Battery Charger and Motor Controller in Roller Blinds

Abstract

This application note is a design guide for Qorvo's ACT2861, PAC55723, and ACT4752 in a battery-powered motorized roller blind system. The ACT2861 serves as the power converter between a small solar panel or a DC power source and a battery pack, while the PAC55723 controls and drives the brushless DC (BLDC) motor that activates the blinds. The ACT4752 manages power for wireless communication circuitry. A short overview of each Qorvo device is followed by a design example.

1. Introduction

Motorized roller blinds have become a staple in smart home automation, enabling automated light control and privacy with the touch of a button or a remote command. These blinds are often battery-powered, housing a rechargeable multi-cell battery pack to avoid the need for external wiring. The battery pack is rechargeable from a small solar panel, USB-C cable, or DC power supply. This application note explains optimized recharging from any of these power sources, motor control and drive with a Power Application Controller® (PAC), and finishes with a practical design example.

2. Roller Blind System Overview

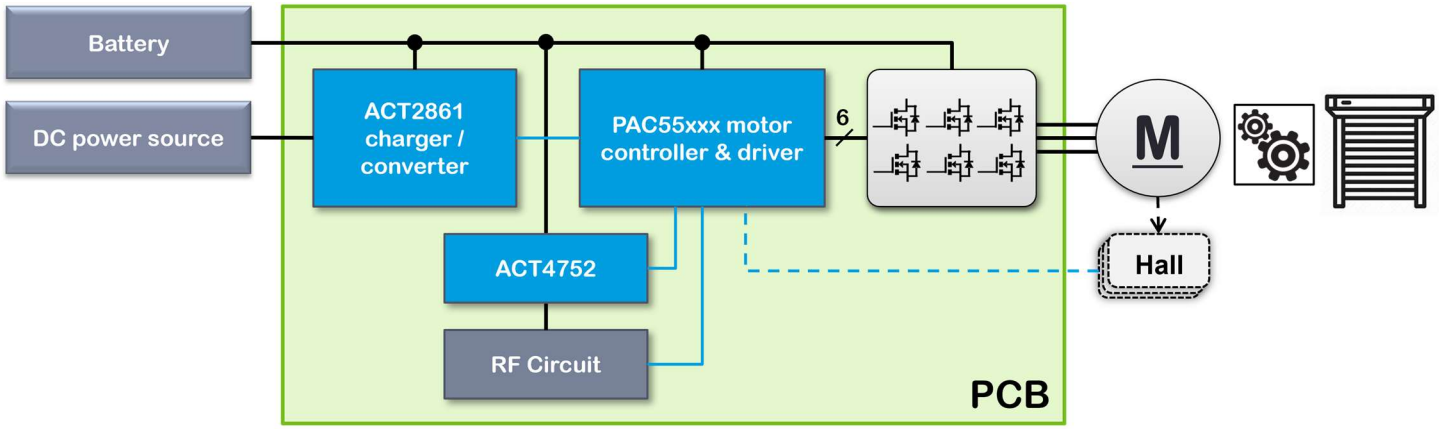

Fig. 2-1. Qorvo soluction for smart roller blind system

Fig. 2-1 shows a block diagram of a small roller blind system with minimal components on the printed circuit board (PCB) thanks to the highly integrated Qorvo solution. The battery pack contains multiple series-connected battery cells, with the cell count designated with suffix S. A typical roller blind battery pack is 3S to 5S lithium manganese oxide (LMO), lithium nickel manganese cobalt (NMC) or lithium iron phosphate (LFP). Another common battery configuration is 8S to 16S nickel metal hydride (NiMH). Battery pack nominal voltages range from 9.6 to 20 V depending on chemistry. The DC power source is USB, small solar panel, DC power supply, or a combination of these.

On the circuit board is the ACT2861 battery charger and converter. It works with any battery chemistry, with allowable battery voltage spanning a range from 4 to 23 V. A Qorvo power management integrated circuit (PMIC) ACT4752 supplies power from the battery to RF circuitry that communicates wirelessly with a remote controller. More information on ACT2861, PAC55xxx motor controller & driver (MCD), and the ACT4752 PMIC follow. The inverter is the common 2-level voltage source inverter made with six MOSFETs in a three-phase bridge.

The motor is typically a 3-phase brushless DC (BLDC) motor with optional Hall-effect rotor position sensors. Other motor types would also work such as a 3-phase permanent magnet synchronous machine (PMSM) or a DC motor. The motor is packaged with a gearbox to drive the blinds.

3. ACT2861 Overview

The ACT2861 battery management system functions as a buck-boost charger with bidirectional power flow capability and works with any battery chemistry. The voltage at VIN relative to PGND can be higher or lower than at VBAT. The input voltage range is 4 to 29 V, and maximum battery voltage is 23 V, which is well suited for 2S to 5S lithium-based battery, or at least 5S NiMH. Input or output maximum current is 4 A. The ACT2861 is highly integrated with built-in safety, power monitoring, sensing, control, and H-bridge power MOSFETs and gate drivers.

