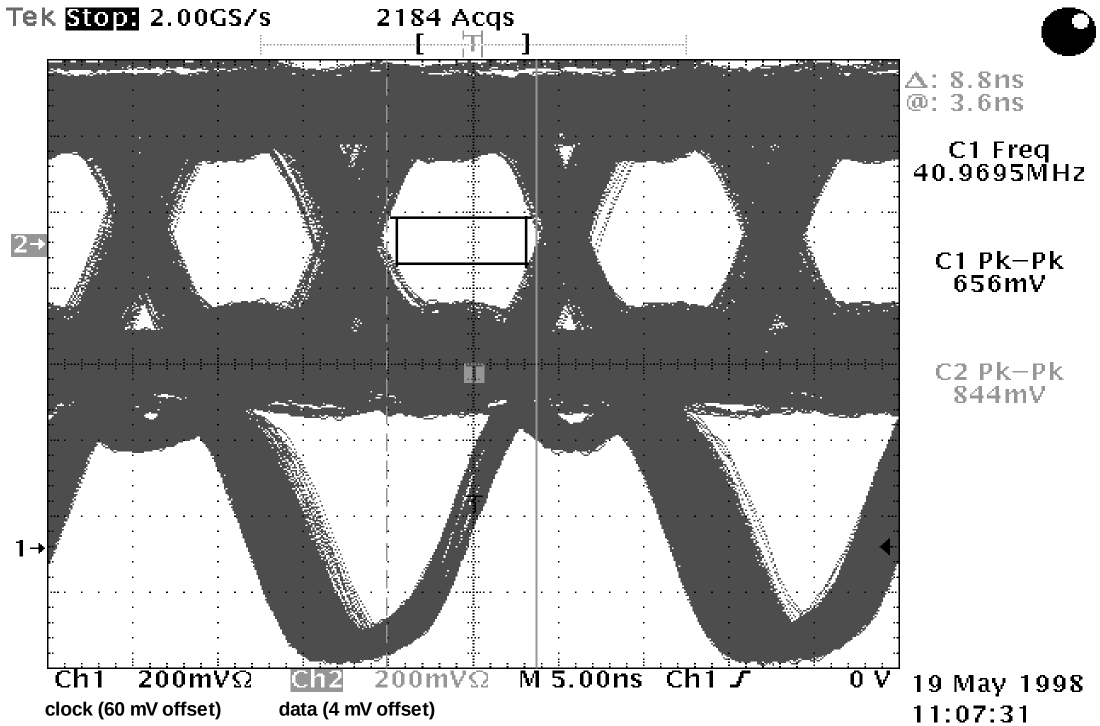


"Eye pattern for 12 meter twist/flat cable and 15 loads"

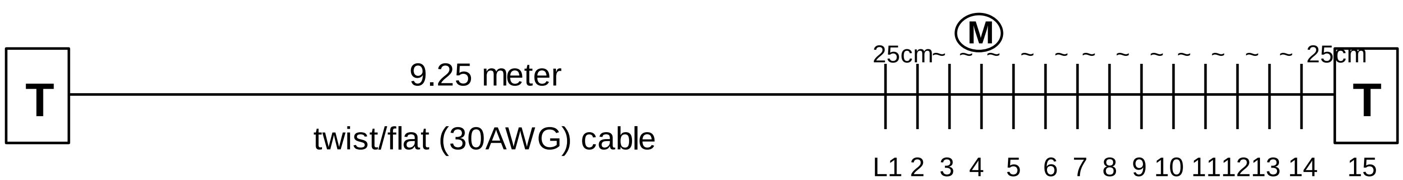
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination = 110 ohm

High Drive



clock (60 mV offset) data (4 mV offset)



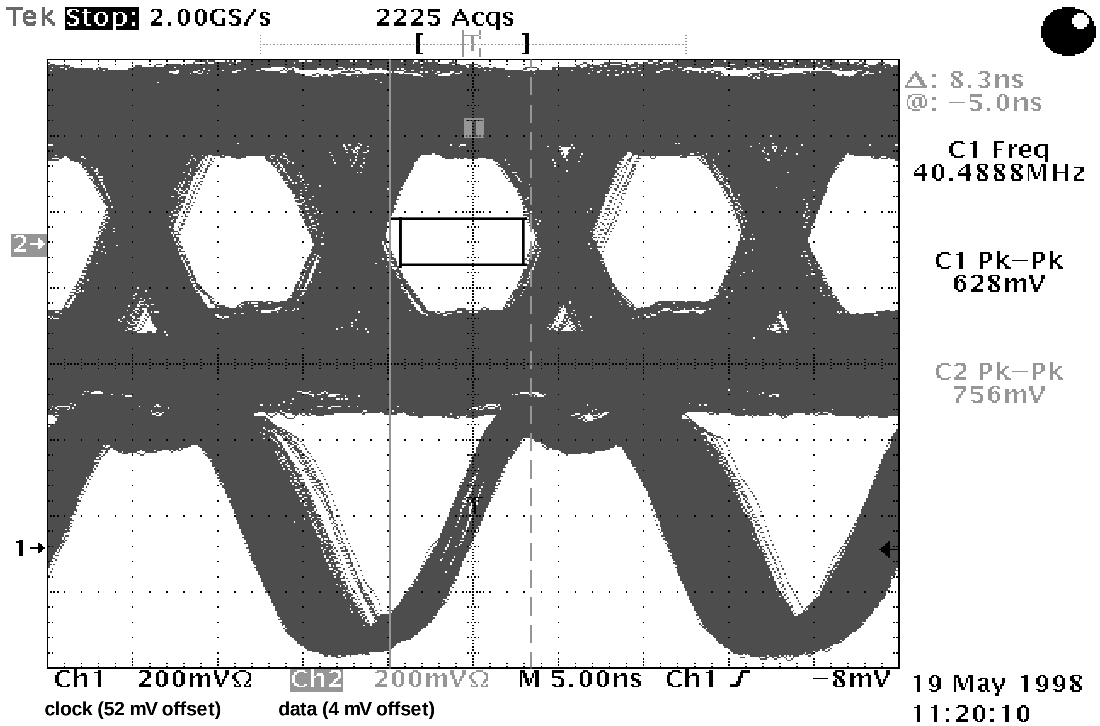
"Eye pattern for 12 meter twist/flat cable and 15 loads"

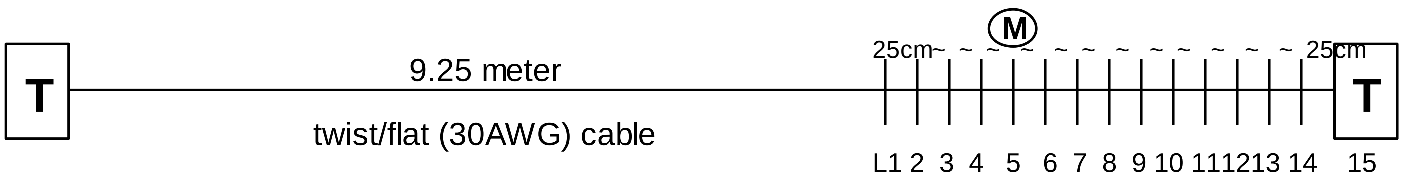
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





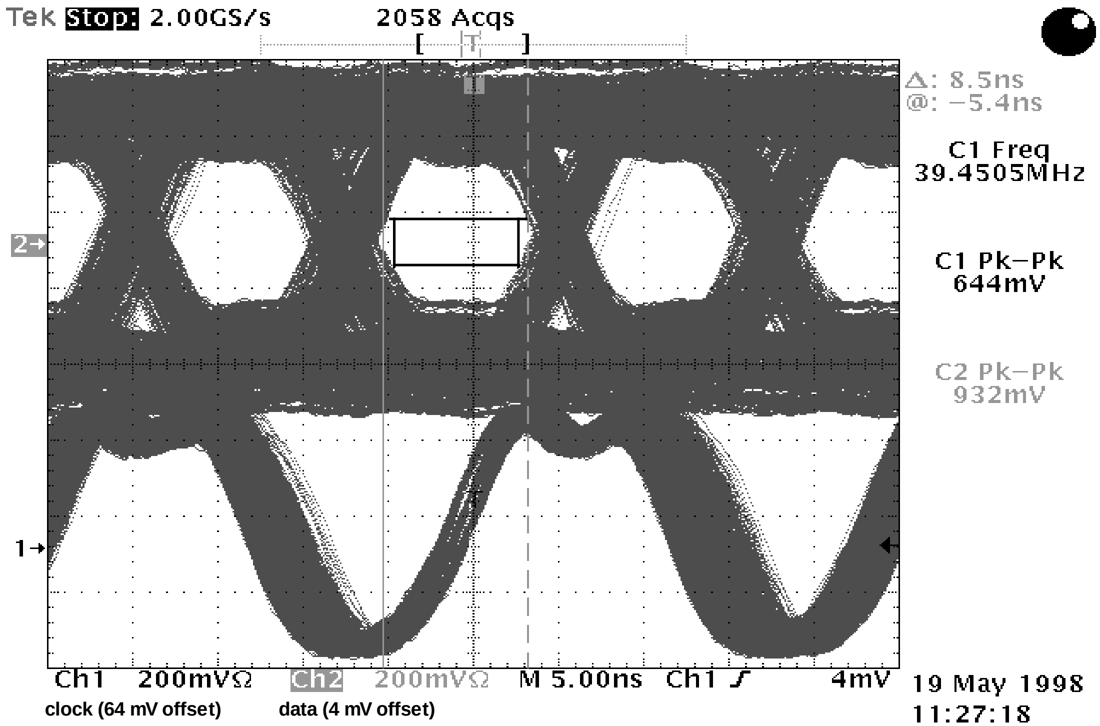
“Eye pattern for 12 meter twist/flat cable and 15 loads”

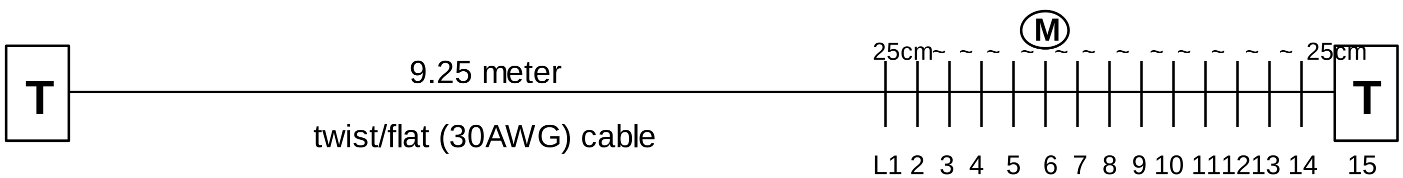
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





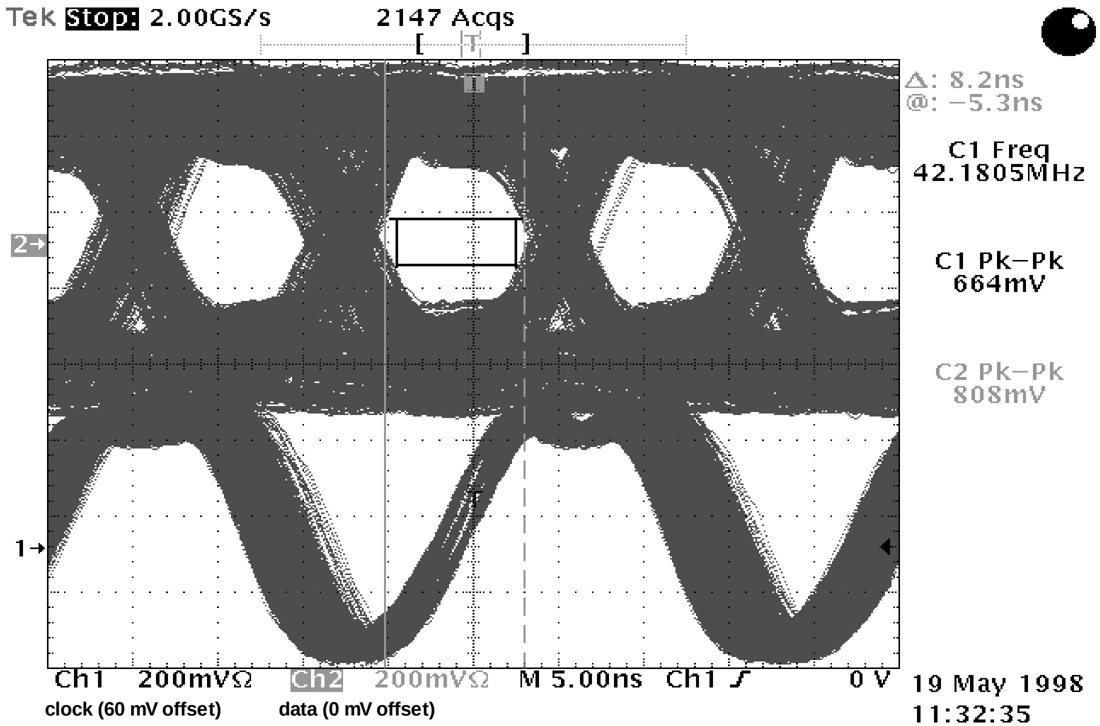
“Eye pattern for 12 meter twist/flat cable and 15 loads”

