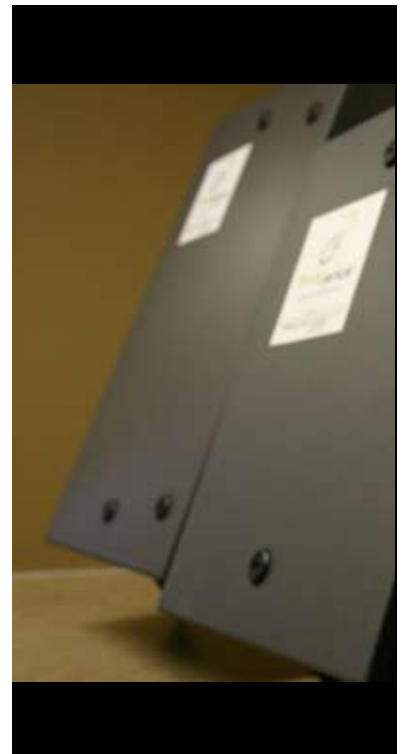


USER'S GUIDE

**Analog Motor Efficiency Controller
Platforms 1, 2, 3 and 4**



SCOPE

This manual provides an overview of the installation, set-up, operation and maintenance of Power Efficiency's Motor Efficiency Controller, Platforms 1, 2, 3 & 4. This manual does not cover all variations in equipment that might be provided for specific contracts, nor does it address every possible contingency of installation, control or overall system application.

Introduction and Features

The motor efficiency controller is a solid-state device that significantly reduces energy use when used with Wye/Star or Delta wound motors that are lightly loaded for much of their duty cycle.

When AC motors are lightly loaded, the magnetizing field is kept far higher than is needed by the load, resulting in excessive magnetizing and resistive losses. The motor efficiency controller is a continuously rated device. It constantly monitors the motor's power factor and adjusts the voltage supplied to it to keep the motor's power factor high while maintaining the speed and torque at the level required by the load at that time. The resulting decrease in volts, amps and watts significantly reduces the overall cost of operating the system.

The motor efficiency controller includes a state soft-start circuit that reduces starting inrush current by as much as 70%. Reduced inrush current reduces contactor wear, mechanical starting stresses on bearings and the associated drive train, insulation damage and overheating, particularly when the motor is stopped and started frequently.

When running continuously, the energy-saving feature further extends the life of the motor by lowering its operating temperature by 10-40°F (6-22°C). An 18°F (10°C) reduction in temperature can double the motor's expected life.

The motor efficiency controller does not control the motor speed. It is not a variable-speed drive and cannot be used in association with one. The motor efficiency controller will not eliminate motor problems such as defective motor insulation, faulty windings, poor lubrication or general disrepair.

Systems Requirements

- The motor should be an induction motor used in a constant speed application.
- The device must be matched to the line voltage (208, 380, 480 etc.)
- The load on the motor should vary and be low at least a moderate portion of the duty cycle.
- The device should be used in conjunction with an across-the-line starter. Please contact Power Efficiency Corporation (800) 975-9111 for additional information and wiring diagrams if a different type of starter is to be used.
- The device should be used in conjunction with an isolating contactor and an overload.

SAFETY GUIDELINES

When used in this manual, the following words indicate the degree of hazard that may be encountered if proper precautions are not taken.

DANGER: Indicates an imminently hazardous situation which, if not avoided, **WILL** result in death or serious injury.

WARNING: Indicates a potentially hazardous situation which, if not avoided, **COULD** result in death or serious injury.

CAUTION: Indicates a potentially hazardous situation which, if not avoided, **MAY** result in minor or moderate injury or equipment damage.

NOTE: Draws attention to other significant information that is important to understanding the installation and operation of the equipment.

