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Keywords: battery, load switch, efficiency, charger

APPLICATION NOTE 4656

External MOSFET Reduces I²R Losses in Smart Power Selector™-Based Chargers

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Dec 15, 2010

Abstract: Battery-to-system (BAT-to-SYS) connection impedance is critical and affects battery runtime by reducing headroom and dissipating power. An external pass transistor lowers the impedance by more than 50%. This application note shows the MAX8662 power-management IC with Smart Power Selector functionality drives an external MOSFET to reduce switch resistance and power dissipation. Performance data are shown.

This design idea appeared in the November 15, 2010 issue of *EE Times*.

Introduction

Most rechargeable battery-powered systems require some type of switching circuit to pass the system load between the battery and charging power. Without this circuitry, the device might not operate immediately when plugged into a charger with a depleted battery. This switching circuitry can be either an external add-on to a charger or integrated within the charger IC. When the switch to pass the load between the battery and charging power is integrated within a Maxim® charger, the charger is said to have Smart Power Selector functionality. The Smart Power Selector feature allows the system to use an adapter or USB power while the battery charges, even from a completely depleted state.

Basic Operation of Smart Power Selector Power Control

The MAX8662 power-management IC contains Smart Power Selector functionality. Internal switches connect the power input (DC) to the system's power output (SYS) and from the battery (BAT) to SYS automatically, as needed. It is important that these switch resistances below.

The MAX8662 provides a 0.1Ω DC-to-SYS resistance and a 0.04Ω BAT-to-SYS resistance. The combined resistance (0.1 + 0.04 = 0.14Ω) is important for allowing the battery to charge at its full rate (1.25A) up to 4.2V with low 4.375V headroom (1.25A = (4.375V - 4.2V)/0.14Ω). The BAT-to-SYS switch resistance is critical for battery runtime, since it is in series with the battery during discharging and charging. The MAX8662's low 0.04Ω BAT-to-SYS switch resistance minimizes power dissipation and voltage drop. At 2A battery discharge currents, for example, the internal switch power loss is 160mW and the voltage drop is 80mV.

Operation with an External MOSFET

Since the BAT-to-SYS switch resistance is critical to runtime and power dissipation, some designs may wish to further reduce resistance with an external MOSFET. **Figure 1** shows how this can be implemented. Q1 (a Fairchild® FDMA510PZ) has an R_{DSON} of less than 30mΩ (max, at V_{GS} = -4.5V) in a 2mm x 2mm package. In the circuit, the MAX8662's active-low POK output drives a small p-channel MOSFET (Q2) to invert the drive to the gate of Q1. Once the DC supply is connected, active-low POK goes low, turns off Q1, and disconnects the battery from the load.

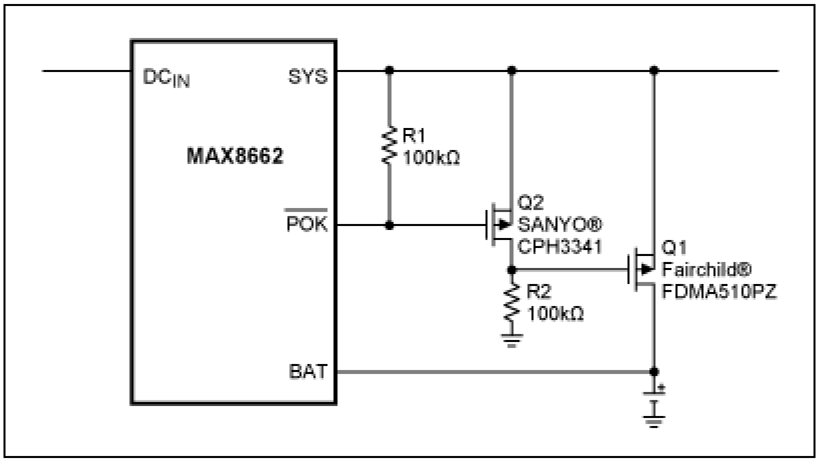

Figure 1. Simplified schematic: reducing I²R losses in Smart Power Selector-based battery chargers.

