LED interface

Apr 25, 2022

LED operating current : 10~30mA

Color	Forward voltage	Required additional resistance for 5V supply : $R = \frac{5 - V_f}{30e^{-6}}$
	1.8V	1067 Ohm
	3.5V	533 Ohm
	3.6V	500 Ohm

So the resistance will be chosen as 1.1k, 600, 600 Ohm

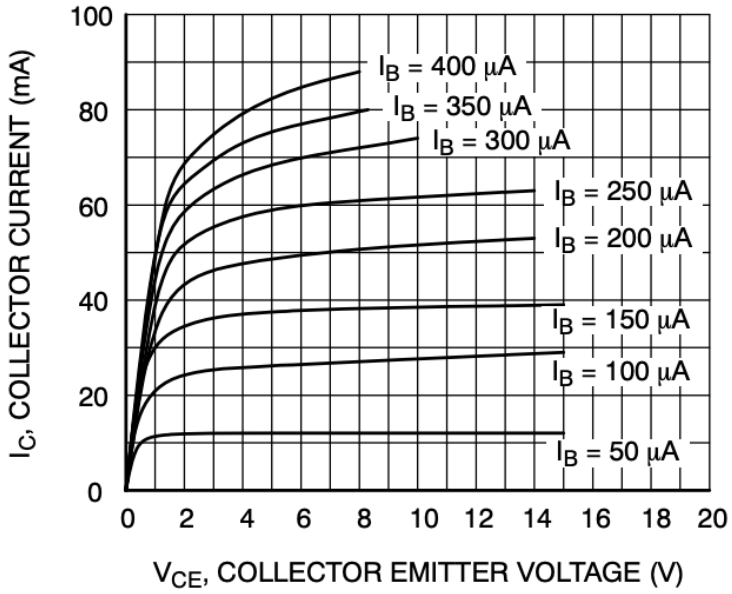


Figure 1. Static Characteristic

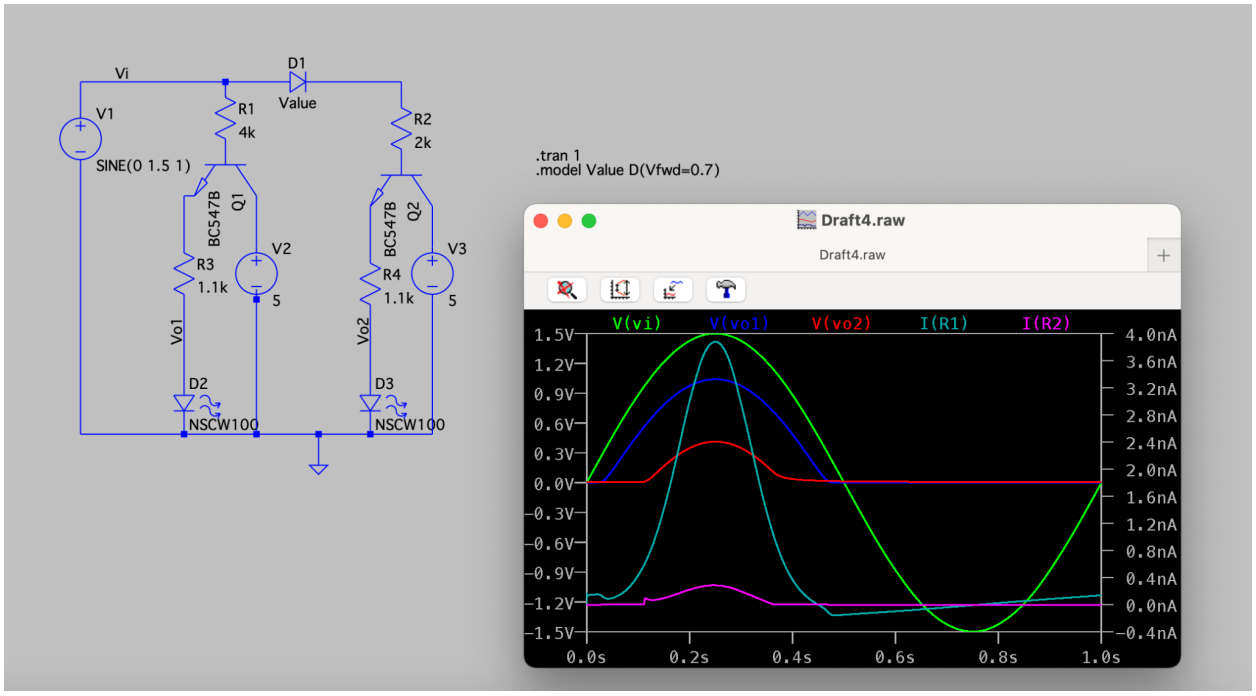
When VCE = 5V, we want the base current to be under 300 uA
For red LED,

