

10A MPPT* Solar Charger & Load Control



**Maximum
Power
Point
Tracking*

Model 5315-01 (V01.01.00)

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1. Introduction

Thank you for selecting the High Sierra Electronics 10 Amp Maximum Power Point (MPPT) Solar Charger and Load Control, Model 5315-01. Simple to install and easy to use, its applications include solar-powered 12V battery management, solar power flashing beacons, and timed pedestrian crossing flashers. The 5315 is capable of driving loads and providing battery charge currents of up to 10 amperes. HSE's advanced MPPT battery charging algorithm optimizes solar array power output to get the most out of your solar powered application. The 5315 features an RS-232C serial interface for configuration and data streaming, and a de-bounced control input which may be activated either by standard logic signals or contact closure with no configuration.

2. Important Safety Information

- Use care when working around batteries. Have plenty of fresh water available to wash any contact with battery acid.
- Batteries emit explosive gasses during charge and discharge. Be sure there is adequate ventilation to allow the gasses to dissipate.
- Do not charge known defective batteries, or connect batteries of improper rating for the system.
- Use only insulated tools and avoid contact with metal when working near batteries.
- Fuses and disconnect devices may be required in the system the charger is used in. These devices are not a part of this High Sierra Electronics product. FUSES MUST BE PROVIDED FOR BATTERIES.
- Use adequately sized battery wires and cables in order to keep voltage drops to a minimum.
- Always double check for correct polarity of Batteries and Solar Panels. Do not rely on color codes alone. Applying incorrect polarity may damage the unit and will void the Warranty.
- The charger is designed to be mounted in an enclosure protected from the elements. Do not allow liquids to enter the charger.
- Improper grounding accounts for many electrical system problems. Be sure to use proper grounding.
- Always mount the controller on a flat vertical surface. The open ends of the case must be on the top and bottom to allow for proper convection cooling.

3. Features & Operation

Charging:

The unit utilizes MPPT to optimize the power delivered from the solar panels to the battery. MPPT can deliver significantly more charge current to batteries because the operational power point (solar V x solar A) is continually optimized in real-time to allow the panel to produce its maximum power for the present conditions.

Three stage Pulse Width Modulation (PWM) charging is used to maximize delivery of that power to the battery with minimal losses. The temperature compensated bulk, absorption and float charging stages deliver complete battery charging and long battery life without gassing.

MPPT technology is most effective when the battery is depleted and during cooler weather. It can provide up to 30% improvement over standard PWM chargers under those conditions. This results in quicker discharge recovery and allows for a smaller panel to be used for a given application.

Load Control:

The unit provides a number of manual and automatic load control features. The two flashing or steady load outputs may be automatically activated by providing a contact closure to the load control terminals when the load control switch is in the "auto" position. This same switch will force the load on or off for manual operation. Flash rate is user adjustable. Pulse Width Modulation (PWM) night dimming is provided without the use of a separate external light sensor.

Overload protection is provided to protect the system. User settable low-voltage disconnect and automatic reconnect is provided to protect batteries from being damaged from excessive discharge.

Timed Operation:

Timed operation has been included for application, such as pedestrian crossings, where the 5315 will activate its load for a set amount of time from an input. For use as a pedestrian crossing flasher, the phrase *the load control input is held low* should be equivalent to *the pedestrian crossing button is pushed*. In other words, a pedestrian crossing switch must pull the load control input logic low. The input does not require a pull-up resistor, even for hundreds of feet of control cable, however one may be added which pulls the input to 5V.

Do not drive the load control input higher than 5 (five) volts. Be sure to observe polarity.

Timed operation mode implements the following features:

- If the timer is set to zero, then the 5315 will activate its load only while the load control input is held low. During this normal on-timed operation input debouncing is defeated.
- "Push + T" timed operation. The 5315 will maintain power to the load while the input is held low, then maintain power to the load for the timer period, until the timer is expired or the input is retriggered (if Retriggerable is set to True, the default behavior).
- In Non-Retriggerable mode, subsequent button pushes are ignored until the original times period expires.
- Timed Operation Control Debouncing. The load control input must be held low continuously for one tenth of a second for the load to be activated. This only is implemented for timed operation, to prevent EMI from triggering the timer.
- Changing the three way mode switch from *auto* to *on* or *off* will cancel the timer immediately.
- Timer range is from 0 to 255 seconds.
- Timer operation is not available with Sleep Mode set to True.

