SMART AIRPORT SYSTEMS

SOLUTIONS FOR SUSTAINABLE AVIATION

# PV90-4

90kVA 400Hz FIXED ELECTRICAL GROUND POWER UNIT

# OPERATING AND MAINTENANCE INSTRUCTIONS


**Document Number: MAN08 PV90-4-OMM-SAS-002**

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# CONTENTS

# 1. Introduction

## 1.1. Revision history

| | | |
|---|---|---|
| Powervamp Ltd | Operating and Maintenance Manual PV90-4 (SAS) | Document: MAN08 PV90-4-OMM-SAS-002 |
| | | Revision: 02 |
| | | Form: REC02 3610 |
| Owner: EM | | Date: 14.01.2020 |

**Table 1: Revision history.**

## 1.2.Description

The PV90-4 system is an Electrical Ground Power Unit designed to service modern aircraft with a 90kVA (Three Phase 200V/400Hz) supply output derived from a utility/mains input (Three Phase 360-480VAC 50/60Hz).

A number of different mounting options are available for the system, depending on what best suits the operator and aircraft environment, including Fixed, Mobile Trailer, Trolley and Bridge Mount.

In addition, optional outputs are also available including separately controlled twin 400Hz Supplies and a 28VDC Transformer Rectifier Unit to service smaller aircraft with a 28VDC supply suitable for steady state and engine cranking type loads.

Key Design Features include:

- Up to 95% Total System Efficiency
- Stainless Steel Enclosure for superior outdoor performance and durability
- AC Inductor & 12 Pulse Rectifier to reduce input Current total harmonic distortion (THDi)
- Advanced Filtering providing a High-Quality Sinewave Output suitable for all known aircraft types (<2% THDv)
- Complies with the latest industry standards for Electrical GSE, including ISO 6858:2017 & MIL-STD 704F.

# 2. SAFETY

**Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, maintain or repair this equipment.**

**Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.**

## 2.1. Safety Symbols

Safety symbols are one of the primary ways to call your attention to the potential hazards associated with the unit operation. For your safety, follow the precautions listed throughout this manual before installation, during operation and periodic maintenance procedures.

| | |
|---|---|
|  | **Caution!**<br>General risk associated with all aspects of installation, adjustment, maintenance and repair. |

| | |
|---|---|
|  | **Risk of Electric Shock!**<br>Risk specifically related to electrical shock. |

| | |
|---|---|
|  | **Hot Surface!**<br>Risk specicially related to hot surfaces / items which could result in burns. |

| | |
|---|---|
|  | **Heavy Item!**<br>Risk specifically related to lifting of heavy items and the associated dangers. |

| | |
|---|---|
|  | **Risk of Entanglement!**<br>Risk specifically related to moving parts and the potential for entanglement. |

## 2.2. Important Notes

| | |
|---|---|
|  | **Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, maintain or repair this equipment.** |

- Read these instructions carefully before operating the system.
- All warnings in this manual must be adhered to.
- All operating instructions should be followed carefully.
- The system requires a three phase and earth input supply. **DO NOT** operate the system without an earthed input supply.
- This manual should be kept in a safe and secure location and made readily available for use by suitably qualified and authorised personnel.
- Never insert any object into ventilation holes or other openings.
- Ruptured fuses must always be replaced with those of the same type and rating. Failure to do so may present a fire hazard.
- Please refer to the equipment overview, which details the weights and dimensions of the equipment supplied. Observe the rules and regulations governing the lifting of equipment. If in doubt, seek assistance with the lifting and movement of heavy items.

| | |
|---|---|
|  | **Even when the input AC power is isolated, hazardous live parts exist within the system. Isolate the input mains / supply to the GPU at the local distribution board or feeder pillar, then wait at least 10 minutes for the DC capacitors to discharge before opening any doors or removing any covers.** |

| | |
|---|---|
|  | **Take care when moving / lifting the unit with a forklift truck! Position forks as wide as possible for the best stability. Assess each lift carefully to ensure the safety of the driver and any surrounding members of staff / public.** |

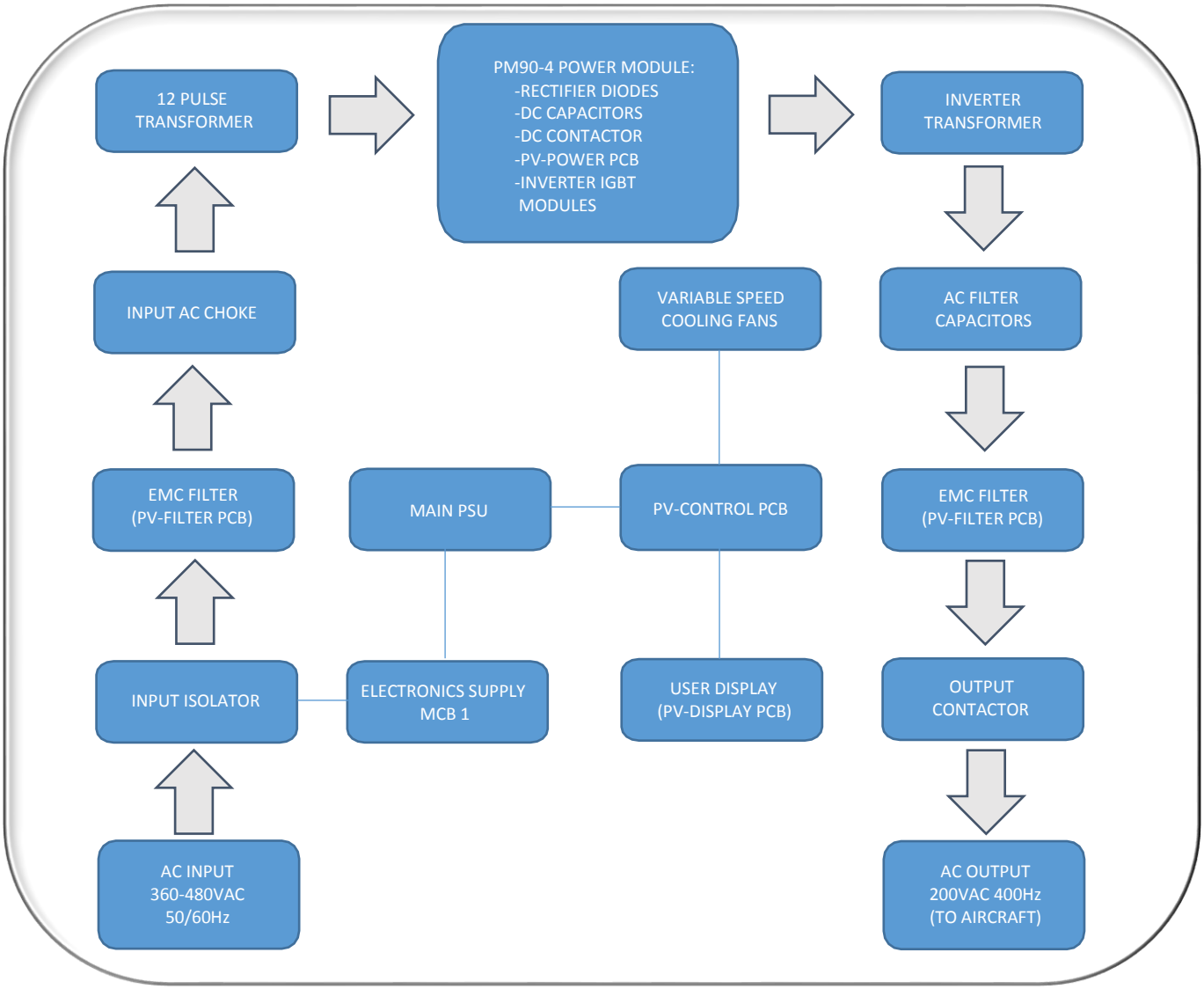
| | |
|---|---|
|  | **Maximum tow speed for the PV90 Trailer is 25 km/h (15 MPH), failure to adhere to this warning may result in tyre failure and serious damage.** |

# SAFETY IS ALWAYS THE PRIMARY CONCERN

# 3. SYSTEM DESCRIPTION

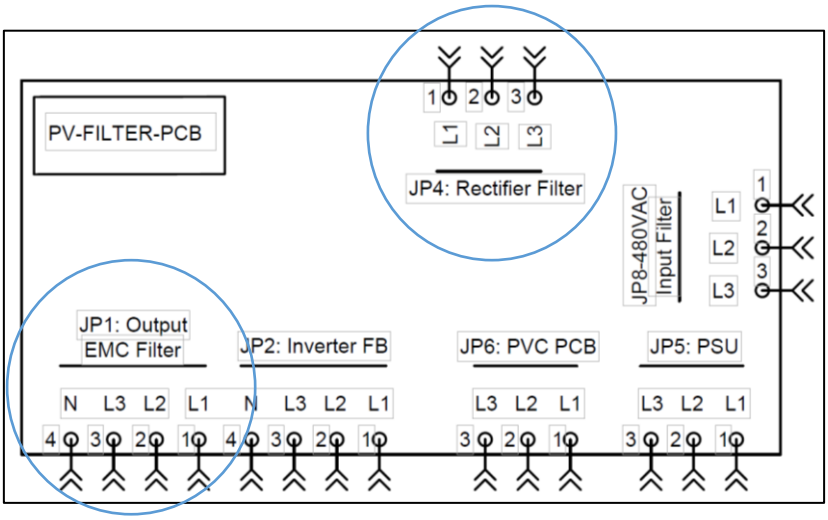
## 3.1. System Operation

The diagram below shows the overall topology of the PV90-4 Ground Power Unit:



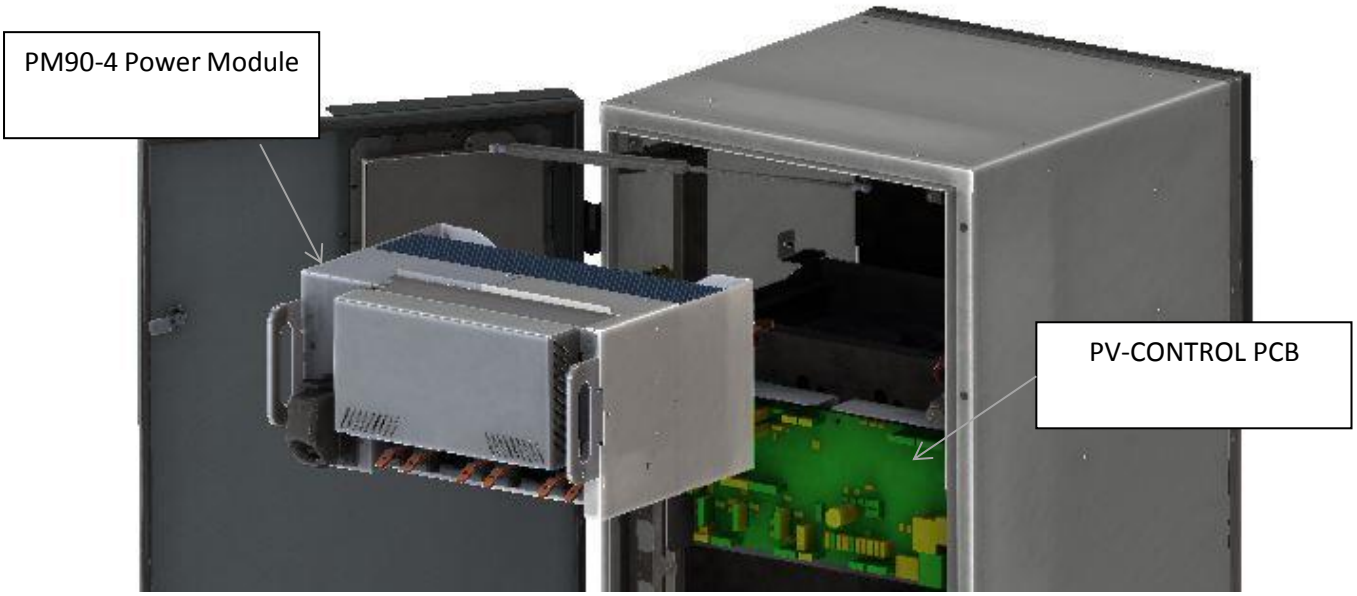

**Input Isolator**
Fitted with terminal shrouds and mechanical door interlock, this ensures maximum user safety as the door cannot be opened until the switch is in the off position. Once this switch is in the on position, the system is in standby ready for use. The input isolator also supplies the system electronics via MCB 1.

**EMC Filter (PV-FILTER PCB)**
Conducted emission filtering to conform to emission regulations. Both Input (Rectifier) & Output Filtering circuit is located on the PV-FILTER PCB. The PV-FILTER PCB is located behind the PV-CONTROL PCB (Refer to below images).




**AC Choke & 12 Pulse Transformer**
Power factor correction and reduced input current harmonics resulting in less stress on the electrical infrastructure.

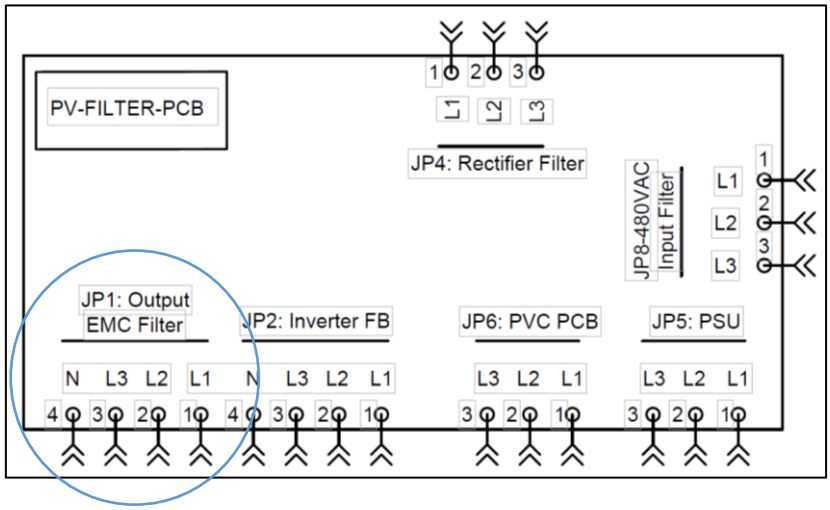
**Power Module (PM90-4)**
The Power Module contains all power conversion devices for the Rectifier (AC-DC) and Inverter (DC-AC) in a single unit, this reduces the typical mean time to repair and therefore reduces downtime. The power module comprises of the following main components:




- **Rectifier Diodes:** 6 x Diode Modules to create a 12 Pulse Diode Bridge for forward conduction and rectification of incoming AC supply, supplied via the removable plug PL1.
- **DC Capacitors**: 4 x 10000uF DC Capacitors creating Bulk DC Storage for smoothing of the DC Bus and connected in parallel by the Rectifier circuit. Creates low ripple DC.
- **DC Contactor:** Contactor to provide a timed control of the connection of the main DC Bus during supply energization. Bypassed via Soft Start circuit to limit inrush current into the DC Capacitors.
- **PV-POWER PCB**: For controlling the High Frequency drive circuitry required for the Inverter IGBT Modules to generate a three-line AC Waveform. Communicates via signals & CAN bus to PV-CONTROL PCB via PL2 37 Way Ribbon Cable.
- **Inverter IGBT Modules**: 6 x IGBT (Insulated Gate Bipolar Transistor) Modules for conversion of DC to AC regulated by the PV-CONTROL/PV-POWER PCB's.

**Inverter Transformer & AC Filter Capacitors:**
A high reactance transformer together with the AC filter capacitors provides a clean isolated 400Hz output to the aircraft. The transformer has a temperature monitoring thermistor, monitored via the PV-CONTROL PCB.

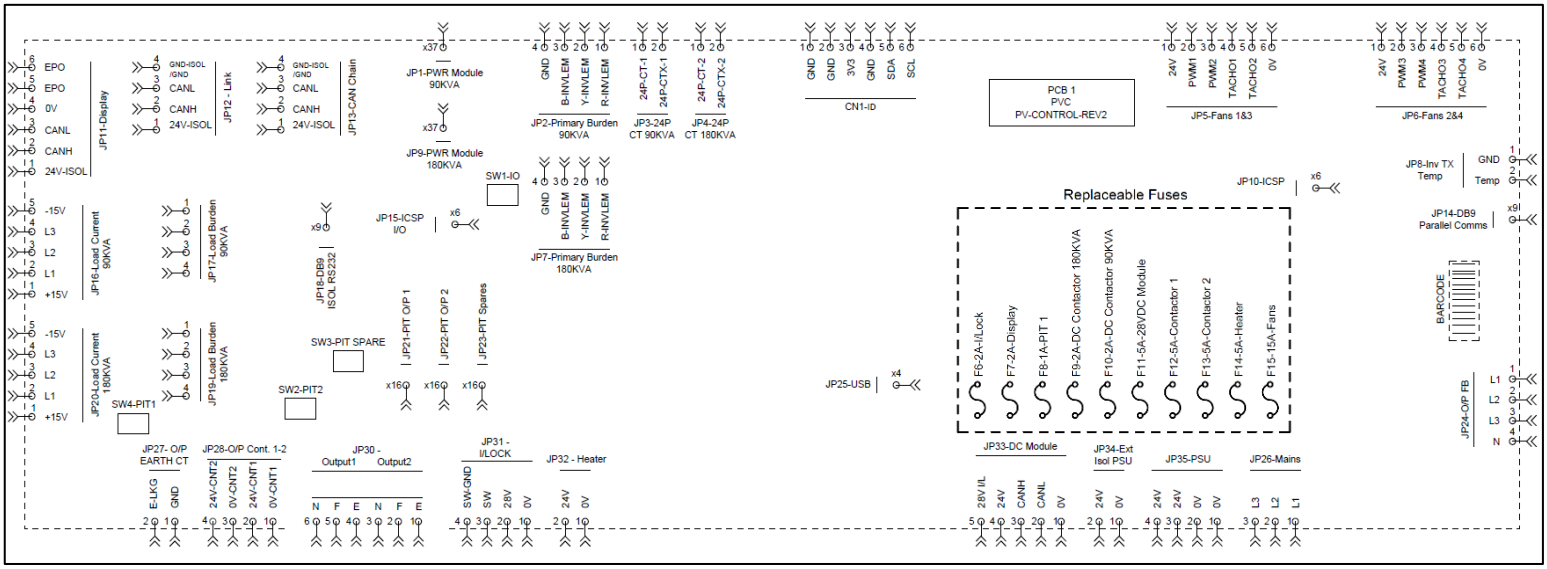
**EMC Filter (PV-FILTER PCB)**
Conducted emission filtering to conform to emission regulations. Both Input & Output Filtering circuit is located on the PV-FILTER PCB.




**Output Contactor:** Controlled from the PV-CONTROL PCB, the contactor is coordinated with the action of the 'F' wire from the aircraft. When the user presses the 'ON' button, the Inverter starts & this contactor closes and will remain closed for as long as the interlock signal is sustained by the aircraft. If there is no feedback from the aircraft within the 5 second window (Boeing 787 compatible & user adjustable), the contactor is disengaged and the Inverter will turn off. Optional additional Contactor can be fitted for secondary 400Hz or 28VDC Outputs.

**MAIN PSU:** Power supply for the main isolated 24V supply to operate all electronics (PCB's, Fans etc.)

**PV-CONTROL PCB:** Operates the Fans, Display, communicates to the power module and external inputs/outputs. The image below provides further details regarding the connections and fuses fitted:




- **PV-CONTROL SW1 – IO Dip-Switch:** 4 switch selections for maintenance:

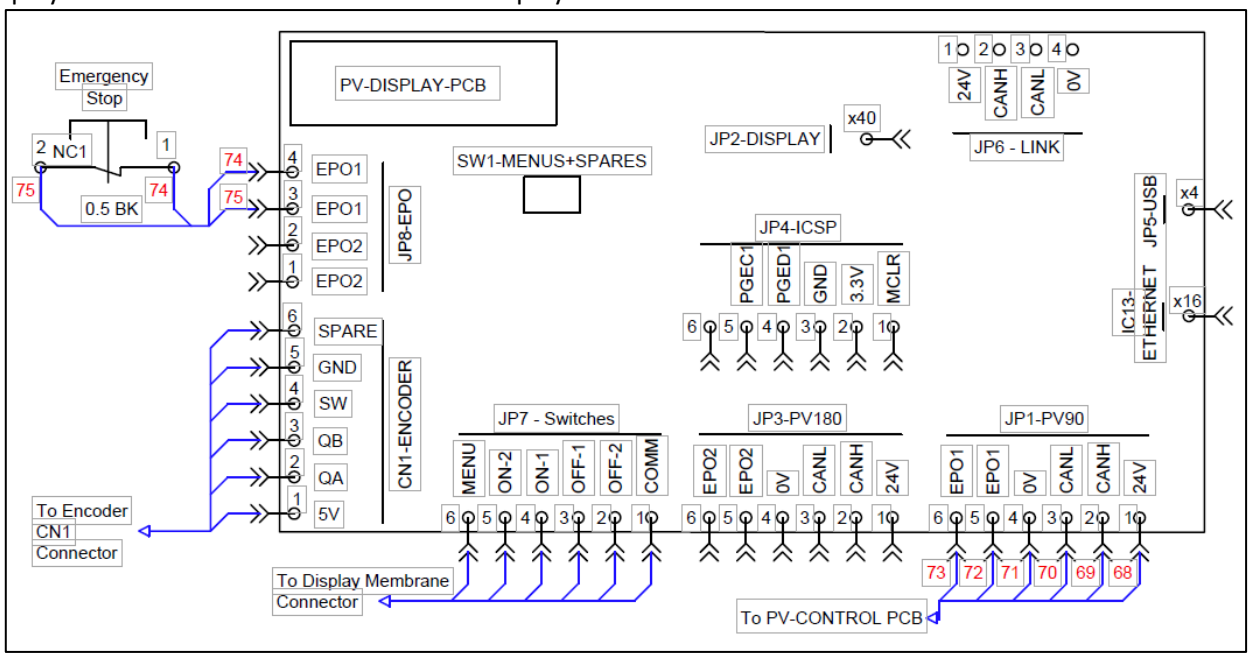
| Switch | Function | ON | OFF |
|---|---|---|---|
| 1 | Spare | | |
| 2 | Spare | | |

| | | | |
|---|---|---|---|
| 3 | Spare | | |
| 4 | Force Bootloader (On start-up) | Enabled | Disabled (default) |

**User Display:** A rugged user interface with heavy duty rubber buttons. A large 5.7inch TFT display screen outputs detailed system information complemented by a user friendly "traffic-light" LED indication system to show system status on the Right-Hand Side (Green = System Healthy, Amber = Warning, Red = System Fault).


**PV-DISPLAY PCB**

Display PCB located behind the main User Display:

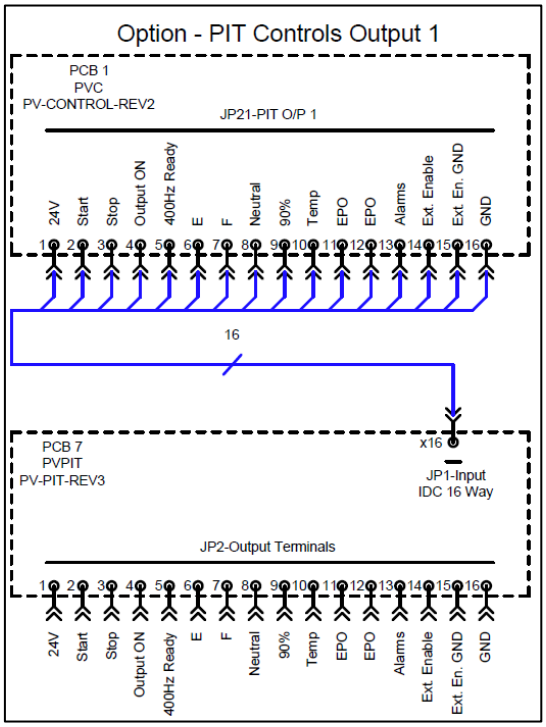



- **PV-DISPLAY SW1 - Menu & Spares Dip-Switch:** 6 switch selections for maintenance:

| Switch | Function | ON | OFF |
|---|---|---|---|
| 1 | Advanced Options | Enabled | Disabled (default) |
| 2 | Spare | | |
| 3 | Spare | | |
| 4 | Spare | | |
| 5 | Test Mode (Factory Use Only) | Enabled | Disabled (default) |
| 6 | Force Bootloader (On start-up) | Enabled | Disabled (default) |

**PV-PIT PCB:**

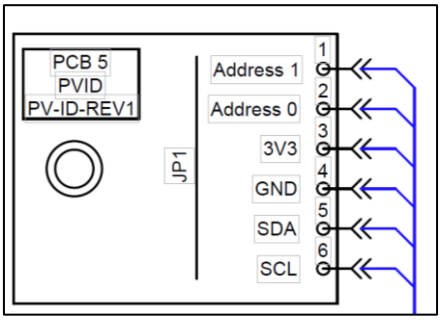
The PV-PIT PCB provides a convenient terminal set for remote control connections (Cable Carriers or Cable Coil Controls, etc.). One is fitted as standard, an additional PV-PIT PCB can be factory installed for a secondary output (Option).



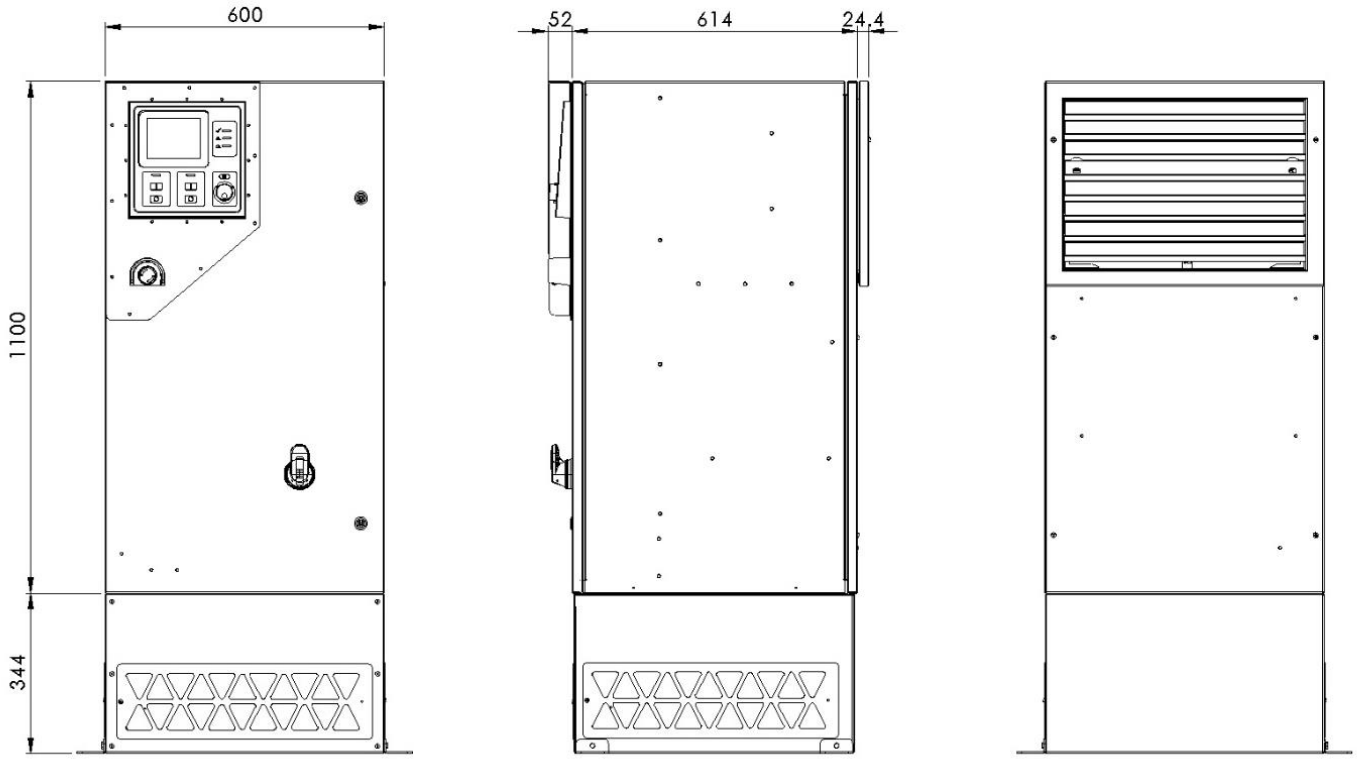

See Section 4.7.8 for more information.

