PL

Advanced Solar Charge Controller

Reference Manual

Read User Guide first

4e

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Contents

Introduction

Please read the User Guide before reading this manual.

In most cases, the User Guide provides all the information needed for effective installation of the PL, and there is no need for the user to read this Reference Manual.

However, in some cases, users with a good understanding of power regulation may wish to customise individual settings or adjust some of the PL's advanced features. This manual describes the procedures for making these adjustments.

Please note that this manual assumes more technical knowledge than the User Guide.

If you are in any doubt, it is recommended you do not adjust the advanced settings described in this manual. Incorrect adjustment may reduce the effectiveness of your PL and could damage your battery.

Additional Installation Notes

Ensure that you have followed the installation instructions on pages 3-5 of the User Guide. The PL can be used for system voltages of up to 48V, so it is safe to connect the power before setting the system voltage.

Always mount the PL vertically with clear airflow around the fins. In hot conditions, do not put the PL in a sealed enclosure, as this will restrict the airflow around it. Do not install the PL in direct sunlight in hot conditions - the heatsink may reach over 70°C in some environments.

The PL is specified up to 50°C ambient temperature. If the LCD display reaches 60°C it will darken and may become unreadable, however it will return to normal when it cools down.

Features

The PL series of solar controllers are exceptionally versatile. They give the user unparalleled capability to adjust the function of the controller and to monitor the performance of the energy system.

To cater for both non technical and technical users, the PL has four preset programs which can be used without needing to understand the details of its operation. For those with a good understanding of power regulation, there is another program which allows all the settings to be adjusted if required.

Once the program has been selected, it is possible to disable any further adjustment. This prevents unauthorised adjustment of settings.

Although the PL is primarily a device to control the charging of batteries from solar electric (photovoltaic) panels, it can also be used with other energy sources such as wind, microhydro and fuel driven generators.

The PL can support a variety of regulation methods. It supports slow speed switching and fixed frequency pulse width modulation (PWM) control in series and shunt modes.

There is provision for a temperature sensor to be attached. There is an input for measuring external voltages. A serial interface is provided for accessories including remaote shunt adapters (PLS) and an RS232 adapter to communicate with a computer/modem (PLI).

There is an interface to a computer or modem for remote monitoring and adjustment. Custom settings can be stored on a computer and uploaded into the PL controller. Data from the PL can be downloaded into the computer and displayed easily.

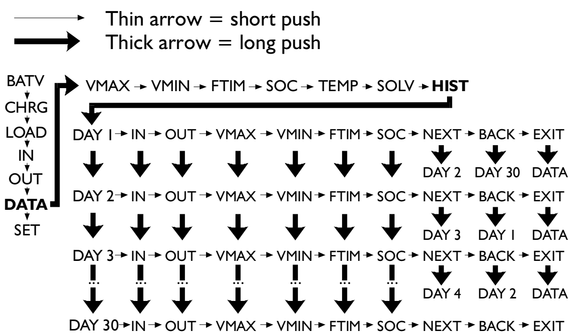
Low battery voltage load disconnection is provided, as are an alarm, facility to control the charging of a second battery bank, control for a back up generator and an event controller which can be used to control lights, pumping, waste energy use and other timer functions. A temperature sensor can be added to correct the regulation voltages for battery temperature.

The PL controller can have external current shunts attached and control larger systems through external switch blocks or relays.

Retrieving Performance Data

The data menu is behind the DATA screen. Figure 1 illustrates the menu structure of the DATA section.

Fig. 1 - The DATA menu structure



Data menu

A long-push on DATA shows performance information for the current day.

The screens in the DATA menu have the following meanings:

VMAX maximum battery voltage since midnight.

VMIN minimum battery voltage since midnight.

FTIM time of day the regulator entered the Float state (see page 7).

SOC estimate of the state of charge of the battery based on the amp hours. A very rough 'fuel gauge' -see below for further details.

TEMP temperature being sensed by the external temperature sensor (if attached).

SOLV solar panel voltage (open circuit) - note that the charge current to the battery is turned off while the PL is displaying this screen.

HIST entry point for history data.

At midnight, VMAX, VMIN, FTIM, SOC, IN and OUT are stored in the history data and reset.

VMAX and VMIN respond very slowly to changes in battery voltage. This allows them to ignore short term voltage fluctuations. (Warning: at reset or initial start up, they can take up to 40 minutes to reach the correct value.)

History display - HIST

Six pieces of data are recorded each day. These are IN, OUT, VMAX,VMIN, FTIM and SOC. These records are available for the past 30 days.

At the start of each day record is the DAY screen. This shows which day's data you are looking at (DAY 1 = yesterday, DAY 2 = the day before, etc.)

For help with navigating through the History, refer to Fig. 1. Note that a short push on the EXIT screen will take you back to the beginning of that day's record.

SOC

SOC (State Of Charge) should be read as a percentage estimate of how full the battery is.

The estimate is based on the amp hour balance counter. This counter keeps a running balance of amp hours in verses amp hours out. The SOC display shows this balance as a percentage of the battery size (see equation below). Note that the battery size must be entered by the installer with the BCAP setting before SOC will be meaningful (see page 12 for details).

Over time, the amp hour balance counter will drift out of line with the real battery state of charge. To realign the counter the PL makes two corrections :

1) When the regulator state changes from Absorb to Float AND the charge duty cycle is less than 25%, SOC is reset to 100%.

2) SOC is capable of reading more than 100%, however as soon as 1Ah of discharge is recorded it will be set back to 100%.

Note: The SOC figure should be treated with caution, as there are several reasons that it may be inaccurate:

- The PL does not automatically have knowledge of the whole system. For SOC to work at all, the PL must be measuring all charge (Ah in) and discharge (Ah out). If the battery can charge or discharge without the knowing PL, SOC will not be meaningful.
- Variations in charge efficiency mean SOC will tend to be a little optimistic.
- The effective capacity of the battery reduces with age. BCAP should be reduced in older batteries to adjust for this.
- Self discharge and variations in temperature will also cause some inaccuracy.

