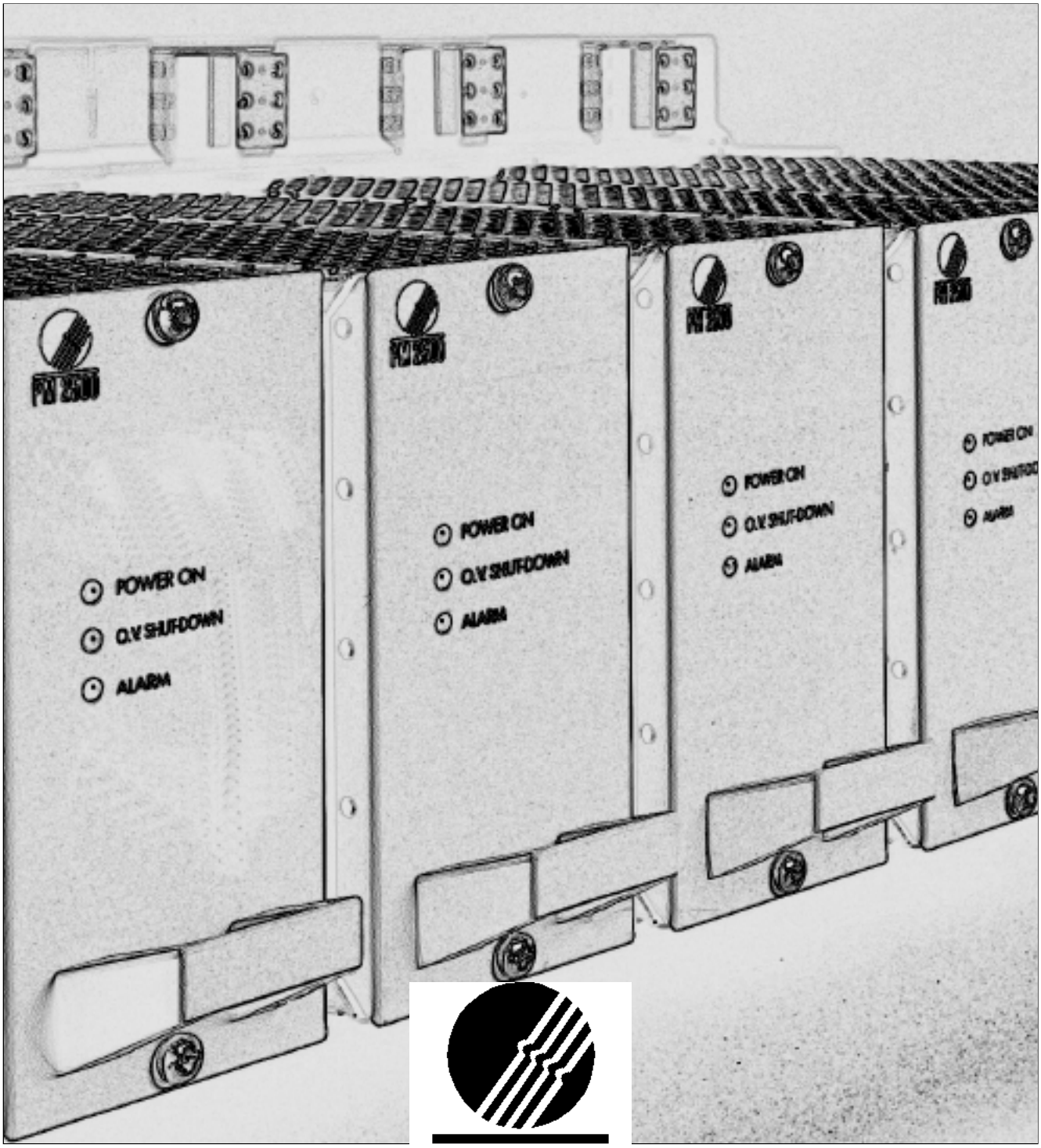
PEPPERL+FUCHS
ELCON



PS RANGE

PS 2500

FAULT TOLERANT POWER SUPPLY

User Instruction Manual

CONTENTS

1.	**SCOPE OF MANUAL**	page	2
2.	**GENERAL**	"	2
3.	**UNPACKING / STORAGE**	"	3
4.	**PRODUCT DESCRIPTION**	"	3
	4.1 GENERAL DESCRIPTION	"	3
	4.2 PRODUCT SPECIFICATIONS	"	4
	4.3 POWER MODULE OPERATING PRINCIPLE	"	7
5.	**INSTALLATION**	"	8
	5.1 SITE REQUIREMENTS / CHASSIS MOUNTING	"	8
	5.2 TEMPERATURE CONSIDERATIONS	"	8
6.	**WIRING**	"	9
	6.1 INPUT SUPPLY LINE	"	9
	6.2 INPUT CONFIGURATIONS	"	10
	6.3 OUTPUT CONFIGURATION	"	10
	6.4 ALARM CONFIGURATION	"	10
7.	**OPERATION**	"	17
	7.1 SUPPLY LINES CHECKS	"	17
	7.2 OUTPUT LINES CHECKS	"	17
	7.3 ALARM LINES CHECK	"	17
	7.4 COMMISSIONING	"	17
8.	**MAINTENANCE**	"	18
9.	**TROUBLESHOOTING**	"	18
	9.1 LOW OUTPUT VOLTAGE	"	18
	9.2 HIGH OUTPUT VOLTAGE	"	18
	9.3 MODULE ALARM	"	18
	9.4 OVERVOLTAGE SHUTDOWN IN A MODULE	"	18
	9.5 UNEQUAL LOAD SHARING	"	18
10.	**WARRANTY**	"	19
	10.1 GENERAL	"	19
	10.2 TERMS-CONDITIONS-WARRANTY LIMITS	"	19

1. SCOPE OF MANUAL

This manual provides information and guidance for installing, operating and maintaining the PS 2500 supply system.

• Warning!

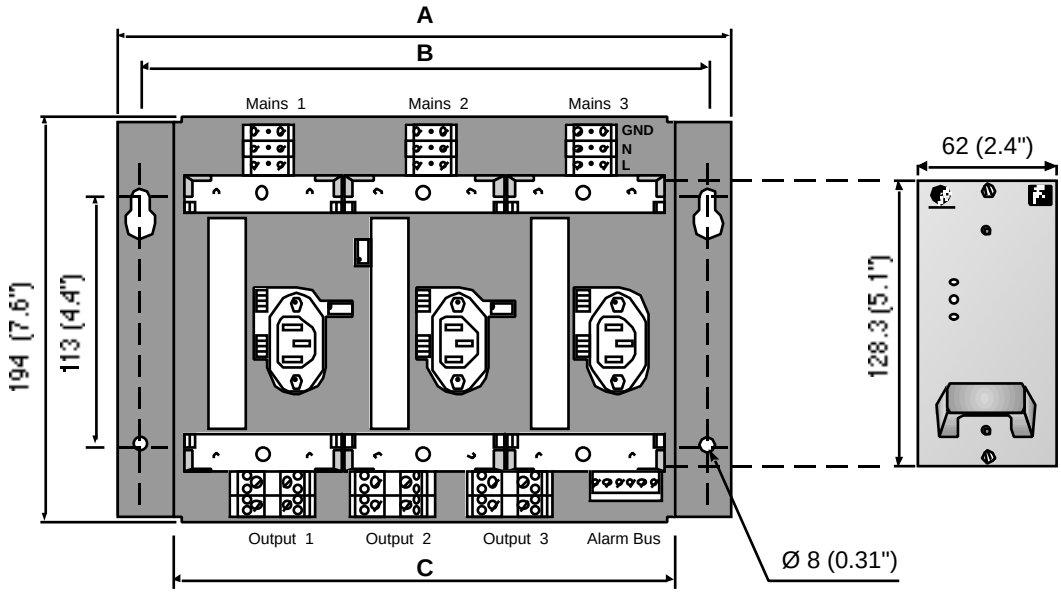
Substantial amounts of voltage, current and power are provided by the supply. READ CAREFULLY THIS MANUAL BEFORE INSTALLATION AND OPERATION TO AVOID RISK OF DAMAGE, FAILURES OR PERSONAL INJURY. Take great care on input and output supply lines protecting from the effects of short circuits, provide the required ground connections.

