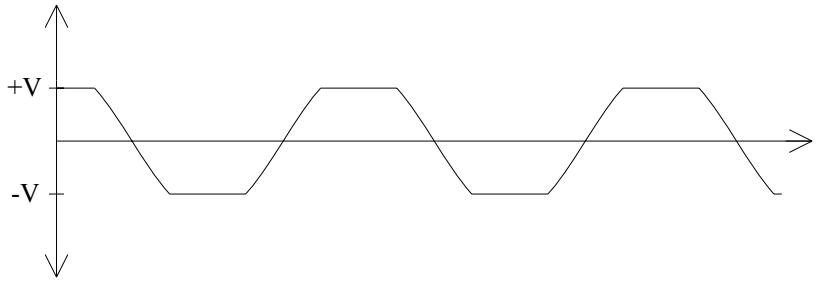
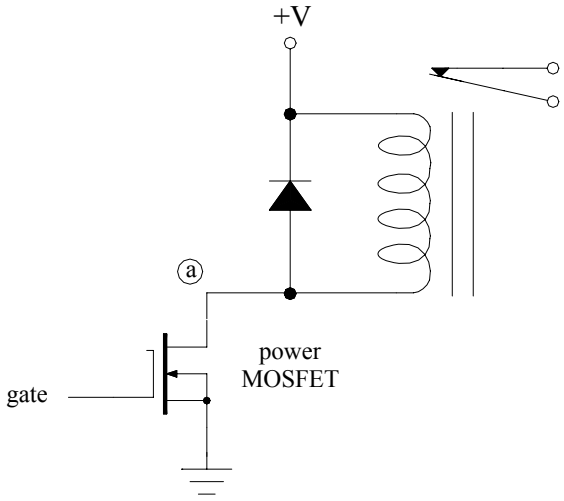
This diode arrangement can also be used to clip input signals going into an amplifier so that it does not get overdriven or damaged. If the second diode is connected to a negative voltage $-V$ instead of ground, any input signals that are too large will be clipped so that they do not exceed $\pm V$.



Another type of diode protection is needed for circuits that drive inductive loads such as relays and electric motors. Here a problem occurs when the current through an inductor is suddenly cut off.

A common example occurs when a transistor is used to control a relay, as shown below:



For now, the only thing we need to know about the transistor is that a positive voltage on the gate causes the transistor to turn on and be a good conductor, while pulling the gate voltage to ground causes the transistor to turn off and behave like an open circuit.

Suppose that initially the transistor is turned on, so that a current flows through the electromagnet coil, opening the relay switch. If the transistor is then turned off, the current through the inductor will be cut off on a time scale of a few nanoseconds.

But, as a result of Faraday's law, this current change will produce a back emf of $V = L\, dI/dt$ across the inductor, which can be very large. For example, if a 100 mA current through a 100 μH coil is cut off within 5 nanoseconds, a voltage of +2000 V would be produced at point *a* in the circuit, destroying the transistor.

Placing a diode across the inductance, as shown above, prevents this. The diode, which is reverse biased while the transistor is turned on, becomes forward biased by the back emf, and conducts, its low resistance short circuiting the back emf and protecting the transistor.

The diode can be thought of as providing a circular path for the current through the inductor to continue flowing briefly after the transistor is turned off.

If you've ever pulled out the plug for a vacuum cleaner or electric motor while it was running, you've probably seen the effect of the back emf in the form of sparks at the plug. Since the field strength required to break down air is about 30,000 V/cm, it's evident that very large voltages are being produced.

The bottom line is that whenever transistors are used to drive an inductive load, a diode (called a *snubber diode*) needs to be inserted across the inductance to prevent circuit damage.