Adjusting Basic Features

Low Battery Disconnect

To prevent battery damage due to over-discharge, the PL has a internal function designed to turn off the load (the equipment powered by your battery) if the battery voltage falls too low. (This feature is also referred to as "Load Control" in some User Guides.)

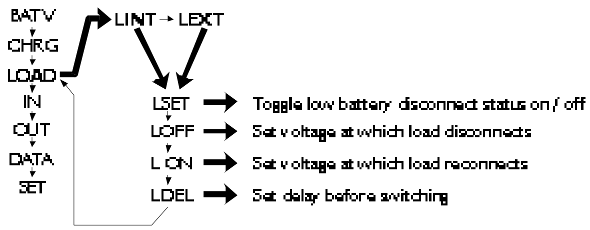
Once turned off, the load will not be reconnected until the voltage rises enough to indicate some recharge has taken place.

This feature is optional, and can be disabled either by connecting the user load direct to the battery, or by setting the parameters to ensure the low battery disconnect function never turns on (eg set LDEL to 0, or L ON < LOFF - see below).

The LOAD indicator at the bottom of the screen is on when the low battery disconnect function wants to disconnect the load. (Note that other settings can override the function, so the LOAD indicator does not necessarily mean that the power actually has been disconnected from the load.)

The Low Battery Disconnect function can also be toggled manually (see Figure 2).

Figure 2 - Low Battery Disconnect Menus (Program 4 only)



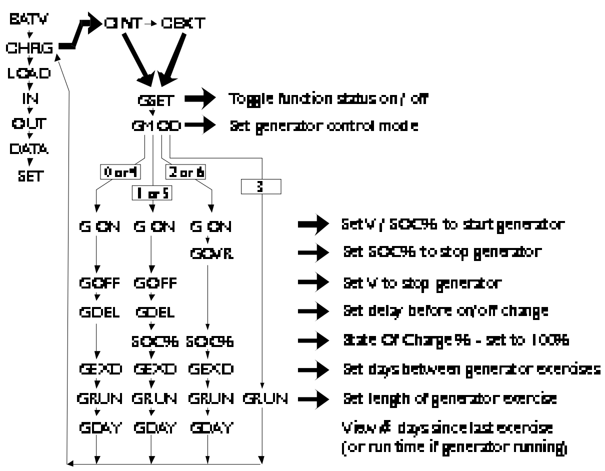
The low battery disconnect function can be set to use the LOAD- terminal, or the G (General Purpose Output) terminal to disconnect the load. Its operation can also be reversed, i.e. it can turn on the terminal when the function decides the load should be disconnected. This can then be used as a low battery alarm or to drive a relay to turn off other loads.

DO NOT CONNECT AN INVERTER OR ANOTHER BATTERY TO THE LOAD- TERMINAL. This terminal is rated at 20A (5A on the PL40). Most inverters draw larger currents than this and have their own low battery cut off circuitry.

Generator Control

The PL has a comprehensive generator controller built in. It works in a similar way to Low Battery Disconnect, using an internal function. It is designed to give a run or stop signal to an electronic start generator. It does not handle the actual generator startup sequence - this should be done by the generator itself.

Figure 3 - Generator Control Menus (Program 4 only)



Note - do not confuse the GSET described above with the screen of the same name described on page 10.

in the GSET screen, a long push will manually change the state of the generator output. The GEN indicator at the bottom of the screen is on when the generator function wants the generator to be running.

The generator can operate in four different modes. The generator mode is selected in the GMOD screen and can be 0-6.

0. Turn on when battery voltage falls to G ON for GDEL minutes. Turn off when the voltage rises to GOFF for GDEL minutes.

1. Turn on when the State of Charge (SOC%) falls to G ON % of the battery capacity. Turn off when the voltage rises to GOFF for GDEL minutes.

2. Turn on when SOC % falls to G ON%. Turn off when SOC% rises to GOFF%. (GOFF% can be greater than 100% to allow some overcharge.)

3. Manual start. When started (in the GSET screen) the generator will run for GRUN hours.

4-6: No Quiet Time

In modes 0,1 & 2, the generator is not allowed to operate from 9pm until 9am so as to enforce a 'quiet time'. Modes 4-6 are the same as modes 0-2 except that there is no quiet time.

Generator Exercise

To prevent the generator from seizing up, it is good practice to exercise the generator periodically. The PL supports this with an automatic generator exercise function which will turn on every GEXD days. The number of days since the last exercise is shown on the GDAY screen. The generator will run for GRUN hours. When running, the elapsed time is shown on the GTIM screen. Both GDAY and GTIM can be adjusted.

There is no generator exercise in mode 3.

Shunt Control

Shunt control is appropriate for wind generators or microhydro systems which require a constant load. In a hybrid system, the solar component can be controlled by the SOL- input and the other component by the shunt control.

The PL supports either series or shunt control or both together. Series control is done through the SOL- input or the expansion board. Shunt control is done through the LOAD- or "G" terminal or the expansion board. This is configured in the LSET and GSET screens (see page 11).

Shunt control can also extend the solar capacity. One array can be connected via SOL- and one can be connected directly to the battery, which is regulated via LOAD-. To use shunt control you need a dedicated load available for the PL to switch. The load must be larger than the charge current you need to regulate.

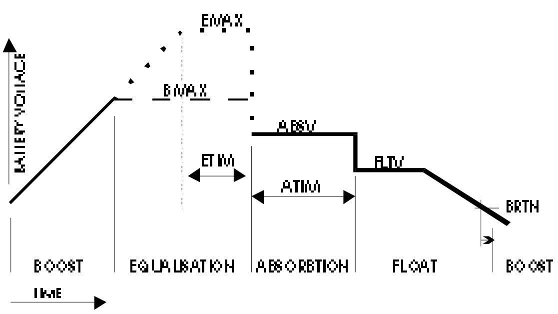
Adjusting Regulation Settings

The Regulation Cycle

The PL's sophisticated regulation system is designed to keep the battery fully charged without overcharging it.

To achieve this, it uses a charge control process with three main states. These states are Boost, Absorption and Float. The PL also uses a fourth state from time to time, called the Equalisation state (See fig 4.)

