S611 Solid State Soft Starter

Product Description

Eaton revolutionized the reduced voltage control marketplace with its advanced feature set and user-friendly User Interface Module to enhance system performance and reduce commissioning times. The S611 adds enhanced functionality with network communications, metering, monitoring and diagnostics capabilities.

The Eaton Line of S611 Reduced Voltage Soft Starters is, multi-functional, easy to install and easy to program. Designed to control the acceleration and deceleration of three-phase motors up to 600V, the line is available from 26 amps through 414 amps.

The S611 is designed to be a complete package combining the SCRs, bypass contactor and overload in one compact unit.

Application Description

Designed to control the acceleration and deceleration of three-phase motors, the S611 soft starter uses Silicon Controlled Rectifiers (SCRs) to control the voltage to soft start and soft stop the motor. After the motor is started, internal run bypass contactors close, resulting in the motor running directly across-the-line. The built-in solid-state overload protects the motor from overload conditions with sophisticated algorithms that model true motor heating, resulting in better motor protection and fewer nuisance trips. Advanced protective and diagnostic features reduce downtime.

A voltage ramp start or current limit start is available. Kick start is available in either starting mode. The soft stop option allows for a ramp stop time that is longer than the coast to stop time. The pump control option provides a smooth transition for starting and stopping a motor and eliminating the “water-hammer” effect that can damage pipes, valves and pumps.

The S611 offers an impressive array of advanced protective features. Not only are the protective features selectable, but many offer variable settings allowing the user to fine tune the starter to meet specific system requirements.

The S611 has an easy to use User Interface Module (UI) that allows the user to configure the device and to read system parameters. The UI includes an LED display and keypad to scroll through the various parameters. The UI allows the user to modify control parameters, enable or disable protections, set communication variables, monitor system parameters such as line voltages and currents, and access the fault queue.

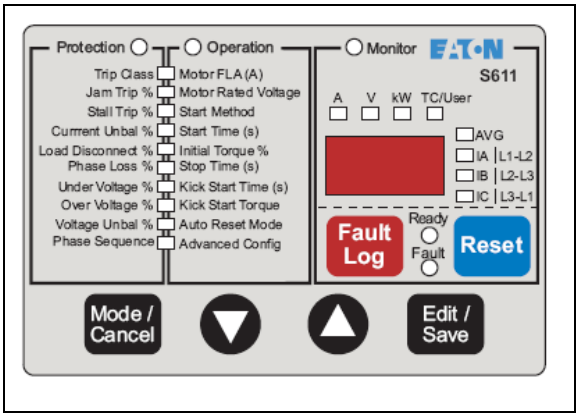

Figure 1 – User Interface

The UI can be removed from the S611 and remote mounted. Kits are available to door mount the UI, enabling users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door. This will help eliminate the possibility of an arc flash incident.

Communications

The S611 has built-in communication capabilities through two communications ports to connect the soft starter to a variety of networks, including Modbus (native), DeviceNet™, and PROFIBUS.

The S611 communication parameters can be configured with the UI . Advanced communication configuration settings provide the system integrator with powerful tools to facilitate system optimization.

