MI Heating Cable

INSULATION RESISTANCE TEST

Insulation resistance is measured between the heating cable sheath and the tails. nVent recommends that the insulation resistance test be conducted using a test voltage of 1000 Vdc, however in the absence of equipment with this capability, a 500-Vdc test is suitable to detect most installation related concerns.

Frequency

Insulation resistance testing is recommended at several stages during the installation process and as part of regularly scheduled maintenance.

• Before installing the cable – minimum 100 MΩ

• For pipe tracing

   − Before installing the thermal insulation – minimum 20 MΩ

   − After installing the thermal insulation – minimum 20 MΩ

• For snow melting, floor heating and freezer frost heave prevention

   − After the cables have been installed – minimum 20 MΩ

   − Continuously during placement of concrete, mortar, asphalt, etc. – minimum 20 MΩ

• Prior to initial start-up (commissioning) – minimum 20 MΩ*

• As part of the regular system inspection

• After any maintenance or repair work

* Under adverse weather conditions, or when the tails or terminal connections have evidence of moisture, lower insulation resistances may be encountered. Wipe tails, face of pot, and all terminal connections with a clean dry rag to eliminate moisture and retest.

Test Criteria
The minimum insulation resistance for a clean, dry, properly installed heating cable should reflect the values shown above, regardless of the heating cable length.

RESISTANCE (CONTINUITY) TEST

Resistance testing is conducted using a standard Digital Multimeter (DMM) and measures the resistance between the cold lead tails. This test should also be done after any maintenance or repair work.

Test Criteria
Measure the resistance of the nVent RAYCHEM MI heating cable with the DMM. Most MI heating cable resistances are less than 100 ohms. The approximate resistance can be calculated using the formula: Resistance (ohms) = Volts^2 / Watts. Voltage and wattage are printed on the heating cable identification tag.

INSULATION RESISTANCE AND CONTINUITY (RESISTANCE) TEST PROCEDURE

1.   De-energize the circuit.

2.   Disconnect the heating cable tails from supply wires or terminal block.

3.   Set megohmmeter test voltage to 0 Vdc or off.

4.   Connect the positive (+) lead to the heating cable sheath.

5.   Connect the negative (-) lead to both heating cable tails simultaneously.

Note: In cases where the opposite end of the heating cable does not terminate in the same junction box, it must be disconnected from the power supply or series connected heating cable and kept isolated from surrounding metal objects to avoid erroneous readings.

6. Turn on the megohmmeter and set the voltage to 1000 Vdc; apply the voltage for 1 minute. Meter needle should stop moving. Rapid deflection indicates a short. Record the insulation resistance value.

7. Turn off the megohmmeter.

8. If the megohmmeter does not self-discharge, discharge phase connection to ground with a suitable grounding rod. Disconnect the megohmmeter.

9. Check the resistance (continuity) of the heating cable between the two tails. Record the resistance value.

10. Disconnect the multimeter.

11. Reconnect heating cable tails to the supply wires or terminal block.

WARNING: Fire hazard in hazardous locations. Insulation resistance tests can produce sparks. Be sure there are no flammable vapors in the area before conducting this test.

FAULT LOCATION TESTING

MI heating cable is the most rugged heating cable available; however, damage does occur occasionally. Most damage occurs during installation due to bending too sharply, damage to the cable from welding torches, objects thrown on the cable, or cutting or drilling through the cable after installation. Using good installation practices and following the "Test Procedures" outlined in the installation manuals will reveal any installation problems and permit faults to be located and repaired prior to commissioning of the system. The distance a fault is located from the end of the cable can usually be pinpointed quite accurately. For embedded heating cables, a heating cable layout drawing will be required to determine exactly where the fault lies.

There are three common methods used for finding faults within a section of heating cable. An overview of each follows. Additional information on locating faults in MI cable is available from nVent.

1. Time Domain Reflectometer (TDR) method

2. Capacitance method

3. High Resistance Fault Locator method

Use Figure 1 to determine the actual cable length, L. This value is used in the calculations following to determine the location of the fault.
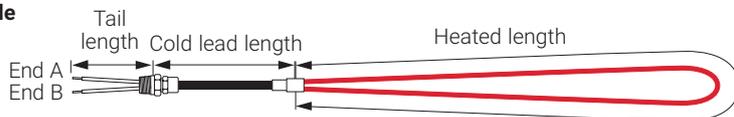
For the TDR and High Resistance Fault Locator methods, L is the sum of the total length of conductor(s) in the "heated length", the total length of conductor(s) in the "cold lead length" and total "tail length". For the capacitance method, L is the sum of the total length of conductor(s) in the "heated length" and the total length of conductor(s) in the "cold lead length". The "heated length" and "cold lead length" can be obtained from the heating cable tag. The "tail length" must be measured.
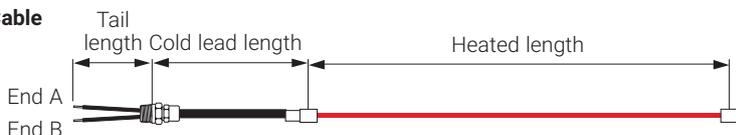
Design B Cable
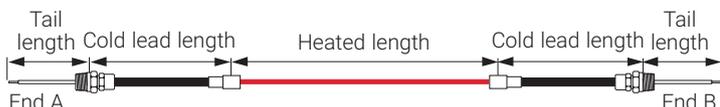
TDR and High Resistance Fault Locator methods: L = tail length + cold lead length + heated length + cold lead length + tail length
Capacitance method: L = cold lead length + heated length + cold lead length

