power solutions australia

solar grid battery interactive sinewave inverter

manual for installation & operation

Inverter types covered:

SGB-3-24,48
SGB-4–32
SGB-5-48,72,108,110,120

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These instructions provide you with basic information for the installation, operation and maintenance of your **p**ower **s**olutions **a**ustralia power converter.

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Introduction

Power Solutions Australia Grid Interactive Inverters provide a means of directly connecting dc renewable sources such as solar photovoltaic arrays and small wind turbines to the electricity grid. Grid connection ensures that all renewable energy generated can be utilised. Surplus energy not used locally is exported to the grid to other electricity users.

Systems with batteries can operate in one of three configurations:

- Without local load output, the inverter starts when renewable input becomes available and shuts down when renewable too small to justify operation.
- With local load supplied from the grid and renewables during normal operation. If the renewables exceed local load excess power is exported, if they are less than local load the shortage will be supplied from the grid. If the grid fails, local load can be sup plied from the battery and from renewable input. The battery will discharge if renewable input is less than local load and be charged when it exceeds local load.
- Reliable Power Solutions provide guaranteed supply should the grid fail, a generator is connected which automatically starts if the grid fails and the battery is discharged. It will shutdown when the battery is recharged, the grid is restored or if not required to support the load.

These modes provide flexible options to configure systems to meet differing customer requirements.

Data logging operates continuously in the inverter to record power, voltage and current variables. Most variables are averaged over 15 minute periods but minimum and maximum values of selected variables during each 15 minute period are also recorded. Data covering up to 8 days of testing is stored in non volatile memory in the inverter. A single day of data or all stored data can be retrieved over a serial link. The oldest day's data is automatically cleared and overwritten as each new day of logged data is added. There is no need to clear logged data from the inverter.

An IBM compatible PC program is provided which converts logged data from the inverter into spread sheet format and extracts event records which record the times at which tests start, change mode and stop as well as other events associated with inverter operation.

An alpha numeric LCD display allows inverter variables to be displayed and allows suitably qualified technicians to adjust operating parameters to optimise system performance.

Operating Procedures

Initial Starting of System

This procedure only needs to be followed when the inverter has been fully shut down and the DC circuit breaker has been opened.

- Close all AC circuit breakers.
- Ensure that ac grid supply is present.
- Connect the battery supply by ensuring that battery fuses and isolators are in place
- Close the DC circuit breaker by pushing the switch down then up.
- Close the renewable input circuit breakers or isolators
- Turn the Inverter on/off switch to on. The inverter will go through its self test sequence. All indicator lights will flash.

When self test completes the top indicator light will be on and steady indicating the inverter is ready to start
When the renewable input brings the battery voltage above the charge voltage setting the inverter will start and connect to the grid.

Shutting the System Down

This procedure only needs to be followed if the system is to be shut down for maintenance or is to be taken out of service for an extended period.

- Turn the inverter off using the on/off switch
- Open the AC circuit breakers
- Open the DC circuit breaker
- Open the renewable input circuit breakers or isolators
- Open the battery isolation fuses to ensure that the inverter standing current does not discharge the battery
- Note The renewable inputs must be wired back to the battery to ensure that should the battery be disconnected high voltages from the renewables are not applied to the inverter.

Turning System On & Off

If required the system can be started and stopped at any time using the on/off switch.

Checking system operation for the first time

- Perform the initial startup procedure described above.
- Check that the inverter starts when the dc voltage exceeds the charge voltage.
- Check that grid voltage is present (shown as generator voltage on the LCD).
- Check that the charge and float voltage settings are appropriate for the battery and compatible with the settings of the renewable regulator.
- Check that the inverter stays on line while it is outputting power (inverter power positive, generator power negative).
- Check that if the renewable inputs are disconnected the inverter shuts down within 4 minutes
- Download the logged data and examine the logged data and event records to confirm that they appear normal.
-

Precautions

Electrical Installation

The installation and electrical connection of this system should only be undertaken by a qualified electrician. Relevant national standards and practices for the installation should be followed. Voltages generated by the equipment are lethal. The system must be earthed.

Generator Installation

The installation of the generator should follow relevant standards and practices for the installation of fuel storage, for ventilation and dispersal of exhaust gas. Exhaust gas in enclosed spaces can kill.

Battery Installation

Batteries are very dangerous. Use insulated tools when working on battery connections and avoid causing shorts.

Inverter Installation

Install in a dry place clear of any water, electrolyte, corrosive aerosols, acid spray etc. Provide adequate ventilation space, do not place near other hot equipment. The inverter contains arcing contacts; do not allow it to be installed where explosive gases mixtures could occur.

Solar Array Installation

The solar array frame must be earthed and varistors installed between the array positive and negative terminals to the array frame both to protect the array and the inverter. Solar array outputs produce high dc voltages. Shorting or disconnecting array wiring which is energised or carrying current can produce dangerous power arcs which are difficult to extinguish.

Electrical Safety

Do not open the inverter enclosure while the system is operating. The system has multiple sources of power, assume all terminals are live unless all power sources are isolated.

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Installation

Mains Wiring

External AC wiring is required to connect to the generator, which should have its own circuit breaker, and to the load. The inverter alone can supply in excess of 70A into a short circuit, and can therefore reliably trip circuit breakers up to 30A. When operating with the generator, fault levels will increase though the inverter will disconnect the generator within 100ms of the phase voltage falling below 200V RMS The combined output current of the inverter and the generator is in excess of 60A. Conductor sizes and temperature ratings should be suitable for this current.

Control Wiring

Control wiring is all low voltage and low current. The current in any digital output circuit should be limited to a maximum of 1A. If circuit loads are higher then an interposing relay should be fitted.

A battery temperature sensor is also supplied and should be connected It should be attached to the centre of one of the sides of one of the batteries. Observe the polarity the voltage across the sensor should be about 4V if much lower reverse the sensor leads.

A renewable shunt is required if renewable dc inputs (solar wind etc.) are used to charge the battery system. It must be connected in the negative lead of the renewable power lead which should be connected to the battery negative. Refer to your supplier for shunt specifications. (Standard in RAP10 inverters)

The enclosed drawings identify the wiring required and the location of all terminals. Refer to your supplier if wiring requirements are different.

Battery Wiring

The high current wiring from the inverter should be connected as directly as possible to the battery bank. The battery bank and its wiring should be arranged to minimise the total inductance of the DC wiring system by keeping the area enclosed by the path from inverter positive output through each battery and back to the inverter negative terminal to a minimum.

Connect other sources of DC power direct to the battery bank. Do not wire the inverter so that power can be supplied from wind or solar direct to the inverter with the battery isolated. Uncontrolled sources which are not limited in voltage by the battery can damage the inverter.

Battery currents up to 100A (300A for 3 phase inverters) can flow during normal operation. If battery fuses or circuit breakers are installed, their rating should be above this and used to protect battery wiring not the inverter. The inverter includes its own dc circuit breakers.

Never disconnect the battery while the inverter is connected. Always shut down the inverter as described in the operating procedures, open its DC circuit breaker, and isolate wind or solar inputs before disconnecting the battery

CAUTION When laying out the battery and working on the battery be aware that metal tools can short across battery terminals and generate high energy arcs which can cause serious burns and eject hot particles. Where battery terminals at potential differences greater than 12V are close together place an insulating barrier between the terminals so tools cannot short between the terminals. When batteries must be disconnected or connected ensure that the inverter is shut down and any other DC supplies to the batteries are isolated and there is negligible current being broken.

When renewable sources are connected to the inverter the battery negative terminal must be earthed to the frame to control induced lightning voltages. Isolate the renewables and remove this link before working on the battery so that accidental connections between battery terminals and frame do not cause battery shorts

When systems operate without renewable input the battery negative terminal is connected via a high value resistor to the inverter frame. This ensures that the inverter electronics which are directly connected to the battery negative do not float at a high potential with respect to frame.

The renewable shunt must be connected in the negative terminal of the battery and must be permanently connected to the battery negative terminal. If a dual pole isolator or circuit breaker is to be used on the renewable input then it must be connected on the source side not the battery side of the shunt.

