Application of RVSS soft starter for centrifuge applications

How to size and configure the S811+ reduced-voltage soft starter for centrifuge applications

Application

The S811+ soft starter may be used to accomplish motor starting using the reduced-voltage method for centrifuge applications. Typically, the motor horsepower or kW rating is used to determine the required size of the soft starter, and the load type is used to determine operational parameter values for optimum performance. With centrifuge applications, the mass of the load must also be considered, as current profiles and ramp times may be significantly different from other types of loads.

Overview

Soft starter sizing is determined by the horsepower or kW rating of the motor, coupled with the mains operating voltage. Please note that all references to sizing the S811+ soft starter are based on motor full load amps (FLA) rather than horsepower. This is to preclude improper sizing due to variations of motor FLA among various motor manufacturers. Using this information, a table or graph is consulted to determine the minimum size of the soft starter for the application. Centrifuge applications are considered to be severe duty, so extended start ramp times must be considered in the selection process to ensure that SCR overheating will not occur. Load currents associated with centrifuge applications generally approximate the 3 x FLA to 4 x FLA range, and start ramp time generally ranges from 120 to 300 seconds with a reduced-voltage soft starter. Because centrifuge applications are highly dependent on the process materials involved and are often specifically designed for a given process, exact start operation parameters are difficult to predict.

S811+ sizing

The catalog tables for the S811+ are based on an inrush value of 300–450 percent FLA of the motor, with maximum start ramp times of 180 seconds. On motors with quadratic loads, current values are generally 250–300 percent FLA. With centrifuge applications, start ramp currents are often 300–350 percent. Additionally, the ramp times also must be considered independently, as when the ramp times increase even though the inrush current does not change, the maximum allowable current capacity is reduced. This is due to the overall heat that the SCR can tolerate and still achieve the required performance.

It is recommended that the S811+ with the extended start ramp time option be selected for centrifuge applications. This will preclude not having the option of extending the start ramp time beyond the standard 180 seconds (up to 360 seconds) if needed.

To calculate soft starter sizing requirements, assume a minimum starting current of 350 percent motor FLA. Refer to **Table 1** to select the appropriate size soft starter under the column indicating 360 seconds maximum ramp time. The values for 180 second ramp times are shown for comparison.

Table 1. Maximum Current Exposure

		Maximum Start Current	
Catalog Number	**Maximum FLA Current**	**Maximum Ramp Time 180 sec**	**Maximum Ramp Time 360 sec**
S811+T18P3S	180	990	495
S811+T24P3S	240	1320	660
S811+T30P3S	300	1650	825
S811+U36P3S	360	1980	990
S811+U42P3S	420	2310	1155
S811+U50P3S	500	2750	1375
S811+V36P3S	360	1980	990
S811+V42P3S	420	2310	1155
S811+V50P3S	500	2750	1375
S811+V65P3S	650	3575	1787
S811+V72P3S	720	3960	1980
S811+V85P3S	850	4675	2337
S811+V10P3S	1000	5500	2750

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Example 1

200 hp motor with 240 FLA at 460V, start ramp time = 360 seconds maximum.

240 x 3.5 = 840A ➡ S811+U36N3L or S811+V36N3L at 990A minimum.

S811+ soft starters that are larger than shown in the example may be selected to achieve higher current capacity margins. Please note that the example denotes 840A for the entire 360-second ramp time. In most cases, the soft starter will not be exposed to this current level for the entire start ramp time. Start ramp times shorter than the 360-second maximum will also provide higher operating margins.

Note: The mass of the centrifuge is not included in the calculation as higher (mass) values result in higher moments of inertia, which directly result in longer start ramp times, up to 360 seconds, rather than simply higher starting currents. This is due to the fact that any given motor has an impedance that does not change with the load characteristics. If the centrifuge is to be started under conditions other than minimum mass (leftover process remaining in the unit), please allow for higher current values. Higher starting currents may be observed due to higher start ramp voltages prior to the motor achieving synchronous speed. In the event that a centrifuge cannot achieve synchronous speed in 360 seconds, it is very likely that motor size and/or drive pulley ratio is improper for the application.

S811+ start parameters

The following soft start parameter values may be used as initial values. Additional parameters such as phase sequence may need to be adjusted. Motor rotation should begin within two seconds of energization. Increase kick-start time and then initial torque to achieve the proper characteristics.

