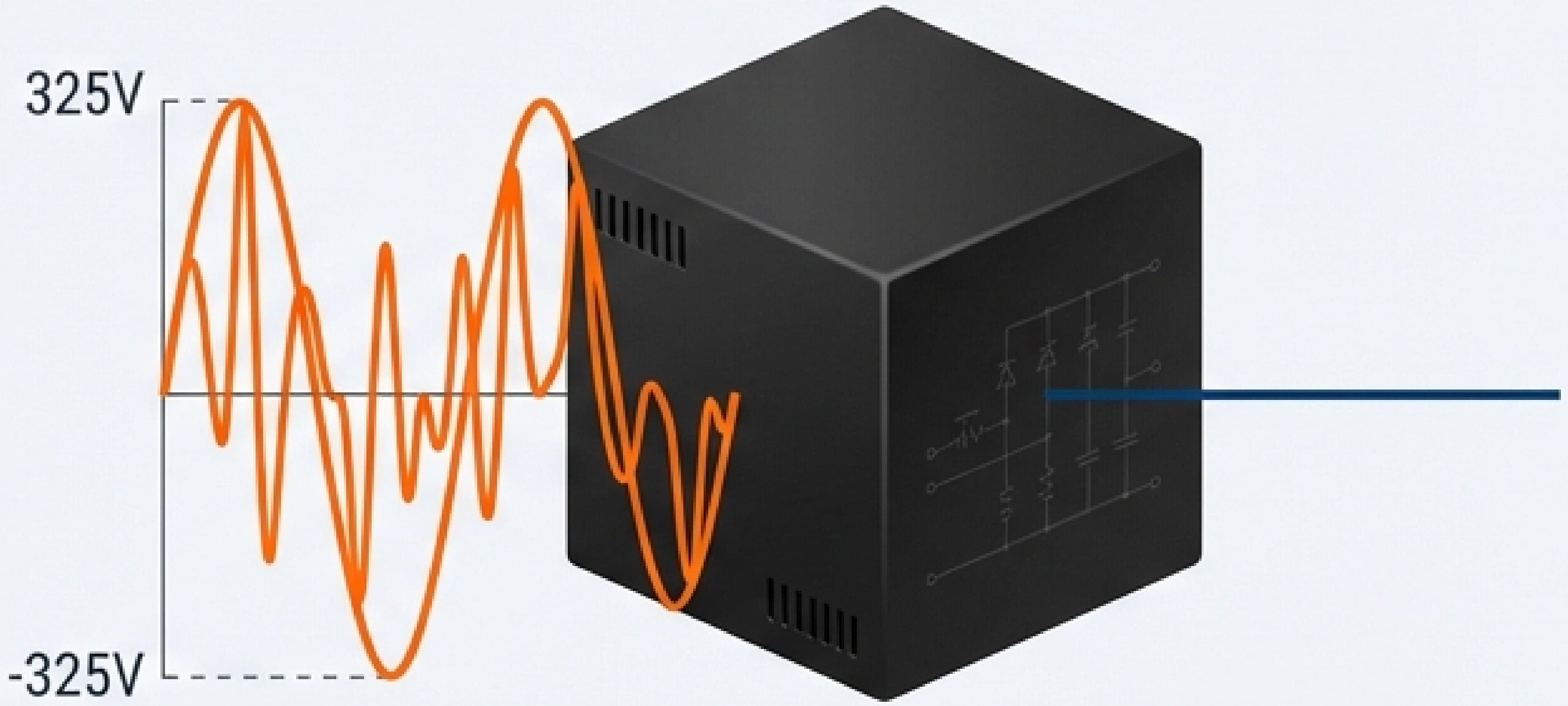
Rectification & Power Supplies

Unit 12 | Phase 2
Electrical Instrumentation



$$V_{DC} = \frac{2V_p}{\pi}$$

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The Raw Material vs. The Requirement

