THE SOFT STARTER GUIDE

Giving your process the best start possible

A report on the functions and benefits of using Soft Starters.

WP SERIES: SS V1
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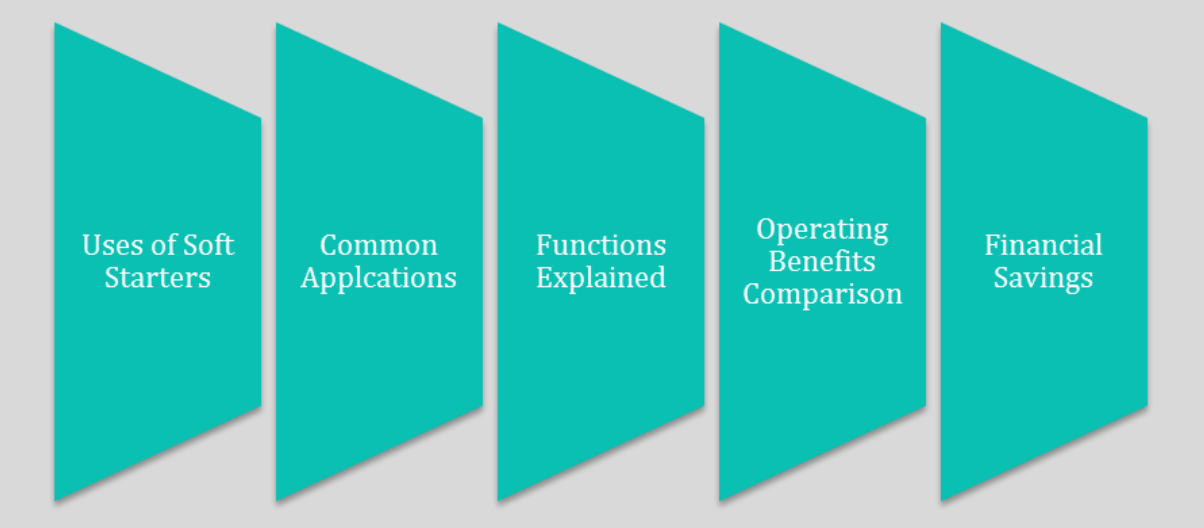
BRIEF INTRODUCTION

THE INTENTIONS OF THIS DOCUMENT

This document has been created to provide you with a basic understanding of the workings of a Soft Starter, as well as the benefits and results they can provide to your process.

AREAS WHICH THIS DOCUMENT WILL COVER

This document will cover the following areas:



WHAT ARE SOFT STARTERS?

Motors often need large amounts of electricity to start moving and to accelerate to full speed. Soft starters are used to reduce inrush currents, improve efficiency and prolong the life of your motors by stopping harsh starts and stops that produce motor heating.

Soft Starters are solid-state instruments which work by gently rising the initial voltage by controlling the current. This allows the motor to slowly accelerate up to full speed in a controlled and gradual way. This is also possible in reverse to stop the motor as soft starters can gradually decelerate the motor to a controlled and safe stop.

A MESSAGE FROM THE TEAM

We hope you find this report helpful in providing you with more of an understanding into Soft Starters. If you still have any questions or if we have missed out any information, please get in touch, we would love to hear from you.
The CD Automation Team.

