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Charge Carrier Characteristics Formulas

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List of 16 Charge Carrier Characteristics Formulas

Charge Carrier Characteristics

1) Conductivity in Metals

Open Calculator

fx $\sigma = N_e \cdot [Charge\text{-}e] \cdot \mu_n$

ex $0.865175 S/m = 3e16/m^3 \cdot [Charge\text{-}e] \cdot 180 m^2/V*s$

2) Convection Current Density

Open Calculator

fx $J_{cv} = \rho \cdot v$

ex $36 A/m^2 = 3 C/m^3 \cdot 12 m/s$

3) Current Density due to Electrons

Open Calculator

fx $J_n = [Charge\text{-}e] \cdot N_e \cdot \mu_n \cdot E_I$

ex $2.965821 A/m^2 = [Charge\text{-}e] \cdot 3e16/m^3 \cdot 180 m^2/V*s \cdot 3.428 V/m$

4) Current Density due to Holes

Open Calculator

fx $J_p = [Charge\text{-}e] \cdot N_p \cdot \mu_p \cdot E_I$

ex $1.647678 A/m^2 = [Charge\text{-}e] \cdot 2e16/m^3 \cdot 150 m^2/V*s \cdot 3.428 V/m$

5) Electrons Diffusion Constant

Open Calculator

fx $$D_n = \mu_n \cdot \left(\frac{[BoltZ] \cdot T}{[Charge\text{-}e]} \right)$$

ex $$44982.46 cm^2/s = 180 m^2/V*s \cdot \left(\frac{[BoltZ] \cdot 290K}{[Charge\text{-}e]} \right)$$

6) Electrostatic Deflection Sensitivity of CRT

Open Calculator

fx $$S_e = \frac{d \cdot L}{2 \cdot \delta \cdot V_e}$$

ex $$1.1E\hat{}\text{-}7 m/V = \frac{2.5mm \cdot 50mm}{2 \cdot 1.15mm \cdot 501509m/s}$$

7) Force on Current Element in Magnetic Field

Open Calculator

fx $$F = i_L \cdot B \cdot \sin(\theta)$$

ex $$0.678823N = 0.48m \cdot 2Wb/m^2 \cdot \sin(45°)$$

8) Hole Diffusion Length

Open Calculator

fx $$L_p = \sqrt{D_p \cdot \tau_p}$$

ex $$0.362214m = \sqrt{37485.39 cm^2/s \cdot 0.035s}$$

9) Holes Diffusion Constant

Open Calculator

fx $$D_p = \mu_p \cdot \left(\frac{[BoltZ] \cdot T}{[Charge\text{-}e]} \right)$$

ex $$37485.39 cm^2/s = 150 m^2/V*s \cdot \left(\frac{[BoltZ] \cdot 290K}{[Charge\text{-}e]} \right)$$

10) Intrinsic Carrier Concentration under Non-Equilibrium Conditions

Open Calculator

fx $$n_i = \sqrt{n_0 \cdot p_0}$$

ex $$1E\hat{}8/m^3 = \sqrt{1.1e8/m^3 \cdot 9.1e7/m^3}$$

11) Intrinsic Concentration

Open Calculator

fx $$n_i = \sqrt{N_c \cdot N_v} \cdot e^{\frac{-E_g}{2 \cdot [BoltZ] \cdot T}}$$

ex $$1.3E\hat{}8/m^3 = \sqrt{1.02e18/m^3 \cdot 0.5e18/m^3} \cdot e^{\frac{-1.12eV}{2 \cdot [BoltZ] \cdot 290K}}$$

12) Thermal Voltage

Open Calculator

fx $$V_t = [BoltZ] \cdot \frac{T}{[Charge\text{-}e]}$$

ex $$0.02499V = [BoltZ] \cdot \frac{290K}{[Charge\text{-}e]}$$

13) Thermal Voltage using Einstein's Equation

Open Calculator

fx $$V_t = \frac{D_n}{\mu_n}$$

ex $$0.02499\text{V} = \frac{44982.46\text{cm}^2/\text{s}}{180\text{m}^2/\text{V*s}}$$