AC: Alternating Current

DC: Direct Current

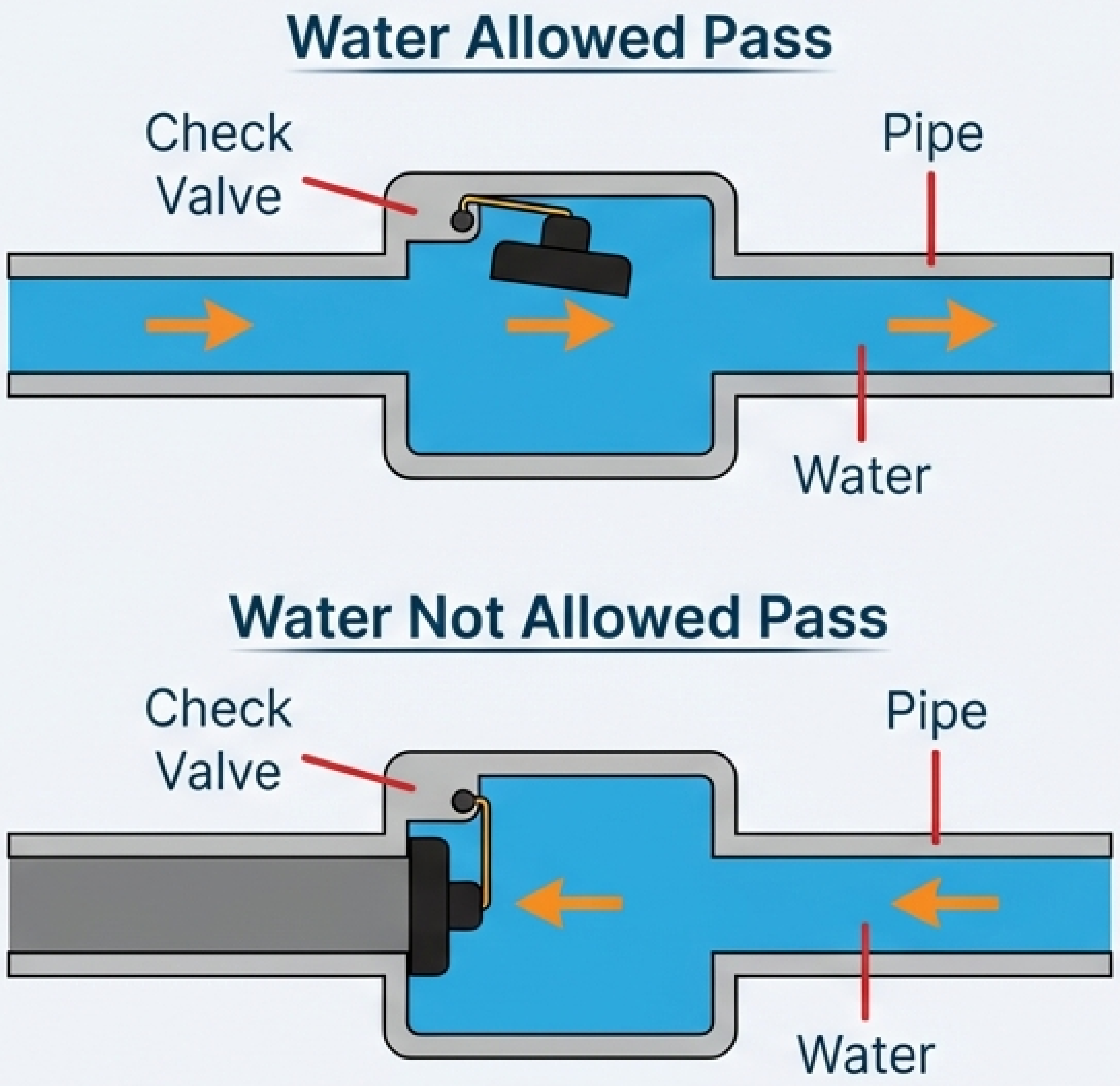
AC: Alternating Current

- Source: Mains Supply (ESB)
- 230V RMS, 50Hz
- Efficient for transmission

DC: Direct Current

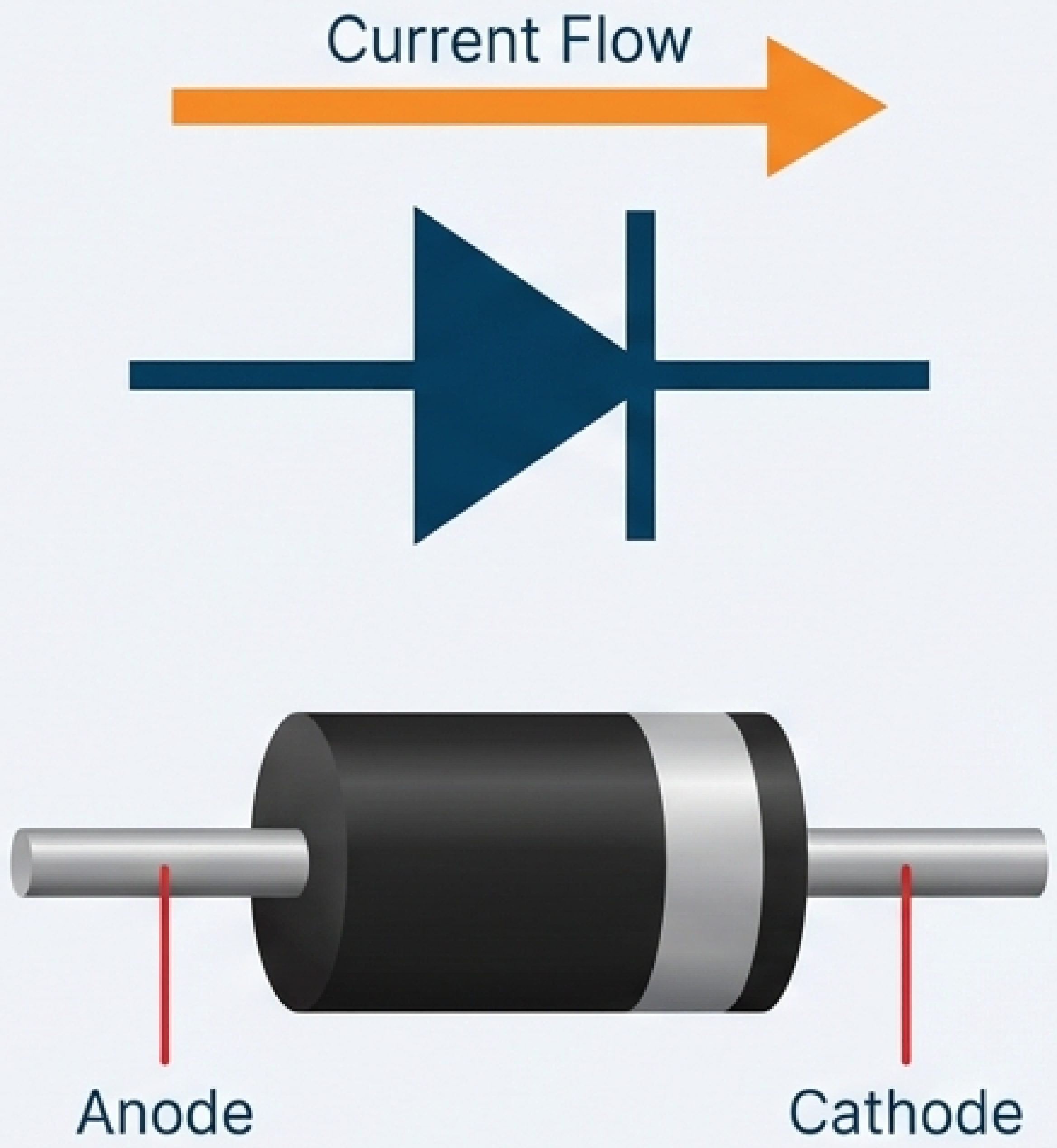
- Source: Batteries/Power Supplies
- One-way constant flow
- Required for Microchips & PLCs

The Gatekeeper: The Semiconductor Diode

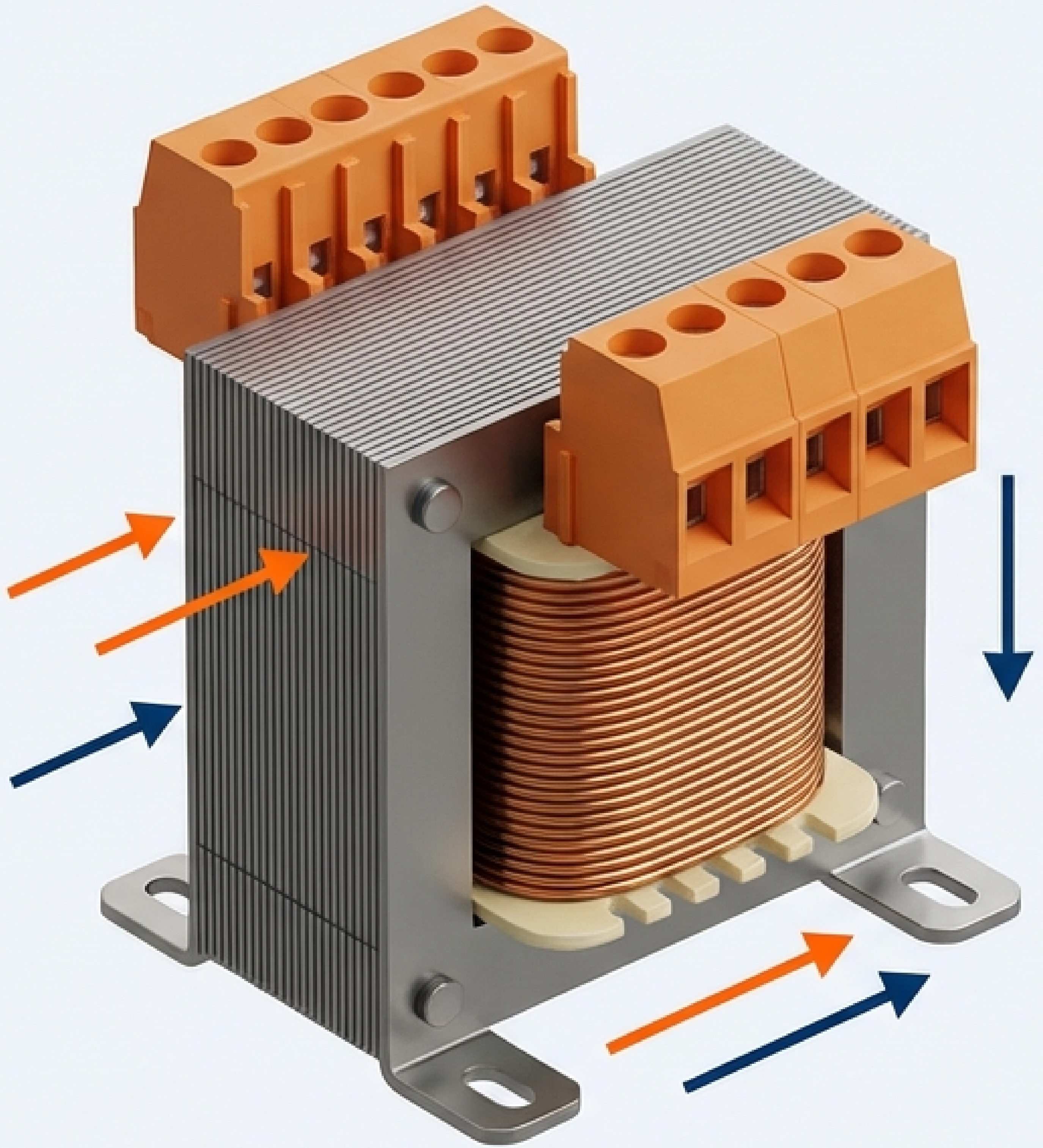


1. **Forward Bias (Switch Closed):** Current flows. Cost ~0.6V.

2. **Reverse Bias (Switch Open):** Current blocked.



