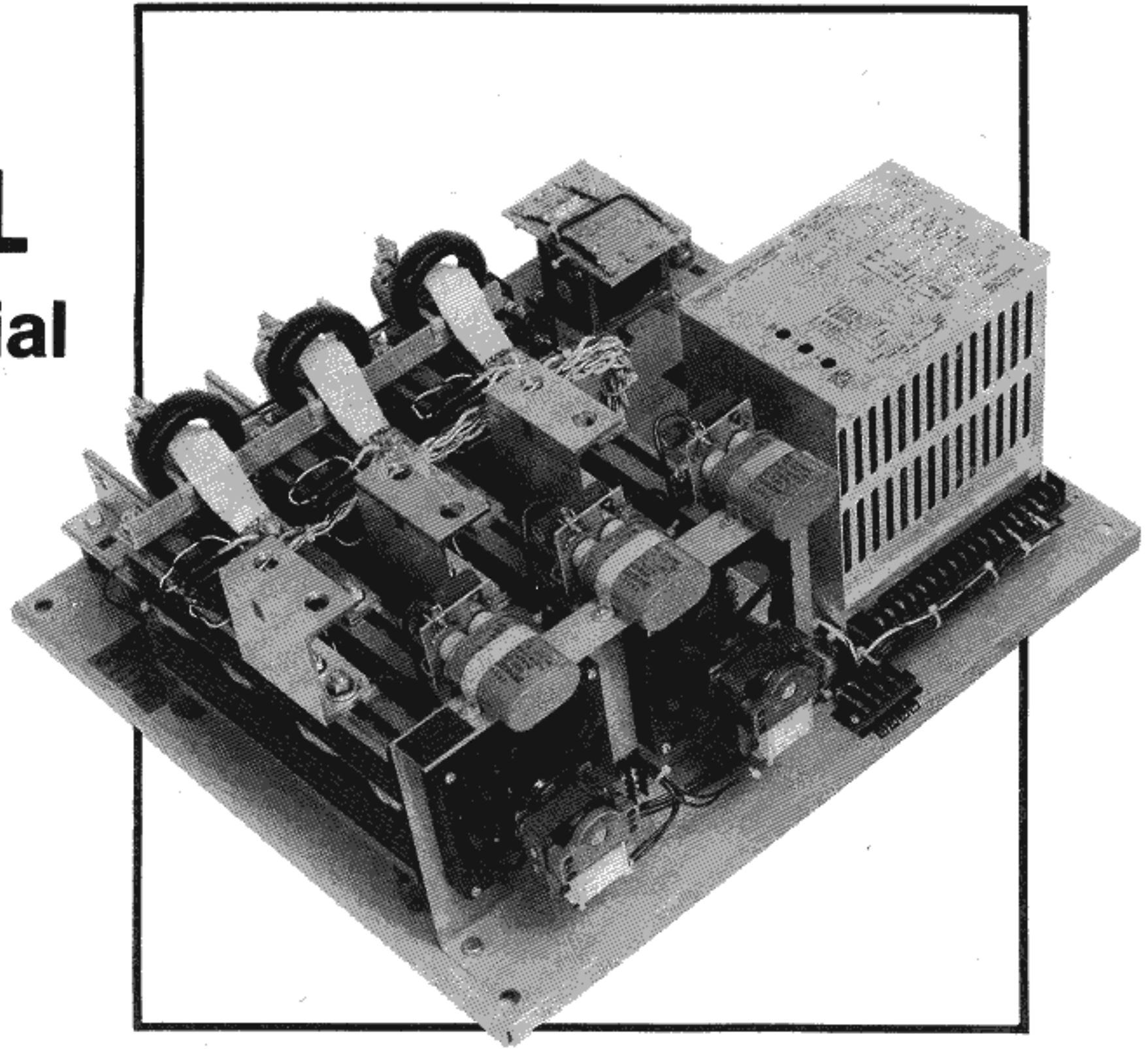


Spang Power Electronics

Phase Angle Control THREE PHASE SCR POWER CONTROL UNITS - for Industrial Control Applications B-SERIES



SPANG Power Control Units for three phase applications are available either with phase angle control or with synchronous firing control of 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
- LED indication of proper phase rotation
- Phase lock loop for firing pulse synchronization
- Firing modules consisting of plug-in printed circuit cards
- Six SCR full converter or three SCR semi-converter configurations
- 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 modular firing circuit package contains three plug-in printed circuit cards with all the electronic circuitry required to perform the control function of any application.