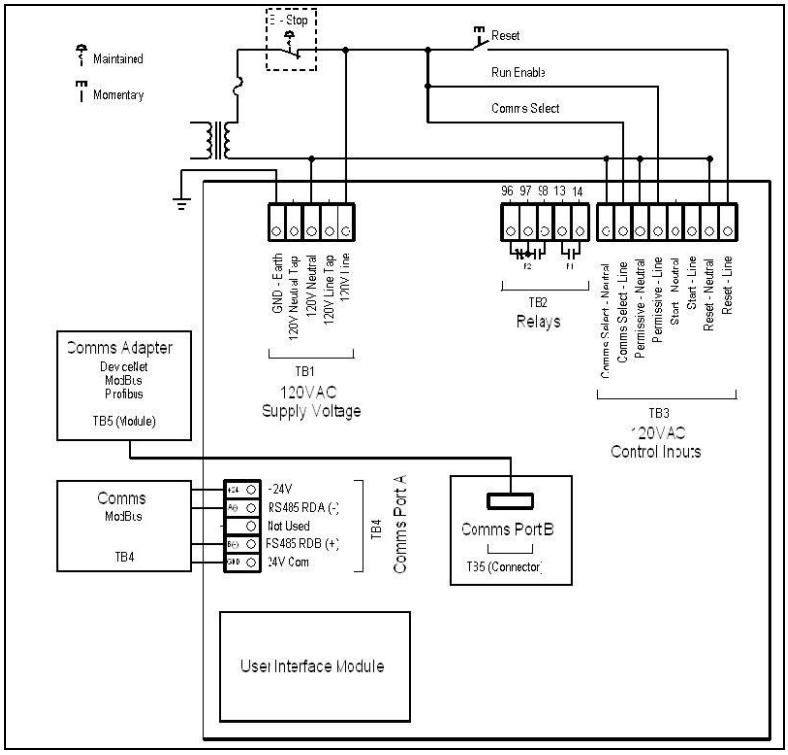

Figure 2 – Control Wiring Diagram

Table 1 - Network Communications Reference

Description	Catalog #	Style #
Modbus Communication Adapter w/o I/O	C441M	3-2372-001A
Modbus Communication Adapter w/ 120VAC I/O	C441N	3-2372-003B
Modbus Communication Adapter w/ 24VDC I/O	C441P	3-2372-004B
DeviceNet Communication Adapter w/ 120VAC I/O	C441K	3-2372-001B
DeviceNet Communication Adapter w/ 24VDC I/O	C441L	3-2372-002B
Profitbus Communication Adapter w/ 120VAC I/O	C441S	3-2398-001B
Profitbus Communication Adapter w/ 24VDC I/O	C441Q	3-2398-002B

Features and Benefits

■ The UI (User Interface Module) provides an intuitive, easy-to-use human interface with powerful configuration capabilities to maximize system performance.
■ Door or device mounted UI enables users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door, eliminating the possibility of an arc flash incident.
■ System operating parameters can be monitored enterprise-wide through a communications network. Increase uptime by providing data for process management and preventive diagnostics.
■ Run bypass mode greatly reduces internal heating created by the greater power dissipation in the SCRs. Bypass contactor directly connects the motor to the line and improves system efficiency by reducing internal power losses.
■ Internal solid-state overload protection provides accurate current measurement and trip settings. Sophisticated algorithms solve a series of differential equations that model true motor heating and cooling, resulting in superior motor overload protection while minimizing nuisance trips. Advanced selectable protective features safeguard the motor and system against a variety of system faults.
■ Internal run bypass contactors and overload protection eliminate the need for additional devices, reducing enclosure sizes, minimizing installation and wiring time and reducing overall assembly size and cost.
■ Wide range of overload FLA settings (50 – 100% of rated frame current) and a selectable trip class (5 – 30) offers users the flexibility to fine tune the starter to match specific application requirements.
■ Variable ramp times and torque control settings provide unlimited starting configurations, allowing for maximum application flexibility.
■ Kick-start feature enables soft starting of high friction loads.
■ Soft stop control for applications where an abrupt stop of the load is not acceptable.
■ Pump control option with sophisticated pump algorithms on both starting and stopping that minimize the pressure surges that cause water hammer. The pump control option will maximize the life of the pump and piping systems while minimizing the downtime caused by system failure.
■ Six SCRs control all three motor phases, providing smooth acceleration and deceleration performance.
■ Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings.
■ Reduce the peak inrush current’s stress on the power system.
■ Minimize peak starting torque to diminish mechanical system wear and damage.
■ 120V AC control voltage enhances ease of connections.

Protective Features

All protective features can be configured, enabled or disabled with the UI or through the communications network.

