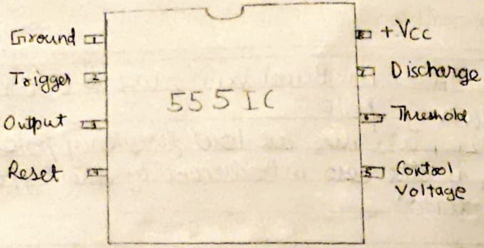
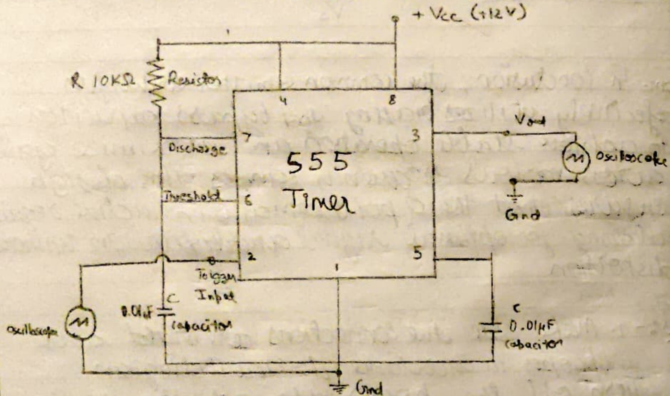


555 IC Timer Pin diagram



Circuit diagram
For Monostable Multivibrator

Experiment :

Date 24/09/2024

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Astable and Monostable Multivibrator using IC-555

Aim:- To study astable and monostable multivibrator using IC-555.

Materials Required:- ae-iitr.vlabs.ac.in (simulator), oscilloscopes, capacitors, 555 timer, connecting wires, trigger, resistors

Theory:- Multivibrators are electronic circuits used to create two-state systems such as flip-flops, timers, and ~~oscill~~ oscillators. They're classified into three types:

1. Astable: No stable state, continuously oscillates between two states.

2. Monostable: One stable state, switches to unstable state upon triggering, then returns after a fixed time.

3. Bistable: Two stable states, switches between them with external triggers (flip-flops).

Monostable Multivibrator

A monostable multivibrator has one stable state and generates a single output pulse of specified width when triggered. The pulse width is controlled by the time constant of resistor (R) and capacitor (C), calculated as

$T = 1.1 \times R \times C$

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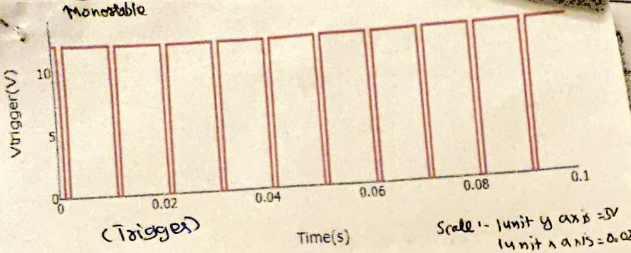
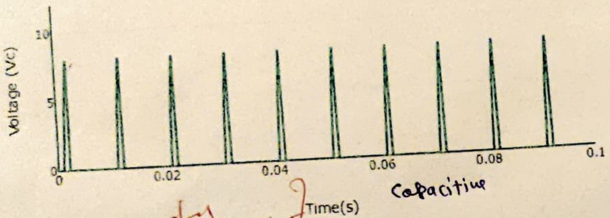
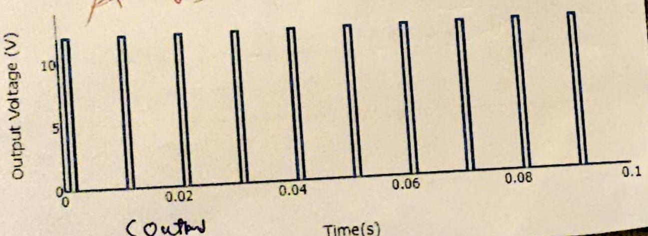
Monostable





Specify values?



Duty Cycle (D%)
11
33
55
77

...ency experiment...

