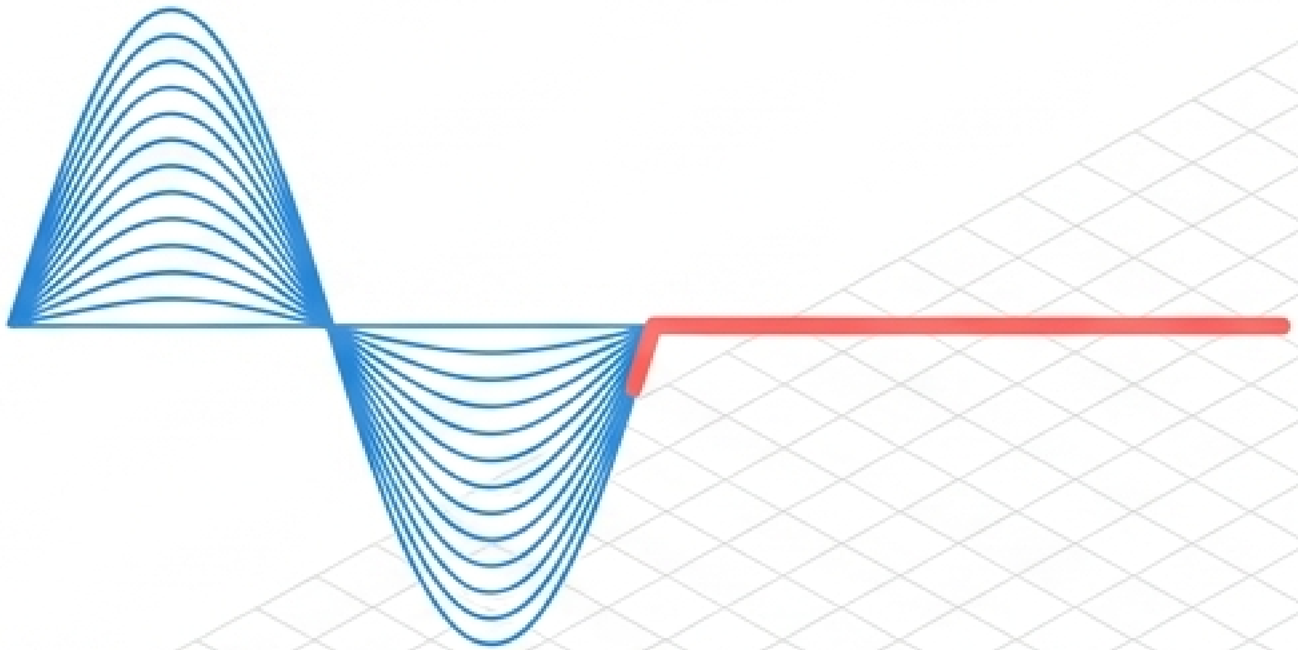
ATME College of Engineering

Simulation Report: Single Phase Half-Wave Diode Rectifier

A virtual prototyping study using MATLAB Simulink



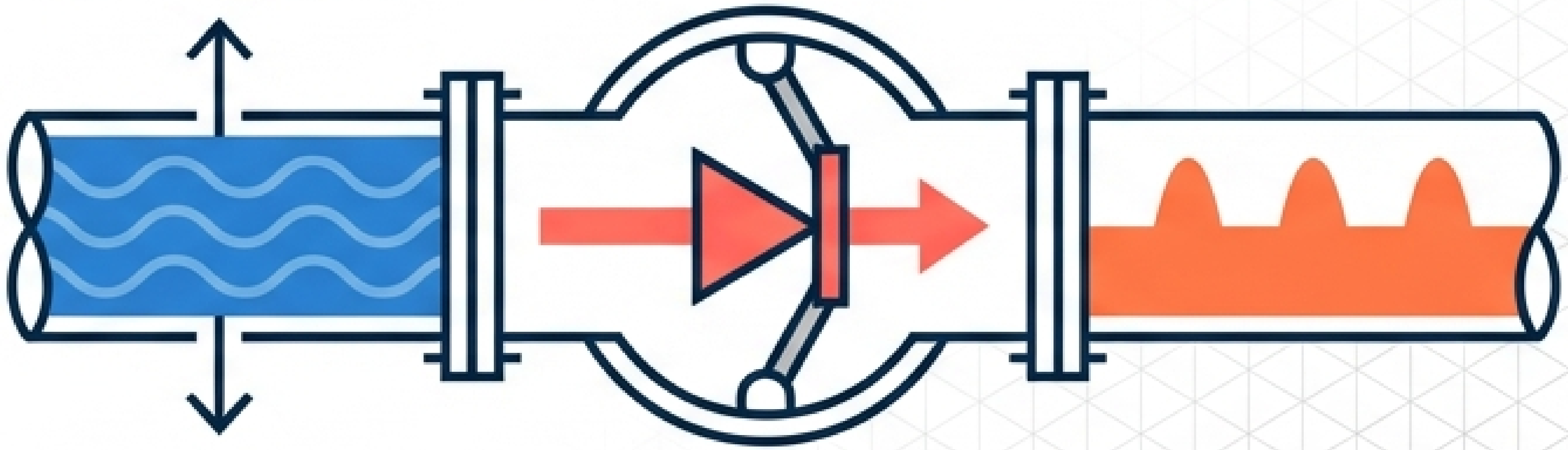
INPUT SUPPLY	LOAD PARAMETER	PLATFORM
100 V / 50 Hz	50 Ω	Simulink
AC Sinusoidal	Resistive (R)	Power Systems Blockset

Core Function and Project Scope

Rectifiers are the fundamental bridge between Alternating Current (AC) and Direct Current (DC). This simulation models the simplest form of this conversion: the Half-Wave Rectifier.

- **Mechanism:** The circuit utilizes a single diode to allow only one half-cycle of the AC source to pass.
- **Application:** Foundational model for understanding power electronics.
- **Setup:** Implementation relies on a basic pairing of a diode and a resistive load.

The Gatekeeper Concept



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Simulation Objectives and Specifications

