5STF 16F1413

Old part no. TR 918F-1590-14

Medium Frequency Thyristor

Properties

- Amplifying gate
- High operational capability
- Optimized turn-on and turn-off parameters
- High operating frequency

Applications

- Power switching applications

Key Parameters

V_{DRM}, V_{RRM}	=	1 400	V
I_{TAV}	=	1 526	A
I_{TSM}	=	21.0	kA
V_{TO}	=	1.628	V
r_T	=	0.121	mΩ
t_q	=	12.5	µs

Types

	V_{RRM}, V_{DRM}
5STF 16F1413..1416	**1 400 V**
5STF 16F1213..1216	**1 200 V**

Conditions:
T = -40 ÷ 125 °C, half sine waveform,
f = 50 Hz, note 1

Mechanical Data

F_m	**Mounting force**	22 ± 2	kN
m	**Weight**	0.48	kg
D_S	**Surface creepage distance**	25	mm
D_a	**Air strike distance**	13	mm

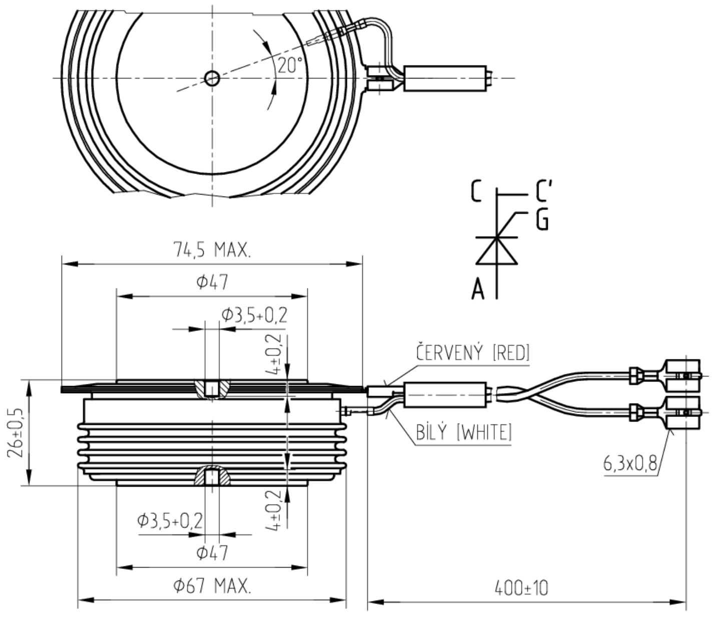

Fig. 1 Case

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Novodvorska 1768/138a, 142 21 Praha 4, Czech Republic
tel.: +420 261 306 250, http://www.abb.com/semiconductors

Maximum Ratings			*Maximum Limits*	*Unit*
V_{RRM} ***V_{DRM}***	**Repetitive peak reverse and off-state voltage** *T_j = -40 ¸ 125 °C, note 1*	**5STF 16F1413..1416** **5STF 16F1213..1216**	**1 400** **1 200**	**V**
I_{TRMS}	**RMS on-state current** *T_c = 70 °C, half sine waveform, f = 50 Hz*		**2 397**	**A**
I_{TAVm}	**Average on-state current** *T_c = 70 °C, half sine waveform, f = 50 Hz*		**1 526**	**A**
I_{TSM}	**Peak non-repetitive surge** *half sine pulse, V_R = 0 V*	*t_p = 10 ms* *t_p = 8.3 ms*	**21 000** **22 400**	**A**
I^2t	**Limiting load integral** *half sine pulse, V_R = 0 V*	*t_p = 10 ms* *t_p = 8.3 ms*	**2 205 000** **2 088 000**	**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*				**1.870**	**V**
V_{T0} r_T	**Threshold voltage** **Slope resistance** *I_{T1} = 2 498 A, I_{T2} = 7 493 A*				**1.628** **0.121**	**V** **mW**
I_{DM}	**Peak off-state current** *$V_D = V_{DRM}$*				**100**	**mA**
I_{RM}	**Peak reverse current** *$V_R = V_{RRM}$*				**100**	**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*	**group of t_q** **5STF 16F1413** **5STF 16F1213** **5STF 16F1416** **5STF 16F1216**			**12.5** **16.0**	**µs**
Q_{rr}	**Recovery charge** *the same conditions as at t_{q1}*				**300**	**µC**
I_{rrM}	**Reverse recovery current** *the same conditions as at t_{q1}*				**120**	**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*		**1 500** **1 000**		**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*	**16.0**	**K/kW**
	anode side cooling	**25.0**	
	cathode side cooling	**45.0**	
R_{thch}	**Thermal resistance case to heatsink** *double side cooling*	**4.0**	**K/kW**
	single side cooling	**8.0**	

Transient Thermal Impedance

Analytical function for transient thermal impedance

$$Z_{thjc} = \sum_{i=1}^{4} R_i (1 - \exp(-t / \tau_i))$$

Conditions:

F_m = 22 ± 2 kN, Double side cooled

Correction for periodic waveforms

180° sine:	**add**	**1.3 K/kW**
180° rectangular:	**add**	**1.8 K/kW**
120° rectangular:	**add**	**3.0 K/kW**
60° rectangular:	**add**	**5.1 K/kW**

