Instruction Leaflet for the S701X25B3S Soft Start Controller with Brake

Description

The S701 soft start controller and dynamic brake is designed to control acceleration and deceleration of three-phase motors. Brake current is adjustable from 0-50 Amps DC. The ramp-up feature is adjustable from 0.5 to 10 seconds. Torque adjustment is adjustable with or without break loose (kick start) function.

Installation

⚠ WARNING

DO NOT INSTALL OR PERFORM MAINTENANCE ON THIS DEVICE WHILE EQUIPMENT IS ENERGIZED. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING WITH INSTALLATION OR MAINTENANCE.

Only qualified persons, as defined in the National Electric Code, who are familiar with the installation, maintenance and operation of this device and the equipment onto which it is to be installed, as well as applicable local, state and national regulations and industry standards and accepted practices regarding safety of personnel and the equipment safety should be permitted to install, maintain or operate this device. These instructions are provided only as a general guide to such qualified persons and are not all-inclusive. They do not cover every application or circumstance which may arise in the installation, maintenance or operation of this equipment. Users are advised to comply with all local, state and national regulations and industry standards and accepted practices regarding safety of personnel and equipment.

⚠ CAUTION

REMOVE ALL POWER FROM THE INSTALLATION BEFORE ATTEMPTING TO INSTALL OR REMOVE THIS DEVICE. THIS INCLUDES L1, L2, L3 AS WELL AS THE CONTROL TERMINALS.

Mounting Guidelines for S701X25B3S

Important — The controller is designed for vertical mounting in free air. If the controller is mounted horizontally, the load current must be reduced to 50% of rated current.

Maintenance

Cooling fins must be kept clean and free from dust. The airflow must not be blocked.

Recommended Mounting Distance, Figure 1

No distance is needed between controllers when mounted side by side in horizontal direction.

Distance from controller(s) mounted over controller(s) in vertical direction — 3.15 in (80 mm) minimum.

Distance to cable trunking or walls from top or bottom of controller — 1.2 in (30 mm) minimum.

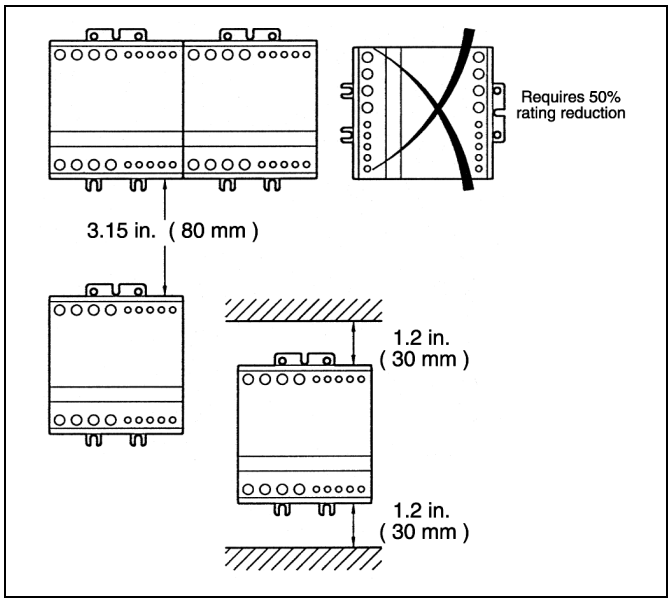

Figure 1. *Recommended Mounting Distance*

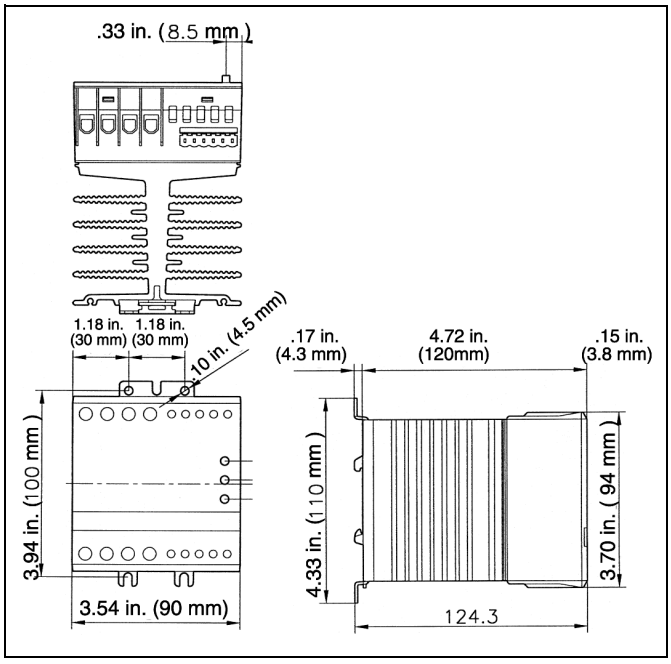

Figure 2. *Dimensions*

Wiring Directions

IMPORTANT

When using electrical or pneumatic tools for screw terminals, observe maximum torque limits.

