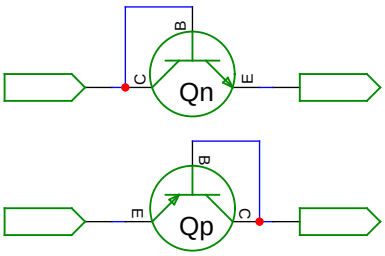
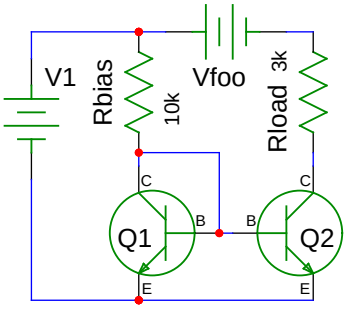
Transistor Current Limitors

2008-07-24

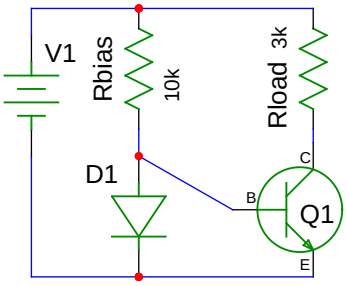


Diode Configuration for a PN Junction
Since every BJT transistor has a diode built in, it can be configured as such.
The voltage drop should be consistent with a silicon diode (about 0.7v).
There's usually a resistor before the collector to set the current through it.
This configuration is used for a matched current mirror configuration.

Simple BJT Current Sinking Mirror (Current Limitor)

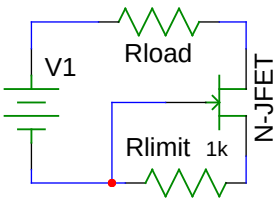


Vfoo is just there for the spice simulations and is 0v.
Q1 and Q2 need to be matched.
Rbias sets the current limit through Q1 and that is mirrored to Q2 (hence the matching).
Q1's base and collector are connected making this a fancy PN diode that's matched with Q2.
Temperature differences between Q1 and Q2 will cause errors. Epoxy them together to share temperatures.
Hotter BJT transistors conduct more current.
Changes in Rload do not effect Q1's current thus the connected bases keep Q2's current constant during Rload change.
Q2 will drop as much or little voltage across its collector-emitter as needed to keep the current constant.
Q2 does the actual current regulation (more like limiting) this way holding the upper value constant.
If Rload falls too low, Q2 will have to drop nearly all the voltage to maintain current. This energy is wasted as heat and will cause a condition in Q2 known as thermal runaway (Q2 over heats while Q1 has a fixed resistance current).
A current sourcing mirror will have this circuit flipped over (PNP transistors on top, emitters on the positive rail, diode mode is still connecting C-B, and resistors are on the bottom).



Simple Diode Current Sinking Mirror (Current Limitor)

This is a lesser version of the "transistor as diode" configuration.
D1 provides a 0.6v drop that should be similar to Q1's B-E drop (but not close enough for high accuracy).
Rbias sets the amount of current flowing through D1. This will be mirrored in Q1.
Current = (V1 - D1_forward_drop) / Rbias
Both transistor and diode should be thermally coupled to help eliminate thermal variations.
This circuit has no thermal runaway protection.



Simple N-JFET Current Limitor

This is the functional equivalent to the BJT Current Limitor.
This version has less parts and JFET's are mostly immune to thermal runaway.
Generally speaking, this version is preferred over the BJT method if using discrete parts.
(JFET pins, top to bottom: Drain, Gate, Source)