Figure 4 - Battery Charge Cycle



Boost

In the boost stage, all the charge current available is used to charge the battery. As the battery charges, its voltage rises. When the voltage reaches the boost maximum voltage BMAX and remains there for 3 minutes, then the controller will automatically advance to the absorption stage. (To adjust BMAX and other regulation settings, see page 8).

Absorption

In this state, the PL tries to keep the battery voltage constant while the last part of the battery charging occurs. This prevents excessive gassing which occurs at high cell voltages. The PL will keep the battery voltage at the absorption voltage ABSV until it has been at this voltage for the absorption time ATIM. If there is a cloudy period and there is insufficient charge current to keep the voltage up to ABSV, then the absorption timer will stop and resume when the voltage comes back up to ABSV. When the absorption time is finished, the PL advances to Float state.

Float

In this state, the battery has been fully charged. The charge current is now used to keep the battery voltage at a level which maintains full charge. This voltage, FLTV, should be below the gassing voltage to avoid excessive electrolyte loss. If charge is drawn from the battery, the PL will allow charging to resume until the battery returns to FLTV.

Equalise (optional)

Many battery manufacturers recommend that the battery bank be given an overcharge occasionally. This is designed to equalise all the cells in the bank by bringing them all up to full charge and to stir up the electrolyte in liquid cells to reduce stratification. This is the role of the Equalise state.

The PL supports an automatic programmed equalisation. This state allows the battery voltage to rise until it gets to the equalisation voltage EMAX and then remain at this voltage for the set equalisation time ETIM. This equalisation is done every EFRQ days. (Typically 30-60 days). Equalisation will begin at 9am on the appropriate day. If ETIM is 0, then equalisation will not occur.

To prevent the controller being trapped in equalise mode for a long time because there is inadequate charge current to reach the equalise voltage, the PL terminates equalise after 4 days.

Returning to Boost state

To get this charge cycle to repeat, the PL must return to the boost state. There are three ways that it can do this.

a. Low Battery Voltage

If the battery voltage falls below the boost return voltage BRTN for more than 10 minutes, then the PL will switch back into the boost state. The delay is necessary to prevent large short term loads causing unnecessary returns to Boost state.

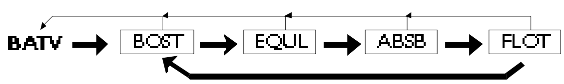
b. Programmed boost cycles (optional)

The PL will automatically do a boost cycle after a set number of days (BFRQ), regardless of battery voltage.

c. Manual boost

The user can manually set the PL into the boost state (or any of the regulation states).

Figure 5 - Manually Changing Regulation State



To manually advance to the next state, do a long push on BATV. This will show the current regulator state. (BOST=Boost, EQUL=Equalise, ABSB=Absorption, or FLOT=Float). A long-push on that state will manually advance the PL into the next state. Or, to return to the BATV screen without changing the state, do a short push.

Note: if ETIM is 0, then the Equalise state will be bypassed. If ATIM is 0, then the Absorb state will be bypassed.

On the BOST and FLOT displays, the battery voltage is shown. On the EQUL and ABSB displays, the time on the equalisation or absorption timer is displayed. When this time gets up to the set time (ETIM or ATIM) the PL will advance to the next state.

Adjusting Regulation Settings

The PL comes with a number of preconfigured programs, which should be suitable for the majority of users. For non-standard installations, one program (Program 4) allows the user to adjust each setting individually.

If you find your are unable to change your settings, it may be because the “lockout” setting is activated. This setting is designed to prevent unwanted tampering, and is described on page 9.

Program Description

0 Use with liquid electrolyte lead acid batteries. The LOAD- terminal is set to turn off when the battery is low.

1 Use with sealed gel lead acid batteries. The LOAD- terminal is set to turn off when the battery is low.

2 Use with liquid electrolyte lead acid batteries. The LOAD- terminal is set to turn on at night and can be used for night lighting.

3 Use with sealed gel lead acid batteries. The LOAD- terminal is set to turn on at night and can be used for night lighting.

4 Program 4 enables customised adjustment of all settings.

Installation instructions for programs 0-3 are on pages 8-9 of the User Guide.

Settings for Program 4

If program 4 is selected, then the full settings list is displayed.

After TIME, VOLT and PROG, there are entry points for three further sub menus:

REG Allows you to customise the regulation settings for the PL (see below for details).

MODE Allows you to adjust other configuration options for the PL - see page 10.

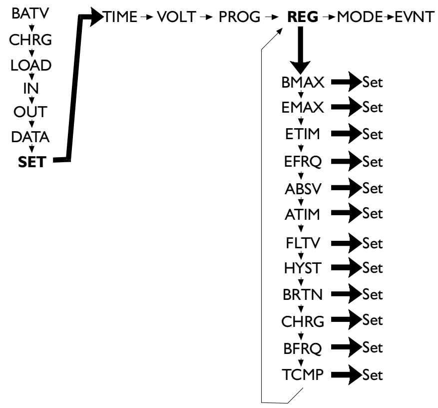
EVNT Settings for the event controller - see page 13

REG Menu - Customising Regulation Settings

To adjust the regulation settings, long-push on “SET”, short-push to “REG”, and long-push (see figure 6).

The settings are described below for 12V systems. For other voltages the range can be scaled from this. (eg. for a 24V system, multiply all figures by 2.)

Figure 6 - Regulation Settings (Program 4 only)



SET/REG Submenu Summary:

Name	Description	Range
BMAX	Maximum voltage in boost mode	13.5-16.5V
EMAX	Equalisation voltage	14.0-17.0V
ETIM	Equalisation time	0-2.0 hours
EFRQ	Number of days between equalisation cycles	20-150
ABSV	Absorption voltage	13.5-15.5V
ATIM	Absorption time	0-4.0 hours
FLTV	Float voltage	13.5-15.0V
HYST	Hysteresis used when not in PWM mode	0.1-1.0V
BRTN	Voltage below which return to Boost mode occurs	11.0-13.0V
CHRG	Charge current limit	1-20(40)A
BFRQ	Maximum number of days between boost cycles	1-20
TCMP	Selection of temperature compensation profile	0-8
	(see below)	

Note: For the State of Charge (SOC) data to be accurate, you must also set the battery capacity BCAP. In Program 4, this setting is accessed via the MODE menu. For more MODE menu details, see page 10.

