UNIT -4

MULTIVIBRATORS

and

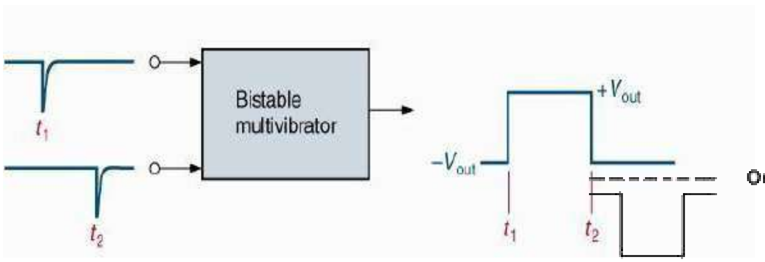
TIME BASE GENERATORS

Multivibrators

- Multivibrator – A circuit designed to have zero, one, or two stable output states.
- There are three types of multivibrators.
  - Astable (or Free-Running Multivibrator)
  - Monostable (or One-Shot)
  - Bistable (or Flip-Flop)

Bistable Multivibrators

- Bistable multivibrator – A switching circuit with two stable output states. The bistable multivibrator has two absolutely stable states
  - Also referred to as a flip-flop.
  - The output changes state when it receives a valid input trigger signal, and remains in that state until another valid trigger signal is received.



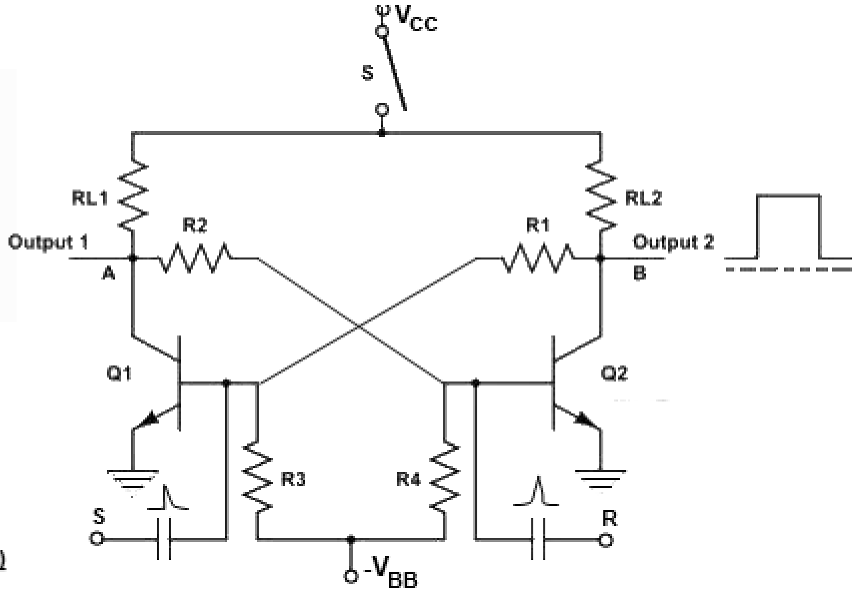
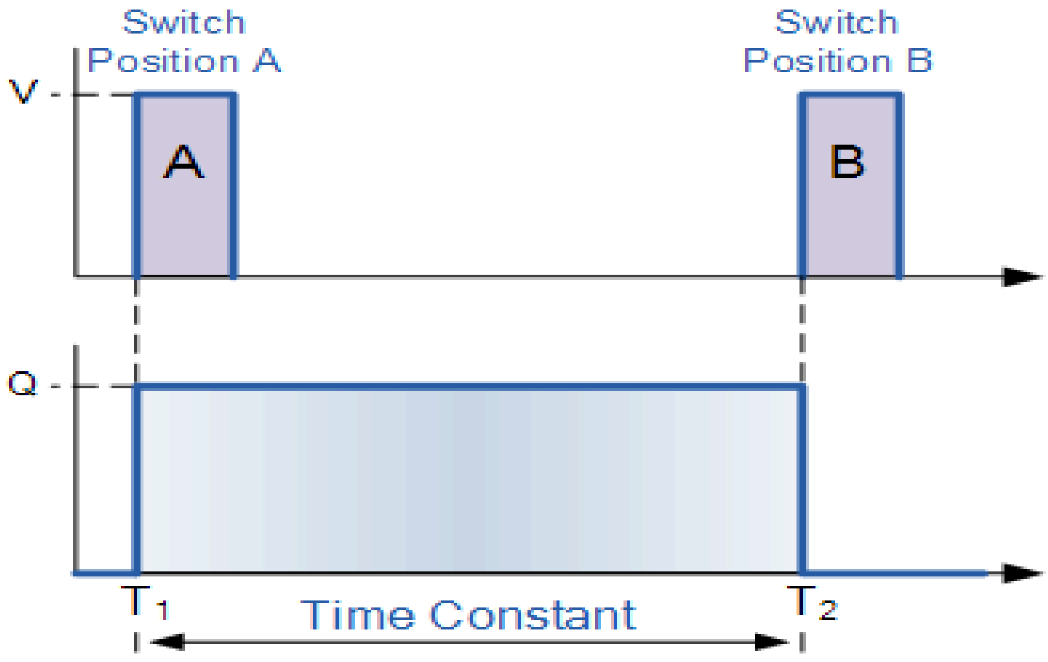


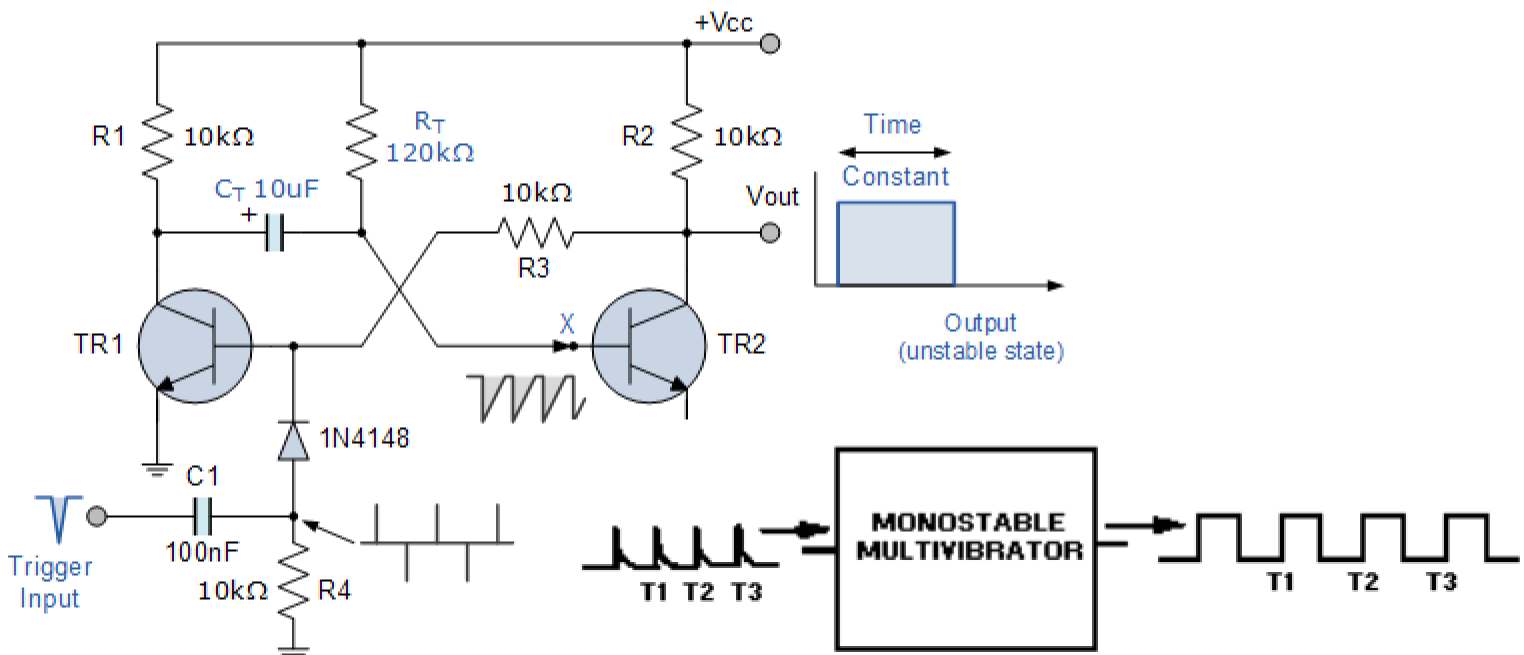
Figure (a)

