Gate specifications

- Gate current to trigger (I_{GT}): Minimum value of the gate current below which reliable turn on of the thyristor can not be guaranteed
- Gate voltage to trigger (V_{GT}): Minimum value of the gate cathode forward voltage below which reliable turn on of the thyristor can not be guaranteed
- Non triggering gate voltage (V_{GNT}): Maximum value of the gate-cathode voltage below which the thyristor can be guaranteed to remain OFF.
-

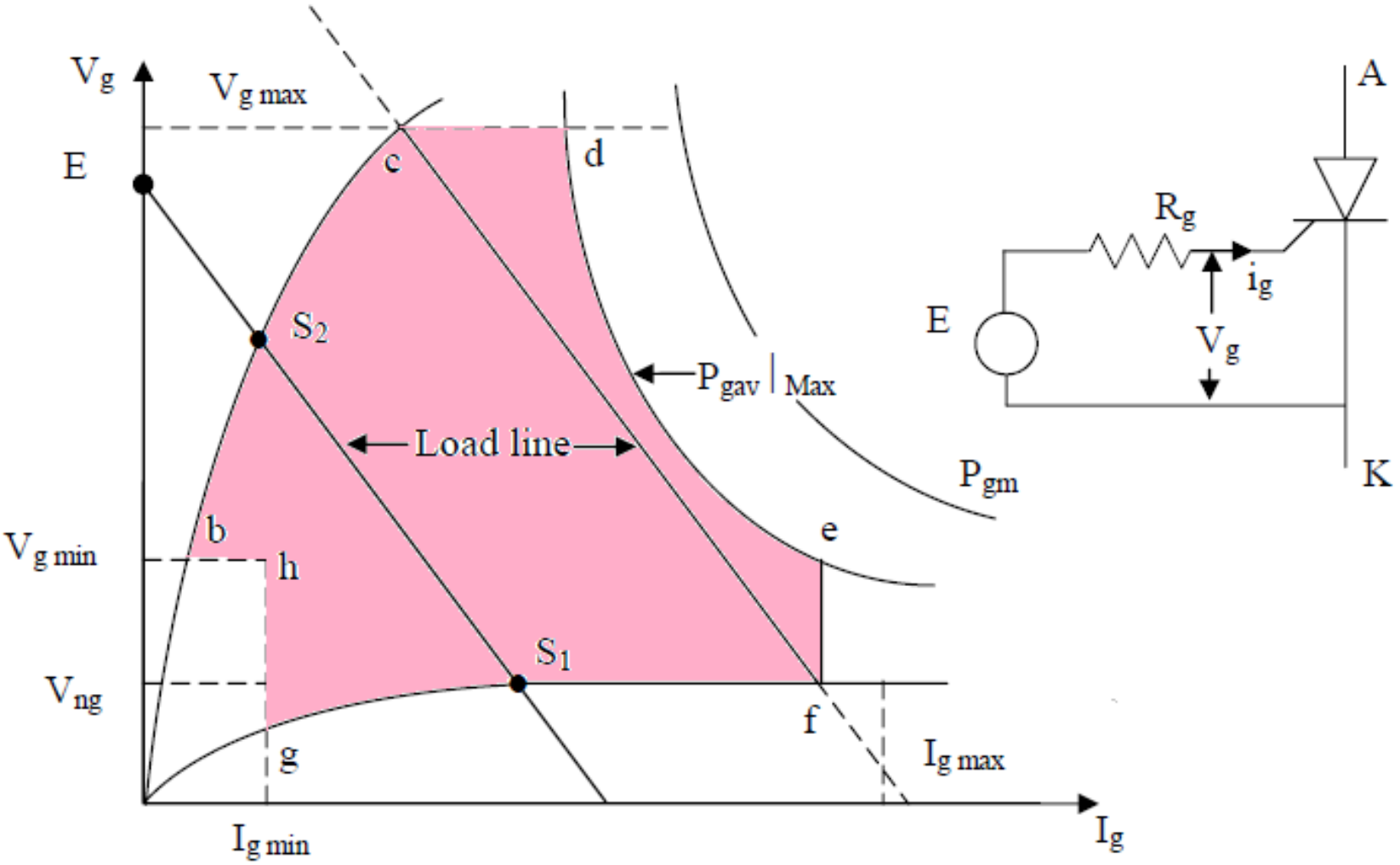
Gate Specifications

- Peak reverse gate voltage (V_{GRM}): Maximum reverse voltage that can appear between the gate and the cathode terminals without damaging the junction.

- Average Gate Power dissipation (P_{GAR}): Average power dissipated in the gate-cathode junction should not exceed this value for gate current pulses wider than 100 μs.

- Peak forward gate current (I_{GRM}): The forward gate current should not exceed this limit even on instantaneous basis.

