LM555 Timer

Optional

The 555 is a highly stable device for generating accurate time delays or oscillation

National Semiconductor:

- LM555 – in bipolar technology
- LMC555 – in CMOS technology

FEATURES:

- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C

http://www.ti.com/lit/ds/symlink/lm555.pdf

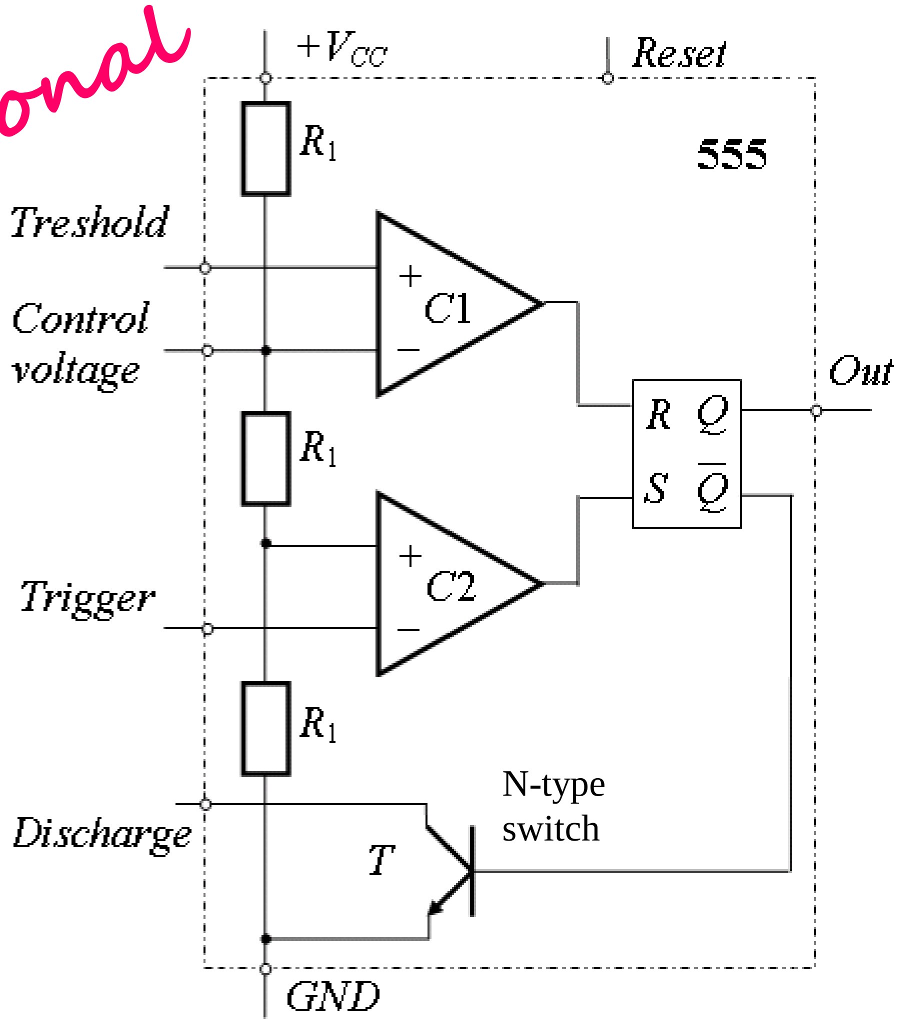
Circuit structure (block diagram)

Optional

The voltage references for $C1$ and $C2$ comparators are set by the R_1- R_1- R_1 network that divides the V_{CC} voltage:

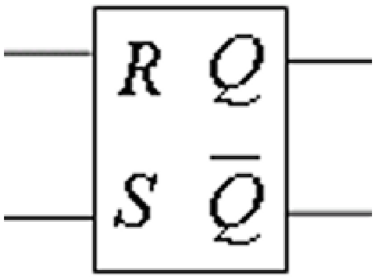
$\frac{2}{3}V_{CC}$ for the noninverting comparator C_1

