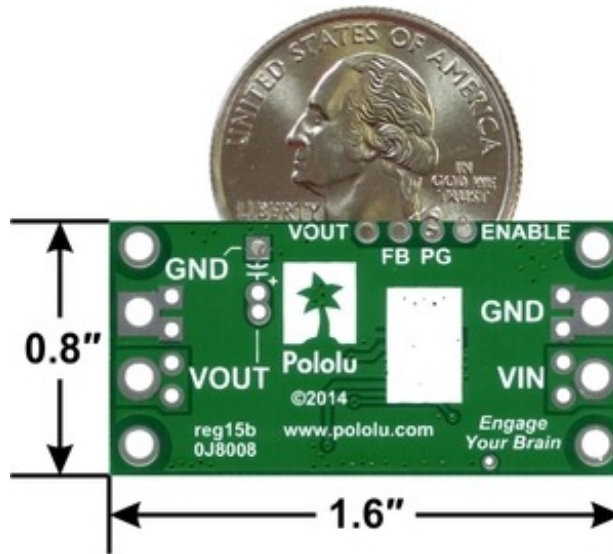


## Pololu 5V, 6A Step-Down Voltage Regulator D24V60F5



### Overview

These high-current step-down (buck) regulators generate a fixed 5 V output from input voltages up to 38 V. They are switching regulators (also called switched-mode power supplies (SMPS) or DC-to-DC converters) and have a typical efficiency between 80% to 95%. The available output current is a function of the input voltage and efficiency (see the Typical Efficiency and Output Current section below), but the input current can typically be as high as 6 A.

A higher-power version of this regulator with a typical maximum output current of 9 A is also available. The two versions of the board look very similar, so the bottom silkscreen includes a blank space where you can add your own distinguishing marks or labels. You should not use the colors of the printing on the tall, cylindrical electrolytic capacitors to differentiate the two versions as these colors are subject to change.

The ENABLE pin can be used to put the board in a low-power state that reduces the quiescent current to approximately 10  $\mu\text{A}$  to 20  $\mu\text{A}$  per volt on VIN, and a PG (power good) indicator makes it easy to monitor the state of the main power for your system. The regulator's output voltage setting can also be lowered by adding an external resistor.

This regulator has built-in reverse-voltage protection, short-circuit protection, thermal shutdown (which typically activates at 160°C), a soft-start feature that reduces inrush current, and an under-voltage lockout that causes the regulator to turn off when the input voltage is below 4.2 V (typical).

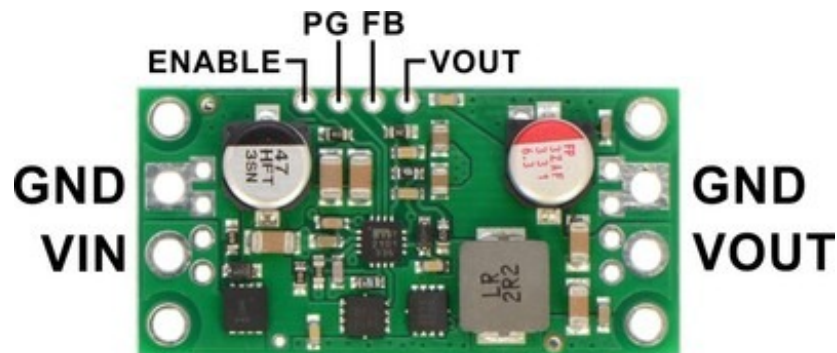
### Features

- **Input voltage: 5 to 38 V** (see below for more details on the regulator's dropout voltage, which affects the low end of the operating range)
- **Fixed 5 V output (with 4% accuracy); this can be lowered by adding an external resistor between FB and VOUT**
- **Typical maximum continuous output current: 6 A**
- **Integrated reverse-voltage protection, over-current protection, over-temperature shutoff, soft-start, and under-voltage lockout**
- **Typical efficiency of 80% to 95%, depending on input voltage and load; the switching frequency automatically changes at light loads to maintain high efficiencies**

