Current Sources and Ramp Generators (Review)

Lab 6: Digital-to-Analog Conversion

ECE 327: *Electronic Devices and Circuits Laboratory I*

Abstract

For the digital-to-analog conversion (DAC) lab, we need to implement a ramp generator (again). In this document, we review ramp generators each built with a *pnp* BJT current source.

Contents

1 Resistor-Biased Ramp Generator

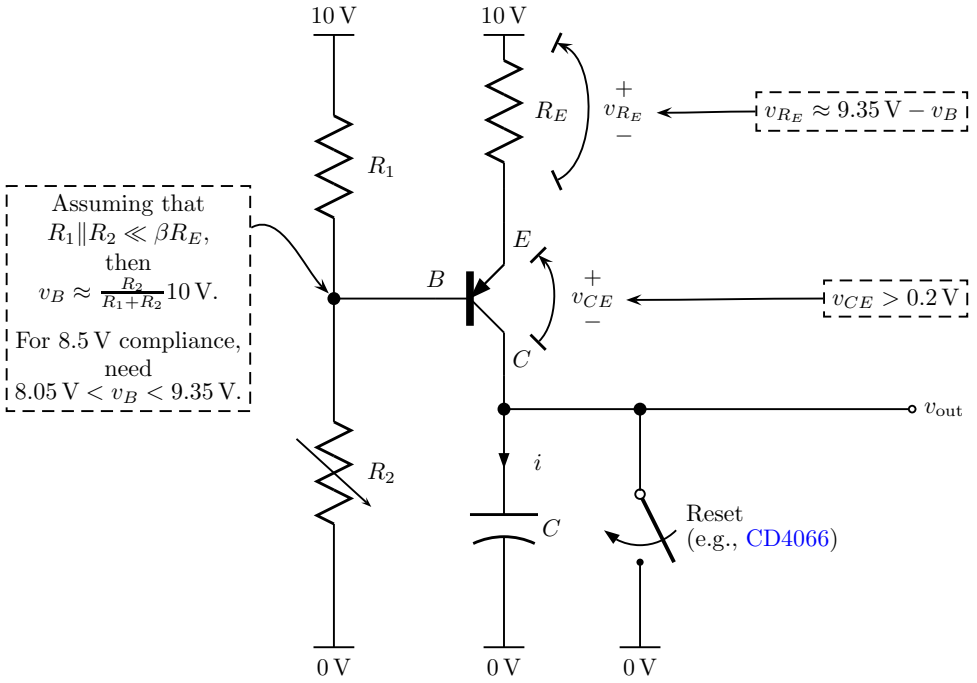


Figure 1.1: Resistor-biased *pnp* BJT (e.g., 2N3906) ramp generator (0–8.5 V compliance).

Use C and the desired v'_{out} to set i. Use i to pick v_B and R_E. Use v_B to pick R_1 and R_2. From Figure 1.1:

$$i = Cv'_{\text{out}} \qquad 8.05\,\text{V} < v_B < 9.35\,\text{V} \qquad \frac{v_{R_E}}{i} = \frac{9.35\,\text{V} - v_B}{i} = R_E \qquad v_B \approx \frac{R_2}{R_1 + R_2} 10\,\text{V}$$

- Due to parasitic resistances, choosing C trades off ramp linearity for reset steepness.
- **MAKE** the R_1–R_2 divider a **POTENTIOMETER** for tuning.
- **For best results**, use $R_1 \| R_2 \ll \beta R_E$ where $\beta \approx 100$ and $R_1 \| R_2 \triangleq R_1 R_2/(R_1 + R_2)$.

