

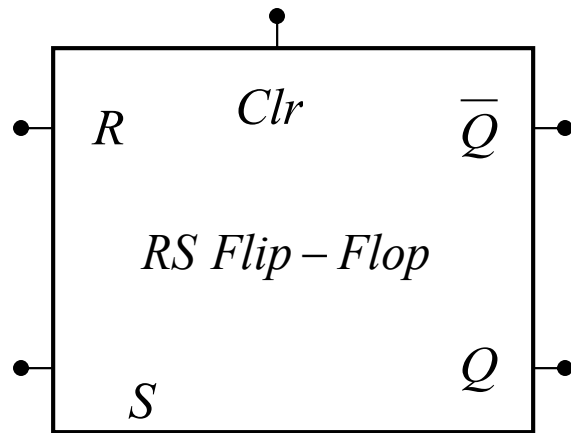
555 Timers

Lecture 13

555 Timer

- An device introduced by Signetics in 1972
- An economical and convenient way to design multivibrator circuits.
- Consists of voltage divider string, two comparators, a RS flip-flop and a switching transistor
- RS flip-flop is a device which can attain one of two states based on the states of its inputs RS.

RS Flip-Flop

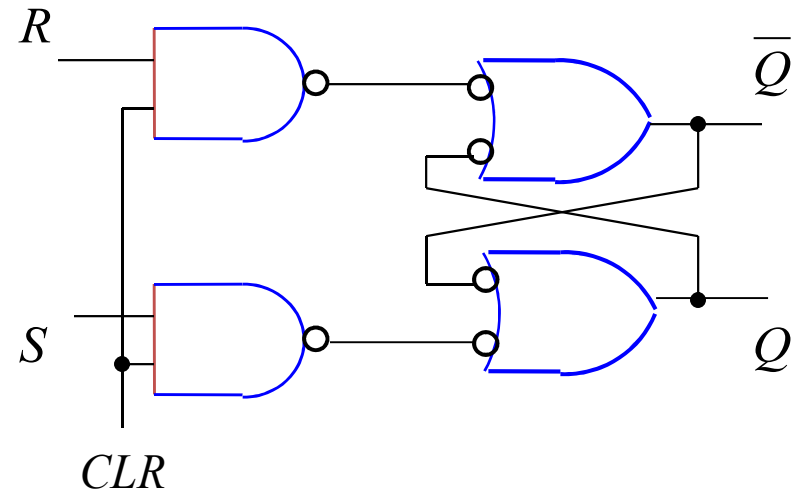


Clr	R	S	Q
0	x	x	0
1	0	0	NC
1	0	1	1
1	1	0	0
1	1	1	?

