

# DS6 series soft start controllers



## Introduction

Eaton's Cutler-Hammer® DS6 solid-state soft start controller is an electronic, self-contained panel- or enclosure-mounted motor soft-starting device. It provides three-phase induction motors with a smooth start, both mechanically and electrically. The DS6 line uses four silicon-controlled rectifiers (SCRs) that are connected in a full wave-power bridge on two phases. The voltage and current applied to the motor are controlled by varying the SCR conduction period. This, in turn, controls the torque developed by the motor. After the motor reaches speed, a bypass contactor is energized to bypass the SCRs. The DS6 is designed to fulfill the industrial service requirements of applications such as chiller starters, pump panels, and machine tools. This device meets all relevant specifications set forth by UL® 508, IEC 60947-4-2, CE, C-Tick, and CSA®.

This leaflet covers basic installation and setup. No publication can take into account every possible situation. If you require further assistance with any aspect of this product or a particular application, contact Eaton.

## Inspection

### General

Upon receipt of the unit, verify that the catalog number and unit options stated on the shipping container match those stated on the order/purchase form.

Inspect the equipment upon delivery. Report any carton damage to the carrier prior to accepting the delivery. Have this information noted on the freight bill. Eaton is not responsible for damage incurred in shipping.

### Unpacking

Remove all packing material from the unit. Be sure to remove all packing material from the lug location.

Check the unit for any signs of shipping damage. If damage to the product is found after unpacking, report it to the freight company. Retain the packing materials for the carrier to review.

Verify that the unit's catalog number and options match those stated on the order/purchase form.

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## Storage

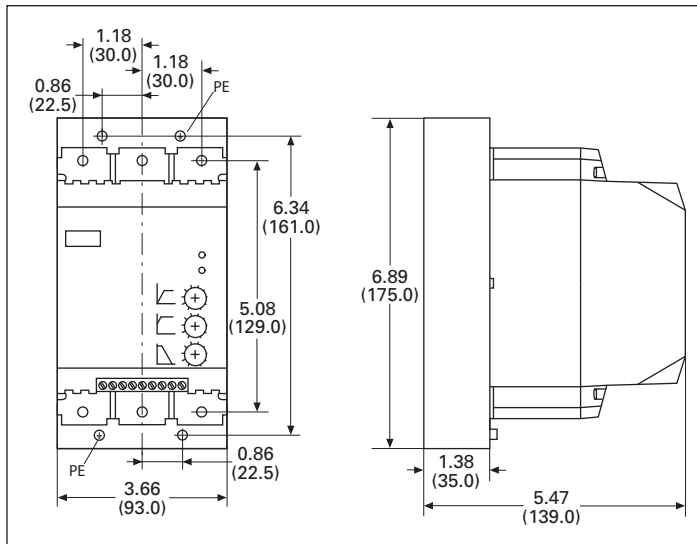
It is recommended that the unit be stored in its original shipping box/crate until it is to be installed.

The unit should be stored in a location where:

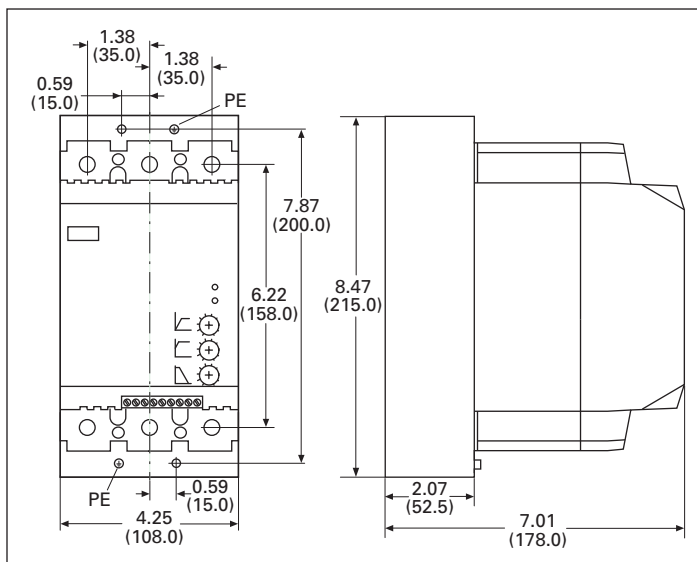
- The ambient temperature is between -13°F to 140°F (-25°C to 60°C)
- The relative humidity is between 0% and 95%, noncondensing
- The environment is dry, clean, and noncorrosive
- The unit will not be subjected to high shock or vibration conditions

