powerguard

Technical Description
Of the
PS System
Generator/Inverter Controller
For
Domestic and Mixed Load Applications

0.25 kVA - 100 kVA

PRACTICAL SOLUTIONS
TO
SAVE FUEL AND REDUCE POLLUTION.

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About Us

Thank you for your enquiry regarding Powerguard systems used for protecting critical and essential equipment and increasing efficiency.

Powerguard is a registered trade name.

Power Systems Warehouse is a specialist supplier of Uninterruptible Power Supplies, Standby Power Supplies, Generators, Inverter Systems, Batteries, Battery Chargers, Static Switches, Manual and Semi-automatic Bypass Switches with power outputs from 50 Watts to 4000 kWatts.

Power Systems Warehouse is the largest OEM manufacturer of Central Battery Emergency Lighting Systems in the UK. We supply both DC Systems and Static Inverter Systems from 100 Watts to 100 kWatts. The Static Inverter Systems can be single or three phase input/outputs.

We have recently extended the range of standby systems to provide back up for motor driven equipment. This would include refrigerators, pumps and fans as well as many other motor driven applications. Powerguard also supply single phase to three phase converters to power motors. These are fully specified inverter systems and the three phase motor runs at full power.

Power Systems Warehouse is dedicated to providing practical and affordable solutions to reduce energy consumption and pollution. Our generator/Inverter Control systems reduce fuel consumption by two thirds. In addition generator life increases by a factor of three and maintenance costs are reduced by the same amount. Our combined heat and power systems reduce the cost of generating electricity and heat for buildings or processes.

We are investing in wind energy and the use of alternative fuels

Our building blocks – chargers – inverters – changeover systems – static switches – are all designed and proven to give a very high performance with exceptional reliability and long life.

The Uninterruptible and Standby Power Systems, Inverters, Static Switches, Bypass Switches, Chargers and Control Systems are state of the art products using the latest technology. They are microprocessor controlled with sophisticated software to enhance the reliability and performance.

We aim to make systems that are different. We manufacture the Standby Systems, Static Switches, Bypass Switches, Inverters, Battery Chargers and Control Systems entirely in the UK.

About Us

This is rare nowadays but it is important to achieve the quality engineering that is essential to the service we believe we should give to our customers.

Power Systems Warehouse also stock a large range of lead acid batteries to suit both UPS/ standby and deep cycle/full traction applications.

You can be confident about ordering a Powerguard system because we stand behind our products absolutely. We give a no strings, no quibble, free on site warranty for the first year of ownership of the bigger systems and a two year replace or repair warranty on the smaller systems.

When you contact Powerguard you will find us very helpful with an unbeatable, in depth, technical knowledge about our products that is entirely at your disposal both before and after your order. We understand Power Systems and can help you.

If required we carry out site surveys followed by a project plan and quotation to solve your power problems in the most effective and economical way possible. We can arrange the supply, positioning, installation and commissioning of the equipment, followed by the most cost effective after sales maintenance agreements in the industry, providing total project management.

We are dedicated to giving our customers the most appropriate and cost effective power solution possible with efficiency, reliability and long life primary design objectives.

We have a proven track record, satisfied customers and reference sites.

Accreditation

Powerguard is a registered trade name owned by Power Systems Warehouse Ltd. We are able to design, build, install and commission power systems up to 4000 kVA.

Power Systems Warehouse is the sole UK importer and distributor for the full range of Vision batteries.

Vision is a world renown manufacturer of premium quality lead acid batteries with sales in over 100 countries.

Power Systems Warehouse is a major distributor for the full range of Eaton Powerware Uninterruptible Power Supplies.

Eaton is a leading global provider of comprehensive power quality and power management solutions, consistently delivering the high 9s of availability demanded by today's digital economy.

Power Systems Warehouse is a major distributor for the full range of SDMO generators.

Specializing in the manufacture of generating sets SDMO offers a wide range of standard sets from 1 to 3000 kVA.

Power Systems Warehouse is registered as a pre-qualified supplier of construction services to the public and private sector procurement.

Uninterruptible Power Supplies - Emergency Lighting and Power - Generators - Installation & Maintenance.

DTI Construction Line Registration Number - 46743

Power Systems Warehouse is registered under the Rail Industry Supplier Qualification & Registration Scheme.

Uninterruptible Power Supplies - Generators - Batteries - Installation & maintenance.

Link-up Registration Number - 20112

Power Systems Warehouse is approved to

BS EN ISO 9001 : 2000 - Quality systems.

Certificate Number - GB 8416

Introduction

Powerguard is a leader in the design and manufacture of inverter systems used in energy saving applications. The key product families are Generator/Inverter Control Systems and Alternative Energy Products.

We provide leading edge solutions and expect to work with our customers to provide expert and professional services. Our success is based on using technology to provide practical answers to power problems. We have many years of experience and the motivation to deliver products of optimum performance and quality that will solve problems for our customers.

Our approach to alternative power systems is based on these principles and will deliver - practical cost effective solutions that will provide many years of trouble free operation. Our systems are designed and manufactured to give over 25 years service with minimal maintenance.

This technical description is designed to give an in depth knowledge of how our Generator/Inverter Control System operates and the component parts used to make up the system. It will also give an insight into the aims of our design team and how the system can dramatically reduce the burning of fossil fuels and the production of greenhouse gases and pollution. Fuel use, generator running time and maintenance is reduced by a minimum of two thirds.

We know that our customers want to have electricity on tap 24 hours per day seven days a week (24/7) just the same as those of us who are connected to the national grid. The only way to guarantee the power for 24/7 is to have an engine driven generator. Our philosophy is to accept that as fact and then devise systems which reduce the need for the generator to start to an absolute minimum. In a typical PS System the generator runs for less than one third of the time.

If you are already generating your own power then the first and most significant step to dramatically increase efficiency is to install a Powerguard PS System.

The next step is to consider alternative energy sources such as wind or solar and combined heat and power.

Features

- RUGGED AND RELIABLE.
- LONG LIFE.
- MICROPROCESSOR CONTROLLED.
- SAVES FUEL.
- SAVES MAINTENANCE.
- INCREASES GENERATOR LIFE.
- PHASE CONTROLLED RECTIFIER FOR RELIABILITY, EASE OF USE AND SCALABILITY.
- CONSTANT CURRENT/VOLTAGE CHARGER.
- SLOW CHARGER WALK IN TO ELIMINATE HIGH CURRENTS.
- TEMPERATURE COMPENSATED FLOAT CHARGE VOLTAGE.
- SOPHISTICATED OPERATION TO INCREASE BATTERY LIFE AND RELIABILITY.
- EQUALISES THE VOLTAGE ACROSS THE BATTERY CONTACTOR BEFORE CLOSING.
- BATTERY SENSING MODE WHEN THE CHARGER STOPS CHARGING EVERY 4 HOURS FOR 20 SECONDS TO CHECK THE BATTERY CONNECTION.
- LOW BATTERY DISCONNECT USING A MAGNETICALLY LATCHED CONTACTOR.
- TIMED OPERATION OF THE CONTACTOR TO REDUCE ARCING AND CHATTER.
- 24/7 POWER.
- VOLT FREE CHANGEOVER CONTACTS TO DRIVE A REMOTE COMMON ALARM.

Features

- TWO BUTTON OPERATION FOR SYSTEM SHUTDOWN.
- SOPHISTICATED CHANGEOVER CONTROL TO MINIMISE DISTURBANCE.
- COMPREHENSIVE MONITORING AND DISPLAY.
- AUDIBLE ALARM WITH MANUAL RESET.
- DUAL INDEPENDENT POWER SUPPLIES WITH MONITORING.
- EASY TO OPERATE.
- ECO-FRIENDLY.
- TWO-BUTTON OPERATION FOR TEST, INITIATED FROM THE FRONT PANEL.
- SAFE OPERATION.
- CLEAR LCD SCREEN.
- DUAL POWER SUPPLY.
- INVERTER INCORPORATES MUSTSTART® TECHNOLOGY.
- INVERTER INCORPORATES POWERFLOW® TECHNOLOGY
- 25 YEAR DESIGN LIFE.
- HIGH SYSTEM EFFICIENCY.
- 12 MONTHS FREE ON SITE WARRANTY (applies to installations on the UK mainland up to 30 miles north of Glasgow)

Non-Technical Clients

The Powerguard PS System is designed to run in conjunction with an engine driven generator set. If you use a generator system and want the increased efficiency and sheer convenience of the PS System you do not need to be technical and you do not need to read this technical description.

You can just agree the specification with our help, purchase the system, get your local electrician to install it or ask us to arrange this for you. We commission the system and from then on the system is automatic.

A lot of our customers would have difficulty changing a three pin plug but they still have the savings and benefits of the Powerguard PS System.

If you do want to know how it all works then read on.

Generator

The PS System is designed to run in conjunction with an engine driven generator. The generator will need to be auto-start and operate on a signal from the PS System. If you have an existing generator that is not auto-start but is electric start then it can be easily and economically upgraded using a module from Deep Sea Electronics or similar.

PS System runs with an auto-start generator.

Electric start machines can be easily upgraded.

The PS System will completely automate the system and it will operate with very little attention from the user.

Automatic operation.

Advice on sizing the PS System is dealt with later in the Technical Description but a couple of things need to be considered when sizing the generator:

1) Generators have two ratings - Standby Power and Prime Power. The Standby Power rating is the highest because the generator will run for short periods when the mains supply fails or when carrying out test and maintenance. The Prime Power rating is more conservative because the generator is the main or only source of power and will therefore run for long periods. For this application we should use the Prime Power rating.

Generator should be chosen on the prime power not the standby rating.

2) Generators are usually rated in kVA at a power factor of 0.8. This means that a 15 kVA generator will give 12 kW of true power. A lot of modern equipment is power factor corrected and therefor the true power kW rating is becoming more important.

Modern electrical equipment is often power factor corrected making the kW rating more important.

