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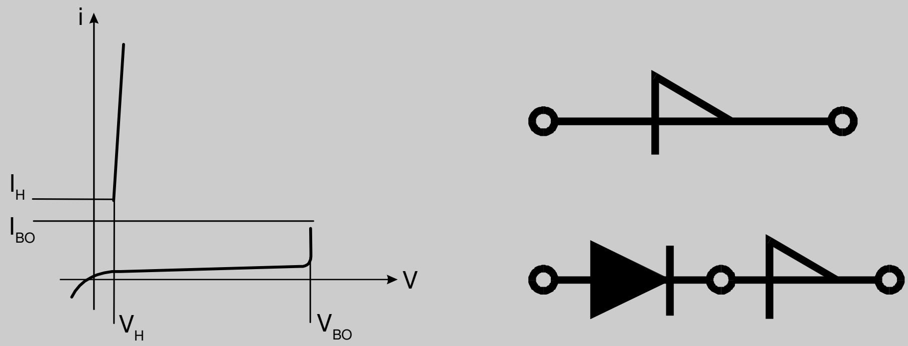
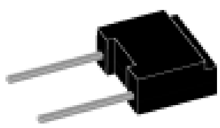
Applications

- Transient voltage protection
- High-voltage switches
- Crowbar
- Lasers
- Pulse generators



Application Note H - 6

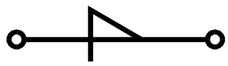


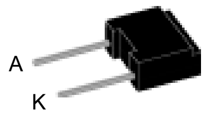
Remark: For special selection of more than 2 pieces IXBOD 1-... for every break down voltage of V_{BO} > 2000 V please contact us.

Single Breakover Diode

V_{BO} = 600-1000V
I_{AVM} = 0.9 A

V_{BO} V	Standard Types
600 ±50	IXBOD 1 -06
700 ±50	IXBOD 1 -07
800 ±50	IXBOD 1 -08
900 ±50	IXBOD 1 -09
1000 ±50	IXBOD 1 -10

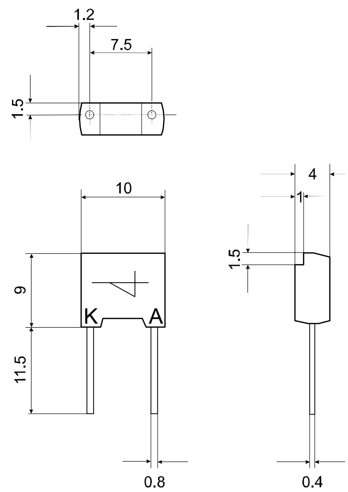




Symbol	Conditions		Ratings	
I_D	T_{VJ} = 125°C;	V = 0,8x V_{BO}	20	µA
V_{BO}		$V_{BO}(T_{VJ}) = V_{BO,\,25°C}\,[1 + K_T\,(T_{VJ} - 25°C)]$		
I_{RMS}	f = 50 HZ; connection pins soldered to printed circuit (conductor 0,035x2mm)	T_{amb} = 50°C	1.4	A
I_{AVM}			0.9	A
I_{SM}	t_p = 0.1 ms;	T_{amb} = 50°C non repetitive	200	A
I^2t	t_p = 0.1 ms;	T_{amb} = 50°C	2	A^2s
T_{amb}			-40...+125	°C
T_{stg}			-40...+125	°C
T_{VJm}			125	°C
K_T	Temperatur coefficient of V_{BO}		$2{\cdot}10^{-3}$	K^{-1}
K_P	coefficient for energy per pulse E_P (material constant)		700	K/Ws
R_{thJA}	- natural convection - with air speed 2 m/s		60 45	K/W K/W
Weight			1	g

Symbol	Conditions		Characteristic Values	
I_{BO}	T_{VJ} = 25°C		15	mA
I_H	T_{VJ} = 25°C		30	mA
V_H	T_{VJ} = 25°C		4 - 8	V
$(dv/dt)_C$	T_{VJ} = 50°C;	$V_D = 0.67{\cdot}(V_{BO} + 100V)$	> 1000	V/µs
$(di/dt)_C$	T_{VJ} = 125°C;	$V_D = V_{BO}$; I_T = 80A; f = 50 Hz	200	A/µs
$t_{q(typ)}$	T_{VJ} = 125°C $dV/dt_{(lin.)}$ = 200V/µs; I_T = 80A; di/dt = -10A/µs	$V_D = 0.67{\cdot}V_{BO}$; V_R = 0V	150	µs
V_T	T_{VJ} =125°C; I_T = 5A		1.7	V
$V_{(TO)}$	For power-loss calculations only		1.1	V
r_T	T_{VJ} = 125°C		0.12	Ω