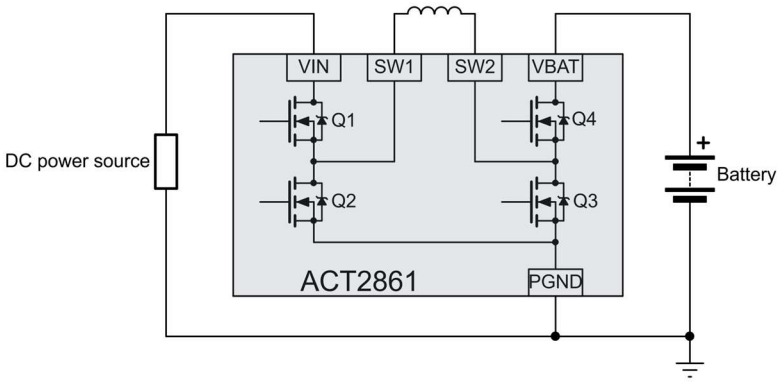

Fig. 3-1. ACT2861 has integrated half-bridge for bidirectional power flow

Fig. 3-1 shows a portion of the ACT2861 block diagram including the internal H-bridge power MOSFETs, inductor, battery, and VIN connections, with bypass capacitors omitted for clarity. The switching frequency is programmable to 125, 250, 500, or 1000 kHz, with a default of 500 kHz for a good tradeoff between inductor size and overall efficiency. The ACT2861 is in charge mode when power flows into the battery pack, and On The Go (OTG) mode when power flows from the battery pack to the VIN & PGND connections. The ACT2861 functions the same in both charger and OTG modes except the timing of switching Q1 through Q4 is adjusted accordingly. In a roller blind application, OTG mode is not needed. When the MOSFETs inside the ACT2861 are off, the battery pack is disconnected from the DC power source.

The ACT2861 incorporates the following safety features:

- Overcurrent or short circuit condition
- Voltage at VIN or VBAT out of range
- Battery overtemperature
- Internal overtemperature
- Excessive time in fast charge mode
- Internal voltage out of range
- Watchdog timer (when enabled)

The ACT2861 can operate in both standalone and host-controlled applications. When standalone, external resistors set the fast charge current, input current limit, and OTG current limit. When using a host microcontroller, registers are accessible by I^2C communication, providing full control of voltage, current, and fault settings. A built-in analog to digital converter (ADC) provides voltage, current, and temperature information. Detailed device and application information are provided in the ACT2861 datasheet.

4. PAC55xxx Overview

There is a wide range of intelligent motor controllers & drivers from Qorvo. As is often the case, multiple part numbers could work well in this application. Application note Qorvo Motor Control & Drive System Guide provides an overview of all Qorvo MCDs and the main differences. It includes PAC55xxx products, each with a 150 MHz MCU with floating point and hardware multiply & divide. It also includes the ACT72350, which is an analog front end combined with a 3-phase driver. Instead of an MCU, the ACT72350 has a Serial Peripheral Interface (SPI) port for register configuration and status so that it works with any microcontroller and provides most of the same features as the highly integrated PAC MCDs.

5. ACT4752 PMIC Overview

The ACT4752 serves as the power converter between the battery pack and the wireless communication subsystem. It features a programmable high-current buck regulator (up to 4 A), a 5 V mini-buck for logic and radios, and a 3.3 V Low Drop-Out regulator (LDO), all integrated in a single 5 × 5 mm package to minimize component count. The main buck output voltage is programmable by analog feedback or by via I²C with a wide range (approximately 3 V up to 24 V) and can deliver up to 4 A of current. The ACT4752 also includes an integrated 5 V “mini-buck” regulator that provides a stable 5V rail at up to 350 mA. In addition to powering external circuits, this 5 V rail also serves as the bias supply for the ACT4752’s own internal logic and gate drivers (hence it is referred to as a *bias* buck converter). Finally, the ACT4752 integrates a small auxiliary LDO regulator that can provide a low-noise voltage for sensitive low-power subsystems. This LDO output is programmable from about 0.9 V up to 4.0 V in fine 12.5 mV steps, and can source up to 20 mA.

6. Design Example

6.1. Charger Selection

Suppose we need to design the power system for a solar, USB, or 24 V DC power supply rechargeable battery-powered roller blind. The battery pack is 3S LMO with 12 V nominal voltage. When charging from USB, the 5 V input must be boosted up to the battery pack voltage. On the other hand, when charging from 24 V DC, the input voltage must be stepped down. Depending on the solar panel, the input voltage could be less than or greater than the battery pack voltage. Therefore, the battery charger must support overlapping input and output voltage ranges, which the ACT2861 does with its 4-switch topology. When charging from a solar panel, maximum power point tracking (MPPT) is feasible by adjusting the ACT2861 current limit by its I^2C interface.

