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TO: X3T9.2 Committee

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SUBJ: Voh/Ioh specification for active negation drivers

SUMMARY

Specifications for limiting the maximum voltage and current to be provided by active negation drivers should be based on compatibility with existing alternate 2 termination circuits. The restrictions imposed by alternate 2 termination compatibility are more limiting than those that would need to be imposed to prevent damage to SCSI devices on a cable with devices employing active negation drivers when one terminator has been removed from the cable.

ALTERNATIVE 2 TERMINATION ISSUES

The approach taken by Bill Spence in his September 6, 1991 memorandum is the correct approach. However, one error in the conclusions and a caveat need to be mentioned. First, the table of Ioh values for a given Voh do not consider that the current from the active negation drivers is split between two terminators. This would double the permissible Ioh values listed. Bill's table should read as follows:

Cable	M	N	Voh	Ioh
P	3	22	3.17	5.82
P	3	18	3.24	7.12
A	2	14	3.19	6.10
A	2	10	3.32	8.54

M=>number of lines being asserted
N=>number of lines being negated

The caveat is this: It is possible that for a short period of time after a selection or reselection and before the data transfer begins, that only a single line may be asserted (BSY) on the bus. Depending on when the device with active negation drivers enables those drivers and when it begins to drive valid data and parity, there may be a time period for which the table generated above does not apply. During this time period the Vol of the BSY signal could be degraded slightly. In practice this is not likely to cause a problem. If this is not acceptable, one possibility would be to require devices with active negation drivers to not enable active negation without valid parity.

Active negation drivers which meet the specifications above have been demonstrated to be effective in the laboratory. A substantial reduction in the maximum values listed above is likely to reduce the effectiveness of active negation drivers.

REFLECTIONS WITH MISSING TERMINATOR

Concerns were expressed at the Transceiver Working Group that active negation drivers might damage other devices on the cable if one of the terminators was removed. The theory was that the double voltage reflection coming from the open ended cable would cause thyristor latchup in CMOS devices on the cable. Simulations and laboratory investigations have thus far indicated that this is not likely to be a problem.

For most of the SCSI protocol chips designed in the last several years, there is no P+ to N- diode in the pad structure. This structure had to be removed to prevent current leakage from the SCSI terminators when the device was powered down. With this diode removed, a CMOS device will not latchup due to voltages above VDD. Damage to the device will not occur until much higher voltage levels when the gate oxide is ruptured or an avalanche breakdown of the N+P- diode is sustained for a long period of time. This has been verified in the laboratory with voltages levels of up to 20 volts.

The concern would be with the older CMOS devices that have a P+N- diode. First, it needs to be understood that to trigger and latchup the parasitic thyristor in a CMOS device requires a sustained level of current during an over/under voltage condition. Short transients can not latchup the thyristor formed from the low gain parasitic bipolar devices. It should also be pointed out that the cable can not create energy. That is, the power along the cable is constant. Where the voltage is at a maximum, the current is at a minimum. The ability of the cable to supply a high level of current at a high voltage is very limited.

Simulations of a 6 meter cable indicate that placing a P+N- diode on the cable clamped the voltage to less than 6 volts. The current conducted by the diode was never greater than 20 ma for a period greater than 20 ns, even when an ideal voltage source (0 supply impedance) was used to generate the voltage step of 3.5 volts on the cable.

Immunity to transients is not often specified for CMOS devices. The two examples that have been found (Intel and Motorola) indicated that the devices would withstand a 2 volt under/over shoot for up to 20 ns. This would be safely within the bounds indicated by the simulation results.

Laboratory tests on an older version of the 53C80 containing the P+N- diode were conducted on a 6 meter cable with one terminator removed. Even when a continuous stream of 5 volt pulses were injected into the cable, no damage to the device was sustained.

Finally, it should be pointed out that the overshoot condition is not fundamentally different from the undershoot condition that has existed on SCSI cables since the beginning of time. Undershoots of greater than 2 volts in magnitude are possible when a terminator is removed. This has never been brought to the committee as a problem. The topology rules to which an IC design must adhere in order to minimize the susceptibility to latchup are the same for both over and under voltage conditions. This is not a case of chip vendors having designed to protect against one situation and not the other. The restrictions suggested for alternate 2 termination compatibility would result in over voltage conditions that are no worse that the under voltage conditions that already exist. There does not appear to be justification for additional restrictions to active negation drivers.