Resistance ALWAYS matters - it's always active

Resistance doesn't turn "on" or "off" - it's a fundamental physical property that's always present. Think of it like the width of a pipe - it's always there affecting flow regardless of water pressure.

When insufficient voltage is applied (2V 1A to a 10V 2A circuit):

Resistance still matters completely! Here's what actually happens:

- The circuit still has its resistance (let's say 5 ohms)
- Current will flow according to Ohm's Law: $2V \div 5\Omega = 0.4A$
- Your 1A power supply is capable of providing more, but the circuit only draws 0.4A
- **The circuit doesn't work properly** because many components need minimum voltage thresholds to function, but resistance is still controlling the current flow

When excessive voltage is applied (15V 3A to a 10V 2A circuit):

Resistance is absolutely critical here:

- The circuit's resistance determines exactly how much current flows: $15V \div 5\Omega = 3A$
- This excess current is what actually destroys the components (they overheat from too much current)
- **Resistance determines the destruction rate** - lower resistance = more current = faster destruction

When correct voltage is applied (10V 2A to a 10V 2A circuit):

- Voltage is set at 10V (what you control)
- Circuit resistance is fixed at 5Ω (built into the circuit design)
- Current automatically settles at: 10V ÷ 5Ω = 2A (determined by Ohm's Law)
- Your power supply needs to be capable of providing at least 2A, but if it can provide 5A, only 2A will be used

The key insight:

Resistance is like a traffic cop that's always on duty - it controls current flow at ANY voltage level. The difference is:

- **Low voltage**: Resistance limits current to safe levels, but circuit doesn't function properly
- **Correct voltage**: Resistance allows proper current for normal operation
- **High voltage**: Resistance still controls current, but now that current is dangerously high

So resistance is always the "mediator" between voltage and current - it never stops mattering. The circuit damage from overvoltage happens precisely because resistance determines how much excess current flows through the components.

Current Limiting Mechanism

Power supplies monitor current flow using precision current-sensing resistors. When current approaches the set limit, a feedback control system automatically reduces voltage to maintain the current limit, protecting both the power supply and the connected circuit.

Practical Examples: Circuit Behavior Under Different Conditions

1. **5V 2A setting on 10V 2A circit**: CV mode at 5V 1A (because 5V ÷ 5Ω = 1A)
2. **5V 3A setting on 10V 2A circuit**: CV mode at 5V 1A (current limit not reached)
3. **10V 3A setting on 10V 2A circuit**: CV mode at 10V 2A (perfect match, current limit not reached)
4. **(15V 2A setting), it goes into CC mode, but let me clarify the details:**

Circuit Foundation

Manufacturer Specification: 10V, 2A **Calculated Circuit Resistance**: 10V ÷ 2A = **5Ω**

This 5Ω is a fixed physical property of the circuit - it doesn't change regardless of what power supply settings you choose. The resistance comes from all the internal components (resistors, wire resistance, semiconductor junction resistances, etc.) combined

Why This Understanding Matters

1. **Circuit resistance is determined by design, not power supply settings**
2. **Current always follows Ohm's Law for any applied voltage**
3. **Power supplies can only control voltage directly - current is a consequence**
4. **Current limiting works by automatically adjusting voltage to achieve the desired current**

This is why you can predict circuit behavior: once you know the resistance (calculated from rated specifications), you can determine the current at any voltage using Ohm's Law.

The power supply does NOT know the circuit's resistance beforehand

This is the key insight - the power supply is completely "blind" to what's connected to it. It doesn't measure or calculate the 5Ω resistance. Instead, it uses a real-time feedback system:

How Current Limiting Actually Works:

Step 1: Power supply tries to establish 15V

- It starts raising voltage toward the 15V you set
- As voltage rises, current begins flowing through your 5Ω circuit

Step 2: Continuous current monitoring

- Inside the power supply, there's a precision current-sensing resistor (very small, like 0.01Ω)
- ALL current flowing to your circuit must pass through this sensor
- The voltage drop across this sensor is proportional to current (Ohm's Law again)
- This creates a "current feedback signal"

Step 3: The control system kicks in

- When current reaches your 2A limit, the current sensor generates a specific voltage signal
- A comparator circuit compares this signal to your 2A setting
- The moment current tries to exceed 2A, the comparator triggers

Step 4: Automatic voltage reduction

- The control system immediately reduces the output voltage
- It keeps reducing until current drops back to exactly 2A
- Since your circuit is 5Ω, this happens when voltage reaches 10V ($2A \times 5\Omega = 10V$)

Step 5: Dynamic equilibrium

- The power supply now "settles" at 10V 2A
- If anything changes (temperature affects resistance, etc.), the system automatically adjusts
- It's constantly trying to reach 15V but being "held back" by the 2A current limit

The Beautiful Feedback Loop:

The power supply essentially asks: "Can I increase voltage without exceeding the current limit?"

- If yes → voltage goes up
- If no → voltage stays put or goes down
- This happens thousands of times per second

Real-world example of this feedback:

- You set 15V 2A and connect your 5Ω circuit
- Power supply output: 10V 2A (CV would have been 15V 3A, but CC kicked in)
- Now you disconnect half the circuit, making it 10Ω total
- Current drops to 1A at 10V
- Power supply thinks: "I can increase voltage now!"
- It raises to 15V, current becomes 1.5A (15V ÷ 10Ω)
- Still under 2A limit, so it stays at 15V

The power supply never "calculates" resistance - it just responds to what actually happens when it tries to deliver power.

This is why current limiting is so effective at protecting circuits - the power supply automatically finds the exact voltage that results in your desired current limit, regardless of what's connected to it.

#34 - Minleaf NPS605W - Part 2 - How does it perform? Let's take a look!