Design A Cable

TDR and High Resistance Fault Locator methods: L = 2 x (tail length + cold lead length) + heated length
Capacitance method: L = (2 x cold lead length) + heated length

Design D Cable

TDR and High Resistance Fault Locator methods: L = 2 x (tail length + cold lead length + heated length)
Capacitance method: L = 2 x (cold lead length + heated length)

***Fig. 1** Determining Actual Cable Length L*

Time Domain Reflectometer (TDR) Method

Fault type: Open circuit, short circuit, wet joints

Instrument required: TDR, such as Bicotest model T631 (see Figure 2 and Figure 3), or equivalent
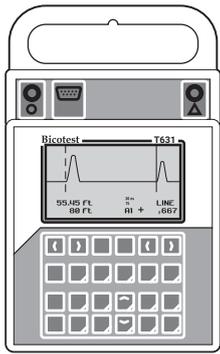
The TDR can locate faults, such as a "short to ground" or "break in the conductor", by sending a pulse along the conductor. When the pulse reaches the fault, it is reflected back and the distance is calculated by the TDR. The cold lead and tails must be included in the length when using the TDR. Refer to the TDR operation manual for complete details on using the instrument.

Fig. 2 *Bicotest Model T631 TDR*

The cable should be tested from both ends to locate the fault. This will also reduce the Propagation Velocity Factor (PVF) error. A value for the PVF must be entered into the TDR before use. For MI cable, the PVF is typically 0.39, but will vary slightly due to variances in manufacturing.
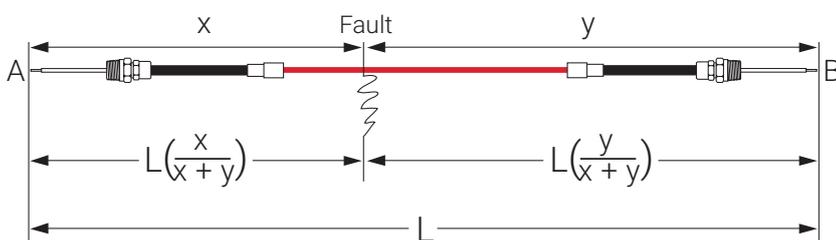
Test the cable from tail to sheath on end A (refer to Figure 1 and Figure 4) and record the "distance" reading (x) from the display. Next, test the cable from tail to sheath on end B and record this distance (y). If the sum of these two readings is equal to the actual cable length, L, the fault has been located.
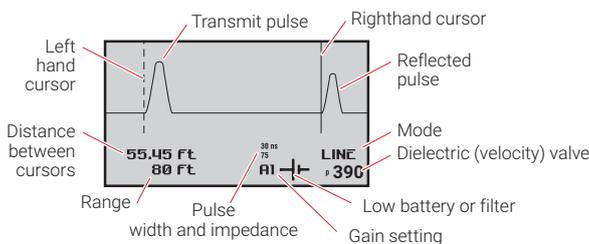
Fig. 3 *Typical Bicotest T631 TDR Display*

If the sum of the two readings is less than L, slightly increase the PVF and repeat the tests. If the sum of the two readings is greater than L, slightly reduce the PVF and repeat the tests. Differences in readings could also mean that more than one fault may exist in the cable.

The fault can also be accurately calculated after taking the first tests, without having to adjust the PVF, by using a ratio method (Figure 4). Divide each TDR reading (distance x from end A and distance y from end B) by the sum of the two TDR readings (x + y), then multiply each result by L. This will give the correct location of the fault from each end.

Distance to fault from end A = $L\left(\dfrac{x}{x+y}\right)$ from end B = $L\left(\dfrac{y}{x+y}\right)$

x + y may be greater or less than L, but the ratio of x to y will be correct.

Fig. 4 *Locating a Fault Using TDR Method*

Capacitance Method

Fault type: Open circuit

Instrument required: Capacitance meter (digital type recommended)

Use the capacitance meter to locate "open circuit" faults in the conductor. Insulation resistance must be at least 5 MΩ.

Test the cable from tail to sheath on end A (refer to Figure 1 and Figure 5) and record the capacitance reading (x). Next, test the cable from tail to sheath on end B and record the capacitance reading (y).

