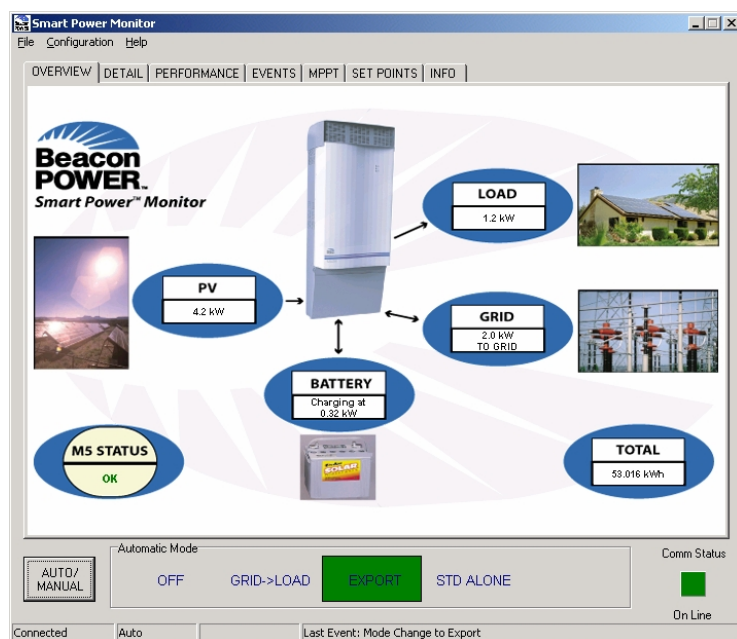




Smart Power™ Monitor

User Manual



P/N PSD-0002

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Introduction

Thank you for choosing the Beacon Power Smart Power™ (SP) Monitor to complement your Smart Power™ M5 power conversion system. We believe the SP Monitor's powerful features – including detailed performance monitoring, data and event logging, and setpoint access – as well as its simple, intuitive interface will impress you with the level of information that it provides while not overwhelming you with complex and obscure controls. After reviewing this manual you will have all the necessary tools to enable you to take full advantage of the benefits of this software.

The Smart Power™ M5, Power Conversion System (PCS) is ready to operate in the utility-connected mode “out of the box” – as soon as it is installed, without further configuration. For users who want more information than is provided by the LED indicators on the front panel of the M5, this monitoring software brings an unprecedented level of flexibility to your system and allows you to see the detailed operational parameters of your PCS. For unique M5 installations, the SP MONITOR also provides the user/installer access to a complete suite of operating modes and setpoints, as well as detailed status information.

For improved versions of this document or the Smart Power™ Monitor, please check for updates on the Beacon Power webpage: www.beaconpower.com.

Contents of the SP Monitor kit

- This Manual
- CD-ROM containing the Microsoft Windows version of the SP Monitor software
- RS-232 (serial PC com port) to RS-485 (M5) adapter
- Communication Cable (standard four wire phone cable terminated RJ-11 with “twist”)

The RS-232 to RS-485 adapter enables your personal computer with the installed SP Monitor software to communicate with the Beacon Power M5 PCS.

Note that the communication cable is not simply ordinary telephone cable. If both ends of the cable are held together side-by-side (with the RJ-11 clip tabs both facing down), a “twisted” cable will have the individual wire strands ordered opposite one another. For example, if the strand order is black, red, green, yellow (when read from the left to the right side) for one end of the cable, the other end of the cable should be ordered yellow, green, red, black (when read from the left to the right side). If the colored wires are in the same order, then the cable is a “straight” cable. A straight cable will **not** allow the SP Monitor software to communicate with the M5.

Software Installation

SP Monitor is installed like most modern Windows applications. Many computers will auto-install the application as soon as the CD is placed into the drive and closed. If your computer does not auto-install click Start -> Run then browse to your CD-Drive and select *setup.exe*, press Open then OK. If you are not installing from a CD, use Windows Explorer to view the contents of the folder where the installation file is located, and double click the file called *setup.exe*. Follow the instructions provided by the installation wizard.

SP Monitor Communication

Packets

The PCS and software communicate by exchanging data packets. The language (i.e., the format of the packets) used to do this is called a protocol. In a typical exchange the software sends a request in packet form to the M5 for information about the M5 operating points and status. This process is referred to as *polling*. The PCS then responds by sending a packet with the requested data; upon receipt of this information, the monitoring software stores the data and uses it as necessary.