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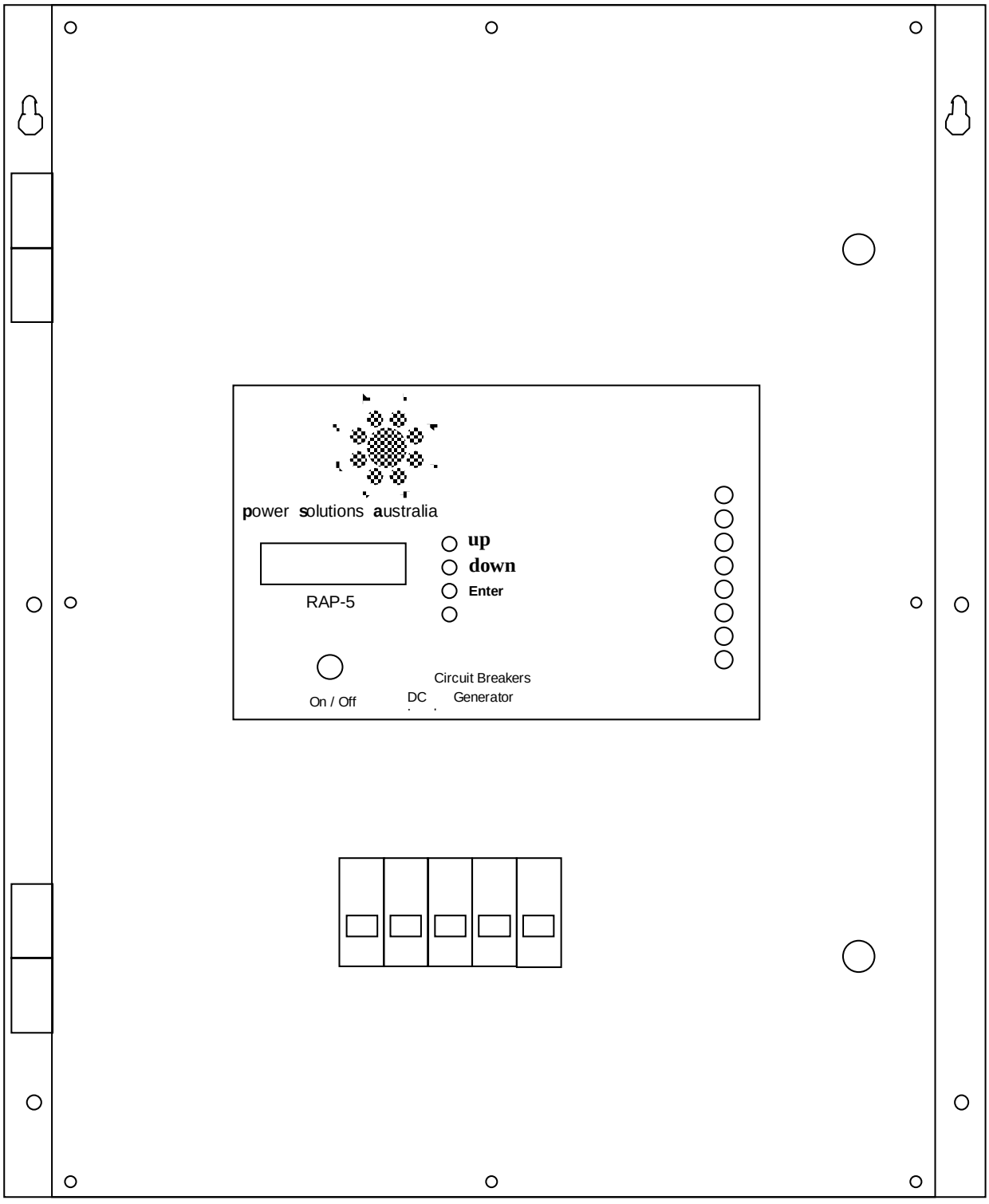
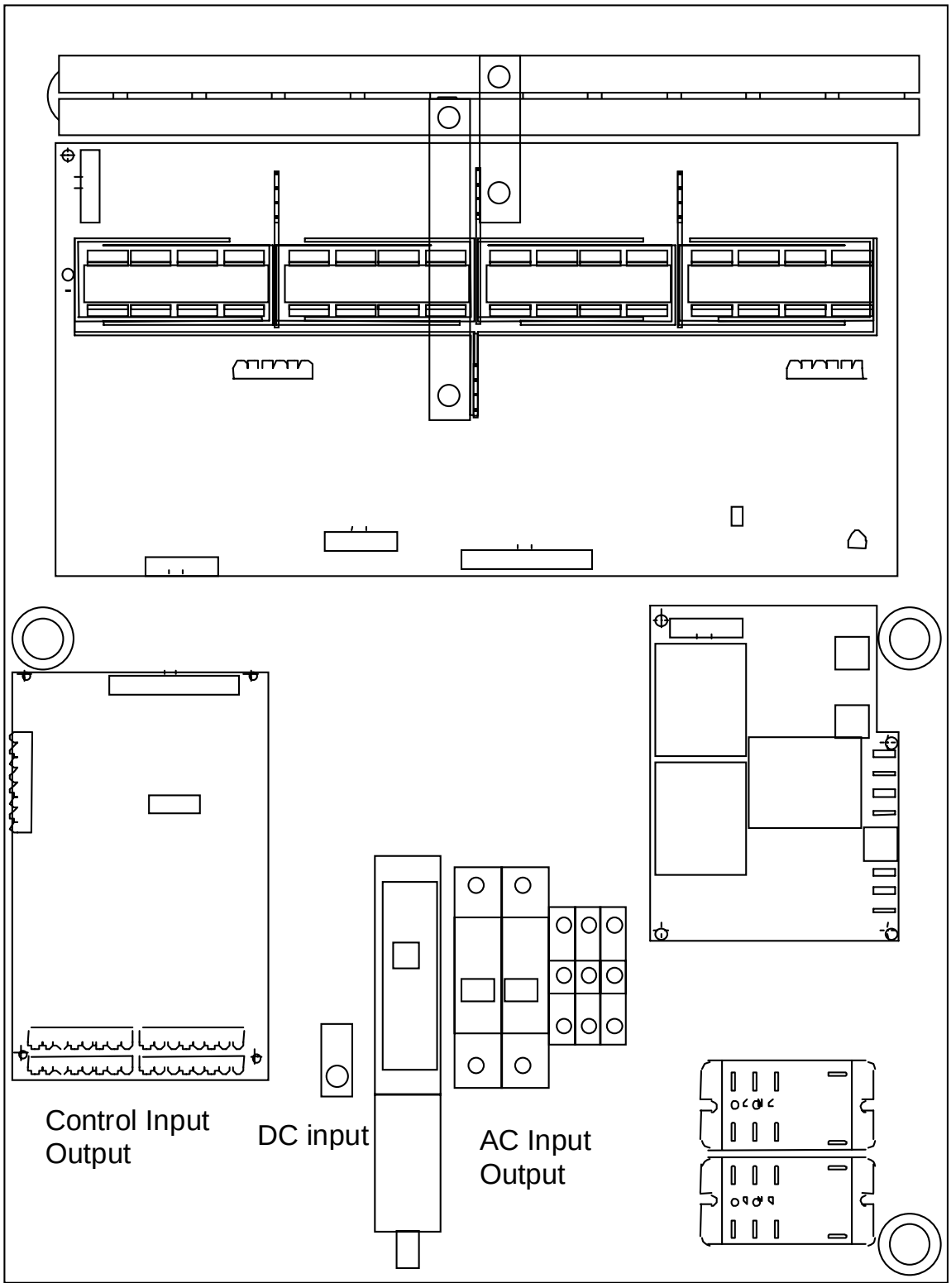
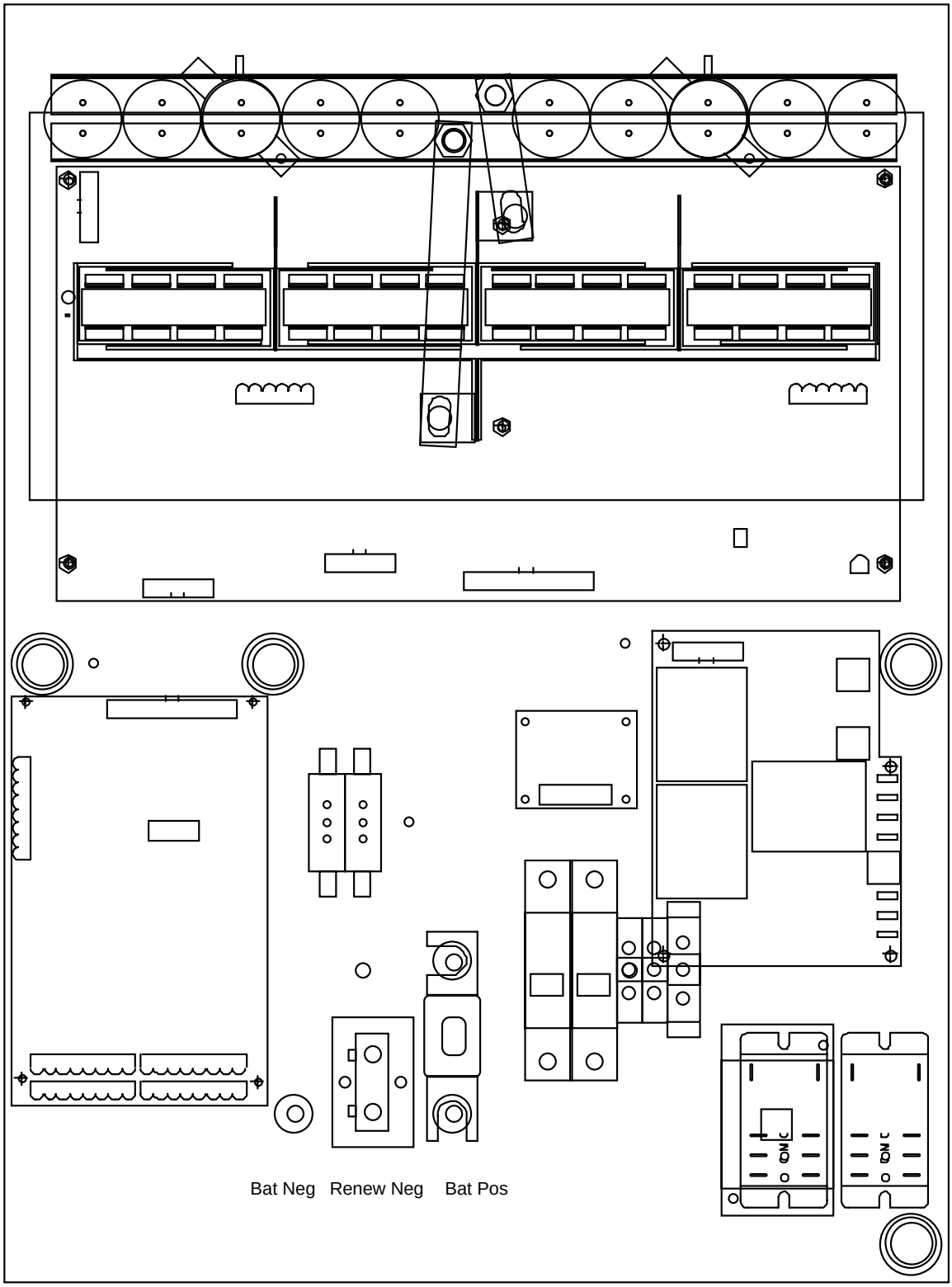
Front View


power solutions australia
up
down
Enter
RAP-5
On / Off
DC
Circuit Breakers
Generator

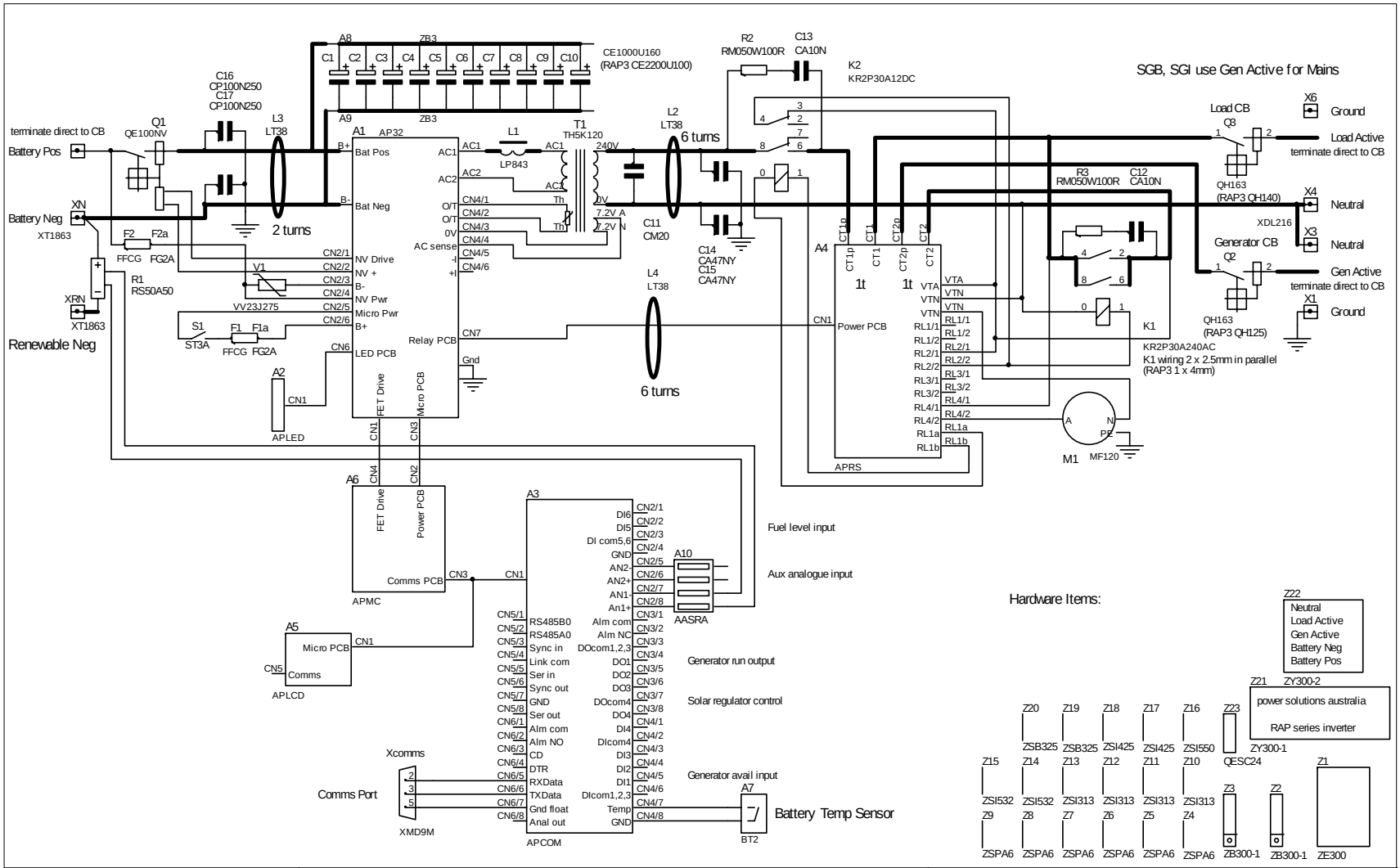
Internal View



Internal View (24V systems)

