GE

Industrial Solutions

WORLDWIDE PARTNER

ASTAT XL/XB Series

Application Design Guide

GE imagination at work

Original Instruction

DET-824 ed. 00

Contents

Soft Starter Selection Made Easy

Selecting the right soft starter is as easy as 1, 2, 3. Simply choose the application, the features you require, then select the best soft starter model to suit your needs.

Additional information is available from brochures and manuals available from GE.

WARNING
This selection guide assumes typical motor and operating conditions. Consult your supplier for applications with:

- High start frequency
- High altitude installations (i.e. > 1000 m)
- High ambient installations (i.e. > 40°C)
- Soft stop times exceeding 30 seconds

What is your application?

Use the table below to select a soft starter based on typical start current and time requirements for your application.

NOTE
Soft starter settings depend on the details of the individual installation (including the characteristics of the starter, motor and load).

Application	300%, 10 seconds	350%, 15 seconds	400%, 20 seconds	450%, 30 seconds
Bow thruster			■	
Centrifuge				■
Chipper				■
Compressor				
centrifugal		■		
reciprocating - loaded				■
reciprocating - unloaded			■	
screw - loaded			■	
screw - unloaded		■		
Conveyor				
horizontal		■		
inclined			■	
vertical (bucket)				■
Crusher				
cone		■		
jaw				■
rotary			■	
Debarker			■	
Fan				
blower / axial (damped)			■	
blower / axial (undamped)				■
centrifugal (damped)		■		
centrifugal (undamped)				■
high pressure				■
Mill				
ball				■
hammer				■
Pump				
bore	■			
centrifugal		■		
positive displacement			■	
submersible		■		
Saw				
bandsaw (headrig)				■
circular (slabber, edger)		■		
Shredder				■

WARNING
This selection guide assumes typical motor and operating conditions. Consult your supplier for applications with:

- High start frequency
- High altitude installations (i.e. > 1000 m)
- High ambient installations (i.e. > 40°C)
- Soft stop times exceeding 30 seconds

What features do you need?

Choose the soft starter that includes the features you require.

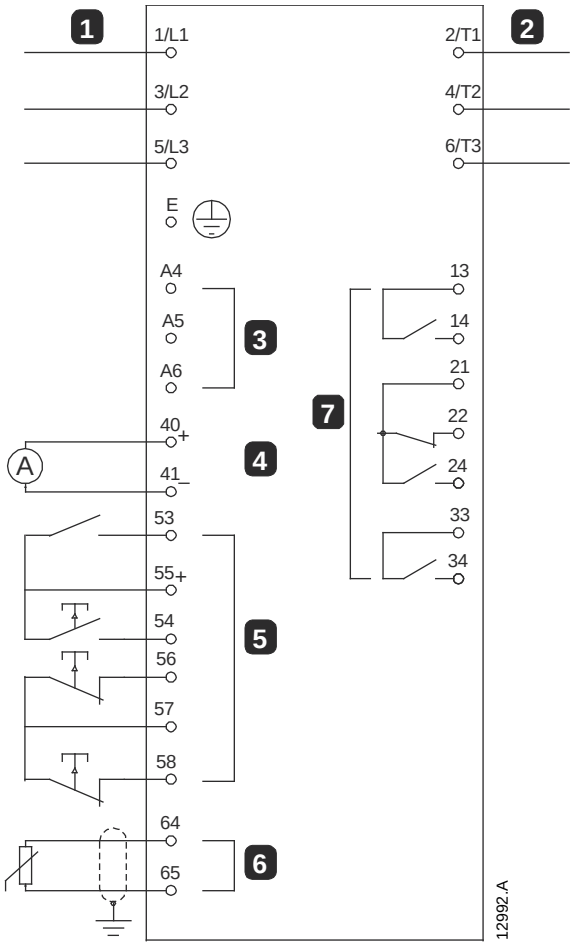
	ASTAT XB	ASTAT XBm	ASTAT XL
Start/Stop			
Soft stop ramp	■	■	■
Timed voltage ramp start	■		
Constant current		■	■
Current ramp		■	■
Torque control			■
Pump control			■
Adaptive control			■
Brake			■
Jog			■
Motor/system protection			
Motor overload		■	■
Phase sequence		■	■
Current imbalance		■	■
Excess start time		■	■
Undercurrent			■
Instantaneous overcurrent			■
Motor thermistor		■	■
Heatsink overtemperature			■
Input trip			■
Shorted SCR			■
Power circuit	■	■	■
Motor connection			■
RS485 failure	■	■	■
Frequency	■	■	■
Bypass			
Internal	■	■	■
Communications			
DeviceNet	■	■	■
Modbus RTU	■	■	■
Profibus	■	■	■
Ethernet (EtherNet/IP, Modbus TCP, Profinet)	■	■	■
USB	■	■	■
Built-in display			■
Remote display	option	option	option

Schematics

ASTAT XL

Current: 23 A ~ 1600 A
Mains Voltage: 200 ~ 690 VAC
Supply frequency: 50/60 Hz
Enclosure: IP20 (up to 105 A) - IP00 for all other models

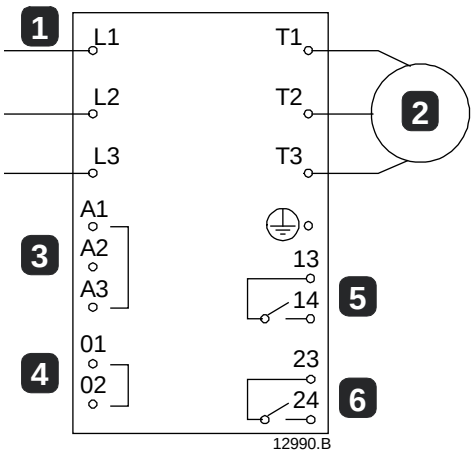
1	Three-phase supply
2	Motor
3	Control voltage (model dependent)
4	Analog output
5	Remote control inputs
54, 55	Start
56, 57	Stop
58, 57	Reset
53, 55	Programmable input A
55, 41	24 VDC output
6	Motor thermistor input (PTC only)
7	Relay outputs
13, 14	Relay output A
21, 22, 24	Relay output B
33, 34	Relay output C



ASTAT XB

Current: 18 ~ 200 A, AC53b
Mains Voltage: 200 ~ 575 VAC
Supply frequency: 45 ~ 66 Hz
Enclosure: IP20 up to 100 A - IP00 for all other models

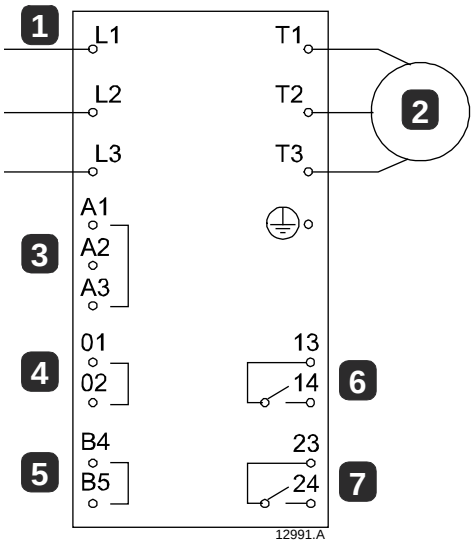
1	Three-phase supply
2	Motor
3	Control voltage (model dependent)
4	Remote control inputs (Start/Stop/Reset)
5	Main contactor output
6	Run relay output



ASTAT XBm

Current: 18 ~ 200 A, AC53b
Mains Voltage: 200 ~ 575 VAC
Supply frequency: 45 ~ 66 Hz
Enclosure: IP20 up to 100 A - IP00 for all other models

1	Three-phase supply
2	Motor
3	Control voltage (model dependent)
4	Remote control inputs (Start/Stop/Reset)
5	Motor thermistor input (PTC only)
6	Main contactor output
7	Programmable output



Which model?

For successful operation, the soft starter must be the correct size for the motor and the application. Select a soft starter which has a current rating at least equal to the motor's full load current (nameplate) rating, at the appropriate start duty.

Which model matches the application?

Select the model of soft starter that has a current rating equal to or greater than the motor's nameplate full load current rating, at the required start duty.

