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# Diode Characteristics Formulas

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# List of 16 Diode Characteristics Formulas

## Diode Characteristics

### 1) Average DC Current

$$\text{fx } I_{\text{av}} = 2 \cdot \frac{I_{\text{m}}}{\pi}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$\text{ex } 3.437747\text{mA} = 2 \cdot \frac{5.4\text{mA}}{\pi}$$

### 2) Capacitance of Varactor Diode

$$\text{fx } C_{\text{j}} = \frac{k}{(V_{\text{b}} + V_{\text{R}})^n}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$\text{ex } 1521.89\mu\text{F} = \frac{5\text{e-}3}{(0.85\text{V} + 9\text{V})^{0.52}}$$

### 3) Cut-off Frequency of Varactor Diode

$$\text{fx } f_{\text{c}} = \frac{1}{2 \cdot \pi \cdot R_{\text{se}} \cdot C_{\text{j}}}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$\text{ex } 3.075577\text{Hz} = \frac{1}{2 \cdot \pi \cdot 34\Omega \cdot 1522\mu\text{F}}$$



#### 4) Diode Equation for Germanium at Room Temperature

$$\text{fx } I_{\text{ger}} = I_o \cdot \left( e^{\frac{V_d}{0.026}} - 1 \right)$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 4841.035\text{A} = 0.46\mu\text{A} \cdot \left( e^{\frac{0.6\text{V}}{0.026}} - 1 \right)$$

#### 5) Ideal Diode Equation

$$\text{fx } I_d = I_o \cdot \left( e^{\frac{[\text{Charge-e}] \cdot V_d}{[\text{BoltZ}] \cdot T}} - 1 \right)$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 12299.53\text{A} = 0.46\mu\text{A} \cdot \left( e^{\frac{[\text{Charge-e}] \cdot 0.6\text{V}}{[\text{BoltZ}] \cdot 290\text{K}}} - 1 \right)$$

#### 6) Maximum Wavelength

$$\text{fx } \lambda_{\text{max}} = \frac{1.24}{E_g}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$\text{ex } 6.4\text{E}^{\wedge}20\text{m} = \frac{1.24}{0.012\text{eV}}$$

#### 7) Non-Ideal Diode Equation

$$\text{fx } I_0 = I_o \cdot \left( e^{\frac{[\text{Charge-e}] \cdot V_d}{\Pi \cdot [\text{BoltZ}] \cdot T}} - 1 \right)$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$\text{ex } 24.35333\text{A} = 0.46\mu\text{A} \cdot \left( e^{\frac{[\text{Charge-e}] \cdot 0.6\text{V}}{1.35 \cdot [\text{BoltZ}] \cdot 290\text{K}}} - 1 \right)$$



8) Quality Factor of Varactor Diode 

$$fx \quad Q = \frac{f_c}{f_o}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)


$$ex \quad 1.098214 = \frac{3.075\text{Hz}}{2.8\text{Hz}}$$

9) Responsivity 

$$fx \quad R = \frac{I_p}{P_o}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad 0.167969 = \frac{430\text{mA}}{2.56\text{W}}$$

10) Saturation Drain Current 

$$fx \quad I_s = 0.5 \cdot g_m \cdot (V_{gs} - V_{th})$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$ex \quad 9.9\text{mA} = 0.5 \cdot 0.036\text{S} \cdot (1.25\text{V} - 0.7\text{V})$$


11) Self-Resonance Frequency of Varactor Diode 

$$fx \quad S_o = \frac{1}{2 \cdot \pi \cdot \sqrt{L_s \cdot C_j}}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

$$ex \quad 2.280541\text{Hz} = \frac{1}{2 \cdot \pi \cdot \sqrt{3.2\text{H} \cdot 1522\mu\text{F}}}$$



12) Thermal Voltage of Diode Equation 

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

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)