Gate Characteristics

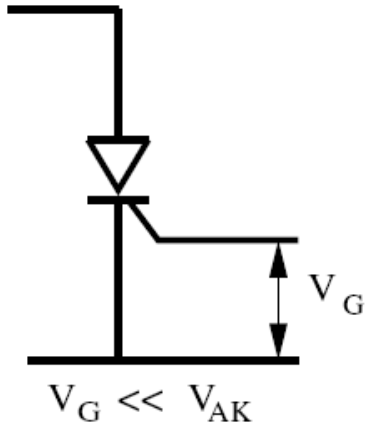


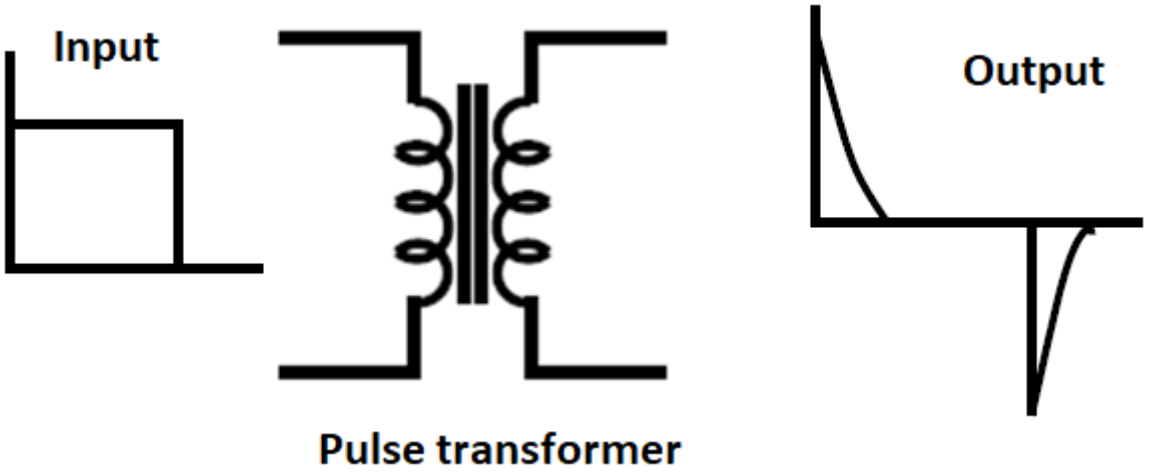
Gate Characteristics

- For the same rating of device the Vg- Ig characteristics are not the same.
- Each devices has maximum gate voltage and gate current and power dissipation.
- Minimum value of Vg and Ig for reliable turn on
- Vng is non gate trigger voltage. Noise should be less than Vng
- Vg = E- IgRg
- Cf represents optimum load line based on E and Rg is selected

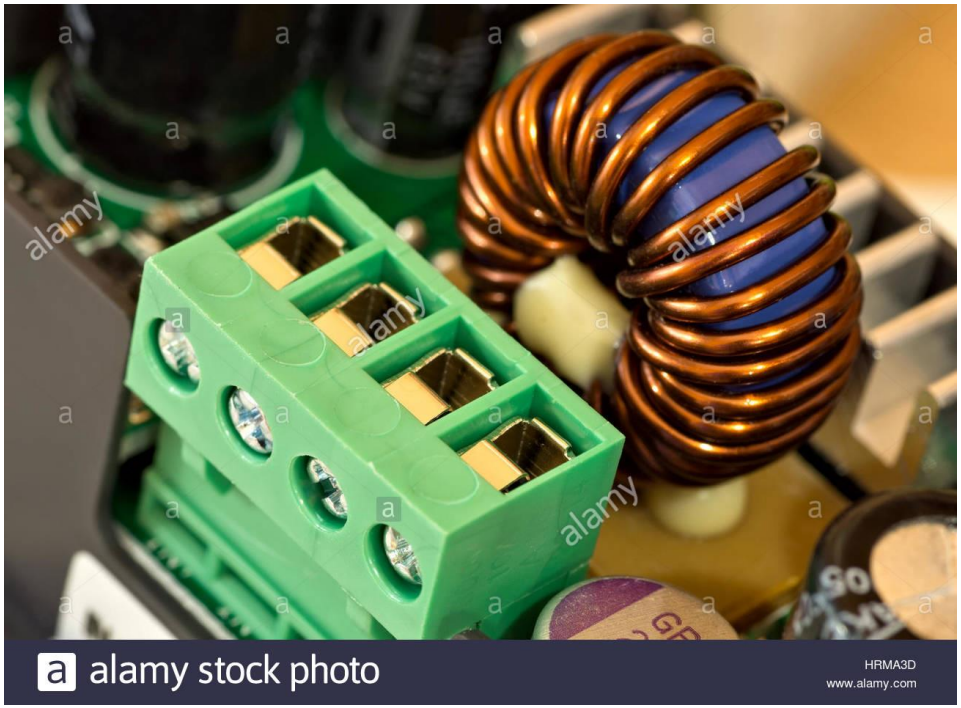
Gate trigger

- IG should be present till IA > I latching
- Control circuit should be isolated from power circuit
- Use of pulse transformer