Stepping Down the Voltage



Key Principles

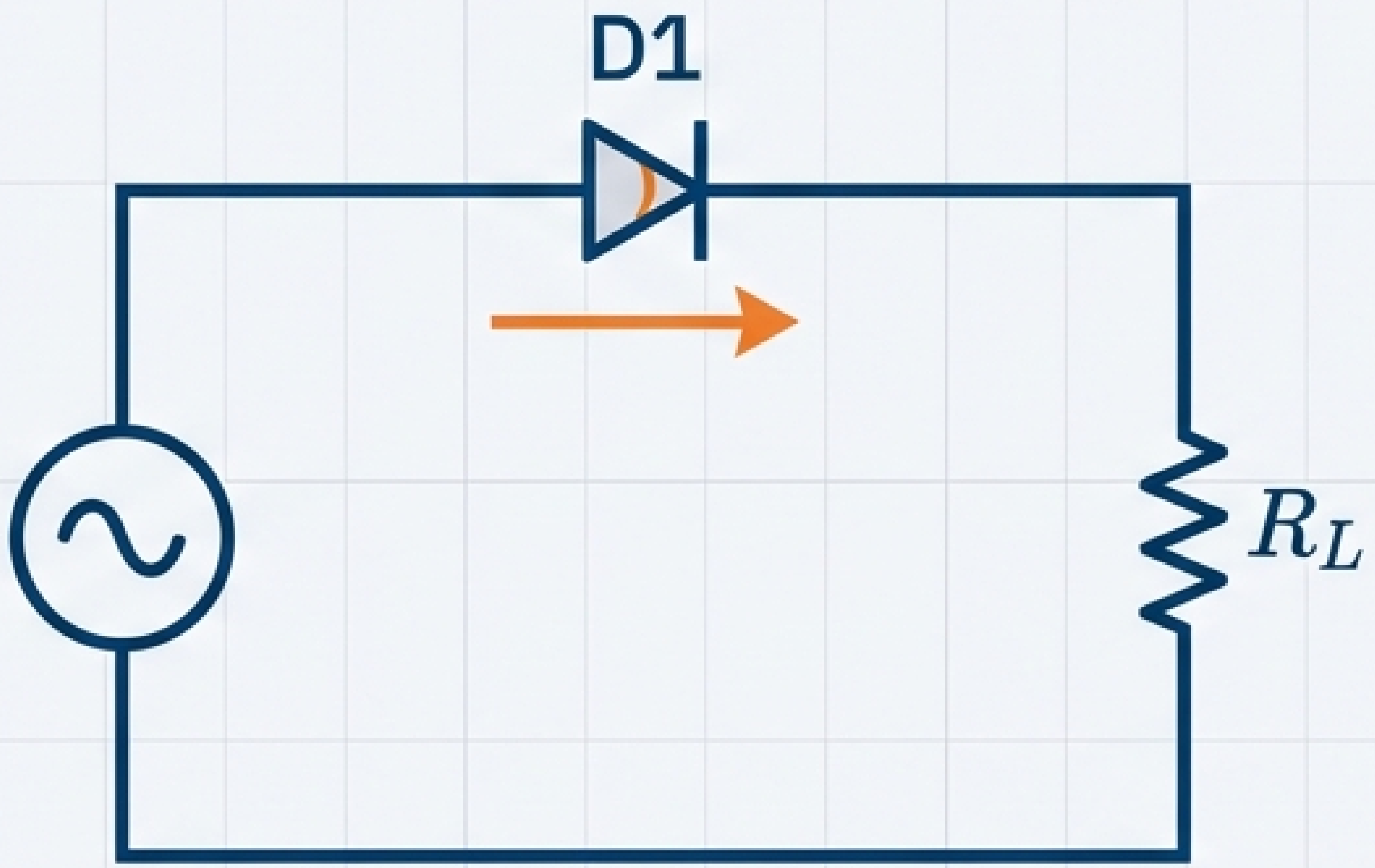
- **Mutual Inductance:** Voltage transfer via magnetic field (AC Only).
- **Isolation:** No electrical connection between Mains and Output.

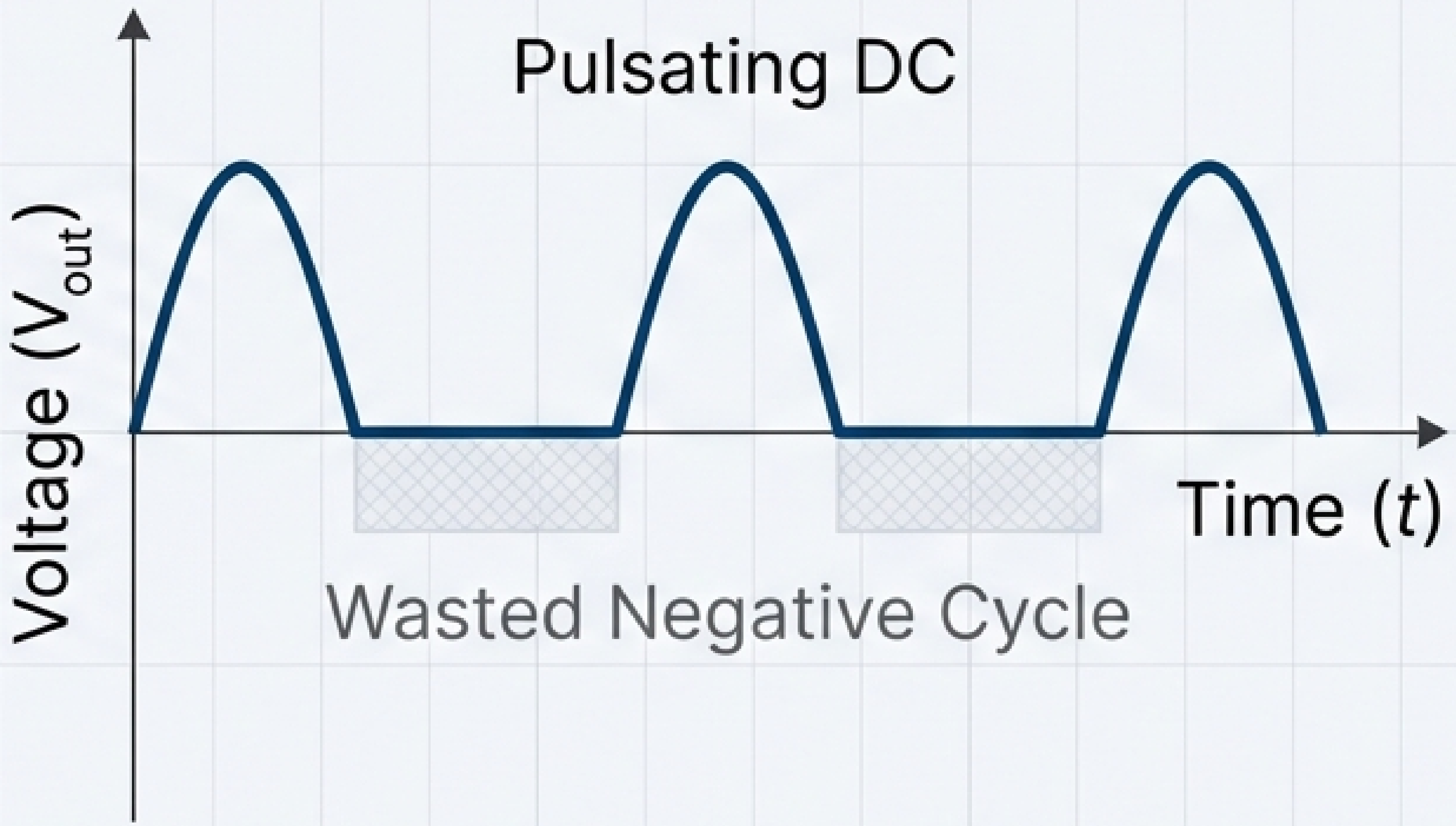
$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Example:

Example: 10:1 Ratio on 240V Input = 24V Output.

