Chap. 5 Oscillators

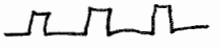
Oscillators are part of most instruments.

Oral discussion:

- signal generators
- function "
- pulse "

} obviously include an oscillator

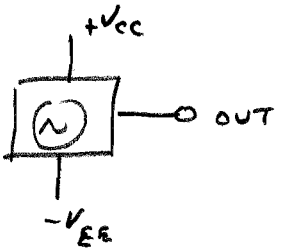
- digital instruments
- computers
- anything with a display that refreshes periodically

} requires a clock 

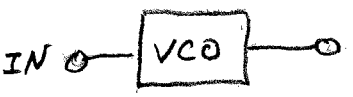
- time measurement
  - freq counter, counts events between a start & stop time ← clock
- analog oscilloscope to sweep e-beam horizontally across screen

kinds of oscillators

all have an output



some have an input

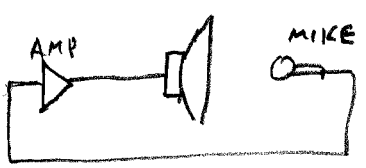


FM freq modulation 

AM amplitude modulat. 

positive feedback

Oscillators use positive feedback

ex. 

timing methods

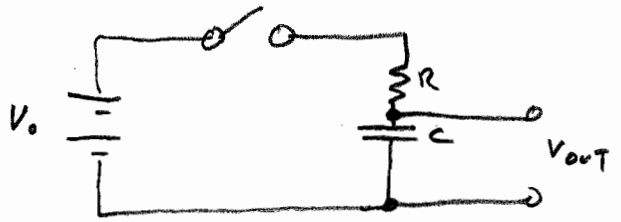
- quartz crystal
  - it's an LCR resonant circuit in a single package
  - 0.01 % or better accuracy
- RC relaxation oscillators
  - period determined by product RC
  - not as accurate, but easier, than quartz crystal. ← student projects!

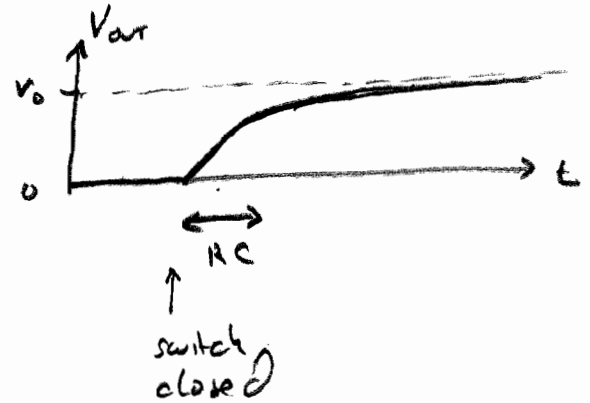
recall

RC time

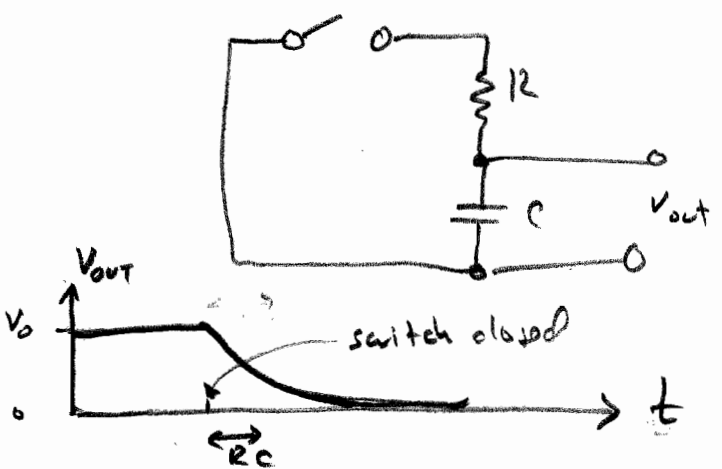
charge $Q = C V$ ← potl. across capacitor

charging starts when switch below is closed



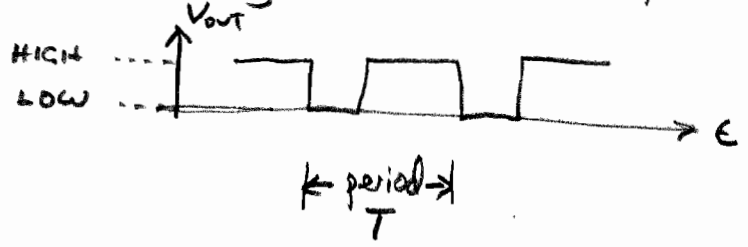


discharging if capacitor is already charged, so that initially it has a potl V_0, then switch below is closed