- Soft start config menu:
  - Start method: Voltage ramp
  - Soft start time: 360 seconds
  - Initial torque: 30 percent
  - Kick-start time: 1 second
  - Kick-start torque: 45 percent
- Overload config menu:
  - Overload trip FLA: Set to motor nameplate FLA
  - Overload trip class: 30
  - Overload on start: Disable
- Protection setup menu:
  - Motor rated volt: Line voltage

Note the time required to achieve synchronous speed. The internal bypass contactors will close when the motor has achieved synchronous speed rather than at the end of the start ramp time. Reduce the start ramp time to the time required to achieve synchronous speed plus 30 seconds. This is to allow for minor variations in centrifuge operation, such as remaining process in the unit during a start attempt.

All other operational characteristics and any troubleshooting information, if needed, may be found in the S811+ User Manual.

Circuit protection devices such as breakers and fuses are to be sized according to accepted standards based on motor capacity and conductor size.

Wye-delta conversions

Many centrifuge applications utilize wye-delta starting methods to reduce current levels during the start cycle. The information provided here is to provide additional information to address assumptions and expectations of system operation and performance when converting from a wye-delta start method to reduced-voltage soft start methods.

Start time

The typical start winding of a wye-delta system provides reduced current by reducing the phase voltage in the winding of the motor. Typically, this value is 33 percent of line voltage, which results in 33 percent of locked rotor current (maximum) during the initial stages of the start process. This current yields approximately 33 percent of locked rotor torque to accelerate the application to synchronous speed. The timer setting required for the application to transition from the start winding to the run winding is usually determined by trial and error or some selected time based on when the application is either at synchronous speed or no longer accelerating. It is often assumed that if a wye-delta system is adjusted for a 360-second run (for example) on the wye windings during the start cycle, this means that the centrifuge cannot accelerate at any other rate. This thinking is not necessarily correct. When a centrifuge is started with the wye-delta method, the initial torque is approximately 33 percent of locked rotor torque due to the reduced phase voltage. Prior to the end of the start timer, the torque relative to phase voltage is still the same as the phase voltage. This means that as the motor accelerates, additional torque is only achieved relative to the motor torque curve at the end of the start cycle; therefore, motor acceleration toward the end of the start cycle may not be as great as in the initial stages of the start.

Operational difficulties with this system may include excessive mechanical wear of belts and pulleys when the motor is switched from the start windings to the run windings and the application is not up to synchronous speed, lack of operational or overload protections, and failures of contactors and/or control devices to name a few.

The reduced-voltage soft starter (RVSS) initial torque parameter is adjusted to 30 percent. This value approximates the same initial torque as would be developed with a wye-delta system starting in the wye configuration. However, due to the rate of (phase) voltage increase during the start ramp time of the RVSS, motor torque is also increasing from increased phase voltage and torque increases relative to the motor torque curve. The net result is a significantly reduced start ramp time. In the event that this increased motor acceleration poses an issue with the centrifuge process, the acceleration rate may be modified by the use of the current limit function of the RVSS.

Start current

Due to the difference of phase voltages when comparing wye and delta windings, it is known that to achieve the same torque developed with a delta configuration as would be with a wye configuration, the delta configuration current increases by a factor of the √3. Attempts to limit delta configuration currents to similar values of wye configuration currents typically will not result in a successful motor start. Please refer to the values of locked rotor amps (LRA) and locked rotor torque (LRT) in Example 2.

Example 2

200 hp motor with 1327 LRA at 460V, locked rotor torque = 957 lb-ft.

Wye configuration = 33 percent of full voltage LRA = 435A ➡ 307 lb-ft torque.

Delta configuration = 435A x √3 = 754A ➡ 307 lb-ft torque.

Delta configuration = 435A ➡ 102 lb-ft torque, insufficient to start motor.

When converting a wye-delta system to an RVSS, the cables from the RVSS to the motor are doubled as the motor is at least a six-lead motor. Cable sizing is normally adequate to meet the demands of the delta configuration start.

Verify that protection devices such as breakers and fuses are sized appropriately for the higher starting currents. In some cases, higher fuse and/or breaker rating may be required.

Supporting documentation

Manuals	Reference Number
S811+ User Manual	MN03900001E

Additional help

In the event that additional help is needed, please contact the Technical Resource Center at 1-877-ETN-CARE, Option 2, Sub Option 2.

Eaton Corporation
Electrical Sector
1111 Superior Avenue
Cleveland, OH 44114 USA
Eaton.com

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