Figure 2 shows the Figure 1 circuit's behavior when a DC supply is connected, while **Figure 3** shows the circuit's performance when the supply is disconnected. Both figures show that when the DC power is removed, most of the load current passes through Q1 and the charger's Smart Power Selector functionality is retained.

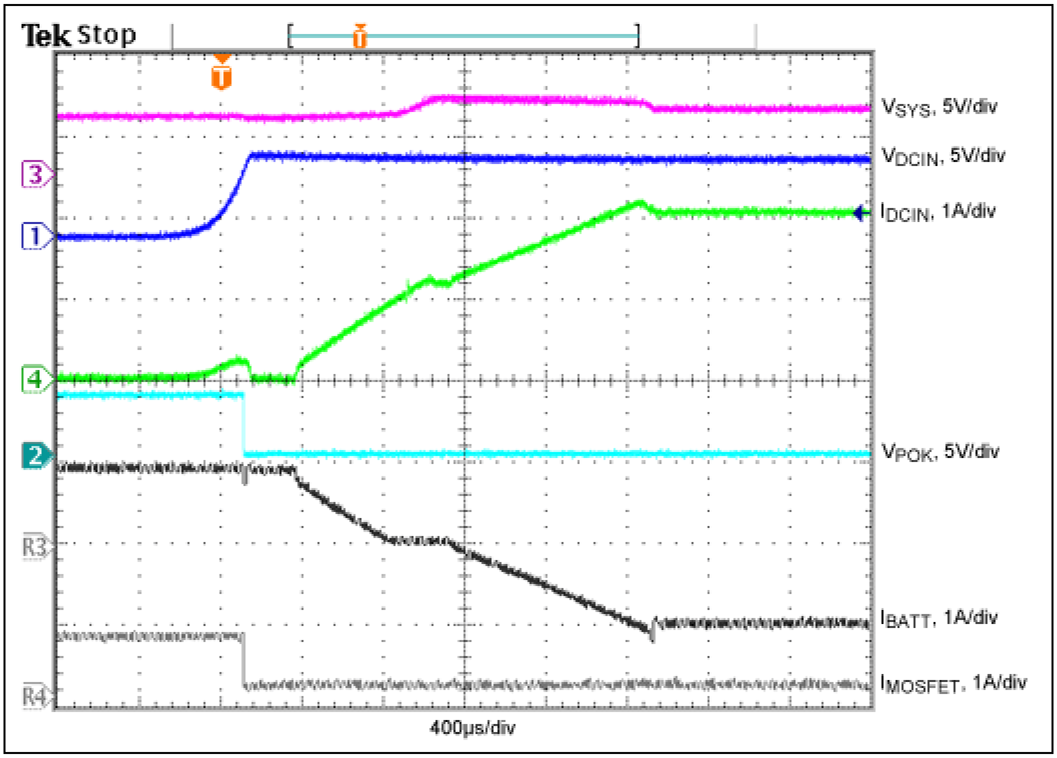

Figure 2. Performance of the Figure 1 circuit when the DC supply is connected.