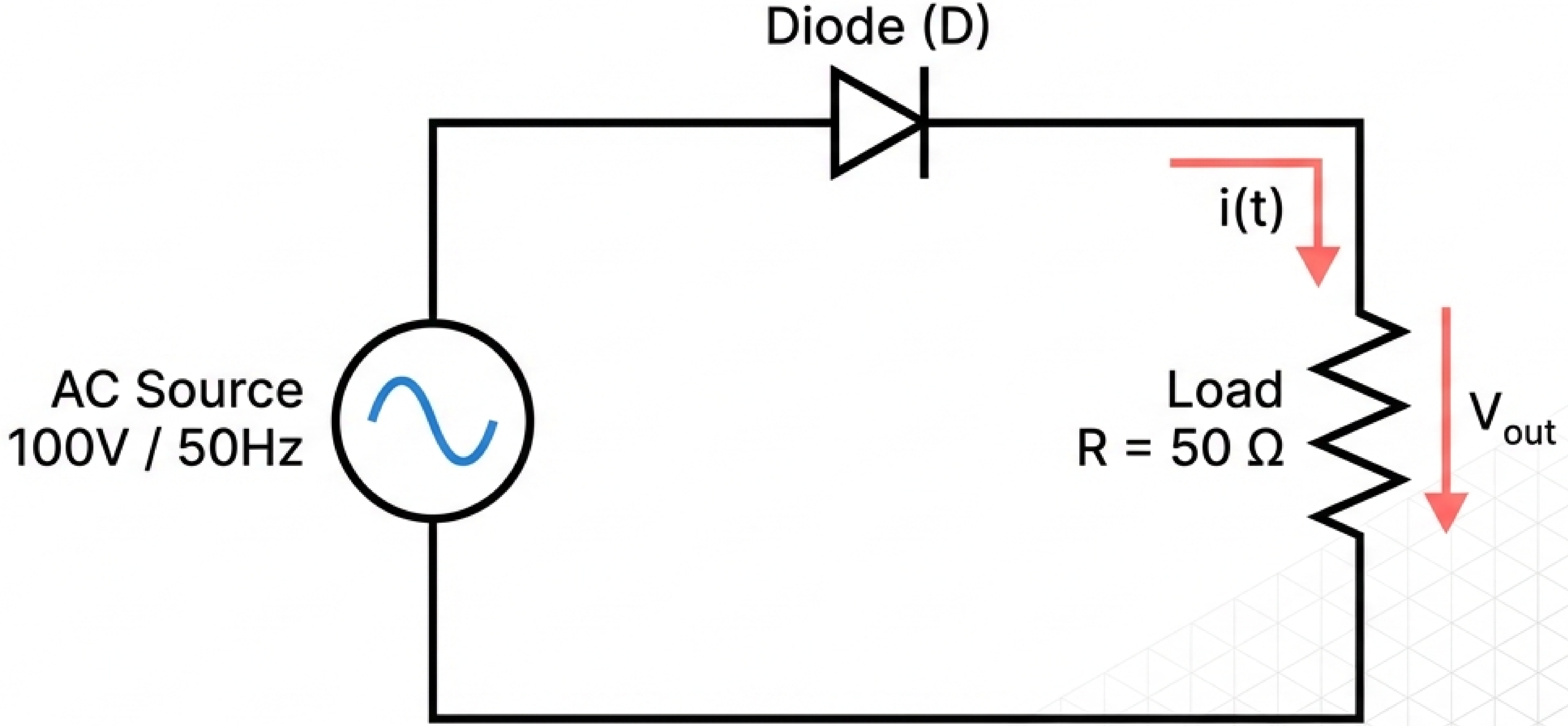
Objectives

1. Model a single-phase half-wave diode rectifier.
2. Visualize and compare input vs. output waveforms.
3. Analyze voltage/current behavior across the load.
4. Verify the rectification process within Simulink.

Technical Constraints

Specification	Value
Source	AC Voltage (100 V Peak, 50 Hz)
Switching Element	Single Diode
Load	50 Ω Resistor
Measurement	Voltage across Load

Theoretical Circuit Topology



JetBrains Mono (Jet BRains (Inter) #466) (Irevin:Inten Tbrey (#EtBrains Mono. The architecture places places the diode in series with the load. The diode acts as a gatekeeper, conducting current only when the **anode is positive** relative to the cathode (Forward Bias).

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Simulink Component Inventory

Power Components

- AC Voltage Source
- Diode
- Series RLC Branch (Set to R)

