Gamatronic Electronic Industries Ltd.

FULL REDUNDANCY POWER SYSTEM

PS1006 MODEL

User Guide and Instruction Manual

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1. INTRODUCTION

The Gamatronic PS1006 power system:

- Provides clean DC power to sensitive equipment such as telecom exchanges and other switching systems.
- Charges the battery bank that provides backup power during a mains failure.

Thus, this system is essentially a DC-UPS with a battery connected to it. The size of the battery determines the backup and charging time. Since the system is current limited, the maximum battery size is based on that limit *(see Battery Design, page 17)* for battery size determination and example).

2. SYSTEM DESCRIPTION

2.1 Overview

The system contains four basic components:

- **Rectifier module(s)**: Convert AC energy to DC energy.
- **Electronic Low Voltage Disconnect (ELVD) device**: Disconnects the battery from the load, preventing damage to the battery when it is over-discharged. The PS1006 has a true semiconductor-based LVD that does not use any mechanical devices (such as relays or contactors). This ensures a reliable operation for years. The PS1006 ELVD uses power MOSFETs to perform the switching job.
  The ELVD has two branches that handle two independent battery sets.
- **System controller:** Monitors and controls the system and also communicates with a PC or network. This is done by an RS232 serial port (standard) or via PPP/SNMP/TCP-IP protocol (optional).
- **Motherboard**

The rectifiers are "hot plugged" and operate in parallel. This enables the user to define an "N+1" or "N+2" redundant system.

Each rectifier has its own current sharing system, providing a complete, precise sharing among rectifiers.

The system can house up to 6 rectifier modules.

Output terminals for connecting the load and battery sets are mounted on the motherboard, which is located behind the removable metal rear panel.

2.2 Block Diagram

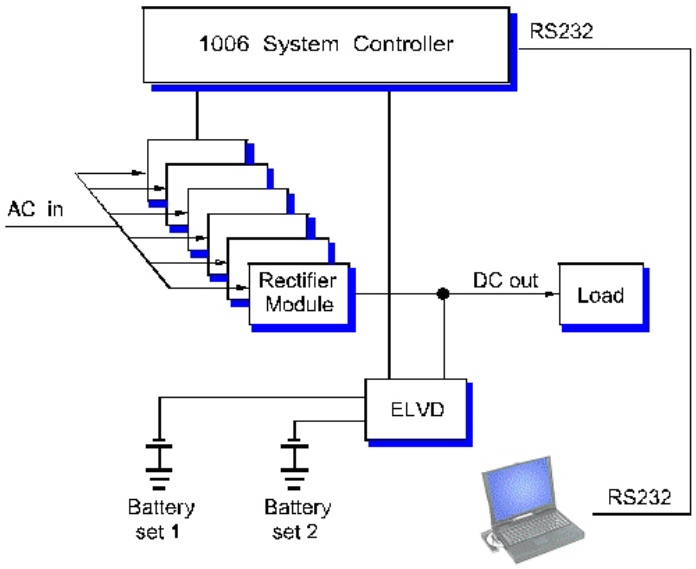

Figure 1: Block Diagram of Power System PS1006

2.3 Main Features

- 1-6 parallel “hot plugged” rectifiers.
- Universal input voltage ($100V_{AC}$ to $240V_{AC}$ continuous, no selectors or switches) for some of the models *(see Technical Specifications for PS1006, page 6)*.
- A built-in dual 60A electronic low voltage load disconnect device (ELVD) for battery protection.
- A high performance, hot-plugged system controller (SC1006/SC1006Net) to measure and monitor voltages, currents, power, temperature, battery parameters and other data. The system can work with or without the controller.
- Temperature compensation is employed to enhance battery life.
- Two battery sets handled in one system.
- Automatic and programmed battery test (for each battery set).
- Remote control and monitoring of the system using a dedicated graphical user interface (GUI). All parameters are displayed on the PC’s monitor.
- Dry-contact signalization (3 alarms).
- Battery terminals protected by a dedicated thermal-magnetic circuit breaker.
- Load terminals protected by a dedicated thermal-magnetic circuit breaker.
- Active current sharing between all the rectifiers in the system for optimal performance

2.4 Front Panel View

Figure 2: Front Panel of PS1006

Figure 2 indicates the following system components:

1. Adjustable 19" mounting flange
2. Rectifier module
3. System controller
4. Handle

2.5 Rear Panel View

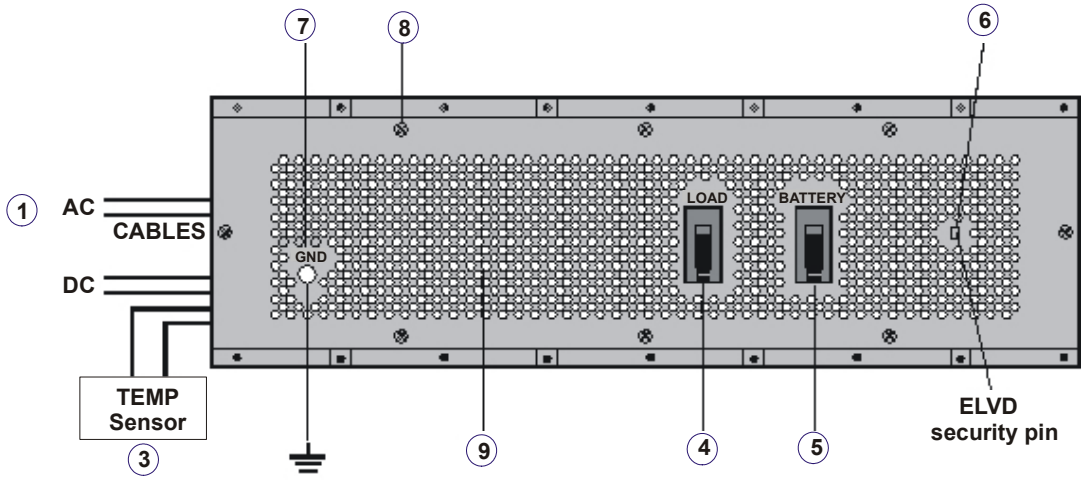

Figure 3: Rear Panel of PS1006

Figure 3 indicates the following system components:

1. Line input AC cord (use the top aperture of the case)
2. DC output terminals (battery and load, use the case's lower aperture)
3. Temperature sensors (optional-2 sensors, use the case's lower aperture)
4. Load input circuit breaker
5. Battery input circuit breaker
6. ELVD module (behind the cover)
7. Ground terminal connection
8. Screws for fastening the rear cover
9. Rear cover

2.6 ELVD

The PS1006 system's Electronic Low Voltage Disconnect device is mounted on the motherboard and accessed from the rear of the system by removing the rear metal cover.

The device, which has two LVDs mounted on one board, is capable of disconnecting two separate battery sets.

The ELVD's aim is to disconnect the battery set(s) from the load when the output voltage falls below a specified value (i.e. the battery is deeply discharged), thus protecting the battery from permanent damage.

The ELVD in the PS1006 system uses power MOSFETs as a switch. These solid-state devices replace the traditional electromechanical relay (or contactor) that has a finite number of operation cycles and must be replaced after a while, as it contains movable parts.

The ELVD is inserted into the motherboard and can easily be replaced, if necessary.

2.7 Battery Test

The batteries are tested periodically and automatically. The length of time between tests is defined by the software.

The system can manage two separate battery sets.

The battery is tested by lowering the rectifier's DC voltage for a pre-defined time and simultaneously measuring the battery voltage.

If the battery is strong and fully charged, the voltage reading will be above a certain level.

If the battery is weak or empty, the voltage reading will be low (i.e., a weak battery does not maintain the high DC voltage of a strong battery).

Since the PS1006 system can manage two battery sets, each battery set is tested separately while the other is disconnected by the ELVD.

The message "passed the test" is displayed on the controller's LCD screen if each battery set status is normal.