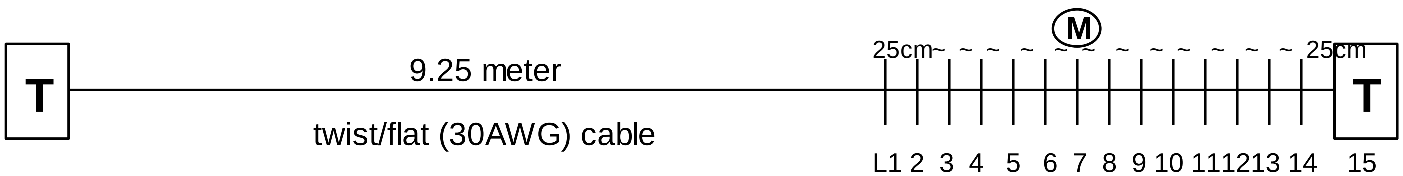
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





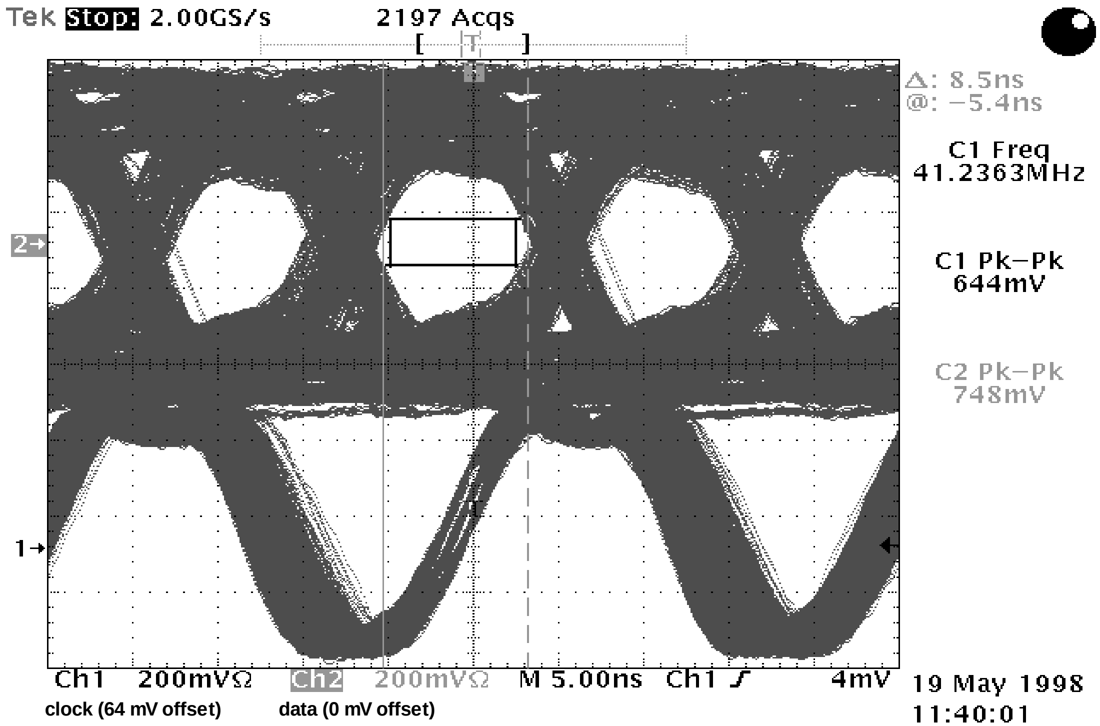
"Eye pattern for 12 meter twist/flat cable and 15 loads"

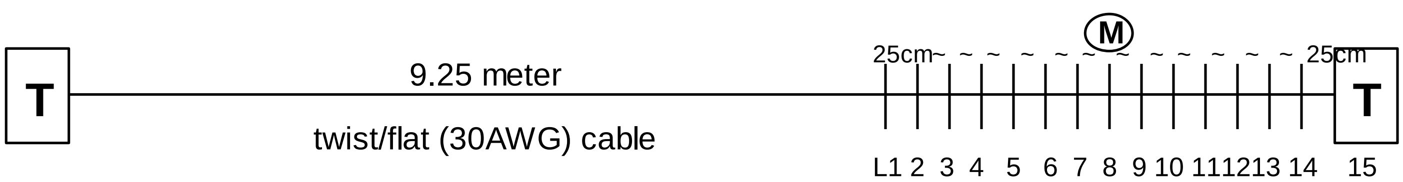
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





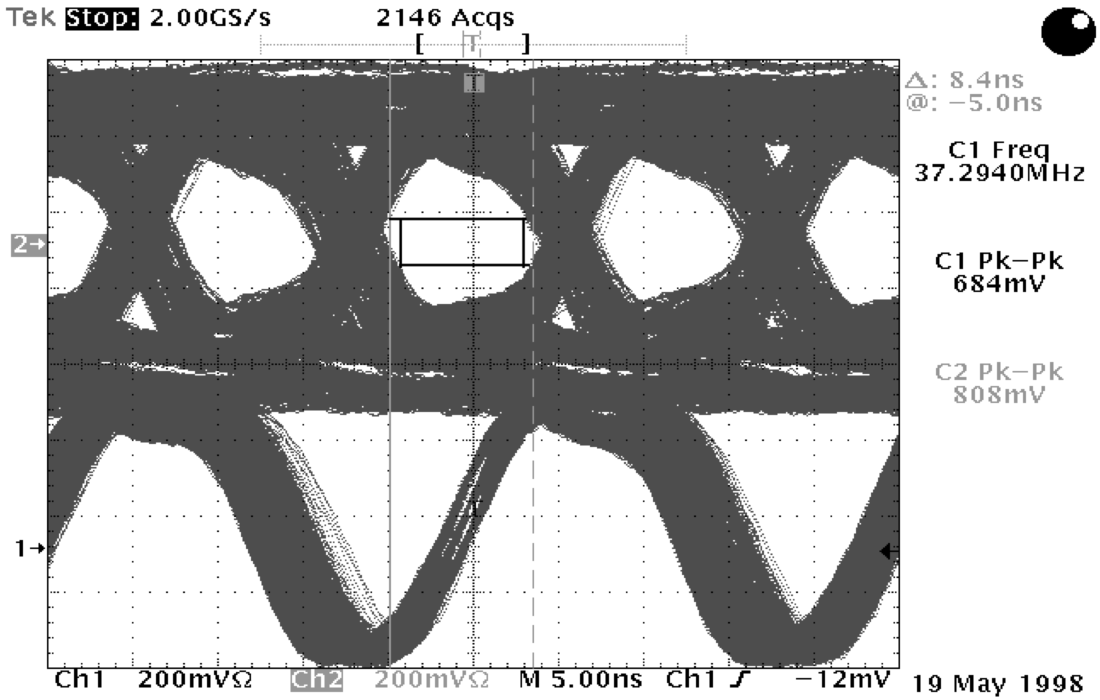
"Eye pattern for 12 meter twist/flat cable and 15 loads"

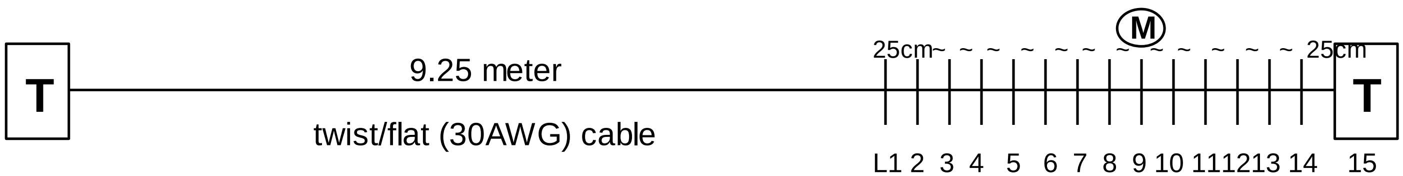
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





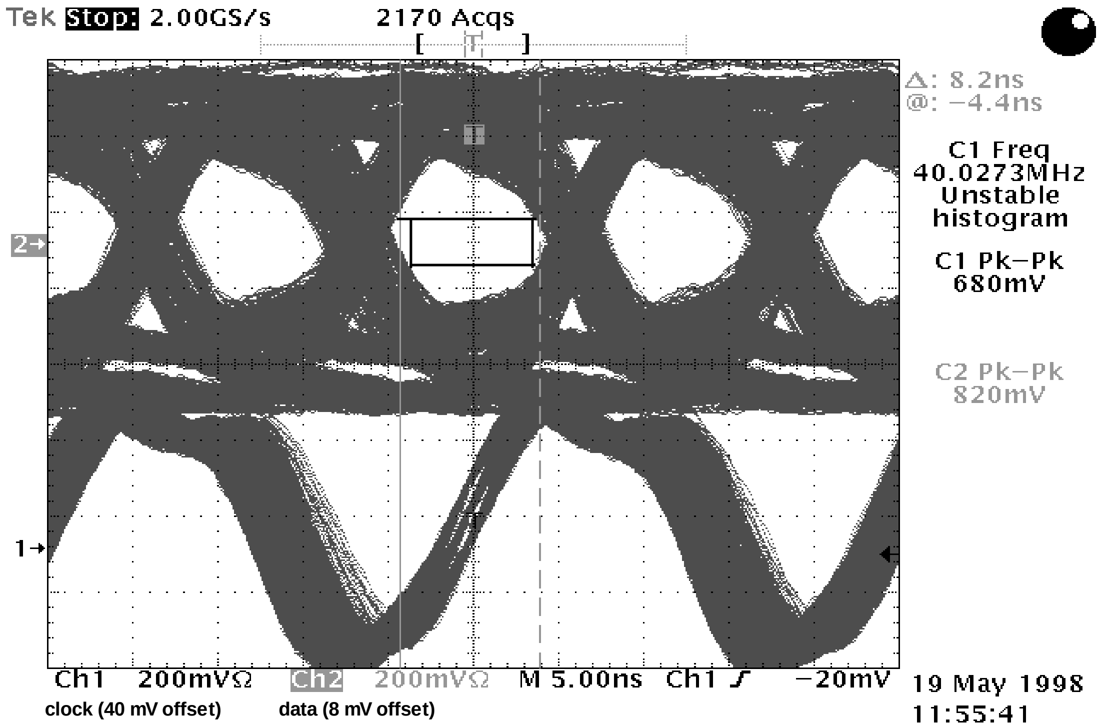
"Eye pattern for 12 meter twist/flat cable and 15 loads"

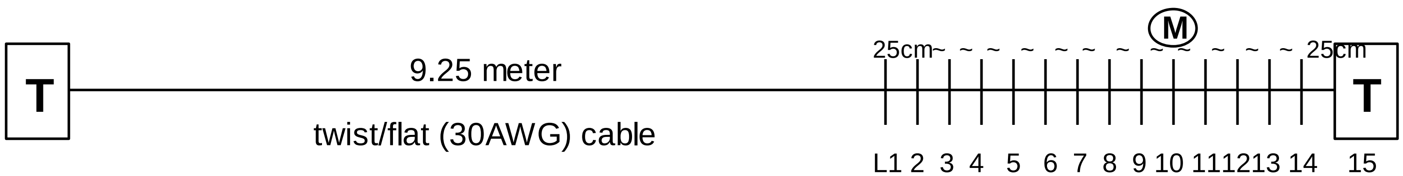
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





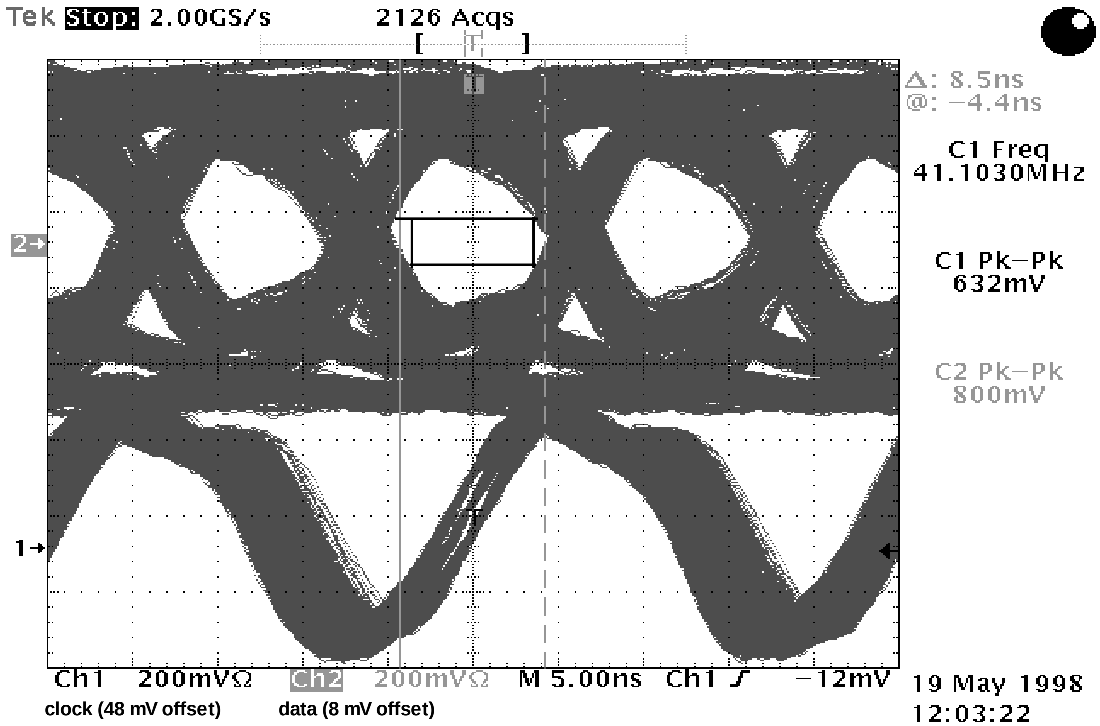
"Eye pattern for 12 meter twist/flat cable and 15 loads"

