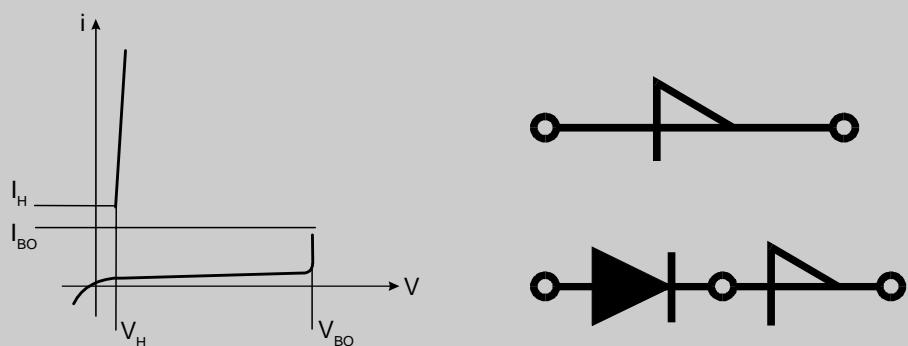
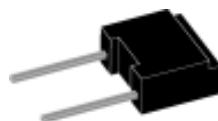


## Applications

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



Application Note H - 6

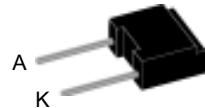


**Remark:** For special selection of more than 2 pieces IXBOD 1-... for every break down voltage of  $V_{BO} > 2000$  V please contact us.

## Single Breakover Diode

**V<sub>BO</sub>** = 600-1000V  
**I<sub>AVM</sub>** = 0.9 A

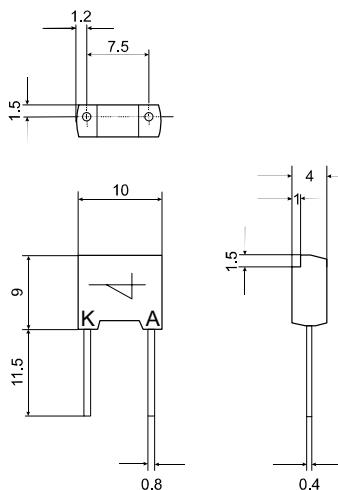
V <sub>BO</sub> V	Standard Types
600 ±50	IXBOD 1 -06
700 ±50	IXBOD 1 -07
800 ±50	IXBOD 1 -08
900 ±50	IXBOD 1 -09
1000 ±50	IXBOD 1 -10



## Symbol    Conditions    Ratings

I <sub>D</sub>	T <sub>VJ</sub> = 125°C; V = 0,8x V <sub>BO</sub>	20	μA
V <sub>BO</sub>		V <sub>BO</sub> (T <sub>VJ</sub> ) = V <sub>BO, 25°C</sub> [1 + K <sub>T</sub> (T <sub>VJ</sub> - 25°C)]	
I <sub>RMS</sub>	f = 50 Hz; T <sub>amb</sub> = 50°C  connection pins soldered to printed circuit (conductor 0,035x2mm)	1.4	A
I <sub>AVM</sub>		0.9	A
I <sub>SM</sub>	t <sub>p</sub> = 0.1 ms; T <sub>amb</sub> = 50°C non repetitive	200	A
I <sup>2</sup> t	t <sub>p</sub> = 0.1 ms; T <sub>amb</sub> = 50°C	2	A <sup>2</sup> s
T <sub>amb</sub>		-40...+125	°C
T <sub>stg</sub>		-40...+125	°C
T <sub>VJm</sub>		125	°C
K <sub>T</sub>	Temperatur coefficient of V <sub>BO</sub>	2·10 <sup>-3</sup>	K <sup>-1</sup>
K <sub>P</sub>	coefficient for energy per pulse E <sub>P</sub> (material constant)	700	K/Ws
R <sub>thJA</sub>	- natural convection - with air speed 2 m/s	60 45	K/W
Weight		1	g

