

Types of Oscillators

From Sine Waves to Square Waves



Phase-Shift Oscillator

Generates sine waves using an amplifier and an RC feedback network.

1

Oscillation Requirements

Loop gain (βA) > 1 , phase shift = 180° .

2

Frequency Formula

$$f = 1 / (2\pi RC\sqrt{16})$$

3

Amplifier Gain

Amplifier gain (A) must be > 29 .

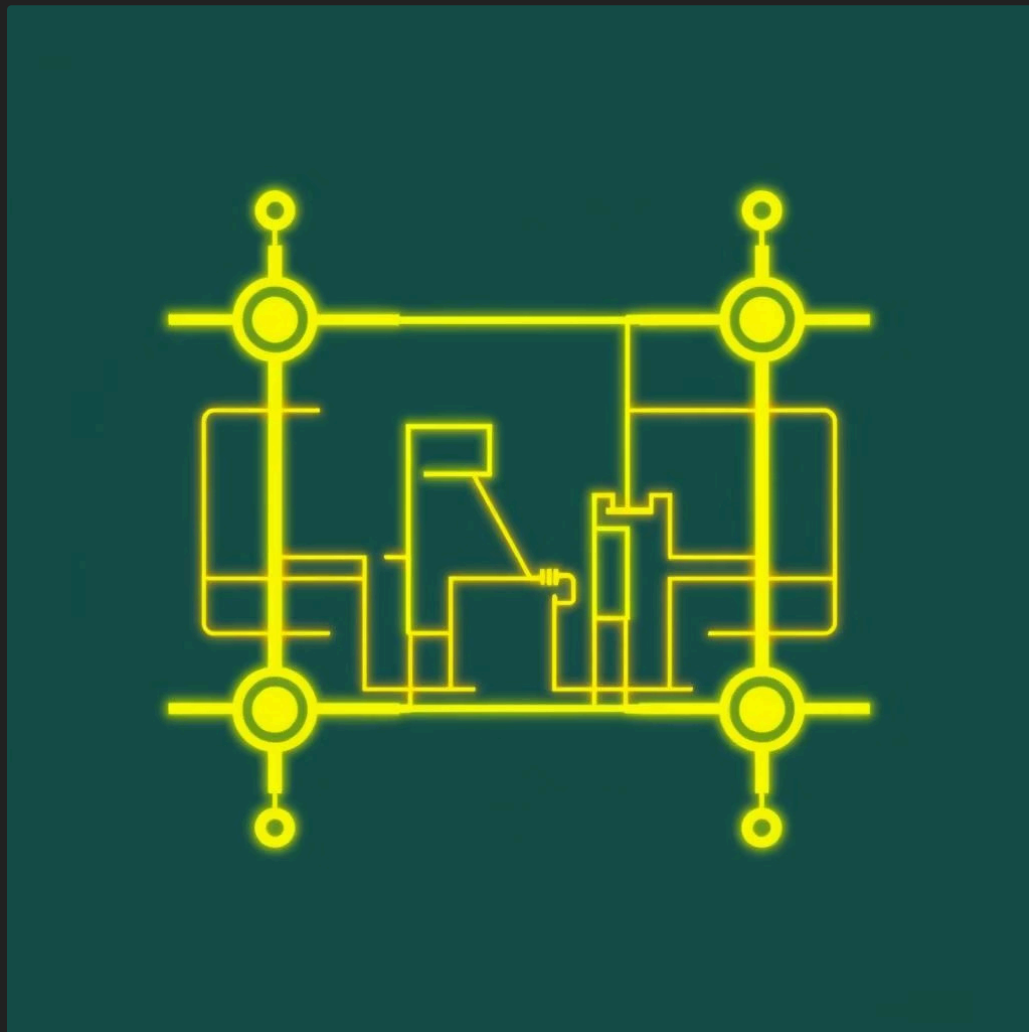
Practical Phase-Shift Oscillators

Adapting the theory for real-world applications.

FET Version

Self-biased FET amplifier with RC feedback.