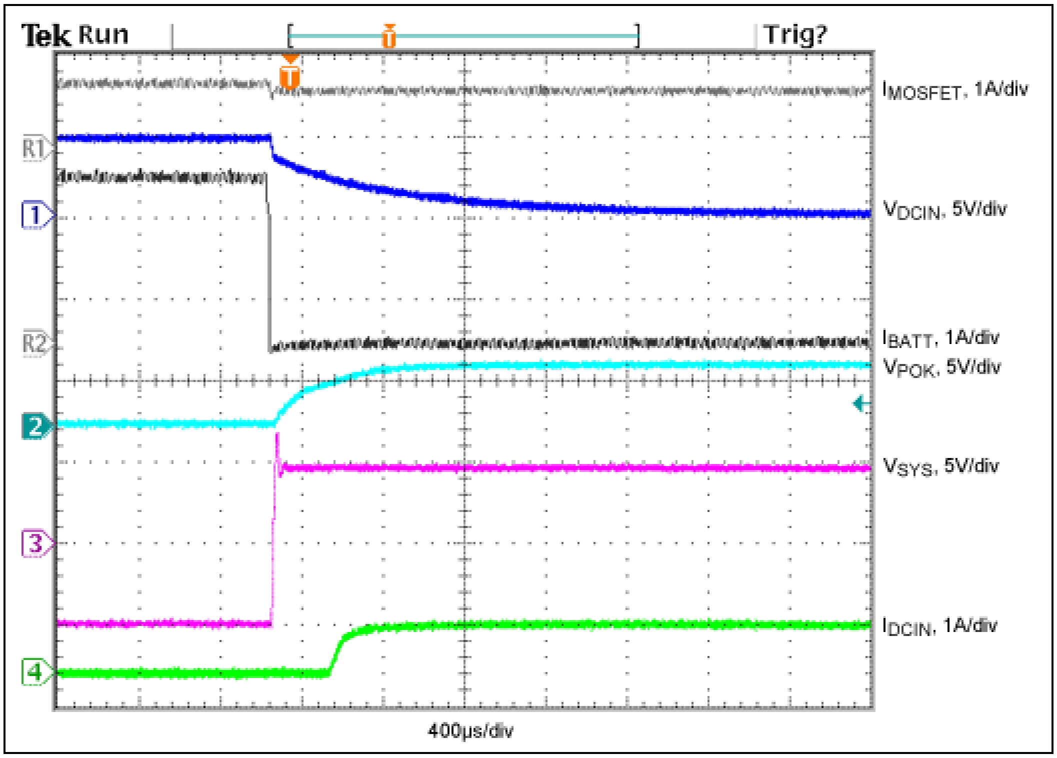

Figure 3. Performance of the Figure 1 circuit when the DC supply is disconnected.

Figure 4 details the improvement of the BAT-to-SYS voltage drop. The measured resistance of a MAX8662 and typical PCB traces is approximately 60mΩ. With the additional MOSFET, that figure drops to approximately 25mΩ.

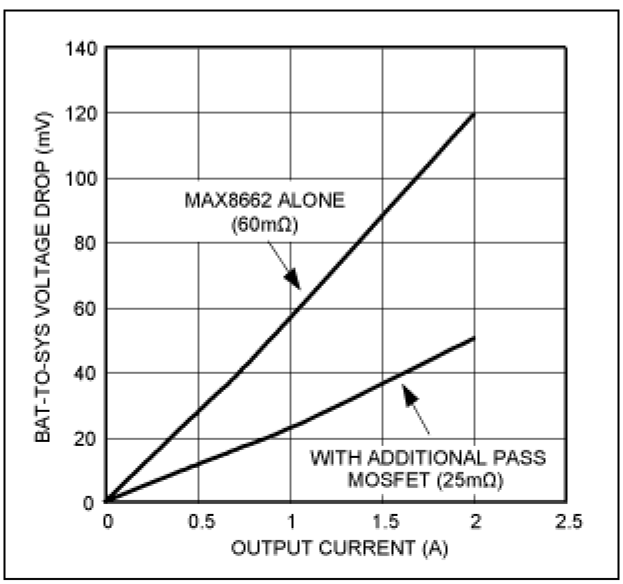

Figure 4. Data for the V_{BATT}-to-SYS voltage vs. load current.

To shorten the delay between when the DC supply disconnects and Q1 turns on, R1 and R2 can be reduced. **Figure 5** shows switchover behavior when DC power is disconnected with R1 = R2 = 10kΩ. With R1 = R2 = 10kΩ, the delay before Q1 begins conducting is reduced by 300µs compared to that of Figure 3 where R1 = R2 = 100kΩ. Using R1 = R2 = 10kΩ has no impact on battery drain, since neither resistor passes current when SYS is using battery power (i.e., when active-low POK is high and Q1 is on). However, there is a slightly increased load on SYS when DC power is applied and the active-low POK is low.