## Dimensions in mm (1 mm = 0.0394")



Symbol	Conditions	Characteristic Values	
I <sub>BO</sub>	T <sub>VJ</sub> = 25°C	15	mA
I <sub>H</sub>	T <sub>VJ</sub> = 25°C	30	mA
V <sub>H</sub>	T <sub>VJ</sub> = 25°C	4 - 8	V
(dv/dt) <sub>C</sub>	T <sub>VJ</sub> = 50°C; V <sub>D</sub> = 0.67·(V <sub>BO</sub> + 100V)	> 1000	V/μs
(di/dt) <sub>C</sub>	T <sub>VJ</sub> = 125°C; V <sub>D</sub> = V <sub>BO</sub> ; I <sub>T</sub> = 80A; f = 50 Hz	200	A/μs
t <sub>q(typ)</sub>	T <sub>VJ</sub> = 125°C; V <sub>D</sub> = 0.67·V <sub>BO</sub> ; V <sub>R</sub> = 0V dV/dt <sub>(lin.)</sub> = 200V/μs; I <sub>T</sub> = 80A; di/dt = -10A/μs	150	μs
V <sub>T</sub>	T <sub>VJ</sub> = 125°C; I <sub>T</sub> = 5A	1.7	V
V <sub>(TO)</sub>	For power-loss calculations only	1.1	V
r <sub>T</sub>	T <sub>VJ</sub> = 125°C	0.12	Ω

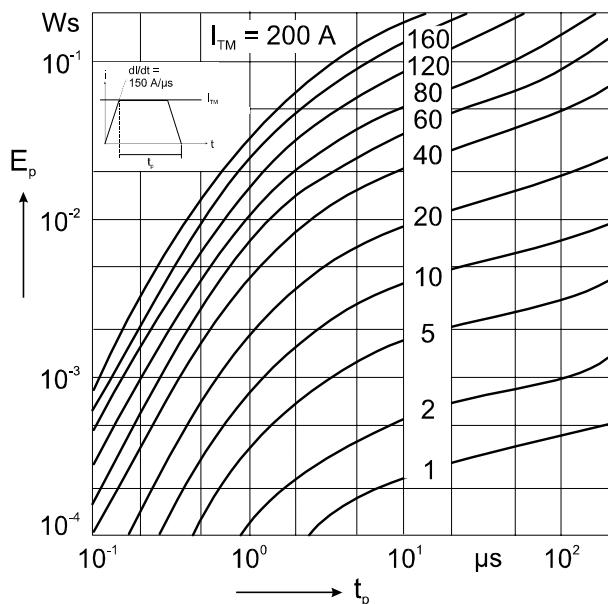


Fig. 1 Energy per pulse for trapezoidal current waveforms (see waveform definition).

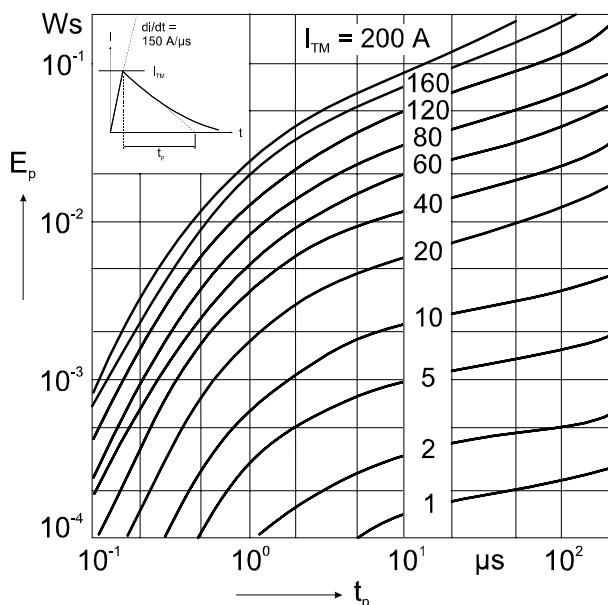


Fig. 2 Energy per pulse for exponentially decaying current pulse (see waveforms definition).