Current Ratings

Model	350%, 10 seconds	400%, 20 seconds	450%, 30 seconds
QLxxB0023D	20 (30)	17 (26)	15 (22)
QLxxB0043D	37 (59)	31 (51)	26 (44)
QLxxB0050D	44 (66)	37 (55)	30 (45)
QLxxB0053D	53 (80)	46 (69)	37 (55)
QLxxB0076D	64 (96)	55 (83)	47 (70)
QLxxB0097D	82 (123)	69 (104)	58 (87)
QLxxB0100D	88 (132)	74 (112)	61 (92)
QLxxB0105D	105 (158)	95 (143)	78 (117)
QLxxB0145D	123 (184)	106 (159)	90 (136)
QLxxB0170D	145 (217)	121 (181)	97 (146)
QLxxB0200D	189 (283)	160 (241)	134 (201)
QLxxB0220D	210 (315)	178 (268)	122 (183)
QLxxX0255D	231 (346)	201 (302)	176 (264)
QLxxB0255D	231 (346)	201 (302)	176 (264)
QLxxB0350D	329 (494)	284 (427)	244 (366)
QLxxX0360D	360 (540)	310 (465)	263 (395)
QLxxX0380D	380 (570)	359 (539)	299 (449)
QLxxB0425D	411 (617)	355 (533)	305 (458)
QLxxX0430D	430 (645)	368 (552)	309 (464)
QLxxB0500D	445 (668)	383 (575)	326 (490)
QLxxB0580D	492 (738)	425 (637)	364 (546)
QLxxX0620D	620 (930)	540 (810)	343 (651)
QLxxX0650D	650 (975)	561 (842)	455 (683)
QLxxB0700D	592 (889)	512 (768)	438 (658)
QLxxX0790D	790 (1185)	714 (1077)	579 (868)
QLxxB0820D	705 (1058)	606 (910)	516 (774)
QLxxB0920D	804 (1206)	684 (1026)	571 (857)
QLxxX0930D	930 (1395)	829 (1244)	661 (992)
QLxxB1000D	936 (1404)	796 (1194)	664 (997)
QLxxX1200D	1200 (1800)	1200 (1800)	1071 (1606)
QLxxX1410D	1410 (2115)	1319 (1979)	1114 (1671)
QLxxX1600D	1600 (2400)	1600 (2400)	1353 (2030)

NOTE
Values in brackets are for inside delta connection.

ASTAT XB/XBm

Model	350%, 10 seconds	400%, 20 seconds	450%, 30 seconds
QSxxB018X	18	17	Not suitable
QSxxB034X	34	30	
QSxxB042X	42	36	
QSxxB048X	48	40	
QSxxB060X	60	49	
QSxxB075X	75	65	
QSxxB085X	85	73	
QSxxB100X	100	96	
QSxxB140X	140	120	
QSxxB170X	170	142	
QSxxB200X	200	165	

NOTE
These duty ratings define the load requirements, not the starter capabilities. Starter current ratings are specified in the user manual. Use these charts to select a soft starter for a particular application.

Typical Motor FLCs

If you don't have accurate information on your motor's start current characteristics, the table below can help you estimate the likely full load current for a particular motor size. This information can help when choosing a soft starter, but will not provide an optimised solution because the characteristics of different motors can vary considerably.

Motor Power		Current rating at different voltages					
kW	HP	220-230 V	380-400 V	440 V	460 V	500 V	660-690 V
7.5	10	27	16	14	13	12	9
11	15	39	22	20	18	18	14
15	20	52	30	27	25	23	17
18.5	25	64	37	33	30	29	21
22	30	75	44	39	35	33	25
25	35	85	52	45	38	39	30
30	40	103	60	52	48	45	35
37	50	126	72	64	59	55	42
45	60	150	85	76	73	65	49
55	75	182	105	90	85	80	61
75	100	240	138	125	117	105	82
90	125	295	170	146	138	129	98
110	150	356	205	178	167	156	118
132	180	425	245	215	201	187	140
140	190	450	260	227	211	200	145
147	200	472	273	236	221	207	152
150	205	483	280	246	226	210	159
160	220	520	300	256	246	220	170
185	250	595	342	295	279	263	200
200	270	626	370	321	304	281	215
220	300	700	408	353	331	310	235
250	340	800	460	401	377	360	274
257	350	826	475	412	387	365	280
280	380	900	510	450	422	400	305
295	400	948	546	473	444	416	320
300	410	980	565	481	452	420	325
315	430	990	584	505	475	445	337
335	450	1100	620	518	505	472	355
355	480	1150	636	549	535	500	370
375	500	1180	670	575	565	527	395
400	545	1250	710	611	610	540	410
425	580	1330	760	650	640	574	445
445	600	1400	790	680	670	595	455
450	610	1410	800	690	678	608	460
475	645	1490	850	730	716	645	485
500	680	1570	900	780	753	680	515
560	760	1750	1000	860	854	760	570
600	800	1875	1085	937	904	825	625
650	870	2031	1176	1015	979	894	677
700	940	2187	1266	1093	1054	962	729
750	1000	2343	1357	1172	1130	1031	781
800	1070	2499	1447	1250	1205	1100	833
850	1140	2656	1537	1328	1280	1168	885
900	1250	2812	1628	1406	1356	1237	937
950	1275	2968	1718	1484	1431	1306	989
1000	1340	3124	1809	1562	1506	1375	1041

What are IP ratings?

IEC 60529 specifies protection ratings for enclosures. These ratings describe the level of protection against dust and liquids entering the enclosure.

IP ratings consist of two numbers. The first number describes the protection against solid objects and the second number describes the level of protection against entry of liquids.

IP	Solids	Liquids
0	No protection.	No protection.
1	Protected against solid objects greater than 50 mm (eg accidental touching by hand).	Protected against vertically falling drops of water (eg condensation).
2	Protected against solid objects greater than 12.5 mm (eg fingers).	Protected against direct sprays of water up to 15° from vertical.
3	Protected against solid objects greater than 2.5 mm (eg tools or wires).	Protected against sprays of water up to 60° from vertical.
4	Protected against solid objects greater than 1 mm (eg tools and small wires).	Limited protection against water sprayed from all directions (limited ingress permitted).
5	Limited protection against dust (some ingress but no harmful deposit).	Limited protection against low pressure jets of water from all directions (limited ingress permitted).
6	Complete protection against dust.	Protected against strong jets of water (limited ingress permitted).
7		Protected against the effects of immersion in water between 15 cm and 100 cm.
8		Protected against extended immersion in water under pressure.

What are NEMA ratings?

NEMA 250 is a product standard that addresses many aspects of enclosure design and performance.

NEMA	Protection against solid objects	closest IP equivalent *
1	Indoor, protection from contact.	IP 20
2	Indoor, limited protection from dirt and water.	IP 22
3	Outdoor, some protection from rain, sleet, windblown dust and ice.	IP 55
3R	Outdoor, some protection from rain, sleet and ice.	IP 24
4	Indoor or outdoor, some protection from windblown dust, rain, splashing water, hose-directed water and ice.	IP 66
4X	Indoor or outdoor, some protection from corrosion, windblown dust, rain, splashing water, hose-directed water and ice.	IP 66
6	Indoor or outdoor, some protection from ice, hose-directed water, entry of water when submerged at limited depth.	IP 67
12	Indoor, protection from dust, falling dirt and dripping non-corrosive liquids.	IP 54
13	Indoor, protection from dust, spraying water, oil and non-corrosive liquids.	IP 54

NOTE

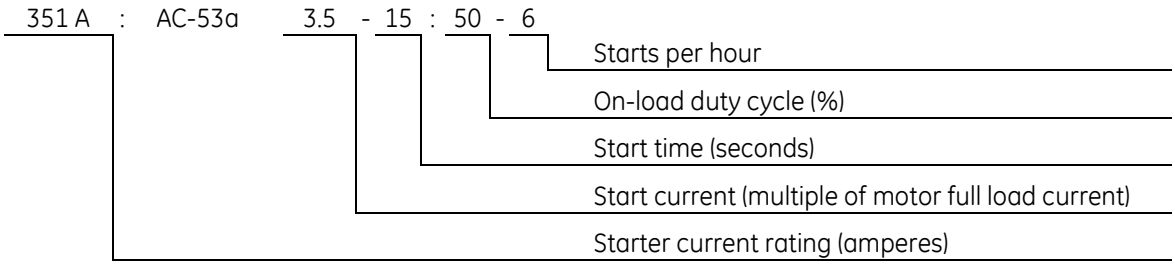
* NEMA and IP ratings are not directly equivalent and this information provides an approximate correlation only.

What are AC53 Utilisation Codes and what do they show about the soft starter's current rating?

The AC53a Utilisation Code defines the current rating and standard operating conditions for a non-bypassed soft starter.

The soft starter's current rating determines the maximum motor size it can be used with. The soft starter's rating depends on the number of starts per hour, the length and current level of the start, and the percentage of the operating cycle that the soft starter will be running (passing current).

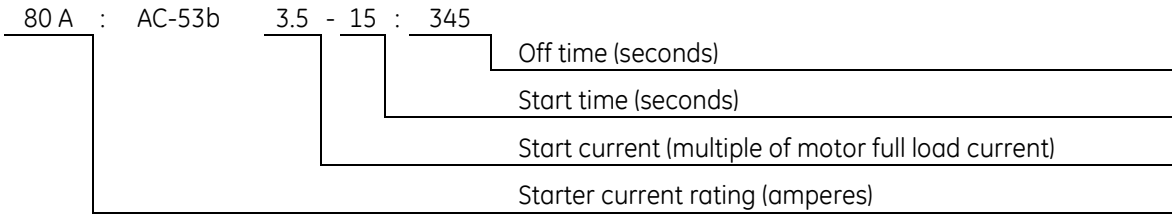
The soft starter's current rating is only valid when used within the conditions specified in the AC53a code - the soft starter may have a higher or lower current rating in different operating conditions.



