

# POWER Miser 2 Solid State Soft-Start Energy Saving Motor Controller



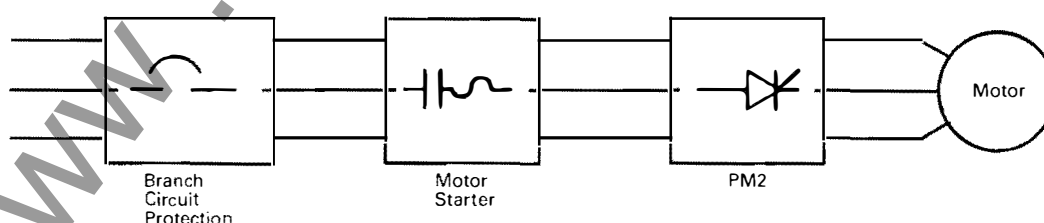
## Description

PM2 Model 3 is introduced to enhance the industry's most complete, U.L. labeled line of solid state soft-start motor controllers. It retains all the features of existing line and adds enhancements like digital firing circuit, STALL/SCR protection which are described later in this publication.

The Westinghouse PM2 Controller controls the voltage applied to the induction motor by phasing back the power semiconductors thru electronic logic. It provides soft and smooth starting and timed acceleration and can be used with standard 3-phase induction motors. The PM2 is installed between electromechanical starter and the motor as shown below.

Time proven silicon controlled rectifiers (SCR's) or thyristors are used on all models except 10 amp model which uses TRIAC's.

JAN 18 1994



Typical Connection Diagram



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Why Soft Start

Across the line or full voltage starting remains the most economical way of starting an induction motor. However starting an induction motor at full line voltage results in an initial inrush current of up to 5-8 times the full load current and the starting torque produced by the motor and applied to the power train and driven load is 1.5 to 2.5 times the motor full load torque. During acceleration even higher torque can be experienced by power train and driven load. Both high inrush current and high starting torque cause problems which may be grouped as follows:

#### Mechanical Problems

- Belts stretching and breaking, and squealing
- Gears breaking
- Couplings wearing out
- Drive train shafts breaking

#### Motor Problems

- Motor insulation deterioration and premature winding failure
- Foundation bolts and mounting failures
- Bearing lock-up and failure
- Motor shaft cracking and breaking
- Excess energy consumption

#### Electric Product Problems

- Contact pitting and wear
- Coil burnout

#### Inrush Current Related Problems

- Voltage drop downstream causing Electro-mechanical starter coils to drop out
- Soft supply systems may not have available current to start motor
- Lighting brown-outs/computer hiccups

#### Fragile Product Problems

- Materials chip, crack, spoil or break
- Positioned products are shifted

By phasing back the power semiconductors PM2 applies a lower voltage to the induction motor. The value of this initial voltage also called initial torque is user selectable then over a period of time the voltage is gradually increased to full line voltage. This time called ramp time is also user selectable.

In this way a smooth stepless start is accomplished which will minimize any of the above problems. The benefits are such that almost every process or plant offers a potential for this product. For more details on the benefits of soft start please see sales aid SA 8600A. Typical applications include the following which are listed by special industry classification (SIC) codes.

#### SIC 20 – Food Processing

- Bottling line equipment
- Conveyers
- Mixers
- Riser Dumpers
- Ovens/Bakery Equipment
- Refrigeration Compressors'
- Chillers
- Air Compressors

#### SIC 22 – Textiles

- Tufting Machines
- Carpet Looms
- Textile Spinners
- Air Compressors
- Exhaust Fans

#### SIC 24 – Lumber & Wood Products

- Cut off Saws
- Wood Hogs
- Sanders
- Planers
- Tenant Shaping Machines
- Air Compressors
- Exhaust Fans
- Wood Working Machines
- Chippers

#### SIC 25 – Furniture & Fixtures

- Milling Machines
- Sanders
- Exhaust Fans
- Air Compressors
- Wood Hogs

#### SIC 26 – Pulp & Paper

- Pumps
- Paper Refiners
- Wood Hogs
- Chippers
- Sifters

#### SIC 28 – Chemicals

- Air Compressors
- Granulators
- Agitators
- Mixers
- Conveyors
- Blowers

#### SIC 29 – Petroleum

- Oil Field Pumps
- Water Pumps
- Fans/Blowers

#### SIC 30 – Rubber & Plastic Products

- Granulators
- Mixers
- Agitators
- Injection Molding Machines
- Pelletizers

#### SIC 32 – Dry Process/Mining

- Underground Conveyors
- Cone Crushers
- Jaw Crushers
- Fans
- Asphalt Mixers
- Cement Mixers
- Conveyors

#### SIC 33 – Metals

- Fans
- Grinders
- Jump Mills
- Cooling Racks
- Outrun Lines
- Reversing Conveyors

#### SIC 35 – Machinery OEMs

- Mining Machinery
- Elevators & Escalators
- Conveyors
- Metal Forming Equipment
- Rolling Mill Machinery
- Food Products Machinery
- Textile Machinery
- Woodworking Machinery
- Pumps
- Air & Gas Compressors
- Blowers & Fans
- Commercial Laundry Equipment
- Food Processing Equipment
- Cold Storage Plant Equipment
- Beverage/Bottling Equipment
- Large Building AC Systems

#### SIC 37 – Transportation

- Shipbuilding
- Pumps
- Rudder Control
- Bulk Conveyors
- Compressors



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Model 3

Feature	Explanation	What They do for You
• Current calibration dip switches	<ul style="list-style-type: none"><li>• Each model can be applied for a wide range of applications</li><li>• Four models cover 1-40 Hp, 230V, and 1-75 Hp, 460V application</li></ul>	<ul style="list-style-type: none"><li>• Increased User/OEM flexibility</li><li>• Reduced distributor inventory</li></ul>
• Dual voltage rating	<ul style="list-style-type: none"><li>• Same model for 208/230 or 460V for rated amps</li><li>• Select voltage by using one of the 2 plugs supplied with the unit</li></ul>	<ul style="list-style-type: none"><li>• Increased User/OEM flexibility</li><li>• Reduced distributor inventory</li></ul>
• Time and torque adjustment	<ul style="list-style-type: none"><li>• Torque (initial voltage) 20-80%</li><li>• Time 1-45 seconds</li></ul>	<ul style="list-style-type: none"><li>• Soft start</li><li>• Stepless acceleration</li><li>• Reduced inrush</li><li>• Reduced wear on motor and drive train</li><li>• Adjust to meet any type of load</li><li>• Limits motor inrush amps</li><li>• Can be set higher for hard to start load</li></ul>
• Current limit <sup>①</sup>	<ul style="list-style-type: none"><li>• Adjustable 250-550% of current rating selected by current calibration dip switches</li><li>• Automatically extends acceleration time to keep line current within setting</li></ul>	<ul style="list-style-type: none"><li>• Reduced power costs</li></ul>
• Energy savings	<ul style="list-style-type: none"><li>• Reduces voltage applied to the motor if under loaded or lightly loaded</li><li>• Can be defeated for multi-motor operation</li></ul>	<ul style="list-style-type: none"><li>• Reduced spare parts inventory</li></ul>
• Common logic board <sup>②</sup>	<ul style="list-style-type: none"><li>• One logic board for all current ratings for a given voltage</li></ul>	<ul style="list-style-type: none"><li>• Protection for SCR's</li><li>• Protection from mis-application</li><li>• Protects motor from stall condition</li></ul>
• Stall/SCR protection <sup>③</sup>	<ul style="list-style-type: none"><li>• Inverse time characteristic with thermal memory</li><li>• Trips in 10 seconds or less at 500% current</li><li>• A N.C. contacts opens on trip which can be used to open upstream starter</li><li>• Reset by removing and reapplying 3-phase power</li></ul>	<ul style="list-style-type: none"><li>• Six SCR's provide smoother control than 3-SCR 3-diode design</li><li>• Digital firing circuit responds better to rapid load changes and provides balanced motor current</li></ul>
• Six SCR control with digital firing circuit <sup>④</sup>	<ul style="list-style-type: none"><li>• Each phase has 2 silicon controlled rectifiers</li></ul>	<ul style="list-style-type: none"><li>• Independent third party certification</li></ul>
• U.L. and C.S.A. listed	<ul style="list-style-type: none"><li>• Listed by Underwriters Laboratories</li><li>• Listed by Canadian Standards Association</li></ul>	<ul style="list-style-type: none"><li>• Suitable for most industrial environments</li></ul>
• NEMA 12 enclosure	<ul style="list-style-type: none"><li>• Heat is dissipated by isolated heat sinks outside the totally enclosed box</li></ul>	<ul style="list-style-type: none"><li>• Permits interface with reversing or 2 speed 2 winding starters</li></ul>
• Remote reset	<ul style="list-style-type: none"><li>• After power is removed the voltage ramp is reset (after 100 milli-second delay) to provide reduced voltage for the next start</li></ul>	<ul style="list-style-type: none"><li>• Remote reset capability</li></ul>
• High line voltage control	<ul style="list-style-type: none"><li>• The reset circuit contacts are brought out to terminal strip and factory jumpered. These can be connected to remote switch or contacts for remote operation</li><li>• For remote reset dry contact rated switches must be used</li></ul>	<ul style="list-style-type: none"><li>• PM2 can be switched on/off without opening the contactor, thus avoiding wear and tear on contacts. For applications involving frequent on/off operations in excess of four per hour refer to application consideration</li></ul>
• Optional dual ramp <sup>⑤</sup>	<ul style="list-style-type: none"><li>• With energy saver circuit on, the controller will limit the voltage applied to the motor to controller's rated voltage under high-line conditions. Incoming voltage should be within the controller's rating</li><li>• 2 adjustments are available for torque (initial voltage) and time</li><li>• External maintained contact closure is required to select one or the other</li></ul>	<ul style="list-style-type: none"><li>• Reduces power costs in installation with high line voltage which are common in off-peak hours</li><li>• Different ramps can be set for reversing or 2-speed applications</li><li>• Different ramps can be set for changing load requirements</li></ul>
• Optional smooth stop <sup>⑥</sup>	<ul style="list-style-type: none"><li>• For smooth stop, the voltage applied to the motor is gradually decreased</li><li>• Adjustable 3-30 sec.</li><li>• External momentary contact closure is required to initiate smooth stop</li><li>• Will operate in phase rotation a-b-c only</li></ul>	<ul style="list-style-type: none"><li>• Useful in pumping applications to reduce "water-hammer" effect</li><li>• Useful for smooth stopping a high friction load</li><li>• Does not require external signal to open the starter</li><li>• Provides phase rotation protection</li></ul>
• Phase sequence protection <sup>⑦</sup>		<ul style="list-style-type: none"><li>• Prevents loss/damage due to inadvertent reversal of motor rotation direction</li></ul>

