PowerGuru Manual V0.1

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This manual describes version 0.1 of Power Guru.

Revision History

Revision Power Guru Manual V0.1	May 2005

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GNOME Documentation Project

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Introduction

This is power monitoring system for Xantrex (was Trace) and Outback Power Systems products.

What is Power Guru ?

Power Guru is a tool for remotely controlling Xantrex and Outback Power Systems products. In my case, an old Trace 4024 and an Outback MX-60.

This all started when I bought a fixer upper, off-grid house... Like many projects, this one seems to have fallen into my lap, more than it was a concious idea. Over time, the concept has evolved into an actual product in development. That project, AbelMon [http://www.senecass.com/abelmon], is a much larger project, and this application Power Guru, is part of that project spun off into a standalone application.

There are other similar products, but for WinDoze are Right Hand Engineer's Winverter [http://www.righthandeng.com] or Maui Solar Software's TraceTools [http://www.mauisolarsoftware.com].

PowerGuru Overview

PowerGuru is an interface to your Inverter or charge controller. It's main purpose is to handle the low-level work of reading and writing from these devices. At this level PowerGuru is an SDK for C,C++, or Java programers to work with Xantrex and Outback products.

The backend of PowerGuru is a daemon that runs all the time and is connected via serial ports to your power production equipment. This daemon handles all the ugly work of interfacing with each device. The daemon has two modes, one is data-logging mode, and the other is a command mode.

Project Goals

The goals of this are project are to make it easy to datalog or remotely control your inverter or charge controller. The daemon is designed to be reasonably small, so it can run on 12VDC low-power computer systems 24 hours a day, 7

days a week. Since everything is done through a network interface, a GUI can use the SDK to talk to the backend for all functionality. This makes it easier for somebody (not me, I suck at GUIs) to write good GUIs, without having to reverse engineer these protocols like I have. I'd prefer to stick to bit-twiddling.

If I'm not home, like on a business trip, I want to be able to check on the status of my house while I'm gone. I have had weird things happen like needing to reboot the charge controller, or a few fuses in the combiner box blowing for no apparent reason. I'd also like to be able to store the default configuration settings for my inverter or controller, and set a new one with my prefered default settings off disk after a full system reset.

If a house is a rental and you are the landlord, or you have an off-grid vacation house, or you are a solar installer, and want to offer remote support for your customers as an additional service, this is the type of thing I want PowerGuru to support.

PowerGuru Data Logging Mode

In this mode, the PowerGuru daemon just polls all the devices that have output data, and writes it directly to an SQL database. The time between data collection cycles can be set by the user, since the amount of data can be huge, and doesn't often vary much.

PowerGuru Command Mode

In this mode, the PowerGuru daemon acts as the remote agent to control the device. Client programs use a network connection (I'm contemplating using SNMP) to operate the commands supported by each device. This enables the settings of each device to be stored and set remotely.

User Interfaces

There are two planned user interfaces for PowerGuru. One is web based, and will enable the plotting of the logged data in various forms. The other interface is designed to run standalone without the need for a PHP enabled web server. It is also designed to be run from a PDA or laptop in the field with a direct serial connection to the device. This is for installers so they can download the default settings they prefer to the device, or extract the current device settings to store in a disk file.

Web Interface

The web interface is written in PHP, and should be supported by most all web servers and browsers. This is primarily a data mining and display application to plot the power readings in graphical manner. This UI is currently under development.

Standalone Interface

I want to be able to run PowerGuru on multiple systems, namely GNU/Linux, Darwin, and Win32. The choice of a cross-platform user interface toolkit that runs on all three is not a trivial decision. Most PDAs these days runs Qtopia (written in QT), PalmOS, or WinCE. Other than Java, a language I truly dislike, the only multi-platform solution supported on all platforms is QT. (called Qtopia on a PDA) I'm not a GUI programer, I'm an embedded systems type, so I'd prefer to only write the GUI once.

