Application Brief
Automotive Door Electronics Architectures

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Introduction

Automotive doors have an increasing variety of features and there are many different ways to implement the control of these features. We'll briefly discuss the different architectures that may be used and the tradeoffs with each.

Figure 1 shows the block diagram of a typical front door electronic control unit (ECU). It is common for the power supply functions and communications interface to be integrated into a system basis chip (SBC). The motor drivers, high-side switches, and LED drivers may be implemented as separate components or may be integrated into a multifunction driver. Some implementations combine these two mostly analog functions into one chip; however, this approach is less flexible in terms of interface options (for example, CAN-FD, Ethernet, and so on.), power supply options (for example, 12V, 24V, 48V), and changing door functions.

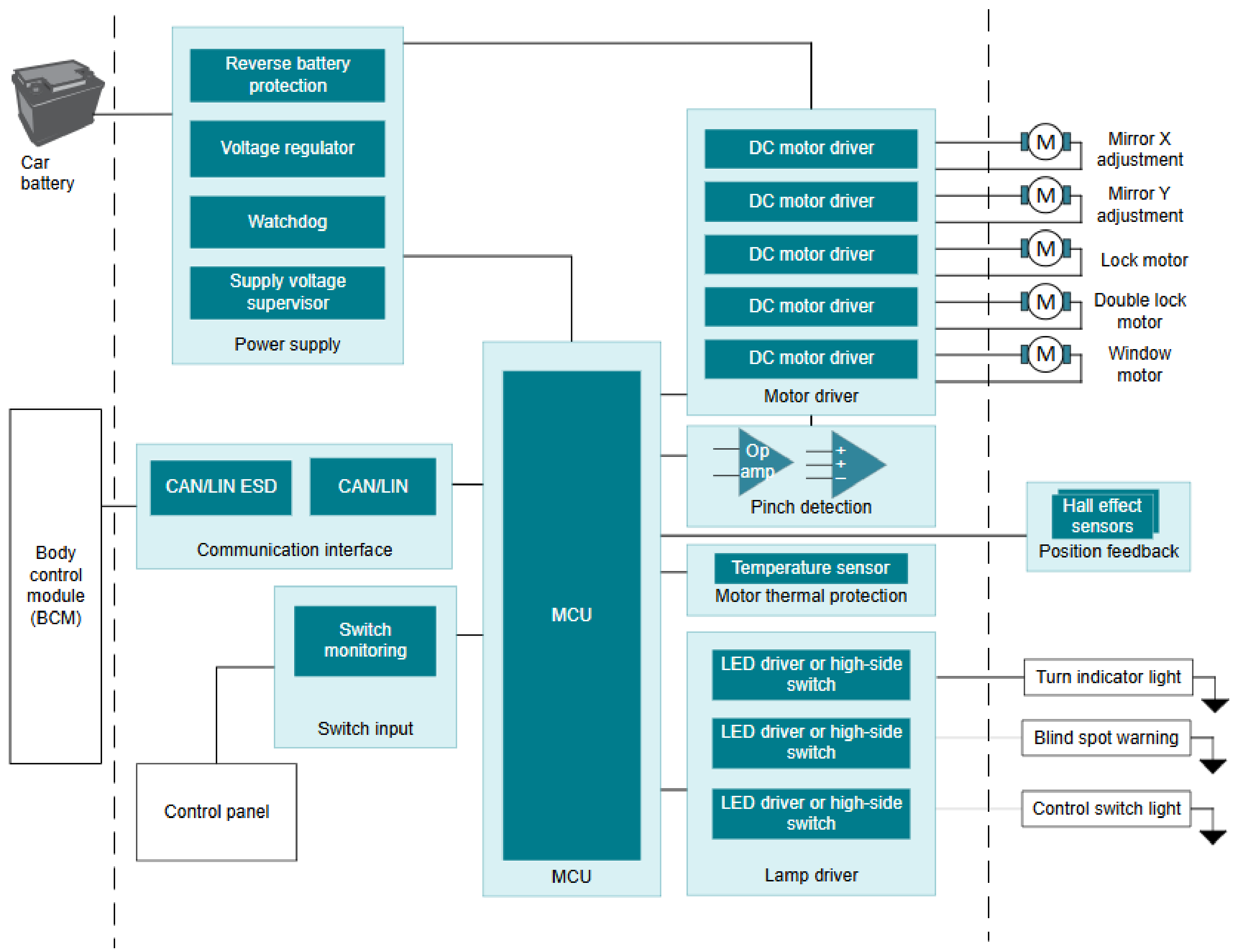

Figure 1. Overview of Door Control Unit

There are a number of architectures that are used in designing the door electronics. In Figure 2 four different versions are shown. The upper left shows four door control units (DCU), each connected to the vehicle network and each controlling all the functions for the door. The upper right shows a front-drives-rear configuration, where the front DCU also controls the functions of the rear door on the same side of the car. The advantage is a reduction in network connections and local controllers required. A drawback for this configuration is the need to route wiring from the front DCU to the buttons and actuators in the rear door.

The bottom left configuration shows *smart motors* for each function, each with its own network connection and with local control of a single function. The bottom right configuration is a variation where the locking functions for doors is controlled from a central ECU or separate e-latch modules.