2. GENERAL

PS 2500 is a modular power supply system composed of a mounting chassis with multiple plug-in hot swappable power converter modules. State of the art resonant switching circuit technology provides high power density and efficiency in limited space.

The combination of multi inputs and N + 1 redundant configuration capability in addition to the automatic detection and signalling of relevant failures results in a flexible, easy to maintain power system also suitable for critical applications. The enclosure has IP20 degree of protection and is intended for installation in enclosed areas (i.e. inside a cabinet or instruments box).

FRONT VIEW



Dimensions		
	PS 2503	**PS 2506**
A	271 mm (10.7")	484.5 mm (19.07")
B	251.2 mm (9.8")	464.6 mm (18.291")
C	220.8 mm (8.7")	435 mm (17.1")

Fig. 1. *Chassis Dimensions.*

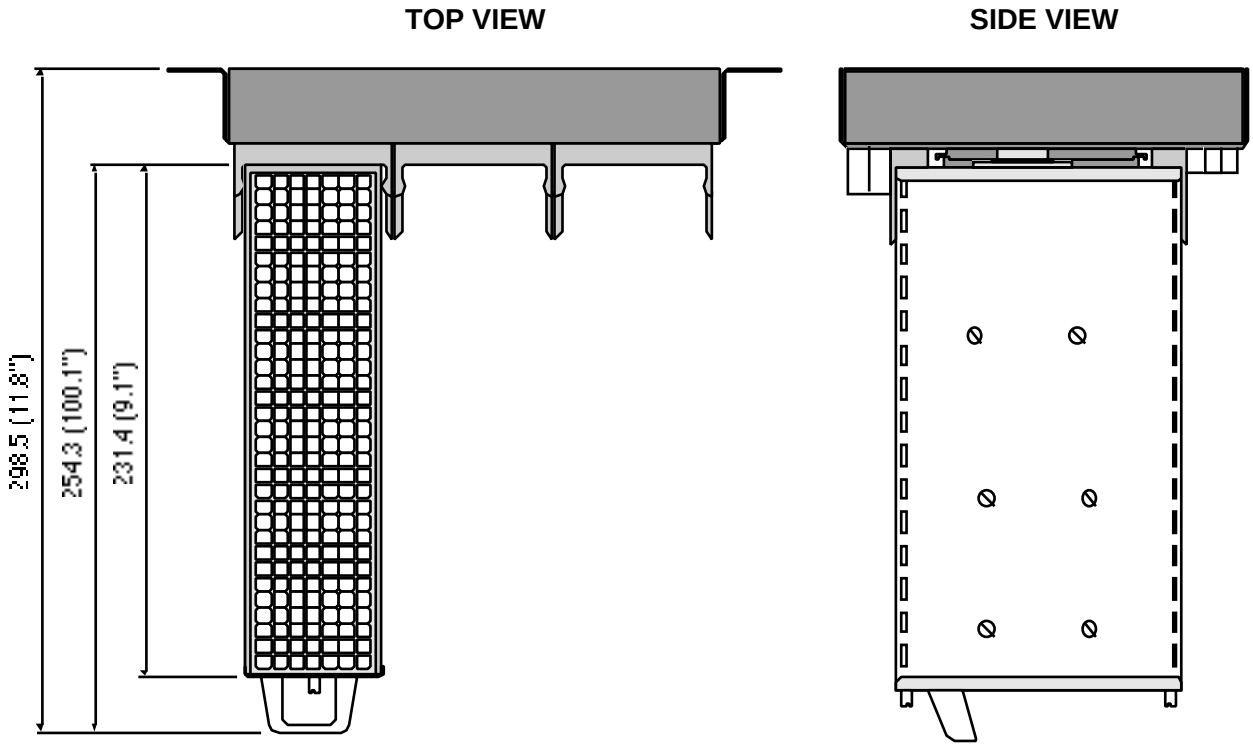


Fig. 2. *Supply Module Dimensions.*

3. UNPACKING / STORAGE

At receipt check packing and contents for integrity, quantity of parts and label characteristics to meet order specs. Report immediately to the shipper in case of damaged or wrong equipment. If not installed immediately, store the parts as recommended below.

Store equipment in their properly sealed packages respecting environmental storage limits.

Provide adequate protection from exposure to:
- rain, excess humidity and temperature excursions beyond -40 to +85°C;
- dust or aggressive, polluting atmosphere (cause of corrosion);
- access by insects / rodents (damaging packing / contents);
- unauthorised tampering or opening of packing;
- mechanical shocks, intense vibrations (loosens fastened parts, induces fatigue failures).

4. PRODUCT DESCRIPTION

4.1 GENERAL DESCRIPTION

PS 2500 has a wall mountable multislot chassis accepting hot swappable plug-in power converter modules providing an isolated output at 24 Vdc nominal.
Two basic formats are available:
- PS 2503 with 1 to 3 power modules (up to 45 Amp output);
- PS 2506 with 1 to 6 power modules (up to 90 Amp output).

Each power module has an individually isolated input port accepting either AC or DC and providing inrush current limiting and power factor control. The output port is also totally isolated and provides up to 15 Amp per module at 24 V nominal (adjustable 22.5 to 28 V from chassis mounted trimmer) with a load sharing configuration for paralleled output operation. Input and output lines can be wired independently or in parallel providing an easy means of arranging battery back-up or N + 1 redundant structures.

System configuration is obtained by wiring and configuration jumpers on the various chassis slots leaving power modules interchangeable and easily swappable under load. All relevant failures in the modules are detected and signalled by individual leds and alarm relays providing a flexible combination of redundancy, fault tolerance and automatic fault detection ideally suited to critical applications.

Full compliance to the EC directives for EMC and low voltage equipment ensure minimum emissions and high immunity in harsh environments. High conversion efficiency normally permits natural convection cooling operation eliminating need of cooling fans for most application requirements.

4.2 PRODUCT SPECIFICATIONS

- **INPUT**

Input line voltage (2500/PM-115):
AC : 115 Vrms nominal (80 to 138 v rms) single phase 44 to 66 Hz.
DC : 90 to 180 Vdc.
Input line voltage (2500/PM-230):
AC : 230 Vrms nominal (161 to 276 Vrms) single phase 44 to 66 Hz.
DC : 180 to 375 Vdc.
Inrush current limiting:
AC : 115 Vrms < 15 A peak a max 5 ms.
AC : 230 Vrms < 8 A peak a max 5 ms.
Steady state input current:
AC : 115 Vrms - 5.8 A average.
AC : 230 Vrms - 2.9 A average.
Internal fuses:
PS 2500/PM-115 - 6 A (5 x 20 mm glass).
PS 2500/PM-230 - 3.15 A (5 x 20 mm glass).
Input Terminals:
3 double sided mains terminals 4 mm^2 (12 AWG).

- **OUTPUT (VOLTAGE)**

Output Voltage:
24 Vdc ±1%, adjustable from 22.5 to 28 Vdc on chassis.
Ripple:
35 mV rms (< 100 mV pk - pk).
Temperature Coefficient of output voltage:
± 0.01% per °C Max.
Line regulation:
Vmin to Vmax Input < 200 mV.
Load regulation (per power module):
0 to 15 Amps Output load < 200 mV.
Turn-on/Turn-off transient:
Output voltage ramps to final value in less than 100 ms (no over / under shoot).

Minimum hold-up time:
> 30 ms at nominal input voltage and output load.

- **OUTPUT (CURRENT)**

Output Current (2500/PM):
0 to 15 A nominal per Power Module.
Short circuit limit (2500/PM):
20 A minimum per Power Module.
Output Current (PS2503/3):
0 to 45 A total nominal.
Output Current (PS2506/6):
0 to 90 A total nominal.
Output terminals:
2 double side output terminals 10 mm^2 (6 AWG), 65 A each.

- **GENERAL**

Isolation:
Output to ground: 2120 Vdc.
Line to ground: 2120 Vdc.
Line to output: 4250 Vdc.
Storage temperature:
- 40°C to + 85°C.
Operating temperature:
- 25°C to + 55°C.
Chassis options
PS2503, 3 position surface mounting chassis accepts 1 to 3 2500/PM Power Modules.
PS2506, 6 position surface mounting chassis accepts 1 to 6 2500/PM Power Modules.
EMI Compatibility
Conforms to EN-50081-2 for conducted and radiated emission.
Conforms to EN-5082-2 for immunity.
Carries CE mark.