Instrumentation

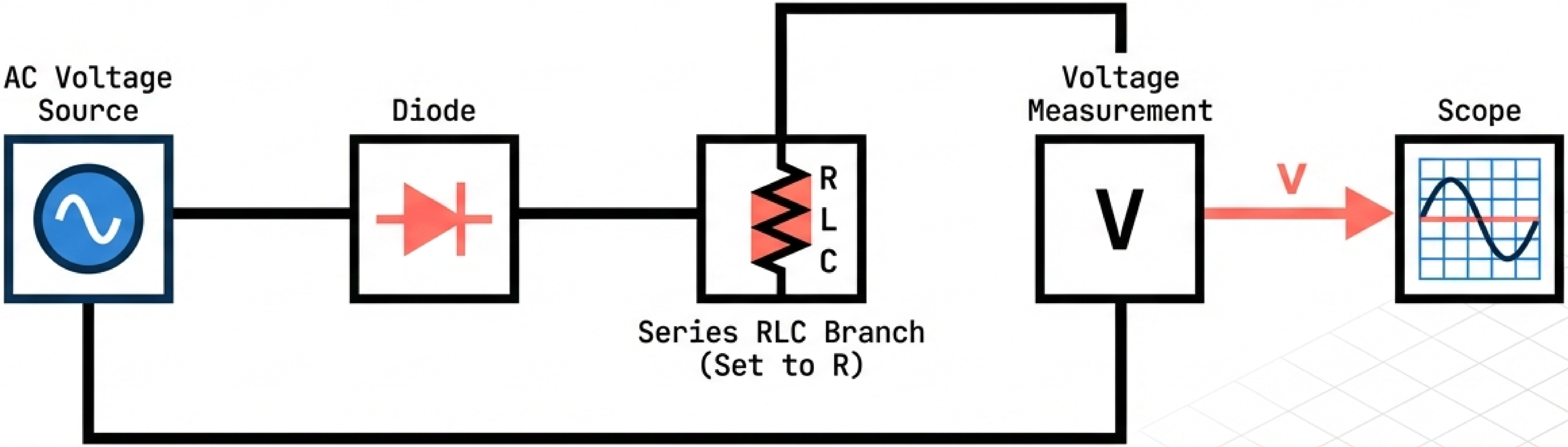
- Voltage Measurement
- Current Measurement
- Scope

Simulation Engine

- Powergui

Essential for discrete simulation solver.

