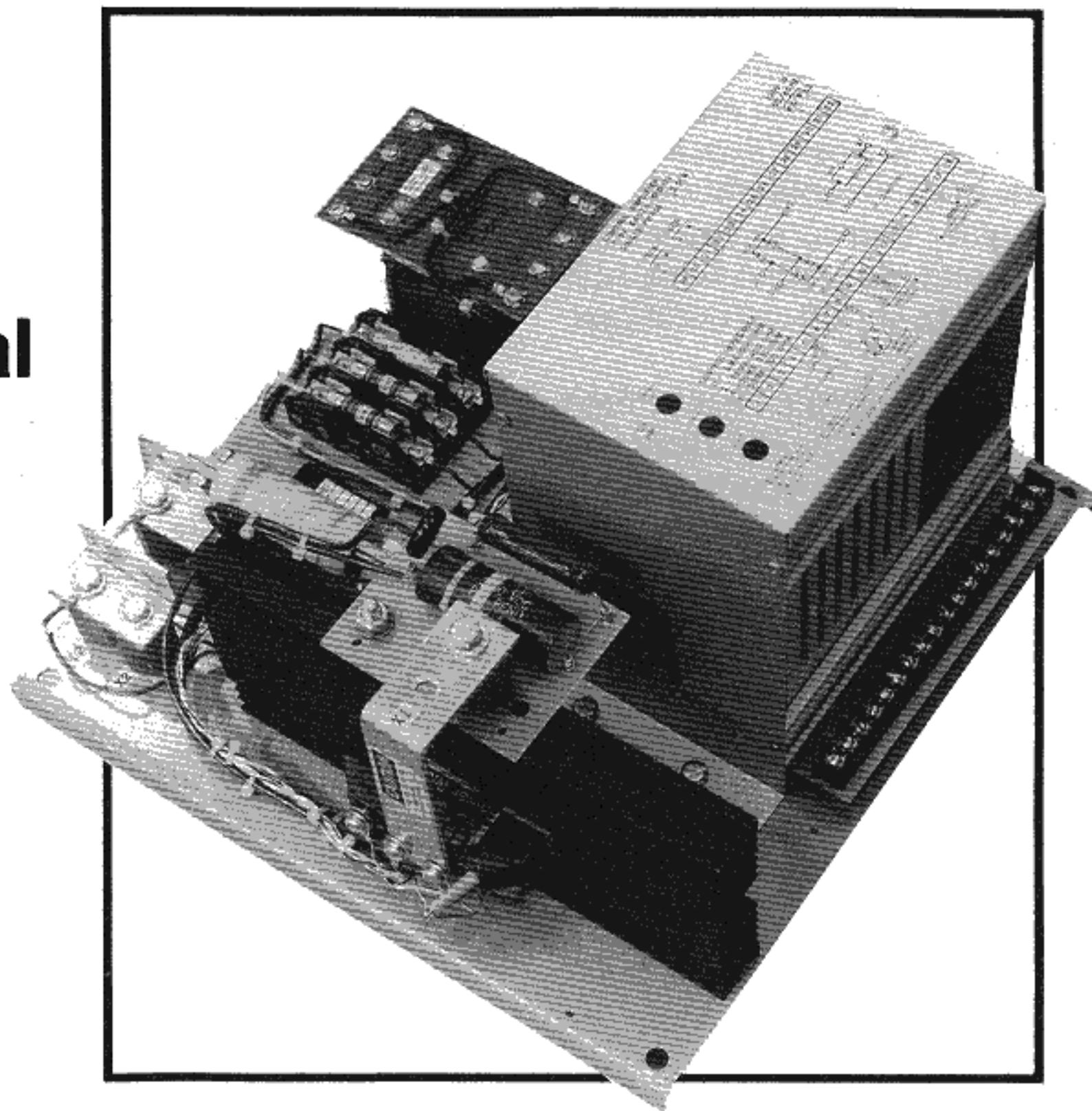


## **Phase Angle Control SINGLE PHASE SCR POWER CONTROL UNITS - for Industrial Control Applications**



SPANG Power Control Units for single phase applications are available either with phase angle control or with synchronous firing control of the SCRs. Synchronous firing PCUs are normally applied to control static loads, such as resistive heating elements (nichrome), which are not affected by age or drastic change in resistance versus temperature.

