sprecher+schuh

PN Softstarter Intelligent Controller Installation Manual for 24A, 35A, 54A, 97A and 135A Controllers

Manual's Purpose

This manual describes the installation, set-up, operation and use of the PN Controller. Basic installation and troubleshooting instructions apply to all of the PN Controllers. The wiring and set-up procedures are only for the PN Controller without options. Wiring and set-up procedures for the PN Controller with options can be found in the following publications:

- Soft Stop Option
- Pump Control Option
- Preset Slow Speed
- Intelli-Brake
- Intelli-Stop
- Slow Speed with Braking

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Renewal Parts 23

Important User Information

Manual's Purpose

This manual describes the installation, set-up, operation, and use of the PN Controller (hereafter referred to as "controller"). Simple troubleshooting is also included. A knowledge of electrical procedures and terminology is needed when using this manual.

NOTE: This manual provides information only for the 24A, 35A, 54A, 97A and 135A controllers. For information concerning the 180A-360A controllers refer to Publication Tech-PN180-360. For information concerning the 500A-1000A controllers refer to Publication No: Tech-PN500-1000.

Precautionary Notes

Paragraphs headed **NOTE** point out specific areas of concern that are critical to your understanding or use of the product.

WARNINGS tell you where people may be hurt if procedures are not followed properly.

CAUTIONS tell you where machinery may be damaged or economic loss can occur if procedures are not followed properly.

Specifications

Controller

Input Voltage - Power Module	200-480 VAC, 3-phase, +10%, -15% 200-600 VAC, 3-phase, +10%, -15%
Control Voltage - Control Module	100-240 VAC, 1-phase, +10%, -15%
Input Frequency - Control and Power	50 and 60 Hz
Repetitive Peak Inverse Voltage Rating	1400V (line voltage 200-480V) 1600V (line voltage 200-600V)
Thermal Capacity	Full Voltage Starting - 600%, 10 seconds Heavy Duty - 450%, 30 seconds Standard Duty - 300%, 30 seconds
Operating Temperature	0˚C to +50˚C
Storage Temperature	-40˚C to +85˚C
Relative Humidity	5 - 95% (non-condensing)
Shock	30G shock peak acceleration for 11 ms
Vibration	2.5G vibration for 60 minutes
Altitude	2000 meters without derating
Noise and RF Immunity	Surge transient 3KV peak, 1500V showering arc
Auxiliary Contact Rating	N.O.-470 VA sealed, 4700 VA inrush, 240 V max., 24 V min. N.C.-275 VA sealed, 2750 VA inrush, 240V max., 24V min.
Diagnostics	Start Fault, Stalled Motor, Temperature Fault, Line Fault
DV/DT Protection	RC Snubber Network
Transient Protection (optional)	Metal Oxide Varistors, 220 joules

Standard Adjustments

Soft Start	2 to 30 seconds
Initial Torque	5 to 90% locked rotor torque
Kickstart	500% current for 0.4 to 2 seconds
Current Limit	50 to 500% full load amperes

Options

Soft Stop	2 to 60 seconds
Preset Slow Speed	Forward: 7% (LOW) or 15% (HIGH) speed Reverse: 10% (LOW) or 20% (HIGH) speed Slow Speed Current adjustment (50 to 450% of full load current)
Pump Control	Starting: 2 to 30 seconds Stopping: 2 to 120 seconds
PN Intelli-Brake Braking	Braking Current 150 to 400% full load amperes
Intelli-Stop	Slow Speed: 7% (LOW) and 15% (HIGH) Slow Speed Current adjustment (50 to 450% full load current) Braking Current (150 to 400% full load current)
Slow Speed with Braking	Slow Speed: 7% (LOW) and 15% (HIGH) Slow Speed Current adjustment (50 to 450% of full load current) Braking Current (150 to 400% full load current) Slow Speed Acceleration Current Adjustment (50 to 400% of full load current)

Installation and Wiring

Inspection

Before installing the controller, make a complete visual check of the controller for damage in shipment or handling. Claims for damaged or missing parts must be made to the carrier as soon as possible after receipt of shipment.

Enclosures

The open-style controller can be installed in an enclosure. **The internal temperature of the enclosures must be kept within the range of 0˚C to 50˚C.**

Ventilated Enclosures

For NEMA Type 1 enclosures, the following guidelines are recommended in order to limit the maximum controller ambient temperature.

There should be a clearance of at least six inches above and below the controller. This area allows air to flow through the heatsink. Ventilation openings are required above and below this air space.

An outlet should be placed at least six inches above the controller. The inlet should be placed near the bottom of the enclosure. It should be capable of accepting a fan rated 110 CFM or greater. A filter is required to prevent contaminants from entering the enclosure.

The minimum vent area should be 10 square inches. For the 97 and 135 amp controller, the minimum vent area should be 36 square inches. Deductions must be made for the grill work or ventilation pattern.

CAUTION: When thermal overload relays are installed in the same enclosure, a barrier should be provided around the relay. However, this should not inhibit air flow on forced air cooled units (97 and 135A).

The following table shows the maximum heat dissipation at rated current for the controllers. For currents lower than rated value, heat dissipation will be lower.

Figure 2.1 - Maximum Heat Dissipation

Controller Current Size	24A	35A	54A	97A	135A
Maximum Watts	110	150	200	285	410

Non-Ventilated Enclosures

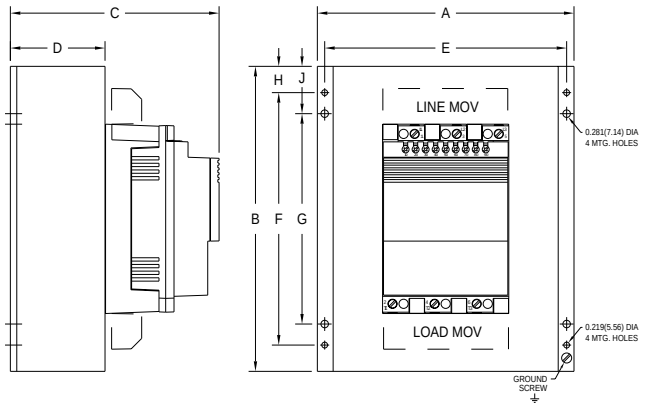
For NEMA Type 12 or non-ventilated enclosures, it is recommended that a by-pass contactor be used. This will allow the controller to start the motor. Once up to full voltage, the controller would be by passed. Note that the energy saver and protective features of the controller would no longer be available. See Page 8, Figure 2.10 for this configuration.

Mounting

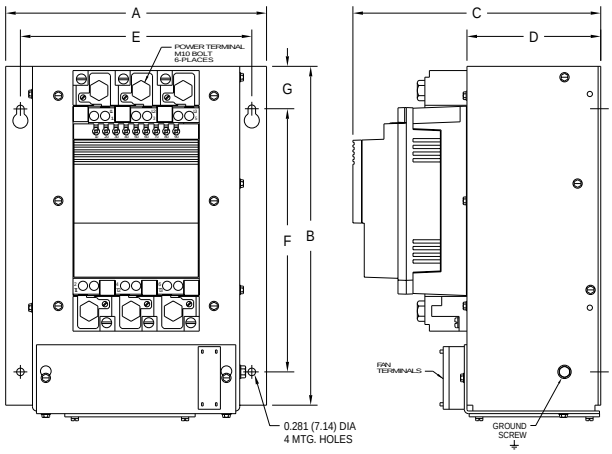
The controller is convection cooled except for the 97A and 135A fan cooled unit. It is important to locate the controller in a position which allows free air flow vertically through the power module. **The controller must be mounted with heatsink fins in a vertical plane and have a minimum of 6 inches free space above and below the controller.** See Figure 2.2.

Figure 2.2 - Dimension Drawings

24, 35 and 54 Amp Controller



97 and 135 Amp Controller



	Unit	A width	B height	C depth	D	E	F	G	H	J	Approximate Ship Weight
24A	mm	154	180	159	50	140	160	140	10	20	4.5 kg
Controller	inch	6-1/16	7-3/32	6-17/64	1-31/32	5-33/64	6-5/16	5-33/64	13/32	51/64	10 lbs
35A	mm	214	240	169	60	200	200	180	20	30	6.8 kg
Controller	inch	8-7/16	9-29/64	6-21/32	2-23/64	7-7/8	7-7/8	7-3/32	51/64	1-3/16	15 lbs
54A	mm	244	290	199	90	230	240	200	25	45	11.3 kg
Controller	inch	9-39/64	11-27/64	7-27/32	3-35/64	9-1/64	9-29/64	7-7/8	63/64	1-25/32	25 lbs
97A and 135A	mm	248	336	230	128	220	250	40	-	-	10.4 kg (97A), 11.8 kg (135A)
Controllers	inch	9-49/64	13-15/64	9-1/16	5-3/64	8-21/32	9-27/32	1-39/64	-	-	23 lbs (97A), 26 lbs (135A)

All dimensions are approximate and are not to be used for construction purposes. Refer to nearest Sales Office or Customer Service in Houston, Texas, for complete dimension drawings.

