POWER WINDOW OR PANEL CONTROLLER

Field of the invention

The present invention concerns a control system for use in activating a motor driven window or panel. One example of such a window or panel is a motor vehicle sunroof.

Background Art

National Highway Traffic Safety Administration Standard 118 contains regulations to assure safe operation of power operated windows. Standard 118 has been amended to apply to power operated roof panels. It establishes requirements for power window control systems located on the vehicle exterior and for remote control devices. The purpose of the standard is to minimize the risk of personal injury that could result if a limb is caught between a closing power operated window and the window frame. The changes to Standard 118 become effective September 1, 1992. Amended Standard 118 states that the maximum force allowable during an auto closure is to be less than 22 pounds onto a solid cylinder having a diameter of between 4 and 200 millimeters.

Certain problems have been identified with operation of existing power window controls. One problem is an undesirable shutdown of the power window control. It is also desirable to detect a soft obstruction in the window travel path as well as a hard obstruction. The gasket area of the window which avoids water seepage into the vehicle can present a problem to the design of a power window control, since the window or panel encounters different resistance to movement in the gasket region. An additional problem is detection of an obstruction when the motor is first activated.

Disclosure of the Invention

The present invention provides method and apparatus for controlling operation of motor vehicle power window systems as well as power roof panels. The control system of the invention includes a sensor, which provides absolute position, speed and direction of movement, and a control circuit for controllably activating a motor to move a window or panel.

In accordance with one embodiment of the invention, the control circuit activates the motor to move a window or panel along a travel path and de-activates the motor if an obstacle is encountered by the window or panel. Striking an obstruction causes the motor current to rise since the energy supplied by the battery is no longer dissipated in rotating the motor shaft. A motor sense circuit coupled to the control circuit senses the motor current as the motor moves the window or panel along its travel path.

In accordance with one aspect of the invention, the control circuit monitors motor current from the motor sense circuit and times a start-up interval each time the motor is energized. The control circuit compares sensed motor current after the start-up interval with a predetermined motor current and stops the motor if the sensed motor current exceeds the predetermined motor current. This will detect an attempt to start movement with an obstruction next to the window or panel.

In accordance with an additional aspect of the invention, the control circuit monitors and saves an indication of motor current vs. position during a ~~calibrating~~ calibration sequence. As the motor moves the window or panel subsequent to the calibration sequence, the control circuit compares sensed motor current with motor currents sensed during the calibration sequence. If too large a deviation in motor current is sensed, the control circuit stops the motor.

The control circuit updates the profile of current vs. position as the window or panel is opened and closed. This updating assures that as the window or panel drive mechanism changes with use, the control circuit maintains an up-to-date profile for detecting obstructions.

These and other features of the invention are described below in the best mode for practicing the invention, which is described in conjunction with the accompanying drawings.

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Brief Descriptions of the Drawings

Figures 1A and 1B are schematics of a power window or panel control circuit constructed in accordance with the present invention;

Figure 2 is a schematic of a position sensor circuit that utilizes a Hall Effect device to sense when a sunroof panel is in a park position;

Figure 3 is a power supply for providing regulated power to the Figures 1A and 1B circuit;

Figure 4 is an interface for coupling inputs to a microprocessor depicted in Figure 1B; and

Figure 5 is a schematic showing pulses produced by a motor shaft encoder that monitors position, speed, and direction of travel of said window or panel.

Best Mode for practicing the Invention

Turning now to the drawings, Figures 1A and 1B depict a circuit 10 for activating a d.c. motor 12 having an output shaft coupled to a transmission that moves a window or panel in a motor vehicle. A pulse width modulation activation of the motor windings controls the speed of motor output shaft rotation as the motor opens or closes the window or panel. When used to operate a power sunroof the control circuit 10 can open the sunroof, close the sunroof, and also tilt open the sunroof to a vent position. The preferred embodiment of the invention concerns a power operated sunroof but other panels or windows could be actuated using the disclosed control circuit 10.