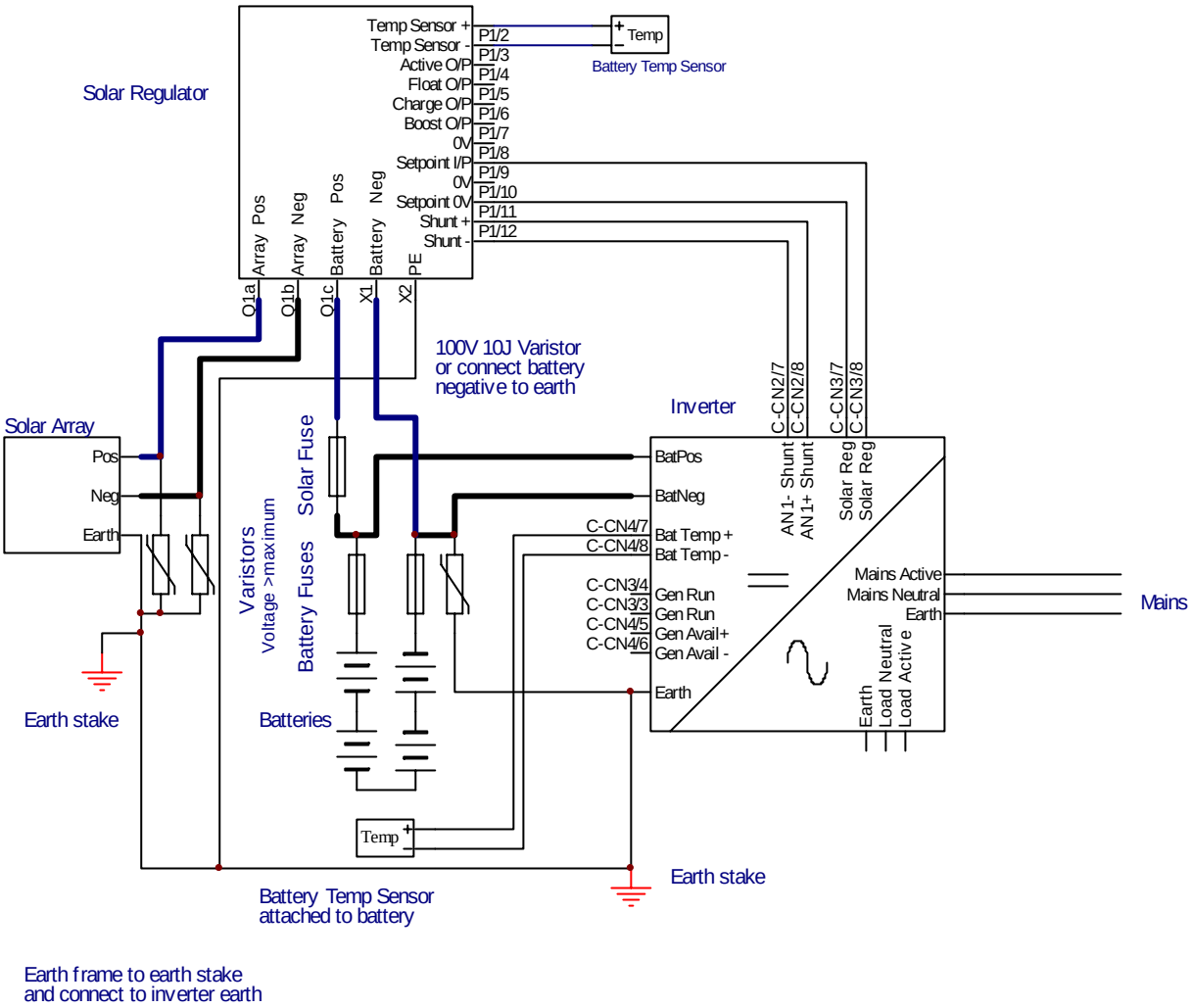


Schematic



Application Protel Schematic 3		Refer to drawing survey for applicable change requests				Power Solutions Australia Pty Ltd	ACN 077092463		
		Rev	Date	Init	Alteration				
File Name		1	24-6-97	GG	Issue for manufacture	Title			
C:\INVERT~1\RAP3~1\RAP3_5~1.SCH		2	14-8-97	GG	Add shunt, comments	RAP 3,5 - schematic			
Drawn GG	Appd	3				Drg No. 300S1	Sheet 1 of 1	Date 29-Aug-1997	Rev 2

Electrical Connections



Battery fuses optional. If fitted rating to be four times maximum inverter current to protect against battery and wiring faults.

Wire renewables directly to battery

Renewable fuse rating to suit, to protect wiring from backfeed from battery.

Minimise battery inductance and lead length with good layout. Keep positive and negative cables close to each other.

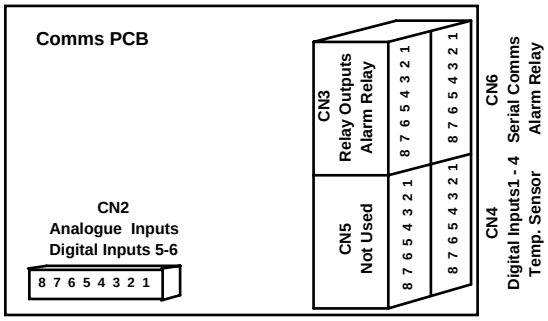
Renewables must have earth stake close by.

If renewables are remote from inverter add earth stake near inverter and connect to renewables earth cable

Comms PCB Connections

Typical Function

Depends on software configuration.



Outputs

Alarm Contact closed (or open) when inverter off or in fault condition.

DO1 Fuel solenoid drive or run signal, closed when generator required to run, open to stop.

DO2 Crank, closed when generator required to crank. Available for other functions in basic run controller.

DO3 Preheat relay drive, closed for 15 seconds before generator is required to start. Available for other functions in basic run controller.

DO4 Used for renewable regulator functions. Closed if regulator voltage should be raised to higher setpoint.

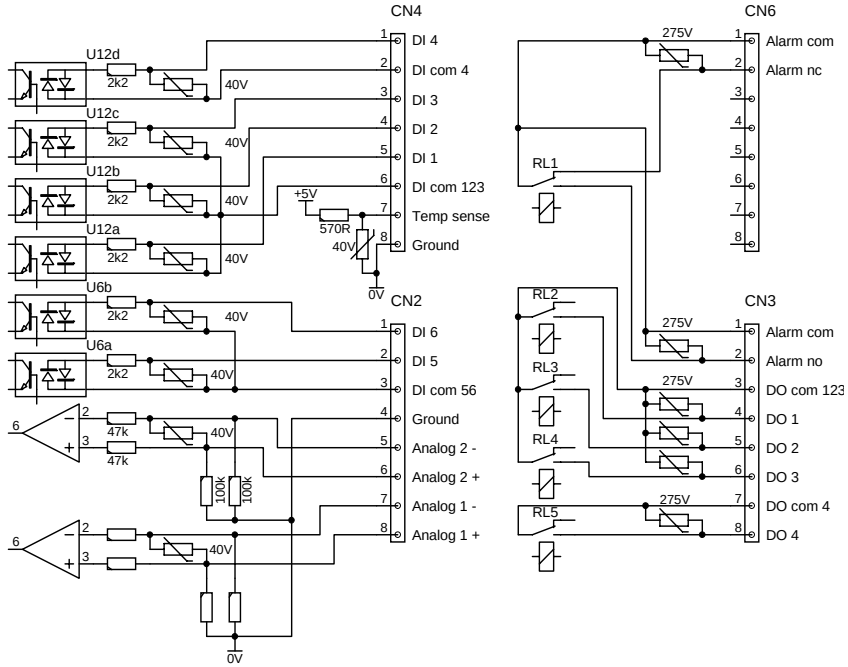
Inputs

DI 1	Generator available input, apply voltage when generator in auto mode.
DI 2	Not used.
DI 3	Remote run input, apply voltage to start generator.
DI 4	Not used.
DI 5	Fuel level low, apply voltage when fuel tank level low.
DI 6	Fuel level shutdown, apply voltage when fuel tank level below generator shutdown level.
AI 1	Analogue Input - Renewable shunt, typically 50mV = 50A.
AI 2	Analogue input - Auxiliary

Specifications

Relay Outputs	24Vdc max	32Vac max	1A max
Digital Inputs	< 3V = False	> 6V = True	30Vdc max
Analogue Inputs	± 250mV differential		± 5V common mode
Temperature Sense	50uA / ºC	5 to 50ºC	open circuit = 20ºC

Simplified Schematic



Normal Operation

Inverter Self Test

The inverter performs a self-check as it starts up. During the self test all the LED indicators on a module flash. Only if no faults are detected will the inverter start. Normal operation is indicated by steady illumination of the top green indicator light.

A flashing green indicator at the top indicates the self-test has detected a fault and the inverter will be not being able to start. If the top green indicator is flashing record the pattern of indicators which are illuminated and advise your supplier.

Automatic Startup

The inverter is set up to start automatically when grid supply is present and when renewable inputs bring the battery voltage up to just above the charge voltage setting. The inverter will then synchronise and hold the battery at the charge voltage for the charge time before dropping the voltage to the float voltage setting.

Inverter On Line

While the inverter is running some power is required to hold the battery at charge voltage (or float voltage). The remaining renewable power will be exported to the grid. Since the battery is normally in a good state of charge and losses are low at float voltage good efficiency can be achieved with appropriate voltage settings.

Automatic Shutdown

When the renewable input is low the inverter will automatically shut down when the power exported is less than zero (averaged over two minutes).

No Grid Supply

If there is no grid supply the inverter will not start and any renewable input will charge the battery. **To avoid overcharging the battery it is important that some form of renewable regulator be used to prevent overcharging the battery**. It is also important that the voltage settings of such a controller be above the normal operating settings of the inverter, otherwise the voltage held on the dc input will lock the renewable input out and the inverter will shut down.

Battery Management

Battery Charging

The battery is held at charge voltage immediately after synchronisation for the charge time and until the charge power into the battery falls, indicating a good state of charge has been achieved. After this time the voltage changes to the float voltage which is held until the inverter shuts down for an extended period. Battery charging is done in constant current, constant voltage mode.

Battery Voltage Settings

Charge and float voltages can be set through the LCD and should be set low to minimise losses. Since this voltage is held for long periods the battery will be charged at a low rate and can maintain a good state of charge.

Boost/Equalise Charge

Once every two weeks (alternate times can be set through the LCD) the system will initiate a boost/equalise charge. This ensures that all cells in the battery reach a high and uniform state of charge by overcharging the battery. The battery voltage is raised to the Boost voltage. Boost voltage is held for the Boost Time (as set on the LCD) before the voltage is reduced back to float voltage. During boost the inverter will not disconnect from the grid, to ensure that if renewable input disappears the boost charge will still be completed.

Two Stage Charging

The first stage of charging is at a lower voltage and higher current than the final charge voltage. This allows high rates of charge on smaller batteries. A single initial charge voltage is now available on the LCD display. The flooded and gel battery charge voltages are the final values which are used after initial charging is completed

The default initial charge value is 2.3V per cell which is suitable for most types of batteries. The charge current applies during the initial charge phase which continues until the battery voltage reaches the initial charge voltage and the charge current (including renewable input if measured) falls below the value set for boost charging. The maximum charge voltage is then raised to the charge voltage selected for that battery type and the maximum charge current is reduced to the boost charge value.

Troubleshooting

Normally your inverter will operate automatically to stop and start the generator and maintain battery charge. However if the system appears to be not operating correctly you can use the indicating lights on the front panel to decide what problem is present and what action to take. The inverter will shut down and where possible automatically restart if an abnormal condition is detected. Typical abnormal conditions, the inverter response and the actions which can be taken by users are listed below.

DC CB TRIP

If a very high current is detected which cannot be controlled electronically, then the dc circuit breaker will trip and must be reset. If it repeatedly trips contact your supplier.

Inverter Shutdown

If multiple shutdowns occur within a short time the inverter will allow up to 10 restarts. After ten restarts have accumulated, within one minute, further restarts will be attempted once per minute.

If the inverter is regularly shutting down, and normal operation cannot be restored by turning the on/off switch off then back on, then contact your supplier.

Field Diagnosis

Full diagnostic procedures are given in the System Diagnostic Procedures in the power solutions australia Reference Manual.

Check inverter LEDs for fault indications

Confirm that inverter passes self test and starts up. If a fault is indicated use diagnostic code to decide if further checking is worthwhile or the fault requires further diagnosis.

