Application Brief
Full-Featured Automotive Side Mirror

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Abstract

The familiar automotive side mirror has evolved from a simple reflective glass to a highly capable subsystem. Side mirrors can provide the driver with not just a rearward view, but also with information about vehicles in your blind spot, automatic dimming when an overtaking vehicle's headlights are too bright, heat to remove ice or fog, and signals to alert other drivers when your car is making a turn. This application brief discusses the requirements and designs for controlling all these features.

Mirror Module Functions

In many cases, the mirror functions can be managed as part of a door module, which can also control the power window, locks, and options such as pop-out handles. In other cases, a separate mirror module can manage the mirror functions. Our design discussed in the following focuses on this second type of partition. Figure 1 illustrates some of the many features that can be found in a full-featured automotive side mirror.

- Network-connected control
- Motorized horizontal and vertical adjustment
- Motorized fold in-out
- Heated mirror surface
- Electrochromic dimming
- Turn signal
- Blind spot warning indicator
- Puddle lamp

Texas Instruments has designs to help designers implement all these functions. In the following paragraphs, we discuss the various sub-circuits and suggest components for implementation.

Connection to Battery System and Network

The functions of the mirror require power from the vehicle power system, typically a 12-V source, and connection to the vehicle network, usually CAN or LIN. In our design, the system basis chip (SBC) TLIN1431-Q1 provides the LIN transceiver connection to the network, as well as a voltage regulator to convert from the 12-V automotive supply to a 3.3V voltage for the microcontroller (MCU) and analog signals. This device also includes a watchdog function to monitor the MCU and provides a reset if needed. An LM74700-Q1 smart diode protects the module against reverse battery conditions.

Control Functions

The microcontroller (MCU) coordinates and controls the functions of the side mirror. The MCU processes messages from the vehicle network, typically either LIN or CAN, and controls the motors, heater and LEDs in response to network commands or button pushes from the vehicle driver.

The MCU monitors the operation of each of the functions, and takes action if any faults are detected, such as overload conditions, excessive temperatures, or voltage supply faults. Our design uses an MSPM0 Arm® Cortex®-M0+ microcontroller to manage all the side mirror functions. For designs where the vehicle network is CAN, the MSPM0G3507 integrates a CAN controller into the MCU. For designs where LIN is the network connection, the MSPM0L1305 can be a good choice. In addition to the typical digital features, these MCUs also integrated useful analog components, including op amps and comparators. This simplifies signal conditioning of sensor inputs and diagnostics, for example.

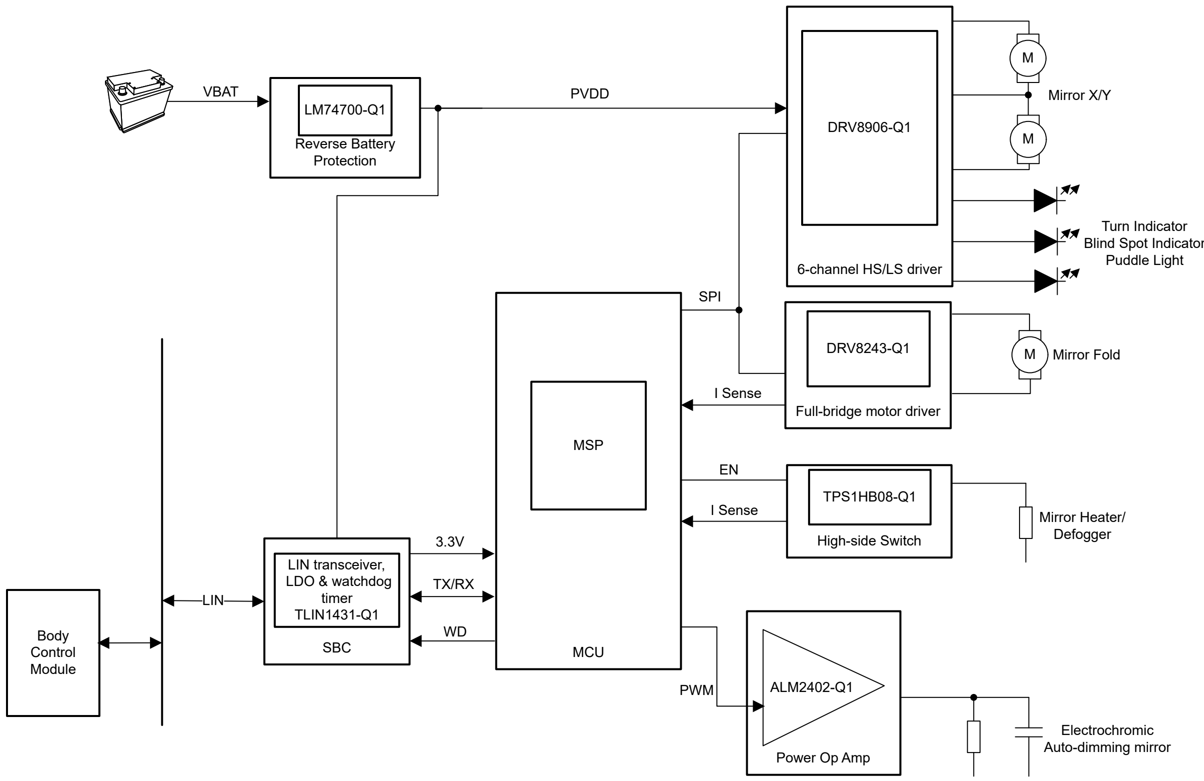

Figure 1. Block Diagram of Typical Side Mirror

Motorized Horizontal and Vertical Adjustment

The horizontal (X) and vertical (Y) adjustment of the mirror position typically use small brushed DC motors, with typical current less than 1A. In our design, three half-bridges of the DRV8906-Q1 drive these two motors, allowing movement in either direction on the X or Y axis. If pulse-width modulation is desired to control the speed of the motion, the DRV8906-Q1 has integrated PWM generators, settable by the MCU through the serial peripheral interface (SPI).