75°C	AWG (mm²)	AWG (mm²)
*	18 - 12 (0.75 - 4)	20 - 16 (0.5 - 1.5)
	2 - 18 (2 x 1-1)	2 x 20 - 18 (2 x 0.5 - 0.75)
*	18 - 10 (0.75 - 6)	20 - 16 (0.5 - 1.5)
	2 x 18 - 14 (2 x 0.75 - 2.5)	2 x 20 - 16 (2 x 0.5 - 1.5)
*	18 - 10 (0.75 - 6)	20 - 16 (0.5 - 1.5)
	2 x 18 - 16 (2 x 0.75 - 1.5)	2 x 20 - 16 (2 x 0.5 - 1.5)
	Posidrive 1 0.5 Nm max. [4.4 lb-in max.]	N/A
	4 mm 0.5 Nm max. [4.4 lb-in max.]	3 mm 0.4 Nm max. [3.5 lb-in max.]

* UL Tested.

Wiring Directions

IMPORTANT

ADJUST "BRAKE TORQUE" TO 1 BEFORE MAINS CONNECTION.

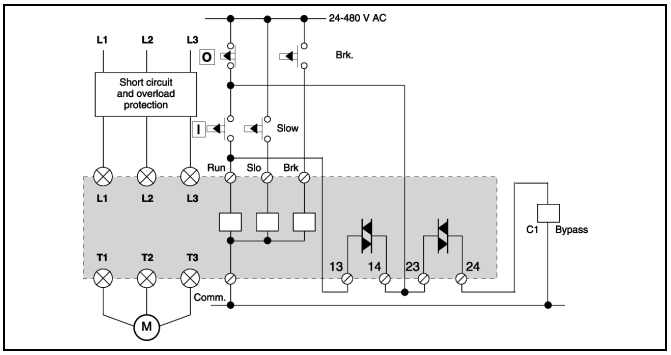

Figure 3. *Wiring Diagram*

Specifications

Table 1. *Thermal Specifications*

Description	Specification
Power dissipation for continuous operation PD max.	2 W/A
Power dissipation for intermittent operation PD	2 W/A x duty cycle
Cooling Method	Natural convection
Mounting	Vertical ±30°
Operating temperature range, EN60947-4-2 (no derating)	-5° to 40°C [23° to 104°F*
Storage temperature, EN60947-4-2	-20° to 80°C [-4° to 176°F]

* UL Tested.

Table 2. *Insulation Specifications*

Description	Specification
Rated insulation voltage	Ui 660 Volt
Rated impulse withstand voltage	Uimp 4 kVolt
Installation category	III

Current Derating

Current Derating in High Temperature Applications

Operation in ambient temperatures exceeding 40°C is possible if the power dissipation is limited either by reducing the steady-state current or by reducing the duty cycle of the soft start controller as shown in **Table 3**.

Table 3. *Temperature Specifications*

Ambient Temperature	S701X25B3S
50°C	20.0A continuous
Limited Duty Cycle Rating by 50°C	25A on-time max. 15 min. Duty cycle max. 0.8
60°C	17A continuous
Limited Duty Cycle Rating by 60°C	25A on-time max. 15 min. Duty cycle max. 0.65

Table 4. *Current Derating by Trip Class*

Overload Trip Class	S701
10A 10 20 30	25A 25A 20A 15A

EMC

This compartment meets the requirements of the product standard EN60947-4-2 and is CE marked according to this standard.

Approvals UL Std. No. 508
Environment Degree of Protection / Pollution Degree: IP20 / 3

Table 5. *Output Specifications*

Description	Specification
Operational Current (max.)	25A AC-53-a, AC-3
Leakage Current (max.)	5 mA AC
Operational Current (min.)	1A
Overload Relay Trip Class	10 or 10A

Table 6. *Control Specifications*

Description	Specification
Control Voltage Range	24 – 300V AC/DC
Pick-up Voltage (max.)	20.4V AC/DC
Drop-out Voltage (max.)	5V AC/DC
Control Current for no operation (max.)	1 mA
Response Time (max.)	100 ms
Control Current/Power (max.)	15 mA / 2 VA
Control Output (SCR) Term. 23-24 for Full-On after Ramp Up function (By-Pass function)	0.5 A AC-14, AC-15 24 – 300V AC 50/60 Hz
Control Output (SCR) Term. 13-14 for Full-On after Ramp Up function (By-Pass function)	0.5 A AC-14, AC-15 24 – 300V AC 50/60 Hz

Product Selection

Table 7. *Product Description and Item Selection*

Line Voltage (V AC) 50/60 Hz	Control* Voltage (V AC/DC)	Motor Size	Item No. (25A)
208 – 230	24 – 300	10 hp / 0.7 – 7.5 kW	S701C25B3S
400 – 480	24 – 300	15 hp / 1 – 11 kW	S701E25B3S
Ramp Up Time	Adjustable from 0.5 – 10 seconds		
Brake Current	Adjustable from 0 – 50 DC		
Initial Torque	Adjustable from 0 – 85% of nominal toque		
200 ms Kick Start Function	Selectable		

* 24 - 480V AC/DC for CE only application.

