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Semiconductor Characteristics Formulas

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List of 13 Semiconductor Characteristics Formulas

Semiconductor Characteristics

1) Conductivity in Semiconductors

$$\text{fx } \sigma = (\rho_e \cdot [\text{Charge-e}] \cdot \mu_n) + (\rho_h \cdot [\text{Charge-e}] \cdot \mu_p)$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)
ex

$$0.868062\text{S/m} = (3.01\text{e}10\text{kg/cm}^3 \cdot [\text{Charge-e}] \cdot 180\text{m}^2/\text{V}^*\text{s}) + (100000.345\text{kg/cm}^3 \cdot [\text{Charge-e}] \cdot 150\text{m}^2/\text{V}^*\text{s})$$

2) Conductivity of Extrinsic Semiconductor for P-Type

$$\text{fx } \sigma_p = N_a \cdot [\text{Charge-e}] \cdot \mu_p$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)
ex

$$0.240326\text{S/m} = 1\text{e}16/\text{m}^3 \cdot [\text{Charge-e}] \cdot 150\text{m}^2/\text{V}^*\text{s}$$

3) Conductivity of Extrinsic Semiconductors for N-type

$$\text{fx } \sigma_n = N_d \cdot [\text{Charge-e}] \cdot \mu_n$$

[Open Calculator !\[\]\(235bfe13ebf007ce2eea9e689707fac7_img.jpg\)](#)
ex

$$5.767836\text{S/m} = 2\text{e}17/\text{m}^3 \cdot [\text{Charge-e}] \cdot 180\text{m}^2/\text{V}^*\text{s}$$

4) Drift Current Density

$$\text{fx } J_{\text{drift}} = J_p + J_n$$

[Open Calculator !\[\]\(a73c1962d20a39dd8fd6a060ae69693f_img.jpg\)](#)
ex

$$49.79\text{A/m}^2 = 17.79\text{A/m}^2 + 32\text{A/m}^2$$

5) Electric Field due to Hall Voltage

$$\text{fx } E_H = \frac{V_h}{d}$$

[Open Calculator !\[\]\(b9742ff0bb3da904abeeee81c2bcb456_img.jpg\)](#)
ex

$$1.888889\text{V/m} = \frac{0.85\text{V}}{0.45\text{m}}$$


6) Electron Diffusion Length

$$\text{fx } L_n = \sqrt{D_n \cdot \tau_n}$$

[Open Calculator !\[\]\(4a60014e8c124e85ae27c7d200855f3f_img.jpg\)](#)
ex

$$44.99123\text{cm} = \sqrt{44982.46\text{cm}^2/\text{s} \cdot 45000\mu\text{s}}$$



7) Energy Band Gap 

$$\text{fx } E_g = E_{G0} - (T \cdot \beta_k)$$

Open Calculator 

$$\text{ex } 0.765601\text{eV} = 0.87\text{eV} - (290\text{K} \cdot 5.7678\text{e-}23\text{J/K})$$

8) Fermi Dirac Distribution Function 

$$\text{fx } f_E = \frac{1}{1 + e^{\frac{E_f - E_f}{|BoltZ| \cdot T}}}$$

Open Calculator 

$$\text{ex } 0.5 = \frac{1}{1 + e^{\frac{52\text{eV} - 52\text{eV}}{|BoltZ| \cdot 290\text{K}}}}$$

9) Fermi Level of Intrinsic Semiconductors 

$$\text{fx } E_{Fi} = \frac{E_c + E_v}{2}$$

Open Calculator 


$$\text{ex } 2.63\text{eV} = \frac{0.56\text{eV} + 4.7\text{eV}}{2}$$

10) Majority Carrier Concentration in Semiconductor 

$$\text{fx } n_0 = \frac{n_i^2}{p_0}$$

Open Calculator 

$$\text{ex } 1.6\text{E}^8/\text{m}^3 = \frac{(1.2\text{e}8/\text{m}^3)^2}{9.1\text{e}7/\text{m}^3}$$

11) Majority Carrier Concentration in Semiconductor for p-type 

$$\text{fx } n_0 = \frac{n_i^2}{p_0}$$

Open Calculator 

$$\text{ex } 1.6\text{E}^8/\text{m}^3 = \frac{(1.2\text{e}8/\text{m}^3)^2}{9.1\text{e}7/\text{m}^3}$$


12) Mobility of Charge Carriers 

$$\text{fx } \mu = \frac{V_d}{E}$$

Open Calculator 

$$\text{ex } 2.987165\text{m}^2/\text{V}^*\text{s} = \frac{10.24\text{m/s}}{3.428\text{V/m}}$$



