Instruction Manual

Current Regulated Power Supply
2200Amps 143 VDC

S.O. 587

Designed and Manufactured By:

Alpha Scientific Electronics Inc.
1868 National Ave.
Hayward Ca. 94545
(510) 782-4747
FAX(510) 782-5474

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Although many safety features have been incorporated into the design of the power supply, dangerously high voltages are present inside the cabinet when the circuit breaker is closed. Extreme care must be taken when any cabinet panel is removed.

Before attempting to install or operate the power supply, read the instruction manual carefully. Refer all operation, maintenance, and service to qualified personnel who are familiar with the contents of this manual. Be certain the intended use of the equipment is in accordance with its capabilities as set forth in this manual.

If shipping damage is indicated, notify the transportation company before proceeding further.

Danger—High Voltage Can Exist, Be Careful

2.0 SPECIFICATIONS

2.1 Input: 480 VAC, 3 Phase, 60 Hertz, 390 KVA

2.2 Output: 2200 Amps @ 143 VDC

2.3 Current Regulation: 0.1% of maximum

2.4 Voltage Ripple: 120 MV RMS into resistive load

2.5 Designed Load Inductance: 0.5 millihenries

2.6 Cooling: 12 GPM water @ 35 PSID nominal

2.7 Current Adjustment:

2.7.1 Local current adjustment: 10 Turn Potentiometer

2.7.2 External current adjustment: 0–10VDC = 0–2200Amps

2.8 Physical: 77-1/4" High x 40-1/4" Wide x 40-1/4" Deep

Estimated weight 2,800 lbs.

3.0 INSTALLATION

3.1 Uncrate and carefully inspect the equipment for shipping damage, loose components etc.

3.2 Set the unit into position, allowing access to remove the left side and front panels.

3.3 Connect cooling water supply and return lines to the 1/2" F.P.T. fittings as marked, IN and OUT at the top of the unit.

3.4 Connect the AC input cables to the top lugs of the main circuit breaker. (NOTE: The control panel is hinged for access.)

3.5 Connect load cables to DC output bus terminals as marked (POS, NEG). Hole pattern is intended for water cooled cables.

3.6 Connect a #4/0 copper (or similar) cable from the frame ground terminal, near the circuit breaker, to good external ground.

3.7 Make external connections to TB1 Connector as follows:

1 2		Normally closed external switch to monitor load, water flow, etc. (or install jumper).
3 4		N.C. Remote "OFF" switch
7 8		N.O. Remote "ON" switch
9	0-10VDC	Remote current set.10VDC = 2200Amps Source must be isolated
10	Common	
11	Shield	
12	Pos	Remote current monitor, 2200A – 100MV Monitor equipment must be isolated
13	Common	
14	Shield	

4.0 OPERATION

4.1 Make sure that all connections are made in accordance with section 3.0 (Installation) and that all cables and services are rated for 100% power.

4.2 Close 6 Amp control power breaker on the power supply cabinet.

4.3 Make sure cabinet panels are in place.

4.4 Turn on cooling water to power supply.

4.5 Momentarily depress the "RESET" push-button.

4.6 Observe the status indicator LED's (light emitting diodes) on the front panel.

4.6.1 The green ready indicator must be ON before the power supply can be started. Any yellow LED's not on indicates an interlock fault that must be corrected.

4.7 Initially set the selector switch for "LOCAL" control.

4.8 Initially set the "Current Set Control" for minimum output.

4.9 Close the main circuit breaker (rotary handle).

4.10 Momentarily depress the "ON" button. Wait several seconds until the soft-start circuit raises the filter voltage to its nominal value.

4.11 Increase the "Current Set Control" to the desired steady state current (2200Amps maximum).

4.11.1 If the current does not increase, check the input phase rotation. (The green indicator on the phase balance monitor inside the front panel must be ON.)

4.12 The power supply may be turned off from any operating level by depressing the "OFF" push-button.

4.13 If there is an interlock fault, the associated status LED will be dark and the main circuit breaker will trip.

5.0 MAINTENANCE

5.1 Routine maintenance will consist of the following tasks:

5.1.1 Keep the equipment clean.

5.1.2 Keep all electrical and hose connections tight (especially high current terminals).

5.1.3 Relay contacts have long life but should be replaced if the contacts become excessively burned or pitted.

5.1.4 Replace any blown fuses with identical types.

5.2 All normal maintenance can be performed through the front or rear panels.

Be sure that all panels are installed before operating the equipment.

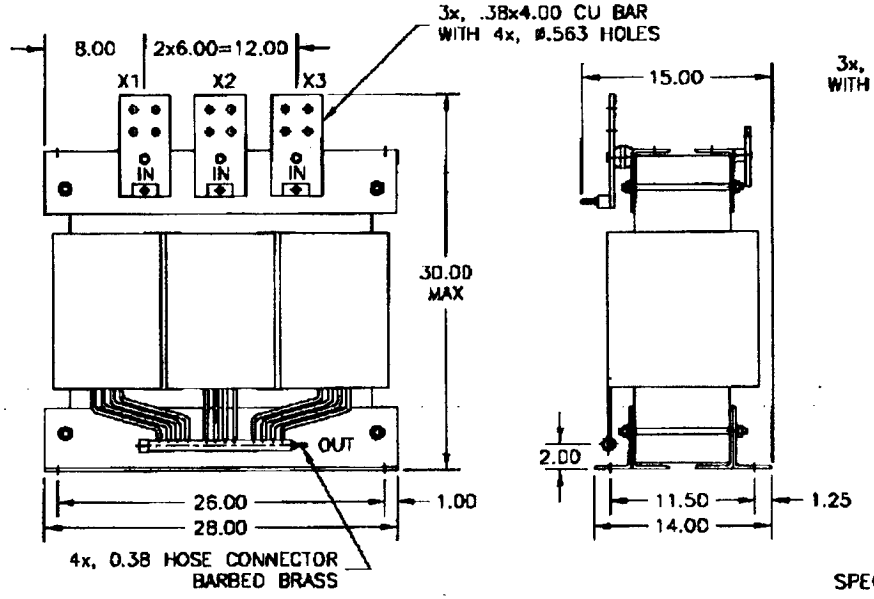
6.0 MANUFACTURERS' DATA SHEETS

TRANSFORMER	POWER MAGNETICS	S28818.0
CHOKE	POWER MAGNETICS	28570.0
24V POWER SUPPLY	SOLA	SLS-24-024T
±15V POWER SUPPLY	SOLA	SLD-15-3030-15T
GATE DRIVE BOARD	ENERPRO	FCOG6100
SNUBBER BOARD	ENERPRO	TSB-6
FLOW SWITCH	MCDONNELL	FS4-3
PHASE BALANCE MONITOR	TIME MARK	C263-480

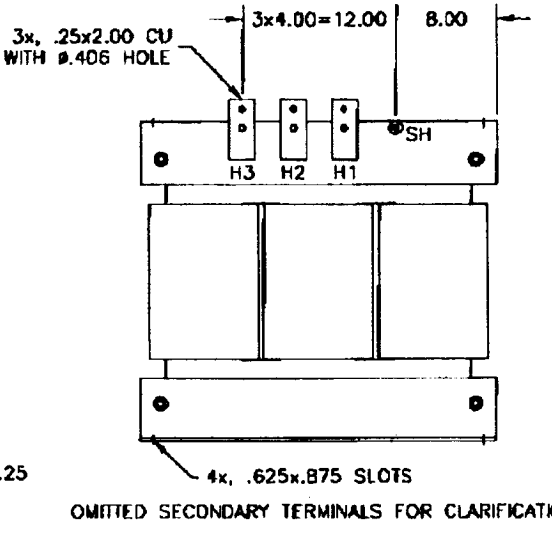
CAGE CODE	DWG NO	SH	REV
86301	S28818.0	1	N/C

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



OMITTED PRIMARY TERMINALS FOR CLARIFICATION

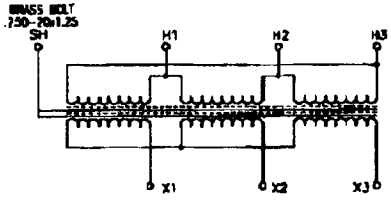


OMITTED SECONDARY TERMINALS FOR CLARIFICATION

SPECIFICATION:

KVA 390, Hz 60, PHASE 3
INS CLASS H
PRIMARY: 480 DELTA
SECONDARY: 125Y L-L @ 390 KVA

WATER REQD: 1.75 GPM
TEMP RISE: 115°/55°C
INRUSH CURRENT 10x OR LESS



TRANSFORMER
KVA 390 Hz 60 PH 3
HV 480 D
LV 125Y L-L @ 390 KVA
TEMP RISE 115°/55°C INS CL H CLG CL WATER
IMPEDANCE 3.6% STYLE S28818.D
WEIGHT 1440 LBS SERIAL NO.
DTC DATE CODE CUSTOMER PN
MADE IN GARDEN CA, U.S.A.

CONTRACT NO.			
APPROVALS		DATE	
DRAWN	C. BROWNE	01/11/02	
CHECKED	TCO. A. R.	01/11/02	
ENGR	TCO. A. R.	01/11/02	
DESIGN AUTHORITY			
ASSY DWG NO 28818-80			
CAD FILE NO 28818801			
DO NOT SCALE DRAWING			

POWER MAGNETICS
SPD TECHNOLOGIES, INC.
GARDEN, CALIFORNIA 90248

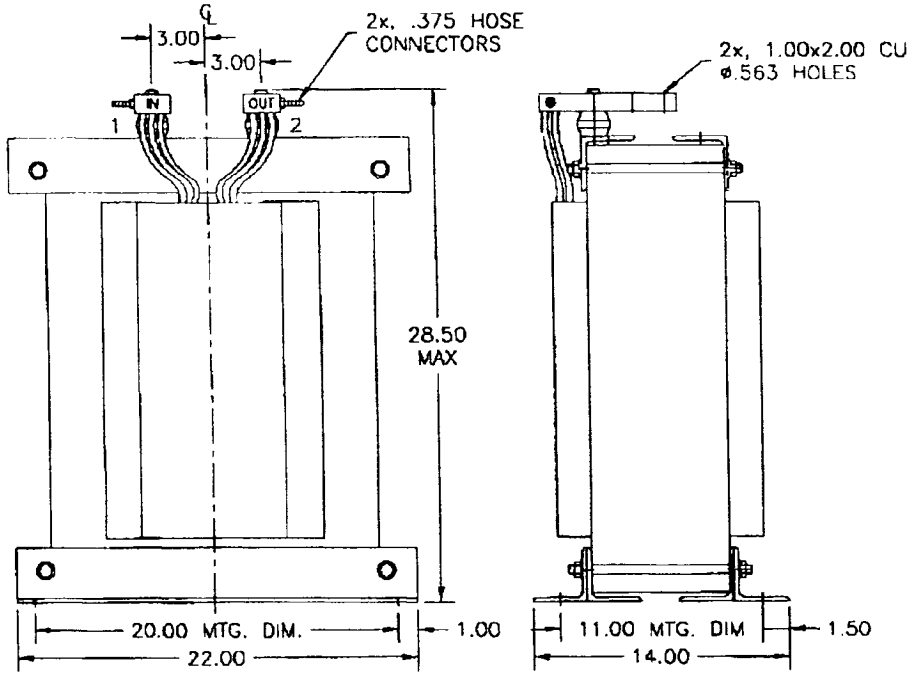
TITLE: TRANSFORMER OUTLINE

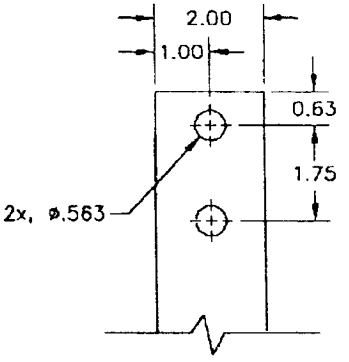
SIZE	CAGE CODE	DWG NO	REV
B	86301	S28818.0	N/C

SCALE NONE WT. LBS 1440 LBS SHEET 1 OF 1

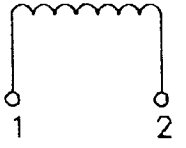
CAGE CODE	DWG. NO.	SH	REV.
86301	28570.0	1	N/C

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED





TERMINALS
1.00x2.00 CU BAR



REACTOR			
Communications SPD Technologies, Inc. Power Magnetics	TYPE	INDUCTOR	
	HENRY	.0002	Hz 360
	AMPERES	2500	PH 1
VOLTAGE CL 600	VOLTAGE	215V P-P	
TEMP RISE 55°C	CLG CL	WATER	INS CL R
STYLE 28570.0	SERIAL NO.		
WEIGHT 790 LBS	MFG DATE CODE		

MADE IN GARDENA CA. U.S.A.