Bistable Multivibrator Waveform

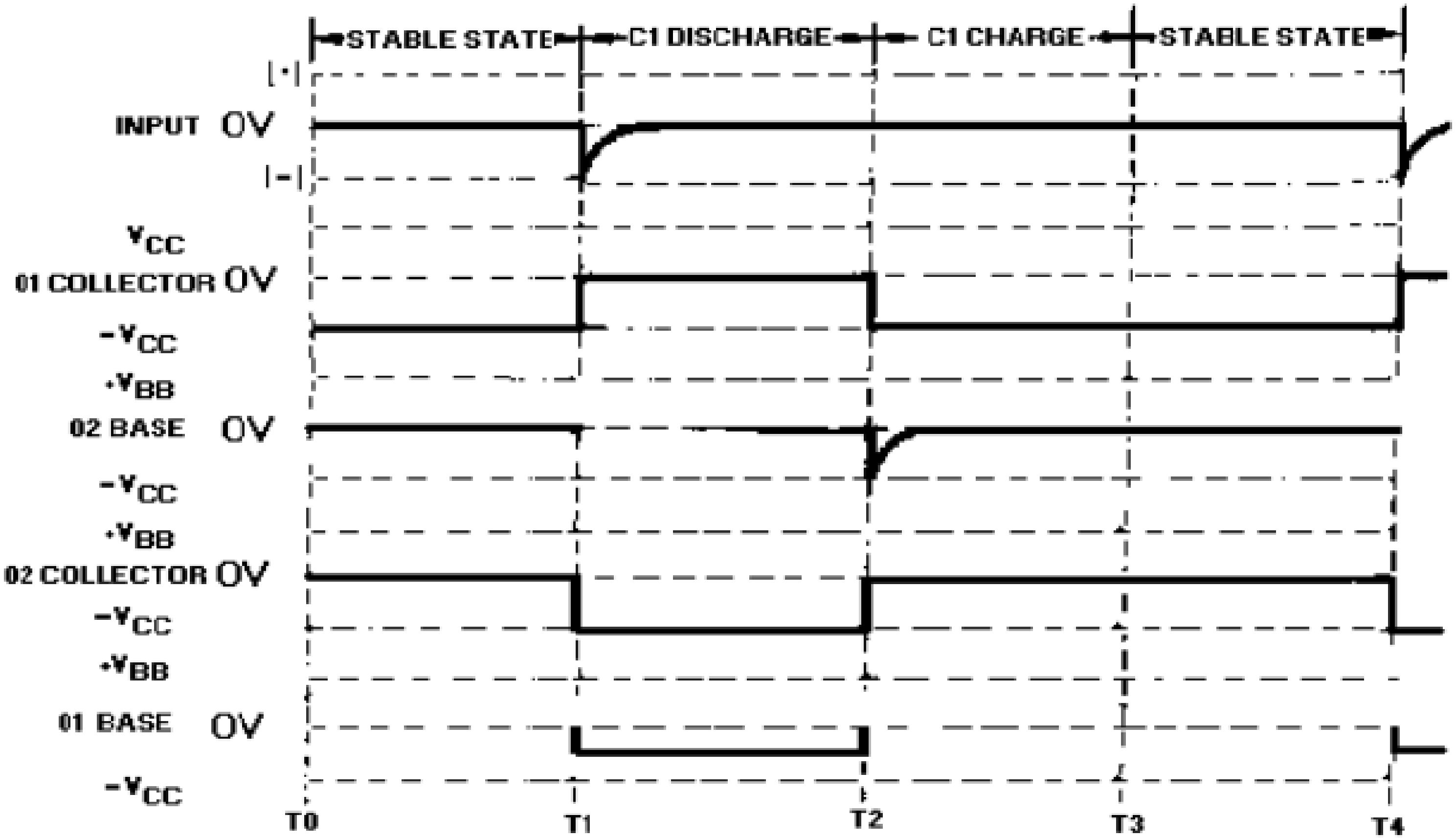


Monostable Multivibrator

- Multivibrators have two different electrical states, an output “HIGH” state and an output “LOW” state giving them either a stable or quasi-stable state depending upon the type of multivibrator. One such type of a two state pulse generator configuration are called **Monostable Multivibrators**.
- **Monostable Multivibrators** have only **ONE** stable state (hence their name: “Mono”), and produce a single output pulse when it is triggered externally. [Monostable Multivibrators]only return back to their first original and stable state after a period of time determined by the time constant of the RC coupled circuit.

