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SCR Characteristics Formulas

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List of 16 SCR Characteristics Formulas

SCR Characteristics

1) Circuit Turn off Time Class B Commutation

$$\text{fx } t_{B(\text{off})} = C_{\text{com}} \cdot \frac{V_{\text{com}}}{I_L}$$

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

$$\text{ex } 1.646154\text{s} = 0.03\text{F} \cdot \frac{42.8\text{V}}{0.78\text{A}}$$

2) Circuit Turn off Time Class C Commutation

$$\text{fx } t_{C(\text{off})} = R_{\text{stb}} \cdot C_{\text{com}} \cdot \ln(2)$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 0.665421\text{s} = 32\Omega \cdot 0.03\text{F} \cdot \ln(2)$$

3) Derating Factor of Series Connected Thyristor String

$$\text{fx } \text{DRF} = 1 - \frac{V_{\text{string}}}{V_{\text{ss}} \cdot n}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 0.939653 = 1 - \frac{20.512\text{V}}{113.3\text{V} \cdot 3}$$



4) Discharging Current of dv-dt Protection Thyristor Circuits

$$\text{fx } I_{\text{discharge}} = \frac{V_{\text{in}}}{(R_1 + R_2)}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 1.875\text{A} = \frac{45\text{V}}{(12.5\Omega + 11.5\Omega)}$$

5) Emitter Current for UJT based Thyristor Firing Circuit

$$\text{fx } I_E = \frac{V_E - V_d}{R_{B1} + R_E}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 1.333333\text{A} = \frac{60\text{V} - 20\text{V}}{18\Omega + 12\Omega}$$

6) Emitter Voltage to Turn On UJT based Thyristor Firing Circuit

$$\text{fx } V_E = V_{RB1} + V_d$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 60\text{V} = 40\text{V} + 20\text{V}$$

7) Frequency of UJT as Oscillator Thyristor Firing Circuit

$$\text{fx } f = \frac{1}{R_{\text{stb}} \cdot C \cdot \ln\left(\frac{1}{1-\eta}\right)}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$\text{ex } 0.138354\text{Hz} = \frac{1}{32\Omega \cdot 0.3\text{F} \cdot \ln\left(\frac{1}{1-0.529}\right)}$$



8) Intrinsic Stand-off Ratio for UJT based Thyristor Firing Circuit

$$\text{fx } \eta = \frac{R_{B1}}{R_{B1} + R_{B2}}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 0.529412 = \frac{18\Omega}{18\Omega + 16\Omega}$$

9) Leakage Current of Collector-Base Junction

$$\text{fx } I_{CBO} = I_C - \alpha \cdot I_C$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 30A = 100A - 0.70 \cdot 100A$$

10) Peak Current Class B Thyristor Commutation

$$\text{fx } I_o = V_{in} \cdot \sqrt{\frac{C_{com}}{L}}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 11.49196A = 45V \cdot \sqrt{\frac{0.03F}{0.46H}}$$

11) Power Dissipated by Heat in SCR

$$\text{fx } P_{dis} = \frac{T_{junc} - T_{amb}}{\theta}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$\text{ex } 2.946309W = \frac{10.2K - 5.81K}{1.49K/W}$$



12) Thermal Resistance of SCR

$$\theta = \frac{T_{\text{junc}} - T_{\text{amb}}}{P_{\text{dis}}}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 1.496761\text{K/W} = \frac{10.2\text{K} - 5.81\text{K}}{2.933\text{W}}$$

13) Thyristor Commutation Voltage for Class B Commutation

$$V_{\text{com}} = V_{\text{in}} \cdot \cos(\omega \cdot (t_3 - t_4))$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$\text{ex } 42.80491\text{V} = 45\text{V} \cdot \cos(23\text{rad/s} \cdot (0.67\text{s} - 1.23\text{s}))$$

14) Thyristor Conduction Time for Class A Commutation

$$t_o = \pi \cdot \sqrt{L \cdot C_{\text{com}}}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$\text{ex } 0.369054\text{s} = \pi \cdot \sqrt{0.46\text{H} \cdot 0.03\text{F}}$$