SPECIFICATION:

FILTER CHOKE WATER COOLED
200 MICROHENRY @ 2500 AMPS
360 Hz, 215V P-P RIPPLE
INS CLASS R, TEMP RISE 55°C
WATER REQD: 0.6 GPM

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON .XX DECIMAL ±.03 .XXX DECIMAL ±.010 ANGLES ±1°	CONTRACT NO.		
	APPROVALS		DATE
	DRAWN	C. BRONES	00/05/27
	CHECKED	FCO. A. R	00/06/27
ASSY DWG NO. 28570-80	ENGR	FCO. A. R	00/06/27
CAD FILE NO. 28570A01	DESIGN ACTIVITY		
DO NOT SCALE DRAWING			

POWER MAGNETICS
SPD TECHNOLOGIES, INC.
GARDENA, CALIFORNIA 90248

TITLE: FILTER CHOKE OUTLINE

SIZE	CAGE CODE	DWG. NO.	REV.
B	86301	28570.0	N/C

SCALE	WT. CALC.	SHEET
NONE	790 LBS	1 OF 1

Linear Open Frame DC Power Supplies
Silver Line Instruction Manual
Models: SLS-05-060-1T, SLS-12-034T, SLS-24-024T

EGS Electrical Group — SOLA/ HEVI-DUTY

EMERSON Industrial Automation

Features

- Easy installation with strip terminal
- Tight regulation: 0.05% Line; 0.05% Load
- Full Output Ratings to +50°C
- Built in OVP on 5 Volt Outputs
- OVP Option for 12V and 24V
- Foldback Current Limiting Overload Protection with Automatic Recovery
- Multi-Tap AC Inputs
- 100% Four-Hour Burn-in
- Please see enclosed "**Terms & Conditions and Sales & Policies & Procedures**"
- UL Recognized
- CSA Certified
- CE Marked
- CB Certified

General Specifications

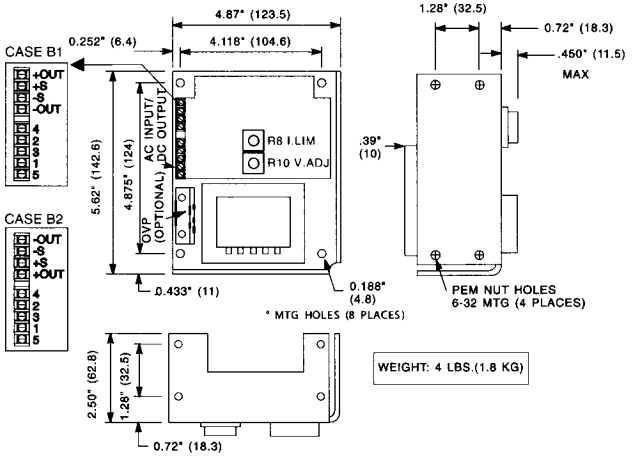
Voltage/Current Ratings	
Model Number	Output
SLS-05-060-1T	+5V / 6.0 A
SLS-12-034-T	+12V / 3.4 A
SLS-24-024-T	+24V / 2.4 A
Operating Temperature Range	0 to +50°C (Derate to 40% at +70°C)
Temperature Coefficient (Typical)	+/- 0.01% / °C
Stability	Within +/- 0.05% (24 hours after warm-up)
Vibration	Per MIL-STD-810C, Method 514
Shock	Per MIL-STD-810C, Method 516
EMI/RFI	Linear power supplies have inherently low conducted and radiated noise levels. For most system applications, these power supplies will meet the requirements of FCC Class "B" and VDE 0871 for Class "B" equipment without additional noise filtering.
Cooling	Forced air. 20 CFM required for full rating Derate 30% for convection cooling.
Input Specifications	
Multi Input (all units)	100/120/220/230/240 VAC selectable +/- 10% except 230 VAC is +15%, -6%
Frequency Range	47-63 Hz (Typical is 60 Hz. Derate output 10% at 50 Hz)
Transient Response Time	50 µsec at 50% load changes for outputs rated up to 6A
Fuse Requirements	Units are *not* fused internally. For safe operation, user must provide input line fuse as per values given in table.
Output Specifications	
Line Regulation	0.05% for +/- 10% change
Load Regulation	0.05% for 50% change
Ripple	3.0 mV maximum peak-to-peak
DC Output Adjustment Range	+/- 5% minimum
Overvoltage Protection	All 5 volt outputs include built-in OVP as standard (setting is 6.2 V +/- 0.4 V). OVP is optionally available on other outputs.
Remote Sensing	All units listed have remote sensing capability.
Overload Protection	125 to 150% foldback current limit

Input AC Connections (See Case B)

For use at	Connect	Apply AC to:	Primary Fuse (SLS-05-0601T) (SLS-12-034T) (SLS-24-024T)
100 VAC	1-3, 2-4	1 & 5	1.6A / 125V
120 VAC*	1-3, 2-4	1 & 4	1.6A / 125V
220 VAC	2-3	1 & 5	0.8A / 250V
230 VAC	2-3	1 & 4	0.8A / 250V
240 VAC	2-3	1 & 4	0.8A / 250V

*Note: Unit is shipped for 120V input from factory.

Mechanical Dimensions: inches (mm)



Case B

*Use **Case B1** Output Configuration for SLS-05-060-1T and SLS-12-034T.*
*Use **Case B2** Output Configuration for SLS-24-024T.*

Note: The SLS models DC output can be adjusted with R10 V. ADJ.
R8 I. LIM is factory set and should not be adjusted by users.

Application Note: User needs to provide earth ground to power supply with either solder to Tab or using washer and nut assembly.

The SLS power supply is shipped from the factory with metal shorting straps connected between the + OUT and + S terminals and the (-) OUT and (-) S terminals. This strapping configuration allows the output of the SLS to be taken from either pair of terminals. This is the standard configuration.

The **remote sense** feature is enabled by removing the shorting straps and connecting the individual OUT and S terminals to the appropriate points of the load. If an OVP circuit is used it should be connected to the + OUT and (-) OUT terminals. The OVP should **never** be connected to the + S, - S terminals without the use of the shorting straps. In all cases it is critical that the terminal screws be **firmly tightened**.

Contact Technical Services at 1-800-377-4384 or tech@sola-hevi-duty.com with any questions.
Visit our website at www.solaheviduty.com

SOLA/ HEVI-DUTY

Linear Open Frame DC Power Supplies
Silver Line Instruction Manual
Model: SLD-15-3030-15T

Features

- Easy installation with strip terminal
- Tight regulation: 0.05% Line; 0.05% Load
- Full Output Ratings to +50°C
- OVP Option 15V
- Foldback Current Limiting Overload Protection with Automatic Recovery
- Multi-Tap AC Inputs
- 100% Four-Hour Burn-in
- Limited Warranty for two years
- UL Recognized
- CSA Certified

General Specifications

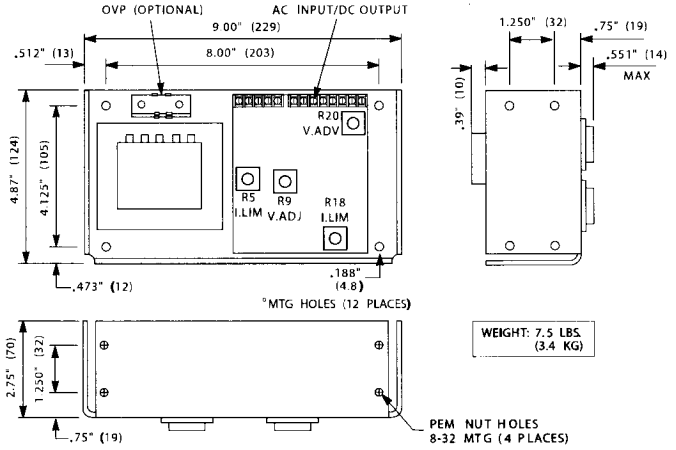
Voltage/Current Ratings		
Model Number	Output 1	Output 2
SLD-15-3030-15T	+15V/3.0A[1]	-15V/3.0A[1]
[1] Outputs are isolated from one another.		
Operating Temperature Range	0 to +50°C (Derate to 40% at +70°C)	
Temperature Coefficient (Typical)	+/- 0.01% / °C	
Stability	Within +/- 0.05% (For 24 hours after warm-up)	
Vibration	Per MIL-STD-810C, Method 514	
Shock	Per MIL-STD-810C, Method 516	
EMI/RFI	Linear power supplies have inherently low conducted and radiated noise levels. For most system applications, these power supplies will meet the requirements of FCC Class "B" and VDE 0871 for Class "B" equipment without additional noise filtering.	
Cooling	Forced air. 20 CFM required for full rating Derate 30% for convection cooling.	
Input Specifications		
Multi Input (all units)	100/120/220/230/240 VAC selectable +/- 10% except 230 VAC is +15%, -6%	
Frequency Range	47-63 Hz (Typical is 60 Hz. Derate output 10% at 50 Hz)	
Transient Response Time	50 µsec at 50% load change	
Fuse Requirements	Units are *not* fused internally. For safe operation, user must provide input line fuse as per values given in table.	
Output Specifications		
Line Regulation	0.05% for +/- 10% change	
Load Regulation	0.05% for 50% change	
Ripple	3.0 mV maximum peak-to-peak	
DC Output Adjustment Range	+/- 5% minimum	
Overvoltage Protection	OVP is optionally available	
Remote Sensing	Refer to Figure 1 for the output(s) with remote sensing.	
Overload Protection	125 to 150% foldback current limit	

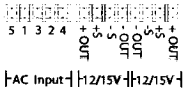
Input AC Connections

For use at	Connect	Apply AC to:	Primary Fuse
100 VAC	1-3, 2-4	1 & 5	2.5A / 125V
120 VAC*	1-3, 2-4	1 & 4	2.5A / 125V
220 VAC	2-3	1 & 5	1.25A / 250V
230 VAC	2-3	1 & 4	1.25A / 250V
240 VAC	2-3	1 & 4	1.25A / 250V

*Note: Unit is shipped for 120V input from factory.

Mechanical Dimensions: inches (mm)





Case I3

Note: The DC outputs can be adjusted with V. ADJ.
I. LIM is factory set on all models and should not be adjusted by users.

Application Note: User needs to provide earth ground to power supply with either solder to Tab or using washer and nut assembly.