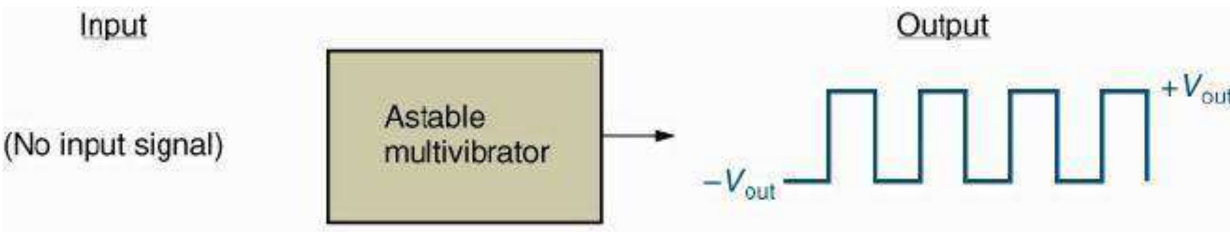


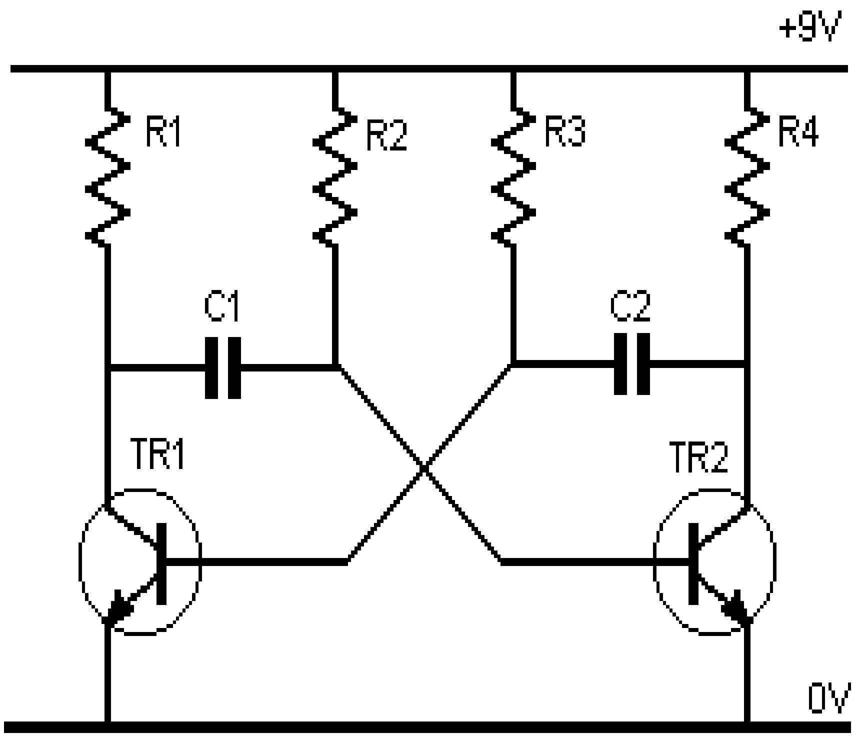
Waveforms

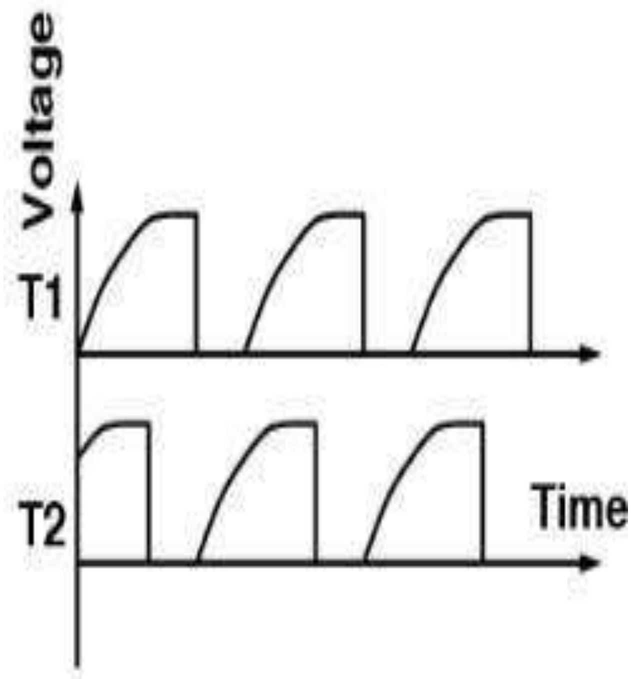


STABLE STATE
C1 DISCHARGE
C1 CHARGE
STABLE STATE
(+)
INPUT 0V
(−)
VCC
01 COLLECTOR 0V
−VCC
+VBB
02 BASE 0V
−VCC
+VBB
02 COLLECTOR 0V
−VCC
+VBB
01 BASE 0V
−VCC
T0
T1
T2
T3
T4