<sup>①</sup> These features apply to Model 3 units only and are not available in PM2A, H.



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

**Table 1 – Standard Conditions for Application**

- Ac supply voltage: 208V  $\pm$  10%  
230, 380, 415, 460, 500, 575, 575V  $\pm$  10-15%  
  
All models suitable for 50 or 60 Hz operation except PM2A is for 60 Hz only and PM2H is for 50 Hz only
- Ambient Temperature: Operating  $-20^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$   
Storage and transportation  $-40^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$
- Humidity: 20 to 95% non-condensing
- Altitude: 3300 ft. maximum

**Table 2 – Adjustments**

Adjustment	Range	Approx. Factory Setting
Ramp time (Time 1)	1-45 sec.	10 sec.
Initial voltage (Torq 1)	20-80%	50%
Current limit (CL)①	250-550%	450%
Energy saving switch (DS1-5)	On/Off	On, DS1-5 Off
Optional dual adj. (Time 2)①	1-45 sec.	10 sec.
Optional dual adj. (Torq 2)①	20-80%	50%
Optional smooth stop time①	3-30 sec.	15 sec.
Current calibration (DS-1) switches (First 4 dip switches)	As shown on instruction board	Off Set at time of installation for motor full load amps
Voltage rating plugs (for dual voltage rated models only)	208/230 or 460V 380 or 415V 500 or 575V	Two plugs supplied loose select and install the plug which matches motor nameplate voltage

① Not available in PM2A, H.

**Table 3 - Catalog No. and Prices**

Standard NEMA 12 Enclosure Catalog Number	Voltage	Motor Full Load Amps Range	Frequency	List Price
PM2-A	208/230 or 460V	1.8-10 Amp	60 Hz	\$ 978
PM2-B	208/230 or 460V	2.3-34 Amp	50/60 Hz	1404
PM2-C	208/230 or 460V	3.4-52 Amp	50/60 Hz	1623
PM2-D	208/230 or 460V	6.8-104 Amp	50/60 Hz	3568
PM2-E	500/575V	2.3-34 Amp	50/60 Hz	1623
PM2-F	500/575V	3.4-52 Amp	50/60 Hz	1841
PM2-G	500/575V	6.8-104 Amp	50/60 Hz	4108
PM2-H	380V	1.8-10 Amp	50 Hz	978
PM2-J	380/415V	2.3-34 Amp	50/60 Hz	1404
PM2-K	380/415V	3.4-52 Amp	50/60 Hz	1623
PM2-M	380/415V	6.8-104 Amp	50/60 Hz	3568

### Optional Features

#### Special Features Logic Board ①

To specify, add suffix "L" to catalog number. This board includes all the standard features, plus:

- 3-30 second adjustable smooth stop with interlock (this is the same NC contact which opens on Stall/SCR protection trip on units without the "L" option)
- Dual starting torque and ramp time adjustments
- Available as factory installed option only.

**List Price Addition: \$328**

#### Type 4X Stainless Steel Enclosure①

Add suffix letter "W" to catalog number

**List Price Addition:**

PM2-B, C, E, F, J, K: **\$650**

PM2-D, G, M: **\$1404**

#### Open Panel Design

Add suffix "P" to catalog number

**List Price Deduction:**

PM2-A, H: **None**

PM2-B, C, E, F, J, K: **\$50**

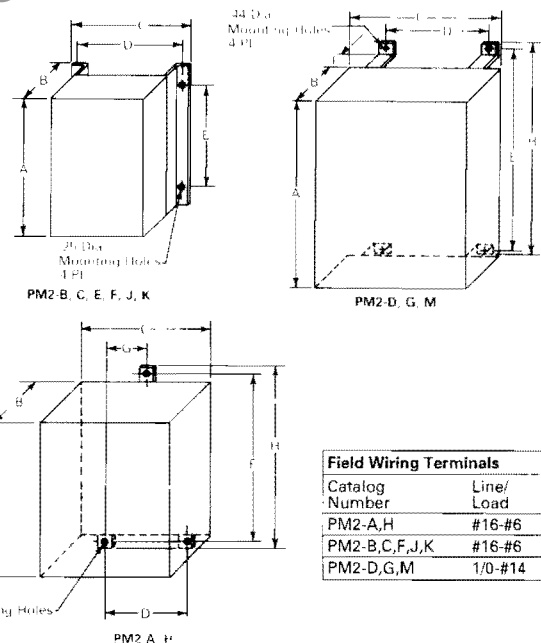
PM2-D, G, M: **\$100**

① Not available on PM2-A, H.

**Table 4 – Dimensions and Weights**

Approximate only not to be used for construction purposes unless approved.

#### Enclosed Units



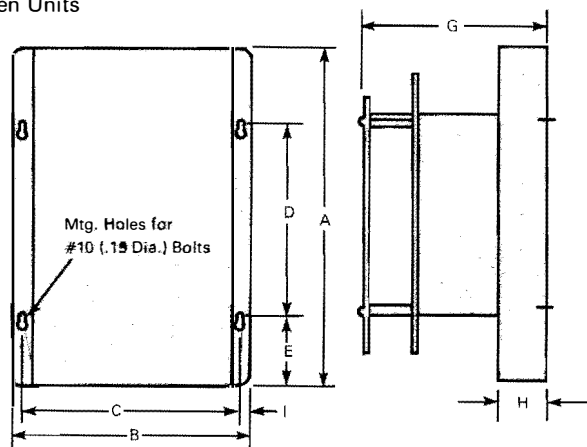
Field Wiring Terminals		
Catalog Number	Line/Load	Ground
PM2-A, H	#16-#6	#16-#6
PM2-B, C, F, J, K	#16-#6	1/0-#14
PM2-D, G, M	1/0-#14	1/0-#14

Catalog Number	Dimensions, Inches								Weight Lbs.
	A	B	C	D	E	F	G	H	
PM2-A, H	11	5 3/4	7 3/4	5 1/8	12	..	2 15/16	12 1/2	10
PM2-B, E, J	14	8 1/2	9 1/4	9 1/8	8	..	..	..	20
PM2-C, F, K	14	8 1/2	9 1/4	9 1/8	8	..	..	..	20
PM2-D, G, M	24	8	24	14 9/16	25 1/8	2 1/4	..	25 1/8	80

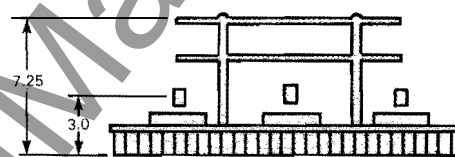
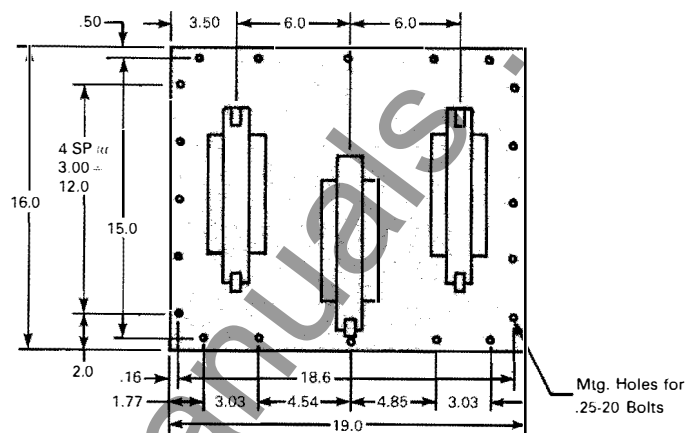


## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Open Units

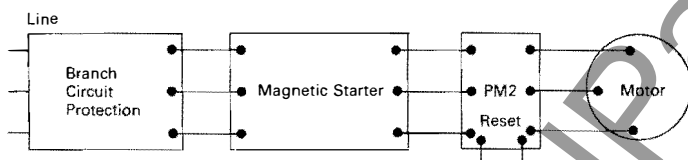


Catalog No.	Dimensions, Inches								Weight Lbs.
	A	B	C	D	E	G	H	I	
PM-2-A, H	12	9.5	8.75	7.56	2.21	4.75	.5	.38	5
PM-2-B, C, E, F, J, K	14	9.85	9.10	8	3	7.5	2	.38	15

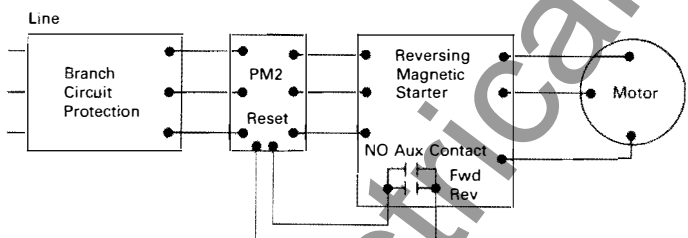


PM2-D, G, M (Weight 30 Lbs.)

### PM2 Customer Connections

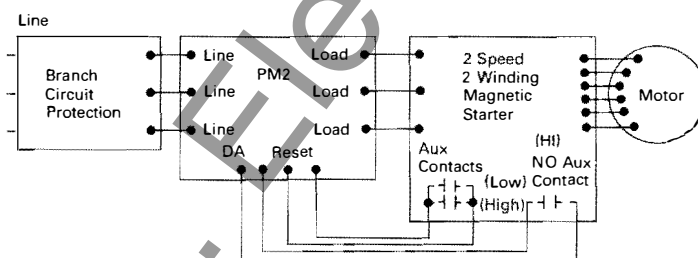


#### Soft Start Only



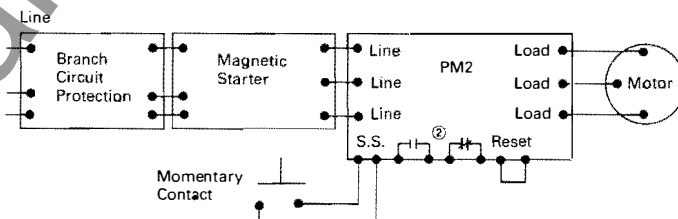
Factory supplied jumper on reset terminals should be removed.

#### Soft Start With Reversing



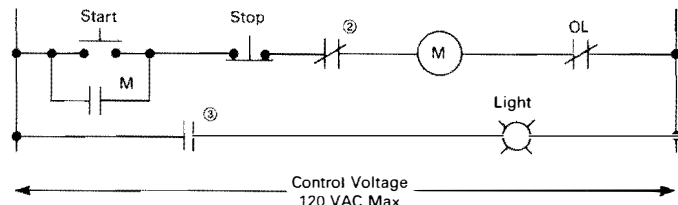
#### Soft Start With 2 Speed, 2 Windings and Dual Adjustment

- 1 Dual adjust not available in PM2-A, H.
- 2 Factory supplied jumper on reset terminals should be removed. Reset is connected in parallel with 1-No. contact on hi speed contactor and 1-No. contact on low speed contactor. Opening and closing of these contacts during transition from one speed to another resets PM2.
- 3 'DA' terminals on PM2 are connected in parallel with 1-No. contact on high speed contactor. Closing of this contact across 'DA' initiates second ramp selected by Torque 2 and Time 2 adjustments.
- 4 The above scheme will provide soft start in either speed when the motor is started after a complete stop. Changing directly from slow speed to high speed or high speed to slow speed will not provide a smooth transition and may cause a current surge.



#### Soft Start With Smooth Stop

1. Smooth Stop not available in PM2-A.
2. There is isolated NC and NO contacts which change states on overcurrent. These same NC and NO contacts also change state when smooth stop ramp-down is complete. These contacts are rated 120 VAC, one ampere and are available for customers use. For example, the NC contact can be used to open the magnetic starter after smooth stop is complete.
3. A momentary contact closure at SS terminals initiates smooth stop.



#### Soft Start With Trip Contact

1. Not available in PM2-A, H.
2. This is a normally closed contact on PM2 which will open on overcurrent. This contact can be used to trip out magnetic starter as shown. Opening of the starter will reset PM2. It is recommended to wait several minutes before attempting a restart. For reversing or multi-speed application this N.C. contact can be similarly connected after overload relay NC contact, to trip the starter.
3. This is a NO contact on PM2 which closes on overcurrent or when smooth stop is completed. On reversing and 2-speed 2-winding applications this contact must be used in conjunction with an external light (supplied by others) to indicate a trip. This is necessary since in these applications contactors are located on the load side of PM2 and opening of contactors will not reset the PM2. After the light comes on the PM2 can be reset by opening and closing the branch circuit breaker (or switch). When smooth stop is required for reversing or 2-speed 2-wind applications, the customer must decide if the NO contact is to be used to indicate completion of smooth stop or an overcurrent condition.



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Application Considerations

#### Multi-Motor Operation

One PM2 can be used to control multiple motors if following conditions are met.

- The current rating of PM2 should be equal to or greater than the total of individual motor full load amps and dip switches must be set for the cumulative full load amps and dip switches must be set for the cumulative full load amps of the motor.
- Energy saver circuit should be turned off.
- The motors should not be mechanically coupled together, i.e. 2 motors on same shaft.
- NEC and local code requirements for individual motor protection and branch circuit protection are met.

#### Installation

Enclosed units must be mounted so heat sink fins are parallel to a vertical mounting structure. The units should have a minimum of six inches clearance on top and bottom for proper ventilation.

Open units should be mounted so that the heat sinks are out in open air thru a properly gasketed cut out in the panel. The temperature inside the enclosure must not exceed 50°C (122°F).

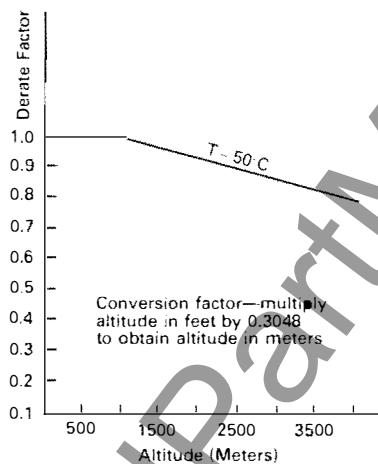
If heat sinks are not brought out in open air, the enclosure should be large enough to dissipate the heat generated by power semi conductors to maintain 50°C (122°F) or less inside the enclosure. Heat loss in watts can be estimated at three times the motor full load amperes. Example: a PM2B connected to a 25HP 460V 34A F.L.A. motor will the estimated loss =  $3 \times 34 = 102$  watts. Heat loss from all other components in the enclosure, e.g., transformers must be considered when deciding upon the size of enclosure.

#### Ambient Temperature

Standard controllers are rated for 50°C (122°F) ambient temperature. For temperatures above 50°C derate by 20%. For every 5°C rise above 50°C up to 60°C (140°F) maximum. Example: PM2B is rated for 34 amps at 50°C. For 55°C the rating would be  $34 \times .8 = 27$  amps maximum.

#### Altitude

Standard controllers are rated for 3300 ft. 1000 meters. Use the following graph for derating above 3300 ft.



#### Derated Curve for Altitude

#### SCR Peak Inverse Voltage (PIV)

Controller Rating	SCR (DIV) Rating
208-230/460 Volts	1200 Volts
575 Volts	1500 Volts

#### Frequent Starting/Stopping

The number of starts and stops depends upon many factors. The most important ones are:

- Position of current limit potentiometer which can be anywhere from 250-550% of the current rating set by dip switches.
- Start time
- Run time
- Off time before next start

The following tables (Table No. 1-4) can be used for guidance in frequent starting/stopping application. These tables are based on worse case condition that the controller will be running at the indicated starting current during the entire start time.

- The number starts per hour in the following tables is based upon the current carrying capacity of PM2. On multiple starts the stall/SCR protection may cause PM2 to trip before the indicated number of starts have been made. If a trip should occur due to multiple starts wait 15 minutes before restarting to avoid damage to PM2.
- Consult motor manufacturer about the effect of multiple starts on motor life.
- Zero off time indicates jogging.

#### Example:

If an application requires 2 starts per minute, 120 starts per hour for a 460V 25HP 34A FLA motor, each cycle is 1/2 minute or 30 sec. If start time is 2 seconds, run time is 25 seconds and off time is 3 seconds.

