TEXAS INSTRUMENTS

D. W. (Bill) Spence
Member Group Technical Staff
Computer Systems Division
Data Systems Group

12501 Research Boulevard • P.O. Box 2909 • MS 2091 • Austin, Texas 78769
512 250-6627 • Fax 512 250-7479 • TWX 910 867-4702 • Telex 73324

MEMORANDUM -- 27 Nov 1990 -- Revised 19 Dec 1990

TO: John Lohmeyer, Chairman, X3T9.2

FROM: Bill Spence, TI

SUBJECT: S/E Cable Test Report No. 4--Rev. 1

This revision adds the sentence starting "HOWEVER,...", the NOTE: paragraph and the paragraph following.

THE BOTTOM LINE

In our in-system performance measurements, Montrose CBL7259 cable displayed very similar characteristics to Madison 4099/4197 cable and Astro 52-107-C cable. With 110-ohm terminators, it supported both synchronous and asynchronous operation over a total bus length of 70 feet, fully loaded.

2. Although the conductors in this particular Montrose cable have a compound insulation which results in a little higher characteristic impedance than the other two cables, the improvement in topside noise margin is paid for by a little decrease in bottomside noise margin. Our test results did not point to any clear benefit from the higher impedance (with 110-ohm terminators). HOWEVER, for systems using the original 132-ohm terminators, the approximately 87 ohms of the inner conductors of this cable would be a definite benefit.

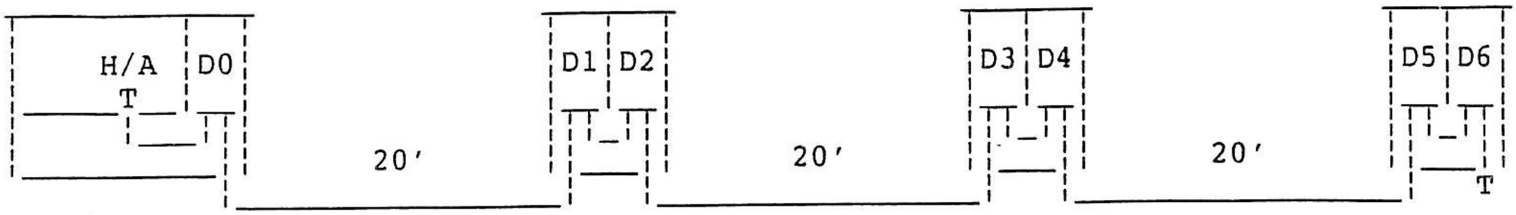
CABLE ASS'Y DESIGN

This test followed the procedures reported in my previous S/E Cable Test Reports Nos. 2 and 3, X3T9.2/90-124, 16 Aug 1990, and X3T9.2/90-157, 14 Oct 1990. This cable likewise has a buffer layer of low-dielectric-constant insulation inside the shield layers. The cable assemblies followed the same pinout scheme: -REQ and -ACK are in the core, the data and parity lines are in the outer layer.

MONTROSE provided the cable and CMS made the cable assemblies for these tests, and we express our gratitude to both.

PHYSICAL LAYOUT

The bus layout again is given in the following diagram:



There are 4 enclosures containing the host and 7 disks, as shown. The host adapter (H/A) includes a regulated 110-ohm terminator (T). Another is at the other end of the bus, applied externally. The bus is daisy-chained through each enclosure by some 2+ ft of regular unshielded, flat, 50-conducter by .050 ribbon cable. The shielded external cables are approximately 20 ft long each. Total bus length is about 70 ft--21 m. (This is a test system, not an example of how TI systems are configured.) The testing of a 21 m S/E bus, vs the 6 m arbitrary limit in the standard, was done both to expand the differences which might be found between cable types AND to illustrate the large performance margin available in S/E SCSI when the cables and terminators are properly chosen.

RESULTS AND WAVEFORMS

As before, the 21-meter total bus length is indicative of the large performance margin offered by 110-ohm terminators and high-quality cables. As before, the system was operated with both asynchronous- and synchronous-data-transfer disks in the end location, and the system ran perfectly for the several hours that th test was continued.