Motor Overload

The S611 includes electronic overload protection as standard. The overload meets applicable requirements for a motor overload protective device. The overload protects the motor from over heat conditions with the use of sophisticated algorithms that model true motor heating, resulting in superior motor protection and fewer nuisance trips.

The S611 calculates a thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur removing power to the motor. Upon trip, the S611 stores the calculated motor heating value and will not allow a motor re-start until the motor has sufficiently cooled. This feature ensures the motor will not be damaged by repeated overload trip, reset and re-start cycles.

The thermal memory value can be monitored through the UI or the communications network. The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs halting the process. Costly system downtime can be avoided.

The trip current is adjusted to match the specific application requirements by entering the motor nameplate full load current rating and trip class. The FLA adjustment includes a 2 to 1 adjustment range. The overload trip class is adjustable from class 5 through class 30. The overload is ambient temperature compensated — meaning its trip characteristics will not vary with changes in ambient temperature. The overload protection can be enabled, disabled, or disabled on start.

Short Circuit
The use of a short circuit protective device in coordination with the S611 is required in branch motor circuits by most electrical codes. Short circuit coordination ratings with both fuses and Eaton molded case circuit breakers are available providing customers with design flexibility. The S611 has short circuit coordination ratings as an open component, an enclosed starter, and in a motor control center.

Jam
Excessive current and torque up to locked rotor levels can occur in a jam condition. The condition can result in stress and damage to the motor, load, mechanical system, and the electrical distribution system. Jam protection prevents the stress and damage from a jam during normal run. After the motor is started, a current greater than 300% FLA setting will cause the starter to trip on a jam fault.

Stall
Excessive current and torque up to locked rotor levels can occur in a stall condition. The condition can lead to an overload trip and result in stress and damage to the motor, load, mechanical system, and the electrical distribution system. Stall protection prevents stress and damage to a motor that has not come up to speed, or stalled after the soft start time. The S611 will trip to protect the system in the event that the motor did not get to the rated speed in the defined soft start period. A current greater than 200% FLA at the end of the soft start period will cause the starter to trip on a stall fault.

Pole Over Temperature
High ambient temperatures, extended ramp times and high duty cycle conditions may cause the S611 power pole conductors to reach a temperature that exceeds their thermal rating. The S611 is equipped with sensors that monitor the temperature of the power poles. Over temperature protection occurs if the device’s thermal capacity is exceeded. The soft starter will trip in over temperature conditions, preventing device failure.

The device pole temperature value can be monitored through the UI or the communications network. This feature can be of use in determining an impending over temperature trip condition.

Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system shutdown can be avoided.

Phase Loss
Loss of a phase can cause a significant increase in the current drawn in the remaining two phases. Phase loss can lead to motor damage before an eventual overload trip occurs. Phase loss is typically an indication of a failure in the electrical distribution system. The S611 will detect a phase loss and trip if any phase current drops below a preset value. The phase loss trip level is adjustable from 0% to 100% of the average of the other two phase levels with an adjustable trip delay of 0.1 to 60 seconds.

Phase Imbalance
Phase current or voltage imbalance can cause a significant increase in the current drawn in the remaining two phases. Phase imbalance can lead to motor damage before an eventual overload trip. Phase imbalance is typically an indication of a failure in the electrical distribution system or the motor. The S611 will detect both current and voltage phase imbalances and trip if any phase becomes imbalanced as compared to the average of the other two phases.

The phase current imbalance trip level is adjustable from 0% to 100% of the average of the current in the other two phases with an adjustable trip delay of 0.1 to 60 seconds.

The phase voltage imbalance trip level is adjustable from 0% to 100% of the average of the voltage in the other two phases with an adjustable trip delay of 0.1 to 60 seconds.

Reset Mode
The S611 can be set up for automatic or manual reset on trip. The manual reset mode requires the operator to physically press the RESET button located on the soft starter. The overload can be manually reset through the UI or through the communications network.

