Finding True Maximum Power Point

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. **Tage Bjorklund, Senior Applications Engineer, Power Products, Linear Technology Corp., USA**

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. 80 V 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 6 V.

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.

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) reduces time to market

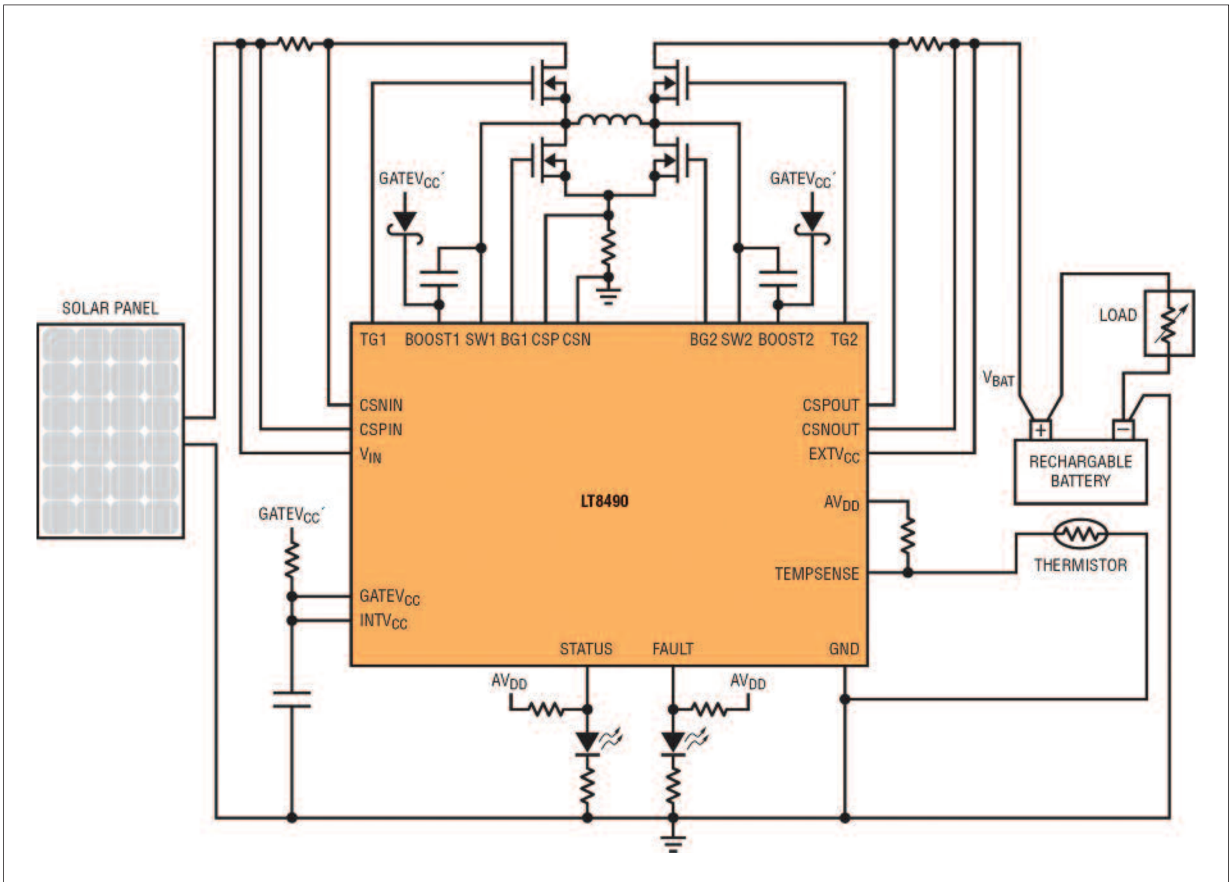

Figure 1: Simplified solar powered battery charger schematic

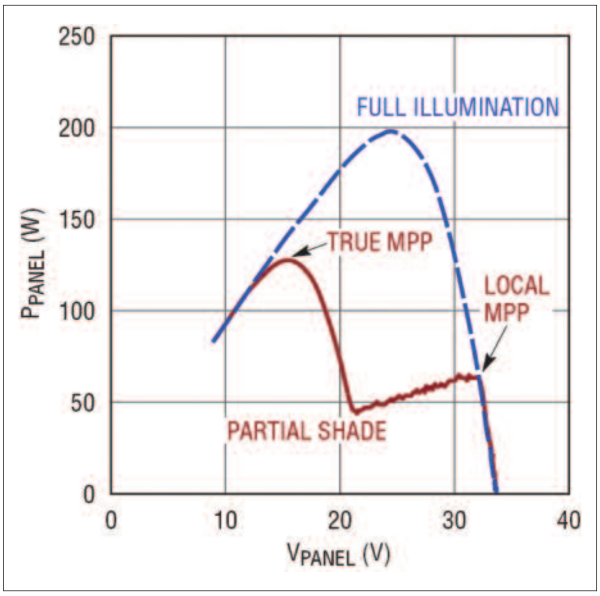

Figure 2: The power curve of a 60-cell 250 W solar panel with entire panel illuminated and with a small shadow partly covering one cell (see Figure 3)

- integrated buck-boost controller allows V_{IN} to be above, below or equal to V_{BAT}
- supports lead-acid and lithium-ion batteries
- 6–80 V V_{IN} and 1.3–80 V 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 6 V to a maximum (cold temperature) open circuit voltage of 80 V; 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 (Figure 1). 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 250 W panel under two different lighting conditions. The maximum power point (200W) occurs at 25 V when the panel is fully illuminated. In partial shade (see Figure 3), the available power at a 25 V panel voltage drops to 50 W, with the new true maximum power point (128 W) appearing at 16 V. Note that the original 25 V/200 W power peak actually moves to a local maximum ~32 V/63 W.

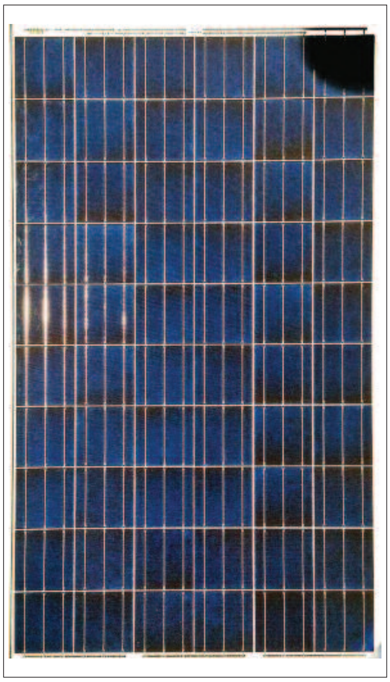

Figure 3: Solar panel shaded in top right corner

This dual local maximum effect is the downfall of traditional MPPT functions found in a number of controllers, for they follow the initial 25 V/200 W peak as it shifts to 32 V/63 W. In contrast, the LT8490 finds the true MPP at 16 V/128 W, yielding an additional 65 W from the panel. It does this by measuring the entire power curve of the panel at regular intervals and locating the true maximum power 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 LiFePO4 cells have charge requirements that are different from lead-acid batteries. Thus some of the built-in and configurable charge control functions are 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; and 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 VIN 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.