Short Circuit Protection

Two types of short circuit protection can be used:

short circuit protection by circuit breaker
short circuit protection by fuses

Short circuit protection is divided into two levels — Type 1 and Type 2.

Type 1 — protects the installation
Type 2 — protects the installation and the semiconductors inside the motor controller

Short Circuit Protection by Circuit Breaker

A 3-phase motor with a correctly installed and adjusted overload relay will not short-circuit totally to earth or between the 3 phases. Part of the winding will normally limit the short circuit current to a value that will cause instantaneous magnetic tripping of the circuit breaker without damage to the soft starter. The magnetic trip response current is approximately 11 times the maximum adjustable current.

Short Circuit Protection by Fuses

Type 1

S701X253BS — protection max. 80A $_{g}$I/$_{g}$L/$_{g}$G 63A T

Type 2

S701X253BS — protection max. I^2t of the fuse 6300A^{2}S

NOTE: When protected by H class fuses, this device is rated for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 600V maximum.

Overload and Short Circuit Protection

NOTE: Use thermal overload protection as required by the National Electric Code (NEC).

It is recommended to overload protect the controller with a manual motor starter which is insensitive to the unbalanced operation condition during the braking operation.

This makes the motor protected also during the brake cycle.

The manual motor starter will also short circuit protect the controller if prospective short circuit limits are observed.

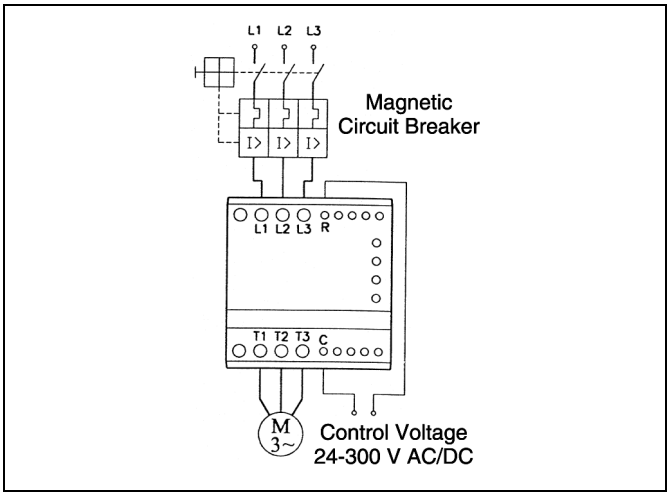

Figure 4. *Overload and Short Circuit Protection*

For Heavy-Duty Applications, derate according to **Table 8**.

Table 8. *Heavy-Duty Applications*

Overload Relay Trip Class	Max. Load Current
10 A (light load)	25A
10 (normal start)	25A
20 (heavy start)	20A
30 (heavy start)	15A

Phase Unbalance

Due to the integral brake function, the motor is overload protected during the brake cycle. The phase unbalance in this mode might trip an overload relay with high sensitivity to phase unbalance.

Utilization Categories (947-4-2)

Table 9. *Utilization Categories*

Item	Specification
AC-52a	Control of slip-ring motor stators
AC-53a	Control of squirrel cage motor

Rating Index (IEC 947-4-2)