I have long prefered GTK+/GNOME over QT/KDE mostly cause I'm a "free software" purist, and I'm not sure I want to learn either QT or Java right now anyway. The original GUI for PowerGuru back when it was still called "TraceGUI" was written in GTK1.2, using the Glade prototyper. This can run on GNU/Linux, Darwin and Win32, but not my PDA.

It is possible to run Tcl/Tk on most PDAs as an addon package. For my Zaurus it needs an X11 environment (I run OpenZaurus (a Debian port) on my Zaurus), plus Gentoo also runs on the Zaurus with X11 support. There are also native Tcl/Tk ports for PalmOS and WinCE, and it has a visual development environment as well. I also used to be

one of the Tcl/Tk maintainers, so I wouldn't have the learning curve and time drain of using QT or Java.

Protocol Reference

PowerGuru supports multiple protocols, since it supports multiple devices. As documentation of these protocols is often non-existant or there is a lot of supporting info needed by developers that isn't covered in the existing manuals, I figured I'd document my experiences with these systems from my perspective as an embedded systems engineer with over 25 years experience.

Xantrex Technical Info

SWCA Cable

The SWCA cable is required for all communication to a Xantrex inverter. The female DB25 connector on the inverter is labeled as *remote*, but it is not a standard RS232-C port. It's actually a "Xantrex Remote Port". The SWCA cable supplied by Xantrex converts this remote interface to a standard RS232-C, where it can communicate to a PC.

The SWCA Cable also comes with an ancient DOS program, which should be thrown out. All this program does is supply a very simple GUI that is a clone of the display on the inverter. If you wanted braindead software, you wouldn't be reading this manual for PowerGuru;

Other similar products, but for WinDoze are Right Hand Engineer's Winverter [http://www.righthandeng.com] or Maui Solar Software's TraceTools [http://www.mauisolarsoftware.com].

Remote Protocol Notes

The Xantrex series of inverters don't support a true remote protocol, like most of us think of them. All the inverter gives us is a simple ASCII based terminal interface. As the inverter's control panel is a 16 character by 2 line LCD display, all output from the inverter fits into 38 character wide lines.

All the settings are continuously displayed while you are at that menu item. This example shows the output from the Meter Menu's Input Amps AC item:

```
Input            amps AC           00  00  00  00  00
```

All data stops being displayed when a different menu heading is selected. There are other problems, since there appears to be no flow control, and a half-duplex connection as well. If there is a lot of output from the meters, when you send a character it often gets ignored. I've found it necessary to send the command character several times until the inverter responds. If you send them too fast, they also get ignored.

To work around this problem, at least in my own software, I had to create a data structure that contains all the command strings that come from the inverter. This way when I go to a desired menu item under a particualar heading, I can check the display to make sure the program is actually where it thinks it is. This synchronization makes sure we're at the proper place before reading or setting data. It also makes it a little slower, but accuracy is important.

The top data logging speed of a Xantrex inverter is about 3-4 complete traversals of all 8 meters per minute. It is also possible to cache readings, and then write them all at once to the database. This is for modem or other intermittent forms of communication to an outside database.

Serial Communications

The serial port on the SWCA cable defaults to 9600 baud, no parity, 8 data bits. I've used both Minicom and Ckermit to successfully control my inverter, as well as my own C/C++ code.

Keyboard Commands

It is possible to control the inverter via a terminal program. Each of the buttons on the inverter's control panel has a keyboard equivalant.

Keystroke	**Function**
1-8 key	Select Inverter. 1 through 8 is the inverter's ID number. 1 is the default.
L key	Menu Headings Left (minus)
R key	Menu Heading Right (plus)
U key	Menu Item Up
D key	Menu Item Down
- or _ key	Set Point Lower
+ or = key	Set Point Higher
| key	Inverter On/Off (same as the red button on the inverter control panel)
G key	Generator On/Off (same as the green button on the inverter control panel)
^S key	Setup Menu (same as pushing the green and red butons on the inverter's control panel at the same time)
? or / key	LED Status
V key	Version number of SWCA
T key	Set Terminal Mode

Displayed Output

This is a list of all of the commands as they are displayed by the inverter. Spacing, etc... are important, since lacking a real protocol, we're stuck parsing these text messages for what we want.

