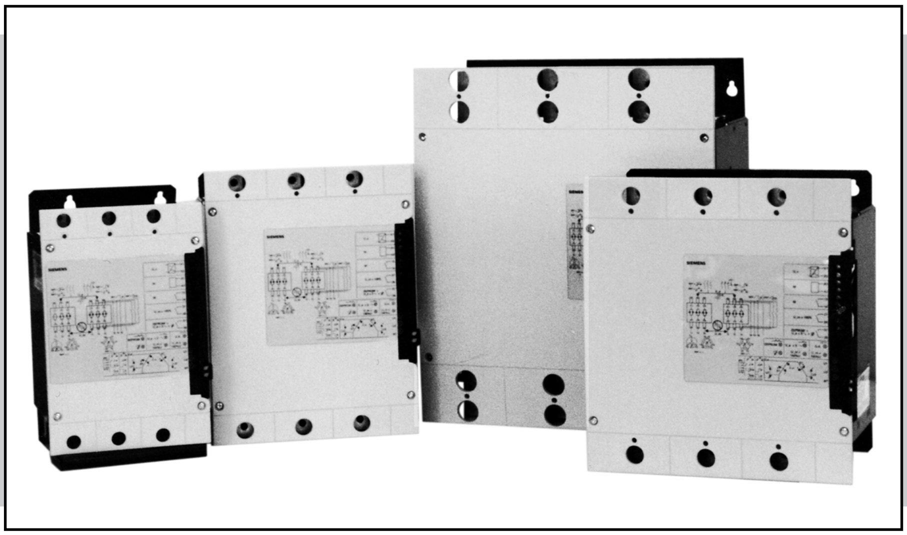
SIEMENS

SFIS-4503A-0600
June 2000

SIKOSTART 3RW35 Instruction Guide



⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.

Always de-energize and ground the equipment before maintenance. Read and understand this manual before installing, operating or maintaining the equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel may result in dangerous conditions which may cause death or serious injury, or equipment or property damage. Follow all safety instructions contained herein.

SIGNAL WORDS

The signal words "**Danger**", "**Warning**" and "**Caution**" used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

Danger - Indicates death or serious injury will result if proper precautions are not taken.

Warning - Indicates death, serious injury or property damage can result if proper precautions are not taken.

Caution - Indicates some injury or property damage may result if proper precautions are not taken.

QUALIFIED PERSON

For the purposes of this manual and product labels a qualified person is one who is familiar with the installation, construction, operation or maintenance of the equipment and the hazards involved. In addition this person has the following qualifications:

(a) **is trained and authorized** to energize, de-energize. clear, ground and tag circuits and equipment in accordance with established safety practices.
(b) **is trained** in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
(c) **is trained** in rendering first aid.

Table of Contents

IMPORTANT

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office. The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

List of Figures

List of Tables

1 Introduction

1.1 Scope of Manual

This manual provides an overview for the installation, setup and operation of the Siemens SIKOSTART 3RW35 controller. Maintenance data consists of troubleshooting and spare parts information. Note that the instructions in this manual do not cover all details or variations in equipment, nor provide for every possible contingency to be met in connection with installation, operation, or maintenance.

1.2 SIKOSTART 3RW35 Features

The SIKOSTART 3RW35 product line is the next generation of Siemens solid state reduced voltage controllers. This controller combines DSP microprocessor and thyristor technologies to provide AC induction motor starting and operation. The sturdy compact frame affords rugged, industrial grade reliability.

The SIKOSTART 3RW35 controller is a dual ramp style controller using phase control for the operation of three-phase induction motors. Each unit includes soft start and stop parameters plus fault detection. The controller can be used with an electromechanical starter or, when combined with an overload relay, the controller can be used as a solid-state starter.

The SIKOSTART 3RW35 controller is available as an open type (compact frame, no enclosure) or in a NEMA 1, 3R, 4, or 12 enclosure. The unit can be ordered as a starter with overload relays or as a combination starter with disconnecting means and circuit overload protection devices. Additional options are also available such as push buttons, pilot lights, and meters.

1.3 Applications and Potential Benefits

Typical applications for the SIKOSTART 3RW35 controller are to soft start and soft stop AC induction motor driven equipment such as fans, pumps and compressors. Applications may also include controlling machines with gearbox, belt or chain drive elements, such as: conveyors, sanders, planers, saws, packaging machines and punch presses.

Using the SIKOSTART 3RW35 controller may provide benefits to the drive system in the following ways:

1) the life of mechanical drive transmission elements is extended, e.g., gearbox jerking is substantially reduced resulting in less wear and tear;
2) reduced starting current relieves the supply network of current peaks; and
3) smoother acceleration of loads eliminates process or product damage.

2 Operating Principle

2.1 Function Overview

The SIKOSTART 3RW35 controller utilizes a voltage ramp design to produce an output voltage to the motor that increases from a customer selected initial voltage to full line supply voltage over an adjustable starting time. This "voltage ramp" produces a reduced current start (soft start) similar to a current limit start without the load dependence of the current limit type start.

In addition to the voltage ramp feature, a constant voltage mode is available which will further limit the starting current. This is obtained by using the MAX START VOLTAGE adjustment, Similarly, stopping time can be adjusted to provide a soft stop for many pumping applications.

The SIKOSTART controller employs a DSP (digital signal processor) to control the motor. This advanced type of microprocessor allows the controller to "contour" the starting and stopping ramps. This contour adjusts for the nonlinearities of an induction motor to produce a smoother and more linear motor start and stop.

2.2 Functional Description

Power Poles. As is shown in the block diagram of figure 1, the incoming main power (L1, L2, L3) is connected to the controller's three power poles which control the voltage to the motor windings. Each power pole consists of two thyristors (SCR's) in a back-to-back arrangement for each phase which allows alternating current to pass to the motor.

Snubber PCB. The snubber printed circuit board(s) contains the trigger circuit for each SCR. The firing signal for each trigger circuit is generated at the logic printed circuit board. The snubber board sensing circuits send data to the logic board for factoring into firing signal generation. The snubber board also includes an RC network for a degree of protection against false firing of the SCR's due to dv/dt and MOV's for transient protection.

Figure 1 3RW35 SIKOSTART Block Diagram Logic PCB. A power supply on the logic printed circuit board accepts control power (X1, X2) and provides power to the central processing unit (DSP), support circuitry, and cooling fan(s). The input coil terminals (A1, A2 & B1 , B2) are for commanding the motor to RUN and STOP In addition, the input coil terminals (C1, C2) are for commanding a KICK START to overcome breakaway friction.

The seven sets of numbered output terminals are for customer control devices related to Motor Running (e.g., start / stop devices), Motor Running at Full Voltage (e.g., to drive a bypass contactor), and Fault (e.g., phase loss or shorted SCR).

Setup Controls. Setup controls are connected to the logic board but are accessible from the controller's front cover. Seven potentiometers provide customer adjustments: Initial Torque 1 & 2 - initial motor start voltage; start time 1 & 2 - the rate of voltage rise (accel ramp time); Decel timer - the length time PUMP STOP power is applied during soft stop; Max start volts - the max starting voltage limit; PFC - the energy saver.

2.3 Three-phase Systems

Since the controller can be used with either wye or delta motors, a brief discussion of currents and voltages for three-phase wye and delta arrangements with balanced loads is included here as an aid to understanding controller setup procedures and to assist in proper controller selection.

Figure 2 shows the voltage waveforms for a three-phase system of three equal voltages separated by 120-degree phase angles. The voltage in phase a, or Ua, leads the voltage in phase b, or Ub, by 120°. Likewise, Ub leads Uc by 120°, and Uc leads Ua by 120°.

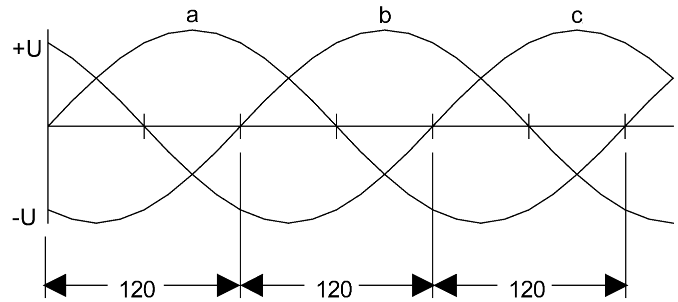


Figure 2 - Basic Three-phase Waveforms

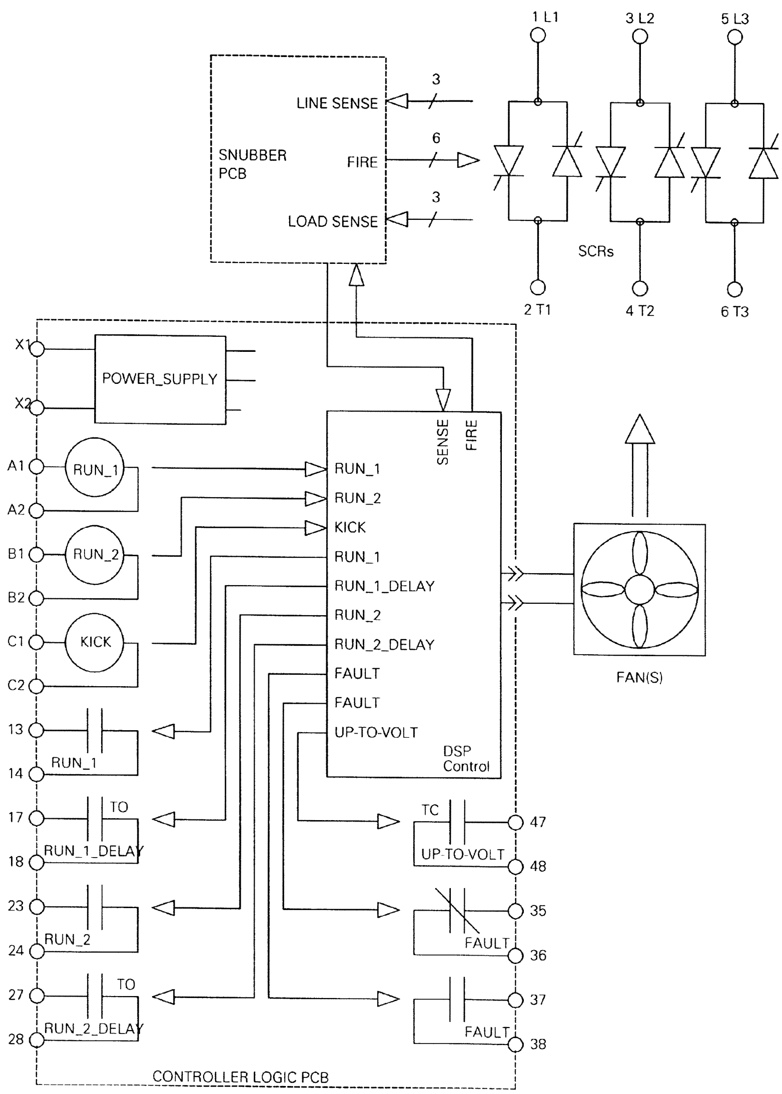
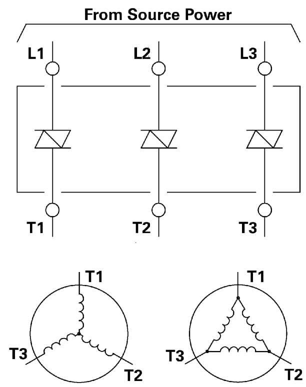


Figure 1 - SIKOSTART 3RW35 Block Diagram

2.3.1 Controller-to-Motor Connections

Wye Motor. The controller can be used for all wye motors. Connecting the controller to a wye motor inserts the thyristors directly in the line wiring, referred to as "In Line" wiring.

