5STF 28H2060

Fast Thyristor

Properties

- Amplifying gate
- High operational capability
- Optimized turn-off parameters

Key Parameters

V_{DRM}, V_{RRM}	=	2 000	V
I_{TAV}	=	2 667	A
I_{TSM}	=	46.5	kA
V_{TO}	=	1.198	V
r_T	=	0.103	mΩ
t_q	=	60	µs

Applications

- Power switching applications

Types

	V_{RRM}, V_{DRM}
5STF 28H2060	**2 000 V**
Conditions: T_j = -40 ÷ 125 °C, half sine waveform, f = 50 Hz, note 1	

Mechanical Data

F_m	**Mounting force**	50 ± 5 kN
m	**Weight**	0.93 kg
D_S	**Surface creepage distance**	36 mm
D_a	**Air strike distance**	15 mm

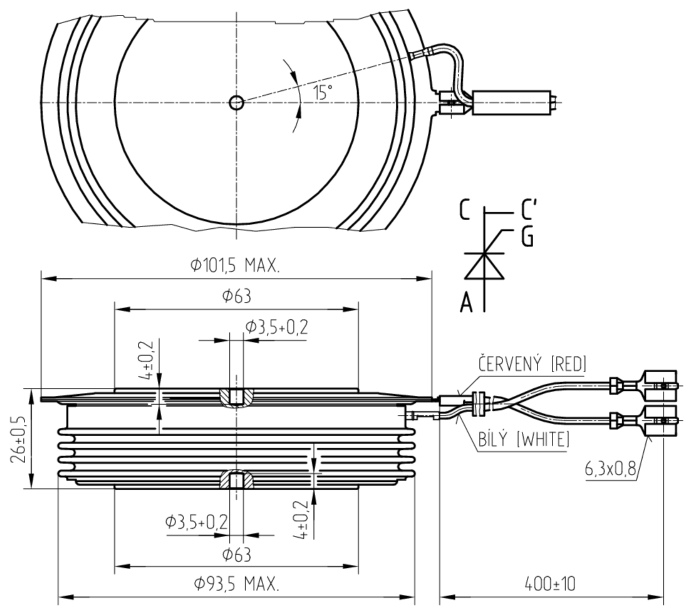

Fig. 1 Case

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Maximum Ratings			***Maximum Limits***	***Unit***
V_{RRM} ***V_{DRM}***	**Repetitive peak reverse and off-state voltage** *T_j = -40 ÷ 125 °C, note 1*		**2 000**	**V**
I_{TRMS}	**RMS on-state current** *T_c = 70 °C, half sine waveform, f = 50 Hz*		**4 189**	**A**
I_{TAVm}	**Average on-state current** *T_c = 70 °C, half sine waveform, f = 50 Hz*		**2 667**	**A**
I_{TSM}	**Peak non-repetitive surge** *half sine pulse, V_R = 0 V*	*t_p = 10 ms* *t_p = 8.3 ms*	**46 500** **49 700**	**A**
I^2t	**Limiting load integral** *half sine pulse, V_R = 0 V*	*t_p = 10 ms* *t_p = 8.3 ms*	**10 810 000** **10 250 000**	**A^2s**
$(di_T/dt)_{cr}$	**Critical rate of rise of on-state current** *I_T = I_{TAVm}, half sine waveform, f = 50 Hz,* *V_D = 2/3 V_{DRM}, t_r = 0.3 µs, I_{GT} = 2 A*		**800**	**A/µs**
$(dv_D/dt)_{cr}$	**Critical rate of rise of off-state voltage** *V_D = 2/3 V_{DRM}*		**1 000**	**V/µs**
P_{GAVm}	**Maximum average gate power losses**		**3**	**W**
I_{FGM}	**Peak gate current**		**10**	**A**
V_{FGM}	**Peak gate voltage**		**12**	**V**
V_{RGM}	**Reverse peak gate voltage**		**10**	**V**
T_{jmin} - T_{jmax}	**Operating temperature range**		**-40 ÷ 125**	**°C**
T_{stgmin} - T_{stgmax}	**Storage temperature range**		**-40 ÷ 125**	**°C**

Unless otherwise specified T_j = 125 °C

Note 1: De-rating factor of 0.13% V_{RRM} or V_{DRM} per °C is applicable for T_j below 25 °C