Dimensions in mm (1 mm = 0.0394")



IXYS reserve at these the right to change limits, test conditions and dimensions; Data according to IEC 60747

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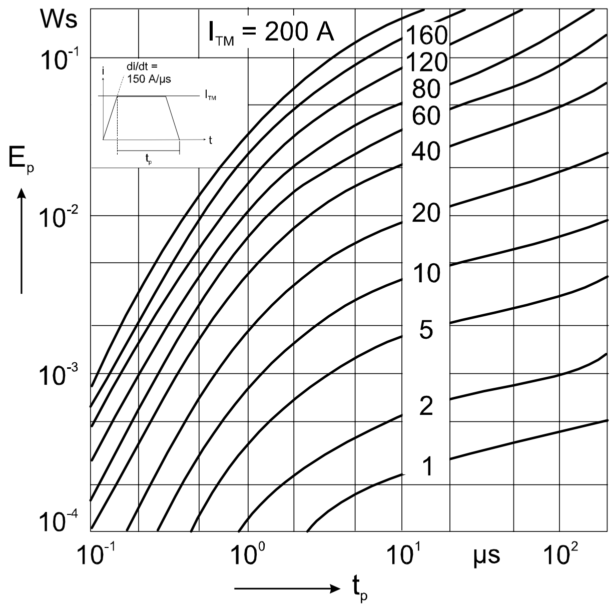


Fig. 1 Energy per pulse for trapezoidal current wafeforms (see waveform definition).

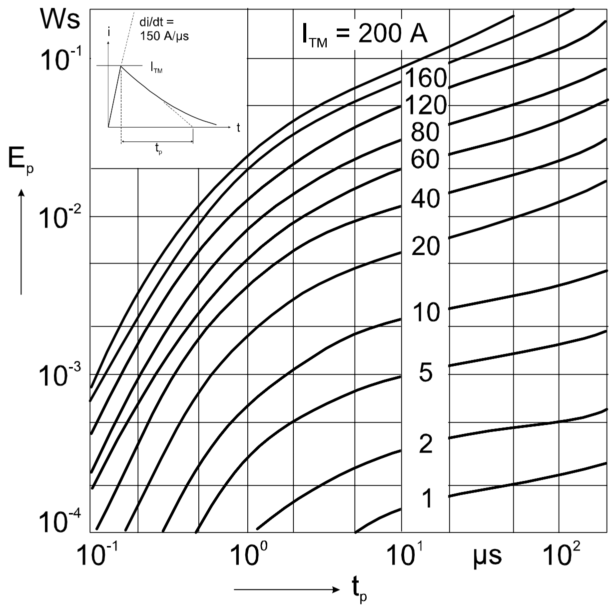


Fig. 2 Energy per pulse for exponentially decaying current pulse (see waveforms definition).

