Design and Simulation of a Series Crystal Oscillator Using 2N2219 Bipolar Junction Transistors in eSim

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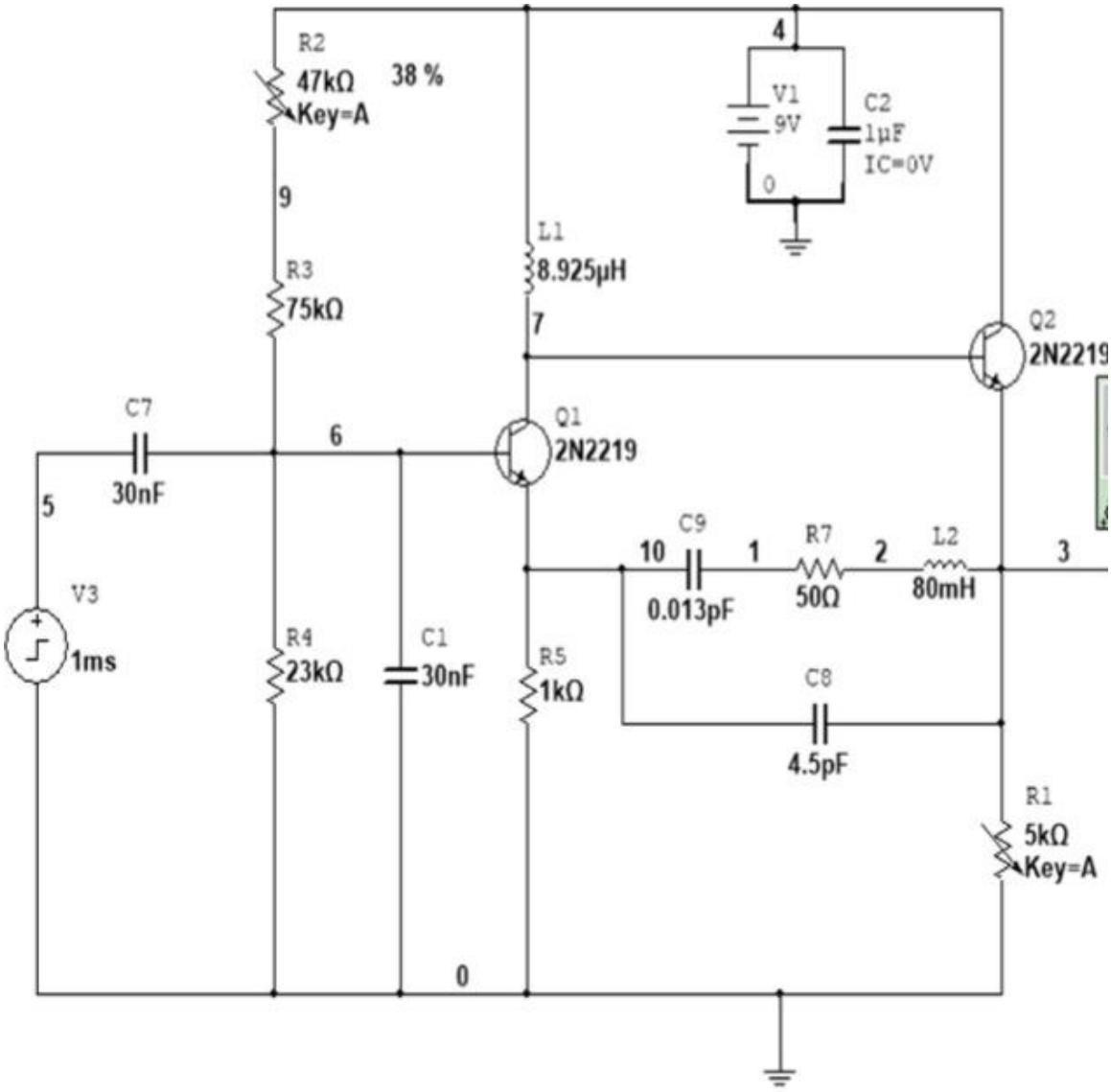
Problem Statement:

Precision and stable oscillation generation using quartz crystals is essential for communication, instrumentation, and signal processing applications. Conventional oscillator circuits using op-amps or complex ICs can suffer from frequency drift and waveform distortion. The need exists for a simple, discrete transistor-based series crystal oscillator circuit that provides stable, low-distortion sine wave oscillation at a desired frequency.

Abstract:

This project focuses on the design and simulation of a series crystal oscillator using two 2N2219 Bipolar Junction Transistors and a quartz crystal modeled as an equivalent RLC circuit. Using the open-source eSim simulation platform, the circuit is analyzed for oscillation startup, frequency stability, and waveform quality. The setup demonstrates the effectiveness of discrete BJT components with crystal feedback to achieve a stable oscillation at a target frequency (e.g., 15 MHz). The simulation results include time-domain voltage waveforms verifying steady sinusoidal oscillation. This project highlights how traditional transistor-based oscillators remain relevant for low-cost, precision oscillator circuit design.

Proposed Circuit:



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Conclusion:

Through detailed design and simulation, the series crystal oscillator built using 2N2219 BJTs demonstrates robust and stable high-frequency oscillations. The project serves as a foundation for understanding transistor-based crystal oscillator fundamentals and offers a replicable circuit for academic and industrial applications. The eSim platform proved effective for simulation and analysis, supporting future enhancements and real-world implementation.

References:

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4. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, 7th Ed., Oxford University Press, 2015.