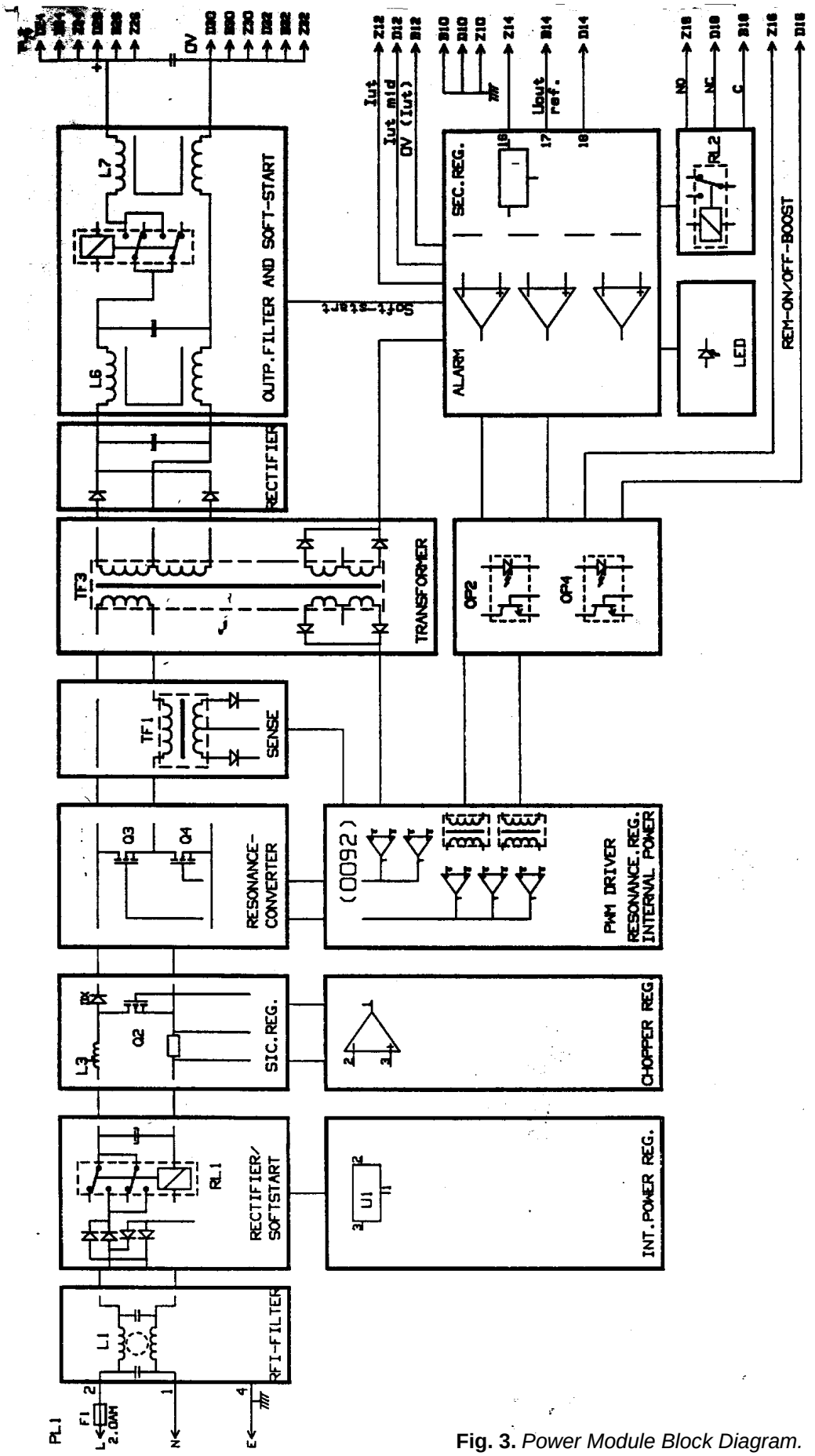


Fig. 3. *Power Module Block Diagram.*

4.3 POWER MODULE OPERATING PRINCIPLE

The Power Module provides an isolated and regulated 24 Vdc output.
Power Conversion circuit is a state of the art high frequency resonant converter. Resonant converter is the most advanced type of circuit topology achieving a combination of high efficiency, compactness, limited component stress and reduced EMI emission.

The conversion transformer is arranged with a capacitor in a resonant circuit and driven just above the L/C system resonant frequency. In so doing switching can occur close to a zero voltage/current minimising switching component stress and dissipation and reducing emission of harmonics

Referring to block diagram in Fig. 3 from the mains input line we identify:

- **RFI FILTER**

Reduces conducted interferences from converter back in the line. Moreover, a varistor protects components after the filter from voltage surges.

- **RECTIFIER / SOFT START**

Input mains ac. voltage is rectified by a diode bridge, a start-up logic limits inrush current at turn-on by inserting via a relay a NTC thermistor on the smoothing capacitor charge path. After charge time transient the relay shorts the NTC out.

- **PRE REGULATOR**

A step-up pre regulating converter (boost type) drives the pulse width of switching transistor in order to maintain a constant voltage output while absorbing a sinusoidal current from the input; in so doing it performs a power factor correction and absorbs a sinusoidal current.

- **RESONANT CONVERTER**

Converts DC input to high frequency AC, the parallel C1/C2 and L1 resonates at a frequency lower than switch drive frequency. As a consequence voltage on transistors Q3, Q4 is always zero at switching time, this reduces power loss, component stress and EMI emission while maximising power conversion efficiency.

- **TRANSFORMER**

The high frequency transformer has a secondary winding stepping down output voltage to the required level, it also provides an input/output galvanic isolation.Additional secondary windings provide power to the auxiliary circuits.

- **RECTIFIER / SENSING**

Output from transformer is rectified by high efficiency shottky diodes and filtered by L/C filters providing a smoothed DC output. Output voltage is sensed by an appropriate control circuit that feeds back to the converter via isolated optocouplers the drive signals to maintain a regulated output voltage.

5. INSTALLATION

5.1 SITE REQUIREMENTS / CHASSIS MOUNTING

Site should be free from excessive vibrations and satisfy at least the operating temperature limits (-25 to +55°C). For maximum reliability and performance specially under high load/temperature condition follow the temperature considerations guide to select the recommended cooling method and follow the relevant installation guidelines.

Chassis is mounted on a flat metal sheet plate or on two properly spaced rails. Drill (according to Fig. 1 and 2) four 5 mm (0.2") DIA holes and tap them 6 MA (or 1/4" NC). Insert the top screws but leave heads proud by some 5 mm (0.2"). Slide the chassis through its top keyed holes and hang it firmly on the screw heads. Install the bottom screws and tighten them all.

5.2 TEMPERATURE CONSIDERATIONS

- **GENERAL CONSIDERATIONS**

Temperature accelerates failure mechanism in every electronic component (Arrhenius criteria). If operating temperature of an equipment is increased by 10° its expected life is almost halved.

Temperature rise depends on dissipated power density, for the same volume more power dissipated produces higher temperature rise. For example a cabinet 600x600x2000 mm dissipating 300W with natural convection cooling produces an internal temperature rise of 10°C, this should be regarded as an ideal case.

Identify the worst load/temperature environment that the power supply will encounter and determine the recommended cooling method using the Fig. 4 diagram. Use convection cooling when the supply load/operating temperature is most time in the lower part of the diagram and free air circulation is ensured. Use forced cooling when the supply load/operating temperature is in the upper part of the diagram for extended periods of time or when a very high system reliability is required.