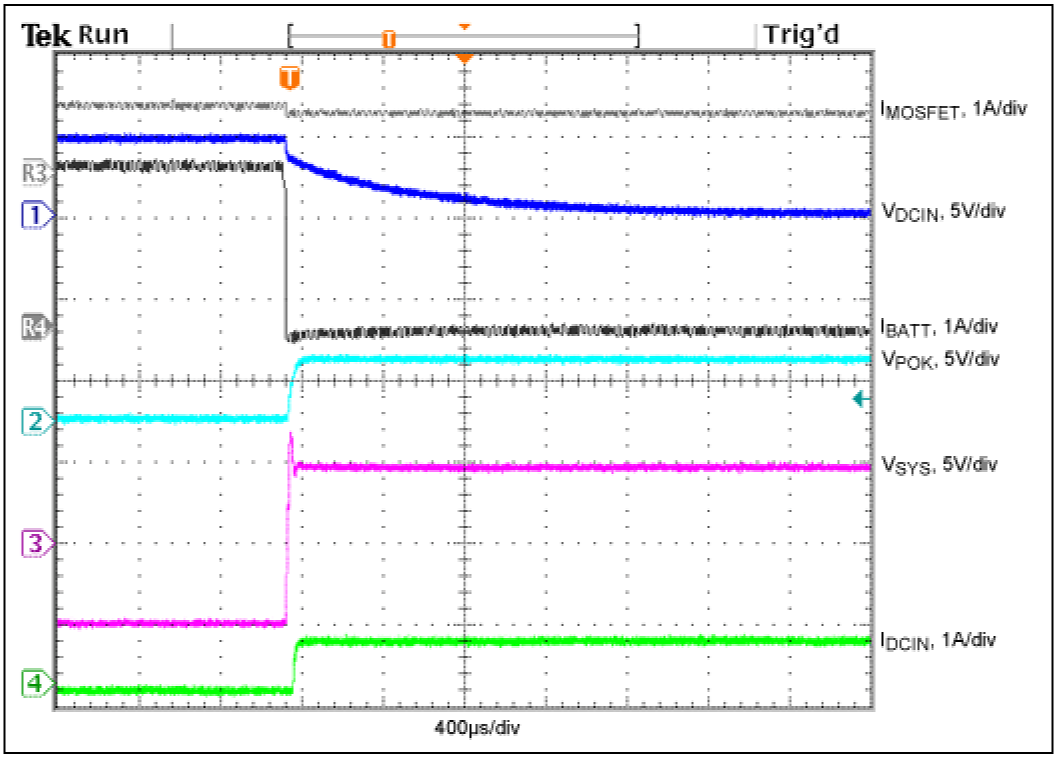

Figure 5. Data show circuit performance when the DC supply is disconnected with R1 = R2 = 10kΩ.

The author wishes to acknowledge Chad Olson and Joe Van for their contributions to this article.

Related Parts		
MAX8606	USB/AC Adapter, Li+ Linear Battery Charger with Integrated 50m Ohm Battery Switch in TDFN	Free Samples
MAX8662	Power-Management ICs for Single-Cell, Li+ Battery-Operated Devices	Free Samples
MAX8662	Power-Management ICs for Single-Cell, Li+ Battery-Operated Devices	Free Samples

MAX8663	Power-Management ICs for Single-Cell, Li+ Battery-Operated Devices	Free Samples
MAX8819	PMIC with Integrated Charger and Smart Power Selector™ in a 4mm x 4mm TQFN	Free Samples
MAX8856	USB/AC Adapter, Li+ Linear Battery Charger with Integrated 50mΩ Battery Switch in TDFN	Free Samples

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