The AC53b Utilisation Code defines the current rating and standard operating conditions for a bypassed soft starter (internally bypassed, or installed with an external bypass contactor).

The soft starter's current rating determines the maximum motor size it can be used with. The soft starter's rating depends on the number of starts per hour, the length and current level of the start, and the amount of time the soft starter will be off (not passing current) between starts.

The soft starter's current rating is only valid when used in the conditions specified in the AC53b code - the soft starter may have a higher or lower current rating in different operating conditions.



What are main contactors?

Soft starters can be installed with or without a main contactor.

A main contactor:

- May be required to meet local electrical regulations.
- Provides physical isolation when the starter is not in use and in the event of a soft starter trip.

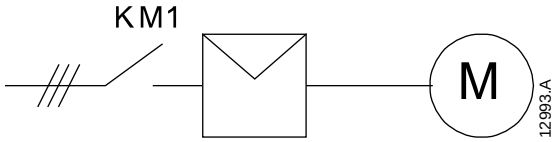
Even in the off state SCRs do not offer a high degree of isolation due to leakage through the SCR and protection networks.

- Protects the soft starter SCRs from severe overvoltage situations (eg lightning strikes).

SCRs are most susceptible to overvoltage damage when in the off state. A main contactor disconnects the SCRs from the supply when the motor is not running, preventing possible damage.

Main contactors should be AC3 rated for the motor FLC.

NOTE
ASTAT XL and ASTAT XB/XBm soft starters provide a relay output, which can be used to control the main contactor. Ensure that the inrush VA rating of the contactor coil does not exceed the rating of the soft starter's relay output.

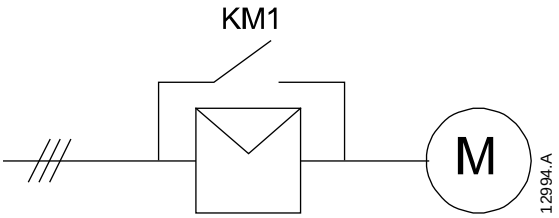


What are bypass contactors?

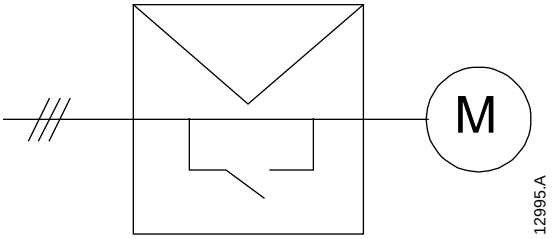
Bypass contactors bridge out a soft starter's SCRs when the motor is running at full speed. This eliminates heat dissipation from the SCRs during run state.

Some soft starters include built-in bypass contactors, others require an external bypass contactor.

External bypass



Internal bypass



Bypass contactors:

- Allow soft starters to be installed in sealed enclosures
- Eliminate the cost of forced-air cabinet ventilation
- Save energy by eliminating SCR losses during run

Bypass contactors should be AC1 rated for the motor FLC. The AC1 rating is adequate because the bypass contactor does not carry start current or switch fault current.

NOTE
ASTAT XB/XBm and certain ranges of ASTAT XL soft starters have built-in bypass relays.

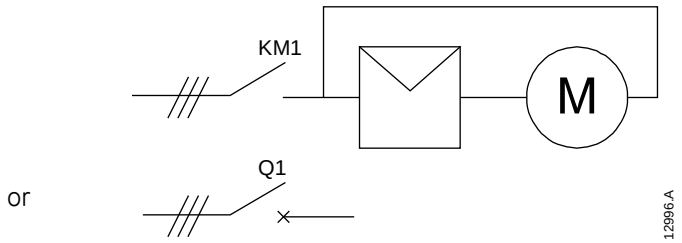
NOTE
ASTAT XL: non-bypassed models (QLxxX0255D ~ QLxxX1600D) have dedicated bypass terminals, which allows motor protection to operate even when the soft starter is bypassed.

To control an externally connected bypass contactor, use a programmable relay set to Run.

What is an inside delta connection?

Inside delta connection (also called six-wire connection) places the soft starter SCRs in series with each motor winding. This means that the soft starter carries only phase current, not line current. This allows the soft starter to control a motor of larger than normal full load current.

When using an inside delta connection, a main contactor or shunt trip MCCB must also be used to disconnect the motor and soft starter from the supply in the event of a trip.



Inside delta connection:

- Simplifies replacement of star/delta starters because the existing cabling can be used.
- May reduce installation cost. Soft starter cost will be reduced but there are additional cabling and main contactor costs. The cost equation must be considered on an individual basis.

Only motors that allow each end of all three motor windings to be connected separately can be controlled using the inside delta connection method.

Not all soft starters can be connected in inside delta.

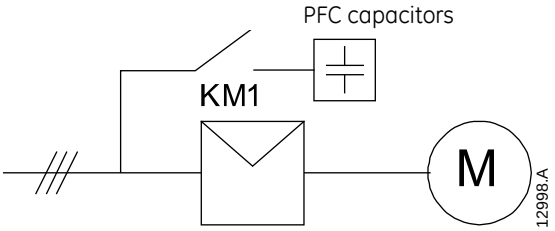
NOTE
ASTAT XL soft starters can be installed using an inside delta connection.

NOTE
ASTAT XB/XBm soft starters **cannot** be installed using inside delta connection.

What is power factor correction?

Individual power factor correction capacitors can be used with soft starters, provided they are installed on the input side of the soft starter and switched in using a dedicated contactor when the motor is running at full speed. The contactor should be AC6 rated for the motor full load current.

Connecting power factor correction capacitors to the output of a soft starter will cause equipment failure due to severe overvoltage. This overvoltage is created by resonance between the inductance of the motor and the power factor capacitance.

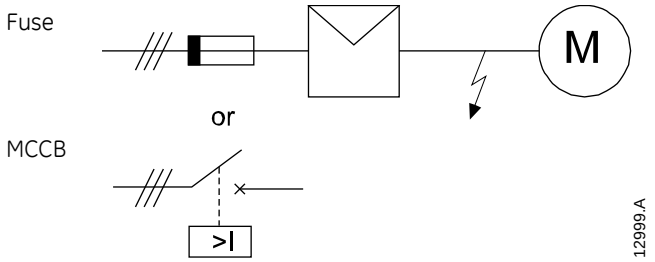


PFC capacitors can be sized using the following formula:

kVA (Cap) = √3 x Vline x 0.8 x motor no load current

How do I ensure Type 1 coordination protection?

Type 1 protection requires that, in the event of a short circuit on the output of a soft starter, the fault must be cleared without risk of injury to personnel. There is no requirement that the soft starter must remain operational after the fault.



Type 1 protection is provided by HRC fuses or a MCCB that form part of the motor branch circuit.

Maximum fuse ratings for Type 1 motor protection are specified in UL and IEC standards.

Fuse	**Rating (% Motor FLC)**
Fuse (non-time delayed)	300%
Fuse (time delayed)	175%
MCCB*	150 ~ 200%

* Consult GE's specifications

As a minimum, the protection method must be able to sustain the required motor start current.

Typical selection criteria are listed below.

		Rating (% Motor FLC), Start Current	
Starter type	**Protection Type**	**< 350% FLC 15 seconds**	**> 350% FLC 15 seconds**
ASTAT XB/XBm	Fuse (non time delayed)	175%	200%
	Fuse (time delayed)	150%	175%
	MCCB*	150- 200%	
ASTAT XL	Fuse (non time delayed)	150%	
	Fuse (time delayed)	125%	
	MCCB*	150 - 200%	

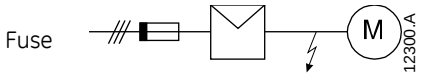
* Consult the manufacturer's specifications

How do I ensure Type 2 coordination protection?

Type 2 protection requires that in the event of a short circuit on the output of a soft starter the fault must be cleared without risk of injury to personnel or damage to the soft starter.

Type 2 protection is achieved by using semiconductor fuses. These fuses must be able to carry motor start current and have a total clearing I^2t < the I^2t of the soft starter SCRs.

Semiconductor fuses for Type 2 circuit protection are additional to HRC fuses or MCCBs that form part of the motor branch circuit protection.

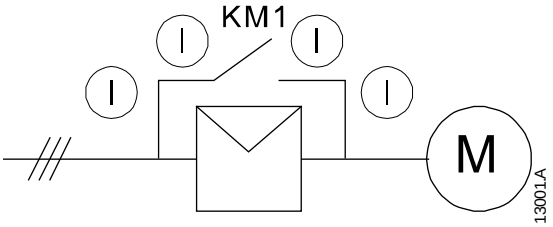


Refer to the soft starter's user manual for semiconductor fuse recommendations.