Time Out

If SP Monitor does not receive packets from the M5 after a significant period of time (after three consecutive polling cycles, to be more exact), the software will go into “time out” mode. This will happen if, for example, the communication line is damaged, disconnected, or a “straight” cable is used instead of a twisted one. Time out mode will also occur if the user disables polling on the SP Monitor (see discussion of the *Configuration Menu* below).

Communications Protocol

The communication protocol between the SP Monitor and the M5 is referred to as half duplex, indicating that *either* the M5 *or* the software can transmit packets on the communication line at any given moment. It is not possible for both to successfully transmit information simultaneously. If both devices attempt to transmit at the same time, the packets will collide and data may be truncated,

damaging the packet. The communications protocol will recognize damaged packets, but it cannot make sense of them and they will be discarded. Damaged packets are inevitable (if rare) with software running on the Microsoft Windows operating system (OS), for it is not a true "real-time" OS. After receiving a truncated packet, SP Monitor will retry up to 11 times to send or receive a good packet from the M5 for critical commands (like mode changes).

The net effect of these communication concerns is that SP Monitor may occasionally perform sluggishly. In such instances it may be necessary to click the mode change buttons more than once before the command will be successfully communicated to the M5. The M5 should confirm mode changes within 4 seconds. If not, retry the command.

Getting Around in SP Monitor

SP Monitor information and controls are found in three general locations in the window:

- 1) Seven tabbed windows (*Overview, Detail, Performance, Events, MPPT, Set Points, and Info*),
- 2) Three pull-down menus (File, Configuration, and Help) at the top left corner of the screen,
- 3) M5 control and status buttons below the tabbed window

Each of these will be described in the subsequent sections of this manual.

Tabbed Application Window

Each of the SP Monitor tabbed panels enable the user to easily control specific M5 functions and to retrieve data from the M5 via a user-friendly graphical interface. All the data from the M5 displayed in these screens is stored in a database, and it is a simple matter to export this data to an Excel or Access compatible file format for further analysis. For more detailed information about manipulating or managing the database for special applications, please contact Beacon Power.

Overview

When you start SP Monitor, your computer will open with the *Overview* panel active as shown in Figure 1. The values displayed on your computer may differ from those shown below. Also note that these values are typically only accurate to approximately +/- 50 watts.

This window gives the user a concise and compact summary of the performance of the various components of your energy conversion system. It displays the amount of power being generated, conditioned or transmitted at the following points: the PV panels, utility grid, batteries, and load. The readouts are grayed if a communications timeout has occurred to let the user know that the data displayed is not fresh.