WARNINGS

1. Hazardous voltages exist inside the motor efficiency controller even when it is off. The motor efficiency controller may have more than one source of electrical power. Each source of electrical power should be provided with its own method of isolation and lockout.
2. Do not operate without the safety covers properly secured.
3. Check the site installation diagram(s) and isolate and lockout ALL sources of electrical power before attempting to install or service the motor efficiency controller.
4. Certain set-up adjustments require that the front cover/door be open when the unit is live. These set ups must be made with a non conductive screwdriver. Do not bring conductive tools or parts (including watches, rings, etc.) near an energized unit that has its cover/door removed. If possible, avoid other work on the equipment when it is live. If this is not possible, follow all necessary codes to prevent electric shock, arc flash and/or fire.
5. The motor efficiency controller is not an isolator. Leakage currents mean that potentially dangerous voltages may exist on its output load terminals even when it is off.
6. Pressing the "Stop" push-button does not remove AC power from the motor efficiency controller and **SHOULD NOT** be used as an emergency stop.
7. Refer to the nameplate for voltage and current ratings. The voltage of the motor efficiency controller and the motor should match.
8. Overload and over-current protection devices must be provided in accordance with national, state and local codes.

9. The motor efficiency controller must be installed, grounded and operated according to all relevant site, national, state and local codes for proper operation.
10. The “Start” and “Stop” control systems must ensure the safety of all persons using the installation.
11. Do not leave foreign objects inside the equipment during installation or use.
12. To avoid overheating and fire, always mount the motor efficiency controller vertically in a well ventilated space.

CAUTIONS

1. Have a suitably qualified electrician/technician install and maintain the motor efficiency controller. This person should read and understand this manual and have a thorough knowledge of the installation, construction, operation and maintenance of this equipment. This person should also know the supplies, loads and controls to which it is connected, the hazards involved and national, state and local codes.
2. Ensure this qualified person has all protective equipment and permits to work required by code and by established site safety procedures.
3. Handle the motor efficiency controller with the necessary level of care needed for electrical equipment of its weight, size and shape. Do not use cables to carry the equipment.
4. Do not mount the motor efficiency controller above a heat source. If this is impossible, sufficient thermal barriers and spacing must be provided to comply with national codes.
5. The motor efficiency controller enclosure can generate sufficient heat to cause injury. The motor efficiency controller must be mounted so that exposure to persons is minimized to prevent accidental contact with hot surfaces.
6. Only authorized spare parts should be used for maintenance of this equipment.
7. Overload and over-current devices used in conjunction with this equipment must be set to properly coordinate with the motor.
8. Excessive start times and duty cycles can overheat and damage the motor. Ensure that the motor specification meets the start time and duty cycle required.
9. Do not fit power factor correction capacitors between the motor efficiency controller and the motor.
10. Do not use with asymmetrically wound motors.

INCOMING INSPECTION

1. Check the carton for signs of visible damage. Report any damage to Power Efficiency Corporation at 702-697-0377.
2. If the equipment is not to be installed immediately, store it in a clean, dry, pollution free area at a temperature between 40-105°F (5-40°C).