Characteristics			***Value***			***Unit***
			min.	***typ.***	***max.***	
V_{TM}	**Maximum peak on-state voltage**	I_{TM} = 2 000 A I_{TM} = 4 000 A			**1.350** **1.610**	**V**
V_{T0} r_T	**Threshold voltage** **Slope resistance** *I_{T1} = 4 188 A, I_{T2} = 12 563 A*				**1.198** **0.103**	**V** **mΩ**
I_{DM}	**Peak off-state current** *$V_D = V_{DRM}$*				**150**	**mA**
I_{RM}	**Peak reverse current** *$V_R = V_{RRM}$*				**150**	**mA**
t_{gd}	**Delay time** *T_j = 25 °C, V_D = 0.4 V_{DRM}, $I_{TM} = I_{TAVm}$,* *t_r = 0.3 µs, I_{GT} = 2 A*				**2.0**	**µs**
t_{q1}	**Turn-off time** *I_T = 1 000 A, di_T/dt = -50 A/µs,* *V_R = 100 V, V_D = 2/3 V_{DRM},* *dv_D/dt = 50 V/µs*				**60.0**	**µs**
t_{q2}	**Turn-off time** *I_T = 1 000 A, di_T/dt = -25 A/µs,* *V_R = 100 V, V_D = 2/3 V_{DRM},* *dv_D/dt = 400 V/µs*				**80.0**	**µs**
Q_{rr}	**Recovery charge** *the same conditions as at t_{q1}*				**2400**	**µC**
I_{rrM}	**Reverse recovery current** *the same conditions as at t_{q1}*				**315**	**A**
I_H	**Holding current**	*T_j = 25 °C* *T_j = 125 °C*		**250** **150**		**mA**
I_L	**Latching current**	*T_j = 25 °C* *T_j = 125 °C*		**500** **300**		**mA**
V_{GT}	**Gate trigger voltage** *V_D = 12V, I_T = 4 A*	*T_j = - 40 °C* *T_j = 25 °C* *T_j = 125 °C*	 **0.25**		**4** **3** **2**	**V**
I_{GT}	**Gate trigger current** *V_D = 12V, I_T = 4 A*	*T_j = - 40 °C* *T_j = 25 °C* *T_j = 125 °C*	 **10**		**1000** **500** **300**	**mA**

Unless otherwise specified T_j = 125 °C

Thermal Parameters		*Value*	*Unit*
R_{thjc}	**Thermal resistance junction to case** *double side cooling*	**10.0**	**K/kW**
	anode side cooling	**16.0**	
	cathode side cooling	**26.5**	
R_{thch}	**Thermal resistance case to heatsink** *double side cooling*	**3.0**	**K/kW**
	single side cooling	**6.0**	

Transient Thermal Impedance

Analytical function for transient thermal impedance

$$Z_{thjc} = \sum_{i=1}^{5} R_i (1 - \exp(-t / \tau_i))$$

Conditions:

F_m = 50 ± 5 kN, Double side cooled

Correction for periodic waveforms

180°	**sine:**	**add**	**1.0 K/kW**
180°	**rectangular:**	**add**	**1.0 K/kW**
120°	**rectangular:**	**add**	**1.5 K/kW**
60°	**rectangular:**	**add**	**3.0 K/kW**

i	1	2	3	4	5
τ_i (s)	0.4871	0.1468	0.0677	0.0079	0.0021
R_i(K/kW)	6.73	1.44	0.65	0.84	0.32