First Attempt: Half-Wave Rectification

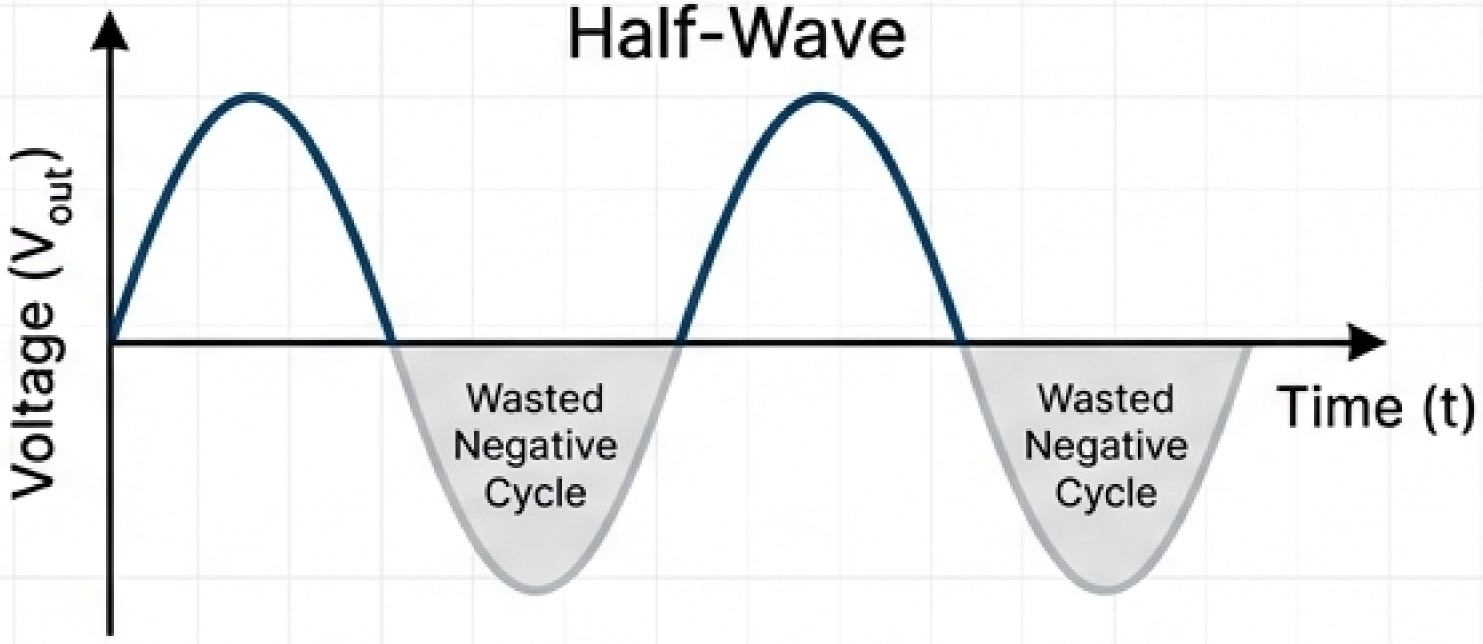


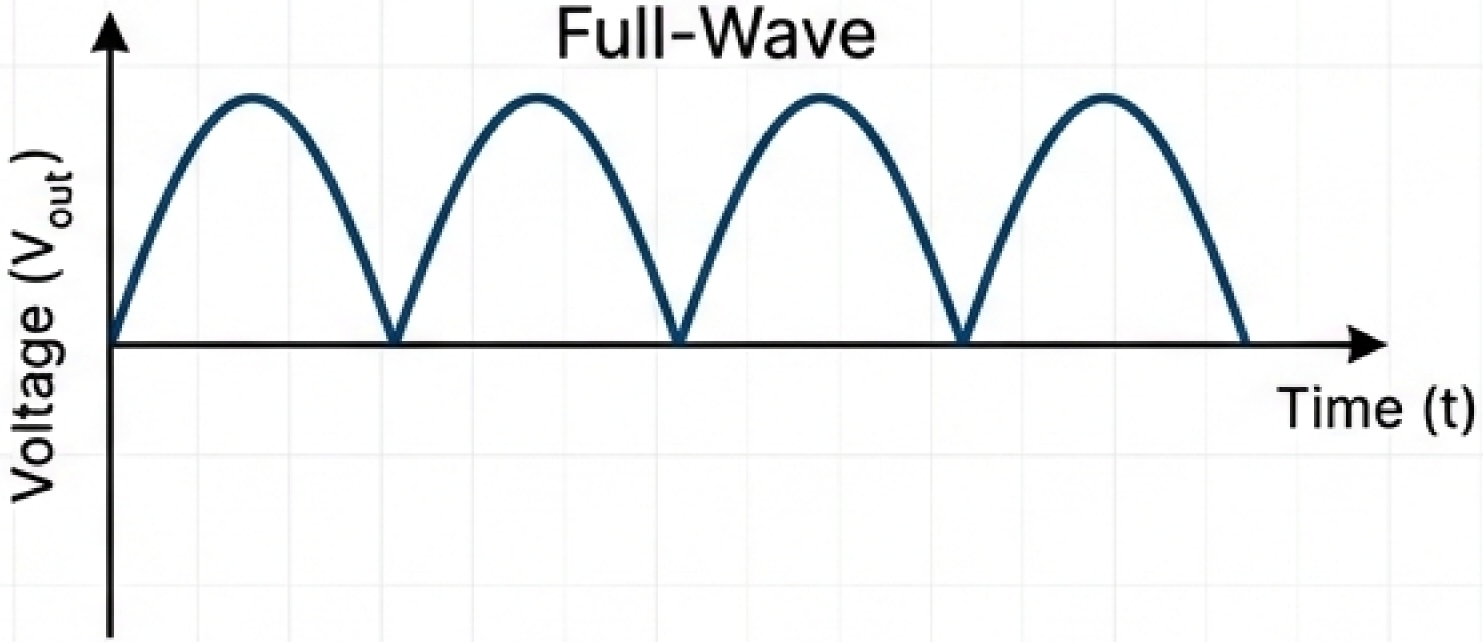


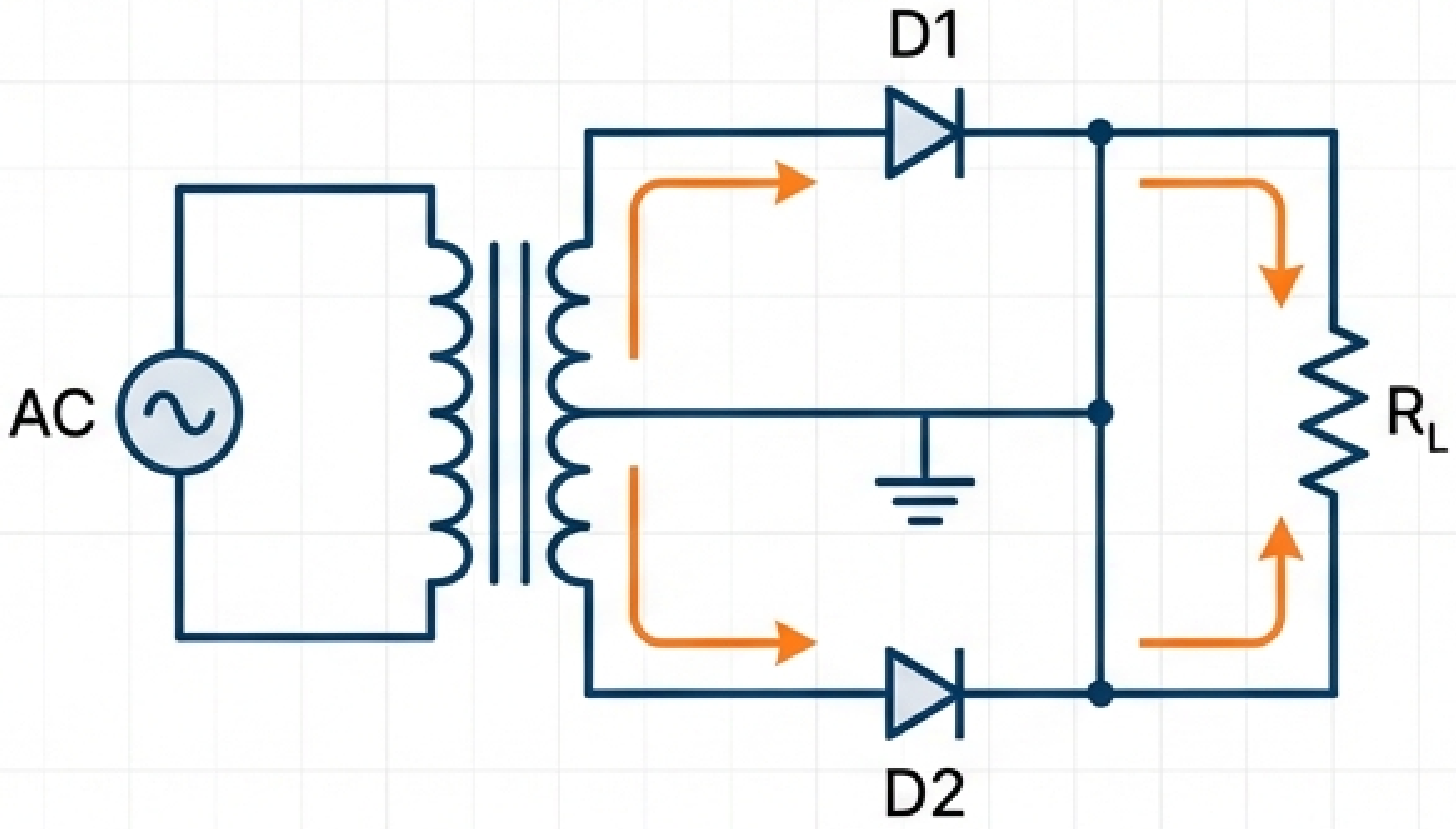
Inefficient: 50% power discarded.

