LAKA/LAKS
SOFT STARTERS

DESIGN GUIDE

KOMPETENZ VERBINDET. **SCHRACK** TECHNIK

Contents

1.0 Warnings

■ **High Voltage Warning**

The LAKA/LAKS contains dangerous voltages when connected to line voltage. Only a competent electrician should carry out the electrical installation. Improper installation of the motor or the LAKA/LAKS may cause equipment failure, serious injury or death. Follow this manual, the National Electrical Code (NEC®) and local safety codes.

■ **Safety Regulations**

1. The soft starter must be disconnected from the mains if repair work is to be carried out.

It is the responsibility of the user or person installing the LAKA/LAKS to provide proper grounding and branch circuit protection according to the National Electrical Code (NEC®) and local safety codes.

■ **Warning Against Unintended Start**

The motor can be brought to a stop by means of digital or bus commands while the soft starter is connected to the mains.

1. If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.

2. A motor that has been stopped may start if faults occur in the electronics of the soft starter, or a temporary fault in the supply mains or the motor connection ceases.

■ **Symbols Used in this Manual**

When reading this manual you will come across different symbols that require special attention. The symbols used are the following:

N.B.!:
Indicates something to be noted by the reader

Indicates a general warning

Indicates a high voltage warning

■ **Avoiding Soft Starter Damage**

Please read and follow all instructions in this manual. Additionally, take special note of the following:

1. Do not connect power factor correction capacitors to the output of LAKA/LAKS soft starters. If static power factor correction is employed, it must be connected to the supply side of the soft starter.

2. Do not apply incorrect voltages to the control input terminals.

Many electronic components are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard, can reduce the life, affect performance, or completely destroy sensitive electronic components. When performing service, proper ESD equipment should be used to prevent possible damage from occurring.

2.0 LAKA/LAKS Overview

2.1 Description

The LAKA/LAKS-Line Series of soft starters comprises two separate ranges, LAKA and LAKS. These ranges share common power and mechanical designs but offer different feature sets.

LAKA soft starters provide TVR (timed voltage ramp) starting and stopping control and are designed for use with an external motor protection device.

LAKS soft starters provide current limit starting control, TVR soft stop and include a range of motor protection features.

N.B.!:

This manual makes reference to LAKA/LAKS, LAKA and LAKS. The LAKA/LAKS designation is used when referring to characteristics common to both the LAKA and LAKS ranges. In all other cases the text refers to the specific range LAKA or LAKS.

Both ranges include an internal bypass function that bypasses the soft starter SCRs during run. This allows the LAKA/LAKS to be installed in a non-ventilated enclosure without the need for an external bypass contactor.

■ **Ordering Type Code**

```
         LAK   _   _   ___
```

A...soft start only
S...soft start plus protection

maximum Voltage Rating (4=200-440Vac)

Starter current rating @ 400Vac
(AC53b 4-6:694) (e.g.: 140: 140A)
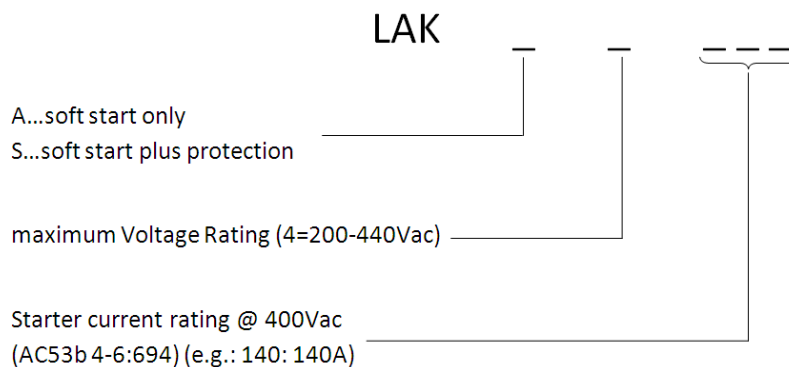
2.2   Ratings

LAKA/LAKS Model	Continuous Ratings (Internally Bypassed) @ 40 ℃ Ambient Temperature, <1000 metres ✴	
	Normal	**Heavy**
18	18 A: AC53b 4-6:594	17 A: AC53b 4-20:580
34	34 A: AC53b 4-6:594	30 A: AC53b 4-20:580
42	42 A: AC53b 4-6:594	36 A: AC53b 4-20:580
48	48 A: AC53b 4-6:594	40 A: AC53b 4-20:580
60	60 A: AC53b 4-6:594	49 A: AC53b 4-20:580
75	75 A: AC53b 4-6:594	65 A: AC53b 4-20:580
85	85 A: AC53b 4-6:594	73 A: AC53b 4-20:580
100	100 A: AC53b 4-6:594	96 A: AC53b 4-20:580
140	140 A: AC53b 4-6:594	120 A: AC53b 4-20:580
170	170 A: AC53b 4-6:594	142 A: AC53b 4-20:580
200	200 A: AC53b 4-6:594	165 A: AC53b 4-20:580
LAKA/LAKS Model	**Continuous Ratings (Internally Bypassed) @ 50 ℃ Ambient Temperature, <1000 metres ✴**	
	Normal	**Heavy**
18	16 A: AC53b 4-6:594	14 A: AC53b 4-20:580
34	31 A: AC53b 4-6:594	26 A: AC53b 4-20:580
42	38 A: AC53b 4-6:594	32 A: AC53b 4-20:580
48	44 A: AC53b 4-6:594	38 A: AC53b 4-20:580
60	55 A: AC53b 4-6:594	47 A: AC53b 4-20:580
75	69 A: AC53b 4-6:594	59 A: AC53b 4-20:580
85	78 A: AC53b 4-6:594	67 A: AC53b 4-20:580
100	100 A: AC53b 4-6:594	86 A: AC53b 4-20:580
140	133 A: AC53b 4-6:594	110 A: AC53b 4-20:580
170	157 A: AC53b 4-6:594	130 A: AC53b 4-20:580
200	186 A: AC53b 4-6:594	152 A: AC53b 4-20:580

✴ Contact IC Electronic for other ratings.

Example

For 140 A model: 140 A: AC53b 4-6:594

140 A: Starter current rating.

AC53b: Load category for soft starters with SCRs bypassed during run.

4-6:   400% start current for 6 seconds.

594:          594 seconds between the end of one start and the beginning of the next start (i.e. 6 starts per hour).