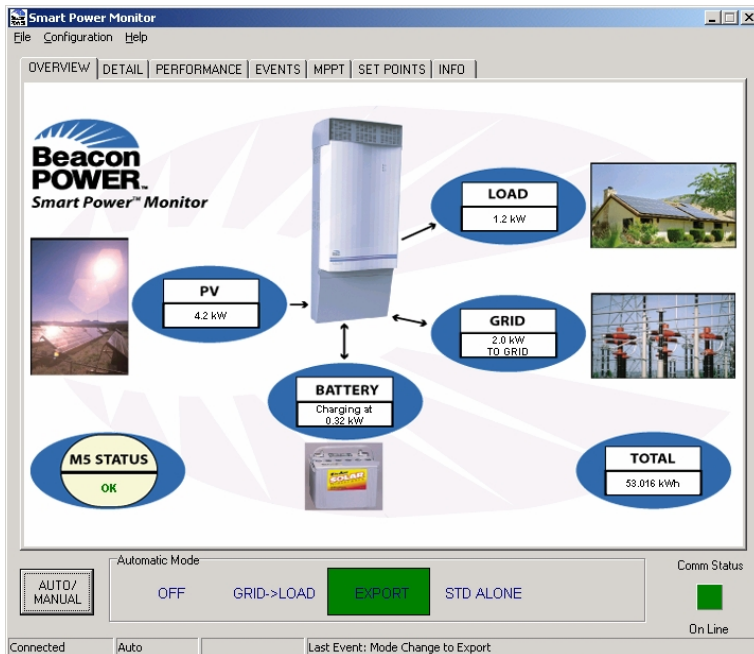


Figure 1: SP Monitor Overview Screen

Detail

The *Detail* window expands upon the information provided in the *Overview* screen, displaying the voltages, currents, powers, and frequencies between each of the nodes of your system as shown in Figure 2. The term “node” is being used loosely in this context to refer to the point of entry or exit from any of the six main blocks in the diagram on this screen, viz., *PV*, *DC-DC CONV*, *BATTERY*, *INVERTER*, *Grid*, and *Load*. Other information is also given such as the battery temperature, fan level and mode status. The green line indicates where power is flowing between the components. As can be seen in Figure 2, the grid is down, so the PV is charging the battery as well as supplying power to the load, but no power is flowing to or from the grid.

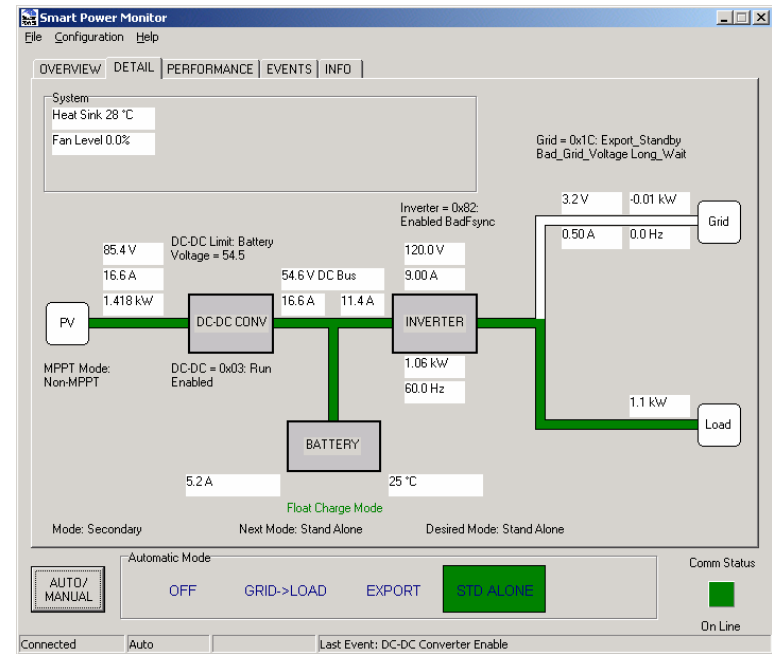


Figure 2: SP Monitor Detail Screen

Note: Even if the *Detail* screen indicates that there is no power being delivered to the *Load*, a voltage may still exist. Since this connection may be live in such circumstances, the path to the *Load* shown on the *Detail* screen will remain green, indicating that if you were to touch the lead from the inverter to the load, you would likely receive an electrical shock.

The sign convention used in the boxes on this screen is as follows: a value is negative if it indicates electrical flow in a direction opposite to the preferred direction. For example, we would prefer not to consume power from the grid to run our loads. We would instead, prefer to be constantly selling power back to the utility (where net metering is available). Hence, when current is flowing to the grid, the current readout next to the *Grid* box is positive and when power is being drawn from the grid, the sign is negative. Similarly, batteries are designed for storing dc power; therefore, when the batteries are charging, the current is positive. When they are exporting power, the battery current indicator is negative, indicating the non-preferred current direction.

Performance

This screen displays the power and voltage from the PV array, power output from the inverter, power delivered to the load, and the power to the grid in a graphical format. By selecting a different date in the pull-down box (located toward the bottom of this window), you can view the historical performance of your PV system. If, for example, you wanted to see how much power your inverter exported to the grid a week ago, you would simply select the date in the pull-down menu, and the graph of that day's data would be plotted. In order to take advantage of this feature, your PV system must have been operational and your M5 connected to the SP Monitor on the date in question.

New data points are added to the graph every 15 minutes. This default sampling rate can be changed by selecting the *Database* window from within the *Configuration* pull-down menu as described in the next section of this manual (under **Pull-down Menus**).

Events

The event log displays information such as mode changes (e.g., from stand alone to export), battery charging status, and anti-islanding events. The M5 is capable of storing up to ten such events at any given time. If six or more events occur before the SP Monitor can download them, they will be internally overwritten in the M5's memory. By changing the polling rate (found in *Configuration Menu* → *Communications*), you can adjust how often this event log is dumped from the M5 to your computer. Ultimately, the event log in the SP Monitor contains only what it is able to successfully download from the M5.