The SLS power supply is shipped from the factory with metal shorting straps connected between the + OUT and + S terminals and the (-) OUT and (-) S terminals. This strapping configuration allows the output of the SLS to be taken from either pair of terminals. This is the standard configuration.

The **remote sense** feature is enabled by removing the shorting straps and connecting the individual OUT and S terminals to the appropriate points of the load. If an OVP circuit is used it should be connected to the + OUT and (-) OUT terminals. The OVP should **never** be connected to the + S, - S terminals without the use of the shorting straps. In all cases it is critical that the terminal screws be **firmly tightened**.

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Visit our website at www.solaheviduty.com

ENERPRO
5780 Thornwood Drive
Goleta, California 93117

http://www.enerpro-inc.com
info@enerpro-inc.com
Report No. R380
June 2008

OPERATING MANUAL FOR SIX-SCR GENERAL PURPOSE GATE FIRING BOARD, PART NO. FCOG6100 REVISION R

INTRODUCTION

This manual is intended to familiarize the user with the salient features and specifications of the firing board. A simple checkout procedure is included together with typical firing circuit signal waveforms.

PRODUCT DESCRIPTION

1.0 Application

The general purpose firing board responds to a voltage or milliamp current signal to produce a delayed set of six 60° spaced high current SCR gate pulses. Different configurations are available upon ordering to suit various types of SCR controllers or converters (rectifiers or inverters).

2.0 LSI Logic Device

All firing circuit logic is contained in a custom 24-pin CMOS LSI gate array. Additional detail on the firing circuit theory is contained in an engineering society paper[1].

3.0 Board Mounted Connectors

The firing board is completely connectorized to simplify maintenance and troubleshooting.

3.1. Gate/Cathode Connectors

The SCR gate/cathode interface is provided by 8-position Mate-N-Lok™ right-angle headers[2], J1 and J2, and mating plugs, P1 and P2. The jacks are keyed to prevent incorrect installation of the mating plugs. Plug P1 accesses the gates and cathodes of the three SCRs having load connected cathodes when the SCRs are arranged in the in-line ac controller or bridge converter configurations. Similarly, plug P2 accesses the gates and cathodes of the three SCRs having line-connected cathodes. Plug P1 or P2 and the associated cable are omitted when the firing board is used with 3-SCR/3-diode circuits.

---

[1] Bourbeau, F. J., "Phase Control Thyristor Firing Circuit: Theory and Applications", Power Quality '89, Long Beach, California.
[2] Vertical headers are available upon request.

3.2. Control Signal Connector

The firing board connects to the gate delay command and inhibit controls through a 12-position Mate-N-Lok™ connector designated as J3. This connector also accesses the outputs of the 24 Vac board mounted transformer (if specified), the 30 VDC rectifier, and the regulated +12/+5 VDC outputs.

3.3. Optional Power Supply Excitation

The board-mounted 24 VA power supply transformer is normally energized by on-board connection to two of the mains voltages which appear at positions 5 and 8 of header J2. When the SCRs are powered from non-standard voltages, the board mounted power supply transformer can be energized through the optional 5-position Mate-N-Lok™ plug/header, P4/J4.

The 24 Vac and 30 VDC connections on the control signal connector, J3, permit the board to be powered from an external source if no onboard transformer is specified. With the board-mounted transformer installed, approximately 10 watts of ac or DC power is available from J3 to power lamps or control relays.

3.4. Optional Reference Connector

In certain applications, the ac mains voltage may not be present at the SCR cathodes or the ac voltage may go to zero during load faults[3]. In these cases, or when galvanic isolation is required between power and control circuits, external phase reference voltages are applied through optional Mate-N-Lok™ plug P5. The mating header, J5, and voltage sensing resistors R6, R7 and R8 are installed on the board space normally occupied by power supply transformer T1. Board power is then obtained externally from 24 Vac or 30 VDC applied through P3/J3.

3.5. Test Signal Input Connector

A 3-position cable header, J7, is used to inject low level 3-phase test reference signals from a firing board test fixture into the delay determinator circuit. This allows the board checkout to proceed without connection to high voltage power. In addition, a three-position Mate-N-Lok™ connector, P7, is available for this purpose or for connection of externally attenuated phase reference signals. The use of P7 and external attenuating resistors allows the use of the onboard transformer while still providing connection to external phase references.

3.6. Auxiliary Regulator Board Connector

Key firing board signals are brought out to a 20-position ribbon cable connector socket, J6, for interfacing with a second printed circuit board which can be conveniently mounted on stand-offs above the firing board. This regulator board can provide various closed-loop functions (torque,

[3] For example, in a 6-SCR interphase transformer converter or an arc welder converter.

speed, position voltage, power, etc.) and diagnostic circuitry. The 20-position connector socket also facilitates board testing.

3.7. GATE DELAY COMMAND

The gate delay command signal, SIG HI, may be configured either as a 4 to 20 mA current command or one of several voltage commands, the default being 0 to 5 Volts. The input resistance presented to the delay command signal SIG HI is determined by resistor R30. This value is selected as 10.0 kΩ when the control signal is designated as a control voltage. The buffer amplifier resistance table below delineates the required resistor values to accommodate different command signal levels. Alternatively, refer to the schematic diagram, E128, revision R.

Table 1. SIG HI Range vs. Buffer Amplifier Component Values

SIG HI Range	**Resistance** (in kΩ unless noted)					
	R16	*R19*	*R25*	*R26*	*R27*	*R30*
0 to 5 V	100	32.4	130	46.4	1.00M	10.0
0.85 to 5.85 V	100	32.4	196	46.4	1.00M	10.0
0 to 10 V	100	32.4	1.00M	90.9	750	10.0
0 to 2 V	274	32.4	78.7	47.5	1.00M	10.0
4 to 20 mA	100	32.4	130	47.5	1.00M	249Ω

4.0 GATE INHIBITS

SCR gating is inhibited by making either or both of the inhibit signal points, designated as $\overline{I_1}$ and $\overline{I_2}$ appearing at J3 (pins 4 and 12 respectively) a logic zero.

In the case of the instantaneous inhibit, $\overline{I_1}$, resistor R32 (1.50 kΩ) on the firing board is provided to pull the $\overline{I_1}$ signal point low if the connection between $\overline{I_1}$ and +12 VDC is opened. This ensures that SCR gating is inhibited if plug P3 is inadvertently disconnected. In applications where the instantaneous gate inhibit function is not utilized, a jumper wire is installed between pins 4 and 6 of P3 to hold $\overline{I_1}$ at +12 VDC when P3 is installed in J3.

The inhibit signal $\overline{I_2}$ is connected to +12 VDC through pull-up resistor R31 (1.50 kΩ) on the firing board. When $\overline{I_2}$ is grounded, the gate delay angle is ramped to the maximum delay angle before gating is inhibited. This is termed the soft-stop shutdown mode. Removing the ground on $\overline{I_2}$ causes gating to be enabled with the delay angle set to the maximum limit. The delay angle then ramps down to the commanded angle. This is termed the soft-start turn-on mode. The soft-stop and soft-start periods are

determined by two timing resistors and a capacitor.

5.0 PHASE-LOSS INHIBIT

A phase loss circuit operates to instantly inhibit SCR gating if the mains phase balance is abnormal or, in the extreme case, if one phase voltage is missing. Gating is enabled when the proper phase balance is restored: gating initiates at the maximum delay angle, and ramps down to the commanded angle at a rate determined by the soft-start RC time constant. The FCOG6100 revision R product features a new, enhanced phase loss detection circuit that is immune to line frequency variations and transient voltages on the SIG HI line.

The phase-loss inhibit circuit is also activated when three phase power is initially applied to the SCRs. Gating is inhibited until the power supply voltage has stabilized. Gating then commences at the delay angle limit and ramps down to the commanded angle at a rate determined by the soft-start RC time constant.

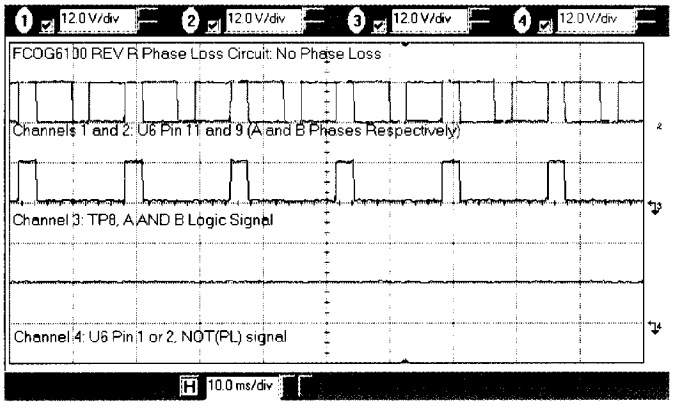


Figure 1. Phase Loss Circuit Signals – No Phase Loss[4]
Channels: 1. Digital A Phase Reference Signal, U6 P11
2. Digital B Phase Reference Signal, U6 P9
3. A and B logic signal, TP8
4. $\overline{PL}$ Signal, U6 P1

[4] All waveforms contained in this document were obtained with the FCOG6100 revision R firing board connected to 240 Vac, 60 Hz, balanced 3-phase power via sockets 2, 5, and 8 of plug P2. The time base of each screenshot has been calibrated for phase measurements as noted at 60 Hz. All component designations refer to drawing E128, revision R.

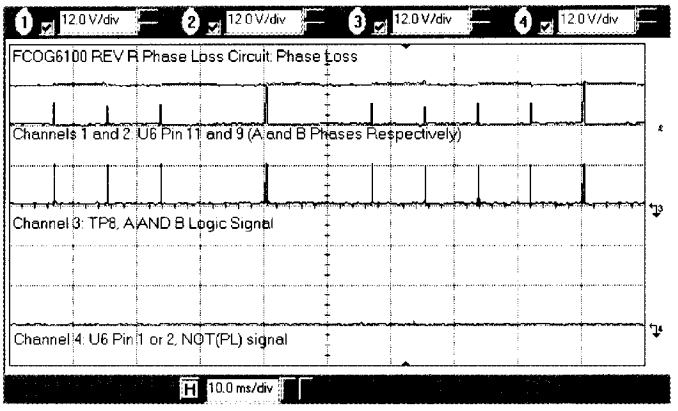


Figure 2. Phase Loss Circuit Signals – Phase Loss
Channels: 1. Digital A Phase Reference Signal, U6 P11
2. Digital B Phase Reference Signal, U6 P9
3. A and B logic signal, TP8
4. $\overline{PL}$ Signal, U6 P1

6.0 REFERENCE PHASE ANGLE SELECTION

Phase shifting the mains phase references by 0° (for controller applications) or by 30° lagging (for converter applications) is achieved by a first-order RC low-pass filter formed by RN6 and C15, C16, and C18. *For 30° lagging references*, the previously referenced capacitors are 0.033 µF film capacitors and RN6 is a 120 kΩ, three-position, isolated SIP resistor network.