6.2. Motor Controller & Driver Selection

For the motor drive, the blind can leverage multiple Qorvo motor-controller solutions. A good option is Qorvo’s PAC55723, a 72 V BLDC motor controller system-on-a-chip that combines a high-performance 150 MHz Arm® Cortex®-M4F control core with integrated power management and gate driver circuits. This all-in-one controller is ideal for this application, as it can directly drive the blind’s BLDC motor with precise speed/position control, while also handling protection and power conversion internally. Alternatively, designers can choose the Qorvo ACT72350, a standalone 160 V three-phase BLDC driver IC featuring a configurable analog front end (AFE) and an integrated high-voltage buck regulator. The ACT72350 provides high-current gate drivers (2 A source/sink) for the motor phases, while its built-in power manager supplies power to an external MCU. The ACT72350 AFE incorporates current sensing and shutdown safeguards. This option allows designers to retain the code base and toolset for a separate MCU. This design example uses the PAC55723.

6.3. Inverter MOSFET Selection

A 40 V MOSFET has sufficient voltage margin. Low power dissipation is required because the PCB is enclosed in a tube. With gear reduction of torque at the motor, the motor current is a few Amps RMS. A MOSFET with less than about 15 mΩ can drive the motor with very little self-heating. There are many such MOSFETs to choose from, including dual MOSFETs, which are two separate MOSFETs in one space-saving package. These generally have logic-level threshold voltage, which works. However, a standard threshold voltage MOSFET has better immunity from spurious turn-on during switching. One example, among many, in a discrete package is DMT47M2SFVW by Diodes Inc.

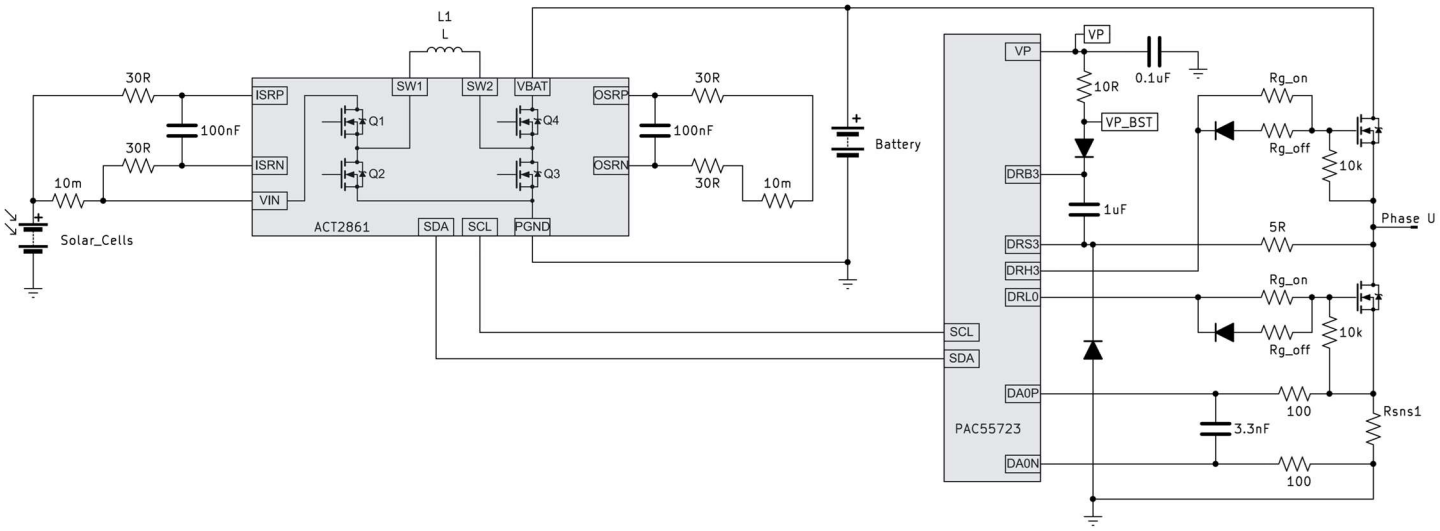

Fig. 6-1. Smart roller blind system simplified schematic

Fig. 6-1 shows a simplified schematic of battery charger and motor controller & driver. Only one of the three inverter half-bridges is shown for clarity. All components are duplicated for the other two half-bridges. Note that the node labelled VP_BST is common (connected) in all three inverter half-bridges. Passive component values are included in the ACT2861 evaluation kit users guide and PAC55723 evaluation kit. Some components are shown above in Fig. 6-1. The ACT4752 buck converter is not included in Fig. 6-1. Example schematics and component selection are available in the ACT4752 evaluation kit.

7. Summary

By leveraging Qorvo's highly integrated devices, the motorized roller blind design achieves seamless multi-source power management, efficient BLDC motor control, as well as power management support for wireless communication subsystems. Typically, a 3S-5S battery pack powers the system, charged via the ACT2861 buck-boost charger from solar, USB, or 24 V DC inputs, while the PAC55723 drives the brushless DC motor and the ACT4752 step-down regulator powers the RF wireless module. This architecture yields a compact, versatile, and energy-efficient solution.

In summary, the combination of the ACT2861, PAC55723, and ACT4752 showcases Qorvo's integrated approach to smart home automation. The result is a compact and flexible motorized roller blind solution that maximizes energy efficiency and reliability, meeting the demands of modern, sustainable smart living.

Revision History

Revision	Authors	Date	Description
A	Alan Molley Jonathan Dodge, P.E.	15 Dec. 2025	Initial revision

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