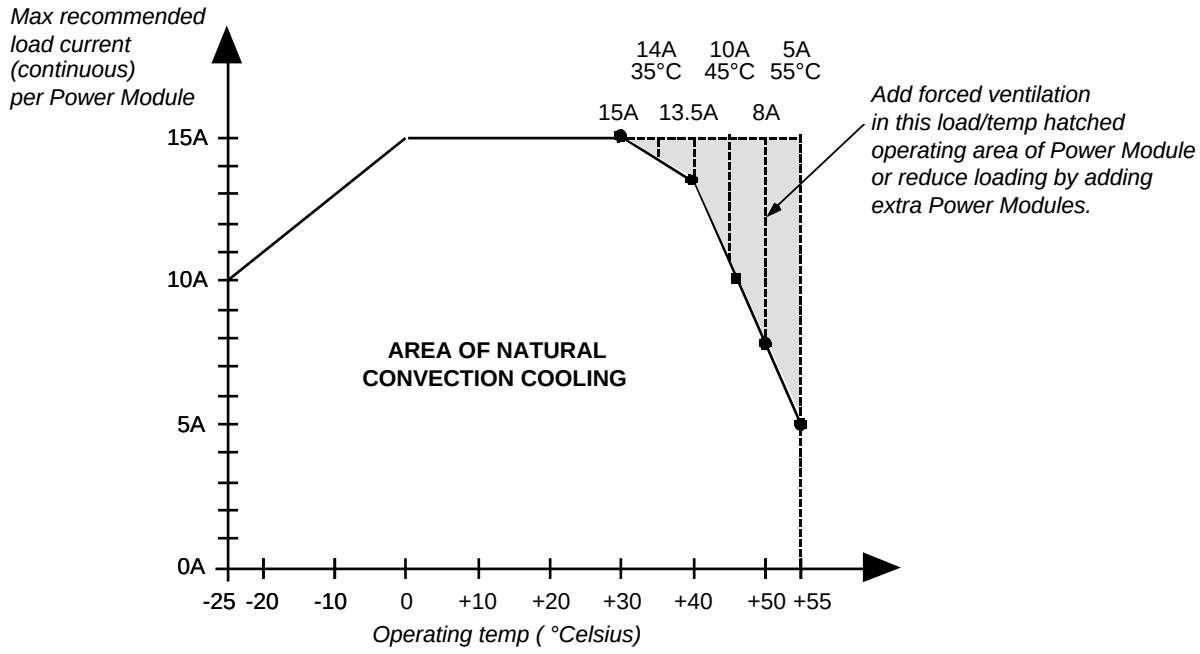


Fig. 4. *DIAGRAM - Recommended Power Module Continuous Load Versus Operating Temperature.*

- **CONVECTION COOLING**

Hot components exchange heat with the surrounding air producing a vertical rising hot air flow that determines new cool air intake to cool the component in a natural convection cooling mode controlled by the intake air temperature and flow.
For good convection cooling install the equipment providing an unobstructed vertical flow of relatively cool (ambient temperature) air entering from the bottom and flow out at a higher temperature from the top as shown in Fig. 4.
Do not stack vertically many power dissipating devices in close proximity to avoid excessive temperature build up at the exit air point.

- **FORCED COOLING**

Forced cooling is obtained by using suitable fans. Fans generate a strong air flow which removes heat from the power generating equipment.
Use two (PS2503) or four (PS2506) 120 mm 100 m^3/h brush less long life fans operated from the output bus at 24 Vdc (e.g. PAPST type) installed immediately below the chassis and blowing air up against the bottom of the Power Modules. Make sure to allow relatively free airflow below the fans and above the supply rack.

6. WIRING

PS2500 system has separate input/output terminal blocks providing simple configurability just by wiring.

- **Warning!**

Connect ground terminals to the mains ground, otherwise lethal voltages may occur.

- **Warning!**

Permanent power module damage will result in case of input voltage overload.

6.1 INPUT SUPPLY LINE

Power line voltage is 115 or 230 Volt (either AC or DC) depending on Power Modules used.
Check supply line voltage to meet Power Module supply (either 230 or 115 V as specified on Power Module side label). Cater for disconnecting capability and overcurrent protection by adequately sized fuses or circuit breakers on the lines.
Table 1 below provides current values and line conductors sizing for 115 and 230 V supply. Multiply the values by the number of Power Modules in the chassis (1 to 3 or 1 to 6) to obtain the total current rating and conductor size.

TABLE 1 - Max current consumption and conductor size per Power Module

Nominal Supply Voltage	Consumption at full load Amp Rms	Peak current Amp Rms	Supply Line conductor recommended section (square mm)
115 V	6 x No. of Power Module	15 x No. of Power Module	2 x No. of Power Module
230 V	3 x No. of Power Module	8 x No. of Power Module	1 x No. of Power Module

6.2 INPUT CONFIGURATIONS

- **SINGLE LINE INPUT**

Use with Uninterruptible Power Systems (UPS) supply or when input line integrity is not critical, wire per sketch in Fig. 5A. For DC input, polarity does not matter.

- **DUAL LINE INPUT**

Use with redundant input line (i.e. primary and back-up) or in battery back-up systems, wire per sketch in Fig. 6A and 6B. For DC input, polarity does not matter. Note that only half of Power Modules will drive the load, size them accordingly.

6.3 OUTPUT CONFIGURATION

- **INDEPENDENT OUTPUTS**

Use for separate output applications, wire per Fig. 7A. Remove load sharing jumpers J11 (21 to 61) and J12 (22 to 62) on chassis to avoid cross influence between Power Modules.

- **COMMONED OUTPUT**

Use for bus connected output or redundant configurations, wire per Fig. 7B. Use solid copper bus bars adequately sized for the total current. Make sure load sharing jumpers J11 (21 to 61) and J12 (22 to 62) on chassis are properly inserted. For multi chassis parallel operation extend load sharing connections at terminals 5 and 6 to the next chassis.

6.4 ALARM CONFIGURATION

- **PARALLEL ALARM**

Connect as per Fig. 8A in parallel the Normally Open (N.O.) alarm contacts on all Power Modules, insert jumpers J14 to J64 and J15 to J65 on chassis as indicated. When any specific relay on a module de-energises under alarm condition, including power off, the circuit will close and actuate an alarm (at terminals 1-2 of the Alarm Terminal Block).
Pulling a Power Module out of the chassis will not actuate an alarm.

- **SERIAL ALARM (with all the modules inserted on the rack)**

Connect as per Fig. 8B in series the Normally Closed (N.C.) alarm contacts on all Power Modules, insert jumpers J13 to J63 and J14 to J64 as indicated. When any specific relay on a module de-energises under alarm condition, including power off, the circuit will open and actuate an alarm (at terminals 2-3 of the Alarm Terminal Block).
Pulling a Power Module out of the chassis will actuate an alarm.
When not all the 3 (or 6) modules are installed into the rack, insert jumpers according to Fig. 8C.

