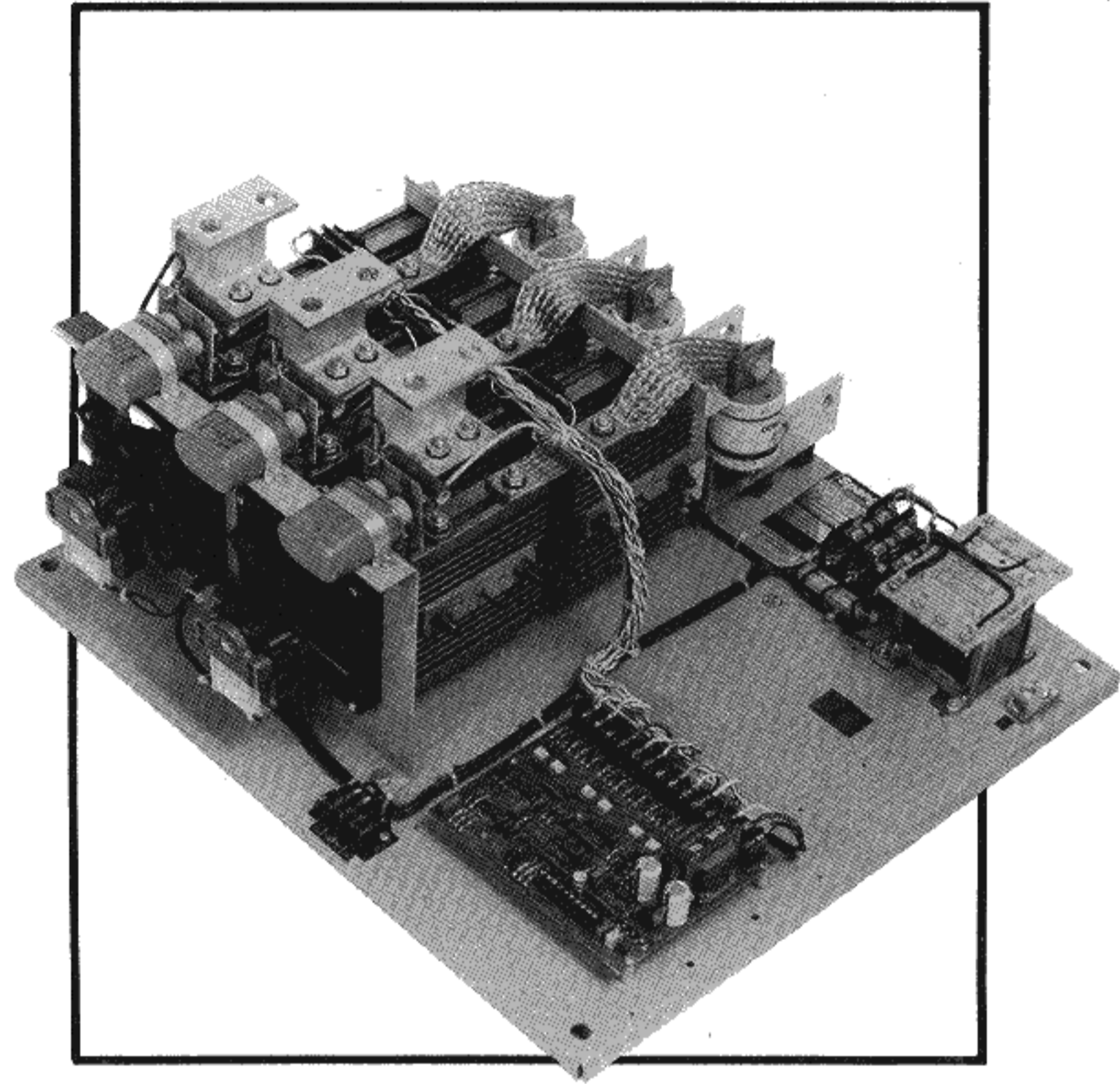


# **Spang Power Electronics**

## **Synchronous Control SINGLE AND THREE PHASE SCR POWER CONTROL UNITS - for Industrial Heating Applications**



SPANG Power Control Units are available either with phase angle control or with synchronous firing control of the SCRs. Phase angle PCUs are normally applied to control dynamic resistive, or transformer-coupled heating element loads.