3. TECHNICAL SPECIFICATIONS FOR PS1006

RECTIFIER MODULES	12-18	12-30	24-15	24-30	48-12	48-25	60-15
Input							
Nominal Voltage (-15%,+12%) Voltage range	100 ~ 240 V_{AC} 85V_{AC} to 270V_{AC}						
Maximal current (at full load) [1]	N*3.5A	N*6A	N*6A	N*10A	N*6A	N*10A	
Frequency	47Hz to 63Hz						
Power factor (at full load)	≥ 0.99						
Output							
Voltage (default)	13.5 ±0.2 V_{DC}		27 ±0.2 V_{DC}		54 ±0.2 V_{DC}		67.5±0.2 V_{DC}
Adjustable range	10 – 15 V_{DC}		20 - 30 V_{DC}		47 - 60 V_{DC}		60 – 75 V_{DC}
Regulation (line & load)	± 0.5%						
Nominal Current [1]	N*18A	N*30A	N*15A	N*30A (Vin>100 V) N*20A (Vin<100 V)	N*12A (Vin>150 V) N*8A (Vin<150 V)	N*25A (Vin >165 V) N*18A (165>Vin>120) [5]	N*15A (Vin>100 V) N*10A (Vin<100 V)
Ripple & noise @ BW=30MHz	200m$V_{p-p,}$ 20mVrms						
Psophometric noise	-52 dbm over 600Ω (<2mV)						
Efficiency (nominal load)	86% @ 230 V_{AC} 82% @ 115 V_{AC}		88% @ 230 V_{AC} 84% @ 115 V_{AC}		89% @ 230 V_{AC} 85% @ 115 V_{AC}	91% @ 230 V_{AC} 87% @ 115 V_{AC}	
Overload current [1] (Short circuit current, Vo=0)	<N*20A N*3A<I_{SC}<N*5A	< N*7A N*6A<I_{SC}<N*8A	<N*16A N*3A<I_{SC}< N*4A	<N*31A (Vin>100 V) <N*21A (Vin<100 V) N*6A<I_{SC}<N*8A	<N*13A (Vin>150 V) <N*9A (Vin<150 V) N*3A<I_{SC}<N*5A	<N*26A (Vin>165V) <N*19A(165V >Vin>120 V) N*4A<I_{SC}<N*6A	<N*18A N*3A<I_{SC}<N*5A
Over-voltage protection	15V		30V		60V		75V
Walk-in time	< 1 sec						
Hold-up time (fully loaded)	40ms	20ms	20ms	10ms	15ms	10ms	
Output current indication	10 LED's bar-graph (1st LED indicates operation only)						
Active current sharing	±10% accuracy at full load						
General							
System controller [2]	Full status monitoring and communication with a PC, dedicated Graphical User Interface						
Withstand voltage (1 min) [3]	3000 V_{AC} INPUT/OUTPUT, 1500 V_{AC} INPUT/GND1000 V_{DC} OUTPUT/GND						
Operating temperature	-10 to 65°C			-10 to 45°C	-10 to 65°C	-10 to 40°C	
Humidity	<95% non-condensing, equipped with standard PS1006 rack						
Storage temperature	-20 to 80°C						
EMC	EN 300 386-2 V1.1.3 (1997), EN55022, EN 6100 –4-2,3,4,5,6,11 EN 61000-3-2 and EN 61000-3-3						
Safety	According to IEC950, EN60950						
Dimension (mm)	Subrack	19” (W); 3U (H) 320 w/o terminals; 360 with terminals (D)					
	Rectifier module	60 (W); 135 (H); 235 (D)mm					
Weight (Kg)	Subrack [1]	(N*1kg)+4.2 kg (fully equipped system – max. 10.2 kg)					
	Rectifier module	1 kg					
ELVD							
Max. current withstand	2x60 ADC or 1x100A						
Trip voltage levels [4]	Disconnect: 42 ± 0.5 V_{DC}, Reconnect (AC line recovers): 49 ± 0.5 V_{DC}						

1. N=number of modules
2. Basic Shelf 1 has V/A meter. Basic Shelf 2 has a system controller.
3. Equivalent DC test voltage is applied to overcome Y-capacitors leakage current to ground. Output is floating (not grounded during test).
4. Programmable with SC1006 if included
5. N*18A to N*12A decreases linearly for Vin<120V [N*12A (for Vin=85 V)]

4. BASIC RECTIFIER MODEL

The rectifier module is the heart of the Full-Redundancy Power System. It is a plugged-in module designed specifically for modular systems. The power factor correction (PFC) device at the input enables clean, harmonic-free, sinusoidal current consumption from the mains. This converter produces a $380V_{DC}$ output, which is then down-converted to the DC output (12V/24V/48V/60V).

A current sharing circuit is responsible for accurate current sharing among the rectifiers. This enables each one of the rectifiers to change its output voltage slightly until sharing is achieved.

The output current is indicated by the LED bar graph shown on the front panel *(see* Figure 4*)*. This bar graph is used to verify the current sharing operation, as well as to indicate the percentage of the full load.

The rectifier module uses a forced cooling system. The speed of the fan used for evacuating the heat from internal components is variable. A special circuit changes the speed of the fan according to the load level. This prolongs the fan's life, thus increasing the Mean Time Between Failure (MTBF) of the rectifier module. Other benefits are reduced audible noise and less dust entering the module.

