SCSI-2 Cable Testing Report

(Low Density Flat Cables and Round Cables)

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1.0 SCOPE

The intent of the following tests was to compare a new generation of high density SCSI-2 cables, connectors, and terminators against their predecessors from the SCSI-1 era. The goal was to determine whether the new family of SCSI-2 accessories will satisfy some of the reliability criteria of the SCSI specification and of Sun systems. The first step taken was to test configurations with full length cables (6 meters = 20 ft), and with one to two drives attached to the SCSI bus. The next step was testing the maximum configurations with full length cables and eight devices attached to the bus (ID = 0 .. 7).

2.0 STRATEGY

High density shielded cables 100 ohms and 70 ohms were used and interconnected to an overall length of 6 meters. Then they were measured and compared to a single piece low density nonshielded flat cable of a similar length. The total length of the SCSI bus exceeded the maximum length of 20 ft defined by the SCSI specification in order to create the worst case one drive situation. The termination power was supplied from the initiator over the whole cable length to support the worst case notion of a real system with full length cables, and two drives attached to the SCSI bus. The termination power was supplied from a separate power supply over the whole cable length for the maximum configuration with full length cables and eight devices attached to the bus to determine margins of a fully loaded system with different cables.

The measurements consisted of both the synchronous and the asynchronous transfers, and were conducted in two different ways. One part was examining the signal waveforms of *REQ-* and *ACK-* for reads and then writes. The other part of the task was running long term reliability tests by checking the integrity of data. This was done by write-read-verify scheme mostly through overnight tests guaranteeing that the number of bits transferred across the bus was higher than $> 10^{11}$ for each case.

3.0 EQUIPMENT USED

1) HP 54111D Digitizing Oscilloscope

2) HP Paint Jet

3) HP 6259B Power Supply

4) Tektronix 2465 Oscilloscope 300MHz

5) Tektronix Oscilloscope with 7A12 TDR Module

6) Tektronix C-5C Oscilloscope Camera

7) Gould K450B Logic Analyzer with Printer

8) Ancot DSC-202 SCSI-bus Analyzer with printer

9) Different Sun Systems

4.0 GLOSSARY OF TERMS AND SIGNALS

SCSI device A host computer adapter or a peripheral controller or an intelligent peripheral that can be attached to the SCSI bus.

SCSI ID The bit-significant representation of the SCSI address referring to one of the signal lines.

initiator A SCSI device (usually a host system) that requests an operation to be performed by another SCSI device

target A SCSI device that performs an operation requested by an initiator.

Terminating power 4.25 volts dc to 5.25 volts dc

Input characteristics signal true 0.0 volts dc to 0.8 volts dc
signal false 2.0 volts dc to 5.25 volts dc

REQ- **Request** is a target signal indicating a request for *REQ/ACK* data transfer handshake.

ACK- **Acknowledge** is an initiator signal to indicate an acknowledgment for a *REQ/ACK* data transfer handshake.

5.0 TESTING RESULTS

Asynchronous / Synchronous Transfers (1 Initiator and 1 Target)

CABLE	Read-Write-Verify > 10^{11} bits		Termination Power $\frac{V_I \ / \ V_T \ [V]}{\text{Voltage Drop [V]}}$	TDR [ohm]
	asynch.	synch.		
High Density 100 ohm	passed with no errors	passed with no errors	4.49 / 4.26 ——— 0.230	75
High Density 70 ohm	passed with no errors	passed with no errors	4.50 / 4.28 ——— 0.220	50
Low Density 105 ohm	passed with no errors	passed with no errors	4.52 / 4.37 ——— 0.150	100

Table 1

Table 1 shows that all cables passed the reliability test of transferring and verifying more than 10^{11} bits of data across the SCSI bus with one initiator and one target. The termination power was supplied from the initiator and measured at both the initiator (V_I)and the target (V_T) terminator side to make sure that it is within the specification range. The voltage drop was measured across the cable length of 20 ft and is the difference between the termination power voltage at the initiator side and the far end target side.

Time-domain reflectometry (TDR) measurements confirmed the impedance of the unconnected cables as specified by the manufacturers. However, the real impedance

changes once the devices and / or their adapters are connected to the bus by connecting the ground pins of the cable together. The real TDR values were measured to show that the high density cables are influenced the most by this. Impedance changes of up to 25 ohms were recorded.

Asynchronous / Synchronous Transfers (1 Initiator and 2 Targets)

CABLE	Read-Write-Verify > 10^{11} bits		Test TermPwr asynch. / synch. V_T [V]	Failing TermPwr asynch. / synch. V_T [V]	TDR [ohm]
	asynch.	synch.			
High Density 100 ohm	passed with no errors	passed with no errors	4.25 / 4.25	< 3.25 / < 3.95	75
High Density 70 ohm	passed with no errors	passed with no errors	4.25 / 4.40	< 3.65 / < 4.25	50
Low Density 105 ohm	passed with no errors	passed with no errors	4.25 / 4.25	< 3.00 / < 3.50	100

Table 2

Table 2 shows that all cables passed the reliability test of transferring and verifying more than 10^{11} bits of data across the SCSI bus with one initiator and two targets, as shown in Figure 1. The high density 70 ohm cable failed to pass the reliability test with the minimum value of the termination power of 4.25 volts at the far end as the SCSI specification defines it. The test termination power voltage had to be raised to 4.4 volts to guarantee reliable operation in the synchronous mode. The failing *TERMPWR* voltage was measured at the far end target terminator by lowering this voltage until the system under operation failed.

Configurations 2 and 3 were used to test out the behavior of the high density terminator. The configuration 2 used the resistor pack TR to terminate the drive T1. In the configuration 3, the high density terminator TH terminated the drive from the outside adapter. The termination power was supplied from a separate power supply at the initiator side, varied and measured at both the initiator and the target terminator to make sure that it is within the specification range. The *REQ- / ACK-* waveforms for all the test cases are displayed in Figures 3 - 14.

Read and write waveforms were recorded at the same time but the differences between them

are so negligible that only the writes were chosen for this report. This reduced the number of pictures displayed for the sake of better readability. A comparison of writes across the cable measured at the initiator and at the far end side are shown on each page.

Asynchronous / Synchronous Transfers (1 Initiator and 7 Targets)

CABLE	Read-Write-Verify > 10^{11} bits		Test TermPwr asynch. / synch. V_T [V]	Failing TermPwr asynch. / synch. V_T [V]	TDR [ohm]
	asynch.	synch.			
High Density 100 ohm	passed with no errors	passed with no errors	4.28 / 4.60	< 4.28 / < 4.60	75
High Density 70 ohm	failed	failed	4.90 / out of range	< 4.90 / < 5.25	50
Low Density 105 ohm	passed with no errors	passed with no errors	4.24 / 4.26	< 3.66 / < 3.94	100

Table 3

Table 3 shows that with more drives on the cable (see Figure 2), the situation considerably changed as compared to the previous table. Actually, only the SCSI-1 low density cable with eight devices (1 initiator and 7 targets), and the termination power kept at its minimum as defined by the SCSI specification, passed the long term reliability test with no errors. The 100 ohm high density cable passes the asynchronous test with the minimum voltage, but for the synchronous test this voltage has to be raised to 4.6 Volts. The 70 ohm high density cable fails to pass the reliability test even with the maximum voltage of 5.25 Volts at the initiator side. It works unreliably in the asynchronous mode and fails completely in the synchronous mode.

The termination power was supplied from a separate power supply with variable voltage from the initiator side of the cable.

The *REQ- / ACK-* waveforms for all the test cases are displayed in Figures 15 - 26. The synchronous test with the 70 ohm high density cable failed, so these pictures are missing.

6.0 SUMMARY

The purpose of these measurements was to find out how reliably the shielded SCSI-2 cables can replace the existing low density nonshielded SCSI-1 ones. In the first approach, full length cables of both types were tested in configurations with one initiator (VME bus host adapter) and one target on the SCSI bus in asynchronous and synchronous transfer modes.