$\frac{1}{3}V_{CC}$ for the inverting comparator C_2



RS flip - flop

basic sequential logic circuits
one-bit memory bistable device



Two inputs, active on HIGH ("1")

set S

reset R

Optional

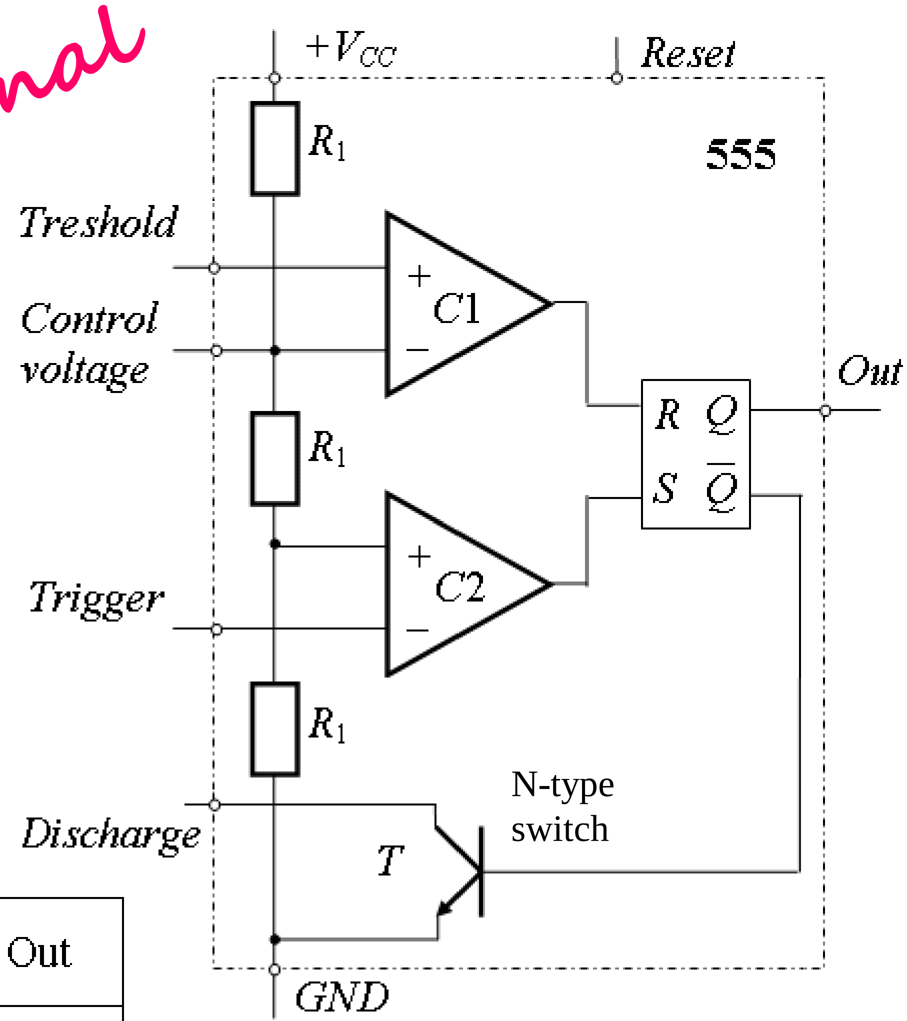
Flip - flop means that it can be **"flipped"** into one logic state or **"flopped"** back into another.