The automatic reset mode allows the soft starter to be automatically reset as soon as the trip condition is no longer present. With the automatic reset mode, after the fault is no longer present, the motor will be restarted as soon as a valid start signal is present.

Phase Reversal
The S611 can determine if the proper line phase sequence is present by default. The device will trip if the line phase sequence is something other than A-B-C. The S611 can be configured to operate under reversed phase conditions (A-C-B).

Shorted SCR Detection
The S611 monitors the operation of the power poles and will trip under a shorted SCR condition.

Open SCR Detection
The S611 monitors the operation of the power poles and will trip under an open SCR condition.

Low Current
Low current conditions can be a result of a loss of load or a failure in the mechanical system. The S611 has low current protection that will trip if the average RMS current falls below a preset value. The low current protection can be programmed as a percent of motor FLA from 0% to 100%.

Low Voltage
Low voltage conditions can result from disturbances in the electrical power distribution system. Low voltage conditions can cause a malfunction and damage to electrical equipment. The S611 has low voltage protection that will trip if the average RMS voltage falls below a preset value. The low voltage protection can be programmed as a percent of nominal voltage from 1% to 99% with a trip delay of 0.1 to 60 seconds.

High Voltage
High voltage conditions can result from disturbances in the electrical power distribution system. High voltage conditions can cause malfunctions or failures of electrical equipment. The S611 has high voltage protection that will trip if the average RMS voltage is greater than a preset value. The high voltage protection can be programmed as a percent of nominal voltage from 101% to 120% with a trip delay of 0.1 to 60 seconds.

Monitoring Capabilities
The S611 has an impressive array of system monitoring capabilities that allow users to access real time process and diagnostic data. This data can be viewed at the device with the UI or through a communications network. Data over a communications network can provide valuable insight into the condition of the equipment and processes. Maintenance and production personnel can monitor critical operational and maintenance data from a central control station that can be located far away from the production facility. Process data can be monitored to determine system anomalies that may indicate a need for preventive maintenance or an Impeding failure.
Adjustments made through the communications network can reduce costs by minimizing the time traveling to the location where the motor controls are located. When faults do occur, real time fault data can assist maintenance in troubleshooting and planning repair resources. Remote reset signals can be given to tripped devices without the need for manual intervention by maintenance personnel.

Average Line Current
Provides the average of the three phase RMS line currents in amps, accurate to within 2%. Current data can be used to indicate a need for maintenance. Increased currents in a fixed load application can indicate a reduction in system efficiencies and performance, signifying system maintenance is due.

Average Pole Current
Provides the average of the three phase RMS pole currents in amps, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications, and will differ in inside-the-delta applications.

Average line current as a % FLA
Provides the average RMS line current as a percentage of the S611 FLA setting.

Three-Phase Line Currents
Provides three RMS phase line currents in amps, accurate to within 2%. Imbalances or changes in the relative phase current to one another can indicate anomalies in the motor or electrical distribution system.

Three-Phase Pole Currents

Provides three RMS phase pole currents in amps, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications.

Three-Phase Line Voltages
Provides the individual RMS three phase line voltages. Imbalances or changes in the relative phase voltage to one another can indicate anomalies in the motor or electrical distribution system. Voltage can be used to monitor electrical distribution system performance. Warnings, alarms and system actions to low or high voltage conditions can be implemented.

Percent Thermal Memory
Provides the real time calculated thermal memory value. The S611 calculates thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur, removing power to the motor. The thermal memory value can be of great use in determining an impending overload trip Condition. Alarms can be implemented in the process monitoring system warning of an Impending trip before a trip occurs, halting the process. Costly system downtime can be avoided.

Pole Temperature
Increases in pole temperature are caused by increases in ambient temperature, start/stop times and start duty cycles. Changes in pole temperatures represent a change in system operating conditions. Identifying unexpected operating conditions or changes can prompt maintenance and aid in process evaluation activities.