i	1	2	3	4
τ_i (s)	0.4653	0.1533	0.0375	0.0034
R_i(K/kW)	5.50	7.24	2.00	1.30

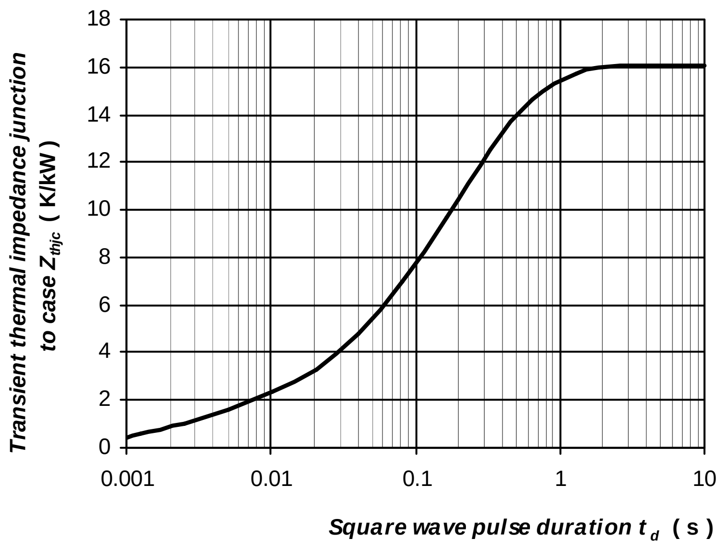


Fig. 2 Dependence transient thermal impedance junction to case on square pulse

On-State Characteristics

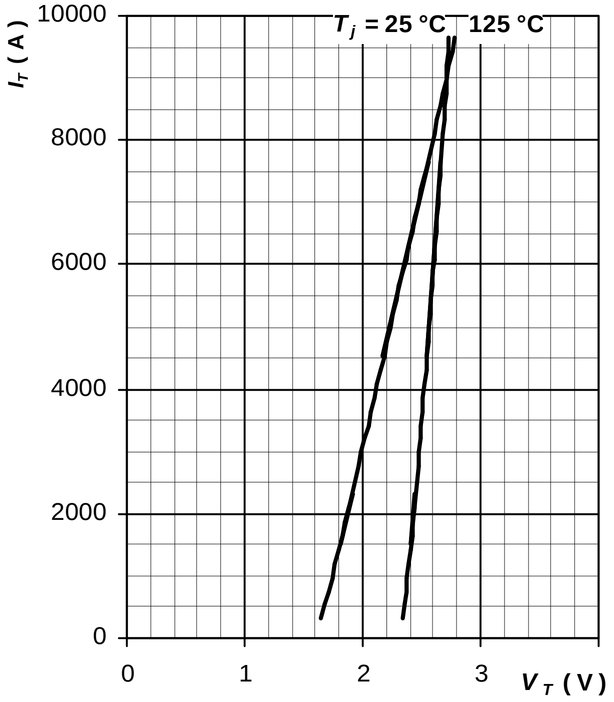
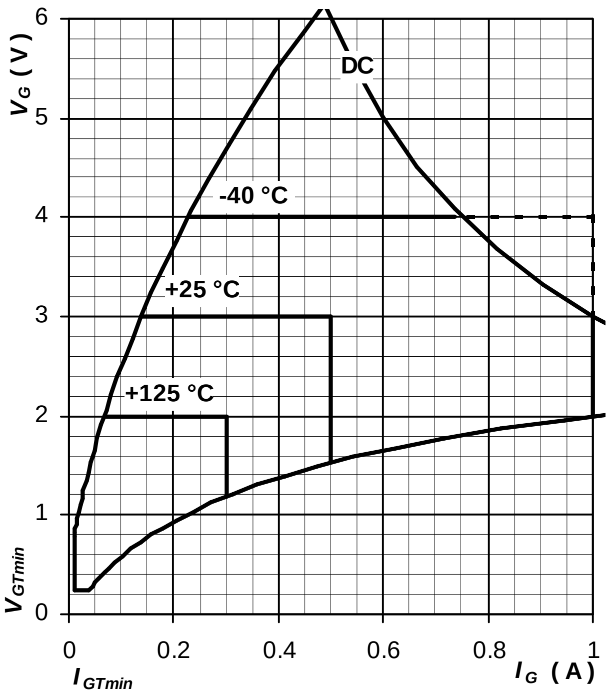


Fig. 3 Maximum on-state characteristics

Gate Trigger Characteristics



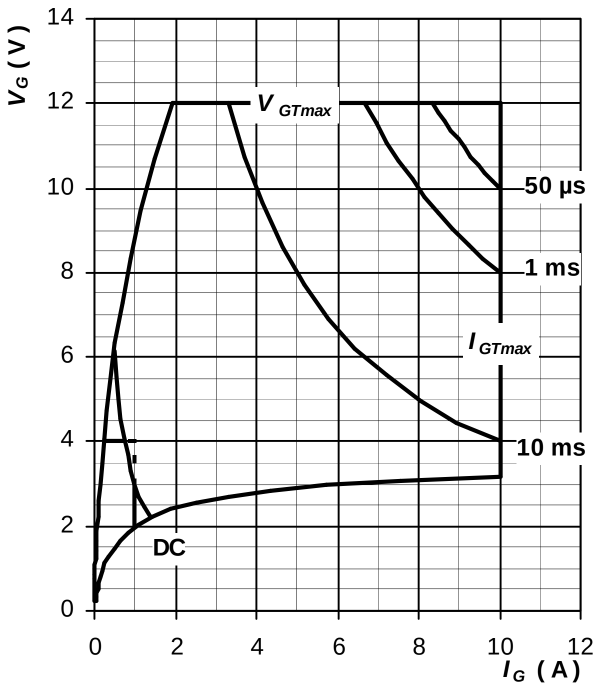


Fig. 4 Gate trigger characteristics

Fig. 5 Maximum peak gate power loss

Surge Characteristics

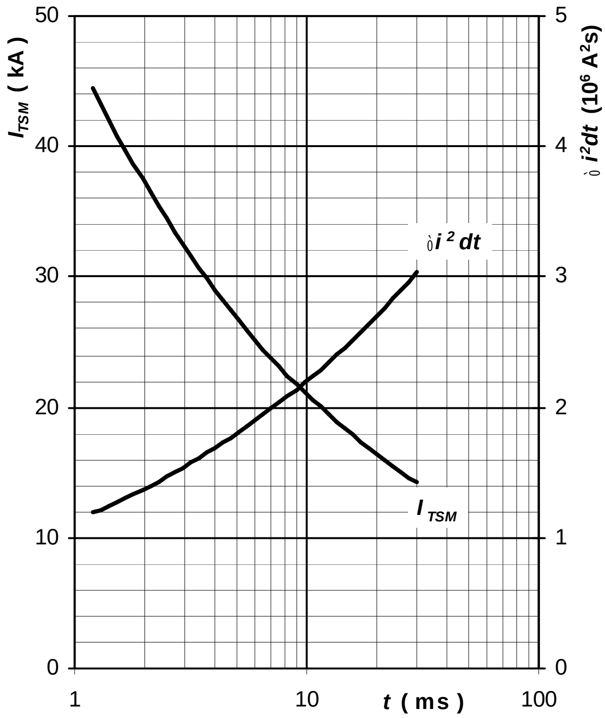


Fig. 6 Surge on-state current vs. pulse length, half sine wave, single pulse, V_R = 0 V, $T_j = T_{jmax}$

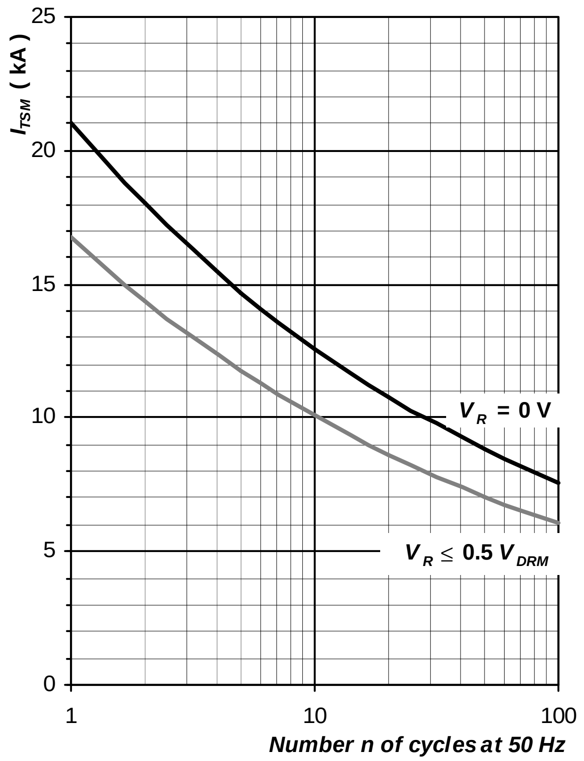


Fig. 7 Surge on-state current vs. number of pulses, half sine wave, $T_j = T_{jmax}$