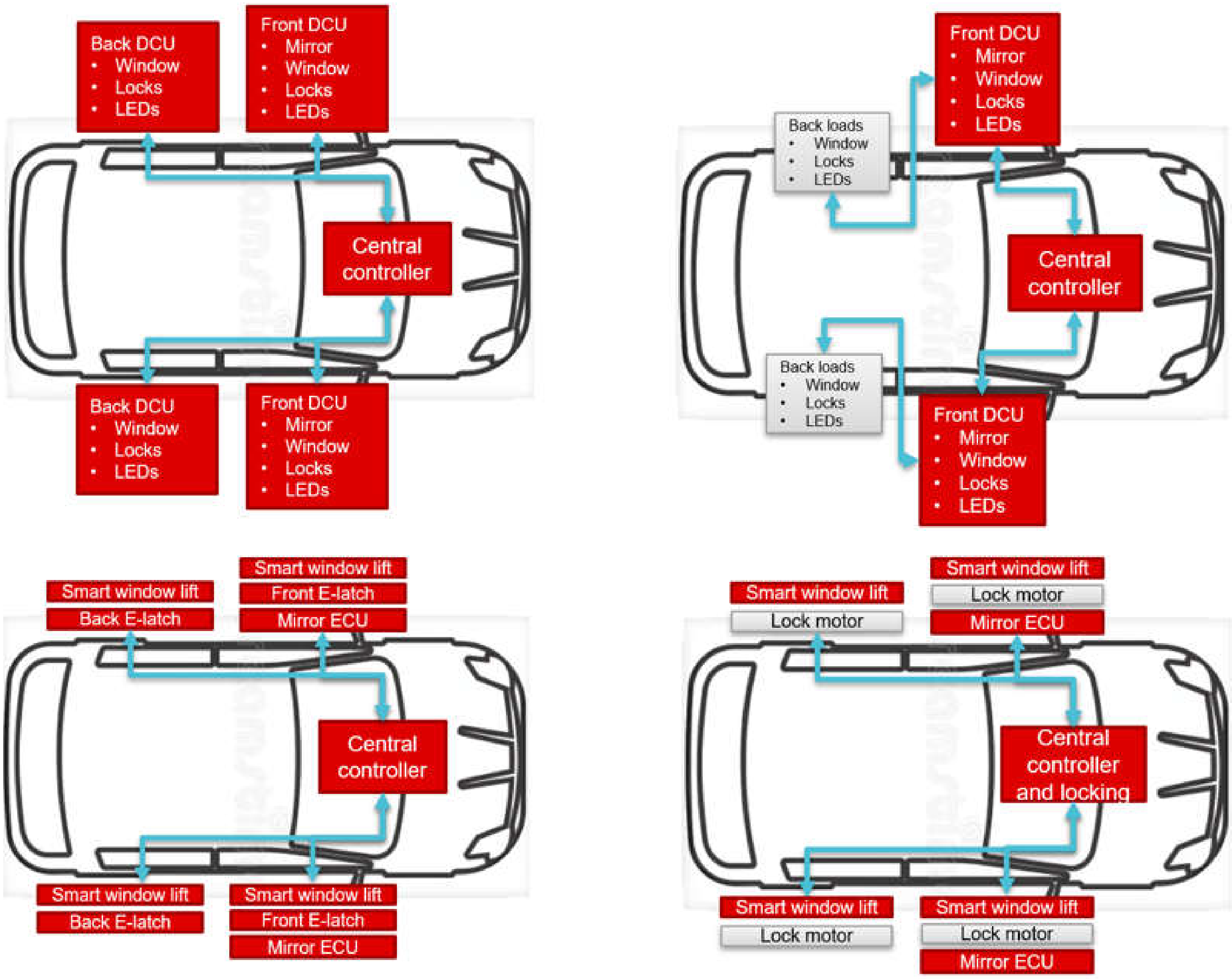

Figure 2. Various Architectures to Implement Door Function Control

In all of these configurations, it is typical for each ECU to have an SBC which connects to the 12V power supply and also integrates a transceiver to the vehicle data bus such as CAN or LIN. A microcontroller unit (MCU) handles interpretation of the network messages, sends commands to the load drivers, and provides feedback to the vehicle and driver.

All-Inclusive Front Door Implementation

In cases where all the functions of the door are implemented in a single door control unit (DCU), the DRV8000 multifunction driver provides a solution integrating numerous functions like motor control, diagnostics, and protection in one device. Its ability to drive various loads such as motors, lamps, and electrochromic elements, combined