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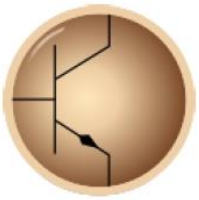

Circuit Simulation Project

https://esim.fossee.in/circuit-simulation-project

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Project Guide: Dr. R. Maheswari

Title of Project: Transistor based Three-phase sine wave generator

Theory/Description:

In this project, three sine waves are generated using the three-phase sine wave generator. Three phase sine wave generator can be used to generate reference signal in three-phase sine wave inverter to obtain sinusoidal pulse width modulation for three-phase sine wave inverter. Referring to the 3-phase sine wave generator circuit we can see three identical transistor stages configured in a cross coupled manner, having equivalent RC timing constants across their bases. Three sine waves with 60-degree phase shift are generated.

Circuit Diagram:

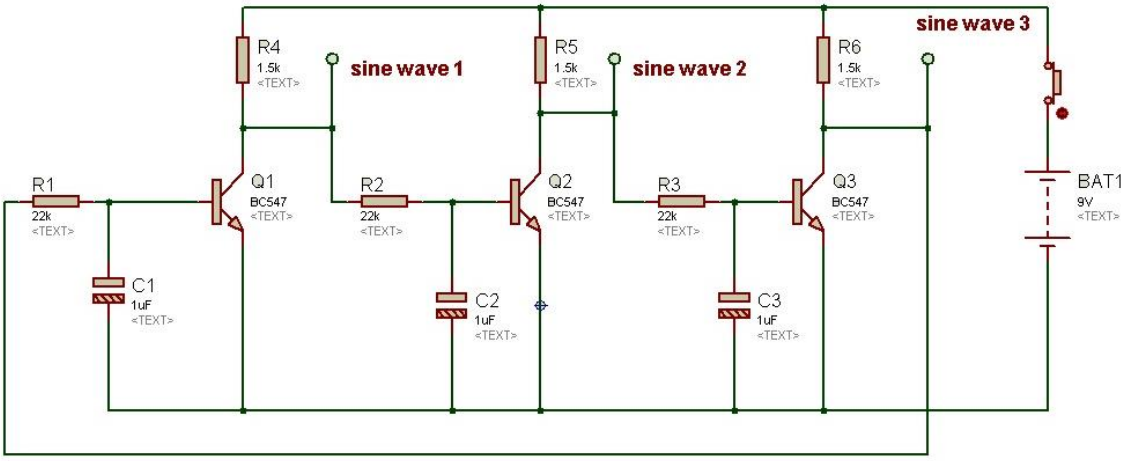


Figure 1: Circuit Diagram of three-phase sine generator

The 22k resistor and the 1uF capacitor essentially become responsible of providing the required delay effect for generating the intended 3 phase signals with 60-degree phase shift. When power is switched ON (Figure 3), the stages may seem to undergo a locked sequence, however since all the capacitors cannot have a precisely same value, the one which has a shade lower value than the other charges up first, triggering a sequential conduction across the transistor.

The middle transistor base capacitor gets charged first, this enables the middle transistor to conduct first which in turn grounds the base of the extreme right transistor preventing it from conducting for that instantaneous moment, but in the meantime the base capacitor of the left or the right transistor also gets charged in tandem which forces the middle transistor to switch OFF and release the right transistor conduction.

The above mutual push and pull procedure induces and settles into a continuous sequential train of conduction across the transistors causing the intended three phase signal pattern to appear across the collectors of the transistors. Owing to the gradual charge and discharge pattern of the capacitors, the resultant signal shape is a pure sine wave.

Model Graph:

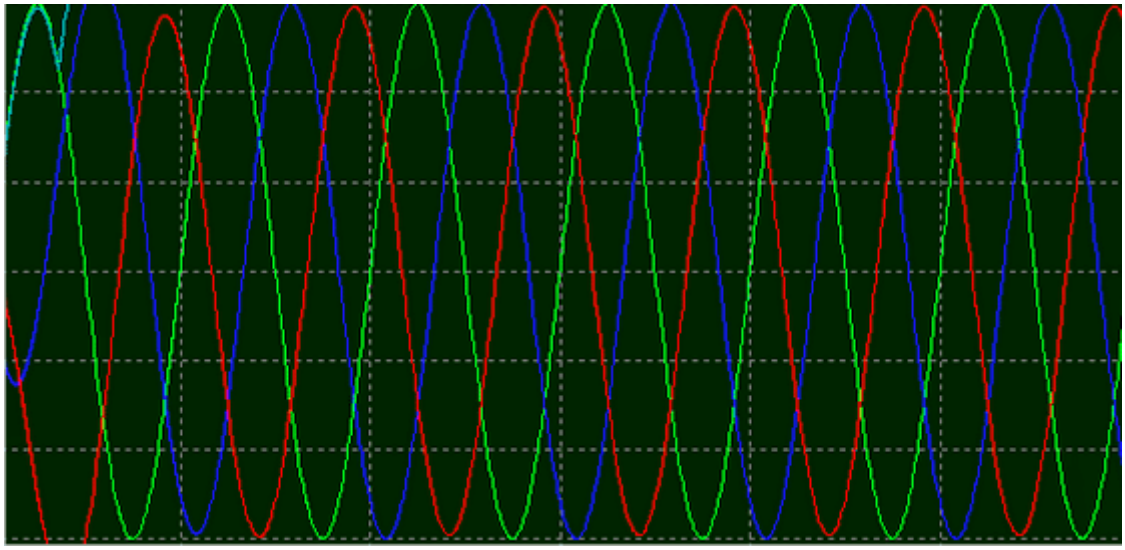


Figure 2: Three sine waves with 60-degree phase shift

Esim Circuit Diagram:

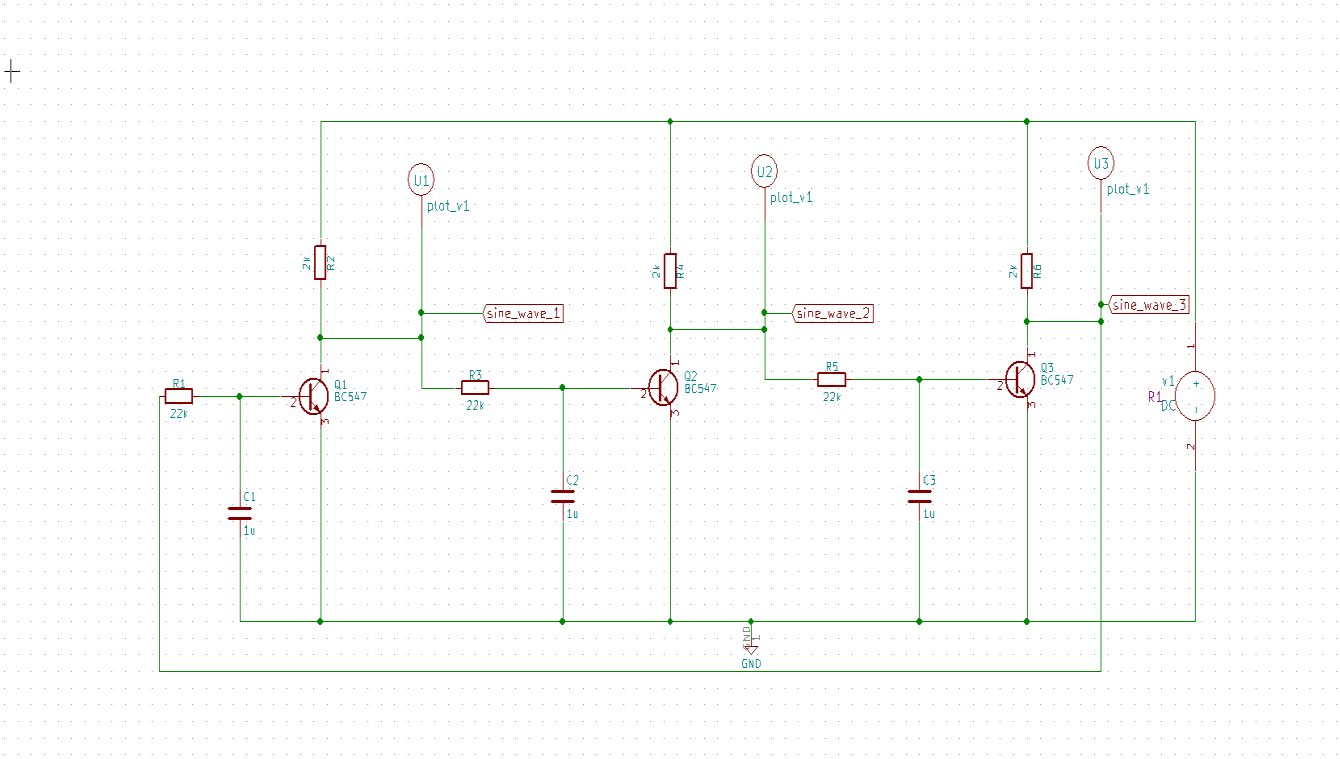


Figure 3: Esim Circuit Diagram (Switch ON condition).