Monitoring & Set-up:

1 second streaming reports of important parameters is provided for diagnostics and remote monitoring. The same serial connection allows for setting up system functions. Maximum charge voltage, charge current, load current, low voltage shutdown, flashing and dimming can all be set from the simple user interface. The prompt "HSE>" precedes data values to allow parsing for remote data collection.

4. Quick Start Instructions

The Quick Start Section provides a brief overview of how to connect and operate the unit. Be sure to familiarize yourself with the entire manual.

Always double check for correct polarity of Batteries and Solar Panels. Do not rely on color codes alone. Applying incorrect polarity may damage the unit and will void the Warranty.

1. Mount the High Sierra Electronics Model 5315-01 on a flat vertical surface with the case openings at the top and bottom.
2. Check that charge and load currents do not exceed the unit's ratings.
3. Check that adequate fusing is provided for batteries and load.
4. Check that adequate grounding has been provided for the system.
5. Set the three way Mode Switch, labeled ON-OFF-AUTO.
6. Connect the loads, observing correct polarity.
Note: Flashing is the default setting for load control. If steady operation is desired, please refer to Section 8 for setup details.
7. If the load will be automatically activated, connect the contact closure source to the load control terminals.
Note: The negative (-) terminal is connected internally to all other negative (-) terminals on the unit.
8. Next, connect the battery. **Observe correct polarity to avoid damaging the unit.** The green system LED should begin flashing, indicating normal operation of the microprocessor and program.
9. Connect the solar array. **Observe correct polarity to avoid damaging the unit.**
10. Switch the Mode Control Switch to on. The load should activate. The amber Load Control LED will begin flashing, indicating the load is forced on.
Note: If there is an overload, the red Overload LED will flash briefly as the unit retests for overload. Normal operation resumes once the overload is removed.
11. Connect the Remote Load Control Switch, if used see specs.
12. Verify proper operation and charging with a DMM.

5. LED Indications

LED	Color	Function	Detail
Top	Green	Flashing= Unit is on & microprocessor is running	Flashing is the normal state for this LED.
2 nd	Green	On = Bulk Charge mode Fast flash = Absorption mode Slow flash = Float mode Off = Charger off	The daily charge cycle will begin with slow flash as the sun comes up (or when very cloudy), followed by Bulk Charge, Absorption and then Float, depending on overall load and discharge that occurred overnight.
3 rd	Amber	Flash = Load Control Switch in ON position On = Load Control Switch in AUTO & Load Active	"Load Active" means a ground (logical low) is applied to the Load Control + terminal
Bottom	Red	On = Low Voltage Disconnect (LVD) Flash = Over-Current-Protection (OCP)	LVD – Check battery & solar panel output & load OCP – Check loads for shorted wires

6. Switch Settings

Mode Switch

ON - Load forced on. Contact closure on the Load Control terminals is inactive.

OFF - Load forced off. Contact closure on the Load Control terminals is inactive.

AUTO - Load is activated by a contact closure or Logical Low applied to the Load Control terminals.

Internal DIP Switch

The two position DIP switch mounted near the toggle switch is not normally used. In cases where high levels of Electromagnetic Interference (EMI) are present, DIP switch 1 may be used to turn off the serial report receiver which disables menu access. DIP switch 2 is not used. The switch is accessed by disconnecting all power sources and carefully removing the circuit card from its standoffs.

7. Data Reporting

The unit streams system status information out the RS-232 serial port. A female D-Sub 9 pin connector is used. Settings for the connection are 9600, 8, N, 1.

Using a standard terminal program (i.e., HyperTerminal for Windows), set up a new connection using the settings listed above. Use a standard serial cable to connect to the unit. With the unit operating, you should observe a line of data being sent every second. Breakdown of the line is as follows;

- **sec, pwm, temp_C, sol_A, sol_V sol_W, bat_A, bat_V, charger, system, load, status, oc_V**
- **sec** - represents the number of seconds since the unit was last started. The unit starts counting over when the count reaches 65537.
- **pwm** - represents the pulse width modulation duty cycle in tenths of a percent (600 represents 60 percent).
- **temp_C** - is the onboard temperature sensor reading in °C.
- **sol_A** - is the current in Amps provided by the solar array.
- **sol_V** - is the solar array voltage, stated in Volts.
- **sol_W** - is the power in Watts provided by the solar array.
- **bat_A** - is the current in Amps flowing into (+) or out of (-) the battery. This value includes the charge current reduced by the current required to run the unit and any active load current.
- **bat_V** - is the battery voltage, stated in Volts.
- **charger** - indicates Charging System status (Bulk, Absorption, Float, Off).
- **system** - indicates current state of the Load Control switch (Off, On, Auto).
- **load** - indicates Load Control terminal status (Open = Off, Closed = On).
- **mode** - indicates Charging System mode (Day, Night).