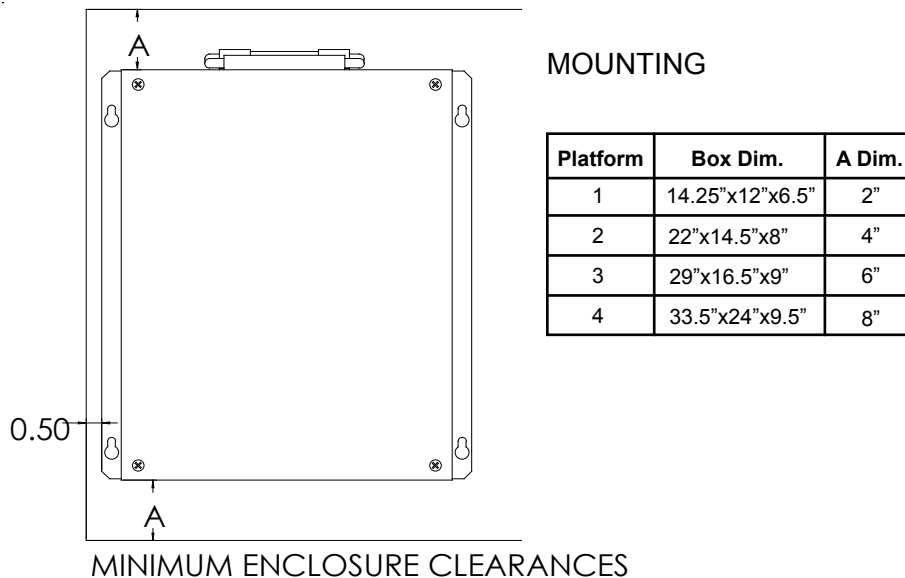
PRE-INSTALLATION CHECKS

1. Make sure that the motor and other equipment are fully operational before installation begins. Take pre-energy saving measurements now.
2. Check that the motor is a constant-speed AC induction motor serving a variable load. The motor efficiency controller does not vary the speed of the motor and will not save significant energy on a motor that is run continually at full load.
3. Check that the enclosure is rated for the environment.
4. Make sure that there is sufficient clearance for the motor efficiency controller to be mounted in a vertical position.
5. Check that the motor efficiency controller will be in a vibration free environment.
6. Check that the motor efficiency controller is rated for the line voltage (208/240, 380/415, 440/480, 575/600VAC). Units are not Interchangeable between voltages.
7. Determine how the control system is configured. Power for the control and safety systems is derived from the line side of the motor efficiency controller. It can be used with an across-the-line or a Wye(Star)-Delta starter. If a different type of starter is to be used please contact Power Efficiency Corporation for assistance (702-697-0377 Attn: Engineering Department). If you attempt to proceed without technical assistance, you may void the warranty.

INSTALLATION - GENERAL

1. To ensure adequate ventilation, mount the motor efficiency controller with its heat sink vertical, with the minimum clearances shown below for proper cooling air flow. The motor efficiency controller is convection cooled (has no fan) and requires minimum clearances for proper cooling air flow. The space below the unit may have to be increased to make allowance for cable bending requirements.
2. When mounting on or over a combustible surface, a floor plate of at least .056 in. (1.43mm) galvanized or 1/16in (1.6mm) uncoated steel extending at least 6 in. (150mm) beyond the equipment on all sides, must be installed.

3. Cable the motor efficiency controller with wires sizes accordance national, state and local codes. Wires shall be copper and have a minimum insulation rating of 90°C. Aluminum wire shall not to be used.



MOUNTING

Platform	Box Dim.	A Dim.
1	14.25"x12"x6.5"	2"
2	22"x14.5"x8"	4"
3	29"x16.5"x9"	6"
4	33.5"x24"x9.5"	8"

4. Supply-side line terminals should be connected to L1, L2 and L3. Motor side load terminals should be connected to T1, T2 and T3 as shown on the relevant following diagram.

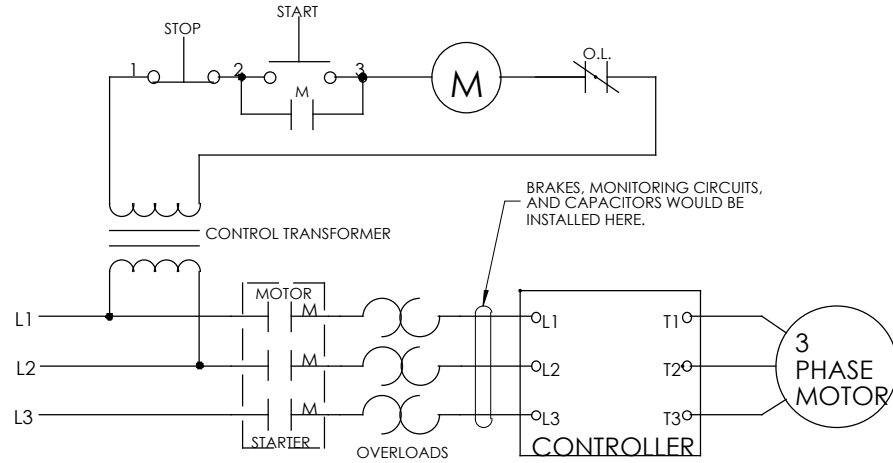
The motor efficiency controller should be wired such that its load terminals are connected directly to the motor's line terminals without any other equipment connected between the two. Capacitors, voltage monitoring or braking mechanisms, if installed must be connected on the line input side of the motor efficiency controller, not the load side.

If the starter being used on your application is other than one of those addressed in this manual, please contact Power Efficiency Corporation at 702-697-0377 for additional information and wiring diagrams.

5. Torque all line and load terminal screws to the torque levels specified.
6. Connect control and signaling wires as required by the relevant control scheme.
7. Ground the motor efficiency controller using the grounding lug(s) provided according to national, state and local codes, and site regulations. Ground wires should be copper and rated according to the relevant codes. Multiple ground wires must be twisted before insertion into the grounding lug(s) provided.
8. After installation, check wiring and carry out wiring and insulation tests.

