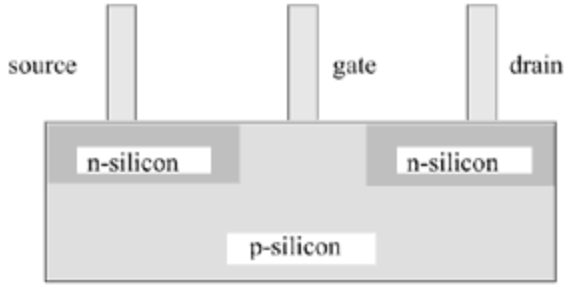
The Journey Inside[SM]: Circuits and Switches
Student Handout: Nonmechanical Switches

Nonmechanical Switches

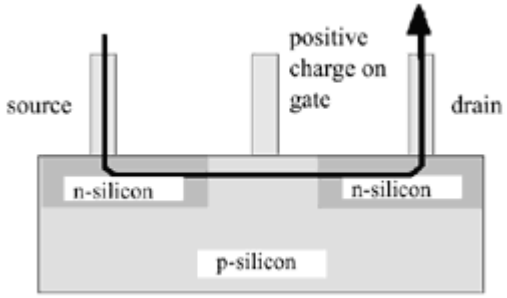
You already know the difference between conductors and insulators. A semiconductor is a material that does allow the flow of electrons but does not do so very well. Semiconductors are useful in electrical circuits because it is possible to change the properties of semiconductors to more efficiently carry current.

Pure silicon is a semiconductor and does not conduct electricity very well. Adding material such as phosphorous or boron, known as impurities, to the silicon results in a material that conducts electricity better than pure silicon does. Both pure and impure silicon are used to make electronic switches called transistors. This same blend of material is used in making integrated circuits.

Transistors make excellent circuit switches because they can be switched from on to off extremely quickly and easily. A transistor has three posts or legs called the source, the gate, and the drain. In the diagram of a transistor given below, the n-type silicon is silicon containing a very small amount of phosphorus. The p-type silicon is silicon containing a very small amount of boron. Adding the correct amount of these elements to silicon allows the silicon to conduct electricity exactly as needed to act as a switch to turn the circuit on and off.



Electrons cannot move from the source to the drain in this transistor because electrons do not naturally flow from n-type silicon to p-type silicon. However, when a positive charge is applied to the gate, the free electrons in the p-type silicon will move to the area between the two pieces of n-type silicon. This current puts the transistor switch into an “on” state. Extra electrons move into the space between the two areas of n-type silicon. Electrons enter the transistor from the source area of n-silicon, move to the drain area of n-silicon, and continue from the transistor through the circuit.



Although there are a variety of transistor types, all work in a similar way.