TEXAS INSTRUMENTS

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MEMORANDUM -- 01 DEC 1989

TO: John Lohmeyer, Chairman X3T9.2

FROM: Bill Spence, Texas Instruments

SUBJECT: Single-ended Cable Test Report

BACKGROUND

Having started developing our SCSI-based systems in 1983, when there were practically no differential SCSI peripherals available, TI has a large installed base of single-ended SCSI and a keen interest in not migrating to differential without a real necessity. In our systems shipped to date, the SCSI bus has been small enough to be highly reliable, even though single-ended. In trial configurations, however, we too have produced rogues' gallery pictures of grotesque waveforms, and we are aware that our ability to expand with present hardware has a limit.

In pursuit of improving our hardware, we have evaluated the Boulay 110-ohm terminator scheme, with considerably improved performance compared to operations with conventional 132 ohm terminators. Now we are enjoying the opportunity to evaluate a new cable under development specifically for single-ended SCSI service, and the waveform improvement is quite impressive. The new cable is a 3M development and is being called PFS, for Pleated-Foil SCSI.

3M'S DESIGN OBJECTIVE

The design objective was to have each of the 18 active conductors be in essentially identical environments, so as to have identical characteristic impedances and propogation delays, and to have that impedance be 90 ohms or greater, measured single ended. (In the actual cables tested, the impedance was 93 ohms.)

3M'S DESIGN CONCEPT

The design concept was to take a 25 conductor ribbon cable of special, high-characteristic-impedance design, and so pleat foil around it that each conductor is in a quasi-coaxial cable environment. This shielding foil greatly reduces the characteristic impedance, of course, which is why it has to be quite high before the foil is applied. (Twenty-five conductors are utilized for flexibility, so that only one-half of the fifty pins of the SCSI connectors necessarily must be ground. Those pins in the half normally grounded are all connected to the shielding foil.)

The situation of these active conductors can be contrasted with those in a conventional round shielded cable composed of 25 twisted pairs. The environments of the active conductors vary considerably, depending on their individual spacial relations to the outer shield and to all the other conductors.

TEST SETUP

Our objective was to make a comparison of operating behavior between the PFS and conventional SCSI cables. The PFS cables made available to us were in 22-foot lengths; the longest conventional cables available to us were 15-foot. In this first series of tests, we strung in series 3 of the PFS cables and compared them to 4 of the conventional cables strung in series.

The coupling between cables was accomplished by daisy-chaining them through our so-called Mass Storage enclosures, within which there is 2 to 3 feet of conventional ribbon cable. In the intermediate enclosures, no device was connected. In the final enclosure, a 380-Mbyte Winchester disk was in operation. Obviously, these are not worse-case situations; later testing will populate the intermediate enclosures. But this relatively simple set-up has provided valuable comparative data. And note that the total bus length is about 80 feet (about 24 meters) in both cases. (It was amazing that in the conventional case the system could operate at all, even in the controlled lab environment. The pictures show, however, that in some cases the noise margin had gone practically to zero.)

PROPOGATION DELAY TEST RESULTS

In these tests, a square wave was applied at the near end and the delay measured to the corresponding wavefronts at the far end of the bus, compared to the near end wavefronts. 110-ohm terminations were used.

Conventional cables:	Maximum propogation-delay time found:	146.7 nanoseconds
	Minimum propogation-delay time found:	138.4 nanoseconds
	Spread:	8.3 nanoseconds
PFS cables:	Maximum propogation-delay time found:	119.8 nanoseconds
	Minimum propogation-delay time found:	116.6 nanoseconds
	Spread:	3.2 nanoseconds

The reduced skew and total delay in the PFS cables points to a probable ability to operate at 25 meters with "fast" SCSI's in excess of 10M transfers/sec.

WAVEFORM TEST RESULTS

Four cases were tested:

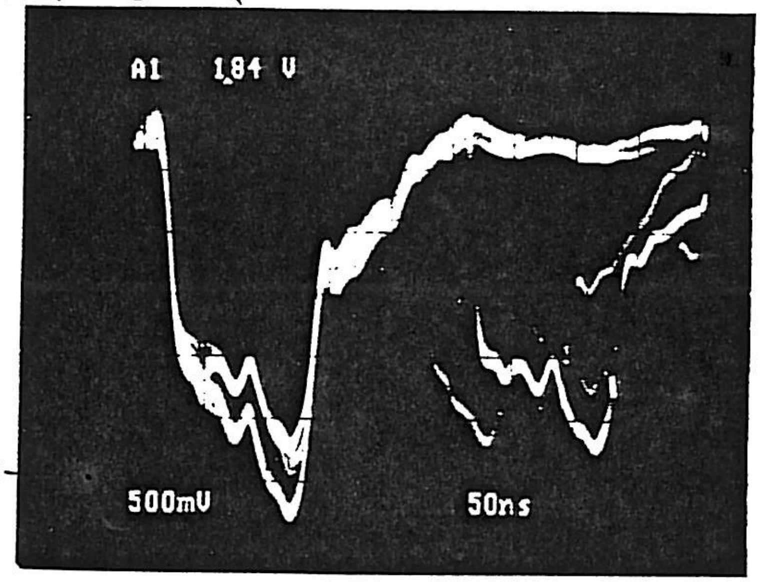
1. Conventional cables 132-ohm terminators
2. Conventional cables 110-ohm terminators
3. PFS cables 132-ohm terminators
4. PFS cables 110-ohm terminators

Both REQ and ACK waveforms were photographed at each end and each intermediate point along the bus. What is here presented, however, is a worst waveform for each case. Choosing worst waveforms was often a close call, but in all cases the ACK signal waveform at the last intermediate station and the corresponding REQ signal waveform at the first intermediate station were as bad as any.