Power Monitoring
S611 does monitor the power and it can displayed on the UI.

Diagnostics

Fault Queue
Current fault and a fault queue containing the last nine system faults can be read through the UI or communications network. Fault identification can minimize troubleshooting time and cost and prevent arc flash incidents. The fault queue can be remotely accessed through a communications network to assist in planning maintenance resources. 30 different faults can be identified by the S611.

Control Status
The S611 provides data that represents system conditions that can be read through the UI or the communications network. This data identifies the status of the system and the control commands the system is requesting of the S611. This can be used for advanced Troubleshooting and system integration activities.

Operation

Starting and Stopping Modes
The S611 has a variety of starting and stopping methods to provide superior performance in the most demanding applications. The motor can be started in either Voltage Ramp Start or Current Limit Start mode. Kick Start and Soft Stop are available within both starting modes.

Voltage Ramp Start
Provides a voltage ramp to the motor resulting in a constant torque increase. The most commonly used form of soft start, this start mode allows you to set the initial torque value and the duration of the ramp to full voltage conditions. Bypass contactors close after ramp time.

- Adjustable initial torque 0 – 85% of locked rotor torque.
- Adjustable ramp time 0.5 – 180 seconds (can be extended with factory modification).

Current Limit Start
Limits the maximum current available to the motor during the start phase. This mode of soft starting is used when it becomes necessary to limit the maximum starting current due to long start times or to protect the motor. This start mode allows you to set the maximum starting current as a percentage of locked rotor current and the duration of the current limit. Bypass contactors close after current limit time.

- Maximum current of 0 – 85% locked rotor current.
- Adjustable ramp time 0.5 – 180 seconds (can be extended with factory modification).

Kick Start
Selectable feature in both Voltage Ramp Start and Current Limit Start modes. Provides a current and torque “kick” for 0 to 2.0 seconds. This provides greater initial current to develop additional torque to breakaway a high friction load.

- 0 – 85% of locked rotor torque
- 0 – 2.0 seconds duration

Soft Stop
Allows for a controlled stopping of a load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or load damage.

- Stop time = 0 – 60 seconds.