User Menus

This is a list of all the User menus. Most users menus don't change anything about how the inverter operates but the time of day setting, and the generator timers. Most of these menues are informational

Inverter Mode

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Inverter OFF SRCH ON CHG	Enumeration	This sets the inverter mode. Off is self explanatory. Search mode puts the inverter in a power-saving mode, and only comes out when the load is over the search limit. (usually 16 watts)
CHG avail. only in FLT mode.	none	Information message
Press red or setpoint button	none	Information message
to move cursor. Move cursor to	none	Information message
Inverter OFF to resetOverCurrent	none	Information message

Generator Mode

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Generator OFF AUTO ON EQ	Enumeration	This sets the generator mode. Auto is for Auto Start, and EQ is for equalizing batteries.
Gen under/over speed	none	Information message
Generator start error	none	Information message
Generator sync error	none	Information message
Load Amp Start ready	none	Information message

Menu Item	Data Type	Description
Voltage Start ready	none	Information message
Exercise Start ready	none	Information message
Move cursor to GEN OFF to reset	none	Information message
generator error.	none	Information message
If no start in 6 trys then error.	none	Information message
If Gen starts & runs for 5 min	none	Information message
then stops the inverter will	none	Information message
not attempt restart until	none	Information message
gen auto start conditions are	none	Information message

Xantrex Engineering

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Press reset now for defaults	Enumeration	This sets the generator mode. Auto is for Auto Start, and EQ is for equalizing batteries.
Revision 4.10	none	Information message

Menu Item	Data Type	Description
5916 195th St NE Arlington, WA	none	Information message
98223 USA	none	Information message
Ph 360-435-8826 Fax 360-435-2229	none	Information message

Meters

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Inverter/charger amps AC	integer	The amount of current the inverter (or when it's in charging mode) is putting out.
Input amps AC	integer	The amount of current that the inverter is receiving from a power source, like the generator.
Load amps AC	integer	This is the amount of current that is being used by AC devices.
Battery actual volts DC	float	This is the actual voltage in DC of the battery bank.
Battery TempComp volts DC	float	This is the temperature compensation voltage in DC.
Inverter volts AC	integer	This is the AC output voltage of the interter.
Grid (AC1) volts AC	integer	This is the AC input voltage of the power grid (assuming you have a grid intertie system).
Generator (AC2) volts AC	integer	This is the AC input voltage from the generator.

Menu Item	Data Type	Description
Read Frequency Hertz	integer	This is the frequency in Hertz of the inverter. In the US, this should be around 60.
AC1 & AC2 volts valid only when	none	Information message
inverter synced to that input.	none	Information message
Batt volt actual is used for	none	Information message
LBCO,HBCO,LBX, LBCI,sell volts	none	Information message
and gen starting	none	Information message
Batt volt temp comp is used for	none	Information message
float,bulk,eq & aux relays	none	Information message

Error Causes

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Over Current	Boolean	This is ON when the inverter is putting out too much current
Transformer overtemp	Boolean	This is on when the inverters transformer is too hot.
Heatsink overtemp	Boolean	This is ON when the heat sink is too hot.

Menu Item	Data Type	Description
High Battery voltage	Boolean	This is ON when the batteries are over voltage.
Low Battery voltage	Boolean	This is ON when the batteries are low.
AC source wired to output	Boolean	This is ON when you have a wiring problem.
External error (stacked)	Boolean	This is ON when there is an error in stacked inverters.
Generator start error	Boolean	This is ON when there is an error in starting the generator.
Generator sync error	Boolean	If this is ON, there is a power problem with your generator.
Gen under/over speed	Boolean	This is ON when the generator is over or under speed.