This bulletin describes synchronous firing PCUs used primarily to control static loads, such as resistive heating elements (nichrome), which are not affected by age or drastic change in resistance versus temperature.

### **STANDARD FEATURES**

- 3  $\emptyset$  conventional 3 leg control and economical 2 leg control
- Fused third leg on 2 leg control
- LED indication of proper phase rotation on 3 phase units
- Variable ratio synchronous control
- Stepless control for proportional electric power
- Units accept all standard control signals
- Electronic design with active integrated circuit networks
- Phase lock loop for firing pulse synchronization
- Immunity to line distortions and fluctuations
- Standard ratings designed for 50° C maximum ambient
- LED indication of firing

## General Description

SPANG manufactures three types of synchronous Power Control Units: (a) a single phase version uses two SCRs connected inverse parallel in one line, and the other line is connected directly to the load (Figure 3); (b) the three phase version is designed in two types: two and three leg control (Figures 1 and 2).

Three leg control uses an SCR and a diode connected inverse parallel in each line to the load, (Figure 1). Two leg control uses two (2) SCRs connected inverse parallel in two of the three lines to the load, (Figure 2). Two leg control uses fewer power components and is more economical. Three phase loads may be either three wire Delta or Wye connected. If control is required to a four wire grounded neutral Wye load, it is recommended to use a three leg, six SCR Power Control Unit. These are available upon request.

### Advantages of Variable Frequency Synchronous Firing:

- Conventional voltmeters and ammeters can be used for instrumentation at 50% to 100% voltage range.
- Infinitely variable output.
- Elimination of RFI.
- Power is distributed evenly over time.

### Theory of Variable Frequency Synchronous Control

Synchronous firing control of thyristors is important for many types of heating and static contactor applications. Other names by which it is known are: Zero Voltage Firing, Zero Angle Firing, Burst Firing, Zero Point Switching, and RFI-less Control. With synchronous firing, the SCRs are used as switches that turn on and off at zero voltage crossover to control complete cycles of power; hence, the voltage being applied to the load is either zero or full line value (Figure 4). With SPANG variable frequency control, power is

proportioned by controlling the cycles of power ON versus the cycles of power OFF at a variable ratio. Control is accomplished at a cycling rate which achieves the smoothest, most continuous required output power. For example, very low output is 1 cycle ON and 100 cycles OFF (Figure 4). A slightly greater control signal gives 1 cycle ON and 30 cycles OFF. Power output of 50% typically provides control of 1 cycle ON and 1 cycle OFF. Greater percentage power output is achieved typically as 3 cycles ON and 2 cycles OFF (60% power) or 6 cycles ON and 1 cycle OFF (86% power). Full output is continuous conduction. For this type of control, a variable time base is used instead of a constant fixed time base for the cycle ON-OFF switching.

### Specifications for Synchronous Control

**Input Voltage:** Ratings are provided for 575, 480, 380, 277, 240, 208, and 120 volt, single or three phase, 50 or 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 chart.

**Adjustments: a.** Gain adjustments provide full output for 50% to 200% standard control signal.

**b.** Bias adjustment for manual control to 100% output.

**Linearity:** Output versus control signal is  $\pm 10\%$  full scale. For  $\pm 1\%$  see regulation options.

**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:  
Units 380 volts & above – 1200 volts  
Units 277 volts & below – 800 volts  
Higher PRV ratings are available for specialized applications.

**Reference Supply:** A 15 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 20 milliamperes.

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

**b.** Larger current sizes are forced-air cooled by integral cooling fans. Bimetallic temperature switches are supplied on all forced-air cooled units with one normally open (NO) contact wired to a terminal block from each SCR heat sink. As an alternate, normally closed (NC) are available on request.

### Options Available

**Current Limit** senses the RMS current and limits the output to an average value over a varying period of time.

**Voltage Limit** senses the RMS voltage and limits the output to an average value over a varying period of time. Voltage limit adjustment is from 50% to 100% of the line voltage by a potentiometer in the firing circuit.

**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.

**Current Regulation** compensates for both line and load fluctuations and provides an output current proportional to the control signal. Current regulation is  $\pm 1\%$  of full scale.