Temperature compensation (TCMP)

A temperature sensor is available which allows the PL to adjust its regulation voltage settings to compensate for variations in battery temperature.

The setting TCMP is used to select a temperature profile which determines how this compensation is achieved.

The PL can automatically sense the presence of a temperature sensor if one of the auto-sense profiles is selected. If operation at temperatures near zero is common, it is better to use the non auto sense profile.

The diagram below shows the temperature compensation curves for each TCMP setting. Consult your battery manufacturer for correct compensation for the battery used.

The temperature sensor should be connected to the green terminal block under the lid at the top left. The stripe on the sensor wire goes to the T- side. The wires may be extended if necessary without affecting the accuracy.

Setting Lockout

In some cases it is desirable to restrict the ability to adjust settings, so as to prevent unwanted tampering. This is done in the TEMP screen under the DATA menu.The TEMP screen shows the temperature if the optional external temperature sensor is installed, or "0.0" if it's not.

Insert diagram here.

To disable settings, long push on the TEMP screen, the "A" indicator will disappear. (A useful memory aid is to consider that "A" stands for "Adjust" on this screen.). Note that the "A" indicator is used on other screens to mean Amps.

To enable adjustment of settings again, repeat the process. If you have successfully enabled settings adjustment, the "A" will reappear while TEMP is showing.

(Note that early models of the PL had a physical link under the cover which achieved the same purpose. If your PL is an early model and you are still unable to change your settings after following the above procedure, you may need to obtain the settings lockout link. Contact your dealer or look up the Plasmatronics web site for more information.)

Settings Used in Programs 0-3

When programs 0-3 are selected, the PL automatically uses the values below in its regulation.

The voltage settings are shown correct for 12V operation. For higher voltages, scale these up (eg. for a 24V system, multiply each voltage figure by 2.)

Setting for program number

Parameter		**0**	**1**	**2**	**3**	
BMAX	15.0	14.2	15.0	14.2	V	
EMAX	16.0	14.0	16.0	14.0	V	
ETIM		1.0	0	1.0	0	Hr
LSET		1	1	4	4	
GSET		2	2	9	9	
BSET	0	0	2	2		

All programs (0-3):

Under CHRG Menu:

GMOD 0 G ON 11.5 V

GOFF 13.8 V GDEL 10 Min

GEXD 30 Days GRUN 1.0 Hr

Under LOAD Menu:

LOFF 11.3 V L ON 12.8 V

LDEL 10 Min

Under SET/REG Menu:

EFRQ 45 Days ABSV 14.0 V

ATIM 2.0 Hr FLTV 13.8 V

HYST 0.4 V BRTN 12.3 V

CHRG (PL20) 20 A CHRG (PL40) 40 A

BFRQ 15 Days TCMP 0

Under SET/MODE Menu:

BAT2 14.0 V PWM 1

ALRM 11.4 V

Under SET/EVNT Menu:

STRT 12 TIME 0 Hr

STOP 12 TIME 25.5 Hr

EMOD 2 TMOD 0

Current Limit

The PL has a built-in charge current limit. If the charge current exceeds the CHRG setting, the PL will reduce the duty cycle to limit the average charge current.

This allows the PL to protect itself from overheating due to excessive charge current. The maximum charge current can also be limited for small batteries. This is useful for systems which are marginal in winter but overpowered in summer.

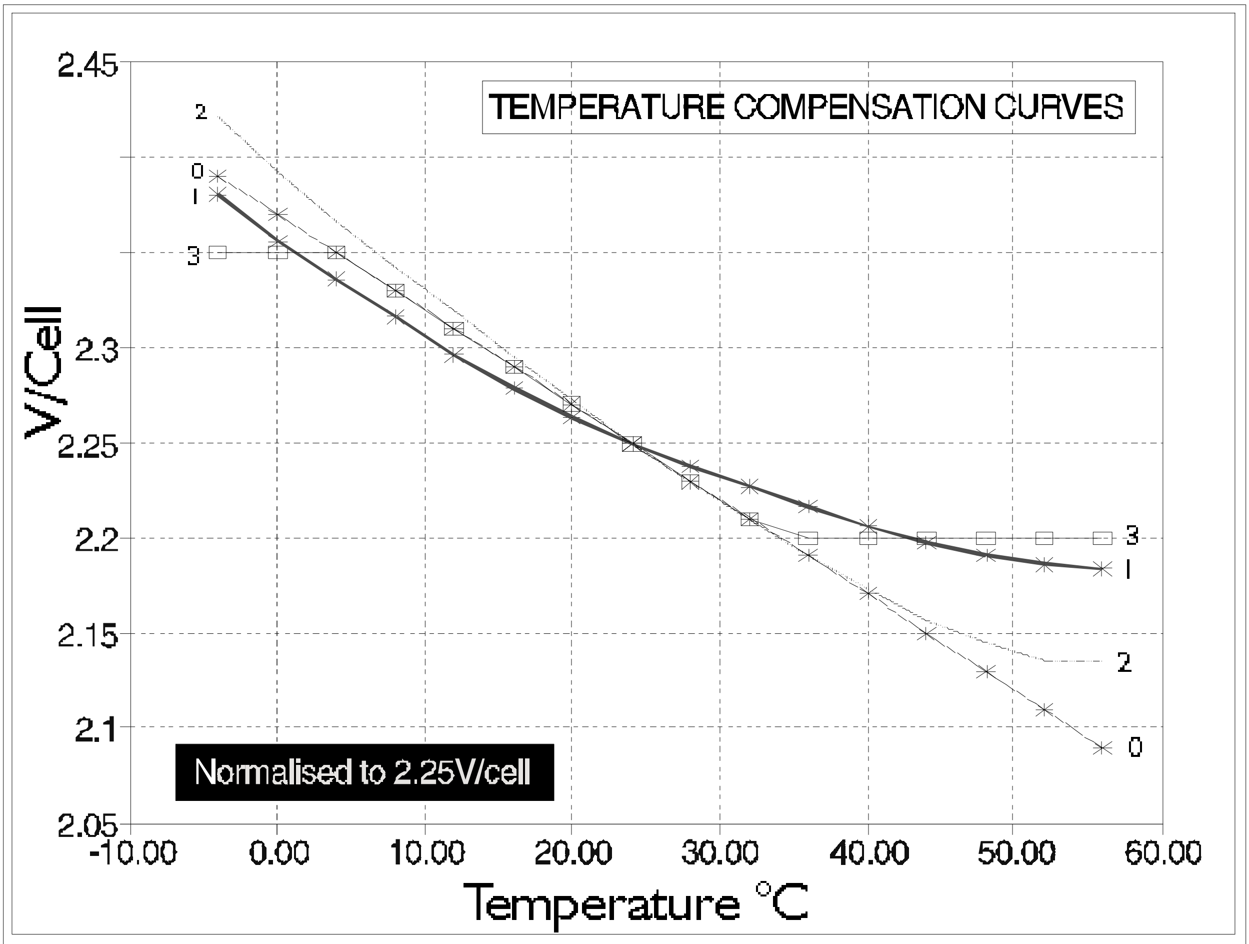
It is also useful for recently installed amorphous cells whose power output is subject to an initial drop. Eg solar cells nominally rated 18A may produce 22A when first installed. This feature will protect against the initial high current.