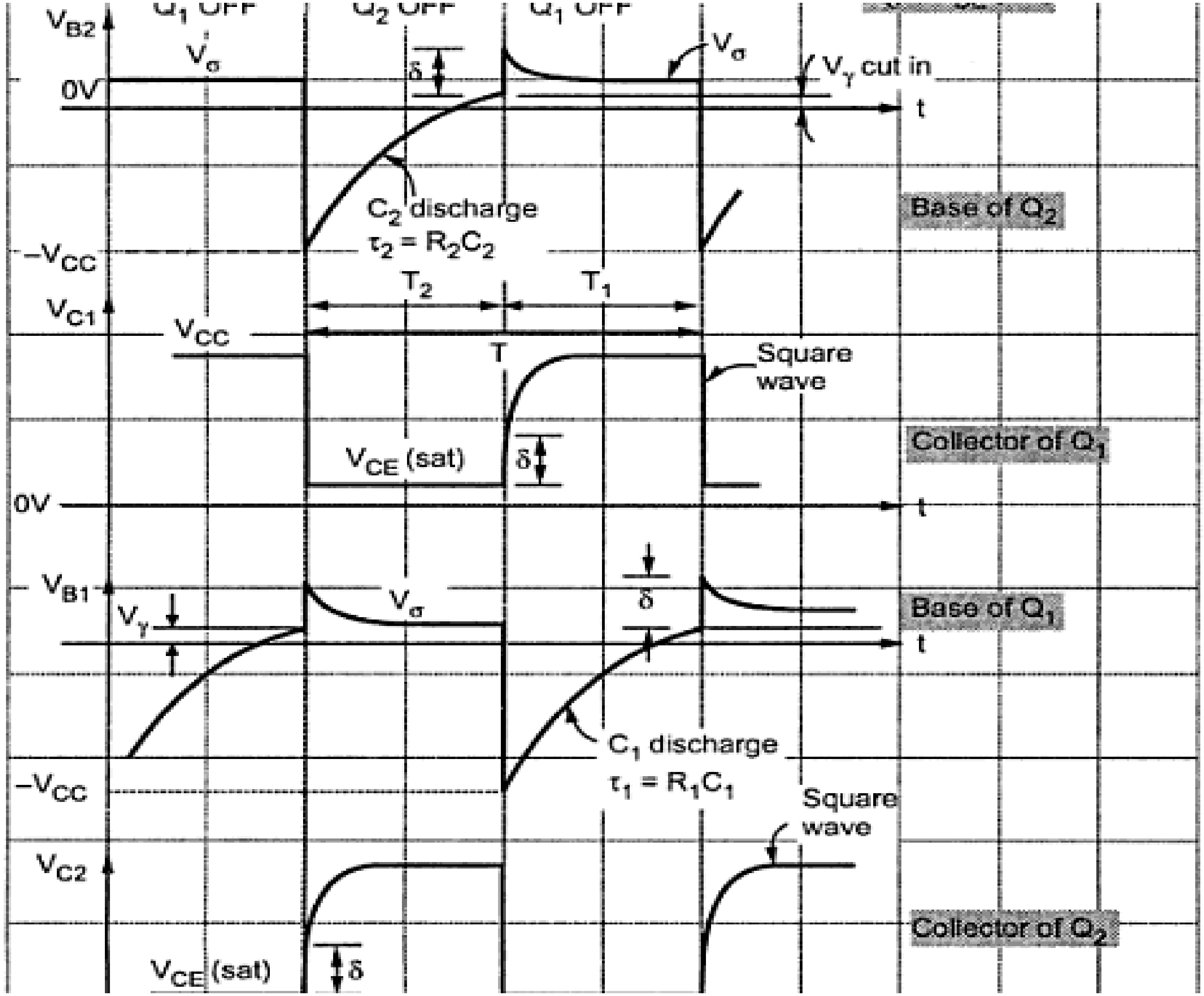
Astable Multivibrator





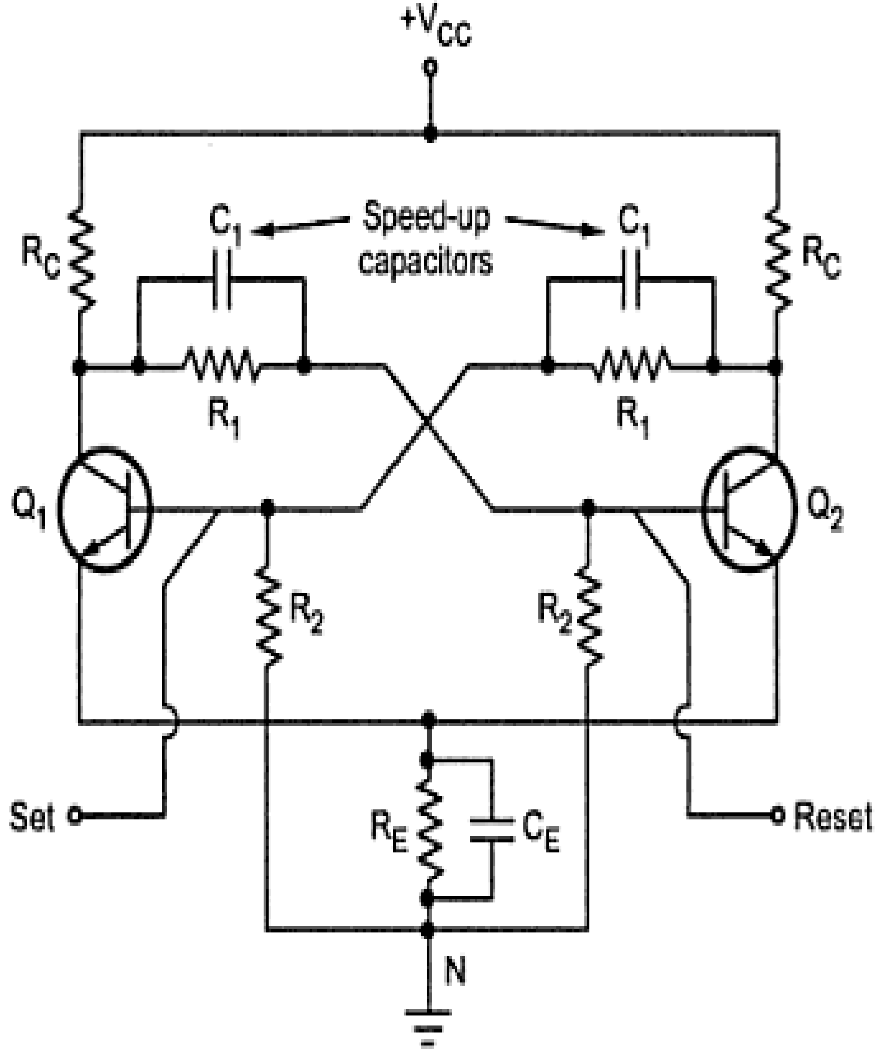


Waveforms



Q_1 OFF
Q_2 OFF
Q_1 OFF
V_{B2}
V_σ
δ
V_σ
V_γ cut in
0V
t
C_2 discharge
$\tau_2 = R_2C_2$
Base of Q_2
$-V_{CC}$
T_2
T_1
V_{C1}
V_{CC}
T
Square wave
Collector of Q_1
V_{CE} (sat)
δ
0V
t
V_{B1}
δ
V_γ
V_σ
Base of Q_1
t
C_1 discharge
$\tau_1 = R_1C_1$
$-V_{CC}$
Square wave
V_{C2}
Collector of Q_2
V_{CE} (sat)
δ

Commutating Capacitors



- Conduction transfers takes two phases
- 1) Transition time
- 2) Settling time

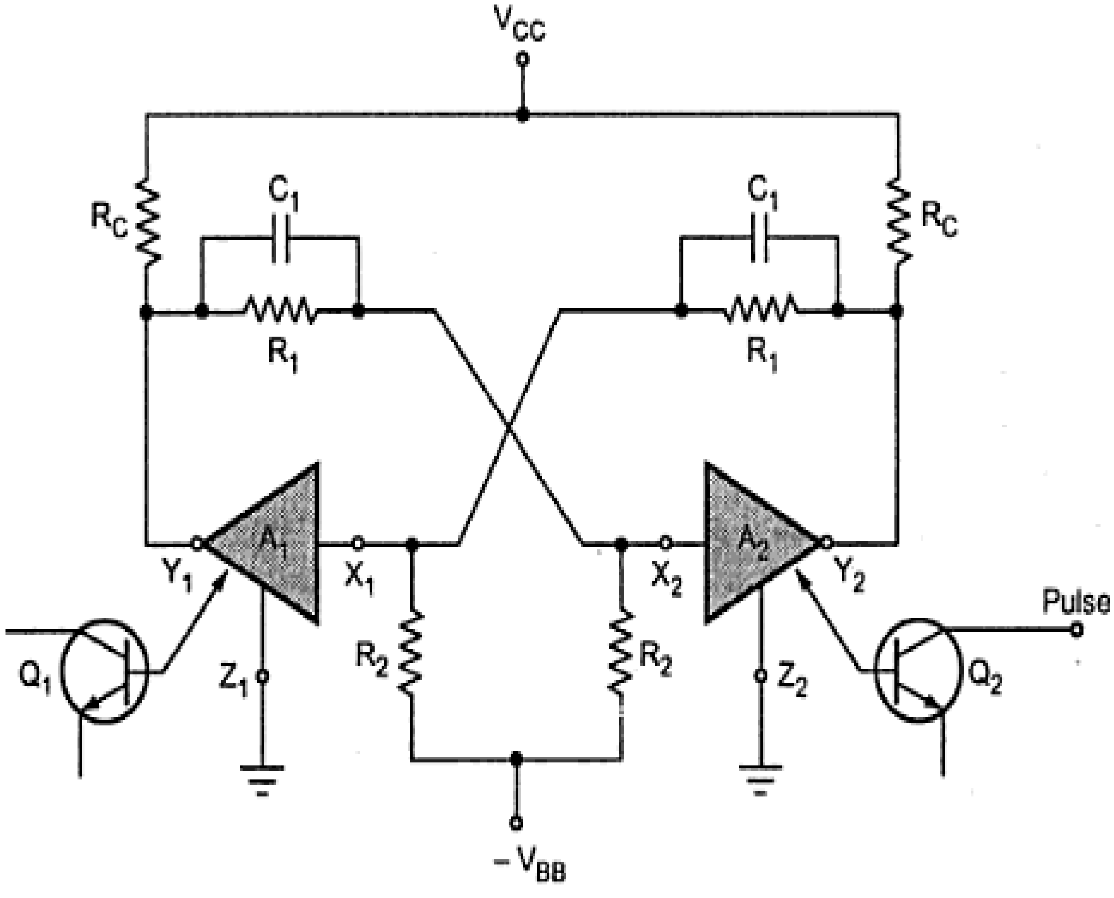
$$f_{max} = \frac{1}{2C_1(R_1 \| R_2)} = \frac{(R_1 + R_2)}{2C_1 R_1 R_2}$$

Triggering the binary

- Two types of triggering
- 1) Symmetrical 2) Unsymmetrical
- In un symmetrical triggering, two triggers are required. One to set the circuit in particular stable state and other is to reset

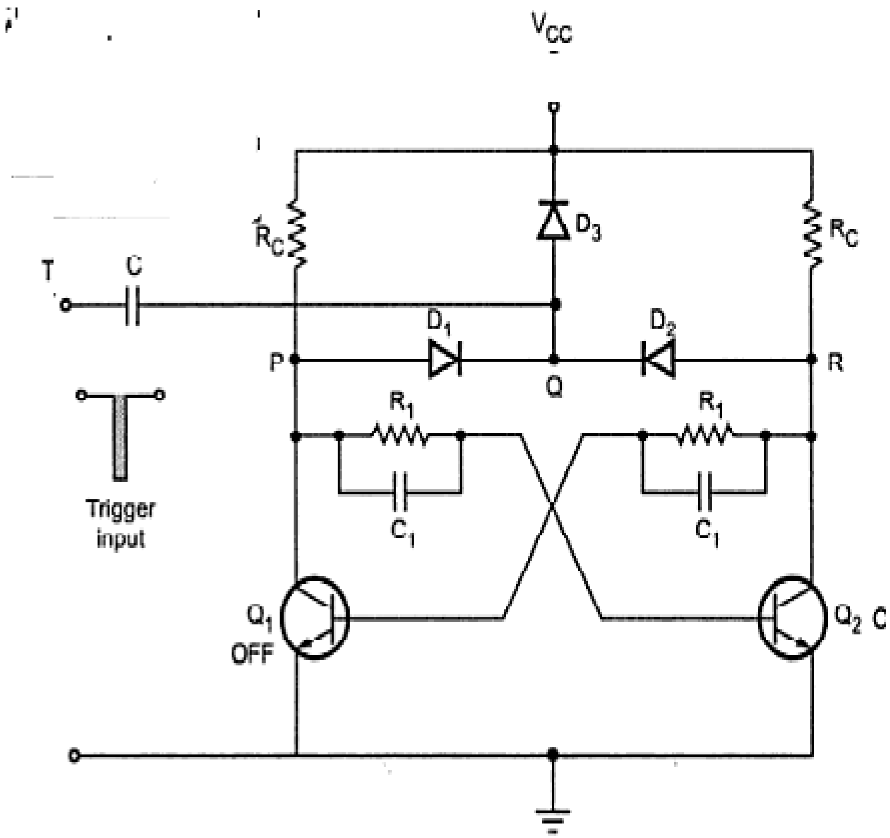
- In Symmetrical triggering , uses only one trigger pulse input to the any of the one transistor

