Long Transmission Line: Exact ABCD Parameters and Performance

Sending-end voltage, current, power factor, efficiency and regulation of a long line from per-km R, L and C by the exact hyperbolic ABCD constants.

Method: Distributed-parameter (hyperbolic) long-line equations

Input parameters

Unit system: SI

Parameter	Value	Unit
Receiving-end line voltage	400.00	kV
Load power	300.00	MW
Load power factor (lagging)	90.000	%
Resistance per phase per km	0.030000	Ω/km
Inductance per phase per km	1.0000	mH/km
Capacitance per phase per km	11.500	nF/km
Line length	350.00	km
Frequency	50.000	Hz

Calculated results

Parameter	Value	Unit
Characteristic (surge) impedance	295.55	Ω
Electrical length |γℓ|	0.37373	
Magnitude of A = cosh γℓ	0.93130	
Sending-end line voltage	426.54	kV
Sending-end current	414.50	A
Sending-end power factor	0.99927	
Efficiency	98.039	%
Voltage regulation	14.500	%
Surge impedance loading	541.36	MW

Notes for this case

• Exact distributed-parameter model: A = D = cosh γℓ, B = Z_c sinh γℓ, C = sinh γℓ / Z_c, per phase with balanced load. Shunt conductance is neglected. Regulation uses the receiving voltage at no load, V_S/|A| (Ferranti rise).

Formula and method

$$\gamma = \sqrt{zy}, \quad Z_c = \sqrt{z/y}, \quad A = D = \cosh \gamma\ell, \quad B = Z_c \sinh \gamma\ell, \quad C = \frac{\sinh \gamma\ell}{Z_c}$$

$$V_S = AV_R + BI_R, \quad I_S = CV_R + AI_R$$

Variables

V_R	Receiving-end line voltage	V
P	Load power	W
$\cos\phi$	Load power factor (lagging)	-
r	Resistance per phase per km	Ω/m

l	Inductance per phase per km	H/m
c	Capacitance per phase per km	F/m
ℓ	Line length	m
f	Frequency	1/s
	Z_c	$
	\gamma\ell	$
	A	$
V_S	Sending-end line voltage	V
I_S	Sending-end current	A
$\cos\phi_S$	Sending-end power factor	-
η	Efficiency	-
Reg	Voltage regulation	-
SIL	Surge impedance loading	W

Method and standards

Exact hyperbolic solution of the telegrapher's equations.

Assumptions and limits

- Balanced three-phase, steady state, uniform line, shunt conductance neglected.

References

Distributed-parameter (hyperbolic) long-line equations

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

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Reopens the calculator with the inputs of this report.