External Current Limiting Circuit

In every power supply application there exists the possibility to short the output to ground causing excessive current to be drawn from the power supply. In order to limit the output current from becoming excessive the following examples of current limiting circuits are suggested.

Current limiting circuit with diodes

The circuit shown in Figure 1 uses a sense resistor in series with the emitter of the pass transistor.

Two diodes between the output of the circuit and the base of the pass transistor provide the current limiting function.

When the circuit is operating within its normal operating range, a small voltage exists across the sense resistor. The sense voltage plus the base emitter voltage is less than the two diode junction voltage drops required to turn on the two diodes allowing them to conduct current.

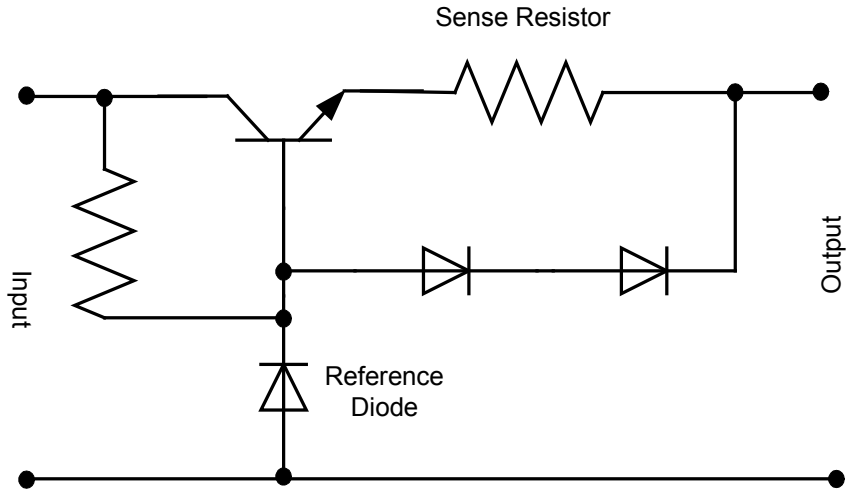
As the current increases so does the voltage across the sense resistor.

When the sense voltage equals the turn on voltage for a diode, the voltage across the sense resistor plus the base emitter junction of the pass transistor will equal the two diode voltage drops, and the two diodes start to conduct current.

When the diodes start conducting current the base emitter voltage of the pass transistor decreases which limits the current that can be drawn through the pass transistor.

The value of the sense resistor can be easily calculated with 0.6V (the turn on voltage of a silicon diode) divided by the maximum current level that the circuit is expected to limit.

Figure 1



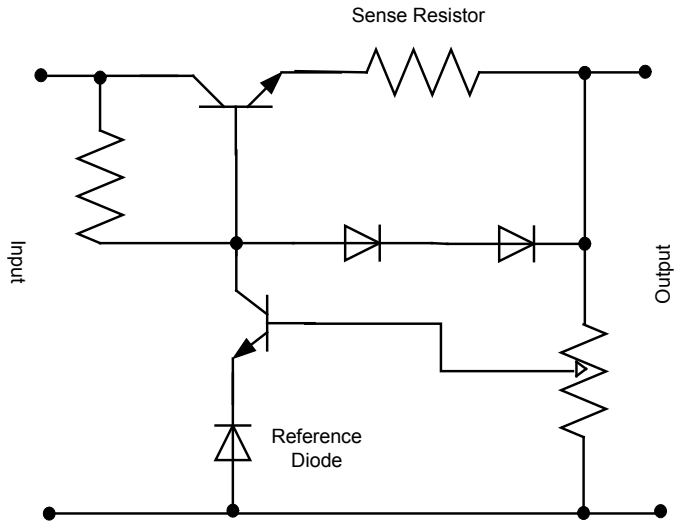
Feedback

The previous example can be modified to provide output voltage feedback to more accurately regulate the output voltage. If the output voltage sense point is taken after the series current sensing resistor the sense voltage drop can be corrected for at the output.

Feedback (continued)

The circuit in Figure 2 provides better regulation than the simple emitter follower regulator. The voltage drop across the current sense resistor can be compensated for as long as there is sufficient voltage drop across the series pass transistor. The output voltage can be adjusted using the output variable resistor.