2.3 General Technical Data

Mains Supply (L1, L2, L3)

LAKA4XXXX/LAKS4XXXX .... 3 x 200 VAC ~ 440 VAC (+ 10% / - 15%)

Supply frequency (at start) .... 45 Hz to 66 Hz

Control Supply (A1, A2, A3)

LAKA/LAKSxxxx .... 110-240 VAC (+ 10% / - 15%) or 380-440 VAC (+ 10% / - 15%)

Current consumption (during run) ....< 100 mA

Current consumption (at power-up) ....10 A

Control Inputs

Start Terminal N1 .... Normally Open, 300 VAC max

Stop Terminal N2 .... Normally Closed, 300 VAC max

Relay Outputs

Main Contactor (Terminals 13, 14) .... Normally Open

6 A, 30 VDC resistive / 2 A, 400 VAC, AC11

Programmable Relay (Terminals 23, 24) .... Normally Open

6 A, 30 VDC resistive / 2 A, 400 VAC, AC11

Environmental

Degree of Protection LAKA/S...X034 to LAKA/S....X100 .... IP20

Degree of Protection LAKA/S...X140 to LAKA/....X200 .... IP00

Operating Temperatures .... - 10 ^{o}C to + 60 ^{o}C

Humidity .... 5% to 95% Relative Humidity

Pollution Degree .... Pollution Degree 3

Vibration .... IEC 60068 Test Fc Sinusoidal

4 Hz to 13.2 Hz: ± 1 mm displacement

13.2 Hz to 200 Hz: ± 0.7 g

EMC Emission

Equipment class (EMC) .... Class A

Conducted radio frequency emission .... 0.15 MHz to 0.5 MHz: < 90 dB (μV)

0.5 MHz to 5 MHz: < 76 dB (μV)

5 MHz to 30 MHz: 80-60 dB (μV)

Radiated radio frequency emission .... 30 MHz to 230 MHz: < 30 dB (μV/m)

230 MHz to 1000 MHz: < 37 dB (μV/m)

This product has been designed for Class A equipment. Use of the product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.

EMC Immunity

Electrostatic Discharge .... 4 kV contact discharge, 8 kV air discharge

Radio frequency electromagnetic field .... 0.15 MHz to 1000 MHz: 140 dB (μV)

Rated impulse withstand voltage (Fast transients 5/50 ns) .... 2 kV line to earth

Rated insulation voltage (Surges 1.2/50 μs – 8/20 ms) .... 2 kV line to earth, 1 kV line to line

Voltage dip and short time interruption .... 100 ms (at 40% nominal voltage)

Short Circuit

Rated short-circuit current .... 10 kA

Heat Dissipation

During Start .... 3 watts / ampere

During Run .... < 7 watts

Standards Approvals

C✓ .... IEC 60947-4-2

CE .... IEC 60947-4-2

2.4 Mechanical Installation

Derate FLC by 15% (FLC * 0.85)
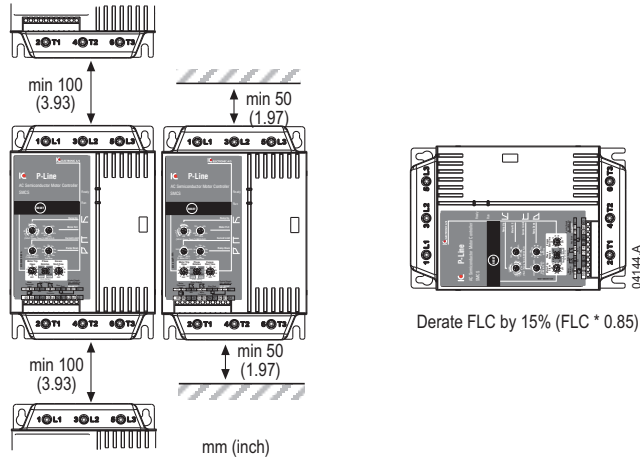
mm (inch)

mm (inch)

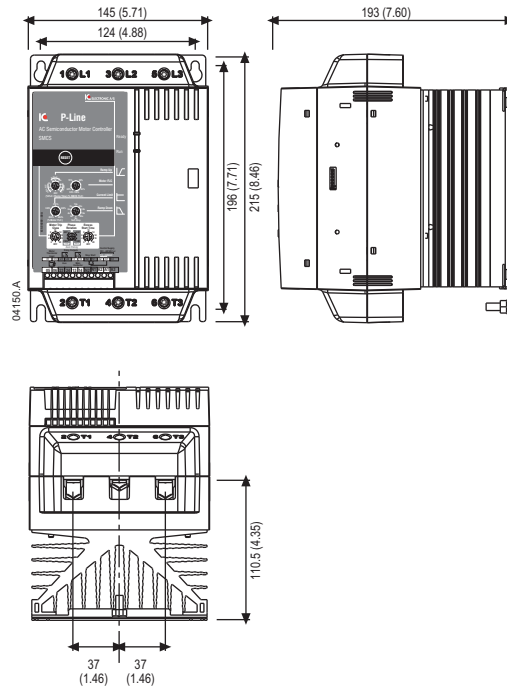| Model	Din Rail	Foot Mounting
18 ~ 200	Not available	Yes

2.5 Dimensions and Weights

LAKAxxxxxx18 ~ LAKAxxxxxx60 (2.6 kg / 5.73 lb)
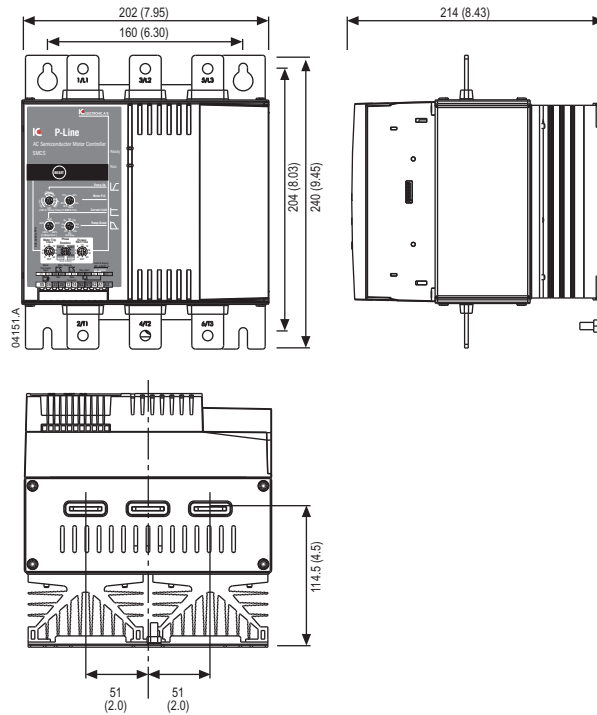LAKSxxxxxx18 ~ LAKSxxxxxx60 (2.6 kg / 5.73 lb)

LAKAxxxxxx75 ~ LAKAxxxxxx100 (4.0 kg / 8.82 lb)
LAKSxxxxxx75 ~ LAKSxxxxxx100 (4.3 kg / 9.48 lb)

LAKAxxxxxx140 ~ LAKAxxxxxx200 (6.1 kg / 13.45 lb)
LAKSxxxxxx140 ~ LAKSxxxxxx200 (6.8 kg / 14.99 lb)

2.6   Cable Size

	mm² (AWG)			mm² (AWG)	
	SMCx85 ~ SMCx100		SMCx140 ~ SMCx200	SMCx85 ~ SMCx200	
	25 - 50 (4 - 1/0)	14 (0.55) mm (inch)	N.A.	11 (0.43) 26 (1.02) 8.5 (0.33) mm (inch)	0.14 - 1.5 (26 - 16)	6 (0.24) mm (inch)
	25 - 50 (4 - 1/0)		N.A.		0.14 - 1.5 (26 - 16)	
	Torx (T20) 4 Nm 2.9 ft-lb		N.A.		N.A.	
	7 mm 4 Nm 2.9 ft-lb		N.A.		3.5 mm 0.5 Nm max 4.4 in-lb max	

75° C Wire. Use copper conductors only.

