Important SCR Characteristics Formulas PDF

Formulas
Examples
with Units

List of 16
Important SCR Characteristics Formulas

1) Circuit Turn off Time Class B Commutation Formula

Evaluate Formula

Formula

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

Example with Units

$$1.6462\,s = 0.03\,F \cdot \frac{42.8\,V}{0.78\,A}$$

2) Circuit Turn off Time Class C Commutation Formula

Evaluate Formula

Formula

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

Example with Units

$$0.6654\,s = 32\,\Omega \cdot 0.03\,F \cdot \ln(2)$$

3) Derating Factor of Series Connected Thyristor String Formula

Evaluate Formula

Formula

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

Example with Units

$$0.9397 = 1 - \frac{20.512\,V}{113.3\,V \cdot 3}$$

4) Discharging Current of dv-dt Protection Thyristor Circuits Formula

Evaluate Formula

Formula

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

Example with Units

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

5) Emitter Current for UJT based Thyristor Firing Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$1.3333\,A = \frac{60\,V - 20\,V}{18\,\Omega + 12\,\Omega}$$

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

Evaluate Formula

Formula

$$V_E = V_{RB1} + V_d$$

Example with Units

$$60\,V = 40\,V + 20\,V$$

7) Frequency of UJT as Oscillator Thyristor Firing Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$0.1384\,\text{Hz} = \frac{1}{32\,\Omega \cdot 0.3\,\text{F} \cdot \ln\left(\frac{1}{1 - 0.529}\right)}$$

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

Evaluate Formula

Formula

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

Example with Units

$$0.5294 = \frac{18\,\Omega}{18\,\Omega + 16\,\Omega}$$

9) Leakage Current of Collector-Base Junction Formula

Evaluate Formula

Formula

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

Example with Units

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

10) Peak Current Class B Thyristor Commutation Formula

Evaluate Formula

Formula

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

Example with Units

$$11.492\,\text{A} = 45\,\text{V} \cdot \sqrt{\frac{0.03\,\text{F}}{0.46\,\text{H}}}$$

11) Power Dissipated by Heat in SCR Formula

Evaluate Formula

Formula

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

Example with Units

$$2.9463\,\text{W} = \frac{10.2\,\text{K} - 5.81\,\text{K}}{1.49\,\text{K/W}}$$

12) Thermal Resistance of SCR Formula

Evaluate Formula

Formula

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

Example with Units

$$1.4968\,\text{K/W} = \frac{10.2\,\text{K} - 5.81\,\text{K}}{2.933\,\text{W}}$$

13) Thyristor Commutation Voltage for Class B Commutation Formula

Evaluate Formula

Formula

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

Example with Units

$$42.8049\,\text{V} = 45\,\text{V} \cdot \cos\left(23\,\text{rad/s} \cdot \left(0.67\,\text{s} - 1.23\,\text{s}\right)\right)$$

14) Thyristor Conduction Time for Class A Commutation Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3691\,\text{s} = 3.1416 \cdot \sqrt{0.46\,\text{H} \cdot 0.03\,\text{F}}$$

15) Time Period for UJT as Oscillator Thyristor Firing Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$7.2278\,\text{s} = 32\,\Omega \cdot 0.3\,\text{F} \cdot \ln\left(\frac{1}{1 - 0.529}\right)$$

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

Evaluate Formula

Formula

$$V_{ss} = \frac{V_{string} + R_{stb} \cdot (n - 1) \cdot \Delta I_D}{n}$$

Example with Units

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

Variables used in list of SCR Characteristics Formulas above

- **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)*
- R_1 Resistance 1 *(Ohm)*
- R_2 Resistance 2 *(Ohm)*
- R_{B1} Emitter Resistance Base 1 *(Ohm)*
- R_{B2} Emitter Resistance Base 2 *(Ohm)*
- R_E Emitter Resistance *(Ohm)*
- R_{stb} Stablizing Resistance *(Ohm)*
- t_3 Thyristor Reverse Bias Time *(Second)*
- t_4 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)*

Constants, Functions, Measurements used in list of SCR Characteristics Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- 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: **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*

- 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)*

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