**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.



## Schematic Drawings of Power Control Units

### Three Phase - Three Leg Control

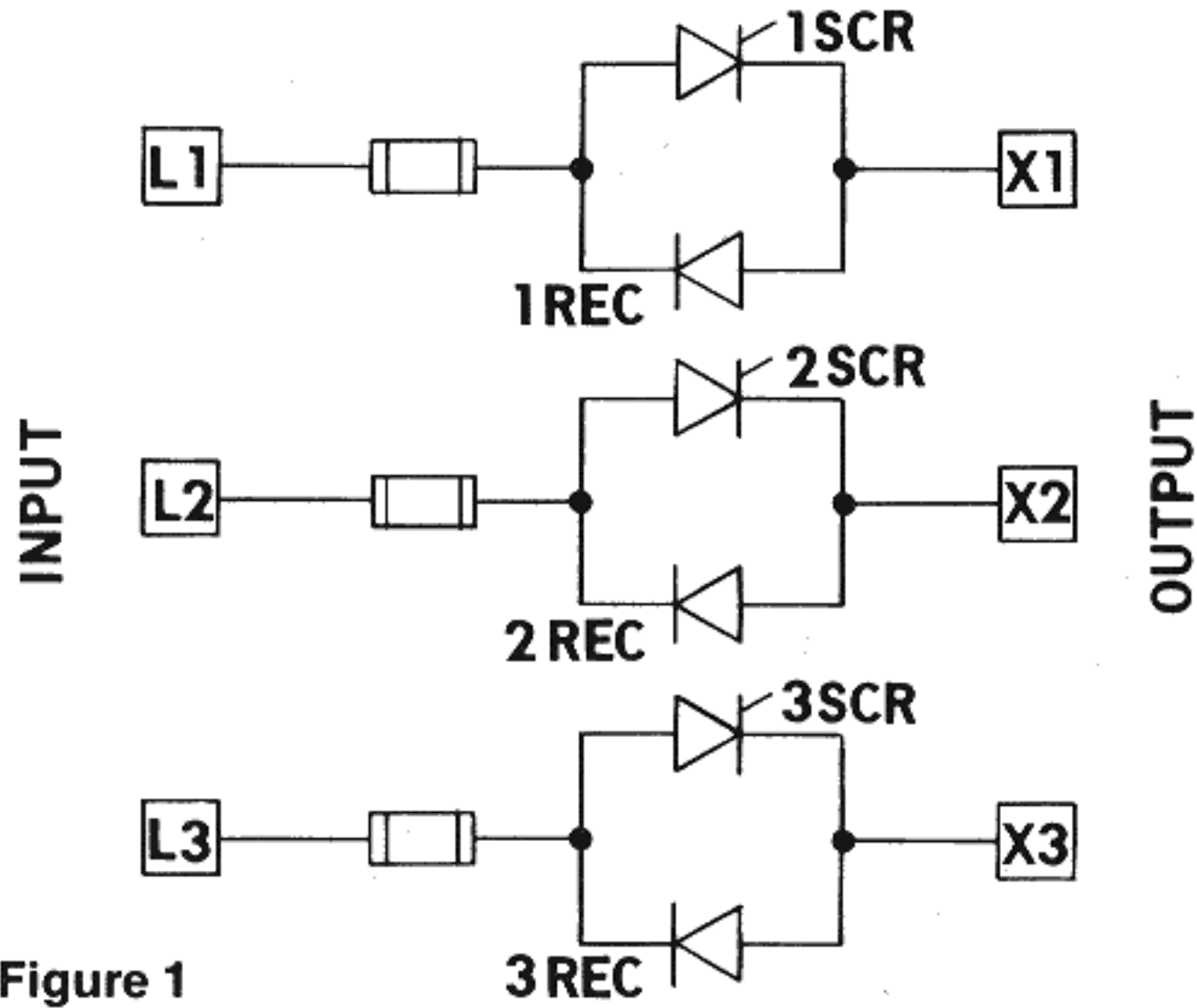


Figure 1

### Three Phase - Two Leg Control

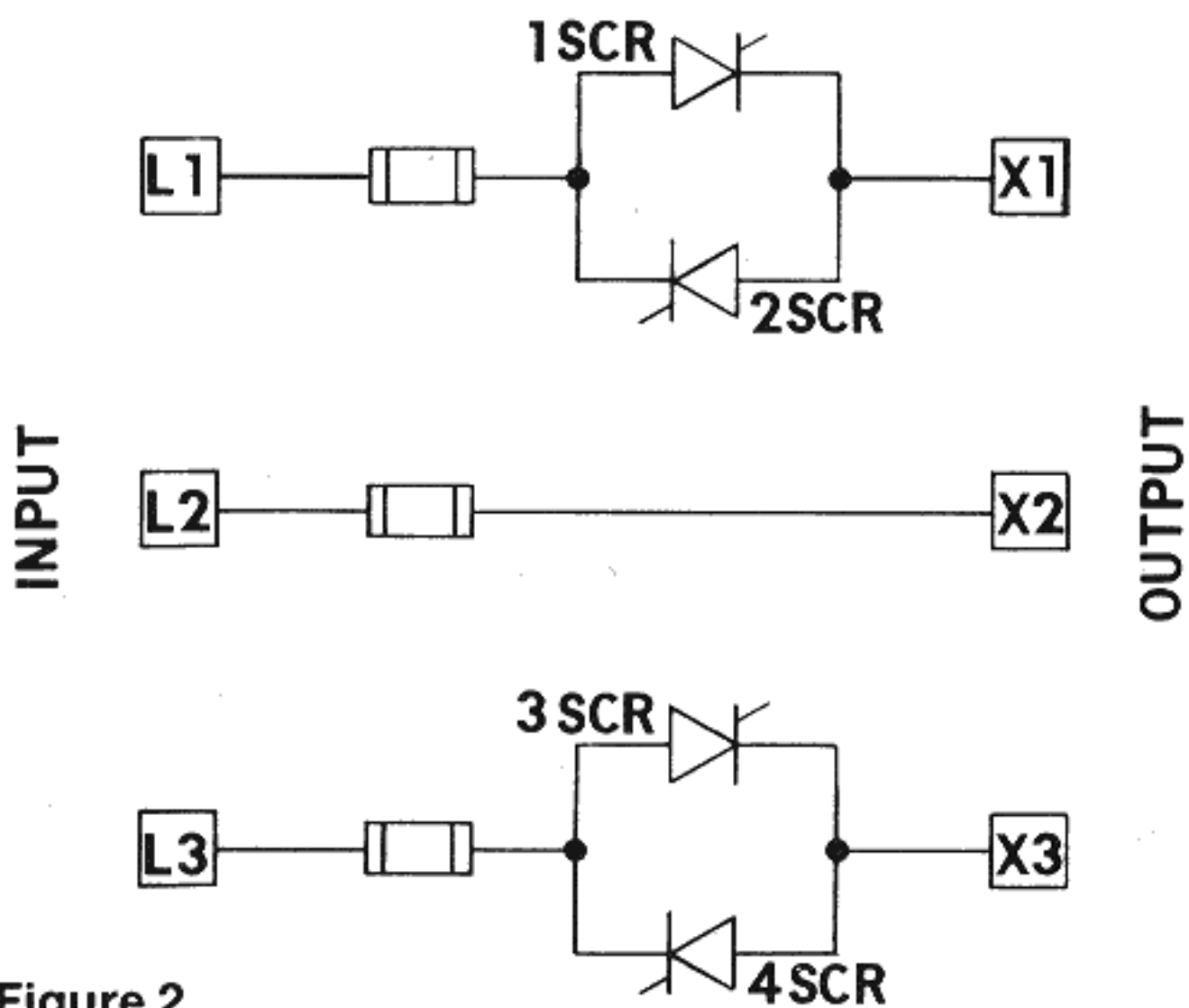