Table 10. *Rating Index*

S701X25B3S
25A: AC-52a:4-13 : 100 – 3000
25A: AC-53a: 8-3 : 100 – 3000

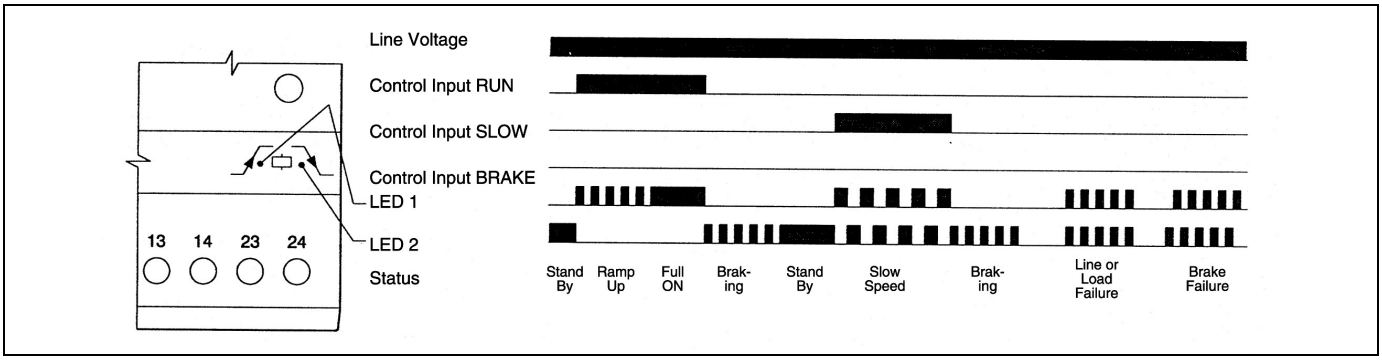

Figure 5. *LED Status Indication*

Upgrading an Existing Motor Control Application to an Automatic "Brake to Stop" Application

Wiring Examples

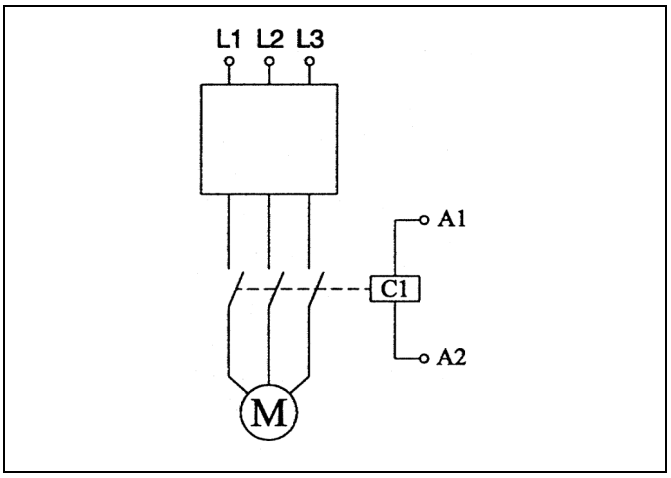

Figure 6. *Existing Standard Motor Control Application*

Motor Control Application

Set **Ramp-Up** and **Initial Torque** adjustments for best startup function.

Adjust **Brake Torque** to reach a complete stop after each working cycle.

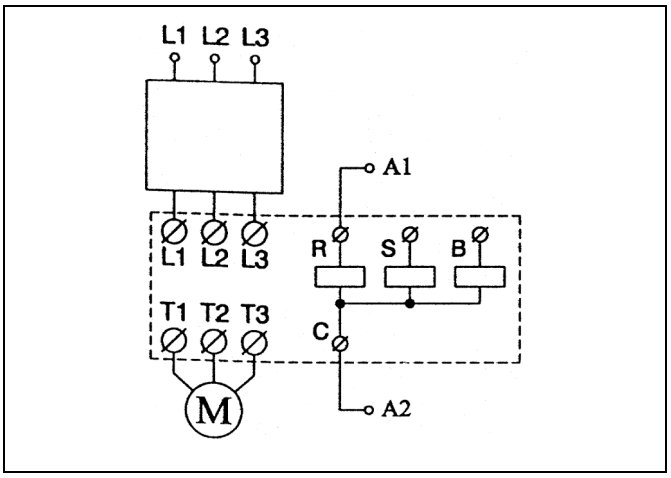

Figure 7. *Motor Control Application with Automatic "Brake to Stop" Function*

Auxiliary Contacts

In existing applications where an auxiliary contact is needed, use terminal 13, 14, and adjust the function mode selector to position I-O (7.5% or 10% slow speed).

If more auxiliary contacts are necessary, a small relay controlled from terminal 13, 14 can be used.