The location of the fault can now be calculated by using the ratio method in Figure 5. Divide each capacitance reading (reading x

from end A and reading y from end B) by the sum of the two capacitance readings (x + y), then multiply each result by the actual cable length, L. This will give the correct distance, not including the tails, of the fault from each end. The sum of the two distances should equal L.
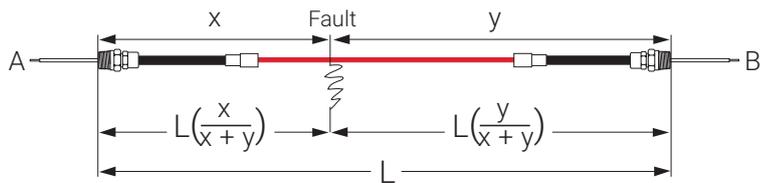
Distance to fault from end A $= L\left(\dfrac{x}{x+y}\right)$ from end B $= L\left(\dfrac{y}{x+y}\right)$

x = Capacitance measured from End A; y = Capacitance measured from End B
x and y must be in the same units (i.e. microfarads or picofarads).

Fig. 5 *Locating a Fault Using Capacitance Method*

High Resistance Fault Locator Method

Fault type: Short to ground

Equipment required: High resistance cable fault locator

The high resistance cable fault locator is used to locate a "short to ground" where the conductor continuity is okay, but insulation resistance is less than 1 MΩ. These instruments are usually based on a Wheatstone bridge, two arms of which are incorporated into the instrument. The other two arms of the bridge are formed by the cable's conductors on each side of the fault position.

They require an external 6-volt lantern battery as a separate voltage source. A potentiometer calibrated in percent permits the bridge to be balanced and the distance to the fault, from the negative end, is read as a percent of the actual cable length, L. Refer to the operation manual for complete details on using the instrument.

Connect the instrument to the tails as shown for design A, B or D cable (refer to Figure 6 or as shown in the operation manual) and "zero" the meter, using the coarse and fine controls, before connecting the lantern battery. Connect the lantern battery and "zero" the meter once more, but by adjusting the calibrated potentiometer. Record the percent reading (x); this is the percent distance from the negative end connection (end A) to the fault. Reverse the battery connection and the leads (negative lead to end B) and repeat the procedure to obtain the percent reading (y); this is the percent distance from the negative end to the fault, but this time from end B. The sum of the two readings, x + y, should equal 100.

The location of the fault can now be calculated by using the ratio method below. Divide each percent reading (reading x from end A and reading y from end B) by 100, then multiply each result by the actual cable length, L. This will give the correct distance of the fault from each end.

Design B Cable

Design A Cable

Design D Cable
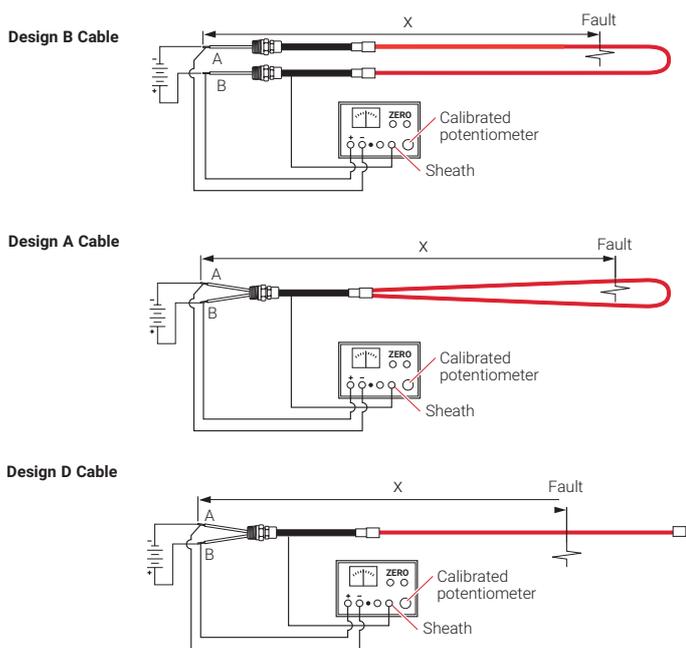
Using the following equation for all three cable configurations

Distance to Fault from end A $= L\left(\dfrac{x}{100}\right)$ Distance to Fault from end B $= L\left(\dfrac{y}{100}\right)$

Fig. 6 *High Resistance Cable Fault Locator Connections*

North America
Tel +1.800.545.6258
Fax +1.800.527.5703
thermal.info@nvent.com

Europe, Middle East, Africa
Tel +32.16.213.511
Fax +32.16.213.604
thermal.info@nvent.com

Asia Pacific
Tel +86.21.2412.1688
Fax +86.21.5426.3167
cn.thermal.info@nvent.com

Latin America
Tel +1.713.868.4800
Fax +1.713.868.2333
thermal.info@nvent.com

Our powerful portfolio of brands:

nVent.com   CADDY   ERICO   HOFFMAN   RAYCHEM   SCHROFF   TRACER

Raychem-ES-H58744-TestingLocatingFaults-EN-1805