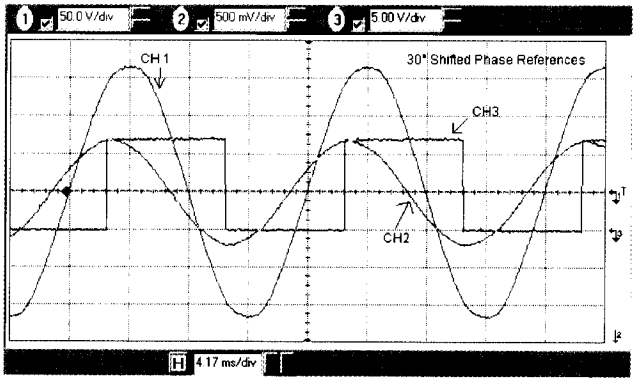


Figure 3. Thirty-degree shifted phase references, Phase A
Channel: 1. Phase A Line-to-Neutral Voltage
2. Attenuated and Filtered Mains Voltage at RN6-3
3. Reference Comparator Output, TP5

For 0° references, 0.01 µF film capacitors may be installed with RN6 = 120 kΩ. Alternatively, 0.033 µF film capacitors may be used with a 33 kΩ, three-position, isolated SIP resistor network installed for RN6. The latter is a preferred scheme if the FCOG6100 may be used as a controller or a converter. This is due to the fact that the three capacitors forming the phase shift network must be matched to within ±1% to ensure uniform shift on each phase. Changing RN6 to change phase shift is a more reliable scheme than changing three precision-matched capacitors; RN6 may be provided in a socket for user convenience if controller or converter operation is desired with one unit.

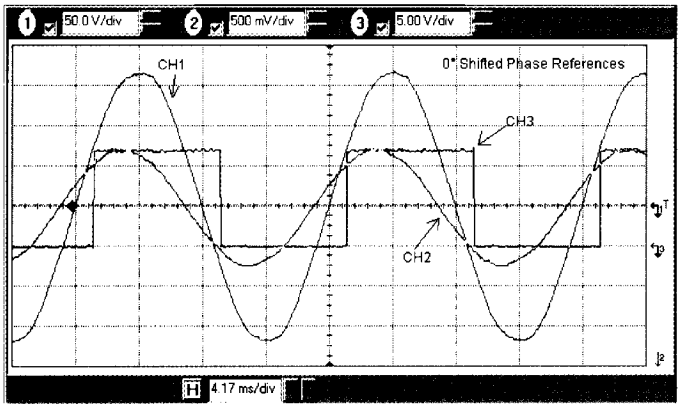
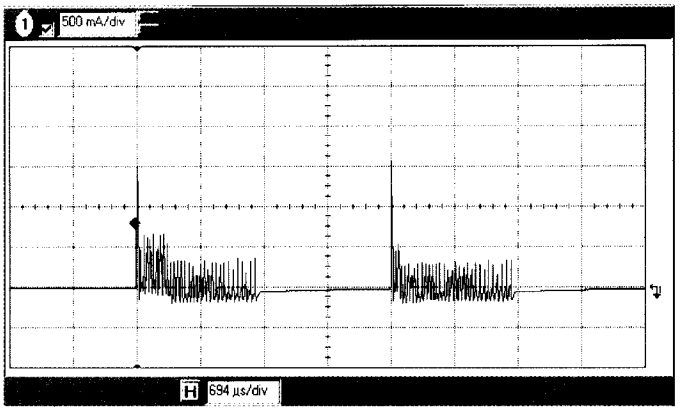


Figure 4. Zero-degree shifted phase references, Phase A
Channel: 1. Phase A Line-to-Neutral Voltage
2. Attenuated and Filtered Mains Voltage at RN6-3
3. Reference Comparator Output, TP5

7.0 GATE PULSE PROFILE SELECTION

A two-position jumper, JU1, enables selection of gate pulse profile. With JU1 installed, the pulse profile is two 30°-wide bursts, each with an initial hard-firing gate pulse, followed by sustaining "picket fence" pulses. With the jumper omitted, the gate pulse profile changes to a single 120°-wide burst with the same hard-firing initial pulse. The initial hard-firing pulse and sustaining pulses help ensure proper SCR conduction.



Figure[5] 5. 2-30° Gate Pulse Profile (Into 1Ω).

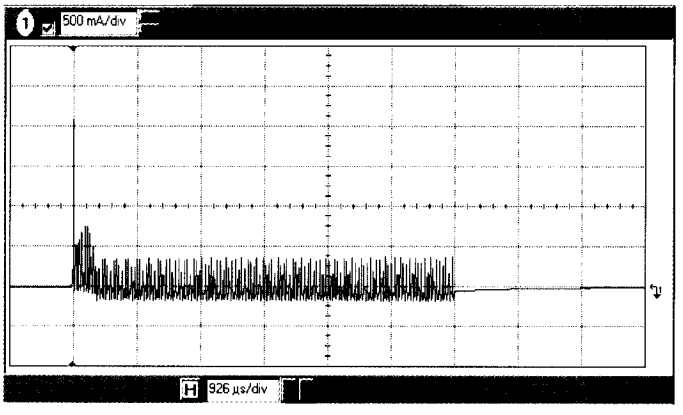


Figure 6. 120° Gate Pulse Profile (Into 1Ω).

[5] Current waveforms obtained using Pearson CT model 2877 (1.0 A/div) with 4 turns terminated with 1.0 MΩ.

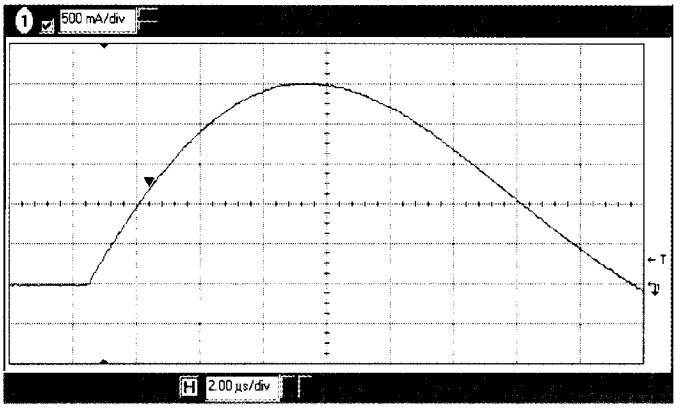


Figure 7. Initial pulse profile detail (Into 1Ω).

The firing circuit uses a phase-locked loop (PLL) circuit locked to the three mains phases. The PLL oscillator output is counted down and decoded into six 120°- wide delayed logic signals. For the 120° single burst profile, the 120°-wide delayed logic signals are modulated by the 23,040 Hz PLL Voltage Controlled Oscillator (VCO) output signal. The two 30°-burst profile is formed by modulating the 120°-wide delayed logic signals with the 23,040 Hz VCO output and the 360 Hz output of a divide-by-64 counter.

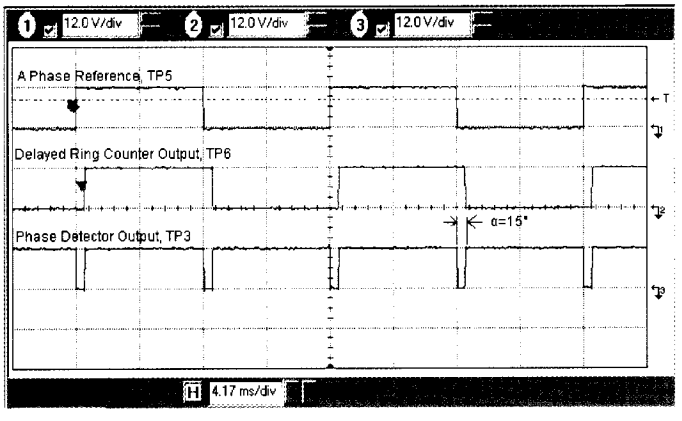


Figure 8. Phase Detector Signals, Phase A: α=15°
Channels: 1. Phase A Reference, TP5
2. Delayed Ring Counter Output, TP6
3. Phase Detector Output, TP3

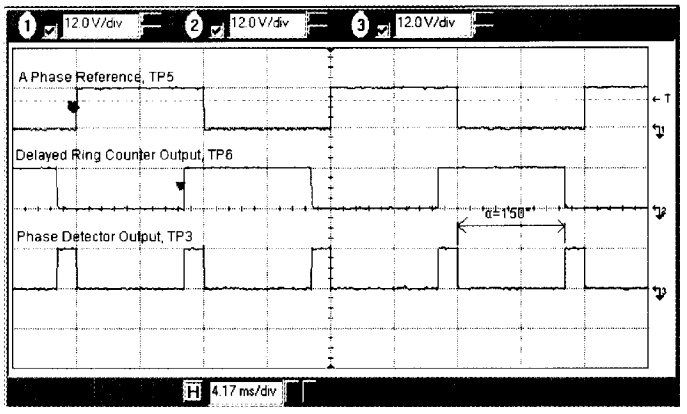


Figure 9. Phase Detector Signals, Phase A: α=150°
Channels: 1. Phase A Reference, TP5
2. Delayed Ring Counter Output, TP6
3. Phase Detector Output, TP3

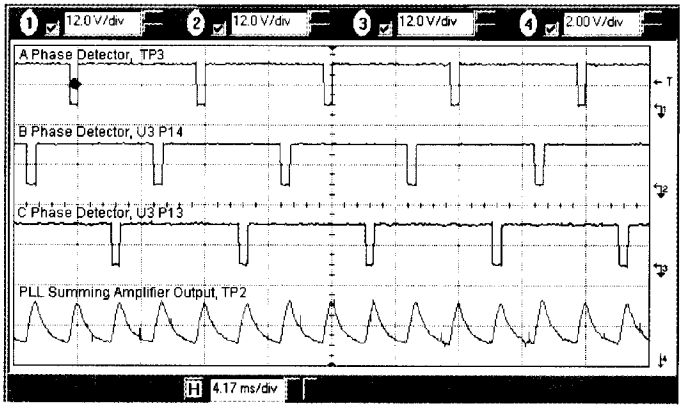


Figure 10. PLL Summing Amplifier Signals: α=15°
Channels: 1. A Phase Detector Output, TP3 (U3 P15)
2. B Phase Detector Output, U3 P14
3. C Phase Detector Output, U3 P13
4. Summing Amplifier Output, TP2

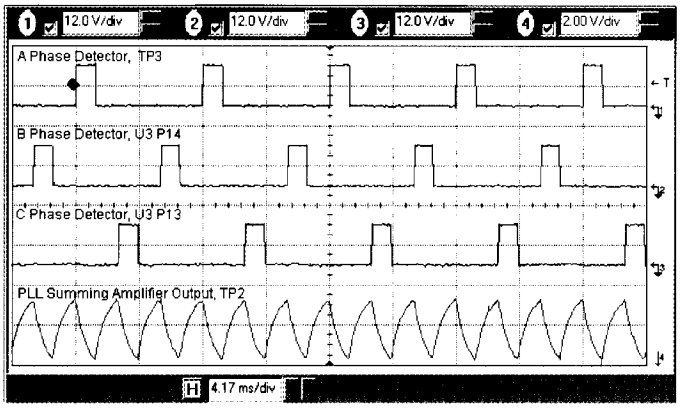


Figure 11. PLL Summing Amplifier Signals: α=150°
Channels: 1. A Phase Detector Output, TP3 (U3 P15)
2. B Phase Detector Output, U3 P14
3. C Phase Detector Output, U3 P13
4. Summing Amplifier Output, TP2

8.0 GATE PULSE AMPLIFIER

The gate pulse amplifier circuitry shown in E128 revision R consists of the following elements:

- Six IRFD110 MOSFETs (Q1 through Q6), excite the primary of each pulse transformer, driven from the LSI outputs.
- Resistors R3 through R5 and capacitors C2 through C4, which form a gate pulse shaping network.
- Pulse modules PM1 through PM6, which provide current drive for the gate of each SCR. Each pulse module consists of a 2:1 ratio transformer tested for 3500 V_{RMS} isolation, two secondary diodes, noise suppression resistors across the primary and across the gate drive output, and a fusible link in series with the output. Each pulse module is potted in a silicone-based material.