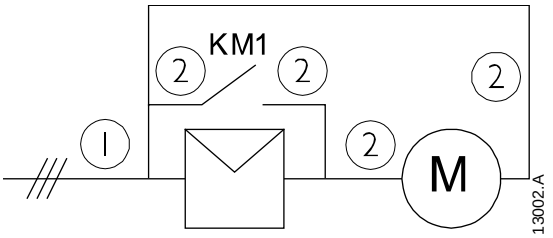
How do I select cable when installing a soft starter?

Cable selection criteria vary according to the nature of the circuit and the location of the soft starter within the circuit.

In-line with external bypass



Inside delta with external bypass



①	Supply cable rating > nominal fuse/MCCB rating > motor FLC x 1.2
②	Inside delta motor circuit cable rating > motor FLC x 0.7

Note: Cable current ratings may need to be derated to account for installation factors (including grouping, ambient temperature and single or parallel cabling). Always follow the manufacturer's instructions.

What is the maximum length of cable run between a soft starter and the motor?

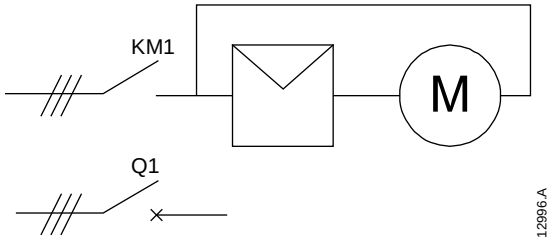
The maximum distance between the starter and motor is determined by the voltage drop and the cable capacitance.

Voltage drop at the motor terminals must not exceed the limit specified in local electrical regulations when the motor is running fully loaded. Cabling should be sized accordingly.

Cable capacitance can be a factor for cable runs that are longer than 500 metres. Consult GE for advice - you will need to provide details about mains voltage, mains frequency and the soft starter model.

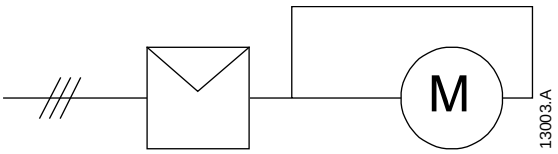
How do I replace a star/delta starter with a soft starter?

If the soft starter supports inside delta connection, simply connect it in place of the star/delta starter.



or (shunt trip)

If the soft starter does not support inside delta connection, connect the delta connection to the output side of the soft starter.



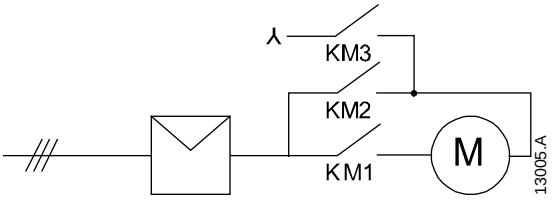
NOTE
ASTAT XL soft starters can be installed using an inside delta connection.

NOTE
ASTAT XB/XBm soft starters **cannot** be installed using inside delta connection.

How do two-speed motors work and can I use a soft starter to control them?

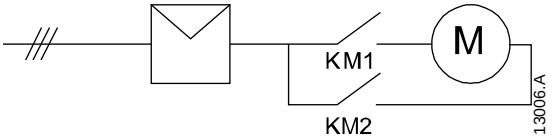
Soft starters can be applied to the two most common types of two-speed motor. In both cases, separate motor protection must be provided for low and high speed operation.

Dahlander motors are special purpose motors often applied to two-speed compressor or fan applications. The motor windings are externally configured using contactors for high speed (dual star) and low speed (delta) operation.



KM1, KM3 = High speed
KM2 = Low speed

Dual-winding motors have two separate pole configurations (eg 4 pole / 8 pole) on a common shaft. Each pole configuration (speed) is selected using an external AC3 rated contactor.



PAM (Pole Amplitude Modulated) motors alter the speed by effectively changing the stator frequency using external winding configuration. **Soft starters are not suitable for use with this type of two-speed motor.**

NOTE
ASTAT XL soft starters are ideal for two-speed motor applications. Dual motor settings allowing separate start profile settings for each speed.

NOTE
ASTAT XB soft starters are designed for use with external motor protection devices and are ideal for two-speed motor applications. ASTAT XBm soft starters (with built in motor protection) are less suitable.

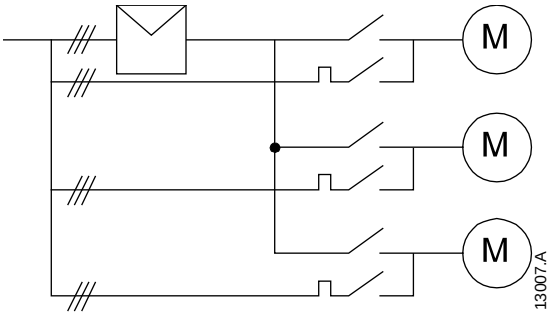
NOTE
Two speed motor applications work best with external motor protection devices. **ASTAT XBm soft starters (with built in motor protection) are less suitable for these applications.**

Can one soft starter control multiple motors separately for sequential starting?

Yes, one soft starter can control two motors in sequence. However, the control and wiring is complex and expensive and any saving in soft starter cost is often outweighed by additional component and labour costs.

In order to use a soft starter in a sequential starting situation:

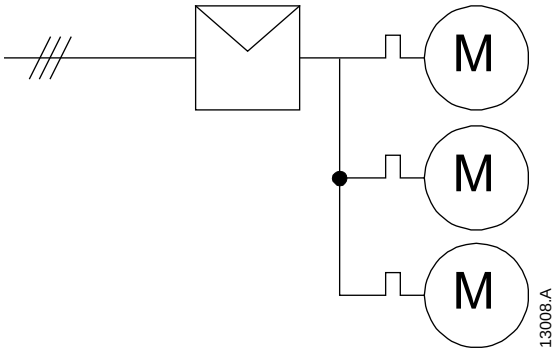
- Each motor must have a separate main contactor, bypass contactor and overload protection
- The soft starter must be suitably rated for the total start duty.



Can one soft starter control multiple motors for parallel starting?

Yes. The circuit configuration and soft starter selection depends on the application.

1. Each motor must have its own overload protection.
2. If the motors are the same size and are mechanically coupled, a constant current soft starter can be used.
3. If the motors are different sizes and/or the loads are not mechanically interlocked, a soft starter with a timed voltage ramp (TVR) start profile should be used.
4. The combined motor FLCs must not exceed the soft starter FLC.

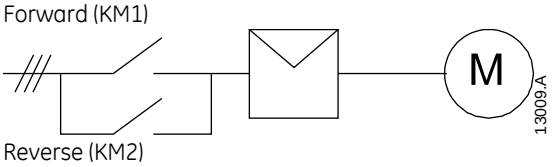


NOTE
ASTAT XL starters provide constant current starting and can be used to parallel start motors which are the same size and mechanically coupled.

NOTE
ASTAT XB open loop starters provide TVR starting and are designed for use with external motor protection devices. ASTAT XB starters are ideal for starting motors in situation (3).

Can soft starters reverse the motor direction?

On their own, soft starters cannot run motors in reverse direction at full speed. However, forward and reverse operation can be achieved by using a forward and reverse contactor arrangement.



Some soft starters also provide a part speed function that runs the motor at slow speed in either forward or reverse, without a reversing contactor. However, reverse operation is limited to short periods at a fixed slow speed.

Which soft starter is best for extreme conditions?

The published ratings for soft starters assume a particular operating environment. If the soft starter needs to operate outside the assumed conditions, the rating must be revised according to GE's instructions.

Typical factors include:

- Start current
- Start time
- Start frequency (number of starts per hour)
- Duty cycle
- Ambient temperature
- Altitude

NOTE
Ratings for GE soft starters are published in the soft starter's user manual. Contact your local supplier for ratings under operating conditions not covered by these ratings charts.

How are soft starters installed in a sealed enclosure?

Soft starters can be installed in sealed enclosures, provided the ambient temperature within the enclosure will not exceed the soft starter's rated temperature.

Heat generated within the enclosure must be dissipated, either through the enclosure's walls or by ventilation. When calculating the heat generated in the enclosure, all heat sources must be considered (eg soft starter, fuses, cabling and switchgear). The enclosure should be protected from direct sunlight to prevent external heating.

To minimise heating, most soft starters are installed in bypassed configuration.

What are harmonics?

Harmonics are voltages and currents that create unwanted heating in motors, cables and other equipment. Harmonics can also disrupt operation of electrical and electronic equipment.

Harmonic generation by soft starters is insignificant and only occurs during starting or soft stopping. IEC 60947-4-2 (8.3.2.1.1) states "harmonic emissions are of short duration during starting, and there are no significant emissions in the FULL-ON state.

No special actions or filtering are required.

NOTE
All GE soft starters comply with the EMC directive on radio frequency emissions and immunity.