For the purposes of this report, only the -REQ waveform generated and the -ACK wavefrom received by the end disk are reproduced. Results of all 4 cables tested to date are presented in decreasing order of apparent S/E impedance, from the low 90's of the 3M PFS to the low 80's of the Madison 4099. The four -REQ waveforms are presented first, followed by the four -ACK waveforms.

As before, the signal transitions through the transition region from 0.8 to 2.0 volts are clean, and good noise margins outside the transition region are maintained. In the -REQ waveforms, since they are taken where -REQ is asserted, the drops are very clean and practically identical. The releases rise initially to step levels proportional to the cable impedances, careful study shows, but again the waveforms are very nearly identical. In the -ACK waveforms, the level to which the received -ACK signal initially drops is again proportional to cable impedance. The slightly better bottomside noise margin of the two lower impedance cables can be readily seen, but again the waveforms display only very small differences.

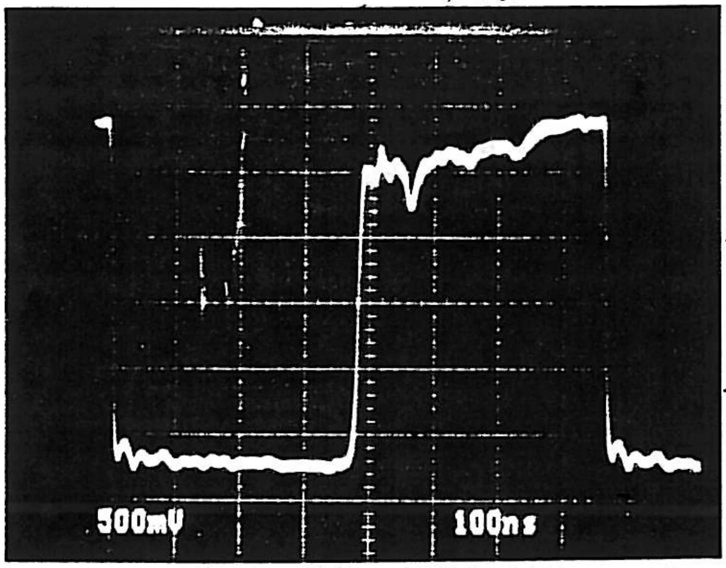
NOTE: Because of time restrictions, we still do not have all cables characterized on a uniform test basis. This additional round of tests, however, emphasizes the likelihood that either an error crept into Astro's listing of their 52-107-C cable as having 90 ohm impedance or that their impedance test method is not aligned with that of the other vendors. These results again show that, tested against the other three vendors, the Astro cable demonstrates an impedance in the low 80's, slightly if at all higher than the Madison 4099.

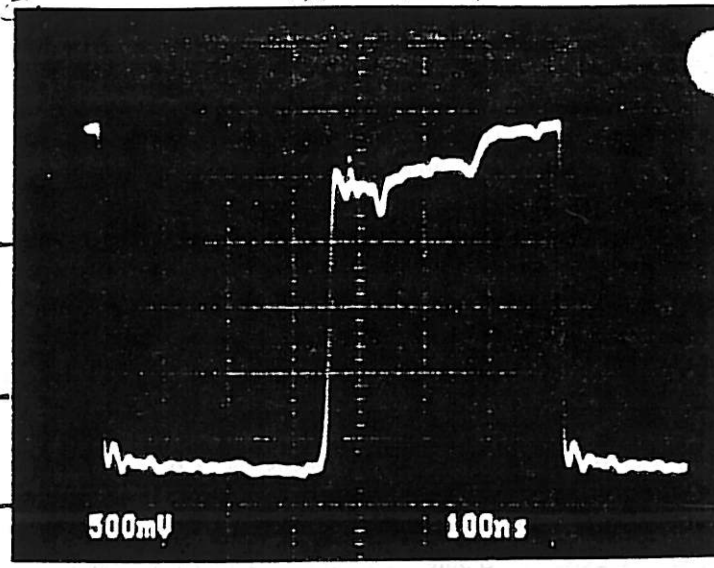
In the companion paper to this one, "S/E Impedance Optimization", X3T9.2/90-185, 27 Nov 1990, the significance of the ratio of cable impedance to terminator impedance, Zc/Zt, was presented, along with the seemingly now obvious fact that best system performance is achieved with that ratio somewhere around 0.75, as opposed to 1.00. The waveforms presented below provide examples of operation in this range. The 3M PFS cable has a ratio of about 0.85, the Montrose about 0.80, and the Astro and Madison cables about 0.75. The brand X cable has a ratio of about 0.40--obviously much too low as shown by no margin above 2.0 v. Less obvious is that the .85 ratio of the 93-ohm 3M PFS cable seems to be a little on the high side. The degree of vulnerability in the release signal (top left waveform on the first page of waveforms) is less, in magnitude and duration, that the degree in the asserted signal (bottom left waveform on the first page of waveforms). The asserted signal does drop below 0.8 volts, as it should, but it lingers longer within a dangerous proximity to that limit than the release signal lingers with respect to the 2.0 v limit.