It is true to say that there are generators and generators. Some of them, probably more often the cheaper ones, are optimistic about the power rating and will struggle when running for long periods at a sustained load. The PS System aims to charge the batteries in less than 8 hours. The charge rate is automatically adjusted to use the surplus power and this means that the generator will be consistently loaded.

It is best to chose a generator that is toward the quality end of the market.

It is worth spending a bit more and going for a reasonable quality generator with a rotational speed of 1500 RPM.

It is best if the rotational speed is 1500 RPM.

As a guide a typical rating for a domestic application will be about 15 kVA.

Typical domestic system-15 kVA

Efficiency and Service Life

The PS System increases efficiency and reduces pollution and the production of greenhouse gases.

There are two main reasons why our customers purchase a PS System. The first is that the system increases efficiency and reduces the need to burn fossil fuel thereby reducing pollution and the production of greenhouse gases. The second is the sheer convenience that a fully automated system brings.

The first reason is important in a more global context in that all of us are trying to minimise the pollution we cause. There is no question that installing a Powerguard PS System to operate with a generator increases the system efficiency dramatically. We recently sold a system to a farmer in Norfolk who has built a new house on the family farm. The new house was built but the cost of connecting to the national power grid was prohibitive so he installed a 15 kVA generator. The generator was running most of the day for most days and consumed about 15 litres of diesel fuel per day. He contacted Powerguard and purchased a PS System. The system was installed and commissioned.

Reduced fuel consumption from 15 to 5 litres per day.

The generator run time and maintenance is reduced by at least two thirds.

The generator run time is now less than 8 hours in 24 and the fuel consumption is less than 5 litres per day. Electrical power is available 24/7.

Type of inverter and charger chosen for high reliability.

We have chosen the type of inverter and charger that we use not only to give the highest efficiencies practicable but also for long term reliability.

How efficient is a system that breaks down and needs expensive repairs?

System fuel use is the ultimate test of efficiency & the PS System is top.

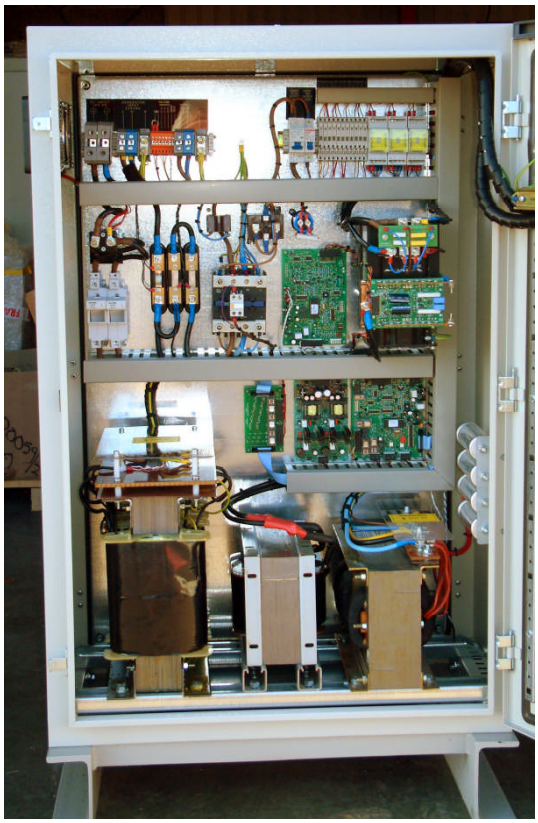
The overall efficiency dictates the amount of fuel used so this is the ultimate measure of any system and the Powerguard PS System comes out on top.

Another reason for the technology is that it is very scaleable. We can easily design and build systems to suit an application. For example if efficiency could be improved by adding another 20 Amps to the charge current we can easily do that. This would raise the overall efficiency of the system and that is the most important factor.

Scaleable and flexible technology.

We believe service life and reliability should be taken into consideration when considering efficiency. Not only is the pollution caused when building

Efficiency and Service Life



A typical internal layout

the system in the first place offset by the increased operating efficiency. It is effectively reduced by the system's long working life making it unnecessary to replace it for at least 25 years.

To manufacture the systems causes pollution so life span is important.

Powerguard PS Systems are designed and built to give over 25 years reliable service with minimum maintenance.

25 years min working life with little maintenance.

If maintenance is required the systems are built so that all of the parts are accessible and can be replaced easily - please see the above picture showing a typical internal layout. We also include full circuit diagrams with the operators manual making it easier for third parties to provide service.

Maintenance and repairs are easy because of the layout of the system as per picture.

Circuit diagrams included with the operators manual.

The life of the generator in a typical PS System is increased by a factor of three reducing the pollution footprint by delaying the need for a replacement.

Generator life increased by factor 3.

We want to sell you a system that is literally fit and forget. One that will give many years of reliable automatic operation - a system with a high overall efficiency. A system that saves money from day one that also has immediate and tangible benefits.

The system saves money and has immediate and tangible benefits.

Mode of Operation

If you generate your own power you need a PS System

General Information

If you generate your own power you need a Powerguard PS System. The PS System is designed for applications where the load varies over 24 hours and the prime source of electrical power is an engine driven generator. It is assumed that the user will require electricity 24/7.

Electricity 24/7.

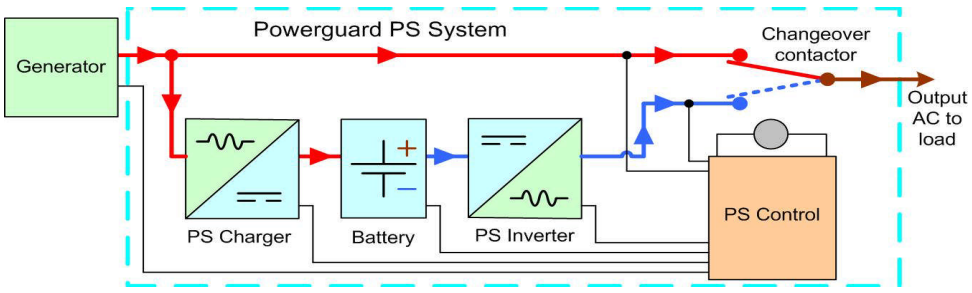
The system works by storing spare energy when the generator is not fully loaded into the batteries and then using the stored energy via an inverter to power the load when the generator is not running.

System stores spare energy in a battery and then uses it to power the load.

The generator has to be auto-start. It must start and stop on a signal from the PS System.

The PS System is completely automatic and there is no need for operator intervention during normal operation.

The system is completely auto-matic.



Simplified schematic of a PS System.

A simplified schematic showing a typical PS System

The above schematic shows the main components of a typical Powerguard PS System. The components shown within the dotted line are all part of the PS System and are housed in a standard floor mounted steel enclosure. The batteries are separate and are usually mounted on an adjacent rack.

Generator powers the load shown by red arrows.

When the generator is running it supplies power to the load via the changeover contactor. At the same time the generator powers the charger recharging the batteries. The path is shown by the red arrows.

Inverter powers the load shown by blue arrows.

When the PS System shuts down the generator the inverter is started and the load is powered via the changeover contactor. The path is shown by the blue arrows.

Mode of Operation

Timed Periods

Real time clock and calendar.

The control incorporates a real time clock and calendar so it can be programmed to operate in the most convenient way for the user. The machine is set at the factory but can be altered on site if required.

Machine set at factory but can be altered.

Remember the generator has to run for a long enough period each day to recharge the batteries.

The generator must run to charge the battery.

The control can be set with two types of timed periods must-run and can-run.

The generator will run in the must-run periods. Must-run periods are set to cover periods when the user knows that loads too big for the inverter are going to be used. When a must-run period ends the generator will shutdown when the load is lower than the inverter 100% load rating.

Must-run periods the generator will run.

The generator will start at the beginning of a can-run period but will automatically shut down after a 15 minute period during which the load on the generator has been stable below the inverter 100% load rating and the battery charger has switched to float mode.

Can-run periods the generator can shut down if conditions are OK.

Start/Stop Conditions

The PS System will automatically start and stop the generator according to the monitored parameters. If the generator is stopped the system changes over to the inverter and vice versa.

PS System automatically starts and stops the generator.

The generator starts and the inverter stops:

1) During the pre-set must-run timed period.

Must-run periods.

2) If the inverter is overloaded more than 100% for 60 minutes.

O/l 100% 60 m.

3) If the inverter is overloaded more than 115% for 30 minutes.

O/l 115% 30 m.

4) If the inverter is overloaded more than 130% for 15 minutes

O/l 130% 15 m.

5) If the inverter is overloaded more than 150% for 5 seconds.

O/l 150% 5 secs.

6) If the battery has been discharged below a pre-set capacity the generator will start for 30 minutes to partially recharge the battery.

Low battery.

Mode of Operation

The generator stops and the inverter starts:

Inverter starts.

7) After the pre-set must-run timed period is over. The generator will not shut down at the end of the must-run timed period if the load is above the 100% inverter load level.

End of timed periods if conditions are OK.

8) During the can-start pre-set timed period if the load on the generator is stable within the rating of the inverter and the battery is fully charged. When both these conditions are met for a 15 minute period the generator will stop. The generator will not shut down at the end of the can-run period if the load is higher than the inverter 100% load rating.

Generator started because of o/l when conditions are correct.

9) If the generator has been started outside of the timed period because of overload it will go off again if the load is stable within the inverter rating for 15 minutes.

The inverter will be switched off:

Inverter switched off if it overloaded and the generator does not start.

10) After 1 minute if the inverter is overloaded and the generator fails to start. It will not reset to come on again until the generator starts and power is applied to the system.

Automatic Operation

Auto operation without operator involvement.

The PS System is designed to be automatic and will operate effectively without operator involvement except for routine maintenance.

Comprehensive display.

The PS System is microprocessor controlled and has many monitoring and display functions. The display is via a front panel mounted PCB using LEDs to indicate the status of the system. Some alarm conditions are accompanied by an audible alarm with a manual reset (the audible alarm resets automatically if the alarm condition is removed). The system is fitted with a battery voltage and charge/discharge current meter. The user interface control has an LCD showing the generator output current, the inverter output current and system output voltage.