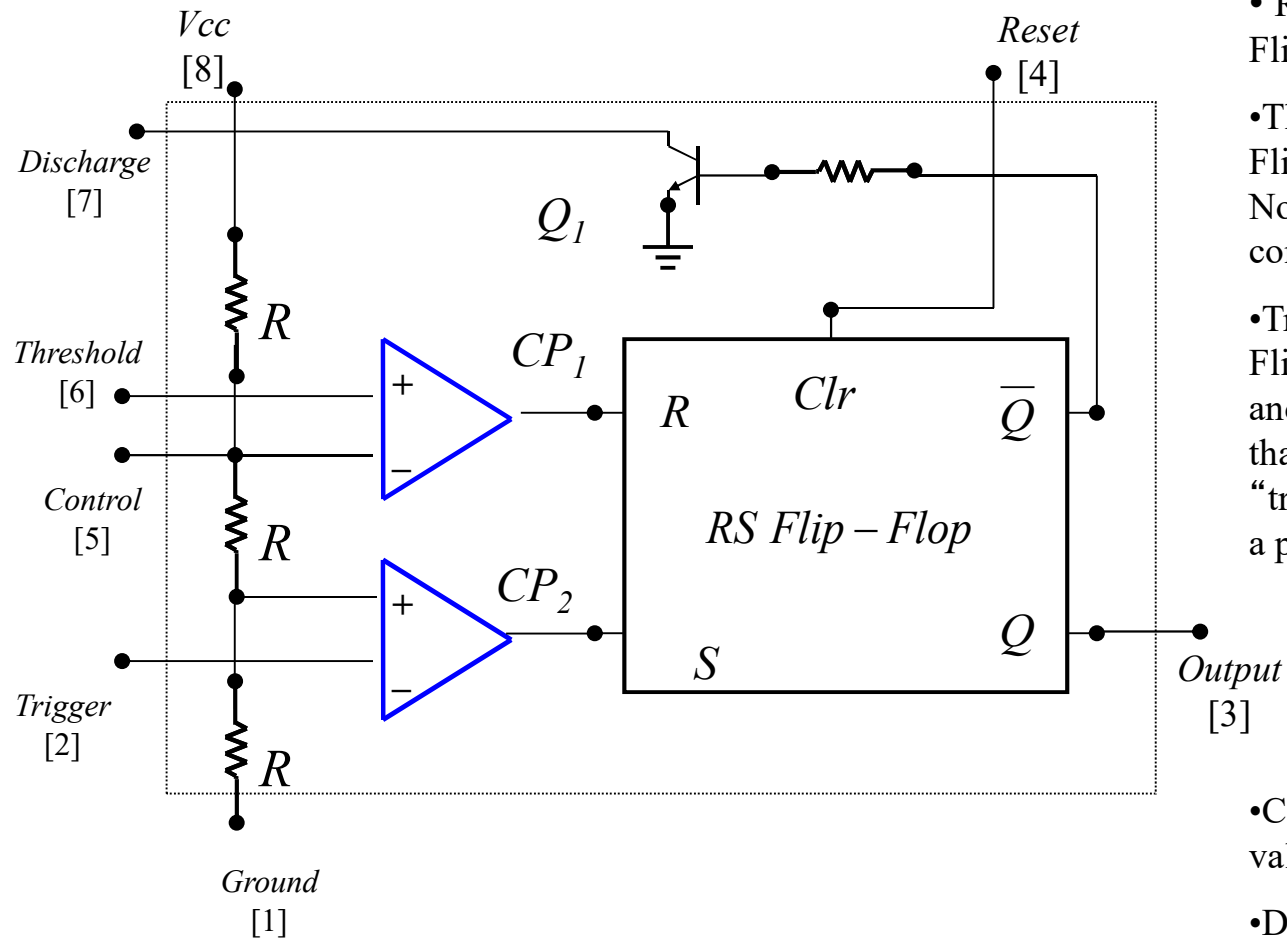
x - don't care

NC – No Change

? - indeterminate

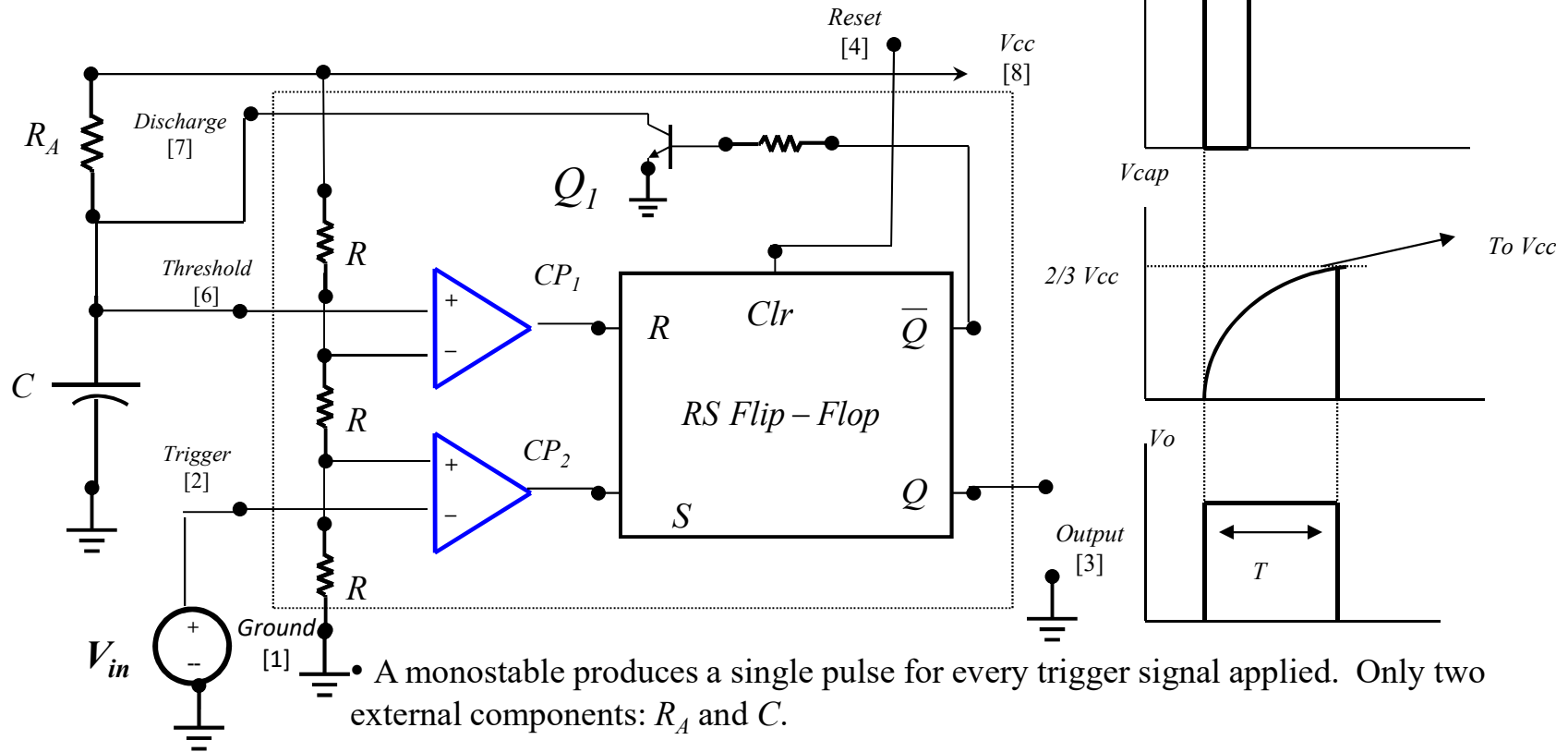


555 Timer



- Reset – will always reset the Flip-flop and usually set to *Vcc*
- Threshold – Value $> 2/3 V_{cc}$ then Flip-flop is RESET, $Q=0$ and $\text{Not}Q=1$ and transistor Q_1 conducts
- Trigger – Value $< 1/3 V_{cc}$ then Flip-flop is SET, $Q=1$ and $\text{Not}Q=0$ and transistor Q_1 is cutoff. Note that the Flip-flop will be “triggered” on the falling edge of a pulse applied to this input
- Control – probe to test threshold value
- Discharge – is the Q_1 output and presents a short to ground when Q_1 conducts

