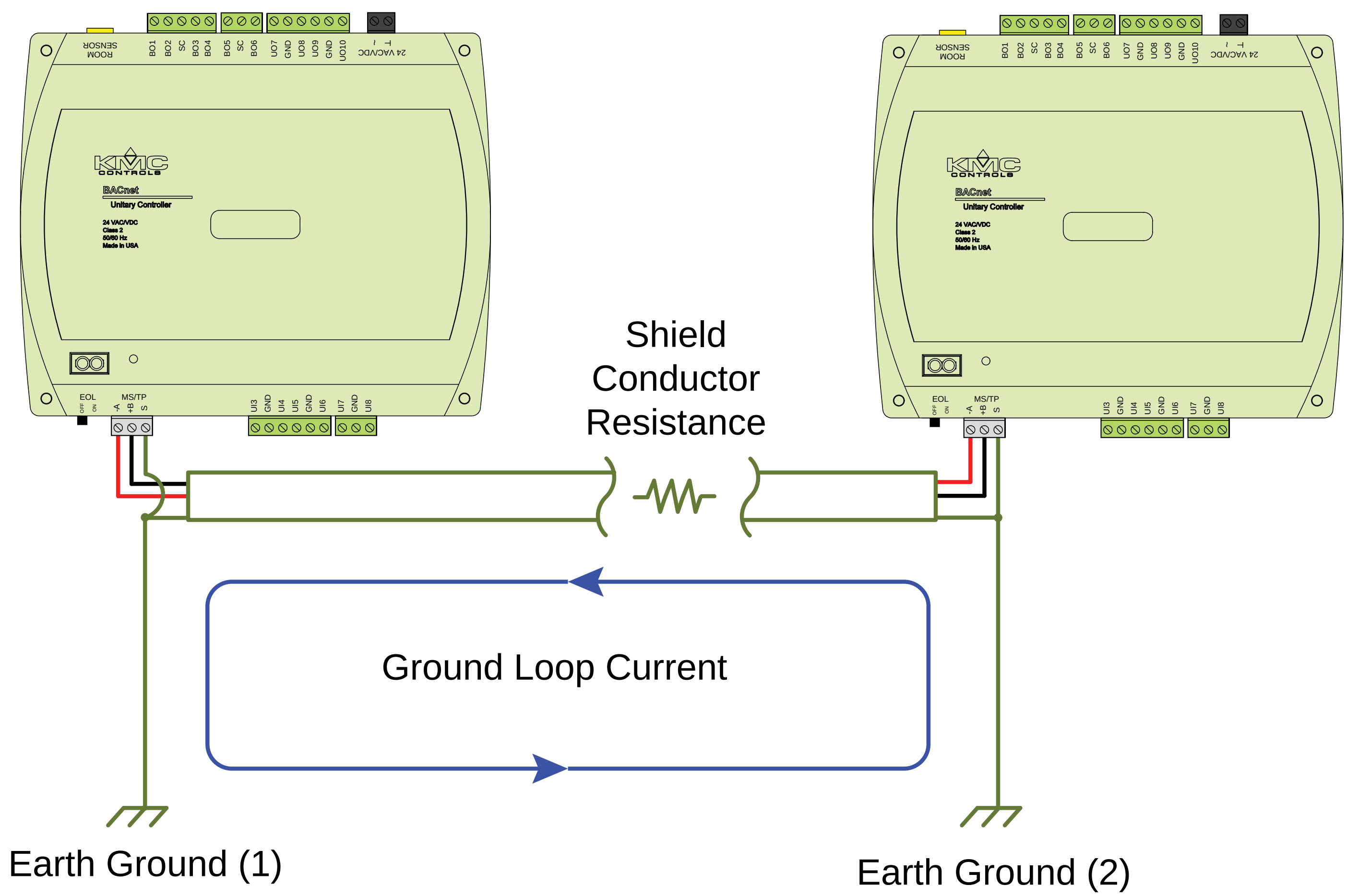
Avoiding and Troubleshooting Ground Loops

Application Guide



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Understanding Ground Loops

Ground loops occur in a network when a small voltage potential exists between two or more "ground" connections. This potential introduces an unwanted current in a signal path, adding noise to the network and possibly even damaging equipment.

All "ground" connections are not created equal.

- A **ground** is the general term for a common connection in an electric or electronic circuit that is often the voltage reference point.
- A **circuit ground** is the common connection for a particular circuit (which might be isolated from the earth ground).
- An **earth ground** is the connection leading to the earth (such as to the grounded conductor in a power outlet or a stake driven deeply into the soil) that is of zero electrical potential.
- A **floating ground** is a circuit ground not connected to earth ground.