$$Vdc = 0.318 \times Vpeak$$

Closing the Gaps: Full-Wave Rectification

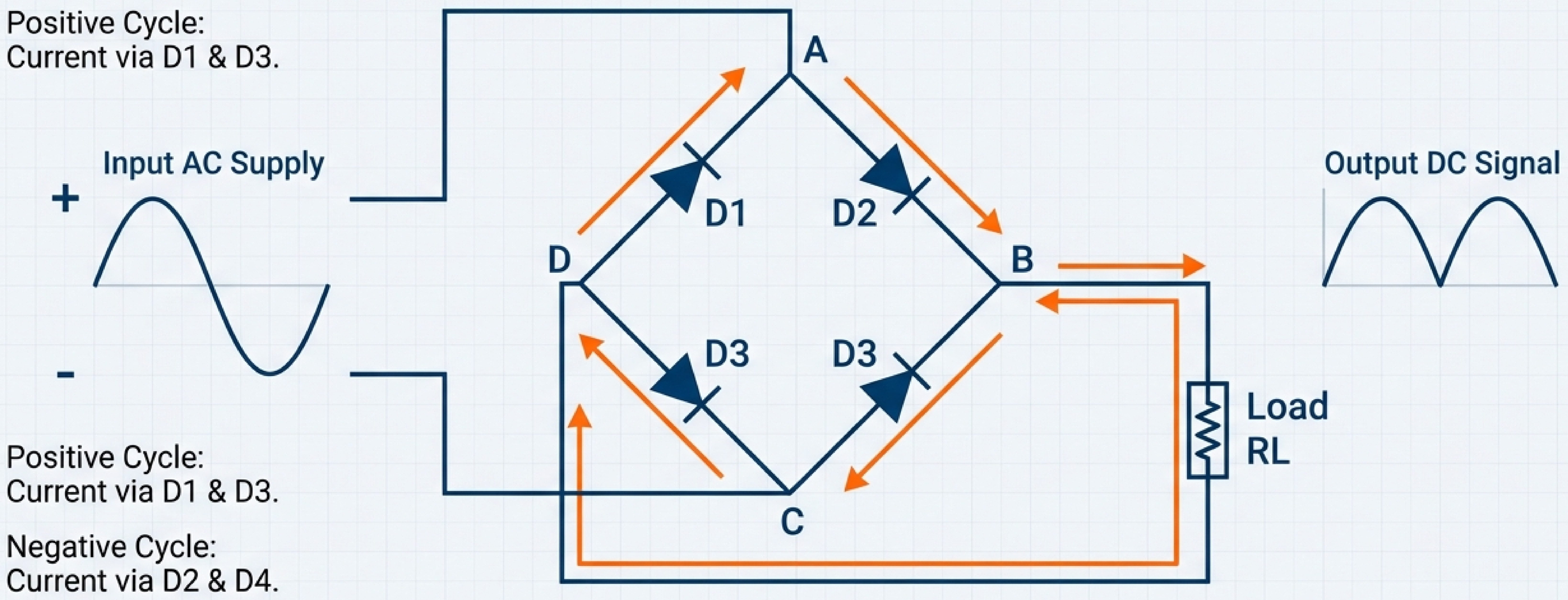






- Utilizes both AC half-cycles.
- Method A: Centre-Tapped Transformer (2 Diodes).
- Method B: Bridge Rectifier (4 Diodes - Industry Standard).

Industry Standard: The Bridge Rectifier



Crucial Outcome: Current always flows through load in the same direction.

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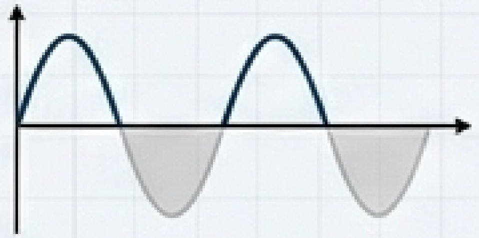
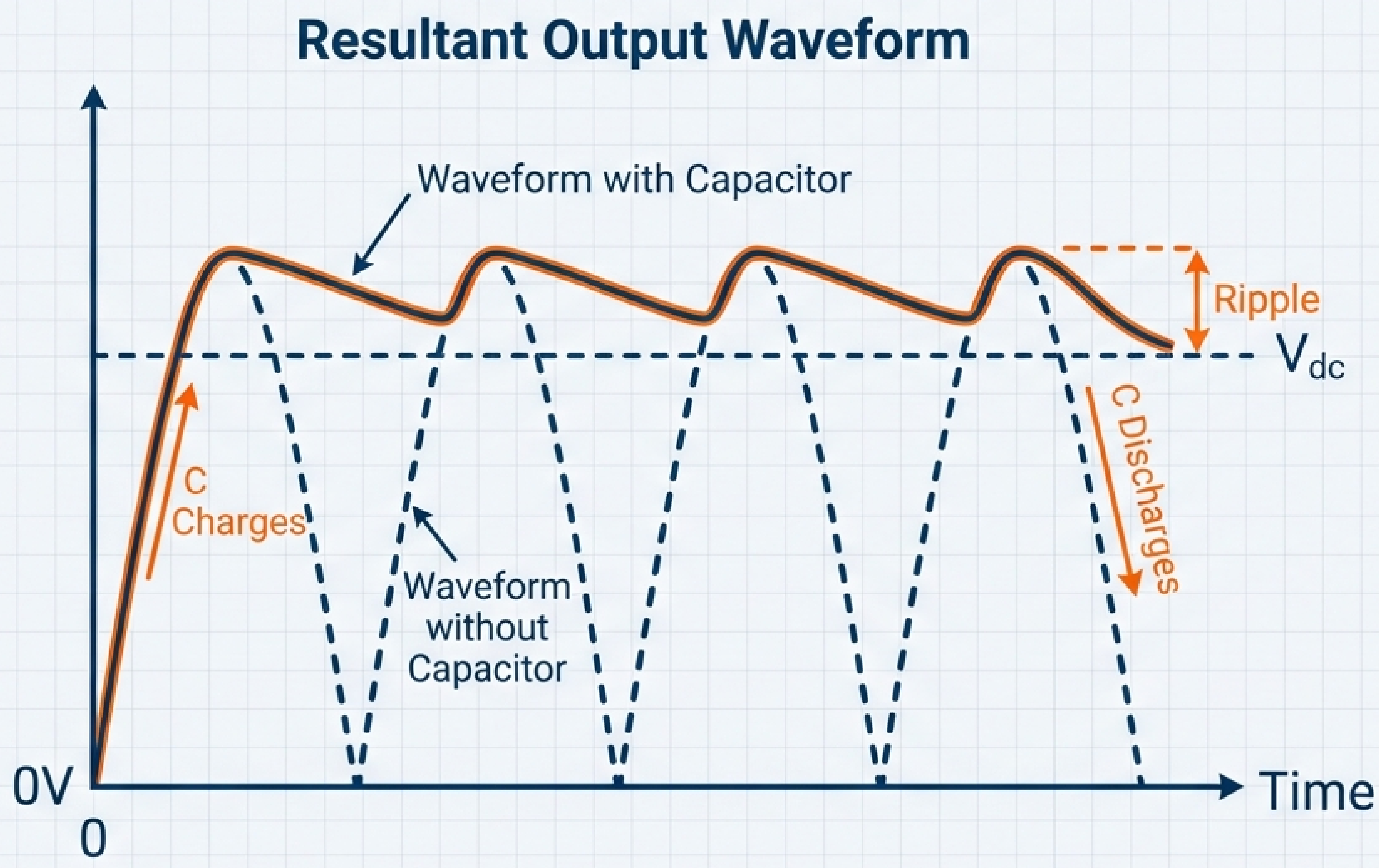
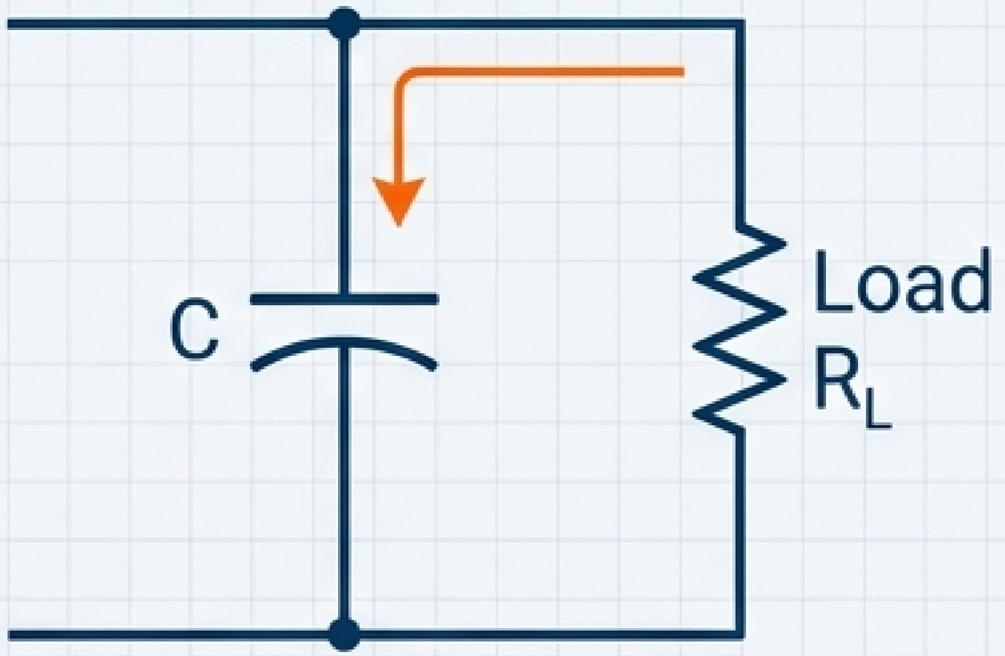
The Numbers: Half-Wave vs. Full-Wave

