Application Brief

Optimize Automotive Body Electronics Designs With AEC-Q100 MSPM0 MCUs

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Every year, automotive manufacturers are integrating more new technologies into their designs to drive improvements in safety, cost, and user experience. Modern vehicles use many microcontrollers with high precision and performance that can withstand the most extreme environments. The market demands in the past few years have shown a clear need for improved consumer experiences in vehicle accessories such as human machine interfaces, window and mirror control, and trunk openers. These applications use devices controlling their respective electronic control units (ECU) by processing real-time data and communicating messages across long distance bus lines between interacting units.

TI's MSPM0 Arm® Cortex®-based M0+ microcontrollers (MCU) include automotive-qualified (AEC-Q100) MCUs that are designed to meet the system demands for body electronic applications. These MCUs offer smaller packaging, simple to use standardized software, high performance low power peripherals, and full spectrum pin-to-pin scalability at an attractive low cost.

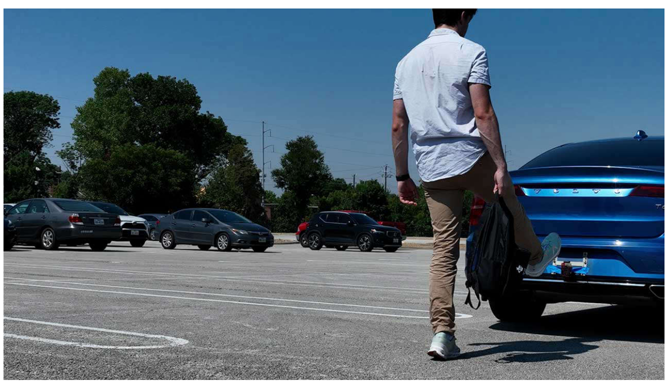

Figure 1. Smart Trunk Opener

Figure 2. Windows and Mirror Control Switches

Why Choose an MSPM0 for Your BCM Design?

- Compute: Energy efficient M0+ CPU with optional Math accelerator
- Sensing: High-performance interconnected analog modules including zero-drift operational amplifiers, high-speed comparators, and ADCs
- Control: Low power, general purpose, advanced, and high-resolution timer modules.
- Packaging Scalability: Pin-to-pin compatibility across portfolio
- Communication: integrated serial communication peripherals consisting of CAN FD, LIN, SPI, I2C, UART and software implementations for SENT.

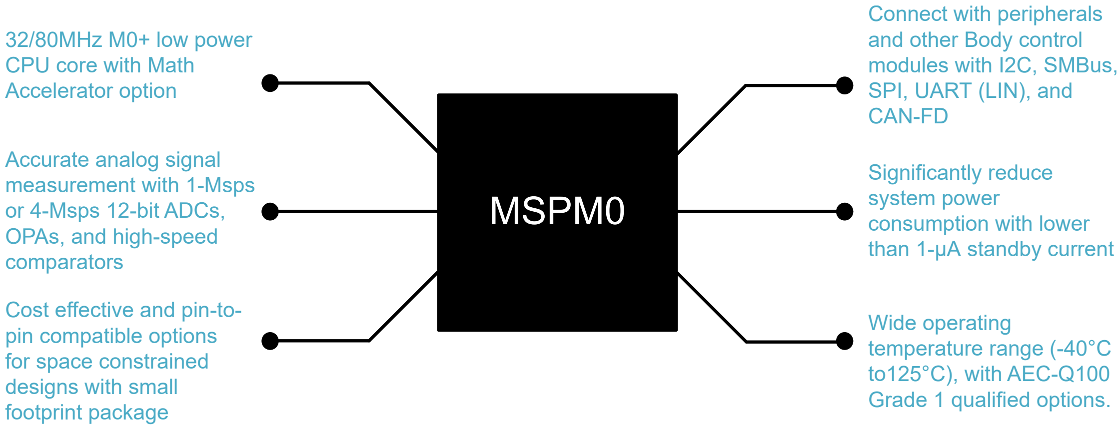

Figure 3. MSPM0 Platform Features and Advantages

What is Body Electronic Control? What are Some Common Components?