## Mounting instructions

The DS6 solid-state soft start controller is easy to mount. It does not require any special tools. To aid you with panel layout, refer to the dimension drawings shown in **Figure 1** and **Figure 2**. Drill and tap holes per mounting hole/slot locations as shown. To mount the unit, use all the hardware specified in **Table 1** of this leaflet. Tighten to the specified torque.



**Figure 1. 25- to 75-Horsepower Models**



**Figure 2. 100- to 150-Horsepower Models**

## **⚠ DANGER—HIGH VOLTAGE**

**HAZARDOUS VOLTAGE CAN CAUSE ELECTRIC SHOCK AND BURNS. TO AVOID SHOCK HAZARD, DISCONNECT ALL POWER TO THE CONTROLLER, MOTOR, OR OTHER CONTROL DEVICES BEFORE ANY WORK IS PERFORMED ON THIS EQUIPMENT. FAILURE TO DO SO WILL RESULT IN PERSONAL INJURY, DEATH, OR SUBSTANTIAL PROPERTY DAMAGE.**

**DO NOT APPLY A DISCONNECT DEVICE ON THE OUTPUT OF THE DS6 SOFT START CONTROLLER UNLESS A MEANS TO TURN OFF THE DEVICE WHEN DISCONNECT SWITCH IS OPEN IS UTILIZED. OPENING THE DISCONNECT WHILE THE SOFT START CONTROLLER IS OPERATING MAY CAUSE A MALFUNCTION. CLOSING THE DISCONNECT SWITCH WHILE THE SOFT START CONTROLLER IS OPERATING WILL RESULT IN POTENTIAL EQUIPMENT DAMAGE AND PERSONNEL HAZARD.**

**Table 1. Mounting Hardware and Torque Specifications**

Frame Size	Screw Size + Flat and Lock Washer	Quantity	Torque Requirements	Unit Weight Lbs (kg)
25–75 hp	5 mm x 55 mm	2	80 lb-in (9 Nm)	4.0 (1.8)
100–150 hp	6 mm x 65 mm	2	123 lb-in (14 Nm)	8.2 (3.7)

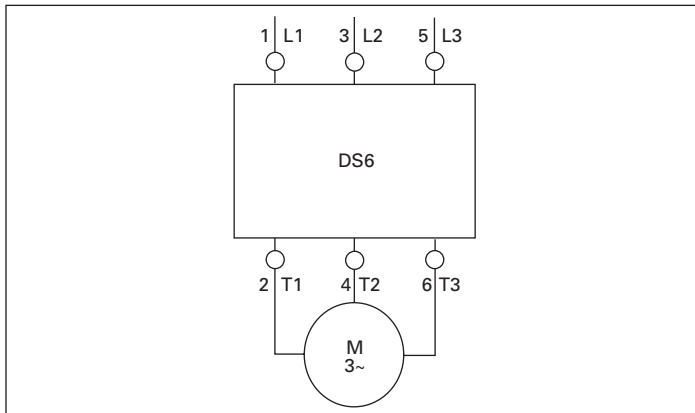
**Table 2. Environmental Requirements**

Description	Requirements
Operating temperature	32°F to 104°F (0°C to 40°C) up to 140°F (60°C) with derating of 1% of rated current per Kelvin
Storage temperature	-13°F to 140°F (-25°C to 60°C)
Elevation	Up to 1000m; up to 2000m with derating of 1% rated current for each 100m
Humidity	Functional to 95% noncondensing.
Operating orientation	Less than 30 degrees from horizontal
Minimum clearance—upper and lower	2.165 inches (55 mm) to a wall, 0.984 inches (25 mm) to a NZM1 (size 1), 1.378 inches (35 mm) to a NZM2 (size 2), consult documentation of the breaker used (ionization emissions)
Minimum clearance—sides	0.0 inches (0 mm)
Minimum clearance—face	0.198 inches (5 mm)
Shock resistance	8g for 11 ms in any direction.
Vibration resistance	2M2 EN 60721-3-2: 10g (3.5 mm amplitude, 9 to 200 Hz)
Environment	Suitable for installation in a pollution Degree 2 environment
Emissions	The device is suitable for use in industrial environments in accordance with EN 55011/22 Class A

## Power wiring

Using the wiring diagrams in **Figure 3**, **Figure 4**, and **Table 3** as guides, connect the line, motor, and power supply wiring in accordance with appropriate local and national codes.