	Half-Wave	Full-Wave
Average DC Voltage (Vdc)	$0.318 \times Vpeak$	$0.637 \times Vpeak$ (Doubles)
Ripple Frequency	50Hz (Hard to smooth)	100Hz (Easier to smooth)
Efficiency	Low (Wasted Cycle) 	High 

Smoothing the Pulses

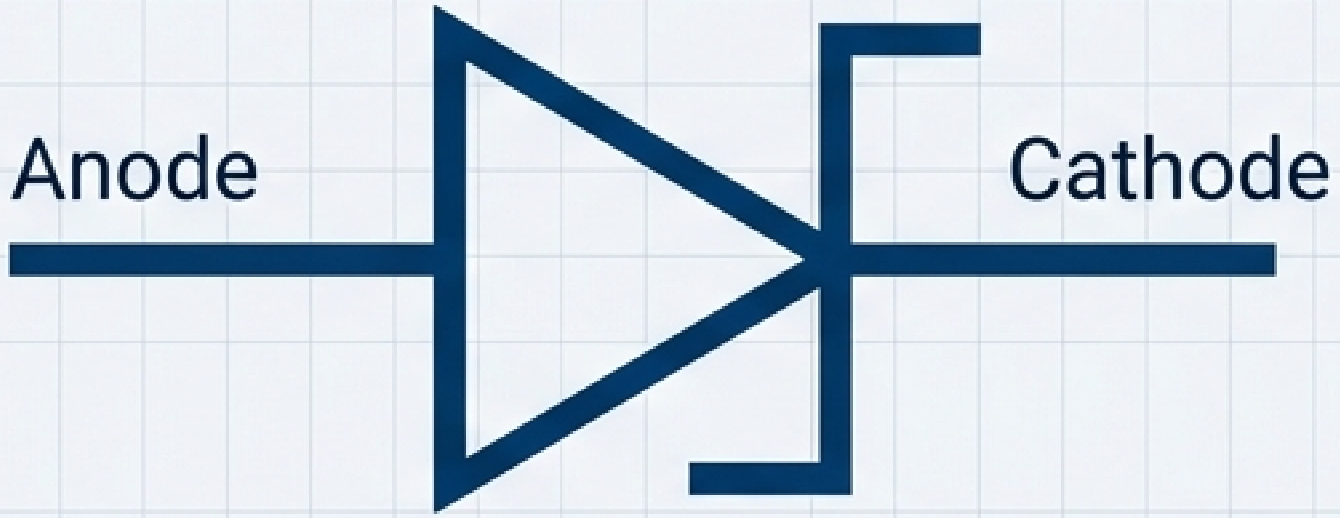


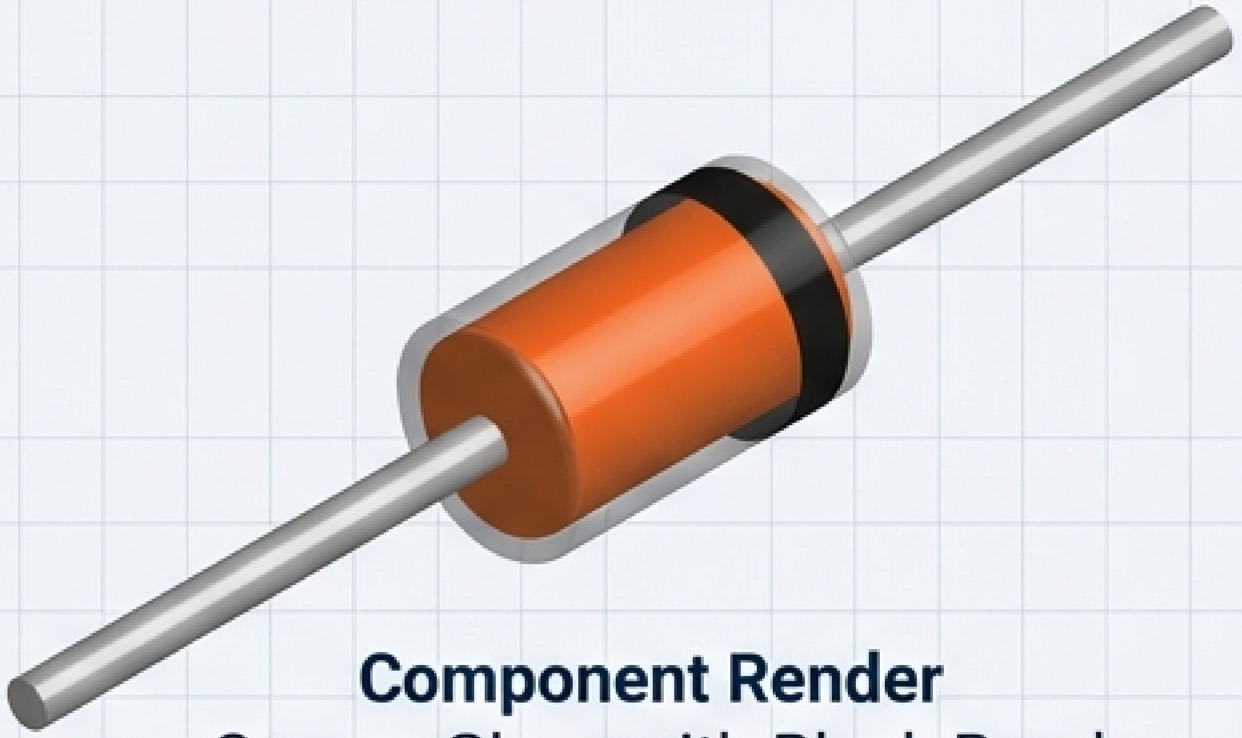


The Reservoir Effect: Capacitor charges on peak, discharges during drops.

Goal: Fill the valleys to create a steady line.

Precision Control: Voltage Regulation





Component Render
Orange Glass with Black Band

- **The Zener Diode:** Operates in **Reverse Breakdown**.
- **Analogy:** A **Pressure Relief Valve**.
- **Function:** **Clamps voltage** at a set level (e.g., 5.1V) regardless of input fluctuation.
- **Configuration:** Connected in **Reverse Bias** (Parallel to load).