Wiring

The controller wiring terminal locations are shown in Figure 2.3. Make wiring connections as indicated in the typical connection diagrams shown in Figures 2.7 through 2.15. Connect the line to terminals L1/1, L2/3 and L3/5. Connect the load to terminals T1/2, T2/4 and T3/6. A provision is available for grounding the isolated heatsink per applicable codes.

Figure 2.3 - Wiring Terminal Locations

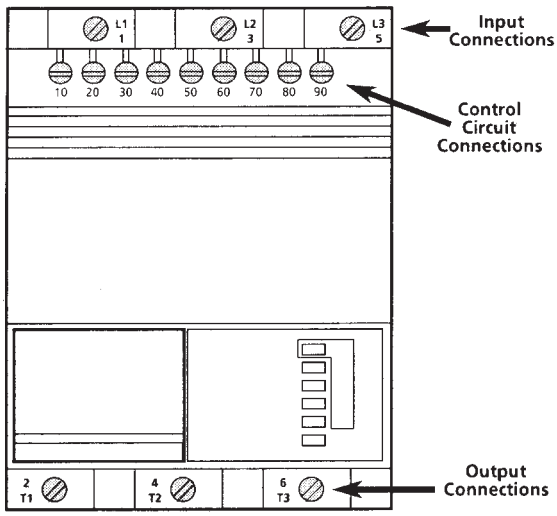


Figure 2.4 - Power Wiring and Power Lug Connections

Controller	Wire Size	
	Metric	AWG
24A-54A	2.5-25mm^2	#14-#4
97A-135A	16-120mm^2	#6-4/0

Tightening Torque				
Wire Size	2.5-6mm^2	10mm^2	16-25mm^2	16-120mm^2
	14-10 AWG	8 AWG	6-4 AWG	6-4/0
Torque	2.80 N-m	3.4 N-m	3.95 N-m	31 N-m
	25 lb-in	30 lb-in	35 lb-in	275 lb-in

Control Power

Control voltage: 100-240 VAC, (+10%/-15%), 1-phase, 50/60 Hz. Connect control power to the controller at terminals 10 and 60. The control power requirement is 30VA. In addition, 45VA capacity is required to operate the heatsink fan on the 97A and 135A controller. Additional control circuit transformer VA capacity may be required depending on the specific application. Use the following figure as a guide for control wiring:

Figure 2.5 - Control Wiring and Tightening Torque

	Wire Size	Torque
Metric	1.5-4mm^2	3.95 N-m
AWG	#14-#12	35 lb-in

The wiring of the control circuit depends on the specific application. Typical connections for a number of typical applications are shown in Figures 2.7 through 2.12.

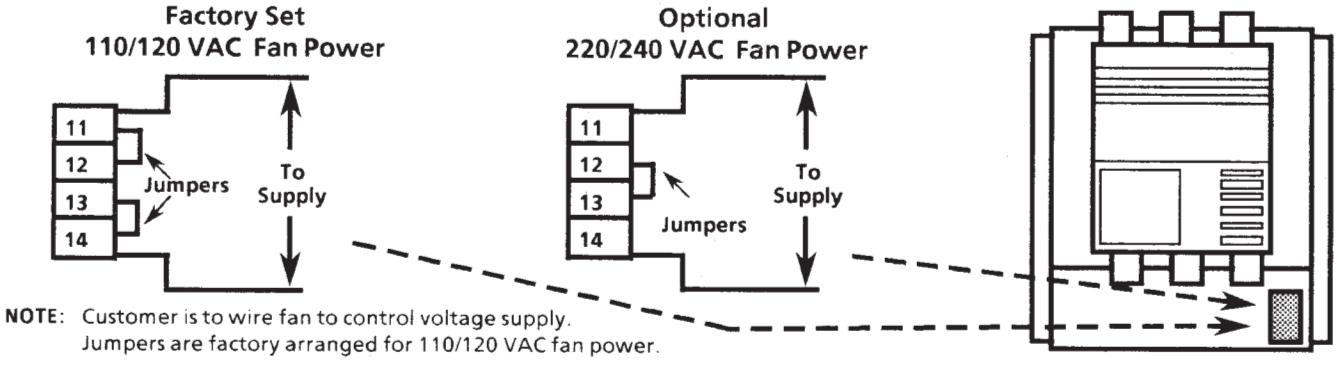
Fan Power

The 97A and 135A controllers have a heatsink fan which requires an additional 45VA capacity. To gain access to the fan connection, see Figures 2.6.

CAUTION: The fan jumpers have been factory installed for 240VAC input. Refer to Figure 2.6 for optional 120VAC fan wiring. After control wiring is complete, replace control terminal strip cover.

NOTE: Jumpers have been factory installed for 240VAC input.

Figure 2.6 - Location of Fan Wiring and Jumpers for 97A and 135A Controller



Typical Connection

Figure 2.7 shows a typical connection for standard control module. See page 13 for a description of the start sequence.

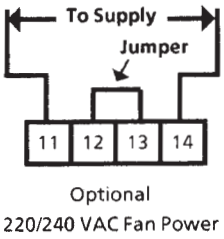
Figure 2.7 - Typical Connection Diagram for Standard Unit

NOTE: For two wire control, remove stop/start pushbuttons and connect two wire device between terminals 10 and 40.

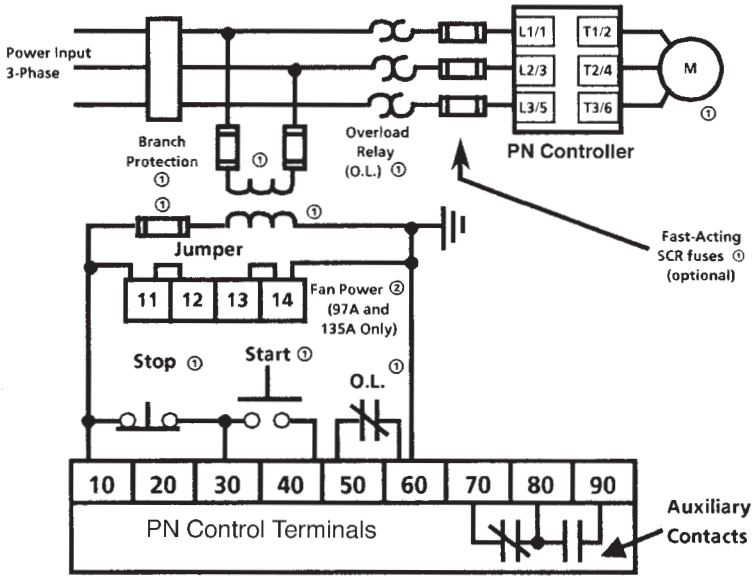
① Customer Supplied

② Customer wires fan to control voltage supply. Jumpers are arranged for 110/120 VAC fan power.

③ Disconnect main power before servicing motor controller or associated wiring. Hazardous voltages are present in the motor circuit even when the solid-state controller is off.



Optional
220/240 VAC Fan Power



Typical Connection with Isolation Contactor

Figure 2.8 shows a typical connection of standard unit for use with an isolation contactor. Starting and stopping of the motor is controlled by the controller. The controller also controls the electromechanical contactor. The contactor provides isolation between the motor and the power lines when the controller is "OFF."

WARNING: When not using an isolation contactor, hazardous voltages are present at the load terminals of the controller when the controller is turned off. Warning labels must be attached to the motor terminal box, the controller enclosure and the control station. Additional circuitry must be included to provide automatic isolation.

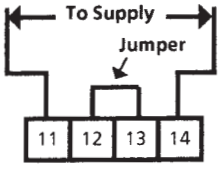
Figure 2.8 - Typical Connection Diagram of Standard Unit with Isolation Contactor

NOTE: For two wire control, remove stop/start pushbuttons and connect two wire device between terminals 10 and 40.