Model Architecture and Signal Flow

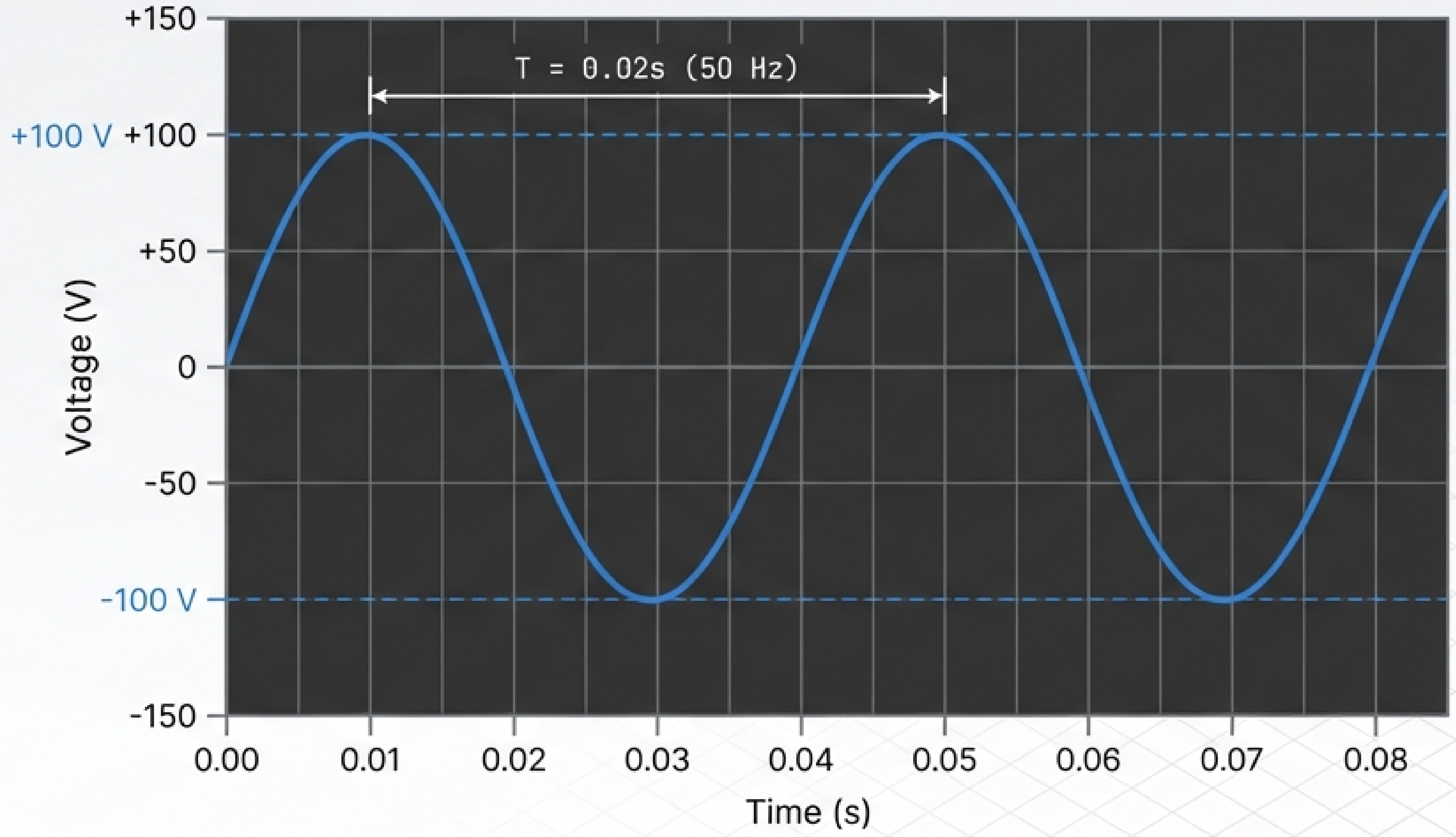


1. Series Connection: Source → Diode → Load
2. Parallel Sensing: Voltage Measurement spans the Load
3. Data Capture: Signal fed to Scope for analysis

