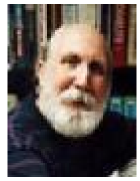


Shop "Tech Talk"   July 2008

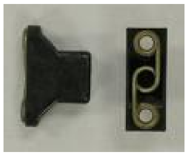
Troubleshooting Electric Motors:Part 3A, Motor Starters

In this note I am going to discuss the 3 phase motor controlled by a standard magnetic motor starter and the same 3 phase motor controlled by a VFD (variable frequency drive). In each case I will assume the motor was running fine and then it suddenly stops for some reason. The tech note is primarily aimed at persons new to industrial maintenance departments.

Case 1, Motor Controlled by Magnetic starter:

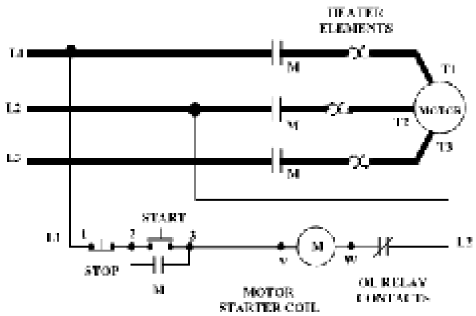
A magnetic starter consists of a contactor connected to a current overload assembly. The contactor part can be likened to a large relay that is operated by applying voltage to the coil of the relay. This voltage can be an ac or dc voltage. In most cases it is 120v ac which is usually supplied from a control transformer close by. If 120v is not used then in order of popularity of use the coil would probably be supplied with whatever voltage the line is . The motor starter is a robust unit and not easily damaged and usually lasts a long time. The overload relay(O/L) is mounted below the contactor part and attached to it. The O/L can have an adjustment screw with a current range associated with it or it may simply have 2 or 3 'heaters' installed in it. These heaters are sized from a chart provided by the manufacturer of the starter so that the correct heaters are installed for the full load current of the motor in question. If the motor is a 10 amp full load motor then you would select heaters for a 10 amp load from the chart (the service factor has already been applied to the heater chart so you do not have to make allowances for this. Below are some photos of starters and their components that will probably be familiar

Adj. O/L



Different Mfrs heaters

It needs to be said that the overload block senses the current on the motor thermally and, if the current and thus heat should rise beyond its set point for a specified time then the mechanism inside the overload block will heat up, trip out, and allow a set of normally closed contacts to open. These contacts are wired in series with the coil of the magnetic starter and when they open the coil voltage will disappear and the contactor part will drop out and de-energize the motor. There are also electronic overload protection units that sense current directly and they are far more accurate and reliable.



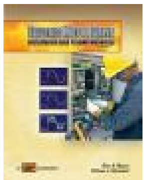
In the schematic to the left we can see that the coil part of the circuit is fed from 2 lines directly off the line , there is no control transformer. This drawing is a standard 3 phase 3 wire start/stop circuit and should be memorized to the point that you can see it in your mind's eye and can write it out at the drop of a hat !! The heater elements are shown in series with the motor and they carry whatever current the motor does. The OL relay contacts are shown, which are associated with the heaters. With this sort of set up if a motor that was running suddenly stops and the starter drops out you should be able, with your meter to verify where the problem lies. In the real world there can be multiple 'stops' ,all in series with the stop pushbutton and also multiple 'starts' all in parallel with the start pushbutton.

The approach should be as follows if the contactor drops out:

- **Does the contactor pull in when we push in the start pushbutton and hold it in? Does the contactor drop out if I let go of the start pushbutton? If the contactor drops out then the maintaining contact 'M' in the schematic (across the start PB) may be bad or not making contact when the contactor pulls in.**
- **Do we still have line voltage available? If not check fuses or breaker further up the line.**
- **Did the starter drop out because the motor overloaded .If so we have to reset the OL after it has cooled down.**
- **If one of the main power contacts was bad then the motor might have 'single phased' and pulled a lot of current. Most starters for sale today will trip out if a single phase condition occurs. If you measure the voltage across (ie from line to load side) for each main power pole on the contactor the voltage drop should not exceed 1 volt. It is important to measure all 3 voltage drops and compare them to each other to see if a particular power pole indicates a problem.**
- **Is the coil good, measure its resistance to see if open.**

Shop "Tech Talk"   July 2008

Troubleshooting Electric Motors:Part 3B ,VFDs



Written below is an overview of some of the possible problems, knowledge and advice needed to help 'new' technicians who are called upon to troubleshoot VFD/Motor combinations. It can not be a fully comprehensive solution to this topic. For a much more complete treatment of the subject I would heartily recommend the following book........'Electric Motor Drive Installation and Troubleshooting', by Glen A Mazur and William J Weindorf, published by American Technical Publishers (ATP) $62, 473 pages , 283 illus.;2003