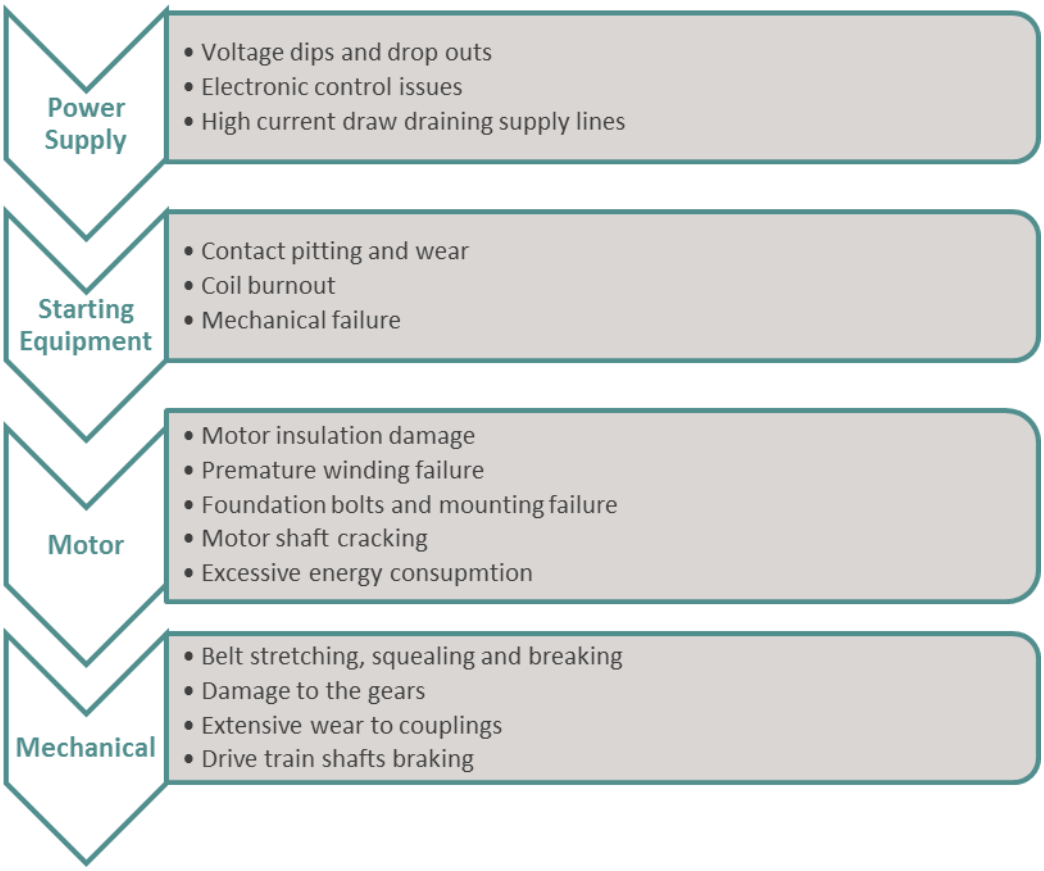
WHY ARE SOFT STARTERS USED

There are many benefits to using Soft Starters but the key reason is to improve control of motors when they start up. By having control over your motors, many benefits are produced such as extended motor life, improved efficiency, and protection of other process equipment.

SOME OF THE MAIN BENEFITS SEEN BY USING SOFT STARTERS ARE:

- Precise regulation of current limit
- Smooth acceleration
- Reliable motor performance
- Improved operating efficiency
- Reductions in motor heating
- Starter contactors live longer
- Reductions in KVA
- Lower energy consumption
- Improved power factor at all load cycles
- No mechanical shock during start up
- Less power surges
- Adjustable performance for specific conditions

BELOW ARE THE MAIN ISSUES, RELATING TO PROCESS DAMAGE, THAT SOFT STARTS HELP YOU PREVENT:



WHERE ARE SOFT STARTERS USED

Soft starters can be used in almost all applications where there are motors.
The most common applications where Soft Starters are needed are where:

- Speed and toque control is required
- Large startup inrush currents need to be reduced
- Torque spikes and tension need to be relieved
- Pumps are used to remove pressure surges

Listed below are **common application** types and the Soft Starter settings we recommend to be used in each. These settings are found on all models and the more advanced models may have additional settings for increased control in your application.

PLEASE NOTE

The torque settings required to initially start the motor vary based on the size of the motor and the initial load. For example a heavy duty load would require more torque to start the motor. We recommend the kick start function for applications with heavy duty loads.