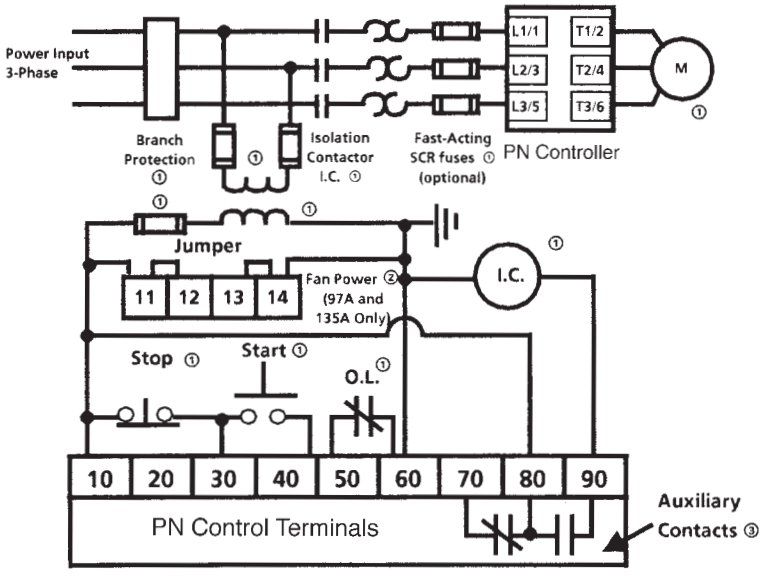
① Customer Supplied

② Customer wires fan to control voltage supply. Jumpers are arranged for 110/120 VAC fan power.

③ Set auxiliary contacts for normal setting.



Optional
220/240 VAC Fan Power



Typical Connection for Retrofit Application

Figure 2.9 shows a typical connection diagram for use in a retrofit application. In this scheme, the controller provides control of the load when the electromechanical starter is energized. This method of controlling the load can be used in applications where the existing control scheme is to remain intact.

Starting and stopping of the motor is controlled by the controller. The controller also controls the electromechanical contactor. The contactor provides isolation between the motor and the power lines when the controller is "OFF."

If a fault occurs, the N.O. auxiliary contact opens and drops out the "M" contactor, thus providing isolation from line potential. In this scheme, the auxiliary contact selection DIP switch must be set for normal auxiliary contact operations.

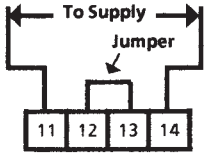
Figure 2.9 - Typical Connection Diagram for Retrofit Applications of Standard Unit

NOTE: For two wire control, remove stop/start pushbuttons and connect two wire device between terminals 10 and 40.

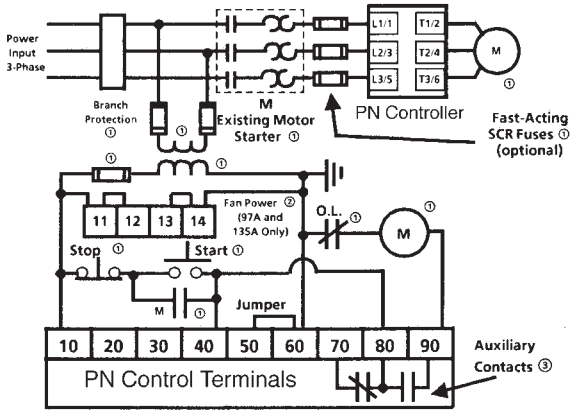
① Customer Supplied

② Customer wires fan to control voltage supply. Jumpers are arranged for 110/120 VAC fan power.

③ Set auxiliary contacts for normal setting.



Optional
220/240 VAC Fan Power



By-Pass Mode

By using the controller as shown in Figure 2.10, a soft start characteristic can be provided. Once the motor has reached full speed, the auxiliary contact on the controller energizes the by-pass contactor.

NOTE: The controller is by-passed in this circuit. Controller features are not available once the by-pass contactor is energized. Also, auxiliary contacts must be set for up to speed operation.

Figure 2.10 - Typical Application Diagram of a By-Pass Contactor with Standard Unit

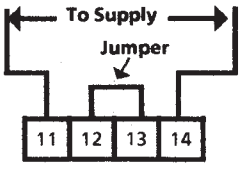
NOTE: For two wire control, replace stop button with 2-wire device and hard wire terminals 10 and 40.

① Customer Supplied

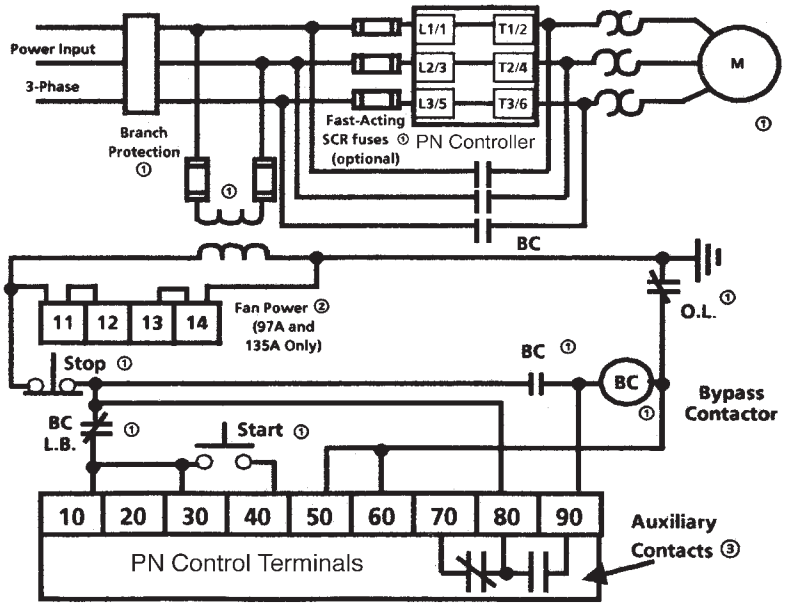
② Customer wires fan to control voltage supply. Jumpers are arranged for 110/120 VAC fan power.

③ Set auxiliary contacts for up-to-speed setting.

④ Disconnect main power before servicing motor controller or associated wiring. Hazardous voltages are present in the motor circuit even when the solid-state controller is off.



Optional 220 /240 VAC Fan Power

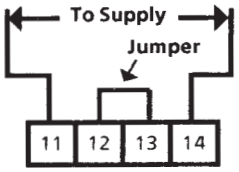


Typical Connection with Shunt Trip Circuit Breaker

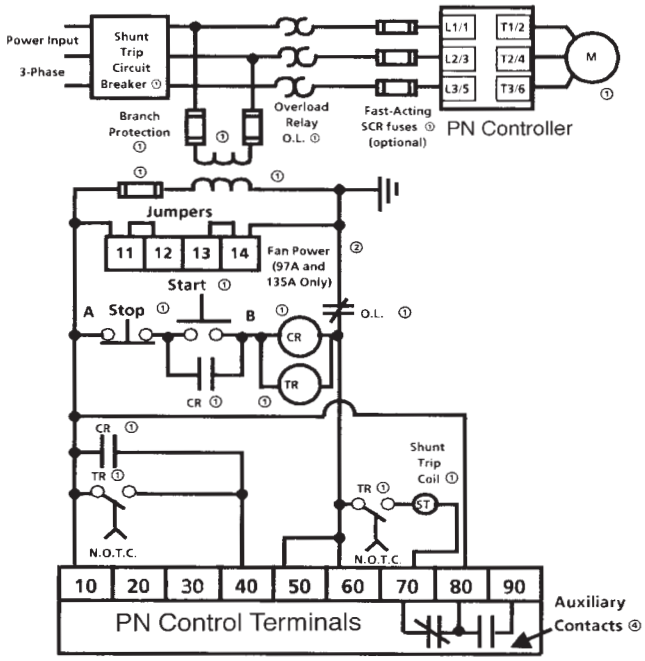
Figure 2.11 shows a typical connection diagram for use with a shunt trip circuit breaker. In this scheme, the electromechanical contactor is eliminated. The shunt trip circuit breaker provides automatic isolation from the main power lines during abnormal conditions and can also be used to provide a manual isolation from the main power lines.

Figure 2.11 - Typical Connection Diagram with Shunt Trip Circuit Breaker

① Customer Supplied
② Customer wires fan to control voltage supply. Jumpers are arranged for 110/120 VAC fan power.
③ For two wire control, remove stop/start pushbuttons and connect two wire device between points A and B.
④ Set auxiliary contacts for normal setting.
⑤ Disconnect main power before servicing motor controller or associated wiring. Hazardous voltages are present in the motor circuit even when the solid-state controller is off.



