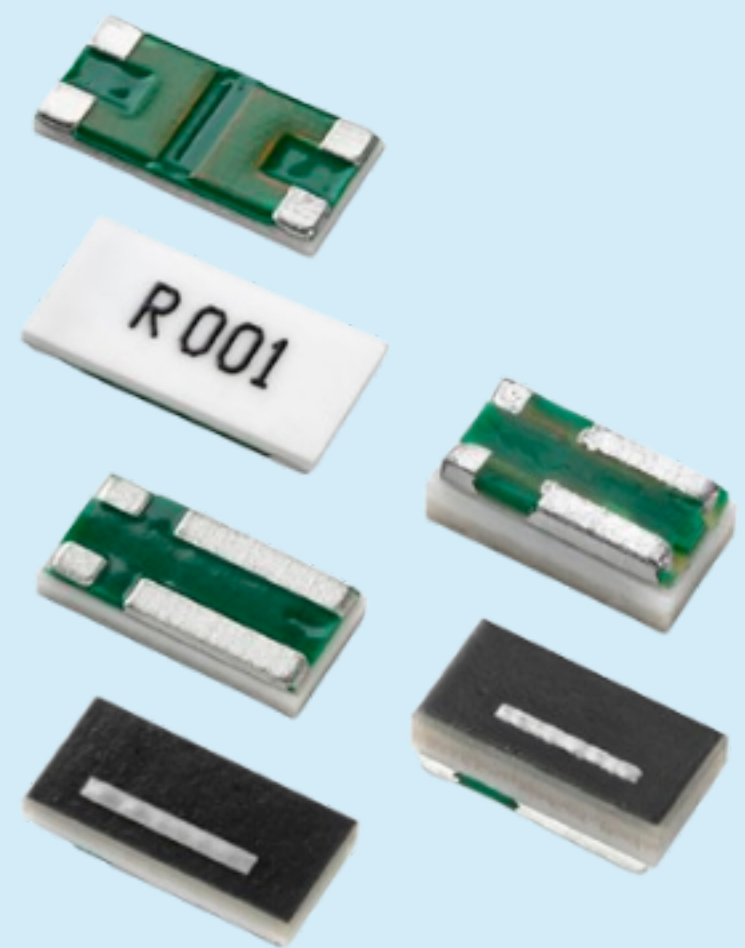
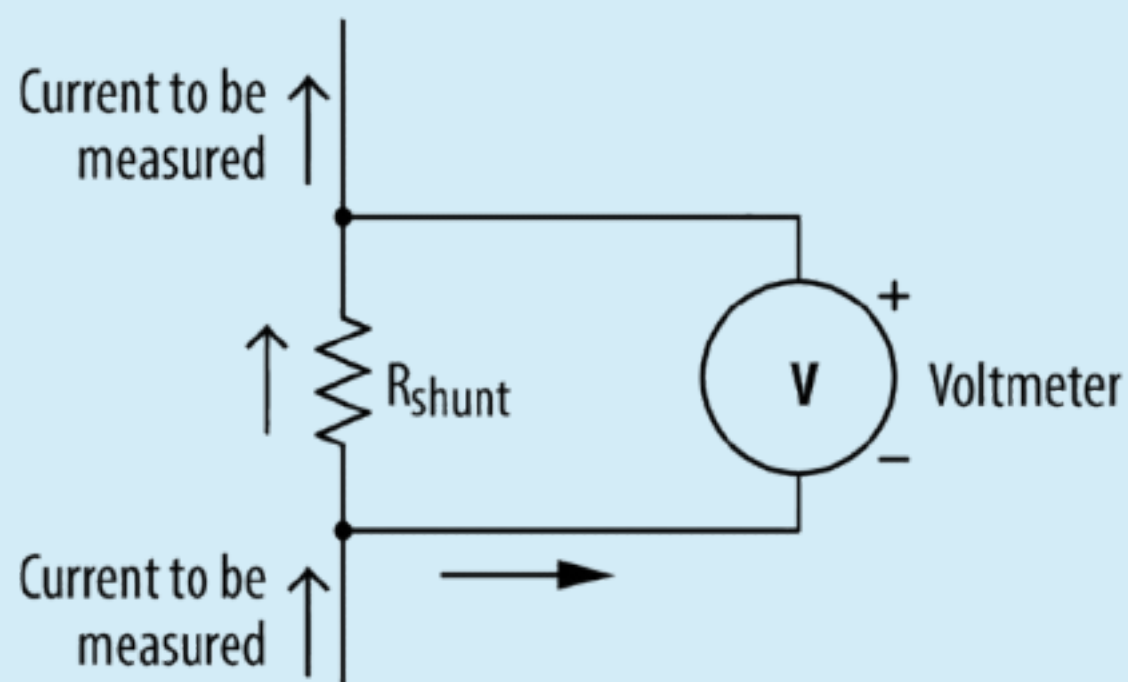


# Current Sense Resistors (Shunt Resistors)

Precision sensing for power control, feedback, and protection.