Delta Motor. The controller can be used for all Delta motors. The motor is hard wired as delta and the controller must be connected and sized with "In Line" wiring as shown in figure 3.



3 or 9 Lead Wye Motors and 3 Lead Delta Motors

Figure 3 - Wye and Delta Motor Connections

2.4 AC Motor Starting and Stopping

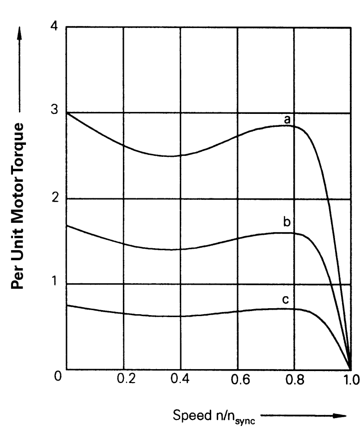
Figure 4 shows three torque/speed curves **(a, b, c)** for a typical induction motor.

a This curve shows the torque/speed relation when the motor starting voltage, U, is 100% of line voltage (Ue).

b This curve shows the relation when the controller voltage potentiometer, U (initial soft start voltage setting) is set for 75% of line voltage.

c This curve shows the relation when the controller voltage potentiometer is set for 50% of line voltage.

The curve **a** motor (without soft starting) produces a very high torque across most of the speed range, whereas, the curves **b** and **c** motors (with soft starting) produce a much lower and adjustable torque. This allows slower and smoother acceleration of the motor and its load.



Torque of the motor in the case of

a direct-on-line starting @Um (0) = 100% Ue

b starting with 3RW35 @Um (0) = 75% Ue

c startingwith 3RW35 @Um (0) = 50% Ue

Figure 4 - Typical Torque/Speed Curves for Motor at Reduced Voltages

2.4.1 Soft Start with Coast to Stop

Figure 5 shows the relationship of voltage and speed with respect to time when a soft start is used with coast to rest. The controller potentiometers have been set as follows.

U The initial voltage is set at approximately 30%.

T1 The start time setting is greater than 0.

T2 The stop time is set at 0 which allows the motor to coast to a stop.

On the voltage/time graph, the voltage starts at U when the run coil is energized and increases to 100% within the T1 time setting. The voltage immediately drops to zero when the run coil is de-energized.

The "speed/time" graph shows the motor accelerating from 0, when the run coil is energized, to operating speed. The time required to accelerate may be more or less than the T1 setting depending on the connected inertia. The motor speed coasts to zero when the motor is de-energized.

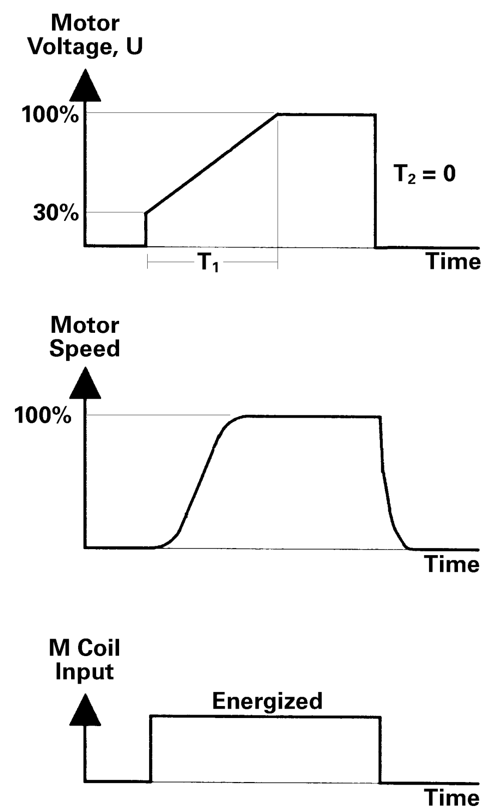


Figure 5 - Voltage, Speed, & Coil Input Curves for Soft Start with Coast to Stop.

2.4.2 Soft Start with Soft Stop

Figure 6, like Figure 5, shows the voltage and speed curves for a soft start but with controlled deceleration. The potentiometers have been set as follows.

U The initial voltage is set at approximately 30%.

T1 The start time setting is greater than 0.

T2 The stop time setting is greater than 0.

T_d The decel timer setting is greater than 0 which allows the motor to soft stop.

The motor starting ramp is similar to the one shown in Figure 5. But, when the run coil is de-energized, a motor stopping ramp is formed where the motor voltage starts at 100% and decreases to U2 (the initial start voltage) within the T2 time setting. Then the voltage drops to zero after the Td time period. The time required to decelerate may be more or less than the T1 setting depending on the connected inertia.

When the run coil is de-energized, the speed decreases throughout the T2 time period and then coasts to zero.

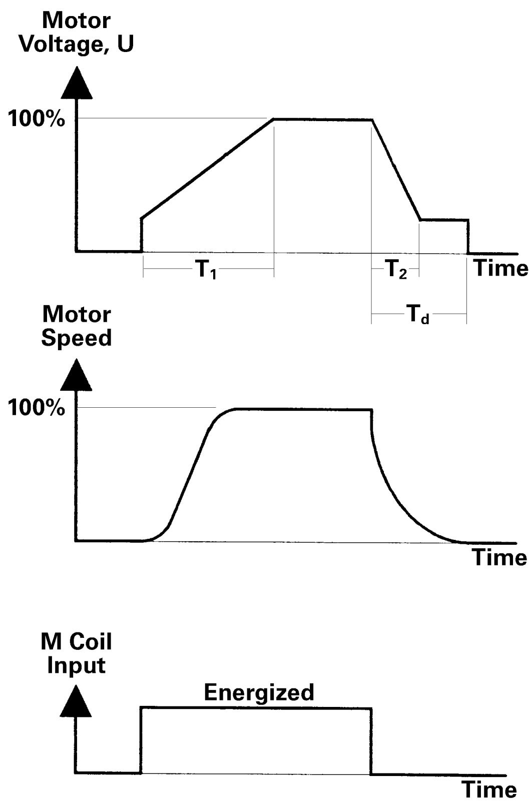


Figure 6 - Voltage, Speed, & Coil Input Curves for Soft Start with Soft Stop.

3 Controller Selection

Each controller has only one rating: "In Line."

Table 1 lists the SIKOSTART controller partial catalog numbers and ratings at various rated voltages.

Table 1 is for "In Line" wiring configurations only and shows current and horsepower ratings for units at various rated voltages.

Table 1 Controller Ratings for "In Line" Wiring Configurations

Catalog Number	In Line Wiring Amps	Horsepower at 50°C			
		200V	230V	460V	575V
3RW3552...	35	10	10	20	30
3RW3554...	57	15	20	40	50
3RW3555...	69	20	25	50	60
3RW3556...	80	25	30	60	75
3RW3558...	105	30	40	75	100
3RW3565...	131	40	50	100	125
3RW3566...	195	60	75	150	175
3RW3567...	248	75	100	200	250
3RW3572...	361	125	150	300	350
3RW3583...	480	175	200	400	500
3RW3584...	720	250	300	600	700
3RW3586...	960	350	400	800	1000

4 Installation

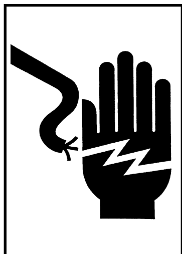
4.1 Incoming Inspection

CAUTION

Heavy equipment.
May cause injury or property damage.

To avoid personal injury or controller damage, do not use the controller cover as a handle when moving and/or positioning the unit.

1. Unpack the controller from the carton and inspect for shipping damage. Check that the items on the packing list agree with the order. File claims for loss or damage with the freight carrier immediately.
2. If the controller will not be installed immediately, it should be stored in a clean, dry area where the ambient temperature is between 0°C and 70°C. Avoid storage environments with corrosive atmospheres or high humidity.



WARNING

Voltage or fire hazard.
Can cause death, serious injury, or property damage.

To prevent electrical shock or burns, do not leave foreign objects (wire clippings, metal chips, etc.) either inside or on top of the controller during installation procedures.

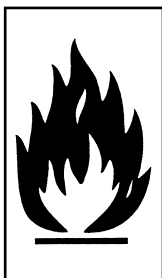
Note: Installation must be performed by qualified personnel as indicated on page 2 of this manual.

3. The carton and packing materials should be retained in case there is a future need to return the controller to the factory for service or repair. The carton and packing material are especially fitted to protect the controller from shipping damage.

If these materials are not used for shipping, claims for shipping damage may be rejected by the freight carrier.

4.2 Mounting

1. Section 8 of the manual contains controller mounting dimensions and data. Air flow through the unit is vertical, from bottom to top.



WARNING

Fire hazard.
Can cause death, serious injury, or property damage.

To prevent a fire, the controller, especially a non-fan-cooled unit, must be mounted with its fins in a vertical direction only. Side ways mounting and improper ventilating can result in fire.

2. Adequate cooling is essential for proper operation. Leave at least 6 inches of clearance above and below the unit to allow unimpeded convection or fan air flow. Wire bending allowance may require more than this recommended minimum clearance.
3. When mounting the controller in an enclosure, the enclosure must be properly sized or ventilated to provide cooling for the continuous power dissipation in the thyristors, approximately 3 watts per ampere of continuous rating. The following vent areas are required for each inlet and each outlet on customer furnished NEMA 1 enclosures, motor control centers, etc.

Vent Area	Continuous Amps	HP at 460V
not req'd	up to 57A	40 HP
20 sq. in.	up to 131A	100 HP
40 sq. in.	up to 248A	200 HP
80 sq. in.	up to 361A	300 HP
120 sq. in.	up to 960A	800 HP

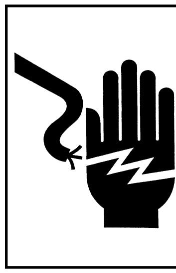
Locate front ventilation air inlet vent at least 3 inches below the bottom edge of the controller. Locate the outlet air vent area at least 6 inches above the controller top edge. Air filters impede air circulation and require a fan at inlet and/or outlet.

Some NEMA 12 enclosures use bypass contactors or heat exchange devices to maintain the integrity of the NEMA 12 rating. Establish a maintenance schedule for enclosures with heat exchangers. Equipment cleaning frequency should be based on the operating environment.

4.3 Installation Precautions

The following precautions are intended for use as guidelines for proper installation of the controller. Because of the variety of applications, all of these precautions may not pertain to your system and they are not all-inclusive. In addition to the following, refer to codes and standards applicable to your particular system.

4.3.1 Motor Branch Circuit



WARNING

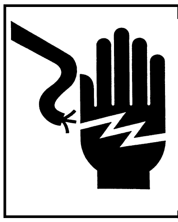
Hazardous voltage.
Can cause death, serious injury, or property damage.

To avoid electrical shock, this controller MUST be wired with branch circuit protection since the controller does not provide electrical isolation to the motor when the controller is OFF.

The National Electrical Code (NEC) and local regulations govern the installation of the SIKOSTART controller and the motor it will control. Refer to NEC Article 430 for requirements and data regarding 1) motor disconnecting means, 2) motor branch circuit short circuit and ground fault protection, and 3) motor overload regulations. Figure 8 shows the components generally required to meet the various regulations. The overload relay indicated in the figure is necessary but the standard SIKOSTART controller is not furnished with an overload relay.

The SIKOSTART controller does not utilize electronic means to protect itself from damage due to short circuits applied to the motor terminals or from the motor terminals to ground. Suitable branch circuit protection must be provided per NEC code.