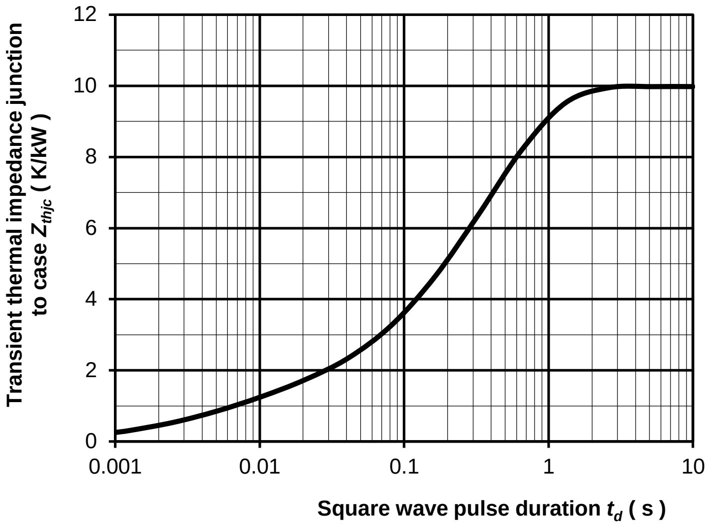

Fig. 2 Dependence transient thermal impedance junction to case on square pulse

On-State Characteristics

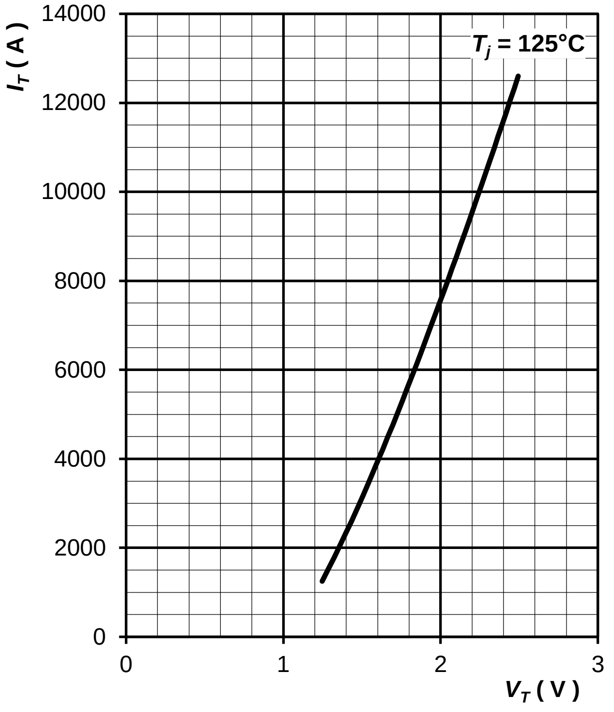

Fig. 3 Maximum on-state characteristics

Gate Trigger Characteristics

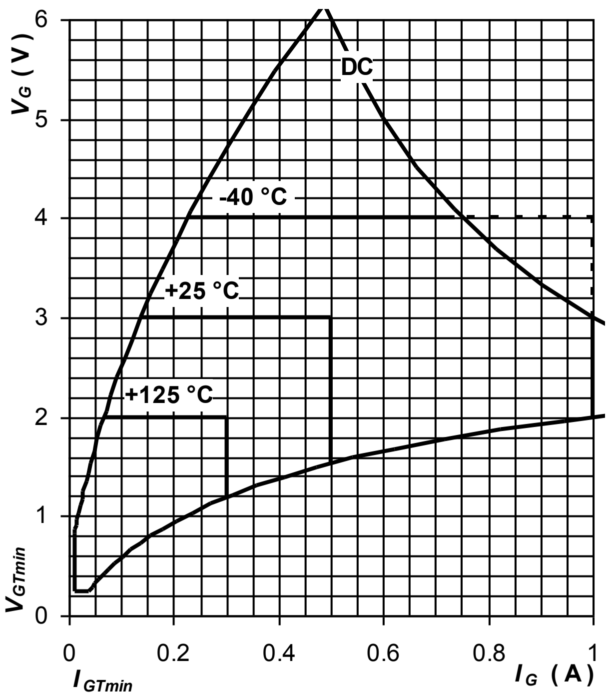

Fig. 4 Gate trigger characteristics

