Application Note

Automotive Door Locks

The Design Challenge:

Two considerations in automotive engineering are weight and reliability. As cars become equipped with more options and safety requirements, the weight of the car increases. As the weight increases, performance characteristics decrease and fuel efficiency decreases. Standard fusing requires wiring through the fuse panel to the circuit being protected. This adds to a vehicle's weight, while the added wiring increases the opportunity for malfunctions. A standard blown fuse must be manually changed, and the circuit is inoperative while the fuse is in the non-functional state. The fuse box must be accessible in order to service fuses, limiting the locations the fuse box can be placed.

Automotive door lock circuits require overcurrent protection. If a door lock is jammed or forced into a position so the lock cannot move in the ordered direction, the IC chips controlling the system can be damaged. A multitude of hazardous situations can occur, such as physical damage to the door or short-circuiting due to water leakage into the door panel or low temperatures causing freezing of mechanical mechanisms. Current designs include wiring from the control module in the cockpit of the car to the door locks via the fuse box under the dash. Using standard fusing, once the fuse is blown, the door locks remain in a non-operative state until the fuse is replaced.

Agency certifications such as those issued by Underwriters Laboratory (UL), are concerned strictly with safety standards. Automotive standards far exceed the testing required by agencies such as UL. The Automotive Electrical Council (AEC) sets forth the standards for passive electrical components in the QEC 200 test standards. These tests are concerned with reliability as well as safety. Companies such as Visteon, Delphi, and Daimler/Chrysler are currently testing to QEC 200 requirements. (For a copy of AEC's QEC 200, please contact your local Bourns sales representative.)

The Application:

In a typical door lock design, the lock motor is energized through a relay by a control processor via an inverter IC (See Figure 1). A pulse is sent to the processor from the contact lock/unlock switch, key lock, motion sensor, door ajar circuit or remote control. The coils of the relay have a positive voltage from V(Batt) at pin 5 to prevent relay chatter from noise or nuisance tripping of the relays (See Figure 1). V(Batt) is typically 12 volts, but will soon be upgraded for the 42 volt automotive platform. The signal from the logic controller is sent to an inverter to bias the coil for current flow through pins 6 or 7 depending on the required workload of unlocking or locking.

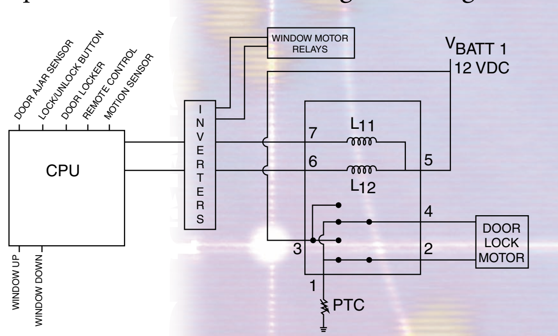

Figure 1

If the coil from pin 5 to pin 7 is energized, the armature from pin 4 will change state to pin 3 conducting current through the door lock motor in a direction to lock the door (See Figure 2). The path of the current will continue from the door lock motor to pin 2 of the relay. At pin 2 the second armature will not be engaged and will continue contacting pin 1, giving a ground through the PPTC. If a short or fault condition were to occur, the excess current flow from V(Batt) through the door lock motor and relay would cause I^2R heating in the PPTC. As the PPTC heats up, the resistance of the PPTC goes exponentially high, isolating the ground and negating circuit flow. Once the overcurrent fault condition is removed, the polymer will return to its semi-crystalline structure with the carbon chains reconnected, and current will once again flow through the PPTC.

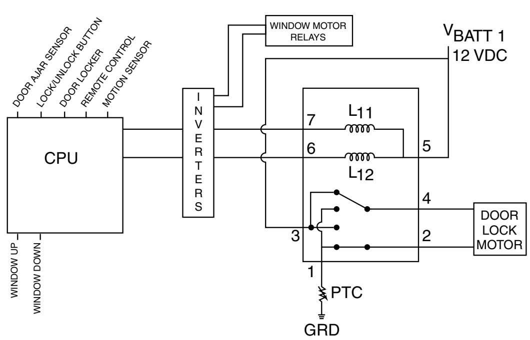

Figure 2

The unlocking portion is similar. The coil from pin 5 to pin 6 of the relay will be energized by the inverter and controller circuit. The armature at pin 1 will change state to pin 3. When this happens, the V(Batt) will let current flow through the contacts at pins 3 and 2 (See Figure 3) through the motor (changing lock position) back through pin 4 to pin 1 to the PPTC and ground, thus changing the state of the lock position.

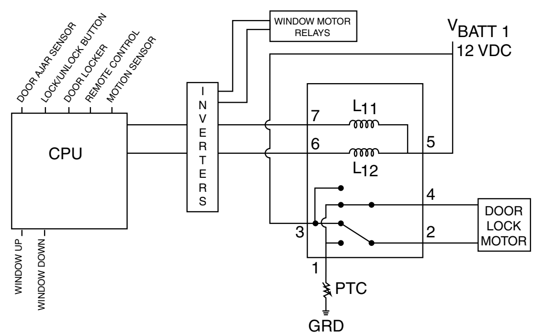

Figure 3

Consult you local Bourns, Inc., representative for additional automotive applications such as:

- Window lifts
- Electric seats
- Wiring harnesses
- Lighting
- Modules
- Underhood applications
- Accessory outlets
- Moon/sun roofs