Power Loss and Maximum Case Temperature Characteristics

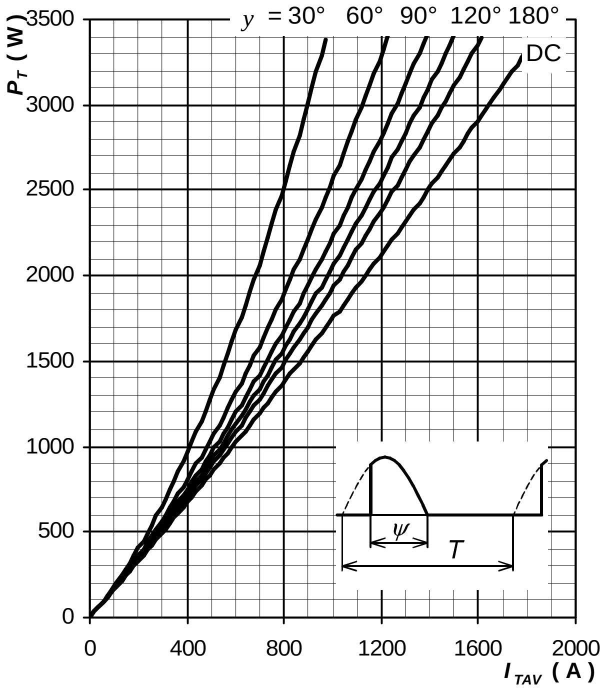


Fig. 8 On-state power loss vs. average on-state current, sine waveform, f = 50 Hz, T = 1/f

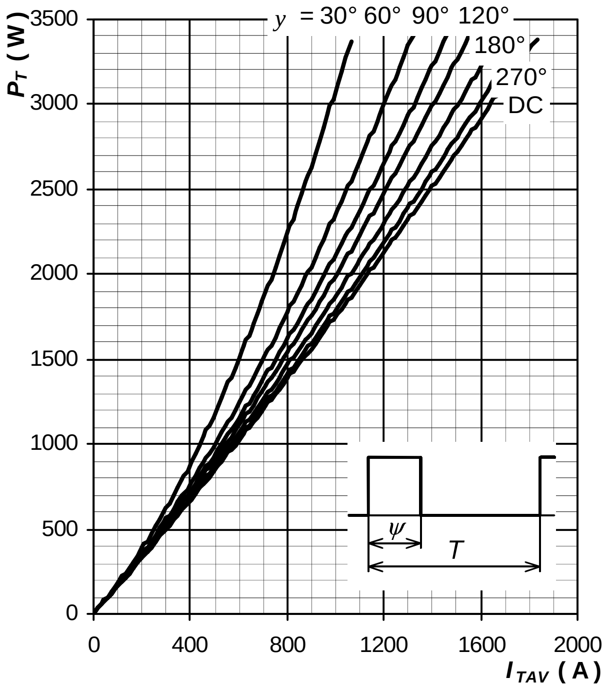
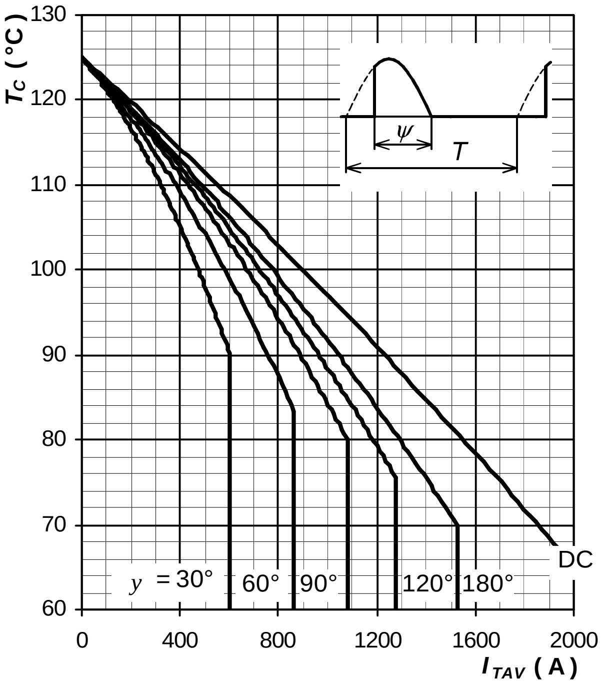


Fig. 9 On-state power loss vs. average on-state current, square waveform, f = 50 Hz, T = 1/f



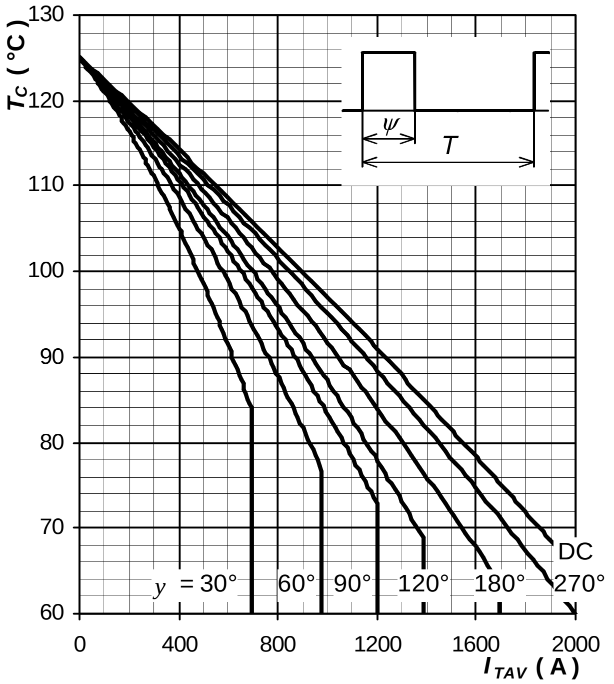


Fig. 10 Max. case temperature vs. aver. on-state current, sine waveform, f = 50 Hz, T = 1/f	*Fig. 11 Max. case temperature vs. aver. on-state current, square waveform, f = 50 Hz, T = 1/f*

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*

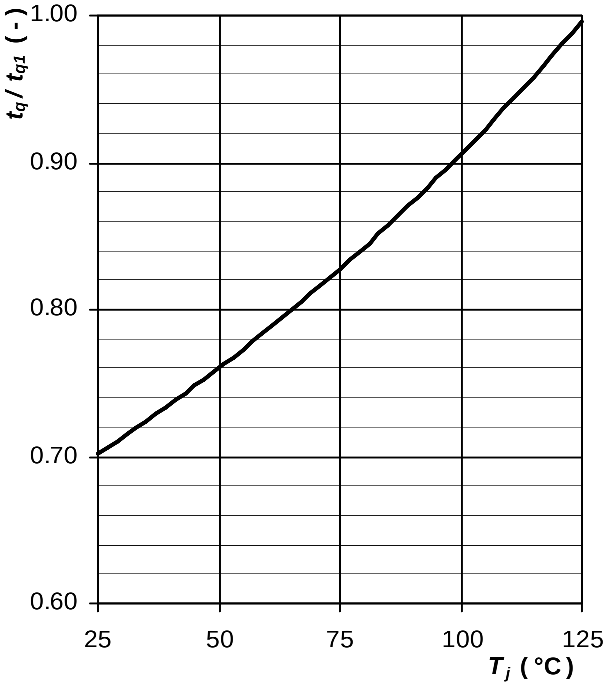
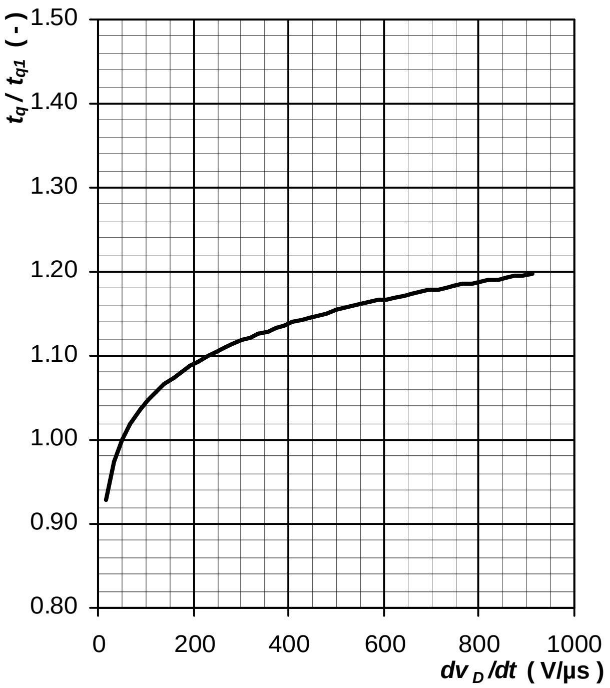