4.3.2 Controller Protection



DANGER

Hazardous voltage.
Will cause death or serious injury.

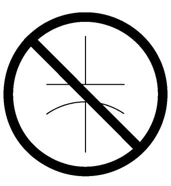
To avoid electrical shock or burn, do not touch controller output terminals when power is applied to the controller.

When planning your installation, be aware of potential hazards to personnel and to the controller that can be caused by control devices used in the system or by unique system features.

Motor Disconnect. When any motor disconnect device connected to the controller output (motor) terminals is opened during operation, the controller continues to source full voltage if running. If the disconnect device is reclosed, the motor will be restarted at full voltage. When the disconnect device is opened, a hazardous voltage is present at the controller output terminals due to thyristor and snubber leakage.

Motor Start/Stop. For normal operation, the controller is designed to start and stop the motor by using signals that are input to the controller's circuitry. Do not use the device that disconnects and reapplies line power to the controller for ordinary starting and stopping of the motor.

Asymmetric Motor Windings. Some delta motors are wound (or re-wound) asymmetrically. This can cause low available starting torque and noisy starting operation.



CAUTION

Hazardous voltage.
May cause property damage.

To avoid damaging solid-state power devices, do not connect power-factor-correcting capacitors to the load side of the controller.

Power-factor-correcting (PFC) Capacitors. Do not use PFC capacitors at the controller output terminals. Connection to the output terminals will damage the controller. If PFC capacitors are used, they must be connected on the line side of the controller.

When an isolation contactor is used with the controller, the PFC capacitors must be disconnected from the controller when the isolation contactor is open (see figure 12).

Hazardous Environment. Depending on the system environment, consideration must be given to unexpected hazards such as an accidental spray of gas, liquid or solid particles or inadvertent contact with moving machinery. Since the controller’s start/stop control circuitry includes solid-state components, a potentially hazardous environment may require the installation of an additional hard wired emergency stop circuit that will either disconnect AC input power to the SIKOSTART controller or disconnect the motor from the controller.

Multiple Motors. When the controller is used for more than one motor, be sure the combined full load current (sum of individual motor FLA’s) does not exceed the controller’s rated output current. Each motor requires separate overload relay protection.

Bypassing the Controller. When the controller is mounted in a sealed enclosure, a bypass contactor generally is used to prevent heat from being generated by the thyristors during running. If not bypassed during operation, supplemental cooling may be required depending on operating current and enclosure size and type.

4.3.3 Electrical Noise Suppression

Noise usually enters solid-state controls through power supply lines, input lines and output lines. Sources of electrical noise which can be suppressed within the power distribution system include:

1) inductive loads, such as relays, solenoids, motors, and motor starters operated by hard-contact devices, such as push buttons or selector switches,
2) AC feeders,
3) high level noise generators, such as arc furnaces, high-frequency welders, large AC machinery, etc.; consider electrostatically shielded power transformers for suppression.

The most reliable way of minimizing noise coupling is to isolate the noise generating devices and associated wiring from sensitive control wiring. Group components and wires according to signal levels and connect noise suppressors close to the noise generators. Noise suppressors are electric components which are used to filter, or minimize, the effect of indirect (capacitive or inductive) coupling.

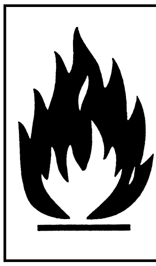
Recommended suppression practices for the noise sources listed above are:

1) For an inductive load, refer to paragraph 4.4.4.
2) On AC feeders, use RF line filters.
3) On high level noise generators, use electrostatically shielded power transformers.

4.4 General Wiring

Many startup difficulties are due to incorrect wiring. Observe the following general instructions as well as the specific instructions in later paragraphs and in system instructions.

4.4.1 Power and Motor Wiring



WARNING

Fire hazard.
Can cause death, serious injury, or property damage.

Welding cable or other wires with fine strands require special terminations and may require repeated torquing of terminals to prevent arcing and possible fire.

Power supply and motor wiring ampacity should be based on the current ratings of the motor as specified on the nameplate and in compliance with NEC and local codes. Power and motor supply wiring should be routed in its own separate conduit or wireway.

Each SIKOSTART controller is available in several power supply voltage range models. Ensure that the supply voltage and frequency are within the rated range of the controller.

When welding cable is used for power wiring, a torque check schedule should be established due to the fine strand characteristic of this cable. If the ends of the cable are not properly compressed, arcing can occur with the risk of a fire.

4.4.2 Grounding

The controller enclosure and the motor frame must be properly grounded in a manner that meets all applicable wiring codes. A ground stud at the line and motor terminals on the controller frame is provided for connecting the SIKOSTART controller to system earth ground.

A complex system must have only one ground point to common power supplies, signal returns, etc. to prevent ground loops. In most cases a large grounded metal object, such as a control cabinet, may be considered a single point. Using a short ground wire to a cabinet is better than using a long ground wire to a terminal barrier bussing point.

4.4.3 Control Wiring

The control wiring is connected at the logic board terminals shown in figure 13.

Control Voltage. Each SIKOSTART controller is available in several control voltage models. Ensure that the control voltage and frequency supplied match the controller model.

Wire Specifications. Each control terminal can accept a maximum of two 14-AWG stranded wires. Be sure ring tongue terminals are sized correctly for the wire.

Labeling. Each wire should be appropriately labeled using tape, shrink-tubing, or other dependable method.

Routing. All control wiring must be kept separate from power and motor wiring and run in its own separate conduit. Keep control wire bundles physically separated from power wiring by at least 6 inches. Where control and power wiring must cross, they should intersect at right angles.

4.4.4 Coil Suppression

Relay, electromechanical brake, or solenoid coils produce electrical noise transients (especially when being de-energized) which can be coupled into the controller circuitry and cause erratic operation. For all such devices connected to or near the controller or its wiring, see figure 7 and observe the following.

24V DC Coils. Connect a diode directly across each DC coil. A 1N4004 diode is acceptable for most 24V DC applications up to 1.0A. A varistor or surge suppressor can also be used in place of the diode.

120V AC Coils. Use an R-C circuit (0.47 mfd, 600V capacitor in series with a 1/4 watt 220 ohm resistor) across each 120V AC coil. An appropriately rated varistor or surge suppressor can be used in place of the R-C circuit, however, R-C circuits are recommended because they limit the rate of rise of noise and thus help eliminate high frequency components.

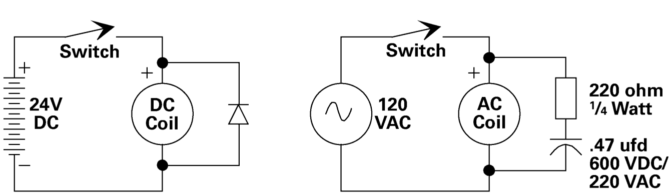
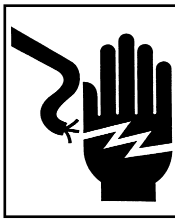


Figure 7 Inductive Load Suppression

4.5 Power and Motor Connections



⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.

To avoid electrical shock or burn, turn off main and control voltages before performing installation or maintenance.

The controller input terminals L1, L2 and L3, are at the top of the unit and the output terminals T1, T2 and T3 are at the bottom of the unit (figure 12). Observe the following:

1. Torque the power and motor terminal set screws according to the wire size as indicated in table 2. Lug kits are listed in Section 10, Spare and Optional parts, of this manual.
2. Torque the ground stud nut according to controller operational current as indicated in table 2.

⚠ CAUTION

Wrong voltage or power rating.
May cause injury or property damage.

To avoid possible injury and controller and/or motor damage, be sure that line and control voltages sources are as specified on controller label, and the motor rating corresponds to the type of wiring used.

Table 2 Terminal Screw and Ground Stud Nut Torque

Threaded Item	Torque (lb-in.)
Terminal Screw	
Wire Size (AWG or MCM)*	
6 to 4	100
3 to 2	125
1	135
1/0 to 2/0	150
3/0 to 4/0	225
250 to 400	290
500 to 600	335
Nut on Ground Stud	
Controller Operational Current	
<= 240A	75
>= 360A	110

* for 75°C Aluminum or Copper Wire

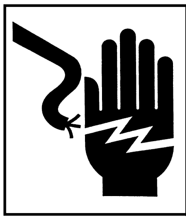
4.5.1 Power Connections

1. Connect the proper capacity 3-phase 50/60 Hz voltage source to the controller input terminals L1, L2, and L3. These terminals are not phase sensitive.

   The voltage source must be correct because:

   a. Connecting the controller to a line voltage higher than its rating will open the protective resistor in the snubber board and prevent controller operation; repair will be required before the controller can be put into operation.

   b. Connecting the controller to a line voltage lower than its rating will: 1) cause erratic controller operation resulting in damage to the motor, or 2) prevent controller operation due to the low control voltage lockout protective feature.



⚠WARNING

Hazardous voltage.
Can cause death, serious injury or property damage.

The controller case must be grounded to earth for operator's safety.

2. Connect the ground terminal (labeled with ground symbol) to earth ground.

4.5.2 Motor Connections

1. The NEC motor overload protection requirement can be met with an optional overload relay. Overload relay kits are listed in Section 10, Spare and Optional Parts, of this manual.
2. For a dual voltage 9-lead wye motor (represented in figures 8 and 9), the 3-lead controller-to-motor terminal connections are listed in Table 2.

Table 2 3-Lead Connections for Dual Voltage 9-Lead Wye Motor

High Voltage Wiring		Low Voltage Wiring	
Controller Terminal	Motor Terminal	Controller Terminal	Motor Terminal
T1	T1	T1	T1 & T7
T2	T2	T2	T2 & T8
T3	T3	T3	T3 & T9
	T4-T7*		T4-T5-T6*
	T5-T8*		
	T6-T9*		

* Jumper

3. For multispeed or reversing applications, the SIKOSTART controller can be used with an electromechanical starter to provide soft start. The controller output must be connected to the line input of the multispeed starter and either side of a reversing starter. Individual motor overload protection should be supplied for each motor speed separately. Control input (A1, A2) is typically run in parallel with the low speed/forward contactor coil and control input (B1, B2) is typically run in parallel with the HIGH speed/reverse contactor coil.
4. When using the controller with part winding motors, these motors must be connected in their full voltage run winding configuration, and the three motor leads connected to the controller output terminals.
5. The motor frame should be connected to the earth ground terminal.

4.6 Control Connections

1. Connect the control power supply (Us) as specified on the controller label to the X1 and X2 terminals; see figure 13.

⚠ CAUTION

Control voltage too high.
May cause property damage.

Connecting the controller to a control voltage higher than its rating will destroy logic board components, thus requiring repair before the controller can be put into service.

2. Connect control circuit pilot devices in accordance with the application. Section 5 provides examples of several typical arrangements.

4.7 Installation Check

1. Check that all wiring and power connections are secure and that mounting bolts are tight.
2. Remove all wire cuttings, installation particles, metal chips and debris before energizing.
3. Shut enclosure doors to protect equipment from dust and personnel from hazardous voltage.

5 Wiring Diagrams

5.1 Typical Applications

This section contains four wiring diagram sets for typical applications as follows.

Figures 8 & 9 - Two Single Speed, Non-reversing Motors, Wired In Line. in a Vented Enclosure

Figures 10 & 11 - Single Speed, Non-reversing Motor, Wired In Line, with Bypass Contactor

Each diagram set consists of two sheets: one showing the power and motor connections and one showing the control wiring.

