Sundstrand PCM
PUMP MOTOR LOAD MONITOR

OWNER'S INSTRUCTION MANUAL

SUNDSTRAND™
FLUID HANDLING

Limited Warranty:

For a period of one year from the original purchased date, Sundstrand Fluid Handling will repair or replace without charge any PCM power monitor that has been proved to be detective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized individuals, misused or abused, or improperly installed and has been used in accordance with the instructions and ratings outlined by this manual. The foregoing is in lieu of any other warranty or guarantee expressed or implied, and we are not responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person, caused by items or our manufacture or sales. In any case, Sundstrand's total liability, under all circumstances, shall not exceed the full purchase price of this monitor.

Record information

PCM MODEL NO. _____

SERIAL NUMBER _____

DATE PURCHASED _____

PURCHASED FROM _____

_____

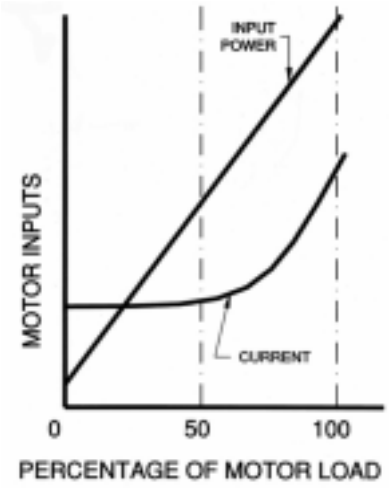
_____

_____

Introduction:

Thank you for choosing the **SUNDSTRAND PCM** motor load monitor for your pump protection application. The **PCM** series incorporates the latest microprocessor technology to sample motor current and voltage to calculate actual motor output power.

The relationships between AC motor current and AC motor input power with respect to motor load are shown in figure 1. The motor current remains almost constant between 0 to 50% of motor load while the motor power increases uniformly with increasing load. Using this linear relationship between input power, the user has a method of linking motor power to the pump performance curve to predict flow rate. Motor output power is calculated by multiplying the measured **input power** by the **motor efficiency** marked on the motor nameplate. This motor efficiency can fluctuate by one or two percent over the entire motor load range depending on the motor manufacturer standards.



Monitoring output power is a simple indicator to determine pump flow, so an operating window can be defined. This window has a low limit (value just above a dry running condition) and a high limit (value equal to the point just prior to cavitation) that are entered into the **PCM** monitor from the four button keyboard on the front panel. If the pump motor operates outside of this window longer than a defined time period, then the **PCM** monitor will open a set of relay contacts that is wired in series with the motor starter coil. When the contacts are open, the motor starter will turn off the electrical power to the pump motor, and then the pump will stop.

Specifications:

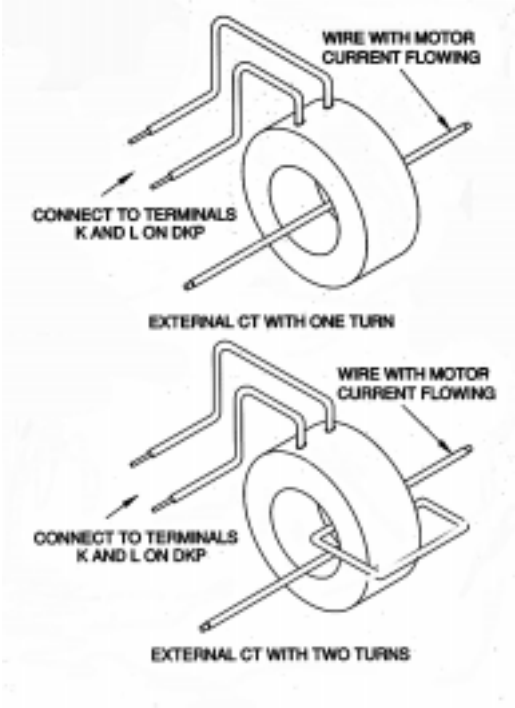
Digital Display	3-digit, 0.3 in. high, 7 segment red LED
Analog Output	Isolated 4-20 mA source (directly proportional to the display range). The maximum load resistance is 400 ohms.
Trip Limit Range	5 to 100% of Full Power Range
Dead Band (Hysteresis)	+5% of Min. limit and -5% of Max. Limit
Start-Up Delay	1-999 seconds (adjustable from keyboard)
Trip Delay Timers	1-99 seconds (adjustable from keyboard)
Phase Detection: Rotation Voltage Degree	 Phase Sequence (order) Phase Difference > 8% Phase Deviation > 5 degree
Frequency Range	45 - 65 Hz
Control Supply	Motor Supply, 3 VA Consumption
Nominal 3-Phase Motor Voltage Range	208 - 230 VAC 380 - 415VAC 440 - 460 VAC 575 - 600 VAC
Current Ranges: Internal CT External CT	 1, 3, 5, and 8 Amp, keyboard selectable Current ratio of N:5 can be used.
Relay Output: Rating Type	 5 Amp @ 250 VAC (non-inductive) SPST, Normally Close
Environment Rating (See page 18 for an optional enclosure)	The unit must be kept away from moisture and out of direct sunlight.
Operating Temperature	+5 to +122°F (-15 to +50 °C)
Enclosure: Material Mounting Rating Dimensions	 Makrolon 8020 (30% GV), UL94V-1 35 mm DIN Rail or flange NEMA 1 Type (IP 20) 2.2 x 2.95 x 4.33 in (75 x 56 x 110 mm)
Safety Approvals	CE

Determine Voltage and Current Requirements:

The specific 3-phase motor voltage range that the unit is designed to work with is marked on the **PCM** nameplate. If this value doesn't match your motor voltage, then contact the factory because a different unit is required. A maximum of 8 amps can be connected directly to the current input at terminals K and L. An external current transformer (CT) with a ratio of N:5 amp is required when the motor current is higher than 8 amps.

Using An External Current Transformer:

The wire that the motor current is flowing through is passed through the hollowed core (center) of the current transformer. The two wire leads from the transformer are connected to terminals **K** and **L** on the **PCM** unit. For some instances, an external transformer can be converted to a different value than what is marked on the device. A 100:5 current transformer can be converted to a 50:5 transformer by wrapping another wire turn through the center of the transformer. The accuracy issue limits the number of wire turns to a maximum of three.