with features like overvoltage/overcurrent protection and diagnostics, enables the creation of robust and compact door control systems for automotive applications.

For zone modules which control and drive the door functions as well as other loads, integration of the drive functions makes sense to reduce component count.

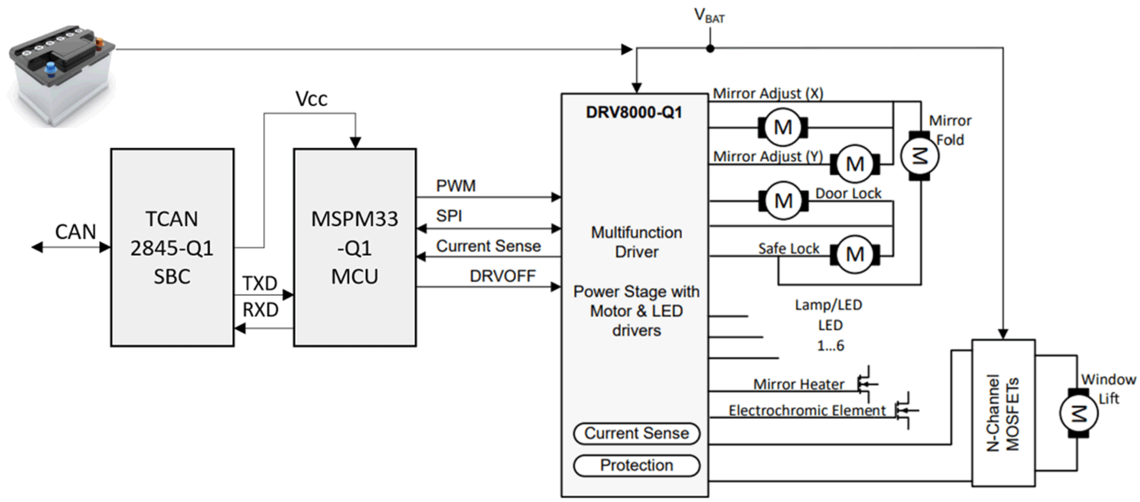

Figure 3. DCU Block Diagram Using DRV8000-Q1

Front Door Implementation With Smart Window Lift

Another configuration segments the window lift function as an edge node separate from the other door functions. In this configuration the window lift is implemented by a smart motor with control and drive electronics directly on the window lift mechanism; each window lift has its own connection to a serial data bus, typically LIN or CAN, and a local microcontroller.