Spang Power Electronics manufactures a three phase, phase angle fired power control unit with six SCR full converter configurations. The full converter uses two (2) SCRs connected inverse parallel in each line to the load (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 208 volt, three 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 for 480 volt units are 1200 volts for 240 and 208 volt units are 800 volts. Higher PRV ratings are available for specialized applications.

Reference Supply: A 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 and 30 amperes are convection cooled.

b. Current sizes from 60 to 1300 amperes are forced-air cooled by integral cooling fans. Bimetallic temperature switches are supplied on all forced-air cooled units with one normally open 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 in all three lines (phases) and limits output to the highest of the three. 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 three phase watt transducer. Output wattage can be regulated to $\pm 1\%$ of set point. Common applications are in control of silicon carbide heating loads.

5. Overcurrent Shutdown 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.

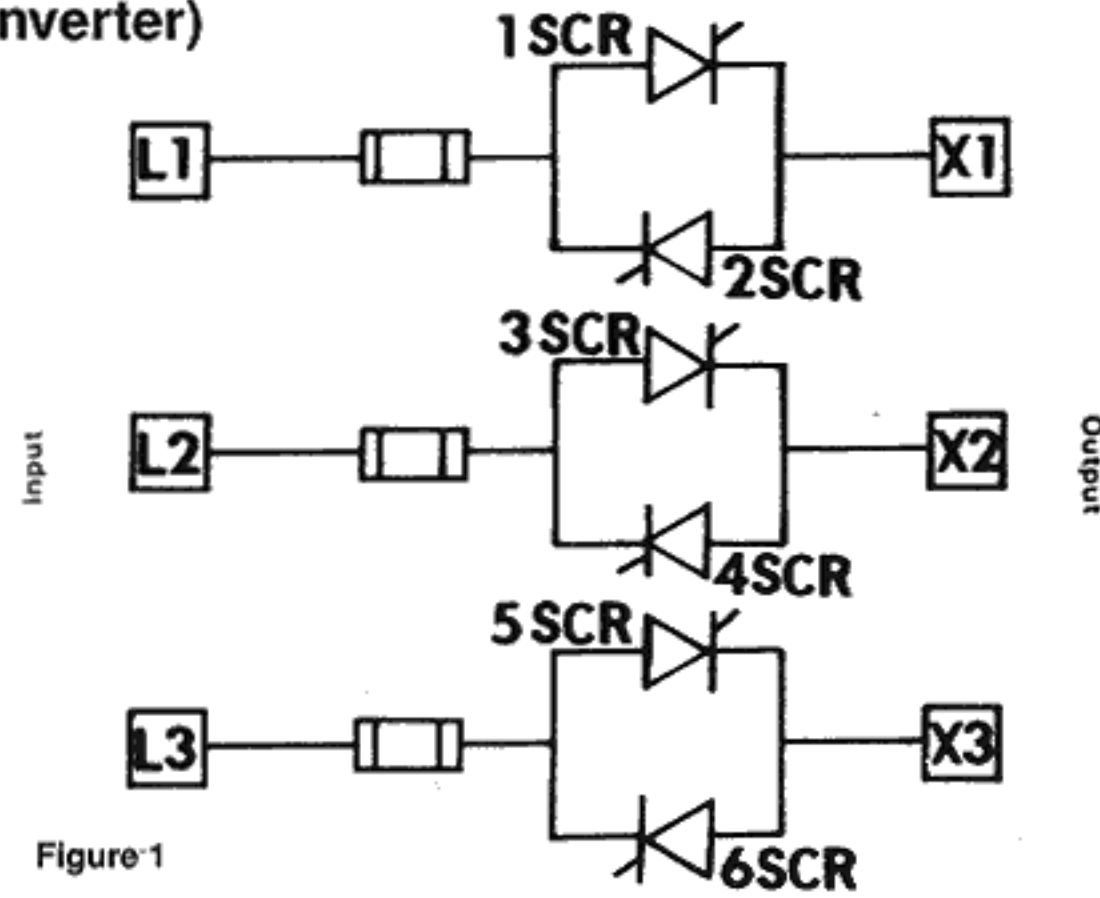
6. NEMA 1 Wall Mounted Enclosures are available for housing the respective Power Control Units. The enclosure features #14 gauge steel construction finished with ASA-61 light gray enamel. Ventilation is provided through expanded metal openings at the bottom and sides of the enclosure. Conduit entrance 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 10 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 Drawings of Power Control Units