Figure 2

### Single Phase Control

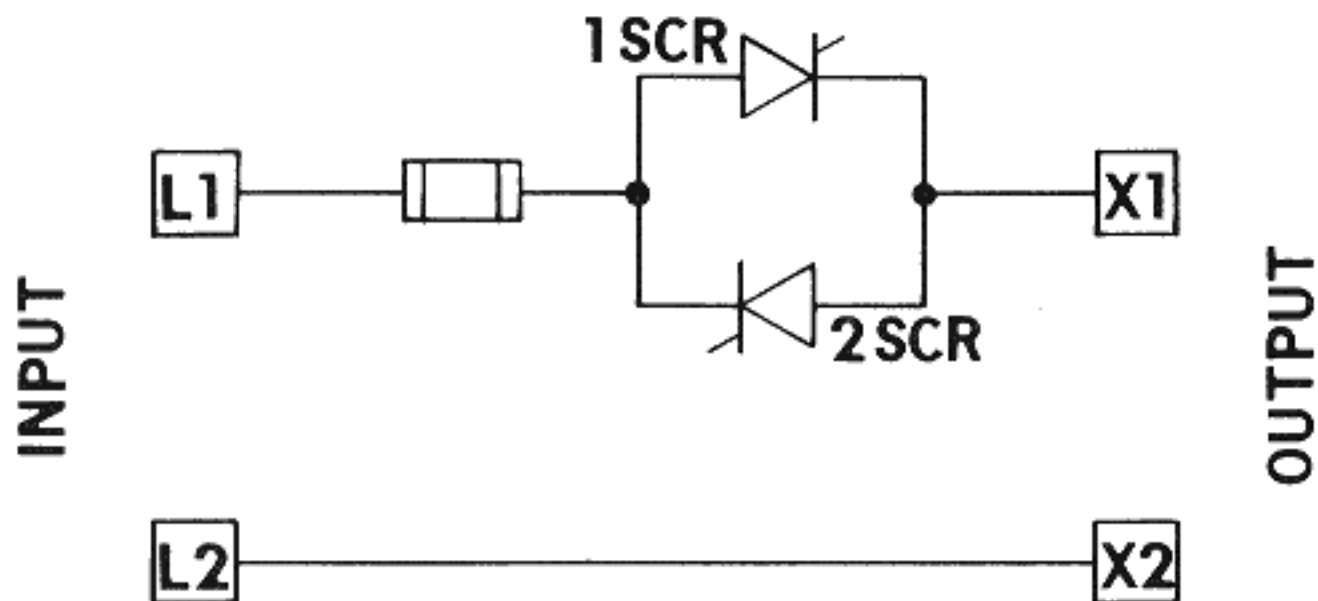
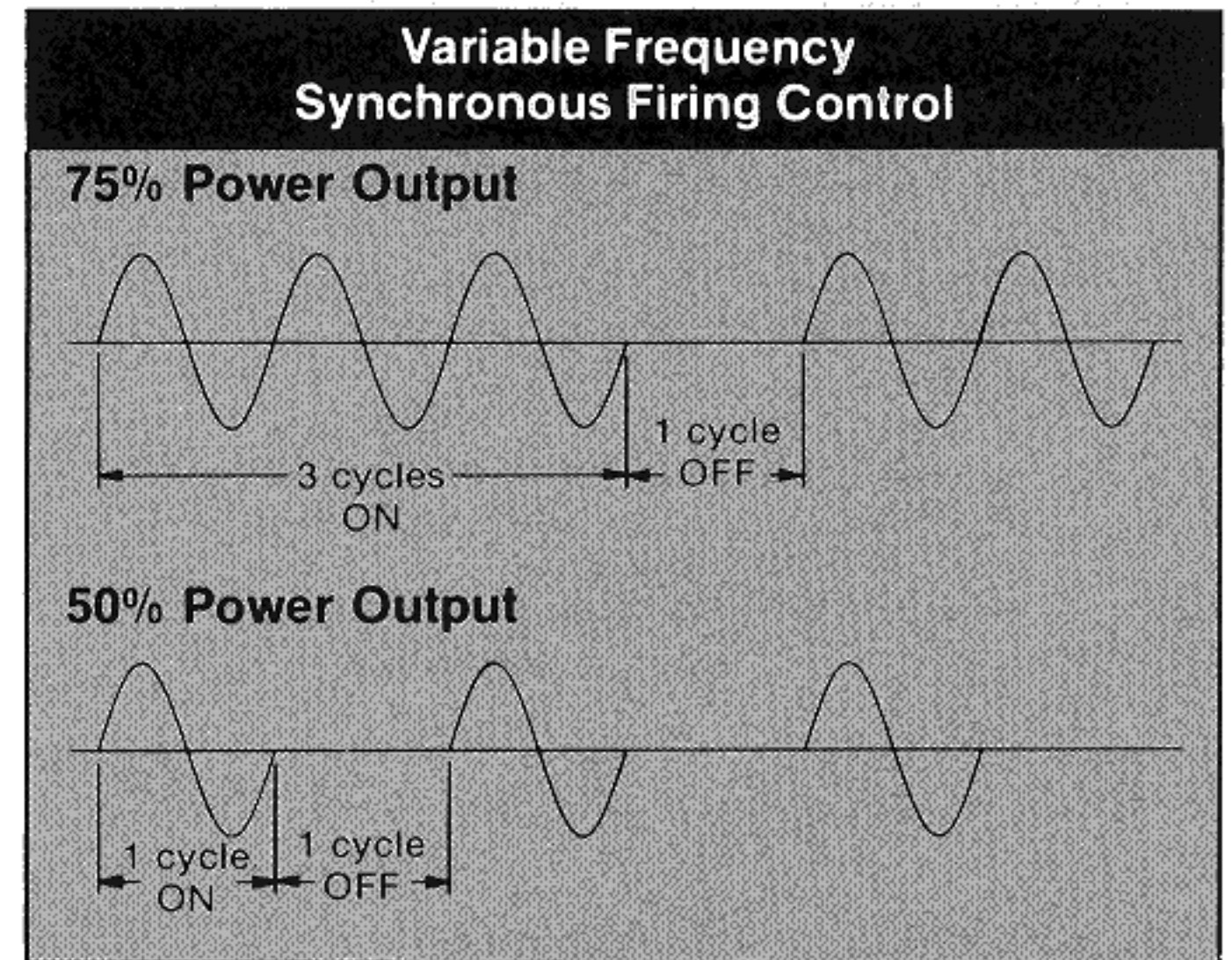