2.7   Semiconductor Fuses

Semiconductor fuses can be used with the LAKA/LAKS soft starter to reduce the potential for damage to SCRs from transient overload currents and for Type 2 coordination. LAKA/LAKS soft starters have been tested to achieve Type 2 coordination with semiconductor fuses. Suitable Bussman and Ferraz semiconductor fuses are detailed below.

If selecting alternate brands, ensure the selected fuse has a lower total clearing I^2T rating than the SCR, and can carry start current for the full starting duration.

Model	SCR I^2T (A^2S)	Bussmann Fuse Square Body (170M)	Bussmann Fuse British Style (BS88)
18	1150	170M-1314	63 FE
34	8000	170M-1317	160 FEE
42	10500	170M-1318	160 FEE
48	15000	170M-1318	180 FM
60	18000	170M-1319	180 FM
75	51200	170M-1321	250 FM
85	80000	170M-1321	250 FM
100	97000	170M-1321	250 FM
140	168000	170M-1322	500 FMM
170	245000	170M-3022	500 FMM
200	320000	170M-3022	500 FMM

2.8 Frequently Asked Questions

- *What is the minimum size of motor that can be controlled using an LAKS closed loop soft starter?*

  Motors connected to an LAKS soft starter must have a full load current rating ≥ 50% of the LAKS nameplate rating. All the motor protections are based on this setting.

  It is possible to operate an LAKS with a small kW motor, for testing purposes. In this case, the motor will effectively start direct on-line, and the LAKS will not protect the motor. The starter will not trip, because there is no undercurrent protection on the LAKS.

- *What is the minimum size of motor that can be controlled using an LAKA open loop soft starter?*

  There is no minimum motor size when using an LAKA open loop soft starter.

- *What type of motor protection does the LAKS have?*

  The LAKS has built-in motor overload protection of the electronic thermal model type. The motor current is continuously monitored and the expected temperature is calculated based on this monitored current.

  The rate of rise of the calculated motor temperature is determined by the Motor Trip Class setting. The lower this setting, the faster the rate of rise of calculated motor temperature. A Motor Overload trip (2 x Ready LED flashes) will occur when the calculated temperature reaches 105%. This protection is similar to a motor trip class setting on a standard thermal overload relay.

  An external motor protection device is not required when using an LAKS soft starter. LAKS is certified to conform to the IEC 60947-4-2 standard for electronic soft starters. The reliability of the motor protection feature is part of this standard.

- *How do I select a LAKA/LAKS soft starter for duty cycles different from those listed in the standard ratings table?*

  The WinStart software package is available for selecting soft starters for different duty cycles.

- *What are the LAKA/LAKS operational ratings before maintenance may be required?*

  The operational ratings for LAKA/LAKS are size-dependent, and are due to the capability of the internal bypass contactor:

  18 ~ 200 A: 100,000 operations

- *When would I use a line contactor?*

  A line contactor may be compulsory for a specific installation.

- *How do I size the fuses of the motor branch circuit when using a LAKA/LAKS soft starter?*

  For current limit settings ≤ 350% and start times ≤ 15 seconds, the nominal rating of standard line supply fuses should be 1.75 x Motor FLC. If motor rated fuses are being used, their nominal rating should be 1.5 x Motor FLC.

  For current limit settings > 350% and start times > 15 seconds, the nominal rating of standard line supply fuses should be 2 x Motor FLC. If motor rated fuses are being used, their nominal rating should be 1.75 x Motor FLC.

- *When would I use semiconductor fuses?*

  Either when specified for an installation, or when Type 2 coordination is required.

  The LAKA/LAKS is internally bypassed, so the SCRs are in use only during starting and soft stopping.

- *What is the current consumption of the LAKA/LAKS control supply?*

  The steady state consumption of the control supply is 100 mA maximum.

  However, the short time inrush current at control supply switch-on can be as high as 10 A.

- *How can the LAKS programmable output relay be used?*

  The programmable output relay provides a normally open contact which can be used for a "Trip" or "Run" output.

  Trip output:
  The relay operates when the LAKS trips on any fault. This can be used to operate a shunt-trip mechanism of an upstream circuit breaker to isolate the motor branch circuit. It could also be used to signal LAKS "Trip" status to an automation system.

  Run output:
  The relay operates on completion of start ramp.

This can be used to operate a contactor for power-factor correction capacitors. It could also be used to signal LAKS "Run" status to an automation system.

- *Is the LAKS suitable for flying start application?*

  Yes. There is a built-in two second delay between the end of one stop and the beginning of the next start. This delay allows the motor flux to decay, eliminating any chance of the LAKS tripping on Power Circuit fault (1 x Ready LED flash) due to detection of motor back EMF when the start signal is applied. The major effect of a flying start is on the actual time the LAKS current limits. The ramp-up time will be reduced and is determined by the motor speed on re-application of the start signal.

- *What is the remote start and stop input impedance? Are any special precautions necessary during installation?*

  The N1/N2 input impedance is approximately 150 kΩ @ 300 VAC and 5.6 kΩ @ 24 VAC/VDC.

  All control wiring, for long runs, should be either twisted pair or shielded cable with the screen earthed at one end. Control wiring should be separated from power cables by a minimum distance of 300 mm.

  If long cable runs cannot be avoided, the best assurance against noise interference is to install an interposing relay in close proximity to the soft starter.

- *Why is it necessary to apply control voltage before (or with) mains voltage?*

  There is a possibility the soft starter could arrive at site with the internal bypass contactors in closed state. On first application of control voltage, the bypass contactors are commanded to open. If mains voltage is applied without control voltage, this step is missed, and the motor may start direct on-line without warning (see Product Note for more detail).

- *How can I clear a trip on the LAKA/LAKS?*

  Trips can be cleared by pressing the Reset button on the soft starter, sending a Reset command from a serial communications network (if used), or by switching the control inputs.

  To clear a trip via the control inputs, the soft starter requires a closed to open transition on the stop input (N2).

- In three wire control, momentarily open the stop input (open A1-N2) by operating the external stop pushbutton.
- In two wire control, if the LAKA/LAKS tripped during operation, remove the start signal (open A1 to N1,N2).
- In two wire control, if the LAKA/LAKS tripped with no start signal present (e.g. LAKS motor thermistor trip), apply then remove the start signal (close then reopen A1 to N1,N2).

⚠️ If a trip is cleared via the Reset button or by a Reset command from the serial communication network, the soft starter will automatically restart if the control circuit uses two-wire control **and** a start signal is present (A1 to N1,N2 is closed).

- *What are the under- and over-frequency trip points for LAKA/LAKS soft starters?*

  The trip points are 40 Hz and 72 Hz. If the frequency falls below 40 Hz or rises above 72 Hz, the soft starter will trip (6 x Ready LED flashes). These trip points are not adjustable.

  A supply frequency trip will also occur if all three phases from the mains supply are lost, or fall below approximately 120 VAC while the soft starter is running.

  A supply frequency trip will occur if the line contactor drops out during running.