Percent off time  $3/30 \times 100 = 10\%$ . Using 500% current limit on PM2B,  $34 \times 5 = 170$  amps. Reading in Table 2 for PM2B at 170 amps, 2 seconds start time, 10% off time, we see we can get only 100 starts per hour.

Table 1

PM2-A, H		Starts Per Hour			
Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
		0%	10%	20%	30%
250%) 25	2	150	200	250	300
	5	35	69	90	120
	15	20	30	40	50
	30	4	8	10	12
300%) 30	2	60	90	120	140
	5	20	30	40	60
	15	5	10	15	20
	30	4	6	8	12
400%) 40	2	20	40	60	90
	5	—	4	8	20
	15	—	—	—	—
	30	—	—	—	—
500%) 50	2	3	10	20	30
	5	—	1	2	4
	15	—	—	—	—
	30	—	—	—	—

Table 2

PM2-B, C, J		Starts Per Hour			
Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
		0%	10%	20%	30%
250%) 85	2	400	500	600	600
	5	150	200	250	300
	15	60	70	80	90
	30	30	35	40	45
300%) 102	2	300	400	500	600
	5	80	120	150	180
	15	40	50	60	70
	30*	20	25	30	35
400%) 136	2	100	200	300	400
	5	60	70	80	90
	15*	30	35	40	45
	30	—	—	—	—
500%) 170	2	60	100	150	200
	5	30	40	50	60
	15	—	—	—	—
	30	—	—	—	—

\* Unit May Trip On Overcurrent



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

Table 3

PM2-C, F, K		Starts Per Hour			
Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
		0%	10%	20%	30%
250%)	2	30	40	70	140
	5	10	25	50	75
	15	8	12	16	20
	30	2	6	10	14
300%)	2	20	30	60	130
	5	8	20	30	60
	15	2	8	14	18
	30*	1	2	4	8
400%)	2	10	20	50	120
	5	3	6	10	18
	15*	—	—	1	2
	30	—	—	—	—
500%)	2	4	12	24	36
	5	—	1	2	4
	15	—	—	—	—
	30	—	—	—	—

\* Unit May Trip On Overcurrent

Table 4

PM2-D, G, M		Starts Per Hour			
Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
		0%	10%	20%	30%
250%)	2	100	150	200	250
	5	30	60	90	120
	15	10	20	30	40
	30	5	10	15	20
300%)	2	60	100	140	180
	5	20	40	60	80
	15	5	15	20	25
	30*	1	5	10	15
400%)	2	20	60	100	120
	5	15	25	35	45
	15*	1	8	12	16
	30	—	—	—	—
500%)	2	10	50	70	80
	5	8	20	30	35
	15	—	—	—	—
	30	—	—	—	—

\* Unit May Trip On Overcurrent

The customer may be able to increase his number of starts by increasing his off-time, limiting the inrush current to a value lower than 500%, or by purchasing a larger unit.

For example, if the current limit can be lowered to 400%,  $34 \times 4 = 136$  amps, the PM2B can give 200 starts per hour if the stall/SCR protection does not cause a trip.

### Phase Sequence

The digital trigger is sensitive to input phase rotation. The incoming lines should be in A-B-C rotation. If motor does not start properly reversing any 2 phases will get A-B-C rotation right. If direction of rotation of motor is important it can be changed by reversing any 2 leads on the load side of PM2.

For above reason, reversing contactors/ starters should be connected to load side of the controller.

The above does not apply to PM2-A, H which do not have digital trigger.

### DV/DT Protection

RC snubber networks provided for DV/DT protection. This prevents false firing of SCR's due to rapid changes in voltage.

### Transient Protection

Not provided.

### Stall/SCR Protection

In the event of an overload the PM2 will trip according to the time current curves shown here.

If a trip occurs, the controller can be reset by momentarily opening the 3-phase line. The thermal memory is built into the circuit and it is advisable to wait several minutes before attempting restart of the motor.

A NC contact opens when trip occurs which can be used for remote indication or opening up-stream contactor. This feature is not available in PM2-A, H.

### Capacitors

Do not connect power factor correcting capacitors to the load (motor) side of the controller, as this can result in serious damage to the controller. Power factor correcting capacitors may be connected to the line side of the controller, at least 10 ft. upstream of the controller.

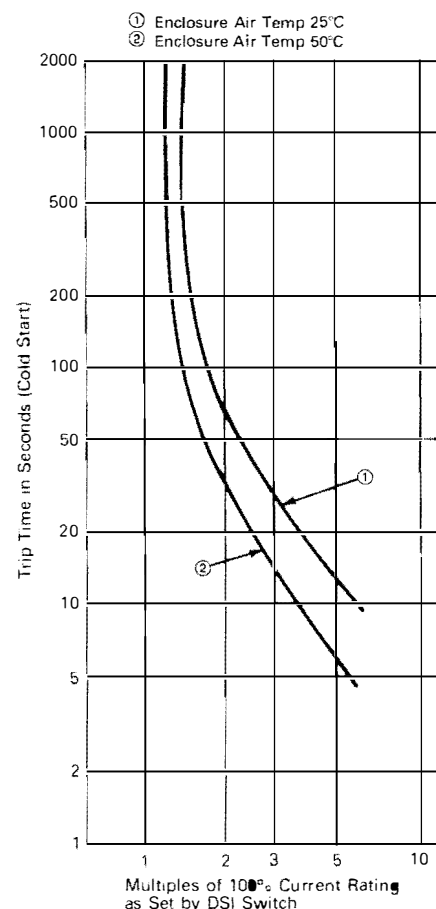
### Overload Capacity

Continuous: 115%

30 Seconds: 250%

5 Seconds: 500%

Overload capacity is based on the current rating of the unit.





## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Model 3 Renewal Parts List

#### 1 Circuit Board

PM2 Cat. No.	Circuit Board Catalog No.	List Price
PM2-A	9032-341A	<b>\$604</b>
PM2-B, C, D	9032-351A	<b>786</b>
PM2-BL, CL, DL	9032-351B	<b>921</b>
PM2-E, F, G	9032-351E	<b>786</b>
PM2-EL, FL, GL	9032-351F	<b>921</b>
PM2-H	9032-341B	<b>604</b>
PM2-J, K, M	9032-351C	<b>786</b>
PM2-JL, KL, ML	9032-351D	<b>921</b>

**2. Power Semi Conductors:** Power semi conductor part nos. for units with 'L' option are the same as for units without 'L' option.

PM2-A, H	9029-397	<b>List Price</b>
	One required per unit. Has three triacs	<b>\$151</b>

	If controller has 3 individual triacs order Part No. 9029-430. Three required per unit.	<b>List Price</b>
		<b>\$68</b>

PM2-B, C, J, K	9029-194	<b>List Price</b>
	Three required per unit. Stick type assembly has 2 SCRs	<b>\$245</b>

PM2-E, F	9029-194 AA	<b>List Price</b>
	Three required per unit. Stick type assembly has 2 SCRs.	<b>\$245</b>

PM2-D, M	9031-379D	<b>List Price</b>
	Three required per unit. Open brick stack assembly has 2 SCRs.	<b>\$895</b>

PM2-G	9031-379E	<b>List Price</b>
	Three required per unit. Open brick stack assembly has 2 SCRs.	<b>\$895</b>

#### 3. Current Transformers (One required per unit)

PM2 Cat. No.	C.T. Cat. No.	List Price
PM2-A, H	9010-110	<b>\$56</b>
PM2-B, C, D, E, F, G, J, K, M	9010-347	<b>56</b>

**4. Voltage Plugs:** The voltage plugs for Model 3 dual voltage rated units are different from previous single voltage units.

Example: PM2-E Model 3 is rated 500/575V

The 575V plug for this unit is different than 575V plug on the previous PM2-E which was rated 575V only.

	Cat. No.	List Price
<b>Single Voltage Units:</b>		
PM2-H 380V Plug	9028-460B	<b>\$66</b>
<b>Dual Voltage Units</b>		
208/230 V Plug	9028-460A	<b>66</b>
460 V Plug	9028-460C	<b>66</b>
380 V Plug	9028-460G	<b>66</b>
415 V Plug	9028-460H	<b>66</b>
500 V Plug	9028-460J	<b>66</b>
575 V Plug	9028-460K	<b>66</b>

**5.** Existing units which do not have Model 3 on nameplate use all the same parts as above except for Circuit Board listed in paragraph 1, only PM2-A, H use the same board since they are not Model 3.

Also as stated in paragraph 4, above voltage plugs for new dual voltage Model 3 units are also different.

For replacement or upgrading existing units to Model 3 features the following part nos. should be offered which will include

- Circuit board with Model 3 features
- New instruction board for Model 3
- New set of voltage rating plugs.