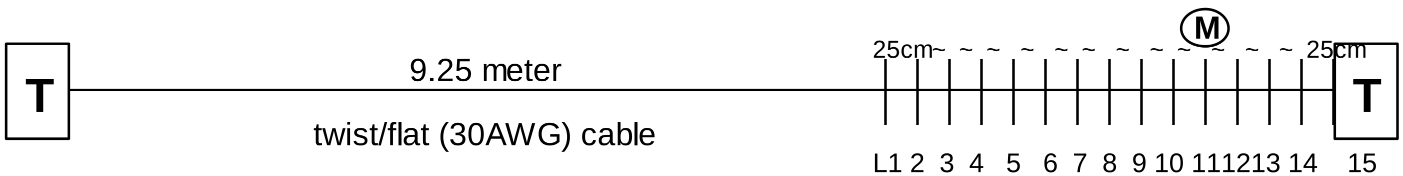
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





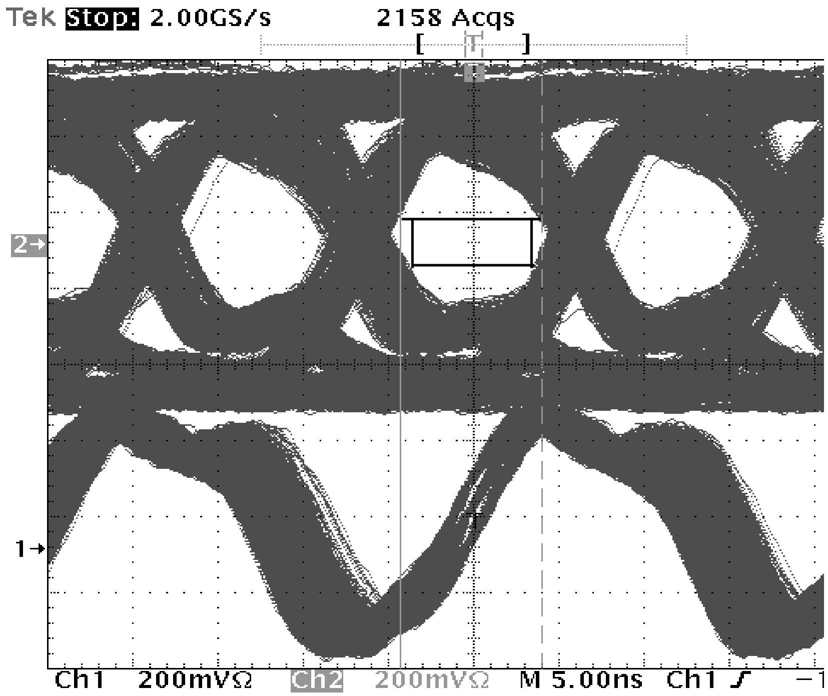
"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

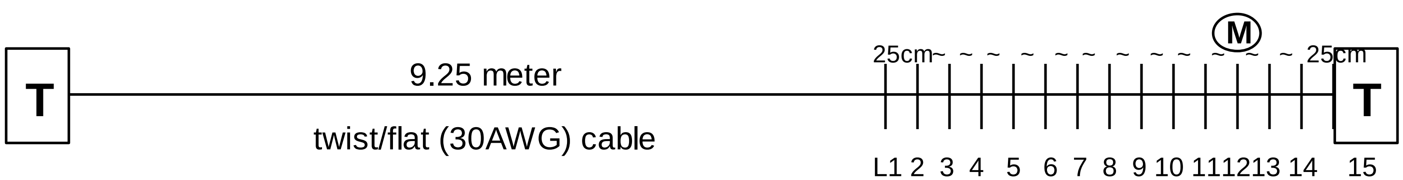
Note: T is resistive termination

= 110 ohm

High Drive



clock (44 mV offset) **data (4 mV offset)**



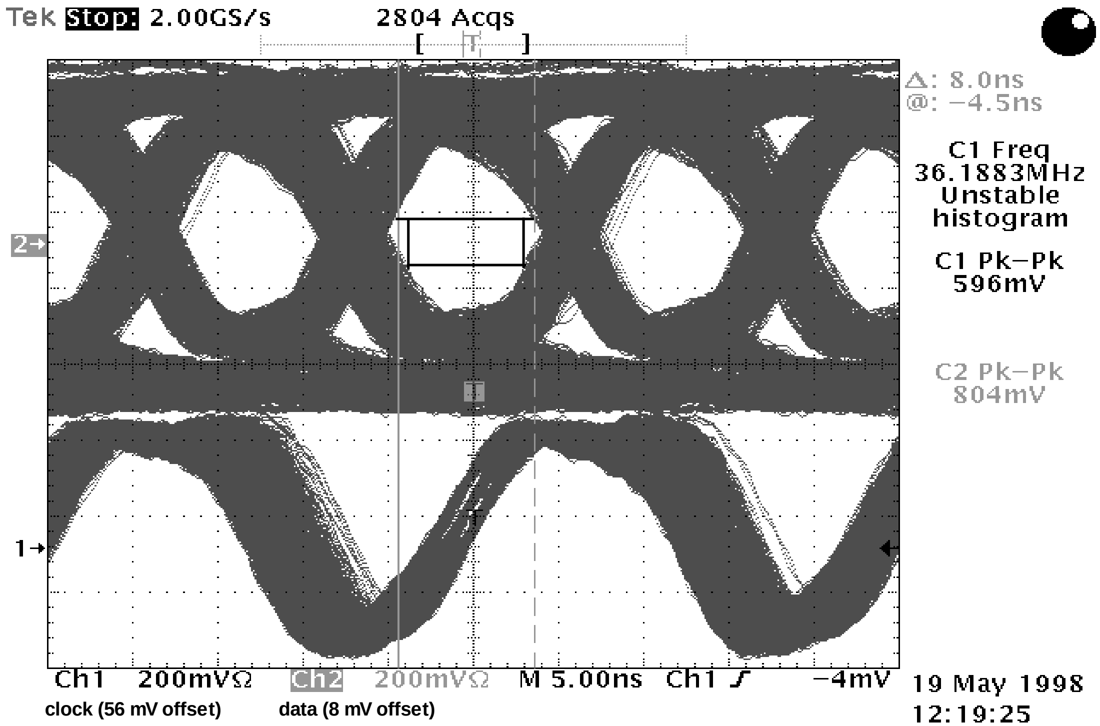
"Eye pattern for 12 meter twist/flat cable and 15 loads"

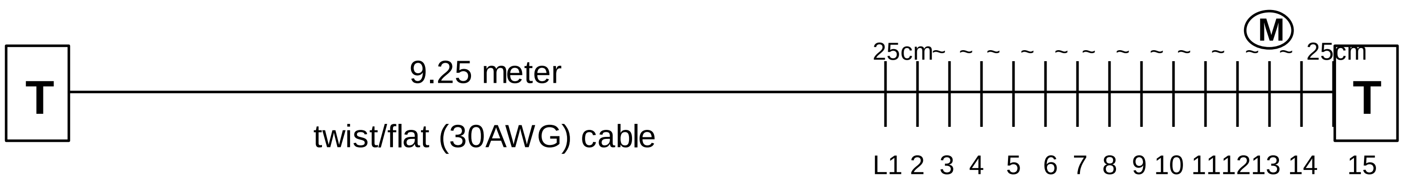
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





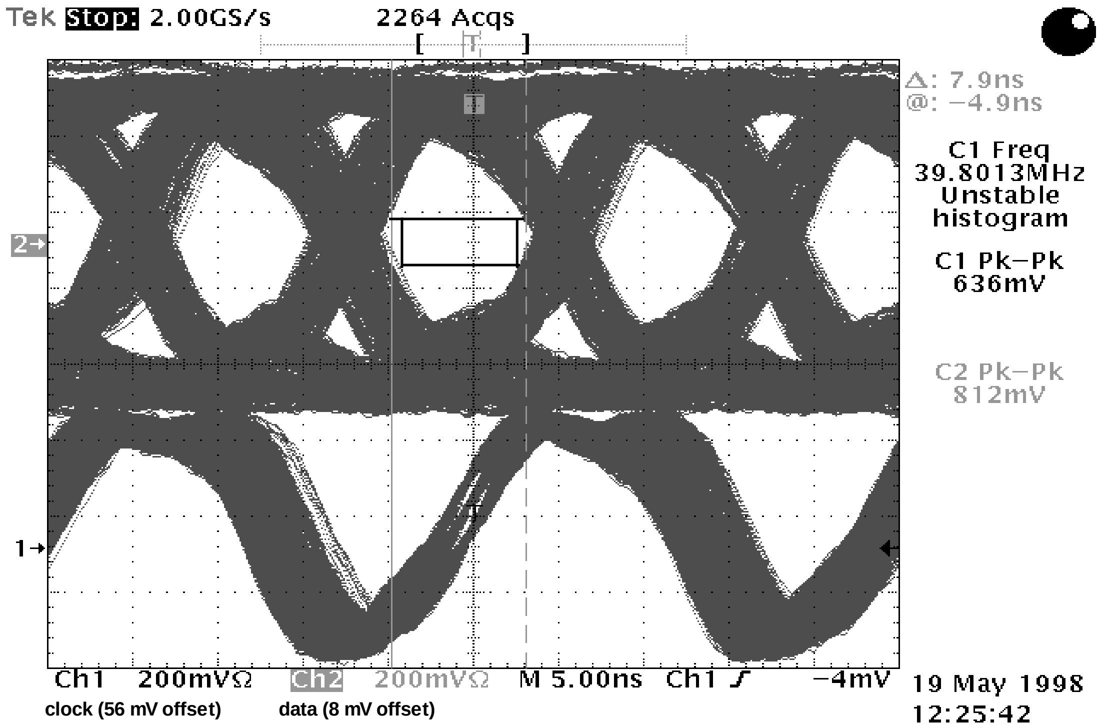
"Eye pattern for 12 meter twist/flat cable and 15 loads"

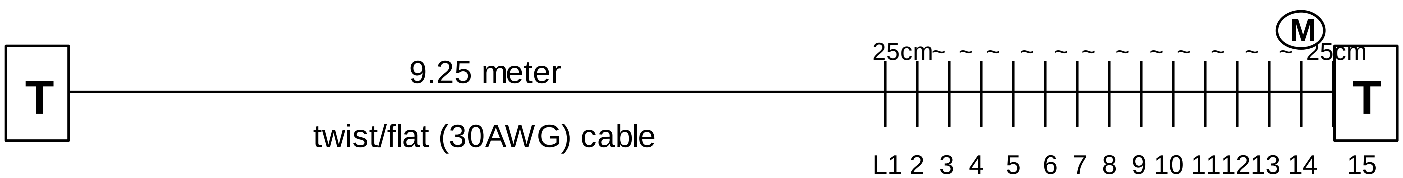
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





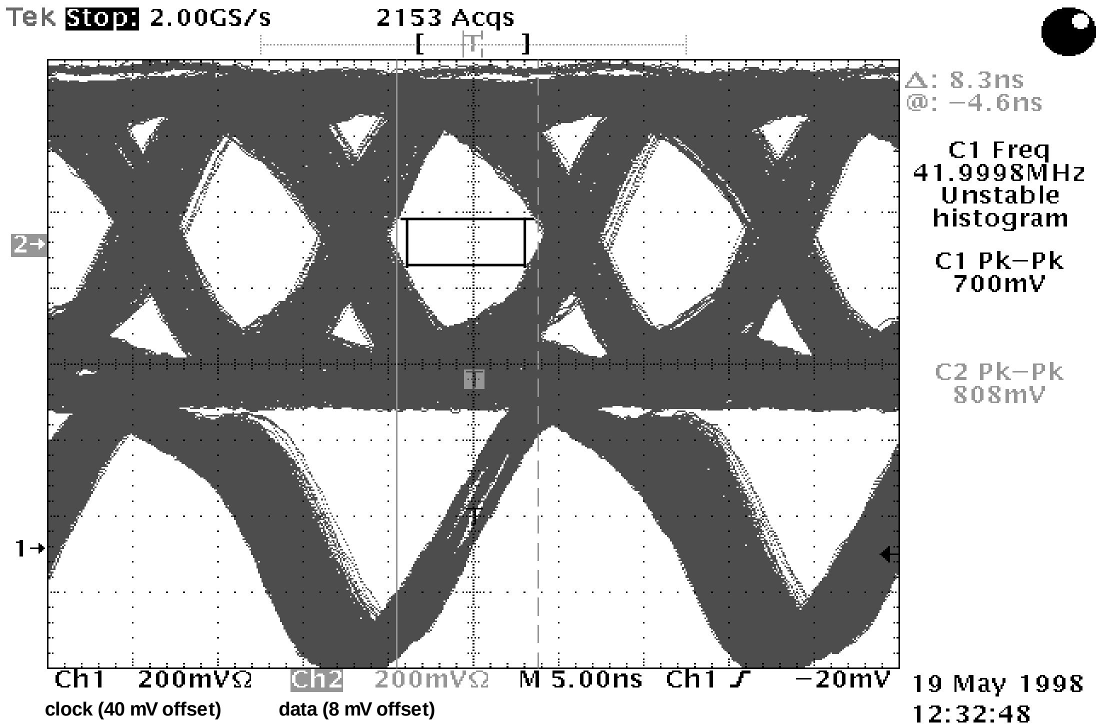
"Eye pattern for 12 meter twist/flat cable and 15 loads"