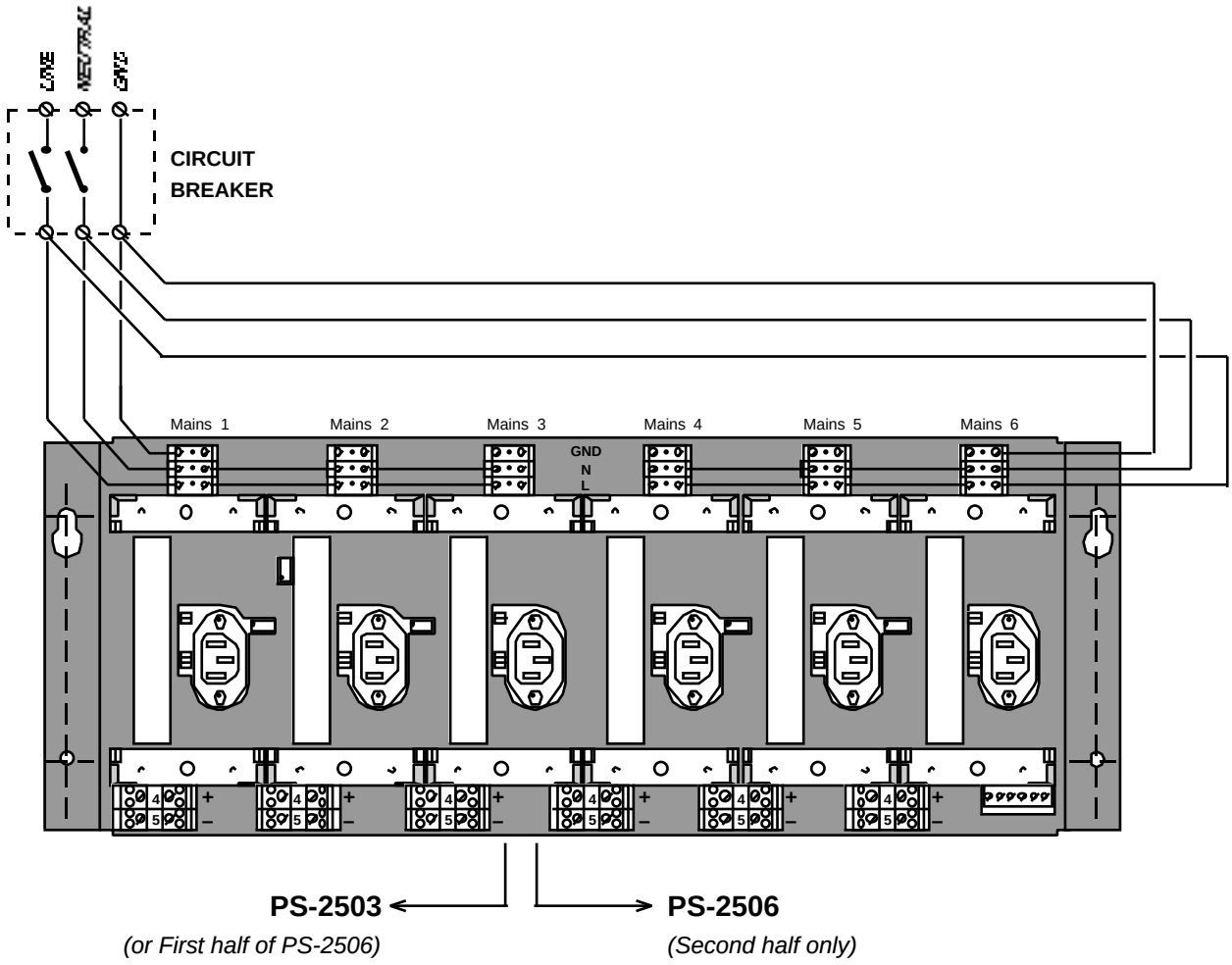
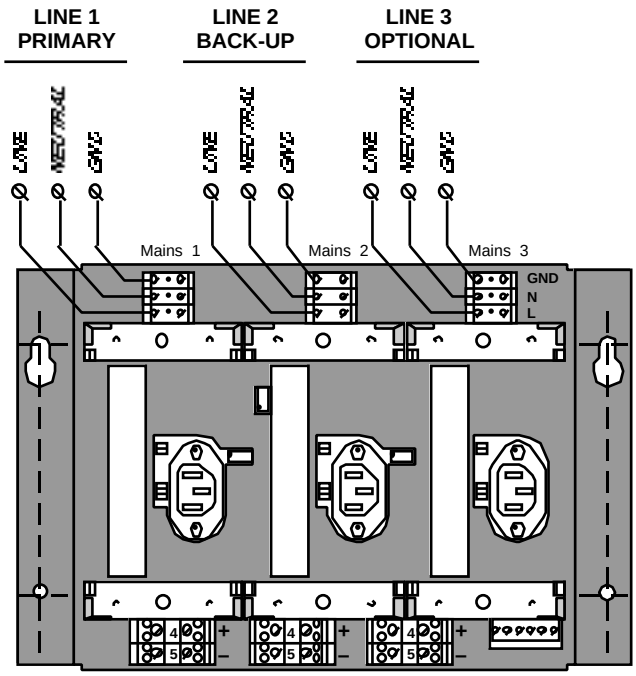
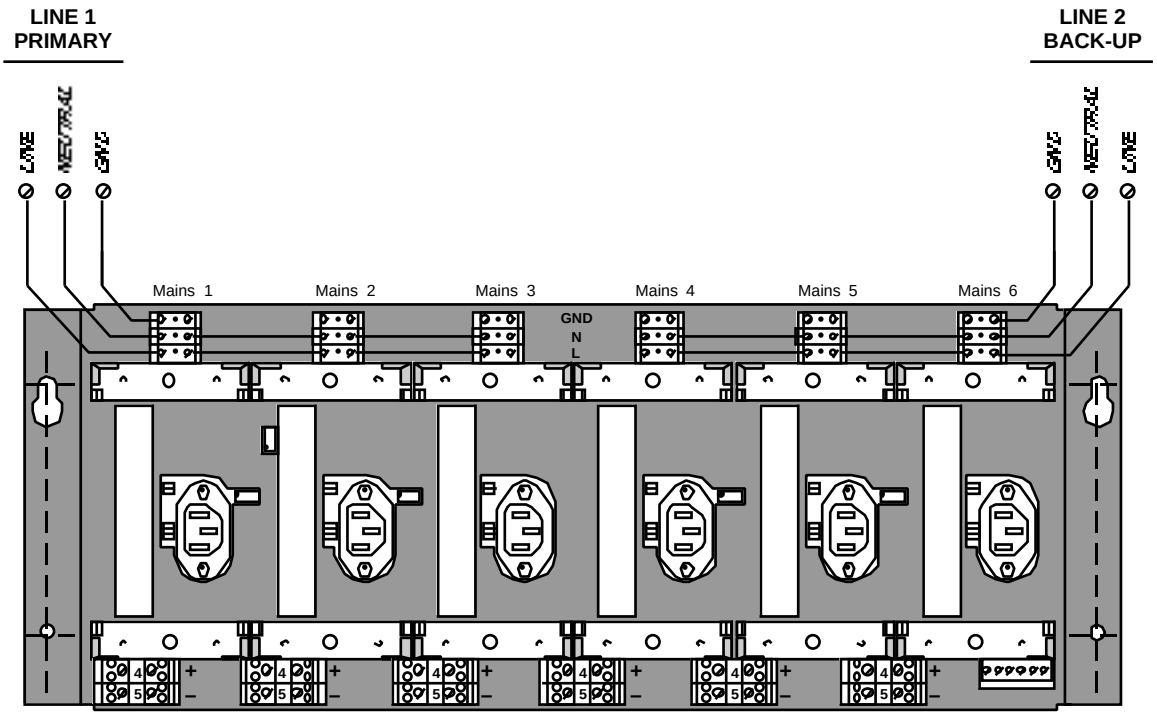