Figure 3

Figure 4



### 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	6 and 8	Connect a 10K ohm 2 watt potentiometer.
Slider of Pot	7	
Lockout (External shutdown contact)	6 and 10	

### Mechanical Features

1. LED indication of firing provided.
2. Electrical control connections are made on screw-type terminal blocks.
3. Isolated semiconductor power blocks are used on smaller current ratings.
4. Bias, gain and limit adjustments are accomplished through standard 20 turn potentiometers.
5. Rugged metal backplate with all components easily accessible.

### Electrical Features

1. Control from 0 to 100% of line voltage.
2. LED indication of phase sequence and phase loss on three phase units with an electrical lockout during abnormal conditions.
3. All three lines are fused on 2-leg synchronous units.

## Ordering Information

### Part Number Code

- J: Synchronous Firing (3-Leg 6 SCR Control, 3 Phase, 4 Wire Wye Load)  
 K: Synchronous Firing (3-Leg Control and Single Phase)  
 L: Synchronous Firing (2-Leg Control)  
 N: Synchronous Firing (3-Leg 6 SCR Control, 3 Phase, 3 Wire Load)

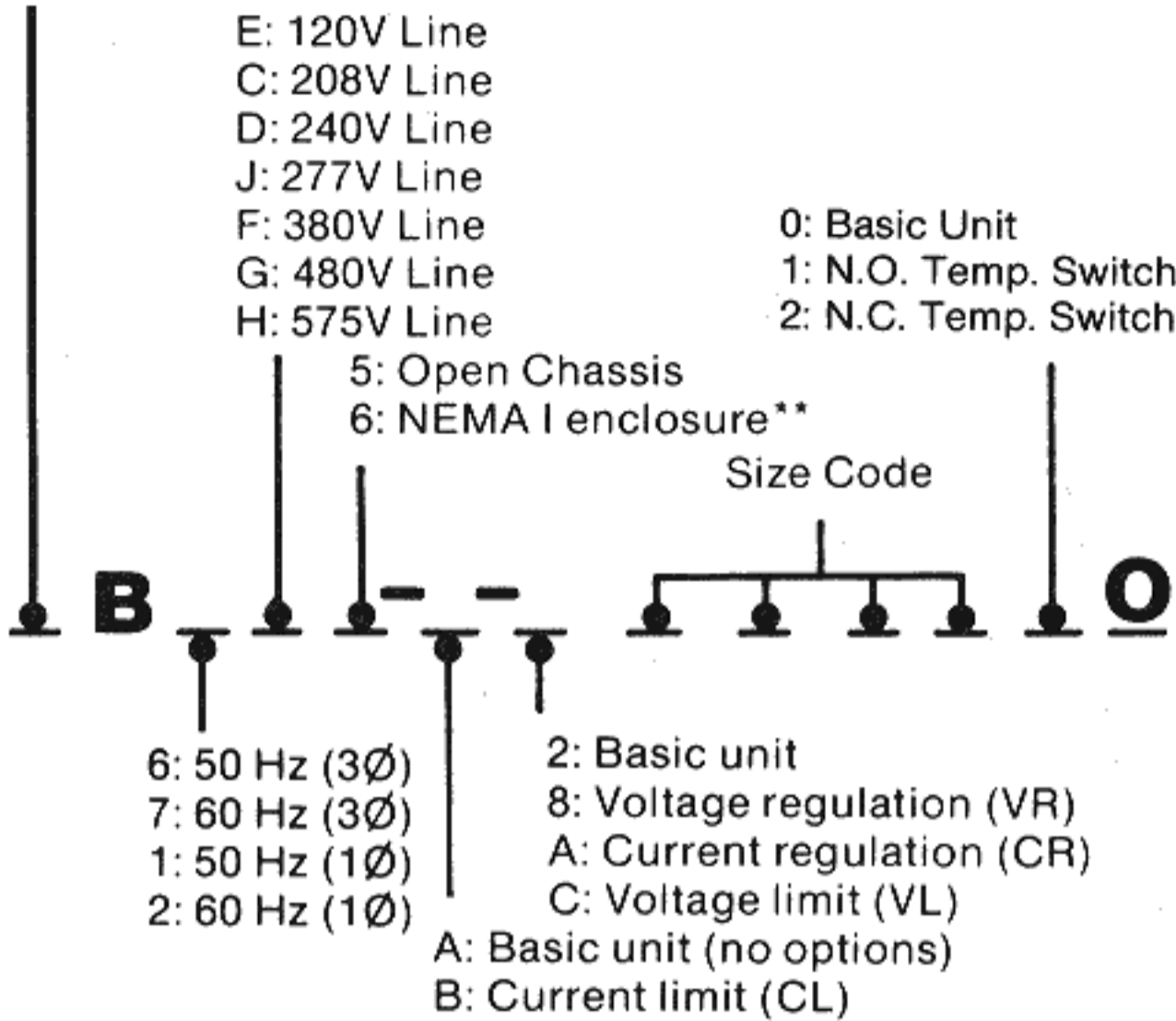
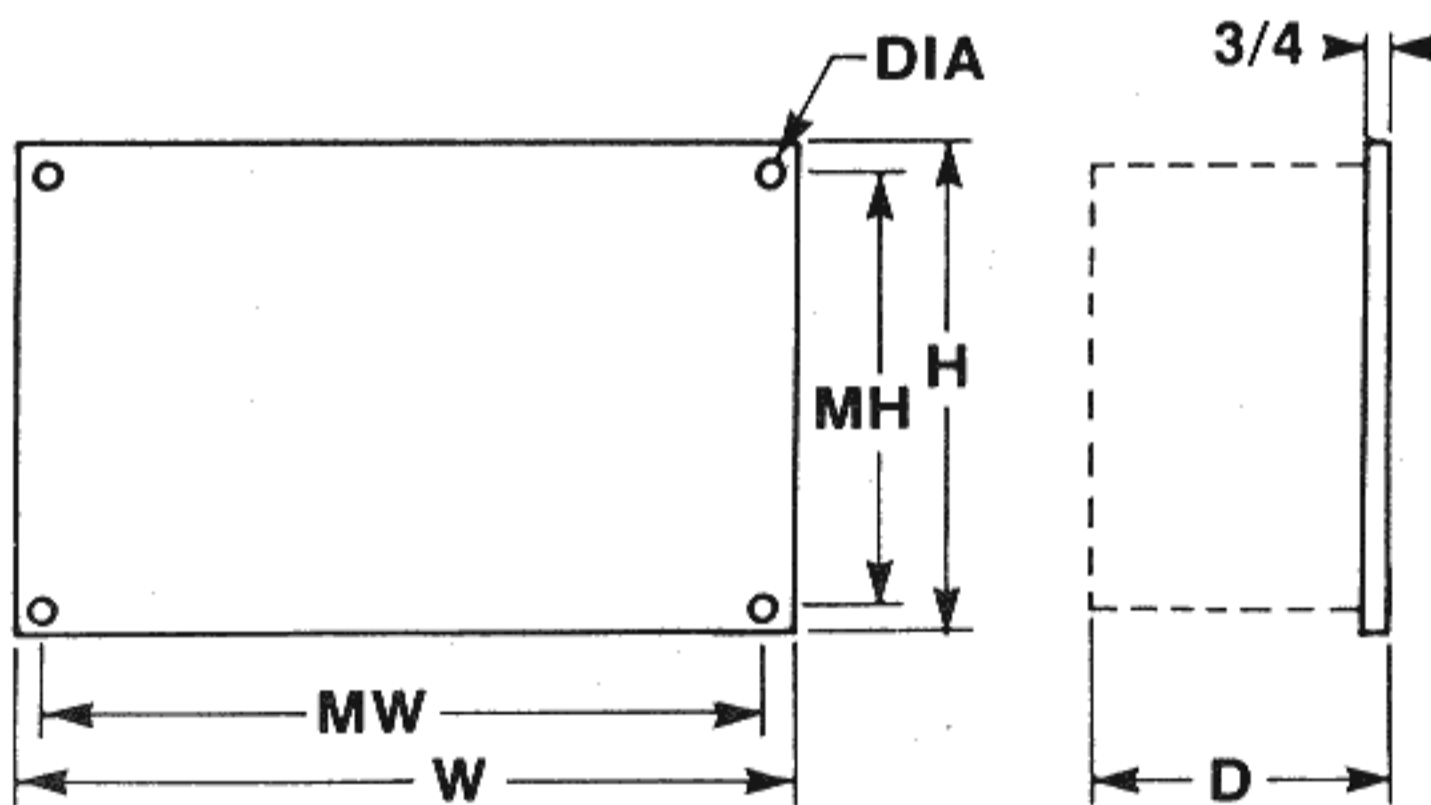