**PV-ID PCB:**

Two PV-ID PCB's are present in the unit containing programmable memory (EEPROM) to electronically identify the modules (Unique Serial Number). One is installed next to the PV-CONTROL PCB (for the Main Unit Information) and one is inside the PM90-4 Power Module. The PV-ID PCB also stores the system settings.

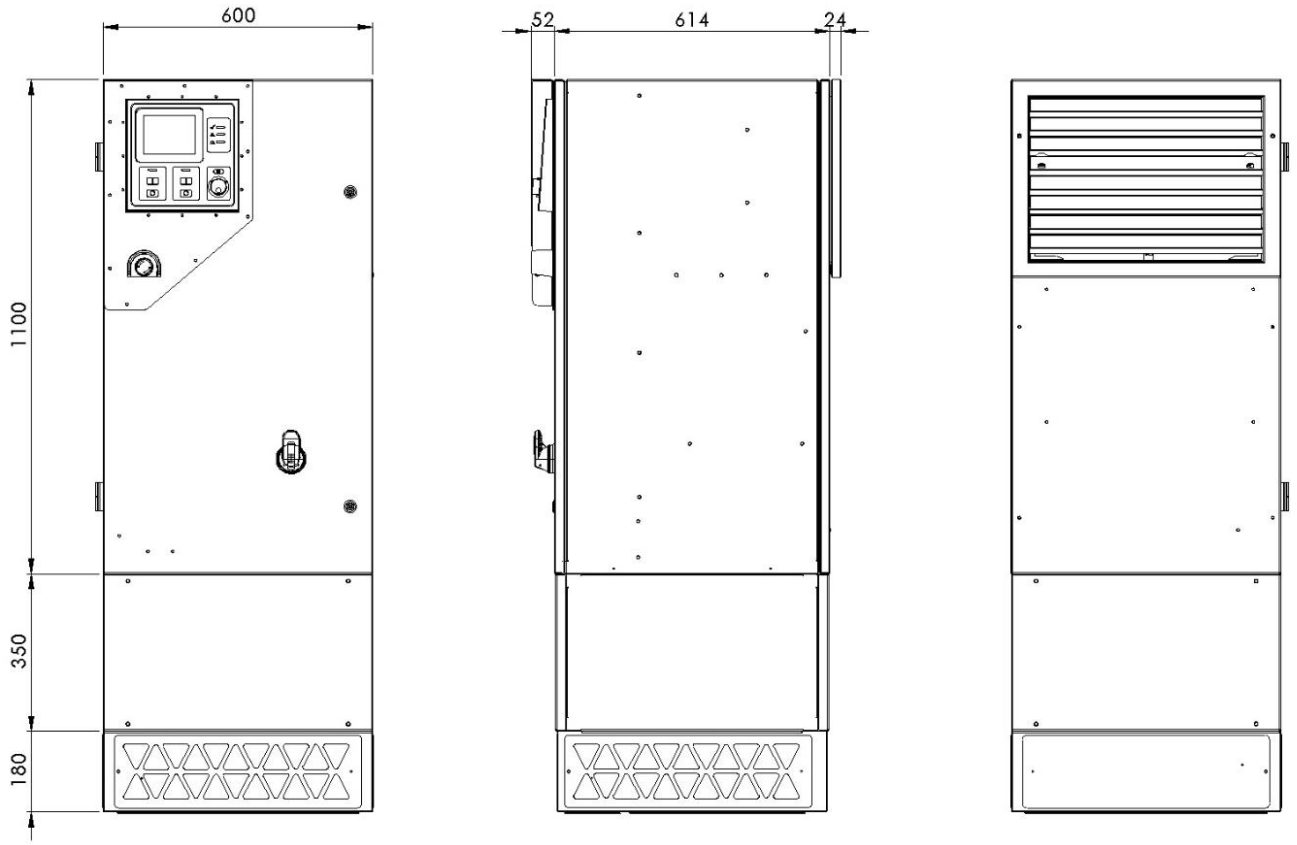


## 3.2. Fixed Installation with Standard Base Module



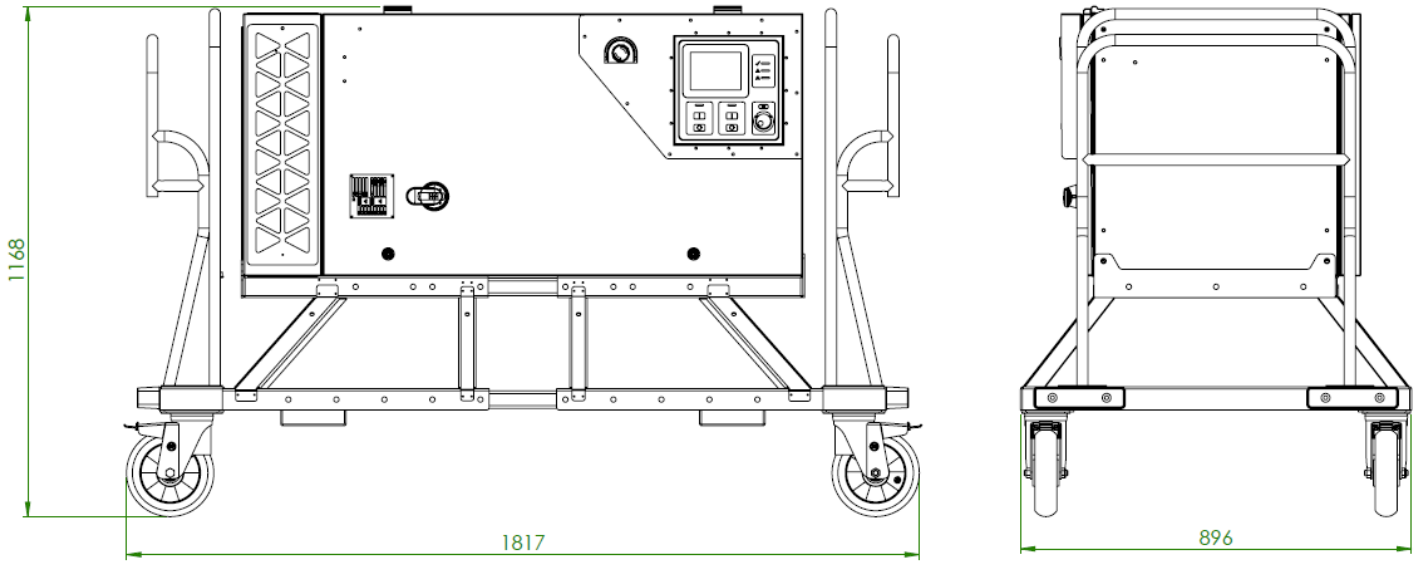

Note: Dimensions in mm

## 3.3. Fixed Installation with 28VDC Base Module



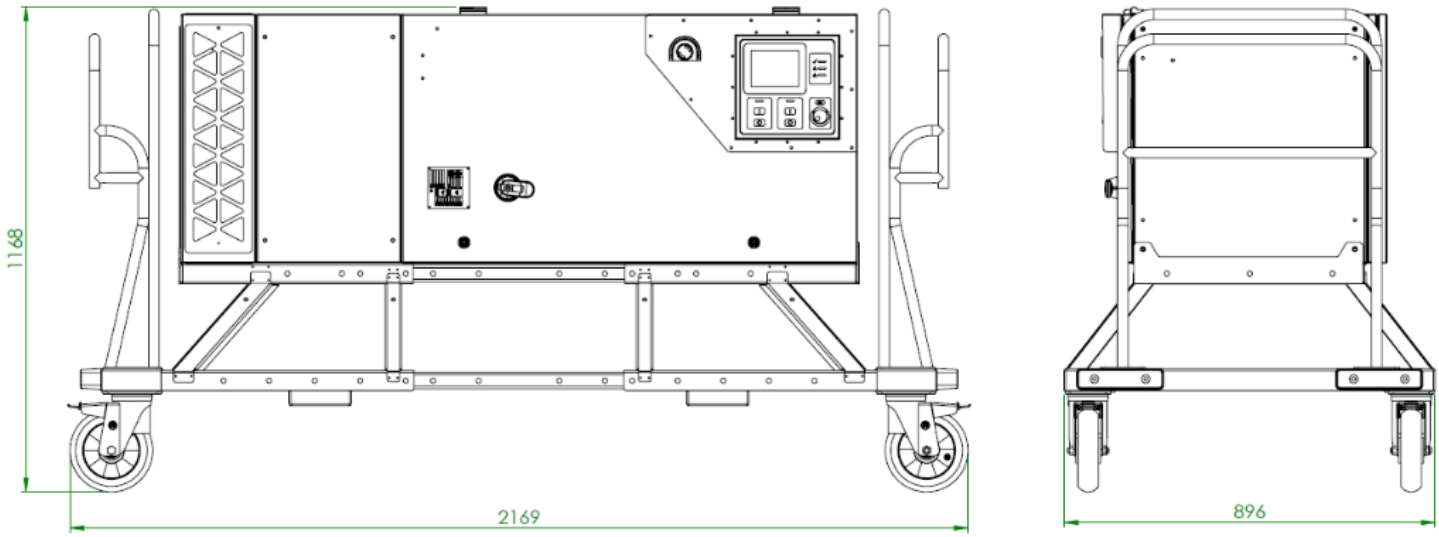

Note: Dimensions in mm

## 3.4. Mobile Hanger Trolley (Horizontal)



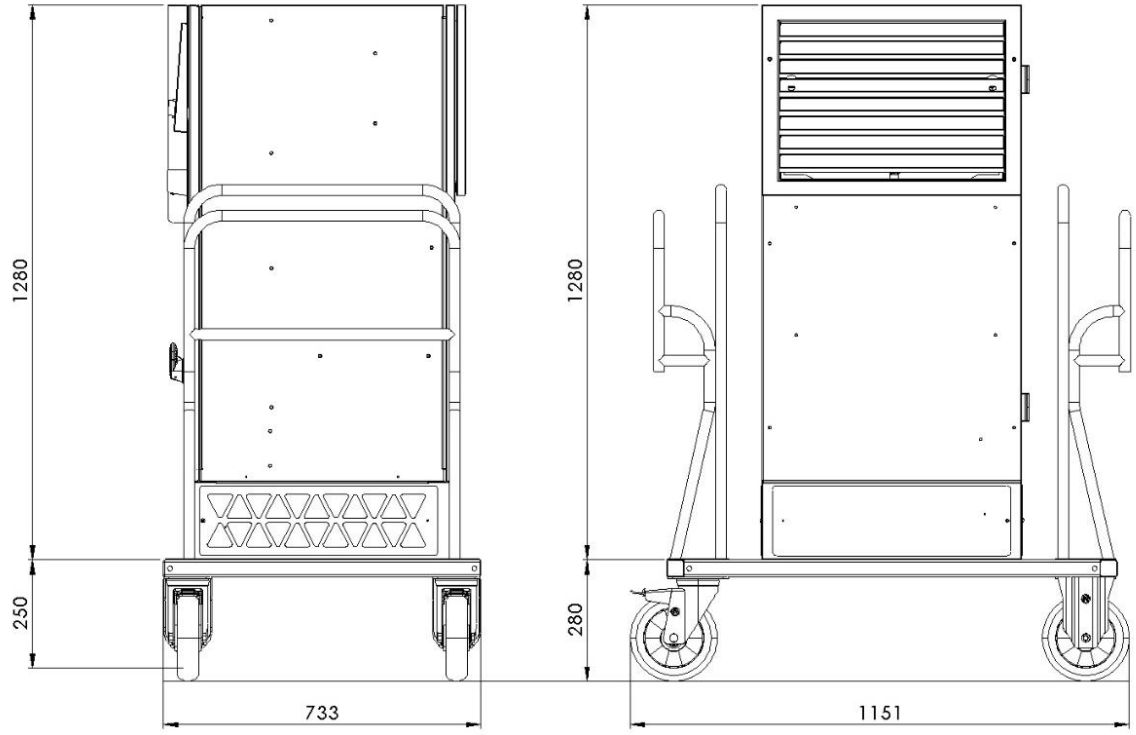

Note: Dimensions in mm

## 3.5. Mobile Hanger Trolley (Horizontal) with 28VDC Base Module



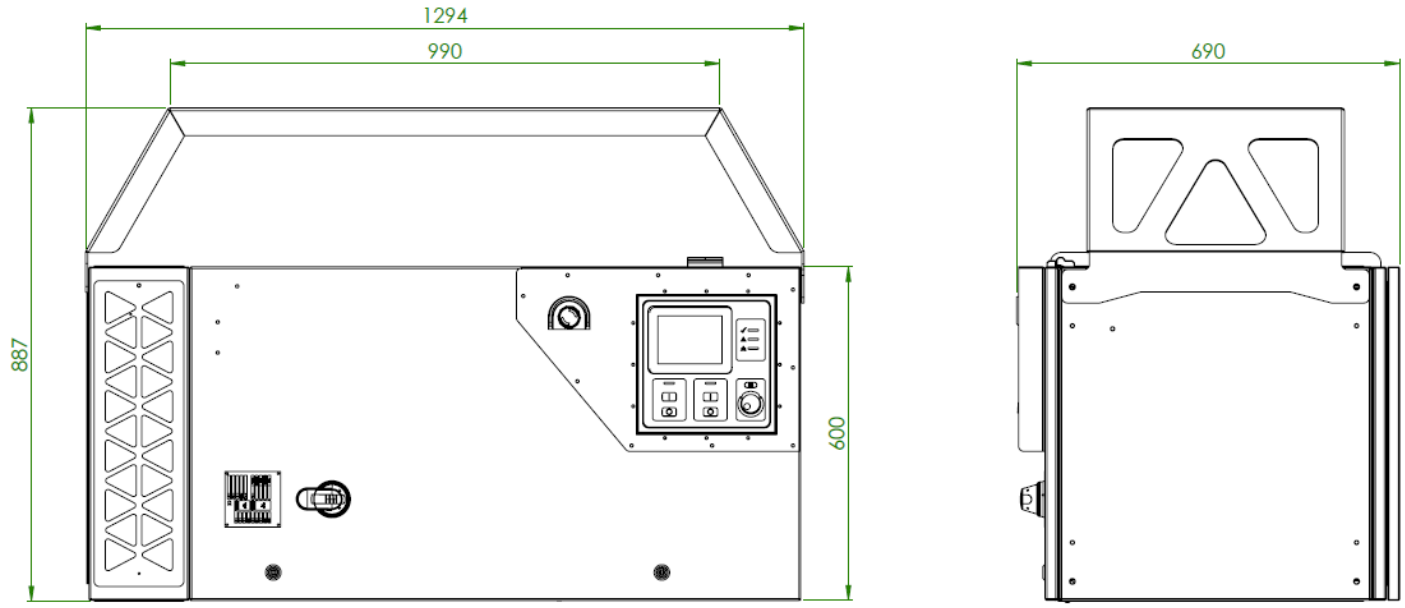

Note: Dimensions in mm

## 3.6. Mobile Hanger Trolley (vertical)



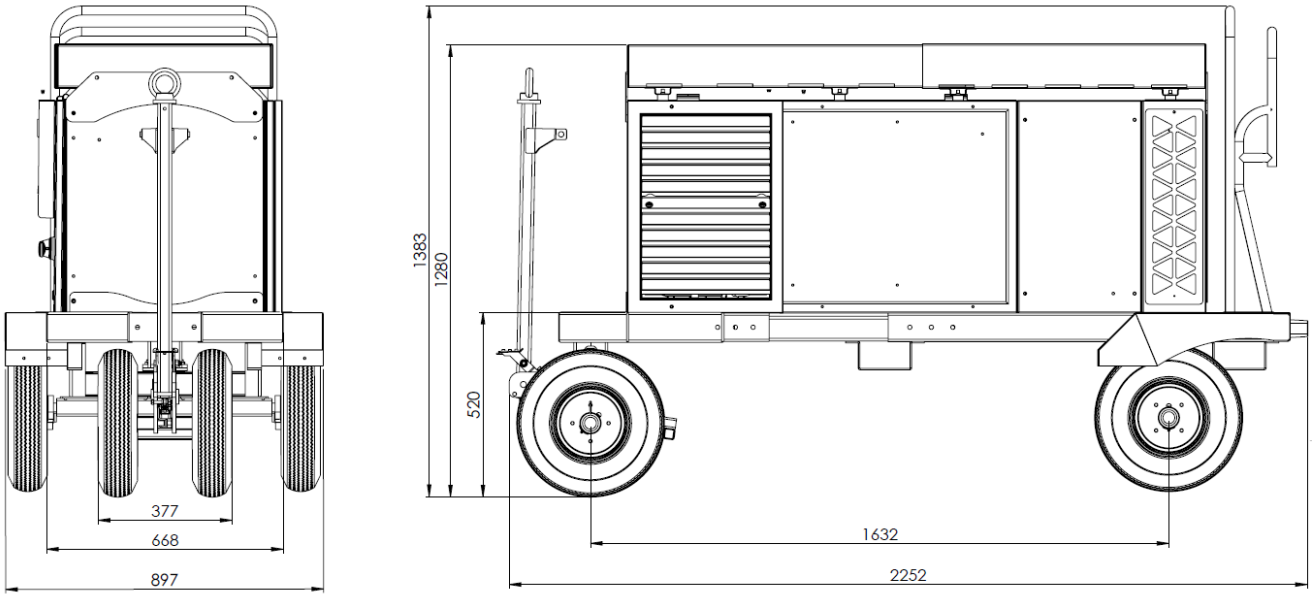

Note: Dimensions in mm

## 3.7. Bridge Mount




Note: Dimensions in mm

## 3.8. Towable Trailer




Note: Dimensions in mm

# 4. DELIVERY & POSITIONING

## 4.1. Delivery

The system will normally be transported on a pallet for ease of transportation. Before accepting delivery, ensure that there is no damage to the system.

| | |
|---|---|
|  | **Use suitable lifting equipment to offload and move the GPU, do not attempt to manhandle.** |

## 4.2. Packing List

- PV90-4 Ground Power Unit
- Door Key
- User Manual
- Output Ferrite Rings x3 (to be fitted to the output cable)

## 4.3. Optional Extras

- Multi-Length Input Cable with 125A 5 pin Commando Plug
- Multi-Length Output Cable with Aircraft Connector
- PV90-4 Towable Trailer
- PV90-4 Hangar Trolley (vertical or horizontal)
- PV90-4 Base Module or PV90-4 28 VDC Base Module
- PV90-4 Bridge Mount Frame
- Lifting Eyes (x4)

## 4.4. Storage

The system should be stored a cool dry place until ready for installation. Do not stack other items / equipment on top of the systems as this may damage the enclosure. Where possible, the system should remain in its packing.

| | |
|---|---|
|  | **To prevent condensation and possible damage to electronic components, do not store outdoors or in environments where condensation is likely to occur.** |

## 4.5. Unpacking & Moving

Remove any shrink wrap and tie straps and dispose of accordingly. Packing should be recycled where possible.

Use a forklift truck or pallet truck to move the system into the desired location. For safety, ensure forks are positioned as wide as possible before lifting.

If the equipment is moved from a cold environment to the operating location, moisture condensation may occur. Before commissioning the system, it must be completely dry. Therefore, an acclimatisation period of at least two hours should be allowed.

| | |
|---|---|
|  | **Take care when moving / lifting the unit with a forklift truck! Position forks as wide as possible for the best stability. Assess each lift carefully to ensure the safety of the driver and any surrounding members of staff / public.** |

| | |
|---|---|
|  | **Use suitable lifting equipment to remove the GPU from its pallet / crate, do not attempt to manhandle.** |

### 4.5.1. Lifting Eyes (optional)

For particular applications, lifting from the top is preferred, for example when armoured cables are pre-installed in ducts directly below the unit, making positioning with a forklift or pallet truck very difficult. This is typical for airport installations.

Lifting eyes are supplied loose for fitting by the person responsible for the lift and should be checked carefully for damage prior to installation.

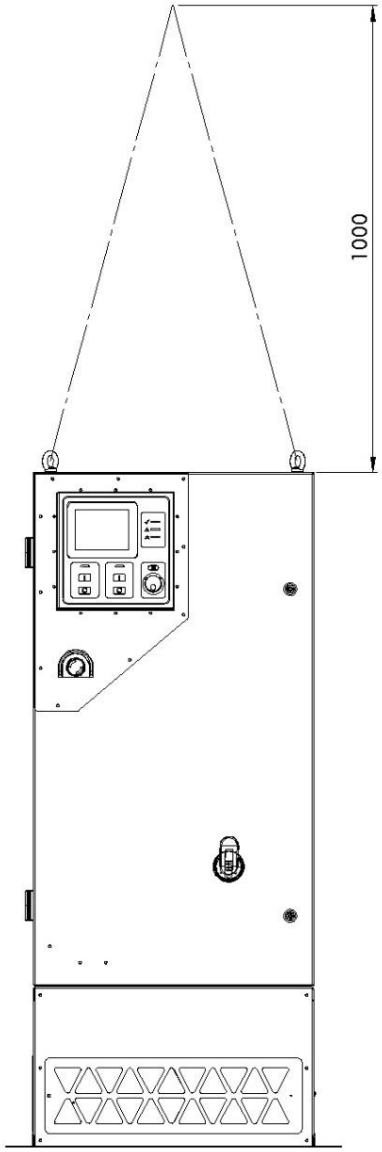
| | |
|---|---|
|  | **Lifting eyes should be checked in accordance with current legislation!** |

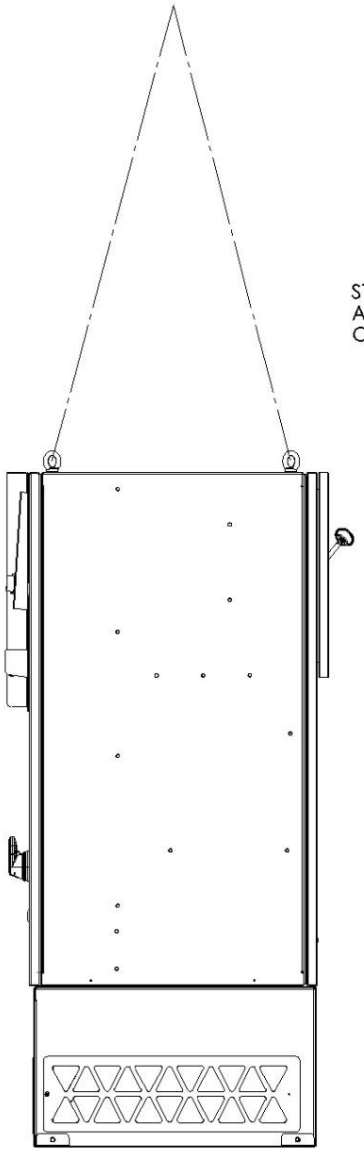
In order to fit the lifting eyes, first remove the standard roof fixing bolts. Ensure washers and bolts are retained for re-fixing following final positioning.


| | |
|---|---|
|  | **WARNING: Avoid stainless steel friction welding. Under no circumstances are powered nut drivers to be used. Avoid permanent seizure of nut to bolt by lubricating stainless steel threads with copper grease or similar.** |

| | |
|---|---|
|  | **IMPORTANT! Following final position, re-fix standard roof bolts making sure correct washers are used to prevent water ingress.** |

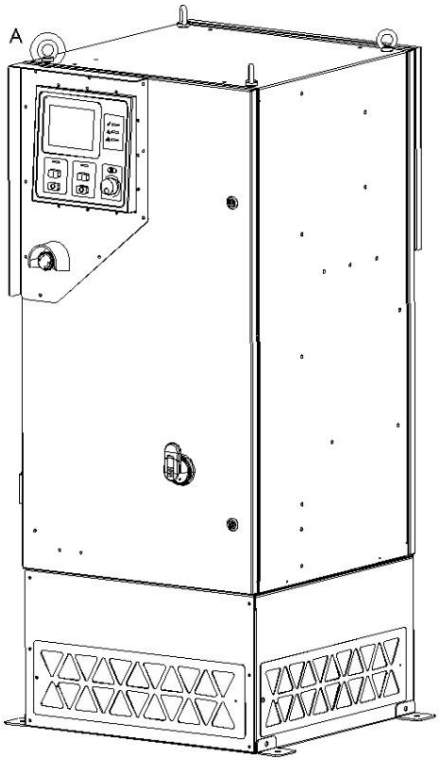
The following illustration details the lifting method, ensure this is followed carefully (in particular the distance from the eye to the lifting point) to prevent damage to the lifting eyes.




DETAIL A
SCALE 1 : 2

STACK REPAIR WASHERS TO
ALIGN THE LIFTING EYES'
ORIENTATION IN THE CENTRE



**EG-Konformitätserklärung**
Entsprechend der EG-Maschinenrichtlinie 2006/42/EG und ihren Änderungen
Hersteller: Otto Ganter GmbH & Co. KG, Triberger Str. 3, 78120 Furtwangen

Hiermit erklären wir, dass die nachfolgend bezeichnete Maschine aufgrund ihrer Konzipierung und Bauart, sowie in der von uns in Verkehr gebrachten Ausführung, den grundlegenden Sicherheits- und Gesundheitsanforderungen der EG-Maschinenrichtlinie 2006/42/EG sowie den unten aufgeführten harmonisierten und nationalen Normen sowie technischen Spezifikationen entspricht. Bei einer nicht mit uns abgestimmten Änderung der Maschine und wenn die Maschine nicht entsprechend den in der Betriebsanleitung aufgezeigten bestimmungsgemäßen Fällen eingesetzt und die regelmäßig durchzuführenden Überprüfungen vorgenommen werden, verliert diese Erklärung ihre Gültigkeit.

**EC Declaration of Conformity**
In compliance with EC Machinery Directive 2006/42/EC, and its amendments
Manufacturer: Otto Ganter GmbH & Co. KG, Triberger Str. 3, D-78120 Furtwangen

This is to assess that the machine described below, in its design concept and type of construction and in the design version marketed by us, complies with the basic safety and health at work requirements of EC Machinery Directive 2006/42/EC and with the harmonised and national standards and technical specifications listed below. In the event of alterations made to the machine not approved by us and if the machine is not used properly as specified in the operating instructions and if no regular inspections are carried out, this declaration is void.

**Produktbezeichnung / Product description: DIN 580**
Einschlägige Richtlinie / Relevant directive:
**EG-Maschinenrichtlinie 2006/42/EG / EC Machinery Directive 2006/42/EC**

Folgende nationale Normen und technische Spezifikationen wurden angewandt:
The following national standards and technical specifications have also been applied:
**DIN 580**
**BGR 500**

For die Zusammenstellung der Konformitätsdokumentation bevollmächtigte Person:
Person authorised to compose the conformity documentation:
Otto Ganter GmbH & Co.KG

Furtwangen, 15.09.2015
Stefan Ganter, Geschäftsführer / Managing Director
Name, Funktion und Unterschrift des Verantwortlichen
Name, function/title and signature of authorised person

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# Betriebsanleitung
# Operating Instruction

Ringschrauben
Lifting eye bolts

DIN 580

Ausgabe - Edition - 09/2015
Art.-Nr. - Article no.
BT-580-V1-09.15

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## de Originalbetriebsanleitung

**Montagehinweise / Gebrauchsanweisung**
Ringschrauben nach DIN 580 dienen vorwiegend als Lastaufnahmemittel zur dauerhaften Befestigung an Bauteilen wie Motoren, Schaltschränken, Getrieben und zu deren Transport.

1. Verwendung nur durch Beauftragte und unterwiesene Personen, unter Beachtung der BGR 500 und außerhalb Deutschlands den entsprechenden landesspezifischen Vorschriften.
Ringschrauben sind erhaben und dauerhaft mit Herstellzeichen, Werkstoff-Kennzeichen (z.B. C15E, A2 oder A4), Tragfähigkeit im axialen Strang (WLL in kg, siehe auch Tabelle/ F in N) und CE Kennzeichen gekennzeichnet.

2. Kontrollieren Sie regelmäßig und vor jeder Inbetriebnahme die Anschlagpunkte auf Schraubensitz, starke Korrosion, Verschleiß, Verformungen etc.