S	R	Q	$\overline{Q}$
0	0	no change	
0	1	0	1
1	0	1	0
1	1	undefined	

"0" => LOW (L)
"1" => HIGH (H)

Circuit structure and operation

Optional



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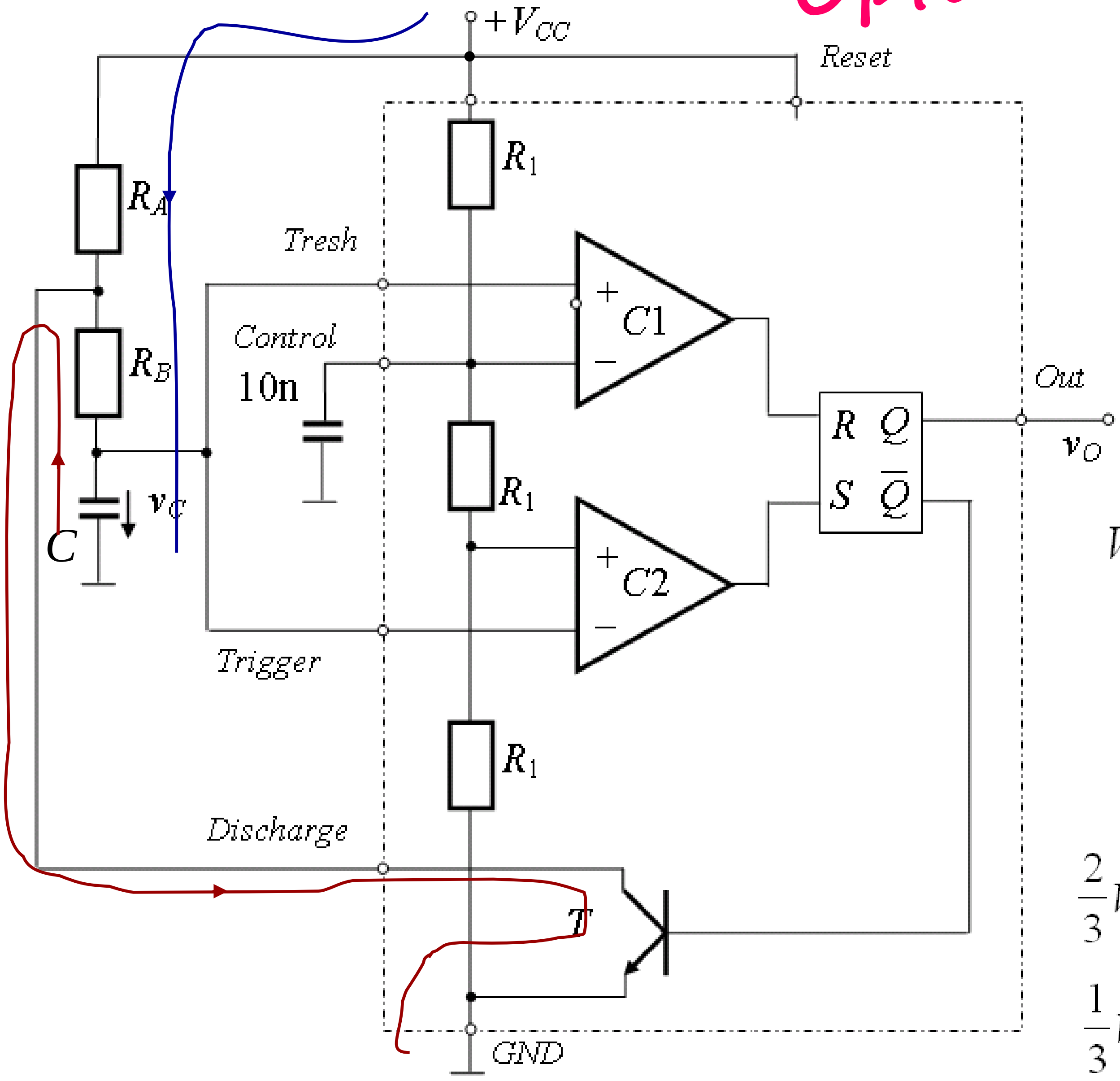
v_{Tresh}	$v_{Trigger}$	R	S	Q	$\overline{Q}$	T	Out
$< \frac{2}{3} V_{CC}$	$< \frac{1}{3} V_{CC}$	L	H	H	L	off	V_{OH}
$> \frac{2}{3} V_{CC}$	$> \frac{1}{3} V_{CC}$	H	L	L	H	sat	V_{OL}
$< \frac{2}{3} V_{CC}$	$> \frac{1}{3} V_{CC}$	L	L	previous state		previous state	previous state