Selecting Motor Current Range Setting:

Maximum Sampling in Amps	Internal CT Setting	External CT Required	Turns	Setting
1	1	NOT REQUIRED		
3	3			
5	5			
8	8			
10	**OFF**	50:5	1	10.1
15	**OFF**	50:5	2	30.3
25	**OFF**	50:5	2	50.5
30	**OFF**	50:5	1	30.3
50	**OFF**	50:5	1	50.5
75	**OFF**	150:5	2	150
150	**OFF**	150:5	1	150
300	**OFF**	300:5	1	300

If the motor nameplate current rating is greater than 8 amps, then an external transformer (CT) is required with the **PCM** unit. Three common CT ratios (50:5, 150:5, and 300:5) were selected to cover the 10 amps through 300 amps ranges listed above. Once a CT value is chosen, the external CT setting and the number of wire turns (wrapped around the CT) must be entered into **PCM** unit during the initial set-up directions on page 10.

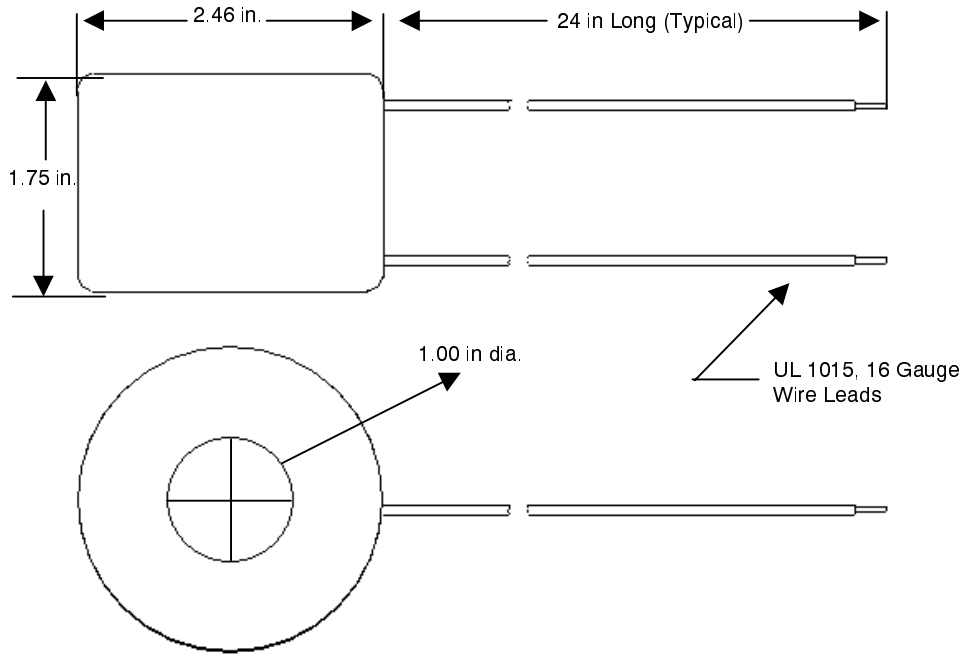
Note: The **PCM** unit is designed to work with these CT ratios if a different or higher range is required in the application.

75:5 100:5 125:5 200:5
250:5 400:5 500:5

Contact **Sundstrand** if you require assistance in using these ratios in the application.

CTs Available From Sundstrand:

Sundstrand uses a donut style current transformer that is recognized by UL (Underwriters Laboratories).

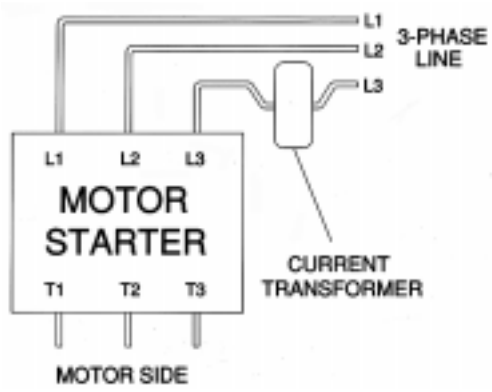


Three stock ratios are available. The PCM model no. indicates what external CT was shipped with the unit.

Industry Designation	Primary Range	Secondary Output
50:5	**0 to 50 amp**	**0 to 5 amp**
150:5	**0 to 150 amp**	**0 to 5 amp**
300:5	**0 to 300 amp**	**0 to 5 amp**

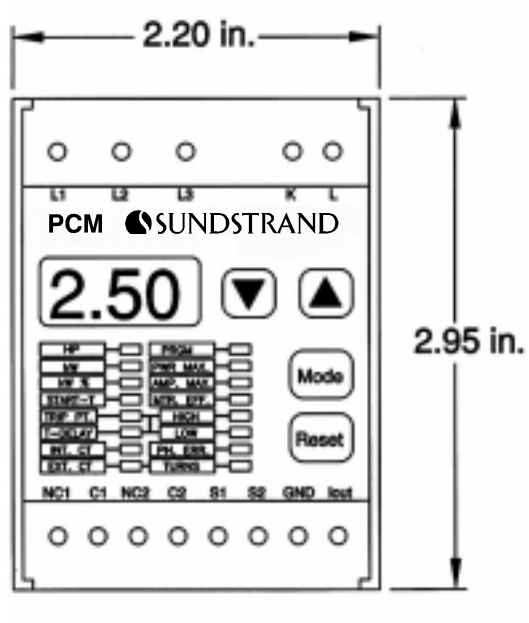
Mounting an External CT:

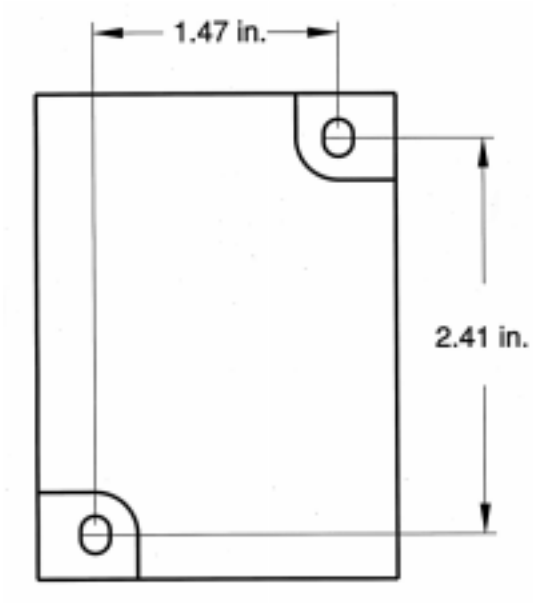
An external current transformer (CT) is installed around the wire connected to the terminal L3 on the motor starter. For a donut shape current transformer, it is recommended that a downward loop be formed in the wire to form a notch where the transformer can be anchored to prevent movement.



Mounting the PCM:

The **PCM** monitor can be mounted inside either a motor starter control cabinet or a similar electrical enclosure to shield it from moisture. Two (size no. 8) screws installed in the corner slots of the **PCM** enclosure will secure the unit to an internal panel. The unit can also be attached to 35 mm DIN rail.