3. Legen Sie den Anbringungsort konstruktiv so fest, dass die eingeleiteten Kräfte vom Grundwerkstoff ohne Verformung aufgenommen werden.
Einschraubtiefe bei Stahl mit einer Zugfestigkeit von Rm >340 N/mm², z. B. S235JR (1.0037); oder GG 25 (0.6025 - lunkerfrei): 1,5 x M (–L). Verwenden Sie bei Einschraubmaterialien mit geringerer Festigkeit Anschlagpunkte mit größerer Einschraublänge. Die BG empfiehlt als Mindesteinschraublänge:
2 x M in Aluminiumlegierungen
2,5 x M in Leichtmetallen mit geringerer Festigkeit
Bei Leichtmetallen, Buntmetallen und Grauguss muss die Gewindezuordnung so gewählt werden, dass die Gewindetragfähigkeit den Anforderungen an das jeweilige Grundmaterial entspricht.
Bei Durchgangslöchern sollte von der Gegenseite eine Mutter (0,8 x d) vollständig und fest aufgeschraubt werden. Bei ausreichender Gewindelänge der Schraube wird zusätzlich die Verwendung einer Scheibe empfohlen.

4. Führen Sie die Lage der Anschlagpunkte so aus, dass unzulässige Beanspruchungen wie Verdrehen oder Umschlagen der Last vermieden werden.
a.) Ordnen Sie den Anschlagpunkt für den einsträngigen Anschlag senkrecht über dem Lastschwerpunkt an.
b.) Ordnen Sie die Anschlagpunkte für den zweisträngigen Anschlag beidseitig und oberhalb des Lastschwerpunktes an.
Achtung: Drehbewegungen während des Transports müssen vermieden werden !
c.) Die Ringschraube ist so zu positionieren, dass Seitenzug vermieden wird (Bild links, falsche Anwendung). Die Krafteinleitung muss in Richtung der Ringebene erfolgen (Bild rechts, richtige Anwendung).

5. Symmetrie der Belastung:
Entnehmen Sie die erforderliche Tragfähigkeit des einzelnen Anschlagpunktes für symmetrische Belastung entsprechend nebenstehender Tabelle.

6. Plane Anschraubfläche (Ø $d_3$) muss gewährleistet sein. Maximale Ansenkung der Gewindebohrung = Nenndurchmesser des Gewindes. Sacklöcher müssen so tief gebohrt sein, dass die Auflagefläche der Ringschraube aufsitzen kann.

7. Bei stoßartiger Belastung oder Vibration kann es zu unbeabsichtigtem Lösen kommen. Sicherungsmöglichkeiten: Anzugsmoment + flüssiges Gewindesicherungsmittel wie z. B. Loctite oder WEICONLOCK (an Einsatzfall angepasst, Herstellerangaben beachten). Sichern Sie grundsätzlich alle Anschlagpunkte, die dauerhaft am Befestigungspunkt verbleiben, z. B. durch Verkleben.

8. Das Anschlagmittel muss in der Ringschraube frei beweglich sein. Beim An- und Aushängen der Anschlagmittel (Anschlagkette, Rundschlinge, Drahtseil) dürfen für die Handhabung keine Quetsch-, Scher-, Fang- und Stoßstellen entstehen. Schließen Sie Beschädigungen der Anschlagmittel durch scharfkantige Belastung aus.

9. Temperatureinsatztauglichkeit:
Ringschrauben DIN 580 können in einem Temperaturbereich von -20°C bis +200°C ohne Einschränkung der Tragfähigkeit eingesetzt werden.

10. Anschlagpunkte dürfen nicht mit aggressiven Chemikalien, Säuren oder deren Dämpfen in Verbindung gebracht werden.

11. Prüfen Sie durch einen Sachkundigen nach der Montage, sowie in Zeitabständen die sich nach Ihrer Beanspruchung richten, mindestens jedoch 1x jährlich, die fortbestehende Eignung des Anschlagpunktes. Dies auch nach Schadensfällen und besonderen Vorkommnissen.
Prüfkriterien zu Punkt 2:
- auf festen Schraubensitz (Anzugsmoment) achten
- Vollständigkeit des Anschlagpunktes
- Verformungen an tragenden Teilen wie Grundkörper und Schraube
- mechanische Beschädigungen wie starke Kerben, insbesondere in auf Zugspannung belasteten Bereichen
- starke Korrosion
- Anrisse an tragenden Teilen
- Funktion und Beschädigung der Schrauben sowie Schraubengewinde

Bestehen Zweifel für eine sichere Benutzung, so muss der Anschlagpunkt bzw. die Anschlageinrichtung aus Sicherheitsgründen der Benutzung entzogen werden. Eine Nichtbeachtung der Hinweise kann zu personellen u. materiellen Schäden führen!

## en Translation of the original operating instruction (de)

**Assembly instructions**
DIN 580 lifting eye bolts are mainly intended for permanent mounting to components such as motors, switchgear cabinets and gears, and for transporting these items of equipment.

1. To be used only by authorised, qualified and instructed personnel in compliance with BGR 500 and with the appropriate national regulations outside Germany.
Lifting eye bolts must be marked permanently raised with manufacturer's mark, material ID (e.g. C15E, A2 or A4), load-bearing capacity in axial direction (WLL in kg, see also Table/ F in N), and with CE symbol.

2. Check the jigging points for proper bolt seat, strong corrosion, wear and tear, deformation, etc. at regular intervals and before every use.

3. Select the attachment point such that the introduced forces are absorbed by the base material without any deformation.
Screw-in depth for steel with a tensile strength of Rm >340 N/mm², e.g. S235JR (1.0037); or GG 25 (0.6025 – without cavities or shrinkage): 1.5 x M (–L). For screw-in material with lower strength, use jigging points with greater screw-in length. Minimum screw-in depths recommended by the Liability Insurance Association:
2 x M in aluminium alloys
2.5 x M in light metal with low strength
For light metals, non-ferrous metals and grey cast iron, select the thread such that the load-bearing capacity of the thread corresponds with the requirements involving the base material.
For through-holes, a nut (0.8 x d) should be fully and firmly bolted from the opposite side. If the thread length of the screw is sufficient, the use of an additional washer is recommended.

4. Select the position of the fixing points such that non-conforming action effects like rotations or load shifts are avoided.
a.) Arrange the jigging point for a single strand sling perpendicular above the load centre.
b.) Arrange the jigging points for a twin strand sling on both sides and above the load centre.
Caution: Avoid turning or rotating movements during transport!
c.) Position the eye bolt such that no shear tension acts on the eye bolt (Illustration below left, incorrect use). The introduced force must act in the direction of the eye bolt plane (illustration below right, correct use)

5. Load symmetry:
See the following table for the specified load-bearing capacity of each jigging point for symmetrical loads.

6. The attachment surface (Ø $d_3$) must be plane. Maximum spot-facing of the thread hole = nominal diameter of the thread. Blind holes must be drilled to a depth to ensure that the contact surface of the eye bolt is well seated.

7. Shock loads or vibrations may cause inadvertent loosening. Securing options: Tightening torque + liquid thread lock agent, e.g. Loctite or WEICONLOCK (depending on use; observe manufacturer's specifications). Always secure jigging points which remain permanently at the fixing point, e.g. by gluing.

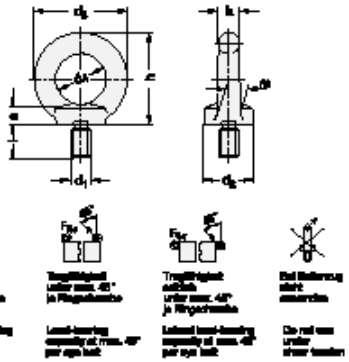
8. The end attachment must be freely movable in the lifting eye bolt. When slinging and removing the end attachments (sling chain, round sling, wire rope), make sure that no pinch, shear, catch or impact points occur. Avoid damage to the end attachments caused by sharp-edged loads.

9. Temperature suitability:
DIN 580 lifting eye bolts may be used without restricting or impairing the load-bearing capacity within the temperature range from -20°C to +200°C.

10. Jigging points must not be allowed to make contact with aggressive chemicals, acids or their vapours.

11. After mounting and installation and in intervals depending on use, however at least once every year, the continued suitability of the jigging point must be checked and inspected by an expert. This also applies after damage or other unusual incidents.
Test criteria to item 2:
- firm seat of the bolt (tightening torque)
- completeness of the jigging point
- deformations at load-bearing parts, e.g. base element and bolt
- mechanical damage, e.g. sharp notches, especially in zones exposed to tension loads
- severe corrosion
- cracks in load-bearing parts
- function and damage, if any, of the bolt and the bolt thread

If there is any doubt with regard to the safe use, the jigging point and/or the jigging equipment must not be used for safety reasons.
Failure to observe these instructions may result in personal injury and material damage!




| $d_1$ | $d_2$ | $d_3$ | $d_4$ | e | h | k |
|---|---|---|---|---|---|---|
| M 8 | 20 | 36 | 20 | 6 | 36 | 8 |
| M 10 | 25 | 45 | 25 | 8 | 45 | 10 |
| M 12 | 30 | 54 | 30 | 10 | 53 | 12 |
| M 16 | 35 | 63 | 35 | 12 | 62 | 14 |
| M 20 | 40 | 72 | 40 | 14 | 71 | 16 |
| M 24 | 50 | 90 | 50 | 18 | 90 | 20 |
| M 30 | 65 | 108 | 60 | 22 | 109 | 24 |
| M 36 | 75 | 126 | 70 | 26 | 128 | 28 |

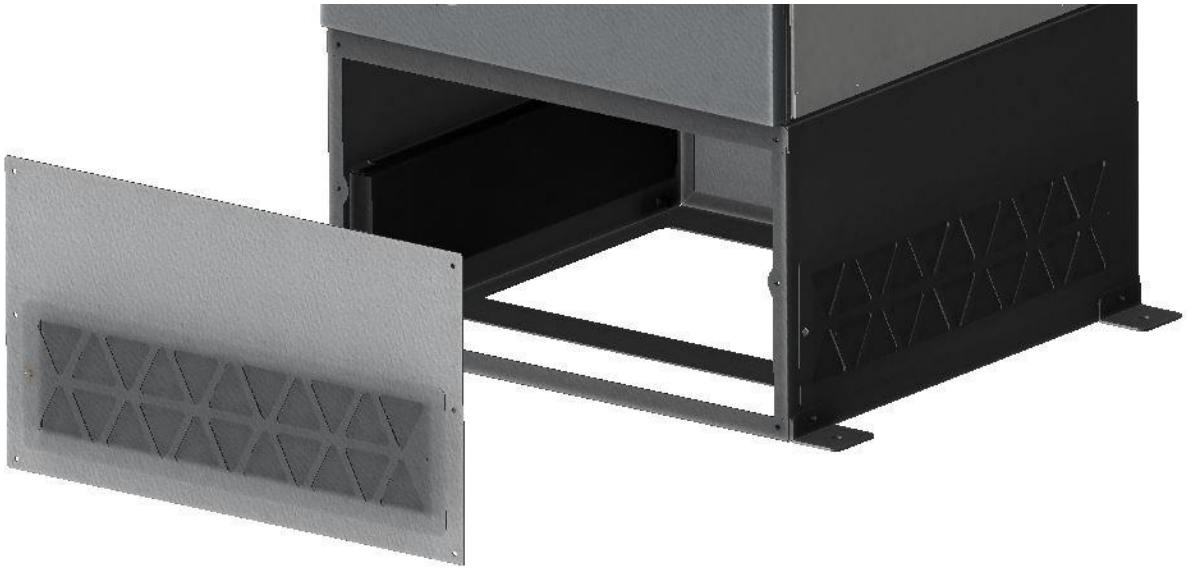
| $d_1$ | l | m | $F_1$ in N | $F_2$ in N | $F_3$ in N |
|---|---|---|---|---|---|
| M 8 | 13 | 10 | 1400 | 1000 | 700 |
| M 10 | 17 | 12 | 2300 | 1700 | 1150 |
| M 12 | 20,5 | 14 | 3400 | 2400 | 1700 |
| M 16 | 27 | 16 | 7000 | 5000 | 3500 |
| M 20 | 30 | 19 | 12000 | 8600 | 6000 |
| M 24 | 36 | 24 | 18000 | 12900 | 9000 |
| M 30 | 45 | 28 | 32000 | 23000 | 16000 |
| M 36 | 54 | 32 | 46000 | 33000 | 23000 |

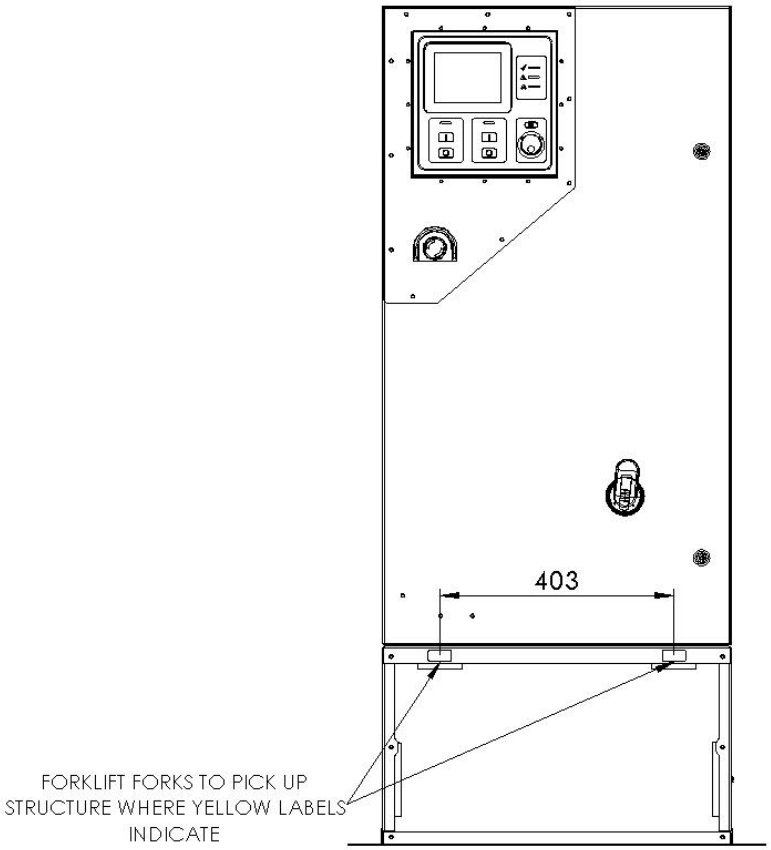
| $d_1$ | Mindestbruchlast im Axialzug kN/ Minimum failure load under axial tension in kN | Mindestbruchlast im Querzug 90° kN/ Minimum failure load under 90° shear tension in kN |
|---|---|---|
| M 8 | 8,2 | 4,1 |
| M 10 | 13,5 | 6,8 |
| M 12 | 20,0 | 10,0 |
| M 16 | 41,2 | 20,6 |
| M 20 | 70,6 | 35,3 |
| M 24 | 105,9 | 53,0 |
| M 30 | 188,3 | 94,2 |
| M 36 | 270,7 | 135,4 |

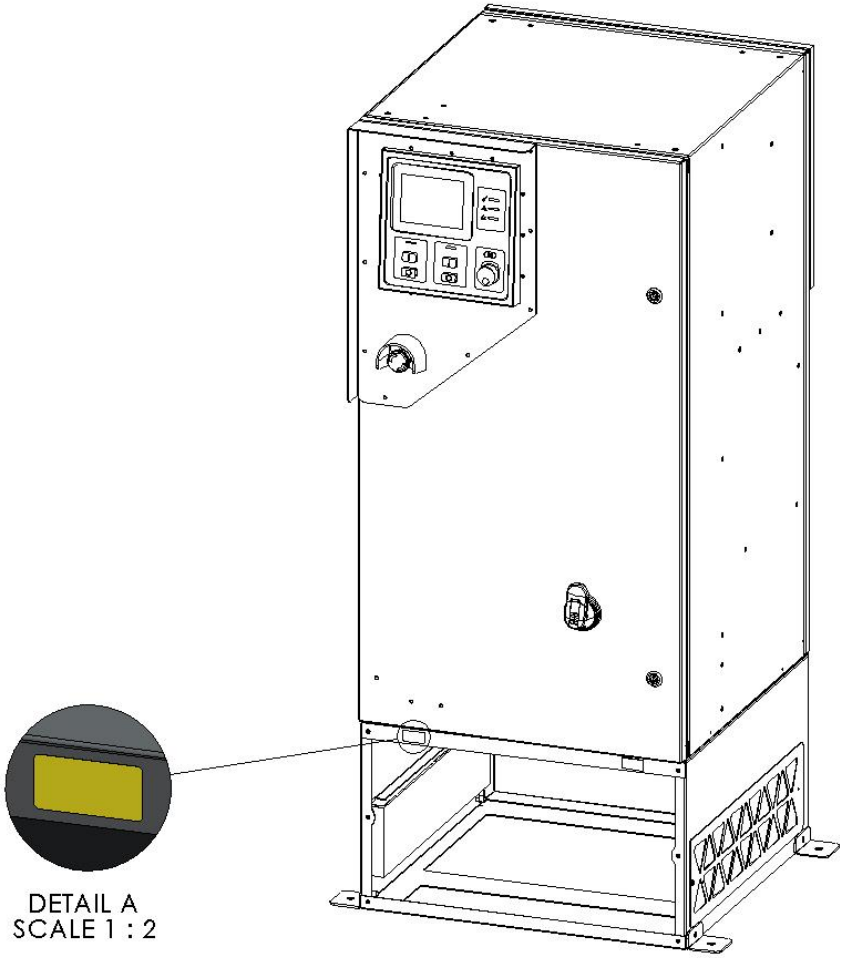
### 4.5.2. Lifting with Base Module

| | |
|---|---|
| ⚠ | **IMPORTANT! For units fitted with the additional base module, the centre of gravity increases (TOP HEAVY!), care must be taken when lifting from below. Ensure forks are positioned are per the following illustrations, failure to adhere to this safety notice could compromise safety and could also cause damage to the unit.** |

Remove Base Module Front Cover as below:





DETAIL A
SCALE 1 : 2

RECOMMENDED POINTS FOR 90kVA PICKUP APPROXIMATELY 400MM APART AS INDICATED BY LABELS; LIFTING CLOSER TO CENTRE MAY PERMANENTLY DAMAGE BASE MODULE

## 4.6. Finding a Suitable Location (Fixed Installation)

The location of the system is crucial to the correct operation and maintenance of the system. Points to consider:

- Is the location free from flooding?
- Is there sufficient space for air inlet / outlet?
- Is the location level?
- Is there sufficient space for cable entry?
- Is there sufficient space for maintenance?

If the answer to any of the above questions is no then you should reconsider the location. Feel free to contact our technical support team if you are unsure. Please see the back page of this manual for contact details.

| | |
|---|---|
|  | **Take care when moving / lifting the unit with a forklift truck! Position forks as wide as possible for the best stability. Assess each lift carefully to ensure the safety of the driver and any surrounding members of staff / public.** |

| | |
|---|---|
|  | **Use suitable lifting equipment to position the GPU, do not attempt to manhandle.** |

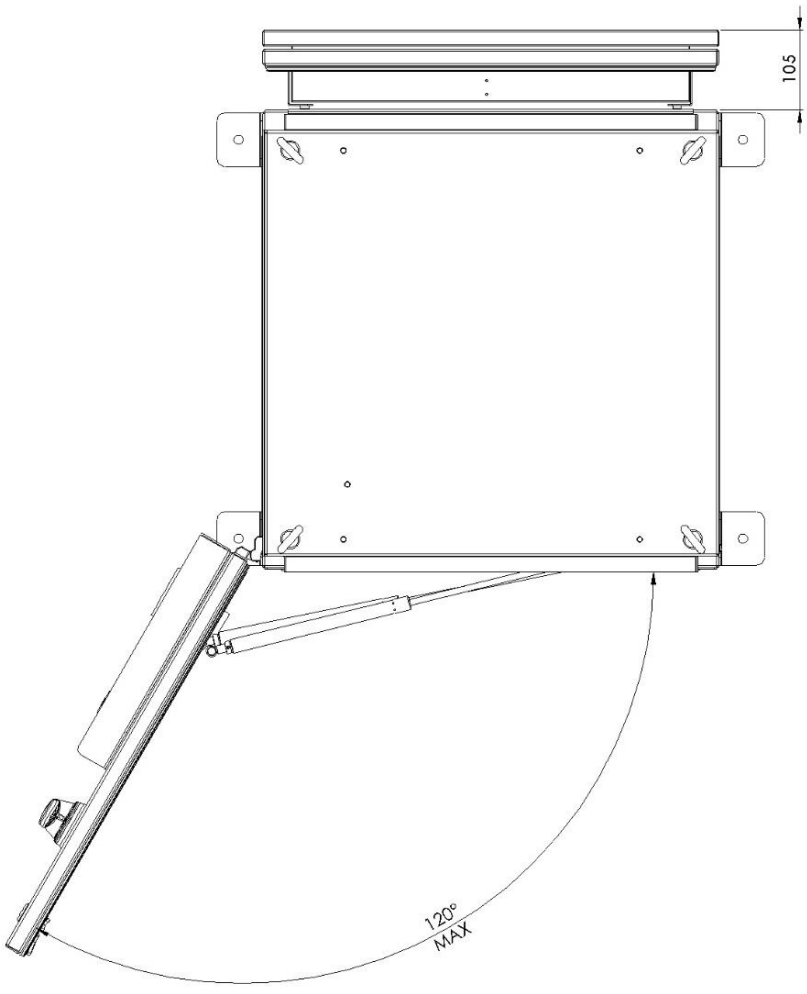
| | |
|---|---|
|  | **Typically, the system will dissipate 50W of heat for every 1000W of connected load, adequate airflow / cooling is critical to ensure reliable operation in enclosed spaces.** |

### 4.6.1. Space Planning

Ensure sufficient space is allowed for around the unit during installation. This will assist with on going maintenance activities.

- A clearance gap of at least 700mm is recommended for the front of the unit to allow the main door to open fully.
- A clearance gap of at least 150mm is recommended on either side of the system for ventilation & maintenance purposes (exhaust filter clearance)
- A clearance gap of at least 500mm is recommended on the rear side of the unit to allow the main filter to be replaced and access to the inverter transformer and filter capacitor section.

See the below image for more detail:

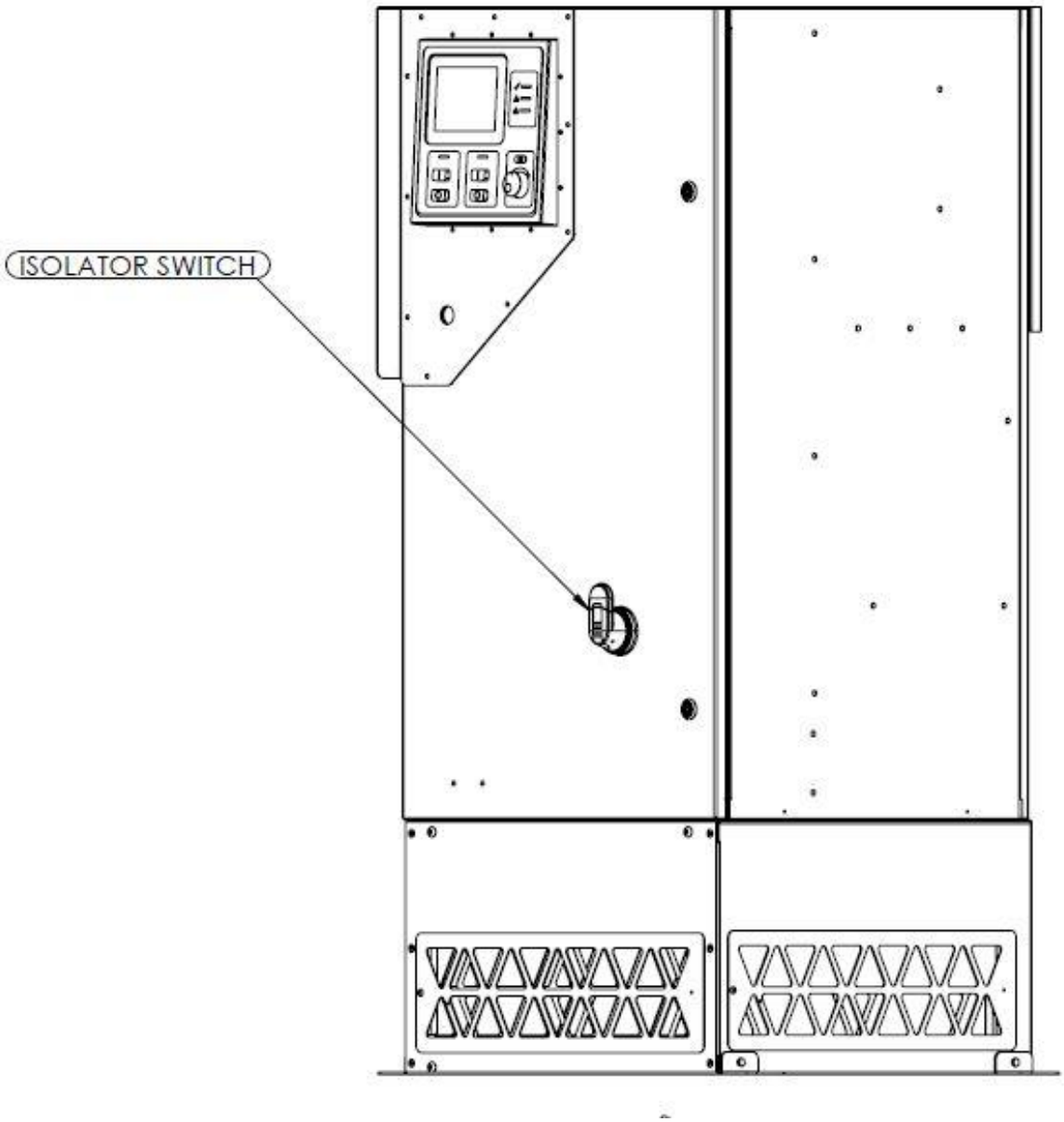


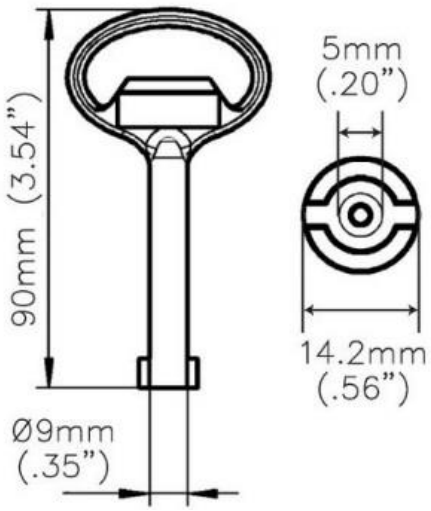
## 4.7. Electrical Installation

| | |
|---|---|
|  | **The PV90-4 is fitted with a door interlocked isolator switch, this prevents the door opening when the switch is in the on position. It is advisable to isolate the unit at the supply breaker / fuse prior to opening the door.** |

### 4.7.1. Front Door

All electrical connections are situated behind the front door, before attempting to open the door, make sure the isolator switch is in the off position, then using the appropriate key (supplied) unlock the door.






Both front and rear doors use the same key, the image to the left provides details of this key for future reference.