Mode of Operation

The inverter can be shut down from the front panel.

Inverter shut down from the front panel.

The system is housed in an enclosure fabricated using 1.6mm sheet steel and is epoxy powder coated. Enclosure access is by a hinged door on the front. Cable entry is though an undrilled gland plate mounted at the top of the enclosure.

Enclosure 1.6mm steel.

Contactors

Overview

Contactors are electro-mechanical but careful design makes them very reliable.

Contactors have to withstand the arduous task of making and breaking the power circuits. This causes wear and tear until the contactor eventually fails. Some contactors have a weakness closing the contacts under load and others a weakness opening the contacts under load.

Contact bounce and arcing must be reduced to increase life.

When a contactor closes the contacts can bounce causing arcing, this can weld them together. When it opens again the welds are broken damaging the contacts. Sometimes it will weld so effectively that it will not open when required causing a system failure.

Still the best solution in many applications.

Conversely, when a contactor opens whilst supplying a load an arc is produced which is extinguished as the gap between the contacts is increased. This causes heat and in some cases will burn the contacts and cause failure.

However, contactors are still the best way of switching power in a lot of circumstances with five main advantages over the semiconductor alternative: -

Easily switched.

Coil isolated.

Virtually 100% efficient.

Disconnects the load from the supply.

Cost less.

1) They are easily switched by energising or de-energising the coil.
2) The coil is isolated from the supply and the load.
3) When they are conducting they are nearly 100% efficient and do not require additional cooling.
4) When the contactor is open the load is isolated from the supply.
5) The cost of implementation is considerably lower.

Careful design gives long life.

Our design engineers have spent a lot of time mitigating and sometimes eliminating the weaknesses. They have achieved this by sophisticated programming of the micro-controllers.

Battery Contactor

Batter contactor prevents permanent damage to the batteries.

The battery contactor is required to protect the battery from damage due to deep discharge. When it is open there is no drain on the battery. The

Contactors

contactor has to open to shut the system down. This would require a normally open contactor that could fail open disconnecting the battery and shutting the system down without warning. To protect the system against contactor failure the Powerguard PS System uses a contactor that is latched shut with a permanent magnet and only requires a pulse to open or close it.

Normally Open but magnetically latched to prevent failure.

When the system first powers up, the charger slowly increases the voltage until it is approximately equal to the battery voltage. Then a pulse is applied to the battery contactor coil closing the contacts and connecting the battery. After the battery contactor is closed the charger walks in again this time bringing up the battery charge current and voltage.

Equalises the voltage across the contactor before closing.

Before the battery contactor opens to isolate the battery the inverter is shut down and the load removed.

Switches off the inverter before opening.

This virtually eliminates arcing and minimises wear and tear on the contactor increasing the life and reliability.

Very little wear and tear.

Changeover Contactor

The PS System is fitted with a heavy duty contactor to change the load over from the generator to the inverter and vice versa. The contactor has to be rated to carry and switch the generator output current. On a 15 kVA generator the full load current is 66 Amps and the contactor fitted will be rated at 80 Amps AC3 (AC3 is an arduous rating that can tolerate the inching of electric motors). However the system is controlled so that virtually all of the changeovers occur at the inverter full load current current or below. A few will occur at the inverter overload current. On a 2.5 kVA inverter the full load current is 11 Amps and the maximum overload current is 22 Amps.

Heavy duty changeover contactor.

Rated AC3 for full load.

Only switches 11 Amps usually in this example.

The changeover contactor is operated well below the maximum rating and will give many years of reliable operation.

Long and reliable life.

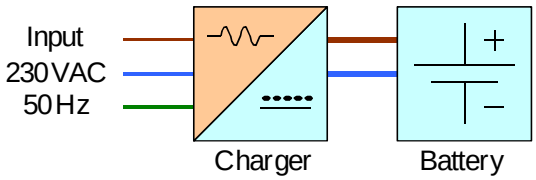
Charger

Total charging system for max life from battery.

Introduction

The Powerguard thyristor controlled battery charger is a total charging system designed to ensure maximum life and reliability from the battery.

Charger block diagram.



The size is based on recharge in <8 hours.

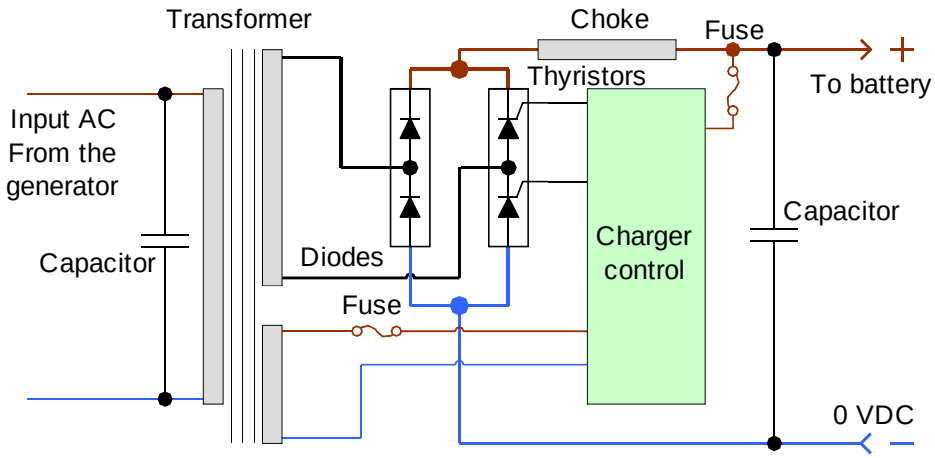
In a PS System the charger represents a significant load to the generator when it is charging the batteries at full power. The size of the charger is chosen to recharge the batteries in less than 8 hours to increase the overall system efficiency. However to prevent overloading the generator the system monitors the load on the generator and adjust the charge rate accordingly. This is in four steps 25%, 50%, 75% and 100% of the charge current.

Automatically adjusts the charge rate to suit the generator load.

The input to the charger is fitted with power factor correction to make it as efficient as possible.

Power factor corrected.

Sketch showing a simplified schematic.



Sketch showing a simplified charger schematic.

Transformer isolates the mains supply from the battery.

The above sketch shows a simplified schematic of the charger. The power from the generator is fed into the transformer primary winding. The power factor correction capacitor is fitted across the input. The transformer isolates

Charger

the battery pack from the mains supply.

The main secondary winding feeds the thyristor controlled bridge rectifier and the positive (brown) output goes to the battery via the choke. The choke is a critical inductance type and helps to smooth out the distortion caused by the rectifier. This along with the capacitor fitted to the output reduces the ripple on the battery increasing service life. The choke also reduces the interference the charger causes in the generator.

Thyristor controlled bridge with choke and capacitor filter.

Reduces interference.

The smaller secondary winding feeds the control circuits.

The charger is microprocessor controlled and has many standard functions.

Microprocessor controlled.

The micro-controller alters the phase angle of the gate firing point of the thyristors to regulate the voltage and limit the current.

Regulates by altering the firing angle.

Three Stage Charging

This method will restore full capacity to the battery quicker than with a float charge type and is the standard method used in our inverter systems. It is important to charge the batteries reasonably quickly to reduce the run time of the generator and increase system efficiency.

Three stage charging for speed and efficiency.

When the charger is powered up into a discharged battery the current is constant at a pre-set level. The voltage control is set at a higher level during this stage, ensuring that the current is maintained for a longer period which charges the battery quicker. As the battery becomes charged the voltage rises and the current reduces. The current is monitored and when it falls to a predetermined level the voltage on the battery is reduced to the float charge value keeping the battery charged without causing damage by excessive charging.

Constant current.

Constant voltage.

Temperature Compensation

As the temperature rises from the median point of 20°C the electrochemical activity in the battery increases and, conversely, decreases as the temperature falls. To prevent damage due to the over or under charging of the battery the charge voltage is compensated. The charger measures the

Temperature compensated.

Measures the ambient temp and adjusts charge voltage.

Charger

ambient temperature and for every °C change will adjust the voltage on the battery by a pre-set amount. The charger will turn off if the ambient temperature goes over 40°C or below 0°C.

Shutdown every 4 hours to check battery connections.

Auto Check

The charger shuts down every four hours for twenty seconds to check that it is properly connected to the battery. If there was a bad connection, the contactor was open or a fuse blown it would give a visual and audible alarm.

Many years of development to give high performance and long battery life.

Conclusion

Powerguard chargers are the result of many years of design, development and experience. Battery life, reliability, performance and efficiency are the four most important design criteria with battery life and reliability top of the list.

Many are used in critical applications and emergency systems.

Careful design has resulted in robust performance and long battery life.

They are used extensively in critical systems such as Emergency Lighting where reliability and performance is crucial.

Fit and forget.

Powerguard chargers are designed for "fit and forget" and will give many years of reliable service even in the most demanding environments.

Batteries

Type of Battery

One of the few batteries capable of giving the full 25 year service life is a nickel/cadmium or NiCad. These are extremely rugged and are ideal for the job. Unfortunately they are very expensive so it is usual to chose a lead acid alternative. NiCad and several types of lead acid batteries are available from Powerguard each one the best on the market in its category.

System service life over 25 years NiCad battery life over 25 years.

A Powerguard PS System charges and discharges the battery on a daily basis. Most batteries do not last very long under these circumstances so the choice of battery is very important.

A lot of lead acid batteries do not like a daily charge/discharge cycle.

The best lead acid battery for the job is a full traction type as fitted to fork lift trucks and electric vehicles. Anybody familiar with the life of a fork lift truck in a busy distribution warehouse will know that it is charged and discharged on a daily basis and still gives many years of reliable service. They are not sealed and will require topping up with distilled water occasionally.

Full traction as per fork lift trucks is the best.

An alternative is the semi-traction battery which is cheaper and valve regulated requiring no maintenance. These batteries will give about 300 100% discharge cycles giving a life of less than 1 year. However if the batteries are only discharged 50% then the life is increased by 3-5 times. Giving a life of 3 to 5 years which is more useful. If we are using this type of battery we will always double the capacity required to ensure that the usual discharge is less than 50%.