Three Phase – Six SCR (Full converter)



Electrical Features

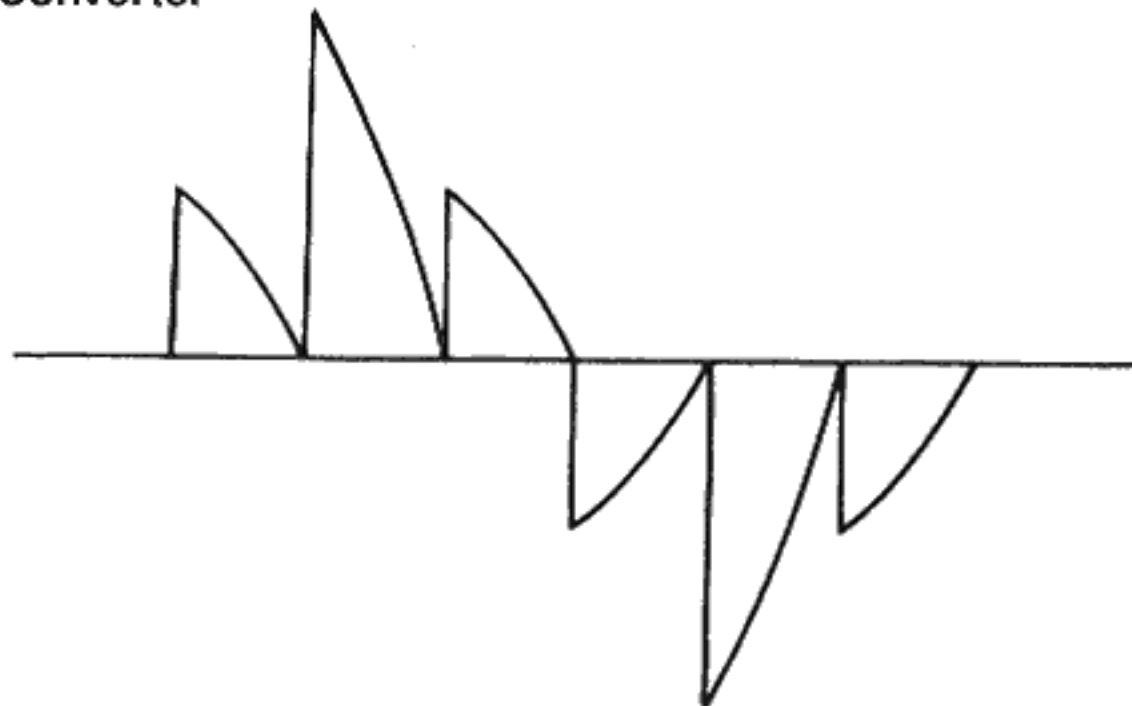
1. Upon initial circuit energization, there is a 4 second dead time for circuit stabilization during which time the SCR gate pulses are inhibited
2. The firing circuit inherently includes a 3-4 second built-in soft start and Transformer Inrush Protection (TIP) feature.
3. The time response and ramp eliminates output overshoot, preventing damaging excessive currents into dynamic loads on either start-up or response to step function control signals.
4. Firing pulses between phases and complementary pairs are balanced within ± 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), momentary power interruption and reversed phase sequence.
7. The firing circuit provides a high frequency pulse train with a rise time of 300 nanoseconds to the SCR gates.

Mechanical Features

1. The unit uses a plug-in card rack assembly with three plug-in printed circuit cards and one receptacle board.
2. Electrical connections are made on screw-type terminal blocks.
3. Card pullers (extractors) are provided as an inherent feature on each plug-in board.
4. Bias, Gain, and Current Limit adjustments are accomplished through standard 20 turn potentiometers easily accessible through the top cover plate.
5. Information for input/output connections, control adjustments and input impedance are readily available on the top cover plate.
6. Diagnostic proper phase rotation is indicated with a light emitting diode (LED).