Setpoints

(only available in Technician or Factory Access Levels) Generally, there is no need to adjust the setpoints since the M5 is configured to work "out of the box". However, if you do require changes to your setpoints, that functionality is provided here. First, the default setpoint file needs to be loaded. Press *Change* and locate the *default setpoints.csv* file. The table will then be populated with the data from the file as well as from the M5 as shown in Figure 3. For reference, the default information is also included in Appendix 1. The values currently stored in the M5 are shown in the *Inverter Value* column. When these values differ from the values in the currently loaded file, they appear in red.

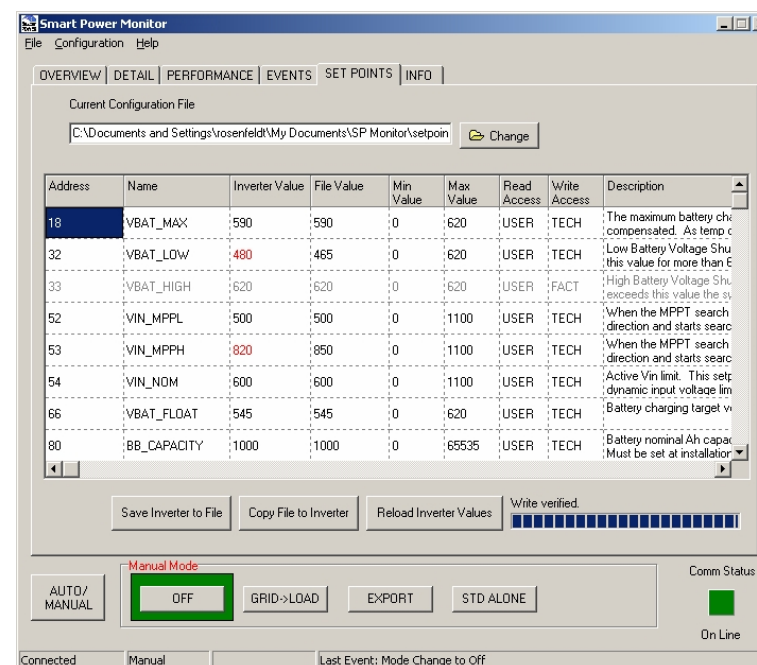


Figure 3: SP Monitor Setpoints Screen

Changing Setpoints

To change a setpoint, double-click on the value in the *Inverter Value* column. Delete the existing value and reenter a new value. The new value must fall within the indicated Minimum and Maximum Values. Press Enter and a confirmation dialog box will appear (Figure 4).

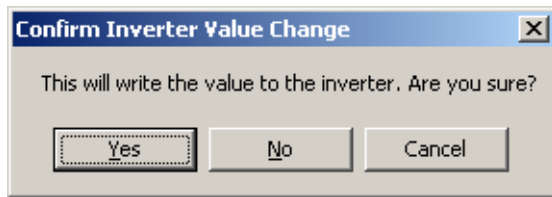


Figure 4: Setpoint Change Confirmation

Click Yes to change the setpoint to the new value. Notice the Write Verification in the bottom right corner (Figure 5).

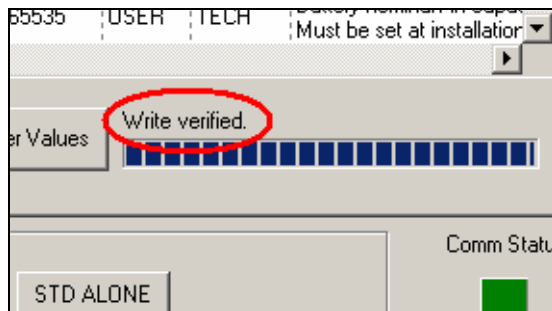


Figure 5: Setpoint Write Verification

Should the setpoint not be properly written to the M5, a dialog will appear (Figure 6). It is best at this point to hit the Reload Inverter Values button to refresh the setpoints shown on the screen.



Figure 6: Setpoint Write Failure

To view the full description of a setpoint, double-click on the description field.

Saving and Loading Setpoint files

If you would like to save all setpoint values from the M5, simply press the 'Save Inverter to File' button. Specify the filename and press Save. To send a setpoint file to the M5, load the file first by pressing 'Change' selecting the file and then clicking the 'Copy File to Inverter' button. Notice the progress bar in the bottom right corner. Currently only factory created setpoint files may be uploaded to the M5.

