Peltier (Thermoelectric) Cooler Capacity and COP

Cooling capacity, electrical input and COP of a Peltier module at a current and temperatures, with the best current and the largest temperature difference.

Method: Thermoelectric cooling couple model

Input parameters

Unit system: SI

Parameter	Value	Unit
Current	4.0000	A
Hot-side temperature	40.000	°C
Cold-side temperature	10.000	°C
Seebeck coefficient per couple	400.00	µV/K
Electrical resistance per couple	0.010000	Ω
Thermal conductance per couple	5.0000e-06	kW/K
Couples	127.00	

Calculated results

Parameter	Value	Unit
Cooling capacity	0.028326	kW
Electrical input	0.026416	kW
Coefficient of performance	1.0723	
Module voltage	6.6040	V
Current for maximum cooling S T_c/R	11.326	A
Largest temperature difference ½ZT_c²	128.28	K

Notes for this case

• Q_c = n(SIT_c − ½I²R − KΔT), P = n(SIΔT + I²R). Negative Q_c means the module cannot hold that temperature difference at this current. COP is typically 0.3–1, far below vapour-compression; Peltier coolers suit small loads, precise control and no moving parts.

Formula and method

$$\dot{Q}_c = n\left(SIT_c - \frac{1}{2}I^2R - K\Delta T\right), \quad P_{in} = n\left(SI\Delta T + I^2R\right), \quad \Delta T_{max} = \frac{1}{2}ZT_c^2$$

Variables

I	Current	A
T_h	Hot-side temperature	K
T_c	Cold-side temperature	K
S	Seebeck coefficient per couple	V/K
R	Electrical resistance per couple	Ω
K	Thermal conductance per couple	W/K
n	Couples	-
$\dot{Q}_c$	Cooling capacity	W
P_{in}	Electrical input	W
COP	Coefficient of performance	-
V	Module voltage	V

I_{max}	Current for maximum cooling S T_c/R	A
ΔT_{max}	Largest temperature difference ½ZT_c²	K

Method and standards

Peltier cooling.

Assumptions and limits

- Constant properties; ideal heat sinks.

References

Thermoelectric cooling couple model

Report details

Report reference	FCC-9VGY-5F4A (the same inputs always give the same reference)
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Calculator	Peltier (Thermoelectric) Cooler Capacity and COP
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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/electronics/peltier-cooler-cop

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.