Simulation Results:

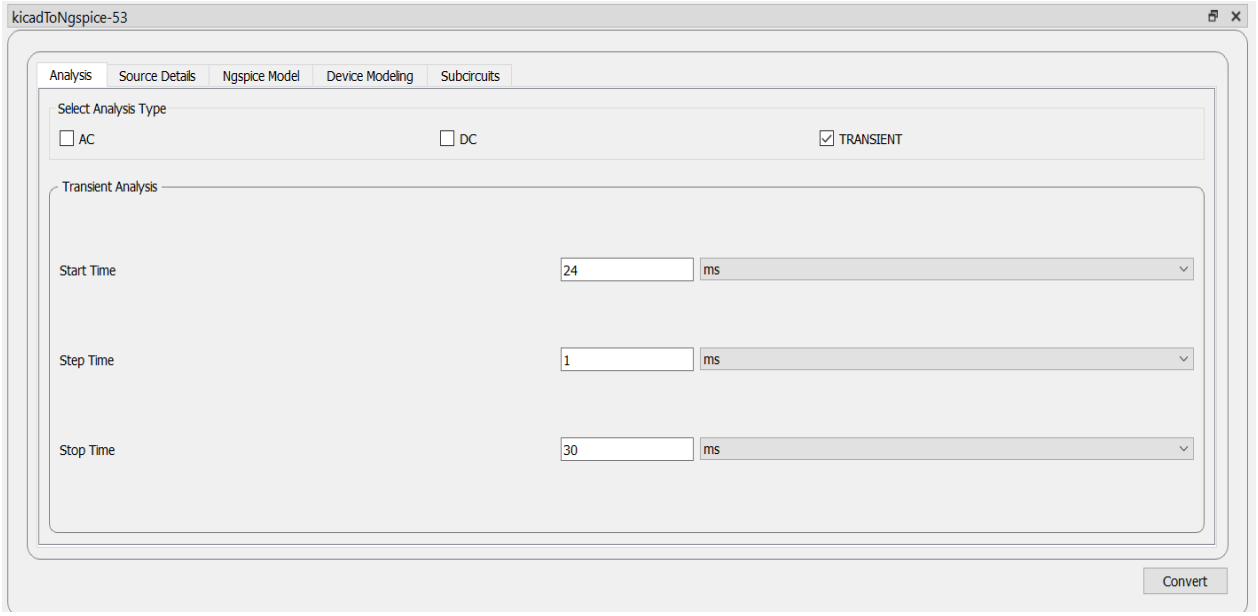


Figure 4: Kicad to NgSpice

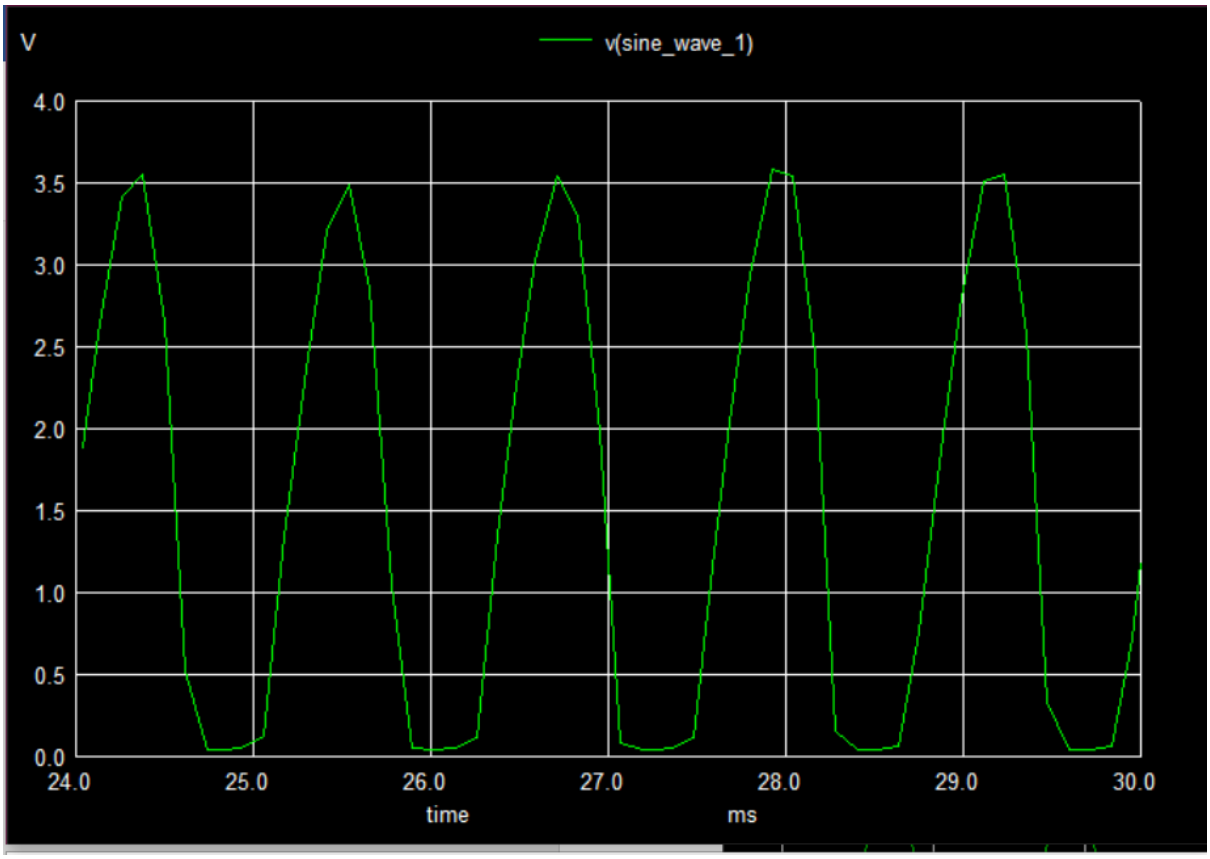


Figure 5: Ngspice output Sine Wave 1