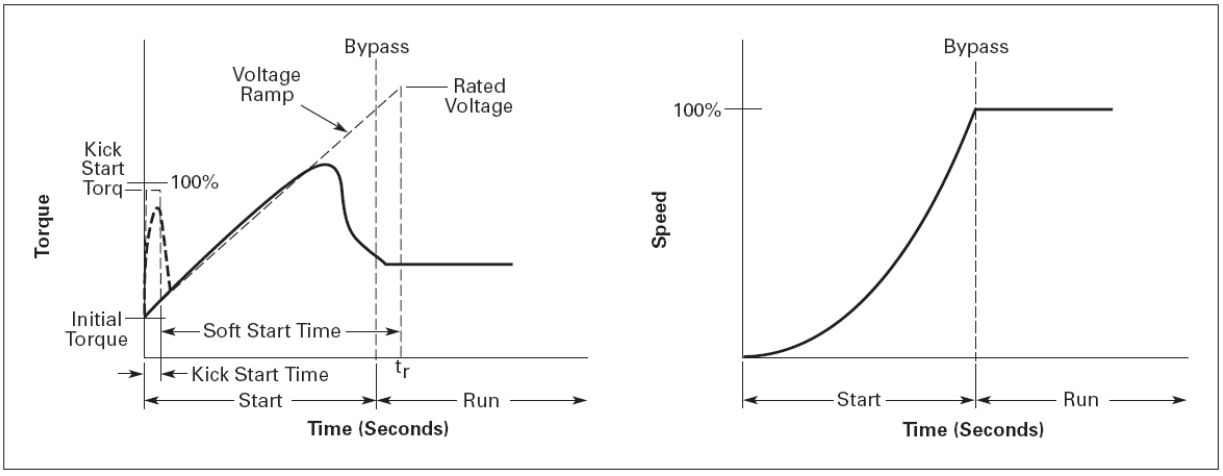

Figure 3 - Ramp Start

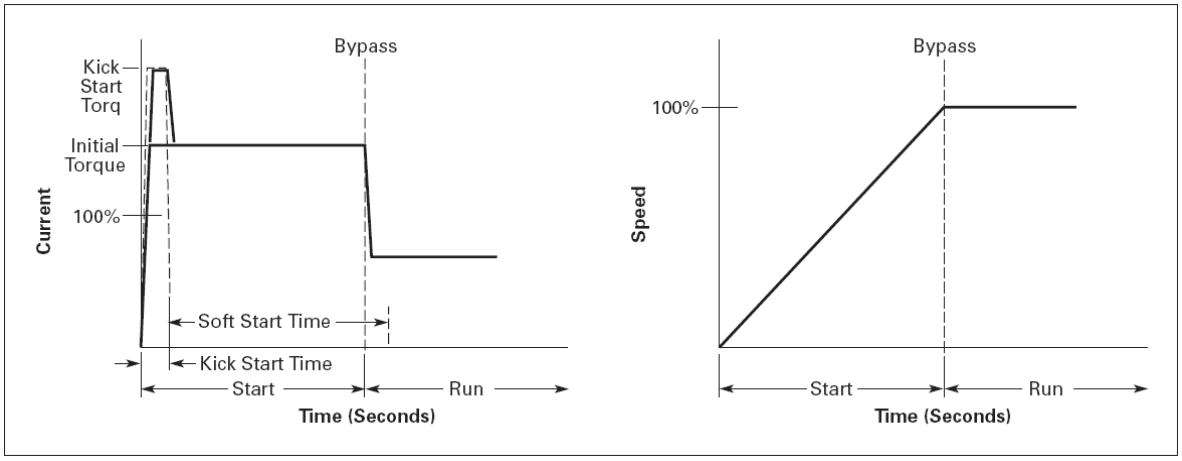

Figure 4 - Current Limit Start

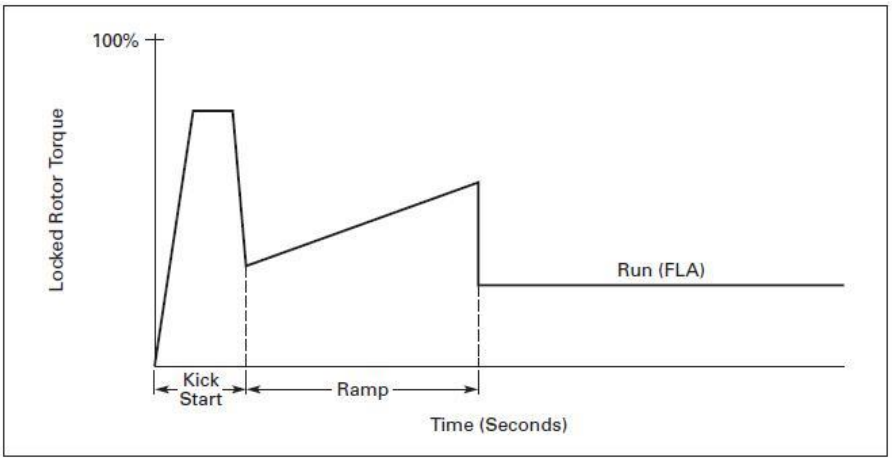

Figure 5 - Kick Start Graphic

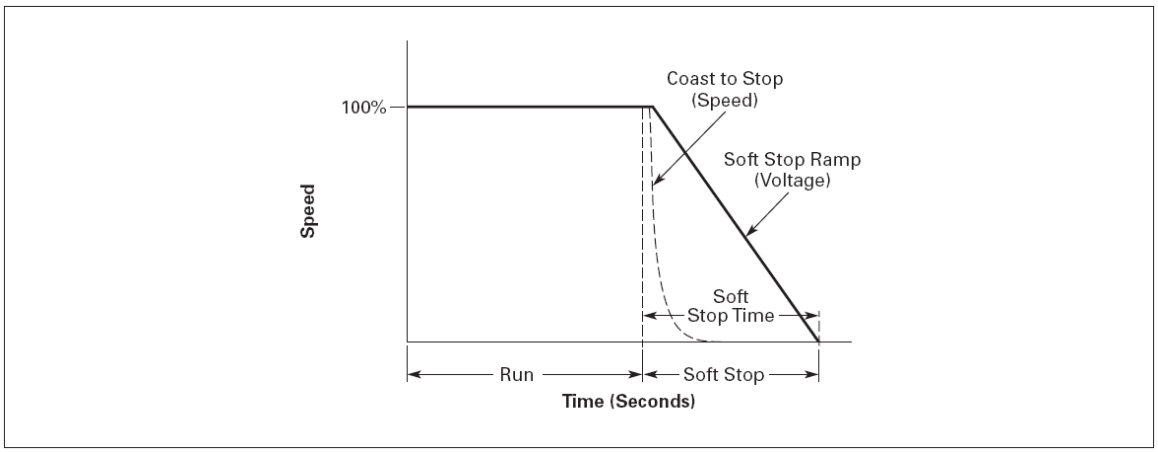

Figure 6 - Stop Ramp Graphic

Edge and Level Sensing Control
Edge or Level Sensing is selected with the Start Control parameter in the Advanced Configuraton Menu. Factory default is Level Sensing.

Edge Sensing
Edge sensing requires 120V AC power be momentarily applied to the Start terminal (with the Permissive terminal 120V AC) to initiate a start under all conditions. After a stop or fault occurs, the 120V AC must be removed, then reapplied to pin 1 before another start can occur. This control configuration should be used when restarting of the motor after a fault or stop must be supervised manually or as a part of a control scheme. The cycling of 120V AC power to the Permissive terminal before starting is required regardless of the position of the auto reset parameter.

Level Sensing
Level sensing will enable a motor to restart after a fault is cleared without cycling 120V AC to the Permissive terminal as long as:

- Permissive terminal is supplied with 120V AC.
- The auto reset parameter is set to enabled,
- All faults have cleared or have been reset.

This control configuration should be used where it is desirable to restart a motor after a fault without additional manual or automatic control. An example of this condition would be on a remote pumping station where it is desirable to automatically restart a pump after a power outage without operator intervention.

