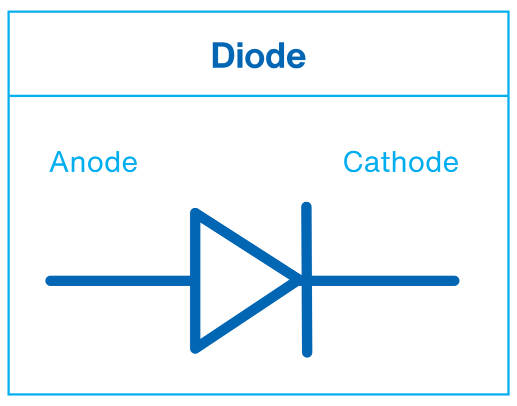
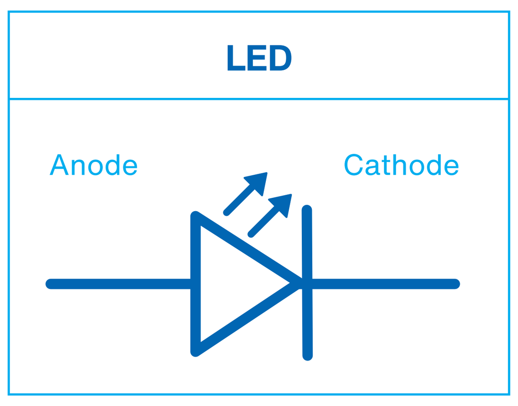
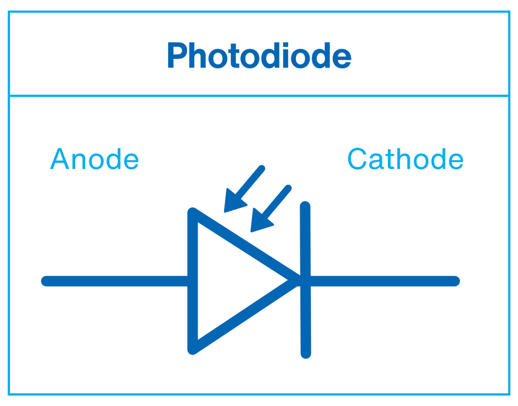
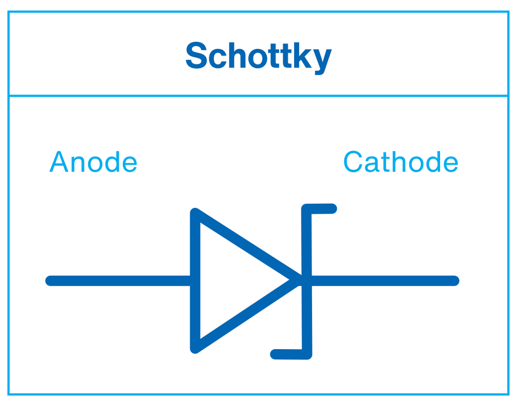
Circuit symbols

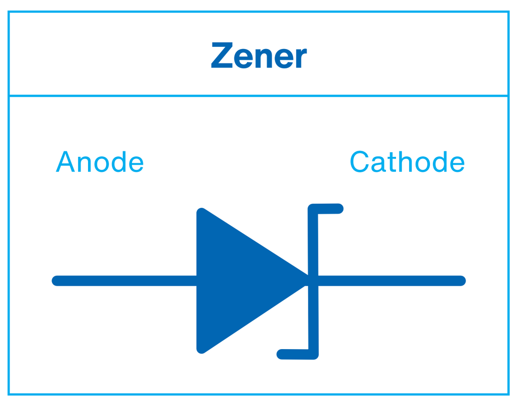
A Diode lets current pass in only one direction. That's the **Forward direction**. Current is blocked in the **Reverse Direction**. This behavior is known as **Rectification**.