14) Time Period of Electron

Open Calculator

fx $$t_c = \frac{2 \cdot 3.14 \cdot [\text{Mass-e}]}{H \cdot [\text{Charge-e}]}$$

ex $$0.155242\text{ns} = \frac{2 \cdot 3.14 \cdot [\text{Mass-e}]}{0.23\text{A/m} \cdot [\text{Charge-e}]}$$

15) Velocity of Electron

Open Calculator

fx $$V_v = \sqrt{\frac{2 \cdot [\text{Charge-e}] \cdot V}{[\text{Mass-e}]}}$$

ex $$501509\text{m/s} = \sqrt{\frac{2 \cdot [\text{Charge-e}] \cdot 0.715\text{V}}{[\text{Mass-e}]}}$$

16) Velocity of Electron in Force Fields

Open Calculator

fx $$V_{ef} = \frac{E_I}{H}$$

ex $$14.90435\text{m/s} = \frac{3.428\text{V/m}}{0.23\text{A/m}}$$

Variables Used

- **B** Magnetic Flux Density *(Weber per Square Meter)*
- **d** Distance between Deflecting Plates *(Millimeter)*
- D_n Electron Diffusion Constant *(Square Centimeter Per Second)*
- D_p Holes Diffusion Constant *(Square Centimeter Per Second)*
- E_g Temperature Dependence of Energy Band Gap *(Electron-Volt)*
- E_l Electric Field Intensity *(Volt per Meter)*
- **F** Force *(Newton)*
- **H** Magnetic Field Strength *(Ampere per Meter)*
- i_L Current Element *(Meter)*
- J_{cv} Convection 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** Screen and Deflecting Plates Distance *(Millimeter)*
- L_p Holes Diffusion Length *(Meter)*
- n_0 Majority Carrier Concentration *(1 per Cubic Meter)*
- N_c Effective Density in Valence Band *(1 per Cubic Meter)*
- N_e Electron Concentration *(1 per Cubic Meter)*
- n_i Intrinsic Carrier Concentration *(1 per Cubic Meter)*
- N_p Holes Concentration *(1 per Cubic Meter)*
- N_v Effective Density in Conduction Band *(1 per Cubic Meter)*
- p_0 Minority Carrier Concentration *(1 per Cubic Meter)*

- S_e Electrostatic Deflection Sensitivity *(Meter per Volt)*
- T Temperature *(Kelvin)*
- t_c Period of Particle Circular Path *(Nanosecond)*
- v Charge Velocity *(Meter per Second)*
- V Voltage *(Volt)*
- V_e Electron Velocity *(Meter per Second)*
- V_{ef} Velocity of Electron in Force Fields *(Meter per Second)*
- V_t Thermal Voltage *(Volt)*
- V_v Velocity due to Voltage *(Meter per Second)*
- δ Deflection of Beam *(Millimeter)*
- θ Angle between Planes *(Degree)*
- μ_n Mobility of Electron *(Square Meter per Volt per Second)*
- μ_p Mobility of Holes *(Square Meter per Volt per Second)*
- ρ Charge Density *(Coulomb per Cubic Meter)*
- σ Conductivity *(Siemens per Meter)*
- τ_p Hole Carrier Lifetime *(Second)*

Constants, Functions, Measurements used

- Constant: **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- Constant: **[Charge-e]**, 1.60217662E-19
  Charge of electron
- Constant: **[Mass-e]**, 9.10938356E-31
  Mass of electron
- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Function: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Millimeter (mm), Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s), Nanosecond (ns)
  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: **Force** in Newton (N)
  Force Unit Conversion

- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Magnetic Flux Density** in Weber per Square Meter (Wb/m²)
  Magnetic Flux Density Unit Conversion
- Measurement: **Magnetic Field Strength** in Ampere per Meter (A/m)
  Magnetic Field Strength Unit Conversion
- Measurement: **Volume Charge Density** in Coulomb per Cubic Meter (C/m³)
  Volume Charge Density Unit Conversion
- Measurement: **Surface Current Density** in Ampere per Square Meter (A/m²)
  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: **Diffusivity** in Square Centimeter Per Second (cm²/s)
  Diffusivity Unit Conversion
- Measurement: **Mobility** in Square Meter per Volt per Second (m²/V*s)
  Mobility Unit Conversion
- Measurement: **Deflection Sensitivity** in Meter per Volt (m/V)
  Deflection Sensitivity Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration 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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