Cable Short-Circuit Withstand (Adiabatic Equation)

Short-circuit current a copper or aluminium conductor withstands for a time by the adiabatic equation $I^2t = k^2S^2$, with k from the temperatures, and the size needed.

Method: IEC 60949:1988 (adiabatic short-circuit calculation; material constants of Table I)

Input parameters

Unit system: SI

Parameter	Value	Unit
Conductor	Copper	
Conductor cross-section	95.000	mm²
Duration of the fault	1.0000	s
Conductor temperature before the fault	90.000	°C
Highest temperature allowed at the end of the fault From your cable's insulation data (cable standard or maker).	250.00	°C
Fault current, RMS symmetrical (to find the size needed)	20.000	kA

Calculated results

Parameter	Value	Unit
Factor k (A·s^½/mm²)	142.87	
Current the conductor withstands for the time	13.573	kA
Smallest cross-section for the fault current	139.98	mm²

Notes for this case

• Adiabatic: no heat leaves the conductor during the fault, which is safe for faults up to about 5 s. Screens, armour and joints have their own limits.

Formula and method

$$k = \sqrt{\frac{Q_c(\beta+20)}{\rho_{20}} \ln\frac{\beta+\theta_f}{\beta+\theta_i}}, \quad I_{max} = \frac{k\,S}{\sqrt{t}}, \quad S_{min} = \frac{I_k\sqrt{t}}{k}$$

Variables

metal	Conductor	-
S	Conductor cross-section	m²
t	Duration of the fault	s
θ_i	Conductor temperature before the fault	K
θ_f	Highest temperature allowed at the end of the fault	K
I_k	Fault current, RMS symmetrical (to find the size needed)	A
k	Factor k (A·s^½/mm²)	-
I_{max}	Current the conductor withstands for the time	A
S_{min}	Smallest cross-section for the fault current	m²

Method and standards

All the fault energy heats the conductor; resistance rises with temperature.

Assumptions and limits

- Adiabatic; conductor only.
- I_k is the RMS symmetrical current; the DC component is neglected. For faults shorter than about 0.1 s the asymmetry matters: use the protective device's let-through I^2t instead.

References

- IEC 60949:1988 (adiabatic short-circuit calculation; material constants of Table I)

Report details

Report reference	FCC-GRJM-BFAW (the same inputs always give the same reference)
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Release checks	3 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/cables/cable-short-circuit-withstand

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.