Info

The *Info* screen is rarely if ever used in normal operation. It reports such things as the model, serial number, and software revision level for your M5. It is often useful to have this data if it should ever be necessary to call Beacon Power technical support for help with any questions or concerns with your M5's performance.

Pull-down Menus

File Menu

EXPORT: This function enables the user to export data from the performance window (discussed below) to a comma separated values (.csv) file. This format can be read by spreadsheet and database software such as Excel and Access. The export feature is beneficial to users who may wish to perform further analysis of their data. For example, by exporting to Excel, it is a simple matter to graph the PV output of your power conversion system over the course of a week, month or even the entire year.

QUIT: Closes the Smart Power™ Monitor screen and ends communication between the M5 and the PC. The PC will stop logging any data.

Configuration Menu

COMMUNICATIONS: (only available in Tech or Factory Access Levels)

This Menu opens a window that gives the status of the information exchange between the M5 and the SP Monitor. Communications may be manually disabled by deselecting the *On Line* box. Deselecting the *Poll Every* check box will cause the software to stop writing the data to the database, but continue to poll the M5 for data. The rate at which the SP Monitor polls the M5 for new data may be adjusted from 200 ms to 5000 ms by clicking the scroll arrows next to the *Poll Every* box. The default rate is 400 ms (=0.4 seconds).

DATABASE: By changing the 15-minute default value in the *Database* window, the user can specify how often the software averages the M5 data and writes these values to the database. Clicking the *Manual Write DB averages* button forces a one time immediate averaging and writing of the M5 data to the database.

ACCESS LEVEL: Initiates the window that enables the user to view and change his/her access level. Higher access is required for certain M5 maintenance operations and to modify setpoints. To reach higher access levels you must call Beacon Power customer service at (978) 694.9121 or Toll-Free: (888) 938.9112 and provide the ten-digit number that automatically appears upon choosing one of the higher access level radio buttons. For example, if you were attempting to get technician level access, SP Monitor would generate a screen similar to the one depicted in

Figure 7. You would then call Beacon Power and provide them with the number 65460-65412 (this number is randomly generated each time you try to change access level). Beacon Power would then give you a key (another number) that you would type into the response box. After clicking on the *Change Access Level* button, you would be granted temporary access to technician level.

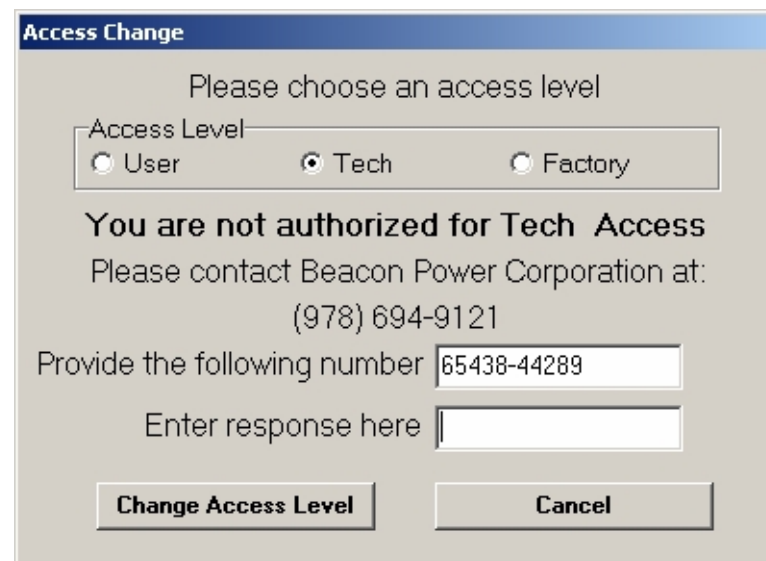


Figure 7: Changing to Technician Access Level

SELECT COM PORT: To reconfigure the communications port that SP Monitor uses to interface with the M5, click on the *Select Com Port* window and choose the correct com port from the pull down list.