Fig. 12 Normalised maximum turn-off time vs. junction temperature



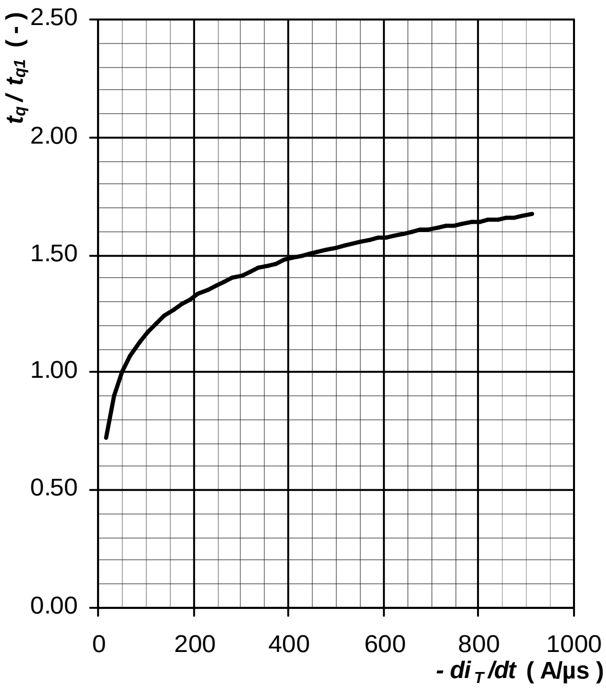


Fig. 13 Normalised maximum turn-off time vs. rate of rise of off-state voltage	Fig. 14 Normalised maximum turn-off time vs. rate of fall of on-state current

Turn-on Characteristics

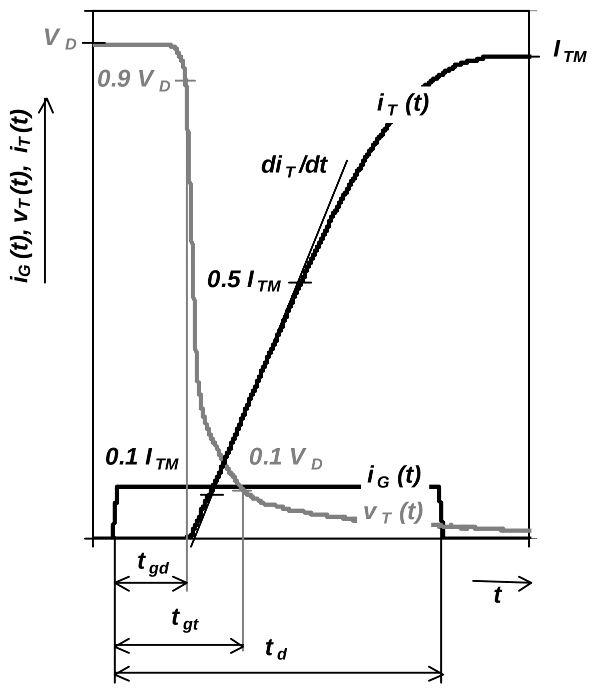


Fig. 15 Typical waveforms and definition of symbols at turn-on of a thyristor

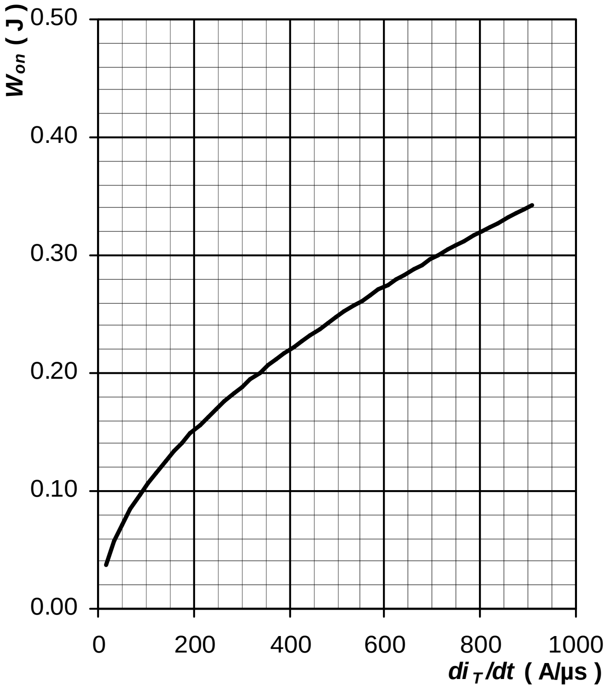


Fig. 16 Maximum turn-on energy per pulse vs. rate of rise on-state current, $T_j = T_{jmax}$

Turn-off Characteristics

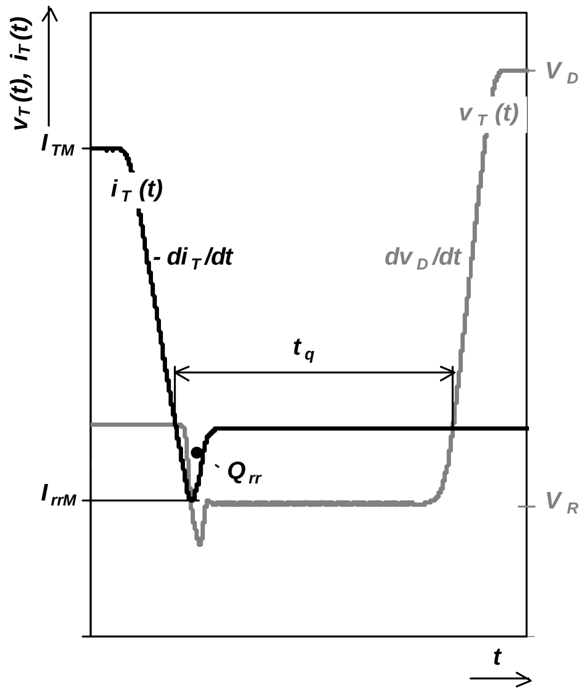


Fig. 17 Typical waveforms and definition of symbols at turn-off of a thyristor, inductive switching without RC snubber