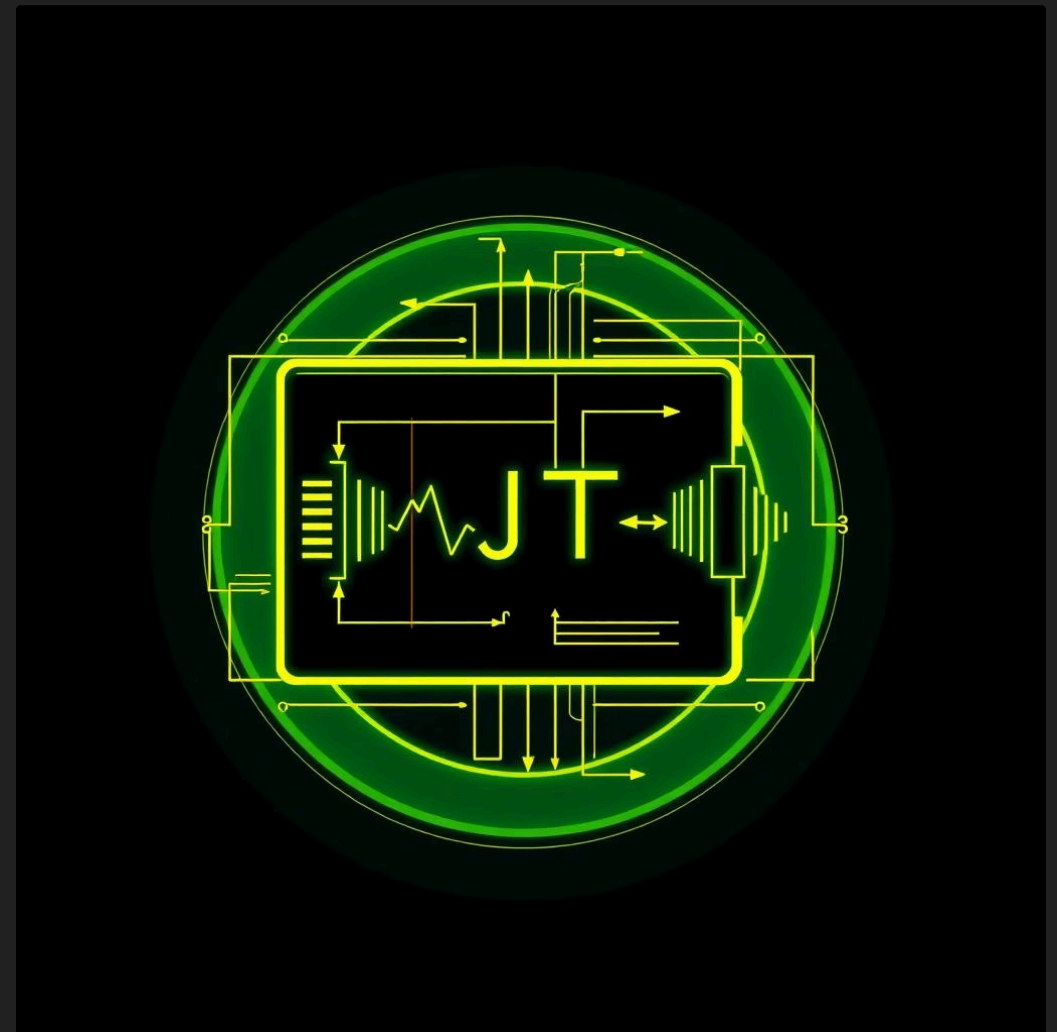
Input impedance assumed infinite, output impedance small.



Transistor Version

Uses voltage-shunt feedback due to transistor's low input resistance.

Frequency and current gain requirements adjusted for loading.



Wien Bridge Oscillator

Utilizes an op-amp and an RC bridge for precise frequency control.

1

Op-Amp Integration

Op-amp provides amplification.

2

RC Bridge

R1, R2, C1, C2 set frequency.

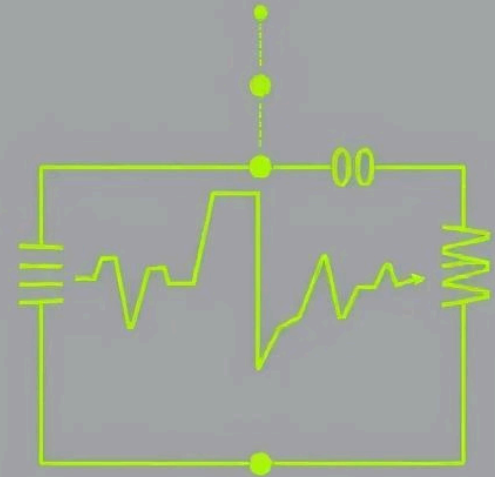
3

Feedback Path

R3, R4 form part of feedback.

If $R1=R2=R$ and $C1=C2=C$, then $f_o = 1 / (2\pi RC)$.

$R3/R4 > 2$ for oscillation.



Tuned Oscillator Circuits

Resonant circuits for specific oscillator types.