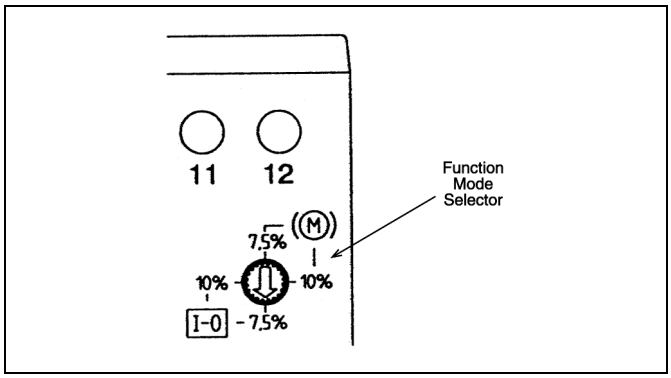

Figure 8. *Auxiliary Contacts*

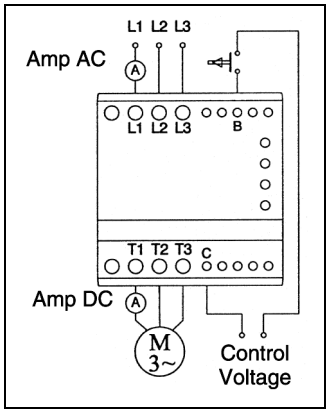

Figure 9. *Automatic Stop Detection*

Automatic Stop Detection

The motor speed is detected by sensing the DC brake current. As this controller can operate a wide range of motors with different wiring configurations, the ohmic resistance of the actual motor has a wide range. Therefore, it is necessary to adjust the "Brake Torque" (DC brake current) to achieve correct function in the actual application.

If the current is set to too low a value, the brake will be switched off before the motor has come to a complete stop. If the current is set too high, it will be out of detection range and cannot be switched off before the end of the built-in maximum time (30 seconds). The LEDs will flash to indicate failure condition. The mains must be switched off and reapplied to reset this condition.

⚠ CAUTION

ON BIGGER MOTORS, THE CURRENT CAN BE ADJUSTED TO A VALUE THAT WILL DESTROY THE CONTROLLER OR OPEN THE CIRCUIT BREAKER OR FUSE.

Before startup of an unknown application, set the Brake Torque adjustment to 1. To measure the brake current, activate the brake control input. The DC brake current can be measured on the output to T1 only. The AC value of the brake current can be measured in L1 or L2. The DC current is approximately 1.5 times the AC current.

DC Brake Current

To achieve maximum brake torque, the DC current is applied on all three motor windings. Direction of current is from T1 to T2 and T3. Braking will be more efficient if the motor is connected in Star.

⚠ IMPORTANT

DO NOT OPEN ANY SWITCHES IN THE DC CURRENT PATH DURING THE BRAKING CYCLE AS THIS MIGHT CAUSE SEVERE BURNING OF THE CONTACTS.

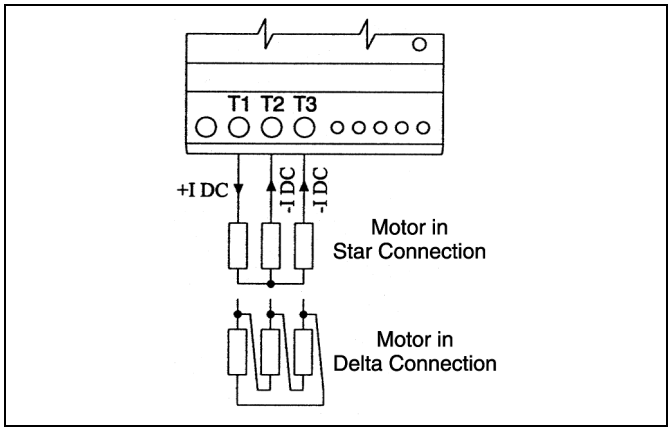

Figure 10. *DC Brake Current*

Timer Controlled Brake Cycle

If the application can only accept a low braking torque below the sensing range of the stop detection, it is possible to connect an external "ON delay" timer to the brake control input.

Functional Description: When control relay D1 and RUN input is switched off timer, T1 will activate the brake input for the adjusted time.

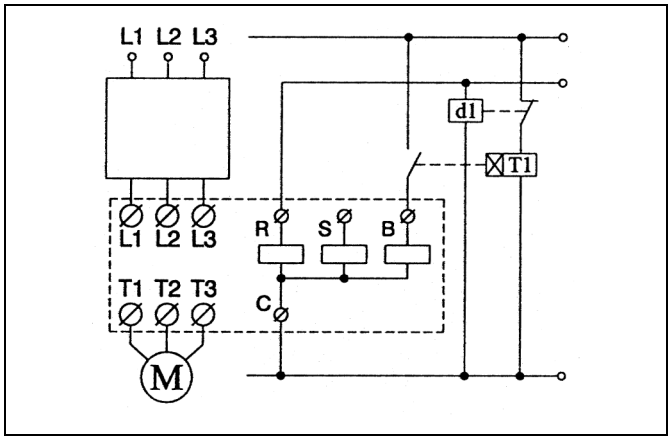

Figure 11. *Timer Controlled Brake Cycle*

Adjusting the Brake Current

When the brake current is set, it is actually a DC voltage that is adjusted. The current is dependent on the ohmic resistance of the windings and the actual connection of the motor, Star or Delta. For small motors, a high DC voltage is necessary and for bigger motors a low voltage can produce sufficient brake current. Therefore, the brake current must be adjusted for the actual application. Before startup of an unknown application, set the brake torque adjustment to “1”. Increase until the desired stop time is achieved. If it is impossible to reach a time long enough for the application, an external timer must be connected.