Phase Angle Firing Control

Three Phase – Full Converter



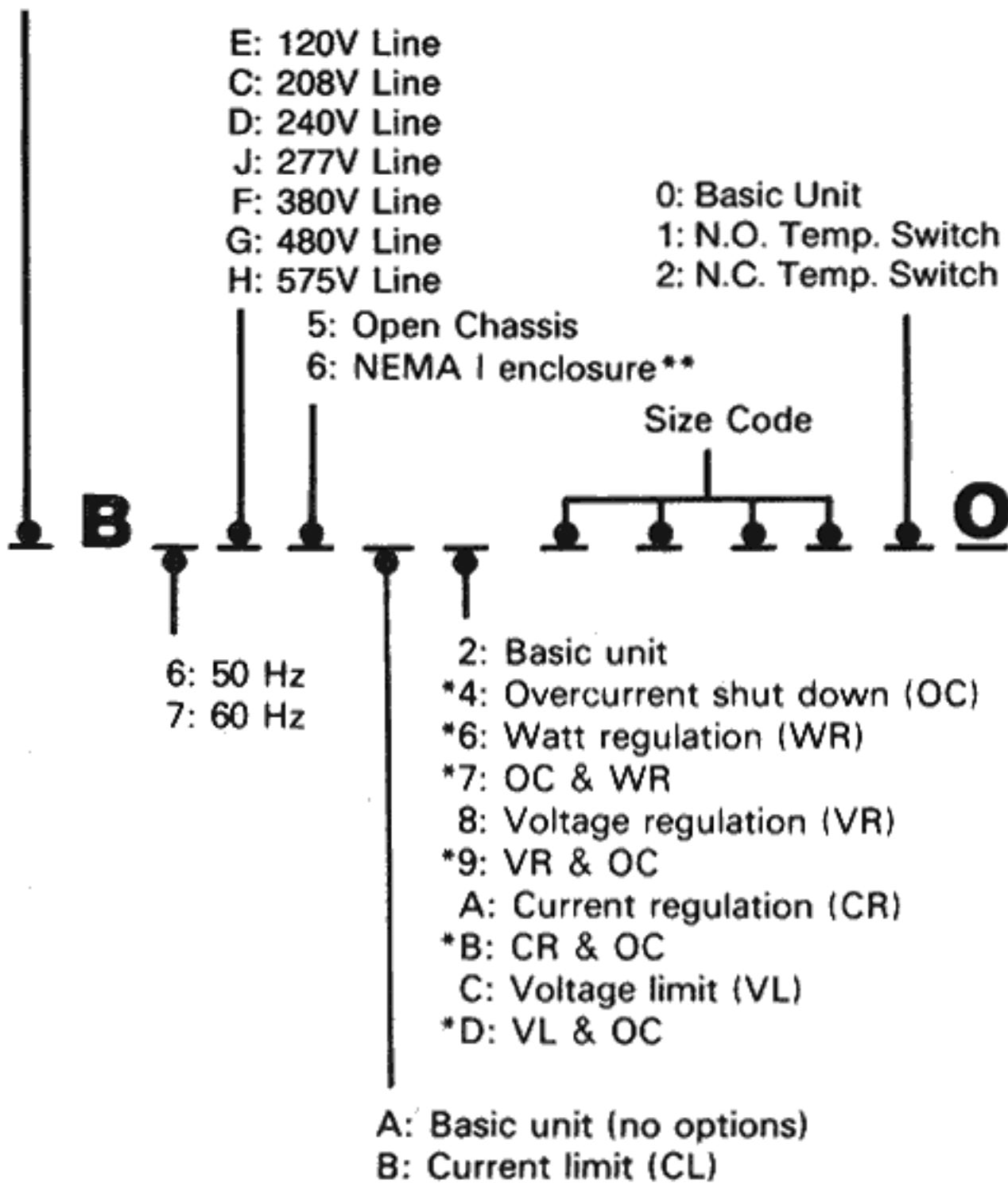
Control Connections

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 ohms 2 watt potentiometer.
Lockout (External shutdown contact)	6 and 17	