Optional
220/240 VAC Fan Power

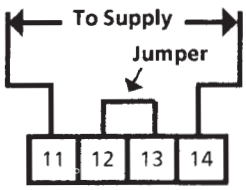


Programmable Controller and Sensor Interface

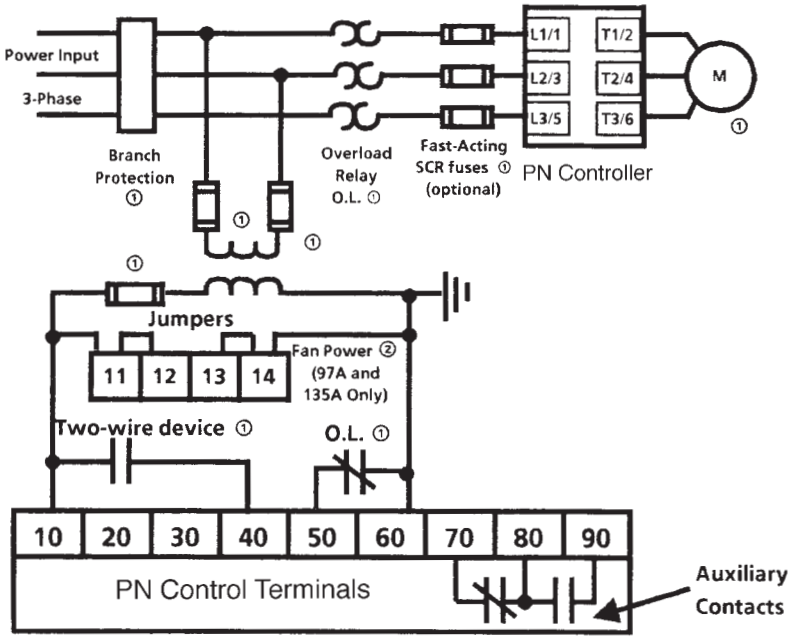
When using solid state devices to operate the PN Controller the voltage and frequency range will be 100-240V, 50/60 Hz. The OFF state leakage current from the solid state device must be less than 6mA. The nominal input current is 25mA at 120VAC and 50mA at 240VAC.

Figure 2.12 - Typical Connection with 2-Wire Control Scheme

NOTE:
① Customer Supplied
② Customer wires fan to control voltage supply. Jumpers are arranged for 110/120 VAC fan power.
③ Disconnect main power before servicing motor controller or associated wiring. Hazardous voltages are present in the motor circuit even when the solid-state controller is off.



Optional
220/240 VAC Fan Power



Power Factor Capacitors

The controller can be installed on a system with power factor correction capacitors. The capacitors must be located on the line side of the controller. This must be done to prevent damage to the SCRs in the controller.

When discharged, a capacitor has essentially zero impedance. For switching, sufficient impedance should be connected in series with the capacitor bank to limit the inrush current. A method of limiting the surge current is to add inductance in the capacitance conductors. This can be accomplished by putting turns or coils in the power connections to the capacitors.

480-600V - 6 inch diameter coil, 8 loops
250V - 6 inch diameter coil, 6 loops

Care should be used in mounting the coils so that they are not stacked directly on top of each other or they will have a canceling effect. Also, the coils should be mounted on insulated supports away from metal parts so they will not act like induction heaters. If an isolation contactor is used, put capacitors in front of contactor.

Fast Acting Current-Limiting Fuses

Fast acting current-limiting fuses are coordinated with the SCRs for protection of the SCRs in the event of short circuits in the load. Refer to Figure 2.13 for recommended fuses.

Figure 2.13 - Fast Acting Current-Limiting Fuses

Fuse Manufacturer	PN Controller Rating				
	24A	35A	54A	97A	135A
Shawmut	A70P60	A70P100	A70P200	A70P300	A70P300
Buss	SPP-4F60	SPP-4F100	SPP-4F150	SPP-4F300	SPP-4F300
Brush	XL70F080	XL70F125	XL70F200	XL70F300	XL70F300

NOTES: 1. Fuse numbers are manufacturer's catalog number.
2. Fuse size listed is for 230V, 460V, or 575V.

CAUTION: The fast acting current-limiting fuses specified in the above table do not provide branch circuit protection. Branch circuit protection in accordance with applicable electrical codes is required even though fast acting current-limiting fuses are used.

Motor Overload Protection

Thermal motor overload protection is not provided unless specified with non-combination controller. It can be separately provided. The overload trip time should be greater than the acceleration time to avoid nuisance tripping.

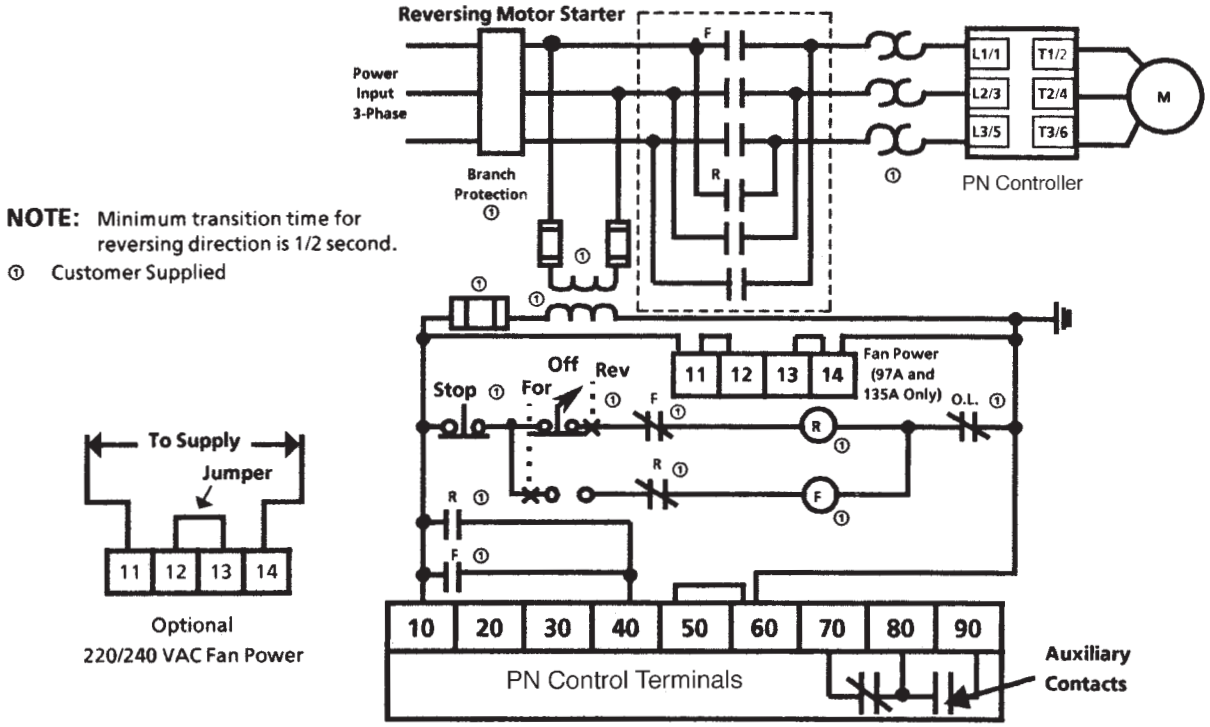
CAUTION: Overload relays should be properly coordinated with the motor.

Protective Module (optional)

A protective module containing metal oxide varistors (MOVs) and capacitors can be installed to protect the power components from electrical transients and/or high electrical noise. The protective modules clip transients generated on the lines and prevent such surges from damaging the SCRs. The capacitors in the protective modules are used to shunt noise energy away from the controller electronics.

WARNING: When installing or inspecting the protective module, make sure the controller has been disconnected from the power source. The protective module must be checked periodically for damage or discoloration. Replace if necessary.