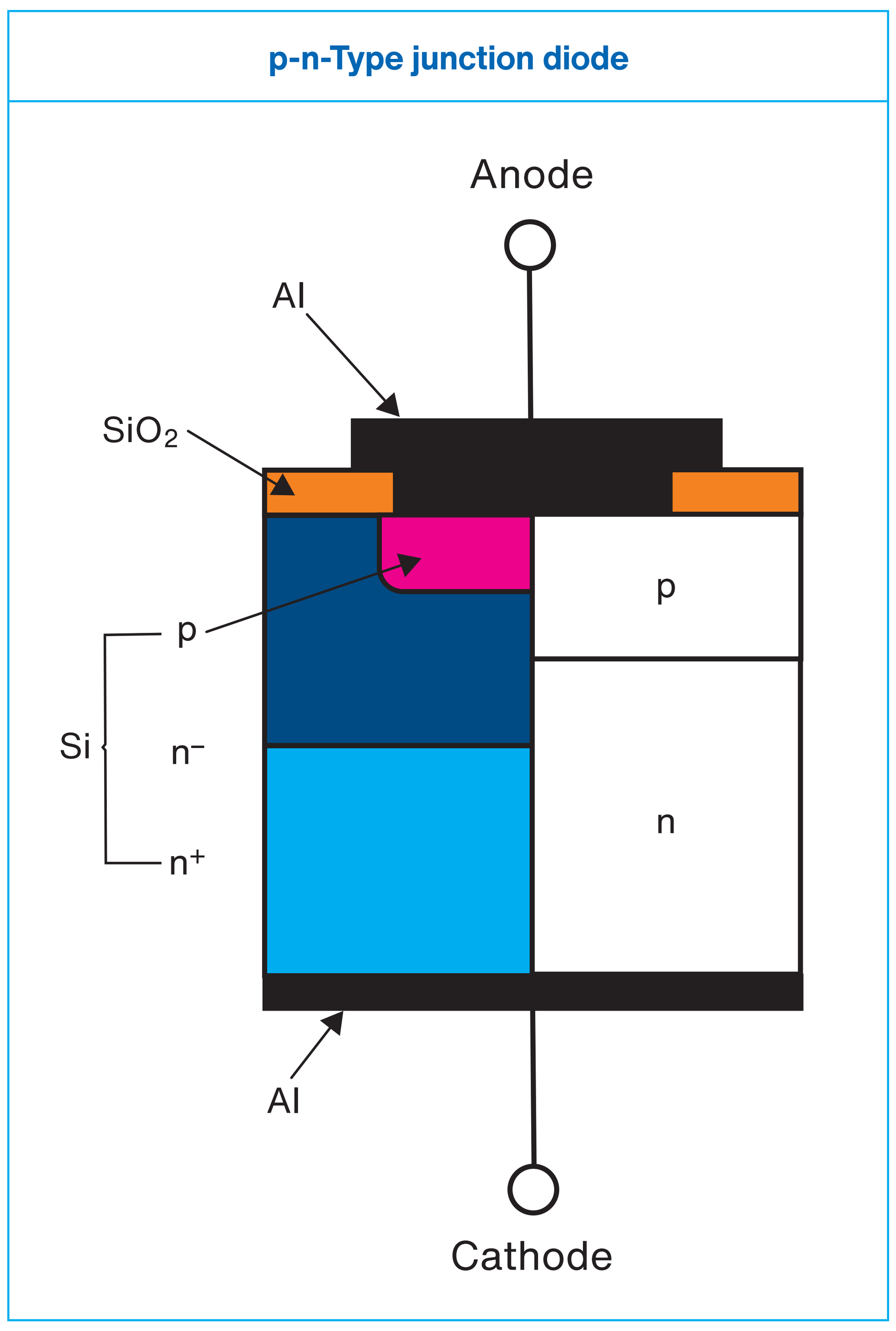


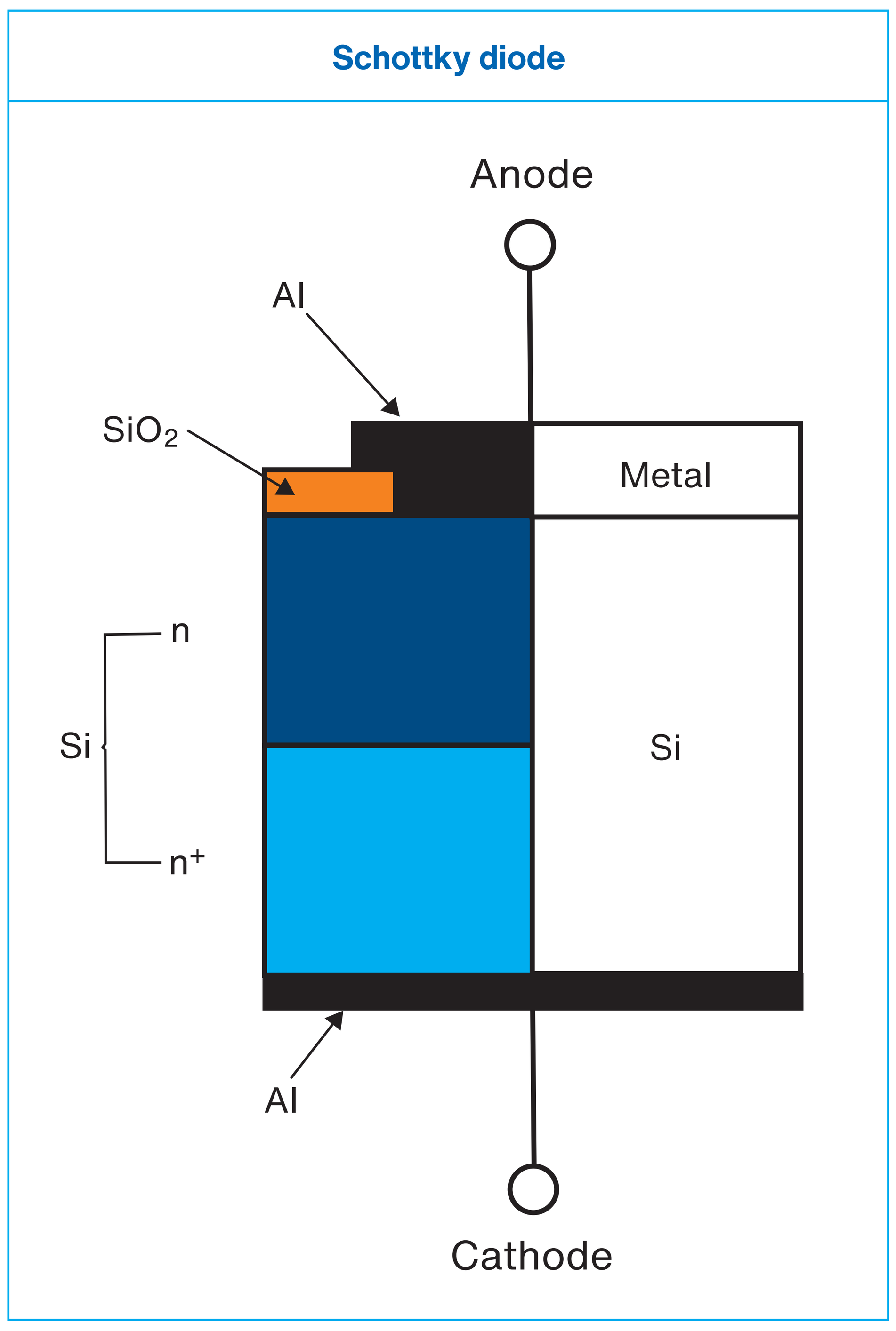
Applications

Rectifiers convert AC electricity into DC.

A diode can protect against **reverse voltage** in many power applications. In the same way they can conduct damaging high voltages away from sensitive electronic devices. (**flyback diode**).

Due to temperature sensitivity of forward voltage drop across the diode, diodes can be used as a silicon bandgap **temperature sensor**.