- 800  $\mu\text{A}$  typical no-load quiescent current; can be reduced to 10  $\mu\text{A}$  to 20  $\mu\text{A}$  per volt on VIN by disabling the board
- “Power good” output indicates when the regulator cannot maintain its set output voltage
- Compact size: 1.6"  $\times$  0.8"  $\times$  0.3" (40.6  $\times$  20.3  $\times$  7.6 mm)
- Four mounting holes for #2 or M2 screws
- Smaller holes for 0.1" header pins and larger holes for terminal blocks offer several options for connecting to the board

### Using the regulator Connections

This boost regulator has six connections: input voltage (VIN), ground (GND), output voltage (VOUT), feedback (FB), ENABLE, and power good (PG).

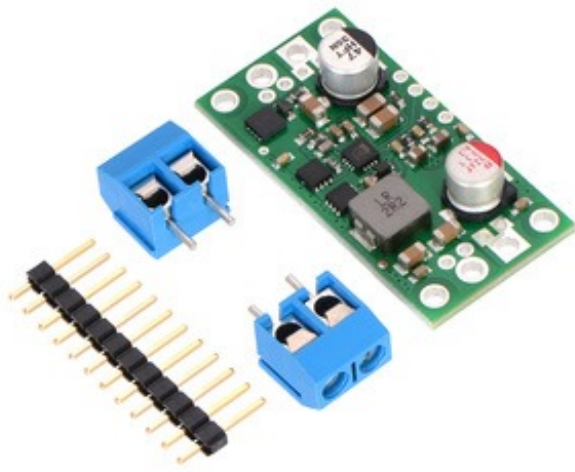


The input voltage, VIN, powers the regulator and can be supplied with voltages up to 38V. The effective lower limit of VIN is VOUT plus the regulator’s dropout voltage, which varies approximately linearly with the load from around 500 mV to a little over a volt (see below for graphs of dropout voltages as a function of the load).

The output voltage, VOUT, is set to 5V by default. The output voltage can optionally be lowered by adding a resistor between the FB pin and VOUT as detailed in the Decreasing the output voltage section below.

The regulator is enabled by default: a 100 k $\Omega$  pull-up resistor on the board connects the ENABLE pin to reverse-protected VIN. The ENABLE pin can be driven low (under 0.6 V) to put the board into a low-power state. The quiescent current draw in this sleep mode is dominated by the current in the pull-up resistor from ENABLE to VIN and by the reverse-voltage protection circuit, which will draw between 10  $\mu\text{A}$  and 20  $\mu\text{A}$  per volt on VIN when ENABLE is held low. If you do not need this feature, you should leave the ENABLE pin disconnected.

The “power good” indicator, PG, is an open-drain output that goes low when the regulator’s output voltage falls below 90% of what it is set to (i.e. 4.5 V with the default 5 V output setting). An external pull-up resistor is required to use this pin.

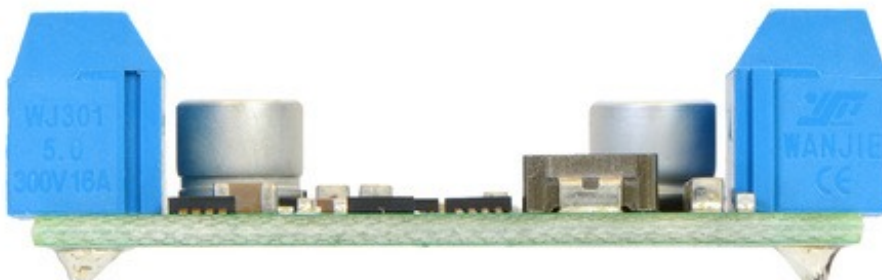


Pololu 5V, 6A Step-Down Voltage Regulator D24V60F5 with included hardware.



Pololu 5V, 6A Step-Down Voltage Regulator D24V60F5, assembled with included terminal blocks.

The connections are labeled on the back side of the PCB, and the board offers several options for making electrical connections. The eight smaller through-holes on the ends of the board are arranged with a 0.1" spacing for compatibility with solderless breadboards, connectors, and other prototyping arrangements that use a 0.1" grid; you can solder pieces of the included 12×1 straight male header strip into these smaller holes. Alternatively, you can solder the included 2-pin 5mm-pitch terminal blocks to the two pairs of larger holes on the ends of the board. For the most compact installation, you can solder wires directly to the board.