Cat No.	PM2 Model 3 Upgrade Kit	List Price
PM2-B, C	9071A20G01	<b>\$866</b>
PM2-D	9071A20G02	<b>866</b>
PM2-BL- CL	9071A21G01	<b>1028</b>
PM2-DL	9071A21G02	<b>1028</b>
PM2-E, F	9071A22G01	<b>866</b>
PM2-G	9071A22G02	<b>866</b>
PM2-GL	9071A23G01	<b>1028</b>
PM2-EL, FL	9071A23G02	<b>1028</b>
PM2-J, K	9071A24G01	<b>866</b>
PM2-M	9071A24G02	<b>866</b>
PM2-JL, KL	9071A25G01	<b>1028</b>
PM2-ML	9071A25G02	<b>1028</b>

#### 6. Installation Manual

Part No.	List Price
9085-8620	<b>\$56</b>





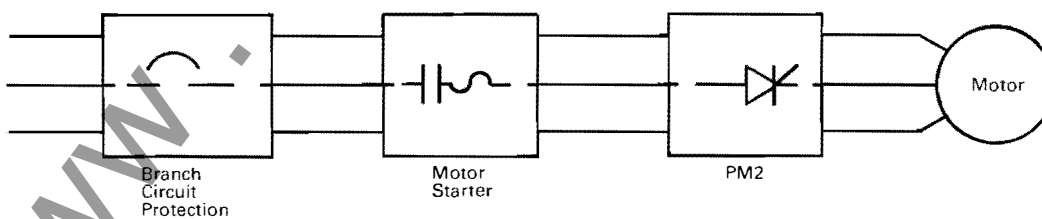
## POWER MISER 2 Solid State Soft-Start Energy Saving Motor Controller

### Description

PM2 Model 3 is introduced to enhance the industry's most complete, U.L. labeled line of solid state soft start motor controllers. It retains all the features of existing line and adds enhancements like digital firing circuit, STALL/SCR protection which are described later in this publication.

The Westinghouse PM2 Controller controls the voltage applied to the induction motor by phasing back the power semiconductors thru electronic logic. It provides soft and smooth starting and timed acceleration and can be used with standard 3-phase induction motors. The PM2 is installed between electromechanical starter and the motor as shown below.

Time proven silicon controlled rectifiers (SCR's) or thyristors are used on all models except 10 amp model which uses TRIAC's.



Typical Connection Diagram



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Why Soft Start

Across the line or full voltage starting remains the most economical way of starting an induction motor. However starting an induction motor at full line voltage results in an initial inrush current of up to 5-8 times the full load current and the starting torque produced by motor and applied to the power train and driven load is 1.5 to 2.5 times the motor full load torque. During acceleration even higher torque can be experienced by power train and driven load. Both high inrush current and high starting torque cause problems which may be grouped as follows:

#### Mechanical Problems

- Belts stretching and breaking, and squealing
- Gears breaking
- Couplings wearing out
- Drive train shafts breaking

#### Motor Problems

- Motor insulation deterioration and premature winding failure
- Foundation bolts and mounting failures
- Bearing lock-up and failure
- Motor shaft cracking and breaking
- Excess energy consumption

#### Electric Product Problems

- Contact pitting and wear
- Coil burnout

#### Inrush Current Related Problems

- Voltage drop downstream causing Electro-mechanical starter coils to drop out
- Soft supply systems may not have available current to start motor
- Lighting brown-outs/computer hiccups

#### Fragile Product Problems

- Materials chip, crack, spoil or break
- Positioned products are shifted

By phasing back the power semiconductors PM2 applies a lower voltage to the induction motor. The value of this initial voltage also called initial torque is user selectable then over a period of time the voltage is gradually increased to full line voltage. This time called ramp time is also user selectable.

In this way a smooth stepless start is accomplished which will minimize any of the above problems. The benefits are such that almost every process or plant offers a potential for this product. For more details on the benefits of soft start please see sales aid SA 8600A. Typical applications include the following which are listed by special industry classification (SIC) codes.

#### SIC 20 – Food Processing

- Bottling line equipment
- Conveyors
- Mixers
- Riser Dumpers
- Ovens/Bakery Equipment
- Refrigeration Compressors'
- Chillers
- Air Compressors

#### SIC 22 – Textiles

- Tufting Machines
- Carpet Looms
- Textile Spinners
- Air Compressors
- Exhaust Fans

#### SIC 24 – Lumber & Wood Products

- Cut off Saws
- Wood Hogs
- Sanders
- Planers
- Tenant Shaping Machines
- Air Compressors
- Exhaust Fans
- Wood Working Machines
- Chippers

#### SIC 25 – Furniture & Fixtures

- Milling Machines
- Sanders
- Exhaust Fans
- Air Compressors
- Wood Hogs

#### SIC 26 – Pulp & Paper

- Pumps
- Paper Refiners
- Wood Hogs
- Chippers
- Sifters

#### SIC 28 – Chemicals

- Air Compressors
- Granulators
- Agitators
- Mixers
- Conveyors
- Blowers

#### SIC 29 – Petroleum

- Oil Field Pumps
- Water Pumps
- Fans/Blowers

#### SIC 30 – Rubber & Plastic Products

- Granulators
- Mixers
- Agitators
- Injection Molding Machines
- Pelletizers

#### SIC 32 – Dry Process/Mining

- Underground Conveyors
- Cone Crushers
- Jaw Crushers
- Fans
- Asphalt Mixers
- Cement Mixers
- Conveyors

#### SIC 33 – Metals

- Fans
- Grinders
- Jump Mills
- Cooling Racks
- Outrun Lines
- Reversing Conveyors

#### SIC 35 – Machinery OEMS

- Mining Machinery
- Elevators & Escalators
- Conveyors
- Metal Forming Equipment
- Rolling Mill Machinery
- Food Products Machinery
- Textile Machinery
- Woodworking Machinery
- Pumps
- Air & Gas Compressors
- Blowers & Fans
- Commercial Laundry Equipment
- Food Processing Equipment
- Cold Storage Plant Equipment
- Beverage/Bottling Equipment
- Large Building AC Systems

#### SIC 37 – Transportation

- Shipbuilding
- Pumps
- Rudder Control
- Bulk Conveyors
- Compressors



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Model 3

Feature	Explanation	What They do for You
• Current calibration dip switches	<ul style="list-style-type: none"><li>• Each model can be applied for a wide range of applications</li><li>• Four models cover 1-40 Hp, 230V, and 1-75 Hp, 460V application</li></ul>	<ul style="list-style-type: none"><li>• Increased User/OEM flexibility</li><li>• Reduced distributor inventory</li></ul>
• Dual voltage rating	<ul style="list-style-type: none"><li>• Same model for 208/230 or 460V for rated amps</li><li>• Select voltage by using one of the 2 plugs supplied with the unit</li></ul>	<ul style="list-style-type: none"><li>• Increased User/OEM flexibility</li><li>• Reduced distributor inventory</li></ul>
• Time and torque adjustment	<ul style="list-style-type: none"><li>• Torque (initial voltage) 20-80%</li><li>• Time 1-45 seconds</li></ul>	<ul style="list-style-type: none"><li>• Soft start</li><li>• Stepless acceleration</li><li>• Reduced inrush</li><li>• Reduced wear on motor and drive train</li><li>• Adjust to meet any type of load</li></ul>
• Current limit <sup>①</sup>	<ul style="list-style-type: none"><li>• Adjustable 250-550% of current rating selected by current calibration dip switches</li><li>• Automatically extends acceleration time to keep line current within setting</li></ul>	<ul style="list-style-type: none"><li>• Limits motor inrush amps</li><li>• Can be set higher for hard to start load</li></ul>
• Energy savings	<ul style="list-style-type: none"><li>• Reduces voltage applied to the motor if under loaded or lightly loaded</li><li>• Can be defeated for multi-motor operation</li></ul>	<ul style="list-style-type: none"><li>• Reduced power costs</li></ul>
• Common logic board <sup>①</sup>	<ul style="list-style-type: none"><li>• One logic board for all current ratings for a given voltage</li></ul>	<ul style="list-style-type: none"><li>• Reduced spare parts inventory</li></ul>
• Stall/SCR protection <sup>①</sup>	<ul style="list-style-type: none"><li>• Inverse time characteristic with thermal memory</li><li>• Trips in 10 seconds or less at 500% current</li><li>• A N.C. contacts opens on trip which can be used to open upstream starter</li><li>• Reset by removing and reapplying 3 phase power</li></ul>	<ul style="list-style-type: none"><li>• Protection for SCR's</li><li>• Protection from mis-application</li><li>• Protects motor from stall condition</li></ul>
• Six SCR control with digital firing circuit <sup>①</sup>	<ul style="list-style-type: none"><li>• Each phase has 2 silicon controlled rectifiers</li></ul>	<ul style="list-style-type: none"><li>• Six SCR's provide smoother control than 3-SCR 3-diode design</li><li>• Digital firing circuit responds better to rapid load changes and provides balanced motor current</li></ul>
• U.L. and C.S.A. listed	<ul style="list-style-type: none"><li>• Listed by Underwriters Laboratories</li><li>• Listed by Canadian Standards Association</li></ul>	<ul style="list-style-type: none"><li>• Independent third party certification</li></ul>
• NEMA 12 enclosure	<ul style="list-style-type: none"><li>• Heat is dissipated by isolated heat sinks out side the totally enclosed box</li></ul>	<ul style="list-style-type: none"><li>• Suitable for most industrial environments</li></ul>
• Remote reset	<ul style="list-style-type: none"><li>• After power is removed the voltage ramp is reset (after 100 milli-second delay) to provide reduced voltage for next start</li><li>• The reset circuit contacts are brought out to terminal strip and factory jumpered. These can be connected to remote switch or contacts for remote operation</li><li>• For remote reset dry contact rated switches must be used</li></ul>	<ul style="list-style-type: none"><li>• Permits interface with reversing or 2 speed 2 winding starters</li><li>• Remote reset capability</li><li>• PM2 can be switched on/off without opening the contactor, thus avoiding wear and tear on contacts. For applications involving frequent on/off operations in excess of four per hour refer to application consideration</li></ul>
• High line voltage control	<ul style="list-style-type: none"><li>• With energy saver circuit on, the controller will limit the voltage applied to the motor to controller's rated voltage under high-line conditions. Incoming voltage should be within the controller's rating</li></ul>	<ul style="list-style-type: none"><li>• Reduces power costs in installation with high line voltage which are common in off-peak hours</li></ul>
• Optional dual ramp <sup>①</sup>	<ul style="list-style-type: none"><li>• 2 adjustments are available for torque (initial voltage) and time</li><li>• External maintained contact closure is required to select one or the other</li></ul>	<ul style="list-style-type: none"><li>• Different ramps can be set for reversing or 2-speed applications</li><li>• Different ramps can be set for changing load requirements</li></ul>
• Optional smooth stop <sup>①</sup>	<ul style="list-style-type: none"><li>• For smooth stop, the voltage applied to the motor is gradually decreased</li><li>• Adjustable 3-30 sec.</li><li>• External momentary contact closure is required to initiate smooth stop</li></ul>	<ul style="list-style-type: none"><li>• Useful in pumping applications to reduce "water-hammer" effect</li><li>• Useful for smooth stopping a high friction load</li><li>• Does not require external signal to open the starter</li></ul>
• Phase sequence protection <sup>①</sup>	<ul style="list-style-type: none"><li>• Will operate in phase rotation a-b-c only</li></ul>	<ul style="list-style-type: none"><li>• Provides phase rotation protection</li><li>• Prevents loss/damage due to inadvertent reversal of motor rotation direction</li></ul>