- *Will the motor start DOL if the start ramp of LAKA open loop soft starter is set to "full voltage"?*

  No, the LAKA will still provide a limited soft start. The voltage is ramped up from 0 to 100% in approximately 0.25 seconds.
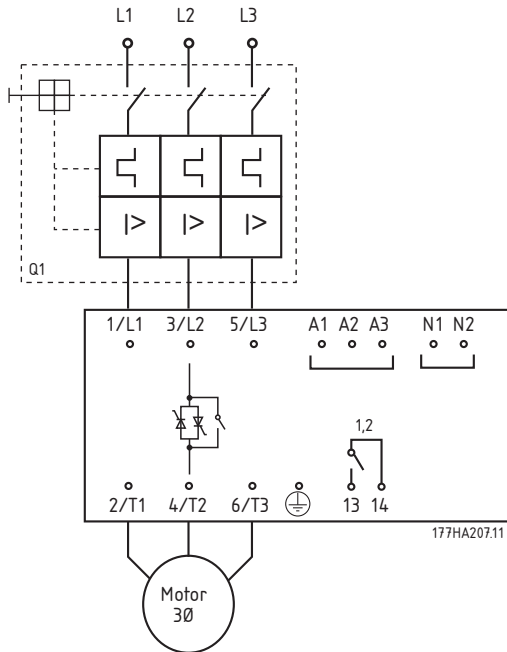
3.0 LAKA

3.1 Overview

LAKA soft starters provide timed voltage ramp soft start and soft stop control. They are designed to be used with an external motor protection device.
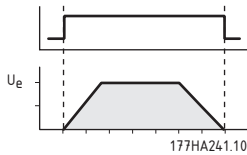
3.2 Electrical Schematics

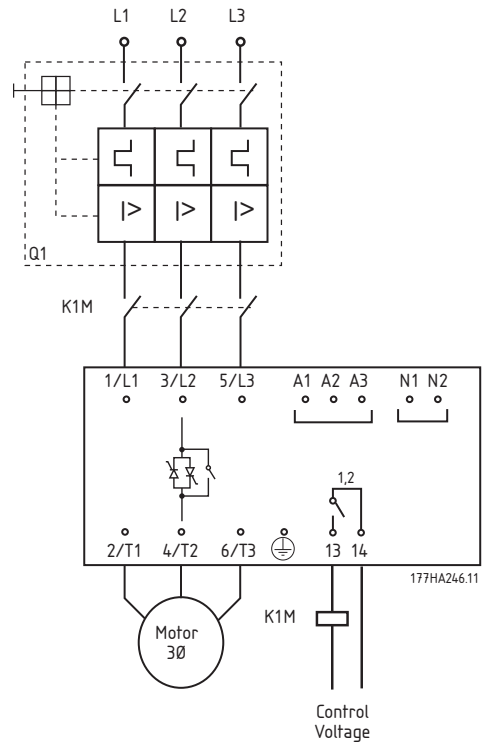*Example 1.* LAKA soft starter installed with a motor protection circuit breaker.

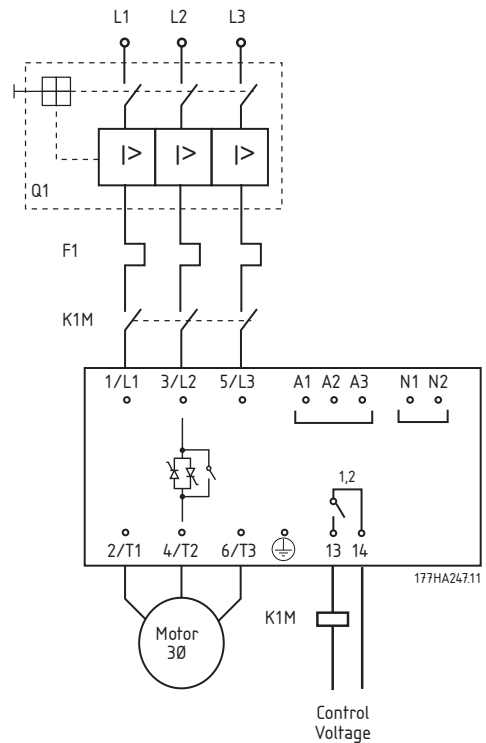177HA207.11

[1] 6 A @ 30 VDC resistive / 2 A 400 VAC AC11

[2] Main contactor.

177HA241.10

Example 2. LAKA soft starter installed with a motor protection circuit breaker and line contactor.
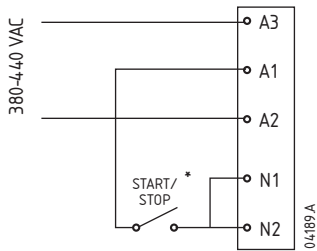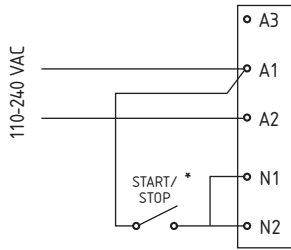

177HA246.11

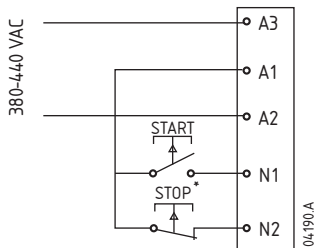*Example 3.* LAKA soft starter installed with a circuit breaker and line contactor.
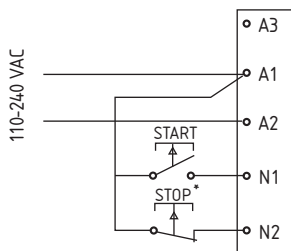

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3.3 Control Circuits

Two wire control
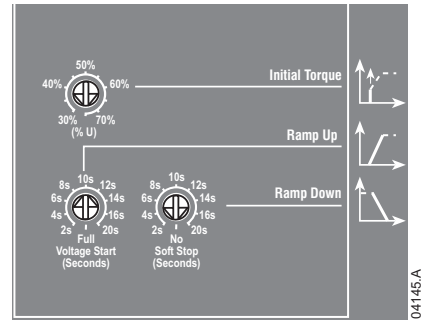

✳ Also resets the soft starter.

Three wire control

✳ Also resets the soft starter.

3.4 User Adjustments
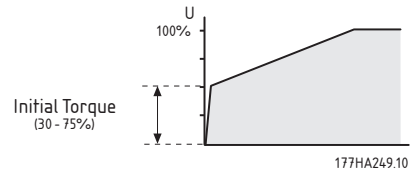

Initial Torque

Value:

30% - 75% Initial Torque   ✳ 75%

Function:

Determines the start torque generated by the motor when the start command is first applied.

Description of choice:

Set so that the motor begins to rotate as soon as the start command is given.

N.B.!:

The Initial Torque setting must be suitable for the application.

Suggested Initial Torque Settings

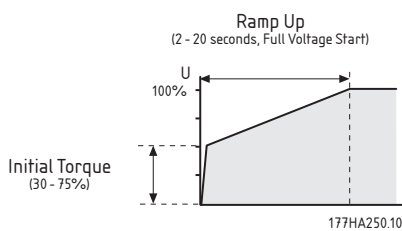| Application	Initial Torque
Centrifugal Pump	50%
Submersible Pump	60%
Screw Compressor	60%
Conveyor	70%
Crusher	70%
Fan	70%
Other applications	70%

Ramp Up

Value:

2 - 20 seconds, Full Voltage   ✷ 10 seconds

Function:

Determines the time taken for voltage to be ramped up to line voltage.

