



## Direct-Attach 4X and 12X Cable Assemblies

Test 500

JF Sawdy, Manager, Signal Integrity Engineering, added 30 awg 8/15/06

### Samples Tested

Type	Wire size (awg)	Length (meters)	Equalized
4X	24	8.5	No
4X	26	7	No
4X	28	6	No
4X	28	0.5	No
4X	24	12.5	Yes
4X	26	9.5	Yes
4X	28	8.5	Yes
12X	28	6	No
4X Angled	28	6	No
4X	30	2	No

### Test Equipment

Tektronix CSA803C Digital Sampling Oscilloscope with SD24 TDR Sampling Heads

Anritsu MP1701B Pattern Generator

atSpeed's *Oculus eXtractor*<sup>TM</sup> software for S-parameter extraction from TDT measurements

Meritec Test Boards #601192 Rev.B and C (2X trace risetime is 36psec)

### Scope of Testing

The following time domain measurements were made:

Impedance, eye pattern, NEXT and FEXT

The following S-parameter measurements were made:

Insertion Loss, NEXT, MDNEXT, ELFEXT, MDELNEXT

*Notes: all risetimes in this report are measured at 20 to 80%*

*"IB specs" refers to InfiniBand<sup>TM</sup> Trade Association Architecture specification requirements for copper cabling*

### Results

**Impedance** of male connector- 92 to 105 ohms @ 100 psec risetime  
(IB specs: 90 to 110 ohms)

#### NEXT (worst case for all lengths and wire sizes)

Risetime (20-80%)	100ps (%)	40ps (%)
1 <sup>st</sup> neighbor	0.60	1.30
2 <sup>nd</sup> neighbor	0.09	0.50
3 <sup>rd</sup> neighbor	0.05	0.35
4 <sup>th</sup> neighbor	0.04	0.33
QAAAA	0.78	2.48
AAQAA	1.38	3.60

(IB specs: less than 4% @ 100psec risetime)

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**FEXT @ 100 psec risetime**

	½ meter	6 meter
	%	%
1 <sup>st</sup> neighbor	0.50	0.12
2 <sup>nd</sup> neighbor	0.12	0.05
3 <sup>rd</sup> neighbor	0.07	0.03

(IB specs: not specified )

**Eye Pattern @ 2.5 Gb/s**

	Height at 0.5 UI (mv)	Width (psec)
All unequalized samples	>316	>300
All equalized samples	>316	>350

(IB specs: min. height = 316mv; min width 300psec with 1 volt p-p source)

**Jitter @ 2.5 Gb/s**

	Width (psec)
All unequalized samples	<100
All equalized samples	<50

(IB specs: 100psec max.)

**Attenuation @ 1.25 GHz**

	Loss (dB)
All unequalized samples	<7.5
All equalized samples	<10

(IB specs: less than 10 dB)

**CX4 S-Parameter data @1.5625 GHz**

	CX4 Requires	½ meter 28 awg	6 meter 28 awg
	dB	dB	dB
Maximum insertion loss	16	0.92	7.8
Minimum return loss	12	20	20
Minimum NEXT	31.8	39.1	40.4
Minimum MDNEXT	29.8	39.0	40.3
Minimum ELFEXT	23.3	42.9	49.7
Minimum MDELFFEXT	21.1	42.7	46.5

Note: CX4 does not allow equalization

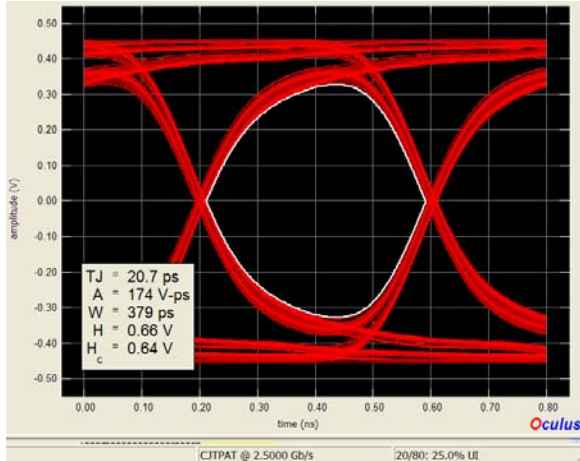
A longer unequalized 28 awg CX4 cable is feasible (~12 meters)

Note: The S-parameter testing is referenced to specification IEEE Draft P802.3ak/D5.3, November 13, 2003: "Amendment: Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4".