This bulletin describes phase angle PCUs used primarily to control dynamic resistive, or transformer-coupled loads.

### **STANDARD FEATURES**

- Electronic design with active integrated circuit networks
- Phase lock loop for firing pulse synchronization
- Standard ratings designed for 50° C maximum ambient
- Stepless control for proportional electric power
- Immunity to line distortions and fluctuations

## General Description

The phase angle firing circuit, used in the SPANG Power Control Units, is a new field-proven design incorporating modern electronic hardware for producing electrical pulses to the gates of the SCRs. Built into the devices are CMOS integrated circuits (both analog and digital), operational amplifiers and phase lock loop circuitry, all of which assure that power line distortions (harmonics, sags, surges, etc.) will not affect the firing of the SCRs. These Power Control Units have exceptional stability, reliability, and versatility, plus the availability of options which can be tailored to specific applications.

The SPANG Single Phase Phase-Angle fired PCU uses two SCRs connected inverse parallel in one of the two lines to the load. The other line is connected directly to the load (see Figure 1).

### Advantages of Phase Angle Firing:

- Conventional voltmeters and ammeters can be used for instrumentation over 0 to 100% voltage range.
- Infinitely variable output.
- Operation into dynamic loads (i.e., transformers).

## Specifications for Phase Angle Control

**Input Voltage:** Ratings are provided for 480, 240, and 120 volt, single phase, 60 hertz lines.

**Ambient:** All ratings are designed for 50°C maximum operating temperature. For operation at higher temperatures (to 65°C maximum), some derating is necessary; please consult factory.

**Input Signals:** 0-5, 1-5, 2-12, 4-20, 10-50ma inputs or a manual potentiometer (all standard temperature controller outputs). See Control Connections.

**Adjustments:** a. Gain adjustments provide full output for 50% to 200% standard control signal.  
b. Bias adjustment for manual control to 100% output.

**Voltage Protection:** a. Transient voltage suppression is provided by metal oxide varistors (MOVs) which clamp high voltage spikes to within the PRV rating of the semiconductors.

b. Standard PRV ratings:  
480 volt units – 1200 volts  
240 volt units – 800 volts  
120 volt units – 400 volts

Higher PRV ratings are available for specialized applications.

**Reference Supply:** A 10-12 volt DC regulated reference supply is available from the firing circuit for connection to a remote potentiometer, from which the Power Control Unit can be controlled manually. This supply is regulated to within  $\pm 1/2\%$  for line voltage variations. Maximum current rating from this reference source is 10 milliamperes.

**Cooling:** a. Current sizes 15, 30 and 60 amperes are convection cooled.

b. Current sizes from 110 to 600 amperes are forced-air cooled by integral cooling fans. Bimetallic temperature switches are supplied on all forced-air cooled units with one NO contact wired to a terminal block from each SCR heat sink. As an alternate, normally closed contacts are available on request.