### 4.7.2. Internal Protection Panel

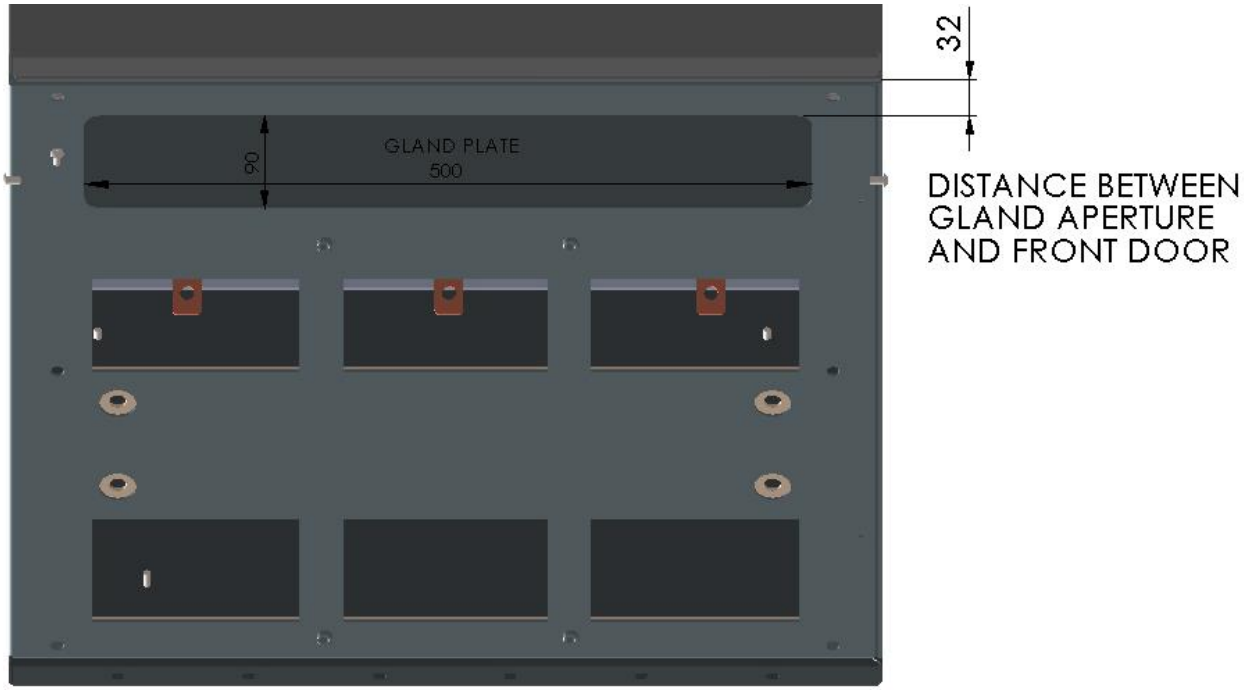
The system is fitted with an additional protection panel (IP2XI) behind the rear door, this provides additional safety for operators when the door is opened. In order to access the electrical connections, this panel must be removed, see illustration below.


PM90-4


PM90-4

### 4.7.3. Gland Plate

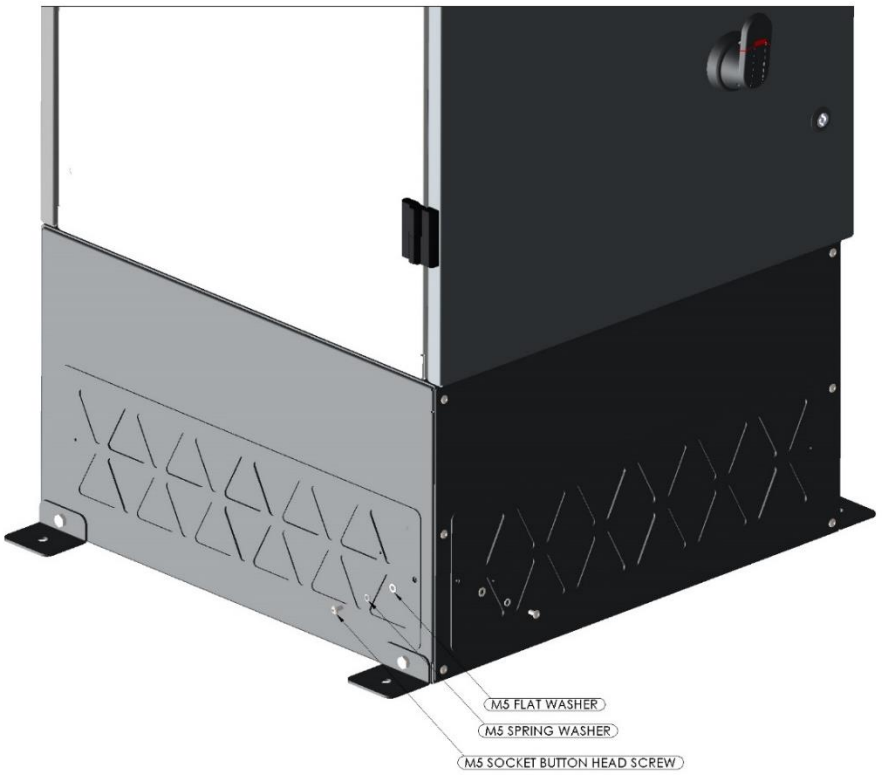
The gland plate must be fitted to prevent ingress of water, vermin and hot exhaust air from entering this section of the GPU, failure to do so may result in premature failure of the unit. Note the dimensions for the gland plate aperture as per the below drawing:

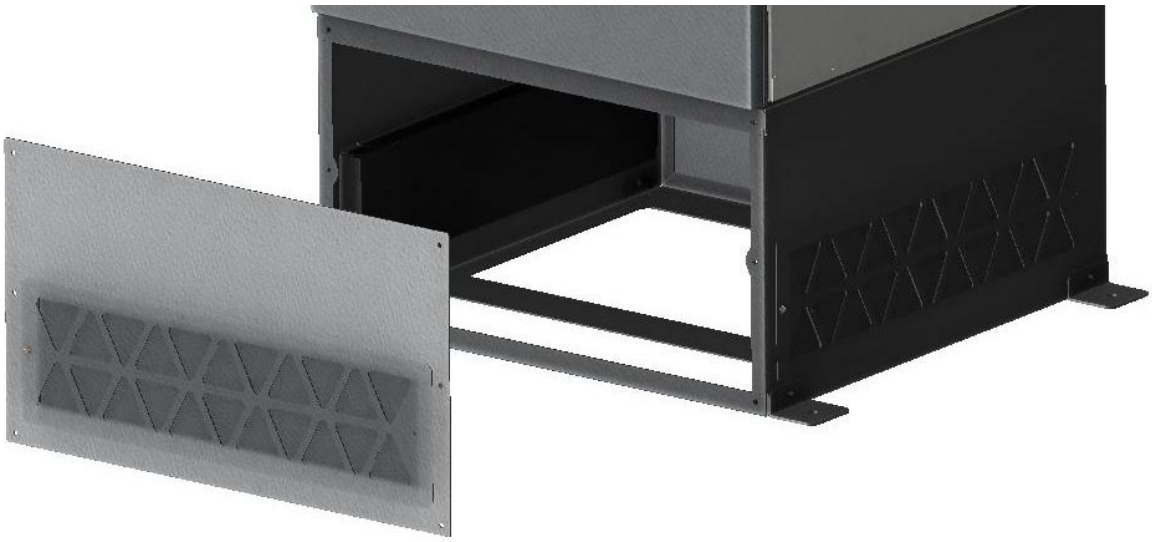


### 4.7.4. Base Module

For fixed installations, Powervamp recommend the use of a base module, this allows for the additional room required to install armoured type cables. Often cable ducts are positioned directly below the unit but on occasion there is a requirement for surface mounted cabling. A removable gland plate is provided when installing surface mounted cabling.

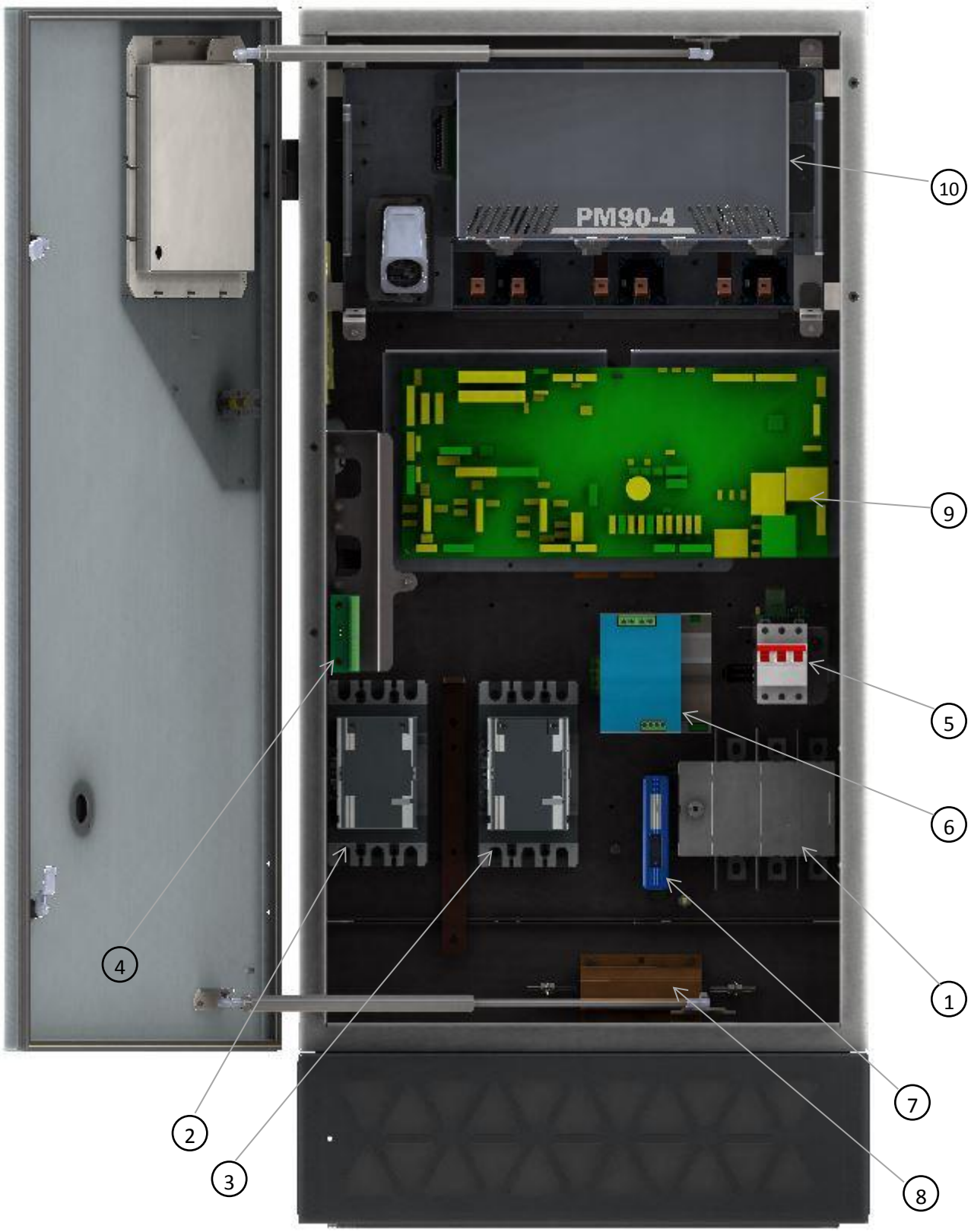
The gland plate is universal so can be moved to any position (front, back side) to accommodate particular installation requirements.



### 4.7.5. Electrical Connections

The diagram below details the main power input / output connection points and noteworthy items:



| No. | Description | Connections |
|---|---|---|
| 1 | Main Input Isolator (door interlocked) | Input Power (L1, L2 & L3). See 4.3.6 |
| 2 | Output 1 Contactor (400Hz) | 400Hz Output 1 (L1, L2 & L3). See 4.3.7 |
| 3 | Output 2 Contactor (400Hz/28VDC - Option) | 400Hz Output 2 (L1, L2 & L3) OR 28VDC Output. See 4.3.7 |
| 4 | PV-PIT PCB (Interface Signals) | Signal Cable (For External Cable Carrier/Cable Coil Remote Control). 12 Core Per Output Recommended. See 4.3.8 |
| 5 | MCB1 (Electronics Supply MCB) | N/A |
| 6 | Main PSU | N/A |
| 7 | External Communications Unit (Option) | For RS-485/Modbus/Ethernet Protocols |
| 8 | Anti-Condensation Heater (Option) | N/A |
| 9 | PV-CONTROL PCB (PV-FILTER PCB located behind) | N/A |
| 10 | PM90-4 Power Module | N/A |

### 4.7.6. Input Mains / Supply

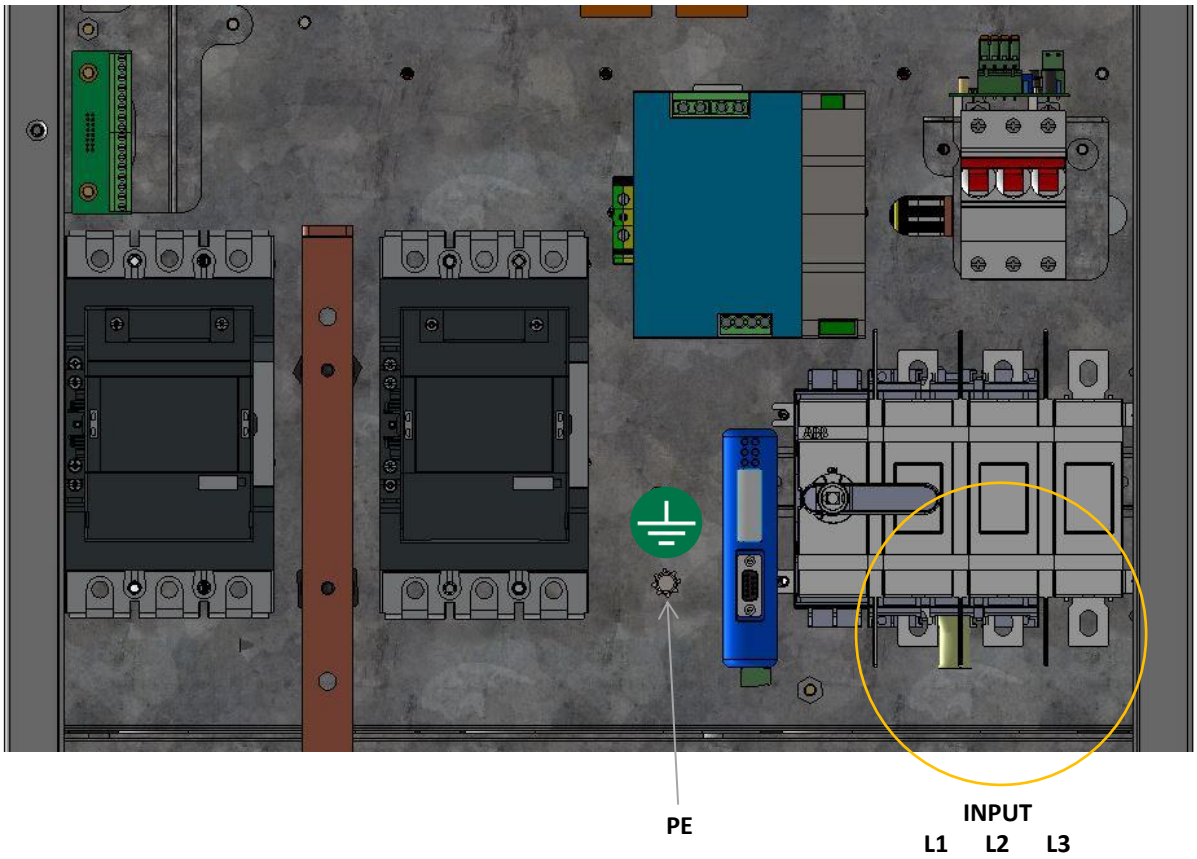
In order to achieve full output power, it is recommended that the input is supplied from a 160A (400V input) / 125A (480V input) fuse or circuit breaker. A smaller input supply can be utilised although this will limit the output load capacity.

| | |
|---|---|
|  | **It is vital that the correct input voltage is applied to the system; please check the rating label for confirmation prior to connection. See also Section 9.0 Technical Data.** |

| | |
|---|---|
|  | **The system has an EMC (electromagnetic conformance) filter; due to the nature of EMC filters there will be some leakage to earth, as such RCD's (residual current device) are not recommended for the input supply at a rating of less than <50mA.** |

| | |
|---|---|
|  | **The system requires a three phase and earth input supply.**<br>**<u>For safety reasons, do not operate the system without an earthed input supply.</u>** |

The input cables terminate directly onto the input isolator (L1, L2 & L3) with the earth ⏚ connection directly to the main earth stud.

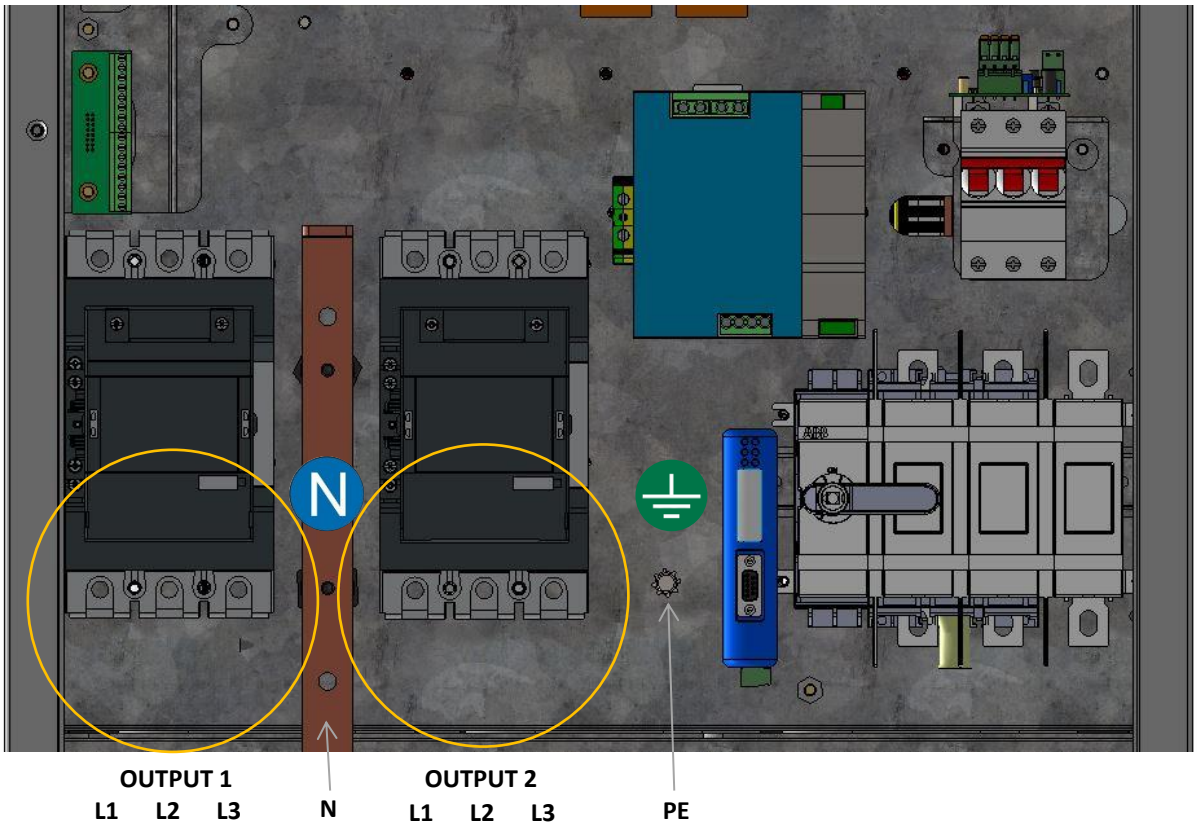


### 4.7.7. 400Hz Output

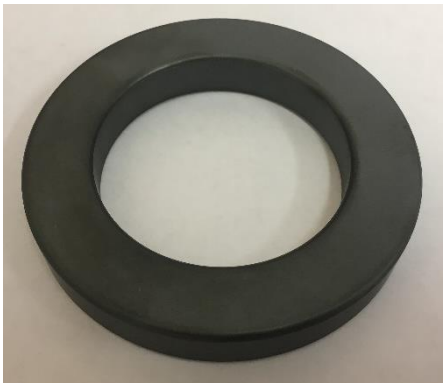
As standard, the output neutral is referenced to earth via a neutral / earth link. It is vital that local legislation is followed and therefore in some instances (where the neutral is referenced elsewhere) this link should be removed.

The system can be supplied with either one or two 400Hz outputs depending on the requirement. In both instances the output cable is connected directly to the output contactor/s and common neutral busbar.

For systems fitted with two outputs, each output is capable of supplying the full load (90kVA), both outputs can be used simultaneously provided the connected load doesn't exceed the system rating.
Note: Output 2 can also be used to feed the Optional 28VDC Output Module.

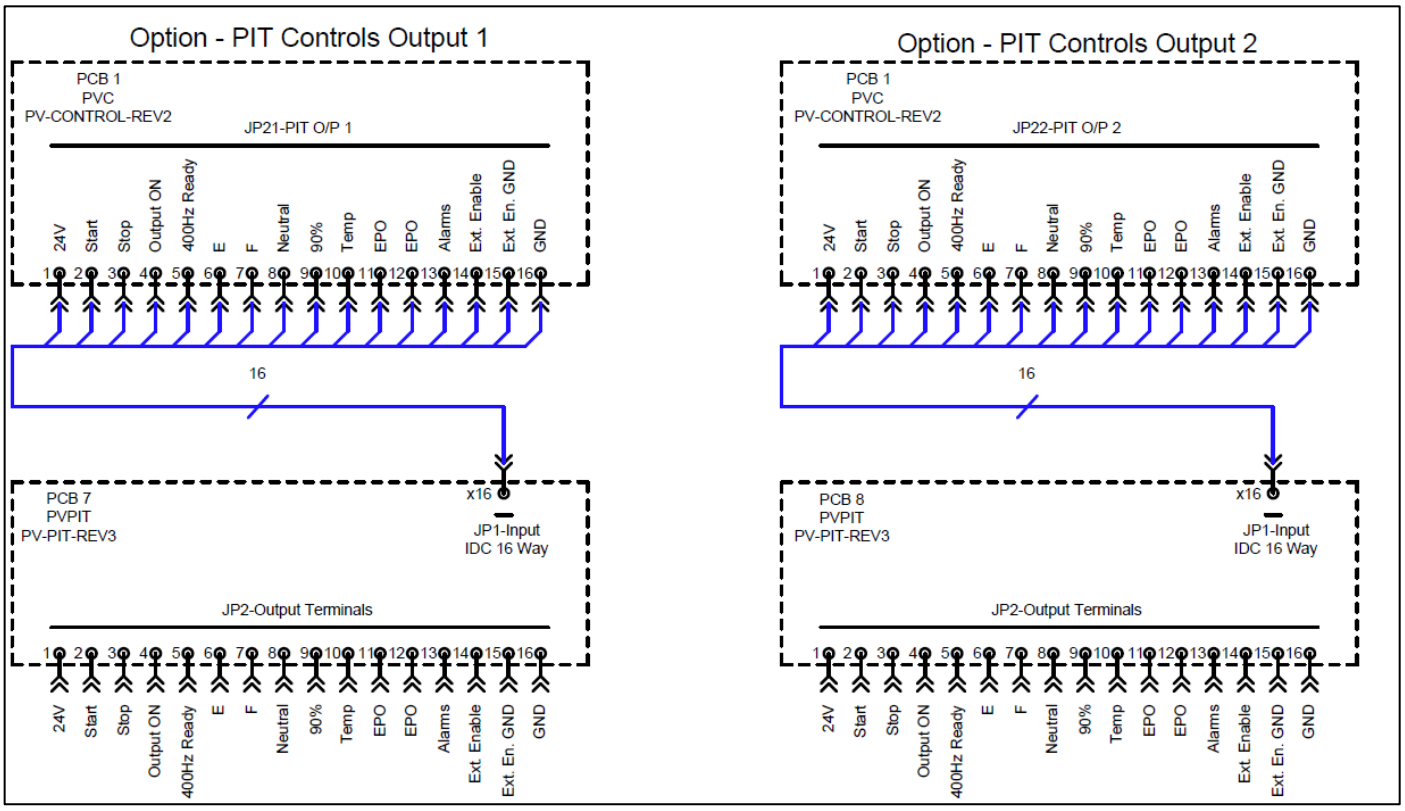



Additional ferrite rings are supplied loose with the PV90-4 GPU, these are for each 400Hz Output and should be fitted to the output cable/s at the time of installation. These rings help reduce output electrical noise to the aircraft. Note: Ensure all 4 cores (L1, L2, L3 & N) pass through the rings in the same direction.



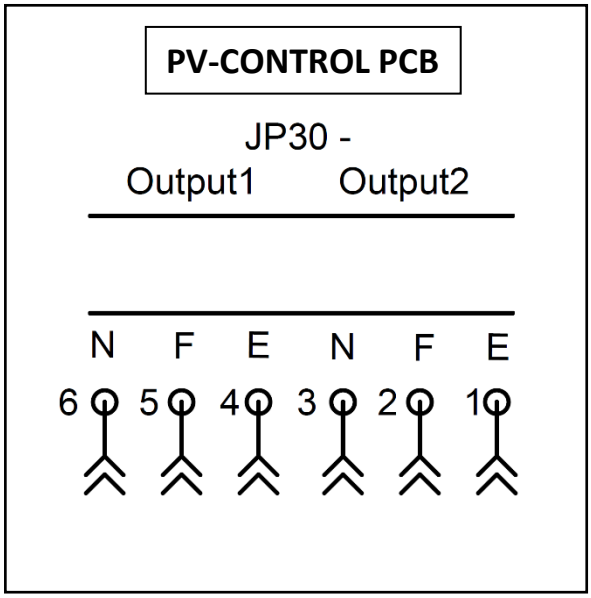
### 4.7.8. Remote Control Connections (PV-PIT PCB)

The PV-PIT PCB controls most of the remote incoming / outgoing signals. One PV-PIT PCB is fitted as standard and a second when a secondary output is used (Optional). To make connection easier, the image below shows various numbers which correspond with the appropriate explanation / diagram below.



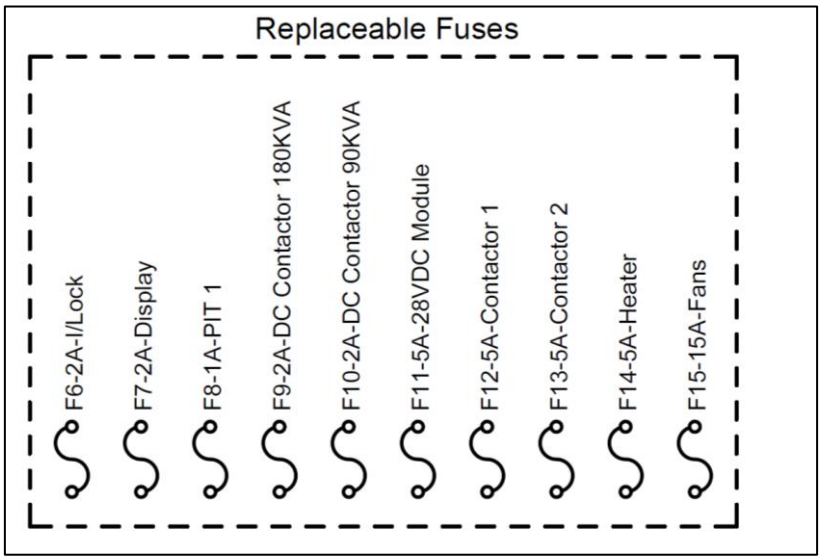

#### 4.7.8.1 Aircraft Interlock Connections ①/②

There is one aircraft interlock connection per output, if only one output is fitted then only ① is used. The diagram below shows further details:



### 4.7.9. Remote Control / Interlock Connections Fuses

Both the PV-PIT & Interlock (Military) 24VDC Supplies are Fused on the PV-CONTROL PCB. Fuse Ratings and details are shown below:




#### 4.7.9.1 USB Data Recording

USB Dongle (optional) mass data storage port, allows additional Data Logging records to be stored. Please contact a sales representative for specific application information.

#### 4.7.9.2 Interface via Link Wireless System

A cloud-based 4G Wireless Communication Monitoring System (Link) (optional) can be provided to suit customer communication needs. Please contact a sales representative for specific application information.

#### 4.7.9.3 Interface via RS232 / RS485 (option)

RS232 / RS485 interface (optional) can be provided to suit customer communication needs. Please contact a sales representative for specific application information.

#### 4.7.9.4 Interface via TCP/IP (option)

LAN / TCP/IP interface (optional) can be provided to suit customer communication needs. Please contact a sales representative for specific application information.