Input Signal Characterization

Analysis Data

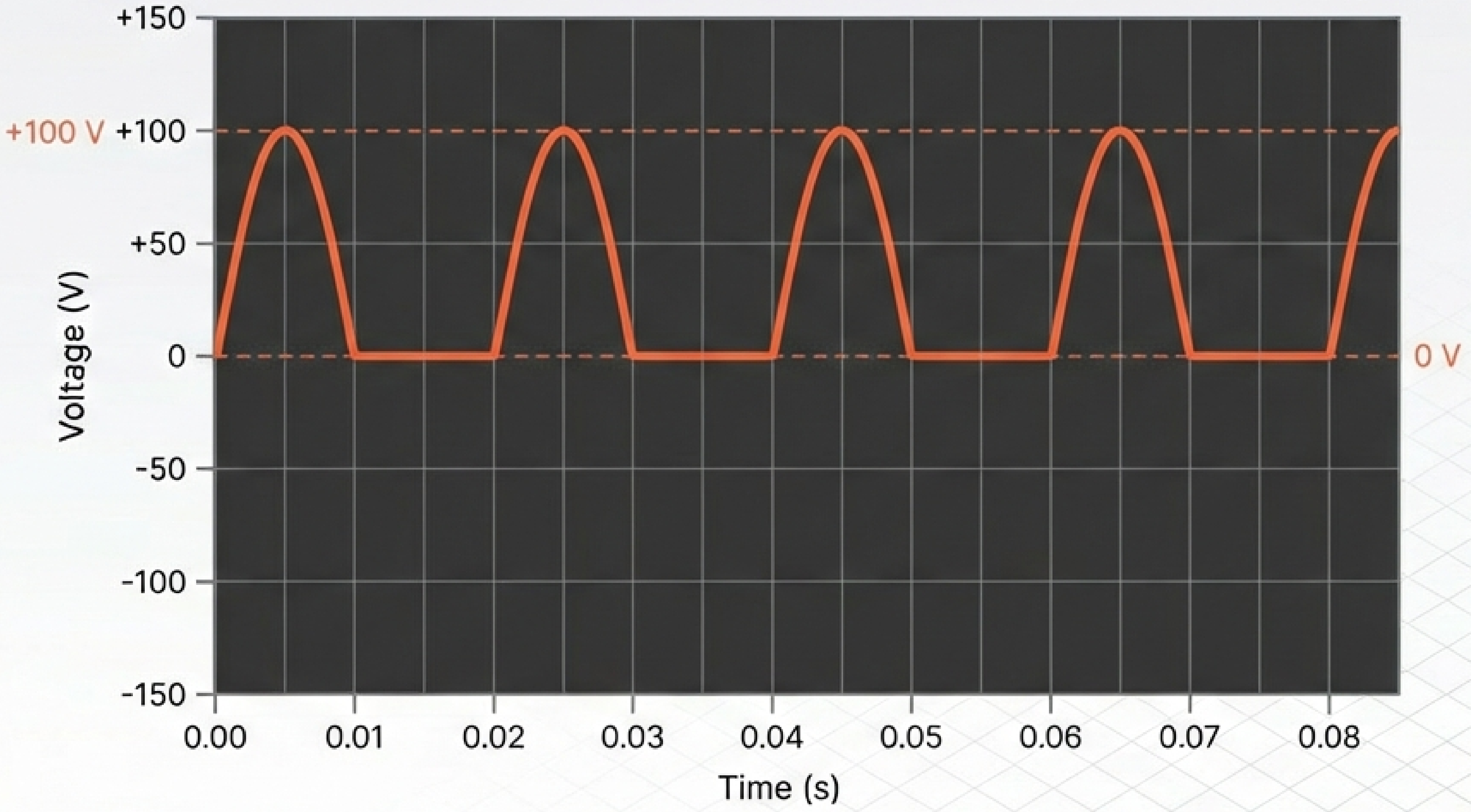
- Waveform: `Sinusoidal AC`
- Amplitude: `100 V Peak`
- Frequency: `50 Hz`
- Polarity: `Symmetrical (+/-)`