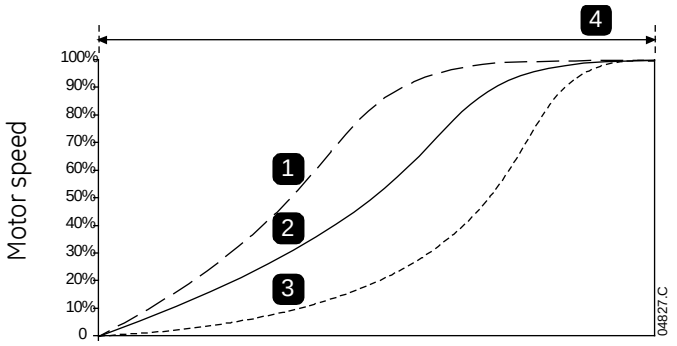
What is Adaptive Control?

Adaptive Control is a new intelligent motor control technique that controls current to the motor in order to start or stop the motor within a specified time and using a selected profile.

For soft starting, selecting an adaptive profile that matches the inherent profile of the application can help smooth out acceleration across the full start time. Selecting a dramatically different profile can somewhat neutralise the inherent profile.

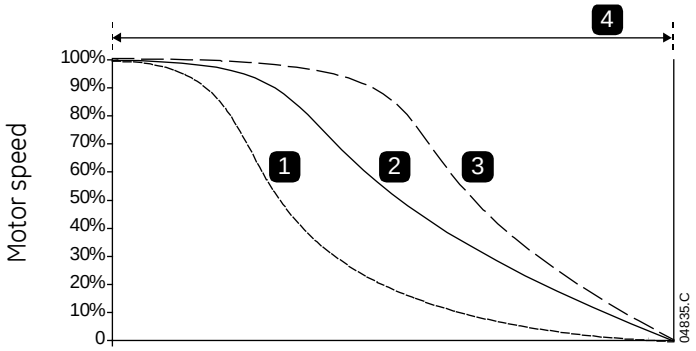
For soft stopping, adaptive control can be useful in extending the stopping time of low inertia loads.

The soft starter monitors the motor's performance during each start, to improve control for future soft starts. The best profile will depend on the exact details of each application. If you have particular operational requirements, discuss details of your application with your local supplier.



Adaptive start profile:

1	Early Acceleration
2	Constant Acceleration
3	Late Acceleration
4	Start time (seconds)



Adaptive stop profile:

1	Early Deceleration
2	Constant Deceleration
3	Late Deceleration
4	Stop Ramp Time

NOTE
Adaptive control is only available on ASTAT XL soft starters connected in-line.

Adaptive control cannot start the motor faster than a direct on-line (DOL) start. If the start ramp time is shorter than the motor's DOL start time, starting current may reach DOL levels.

What is the jog function?

Jog runs the motor at reduced speed (approximately 11% of full running speed), to allow alignment of the load or to assist servicing.

The ASTAT XL offers advanced jog functionality, including the ability to program a customised jog profile for applications where the pre-programmed jog torque is not sufficient to accelerate the motor as required.

NOTE
Jog is only available on ASTAT XL soft starters connected in-line.

Soft start and soft stop are not available during jog operation.

What is DC braking and how is it used?

DC braking uses DC injection to slow the motor.

When the soft starter receives a stop command, it slows the motor to approximately 70% of full speed. The starter then applies maximum brake torque to stop the motor in the programmed time.

Compared with soft braking, DC braking:

- does not require the use of a DC brake contactor
- controls all three phases so that the braking currents and associated heating is evenly distributed through the motor.

NOTE
DC braking is only available on ASTAT XL soft starters connected in-line.

Brake operation causes motor heating. If you are using brake, enable the motor temperature check or allow sufficient restart delay.

NOTE
The extra features built into soft starters can reduce the overall installed cost of the equipment and reduce the long-term maintenance requirement.

What is soft braking and how is it used?

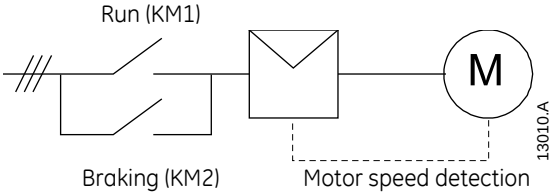
Soft braking is one of two techniques used by soft starters to shorten motor stopping time. The other technique is DC braking.

Soft braking uses reversing contactors on the input of the soft starter. When the soft starter receives a stop command, it operates the reversing contactors and the motor is effectively soft started in the reverse direction. This applies a braking torque to the load.

Compared to DC braking, soft braking:

- causes less motor heating
- provides more braking torque for a given current

Soft braking is better for extremely high inertia loads.



What is the minimum start current with a soft starter?

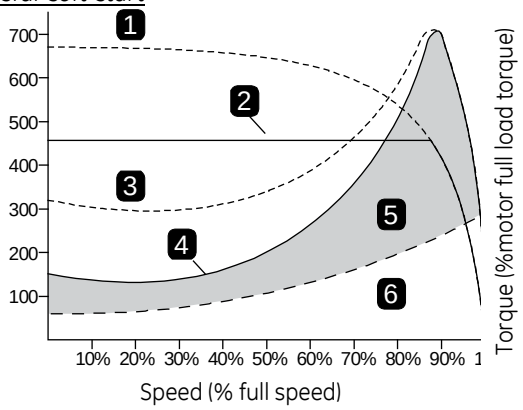
Soft starters can limit start current to any desired level. However, the minimum level of start current for a successful start depends on the motor and load.

To start successfully, the motor must produce more acceleration torque than the load requires, throughout the start.

Reducing the start current also reduces the torque produced by the motor. The start current can only be lowered to the point where the torque output remains just greater than the load torque requirement.

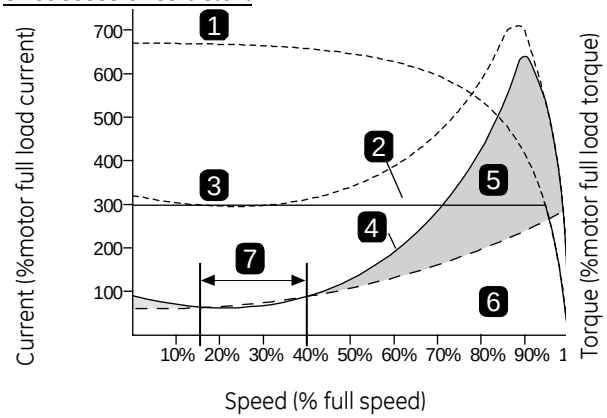
The likely start current can be estimated from experience, but more precise predictions require analysis of motor and load speed/torque curves.

Successful soft start



1	Full voltage current
2	Current Limit
3	Full voltage start torque
4	Torque output at current limit
5	Acceleration torque
6	Load torque

Unsuccessful soft start



1	Full voltage current
2	Current Limit
3	Full voltage start torque
4	Torque output at current limit
5	Acceleration torque
6	Load torque
7	Stall

Can soft starters control an already rotating motor (flying load)?

Yes, soft starters can start motors that are already rotating.

In general, the faster the motor is rotating in the forward direction, the shorter the start time will be.

If the motor is rotating in the reverse direction, it will be slowed to a standstill and then accelerate forwards. Allow for the extended start time when rating the soft starter.

No special wiring or soft starter setup is required.

What is motor thermal capacity?

A motor's thermal capacity is the maximum time a motor can run at locked rotor current from cold. Thermal capacity is also referred to as "maximum locked rotor time" or "maximum DOL start time". This information is usually available from the motor datasheet.

How is the motor thermal model different from other forms of overload protection?

- The motor thermal model offers precise motor protection normally only available from high-end motor protection relays.
- Protection is based on the motor's actual thermal capacity.
- Motor temperature is continually modelled.
- The thermal model accounts for different heating and cooling rates when the motor is in different operating states (starting, running or stopped).
- Both iron and copper losses are modelled.
- The accuracy of the motor thermal model means the motor can be used to its maximum potential without nuisance tripping.

Thermal overload relays are imprecise because:

- The mass of the bimetal strips in the thermal overload is fixed and cannot be altered to match motor characteristics.
- They do not account for iron loss.
- They do not allow for different cooling rates at different stages of motor operation.
- The bimetal strips are affected by their ambient temperature, which is typically different from the motor's ambient temperature.
- Adjustment is imprecise.

Inverse time-current and I^2T electronic overloads offer limited protection because:

- The trip curves do not closely match motor heating.
- Inverse time-current protection does not account for motor temperature before the overload.
- They do not typically allow for differing cooling rates at different stages of motor operation.
- They do not account for iron loss.
- Adjustment is limited.

How is the motor thermal model different from other forms of overload protection?

The motor thermal model offers precise motor protection normally only available from high-end motor protection relays.

- Protection is based on the motor's actual thermal capacity.
- Motor temperature is continually modelled.
- The thermal model accounts for different heating and cooling rates when the motor is in different operating states (starting, running or stopped).
- Both iron and copper losses are modelled.

The accuracy of the motor thermal model means the motor can be used to its maximum potential without nuisance tripping.

Thermal overload relays are imprecise because:

- The mass of the bimetal strips in the thermal overload is fixed and cannot be altered to match motor characteristics.
- They do not account for iron loss.
- They do not allow for different cooling rates at different stages of motor operation.
- The bimetal strips are affected by their ambient temperature, which is typically different from the motor's ambient temperature.
- Adjustment is imprecise.