Motorized Fold In or Out

In tight parking spaces, every inch of width counts. Folding side mirrors can reduce the width of the car by several inches on each side, preventing damage from scraping on obstacles and allowing more room to exit and enter the car. When motorized, this feature is typically implemented with a brushed DC motor, requiring a simple full-bridge drive, with a current of a few amps. In our design, we use the DRV8243-Q1 fully-integrated motor driver, which can drive up to 12 amps. Since the mirror fold has a limited range of motion, typically about 90 degrees, we want to stop driving when the mirror reaches either the fully open or fully closed position. The DRV8243-Q1 has an output signal proportional to the motor current, so we can determine the end-of-travel when the motor current increases as it reaches a stall point. We can also set an adjustable current limit, so the motor torque does not cause binding.

Heated Mirror Surface

Snow and ice can obscure the mirror, so a resistive heating element is built into the back surface of many side mirrors, allowing the driver to defrost the mirror without manually cleaning it. Depending on the size of the mirror, the heater may require a few amps of current. Our design uses a TPS1HB08-Q1 high-side switch to supply the heater current. This device has an $R_{DS(ON)}$ of 8 milliOhms for driving currents up to 10A. An adjustable current limit and comprehensive diagnostics ensure reliable operation.

Electrochromic Dimming

Electrochromic tinting allows a mirror to change the reflectivity to reduce glare when needed. When no voltage is applied, the electrochromic coating is clear, allowing normal reflectivity. When a voltage is applied, the coating darkens, reducing the amount of reflected light. The electrical properties of the coating require a relatively large charge to change the tint, with a larger current required for a larger surface area. Typically the tint can be set in a continuous range, from completely transparent to very dark, depending on the applied voltage. In our design, an ALM2402-Q1 power op amp is used to supply the current needed along with the continuously-variable voltage in response to a DAC output from the MCU.

Illumination and Indicators

In addition to a rearward view, the side mirror has taken on additional functions to provide information to the driver and to other vehicles. Turn indicators on the outer edge of the mirror increase the visibility of that signal beyond the traditional front and rear blinkers. A blind spot warning indicator is provided to shine through the mirror surface and alert the driver to surrounding traffic. A puddle light shining downwards from the bottom of the mirror stalk lights the ground near the door, assisting the driver approaching the parked car. Other illumination might include front-facing spotlights and running lights or trim illumination. Our design uses three of the DRV8906-Q1 channels to provide high-side drive for these LEDs. If more channels are needed, devices with up to 12 channels are available in that same footprint. On-chip PWM generators are settable through the SPI interface for any desired level of brightness for each channel.

Example Implementation

Figure 2 shows an implementation of the side mirror module block diagram of Figure 1. This board includes all the features described, as well as buttons, connectors, and test points for bench evaluation of the circuits. In a production mirror module, these extra components are not needed, reducing the size of the board.

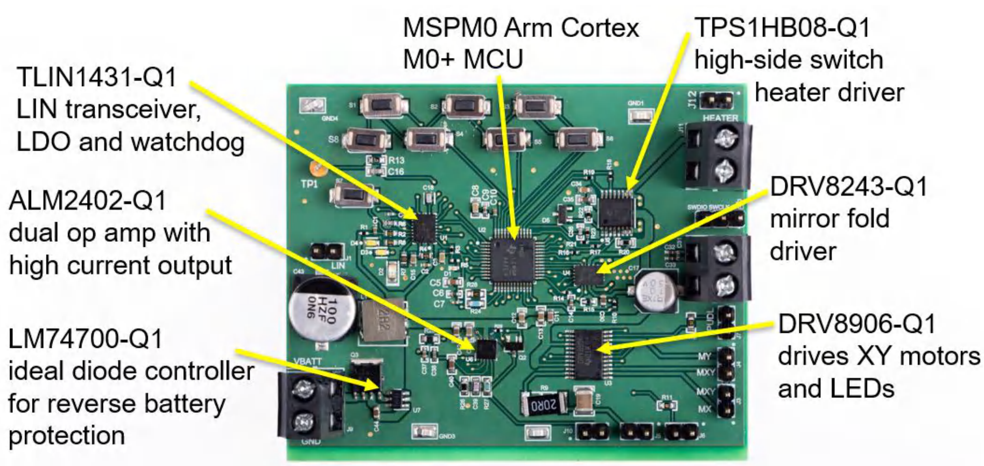

Figure 2. Example Implementation of Side Mirror Module Design

Summary

Automotive side mirrors have evolved to have many features to enhance safety and convenience for drivers and passengers. Texas Instruments has a broad portfolio of devices available for these functions, and our example gives designers a head-start in understanding and choosing designs for side mirror applications.

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