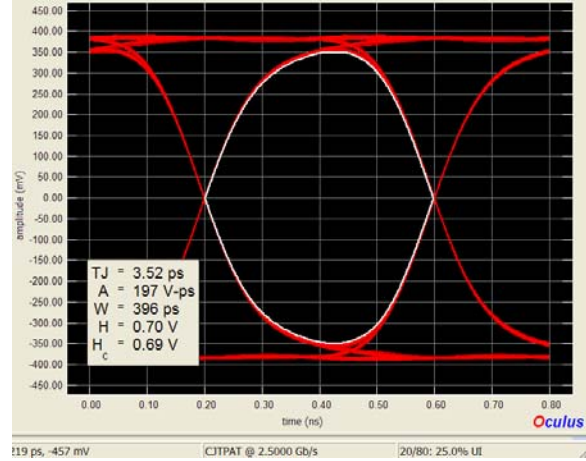
### Eye Pattern Diagrams for 30 awg assemblies @ 2.5 and 5.0 Gb/s based on S-Parameter Extractions

The source used in these simulations is 1000mv pk-pk, no jitter, CJTPAT bit pattern, 25%UI risetime (20-80%)

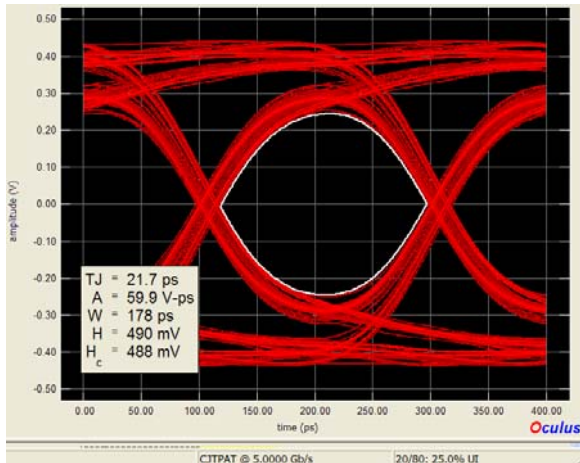
Note: the right-hand eye diagrams show that equalization in the form of passive components or in the driver/receiver silicon will significantly improve these eyes.



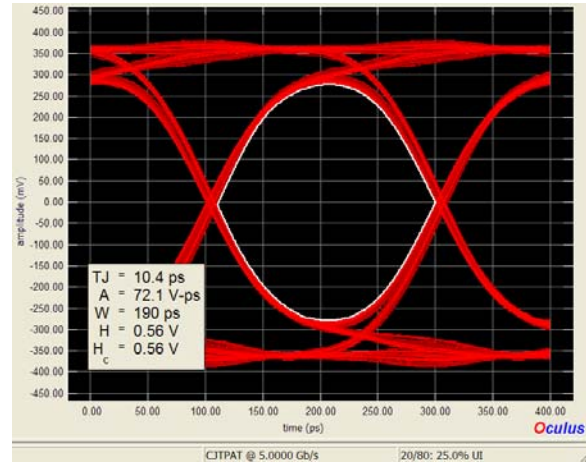
2 meter 30-awg unequalized assembly at 2.5 Gb/s data rate  
Jitter = 21psec  
Eye height at 50%UI = 640mv



2 meter 30-awg equalized assembly at 2.5 Gb/s data rate  
Jitter = 3.5psec  
Eye height at 50%UI = 690mv