Figure 5 Chassis Outline



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.

### 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.

## 3Ø Ratings and Chassis Dimensions (inches)

Size Code	Current Rating AC Amps	KVA Rating			Refer to Figure 5					
		208V	240V	480V	H	W	D	MH	MW	DIA
1500	15	5.4	6.24	12.5	16	14	10	15	13	3/8
3000	30	10.8	12.5	25.0	16	14	10	15	13	3/8
6000	60	21.6	25.0	50.0	18	14	10	17	13	3/8
9000	90	32.4	37.4	75.0	18	14	10	17	13	3/8
1110	110	39.6	45.7	91.4	20	22	12	18½	20½	1/2
1510	150	54	62	125	20	22	12	18½	20½	1/2
2510	250	90	104	208	20	22	12	18½	20½	1/2
3510	350	125	145	290	20	22	12	18½	20½	1/2
4510	450	162	187	374	20	22	12	18½	20½	1/2
6010	600	216	250	500	20	24	12	18½	22½	1/2
8010	800	288	332	665	26	36	15	24½	34½	1/2
1020	1000	360	416	832	26	36	15	24½	34½	1/2
1320	1300	468	540	1080	42	37	24	40½	35½	1/2

\*\*3Ø NEMA 1 enclosures are available. For the above current sizes, dimensions (inches) are as follows:

Size	H	W	D
1500 thru 9000	26	17	12
1110 thru 1510	30	25	14
2510 thru 6010	42	27	14
8010 thru 1020	52	39	16
1320***	76	44	30

\*\*\*This size uses a free standing, floor mounted cabinet; all others are wall mounted.

## 1Ø Ratings and Chassis Dimensions (inches)

Size Code	Current Rating AC Amps	KVA Rating			Refer to Figure 5					
		120V	240V	480V	H	W	D	MH	MW	DIA
1500	15	1.8	3.6	7.2	14	12	10	13	11	3/8
3000	30	3.6	7.2	14.4	14	12	10	13	11	3/8
6000	60	7.2	14.4	28.8	14	14	10	13	13	3/8
1110	110	13.2	26.4	53	14	14	10	13	13	3/8
1710	175	21	42	84	16	15	10	15	14	3/8
2510	250	30	60	120	20	15	12	18½	13½	1/2
4010	400	48	96	192	20	15	12	18½	13½	1/2
5010	500	60	120	240	20	15	12	18½	13½	1/2
6010	600	72	144	288	20	15	12	18½	13½	1/2

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

Size	H	W	D
1500 thru 3000	22	15	12
6000 thru 1110	26	17	12
1710	30	18	14
2510 thru 6010	42	18	14