Table 1 shows that no errors were observed during the long term tests while transferring and verifying large amounts of data (> 10^{11} bits). All SCSI devices were single-ended and the terminating power was close to the minimum voltage as defined by the SCSI specification, but well within the allowed voltage range.

In the next step, a configuration with three devices, one initiator and two targets, was created. Table 2 shows that all configurations passed the long term reliability test but the termination voltage for the synchronous operation with the 70 ohm high density cable had to be raised to a minimum of 4.4 volts. For this case, Figures 3 - 14 satisfy the input characteristics as defined by the SCSI specification.

In the next round of measurements, a full blown configuration with maximum length cables and eight devices on the SCSI bus was utilized to complete this investigation. Table 3 shows that the 70 ohm cable failed in both asynchronous and synchronous modes of operation. The termination power voltage at the last target had to be raised to 4.9 volts (5.25 volts at the initiator side) to enable some operation in the asynchronous mode but the reliability test failed very quickly after several verification cycles. No operation was possible in the synchronous mode.

The *TERMPWR* voltage had to be raised to 4.6 volts in the synchronous mode of the high density 100 ohm SCSI-2 cable to assure reliable operation.

The low density SCSI-1 cable passed the reliability test with the fully loaded system at the minimum voltage of 4.25 volts at the last target as defined by the SCSI specification. Table 3 shows that this was the only case with enough margin for reliable operation.

The measured results indicate that we need to utilize SCSI-2 shielded high density round cables of a higher impedance to match the performance of SCSI-1 low density cables. Devices connected to the cable will lower its impedance by 25 - 30 ohms, so that a cable with a minimum 120 ohms will be desired to approach the performance of a SCSI-1 low density flat cable. An overall impedance of approximately 90 - 95 ohms of such a round cable configuration will provide enough margin for a reliable operation. Other means as low drop protection devices and separate termination power will only enhance this effort.

7.0 ACKNOWLEDGMENTS

I wish to acknowledge James Allen, Dexter Anderson, Rich Clewett, Roger Butler-Fielden, Jim Kahn, Allan Lancendorfer, Joe Miseli, Alex Pappas, Curt Ridgeway, Paul Rikkonen, Bob Snively, Pat Thurber, and Hao Tran for their help and valuable information in the preparation of this document. I would like to thank especially Tom Lane for continuous support during the measurements .

List of Vendors that Provided Test Samples

AMP Incorporated, Intercom Division, Harrisburg, PA

Robert Whiteman, Product Manager , (717) 780-7481
Charles Brill, Computer Standards, (717) 561-6198, FAX (717) 561-6179

- Furukawa 70 ohm shielded cable with AMP connectors
- High density terminators

Amphenol Corporation, Interconnect Products Division, Endicott, NY

Bill Sopchak, Product Manager, (607) 786-4307, FAX (607) 786-4311
Richard Somers, V.P., QuadRep Inc, (408) 432-3300

- C&M 100 ohm shielded cable with AMP and Honda connectors
- Passive and active terminators

Astro Wire and Cable, Worchester MA

Peter Blackford, Chief Engineer, (800) 447-1128, (617) 754-3281

- 100 ohm +-10 ohm shielded cable

Icontec Incorporated, Milpitas, CA - Manufacturing and assembly company

Allen Haigh, V.P., (408) 945-7766, FAX (408) 945-4360

- Cables designed and built by Icontec, 110 ohm +-10% differential impedance

Fujitsu Component of America, Inc. Santa Clara, CA

Joel Urban, Marketing Manager, (408) 562-1722, FAX (408) 727-0355
Bob Thornton, Product Engineer, (408) 562-1735

- Connectors, terminators and Furukawa 70 and 100 ohm shielded cables

Madison Cable, Worchester, MA

John Osborne, Product Manager, (508) 752-7320

- 105 ohm +-7 ohm and 120 ohm +-10 ohm shielded cable

Methode Electronics, Chicago, IL

John Cannon, Product Manager, (312) 867-9600 / X371, FAX (312) 867-9130
Bob Masterson, Applications Eng. Mgr, (303) 695-1333
Roger Fontenot, Sales Engineer, (408) 262-3812

- In-line and end of line terminators

Quintec Interconnect, San Jose, CA - Cable assembly company

Greg Sulger, Sales Engineer, (408) 272-8000

- Providing Astro or Madison shielded cable

Cables that have been used for the testing were supplied by AMP Inc, Amphenol, Icontec, and Quintec. The cables were build to Sun's assembly specifications:

8 x 530-1434-01 0.45 meter Shielded SCSI-2 Male-Male connectors
5 x 530-1508-01 1.20 meter Shielded SCSI-2 Male-Male connectors
2 x 530-1435-02 2.00 meter Shielded SCSI-2 Male to 50-pin Sub-D Male

The cable vendors used were Astro, C&M, Furukawa, and Madison Cable, connector vendors were AMP, Honda and Fujitsu. Terminators have been supplied by AMP, Amphenol, Fujitsu and Methode.

Asynchronous / Synchronous SCSI Cable Test Configurations with 1 Initiator (I) and 2 Targets (T0, T1)

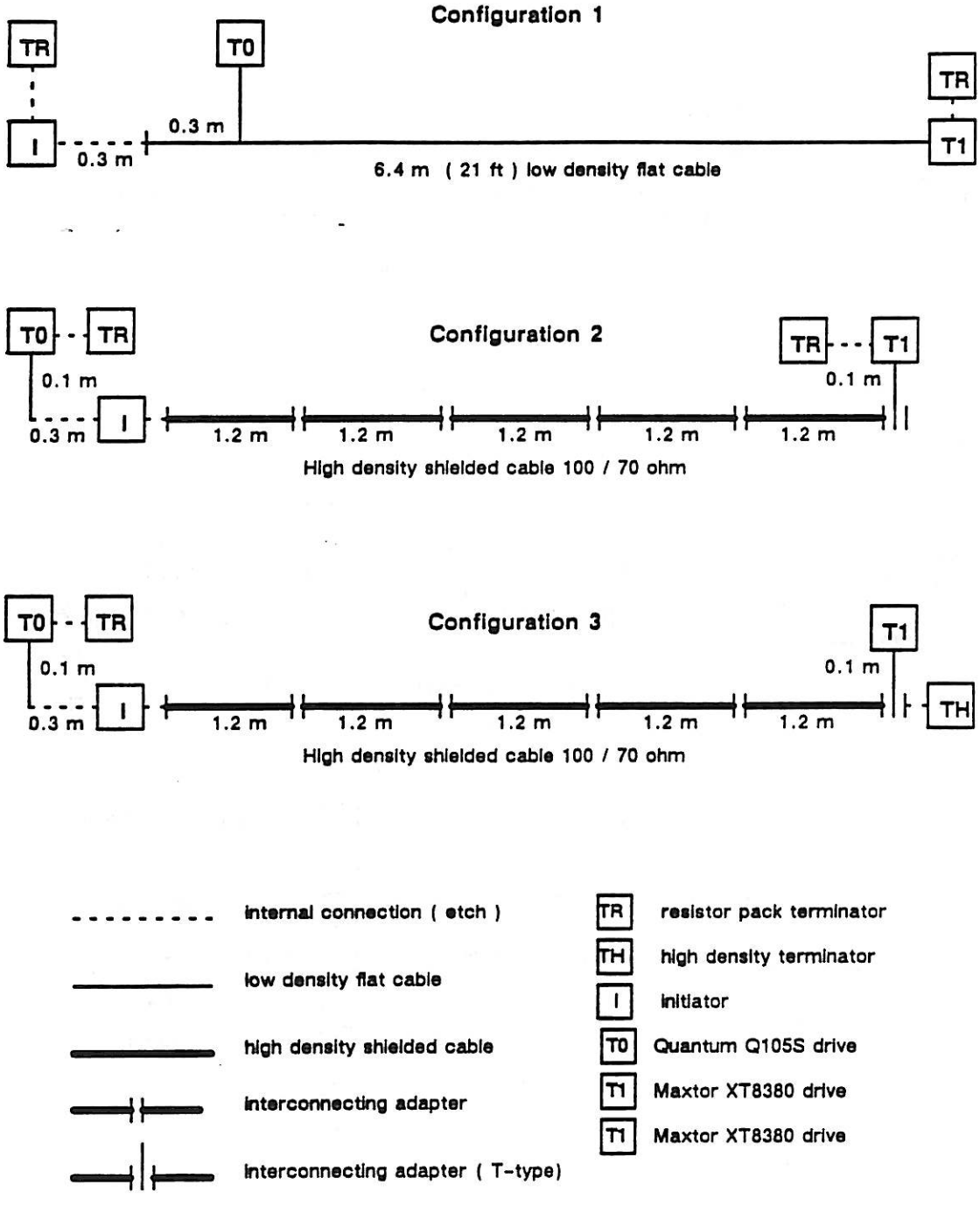
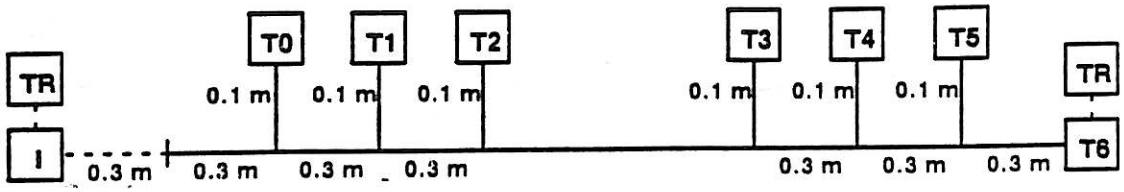


