Session 20

ECU design for door glass control

Designing an ECU (Electronic Control Unit) specifically for controlling car door glass involves a combination of hardware and software elements, focusing on features like motor control, safety functions, and communication with other vehicle systems.

Here's a breakdown of the key considerations for such an ECU design:

1. Core components and architecture

- Microcontroller (MCU): This serves as the "brain" of the ECU, executing the software that manages the door glass control functions. It needs to be an automotive-grade MCU, ideally with integrated features like CAN and LIN modules for communication. Examples include the NXP S12G128 chip, according to Intelligence Science and Technology Press.
- Memory: Flash memory stores the ECU's software and configuration data, while RAM is used for temporary data storage during operation.
- Power Supply: A robust power supply circuit is crucial for reliable operation in the vehicle's electrical environment.
- Input/Output Interfaces: These connect the ECU to sensors (e.g., switches, position sensors) and actuators (e.g., window motors).
- Motor Drivers: High-performance motor drivers are essential for controlling the DC motor that raises and lowers the window glass. These drivers often include enhanced diagnostics for robust motion control systems.
- Communication Interfaces: CAN and LIN modules are typically integrated into the MCU to facilitate seamless integration with other vehicle communication networks, according to Renesas Electronics.

2. Key functionalities

- Window Motor Control: The ECU needs to provide forward and reverse control for the window motor, allowing the window to be raised and lowered accurately.
- Anti-Pinch Function: This crucial safety feature prevents injuries by detecting obstacles and stopping or reversing the window's movement if an obstruction is

encountered. This often involves a current ripple algorithm that analyzes the motor's current to detect blockages.

- Sensor-based Control: The ECU monitors signals from various sensors, including window lift switches, and potentially other inputs like rain or darkness, to trigger automated window actions.
- Adaptive and Self-Learning Anti-Pinch: This function ensures consistent anti-pinch performance by adapting to wear and tear in components like sealing strips and motors, according to Intelligence Science and Technology Press.

3. Communication and networking

- CAN and LIN Bus: These are commonly used in-vehicle communication protocols. The ECU communicates with other modules (e.g., body control module, door control units) via these networks.
- Message Formats: Defined message formats are needed for status updates and commands between the ECU and other modules.

4. Software design

- Operating System (OS): The ECU will likely run an embedded operating system to manage tasks and resources.
- Application Software: This contains the logic for controlling the door glass, processing sensor data, implementing anti-pinch functions, and communicating with other systems.
- Model-Based Design: Using tools like MATLAB and Simulink can simplify the design, generate code automatically, and reduce development costs and time.

5. Mechanical design

- Compact Size: The ECU needs to be small enough to fit within the limited space inside the door.
- Robust Housing: The housing must protect the electronics from the harsh automotive environment (vibrations, temperature variations, and potential water ingress).

- Connectors: Standardized connectors like StAK50h, Stac64, and Mini50, widely accepted in the automotive industry, are used to connect the ECU to the vehicle wiring harness.

6. Safety and reliability

- Diagnostics: Comprehensive diagnostic features help identify and troubleshoot faults within the system.
- Fault Identification: The system needs to be able to detect errors and potentially trigger alerts like sirens or flashers in case of malfunctions.
- ISO 26262 Compliance: Adherence to automotive safety standards like ISO 26262 is critical to ensure the reliability and safety of the system, especially for safety-critical functions like anti-pinch.

In essence, the ECU design for door glass control requires a sophisticated blend of hardware and software engineering, focused on delivering precise, safe, and user-friendly window operation in a demanding automotive environment.

Sample Pseudocode

```
while (1) {
   buttonUp = readWindowUpSwitch();
   buttonDown = readWindowDownSwitch();
   position = readPositionSensor();
   current = readMotorCurrent();

   if(buttonUp && position != FULLY_CLOSED) {
      driveMotorUp();
   } else if(buttonDown && position != FULLY_OPEN) {
      driveMotorDown();
```

```
    } else {
        stopMotor();
    }

    if(current > CURRENT_THRESHOLD) { // anti-pinch detection
        stopMotor();
        driveMotorDownForShortTime();
    }
}
```