Triggering the binary



- Unsymmetrical

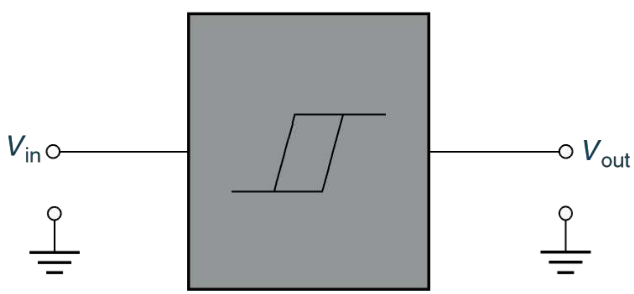
symmetrical



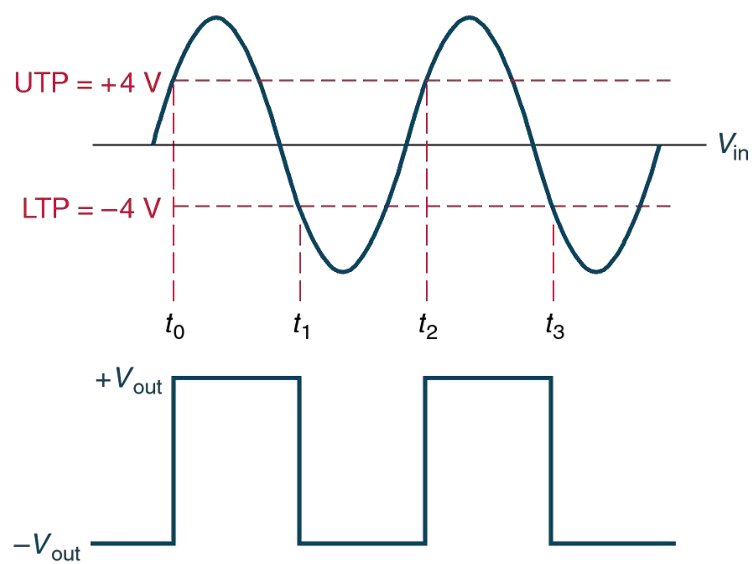
- symmetrical

Schmitt Triggers

- Schmitt trigger – A voltage-level detector.
- The output of a Schmitt trigger changes state when
  - When a positive-going input passes the upper trigger point (UTP) voltage.
  - When a negative-going input passes the lower trigger point (LTP) voltage.

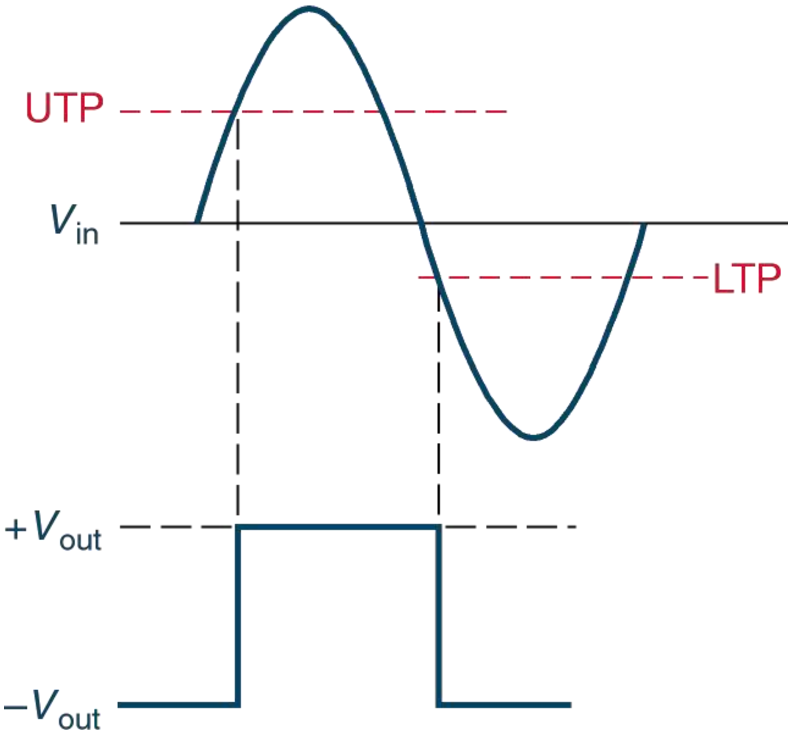


Note: The symbol shown in the block is commonly used to represent Schmitt trigger circuits.



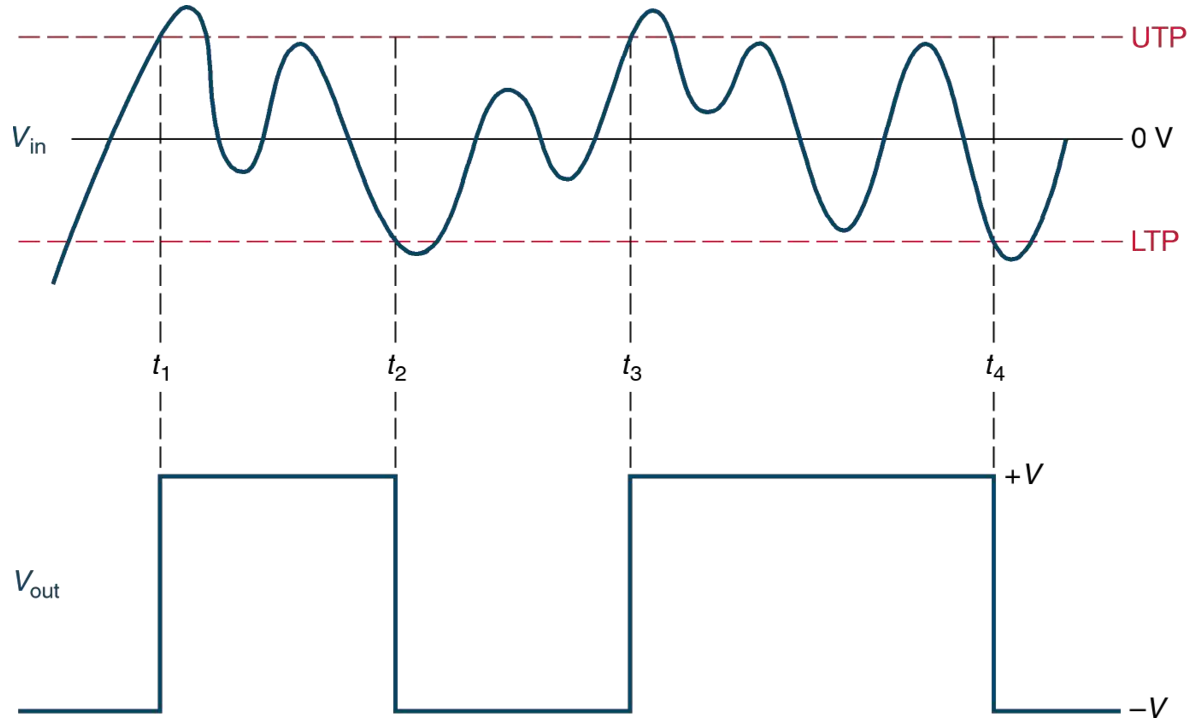
Trigger Point Voltages

- Trigger point voltages may be equal or unequal in magnitude, and are opposite in polarity.