Output Signal Verification

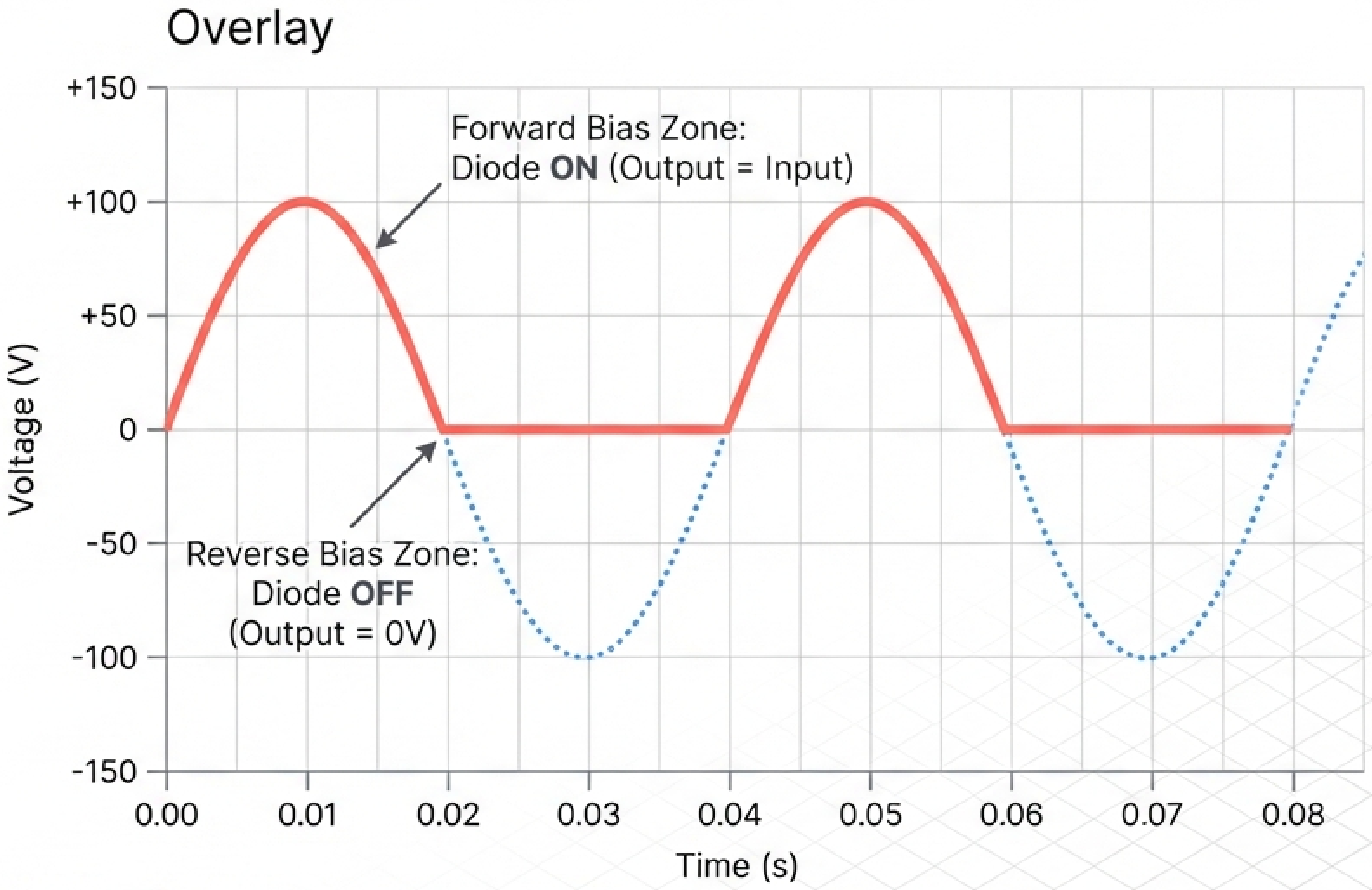
Analysis Data

- Waveform: Pulsating DC
- Positive Cycle: Conducts
- Negative Cycle: Blocked (Clipped)
- Current Flow: Unidirectional