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

13) Voltage Equivalent of Temperature 

$$fx \quad V_{\text{temp}} = \frac{T_{\text{room}}}{11600}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$ex \quad 0.025862V = \frac{300K}{11600}$$

14) Zener Current 

$$fx \quad I_z = \frac{V_i - V_z}{R_z}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 150.1344mA = \frac{21.21V - 10.6V}{70.67\Omega}$$

15) Zener Resistance 

$$fx \quad R_z = \frac{V_z}{I_z}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$ex \quad 70.66667\Omega = \frac{10.6V}{150mA}$$



## 16) Zener Voltage

**fx**  $V_z = R_z \cdot I_z$

Open Calculator 

**ex**  $10.6005V = 70.67\Omega \cdot 150mA$



## Variables Used

- $C_j$  Capacitance of Varactor Diode (*Microfarad*)
- $E_g$  Energy Gap (*Electron-Volt*)
- $f_c$  Cut-off Frequency (*Hertz*)
- $f_o$  Operating Frequency (*Hertz*)
- $g_m$  Transconductance Parameter (*Siemens*)
- $I_0$  Non Ideal Diode Current (*Ampere*)
- $I_{av}$  Direct Current (*Milliampere*)
- $I_d$  Diode Current (*Ampere*)
- $I_{ger}$  Germanium Diode Current (*Ampere*)
- $I_m$  Peak Current (*Milliampere*)
- $I_o$  Reverse Saturation Current (*Microampere*)
- $I_p$  Photo Current (*Milliampere*)
- $I_s$  Diode Saturation Current (*Milliampere*)
- $I_z$  Zener Current (*Milliampere*)
- $k$  Material Constant
- $L_s$  Inductance of Varactor Diode (*Henry*)
- $n$  Doping Constant
- $P_o$  Incident Optical Power (*Watt*)
- $q$  Quality Factor
- $R$  Responsivity
- $R_{se}$  Series Field Resistance (*Ohm*)










- $R_z$  Zener Resistance (Ohm)
- $s_o$  Self Resonance Frequency (Hertz)
- $T$  Temperature (Kelvin)
- $T_{\text{room}}$  Room Temperature (Kelvin)
- $V_b$  Barrier Potential (Volt)
- $V_d$  Diode Voltage (Volt)
- $V_{gs}$  Gate Source Voltage (Volt)
- $V_i$  Input Voltage (Volt)
- $V_R$  Reverse Voltage (Volt)
- $V_t$  Thermal Voltage (Volt)
- $V_{\text{temp}}$  Volt-Equivalent of Temperature (Volt)
- $V_{th}$  Threshold Voltage (Volt)
- $V_z$  Zener Voltage (Volt)
- $\lambda_{\text{max}}$  Maximum Wavelength (Meter)
- $\Pi$  Ideality Factor









## Constants, Functions, Measurements used






- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **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)  
*Length Unit Conversion* 
- **Measurement:** **Electric Current** in Milliampere (mA), Ampere (A), Microampere ( $\mu\text{A}$ )  
*Electric Current Unit Conversion* 
- **Measurement:** **Temperature** in Kelvin (K)  
*Temperature Unit Conversion* 
- **Measurement:** **Energy** in Electron-Volt (eV)  
*Energy Unit Conversion* 
- **Measurement:** **Power** in Watt (W)  
*Power Unit Conversion* 
- **Measurement:** **Frequency** in Hertz (Hz)  
*Frequency Unit Conversion* 
- **Measurement:** **Capacitance** in Microfarad ( $\mu\text{F}$ )  
*Capacitance Unit Conversion* 



- **Measurement: Electric Resistance** in Ohm ( $\Omega$ )  
*Electric Resistance Unit Conversion* 
- **Measurement: Electric Conductance** in Siemens (S)  
*Electric Conductance Unit Conversion* 
- **Measurement: Inductance** in Henry (H)  
*Inductance Unit Conversion* 
- **Measurement: Electric Potential** in Volt (V)  
*Electric Potential 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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