Semi traction a cheaper alternative.

100% discharge 1 year life - 50% discharge 3-5 years life.

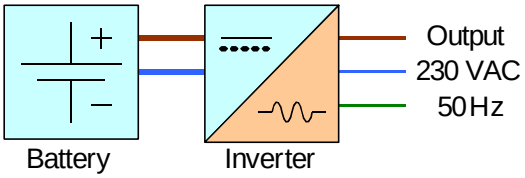
Inverter

DC power from a battery converted to AC mains.

General Information

An Inverter converts Direct Current (DC) power from a DC source usually a battery into Alternating Current (AC). The mains supply that we use every

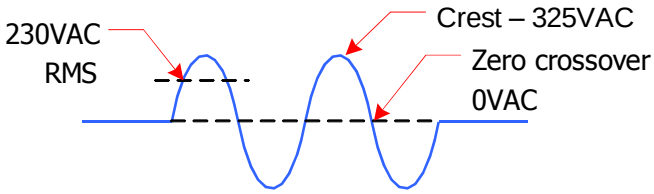
Inverter block diagram.



Normal mains power is 230VAC - 50Hz - sine-wave.

day to power our homes, offices, shops and factories is AC with a voltage of 230 Volts and a frequency of 50 Hz. The mains supply is a sine-wave an example of which is shown in the following sketch.

Sketch of a sine-wave.



Sketch showing a sine-wave

The output is an exact mimic of the normal mains supply.

Powerguard Inverters have an output which is an exact mimic of the mains supply - 230 VAC - 50 Hz - sine-wave and will power all standard electrical equipment as well as or better than the mains supply.

Ideal for sensitive or critical loads.

Powerguard Inverters have a regulated low distortion output ideal for computers, sound systems and telecommunications equipment.

Inverters used extensively in emergency systems.

Most of the inverters we manufacture are used in emergency systems. They have to be rugged and reliable because they are installed in critical applications where safety is the paramount concern. They are installed in hospitals, theatres, cinemas, office blocks, factories and many other public buildings.

Very reliable giving a long service life.

Powerguard inverters are very reliable and will give long and trouble free service with the minimum maintenance.

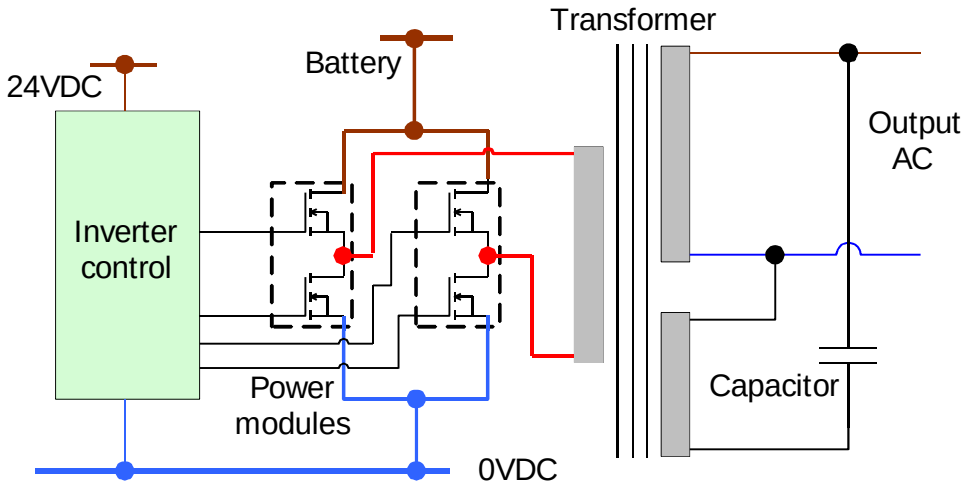
Inverter System

The inverter is made up of three basic parts:

Inverter

1) Inverter control
2) Power modules
3) Transformer

Three parts to the inverter.



Sketch showing a typical inverter schematic

Sketch showing a typical inverter schematic.

Inverter Control

Powerguard inverters are microprocessor controlled for the maximum reliability and efficiency. The control continually monitors and adjusts all of the parameters of the system and drives the display.

Microprocessor control reliability and efficiency.

The control also generates the waveforms required for the power module drivers.

Power Modules

Powerguard power modules are designed and built to switch the heavy DC currents needed to drive the transformer and load. Each module is a two channel design to facilitate push-pull, half-bridge or full-bridge requirements.

Unique power modules for switching large DC currents.

Each channel can be fitted with up to five power Field Effect Transistors (FET).

Each FET is rated at 90 Amps giving a notional output per channel of 450 Amps however it is Powerguard policy to rate the transistors at 50% of the of the 75°C rating giving 37 Amps per device and 185 Amps per channel.

The power modules are rated conservatively for long term reliability and efficiency.

Inverter

Power modules can be paralleled for high currents.

The power modules are designed to work in parallel allowing large DC currents to be reliably and efficiently switched.

New state of the art drivers.

Powerguard have just developed a new state of the art power module driver. This not only switches the power modules very efficiently but can detect a fault and shutdown within 10 µS protecting the machine from severe overloads and short circuits increasing the reliability.

Transformer

Transformers developed over 25 years.

Powerguard transformers are the latest versions of a pedigree going back 25 years. They are ferro-resonant and have many characteristics that make them ideal for most inverter applications. We have designed them so that if the output is short circuited the current is limited to twice the normal full load current. This helps to protect the electronics increasing reliability.

Short circuit proof and very reliable.

The transformers provide a filtered and regulated output ideal for all electrical equipment designed to run on the normal mains electricity supply.

Conclusion

Many years of design and development giving a very robust performance, high reliability and efficiency.

Powerguard inverters are the result of many years of design, development and experience.

Careful design has resulted in robust performance for example the output of a fully loaded inverter can be short circuited for longer than 5 seconds and when the short is removed the load will power up again as normal. The output can be overloaded 150% for 15 minutes and overloaded 125% for 30 minutes.

Inverters are ideal for the PS System.

Powerguard inverters are ideal for the PS System - they can be severely overloaded on a regular basis without damage they will just keep going.

Fit and forget.

Powerguard inverters are designed for "fit and forget" and will give years of reliable service even in the most demanding environments.

Power Supply

In systems that have a battery voltage over 24 VDC a DC-to-DC power supply is fitted to provide 24 VDC to power the control circuits from the battery.

The power supply has full parallel redundancy and is very reliable.

The DC-to-DC power supply has two independent switch mode converters operating in parallel redundancy each one feeding through diodes. Each of the converters is monitored by the control and if one fails a visual and audible alarm is given.

Monitored and alarmed.

This gives a very reliable system giving an alarm and allowing time for service. The failure of both supplies during operation is extremely unlikely.

Virtually impossible for both supplies to fail at the same time.

Volt Free Alarm Contacts

Volt free common alarm contacts for a remote panel.

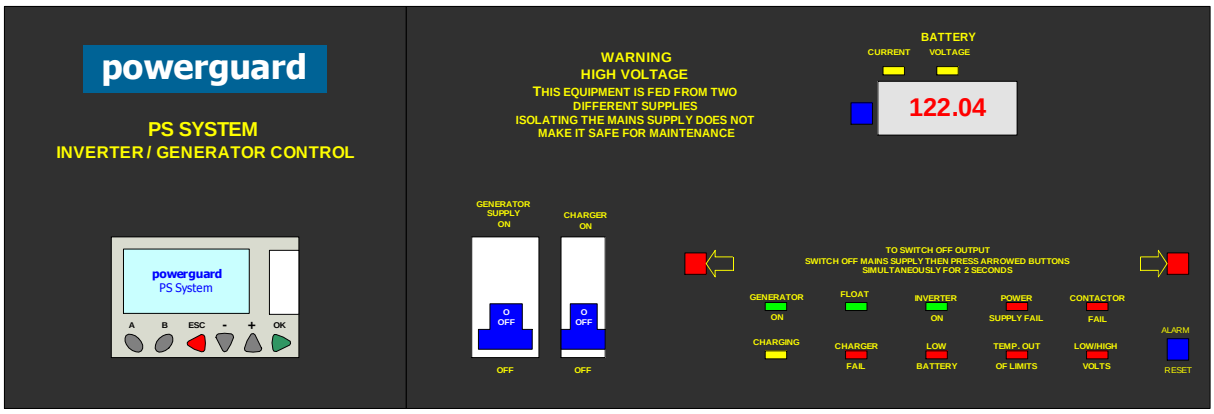
A set of volt free common alarm contacts are wired to three orange screw terminals adjacent to the input and output terminals.

These allow an interface to either a remote common alarm or a building management system.

If any of the systems alarms are triggered the contacts operate.

Powerguard can supply a standard remote alarm panel if required.

Fascia Panel



Sketch showing a typical full fascia panel

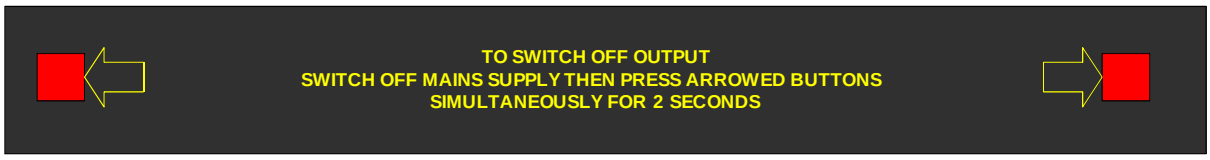
Overview

The front panel is fitted with two MCBs as per the above sketch:

The one shown on the left is the generator supply and switches the generator output to the load through the changeover contactor.

The one on the right switches the charger on and off. If the generator is running and the charger is switched off the system will think that the generator has switched off and changeover to the inverter.

