Converting AC to DC from the Wall

When you plug a power supply into the wall, you're getting AC (alternating current) at about 120V in North America or 230V in Europe. This AC voltage constantly switches direction 50-60 times per second. Here's how it gets converted:

Step 1: Voltage Transformation A transformer steps down the high AC voltage to a lower AC voltage that's closer to what you need. So 120V AC might get stepped down to 15V AC or 30V AC.

Step 2: Rectification Diodes convert the AC to pulsating DC. Think of diodes as one-way valves for electricity - they only let current flow in one direction. A bridge rectifier uses four diodes arranged in a diamond pattern to flip the negative portions of the AC wave upward, creating bumpy but positive DC.

Step 3: Filtering Large capacitors smooth out those bumps. Capacitors store electrical energy and release it during the gaps, like a water tank that fills up and provides steady flow even when the input is intermittent. This creates relatively smooth DC voltage.

Step 4: Regulation Voltage regulators maintain a constant output despite variations in input voltage or load changes. This is crucial for providing stable power.

How Adjustable Power Supplies Work

Now for your 30V/10A power supply that can output lower values - this involves sophisticated control circuits:

Switching Regulation (Most Modern Supplies) The power supply rapidly switches the DC on and off thousands of times per second using transistors as electronic switches. By varying how long the switch stays "on" versus "off" (called duty cycle), it controls the average voltage output.

- 50% on-time might give you 15V output
- 25% on-time might give you 7.5V output
- The switching happens so fast (20,000-100,000 times per second) that the output appears steady

Current Limiting The power supply continuously monitors how much current is flowing. It does this using current sense resistors - tiny precision resistors that create a small voltage drop proportional to current flow. When you set a current limit:

- The control circuit watches this voltage drop
- If current tries to exceed your setting, the circuit automatically reduces voltage to keep current at the limit
- This protects both the power supply and whatever you're powering

Feedback Control System The power supply uses feedback loops - it constantly measures its actual output and compares it to what you've set:

- If output voltage starts to drop (maybe because load increased), the control circuit increases the switching duty cycle
- If output tries to rise, it decreases the duty cycle
- This happens hundreds of thousands of times per second, maintaining precise control

User Interface When you turn the voltage knob or press buttons:

- You're adjusting a reference voltage in the control circuit
- This reference tells the feedback system what voltage to maintain
- The current limit works similarly - you're setting a reference current level

Constant Voltage vs Constant Current Modes

- In constant voltage mode: the supply maintains your set voltage and current varies based on load
- In constant current mode: if you hit the current limit, the supply reduces voltage to maintain that exact current
- Many supplies can operate in both modes automatically

Why This Works The key insight is that electrical loads will only draw the current they need at a given voltage. If you set 12V and connect a circuit that needs 2A, it will draw 2A. If your power supply can provide 10A, the extra 8A capacity just sits there unused - it's available if needed but doesn't get forced into the circuit.

This is why having a power supply with higher current capability than you need is safe, while having higher voltage capability requires careful setting to avoid damage.

Constant Voltage & Constant Current Power Supply Basics || CV and CC Mode

How does the power supply determine which mode it should be in?

Understanding Constant Voltage and Constant Current