RECOMMENDED SETTINGS

Application Type	Ramp Up Time (sec.)	Ramp Down Time (sec.)	Initial Voltage Uini (%)	Current Limit (x Ie)	Torque Control
Axial Fan	10	OFF	30%	4.0	OFF
Band Saw	10	OFF	30%	4.0	OFF
Bow Thruster	10	OFF	30%	1.5-3	OFF
Centrifugal Fan	10	OFF	30%	4.0	OFF
Centrifugal Pump	10	10-20	30%	3.5	ON
Circular Saw	10	OFF	30%	4.0	OFF
Compressor	5	OFF	30%	3.5	OFF
Conveyor Belt	10	OFF	40%	4.0	OFF
Crusher	10	OFF	30%	4.0	OFF
Cutter	10	OFF	30%	4.0	OFF
Escalator	10	OFF	30%	3.5	OFF
Grinder	10	OFF	30%	4.0	OFF
High Pressure Pump	10	10	50%	4.5	ON
Hydraulic Pump	10	OFF	30%	3.5	OFF
Lift/Elevator	10	OFF	30%	3.5	OFF
Mill	10	OFF	30%	4.0	OFF

SOFT STARTER FUNCTIONS EXPLAINED

RAMP UP

The trimmer adjusts how fast the acceleration ramp is. The time indicates how quickly the voltage is increased from the initial voltage to the full voltage. This determines how quickly the motor gets up to full voltage/speed.
The ramp time should not be too long as this just produces unnecessary heating of the motor and it can also cause the overload relay to trip. See figure 1 for a graph on what the ramp up feature does to the torque during start up.

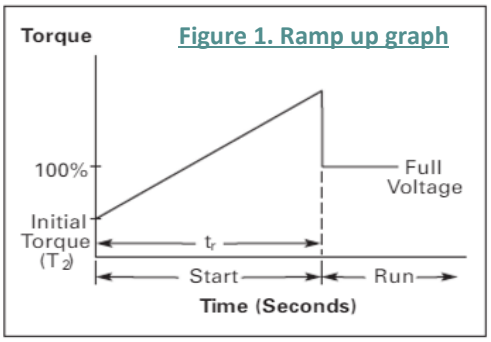


Figure 1. Ramp up graph

WHY REDUCE THE VOLTAGE START UP?

Reducing the voltage limits the inrush current that the motor draws during startup. A large current inrush can cause line voltage to drop which can affect voltage sensitive machinery in other parts of your process. Another concern is that reaching high peak currents can blow fuses and damage electrical hardware. Inrush currents can also create magnetic shocks which damage the internal motor windings, resulting in reduced life span of motors. Not only that but torque spikes created with inrush currents can cause system failures and damage to motor shafts, belting, gear boxes and drive trains.

RAMP DOWN

The trimmer adjusts how quickly the deceleration ramp is. The time indicates the difference between full voltage output and the initial voltage. This produces a longer stop time so that motors slow down gradually. See figure 2 for a graph on how the ramp down function brings motors to a controller stop.

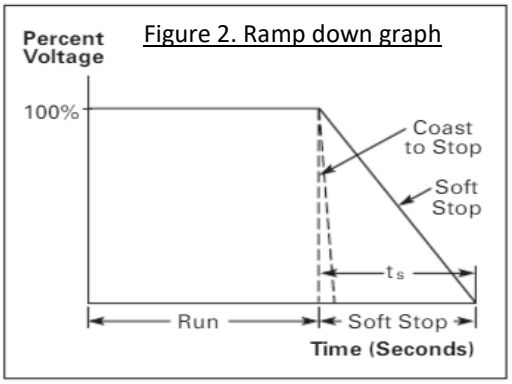


Figure 2. Ramp down graph

SOFT STARTER FUNCTIONS EXPLAINED

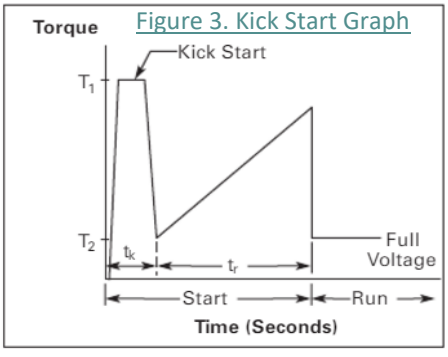
INITIAL TORQUE

All motors require an initial amount of torque to start rotation and then a continued amount of torque to maintain speed. The trimmer on the front allows you to adjust the initial voltage apply to the motor and therefore the torque at the start. If this is turned up too high you will **NOT** get the soft start effect. When you reduce the initial current you also reduce the ability for the motor to generate torque. It is important to remember that too much torque can cause mechanical stresses and internal damage but also if there is not enough torque this can cause the motor to stall or struggle to start .