Thermal Protection

The internal temperature sensor protects the PL by reducing the charge current if it is getting too hot.

Adjusting Configuration Settings

The MODE submenu contains the settings for the configuration of the PL.



SET/REG/TCMP Selection Summary:

TCMP	Function	Data Source
0	-5mV/°C linear auto sense	General purpose - use this if in doubt
1	gentle curve auto sense	BP Solar Block
2	steeper curve auto sense	Sonnenschein Dry Fit
3	limited range curve auto sense	Absolyte battery
4	-5mV/°C linear non auto sense	General purpose - use this if in doubt
5	gentle curve non auto sense	BP Solar Block
6	steeper curve non auto sense	Sonnenschein Dry Fit
7	limited range curve non auto sense	Absolyte battery
8	no temperature sensor	N/A

SET/MODE Submenu Summary:

Name	Description	Range
LSET	Select the use of the LOAD-	0-11
GSET	Select the use of the "G" terminal	0-11
BSET	Select the use of the B- sense input	0-2
BAT2	Regulation voltage for 2nd battery control	13.0-16.0V
PWM	Select which terminals use PWM	0-3
BCAP	Amp hour capacity of the battery bank	20-20,000Ah
ALRM	Alarm voltage	10.0-18.0V
RSET	Resets today's Performance Data to zero	

LSET & GSET

There are two output terminals on the PL (LOAD- and "G") and six logical functions. The LSET and GSET settings define which of the six functions controls each of these output terminals.

The PL's six internal "functions" are normally used as follow:

- one function activates the low battery disconnect, and turns on the "LOAD" indicator on the bottom of the PL's screen
- another activates a backup generator, which also turns on the "GEN" indicator on the bottom of the PL's screen
- a third function determines when to start charging a second battery
- a fourth function determines when to set off a low battery alarm
- a fifth function controls shunt regulation
- a sixth function is used by the event controller to determine when the pre-set event should occur.

If the PL's optional expansion board is connected, all of these functions can be used at once. However, in many cases, only one or two of these functions will be needed. The LSET and GSET settings allow you to choose which functions control the PL's output terminals, and how.

The LSET setting allows you to choose which function controls the LOAD- terminal, and whether the terminal is on or off when the function is active. The GSET setting allows you to choose which function controls the general purpose "G" terminal (under the cover), and whether it is on or off when the function is active.

(Note that there are other screens called LSET and GSET, whose functions are described on page 6.)

LSET and GSET both use the table below:

Set/MODE/LSET and GSET Selection Summary:

#	Function	Terminal is:
0	Low battery disconnect	on when function wants to disconnect battery
1	Low battery disconnect	off when function wants to disconnect battery
2	Generator control	on when function wants to run generator
3	Generator control	off when function wants to run generator
4	Event control	on when event is on
5	Event control	off when event is on
6	2nd battery charge control	on when battery 2 should charge
7	2nd battery charge control	off when battery 2 should charge
8	Alarm output	off when battery voltage < alarm setting
9	Alarm output	on when battery voltage < alarm setting
10	Shunt control	off when function wants to disconnect shunt load
11	Shunt control (not available if PWM= 2 or 3)	on when function wants to disconnect shunt load

BSET: Configuring Battery Negative (B-) input

The input labelled B- (under the cover) is intended as a sense input for the battery negative voltage. This can be connected directly to the battery negative terminal and will read the true battery negative voltage. This is important if there is significant voltage drop along the wiring (or the fuse) between the BAT- terminal on the PL and the real battery negative. (If there is significant voltage drop on the positive side, then take the BAT+ terminal on the PL directly to the battery positive. If this would compromise the safety scheme, it can be wired through a separate small fuse.).

If the B- input is not being used for this, then it can be used for sensing the voltage on a second battery being charged or for providing a voltage input for the event controller (VEXT).

SET/MODE/BSET Selection Summary:

Selection	Function
0	B- input used for battery negative voltage sensing
1	2nd battery voltage sensing
2	external input VEXT, used by event controller

If BSET is set to 0 and the B- terminal is not connected, the PL will sense this and ignore the B- input.

BAT2 - Second battery control

On many afternoons, there is power available from the solar panels but it is wasted because the batteries are already full by then. This power could be used to charge a second or reserve battery bank. The PL has a separate controller for a 2nd battery built into it. This only allows the second battery to charge if the PL has reached the float state and the voltage on the 2nd battery is below the setting in the BAT2 screen.