Fig. 5A. *Single Input Line Connection.*



PS-2503

Fig. 6A. *Multi Input Line Connections.*



PS-2506

Fig. 6B. *Dual Input Line Connections.*

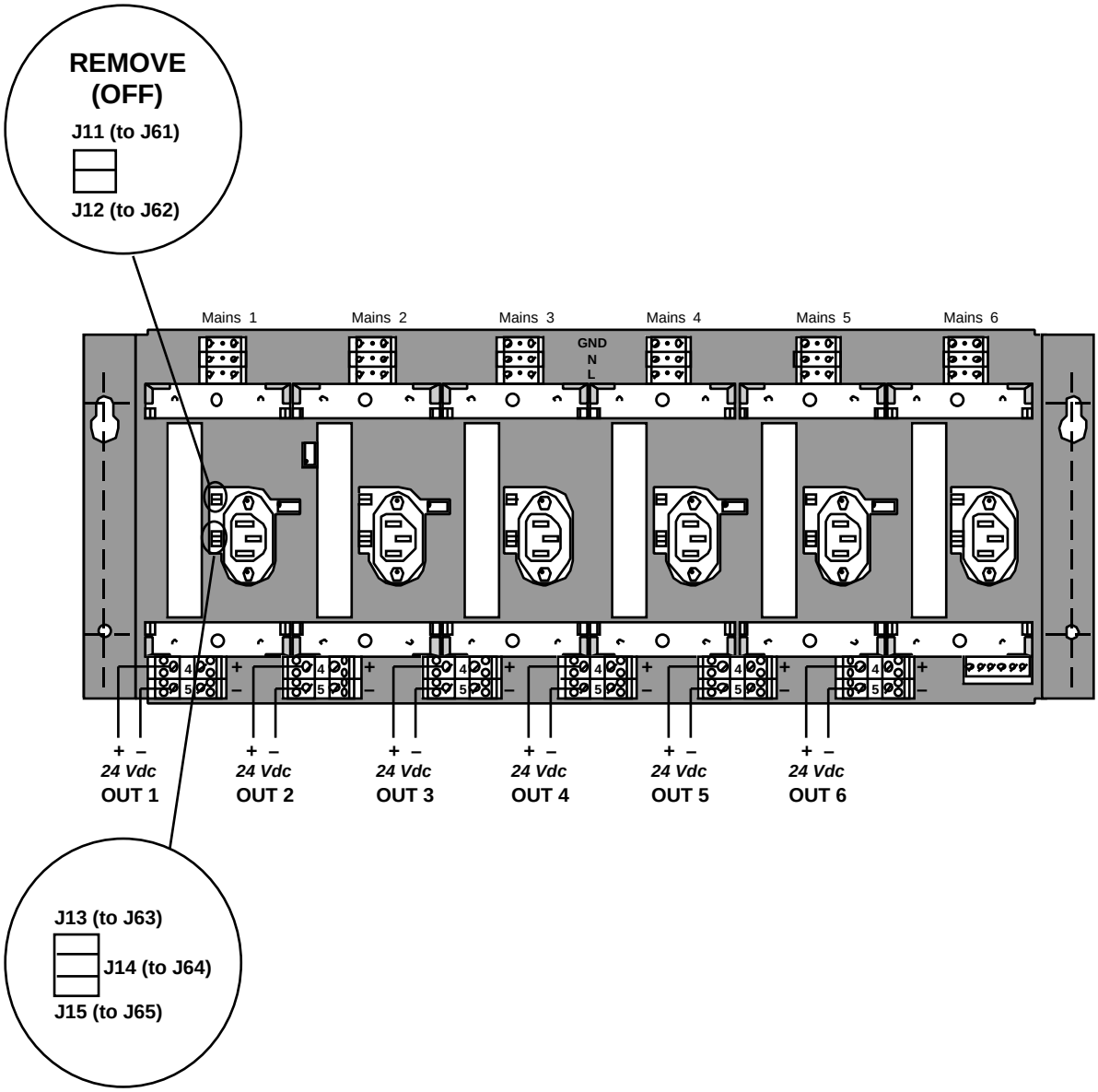


Fig. 7A. *Independent Output Lines.*

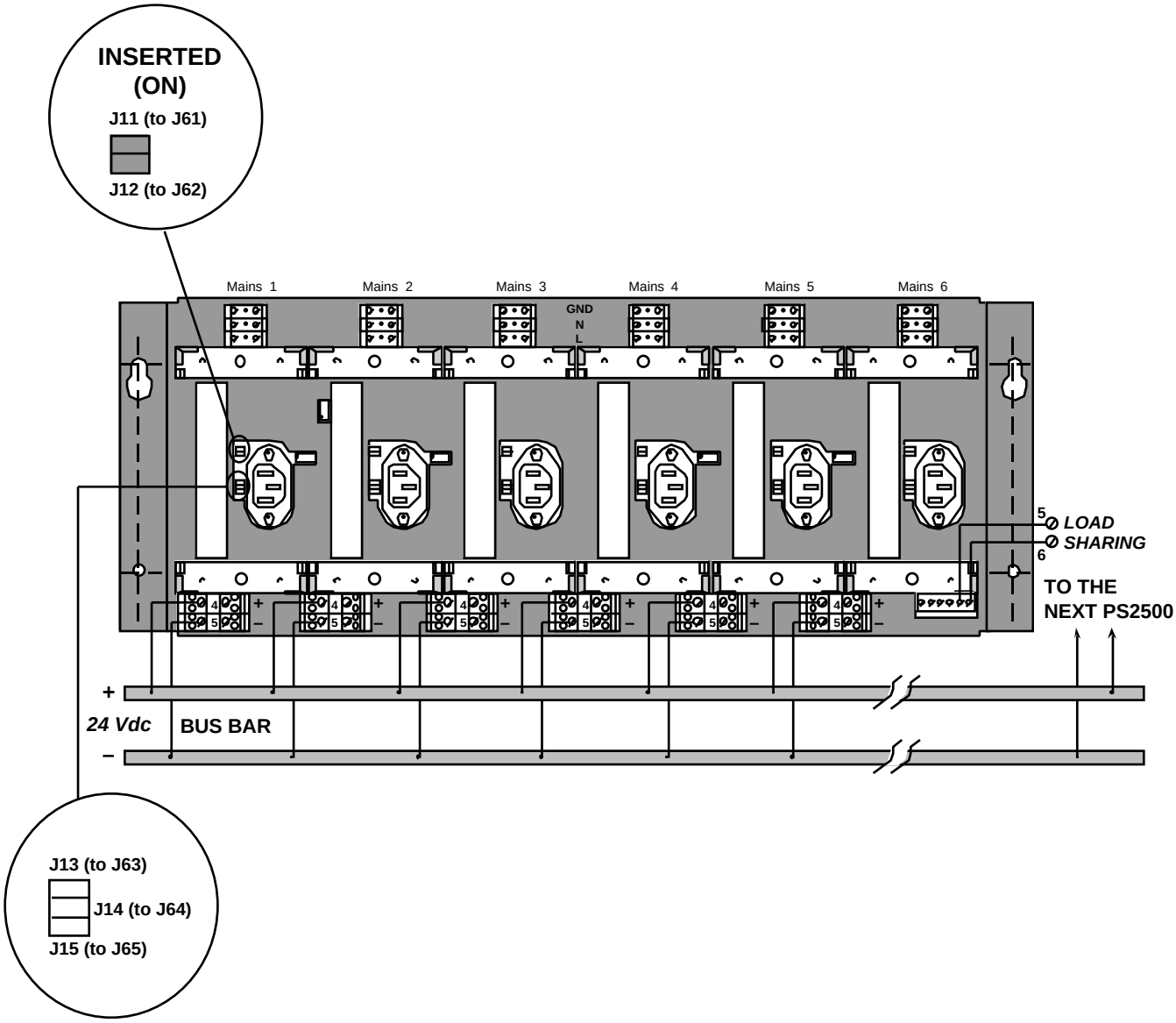


Fig. 7B. *Bus Bar Commoned Output Line.*

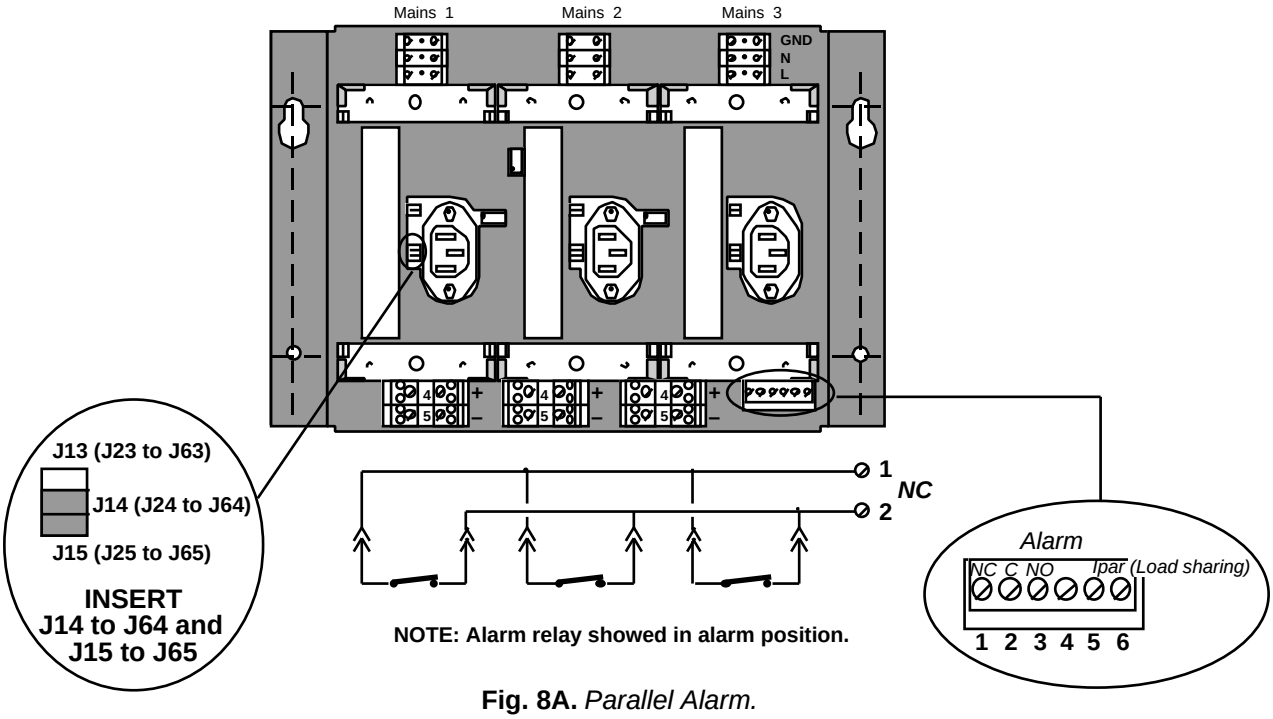


