Important SSD Junction Formulas PDF

Formulas
Examples
with Units

List of 16
Important SSD Junction Formulas

1) Absorbed Power Formula

Evaluate Formula

Formula

$$P_{abs} = P_i \cdot \exp(- b \cdot \alpha)$$

Example with Units

$$0.1073\,\text{W} = 0.22\,\text{W} \cdot \exp(- 0.46\,\mu\text{m} \cdot 15608.42\,\text{cm}^{-1})$$

2) Absorption Coefficient Formula

Evaluate Formula

Formula

$$\alpha = \left(- \frac{1}{b} \right) \cdot \ln\left(\frac{P_{abs}}{P_i} \right)$$

Example with Units

$$15068.417\,\text{cm}^{-1} = \left(- \frac{1}{0.46\,\mu\text{m}} \right) \cdot \ln\left(\frac{0.11\,\text{W}}{0.22\,\text{W}} \right)$$

3) Acceptor Concentration Formula

Evaluate Formula

Formula

$$N_a = \frac{|Q|}{[\text{Charge-e}] \cdot x_{no} \cdot A_j}$$

Example with Units

$$7.9\text{E+}35\,1/\text{m}^3 = \frac{13\,\text{C}}{1.6\text{E-}19\,\text{C} \cdot 0.019\,\mu\text{m} \cdot 5401.3\,\mu\text{m}^2}$$

4) Cross-Sectional Area of Junction Formula

Evaluate Formula

Formula

$$A_j = \frac{|Q|}{[\text{Charge-e}] \cdot x_{no} \cdot N_a}$$

Example with Units

$$5405.7041\,\mu\text{m}^2 = \frac{13\,\text{C}}{1.6\text{E-}19\,\text{C} \cdot 0.019\,\mu\text{m} \cdot 7.9\text{e}35\,1/\text{m}^3}$$

5) Donor Concentration Formula

Evaluate Formula

Formula

$$N_d = \frac{|Q|}{[\text{Charge-e}] \cdot x_{po} \cdot A_j}$$

Example with Units

$$2.5\text{E+}35\,1/\text{m}^3 = \frac{13\,\text{C}}{1.6\text{E-}19\,\text{C} \cdot 0.06\,\mu\text{m} \cdot 5401.3\,\mu\text{m}^2}$$

6) Junction Capacitance Formula

Evaluate Formula

Formula

$$C_j = \left(\frac{A_j}{2}\right) \cdot \sqrt{\frac{2 \cdot [Charge\text{-}e] \cdot k \cdot N_B}{V - V_1}}$$

Example with Units

$$0.023\,\mu F = \left(\frac{5401.3\,\mu m^2}{2}\right) \cdot \sqrt{\frac{2 \cdot 1.6E\text{-}19\,C \cdot 1.59\,\mu m \cdot 1e28\,1/m^3}{120\,V - 50\,V}}$$

7) Junction Transition Width Formula

Evaluate Formula

Formula

$$W_j = x_{no} \cdot \left(\frac{N_a + N_d}{N_a}\right)$$

Example with Units

$$0.025\,\mu m = 0.019\,\mu m \cdot \left(\frac{7.9e35\,1/m^3 + 2.5e35\,1/m^3}{7.9e35\,1/m^3}\right)$$

8) Junction Voltage Formula

Evaluate Formula

Formula

$$V_j = V - \left(R_{se(p)} + R_{se(n)}\right) \cdot I$$

Example with Units

$$119.9\,V = 120\,V - \left(23.3\,\Omega + 476.7\,\Omega\right) \cdot 0.2\,mA$$

9) Length of P-Side Junction Formula

Evaluate Formula

Formula

$$L_p = \left(\frac{I_{opt}}{[Charge\text{-}e] \cdot A_j \cdot g_{op}}\right) - \left(W_j + L_{dif}\right)$$

Example with Units

$$5.4E{+}9\,\mu m = \left(\frac{0.135\,mA}{1.6E\text{-}19\,C \cdot 5401.3\,\mu m^2 \cdot 2.9e19}\right) - \left(0.025\,\mu m + 0.0056\,\mu m\right)$$