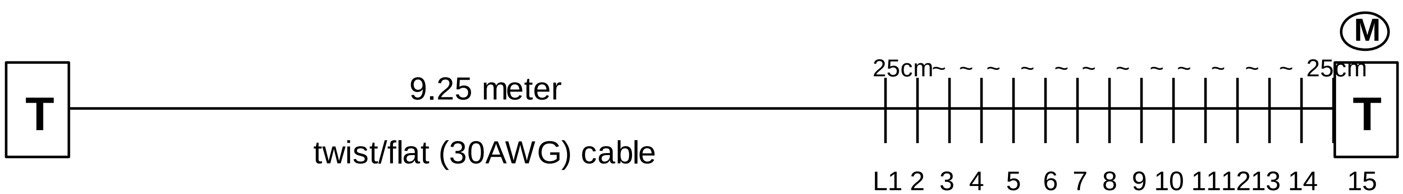
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

High Drive





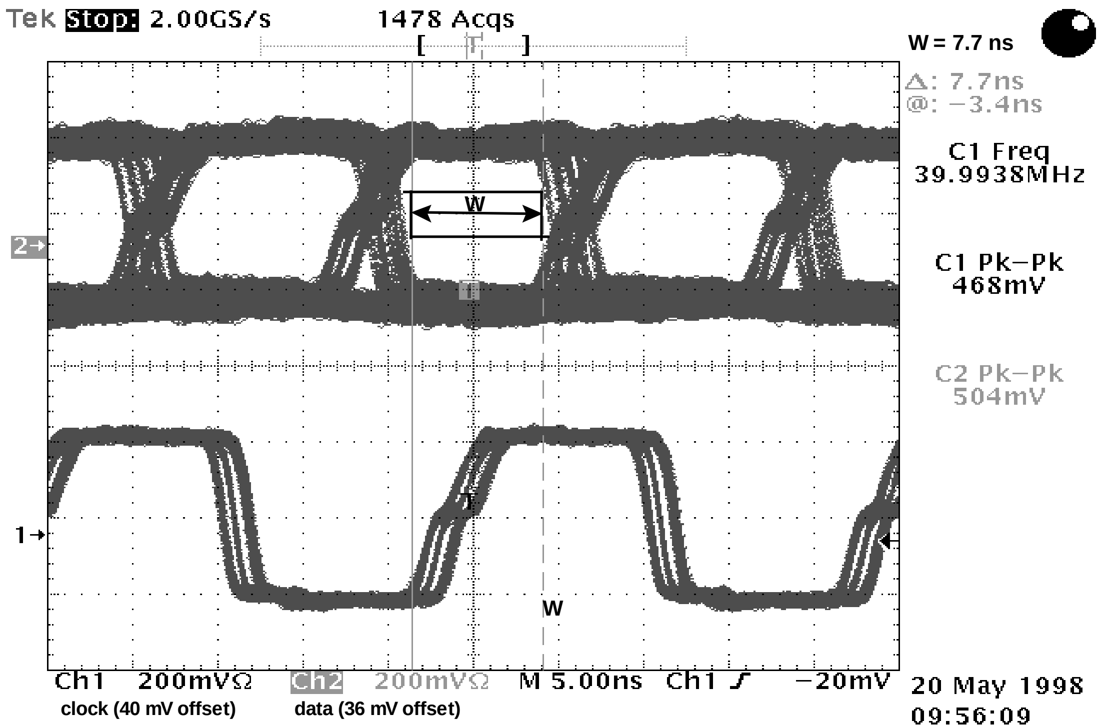
"Eye pattern for 12 meter twist/flat cable and 15 loads"

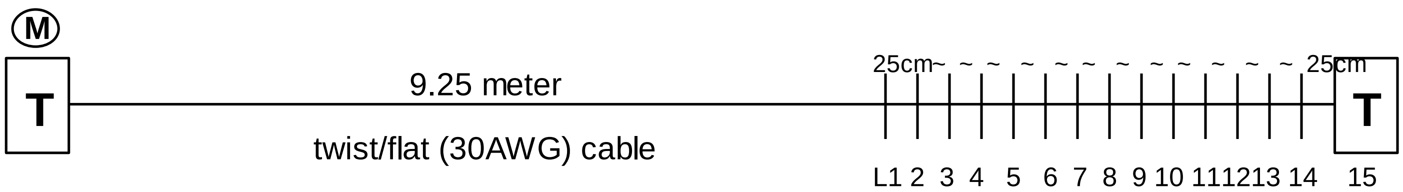
(trigger +/- 60 mV from center of clock)

Note: T is resistive termination

= 110 ohm

Low Drive



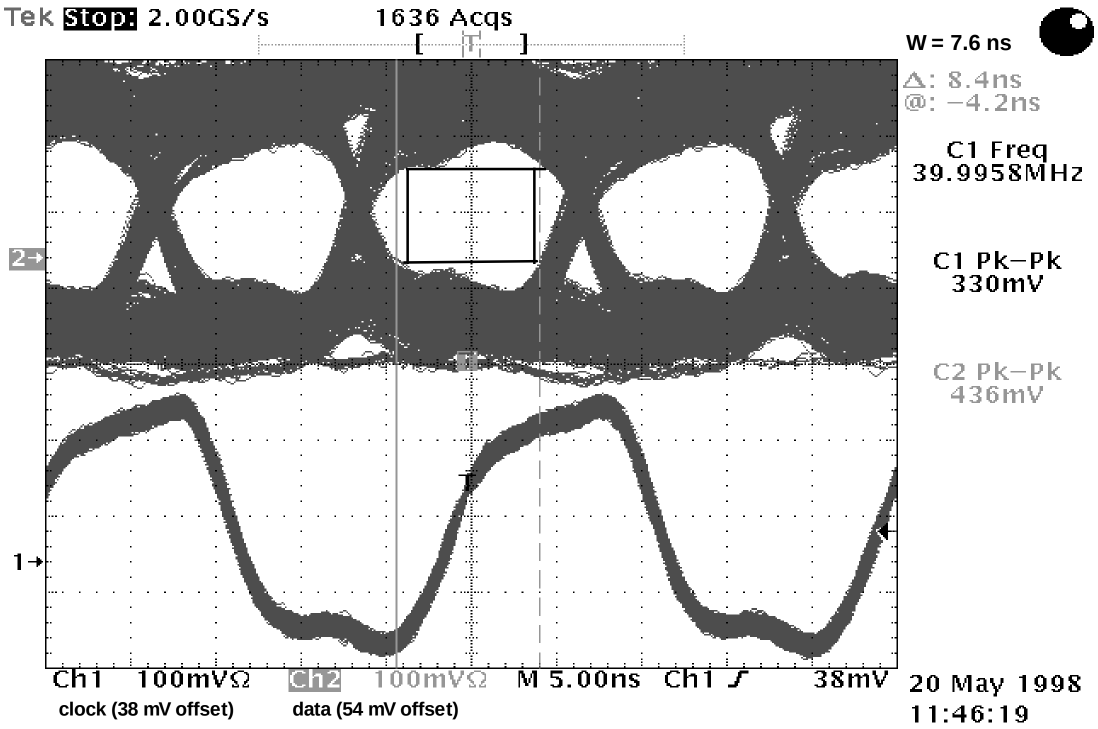


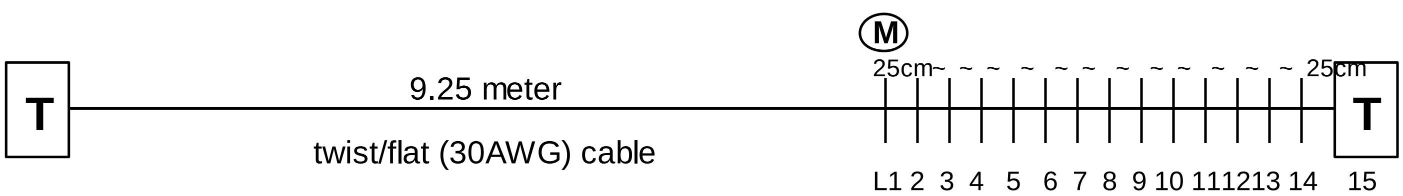
Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive



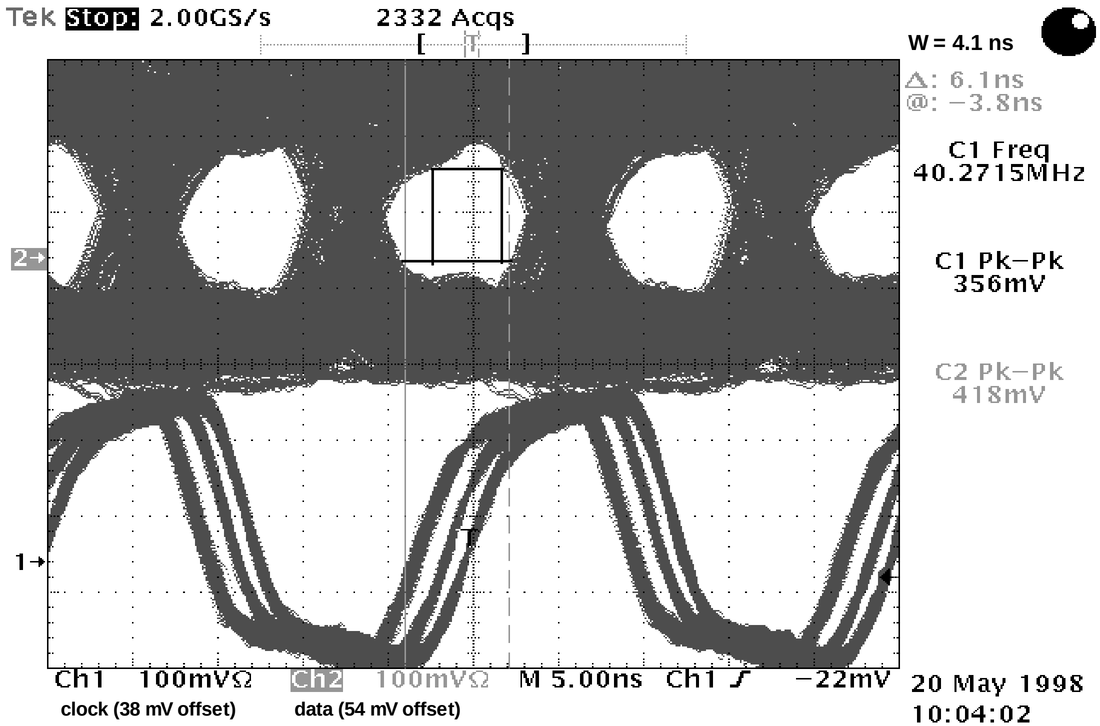


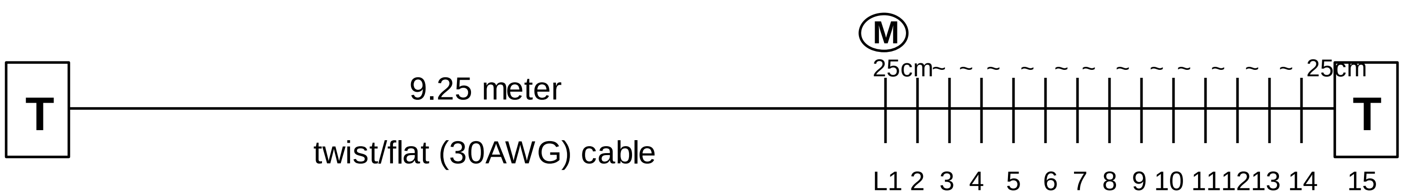
Note: reduced drive level

“Eye pattern for 12 meter twist/flat cable and 15 loads”

(trigger at center of clock)