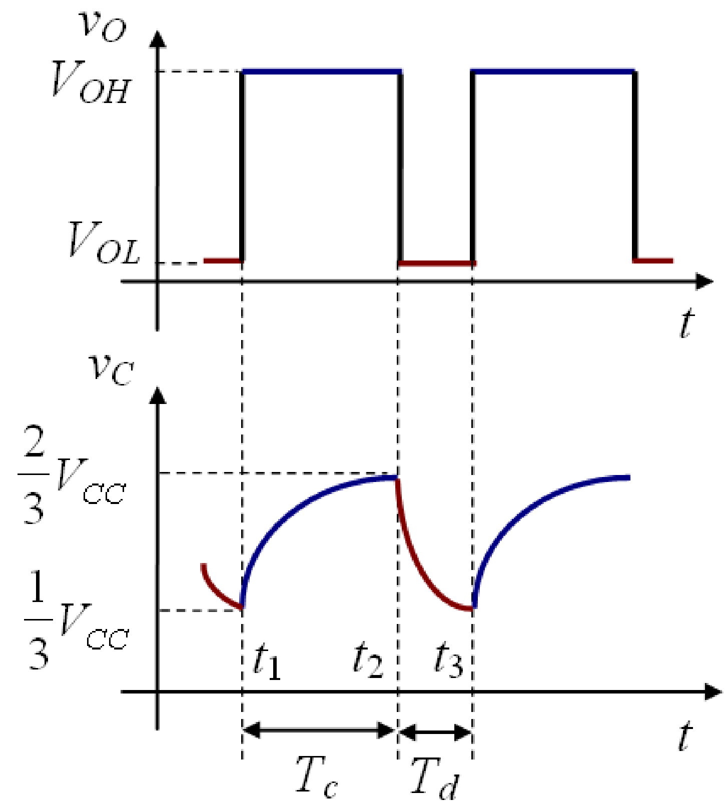
Optional

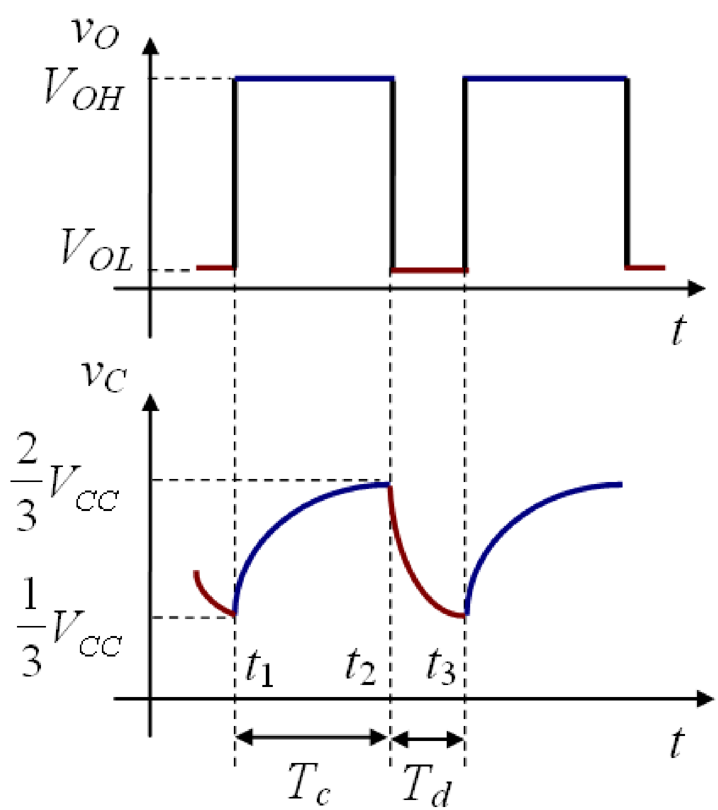
Astable multivibrator circuit



$$\tau_c = (R_A + R_B)C$$

$$\tau_d = R_B C$$





$$v_C(t) = v_C(0)e^{-\frac{t}{\tau}} + \left(1 - e^{-\frac{t}{\tau}}\right)v_C(\infty)$$