Figure 2



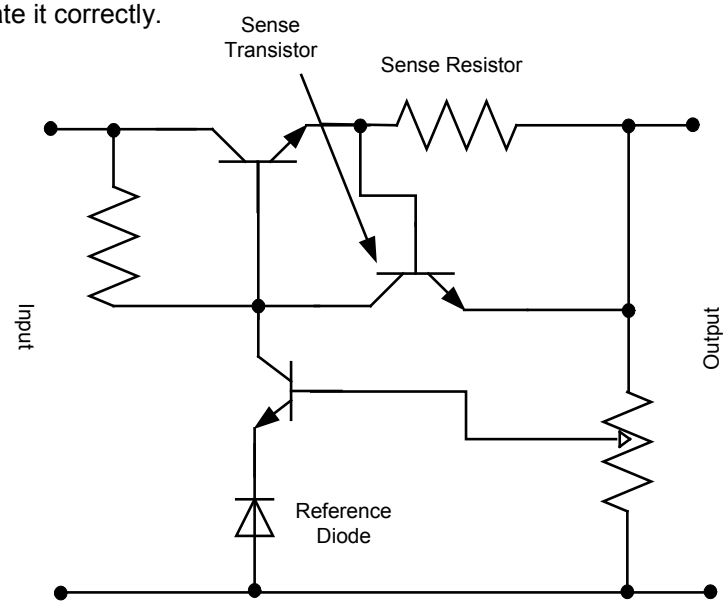
Current Limiting with Sense Transistor

The previous example can be modified to replace the two diodes with a current sense transistor as shown in Figure 3 (next page).

As the voltage across the current sense resistor reaches 0.6V the current sense transistor starts to turn on. As the transistor turns on the voltage at the base of the pass transistor is pulled down preventing any increase in the output current. The value of the sense resistor is 0.6V/maximum current. The current sense transistor needs to have a large enough current capacity to conduct the base current of the pass transistor.

As the regulator sense point is after the current sense resistor any voltage drop across the resistor will not affect the output voltage. The sense resistor voltage will be compensated for by the regulator as long as there is sufficient voltage across the pass transistor to regulate it correctly.

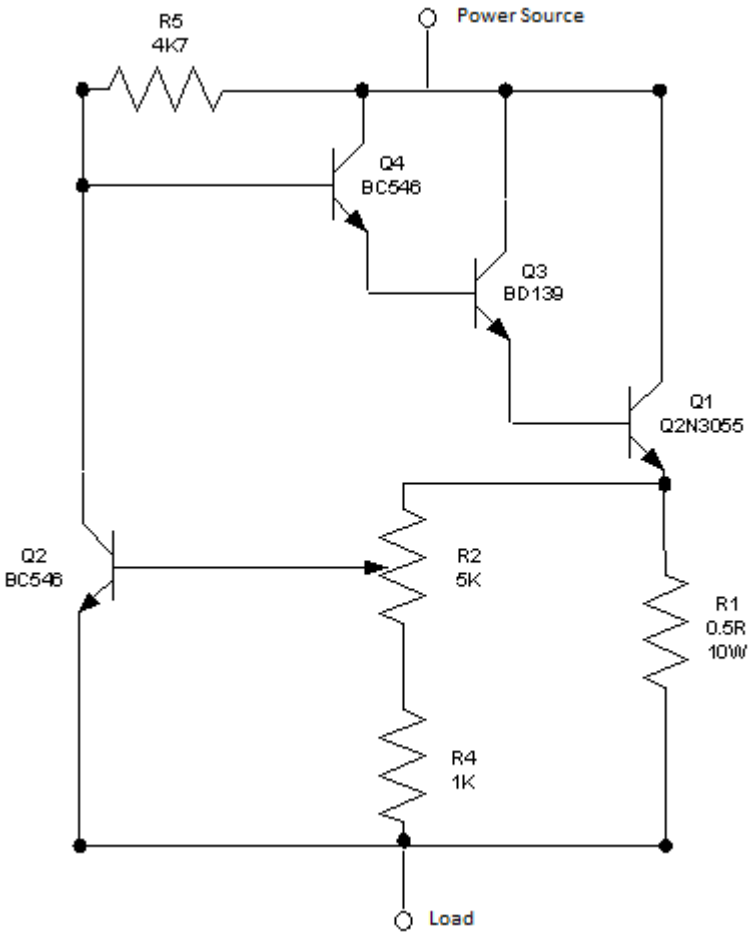
Figure 3



Current Limiting up to 8.4A

This circuit shown in Figure 4 (next page) provides automatic current limiting up to 8.4A. Unlike a current limiter that uses only a resistor, this current limiting circuit doesn't drop the output voltage, or at least keeps the voltage drop to a minimum, until a certain current level is exceeded. This current level limit is adjustable from 1.4A to 8.4A using a potentiometer. The component values can be modified to provide different current limiting range.

Figure 4



R1 is the current sense resistor. When R2 potentiometer is at minimum resistance (the center tap connected to R1), and the current drawn by the load reaches 1.2A the voltage across R1 will reach 0.6V and Q2 begins to conduct current and shorts the base voltage of Q4 to ground. The shorting of Q4 base to ground reduces the base current and the output voltage sensed by the load, preventing the current from flowing further.
If it is required, lower the current threshold range change the R1 to 1R and the adjustment range will be about 0.7A to 4.2A.
The 2N3055 transistor can handle significant power, so it is important that it has sufficient heat sinking.
The worst case condition is when the load is shorted to ground (zero resistance). If the current is limited to 8.4A the circuit can handle maximum source voltage of 14V. When the current is limited to 4.2A the circuit can handle up to 27V source voltage.
The maximum voltage can be handled by this circuit is 60 volt, but at that maximum voltage the current can be safely set to 1.9A when the load is shorted to ground.