

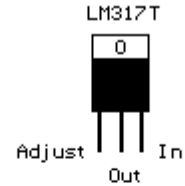
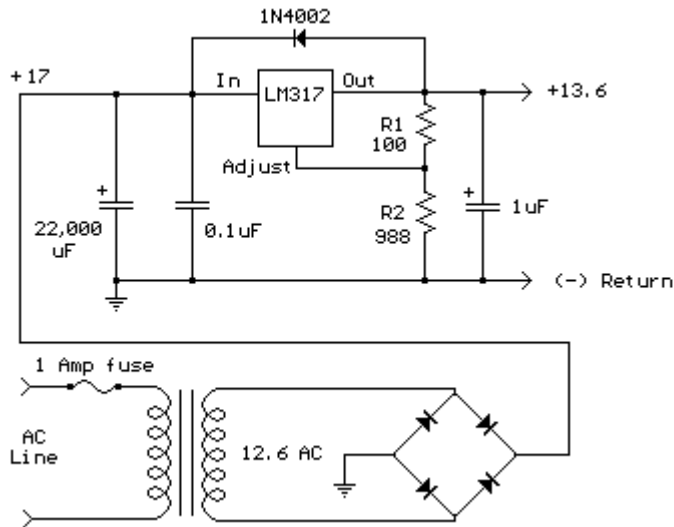
## LM317T Variable Voltage Regulator

The LM317T is an adjustable 3 terminal positive voltage regulator capable of supplying in excess of 1.5 amps over an output range of 1.25 to 37 volts. The device also has built in current limiting and thermal shutdown which makes it essentially blow-out proof.

Output voltage is set by two resistors R1 and R2 connected as shown below. The voltage across R1 is a constant 1.25 volts and the adjustment terminal current is less than 100uA. The output voltage can be closely approximated from  $V_{out}=1.25 * (1+(R2/R1))$  which ignores the adjustment terminal current but will be close if the current through R1 and R2 is many times greater. A minimum load of about 10mA is required, so the value for R1 can be selected to drop 1.25 volts at 10mA or 120 ohms. Something less than 120 ohms can be used to insure the minimum current is greater than 10mA. The example below shows a LM317 used as 13.6 volt regulator. The 988 ohm resistor for R2 can be obtained with a standard 910 and 75 ohm in series.

When power is shut off to the regulator the output voltage should fall faster than the input. In case it doesn't, a diode can be connected across the input/output terminals to protect the regulator from possible reverse voltages. A 1uF tantalum or 25uF electrolytic capacitor across the output improves transient response and a small 0.1uF tantalum capacitor is recommended across the input if the regulator is located an appreciable distance from the power supply filter. The power transformer should be large enough so that the regulator input voltage remains 3 volts above the output at full load, or 16.6 volts for a 13.6 volt output.

[LM317 Data Sheet](#)



R1	R2	Out
100	988	13.6
100	860	12
100	620	9
100	380	6
100	140	3
100	20	1.5

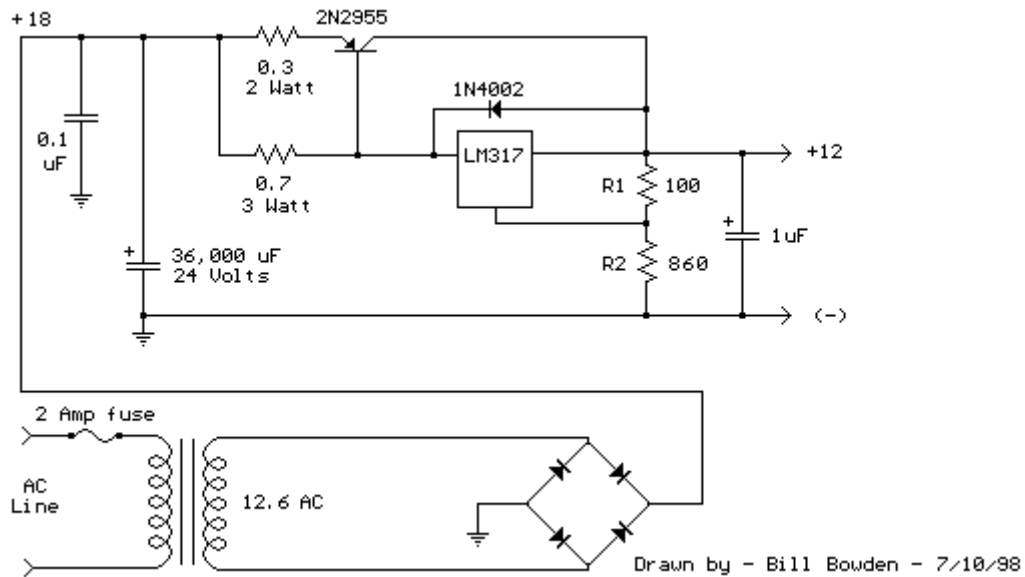
Drawn by - Bill Bowden - 07/10/98

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## LM317T Voltage Regulator with Pass Transistor