Description of choice:

Set to optimise motor acceleration and/or start current. Short ramp times result in quicker acceleration and higher start currents. Long ramp times result in slower acceleration and lower start current.

Ramp Up
(2 - 20 seconds, Full Voltage Start)

177HA250.10

N.B.!:

The Ramp Up time must be long enough for the motor to reach full speed before the LAKA/LAKS enters bypass mode.

Determining the Ramp Up time

1. Set the Ramp Up time to 20 seconds.

2. Set the Initial Torque as required for the application.

3. Attach a current monitoring device to output T1.

4. Start the motor under normal load conditions. Record the time required for the measured current to fall to (or below) the motor's rated full load current (t_1) then stop the motor.

5. Set the Ramp Up time = t_1.

Ramp Down

Value:

2 - 20 seconds, No Soft Stop   ✷ No Soft Stop

Function:

Sets the time of the soft stop voltage ramp. The soft stop function extends motor deceleration time by ramping down voltage supplied to the motor when a stop is initiated.

Description of choice:

Set the ramp time to optimise stopping characteristics for the load.

Ramp Down
(2 - 20 seconds, No Soft Stop)

177HA251.10
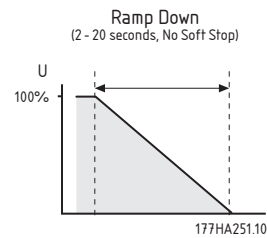
3.5   Indication
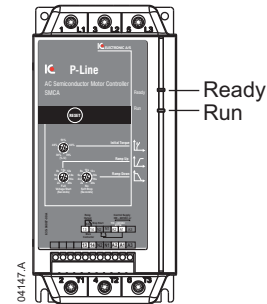
Ready
Run

LED	OFF	ON	FLASH
Ready	No control power	Ready	Starter tripped
Run	Motor not running	Motor running at full speed	Motor starting or stopping

3.6   Fault Finding

| Ready LED	Description
☀ x 1	Power Circuit: Check mains supply L1, L2, L3, motor circuit T1, T2, T3 and soft starter SCRs.
☀ x 6	Supply Frequency: Check supply frequency is in range.
☀ x 8	Network Communication Failure (between interface and network): Check network connections and settings.
☀ x 9	Starter Communication Failure (between starter and interface): Remove and refit interface.

4.0 LAKS

4.1   Overview

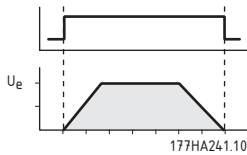LAKS soft starters provide current limit soft start, soft stop and a range of motor protection functions.

4.2   Electrical Schematics

Example 1. LAKS soft starter installed with a system protection circuit breaker complete with a shunt trip device.
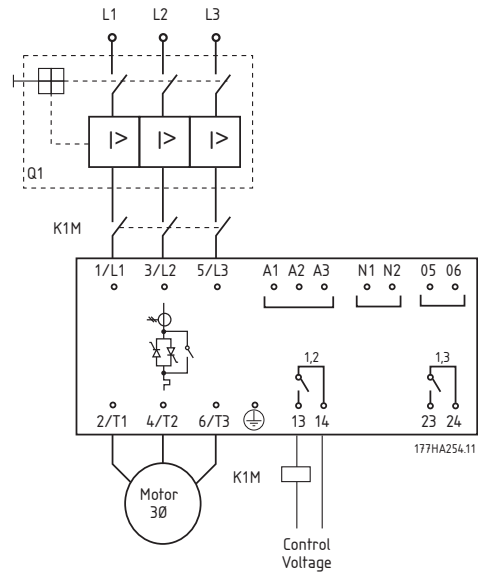

177HA253.11

[1] 6 A @ 30 VDC resistive / 2 A 400 VAC AC11.
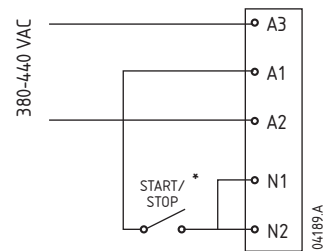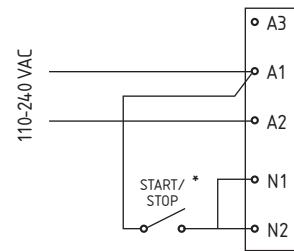
[2] Main contactor.

177HA241.10
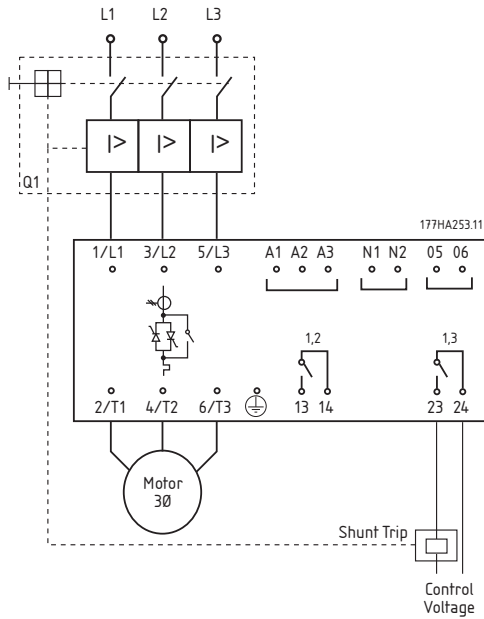
[3] Auxiliary relay function = Trip (see below).

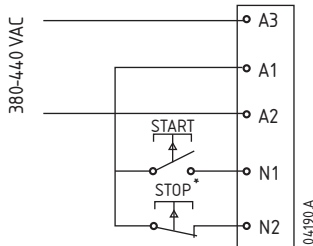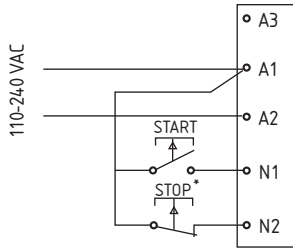*Example 2.* LAKS soft starter installed with a system protection circuit breaker and line contactor.

177HA254.11
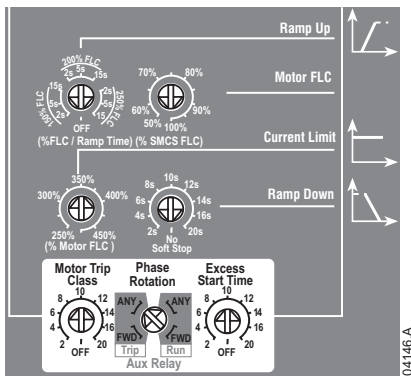
4.3   Control Circuits

Two wire control

04189-A

✳ Also resets the soft starter.

Three wire control

110–240 VAC

A3
A1
A2
START
N1
STOP *
N2

380–440 VAC

A3
A1
A2
START
N1
STOP *
N2

04190.A

* Also resets the soft starter.