Inverse time-current and I^2T electronic overloads offer limited protection because:

- The trip curves do not closely match motor heating.
- Inverse time-current protection does not account for motor temperature before the overload.
- They do not typically allow for differing cooling rates at different stages of motor operation.
- They do not account for iron loss.
- Adjustment is limited.

What are the key benefits of soft start?

Soft start enhances motor start performance in many ways including:

- Smooth acceleration without the torque transients associated with electro-mechanical reduced voltage starters.
- Voltage or current is applied gradually, without the voltage and current transients associated with electro-mechanical reduced voltage starters.
- Lower start currents and/or shorter start times because constant current control gives higher torque as motor speed increases.
- Easy adjustment of start performance to suit the specific motor and load.
- Precise control over the current limit.
- Consistent performance even with frequent starts.
- Reliable performance even if load characteristics vary between starts (eg loaded or unloaded starts).

In addition to superior starting performance, soft starters also provide a range of features not available from other reduced voltage starters. This includes areas such as:

- Soft stop (which helps eliminate water hammer)
- Braking
- Motor and system protection
- Metering and monitoring
- Operating history and event logs
- Communication network integration

NOTE
The extra features built into soft starters can reduce the overall installed cost of the equipment and reduce the long-term maintenance requirement.

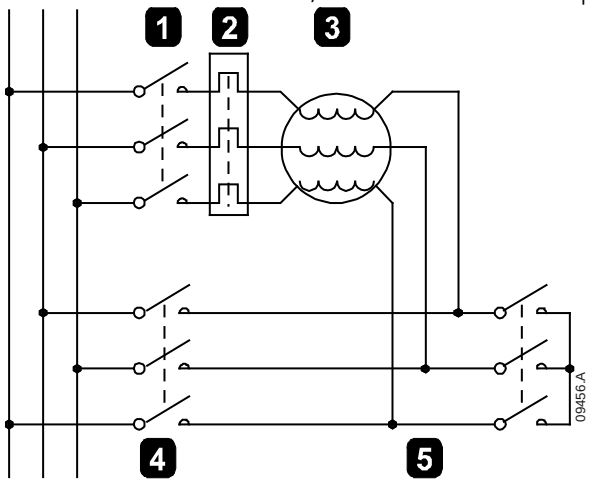
How does soft start compare with star/delta starting?

Compared with star/delta starters, soft starters are much more flexible and provide a smooth start with no risk of transients.

- Star/delta starters offer limited performance because:
- Start torque cannot be adjusted to accommodate motor and load characteristics.
- There is an open transition between star and delta connection that results in damaging torque and current transients.
- They cannot accommodate varying load conditions (eg loaded or unloaded starts).
- They cannot provide soft stop.

The main advantages of star/delta starters are:

- They may be cheaper than a soft starter.
- When used to start an extremely light load, they may limit the start current to a lower level than a soft starter. However, severe current and torque transients may still occur.



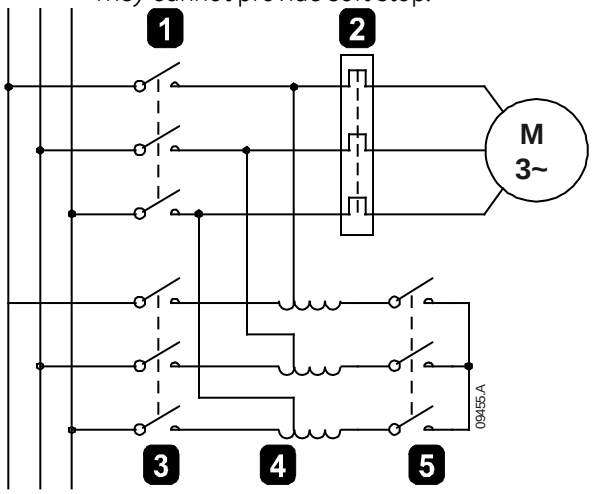
1	Main contactor
2	Thermal overload
3	Motor (three-phase)
4	Delta contactor
5	Star contactor

How does soft start compare to auto-transformer starting?

Compared with auto-transformer starters, soft starters are much more flexible and provide a much smoother start.

Auto-transformer starters offer limited performance because:

- They offer only limited ability to adjust start torque to accommodate motor and load characteristics.
- There are still current and torque transients associated with steps between voltages.
- They are large and expensive.
- They are especially expensive if high start frequency is required.
- They cannot accommodate changing load conditions (eg loaded or unloaded starts).
- They cannot provide soft stop.



1	Run contactor
2	Thermal overload
3	Start contactor (A)
4	Auto-transformer
5	Start contactor (B)

How does soft start compare to primary resistance starting?

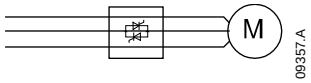
Compared with primary resistance starters, soft starters are more flexible and reliable.

Primary resistance starters offer limited performance because:

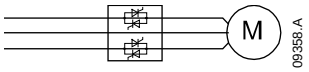
- Start torque cannot be fine-tuned to match motor and load characteristics.
- Current and torque transients occur at each voltage step.
- They are large and expensive.
- Liquid resistance versions require frequent maintenance.
- Start performance changes as the resistance heats up, so multiple or restart situation are not well controlled.
- They cannot accommodate changing load conditions (eg loaded or unloaded starts).
- They cannot provide soft stop.

Are all three phase soft starters the same?

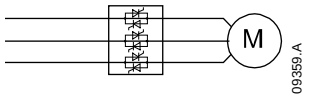
No. There are different styles of soft starter which control the motor in different ways and offer different features.



Single phase control
These devices reduce torque shock at start but do not reduce start current. Also known as torque controllers, these devices must be used in conjunction with a direct on-line starter.



Two phase control
These devices eliminate torque transients and reduce motor start current. The uncontrolled phase has slightly higher current than the two controlled phases during motor starting. They are suitable for all but severe loads.



Three phase control
These devices control all three phases, providing the optimum in soft start control. Three phase control should be used for severe starting situations.

Soft starter communication options

GE soft starters can connect easily to Modbus, Profibus, DeviceNet or Ethernet communication networks, using simple add-on communication interfaces.

All communication interfaces allow you to:

- control the soft starter
- monitor the starter's operational or trip status
- monitor the starter's current level and motor temperature (using the motor thermal model)

Some protocols also allow you to read and write soft starter parameters (some soft starter models only).

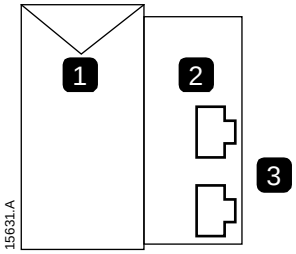
For installations with no existing network, GE also offers GE ASTAT Setup Tool ed.3, a PC-based software program which allows control, monitoring and parameter management via an RS485 or USB connection. Contact your local GE representative for more information.

NOTE
You can only use communication modules from the ASTAT XB/ ASTAT XBm/ ASTAT XL product line.

Ethernet Modules (Ethernet/IP, Modbus TCP and Profinet)

ASTAT XL and ASTAT XB/XBm soft starters can connect to an Ethernet network using an Ethernet Module.

Separate modules are available for Ethernet/IP, Modbus TCP and Profinet.



1	Soft starter
2	Ethernet Module
3	Ethernet port

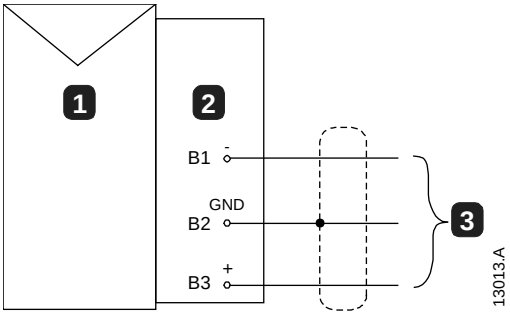
- The Ethernet Module is powered from the soft starter.
- Each soft starter requires a separate Ethernet Module.
- Software tools are available to support module configuration.

Tested and certified by Profibus and Profinet International.

Tested and certified by ODVA.

Modbus RTU options

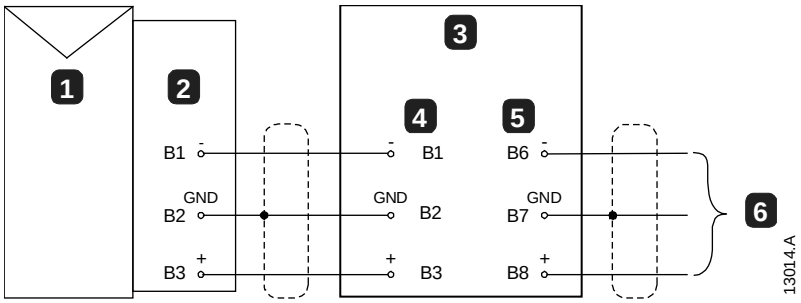
ASTAT XL and ASTAT XB/XBm soft starters can operate as slaves on a Modbus RTU network via a Modbus Module.