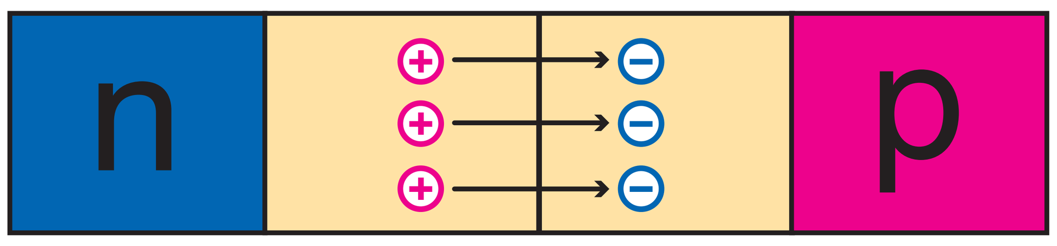




Important terms

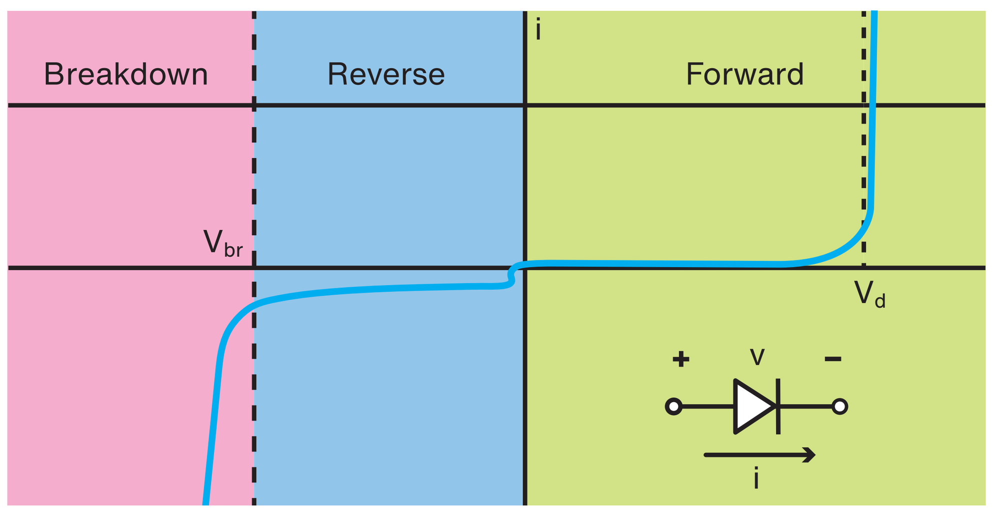
A **semiconductor diode** is based on either a p-n-type semiconducting crystal (usually Silicon, Germanium or Gallium-Arsenide) or a Metal/Semiconductor junction (**Schottky-Diode**).

Conductivity depends on the direction of the current flow. When the n-type and p-type materials are combined, a momentary flow of electrons occurs from the n to the p side resulting in a third region between the two where no charge carriers are present: The **depletion region**.



The depletion zone prevents any significant electric current flow if an external voltage is placed across the diode with the same polarity as the built-in potential; this is the **reverse bias** phenomenon.

If an external voltage greater than and opposite to the built-in voltage is applied, a current will flow and the diode is **turned on** with a **forward bias**; it has a **forward threshold voltage**, above which it conducts and below which conduction stops.