The LM317T output current can be increased by using an additional power transistor to share a portion of the total current. The amount of current sharing is established with a resistor placed in series with the 317 input and a resistor placed in series with the emitter of the pass transistor. In the figure below, the pass transistor will start conducting when the LM317 current reaches about 1 amp, due to the voltage drop across the 0.7 ohm resistor. Current limiting occurs at about 2 amps for the LM317 which will drop about 1.4 volts across the 0.7 ohm resistor and produce a 700 millivolt drop across the 0.3 ohm emitter resistor. Thus the total current is limited to about  $2 + (.7/.3) = 4.3$  amps. The input voltage will need to be about 5.5 volts greater than the output at full load and heat dissipation at full load would be about 23 watts, so a fairly large heat sink may be needed for both the regulator and pass transistor. The filter capacitor size can be approximated from  $C=IT/E$  where I is the current, T is the half cycle time (8.33 mS at 60 Hertz), and E is the fall in voltage that will occur during one half cycle. To keep the ripple voltage below 1 volt at 4.3 amps, a 36,000 uF or greater filter capacitor is needed. The power transformer should be large enough so that the peak input voltage to the regulator remains 5.5 volts above the output at full load, or 17.5 volts for a 12 volt output. This allows for a 3 volt drop across the regulator, plus a 1.5 volt drop across the series resistor (0.7 ohm), and 1 volt of ripple produced by the filter capacitor. A larger filter capacitor will reduce the

input requirements, but not much.

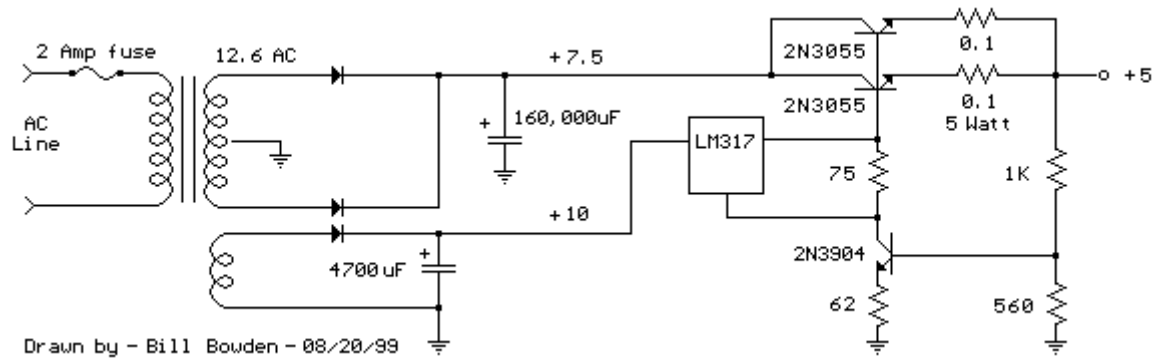


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## High Current Regulated Supply

The high current regulator below uses an additional winding or a separate transformer to supply power for the LM317 regulator so that the pass transistors can operate closer to saturation and improve efficiency. For good efficiency the voltage at the collectors of the two parallel 2N3055 pass transistors should be close to the output voltage. The LM317 requires a couple extra volts on the input side, plus the emitter/base drop of the 3055s, plus whatever is lost across the (0.1 ohm) equalizing resistors (1 volt at 10 amps), so a separate transformer and rectifier/filter circuit is used that is a few volts higher than the output voltage. The LM317 will provide over 1 amp of current to drive the bases of the pass transistors and assuming a gain of 10 the combination should deliver 15 amps or more. The LM317 always operates with a voltage difference of 1.2 between the output terminal and adjustment terminal and requires a minimum load of 10mA, so a 75 ohm resistor was chosen which will draw  $(1.2/75 = 16\text{mA})$ . This same current flows through the emitter resistor of the 2N3904 which produces about a 1 volt drop across the 62 ohm resistor and 1.7 volts at the base. The output voltage is set with the voltage divider (1K/560) so that 1.7 volts is applied to the 3904 base when the output is 5 volts. For 13 volt operation, the 1K resistor could be adjusted to around 3.6K. The regulator has no output short circuit protection so the output probably should be

fused.



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## Simple Adjustable Voltage Source

A simple but less efficient method of controlling a DC voltage is to use a voltage divider and transistor emitter follower configuration. The figure below illustrates using a 1K pot to set the base voltage of a medium power NPN transistor. The collector of the NPN feeds the base of a larger PNP power transistor which supplies most of the current to the load. The output voltage will be about 0.7 volts below the voltage of the wiper of the 1K pot so the output can be adjusted from 0 to the full supply voltage minus 0.7 volts. Using two transistors provides a current gain of around 1000 or more so that only a couple milliamps of current is drawn from the voltage divider to supply a couple amps of current at the output. Note that this circuit is much less efficient than the 555 timer dimmer circuit using a variable duty cycle switching approach. In the figure below, the 25 watt/ 12 volt lamp draws about 2 amps at 12 volts and 1 amp at 3 volts so that the power lost when the lamp is dim is around  $(12-3 \text{ volts} * 1 \text{ amp}) = 9 \text{ watts}$ . A fairly large heat sink is required to prevent the PNP power transistor from overheating. The power consumed by the lamp will be only  $(3 \text{ volts} * 1 \text{ amp}) = 3 \text{ watts}$  which gives us an efficiency factor of only 25% when the lamp is dimmed. The advantage of the circuit is simplicity, and also that it doesn't generate any RF interference as a switching regulator does. The circuit can be used as a voltage regulator if the input voltage remains constant, but it will not compensate for changes at the input as the LM317 does.