7.1 RC

oscilloscope

µF capacitor

Astable Multivibrator

Experiment :

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Advantages:

- Requires only a single trigger pulse
- Simple and low-cost design.

Disadvantages:

- Trigger pulse must be spaced longer than RC time constant.

Applications:

- Timer circuits, pulse generators and signal restoration.

Astable Multivibrator

An astable multivibrator oscillates continuously between high and low output states without external input, producing square or rectangular waveform. It's time periods are calculated as:

- High state duration: $T_{high} = .693 \times (R_1 + R_2) \times C_1$
- Low state duration: $T_{low} = 0.693 \times R_2 \times C_1$
- Frequency: $\frac{1.44}{(R_1 + 2R_2) \times C_1}$

Advantages:

- No external trigger required
- Simple and continuous operation.

Disadvantages:

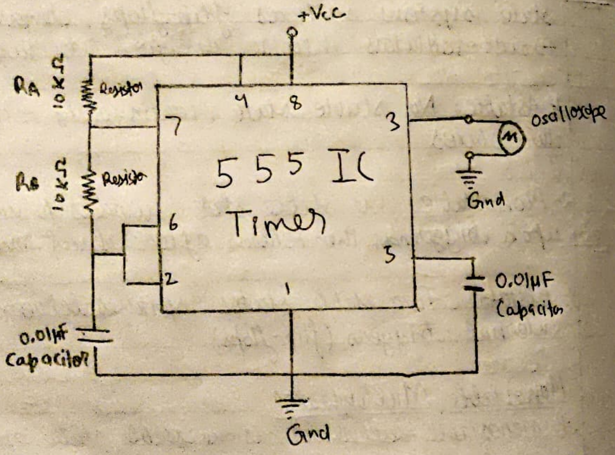
- High energy consumption.

S.No.	Resistor R (KΩ)	Capacitance C (μF)	Pulse width (Ton msec)	Duty cycle (D%)
1.	10	.1	1.1	11
2.	30	.1	3.3	33
3.	50	.1	5.5	55
4.	70	.1	7.7	77

Monostable Multivibrator

Match theory & experiment

$P_w = 1.1\,RC$



Astable Multivibrator

Advantages:

- Requires only a single trigger pulse
- Simple and low-cost design.

Disadvantages:

- Trigger pulse must be spaced longer than RC time constant.

Applications:

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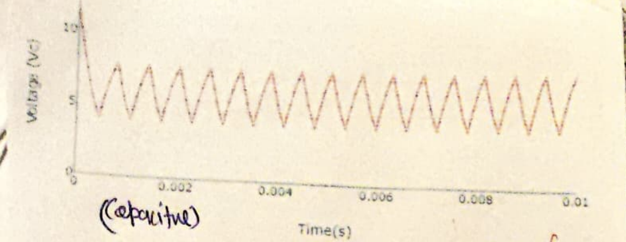
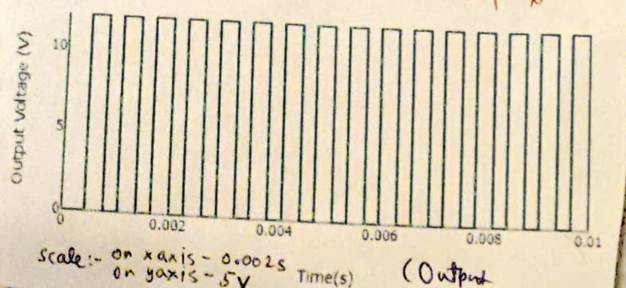
Table Title

Astable Multivibrator



(Capacitive)

Specify details



Scale :- on x axis - 0.002 s
on y axis - 5 V

(Output

Pulse width	Time	Duty Cycle (D%)	Frequency (Hz)
		63.01	1.34
		69.53	1.14
		73.65	0.98
		76.79	0.86

Pulse width ~~Duty Cycle~~ = 1.1 R C

R is in Ω

C is in Farad

[for Monostable]

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· Cannot achieve a duty cycle less than or equal to 50%.

Applications:

· Timer circuits, oscillators, and signal generation in radios and T.V systems.

