

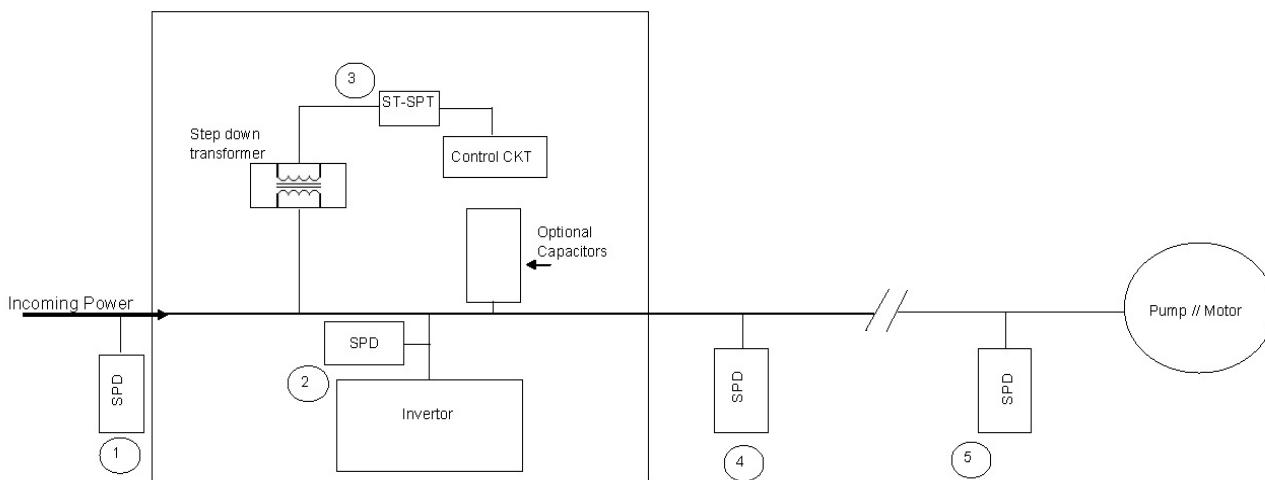
## Protection of Drives

The use of various types of drives to control motors is very common. The purpose of the drive is to increase the efficiency or to manage the speed of the motor being controlled. Through various processes and control mechanisms, the drive often reshapes the sinewave to provide a signal to the motor that allows for greater efficiency or varies the frequency of the signal to control the speed of the motor.

Due to the action of the drive, the power quality of the electrical environment can be compromised. That is, the drives can create voltage surges and harmonics on the system.

There are various technologies available that aid in correcting these issues. This application note focuses on applying surge protective devices (SPDs) to a drive system to mitigate the damage that can occur due to the voltage surges while considering the effects of the harmonics on the surge protective device.

Drive Cabinet



**Figure 1 – One Line Diagram of a Typical Drive Layout**

## Application of SPDs

To aid in the description of the application of SPDs to a drive system, please refer to Figure 1.

This figure illustrates a typical drive layout. The incoming power is usually delta configured (3 phases and ground). Often the incoming voltage is 480 V, but other voltages may be used. The incoming power is usually stepped down to a lower voltage (typically 120 Vac) that provides power to the control circuit. The control circuit contains sensitive electronics. Once the power is acted upon by the drive the output is fed to the motor.

As noted, there are four opportunities for protecting the typical drive system – each are labeled with a circled number and are described below.



**Drive Input.** Protecting the drive input is an essential step in protecting the drive system.

Providing protection at this location prevents surge damage due to events propagated on the electrical system from upstream sources, external events such as lightning and switching surges created by the utility, and the interaction of multiple drives on the same system.

At this location, a parallel connected, threshold clamping device is appropriate (one without sine wave tracking). Sine wave tracking is not recommended for this location due to the fact that this location is typically more

susceptible to impulse transients as opposed to ringwave transients.

**2** *Inverter Input.* The inverter input is one of the most sensitive and critical areas of the drive itself. It is at this location that care must be taken and the proper survey conducted. You may install a parallel connected, sine wave tracking device provided you have confirmation that within this drive that no additional capacitor have been installed to mitigate harmonic currents.

**IF THEY HAVE**, then at this location, a parallel connected, threshold clamping device is appropriate (one without sine wave tracking). Sine wave tracking would not be recommended for this location due to the high harmonic content that necessitated the installation of additional capacitors. Installation of sine wave tracking devices at this location will lead to failure of the SPD.

**3** *Control Circuit.* The control circuit contains sensitive electronics that can be damaged by the environment created by the drive or by surges from external sources. Protection at this location is essential.

Since this circuit is isolated by a step down transformer and it feeds sensitive electronics, a series connected SPD with sine wave tracking is recommended for this location.

**4** *Drive Output.* Protecting the immediate drive output is recommended when the length (labeled "L" in Figure 1) of the connection between the drive and the motor is longer than 50 ft (15 m) or if the connection is routed along an external wall or outdoors.

One reason for protecting at the immediate output when the length of the connection to the motor is long is due to reflected waves that can occur as the signal (often higher frequency) from the output of the drive reaches the motor and is then reflect back and forth between the drive and the motor. This action can create "voltage piling" – the reflected voltage adds to the nominal

voltage and other reflected waves. The SPD will aid in reducing the voltage peaks of the reflected waves.

More importantly, if the connection between the drive and the motor extends outdoors, along a path that is exposed to the environment or close to the building's steel structure, protection at this location is important to diminish the effects of direct lightning or induced voltage surges due to nearby lightning. These surges can cause damage to the drive, even if protection is provided at the motor input.

At this location, a parallel connected, threshold clamping device is appropriate (one without sine wave tracking). Sine wave tracking is not recommended for this location due to the high harmonic content of the signal due to the normal operation of the drive. Installation of sine wave tracking devices at this location will lead to failure of the SPD. Utilizing a threshold clamping device at this location will eliminate this possibility.

**5** *Motor Input.* Protecting the motor input is an essential step in protecting the drive system. Providing protection at this location prevents surge damage due to events propagated from the drive output to the motor input. Providing protection at this location aids in extending the life of the motor as the SPD helps to prevent damage to the windings and bearings of the motor due to surges.

Further, if the connection between the drive and the motor extends outdoors, along a path that is exposed to the environment or close to the building's steel structure, protection at this location is important to diminish the effects of direct lightning or induced voltage surges due to nearby lightning. These surges can cause damage to the motor, even if protection is provided at the drive output.

At this location, a parallel connected, threshold clamping device is appropriate (one without sine wave tracking). Sine wave tracking is not recommended for this location due to the high harmonic content of the signal due to the normal operation of the drive. Installation of sine wave tracking devices at this location will lead to failure of the SPD. Utilizing a threshold clamping device at this location will eliminate this possibility.