# 5. COMMISSIONING

## 5.1. Operational and Environmental Conditions after Commissioning

For installations where there is a risk of condensation, the unit must be left switched on (standby mode), this provides optimal conditions for the electronic components and avoids humidity in the form of condensed water from reaching vital parts.

| | |
|---|---|
|  | **To prevent condensation and possible damage to electronic components, the unit must be switched on (standby mode) at all times.** |

If for some reason the unit has been left without input power for a period of time, a visual inspection for signs of humidity should be carried out. If humidity is discovered on any of the internal parts, the parts must be left to dry out before completely before input power is applied.

| | |
|---|---|
|  | **Risk of electric shock! Only qualified engineers should attempt to commission this system, failure to commission the system correctly could invalidate the warranty.** |

**NOTE: The following points are for commissioning purposes only and are not part of the normal 'Start-up' / 'Shut-down' procedure.**

1. Perform a visual check for mechanical damage and loose connectors / connections.
2. For systems supplied on a trolley or trailer, check tyre pressures (where applicable) as well as brake operation.
3. Ensure that the input supply is connected correctly and securely.
4. Ensure that the output cables are connected correctly and securely.
5. Ensure ferrite rings are fitted correctly to the output cables.
6. Ensure interlock and remote-control cables are connected correctly and securely.
7. Perform relevant dead tests on output cables to confirm no short-circuit between any of the phases and also earth/ground.
8. Close all doors securely, then turn on the input supply to the system.
9. Check that MCB1 is in the ON position and the EPO is out.
10. Turn on input isolator at the rear of the system.
11. Wait for the system to initialise and for the Display to Activate, showing a Green Tick for Healthy System Status.
12. The green button can now be pressed to start the inverter. The display should now indicate the correct inverter (output) voltage.
13. Test system with load bank to confirm output voltage, phase rotation and interlock functions.
14. Setup output line drop compensation with load bank to within standard limits. 115.0VAC @ 72kW load is recommended. See Display Section for detail regarding setup and line drop compensation settings.
15. Check weather seals, in particular roof bolt seals which may have been removed to fit the lifting eyes.
16. Ensure all internal protection panels are fitted and doors are closed properly.

# 6. SYSTEM OPERATION

## 6.1. Display

| Buttons | | | | | |
|---|---|---|---|---|---|
| ◯ | - | Rotary Navigation (Left-Right) | ≡ | - | Access Menu Screen |
| ◯ | - | Rotary Navigation (Up-Down) | I | - | Inverter ON |
| ◯ | - | Rotary Navigation – Enter (Press) | O | - | Inverter OFF |
| ≡ | - | Menu Access | - | - | - |


| Indications (Membrane) | | | | | |
|---|---|---|---|---|---|
| ✓ | - | System OK (Green) | Green LED (1) | - | Power to the aircraft (Output 1) |
| ⚠ | - | Warning (Amber) | Green LED (2) | - | Power to the aircraft (Output 2) |
| ✶ | - | System Fault (Red) | - | - | - |

| Display Icons | | | | | |
|---|---|---|---|---|---|
|  | - | 400Hz Interlock Received (Output Active. Connected to Aircraft) |  | - | 28VDC Interlock Received (Output Active. Connected to Aircraft) |
|  | - | 400Hz Interlock Not Received (Output Active. Not connected to Aircraft) |  | - | 28VDC Interlock Not Received (Output Active. Not connected to Aircraft) |
| | | | | | |
|  | - | System Information |  | - | System Settings |
|  | - | Datalogger |  | - | Input Settings |
|  | - | USB Read/Write Firmware Update |  | - | Output Settings |
| | | | | | |
|  | - | Fan Healthy |  | - | Fan Failed |

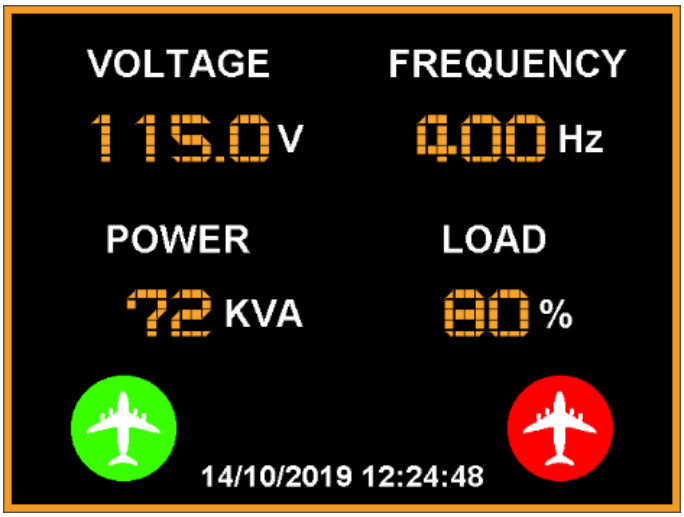
The GPU is factory configured to one of the following three modes:

- Single 400Hz Output
- Dual 400Hz Output
- Single 400Hz Output + 28 VDC Output (combination output)

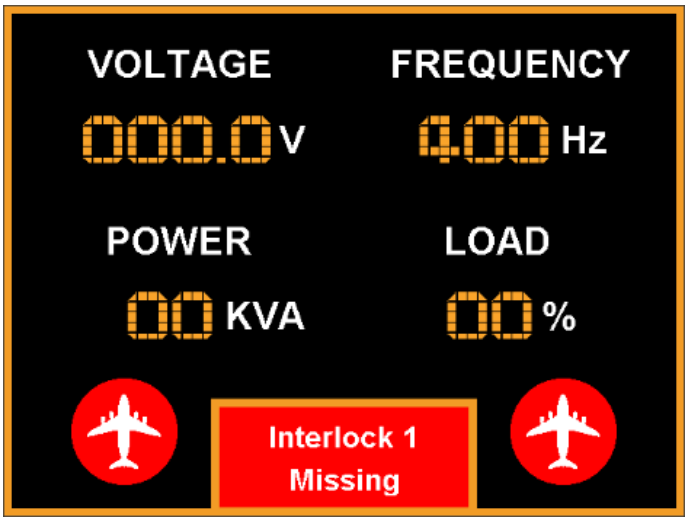
The display indicators will differ depending on which of the above configurations are selected. See further details below:

### 6.1.1. Output Active - Example

**NORMAL OPERATION – SINGLE OUTPUT ACTIVE – INTERLOCKED**




**FAULT MODE – REQUIRES ATTENTION / RESET (Alarm will appear with text)**

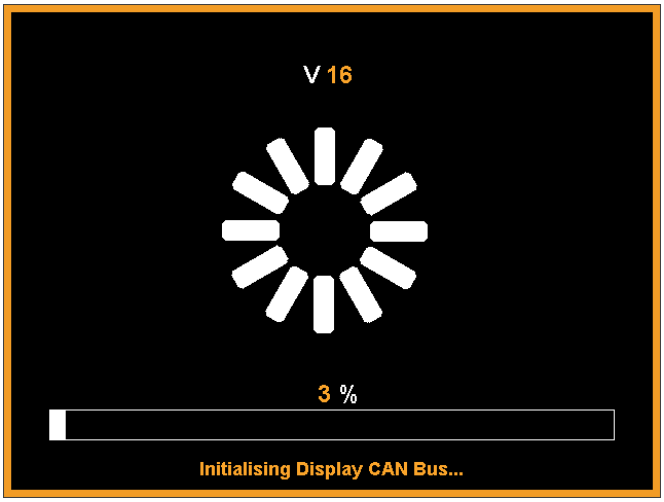



### 6.1.2. Display Metering

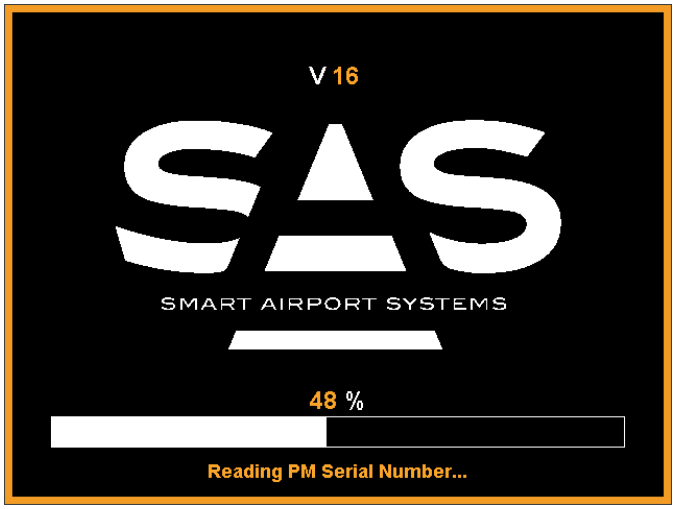
The display screen provides useful measurements of all critical parameters which assist the user during setup and fault finding.

The various screens are detailed below.

**Initialising Screen:**




**Loading Screen(s):**

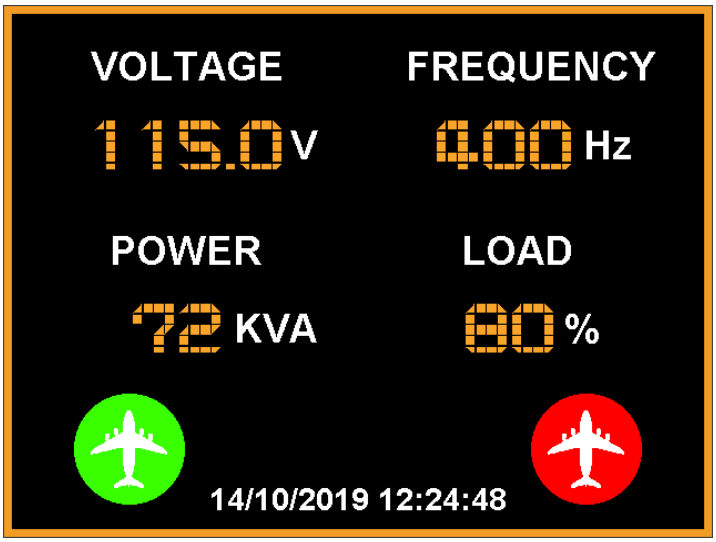



**Screensaver:**

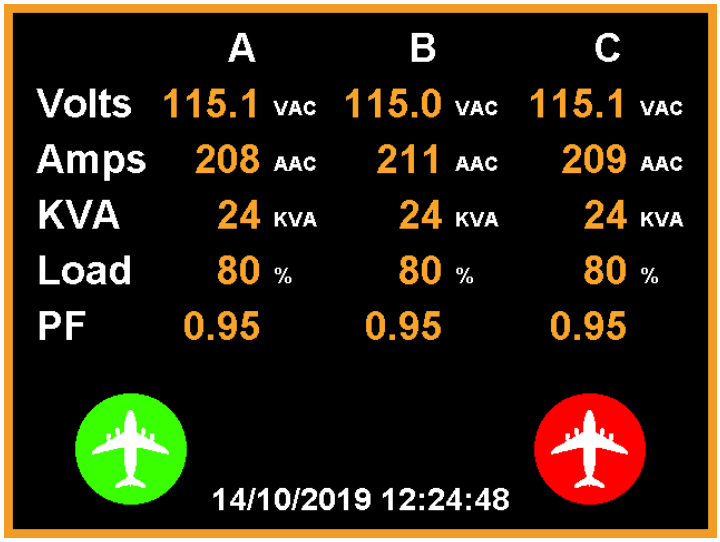


When operating, the user can use the Rotary Encoder (turn) to scroll through the various screens:

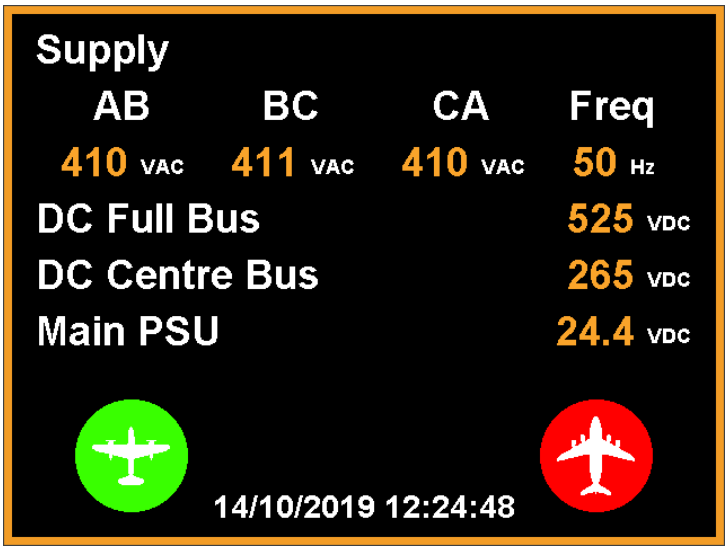
**Main Screen 1:**



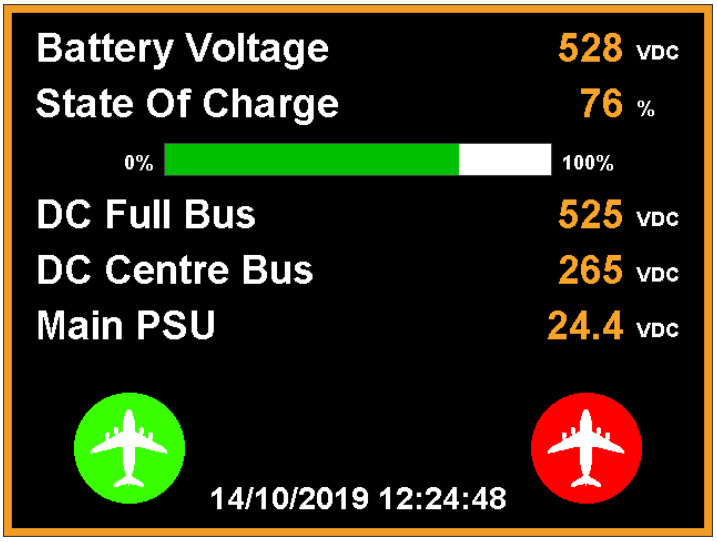
**Main Screen 2:**



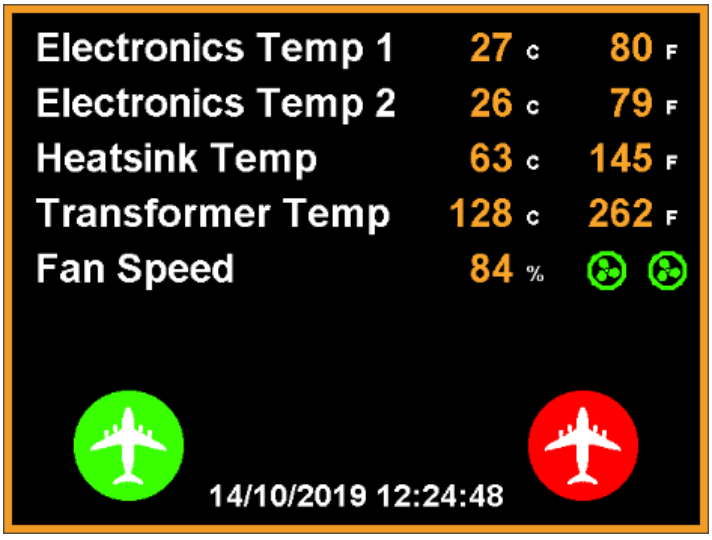

**Main Screen 3:**



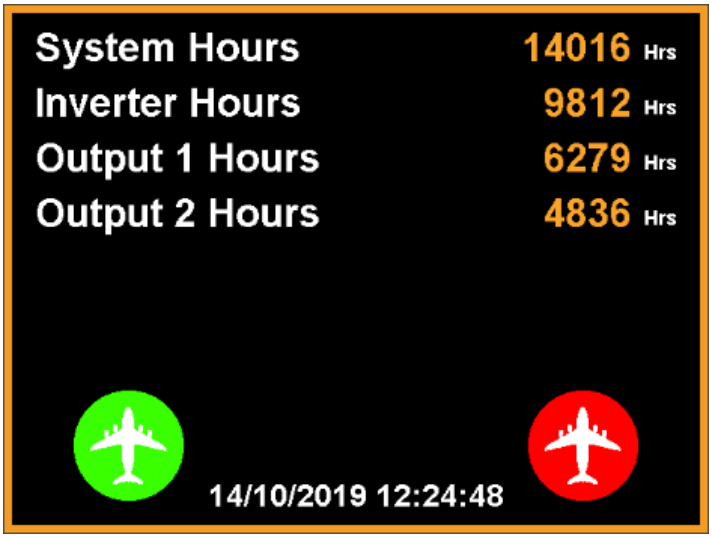

**Main Screen 3 (E-GSE Mode):**



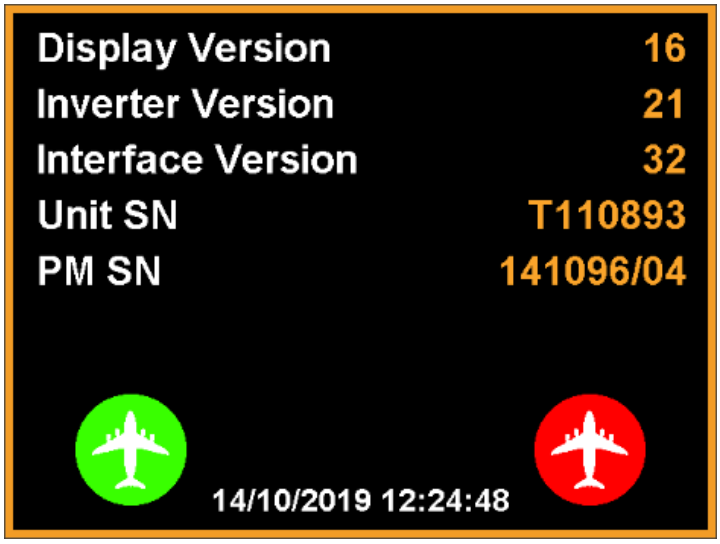

**Main Screen 4:**




**Main Screen 5:**



**Main Screen 6:**




### 6.1.1. Display Menu

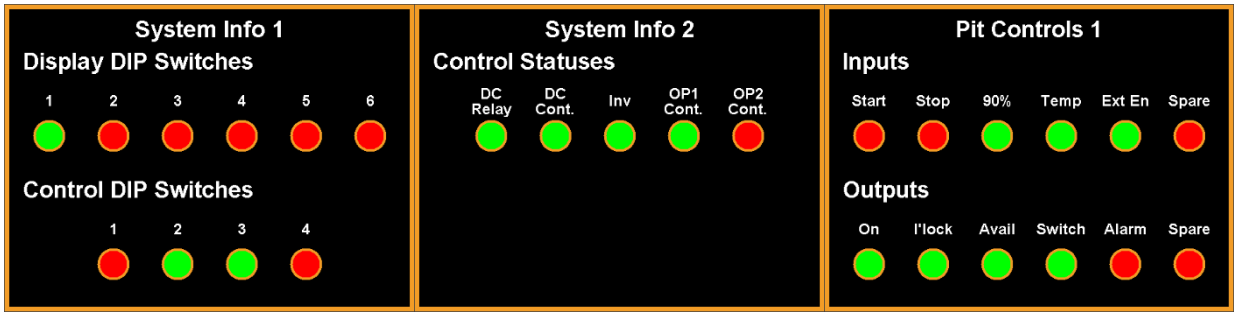
When operating, the user can use the Menu Button (☰) to access the system parameters and settings:

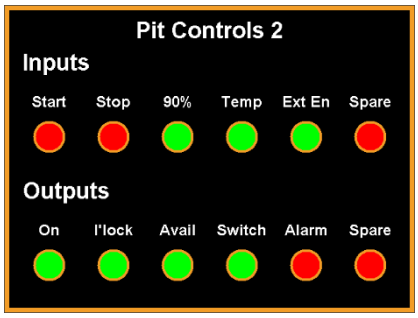
Navigating through the menu functions is simple, to get started, press the menu button and then use the Rotary Encoder to move the cursor to the appropriate function / setting. Then press the Rotary Encoder down to access that Manu.

Each menu entry allows access to a different set of functions. Please examine the figure below for further information on which menu is used to access a certain function. The user can then follow the on-screen commands in order to gain access to that function and make any changes.

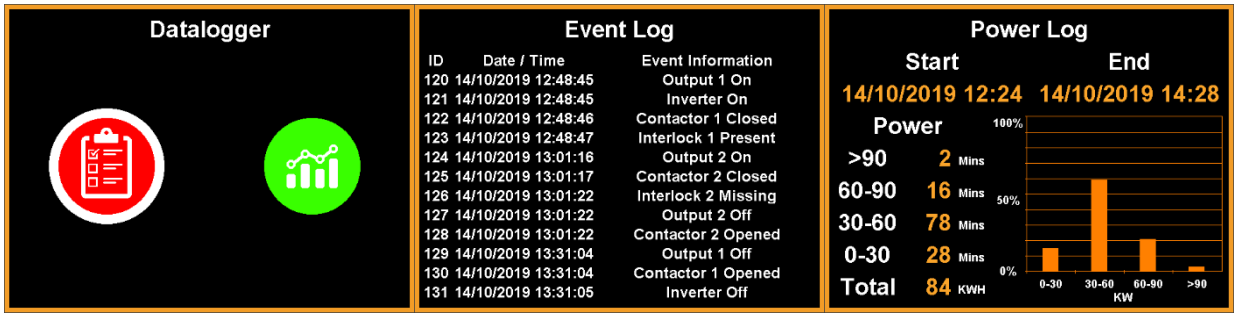
**Main Menu Screen:**

**System Information Screens:**




**Datalogger Screens:**




**USB Screens:**

**System Settings:**

| System Settings |
|---|
| Pit Controls 1 |
| Pit Controls 2 |
| Thermal Settings |
| Flight Entry |
| Display Settings |
| Time / Date |
| Language |

| Pit Controls 1 | |
|---|---|
| Enable | On |
| Start | NO |
| Stop | NO |
| External Enable | Off |
| 90% Switch | Off |
| Temperature Switch | Off |

| Pit Controls 2 | |
|---|---|
| Enable | On |
| Start | NO |
| Stop | NO |
| External Enable | Off |
| 90% Switch | Off |
| Temperature Switch | Off |

| Thermal Settings | |
|---|---|
| Fan Idle | Off |
| Fan Boost | Off |
| Heater | Off |

| Flight Entry | |
|---|---|
| Flight Entry | Off |

| Display Settings | |
|---|---|
| Backlight | 100 % |

| Time / Date | |
|---|---|
| Time | 12:24 |
| Date | 14/10/2019 |
| Format | dd/mm/yyyy |

| Language | |
|---|---|
| Language | English |

**Input Settings:**

| Input Settings | |
|---|---|
| Low Input Volts | Off |
| Battery GPU | Off |
| Input Earth Mon | Off |

**Output Settings:**

| Output Settings |
|---|
| AC Output Settings |
| DC Output Settings |
| Interlock Settings |
| Output Monitoring |
| Output Configuration |

| AC Output Settings | |
|---|---|
| Target A | 115.0 VAC |
| Target B | 115.0 VAC |
| Target C | 115.0 VAC |
| Line Drop A | 2.4 % |
| Line Drop B | 2.4 % |
| Line Drop C | 2.4 % |

| DC Output Settings | |
|---|---|
| Target Voltage | 28.5 VDC |
| Line Drop | 4 % |
| Current Limit | 2400 ADC |

| Interlock Settings | |
|---|---|
| Civillian / Military | Civillian |
| Timeout | 3.0 s |
| Override 1 | Off |
| Override 2 | Off |

| Output Monitoring | |
|---|---|
| Output Earth Mon | Off AAC |
| Neutral-Earth Relay | Off |
| Neutral Supervision 1 | Off VAC |
| Neutral Supervision 2 | Off VAC |

| Output Configuration | |
|---|---|
| Output Config | 2x 400Hz |
| Mode | Simultaneous |

### 6.1.1. Display Menu Structure Chart

| | | | | |
|---|---|---|---|---|
| Main Menu | System Information | - | | |
| | Datalogger | Event Datalogger | - | |
| | | Power Datalogger | - | |
| | USB | Update Display Firmware | - | |
| | | Update Interface Firmware | - | |
| | System Settings | Pit Controls 1 | Enable | On |
| | | | | Off |
| | | | Start | NO |
| | | | | NC |
| | | | Stop | NO |
| | | | | NC |
| | | | External Enable | Off |
| | | | | NO |
| | | | | NC |
| | | | 90% Switch | Off |
| | | | | NC |
| | | | | NO |
| | | | Temperature Switch | Off |
| | | | | NC |
| | | | | NO |
| | | Pit Controls 2 | Enable | On |
| | | | | Off |
| | | | Start | NO |
| | | | | NC |
| | | | Stop | NO |
| | | | | NC |
| | | | External Enable | Off |
| | | | | NO |
| | | | | NC |
| | | | 90% Switch | Off |
| | | | | NC |
| | | | | NO |
| | | | Temperature Switch | Off |
| | | | | NC |
| | | | | NO |
| | | Thermal Settings | Fan Idle | Off |
| | | | | On |
| | | | Fan Boost | Off |
| | | | | On |
| | | | Heater | Off |
| | | | | On |
| | | Flight Entry | Flight Entry | Off |
| | | | | On |
| | | Display Settings | Backlight | 5-100% |

| | | | | |
|---|---|---|---|---|
| | | Time / Date | Time | - |
| | | | Date | - |
| | | | Format | dd/mm/yyyy |
| | | | | mm/dd/yyyy |
| | | | | yyyy/dd/mm |
| | | | | yyyy/mm/dd |
| | | Language | Language | English |
| | Input Settings | Low Input | | Off |
| | | | | On |
| | | Battery GPU | | Off |
| | | | | On |
| | | Input Earth Monitoring | | Off |
| | | | | Spare Input 1 |
| | | | | Spare Input 2 |
| | Output Settings | AC Output | Target A | 112.0-119.5VAC |
| | | | Target B | 112.0-119.5VAC |
| | | | Target C | 112.0-119.5VAC |
| | | | Line Drop A | 0-10% |
| | | | Line Drop B | 0-10% |
| | | | Line Drop C | 0-10% |
| | | DC Output | Target Voltage | 26.0-29.0VDC |
| | | | Line Drop | 0-10% |
| | | | Current Limit | 600-2400A |
| | | Interlock | Civillian / Military | Civillian |
| | | | | Military |
| | | | Timeout | 3.0-10.0s |
| | | | Override 1 | Off |
| | | | | On |
| | | | Override 2 | Off |
| | | | | On |
| | | Output Monitoring | Output Earth Monitoring | Off |
| | | | | 0-10AAC |
| | | | Neutral-Earth Relay | Off |
| | | | | Spare Input 1 |
| | | | | Spare Input 2 |
| | | | Neutral Supervision 1 | Off |
| | | | | 1-50VAC |
| | | | Neutral Supervision 2 | Off |
| | | | | 1-50VAC |
| | | Output Configuration | Output Config | 1x 400Hz |
| | | | | 2x 400Hz |
| | | | | 400Hz + TRU DC |
| | | | | 400Hz + Inv DC |
| | | | Mode | Simultaneous |
| | | | | Individual |

### 6.1.7. Display Menu – Modifying Settings

During normal operation the system settings cannot be modified and can only be viewed. Adjusting the PV-DISPLAY PCB Dip Switch SW1-1 into the ON position allows the user to modify all settings using the Rotary Encoder.

Navigate to the relevant menu and Modify the setting by pressing the Rotary Encoder button and adjusting as necessary.

| | |
|---|---|
|  | **Warning: Only trained personnel should adjust parameters within this menu. Disabling / adjusting safety features can lead to serious injury.**<br>**Ensure PV-DISPLAY PCB SW1-1 is set to the OFF position following initial setup / commissioning.** |

### 6.1.8. 400Hz Setup - Example

- **Line Drop Compensation**
  This feature automatically adjusts the output voltage to compensate for the voltage drop in the output cable. It is not normally necessary to adjust this setting after the initial commissioning as the setting will be stored within the systems non-volatile memory.

