You've got a bad fuse in your three-phase disconnect or combination motor starter. With several to pick from, how do you know which one is the culprit? Use these simple troubleshooting methods to find out quickly.

Ideally circuits should be de-energized to replace a fuse, but initial troubleshooting is sometimes done on live circuits. Remember, always wear the appropriate personal safety gear. The first step is to open the panel and visually inspect it for arcing or burning – good indications of a phase-to-ground fault that is popping the fuse. A damaged enclosure or component will require replacement.

The first step, after opening the enclosure, is always to test the line side voltage, which should be hot. After that, one of several methods can be used to isolate a bad fuse:

- **Current measurement:**
  Use a clamp to read the current on each phase: the phase with an open fuse will have zero current. Of course this assumes that normal loads are still running on the good phases. On three-phase induction motors, this method is particularly useful. That's because a three-phase induction motor will continue to run even if one of the phases is dead (unless control circuit power is drawn from that phase, in which case the motor starter will trip). Eventually, the motor will overheat and the overloads should trip. The condition is called single-phasing. A clamp can easily spot the open phase.

Of course, there is still the question of why the fuse opened. A clamp can also be used to test if overloading caused a fuse to open. Use a Fluke 337 with a min/max function, or a 180 Series DMM in min/max mode with a clamp accessory. Leave the clamp attached for a normal load cycle. You will be able to capture the worst-case load on the circuit.
• **Same phase voltage measurement:** Use a DMM or clamp meter in volts ac mode to measure across each fuse: one probe contacts the line side, one probe contacts the load side of the fuse. A good fuse will have zero voltage drop across it. There might be a voltage drop in the mV range due to the resistance of the fuse clips, but anything above this is suspect.

• **Phase-to-phase voltage measurement:** Connect one probe to the line side of phase A. Test for fuses on phases B and C by connecting the other probe to the load side of each fuse in turn. If fuses B and C are good, you will read normal phase-to-phase voltage (the same as if you had connected to the line side of phase B and C). To complete the test on the phase A fuse, move the line side connection to another phase (B or C) and connect the second probe to the load side of phase A. If a fuse is bad, you will read less than the phase-to-phase voltage. For example, if you were measuring from the line side of phase A, and there was a solid ground fault on the load side of B or C, you would read the phase-to-ground voltage (about 277 V in a 480 V system).

**De-energized circuits**

Once a bad fuse is suspected, the circuit should be de-energized:

• Open the safety switch or combo starter (turn the handle to off). Open the enclosure, but keep in mind that the line side (top) of the switch remains hot.

• Since the fuses are now isolated from the line and de-energized, it is possible to use the ohms function of a DMM or clamp meter to check them. Read across each individual fuse, line to load side. A good fuse will read close to zero ohms, indicating continuity. An open fuse will read infinite ohms (OL). Modern fuses will fail open, without partial resistance.

• Take an additional reading across the fuse clips, line to load. If there is even a low ohms reading, check the condition of the fuse clip. Old fuse clips that are losing their spring tension may not grip the fuse tightly enough. This can show up as overheating and discoloration of the fuse clip.

Fuses should always be pulled and replaced under de-energized conditions. Use fuse pullers designed for this job. In the event that you are ever required to pull a fuse in a live circuit (where two of the phases are still live), be sure to wear the proper personnel protective equipment. Remembering that the line side remains hot, pull the line side first and the load side second. When replacing the fuse, insert the load side first, line side second.