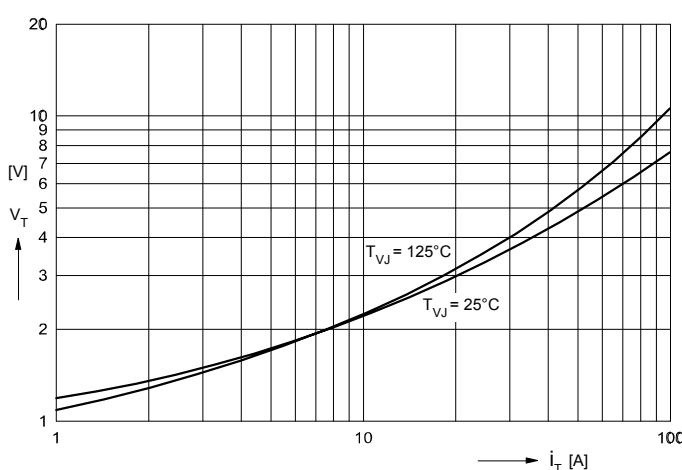


Fig. 3 On-state voltage

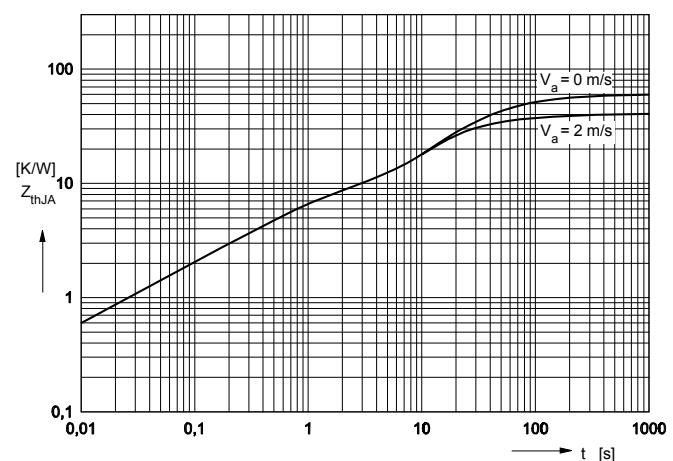


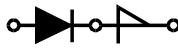
Fig. 4 Transient thermal resistance.

## Breakover Diode Modules

Version: R



Version: RD



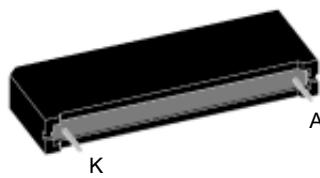
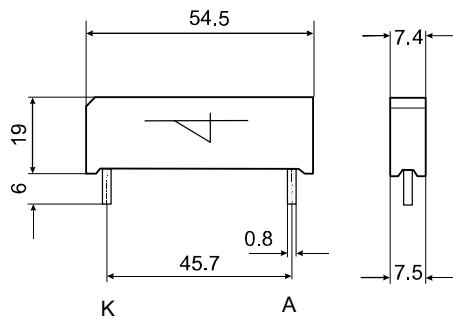
$V_{BO}$	Standard	BOD -	$V_{BO}$	Standard	BOD -	$V_{BO}$	Standard	BOD -
V	Types	Elements	V	Types	Elements	V	Types	Elements
1200 ±50	IXBOD 1 -12R(D)	2	2000 ±50	IXBOD 1 -20R(D)	3	3400 ±100	IXBOD 1 -34R	4
1300 ±50	IXBOD 1 -13R(D)	2	2100 ±50	IXBOD 1 -21R(D)	3	3600 ±100	IXBOD 1 -36R	4
1400 ±50	IXBOD 1 -14R(D)	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	2-3 BODs					D-Version
		2 BODs	3 BODs	4 BODs			
$I_D$	$T_{VJ} = 125^\circ C; V = 0,8x V_{BO}$	100	100	100	100	100	μA
$V_{BO}$					$V_{BO}(T_{VJ}) = V_{BO, 25^\circ C} [1 + K_T(T_{VJ} - 25^\circ C)]$		
$I_{RMS}$	$f = 50 \text{ Hz}; T_{amb} = 50^\circ C$ 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	
$I_{SM}$	$t_p = 0.1 \text{ ms}; T_{amb} = 50^\circ C$ non repetitive	200	200	200	50	A	
$I^2t$	$t_p = 0.1 \text{ ms}; T_{amb} = 50^\circ C$	2	2	2	0.125	A²s	
$V_T$	$T_{VJ} = 125^\circ C; I_T = 5A$	3.4	5.1	6.8	27	V	
$V_{(TO)}$	For power-loss calculations only	2.2	3.3	4.4	17.5	V	
$r_T$	$T_{VJ} = 125^\circ C$	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	20	20	20	K/W	
Weight	typical	14	14	14	14	g	

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

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

032



Dimensions in mm (1 mm = 0.0394")

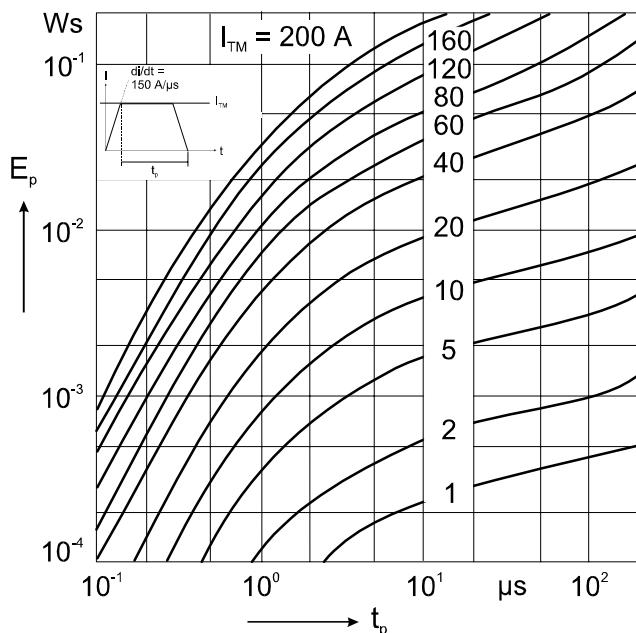


Fig. 5 Energy per pulse for single BOD element for trapezoidal wave current.  $E_p$  must be multiplied by number of elements for total energy.

