

# Department of Electrical and Electronics Engineering

SAP-PBL

Course Code: 19EE502



## WAVEFORM GENERATOR

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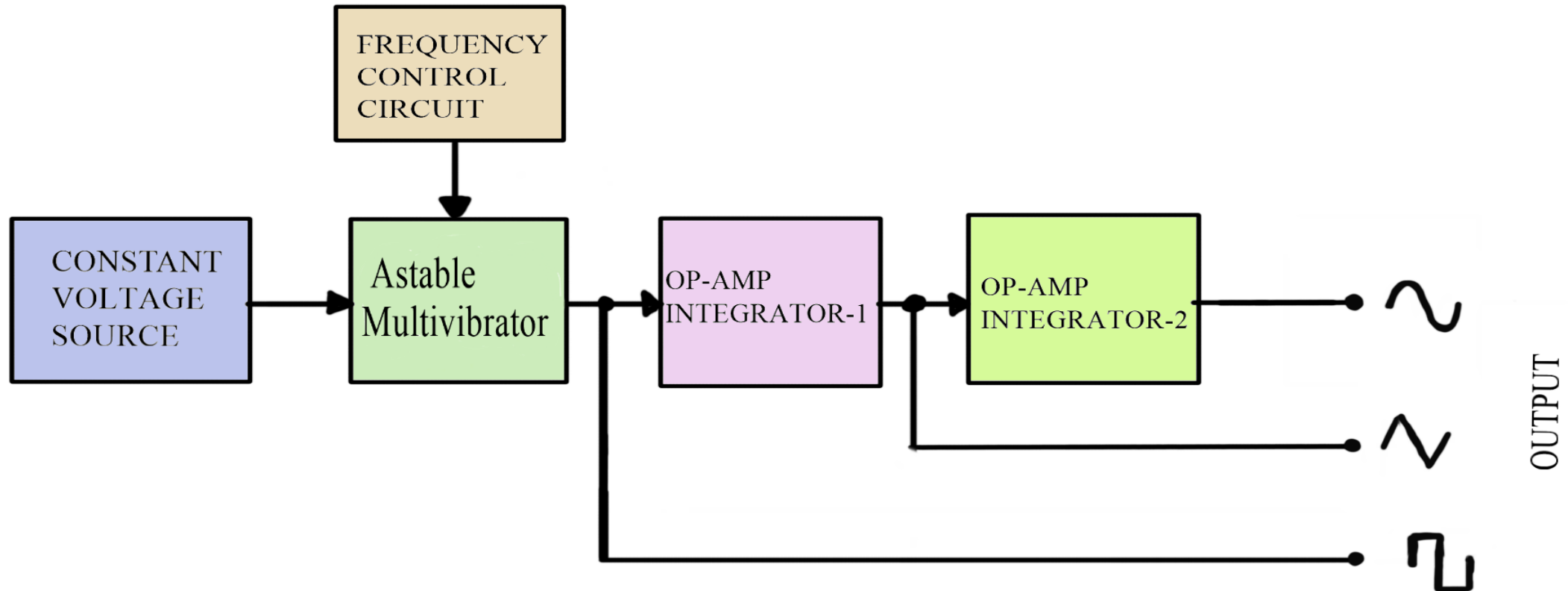
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## Introduction