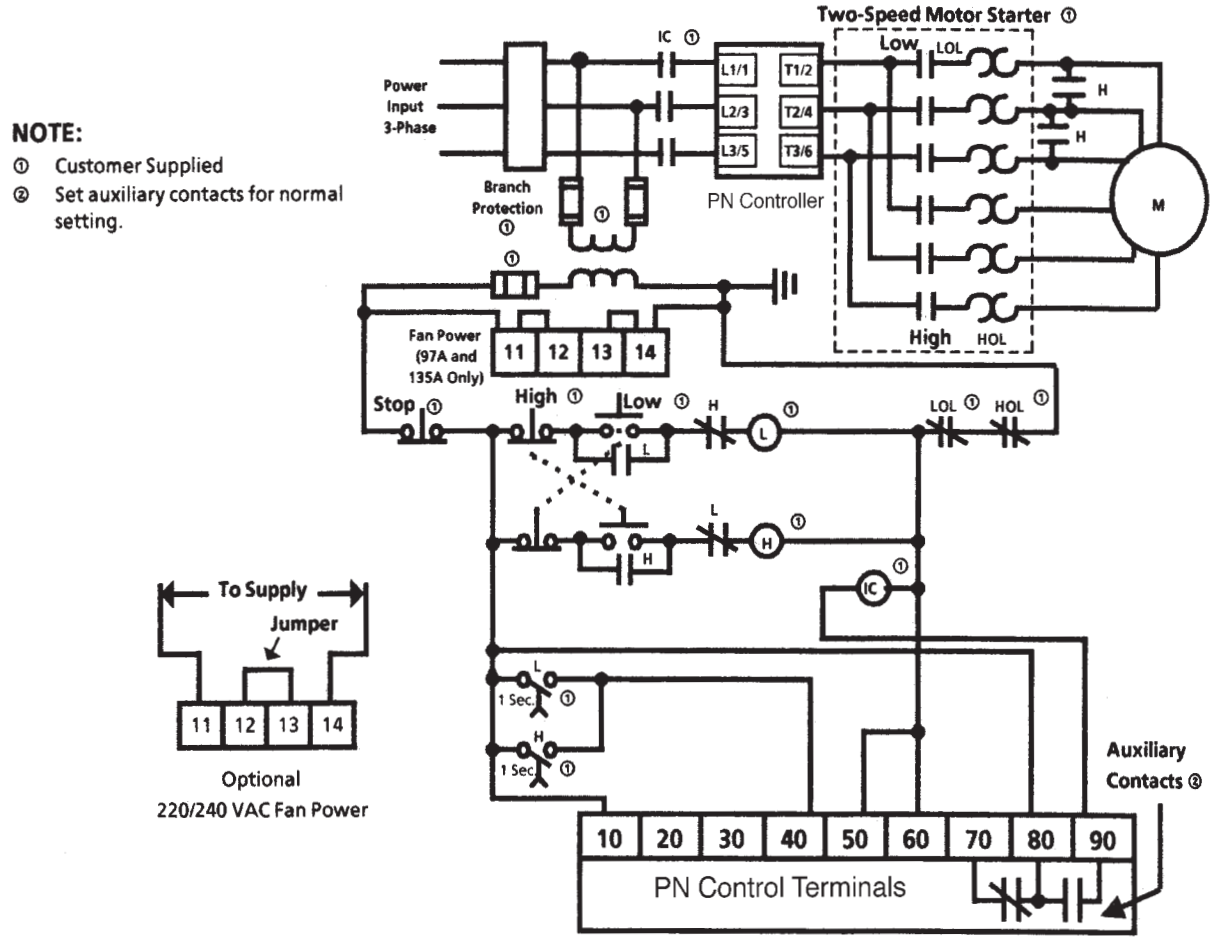
Figure 2.14 - Typical Application with a Single-Speed, Reversing Starter



NOTE: Minimum transition time for reversing direction is 1/2 second.

① Customer Supplied

Figure 2.15 - Typical Application with a Two-Speed Motor Starter



NOTE:

① Customer Supplied

② Set auxiliary contacts for normal setting.

Set-Up Procedures for Controller without Options

Protective Features

During the “Starting” and “Running” modes, the controller’s microcomputer monitors the following conditions. If any of the conditions exist, the controller shuts down and lights the FAULT LED and the appropriate LED. The controller provides the following protection:

- Start Fault
- Stalled Motor
- Temperature Fault
- Line Fault

Any fault condition will cause the auxiliary contacts to change over and hold in circuit to release.

NOTE: The Fault LEDs remain ON as long as control power is applied to the logic. If control power is removed, the controller resets and the LEDs turn off. The controller also has advisory LEDs. They indicate:

- Energy Saver Active
- Stopping Mode
- Starting Mode
- Running Mode
- Control Voltage Present

Start Fault

The Start Fault indicates an abnormal condition has been sensed. This is any fault which causes faulty SCR firing (for example, open SCR gate). If the fault occurs in this category, the controller will attempt to restart three times. After the third unsuccessful start, the controller will go into a fault condition. The FAULT and START LEDs light.

Stalled Motor

The controller is designed to sense motor stall in both the “Starting” and “Running” modes. If during the “Starting” cycle, the controller senses that the motor is stalled and the motor remains stalled, the controller shuts down in a predetermined time based on the selected ramp time. In the “Running” mode, the controller will trip in 5 seconds in the event of a locked rotor condition. The FAULT and STALL LEDs light. Starting stall trip times are illustrated in the table in Figure 3.1. The stall option does not replace the need for properly coordinated overload relay protection.

Figure 3.1 - Starting Stall Trip Characteristics

Maximum Stall Trip Times from Start (sec)		5	7	10	10	20	25	30	20	35
Start Times (sec)	Soft Start	-	2	5	10	20	25	30	-	-
	Current Limit	-	-	-	-	-	-	-	15	30
	Full Voltage	1/4	-	-	-	-	-	-	-	-

Temperature Fault

The microcomputer monitors the temperature of the SCRs by means of internal thermistors. When the power poles’ maximum rated temperature is reached, the microcomputer turns off the SCRs. The controller trips and the FAULT and TEMP LEDs light.

An overtemperature condition could indicate inadequate ventilation, high ambient temperature, overloading or excessive cycling. If an overtemperature condition exists at start-up, the SCR gate signals will be inhibited to guard against start-up, the controller will trip and the appropriate LEDs light. After the SCR temperature is reduced to allowable levels, the fault can be reset by removing and reapplying the control power.

Line Fault

The line fault indicates an abnormal condition has been sensed in the line. Conditions that will cause line fault indications are phase loss, open motor lead and shorted SCR.

If detected in either the “Starting” or “Running” modes, the controller trips and the FAULT and LINE LEDs light.

Factory Setting

The controller has been factory set for the following as shown in Figure 3.3:

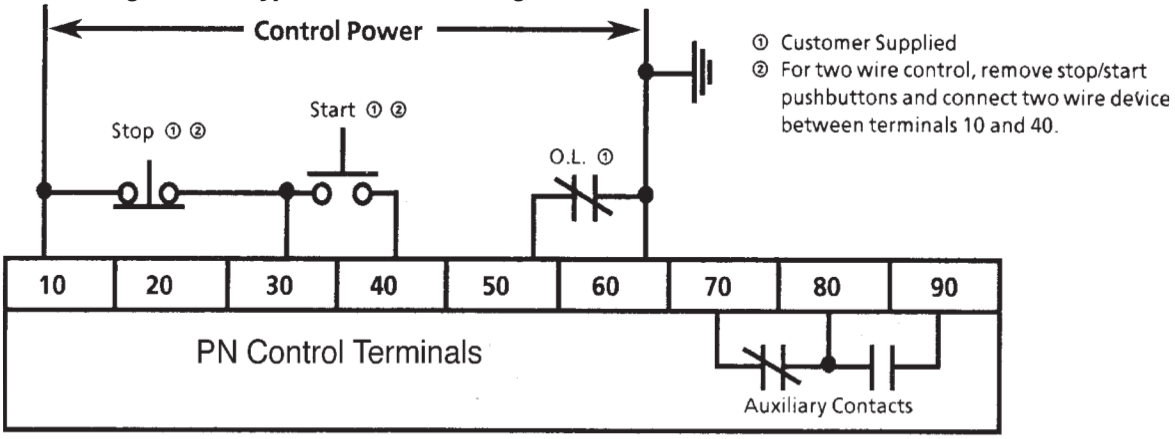
- 10 second soft start
- Energy Saver “OFF”
- Initial Torque 70%
- Auxiliary Contacts “OFF” (Normal)
- Stall feature “OFF”
- Kickstart “OFF”

Start Sequence

When wired as indicated in the typical connection diagram, the controller operates as follows:

Pressing the Start pushbutton signals the controller to initiate the “Start” sequence, provided the overload contacts are closed. The STARTING LED turns on, the internal hold-in circuit latches across terminals 30 and 40 and the Form C auxiliary contacts simultaneously change state (if so selected on the DIP switches). The controller then applies voltage to the motor to an initial value. This voltage rise continues (in the soft start mode) until the motor reaches full voltage or the motor is up-to-speed. At that point, the RUNNING LED turns on and the STARTING LED turns off. If “up-to-speed” auxiliary contacts are selected instead of normal auxiliaries, these auxiliary contacts would change state at this time.

Figure 3.2 - Typical Connection Diagram for Standard Unit



WARNING: Disconnect main power before servicing motor controller or associated wiring. Hazardous voltages are present in the motor circuit even when the solid-state controller is off.

Normal Stop Sequence

Pressing the Stop pushbutton signals the controller to initiate a shutdown. The controller stops firing the SCRs allowing the load to stop. When the logic completes its shutdown sequence, it releases the latch circuit across terminals 30 and 40 and the Form C auxiliary contacts change over. The RUNNING LED turns off.

Overload Trips

When an overload trip occurs, the normally closed contact (wired into terminals 50 and 60) opens, causing the controller logic to shut off immediately.

Fault Trips

During the “Starting” and “Running” modes, the controller’s microcomputer monitors the following conditions. If any of the conditions exist, the controller shuts down, changes state of the auxiliary contacts, and turns on the FAULT LED and the appropriate LED.