Body electronic controls are some of the primary ECUs in a vehicle, they consist of the control mechanisms for various interfaces found in vehicles. Some examples of these mechanisms include trunk opener, E-shifter, window, and side mirror control modules. These systems are essential in modern vehicles as they are responsible for managing and controlling real-time electronic operations that relate to the body of the car. These designs use small low-power integrated circuits (IC) that compute in conjunction with other subsystems in the vehicle to properly use system functionality and safety.

Some common components are found in body electronic designs:

- Low-power MCU: A low-power MCU is necessary to allow high performance and integration at minimal power consumption. The microcontroller contains the central processing unit for the system.
- Motor driver: Depending on the type of motor, this IC is responsible for generating sequences of electrical pulses (PWMs) or it manages the speed and direction of the motor.
- Temperature sensor: Temperature sensing components like thermistors interface with the microcontroller to monitor the ambient temperature of the system.
- Communication interfaces: Communication interfaces allow for the transmission of messages between peripherals in a subsystem or between other control units on the main bus.
- LED driver: The LED driver takes in the control signals at precise frequencies sent out by the microcontroller to drive the current needed for a specific color display.

To better understand how automotive-qualified MSPM0 MCUs benefit body electronics designs, let's look at some common applications throughout modern vehicles.

Dual-Window Drive Module

Commonly found in most modern vehicles, the dual window control unit is responsible for managing the electrical supply to the windows, allowing them to be raised or lowered with ease. The user typically interfaces with the window control module through switches located on the door panel.

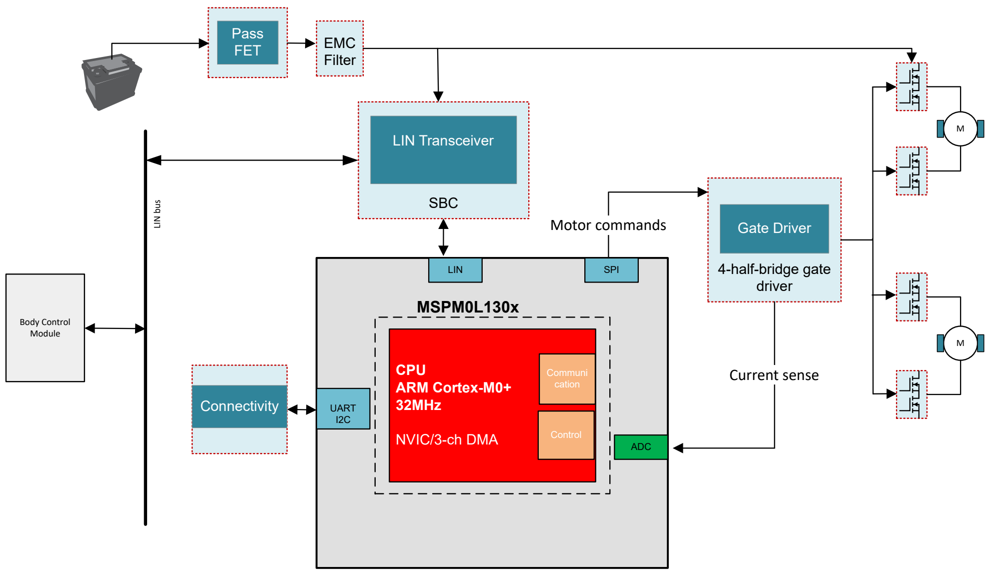

Figure 4. MSPM0 Dual-Window Drive Module System Block Diagram

Side Mirror Module

The side mirror module is an electronic unit responsible for controlling the various functions of the side mirrors, such as adjusting their positions and folding them inwards. The side mirror module is connected to the car's body control module. The user typically interfaces with the side mirror through control switches located near the driver seat.