**Note:** To provide optimum motor protection, the line and motor power wiring should be tightly bundled and run perpendicular to the orientation of the DS6. Soft start controller to motor cable length is not to exceed 325 ft (100m).



**Figure 3. Power Wiring Diagram for 230/400 and 400/460V Line Voltages**

**Table 3. Power Wire Sizing and Torque Requirements**

Frame Size	Wire Size	Torque	Wire Strip Length
25–75 hp	12–8 AWG	53 lb-in	0.65 in
25–75 hp	6–2/0 AWG	80 lb-in	0.65 in
100–150 hp	12–8 AWG	44 lb-in	0.87 in
100–150 hp	6 AWG—350 kcmil	123 lb-in	0.87 in

### **⚠ DANGER**

**HAZARDOUS VOLTAGE. WILL CAUSE DEATH OR SERIOUS INJURY. HAZARDOUS VOLTAGE IS PRESENT IN THE OFF/STOP STATUS OF THE SOFT START CONTROLLER WHEN THE LINE VOLTAGE IS ENERGIZED.**

**Table 4. Product Selection—Horsepower Ratings**

Catalog Number	Rated Current (A)	Motor Power			Maximum Allowable Breaker Size ①	Maximum Allowable Fuse Size ①
		200V (hp)	230V (hp)	460V (hp)		
DS6-34DSX041N0-N	40	10	10	30	HFD3150L	150A Class RK5
DS6-34DSX055N0-N	52	15	20	40	HFD3200L	200A Class RK5
DS6-34DSX068N0-N	65	20	25	50	HJD3250	200A Class RK5
DS6-34DSX081N0-N	77	25	30	60	HKD3300	300A Class RK5
DS6-34DSX099N0-N	96	30	30	75	HKD3350	350A Class RK5
DS6-34DSX134N0-N	124	40	50	100	HKD3350	500A Class RK5
DS6-34DSX161N0-N	156	50	60	125	HLD3450	500A Class RK5
DS6-34DSX196N0-N	180	60	75	150	HLD3500	500A Class RK5

① Maximum values are higher than allowed per NEC® 430.52 and UL 508A 31.1.

**Table 5. Product Selection—kW Ratings According to IEC 60947-4-2**

Catalog Number	Rated Current (A)	Motor Power		Maximum Allowable Breaker Size ①	Maximum Allowable Fuse Size ①
		230V (kW)	400V (kW)		
DS6-34DSX041N0-N	41	11	22	HFD3150L	150A Class RK5
DS6-34DSX055N0-N	55	15	30	HFD3200L	200A Class RK5
DS6-34DSX068N0-N	68	15	37	HJD3250	200A Class RK5
DS6-34DSX081N0-N	81	22	45	HKD3300	300A Class RK5
DS6-34DSX099N0-N	99	30	55	HKD3350	350A Class RK5
DS6-34DSX134N0-N	134	30	75	HKD3350	500A Class RK5
DS6-34DSX161N0-N	161	45	90	HLD3450	500A Class RK5
DS6-34DSX196N0-N	196	55	110	HLD3500	500A Class RK5

① Maximum values are higher than allowed per NEC 430.52 and UL 508A 31.1.