5.2 Circuit Devices

Common Circuit Devices. Some circuit devices common to each application shown include:

- an overload relay (1OL, 2OL) for motor protection;
- either a circuit breaker (1CB) or a fused disconnect switch (1DS/1FU) to connect and disconnect main power to the application;
- a Start/Stop control that is connected so when the start switch is pushed, the RUN coil in the controller is energized, and the controller RUN interlock contact closes and latches in the RUN coil. When the stop switch is pushed or power is lost, the circuit is broken and the controller drops out which shuts off power to the motor.

Bypass Contactor. The applications shown in figures 10 and 11 includes a bypass contactor (2M). The bypass contactor is rated to handle the running current of the motor but not the starting current. The bypass contactor remains open until the controller has soft-started the motor. Once the motor is operating at line voltage, the Up-to-Voltage contact closes and the bypass contactor is energized causing motor current to flow through the bypass contactor rather than the controller.

A bypass contactor is useful when the controller is mounted in a NEMA 4, 12 or other airtight enclosure. When the motor current is routed through the bypass contactor, no current is flowing through the controller SCR's, and the controller generates no heat.

Isolation Contactor. Some applications include an isolation contactor. The isolation contactor is energized when the controller is operating (RUN coil is On) and provides power to the windings of the 6-lead delta motor. If a controller fault occurs, the fault contact opens which de-energizes the isolation contactor and the motor stops.

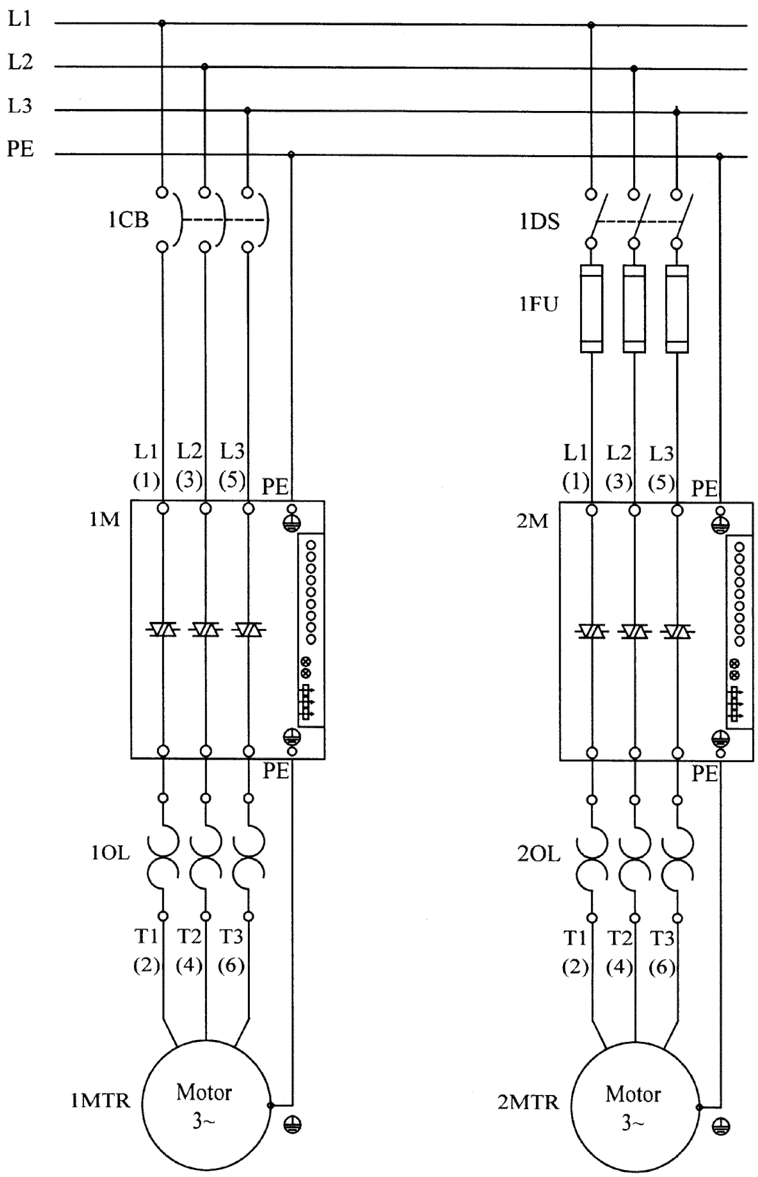


Figure 8
Power wiring for single speed, non-reversing motors in a vented enclosure (circuit breaker, left, or fusible disconnect, right).

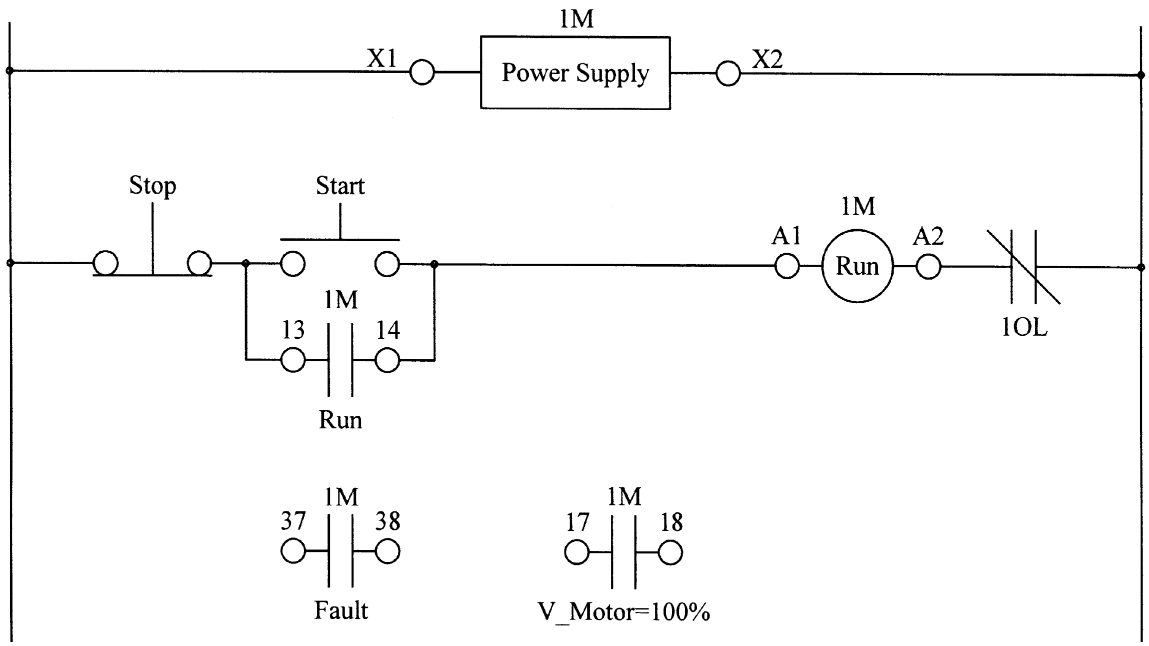


Figure 9
Typical power wiring for single speed, non-reversing motors in a vented enclosure (circuit breaker or fusible disconnect)

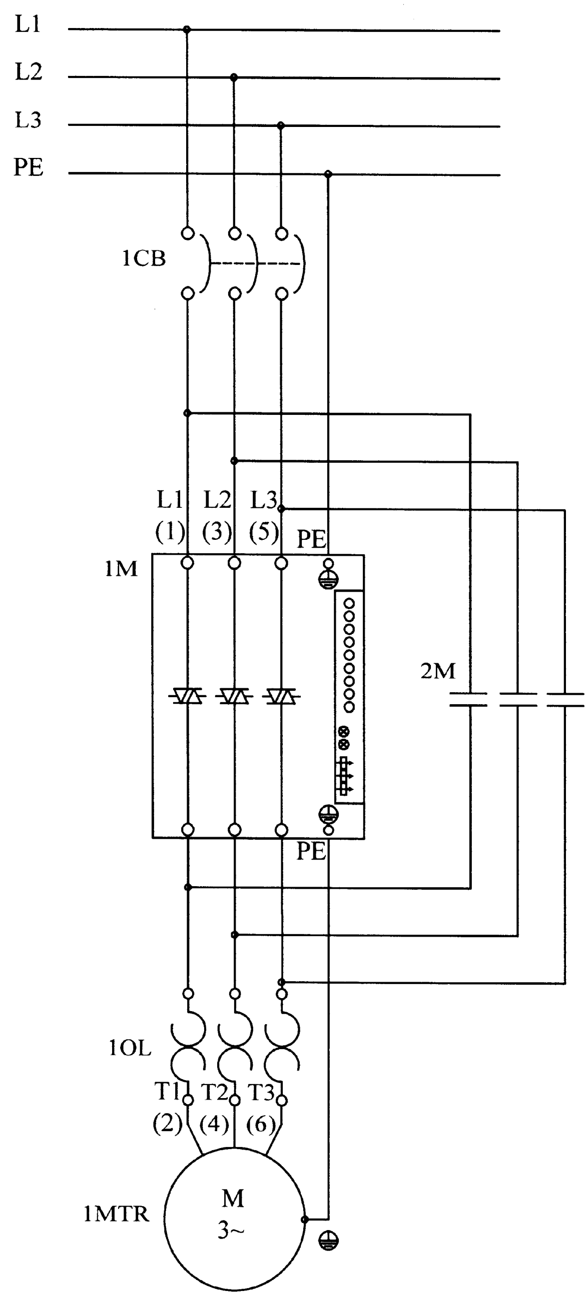


Figure 10
Typical power wiring for a single speed, non-reversing motor, wired with bypass contactor

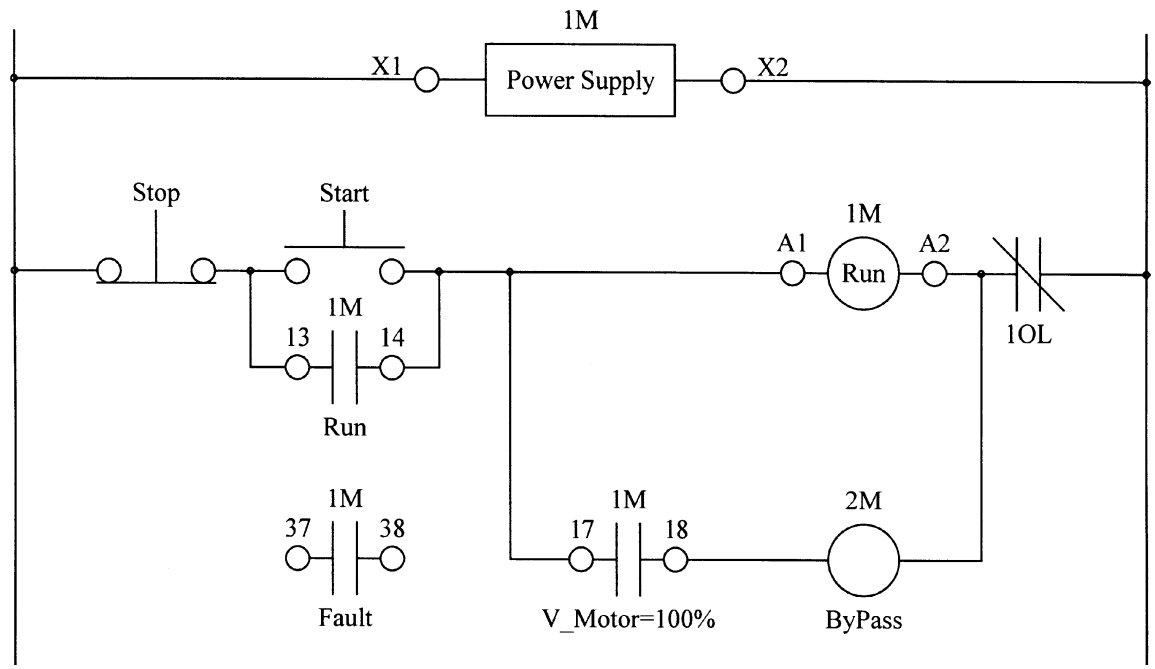


Figure 11
Power wiring for a single speed, non-reversing motor, wired with bypass contactor

