Troubleshooting VFD Problems

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When troubleshooting the electrical system that interfaces to your drive, remember that many areas outside of the drive can cause the drive to react adversely. Here are some tips to follow.

The service department of a variable frequency drives manufacturer frequently sees the following scenario: A frustrated user calls with what he perceives to be a defective piece of equipment. As the technician begins probing for information, the user's frustration boils over, often with an exclamation along the lines of "what a piece of junk!" As the service technician asks the pertinent questions, the exasperated user relays the details of a drive that is continually tripping on a fault until the user is at the end of his rope, not knowing what to do.

Modern variable frequency drives are a marvel of technology and can often be a bit intimidating to those unfamiliar with power electronics. With this in mind, let's examine the factors that can contribute to incorrect performance of a drive unit with the assumption that the drive still turns the motor correctly.

If we rule out internal problems with the drive, what else can cause a drive to run poorly?

When troubleshooting VFDs, start with a thorough visual inspection; clean any dirt, dust and corrosion from the drive; check all wiring connections for tightness; check line voltages and current coming into the drive; and check the drive output for voltage and current.

Remember that a drive is a sensitive electronic device. Unlike equipment that is run across the line, it is not designed to provide maximum power to the load until the motor or the system collapses. The drive will respond to fluctuations in system conditions and eventually drop off on a fault indication, depending on what part of the system is malfunctioning.

So how does one go about diagnosing this type of drive problem?

The best way to start looking for problems in the system is to take a system-wide approach. This sounds a bit simplistic, but let's look at the approach. When diagnosing fault tripping in a drive system, begin with the basic preventative maintenance overview. Laying out the steps of a good PM schedule is essential. These steps are as follows:

1. *Check the system over with a good visual inspection.* Look for running or dripping water, high humidity, excessive temperature extremes, excessive dirt or contaminant debris, and corrosive agents located near or under the equipment.

   Here's a good rule of thumb: If you would not place a television near the drive because of the physical environment, then the drive may have problems. If the drive does not have a sealed enclosure to handle rough environmental conditions, care must be taken to protect the drive assembly.

2. *Clean the drive of dirt, dust and corrosion.* Depending on the environment, there may be significant problems with contaminants. The drive should be relatively clean. Do not allow significant amounts of dirt to build up on the heatsink of the drive. This may prevent sufficient cooling of the drive semiconductors and may damage cooling fans and cause overtemperature problems.

3. *Check all wiring connections for tightness.* Loose connections in the wiring of the drive to the incoming power and to the motor are a major cause of drive failure. As the drive performs day in and day out, the constant cycle of increasing in temperature and subsequent cooling can cause the connections to loosen over time.

   Depending on the manufacturer of the unit, the wire used may be highly stranded for flexibility. This type of wire may be difficult to keep tight. Loose connections can contribute to overcurrent trips, destroy IGBTs, cause input rectifiers to fail, and burn terminals on contactors and switches.

4. *Check the line voltages and currents coming into the drive.* These voltages should be balanced within five percent. Unbalanced line voltage can cause significant problems. Check the current coming into the input of the drive next.

   Current levels can differ a bit more from phase to phase without causing too much concern, but there is the possibility of finding one line completely dead. Remember, most drives today can still run the motor with one phase of the incoming power missing.

5. *Check the drive output for voltage and current.* The drive produces the waveform going to the motor. On most drives, the voltage from the inverter section should be balanced within a couple of volts and the current should be balanced, as well. Large variations cause the motor to shake violently and can cause motor problems.

These are the basic first steps to determining the problem with any given drive. This process should be done on a periodic basis. If these procedures are followed, most problems can be eliminated and the drive should deliver trouble-free service for many years.

Modern drives are amazingly reliable. With advances in semiconductor technology and increased buss capacitor performance, many of the problems that previously plagued drive manufacturers are all but gone. All of the major drive manufacturers build a relatively sturdy and reliable drive. Minimum internal failures ever occur. Problems outside of the drive now contribute to a large number of drive failures and are a major cause of nuisance tripping.