### Considerations:

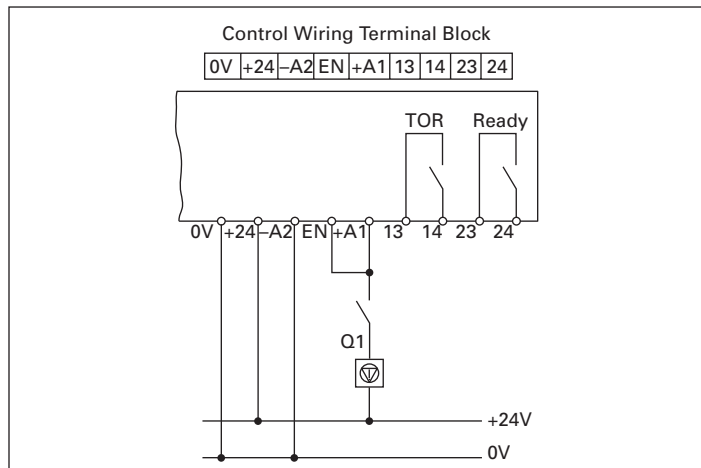
1. Either XTOB, C306, or C396 series or equivalent overload protection devices may be selected.
2. Isolation contactor is optional for normal applications. It is recommended for mains isolation.

## Control wiring

A minimum of 16 AWG should be used between the power supply and the 24 Vdc + and – terminals.

Terminal connections are to be secured to a torque value of 3.6 lb-in.

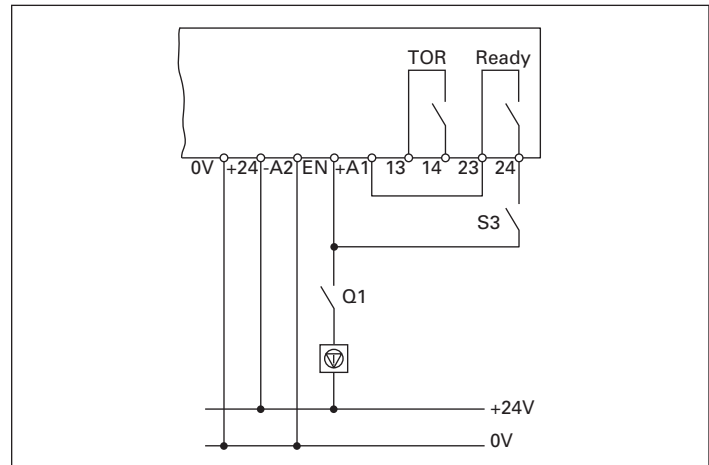
Control wiring is connected to the DS6 soft start controller by a 9-pin terminal block located on the front of the unit. Use the wiring diagrams in **Figure 4**, **Figure 5**, and the information in **Table 7** as guides.



**Figure 4. Direct Start**

**Table 6. Terminal Designations**

Terminal	Description
0V	Control ground or power supply common
+24	Plus 24 Vdc from power supply
–A2	Common with 0V, connected externally
EN	Start command enable/stop command
+A1	Start command/ramp stop command
13, 14	Top of ramp contacts—NO
23, 24	Ready status contacts—NO



**Figure 5. Direct Start With Soft Stop**

**Table 7. DS6 Terminal Control Block Wiring**

Name	Block Designation	Input	Connections
Circuit common	0V	Common	Common
Power	+24	24 Vdc nominal (see 24 Vdc power supply requirements) section for sizing of power supply	+24 Vdc power from power supply
–A2	–A2	Control power common	Common
Enable	EN	24 Vdc maintained	START command with +A1 energized. Remove for STOP command
+A1	+A1	24 Vdc maintained	START command with EN energized. Remove for STOP RAMP command
Relay	13	NO contact rated @ 250 Vac, 3A resistive, 1A inductive	Top of ramp signal—in bypass
	14	NO contact rated @ 250 Vac, 3A resistive, 1A inductive	Top of ramp signal—in bypass
Relay	23	NO contact rated @ 250 Vac, 3A resistive, 1A inductive	READY status signal
	24	NO contact rated @ 250 Vac, 3A resistive, 1A inductive	READY status signal

## 24 Vdc power supply requirements

The 24 Vdc power supply for your DS6 soft start controller must meet or exceed the following requirements:

- Minimum steady-state current: 1W (35 mA)
- Minimum start command current: 2W (65 mA)
- Minimum bypass contactor inrush current: 600 mA for 50 ms
- Voltage stability: 24 Vdc +10%/–15%

## Operations

- 24 Vdc control voltage is applied to terminal +24
- The status light will illuminate after the starter has completed initialization, closing contacts 23/24, and indicating READY status
- Line voltage is applied to the starter by closing the mains contactor
- The soft start controller issues a START command by applying +24 Vdc to terminals EN and +A1. Contacts 13 and 14 will close when the end of the ramp time is reached

**Note:** Bypass contactors close at the end of ramp time + ~0.18 seconds. It is important to correctly set the ramp time, so the bypass contactors will close within 5 seconds after the motor has achieved rated RPM.