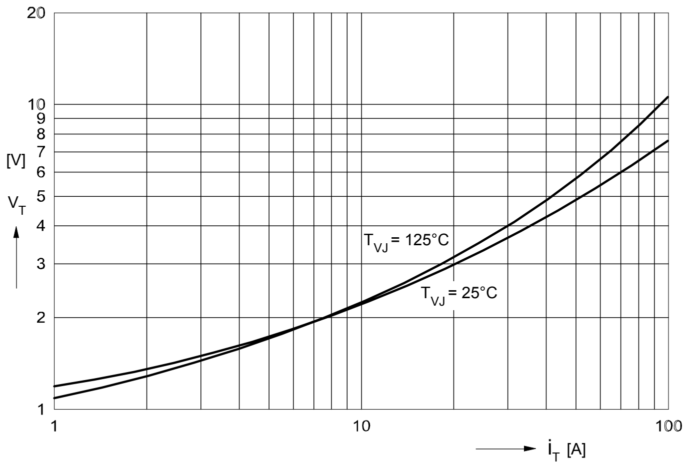


Fig. 3 On-state voltage

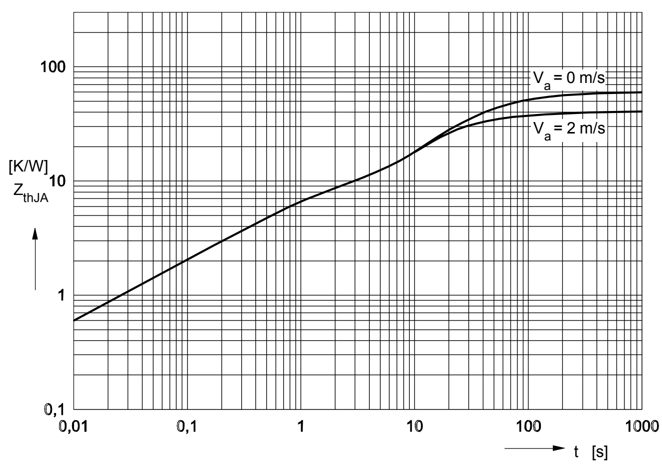
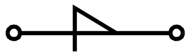
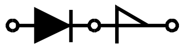


Fig. 4 Transient thermal resistance.

Breakover Diode Modules

Version: R  Version: RD 

V_{BO} V	Standard Types	BOD - Elements	V_{BO} V	Standard Types	BOD - Elements	V_{BO} V	Standard Types	BOD - Elements
1200 ±50	IXBOD 1 -12R(D)	2	2000 ±50	IXBOD 1 -20R(D)	3	3400 ±100	IXBOD 1 -34R	4
1300 ±50	IXBOD 1 -13R(D)	2	2100 ±50	IXBOD 1 -21R(D)	3	3600 ±100	IXBOD 1 -36R	4
1400 ±50	IXBOD 1 -14R(D)	2	2200 ±50	IXBOD 1 -22R(D)	3	3800 ±100	IXBOD 1 -38R	4
1500 ±50	IXBOD 1 -15R(D)	2	2300 ±50	IXBOD 1 -23R(D)	3	4000 ±100	IXBOD 1 -40R	4
1600 ±50	IXBOD 1 -16R(D)	2	2400 ±50	IXBOD 1 -24R(D)	3	4200 ±100	IXBOD 1 -42R	4
1700 ±50	IXBOD 1 -17R(D)	2	2500 ±50	IXBOD 1 -25R(D)	3			
1800 ±50	IXBOD 1 -18R(D)	2	2600 ±100	IXBOD 1 -26R(D)	3			
1900 ±50	IXBOD 1 -19R(D)	2	2800 ±100	IXBOD 1 -28R(D)	3			
			3000 ±100	IXBOD 1 -30R(D)	3			
			3200 ±100	IXBOD 1 -32R(D)	3			

Symbol	Test Conditions	2 BODs	3 BODs	4 BODs	2-3 BODs D-Version	
I_D	T_{VJ} = 125°C;V = 0,8x V_{BO}	100	100	100	100	µA
V_{BO}				$V_{BO}(T_{VJ}) = V_{BO,\,25°C}\,[1 + K_T\,(T_{VJ}$ - 25°C)]		
I_{RMS}	f = 50 HZ; T_{amb} = 50°C connection pins soldered to printed circuit (conductor 0,035x2mm)	2.0	1.4	1.1	0.3	A
I_{AVM}		1.25	0.9	0.7	0.2	A
I_{SM}	t_p = 0.1 ms; T_{amb} = 50°C non repetitive	200	200	200	50	A
I^2t	t_p = 0.1 ms; T_{amb} = 50°C	2	2	2	0.125	A^2s
V_T	T_{VJ} =125°C; I_T = 5A	3.4	5.1	6.8	27	V
$V_{(TO)}$	For power-loss calculations only	2.2	3.3	4.4	17.5	V
r_T	T_{VJ} =125°C	0.24	0.36	0.48	3	Ω
T_{amb}		-40...+125	-40...+125	-40...+125	-40...+125	°C
T_{stg}		-40...+125	-40...+125	-40...+125	-40...+125	°C
T_{VJm}		125	125	125	125	°C
K_T	Temperatur coefficient of V_{BO}	$2{\cdot}10^{-3}$	$2{\cdot}10^{-3}$	$2{\cdot}10^{-3}$	$2{\cdot}10^{-3}$	K^{-1}
K_P	coefficient for energy per pulse E_P (material constant)	700	700	700	700	K/Ws
R_{thJA}	- natural convection - with air speed 2 m/s	20 16	20 16	20 16	20 16	K/W K/W
Weight	typical	14	14	14	14	g