- **oc_V** - is the effective open circuit voltage of the solar panel and is used for triggering night mode. This voltage is useful in setting S(O)l_volts_daylight to result in entering night mode at the desired light level.

Specific event messages are streamed on a new line when they occur:

- **Wake up!** - is streamed each minute to indicate the unit is waking up to check for solar input (sun) or Load Control activation.

Example:

Solar Flasher by High Sierra Electronics Copyright 2014 V01.01.00

```
sec pwm temp_C sol_A sol_V sol_W bat_A bat_V charger system load mode oc_V
HSE>1021 780 25.24 0.09 17.22 1.54 0.06 13.16 Float Auto Off Night 17.27
HSE>1022 778 25.24 -0.09 17.25 -1.55 -0.06 13.11 Float Auto Off Night 17.27
HSE>1023 780 25.24 -0.03 17.22 -0.51 0.03 13.16 Float Auto Off Night 17.27
HSE>1024 778 25.24 -0.09 17.22 -1.54 -0.03 13.11 Float Auto Off Night 17.27
HSE>1025 780 25.24 0.12 17.22 2.06 0.03 13.16 Float Auto Off Night 17.03
```

This display will include 15 lines of data then re-print the header, for human readability. Lines of machine-readable data are preceded by the prompt **HSE>**. The seconds column is a 16-bit value and will roll-over after 65535 seconds.

8. Setup Menu

With the unit reporting as above, press the ESC key. The unit enters into the setup mode shown below. Pressing the ESC key returns the unit to the report mode. If no input has occurred within 60 seconds, the unit returns to streaming report mode.

Note: to enter the setup mode when sleep mode is active, wait for the Wake up! cycle that occurs once a minute and press any key.

Note that inputs are case-insensitive.

Example:

After connecting through a RS-232 terminal, the data stream may be interrupted by pressing a key. After pressing a key, the following menu will be displayed, however the default settings may be set differently.

HSE> Solar Flasher by High Sierra Electronics Copyright 2014 V01.01.00

HSE> Commands:

HSE> (D)imming = True

HSE> ma(X)_dimming = 25%

HSE> flashing_(M)ode = True

HSE> (F)lash_rate(sec)= 0.50 S

HSE> max_charging_(A)mpps= 10.00 A

HSE> max_charging_(V)olts= 14.30 V

HSE> f(L)oad_volts= 13.70 V

HSE> bat_volts_dis(C)on= 11.20 V

HSE> bat_volts_(R)econ= 12.00 V

HSE> s(O)l_volts_daylight= 14.00 V

HSE> (T)imer period= 0 seconds

HSE> R(E)triggerable operation= True

HSE> (ESC) to exit.

HSE>sec pwm temp_C sol_A sol_V sol_W bat_A bat_V charger system load mode oc_V

HSE>900 780 25.24 -0.03 17.25 -0.51 0.03 13.14 Float Auto Off Night 17.01

After hitting escape again, or no input from user, the display will revert to streaming data.

(D)imming – This function provides for PWM night dimming of the load when the system detects low levels of light (approximately 5 foot candles).

- Press D. T enables and F disables dimming and regenerates the Setup screen. Continue with your next change or press ESC to return to the streaming mode.

ma(X) dimming – This parameter sets the duty-cycle for dimming at night. Range is 10% to 100%. 25% represents 25% of full brightness, or 75% dimmed.

- Press X. Enter two digits representing the percent of full brightness desired when dimmed (25 = 25%). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

flashing_(M)ode – This parameter sets the Load Output to alternately flash (True) or for steady operation (False).

- Press M. T enables flashing and F enables steady state. Continue with your next change or press ESC to return to the streaming mode.

(F)lash_rate(sec) – This parameter sets the sets flash rate for the alternately flashing outputs. Range is 0.1-2.5 Seconds.

- Press the letter F. Enter three digits representing the desired flash rate (time on) in hundredths of a Second (050 = 0.5 Second on, or 60 flashes per minute). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

max_charging_(A)mps – This parameter sets the maximum allowed charging current. This setting might be lowered to prevent charging a smaller capacity battery at too high a rate. Range is 0.00A to 10.00A.