KIOSK: It is often convenient to direct SP Monitor to automatically display some or all of the tabbed panels in sequence. Choosing *Kiosk* in the *Configuration* menu will bring up a window in which you may specify how long each panel should be displayed (*Dwell Time* in seconds). You may also choose not to display particular panels by deselecting the check box next to it. After entering this information, click on *Cycle Tabs Start*. SP Monitor will continuously tab through the selected panels using the selected dwell times. This function is particularly useful in schools or other applications where it is desirable for an audience to be able to readily see much of the information provided by the SP Monitor

without any direct physical contact with the computer. To stop the cycling, click the *Cycle Tabs Stop* button.

EMAIL SETTINGS: (*only available in Technician or Factory Access Levels*) Opens a window to establish automatic emailing of the data and event logs via either a Network or dial-up modem connection as shown in Figure 8.

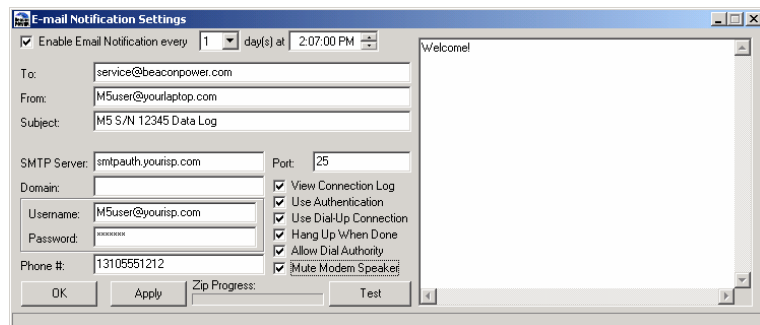


Figure 8: E-mail Notification Settings Window

To arrange to have emails automatically sent on a regular basis, click the *Enable Email Notification* check box, choose how often the emails should be sent from the drop down list of days and select the time of day the emails should be sent using the scroll buttons. Enter the recipients email address, the sender's email address and a descriptive Subject. Enter the rest of the information as required for your connection. When complete, click the *Apply* button. To confirm that the settings are correct, click the *Test* button and verify that the recipient did receive the email as specified. When satisfied, click *OK*. Emails will automatically be sent according to the parameters established, as long as the Smart Power™ Monitor is running and the connection is available.

The “Allow Dial Authority” checkbox allows certain modem models to dial out and not be interrupted by the logging process. To determine if your modem requires dial authority, first, attempt to dial out with this check box unchecked. If the modem is not able to dial out, your modem requires preference over the logging function. Check the “Allow Dial Authority” check box, press “Apply” and try again.

Help Menu

Please contact Beacon Power customer service at (978) 694.9121 or Toll-Free: (888) 938.9112 if you have any questions. We welcome the opportunity to offer our customers the personal attention they deserve.

M5 Control and Status Buttons

The status buttons and the auto/manual toggle button are located just below the tabbed window. A close-up of these controls is shown below in Figure 9. In this figure, the M5 is in automatic mode, which means that the M5 decides the most efficient way of operating. If, for example, your system is generating excess power, it will automatically export power to the grid (as indicated in Figure 9 by the green box around *Export* mode) while keeping your batteries at their optimal operating voltage. If your loads require you to draw power from the grid, the display would switch to the *Grid->Load* mode. If utility power were interrupted for some reason, the green box would illuminate *STD Alone* mode. On the right hand side of the screen, the green *Comm Status* light and the words "On Line" indicate that SP Monitor is communicating with the M5. If the communications cable between the computer and the M5 were defective or absent or if you manually disable communications with the M5 (see *Configuration Menu* above), this would be red and display "On Line Timeout".

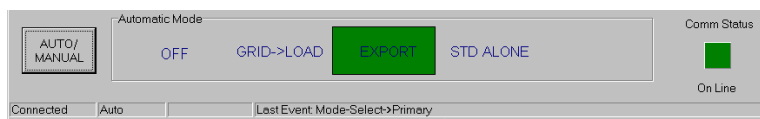


Figure 9: The M5 Control and Status Bar

To toggle between automatic and manual operation click on the *auto/manual* button. In general, Beacon Power does not recommend changing your M5 to manual operation. If you click on the *auto/manual* button, the warning shown in Figure 10 will appear, asking you to reconsider. The *Auto/Manual* button will blink red to remind you to return the M5 to automatic mode as soon as you have completed your manual adjustments to the M5.