4.1 Simplified Block Diagram of a Rectifier

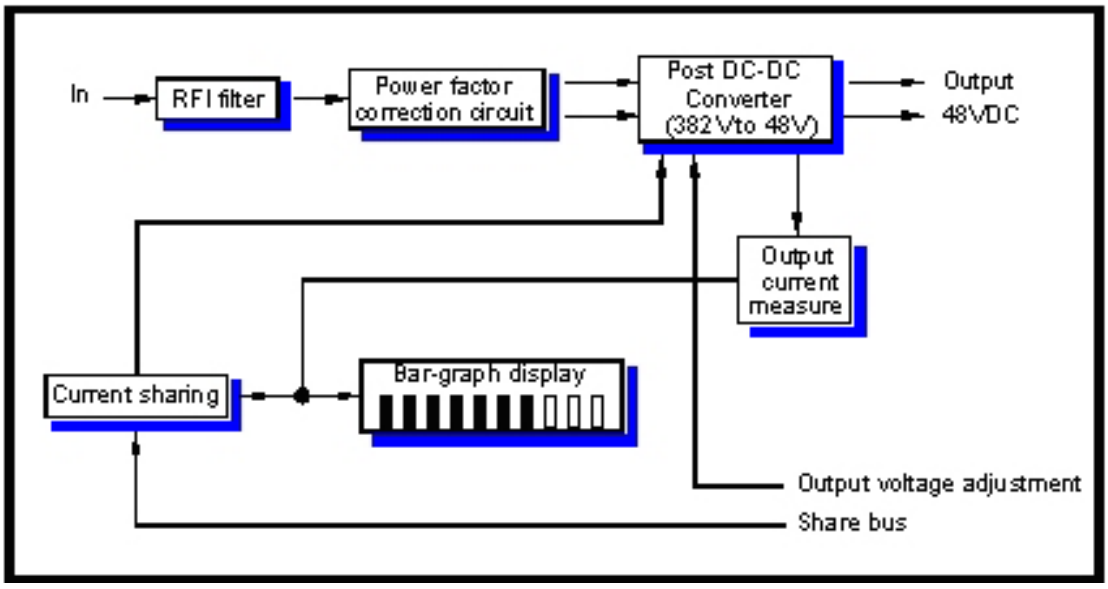

Figure 4: Simplified Block Diagram of a Rectifier (48V output is shown)

4.2 Front Panel of a Basic Rectifier

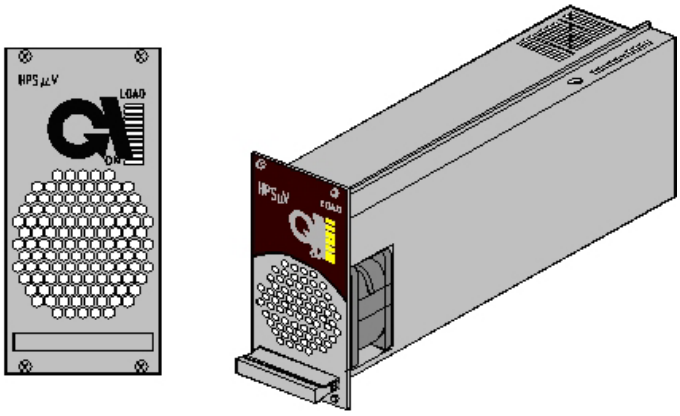

Figure 5: Front Panel of a Basic Rectifier

4.3 Rear Panel of a Basic Rectifier

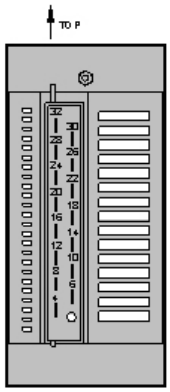

Figure 6: Rear Panel of a Basic Rectifier

The following table describes the assignments and functions of Pins on a Rectifier's Rear Panel:

PIN #	NAME	DESCRIPTION	SIGNAL LEVEL
32	PE	Protective Earth (Ground)	0V
30	Phase	Utility Phase	85-270VAC
28	Neutral	Utility Neutral	0V
26	Not Connected	---	---
24	PE	Protective Earth (Ground)	0V
22	+24V1	Internal 24VDC	24VDC
20	ALRM1	Faulty Module Signal (-) (open emitter type)	See pin 18
18	ALRM2	Faulty Module Signal (+) (open collector type)	Max. 35VDC/5mA referenced to ALRM1
16	SHR	Current Sharing Bus	0-5V
14	COM	Internal Common	0V
12	V-ADJ	Vout Adjust Pin	0-5V referenced to -Vout
10	+Vout	Output Positive Pole	60/48/24/12VDC
8	-Vout	Output Negative Pole	0V
6	+Vout	Output Positive Pole	48VDC / 24VDC
4	-Vout	Output Negative Pole	0V

4.4 Rectifier Specifications (Single Module)

	12-18	12-30	24-15	24-30	48-12	48-25	60-15
Input							
Nominal Voltage (-15%,+12%) Voltage range	100 ~ 240 V_{AC} 85V_{AC} to 270V_{AC}						
Maximal current (at full load)	3.5A	6A	6A	10A	6A	10A	
Frequency	47Hz to 63Hz						
Power factor (at full load)	≥ 0.99						
Output							
Voltage (default)	13.5 ±0.2 V_{DC}		27 ±0.2 V_{DC}		54 ±0.2 V_{DC}		67.5±0.2 V_{DC}
Adjustable range	10 – 15 V_{DC}		20 - 30 V_{DC}		47 - 60 V_{DC}		60 – 75 V_{DC}
Regulation (line & load) [1]	± 0.5%						
Nominal Current	18A	30A	15A	30A (Vin>100 V) 20A (Vin<100 V)	12A (Vin>150 V) 8A (Vin<150 V)	25A (Vin >165 V) 18A (165 >Vin>120) 18A to 12A decreases linearly for Vin<120V 12A (Vin=85 V)	15A (Vin>100 V) 10A (Vin<100 V)
Ripple & noise @ BW=30MHz	200mV_{p-p} 20mVrms						
Psophometric noise	-52 dbm over 600Ω (<2mV)						
Efficiency (nominal load)	86% @ 230 V_{AC} 82% @ 115 V_{AC}		88% @ 230 V_{AC} 84% @ 115 V_{AC}		89% @ 230 V_{AC} 85% @ 115 V_{AC}	91% @ 230 V_{AC} 87% @ 115 V_{AC}	
Overload current (Short circuit current, Vo=0)	<20A 3A < I_{SC} < 5A	<7A 6A < I_{SC} < 8A	<16A 3A < I_{SC} < 4A	< 31A (Vin>100 V) < 21A (Vin<100 V) 6A < I_{SC} < 8A	< 13A (Vin>150 V) < 9A (Vin<150 V) 3A < I_{SC} < 5A	< 26A (Vin>165V) <19A (165V >Vin>120 V) 4A < I_{SC} < 6A	<18A 3A < I_{SC} < 5A
Over-voltage protection [2]	15V		30V		60V		75V
Walk-in time	< 1 sec						
Hold-up time (fully loaded)	40ms	20ms	20ms	10ms	15ms	10ms	
Output current indication	10 LED's bar-graph (1st LED indicates operation only)						
Active current sharing	±10% accuracy at full load						
General							
Withstand voltage (1 min) [3]	3000 V_{AC} INPUT/OUTPUT, 1500 V_{AC} INPUT/GND1000 V_{DC} OUTPUT/GND						
Operating temperature	-10 to 70°C			-10 to 50°C	-10 to 70°C	-10 to 45°C	
Humidity	<95% non-condensing, equipped with standard PS1006 rack						
Storage temperature	-20 to 80°C						
Safety	According to IEC950, EN60950						
Dimension (mm)	60 (W); 135 (H); 235 (D)						
Weight (kg)	1 kg						