Fig. 8A. *Parallel Alarm.*

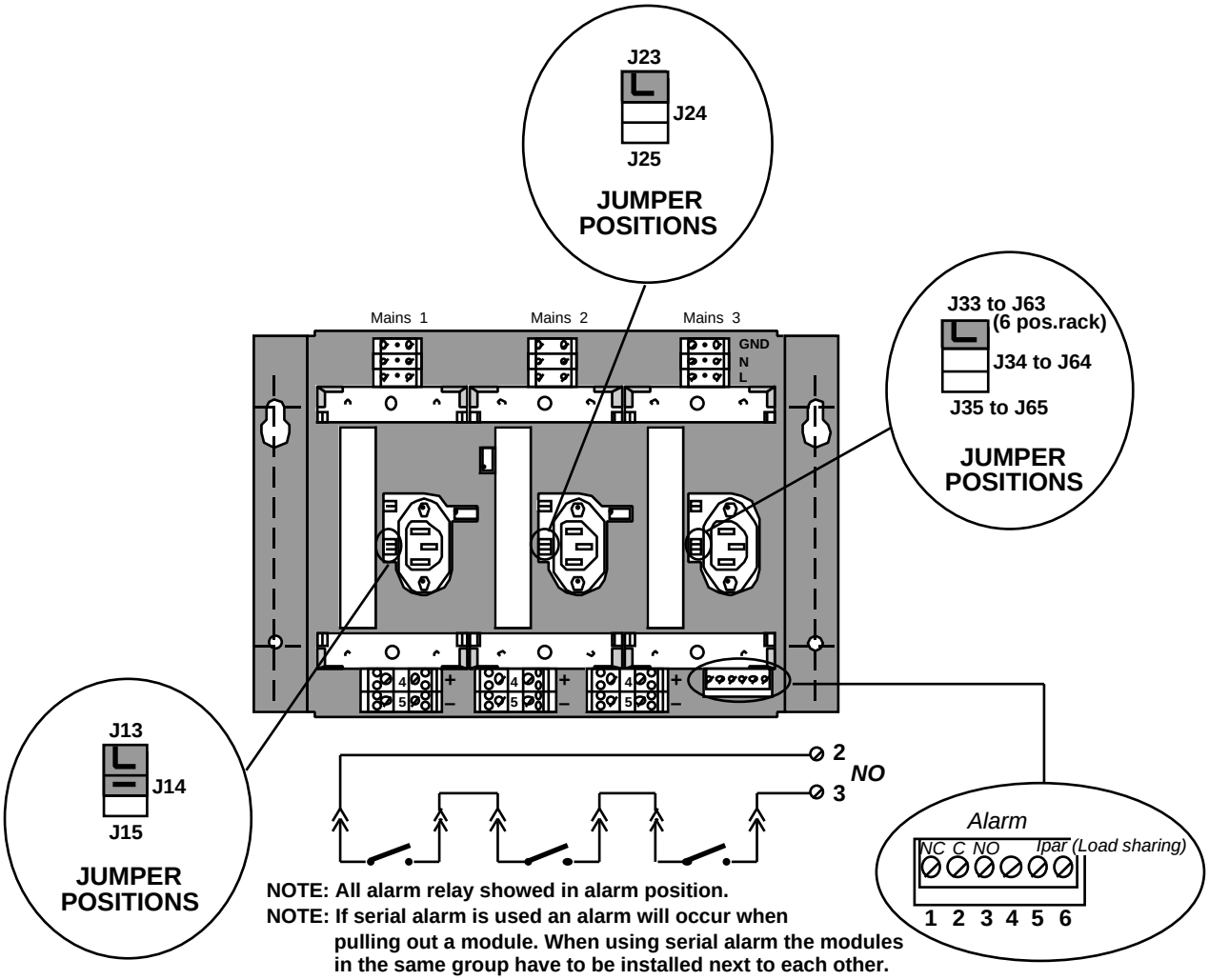


Fig. 8B. *Serial Alarm, with all three/six modules installed.*

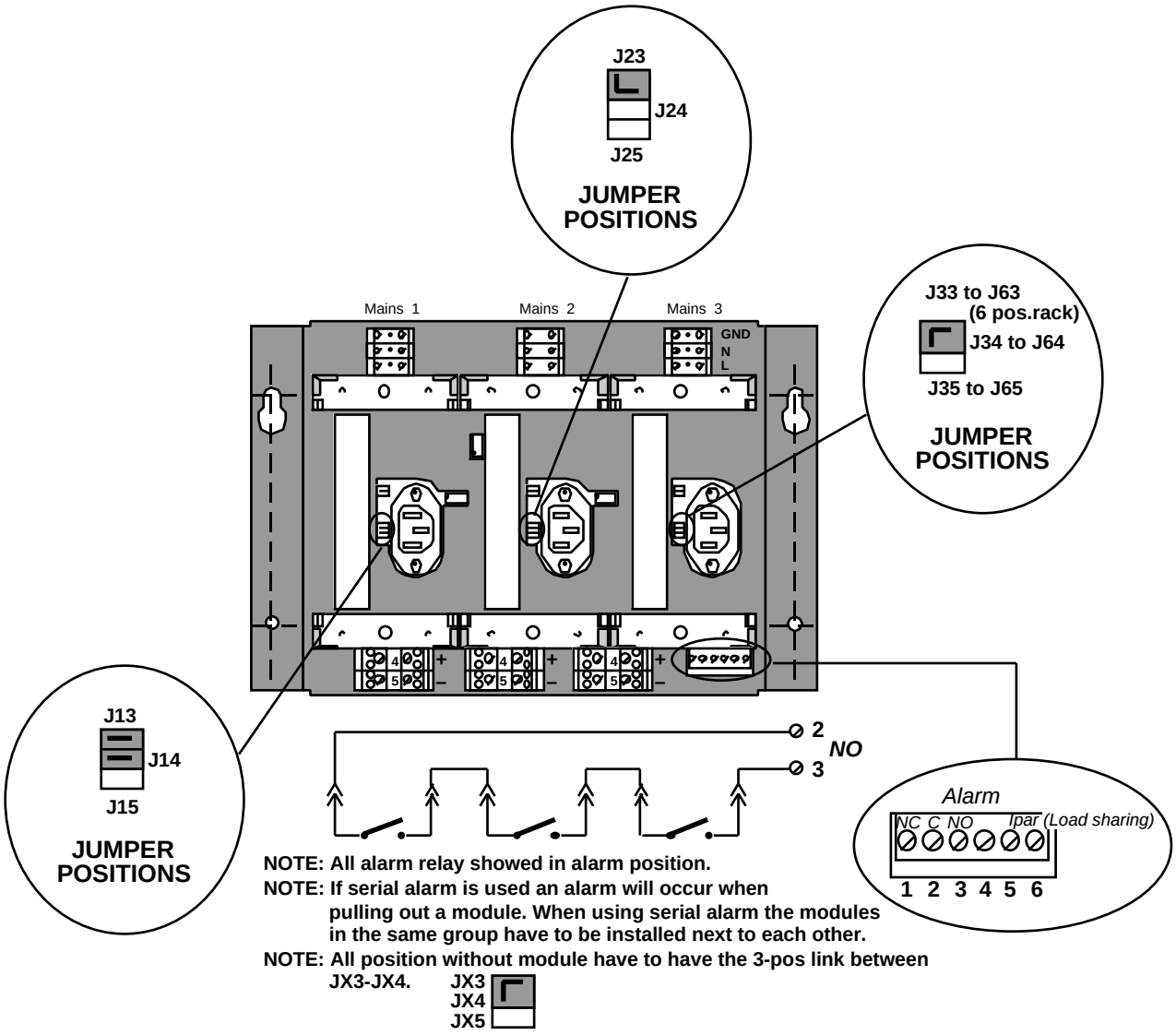


Fig. 8C. *Serial Alarm, with less than three/six modules installed.*

7. OPERATION

- **Warning!**

Do not plug and power up modules on the chassis before checking all the system as recommended.