Low Drive



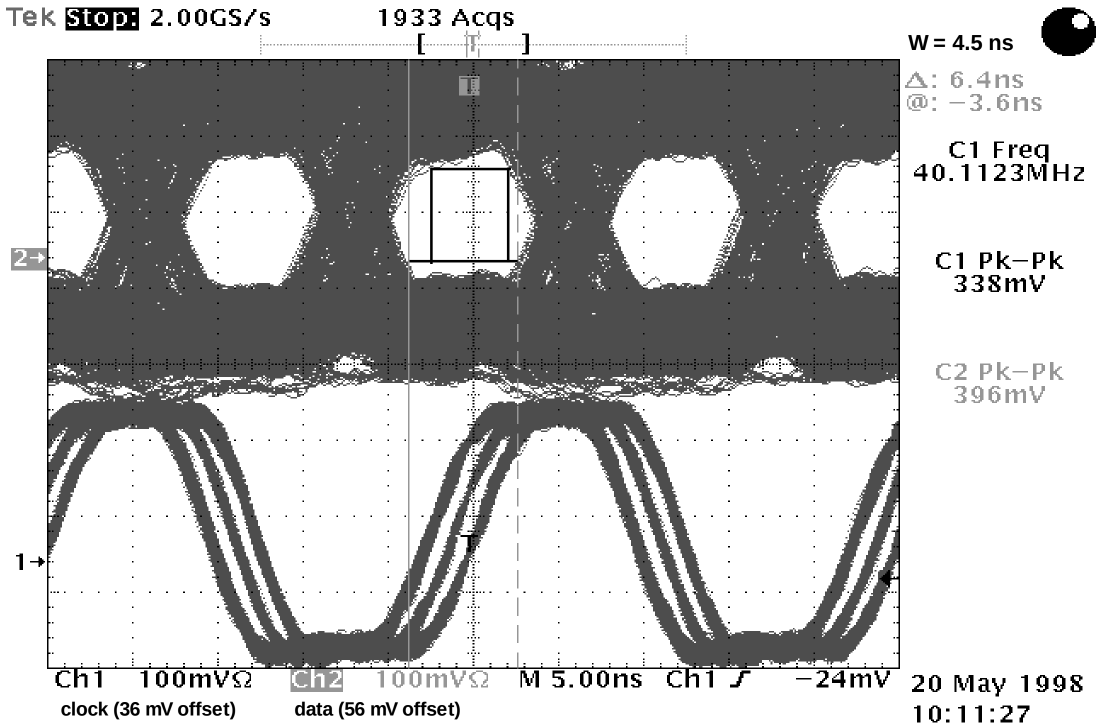


Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive

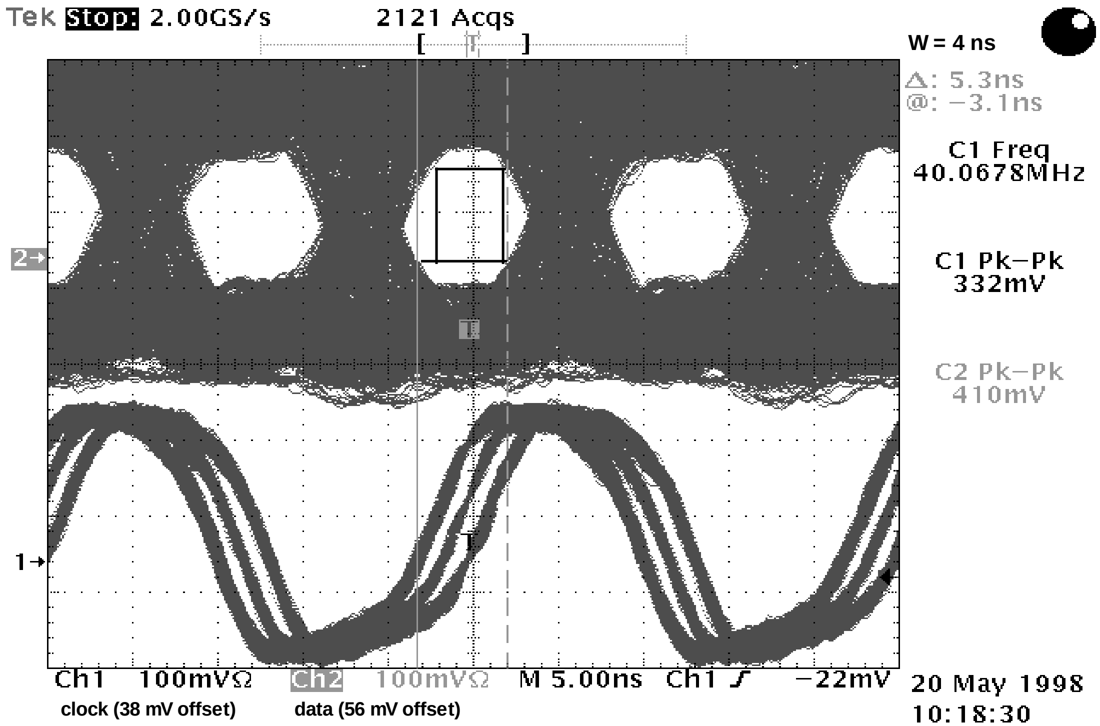


Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive

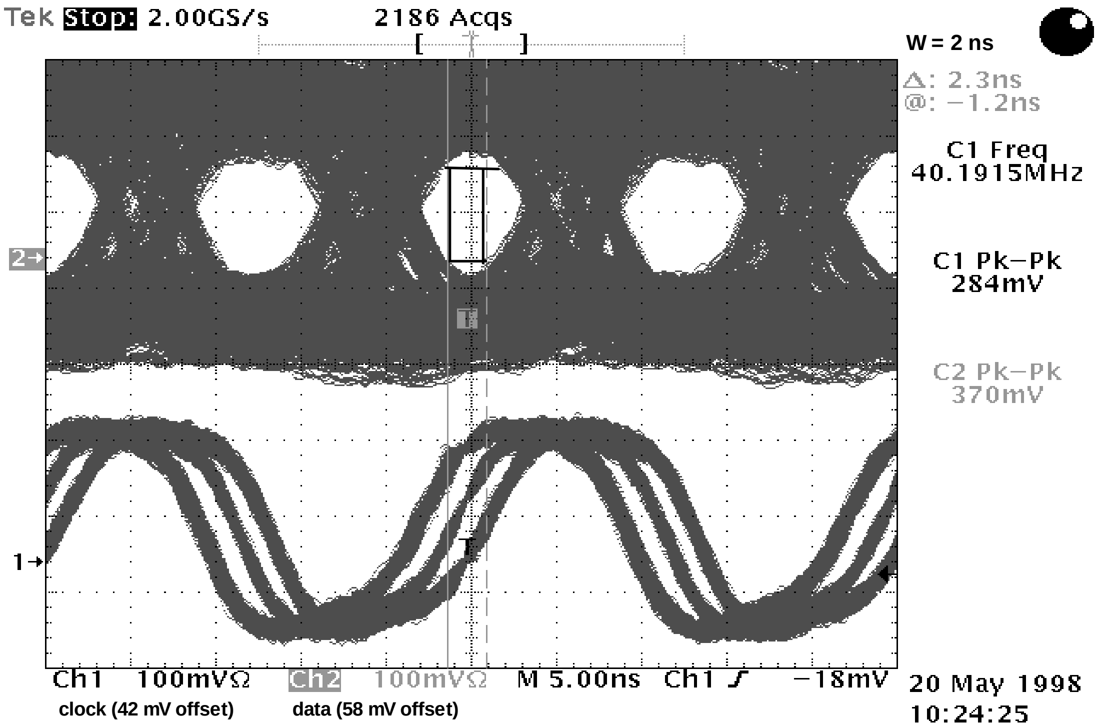


Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive

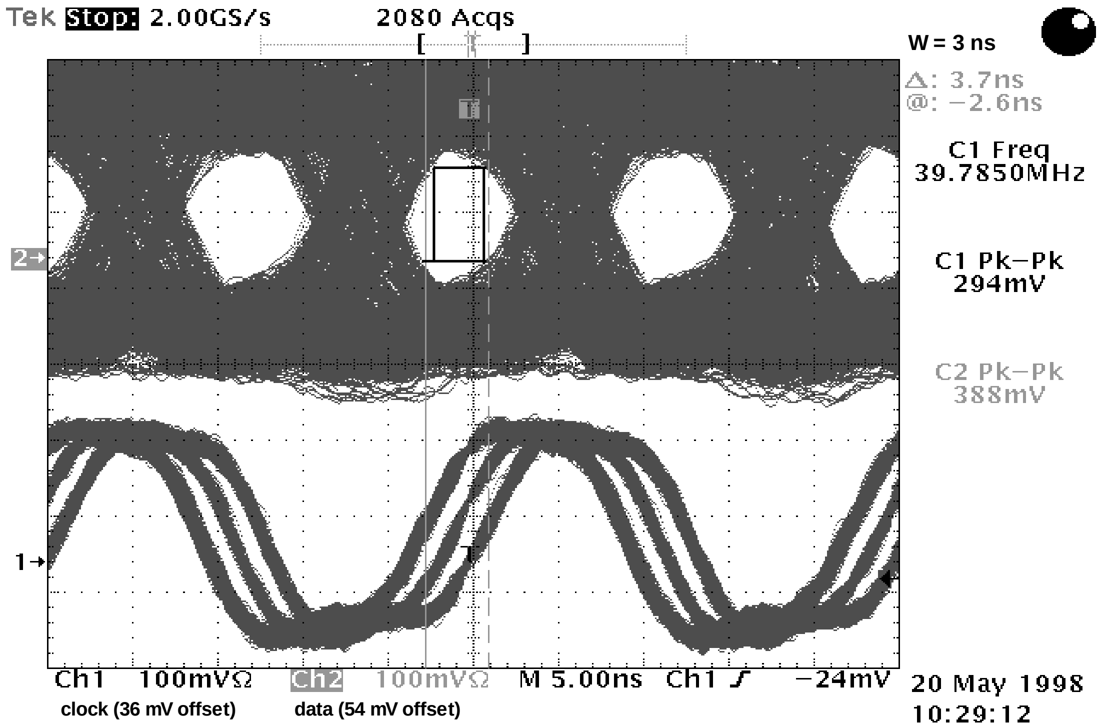


Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive

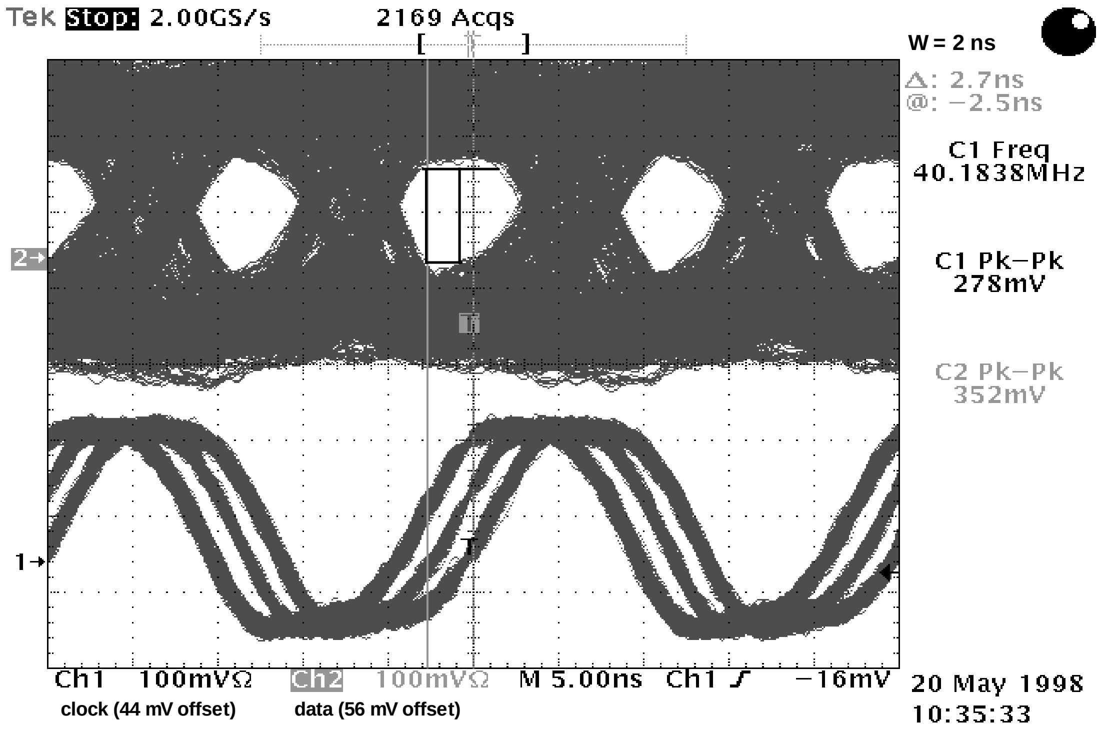


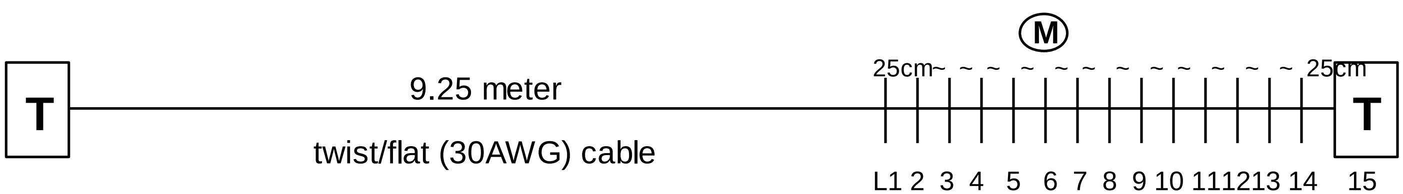
Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive