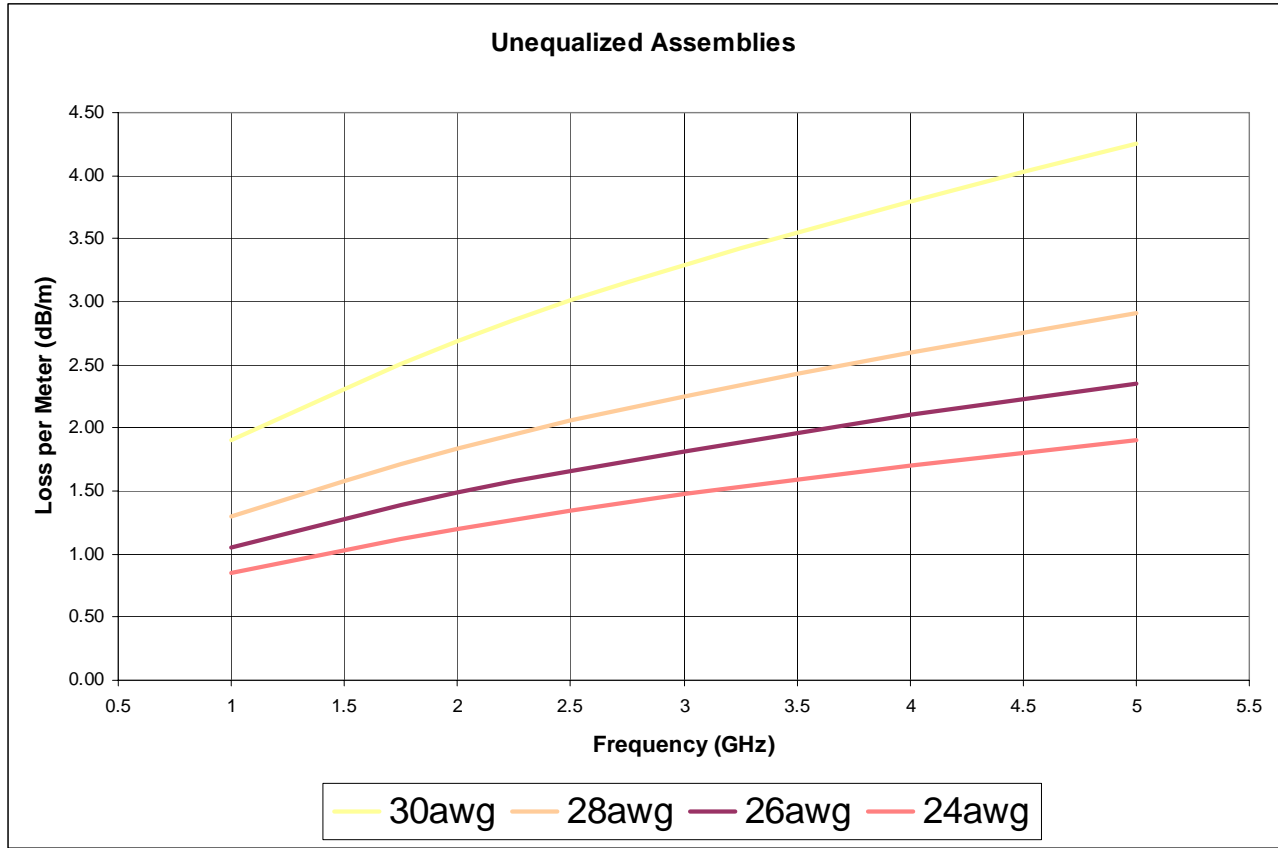


2 meter 30-awg unequalized assembly at 5.0 Gb/s data rate  
Jitter = 22psec  
Eye height at 50%UI = 488mv



2 meter 30-awg equalized assembly at 5.0 Gb/s data rate  
Jitter = 10.4psec  
Eye height at 50%UI = 560mv

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### Loss per Meter Chart

This graph shows the Loss per Meter of Meritec's 4X and 12X cable assemblies for our four standard wire sizes. This chart is useful for those standards that specify S21 Attenuation limits at a specific frequency. To calculate the loss for a particular application, select the frequency of interest on the X-axis. Find the corresponding loss per meter on the Y-axis. Multiply the loss per meter times the desired cable length in meters. The result represents the total loss of the assembly at the frequency of interest.

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