Figure 1

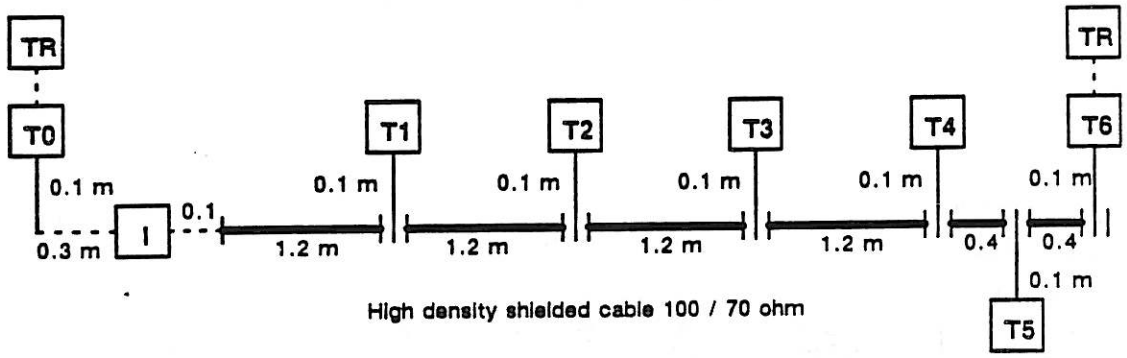
Asynchronous / Synchronous SCSI Cable Test Configurations
with 1 Initiator (I) and 6 Targets (T0 - T6)

Configuration 1



6.4 m (21 ft) low density flat cable

Configuration 2



High density shielded cable 100 / 70 ohm

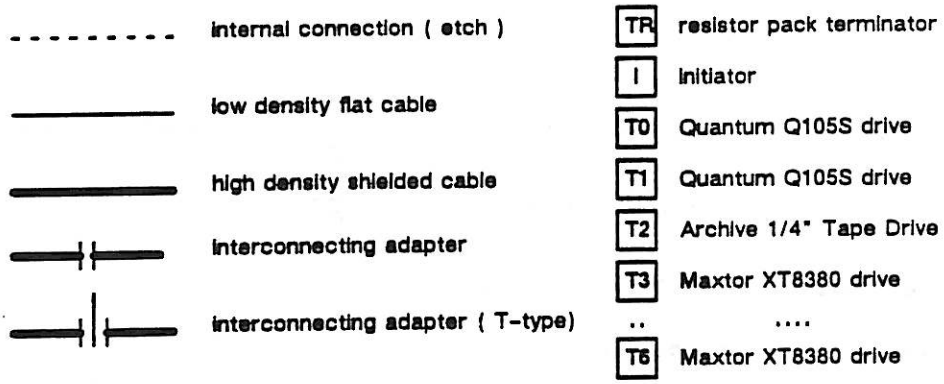
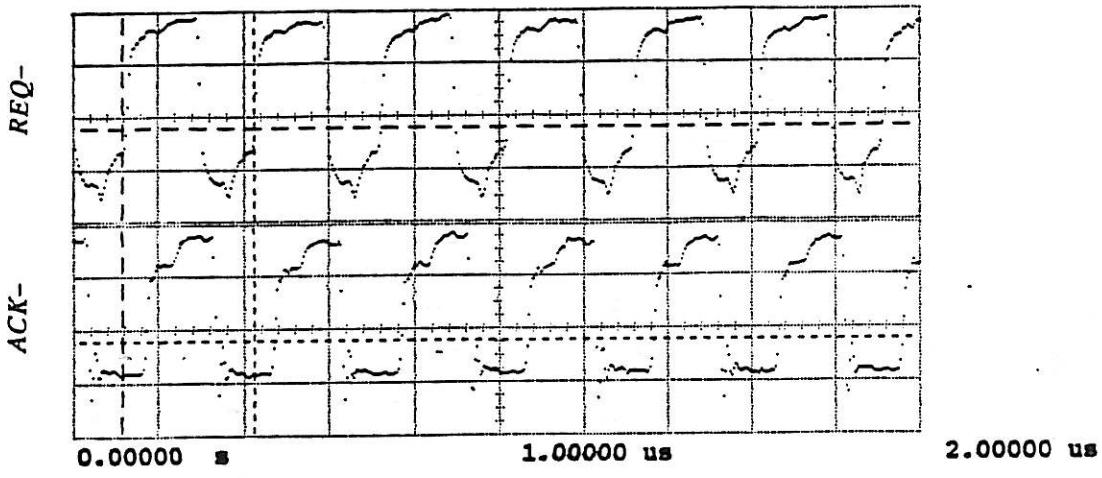


Figure 2

Asynchronous Transfers SCSI-2 High Density 100 ohm Cable (20 ft)
(1 Initiator and 2 Targets)

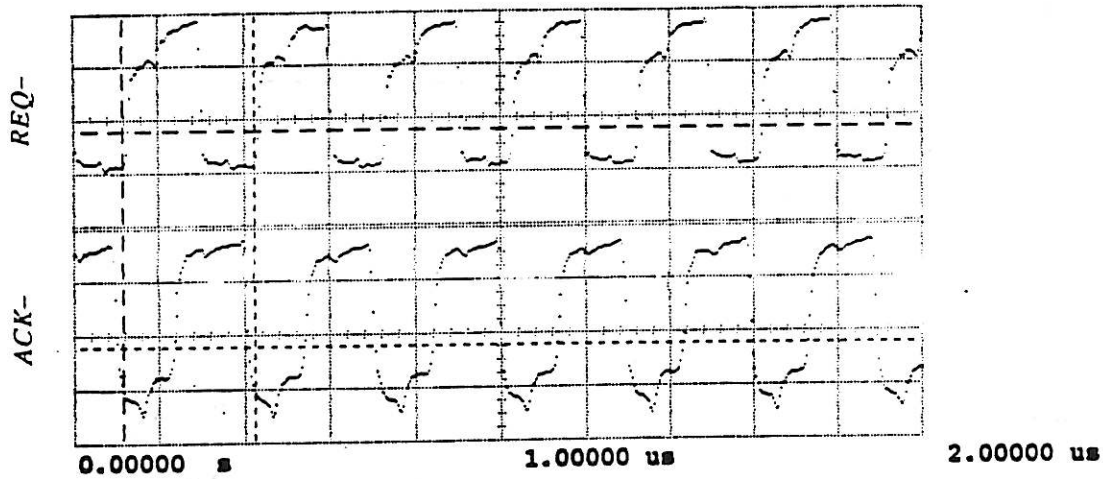
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	308.000 ns			
■Start	=	116.000 ns	Stop	=	424.000 ns