- Press A. Enter four digits representing the maximum charge current in hundredths of an Amp (1000 = 10.00A). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

max_charging_(V)olts – This parameter sets the maximum charge voltage. Once this voltage is reached, the unit transitions into the Absorption mode and holds this voltage for one hour. The default for this setting is 14.3V (suitable for sealed lead acid batteries). Values for other battery types are listed below. Range is 0.00V to 15.00V.

- Press V. Enter four digits representing the maximum charge voltage in hundredths of a Volt (1410 = 14.30V). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

f(L)oat_volts – This parameter sets the float voltage. Once the system has been in the Absorption mode for one hour, the unit transitions into the Float mode. The voltage is allowed to drop to this voltage setting and is held there. The default for this setting is 13.7 V suitable for sealed lead acid batteries. Nominal values for other battery types are listed below. Range is 0.00V to 15.00V.

- Press L. Enter four digits representing the maximum charge voltage in hundredths of a Volt (1370 = 13.70V). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

bat_volts_dis(C)on – This parameter sets the battery voltage at which the load is disconnected in order to avoid battery damage from excessive discharge. The default for this setting is 11.2V. Range is 10.00V to 12.00V.

- Press C. Enter four digits representing the low voltage disconnect point in hundredths of a Volt (1120 = 11.20V). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

bat_volts_(R)econ – This parameter sets the battery voltage at which the load is reconnected upon battery voltage rise following a low voltage disconnect. The default setting is 12.0V. Range is 12.00V to 15.00V.

- Press R. Enter four digits representing the rising voltage reconnect voltage in hundredths of a Volt (1200 = 12.00V). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

S(O)l_volts_daylight – This parameter sets the sets the threshold at which the system enters into sleep and/or dimming mode (if enabled). The default setting is 14.00V. Range is 9.00V to 20.00V. $\pm 0.5V$ hysteresis is provided to minimize undesired mode switching. Refer to troubleshooting section if high levels of ambient light interfere with activation of night dimming.

- Press the letter O. Enter four digits representing the sleep/dimming threshold in hundredths of a Volt (1400 = 14.00V). Press ENTER. Continue with your next change or press ESC to return to the streaming mode.

(T)imer period – this parameter sets the amount of time that the 5315 will deliver power to the load after the load control input is allowed high after being pulled low for more than one-tenth of a second. Press **T** then enter an integer value between 0 and 255 and press **Enter**. The default setting is 0 for non-timed operation.

R(e)triggerable – This enables or disables retriggerable mode (refer to Section 8, subheading *Timed Operation Mode*.) Press **E**, then either **T** to enable or **F** to disable (shown as true or false) then press **Enter**. The default setting is true.

9. Battery Voltage Settings

Refer to battery manufacturer’s specifications for exact settings.

For 25°C	Gel	Sealed	Flooded
Max Charge V	14.0V	14.3V	14.4V
Float V	13.7V	13.7V	13.7V
Low V Disconnect	11.2V	11.2V	11.28V
Low V Reconnect	12.0V	12.0V	12.0V

10. Maintenance Requirements

Maintenance inspection is recommended at least twice a year to assure long life and optimal performance.

- Check that all terminal connections are secure on the charger, battery, solar panel and load.
- Check that unit is securely mounted in a clean & dry protected area.
- Verify cabinet ventilation holes are not blocked.
- Inspect for debris, insects, rodents, nests or corrosion.
- Connect to the serial port and monitor 1 second reports to verify normal operation. Activate setup menu and verify settings are as desired.
- Check that LED indications are correct for the current system status.
- Remedy deficiencies and make appropriate notations in maintenance log.

11. Troubleshooting

1. Troubleshooting should be done by qualified service personnel.
2. Batteries store energy and can be dangerous if shorted.
3. Be careful when working with energized circuitry.
4. The charger does not house fuses or circuit breakers and there are no user replaceable parts inside.
5. The advanced MPPT charging method may buck some bench power supplies. Bench testing should be done with a solar panel or 18V battery.

Check that no external circuit breakers or fuses are tripped.