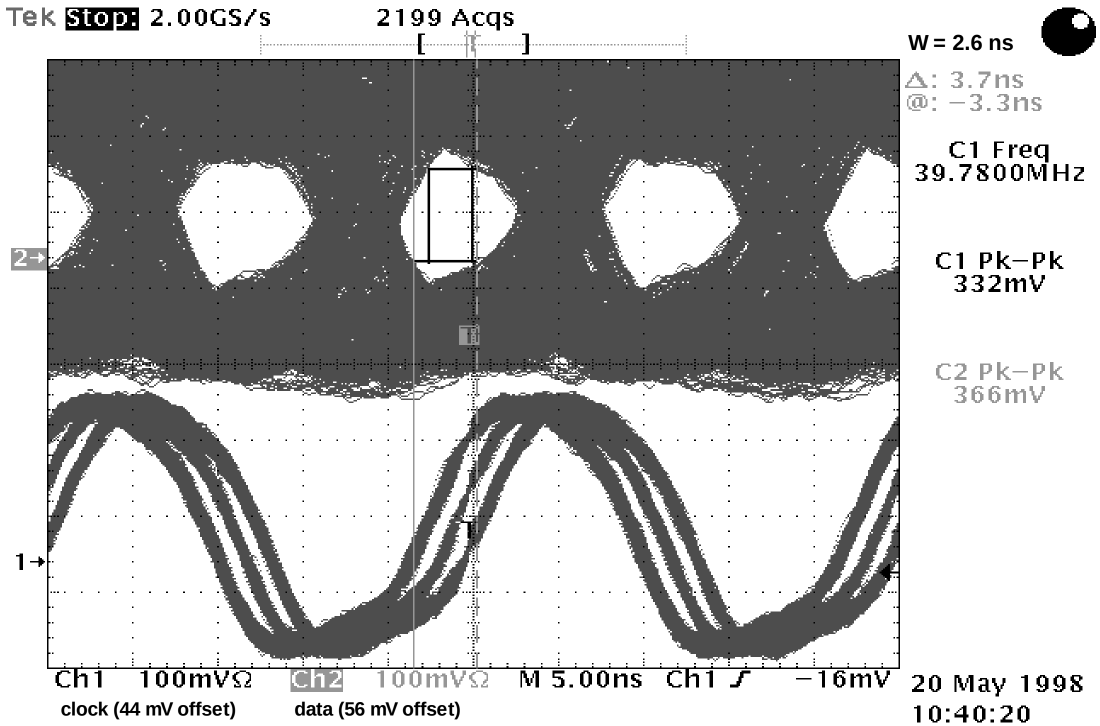


Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive

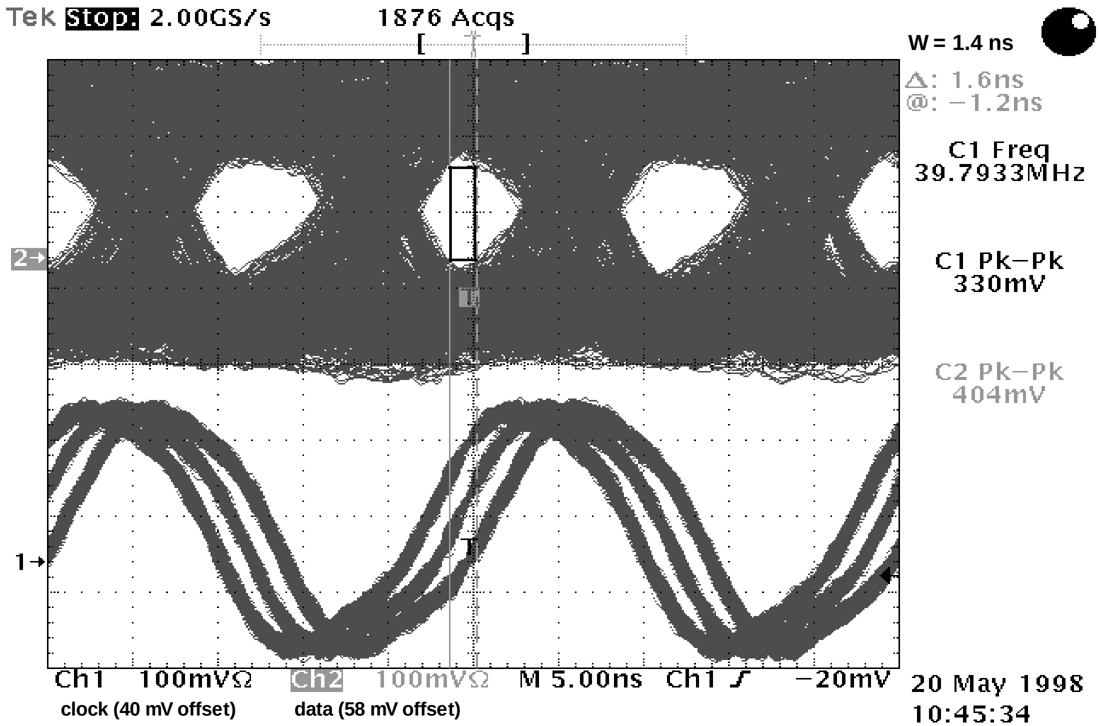


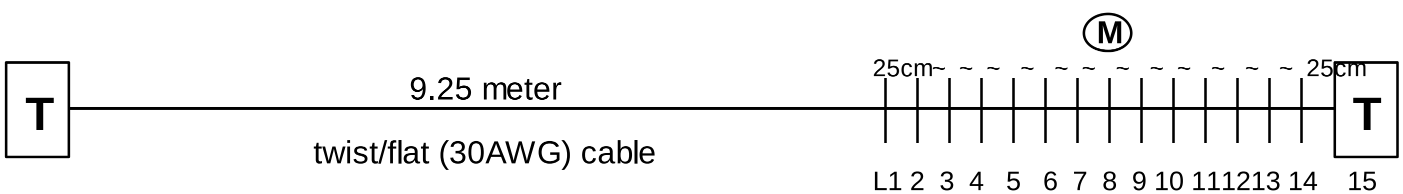
Note: reduced drive level

“Eye pattern for 12 meter twist/flat cable and 15 loads”

(trigger +/- 60 mV from center of clock)

Low Drive



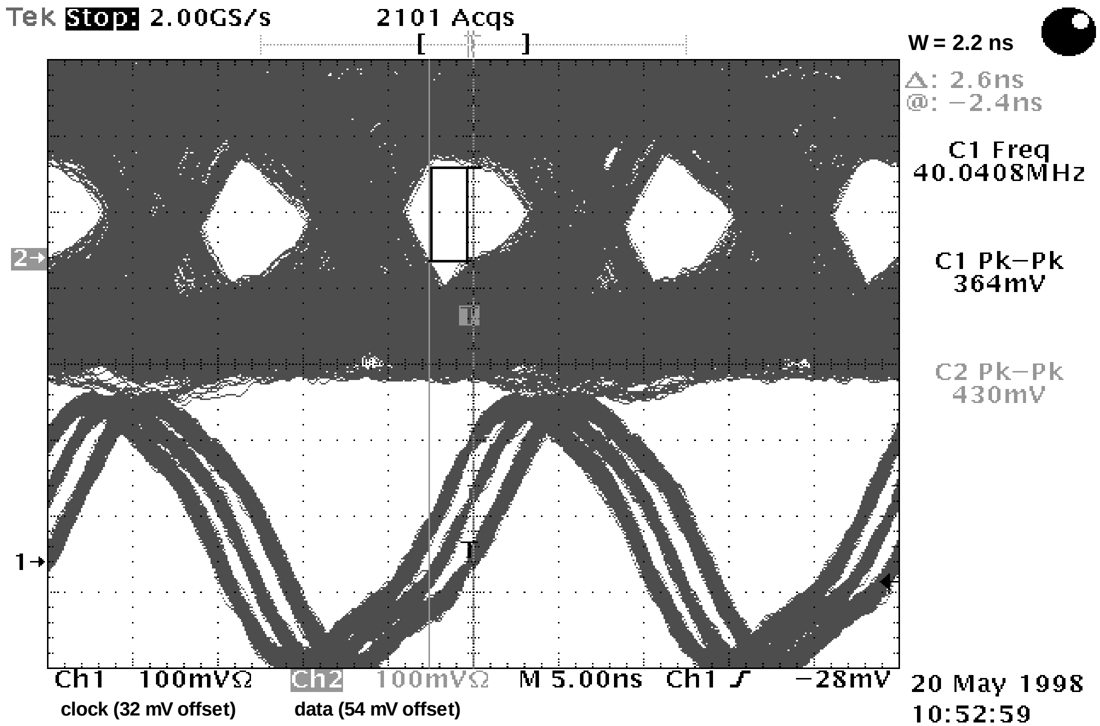


Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive

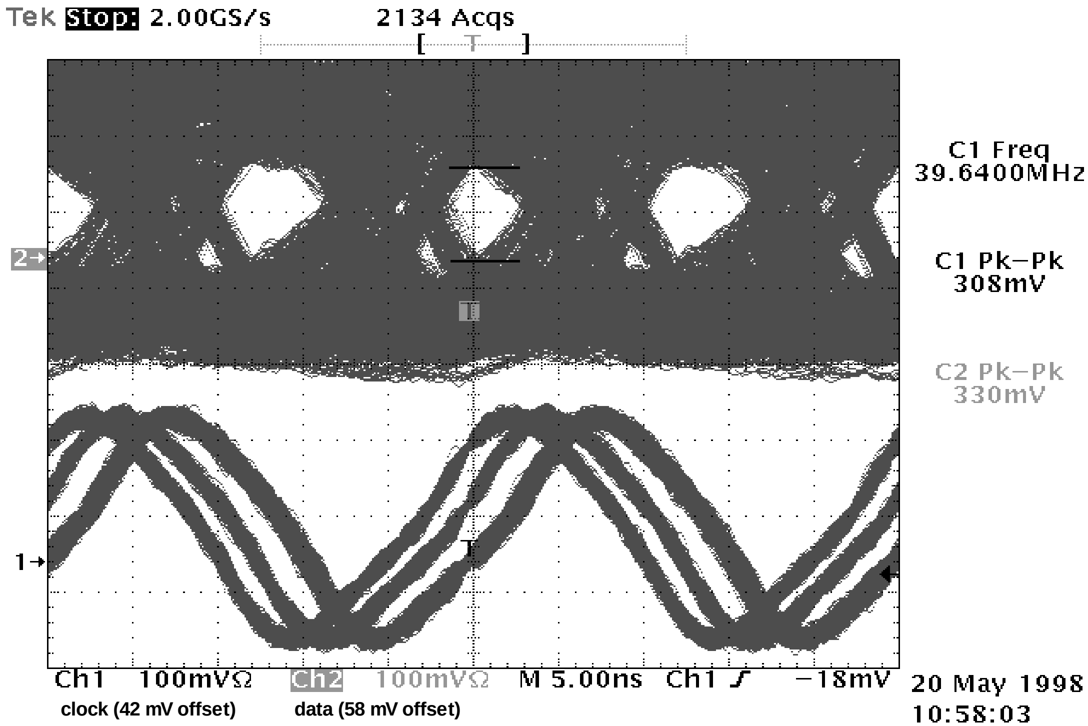


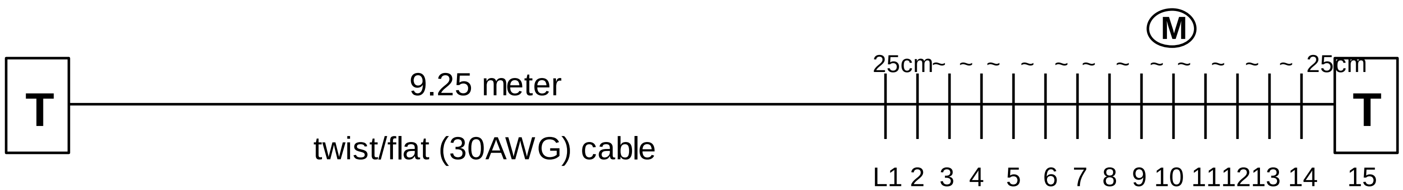
Note: reduced drive level

“Eye pattern for 12 meter twist/flat cable and 15 loads”

(trigger +/- 60 mV from center of clock)

Low Drive



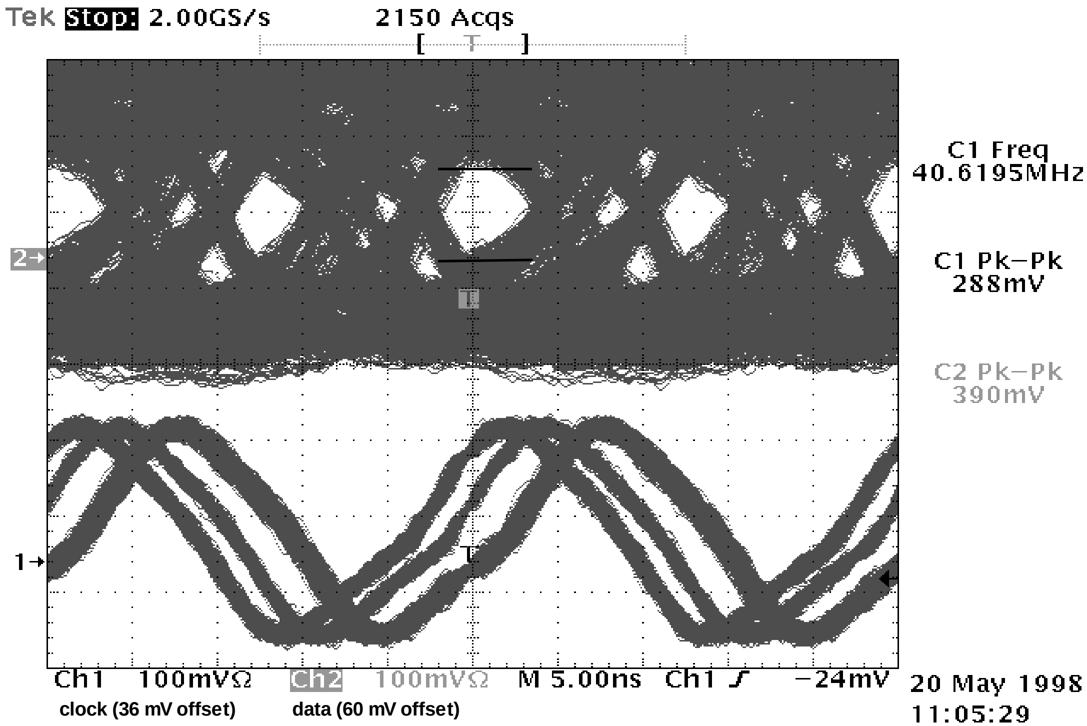


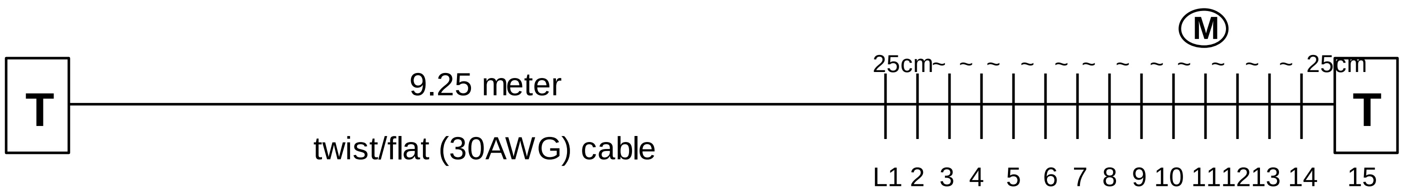
Note: reduced drive level

“Eye pattern for 12 meter twist/flat cable and 15 loads”