Figure 3

Write across the cable, measured at the far end side

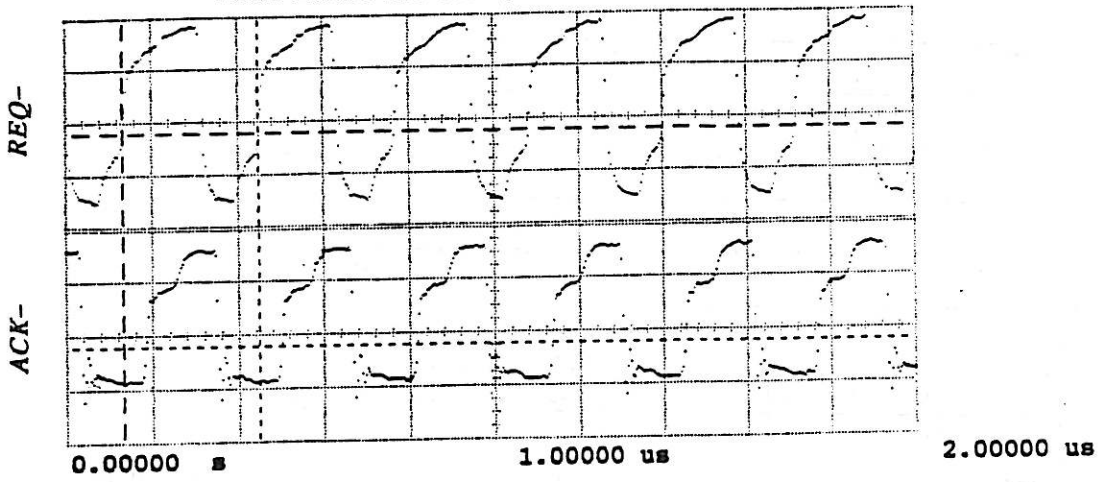


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	308.000 ns			
■Start	=	116.000 ns	Stop	=	424.000 ns

Figure 4

Asynchronous Transfers SCSI-2 High Density 70 ohm Cable (20 ft)
(1 Initiator and 2 Targets)

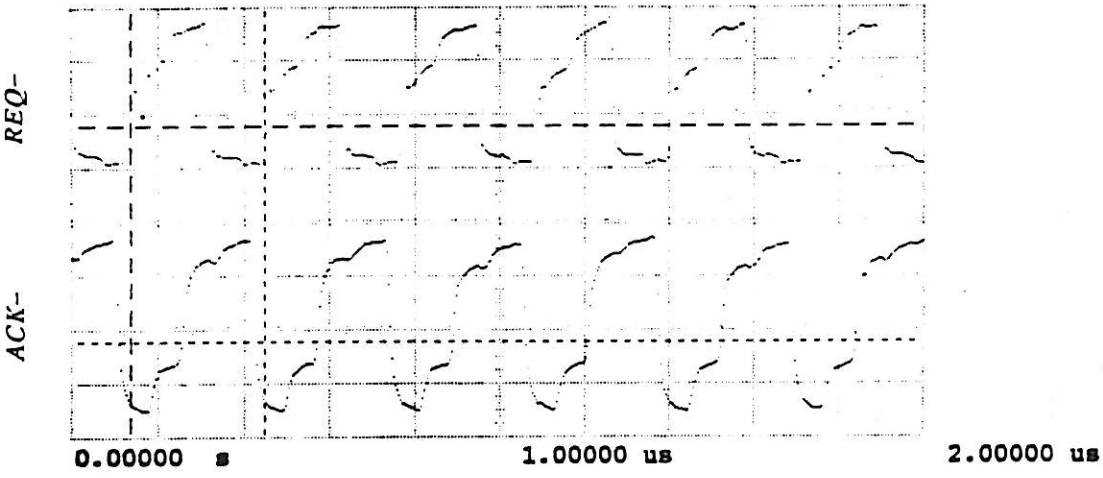
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	317.340 ns			
■Start	=	130.660 ns	Stop	=	448.000 ns

Figure 5

Write across the cable, measured at the far end side

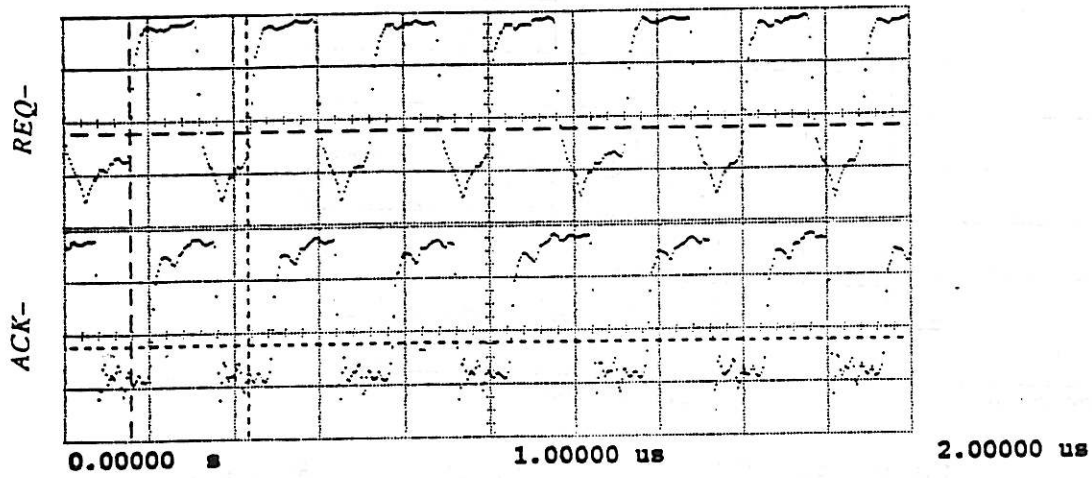


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	312.780 ns			
■Start	=	135.220 ns	Stop	=	448.000 ns

Figure 6

Asynchronous Transfers Low Density SCSI-1 Cable (21 ft = 6.4 m)
(1 Initiator and 2 Targets)

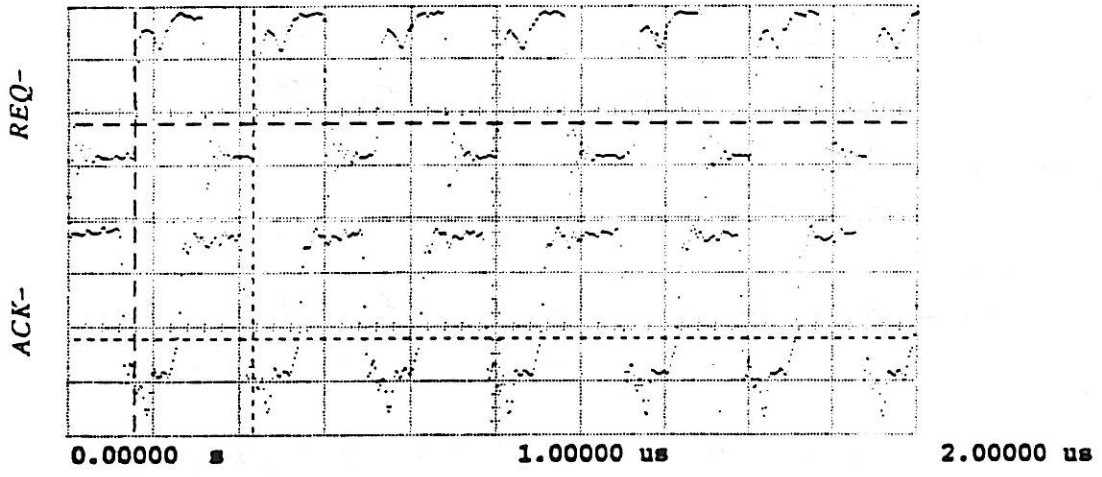
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	276.090 ns			
■Start	=	155.910 ns	Stop	=	432.000 ns

