

80V Buck-Boost Lead-Acid and Lithium Battery Charging Controller Actively Finds True Maximum Power Point in Solar Power Applications

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In solar power systems, the bulk of the expense is in the panel and batteries. Any cost-effective solar power solution maximizes the capacity usage and lifetime of these components. For instance, a high quality charger increases battery run time, reducing capacity requirements, and extends battery lifetime, minimizing maintenance and replacement costs. Likewise, using a DC/DC controller that extracts the maximum available energy from the solar panel reduces the size and cost of the panels required.

The LT8490 is a charge controller for lead acid and lithium batteries that can be powered by a solar panel or a DC voltage source. It includes true maximum power point tracking (MPPT) for solar panels and optimized built-in battery charging algorithms for various battery types—no firmware development required. 80V input and output ratings enable the LT8490 to be used with panels containing up to 96 cells in series. The power stage uses four external N-channel MOSFETs and a single inductor in a buck-boost configuration. Unlike most charge controllers, the buck-boost configuration allows the charger to operate efficiently with panel voltages that

are below, above or equal to the battery voltage. The minimum panel voltage is 6V.

Batteries live longer and run longer when the charge algorithm is optimized for the battery type. Likewise, a high performing MPPT charger, which tracks the solar panel maximum power point during partial shade conditions, allows the use of a smaller and lower cost solar panel. Creating a discrete-component charger solution to perform all of these duties would be costly and time consuming, typically requiring a microcontroller, a high performance switching regulator and a lengthy firmware development cycle.

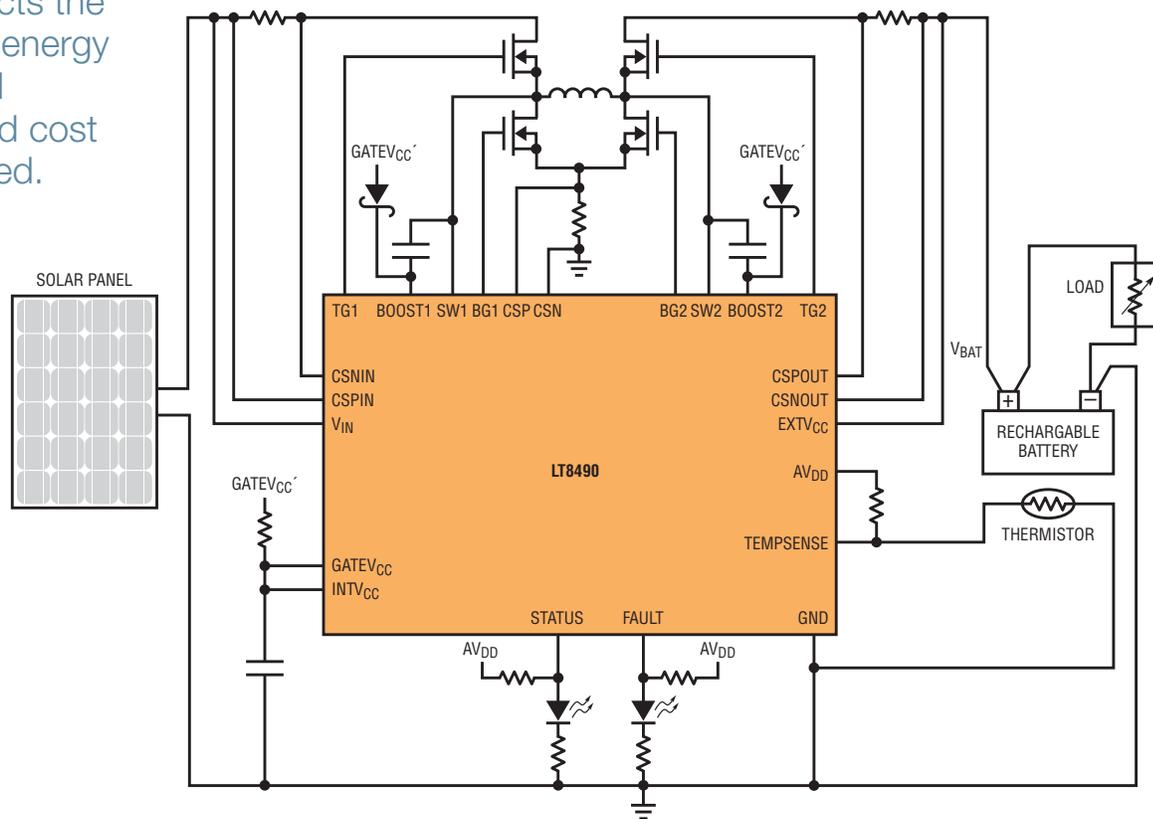


Figure 1. Simplified solar powered battery charger schematic

Dual local maximums are the downfall of the conventional MPPT found in a number of controllers. In contrast, the LT8490 finds the true MPP, yielding twice the charge power—or even higher in other shade conditions.