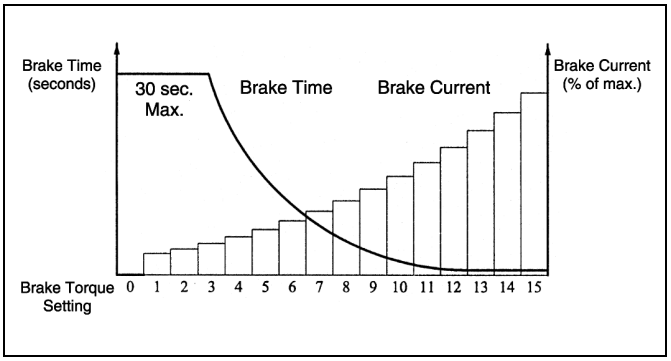

Figure 12. *Adjusting the Brake Current*

Directed Wired START-STOP and Control of Bypass Contactor

Note the setting of the operation mode selector.

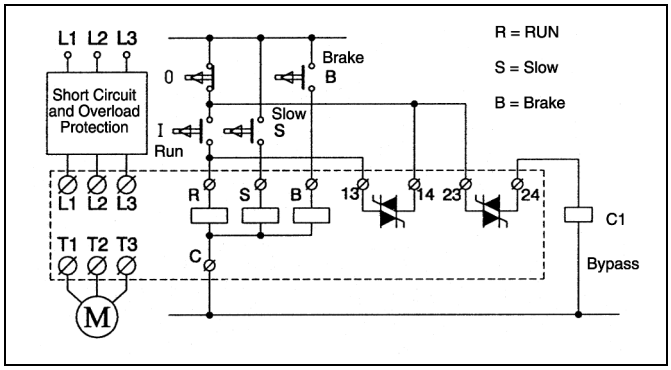

Figure 13. *Wiring Diagram for START-STOP Control*

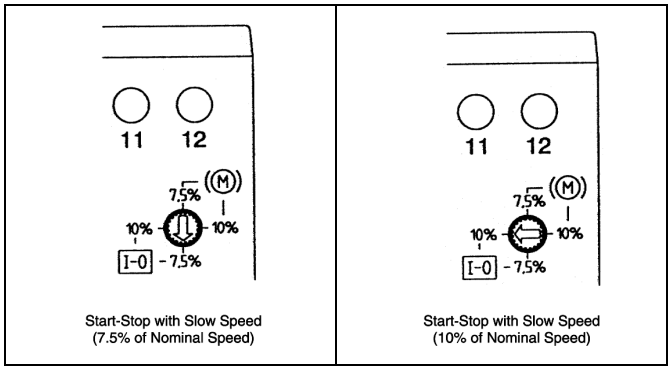

Figure 14. *Settings by START-STOP Control*

NOTE:

1) If the motor is running when the controller is switched on, the auto brake mode will stop the rotation.

2) When RUN signal is present on powerup, the controller will start the motor.

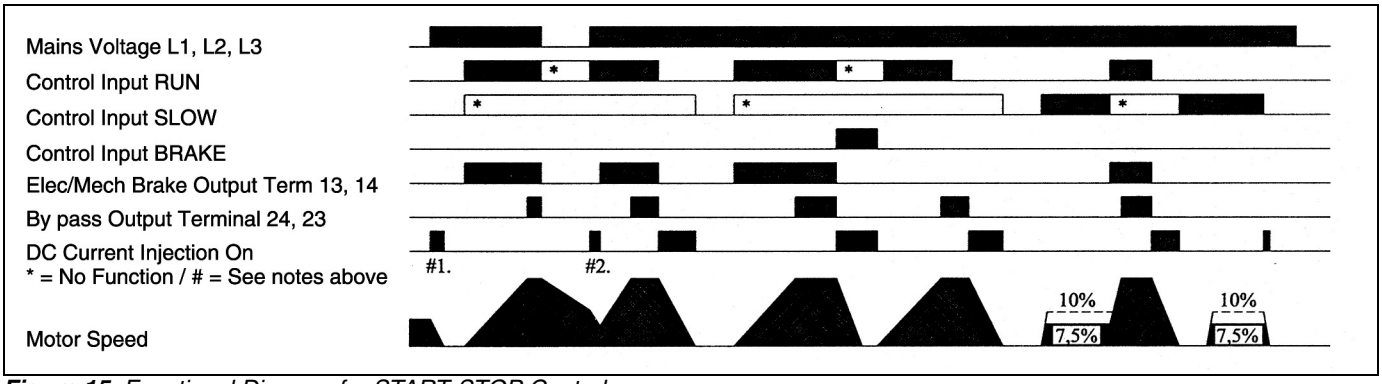

Figure 15. *Functional Diagram for START-STOP Control*

Control of Mechanical Brake and Bypass Contactor

Note the setting of the operation mode selector.