“You can’t control what you can’t measure.”  
And in electronics — current sensing starts here.



**Anup Mondal**  
Electrical Engineer

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1

# What is a **Current Sense Resistor**?

A low-value precision resistor used to measure current by detecting the **voltage drop** ( $V = I \times R$ ) across it.

Also known as a **shunt resistor** or **sense resistor**.

 Typical values: **0.1 mΩ to 1 Ω**

High accuracy, low temperature drift, and tight tolerance are critical.

## Working Principle

By Ohm's law:  $V_{\text{sense}} = I_{\text{load}} \times R_{\text{sense}}$

That voltage is amplified by:

- Op-amp current sense amplifiers
- Dedicated ICs (INA series, etc.)
- ADC inputs for current monitoring

# Placement in Circuit

## 1 High-Side Sensing:

- Placed between supply and load.
- Measures total load current.
- Needs high common-mode voltage amplifier.

## 2 Low-Side Sensing:

- Placed between load and ground.
- Simple, cost-effective.
- May cause ground disturbance.

# Key Design Parameters

Parameter	Description
Resistance (R)	Typically 0.1 mΩ–1 Ω
Power Rating (P)	( $P = I^2 \times R$ )
Tolerance	0.1%–1% for precision
TCR (ppm/°C)	Temperature Coefficient of Resistance
Package Type	1206, 2512, or metal-strip/4-terminal types

# Power & Thermal Considerations

Even small resistances can dissipate significant power.

Example:

$$I=10\text{A}, R=10\text{m}\Omega \Rightarrow P=1\text{W}$$

Use metal alloy or Kelvin-type resistors for accuracy.

Mount on thick copper planes for heat spreading.

# Types of Current Sense Resistors

- ◆ **Thick Film:** Low cost, moderate accuracy
- ◆ **Metal Film:** Better stability & TCR
- ◆ **Metal Strip / Foil:** High precision, low inductance
- ◆ **4-Terminal (Kelvin):** Accurate sensing by eliminating lead resistance

# Applications:

- ✓ Power supply current monitoring
- ✓ Battery management systems (BMS)
- ✓ Motor drive feedback loops
- ✓ DC-DC converter current limiting
- ✓ LED driver current regulation
- ✓ Energy meters & protection circuits



## Design Tips

- ✓ Select the smallest  $R$  that provides measurable voltage (50–200 mV typical).
- ✓ Ensure the resistor can handle  $I^2R$  power loss safely.
- ✓ Minimize parasitic inductance for fast transient measurements.
- ✓ For precision, use Kelvin connections and low-TCR materials.

# Key Takeaways:

⚡ The **Current Sense Resistor** is the *eyes of your power system*.

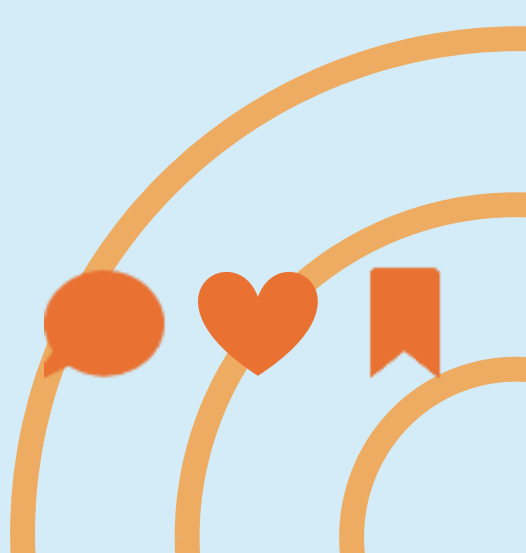
It translates current into voltage — enabling control, protection, and efficiency.

*In high-performance designs, accuracy and thermal stability make all the difference.*

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