For the remaining door functions in this configuration, the DRV8001 is a good choice. It integrates drive and control circuits for the locks, mirror functions, and illumination into a single chip. Figure 4 shows the block diagram for the DRV8001 with typical loads.

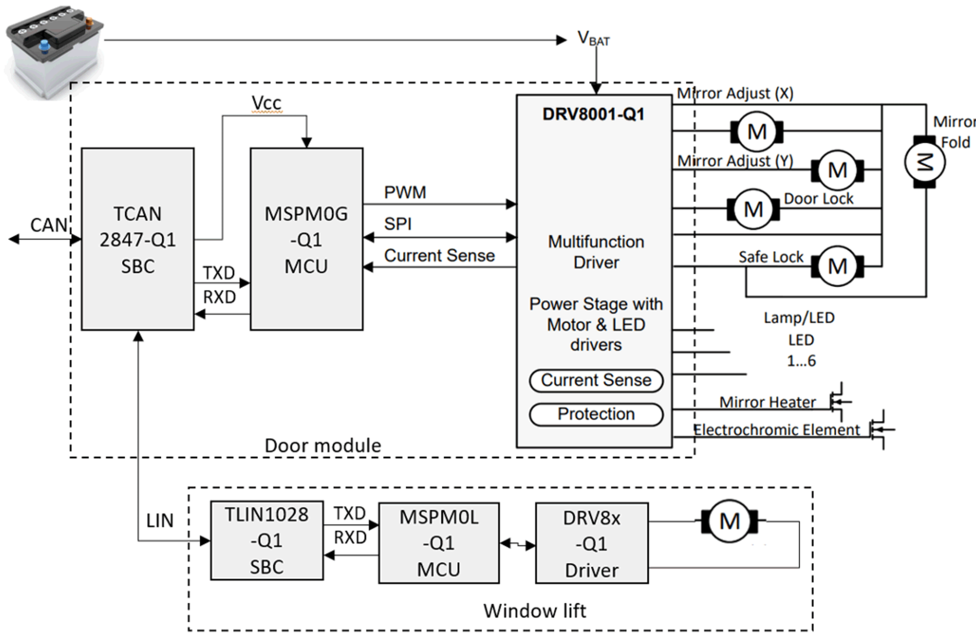

Figure 4. DCU Block Diagram with DRV8001-Q1 and Smart Window Lift

Rear Door Configuration

Rear doors typically have a reduced set of features compared to front doors. The absence of a side mirror simplifies the requirements, but the rear door will still typically have a power window lift and power lock, as well as LED illumination for buttons. Some models may also have features such as powered window shades or smart glass tinting, ambient LED lighting, or soft close/open features. Figure 5 shows a block diagram of a typical rear door. Like the front door, there are various configurations to implement the circuitry associated with the rear door functions.