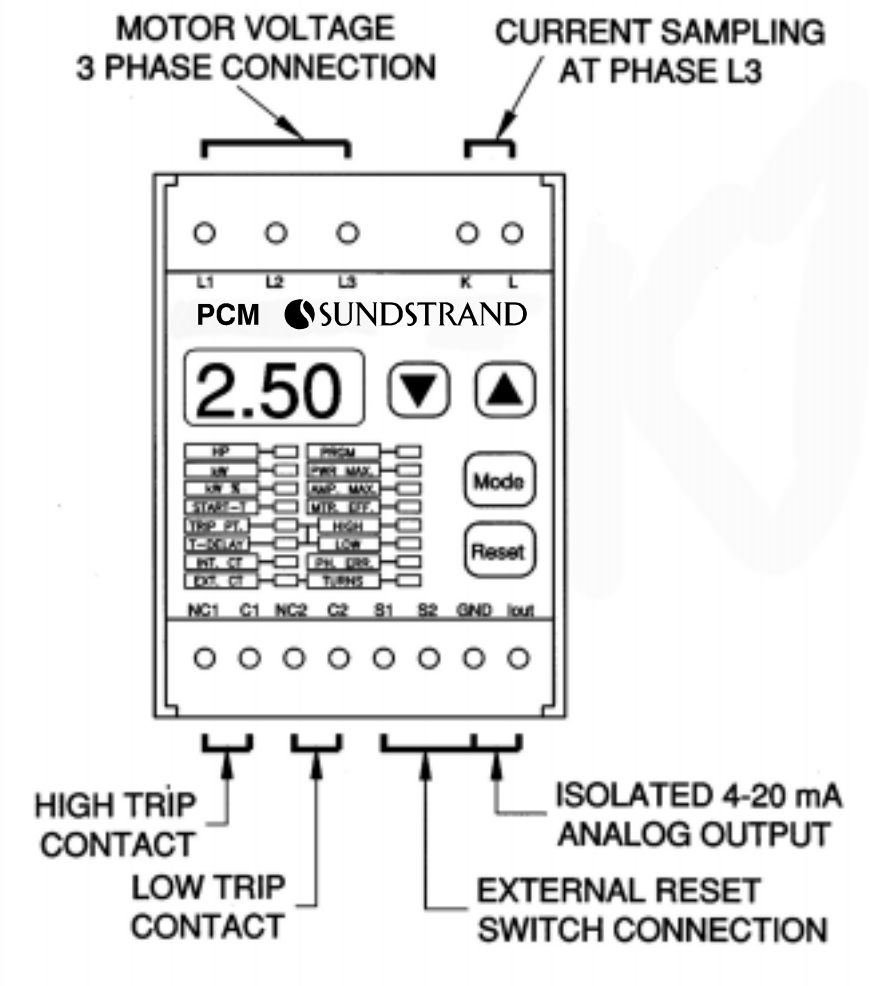


CAUTION

The PCM monitor is directly connected to the AC supply that powers the motor, and *dangerous voltage potentials* are present. All installation and servicing must be performed by qualified personnel with the AC supply disconnected and locked out.

Installation Wiring:

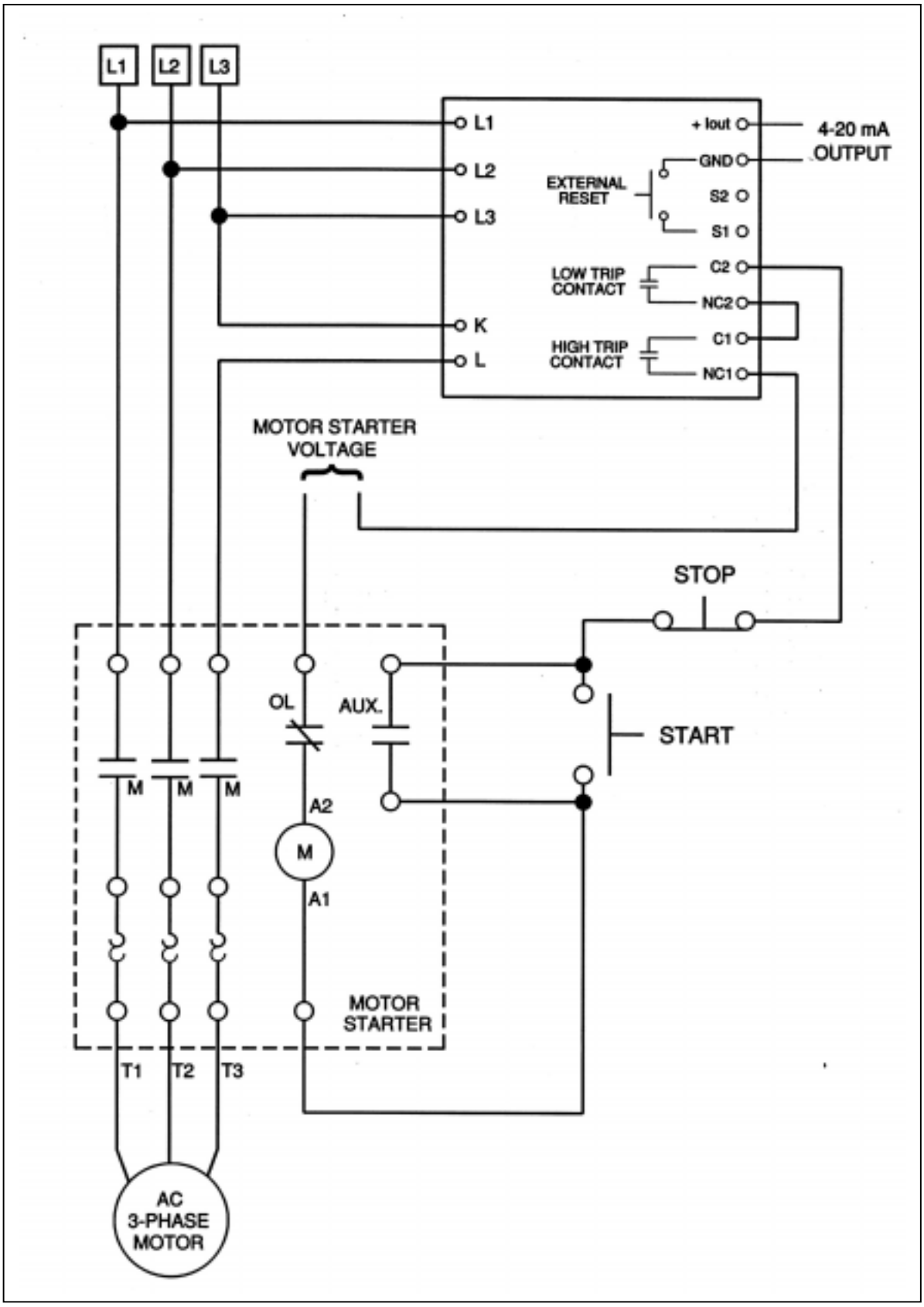
It is **strongly recommended** that all **wiring be done** according **to local electrical codes**.