Figure 7

Write across the cable, measured at the far end side

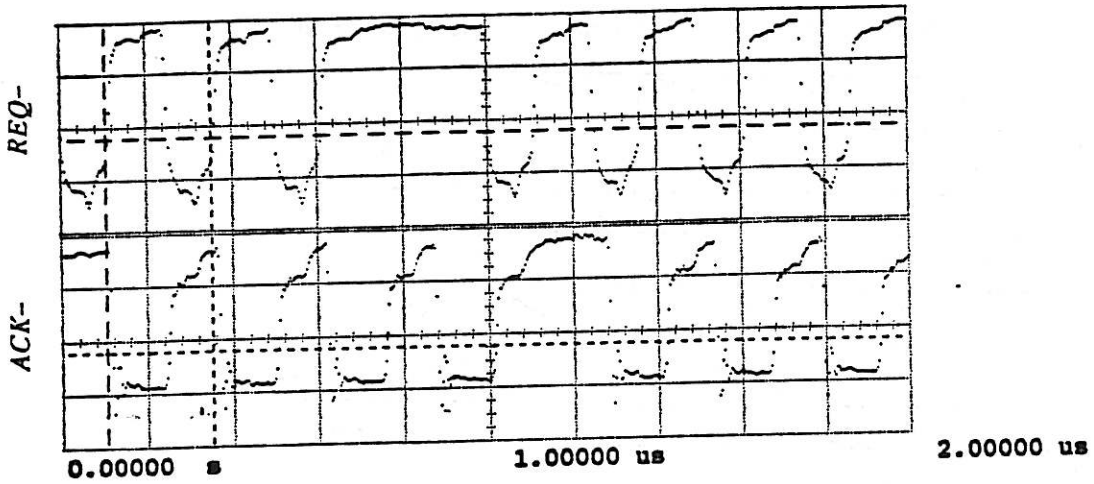


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	276.090 ns			
■Start	=	155.910 ns	Stop	=	432.000 ns

Figure 8

Synchronous Transfers SCSI-2 High Density 100 ohm Cable (20 ft)
(1 Initiator and 2 Targets)

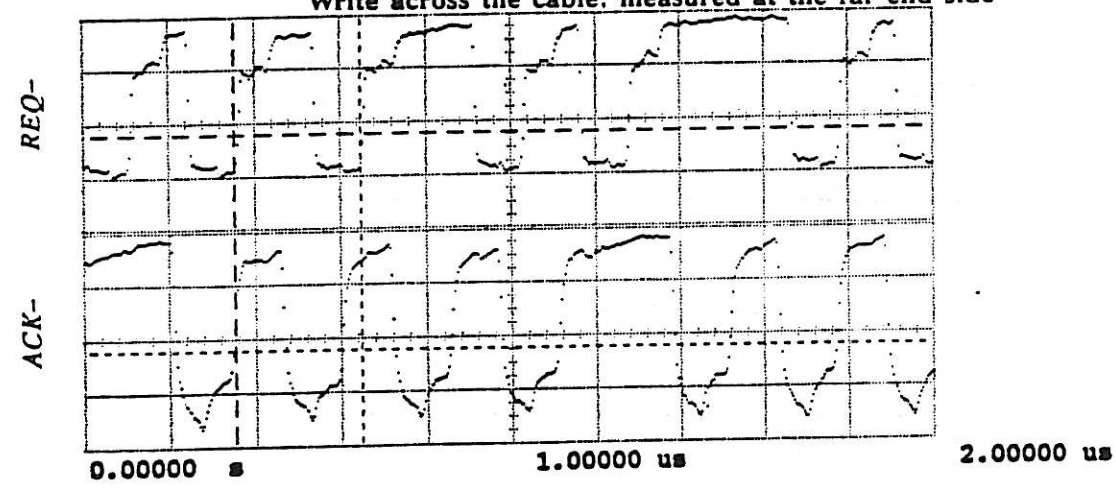
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ns
■Delta V	=	-720.0 mVolts	Vmarker2	=	80.00 mVolts
■Vmarker1	=	800.0 mVolts			
■Delta T	=	248.000 ns	Stop	=	352.000 ns
■Start	=	104.000 ns			

Figure 9

Write across the cable, measured at the far end side

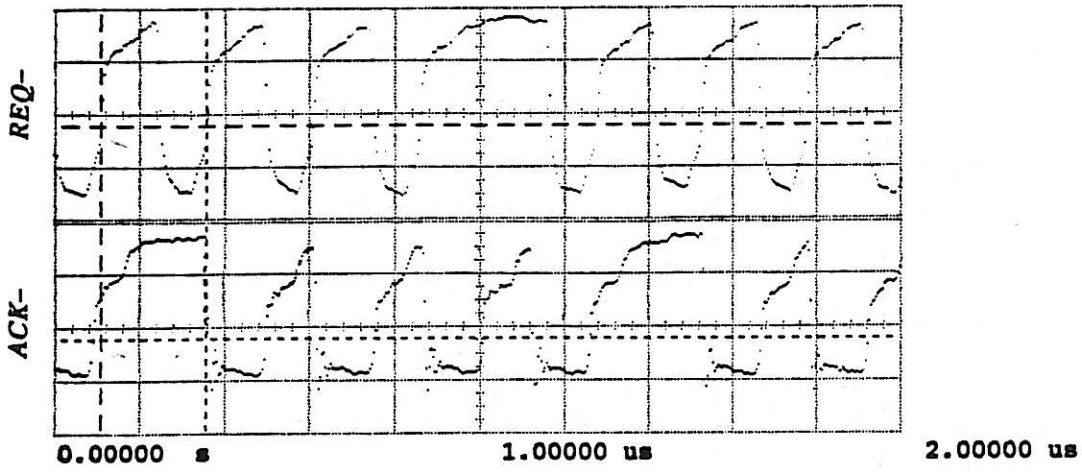


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ns
■Delta V	=	-720.0 mVolts	Vmarker2	=	80.00 mVolts
■Vmarker1	=	800.0 mVolts			
■Delta T	=	296.000 ns	Stop	=	648.000 ns
■Start	=	352.000 ns			

Figure 10

Synchronous Transfers SCSI-2 High Density 70 ohm Cable (20 ft)
(1 Initiator and 2 Targets)

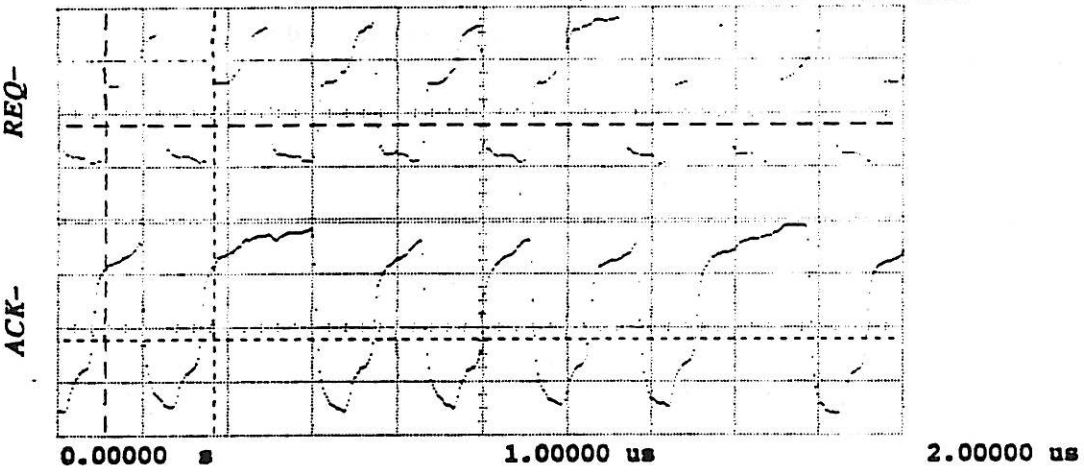
Write across the cable, measured at the initiator side



Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ns
Delta V	=	-720.0 mVolts			
Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
Delta T	=	247.730 ns			
Start	=	108.270 ns	Stop	=	356.000 ns

