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Madison Cable Corporation

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Subject: SCSI-2 Cable Testing Procedures

Enclosed please find impedance test procedures for November mailing.

Sincerely,

Chuck Grant

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Quality Engineer

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Single Ended Characteristic Impedance Test Method For Round Twisted Pair SCSI Cables

This procedure provides a basic outline for measurement standardization. For measurement details the operational manual of the test equipment should be consulted.

1.0 EQUIPMENT

1.1 Single ended time domain reflectometer (TDR) with a 1 nanosecond maximum rise time. Example - Hewlett Packard 54120T

1.2 Precision impedance reference line. Example - 50 +/- 1 ohm coaxial cable

1.3 Test fixture - appropriate interconnection hardware to connect cable under test to reference line.

2.0 SAMPLE PREPARATION

2.1 Sample length - 10 feet.

2.2 Strip jacket back 1 1/4 inches maximum.

2.3 Pigtail braided shield back to jacket.

2.4 Strip conductor insulation back approximately 1/2 inches.

2.5 Electrically connect one wire of each pair to the overall shield.

3.0 MEASUREMENT

3.1 Connect conductor to be measured to center conductor of test fixture.

3.2 Connect shield and one wire of each pair to the shield or ground terminal of the test fixture.

3.3 Record the average reflection coefficient. The average shall be measured between 2 and 4 nanoseconds from the test fixture/cable interface.

3.4 Calculate the characteristic impedance as follows:

$$Zc = Zr\left(\frac{1 \pm P}{1 - P}\right)$$

Where: Zc is the measured characteristic impedance.
Zr is the average impedance of the reference line.
P is the average reflection coefficient.

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Differential Characteristic Impedance Test Method For Round Twisted Pair SCSI Cables

This procedure provides a basic outline for measurement standardization. For measurement details the operational manual of the test equipment should be consulted.

1.0 EQUIPMENT

1.1 Time domain reflectometer (TDR) with a 1 nanosecond maximum rise time. Example - Hewlett Packard 54120T

1.2 Precision impedance reference line(s). Example - 50 +/- 1 ohm coaxial cable

1.3 Test fixture - appropriate interconnection hardware to connect cable under test to reference line.

2.0 SAMPLE PREPARATION

2.1 Sample length - 10 feet.

2.2 Strip jacket back 1 1/4 inches maximum.

2.3 Pigtail braided shield back to jacket.

2.4 Strip conductor insulation back approximately 1/2 inches.

3.0 MEASUREMENT

3.1 The differential characteristic impedance shall be determined by one of the 4 options that follow.

3.2 For each measurement the average reflection coefficient shall be measured between 2 and 4 nanoseconds from the test fixture/cable interface.

3.3 Option 1 - Dual step differential TDR

3.3.1 Connect pair to be measured to the test fixture.

3.3.2 Shield and other conductors are allowed to float.

3.3.3 Record average reflection coefficient

3.3.4 Calculate the characteristic impedance as follows:

$$Zc = Zr\left(\frac{1 + P}{1 - P}\right)$$

Where: Zc is the measured characteristic impedance.
Zr is the average impedance of the reference line.
P is the average reflection coefficient.

3.4 Option 2 - Single step differential TDR

3.4.1 The reference line and test fixture are connected to the TDR channel containing the step generator output, plus one other channel.

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3.4.2 Connect pair to be measured to the test fixture.
3.4.3 Tie the overall shield and all other conductors to the scope ground.
3.4.4 Display channel 1 - channel 2 on TDR.
3.4.5 Record average reflection coefficient.
3.4.6 Calculate the characteristic impedance as specified in 3.3.4

3.5 Option 3 - Single ended TDR with a balun
3.5.1 The balun is connected between TDR and reference line.
3.5.2 The balun may introduce error to the measurement. A known load, (example - precision resistor matched to reference line) should be measured to verify measurement accuracy.
3.5.3 Connect pair to be measured to the test fixture.
3.5.4 Shield and other conductors are allowed to float.
3.5.5 Record average reflection coefficient.
3.5.6 Calculate the characteristic impedance as specified in 3.3.4

3.6 Option 4 - Single ended TDR using 3 terminal measurement technique.
3.6.1 Select a pair to be measured, tie all other wires and the shield together.
3.6.2 The first conductor of the pair, the second conductor of the pair, and the shield with the other conductors will be known as terminals 1, 2, and 3 respectively.
3.6.3 Connect terminal 1 to the center conductor of the test fixture. Connect terminals 2 and 3 to the shield or ground of the test fixture. Record the average reflection coefficient. Call this measurement Pa.
3.6.4 Connect terminal 2 to the center conductor of the test fixture. Connect terminals 1 and 3 to the shield or ground of the test fixture. Record the average reflection coefficient. Call this measurement Pb.
3.6.5 Connect terminals 1 and 2 to the center conductor of the test fixture. Connect terminal 3 to the shield or ground of the test fixture. Record the average reflection coefficient. Call this measurement Pc.
3.6.6 Calculate the characteristic impedance as follows:

$$Z_{char.} = Z_r \left(\frac{4\,(1 + Pc)\,(1 - Pa\,Pb)}{4\,(1 + PC)\,(1 - Pa)\,(1 - Pb) - (1 - Pc)\,(1 - Pa\,Pb)} \right)$$

$$Z_a = Z_r \left(\frac{1 + Pa}{1 - Pa} \right)$$

$$Z_b = Z_r \left(\frac{1 + Pb}{1 - Pb} \right)$$

$$Z_c = Z_r \left(\frac{1 + Pc}{1 - Pc} \right)$$

$$Z_{char.} = \frac{4\,Z_c\,(Z_a + Z_b)}{8\,Z_c - (Z_a + Z_b)}$$