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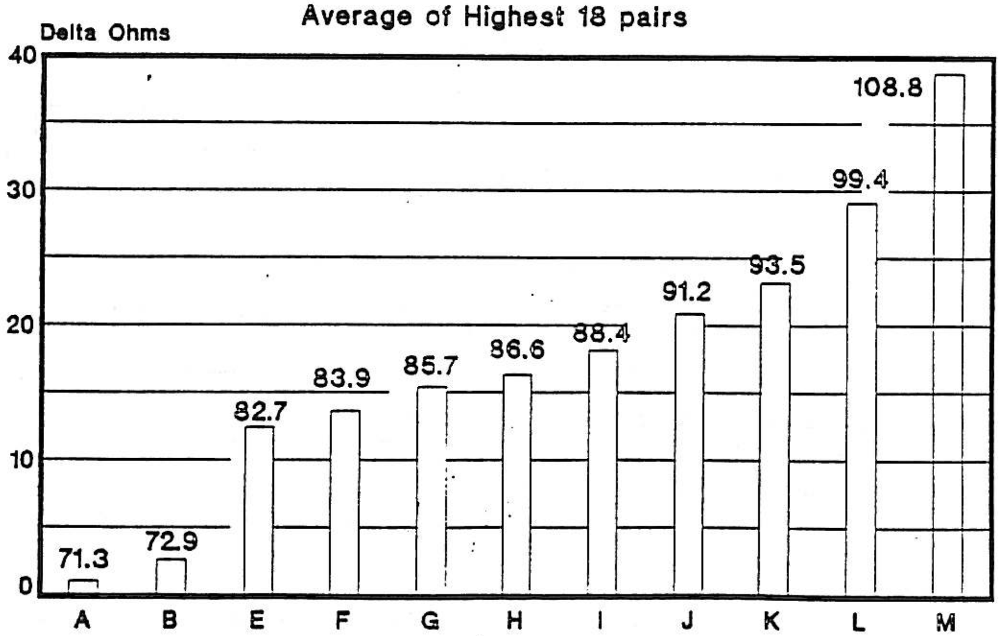
Date: 15 Feb 90
To: X3T9.2 SCSI Committee Members
From: Kurt Chan
Subject: Shielded Cable Evaluation

In X3T9.2/90-20 I presented the single-ended characteristic impedance data for 13 shielded cables taken by Tom Dibiec of Belden. Since then, I've performed yet another (and hopefully the last) set of single-ended cable tests in an attempt to correlate characteristic impedance with real-world SCSI behavior. Eleven of the original set of cables were cut to 5.4 meters and terminated with SCSI-1 connectors. The single-ended impedances for these cables are shown graphically.

Cable	Description	Cable	Description
A	Furukawa DT-882814	I	Astro 28/30AWG
B	Madison 4084	J	C&M 28AWG
E	Madison 4099	K	C&M 28/30AWG
F	Belden P1309	L	Furukawa DT-891055
G	Montrose SCSI-2	M	Berktek 28/30AWG
H	C&M 15030	X	Unshielded .050" Ribbon

Shielded Cable Test
Characteristic Impedance (SE TDR)
Average of Highest 18 pairs



Test Methodology

The figure below depicts the test fixture used. The fixture contains both the driving and receiving circuitry. A 16-bit data pattern is driven onto the cable and compared to the original pattern at the near end.

Two parameters were varied independently: the pulse width output by the pulse generator and the TERMPWR voltage. The pulse width measures the settle+compare time of the system, and the TERMPWR voltage indirectly measures the high level voltage and current margins of the system.

Resolution on TERMPWR is 10mV. Resolution on settling time is 100ps, but is rounded to the nearest nanosecond.