Figure 11

Write across the cable, measured at the far end side

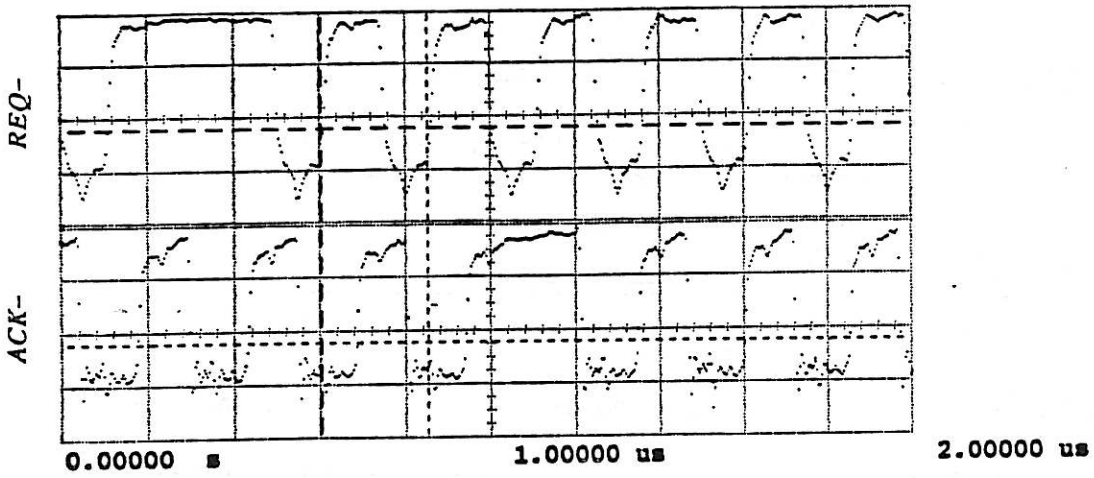


Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ns
Delta V	=	-720.0 mVolts			
Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
Delta T	=	255.680 ns			
Start	=	112.320 ns	Stop	=	368.000 ns

Figure 12

Synchronous Transfers Low Density SCSI-1 Cable (21 ft = 6.4 m)
(1 Initiator and 2 Targets)

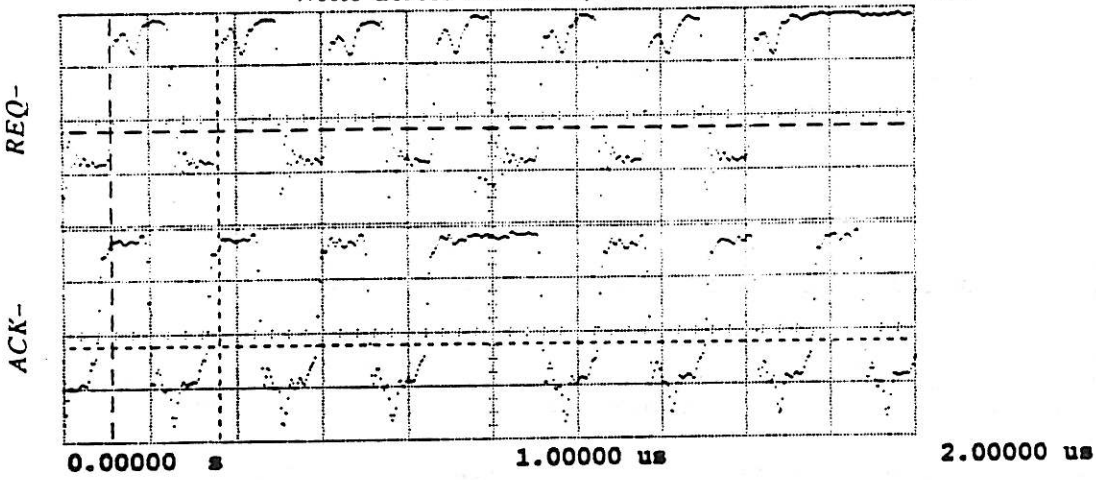
Write across the cable, measured at the initiator side



∎Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
∎Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
∎Delta V	=	-720.0 mVolts			
∎Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
∎Delta T	=	248.000 ns			
∎Start	=	604.000 ns	Stop	=	852.000 ns

Figure 13

Write across the cable, measured at the far end side

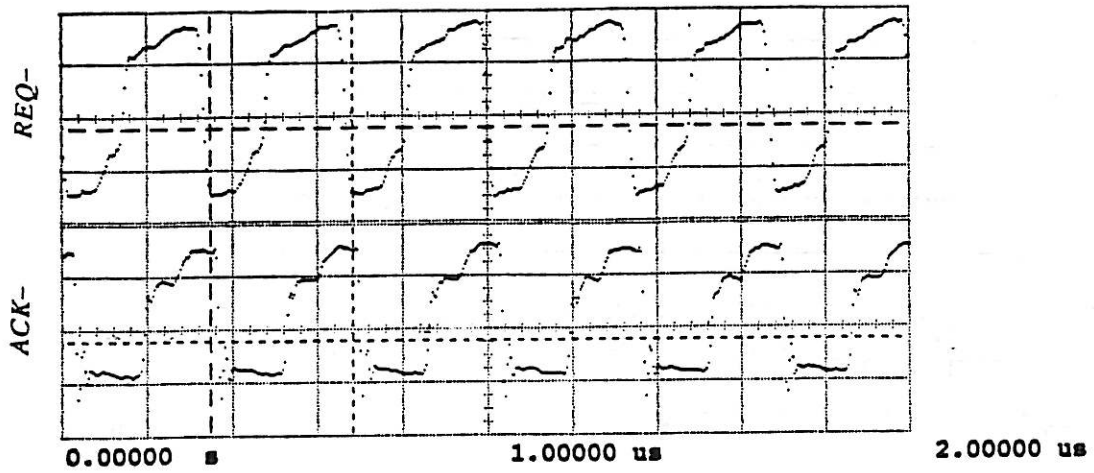


∎Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
∎Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
∎Delta V	=	-720.0 mVolts			
∎Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
∎Delta T	=	249.430 ns			
∎Start	=	110.570 ns	Stop	=	360.000 ns

Figure 14

Asynchronous Transfers SCSI-2 High Density 100 ohm Cable (20 ft)
(1 Initiator and 7 Targets)

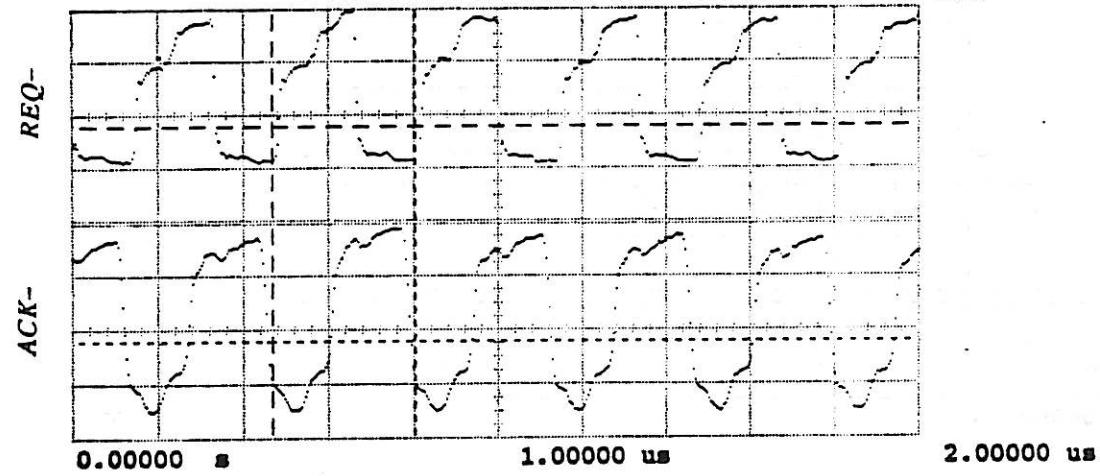
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	336.000 ns			
■Start	=	348.000 ns	Stop	=	684.000 ns