DIRECT ACROSS-THE-LINE STARTING SYSTEM

The following wiring diagram shows a typical across-the-line starter.



The motor efficiency controller should be fed from a motor starter and the control system should include motor overload protection. The system should be fed from a legal isolator that will safely disconnect all sources of supply from the motor efficiency controller, the motor and the protection and control system, via a short circuit protection device(s).

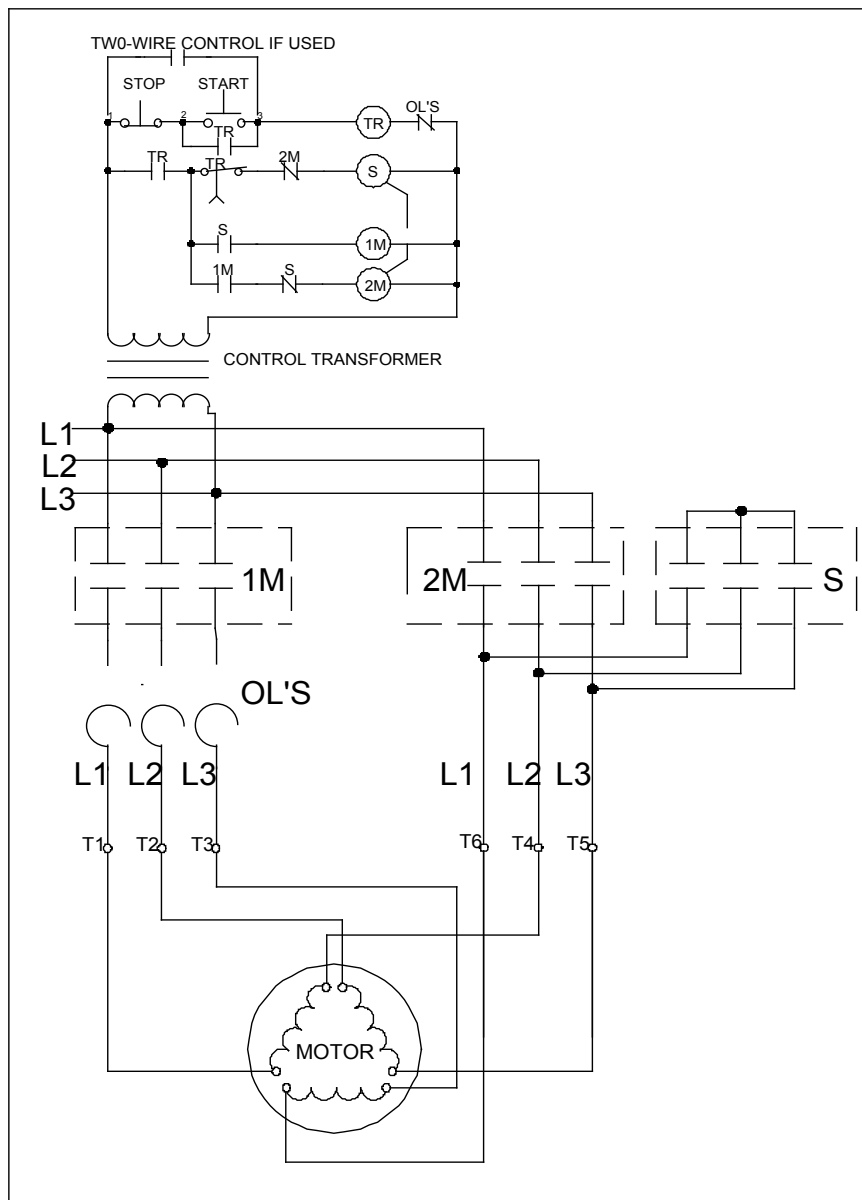
WYE/STAR-DELTA STARTING SYSTEMS

Wye/Star-Delta starting is one of the most commonly used methods for soft-starting an AC induction motor, and can reduce the starting current by 30% with a corresponding reduction in starting torque.