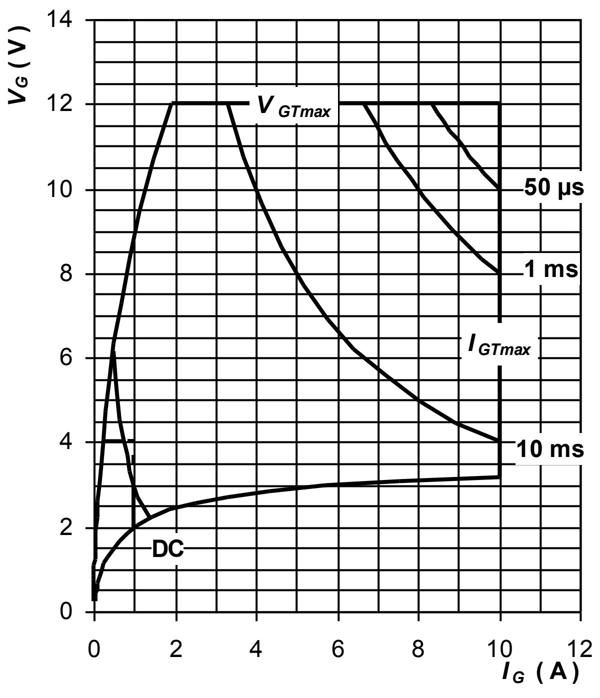

Fig. 5 Maximum peak gate power loss

Surge Characteristics

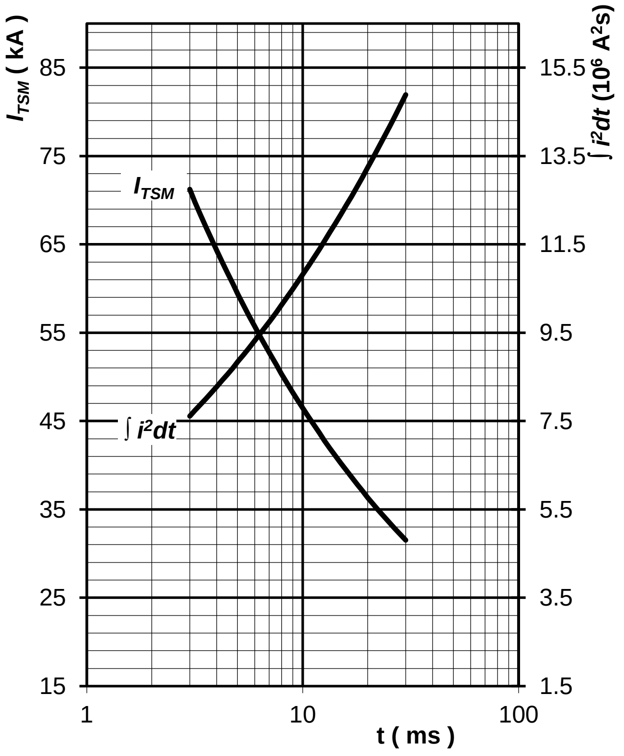

Fig. 6 Surge on-state current vs. pulse length, half sine wave, single pulse, V_R = 0 V, $T_j = T_{jmax}$

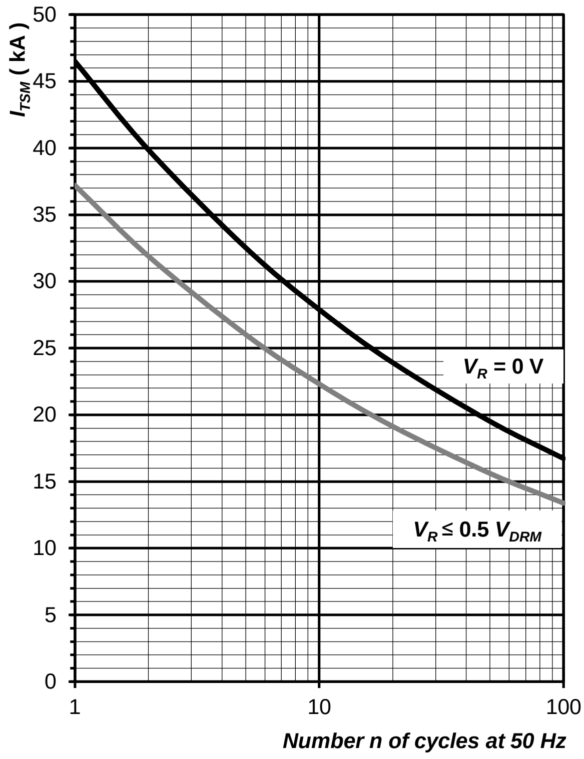

Fig. 7 Surge on-state current vs. number of pulses, half sine wave, $T_j = T_{jmax}$