Colpitts Oscillator

Uses two capacitors and one inductor in the feedback network.

$$f_0 = 1 / (2\pi\sqrt{LC_{eq}}), \text{ where } C_{eq} = (C1C2)/(C1+C2)$$



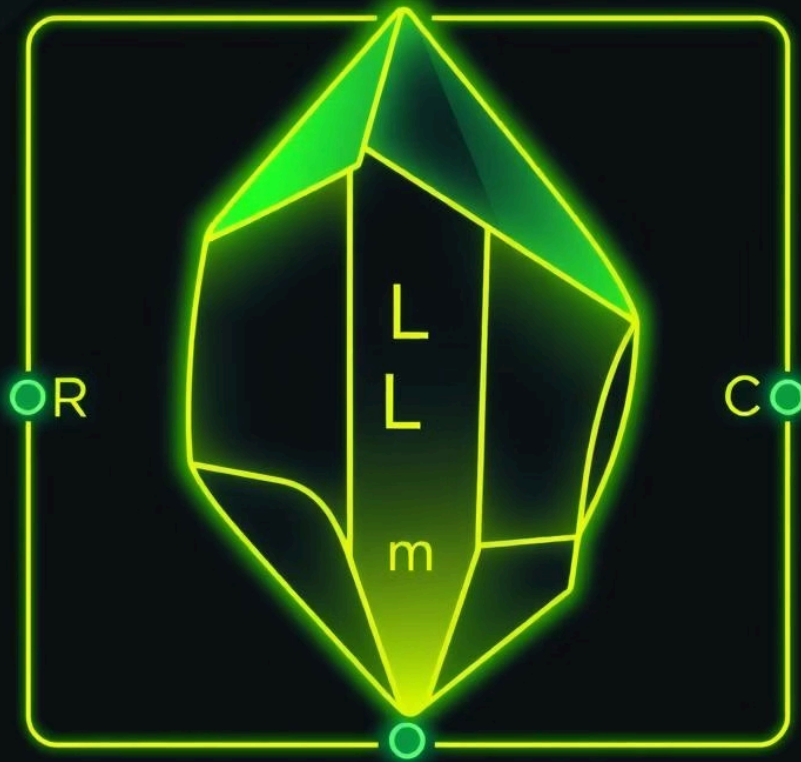
Hartley Oscillator

Uses two inductors and one capacitor in the feedback network.

$$f_0 = 1 / (2\pi\sqrt{L_{eq}C}), \text{ where } L_{eq} = L1 + L2 + 2M$$

Crystal Oscillator

High stability using piezoelectric quartz crystals.



Piezoelectric Effect

Mechanical stress creates voltage, voltage creates distortion.

Equivalent Circuit

Represents crystal's electromechanical resonance.

High Q Factor

Typically 20,000, up to 10^6 for extreme stability.

Unijunction Oscillator

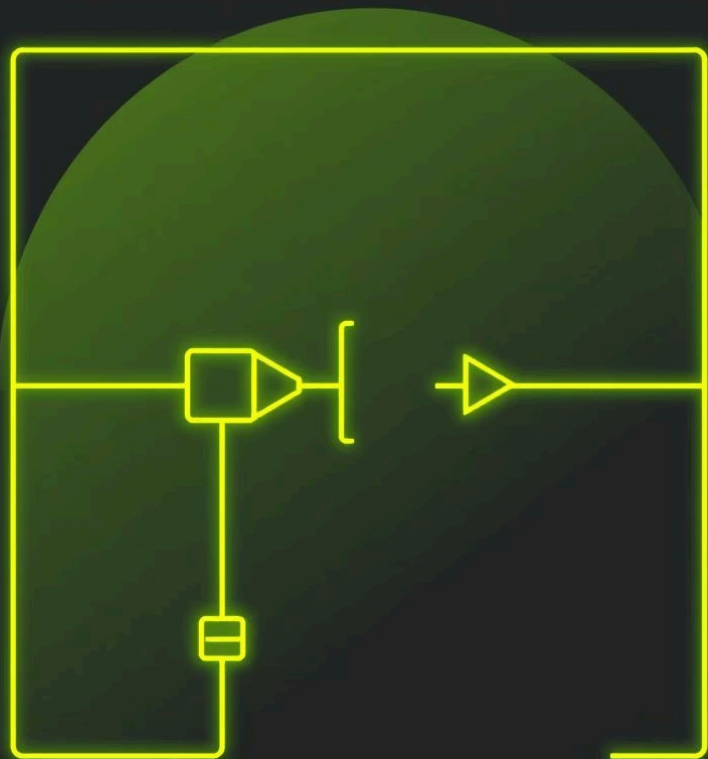
Generates pulse signals for digital applications.

Relaxation Oscillator

Uses a unijunction transistor (UJT).

RT and CT are timing components.

$f_o \approx 1.44 / (RTCT)$ for $\eta = 0.5$.



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Waveforms

Capacitor charges, UJT fires, discharges.

Produces sawtooth at emitter, pulses at bases.