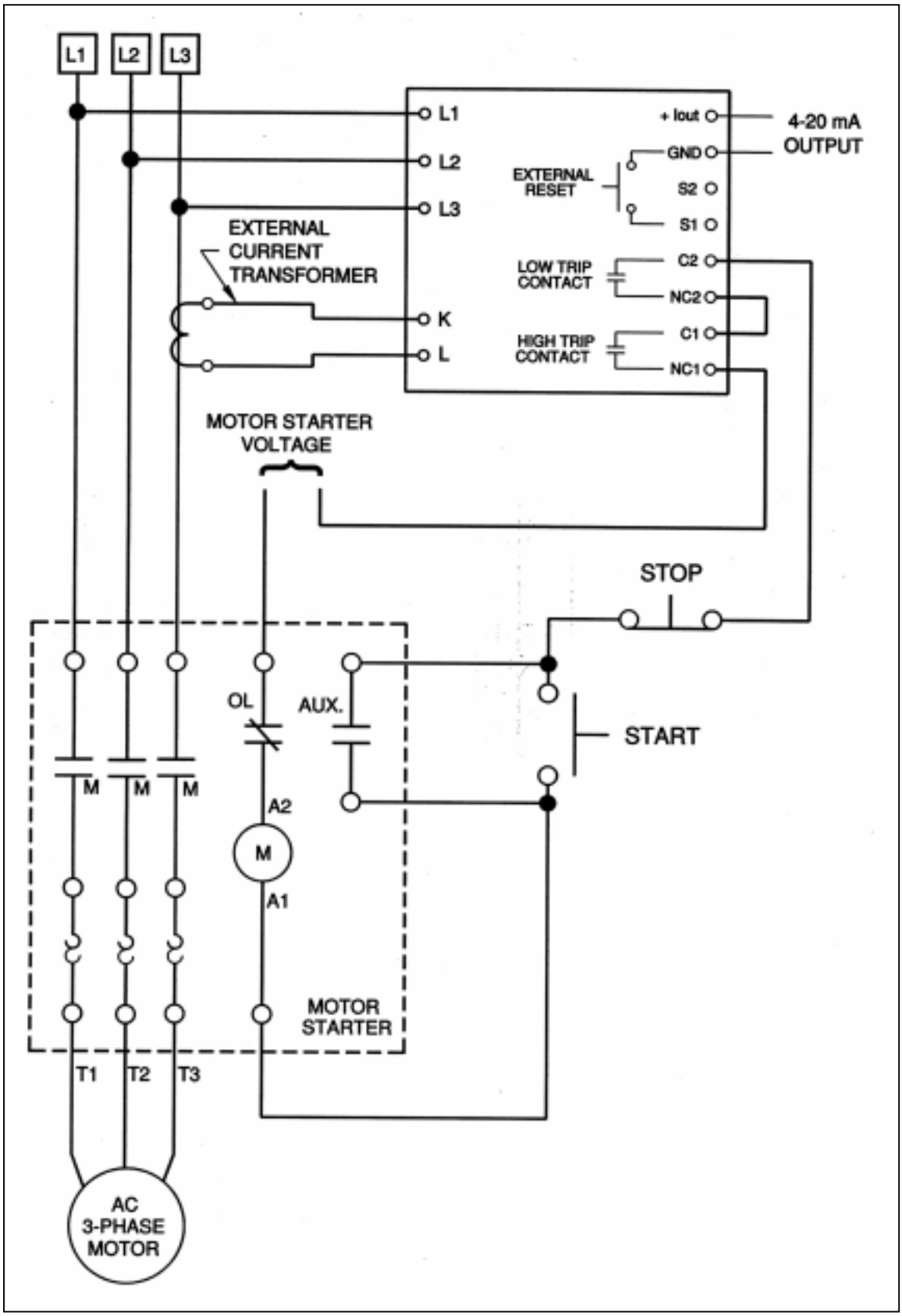
Terminal	Description	Terminal	Description
L1	Phase Voltage L1 Input	NC2	Low Trip Contact In
L2	Phase Voltage L2 Input	C2	Low Trip Contact Out
L3	Phase Voltage L3 input	S1	External Reset
K	Phase Current L3 In	S2	**Do not use**
L	Phase Current L3 Out	GND	DC Ground
NC1	High Trip Contact In	I_{OUT}	4-20 mA Output
C1	High Trip Contact Out		

Note:

1. The terminal block will accept a maximum of 12 gauge wire.
2. The maximum recommended tighten torque for the terminal block screws is 7 in-lb.



Motor Current **Less Than 8 AMPS**



Motor Current **Greater than 8 AMPS**

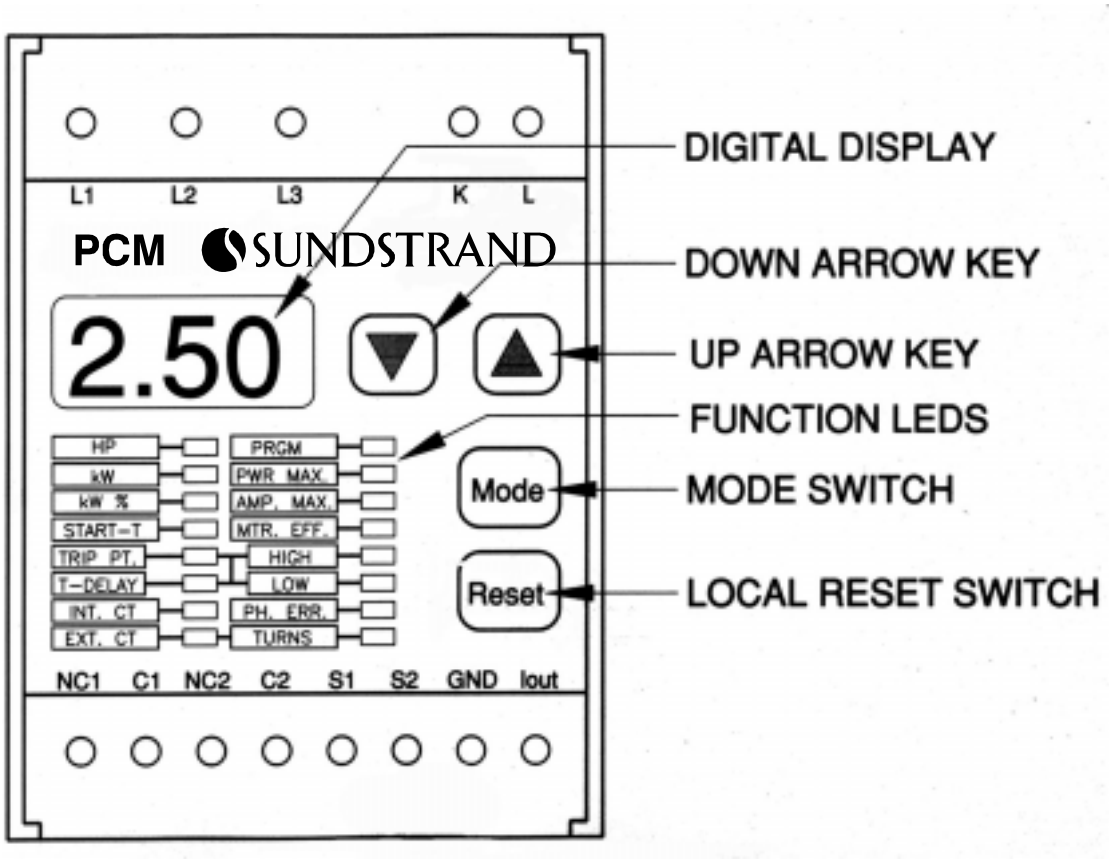
Initial Set-Up of the PCM Unit:

Before starting the pump motor, data (parameter information) is entered into the **PCM** monitor's memory for it to operate correctly. This information consists of selecting:

- Power reading displays units (HP, kW, kW%)
- Internal CT range (1, 3, 5, 8 amps)
- External CT value (required if motor current is greater than 8 amps)
- Number of wire turns wrapped around the external CT
- Motor Efficiency value marked on the motor nameplate
- Motor start-up time delay value (1 to 999 seconds)
- High and Low Trip Limit values (5% to 100% of maximum power range)
- Two Trip time delay values (1 to 99 seconds)

With the **PCM** monitor wired as shown on page 6 (or page 7 for motor current greater than 8 amps), the electrical power is applied to the terminals marked L1, L2, and L3. The digital display will read 0.00 because the **motor is not on**.

Pressing the **Mode** key (twice) activates the programming portion of the monitor and advances the program to the **start-up time delay** entry. The time delay value (in seconds) is entered by pressing either the **UP** or **DOWN** keys. When the desired value is displayed on the front panel, the **Mode** key is pressed (once) to accept the value and to advance to the next data entry. This process is repeated until all of the required data is entered, and the **PRGM LED** will be off. If the **UP** or **DOWN** keys are not pressed within a 5 second period after the **Mode** key is pressed, then the unit will revert back to the **Ready** mode. All data entered before this event is automatically saved, and the monitor will immediately use the new data values. A step by step data entry chart is illustrated on pages 12 and 13.



LED ON	Notes
HP	The power reading is shown in horsepower.
kW	The power reading is shown in kW.
kW%	The power reading is shown as percentage of kW capacity.
TRIP PT.	The displayed power value is a trip point.
LOW	The displayed value is a Low Trip (limit) point.
HIGH	The displayed value is a High Trip (limit) point.
INT. CT	The amp range entered for the internal CT.
EXT. CT	The external CT ratio setting entered.
TURNS	The number of wire turns wrapped around the external CT.
PH. ERR.	A 3-phase line problem exists with either a phase voltage balance, phase shift, or phase sequence.
AMP MAX	The maximum current range permitted with the unit based on CT information entered.
PTR MAX.	The maximum power capacity calculated for the monitor.
MTR. EFF.	The motor efficiency value (50 to 100) entered.
START-T	The start-up time delay (1 to 999 sec.) entered.
T-DELAY	The time delay (1 - 99 sec.) entered for a trip.
PRGM	The monitor is in the program mode.

Programming Steps

	ACTION	LED	Function LED On	DISPLAY
01	PRESS MODE Key	PRGM	PTR MAX.	#VALUE
02	PRESS MODE Key	PRGM	T-START	#VALUE
03	PRESS ↑ OR ↓ Key	PRGM	T-START	#VALUE
04	PRESS MODE Key	PRGM	TRIP PT., HIGH	#VALUE
05	PRESS ↑ OR ↓ Key	PRGM	TRIP PT., HIGH	#VALUE
06	PRESS MODE Key	PRGM	TRIP PT., LOW	#VALUE
07	PRESS ↑ OR ↓ Key	PRGM	TRIP PT., LOW	#VALUE
08	PRESS MODE Key	PRGM	T-DELAY, HIGH	#VALUE
09	PRESS ↑ OR ↓ Key	PRGM	T-DELAY, HIGH	#VALUE
10	PRESS MODE Key	PRGM	T-DELAY, LOW	#VALUE
11	PRESS ↑ OR ↓ Key	PRGM	T-DELAY, LOW	#VALUE
12	PRESS MODE Key	PRGM	Int. CT	#VALUE
13	PRESS ↑ OR ↓ Key	PRGM	Int. CT	#VALUE
14	PRESS MODE Key	PRGM	EXT. CT	#VALUE
15	PRESS ↑ OR ↓ Key	PRGM	EXT. CT	#VALUE
16	PRESS MODE Key	PRGM	EXT. CT, TURNS	#VALUE
17	PRESS ↑ OR ↓ Key	PRGM	EXT. CT, TURNS	#VALUE
18	PRESS MODE Key	PRGM	MTR. EFF.	#VALUE
19	PRESS ↑ OR ↓ Key	PRGM	MTR. EFF.	#VALUE
20	PRESS MODE Key	PRGM	AMP. MAX.	#VALUE
21	PRESS MODE Key	PRGM	Horsepower or kW or kW%	HP or P or Po
22	PRESS ↑ OR ↓ Key	PRGM	Horsepower or kW or kW%	HP or P or Po
23	PRESS MODE Key		Horsepower or kW or kW%	#VALUE