15) Time Period for UJT as Oscillator Thyristor Firing Circuit

$$T_{\text{UJT(osc)}} = R_{\text{stb}} \cdot C \cdot \ln\left(\frac{1}{1 - \eta}\right)$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$\text{ex } 7.227813\text{s} = 32\Omega \cdot 0.3\text{F} \cdot \ln\left(\frac{1}{1 - 0.529}\right)$$



16) Worst Case Steady State Voltage across First Thyristor in Series Connected Thyristors

[Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)

$$\text{fx } V_{\text{ss}} = \frac{V_{\text{string}} + R_{\text{stb}} \cdot (n - 1) \cdot \Delta I_{\text{D}}}{n}$$

$$\text{ex } 113.504\text{V} = \frac{20.512\text{V} + 32\Omega \cdot (3 - 1) \cdot 5\text{A}}{3}$$



Variables Used










- **C** Capacitance (*Farad*)
- **C_{com}** Thyristor Commutation Capacitance (*Farad*)
- **DRF** Derating Factor of Thyristor String
- **f** Frequency (*Hertz*)
- **I_C** Collector Current (*Ampere*)
- **I_{CBO}** Collector Base Leakage Current (*Ampere*)
- **I_{discharge}** Discharging Current (*Ampere*)
- **I_E** Emitter Current (*Ampere*)
- **I_L** Load Current (*Ampere*)
- **I_O** Peak Current (*Ampere*)
- **L** Inductance (*Henry*)
- **n** Number of Thyristors in Series
- **P_{dis}** Power Dissipated by Heat (*Watt*)
- **R₁** Resistance 1 (*Ohm*)
- **R₂** Resistance 2 (*Ohm*)
- **R_{B1}** Emitter Resistance Base 1 (*Ohm*)
- **R_{B2}** Emitter Resistance Base 2 (*Ohm*)
- **R_E** Emitter Resistance (*Ohm*)
- **R_{stb}** Stabilizing Resistance (*Ohm*)
- **t₃** Thyristor Reverse Bias Time (*Second*)
- **t₄** Auxiliary Thyristor Reverse Bias Time (*Second*)





- T_{amb} Ambient Temperature (Kelvin)
- $t_{B(off)}$ Circuit Turn Off Time Class B Commutation (Second)
- $t_{C(off)}$ Circuit Turn Off Time Class C Commutation (Second)
- T_{junc} Junction Temperature (Kelvin)
- t_o Thyristor Conduction Time (Second)
- $T_{UJT(osc)}$ Time Period of UJT as Oscillator (Second)
- V_{com} Thyristor Commutation Voltage (Volt)
- V_d Diode Voltage (Volt)
- V_E Emitter Voltage (Volt)
- V_{in} Input Voltage (Volt)
- V_{RB1} Emitter Resistance Base 1 Voltage (Volt)
- V_{SS} Worst Case Steady State Voltage (Volt)
- V_{string} Resultant Series Voltage of Thyristor String (Volt)
- α Common-Base Current Gain
- ΔI_D Off State Current Spread (Ampere)
- η Intrinsic Stand-off Ratio
- θ Thermal Resistance (Kelvin per Watt)
- ω Angular Frequency (Radian per Second)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **cos**, $\cos(\text{Angle})$
Trigonometric cosine function
- **Function:** **ln**, $\ln(\text{Number})$
Natural logarithm function (base e)
- **Function:** **sqrt**, $\sqrt{\text{Number}}$
Square root function
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Electric Current** in Ampere (A)
Electric Current Unit Conversion 
- **Measurement:** **Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement:** **Power** in Watt (W)
Power Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Capacitance** in Farad (F)
Capacitance Unit Conversion 
- **Measurement:** **Electric Resistance** in Ohm (Ω)
Electric Resistance Unit Conversion 
- **Measurement:** **Inductance** in Henry (H)
Inductance Unit Conversion 
- **Measurement:** **Thermal Resistance** in Kelvin per Watt (K/W)
Thermal Resistance Unit Conversion 



- **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement: Angular Frequency** in Radian per Second (rad/s)
Angular Frequency Unit Conversion 



Check other formula lists

- **SCR Characteristics Formulas** 

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