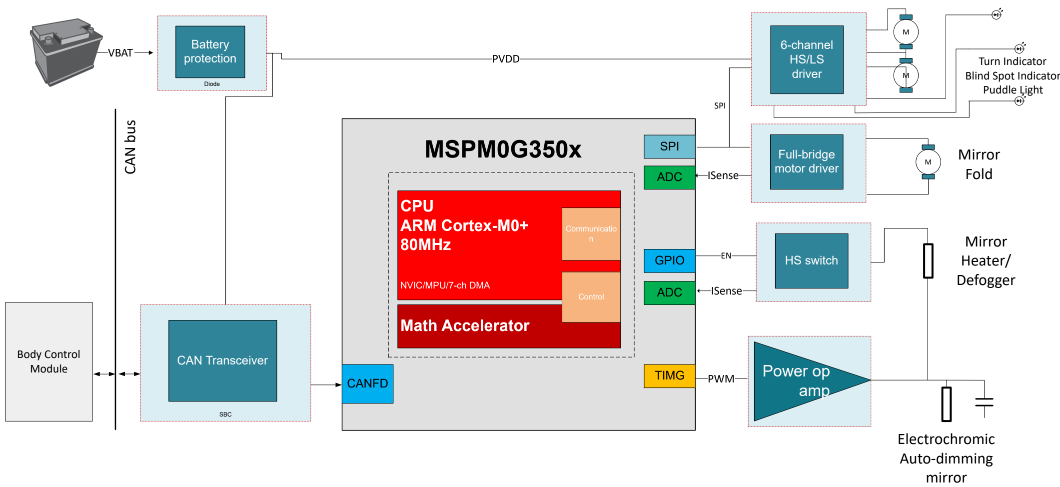

Figure 5. Side Mirror Module System Block Diagram

MSPM0 in Electronic Side Mirror and Window Control Designs

Key feature requirements for MCUs in these applications:

- PWM
- CAN FD or LIN
- 12-bit ADC
- SPI or I2C
- Watchdog timer

In these designs, the MSPM0 MCU plays the critical role of the main controller and processor for all interfacing components on the PCB. In active mode, the power consumed is 96uA/MHz at room temperature. In standby mode, only 1uA running current is consumed. The MCU is able to stay in a low-current sleep mode until the user activates a switch. In this low-power mode, several modules such as ADC, comparator, RTC, and Watchdog timer can operate simultaneously, thereby reducing overall power consumption.

When prompted, the MCU is sends control signals through SPI or with PWMs to the motor drivers. In this serial communication procedure, the MCU is operating as the host. It is able to configure the driver's internal registers to read the status and set the PWM frequencies necessary to drive the movement of the mirror and windows. MSPM0G350x contains three types of timers that can be used for PWM output: 16-bit resolution general purpose, 16-bit advanced control, and a 32-bit high resolution. These timers also support synchronization and cross trigger connections within the same power domain.

The MCU is also receiving analog inputs from the motor drivers to monitor the current flowing through the motor. With 12-bit ADC sample rates upwards of 4 MSPS, measurement of the current flowing through the motor can occur efficiently, which allows the MCU to adjust the driver's current control settings in real-time.

The MSPM0 portfolio also contains an integrated highspeed CAN FD in packages as small as 5x5mm^2. This peripheral allows for quick and reliable access through the CAN transceiver and to the main bus, where serial communication between the body control units can occur.

Smart Trunk Opener

The smart trunk opener electrical control unit is responsible for receiving inputs from proximity sensors and sends the necessary outputs to control the opening and closing of the trunk. This system provides a convenient and safe way for the user to interact with the trunk without having to physically touch the car.