Check voltage of inverter both standalone and when operating in parallel with grid. If outside normal tolerance check grid voltage.

If inverter fails to synchronise and run in parallel check the frequency and voltage of the grid, that the grid voltage is present on the synchronising input and on the grid contactor. Check the phase rotation of the inverter and generator in three phase systems.

LED Indications

All Flashing

This special test pattern is displayed while the inverter is testing its circuits after starting up.

All On or All Off

All indicators are on briefly as the inverter is switched on. Immediately after this they go into an upwards moving all flashing pattern while the inverter tests its circuits.

If indicators remain on permanently, or come on is some random pattern, and stay on, then the internal microprocessor is not starting correctly. Contact your supplier to seek further advice.

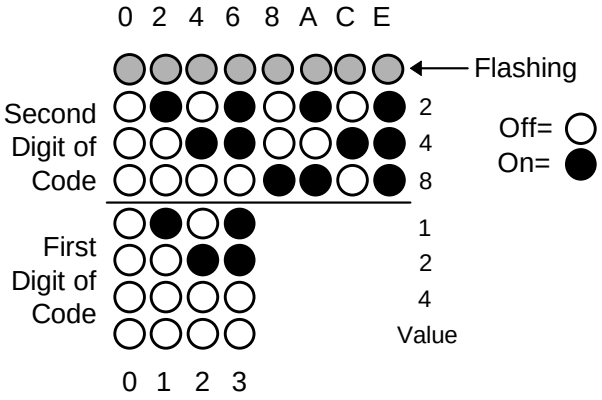
If indicators don't come on at all after the inverter is turned on after being off for several seconds then the battery may be completely discharged or the inverter has an internal power supply fault. Check the battery voltage, if it is less than 70% of normal it will have to be recharged. If the battery voltage is normal contact your supplier to seek further advice.

Normal

Indicates power on and inverter hardware and software functioning normally and that the indicators below have the functions listed marked on the panel.

Fault

Indicates an internal inverter hardware or software fault. In this situation other indicators are steady and display a code identifying the type of fault. If a fault is not serious the inverter will start after 10 seconds of displaying the fault code. However if a serious fault is present the inverter will not start and you should contact your supplier after recording which indicators are on:



On Load

Indicates that inverter is running and AC output is available at the terminals.

Seeking Load

Flashing with a brief on long off indicates that inverter is waiting for load on the output terminals before starting up.

Unavailable

Flashing (50% on 50% off) indicates that the inverter is not available to startup, because it is in a fault or overload recovery situation. (In a 3 phase or parallel type system this means one of the following: It is in a fault or overload recovery state, it cannot communicate with a slave or one of the slaves is not in the proper state to allow startup. For a slave it means it is unable to communicate with the master or it is in a fault or overload recovery state.)

Synchronised

Indicates that inverter is running synchronised and in parallel with a generator or external supply. In this situation the inverter can charge the batteries or if a heavy load is present both the inverter and the AC generator work together to supply any load up to the sum of the inverter and generator capabilities.

Unable to Synchronise

Indicates that it is unable to complete synchronisation because the external supply is out of tolerance. The type of flash indicates whether the voltage or frequency is high or low. If this occurs you need to get the generator supplier to adjust the governor speed setting or the output voltage. It may help to put some load on the output of the diesel to stabilise the voltage and frequency. Refer to questions and answers section for further information

Charging

Indicates that battery is being charged, if the load is temporarily higher than the generator can provide and the inverter is supplying power from the batteries as well as the generator this light will go out and come back on while the generator is running

If the batteries have been fully charged but the system load is high the generator will remain running and the batteries will be float charged. During float charge this indicator will be dark

Boost Charge

Indicates that the batteries are having their weekly boost / equalise charge. Boost charging ensures that individual cells in the battery bank do not gradually discharge. The generator will be held running for two hours after normal charging is complete to do this charge, so if the generator seems to be running for a long time check if this indicator is flashing. A long push (approx. 2 seconds) of the Enter push-button will start or terminate a boost / equalise cycle

Low DC Volts

If this indicator is on after the inverter has been delivering power without the generator for some hours it may be sufficient to remove all load from the inverter to allow the battery voltage to recover. Once this has occurred

and the generator problem (perhaps no fuel) has been fixed the inverter will restart and the generator will also be started

If the system has been unattended and the generator has been inoperable for days it may help to turn the inverter off for some hours to allow recovery and then back on after fixing the generator problem

Check that the generator is operational, that the Gen OK light is on and follow the procedure described under Generator Stops.

High DC Volts

A DC overvoltage will shut the inverter down and is indicated by the high DC volts indicator on the front panel. The inverter will restart when the voltage falls to within tolerance.

This could be caused by a faulty battery bank or other sources of power such as wind or solar power charging the batteries to excessive voltages. Get your supplier to check the voltage set on the voltage regulators for any charging equipment attached to the batteries.

Overload

Sustained overloads in excess of 10 seconds at more than 200% load or short circuits will cause the inverter to shut down. It will restart after a delay of up to 60 seconds. This is indicated by the overload indicator being on and the second yellow indicator flashing.

Turn off any heavy loads. If heavy loads are to be placed on the system start the generator first using the remote start/stop switch if available. The generator can also be started manually. If the overload persists after the heavy loads are removed open the load circuit breaker. If the inverter then works correctly there may be a short in the house wiring, consult your supplier or an electrician.

Transient over-current conditions, which may occur due to the application of heavy loads, may occasionally cause shut downs lasting less than second. The inverter will restart almost immediately. If the generator was already running before the inverter shut down the load was definitely too large

Over Temperature

Over temperature of the transformer or the power FETs will cause the inverter to shut down and the overload or over-temperature indicators to be illuminated. Once the system cools down the inverter will restart. It has probably been running with sustained high loads for an extended time. If the generator was not running check the generator indications below. It may be that the generator failed to start to meet a load which normally the inverter and generator would share.

Check that the inverter is adequately ventilated and that hot air from the generator is not overheating the inverter.

Generator OK

Not used in SGB

Failed to Start

Not used in SGB

Generator Stop

Not used in SGB

Generator Fault

Not used in SGB

LCD Display

Below are listed the various LCD displays and their function. There are two types of displays: Standard displays are always available and display measured values or important parameters controlling the inverter operation. Edit displays allow parameters to be adjusted and are only displayed when the edit enable switch is on. This provides security against accidental changes to system operating parameters. The values shown are typical of a 5kW 120V system.

Different display pages are accessed by moving forward using the Up push-button or moving backward using the Down push-button.

When standard displays are on the LCD the Enter push-button can be used to start or stop the generator with a short push. A long push (approx. 2 seconds) starts or terminates a boost / equalise cycle. If the generator is running a short push will stop the generator. If a boost has been initiated automatically or manually or is in progress it can be cancelled using a long push.

If edit displays are on the LCD the Enter push-button initiates data entry mode and makes the modified data permanent.

Standard Display Pages

```
Power Solut  GIM
Running Selftest
```

This display appears while the inverter is running its self test functions. If it remains on the self test has failed, the top green LED will be flashing and the remaining LEDs indicate a code which identifies the test which failed.

```
Power Solutions
  GIM Inverter
```

This display appears after self test has completed and normal operation has started. If a data editing display is selected, and there are no key presses for 60 seconds, the editing display is cancelled and this display returns.

```
dc Volt   123.16
dc Amp      1.2
```

Battery dc voltage and inverter dc current. A positive current value indicates the battery is being charged by the inverter, a negative value indicates that the inverter is discharging the battery. Inverter dc current does not include renewable charge current or dc load current.

```
Load kW    0.135
ac Volt      241
```

Load kW is the total ac system load being supplied excluding power being supplied by the generator to charge the batteries. Ac voltage is the nominal load voltage. The voltage at the actual terminals may differ slightly from this value. When operating with a generator, values more than 7% different from nominal indicate that the generator voltage may need adjustment.

```
Load kW     0.15
L KWh/Day   1.81
```

Load kW is the same as the previous display. L kWh/Day is the average energy supplied per day averaged over 7 days. It compensates for the number of days the inverter has been operating so the value can be correct after only one day.

```
Gen. kW     0.47
Inv. kW    -0.33
```

Generator power indicates the load on the generator including load being supplied directly and power being used to charge the batteries. Generator power is normally positive. If the inverter is connected to the mains and is being used to export power to the network, for example from solar panels, then the generator power value will be negative when power is being exported and positive when power is being drawn from the power network.

```
Inv. Hz    50.02
Gen. Hz    50.01
```

Inv Hz is the inverter operating frequency and Gen Hz the generator operating frequency. The generator frequency will differ from the inverter frequency when it initially starts and before it synchronises. When synchronised, and operating with the generator, the two frequencies will be very similar. If the generator frequency is zero then the generator is not operating or the voltage is out of tolerance. If the generator frequency is out of tolerance the inverter will not synchronise.

```
Gen Volt     249
Gen. Hz    50.01
```

Gen.Hz is the generator operating frequency and Gen Volt the generator output voltage. When operating synchronised the generator voltage will be the same as the inverter voltage. When the inverter is initially turned on or if the inverter output voltage has been adjusted to other than the nominal value using RV4 on the power

pcb rather than using the LCD to adjust output voltage the voltage indicated may be in error several volts. When the generator is off a small value may be indicated.

```
Inv kVAr    -0.32
Gen kVAr     0.37
```

Inv kVAR is the inverter reactive power output, a positive value indicates that the inverter is supplying VARs ie a lagging motor load results in a positive VAR value. Gen kVAr is the generator reactive power value. The sum of these two values is the load reactive power. Large complementary values of inverter and reactive power (in excess of 30% of inverter rating) indicate that the inverter and generator voltage do no match well and either the generator or inverter output voltage should be adjusted. A positive inverter reactive power value can be reduced by reducing the inverter output voltage or increasing the generator voltage.

```
Dis Ah       23.2
DC Volt     123.4
```

Dis Ah is the battery estimated discharge ampere hour. The value is near zero when the battery is in a high state of charge and will increase to a positive value as the battery is discharged. When the value reaches the relevant generator start discharge threshold the generator will be started provided the battery voltage is sufficiently low to indicate that it is being discharged. During charging the value may go negative if more ampere hour are restored to the battery than were extracted. When the generator shuts down after the battery reaches a high state of charge the value will be adjusted back to zero if it is significantly different from zero.
DC Volt is the battery voltage as described above.

```
Ren Amp       1.3
Aux mV       23.2
```

Ren Amp is the measured renewable input current as measured on the optional renewable input shunt. This value is used in calculating the battery discharge ampere hour.
Aux mV is the dc voltage on the auxiliary analog input analog input 2. It can represent various variables in different systems. If there is dc load present, and the system is set up to monitor it via a standard 50mV 50A shunt, then it represents the dc load in Amps. DC load is logged and used to calculate battery net charge current and state of discharge. It may be used to monitor insolation or any other variable in which case the value is only logged and the calibration depends on the transducer scaling.

```
Htsnk.C       28
Btry.C        20
```

Htsnk C is the internal heatsink temperature. If fans are fitted they are switched on when this reaches 50C and off when they fall to 45C. If the temperature rises above 55C the charge current is reduced to reduce the risk of thermal shutdown during battery charging. Btry C is the battery temperature as sensed by the battery temperature sensor. If no sensor is fitted the indication will normally be shown as zero, the battery temperature compensation is disabled and the nominal values for battery charge voltages are used.

```
BatSize Ah   400
GenSize kW  6.00
```

Battery size is the capacity in ampere hour set using the battery size edit page. It is used to set the depth of discharge allowed so a value which is too large will cause higher depth of discharge and a value which is too small will result in more frequent generator starts. If the battery is small it may also be necessary to reduce the charge and boost currents to meet the manufacturers recommendations. Gen size is the Generator power (not kVA rating set using the generator size edit page.

```
Charge V   144.0
Boost V    147.0
```

Chrge V is the normal battery charge voltage before application of any battery temperature compensation
Boost V is the battery equalisation or boost voltage. The battery will be held at this voltage for a period of at least four hours and until the charge current has fallen to below 10% of the battery capacity.

```
Float V    139.8
Sealed battery
```

Float V is the battery float voltage. The battery will be held at this voltage after charging or after an equalise charge is completed if the generator continues running for example because of sustained load on the system. The message below indicates that the set of battery charge voltages which have been selected are those applicable to sealed or gel type batteries. The other set of voltages which can be selected are those applying to flooded batteries which are generally higher but can also be adjusted using the relevant edit pages.

```
GenStartV  117.0
ShutDwnV   110.0
```

GenStart V is the battery voltage averaged over 15 seconds which will start the generator independent of the state of battery charge ShutDwnV is the battery voltage averaged over 15 seconds which will shut the inverter down to avoid over discharge of the battery. After such a shutdown the battery voltage must recover to above the nominal battery voltage (by renewables charging the battery) or there must be AC power present from the generator allowing the inverter to synchronise and start to charge the battery.

```
|Std. Dis Ah   79|
|Shut Dis Ah  239|
```

Std Dis Ah is the discharge ampere hour which will normally cause the generator to start and recharge the battery. Shut Dis Ah is the battery depth of discharge which will cause the inverter to shut down to prevent the battery being over discharged. A depth of discharge of zero prevents shutdown on ampere hour and the inverter shuts down purely on battery voltage.

```
|Min. Dis Ah   26|
|Nite Dis Ah  118|
```

Min Dis Ah is the minimum discharge in ampere hour which allows the generator to start at the preferred charge hour, refer below.