## Options Available

1. **Current Limit** senses RMS current and limits output. Current limit adjustment is from 5% to over 100% of rating by a potentiometer in the firing circuit.
2. **Voltage Regulation** adds RMS voltage feedback to the standard model. Voltage regulation is  $\pm 1\%$  for line voltage excursions of +10%, -15% of nominal. This option also improves control linearity to  $\pm 1\%$  from 0 to 100% output.
3. **Current Regulation** compensates for both line and load fluctuations and provides a constant RMS current proportional to the control signal. Current regulation is  $\pm 1\%$  of set point.
4. **Watt Regulation** is accomplished by addition of voltage and current feedback into a watt transducer. Output wattage can be regulated to  $\pm 1\%$  of set point. Common applications are in control of silicon carbide heating loads.
5. **Fast Gate Shut-Off** is an electronic turn-off of the gate firing pulses within 8.33 milliseconds (1/2 cycle at 60 Hz) by sensing an overcurrent condition and applying the shut-off signal to the firing circuit. For most applications where this is to be used (e.g., protection against short circuits or load faults) external current limiting impedance must be added to insure protection of the power SCRs. Consult the factory for advice on this coordination.
6. **NEMA 1 Wall Mounted Enclosures** are available for housing the respective Power Control Units. The enclosure features #14 gauge steel construction finished with ASA-61 light gray enamel. Ventilation is provided through expanded metal openings at the bottom and sides of the enclosure. Conduit entrance can be through the top, bottom or lower sides as required. The access door is hinged with a locking handle.
7. **Combinations of the above listed options** — Refer to page 14 for possible option combinations and corresponding ordering part number.
8. **Special Options** — Custom options such as pilot lights, meters, circuit breaker additions, water cooling, separate firing circuit assembly, and others are available. Please contact the factory for description, pricing, and advice on your custom requirements.

