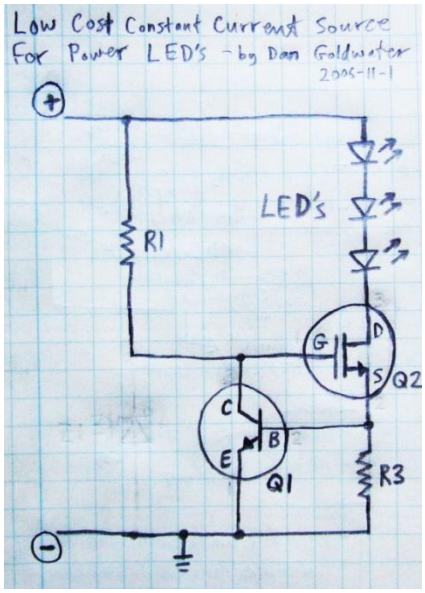
LED Driver



How does it work?
- Q2 (a power NFET) is used as a variable resistor. Q2 starts out turned on by R1.

- Q1 (a small NPN) is used as an over-current sensing switch, and R3 is the "sense resistor" or "set resistor" that triggers Q1 when too much current is flowing.

- The main current flow is through the LED's, through Q2, and through R3. When too much current flows through R3, Q1 will start to turn on, which starts turning off Q2. Turning off Q2 reduces the current through the LED's and R3. So we've created a "feedback loop", which continuously monitors the LED current and keeps it exactly at the set point at all times. transistors are clever, huh!

- R1 has high resistance, so that when Q1 starts turning on, it easily overpowers R1.

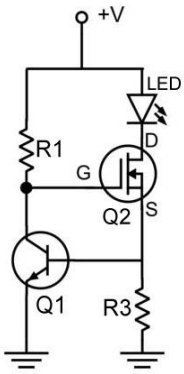
- The result is that Q2 acts like a resistor, and its resistance is always perfectly set to keep the LED current correct. Any excess power is burned in Q2. Thus for maximum efficiency, we want to configure our LED string so that it is close to the power supply voltage. It will work fine if we don't do this, we'll just waste power. this is really the only downside of this circuit compared to a step-down switching regulator!

Setting the current!
The value of R3 determines the set current.

Calculations:
- LED current is approximately equal to: 0.5 / R3
- R3 power: the power dissipated by the resistor is approximately: 0.25 / R3.
Choose a resistor value with at least 2x the power(wattage) calculated so the resistor does not get burning hot.

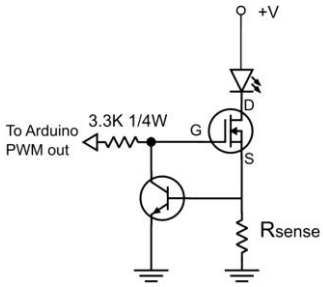
For a 700mA LED current:
R3 = 0.5 / 0.7 = 0.71 ohms. Closest standard resistor is 0.75 ohms.
R3 power = 0.25 / 0.71 = 0.35 watts. We'll need at least a 1/2 watt rated resistor.

Parts used:
R1: Approximately 100k-ohm resistor(1/4 watt) Such as: Yageo CFR-25JB series
R3: Current set resistor(1 watt+) A good 2-watt choice is: Panasonic ERX-2SJR series
Q2: Fairchild FQP50N06L (N-channel logic-level FET)
Q1: Fairchild 2N5088BU (NPN Transistor)



Maximum limits:
The only real limit to the current source circuit is imposed by NFET Q2. Q2 limits the circuit in two ways:

1) Power dissipation. Q2 acts as a variable resistor, stepping down the voltage from the power supply to match the need of the LED's. So Q2 will need a heatsink if there is a high LED current or if the power source voltage is a lot higher than the LED string voltage. (Q2 power = dropped volts * LED current). Q2 can only handle 2/3 watt before you need some kind of heatsink. with a large heatsink, this circuit can handle a LOT of power & current - probably 50 watts and 20 amps with this exact transistor, but you can just put multiple transistors in parallel for more power.



2) Voltage. the "G" pin on Q2 is only rated for 20V, and with this simplest circuit that will limit the input voltage to 20V (Lets say 18V to be safe). If you use a different NFET, make sure to check the "Vgs" rating.

Thermal sensitivity:
The current set-point is somewhat sensitive to temperature. This is because Q1 is the trigger, and Q1 is thermally sensitive. the part number I specified above is one of the least thermally sensitive NPN's I could find. even so, expect perhaps a 30% reduction in current set point as you go from -20C to +100C. That may be a desired effect, it could save your Q2 or LED's from overheating.

Source: http://www.instructables.com/id/Circuits-for-using-High-Power-LED-s/step6/The-new-stuff-Constant-Current-Source-1/