9.0 50/60 Hz OPERATION

The FCOG6100 Revision R provides enhanced frequency insensitivity compared to older revisions. A frequency compensation circuit reduces gate drive angle variance with respect to frequency. The gate drive angle deceases by approximately 5° for a 10 Hz decrease in frequency from 60 Hz to 50 Hz. Older configurations exhibited a gate drive angle decrease of approximately 12.5° for the same line frequency change.

For operation with line frequencies in the range of 45 to 60 Hz, no modification to the frequency compensation circuit is required. For

variable-frequency applications, Enerpro's FCOVF6100 provides similar functionality as the FCOG6100, but is tailored for continuous line frequency variations between 30 and 150 Hz.

10.0 ELECTRICAL SPECIFICATIONS

The electrical specifications of the General Purpose Firing Board are summarized in the table below. Part numbers refer to drawing E128, revision K.

Table 2. Electrical Specifications.

Characteristic	Performance Requirement	Supporting Information
1. Board-mounted power supply for control electronics and SCR gate drive	24 VA 1Φ 50/60 Hz fused board-mounted transformer T1. Center-tapped primary connected for 240V or 480V. 120V/240V or 380V available. Primary connected to mains via SCR cathodes at J2-5,8.	Option 1: For operation on non-standard mains voltage, energize T1 from 120, 240, 380, or 480 Vac through optional connector J4. Option 2: Omit T1 and apply 24Vac or 30VDC to J3.
2. Line voltage reference sensing	Resistive attenuators and 60° phase shift single-pole filters.	Reference signals automatically interchanged for negative phase sequence.
3. Load voltage sensing (optional)	Resistive attenuators provide low level analog of load voltage	Useful for induction motor or generator voltage feedback.
4. PLL reference signal phasing with respect to mains line-to-neutral voltage: a. Reference signals in phase with mains voltage. b. Reference signals lagging mains by 30°	Applications: a. AC controllers with high power factor loads. b. Converters or AC controllers with low power factor loads.	See Section 8.0: Reference Phase Angle Selection.
5. SCR gate waveform. a. Mode 1 b. Mode 2	Pulse profile: a. Two 30° bursts of 32 pulses (23,040 Hz carrier) b. 120° burst of 128 pulses (23,040 Hz carrier)	See Section 9.0: Gate Pulse Profile Selection. a. JU1 Installed b. JU1 Open
6. Gate Delay Command Input	0-5 VDC 0.85-5.85 VDC 0-10 VDC 0-2 VDC 4-20 mA	See Section 4.0: Gate Delay Command
7. Control signal isolation from ground	653 kΩ	Produced by three 2.00 MΩ mains voltage sense resistors.
8. Gate delay steady-state transfer function	An increase in command voltage produces a proportional decrease in gate delay angle, α.	α_{max} and α_{min} change equally with change in R_{BIAS} (R17). (α_{max} - α_{min}) changes with R_{SPAN} (R15).
9. Gate delay dynamic transfer function bandwidth	Attenuation: -3dB at 119 Hz. Phase shift: -45° at 68 Hz	Frequency response may be modified by changing summing amplifier parameters.
10. Gate delay angle balance	Gate pulses for same polarity SCRs are displaced by 120° ± 1.0°. Gate pulses for opposite polarity SCRs are displaced by 180° ± 1.0°.	Assumes balanced line-to-line mains voltage. Balance determined by reference comparator offset and attenuation/filter component tolerances.
11. Effect of frequency	Δ_α/Δ_F = 0.2°/Hz. Improvement over prior versions with active frequency compensation circuit.	See Section 11.0: 50/60 Hz Operation
12. Effect of phase rotation	None.	SCR gating sequence matches mains voltage sequence.
13. Effect of mains voltage distortion.	1. Unaffected by false reference voltage zero crossing. 2. 60° filter attenuates 5th harmonic by 12.8 dB relative to fundamental.	1. No PLL response to short-time false reference logic states. 2. Reference filter attenuates the 5th, 7th, 11th, etc harmonics from 6-pulse SCR switching.
14. Lock acquisition time	Approximately 30 ms.	Gating is inhibited for 20 ms or longer at

		power-on. Inhibit period depends on soft-start time constant.
15. Soft-start	Gating commences at α_{max} and exponentially decays to the commanded delay when $\overline{I_2}$ is ungrounded (J3-12).	Soft-start time constant is set by soft-start timing resistor and capacitor.
16. Soft-stop	Gate-delay angle ramps to α_{MAX} before being inhibited by grounding $\overline{I_2}$.	Soft-stop time constant is set by soft-stop timing resistor and capacitor
17. Phase loss inhibit	Loss of a mains voltage or severe phase unbalance causes gate inhibit.	Gating resumes with $\alpha = \alpha_{MAX}$. Ramps to commanded delay angle as determined by soft-start time constant. Circuit operation is immune to line frequency variations and SIG HI transients.
18. Power-on inhibit	Phase loss inhibit circuit is activated at power-on.	Same delay angle response as with phase loss inhibit.
19. Instantaneous inhibit	Opening the connection of $\overline{I_1}$ to +12VDC instantly inhibit SCR gating. Closing this connection instantly enables SCR gating.	Gating is inhibited if P3 is removed.
20. SCR gate current individual pulse width	T_{ON} and T_{OFF} vary from 15 µs to 28 µs.	Gate current ON and OFF time vary with gate delay angle due to 360 Hz FM in the VCO output.
21. Peak gate drive open circuit voltage	15 V	Supply voltage = 30 VDC
22. Peak gate drive short circuit current	2.0 A	Measured with 30 VDC supply and 1.0 Ω load resistor.
23. Gate drive current rise time (short circuit)	0.5 A in 0.5 µs	Measured with 30 VDC supply and 1.0 Ω load resistor.
24. Ambient temperature	0° - 65° C	Forced air cooling required for ambient temperatures > 65° C

11.0 INSTALLATION AND CHECKOUT

The following procedure should be followed to ensure proper operation prior to the application of mains power to the SCR unit. An EP1032A transformer (240V/480Vac) T1 is assumed.

11.1. *Ensure that the power is off.* Wire a plug, P2, with mains voltage connected to sockets 2, 5, and 8. Insert plug P2 into header J2.

11.2. If the FCOG6100 board is set up to obtain board power from the SCR cathodes proceed to step 12.3. If not, connect the appropriate power to J4; J4-1 and J4-5 for 480Vac or J4-3 and J4-5 for 240Vac board power.

11.3. Install plug P3 with the 0/5Vdc delay command signal, signal common, and inhibit contact closure leads wired to the plug.

11.4. Energize the mains voltage; this will energize the FCOG6100 board. (Alternatively, energize the mains voltage and then energize the FCOG6100 by 120 Vac, 24 Vac, 30 VDC, or as specified).

11.5. Verify the presence of regulated +12 VDC ± 5% at J3-6 and regulated +5 VDC ±5% at J3-7 with a multimeter.

11.6. Verify that the PLL is in lock and the mains voltages are balanced by noting the Phase Loss LED is not lit.

11.7. Verify that the DC level of the VCO control voltage at TP2 is approximately 5.0 VDC. This voltage is factory-set by selection of the VCO timing select resistor.

11.8. Determine the PLL gate delay angle from the pulse width of the A-phase detector output at TP3: Calibrate the oscilloscope time-base at 20°/div (0.926 ms/div at 60 Hz). Read the gate delay angle directly from the TP3 pulse off time.

11.9. Vary the delay command voltage from 0 VDC to 5.0 VDC. Observe that the gate delay angle at TP3 has the desired minimum and maximum values.

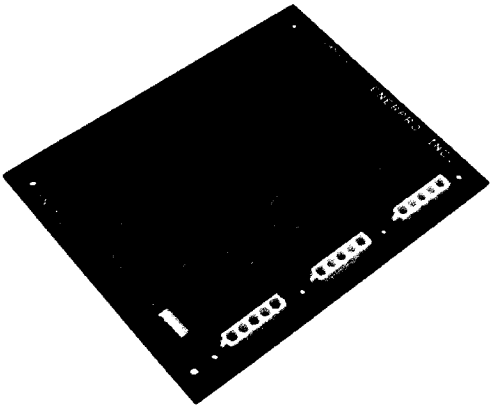
11.10. To increase the minimum and maximum gate delay angles by an equal amount, increase the value of the delay bias resistor, R17. To increase the difference between the maximum and minimum delay angles, reduce the value of the delay span resistor, R15.

Document Revision History			
Revision	**Date**	**Notes**	**Approval**
NC	06/2008	Initial release	JTM
A	12/2009	Correct SIG HI values in Table 1	JTM

TSB

ENERPRO®

TSB Connectorized Snubber Circuit Boards



Description
Enerpro's TSB family of snubber circuit boards provide high-quality RC snubber circuits in a convenient, connectorized, panel-mountable package. Models with one, two, three and six circuits are available. These boards provide the static power conversion industry with a rugged, reliable snubber product that reduces design time and minimizes inventory requirements.

Application
In SCR converters or AC controllers, a high rate-of-rise in anode-to-cathode voltage, or dV/dt, occurs when an SCR conducts or commutates. Inductive loads typically induce high peak voltages when the SCR current is interrupted. Resistor-capacitor snubber circuits limit the dV/dt across the SCRs, preventing erratic operation and device damage.

Available Circuits
TSB-1: Single RC circuit for use in anti-parallel SCR AC controller applications.

TSB-2: Two RC circuits for use in SCR bridge rectifier circuits or other applications where two SCRs share a common connection.

TSB-3: Three RC circuits for three-phase AC controllers or semiconverters.

TSB-6: Six RC circuits provide flexibility for a variety of three-phase applications, including:

- In-line AC controllers
- Two-speed motor starters
- Reversing motor starters
- Star converters
- Six- or twelve-pulse bridge converters
- Tap changers

Operational Features
The TSB family utilizes WIMA brand high voltage, pulse-rated metal film capacitors exclusively for their superior performance, reliability, and service life.

Amp Universal Mate-N- Lok® connectors provide easy installation and replacement; connector tooling is identical to all other Enerpro firing and regulator board products.

Creepage distances exceed 10 mm (0.4 inches) for operation to 600 Vac as specified in UL-508.

All circuit boards are assembled at the Enerpro plant in Goleta, California and are manufactured by a UL-approved fabricator from 2.4 mm thick FR4 fire-resistant fiberglass epoxy laminate with one-ounce copper and full solder mask. All boards are protected with urethane conformal coating per MIL-1-46058, Type UR to provide excellent performance at high line voltages.

