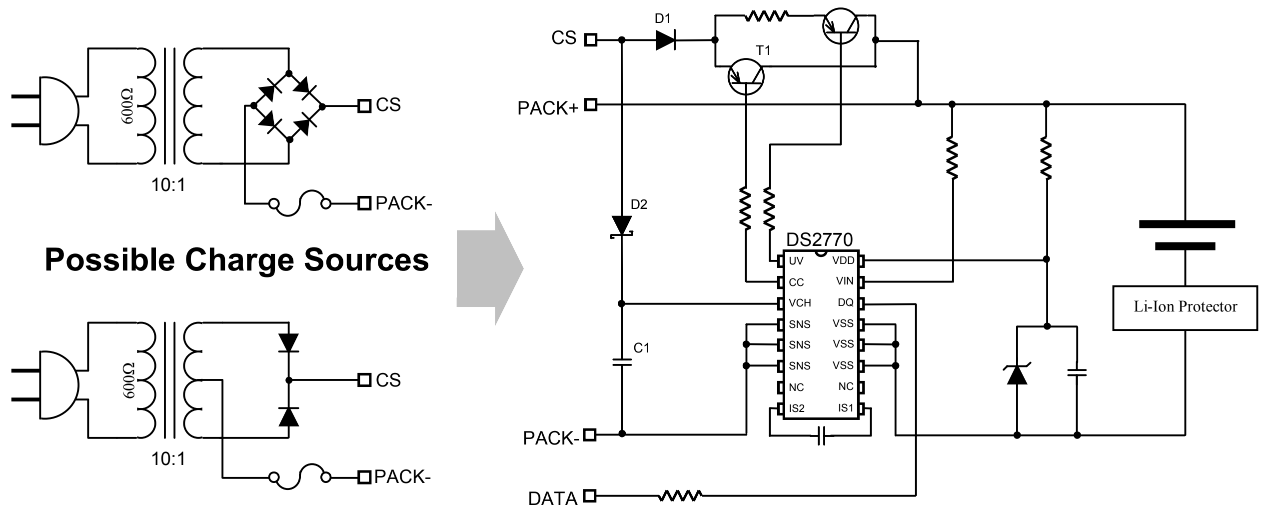
Application Note 223
DS2770-Based Charging with Unregulated Sources

Introduction

Cost is a major concern in portable consumer electronics. The portable equipment maker can reduce component count and lower costs by designing the application to support charging with unregulated charge sources. With minor modification to the application circuit, the DS2770 can support a variety of current limited full-wave rectified charge sources.

Figure 1. Application Circuit and Sample Unregulated Charge Sources

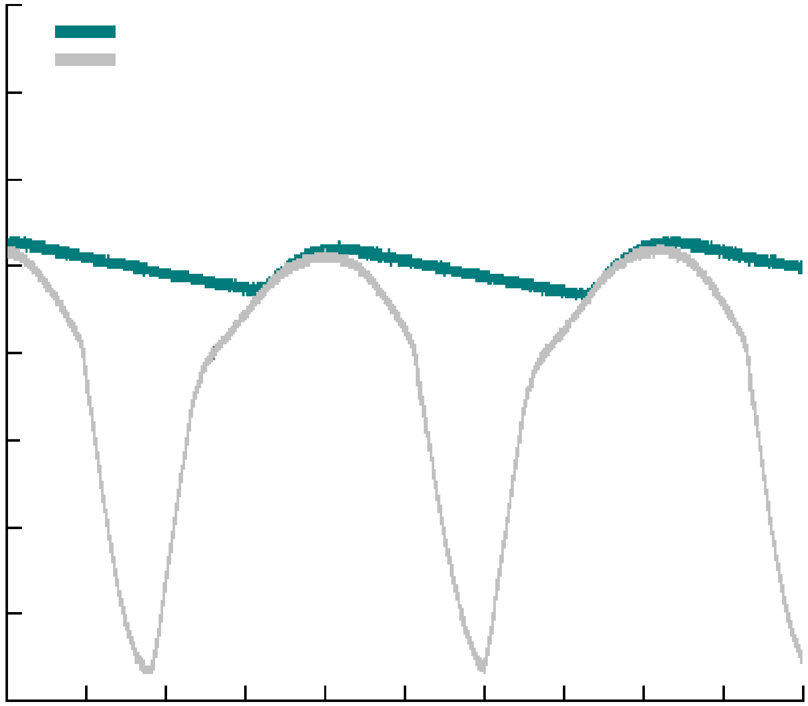


Operation

When the charge source is connected to the circuit between the CS and PACK- pads, the DS2770 will detect the source presence and begin to charge the cell. The voltage applied to the V_{CH} pin must not fall below the battery voltage during charging or the DS2770 will assume the source has been removed and terminate the charge prematurely. Figure 1 shows the modified application circuit to prevent this from occurring.

While the source voltage is higher than the cell voltage, charge flows into the cell and the voltage on V_{CH} is forced above the voltage on V_{DD}. While the source is lower than the cell voltage, capacitor C1 maintains V_{CH} at a level above the cell voltage, Schottky diode D2 prevents capacitor C1 from discharging through the charge source, and diode D1 prevents the battery from discharging through the charge source. Figure 2 shows the relationship between the charge source voltage, V_{CH} pin voltage, and cell voltage during charging. A Schottky diode was selected for D2 and a regular diode was selected for D1 to provide at least a 0.5V margin on V_{CH} over V_{DD}. Capacitor C1 must be large enough to maintain the voltage on V_{CH} for the entire period the charge source is lower than the cell voltage. Calculation of the capacitance value is described in the next section.

Figure 2. Unregulated Charge Source and V_{CH} Pin Waveforms



Capacitance Calculation

Capacitor C1 prevents the voltage at the V_{CH} pin from falling below the cell voltage for the duration of the charge source low period (time t_{low} in Figure 2). During this time the 150µA load (data sheet maximum) through the V_{CH} pin drains C1. The minimum capacitance value required can be derived starting from the standard equation:

$$I = C\,\frac{dv}{dt}$$

Where dt is the low period t_{low}, dv is the voltage difference from the V_{CH} pin to the cell voltage at the start of t_{low}, and I is the internal load on the V_{CH} pin. To solve for C, the equation can be rewritten as:

$$C = I_{VCH} \cdot \frac{t_{low}}{(V_{D1} + V_{T1} - V_{D2})}$$

Solving for this example:

$$C = 150\mu A \cdot \frac{7ms}{(0.7V + 0.2V - 0.2V)}$$

$$C = 1.5\mu F$$

1.5µF is the minimum value for C1 not considering device tolerances. To ensure proper operation for a specific application use worst case tolerances for all components including the tolerance of C1 itself and the worst case timing for the width of t_{low}.

Summary

The DS2770 is able to charge Li+ cells even when used in conjunction with lower-cost unregulated power sources. The voltage on V_{CH} must be maintained above the cell voltage for the duration of the charge. This can be accomplished with minimal external components.