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Calculating Zener Protection

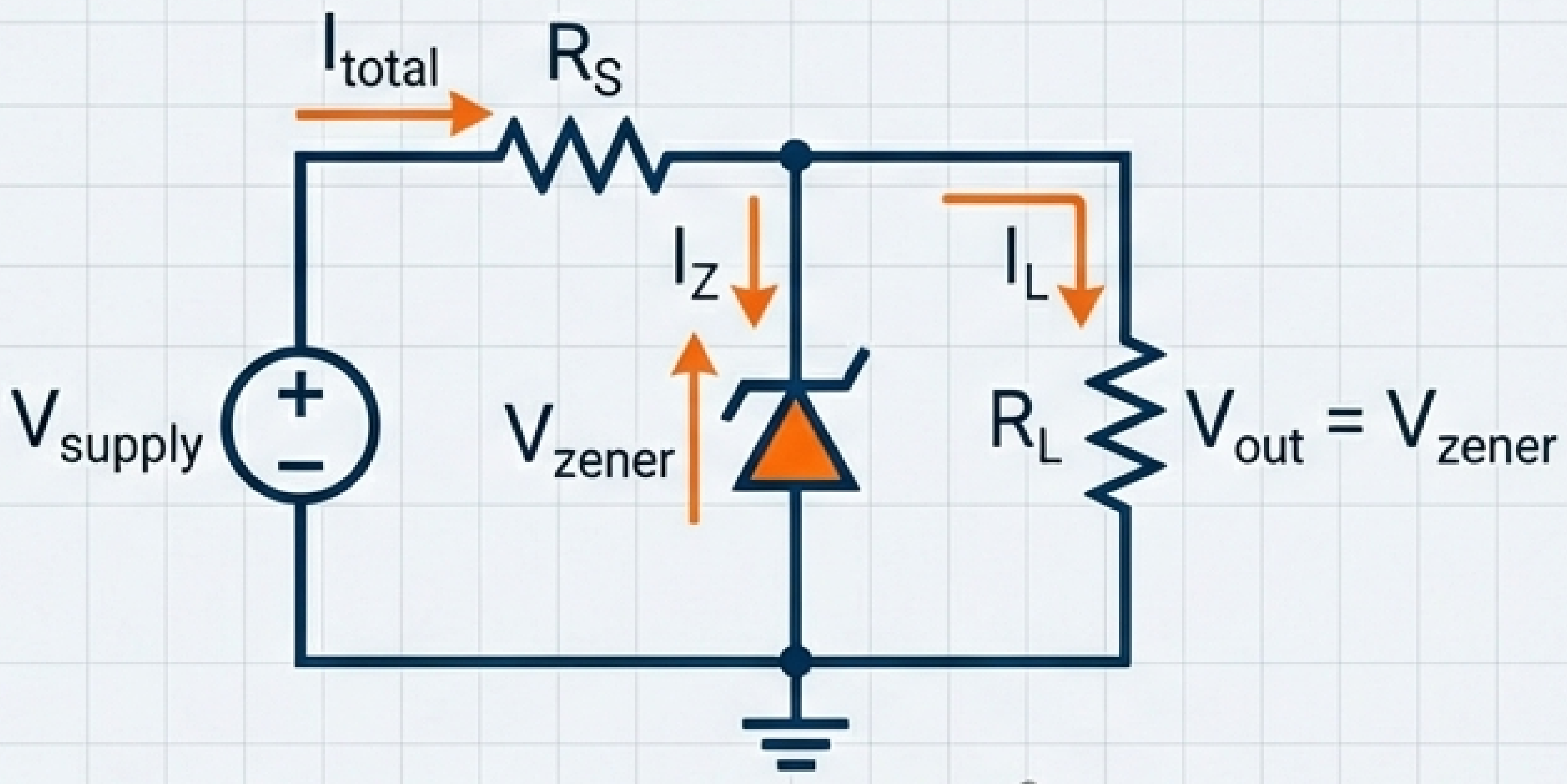
The Zener needs a **Series Resistor** (RS) to limit current and prevent destruction.

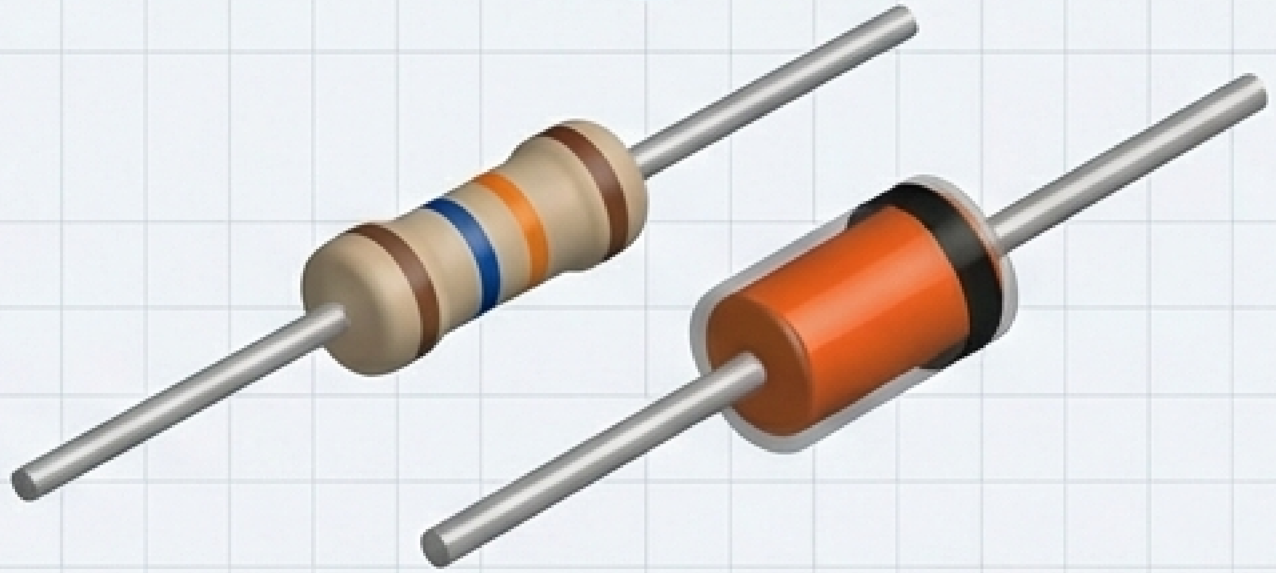
$$R_S = \frac{V_{supply} - V_{zener}}{I_{total}}$$