Enerpro *applications engineers are available by e-mail or fax for applications assistance.*

Board Dimensions		
Model	***L x W x D (mm)***	***Mounting Centers (mm)***
TSB-1	64 x 127 x 31	48 X 115
TSB-2	112 x 127 x 31	97 X 115
TSB-3/6	191 x 127 x 31	172 x 115
TSB-6/12	191 x 153 x 31	172 x 127

Ordering Guide		
Parameter	***Description***	***Code***
Number of Snubber Circuits	**1** **2** **3** **6**	
Mains Voltage	Note maximum ac mains voltage	
Load Type	**AC** **DC**	
Capacitor Value (uF x 100)		
Resistor Value (Ohms)		
Resistor Power (Watts)		
Connector Type	**0** *Right-angle* **1** Vertical	

Enerpro, Inc.
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Goleta, CA 93117 (USA)
Tel: (805) 683-2114
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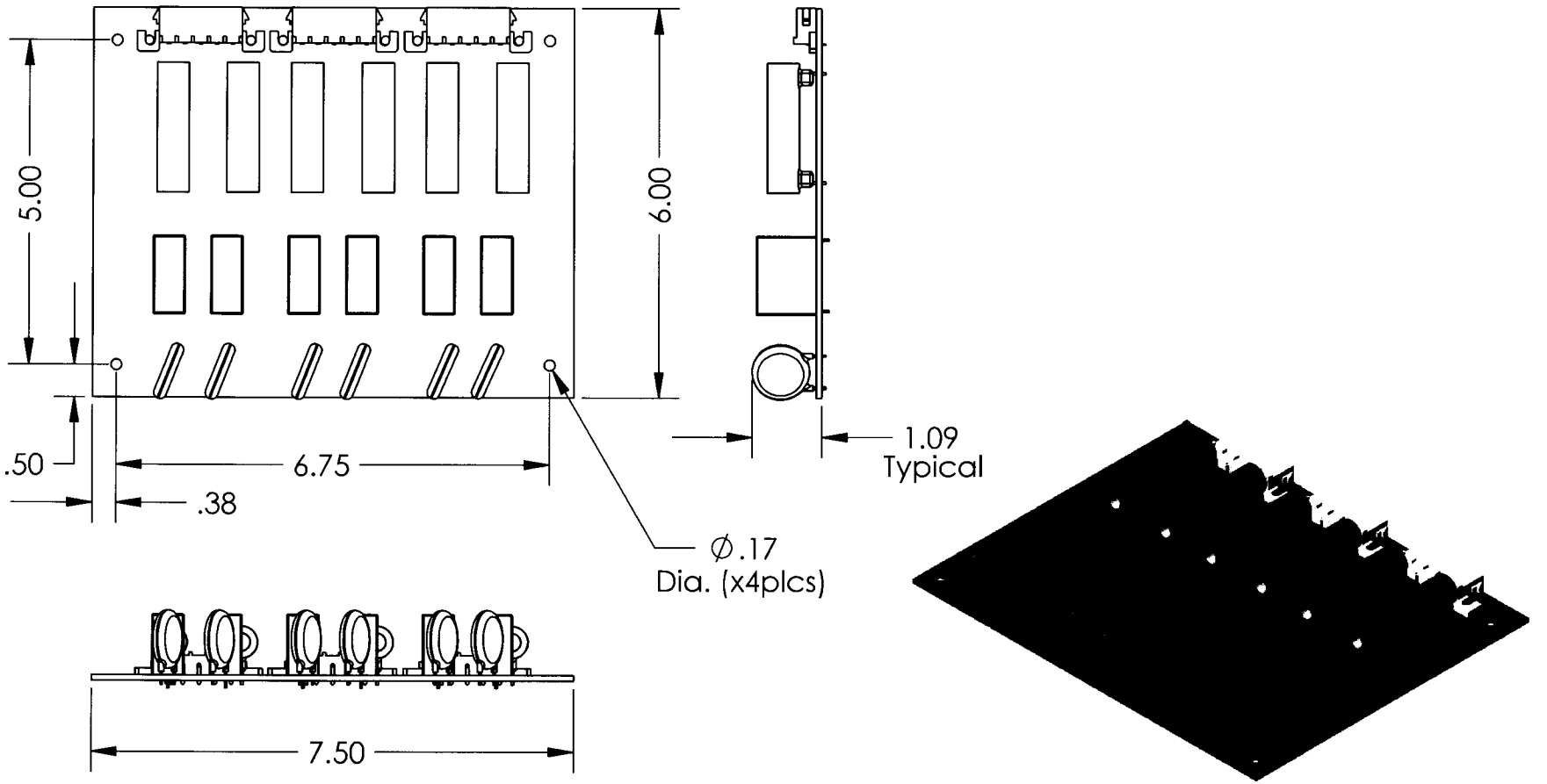
Fax: (805) 964-0798
info@enerpro-inc.com
www.enerpro-inc.com



NEXT ASSY

USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ± .050"

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	jpm	4/24/07
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

ENERPRO, Inc.
Goleta, CA USA

TITLE:

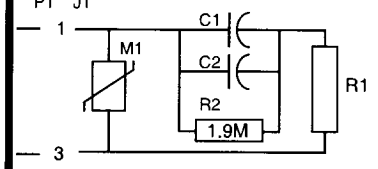
TSB6Phys
6 Circuit Snubber

SIZE DWG. NO. REV
A TSB6Phys

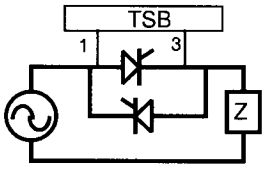
SCALE: 1:2.5 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

P.N. TSB-1T-01

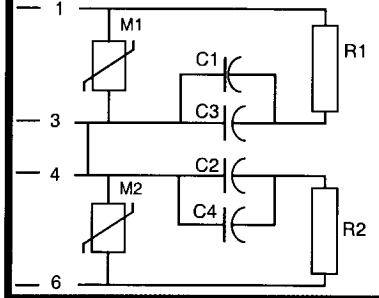


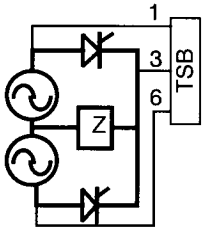
Typical Applications



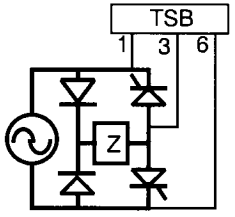
single phase
ac controller

P.N. TSB-2T-01



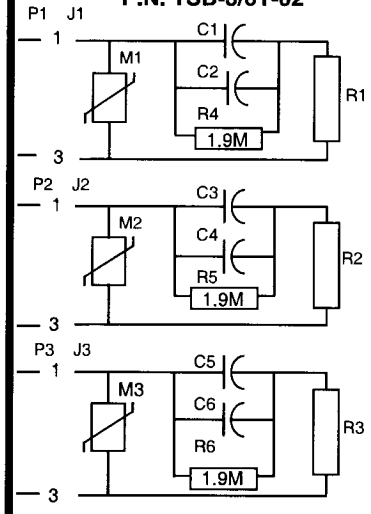


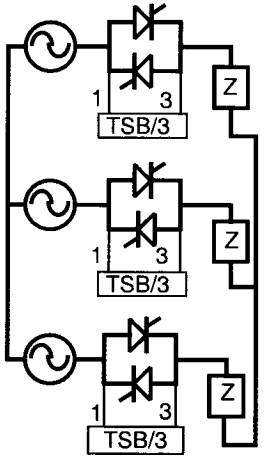
single way full
converter



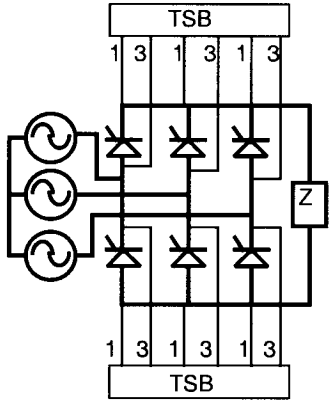
bridge semi-
converter

P.N. TSB-3/6T-02



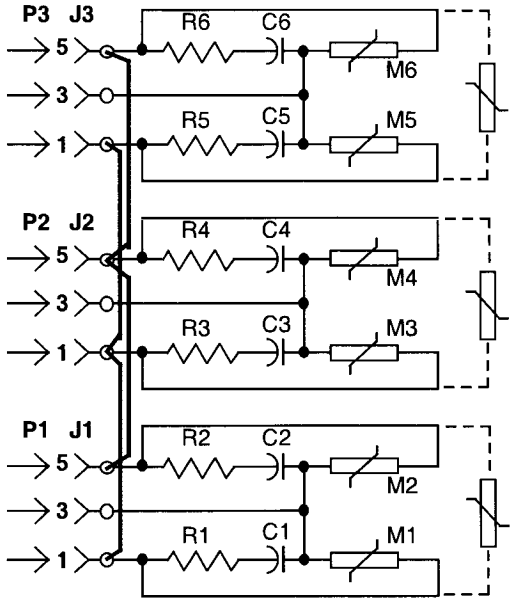


three phase
ac controller



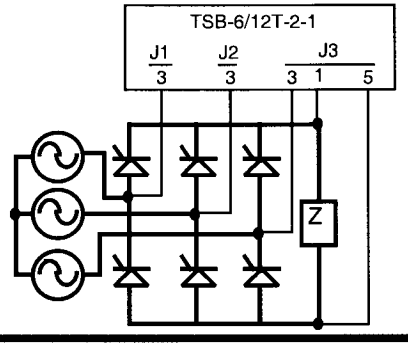
three phase
bridge converter
(2 TSB required)

P.N. TSB-6/12T-2-1



OPTIONAL
MOV CONNECTION
FOR SERIES R-C
CIRCUITS

ON-BOARD JUMPER
CONFIGURATION FOR
THREE PHASE BRIDGE
SHOWN



three phase
bridge converter
(1 TSB required)

GENERAL DESCRIPTION

1. Standard capacitor values are .15 µF, .22µF and .30 µF / 1500V.
2. Standard resistor value is 35 Ω / 20 watt.
3. Specify 240, 520 or 630 Vac MOV's.
4. Mating plug is AMP P.N. 1-480700-0.
5. Material is .093 in. thick G10 epoxy-glass.
6. Creepage distances exceed .40 in. for operation to 600 Vac as specified in UL-508.

CIRCUIT BOARD DIMENSIONS

MODEL	L x W x H	MTG CTRS
TSB-1T-01	2.50x5.00x1.20	1.90x4.53
TSB-2T-01	4.40x5.00x1.20	3.80x4.53
TSB-3/6T-02	7.50x5.00x1.20	6.75x4.53
TSB-6/12T-1-2	7.50x6.00x1.20	6.75x5.00

Approvals	Date
drawn: fjb	4-21-87
rev. web	2-10-88

ENERPRO

SINGLE BOARD CONNECTORIZED SNUBBER CIRCUITS

REV. 2-10-88: ADD TSB-6/12T-2-1

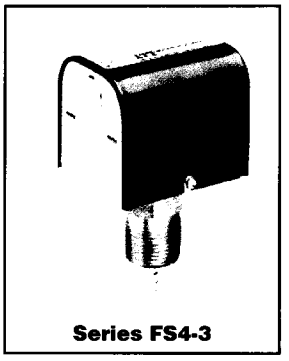
Drawing No. **E251**

Flow Switches – Liquid

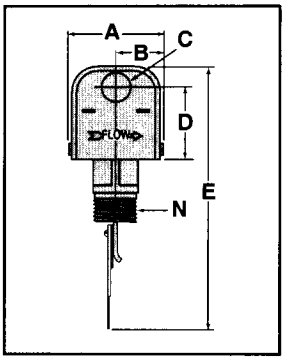
Series FS4-3 (for specified models)

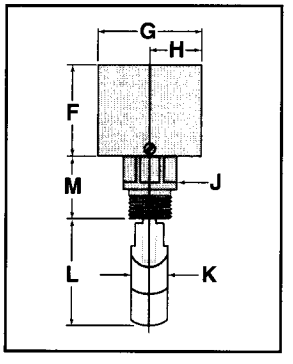
General Purpose Liquid Flow Switches

- Universal design serves the widest variety of applications
- For starting or stopping electrically operated equipment such as signal lights, alarms, motors, automatic burners, metering devices and others
- Replacement for common flow switches from Johnson/Penn, Potter/Taco, Watts, Hydrolevel and other manufacturers
- 1" NPT
- Two electrical knock-outs allows connection from either end
- Sensitivity adjusting screw makes flow adjustment easy
- Single pole, double throw snap switch
- Hardened stainless steel bearings minimize friction
- Sealed Monel bellows
- Four stainless steel paddles included - 1", 2", 3" & 6" (25, 50, 80, & 150mm)
- Optional features
  - Two SPDT switches to make or break two separate circuits
  - Materials of construction suitable for corrosive liquids
  - BSPT threads
- Minimum temperature (fluid or ambient) 32°F (0°C)
- Maximum temperature 300°F (149°C)
- Maximum pressure 160 psi (11.3 kg/cm²)