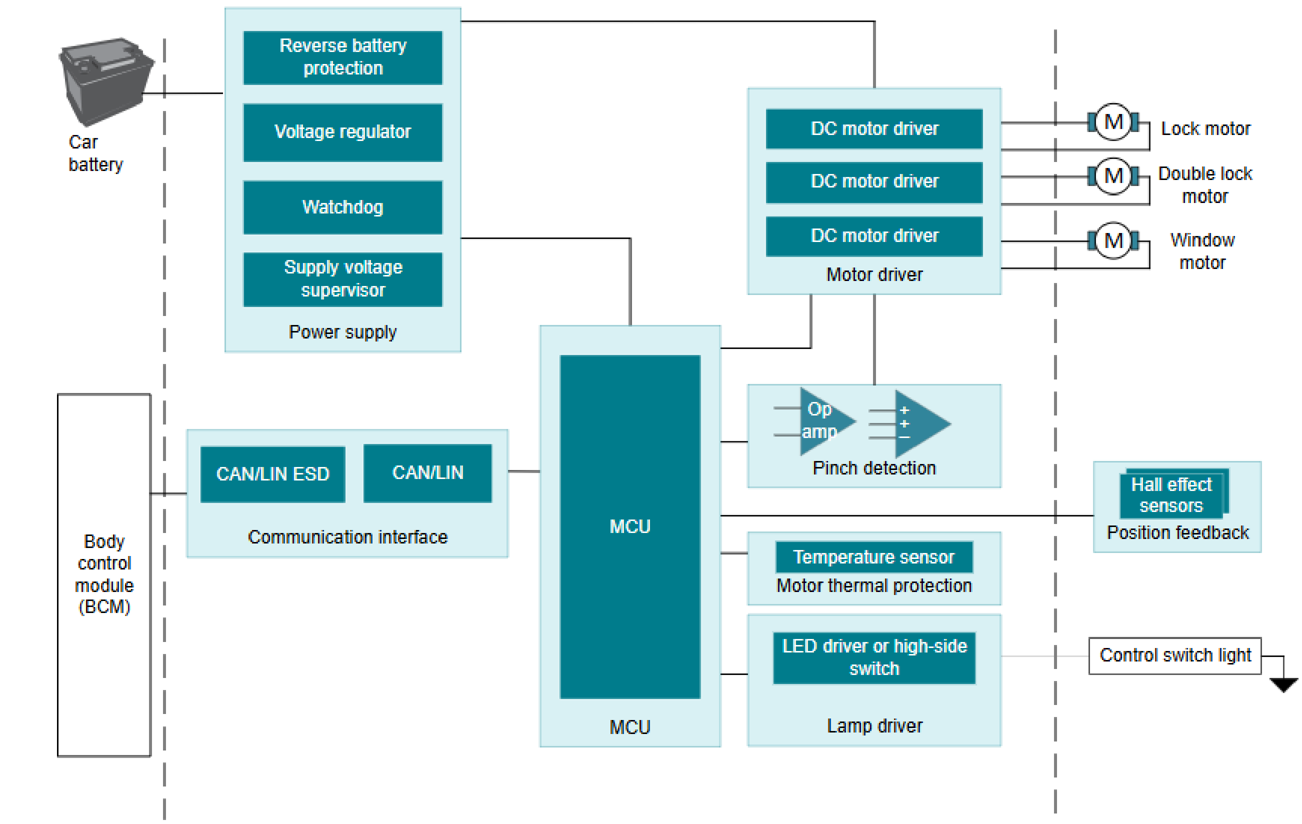

Figure 5. Rear Door Block Diagram

Figure 6 shows the DRV8002-Q1 multifunction driver implementing the drive functions for a typical rear door design. Like others in this family, it integrates the control, drive, and diagnostic circuits for each load into a single chip.