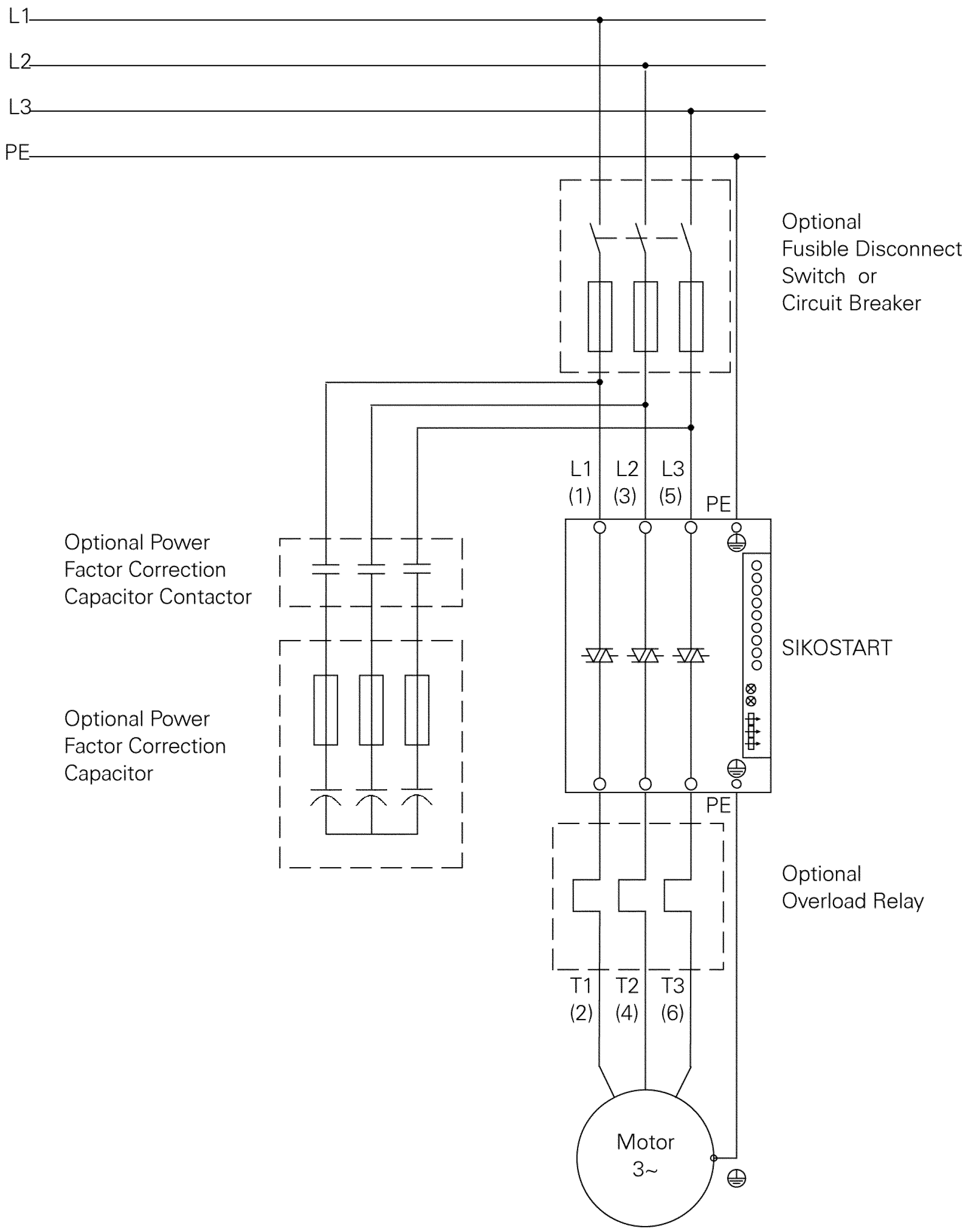
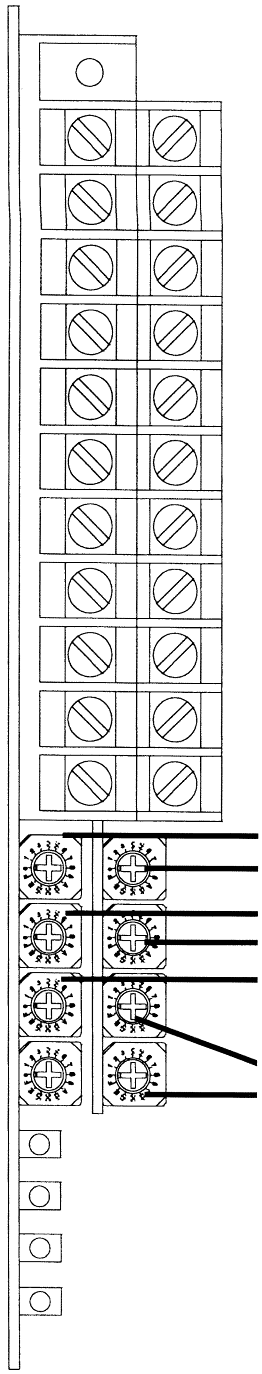


Figure 12 - SIKOSTART Controller Power and Motor Connections

FUNCTION	TERMINAL NUMBERS
Control Power	X1/X2
Run #1 Coil	A1/A2
Run #2 Coil	B1/B2
Kick Start Coil	C1/C2
Run #1 Instant Contact NO	13/14
Run #1 Delayed Contact NO	17/18
Run #2 Instant Contact NO	23/24
Run #2 Delayed Contact NO	27/28
Fault Contact NO	37/38
Fault Contact NC	35/36
Up To Voltage Contact NO	47/48
Initial Torque #1 /Initial Torque #2	
Start Time #1 /Start Time #2	
Decel Timer /Max Start Volts	
Not Used /PFC	
Power On	
On=Running Flash=Phase Loss	
Up To Voltage	
Shorted SCR	



IMPORTANT:
When the DECEL TIMER is set to a value greater than zero, ramp 2 settings become decel settings and run #2 coil is not used. With DECEL TIMER = 0 the ramp 2 settings are for a second start ramp.

Figure 13 - SIKOSTART Terminal Connections, Potentiometers, and Indicators

6 Setup and Operation

6.1 Setup Controls

⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.

To avoid electrical shock or burn, turn off main and control voltages before performing installation or maintenance.

The SIKOSTART 3RW35 has two separately adjustable ramps, each having voltage and ramp settings. If the decel timer is set to a value other than zero, the second ramp is changed to a decel ramp, utilizing the soft stop capabilities of the SIKOSTART 3RW35.

The setup controls are at the right side of the controller and are accessible without removing the cover. Figure 13 shows the eight potentiometer controls. Values of the potentiometer settings are listed in Table 4. Use a small screwdriver to change the potentiometer setting, rotating clockwise to increase and counterclockwise to decrease.

All potentiometers are 16 position digital devices.

Start Time 1 & 2 - set the start times (acceleration times) for ramps 1 & 2 for normal dual ramp operation. If the Decel Timer is set greater than zero, then ramp #2 is changed to a decel ramp.

Initial Torque 1 & 2 - set the initial voltage at a percentage of the line voltage: 30-80%. the initial setting should be the level that causes the motor shaft to turn as soon as the Run signal is given. Note, if the Decel Timer is set greater than 0, the #2 torque is changed to the decel torque at the end of the soft stop.

Decel Timer - sets the length of time that the motor is energized during a pump/soft stop. Note, if the Decel Timer is set greater than 0, the pump stop function is enabled and replaces the normal dual ramp soft start function. Ramp #1 is the start ramp and ramp #2 is the stop ramp in this case.

Max Voltage - sets the highest starting voltage during the start ramp. This produces a limited current start.

PFC - sets the energy saving feature. On lightly loaded motors, the motor voltage is reduced which saves energy. If the motor load increases, the motor voltage is increased proportionately. Note, setting PFC to F disables the function.

Table 4 Potentiometer Setting Values

Dial Setting	Initial Voltage (% Full Voltage)	Start Time (Seconds)
0	30	0.5
1	33	1.0
2	36	2.0
3	40	4.0
4	43	6.0
5	46	8.0
6	50	10
7	53	12
8	56	15
9	60	20
A	63	25
B	66	30
C	70	35
D	73	40
E	76	50
F	80	60

6.2 LED Indicators

There are four LED indicators located below the potentiometers. These LEDs indicate controller status and fault conditions as follows:

LED1 Control Power - indicates that control voltage is applied and is above the minimum required for operation.

LED2 Running - indicates that the motor is running when it is lit continuously. Flashing indicates that there is a voltage phase loss at the incoming main power source.

LED 3 Up-to-voltage - indicates that the controller has finished the starting ramp and the motor is running at full voltage.

LED 4 Shorted SCR - indicates that the controller senses a shorted SCR and that service may be required.

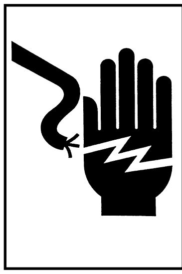
See Section 9 for troubleshooting details.

6.3 Controller Setup

Before the initial startup, set the controls as follows.

1. Set Start Time T1 and T2. This setting is application dependent, affected by load torque, motor voltage, and total inertia. Rotate potentiometer to the mid position, 8, to obtain a start time of 15 seconds.
2. Set Initial Voltage IT1 & IT2. Set potentiometer at the midrange position 8.
3. Set Stop Timer. The 0 setting allows the load to coast to rest. If the soft stop feature is required for the application, set to the 8 position.

6.4 Preliminary Checks



⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.

To avoid electrical shock or burn, turn off main and control voltages before performing installation or maintenance.

With main power disconnect device open and control power off, check the following.

1. Power and Motor Connections. Check that the controller has been properly connected to the power source and motor per figure 12.
2. Control Connections. Check that control power, the start/stop control, and applicable devices have been properly connected to the control terminal board (figure 13).
3. AC Line Power Verification. Verify that each phase of the AC line power at the disconnect device is within the rated value of the controller as indicated on the controller nameplate.
4. Ground Check. Use an ohmmeter set to its highest scale and observe the following.
   a. Check for a ground between each controller output terminal (T1, T2, T3) and chassis ground. Each terminal to ground reading should be over 500K ohms.
   b. The measurement between each input terminal (L1, L2, L3) and ground should be over 500K ohms.

6.5 Initial Energization

⚠ WARNING

Hazardous Voltage.
Can cause death, serious injury, or property damage.

To avoid electrical shock or burn, do not operate controller with either the cover or the control terminal finger guard removed.

1. Temporarily remove run signal connections by opening the circuit at control terminals A1 and A2.
2. Turn on main AC power and control power to the controller; LED 1 comes on.
3. Measure input AC voltages L1 to L2, L2 to L3, and L3 to L1. Voltages should be within the controller's rated range and balanced for proper motor operation.