Switching Off The System



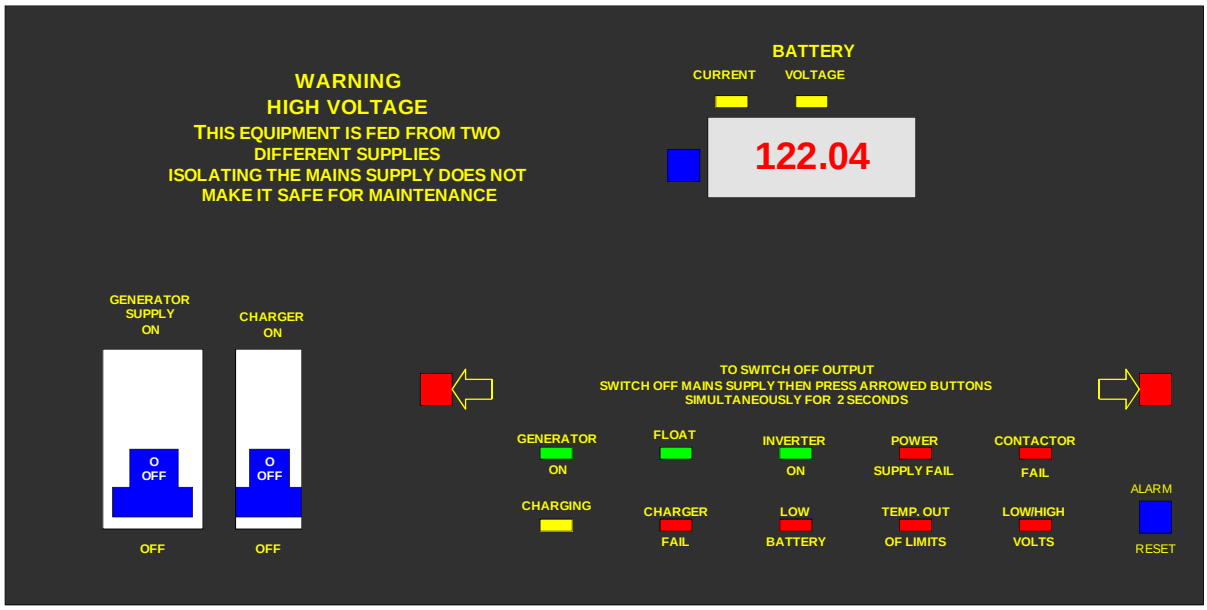
Before the system can be switched off the inverter has to be running.

Switch off the "Generator Supply" and the "Charger" MCB situated on the front fascia panel. This will cause the inverter to start.

Press the two red arrowed buttons shown on the above sketch simultaneously for 2 seconds and the system will shutdown.

The system can only be restarted when the generator is on and the MCBs are switched on.

Fascia Panel



Sketch showing the LEDs and digital meter

Generator On– LED

The green "Generator On" LED is on when the generator is running supplying the load and recharging the batteries.

Float – LED

The green "Float" LED is on when the charger switches to float charge. The charger has recharged the batteries during the bulk charge phase and to protect the battery from overcharge the system automatically lowers the charge rate. The float charge voltage keeps the batteries fully charged without damage and is temperature compensated.

Inverter On– LED

The red "Inverter On" LED is on when the inverter is supplying the load from the batteries.

Power Supply Fail – LED

The system is fitted with a dual power supply with two independent outputs. If one or both of the power supplies fails the Red LED is on.

24 VDC systems do not have an internal power supply board.

Contactor Fail – LED

The red "Contactor Fail" LED is on when a failure has been detected on the changeover contactor.

Fascia Panel

Charging – LED

The amber "Charging LED" is on to indicate that the bulk charge phase is taking place prior to the system switching to float mode.

Charger Fail – LED

The red "Charger Fail" LED is on when the battery charging system has a fault and is not charging.

The LED is off when the system is running from the batteries.

Low Battery – LED

The red "Low Battery" LED is on when the battery voltage falls to a predetermined level to warn of impending low battery shutdown.

Temp. Out of Limits

The red "Temp Out of Limits" LED is on when the ambient temperature is less than 0°C or more than 40°C. The charger shuts down.

Low/High Volts – LED

The red "Low/High Voltage" LED is on when the charger output is too low or too high in the float mode.

Alarm Reset – Button

Pressing the blue reset alarm button silences the audible alarm.

Digital LED Meter

The value is displayed on a 4 digit LED display so it can be easily seen even in poorly lit areas.

The digital meter indicates the battery voltage and current both charge and discharge. The reading is toggled between voltage and current by the adjacent push button. Two amber LEDs indicate the status of the displayed reading. A minus sign is displayed before the value if the battery is discharging.

Fascia Panel

Digital LCD and Control

Sketch showing the LCD and control

The following sketches show the information that is displayed when different modes of operation are active. The following pages show the information displayed during normal automatic operation.

```
GEN VOLTAGE:  00230
GEN CURRENT:  00065
GEN  O/RIDE PRESS A
DD.MM.YY      HH:MM
```

Page 1

The display page 1 shows the generator output voltage and the generator output current.

The display also indicates that the generator can be overridden by pressing "Button A". In this mode the generator will run continuously.

The date and time of day is also shown

```
INV VOLTAGE:  00230
INV CURRENT:  00065
GEN  O/RIDE PRESS A
DD.MM.YY      HH:MM
```

Page 2

The display page 2 shows the inverter output voltage and the inverter output current.

The display also indicates that the generator can be overridden by pressing "Button A". In this mode the generator will run continuously.

The date and time of day is also shown.

Fascia Panel

GENERATOR OVERRIDE
PRESS ESC FOR
NORMAL OPERATION
DD.MM.YY HH:MM

Page 3

The display page 3 shows that the generator is in override (continuous operation) and can be returned to normal operation by pressing the "ESC" button. 

The date and time of day is also shown.

GENERATOR
STOPPING

Page 4

The display page 4 shows that the generator has been switched off and is stopping.

GENERATOR
STARTING

Page 5

The display page 5 shows that the generator has been switched on and is starting.

LOW BATTERY
GENERATOR START

Page 6

The display page 6 shows that the generator has had to start in an off period because the battery has become too discharged threatening a system shutdown.

The generator will run for 30 minutes to partially recharge the batteries.

HOLIDAY MODE
PRESS UP FOR
NORMAL OPERATION
DD.MM.YY HH:MM

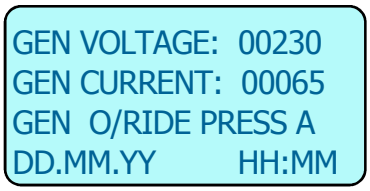
Page 7

The display page 7 shows that the system is in holiday mode. In this mode the system will keep the generator run time to a minimum to recharge the batteries even in must-run periods.

Press the "UP" button  to toggle the system in and out of Holiday Mode.

Fascia Panel

Setting the Time and Date



Page 1

When a page is being displayed that shows the date and time such as Page 1 shown on the left - they can be easily changed as follows:-

The date on the sketch is DD.MM.YY format for the day, month and year.

The time is HH.MM format for hour and minute using the 24 hour clock. 2:00 AM becomes 02:00 and 2:00 PM becomes 14:00.

Use the "Up" and "Down" keys to place the cursor on the data to modify.

Confirm by pressing the "OK" key and the selected data will flash.

Use the "Up" and "Down" keys to scroll to the desired value.

Confirm by pressing the "OK" key.

Setting the Must-run and Can-run Periods

Press the "OK" and "ESC" buttons together.

Scroll to "Parameters" using the "Up" and "Down" buttons.

Press "OK"

Select the FBD number

Press "OK"

Use the "Up and "Down" buttons to change to the FBD number required

FBD 013 = Must-run and FBD 089 = Can-run.

Press "OK"

Use the "Up" and "Down" buttons to move the cursor to the N number relating to the time to be changed as per the following chart.

00 = 1st on time - 01 = 1st off time

02 = 2nd on time - 03 = 2nd off time

Press "OK"

Fascia Panel

Use the "Up and "Down"   buttons to alter the times.

Press "OK" 

Use the same procedure to alter the other preset times.

Press the "ESC"  button the required number of times to return to the normal display.

Must-run and Can-run Periods

Two must-run and one can-run period per day.

7 day timer

The system is set up for two must-run and one can-run periods per day on a 7 day timer. The system can be set for more periods or for different periods on different days if needed but these have to initialised at the factory and transferred to site using a memory module.

Generator must run long enough to recharge batteries.

It has to be remembered that the generator must run long enough to recharge the batteries ready for the periods when the inverter should run.

When the inverter runs the generator noise, fumes, fuel consumption and wear and tear are not taking place.

Generator reduced to less than 8 hours per day.

In a 24 hour period we aim to reduce the generator run time to less than 8 hours.

Must-run periods cover loads bigger than inverter.

During a must-run period the generator must run. These periods should be chosen to cover the times during which it is known that loads will be applied that are greater than the inverter 100% load rating. This will reduce the times the generator starts due to inverter overload.

During the can-run period the generator will run until two conditions are met for a 15 minute period.

Can-run enables the generator to shut down ASAP.

1) The generator load is stable at less than the inverter 100% load rating.
2) The battery is fully charged and the charger has switched to the "Float" mode.

Mixture of must-run and can-run the best.

It can be seen that a mixture of must-run and can-run periods will be the most efficient way to operate the system. Must-run to reduce inverter overload and can-run to allow the generator to shut down as soon as possible.

Factory set times.

The times set at the factory are as follows:-

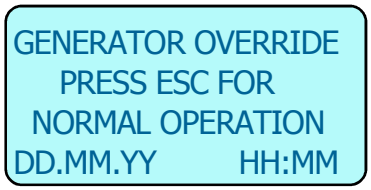
Must-run - 06:30 to 09:00 and 16:00 to 18:00

Can-run - 18:00 to 21:30

Generator Override and Holiday Mode

Generator Override

The system can be put into "Generator Override" mode by pressing the "A" button. 



Page 3

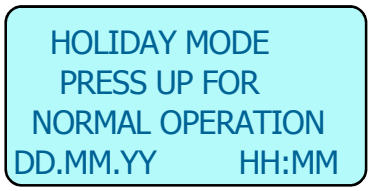
It can be returned to normal automatic operation by pressing the "ESC" button. 