· Amateur Radio systems

Duty Cycle : Ratio of time for which the output is Hight to the total time.

$$\text{Duty Cycle } \% = \frac{\text{Time High}}{\text{Total Time}} \times 100 = \frac{T_1}{T} \cdot 100 = \frac{(R_1+R_2)}{(R_1+2R_2)} \times 100$$

$$\text{Time period } T = \text{Time high} + \text{Time Low}$$
$$= 0.693 \times (R_1 + 2R_2) \times C_1$$

25/10/24

Conclusion:- Thus we can conclude that multivibrators are versatile circuits used in various applications requiring timing, oscillation and storage. Monostable multivibrators are ideal for generating single pulses while ~~a stat~~ astable multivibrators produce continuous oscillations, making them suitable for a wide range of electronic systems.

Precautions :- 1. Ensure I.C. doesn't overheat.

2. Ensure Capacitor discharges properly.

3. Ensure supply voltage doesn't exceed IC555 voltage rating.

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	Resistance (R_A)(KΩ)	Resistance (R_B)(KΩ)	Capacitance (C)(μF)	Pulse Width (τp msec)	Time constant (T)(msec)	Duty Cycle (D%)	Frequency (Hz)
1.	3	3.9	.1	.476	.745	63.89	1.34
2.	5	3.9	.1	.614	.883	69.53	1.14
3.	7	3.9	.1	.752	1.021	73.65	0.98
4.	9	3.9	.1	.890	1.159	76.79	0.86

Astable Multivibrator

Pulse Width ~~Duty Cycle~~ = 1.1 RC [for Monostable]

R is in Ω

C is in Farad

Experiment :

Date

Page No.

· Cannot achieve a duty cycle less than or equal to 50%.

Applications:

· Timer circuits, oscillators, and signal generation in radios and T.V systems.

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A Batra 25/10/24

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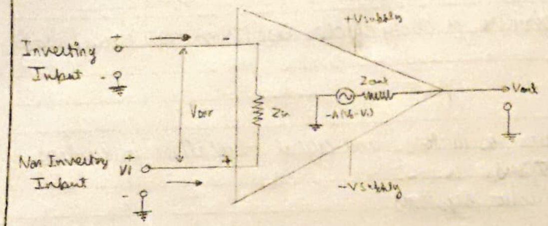
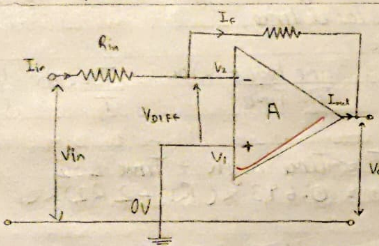
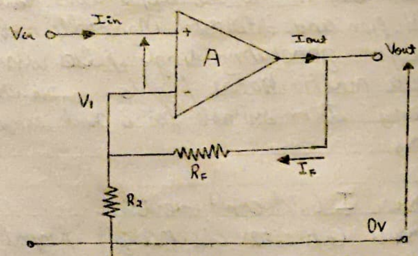


"Operational Amplifier"



"Inverting Amplifier" (Op-AMP)



"Non-Inverting Amplifier" (Op-Amp)

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OP-AMP : Inverting and Non Inverting

Aim:- Study of the basic properties of Operational amplifier : inverting and non-inverting amplifiers

Apparatus: Connecting Wires, operational amplifier, resistors, Ammeter, Voltmeter, Grounding, vlabs.iitkgp.ac.in (simulator)

Theory:- An operational Amplifier (Op-Amp) is a linear device with three terminals : two high-impedance inputs [(inverting) and (non-inverting) and one output. It amplifies the voltage difference between its inputs.

Ideal Op Amp Characteristics

- Infinite open loop gain (A_0)
- Infinite Input Impedance
- Zero Output Impedance
- Zero Offset Voltage
- Infinite Bandwidth

Inverting OP Amp Configuration: In this setup, a feedback resistor (R_2) connects the output to the inverting input, stabilizing the gain. The non inverting input terminal is grounded, creating a virtual ground.