STEP	DEFINITION
01	The monitor calculates the maximum power range (HP or kW) that the unit can display.
02	The High and Low Trip functions are disabled during motor start-up for a fixed period of time (start-up delay value). (Default = 15 seconds)
03	The UP and DOWN keys are used to enter a value from 1 to 999 seconds.
04	The High Trip relay contact will open and latch if the display reading is higher than the High Trip point value. (Default = maximum power value)
05	The UP and DOWN keys are used to enter the High Trip value.
06	The Low Trip relay contact will open and latch if the display reading is lower than the Low Trip point value. (Default value = 5% of the maximum power value)
07	The UP and DOWN keys are used to enter Low Trip value.
08	A time delay is the minimum time about which the display reading must be higher than High Trip value before the trip function will activate. (Default = 5 seconds)
09	The UP and DOWN keys are used to enter High Trip time delay value from 1 to 99 seconds.
10	A time delay is the minimum about time, which the display reading must be lower than the Low Trip value before the trip function will activate. (Default = 15 seconds)
11	The UP and DOWN keys are used to enter Low Trip time delay value from 1 to 99 seconds.
12	Select the current range (OFF, 1, 3, 5, or 8 Amp.) for the internal CT:
13	The UP OR DOWN keys are used to enter the current range: OFF 1 Amp. 3 Amp. 5 Amp. 8 Amp. (Default = 5 amp)
14	When the motor current is greater than 8 Amps, then an external CT is used with the internal CT set to OFF. The unit is programmed to work with CT with the ratios of xxx:5.
15	The UP OR DOWN keys are used to select the external CT setting: OFF, 10.1= 50:5 CT w/.2 multiplier), 30.3 (50:5 CT w/.6 multiplier), 50=50:5 CT, 75=75:5 CT, 100=100:5 CT, 125=125:5 CT, 150=150:5 CT, 200=200:5 CT, 250=250:5 CT, 300=300:5 CT, 400=400:5 CT, 500=500:5 CT (Default = OFF)
16	To increase the sensitivity of the monitor, additional wire turns are added to external CT. (Default = one turn.)
17	The UP OR DOWN keys are used to indicate the number of wire turns (wraps) that are around the external CT: 001=One 002= Two 003= Three
18	The efficiency value for 100% of motor full load is used to calculate motor output power.
19	The UP OR DOWN keys are used to enter a motor efficiency value of 50 to 100.
20	Based on the information entered in steps 13, 15, and 17, the monitor calculates the maximum current value that the unit can sample (measure).
21	Enter the parameter units (horsepower, kilowatt, or kilowatt %) that the measured electrical power will be displayed in. (Default = HP.)
22	The UP OR DOWN keys are used to select the parameter unit LED: HP -Horsepower kW -kilowatt kW% -Percent of kW load
23	Reads the measured motor power.

Determining the Low and High Trip Points:

The PCM is a pump protection device designed to prevent the pump from being operated outside of its design envelope. During PCM programming and pump operation DO NOT RUN THE PUMP DRY or run the pump continuously with the discharge valve closed.

The maximum and minimum limit settings are the means of adjustment to establish the levels at which the PCM alarm relay is to operate and will be determined by the particular load condition on site. Note that since the power required will vary with specific gravity and viscosity settings will change if the fluid properties, composition, and/or temperature change.

The MAXIMUM limit is designed to stop the pump and initiate an alarm for the following conditions.

- Seizure of rotating parts
- High flow operation (running on the end of the curve)
- Increase in the fluid's viscosity

The MINIMUM limit is designed to stop the pump and initiate an alarm for the following conditions.

- Pump dry run, loss of prime
- Low flow
- Severe cavitation
- Magnetic decoupling (Magnetic Drive Pumps)
- Reduction in fluid viscosity

If the pump performance curve is available, then the Low Trip point can be determined by reading the minimum motor output power required for the minimum flow (plus magnetic coupling losses – if applicable). The High Trip point can be set to equal the EOC power listed on the pump specification sheet.

The Low and High Trip values can also be derived by running the pump and observing the power readings at:

- Normal Operating Flow (**NOF**)
- Dead Heading (The discharge valve fully closed)
- Maximum Flow Rate (The discharge valve fully opened)

To operate a system when the trip values are not known, it is recommended that the initial trip values be set as follows before starting the motor:

Low Trip →	Lowest value permitted with the unit (i.e. the minimum flow as stated in specification sheet)
High Trip →	Highest value permitted with the unit

1. Make sure that the suction pipe and the pump are filled with liquid, and the suction valve is open.

2. Start the pump, and adjust the discharge valve until the normal operating flow (**NOF**) is reached.

3. Record the power reading for future reference.

4. Close the discharge valve completely, and record the power reading.

Caution:	**Do not run the pump with the discharge value closed for longer than 5-10 sec.**

5. Open the discharge valve until the normal operating flow is reached again.

6. Press the mode button on the PCM unit until the Low Trip function LED is displayed.

7. Use the UP (↑) key to set the Low Trip value to be higher than the power value recorded when the discharge valve was closed. As a guideline, the Low Trip value should be equal or greater than:

   1.05 x Recorded Power Value when discharge is valve closed

8. Open the discharge valve fully, and record this value.

9. Adjust the discharge valve until the normal operating flow is reached again.

Caution:	**Do not run out on the pump curve if throttling is necessary because cavitation may occur.**

10. Press the mode button on the PCM unit until the High Trip function LED is displayed.

11. Use the Down (↓) to set the High Trip value to be equal to the power value recorded when the discharge valve was fully open. If this value equals the power value at the normal operating flow, then the High Trip value should be set to equal the power rating stamped on the motor nameplate.

12. Let the pump run for a few hours to allow the AC motor to warm-up.

13. Repeat steps 4 - 10 to observe any variation in the power readings. The trip values may need to be fine-tuned to compensate for the power variation between a cold (not used for 24 hours) motor and hot (operating for 2 hours or more) motor.

Isolated Analog 4-20 mA Output:

A secondary monitoring signal of 4-20 mA is available at terminals I_{OUT} and GND on the unit. The signal specifications are:

Digital Display Reads Zero	Output of 4 mA
Digital Display Reads Maximum Power Value	Output of 20 mA
Maximum Load Impedance	400 Ohms
Minimal Isolation Voltage to Measured Voltage	1500 VAC

3-Phase Monitoring Circuitry:

Three Phase monitoring feature is available on all PCM units. This feature inspects the 3-phase voltage supply connections to the motor for:

- Incorrect Phase Sequence
- Phase Voltage Deviation Greater than 8 %
- Phase Angle Deviation Greater than 5 degrees

If the PCM unit detects a violation in any of these three areas indicated, then the unit will immediately generate a High trip alarm and flash an error code on the digital display.