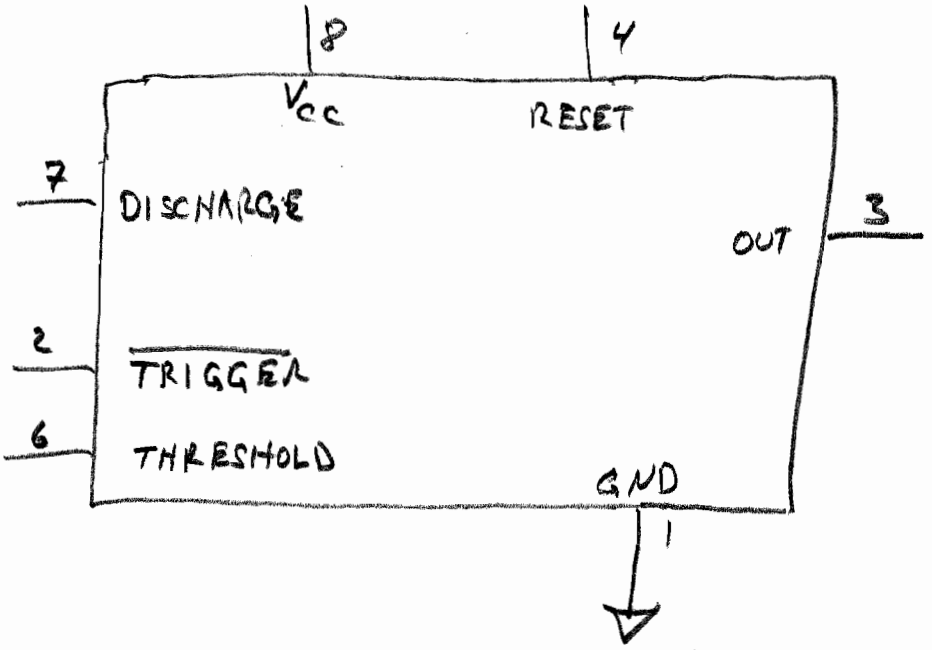


555 Timer Chip

Easiest way to make a pulse train



It is an 8-pin IC



Requires a single-sided power supply

e.g. V_{cc} = +5V or +9V
& GND = 0V

oral discussion: "single-sided" vs. "dual" power supply
op amps, digital chips, etc.

555 inputs:

pin 6	THRESHOLD	is actuated by input $< \frac{1}{3}V_{cc}$
pin 2	$\overline{\text{TRIGGER}}$	" " " " $> \frac{2}{3}V_{cc}$

