Battery Heat Generation and Temperature Rise

Irreversible (Joule) and reversible (entropic) heat of a battery cell and pack at a current, and the adiabatic temperature rise rate from the pack mass.

Method: Bernardi battery heat generation

Input parameters

Unit system: SI

Parameter	Value	Unit
Cell current (positive discharge)	50.000	A
Cell internal resistance	0.002000	Ω
Cell temperature	25.000	°C
Entropic coefficient of open-circuit voltage (V/K)	-1.0000e-04	
Cells in the pack	96.000	
Pack mass	300.00	kg
Pack specific heat	1.0000	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Joule heat per cell	0.005000	kW
Reversible heat per cell	0.001491	kW
Total heat per cell	0.006491	kW
Pack heat	0.62311	kW
Adiabatic temperature rise rate	0.002077	K/s

Notes for this case

- Bernardi form: Q = I²R − IT(dU/dT) with I positive on discharge. The reversible term changes sign between charge and discharge and matters at low C-rates; Joule heat dominates at high rates. The temperature rise rate assumes no cooling.

Formula and method

$$\dot{Q} = I^2 R - IT\frac{dU}{dT}, \quad \frac{dT}{dt} = \frac{n\dot{Q}}{mc_p}$$

Variables

I	Cell current (positive discharge)	A
R	Cell internal resistance	Ω
T	Cell temperature	K
dU/dT	Entropic coefficient of open-circuit voltage (V/K)	-
n	Cells in the pack	-
m	Pack mass	kg
c_p	Pack specific heat	J/(kg·K)
$\dot{Q}_{irr}$	Joule heat per cell	W
$\dot{Q}_{rev}$	Reversible heat per cell	W
$\dot{Q}$	Total heat per cell	W
$\dot{Q}_{pack}$	Pack heat	W

dT/dt	Adiabatic temperature rise rate	K/s

Method and standards

Battery heat.

Assumptions and limits

- Uniform temperature; constant properties.

References

Bernardi battery heat generation

Report details

Report reference	FCC-YDXN-66Z5 (the same inputs always give the same reference)
Generated	23 November 2026, 18:08 UTC
Calculator	Battery Heat Generation and Temperature Rise
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/batteries-ups/battery-heat-generation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.