Time of Day

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Clock hour	time	This sets the hours part of the current time.
Set Clock minute	time	This sets the hours part of the current time.
Set Clock second	time	This sets the seconds part of the current time.

Generator Timer

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Start Quiet time h:m	time	This is the the start of the time period when the when your generator won't be started automatically.
End Quiet time h:m	time	This is the the end of the time period when your generator won't be started automatically.
inverter synced to that input.	none	Information message
Gen doesnt run during quiet	none	Information message
time unless batt volts is less	none	Information message
than LBCO volts for 30 seconds	none	Information message
or load > load start amps.	none	Information message
To defeat timers set start = end	none	Information message
If exercise days set to 1 then	none	Information message
gen will always start @ endquiet	none	Information message

END USER MENU

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
END USER MENU	none	This means you are at the end of the user menus. Inverter Setup

Menu Item	Data Type	Description
		must be pressed to get to the Setup menu.

Setup Menus

This is a list of all the setup menus. Unlike the user menus, you should know what you are doing before you change any of these values. If something goes wrong, reset your inverter to the factory defaults.

Inverter Setup

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Grid Usage FLT SELL SLT LBX	Enumeration	This sets the grid usage.
Set Low battery cut out VDC	integer	This sets the low battery cut out voltage.
Set LBCO delay minutes	integer	This sets the LBCO delay.
Set Low battery cut in VDC	Boolean	This sets the low battery cut in voltage.
Set High battery cut out VDC	integer	This sets the high battery cut out voltage.
Set search watts	integer	This sets the wattage that determines when the inverter comes out of search mode, and turns on.
Set search spacing	integer	This sets the search watts increment/decrement increment, which must be a multiple of 16.

Battery Charging

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Bulk volts DC	float	This is the amount one must reach before selling power.
Set Absorbtion time h:m	time	This sets the absorbtion time.
Set Float volts DC	float	This sets the float voltage.
Set Equalize volts DC	float	This sets the equalization voltage.
Set Equalize time h:m	time	
Set Max Charge amps AC	float	This sets the maximum charging current.
Set Temp Comp LeadAcid NiCad	Enumeration	This ets the type of the battery, so temperature compensation works.

AC Inputs

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Grid (AC1) amps AC	integer	This sets the Grid current input.
Set Gen (AC2) amps AC	integer	This sets the generator current input.
Set Input lower limit VAC	integer	This sets the lower input voltage.
Set Input upper limit VAC	integer	This sets the upper input voltage.

Menu Item	Data Type	Description
In SELL mode AC1 input VAC limits	none	Information message
fixed at 88% to 110% of nominal.	none	Information message

Gen Auto Start setup

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Load Start amps AC	integer	This sets the voltage for when the generator should come on to help with a high load.
Set Load Start delay min	float	This sets the delay in fractions of a minute for the generator to delay when starting.
Set Load Stop delay min	float	This sets the delay in fractions of a minute for the generator to delay when stopping.
Set 24 hr start volts DC	float	
Set 2 hr start volts DC	float	
Set 15 min start volts DC	float	
Read LBCO 30 sec start VDC	float	
Set Exercise period days	integer	
Set Exercise period days	none	Information message

Menu Item	Data Type	Description
Set Exercise to 0 to defeat	none	Information message
See menu 9 to set LBCO	none	Information message

Gen starting details

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set RY7 Function GlowStop Run	Enumeration	
Set Gen warmup seconds	integer	
Set Pre Crank seconds	integer	
Set Max Cranking seconds	integer	
Set Post Crank seconds	integer	

Auxilary Relays R9 R10 R1

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Relay 9 volts DC	float	Set the voltage for when relay 9 should turn on.
R9 Hysteresis volts DC	float	Set the hysteresis level for relay 9.

