Performance of Northwire Data*CELL*® Foundation Fieldbus Type H1 Cables in Improper Installation Situations

Test Report:

Purpose of the test:

The purpose of this test was to duplicate the conditions of an improper installation and examine the effects of those installation practices on the electrical characteristics of the test samples. The cable samples were tested for characteristic impedance, conductor-to-conductor capacitance and inductance.

Cables tested:

The following cables were tested:

1. Northwire DataCELL FF Type H1 Cable, Part number FH1-162-001, 16 AWG, 1 pair 100 Ω nominal cable.
2. Northwire DataCELL FF Type H1 Cable, Part number FH1-1616-001 16 AWG, 8 pair 100 Ω nominal cable.

Test and measurement instruments used:

Testing was conducted using a Hewlett Packard 4192A LF Impedance Analyzer with a HP 16047E Test Fixture.

Test methodology:

A 10 foot section of each cable was prepared by removing 2" of jacket and shielding material from each end of the sample. Each conductor under test was prepared by removing 0.75" of insulation from both ends. Measurement of the electrical parameters listed above was done at a frequency of 31.25 kHz with the exception of conductor resistance which was measured at 1 kHz. The testing proceeded as follows:

1. A straight 10 ft section of each cable was laid across a non conducive surface and tested for characteristic impedance, conductor-to-conductor capacitance, inductance and conductor resistance. Each of the tests was performed as outlined below.

    a. Characteristic Impedance: Characteristic impedance measurements were taken using a single ended technique similar to the Open and Short Circuit method outlined in ASTM D 4566. Test measurements were taken at a frequency of 31.25 kHz. The measurements and calculations are done as follows:

        i. The near end of the cable sample is secured in the 16047E test fixture while the far end of the sample is left open. An impedance measurement, Zoc, was taken.
        ii. The far end of the conductors under test were twisted together to create a short circuit and another impedance measurement, Zsc, was taken.
        iii. The following formula is used to calculate characteristic impedance based on those measured values:

$$Zo = \sqrt{Zoc \times Zsc}$$

Example calculation:

Zoc = 24180 Ω and Zsc = 0.4487 Ω

Therefore,

$$Zo = \sqrt{Zoc \times Zsc} = \sqrt{22480 \times 0.4487} = 100.4\ \Omega$$

b. Capacitance (conductor-to-conductor): Capacitance measurements were taken at a frequency of 31.25 kHz. The measurements and calculations are done as follows:

   i. The near end of the cable sample is secured in the 16047E test fixture while the far end of the sample is left open.
   ii. The capacitance measurement is taken and converted to the appropriate per unit length measurement specified on the drawing.

c. Inductance: Inductance measurements were taken at a frequency of 31.25 kHz. The measurements were taken as follows:

   i. The near end of the cable sample is secured in the 16047E test fixture, while the far end of the conductors under test are shorted.
   ii. The inductance measurement is taken and converted to the appropriate per unit length measurement specified on the drawing.

d. Conductor resistance: For this experiment the inductor resistance measurements were also taken on the HP 4192A Impedance Analyzer. This measurement was taken at a frequency of 1 kHz. The measurements were taken as follows:

   i. The near end of the cable sample is secured in the 16047E test fixture while the far ends of the conductors under test are shorted.
   ii. The resistance measurement, R, is taken and converted to the appropriate per unit length measurement specified on the drawing. The most common unit of measure is Ω/1000'.

      Example calculation:

      R = 0.1362 Ω

      The resistance value is divided by 20' because the value shown was a loop resistance value. That result is multiplied by 1000 to give the resistance per 1000'.

$$\frac{R}{20'} = \frac{0.1362}{20} = 0.00681 \times 1000 = \frac{6.81\Omega}{1000'}$$

2. The cable samples were then tightly coiled with a bend radius of approximately 2x the cable diameter. The electrical tests described above were repeated with the sample in this configuration. The results from these tests are shown in the tables below:

Part Number: FH1-162-001		
Description: 16 AWG, 2 pair		
	Straight sample	**Coiled sample**
Characteristic Impedance (Ω)	99.75	99.22
Capacitance (cond-to-cond) (pF/ft)	21.07	21.18
Inductance (µH/ft)	0.2188	0.218
Conductor Resistance (Ω/1000')	4.19	4.26

Part Number: FH1-1616-001		
Description: 16 AWG, 8 pair (2 pair tested)		
	Straight sample	**Coiled sample**
Characteristic Impedance (Ω)	99.3 99.8	97.78 99.56
Capacitance (conductor-to-conductor) (pF/ft)	20.71 21.00	21.35 21.19
Inductance (µH/ft)	.2160 .2220	.2150 .2214
Conductor Resistance (Ω/1000')	4.24 4.3	4.25 4.31