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X3T9.2/90- 20 R0

Date: January 4, 1990
 To: X3T9.2 SCSI Committee Members
 From: Kurt Chan
 Subject: Shielded Cable TDR Measurements

Thanks to Belden and Tom Dibiec for performing these single-ended TDR measurements per the methods we agreed on in Raleigh (October plenary).

CABLES REPRESENTED

Cable	Description	Cable	Description
A	Furukawa DT-882814	H	C&M 15030
B	Madison 4084	I	Astro 28/30AWG
C	C&M SCSI-1	J	C&M 28AWG
D	Icontec E73138 28AWG	K	C&M 28/30AWG
E	Madison 4099	L	Furukawa DT-891055
F	Belden P1309	M	Berktek 28/30AWG
G	Montrose SCSI-2		

SINGLE-ENDED TDR IMPEDANCE

(cables listed from left to right in order of increasing impedance, 18 pair statistics assume SCSI signals are connected to the 18 highest-impedance pairs)

	A	B	C	D	E	F	G	H	I	J	K	L	M
Mean (25prs)	69.23	71.70	75.34	76.43	81.06	81.48	84.61	84.95	87.01	88.71	91.60	98.12	106.53
Mean (18prs)	71.27	72.89	78.00	79.49	82.68	83.93	85.71	86.56	88.41	91.18	93.50	99.44	108.83
SDev (18prs)	5.12	1.65	6.66	7.18	2.09	5.88	1.59	2.89	2.30	5.60	3.40	2.76	5.47
Skew (18prs)	11.62	5.78	16.14	19.39	8.13	13.92	5.28	9.15	7.51	16.12	10.87	6.81	15.59
Skew% (18prs)	16.30	7.93	20.69	24.39	9.83	16.59	6.16	10.57	8.49	17.68	11.63	6.85	14.33

Skew is the impedance difference between the highest and lowest impedance signal pairs.
 Skew % is impedance skew expressed as a percentage of the mean impedance.

RAW DATA

(The 25 pairs are listed in ascending impedance from top to bottom)

A	B	C	D	F	E	G	H	I	J	K	L	M
62.88	68.01	66.86	67.29	76.58	74.16	79.23	77.19	72.91	80.87	85.83	93.88	99.75
63.90	68.16	67.55	67.97	76.60	74.29	80.43	79.89	84.61	80.94	86.05	93.91	100.20
63.95	68.55	67.76	68.12	76.65	74.73	81.29	80.41	84.86	81.54	86.33	93.91	100.40
64.04	68.74	68.86	68.39	76.95	75.23	82.77	80.77	85.03	82.78	86.35	94.70	100.58
64.08	68.78	69.01	69.05	77.05	75.87	82.86	81.01	85.46	83.03	87.16	95.43	100.81
64.39	68.99	69.75	69.30	77.21	75.87	82.91	81.35	85.46	83.32	87.48	95.54	101.08
64.53	69.16	69.77	69.83	77.21	76.04	83.00	81.77	85.70	83.98	87.65	95.71	101.58
64.80	69.25	69.88	70.18	77.98	76.57	83.19	82.70	85.78	84.28	88.01	95.86	102.05
64.82	70.00	70.18	70.47	79.62	76.76	83.46	82.78	86.26	84.44	88.20	95.90	102.32
64.86	70.47	70.34	70.73	80.41	76.95	84.05	82.80	86.41	85.37	89.57	95.99	102.39
64.86	70.89	70.55	71.45	80.55	77.05	84.19	83.94	86.54	85.63	90.00	95.99	102.49
64.89	72.00	70.82	71.98	81.08	77.37	84.64	84.55	86.56	86.04	90.33	96.11	103.09
64.96	72.96	70.85	72.67	81.49	77.42	84.84	85.14	86.71	86.71	90.59	96.20	103.23
65.07	73.08	71.09	73.21	82.42	77.98	85.06	85.74	86.80	86.87	90.71	96.26	104.11
73.89	73.21	71.36	74.16	82.75	79.43	85.23	85.76	87.04	86.89	93.20	100.33	104.63
74.60	73.21	81.41	80.63	82.78	87.48	85.28	87.48	87.36	87.21	93.95	100.38	111.60
74.75	73.27	82.54	83.05	82.78	87.85	85.30	88.58	87.46	91.86	95.26	101.03	111.79
74.80	73.33	83.24	83.76	83.53	88.14	85.35	88.95	88.26	93.97	95.31	101.40	111.89
75.34	73.52	83.62	84.23	83.64	88.20	86.00	88.99	88.33	95.33	95.60	101.70	112.07
75.38	73.85	83.85	84.99	83.89	88.93	86.78	89.10	89.30	95.69	95.62	101.84	112.15
75.50	74.13	83.90	85.54	84.26	89.61	87.06	89.51	89.43	95.96	96.16	101.91	112.21
75.77	74.44	84.30	86.15	84.59	89.96	87.76	89.53	91.40	96.43	96.46	101.93	112.71
75.90	74.63	84.55	88.85	85.04	90.21	88.01	89.82	91.88	97.75	96.61	102.07	115.04
76.29	74.78	85.45	89.16	85.24	90.29	88.10	90.92	92.53	100.35	98.61	102.28	117.47
76.42	75.03	86.02	89.57	86.11	90.49	88.47	91.04	93.29	100.40	98.88	102.67	117.64

COMPARING DIFFERENTIAL vs. SINGLE-ENDED TDR MEASUREMENTS

In Raleigh, a question was raised as to whether or not there was a relationship between SE and Differential TDR measurements on shielded SCSI cables. The table below shows some data taken from four cable samples.

Cable	SE	Diff[1]	Diff[2]	Ratio[1]	Ratio[2]
C&M	75.34	121.71	118.49	1.615	1.573
4099	80.67	131.50	125.19	1.630	1.552
4084	71.70	112.75	108.72	1.573	1.516
Montrose	84.61	133.94	127.60	1.583	1.508
Mean	78.08	124.98	120.00	1.600	1.537
StdDev	4.94	8.41	7.32	0.023	0.026

LEGEND

SE	Tektronix 7812 single-ended TDR
Diff[1]	Tektronix 11802 differential TDR
Diff[2]	3-measurement differential method using Tek 7812
Ratio[1]	Ratio of Diff[1] to SE
Ratio[2]	Ratio of Diff[2] to SE

Conclusion: For the four cable samples measured, the single-ended measurements were $64 \pm 2\%$ of the differential measurements across both measurement methods. Dividing the SE TDR values in the preceding tables by 0.64 will give a rough estimate of differential impedance.