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T300MVi Drive Speed Search and Restart Capabilities

In a normal induction motor starting operation with a drive, the output of the drive is synchronized with the induction motor flux which is derived from the applied stator voltage and resulting current flow. The output frequency starts from an initial value of zero, motor speed is also zero and ramps up synchronized together.

However, starting on an already spinning motor either in the same or reverse direction is a challenge. In the case of across the line starting, it is usually required that the system come to rest before starting. In the case of adjustable speed drives, the drive may have difficulty since it normally starts at zero speed and the motor is turning at a different speed. High currents result and the drive may shut down.

Drive manufacturers recognizing the need to start into rotating loads developed a software solution that usually does the following steps on starting after power loss:

1. The drive output voltage is set to some low voltage such as 10%.
2. The drive starts outputting varying frequency at the same fixed low voltage from zero to full speed.
3. The motor rotor is at some rotational speed different from the drive frequency. When the drive puts low voltage to the motor at the wrong frequency, the current will go to a specific level. As the drive is scanning the frequency band forward and reverse, there will occur at some point where the rotor speed will match the stator scanning frequency, at which time the current in the stator drops dramatically and the drive software recognizes the instantaneous current change as the rotational speed of the rotor.
4. The drive software once it has determined the correct rotational frequency, raises the voltage to normal and the drive is now in control of the motor.

The disadvantages of the above method are many. The scanning takes time and the motor may lose significant speed. If you scan too quickly, the software may not detect the motor speed. In the case of low inertia systems, the motor speed may be dynamic and the software cannot react

quickly enough. This method works generally well for high inertia loads such as a fan using a voltage source drive. However in case of high inertia loads and with use of current source inverter technology, the motor may self excite with the drive motor filter capacitors and not have the motor field collapse; to avoid such self excitation, an output contactor may be needed to temporarily disconnect from the drive.

With voltage source drives, it is commonly known that induction motors will no longer have a terminal voltage on the motor shortly after the loss of power (2-4 seconds) even if the motor is still rotating. Not commonly known, the induction motor has magnetic hysteresis in the iron of the rotor that makes it a miniature three phase generator. Any induction motor, even if power has been off for a long time will generate a low three phase voltage if rotated by external means. This voltage is used to detect rotation in electronic devices called backspin detectors that are commonly used in the oilfield for delaying start on submersible pump motors turning backwards due to a falling column of oil.

Starting in 1993, Toshiba drives utilized this three phase residual voltage in the motor exactly the same as an encoder feedback to determine motor speed and direction before starting. The drive had additional custom hardware internally that would make quadrature pulses similar to a commercial encoder A and B output directly from the sine wave voltage being detected. The advantage of this method allows the drive instant information of the motor speed and direction which allows the drive to take immediate control and start with no delay.

Toshiba has both methods available in the drive. When the direct detection method described above is enabled in the T300MVi medium voltage drive, the drive keypad display shows the frequency the motor is rotating as soon as power is turned on. When a start command is enabled, the drive starts exactly at the frequency of the rotating motor, ramps voltage to normal and then accelerates or decelerates the motor to the commanded speed and direction.

Induction motors that have too much power back for the drive to return the load to normal speed will torque limit at an adjustable setting until the dynamic conditions return to reasonable levels and then motor will resume normal commanded speed.

If you have questions regarding this control system, enabling the software or any other features of the drive, please call Tundra Boiler and Instrumentation toll free at 1-800-265-1166. If you prefer you can also make inquires to both Angelo Cultrera at angeloc@tundrasolutions.ca, or Kevin Dancek at kevind@tundrasolutions.ca.