Current Relationships: (1) $I = \frac{(V_{in} - V_{out})}{R_{in} + R_F}$ (3) $I = \frac{(V_2 - V_{out})}{R_F}$

(2) $I = \frac{(V_{in} - V_2)}{R_{in}}$

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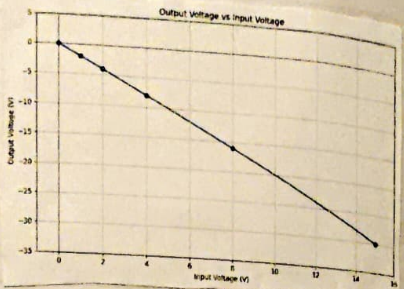
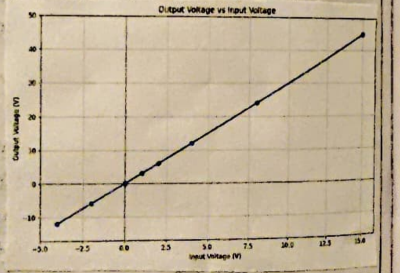
S.No.	Input Voltage (V)	Output Voltage (V)	Current (mA)
1.	-4	8.00	-1
2.	-2	4.00	-.500
3.	0	0.00	0
4.	1	-2.00	0.250
5.	2	-4.00	0.500
6.	4	-8	1.0
7.	8	-16	2.0
8.	15	-30	3.75



Inverting Op-Amp:
$R_F = 2k\Omega$ $R_1 = 1k\Omega$

On x axis one unit = 2V
On y axis one unit = 5V

S.No.	Input Voltage (V)	Output Voltage (V)	Current (mA)
1.	-4	-12.0	-1.33
2.	-2	-6.0	-.667
3.	0	0.0	0
4.	1	3.0	.333
5.	2	6.0	.667
6.	4	12.0	1.33
7.	8	24.0	2.67
8.	15	45.0	5.0



Non-Inverting Op-Amp:
$R_F = 2k\Omega \cdot R_1 = 1k\Omega$

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Setting $V_2 = 0$ (virtual ground)

- $I = \frac{V_{in}}{R_{in}} = \frac{-V_{out}}{R_f}$

Closed loop Gain $(A_1) = \frac{V_{out}}{V_{in}} = -\frac{R_F}{R_{in}}$

Output Voltage $(V_{out}) = -\frac{R_f}{R_{in}} \times V_{in}$

Non-Inverting Op-Amp Configuration: Here the input is applied to the non-inverting terminal, resulting in a positive gain. The inverting terminal is grounded through another resistor (R_2) with feedback through R_x.

Potential Difference: $V_1 = \frac{R_2}{(R_2+R_F)} \times V_{out}$

In Ideal Conditions, $V_1 = V_{in}$: $V_{in} = R_2/(R_2+R_F) \times V_{out}$

Closed loop Gain (A_1): $A_1 = \frac{V_{out}}{V_{in}} = 1 + \frac{R_F}{R_2}$

Output Voltage (V_{out}): $V_{out} = \left(1 + \frac{R_F}{R_2}\right) \times V_{in}$

To summarise Op-Amps are versatile components used in various configurations to achieve different gain ~~characteris~~ characteristics and phase relationships essential for many analog applications.

Conclusion:- From the graph, plotted by output voltage and input voltage where they are on y and x axis respec-

CLASSTIME

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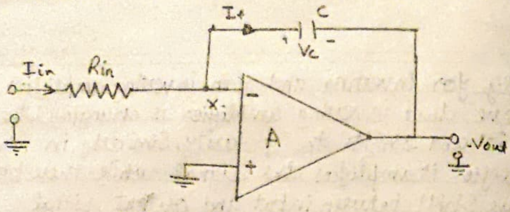
-tively for inverting and non inverting amplifier we can observe that inverting amplifier is changing the phase by 180° and shifts the polarity. Similarly in non-inverting amplifier it amplifies the signal while there being zero phase Shift between input and output signal