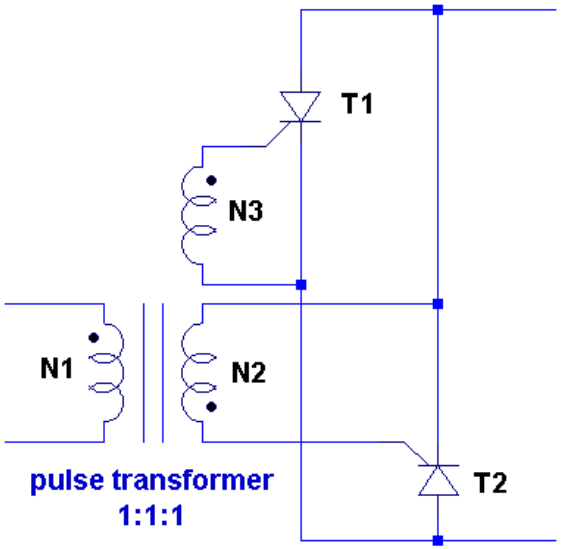


Pulse transformer

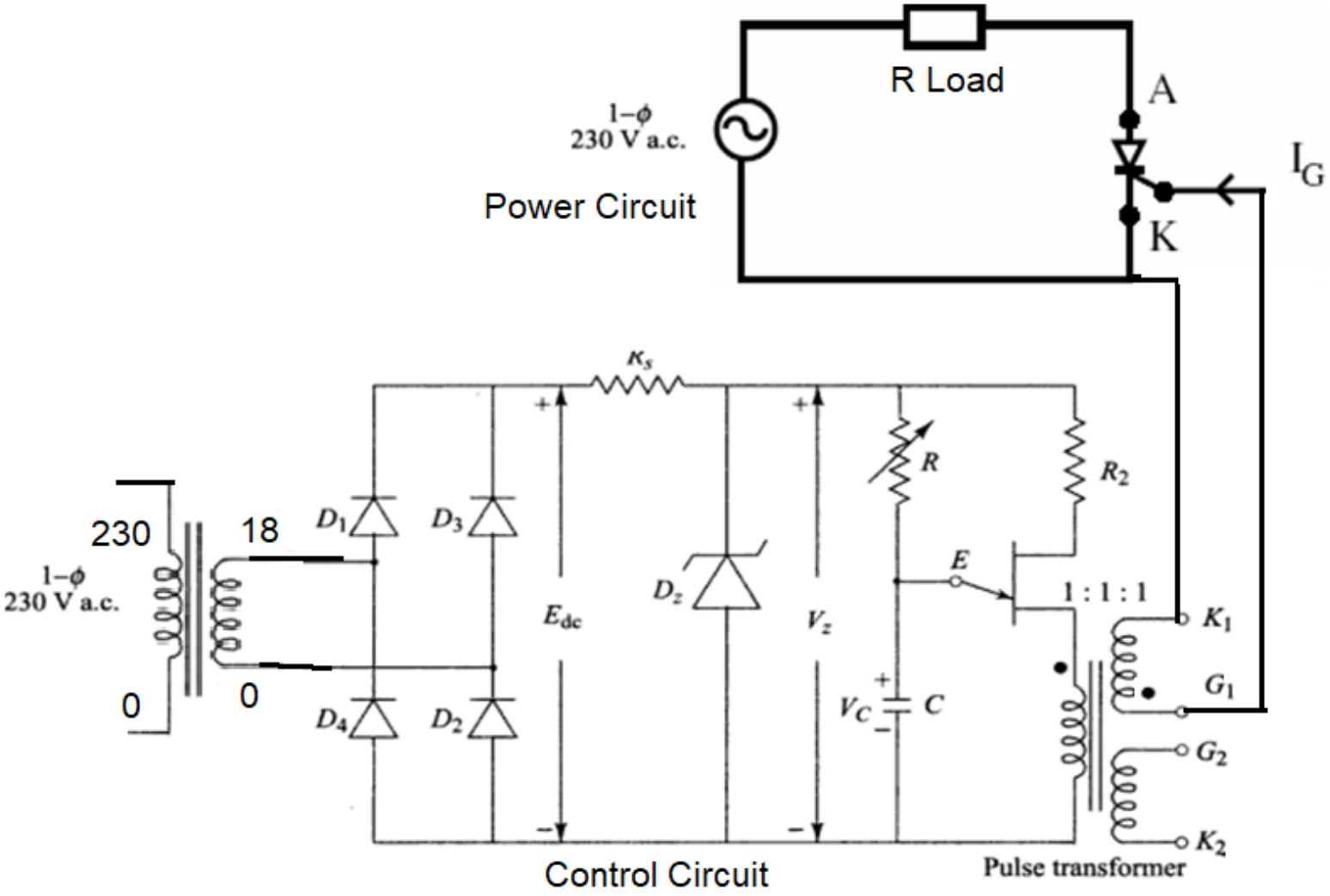


Pulse transformer

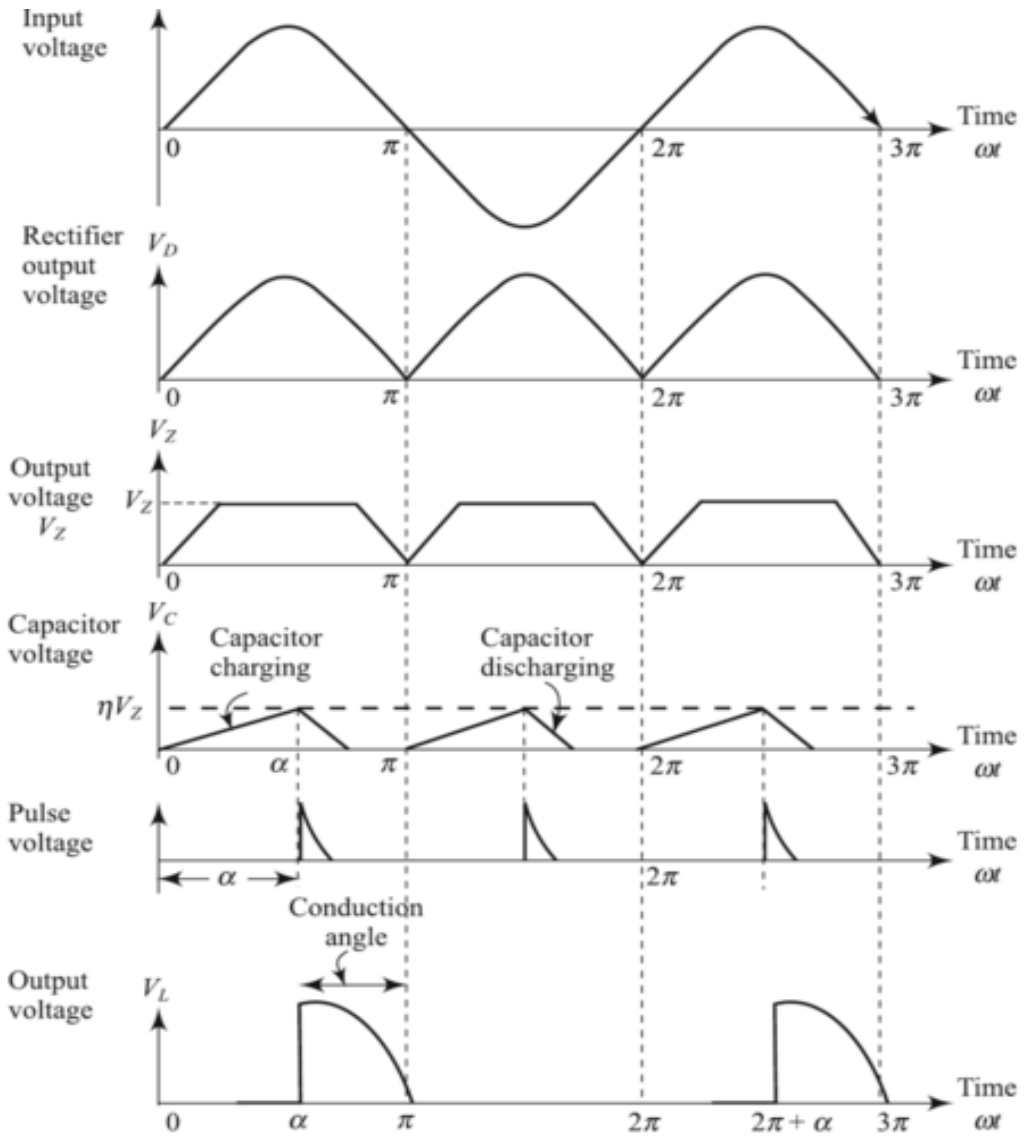
- Pulse transformer is designed for 10 kHz
- $E = 4.44 \phi_m f T_{ph}$ => $E/T_{ph} = 4.44 \phi_m f$
- As f increases voltage /turn increase
- Transformer becomes compact