   When the line voltages are not equal, unbalanced currents in the stator windings occur. A small percentage voltage unbalance results in a much larger percentage current unbalance. Consequently, the temperature rise of the motor operating at a particular load and percentage voltage unbalance is greater than for the motor operating under the same conditions with balanced voltages. For further information, refer to NEMA Standard MG 1-14.35.
4. Measure individual input AC voltages L1, L2 and L3 to ground. On most systems, voltage will be about 57% of line voltage and nearly equal. Any unbalanced voltage may indicate an undesired ground in the motor or the SIKOSTART controller.
5. Measure the control voltage. It should be within -15% to +10% of the nominal controller rating.
6. Measure voltage across each pole of the SIKOSTART controller, i.e., L1 to T1, L2 to T2, and L3 to T3.

   These voltages should be nearly equal. Low voltage, zero voltage, or unequal voltages indicate 1) the load circuit to the motor is open or improperly grounded, or 2) an SCR is shorted or bad (usually indicated by a double flashing LED 2; refer to the troubleshooting section).

   To check the load circuit, disconnect power to the controller, check and correct connections and close any load circuit switching device(s). Energize the controller and recheck voltage across each pole.
7. De-energize main AC power and control power. Unit is now ready. Reconnect actuating signal wires to terminals A1 and A2.
8. Energize main AC power and control power. Initiate start by actuating pilot device(s). Check for proper operation and desired starting performance. Verify proper motor rotation; if required, reverse rotation by interchanging motor leads. Adjust potentiometers per paragraph 6.6.

6.6 Motor Starting Adjustments

⚠WARNING

Hazardous voltage.
Can cause death, serious injury, or property damage.

To avoid electrical shock or burn, turn off main and control voltages between starts when making adjustments.

Observe the motor during the first trial starts. With the setup controls adjusted as described in paragraph 6.3 and controller LED 1 on, start the motor.

Initial Voltage U. Ideally, the motor begins to rotate almost immediately after starting voltage is applied to it and the load begins to move. If the motor fails to start rotating when the starting voltage is applied, increase the U potentiometer setting. If the motor accelerates too quickly, decrease the U setting. Repeat trial starts until the load just begins to move when power is first applied.

Additional initial voltage may be needed if motor is subject to starting load variance such as stiff belts, cold grease or process loading.

Start Time T1. During setup procedures, T1 was set to a mid range acceleration ramp time. If the controller ramp ends before the motor reaches full speed, turn run signal off and increase the T1 setting. Repeat trial starts to achieve a smooth acceleration to full speed (LED 2 changes from single blinking mode to continuously on) before the T1 time elapses.

Stop Time T2. For most applications, the motor load will coast to rest; T2 setting equals 0.

A soft stop is required for some applications, e.g., to reduce water hammer in a pumping system. For a soft stop, most applications require the stop time T2 to be equal to or longer than the start time T1. Turn run signal off before changing the T2 setting.

Record actual settings in the spaces provided for future reference.

Initial Torque #1	________
Initial Torque #2	________
Start Time #1	________
Start Time #2	________
Decel Timer	________
Maximum Start Volts	________
Not Used	________
PFC	________
(“0” is min, “F” is max)	________

7 Electrical Specifications

Main Voltage Required (± 15%)
In Line Application: 200/460V AC or 400/600V AC (specified by catalog no.)

Control Voltage Required
120V AC, +10%, -15%
Control power requirements are listed below.

AC Frequency & Phase
50/60 Hz, working 45 to 65 Hz; 3 phase

Temperature Range
0° to 50°C (32° to 122°F), inside enclosure in which unit is mounted. Derate 33% for each 10°C over 50°C to a maximum of 70°C.

Overcurrent Protection
The standard SIKOSTART controller is not equipped with overload protection. The user must provide overload protection.

Permissible Altitude
1000m at rated output
2000m at 87% output
3000m at 77% output

Ratings for Frequent Starts and Stops, Plugging or Jogging Applications
Occasional - 20 times in any **60 minute** period:
Controller rating to be 133% of motor rating.
Severe - 5 times in any **60 second** period:
Controller rating to be 200% of motor rating.
Very Severe - 10 times in any **60 second** period:
Controller rating to be 300% of motor rating.

Controller Current Ratings During Start and Run:

Current	**Cold @ 50°C**
115%	Continuous
200%	480 sec.
300%	120 sec.
450%	300 sec.
500%	20 sec.
600%	10 sec.

Adjustment Ranges - 16 Settings Each:

Start Time (Accel Ramp) ½ to 60 seconds*
Stop Time (Decel Ramp) ½ to 60 seconds
Max Starting Voltage 30% to 80% of nominal voltage (approximately 10% to 64% on normal starting torque)

*Acceleration time of the motor may be less than the Start Time setting and will vary depending on the load friction and inertia characteristics of the system.

Input (RUN) Coil

Coil Voltage	120 VAC
Isolation Voltage	1500 VAC
Input Current	10mA@120VAC
On Voltage	85 VAC max.
On Current	6 mA min.
Off Voltage	40 VAC max
Off Current	3 mA min.
Input Impedance	13k Ω

Solid State Outputs

Seven are available for the user

Rating	NO & NC contacts are rated at 1.0 Amp at 120V AC.
Run #1 & 2 Instant Contact NO	When controller is operating, the RUN contact is closed.
Run #1 & 2 Delayed Contact NO	NO contact closes immediately on RUN, but delays 100ms on dropout.
Fault NO & NC	The FAULT NO contact closes and FAULT NC contact opens for a shorted thyristor.
Up - To - Voltage	When NO contact closes, motor is running at 95% to 100% of line voltage (after starting is completed).

Electrical Data

Catalog Number	Operational Current Rating (Amperes)	Power Dissipation @ Rated Current (Watts)	Surge Capacity (1 cycle) (Amps)	I^2t, (1/2 cycle) Controller (A^2-sec)	Current Limit Dual Element Fuse Rating*
3RW3552...	35	84	2000	15,000	60A - RK1
3RW3554...	57	154	2,250	18,000	100A - RK1
3RW3555...	69	166	4,000	80,000	100A - RK1
3RW3557...	80	192	4,000	80,000	100A - RK1
3RW3558...	105	252	7,850	257,000	150A - RK1
3RW3565...	131	315	7,850	257,000	200A - RK1
3RW3566...	195	468	7,850	234,000	300A - RK1
3RW3567...	248	595	11,000	416,000	400A - RK1
3RW3572...	361	866	15,000	815,000	600A - RK1
3RW3583...	480	1152	29,000	2,600,000	800A - RK1
3RW3584...	720	1728	29,000	2,600,000	1200A - RK1
3RW3586...	960	2304	61,000	15,800,000	1600A - RK1

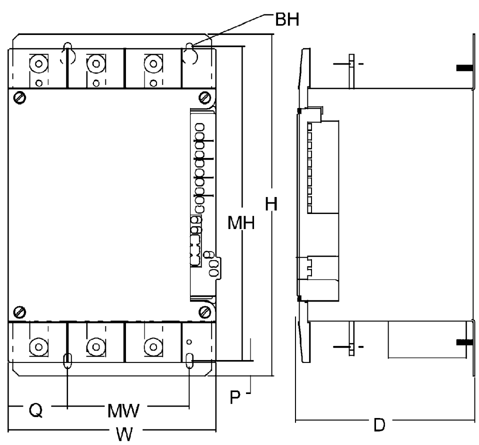
* Fuse rating should not exceed 175% of full load motor rating for class RK1 and L fuses for Type 2 protection.

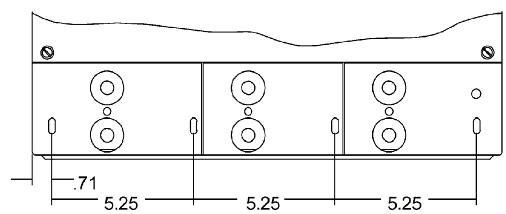
	Current Required (Milliamperes)	
Controller Current Rating (Amperes)	120V AC Control Voltage Control	Fans
35, 57	100	N/A
69, 80, 105	100	200
131, 195, 248	100	150
361	100	300
480, 720, 960	100	450

8 Dimensions

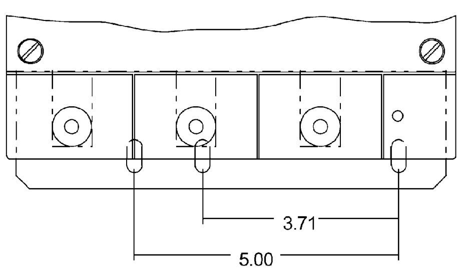
8.1 Dimensions (Inches)

Catalog Number	Ie, Wye (Amps)	Width (W)	Height (H)	Depth (D)	Mount Width (MW)	Width Offset (Q)	Mount Height (MH)	Height Offset (P)	Mount Hole (BH)
3RW355...	35-105	8.50	14.00	7.36	5.00/ 3.71	2.42	12.88	0.62	0.25 (4)
3RW356...	131-248	11.49	15.00	7.46	9.75	0.87	13.07	1.08	0.25 (4)
3RW3572...	361	13.56	16.4	8.83	11.25	1.16	13.21	1.77	0.25 (4)
3RW3584...	480, 720	17.42	20.35	9.10	5.25 (3)	0.71	17.71	1.24	0.25 (8)
3RW3586...	960	17.62	28.32	8.68	3.99/ 5.44/ 5.44	0.91	25.71	1.13	0.25 (8)

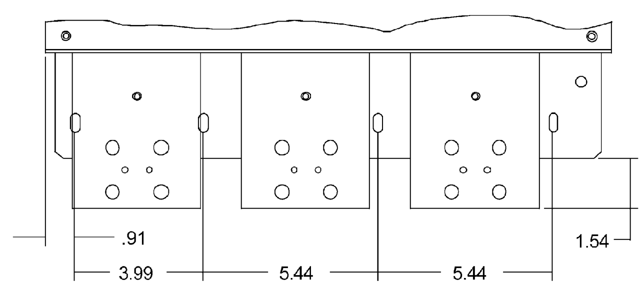




3RW3584-.. Upper & Lower Mounting Hole Locations



3RW355-



3RW3586-.. Upper & Lower Mounting Hole Locations

Figure 14 - Dimensions

9 Troubleshooting

9.1 Maintenance and Troubleshooting

⚠ WARNING

Failure to properly maintain this equipment can result in death, serious injury, property damage or product failure.

Follow the instructions listed below.

The instructions referred to below should be carefully reviewed, understood and followed regularly:

Step 1. The following NEMA standards should be used as the basis of a preventive maintenance program:

ICS 1.1-1984 (R1988) "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control"

ICS 1.3-1986 (R1991) "Preventive Maintenance of Industrial Control and Systems Equipment."

Step 2. If the torque requirements for wiring connections are not legible, refer to UL 486 "Equipment Wiring Terminals" for nominal torque values.

Step 3. In the circumstance of a fault condition as indicated by the opening of a short circuit protective device, refer to Annex A ("Maintenance of Motor Controllers After a Fault Condition") of NEMA standard ICS 2-1993 "Industrial Control and Systems, Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC pr 750 Volts DC."

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office.

Dangerous voltages are present in the equipment which can cause death, serious injury, or property damage. Always deenergize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel.

The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which can cause death, serious injury, or equipment damage. Follow all safety instructions contained herein.

9.2 Troubleshooting Tables

Two LED indicators on the SIKOSTART controller provide fault indications as listed in Table 5 which includes recommended checks and remedies. See Section 6.2 for a description of these LED's.

Table 6 is a general troubleshooting table listing troubles, their possible causes, and recommended checks and remedies.

Table 5 LED Fault Indications

Indication	Cause	Check/Remedy
LED 2 single flashing	Phase loss	Verify that proper three-phase incoming power is present per paragraph 6.5, steps 3 and 4.
LED 2 double flashing	EEPROM error	Cycle power 2 or 3 times via the main breaker to reset EEPROM. If this does not work, replace the logic board. Replacement instructions are included with the new logic boards. Return the faulty logic board to the factory.
LED 4 illuminated	Shorted SCR	Check SCR's as described in paragraph 9.3.