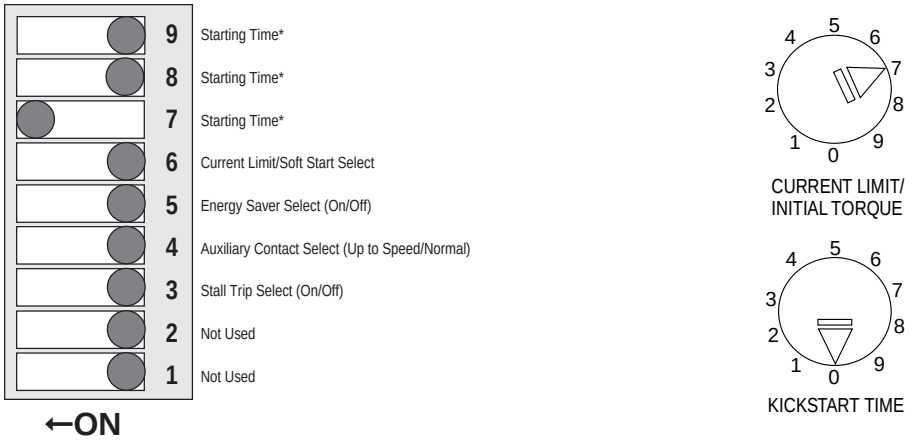
- Start Fault
- Line Fault
- Temperature Fault
- Stalled Motor

Once tripped, the controller cannot be restarted until control voltage is cycled. To rest the controller, remove control power and reapply. Refer to Page 12, Protective Features, for additional details.

Customer Settings

After the controller has been installed, further set-up may be necessary. This set-up is accomplished through DIP and digital rotary switches located on the front of the controller. See Figure 3.3.

Figure 3.3 - Switch Access Door and Factory Switch Setting (without options)



***NOTE**: The time it takes for the motor to come up to speed may be less than the start time setting and will vary depending on the frictional and inertial characteristics of the system.

If the factory settings are not suitable for the specific application, Figures 3.5, 3.7 and 3.9 describe how to set the standard unit for Soft Start with Kickstart, Current Limit and Full Voltage Starting. For instructions on how to set controller with options, please refer to the appropriate Option Publications.

WARNING: Disconnect power before opening access door.

Use a small screwdriver to pry open the access door. Set the switches to meet application requirements.

Soft Start

This starting method has the most general application. The motor voltage is raised to an initial torque value. This is adjustable between 5 and 90% of locked rotary torque. The motor voltage is gradually increased during the ramp period, which can be adjusted from 2 to 30 seconds. These customer settings should be set for the best starting performance over the required load range.

Soft Start with Kickstart

A kickstart or boost can be provided. This is intended to provide a current pulse of 500% of full load current and is adjustable from 0.4 to 2 seconds. This will allow the motor to develop additional torque at start.

Customer Settings

Soft Start Selection without Options (refer to Figure 3.5)

1. Starting Time - Set switches 7-9 according to the period desired. For example, if you want a ramp of 20 seconds, switch 7 would be ON and switches 8 and 9 would be OFF.
2. Kickstart Time - Set Kickstart Time rotary digital switch to the desired value.
3. Initial Torque - Set Initial Torque rotary digital switch to the desired value.
4. Current Limit/Soft Start - For soft start operation, switch 6 must be OFF.
5. Energy Saver Select - Set switch 5 ON if you want the energy saver feature (or OFF if you do not want this feature active).
6. Auxiliary Contact Select - Set switch 4 OFF if you want “normal” auxiliary contacts, ON if you want “up-to-speed” auxiliary contacts.
7. Stall Select - Set switch 3 ON if you want the stall feature (or OFF if you do not want this feature active).
   NOTE: For resistive load operation, switch 3 and switch 5 must be OFF.

Figure 3.4 - Soft Start with Kickstart

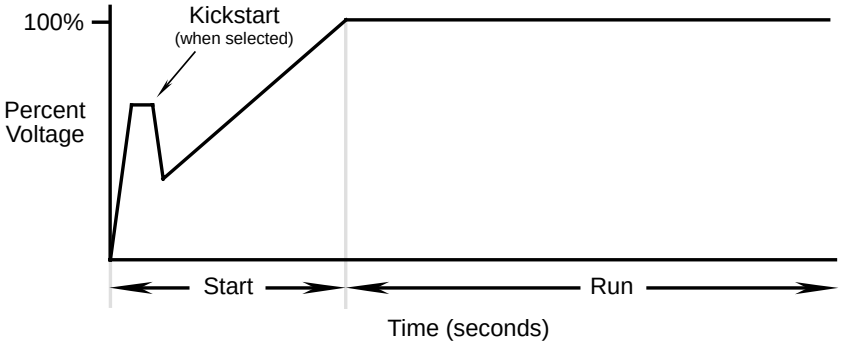
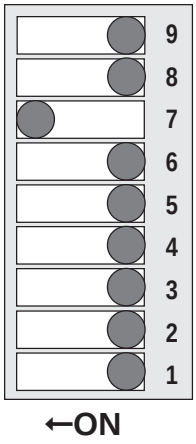


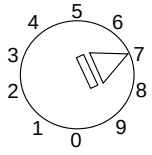
Figure 3.5 - Set-Up Procedure for Soft Start (without options)



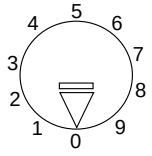
9 Starting Time*
8 Starting Time*
7 Starting Time*
6 Current Limit/Soft Start Select
5 Energy Saver Select (On/Off)
4 Auxiliary Contact Select (Up to Speed/Normal)
3 Stall Trip Select (On/Off)
2 Not Used
1 Not Used

EXAMPLE: DIP switch on left is set for 20 second ramp.

Switch Number	Time (seconds)					
	2	5	10	20	25	30
9	ON	Off	ON	Off	ON	Off
8	Off	ON	ON	Off	Off	ON
7	Off	Off	Off	ON	ON	ON
6	Off					
5	ENERGY SAVER SELECT					
4	AUXILIARY CONTACT SELECT					
3	STALL SELECT					
2	NOT USED					
1	NOT USED					



CURRENT LIMIT/
INITIAL TORQUE



KICKSTART TIME

Initial Torque Level

Position	0	1	2	3	4	5	6	7	8	9
% of Locked Rotor Torque	5	10	20	30	40	50	60	70	80	90

Kickstart Time

Position	0	1	2	3	4	5	6	7	8	9
Time (sec)	Off	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

Customer Settings

Current Limit Start Selection without Options (refer to Figure 3.7)

This starting mode is used when it is necessary to limit the maximum starting current. This can be adjusted for 50 to 500% of full load amperes as shown in Figure 3.6.

1. Starting Time - Set switches 7-9 according to the time desired. For example, if you want current limit active for 30 seconds, switches 6 and 9 would be ON and switches 7 and 8 would be OFF.
2. Kickstart Time - Set Kickstart Time rotary digital switch to OFF.
3. Current Limit/Soft Start - Switch 6 must be ON in the current limit mode. Set Current Limit rotary digital switch accordingly. For example, if you want to restrict the starting current to 300% of full load amperes, set rotary switch to position 5.
4. Energy Saver Select - Set switch 5 ON if you want the energy saver feature (or OFF if you do not want this feature active).
5. Auxiliary Contact Select - Set switch 4 OFF if you want “normal” auxiliary contacts, ON if you want “up-to-speed” auxiliary contacts.
6. Stall Select - Set switch 3 ON if you want the stall feature (or OFF if you do not want this feature active).

   NOTE: For resistive load operation, switch 3 and 5 must be OFF.

Figure 3.6 - Current Limit

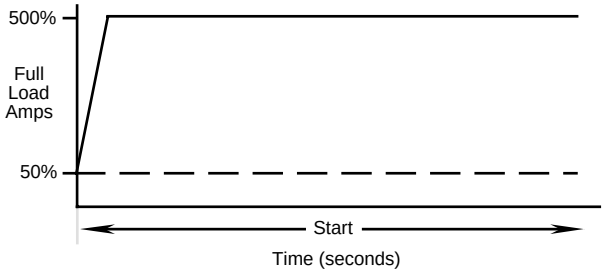
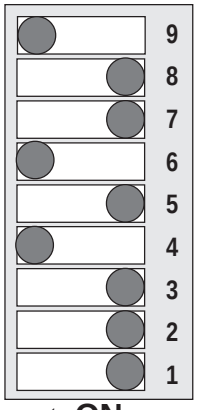


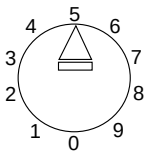
Figure 3.7 - Set-Up Procedure for Current Limit (without options)



Starting Time*
Starting Time*
Starting Time*
Current Limit/Soft Start Select
Energy Saver Select (On/Off)
Auxiliary Contact Select (Up to Speed/Normal)
Stall Trip Select (On/Off)
Not Used
Not Used

EXAMPLE: DIP switch is set for 30 second current limit time.