Ordering Information

3 Phase Power Control Units — AC Output

F.: 6 SCR full converter



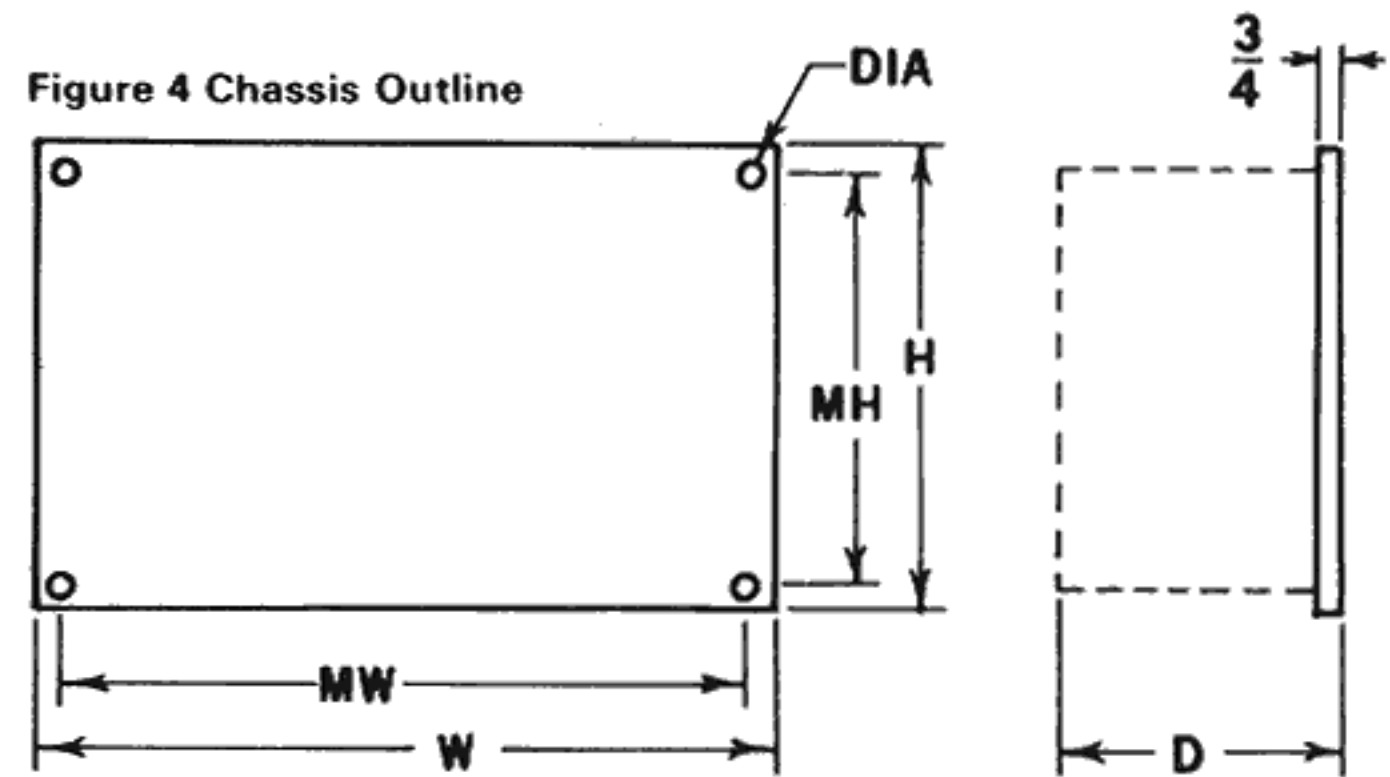
*PCUs with these options must be tailored to individual requirements; consult factory before ordering. An additional 10" is required in height dimension for both chassis and NEMA I enclosures.

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.

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.

Figure 4 Chassis Outline



Ratings and Chassis Dimensions (inches)

Size Code	Current Rating AC Amps	KVA Rating			Refer to Figure 4					
		208V	240V	480V	H	W	D	MH	MW	DIA
1508	15	5.4	6.24	12.5	16	14	10	15	13	3/8
3008	30	10.8	12.5	25.0	16	14	10	15	13	3/8
6008	60	21.6	25.0	50.0	18	14	10	17	13	3/8
9008	90	32.4	37.4	75.0	18	14	10	17	13	3/8
1118	110	39.6	45.7	91.4	20	22	12	18 1/2	20 1/2	1/2
1518	150	54	62	125	20	22	12	18 1/2	20 1/2	1/2
2518	250	90	104	208	20	22	12	18 1/2	20 1/2	1/2
3518	350	125	145	290	20	22	12	18 1/2	20 1/2	1/2
4518	450	162	187	374	20	22	12	18 1/2	20 1/2	1/2
6018	600	216	250	500	20	24	12	18 1/2	22 1/2	1/2
8018	800	288	332	665	26	36	15	24 1/2	34 1/2	1/2
1028	1000	360	416	832	26	36	15	24 1/2	34 1/2	1/2
1328	1300	468	540	1080	42	37	24	40 1/2	35 1/2	1/2

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

Size	H	W	D
1508 thru 9008	26	17	12
1118 thru 1518	30	25	14
2518 thru 6018	42	27	14
8018 thru 1028	52	39	16
1328***	76	44	30

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