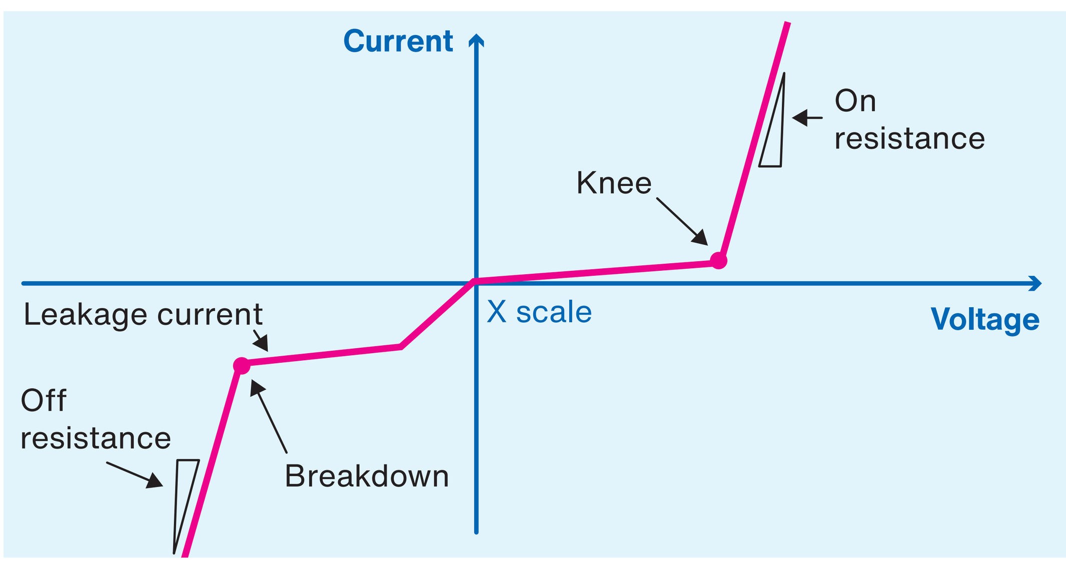


If the reverse bias is beyond the peak inverse voltage (PIV), **reverse breakdown** occurs. This causes a large increase in current that usually damages the device permanently, an effect used deliberately in the **avalanche diode**.

In the **Zener diode**, the reverse voltage is fixed to a known value (**Zener voltage**); avalanche does not occur. The device does not attain its full blocking capability until the reverse current ceases.

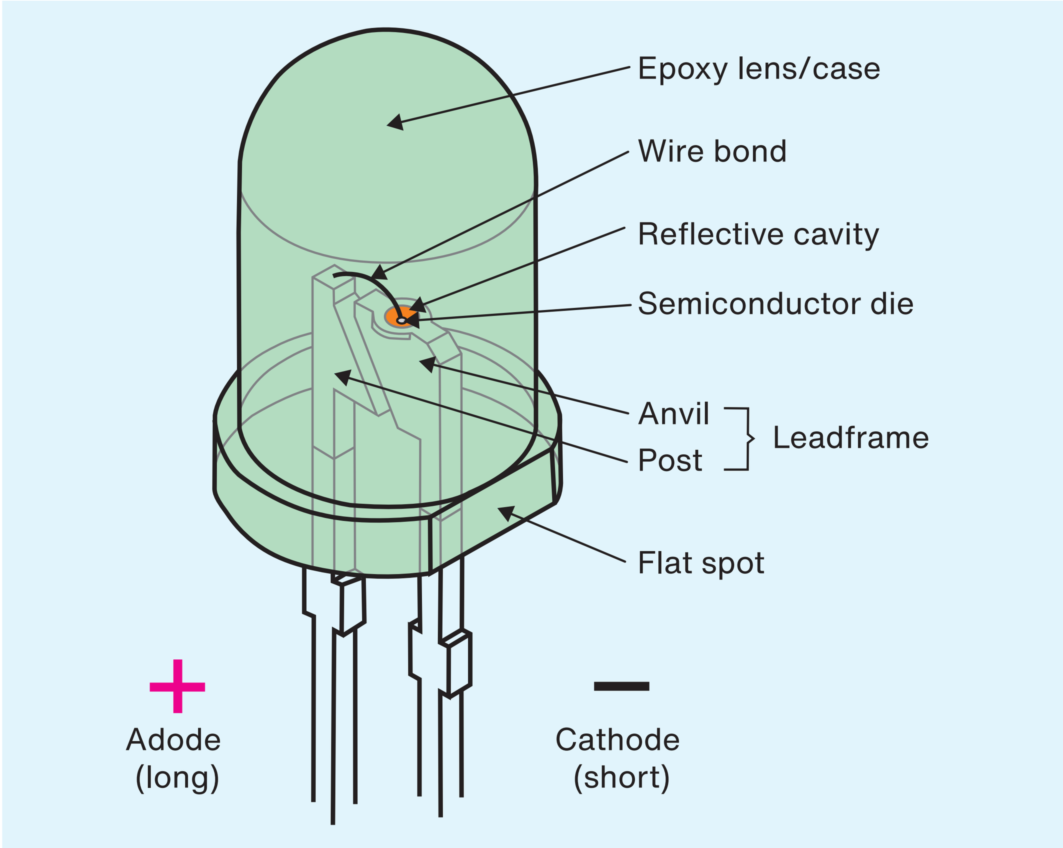
If the bias is smaller than the PIV, the reverse current is very small. For a normal **P–N rectifier diode**, the reverse current is very low.