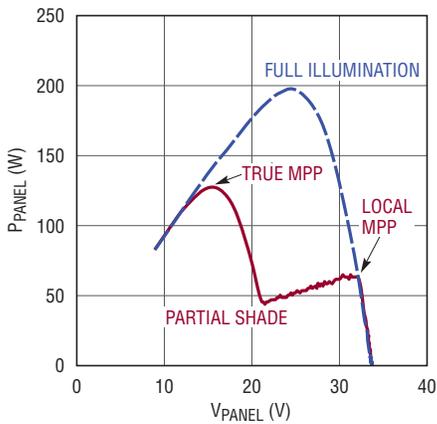


Figure 2. The power curve of a 60-cell 250W solar panel with entire panel illuminated and with a small shadow partly covering one cell (Figure 3)

COMPLETE SINGLE-IC SOLAR POWERED BATTERY CHARGER SOLUTION

The LT8490 is an MPPT battery charger controller with a long list of features including:

- integrated MPPT algorithm (no firmware development required) greatly reduces time to market
- integrated buck-boost controller allows V_{IN} to be above, below or equal to V_{BAT}
- supports lead-acid and lithium-ion batteries
- $6V-80V V_{IN}$ and $1.3V-80V V_{BAT}$

The LT8490 can be powered by a solar panel or any DC voltage source. For a particular battery voltage, a wide range of solar panel types can be used, as the panel voltage can be lower or higher than the battery voltage. The LT8490 accepts panel inputs from 6V to a maximum (cold temperature) open circuit

voltage of 80V; a range corresponding to 16 to 96 series-connected solar cells.

Since the power stage is external, it can be optimized for the application. Charge current limits (and input current limit when a DC voltage source is used) can be configured as needed.

True Maximum Power Point Tracking

When operating from a solar panel, the LT8490 maintains the panel voltage at the panel's maximum power point. Even during partial shade conditions, when more than one local maximum power point appears (an effect of bypass diodes inside the solar panel), the LT8490 detects and tracks the true maximum.

Figure 2 shows the P-V curves for a common 60-cell 250W panel under two different lighting conditions. The maximum power point (200W) occurs at 25V when the panel is fully illuminated. In partial shade (see Figure 3), the available power at a 25V panel voltage drops to 50W, with the new true maximum power point (128W) appearing at 16V. Note that the original 25V/200W power peak actually moves to a local maximum ~32V/63W.

This dual local maximum effect is the downfall of traditional MPPT functions found in a number of controllers, for they follow the initial 25V/200W peak as it shifts to 32V/63W. In contrast, the LT8490 finds the true MPP at 16V/128W, yielding an additional 65W from the panel. It does this by measuring the entire power curve of the panel at regular intervals and locating the true maximum power

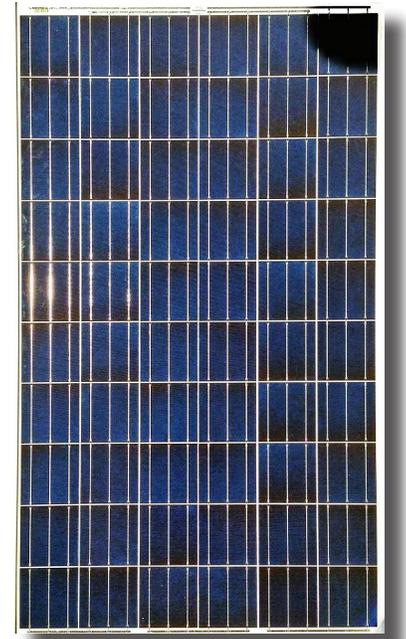


Figure 3. The solar panel shaded in top right corner

peak at which to operate. In this case, more than twice as much charge power is extracted, with even greater gains possible in other shade conditions.

