

TECH TIPS



Selecting the optimum soft starter for your specific application

When starting AC motors, the LRA (Locked Rotor Amperage), also called inrush current, can reach a level of five to nine times the FLA (Full Load Amperage), which is the rated current for the motor.

With high-efficiency motors (Efficiency Classes IE2, IE3, and IE4 per IEC 60034-30), the inrush current can be up to fifteen times the motor's rated current. The high starting current may cause electrical or mechanical problems, including light flickering, torque oscillation, water hammering in pumping applications, or even motor and load vibration.

There are several methods of starting AC motor loads. The most basic is the Direct on Line (DOL) method which utilizes comparatively inexpensive mechanical or solid-state devices, such as contactors or Solid State Relays (SSRs), that always apply the full line voltage to the motor.

Another popular starting method employs Star-Delta mechanical starters. These temporarily reduce the voltage in motor windings and therefore limit the inrush current. However, when the motor transitions from a star (reduced) voltage to a delta (full) voltage, this may still result in a very high inrush current.

A Variable Frequency Drive (VFD) can also be used as a motor starter. A VFD is an all-electronic motor controller that can be used to soft start and stop as well as control the speed of the motor. However, it is typically expensive and much more complicated to set up than any other starter.

A soft starter is a type of AC motor controller that uses electronic switches, such as Silicon Controlled Rectifiers (SCRs) or Insulated

Gate Bipolar Transistors (IGBTs) and the phase-angle principle to provide a slow ramp-up or current limiting during startup, or a slow ramp-down when stopping the motor. Soft starters are often just as easy to install as contactors or SSRs and much easier to implement than a Star-Delta starter or VFD.

The configuration of a soft starter is typically much more straightforward than a VFD. It may only involve an adjustment of few rotary switches. The soft starter may use a voltage ramp algorithm, where the user only has to set the duration of the ramp-up and the initial torque, or use a current limit algorithm where only the maximum allowable inrush current is needed for setup.

Leading manufacturers of soft starters, such as Carlo Gavazzi, offer application-specific products that self-adjust and optimize the start/stop process, making the configuration of a soft starter as simple as using a contactor or SSR.

There are several different types of soft starters on the market and single-phase soft starters can be used with most types of single-phase motors:

- Permanent Split Capacitor (PSC)
- Capacitor Start Induction Run (CSIR)
- Capacitor Start Capacitor Run (CSCR) motors

These devices may either use a start capacitor or eliminate the need for one. Applications include pumps, piston compressors, fans, and scroll compressors. Three-phase soft starters are used to control up to 3-phases of an induction motor. 2-pole, 3-phase devices are an economical solution in which only 2 of the 3 phases are being controlled.

The benefits of such solutions include smaller size, lower heat dissipation, and a typically lower cost.

The drawback, however, is the imbalance caused by the uncontrolled phase. By contrast, 3-pole, 3-phase starters minimize phase imbalance but are larger, have higher heat dissipation, and are generally more expensive.

How to select a soft starter

The fundamental questions that need to be answered include:

01 WHAT TYPE OF MOTOR IS USED IN THE APPLICATION?

Soft starters are either designed for one or several types of motors. For example, the RSBT series from Carlo Gavazzi is intended to start 3-phase scroll compressors only.

Typically such application-oriented devices offer superior performance and may greatly simplify the setup to the point where no adjustments are necessary.

However, most soft starters are built with application flexibility in mind, where one product can be used to control several types of motor loads such as pumps, fans, or grinders. Such products are ordinarily more complicated to install and configure.

02 WHAT IS THE LINE VOLTAGE?

Solutions from leading soft starter manufacturers cover all standard low-level AC voltages from single-phase 110VAC to three-phase 690VAC.

Simply match the operational voltage of the soft starter with the specified line voltage.

03 WHAT AMPERAGE SIZE IS NEEDED?

Single-phase soft starters are typically rated up to 37 Amps, while 3-phase are available to more than 1,000 Amps per pole.

However, when selecting the amperage size of the soft starter, it is important to consider other factors and not just the FLA rating of the motor on its nameplate.

The kilowatt (kW) or horsepower (Hp) rating of the motor, application type, required trip class, ambient temperature, the spacing between units, required ramp-up time, and the overload cycle all affect the size and may even require soft starter oversizing.

04 WHAT CONTROL SIGNAL AND COMMUNICATION ARE BEING USED?

Options to control soft starters include conventional AC or DC signals such as 24 VDC, 24 VAC, 120 VAC, and others, or may not require any control signals as the startup may be initiated by another device upstream.

More advanced devices offer communication options, including most Fieldbus and industrial Ethernet protocols.

Additional benefits of using soft starters with communication include monitoring of the load and real-time performance measurement, such as the energy consumption of the motor.

05 ARE OVERLOAD AND SHORT-CIRCUIT PROTECTION NEEDED?

If overload protection of a motor is required, users often have a choice of using a soft starter with a built-in electronic motor overload or an external bi-metallic or electronic overload device.

Approval agencies and local electrical code authorities may also require suitable in-line short circuit protection.

06 IS AN INTERNAL BYPASS ACCEPTABLE?

Users may choose between internally or externally bypassed soft starters, a selection that will affect the size and potentially the endurance of the starter. SCR semiconductors generate heat while conducting current.

The concept of bypassing semiconductors means that SCRs are only utilized during the motor's starting and stopping, but not during the motor's full voltage operation.

This reduces the heat generated and, therefore, the size of the appropriate heat sink. Soft starters can be bypassed either internally with built-in power relays or externally with a fully-rated IEC contactor. Internally bypassed soft starters have a comparatively smaller footprint while externally bypassed soft starters provide a more robust although more expensive solution.

07 TURN TO EXPERT FOR HELP

Turn to experts who are a great knowledge resource, such as CARLO GAVAZZI as they can provide expert insight and advice on specifying and implementing the ideal solution, which provides maximum benefits.

Look for a partner with an international distribution network and experienced personnel who can assist you by email, phone, web conference or in person.