Surge Impedance and Surge Impedance Loading

Surge (characteristic) impedance and surge impedance loading (natural load) of a line or cable from its inductance and capacitance per km, with wave velocity.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Line voltage	220.00	kV
Inductance (mH/km)	1.0000	
Capacitance (nF/km)	11.500	

Calculated results

Parameter	Value	Unit
Surge impedance	294.88	Ω
Surge impedance loading	164.13	MW
Wave velocity	294,884	km/s

Notes for this case

• At SIL, reactive power generated by line capacitance equals that absorbed by its inductance and voltage is flat along the line. Overhead lines are about 300–400 Ω; cables 30–60 Ω.

Formula and method

$$Z_c = \sqrt{\frac{L'}{C'}}, \quad SIL = \frac{V^2}{Z_c}, \quad v_w = \frac{1}{\sqrt{L'C'}}$$

Variables

V	Line voltage	V
L'	Inductance (mH/km)	-
C'	Capacitance (nF/km)	-
Z_c	Surge impedance	Ω
SIL	Surge impedance loading	W
v_w	Wave velocity	m/s

Method and standards

Lossless line.

Assumptions and limits

- Lossless line (R and G neglected). L' is entered in mH/km and C' in nF/km; the page warns if their product gives a wave velocity above the speed of light, which means the two values are inconsistent.
- Lossless line.

References

• Stevenson and Grainger
• Power System Analysis (McGraw-Hill, 1994); Kothari and Nagrath
• Modern Power System Analysis
• 4th ed. (2011) (Z_c = √(L/C), SIL = V²/Z_c)

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/electrical/power/surge-impedance-loading

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.