Power Loss and Maximum Case Temperature Characteristics

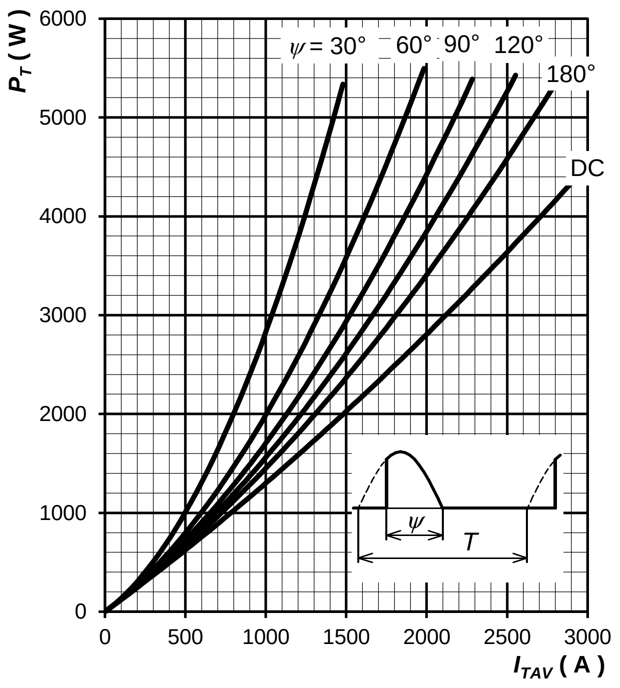

Fig. 8 On-state power loss vs. average on-state current, sine waveform, f = 50 Hz, T = 1/f

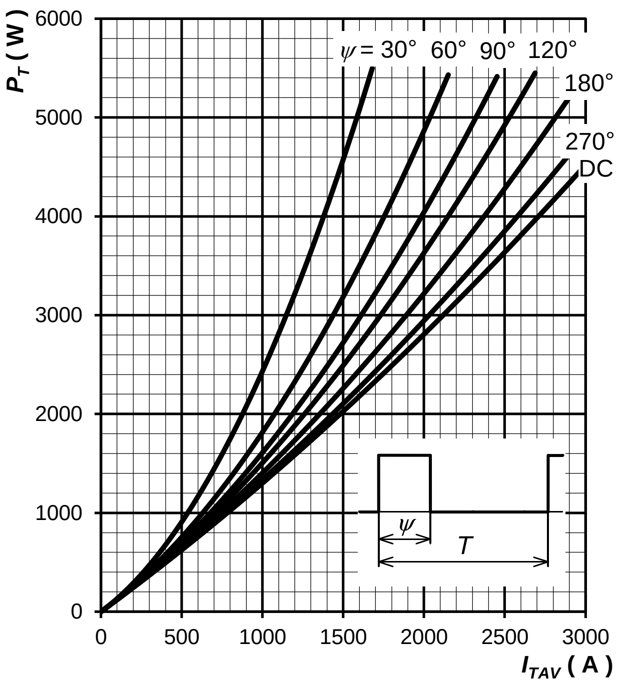

Fig. 9 On-state power loss vs. average on-state current, square waveform, f = 50 Hz, T = 1/f

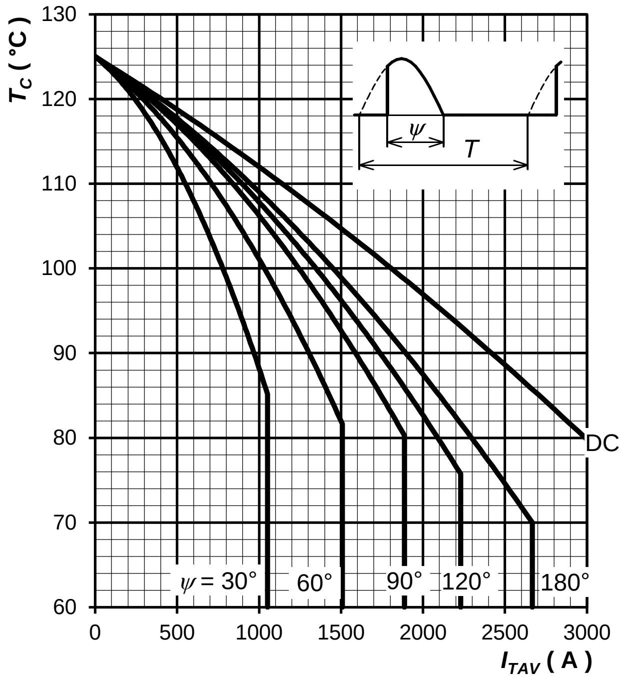

Fig. 10 Max. case temperature vs. aver. on-state current, sine waveform, f = 50 Hz, T = 1/f