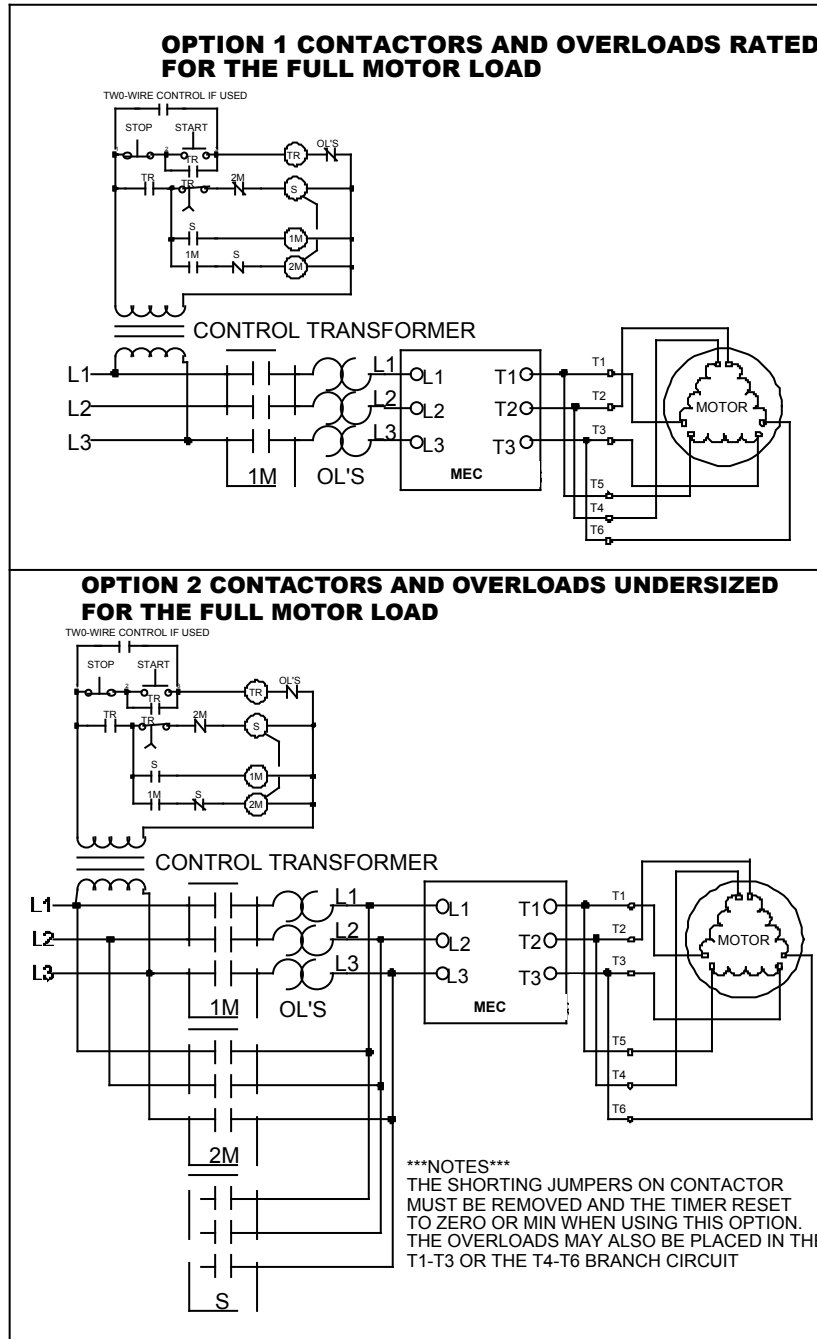
When fitting a motor efficiency controller in place of this type of starter, the starter's overloads and controls can still be used if they are correctly reconnected as shown in the following arrangements.

The following diagram shows a typical Wye/Star-Delta starter before the motor efficiency controller is fitted.

WYE/STAR-DELTA SYSTEM – BEFORE INSTALLATION



The following diagrams show typical Wye/Star-Delta starters after the motor efficiency controller is fitted. Option 1 shows the arrangement where the overloads and contactors are rated for the full motor load. Option 2 shows the arrangement if they are not.



WYE/STAR-DELTA SYSTEM – AFTER INSTALLATION

Again, regardless of which system is used, it should be fed from a legal isolator that will safely disconnect all sources of supply from the motor efficiency controller, the motor and the protection and control system, via a short circuit protection device(s).