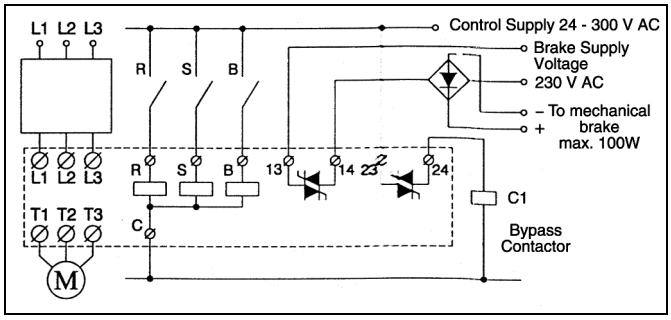

Figure 16. *Wiring Diagram for Brake Control*

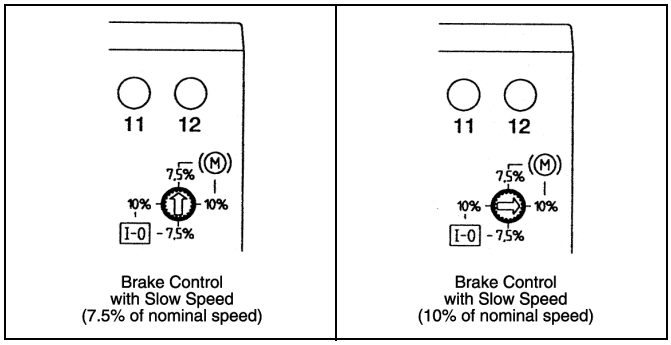

Figure 17. *Settings by Brake Control*

NOTE:

1) If the motor is running when the controller is switched on, the auto brake mode will stop the rotation.

2) When RUN signal is present on powerup, the controller will start the motor.

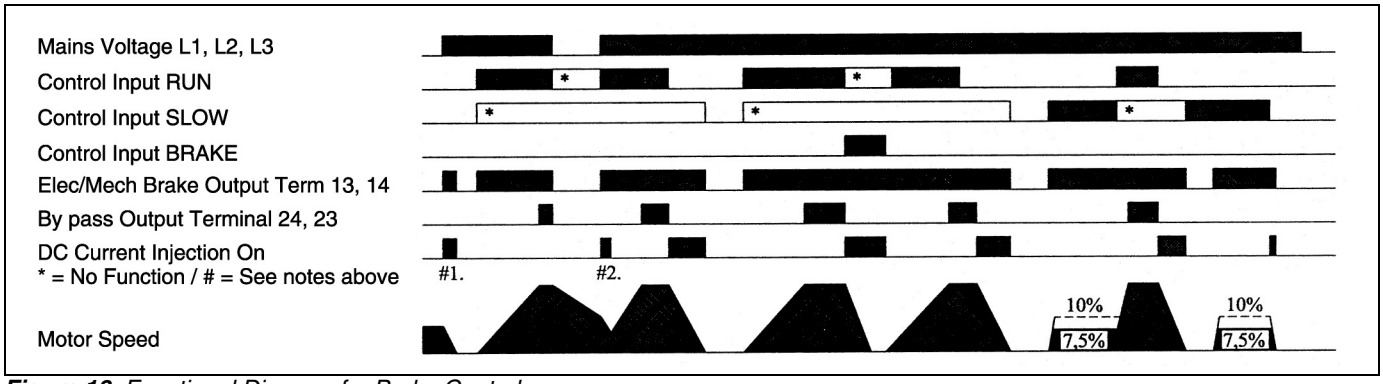

Figure 18. *Functional Diagram for Brake Control*

Slow Speed Operation

The slow speed option is intended for short time operation in applications where exact positioning is needed; for example, cranes. The motor operates at full speed until the application reaches the early limit switch, the motor is braked until stop is detected. It then continues until the final position and brakes down to a stop in the exact position.

There are two selectable speeds, 7.5% and 10% of nominal speed. Torque levels are lower than nominal torque. In slow speed 7.5% mode, the operational current in L2 is approximately 2.5 times the nominal current. In slow speed 10% mode, the operational current in L2 is approximately 2 times the nominal current, but with lower torque.