Generator override would be used to cover an unusual period outside the normal must-run periods when it is known that loads greater than the maximum inverter load will be applied.

It is used to reduce the generator startups caused by inverter overload.

Holiday Mode

The system can be put into "Holiday Mode" by pressing the "Up" button. 



Page 7

It is returned to normal timed operation by pressing the "Up" button again.

Holiday mode is designed to minimise the generator run time when the building is unoccupied. This could be when the occupants are on holiday or away on business for a few days.

The must-run periods become can-run periods and the generator will be shut down as soon as possible when the following criteria are met for a 15 minute period:-

1) The load is stable at less than the inverter 100% load level.
2) The battery is fully charged and the charger has switched to the "Float" mode.

Choosing a PS System

It would be better to monitor the load pattern over 24 hours.

If there is an existing generator supplying power it would be relatively easy to monitor the generator output over a typical 24 hour period to give us an accurate pattern of load usage allowing us to specify the PS System accurately. However in new installations where the generator is installed with the PS System we must estimate the loads on the system. In fact most systems are estimated and this can be done reasonably accurately.

Virtually all systems are estimated.

Our object is to reduce generator run time to a maximum 8 hours per day so we will base all our calculations on this starting point. We will build into the system extra capacity so that the PS System control can reduce the generator run time to the lowest practicable period.

Extra capacity built into the system to reduce generator run time.

The generator must have a rating large enough to supply the heavy loads such as washing machines, dish washers and cookers and at the same time recharge the batteries. The battery charger will automatically adjust its charge rate to allow peak loads to run but we still have to recharge the batteries within the 8 hours. The system is more efficient if the ratings of the generator and inverter are kept as accurate as possible but it is better to err on the high side rather than risk overloading the system.

Generator must have spare capacity to charge the battery.

The generator load should be estimated by adding up the appliances that will be running in a relatively short time period. We will then add the charger load when it is determined. A generator sized to run a typical medium domestic property would be about 15 kVA.

The generator load is appliances that will run for a short time.

The inverter rating must be estimated to run all of the off peak loads these will include lights, television, computers and maybe a 2 kW kettle. A typical size for a medium domestic property would be 2 to 3 kVA.

The inverter load is all of the off peak loads.

The average inverter load must be estimated and this is the most difficult to do. This includes the above averaged out with the period of very light load usually when everybody has gone to bed. It may include some security lighting and small load appliances. An effort should be made to keep the average inverter load as small as possible.

The inverter average load is the average over the 16 hours.

Choosing a PS System

Lets opt for a system similar to one that was recently installed as follows:-

Generator prime power rating - 15 kVA

15 kVA generator.

Inverter rating - 2.5 kVA

2.5 kVA inverter.

Average inverter load - 1 kVA

1 kVA average load.

Generator must-run periods - 06:30 to 09:00 and 16:00 to 18:00

Generator can-run period - 18:00 to 21:30

Must-run and can-run periods.

We chose the battery to supply the average inverter load for a minimum of 16 hours.

Battery to supply average inverter load for 16 hours.

Inverter average current - 28 Amps.

Battery Amp/hours - 28 Amps x 16 hours = 448 Amp/hours.

The batteries we are using in this system will only last 1 year if they are cycled 100% every day whereas they will last at least 3 years if they are cycled about 50%. So it is good economy to double the size of the battery.

Battery capacity x 2 to increase battery life.

Battery Amp/hours - 448 Amp/hours x 2 = 896 Amp/hours.

The battery we will use is 4 strings of 200 Amp/hour deep cycle batteries giving - 4 x 200 Amp/hours = 800 Amp/hours.

800 Amp/hours battery capacity.

The charger rating is based on C10 which is the battery capacity divided by 10 = 80 Amps. If the calculated requirement was higher than C10 we would increase the size of the battery capacity.

Charger C10 rating.

The calculated charge rate - 448 Amp/hours ÷ 8 hours ÷ 0.9 losses = 63 Amps. The C10 rating of 80 Amps provides spare capacity to reduce the charge time making the system more efficient.

80 Amp charger gives some spare capacity increasing efficiency.

Examples

Two examples one a farm in Norfolk the other a private house near Cambridge.

General Information

Recently two Powerguard PS Systems were installed in typical domestic applications. One at a farm in Norfolk the other at a private house near Cambridge.

Norfolk

Mains connection too expensive so a 15 kVA generator installed.

This is a new farm house built in a place where connection to the mains power grid was prohibitively expensive. Instead a 15 kVA generator was installed and because electricity was required 24/7 it had to run all day every day. The generator consumed about 15 litres per day of diesel fuel. This was not very efficient and Powerguard was contacted about a PS System.

Running costs too high. Install a PS System.

Our calculations are based on the generator running for a maximum of 8 hours and the inverter running for the remaining 16 hours out of the 24 period.

In situ picture of the PS System at the Norfolk farm.

2.5 kVA inverter.

48 VDC battery pack.

The inverter rating required to run the off peak loads was estimated at 2.5 kVA. The battery voltage required to run a 2.5 kVA inverter is 48 VDC. The average inverter load over the 16 hour off peak period was estimated at 1 kVA.

1 kVA average load.

Battery discharge current 28 Amps.

The battery discharge current for an average inverter load of 1 kVA is about 28 Amps. Multiply this by the 16 hours running time and we have 448 Amp/hours.

448 Amp/hours required.

The type of battery used would provide about 300 discharge cycles if the discharge was near 100% whereas this increases to 1500 if the battery is

Examples

discharged to 50% of its capacity. To increase the life of the battery we doubled the required 448 Amp/hours to 896 Amp/hours. We used 4 strings of 200 Amp/hour deep cycle batteries giving a total of 800 Amp/hours.

Battery capacity doubled to 800 Amp/hours to increase battery life.

The charger has got to be rated correctly or it can let the whole system down. With this particular type of battery we prefer to keep the charge rate below C10 which is the capacity - 800 Amp/hours divided by 10 = 80 Amps. This charge rate easily exceeds the current rating needed to replace the system requirement of 448 Amp/hours in 8 hours which calculates to about 63 Amps. The increased charge rate makes the system more efficient by reducing generator run time. This PS System was fitted with an 80 Amp charger.

80 Amp charger gives some spare capacity.

Cambridge

The generator at this location is 13.3 kVA and was switched on and off when required to save fuel. This became more and more inconvenient to the aging owners. It was decided to contact Powerguard to purchase a PS System. The operation of the system is similar to the Norfolk unit but the size is different.

Manual operation of the generator became too burdensome decided to automate with a PS System.

The inverter is 2 kVA and the average inverter load was estimated at 500 VA.

3 strings of 200 Amp/hour deep cycle batteries giving a total of 600 Amp/hours at 48 VDC.

The charger is continually rated at 60 Amps.

In situ picture of the PS System installed near Cambridge.

13.3 kVA generator.

2 kVA inverter.

500 VA average load.

60 Amp charger.

Installation, Commissioning and Maintenance

Installation

The installation of this equipment must be carried out by properly trained personnel adhering to all the requirements of the IEE Wiring Regulations 16th Edition and any other applicable national or international standards that apply to electrical installations generally and engine driven generator and battery installations in particular.

Commissioning

Only properly trained and experienced personnel should commission the system.

Maintenance

The Powerguard PS System should be maintained by properly trained personnel in accordance with the manufacturers instructions and applicable national and international standards. The PS System must be isolated from the incoming mains/generator supply and the battery supply before any maintenance work is carried out.

Please make sure that the air flow in not restricted by making sure that there is at least a 100mm gap on the fan side of the machine.

Alternative Energy

Wind, Solar and Other Alternative Energy

Having taken the first major step to make your electricity generation more efficient by installing a Powerguard PS System further steps can be taken to reduce costs further. The PS System works by using excess power from the generator to charge the batteries and then utilising this stored power via an inverter to power light loads. This significantly reduces the generator run time to less than 33% saving fuel and maintenance.

However the generator has to run for a certain period up to 8 hours per day to recharge the batteries. It can be seen that if an alternative method was used to recharge the batteries such as a wind turbine the generator run time could be reduced even further to below 20% per day and even not running some days at all.

The addition of an alternative energy source to recharge the batteries adds significantly to the efficiency of the system and would reduce pollution and the production of greenhouse gases.

Water driven turbines and solar power can also be used to achieve the same reductions but generally the cost is higher and implementation more difficult.

Wind generators used in conjunction with a PS System are generally cheaper and more efficient because they are producing power to charge batteries and do not have to be synchronised and run at a constant speed.

Alternative Generator Fuel

Most diesel engines can be converted to run on alternative fuel such as bio-diesel and vegetable oil. Powerguard can advise on the implementation of alternative fuel if required.

Combined Heat and Power

Roughly speaking if we produce 15 kW of electrical power using an engine driven generator we waste 30 kW of the energy from the fuel as heat - 15 kW into the water jacket and 15 kW up the exhaust pipe. Powerguard believe that the most cost effective next step after purchasing a PS System is to look at recovering a significant proportion of the wasted heat and utilising it to reduce space heating and hot water costs.

Powerguard has a lot of experience in these systems and can offer practical and cost effective solutions.

