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ECE/CS 3720: Embedded System Design (ECE 6960/2 and CS 6968)

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Lecture 17: Relays and Motors

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Introduction to Relays

- A relay is a device that responds to a small current or voltage change by activating a switches or other devices.
- Used to remotely switch signals or power.
- Input control usually electrically isolated from output.
- Input signal determines whether switch is open or closed.

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Various Relay Configurations

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Types of Relays

- Classic general-purpose relay has an EM coil and can switch power.
- The solid-state relay (SSR) has an input-triggered semiconductor power switch.
- The read relay has an EM coil and can switch low level DC electronic signals.
- The bilateral switch uses CMOS, FET, or biFET transistors (technically not a relay but behaves similarly).

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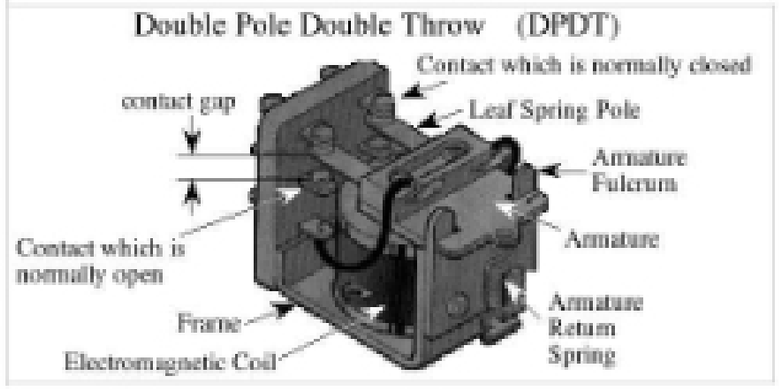
Drawing of an EM Relay



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Electromagnetic Relay Basics

- Input circuit is an EM coil with an Iron Core.
- Output switch includes two sets of silver or silver-alloy contacts (called *poles*).
- One set is fixed to the relay *frame*, and other is located at end of leaf spring poles connected to the *armature*.
- Contacts held in "normally closed" position by the armature return spring.
- When input circuit energizes EM coil, a "pull-in" force is applied to the armature and "normally closed" contacts break while "normally open" contacts are made.

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Solid State Relays

- Developed to solve limited life expectancy and contact bounce problems since they have no moving parts.
- Also, faster, insensitive to vibrations, reduced EMI, quieter, and no contact arcing.
- Optocoupler provides isolation between the input circuit (pseudocoil) and the triac (pseudocontact).
- Signal from phototransistor triggers the output triac so that it switches the load current.
- Zero-voltage detector triggers triac only when AC voltage is zero, reducing surge currents when triac is switched.
- Once triggered, triac conducts until next zero crossing.

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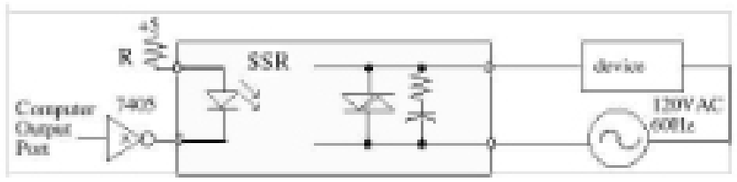
Solid State Relays



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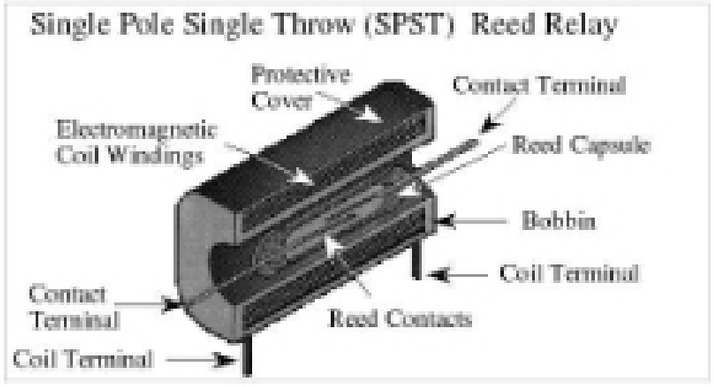
Reed Relays



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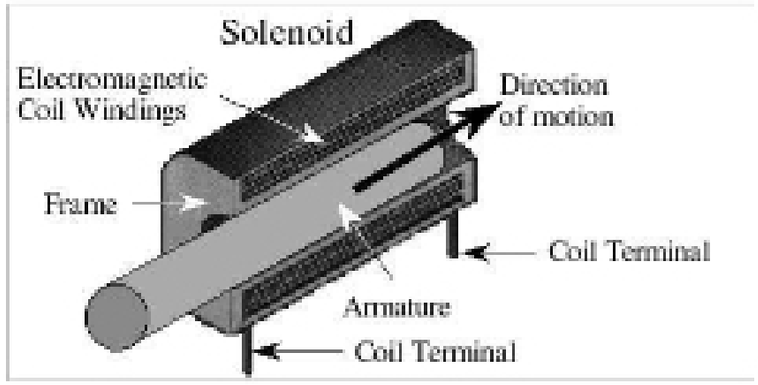
Solenoids



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Pulse-Width Modulated DC Motors

- DC motor also has frame that remains motionless and an armature that moves in this case in a circular manner.
- When current flows through EM coil, magnetic force created that causes rotation of the shaft.
- Brushes positioned between frame and armature used to alternate the current direction through the coil so that a DC current generates a continuous rotation of the shaft.
- When current removed, shaft is free to rotate.
- Pulse-width modulated DC motor activated with fixed magnitude current but duty cycle varied to control speed.

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Interfacing EM Relays, Solenoids, and DC Motors

- Interface circuit must provide sufficient current and voltage to activate the device.
- In off state, input current should be zero.
- Due to inductive nature of the coil, huge back electromotive force (EMF) when coil current is turned off.
- Due to high speed transistor switch, there is a large di/dt when the coil is deactivated (activation also but smaller).
- Voltages can range from 50 to 200V.
- To protect the driver electronics, a snubber diode is added to suppress the back EMF.