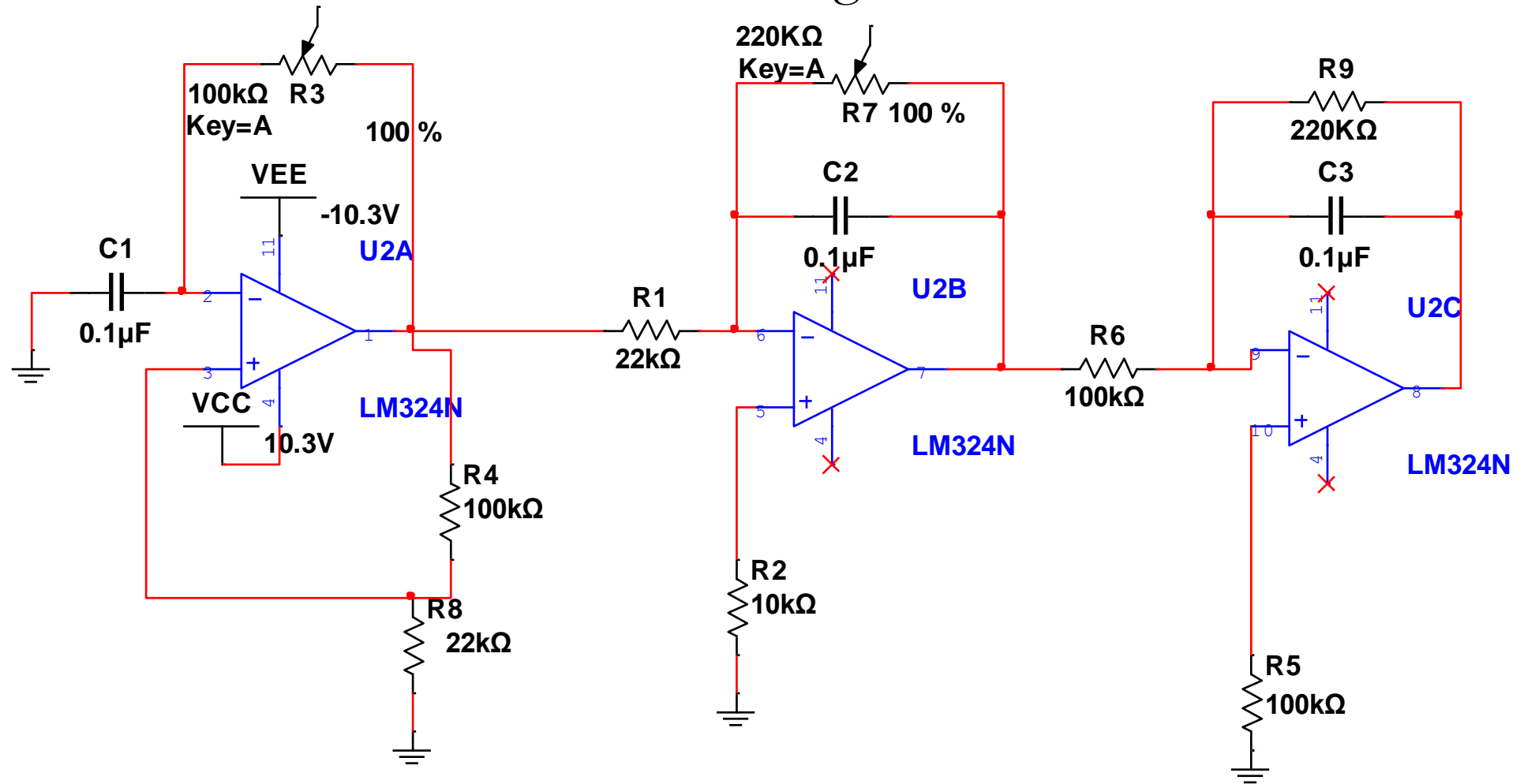
- A function generator is an electronic device that can produce a variety of different waveforms like sinusoidal, triangular, rectangular, square waveforms
- The circuit works on the principle of just using op amp.
- The LM324 is a quad op amp, meaning it's composed of 4 independent op amp.
- In this function generator the first op amp produces a square wave. After that, the circuit uses 2 integrator circuits to convert the square wave into triangle and sine wave signals
- The waveforms of these frequencies may be adjusted from 1hertz to a 10 kHz
- The analog function generator and digital function generators are types of function generators

