Gamatronic Electronic Industries Ltd.

RECTIFIER FOR TELECOMMUNICATIONS

MODELS:
HPSµV 24-100
HPSµV 48-50

User Guide and Instruction Manual

Release 1.1

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1. Introduction

The Gamatronic HPSμV rectifier supplies precise, regulated clean DC power to telecommunication equipment, exchanges and similar equipment.

1. The HPSμV rectifier, which is fed with a one phase input voltage, operates with soft switching technology creating a power factor close to 1. This implies a pure sinusoidal input current.
2. The rectifier complies with the strictest requirements demanded by the various types of applications, especially in telecommunications, by providing:
   a. High output stability
   b. Low ripple and noise
   c. Excellent dynamic response to load change
3. The rectifier is designed for mounting in suitable racks and may be used as either a standalone unit or in parallel with other identical units (N + 1).
4. In a parallel configuration either system controller SC2012 or SC2012NET control the rectifiers. The controller allows accurate current sharing between the rectifiers as well as providing additional important features.

1.1 Features

1. High overall efficiency
2. A microcontroller guarantees precise rectifier operation
3. Power factor of almost 1
4. Very low input harmonic distortion (THD < 6%)
5. Serial port communication with an external controller or computer
6. Voltage, current, temperature and various other parameter data are available via the serial port
7. Stand-alone or parallel connection with identical units (up to six units in a 19" shelf or seven units in a 23" shelf)
8. An output diode enables “Hot Swap” operation
9. Active current sharing during parallel operation
10. Small dimensions and low weight (signifies a very small volume – power ratio)
11. Voltage, current, temperature and fault status digital display

2. SAFETY PRECAUTIONS

2.1 Warnings

1. Read all the safety precautions detailed below to avoid unnecessary injury, damage to the rectifier or damage to any other products connected to it.
2. Use the rectifier for its intended purpose only and according to the instructions provided to avoid any potential hazards.
3. Only trained and authorised personnel may perform maintenance procedures to the rectifier.

2.2 Safety Instructions

1. Connection to the mains must be with the original electrical cable or similar power cable complying with local safety standards. The conductors' cross-section must be at least 2.5mm.
2. Easily accessible plug and mains socket allow quick and safe disconnection from the mains when necessary.
3. The rectifier does not have an input circuit breaker. Thus, the rectifier may only be switched off by disconnecting the mains power cable.
4. A circuit breaker must be fitted to the rectifier from the AC distribution board to provide full protection in the case of a short circuit in the rectifier's input.
5. **Ground the rectifier.**
   The rectifier is grounded via the ground wire in the mains power cable. To prevent electrocution the ground wire must be connected to the ground point in the installation.

   Ensure that the rectifier is correctly grounded before connecting the rectifier's inputs and outputs.
6. **Do not operate the rectifier without covers.**
   Do not operate if the covers or panels have been removed.
7. **Exposed connections or components.**
   Do not touch the conductors or other exposed components when the rectifier is operating or connected to the mains.
8. **Do not operate if a malfunction is suspected.**
   A fully qualified service technician must check all suspected faults and malfunctions.
9. **Ensure proper ventilation.**
   Leave at least a 20cm space from the back and sides of the rectifier.
10. **Fire prevention**.
    The rectifier is anti inflammable. It is made of flame retarding materials, but since it concentrates a lot of energy, do not install it in a flammable environment. It must be installed in a suitable cupboard, enclosure or external rack.

11. **Electric Shock prevention.**
    Do not insert foreign objects into the enclosure's holes. Use an external cupboard for extra protection.
12. **Do not operate in wet or humid conditions.**
13. **Do not exceed the ambient temperature limit specified in Table 4: Technical Specifications.**
14. **Do not energize a wet rectifier.**
15. **Do not operate in an explosive atmosphere.**
16. **Ensure that the rectifier's surfaces and ventilation holes are kept clean and dry at all times.**

2.3 Safety Symbols and Terminology

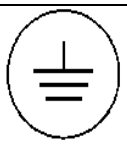
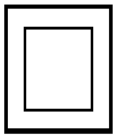
Listed below are the safety terms and symbols used in this manual:

Warning: Warning notices describe situations or practices that may result in injury or loss of life.

Caution: Caution notices describe situations or practices that may cause damage to the equipment or other property.

2.4 Accepted Safety Symbols

Listed below are the safety symbols appearing on the product:

			
Warning High Voltage	**Safety Ground Terminal**	**Caution Refer to Operation Manual**	**Double Insulation**

3. OPERATION PRINCIPLES

This chapter describes the HPSμV rectifier's internal structure and operation mechanism. The following topics are covered:

1. Block diagram and electrical operation description
2. The power components
3. Front panel controls and indicators
4. Rear panel description
5. Connector pin mapping
6. Communication with peripherals

3.1 Block Diagram Description

The rectifier's main parts, described below, are shown in figure 3.1.

