Semiconductor Conductivity: Intrinsic and Doped

Intrinsic carrier concentration at a temperature from its 300 K value and band gap, intrinsic and n-type conductivity and resistivity from carrier mobilities.

Method: Intrinsic and extrinsic carrier statistics

Input parameters

Unit system: SI

Parameter	Value	Unit
Intrinsic carrier concentration at 300 K (per m³)	1.0000e+16	
Band gap	1.1200	eV
Temperature	100.00	°C
Electron mobility (m²/V·s)	0.14000	
Hole mobility (m²/V·s)	0.045000	
Donor concentration (per m³, 0 for intrinsic)	1.0000e+21	

Calculated results

Parameter	Value	Unit
Intrinsic carriers at T (per m³)	9.6905e+17	
Intrinsic conductivity	0.028723	S/m
Intrinsic resistivity	34.815	Ω·m
Doped (n-type) conductivity	22.431	S/m
Doped resistivity	0.044582	Ω·m

Notes for this case

• n_i ∝ T^{3/2}exp(−E_g/2kT), scaled from its 300 K value; σ = q(nμ_e + pμ_h). With donors fully ionised, n = N_d/2 + √(N_d²/4 + n_i²) and p = n_i²/n, which covers both the extrinsic range and the intrinsic range at high temperature. Mobilities are taken as constant; in practice they fall with temperature and doping (lattice and impurity scattering).

Formula and method

$$n_i = n_{i,300}\left(\frac{T}{300}\right)^{3/2}\exp\left[-\frac{E_g}{2k}\left(\frac{1}{T}-\frac{1}{300}\right)\right], \quad \sigma = q(n\mu_e + p\mu_h)$$

Variables

$n_{i,300}$	Intrinsic carrier concentration at 300 K (per m³)	-
E_g	Band gap	J
T	Temperature	K
μ_e	Electron mobility (m²/V·s)	-
μ_h	Hole mobility (m²/V·s)	-
N_d	Donor concentration (per m³, 0 for intrinsic)	-
n_i	Intrinsic carriers at T (per m³)	-
σ_i	Intrinsic conductivity	S/m
ρ_i	Intrinsic resistivity	Ω·m
σ_n	Doped (n-type) conductivity	S/m
ρ_n	Doped resistivity	Ω·m

Method and standards

Conductivity.

Assumptions and limits

- Non-degenerate; full donor ionisation; constant mobilities and band gap.

References

Intrinsic and extrinsic carrier statistics

Report details

Report reference	FCC-1TMA-1KVM (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Semiconductor Conductivity: Intrinsic and Doped
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/materials/properties/semiconductor-conductivity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.