Nite Dis Ah is the depth of discharge allowed before the generator is started to charge the battery when the generator is locked out (see below).

```
|GenShut kW  1.96|
|ChgShut kW  2.23|
```

These are the power levels on the generator and for the battery charge power above which the generator will be kept operating. Charge Shut kW is calculated from minimum charge power setting and battery size as described in the Edit display section below.

```
|In Charg V 238.0|
|PrefGen hr    17|
```

In Charg V is the initial maximum charge voltage used while the current is limited to the charge current. Once the charge current falls below the boost current setting the voltage is raised to the charge voltage and the current is reduced to the boost current.

PrefGen hr is the hour at which the the generator will start if the minimum discharge level of the battery is exceeded. It is normally set to 17, ie 5pm when solar charging should be complete.and helps ensure that generator. A value of zero results in no preferred generator running time. Values from 1 to 24 correspond to 1am to midnight. Both values can be set in the edit pages.

```
|LockGen hr     0|
|UnlockG hr     0|
```

LockGen hr is the time at and after which the generator is inhibited from starting. UnlockG hr is the time at which this inhibition is removed. A value of zero for either makes lockout immediately ineffective. Values from 1 to 24 correspond to 1am to midnight. Both values can be set in the edit pages.

```
|Day to Boost   7|
|Bstfrq Day    14|
```

Day to Boost is the number of days until the next boost /equalise charge takes place. Bstfrq Day is the time in days between automatic boost cycles. It can be set in the edit pages

```
|V2.0X 120V 5kW |
|30 July 1996   |
```

This is the software version identification. Give this information to your supplier when reporting any problems

Default Parameters

Most default parameters are suitable for immediate operation of the inverter. However basic parameters as listed below may need adjustment and all parameters should be reviewed to check that they are reasonable for the equipment installed. In particular if sealed batteries are used the Sealed Battery parameters may have to be selected by setting the appropriate DIL switch as shown in the DIL switch settings sheet enclosed in the manual..

Basic Parameters

Battery size

Battery size is used to set the depth of discharge allowed so a value which is too large will cause higher depth of discharge and a value which is too small will result in more frequent generator starts.

Charge, Boost Current

If the battery is small it may also be necessary to reduce the charge and boost currents to meet the manufacturers recommendations. (Note in a three phase inverter the charge current and boost current settings are the per phase current, hence a setting of charge current setting of 30A will generate an actual charge current of 90A in a three phase inverter. However minimum charge power is the full three phase charge power)

Generator Size

Generator maximum size limits the maximum power drawn from the generator to charge the battery and to supply load. For example with a 7 kW GenMax setting on a system which has a load of 5 kW will limit the charge power to 2kW so the maximum load on the generator does not exceed 7kW. Typically generator are rated in kVA and the corresponding GenMax value should be 0.8 time the kVA rating.

If a generator is old or in poor condition the engine may not even be capable of this level of power. If when operating with the inverter the generator frequency falls below 47Hz it may be necessary to reduce the GenMax setting or to adjust the governor. When the generator synchronises and before significant load is placed on the system the frequency should be no lower than 51Hz and no higher than 54Hz.

Charge Voltage, MinChargePower, ChargeShut kW, Charge Time

These parameters determine the level to which the battery is recharged before the generator is shut down. If the battery is always fully recharged the generator will be kept running for long times at light loads and low fuel efficiency to put the final 15% of charge into the battery. The charge efficiency of the battery is also low under these conditions.

Choosing a low charge voltage reduces corrosion in the battery but increases charge time, a higher charge voltage charges at the highest possible rate reducing generator run time. The charge time is the time which the battery voltage must be maintained at the charge voltage before the generator is allowed to shut down, at the same time the minimum charge power must be satisfied to ensure that the battery has reached the desired state of charge.

The appropriateness of the settings can be determined by checking the battery Specific Gravity measurements of the battery electrolyte after charging is complete. The battery should be around 70% charged. If the SG values are too low consider increasing the charge time, charge voltage or decreasing the minimum charge power.

Periodically the boost/boost charge takes place, this takes the battery up to a high state of charge and is terminated based purely on time at the boost charge voltage. If renewable inputs are available they can also be used to complete boost charging without running the generator provided the charge controller is coordinated with the inverter. The appropriateness of the boost charge settings can also be assessed from the Specific Gravity measurements of the battery electrolyte after boost charge completes. If the SG values are too low consider increasing the boost voltage, or boost time.

Initial Charge Voltage, Charge Voltage, Charge Current and Boost Current

The initial charge voltage is the first setting used when battery charging starts. It is held at this value until the charge current falls below the boost current when the voltage is raised to the charge voltage and the charge current is limited to the boost current for the final charge. This allows maximum charge rate on some batteries where the manufacturer allows higher charge current while battery voltage is low. If there is no such limitation or the battery is very large compared to the inverter capacity the initial charge voltage may be set to the final charge voltage.

The Boost current should not be set to a low value or the final stage of charging may be extended. Boost charging normally takes place at low currents anyway because the boost charge is not started until a normal charge has been competed and the charge current has fallen to a low value.

Edit Display Pages

These displays only appear when the mode switch 7 on the comms PCB is turned on. Key parameters are displayed in the standard pages but they can only be changed from edit pages. The top line of an edit page shows the value and the second line the maximum and minimum values which may be set.

The inverter comes with a set of default parameters. As the installer you may need to adjust parameters to:

- Set the correct battery size.
- Change charge, boost or float voltage voltages from the standard values. Some batteries need higher voltages for longer times to achieve good states of charge.
- Allow recognition of effective charging from renewables if the renewable regulator does not hold the battery volts above the renewable float voltage when charging from renewable sources is complete.
- Set the generator size to the correct value to prevent overloading and low frequency operation
- Allow the system to be permanently connected to mains supply and to export significant surplus energy from renewable inputs such as solar or wind.
- Raise or lower the ac output voltage, perhaps to match a generator which cannot be easily adjusted.

Note

The battery type must be set for either Valve Regulated (sealed) or Flooded using the appropriate DIL switch on the Comms PCB.

The considerations involved in choosing the parameter settings are discussed in the list of editable parameters below.

Parameter Storage

Parameters are held in RAM memory for use by the inverter. The editing process described below changes the value in RAM and when editing is complete the entry function stores two copies of the parameter values in an EEPROM.

Whenever the inverter starts operation it attempts to load the values from EEPROM if either copy is valid it will load the values from EEPROM and display the message 'Params Loaded OK' If the default values are still in effect or if both copies of the parameters in EEPROM are invalid the message 'Default Params' will be displayed and the default values will be loaded from ROM.

There are separate sets of values for 50Hz and 60Hz operation and for Sealed (Gel Batteries) and for Flooded batteries. These alternate values are only effective and can only be changed if the mode switch is set for the corresponding mode of operation using the mode switch on the Comms PCB. For example, to edit the 60Hz frequency limits, the inverter must be set for 60Hz operation.

Editing a Value

Values may only be edited when an edit page is selected. This is done by setting the mode switch 7 to on, and then using the Up and Down push-buttons to select the desired display. An edit page has only one variable displayed and shows upper and lower limits for that variable on the bottom line.

To edit a value push the Enter push-button for a short time, an arrow symbol will appear on the display.

Use the Up and Down push-buttons to step the value to the desired setting.

Press the Enter push-button for a short time while the arrow symbol is displayed to make the value permanent. The message 'Param updated' will appear on the display and the arrow symbol will disappear.

The arrow symbol will disappear if no push-buttons are operated for 5 seconds and the up down push-buttons revert to their normal function of stepping between display pages.

If no push-buttons are pressed for one minute the message 'Params Unchanged' will appear and the standard display will appear.

Restore a Parameter to the Default Value

To restore a parameter on the display to the default value select the relevant edit page. Press the Enter push-button to enable editing, then press the Enter push-button for two seconds and release. The default value will be restored on the display. To make the default value permanent (if the parameters have been modified) press the Enter push-button for a short time to store the value in the same way as if it had been changed and had to be made permanent.

Restore all Parameters to Defaults

To restore all parameters to default values select any edit display. Press both up and down push-buttons simultaneously for two seconds and release. The message ‘Default params’ will be displayed and the default values will be used by the inverter. Previous values in the EEPROM are erased. No further action is required. Whenever the system is started the default values will be loaded from EPROM. Values in the EEPROM will be ignored.

Parameters and Software Versions

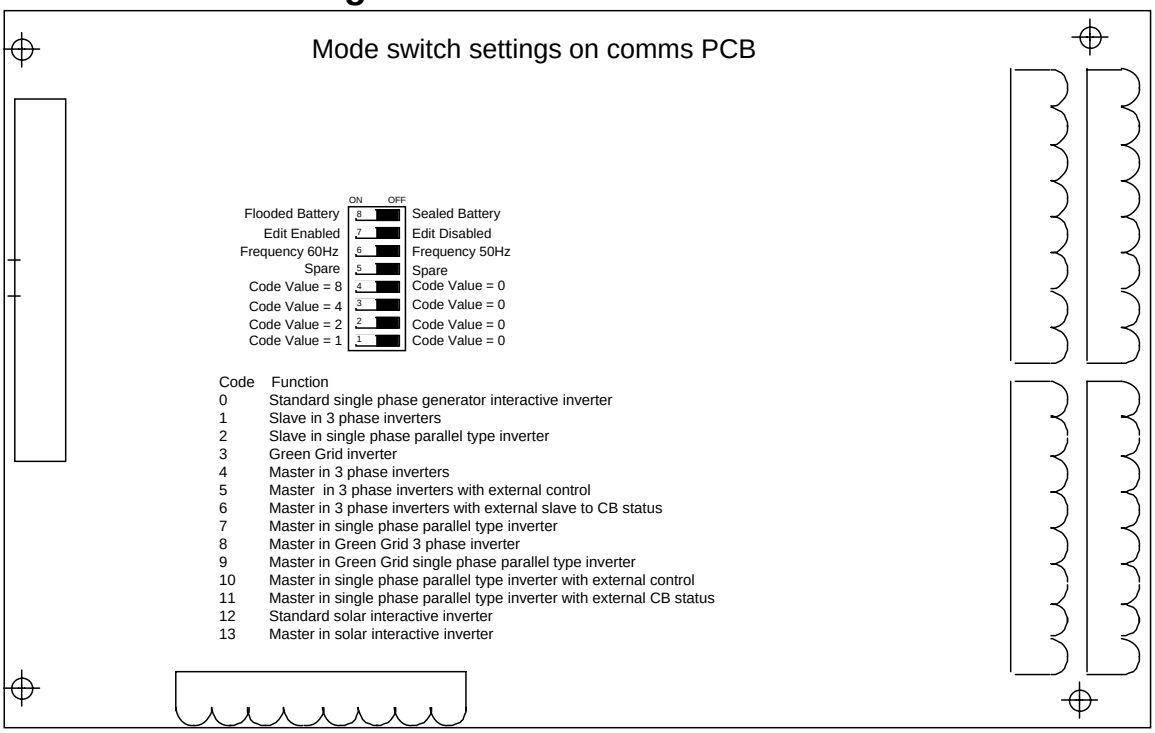
From time to time new software versions may become available which upgrade the performance of the system. Most upgrades will improve the ability of the system to automatically adjust to unusual conditions. If a system is

operating well and the features added to the upgrade do not affect a particular installation there is no need to routinely upgrade the software. If the upgrade will be beneficial to a particular site then the new software should be installed. Changes to the parameter organisation in new versions may be different from earlier versions. In this case the message 'Default params' will appear when the new version is started and it will be necessary to re-enter the parameter values if the default values in the new version are not suitable.

