Transistors - Calculating Base Resistor for Switching
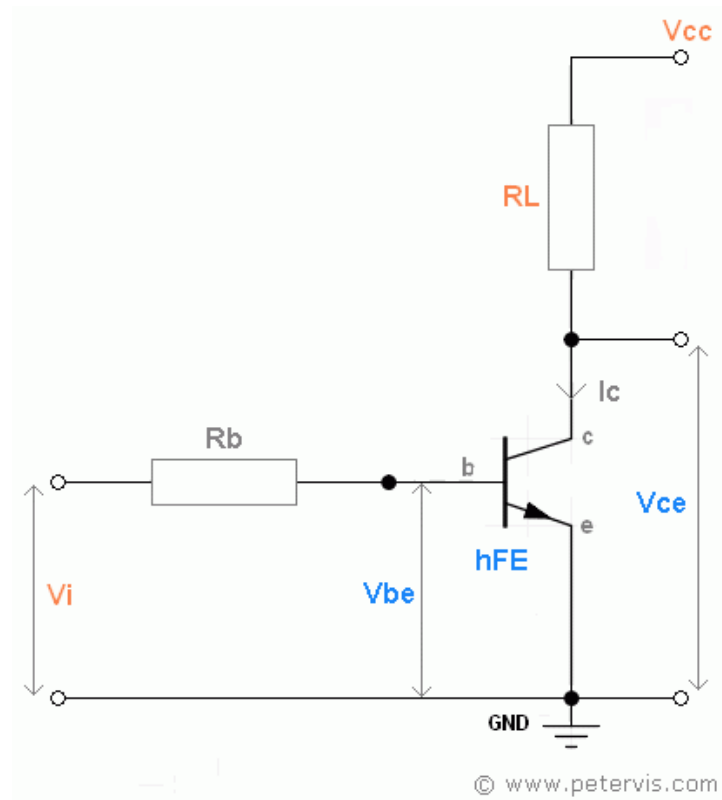
Overview

We will calculate the value of Rb based on the following circuit:

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Questions to Ask when Sizing

- Can your transistor handle the load through the collector? Does it exceed Ic(max)?
- Can the transistor handle supply voltage? Vcc > Vce (max) ?
- Find the worst case current gain during saturation. Ic
- Calculate the minimum base current. Ib
- **Compare base current Ib max current your micro controller can deliver.**
- Find worst case (highest) Vbe
- Calculate voltage drop across base resistor using Vbe and micro controller output
- Calculate required base resistor Rb.
- Calculate collector power dissipation.

Calculating the Rb Value

+12V

R1 155

NPN

RB

+3V3

GND
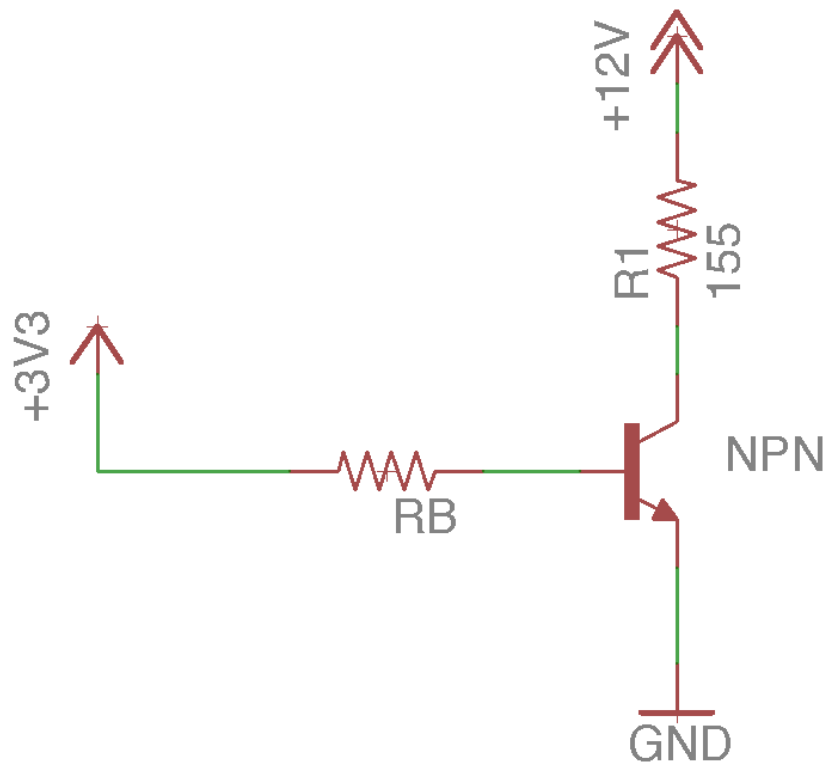
Precondition	Value
Vcc	12v
Vi	3.3v
RL	155
NPN BC337	
Vbe(sat)	1.2v
Vce(sat)	0.7v
hFE (@100mA)	100

Calculations for Ic:

Ic = (Vcc-Vce)/RL = 11.3v/155 = 73 mA

Calculation for Vb

Vb = Vi - Vbe(sat) = 3.3 - 1.2 = 2.1v

Calculating using Ib=Ic/10 (*** Best Approach)

It is common to assume that base current is 1/10 of the collector current.

Ib = Ic/10 = 73/10 = 7.3mA

Rb = Vb/Ib = 2.1/0.0073 = 288

Confirm: Can the micro controller deliver Ib current required?

Tested with 220 and it worked.

Calculating using hFE

To guarantee that the transistor operates in the saturation region, we multiply the base current by a factor of three.

hFE=100 (@100mA)

Ib = Ic/Hfe = 73/100 = 0.73mA

Rb = Vb/Ibx3 = 2.1/(0.00073x3) = 959

This would be the max value for Rb.

Calculating using the online calculator

hFE=100

Rb = 960

This would be the max value for Rb.

Formulas

Ic=(V-Vce)/RL

Ib=Ic/hFE

Rb=(Vi-Vbe)/(3*Ib)

References

Reference	URL
Base Resistor Calculator	https://www.petervis.com/GCSE_Design_and_Technology_Electronic_Products/transistor_base_resistor_calculator/transistor_base_resistor_calculator.html
Discussion Forum	https://forum.allaboutcircuits.com/threads/calculating-base-resistor-for-transistor.78483/