1	Soft starter
2	Modbus Module
3	RS485 connection onto a Modbus RTU network

- The Modbus Module is powered by the soft starter.
- Each soft starter requires a separate Modbus Module.
- A Modbus RTU network can support up to 31 Modbus Modules as slaves.
- The module is configured using 8-way DIP switches. For more information on using the Modbus Module, see the Modbus Module instructions or contact your local representative.

ASTAT XB/XBm soft starters can also connect to a Modbus RTU network using a Remote Operator as a Modbus RTU gateway.

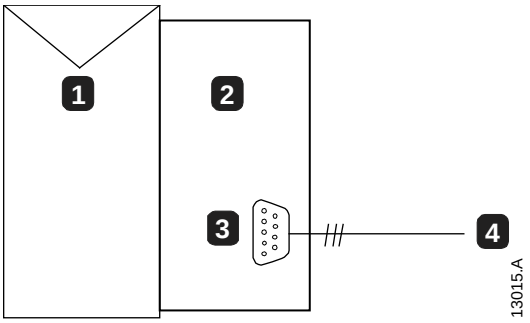


1	Soft starter
2	Serial interface
3	Remote operator
4	RS485 Starter
5	RS485 Network
6	RS485 connection onto a Modbus RTU network

- The Remote Operator requires an external 18-30 VAC/VDC supply. The Serial Interface is powered by the soft starter.
- Each soft starter requires a separate Remote Operator and Serial Interface.
- A Modbus RTU network can support up to 31 Remote Operators as slaves.
- Parameters 1 to 5 of the Remote Operator configure it for use as a Modbus slave device. For more information on using the Remote Operator as a Modbus RTU gateway, see the Modbus Module instructions or contact your local GE representative.

Profibus Module

ASTAT XL and ASTAT XB/XBm soft starters can connect to a Profibus network using the Profibus Module.



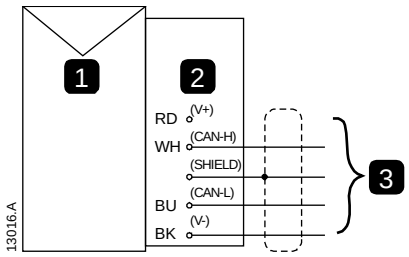
1	Soft starter
2	Profibus Module
3	Standard DB9 connection
4	Profibus DP (3-wire network cable)

- The Profibus Module requires an external 24 VDC supply.
- Each soft starter requires a separate Profibus Module.
- A Profibus DP network can support up to 31 Profibus Modules as slaves.
- The Profibus node address is selected using two rotary switches on the interface. The module automatically detects the data rate.
- The GSD installation file is available from the GE website. For more information on using the Profibus Module, see the Profibus Module instructions or contact your local representative.

PI CERTIFIED PROFIBUS · PROFINET Tested and certified by Profibus and Profinet International.

DeviceNet Module

ASTAT XL and ASTAT XB/XBm soft starters can connect to a DeviceNet network using the DeviceNet Module.



1	Soft starter
2	DeviceNet Module
3	Standard 5-wire connection onto a DeviceNet network 120 Ω termination resistors are required at each end of the network cable

- The DeviceNet Module is powered from the network.
- Each soft starter requires a separate DeviceNet Module.
- A DeviceNet network can support up to 63 DeviceNet Modules as slaves.
- The DeviceNet node address (MAC ID) and data rate are selected using three rotary switches on the module.
- The EDS installation file is available from the GE website. For more information on using the DeviceNet Module, see the DeviceNet Module instructions or contact your local representative.

DeviceNet CONFORMANCE TESTED Tested and certified by ODVA.

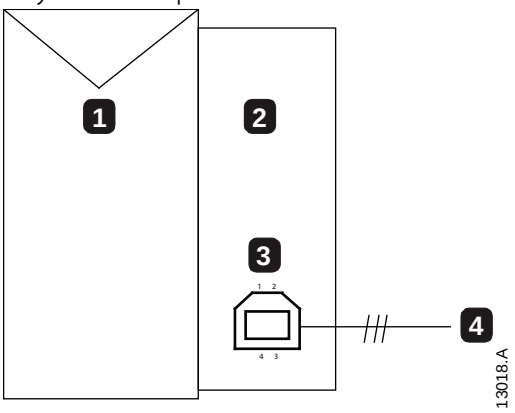
USB Module

ASTAT XL and ASTAT XB/XBm soft starters can be connected to a PC running GE ASTAT Setup Tool ed.3 via the USB Module.

- The USB Module is powered by the soft starter.
- Each soft starter requires a separate USB Module.
- GE ASTAT Setup Tool ed.3 software drivers will configure the USB port automatically once connected.

The same USB port must be used to connect the module to the PC every time.

- For more information on connecting and using the USB Module, see the USB Module Instruction or contact your local representative.



1	Soft starter
2	USB Module
3	Standard USB port
4	USB cable

Remote Operator

ASTAT XB/XBm soft starters can be managed using a Remote Operator. The Remote Operator allows remote control and monitoring of individual soft starters in installations with no central communication network.

The Remote Operator communicates with the soft starter via a Serial Interface.

- The Remote Operator requires an external 18-30 VAC/VDC supply. The Serial Interface is powered by the soft starter.
- Each soft starter requires a separate Remote Operator and Serial Interface.
- No configuration is required. For more information on using the Remote Operator, refer to the Remote Operator instructions or contact your local representative.

NOTE
If required, each soft starter can support two Remote Operators. Connect the RS485 Starter terminals of the second Remote Operator to the RS485 Network terminals of the first Remote Operator. The second Remote Operator does not require a Serial Interface.

Remote Control Panel

A remote control panel (RCP) can be installed with the ASTAT XL. The RCP can be mounted up to 3 metres away from the starter, for control and monitoring.

The starter can be controlled and programmed from either the RCP or the keypad on the starter. Both displays show the same information.

- No set-up or configuration is required.
- The RCP can be used to transfer parameters between multiple starters with the same software version.
- The RCP can be connected or disconnected while the starter is running.

Glossary

A

AC53 Utilisation Code - The standard method of describing a soft starter's operating parameters, including current rating and start conditions.

Auger - a device to move material or liquid by means of a rotating helical flighting (the same method a drill bit uses to remove shavings from a hole being drilled). The material moves along the axis of rotation. The flighting may or may not be enclosed in a tube.

B

Blower - see 'Fan'.

Bow thruster - a method of improving manoeuvrability of large ships. A bow thruster normally takes the form of a tunnel through the bow below the waterline, with an impeller which can create thrust to make the ship turn.

C

Carding machine - a machine which brushes raw or washed fibres to prepare them as textiles.

Centrifuge - a machine which removes solids from liquids or separates liquids from liquid mixtures with simultaneous removal of the solids.

Chipper - a machine used for reducing wood (generally tree limbs or trunks) to wood chips.

Compressor, centrifugal - Centrifugal compressors use a vaned rotating disk or impeller in a shaped housing forces the gas to the rim of impeller increasing the velocity of the gas. A diffuser (divergent duct) section converts the velocity energy to pressure energy. These are used for continuous, heavy industrial uses.

Compressor, piston - see 'Compressor, reciprocating'.

Compressor, positive displacement - see 'Compressor, reciprocating'.

Compressor, Reciprocating - uses pistons driven by a crankshaft. Small reciprocating compressors from 5 to 30 HP are commonly seen in automotive applications and are typically for intermittent duty. Larger reciprocating compressors up to 1000 HP are still commonly found in large industrial applications, but their numbers are declining as they are replaced by less costly rotary screw compressors.

Compressor, **screw** - a machine which forces gas into a smaller space, using two meshed rotating positive-displacement helical screws.

Conveyor, horizontal - a system which carries materials or packages from one place to another, using a continuous moving belt.

Conveyor, vertical - a system which raises and/or lowers materials on a vertical plane, typically in buckets or scoops.

Crusher, cone - a machine which crushes material into smaller pieces. A cone crusher consists of inner and outer vertical crushing cones. The outer cone has its wide end upward, and the inner cone has its apex upward. Material travels down between the two cones and is crushed into progressively smaller pieces until it is small enough to fall out through the gap between the two cones at the bottom.

Crusher, jaw - a jaw crusher consists of a pair of vertical jaws. One jaw is fixed and the other moved back and forth relative to it. The jaws are farther apart at the top than at the bottom, forming a tapered chute so that the material is crushed smaller and smaller as it travels downward until it is small enough to escape from the bottom opening.

Crusher, roller - a type of intermediate crusher consisting of a pair of horizontal cylindrical rollers through which material is passed. The two rollers rotate in opposite directions, crushing material between them.

Current Limit - (1) a method of soft starting a motor by limiting the maximum amount of current the motor can draw during the start. (2) The maximum amount of current the soft starter will allow a motor to draw during a current limit start.

Current Ramp - a method of soft starting a motor by gradually increasing the amount of current from a specified point to the current limit.

