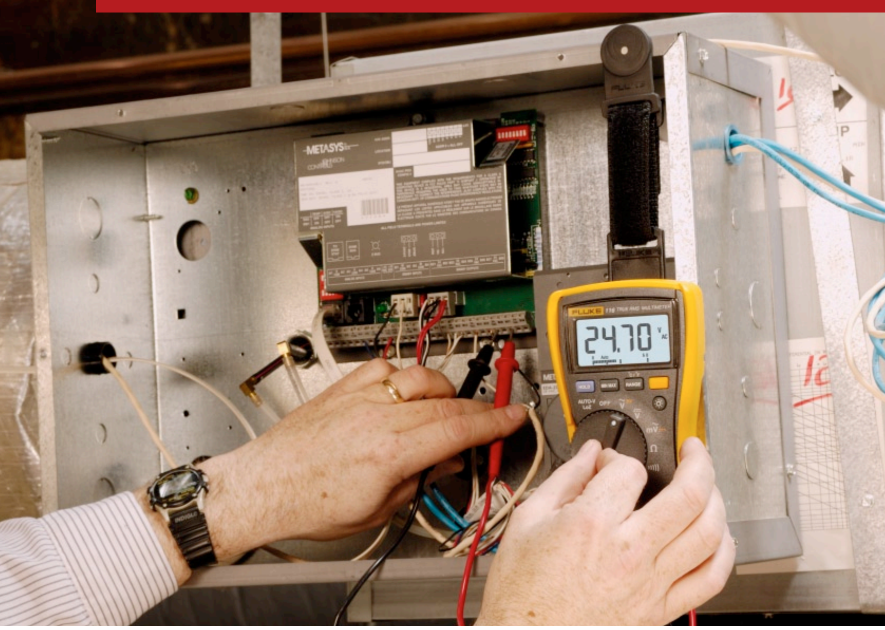
Troubleshooting modern DDC systems

Application Note

The vast majority of commercial buildings today include direct digital control (DDC) systems. These systems are also known by other names such as facility management systems (FMS) and building automation systems (BAS), and they're typically maintained by an HVAC controls technician. Building operations use these systems for HVAC system control, fault alarming, energy monitoring, and many other critical functions.

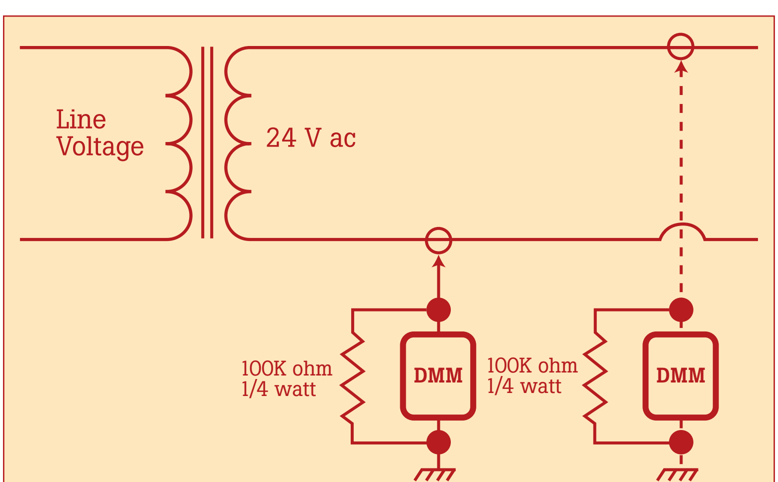


Properly operating these systems depends on following accurate installation and wiring guidelines for the various devices. For troubleshooting, use a high quality digital multimeter (DMM). Avoid inferior and older analog meters. This is a case where inaccurate or misleading readings can substantially affect your outcomes. Common problem areas include incoming power, ground loops, communications such as RS-485, inputs (both analog and digital), and outputs (both analog and digital).

This article describes several common troubleshooting and diagnostic procedures for DDC system wiring.

Testing for transformer isolation to ground

This test checks whether the transformer power supply is properly isolated from ground. If not, the controller communications may be disrupted. You can test the transformer secondary with a good digital ohmmeter to ground. The resistance between the secondary and ground should be above the manufacturer-specified level.