$$t \in (t_1,\ t_2)$$

$$\frac{2}{3}V_{CC} = \frac{1}{3}V_{CC}e^{-\frac{T_c}{\tau_c}} + \left(1 - e^{-\frac{T_c}{\tau_c}}\right)V_{CC}$$

$$T_c = (R_A + R_B)C\ln 2 \approx 0{,}69(R_A + R_B)C$$

$$t \in (t_2,\ t_3)$$

$$\frac{1}{3}V_{CC} = \frac{2}{3}V_{CC}e^{-\frac{T_d}{\tau_d}} + \left(1 - e^{-\frac{T_d}{\tau_d}}\right)\cdot 0$$

$$T_d = R_B C\ln 2 \approx 0.69 R_B C$$

$$T = T_c + T_d = (R_A + 2R_B)C\ln 2 \approx 0{,}69(R_A + 2R_B)C$$

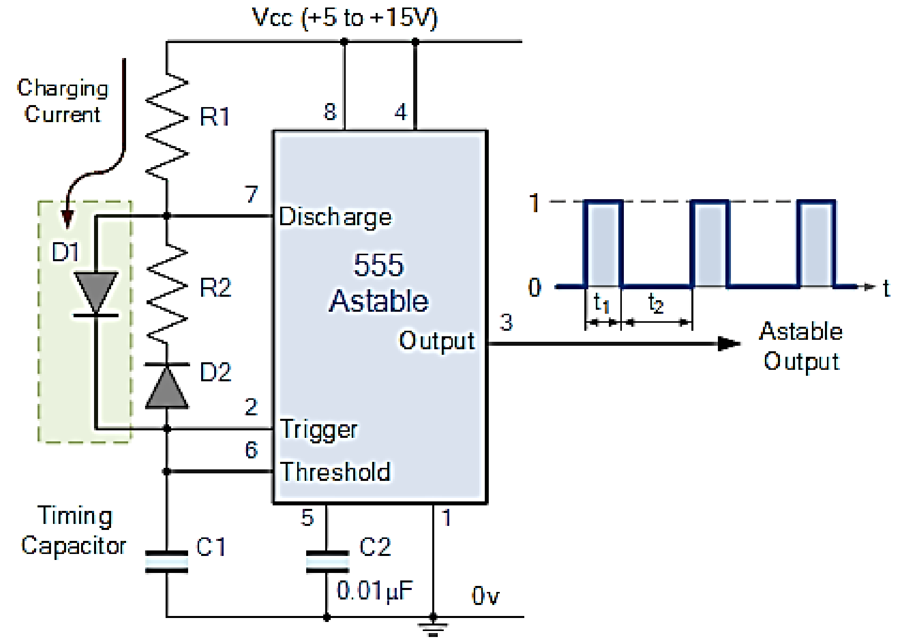
Duty cycle

$$\delta = \frac{T_c}{T_c + T_d} = \frac{R_A + R_B}{R_A + 2R_B}$$

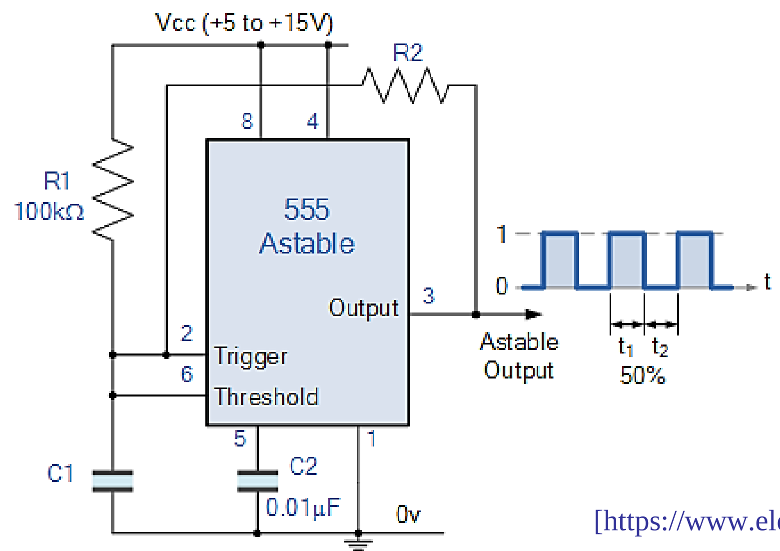
Optional

Improved 555 Oscillator Duty Cycle

Optional

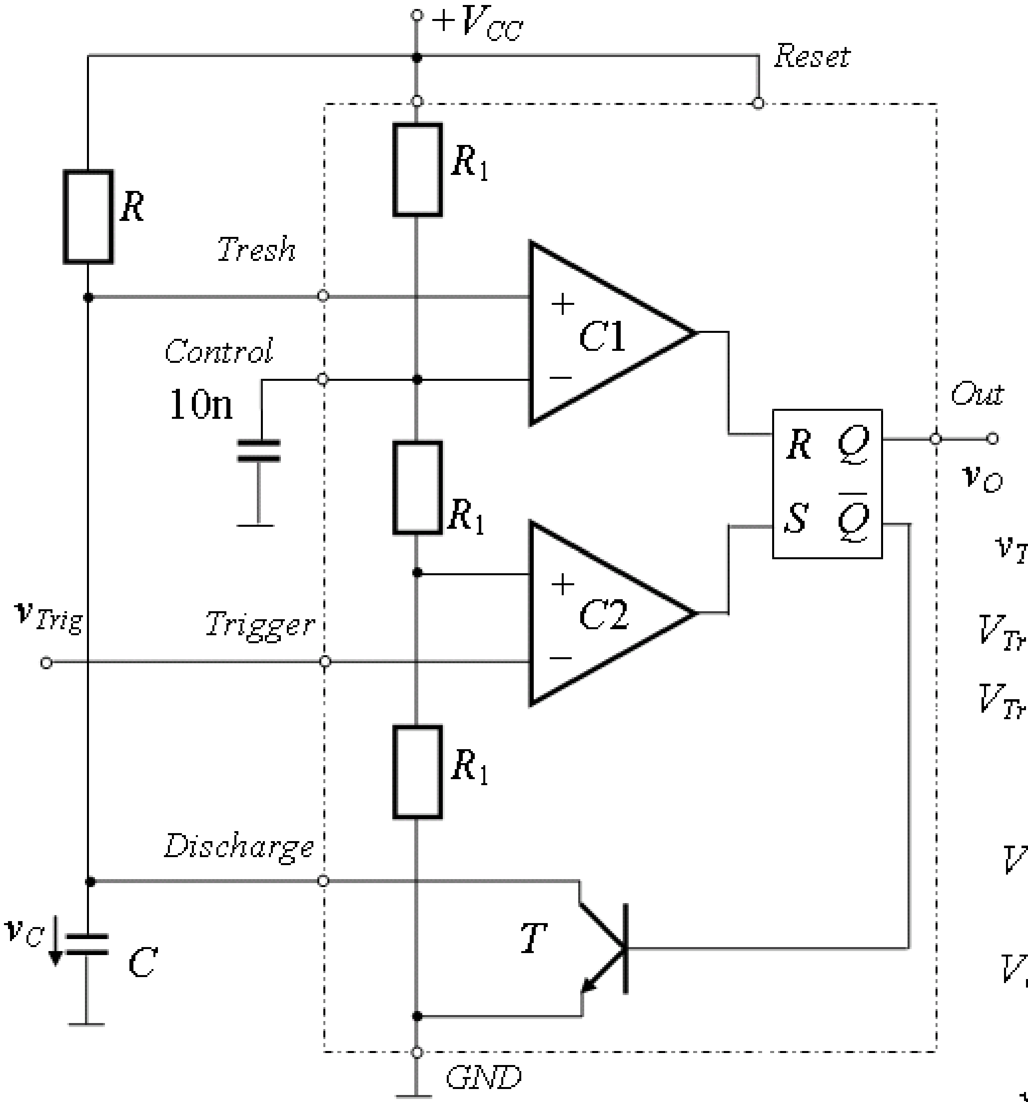


50% Duty Cycle Astable Oscillator