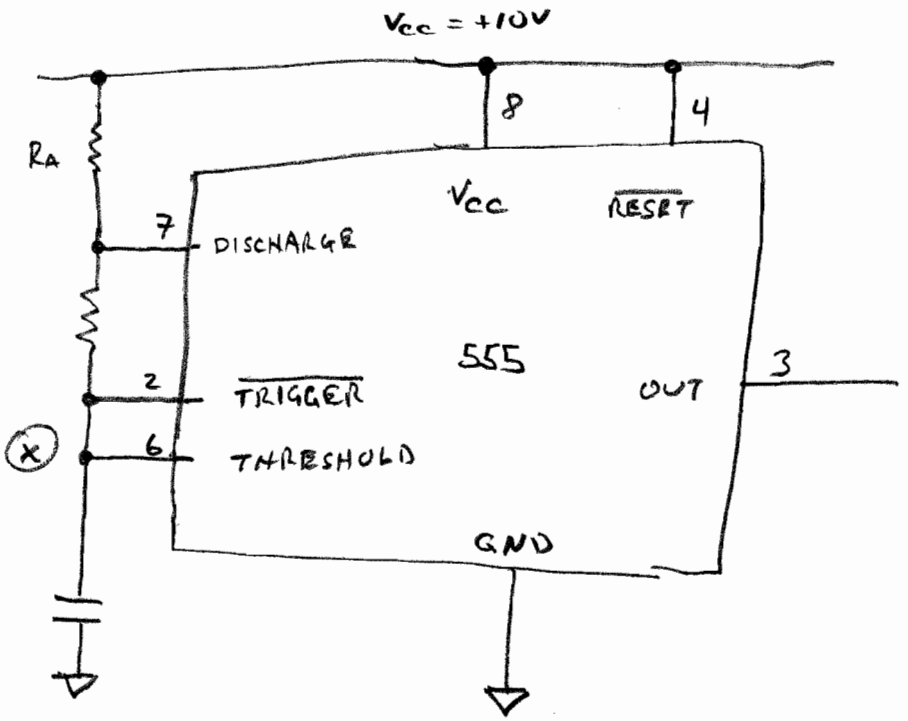
555 outputs

pin 3	OUT	a voltage, either HIGH or LOW
pin 7	DISCHARGE	a transistor switch, inside the chip, determines whether pin 7 is: • open circuit, or • shorted to GND

555 rules

two different input conditions	what happens at outputs
(a) $V_{\overline{\text{TRIGGER}}} < \frac{1}{3}V_{cc}$	OUT → HIGH and DISCHARGE pin is open
(b) $V_{\text{THRESHOLD}} > \frac{2}{3}V_{cc}$	OUT → LOW and DISCHARGE pin is shorted to GND

Fig 5.33 of text:



draw big

Time History, in three steps:

① Suppose initially C has no charge

Recall $Q = CV$ ← volt drop across cap.

$\Rightarrow (V_x - 0) = 0$

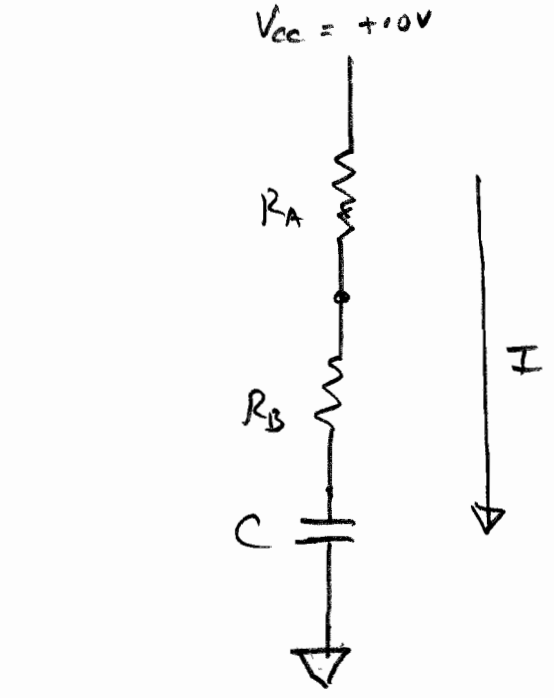
node (X) is connected to $\overline{\text{TRIGGER}}$

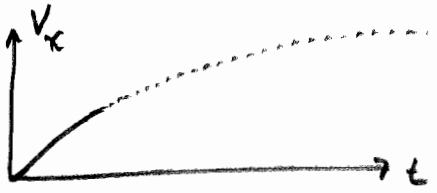
$\Rightarrow V_{\overline{\text{TRIGGER}}} = 0 < \frac{1}{3} V_{cc}$

$\Rightarrow$ rule ② applies

$\Rightarrow$ { OUT is HIGH
DISCHARGE (pin 7) is open

so the capacitor can charge thru R_A & R_B





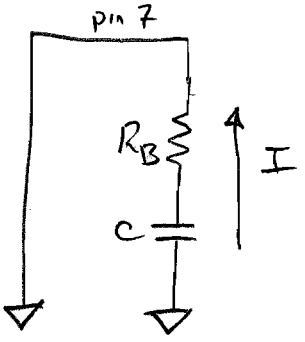
(2) capacitor continues to charge up in step (1) until

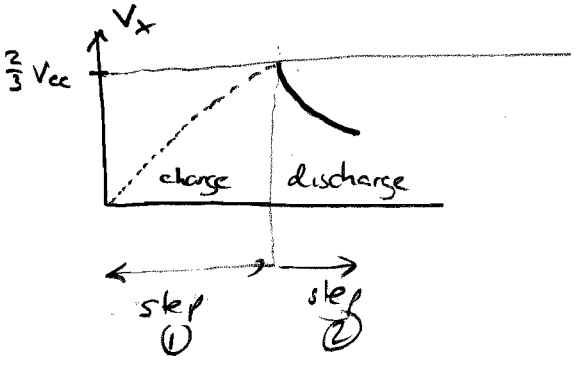
$V_x = V_{THRESHOLD} > \frac{2}{3} V_{cc}$