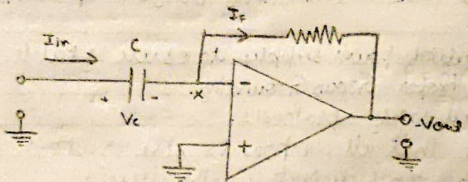
Precautions:-

1. Double check all connections before powering the circuit
2. Use a regulated power supply to ensure stable voltages
3. Ensure Proper ~~[illegible]~~ Grounding.
4. Follow all safety protocols.
5. Ensure that all components are rated for the voltages and currents in the circuit

K Batra
28/11/24



Integrator



Differentiator

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O.P. Amp- Differentiator and Integrator

Aim:- Study of differentiator and Integrator using operational amplifier

Apparatus:- Operational Amplifier, Connecting Wires, Power Input, Resistor, Capacitor, grounding, vlabs.iitkgp.ac.in (simulator), oscilloscope

Theory:- Integrator Circuit

Configuration:- Similar to an inverting amplifier, but with a capacitor (C) as feedback.

Function:- Performs mathematical integration; output voltage is proportional to input signal's amplitude and duration.

Key Equations:-

- $V_c = -V_{out}$
- $I_{in} = V_{in}/R_{in} = C\, dV_{out}/dt$
- $V_{out} = -\frac{1}{R_{in}C}\int V_{in}\, dt$
- In frequency domain: $V_{out} = -\frac{1}{j\omega R_{in}C} V_{in}$ (180° phase shift)

Differentiator Circuit

- Configuration:- Input connected to the inverting terminal through a capacitor (C) with feedback via resistor. (Rf)

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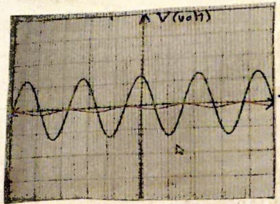
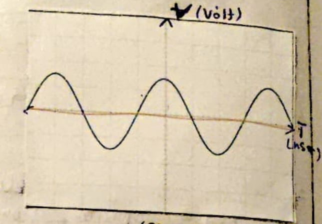
INTEGRATOR



(1)



(2)

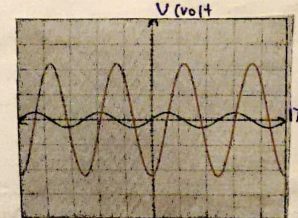
Blue waveform :- Input signal
Orange waveform :- Output signal

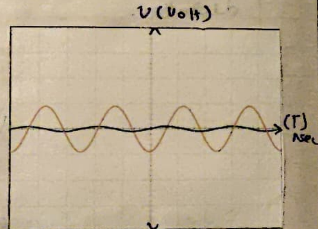
(1) R = 1KΩ , C = 0.5μF
~~C = 0.5μF~~
Frequency = 4500 Hz
Amplitude = 1.4V

(2) R = 2KΩ , C = 1μF
Frequency = 2500 Hz
Amplitude = 1.5V

On y axis 1 unit = 1V
~~On x axis 1 unit =~~

DIFFERENTIATOR





(3) R = 1KΩ , C = 0.6μF
Frequency = 4000 Hz
Amplitude = 0.3V
Blue waveform :- Input
Orange waveform :- Output

(4) R = 2.4KΩ , C = 0.3μF
Frequency = 4000 Hz
Amplitude = 0.1V

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- Function :- Performs mathematical differentiation; output is the first derivative of the input signal.

Key Equations: • $I_{in} = -V_{out}/R_f$ • $(dQ/dt) = C\,dV_{in}/dt$
• $Q = C \cdot V_{in}$ • $V_{out} = -R_f C \frac{dV_{in}}{dt}$

Conclusion :- From the experiment we can observe how an integrator and differentiator works and their waveforms and how each op amp behaves using an oscilloscope.

Precautions :-
1. Double ~~ch~~ check all connections before powering the circuit.
2. Use a regulated power supply.
3. ~~E~~ Ensure proper grounding.
4. Follow all safety protocols.
5. Ensure components are rated for the voltages / currents used.

RBala
28/11/24

CLASSTIME