1. An RFI Input Filter, which filters the input voltage reducing the high frequency common mode and differential interferences at the input stage (see no. 1 on figure 3.1).
2. The power factor corrector (see no. 2 on Figure 1), which is a boost converter, converts the rectifier's AC Input to a steady $380V_{DC}$. The power factor corrector (PFC) ensures a sinusoidal input current and reduces the input harmonic distortion to a minimum.
3. The PFC, which is a boost converter, converts the input voltage (AC) to DC using soft switching technology. The boost allows system operation within the input range during extreme voltage and frequency changes.
4. The resonant converter (second conversion) converts the power factor output voltage ($380V_{DC}$) to a steady, clean $54V_{DC}$ voltage. (This is the nominal voltage that can be changed by either the rectifier's front panel control or serial port communication).

Note: *Both the power factor corrector and resonant converter are mounted on the same printed circuit board, which holds all the high power components, including transistors (IGBT and MOSFET), transformers, diodes and heatsink.*

5. The control unit (see no.4 on Figure 1) measures and assesses the rectifier's parameter statuses then communicates this data to an external system controller or computer via serial port communication. The status of the individual parameters are also displayed via LED indicators on the control unit's front panel.
6. The control unit, which is mounted on a separate circuit board, consists of the following parts:
    d. Microcontroller and A/D, D/A converters (analog – digital, digital – analog)
    e. Voltage and current measurement circuits
    f. Communication elements

7. The control unit's display (current, voltage, temperature, LEDs, push buttons) and calibration trimmers (for different V/A) are located on the rectifier's front panel (see no. 5 on Figure 1).

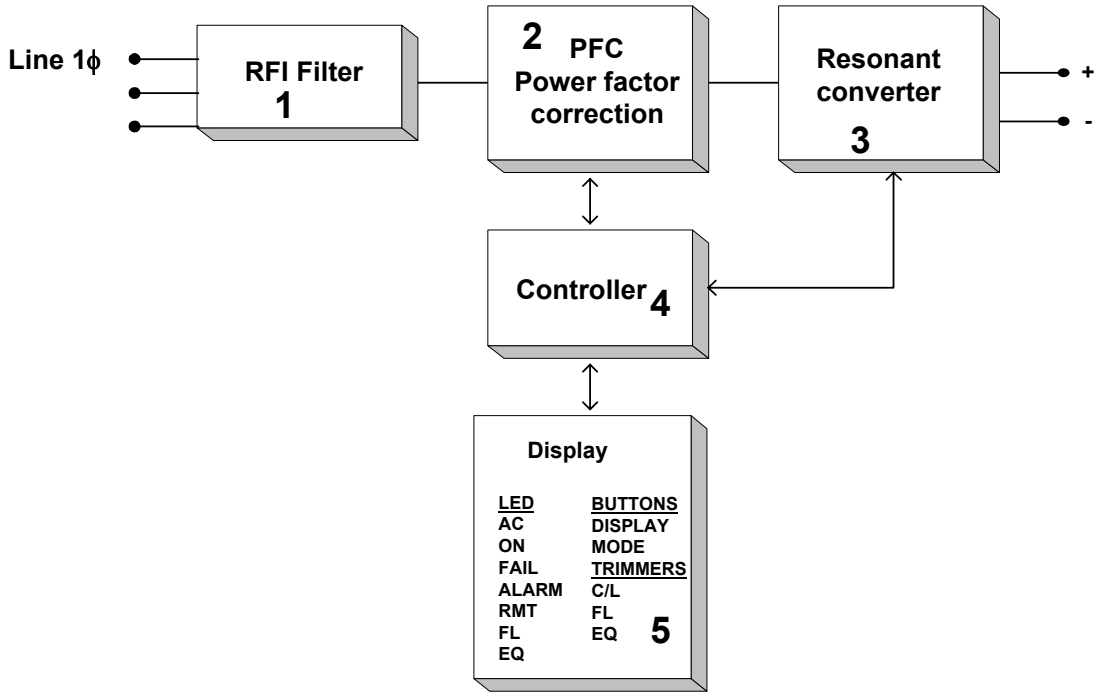


Figure :1 Block Diagram of the HPSμV Rectifier

3.2 The Rectifier's Components

The HPSμV rectifier's principle components and their function are detailed in the table below:

NO. ON FIGURE 2	COMPONENT NAME	DESCRIPTION
1.	P100 Connector	An Elcon connector comprises all of the converter's essential connections: AC voltage, DC voltage, communication connections for remote operation via a system controller and dry contact points).
2.	PC958 Filter	The AC input filter filters the DC voltages at the rectifier's output (RFI filter)
3.	PC963 Board	The rectifier's power unit. The electronic board includes the power elements, which operate at high frequency converting the rectifier's AC voltage to DC voltage
4.	PC962 Board	The rectifier's control unit, which operates the rectifier's: 1. Power unit (PC959) 2. Front panel display circuit (PC996) 3. Communication to the system controller (via P100 connector)
5.	PC996 Panel	The front panel display circuit with the rectifier's status indicators, including: 1. Voltage, current, temperature and fault digital display 2. LED indicators indicating normal, fault and control modes 3. Self adjusting voltage and current limit calibration trimmers
6.	PC998 Board	Input voltage connection circuit to fans and fan status sensors
7.	Fans	Two parallel fans remove the internal hot air in the rectifier via the rack's rear panel
8.	CR-1	A thyristor bridge (SCR) connected to the power unit to soft start the rectifier

Table 1: The Rectifier's Components and Their Functions

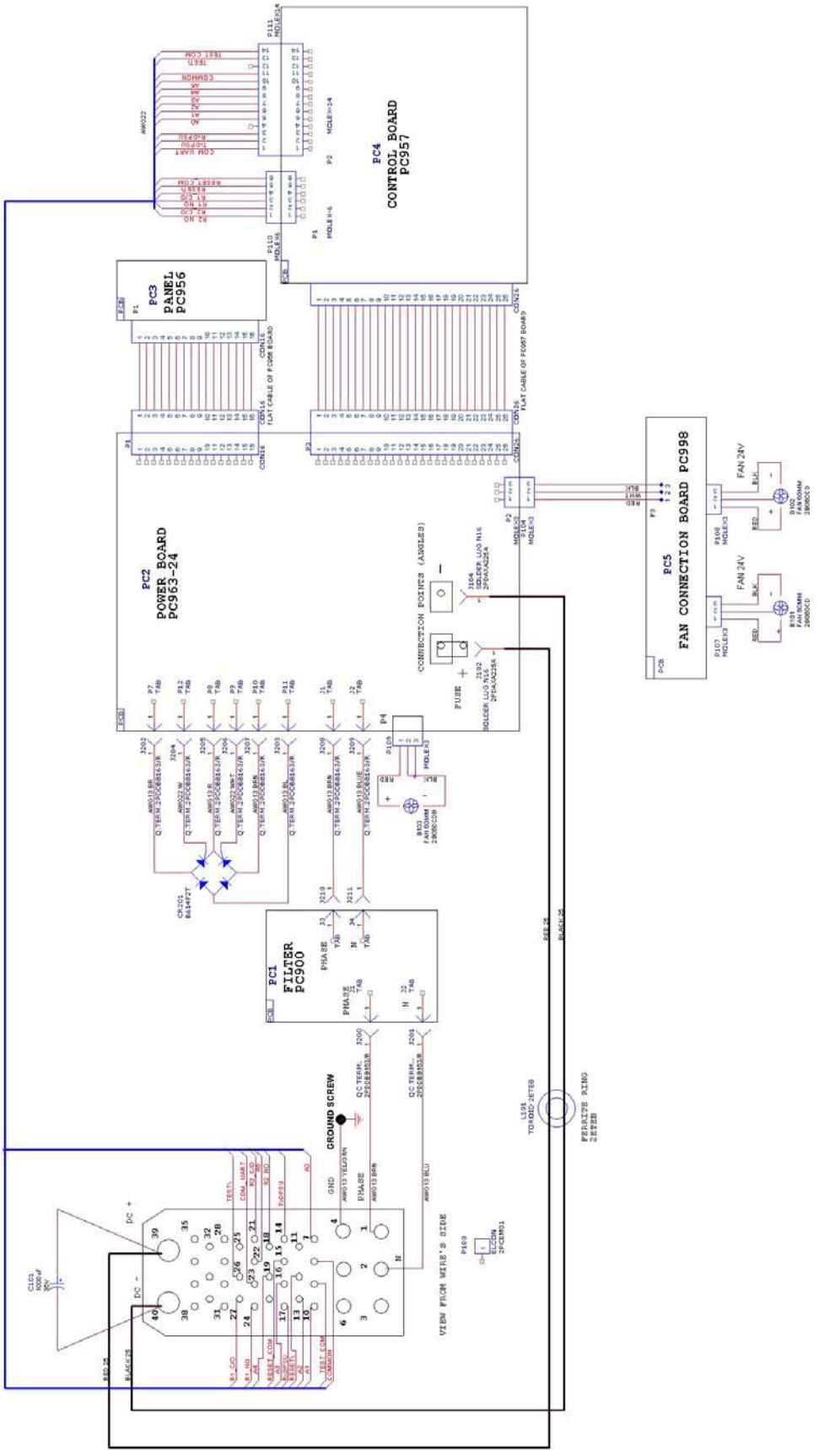


Figure :2 Main Electrical Components 24-100

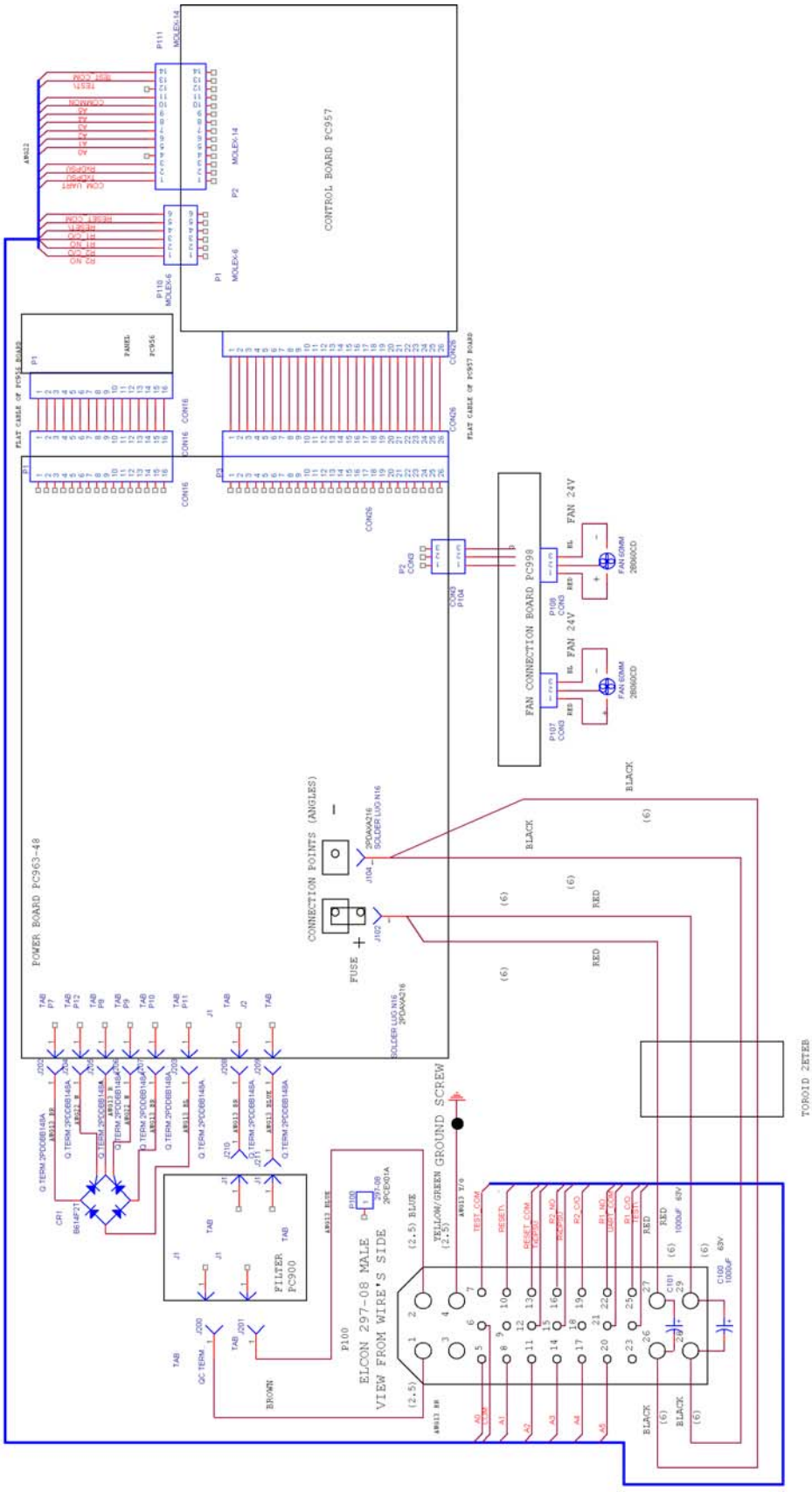


Figure :3 Main Electrical Components 48/50

3.3 The Front Panel

The rectifier's front panel is depicted in Figure 3. The various indicators, measures and buttons and their functions are described in Table 2 following:

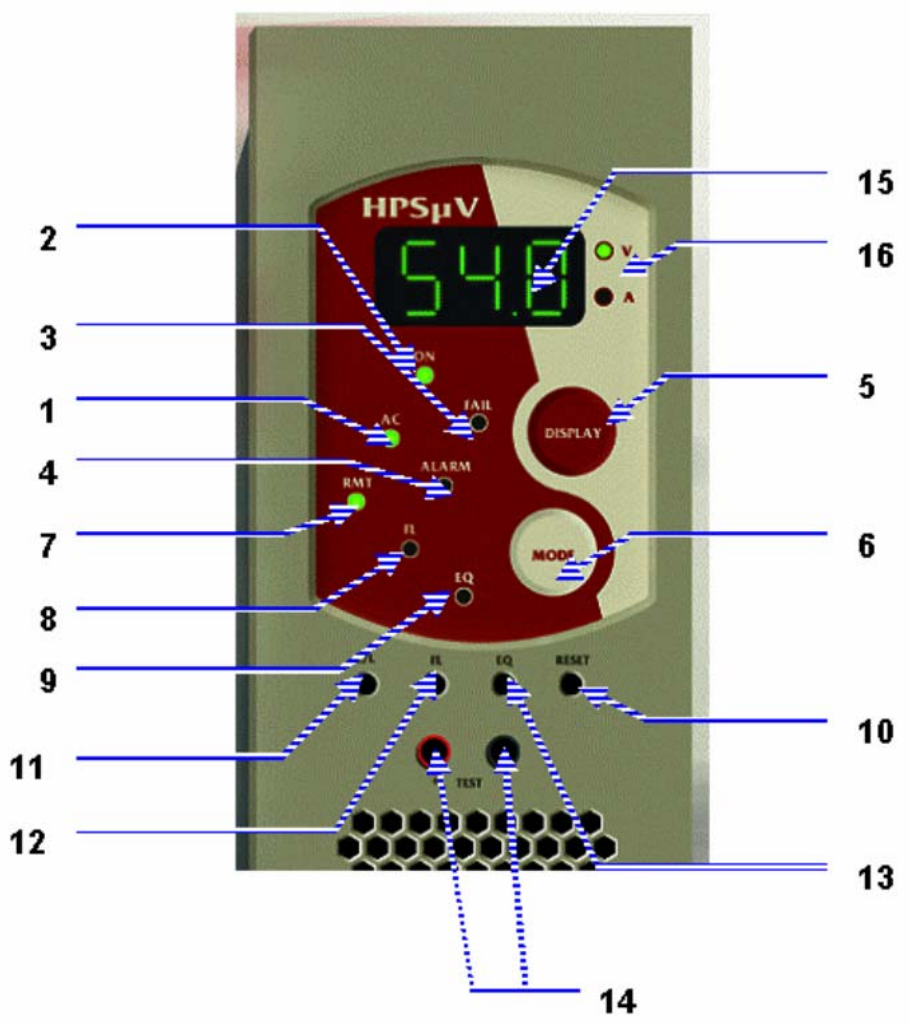


Figure :4 The Rectifier's Front Panel

NO. ON FIGURE 3	COMPONENT NAME	DESCRIPTION
1.	AC LED	A continuous green light indicates a normal AC input voltage
2.	"ON" LED	1. A continuous green light indicates a normal DC output voltage 2. No light indicates an abnormal DC output voltage 3. A flashing light indicates the rectifier is operating at its current limit
3.	"FAIL" LED	1. No light indicates the rectifier is operating in normal mode 2. A continuous red light indicates a fault in the rectifier, such as low or overvoltage, overtemperature, faulty fan
4.	ALARM LED	A continuous red light indicates a fault in the system, such as low DC voltage or communication failure
5.	DISPLAY button	Determines whether the voltage, current or internal temperature reading is displayed. The displayed reading indicates by the light status to the right of the digital display: V = Voltage, A = Current, No light = temperature
6.	MODE button	Determines the battery charging mode: FL = Floating, EQ = Equalising, RMT = Remote (controlled by system controller)
7.	RMT LED	Indicates the rectifier is controlled by an external system controller i.e. the remote mode – the default mode
8.	FL LED	Indicates the rectifier is in the floating mode and not controlled by the system controller
9.	EQ LED	Indicates the rectifier is in the equalising mode and not controlled by the system controller
10.	RESET button	Press this button to reset the rectifier. (The reset procedure includes rectifier shutdown and restarting)
11.	C/L trimmer	Adjusts the rectifier's current limit
12.	FL trimmer	Adjusts the floating voltage. This trimmer may only be used when the rectifier is operating in the floating FL mode
13.	EQ trimmer	Adjusts the equalising voltage. This trimmer may only be used when the rectifier is operating in the equalising FL mode
14.	Test Points	These points are used to measure the rectifier's output voltage. They operate as follows: 1. The output voltage is measured just before the output diode 2. The test points are protected from short-circuiting 3. The test points are protected against electrostatic discharge – ESD

Table 2: The Front Panel Indicators and Their Function

3.4 The Rear Panel

The rectifier's rear panel connector is depicted below in Figure 4. The Elcon connector houses the AC, DC, controller communication and dry contact connections. Guiding pins on the connector smoothly mate the two plugs (male and female) on positioning the rectifier, without causing any damage to the pins themselves.