KICK START

The kick start function is used when a motor has a high friction load and additional torque is required to break away and begin rotation. This is produced by allowing the motor to draw more current to produce torque. After the kick start time, the current is reduced back to the normal preset. The kick start current level and the duration are both adjustable. See figure 3 for a graph on how the kick start feature works.

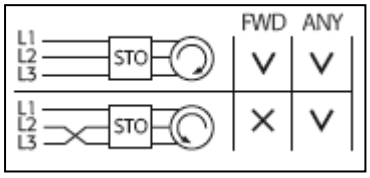
Figure 3. Kick Start Graph



PHASE SEQUENCE

The phase sequence is the order in which each phase reaches full voltage.
If this sequence is wrong the Soft Starter will trip. Figure 4 shows the phase sequence options.

Figure 4. Phase Sequence Options



SOFT STARTER FUNCTIONS EXPLAINED

CURRENT LIMIT

Current limit is where the Soft Starter makes sure the current doesn't rise above a certain point. When the current limit is reached, the Soft Starter stops for a short time until the current drops below a certain limit, and then it continues ramping up to full voltage. A current limit will also hold the torque at a certain limit. This is an option that is used in applications where limiting starting current is required or where there is a heavy-duty start. Figure 5. Shows a graph of what the current limit feature does to the torque during a normal start up.

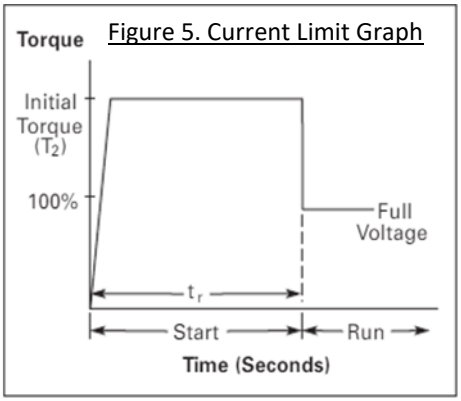


Figure 5. Current Limit Graph

MOTOR FULL LOAD CURRENT (FLC)

This setting allows you to configure the full load current on the Soft Starter. This will protect the motor by limiting the current from going over the point and overloading the motor.

MOTOR TRIP CLASS

This relates to the motor overload relay and provides overload protection for your motor. This trip class must be set to match installation limitations. A common misconception is that the overload relay/trip class is how quickly the motor starts, when it's actually protection against surges.

EXCESS START TIME

Increases the time of the startup before full voltage is reached. This is used for very heavy duty loads that need extra time to start properly with minimized machine stress and current spikes.

OPERATING BENEFITS OF SOFT STARTERS VS AUTO TRANSFORMER STARTERS

The table below shows the benefits of using a basic Soft Starter vs using a traditional auto transformer starter. There are additional benefits for using more advanced Soft Starters.

	Auto Transformer Starters	Soft Starters
Function	Several moving parts so maintenance is needed and sparking is unavoidable.	No moving parts so less maintenance and sparking resulting is less hazards.
	Motor starts with heavy jerks and shudders during start up and with a high inrush current. This damages the motor winding, increasing costs.	Motor starts smoothly with no jerks. This extends the motors life and reduces maintenance costs.
	The valve on the delivery side needs to be operated when switching the motor on or off.	You do not need to operate the valve on the delivery side when switching the motor on or off.
	No protection, so valve operation is essential.	Protection against back thrust during switching off.
	Number of starts and stops limited by the motor windings getting too hot.	No limitations to the number of starts and stops per hour.
	No function to control the rate of acceleration.	Adjustable acceleration to suit specific load requirements, making acceleration up to full speed as quick and as efficient as possible.
	In rush current restricted to the maximum of 400% of the motors full load current.	The inrush current is restricted to 200% of the motors full load current (FLC).
Economic	No savings are achieved with this starter method.	Energy savings: Approx. Rs. 15000 to Rs. 50000 per annum, per Soft Starter. This will vary based on load conditions.
	No power factor improvements are achieved with this starter method.	Power factor can be reduced by up to 0.05, which reduces energy costs and helps to avoid KEB penalties.
	Maintenance costs very high due to unprotected motors and moving parts that need servicing.	Less maintenance producing more cost savings per year (protected motor, no moving parts)
Protection	Large periods of down time for maintenance work.	Minimal down time increasing productivity.
	No protections available	Various protections available such as over voltage, phase reversal, short circuit, overload.
	Not available.	Current limit is available to control the maximum current that the motor can draw from the supply.