  We would recommend adjusting this setting when a new cable is installed or when problems with voltage tolerances occur at the aircraft.

| | |
|---|---|
|  | **This setting must only be adjusted with use of a load bank and calibrated voltmeter, adjustment is not recommended when connected to an aircraft.** |

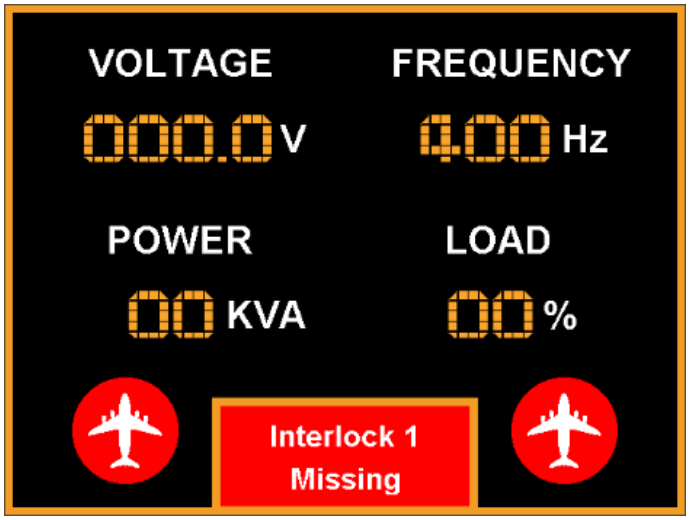
  - Connect a load bank and apply a reasonable load >50%
  - Measure voltage at load bank using a calibrated 400Hz voltmeter
  - Press the Menu Button
  - Select Output Settings icon
  - Navigate to the until Line Drop Comp (%) is shown for chosen output (L1, L2 or L3).
  - Use the Rotary Encoder & Button to increase/decrease Line Drop Compensation percentage to achieve the correct voltage at the load bank. This must be repeated for each phase.
  - Press Menu to exit once all necessary adjustments have been made.
  - Press Menu to return to default screen.

- **Output Voltage Adjustment**
  Occasionally the operator may prefer a slightly higher or lower nominal output voltage, for example adjusting the nominal output from 115.0 volts to 115.5 volts.

  - Press the Menu Button
  - Select Output Settings icon
  - Navigate until Voltage Adjustment is shown for chosen output (L1, L2 or L3).
  - Use the Rotary Encoder & Button to increase/decrease Output Voltage as required.
  - Press Menu to exit once all necessary adjustments have been made
  - Press Menu to return to default screen

| | |
|---|---|
|  | **Warning: Measure output voltage with a calibrated voltmeter prior to connecting to aircraft.** |

### 6.1.9. Display Alarms




The above example shows the default display screen with a system alarm. There are numerous alarms which provide comprehensive system information and diagnostics.

**The following section is intended to be read in conjunction with Section 6 (Troubleshooting & Repair)**

As a general rule, please press and hold the red OFF button & see if the unit recovers on its own. The procedures below assume that the engineer shuts the unit down completely before checking any of the electronics described below.

| | Alarm | Description | Possible Causes / Suggested Action |
|---|---|---|---|
| | | **System** | |
| 1 | AC-DC PSU Fault | The Main DC PSU Unit Voltage is outside normal parameters or faulty. | Check Input Supply Voltage & phases present. Check MCB 1 is ON Check Electronics PSU is operating (Replace if necessary) Replace PV-CONTROL PCB if problem persists. |
| 2 | EPO Alarm | The EPO alarm has been pressed. | The continuity of the EPO path has been broken. Check the continuity of the EPO switch for correct operation. Check that the 'Output 1 & 'Output 2' external control paths are closed. Check continuity of EPO wiring to the PV-PIT PCB. Replace the PV-CONTROL PCB if no other fault found. |
| 3 | Fan Warning | Fan warning means that one of the fan tachometer feedbacks is incorrect. The unit will put the remaining fans to full speed to try to maintain operation. | Press and hold red OFF button to Reset. If one or more fans has a problem then the Fan Warning alarm will latch. Replace fan assembly, if the problem persists then replace the PV-CONTROL PCB. |
| 4 | Fan Fault | Both fans have failed, the Inverter is now inhibited. | Press and hold red OFF button to Reset. If one or more fans has a problem then the Fan |

| | | | |
|---|---|---|---|
| | | | Warning alarm will latch. Replace the fan assembly, if the problem persists then replace the PV-CONTROL PCB. |
| 5 | Heatsink Overtemp | One of the thermal switches has detected a high temperature. | Turn off the unit, wait 10 minutes for the DC to dissipate completely. Check air filter for clogging / debris, clean if required. If the Fan Warning / Failure alarm is also present then this is the likely cause of the fault. Refer to fan warning / failure below. |
| 6 | Transformer Overtemp | One of the thermal switches has detected a high temperature. | Turn off the unit, wait 10 minutes for the DC to dissipate completely. Check air filter for clogging / debris, clean if required. If the Fan Warning / Failure alarm is also present then this is the likely cause of the fault. |
| 7 | Neut - Earth Relay | The Neutral/Earth Voltage Relay (Option) has operated. | Check Output Neutral & Earth Connections, plugs and leads for damage. Check earthing and if actual voltage is present with respect to neutral. If no voltage is present, replace PV-CONTROL PCB. |
| 8 | Input Earth Missing | The Earth Fault PCB (Option) has detected a missing Earth | Check Input Earth Connection and system is correctly bonded for safety purposes. Do NOT attempt to operate the unit if the earthing conditions are compromised. |
| 9 | Output Earth Fault | - | Check Output Neutral & Earth Connections, plugs and leads for damage. Check earthing and if actual voltage is present with respect to neutral. If no voltage is present, replace PV-CONTROL PCB. |
| **Supply** | | | |
| 10 | Supply Freq Low | The incoming AC Supply Frequency is <46Hz | Check incoming Supply is correct and within system tolerance (See 9. Technical Data) |
| 11 | Supply Freq High | The incoming AC Supply Frequency is >66Hz | Check incoming Supply is correct and within system tolerance (See 9. Technical Data) |
| 12 | Supply Undervoltage | The incoming Supply (AC/DC) is below tolerance. | Check incoming Supply is correct and within system tolerance (See 9. Technical Data)<br>Check Input Connections from Input Isolator to PV-FILTER PCB and PV-CONTROL PCB.<br>Check MCB 1 is ON.<br>If problem persists, replace PV-CONTROL PCB |
| 13 | Supply Overvoltage | The incoming Supply (AC/DC) is below tolerance. | Check incoming Supply is correct and within system tolerance (See 9. Technical Data)<br>Check Input Connections from Input Isolator to PV-FILTER PCB and PV-CONTROL PCB.<br>Check MCB 1 is ON.<br>If problem persists, replace PV-CONTROL PCB |
| 14 | Supply Phase Rotation | The Phase Rotation is Anti-Clockwise. Note: Clockwise phase rotation is only required for the 24 Pulse Rectifier (Option) | Swap any incoming phases to provide Clockwise Phase Rotation. |
| **Rectifier** | | | |
| 15 | Rectifier Inhibited | The rectifier operation is inhibited by one or more of the following alarms:<br>• Supply Undervoltage/Overvoltage<br>• Rectifier DC Imbalance<br>• Phase rotation<br>• Fan Failure<br>• External Disable / Inhibit | All of these alarms come up individually on a scrolling basis - which will point to the cause of this alarm – please refer to that section of this table.<br>Some alarms such as AC-DC PSU fault may have resulted from a short interruption of the mains |

| | | | |
|---|---|---|---|
| | | • EPO Alarm | / supply & can be reset by pressing and holding the red OFF button |
| 16 | Rectifier No DC Feedback | DC bus voltage is not present when expected. | Check incoming Supply is correct and within system tolerance (See 9. Technical Data)<br>Press and hold red OFF button, if the fault persists then replace the power module. |
| 17 | Rectifier Soft Start Timeout | The Soft Start Contactor inside the Power Module hasn't opened/closed as expected. | Press and hold red OFF button, if the fault persists then replace the power module. |
| 18 | Rectifier DC Undervoltage | DC bus voltage is below maximum level. | Check incoming Supply is correct and within system tolerance (See 9. Technical Data)<br>Press and hold red OFF button, if the fault persists then replace the power module. |
| 19 | Rectifier DC Imbalance | DC Imbalance present on Power Module internal DC bus | Press and hold red OFF button, if the fault persists then replace the power module. |
| 20 | Rectifier DC Overvoltage | DC bus voltage is above maximum level. | Press and hold red OFF button, if the fault persists then replace the power module. |
| 21 | Rectifier DC Ripple | DC bus ripple voltage is above maximum level. | Press and hold red OFF button, if the fault persists then replace the power module. |
| **Inverter** | | | |
| 22 | Inverter DC GPU Alarm | N.B: For Future Development | N.B: For Future Development |
| 23 | Inverter DC Low | DC bus voltage is below minimum level to operate the Inverter. | This alarm would normally appear with other alarms, go to their appropriate section to resolve:<br>• Supply Undervoltage / Overvoltage<br>• Overload<br>• No DC Feedback<br>• AC-DC PSU Fault |
| 24 | Inverter DC Overvoltage | DC bus voltage is above maximum level. | Press and hold red OFF button, if the fault persists then replace the power module. |
| 25 | Inverter DC Undervoltage | DC bus voltage is below maximum level. | Check incoming Supply is correct and within system tolerance (See 9. Technical Data)<br>Press and hold red OFF button, if the fault persists then replace the power module. |
| 26 | Inverter Elec Overtemp | One of the thermal switches has detected a high temperature. | Turn off the unit, wait 10 minutes for the DC to dissipate completely. Check air filter for clogging / debris, clean if required. If the Fan Warning / Failure alarm is also present then this is the likely cause of the fault. |
| 27 | Inverter IGBT Fault | The Inverter power section monitoring has picked up a fault. | Generally, this could only occur if an inadvertent short-circuit was put on the output cable. If there is no outgoing load issue, change the power module. |
| 28 | Inverter NBPT Event | The system has detected a NBPT (No Break Power Transfer) with an Aircraft | Generally, this shouldn't cause a trip and is useful for maintenance and monitoring purposes. If problem persists, replace the power module followed by the PV-CONTROL PCB. |
| 29 | Inverter Overload | The Inverter power section monitoring has picked up a fault. | Generally, this could only occur if an inadvertent short-circuit was put on the output cable. If there is no outgoing load issue, change the power module. |

| | | | |
|---|---|---|---|
| 30 | Inverter Overvoltage | The power module has detected an out of spec voltage & has shut down to protect the load. | Connect a load bank & monitor the load terminals for correct voltage under all loads. Change the power module if a fault is found. Check AC Output Filter Capacitors for 340uF per phase, replace if necessary. |
| 31 | Inverter Undervoltage | The power module has detected an out of spec voltage & has shut down to protect the load. | Connect a load bank & monitor the load terminals for correct voltage under all loads. Change the power module if a fault is found. Check AC Output Filter Capacitors for 340uF per phase, replace if necessary. |
| 32 | Inverter PSU Fault | The Inverter PSU level is outside normal parameters. | Press and hold red OFF button, if the fault persists then replace the power module. |
| 33 | Inverter Short Circuit | The Inverter power section monitoring has picked up a fault. | Generally, this could only occur if an inadvertent short-circuit was put on the output cable. If there is no outgoing load issue, change the power module. |
| **Output 1** | | | |
| 34 | Interlock 1 Missing | The Aircraft Interlock Signal is missing | Ensure Plug is fully inserted into Aircraft with Auxiliary/Interlock supply available. Check continuity of interlock wires (E and F) between the output power plug and the PV-PIT PCB. With aircraft interlock signal active, check for 28 VDC between output neutral and the F Pin of the Interlock plug on the PV-PIT PCB. If 28 VDC is present but display fails to show interlock LED, replace PV-CONTROL PCB. |
| 35 | Interlock 1 Lost | The Aircraft Interlock Signal is lost | Ensure Plug is fully inserted into Aircraft with Auxiliary/Interlock supply available. Check continuity of interlock wires (E and F) between the output power plug and the PV-PIT PCB. With aircraft interlock signal active, check for 28 VDC between output neutral and the F Pin of the Interlock plug on the PV-PIT PCB. If 28 VDC is present but display fails to show interlock LED, replace PV-CONTROL PCB. |
| 36 | Interlock 1 Overridden | - | Activated by User. Automatically disables after Output Power is turned OFF. |
| 37 | 90% Switch 1 Lost | The 90% Switch Signal (Optional) is lost | Ensure Plug is fully inserted into Aircraft. Check operation of 90% Microswitch (Aviation Plug). Check Continuity of 90% Control Lines from Plug to PV-PIT PCB. If Continuity is good and 24VDC Signal is present and closed on the 90% lines, replace PV-CONTROL PCB |
| 38 | Temp Switch 1 Lost | The External Temperature Switch Signal (Optional) has been lost. | Check operation of Temperature Microswitch (Aviation Plug). Check Continuity of Temp Control Lines from Plug to PV-PIT PCB. If Continuity is good and 24VDC Signal is present and closed on the Temp lines, replace PV-CONTROL PCB. |

| | | | |
|---|---|---|---|
| 39 | Neutral Voltage 1 | The Neutral Sense Wire (Z Wire) has exceeded the programmed limit | Check Z Wire for voltage – Aviation Cable Assembly/Plug may be damaged or with a ruptured Neutral Pin. Replace as required.<br>Check Continuity of Z Wire Control Lines from Plug to PV-PIT PCB.<br>If Continuity is good and no voltage is detected, replace PV-CONTROL PCB. |
| **Output 2** | | | |
| 40 | Interlock 2 Missing | The Aircraft Interlock Signal is missing | Ensure Plug is fully inserted into Aircraft with Auxiliary/Interlock supply available.<br>Check continuity of interlock wires (E and F) between the output power plug and the PV-PIT PCB.<br>With aircraft interlock signal active, check for 28 VDC between output neutral and the F Pin of the Interlock plug on the PV-PIT PCB.<br>If 28 VDC is present but display fails to show interlock LED, replace PV-CONTROL PCB. |
| 41 | Interlock 2 Lost | The Aircraft Interlock Signal is lost | Ensure Plug is fully inserted into Aircraft with Auxiliary/Interlock supply available.<br>Check continuity of interlock wires (E and F) between the output power plug and the PV-PIT PCB.<br>With aircraft interlock signal active, check for 28 VDC between output neutral and the F Pin of the Interlock plug on the PV-PIT PCB.<br>If 28 VDC is present but display fails to show interlock LED, replace PV-CONTROL PCB. |
| 42 | Interlock 2 Overridden | - | Activated by User. Automatically disables after Output Power is turned OFF. |
| 43 | 90% Switch 2 Lost | The 90% Switch Signal (Optional) is lost | Ensure Plug is fully inserted into Aircraft.<br>Check operation of 90% Microswitch (Aviation Plug).<br>Check Continuity of 90% Control Lines from Plug to PV-PIT PCB.<br>If Continuity is good and 24VDC Signal is present and closed on the 90% lines, replace PV-CONTROL PCB |
| 44 | Temp Switch 2 Lost | The External Temperature Switch Signal (Optional) has been lost. | Check operation of Temperature Microswitch (Aviation Plug).<br>Check Continuity of Temp Control Lines from Plug to PV-PIT PCB.<br>If Continuity is good and 24VDC Signal is present and closed on the Temp lines, replace PV-CONTROL PCB. |
| 45 | Neutral Voltage 2 | The Neutral Sense Wire (Z Wire) has exceeded the programmed limit | Check Z Wire for voltage – Aviation Cable Assembly/Plug may be damaged or with a ruptured Neutral Pin. Replace as required.<br>Check Continuity of Z Wire Control Lines from Plug to PV-PIT PCB.<br>If Continuity is good and no voltage is detected, replace PV-CONTROL PCB. |

## 6.2. Start-up/Shut-down Sequence

**Only trained personnel should operate this equipment.**

**Ensure correct installation prior to applying power for the first time - voltage, phase rotation and frequency MUST be within tolerance, see Section 9.0 Technical Data within this manual for further information.**

### 6.2.1. Start-up (For standby/ready state):

1. Check that emergency stop button has been released and that MCB1 is in the ON position.
2. Turn on the main isolator.
3. Allow 10-20 seconds for the system to initialise before pressing the green button. Check that the Traffic Light "Tick" LED (Green) is illuminated and no alarms are present. The system is now ready for use.

### 6.2.2. Shut-down (For standby/ready state):

1. Press the red (off) button.
2. Turn off the main isolator.
3. Allow 10 minutes for the DC to discharge internally before opening any doors.

Note: If the unit is switched off & on again within a 2-minute period, false alarms may be displayed, in this event press and hold the red OFF (0) button to reset the display alarms.

## 6.3. Basic Operation

### 6.3.1. Power-On Procedure (Normal operation, with aircraft):

1. Fully insert aircraft connector into aircraft receptacle.
2. Press the OUTPUT ON (Green button - I). The Aircraft Interlock symbol will now change colour from Red to Green on the display if the unit is connected to an aircraft.

### 6.3.2. Power-Off Procedure (Normal operation, with aircraft):

1. Press the OUTPUT OFF (Red button - O).
2. Disconnect output cable from the aircraft.

### 6.3.3. Aircraft Interlock Safety System

This GPU incorporates an interlock safety system which disconnects the output power if the interlock signal from the aircraft is lost. When the 'ON' button is pressed, the inverter will start and supply power to the aircraft, if after 5 seconds the system does not sense an interlock signal from the aircraft, the output will disconnect.

For service, maintenance and test purposes, the interlock system can be overridden from the display panel. To ensure personal health and safety, the ground power unit automatically returns to its initial interlock mode, once it receives the interlock signal from the aircraft.

| | |
|---|---|
|  | **The aircraft interlock safety system should only be overridden for service and maintenance by qualified electrical personnel.** |

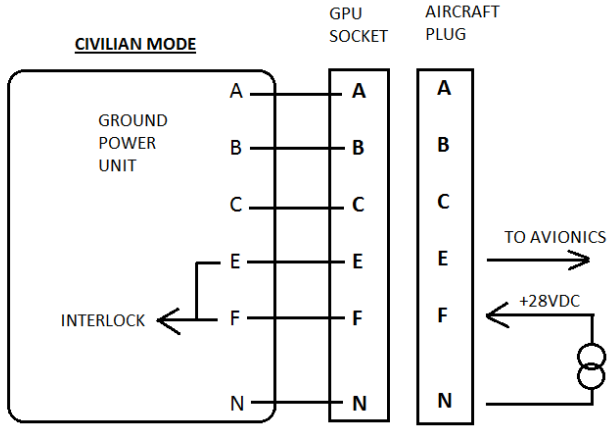
| | |
|---|---|
|  | **Selecting interlock override will cause the pins on the aircraft connector to become live if power is turned on, appropriate precautions should be taken when handling the aircraft connector.** |

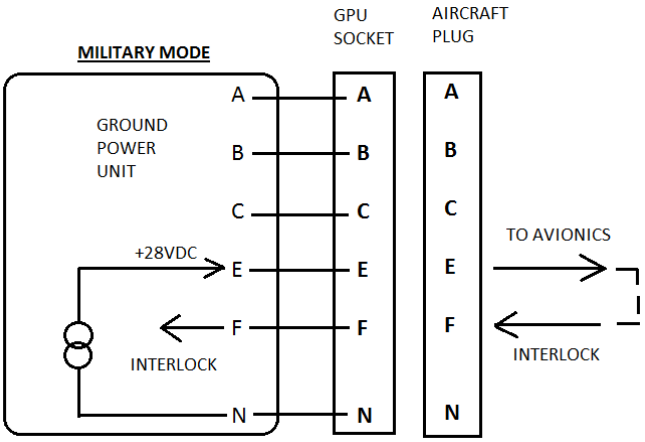
If power disconnects after 5 seconds, first check the aircraft connector is fully engaged and the correct interlock type (military or civilian) is selected. Note: An “Interlock Missing” Alarm will be shown in this event. If necessary, the interlock can be overridden by going to the ‘Interlock Settings’ in the ‘Output Settings’ Menu (only adjustable if Dip-switch SW1-1 is selected to ‘ON’ on the PV-DISPLAY PCB)
The interlock override will reset when the ‘OFF’ button (Red) is pressed or when the input power is disconnected.

### 6.3.4. Civilian / Military Interlock:

During factory testing, the interlock is set to Civilian as the default. If power disconnects after 5 seconds, first check the aircraft connector is fully engaged and the correct interlock type (military or civilian) is selected.

Note: Military Interlock arrangement is an Optional Extra and requires an additional PSU to be fitted by the Factory.



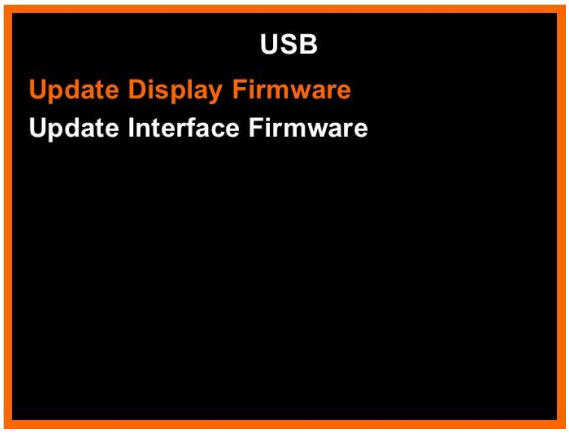



### 6.3.5. Software Update Procedure

The PV90-4 Control PCB and Display operating software can be upgraded by saving the latest version onto a standard USB drive.
To upgrade the PV-DISPLAY PCB please insert the USB drive into the USB port located on the back of the User Display and follow the instructions below. To upgrade the PV-CONTROL PCB please insert the USB drive onto the designated USB port on the PV-CONTROL PCB and follow the instructions below.

**Update Software – Step 1**

From the Main Menu Screen, please select the USB Menu Icon and then press the rotary encoder down in order to access the software update functionality.




**Update Software – Step 2**

From the USB configuration menu please select the "**Update Display Firmware"** option to upgrade display software or select the **"Update Interface Firmware"** to upgrade the Control PCB software and then press the rotary encoder down to access the menu.


**Update Software – Step 3**

The system will verify the external media is present. Please ensure the USB drive is inserted into the relevant USB port and wait for the software update process to begin.


**Update Software – Step 4**

The software will then search a file of higher version than the current version which starts with filename **"PV904-DIS-Vxx"** or **"PV904-INT-Vxx"** where xx represents the software version number.

Note: If the file with right filename not present onto the USB drive, it will display the message **"File Not Found"**.

If the file with higher version not found, it will display the message **"No New Firmware Found"**.


**Update Software – Step 5**

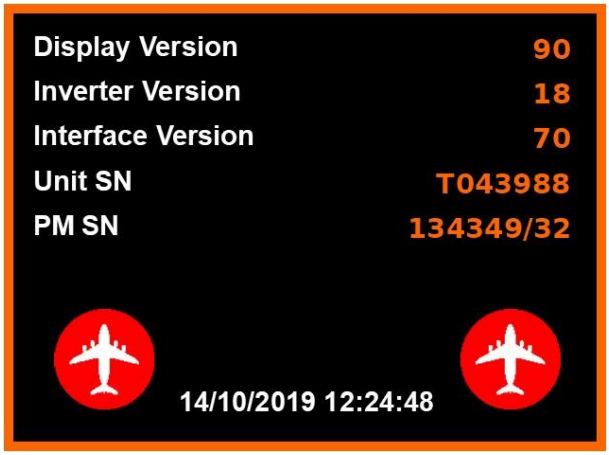
Before upgrading the software, unit will verify that the data present onto the file is correct and not corrupted.

If the file verification is failed, please try again by ensuring the correct file is present on the USB drive and follow the steps again.


**Update Software – Step 6**

If the unit is verified that all of the required software is present onto the USB, it will begin the update. During the update the display will indicate the progress of the update.

Note: Do not exit this menu while software update process is ongoing. Restart the Unit or exit out from this menu will stop the software update.




**Update Software – Step 7**

To confirm that the new software has been downloaded, the Display Version / Interface Version shown on this screen should match the new software version.

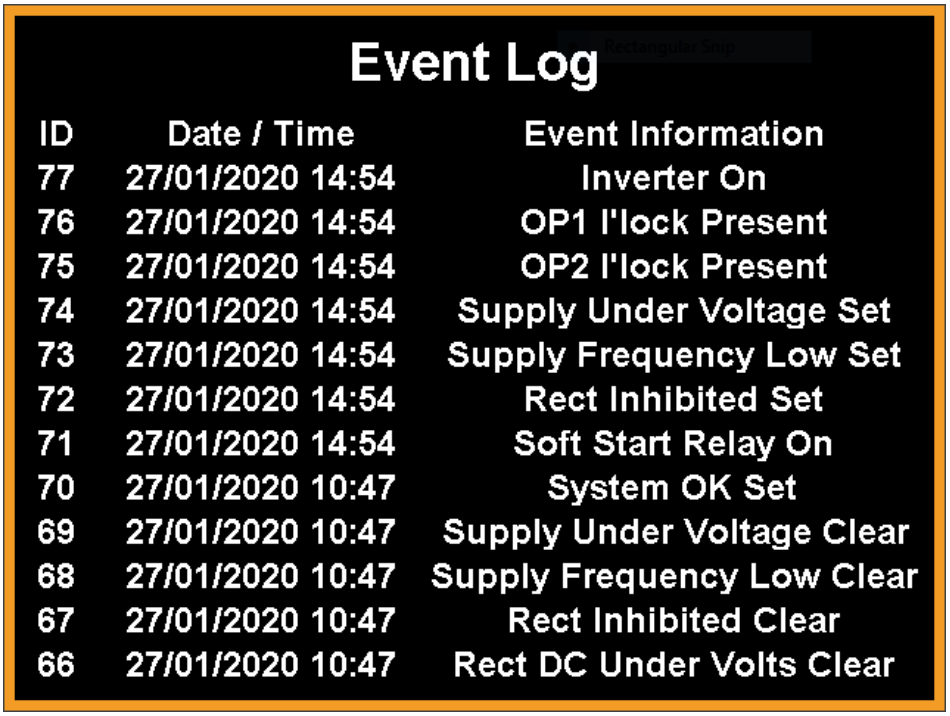
Note: As a failsafe, both the PV-DISPLAY & PV-CONTROL PCB's have the facility to force the system to carry out the software update process. This is initiated by putting the SW-1 Dipswitch 4 (IO-PV-CONTROL PCB) or SW-1 Dipswitch 6 (PV-DISPLAY PCB) into the Enabled position and re-energising the system. If this operation is carried out, the Dipswitch **must** be returned to the default Disabled position prior to being put into service.

### 6.3.6. Event Datalogger

The PV90-4 Ground Power Unit features the ability to record up to a maximum of 1000 of the most recent events/alarms occurred in time. When the limit is reached, the firmware will begin to delete the oldest record to store the most recent one. It records the Date/Time of both when event is occurred and also when the event is cleared. It also records all the useful measurements, whole unit configuration and the status of the system at the time of event. The PV90-4 also provides the separate "Event log" and "Data Download" display menu screens to help user to navigate through the event log data onto the display or to download the recorded event log data to the external USB and view it on a PC. When downloading the data to the USB, the firmware will create the new folder EventLog if it does not exist and each time create a new file named in time/date reference 30_01_2020_08_27_50 and save the files inside the folder to keep all the event log data together.

**Event Log Screen**

The Event Log Screen will display the recorded events starting from the most recent first. The user can then move the rotary encoder clockwise/anticlockwise to scroll backwards and forwards in time through the events. Note: there may be a delay in scrolling when new data is being stored.