Symbol	Test Conditions	Characteristic Values <u>both</u> Versions R & RD	2 BODs	3 BODs	4 BODs	
I_{BO}	T_{VJ} = 25°C		15	15	15	mA
I_H	T_{VJ} = 25°C		30	30	30	mA
V_H	T_{VJ} = 25°C		4 - 8	4 - 8	4 - 8	V
$(dv/dt)_C$	T_{VJ} = 50°C; $V_D = 0.67{\cdot}(V_{BO}$ + 100V)					
	- V_{BO} bis 1500V		> 1000	-	-	V/µs
	- V_{BO} 1600 - 2000V		> 1500	-	-	V/µs
	- V_{BO} 2100 - 2500V		-	> 2000	-	V/µs
	- V_{BO} 2600 - 3000V		-	> 2500	-	V/µs
	- V_{BO} 3200 - 3400V		-	-	> 3000	V/µs
	- V_{BO} 3600 - 4200V		-	-	> 3500	V/µs
$(di/dt)_C$	T_{VJ} = 125°C; $V_D = V_{BO}$; I_T = 80A; f = 50 Hz		200	200	200	A/µs
$t_{q(typ)}$	T_{VJ} = 125°C $V_D = 0.67{\cdot}V_{BO}$; V_R = 0V $dv/dt_{(lin.)}$ = 200V/µs; I_T = 80A; di/dt = -10A/µs		150	150	150	µs

IXYS reserve at these the right to change limits, test conditions and dimensions; Data according to IEC 60747

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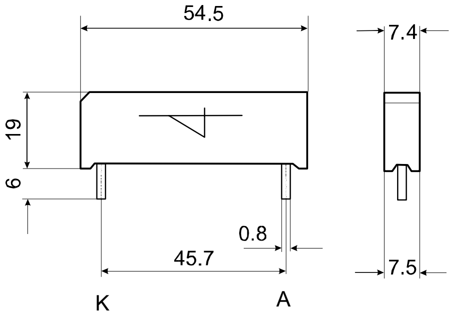
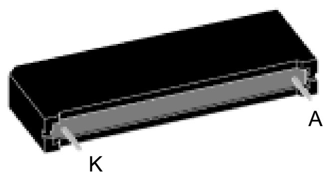




Dimensions in mm (1 mm = 0.0394")

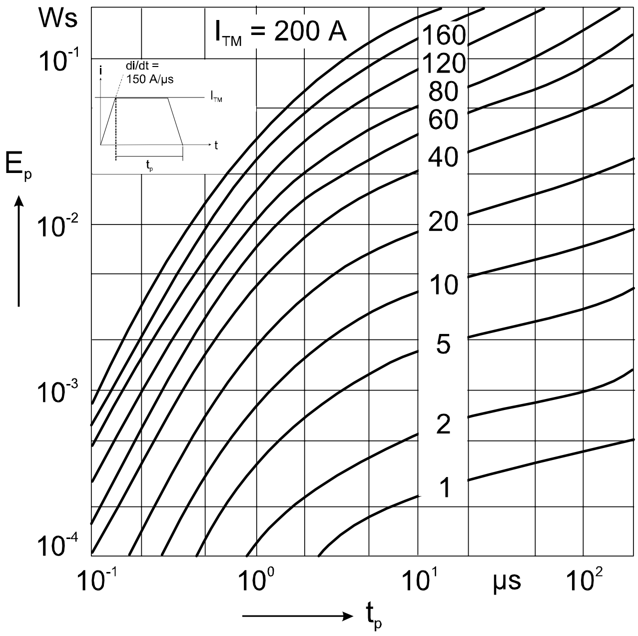


Fig. 5 Energy per pulse for single BOD element for trapezoidal wave current. E_P must be multiplied by number of elements for total energy.