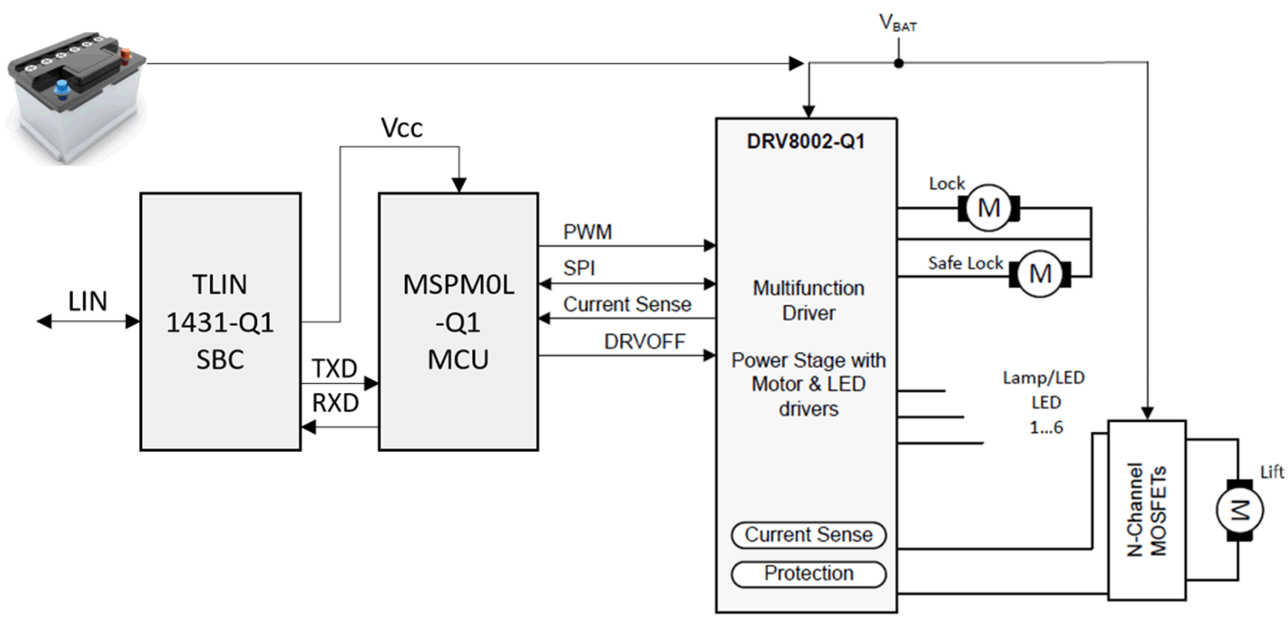

Figure 6. Back Door Block Diagram With DRV8002-Q1

Future Trends

Recent trends in door electronics include the migration towards zonal architectures, increased use of high-speed networks such as Ethernet and CAN XL, introduction of 48V power supply options, and remote control of edge nodes. These trends enable the integration of additional features, lower cabling weight, and software defined vehicle (SDV) capabilities. Figure 7 illustrates how a few of these trends might be implemented.

