Transformer Voltage Regulation at Any Load and Power Factor

Voltage regulation of a transformer from its percentage resistance and reactance, the load and power factor (lagging or leading), with the secondary voltage.

Method: Approximate regulation formula ε = a(ε_r cos φ + ε_x sin φ) + [a(ε_x cos φ − ε_r sin φ)]²/200 (in %; M.G. Say, Performance and Design of AC Machines)

Input parameters

Unit system: SI

Parameter	Value	Unit
Percentage resistance (copper loss / rating)	1.2000	%
Percentage reactance	4.5000	%
Load as a share of rating	100.00	%
Load power factor	0.80000	
Load is	Lagging (inductive)	
No-load secondary voltage	433.00	V

Calculated results

Parameter	Value	Unit
Percentage impedance	4.6573	%
Voltage regulation	3.7015	%
Secondary voltage on load	416.97	V
Voltage drop	16.027	V

Notes for this case

- Regulation is the fall from no-load to on-load voltage, as a share of the no-load (rated) voltage.

Formula and method

$$\varepsilon = a(\varepsilon_r \cos\varphi \pm \varepsilon_x \sin\varphi) + \frac{[a(\varepsilon_x \cos\varphi \mp \varepsilon_r \sin\varphi)]^2}{2}$$

Variables

ε_r	Percentage resistance (copper loss / rating)	-
ε_x	Percentage reactance	-
a	Load as a share of rating	-
$\cos\varphi$	Load power factor	-
load	Load is	-
$V_{2,0}$	No-load secondary voltage	V
ε_z	Percentage impedance	-
$\mathcal{E}$	Voltage regulation	-
V_2	Secondary voltage on load	V
ΔV	Voltage drop	V

Method and standards

Per-unit phasor diagram of the equivalent circuit, expanded to second order (+ for lagging, − for leading).

Assumptions and limits

- Per-unit values on the transformer rating.

References

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Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/transformers/transformer-voltage-regulation

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Reopens the calculator with the inputs of this report.