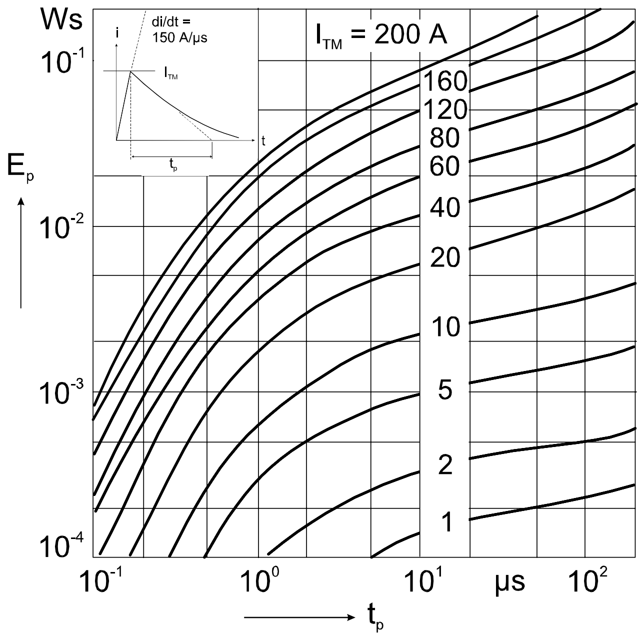


Fig. 6 Energy per pulse for single BOD element for exponentially decaying current pulse. E_P must be multiplied by number of elements for total energy.

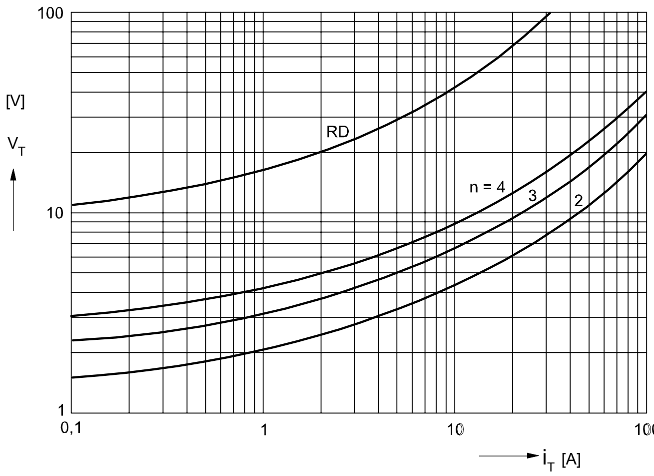


Fig. 7 On-state voltage at T_{VJ} = 125°C.

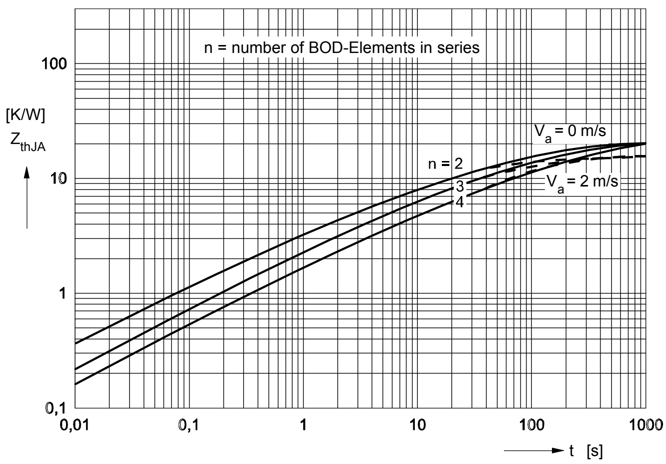
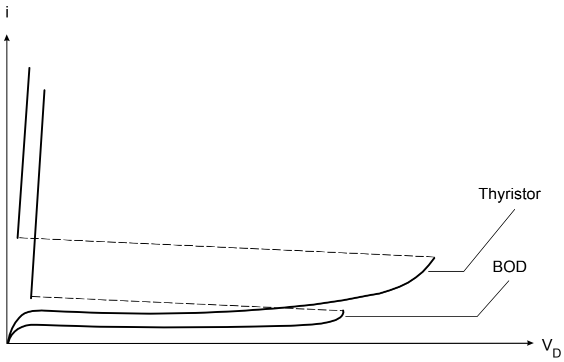


Fig. 8 Transient thermal resistance.

Application

Protection of thyristors against overvoltages in forward direction.