Pololu 5V, 6A Step-Down Voltage Regulator D24V60F5, side view.

The board has four mounting holes intended for #2 or M2 screws. The mounting holes are at the four corners of the board and are separated by 1.4" horizontally and 0.6" vertically.

### Decreasing the output voltage

The set voltage can optionally be decreased by adding an external resistor between the FB and the neighboring VOUT pin. The equations below show how the output voltage relates to the value of an external resistor, R:

$$\text{VOUT} = ((5.24 * R) / (16.2 \text{ k}\Omega + R) + 1) * 0.8 \text{ V}$$

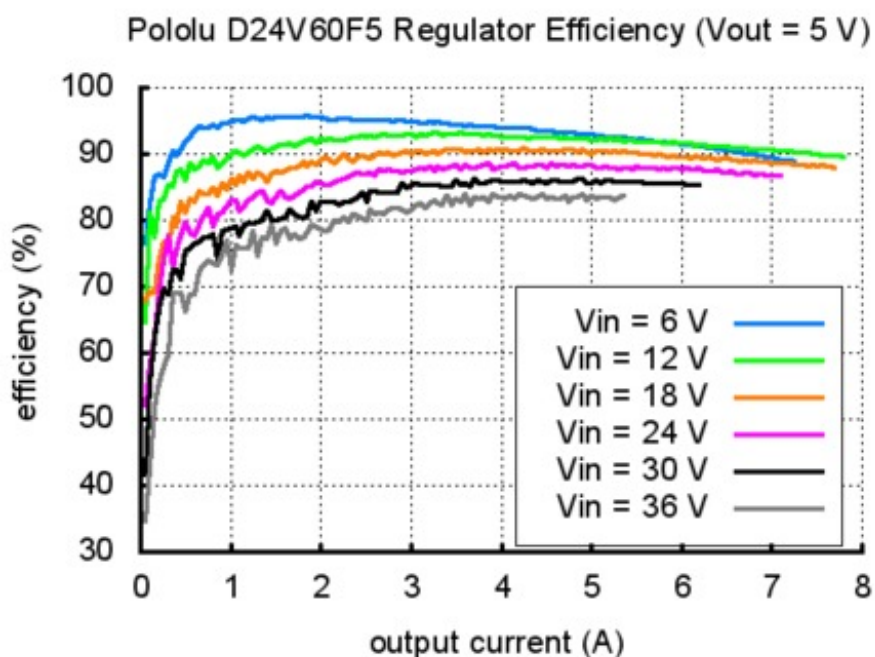
$$R = ((\text{VOUT} - 0.8 \text{ V}) / (5 \text{ V} - \text{VOUT})) * 16.2 \text{ k}\Omega$$

For example, to get an output voltage of 3.3 V, you could put a 23.7 k $\Omega$  resistor between FB and VOUT.

The minimum VOUT for this regulator is 0.8 V. Please note that the small VOUT pin next to FB is not intended to source much current; its purpose is to provide a convenient spot for connecting a voltage-adjustment resistor.

### Typical efficiency and output current

The efficiency of a voltage regulator, defined as (Power out)/(Power in), is an important measure of its performance, especially when battery life or heat are concerns. As shown in the graphs below, these switching regulators have an efficiency of 80% to 95% for most combinations of input voltage, and load.