D

Debarker - a machine that removes bark from whole logs.

Decanter - a type of centrifuge.

Drum carder - see 'Carding machine'.

E

Edger - a machine that cuts large timber sections into usable sizes with minimal raw material wastage.

Escalator - a type of conveyor for transporting people, consisting of a staircase whose steps move up or down on tracks that keep the surfaces of individual steps horizontal.

F

Fan, axial - a fan with blades that turn around a shaft. The blades force air to move parallel to the shaft, so air blows across the axis of the fan.

Fan, centrifugal - a fan which pulls air in near the shaft and forces it outwards. The air exits through an opening in the outer edge of the scroll-shaped fan casing. A centrifugal fan produces more pressure for a given air volume than an axial fan.

Fan, radial - see 'Fan, centrifugal'.

Full load current - the amount of current a motor will draw when operating fully loaded and at full speed.

Full load torque - The amount of torque a motor will produce when operating fully loaded and at full speed.

G

Grinder - a machine which reduces the size of small particles through attrition and compressive forces at the grain size level. For mechanisms producing larger particles, see 'Crusher'.

Gyratory crusher - see 'Crusher, cone'.

H

Hydraulic power pack - A hydraulic pump which is used to supply pressurised hydraulic fluid.

I

IP Rating - a description of the soft starter's physical format, according to IEC 60529.

K

Kickstart - a method of soft starting a motor by adding a short burst of high current to the beginning of a current limit or current ramp start.

L

Locked rotor current - the amount of current a motor will draw in a locked rotor situation. Locked rotor current is described as a percentage of full load current, and is the amount of current the motor will draw during a full voltage start.

Locked rotor time - the maximum amount of time a motor can safely run at locked rotor current.

Locked rotor torque - the amount of torque a motor will produce in a locked rotor situation (at locked rotor current). Locked rotor torque is described as a percentage of full load torque, and is the amount of torque the motor will produce during a full voltage start.

M

Mill, ball - a machine which grinds (or mixes) materials like ores, chemicals, ceramics and paints. Ball mills are cylindrical and rotate around a horizontal axis. The main chamber is partially filled with the material to be ground plus the grinding medium (usually stainless steel balls). When the cylinder rotates, a cascading effect reduces the material to a fine powder.

Mill, hammer - a machine used to crush material (usually soft material such as coal). Hammer mills consist of horizontal rotating disks with heavy metal bars attached to the edges by hinges. When the disks

rotate, the bars repeatedly strike the material to be crushed. The raw material is contained within a cage, and falls through openings at the bottom when reduced to the required size.

Mill, roller - a type of intermediate crusher consisting of a pair of horizontal cylindrical rollers through which material is passed. The two rollers rotate in opposite directions, crushing material between them.

Milliscreen - a machine which separates solids from slurry, using an inclined rotating drum with perforated sides.

Mixer - a machine which combines ingredients.

N

Nameplate rating - see 'full load current'.

NEMA - a description of the soft starter's physical format, according to the National Electrical Manufacturers' Association standard.

P

Pelletiser - a machine which converts fine particles into solid pellets.

Planer - a machine which reduces boards to a specified thickness. Infeed and outfeed rollers draw the board through the machine over a cutter head.

Press - a machine which changes the shape and internal structure of metals (usually steel).

Pump - a machine which moves fluids.

Pump, bore - a submersible pump with a small diameter, suitable for operation down bores.

Pump, centrifugal - a pump which contains a rotating impeller inside a stationary cavity. The impeller causes the fluid to rotate, and thereby move from inlet to outlet under its own momentum. As the fluid travels through the impeller passage, its absolute velocity increases. In the volute, diffuser, or ring type cavity the fluid velocity is reduced and its energy converted to pressure energy.

Pump, positive displacement - a pump which forces fluid to move by reducing the volume of the pump chamber. Unlike centrifugal pumps, positive displacement pumps are suitable for a very high viscosity of the pumped fluid. Positive displacement pumps include rotary (lobe, screw or gear pump) and reciprocating (piston or diaphragm pump) types. Reciprocating pumps may also be suitable for metering and dosing applications.

Pump, slurry - a centrifugal pump suitable for pumping slurry.

Pump, submersible - a pump which has a hermetically sealed motor close-coupled to the pump body and which is submerged in the fluid to be pumped.

Pump, vacuum - a pump which removes gas from a sealed volume in order to create a partial vacuum. Multiple pumps may be used, in series or in parallel, in a single application.

R

Re-pulper - a machine which re-pulps raw product for further processing.

Rotary table - a large rotating table which is used to sort or move material.

S

Sander - a machine which rubs an abrasive surface over raw material (usually timber) to produce a smooth finish.

Saw - a machine which uses teeth or a serrated edge to cut materials.

Saw, bandsaw - a saw where the cutting edge is a long, thin strip of metal with teeth on one side. Timber mills use band saws for ripping lumber. The saw bands need to be removed and serviced regularly, often after only several hours of operation.

Saw, circular - a saw where the cutting edge is a large rotating disk with teeth on the outer edge.

Screw feed - see 'Auger'.

Separator - a type of centrifuge.

Shredder - a machine that tears objects into smaller pieces. The most common types are paper, plastic and wood shredders.

Slabber - a machine which consists of several saws. The slabber cuts edged logs into smaller pieces before further processing.

Slicer - a machine that slices materials. A slicer usually has more than one blade.

Stirrer - a machine which stirs fluids.

T

Travelator - a type of conveyor. The belt moves slowly along a horizontal path or incline to transport people. Also called "moving walkway" or "moving sidewalk".

Tumbler - a machine which rotates to turn material over during drying or other processes.

V

Vibrating screen - a machine which separates particles of different sizes by vibrating in a horizontal plane. Smaller particles fall through gaps in the plane.

W

Winch - a machine which winds ropes or cables.

Wire draw machine - a machine which reduces the diameter of metal wire. Wire is drawn through progressively narrower dies until it reaches the required diameter.

GE

Industrial Solutions

GE is a first class global supplier of low and medium voltage products, including wiring devices, residential and industrial electrical distribution components, automation products, enclosures and switchboards. Demand for the company's products comes from wholesalers, installers, panel builders, contractors, OEMs and utilities worldwide.

www.ge.com/ex/industrialsolutions
www.ge.com/uk/industrialsolutions

Belgium
GE Industrial Belgium
Nieuwevaart 51
B-900D Gent
Tel. +32 (0)9 265 21 11

China
GE Industrial Solutions
4F, Building 2, CTP,
No.1 Hua Tuo Rd. Zhang
Jiang Hi-Tech Park,
Shanghai 201203
Tel. +86 21 3877 788

Finland
GE Industrial Solutions
Kuortaneenkatu 2
FI-00510 Helsinki
Tel. +358 (0)10 394 3760

France
GE Industrial Solutions
Paris Nord 2
13, rue de la Perdix
F-95958 Roissy CDG Cédex
Tel. +33 (0)800 912 816

Germany
GE Industrial Solutions
Robert-Bosch Str. 2a
D-50354 Hürth-Efferen
Tel. +49 (0) 2233/ 9719-0

Hungary
GE Hungary Kft.
Vaci ut 81-83.
H-1139 budapest
Tel. +36 1 447 6050

Italy
GE Industrial Solutions
Centro Direzionale Colleoni
Via Paracelso 16
Palazzo Andromeda B1
I-20864 Agrate Brianza (MB)
Tel. +39 039 637 3701

Netherlands
GE Industrial Solutions
Parallelweg 10
NI-7482 CA Haaksbergen
Tel. +31 (0)53 573 03 03

Poland
GE Power Controls
Ul. Odrowaza 15
03-310 Warszawa
Tel. +48 22 519 76 00

Ul. Leszczyńska 6
43-300 Bielsko-Biała
Tel. +48 33 828 62 33

Portugal
GE Industrial Solutions
Rua Camilo Castelo Branco, 805
Apartado 2770
P-4401-601 Vila Nova de Gaia
Tel. +351 22 374 60 00

Russia
GE Industrial Solutions
27/8, Electrozavodskaya street
Moscow, 107023
Tel. +7 495 937 11 11

South Africa
GE Industrial Solutions
Unit 4, 130 Gazelle Avenue
Corporate Park Midrand 1685
P.O. Box 76672 Wendywood 2144
Tel. +27 11 238 3000

Spain
GE Industrial Solutions
P.I. Clot del Tufau, s/n
E-08295 Sant Vincenç de Castellet
Tel. +34 900 993 625

United Arab Emirates
GE Industrial Solutions
Injaz Building, 3rd Floor
Dubai INternet City
PO Box 11549, Dubai
Tel. +971 4 4546912

United Kingdom
GE Industrial Solutions
2 The Arena,
Downshire Way
Bracknell, Berkshire
RG12 1PU
Tel. +44 (0)800 587 1239

United States
GE Industrial Solutions
41 Woodford Avenue
Plainville, CT. 06062
www.geindustrial.com

GE imagination at work

È710 - 16194 - 00AQÉÍ
710-16194-00A