$$300 * 10^{-6} = \frac{1.5}{1.1 * 10^3 + R_1}$$

$$R_1 = \frac{1.5}{300 * 10^{-6}} - 1.1 * 10^3 = 3900$$

A 4k Ohm resistor may suffice

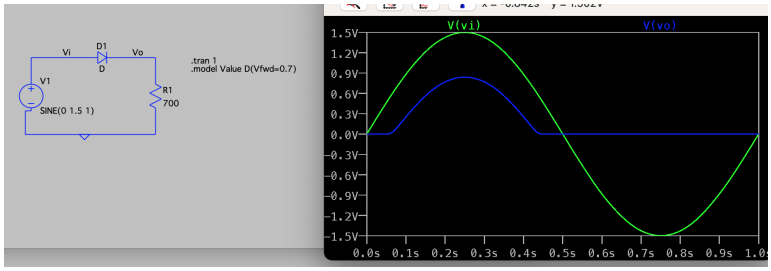
The strategy:
Make LED shine the more we look towards a certain direction. Another LED shines only when a certain threshold is crossed. For convenience, we use 0.7 for now.
Result : Not how I imagined. The Diode does not threshold the Vi by 0.7V, the base current is not calculated by Vi divided by total resistance from base to emitter to ground. Several checks are required :



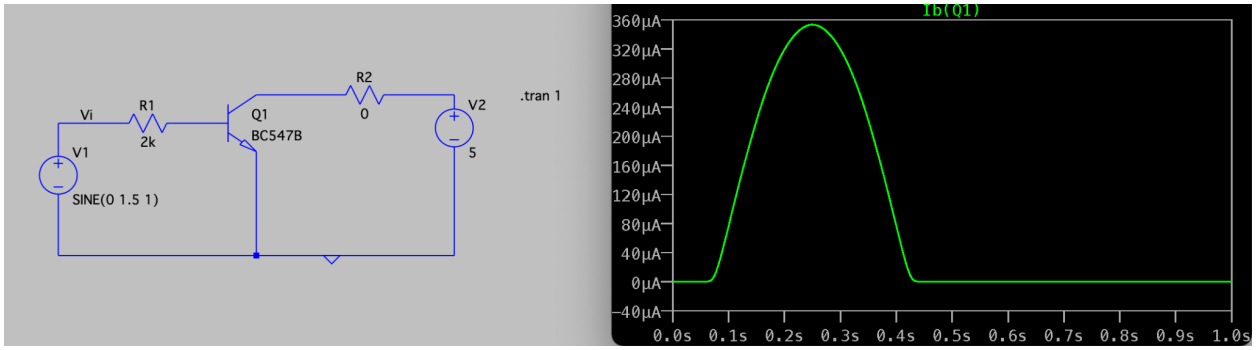
1. Check that diode does reduce the input voltage by 0.7
2. Find ways to determine base current

Answers:

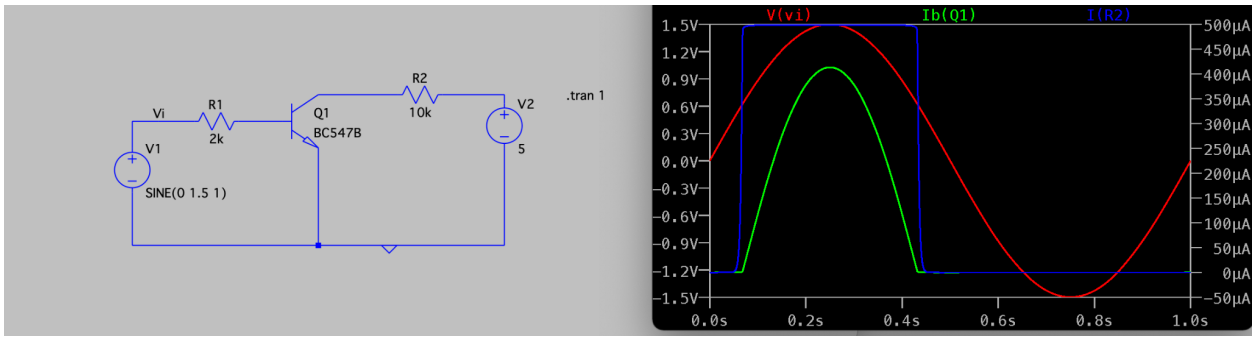
1. It does, so the main problem may be the bjts



2. By experimenting in LTSpice, the resistor at base is the main determinant of the base current. Resistance at the emitter will affect the current highly, but if the resistance is placed at the collector, the effect is minimal, and the current can be well predicted.
   P.S., in hindsight, we have done that in workshops already and that is the same circuit we were doing.



Step 1 : Pick an R1 so that the Ib falls in the operating region



Step 2 : Placing R2 at the collector side, the current over R2 can simply be obtained by V2/R2. From what we are seeing, there is a readily thresholding from the bjt. So we could use this to do the thresholding for us, and use other circuits to detect the lower gaze angles.