Even an "earth ground" in one location may have a slightly different potential than an "earth ground" somewhere else. Connecting two "grounds" of even slightly different potential creates a loop with current flowing through it.

Even if two grounds have identical potentials, any conductor linking them must have some slight resistance. The small resistance results in a small voltage difference between one end of the conductor and the other when current is flowing through it. (A simplified diagram of this example is shown on the previous page.)

Since the impedance of the loop is low, even a few volts difference in potential can create several amps of current, **disrupting communication and perhaps even destroying components**. Making such a situation even worse, electrical storms may momentarily cause large potential differences, resulting in very high and damaging current flows.

Good network planning and wiring practices will avoid most problems with ground loops and save considerable time and expense.

Avoiding Ground Loops

With KMC devices, using **Ethernet** communications instead of MS/TP where practical greatly reduces the risk of ground loops:

- Use routers (e.g., **BAC-5051E**) with Ethernet connections for spans between MS/TP subnetworks.
- Use Conquest Ethernet-enabled "E" controllers instead of MS/TP controllers where applicable.

NOTE: Ethernet connections in KMC devices use in-circuit isolation that prevents ground loops. The BAC-5051E has a single, isolated MS/TP port that prevents it from passing ground loop currents.

NOTE: For more information about KMC Ethernet models, see the **Conquest Selection Guide**.

To avoid ground loops within **MS/TP** networks and subnetworks, however, take care to provide only one electrical path to ground and follow good wiring practices, such as:

- Connect the shield to an earth ground at one end of the network only.
- Connect the shields of the cables together at each controller. Do **not** connect the drain wire to the controller ground. KMC controller "S" connections are not

connected to the controller grounds, but other devices may have the equivalent terminal connected to their grounds. For such devices, use a wire nut instead of the terminal to connect the drain wires.
- Use 18 gauge, twisted pair, shielded cable with capacitance of no more than 50 picofarads per foot for all network wiring. Belden cable model #82760 meets the cable requirements.
- Connect the – terminal in parallel with all other – terminals.
- Connect the + terminal in parallel with all other + terminals.

NOTE: See more information in **Planning BACnet Networks (Application Note AN0404A)** in the Digital Designer's Guide.

In addition to network wiring, take care to keep **transformers** from causing ground loops:

- KMC recommends that the 24 VAC secondaries of transformers powering controllers should be **floating**.
- If the transformer secondary powering a controller is required to be **grounded**, careful thought must be given to the system design—especially if half-wave devices (such as KMC controllers) and full-wave devices are mixed. See **Tips for Connecting 24-volt Power (Application Note AN0604D)** in the Digital Designer's Guide for more information.

If **multiple grounded building transformers** are on separate floors or sections of a multi-story building, the difference in ground potentials of those transformers may cause ground loops. Some possible solutions under those circumstances include:

- Use **KMD-5575 network repeater-isolators** to connect different network sections or floors wherever there is a separate building transformer. (Up to seven repeaters can be used per MS/TP network.) This has the additional advantages of helping troubleshoot problems (since individual floors can be isolated) and providing additional protection to the controllers (from high-voltage spikes from contactors and other sources).
- Use **isolation transformers** on the secondaries of every transformer powering every controller. (Since there is some loss in any transformer, however, adding an isolation transformer may require a larger capacity than the original transformer provides.)

NOTE: When any MS/TP network spans multiple buildings, use a **KMD-5567 surge suppressor** wherever a network exits or enters a building.

Troubleshooting Ground Loops

Symptoms of ground loops in KMC controller networks may include one or more of the following network communication problems:

- Misreadings or no readings of inputs.
- Controllers dropping off the network.
- Inability to pass network points.
- Network bulbs illuminate.
- Multiple attempts required to open data screens.

Such symptoms may have other causes as well. To **troubleshoot** for ground loops:

- On a (floating) controller, measure the VAC from the phase terminal to an earth ground and repeat from the common terminal to an earth ground. No voltage (or only reactive voltage) should be read. If 24 VAC is read, there is a ground in the system.
- Check the connections of grounds and wiring at all controllers.

- Segment the network by disconnecting the network wiring and resetting the controllers to isolate the problem.
- Disconnect a length of wiring on both controllers and check for continuity between the conductors and ground. There should be none. Continuity may indicate the cable is severed or the insulation is broken, allowing a conductor to contact ground between the controllers.

Handling Precautions

For **digital and electronic** sensors, thermostats, and controllers, take reasonable precautions to prevent electrostatic discharges to the devices when installing, servicing, or operating them. Discharge accumulated static electricity by touching one's hand to a securely grounded object before working with each device.

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