If the auto reset feature is used, CAUTION must be exercised to assure that any restart occurs in a safe manner.

Product Selection
Motor applications and customer needs come in many different varieties. With the standard and severe duty rating tables, we have attempted to provide guidelines on what the Soft Starter is capable of. If the application falls under these categories, you can use these charts. For other applications, or when a question arises, consult with your local Eaton Representative or call the Eaton Technical Resource Center.

300% FLA @ 15 Seconds @ 50C.

Table 3 – Horsepower Ratings

S611 Horsepower Ratings									Catalog Number
	60 Hz								
	200V		230V		460V		575 - 600V		
Max. Current	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	
52A	15	10	15	15	40	30	50	40	S611A052N3S
65A	20	15	20	20	50	40	60	50	S611A065N3S

77A	20	20	25	20	60	50	75	60	S611A077N3S
99A	30	25	30	30	75	60	100	75	S611B099N3S
125A	40	30	40	40	100	75	125	100	S611B125N3S
156A	50	40	60	50	125	100	150	125	S611C156N3S
180A	60	50	60	60	150	125	150	150	S611C180N3S
242A	75	60	75	75	200	150	250	200	S611D242N3S
302A	100	75	100	100	250	200	350	250	S611E302N3S
361A	125	100	150	125	300	250	350	300	S611E361N3S
414A	150	125	NA	150	350	250	450	350	S611F414N3S

Options

Pump Control

For pump control option, change the **9th** digit in the Catalog Number to **P**.