New UI

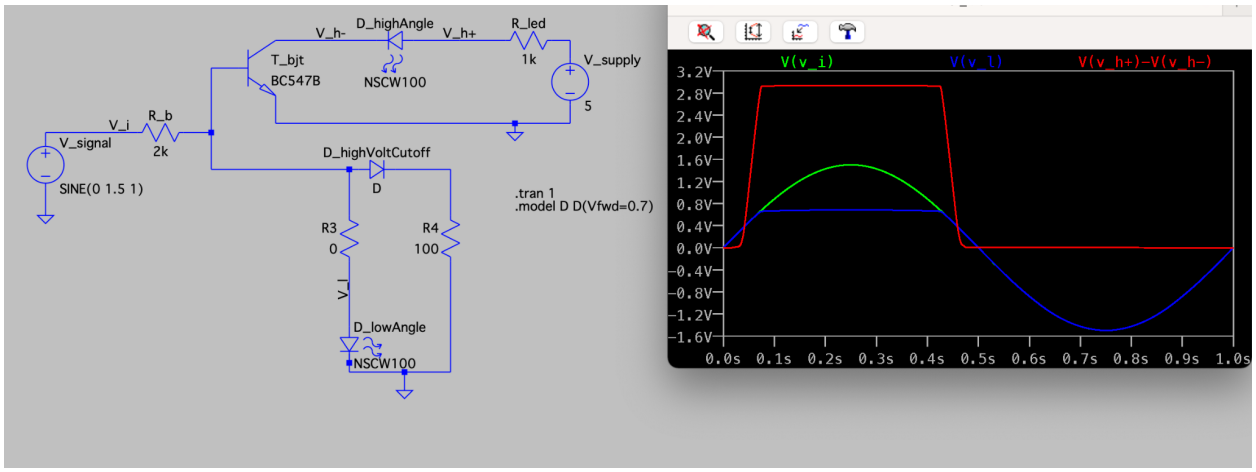


Fig : (Top circuit) Lights when gaze angle surpasses certain threshold. (Bottom circuit) Lights when gaze angle below threshold

Though the resistors are arbitrarily chosen except for R_b , it sure is off for a good start.
Issues:

1. V_l may not be enough to light the LED for low angle

2. The threshold for V_h can be increased, but simply adding another diode reduces the voltage by too much.

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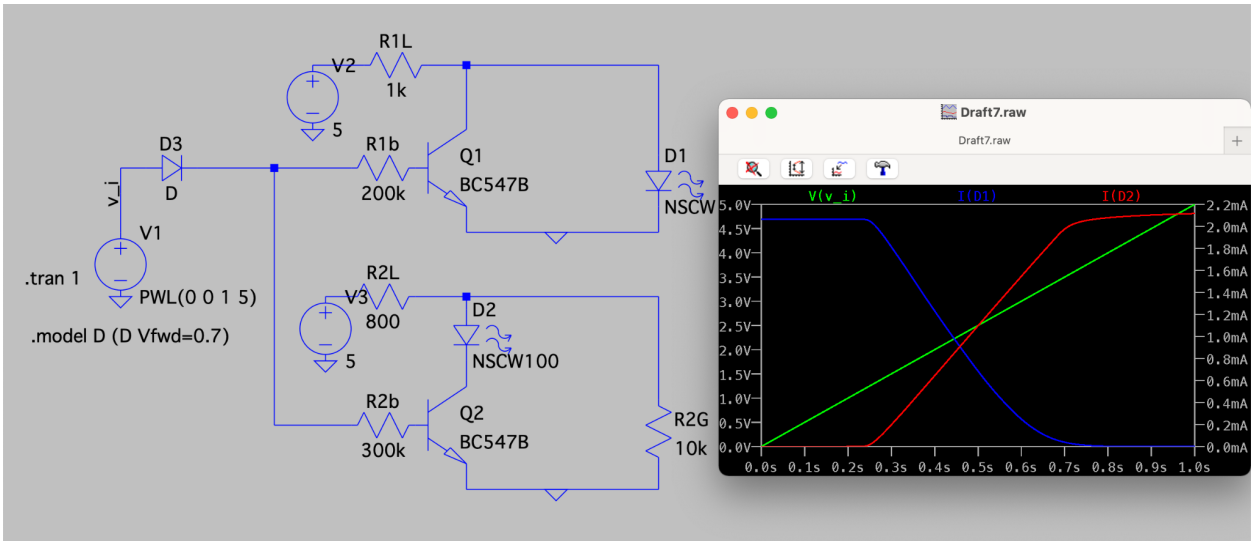

A new scheme is used
Now LED D1 shines at low gaze angle, while LED D2 at high angle.
We could make D1 band pass, rising up only at a certain voltage, but that would increase the number of transistors required, which we only have 4 in total, so I did not implement that.

NEW ISSUE:
Signal voltage changed from 1.5V to 5V, since 1.5V can't even pass through a diode without dropping half of the signal magnitude. New gain will have to adapt to provide a 5V signal.