4.4 Adjustments

Ramp Up
200% FLC
2s 5s 15s
70% 80%
Motor FLC
15s
5s
2s
60% 90%
OFF
50% 100%
(%FLC / Ramp Time) (% SMCS FLC)
Current Limit
350%
10s 12s
8s 14s
300% 400%
6s 16s
Ramp Down
4s
250% 450%
2s 20s
(% Motor FLC)
No
Soft Stop

Motor Trip Class | Phase Rotation | Excess Start Time
8 10 12
ANY ANY
8 10 12
6 14 6 14
4 16 FWD FWD 4 16
2 20 2 20
OFF Trip Run OFF
Aux Relay

04146 A

Current Ramp (% FLC / Ramp Time)

Value:

150% Motor FLC (2, 5 or 15 seconds)   * Off
200% Motor FLC (2, 5 or 15 seconds)
250% Motor FLC (2, 5 or 15 seconds)
Off

Function:

Sets the initial start current and ramp time for the current ramp start mode.

Description of choice:

Current ramp provides an extended soft start by gradually increasing the start current from an initial level to the selected current limit. The initial start current and ramp duration are both selectable.

Ramp Time
(2, 5, 15 seconds, OFF)
I
400%
300%
200%
100%
Initial Start Current
(150% FLC, 200% FLC, 250% FLC)
177HA257.10
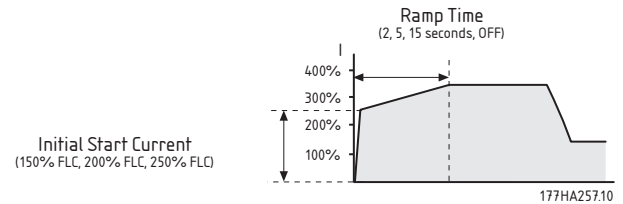
Current ramp start mode is commonly used in two circumstances.

1. For applications where start conditions vary between starts, current ramp provides an optimum soft start irrespective of motor loading (e.g. a conveyor that may start loaded or unloaded).
    In this case, use the following settings:

    - Set *Current Limit (% Motor FLC)* so that the motor can accelerate to full speed when fully loaded.
    - Set *Current Ramp (% FLC / Ramp Time)* so that:
        - the initial start current allows the motor to accelerate when unloaded
        - the ramp time provides the desired starting performance

2. On generator set supplies where a gradual increase in current is required to allow greater time for the generator set to respond to the increased loading.
    In this case, use the following settings:

    - Set *Current Limit (% Motor FLC)* as desired.
    - Set *Current Ramp (% FLC / Ramp Time)* so that:
        - the initial start current is lower than the setting for *Current Limit (% Motor FLC)*
        - the ramp time achieves the desired gradual draw of start current
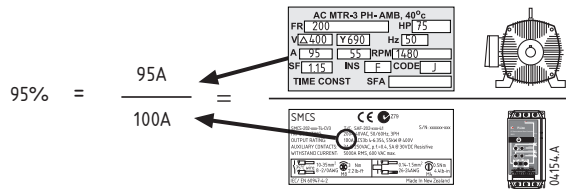
Motor FLC (% LAKS FLC)

Value:

50% - 100% LAKS FLC   * 100%

Function:

Calibrates the LAKS for the full load current of the motor.

Description of choice:

$$95\% = \frac{95A}{100A} =$$

Current Limit (% Motor FLC)
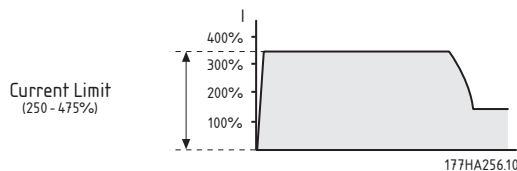
Value:

250% - 475% Motor FLC   ✲ 350%

Function:

Sets the desired starting current limit.

Description of choice:

The current limit should be set so that the motor accelerates easily to full speed.

N.B.!:
Start current must be great enough to allow the motor to produce sufficient torque to accelerate the connected load. The minimum current required to do this is dependent on motor design and load torque requirements.
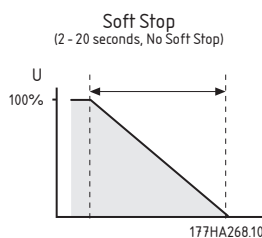
Soft Stop Ramp Time

Value:

2 - 20 seconds, No Soft Stop   ✲ No Soft Stop

Function:

Sets the time of the soft stop voltage ramp. The soft stop function extends motor deceleration time by ramping down voltage to the motor when a stop is initiated.

Description of choice:

Set the ramp time to optimise stopping characteristics for the load.
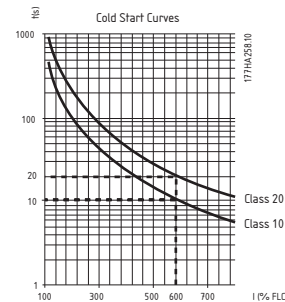

Motor Trip Class

Value:

2 - 20, Off   ✲ 10

Function:

Calibrates the LAKS motor thermal model according to the desired motor trip class.

Description of choice:

Phase Rotation

Value:

ANY, FWD   ✲ ANY
ANY = Forward and Reverse rotation permitted
FWD = Forward rotation only

Function:

Sets the allowable phase rotation of the incoming supply.

Description of choice:

The LAKS is phase rotation insensitive. This function allows motor rotation to be limited to one direction only, for applications where reverse rotation may damage the load.

N.B.!:
Phase Rotation and Auxiliary Relay are configured using a shared switch.

1. Set the Phase Rotation by turning the switch up (Any Rotation) or down (Forward Only).

2. Then set the Auxiliary Relay functionality by turning the switch to the left (Trip) or right (Run).
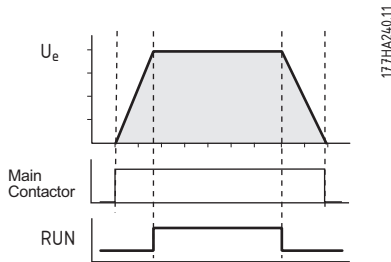
Auxiliary Relay

Value:

Trip, Run   ＊ Trip

Function:

Sets the functionality of the Auxiliary Relay
(Terminals 23, 24).

Description of choice:

Set as required, using the combined Phase
Rotation/Aux Relay adjustment.

Excess Start Time
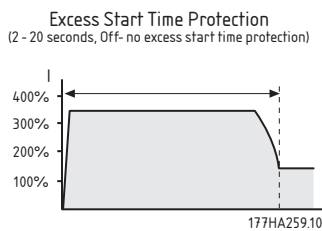
Value:

2 - 20 seconds, Off   ＊ 10 seconds

Function:

Sets the maximum allowable start time.

Description of choice:

Set for a period slightly longer than the normal
motor starting time. The LAKS will then trip if the
start time exceeds normal.

Excess Start Time Protection
(2 - 20 seconds, Off- no excess start time protection)

This provides early indication that the application
conditions have changed or that the motor has
stalled. It can also protect the soft starter from
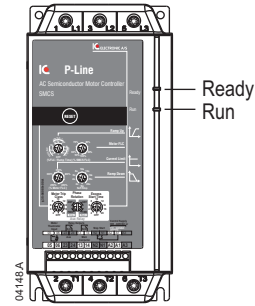being operates outside its rated start capability.