555 Monostable ^{V_{in}}



$$v_c(t) = K_1 + K_2 e^{-t/R_A C}$$

$$v_c(0) = 0 = K_1 + K_2$$

$$v_c(\infty) = +A = K_1$$

$$v_c(t) = A(1 - e^{-t/R_A C})$$

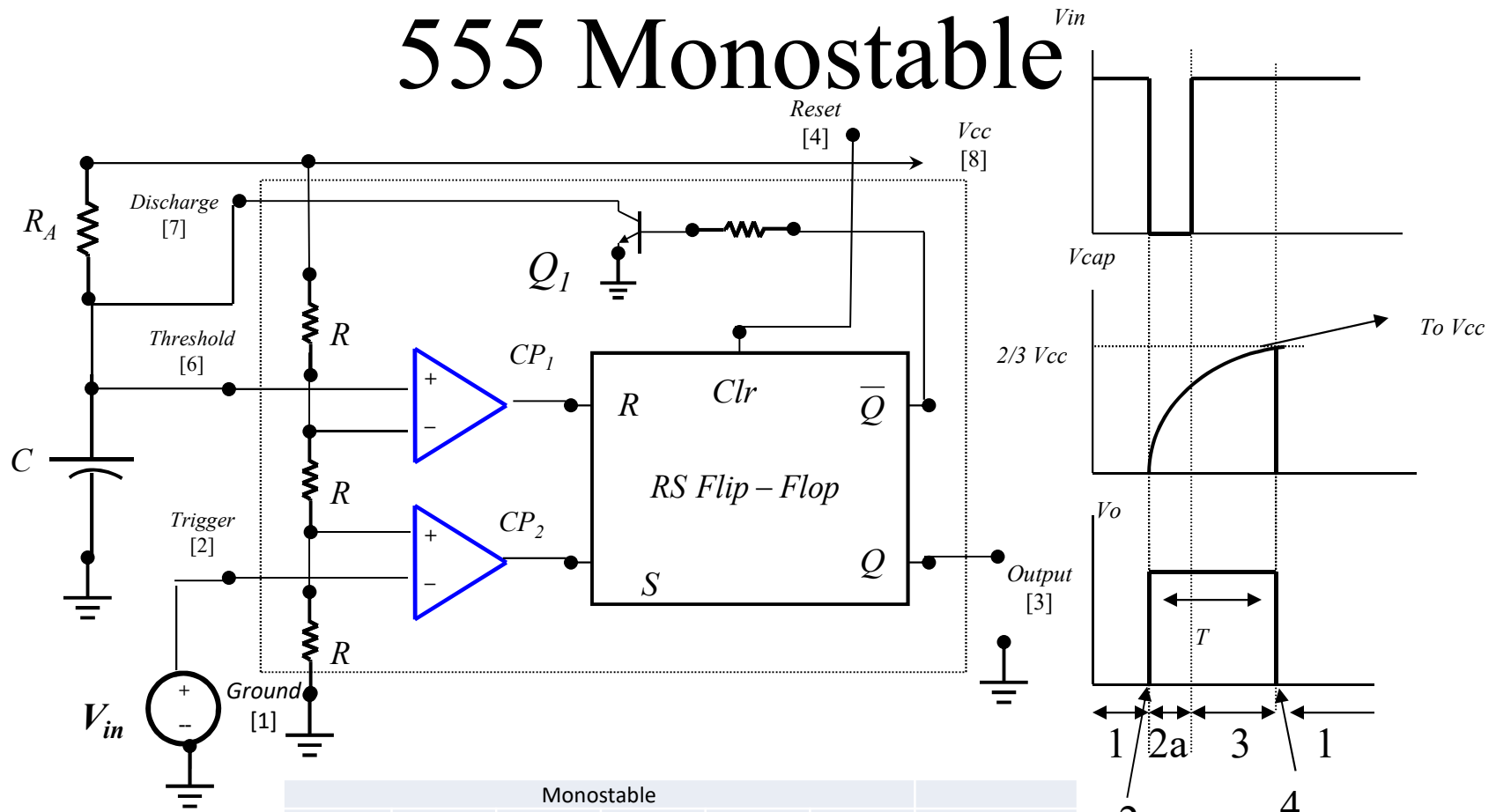
$$v_c(T) = \frac{2A}{3} = A(1 - e^{-T/R_A C})$$

$$\therefore T = R_A C \ln(3)$$

- When the trigger drops below $1/3 V_{cc}$, the comparator CP_2 causes the flip-flop to be