YASKAWA

Application Note - Using Stall Prevention to Suppress Overloads

Purpose

This document describes how to set up a Yaskawa drive to suppress nuisance overload faults that may be encountered with systems that are slightly undersized or unexpectedly operate into the motor service factor.

Applicable Products

- GA800
- GA500
- A1000
- Z1000
- P1000
- U1000
- V1000
- J1000

Background

Increasing pressure to control costs and increase efficiency often means products are selected to perform the job at hand with little or no excess capacity. Days of over-sizing products to insure adequate operation are becoming rare due to increased losses, longer payback periods, and additional real estate associated with the larger product. Products such as motors and drives that were often oversized in past times are now often selected to operate at or near their maximum capabilities. In many cases, product selection may be only marginally sufficient to power the intended load, leaving little or no extra capacity for unexpected variances of the systems in which they operate.

Challenges

When systems turn out to be different from what was initially expected, a marginally sized drive and motor may experience extra load that may push either into overload regions. For example, overload may occur in pumping systems in which an unexpected check valve is installed and the additional losses push the motor into the service factor. Or, consider an air handler system in which an air mixing damper is opened wider than planned allowing a greater amount of air to enter the system, resulting in overloading of the blower responsible for moving the air. Drive faults of OL2 (drive overload) and/or OL1 (motor overload) may be encountered during such overloads.

Some applications may experience overloads when the load inertia is large and rapid acceleration rates are used. Consider an induced draft fan for example. When the fan motor and drive are selected based solely on the expected running load, there may be little to no extra capacity to change speeds to regulate system pressure. The torque required to accelerate the large blower inertia may push the drive beyond its typical operating capacity. Additionally, the ID fan may experience extra load at startup until the proper operating air temperature has been achieved. This may result in drive nuisance over current or overload shut downs. Increasing the size of the motor and drive may be an expensive and labor intensive proposition. Therefore, a method of obtaining maximum production from a drive/motor combination while suppressing nuisance overload shutdowns is desirable.

Stall Prevention

Stall prevention may best be thought of as a motor current limiting feature. Unlike an overload relay that simply monitors the current level and opens when the current is excessive over a period of time (leaving the system inoperable), the drive can take action to suppress the current and suppress the overload from occurring altogether. With stall prevention, the drive monitors output current and automatically adjusts its output frequency to keep current beneath a programmable threshold. When this threshold is set to be beneath the drive and motor rated current levels, current is limited so that drive and motor overload protection features do not need to activate. This keeps the system running at acceptable current levels for both motor and drive.

Stall prevention is suitable for all load types including variable and constant torque applications, however, it is particularly useful with centrifugal load applications such as fans and pumps. When overload is encountered, the drive reduces the frequency to the motor, reducing the speed of the motor. A centrifugal load requires less torque as the speed decreases which means the current will decrease as the speed reduces. In this manner, the drive can be used to keep current beneath a user adjustable level that is often set to drive or motor FLA (full load amps).

During stall prevention, the operating speed of the motor may not be in agreement with the set point, however, the system will stay operating instead of faulting and needing to be reset. Oftentimes, a speed reduction of only a hertz or two is all that may be required to keep the system operating, and such a small reduction is likely unnoticed by building occupants or system operators. A system that shuts down will quickly be evident to these same individuals.

Common Applications

A common application of stall prevention is in HVAC systems that are sized to move a particular volume of air at a given temperature and humidity level. When the temperature or humidity varies from normal, the blower may be subject to increased load. A condition of this nature may be encountered in early morning hours of fan operation when the air is more dense. In a system that has been sized marginally for the specified conditions, overload may be encountered with the extra unexpected load. However, stall prevention can be used to limit the current to remain within motor and drive rating. The drive output frequency may automatically reduce by a small amount until moisture or temperature return within specified levels at which time the drive output frequency will automatically return to the full set point level. The drive can be considered to be “self-regulating” to obtain maximum performance for the conditions at hand.

Another frequent use of stall prevention is when pump motors operate into the service factor yet the drive has not been sized to accommodate service factor operation. This situation may be common when there are unexpected contours or elevations in piping or at startup of the system when the pressure has not yet achieved set point and full speed is needed. Here, stall prevention can be used to limit the output current to the drive’s maximum continuous rating to make full use of the system under the existing conditions. Similar to the HVAC example, a small reduction in motor speed usually does not have a large impact on pump output but seamlessly suppresses the overload condition, eliminating the drive from needing manual intervention. The result is a system that can be used to its fullest capacity under the conditions that are present without shutting down or overtaxing the equipment.

One may also consider using stall prevention when performing startups during which worst case loading conditions cannot be produced. Rather than leaving critical machinery operating not knowing if it will shut down when the load increases to maximum level, stall prevention can be programmed to limit the current to a level satisfactory to the drive and motor, greatly reducing the chance of shut down due to overload. This may be encountered in HVAC systems when blower startups are performed prior to the system being “balanced” and full speed operation is prohibited. Here, the stall prevention feature can be adjusted to limit current to the lesser of motor or drive current rating, protecting both components and reducing the chance for shut down during full commissioning of the equipment.

Programming

Yaskawa drives incorporate two stall prevention levels, one that is used during acceleration and another that activates during steady speed operation. When used together, current can be limited to eliminate nuisance faults and protect machinery.

The following parameters are used to enable and set the stall prevention feature.

Table 1: Stall Prevention Parameters

Parameter	Setting	Units	Name	Description
L3-01	1	-	Acceleration Stall Prevention Selection	Enables stall prevention during acceleration
L3-02	100	%	Acceleration Stall Prevention Level	Set the stall prevention level to the lower of motor FLA or drive rating. Set in % of drive rating (ex. motor FLA / drive rating).
L3-05	2	-	Running Stall Prevention Selection	Enables stall prevention during steady speed; uses decel time 2
L3-06	100	%	Running Stall Prevention Level	Set the stall prevention level to the lower of motor FLA or drive rating. Set in % of drive rating (ex. motor FLA / drive rating).
L4-02	20	Hz	Speed Agree Width	Sets the transition point between acceleration and steady running. Set to maximum for widest coverage
C1-04	10.0	s	Deceleration Time 2	Sets the frequency reduction rate
C1-01 C1-02	100.0	s	Acceleration Time 1 Deceleration Time 1	Sets the acceleration & deceleration time to maximum frequency (as entered into E1-04)

NOTE: Settings above apply to a typical HVAC blower application in which the motor and drive share the same current ratings.

Adjustment Guidelines:

L3-02 and L3-06

In order to protect both motor and drive, stall prevention levels (L3-02 and L3-06) are generally set to the same value which is typically dictated by the lesser of motor FLA or drive rated output current. Stall prevention levels are set in % with respect to drive rated output current.

Example 1: Motor FLA =110 Arms, Drive Output Current Rating = 124 Arms
Set L3-02 and L3-06 = 89 % (or 110 A/124 A)

Example 2: Motor FLA = 130 Arms, Drive Output Current Rating = 124 Arms

Set L3-02 and L3-06 = 100 % (or 124 A/124 A)

Example 3: Motor FLA = 110 Arms (motor is expected to operate into the 1.15 service factor), Drive Output Current Rating = 124 A

Set L3-02 and L3-06 = 100 % (motor operating point is 126 Arms (110 A x 1.15), but drive is only 124 A and using lesser of the two dictates 100 % (124 A/124 A))

<ins>C1-04</ins>

Set deceleration time 2 (C1-04) to a value that generates suitable current limiting but does not result in instability. Typical settings for large inertia centrifugal load types such as fans and blowers is to set C1-04 to approximately 1/10th the value as set in the normal deceleration setting (C1-02). This assumes C1-02 has been increased sufficiently to keep the motor from faulting on overvoltage during normal ramp down stopping.

For centrifugal pumps a setting of approximately 1/5th the deceleration time is generally all that is required.

> Example 1: Centrifugal blower, set C1-02 = 100 s; set C1-04 = 10 s
> Example 2: Centrifugal pump, set C1-02 = 20 s; set C1-04 = 4 s

<ins>L4-02</ins>

Set the speed agree detection width (L4-02) to 20 Hz to accommodate a wide range of load conditions.

<ins>C1-01 and C1-02</ins>

Set acceleration time (C1-01) and deceleration time (C1-02) to values that are suitable for the load type. Recommended settings for a few common load types are:

- C1-01 & C1-02 = 100 s for standard fans & blowers
- C1-01 & C1-02 = 20 s for centrifugal pumps & compressors
- C1-01 & C1-02 = 300 s for large induced draft fans

Confirming Stall Prevention Operation

After programming the previously listed parameters, the system should be checked to confirm the desired operation and current limiting is achieved. The system should be operated while closely monitoring the drive keypad. DriveWizard can also be used to monitor the drive status.

When stall prevention is working, the following can be observed:

- Output current level in monitor U1-03 should be limited to the value entered into L3-02 and L3-06
  Note: A setting of 100 % for L3-02 and L3-06 will result in drive rated output current as listed on the drive nameplate.
- Output frequency monitor U1-02 will be below the frequency set point in monitor U1-01

If the output frequency monitor U1-02 matches the set point monitor U1-01 at steady speed, this means stall prevention is not activating and the system is operating as normal. Here, the output current monitor U1-03 will likely show the current to be below the stall prevention level programmed in L3-02 and L3-06. Therefore, stall prevention is not being called upon to limit the current and operation is considered normal.

Consult the factory for any additional support.