Series FS4-3





Electrical Ratings

Voltage	Motor Switch Rating (Amperes)		Pilot Duty
	Full Load	Locked Rotor	
120 VAC	7.4	44.4	125 VA at 120 or 240 VAC 50 or 60 cycles
240 VAC	3.7	22.2	

Dimensions, in. (mm)

A	B	C	D	E	F	G
3 (76)	1½ (38)	⅞ (22)	2 7/32 (56)	8 7/16 (211)	2 15/16 (75)	3⅜ (86)

H	J	K	L	M	N NPT
1 11/16 (43)	1 7/16 (37)	1⅛ (29)	3 7/16 (87)	2 1/16 (52)	1

Flow Switches – Liquid

Series FS4-3 (continued)
General Purpose Liquid Flow Switches

Flow Rates

Pipe Size NPT in.	Settings	Mode of Operation: Flow gpm (lpm)	Mode of Operation: No Flow gpm (lpm)	Max. Flow Rate gpm (lpm) w/o Paddle Damage
1	Factory or Minimum	6 (22.7)	3.6 (13.6)	27
	Maximum	10.2 (38.6)	9.2 (34.8)	(102.2)
1¼	Factory or Minimum	9.8 (37.1)	5.6 (21.2)	47
	Maximum	16.8 (63.6)	15 (56.8)	(177.9)
1½	Factory or Minimum	12.7 (48.1)	7 (26.5)	63
	Maximum	23 (87.1)	19.5 (73.8)	(238.5)
2	Factory or Minimum	18.8 (71.2)	9.4 (35.6)	105
	Maximum	32.8 (124.1)	24 (90.8)	(397.4)
2½	Factory or Minimum	24.3 (92)	11.6 (43.9)	149
	Maximum	42.4 (160.5)	37.5 (141.9)	(564)
3	Factory or Minimum	30 (113.6)	12 (45.4)	230
	Maximum	52.1 (197.2)	46.1 (174.5)	(870.6)
4	Factory or Minimum	39.7 (150.3)	19.8 (74.9)	397
	Maximum	73.5 (278.2)	64.2 (242)	(1502.7)
5	Factory or Minimum	58.7 (222.2)	29.3 (110.9)	654
	Maximum	115 (435.3)	92 (348.2)	(2415.4)
6	Factory or Minimum	79.2 (300)	39.6 (150)	900
	Maximum	166 (628.3)	123 (465.6)	(3406.5)

Values are ± 10%

NOTE: DO NOT USE LIQUID FLOW SWITCHES ON SYSTEMS WITH FLOW GREATER THAN 10 FEET (3M) PER SECOND.

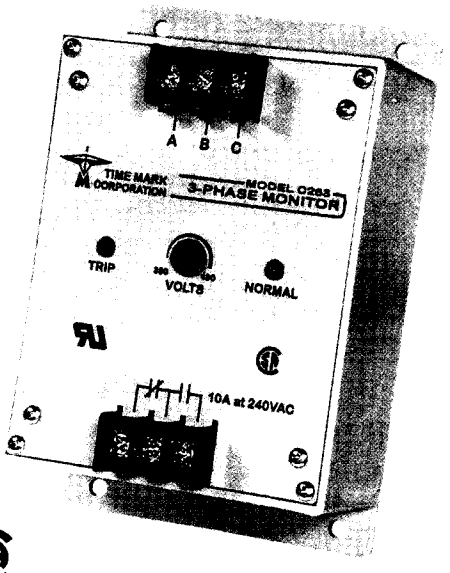
Ordering Information

Model Number	Part Number	Description	Weight lbs. (kg)
FS4-3	114400	General purpose flow switch	1.9 (0.9)
FS4-3J	114610	FS4-3 w/BSPT connections	1.9 (0.9)
FS4-3-RPT	114639	FS4-3 w/test button	1.9 (0.9)
FS4-3Z	114410	FS4-3 w/ANSI terminal connections	1.9 (0.86)
FS4-3D	114550	FS4-3 w/2 SPDT switches	2.3 (1.0)
FS4-3S	114641	FS4-3 w/SS body, monel bellows	1.9 (0.9)
FS4-3SJ	176216	FS4-3S w/BSPT connections	1.9 (0.9)
FS4-3DS	114642	FS4-3S w/2 SPDT switches	3.3 (1.5)
FS4-3J-E	114611	FS4-3J-CE conformance rated	1.9 (0.9)
FS4-3D-E	114552	FS4-3D-CE conformance rated	1.9 (0.9)
FS4-3S-E	114646	FS4-3S-CE conformance rated	1.9 (0.9)

See page 132 for CE Conformance information

MODEL 263

3-Phase Monitor



- **Detects Phase Loss or Reversal and Low Voltage**
- **400Hz and Gold Contact Options**
- **Automatic or Manual Reset**
- **UL Recognized and CSA Certified**

DESCRIPTION

The **Model 263** continuously monitors 3-phase power systems for phase loss, low voltage and phase reversal. The monitor consists of a solid-state sensing circuit, driving an electromechanical relay.

Applying correct voltage and phase rotation energizes the relay. When properly adjusted, a fault condition will cause the relay to de-energize, even when regenerated voltage is present.

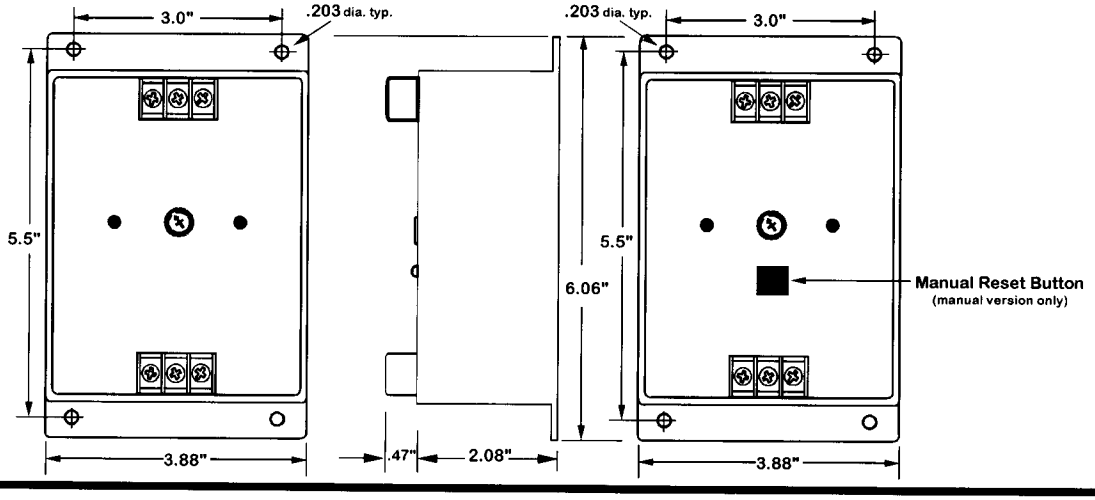
When the fault is corrected, the Model 263 automatically resets. A manual reset version is also available. The SG Model has silver with gold flash contacts for low current applications.

The Model 263 does not require a neutral connection, and can be used on Wye or Delta systems. Each of the five different voltage ranges is adjustable to allow the monitor to be set for existing conditions. NORMAL and TRIP LED indicators are provided to aid in adjustment and system troubleshooting.

SPECIFICATIONS

AUTO Reset MANUAL Reset GOLD-AUTO Reset GOLD-MAN Reset	A263 A263M A263SG A263SGM	B263 B263M B263SG B263SGM	C263 C263M C263SG C263SGM	D263 D263M D263SG D263SGM	EX263 EX263M EX263SG EX263SGM
Nominal AC voltage (phase to phase)	120 VAC	208/240VAC	480 VAC	575 VAC	380 VAC
Adjustment Range	85-120V	160-240V	380-480V	450-575V	300-400V
Frequency	60 Hz	60 Hz	60 Hz	60 Hz	50 Hz
Power Consumption	0.75W	1.5W	4.5W	7.5W	4.5W
Transient Protection	2500 VRMS for 10msec				
Repeat Accuracy	± 0.1% of setpoint (fixed conditions)				
Response Time	50 msec				
Dead Band	Approximately 2%				
Output Contacts	All **SG** models: SPDT silver w/gold flash 5 amps at 120VAC resistive All other models: SPDT 10 amps at 240 VAC resistive				
Expected Relay Life	Mech: 10 million operations Elec: 100,000 operations at rated load				
Operating Temp	- 40° to +131° F				
Humidity Tolerance	0 - 97% w/o condensation				
Enclosure Material	ABS plastic				
Mounting	surface				
Weight	9.5 oz				
Agency Approvals	ALL VERSIONS - UL Recognized and CSA Certified				

DIMENSIONS



Telephone: Main - (918) 438-1220
Sales - (800) 862-2875
Fax: (918) 437-7584

E-mail: sales@time-mark.com
Internet: http://www.time-mark.com

TIME MARK CORPORATION

11440 East Pine Street
Tulsa, Oklahoma 74116

Doc No. 87A124 12/00

TIME MARK is a division of AEMT, Inc.

MODEL 263 3-Phase Monitor

READ ALL INSTRUCTIONS BEFORE INSTALLING, OPERATING OR SERVICING THIS DEVICE.
KEEP THIS DATA SHEET FOR FUTURE REFERENCE.

GENERAL SAFETY

POTENTIALLY HAZARDOUS VOLTAGES ARE PRESENT AT THE TERMINALS OF THE MODEL 263. ALL ELECTRICAL POWER SHOULD BE REMOVED WHEN CONNECTING OR DISCONNECTING WIRING. THIS DEVICE SHOULD BE INSTALLED AND SERVICED BY QUALIFIED PERSONNEL.

Installation Instructions

INSTALLATION

Connect the 3-phase wires to the terminals marked **A**, **B** and **C**.

The control wiring will be connected to the opposite end of the unit, to the terminals with the contact markings. Markings on the unit are the failed condition of the contacts.

AUTOMATIC RESET VERSIONS:

Apply power. If the contacts do not transfer (TRIP LED-Off), check that all three phases are present and of the correct voltage.

If all phases are correct, rotate the VOLTS adjustment potentiometer counter-clockwise, to the low position.

If the contacts still do not transfer, remove power from the unit. Reverse any two of the three input wires and re-apply power. The contacts should transfer to the energized condition; N.O. contact-closed, NORMAL LED-On.

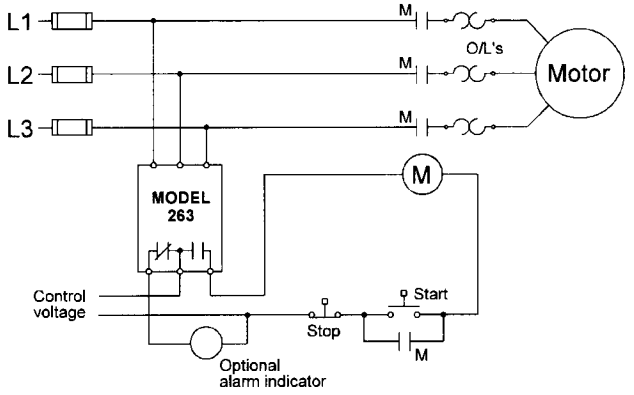
MANUAL RESET VERSIONS:

Apply power and press the RESET button. If the contacts do not transfer (TRIP LED-Off), check that all three phases are present and of the correct voltage.