Notes:

1. Share bus is grounded and enabled, single rectifier test.
2. Hiccup operation mode.
3. Equivalent DC test voltage is applied to overcome Y-capacitors leakage current to ground. Output is floating (not grounded during test).

4.5 Rectifier Calibration

Calibration of the PFC module is simple and involves a single trimmer, which adjusts the output voltage.

To calibrate the rectifier:

1. Access the trimmer (see no. 1 in Figure 7) via the small opening at the top of the cover.
2. Set the output voltage precisely, using a DMM (54V to 48-xx models, 27V to 24-xx models, 13.5V to 12-xx models and 67.5V to 60-xx models).

***Note**: Other voltages are possible. Please consult Gamatronic specialists regarding a specific model.*

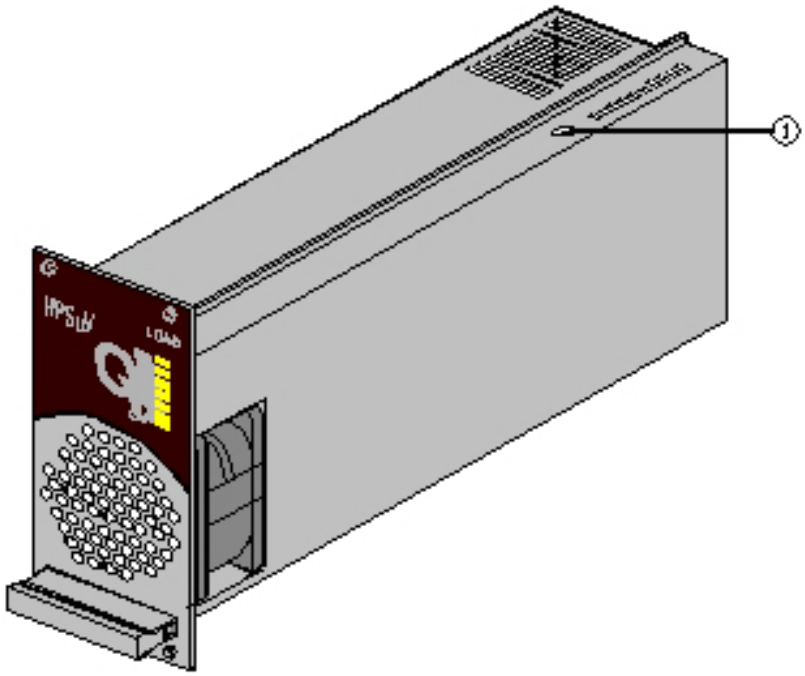

Figure 7: Rectifier Calibration Point

5. SC1006 SYSTEM CONTROLLER

The PS1006 system uses a special SC1006 system controller.

A comprehensive description of this controller is provided in a separate manual supplied with this documentation.

The SC1006 controller is designed to be used with a PC monitor, so the indication buttons on the front panel are limited.

Only the most important indications are provided on the front panel, along with the audible alarm.

System controller SC1006 also corrects the system's DC output voltage by measuring and correcting it in a negative feedback loop. This ensures a 0.5% absolute error in all conditions.