(trigger +/- 60 mV from center of clock)

Low Drive



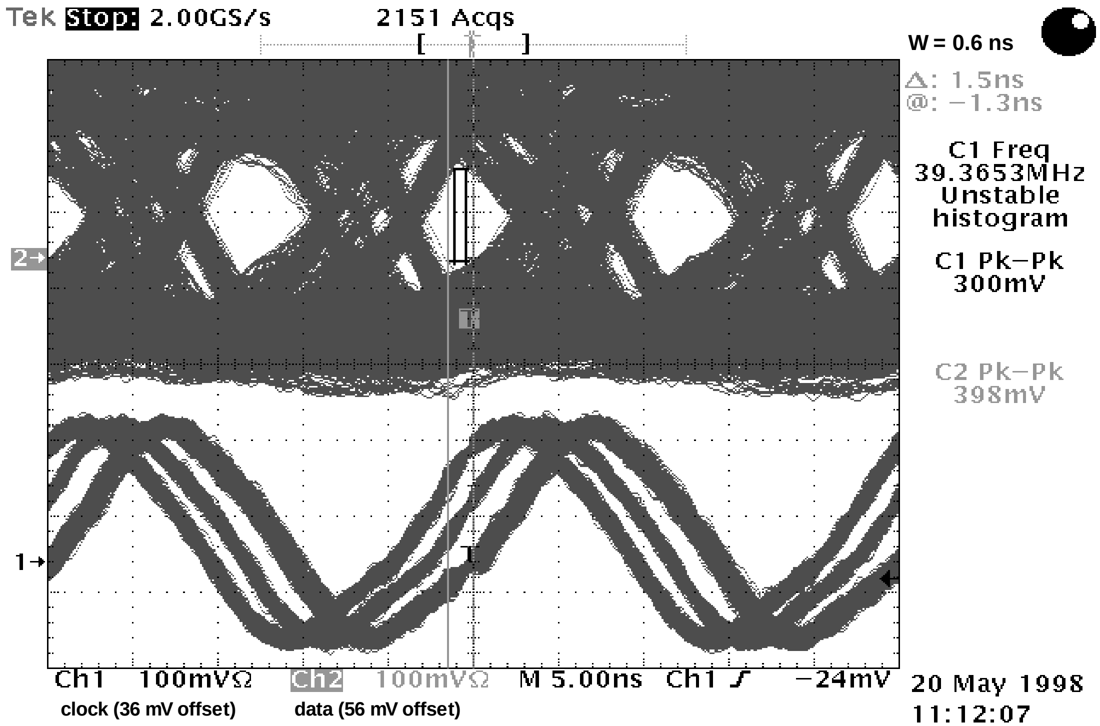


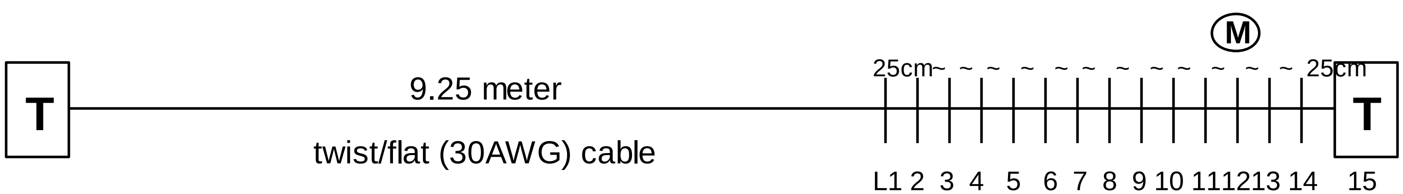
Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive



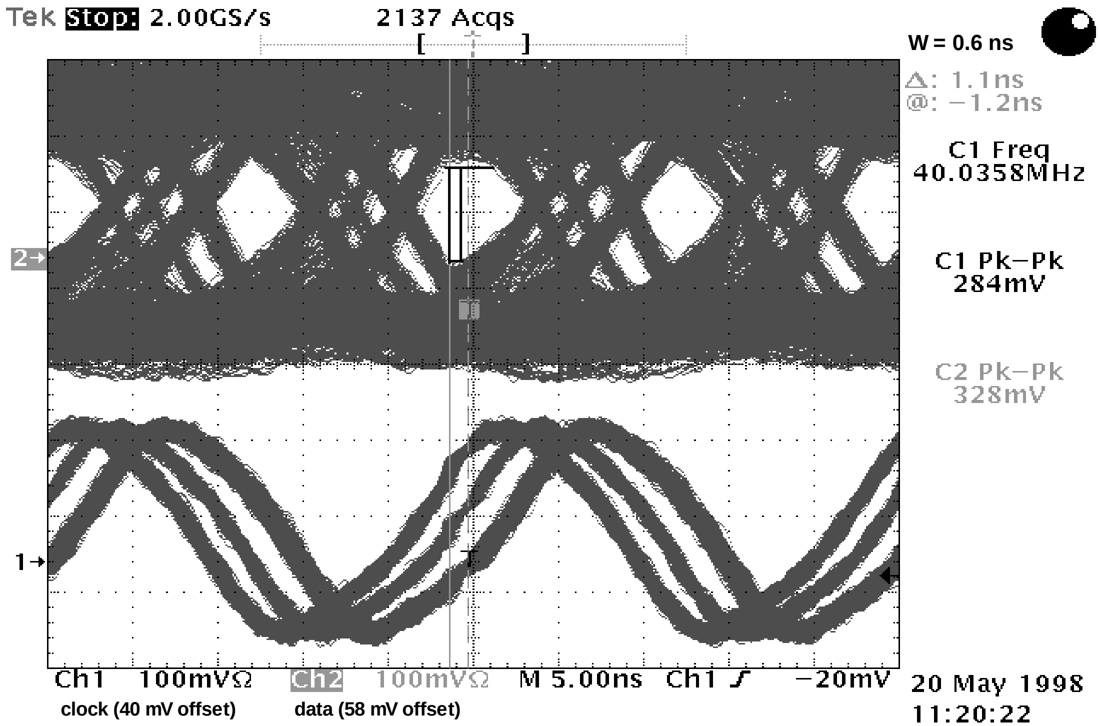


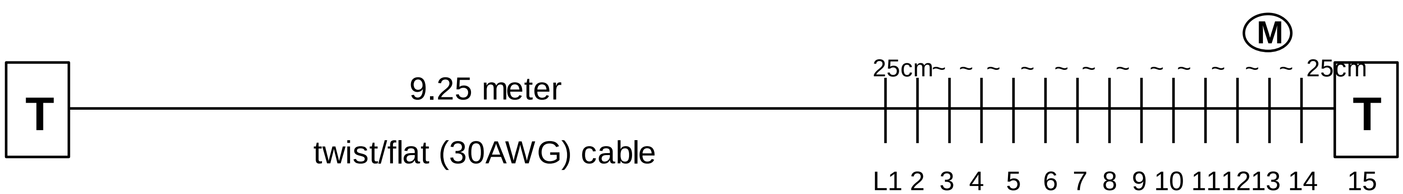
Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive



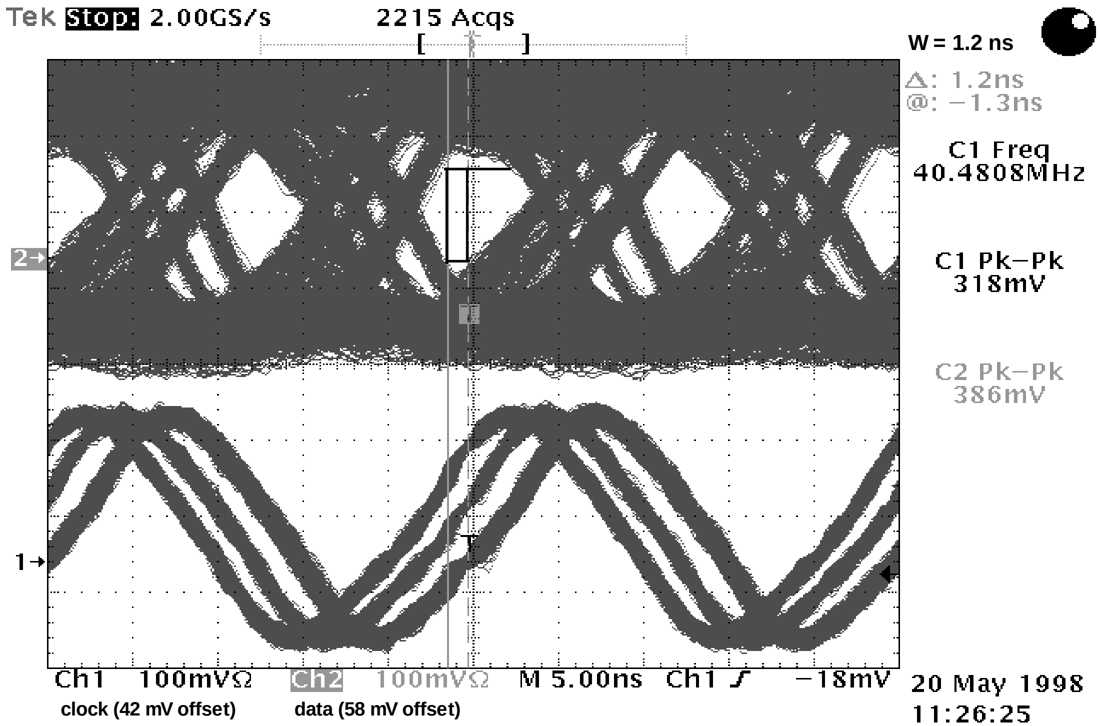


Note: reduced drive level

“Eye pattern for 12 meter twist/flat cable and 15 loads”

(trigger +/- 60 mV from center of clock)

Low Drive

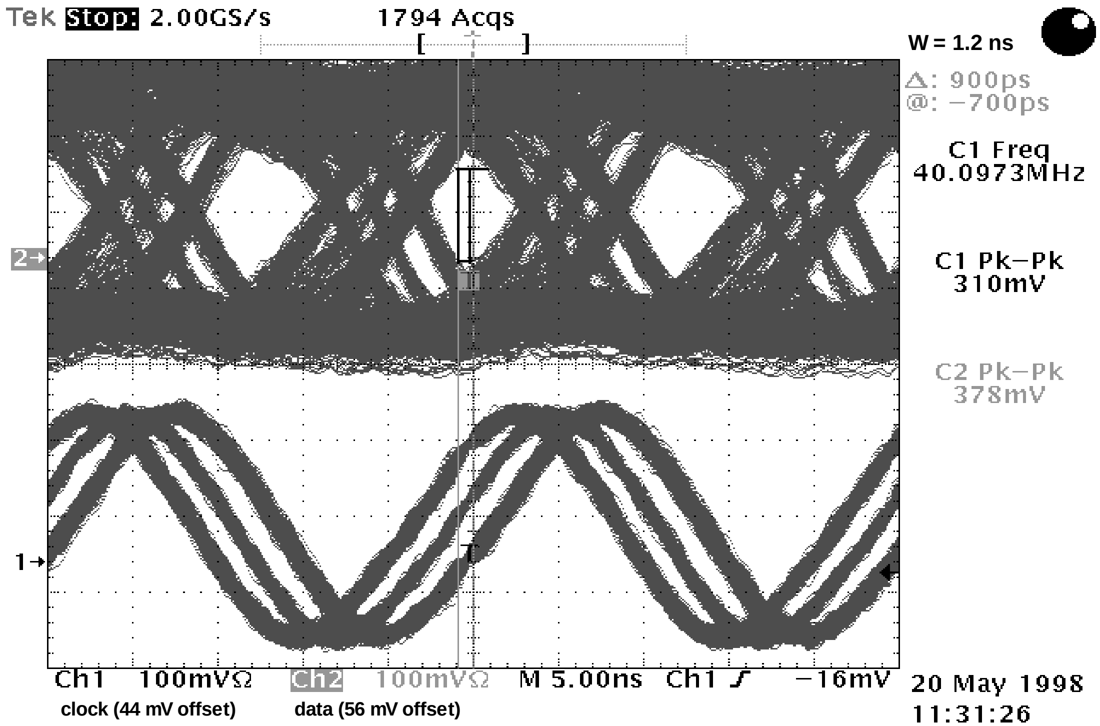


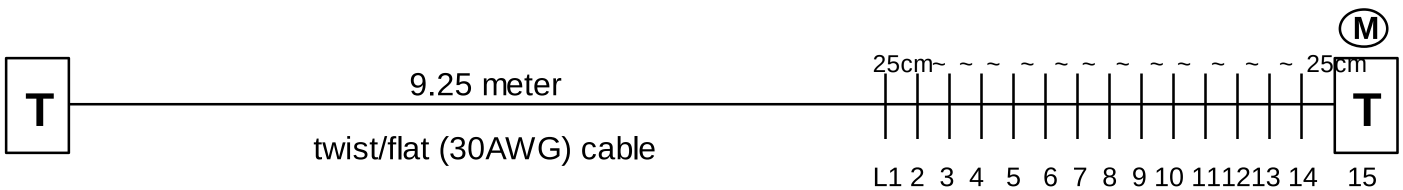
Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Low Drive