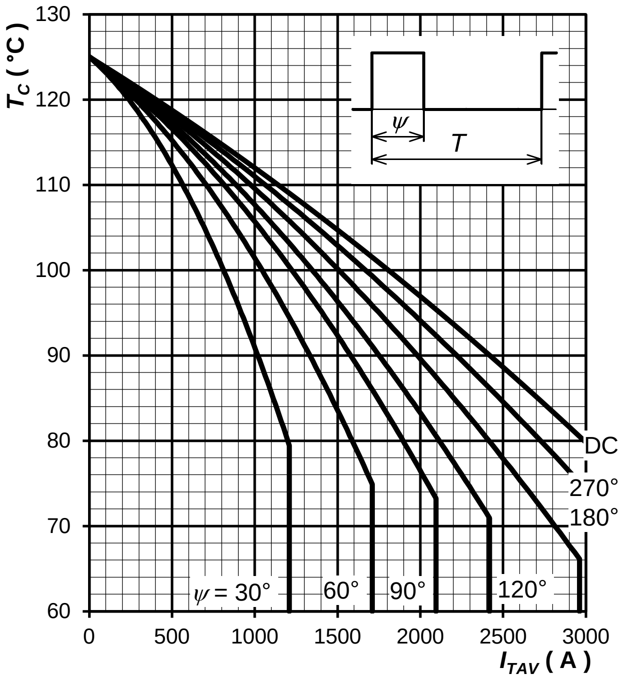

Fig. 11 Max. case temperature vs. aver. on-state current, square waveform, f = 50 Hz, T = 1/f

Note 2: Figures number 8 ÷ 11 have been calculated without considering any turn-on and turn-off losses. They are valid for f = 50 or 60 Hz operation.

Turn-off Time, Parameter Relationship

Maximum values of turn-off time at application specific conditions are given by using this formula:

$$t_q = t_{q1} \cdot \frac{t_q}{t_{q1}}(T_j) \cdot \frac{t_q}{t_{q1}}(dv_D / dt) \cdot \frac{t_q}{t_{q1}}(-di_T / dt)$$

where:

t_{q1} *is turn-off time at standard conditions, see section "Characteristics"*

$\frac{t_q}{t_{q1}}(T_j)$ *is factor to be taken from fig. 12*

$\frac{t_q}{t_{q1}}(dv_D / dt)$ *is factor to be taken from fig. 13*

$\frac{t_q}{t_{q1}}(-di_T / dt)$ *is factor to be taken from fig. 14*

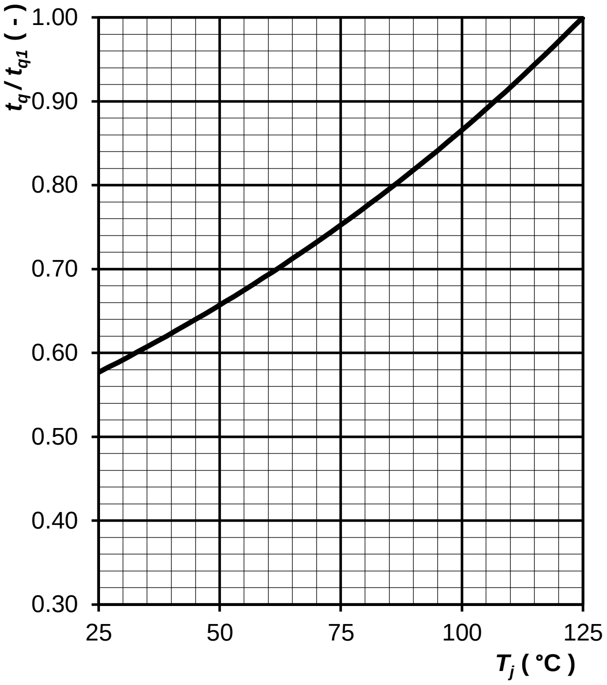

Fig. 12 Normalised maximum turn-off time vs. junction temperature

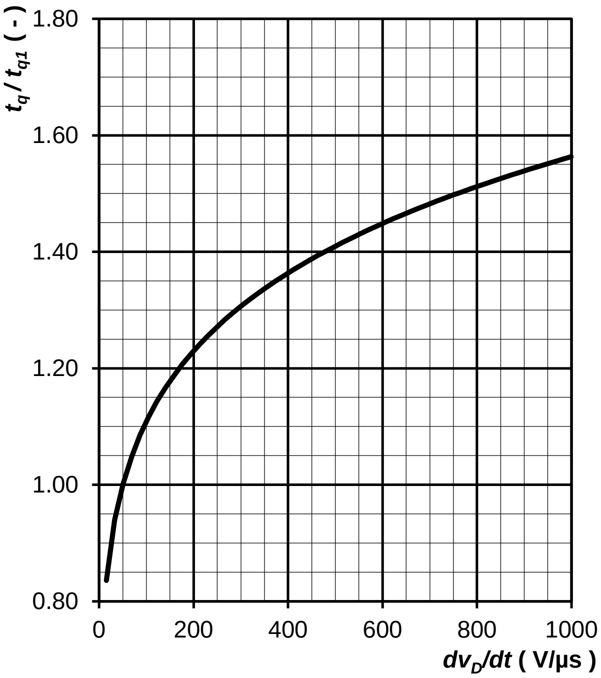

Fig. 13 Normalised maximum turn-off time vs. rate of rise of off-state voltage

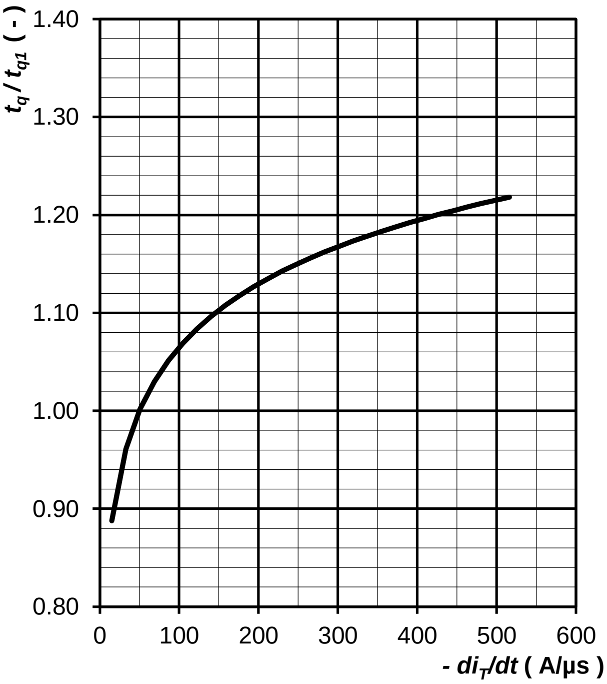

Fig. 14 Normalised maximum turn-off time vs. rate of fall of on-state current

Turn-off Characteristics

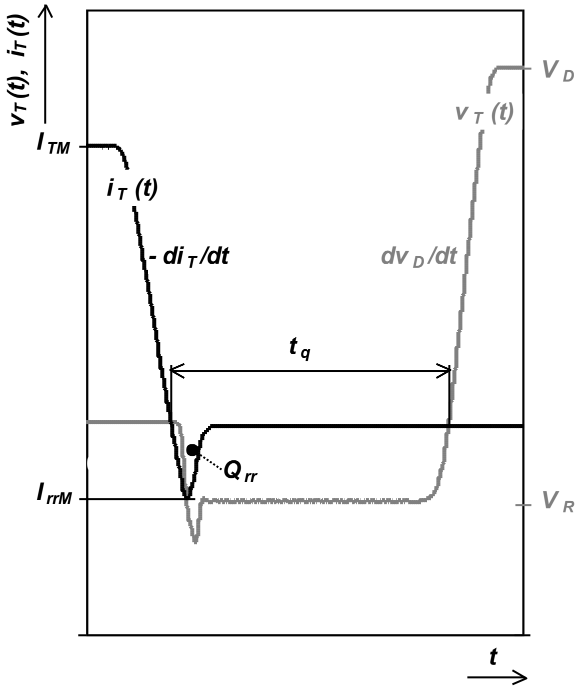

Fig. 17 Typical waveforms and definition of symbols at turn-off of a thyristor, inductive switching without RC snubber