<sup>①</sup> These features apply to Model 3 units only and are not available in PM2A, H



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

**Table 1 – Standard Conditions for Application**

- Ac supply voltage: 208V  $\pm$  10%  
230, 380, 415, 460, 500, 575V  $\pm$  10-15%  
  
All models suitable for 50 or 60 Hz operation except  
PM2A is for 60 Hz only and PM2H is for 50 Hz only
- Ambient Temperature: Operating  $-20^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$   
Storage and transportation  $-40^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$
- Humidity: 20 to 95% non-condensing
- Altitude: 3300 ft. maximum

**Table 2 – Adjustments**

Adjustment	Range	Approx. Factory Setting
Ramp time (Time 1)	1-45 sec.	10 sec.
Initial voltage (Torq 1)	20-80%	50%
Current limit (CL)①	250-550%	450%
Energy saving switch (DS1-5)	On/Off	On, DS1-5 Off
Optional dual adj. (Time 2)●	1-45 sec.	10 sec.
Optional dual adj. (Torq 2)①	20-80%	50%
Optional smooth stop time①	3-30 sec.	15 sec.
Current calibration (DS-1) switches (First 4 dip switches)	As shown on instruction board	Off Set at time of installation for motor full load amps
Voltage rating plugs (for dual voltage rated models only)	208/230 or 460V 380 or 415V 500 or 575V	Two plugs supplied loose select and install the plug which matches motor nameplate voltage

① Not available in PM2A, H.

**Table 3 – Catalog No. and Prices**

Standard NEMA 12 Enclosure Catalog Number	Voltage	Motor Full Load Amps Range	Frequency	List Price
PM2-A	208/230 or 460V	1.8-10 Amp	60 Hz	\$ 940
PM2-B	208/230 or 460V	2.3-34 Amp	50/60 Hz	1350
PM2-C	208/230 or 460V	3.4-52 Amp	50/60 Hz	1560
PM2-D	208/230 or 460V	6.8-104 Amp	50/60 Hz	3430
PM2-E	500/575V	2.3-34 Amp	50/60 Hz	1560
PM2-F	500/575V	3.4-52 Amp	50/60 Hz	1770
PM2-G	500/575V	6.8-104 Amp	50/60 Hz	3950
PM2-H	380V	1.8-10 Amp	50 Hz	940
PM2-J	380/415V	2.3-34 Amp	50/60 Hz	1350
PM2-K	380/415V	3.4-52 Amp	50/60 Hz	1560
PM2-M	380/415V	6.8-104 Amp	50/60 Hz	3430

**Optional Features****Special Features Logic Board①**

To specify, add suffix "L" to catalog number. This board includes all the standard features, plus:

- 3-30 second adjustable smooth stop with interlock (this is the same NC contact which opens on Stall/SCR protection trip on units without the 'L' option)
  - Dual starting torque and ramp time adjustments
  - Available as factory installed option only.
- List Price Addition: \$315**

**Type 4X Stainless Steel Enclosure①**

Add suffix letter "W" to catalog number

**List Price Addition:**PM2-B, C, E, F, J, K: **\$625**PM2-D, G, M: **\$1350****Open Panel Design**

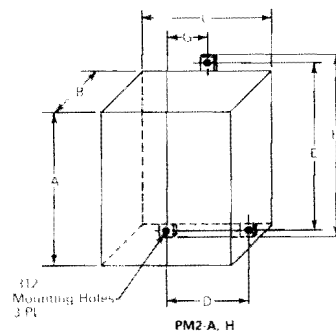
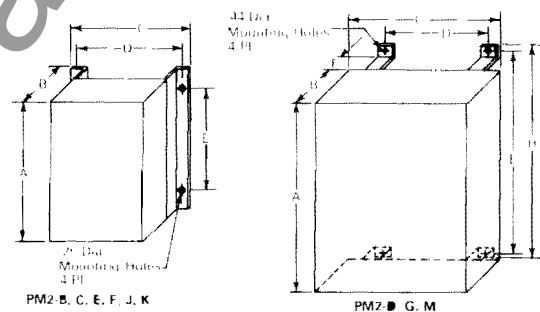
Add suffix "P" to catalog number

**List Price Deduction:**PM2-A, H: **None**PM2-B, C, E, F, J, K: **\$50**PM2-D, G, M: **\$100**

① Not available on PM2-A, H.

**Table 4 – Dimensions and Weights**

Approximate only not to be used for construction purposes unless approved.

**Enclosed Units**

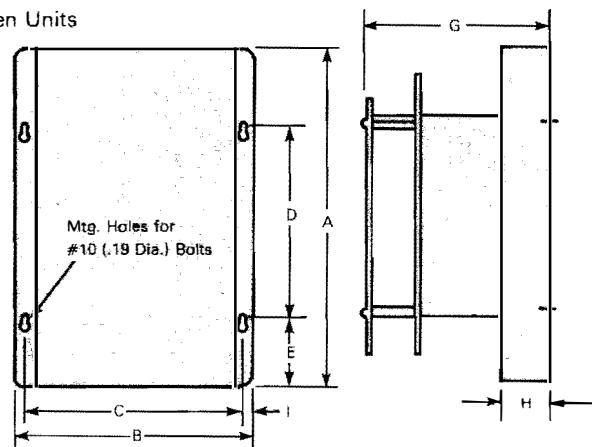
Field Wiring Terminals		
Catalog Number	Line/Load	Ground
PM2-A, H	#16-#6	#16-#6
PM2-B, C, E, F, J, K	#16-#6	1/0-#14
PM2-D, G, M	1/0-#14	1/0-#14

Catalog Number	Dimensions, Inches								Weight Lbs.
	A	B	C	D	E	F	G	H	
PM2-A, H	11	5 3/4	7 3/4	5 7/8	12	..	2 1/8	12 1/2	10
PM2-B, E, J	14	8 1/2	9 7/8	9 3/8	8	..	..	..	20
PM2-C, F, K	14	8 1/2	9 7/8	9 3/8	8	..	..	..	20
PM2-D, G, M	24	8	24	18	25 1/8	2 1/4	..	25 3/8	80

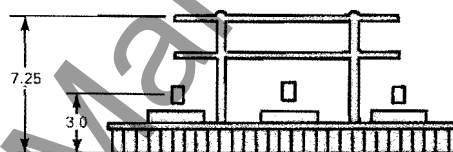
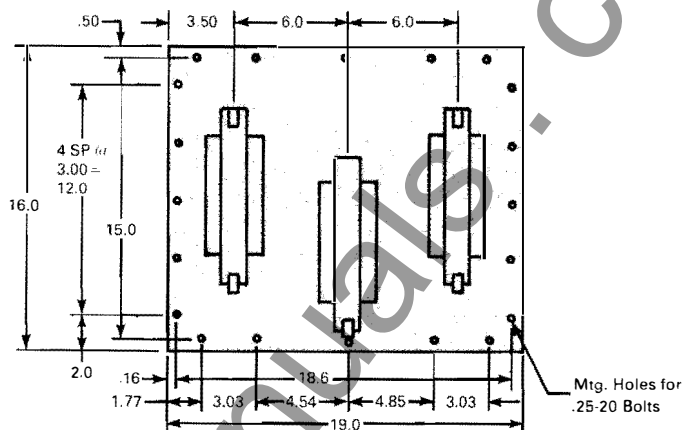


## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

Open Units

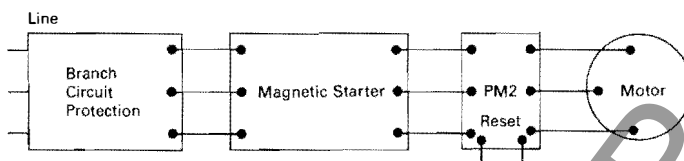


Catalog No.	Dimensions, Inches									Weight Lbs.
	A	B	C	D	E	G	H	I		
PM2-A, H	12	9.5	8.75	7.56	2.21	4.75	.5	.38		5
PM2-B, C, E, F, J, K	14	9.85	9.10	8	3	7.5	2	.38		15

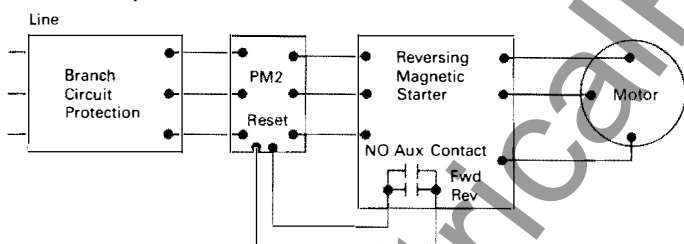


PM2-D, G, M (Weight 30 Lbs.)

### PM2 Customer Connections

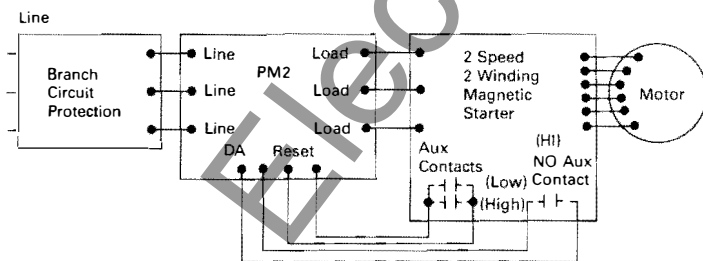


Soft Start Only



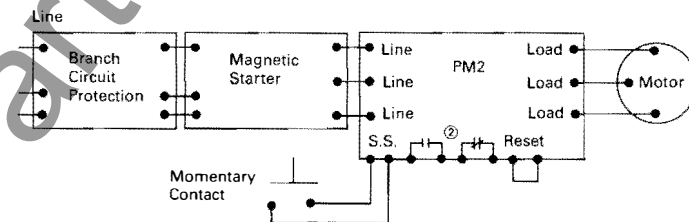
Factory supplied jumper on reset terminals should be removed.

Soft Start With Reversing



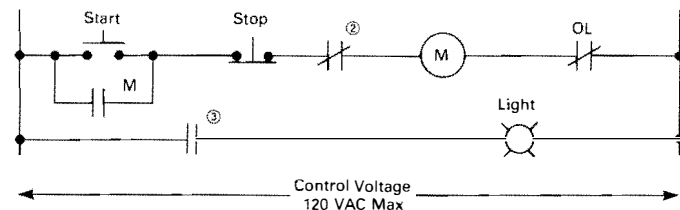
Soft Start With 2 Speed, 2 Windings and Dual Adjustment

- 1 Dual adjust not available in PM2-A, H.
- 2 Factory supplied jumper on reset terminals should be removed. Reset is connected in parallel with 1 No. contact on hi speed contactor and 1 No. contact on low speed contactor. Opening and closing of these contacts during transition from one speed to another resets PM2.
- 3 'DA' terminals on PM2 are connected in parallel with 1-No. contact on high speed contactor. Closing of this contact across 'DA' initiates second ramp selected by Torque 2 and Time 2 adjustments.
- 4 The above scheme will provide soft start in either speed when the motor is started after a complete stop. Changing directly from slow speed to high speed or high speed to slow speed will not provide a smooth transition and may cause a current surge.



Soft Start With Smooth Stop

1. Smooth Stop not available in PM2-A.
2. There are isolated NC and NO contacts which change states on overcurrent. These same NC and NO contacts also change state when smooth stop ramp-down is complete. These contacts are rated 120 VAC, one ampere and are available for customers use. For example, the NC contact can be used to open the magnetic starter after smooth stop is complete.
3. A momentary contact closure at SS terminals initiates smooth stop.



Soft Start With Trip Contact

1. Not available in PM2-A, H.
2. This is a normally closed contact on PM2 which will open on overcurrent. This contact can be used to trip out magnetic starter as shown. Opening of the starter will reset PM2. It is recommended to wait several minutes before attempting a restart. For reversing or multi speed application this N.C. contact can be similarly connected after overload relay NC contact, to trip the starter.
3. This is a NO contact on PM2 which closes on overcurrent or when smooth stop is completed. On reversing and 2-speed 2-winding applications this contact must be used in conjunction with an external light (supplied by others) to indicate a trip. This is necessary since in these applications contactors are located on the load side of PM2 and opening of contactors will not reset the PM2. After the light comes on the PM2 can be reset by opening and closing the branch circuit breaker (or switch). When smooth stop is required for reversing or 2-speed 2-wind applications, the customer must decide if the NO contact is to be used to indicate completion of smooth stop or an overcurrent condition.



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Application Considerations

#### Multi-Motor Operation

- One PM2 can be used to control multiple motors if following conditions are met.
- The current rating of PM2 should be equal to or greater than the total of individual motor full load amps and dip switches must be set for the cumulative full load amps of the motor.
  - Energy saver circuit should be turned off
  - The motors should not be mechanically coupled together, i.e. 2 motors on same shaft.
  - NEC and local code requirements for individual motor protection and branch circuit protection are met.

#### Installation

Enclosed units must be mounted so heat sink fins are parallel to a vertical mounting structure. The units should have a minimum of six inches clearance on top and bottom for proper ventilation.

Open units should be mounted so that the heat sinks are out in open air thru a properly gasketed cut out in the panel. The temperature inside the enclosure must not exceed 50°C (122°F).

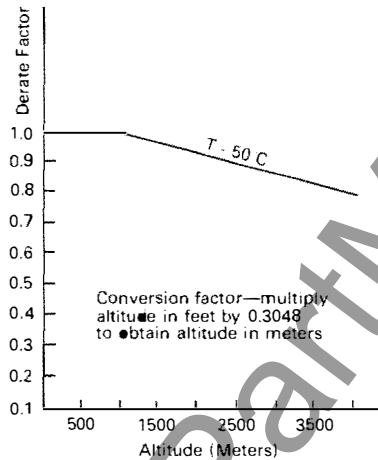
If heat sinks are not brought out in open air, the enclosure should be large enough to dissipate the heat generated by power semi conductors to maintain 50°C (122°F) or less inside the enclosure. Heat loss in watts can be estimated at three times the motor full load amperes. Example: a PM2B connected to a 25HP 460V 34A F.L.A. motor will the estimated loss =  $3 \times 34 = 102$  watts. Heat loss from all other components in the enclosure, e.g., transformers must be considered when deciding upon the size of enclosure.

#### Ambient Temperature

Standard controllers are rated for 50°C (122°F) ambient temperature. For temperatures above 50°C derate by 20%. For every 5°C rise above 50°C up to 60°C (140°F) maximum. Example: PM2B is rated for 34 amps at 50°C. For 55°C the rating would be  $34 \times .8 = 27$  amps maximum.

#### Altitude

Standard controllers are rated for 3300 ft. 1000 meters. Use the following graph for derating above 3300 ft.



#### Derate Curve for Altitude

#### SCR Peak Inverse Voltage (PIV)

Controller Rating SCR (DIV) Rating  
208-230/460 Volts 1200 Volts  
575 Volts 1500 Volts

#### Frequent Starting/Stopping

The number of starts and stops depends upon many factors. The most important ones are:

- Position of current limit potentiometer which can be anywhere from 250-550% of the current rating set by dip switches.
- Start time
- Run time
- Off time before next start

The following tables (Table No. 1-4) can be used for guidance in frequent starting/stopping application. These tables are based on worse case condition that the controller will be running at the indicated starting current during the entire start time.

- The number of starts per hour in the following tables is based upon the current carrying capacity of PM2. On multiple starts the stall/SCR protection may cause PM2 to trip before the indicated number of starts have been made. If a trip should occur due to multiple starts wait 15 minutes before restarting to avoid damage to PM2.
- Consult motor manufacturer about the effect of multiple starts on motor life.
- Zero off time indicates jogging.