[https://www.electronics-tutorials.ws/waveforms/555_oscillator.html]

Monostable multivibrator circuit

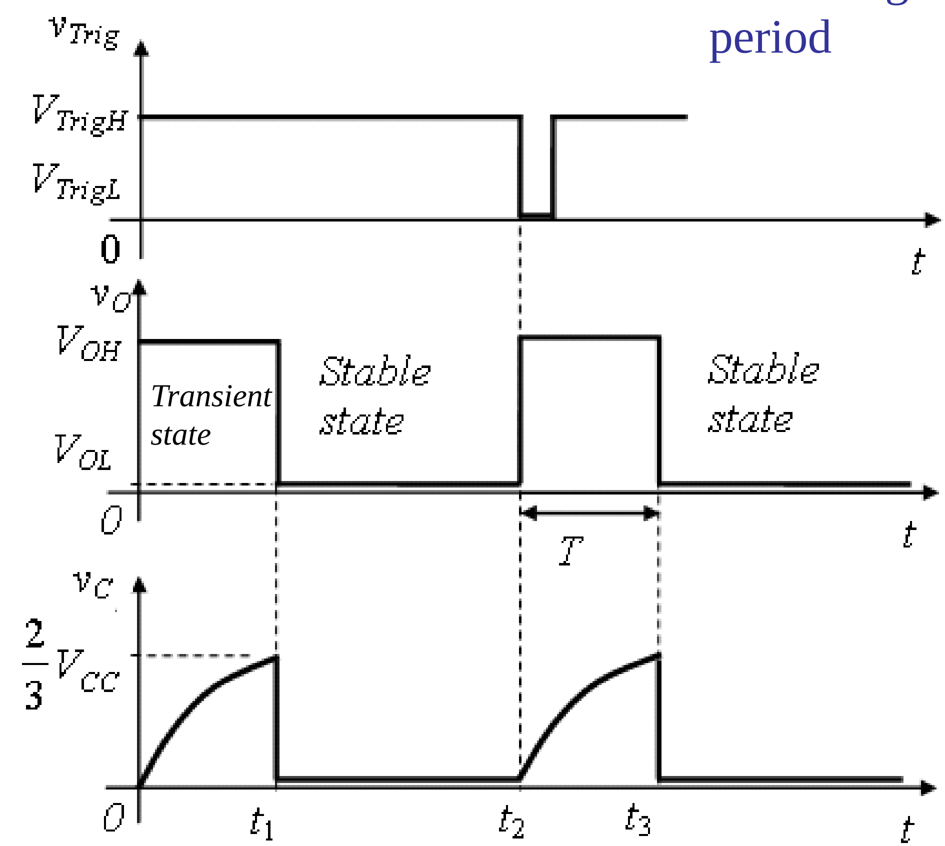


$$t \in (t_2, t_3) \qquad \tau = RC$$

$$\frac{2}{3}V_{CC} = 0 \cdot e^{-\frac{T}{\tau}} + \left(1 - e^{-\frac{T}{\tau}}\right)V_{CC}$$

$$T = RC \ln 3 = 1.1RC$$

T – timing period



Optional

$$V_{TrigH} > \frac{1}{3}V_{CC}$$

$$V_{TrigL} < \frac{1}{3}V_{CC}$$