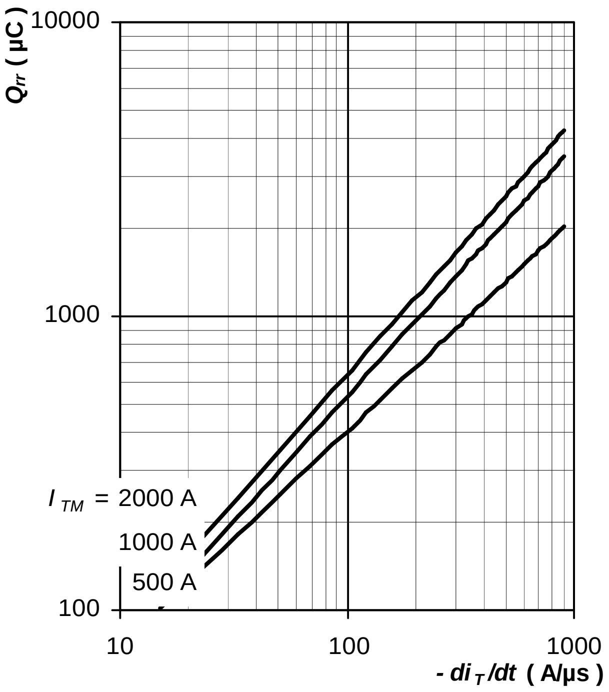


Fig. 18 Max. recovered charge vs. rate of fall on-state current, trapezoid pulse, V_R *= 100 V,* $T_j = T_{jmax}$

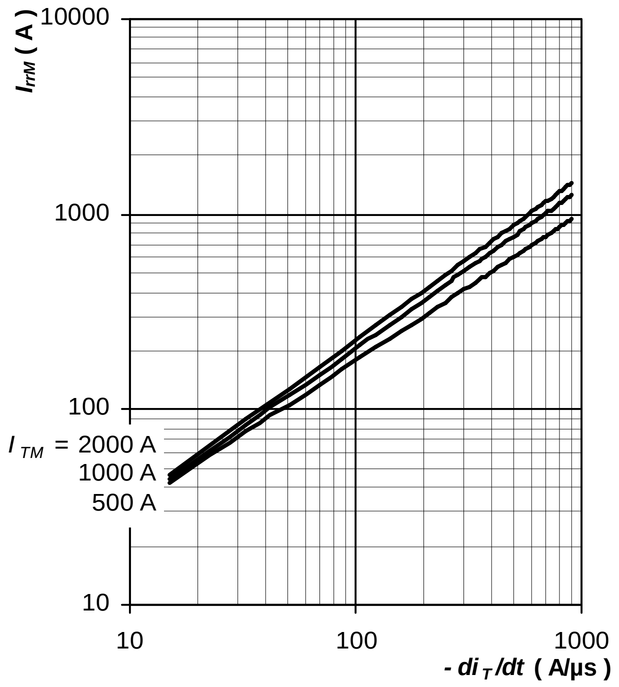


Fig. 19 Max. reverse recovery current vs. rate of fall on-state current, trapezoid pulse, V_R = 100 V, $T_j = T_{jmax}$

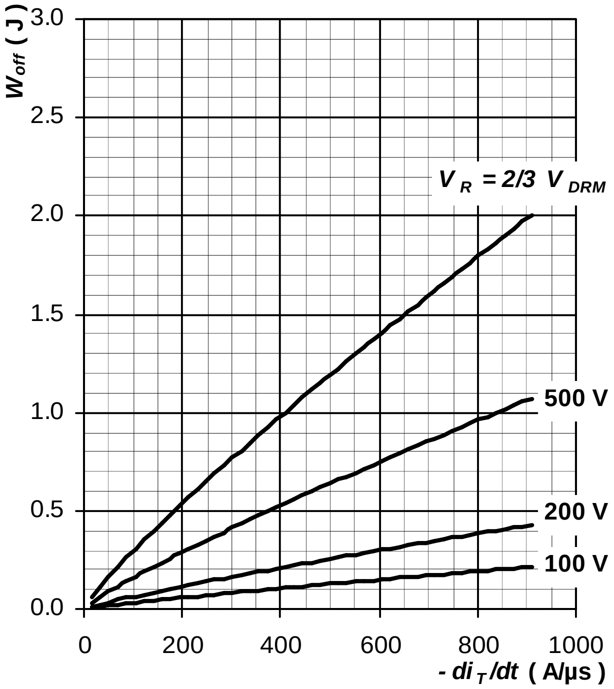
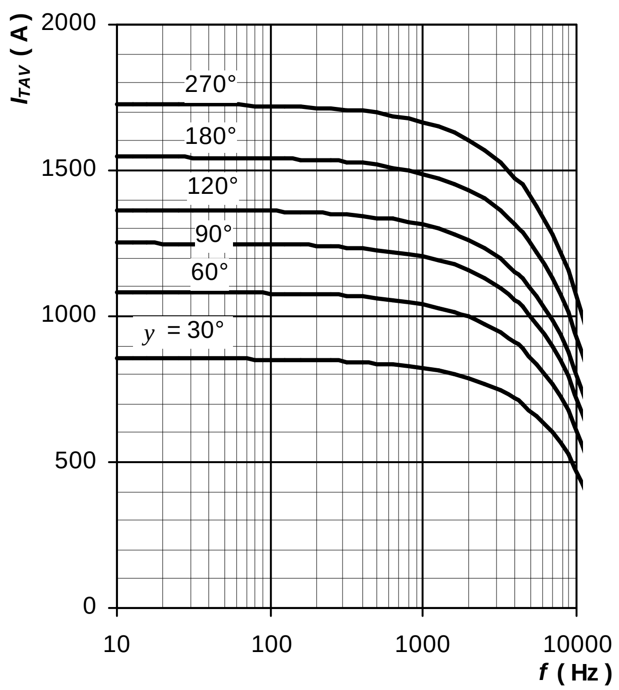


Fig. 20 Maximum turn-off energy per pulse vs. rate of fall on-state current, trapezoid pulse, inductive switching without RC snubber, I_{TM} = 2 000 A, $T_j = T_{jmax}$