## Schematic Drawing

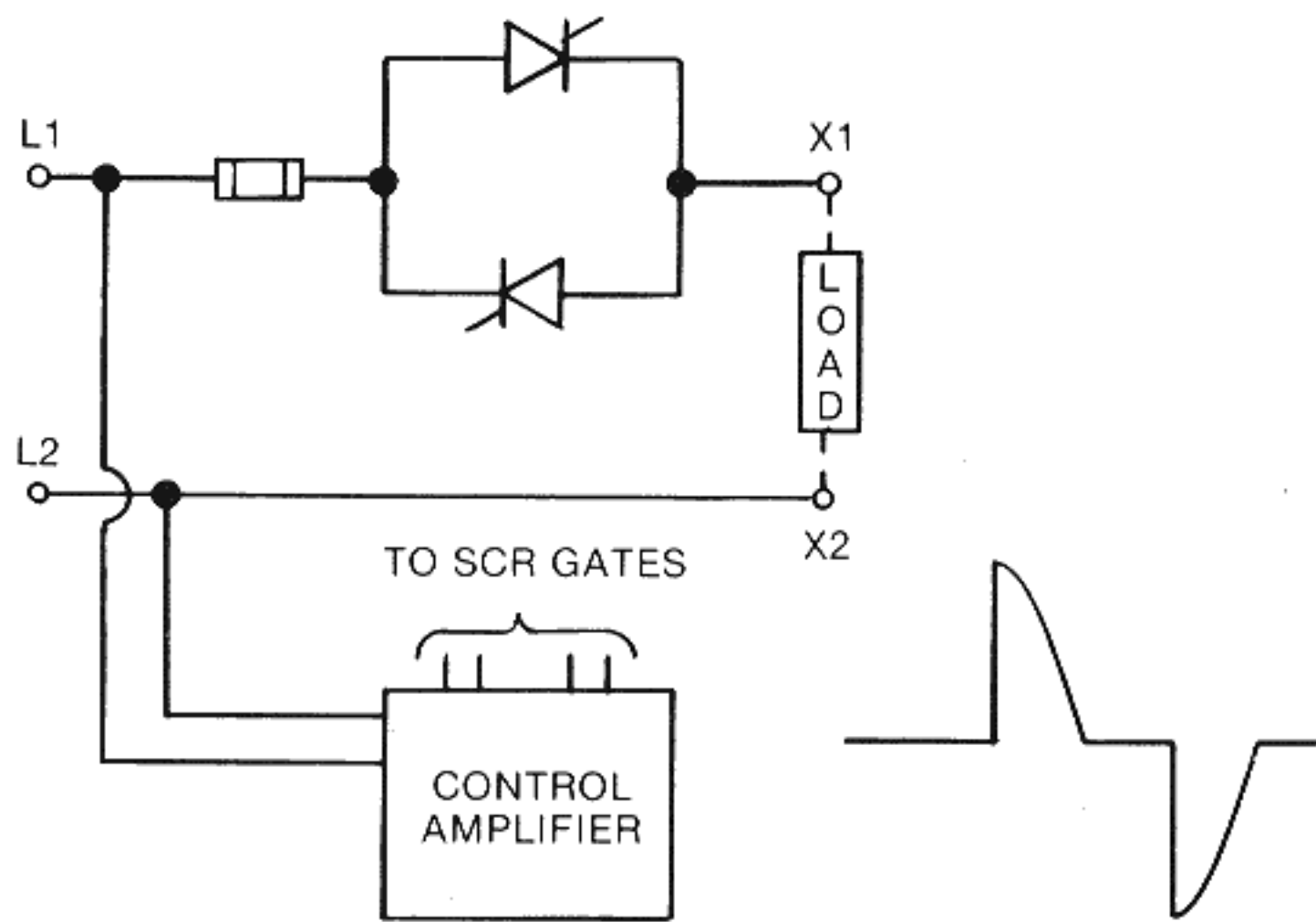


Fig. 1 Single Phase Converter & Waveform

## Electrical Features

1. Upon initial energization, there is a 4 second dead time for circuit stabilization during which time the SCR gate pulses are inhibited.
2. The firing circuit inherently includes a 3-4 second built-in soft start and Transformer Inrush Protection (TIP) feature.
3. The time response and ramp eliminates output overshoot, preventing damaging excessive currents into dynamic loads on either start-up or response to step function control signals.
4. Firing pulses between complementary pairs are balanced within  $\pm 2$  electrical degrees.
5. Output control parameters of current, voltage, or power are tightly regulated and linearly responsive to input signal ( $\pm 1\%$ ) with use of feedback options.
6. Gate output pulses from the firing circuit are inhibited during power start-up (turn-on) and momentary power interruption.
7. The firing circuit provides a high frequency pulse train with a rise time of 300 nanoseconds to the SCR gates.

## Control Connections

DC Control Signal	Input Control Terminal Points	Input Impedance
0-5 ma	1 (+)-5 (-)	1000 ohms
2-12 ma	2 (+)-5 (-)	400 ohms
4-20 ma	3 (+)-5 (-)	250 ohms
10-50 ma	4 (+)-5 (-)	100 ohms
0-10 v	7 (+)-5 (-)	200K ohms
Contact Closure	6 and 7	
Manual Control: Ends of Pot Slider of Pot	6 and 8 7	Connect a 10K ohm 2 watt potentiometer
Lockout (External shutdown contact)	6 and 17	

## Mechanical Features

1. The unit uses a plug-in card rack assembly with three plug-in printed circuit cards and one receptacle board (HB).
2. Card pullers (extractors) are provided as an inherent feature on each plug-in board (HB).
3. Bias, Gain, and Current Limit adjustments are accomplished through standard 20 turn potentiometers.
4. Information for input/output connections, control adjustments and input impedance are readily available on the top cover plate (HB).
5. Electrical control connections are made on screw-type terminal blocks.
6. Forced air cooling provided on 110 ampere sizes and above.
7. Isolated semiconductor power blocks are used on smaller current ratings.

