

es where the input can collapse in overcurrent conditions. An integrated 2-A switch driven by a bootstrapped supply maximizes efficiency during charging.

The LT3652 can be configured to charge at average currents to 2 A. The user sets the max charge current by choosing an inductor sense resistor, so that the max average current through the sense resistor creates a 100-mV drop. The sense resistor in Fig. 1 is 0.05 Ω. Besides having the appropriate inductance, the selected inductor must have a saturation current equal to or exceeding maximum peak current.

CHARGING THE BATTERY

The charge and discharge capacity of a battery is in terms of “C,” given as ampere-hours (Ah). The actual battery capacity depends on the C-rate and temperature. Most batteries are rated at 1 C. A discharge of 1 C draws a current equal to the rated capacity. For example, a battery rated at 1,000 mAh provides 1,000 mA for one hour if discharged at a 1-C rate.

The LT3652 charger IC uses a charge-current-based C/10 termination scheme to end a charge cycle when the battery charge current falls to one-tenth of its programmed maximum charge current. It also contains an internal charge-cycle control timer for timer-based termination. When using the internal timer, the IC combines C/10 detection with a programmable time constraint, during which the charging cycle can continue beyond the C/10 level to top-off a battery.

A capacitor connected from Timer pin 6 to ground sets the end-of-charge (EOC) time. A 0.68-μF capacitor generates a three-hour timer EOC and a precondition limit time of 22.5 min. When using the timer-based scheme, the IC also supports bad battery detection, which triggers a system fault if a battery stays in precondition mode for more than one-eighth of the total charge-cycle time.

If a timer-based termination is not desired, you can disable the timer function by connecting the TIMER pin to ground (Fig. 1). With the timer function disabled, charging terminates when the charge current drops below a C/10 threshold.

After terminating the charge, the LT3652 automatically enters a low-current standby mode where supply bias currents drop to 85μA. The IC continues to monitor the battery voltage while in standby, and if that voltage falls 2.5% from the full-charge float voltage, the LT3652 engages an automatic charge-cycle restart. The IC also automatically restarts a new charge cycle after a bad battery fault once the failed battery is removed and replaced with another battery.

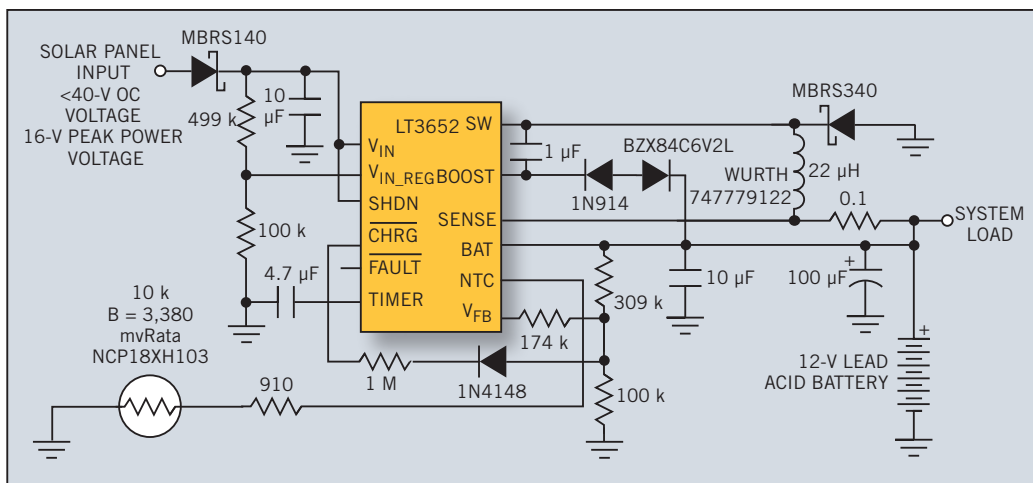


Fig. 3. 1-A solar panel powered three-stage 12-V lead-acid fast/float charger.

The IC contains provisions for a battery-temperature monitoring circuit using a thermistor during the charging cycle. If the battery temperature moves outside the safe charging range (0° to 40°C), the IC suspends charging and signals a fault condition until the temperature returns to the safe range.

A shutdown mode can disable all charging functions. This precision threshold allows the use of the $\overline{\text{SHDN}}$ pin 3 to incorporate UVLO (undervoltage lockout) functions. Pulling the $\overline{\text{SHDN}}$ pin below 0.4 V causes the IC to enter a low-current shutdown mode where V_{IN} current reduces to 15 μA. Typical $\overline{\text{SHDN}}$ input bias current is 10 nA. When not charging, the IC draws less than 1 μA from the battery.

The open-collector $\overline{\text{CHRG}}$ pin 4 and the $\overline{\text{FAULT}}$ pin 5 usually use a resistor pulled up to a reference voltage. These status pins can be pulled up to voltages as high as V_{IN} when disabled, and can sink currents up to 10 mA when enabled.

During a battery charging cycle, if the required charge current is greater than 1/10 of the programmed max current (C/10), $\overline{\text{CHRG}}$ pin 4 is pulled low. A temperature fault also causes this pin to be pulled low. After C/10 charge termination, or if the internal timer is used for termination and charge current is less than C/10, the pin stays at high-impedance.

$\overline{\text{FAULT}}$ pin 5 indicates fault conditions during a battery charging cycle. A temperature fault causes this pin to be pulled low. If the internal timer is used for termination, a bad battery fault also causes this pin to be pulled low. If no fault conditions exist, this pin remains high-impedance.

SEALED LEAD-ACID BATTERY APPLICATION

Fig. 3 shows a sealed lead-acid battery using the LT3652. This 1-A circuit fast-charges with CC/CV characteristics up to 14.4 V. If the charge current falls to 0.1 A, the charger switches to 13.5-V float-charge mode.

The charger re-initiates the 14.4-V fast-charge mode if the battery voltage falls below 13.2 V and trickle charges at 0.15 A if the battery voltage is below 10 V. A resistor divider between BAT pin 9 and V_{FB} pin 7 programs the output battery float voltage. Ⓞ