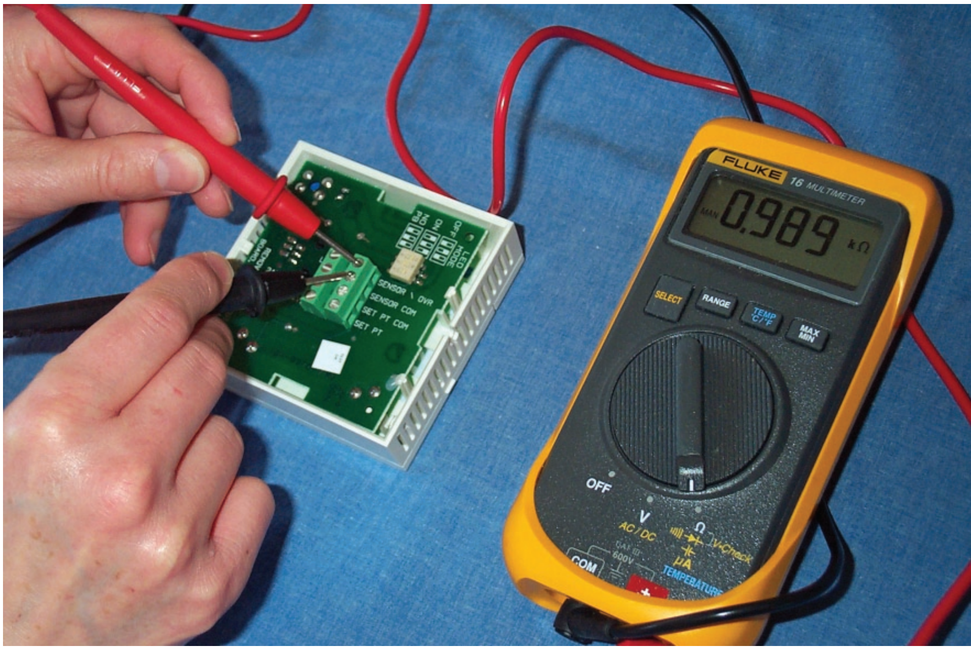
Testing for transformer isolation to ground.

Testing for RS-485 communications

Many DDC systems use an RS-485 Bus. This communication bus is a "daisy chain" communications line. Essentially, it consists of three wires that carry three signals: RS-485+, RS-485–, and REF. The RS-485+ and RS-485– lines carry the actual data signals. The Com line provides a common reference so that each connected device is capable of electrically receiving and transmitting data by creating a common voltage reference among all the devices connected together by the RS-485 Bus.

The system needs three wires. It is important that the RS-485+ and RS-485– lines are twisted together, because that allows most induced noise (common-mode noise) from external sources to affect both lines equally, thereby canceling it out. In most installations, the RS-485 Bus works fine with unshielded cable. However, in noisy environments, such as near gas ignition devices and arc welders, shielded twisted wire must be used. Otherwise, the noise disrupts RS-485 communications and the field controllers. Opto-isolation is another important feature of the RS-485 Bus. Isolation prevents interruption of all bus communication if any of the bus controllers become grounded.

This procedure will test for proper levels of RS-485 voltage on three wires; RS-485+, RS-485-, and Com. Fortunately, RS-485 voltage levels are standardized for many manufacturers. For instance here are the readings taken from a typical job:



Checking sensors.

Use a digital multimeter for these tests. If these voltage levels are not present, you have a problem with the communication trunk wire or one of the controllers. Test halfway across the length of the trunk for the proper voltages and then split in half again and again until you find the problem controller.

Testing for communication trunk isolation

Testing communication trunk isolation from ground is very similarly to testing power supply. Test the RS-485 communications wire to ground with a good quality digital ohmmeter. The resistance must be above a specific level or the communications trunk is not isolated properly. If it isn't, one of the inputs, outputs, or even the power supply may be improperly grounded.

Testing for analog input resistance values

You can easily check thermistors and other analog inputs by testing their resistance and matching that to a manufacturer-supplied chart. Use a good quality thermometer to determine if the sensor readings are on the proper spot on the chart. Thermistor type sensors can be either PTC or NTC. A PTC sensor will increase its resistance value as the temperature increases, and vice versa. An NTC sensor resistance value will decrease on a temperature increase, and vice versa.

Voltage from RS-485+ to RS-485– = +0.36 V dc to 0.92 V dc
(DMM+ probe on RS-485+ terminal; DMM- probe on RS-485– terminal.)

Voltage from RS-485+ to Com = +2.45 V dc to 2.98 V dc
(DMM+ probe on RS-485+ terminal; DMM- probe on Com terminal.)