1. As you probably already know the VFD is an electronic speed controller and it works by supplying a variable voltage and frequency to the motor in order to vary its speed. The ratio of voltage to frequency remains a constant,in the case of a 460v , 60Hz drive the ratio is 7.66:1. There are several things a troubleshooter can measure to decide if the drive is OK. If the drive is determined to be bad then it should be sent off for repair and/or replacement, as most repairs are outside the scope of most small industrial plants.
My experience is that a drive will work perfectly day in and day out, up to the point of failure, and then it is 'kaput'.
As a technician it is to our advantage to 'allow' the drive to operate in the best conditions we can, thus assuring a long , fault free life for the drive. What are some of these conditions? Well because it is electronic it has temperature limitations ie it can only get just so hot and then it will fail. So our job is to ensure that we keep it as cool as we can either by fans or air conditioned space or keeping its filters clean. It is also important to keep the drive dry—free from condensation and moisture.
I have often asked , if you personally had a $1,000 television set would you like it to operate where the drive is situated?
You may say that when it was installed no real provision was made for this to happen so why bother now.
I suggest that if the drive works flawlessly for as long as it possibly can then it will do more work or make more 'widgets' and thus help the company you work for to be more successful plus it will create less problems for you—a winner all the way around!

2.The most crucial time for a VFD is its initial installation and the next most crucial time is if it has been removed from service and then is reinstalled in its location. *This same logic applies to an electric motor*. A good installation guarantees our best chance for success.
3.A VFD has to have the input power connected to it, and 3 lines connectedfrom the VFD to the motor. Here is the first chance to blow up the drive. DO NOT ASSUME THIS IS EASY! In fact it is your first test and the most important thing you have to do. Do not assume that the voltage of the drive is the same as the voltage where you have to install it. Read the nameplate on the drive! Drives are not dual voltage rated like motors, they are single voltage rated.
A lot of drives do not have L1,L2,L3 as input wires and T1,T2,T3 as the motor terminals. Instead they may have R,S,T, as power input terminals and U,V,W as the terminals that connect to the motor. Also the input terminals may not be physically above the output terminals ,they may be in the same line. *Be sure you connect the right wires to the right terminals*. If you are not sure ASK!

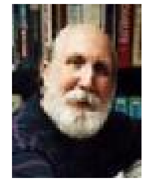
4.Once the drive is hooked to the power and to the motor correctly we are half way home. At this point if the drive has a digital keypad you should be able to RUN and STOP the motor, *be sure the speed control is set for minimum speed so that you can ramp up the motor slowly while looking at the current of the motor, we don't want any full speed surprises here*!

5.Now lets say that we have been in production for some time and the drive suddenly 'faults' out. You are called to investigate it. What do you do? The first thing to notice is what fault the readout is indicating and is the code flashing or steady. At this point you need to access the manual for the drive to interpret what the fault code is telling you. *There is no substitute for reading and understanding the manual, it can save hours of heart ache and disappointment.*

6.Let us say then that after reading the manual you have reason to doubt the motor. At this point I would power down the drive/motor combination, disconnect the motor wires from the drive, power up the drive, reset the fault indication and see if the drive will operate without giving us a fault indication. If it does the drive is more than likely OK

7*. I have always thought that it would be a good idea to have a small 3 phase motor that we know is good wired up with about 10 feet of rubber power cord as a spare test motor.* The motor could have some sort of handle on it to make it easy to carry. This motor will only be used under NO LOAD conditions. It will simply test the drive to see if it will put out a 3 phase voltage and frequency.

Shop "Tech Talk"   July 2008



Troubleshooting Electric Motors:Part 3B, VFDs contd.

8.If we had such a motor I would connect it to the drive and see if we could run it manually from the digital operator. Even to do this we need to know how to change parameters in the drive to go from remote START/STOP (if we have a remote start/stop setup) to local control via the keypad. Also later on in the course of troubleshooting we may need to restore the VFD to the initial factory parameters which will usually allow a connected motor to run normally from the keypad . None of this can be done unless the manual has been studied and the procedures known. There is no short cut to this!

9.*I would suggest that a list of those parameter 'settings' that are different from the factory settings,the ones that have been deemed necessary for each particular VFD application in use in the plant be kept updated and at the point of use, together with a 'cheat sheet' showing how to program the drive for various conditions that you know are bound to occur.*

10.It sounds like a lot of work but it will prove its worth every time it is used.

11.At this point in time you should know if it is the drive giving the problem or the motor. If you have to troubleshoot the motor then I would recommend the steps outlined in the previous troubleshooting Tech Talks.
Often speed is of the essence when a line stops because of a drive problem or a motor problem. The use of substitute motors and then if necessary a substitute drive to me would be a prudent move in order to save time. When choosing a substitute drive it may be necessary to disconnect the motor from its load so as not to overload the drive, if the substitute drive is rated lower than the HP of the motor. For instance if we had a 5HP motor we could use a 2HP drive to test it, if the motor was running without its load. Once we can get the motor running using the smaller drive and we measure the current on all 3 legs and prove to ourselves that the currents are equal we have gone a long way to proving that the motor is fine.

In summary:
Even though a person, new to industrial maintenance, has to troubleshoot a drive/motor combination, by following the advice and warnings presented in this article he/she should be able to avoid a calamity.
It is by avoiding such calamities and following sound advice that we all live to mature into good dependable troubleshooters.

Holland Industrial,518 West Montgomery Street,Henderson,NC.,27536

Tel. 1-800-232-7541, Fax 1-252-492-2444 , E-Mail: sales @ hollandindustrial.com