

Poynting Vector

Electrical Engineering

Where electromagnetic power flows, and how much crosses a square metre.

The Poynting vector gives the direction and the density of electromagnetic power flow.

$$\mathbf{S} = \mathbf{E} \times \mathbf{H} \cdot \mathbf{S}_{\text{avg}} = |\mathbf{E}|^2 / (2\eta)$$

1 V/m in free space

$|\mathbf{E}|^2 \div 2\eta_0$

1.33 mW/m²

Direction of $\mathbf{S}$

Right-hand rule.

$\mathbf{E}$ crossed into $\mathbf{H}$

Into a conductor

Power absorbed.

$\mathbf{S}$ points inward

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✗ **Reading $\mathbf{S}$ as the energy stored in the field**

✓ **$\mathbf{S}$ is a flow, in watts per square metre**

Stored energy density is $\frac{1}{2}\epsilon\mathbf{E}^2 + \frac{1}{2}\mu\mathbf{H}^2$, a different quantity with different units.
The Poynting vector describes transport, not storage.

Power in a coaxial cable travels through the dielectric between the conductors, not inside the copper. The copper only guides it.