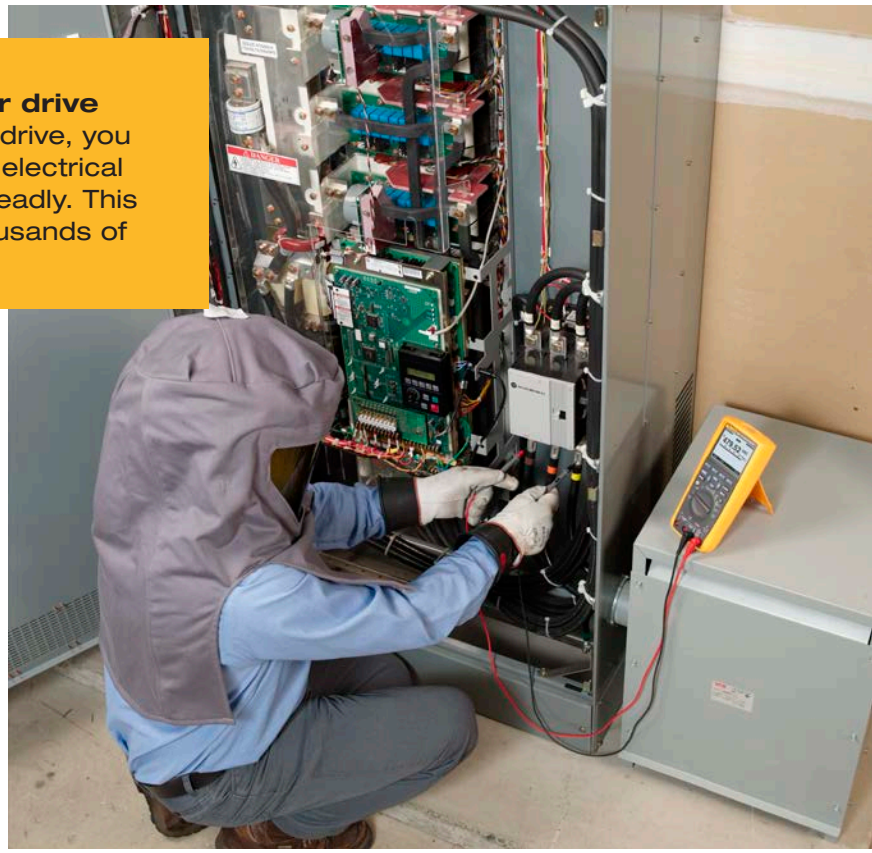
APPLICATION NOTE

How to troubleshoot a large motor drive safely

Use these guidelines with any motor drive
Any time you troubleshoot a large motor drive, you run the risk of both electric arc flash and electrical shock. Arc blasts are less frequent but deadly. This kind of shortcircuit can let loose with thousands of amperes of fault current.



An electric arc flash produces the highest temperatures on earth—up to 35,000 °F (19,426 °C)—causing all materials (metals, liquids, plastics—everything) to vaporize and expand explosively. The blast pressure can throw a person across a room, and spray a person with shrapnel and molten metal droplets. Aside from the primary danger of being burned, intense pressure and sound can cause physical injury and deafness. The input power requirements for a large motor drive puts it in the high risk category for arc flash.

Electrical shock is more commonplace. A slip of the hand and you or your tool connects with a live component. It happens when you're working too fast or you get distracted while working. Not as destructive as an arc blast, but still deadly.

To guard against either of these dangers, especially when working on large motor drives, always follow basic electrical safety procedures and wear the right personal protective equipment (PPE).

NFPA 70E regulations have changed

The National Fire Protection Agency (NFPA) 70E Standard specifies electrical safety practices and equipment for working on live electrical components. The standard categorizes test tools as part of PPE and maps out what level and extent of PPE to use for different risk levels. It also describes how to conduct an arc hazard assessment and what level of safety training is required in order to work in a live electrical environment.

Correct PPE will go a long way toward protecting you from electrical shock injury. For arc flash, it's a last line of defense. In neither case does PPE substitute for safe work practices or engineering controls that can reduce the danger of the exposure to arc flash.

To assess whether your test tools meet the requirements, look for the symbol of an independent testing lab such as UL, CSA, TÜV or other nationally recognized testing laboratrory (NRTL). That symbol can only be used if the product successfully completed third-party testing based on national or international standards. Only then will you know for sure that a digital multimeter (DMM) or other test gear design has been subjected to rigorous real-world tests, such as 12 kV positive and negative impulses applied to the input jacks.