- To initiate a STOP command, remove +24 Vdc from terminal EN and +A1 or EN
- To initiate a RAMP STOP command, remove +24 Vdc from terminal +A1

## Adjusting the soft start controller parameters

There are three adjustments to the DS6 soft start controller:

- t-Start = ramp time
- u-Start = initial voltage (torque)
- t-Stop = stop ramp time

**Note:** In all cases, motor rotation should begin within 2–3 seconds after the START command is sent to the soft start controller.

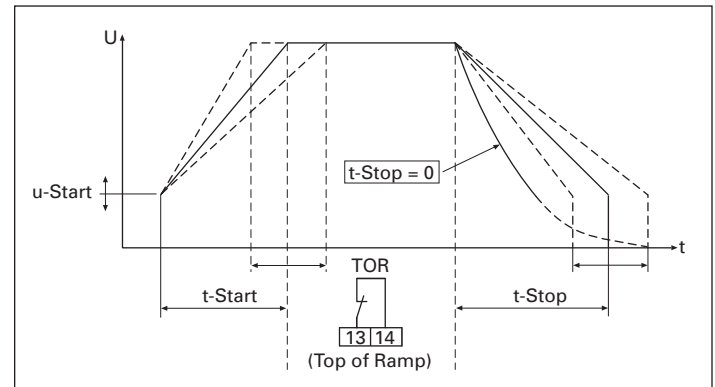


Figure 6. DS6 Ramp Functions

**Table 8. DS6 Parameters**

Application	t-Start	t-Stop	u-Start	Break-Away Torque	Remarks
Axial-flow compressor	25s	—	48%	50%	
Bandsaw	10s	—	42%	35%	
Drill, unloaded	10s	—	29%	10%	
Crusher, empty at start	20s	—	56%	75%	Possible high inertia
Carding machine (combing cotton)	20s	—	64%	100%	
Conveyor, horizontal, loaded	25s	30s	76%	150%	
Conveyor, horizontal, unloaded	25s	30s	48%	50%	
Conveyor, vertical, loaded	25s	30s	82%	175%	
Conveyor, vertical, unloaded	25s	30s	59%	85%	
Conveyor, vertical drop, loaded	25s	30s	37%	25%	
Conveyor, vertical drop, unloaded	25s	30s	44%	40%	
Crusher, swing hammer	25s	—	70%	125%	Eccentric load, high starting torque
Chiller	5s	—	37%	25%	
Piston compressor, unloaded	10s	—	64%	100%	
Circular saw	20s	—	48%	50%	Possible high inertia
Ball mill	20s	—	48%	50%	Eccentric load
Flour mill	20s	—	44%	50%	
Mixer, liquids	10s	—	37%	40%	
Mixer, plastic materials	10s	—	70%	125%	Possible high starting torque
Mixer, powder materials	10s	—	70%	125%	Possible high starting torque
Mixer, dry materials	15s	—	56%	75%	
Pelletizing machine	20s	—	64%	100%	
Pump, piston	25s	30s	82%	175%	Possible high starting torque
Pump, centrifugal	10s	30s	37%	25%	
Moving pavement, unloaded	20s	—	37%	25%	
Escalator	10s	—	48%	50%	
Rotary compressor, unloaded	20s	—	42%	35%	
Agitator	15s	—	42%	35%	
Grinder, unloaded	10s	—	37%	25%	Possible high inertia
Feed screw	20s	—	82%	175%	Possible high starting torque
Compressor, screw, unloaded	25s	—	40%	30%	
Press, flywheel	25s	—	76%	150%	Possible high starting torque
Drier, rotating	20s	—	64%	100%	
Blower, axial fan, flaps closed	40s	—	37%	25%	
Blower, axial fan, flaps open	30s	—	37%	25%	
Blower, centrifugal fan, valve closed	40s	—	42%	35%	
Blower, centrifugal fan, valve open	30s	—	35%	20%	
Vibroconveyor	25s	—	76%	150%	Possible high starting torque
Vibrating screen	20s	—	51%	60%	Possible high starting torque
Rolling mill	25s	—	48%	—	
Washing machine	25s	—	64%	100%	High transmission ratio
Centrifuge	60s	—	61%	90%	High inertia, long ramp time

**Notes:** u-Start % values are voltage settings, as the starting torque is dependent on the application.

Applications with high starting torque are not suitable for DS6 soft start controllers. In some cases, over-sizing to a larger unit may be a solution. Consult Eaton's Technical Resource Center at (877) 386-2273.