Recording Parameter Settings

After you have adjusted parameters you should always record the values you have set in the rear of your manual. This will enable the values to be checked if problems are experienced or restored if the system parameters have to be re-entered, for example after a software upgrade.

Mode Switch Settings



Code	Function
0	Standard single phase generator interactive inverter
1	Slave in 3 phase inverters
2	Slave in single phase parallel type inverter
3	Green Grid inverter
4	Master in 3 phase inverters
5	Master in 3 phase inverters with external control
6	Master in 3 phase inverters with external slave to CB status
7	Master in single phase parallel type inverter
8	Master in Green Grid 3 phase inverter
9	Master in Green Grid single phase parallel type inverter
10	Master in single phase parallel type inverter with external control
11	Master in single phase parallel type inverter with external CB status
12	Standard solar interactive inverter
13	Master in solar interactive inverter

Edit Display List

```
|BatSize Ah   400|
| >    20, < 3000|
```

This is the size of the battery in ampere hour. The value set should be the capacity of the battery at the typical discharge rate expected in the system.

```
|GenMax kW    6.0|
| >   1.0, < 15.0|
```

This is the maximum power which will be held on the generator for any sustained time. It must be set at less than 80% of the nominal KVA rating of the generator to ensure the generator is not overloaded. In a system supplied from the grid it is the maximum power which will be drawn from the grid.

```
|MinStrtDis %   5|
| >     4, <   80|
```

This is the minimum depth of discharge which will start the generator at the preferred charge hour.

```
|GenStrtDis %  20|
| >     4, <   80|
```

This is the depth of discharge which normally starts the generator except during the lockout time. It is expressed as a percentage of the battery size. For example a battery of 200Ah would be discharged by 66 ampere hour if the GenStrtDis was set to 33%.

```
|NiteStrtDis % 30|
| >     4, <   80|
```

This is the depth of discharge expressed as a percentage of the battery capacity which will start the generator during the lockout time. Normally it is set to a higher value than the standard depth of discharge to help keep the generator off during the lockout time. However if it doesn't matter when the generator runs or if the system design is such that the generator has to run at night it should be set to the same value as the standard discharge.

```
|GenStartV  117.0|
| > 111.6, <125.4|
```

GenStart V is the battery voltage averaged over 15 seconds which will start the generator independent of the state of battery charge.

```
|GenHoldOn %   32|
| >    20, <   50|
```

If the two minute average power level power produced by the generator is above this value, which is set as a percentage of the generator maximum rating, the generator will be kept running. A high value can cause the generator to start and stop more frequently. A low value can be used to keep the generator running provided the load is high and only revert to inverter o only operation when the load is low. It should not be set to too low a value or the generator will run for extended time at low load and low fuel efficiency.

The generator power must be below this value and below the minimum charge power set below before the generator is shut down.

```
|MinChrgPwr %   4|
| >     2, <    9|
```

If the battery charge current is above this value, set as a percentage of the nominal energy storage capacity of the battery, the generator will be kept running. For example if a system had a 400Ah battery at 120V the nominal storage capacity is 48kWh, 4% of this is 1.92kWh, so the generator would be kept running until the charge power had fallen below 1.92 kW. It is used to ensure that the battery has reached a good state of charge before the generator is shut down. The charge time can also be used to ensure that the battery has reached a good state of charge.

```
|NomAc Volt   240|
| >   210, <  260|
```

This is the nominal ac output voltage. Changing this value adjusts the output voltage. The potentiometer RV4 should be used to adjust the actual output voltage to correspond to this value. This ensures that the actual value corresponds to the indicated value and that the generator voltage is correctly displayed.

```
|RevPwr kW  -1.00|
| >-10.00, <-0.20|
```

RevPwr kW is the reverse power which is allowed to flow into the generator before disconnection takes place assuming that the generator has run out of fuel or the generator has been turned off manually and the inverter must disconnect to prevent it being driven as a motor.

```
|Hi Lim Hz  55.02|
| < 65.00, >50.10|
```

This is the maximum frequency at which the inverter will synchronise to the generator or stay synchronised to the generator. Values above 55Hz are not recommended as they may cause overloading and overheating of

compressor loads such as refrigerators and air conditioners. If the generator frequency is excessively high it should be adjusted if possible.

```
Lo Lim Hz  45.00
 < 49.90, >43.00
```

This is the minimum frequency at which the inverter will synchronise or stay synchronised to the generator. Values below 45 Hz are not recommended as they may cause saturation and overheating in motors such as refrigerators.

```
ShutDisch %   60
 >     0, <   90
```

This is the battery depth of discharge at which the inverter will shut down to prevent over discharge of the battery. If renewables are providing charge current to the battery and there is no renewable shunt a value of zero should be used to disable shutdown on depth of discharge. Shutdown will then only be based on battery voltage. In systems without renewables and where a renewable shunt is fitted a typical value would be 60% of battery capacity.

```
ShutDwnV   111.0
> 102.0, < 111.0
```

ShutDwnV is the battery voltage averaged over 15 seconds which will shut the inverter down to avoid over discharge of the battery. After such a shutdown the battery voltage must recover to above the nominal battery voltage (by renewables charging the battery) or there must be AC power present from the generator allowing the inverter to synchronise and start to charge the battery.

```
RenFloat V 136.2
 > 126.6, <144.0
```

This voltage is used to monitor the effect of renewables charging the battery particularly if there is no renewable shunt present. If this voltage is exceeded for the RenFloat hr the battery is considered charged, the battery ampere hour is adjusted and boost charging is deferred for half a day.

```
RenFloat hr  2.0
 >   0.3, < 12.0
```

See RenFloat V description above.

```
Shunt A/mV  1.00
 >  0.20, < 5.00
```

This is the calibration constant for the renewable current measuring shunt. The default value is 1.00 A/mV which corresponds to a 50mV 50A shunt or a 100mV 100A shunt. A 50mV 100A shunt would require a value of 2A/mV. If large currents are being measured a 100mV or even 150mV shunt is preferred as this minimises errors in measurement.

```
In Chrg V  139.8
 >126.0, < 144.0
```

This is the initial charge voltage, which is applied when charging starts, at full charge current. Once the charge current has fallen below the boost current setting the final charge voltage is applied, the current is reduced to the boost current setting. The final charge is competed at the charge voltage and boost current. It is held at the charge voltage until the charge time and minimum charge power conditions are satisfied. This allows maximum charge rates to be applied at high efficiencies as many battery manufacturers allow higher charge currents while the battery voltage is low.

```
Float V    139.8
 >126.0, < 144.0
```

This is the battery voltage maintained after the battery has reached charge condition and while it remains connected to a source of ac power such as the generator or mains. In systems with mains supply permanently available a lower float voltage should be set.

```
Charge V   144.0
 >132.0, < 147.0
```

This is the battery voltage maintained in the charge condition provided the battery current is below the charge current limit and while the charge time described below has not been satisfied. The battery is brought to this voltage and held for the charge time set below and until the charge power has fallen to less than the minimum charge power set above.

```
Chg Time hr  0.3
 >   0.3, < 12.0
```

This is the time that the inverter holds the battery at the charge voltage before shutting the generator down provided the charge power is below its setting and the generator load is below its shutdown level.

```
Boost V    147.0
 >132.0, < 147.0
```

This is the maximum battery voltage during a boost or equalise. This voltage is set after a normal charge is completed. Boost charges occur when the specified number of days has elapsed but also depend on how often renewables charge the battery. The battery must be at this voltage for the boost time value set below.

```
Bst Time hr  3.0
 >   1.0, < 12.0
```

Refer Boost V description above.

```
Charge Amp    30
 >   10, <    35
```

This is the maximum battery current supplied while the inverter is charging the battery. The value should be set to hold the charge current within the battery manufacturers ratings. Lower values can be used to prevent the inverter shutting down on over temperature during periods of sustained charging and at high temperatures. In a three phase system this figure applies to the master phase, and the total current charge current is three times this value.

```
Boost Amp     20
 >    5, <    30
```

This is the maximum battery current supplied while the inverter is boosting or equalising the battery. The value should be set to keep the boost current within the battery manufacturers recommendations, particularly if the battery bank is small. In a three phase system this figure applies to the master phase, and the total current charge current is three times this value.

```
BstFrq Day    14
 >    3, <    63
```

BstFrqDay allows the number of days between automatic boost cycles to be adjusted. It should be adjusted along with charge voltage, charge time and boost time to balance generator running time and battery performance. Too frequent boosting will increase generator running time but can be offset by having short charge times and high minimum charge power parameters to reduce the level of recharge during normal charge cycles.

```
PrefGen hr    20
 >    5, <    30
```

PrefGen hr is the hour at which the the generator will start if the minimum discharge level of the battery is exceeded. It is normally set to 17, ie 5pm when solar charging should be complete.and helps ensure that generator. A value of zero results in no preferred generator running time. Values from 1 to 24 correspond to 1am to midnight. Both values can be set in the edit pages.

```
LockGen hr    20
 >    5, <    30
```

LockGen hr.is the time at and after which the generator is inhibited from starting on standard discharge. It will still start on low battery voltage and if the maximum discharge is exceeded. A value of zero makes lockout immediately ineffective. Values from 1 to 24 correspond to 1am to midnight.

```
UnlockG hr    20
 >    5, <    30
```

UnlockG hr is the time at which normal generator starting conditions are is restored. A value of zero makes lockout immediately ineffective. Values from 1 to 24 correspond to 1am to midnight.

```
Time hr       20
 >    0, <    23
```

This allows the time of day hours to be set if the system is being used without data logging. With data logging the complete year, month day hour and minute can be set using the TU command over the serial port.

```
Time min      20
 >    0, <    59
```

This allows the time of day minutes to be set if the system is being used without data logging. With data logging the complete year, month day hour and minute can be set using the TU command over the serial port.