- Size of transformer reduces.



Syn. UJT trigger circuit

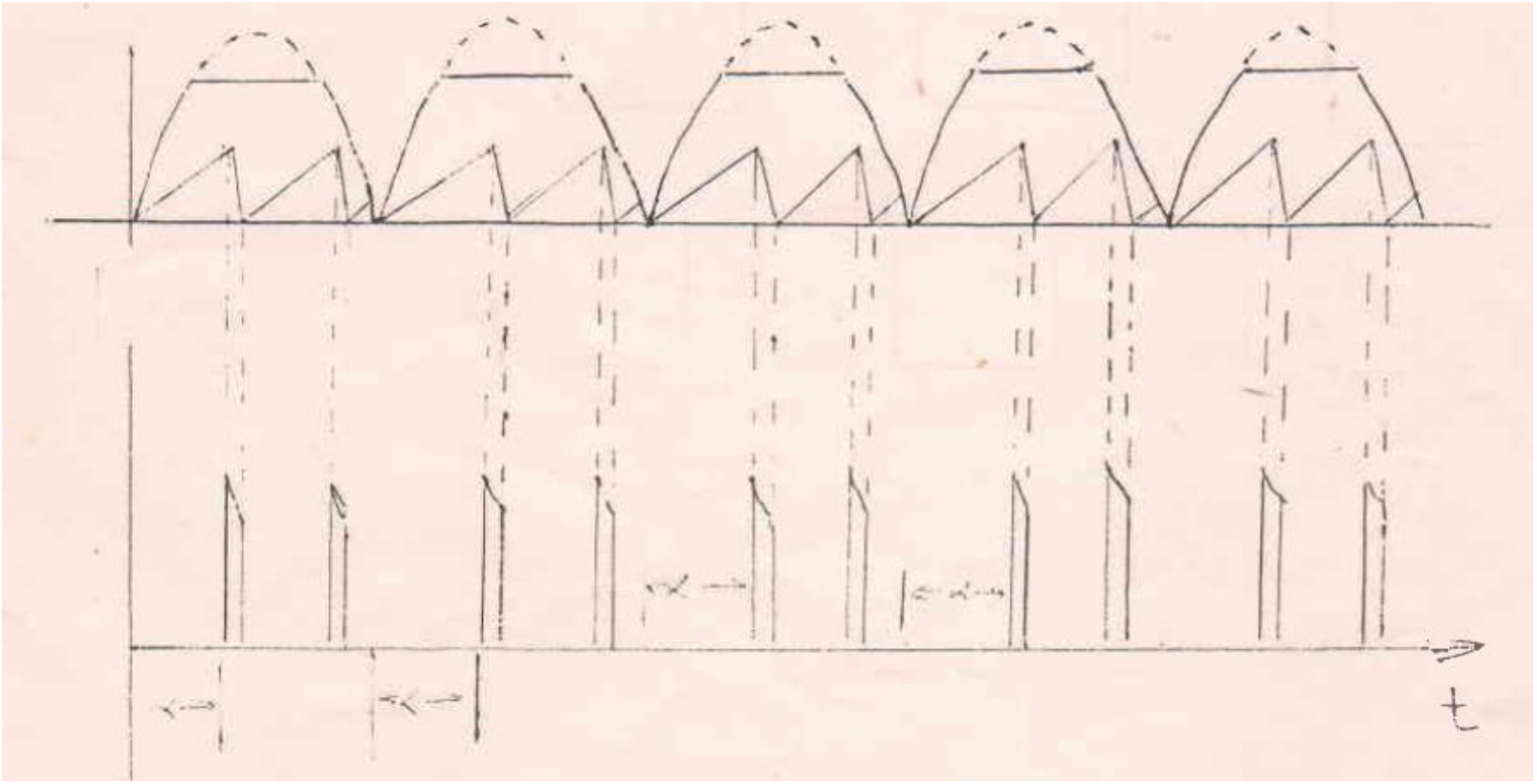


waveforms


Input voltage
Time
ωt
0
π
2π
3π
Rectifier output voltage
V_D
Output voltage V_Z
V_Z
Capacitor voltage
V_C
Capacitor charging
Capacitor discharging
ηV_Z
α
Pulse voltage
Conduction angle
Output voltage
V_L
2π + α