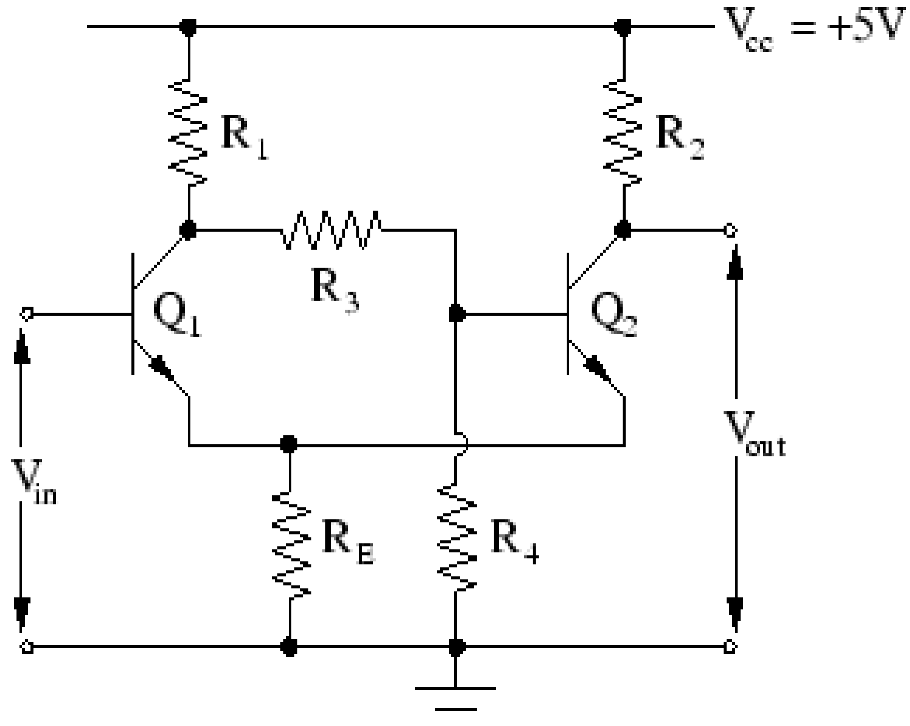


Hysteresis

- Hysteresis – A term that is often used to describe the range of voltages between the UTP and LTP of a Schmitt trigger.



Schmitt trigger using transister



Astable multivibrator to generate a square wave of 1 kHz:

$$h_{fe} = 25$$

- Assume NPN transistor with
- Let

$$I_c = 5mA$$

$$V_{cc} = 12V$$

$$T_1 = T_2 = T/2$$

- Assume symmetrical square wave i.e.
- Neglect the junction voltages.
- We have f= 1 kHz
- So, T=1/1kHz = 1ms

- Let Q_2 ON and Q_1 OFF. Then

R_{c2} R_{c1}

$=(12-0)/5\,\Omega$

$=2.4\,k$ I $=$

$$i_{B2(\min)} = \frac{I_{C2(sat)}}{h_{fe}}$$

$=5/25$

$=0.2\text{mA}$

Q_2

- Whe[illegible]n :

$$i_{B2} = 1.5 x i_{B2}(\min)$$

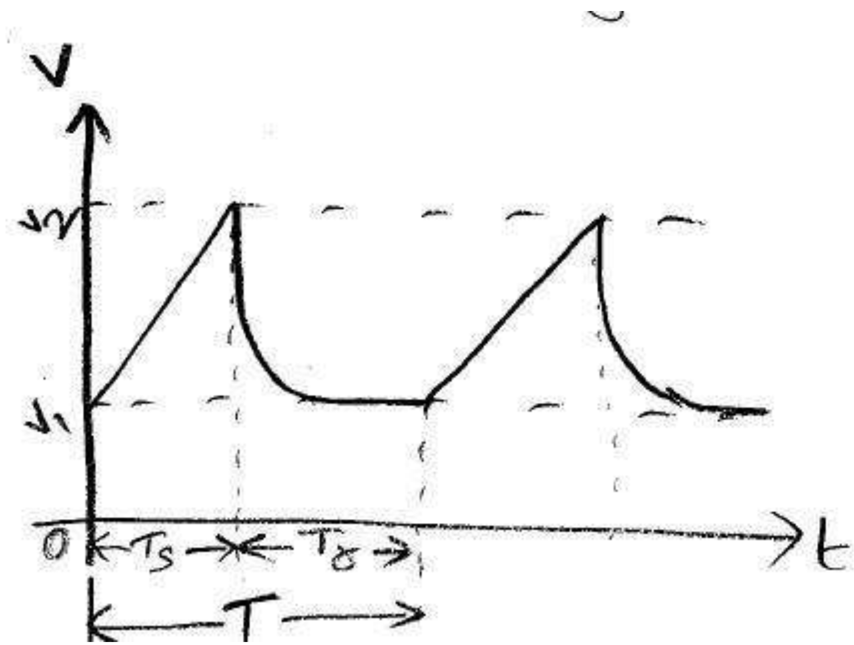
=1.5X0.2

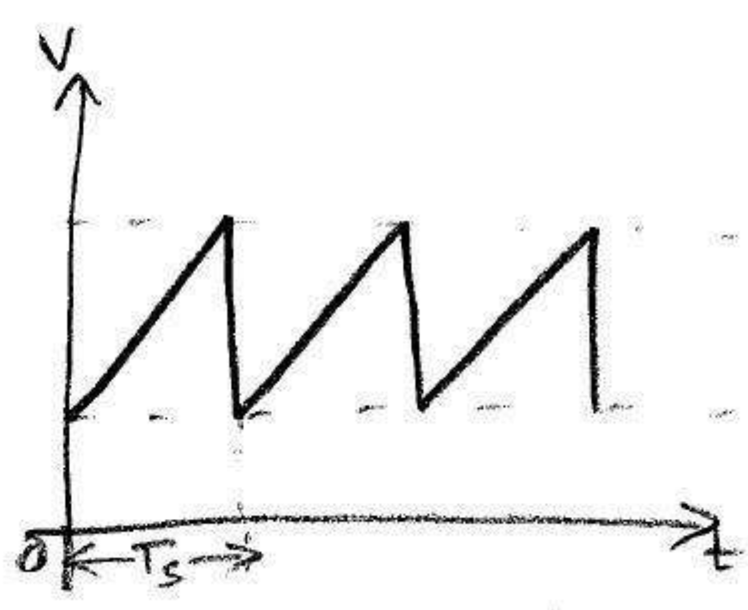
=0.3mA

Applications

- Oscillator
- Timer
- Voltage –to- frequency converter
- Voltage controlled oscillator
- Clock source
- Square wave generator

General features of time base generator





Time base generator

Constant current charging

- A capacitor is charged with constant current source.
- As it charged with constant current, it is charged linearly.

Miller circuit:

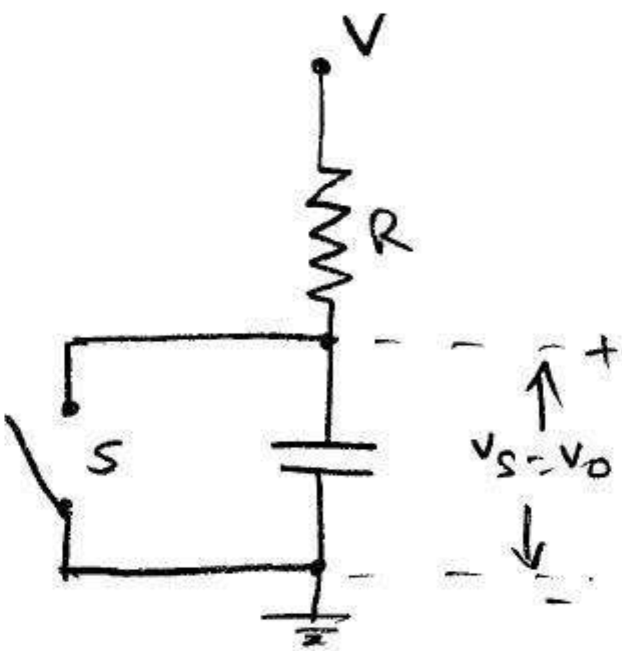
- Integrator is used to convert a step waveform to ramp waveform.