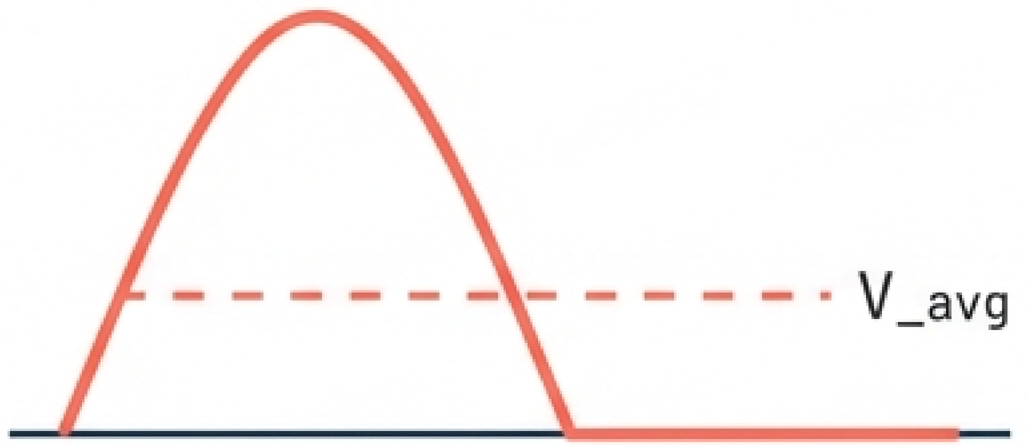
NotebookLM

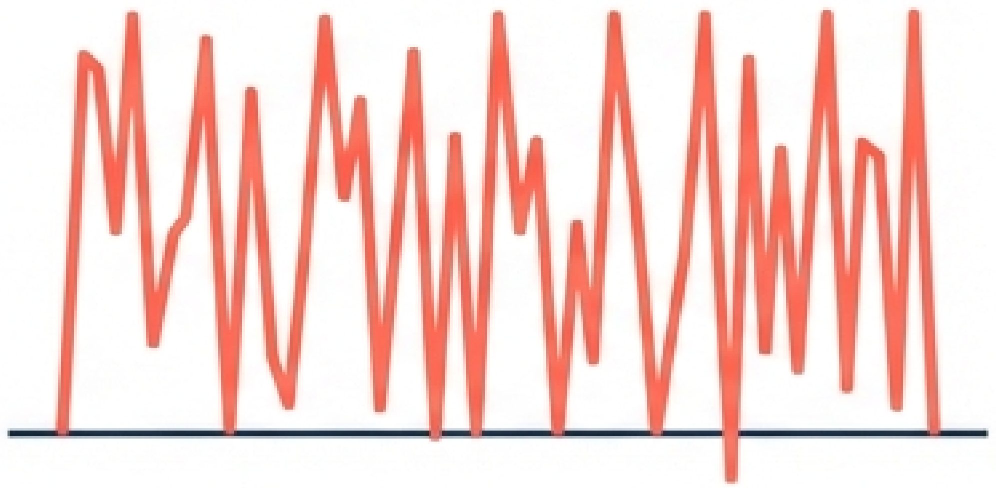
The Rectification Process Visualized

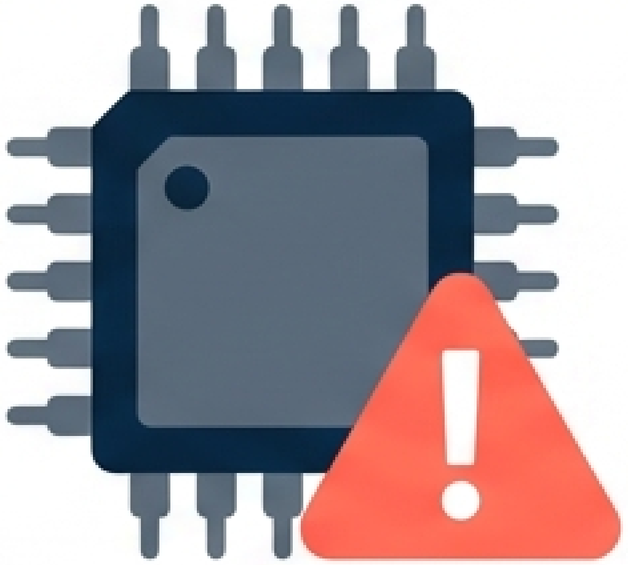


Visual confirmation of the 'Clipping' effect. The diode acts as an open switch during the negative half-cycle.

Evaluating Output Quality







Reduced Average Voltage

Because energy is delivered only 50% of the time, the average DC voltage is significantly lower than the input peak voltage (approx 31.8% of Vpeak).

High Ripple Factor

The output is not a steady line. It pulses from 0 to 100V and back. This extreme fluctuation is called “Ripple”.

Implication for Load

Raw pulsating DC is unsuitable for sensitive electronics without further smoothing (capacitors).

Strategic Advantages and Limitations

Advantages

- **Simplicity**: Minimal component count (1 Diode).
- **Cost Effective**: Extremely low implementation cost.
- **Robustness**: Fewer points of failure.

Limitations

- **Signal Quality**: High ripple requires heavy filtering.
- **Efficiency**: Low (utilizes only half the AC signal).
- **System Impact**: DC saturation risk for transformers.

Final Engineering Assessment

Summary of Findings

- The Single Phase Half-Wave Rectifier was successfully modeled and simulated.
- Waveform analysis confirms the blocking of negative half-cycles.
- **MATLAB Simulink** provides an accurate "glass box" environment for visualizing power electronics theory.

Status: VERIFIED & COMPLETE