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## Block Diagram



## Circuit Diagram



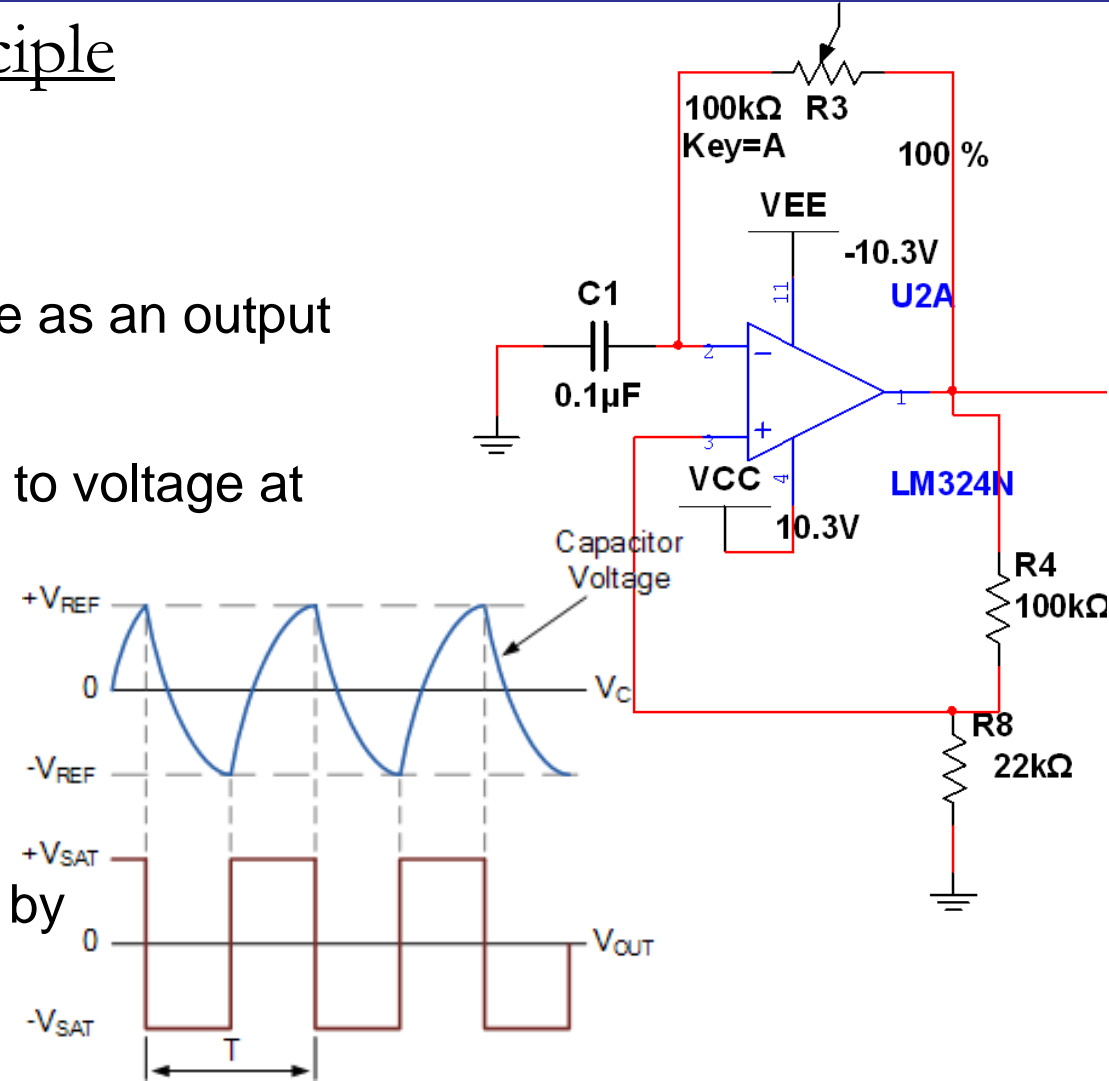
## Component Description

Sl. No.	Components used	Rating	Quantity
1	LM324 op amp		1
2	Resistor	10k $\Omega$	1
3	Resistor	100k $\Omega$	3
4	Resistor	22k $\Omega$	2
5	Resistor	220k $\Omega$	1
6	Ceramic Capacitor	0.1 $\mu$ F	3
8	Potentiometer	220k $\Omega$	1
9	Potentiometer	100k $\Omega$	1
10	General PCB		1
11	DSO		
12	RPS		

## Working Principle

This circuit consist of three stages ,

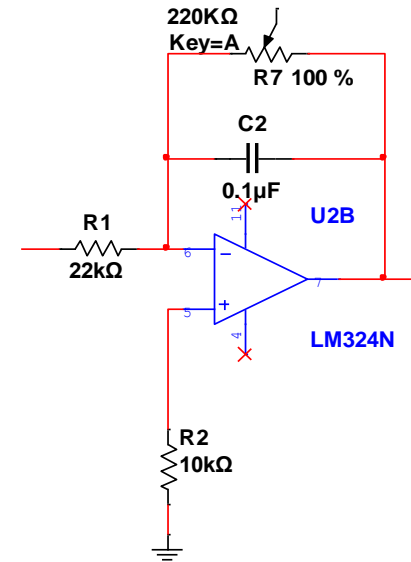
- Stage 1
  - In this stage Astable multivibrator produces square wave as an output
  - Let's assume that capacitor is completely discharged
  - Voltage at the inverting terminal is greater than or equal to voltage at the non- inverting terminal, output will change its state.
  - The capacitor now sees a negative voltage,  $-V(\text{sat})$  across its plates
  - This reversal of the output voltage causes the capacitor to discharge toward the new value of  $V_{\text{out}}$  at a rate dictated by their RC time constant