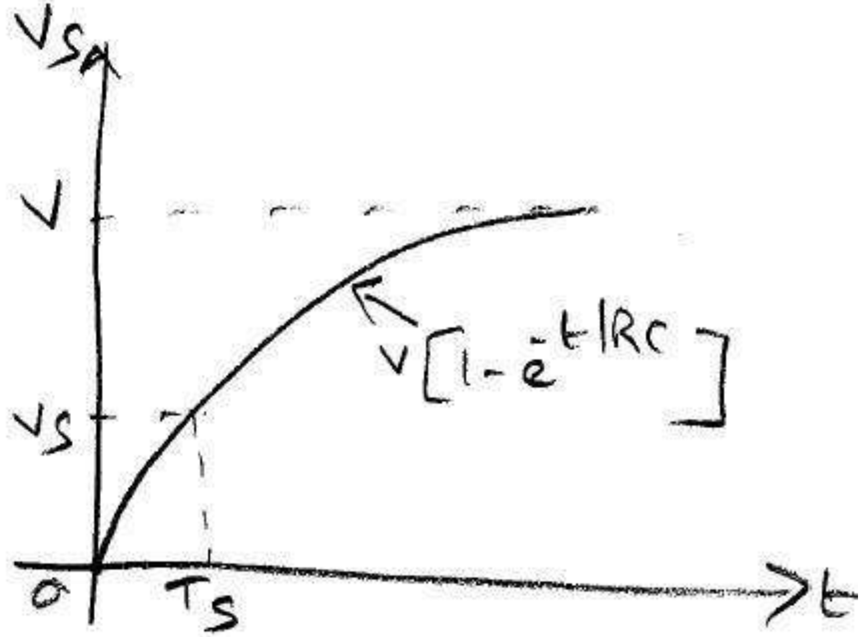
Bootstrap circuits

- A constant current source is obtained by maintaining nearly constant voltage across the fixed resistor in series with capacitor.

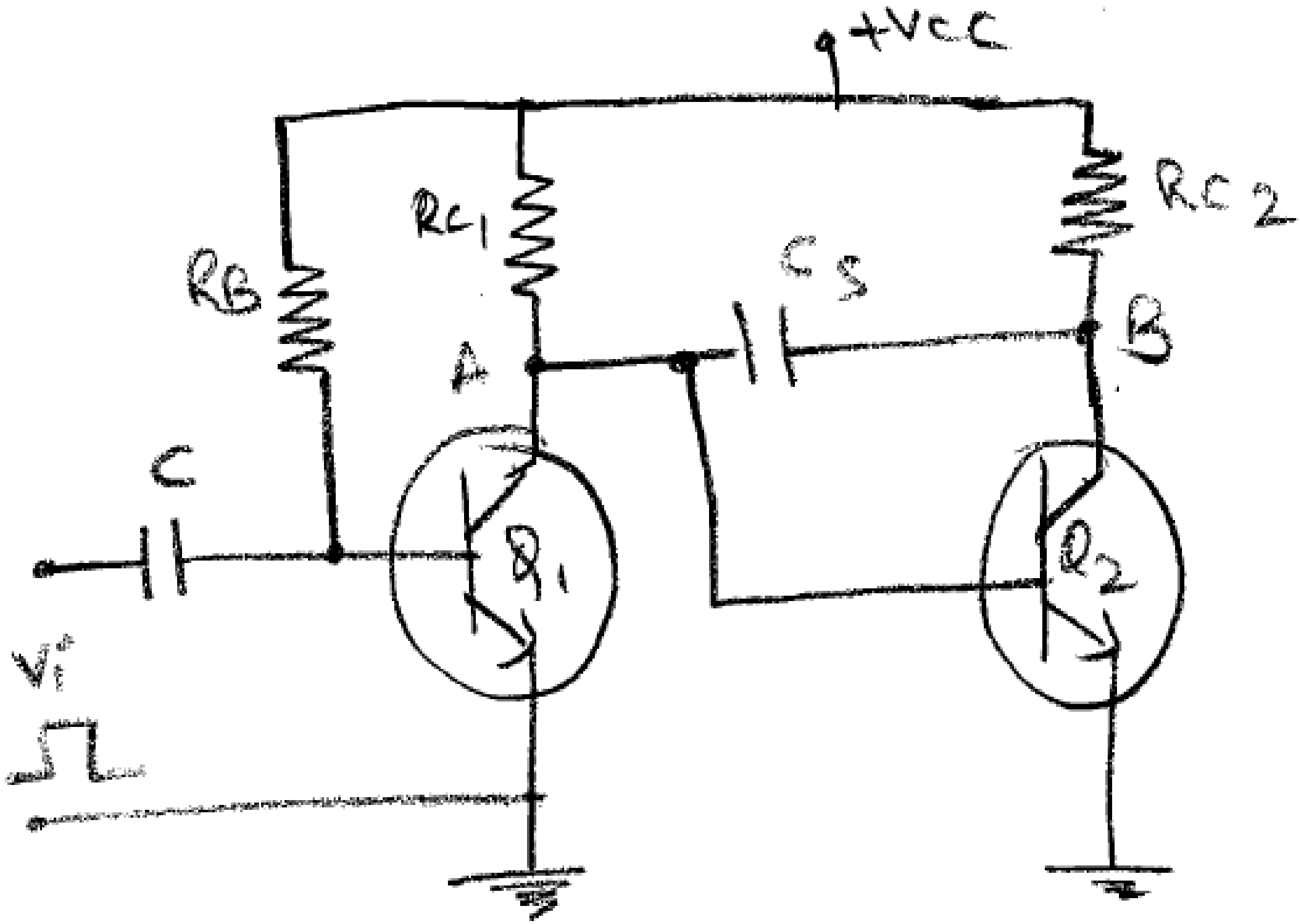
Compensating network is used to improve the linearity of bootstrap and miller time base generator