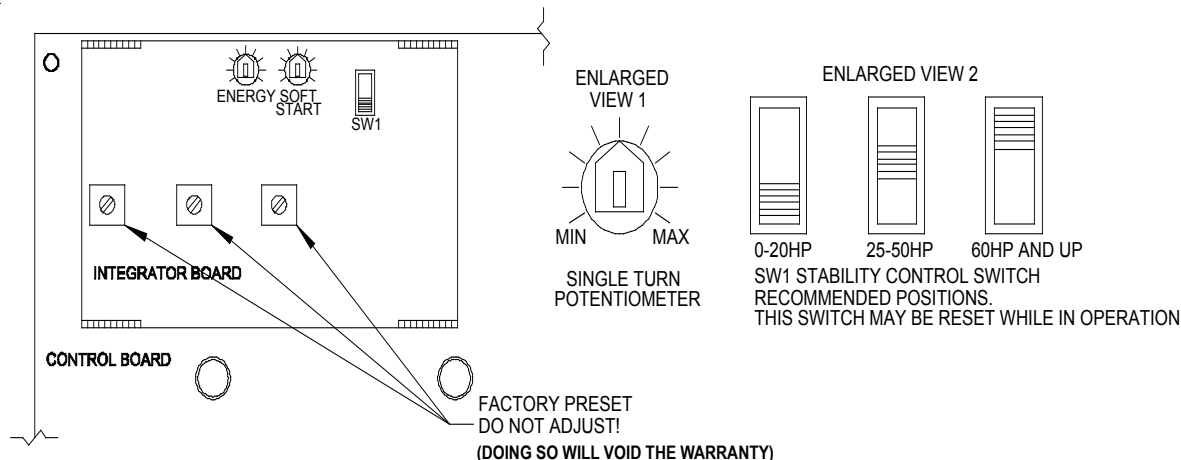
SET UP AND ADJUSTMENT - INTRODUCTION

Once the motor efficiency controller has been properly installed and inspected and has passed circuit continuity and insulation dielectric tests, it is ready to be energized and adjusted for operation.

Set-up of the motor efficiency controller is accomplished with two adjustments:

- a) The “Soft-Start” adjustment determines the degree of soft-start (the elapsed time to full voltage) applied to the voltage. Do not apply long duration soft-starts to loaded motors. Some motors will not start with soft starters.
- b) The “Energy” adjustment is used to reduce the energy consumption of a motor when lightly loaded. This adjustment will set the lowest proper operating voltage. Additional energy will be automatically delivered as the motor increases.

There are also three balancing potentiometers that are pre-set at the factory. These should not be adjusted. Doing so will invalidate the warranty.



If there are problems at any time during the following procedure, stop and check anything that your experience says may be relevant. If there is nothing obvious, consult Power Efficiency Corporation for advice.

Set Up and Adjustment – Initial Checks

1. With all sources of incoming power isolated and locked off, remove the motor efficiency controller front cover or unlock and open the door. Check that all connections are proper, tight and that all PCB connectors are properly engaged.
2. Set the Soft-Start and Energy adjustments to minimum.
3. Use an Ohmmeter set to its highest scale to check that the resistance between each line and load terminal in turn (L1, L2, L3, T1, T2, T3) to the chassis ground is greater than 500 kilohms.

4. Unplug the leads from the power supply transformer to the Gate Drive Board (P7).
5. If a Bypass Switch is fitted, turn it to the normal or off position and energize the source(s) of supply. Use a voltmeter to check that the line-to-line voltages are within the motor efficiency controller rated range (-15% to +10% of nominal) and that they are balanced. A voltage out balance will produce a far greater current out of balance in the motor, resulting in a higher overall motor temperature rise.
6. When the line-to-line voltages are balanced, use a voltmeter to check that the voltage of each line and load terminal to ground is at about 58% of the line to line voltages recorded. An out of balance may indicate that one phase is to some extent shorted to ground somewhere in the motor efficiency controller, the motor or elsewhere in the system.
7. Isolate and lock off all the sources of supply. If a Bypass Switch is fitted, turn it to the bypass or "On" position to connect the motor directly to the motor efficiency controller incoming supply. Connect the supply directly to the load and take the motor efficiency controller out of service. If there is no Bypass Switch, link the line and load terminals together (L1-T1, L2-T2, L3-T3) to take the motor efficiency controller out of service.
8. Plug the leads from the power supply transformer back into the Gate Drive Board (P7).
9. Replace the front cover or close and lock the door. Reconnect and energize the source(s) of supply and start the motor. Check for proper rotation.