This scheme requires that the positives of the two batteries be joined together. The PL can read the voltage on the second battery from the B- sense input if BSET=1, or it can use the VEXT input on the expansion board otherwise. A relay will be required to switch the negative of the solar panel from the SOL- terminal of the PL to the negative terminal on the second battery (see fig 9). This relay can be switched by either the LOAD- or "G" terminals, or the relays on the optional expansion board can be used. If appropriate, only part of the array need be switched to the second battery.

Second battery control is not suitable for use in negative ground systems such as many vehicles.

PWM

When the PL is trying to keep the battery voltage constant, it does this by turning the charge current on or off as required. It can do this slowly or quickly. In the slow mode, there must be at least 0.25 sec between changes. This virtually eliminates any audio or radio frequency interference. In the fast mode, the PL uses pulse width modulation (PWM) at 200Hz. This may generate some audio or radio frequency interference.

The switching mode is selected in the PWM screen. Both the SOL- terminal and the LOAD- terminal (but not the "G" terminal) can use Pulse Width Modulation control.

SET/MODE/PWM:

Selection	Function
0	No PWM used
1	PWM on SOL- terminal only
2	PWM on LOAD- terminal only
3	PWM on both

The PWM output is available on the expansion board as well, regardless of this setting.

When not in PWM mode, the PL allows the voltage at which the charge turns back on to be lower than the voltage at which it turns off. This gap is called hysteresis and is adjustable (HYST). The larger the hysteresis, the slower the switching on and off.

The radio frequency interference from the PL has been tested in PWM mode and found to be very low. It is at least 15dB below the domestic limit for European and Australian EMI compliance standards. More care must be taken at higher system voltages (particularly 48V) because the inductance of the wiring to the photovoltaic panels can cause some ringing on turn-off. Keep wiring as short as possible.

On long wiring runs at higher voltages, some damping may be necessary and possibly some external clamping of transients. With highly inductive wiring, the transients may be large enough to damage the FET switch. Consult the factory if further information is required.

It is recommended that PWM control be used unless there is good reason not to, as it provides much smoother control.

PWM should only be enabled on the LOAD- terminal if the PL is using LOAD- as a shunt regulator with no relay.

BCAP

BCAP sets the effective Amp-hour capacity of the battery being charged by the PL. This is used by the State of Charge data screen described on page 4. A long push on BCAP allows you to set this value.

BCAP's range is 20-20,000Ah. Starting at 200, short pushes will increment BCAP by 20Ah until it reaches 1000 Ah. At this point, the increment increases to 100Ah and the display changes to thousands - i.e. 1000 is 1.0, and 1100 is 1.1. When the display reaches 20,000Ah (shown as 20.0), it will cycle back to 20Ah (shown as 20).

ALRM

Long-push here to set the alarm voltage. If the battery voltage falls below the alarm voltage, the PL will activate its internal Alarm function. If the LSET / GSET settings have been configured appropriately, this can be used to set off an audible alarm (or any other type of alarm). See page 11 for details on LSET and GSET.

RSET

A long-push on RSET will reset the microprocessor, which is similar to a reboot on a computer.

RSET also resets today's Performance Data and the clock to zero.

Note that you will need to reset the time on the PL's internal clock, but your other settings will be retained.

The Event Controller

The event controller allows something to happen when a set of conditions are met. There are an unlimited number of applications for this feature, such as:

- Turning on a light at night
- Using 'waste' energy pumping water in the afternoon if the PL is in the float state
- Sensor operated timed lighting at night
- Turning on sprinklers for an hour if it's over a certain temperature

Using the Event Controller

Step 1

Many users will not need the event controller, so in Programs 0-3 it is automatically disabled. For users who do wish to use the event controller, Program 4 must be selected. (See page 9 for instructions).

Step 2

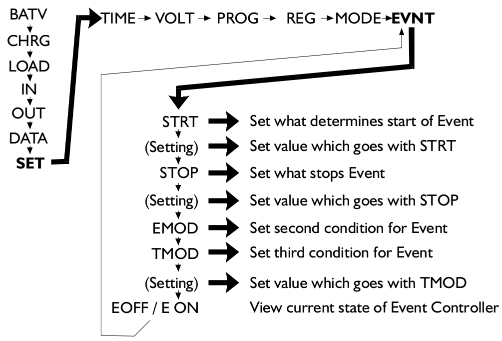
It is also necessary to tell the PL which output terminal will be controlled by the Event Controller. This is done using the LSET setting (to use the LOAD- terminal) or the GSET setting (to use the "G" General Purpose terminal). The use of these is described on page 11. To use the event controller, one of these settings must be set to "4" or "5".

Step 3

Next, the PL must be told what signifies the start of the event.

Move to the EVNT menu, as shown in Figure 7. A long-push on EVNT will move to the STRT setting.

Figure 7 - Event Control Menu (Program 4 only)



STRT uses the following table to determine what will start the event:

SET/EVNT/STRT Selection Summary

STRT	Event starts when	Value to set
0	Solar panel voltage (open circuit) > setting	SOLV
1	Solar panel voltage (open circuit) < setting	SOLV
2	External voltage VEXT > setting	VEXT
3	External voltage VEXT < setting	VEXT
4	PB* is on and time > setting	TIME
5	PB* is off and time > setting	TIME
6	PBext* is on and time > setting	TIME
7	PBext* is off and time > setting	TIME
8	Repeat start at 10 min intervals if time > setting	TIME
9	Repeat start at 30 min intervals if time > setting	TIME
10	Repeat start at 1hr intervals if time > setting	TIME
11	Repeat start at 2hr intervals if time > setting	TIME
12	Time > setting	TIME
13	ExtD* is active and time > setting	TIME
14	Repeat start at a set rate (1-240 min)	RATE
15	Repeat start at a set rate (0.1-25.5h)	RATE

*Note: "PB" means a push-button switch. If you wish to use this option, you must wire a switch or other trigger between the B- terminal and the BAT- terminal.