Exponential sweep circuit

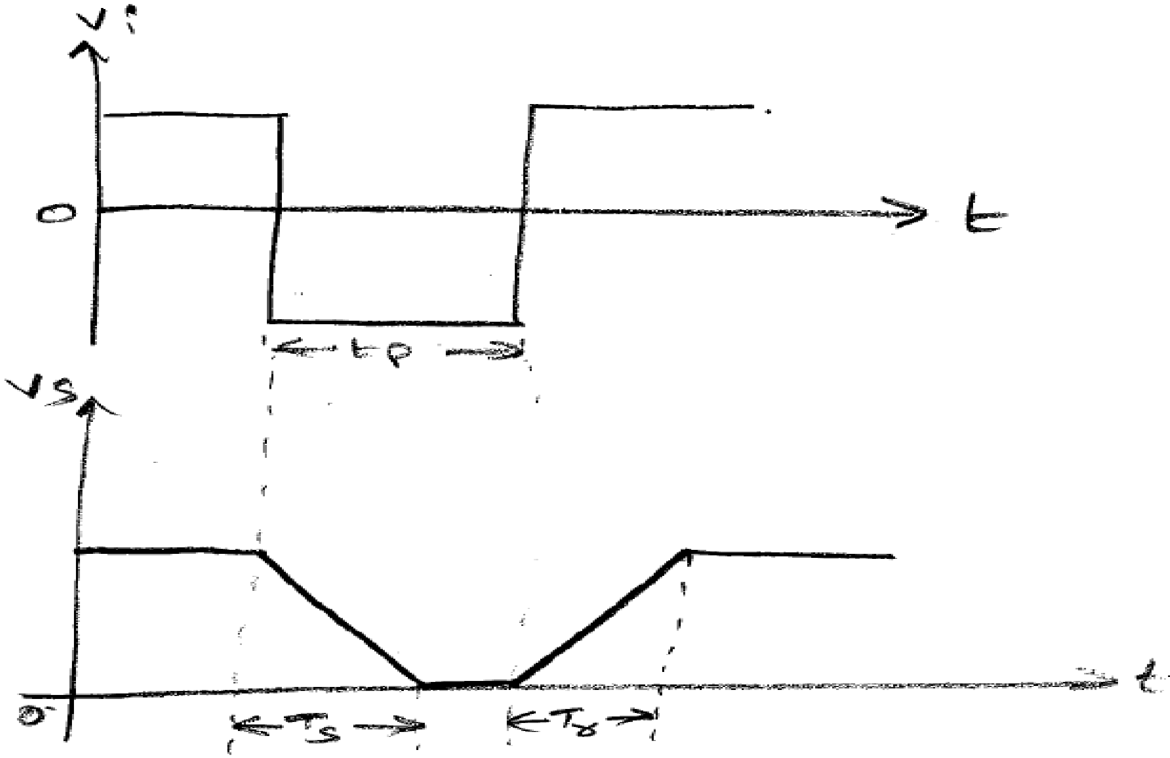




Transistor miller time base generator

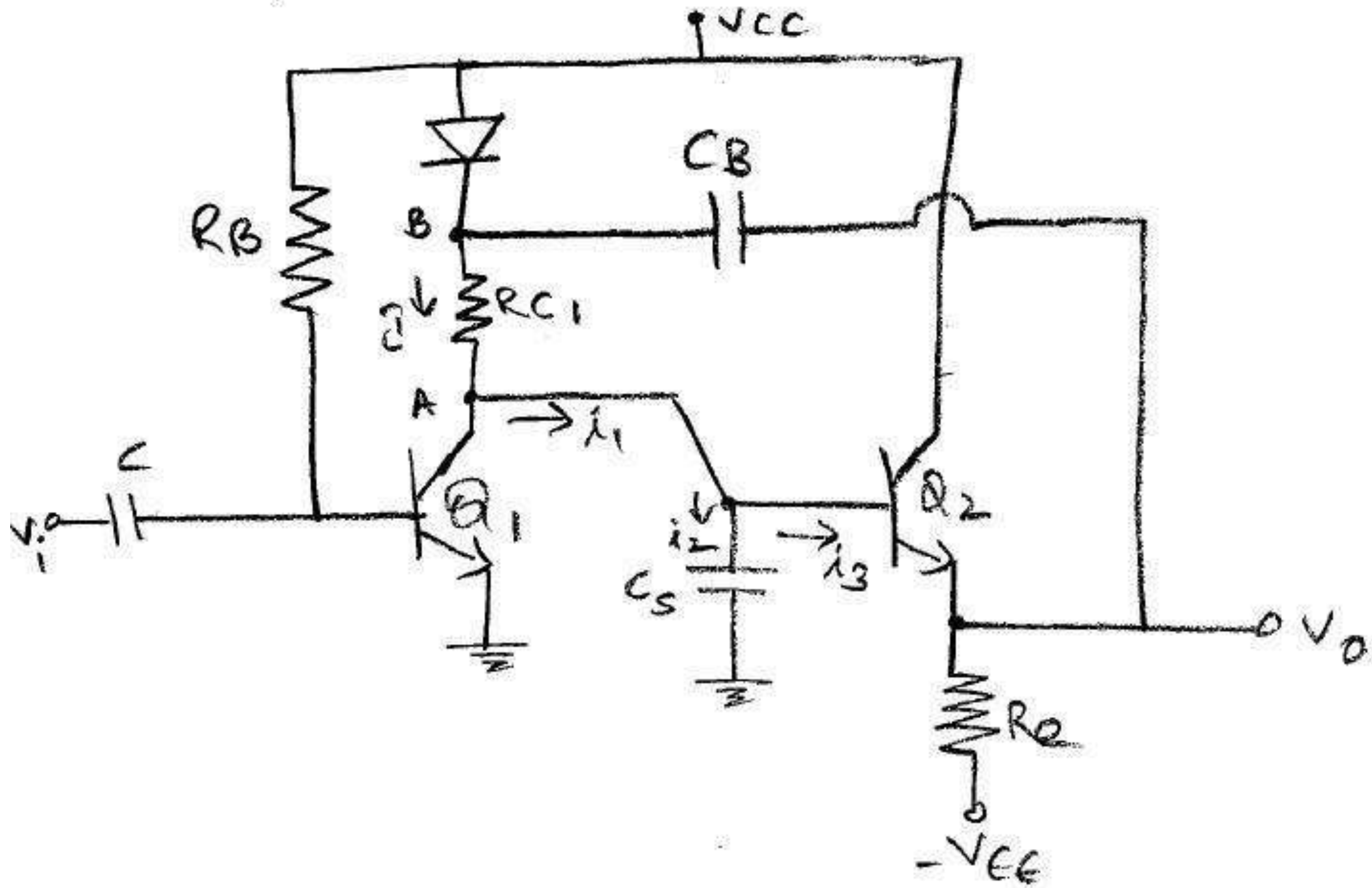


Input and output waveforms

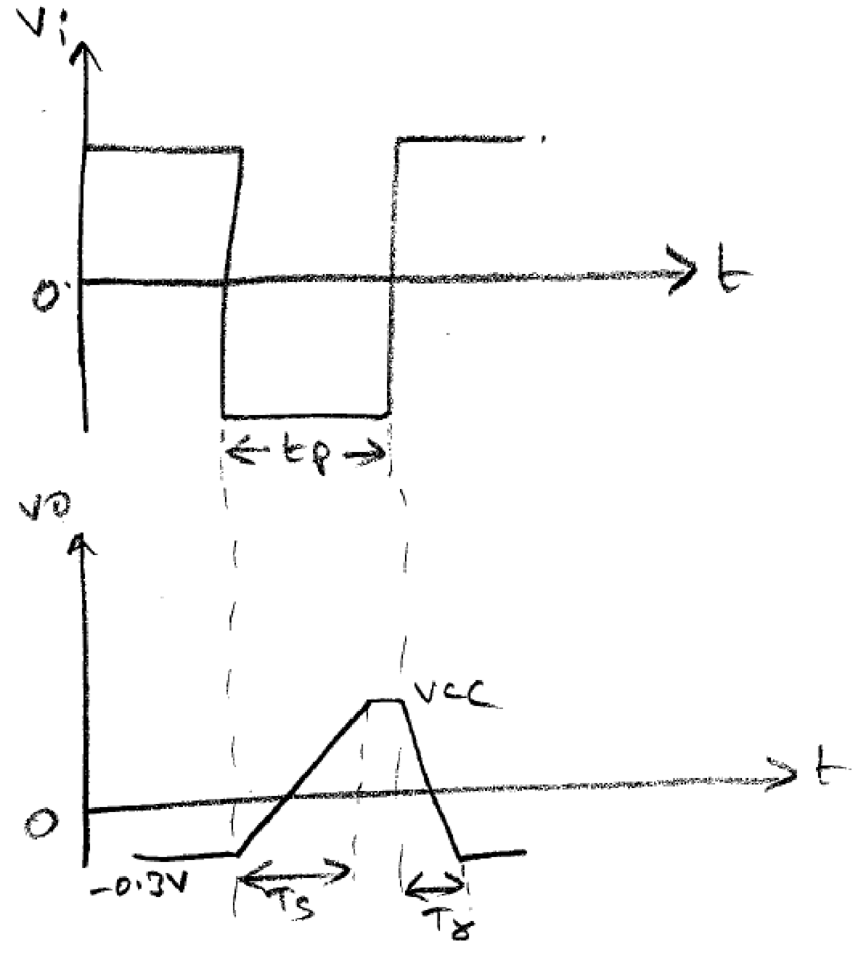


$T_s \leq T_p$

Transistor bootstrap time base generator



Input and output waveforms



Comparision of Miller and Bootstrap time base generator

Bootstrap sweep circuit	Miller sweep circuit
1) The circuit employs positive feedback.	1) The circuit employs negative feedback.
2) The circuit generates positive going ramp.	2) The circuit generates negative going ramp.
3) The circuit employs an emitter follower whose gain is nearly unity.	3) The circuit requires an amplifier whose gain is very very large (ideally infinite).
4) The amplifier must have high input resistance.	4) Amplifier with high input resistance is not very essential.