If charging or load control does not seem to be functioning properly, first observe the LED indicators and compare to the reference chart in Section 5. The System LED (green) flashes rapidly to show the unit is on and the microprocessor is running. It flashes very slowly while sleep mode is active. If the LED is not flashing and battery voltage is present at the unit, the microprocessor may have encountered a fault. To reset the unit, disconnect the solar array and remove the positive battery wire from the charger. Wait at least 10 seconds and reconnect the battery wire. The green System LED (top) should begin to flash normally, indicating the microprocessor is running. If still not resolved, contact High Sierra Electronics for an RMA number to return the unit for repair.

A further useful tool for troubleshooting is observation of the 1 second streamed EIA-232 data from the 9-pin connector at the top left of the unit. Voltage and current are displayed for the solar panel and battery, as well as other useful information. The streamed data includes text event messages that provide insight as to system status. Text is provided to indicate the charging state and load activation status. Refer to the data reporting and setup menu sections above for details.

Battery is not charging :

First check that the battery is properly connected and no circuit breakers or fuses are tripped. Using the streamed data reports or a voltmeter, verify solar input is present at the charger. Verify battery voltage can be measured at the battery terminals of the charger. Verify that the green System LED is flashing normally. Check solar panel output by checking that it produces both the expected voltage and current in full sun.

Load does not activate:

First, check that the load is connected properly and switch the load control to ON. Check for illumination of the Low Voltage Disconnect/Over-current LED. Check load outputs with meter.

Night Dimming does not activate -

High levels of ambient light at night (i.e., from a nearby luminary or signage) may keep the system from registering the required low level of light to activate the dimming feature (if enabled). This is not a fault, but is a field condition that can perhaps be mitigated. If acceptable to activate dimming at a higher level of light, the **S(O)l_volts_daylight** parameter can be changed to a higher value (try 15.00V). In some cases, shielding the solar panel from the artificial light source may be possible without shielding the panel from the daylight necessary to charge the batteries year-round. In severe cases moving the solar panel some distance from the artificial light source may be required in order to take advantage of the night dimming feature.

Firmware Version

Contact High Sierra Electronics, Inc. for a no-charge firmware upgrade if the firmware in your unit is lower than V0.33 Upgrade requires returning the unit to our factory.

12. Specifications

Solar Panel Sizing:	up to 10A (50 to 170 Watt)
Maximum Charge Current:	0A to 10A, Default = 10A
Maximum Charge Voltage:	0V to 15V, Default = 14.1V
Reverse Current Flow Protection:	via FET
Float Voltage:	0V to 14V, Default = 13.7V
Load Control Input Pull-up Current:	50 μ A to 400 μ A (250 μ A) typical.
Load control input absolute maximum voltage range:	-0.3 to +7.5 V.
Temperature Compensation:	-30mV/ $^{\circ}$ C above 23 $^{\circ}$ C
Self Consumption:	15mA (3mA sleep mode)
Load Activation:	ON/OFF/AUTO toggle switch
Auto Load Activation:	Contact Closure, or Logical Low (<1.0V)
Maximum Loads:	Resistive load or LED Beacons Flashing: 5A/side Non-flashing: 5A per side (10A max with paralleled output). 50% duty-cycle, 5 min max above 5A total load. 1V p-p ripple typical Overload Protection (not applicable when dimmed)
Night Dimming:	Per DOT specifications, 10-100%, Default = 25% brightness (75% dimmed) (i.e., TXDOT TO-4051 Solar-Powered Photovoltaic Flasher Assembly & DMS-11150)
Dimming Type:	~100Hz Pulse Width Modulation
Timer Operation Range:	0 to 255 seconds.
Retriggerable:	True/False
Debounce window:	104ms
User Menu Input:	case insensitive
Flashing (when enabled)	0.1-2.5 Seconds, Default = 0.5 Seconds time on for 1.0 Second cycle time
Low Voltage Disconnect:	10-12V, Default = 10.8V
Rising Voltage Reconnect:	12-15V, Default = 12.2V
Surge Protection:	Transient voltage suppressors
Reverse-current Protection:	via MOSFET
Connections:	Screw terminals (12 AWG max)
Dimensions:	6-1/16" x 3-3/8" x 1-3/4"
Mounting:	Mount vertically. Rectangular pattern 7"L x 3-3/16"W. 4 - 1/2" #8 sheet metal screws
Operating Temperature:	-40 $^{\circ}$ C to +50 $^{\circ}$ C (-40 $^{\circ}$ F to +122 $^{\circ}$ F)
Storage Environment:	-55 to +85 $^{\circ}$ C, Humidity 100% (non-condensing)
Warranty:	3 years, limited