Motor energization is accomplished by controlled actuation of a solid state device (semiconductor) Field Effect Transistor (FET) 20 (Fig 1B) which could also be a transistor, triac, or SCR whose conductive state is controlled by a micro-processor controller 22. Although a microprocessor controller 22 is used in the preferred embodiment of the invention, hard-wired circuitry could be used to implement the disclosed controlled motor energization.

Power is applied to the motor 12 from the motor vehicle battery. As seen in Figure 1A a battery input 24 is coupled through a resistor 26 to one of two single pole double throw relays 30,32. When one or the other of the contacts 30a,32a of the relays 30, 32 are closed, a current path from the battery input 24 through the motor windings to ground is controlled by the conductive state of the FET 20.

Power Supply

A power supply 40 depicted in Figure 3 supplies a regulated voltage for powering the circuit 10. The power supply also protects the circuit 10 from external transients which could cause failure of the circuit 10. A metal oxide varistor 42 is used as a transient suppressor and a diode 44 protects the control circuit 10 from inadvertent reverse battery connection.

An ignition input 46 is used to control the condition of the power supply 40. When the ignition input goes high in response to the motorist actuation of the ignition key to either run,start,or accessory position, the high signal is transmitted through a diode 48 to a gate input of a transistor 50. This causes a second transistor 52 to conduct which applies the battery voltage to a voltage regulator 54. An output from the regulator 54 is a regulated voltage VCC for powering the circuit 10.

The power supply 40 is temporarily latched into operation for a time after the ignition signal has been removed when the user switches the ignition off. A diode 60 is connected to an output from the controller and latches the power supply 40 in the on condition. Latching of the power supply allows the circuit 10 to automatically close the power sunroof after the ignition key is turned to an off position. An advantageous feature of activating the power supply 40 and hence the circuit 10 only when the ignition is switched on is to reduce quiescent current.

External Interface

Figure 4 depicts an interface 62 that couples additional signals to the circuit 10 by means of a series of pull-up resistors 64a - 64g. The input designations on the left of Figure 4 are active when they are pulled low. Corresponding labels are seen at the left of Figure 1B. The inputs are summarized here and referred to below in describing detailed operation of the circuit 10.

An open input 66 is a momentary type input activated by the motorist and is used to open the sunroof. A close input 68 is also a momentary type input and

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is used to close the sunroof. A vent input 70 is a momentary type input and is used to move the sunroof to a vent position. Two phase inputs 72,74 are inputs that are connected to a position encoder. The phase inputs are toggled in a quadrature fashion and are used to provide sunroof panel speed, direction, and position feedback to the microprocessor 22.

Figure 5 depicts representative phase 1 and phase 2 signals from a motor shaft encoder, however, other position sensors such as a potentiometer or linear encoder can be used. At a given sampling time, the status of the two phase inputs is either 00, 01, 10 or 11. The transition states of these inputs allow the controller 22 to determine motor rotation direction. If the phase signals change, for example, from a 00 state to a 10 state, the motor is rotating in one sense. If the transition is from a 00 state to a 01 state, rotation is in an opposite sense. By monitoring the rate of change of the pulses, the controller 22 also determines motor speed. Finally, by counting pulses received as the sunroof moves from a park or closed position, the controller 22 can determine the position of the sunroof.

Motor Direction

In addition to controlling the pulse width modulation of the motor 12 the microprocessor controls the direction of motor actuation. Two microprocessor outputs 80,82 are used to activate Darlington switching transistors 84,86. When one transistor 84 is active an associated relay coil 30b is energized and the battery input 24 is coupled through the contact 30a to a motor terminal 12a. When the transistor 84 is not conducting, the coil 30b is not energized and the contact 30a couples the motor terminal 12a to the FET 20.

The Darling transistor 86, coil 32b and contact 32a are similarly configured to selectively connect the battery and FET connections to the motor terminal 12b. The outputs 80,82 from the microprocessor 22 can also be pulse width modulated to decrease motor drive torque as well as regulate the motor speed. When both coils 30a,30b are energized the motor windings are shorted to produce a braking effect.

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