2 Diode-Biased Ramp Generator

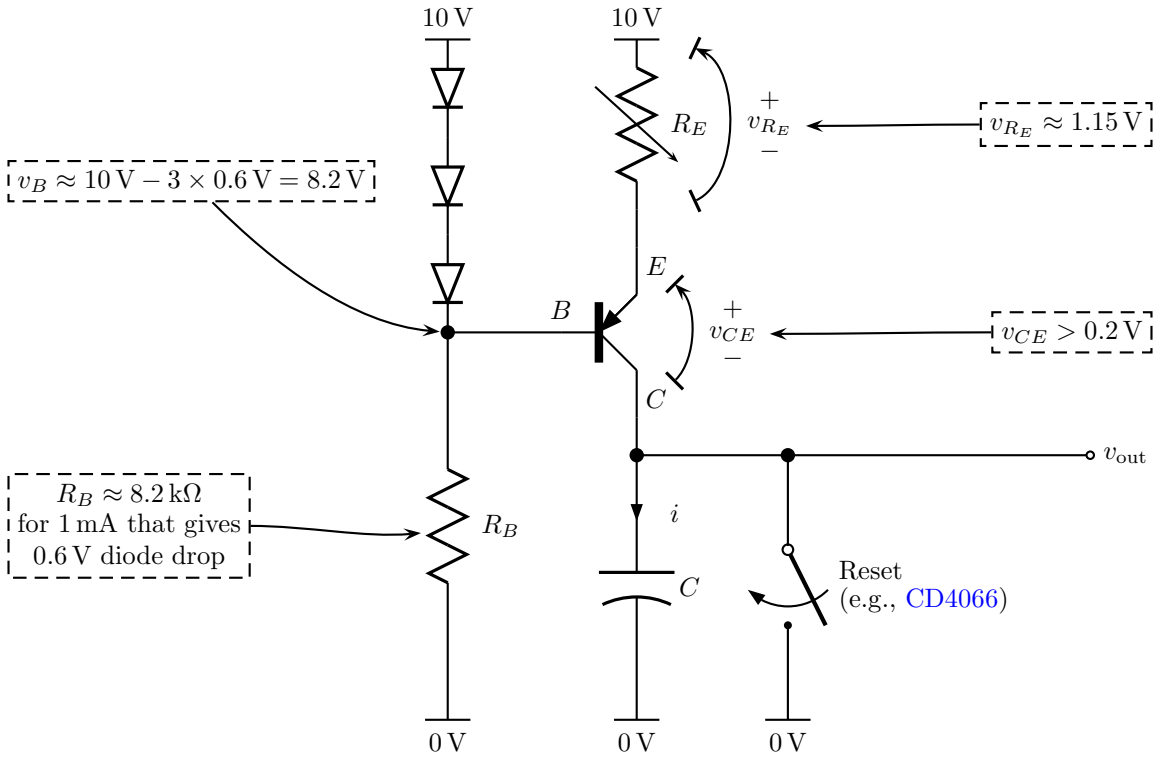


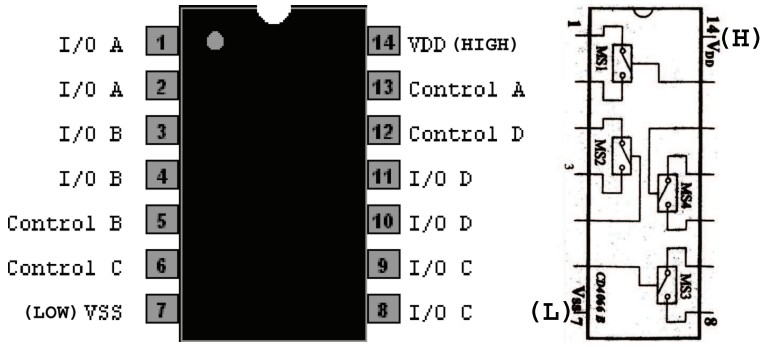
Figure 2.1: Diode-biased *pnp* BJT (e.g., 2N3906) ramp generator (0–8.65 V compliance).

Use C and the desired v'_{out} to set i. Use i to pick R_E. From Figure 2.1:

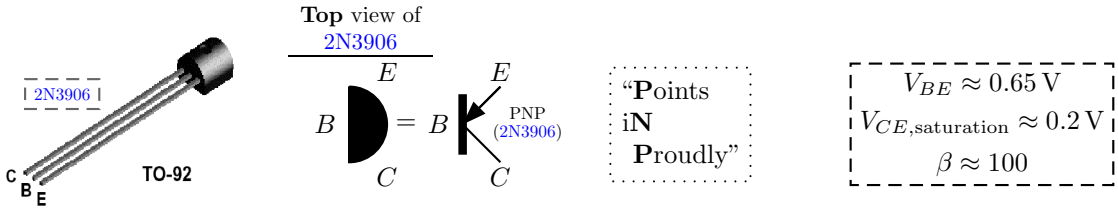
$$\boxed{i = Cv'_{\text{out}}} \qquad \boxed{\frac{v_{R_E}}{i} = \frac{1.15\,\text{V}}{i} = R_E}$$

- Due to parasitic resistances, choosing C trades off ramp linearity for reset steepness.
- **MAKE** the R_E resistor a **variable resistor** (i.e., two adjacent pins of a potentiometer) for tuning.

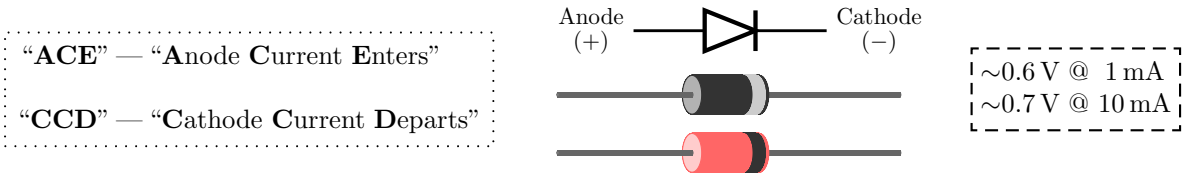
A Parts



(a) CD4066 solid-state switch



(b) 2N3906 PNP BJT transistor



(c) 1N914 silicon diode (generic small-signal diode)

Figure A.1: Part pin-outs.