If the motor efficiency controller is replacing a Wye-Delta starter, this test will result in starting currents that are high compared with those that would be expected with the Wye-Delta starter or the motor efficiency controller. This situation may result in trips from the existing overloads which may have to be removed temporarily from the circuit or otherwise disabled. The exact disabling method will depend on the application.

10. If the rotation is correct, let the motor run up to full speed, checking for any unusual events.
11. Turn the motor off. When it has stopped rotating, isolate and lock off all the sources of supply.

SET UP AND ADJUSTMENT - ADJUSTMENTS

1. Remove the motor efficiency controller front cover or unlock and open the door. Turn the Bypass Switch (if fitted) to the normal or "Off" position or remove the links from the line to load terminals to place the motor efficiency controller back in service. Never switch to and from bypass while the motor is running.
2. Connect an ammeter to the motor efficiency controller line supply.
3. Set the "Soft-Start" to 12 o'clock, re-energize the source(s) of supply and re-start the motor with no (or minimum) load applied.
4. If the soft start ramp ends before the motor is at full speed, use a non-conductive screwdriver to turn the "Soft-Start" adjustment clockwise towards "Max" to increase the start-up time.
5. Adjust the "Soft-Start" one notch at a time until the maximum desired starting current is achieved, using repeated starts and stops. Turn clockwise (towards max) to reduce the current, anti-clockwise to increase it. When satisfactory start current is achieved, adjust the soft start one notch clockwise (towards max) to ensure that the start current is always below the desired level.
6. Let the motor run unloaded without event for a few minutes. Then gradually turn the "Energy" adjustment clockwise with a non-conductive screwdriver towards "Max" to decrease the voltage to the motor. As the motor's voltage decreases, its load current rises to maintain the power to the load constant. But this is offset by a greater decrease in the magnetizing current, resulting in a net current reduction that produces an energy savings.
7. If no voltage adjustment is possible, or the motor stops running smoothly as soon as any adjustment is made, please contact Power Efficiency Corporation for instructions.
8. As the "Energy" adjustment is increased, the amperage will reduce until it reaches a minimum and starts to rise again. This is the point at which reductions in magnetizing current are no longer offsetting the increase in load current.
9. This is the lowest possible setting. Decrease the adjustment at this point slightly to ensure smooth running. If the motor still does not run smoothly, decrease the adjustment further until smooth running is achieved.
10. Turn the motor off. When it has stopped rotating, isolate and lock off all the sources of supply. Remove all measuring equipment and replace the front cover, or close and lock the front door.
11. Make sure that machine operators and maintenance personnel have been notified of the motor efficiency controller installation and its operation procedures.

ENERGY SAVING MEASUREMENTS

If the motor efficiency controller is fitted with a Bypass Switch, the switch can be used to facilitate periodic checks on the energy that is being saved by the motor efficiency controller as follows:

1. Turn the motor off. When it has stopped rotating, isolate and lock off all the sources of supply. Remove the motor efficiency controller front cover or unlock and open the door. Turn the Bypass Switch to the bypass or "On" position to take the motor efficiency controller out of service. Never switch to bypass while the motor is running.
2. Connect a recording poly-phase power meter to the motor efficiency controller line supply, replace the front cover or door, re-energize the source(s) of supply and re-start the motor. Leave the motor efficiency controller in this state, recording the power (kW) over a period of time that encompasses a typical duty cycle for the load.
3. Turn the motor off again. When it has stopped rotating, isolate and lock off all the sources of supply again. Turn the Bypass Switch to the service position to place the motor efficiency controller back in service. Never switch from bypass while the motor is running.
4. Replace the front cover or door, re-energize the source(s) of supply and re-start the motor. Record the power (kW) over a period of time that encompasses a similar typical duty cycle for the load.
5. Turn the motor off again. When it has stopped rotating, isolate and lock off all the sources of supply again. Disconnect the poly-phase power meter, replace the front cover or door, re-energize the source(s) of supply and re-start the motor.