So how does one look for the source of the problem? Think of your drive system as a group of areas working in

For pumps with flat pump curves or when suction pressure varies, some drives offer enhanced sleep functionality to optimize control for shutting down the pump at low flows. Other drives use dry pump detection to protect the pump against damage should the operation run dry. Still others have pipe fill mode features that prevent water hammer.

harmony. When the system has a problem, divide the system into pieces to determine where to start looking. The major areas are as follows:

- The input system
  - o Branch circuit protection
  - o Input contactor from the motor control center (if used)
  - o Wiring from the motor control center or branch circuit
  - o Input to the drive (disconnect switch or contactor)
  - o Input bridge
- The drive itself
- The motor
  - o Motor overload (if used)
  - o Motor wiring and conduit
  - o Motor disconnect (if used)
  - o Wiring to the motor
  - o The motor itself

Problems with the input to the drive can cause a number of failures. A drive can experience overvoltage or undervoltage trips due to line surges or sags. Or, a drive may experience overcurrent trips or possibly a motor-related fault such as an overload.

When dealing with these kinds of faults, a timeline can be very helpful. Document the time of day that the trips occur and then try to determine a pattern. Perhaps the unit trips every day about 10:00 AM. Perhaps the unit trips on undervoltage when the weather gets above 100-deg F. If a pattern of these trips can be established, then a plan of attack can be developed. Remember that the drive is reacting to outside problems by tripping off.

Many other problems can cause the drive input to react. If you suspect a problem with the input power, it may be advantageous to have a power quality testing company install moni-

Many problems outside the drive can cause adverse reactions from the drive, so it is important to also consider the input system and the motor.

What's a Megger?

Megger stands for meg-ohm meter. The meter has a voltage charge that is generated and then takes a meg-ohm reading of the insulation at the voltage of the generated field to earth ground.

This type of reading gives the technician an indication of the relative strength of the insulation in meg-ohms at applied voltage of the meter – the smaller the number, the weaker the insulating properties of the wire to ground.

High meg-ohm readings indicate a good insulating factor of the motor, and very low readings indicate a motor that is about to allow electricity to leak to the ground of the frame.

toring equipment and diagnose the line problems. Poor power quality will often cause needless drive fault trips.

Moving to the back of the drive, we can examine some motor-related issues that are a source of many unresolved fault trips. If problems are suspected with the motor or the attaching wire, it is best to apply a Megger to the motor system.

Much confusion about this exists in the field. Try to start the process with the wires coming from the drive. My suggestion is to use a 1000-V Megger (meg-ohm meter) if one is available, but a 500-V Megger will do. Do not use the Megger

on the output of the drive! A Megger will destroy the IGBTs if used on them, particularly an electronic Megger. The voltage spikes will exceed the peak inverse voltage of the IGBTs and cause them to deteriorate. This will eventually cause a defective transistor.

The reason for starting with the wiring from the drive is to divide and conquer the system. All too often, the motor is disconnected at the junction box, only to find that the motor is fine and that the problem actually started with the wiring to the motor. Start with the wire and the motor. If a ground fault is detected, a simple process of elimination will find the problem.

An example would be a situation in which a T1 lead is found to go to ground. Starting with the wire, the next step is to go to the motor disconnect switch (if installed) and disconnect the motor. If the problem goes away, then the problem is with the wire. If the problem persists, then go to the motor. Remove the bindings at the motor and Megger it. If the problem goes away, the problem is with the wires. If the problem is the motor, you must remove the bindings anyway to replace the motor.

When performing this test, remember that most wire is not rated to be submerged in water. A flooded conduit will break down and begin to leak the current to ground. This condition often starts as an overcurrent problem before the drive begins to ground fault trip.

So a situation can arise in which you've already experienced a ground fault trip, but can't find any ground faulting in the system. This may be due to dampness in the motor system, which can be addressed by reprogramming the drive to dehumidify the motor by passing a DC current through the system while the motor is resting. Most major manufacturers of quality drives have a program provision to allow you to "dry out" a motor with the program point. Check the owner's manual for this information.

As you can see, many areas outside of the drive can cause the drive to react adversely. Careful examination of these areas will eliminate much distress and provide a long and trouble-free life for your system.

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