In order to demonstrate that the waveforms above hadn't simply stuck to the scope screen, some lower quality cables were substituted, and these waveforms follow the ones above. In the -REQ waveform, the low cable impedance shows up very clearly in the lower step on release of signal. In the -ACK waveform, the lower level of fall which might be expected from the lower impedance is largely nullified by the higher cable loss acting on the received -ACK signal.

The final two waveforms are included only to illustrate an interesting phenomenon. The very high level on release and the poor pulldown of the received signal point to very high cable impedance--or, more accurately, a high ratio of cable impedance to terminator impedance. The actual cause turned out to be that inadvertently we had picked up, for one of the interior boxes in this test, a box containing a disk from which the inboard terminator packs had not been removed. Two terminators, then, were sending current through the the -REQ line while it was asserted, so that when it was released, a tremendous voltage waveform step was first experienced. Conversely, the current wave transmitted through the -ACK line when it was asserted at the host was partially sucked off by the intermediate terminator, leaving insufficient current initially to give a good pull down at the receiving end. Moral: be sure you get rid of the inboard terminators in all devices not at the very ends of the SCSI bus.

T2 -REQ





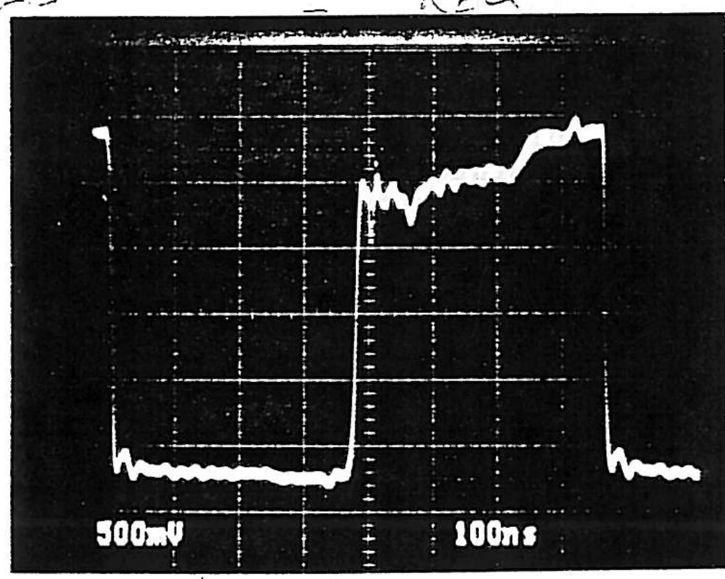
-2-
.8-
-0-

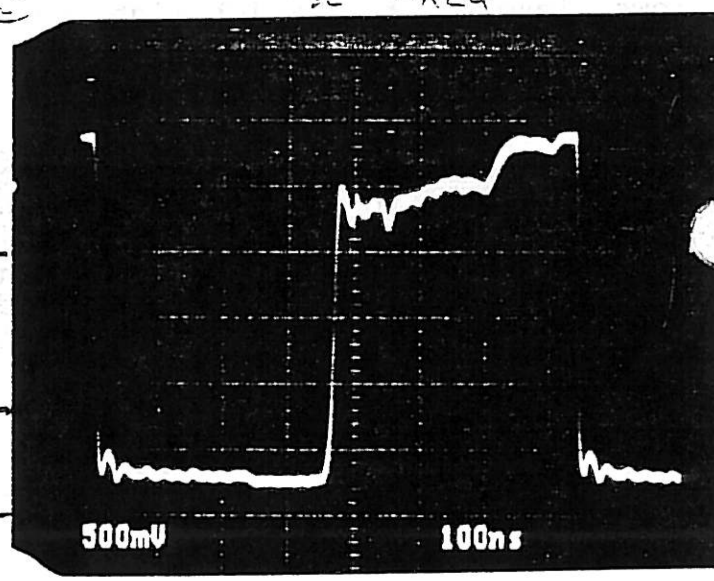
3M PFS

MONTROSE

T2 -REQ