Example:

If an application requires 2 starts per minute, 120 starts per hour for a 460V 25HP 34A FLA motor, each cycle is 1/2 minute or 30 sec. If start time is 2 seconds, run time is 25 seconds and off time is 3 seconds.

Percent off time  $3/30 \times 100 = 10\%$ . Using 500% current limit on PM2B,  $34 \times 5 = 170$  amps. Reading in Table 2 for PM2B at 170 amps, 2 seconds start time, 10% off time, we see we can get only 100 starts per hour.

Table 1

PM2-A, H		Starts Per Hour				
Starting Current AC Amps		Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%)	25	2	150	200	250	300
		5	35	69	90	120
		15	20	30	40	50
		30	4	8	10	12
300%)	30	2	60	90	120	140
		5	20	30	40	60
		15	5	10	15	20
		30	4	6	8	12
400%)	40	2	20	40	60	90
		5	—	4	8	20
		15	—	—	—	—
		30	—	—	—	—
500%)	50	2	3	10	20	30
		5	—	1	2	4
		15	—	—	—	—
		30	—	—	—	—

Table 2

PM2-B, C, J		Starts Per Hour				
Starting Current AC Amps		Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%)	85	2	400	500	600	600
		5	150	200	250	300
		15	60	70	80	90
		30	30	35	40	45
300%)	102	2	300	400	500	600
		5	80	120	150	180
		15	40	50	60	70
		30*	20	25	30	35
400%)	136	2	100	200	300	400
		5	60	70	80	90
		15*	30	35	40	45
		30	—	—	—	—
500%)	170	2	60	100	150	200
		5	30	40	50	60
		15	—	—	—	—
		30	—	—	—	—

\*Unit May Trip On Over-Current



## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

Table 3

PM2-C, F, K		Starts Per Hour			
Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
		0%	10%	20%	30%
250%)	130	2	30	40	70
		5	10	25	50
		15	8	12	16
		30	2	6	10
300%)	156	2	20	30	60
		5	8	20	30
		15	2	8	14
		30*	1	2	4
400%)	208	2	10	20	50
		5	3	6	10
		15*	—	—	1
		30	—	—	—
500%)	260	2	4	12	24
		5	—	1	2
		15	—	—	—
		30	—	—	—

\*Unit May Trip On Over-Current

Table 4

PM2-D, G, M		Starts Per Hour			
Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
		0%	10%	20%	30%
250%)	250	2	100	150	200
		5	30	60	90
		15	10	20	30
		30	5	10	15
300%)	300	2	60	100	140
		5	20	40	60
		15	5	15	20
		30*	1	5	10
400%)	400	2	20	60	100
		5	15	25	35
		15*	1	8	12
		30	—	—	—
500%)	500	2	10	50	70
		5	8	20	30
		15	—	—	—
		30	—	—	—

\*Unit May Trip On Over-Current

The customer may be able to increase his number of starts by increasing his off-time, limiting the inrush current to a value lower than 500%, or by purchasing a larger unit.

For example, if the current limit can be lowered to 400%,  $34 \times 4 = 136$  amps, the PM2B can give 200 starts per hour if the stall/SCR protection does not cause a trip.

### Phase Sequence

The digital trigger is sensitive to input phase rotation. The incoming lines should be in A-B-C rotation. If motor does not start properly reversing any 2 phases will get A-B-C rotation right. If direction of rotation of motor is important it can be changed by reversing any 2 leads on the load side of PM2.

For above reason, reversing contactors/starters should be connected to load side of the controller.

The above does not apply to PM2-A, H which do not have digital trigger.

### DV/DT Protection

RC snubber networks provided for DV/DT protection. This prevents false firing of SCR's due to rapid changes in voltage.

### Transient Protection

Not provided.

### Stall/SCR Protection

In the event of an overload the PM2 will trip according to the time current curves shown here.

If a trip occurs, the controller can be reset by momentarily opening the 3-phase line. The thermal memory is built into the circuit and it is advisable to wait several minutes before attempting restart of the motor.

A NC contact opens when trip occurs which can be used for remote indication or opening up-stream contactor. This feature is not available in PM2-A, H.

### Capacitors

Do not connect power factor correcting capacitors to the load (motor) side of the controller, as this can result in serious damage to the controller. Power factor correcting capacitors may be connected to the line side of the controller, at least 10 ft. upstream of the controller.

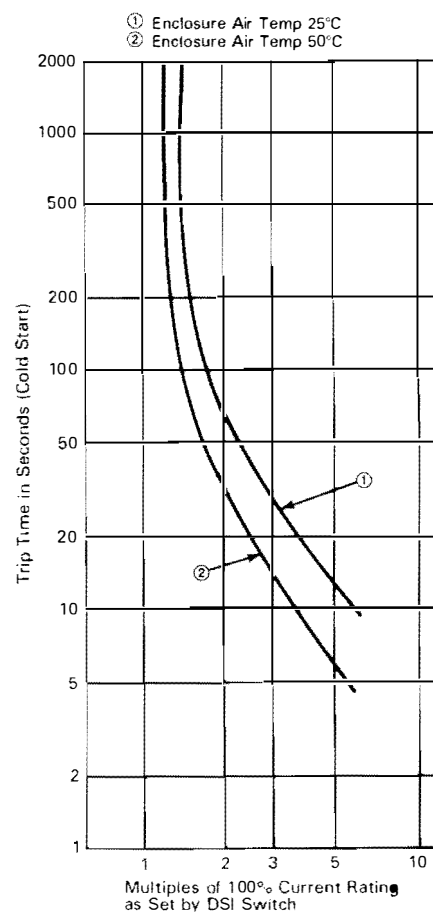
### Overload Capacity

Continuous: 115%

30 Seconds: 250%

5 Seconds: 500%

Overload capacity is based on the current rating of the unit.





## Power Miser 2 Solid State Soft-Start Energy Saving Motor Controller

### Model 3 Renewal Parts List

#### 1 Circuit Board

PM2 Cat. No.	Circuit Board Catalog No.	List Price
PM2-A	9032-341A	\$580
PM2-B, C, D	9032-351A	755
PM2-BL, CL, DL	9032-351B	885
PM2-E, F, G	9032-351E	755
PM2-EL, FL, GL	9032-351F	885
PM2-H	9032-341B	580
PM2-J, K, M	9032-351C	755
PM2-JL, KL, ML	9032-351D	885

**2. Power Semi Conductors:** Power semi conductor part nos. for units with 'L' option are the same as for units without 'L' option.

PM2-A, H	9029-397	List Price
	One required per unit. Has three triacs	\$145

	If controller has 3 individual triacs order Part No. 9029-430. Three required per unit.	List Price
		\$65

PM2-B, C, J, K	9029-194	List Price
	Three required per unit. Stick type assembly has 2 SCRs	\$235

PM2-E, F	9029-194 AA	List Price
	Three required per unit. Stick type assembly has 2 SCRs.	\$235

PM2-D, M	9031-379D	List Price
	Three required per unit. Open brick stack assembly has 2 SCRs.	\$860

PM2-G	9031-379E	List Price
	Three required per unit. Open brick stack assembly has 2 SCRs.	\$860

#### 3. Current Transformers (One required per unit)

PM2 Cat. No.	C.T. Cat. No.	List Price
PM2-A, H	9010-110	\$53
PM2-B, C, D, E, F, G, J, K, M	9010-347	53

**4. Voltage Plugs:** The voltage plugs for Model 3 dual voltage rated units are different from previous single voltage units.

Example: PM2-E Model 3 is rated 500/575V

The 575V plug for this unit is different than 575V plug on the previous PM2-E which was rated 575V only.

	Cat. No.	List Price
Single Voltage Units:		
PM2-H 380V Plug	9028-460B	\$63
Dual Voltage Units		
208/230 V Plug	9028-460A	63
460 V Plug	9028-460C	63
380 V Plug	9028-460G	63
415 V Plug	9028-460H	63
500 V Plug	9028-460J	63
575 V Plug	9028-460K	63

**5. Existing units which do not have Model 3 on nameplate use all the same parts as above except for Circuit Board listed in paragraph 1, only PM2-A, H use the same board since they are not Model 3.**

Also as stated in paragraph 4, above voltage plugs for new dual voltage Model 3 units are also different.

For replacement or upgrading existing units to Model 3 features the following part nos. should be ordered which will include

- Circuit board with Model 3 features
- New instruction board for Model 3
- New set of voltage rating plugs.

Cat. No.	PM2 Model 3 Upgrade Kit	List Price
PM2-B, C	9071A20G01	\$832
PM2-D	9071A20G02	832
PM2-BL- CL	9071A21G01	988
PM2-DL	9071A21G02	988
PM2-E, F	9071A22G01	832
PM2-G	9071A22G02	832
PM2-GL	9071A23G01	988
PM2-EL, FL	9071A23G02	988
PM2-J, K	9071A24G01	832
PM2-M	9071A24G02	832
PM2-JL, KL	9071A25G01	988
PM2-ML	9071A25G02	988

#### 6. Installation Manual

Part No.	List Price
9085-8620	\$53