$$V_{BO}\,(T_{VJ}) = V_{BO,\,25°C}\,[1+KT(T_{VJ} - 25°C)]$$



Calculation example

a. The maximum junction temperature shall be calculated for a module IXBOD 1 -30R at an ambient temperature T_a = 60 °C, an exponentially decaying current I_{TM} = 40A, a pulsewidth tp = 2 µs, an operating frequency f = 50 Hz and natural convection. From the diagram Fig. 6 the energy per pulse is obtained:

$$E_{p1} = 6 \times 10^{-3}\ Ws$$

For a module IXBOD1-30R the number of single IXBOD elements is:

$$n = 3$$

At natural air cooling the thermal resistance junction to ambient amounts to (Fig.8):

$$R_{thJA} = 20K/W$$

and the unknown temperature can be calculated as:

$$T_{VJmax1} = T_a + n \cdot f \cdot E_p \cdot R_{thJA} + K_p \cdot E_p$$

$$T_{VJmax1} = 60 + 18 + 4.2 = 82.2°C$$

b. If following these steady-state conditions an overload for 1 minute occurs with I_{TM}= 60 A and a pulse-width tp = 4 µs at the same operating frequency f = 50 Hz, then the resulting maximum junction temperature is calculating as follows:

$$T_{VJmax2} = T_{VJmax1} + (E_{p2}-E_{p1}) \cdot n \cdot f \cdot Z_{thJA}(t) + Kp \cdot (E_{p2}-E_{p1})$$

The diagrams Fig. 11 and Fig. 8 show

$$E_{p2} = 14x10^{-3}\ Ws$$
$$Z_{thJA}(t = 1min) = 12K/W$$

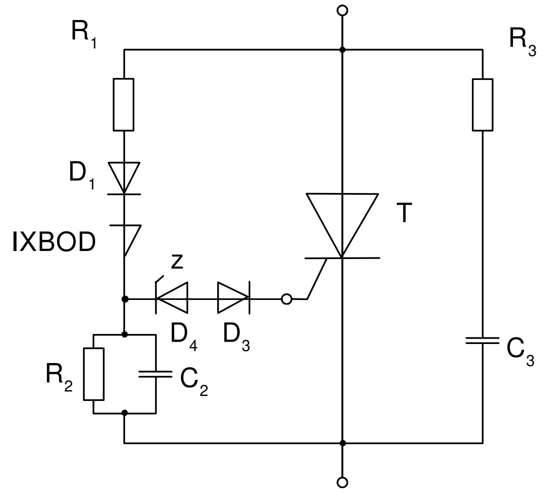
From what follows:

T_{VJmax2} = 82.2 + 14.4 + 5,6 = 102.2 °C

which is allowed because the maximum admissible junction temperature T_{VJM} = 125 °C.

Example of a circuit

A simple emergency triggering circuit.



- T : Thyristor
- R_1 : Current limiting resistance (0 - 200 Ω)
- D_1 : Series-diode (fast recovery diode)
- D_3 : Protection diode
- D_4 : Zener diode, typical V_Z : 3-6 V
- R_2, C_2 : Protection against parasitic triggering; recommended values:
  R_2 : 100 - 1000 Ω
  C_2 : 22 - 47 nF
- R_3, C_3 : Snubber network of the thyristor

Notice

1. A IXBOD element has a maximum reverse blocking voltage of 10V.

2. For higher reverse voltages a fast, soft recovery diode must be connected in series (Fig. 9). This diode must fulfill the conditions of Fig. 10.

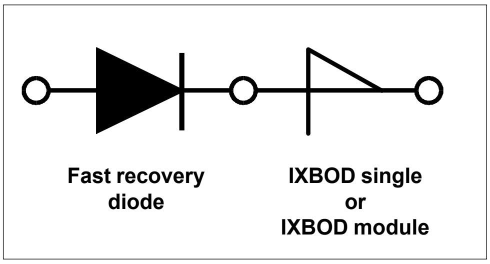


Fig. 9 IXBOD protection by a fast recovery diode.

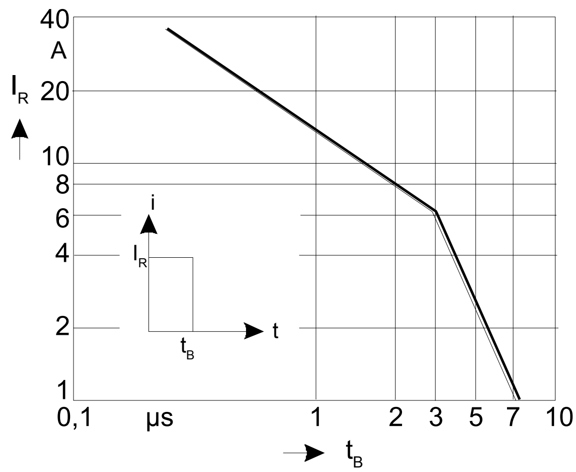


Fig. 10 Maximum peak value of the reverse current admissible for a given pulse-width t_B, which is required for the suitable fast recovery series-diode.