Syn. UJT trigger circuit

- Waveforms

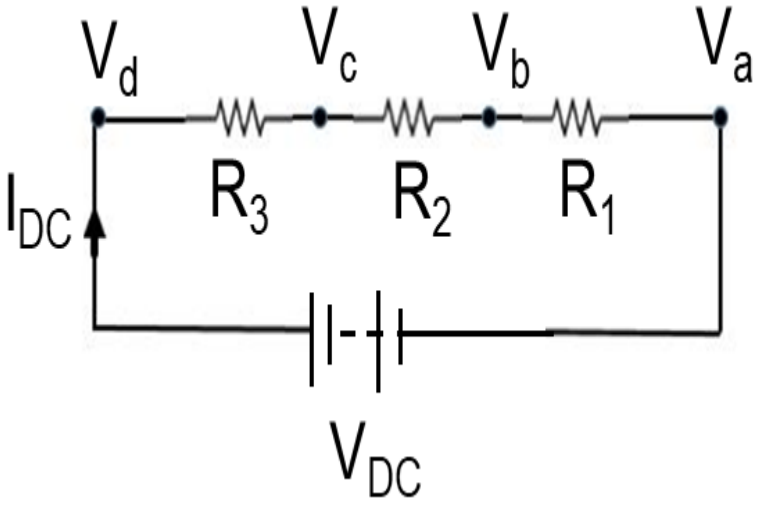


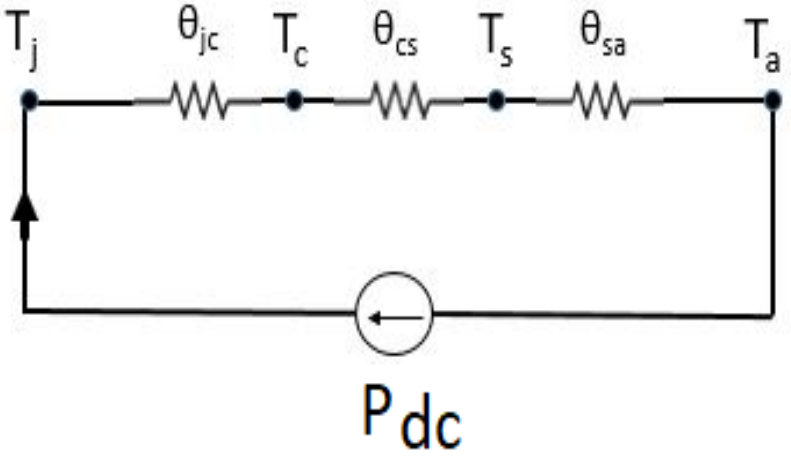
Thyristor losses

- Forward conduction loss
- Forward and reverse voltage blocking loss
- Switching loss
- Gate power loss
- PD = Total power dissipation in the thyristor

Thermal and Electrical circuit

Electrical Circuit	Thermal circuit
Current	Power dissipation
Voltage difference	Temp. difference
Resistance	Thermal resistance