Mounting and Connecting

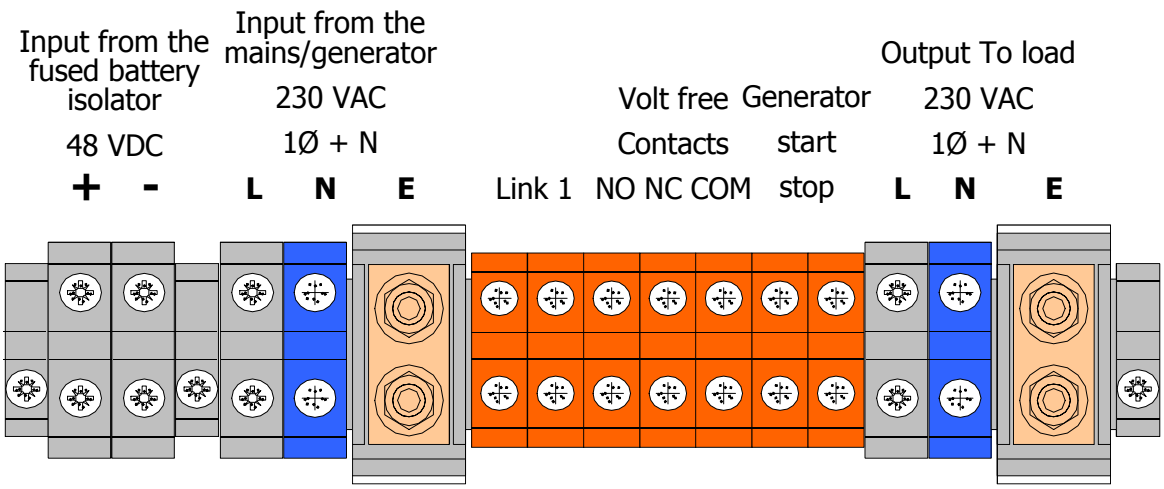
Make sure all the inputs are isolated - mains/generator supply and the battery supply - before making the connections to the PS System.

The input, output and control cables must be taken through the removable gland plate at the top of the enclosure using appropriate glands. Remove the gland plate before drilling to ensure no swarf goes into the system. Make sure all of the voltages are compatible before connection. Measure the battery voltage with a meter.

The PS System must be earthed.

Check that the battery input contactor is open.

The following sketch shows the input and output connections:-



Sketch showing the input and output connections.

Battery connections

Switch off the external battery isolator and remove the fuse carriers.

Connect the positive lead into the positive connector as shown above and connect the other end to the positive connection on the battery isolator. The positive lead is usually coloured brown.

Connect the negative lead into the negative connector as shown above and connect the other end to the negative connector on the battery isolator. The negative lead is usually coloured blue.

Mounting and Connecting

Output connections

Connect one end of the output Live wire to the load distribution Live terminal - **L**

Connect the other end of the output live wire to the appropriate system output terminal marked - **L**

Connect one end of the output Neutral wire to the load distribution Neutral terminal - **N**

Connect the other end of the output Neutral wire to the appropriate system output terminal marked - **N**

Connect the Earth wire in a similar manner to the terminals marked - **E**

Input Connections

Connect one end of the input live wire to the appropriate system input terminal marked - **L**

Connect the other end of the input Live wire to the mains/generator Live terminal marked - **L**

Connect one end of the input Neutral wire to the appropriate system input terminal marked - **N**

Connect the other end of the input Neutral wire to the mains/generator Neutral terminal - **N**

Connect the Earth wire in a similar manner to the terminals marked - **E**

There are special requirements for the earthing arrangements on generators and care should be taken to ensure that best practice in compliance with any applicable national and international standards is adhered to.

Typical Specification

Powerguard Inverter

Input	Voltage		48 VDC nominal
	Voltage range		40 – 60 VDC
	Current	full load	≈ 60 Amps at 48 VDC
		half load	≈ 36 Amps at 48 VDC
		no load	≈ 6 Amps at 48 VDC
Output	Voltage		230 VAC
	Voltage range		± 5%
	Frequency		50 Hz
	Waveform		Sinusoidal
	THD		< 5% into a linear load.
	Power		2500 VA
	Rating		Continuous
	Overload %		>100% for 60 mins - >115% for 30 mins.
			>130% for 15 mins - >150% for 5 secs.
	Short-circuit		Approx. 2 x full load current.
	Short circuit duration		5 seconds
	Efficiency	full load	≈ 85 %
		half load	≈ 80 %
		quarter load	≈ 70 %

Protection: Input fuse, inherent flux de-coupling, ultra fast electronic cycle by cycle current limit and ultra fast power module spike suppression.

Powerguard Automatic Battery Charger

Charger	Type	Microprocessor controlled thyristor
		3 stage
		Constant current – constant voltage
	Filter	Critical inductance choke
Input	Voltage	230 VAC
	Frequency	50 Hz
Output	1st Stage Voltage	57 VDC
	Current	80 Amps
	Rating	Continuous
	Float charge	54 VDC @ 20°C
		Temperature compensated

Typical Specification

	The charger current automatically adjusts to make the best use of the available generator capacity.	
Protection	Input MCB – output fuses – automatic current limit	

Battery Pack

Battery	Type	Valve regulated lead acid (VRLA)
	Model	6FM200D
	Battery capacity	200 Amp/hours
	Layout	4 strings of 4 batteries
	Battery blocks	12
	Pack voltage	48 VDC nominal
	Pack Capacity	800 Amp/hours

Generator starts When a relay contact closes and stops when the relay contact opens.

Powerguard System Control

The generator needs to be upgraded by using the appropriate Deep Sea control module. The generator must start when the control provides a signal and stop when the signal is removed.

The control consists of a microprocessor control unit incorporating a real time clock, changeover contactor and various voltage and current sensors.

The control will automatically start and stop the generator and inverter and transfer the load between the two. When the transfer takes place there will be a short beak in the supply to the load. The system is designed to minimise the disruption caused to the load by keeping the changeovers to a minimum.

Enclosure: 800mm w x 1350mm h x 400mm d

Connections: Screw connections

Load Calculations

We are aiming to keep the generator run time to less than 8 hours in any 24-hour period. The inverter has to run for 16 hours.

A 2500 VA inverter has an average discharge current of about 64 Amps at full load. The inverter will not be operating at full load most of the time so we have to estimate an average load which is 1000 VA.

1000 VA gives an average discharge current of about 28 Amps for 16 hours = 448 Amp/hours.

If the battery offered is discharged completely every day the life would be about 200-300 days. If we usually discharge the battery less than 50% the life would increase 3-5 times.

448 Amp/hours x 2 = 896 Amp/hours. The battery pack required is 800 Amp/hours.

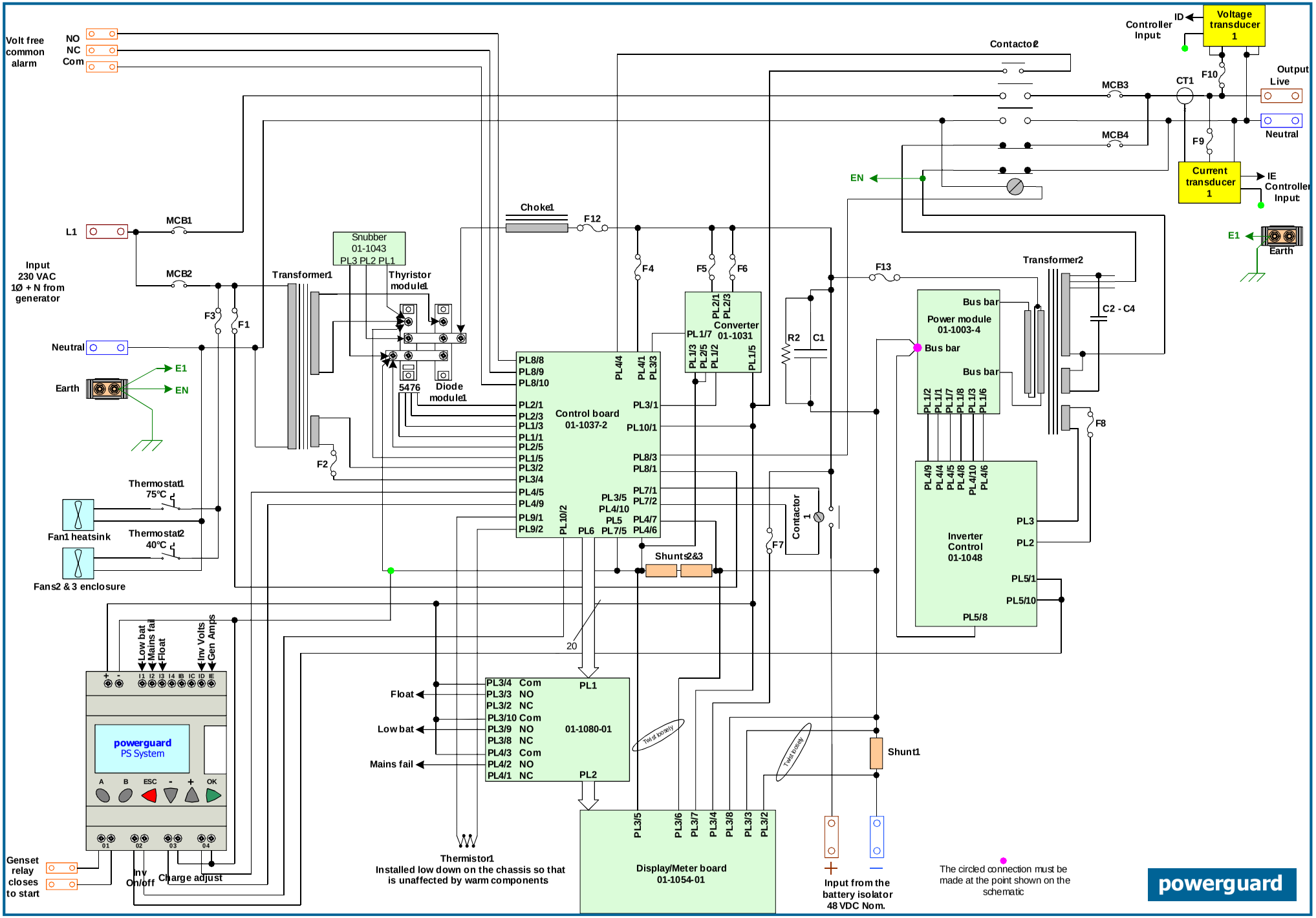
Other Products and Services

Powerguard supply a wide range of power equipment and services including: -

1) Uninterruptible Power Supplies
2) Engine driven Generators
3) Central Battery Emergency Lighting Systems
4) 5 year life Batteries
5) 10 year life Batteries
6) 15 year life Batteries
7) 20 year life Batteries
8) Deep cycle Batteries
9) Full Traction Batteries
10) NiCad Batteries
11) Battery Chargers
12) Inverters
13) Rectifier Systems for 24 VDC or 48 VDC
14) Bypass Switches
15) Static Switches
16) Site Surveys
17) Full Installation
18) Commissioning