If the total current drawn with the motor efficiency controller in service is less than when it is out of service, then the motor efficiency controller is saving energy.

This test can be carried out after installation of the motor efficiency controller to determine whether this is an appropriate installation. Typically, the more time that the motor spends on low load during the duty cycle, the greater the savings that can be expected.

OPERATION

The motor efficiency controller is fully automatic and will provide many years of service. While the motor efficiency controller is operating, the volts and amps will vary in response to the motor load.

MAINTENANCE

1. Regularly check that the airflow over the heat-sink fins is unimpeded and the heat-sink is clean, dry and dust free. Frequency of these inspections will depend on site conditions.
2. Check that the motor efficiency controller shows no signs of overheating, corrosion or physical damage.

POWER EFFICIENCY CORPORATION LIMITED WARRANTY

Power Efficiency Corporation (Seller) warrants to Purchaser that any products provided by Seller hereunder are free from defects in material and/or workmanship under normal use and operation during the warranty period stated herein. If any products provided hereunder prove to be defective in material and/or workmanship within two years from date of sale, Seller, if promptly notified thereof in writing, will correct such defect at Seller's own expense by (at Seller's option) repairing or replacing the defective products. Warranty is contingent upon conditions of operation being normal at all times and the product not being subjected to abnormal stresses including, but not limited to, incorrect primary voltage and frequency, improper ventilation or exposure to weather if improperly enclosed. This Warranty will not be extended to any product which has been subject to misuse, negligence, accident, improper installation or operation, nor to any product which has been repaired or altered by any party other than the Seller.

Claims for defective products shall be subject to verification by an authorized employee of the Seller. No products shall be returned to Seller without Seller's prior written consent. Products which Seller consents to have returned shall be shipped prepaid F.O.B. to Seller's factory or other location designated by Seller. Seller shall not assume responsibility or accept invoices for unauthorized repairs or alterations to its products, whether or not thought to be defective. Any replacement or repaired product furnished under this Warranty shall be warranted by Seller for the balance of the Warranty period and under the same Warranty conditions as applicable to the original product.

The foregoing Warranty does not apply to experimental, prototype, demonstration or developmental products. Seller makes no warranty on products manufactured by others which are resold by Seller. Seller shall use all reasonable efforts to obtain from each such product manufacturer, in accordance with the manufacturer's warranty or customary practice the repair or replacement of products that prove defective in material and/or workmanship.

The foregoing warranties shall apply to products which are repaired by the Seller, except that the Warranty is limited to that portion of the product that was repaired or replaced. This Warranty is in lieu of any other warranty, express or implied, and any other rights or remedies.

Seller shall pay transportation charges for products returned to Seller and delivered to Buyer only if Seller is responsible under the terms of this Warranty. Buyer shall notify Seller, in writing, of any intention to return an allegedly defective product. Buyer shall give such advance notification to allow Seller to arrange for shipment, should Seller so desire. Purchaser's remedies under this warranty are limited to repair or replacement as set forth above.

IN NO EVENT SHALL SELLER OR ITS SUPPLIERS BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING, BUT NOT LIMITED TO LOSS OF PROFIT OR REVENUES, LOSS OF USE OF THE PRODUCTS PROVIDED OR ANY ASSOCIATED PRODUCTS OR EQUIPMENT, COST OF CAPITAL, COST OF SUBSTITUTE PRODUCTS OR EQUIPMENT, FACILITIES, DOWNTIME EXPENSES OR CLAIMS OF PURCHASER'S CUSTOMER FOR SUCH COSTS.

Buyer is hereby invited to extend the Warranty as stated above to five years for the cost of \$200.00. All conditions and limits stated above will be included. If requested and purchased, Buyer will receive from Seller a certificate of extended warranty.

WARNING: Improperly installing and/or maintaining these products can result in death or serious personal injury. These devices are operated by high voltages and should be installed and maintained by qualified personnel. Before attempting installation or maintenance, read and understand all instructional materials related to the product. This warning is published solely for information purposes and should not be considered all-inclusive. If further information is required, please consult Power Efficiency Corporation at (702) 697-0377.

NOTES:

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