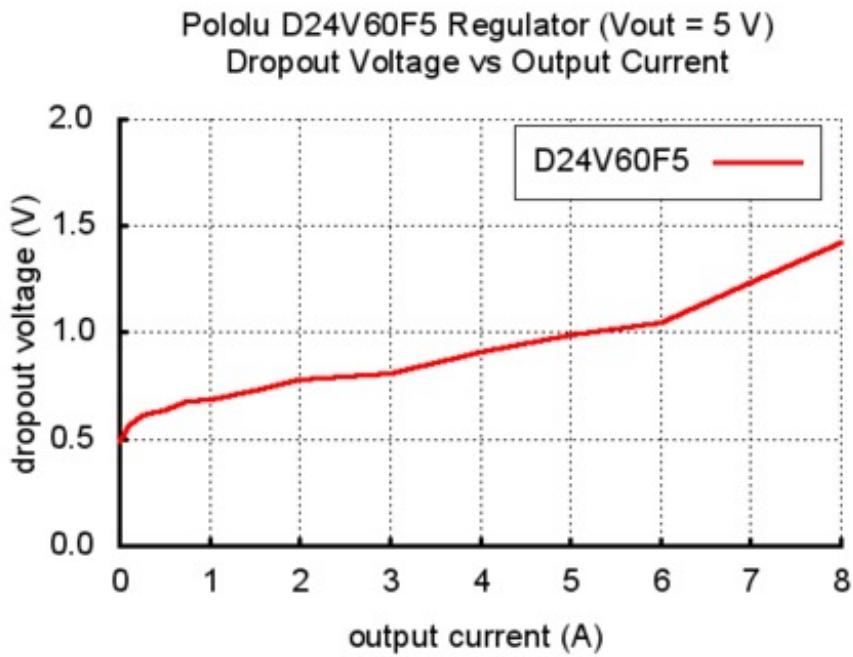
The maximum achievable output current of the board depends on many factors, including the ambient temperature, air flow, heat sinking, and the input and output voltage.

During normal operation, this product can get hot enough to burn you. Take care when handling this product or other components connected to it.

### Typical dropout voltage

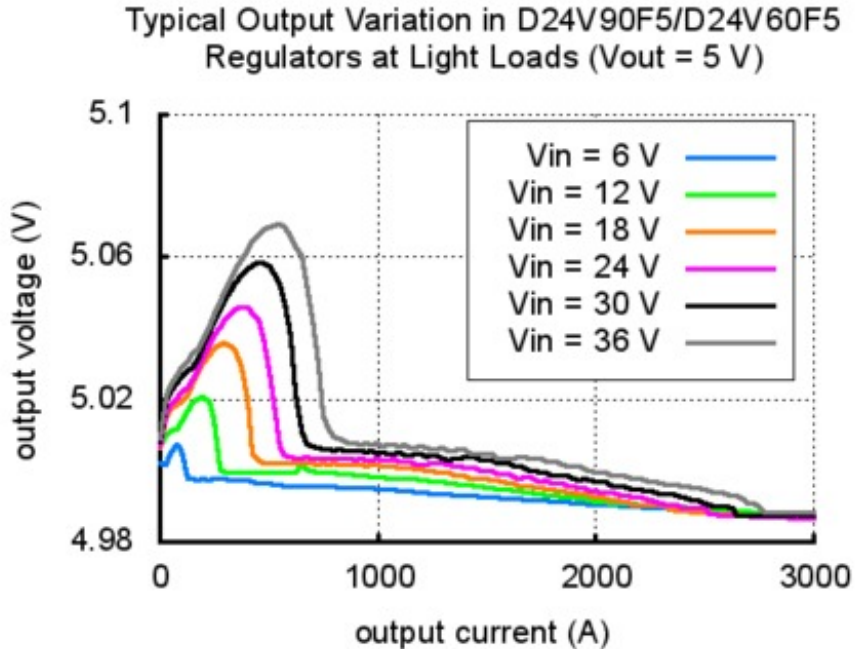
The dropout voltage of a step-down regulator is the minimum amount by which the input voltage must exceed the regulator's target output voltage in order to ensure the target output can be achieved. For example, if a 5 V regulator has a 1 V dropout voltage, the input must be at least 6 V to ensure the output is the full 5 V. The following graph shows the dropout voltages for the

D24V60F5 regulator as a function of the output current:



### Switching frequency and behavior under light loads

The regulator generally operates at a switching frequency of around 470 kHz, but the frequency drops when encountering a light load to improve efficiency. This could make it harder to filter out noise on the output caused by switching. This also causes small variations in the output voltage like those shown in the graph below:



[Documentation on producer website.](#)