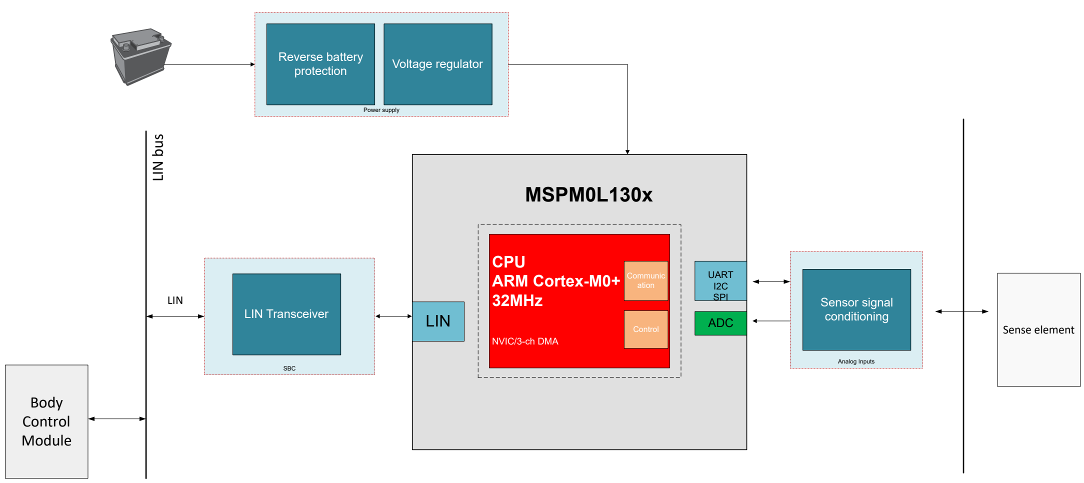

Figure 6. MSPM0 Kick to-open-Trunk Module System Block Diagram

MSPM0 in Trunk Opener Designs

Key feature requirements for MCUs in these applications:

- PWM
- LIN
- 12-bit ADC
- Comparator (COMP)
- I2C or SPI

Similar to the previous design, the MCU serves as the host receiving front-end analog readings from a proximity sensor and then sends the packets of information to the LIN bus to trigger the unlocking of the door. Below is a simple example flow chart implementation of this design:

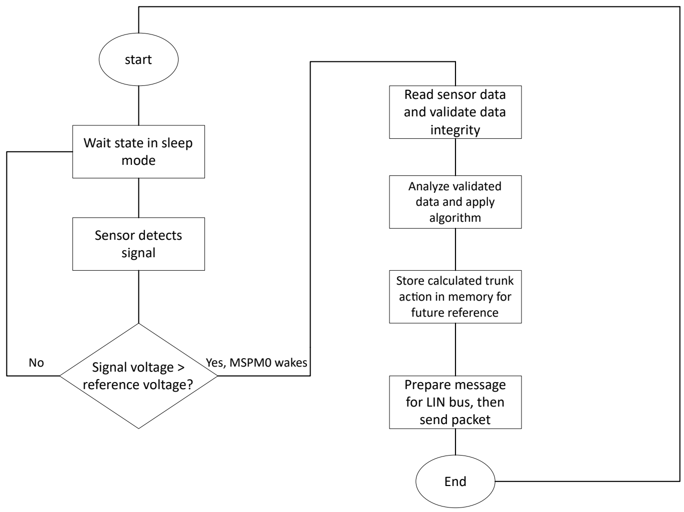

Figure 7. MSPM0 Kick to-open-Trunk Module Example Flow Chart

Beginning at the top left, we have the start state, or the initial state after the boot up of the device. The MSPM0 starts in a sleep mode meaning the CPU is off waiting for an interrupt trigger. In this low power wait state, the Watchdog timer is active checking for any faults and running alongside the Real-time clock that is keeping track of time for the next system update. After some time, the proximity sensor detects a signal. That signal is then fed into the registered comparator pin of the MSPM0. If the sensor signal voltage is higher than the configured reference voltage, the output is high trigging the MSPM0 to wake up from sleep mode in as fast as 10µs. The CPU is now active. The ADC then takes the analog sensor data and converts it to digital. The data is then validated using the cyclical redundancy check (CRC) module to verify the integrity. After that, the data is analyzed by the CPU, an algorithm is applied based on desired action of trunk. From the system perspective for example, there can be different heights of the trunk opening, or a sensor can be activated to check if there is an object blocking the motion path of the trunk door. After this instruction, the data is then stored in memory for future reference. In parallel, the message for the LIN is prepared and finally transmitted to the body control module through the LIN bus.

Getting Started Today With MSPM0 Automotive MCUs

Order an MSPM0 Launchpad today to start evaluating MSPM0 for your body electronic control designs. Jump start you design with MSPM0 code examples and interactive online trainings. You can also find other resources using these links:

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- MSPM0 Software Development Kit
- MSPM0 Programming Tools
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