N.B.!:
Ensure the Excess Start Time protection
setting is within the LAKS rated capability.

4.5   Motor Thermistor
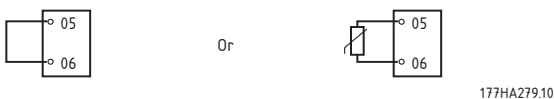
Motor thermistor cut out value = 2.8 kΩ.

4.6   Indication

| LED	OFF	ON	FLASH
Ready	No control power	Ready	Starter tripped
Run	Motor not running	Motor running at full speed	Motor starting or stopping

4.7   Fault Finding

Ready LED	Description
☀ x 1	Power Circuit: Check mains supply L1, L2, L3, motor circuit T1, T2, T3 and soft starter SCRs.
☀ x 2	Excess Start Time: Check load, increase Current Limit or adjust Excess Start Time setting.
☀ x 3	Motor Overload: Allow motor to cool, reset soft starter and restart. Soft starter cannot be reset until motor has cooled adequately.
☀ x 4	Motor Thermistor: Check motor ventilation and thermistor connection B4, B5. Allow motor to cool.
☀ x 5	Phase Imbalance: Check line current L1, L2, L3.
☀ x 6	Supply Frequency: Check supply frequency is in range.
☀ x 7	Phase Rotation: Check for correct phase rotation.
☀ x 8	Network Communication Failure (between module and network): Check network connections and settings.
☀ x 9	Starter Communication Failure (between starter and module): Remove and refit accessory module.

5.0 Soft Start Application Guide

This section provides data useful in the selection and application of soft starters.

5.1   Reduced Voltage Starting

When started under full voltage conditions, an AC induction motor will initially draw locked rotor current and produce locked rotor torque. During motor acceleration the current will fall, while torque will first increase to break down torque and then fall to full speed levels. Motor design determines the magnitude and shape of both the current and torque curves.
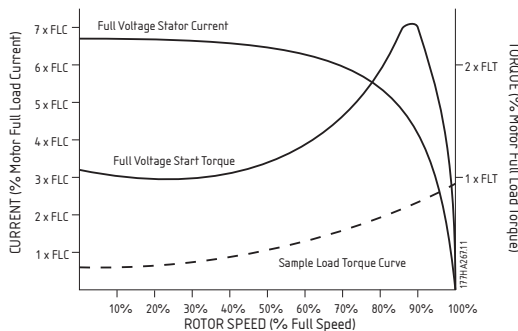
Starting performance of motors with similar full speed characteristics can vary dramatically. Locked rotor currents can range from 500% to in excess of 900% of motor full load current. Similarly, locked rotor torques can range from as low as 70% to as much as 230% of motor full load torque. These performance characteristics are determined by the design of the motor and set the limits of what can be achieved by the application of a reduced voltage starter.

For applications where it is critical to minimise start current and/or maximise start torque, it is important to ensure that a motor with low locked rotor current and high locked rotor torque is used.

When a reduced voltage starter is used, motor start torque is reduced by the square of the current reduction as shown in the formula below.

$$T_{ST} = LRT \times \left(\frac{I_{ST}}{LRC} \right)^2$$

T_{ST} = Start torque
I_{ST} = Start current
LRC = Motor locked rotor current
LRT = Motor locked rotor torque

Start current can be reduced only to the point where the resulting start torque still exceeds the torque required by the load. If the torque output from the motor falls below the torque required by the load at any point during motor starting,

acceleration will cease and the motor/load will not reach full speed.

The most common reduced voltage starters are:

- Star/Delta starters
- Auto-transformer starters
- Primary resistance starters
- Soft starters

Star/Delta starting is the cheapest form of reduced voltage starting, however performance is limited. The two most significant limitations are:

1. There is no control over the level of current and torque reduction. These are fixed at one third of the full voltage levels.

2. There are normally large current and torque transients as the starter changes from star to delta. This causes mechanical and electrical stress, and can often result in damage. The transients occur because the motor continues to spin when it is disconnected from the supply. This causes the motor to act as a generator, and the output voltage may be at the same amplitude as the supply. This voltage is present when the motor is reconnected in delta configuration, and can be exactly out of phase with the supply. The result is a current of up to twice locked rotor current, and torque up to four times locked rotor torque.

Auto-transformer starting offers more control than the star/delta method, but voltage is still applied in steps. Limitations of auto-transformer starting include:

1. Torque transients caused by switching between voltages.

2. Limited number of output voltage taps restricts the ability to precisely select the ideal starting current.

3. High price for models suitable for frequent or extended starting conditions.

4. Inability to provide an effective reduced voltage start for loads with varying start requirements (for example a material conveyor may start loaded or unloaded). The auto-transformer starter can only be optimised for one condition.

Primary resistance starters employ either a "fixed metal" or "liquid electrolyte" resistance to reduce the voltage applied to a motor during start. Primary resistance starters also provide greater starting control than star/delta starters. However, they do

have a number of characteristics that reduce their effectiveness. These include:

1. Difficult to optimise start performance when commissioning because the resistance value must be calculated when the starter is manufactured and is not easily changes later.

2. Poor performance in frequent starting situations. The resistance value changes as heat is generated during a start, so a long cool down period is required between starts.

3. Poor performance for heavy duty or extended starts because heat build-up in the resistors changes the resistance value.

4. Cannot provide an effective reduced voltage start for loads with varying start requirements.

■ **Soft Starters**

Electronic soft starting is the most advanced form of reduced voltage starting. The technology offers superior control over starting current and torque. Additionally the more advanced soft start systems also provide advanced protection and interface functions.

The main starting and stopping advantages offered include:

- smooth application of voltage and current without steps or transients
- user control over the starting current and starting torque through simple programming adjustments
- frequent start capability without performance variations
- optimum start performance for every start even in applications where the load varies between starts
- soft stop control for applications such as pumps and conveyors
- braking for reducing deceleration times

5.2   Types of Soft Start Control

The term 'soft start' is applied to a range of technologies. These technologies all relate to motor starting but there are significant differences in the methods used and the benefits available.

Some of the key differences are described below.

Control philosophy: Soft starters can generally be divided into two groups.

- Timed Voltage Ramp (TVR) systems
- Current controlled systems

TVR starters control voltage applied to the motor in a preset manner and receive no feedback on motor starting current. Control of start performance is provided to the users through settings such as Initial Voltage and Ramp up time. Soft Stop is also commonly available and provides the ability to extend motor stopping times.

Current controlled soft starters monitor motor current and use this feedback to adjust voltage so that user specified starting current is maintained. Soft Stop is also provided as are range of motor protection functions.

Power assemblies: Soft starters can provide control of one, two or all three phases.

Single-phase controllers remove the torque shock associated with motor starting but provide no significant current reduction. They must be used with a line contactor and motor overload. They are suitable for very small motors and should only be applied to light applications with low to medium start frequency.

Two-phase controllers control two phases while the third phase is uncontrolled. These controllers provide soft start and current reduction. Care should be taken to ensure that the control algorithms of two-phase controllers balance the output waveform in order to provide a symmetrical waveform. Basic two-phase controllers subject the motor to an asymmetrical output waveform which creates a DC field in the motor. This stationary DC field increases the required start current and increases motor heating. Such unbalanced controllers should not be applied to high inertia loads or in situations with high start frequencies.