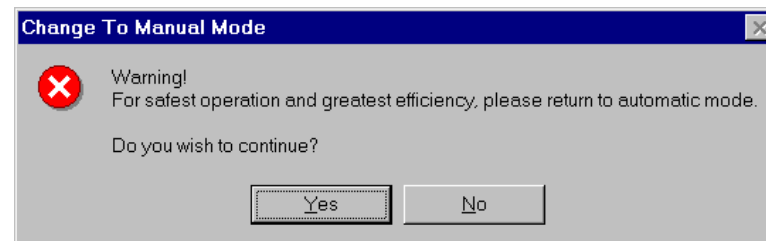


Figure 10: Warning displayed when attempting to switch to manual control of the M5

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Appendix 1: Setpoint Definitions

Address	Name	Default	Units	Min	Max	Access Level	Description
18	VBAT_MAX	590	Volts	0	620	Tech	The maximum battery charging voltage allowed. Non-temperature compensated. As temp compensated voltage could go to very high voltages at very low temperatures, this control is needed to protect the M5 and any connected DC equipment
32	VBAT_LOW	465	Volts x10	0	620	Tech	Low Battery Voltage Shutdown. If the battery voltage stays below this value for more than 60 seconds, the system will shutdown. If the battery voltage returns to above this value the shutdown will clear.
33	VBAT_HIGH	620	Volts x10	0	620	Tech	High Battery Voltage Shutdown. If the battery voltage reaches or exceeds this value, the system will shutdown.
52	VIN_MPPL	500	Volts x10	0	1100	Tech	When the MPPT search algorithm drops to this value, it reverses direction and starts searching up again. If the true MPP is below VIN_MPPL, the input will

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Appendix 1: Setpoint Definitions

							be held at VIN_MPPL.
53	VIN_MPPH	850	Volts x10	0	1100	Tech	When the MPPT search algorithm exceeds this value, it reverses direction and starts searching downwards. If the true MPP is above VIN_MPPH, the input will be held at VIN_MPPH.
54	VIN_NOM	600	Volts x10	0	1100	Tech	Active Vin limit. This setpoint is the initial load value for the dynamic input voltage limit. If MPPT is on (set by option word 0x7F), it is the initial value for MPP tracking – at low input current (less than 0.3A), the PV array is controlled to operate at this voltage. If MPP tracking is off, this value becomes the lower limit of DCDC operation. If the input voltage drops to VIN_NOM, the dc/dc converter will back off and maintain the input at VIN_NOM. In a similar manner to DCL control, if MPPT is off, the Vin limit can be changed dynamically using the ccSET_INPUT_VOLTAGE_LIMIT command. This command should be

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							used rather than changing the setpoint when the unit is running as a/ this setpoints are only loaded at startup, and b/ multiple writes to setpoint FLASH memory will ultimately cause the memory to fail.
66	VBAT_FLOAT	545	Volts x10	0	620	Tech	Battery charging target voltage when the system is in float mode.
80	BB_CAPACITY	800	Ah x10	0	65535	Tech	Battery nominal Ah capacity. Used in state of charge calculations. Must be set at installation for SOC % to read accurately.
111	COMM_ADDRES S	65535		0	65535	Tech	The Standard Inverter Protocol (SIP) address of the M5. Set to 65535 (-1) at shipment. Any value will work for a single M5 system as monitoring products use address zero (broadcast) to poll a single M5. Multiple M5 systems require that this setpoint be set to a unique value.
138	GC_LINE_RESIS TANCE	0	milli-ohms	0	65535	Tech	When in export mode, allowance can be made for the voltage rise between inverter and point of connection. (Ref IEEE 929). This can be very useful if the inverter is connected via long cable runs to the utility service. For example, if a

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Appendix 1: Setpoint Definitions

							system is installed and experiences over voltage trips in export mode, and the voltage rise at full output (40A) is seen to be 4 Volts, then this setpoint can be set to 100 (milli-ohms). The inverter will then calculate the actual voltage at the Point of Connection for its under and over voltage trip points. NOTE: The M5 has been tested in accordance with UL1741 to function with factory trip points set at 106VAC and 132VAC and field adjustable trip points extending to 103VAC and 135VAC. Voltage trip points outside this window will void the UL listing.
139	RELAY3_FUNC TION	1	Binary	0	1	Tech	if =1, relay three toggles at once per second if the unit is shutdown. if =0, relay three does nothing in this software version