Technical Note 053

Broken belt detection using primary settings Monitoring torque vs current

Many building automation systems (BAS) require a broken belt detection for certain applications. This indication, also known as proof-of-flow, can then be used to verify that a fan is moving air in the monitored space. The BAS contractor is responsible for the cost of the required hardware, installation, and startup calibrations. This function is intended to create an alert before a problem becomes a serious issue. For example: loss of control of temperature in a conditioned space, or equipment damage (frozen coil) caused by loss of air circulation. There are a variety of ways to detect the broken belt condition.

Before variable frequency drives became prevalent, the traditional hardware of choice was a current monitoring relay, or current switch. This device is installed on one output wire to the motor. After a successful equipment startup, a technician from the BAS company adjusted the trip level to indicate when the motor is not loaded, based on the current setting. This current-based detection method is fine for motors that always run at full speed across-the-line. The load current can be measured, and no-load current can be estimated or measured. Variable speed applications using drives make this traditional method much less accurate for several reasons.

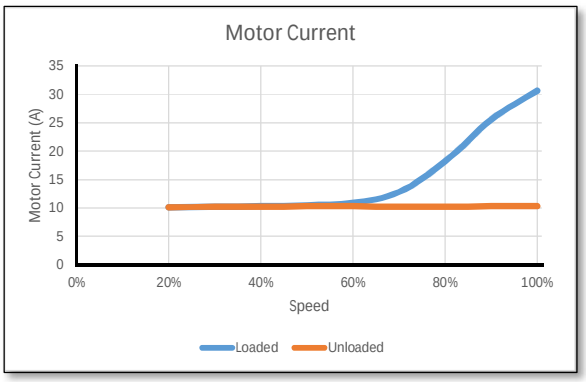

Figure 1: Motor current based on speed

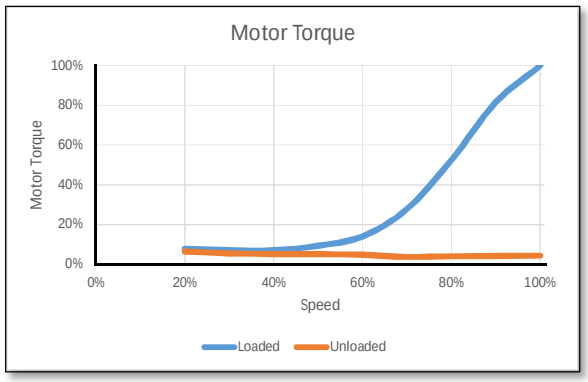

Figure 2: Motor torque based on speed

The load in typical HVAC applications has a variable torque or squared load profile. This means load current increases with the square of speed. Without any load, an induction motor draws only magnetizing current; approximately 30% of motor FLA. In the region below 66% speed, Figure 1 shows very little difference in motor current between lightly loaded and no-load conditions. This minimal difference makes underload detection unreliable in that region.

By comparison, Figure 2 shows how monitoring torque provides a greater difference between loaded and no-load situations. Using torque as the basis for measurement makes detecting loss of load reliable down to at least 50% of motor speed. This earlier and bigger difference between the blue and orange lines, means that sensing torque, and not current, results in a more reliable and faster broken belt indication. The traditional current sensor solution for identifying broken belt conditions does not monitor torque. However, a drive does calculate torque, thus a drive can be used to identify broken belt conditions instead of a current sensor.

The drive monitors the motor torque value, thus the drive can be used to identify the lowest torque used with the connected load. The most accurate method to measure that value is to uncouple the load by removing the belt. However, that may not be practical or possible. The more typical technique is to run the motor at the lowest operational speed for that driven load. At that speed and load, the measured torque value is used as the minimum torque required during normal operation.

To display Motor torque, start at the home screen. Select Menu > Diagnostics > Drive actual values > Motor torque, as shown in Figure 3. With Motor torque displayed, turn the drive on and run the motor at the minimum load point. Note the Motor torque value.