The improvement of waveform with the PFS cables is dramatic. The notorious rise sluggishness attributed to single-ended is eliminated. With the 110 ohm terminators, there appears to be a large margin to handle common-mode noise.

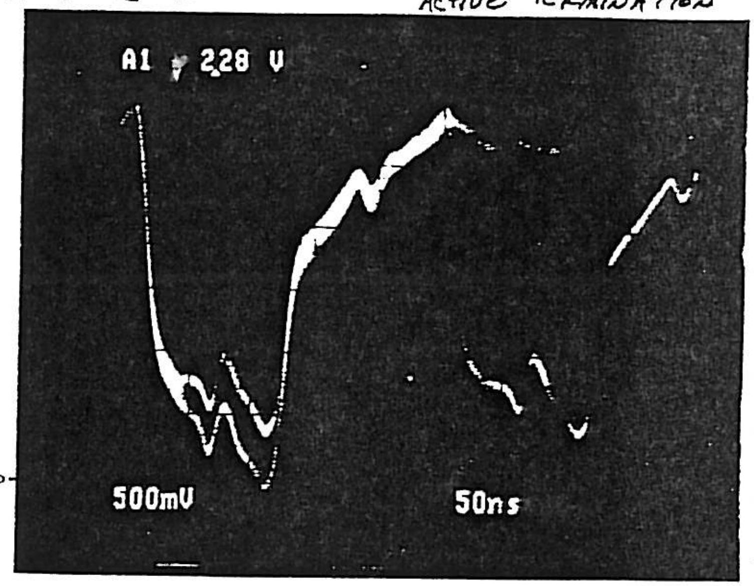
Of interest also is the small visual improvement in waveform of the conventional cables when substituting the 110 ohm terminators for 132 ohms. The improvement in actual performance was more than these waveforms would suggest. My explanation: it is easy to recognize which waveforms will work well; it is not so easy to recognize just which waveform defects will prove to be unacceptable.

REQ- @ #2



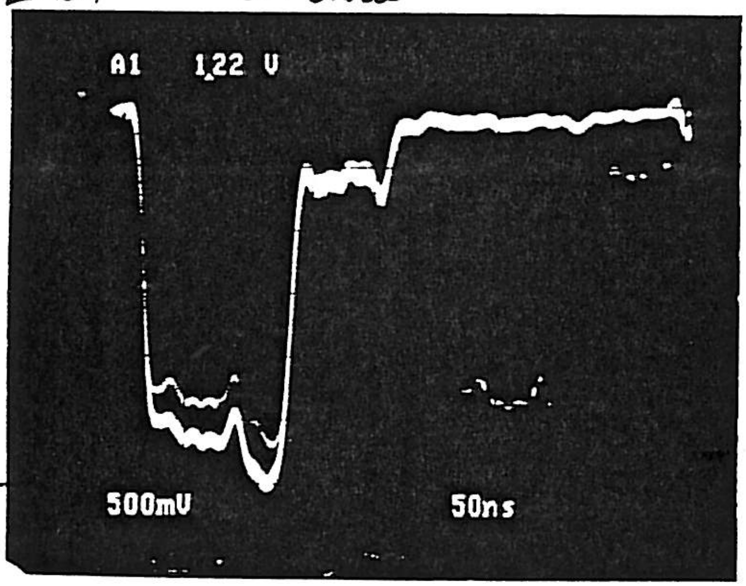
CASE 1

REQ- @#2 ACTIVE TERMINATION



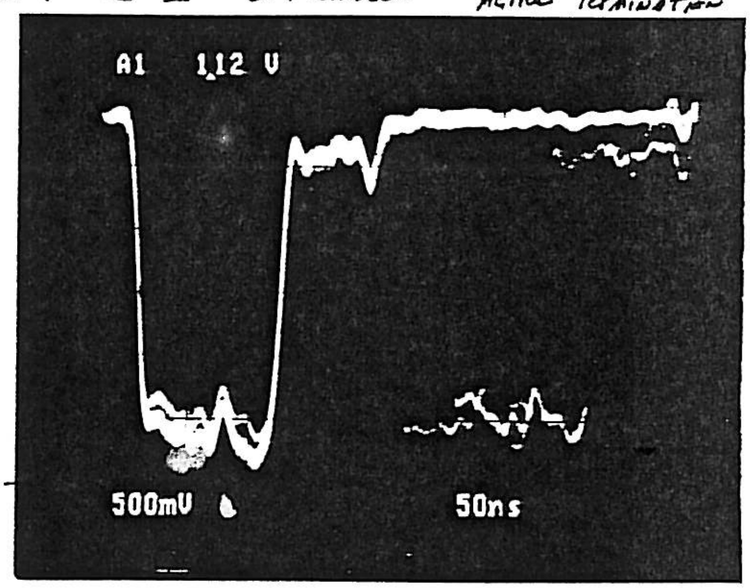
CASE 2

#2 REQ 3M CABLES



CASE 3

REQ- @#2 3M CABLES ACTIVE TERMINATION



CASE 4