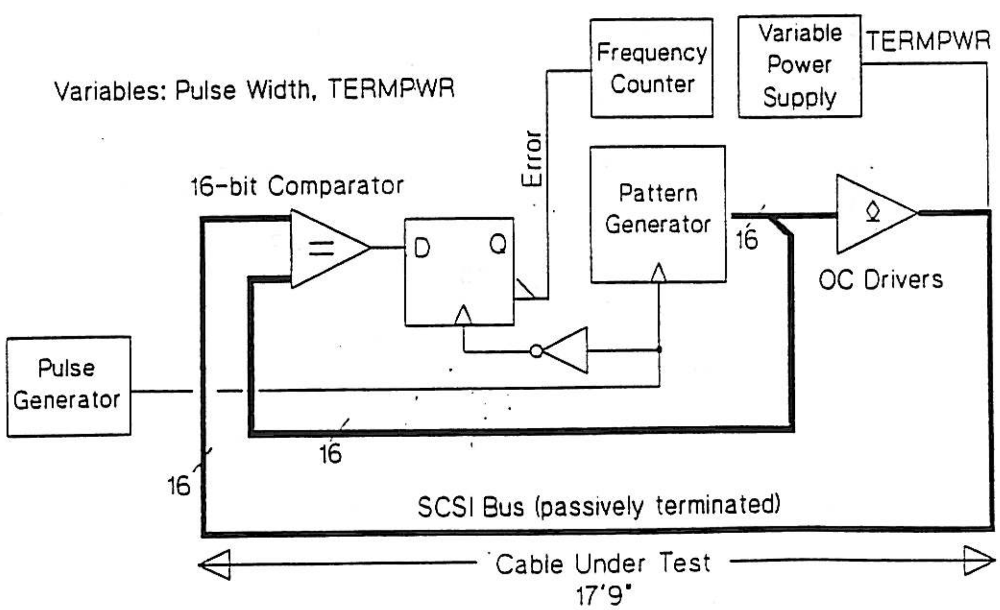
When settling time was measured, TERMPWR was held to 4.25V. When TERMPWR was being measured the pulse width was held to 100ns. In both cases the repetition rate was 5MHz.

The patterns used were pseudo-random, in addition to some walking transition patterns.

As an additional experiment, a 25 meter cable was tested with Alt-1 and Alt-2 single-ended terminators to determine differences in their ability to drive very long cables. Alt-2 terminations improved both settling time and low TERMPWR immunity significantly:

	Alt-1	Alt-2	Delta	Conditions
Settling Time	178ns	168ns	10ns	f=2MHz, V(term)=4.25V
TERMPWR	3.50V	2.87V	.63V	f=2MHz, 50% duty cycle