Figure 15

Write across the cable, measured at the far end side

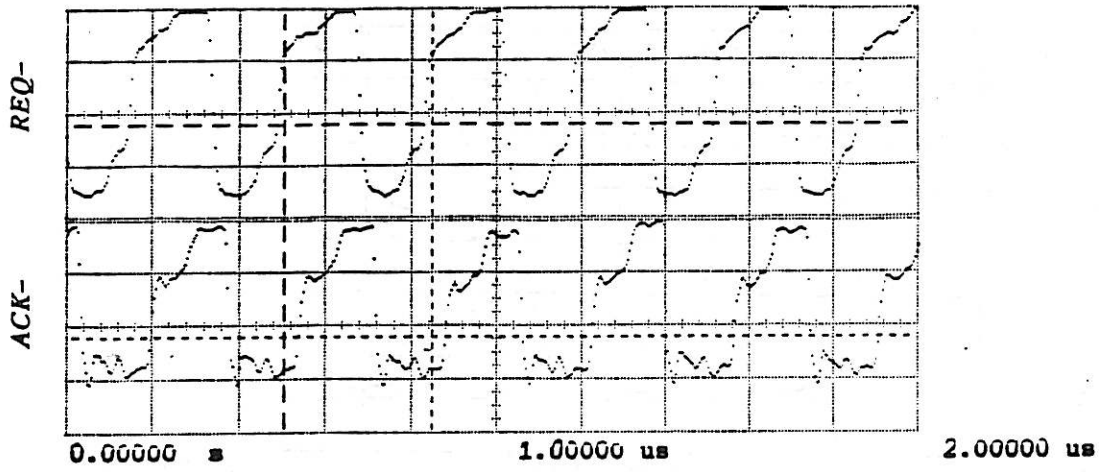


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	336.000 ns			
■Start	=	468.000 ns	Stop	=	804.000 ns

Figure 16

Asynchronous Transfers SCSI-2 High Density 70 ohm Cable (20 ft)
(1 Initiator and 7 Targets)

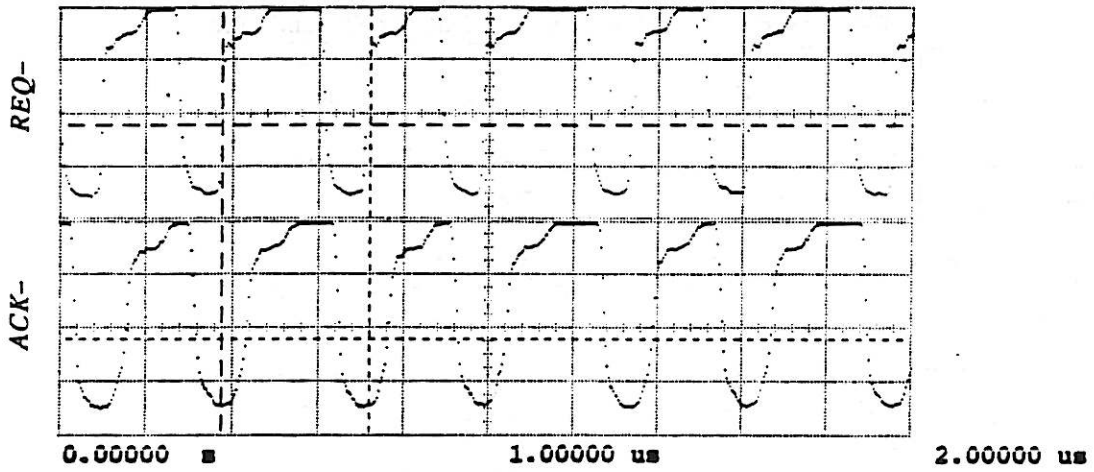
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 volts
■Ch. 2	=	100.0 mvolts/div	Offset	=	100.0 mvolts
Timebase	=	200 ns/div	Delay	=	0.00000 s
■Delta V	=	-720.0 mvolts			
■Vmarker1	=	800.0 mvolts	Vmarker2	=	80.00 mvolts
■Delta T	=	344.000 ns			
■Start	=	504.000 ns	Stop	=	848.000 ns

Figure 17

Write across the cable, measured at the far end side

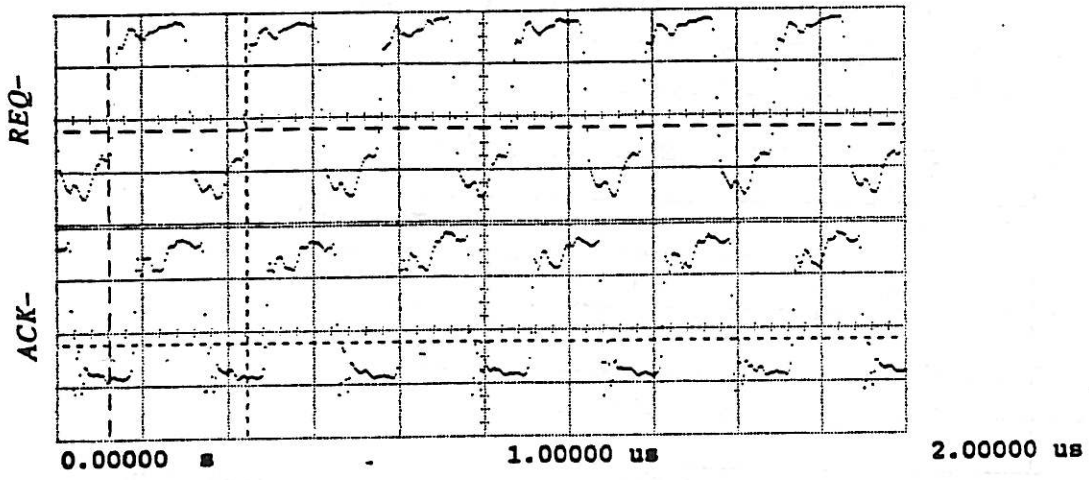


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	0.00000 s
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	344.000 ns			
■Start	=	376.000 ns	Stop	=	720.000 ns

Figure 18

Asynchronous Transfers Low Density SCSI-1 Cable (21 ft = 6.4 m)
(1 Initiator and 7 Targets)

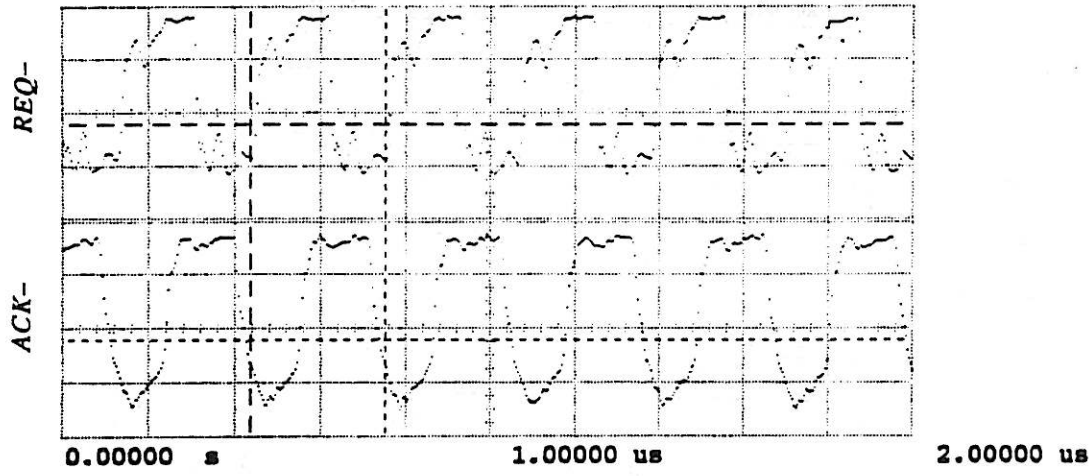
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	320.000 ns			
■Start	=	124.000 ns	Stop	=	444.000 ns