Table 6 Troubleshooting

Trouble	Cause	Check/Remedy
Motor does not start and LED 1 is not on.	No main power	Check input side of terminals L1, L2 and L3 for open disconnect switch, breaker trip, or insecure terminal connections. Verify that proper three-phase incoming power is present per paragraph 6.5, steps 3, 4 and 6.
	No control power	Check input side of control terminals X1 and X2 for blown fuse, any open circuit condition or insecure terminal connections. Verify that proper control voltage is present (within +10%,-15% of nominal controller rating). If the control circuit includes a con trol power transformer (CPT), verify that the CPT primary voltage is present and proper for the CPT primary tap.
Motor does not start and LED 1 is on	Motor not connected	Check that any series disconnect switch or isolating contact is closed. Check for tripped overload relay. Determine and remedy cause of trip per "Motor overload relay trips..." trouble below. Verify that the motor is connected to the controller. With proper incoming power and the motor connected but stopped, voltmeter readings across terminals T1 and T2, T2 and T3, and T3 and T1 should be zero. A reading of line voltage indicates that the motor is not connected properly.
Motor does not start, LED1 is on and LED 2 is not illuminated.	Discontinuity in the control input circuit to the Run coil	Check that control power is present at terminals A1 and A2. If power is not present, check for insecure wiring connections at terminals A1 and A2, at applicable control terminals (13, 14, etc.), and at the control devices (e.g., start-stop device, isolation contact) used in the input circuit to the Run coil.
	Bad cable connection or defective printed circuit board (PCB) component	Remove control power and check that Logic PCB-to-Snubber PCB cable is secure. If secure, remove main power and replace Logic PCB and/or snubber PCB.
	Faulty motor	Troubleshoot motor according to the manufacturer's instructions.
Motor starts but does not come up to speed	Controller not finished ramping to line voltage	Check that LED 3 is on, which indicates output voltage equals line voltage. If motor is coming up to speed too slowly, decrease Start Time T1 and/or increase Initial Voltage U; refer to paragraph 6.6.
Motor growls or hums at start but comes up to speed	Initial Voltage U is set too low	Raise setting of Initial Voltage U until motor just starts to rotate when power is first applied; refer to paragraph 6.6.
Motor growls at start and does not come up to speed.	Motor unable to start load.	Check load for mechanical blockage (rocks, logs, seized bearings, etc.). Increase motor size; for proper controller selection, refer to section 3.
	Controller not finished ramping to line voltage.	Check that LED 3 is on, which indicates output voltage equals line voltage. If motor is coming up to speed too slowly, decrease Start Time T1 and/or increase Initial Voltage U; refer to paragraph 6.6.
	Shorted SCR (LED 4 is on)	Check SCR's as described in paragraph 9.3.

Table 6 Troubleshooting - Continued

Trouble	Cause	Check/Remedy
Motor comes up to speed too quickly or slowly	Improper settings	Adjust Start Time T1 and Initial Voltage U settings per paragraph 6.6.
	Load is too light or too heavy.	Adjust load or consider decreasing or increasing motor size; for proper controller selection, refer to section 3.
Motor starts hard, not softly	Improper setup	Refer to paragraph 6.6 for motor starting adjustments.
	Shorted SCR (LED 4 is on)	Check SCR's as described in paragraph 9.3.
	Unsuitable delta motor	A certain delta motor design (wired Inside Delta) will not start softly with a high friction load (e.g., conveyor), only with a low friction load (e.g., water pump). The soft start produces balanced three-phase power to the motor, but it becomes stuck at a low rpm until the end of the start ramp at high current. It then jumps quickly to full speed due to the high voltage and current.
Controller is off but motor is running	Shorted SCR's while running	Check voltage from terminal A1 to A2 to verify that Run coil is not energized. Check SCR's as described in paragraph 9.3.
Motor overload relay trips during starting	Motor is overloaded while running	Check for a mechanical cause of overload and clear.
Motor not able to accelerate load		Check that motor comes up to speed when started by applying across-the-line full voltage directly to the motor. An alternative is to use the controller with T1 set at 0 (0.5 seconds) and U at F (80% full voltage). a. If motor can't accelerate the load, increase motor size; for proper controller selection, refer to section 3. b. If motor accelerates the load, continue checking the following causes.
	Improper overload relay heaters	Check heater table to determine correct heater size.
	Overload relay current transformers incorrectly wired.	Verify current transformer wiring per applicable diagram(s).
Motor branch circuit protection trips during starting or running	Branch circuit protective device incorrectly sized	Size the device in accordance with all applicable codes (NEC/CEC).
		Check circuit breaker trip settings.
	Incorrect power wiring causing a short on input or load side of controller	Check all power wiring connections to determine if a phase-to-phase or phase-to-ground short is present.

9.3 Shorted SCR Checks

Perform one of the following checks to identify any shorted SCR's. These checks require no disassembly of the unit. Extensive SCR tests are detailed in later paragraphs.

⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.

High voltage is present on all controller components except heat sinks, current transformers, and the basic control board. All bus bars, terminals, snubber boards and the SCR's are energized at rated voltage. Use established safety procedures to avoid injury.

9.3.1 Resistance Check

Use an ohmmeter to check for shorted SCR(s) as follows.

1. Disconnect and lock out all power to unit.
2. Measure the resistance from the line to load terminals (L1 to T1, etc.), across each phase of the controller.
3. Any reading of less than 3,000 ohms indicates a shorted SCR that must be replaced. Note that the reading can be as high as 3,000,000 ohms.

9.3.2 Voltage and Load Check

Main and control power are connected to the unit for this check. To prevent motor operation during testing, disconnect the run signal at terminals A1 and A2.

1. Measure AC voltage across each pole and check the load circuit as described in paragraph 6.5, step 5.
2. If voltage measurements indicate a shorted SCR, replace the SCR.

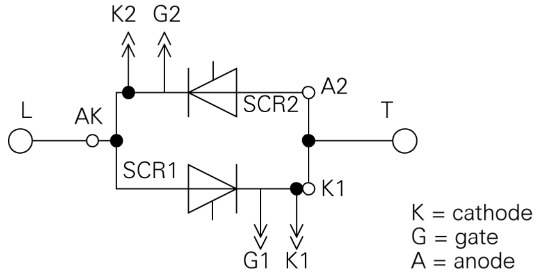
9.4 Thyristor (SCR) Functional Testing

The following basic and advanced tests may be used to verify SCR module functionality.

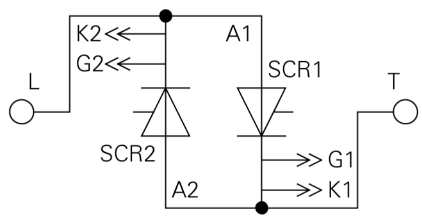
9.4.1 SCR Description

Thyristor description and illustrations are included here to help identify the terminals for the functional tests.

The power switching device is furnished as an insulated dual SCR module. The two SCR's in each module are connected in inverse parallel (back-to-back). One module, or power pole, in each line gives bidirectional control of the AC voltage. Typical connections are shown in figure 15. Each SCR has two internally connected cathode terminations, a large power cathode terminal, and a smaller auxiliary cathode terminal or wire for the control connection.



Typical Isolated Power Module



Typical Isolated Power Pole

Figure 15 - Typical Isolated Power Pole and Power Module

A forward biased SCR (anode positive, cathode negative) will turn on and conduct current if positive control voltage is applied to the gate terminal and gate current flows inside the SCR junction to the cathode. The SCR turns on and stays on at anode currents above the latching value. It remains on until anode current falls below the holding value.

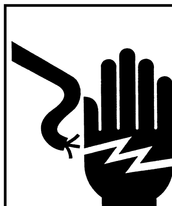
The module and SCR characteristics listed below are representative of all modules and SCR's. The value for each characteristic is a "typical" value.

Illustrations identifying terminals and connections for thyristors of various current ratings are included at the end of this section.

9.4.2 Test Equipment

The following equipment is used for the functional tests.

1. Portable DC multimeter - volts, ohms, and amperes (analog type preferred).
2. Insulation tester - 1,000 volt DC megohmmeter ("megger") battery operated amp probe AMB-4D or similar.
3. 9-volt battery NEDA 1604.
4. 100-ohm resistor, 1 watt minimum.
5. 20-ohm resistor, 5 watts minimum.
6. Battery clip and clip leads.



⚠ DANGER

Hazardous voltage.
Will cause death or serious injury.

To avoid electrical shock or burn, disconnect and lock out all power sources from controller before testing.

Ground or case internal insulation . . . . .2500V AC rating

SCR reverse blocking voltage . . . . .rating 1300V peak

SCR forward off state voltage . . . . .rating 1300V peak

Reverse leakage current and
forward off state leakage
current at room temperature
and operating voltage levels . . . . . .less than one milliamp

Gate junction typical resistance
range as measured with
typical multimeter ohms scales . . . .10 ohms to 50 ohms

Gate trigger voltage to switch on . . . . .2V DC

Gate trigger current to switch on . . . . .100 milliamps DC

Anode circuit holding and
latching currents . . . . .300 milliamps to 1 amp

9.4.3 Basic SCR Tests

Make sure all power sources are disconnected from controller and locked out before performing the following test. See figures 18 through 20.

Test 1 - Verify Gate Integrity

1. Disconnect gate circuit wires only from each gate terminal.
2. Use a multimeter to measure each SCR gate junction resistance.
3. Connect one meter lead to gate terminal ‘TG.’
4. Check gate resistance both to power cathode terminal ‘T’ and to the auxiliary cathode terminal ‘TK.’ Typical readings are 10 to 50 ohms. Open or short readings indicate a damaged or defective SCR.
5. Repeat the measurements from ‘LG’ to ‘L’ and from ‘LG’ to ‘LK.’ All SCR’s in a controller should have similar values.

Test 2 - Verify Module Ground Insulation

1. Disconnect line ‘L’ and motor load ‘T’ power connections from power terminals or thyristor module.
2. Use the megger 1,000V DC range to test between case base or heat sink and each power terminal ‘L’ and ‘T.’ A high megohm reading at 1,000V indicates 2,500V case insulation is OK.

Test 3 - Verify Off State Blocking and Reverse Blocking Voltage

1. Disconnect the module anode to cathode power terminal jumper (figures 18 - 20) to test individual SCR’s for reverse blocking and forward off state voltage.
2. Connect the megger across anode ‘A’ and cathode ‘K’ terminals of one SCR; set megger to 1,000V setting. A typical reading of greater than one megohm indicates an acceptable SCR and leakage current of less than one milliamp at 1,000V DC.
3. Reverse the meter polarity and repeat the step 2 measurement.
4. Proceed to the other SCR in the module. Make the anode and cathode meter connections and measure for both polarities.
5. A short circuit or a measurement below one megohm probably indicates a defective SCR.

9.4.4 Advanced SCR Tests

Note: Steps using the battery should be performed quickly to avoid draining the battery.

Test 1 - Check Gate Triggering

Gate triggering “on” can be demonstrated by using the 9V battery as a gate source and the megohmmeter as a high voltage low current DC power source as indicated in figure 16. Use the multimeter DC voltage range to determine the DC output voltage polarity of the megohmmeter if the megger is not marked.

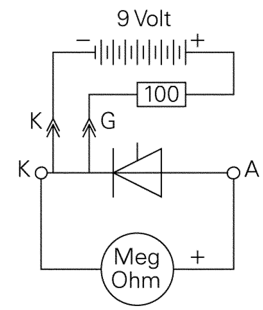


Figure 16 - Gate Triggering Test Diagram

Note: Gate and one cathode wire must be disconnected.