Charge Control Functions

Charge algorithms can be configured according to the requirements of each application by adjusting the voltage on two configuration pins. Lead-acid batteries built with AGM, gel and wet cell technologies require slightly different charge voltages for best lifetime, and Li-ion and $LiFePO_4$ cells have charge requirements that are different from lead-acid batteries. Some of the built-in and configurable charge control functions are:

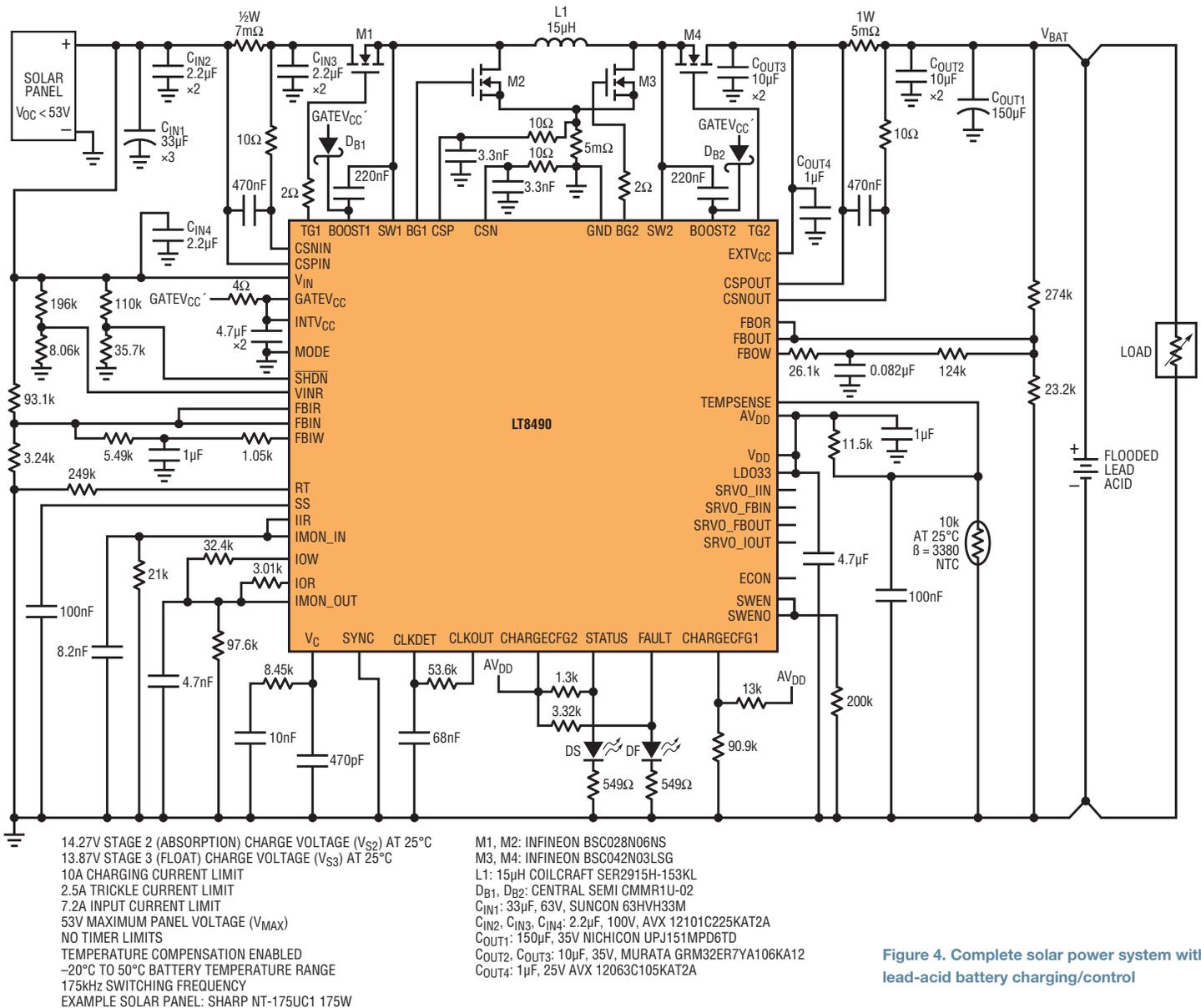


Figure 4. Complete solar power system with lead-acid battery charging/control

- charge voltage temperature compensation (typically for lead-acid batteries) using NTC sensor
- over or under battery temperature stops charge current to protect the battery
- dead battery detection stops the charging, to avoid a hazard
- adjustable trickle charging of a deeply discharged battery reduces risk of damage
- constant current charging that changes to constant voltage charging as the battery voltage reaches its final value

- reduction of charge voltage to a lower float voltage level when the battery is fully charged
- charging time limits can be set when operating from a DC voltage source

CONCLUSION

The LT8490 is a full-featured true MPPT charge controller that can operate from a solar panel or a DC voltage source with a voltage range from 6V to 80V, charging lead-acid or lithium batteries from 1.3V to 80V. The power stage is easily configured by selecting four MOSFETs and

an inductor, allowing the charger to operate with V_{IN} above, below or equal to the battery voltage. All necessary functions are included, with built-in battery charging algorithms and MPPT control, requiring no firmware development. ■