Figure 19

Write across the cable, measured at the far end side

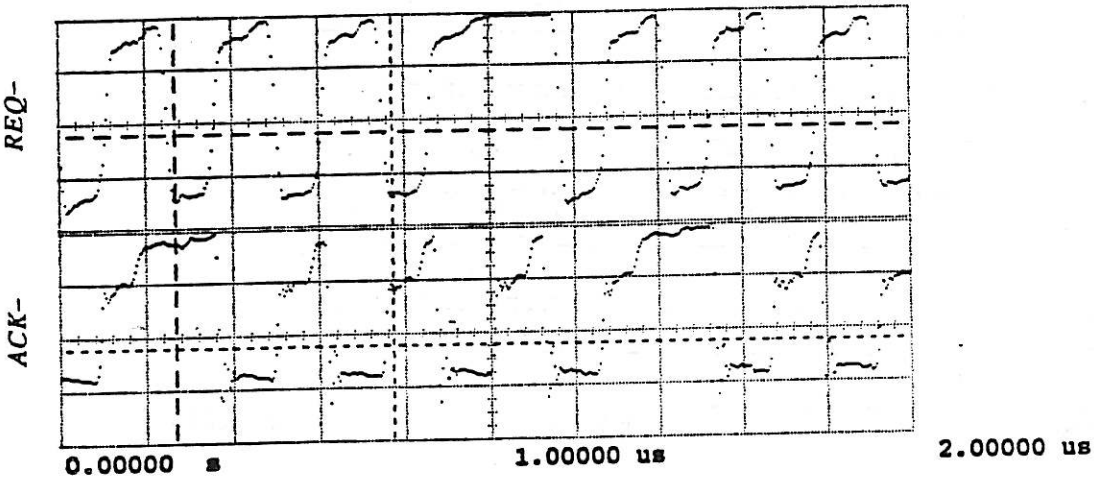


■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	316.000 ns			
■Start	=	436.000 ns	Stop	=	752.000 ns

Figure 20

Synchronous Transfers SCSI-2 High Density 100 ohm Cable (20 ft)
(1 Initiator and 7 Targets)

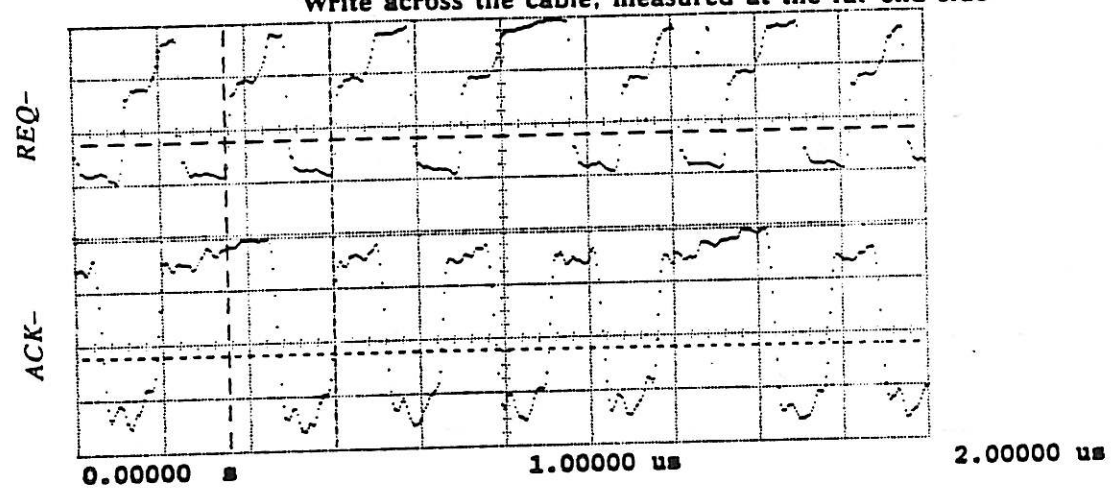
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	504.000 ns			
■Start	=	268.000 ns	Stop	=	772.000 ns

Figure 21

Write across the cable, measured at the far end side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	248.000 ns			
■Start	=	352.000 ns	Stop	=	600.000 ns

Figure 22

Synchronous Transfers SCSI-2 High Density 70 ohm Cable (20 ft)
(1 Initiator and 7 Targets)

Write across the cable, measured at the initiator side

TEST FAILED

Figure 23

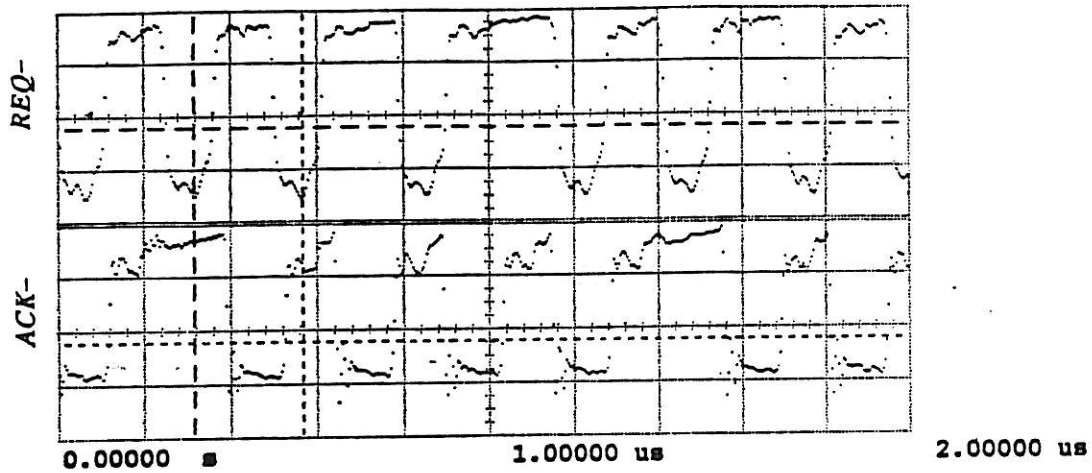
Write across the cable, measured at the far end side

TEST FAILED

Figure 24

Synchronous Transfers Low Density SCSI-1 Cable (21 ft = 6.4 m)
(1 Initiator and 7 Targets)

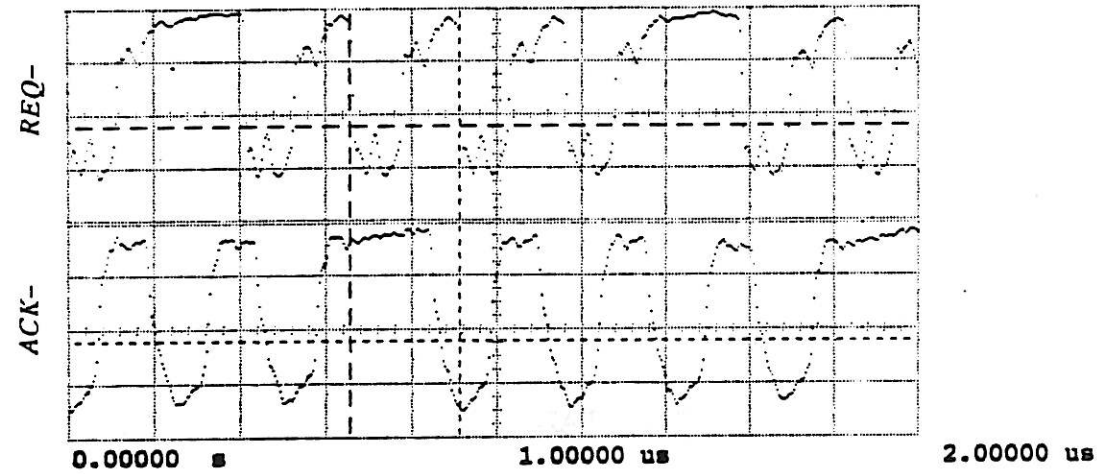
Write across the cable, measured at the initiator side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	252.000 ns			
■Start	=	316.000 ns	Stop	=	568.000 ns

Figure 25

Write across the cable, measured at the far end side



■Ch. 1	=	1.000 Volts/div	Offset	=	1.000 Volts
■Ch. 2	=	100.0 mVolts/div	Offset	=	100.0 mVolts
Timebase	=	200 ns/div	Delay	=	000.000 ms
■Delta V	=	-720.0 mVolts			
■Vmarker1	=	800.0 mVolts	Vmarker2	=	80.00 mVolts
■Delta T	=	256.000 ns			
■Start	=	656.000 ns	Stop	=	912.000 ns

Figure 26