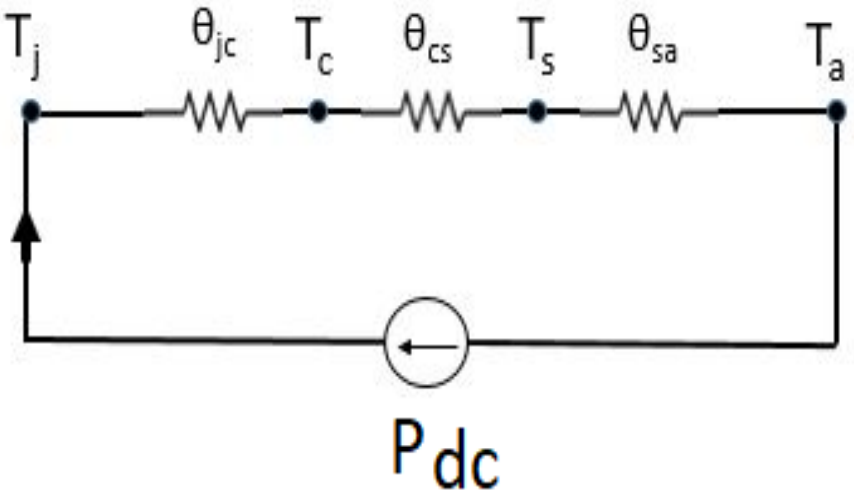




Thermal equivalent circuit- Parameters

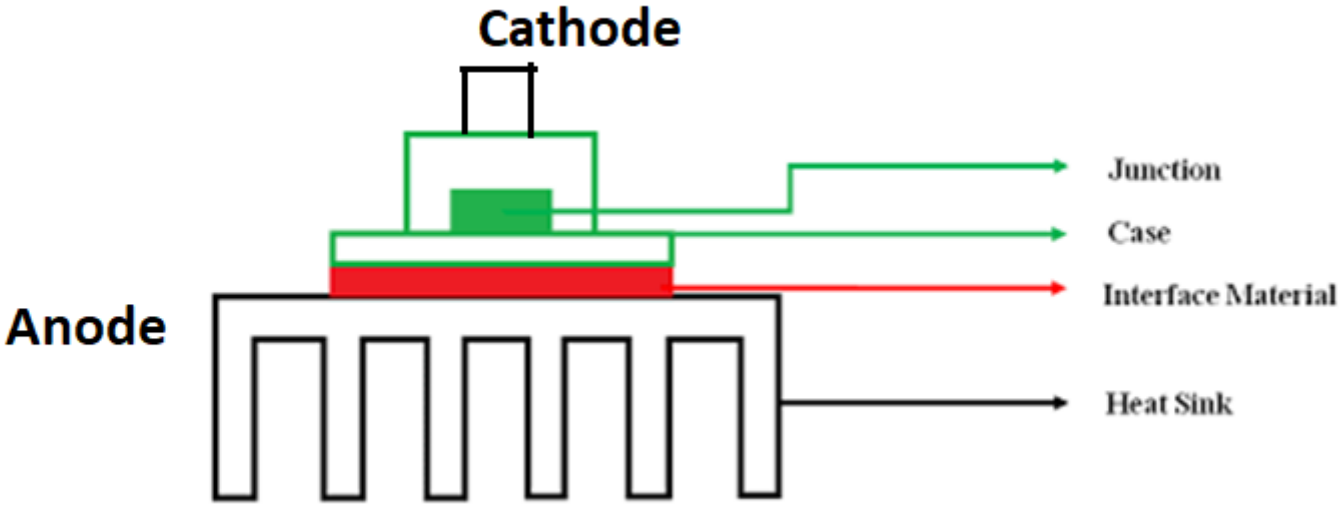
- P_{DC} = Total power loss in the device (W)
- θ_{SA} => Thermal resistance between sink and air (^{0}C/W)
- θ_{CS} => Thermal resistance between sink and case (^{0}C/W)
- θ_{JC} => Thermal resistance between case and junction (^{0}C/W)

- Ta => Ambient temp. (^{0}C)
- Ts => Heat sink temp (^{0}C)
- Tc => Case temp (^{0}C)
- Tj => Junction temp (^{0}C)



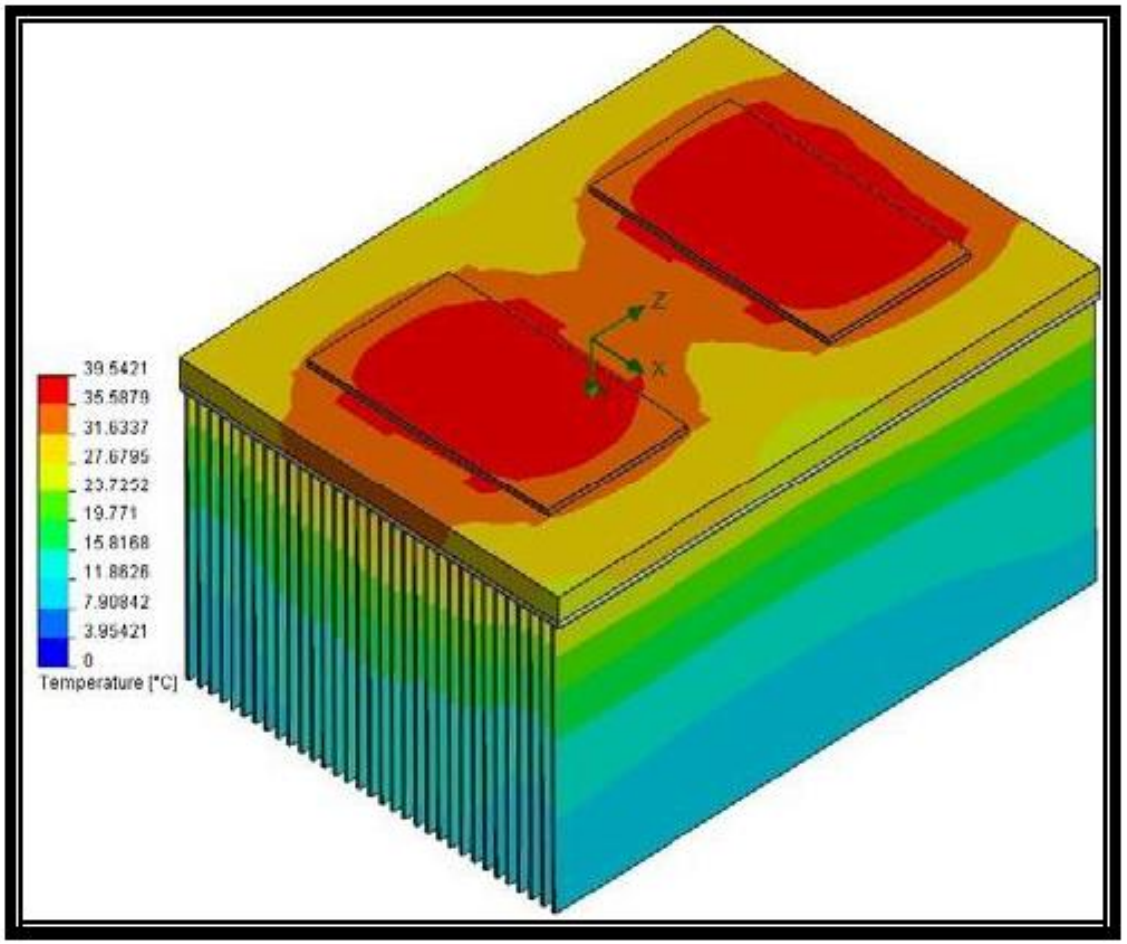
Junction Temp Calculations

- Temp calculations
- $T_j = T_a + P_{DC}(\theta_{SA} + \theta_{CS} + \theta_{JC})$
- $T_c = T_a + P_{DC}(\theta_{SA} + \theta_{CS})$
- $T_s = T_a + P_{DC}(\theta_{SA})$