Top SIX

Steps for troubleshooting any motor drive

1. **Prep checklist: Plan the job using NFPA 70E Annex E**
2. **Know the project details**
3. **Read the drive fault codes**
4. **Discharge the dc bus capacitors**
5. **Follow the next steps in the drive's instruction manual to isolate the fault**
6. **Look for improper installation as a fault source**

The drive troubleshooting process

Troubleshooting any motor drive is for trained, certified technicians only. NFPA 70E specifies workers must be qualified persons to troubleshoot in this environment.

Caution: never approach a variable speed motor drive without first obtaining its instruction manual.

Here's an overview of the entire drive-troubleshooting process:

- Complete a job-preparation analysis using NFPA 70E Annex E, the drive instruction manual, and local jurisdiction rules and regulations
- Photograph the drive and note any error codes
- Obtain the electronic or paper maintenance records for the drive
- Obtain the instruction manual (download it from the manufacturer's website if no paper copy exists). Read and understand all the "ATTENTION" (warning, caution) statements in the drive manual

- Disconnect lockout/tagout input power; verify your test instrument using a known voltage source or a qualified proving unit, then verify absence of voltage before opening any part of the drive
- Verify that the DC bus capacitors are discharged—wait a full five minutes, then check for 0 V dc.
- Follow the steps in the drive manual for troubleshooting

Prep checklist: Plan the job using NFPA 70E Annex E

NFPA 70E provides a "Electrical Safety Program" in Annex E. Begin by reviewing Annex E and the drive instruction manual. Here is what Annex E has to say, paraphrased and adapted for a motor drive:

Identify

- Hazards
- Voltage—input and output of the drive
- Skills required
- Any possible back-feed source once power is off
- Any unusual work conditions
- Number of people needed
- The shock protection boundaries
- The available incident energy (short-circuit fault current)
- Arc flash protection boundary

Ask

- Can the drive be de-energized?
- Can adequate time be set aside for downtime to finish the troubleshooting?
- Who needs to sign off on the shut-down?
- Is a "safety person" required?

Check

- Plant wiring plans.
- Drive manual.
- Plant safety procedures.
- History of the drive, maintenance records, and who is the in-house expert?
- Need updated information from the drive manufacturer?

Know

- Who else needs to know?
- Who is in charge?

Think

- About the unexpected event. "What if...?"
- Lock—tag—test—try.
- Test for voltage first.

- Use the right PPE, tools and equipment.
- Check all the grounding to make sure it conforms to the drive manual's instructions.
- Install barriers and barricades. Prepare for an emergency
- Is the standby person CPR trained? (Don't work alone.)
- Where is emergency equipment?
- Where is the nearest telephone?
- Where is the fire alarm?
- Might confined space rescue be required?
- How do you shut off everything in an emergency?
- Where is the fire extinguisher?
- Are radio communications established, if possible?

Know the project details

Start with the proper PPE. Determine the risk category for PPE by checking the input power requirements for the drive you're planning to work on. A system capacity of 460 V ac units = 85,000 amps symmetrical fault current capacity (65,000 amps if a circuit breaker is used instead of fuses.)

Read the drive fault codes

The drive displays alarm and fault codes to assist in troubleshooting when a problem develops during self-tuning or drive operation. If an alarm condition occurs, the drive continues to run and a two- or three-digit alarm code flashes on the display. If a fault occurs, the drive coasts to rest and display a two- or three-digit fault code.

Warning: Discharge the dc bus capacitors

After disconnecting input power, wait five minutes for the dc bus capacitors to discharge, then check the voltage with a DMM to ensure that the dc bus capacitors are fully discharged (0 V dc) before touching any internal components.

Follow the next steps in the drive's instruction manual to isolate the fault

1. Disconnect the motor from the drive.
2. Check all ac line and dc bus fuses.
3. If a fuse is open, use a multimeter to check the input diodes and output IGBTs.
4. Reconnect the motor to the drive.

Look for improper installation as a fault source

- Are the drive and motor grounded exactly as specified in the instruction manual?
- Are control signal wires and power cables in the same conduit? This can cause drive malfunction.
- Are unused wires in conduits grounded at both ends? They must be.

Following this process will enable you to work safely, avoiding accidental arc flash or electrical shock as you troubleshoot a large motor drive.

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