Menu Item	Data Type	Description
Set Relay 10 volts DC	float	Set the voltage for when relay 9 should turn on.
R10 Hysteresis volts DC	float	Set the hysteresis level for relay 9.
Set Relay 11 volts DC	float	Set the voltage for when relay 9 should turn on.
R11 Hysteresis volts DC	float	Set the hysteresis level for relay 9.
close on batt > setpoint	none	Information message
open on batt < setpoint - Hys	none	Information message
relays have 2 second delay on	none	Information message
close, 0.1 sec delay on open	none	Information message

Bulk Charge Trigger Timer

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Start Bulk time	time	
To disable timer set to 00:00	none	Information message
If grid timer active set bulk	none	Information message

Menu Item	Data Type	Description
time after start charge time.	none	Information message
In SLT mode dont disable this	none	Information message
timer. It is the daily chg time.	none	Information message

Low Battery Transfer (LBX)

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Low Battery transferVDC	float	
Set Low battery cut in VDC	float	
See menu 9 to enable LBX mode	none	Information message
Make sure LBX is above LBCO volts	none	Information message

Battery Selling

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Battery Sell volts DC	float	
Set Max Sell amps AC	integer	

Menu Item	Data Type	Description
See menu 9 to enable SELL mode	none	Information message

Grid Usage Timer

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Set Start Charge time	time	Set the start time for charging the batteries.
Set End Charge time		Set the time to stop charging the batteries.
After Start Charge time:	none	Information message
SELL mode charges battery	none	Information message
FLT mode charges battery	none	Information message
After End Charge time:	none	Information message
SELL mode sells battery to AC1	none	Information message
FLT mode drops AC1 and inverts	none	Information message
timer on when start <>> end	none	Information message
timer off when start = end	none	Information message

Menu Item	Data Type	Description
Sell and float modes use timer.	none	Information message
SLT and LBX mode ignore timer.	none	Information message

Grid Usage Timer

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
Batt temp comp changes battery	none	Information message
voltage reading away from actual	none	Information message
HBCO resets at: 6v/48,3v/24 and	none	Information message
1.5v/12v under HBCO	none	Information message
LowBattTransfer used in LBX, FLT	none	Information message
modes only. Goes back to battery	none	Information message
at LowBattCutIn. (aka LBCI)	none	Information message
For LBX mode set float&bulk volts	none	Information message
below LBCI so charger won't	none	Information message

Menu Item	Data Type	Description
cycle batteries up and down and	none	Information message
set LBCO below LBX	none	Information message

END SETUP MENU

These are the messages as displayed by the inverter:

Menu Item	Data Type	Description
END SETUP MENU	none	You are at the end of the setup menu items, and have to press menu heading down top continue.

Outback Power Systems

Unlike the Xantrex products, the Outback products support a real protocol with real flow control.

Serial Port

The Outback serial port runs at 19200 baud, 8 data bits, no parity, and 1 stop bit. Outback appears to use real UARTs, thank you!

Flow Control

Flow control to an Outback product is done via the DTR and RTS pins on the serial cable. This is a non-standard way to control the flow of data, but it works. For data to flow, the DTR pin must be held HIGH (on), and the RTS pin must be held LOW (off). Toggling either DTR or RTS pins achieves the same effect, but I've been using the DTR pin myself. To get a clean connection, you'll also want to turn off any XON/XOFF types of flow control.

I have also noticed that there are no serial communications programs that run under Unix that can handle this style of flow control. Both Kermit and Minicom only support the standard ways of flow control, and don't let you selectively turn off or on the serial port pins. On Windows I've been told that the only program that does this correctly is called Terminal [http://bray.velenje.cx/avr/terminal/] I added a "console" mode to PowerGuru so I can use my own software rather than depend on 3rd party software that doesn't do the trick.

MX Message Frame

An MX status message frame is comprised of 49 ASCII numerical characters. A newline used to signify the start of a frame and carriage return is used to signify the end of the frame. These are the only two non ASCII in a message.