Event Log

| ID | Date / Time | Event Information |
|---|---|---|
| 77 | 27/01/2020 14:54 | Inverter On |
| 76 | 27/01/2020 14:54 | OP1 I'lock Present |
| 75 | 27/01/2020 14:54 | OP2 I'lock Present |
| 74 | 27/01/2020 14:54 | Supply Under Voltage Set |
| 73 | 27/01/2020 14:54 | Supply Frequency Low Set |
| 72 | 27/01/2020 14:54 | Rect Inhibited Set |
| 71 | 27/01/2020 14:54 | Soft Start Relay On |
| 70 | 27/01/2020 10:47 | System OK Set |
| 69 | 27/01/2020 10:47 | Supply Under Voltage Clear |
| 68 | 27/01/2020 10:47 | Supply Frequency Low Clear |
| 67 | 27/01/2020 10:47 | Rect Inhibited Clear |
| 66 | 27/01/2020 10:47 | Rect DC Under Volts Clear |

**Viewing the Event Log Data on a PC**

If the USB data logger facility is being used, first safely remove the USB device and connect it to a PC. Open the USB Drive folder and browse to the Eventlog folder and open the log file in a compatible Spreadsheet/CSV file format viewing software. Each file name contains the date and time of when it was created. The first column of the data contains the date and time of each record. Note, depending on the software platform used, it may hide the seconds value, to display this please ensure the custom format of the data column is as follows: dd/mm/yyyy hh:mm:ss

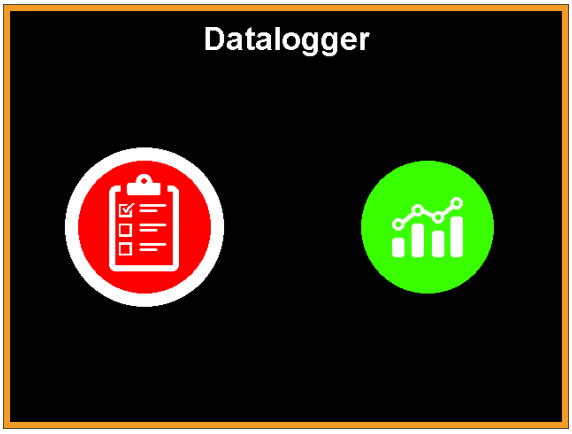
The proceeding columns contains:

- The information about which event has occurred at that time.
- The system status, output status and configuration of the whole unit.
- The information about the input supply voltages and line drops at each phase. The output frequency, Average Voltage, Total Power, Total Load etc.
- Any active error messages and system alarms.

## Data Menu Access

### Main Menu

From the Main Menu Screen, please select the Datalogger Menu Icon and then press the rotary encoder down in order to access the Datalogger functionality.




### Datalogger Menu

From the Datalogger Menu Screen, please select the Event Log Menu Icon to view the recorded events.


### Event Log View Menu

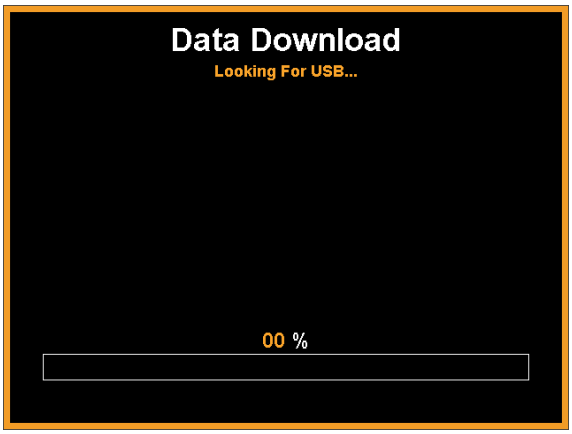
The Event log view screen displays all the recorded events. The user can then move the rotary encoder clockwise/anticlockwise to scroll backwards and forwards in time through the events.

**Data Download**

From the Main Menu Screen, please select the USB Menu Icon and then press the rotary encoder down in order to access the “Data Download” functionality.

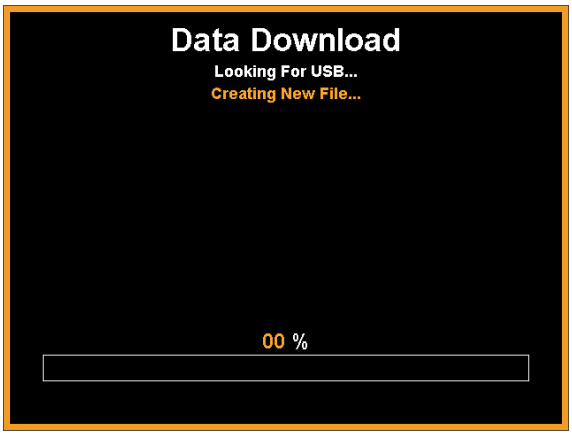

**Data Download**

From the USB configuration menu please select the “**Data Download”** option and then press the rotary encoder down to start the Event log data download process.



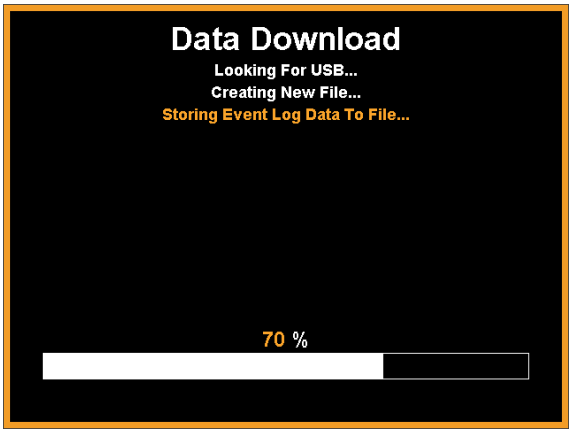

**Data Download**

Please insert the USB drive to the back of the unit display and ensure that the power to the unit is not interrupted during this process.




**Data Download**

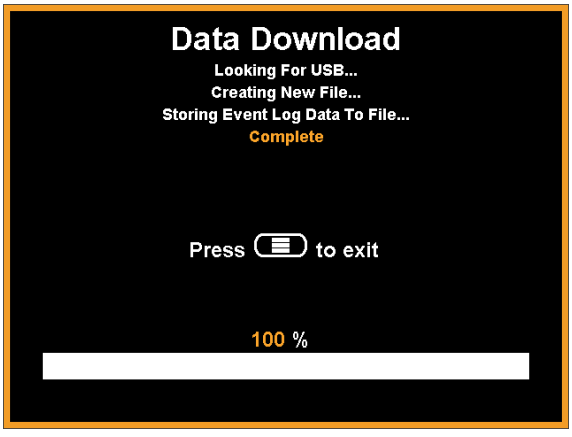
The firmware will first create a folder EventLog if it does not exist and then create the file 30_01_2020_08_27_50 inside the folder on USB to store the Event log data.




**Data Download**

The firmware start storing the Event log data to the file. The data is stored as a comma separated variable (csv), which can be read by Microsoft Excel. During the storage of data to the USB, the display will indicate the user about the progress.

Note: Please do not exit this menu while process is ongoing. Restart the Unit or exit out from this menu will stop the process.




**Data Download**

Data Download is complete, the user can press the exit menu button.

# 7. TROUBLESHOOTING & REPAIR

| | |
|---|---|
|  | **Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, maintain or repair this equipment.** |
|  | **Isolate the input supply to the GPU at the local distribution board or feeder pillar, then wait at least 10 minutes for the DC capacitors to discharge before opening any doors or removing any covers.** |
|  | **The fans are exposed when the rear door is open, do not open the any doors without isolating the unit.** |

The table on the following page details a list of all system alarms with suggested corrective actions in priority order.

**The following section is intended to be read in conjunction with Section 6.1.9 (Display Alarms) – which gives a more detailed description of the alarm and corrective actions.**

| Alarm | | Corrective Action (In Prioritised Order – 1, 2, 3…) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mains / Supply Fail** | 1 | 2 | | | 4 | | 3 | 5 | | 8 | | | | | 7 | | | | | 6 | | 9 | 10 |
| **Rectifier Inhibited** | 1 | 2 | | | | | 4 | 3 | | 5 | | | | | | | | | | | | 6 | 7 |
| **Supply Phase Rotation** | 1 | | 2 | | 4 | | | | | 6 | | | | | 5 | | | | | 3 | | 7 | 8 |
| **Supply Freq Low/High** | 1 | 2 | | | 5 | | 3 | 4 | | 8 | | | | | 7 | | | | | 6 | | 9 | 10 |
| **Supply Under/Overvoltage** | 1 | 2 | | | 5 | | 3 | 4 | | 8 | | | | | 7 | | | | | 6 | | 9 | 10 |
| **Rectifier DC Undervoltage** | 1 | 2 | | | | | 3 | | | 4 | | | | | | | | | | | | 5 | 6 |
| **Rectifier DC Overvoltage** | 1 | 2 | | | | | 3 | | | 4 | | | | | | | | | | | | 5 | 6 |
| **Rectifier DC Imbalance/Ripple** | 1 | 2 | | | | | 3 | | | 4 | | | | | | | | | | | | 5 | 6 |
| **Rectifier No DC Feedback** | 1 | 2 | | | | | 3 | | | 4 | | | | | | | | | | | | 5 | 6 |
| **Inverter Undervoltage** | 1 | 2 | | | | 3 | | | | 5 | 7 | | | 4 | | | | | | | | 6 | 8 |
| **Inverter Overvoltage** | 1 | 2 | | | | 3 | | | | 5 | 7 | | | 4 | | | | | | | | 6 | 8 |
| **Inverter Overload/Short** | 2 | 3 | | | | | | | | 4 | | | | 1 | | | | | | | | 5 | 6 |
| **Inverter IGBT Fault** | | | | | | | | | | 1 | | | | | | | | | | | | 2 | 6 |
| **Neutral Voltage 1 / 2** | | | | | | | | | | | | | | | 4 | 1 | | 2 | | 3 | | 5 | 6 |
| **90% Switch 1/ 2** | | | | | | | | | | | | | | | 3 | | | 1 | | 2 | | 4 | 5 |
| **Temp Switch 1 / 2** | 1 | | | | | | | | 5 | 6 | | | 2 | | | | | | 3 | 4 | | 6 | 8 |
| **Ambient Overtemp** | 1 | | | | | | | | 5 | 6 | | | 2 | | | | | | 3 | 4 | | 6 | 8 |
| **Transformer Overtemp** | 1 | | | | | | | | 5 | 6 | | | 2 | | | | | | 3 | 4 | | 6 | 8 |
| **Heatsink Overtemp** | 1 | | | | | | | | 5 | 6 | | | 2 | | | | | | 3 | 4 | | 6 | 8 |
| **EPO Alarm** | | | | 1 | | | | | | | | | | | 4 | | 3 | | | | 2 | 5 | 6 |
| **Fan Warning** | 2 | | | | | | | | 5 | | | 1 | | | 6 | | | | 3 | 4 | | 7 | 8 |
| **Fan Fault** | 2 | | | | | | | | 5 | | | 1 | | | 6 | | | | 3 | 4 | | 7 | 8 |
| **AC-DC PSU Fault** | 1 | 2 | 3 | | 4 | | | | | | | | | | 6 | | | | | | 5 | 7 | 8 |
| | Press and hold red OFF Button (0) | Check Display for Additional Alarms | Check Input Supply | Depress Emergency Stop Button | Check MCB 1 is ON | Check Inverter Voltage via Display | Check Supply Voltage Feedback on the Display is Present and Correct | Check Input Voltage and Frequency are within Tolerance | Replace Fan Assembly | Replace the Power Module | Replace AC Filter Capacitors | Check for Fan Failure Alarm, Visual Check of the Fans | Let the Unit Cool Down, then Reset + Start | Remove Load and Reset the System | Replace PV-CONTROL PCB | Check Neutral Earth Link is Fitted | Check Wiring of the Switch | Check Output Cable Insulation and Continuity. | Check Air Filters are Clean and Clear of Obstructions | Test the fans for operation. Check Fuse 15 on the PV-CONTROL PCB. | Check all Wiring to PV-CONTROL PCB for any Loose or Crossed | Replace Display | Refer to Section 6.1.9 for Further Detail | Call Service and Maintenance Department |

| Fault | Corrective Action (In Prioritised Order – 1, 2, 3…) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No Display Indication** | | | | | | | | | 2 | 3 | | | | | 1 | 4 | 5 | 6 |
| **Interlock Missing/Lost** | | | | | | | | | | 4 | | 2 | | | 1 | | 3 | 5 |
| **Rectifier Soft Start Timeout** | 1 | 2 | | | | 5 | | | | | | | | | | 3 | 4 | 6 |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | Press and hold red OFF Button (0) | Check Display for Additional Alarms | Check / Replace USB Dongle | Check External Inhibit / Control Input | Check Fuses on PV-CONTROLPCB (Fuses F12, 13) | Replace Power Module | Check Supply Voltage Feedback on the Display is Present and Correct | Check Input Voltage and Frequency | Check Fuses on PV-CONTROL PCB (Fuses F8 & F6) | Replace PV-CONTROL PCB | Check Wiring of the Switch | Check Output Cable Insulation and Continuity. | Check Air Filters are Clean and Clear of Obstructions | Check Door is Closed Correctly | Check all Wiring to PV-CONTROL PCB for any Loose or Crossed Connections | Replace Display | Refer to Section 6.1.9 for Further Detail | Call Service and Maintenance Department |

# 8. SERVICE & MAINTENANCE

**NOTE: IT IS ESSENTIAL THAT THIS EQUIPMENT BE REGULARLY CHECKED & TESTED BY QUALIFIED & COMPETENT SERVICE ENGINEERS. PLEASE CONTACT OUR SERVICE DEPARTMENT FOR MORE INFORMATION/DETAILS.**

**Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, maintain or repair this equipment.**

**Isolate the input supply to the GPU at the local distribution board or feeder pillar, then wait at least 10 minutes for the DC capacitors to discharge before opening any doors or removing any covers.**

## 8.1. Recommended Routine maintenance

All systems should be checked regularly in accordance with current legislation. The check-list below details Powervamp's recommended check / test schedule which should be followed for safety as well as ensuring equipment warranty remains intact. Daily checks are aimed at operators / ramp staff, any faults should be reported immediately.

| Check Type | Check Item | Daily | Monthly | 6 Monthly |
|---|---|---|---|---|
| General | Display for Green ✓ LED, No Alarms | ✓ | | |
| | Air Filters are Clean | | ✓ | |
| | Inspect Unit for Physical Damage | ✓ | | |
| | Check Ground Fixing Bolts (if applicable) | | | ✓ |
| | Wheels & Brakes (if applicable) | ✓ | | |
| | Cabinet Door Locks | | ✓ | |
| | Cabinet Door Hinges | | ✓ | |
| | Cabinet Door / Roof Weather Seals | | | ✓ |
| | Information / Safety Decals | | ✓ | |
| Electrical | Input Isolator Switch Functional Test | | | ✓ |
| | Emergency Stop Functional Test | | | ✓ |
| | Aircraft Leads (basic check) | ✓ | | |
| | Aircraft Connectors (basic check) | ✓ | | |
| | Aircraft Leads (comprehensive check) | | | ✓ |
| | Aircraft Connectors (Comprehensive check) | | | ✓ |
| | Earth Bonding | | | ✓ |
| | Output Cable Insulation | | | ✓ |
| | Check all Electrical Connections are Tight | | | ✓ |
| | Load Bank & Interlock Functionality Test | | | ✓ |

## 8.2. Air Inlet Filter Replacement

| | |
|---|---|
|  | **Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, maintain or repair this equipment.** |

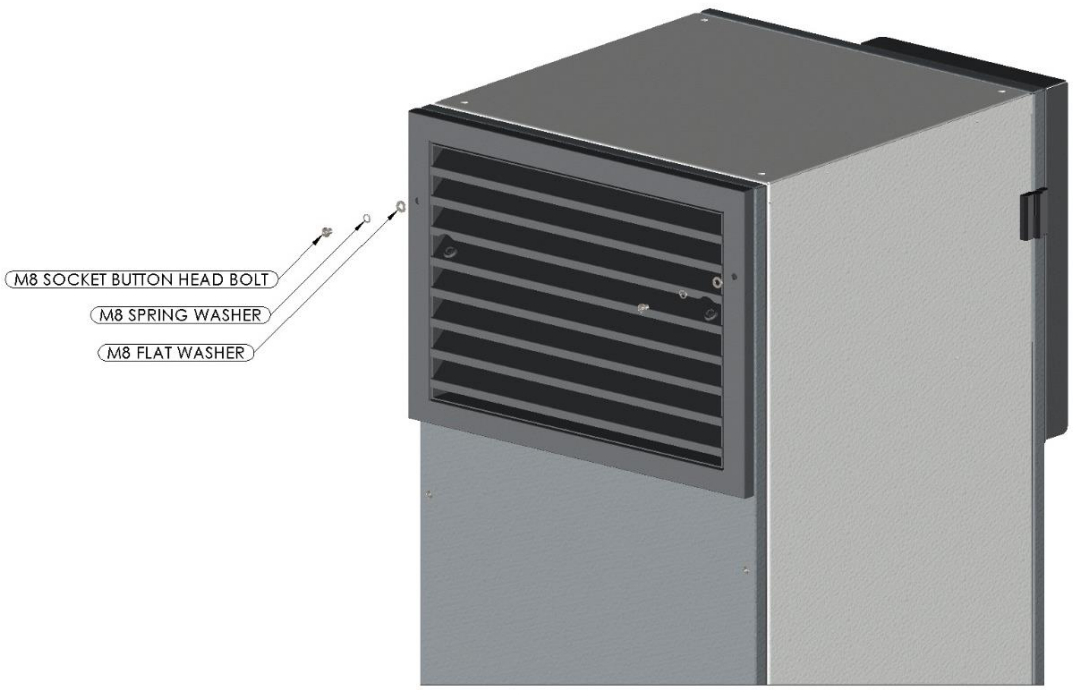
The PV90-4 utilises fans to keep critical components cool, this requires airflow into the enclosure via the louver door and associated air filter. This filter will become blocked over time, the actual time depends on environmental conditions. The filter should be inspected regularly and replaced or cleaned when required. The filter is visible from the outside of the unit, look up through the louver door, a flashlight may be required.

The PV90-4 can be supplied in either vertical or horizontal rotation, this will determine the inlet louver type. There are different methods for replacing the filter depending on the louver type.

### 8.2.1. Vertical Rotation:

In order to change the filter, the louver door must be opened, this requires a panel key (supplied with unit). The louver door is fitted with a mechanical stopper, this prevents the door from fully opening, while still allowing just enough room for the filter cartridge to be removed. This feature allows the filter to be changed without isolating the unit, note that this procedure should only be attempted when the unit is in standby. Do not attempt in adverse weather conditions.

1. Isolate unit or ensure unit is in standby (fans running slowly).
2. (Newer models): Open louver door utilising panel key (supplied) OR disconnect the Filter fixing panel bolts as shown below:



3. Only the front mesh panel needs to be removed to access the filter cartridge. Replace with new cartridge or wash as required, then follow steps 1-2 in reverse.

### 8.2.2. Horizontal Rotation:

In order to change the filter, the louver door must be opened, this requires a panel key (supplied with unit). The louver door is not fitted with a mechanical stopper, for safety reasons the unit should be isolated (switched off) before attempting to change the filter. Do not attempt in adverse weather conditions.

| | |
|---|---|
|  | **Isolate the input supply to the GPU by switching off the Input Isolator [S1], then wait at least 10 minutes for the DC capacitors to discharge before opening any doors or removing any covers.** |

1. Isolate unit by switching off the input isolator.
2. Open louver door utilising panel key (supplied) and secure louver door in open position with door stay provided.

3. Slide out filter cartridge by first pushing up (spring loaded) and then towards the unit to bypass the catch.

4. Completely remove cartridge.
5. Replace with new cartridge, then follow steps 1-5 in reverse.

### 8.2.3. Filter Cleaning:

Remove retainer bar by pressing into filer media (stud fixing), then slide retainer bar diagonally as shown in the illustration below. Replace filter media or thoroughly dust / vacuum until clean. Time permitting, the filter media can be washed with water, take care not to install when wet as this could cause serious damage to the unit. Reassemble cartridge and follow steps 1-5 in reverse.

## 8.3. Air Exhaust Filter Replacement

| | |
|---|---|
|  | **Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, maintain or repair this equipment.** |

Some PV90-4 models are fitted with exhaust filters, the exhaust filter protects the internal components from water ingress. This is typically required for the following:

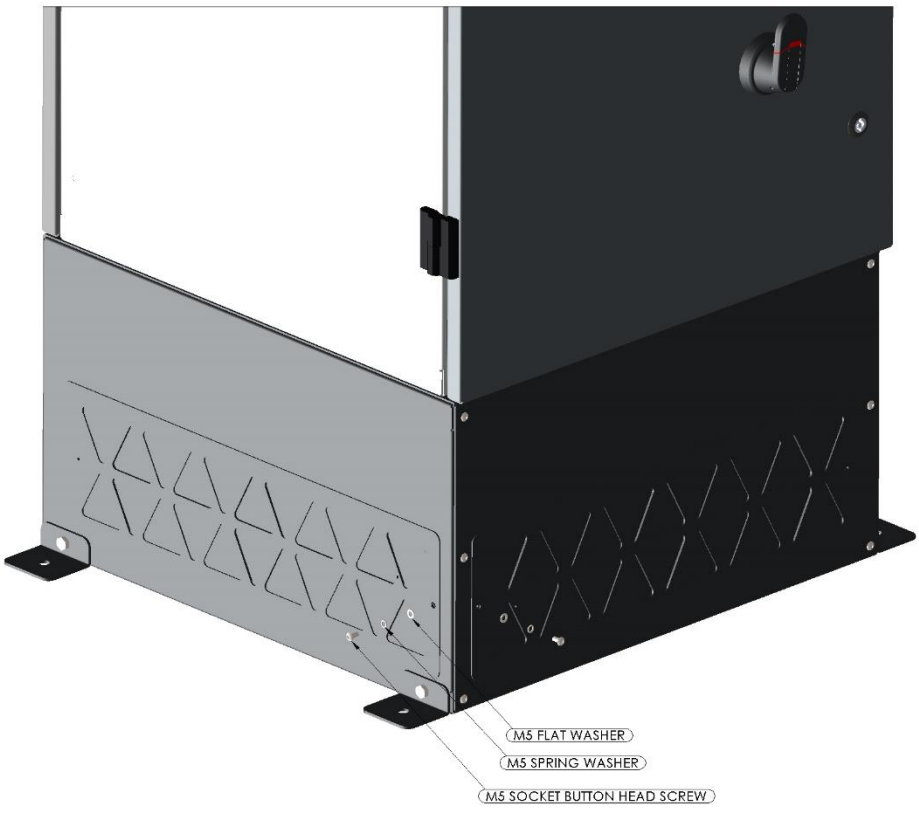
- Outdoor fixed installations (such as airports) where there is a possibility high-pressure cleaning in close proximity to the GPU could lead to water ingress from underneath. For these installations the optional base module should be fitted.
- Horizontally mounted units (trolley or trailer) where the exhaust outlet is exposed.

These filters will become blocked over time, the actual time depends on environmental conditions. The filter should be inspected regularly and replaced or cleaned when required. The filter is visible from the outside of the unit, a flashlight may be required.

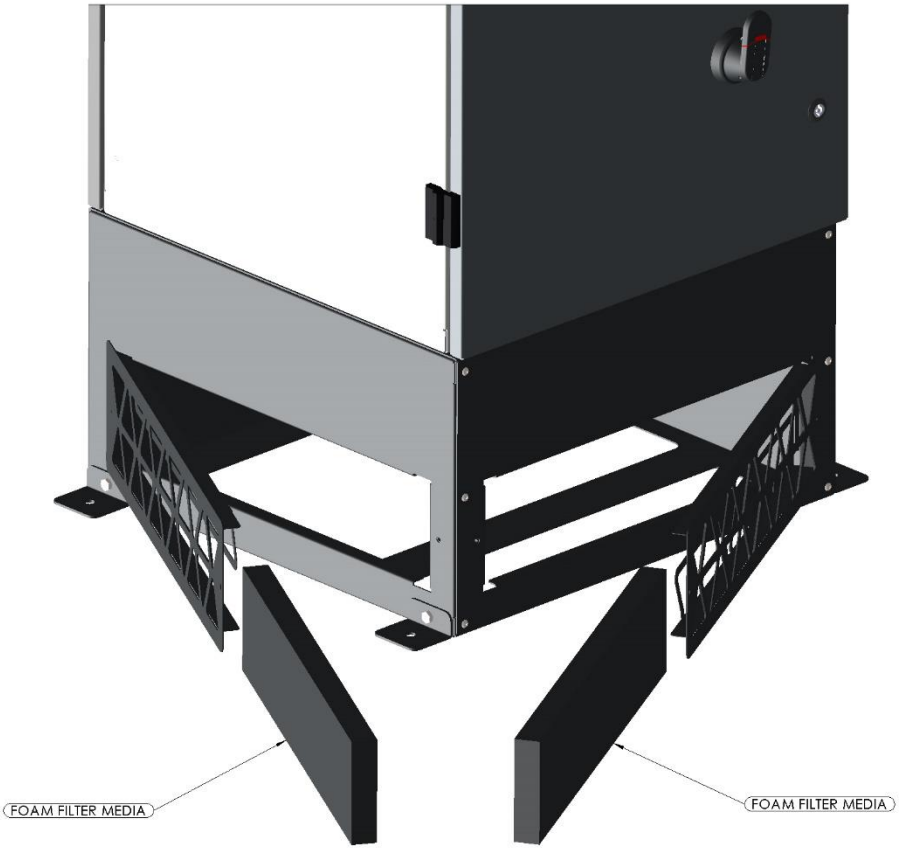
### 8.3.1. Vertical Rotation (with base module):

In order to change the filter, the cover plates must be removed, in principle, the filter can be changed without isolating the unit, note that this procedure should only be attempted when the unit is in standby. Do not attempt in adverse weather conditions.

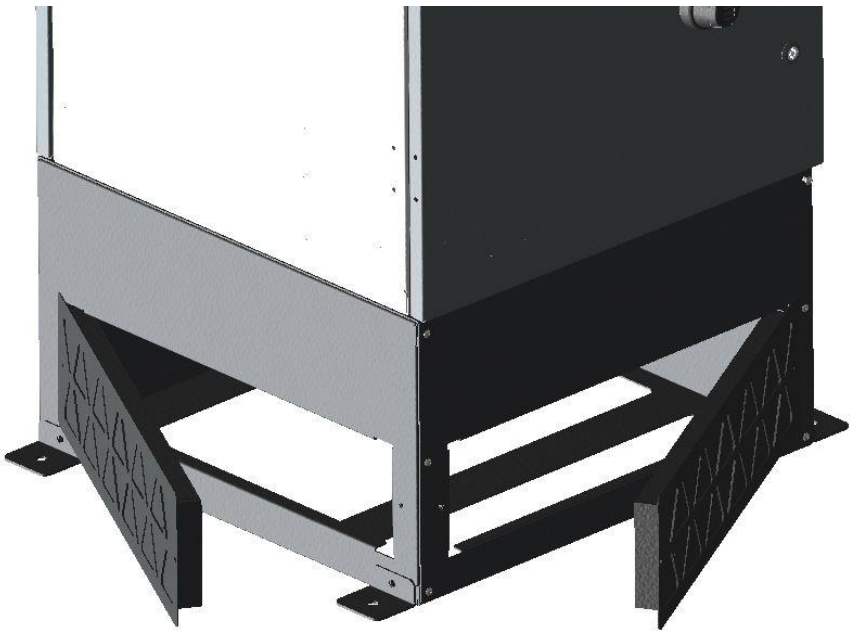
1. Isolate unit or ensure unit is in standby (fans running slowly).
2. Remove filter cover panels as illustrated below.



3. Replace filter media or thoroughly dust / vacuum until clean. Time permitting, the filter media can be washed with water, take care not to install when wet as this could cause serious damage to the unit.




4. Replace filter cover panels. Restore the filter media metalwork and ensure the fixings are secure prior to re-energisation.