A small forward bias leads to a small forward current and to an exponential current-voltage curve. The forward voltage at which the diode starts to conduct is he **knee voltage** or **cut-in voltage**.



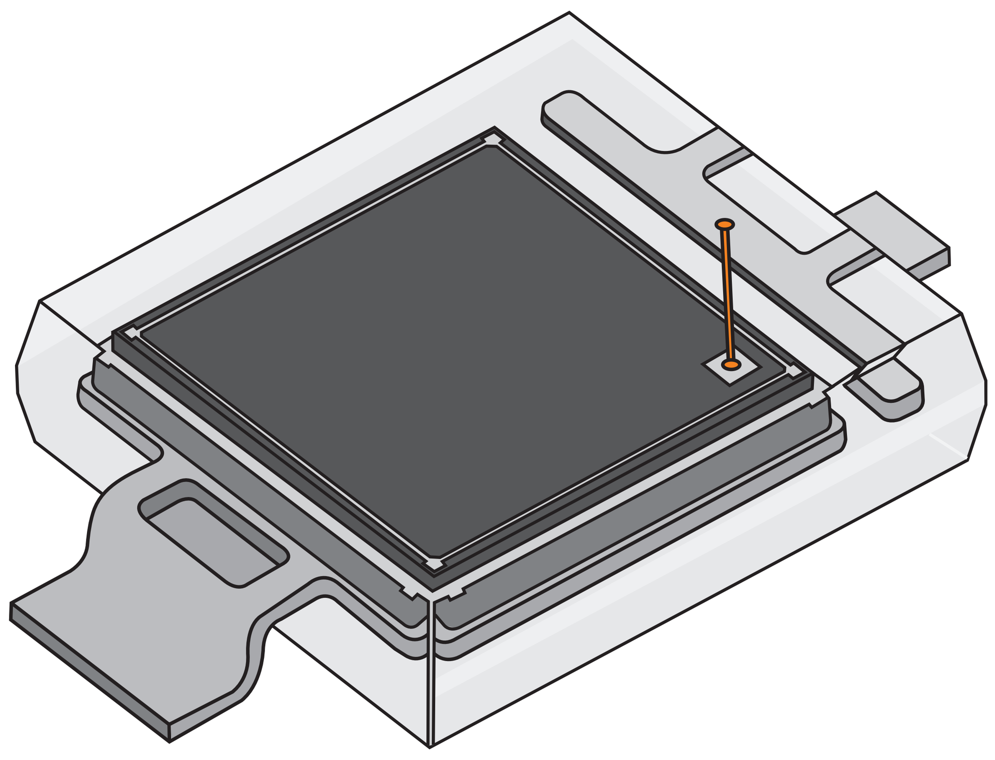
With larger forward currents, ohmic resistance dominates the behavior.

A **LED** (Light Emitting Diode) is formed from a direct band-gap semiconductor such as gallium arsenide. Depending on the material, it emits wavelengths from the infrared to the near ultraviolet. An LED may be paired with a **photodiode** or **phototransistor** in the same package, to form an **opto-isolator**.



An LED-like structure contained in a resonant cavity emits laser radiation. **Laser diodes** are commonly used in optical storage devices and for high speed optical communication.

Since all semiconductors are subject to the usually unwanted optical charge carrier generation, electronics makes use of this phenomenon in **Photodiodes**. They can sense light (**photodetector**) and can be used in solar cells, in photometry, or in optical communications.



The **Shockley equation** describes an ideal diode's behavior:

$$I = I_s \left(e^{\frac{V_D}{nV_T}} - 1\right)$$

I is the diode current, IS is the reverse bias saturation current,VD is the voltage across the diode, VT is the thermal voltage, and n is the ideality factor, quality factor or emission coefficient. n varies from 1 to 2 (though can in some cases be higher), depending on the fabrication process and semiconductor material and is set equal to 1 for the case of an “ideal” diode.