## Ordering Information

### Single Phase Power Control Units — AC Output

H: Modular firing circuit

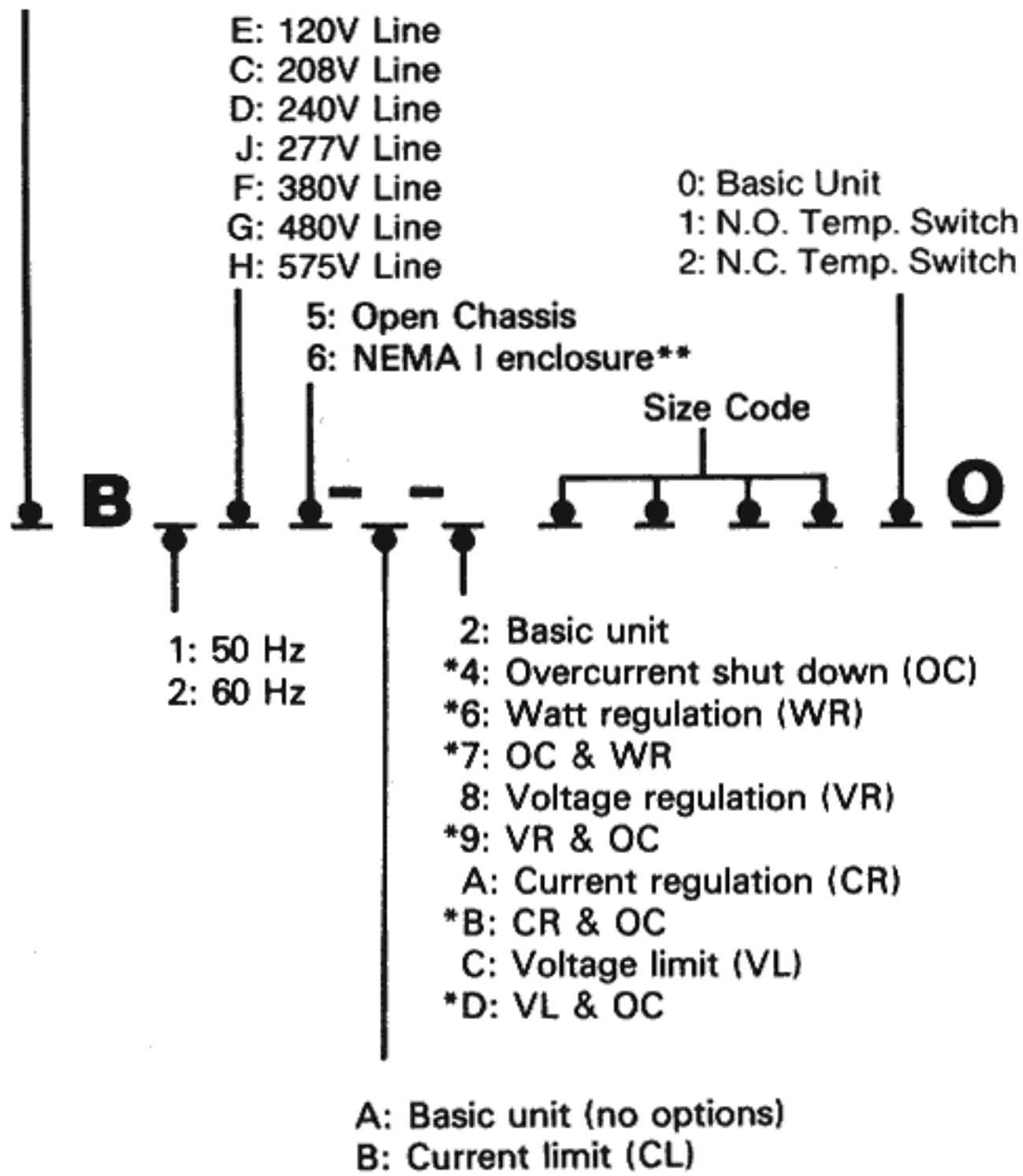
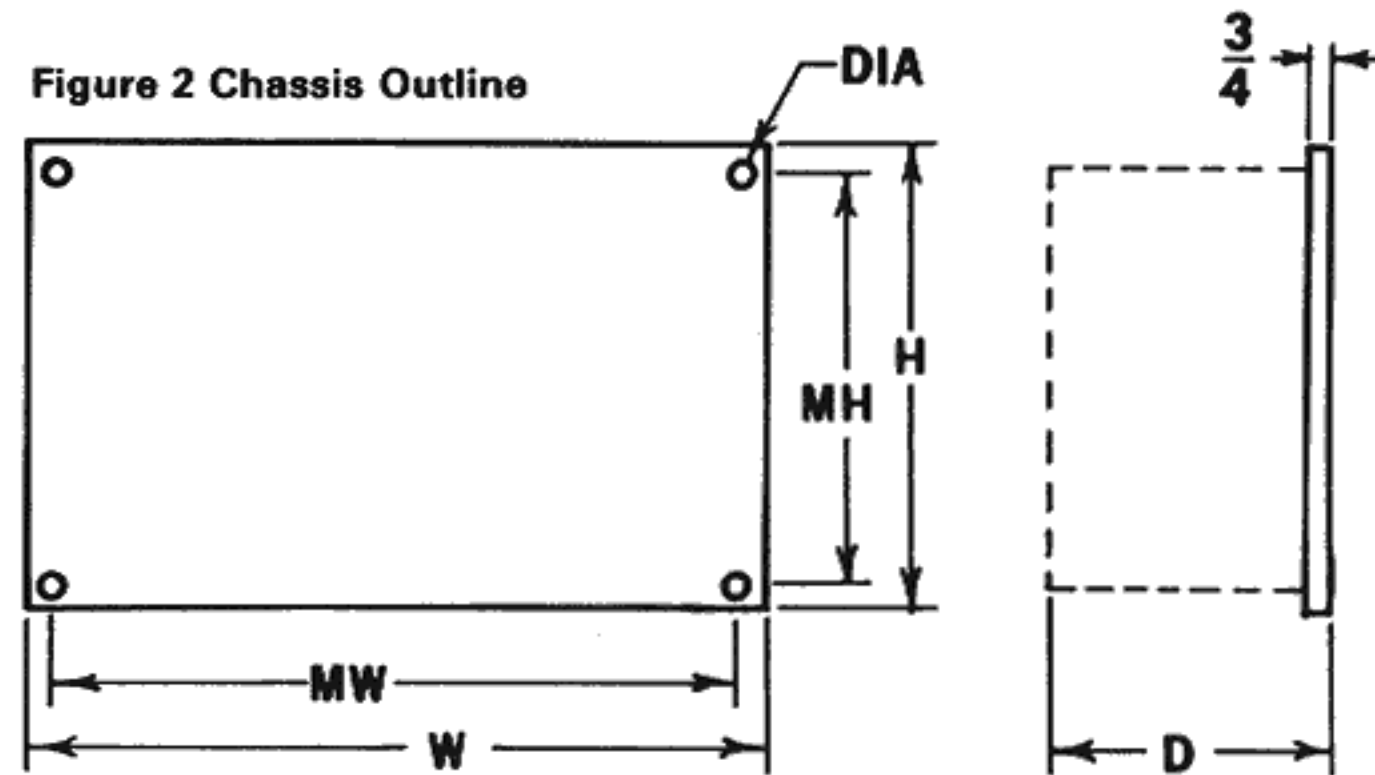