On my MX60 (bought roughly 2003), the address field is always wrong. On my unit it says '0', as if it were an FX inverter. Maybe this is because I don't have an FX inverter, I have a Xantrex (Trace) 4024. I plan to put an FX inverter in the Solar Lab [http://www.senecass.com/lab.html], but right now I'm still dealing with saving up the cash for one...

```
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
0,00,32,30,000,128,00,00,000,00,265,002,140,039
```

Index	Byte Value	Data Field	Description
1	10	Message Start Frame	This is an New Line character denoting the start of the status page.
2	X	MX address	The MX address is an ASCII 'A' for unit 0, and an ASCII 'B' to 'K' for the other 9 units.
3	44	Field Separator	ASCII Comma character
4	48	Unused	ASCII Zero characters are used to fill unused fields.
5	48		
6	44	Field Separator	ASCII Comma character
7	X	Charger current	Range 00-99. This is the current the charger is putting into the batteries. 1 amp increments are used.
8	X		
9	44	Field Separator	ASCII Comma character
10	X	PV current	Range 00-99. The current coming from the photovoltaic panels. 1 amp increments are used.
11	X		
12	44	Field Separator	ASCII Comma character

Index	Byte Value	Data Field	Description
13	X	PV Input Voltage	Range 000-256. This is the voltage coming from the photovoltaic panels to the charge controller.
14	X		
15	X		
16	44	Field Separator	ASCII Comma character
17	X	Daily Kilowatt Hours	Range 000-999. This is the daily kilowatt hours used since daybreak.
18	X		
19	X		
20	44	Field Separator	ASCII Comma character
21	48	Unused	ASCII Zero characters are used to fill unused fields.
22	48		
23	44	Field Separator	ASCII Comma character
24	X	MX Aux Mode	Range 00-99. This is the current Auxilary Mode. The value is used to do a tabke lookuop for the mode.
25	X		
26	44	Field Separator	ASCII Comma character
27	X	Error Modes	Range 000-256. The Error Mode is currently unimple-mented in the MX.
28	X		
29	X		
30	44	Field Separator	ASCII Comma character
31	X	MX Charger Mode	Range 00-99. The MX Charger Mode is used to do a table lookup for the mode.
32	X		
33	44	Field Separator	ASCII Comma character

Index	Byte Value	Data Field	Description
34	X	Battery Voltage	Range 000-999. The Battery Voltage is a 3 digit floating point number with the last digit as the fraction. So 251 volts becomes 25.1 volts. Resolution is 0.1V for 12V, 0.2 for 24V, and 0.4 for 48V systems.
35	X		
36	X		
37	44	Field Separator	ASCII Comma character
38	48	Unused	ASCII Zero characters are used to fill unused fields.
39	48		
40	48		
41	44	Field Separator	ASCII Comma character
42	48	Unused	ASCII Zero characters are used to fill unused fields.
43	48		
44	48		
45	44	Field Separator	ASCII Comma character
46	X	Checksum	Range 000-999. The Message checksum is calculated be adding all the digits of the message together, one at a time.
47	X		
48	X		
49	13	Send of Frame	The end of the message frame is a Carriage Return.

MX Message Data Tables

There are a few tables used to lookup values from the messages. Error codes are not implemented at this time, but the Auxilary and Charger Mode data fields both need to be looked up from a tables.

MX Auxilary Modes

The Auxilary mode is the current mode running on the MX.

Value	Mode
"00"	Disabled.

Value	Mode
"01"	Diversion.
"02"	Remote
"03"	Manual
"04"	Vent Fan
"05"	PV Trigger

MX Charger Modes

The Charger mode is the current operating mode of the charger.

Value	Mode
"00"	Disabled.
"01"	Float.
"02"	Bulk
"03"	Aborb
"04"	EQ

FIXME: add much more content!!!

Authors

PowerGuru was written by Rob Savoye (<rob@senecass.com>). Please send all comments, suggestions, and bug reports to <rob@senecass.com>. I am available for consulting on a variety of renewable energy and free software technologies. More details at http://www.senecass.com

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