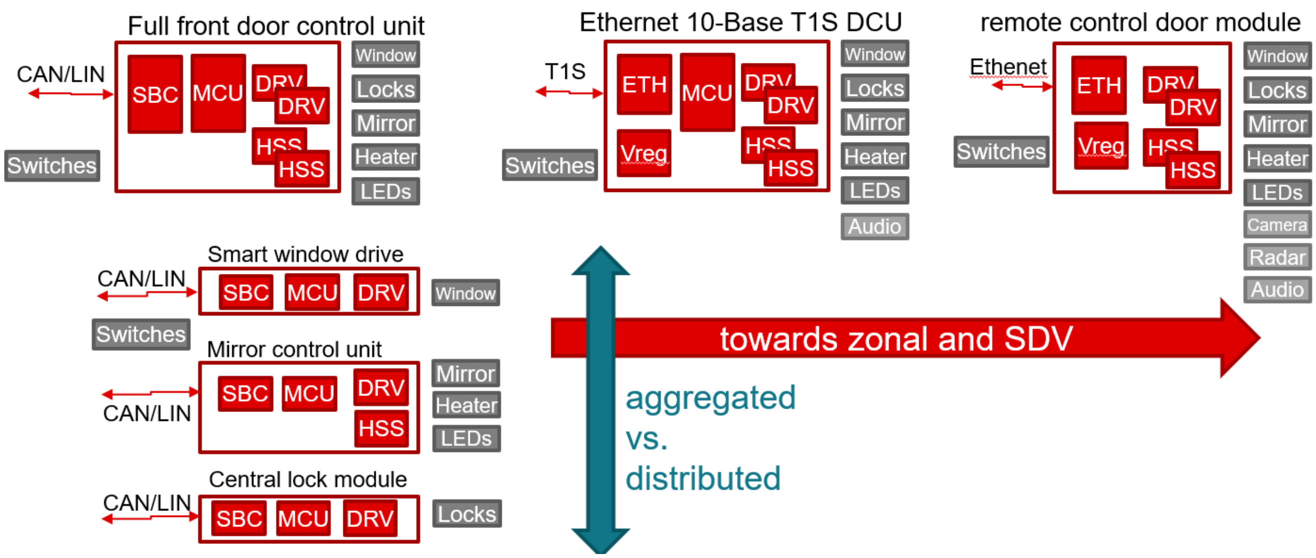

Figure 7. Future Evolution of Door Electronics

DRV800x Flexibility in Evolving Vehicle Technologies

The DRV800x-Q1 family of multi-function drivers gives designers the flexibility to meet the challenges of future door architectures. Figure 8 shows a DCU with 48V supply with the high-power window lift motor using a 48V motor, and the lower-power functions remaining on a 12V supply. This reduces the supply current to the door, allowing lighter cable harness, while requiring no re-design of the established mirror and lock mechanisms. Partitioning the DCU chips in this manner also allows designers to take advantage of enhanced communications protocols such as CAN-XL or Ethernet.

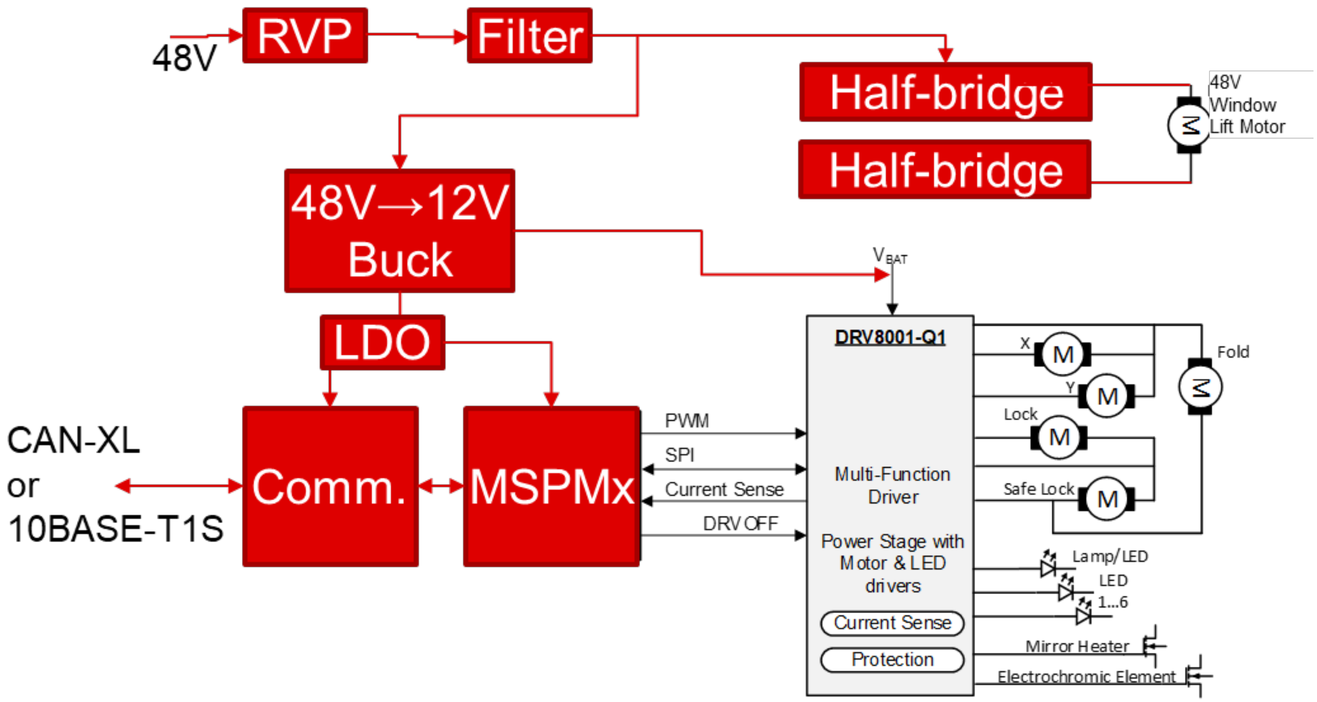

Figure 8. DCU with 48-V Window Lift, Advanced Communication

Conclusion

As automotive door features and requirements continue to evolve, designers have many options for implementing the electronics. Texas Instruments can help engineers design for any of these architectures.