1. Connect megohmmeter positive lead to SCR anode ‘A’ and connect meter negative to the SCR cathode ‘K.’
2. Connect 9V battery negative to the SCR cathode ‘K.’ Connect the 100-ohm resistor to battery positive.
3. Energize the megohmmeter and note reading.
4. Touch the open end of the 100-ohm resistor to the appropriate SCR gate ‘TG’ or ‘LG.’ Megger reading should go to short.
5. Open the resistor connection to the gate. The megger reading should rise to the reading noted in step 3.
6. Repeat connections and test sequence on the other SCR in the module to verify its gating.

This test is for gating only since the megger cannot provide enough anode current to latch or hold the SCR “on.” The SCR turns off when gate current is removed.

Test 2 - SCR Latching and Holding

If latching or holding current SCR characteristics must be validated, perform the following low voltage test using resistors, battery (see note), and multimeter; see figure 17.

Note: For the largest sizes of SCR's, paralleled batteries and/or heavy duty batteries may be needed to deliver sufficient current to latch and hold.

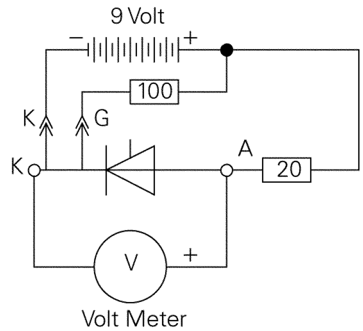


Figure 17 - Latching/Holding Test Diagram

1. Connect battery minus to SCR cathode 'K.'
2. Connect battery positive to the 100-ohm resistor; leave other resistor end open.
3. Also, connect battery positive to the 20-ohm resistor and the other resistor end to the SCR anode 'A.'
4. Select DC voltage scale on the multimeter.
5. Connect the meter positive to the SCR anode 'A' and meter negative to the cathode 'K.' Meter reading should be approximately 9V DC.
6. Touch the open 100-ohm resistor end to the appropriate SCR gate 'TG' or 'LG.' Meter reading should drop to approximately 1V DC. Open the resistor connection to the gate; meter should remain at 1V. (See note above re batteries.)
7. Disconnect all wires and meter.
8. Repeat above sequence on the second SCR in the module.

Select between figures 18 through 20 which layout works best for the situation.

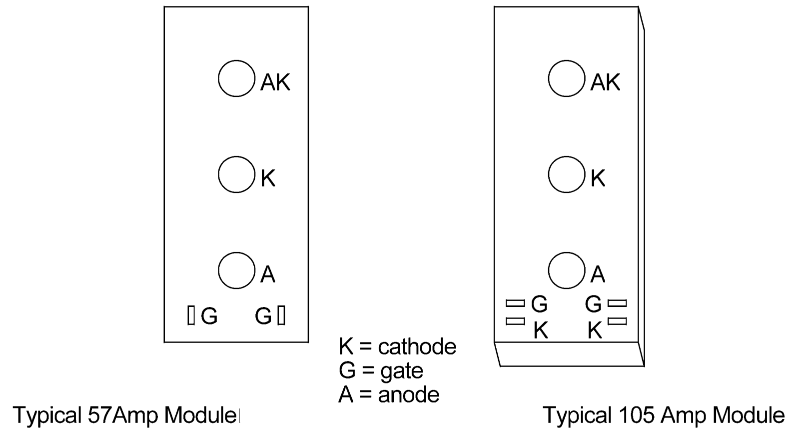


Figure 18 - for 3RW355*-..

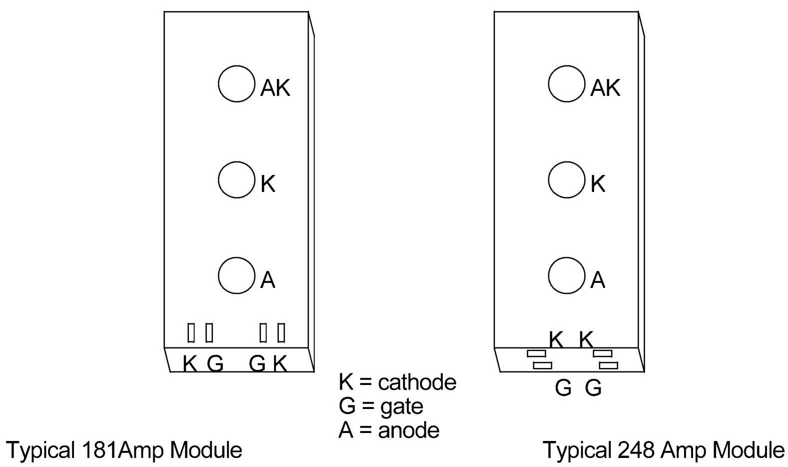


Figure 19 - for 3RW356*-..

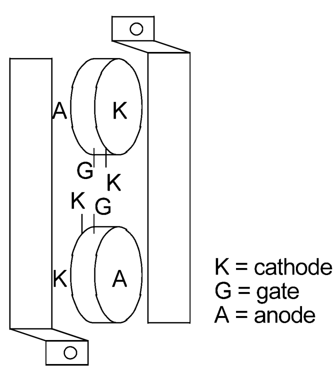


Figure 20 - Typical configurations

10 Spare and Optional Parts

10.1 Spare Parts

Table 7 lists the catalog numbers for the logic board, cooling fan(s), snubber board(s) and power modules plus the quantity required for each controller.

10.1.1 Controller Amps, Uc and Ue

Three ratings identify each controller: current (Amps - In Line or Inside Delta), control supply voltage Uc (120V AC) and main supply voltage Ue (200-400V AC, 400-575V AC). Each spare part relates to one or more of the ratings, e.g., each cooling fan corresponds to the Amps and Uc ratings regardless of the Ue ratings (Ue = All, where All means either main voltage selection),whereas, each snubber board corresponds to the Amps and Ue ratings regardless of the Uc ratings (Uc = All, where All means any of the three control power choices).

10.1.2 Fan Orientation

From one to three cooling fans are used per controller depending on the ratings. When one fan is used, it is mounted centrally along the width of the unit. When two fans are used, one is mounted to the left (L) and the other to the right (R). Left and right are defined by facing the cover of the unit, consequently, the fan on the left is the furthest from the control terminals. Similarly, when three fans are used, mounting locations are left (L), center (Ctr), and right (R).

Table 7 Spare Parts

Logic Board and Cooling Fan Catalog Numbers

Amps **In Line**	**Uc = 120V AC** **Ue = All**
Logic Board	
35 - 960	**1/Controller** 91D84060005
Cooling Fan	
35 - 57	**0/Controller** n/a
69 - 105	**2/Controller** 3RW3950-8DC38
131 - 248	**1/Controller** 3RW3960-8DC38
361	**2/Controller** 3RW3960-8DC38
480 - 720	**3/Controller** 3RW3960-8DC38
960 3RW3960-8DC38	**3/Controller** 3RW3960-8DC38

Table 7 Spare Parts - Continued

Snubber Board and Power Module (Pole) Catalog Numbers

Amps In Line	Snubber Board: Uc = All Ue = 200-400V AC	Snubber Board: Uc = All Ue = 400-575V AC	Power Module (Pole): Uc = All Ue = 200-400V AC	Power Module (Pole): Uc = All Ue = 400-575V AC
	1/Controller	**1/Controller**	**3/Controller**	**3/Controller**
35	3RW3958-7DC84	3RW3958-7DC85	3RW3954-5DC84	3RW3954-5DC85
57	3RW3958-7DC84	3RW3958-7DC85	3RW3954-5DC84	3RW3955-5DC85
69	3RW3958-7DC84	3RW3958-7DC85	3RW3955-5DC84	3RW3956-5DC85
80	3RW3958-7DC84	3RW3958-7DC85	3RW3956-5DC84	3RW3957-5DC85
105	3RW3958-7DC84	3RW3958-7DC85	3RW3958-5DC84	3RW3958-5DC85
131	3RW3967-7DC84	3RW3967-7DC85	3RW3965-5DC84	3RW3965-5DC85
195	3RW3967-7DC84	3RW3967-7DC85	3RW3966-5DC84	3RW3966-5DC85
248	3RW3967-7DC84	3RW3967-7DC85	3RW3967-5DC84	3RW3967-5DC85
	3/Controller	**3/Controller**	**3/Controller**	**3/Controller**
361	3RW3972-7DC84	3RW3972-7DC85	3RW3972-5DC84	3RW3972-5DC85
480	3RW3984-7DC84	3RW3984-7DC85	3RW3983-5DC84	3RW3983-5DC85
720	3RW3984-7DC84	3RW3984-7DC85	3RW3984-5DC84	3RW3984-5DC85
960	3RW3986-7DC84	3RW3986-7DC85	3RW3986-5DC84	3RW3986-5DC85

10.2 Optional Parts

10.2.1 Lug Kits

Table 7 lists lug kits for use with the SIKOSTART 3RW35 controllers. Each kit provides a method of adapting a controller for use with aluminum or copper power wiring. One kit contains lugs for either the line or load side of the controller. Two kits are required to add lugs to both line and load terminals.

Figure 21 shows a lug in position for mounting to the terminal. The table 7 Lug Hardware Torque column indicates the torque required for the screw that secures the lug to the controller terminal. The Wire Size Range column lists the wire sizes that the lug can accommodate. Table 2 in this manual indicates the torque required for the set screw that secures the wire in the lug.

Complete installation instructions are furnished with each lug kit.

Note:
Mount lug under terminal as shown.

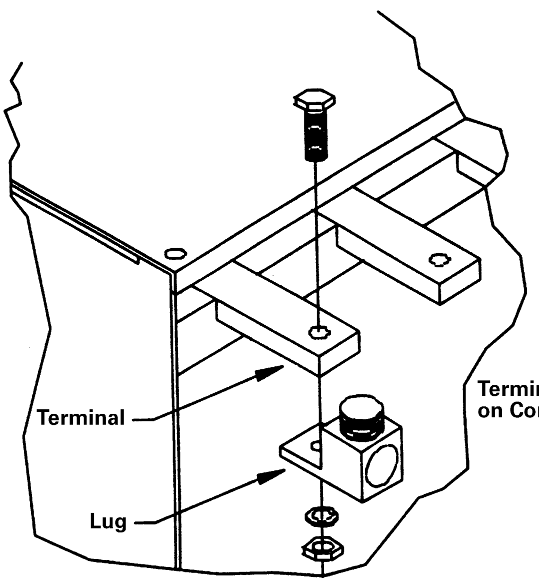


Figure 21 - Mounting Lug on Terminal Point

Table 8 Lug Kits

Wye Operational Current Rating	Lug Kit Part Number	Lug Hardware Torque (lb-in.)	Wire Size Range
35, 57, 69, 80 & 105	91D81755011	75	2/0 to # 14 AWG
131 & 195	91D81755012	275	350 MCM to #6 AWG
248	91D81755013	275	(1) 600 MCM to #6 AWG or (2) 250 MCM to #1/0
361	91D81755016	275	(2) 350 MCM to #4 AWG
480 - 720	91D81755014	275	(3) 350 MCM to #6 AWG
960	91D81755015	275	(4) 350 MCM to #6 AWG

Siemens Energy & Automation, Inc.
1000 McKee Street
Batavia, IL 60510
Tel: 630/879-6000
Tel: 800/323-5450
http://www.siemens.com/controlsusa

Publication No. SFIS-4503A-0600
Subject to change without prior notice
Printed in the U.S.A.