Standard Display List

```
|Power Solut GIM|
|Running Selftest|
|Power Solutions|
|  GIM Inverter |
|dc Volt   123.16|
|dc Amp      1.2|
|Load kW     0.15|
|ac Volt      241|
|Load kW     0.15|
|L KWh/Day   1.81|
|Gen. kW     0.47|
|Inv. kW    -0.33|
|Inv. Hz    50.02|
|Gen. Hz    50.01|
|Gen Volt     249|
|Gen. Hz    50.01|
|Inv kVAr   -0.32|
|Gen kVAr    0.37|
|Dis Ah      23.2|
|DC Volt    123.4|
|Ren Amp       1.3|
|Aux mV       23.2|
|Htsnk.C       28|
|Btry.C        20|
|BatSize Ah   400|
|GenSize kW  6.00|
|Charge V   144.0|
|Boost V    147.0|
|Float V    139.8|
|Sealed battery |
|GenStartV  117.0|
|ShutDwnV   110.0|
|Std. Dis Ah   79|
|Shut Dis Ah  239|
|Min. Dis Ah   26|
|Nite Dis Ah  111|
|GenShut kW  1.96|
|ChgShut kW  2.23|
|In Charg V 238.0|
|PrefGen hr    17|
|LockGen hr     0|
|UnlockG hr     0|
|Day to Boost   7|
|Bstfrq Day    14|
|V2.0X 120V 5kW |
|30 July 1996   |
```

Edit Display List

```
|BatSize Ah   400|
| >    20, < 3000|
|GenMax kW    6.0|
| >   1.0, < 15.0|
|MinStrtDis %   4|
| >     4, <   80|
|GenStrtDis %   5|
| >     4, <   80|
|NiteStrtDis %  6|
| >     4, <   80|
|GenStartV  117.0|
| > 111.6, <125.4|
|GenHoldOn %   32|
| >    20, <   50|
|MinChrgPwr %   4|
| >     2, <    9|
|NomAc Volt   240|
| >   210, <  260|
|RevPwr kW  -0.30|
| > -2.00, <-0.20|
|Hi Lim Hz  55.02|
| < 65.00, >50.10|
|Lo Lim Hz  45.00|
| < 49.90, >43.00|
|ShutDisch %   60|
| >     0, <   90|
.|ShutDwnV   111.0|
|> 102.0, < 111.0|
|RenFloat V 136.2|
| > 126.6, <144.0|
|RenFloat hr  2.0|
| >   0.3, < 12.0|
|Shunt A/mV  1.00|
| >  0.20, < 5.00|
|In Chrg V  139.8|
| >126.0, < 144.0|
|Float V    139.8|
| >120.0, < 144.0|
|Charge V   144.0|
| >132.0, < 147.0|
|Chg Time hr  0.3|
| >   0.3, < 12.0|
|Boost V    147.0|
| >132.0, < 147.0|
|Bst Time hr  3.0|
| >   1.0, < 12.0|
```

```
|Charge Amp    30|
| >   10, <    35|
|Boost Amp     20|
| >    5, <    30|
|BstFrq Day    14|
| >    3, <    63|
|PrefGen hr    20|
| >    5, <    30|
|LockGen hr    20|
| >    5, <    30|
|UnlockG hr    20|
| >    5, <    30|
|Time hr       20|
| >    0, <    23|
|Time min      20|
| >    0, <    59|
```

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Monitor Interface & Parameter Setting

Using the Real Time Monitor Interface

Monitor Program

A monitor program runs constantly at low priority in the inverter. It provided the ability to monitor internal variables in real time and to display and change selected parameters which control the operation of the inverter. The present interface is direct into the inverter is limited in the facilities and convenience of operation. A PC based interface is under development which will simplify access and extend the facilities available.

Memory Variables

To use the existing facility requires knowledge of the location of variables inside memory, the descriptions below list the commands available and some of the procedures. For any system Power Solutions Australia can provide lists of the location of key variables and variable scaling. At present there are two versions of the monitor in use. Systems with ROMs prior to Nov 19 '95 have only hexadecimal input and output of variables and the ability to input values only one byte at a time. Systems after that date allow decimal input and display of data as well as the ability to input double byte decimal values (most variables and parameters are represented by 16 bit integers stored in two bytes).

In the commands listed below variables such as address or data can be input as hexadecimal, if not preceded by a sign, eg 10B0 or as a decimal value if the number is preceded by a + or - sign eg +4272. A hexadecimal value of FFFF can be input as -1. More details of hexadecimal and decimal variables are given below in the section describing parameter modification.

Monitor Commands

The commands available include:

SI xxxxxxxxxxxxxxxxxxxxxxxxxx

An alpha numeric string of up to 48 ASCII Characters can be stored in non volatile memory to identify the site or the equipment when retrieving logged data. The string is stored in non volatile memory in the real time clock chip. It is not necessary to have battery backed RAM to store the data.

SV

Displays the software version number and the identity string if present.

STG

Start the generator provided it is under auto control.

SPG

Stop the generator provided it is under auto control.

STB

Initiate a boost cycle when the battery is next charged.

SPB

Terminate a boost cycle either before it has been started or after it has started and set the days to the next boost to the days between boost as entered on the LCD.

IB adr adr adr adr (up to 10 addresses)

Display contents of internal memory in byte format (address range 0 to FF or 0 to +255 dec) Up to 10 addresses can be requested, they will be displayed in hexadecimal and their contents continuously updated until another key is pressed.

IW adr adr adr adr (up to 10 addresses)

Display contents of internal memory in word format (address range 0 to FF or 0 to +255 dec) Many internal values such as power are held in two byte word format. Up to 10 addresses can be requested, they will be displayed in hexadecimal and their contents continuously updated until another key is pressed.

XB adr adr adr adr (up to 10 addresses)

Display contents of external memory in byte format (address range 0 to FFFF hex or 0 to +644535 dec) Up to 10 addresses can be requested, they will be displayed in hexadecimal and their contents continuously updated until another key is pressed.

XW adr adr adr adr (up to 10 addresses)

Display contents of external memory in word format (address range 0 to FFFF hex or 0 to +644535 dec) Many internal values such as power are held in two byte word format. Up to 10 addresses can be requested, they will be displayed in hexadecimal and their contents continuously updated until another key is pressed.

XD adr adr adr adr (up to 10 addresses) New in systems after Nov 95 only

Display contents of external memory in decimal word format (address range 0 to FFFF hex or 0 to +644535 dec) The value is displayed as a signed decimal integer in the range -32768 to +32767.

Parameter values defining system operating conditions can be displayed in this format. Many internal values such as power are held in two byte word format. Up to 10 addresses can be requested. They will be displayed and their contents continuously updated until another key is pressed.

I adr1 adr2

Dump the contents of internal memory from adr1 to adr2 to the serial port. This is useful to get a picture of what is happening. By capturing this to file a compete picture of the state of the inverter can be captured for later analysis.

X adr1 adr2

Dump the contents of external memory from adr1 to adr2 to the serial port. This is useful to get a picture of what is happening. By capturing this to file a compete picture of the state of the inverter can be captured for later analysis.

TD

Display internal time of day in format YY DDD HH MM SS. The value DDD is the day of the year with January 1 being day 1. All values displayed are in decimal format in all versions of the monitor..

TU yy mm dd hh mm

Update internal time in the form year month day of month hour and minute. All values are input in decimal format and do not require a preceding sign. For example TD 95 11 20 19 25 sets the date to 20 November 1995 and the time to 7 25 PM and 00 second. To synchronise to seconds. wait until the change to the new minute before hitting the enter or return key on your keyboard.

QUI

This command shuts down the inverter and takes it back to a standalone monitor program. A # prompt is displayed by this monitor. Provided the watchdog timer has been inhibited by inserting the Watchdog Inhibit Link on the Power PCB the inverter will remain shutdown. At the # prompt the command G 0 will restart the inverter and the command G 10 will allow access to hardware test procedures to check the I/O hardware, including the output relays, input status and the mode test switch.

Normally the Watchdog Inhibit link is removed and after half a second the inverter will automatically restart after a QUI command.

Modifying parameters via the Serial Port

To modify parameters directly via a terminal attached to the serial port or via a modem requires knowledge of the location of the parameter in memory, its scaling and the consequences of making the change to the value. Scaling and location information changes with different types of inverter and software releases. Power Solutions Australia can provide this information in the form of a partial memory map for particular systems if advised of the software version, date, the customer order number and date. The significance of the variables is described. Modification should only be undertaken by experienced staff and preferably over a communications link with an error correcting protocol operational. It should never be undertaken if connected via a modem connection which is showing significant numbers of garbage characters.

Identify the parameter to be changed

Use the partial memory map for the particular system to identify the location. Compute the value which should be in that location. It will be useful to know the hexadecimal value for that parameter. Generate the decimal value from the known scaling factors and use a calculator such as the Windows scientific calculator to convert the value to hexadecimal. Hexadecimal numbers use base 16 rather than base 10 so counting goes 0 1 2 3 4 5 6 7 8 9 A B C D E F then 10 11 etc.

Display the contents of the existing parameter area using the command X 500 57F while capturing to a disk file to obtain a copy of the existing values for reference purposes. Locate the address of the particular variable, the lowest address contains the least significant digits and the next address the most significant digits.

Confirm the contents using the command XW nnn to display the word value in hexadecimal or XD nnn to display the value in decimal format.

In recent systems the command WD (Write word Decimal) is available to directly write a double byte value using a decimal input format. A typical command would be WD 504 +6000. Recent systems allow mixed entry of hexadecimal numbers and decimal numbers. Hexadecimal numbers have no preceding sign, hence the address 504 to which the value is to be loaded is a hexadecimal number and the value loaded +6000 has a preceding sign and is therefore a decimal value.

If decimal input is not available the value must be updated a byte at a time using the WX (Write eXternal memory) command. The format for the same example above (note 6000 decimal is 1770 hexadecimal) is WX 504 504 70 to load the least significant byte and WX 505 505 17 to load the most significant byte. The two address for the WX command allow multiple bytes to be filled with the same value, so the above command fills location 504 to location 504 with the same value. After each command a response confirming the addresses loaded and the values loaded will be displayed. In many cases it is sufficient to modify just the most significant byte of the value.

Once the new value has been input confirm that the correct value is loaded in the correct location using the XW or XD command.

Once confirmed the new values should be loaded to EEPROM using the command EU.(Eeprom Update). This will prevent the original values being overwritten when the system is restarted or when the parameter values are checked every hour. Because checking takes place on the hour avoid making changes in the few minutes before the hour change.

Standard scalings

The following scaling values have been applied to all inverters

DC voltage	24V systems 1mV per bit	24.000V = +24000 (dec) or 5DC0 (hex)
	48V systems 2mV per bit	48.000V = +24000 (dec) or 5DC0 (hex)
	96 to 120V 5mV per bit	120.00V = +24000 (dec) or 5DC0 (hex)
DC current	All systems 0.05A per bit	10.0A = 200 (dec) or C8 (hex)
Battery Ah	All systems 0.1 Ah per bit	100Ahr = 1000 (dec) or 3E8 (hex)
AC voltage	All systems 0.25V per bit	240Vac = 960 (dec) or 3C0 (hex)
AC Power	Varies depending on size of system typical values are 1W per bit on 3 and 5kW inverters down to 0.25W per bit on small systems and up to 5.0W per bit on the largest systems.	

If the value is not immediately available from documentation the scaling can be inferred from the known generator size on a system and checking the Generator Maximum Power variable in the parameters values read out of the site parameter area. Alternately the site.txt file used to process logged data includes the AC power calibration as the variable POWERCON=.

Data Logging

Introduction

The inverter optionally includes an RS232 serial port which can be used to retrieve logged data and to diagnose operation of the inverter either using a local terminal, a directly connected PC or remotely via a modem. The data collected will be permanently stored and will not be lost if the power to the inverter is turned off.

Password protection:

A fixed two level password system has been provided to prevent casual hackers from manipulating systems. It does not provide high levels of security because passwords are fixed to avoid the need to provide access should the password be lost and to prevent manipulation by people changing passwords. If high security is required modems with security features including ring back should be used.

No password is required to retrieve logged data so the passwords do not have to be widely distributed.

The first password gives access to the help menu and the ability to display and set the time of day. Both passwords are required to access facilities to display and manipulate internal data and to change parameters.

Password entry is by typing p xxxx to enter the low priority password and p yyyy to enter the high priority password. The low priority password must be entered before the high priority password. The strings xxxx and yyyy are fixed for all systems. and are supplied to customers with their systems.

Connecting via a PC

A PC can be connected direct to the inverter using a serial null modem cable. The inverter has a 25 way male DB25 connector implemented as a DTE similar to the male connectors used for serial connectors on PCs. Any cable which allows serial communications between PCs should work.

Power solutions australia can provide a standard cable suitable for direct connection of the inverter to a PC.

The PC should use a standard terminal program such as Telix if operating under DOS or the Terminal accessory can be used under Windows. The program should have the capacity to capture as a text file, ASCII data received from the inverter. Communications parameters are 2400 Baud, 8 bit, no parity, 1 stop bit. Use XON/XOFF flow control not RTS/CTS hardware control.