Notes

Notes


Volt free common alarm
NO
NC
Com
L1
MCB1
Input 230 VAC 1Ø + N from generator
MCB2
Neutral
Earth
E1
EN
F3
F1
F2
Transformer1
Snubber 01-1043 PL3 PL2 PL1
Thyristor module1
5476
Diode module1
Choke1
F12
F4
F5
F6
Control board 01-1037-2
PL8/8
PL8/9
PL8/10
PL2/1
PL2/3
PL1/3
PL1/1
PL2/5
PL1/5
PL3/2
PL3/4
PL4/5
PL4/9
PL9/1
PL9/2
PL10/2
PL6
PL4/4
PL4/1
PL3/3
PL3/1
PL10/1
PL8/3
PL8/1
PL7/1
PL3/5
PL7/2
PL4/10
PL5
PL4/7
PL7/5
PL4/6
PL2/1
PL2/3
Converter 01-1031
PL1/7
PL1/3
PL2/5
PL1/2
PL1/5
R2
C1
F13
Transformer2
C2 - C4
Bus bar
Power module 01-1003-4
Bus bar
Bus bar
PL1/2
PL1/1
PL1/7
PL1/8
PL1/3
PL1/6
F8
PL4/9
PL4/4
PL4/5
PL4/8
PL4/10
PL4/6
Inverter Control 01-1048
PL3
PL2
PL5/1
PL5/10
PL5/8
Contactor 1
F7
Shunts2&3
Thermostat1 75°C
Fan1 heatsink
Thermostat2 40°C
Fans2 & 3 enclosure
Low bat
Mains fail
Float
Inv Volts
Gen Amps
I1 I2 I3 I4 IB IC ID IE
powerguard PS System
A B ESC - + OK
01 02 03 04
Genset relay closes to start
Inv On/off
Charge adjust
20
Float
Low bat
Mains fail
PL3/4 Com
PL3/3 NO
PL3/2 NC
PL3/10 Com
PL3/9 NO
PL3/8 NC
PL4/3 Com
PL4/2 NO
PL4/1 NC
PL1
01-1080-01
PL2
Twist evenly
Twist evenly
PL3/5
PL3/6
PL3/7
PL3/4
PL3/8
PL3/3
PL3/2
Display/Meter board 01-1054-01
Thermistor1
Installed low down on the chassis so that is unaffected by warm components
Shunt1
Input from the battery isolator 48 VDC Nom.
The circled connection must be made at the point shown on the schematic
Contactor2
MCB3
MCB4
CT1
F10
F9
F11
Voltage transducer 1
Controller Input
ID
Output
Live
Neutral
Current transducer 1
IE
Controller Input
E1
Earth
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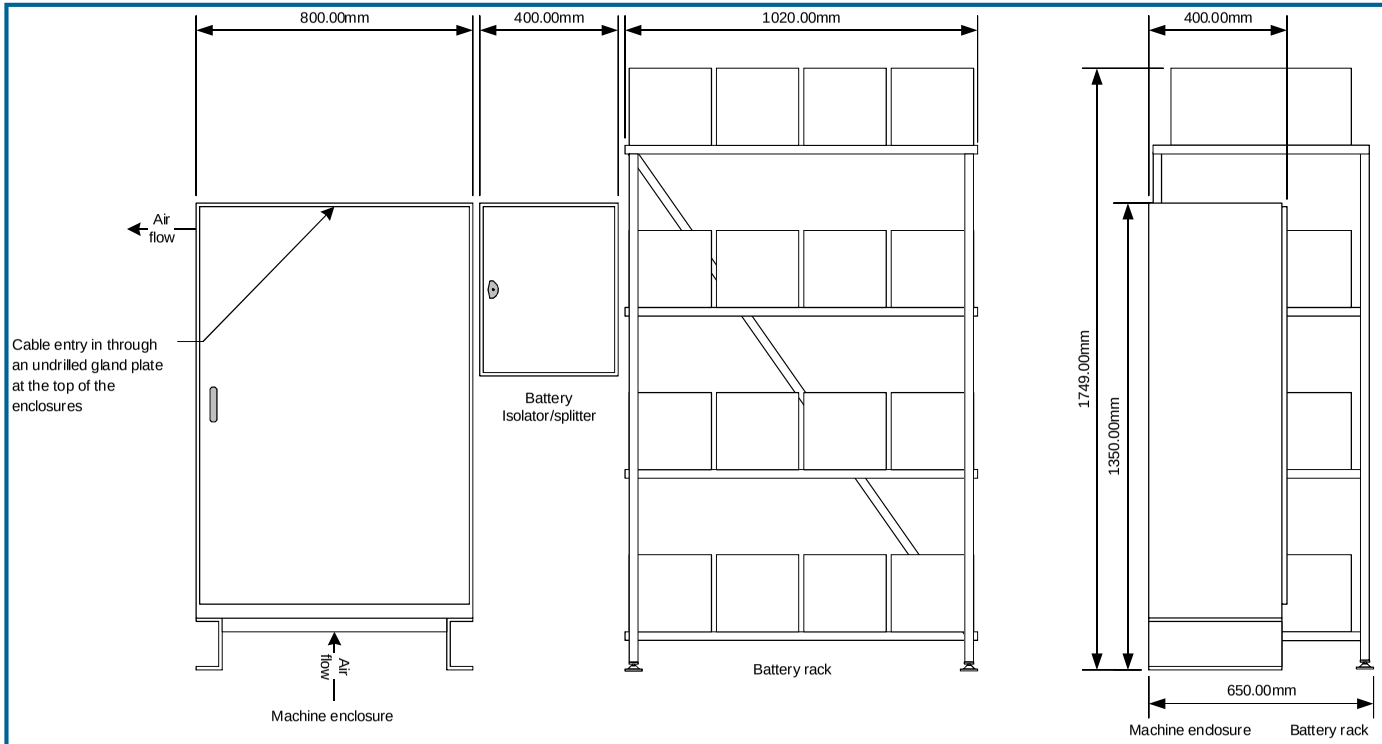
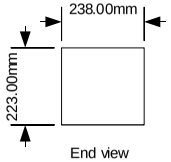
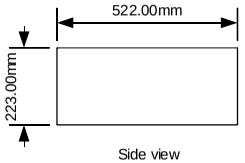
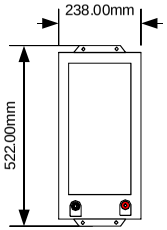
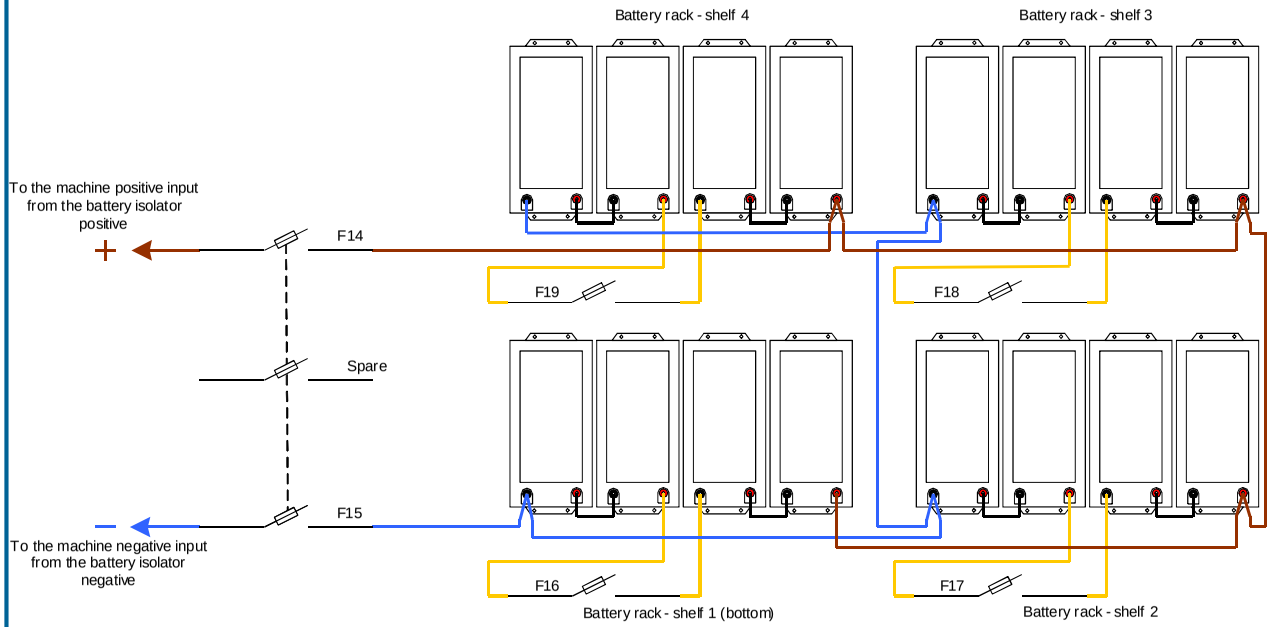






Dimensions of Vision battery - 6FM200D
Weight - 65 kgs
Connections - 8 mm bolt





All supplied with the system

4 strings of4 off 6FM200D
16 off battery blocks
24 Cells in series
48 VDC Nominal

8 off inter block links– short

8 off battery string to fuse holder links

1 off battery positive to isolator positive link
1 off isolator positive to machine positive link
3 off battery positive to battery positive links

1 off battery negative to isolator negative link
1 off isolator negative to machine negative link
3 off battery negative to battery negative links

This information is given for guidance only and it is up to the installer to make sure that the installation conforms to best practice and any applicable safety and technical standards that apply . Battery shapes and wire colours shown are indicative only.
When the battery pack has been assembled use a voltmeter to check that the voltage is compatible to the rating plate on the machine.

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