Figure 2 Chassis Outline



### Ratings and Chassis Dimensions (inches)

Size Code	Current Rating AC Amps	KVA Rating			Refer to Figure 2					
		120V	240V	480V	H	W	D	MH	MW	Dia.
1508	15	1.8	3.6	7.2	14	12	10	13	11	3/8
3008	30	3.6	7.2	14.4	14	12	10	13	11	3/8
6008	60	7.2	14.4	28.8	14	14	10	13	13	3/8
1118	110	13.2	26.4	53	14	14	10	13	13	3/8
1718	175	21	42	84	16	15	10	15	14	3/8
2518	250	30	60	120	20	15	12	18½	13½	½
4018	400	48	96	192	20	15	12	18½	13½	½
5018	500	60	120	240	20	15	12	18½	13½	½
6018	600	72	144	288	20	15	12	18½	13½	½

\*PCUs with these options must be tailored to individual requirements; consult factory before ordering. An additional 8" is required in height dimension for both chassis and NEMA 1 enclosures.

Instruction and operating manuals are provided on each Power Control Unit order. When multiple manual copies are required, they can be supplied at extra cost.

\*\*NEMA 1 enclosures are available. For the above current sizes, dimensions (inches) are as follows:

Size	H	W	D
1508 thru 3008	22	15	12
6008 thru 1118	26	17	12
1718	30	18	14
2518 thru 6018	42	18	14

### Terminal Locations

Control terminals are at lower right of all units. Power terminals are located with line terminals at the top left, and load terminals at the lower left.