Switch Number	Time (seconds)	
	15	30
9	Off	ON
8	Off	
7	Off	
6	ON	
5	ENERGY SAVER SELECT	
4	AUXILIARY CONTACT SELECT	
3	STALL SELECT	
2	NOT USED	
1	NOT USED	

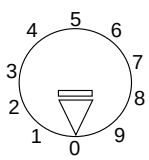


CURRENT LIMIT/
INITIAL TORQUE

EXAMPLE: Current limit rotary switch at 300%.

Current Limit

Position	0	1	2	3	4	5	6	7	8	9
% of Full Load Current	50	100	150	200	250	300	350	400	450	500



KICKSTART TIME

Kickstart Time

Position	0	1	2	3	4	5	6	7	8	9
Time (sec)	Off	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

Customer Settings

Full Voltage Start Selection without Options (refer to Figure 3.9)

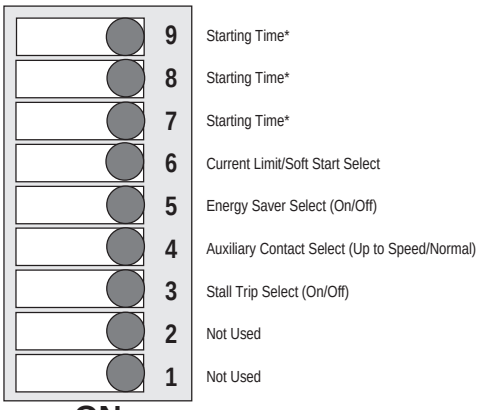
This mode is used for applications requiring across the line starting. The ramp time is set for less than 1/4 second as shown in Figure 3.9.

1. Starting Time - For full voltage starting, switches 7-9 must be OFF. This results in a ramp period of less than 1/4 second.
2. Kickstart Time - Set Kickstart Time rotary digital switch to OFF.
3. Initial Torque - Set Initial Torque rotary digital switch to 9.
4. Current Limit/Soft Start - For full voltage starting, switch 6 must be OFF.
5. Energy Saver Select - Switch 5 must be OFF. Energy Saver is not available.
6. Auxiliary Contact Select - Set switch 4 OFF if you want "normal" auxiliary contacts, ON if you want "up-to-speed" auxiliary contacts.
7. Stall Select - Set switch 3 ON if you want the stall feature (or OFF if you do not want this feature active).

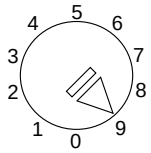
   NOTE: For resistive load operation, switch 3 must be OFF.

Figure 3.8 - Full Voltage

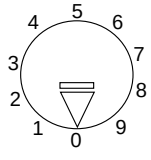
Figure 3.9 - Set-Up Procedure for Full Voltage (without options)



Switch Number	Time (seconds)
	1/4
9	Off
8	Off
7	Off
6	Off
5	ENERGY SAVER SELECT
4	AUXILIARY CONTACT SELECT
3	STALL SELECT
2	NOT USED
1	NOT USED



CURRENT LIMIT/ INITIAL TORQUE



KICKSTART TIME

Initial Torque

Position	0	1	2	3	4	5	6	7	8	9
% of Locked Rotor Torque	5	10	20	30	40	50	60	70	80	90

Kickstart Time

Position	0	1	2	3	4	5	6	7	8	9
Time (sec)	Off	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

Troubleshooting

For safety of maintenance personnel as well as others who might be exposed to electrical hazards associated with maintenance activities, the safety related work practices of NFPA 70E, Part II, should always be followed when working on electrical equipment. Maintenance personnel must be trained in the safety practices, procedures, and requirements that pertain to their respective job assignments.

WARNING: To avoid shock hazard, disconnect main power before working on the controller, motor, or control devices such as Start/Stop pushbuttons. Procedures that require parts of the equipment to be energized during troubleshooting, testing, etc., must be performed by properly qualified personnel, using appropriate work practices and precautionary measures as specified in NFPA 70E, Part II.

CAUTION: Disconnect the controller from the motor before measuring insulation resistance (IR) of the motor windings. Voltages used for insulation resistance testing can cause failure of SCRs. Do not make any measurements on the controller with an IR tester (megger).

NOTE: The time it takes for the motor to come up to speed may be less than the Start Time setting and will vary depending on the frictional load and inertial characteristics of the system.

NOTE: Depending on the application, Intelli-Brake Braking, Intelli-Stop and Slow Speed with Braking options may cause some vibration or noise during the stopping cycle and this may be minimized by lowering the braking current. If this is a concern in your application, consult the factory prior to applying these options.

Figure 4.1 - Motor will not start (no output voltage to motor)

Symptom	Possible Cause	Remedy
"CONTROL VOLTAGE" LED On	● Pilot devices ● Control voltage ● Failed control module	● Check wiring ● Check control voltage ● Replace control module
"CONTROL VOLTAGE" LED Off	● Control voltage not present ● Overload trip ● Failed control module	● Check for correct control voltage ● Check overload relay and heater element selection ● Replace control module
"START" LED On	● Open gate circuitry	● Perform resistance check; replace power module if necessary
"STALL" LED On	● Motor rotor locked ● Stall select switch set incorrectly ● Failed control module	● Correct source of stall ● Check DIP switch #3 for correct setting ● Set stall feature off (DIP switch #3 to Off) then attempt to start motor ● Replace control module
"TEMP" LED On	● Controller ventilation blocked ● Motor overloaded ● Controller duty cycle exceeded ● Fan failure (if used) ● Ambient temperature limit exceeded ● Failed thermistor ● Failed control module	● Check for proper ventilation ● Correct motor overload condition ● Check application duty cycle ● Check for correct fan operation, replace if necessary ● Wait for controller to cool or provide external cooling ● Replace Power Pole ● Replace control module
"LINE" LED On	● Open line condition ● Phase unbalance ● Motor not connected properly ● Shorted SCR ● Open gate resistors ● Motor instability ● Failed control module	● Check for open line (e.g., blown line fuse) ● Check power system ● Check for open load lead ● Check for shorted SCR, replace if necessary ● Perform resistance check; replace power module if necessary ● Check motor ● Replace control module

Figure 4.2 - Motor rotates but does not accelerate to full speed

Symptom	Possible Cause	Remedy
"CONTROL VOLTAGE" LED On	● Mechanical problems ● Failed control module	● Check for binding or external loading and correct ● Repair or replace motor ● Replace control module
"CONTROL VOLTAGE" LED Off	● Control voltage not present ● Overload trip ● Failed control module	● Check for correct control voltage ● Check overload relay and heater element selection ● Replace control module
"START" LED On	● Open gate circuitry	● Perform resistance check; replace power module if necessary
"STALL" LED On	● Motor rotor locked ● Stall select switch set incorrectly ● Failed control module	● Correct source of stall ● Check DIP switch #3 for correct setting ● Set stall feature off (DIP switch #3 to Off) then attempt to start motor ● Replace control module
"TEMP" LED On	● Controller ventilation blocked ● Motor overloaded ● Controller duty cycle exceeded ● Fan failure (if used) ● Ambient temperature limit exceeded ● Failed thermistor ● Failed control module	● Check for proper ventilation ● Correct motor overload condition ● Check application duty cycle ● Check for correct fan operation, replace if necessary ● Wait for controller to cool or provide external cooling ● Replace Power Pole ● Replace control module
"LINE" LED On	● Open line condition ● Motor not connected properly ● Shorted SCR ● Failed control module	● Check for open line (e.g., blown line fuse) ● Check for open load lead ● Check for shorted SCR, replace if necessary ● Replace control module

Figure 4.3 - Motor stops while running

Symptom	Possible Cause	Remedy
"CONTROL VOLTAGE" LED On	● Mechanical problems ● Pilot devices ● Failed control module	● Check for binding or external loading and correct ● Check for normal "stop" operation ● Replace control module
"CONTROL VOLTAGE" LED Off	● Control voltage not present ● Overload trip ● Failed control module	● Check for correct control voltage ● Check overload relay and heater element selection ● Replace control module
"START" LED On	● Open gate circuitry	● Perform resistance check; replace power module if necessary
"STALL" LED On	● Motor rotor locked ● Stall select switch set incorrectly ● Failed control module	● Correct source of stall ● Check DIP switch #3 for correct setting ● Set stall feature off (DIP switch #3 to Off) then attempt to start motor ● Replace control module
"TEMP" LED On	● Controller ventilation blocked ● Motor overloaded ● Controller duty cycle exceeded ● Fan failure (if used) ● Ambient temperature limit exceeded ● Failed thermistor ● Failed control module	● Check for proper ventilation ● Correct motor overload condition ● Check application duty cycle ● Check for correct fan operation, replace if necessary ● Wait for controller to cool or provide external cooling ● Replace Power Pole ● Replace control module
"LINE" LED On	● Open line condition ● Motor not connected properly ● Shorted SCR ● Failed control module	● Check for open line (e.g., blown line fuse) ● Check for open load lead ● Check for shorted SCR, replace if necessary ● Replace control module