13) Saturation Voltage using Threshold Voltage 

$$fx \quad V_{ds} = V_{gs} - V_{th}$$

[Open Calculator](#) 

$$ex \quad 0.55V = 1.25V - 0.7V$$



Variables Used















- d Conductor Width (Meter)
- D_n Electron Diffusion Constant (Square Centimeter Per Second)
- E Electric Field Intensity (Volt per Meter)
- E_c Conduction Band Energy (Electron-Volt)
- E_f Fermi Level Energy (Electron-Volt)
- E_{Fi} Fermi Level Intrinsic Semiconductor (Electron-Volt)
- E_g Energy Band Gap (Electron-Volt)
- E_{G0} Energy Band Gap at 0K (Electron-Volt)
- E_H Hall Electric Field (Volt per Meter)
- E_v Valance Band Energy (Electron-Volt)
- f_E Fermi Dirac Distribution Function
- J_{drift} Drift Current Density (Ampere per Square Meter)
- J_n Electron Current Density (Ampere per Square Meter)
- J_p Holes Current Density (Ampere per Square Meter)
- L_n Electron Diffusion Length (Centimeter)
- n_0 Majority Carrier Concentration (1 per Cubic Meter)
- N_a Acceptor Concentration (1 per Cubic Meter)
- N_d Donor Concentration (1 per Cubic Meter)
- n_i Intrinsic Carrier Concentration (1 per Cubic Meter)
- p_0 Minority Carrier Concentration (1 per Cubic Meter)
- T Temperature (Kelvin)
- V_d Drift Speed (Meter per Second)
- V_{ds} Saturation Voltage (Volt)
- V_{gs} Gate Source Voltage (Volt)
- V_h Hall Voltage (Volt)
- V_{th} Threshold Voltage (Volt)
- β_k Material Specific Constant (Joule per Kelvin)
- μ Charge Carriers Mobility (Square Meter per Volt per Second)
- μ_n Mobility of Electron (Square Meter per Volt per Second)
- μ_p Mobility of Holes (Square Meter per Volt per Second)
- ρ_e Electron Density (Kilogram per Cubic Centimeter)
- ρ_h Holes Density (Kilogram per Cubic Centimeter)



- σ Conductivity (Siemens per Meter)
- σ_n Conductivity of Extrinsic Semiconductors (n-type) (Siemens per Meter)
- σ_p Conductivity of Extrinsic Semiconductors (p-type) (Siemens per Meter)
- τ_n Minority Carrier Lifetime (Microsecond)



Constants, Functions, Measurements used

- **Constant: [BoltZ]**, 1.38064852E-23 Joule/Kelvin
Boltzmann constant
- **Constant: [Charge-e]**, 1.60217662E-19 Coulomb
Charge of electron
- **Constant: e**, 2.71828182845904523536028747135266249
Napier's constant
- **Function: sqrt**, sqrt(Number)
Square root function
- **Measurement: Length** in Meter (m), Centimeter (cm)
Length Unit Conversion 
- **Measurement: Time** in Microsecond (μ s)
Time Unit Conversion 
- **Measurement: Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement: Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Energy** in Electron-Volt (eV)
Energy Unit Conversion 
- **Measurement: Surface Current Density** in Ampere per Square Meter (A/m^2)
Surface Current Density Unit Conversion 
- **Measurement: Electric Field Strength** in Volt per Meter (V/m)
Electric Field Strength Unit Conversion 
- **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement: Electric Conductivity** in Siemens per Meter (S/m)
Electric Conductivity Unit Conversion 
- **Measurement: Density** in Kilogram per Cubic Centimeter (kg/cm^3)
Density Unit Conversion 
- **Measurement: Diffusivity** in Square Centimeter Per Second (cm^2/s)
Diffusivity Unit Conversion 
- **Measurement: Mobility** in Square Meter per Volt per Second ($m^2/V*s$)
Mobility Unit Conversion 
- **Measurement: Carrier Concentration** in 1 per Cubic Meter ($1/m^3$)
Carrier Concentration Unit Conversion 
- **Measurement: Heat Capacity** in Joule per Kelvin (J/K)
Heat Capacity Unit Conversion 



Check other formula lists

- [Charge Carrier Characteristics Formulas](#) 
- [Diode Characteristics Formulas](#) 
- [Electrostatic Parameters Formulas](#) 
- [Semiconductor Characteristics Formulas](#) 
- [Transistor Operating Parameters Formulas](#) 

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