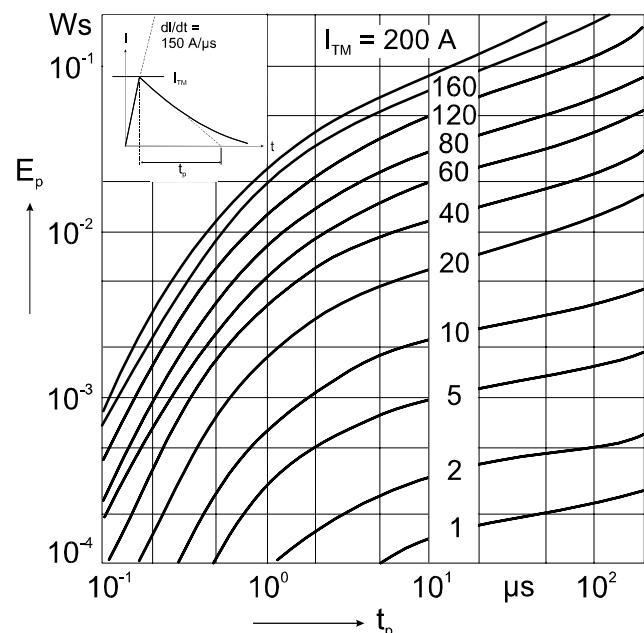


Fig. 6 Energy per pulse for single BOD element for exponentially decaying current pulse.  $E_p$  must be multiplied by number of elements for total energy.

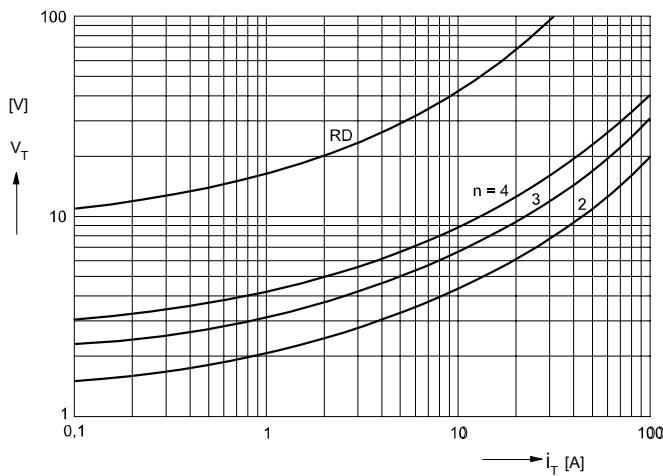


Fig. 7 On-state voltage at  $T_{VJ} = 125^\circ\text{C}$ .

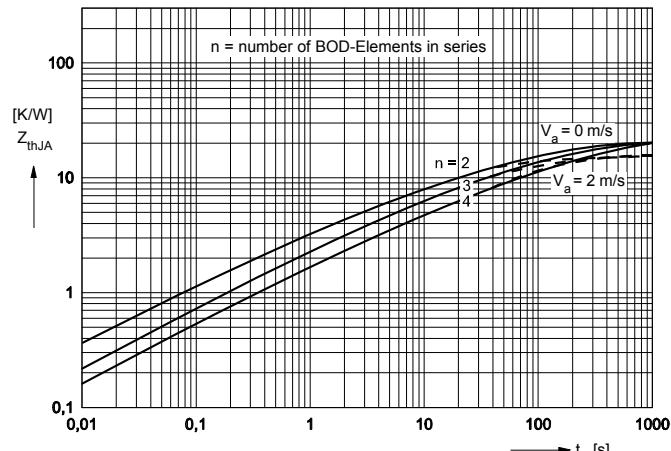
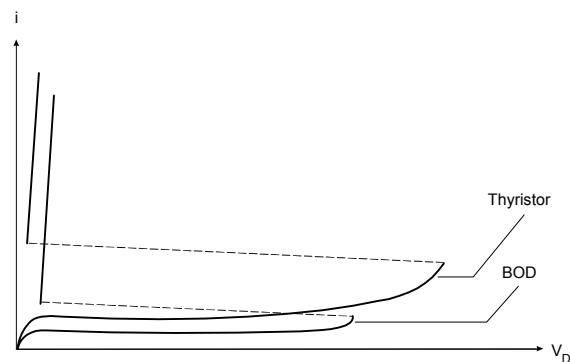


Fig. 8 Transient thermal resistance.