Figure 4.4 - Miscellaneous situations

Symptom	Possible Cause	Remedy
Motor current and voltage fluctuates with steady load	● Check motor ● Energy Saver	● Verify the application of standard squirrel cage induction motor ● Set Energy Saver Off (DIP switch #5 to Off) then restart. If problem stops, replace control module; If problems persists, shut off ALL power to controller and check connections.
Erratic operation	● Loose connections	● Shut off ALL power to controller and check for loose connections
Accelerates too fast	● Incorrect starting time ● Incorrect kickstart ● Incorrect initial torque ● Incorrect current limit setting	● Increase starting time/Lower initial torque ● Lower kickstart ● Increase initial torque ● Decrease current limit
Accelerates too slow	● Incorrect starting time ● Incorrect kickstart ● Incorrect initial torque ● Incorrect current limit setting	● Decrease starting time ● Increase kickstart time ● Increase initial torque ● Increase current limit
Fan doesn't operate (97A and 135A only)	● Fan not wired properly	● Check fan wiring ● Replace fan if necessary
Motor stops too quickly with soft stop option	● Incorrect settings	● Verify that DIP switch settings are correct
Motor stopping time is too slow with soft stop option	● Incorrect settings ● Misapplication	● Verify that DIP switch settings are correct ● The soft stop option is intended for loads that stop suddenly when voltage is removed from the motor
Motor surges still occur with soft stop option	● Misapplication	● The soft stop option is intended for loads that stop suddenly when voltage is removed from the motor ● Refer to the Pump Control Option publication
Motor overheats①	● Duty Cycle	● Preset Slow Speed Option: Extended operation reduces motor cooling efficiency. Consult motor manufacturer for limits of operation. ● Intelli-Brake Braking Option: Check duty cycle.② ● Intelli-Stop Option: Extended operation at the preset slow speed level reduces motor cooling efficiency. Consult motor manufacturer for limits of operation. Verify maximum inertia limits.②

① When applying Intelli-Brake, Intelli-Stop, Preset Slow Speed and Slow Speed with raking, it may be necessary in some applications to consult with motor manufacturer on motor heating due to the duty cycle, high load inertia or other application parameters.

② Depending on the application, the PN Intelli-Brake Braking, Intelli-Stop and Slow Speed with Braking options may cause some vibration or noise during the stopping cycle and this may be minimized by lowering the braking current. If this is a concern in your application, consult the factory prior to applying these options.

Control Module Removal

The control module is not intended for field repair. The entire module must be replaced in the event of failure. The following procedure must be followed before unplugging the control module.

WARNING: To avoid shock hazard, disconnect main power before working on the controller, motor or control devices such as Start/Stop pushbuttons.

CAUTION: Make sure that wires are properly marked and DIP switch settings are recorded.

Control Module Removal (cont'd)

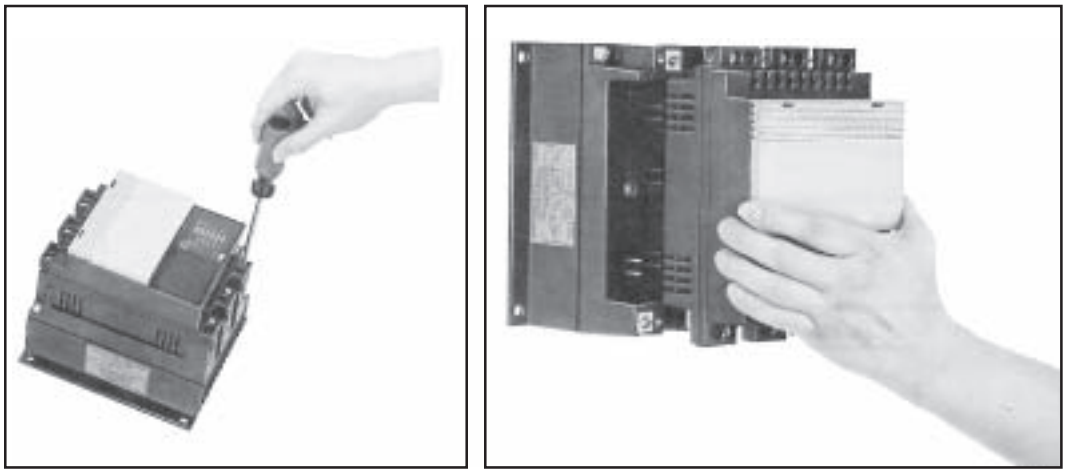
1. Remove all control wires.
2. Remove six screws as shown in Figure 4.5.
3. Unplug control module from power modules by pulling forward.

CAUTION: When removing control module make sure power module pins do not bend. Make sure pins are not bent prior to installing control module.

The gold interconnection pins on the power poles are protected with a special contact lubricant. **DO NOT CLEAN OR WIPE THESE PINS**. This contact lubricant is necessary for proper operation. Inspect each pin prior to assembly of the control module. If the lubricant is missing, apply a thin film of the recommended contact lubricant.

The approved contact lubricant is NYOGEL 759G, manufactured by William F. Nye, Inc. Specialty Lubricants, New Bedford, MA 02742, USA. To install control module, follow the reverse order for removal.

Figure 4.5 - Removal of Control Module



Power Module Resistance Check

If a power module needs to be checked use the following procedure:

WARNING: To avoid shock hazard, disconnect main power before working on the controller, motor or control devices such as Start/Stop pushbuttons.

CAUTION: Make sure that wires are properly marked and DIP switch settings are recorded.

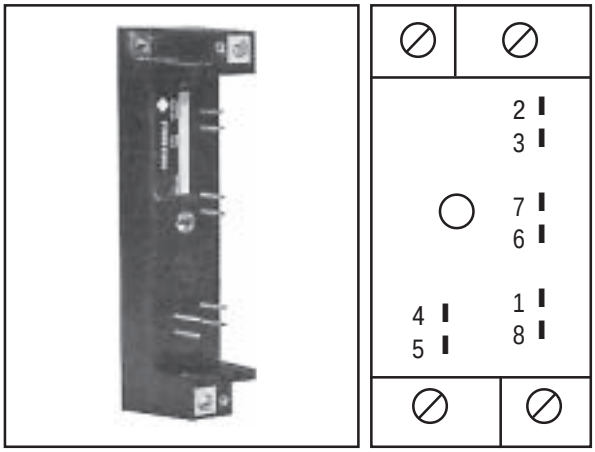
1. Disconnect ALL power from the controller.
2. Remove six screws as shown in Figure 4.5.
3. Using an ohmmeter, measure the resistance between the line and load terminals of each phase on the controller. The resistance should be greater than 10,000 ohms.
4. Unplug control module from power modules by pulling forward.
5. Measure resistance between pins 1 and 2. Resistance should be 19,000 ohms, ±5%.
6. Measure resistance between pins 7 and 8. Resistance should be 19,000 ohms, ±5%.

Power Module Resistance Check (cont'd)

7. Measure resistance between pins 2 and 3. Resistance should be less than 100 ohms.
8. Measure resistance between pins 6 and 7. Resistance should be less than 100 ohms.
9. Measure resistance between pins 4 and 5. Resistance should be less than 250 ohms.

If the power module fails for any of the above tests, replace it. The gold interconnection pins on the power module are protected with a special contact lubricant. **DO NOT CLEAN OR WIPE THESE PINS**. This contact lubricant is necessary for proper operation. Inspect each pin prior to assembly of the control module. If the lubricant is missing, apply a thin film of the recommended contact lubricant. The approved contact lubricant is NYOGEL 759G, manufactured by William F. Nye, Inc. Specialty Lubricants, New Bedford, MA 02742, USA.

Figure 4.6 - Pin Location for Power Module Resistance Check



Renewal Parts

Description	Controller Rating	Line Voltage Rating
Control Module (Standard)	All	All
Preset Slow Speed	All	All
Soft Stop	All	All
Pump Control	All	All
Intelli-Brake	24A-54A 97A-135A	All All
Intelli-Stop	24A-54A 97A-135A	All All
Slow Speed with Braking	24A-54A 97A-135A	All All
Power Modules	24A	200-480 200-600
	35A	200-480 200-600
	54A	200-480 200-600
	97A	200-480 200-600
	135A	200-480 200-600
Fan	97A-135A	All

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