Two versions are available:

1. Standard RS232 serial communication
2. NET version - both standard RS232 serial communication and PPP/SNMP/TCP-IP communication

***Note**: The standard version can be upgraded to the NET version.*

The SC1006 controller is shown in Figure 8

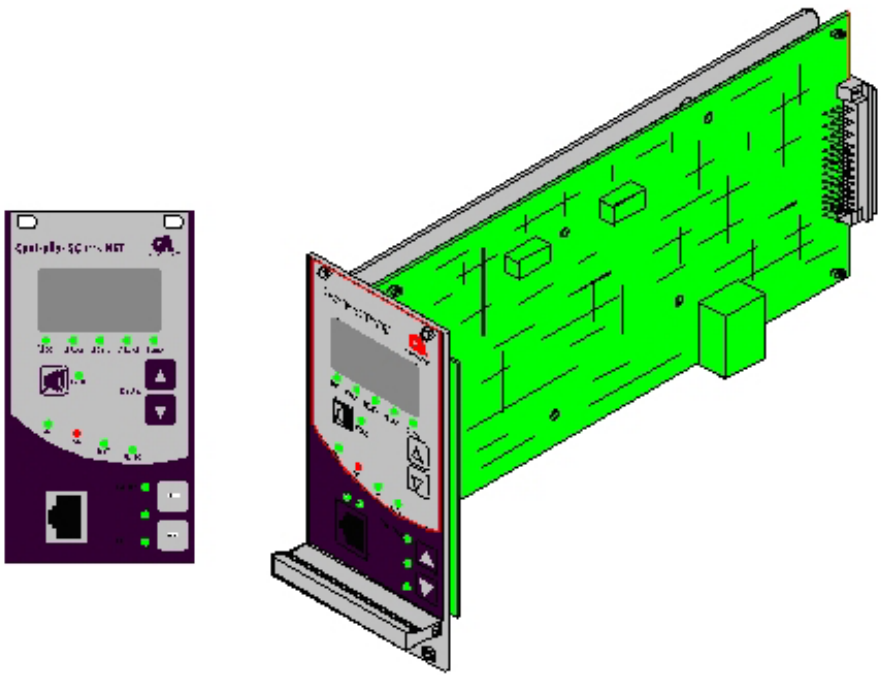

Figure 8: SC1006 System Controller

6. V/A METER (OPTIONAL)

The PS1006 system has a low-cost alternative to the advanced controller that contains a 3-digit Volt-Ampere Meter.

This meter:

- Displays the output voltage and current simultaneously.
- Includes the ELVD and an audible alarm.
- Allows the system DC voltage to be set by the hidden potentiometer at the bottom (VOLT ADJ).

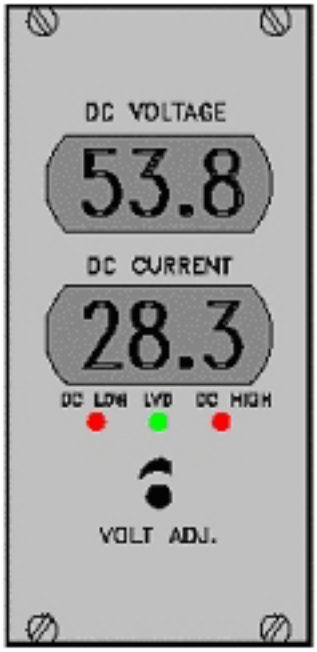

Figure 9: V/A Meter

7. INSTALLATION PROCEDURES

7.1 Safety Instructions

ATTENTION

Read the following safety information carefully before using this power supply

CAUTION identifies conditions and actions that may damage the power supply.

WARNING identifies conditions and actions that expose the user to hazard(s).

- **WARNING** - Restricted Access Location: This power system should be used with a specific cabinet only. The cabinet provides a fire and electrical enclosure for the system and also enhances EMI/RFI performance.
  Safety standards are applicable to this unit providing that its cabinet encloses it.
- **WARNING** - This power supply must be grounded to the protective earth (PE).
  The unit receives the connection from the power cord and from the rack itself.
- **WARNING** - Do not allow any object to be inserted into the unit through the ventilation holes.
- **WARNING** - Do not allow any liquids to get into the unit through the ventilation holes.
- **WARNING** - Always switch off the power switch and detach the AC cord before you remove the power supply from the rack.
- **WARNING** - Do not open the unit. Danger of electrical shock exists for several minutes after unplugging from the mains.
- **WARNING** – While replacing fuses always use the same type and rating as the original.
- **CAUTION** – Do not block the ventilation holes. This may cause a high temperature rise in the unit and, as a result, damage it or shorten its life.

7.2 General

The system should be wired to the load(s) and battery set(s) as illustrated in Figure 10.

The rear cover should first be removed in order to gain access to the motherboard's terminals.