Temp distribution in heat sink

- Temp rise



Thermal Resistance

- Data sheet
- Ruttonshaha international rectifiers
- IRK 800 series power module

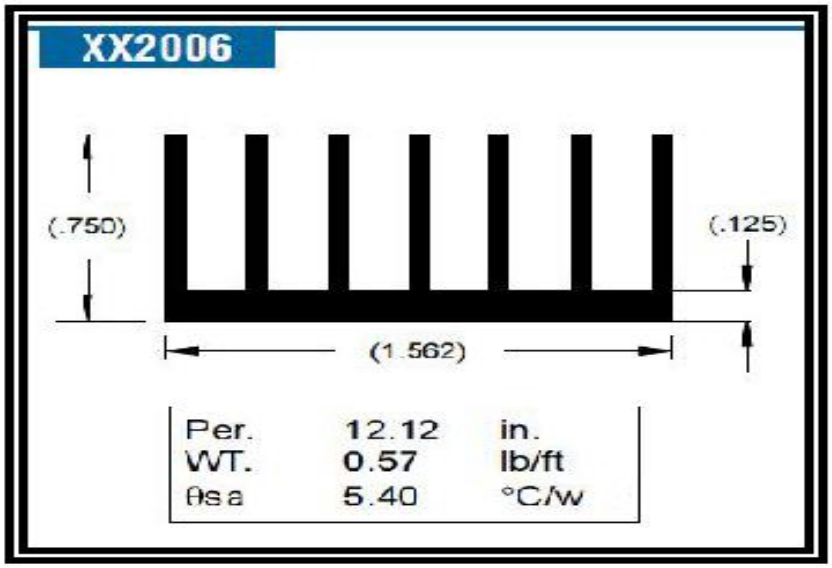
THERMAL AND MECHANICAL SPECIFICATION

	Parameter	800	Units	Conditions
T_J	Max. operating temperature range	-40 to125	°C	
T_{stg}	Max. storage temperature range	-40 to 125		
$R_{thJ\,C}$	Max. thermal resistance, junction to case	0.0250/0.0500	°C/W	Per module / per arm.
$R_{thC\,h}$	Max. thermal resistance, case to heatsink	0.0080/0.0160	°C/W	Per module / per arm.
T	Mounting tourque, ±15%	9 (18)	Nm	To heatsink & to (terminal)
W	Weight	3500	gm.	

Heat sink thermal resistance

- Heat sink thermal resistance is provided by heat sink manufacture

Extrusion Data:



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wakefield-vette

Numerical Problem

- Calculate the power loss in the device with following data
- Junction temp= 125^0C
- Θ_{jc} = 0.16^0C/W and Θ_{cs} = 0.06^0C/W
- Sink temp = 65^0C
- Solution
- $T_j = T_a + P_{DC}(\theta_{SA} + \theta_{CS} + \theta_{JC})$

$$T_j = (T_a + P_{DC}\theta_{SA}) + P_{DC}(\theta_{CS} + \theta_{JC})$$

$$T_j = T_S + P_{DC}(\theta_{CS} + \theta_{JC})$$

- Power dissipation =272.72 W

Data sheet of Thyristor

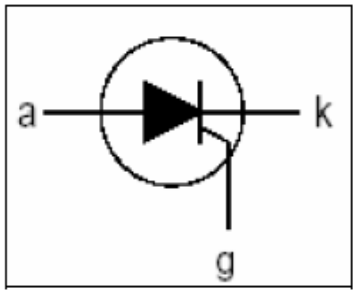
COMSET SEMICONDUCTORS

BT152 Series

THYRISTORS

FEATURE

Glass passivated thyristors in a plastic TO220 package. They are intended for use in applications requiring high bidirectional blocking voltage capability and high thermal cycling performance.
Typical applications include motor control, industrial and domestic lighting, heating and static switching.
Compliance to RoHS.



Data sheet of Thyristor

ABSOLUTE MAXIMUM RATINGS

Symbol	Ratings	Value			Unit
		BT152-400R	BT152-600R	BT152-800R	
V_{DRM}	Repetitive peak off-state voltage	450	650	800	V
V_{RRM}	Repetitive peak reverse voltage	450	650	800	
$I_{T(RMS)}$	RMS on-state current	20			A
$I_{T(AV)}$	Average on-state current	13			A
I_{TSM}	Non-repetitive peak on-state current	200			A
P_{GM}	Peak gate power	20			W
$PG_{(AV)}$	Average gate power	0.5			W
T_{stg}	Storage temperature range	-40 to +150			°C
T_J	Operating junction temperature	125			°C

THERMAL CHARACTERISTICS

Symbol	Ratings	Value	Unit
$R_{\delta j\text{-}mb}$	Thermal resistance junction to mounting base	≤ 1.1	°C/W
$R_{\delta JA}$	Thermal resistance junction to ambient	≤ 60	