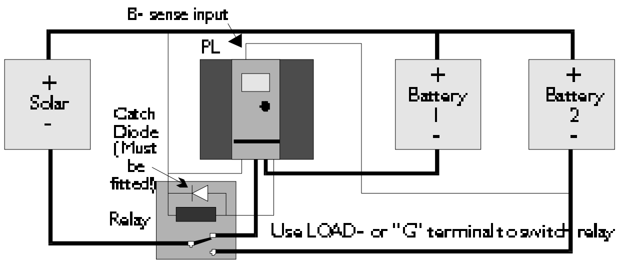
"Pbext" is only relevant if the optional expansion board is connected. It refers to the push-button input on the expansion board. "EXTD" is also relevant only if the expansion board is connected. It refers to the digital input from the expansion board.

After setting the STRT value, a short-push will move you to the setting which goes with that STRT value. For example, if you set STRT to “1”, you will see SOLV. Whenever the solar panel voltage drops below the value you set in SOLV, the “event” will start.

Step 4

Use the STOP setting to tell the PL what signifies the end of the “event”.

Fig. 9 Second Battery Control



The STOP setting uses the following table:

SET/EVNT/STOP Selection Summary

STOP	Event stops when	Value to set
0	Solar panel open circuit voltage > setting	SOLV
1	Solar panel open circuit voltage < setting	SOLV
2	External voltage VEXT > setting	VEXT
3	External voltage VEXT < setting	VEXT
4	PB off and time > setting	TIME
5	PB on and time > setting	TIME
6	PBext on and time > setting	TIME
7	PBext off and time > setting	TIME
8	Repeat stop at 1 min intervals if time > setting	TIME
9	Repeat stop at 3 min intervals if time > setting	TIME
10	Repeat stop at 6 min intervals if time > setting	TIME
11	Repeat stop at 12 min intervals if time > setting	TIME
12	Time > setting	TIME
13	ExtD is active and time > setting	TIME
14	Stop after a set run time (1-240min)	RUN
15	Stop after a set run time (0.1-25.5h)	RUN

*Note:

“PB”, “Pbext”, “EXTD” have the same meanings as in the STRT table.

After setting the STOP value, a short-push will move you to the setting which goes with that STOP value.

For example, if you set STOP to “12”, you will see TIME. The “event” will then continue until the time is after the time you specify in the TIME setting. One use of this combination of STRT and STOP could be to turn a light on between dusk and 11pm.

Step 5

Next, a short-push brings the EMOD setting and then the TMOD setting. These settings can be used to set more conditions which determine the event.

In the example above, the EMOD setting can be used to ensure the light only turns on if the PL is in the Float state (EMOD=1).

If additional conditions are not needed, they can be set to zero and they will be disregarded (always active).

SET/EVNT/EMOD Selection Summary

EMOD	EMOD is active when:
0	Always active (ie EMOD condition is irrelevant)
1	PL is in Float mode
2	its night
3	it’s day
4	ExtD is active
5	PL is in Float and it’s night
6	PL is in Float and it’s day
7	PL is in Float and ExtD is active
8	it’s night and ExtD is active
9	it’s day and ExtD is active
10	PL is in Float and it’s night and ExtD is active
11	PL is in Float and it’s day and ExtD is active

SET/EVNT/TMOD Selection Summary

If you use TMOD settings 0-6, the Low Battery Disconnect function overrides the Event Controller, and your battery will be protected. Using settings 8-14 allows the Event Controller to override the Low Battery Disconnect function, and your battery will not be protected.

TMOD	TMOD is active when	Value to set	LBD
0	Always active (TMOD irrelevant)	None	Y
1	temperature > setting	TEMP	Y
2	temperature < setting	TEMP	Y
3	VEXT > setting	VEXT	Y
4	VEXT < setting	VEXT	Y
5	Time > setting	TIME	Y
6	Time < setting	TIME	Y
7	Do not use		
0	Always active (TMOD irrelevant)	None	N
9	temperature > setting	TEMP	N
10	temperature < setting	TEMP	N
11	VEXT > setting	VEXT	N
12	VEXT < setting	VEXT	N
13	Time > setting	TIME	N
14	Time < setting	TIME	N

(Note: if BSET=2, then VEXT is the voltage on the B- input. This is offset so that 80 on the VEXT setting screen is 0V. It is scaled in 0.1V steps so that +2V is represented by 100, or -3V is represented by 50.)

After setting the TMOD value, a short-push will move you to the setting which goes with that TMOD value, similar to STRT and STOP.

Step 6

Finally, a short-push displays a screen which tells you the current state of each of the conditions, and whether the "event" is currently active.

If the "event" is inactive, then to turn it on all three conditions (STRT, EMOD and TMOD) must become active (ie. "1").

When the "event" is active, if the STOP condition takes place or the TMOD or EMOD condition goes inactive (ie "0"), then the event will turn off.

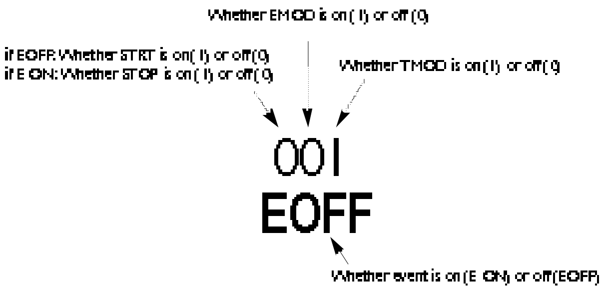
If the display shows "E ON" then the "event" is currently active. If it shows "EOFF" then the "event" is currently not active, but will become active when all of the preset conditions are met.

The numeric figure shows the state of each of these conditions.

The first digit shows the status of the STRT and STOP conditions. If the event is off (EOFF), the first digit shows the state of the STRT condition. (0 = inactive, 1 = active). If the event is on (E ON) the first digit shows the state of the STOP condition. In the example, above, this figure will be "0" during the day (i.e. STRT condition is inactive), then "1" at dusk when the solar panel voltage drops to the pre-set SOLV value. If the battery was fully charged, the event will start: the display will change to "E ON" and the first digit it will flick back to "0" to show that the STOP condition is inactive. If the battery was not fully charged, the event will not start, the display will stay on "EOFF", and the first digit will remain on "1" until either the PL enters the Float state (when the event will start), or 11pm comes (when it will flick to 0 until next evening).