10) Net Distribution of Charge Formula

Evaluate Formula

Formula

$$x = \frac{N_d - N_a}{G}$$

Example with Units

$$-0.075 = \frac{2.5e35\,1/m^3 - 7.9e35\,1/m^3}{7.2e36}$$

11) N-Type Width Formula

Evaluate Formula

Formula

$$x_{no} = \frac{|Q|}{A_j \cdot N_a \cdot [Charge\text{-}e]}$$

Example with Units

$$0.019\,\mu m = \frac{13\,C}{5401.3\,\mu m^2 \cdot 7.9e35\,1/m^3 \cdot 1.6E\text{-}19\,C}$$

12) P-N Junction Length Formula

Evaluate Formula

Formula

$$L_j = k + L_{eff}$$

Example with Units

$$1.76\,\mu m = 1.59\,\mu m + 0.17\,\mu m$$

13) Quantum Number Formula

Evaluate Formula

Formula

$$n = [Coulomb] \cdot \frac{L}{3.14}$$

Example

$$2.0036 = 9E{+}9 \cdot \frac{7e{-}10}{3.14}$$

14) Series Resistance in N-type Formula

Evaluate Formula

Formula

$$R_{se(n)} = \left(\frac{V - V_j}{I}\right) - R_{se(p)}$$

Example with Units

$$476.7\,\Omega = \left(\frac{120\,V - 119.9\,V}{0.2\,mA}\right) - 23.3\,\Omega$$

15) Series Resistance in P-type Formula

Evaluate Formula

Formula

$$R_{se(p)} = \left(\frac{V - V_j}{I}\right) - R_{se(n)}$$

Example with Units

$$23.3\,\Omega = \left(\frac{120\,V - 119.9\,V}{0.2\,mA}\right) - 476.7\,\Omega$$

16) Total Acceptor Charge Formula

Evaluate Formula

Formula

$$|Q| = [Charge\text{-}e] \cdot x_{no} \cdot A_j \cdot N_a$$

Example with Units

$$12.9894\,C = 1.6E{-}19\,C \cdot 0.019\,\mu m \cdot 5401.3\,\mu m^2 \cdot 7.9e35\,1/m^3$$

Variables used in list of SSD Junction Formulas above

- **|Q|** Total Acceptor Charge *(Coulomb)*
- **A_j** Junction Area *(Square Micrometer)*
- **b** Sample Thickness *(Micrometer)*
- **C_j** Junction Capacitance *(Microfarad)*
- **G** Graded Constant
- **g_{op}** Optical Generation Rate
- **I** Electric Current *(Milliampere)*
- **I_{opt}** Optical Current *(Milliampere)*
- **k** Constant Length Offset *(Micrometer)*
- **L** Potential Well Length
- **L_{dif}** Diffusion Length of Transition Region *(Micrometer)*
- **L_{eff}** Effective Channel Length *(Micrometer)*
- **L_j** Junction Length *(Micrometer)*
- **L_p** Length of P-Side Junction *(Micrometer)*
- **n** Quantum Number
- **N_a** Acceptor Concentration *(1 per Cubic Meter)*
- **N_B** Doping Concentration of Base *(1 per Cubic Meter)*
- **N_d** Donor Concentration *(1 per Cubic Meter)*
- **P_{abs}** Absorbed Power *(Watt)*
- **P_i** Incident Power *(Watt)*
- **$R_{se(n)}$** Series Resistance in N Junction *(Ohm)*
- **$R_{se(p)}$** Series Resistance in P Junction *(Ohm)*
- **V** Source Voltage *(Volt)*
- **V_1** Source Voltage 1 *(Volt)*
- **V_j** Junction Voltage *(Volt)*
- **W_j** Junction Transition Width *(Micrometer)*
- **x** Net Distribution
- **x_{no}** Charge Penetration N-type *(Micrometer)*
- **x_{po}** Charge Penetration P-type *(Micrometer)*
- **α** Absorption Coefficient *(1 per Centimeter)*

Constants, Functions, Measurements used in list of SSD Junction Formulas above

- constant(s): **[Charge-e]**, 1.60217662E-19
  Charge of electron
- constant(s): **[Coulomb]**, 8.9875E+9
  Coulomb constant
- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Functions: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Functions: **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 Micrometer (µm)
  Length Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Area** in Square Micrometer (µm²)
  Area Unit Conversion
- Measurement: **Electric Charge** in Coulomb (C)
  Electric Charge Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Capacitance** in Microfarad (µF)
  Capacitance Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration Unit Conversion
- Measurement: **Reciprocal Length** in 1 per Centimeter (cm^{-1})
  Reciprocal Length Unit Conversion

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