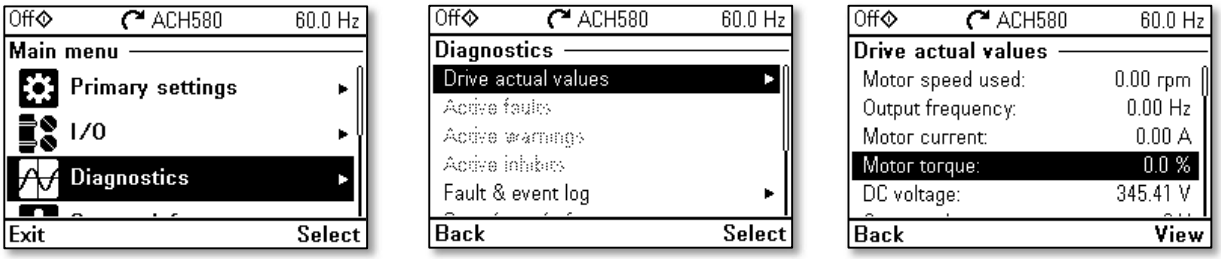

Figure 3: Path to Motor torque

Primary settings makes the setup of this feature as simple as pushing a few buttons. Select Primary settings > Advanced functions > Under load detection; then Enable underload detection as shown in Figure 4. Since torque is preset, the next steps are to determine the appropriate trip levels, trip time and what actions to take in response to an underload condition.

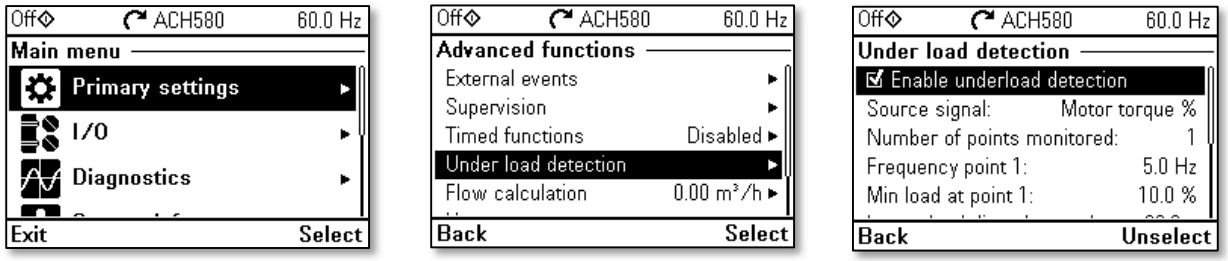

Figure 4: Path to Under load detection

The remaining menu selections determine what actions will occur when an underload is detected. The value entered at minimum load at point 1 should be just below the lowest actual Motor torque measured earlier. Based on the HVAC load profile, the frequency setting at point 1 often falls between 20 Hz and 30 Hz. The drive can ignore short load dips, that time value is configurable. The default action of Warning/Fault is to display a warning after half of the load dip time has elapsed, and the drive trips on a fault after the full dip time limit has elapsed.

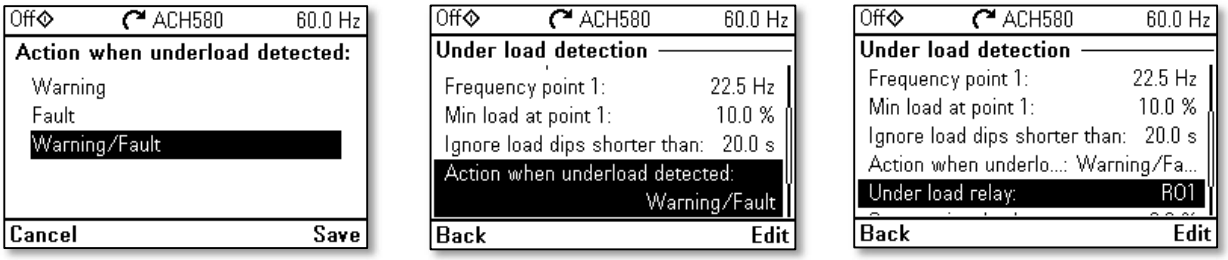

Figure 5: Action for Under load detection response

Primary settings allows the user to set a relay output to indicate that this specific fault has occurred. That relay contact replaces the traditional current relay or switch, with no additional cost. Another way to use this feature is to monitor that relay output over a communication network, such as BACnet. If the BAS is set to monitor faults over their network, this specific fault can be detected. Monitoring that status also replaces the traditional current relay.

The ACH580 underload detection offers multiple benefits:

- Monitoring motor torque instead of current improves the accuracy of broken belt detection.
- Primary settings simplifies setup.
- It eliminates the requirement for a current monitoring relay.
- The detection can be monitored over a BAS network.