Three-phase controllers control all phases and are best suited for very large motors.

External or internal bypass connection: The SCRs in a soft starter can be bypassed once the motor is up to speed. This reduces heat generation and prevents damage to the SCR from overcurrent or overvoltage events that occur while the motor is running. Some soft starters include built-in bypass contactors while other provide terminals for connection of an external bypass contactor.
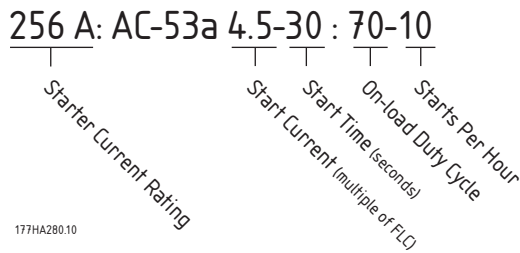
5.3   Understanding Soft Starter Ratings

The maximum rating of a soft starter is calculated so the junction temperature of the power modules (SCRs) does not exceed 125 °C. Five operating parameters affect the SCR junction temperature: Motor Current, Start Current, Start Duration, Number of Starts Per Hour, Off Time. The full rating of a particular soft start model must account for all

these parameters. A current rating on its own is not sufficient to describe the capability of a soft starter.

IEC 60947-4-2 details the AC53 utilisation categories for describing a soft starter's ratings. There are two AC53 codes:
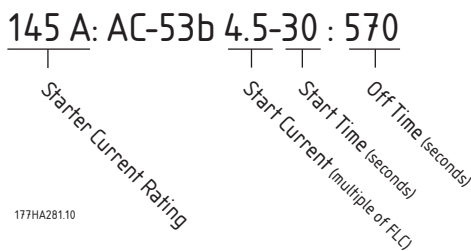
1. AC53a: for soft starters used without bypass contactors.
   For example, the following AC53a code describes a soft starter capable of supplying a 256 A run current and a start current of 4.5 x FLC for 30 seconds 10 times per hour where the motor runs for 70% of each operating cycle (operating cycle = 60 minutes / starts per hour).

256 A: AC-53a 4.5-30 : 70-10

Starter Current Rating

Start Current (multiple of FLC)

Start Time (seconds)

On-load Duty Cycle

Starts Per Hour

177HA280.10

- Starter Current Rating: Maximum FLC rating of the motor to be connected to the soft starter given the operating parameters specified by the remaining items in the AC53a code.
- Start Current: The maximum start current that will be drawn during start.
- Start Time: The time taken for the motor to accelerate.
- On-load Duty Cycle: The percentage of each operating cycle that the soft starter will run.
- Starts Per Hour: The number of operating cycles per hour.

2. AC53b: for soft starters used with bypass contactors.
   For example, the following AC53b code describes a soft starter which, when bypassed, is capable of supplying 145 A run current and a start current of 4.5 x FLC for 30 seconds with a minimum of 570 seconds between the end of one start and the commencement of the next.

145 A: AC-53b 4.5-30 : 570

Starter Current Rating

Start Current (multiple of FLC)

Start Time (seconds)

Off Time (seconds)

177HA281.10

In summary, a soft starter has many current ratings. These current ratings are dependent on the

start current and operational performance required by the application.

To compare the current rating of different soft starters it is important to ensure that operating parameters are identical.

5.4 Model Selection

N.B.!:
To fully understand the model selection procedures it is important to have a good knowledge of the fundamental principles of soft starter ratings. See *Understanding Soft Starter Ratings*.

To select the correct LAKA/LAKS model:

1. Determine whether the application requires a normal duty or heavy duty rating. The table below can be used as a guide.

2. See the tables in *Ratings* and select a LAKA/LAKS model with full load current greater than that of the motor.

Application	Duty
General and Water	
Agitator	Normal
Centrifugal Pump	Normal
Compressor (screw, unloaded)	Normal
Compressor (reciprocating,	Normal
unloaded)	Normal
Conveyor	Normal
Fan (damped)	Heavy
Fan (undamped)	Heavy
Mixer	Normal
Positive displacement pump	Normal
Submersible pump	
Metals and Mining	
Belt conveyor	Heavy
Dust collector	Normal
Grinder	Normal
Hammer mill	Heavy
Rock crusher	Normal
Roller conveyor	Normal
Roller mill	Heavy
Tumbler	Normal
Wire draw machine	Heavy
Food Processing	
Bottle washer	Normal
Centrifuge	Normal
Dryer	Heavy
Mill	Heavy
Palletiser	Heavy
Separator	Heavy
Slicer	Normal

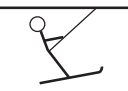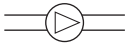| Pulp and Paper	
Dryer	Heavy
Re-pulper	Heavy
Shredder	Heavy
Petrochemical	
Ball mill	Heavy
Centrifuge	Normal
Extruder	Heavy
Screw conveyor	Normal
Transport and Machine Tool	
Ball mill	Heavy
Grinder	Normal
Material conveyor	Normal
Palletiser	Heavy
Press	Normal
Roller mill	Heavy
Rotary table	Normal
Lumber and Wood products	
Bandsaw	Heavy
Chipper	Heavy
Circular saw	Normal
Debarker	Normal
Edger	Normal
Hydraulic power pack	Normal
Planer	Normal
Sander	Normal
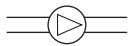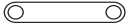
N.B.!:

The above start current requirements are typical and appropriate in most circumstances. However, start torque requirements and performance of motors and machines do vary. Please contact IC Electronic if the application requires duties other than listed in this manual.

5.5 Typical Applications

LAKA/LAKS soft starters can offer benefits for almost all motor starting applications. Typical advantages are highlighted in the table below.

Application	Benefits
Pumps	• Minimised hydraulic shock in pipelines during start and stop. • Reduced starting current. • Minimised mechanical stress on motor shaft. • Phase rotation protection prevents damage from reverse pump rotations.
Conveyor Belts	• Controlled soft start without mechanical shocks, e.g. bottles on a belt do not fall over during starting, minimised belt stretch, reduced counterbalance stress. • Controlled stop without mechanical shock (soft stop). • Optimum start performance even with varying starting loads (e.g. coal conveyors start loaded or unloaded). • Extended mechanical lifetime. • Maintenance-free.
Centrifuges	• Smooth application of torque prevents mechanical stress. • Reduced starting times over star/delta starting.
Ski Lifts	• Jerk-free acceleration increases skier comfort and prevents swinging T-bars etc. • Reduced starting current allows starting of large motors on a weak power supply. • Smooth and gradual acceleration whether the ski lift is lightly or heavily loaded. • Phase rotation protection prevents operation in reverse direction.
Compressors	• Reduced mechanical shock extends the life of the compressor, couplings and motor. • Limited start current enables large compressors to be started when maximum power capacity is limited. • Phase rotation protection prevents operation in reverse direction.
Fans	• Extended coupling life though reduced mechanical shock. • Reduced start current enables large fans to be started when maximum power capacity is limited. • Phase rotation protection prevents operation in reverse direction.
Mixers	• Gentle rotation during start-up reduces mechanical stress. • Reduced starting current.