Frequency Ratings



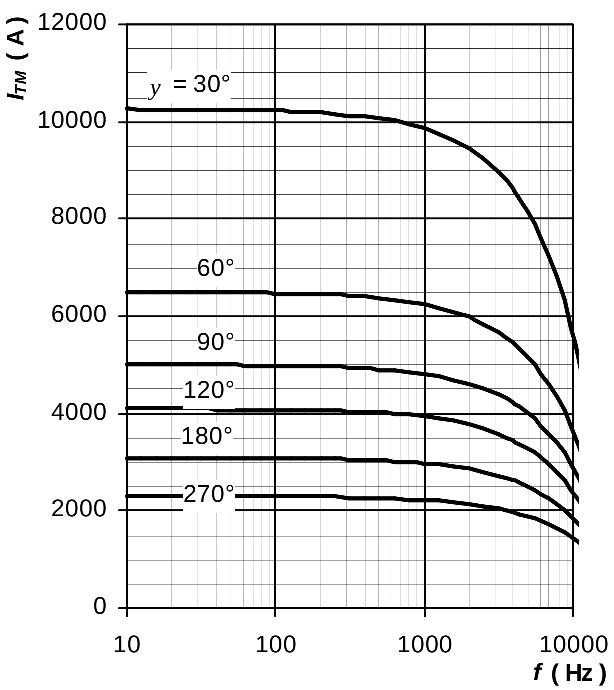
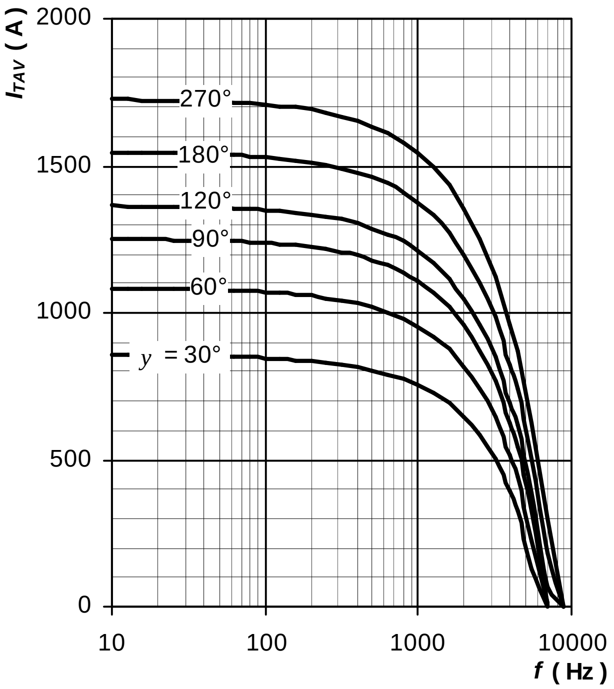


Fig. 21 Average on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 100 A/µs, V_R = 100 V

Fig. 22 Maximum on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 100 A/µs, V_R = 100 V



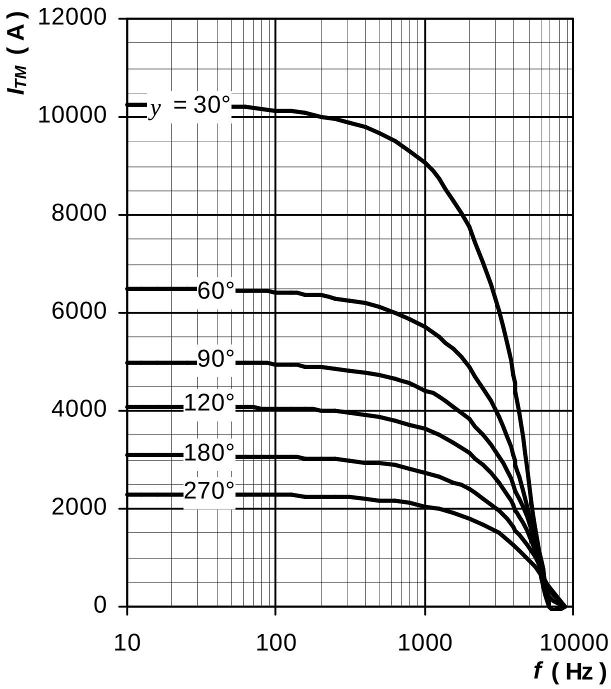
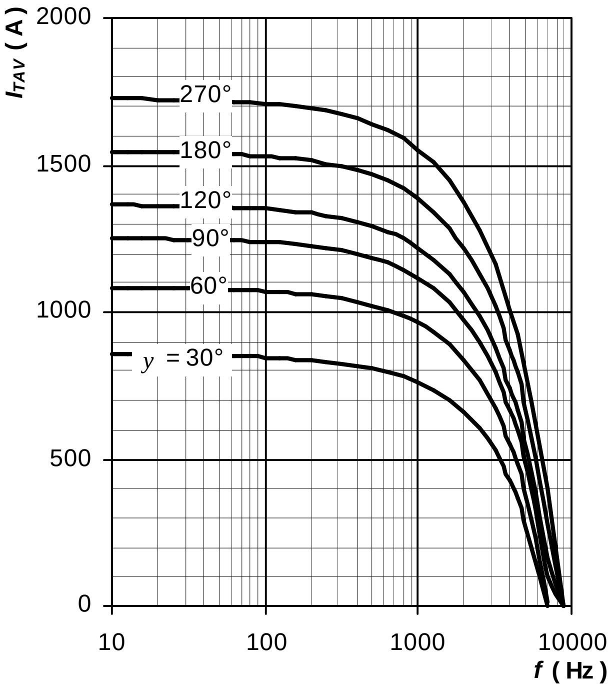


Fig. 23 Average on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 100 A/µs, V_R = 2/3 V_{DRM}

Fig. 24 Maximum on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 100 A/µs, V_R = 2/3 V_{DRM}

Frequency Ratings



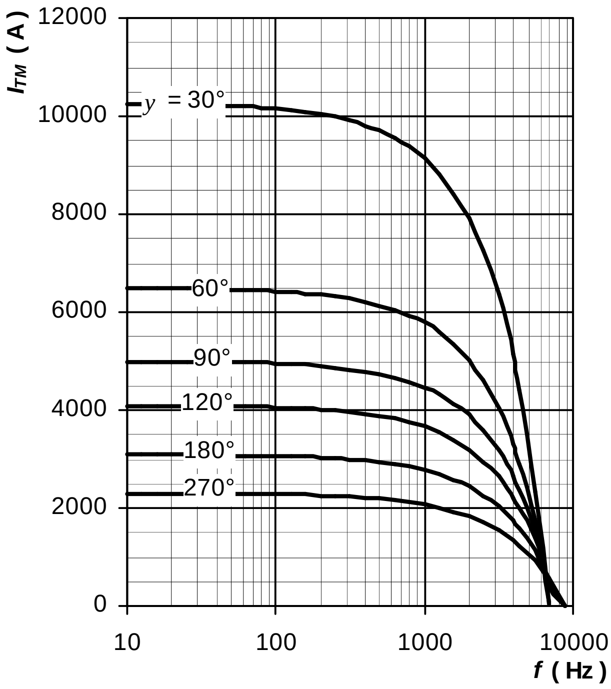
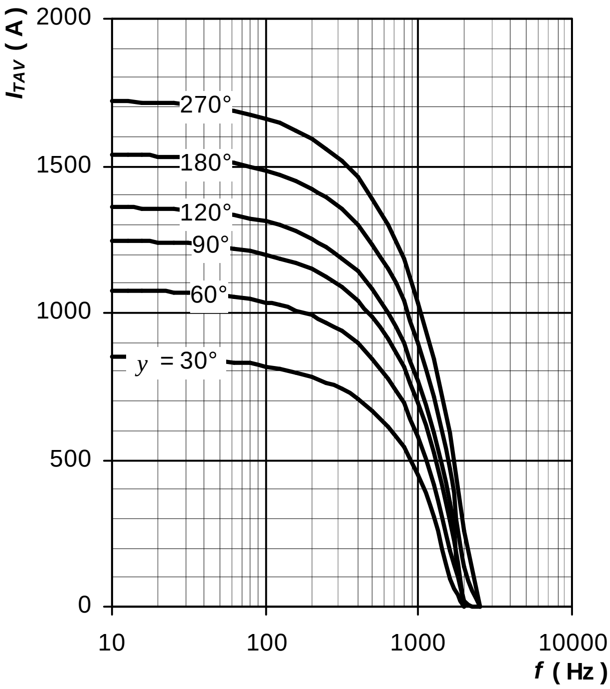