## Application

Protection of thyristors against overvoltages in forward direction.

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



### Calculation example

- a. The maximum junction temperature shall be calculated for a module IXBOD 1 -30R at an ambient temperature  $T_a = 60^\circ C$ , an exponentially decaying current  $I_{TM} = 40A$ , a pulsewidth  $t_p = 2 \mu s$ , 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):

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

and the unknown temperature can be calculated as:

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

$$T_{VJmax1} = 60 + 18 + 4.2 = 82.2^\circ C$$

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

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

The diagrams Fig. 11 and Fig. 8 show

$$\begin{aligned} E_{p2} &= 14 \times 10^{-3} Ws \\ Z_{thJA}(t = 1min) &= 12 K/W \end{aligned}$$

From what follows:

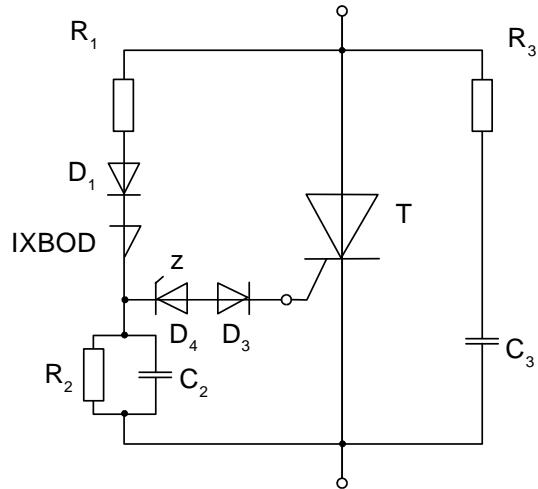
$$T_{VJmax2} = 82.2 + 14.4 + 5.6 = 102.2^\circ C$$

which is allowed because the maximum admissible junction temperature  $T_{VJm} = 125^\circ C$ .

## Example of a circuit

A simple emergency triggering circuit.

- T : Thyristor
- R<sub>1</sub> : Current limiting resistance (0 - 200 Ω)
- D<sub>1</sub> : Series-diode (fast recovery diode)
- D<sub>3</sub> : Protection diode
- D<sub>4</sub> : Zener diode, typical V<sub>z</sub>: 3-6 V
- R<sub>2</sub>, C<sub>2</sub> : Protection against parasitic triggering; recommended values:  
R<sub>2</sub> : 100 - 1000 Ω  
C<sub>2</sub> : 22 - 47 nF
- R<sub>3</sub>, C<sub>3</sub> : 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.

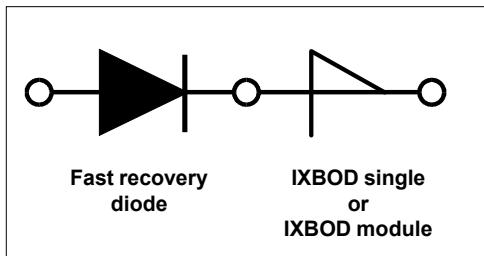


Fig. 9 IXBOD protection by a fast recovery diode.

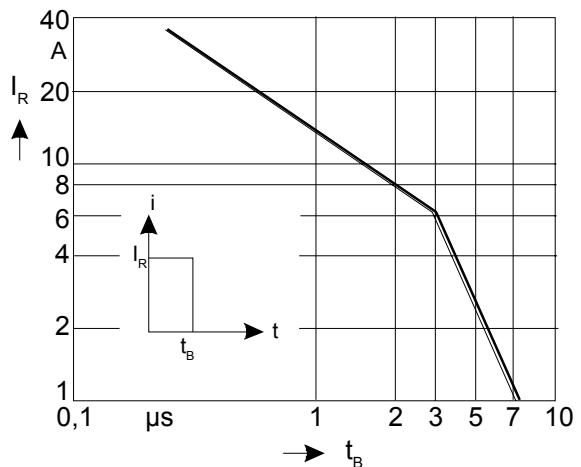


Fig. 10 Maximum peak value of the reverse current admissible for a given pulse-width t<sub>B</sub>, which is required for the suitable fast recovery series-diode.