Note: reduced drive level

"Eye pattern for 12 meter twist/flat cable and 15 loads"

(trigger +/- 60 mV from center of clock)

Eye opening average value:

High Drive Board	**8.36 ns**
Low Drive Board	**2.26 ns**

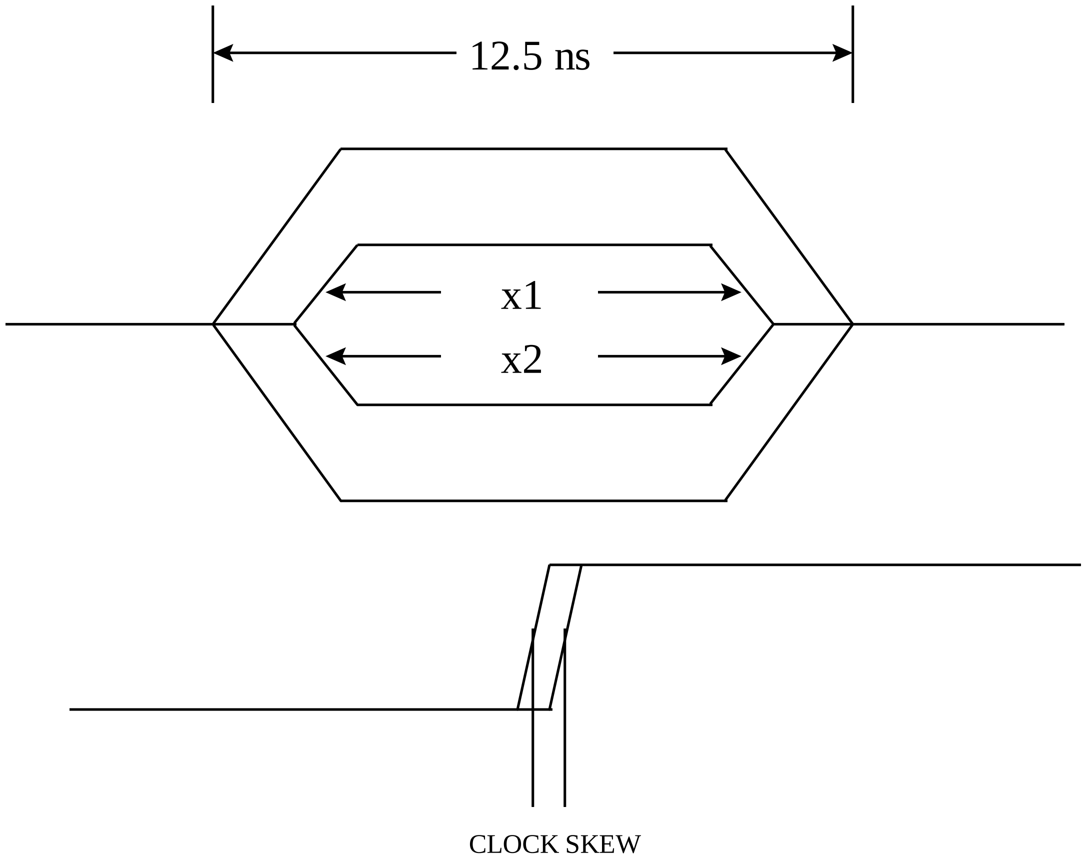
Minimum eye opening:

High Drive Board	**7.5 ns**
Low Drive Board	**0.0 ns**

SUMMARY

- High drive level shows decent eye pattern.
- Drive level is important when reflections and ISI are present.
- More sensitive receiver would provide more margin.
- Offset balance becomes more of an issue.
- Driver level equalization determines how much of the eye is usable.
- Equalization (ISI compensation) at transmitter should improve patterns.

MARGIN

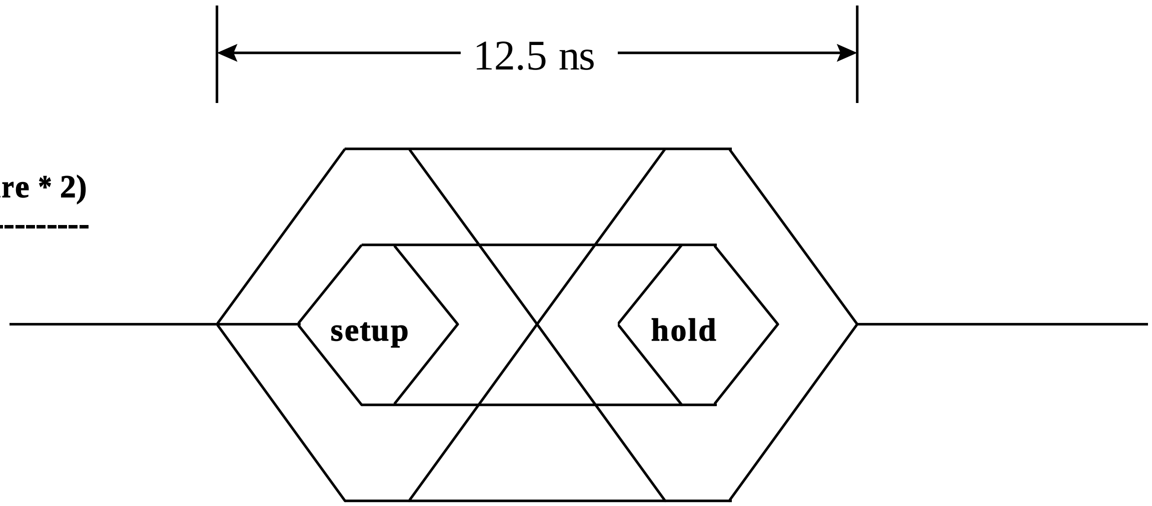


But in SCSI both the data and clock (REQ/ACK) are pseudo random.

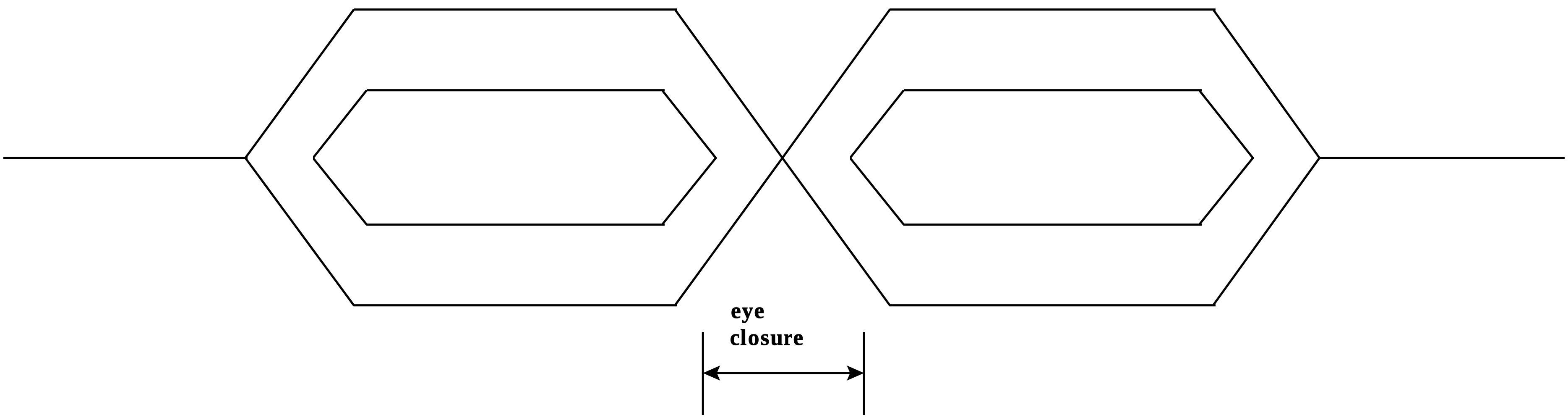
MARGIN

margin = period - (eye closure * 2)

$$\text{margin} = \frac{\text{period} - (\text{eye closure} * 2)}{2}$$



Does not include RCV, cable skew and FF.



MARGIN

$$\text{margin} = \frac{\text{period} - (\text{eye closure} * 2)}{2}$$

Example eye closure = 4.14 ns

$$\text{margin} = \frac{12.5 - (4.14 * 2)}{2}$$

margin = 2.11 ns

This 2.11 needs to cover cable skew (1.2 ns), RCV, and FF (setup or hold)

Pseudo-random mode of the clock is a big unknown.

ISSUES

ISI on both data and clock caused by NRZ data and non-regular clock.

Non-zero cancellation of the bias on the bus.

Cable skew increases with distances.

POSSIBLE SOLUTIONS

Use ISI compensation techniques to control ISI distortion on both data and clock.
Increased drive levels.
Feedback cancellation of the bias at the receiver.
Use circuit to cancel out cable skew.
Use scheme that provides a regular clock period.
Encoding of the data to decrease ISI problems.

NAME	B/Sec (16 bit)	MHz	Technique
Fast40	80	40	Single Edge clocking / LVD with bias cancelled by asymmetric drive.
Fast80	160	40	Above plus / Dual Edge Clock / ISI compensation of data and Clock / higher min drive level / auto zero offset
Fast160	320	80	Above plus, / free running clock / auto cable deskew using training sequence.
Fast320	640	160	Above plus / encoding of data / reduced length.

ISI COMPENSATION (Equalization)

Being implemented in serial links today.

Can equalize either transmitter or receiver (National has receiver part, CLC014).

Lot of analysis and research available.

Easy to implement in transmitter. Can be very complex or simple.

ISSUES

How well would it work on NRZ data (serial links have limited frequency band due to encoding versus NRZ which from DC)?

Would a fairly simple equalization scheme be effective since we have 20 lines to deal with?

References to look at:

Transmitter Equalization for 4Gb/s Signalling
http://csl.Stanford.EDU/~billd/ OR ftp://ftp.ai.mit.edu/pub/cva/hot_i.ps.Z

Slides to go with above paper:
Interconnections with High-Speed Digital Systems conference
http://soliton.ucsd.edu/ihsds/santafe97/index.html
then: postscript file, John Poulton, UNCC, "Multi-gigabit ...
or http://soliton.ucsd.edu/ihsds/santafe97/slides/gbcmos_poulton.ps

Web site showing the test results for the above papers:
http://www.cs.unc.edu/~fast_links/ AND http://www.cs.unc.edu/~fast_links/results.html

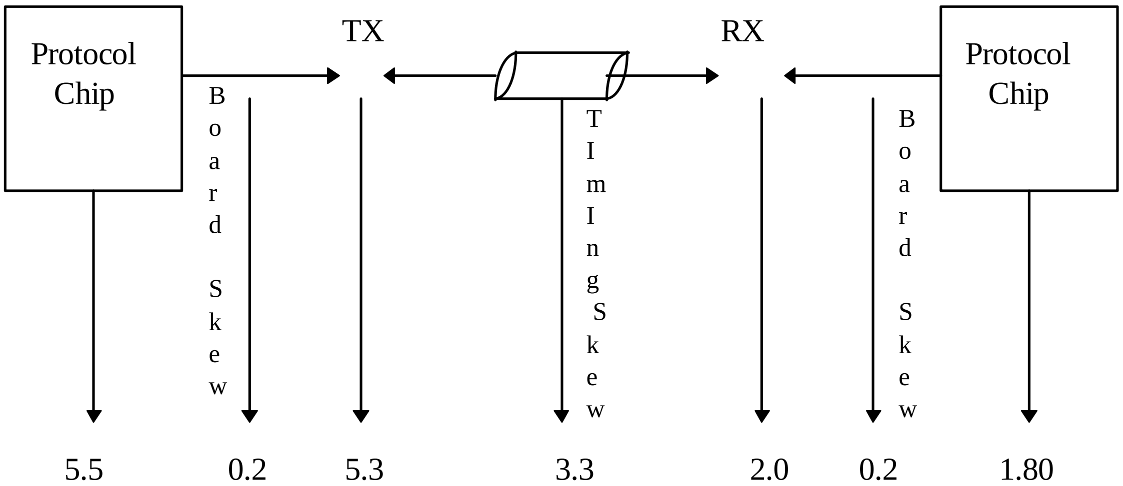
One other paper on subject (not found on a web site):

FP 15.1: A 1.0625Gbps Transceiver with 2x-Oversampling and
Transmit Signal Pre-Emphasis, ISSCC97, pages 238-239 &464,
A Fiedler et al.

SCSI TIMING VALUES FOR FAST80

*Receive Minimum Edge to Edge	9.0
Receive Hold Time	1.8
Receive Setup Time	1.8
Receive Period Tolerence	0.75
Signal Timing Skew	3.2
System Deskew Delay	4
*Transmit Minimum Edge to Edge	11.0
Transmit Hold Time	5.5
Transmit Setup Time	5.5
Transmit Period Tolerence	0.75

***These two items are called Receive Assertion Period and Transmit Assertion Period on Single edge clocking systems. These are redefined as above for dual edge systems.**



Signal timing skew includes cable skew and signal distortion skew.

Distortion skew includes ISI (intersymbol interference) and signal crossing time through the receiver detection range.

Timing is done for internal transmitter and receiver only.