The second digit shows the state of the EMOD condition. In the example above, this digit will be "1" when the battery is in the Float state, and "0" if it is in the Boost, Equalise or Aborption states.

The third digit shows the state of the TMOD condition. In the example above, TMOD was not used, and this digit will always be "1".



Examples:

To turn a light on all night

STRT	TIME	STOP	TIME	EMOD	TMOD
12	0	12	250	2	0

The first four conditions have the effect of making STRT and STOP irrelevant. The STRT condition will always be on, and the STOP condition well never happen: the time will always be greater than 0 (midnight), and as the time returns to 0 after 23.9 (6 minutes to midnight), it will always be less than 25.0, which is a non-existent time.

In practice, the EMOD condition will determine whether the event is on or off. Because it is set to 2, it will be on at night. If a light is wired to the LOAD- terminal and LSET=5, then the light will turn on at night.

(Note: if the optional expansion board is not being used, it may be easier to set STOP to 13, which will never be true as EXTD will always be off. Setting TIME to 250 can be time consuming).

Pushing a button turns a light on at night for 10 minutes:

STRT	TIME	STOP	RUN	EMOD	TMOD
4	0	14	10.0	2	0

If the push-button is wired up, the STRT condition will turn on with the push-button input (the time will always be greater than 0). It will stop after 10 minutes due to the STOP and RUN settings. EMOD=2 makes sure that this will only happen at night - during the day pressing the push-button will have no effect.

Pump water if battery is fully charged until tank is full (ie switch in tank turns off):

STRT	Set 1	STOP	Set2	EMOD	TMOD	Set3
12	0	5	0	1	0	-

The STRT condition is always true, as the time is always greater than 0. However, until the PL switches into the Float state, EMOD will not be active. When the PL enters Float state, EMOD will become active and, as STRT is always true and TMOD is always true, the pumping will start. The STOP condition becomes true when a switch in the tank (wired between the PL's BAT- and B- terminals) switches off, i.e. the tank is full.

Turn on sprinkler between 6pm and 7pm if it is over 25°C and there is water in the tank

STRT	Set 1	STOP	Set2	EMOD	TMOD	Set3
12	180	12	190	4	1	25

The STRT condition will become active when the time is after 6pm (i.e. 18:00 hours, or 18.0). The STOP condition will become active when the time is after 7pm. EMOD will become active when the digital input from the expansion board is active.

Water garden for 5 minutes every 100 min from 10am until nightfall

STRT	Set 1	STOP	Set2	EMOD	TMOD	Set3
14	100	14	5	3	5	100

Accessories

There are four accessories which can enhance the usefulness of the PL controller.

All four of these plug into the serial port which is under the lid on the left hand side.

Remote Control PLM

The PL can be accessed remotely with the remote control. All of the functions work in the same way as on the actual controller.

External Shunt Adaptor PLS

Up to two external shunts can be added to the PL to allow it to measure larger currents than it is capable of directly. The shunt adaptor measures the current in a shunt, converts it to digital information and sends it back to the PL. The connection to the shunt is DC isolated from the PL and so the shunt can be placed in any part of the circuit. Currents up to 250A can be read. A jumper on the PLS defines whether the data is load or charge current.

Expansion board PLX

The expansion board allows full use of all the capabilities of the PL controller. It provides relays to switch external devices and more sense inputs.

Computer/Modem interface PLI

An RS232 level serial interface is available which allows the PL to communicate with a computer or be remote accessed via a modem. This is a quick way to load settings into the PL or extract performance data. All of the data is remotely accessible, and all settings can be adjusted. Software is available for IBM compatibles to make this easy. Data can then be loaded into a spreadsheet or other applications.

Specifications

(Numbers in brackets are specifications for the PL40 model.)

Nominal system voltages	12,24,32,36,48	V
Maximum voltage BAT+ to BAT-	100	V
Max short term voltage BAT+ to BAT-	120	V
Maximum voltage BAT+ to SOL-	100	V
Max voltage LOAD- to BAT-	60	V
Max voltage "G" terminal to BAT-	60	V
Max voltage B- sense to BAT-	+/-10	V
Max. continuous charge current (SOL-)	20 (40)	A
Max. continuous load current (LOAD-)	20 (5)	A
Max. short term load current	25 (7)	A
Max "G" terminal output current	120	mA
Temp sensor range	-5 - 50	°C
Max. storage/operating temperature	70	°C
Supply Current	9 (14)	mA
Meter Accuracy	<+/-2% +/-1 display digit	

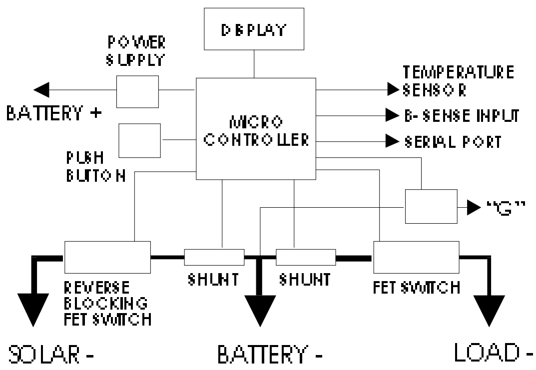
Thermal derating

The current rating of the PL must be reduced at high ambient temperatures or the display will darken until it is unreadable. The currents indicate what can be done at the same time. Because the limit is due to heating, there are many combinations of charge and load current which will produce the same heat level. This table shows the limits of each combination.

Air temperature around the PL (°C)	Charge Current Max		Load Current Max	
	PL20	PL40	PL20	PL40
40°C	20 A	40A	20 A	5A
44	20	40	0	0
	18	37	10	5
	13		20	
48	35	0		
50	18	32	0	0
	5		20	
	13		10	
55	13	28	0	0
	0		20	

Block Diagram of PL Hardware

The PL controller has a reverse blocking mosfet switch between the SOL- terminal and the BAT- terminal and a mosfet switch between the LOAD- terminal and the BAT- terminal. There is also a low current mosfet switch to drive a generator control or alarm relay.



Complete Menu System
(Custom settings program - program 4)