Fig. 25 *Average on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 500 A/µs, V_R = 100 V*

Fig. 26 *Maximum on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 500 A/µs, V_R = 100 V*



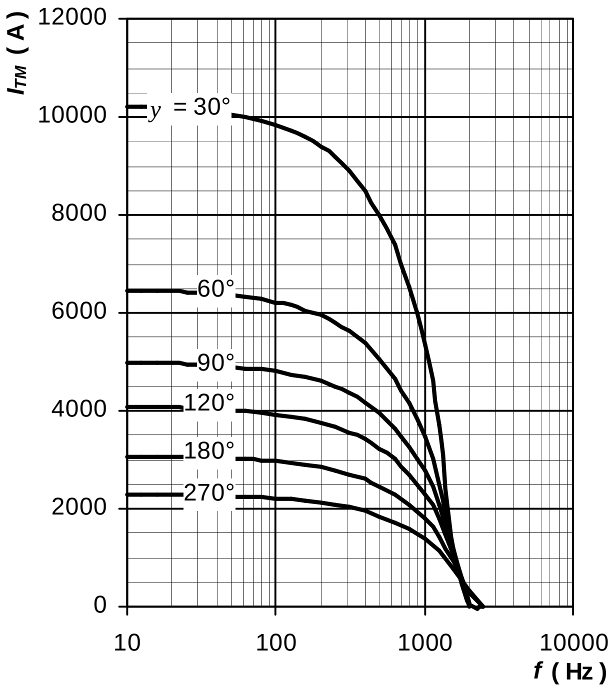
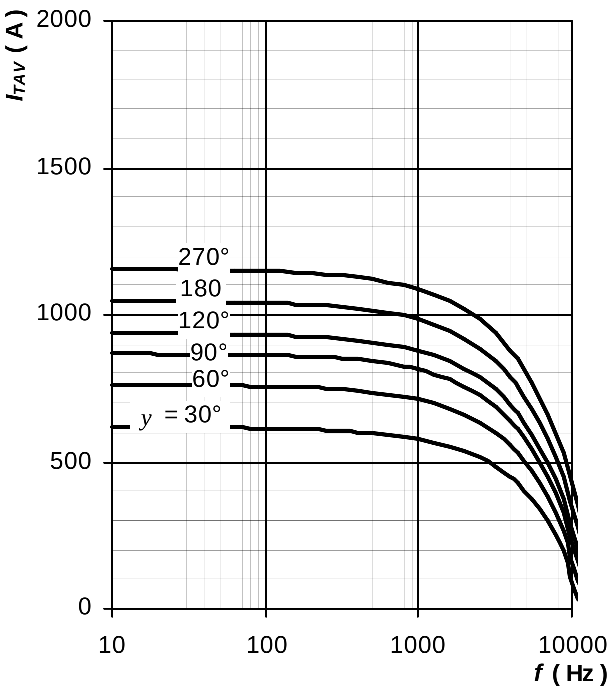


Fig. 27 *Average on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 500 A/µs, V_R = 2/3 V_{DRM}*

Fig. 28 *Maximum on-state current vs. frequency, trapezoid waveform, T_C = 70 °C, di_T/dt = ± 500 A/µs, V_R = 2/3 V_{DRM}*

Frequency Ratings



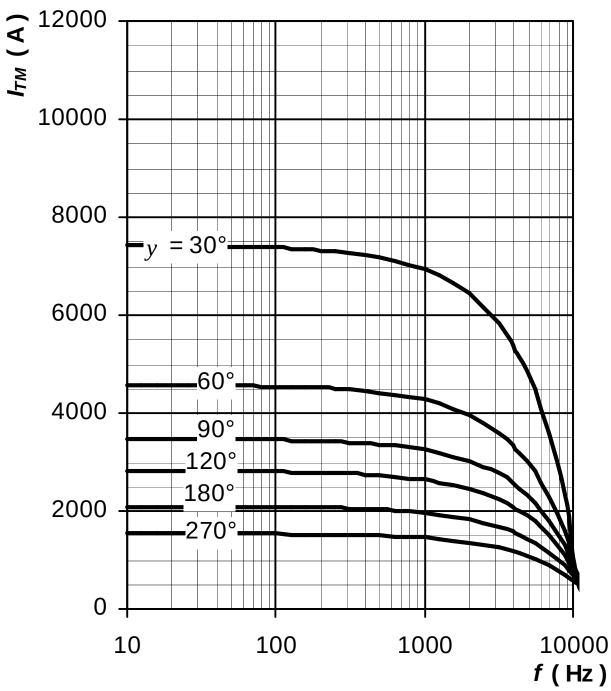
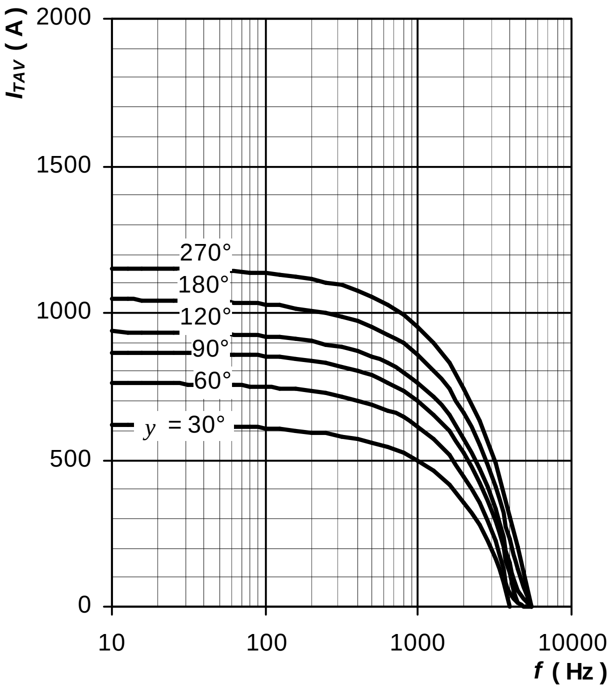


Fig. 29 *Average on-state current vs. frequency, trapezoid waveform,* T_C *= 90 °C,* di_T/dt *= ± 100 A/µs,* V_R *= 100 V*

Fig. 30 *Maximum on-state current vs. frequency, trapezoid waveform,* T_C *= 90 °C,* di_T/dt *= ± 100 A/µs,* V_R *= 100 V*