SET and Q_1 opens and C begins to charge through R_A . When the voltage of the capacitor reaches $2/3 V_{cc}$, the comparator CP_1 causes the flip-flop to be RESET and Q_1 saturates presents a “zero” resistance to ground for the capacitor to discharge through.

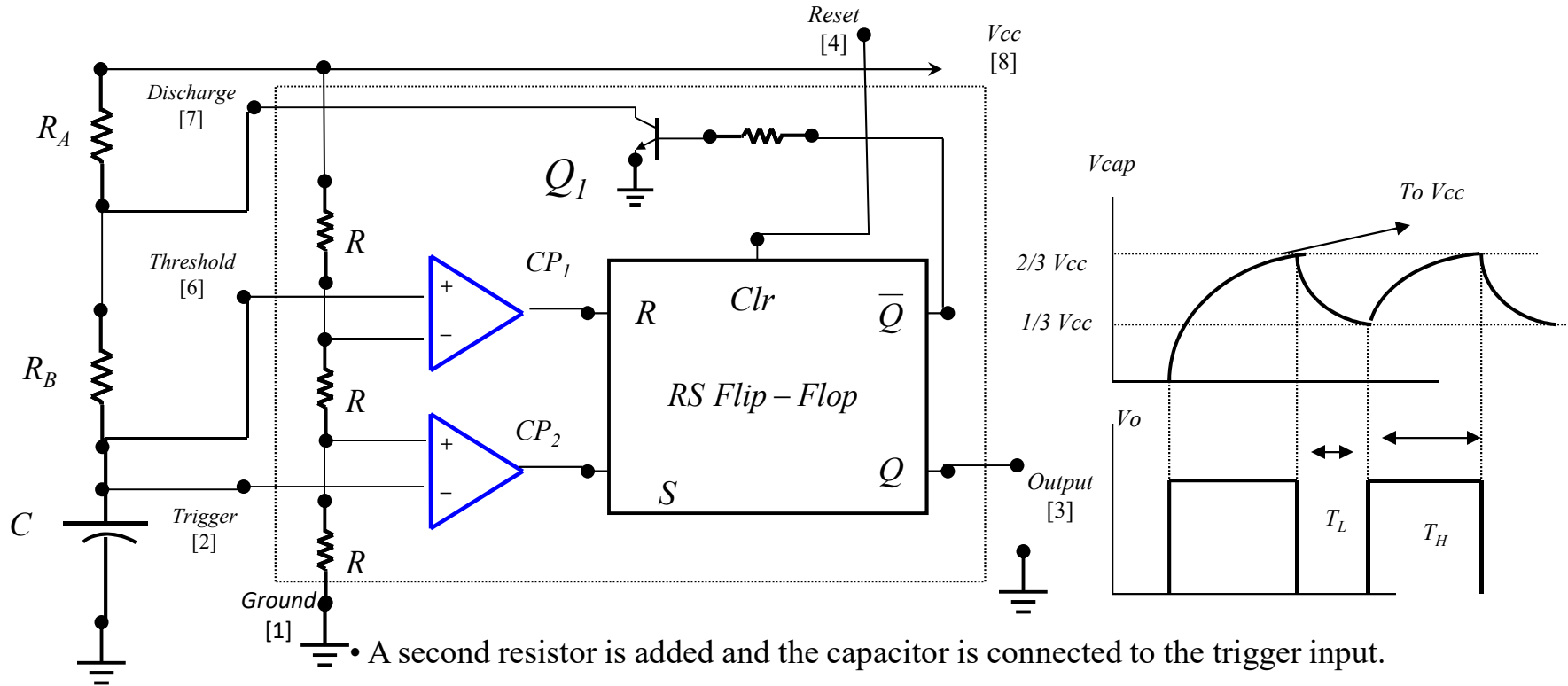
- As a result a single pulse of width $T = R_A C \ln(3)$ is produced.