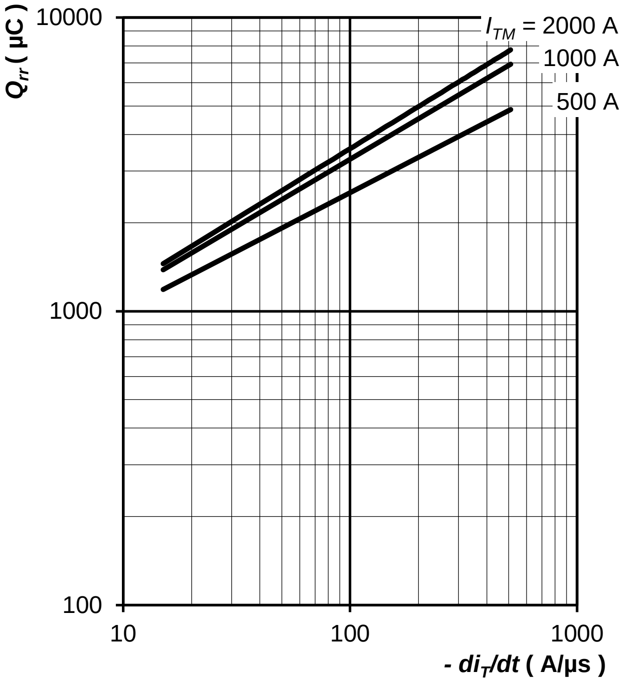

Fig. 18 Max. recovered charge vs. rate of fall on-state current, trapezoid pulse, V_R = 100 V, $T_j = T_{jmax}$

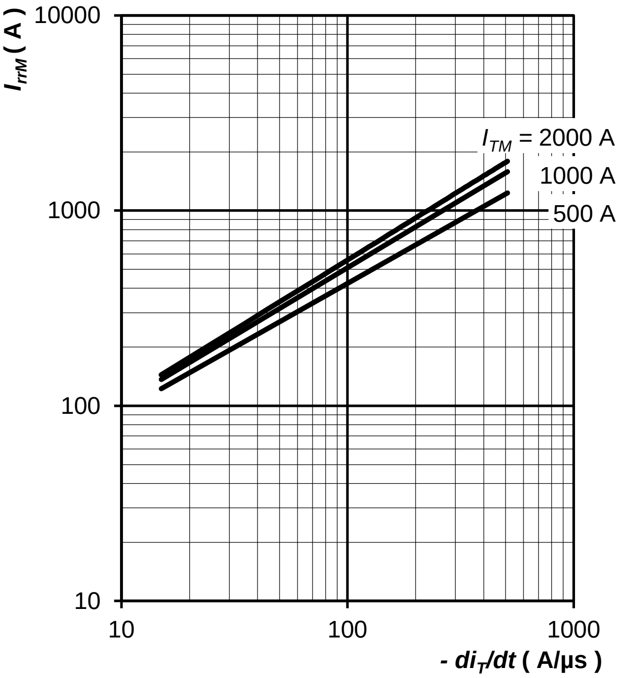

Fig. 19 Max. reverse recovery current vs. rate of fall on-state current, trapezoid pulse, V_R = 100 V, $T_j = T_{jmax}$

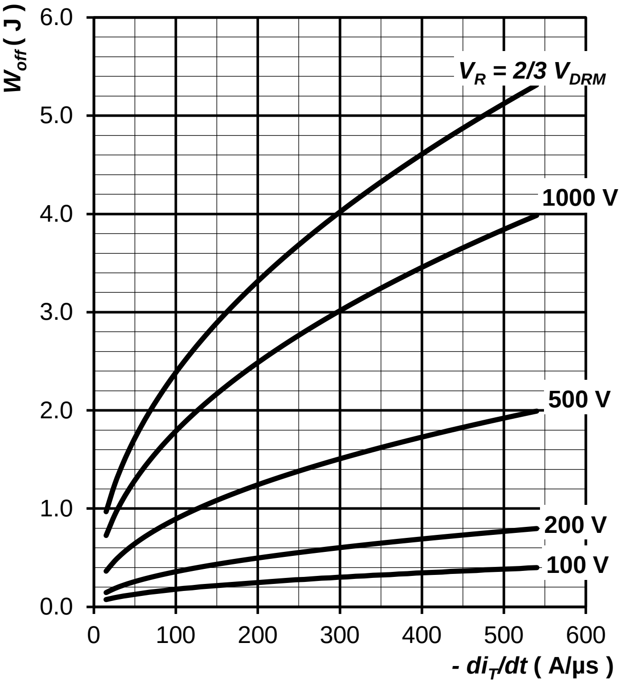

Fig. 20 Maximum turn-off energy per pulse vs. rate of fall on-state current, trapezoid pulse, inductive switching without RC snubber, I_{TM} = 2 000 A, $T_j = T_{jmax}$

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