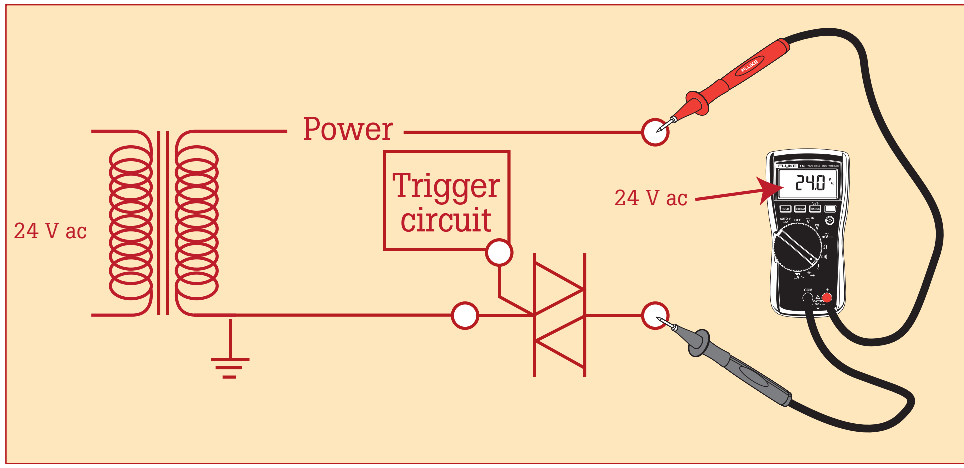
Voltage from RS-485– to Com = +2.06 V dc to 2.54 V dc
(DMM+ probe on RS-485– terminal; DMM- probe on Com terminal.)

The coefficient of a thermistor type sensor is the amount of resistance change per degree F change. For instance, a thermistor type sensor may have a coefficient of 2.2 Ω per degree F. This means that this sensor resistance value will change 2.2 Ω every time the temperature changes 1 °F. The base or nominal value is given as well. A common number that is used is 1000 Ω at 70 °F. This means that this sensor will have a base reading of 1000 Ω at 70 °F. If it's coefficient is 2.2 Ω per °F, and if it is a PTC sensor, then the resistance value will increase by 2.2 Ω for every 1 °F temperature change at the sensor. Using an accurate digital multimeter and thermometer, it's easy to find if the sensor is reading properly. Since 2.2 Ω per °F is commonly used, it's easy to understand why the resistance due to long wire runs can effect the reading of the sensor.

Sensor troubleshooting

To confirm that the element is functioning correctly:

1. Measure the temperature at the sensor using an accurate thermometer.
2. Determine the element resistance at ambient temperatures by applying the appropriate compensation (for models with nominal resistance values less than 1,000 Ω).
3. Measure the resistance of the sensor using an ohmmeter and compare actual and expected values.
4. Replace the sensor if the measurement indicates:
   a. open circuit (infinite resistance)
   b. short circuit (zero resistance)
   c. out of tolerance indicated for the sensor



Input/output tests.

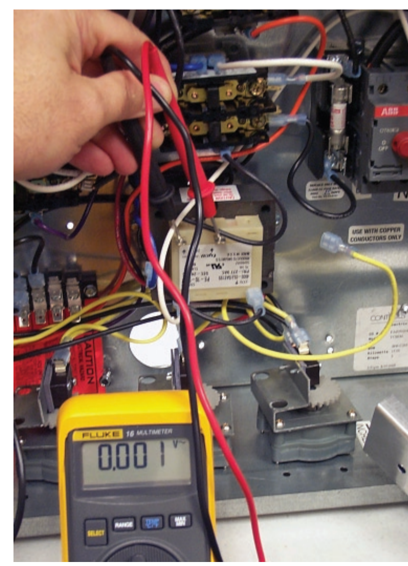
Testing digital inputs and outputs

Examples of digital inputs include the following:

- **Differential pressure switch:** Status/Flow
- **Current sensing switch:** Status for a fan, pump, etc
- **Occupied:** Time clock or supervisory control
- **Power meter:** Accumulator. A special function of a binary input that sets it up to count utility meter pulses.

Digital outputs are used to turn field equipment on and off. Many DDC systems use triacs (solid state relays) to energize and deenergize the control circuits.

It's easy to check the electrical continuity on digital input and output wiring. Disconnect the wires from the controller and digital device, connect your meter and read the resistance. Normally open and normally closed contacts must be set up properly. If 24 V ac should be present at a DO, the voltage can be easily checked with a digital multimeter.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Printed in U.S.A. 11/2008 3399479 A-EN-N Rev A