CASE STUDY & FINANCIAL PAYBACK

We tested two big motors for grinding machines both of which suffered from poor and inconsistent power consumption. They varied in the range of 25-90% of the rated motor capacity (150 kW). We tested the motors before and after setting up a soft starter to see what results were produced in terms of energy efficiency.

THE MOTOR SPECIFICATIONS

Average power consumption: 100kW
Operating hours per year: 4000 hours
Number of starts/stops: 3 starts per operating hour (12000 times as year)

ENERGY CONSUMPTION

Annual energy consumption per year with just the motor: 400,000 kWh/annum
Annual energy consumption per year with a basic soft starter: 380,000 kWh/annum
Annual energy saving: 20,000 kWh/annum

COSTS AND PAYBACK

Power Tariff including taxes and surcharges: 9.33p/kWh (£0.0933/kWh)

Average power costs without soft starters: £37,320 per year
Average power costs with a basic soft starter: £35,454 per year
Cost Saving over one year: £1,866
Installation cost: Unit = £450, Labor = £50 per hour x 2 hours Total = £550
Payback period: 3 ½ months (14 weeks)

NOTES

The savings increase if the frequency of starts and stops are higher.
The payback does not take into account equipment life, power factor, electrical stability or harmonics that could deteriorate the internal workings of the motor.
Please also note that these calculations are approximations as the exact energy saving will vary based on the load conditions. Soft Starters working with heavier loads will produce more noticeable energy savings. Additional savings are produced with less motor maintenance due to better control.

PRODUCT INFORMATION

Our product offering consists of three Soft Starters; the STB (basic), the STO (mid) and the STE (enhanced). Below is a brief overview of our Soft Starter range.

THE STB BASIC PERFORMANCE SOFT STARTER

Suitable for 3 phase 3 wire AC motors.

- Configurable Kick Start 100 to 300 msec
- 6A to 200A – 3, 3.5, 4 & 4.5 inch formats
- Isolated start/stop command (option)
- DIN Rail Mounting (6A-32A)
- Internal bypass relay

Adjustable settings:

+ Ramp up
+ Ramp down
+ Initial torque

THE STO MID PERFORMANCE SOFT STARTER

Suitable for 3 phase 3 wire AC motors.

- 48A to 200A – 3, 3.5, 4 & 4.5 inch formats
- Configurable Kick Start 100 to 300 msec
- Internal electronic overload relay
- Internal bypass relay
- Various communication options available (Modbus RTU and USB device standard)

Adjustable settings:

+ Excess start time
+ Current limit
+ Motor trip class
+ Current ramp
+ Motor FLC
+ Soft stop
+ Phase sequence

THE STE ENHANCED PERFORMANCE SOFT STARTER

Suitable for 3 phase 3 wire AC motors.

- 48A to 200A – 3, 3.5, 4, 4.5 inch formats
- Full colour touch screen display
- Two configurable digital inputs & outputs
- Internal bypass relay
- Various communication options available (Modbus RTU and USB device standard)

Adjustable settings:

+ Excess start time
+ Current limit
+ Motor trip class
+ Current ramp
+ Motor FLC
+ Soft stop
+ Phase sequence

COMPANY INFORMATION

For any further enquires or questions you might have please get in touch using the details below;

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