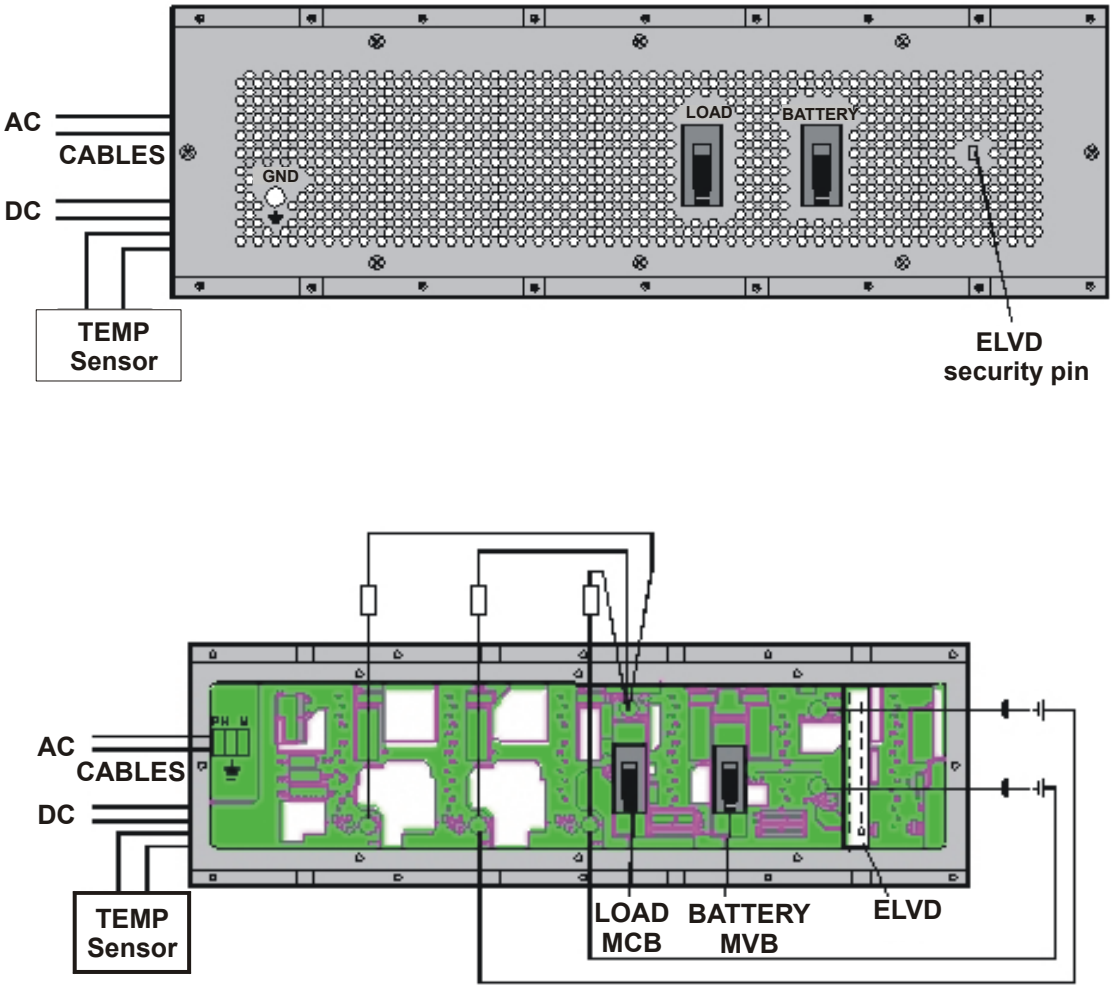

Figure 10: Battery and Load Wiring Connections

7.3 Installing the System

1. Verify that the load, battery and line input's circuit breakers are disconnected. Access the internal connections by carefully opening the rear cover.
2. Connect the shelf to the battery and load via the battery and load terminals on the rear panel *(see Figure 10)* and close the rear cover with its screws.
3. Plug the AC input cord into the mains.
4. Turn on the line circuit breaker and verify that the modules' display is activated. Verify that the system controller (right-handed) is operating.
5. Install the GUI software "**PSM1006 AMIGA**" on your PC.
6. Connect the communication cable from the controller's RS232 terminal to the PC. The GUI should indicate normal communications and measurements.
7. Verify that no red LEDs are lit.
8. Switch on the load and battery circuit breakers.
9. The system is ready for use.
10. Use the software to change the system's settings (e.g. float/boost charging voltage) if necessary.

7.4 Dry Contact Signalization

The system also provides 3 floating signals for system status indication, as well as the data provided by the controller via the RS232 terminal.

These signals are accessible via the connections on the motherboard, marked "P16" on Figure 11.

The dry contacts are assigned to any events and are programmable by the software. Refer to the SC1006 controller booklet for details.

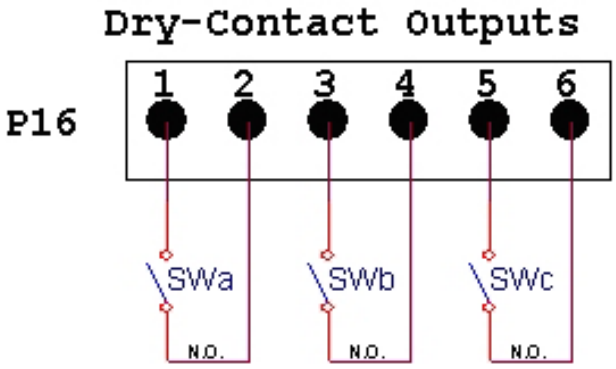

Figure 11: P16 Electrical Connections

Notes:

1. *Ratings for the switches SWa – SWc are 50V/1A maximum.*
2. *"N.O." = Normally Open (the event causes this switch to contact).*

7.5 Temperature Compensation

As in similar advanced DC systems, the PS1006 has a temperature compensation mechanism. This means that the temperature measured by the system compensates the output voltage.