V_{supply}: Unregulated Input

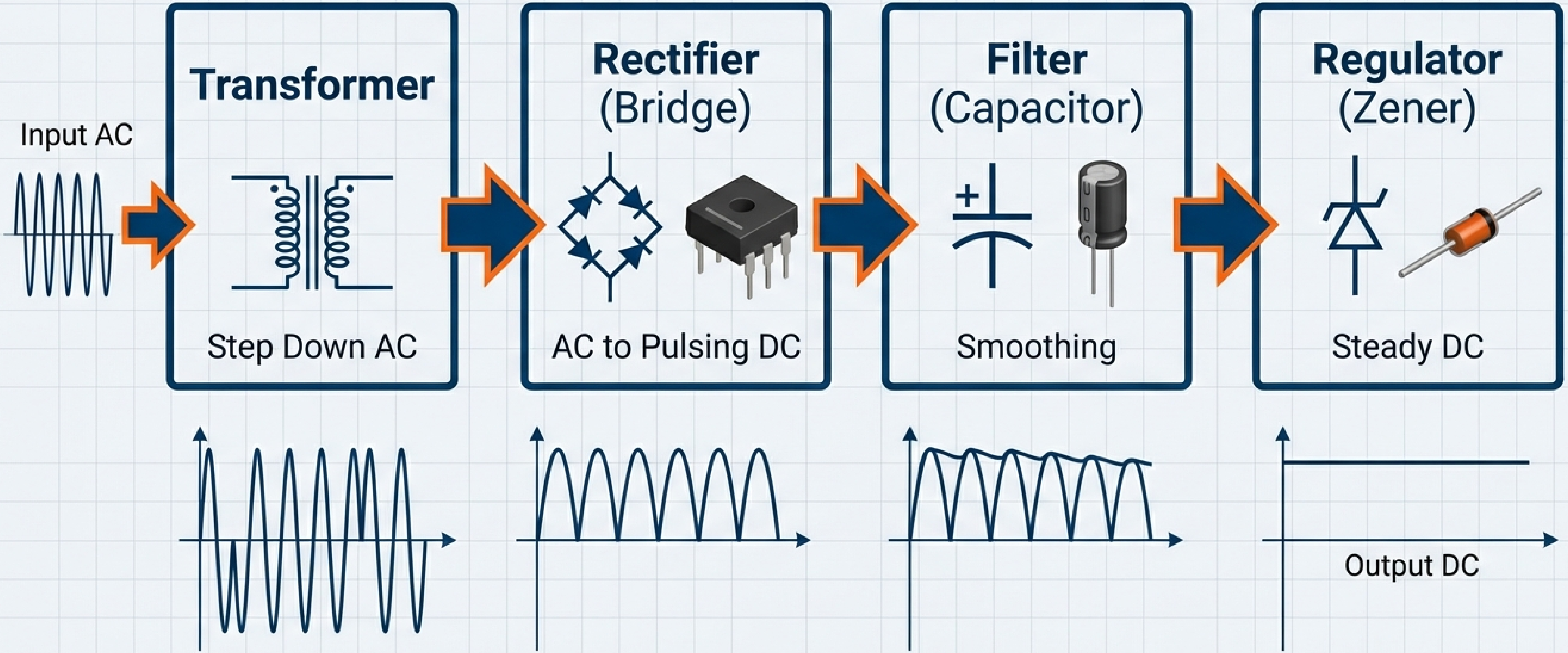
V_{zener}: Regulated Output

I_{total}: Total Circuit Current



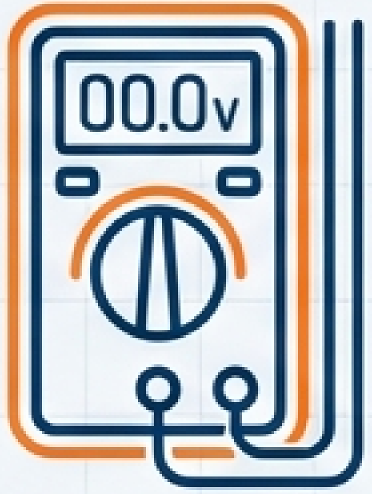


The Complete Power Supply Chain

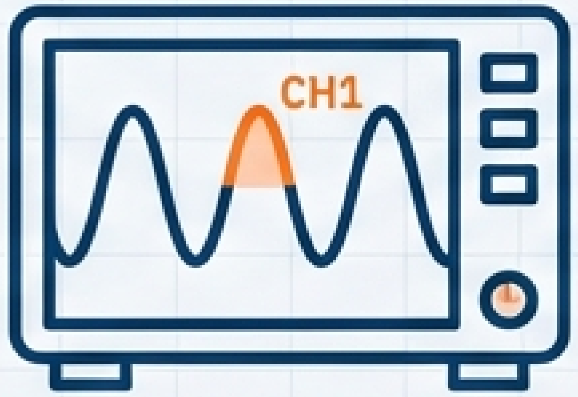


Fault Finding & Diagnostics

Tools



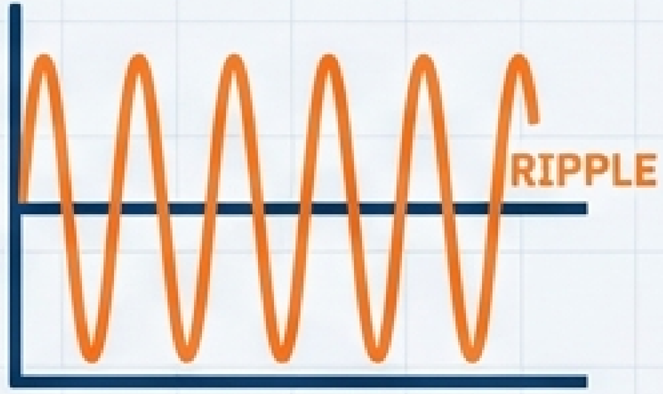
Digital Multimeter
Measures RMS voltage & Resistance.



Oscilloscope
Visualizes shape (Ripple, Distortion) & Peak Voltage.

Common Faults

Blown Fuse
Suspect Shorted Diode.

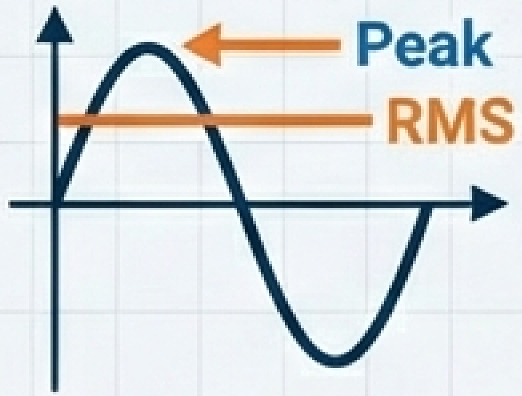


Low/Ripply Output
Suspect Open Capacitor or Open Diode.

Exam Note: $V_{peak} = Vrms \times 1.414$

Essential Formulas Cheat Sheet

RMS & Peak Voltage



$$V_{rms} = 0.707 \times V_{peak}$$

$$V_{peak} = 1.414 \times V_{rms}$$

DC Output Voltage

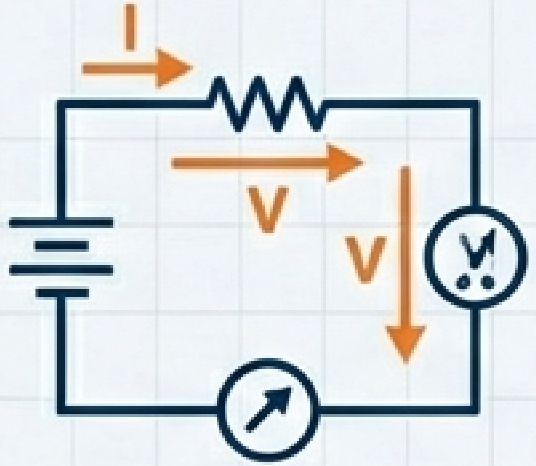
Half-Wave: $V_{dc} = 0.318 \times V_{peak}$

Full-Wave: $V_{dc} = 0.637 \times V_{peak}$

Fundamental Laws

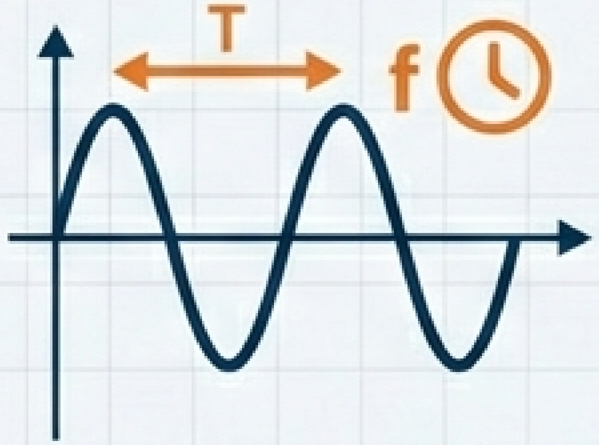
Ohm's Law: $I = V/R$

Power: $P = V \times I$

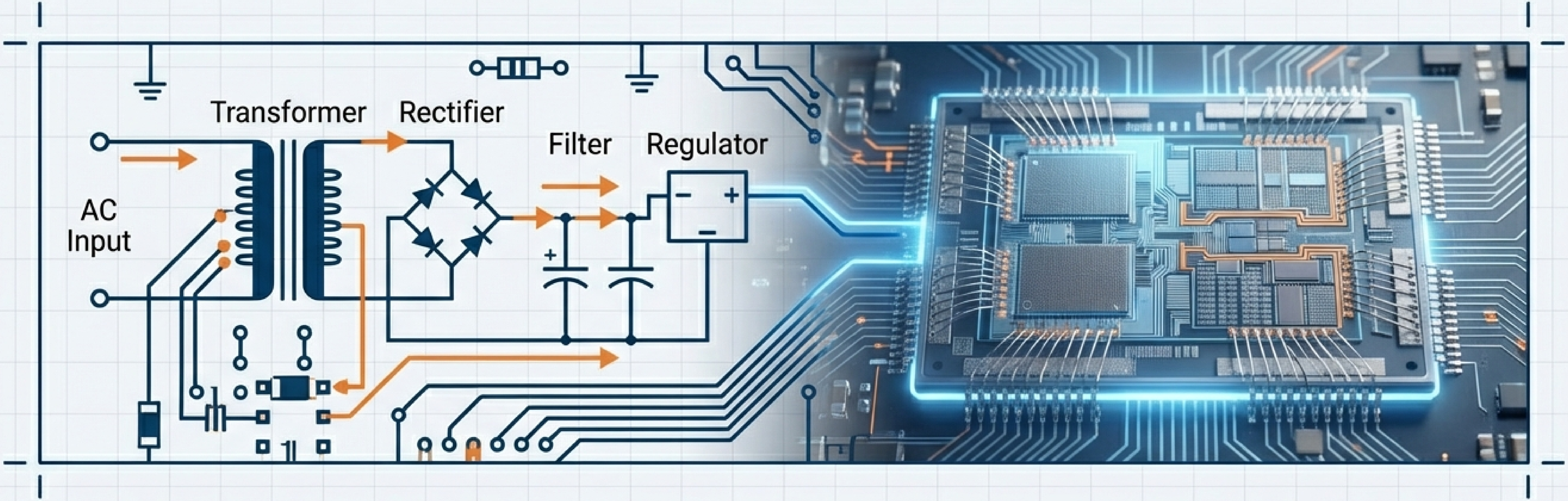


Frequency & Period

$$f = 1/T$$



Power Transformed



From dangerous AC to precision DC.

Process: Transformer → Rectifier → Filter → Regulator

Ready for Questions.

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