T2 -REQ





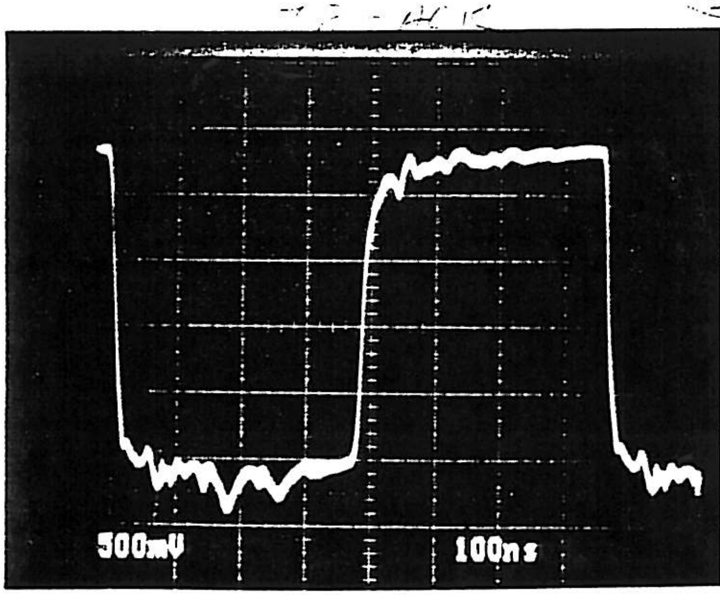
-2-
.8-
-0-

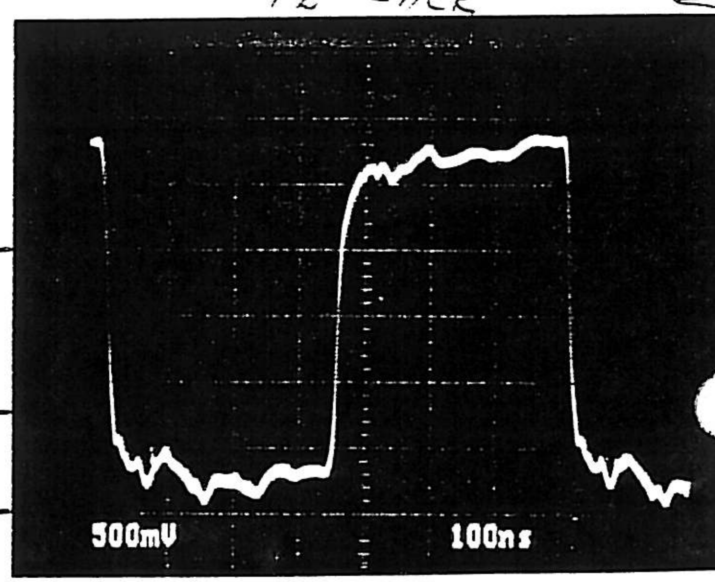
ASTRO

MADISON

T2 -ACK

22



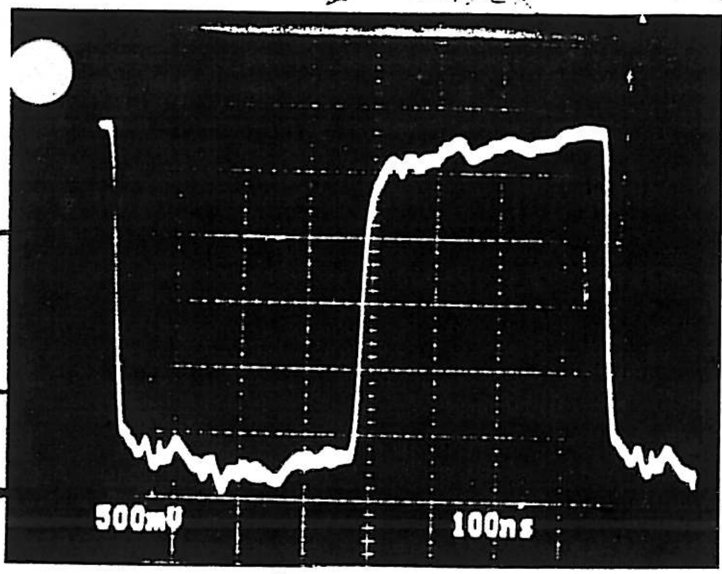


-2-
.8-
-0-

3M PFS

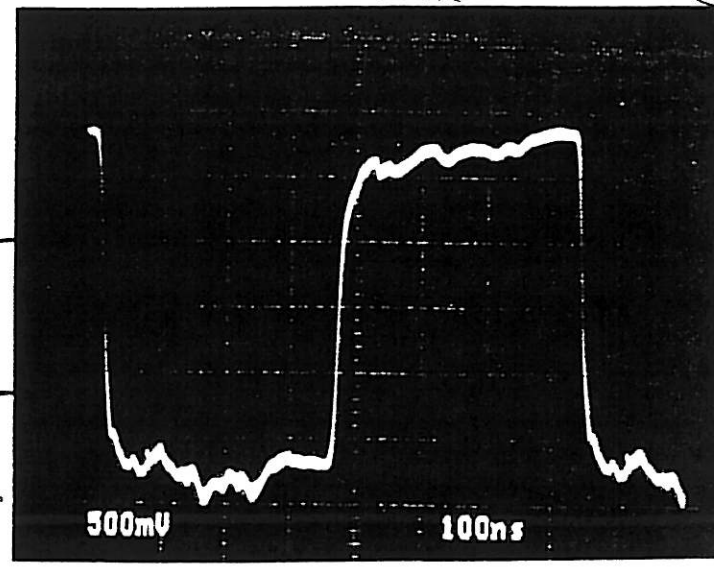
MONTROSE

T2 -ACK



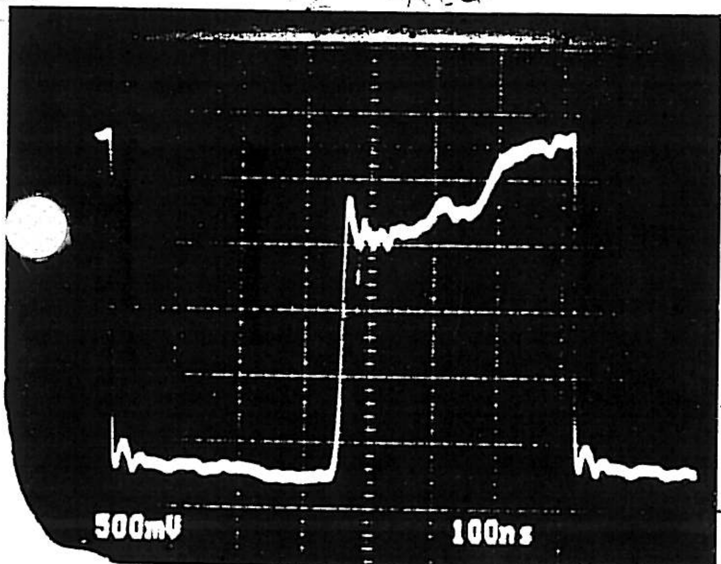
ASTRO

T2 -ACK



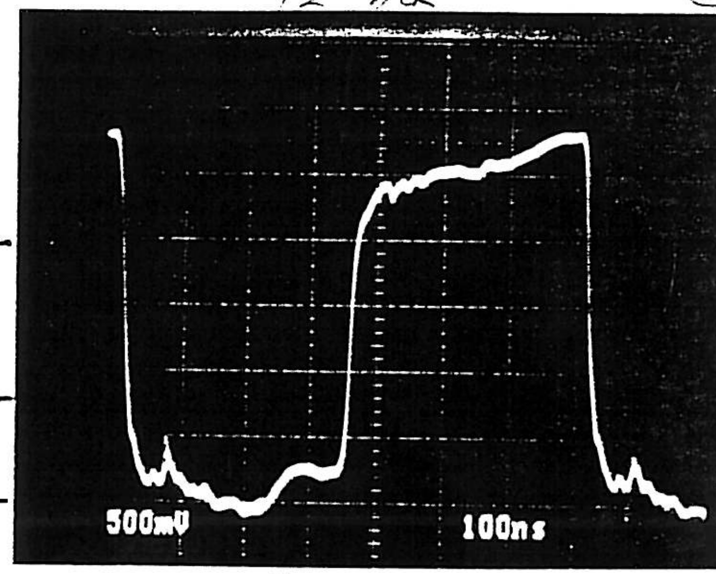
MADISON

T2 -REQ

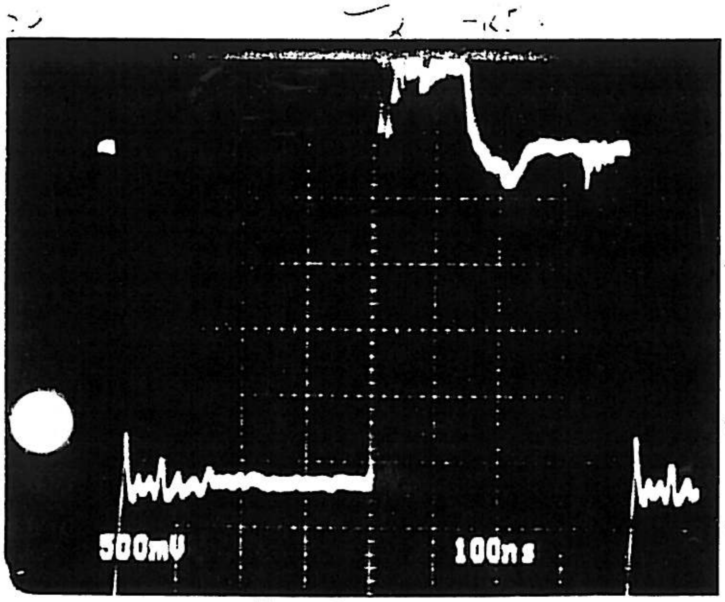


BRAND X

T2 -ACK

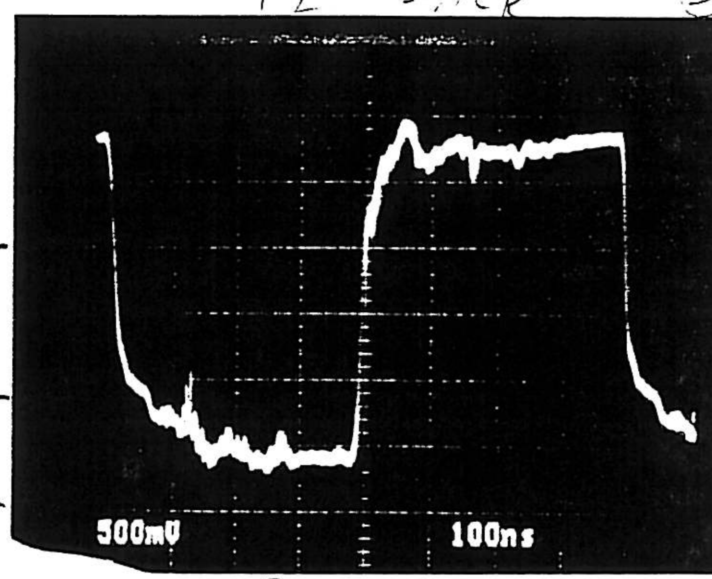


BRAND X



3 TERMINATORS

T2 -ACK



3 TERMINATORS