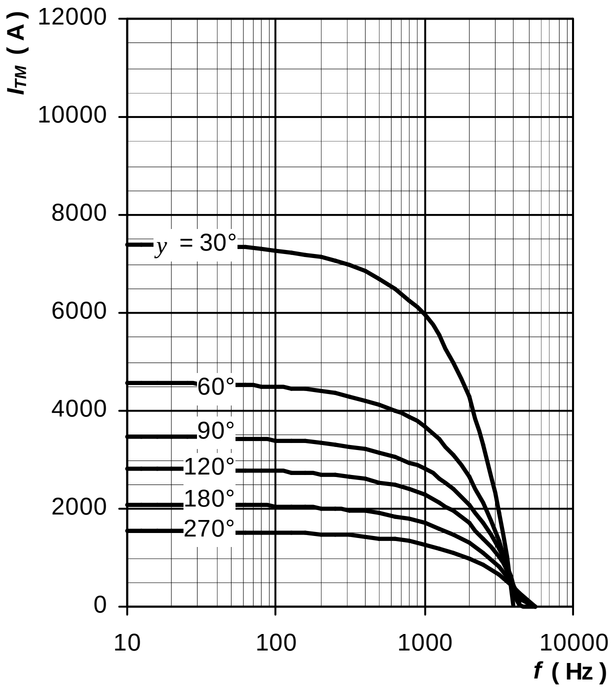
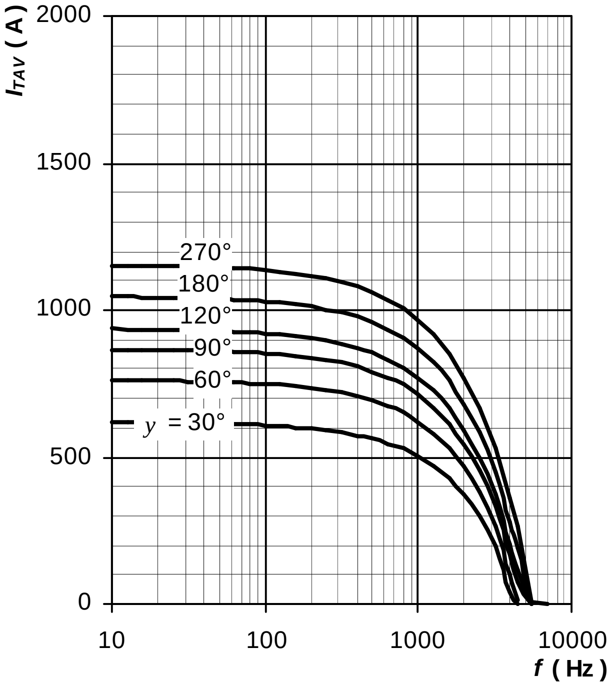


Fig. 31 *Average on-state current vs. frequency, trapezoid waveform,* T_C *= 90 °C,* di_T/dt *= ± 100 A/µs,* V_R *= 2/3* V_{DRM}

Fig. 32 *Maximum on-state current vs. frequency, trapezoid waveform,* T_C *= 90 °C,* di_T/dt *= ± 100 A/µs,* V_R *= 2/3* V_{DRM}

Frequency Ratings



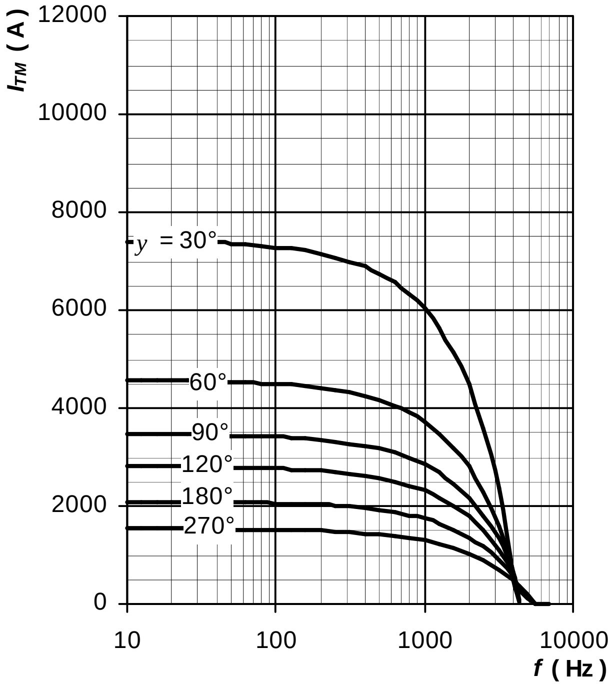


Fig. 33 Average on-state current vs. frequency, trapezoid waveform, T_C = 90 °C, $di_T/dt = \pm$ 500 A/µs, V_R = 100 V

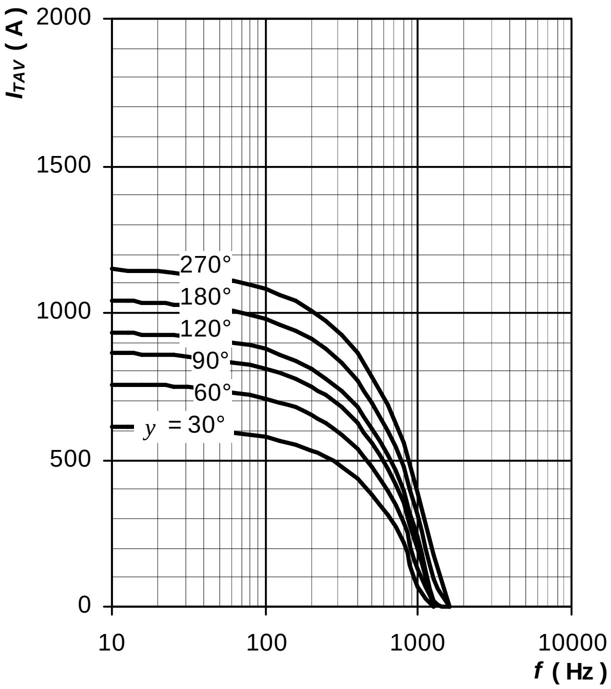


Fig. 35 Average on-state current vs. frequency, trapezoid waveform, T_C = 90 °C, $di_T/dt = \pm$ 500 A/µs, V_R = 2/3 V_{DRM}

Fig. 34 Maximum on-state current vs. frequency, trapezoid waveform, T_C = 90 °C, $di_T/dt = \pm$ 500 A/µs, V_R = 100 V

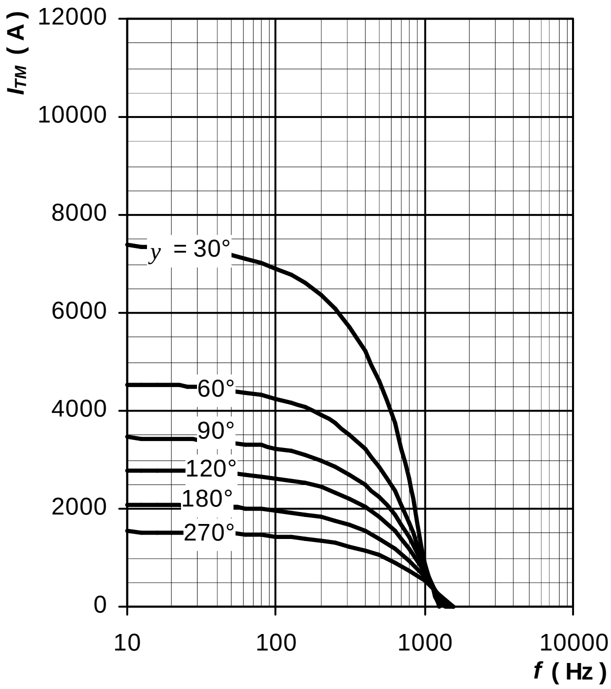


Fig. 36 Maximum on-state current vs. frequency, trapezoid waveform, T_C = 90 °C, $di_T/dt = \pm$ 500 A/µs, V_R = 2/3 V_{DRM}

Notes: