



AUTOMATION & IIOT

Protecting servomotors from self destruction

Servomotors are obedient servants. They will try to do whatever is asked of them, so they must be protected from overheating and self destruction. Here are some methods to avoid problems

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Switching from general-purpose drives and motors to high-performance servo systems is a giant step forward in machine flexibility, throughput, uptime and end-product quality. Yet, highly dynamic demands placed on closed-loop servo systems make overload protection more complex than with traditional drives.

Thermal overload need not be a problem as long as precautions are taken to ensure that both the servomotor and drive operate within safe bounds, under all operating conditions.

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Another section may need to operate at high peak torque for running a cam profile on a sealer. Still another section will require variable levels of torque and power, such as for unwinding and rewinding. Each section may have totally differing requirements for continuous, intermittent and peak torque while operating over a speed range as broad as 1,000:1.

To fully benefit from all that servos offer, each servo-driven section must be treated as a stand-alone entity with its own unique power and speed requirements. This dictates that each servo be sized to effectively accomplish its task without danger of overload.

Unfortunately, no industry standards exist to guarantee a safe selection of servos. It's difficult to obtain an apples-to-apples comparison when various manufacturers present performance data under varying conditions. To ensure that motor selection itself isn't a contributing factor to thermal problems, the following issues must be carefully analyzed.

Servomotor selection

A servomotor's continuous torque rating is one measure of its ability to dissipate heat losses caused by resistance in the electrical windings and other factors. The rating may be listed for operation under various ambient conditions and different maximum temperatures — some without conduction of heat to the machine, and others with varying sizes of heat sinks. One can achieve nearly any rating, given a large enough heat sink.

The ability of a servomotor to dissipate heat is roughly proportional to the motor's surface area. By mounting the motor to a plate, or heat sink, [Figure 1](#), the total surface area is frequently increased 50 to 100%. This can lead to an artificially high rating on a specification sheet that could likely cause thermal problems down the line if a similar heat sink isn't used.

The average operating speeds should also be considered in selecting a servomotor that can handle the job without danger of thermal overload. [Figure 2](#) shows the continuous motor torque for a servomotor rated at 330 in-lb and 4,000 rpm. If it were to run continuously at 4,000 rpm, it would only be able to deliver 75 lb-in. of torque on a continuous basis.

System performance

Another common error is made when specifiers ignore drive (amplifier) capabilities, and select a servo on the sole basis of spec-sheet motor performance. While the continuous torque rating is generally a

For example, the servomotor performance curve shown in [Figure 3](#) indicates that five times the motor's rated continuous torque is available to a rated speed of 5,000 rpm. However, this five-times value is generally the maximum torque that a motor can deliver for only a short time without demagnetizing the magnets. Plus the motor can not dissipate the heat this load produces for more than a few seconds, if that long.

This same motor, when matched to the appropriate servo drive, forms a servosystem that has only twice the motor's continuous torque available, and then only to 3,000 rpm. The available torque decreases from that point to zero at the motor's maximum rated speed of 5,000 rpm. Thus, what may have appeared to be a high-torque, 5,000 rpm system is really only usable at much lower torque values and operable to 3,000 or 4,000 rpm.

Both the servomotor and servo drive impose certain limits on performance. Considering either component alone yields an incomplete picture. Therefore, it is necessary to look at them as a system.

Properly presented, system performance curves provide a total picture of performance under both continuous and peak torque conditions. However, you must analyze carefully all the data and understand its significance. For example, one drive-motor manufacturer rates a servo system depicted in [Figure 4](#) as a system having capability of 4,500 rpm (speed at which zero continuous motor torque is available); while another will rate it at 4,000 rpm (speed at which voltage for the drive reaches zero). Still another will rate the system at 3,000 rpm (speed at which a reasonable level of peak torque is available for acceleration and deceleration).

Servomotor thermal protection

Servomotor protection is simply a matter of ensuring that internal temperatures don't exceed design maximums. An effective protection technique is to embed individual thermal sensors or switches within each phase of the servomotor windings. This protects the servomotor under all operating conditions, including high-heat conditions generated from high torque at standstill.

Thermal devices also protect a servomotor over a wide range of ambient operating conditions. Some schemes monitor motor current only, which ignores the impact of ambient conditions. Servomotors operating in a refrigerated environment, for example, may safely reach higher than- rated continuous

Conventional systems shut down immediately when an excessive temperature is detected, often resulting in tool damage, scrap product, and lengthy delays in fault recovery.

By contrast, a *controlled shutdown* is more sensible, because a servomotor has a fair amount of time before damage will occur. Once a thermal sensor “trips,” the control takes steps to complete the current operation, if possible, then initiate a shut down in an orderly manner.

Servodrive thermal protection

A servo drive (amplifier) is a far more complex device to protect. Whereas servomotors have from seconds to minutes to guard against an overload, a servodrive must react within fractions of a second.

Either of two extreme thermal overload conditions can damage a servo drive:

- A slight overload that lasts a long time, typically detected by a thermal sensor or switch mounted on the drive’s heat sink.
- A large overload in which temperatures within the drive’s power transistors rises to destructive levels in only a few tenths of a second.

To protect against a potentially dangerous transient overload condition, one can monitor the current supplied by the drive. In the event of such an overload, the drive automatically reduces its current to a safe level — typically the continuous rating of the drive. This protection is usually accomplished through current foldback.

However, operation under current foldback conditions should be avoided with closed-loop servo systems. While the drive is busy protecting itself from destruction, the servomotor is no longer following the command of the main control. The effects of current foldback could range from a single poor-quality part to decreases in general end-product quality to serious tooling damage.

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