Medium Transmission Line: Nominal-π Model

Sending-end voltage, current, power factor, regulation and efficiency of a medium-length line by the nominal-π model with half the line capacitance at each end.

Method: Stevenson and Grainger; Power System Analysis (McGraw-Hill, 1994); Kothari and Nagrath; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Receiving-end line voltage	132.00	kV
Load power	50.000	MW
Load power factor (lagging)	85.000	%
Total resistance per phase	15.000	Ω
Total reactance per phase	50.000	Ω
Total shunt susceptance per phase, in siemens	3.5000e-04	

Calculated results

Parameter	Value	Unit
Sending-end line voltage	149.10	kV
Sending-end current	242.13	A
Sending-end power factor	0.84477	
Voltage regulation	13.951	%
Efficiency	94.654	%

Notes for this case

• Nominal-π: valid for about 80–250 km. Regulation uses the no-load receiving voltage V_S/|1 − XB/2|, with the exact |A| = |1 + YZ/2| (Ferranti rise).

Formula and method

$$\vec{I}_L = \vec{I}_R + j\frac{B}{2}\vec{V}_R, \quad \vec{V}_S = \vec{V}_R + \vec{I}_L(R + jX), \quad \vec{I}_S = \vec{I}_L + j\frac{B}{2}\vec{V}_S$$

Variables

V_R	Receiving-end line voltage	V
P	Load power	W
$\cos\phi$	Load power factor (lagging)	-
R	Total resistance per phase	Ω
X	Total reactance per phase	Ω
B	Total shunt susceptance per phase (S)	-
V_S	Sending-end line voltage	V
I_S	Sending-end current	A
$\cos\phi_S$	Sending-end power factor	-
Reg	Voltage regulation	-
η	Efficiency	-

Method and standards

Nominal-π equations.

Assumptions and limits

- Balanced; lumped parameters. The no-load receiving voltage is V_S/|A| with A = 1 + YZ/2 = 1 − XB/2 + jRB/2.
- B is entered in siemens in every unit system.

References

- Stevenson and Grainger
- Power System Analysis (McGraw-Hill, 1994); Kothari and Nagrath
- Modern Power System Analysis
- 4th ed. (2011) (medium line, nominal-π)

Report details

Report reference	FCC-1QQY-KB4T (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Medium Transmission Line: Nominal-π Model
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 reference cases of this calculator, computed independently, are checked on every release

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This calculator online

https://calc.firecad.com/electrical/power/medium-line-nominal-pi

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