555 Monostable



	Monostable					
State	1	2	2a	3	4	1
Vin	High	Low	Low	High	High	High
S	0	1	1	0	0	0
R	0	0	0	0	1	0
Q	0	1	1	1	0	0
Qnot	1	0	0	0	1	1
Transistor	ON	OFF	OFF	OFF	ON	ON
Vcap	0	0	<2/3 Vcc	<2/3 Vcc	=2/3Vcc	0

555 Astable



- At startup the capacitor voltage is less than $1/3 V_{cc}$, the flip-flop is SET (via the trigger comparator), Q1 opens and C begins to charge through R_A and R_B .
- As the capacitor voltage reaches $2/3 V_{cc}$, the flip-flop is RESET (via the threshold comparator), Q1 saturates, and the capacitor starts to discharge through R_B .
- When the capacitor voltage drops below $1/3 V_{cc}$, the flip-flop is SET again, Q1 reopens, and the process restarts again.

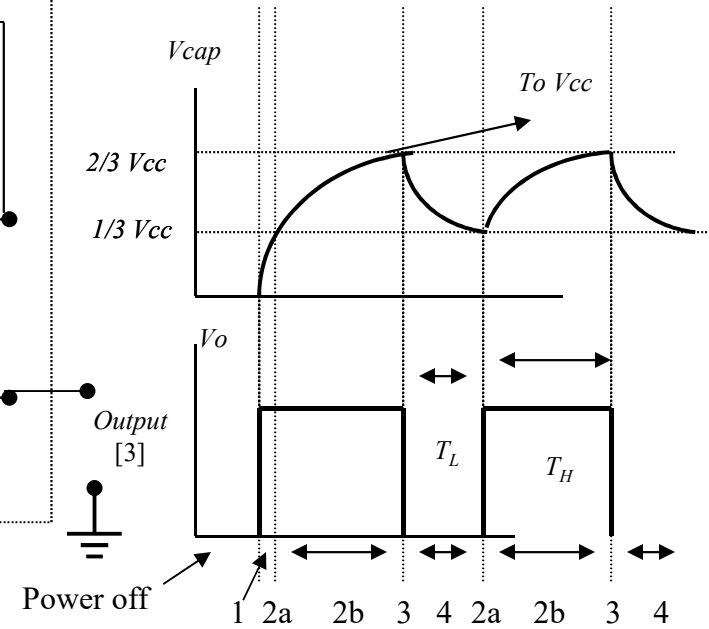
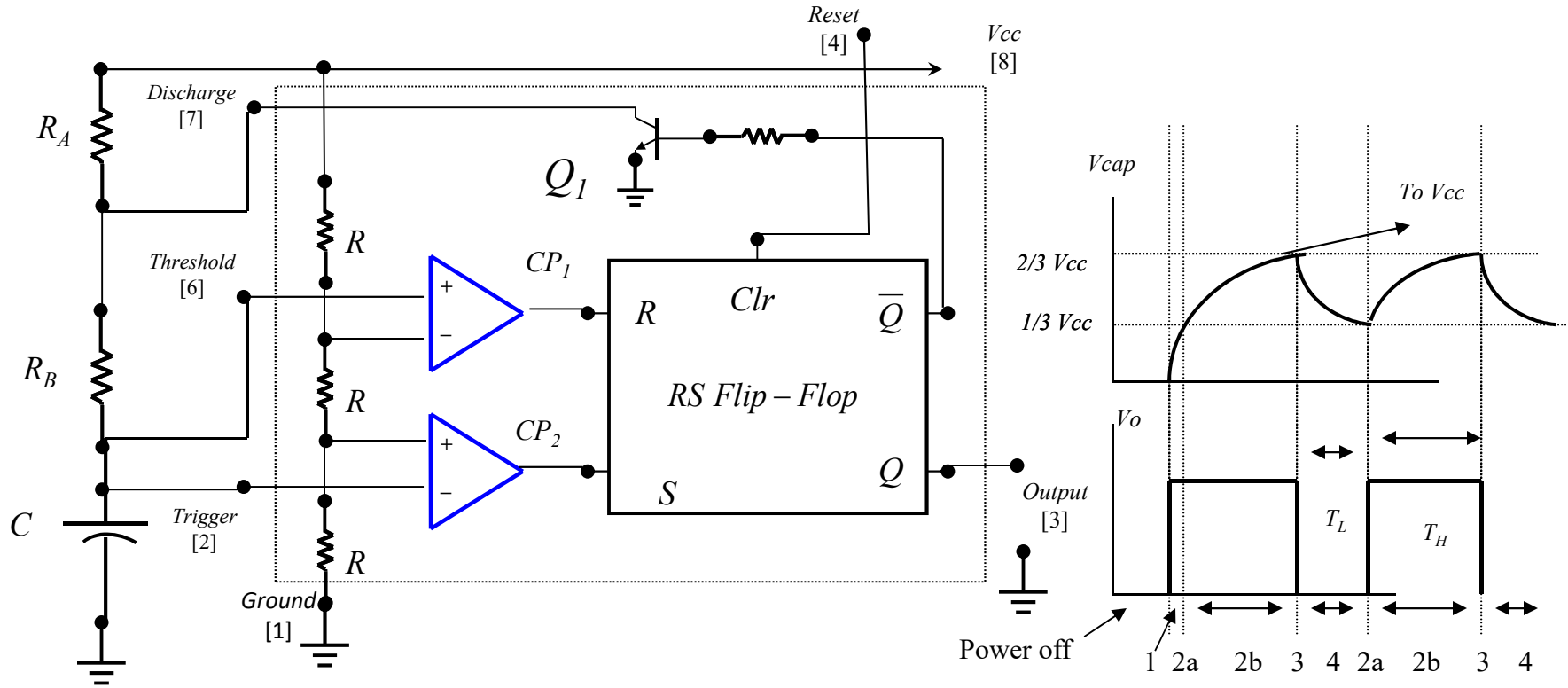
$$T_H = (R_A + R_B)C \ln(2)$$

$$T_L = R_B C \ln(2)$$

$$T = T_H + T_L$$

$$= (R_A + 2R_B)C \ln(2)$$

555 Astable



Astable									
State	1	2a	2b	3	4	2a	2b	3	4
V_{cap}	$<1/3V_{cc}$	$=1/3V_{cc}$	$<2/3V_{cc}$	$=2/3V_{cc}$	$<2/3V_{cc}$	$=1/3V_{cc}$	$<2/3V_{cc}$	$=2/3V_{cc}$	$<2/3V_{cc}$
S	1	0	0	0	0	1	0	0	0
R	0	0	0	1	0	0	0	1	0
Q	1	1	1	0	0	1	1	0	0
Qnot	0	0	0	1	1	0	0	1	1
Transistor	OFF	OFF	OFF	ON	ON	OFF	OFF	ON	ON
RC	$(R_a+R_b)C$	$(R_a+R_b)C$	$(R_a+R_b)C$		R_bC		$(R_a+R_b)C$		R_bC

Homework

- 555 Timer
 - Problems: 12.18-20

Homework

- 555 Timer
 - Problems: 12.18-20