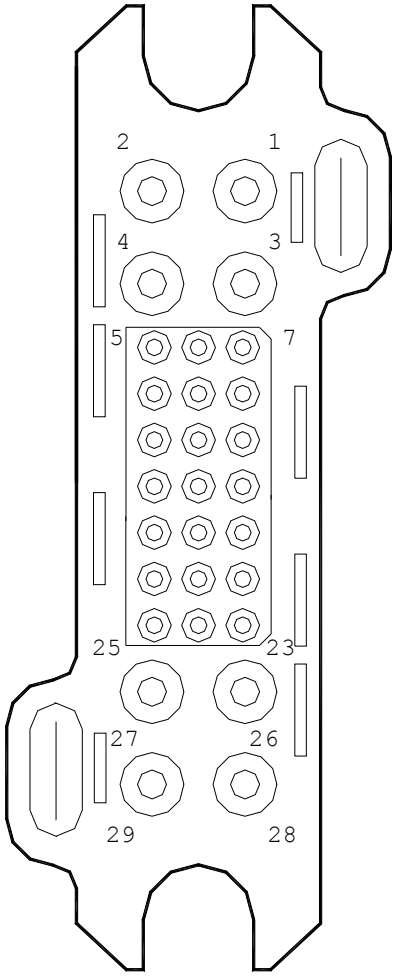


Figure :5 The Rectifier's Rear Panel Elcon Connector

Note: *Refer to Table 3 for a detailed account of the individual pin number assignments*

3.4.1 Connector Pin Assignment

The rectifier's connector pin assignment is detailed in Table 3 below:

PIN NO.	DESCRIPTION	INPUT/OUTPUT	VOLTAGE LEVEL
1.	Neutral	Input	230V
2.	Phase	Input	230V
3.	Earth	Input	0
4.	Not connected		
5.	Not connected		
6.	Not connected		
7.	Not connected		
8.	A0	Communication	5V
9.	Not connected		
10.	Not connected		
11.	A11	Communication	5V
12.	Not connected		
13.	UART COM	Communication	5V
14.	A2	Communication	5V
15.	Not connected		
16.	RS232	Communication	5V
17.	A3	Communication	5V
18.	Not connected		
19.	RS232	Communication	5V
20.	COM	Communication	5V
21.	A5	Communication	5V
22.	R LOAD	Communication	5V
23.	A4	Communication	5V
24.	CURR SHAR	Communication	5V
25.	+12VDC	Input/Output auxiliary voltage	12V
26.	+48VDC	Output, +ve line	48V
27.	+48VDC	Output, +ve line	48V
28.	-48VDC	Output, -ve line	48V
29.	-48VDC	Output, -ve line	48V

Table 3: The Rectifier's Connector Pin Assignment

3.5 Communication with Computers/Controllers

The HPSµV rectifier may be connected to either a personal computer or system controller (model SC2012 or SC2012NET) via RS232 serial port communication.

Both the computer and system controller connections enable complete rectifier control and management due to parameter measurements and operation mode statuses being transferred from the rectifier's circuits to the peripheral connections.

Both connections perform the following:

3.5.1 System Controller / Computer Measurements / Status Notifications:

1. Rectifier output voltage, output current and internal temperature and transfer of readings to the system controller
2. The rectifier's operating status – normal / abnormal
3. Assorted faults, such as high / low output voltage
4. Fan status – normal / abnormal
5. Rectifier operating at its current limit
6. Rectifier shutdown due to overtemperature

3.5.2 System Controller Actions:

1. Output voltage calibration and adjustment
2. Current limit adjustment
3. Rectifier shutdown due to high AC voltage
4. Rectifier shutdown and activation
5. Rectifier voltage adjustments vs. ambient battery temperature
6. Equalising or floating mode selection (EQ or FL)

4. TECHNICAL SPECIFICATIONS

The table below details the HPSµV rectifier's technical specifications:

OUTPUT	24V/100A	48V/50A	REMARKS
INPUT			
Voltage	$208V_{AC}$, $230V_{AC}$ ±15%		Input voltage range
Current	13.2A max	13A max	At nominal input voltage
Frequency	45Hz - 65Hz		
Power Factor	0.99		At input voltage $230V_{AC}$, maximum load
THD	<6%		Under nominal conditions
Inrush current	None		
OUTPUT			
Nominal voltage	$27V_{DC}$	$54V_{DC}$	Without an external control, other voltages are possible as required
Voltage range	$24V_{DC}$–$29V_{DC}$	$45V_{DC}$ – $57V_{DC}$	May be adjusted with the controller
Nominal current	100A	50A	
Local float mode: Adjustable between:	$27.5V_{DC}$ $24V_{DC}$–$28V_{DC}$	$54V_{DC}$ $48V_{DC}$ – $55V_{DC}$	
Local equalize mode: Adjustable between:	$27.5V_{DC}$ $25V_{DC}$–$29V_{DC}$	$55V_{DC}$ $49V_{DC}$ – $57V_{DC}$	
Static stability	1%		For full range of AC input and DC output
Psophometric noise	<1.5mV		w/o battery
Dynamic stability	< ±1.5V Recovery time <5msec		During load changes from 10% - 100% or vice versa
Ripple	<200mV <50mV		RMS peak-to-peak
Protection	Overcurrent, Overvoltage Overtemperature Fan failure		