If all phases are correct, rotate the VOLTS adjustment potentiometer counter-clockwise, to the low position and press the RESET button.

If the contacts still do not transfer, remove power from the unit. Reverse any two of the three input wires and re-apply power. Press the RESET button. The contacts should then transfer to the energized condition; N.O. contact-closed, NORMAL LED-On.

TYPICAL APPLICATION



Shown De-Energized

ADJUSTMENT SETTINGS

NOTE: During adjustment, you may wish to install a jumper across the control contacts, to prevent cycling the load on and off.

AUTOMATIC RESET VERSIONS:

Rotate the VOLTS adjustment slowly clockwise, until the contacts transfer to the failed condition (TRIP LED-On).

Slowly turn the adjustment back counter-clockwise, until the contacts reset to the normal condition (TRIP LED-Off).

Remove the jumper, if installed. This setting will be correct for most applications.

If nuisance tripping occurs, turn the adjustment slightly farther counter-clockwise. In adjustments to eliminate nuisance tripping, the VOLTS adjustment should be rotated in very small increments, until the true nuisance trips are eliminated.

MANUAL RESET VERSIONS:

During adjustment, you will need to press and hold the RESET button.

Rotate the VOLTS adjustment slowly clockwise, until the contacts transfer to the failed condition (TRIP LED-On). A slight buzz in the contacts may occur when the relay is at the transfer point to the failed condition. This is normal and will not occur in operation.

Slowly turn the VOLTS adjustment back counter-clockwise, until the contacts reset to the normal condition (NORMAL LED-On).

Release the RESET button, and remove the jumper, if installed. This setting will be correct for most applications.

If nuisance tripping occurs, turn the adjustment slightly farther counter-clockwise. In adjustments to eliminate nuisance tripping, the VOLTS adjustment should be rotated in very small increments, until the true nuisance trips are eliminated.

WARRANTY

The **Model 263 3-Phase Monitor** is covered by Time Mark Corporation's exclusive **5-Year Unconditional Warranty.** Should this device fail, for any reason, within five years from the date of purchase, we will repair or replace it free. Contact the Time Mark Sales department, Monday through Friday; 8 a. m. to 5 p.m., CST, for further details.

Telephone: Main - (918) 438-1220
Sales - (800) 862-2875
Fax: (918) 437-7584

E-mail: sales@time-mark.com
Internet: http://www.time-mark.com

TIME MARK CORPORATION

11440 East Pine Street
Tulsa, Oklahoma 74116

Doc No. 87A124 12/00

TIME MARK is a division of AEMT, Inc.

7.0 REPLACEMENT PARTS LIST

Oster Magnetics Power Supply
2200A, 143VDC, 315KW

Designation	Description (Job 587)	Mfg. Part No.	Qty Per P.S.
C1	Capacitor, 47,000MFD 160VDC	UCC U32D160LG473M76X219HP	6
CB1	Circuit Breaker, 3 Ph. 800A	ABB S6N800BW	1
CB2	Circuit Breaker,	ABB S273-K6	1
D1	Diode	Powerex R9G00622XX	1
F1	Fuse, 6 Amp 600VAC	G/S ATQ-6	1 *
F2	Fuse, 1.6Amp 600VAC	G/S ATQ 1-6/10	1 *
F3	Fuse, 1 Amp 600 VAC	G/S ATQ-1	1 *
F4	Fuse, 2500 Amp	G/S A25X2500-128	1 *
FAN	Fan, 550cfm, 120VAC	Comair-Rotron 020188	1
K1,2	Relay, 24VDC 3-Pole	IDEC RH3B-UDC24V	2 *
K3,4	Relay, 24VDC 4-Pole	IDEC RH4B-UDC24V	2 *
L1	Choke 200microhenry @ 2500ADC	Power Magnetics 28570.0	1
LED	Light Emitting Diode, Green	HP HLMP-3502	1
LED	Light Emitting Diode, Red	HP HLMP-3300	1
LED	Light Emitting Diode, Yellow	HP HLMP-3400	3
M1	Meter, 50mv DC, 0-2500ADC	Simpson 2123-CS0355	1
M2	Meter, 150 VDC	Simpson 2123-17533	1
MS1	Meter Shunt	Empro F-2500-100	1
PC1	Snubber PC Board	Enerpro TSB-6	1 *
PC2	Gate Drive PC Board	Enerpro FCOG 6100	1 *
PC3	Error Amp PC Board	Alpha C08300	1 *
PS1	Power Supply 24VDC, 2.5Amp	Sola SLS-24-024T	1 *
PS2	Power Supply ±15VDC	Sola SLD15-3030-15T	1 *
PH.BAL	Phase Balance Monitor	Time Mark C263-480	1
POT1	Potentiometer 10 Turn 50K	Bourns 3400S-503	1
R1	Resistor, 150 ohm, 225 Watt	Ohmite L225J150	1
SCR	Silicon Controlled Rectifier	Powerex T9G0061003DH	6 *
SW1	Water Flow Switch	McDonnell FS4-3	1
SW2	Temp. Switch opens @ 180°F	Selco OA-180	5
SW3	Rotary Switch, 4 pole, 3 pos.	C&K A40315RNZQ	3
T1	Transformer 480VAC, 3Ph., 60Hz	Power Magnetics S28818.0	1
T2	Control Transformer	Acme TA-83221	1

(* Spare Parts Kit Included)

8.0 WARRANTY

The following is the sole warranty between Alpha Scientific Electronics, Inc. (Herein call "the company") and its respective customers.

Our equipment has been thoroughly tested and inspected. It is warranted for a period of one year, from the date of first shipment. This warranty requires that the instructions have been followed, no accident or misuse has occurred and the equipment was used within its rating. Any parts, except fuses, lamps, or batteries, which are defective or have become defective, in the judgment of the company, will be repaired or replaced at no charge. All replaced parts become the property of the company.

No material or equipment shall be returned to the company, nor shall any part be repaired or replaced without prior authorization from the company. Material or equipment that is returned shall be adequately packaged and shipped freight prepaid. Because of the size and weight of some of our products, it may be more prudent to have the equipment repaired on the customer's site. In such cases, the company, at its sole discretion, may elect to send a field serviceman to the site. Other mutually acceptable arrangement may be discussed.

The company does not accept responsibility for improper use or operation of auxiliary equipment supplied be others, such as, test equipment, loads, power lines, computers, etc. Although, in many cases, our equipment is designed to be protected in case of auxiliary equipment failure or misapplication, no warranty is assumed or implied, except as stated herein.

The company will not be liable for damages including lost profits, lost savings, down time, or any other incidental or consequential damages arising from the use or inability to use the product.

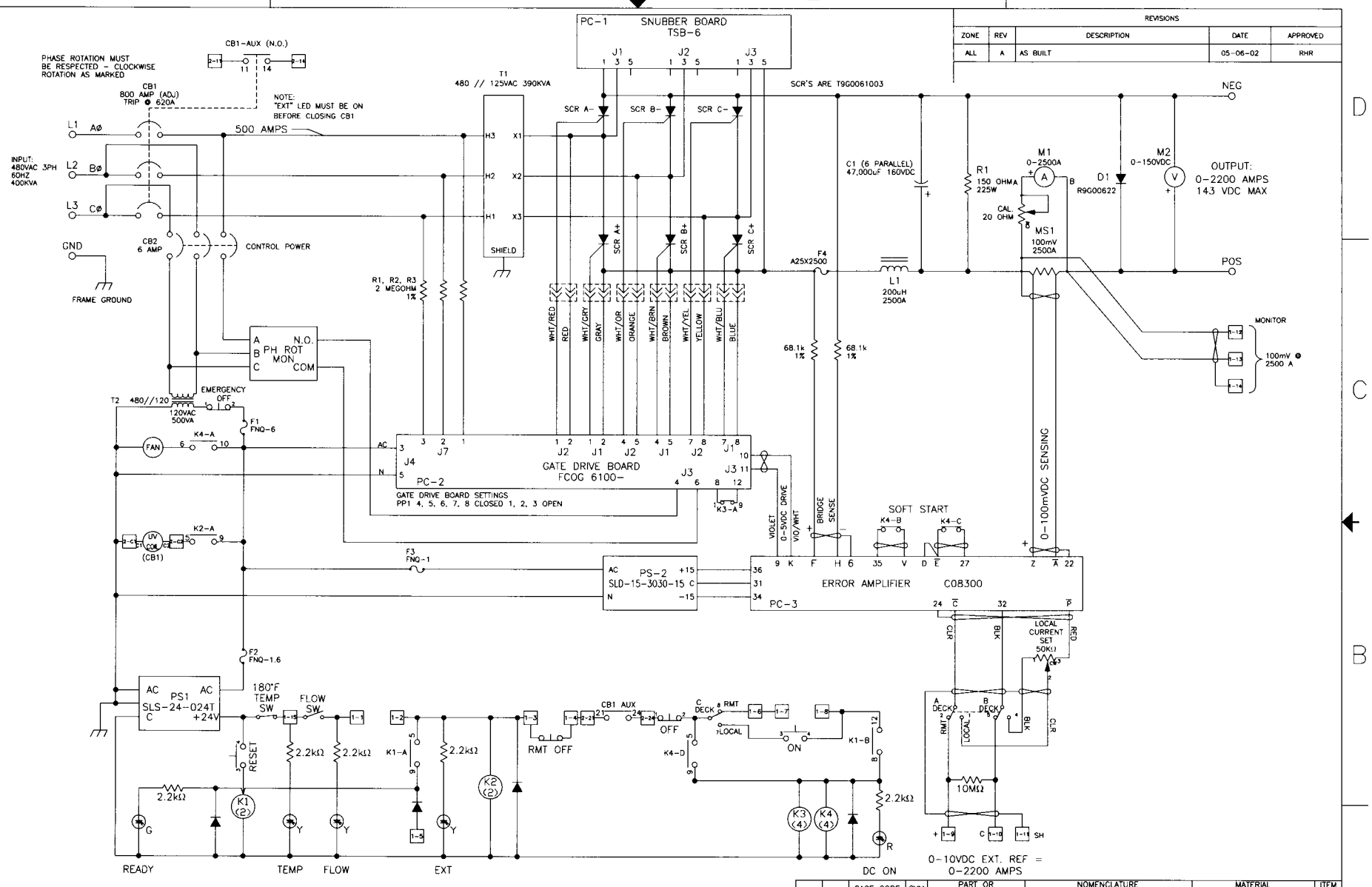
Warranty work will not be performed while the customers account is delinquent. Warranty work will resume upon receipt of the outstanding invoices, plus any late charges, if applicable.

9.0 TEST REPORT

NOT AVAILABLE.

10 .0 DRAWINGS

POWER SUPPLY, MAIN SCHEMATIC	08268



REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
ALL	A	AS BUILT	05-06-02	RHR

QTY REQD	CAGE CODE	SYM	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE IN INCHES. TOLERANCES ARE: FRACTIONS DECIMALS .X= .XX= .XXX= DO NOT SCALE DRAWING

MATERIAL

FINISH

CONTRACT NO. OSTER J587

APPROVALS	DATE
DRAWN RW BAILEY	02-04-02
CHECKED RH RUMRILL	05-08-02
ENGR RH RUMRILL	12-15-01

ALPHA SCIENTIFIC ELECTRONICS
1868 National Ave
Hayward, CA 94545

SCHEMATIC
POWER SUPPLY
2200A @ 143VDC, CURRENT REG. 0.1%

SIZE	CAGE CODE	DWG NO.	REV
C		08268	A

SCALE | SHEET