Table 3 – Horsepower Ratings – Pump Control Option

S611 Horsepower Ratings									Catalog Number
	60 Hz								
	200V		230V		460V		575 - 600V		
Max. Current	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	
52A	15	10	15	15	40	30	50	40	S611A052P3S
65A	20	15	20	20	50	40	60	50	S611A065P3S
77A	20	20	25	20	60	50	75	60	S611A077P3S
99A	30	25	30	30	75	60	100	75	S611B099P3S
125A	40	30	40	40	100	75	125	100	S611B125P3S
156A	50	40	60	50	125	100	150	125	S611C156P3S
180A	60	50	60	60	150	125	150	150	S611C180P3S
242A	75	60	75	75	200	150	250	200	S611D242P3S
302A	100	75	100	100	250	200	350	250	S611E302P3S
361A	125	100	150	125	300	250	350	300	S611E361P3S
414A	150	125	NA	150	350	250	450	350	S611F414P3S

Standards and Certifications

- IEC 60947-4-2
- UL Listed
- CSA Certified (3211 06)

Technical Data and Specifications

Soft Starter (Partial Catalog Number)		S611A052	S611A065	S611A072	S611B099	S611B125	S611C156	S611C180	S611D242	S611E302	S611E361	S611F414
Max. Current Capacity	A	52	65	77	99	125	156	180	242	302	361	414
FLA Range	A	26 - 52	32.5 - 65	38.5 - 77	48 - 99	62.5 - 125	78 - 156	90 - 180	120 - 242	151 - 302	180.5 - 361	207 - 414
Dimensions												
Width	inch (mm)	11.58 (294)			11.58 (294)		11.58 (294)		11.58 (294)	17.56 (446)		17.56 (446)
Height	inch (mm)	19.45 (494)			19.45 (494)		20.83 (529)		20.83 (529)	31.15 (791)		31.15 (791)
Depth	inch (mm)	7.46 (189)			7.46 (189)		8.37 (213)		8.37 (213)	9.54 (242)		9.54 (242)
Weight	lb. (kg)	24 (11)			24 (11)		33 (15)		38 (15)	86 (39)		102 (46)
General Information												
Bypass Mecahnical Lifespan		10M										
Insulating Voltage	V	660										
Ramp Time Range	seconds	0.5 - 180										
Resistance to Vibration	g.	1										
Resistance to Shock	g.	Meets ITSA Standards										
Electrical Information												
Operating Voltage	V	130 - 600										
Operating Frequency	Hertz	47 - 63										
Overload Setting (Frame)	% FLA	50 - 100										
Trip Class		5,10,20,30										
Cabling Capacity (IEC 947)												
Number of Conductors		1								2		
Wire Sizes	AWG	14 - 2/0					2 - 600mcm					
Type of connectors		Lug										
Control Wiring												
Wire Sizes	AWG	22 - 12										
Number of Conductors		2 (or one 12 - 14 AWG)										
Torque Requirements	lb-in	3.5										
Max. Size	AWG	12										
Control Power Requirements												
Voltage Range (120V ± 10%)	V	108 - 132										
Steady State current	A	0.375								0.75		
Inrush Current	A	0.5								1		
Ripple	%	1										
Relays (1) Class A and C												
Voltage AC - maximum	V	120										
Voltage DC - maximum	V	24										
Amps - Maximum	A	3										
Environment												
Temperature - Operating	°C	-20 to +50										
Temperature - Storage	°C	-40 to +85										
Altitude	Meters	<2000 meters, Derate 0,5% per 100 meters>2000 meters										
Humidity	%	<95% Non-condensing										
Operating Position		Vertical, Line Side Up										
Pollution Degree IEC947-1		3										
Impulse Withstand Voltage IEC947-4-1	V	6000										