Display Reading	Definition
PH1	Incorrect Phase Sequence
PH2	Phase Voltage Deviation Greater than 8 %
PH3	Phase Angle Deviation Greater than 5 degrees

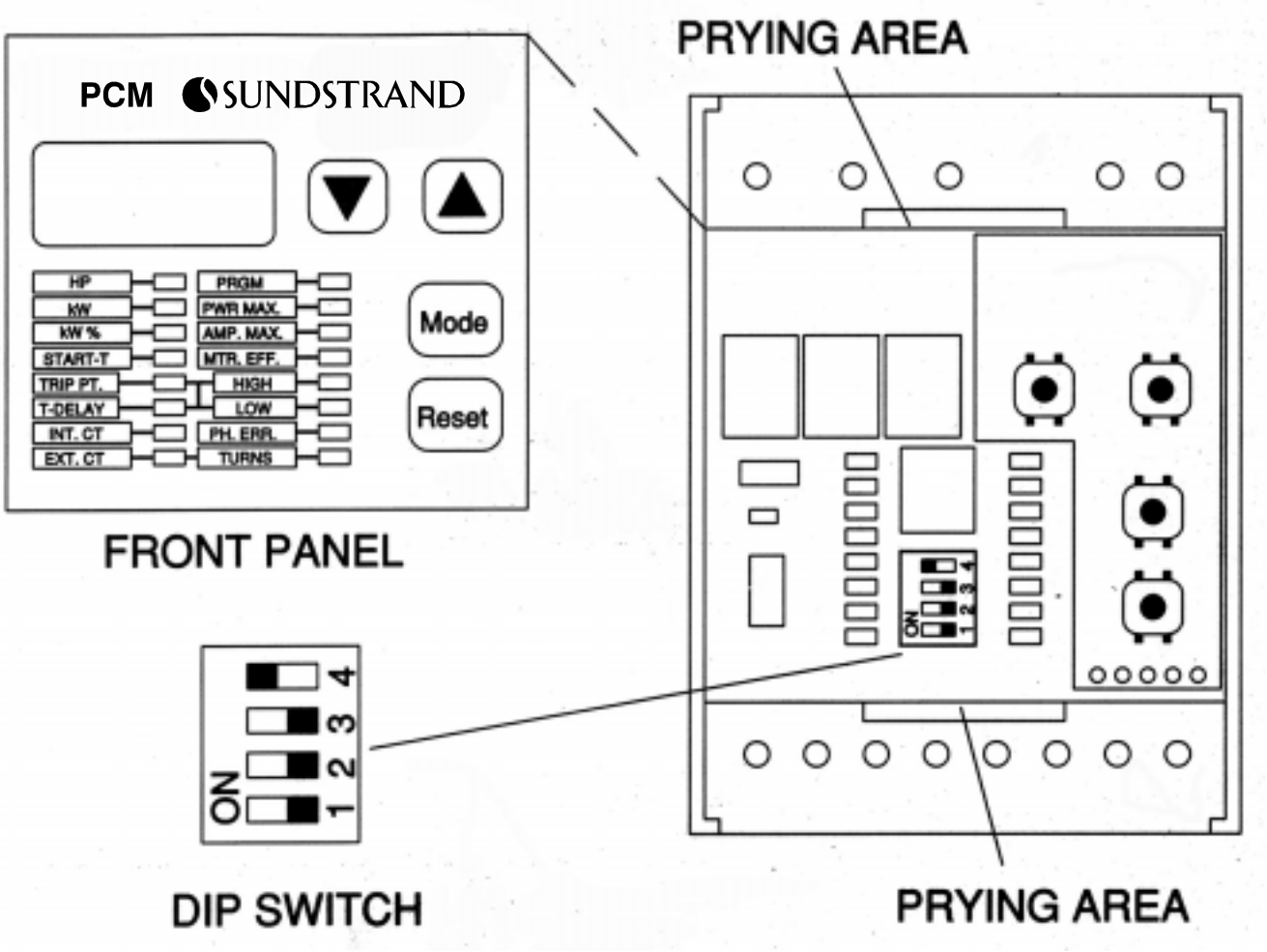
The error must be corrected before the PCM unit will permit the motor to start. This feature can be disabled by placing switches 2 and 3 on an internal dip switch to an **off** position.

Program Lock/Unlock Feature:

To prevent someone from changing the parameters entered in the unit, place switch 1 on the internal dip switch to the **on** position. The user can still review the parameters stored in the unit, but the Up (↑) and Down (↓) keys are disabled.

Internal Dip Switch Location and Access:

Instructions:



1. Disconnect the main power to the PCM unit.

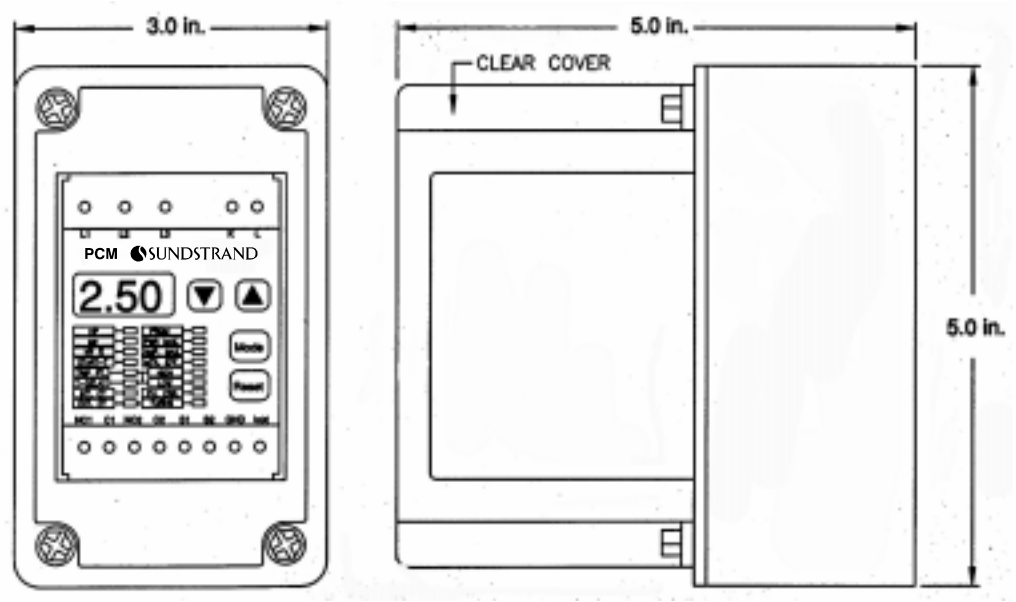
2. Remove the front panel cover by prying with a screwdriver or a flat tip tool at one of the two prying locations indicated.

3. Change the switch settings and reassemble the unit again.

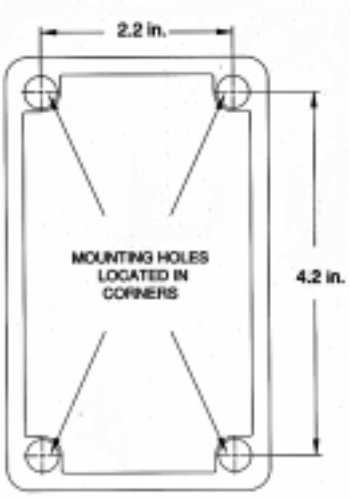
   Note: All PCM units are shipped with the dip switch set for:

Dip Switch Position	Status	Condition
1	OFF	Programming Keys Unlocked
2	OFF	Phase Sequence Detection Disabled
3	OFF	Phase Voltage and Degree Disabled
4	ON	Power Down Alarm Disabled

OTHER PCM OPTIONS:
NEMA-4X Enclosure:



An optional, polycarbonate enclosure with a clear cover and prepressed PG knockouts is available to mount the PCM outside of a motor control cabinet. Four #8 screws are installed in the corners of the enclosure body to secure it to a wall or a door on the motor cabinet door. Proper sealing procedures must be followed to prevent moisture from entering the knockout, and the clear cover should be attached to the unit at all times.