Start the program and in terminal mode type H cr (where cr represents the return key on the keyboard) until the inverter returns with the help menu and a > prompt is displayed. If there is no response check the RS232 cable It may not have the wires connecting pins 2 & 3 transposed. The inverter also outputs a serial message on startup. To further test your connection turn the on/off switch off and back on. The message should be displayed without any input being required from the terminal.

Connecting via a Modem

The modem at the inverter end must be set up according to auto answer, to default to 2400 Baud and to operate without returning result codes. This is described in Modem Setup Procedure below. The modem should be connected to the inverter using standard modem cable identical to that used to connect a modem to a computer. No null modem adaptor, gender changers or special cables are required. The connection of the modem to the telephone line should include an approved surge diverter connected to the inverter and modem local ground.

Power Solutions Australia can provide, as an option, a modem, serial cable and surge diverter already pre-configured to auto answer and work with the inverter into a standard telephone line. A matching modem for use at the central monitoring point can also be provided. Power Solutions Australia can advise on the suitability of different modem types.

The PC should use a standard terminal program such as Telix if operating under DOS or the Terminal Accessory can be used under Windows. The program should have the capacity to capture as text file ASCII data received from the inverter Communications parameters are 8 bit no parity 1 stop bit.

Dial the phone number of the modem at the inverter. When the modem answers type H cr where cr represents the return key on the keyboard until the inverter returns with the help menu and a > prompt is displayed.

Retrieving Logged Data

File name convention

Use the menu or command keys to set the program to capture a text file. The file name convention is CCCnn.RTV where CCC represents a three character code for the site name and nn represents a two number retrieval number or code. The extension RTV representing ReTrieVed data is used by the data conversion program to simplify file retrieval and processing.

Get All data

Type GA cr (Get All) to initiate transfer off all data records available. If the system has been operating for a sufficient time nine records will be transferred. This will include the eight most recent complete days and the current day, which will be incomplete with zero values in unused records. Nine records take up some 63k bytes of disk space and take about 5 minutes to be received at 2400 Baud.

Get Day data

Type GDddd cr (Get Day) to initiate transfer off a single day of data. ddd is the day number in the year (Jan 1 = 1, Dec 31 = 365, 366 in a leap year). The current day can always be obtained by typing the TD command described below.

When transfer is complete the > prompt will reappear. Use the command or menu keys to terminate capture of the file. It is recommended that the data be converted immediately to confirm that there has been no corruption. If the data appears corrupted or shows corruption after processing repeat the retrieval using the GA command. There is no need to reset the data memory, the oldest day's data is automatically cleared when a new day starts. Hence if retrieval is not done regularly every seven or eight days there will be gaps in the data but it will always be possible to retrieve full records for the last eight days.

Date Time display

It is always worth checking the time of day when data is retrieved. Type TD cr the inverter will respond with yy ddd hh mm ss where yy is the year ddd the day number of year hh the hour of day in 24 hour format and mm and ss the hours and minutes respectively.

Time Update

To change the time enter TU yy mm dd hh mm cr. All values are input in decimal format and do not require a preceding sign. For example TD 97 06 20 19 25 sets the date to 20 June 1997 and the time to 7 25 PM and 00 second. There is no second setting facility, wait till zero seconds before hitting the return key. The date is set as year month and day, the inverter converts this to a day number for internal use and for recording in the logged data records. The time should be set to standard not daylight saving time. If the time is advanced past a 15 minute time (xx00 xx15 xx30 or xx45 hours) there will be a gap in the logged data corresponding to the missed 15 minute logging time (or times).

Remote shutdown of inverter

If connected via modem hang up the phone using the command from your program. Do not use the Quit command as this turns the inverter off, in early software versions. If the power is lost to the modem the inverter can only be started by someone on site turning the on/off switch off and back on. In software versions later than 20 August 94 the command is QUI and while this command still shuts down the inverter it will automatically be restarted by the watchdog timer.

Processing Logged Data

Converting data

The retrieved data file can be converted to a text file suitable for reading into a spreadsheet using the program inconvd.exe which operates under DOS or iconvw.exe which operates under Windows. The files CCCnn.RTV and CCC.TXT should be in the same directory as the conversion program.

Site file

The file CCC.TXT is called the site file. Itcontains heading information for the columns of the spreadsheets, the event file and some parameter definitions. A description of this file is included in the file Readme.txt distributed with the conversion program.

ICONVW program

On starting the program asks for the site code (CCC) and then the retrieve code (nn). It then asks if the user wishes to override the date in the retrieved file. This may be necessary if the time of day clock in the inverter has not been correctly set and incorrect dates are in the retrieved data. The date should be entered in the format YY MM DD. The date should be the known date of the first record in the retrieved data file. This would normally be the date of retrieval minus 8 days if 9 data records were retrieved. **Normally it should not be necessary to select this option.**

If the date is not being bypassed then the program will ask for the year number of the first data record. At present the year value in the logged data record is zero and the year of the first data record in the retrieved data must be entered. Entering a negative value will force the value from the year field in the logged data to be used and can be used with later releases of the inverter data logging software.

Created files

Outputs of the conversion program include a Logged Data file CCCnn.TXT containing 96 of 15 minute averages and peak values for each day. The format is text values separated by tabs which is compatible with standard spreadsheet programs.

A second file CCCnnS.TXT is a 24 hour summary containing totalisators of load energy, source (diesel energy) and diesel running hours. Also included are 24 hour load energy, 24 hour diesel energy, and 24 Hour diesel running hours. All of these are derived from the 24 Hour totalisator record in the logged data. Additional fields are calculated from the 15 minute data. This file is also formatted ready for import into spreadsheet programs.

To use these files with a spreadsheet it is necessary to import them as text files. Check the file options of your spreadsheet program and set the mode to accept tab separated values. Once in the spreadsheet data can be plotted and graphed.

The Event File CCCnn.EVT is a text file containing a record of up to 32 events per day. These events are of two types, events type zero which record normal transitions from state to state, and non zero events which record diagnostic and fault recovery information. The file records the time of events with a brief description of the type of event together with the state of the inverter, the generator controller and the scheduler.

Generating Spreadsheets and Graphs in EXCEL

The text files CCCnn.TXT and CCCnns.TXT are suitable for directly importing into Excel to create spreadsheets and to generate graphs. In File Open choose text and tab separated format.

On the disk supplied there is a sample Excel file which has a number of graphs included as workbook sheets. Open the Sample file, then Open the converted file (Open, File Type = Text, at the first dialogue box of the import wizard check that Original Data Type is Tab Delimited, then click Finish). Select All in your converted file, Copy the data then move to the Sample file. Select All and then Paste the data in and the graphs should all be updated with the new data.

You may need to alter the scale of some of the graphs to suit your data. You may also create new graphs with different or additional data using the standard Excel facilities.

Troubleshooting Logged Data

During normal operation the conversion program records that it has loaded the site parameters. Then after each day's block of data has been processed it records the number of valid lines of binary data processed and the number of lines rejected as bad. Each day's block of data includes 106 lines of data so the count should proceed in steps of 106 up to 954 if 9 days' data is being processed. It is normal for there to be one or more non binary lines at the beginning and end of the retrieved file but the bad line count should not increment while processing the main body of the file. If it does or if the good line count does not increment in steps of 106 then the retrieved data is corrupt and should be re-retrieved.

If either the retrieved data file or the site parameter file are not present then the name of the missing file will be announced and the output file will not be generated. Possible causes are:

The conversion program, site parameter file and retrieved data file are not in the same common directory.

The site parameter file has not been created or does not have the same site code at the retrieved data

The number of the retrieval to be processed is not available or has been retrieved into another directory.

If the program terminates displaying an error message copy down the details and send a copy of the retrieved data file, the site parameter file and the version number of the conversion program to Power Solutions Australia for analysis. Check if the program operates correctly with a different retrieved data file or a different parameter file. If the retrieved data appears to be the cause of the error, re-retrieve the data if possible and try re-analysing the data.

Manipulating Logged Data

The eight plus day records generated in the Detailed Log files are of a convenient length to graph to explore daily patterns. Once imported into a spreadsheet and saved as a spreadsheet file the corresponding .TXT file can be deleted. One convenient method of graphing is to have pre defined graph formats available and to link these to each succeeding Logged Data File to display and print the new data.

The 24 Hour summary files are intended to provide a means of long term monitoring of key variables. The last record in any retrieval will generally be incomplete but provided data is retrieved every eight days a complete version of this day will be available from the next retrieval. It is therefore possible to copy the new data into a previous spreadsheet overwriting any duplicated or incomplete days with complete data from the new files.

If data is retrieved less frequently than every eight days then the summary data will have gaps but the totalisators will continue to record the total values until the system is reset by shutting the inverter down and restarting it. Later versions of inverter software may make these totals non volatile.

The event records in the .EVT files record changes to inverter state and are useful to track the sequence of events during normal and abnormal operation. The text explanation attached to each event lists the nature of the event.

Full details of the logged data is included in the file Readme.txt distributed with the data conversion program.

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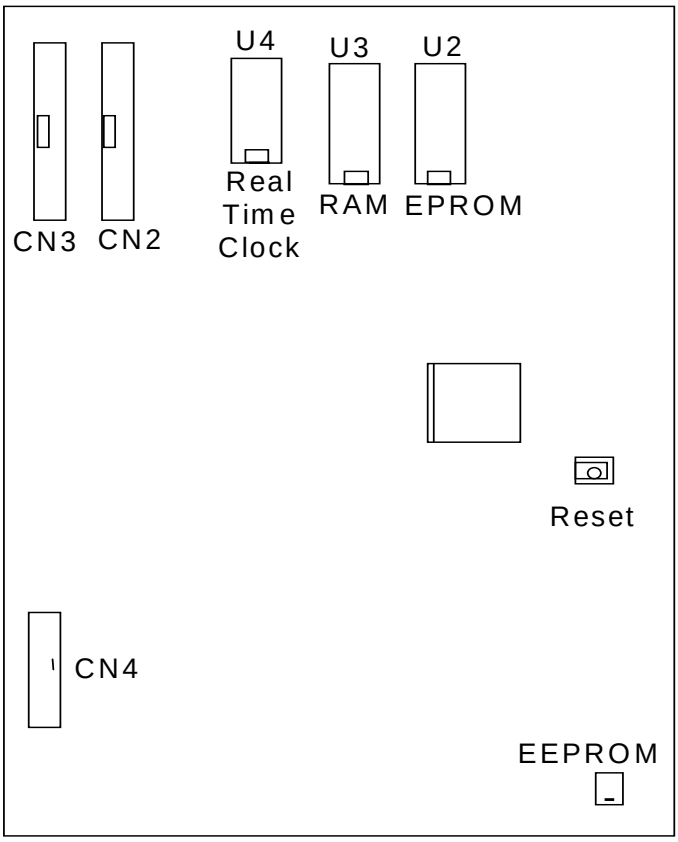
Upgrading & Replacing Software

Turn off power using ON/OFF switch. All LEDs should be extinguished
Be aware that AC power can be present on contactor terminals if other power sources are not isolated
Open front cover, before touching any circuit, ground yourself to remove static electricity by touching the chassis.
Remove U2 from its socket by levering up with a small screwdriver and replace with supplied software version
Confirm that U7 has designation ending...12A1-3 or MEMG, Replace with .....12A1-3 if not.
Check that all pins have gone into the socket and that none are bent
Check the orientation of all ICs replaced. The index mark on the end of the IC should be as illustrated.
Turn inverter back on using ON / OFF switch.
After confirming that new software is functioning correctly return old software to your supplier or Power Solutions Australia Suite 5, 20 Fletcher Rd, Mooroolbark Vic 3138. Pack carefully in packing supplied with new software.
If system has been customised using the LCD verify that the message 'Params Loaded OK' appears on power up. If not use the LCD to enter the customised values again.
Important
Check that the mode switch settings on the DIL switch on the Comms or LCD display do not have to be modified from the original configuration for the new software.
Software versions after 1 July 95 may use different mode switch settings. See the section on mode switch settings.



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