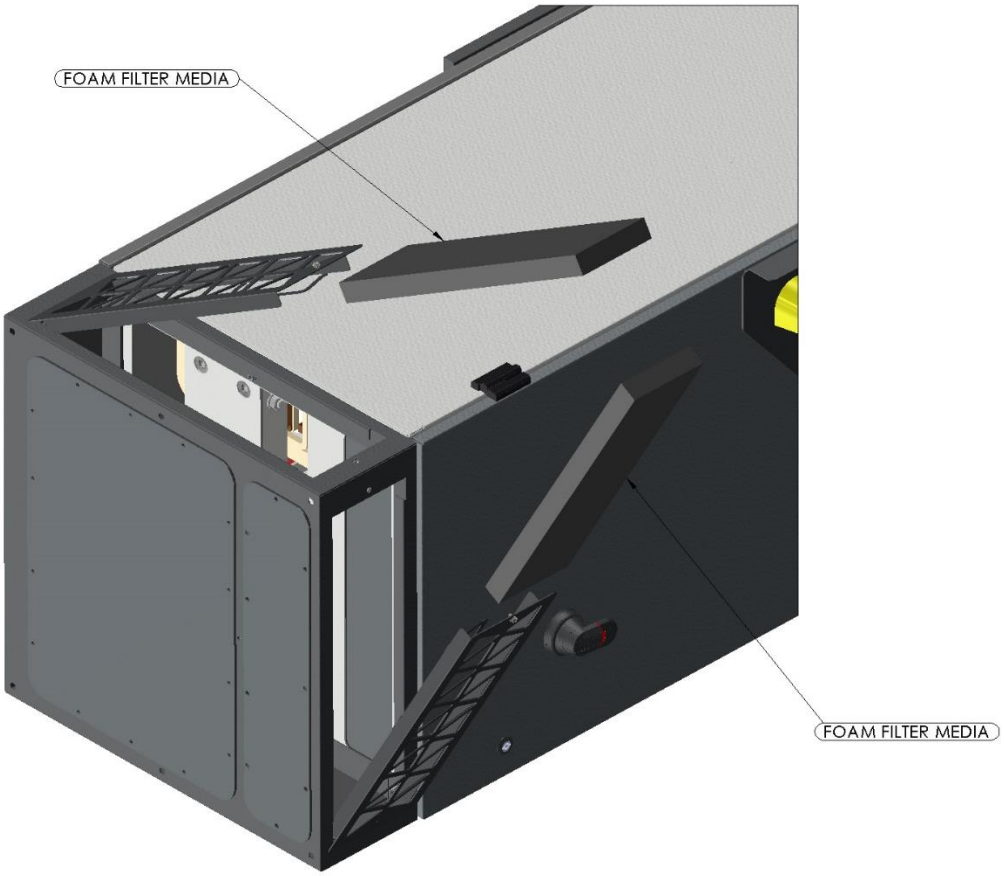


### 8.3.2. Horizontal Rotation:

For safety reasons the unit should be isolated (switched off) before attempting to change the filter. Do not attempt in adverse weather conditions.

| | |
|---|---|
|  | **Isolate the input supply to the GPU by switching off the Input Isolator [S1], then wait at least 10 minutes for the DC capacitors to discharge before opening any doors or removing any covers.** |

1. Isolate unit by switching off the input isolator.
2. Unscrew the bolts holding the exhaust louver in place, then replace the filter media, as shown in the below images:


3. Restore the filter media metalwork and ensure the fixings are secure prior to re-energisation.

## 8.4. Pluggable Power Module

This system is fitted with a pluggable power module. In the unlikely event of a system failure, the 'Heart' of the machine can be easily replaced by front line maintenance staff in a matter of minutes. The Power Module contains all power devices and drive PCB's which means there is a one-fix solution for most faults.

#### 8.4.1.1 Replacing the Power Module

| | |
|---|---|
|  | **Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, maintain or repair this equipment.** |
|  | **Prior to disconnecting this power module, a competent person must ensure the following steps have been performed!** |
|  | **Isolate the input supply to the GPU at the local distribution board or feeder pillar, then wait at least 10 minutes for the DC capacitors to discharge before opening any doors or removing any covers.** |
|  | **Take care when lifting the power module, two-man lift required!** |
|  | **Take care when lifting the power module, the heatsink temperature can be in excess of 80°C! If necessary, allow a cool off period before removing.** |

To changeover the power module for this Ground Power Unit (GPU), please perform the following steps:

1. Isolate the GPU from the input supply.
2. Wait for 10 minutes to allow DC capacitors to discharge.
3. Open front door (full length door with display panel)
4. Remove the safety panel

5. Measure between cables 11,12,21,22,31 & 32 with a voltage meter to ensure there is no voltage remaining on the DC capacitors (measure between each connection and earth). Then disconnect the 6 x cables as illustrated below.

It is essential that these cables are replaced in the correct sequence, colour coding & labelling assists with this.

6. Connectors marked PL1 and PL2 must be then disconnected from the power module. PL1 is removed by pulling on the lever; PL2 is loosened via the screws either side of the connector.

7. Two fixing brackets are also positioned in the top and bottom corners to mechanically secure the module. These should also be removed.

8. The power module can now be replaced. Ensure the Power Module is secured into position and the retaining brackets are re installed

9. Reconnect cables 11,12,21,22,31 & 32. Ensure all cables are in the correct order and the terminations are secure.

10. Plug in and secure PL1 and PL2 connectors.

11. Replace safety panel.

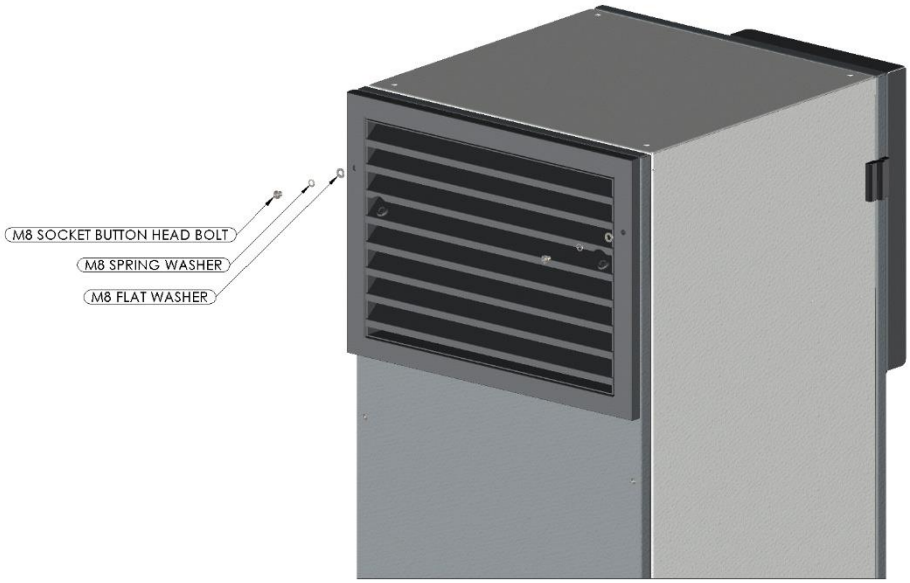
12. Close and lock all doors. The input supply can now be returned to the GPU and the system powered up for use.

## 8.5. Fan Replacement

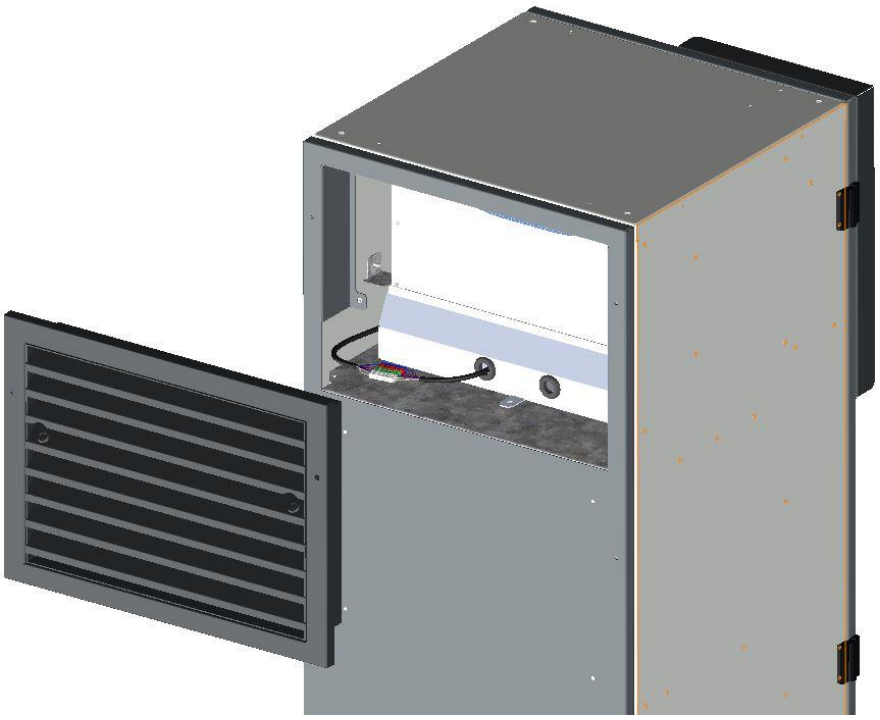
The fan assembly consists of 2 x 24VDC rotary cooling fans positioned on a removable tray structure for ease of maintenance. This assembly is located behind the main air intake filter, it is therefore necessary to remove the Air Intake Filter prior to replacing the cooling fans.

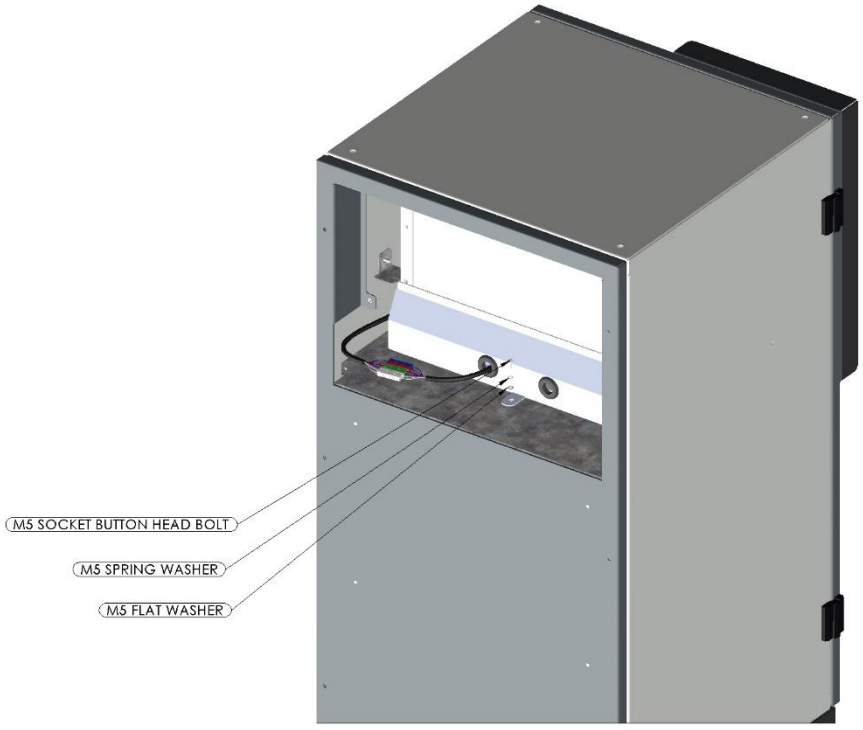
| | |
|---|---|
|  | **Ensure the system is isolated from the supply before undertaking this procedure.** |

1. Remove the Main Air Filter Assembly as shown below:

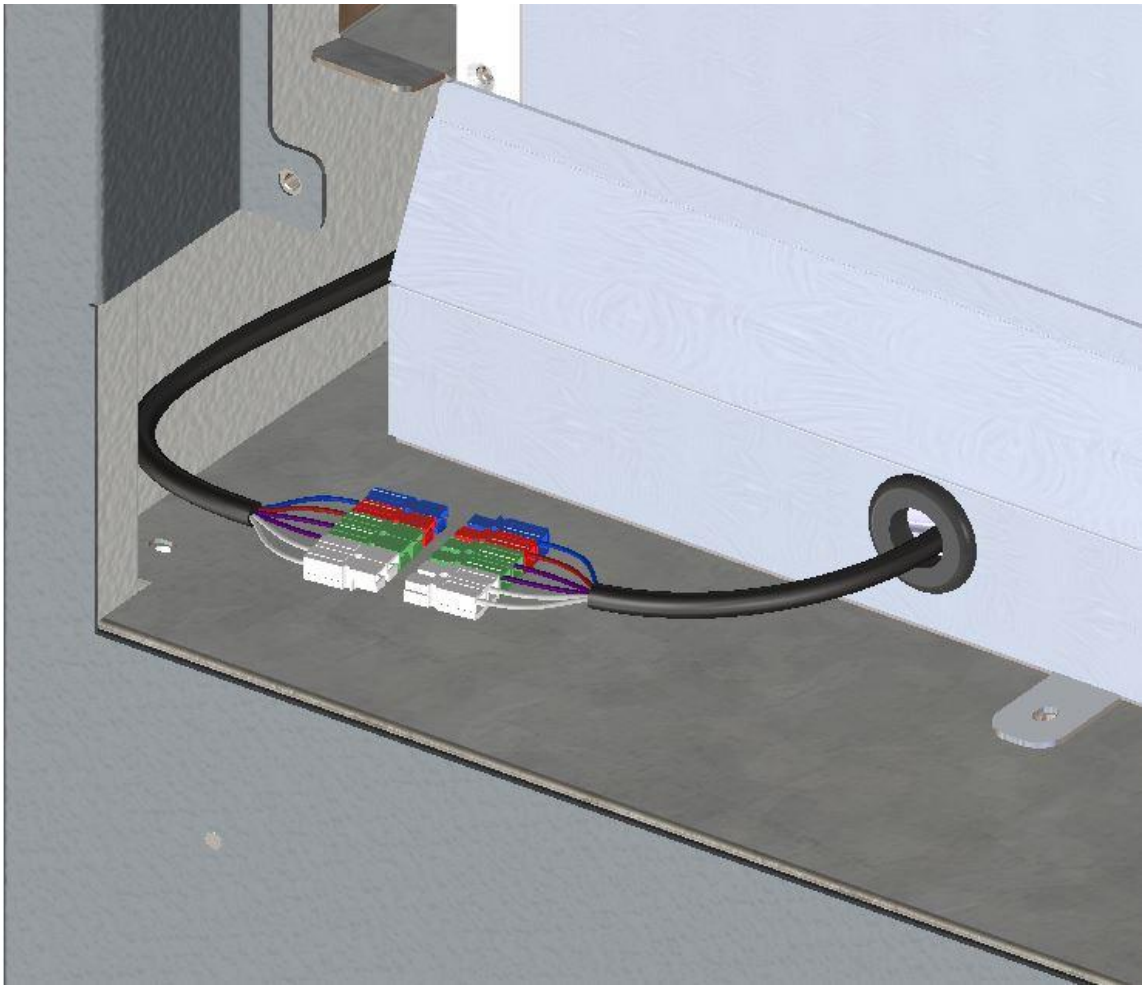



Note: the Filter Cartride itself can be kept inside the main assembly and does not need to be removed for this procedure.

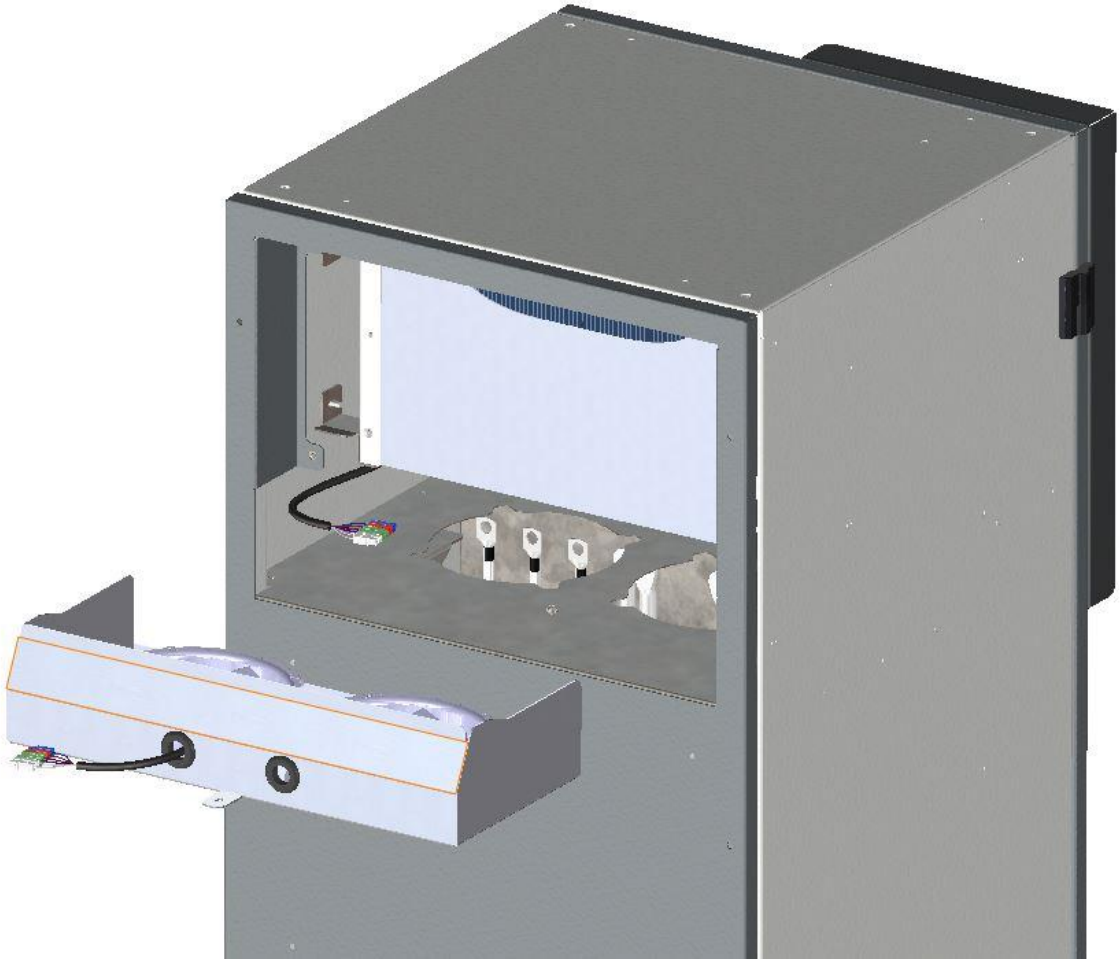





2. Remove the Fan Tray Fixing Bolt as shown above.



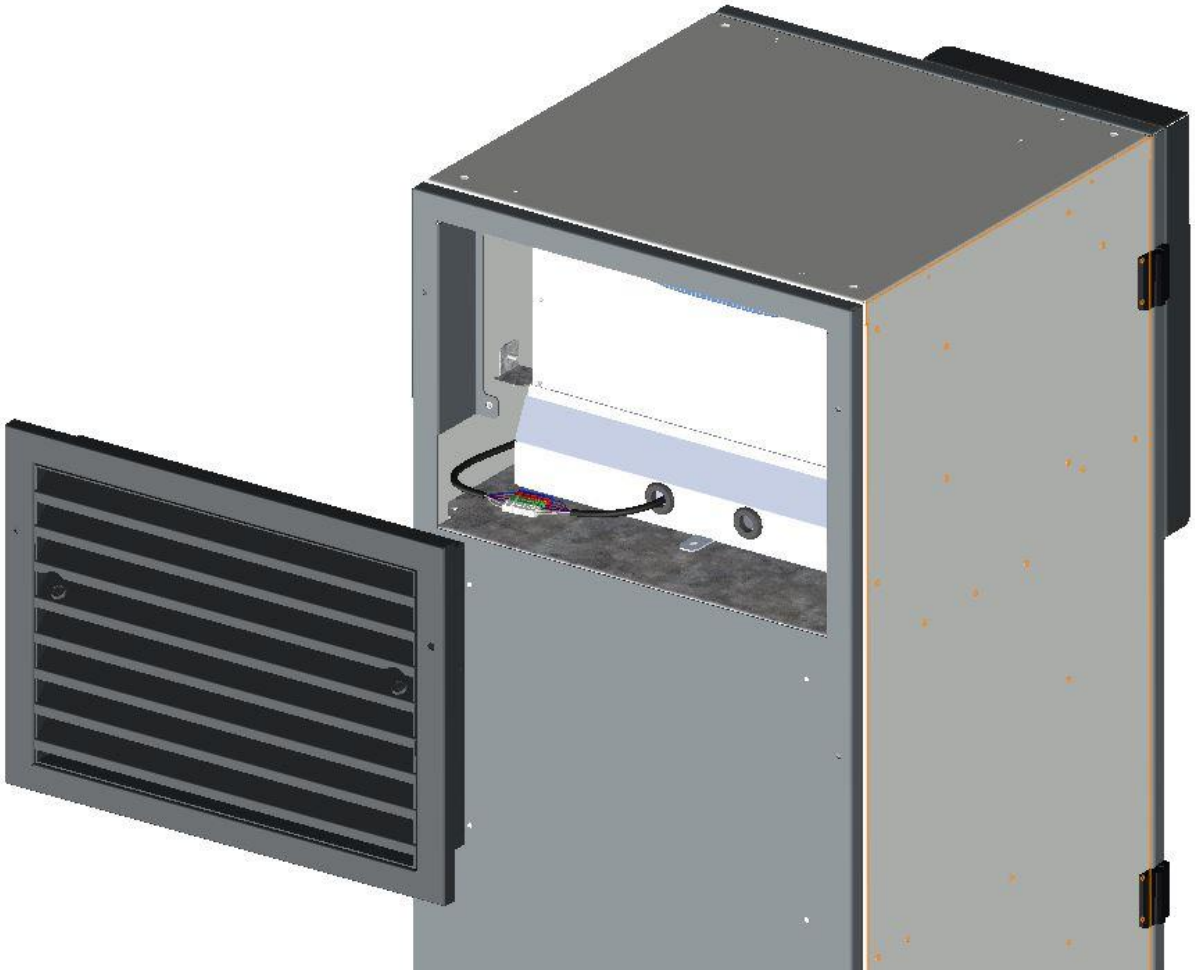
3. Disconnect the Fan Assembly Plug/Socket Connector, as shown above.



4. Remove the Fan Assembly by sliding it out.

5. Replace entire assembly or individual faulty fan (Note: pay attention to signal cable polarity):
    - +24V / RED / Wire Numbers 76(Fan 1) & 82(Fan 2)
    - PWM / VIOLET / Wire Numbers 77(Fan 1) & 78(Fan 2)
    - TACHO / WHITE / Wire Numbers 79(Fan1) & 80(Fan 2)
    - 0V / BLUE / Wire Numbers 80(Fan 1) & 83(Fan 2)

6. Reconnect the Fan Assembly Plug/Socket Connector, and repeat the above steps in reverse.



7. Close and lock all doors. Ensure the System is restored to original condition. The Supply to the system can now be returned.

## 8.6. Warranty

All equipment is guaranteed against faults attributable to faulty design, components and workmanship while operating under normal conditions for a period of 12-months from date of purchase. During this period all faulty components will be replaced free of charge. Labour and travelling costs involved therein shall be included assuming main land UK. All call-outs which cannot be attributed to faults or malfunctions on our equipment, shall be charged at our standard service rates and be for your account.
Our liability under our guarantee is limited to the above and we do not accept any responsibility for any consequential loss.

## 8.7. Extended Warranty

On occasion, the standard 12-month warranty may be extended, please refer to purchase documentation for details. In order to validate the extended warranty, the unit must be serviced annually by Powervamp or factory trained personnel. See terms and conditions for further details.

## 8.8. Maintenance and Backup Service

All spares are stocked in the UK(Europe) and Boise, Idaho (Mainland US) and replacement parts are guaranteed for a minimum of ten years. At the expiry of the Warranty period, it is strongly recommended a Formal Maintenance Agreement is undertook and this would necessitate the negotiation of a separate contract.

# 9. TECHNICAL DATA

| | | | | |
|---|---|---|---|---|
| **PV90-4 GPU** | | | | |
| Rated Output Power (kW) | 90.0 | | | |
| Rated Apparent Power (kVA) | 90.0 | | | |
| **INPUT** | | | | |
| Number of Phases | 3 | 3 WIRE + E (No Neutral Required) | | |
| Nominal Input Voltage | 400-480VAC (Down to 315VAC with 30kVA Load) | | | |
| Voltage Tolerance | + / - 15% | | | |
| Nominal Input Frequency | 50/60Hz (+ / - 10%) | | | |
| Rectification | 12 Pulse (24 Pulse Option) | | | |
| Current Distortion | <5% @ 100% LOAD | | | |
| Power Factor | >0.98 @ 100% LOAD | | | |
| Inrush Current | N/A | | | |
| Line Current (380VAC Supply) | 146A @ 100% LOAD | | | |
| Line Current (480VAC Supply) | 116A @ 100% LOAD | | | |
| Recommended Maximum Input Circuit Breaker | 160A | | | |
| **OUTPUT** | | | | |
| Number Of Phases | 3 | 3 WIRE + N + E | | |
| Nominal Output Voltage | 200 / 115 VAC Three Phase | | | |
| Voltage Adjustment | 112-119.5V (L – N) | | | |
| Crest Factor | 1.414% +/- 0.04 | | | |
| Static Voltage Regulation | < 0.5% | | | |
| Dynamic Voltage Regulation | MIL-STD-704F | | | |
| Nominal Output Frequency | 400Hz (+/- 0.01%) | | | |
| Total Harmonic Distortion | <2% (1% typical) | | | |
| Phase Angle Symmetry | 120° (+/- 1%) for balanced load, 120° (+/- 2%) 30% unbalanced load | | | |
| Load Power Factor | 0.7 Lag – 0.95 Lead | | | |
| Overload | 125% for 10 Minutes | | | |
| | 150% for 60 Seconds | | | |
| | 200% for 30 Seconds | | | |
| | 300% for 10 Seconds | | | |
| | 400% for 1 Second (1100A Peak Inrush) | | | |
| **EFFICIENCY** | | | | |
| 100% LOAD | > 95% (90kVA @ 0.8PF) | | | |
| 50% LOAD | > 95% (45kVA @ 0.8PF) | | | |
| STANDBY LOSSES | < 80W | | | |
| NO LOAD LOSSES | ~ 2.2kW | | | |
| **GENERAL** | | | | |
| Operating Temperature | | -40 to +50°C | | |
| Altitude | | MAX 2000m Before De-rating | | |
| Protection Level | | IP 55 | | |
| Colour | | RAL 7035 / RAL 7021 | | |
| Noise Level | | < 65dBA @ 1m | | |
| Dimensions | | | | |
| **Height** | **Width** | **Depth** | **Weight** | |
| **Standard 90.0kVA** | | | | |
| 1100mm / 43.3in | 600mm / 23.6in | 690mm / 27in | 380kg / 837lbs | |
| **90.0kVA with Base Module** | | | | |
| 1446mm / 57in | 600mm / 23.6in | 690mm / 27in | 420kg / 925lbs | |
| **90.0kVA with 28VDC Module** | | | | |
| 1630mm / 64in | 600mm / 23.6in | 690mm / 27in | 580kg / 1278lbs | |
| **STANDARDS** | | | | |
| Safety (CE) | | | EN 61558-1:2005/A1:2009 | |
| Safety (Standard for Power Units other than Class 2) | | | UL 1012 (Pending) | |
| EMC – Emissions (CE) | | | EN 61000-6-4:2019 | |
| EMC – Immunity (CE) | | | EN 61000-6-2:2019 | |
| Specification for 400Hz Aircraft Power | | | DFS400 | |
| Aircraft Ground Support Electric Supplies | | | ISO 6858:2017 | |
| General Requirements for Ground Support Equipment | | | BS 2G 219 | |
| Aircraft Electric Power Characteristics | | | MIL-STD-704F | |
| Ground Equipment 400Hz Ground Power Performance Requirement | | | SAE ARP 5015&SAE AIR 5387 | |

# 10. DISPOSAL INSTRUCTIONS

## 10.1 Dismantling

The removal work must be carried out by qualified personnel.
Before dismantling the system make sure to apply the procedures for shutting down the unit.

| | |
|---|---|
|  | **Warning: Ensure any incoming suppliers are isolated before removing any doors or covers.** |

## 10.2 Disposal

The system is made mainly of stainless steel (except electrical equipment) and must be disposed of according to the current local and environmental regulations.
Take special care regarding system condition, existing regulations and compliance with current regulations when disposing of the following items:

- Electrical parts (including circuit boards).
- Plastic (housing).
- Sheet metal, stainless steel, copper, aluminum (separate by material).

In EU countries, all electrical/electronic items must be disposed of in accordance with the WEEE Directive (2012/19/EU).

Oils, solvents, cleansers and contaminated cleaning tools (brushes, rags, etc.) must be disposed of in accordance with local legislation and the instructions in the safety data sheets of the manufacturers.

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