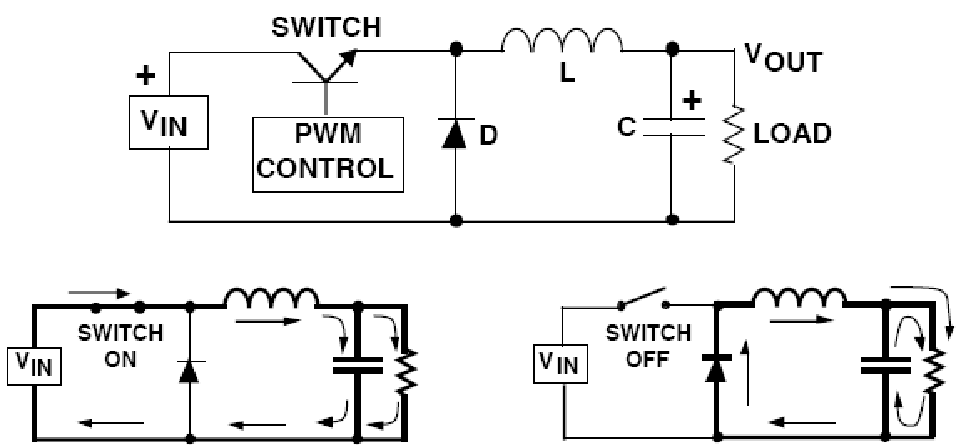
# BUCK AND BOOST REGULATOR

**Buck Regulator:**

The most commonly used switching converter is the Buck, which is used to down-convert a DC voltage to a lower DC voltage of the same polarity. This is essential in systems that use distributed power rails (like 24V to 48V), which must be locally converted to 15V, 12V or 5V with very little power loss. The Buck converter uses a transistor as a switch that alternately connects and disconnects the input voltage to an inductor (see Figure).




The lower diagrams show the current flow paths (shown as the heavy lines) when the switch is on and off. When the switch turns on, the input voltage is connected to the inductor. The difference between the input and output voltages is then forced across the inductor, causing current through the inductor to increase. During the on time, the inductor current flows into both the load and the outputcapacitor (the capacitor charges during this time).

When the switch is turned off, the input voltage applied to the inductor is removed. However, since the current in an inductor can not change instantly, the voltage across the inductor will adjust to hold the current constant. The input end of the inductor is forced negative in voltage by the decreasing current, eventually reaching the point where the diode is turned on. The inductor current then flows through the load and back through the diode. The capacitor discharges into the load during the off time, contributing to the total current being supplied to the load (the total load current during the switch off time is the sum of the inductor and capacitor current).


FIGURE 30. BUCK REGULATOR INDUCTOR CURRENT

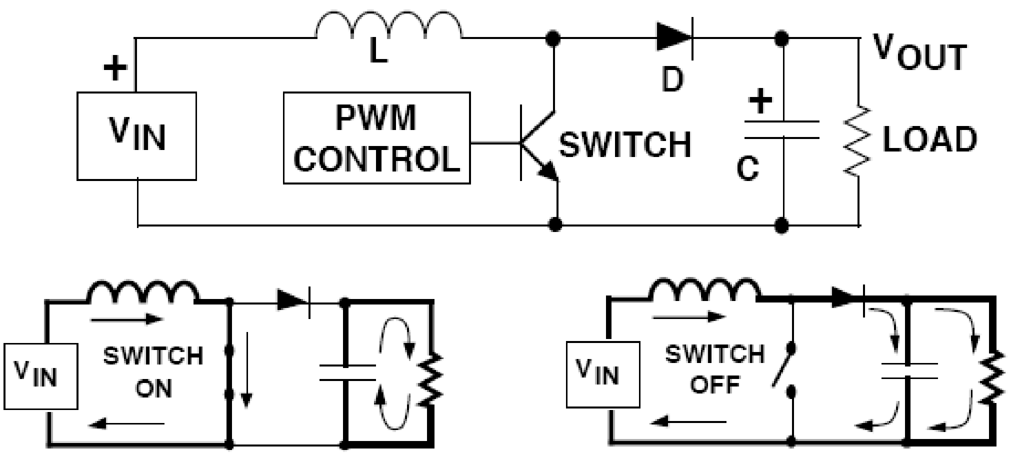
The shape of the current flowing in the inductor is similar to previous figure. As explained, the current through the inductor ramps up when the switch is on, and ramps down when the switch is off. The DC load current from the regulated output is the average value of the inductor current. The peak-to-peak difference in the inductor current waveform is referred to as the inductor ripple current, and the inductor is typically selected large enough to keep this ripple current less than 20% to 30% of the rated DC current.

**Continuous vs. Discontinuous operation**

In most Buck regulator applications, the inductor current never drops to zero during
Full-load operation (this is defined as continuous mode operation). Overall performance is usually better using continuous mode, and it allows maximum output power to be obtained from a given input voltage and switch current rating. In applications where the maximum load current is fairly low, it can be advantageous to design for discontinuous mode operation. In these cases, operating in discontinuous mode can result in a smaller overall converter size (because a smaller inductor can be used).Discontinuous mode operation at lower load current values is generally harmless, and even converters designed for continuous mode operation at full load will become discontinuous as the load current is decreased (usually causing no problems).

**Boost Regulator:**

The Boost regulator takes a DC input voltage and produces a DC output voltage that is higher in value than the input (but of the same polarity). The Boost regulator is shown in Figure, along with details showing the path of current flow during the switch on and off time. Whenever the switch is on, the input voltage is forced across the inductor which causes the current through it to increase (ramp up).




When the switch is off, the decreasing inductor current forces the "switch" end of the inductor to swing positive. This forward biases the diode, allowing the capacitor to charge up to a voltage that is higher than the input voltage. During steady-state operation, the inductor current flows into both the output capacitor and the load during the switch off time. When the switch is on, the load current is supplied only by the capacitor.

**Output Current and Load power:**

An important design consideration in the Boost regulator is that the output load current and the switch current are not equal, and the maximum available load current is always less than the current rating of the switch transistor. It should be noted that the maximum total power available for conversion in any regulator is equal to the input voltage multiplied times the maximum average input current (which is less than the current rating of the switch transistor). Since the output voltage of the Boost is higher than the input voltage, it follows that the output current must be lower than the input current.