Shielded Cable Assembly Test Fixture

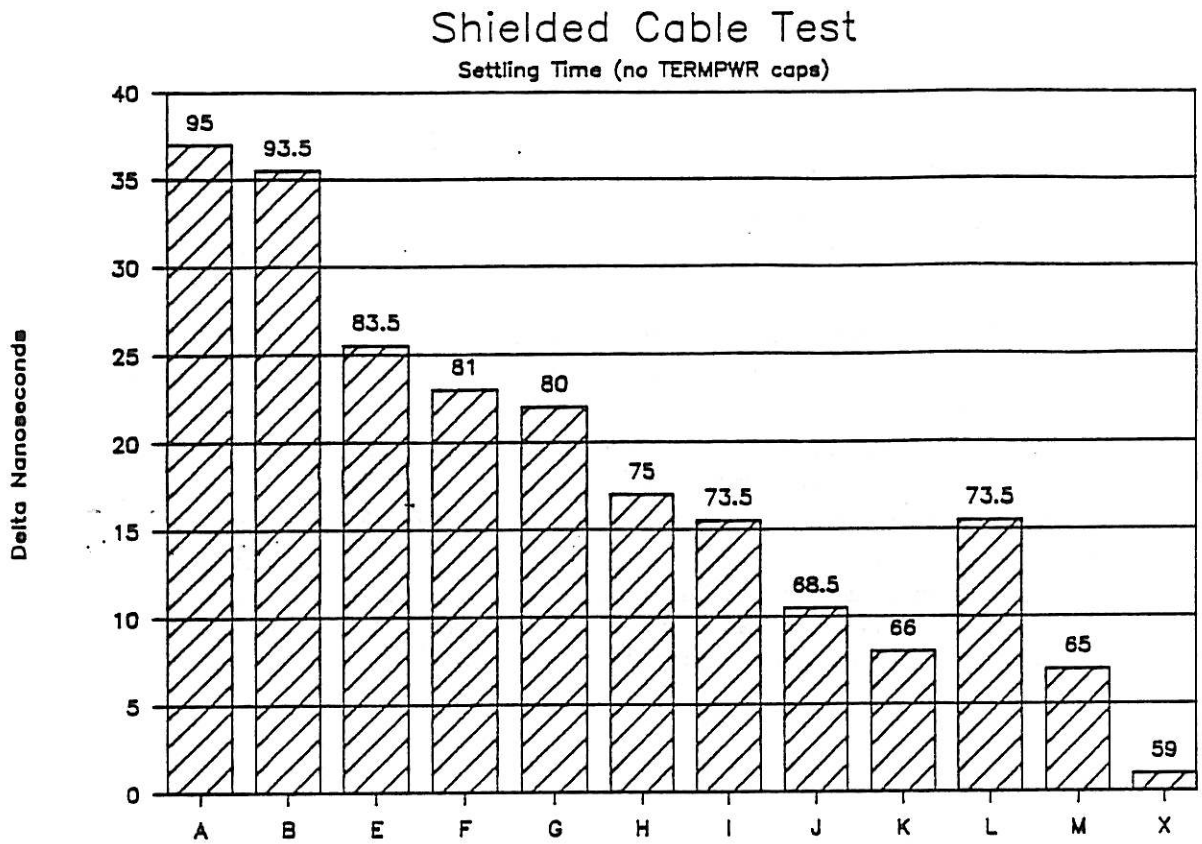


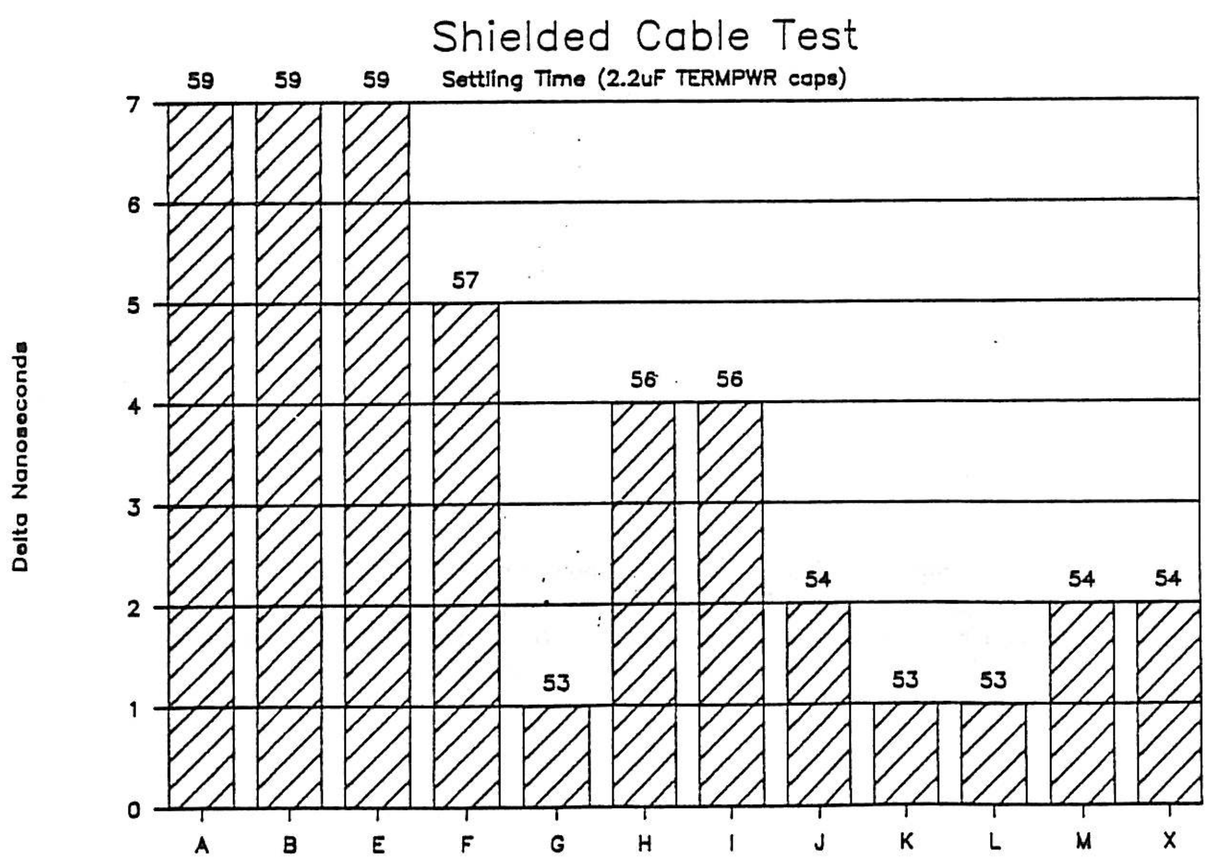
Conclusions

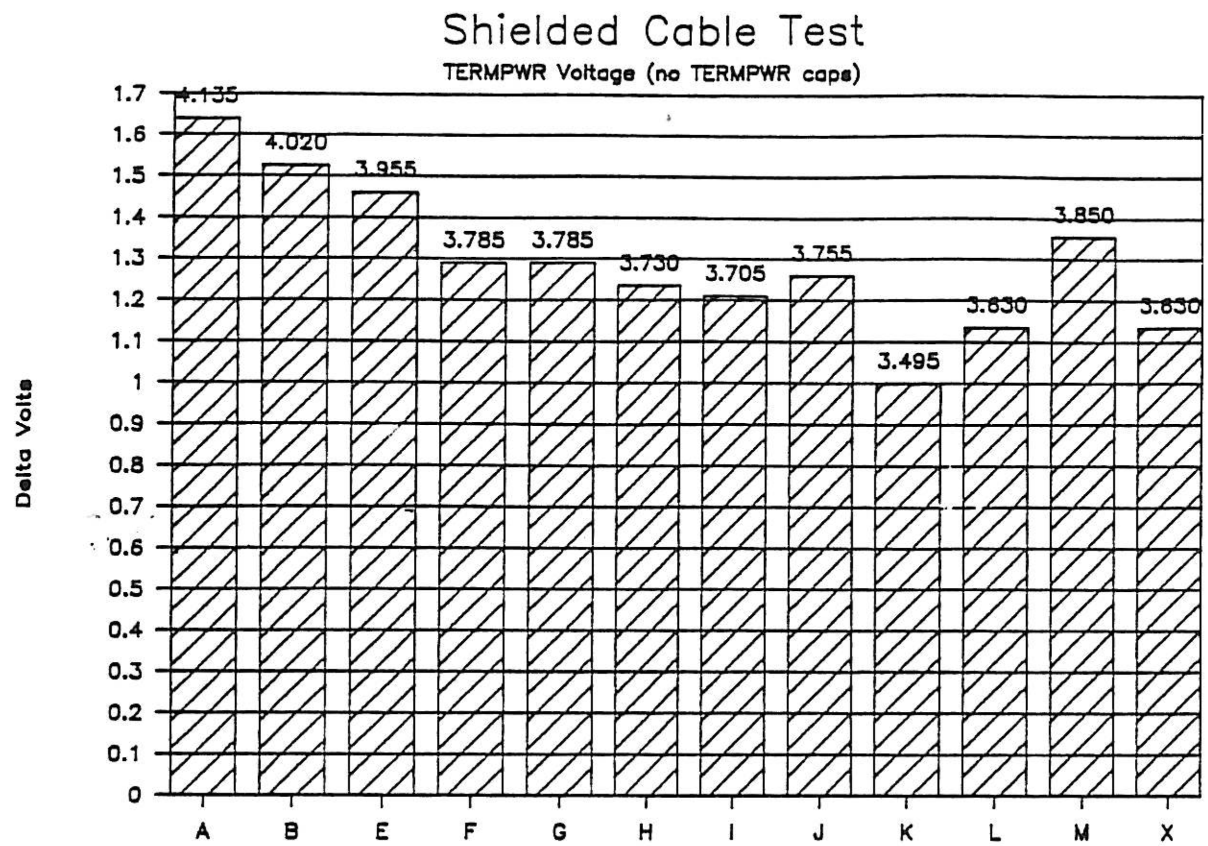
The results of the tests are shown on the next two pages. Each test was performed on the cables with and without TERMPWR capacitors. From this data and other experiments HP has performed, we have concluded:

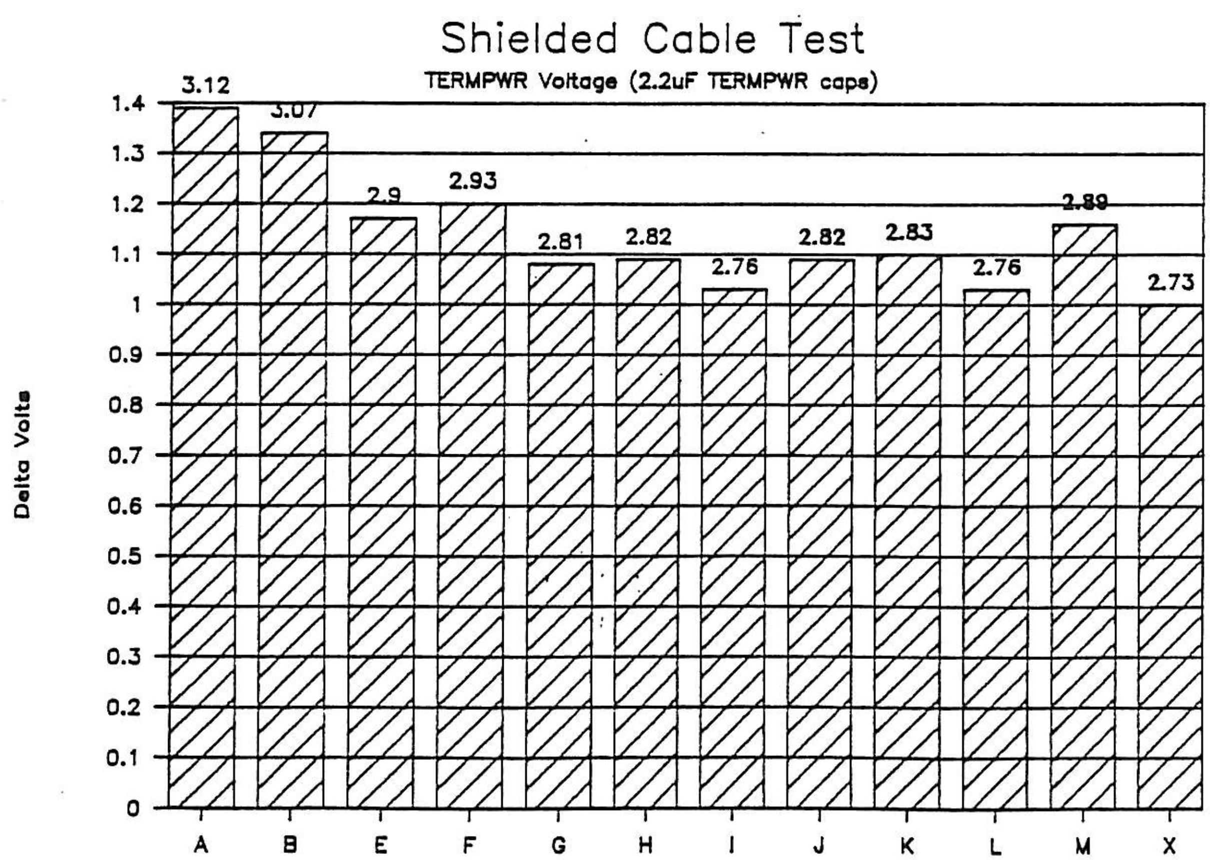
1. In general, the higher impedance cables withstood lower TERMPWR voltages and exhibited faster settling times than their lower impedance counterparts. There are exceptions, however the general trend is evident.
2. TERMPWR capacitors significantly reduced the both the settling times and the minimum TERMPWR voltage before failure, supporting previous evidence that they are crucial to an effective Alt-1 (passive) termination.
3. Higher impedance cables *can* cause problems in systems which have low impedance stubs, or which have sections of cable which have degraded impedance (such as ribbon cable adjacent to ground planes). This observation doesn't detract from the general recommendation to keep Z_0 high.
4. In general, good system design practices such as TERMPWR capacitors, Alt-2 termination, maximal device spacing, minimal device signal capacitance, etc. will *minimize* the measurable differences between highest and lowest impedance cables; the worst cables in the best environments will almost always outperform the best cables in the worst environments [1].

[1] For example, at 1.65ns/ft, we expect about 30ns delay in the cable. The logic accounts for another 25-30ns, giving a total of 55-60ns. With TERMPWR capacitors, the settling time graphs demonstrate how this ideal is realized (actual measurements ranged from 54-59ns). Without them, the best shielded cable was slower than the worst cable that had the capacitors!


Shielded Cable Test
Settling Time (no TERMPWR caps)
Delta Nanoseconds
0
5
10
15
20
25
30
35
40
95
93.5
83.5
81
80
75
73.5
68.5
66
73.5
65
59
A
B
E
F
G
H
I
J
K
L
M
X


Shielded Cable Test
Settling Time (2.2uF TERMPWR caps)
Delta Nanoseconds
0
1
2
3
4
5
6
7
59
59
59
57
53
56
56
54
53
53
54
54
A
B
E
F
G
H
I
J
K
L
M
X


Shielded Cable Test
TERMPWR Voltage (no TERMPWR caps)
Delta Volts
4.135
4.020
3.955
3.785
3.785
3.730
3.705
3.755
3.495
3.630
3.850
3.630
A B E F G H I J K L M X


Shielded Cable Test
TERMPWR Voltage (2.2uF TERMPWR caps)
Delta Volts
3.12
3.07
2.9
2.93
2.81
2.82
2.76
2.82
2.83
2.76
2.89
2.73
A B E F G H I J K L M X