7.1 SUPPLY LINES CHECKS

A) Grounding conductor to be connected and firmly secured to the GND terminals.
B) Input lines to be protected by appropriately sized fuses or sectioning circuit breakers (turn them off).
C) Line conductors to be of adequate size and firmly secured with no exposed conductors risking contacts with the chassis or short circuits.
D) Supply line voltage to meet Power Module rating (check on side label)

7.2 OUTPUT LINES CHECKS

A) Output polarity to be correct (severe damage to the powered equipment might result in case of reverse polarity powering).
B) Output voltage value 24V, (check on side label of Power Modules).
C) Output conductors to be of adequate size and firmly secured with no exposed conductors risking contacts with the chassis or short circuits.
D) Load sharing configuration jumpers (and terminal 5 and 6 connection in case of multi chassis load sharing) to be appropriately set (see section 6).

7.3 ALARM LINES CHECKS

A) Alarm circuit to be correctly wired and conductors firmly secured with no exposed conductors risking contacts with the chassis or short circuits.
B) Alarm configuration jumpers to be appropriately set (see section 6).

- **Warning!**

Correct any erosion wiring or configuration before operating the system.

7.4 COMMISSIONING

A) Pull out all Modules from the chassis.
B) Disconnect load on 24V output bus and switch input mains ON.
C) Plug one of the PM 2500 in position 1 of the chassis, and check output to be within limits (for a 24V nominal output 23.76 to 24.24V).

Modules are factory calibrated for 24V ±1% output, they do not require adjustment. [If a different output voltage is required (within the 22.5 to 28V range), adjust trimmer P11 on the chassis to obtain the desired output].

D) Repeat step C), using the same module plugged in rack position 2, 3 etc. and check output voltage to be within limits [for different output voltage, adjust the corresponding trimmer P21, P31 etc. on the chassis (see Fig. 1 for trimmer location)].
E) Turn power off, reconnect the load, plug in and tighten all modules in the chassis with the fixing screws.
F) Turn power ON, only green led should appear (no alarms). If any alarm is displayed, check mains voltage, module configuration and adjustment, if problem remains refer to section 9 (troubleshooting).

8. MAINTENANCE

Supply Systems do not require special maintenance except the normal periodic functional check and cleaning.

Keep Power Module air inlets and outlets free from dust or particles that may prevent free air circulation through the cabinet and in the enclosure. Accumulation of dust on heat dissipating surfaces limits heat exchange with the surrounding air reducing heat sinking capability.

Periodically (every year) check and record output voltage value to trace any long term deviation.

9. TROUBLESHOOTING

A number of abnormal conditions with the recommended action steps is given below, identify your alarm condition and follow the recommended actions, if the first action does not solve the problem step to the next. If all recommended actions do not succeed contact our service department.

9.1 LOW OUTPUT VOLTAGE

- Measure input mains voltage to be within limits.
- Check total output current not to exceed maximum capacity (15 Amp per Power Module).
- Localise the faulty module and replace it.

9.2 HIGH OUTPUT VOLTAGE

- Localise the faulty module and replace it.

9.3 MODULE ALARM

- Localise the faulty module and replace it.

9.4 OVERVOLTAGE SHUTDOWN IN A MODULE

- Localise the faulty module.
- Pull out the module and then plug it in again.
- Replace the module.

9.5 UNEQUAL LOAD SHARING

- Localise module and adjust output voltage level.
- Replace Power Module.

10. WARRANTY

10.1 GENERAL

Elcon offers an extended period of warranty assistance performed at their factory. Each instrument to be repaired is thoroughly analysed to locate the cause and mode of possible faults and correlate them with the initial, intermediate, and final testing documentation. This allows Elcon to trace with more accuracy the fault causes, thus obtaining valuable indications, reliability statistics, and qualitative evaluation for the purpose of maintaining the quality and reliability of their products under strict control.

10.2 TERMS - CONDITIONS - WARRANTY LIMITS

1. Terms

Elcon Instruments certifies that all the instruments of their manufacture are immune from defects or loss of essential quality, and whenever they are apparatus, Elcon also guarantees proper operation. The duration of the warranty period is clearly indicated in the order confirmation and starts from the date of delivery or on site test (if required). Unless otherwise specified the warranty is for 12 months, from delivery date.
The warranty does not cover consumable items.

2. Form of report

The action due to the customer for vices, defects, or loss of quality is subject to the terms of articles 1495, 1497 C.C. (Italian Civil Code). The denunciation of the defect or quality loss must be made by the customer by registered mail, telex, fax, or equivalent written form to be sent to the main office of Elcon Instruments.

3. Limit - burden - obligation of the customer to conserve the warranty

A) The warranty is limited to repairing and substitution, FOB Elcon Instruments factory, of the useless parts, for a confirmed defect of materials and/or workmanship, free of charge, and the remaining, shipping, dismounting and mounting expenses (operations that in any case must be done in accordance with the supplier), at the customer's charge. In no case Elcon Instruments will be held responsible for expenses, for loss of profit and/or damage, direct or indirect, that can be incurred by the customer due to a fault or defect of the material.

B) The warranty ends for instruments or materials damaged by:
- shipment;
- storage non conforming to the instruction manual specifications;
- incorrect installation;
- loss of adequate protection for the type of installation (mechanical, climatic, etc.);
- incorrect application of power supply voltage;
- erroneous wiring of the power supply line (applied on input or output measuring circuits)

C) The warranty ends for instruments or materials if repaired, modified, or simply tampered with, even if only in part, by personnel not authorised by Elcon Instruments and also ends if used in improper way and/or not conforming with the given instructions.

D) The warranty is valid only if payment has been received from the customer in a timely fashion, as per the original agreement; otherwise it is void.

E) All parts that are subject to normal wear and inevitable deterioration are excluded from this warranty.

F) In case of having to return the instrument to one of the Elcon Instruments authorised labs for repair, the customer shall obtain a written authorisation with shipping instructions from Elcon Instruments. Shipment expenses, all the concerned burdens, and the risk of loss or damage of the returned instrument are exclusively born by the customer. The same rules apply also when the instrument needs to be replaced.

G) During the warranty period, the customer will allow any personnel appointed by Elcon Instruments to execute control of the instruments and materials.

H) The customer cannot require cancellation of the contract in reason of vices or defects, but only their elimination or, when they cannot be repaired, the replacement of the instruments, if available on the market. In case the replacement is for any reason impossible, Elcon Instruments has the faculty to offer instruments of the same or equivalent type, quality and efficiency, suitable to the same use. If the customer refuses such offer without justified motivation he is entitled to reimbursement of the money already paid or a refund of the real incurred expenses.

I) For items subsupplied by Elcon Instruments the standard warranty terms as given by the original manufacturer are applicable.

J) The warranty must be considered for material repaired, substituted on ex works basis.

K) Such warranty replaces and supersedes any other declared or implicit warranty.

ELCON REPRESENTATIVE & DISTRIBUTOR:

www.elconinstruments.com

Worldwide Headquarters
Pepperl+Fuchs GmbH • K nigsberger Allee 87
68307 Mannheim - Germany
Tel. +49 621 776-0 • Fax +49 621 776-10 00
http://www.pepperl-fuchs.com
e-mail: info@de.pepperl-fuchs.com

USA Headquarters
Pepperl+Fuchs Inc. • 1600 Enterprise Parkway
Twinsburg, Ohio 44087 • Cleveland - USA
Tel. +330 425 35 55 • Fax +330 425 46 07

Asia Pacific Headquarters
Pepperl+Fuchs Pte Ltd • P+F Building
18 Ayer Rajah Crescent • Singapore 139942
Tel. +65 779 90 91 • Fax +65 873 16 37

Italy Headquarters
Pepperl+Fuchs Elcon
Via delle Industrie, 4 • 20050 Mezzago (MI) - Italy
Tel. +39 039 6292 1 • Fax +39 039 6292 240
e-mail: info@elconinst.com