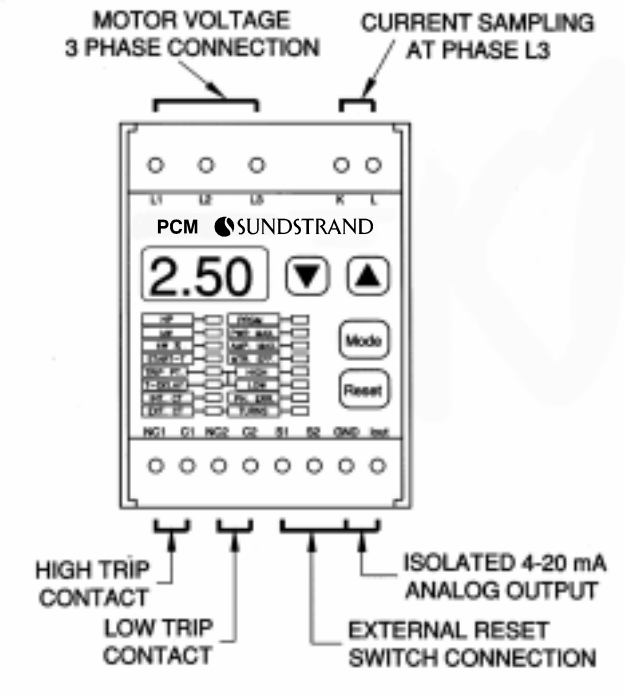


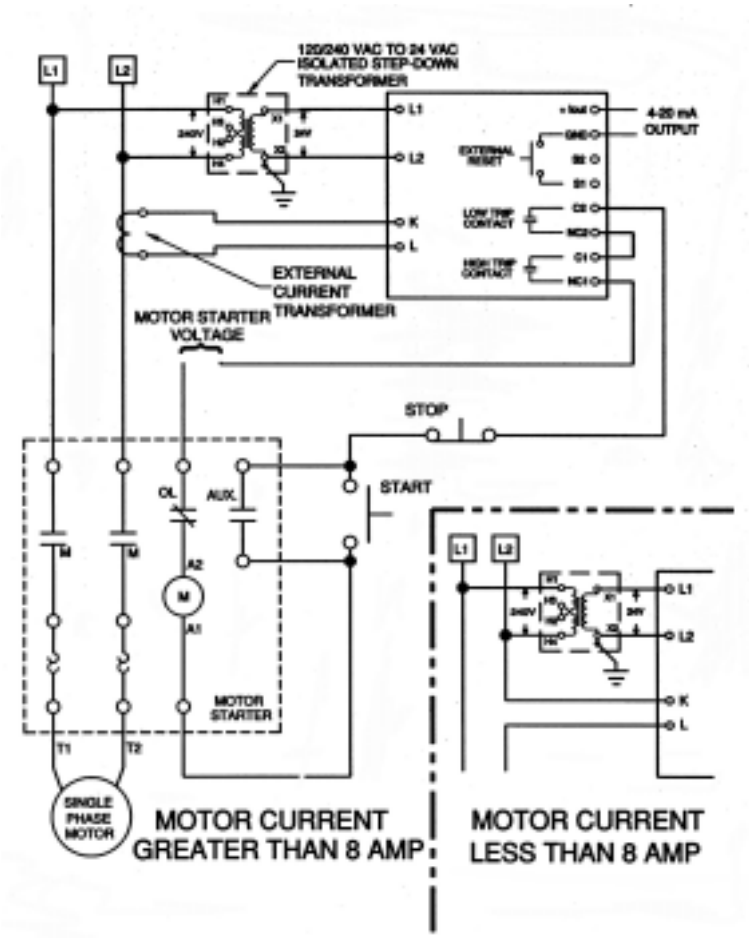
Mounting Footprint

Enclosure Material	
Body	Glass fiber reinforced Polycarbonate
Cover	Polycarbonate
Cover screws	Polyamide
Gasket	EPDM (Ethylene-prophenediene-monomer)
Flame Resistance	
Cover	UL 94-V2
Body	UL 94-V1
Dimensions	3 x 5 x 5 in. (76.2 x 127 x 127 mm)
Prepressed Knockout	PG16 (0.9 in. dia.), PG21 (1.1 in. dia.)

Single-Phase Power Monitor:

Single-phase motor (120/240 VAC) voltage versions of the **PCM** power monitor can be specially ordered. These units have an output power range from 0.5 Hp (0.37 kW) to 5.0 Hp (3.7 kW). A 24 VAC isolation transformer (which is included with the unit) must be connected between the single-phase **PCM** monitor power input and the motor supply.





Single Phase Wiring Diagram

Troubleshooting:

Condition	Suggestion
The digital display is not illuminated while 3-phase power is applied.	There is no voltage reaching terminals L1 and L2 on the PCM. Have a qualified person check the phase fuses and wiring to the PCM unit. The 3-phase voltage is not in the rated voltage range of the PCM unit. Check the PCM nameplate. The internal fuse on the voltage pc board may be open. Contact Sundstrand for further assistance.
The digital display reads zero while the motor is operating.	There is no current sample reaching the PCM unit. Have a qualified person check the wire connections at terminals K and L. If an external transformer is used, then the transformer must be check with a current probe to verify that it is functioning properly.
The unit will not Low Trip.	The Low Trip delay may be set to high. Press the mode button (six times) to view and change the time value. The power reading is less than 5% of the maximum power range of the PCM unit. Disconnect the power to the motor and the PCM unit. Refer to page 10 in the manual for instructions on decreasing the current range.
The display reads PH1 or PH2 or PH3 and the High Trip LED is flashing.	The 3-phase monitoring feature is **on** and has detected a problem with the 3-phase supply connection. Refer to page 16 for further information.
The motor does not trip on High Trip settings.	The High Trip delay may be set to high. Press the mode button (four times) to view and change the time value.
The Trip LED is flashing at ½ second cycle, but the motor is not off.	The Trip relay contacts may be welded together. Have a qualified person check the continuity of the contacts. Contact Sundstrand for further assistance.
The unit trips the motor during short underload or overload conditions.	Increase the trip time delays to compensate for the intermittent load surges.
The UP and DOWN keys on the panel do not work..	The program lock command is engaged. Refer to page 16 in the manual for further information.

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