OUTPUT	24V/100A	48V/50A	REMARKS
Overall efficiency	>90%	>91%	At nominal input voltage $230V_{AC}$ and nominal load
ENVIRONMENTAL			
Acoustic noise	<50dBA		At a distance of 1m
ESD immunity	15KV air discharge		
Soft start	Nominal value within 10sec of turn-on		
Ambient Temperature	Operating: -5ºC to 45ºC Storage: -40ºC to 70ºC		
Relative Humidity	95%		
Current Sharing	10%		At 10% - 100% load
FRONT PANEL			
Front Panel Display	DC voltage, DC current, internal temperature, high voltage, high temperature, fan failure		
LED Indicators	ON, AC OK, remote mode, floating / equalizing mode, fail alarm		
Adjustments	Current limit, local floating voltage, local equalizing voltage		
Weight	4.5kg		
Dimensions (in mm)	(W × D × H) 71 × 440 × 226		For 6U shelf
MTBF	603,000 hours		
SAFETY			
Isolation Primary to secondary	<4200V_{DC}		
Safety	According to EN60950		
Electric Interferences	According to EN55022 class B FCC 15 Class A		

Table 4: Technical Specifications

5. INSTALLATION

1. The rectifier is designed for installing on racks with suitable shelves.
2. Two types of shelves are available for installing the rectifier units: the 19" shelf, which can hold up to 6 units, and the 23" shelf up to 7 units.
3. A female plug is fitted to the shelf and a male plug is fitted on the rectifier.

5.1 Installing the Rectifier

1. Select the desired position on the shelf for installing the rectifier.
2. Slide the rectifier along the tracks. The connector at the back of the rectifier connects with the connector at the back of the shelf using the guiding pins.
3. Tighten the four screws on the front of the rectifier to secure the unit properly in place, using a standard number 1 screwdriver. Avoid asserting excessive force.
4. Connect the rectifier to the mains using a Type C, 16A current magnetic circuit breaker.

6. MODULAR CONFIGURATION

6.1 Parallel Connection

The rectifier may be connected and installed in parallel with other identical rectifiers. This type of configuration provides a high current output together with a system controller for measurement and control of the system.

Up to twelve rectifiers connected in parallel may be monitored and controlled when connected with system controller SC2012.

Up to sixty-four rectifiers connected in parallel may be monitored and controlled when connected with system controller SC2012NET.

A battery connected to the output ensures a continuous power supply during a mains power failure or operational failure of one or more rectifiers in the system

The modular rectifier supplies a precisely regulated, clean DC voltage to telecommunication equipment, exchanges and similar equipment.

A modular power system fitted with rectifiers is composed of the following sub-elements:

1. A rack housing shelves for 1 to 12 to 64 power supplies operating in parallel.
2. Rectifiers
3. System controller (SC2012 or SC2012NET)
4. Input and output connection lines with appropriate protection mechanisms (AC / DC panels).
5. A backup battery to be installed within or outside the rack depending on its size.

The modular configuration is represented in Figure 5.