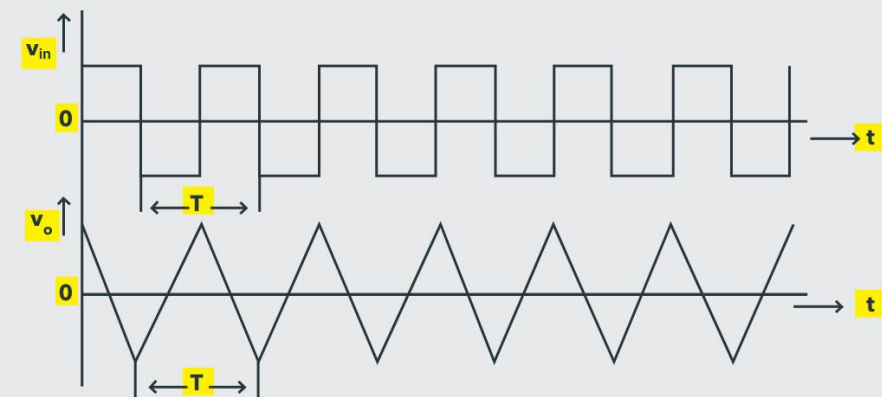
## Contd:

### ➤ Stage 2

- It is an Op-Amp integrator with DC gain control
- During the positive half-cycle of the square wave input, a constant current  $I$  flows through the input resistor  $R_1$
- Since the current flowing into the op-amp internal circuitry is zero, effectively all of the current flows through the feedback capacitor  $C_f$ . This current charges the capacitor.
- Since the capacitor connected to the virtual ground, the voltage across the capacitor is the output voltage of the op-amp.
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Input And Output Waveforms of A Integrator (Square Wave Input)

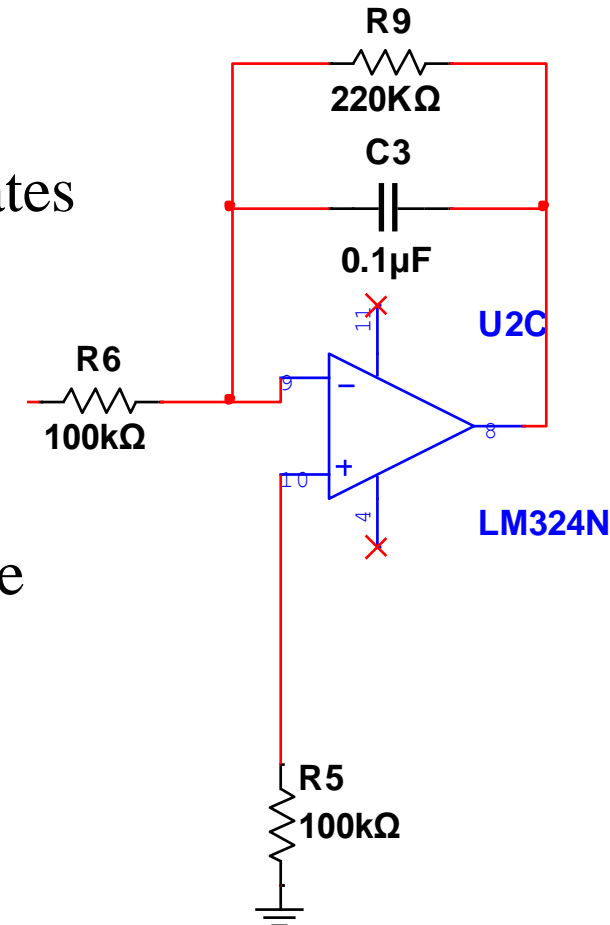


Electronics Hub



Contd.

- Stage 3 is also op amp integrator with DC gain control
- It takes triangle wave from previous stage output as input and it integrates to produce sine wave
- As the amplifier act as a low pass filter, the high-frequency harmonics are greatly reduced
- The output sine wave only consists of low-frequency harmonics and the output will of low amplitude.



## Results and Discussion



Square wave

## Results and Discussion



Triangular wave

## Results and Discussion



Sine Wave

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## Troubleshooting(if any)

Initially we were not able to get square wave output, when we rechecked the circuit we found that there was one wrong connection and they were corrected.

## Conclusion

- The circuit we designed produced output as square wave in first stage, Triangular wave in second wave and sine wave in third stage
- The wave form which we generated is similar to the one which we have simulated using NI multisim

## Reference

- <http://www.learningaboutelectronics.com/Articles/Function-generator-circuit.php>
- <https://www.elprocus.com/what-is-function-generator-circuit-diagram-its-specifications/>
- <https://www.electronics-tutorials.ws/opamp/op-amp-multivibrator.html>
- <https://circuitdigest.com/tutorial/op-amp-integrator-circuit-working-construction-applications>

# Thank You