Two sensors are treated by the system. Please note that the sensors are of the current-source type and possess a polarity that must not be altered.

The calculated temperature is the average of the two measurements. In case one sensor is absent or defective, the system will ignore this sensor and treat the normal sensor only. The temperature value is displayed on the PC screen and is used to calculate the compensation. The compensation coefficient is negative and is programmable by the software. Typical compensation value is [–72mV/°C].

The sensors' connections, marked as "P14" on Figure 12 below, are mounted on the motherboard.

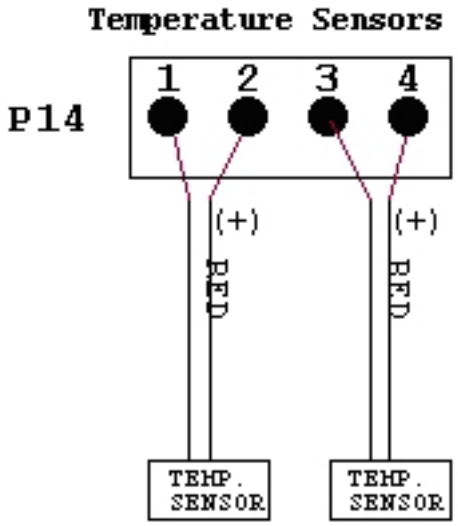

Figure 12: P14 Sensor Connections

8. BATTERY DESIGN

8.1 Determining the Battery Size

This section explains how to determine the correct size of the battery to be connected to the system.

The role of the battery is to power the load during a mains failure and then be recharged by the system when the mains recovers.

At this point, the rectifiers are loaded to maximum, as they have to provide power to both the load and the empty battery.

8.2 Design Example

Assuming that the requirement for long battery backup time is 8 hours, then:
TBACKUP = 8 hours

Assuming that the load current is 20A at 48V, then:
ILOAD = 20A

The required capacity of the battery is the following:
TBACKUP * ILOAD = 160AH

This means that a bank of four 12V 160AH batteries is required to receive a total of 48V 160AH.

After the line recovers, the battery's recharge time is calculated as 20 hours.

A 15% safety margin is added to the recharge time.

The current that recharges the battery is as follows:
IRECHARGE = 160AH * 1.15 / TRECHARGE = 184AH / 20H = 9A

The rectifiers must now provide a total current of:
ITOTAL = IRECHARGE + ILOAD = 20A + 9A = 29A

A minimum of 3 rectifier modules are needed for the specified current consumption:
N = ITOTAL / 6A (12A is the maximum capacity of one module)

Therefore, for an N+1 redundant system we need: N+1 = 4 rectifier modules.

9. ADDITIONAL INFORMATION

9.1 Troubleshooting

The table below solves some of the problems which might arise. Refer to it before calling for service.

SYMPTOM	POSSIBLE CAUSE	REMEDY
ELVD LED is on	1. No AC input. 2. Output voltage is too low.	1. Check that the line MCB is on. 2. Check that the system is connected to the mains.
No backup time when AC is absent	Battery is not connected.	Check battery cables and circuit breaker.
Load is not operating	Load is not connected.	Check load cables. Check load circuit breaker.
No current sharing among rectifiers (more then 2 segments difference between any two modules).	1. Load is too high (rectifiers are in current-limit mode). 2. Rectifier(s) are not properly adjusted.	1. Decrease the load or add rectifiers to the system. 2. Re-adjust the voltage of the problematic rectifier(s).
Battery backup time is too low	1. Battery is too small for the application. 2. Charging voltage is too low. 3. Weak battery.	1. Increase battery capacity 2. Raise the system output voltage from the PC. 3. Replace the battery and check ambient temperature according to manufacturer's instructions.

9.2 Ordering Information

ITEM	Catalog number
Main rack frame (rectifier not included)	102041006-3UG
48V-12A Rectifier/ Power Supply module	1020480012F
48V-25A Rectifier/ Power Supply module	1020480025-S
60V-15A Rectifier/ Power Supply module	1020600015F
24V-15A Rectifier/ Power Supply module	1020240015F
24V-30A Rectifier/ Power Supply module	1020240030U
12V-18A Rectifier/ Power Supply module	1020120018
12V-30A Rectifier/ Power Supply module	1020120030U
SC1006 System Controller - standard	102SC1006
SC1006 System Controller - NET	102SC1006NET
Dual Electronic LVD board (ELVD)	29CA513
Motherboard	29CA510
PSM1006 AMIGA Software CD	19990070
(Cabinet for 6 rectifiers + V/A meter)	102SH61519"-1