Data sheet of Thyristor

BT152 Series

ELECTRICAL CHARACTERISTICS

TC=25°C unless otherwise noted

Symbol	Ratings	Test Condition(s)		Min	Typ	Max	Unit
V_{DRM}	Repetitive peak off-state voltage		BT152-400R	450	-	-	V
			BT152-600R	650	-	-	
			BT152-800R	800	-	-	
V_{RRM}	Repetitive peak reverse voltage		BT152-400R	450	-	-	
			BT152-600R	650	-	-	
			BT152-800R	800	-	-	
I_{GT}	Gate trigger current	V_D = 12 V; I_T = 100 mA		-	-	32	mA
V_{GT}	Gate trigger voltage	V_D = 12 V; I_T = 100 mA		-	-	1.5	V
I_L	Latching current	V_D = 12 V; I_{GT} = 100 mA		-	-	80	mA
I_H	Holding current	V_D = 12 V; I_{GT} = 100 mA		-	-	60	mA
I_D	Off-state current	$V_D = V_{DRM\,max}$; T_j = 125°C		-	-	1	mA
I_R	Reverse current	$V_R = V_{RRM\,max}$; T_j = 125°C		-	-	1	mA
V_T	On-state voltage	I_T = 40 A		-	-	1.75	V

Data sheet of Thyristor

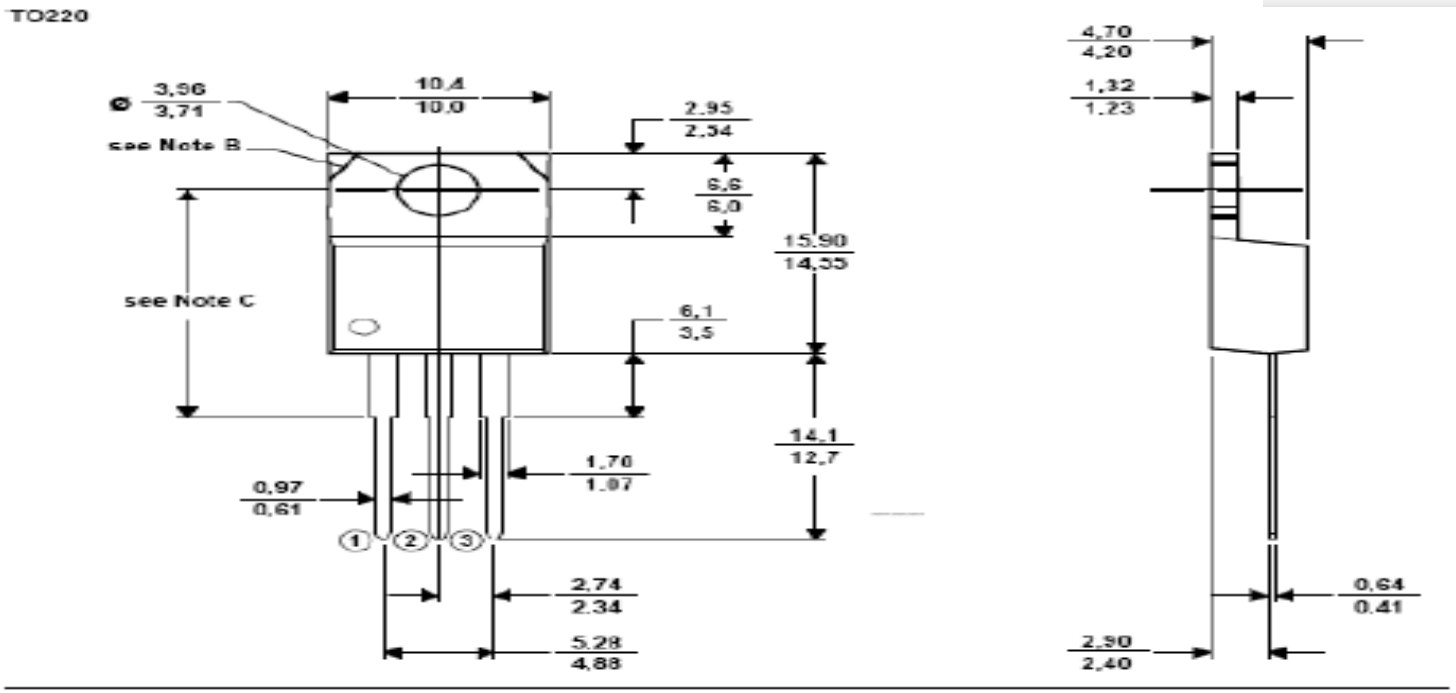
DYNAMIC CHARACTERISTICS

TC=25°C unless otherwise noted

Symbol	Ratings	Test Condition(s)	Min	Typ	Max	Unit
dV_D/dt	Critical rate of rise of off-state voltage	V_{DM} = 67% V_{DRMmax} T_J = 125°C Exponential waveform; gate open circuit	200	300	-	V/µs
t_{gt}	Gate controlled turn-on time	I_{TM} = 40 A; V_D = V_{DRMmax} I_G = 0.1 A; dI_G/dt = 5 A/µs	-	2	-	µs
t_q	Circuit commutated Turn-off time	V_{DM} = 67% V_{DRMmax} T_J = 125°C I_{TM} = 50 A; V_R = 25 V R_{GK} = 100 Ω dI_{TM}/dt = 30 A/µs dV_D/dt = 50 V/µS	-	70	-	µs

Data sheet of Thyristor

MECHANICAL DATA CASE TO-220



Pin 1 :	Main Terminal 1
Pin 2 :	Main Terminal 2
Pin 3 :	Gate
Case :	Main Terminal 2

Any Questions?