## Faults

In the event of a motor stop due to a trip condition by the soft start controller, the FAULT status LED will be illuminated (flashing). In this case, one or more conditions found in **Table 9** may have occurred.

Use standard troubleshooting techniques to determine the cause of the trip. The DS6 does not provide any specific method of identifying the cause of the trip.

**Table 9. DS6 Basic Troubleshooting Guide**

Possible Problem	Possible Solution
<b>Fault LED illuminates during the operation of the DS6 soft start controller</b>	
Control voltage loss	Check for the following conditions: power supply failure and/or intermittent operation and voltage stability. Check all connections for condition and security. Verify proper size and capacity of the power supply.
EN and heat sink temperature less than 0°C	Verify that unit temperature is not below 0°C during application of control voltage or starter operation.
<b>Fault LED illuminates during start ramp, TOR, or stop ramp</b>	
Mains connection open or undervoltage	Check for the following conditions: verify presence and stability of mains voltage. Check system for phase loss. Check main breaker and/or isolation contactor and/or reversing contactors are not open or have been cycled during starter operation, and verify proper operation. Verify all connections for condition and security.
Motor connection open	Check for the following conditions: verify proper motor cable connections, and check for condition and security. Verify installation and integrity of motor coupling to load. Test motor for proper condition. Check that isolation and/or reversing contactors are not open.
Heat sink temperature less than 0°C or above 80°C	Verify that unit temperature is not below 0°C or above 80°C.
Bypass contactor(s) closed during start ramp or stop ramp time	Verify that bypass contactor(s) do not close when START command is initiated and remain open until top of ramp is achieved. Verify that bypass contactor(s) open when STOP command or STOP RAMP command are initiated.
Bypass contactor not closed after ramp time	Verify that bypass contactor(s) close at top of ramp and remain closed until STOP command or STOP RAMP command are initiated.
SCR fault	Verify that one or more of the SCRs are not open. Verify that one or more of the SCRs are not shorted.

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## Service

For additional information on this product, please call Eaton's Technical Resource Center at (877) 386-2273 or visit our Web site at [www.eaton.com](http://www.eaton.com).

Service and repair is available from Eaton or several factory-authorized regional service centers. Please contact Eaton's Product Integrity Center at (800) 345-0434 for the location nearest to you.

For field service or start-up assistance 24 hours a day, 7 days a week, please call (800) 498-2678.

The following chart describes LED operation during motor start, run, and stop conditions.

**Table 10. LED Operation During Motor Start, Run, and Stop Conditions**

Condition	Motor Status	Ready Contacts	TOR Contacts	Error LED	Run LED
24 Vdc applied and initialization complete	Off	Closed	Open	Flashing—short pulse	Flashing—short pulse
Terminal EN energized	Off	Closed	Open	Off	Flashing—short pulse
Terminals EN and +A1 energized	START command—motor rotation	Closed	Open	Off	Flashing—long pulse
End of ramp time	At rated RPM	Closed	Closed	Off	On
Terminal +A1 de-energized EN-energized	STOP command—ramp stop	Closed	Open	Off	Flashing—long pulse
Terminal EN de-energized	STOP command—coast	Closed	Open	Flashing—short pulse	Flashing—short pulse
Error detected	Off	Open	Open	Flashing—long pulse	Off

**Notes:** Terminals EN and +A1 may be connected together to provide START and STOP commands. If this is the case, a normal ramp start with a normal stop (coast) will be selected.

When signaling a STOP command, either terminal may be de-energized. If terminal +A1 is de-energized, a ramp stop will be selected. If terminal EN is de-energized, a normal stop (coast) will be selected. To initiate another start, simply re-energize the controlled (switched) terminal.

During ramp start or ramp stop, the RUN LED will be flashing—long pulse.

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