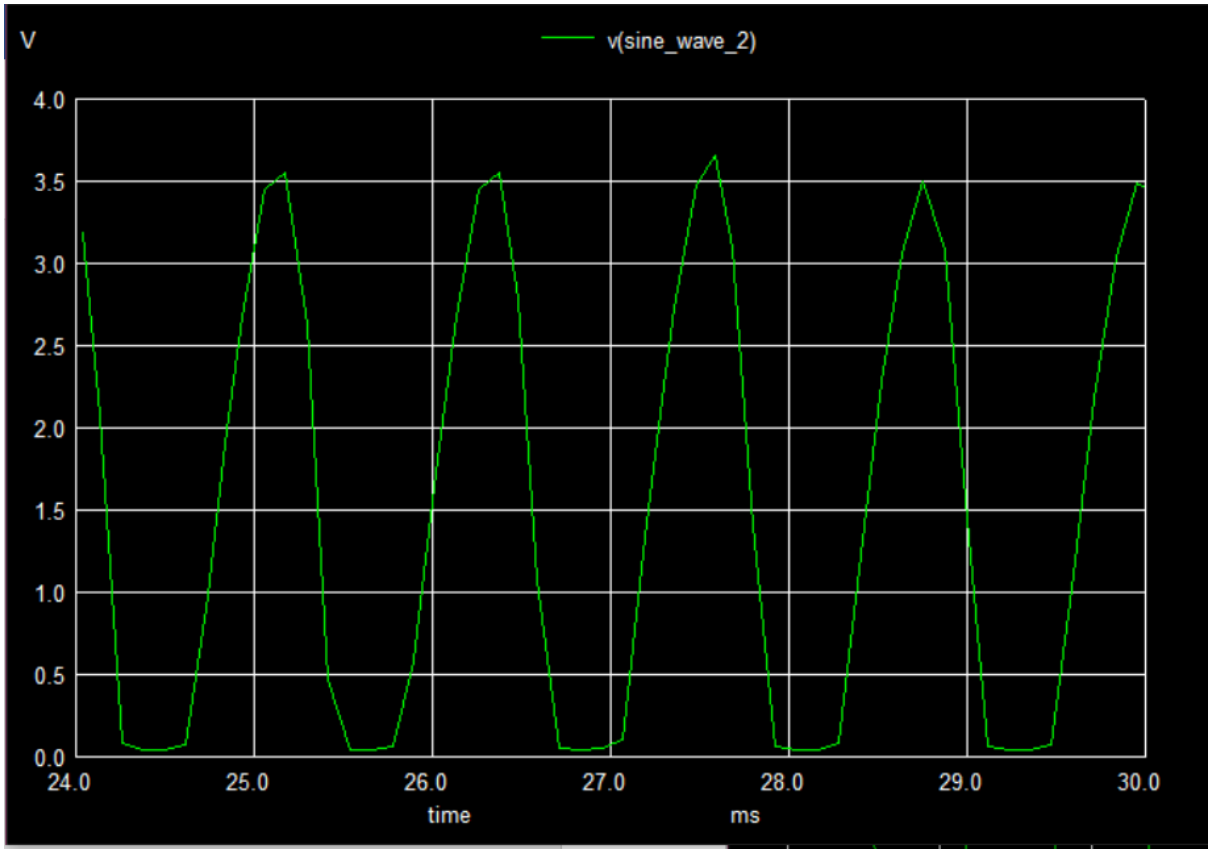


Figure 6: NgSpice output Sine Wave 2

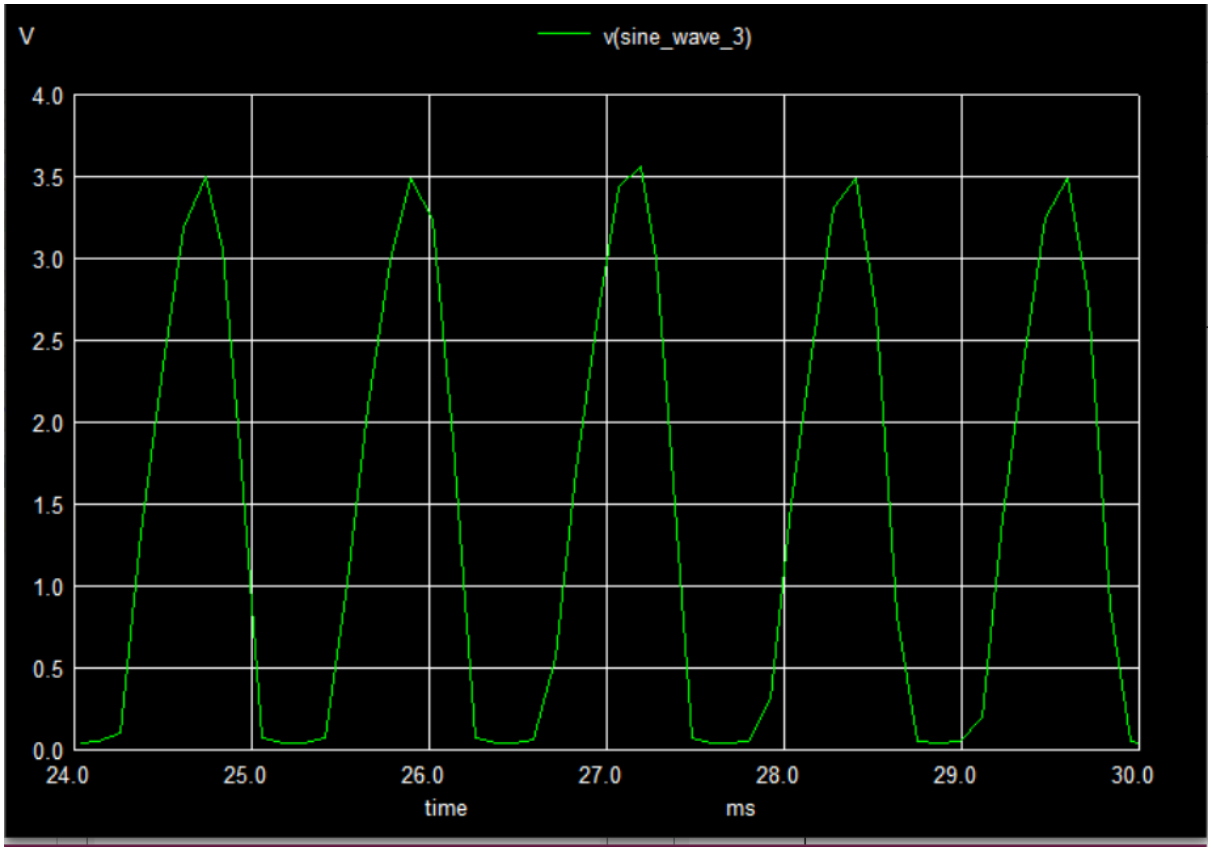
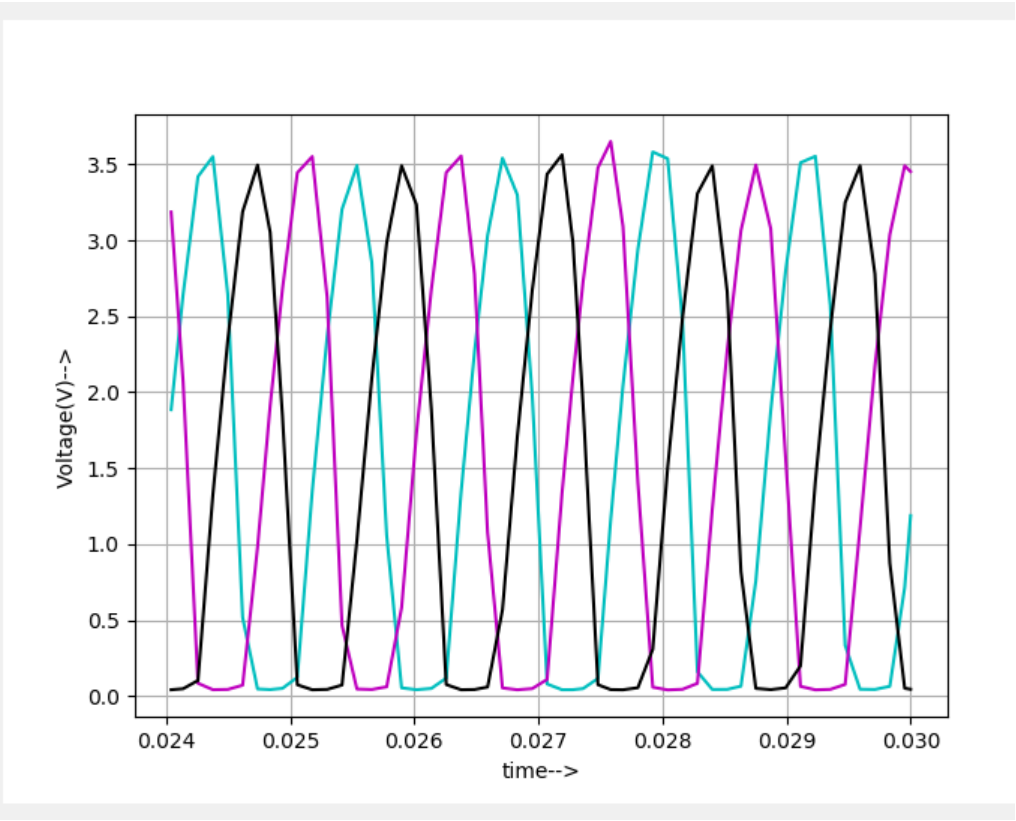
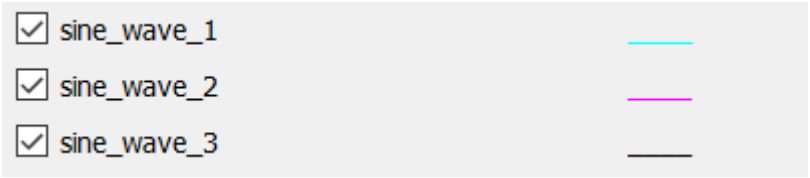


Figure 7: NgSpice output Sine Wave 3



(a)



(b)

Figure 8: (a) Combined waveform of all the three waves with 60-degree phase shift (b) Legend

Conclusion:

Hence, three sine waves with 60-degree phase shift were generated and appropriate waveform is obtained.

References:

https://www.homemade-circuits.com/3-phase-signal-generator-using/

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