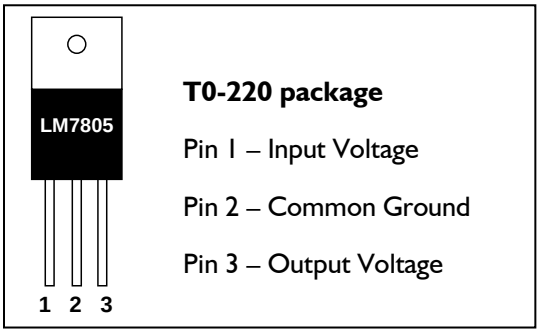
Voltage Regulators

Integrated circuits are very useful in a wide range of applications, but they do have limitations. The data sheets provided by the manufacturer contain information about the range of conditions in which the circuits will function properly, including temperature, voltage, current, number of devices that may be connected and so forth.

It is important when using integrated circuits that the supply voltage be controlled so that it does not exceed the limits and damage the circuits. The TTL logic circuits that we generally work with in the classroom are designed to operate with a 5 volt power supply. When you are building circuits on the PencilBox Logic Trainer, the voltage is controlled by the built in circuitry. When we use a 9-volt battery as the power supply, we must also use a device called a voltage regulator.

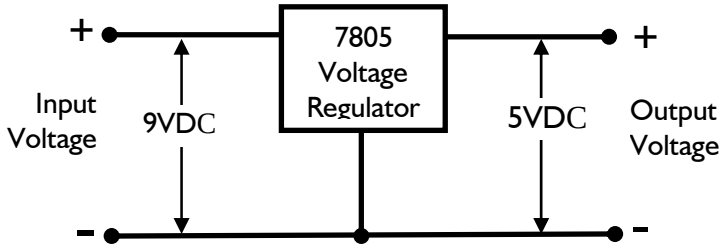
Voltage regulators are commonly found in every power supply for electronic devices, whether it is the power pack you plug into the wall for your video games, cell phones or battery chargers; or in a box inside larger devices like the computer or printer. Those devices also use transformers to lower the voltage to a usable level, and rectifiers to change the voltage into DC. The function of the voltage regulator is to maintain the voltage at a fixed level, regardless of changes in the input voltage or the load being drawn by the connected devices.

Voltage regulators are available in a range of voltages and capacities. The LM78*XX* series is capable of handling up to one Ampere of load current, and controlling input voltages up to 35 volts. The last two digits of the part number indicate the output voltage, and chips with outputs of 5, 6, 8, 9, 10, 12, 15, 18 and 24 volts are available. So, for example, a 7412 chip would have an output of 12 volts DC, and the regulator we will be using, the 7805 has an output voltage of 5 volts DC.



The 7805 comes in a 3-pin package known as the TO-220. (Power transistors, SCRs and other devices may also come in the same package, so you must read the part number to be sure you have the correct part.)

The voltage regulator must be connected in the circuit as shown in the schematic diagram below.



Although the package is small, there are several components inside the voltage regulator to make it function. The circuit below is a simple version of a voltage regulation circuit. The principle of the circuit is that the level of the output voltage feeds back to control the transistors Q1 and Q2. When the output voltage rises, the current flow through Q1 is restricted, keeping the circuit in balance at the desired voltage level. A key to the operation of the circuit is the Zener diode, a device which conducts electricity when the voltage exceeds a preset level, thus maintaining a constant reference voltage at that point in the circuit.