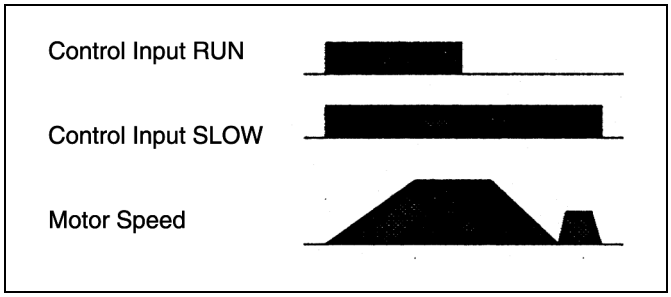

Figure 19. *Functional Diagram for Slow Speed Operation*

Note that the RUN input signal has priority over the SLOW input signal. If brake torque is adjusted to 0, slow speed will be ignored.

How to Adjust Time, Initial Torque and Brake Torque, Figure 20

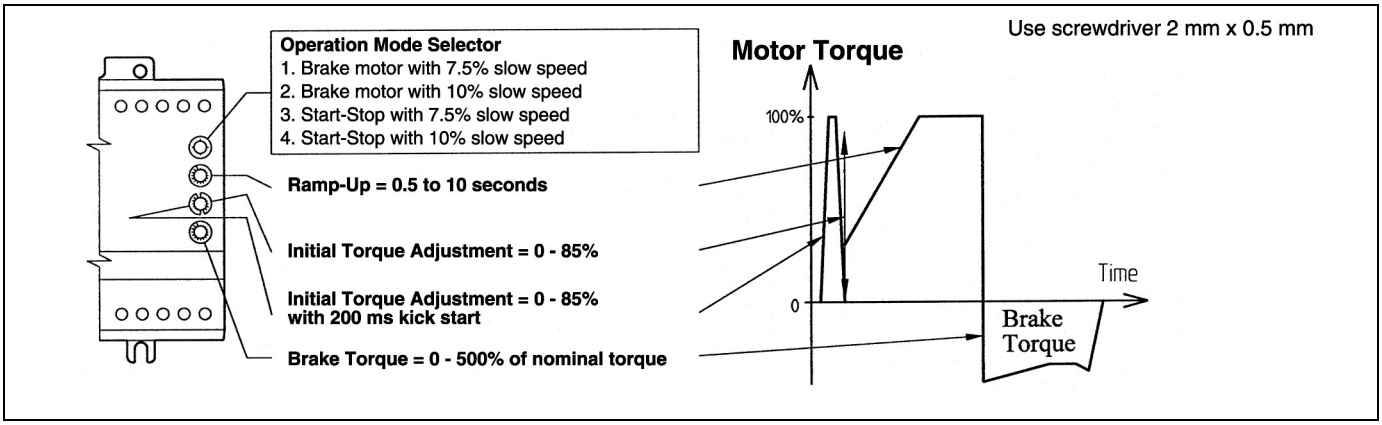

Figure 20. *Time, Initial Torque and Brake Torque Adjustment*

Note that the soft starter will read time and torque settings in standby mode, i.e., after the brake cycle. Repeated starts may trip the motor protection relay.

⚠ IMPORTANT

DO NOT SET THE ROTARY SWITCHES IN BETWEEN POSITIONS, AS THIS CORRUPTS THE TIME AND TORQUE ADJUSTMENT.

⚠ CAUTION

SET THE BRAKE TORQUE SWITCH TO 1 BEFORE SWITCHING THE CONTROLLER ON.

Standard Load with Automatic Brake Cycle

Table 11. *Standard Load with Automatic Brake*

Position	Setting/Adjustment
8,2 0	Set the **Ramp-Up** switch to maximum.
	Set the **Brake Torque** switch to 1.
	Set the **Initial Torque** switch to minimum.
	Apply control signal for a few seconds. If the load does not rotate immediately, increment the **Initial Torque** and try again. Repeat until the load starts to rotate immediately on startup.
	Adjust **Ramp-Up** time until the desired start time is obtained.
	Adjust the **Brake Torque** time until the desired stop time is obtained. If the current is set too high, the zero speed detect will not function. If the current is set too low, the zero speed detect will not function. To achieve a longer braking time, an external timer must be installed.

High Inertia Loads with Stiction

If it is not possible to reach a smooth start for an application, it may be necessary to kick start/break loose the load.

Table 12. *High Inertia Loads*

Position	Setting/Adjustment
8,2 0	Set the **Ramp-Up** switch to maximum.
0	Set the **Brake Torque** switch to 1.
0	Set the **Initial Torque** switch to minimum kick start mode.
	Apply control signal for a few seconds. If the load stops right after the 200ms “kick”, increment the **Initial Torque** and try again. Repeat until the load continues to rotate after the “kick”.
	Adjust **Ramp-Up** time to the desired start time (the scale is in seconds) and start the motor.
	Adjust the **Brake Torque** time until the desired stop time is obtained. If the current is set too high, the zero speed detect will not function. If the current is set too low, the zero speed detect will not function. To achieve a longer braking time, an external timer must be installed.

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