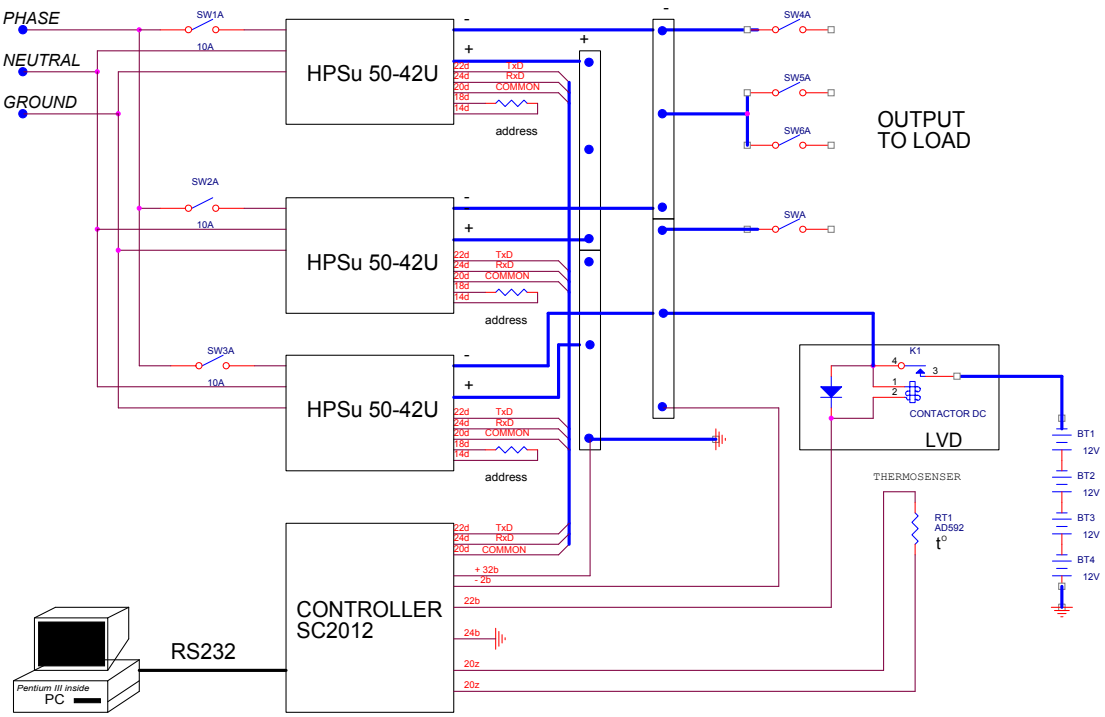


Figure :6 Modular Configuration of Power Supplies and Rectifiers

Key	Function
LVD:	Low voltage disconnect for battery disconnection when battery voltage is low
SC2012:	The system controller
HPSμ50-42U:	The rectifier unit
RS232:	The serial port communication connection (Local EM)

6.2 The Controller's Features and Functions

The SC2012NET system controller provides all the monitoring and control functions required by the system. Operating statuses, alarms and other messages are displayed on the controller's LCD display. The functions can either be manually or automatically activated.

Typical system features include:

1. Measurement and display of the input line parameters
2. Measurement and display of the rectifiers and power supplies' parameters (such as voltage, current, temperature, faults)
3. Current sharing between rectifiers
4. Measurement and display of battery parameters

5. Floating or automatic and manual equalising battery charging mechanism. Includes charging voltage correction capability according to the battery's ambient temperature
6. Detection and notification when battery voltage is low. Battery is automatically disconnected (LVD)
7. Isolated dry contacts for sending alarms
8. Communication port with external computer
9. Real time event notification and log
10. Log of last 256 events

A complete detailed account of the controller's features and functions may be found in the manual "Power System Controller Model SC2012NET, Instruction Manual".

7. TROUBLESHOOTING AND MAINTENANCE

Details of maintenance procedures and troubleshooting are outlined in this chapter.

Maintenance procedures include:

1. Cleaning the rectifier
2. Testing

7.1 Cleaning the Rectifier

1. Switch off the rectifier via the input switch on the distribution board.
2. Clean the front panel using a dry cloth.

IMPORTANT

Do not use cleaning detergents or solvents.

Do not use water under any circumstances. Water may diffuse inside the rectifier causing a short circuit and damage.

7.2 Testing the Rectifier

1. Attach the rectifier to the shelf via the Elcon connector.
2. Switch on the line circuit breaker.
3. Verify that the “ON” and “AC OK” LEDs on the front panel are lit with a continuous green light.
4. Verify that the “ON” LED is not flashing. A flashing LED indicates overload.
5. Using a digital voltage meter, DVM, measure the output voltage at the test points on the front panel.

   The voltage is measured just before the output diode. The difference between the set voltage and measured voltage may be up to $0.6V_{DC}$. In the absence of a voltmeter, voltage readings may be taken using the system controller.

   The DC voltage measuring points are protected against short-circuiting.

   To avoid measurement error, use a high resistance voltmeter i.e. with resistance greater than 1MΩ, such as the Fluke 87.

7.3 Troubleshooting

	PROBLEM	SOLUTION
1	No LED lights are lit. There is no response from the rectifier.	1. Verify that the input circuit breaker is switched on. 2. Check the AC voltage is normal, i.e., 230V_{AC} ±15%. 3. Verify that the rectifier is installed in its correct position and secured by screws.
2	The "AC" LED is lit. The "ON" LED is flashing.	1. Check the current load. The rectifier is indicating an overload. 2. A discharged battery is connected to the rectifier output (or following a power failure). Wait before recharging the battery.
3	Abnormal current sharing between rectifiers.	1. The RMT LED is unlit. Either the FL or EQ LED is lit. Manually transfer the rectifier to the remote mode using the RMT button on the rectifier's front panel 2. The RMT LED is lit. Wait several minutes until the current sharing between rectifiers is normal.
4	The word "FAN" is displayed.	1. A fan is not working properly. 2. Remove the rectifier. 3. Replace the faulty fan. Only a trained, certified technician should carry out the procedure.
5	The word "HIV" is displayed	1. High voltage at rectifier's output 2. Press RESET and wait a minute. If the fault persists replace the rectifier.
6	The word "LOV" is displayed	1. Low voltage at rectifier's output 2. Press RESET and wait a minute. If the fault persists replace the rectifier.
7	The word "HIT" is displayed	1. The rectifier's internal temperature is too high (>90ºC) 2. Press RESET and wait a minute. If the fault persists replace the rectifier. ***Note**: The rectifier automatically shutdowns at 90ºC and restarts when the temperature falls to 60ºC*

Table 5: Potential Equipment Problems and Solution