$\Rightarrow$ rule (5) applies

$\Rightarrow$ { OUT IS LOW
DISCHARGE (pin 7) is shorted to GND

so the capacitor will discharge thru R_B





③ capacitor continue to discharge in step ② until

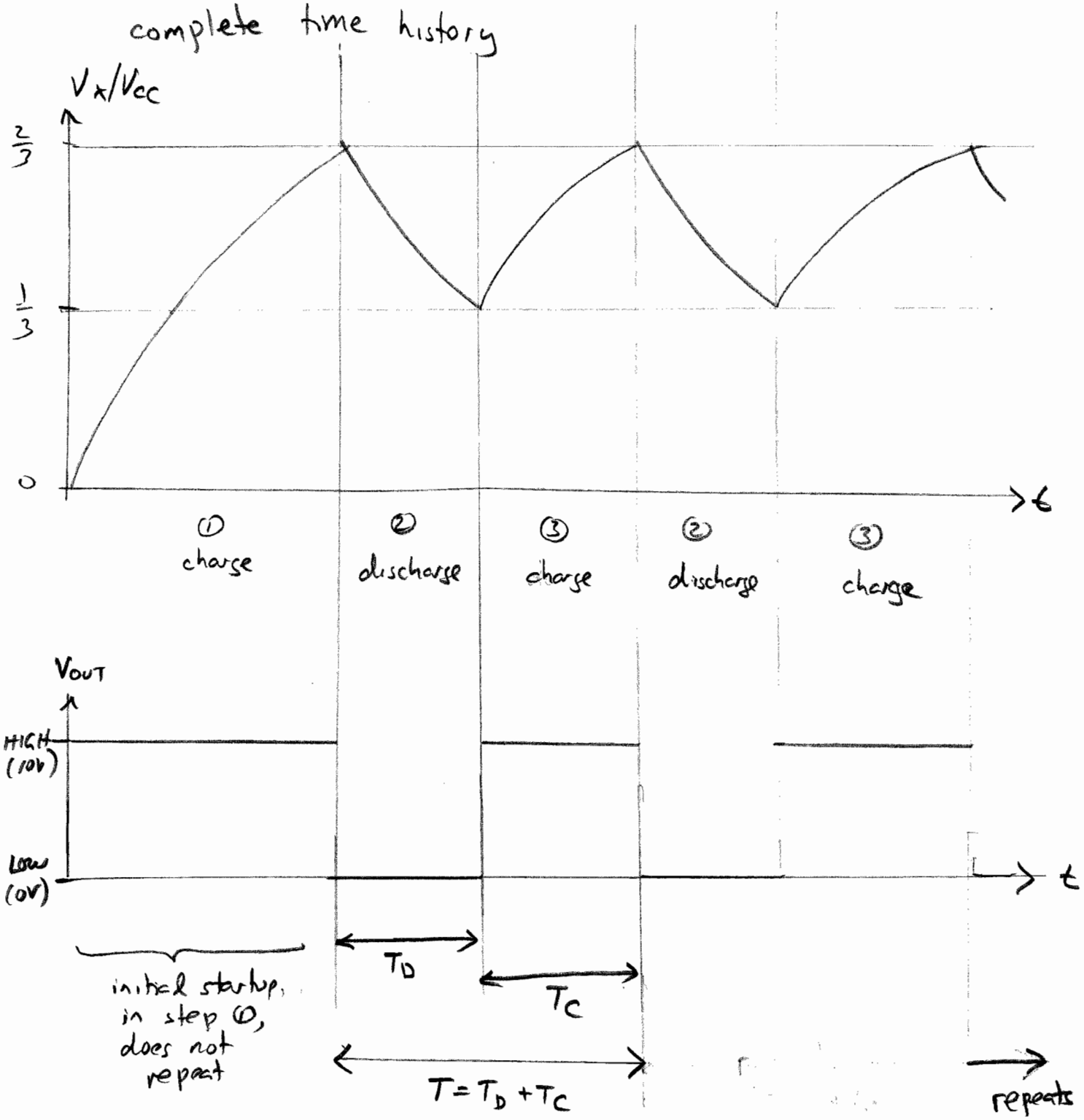
$$V_x = V_{\overline{TRIGGER}} < \frac{1}{3} V_{cc}$$

$\Rightarrow$ rule ② applies again

$\Rightarrow$ { OUT is HIGH
DISCHARGE (pin 7) is open

capacitor charges thru R_A & R_B

complete time history



↑ period T

calculate T in homework

multisym 2003