DUAL ASYMMETRICAL BREAKOVER DIODE

The BR216 is a monolithic dual asymmetrical 65 V breakover diode in the TO-220AB outline.
Each half of the device conducts normally in one direction, but in the other direction it acts as a breakover diode.
The controlled breakover voltage and peak current handling capability together with high holding current make it suitable for two-line to earth transient overvoltage protection in applications such as telephony equipment and remote instrumentation lines.
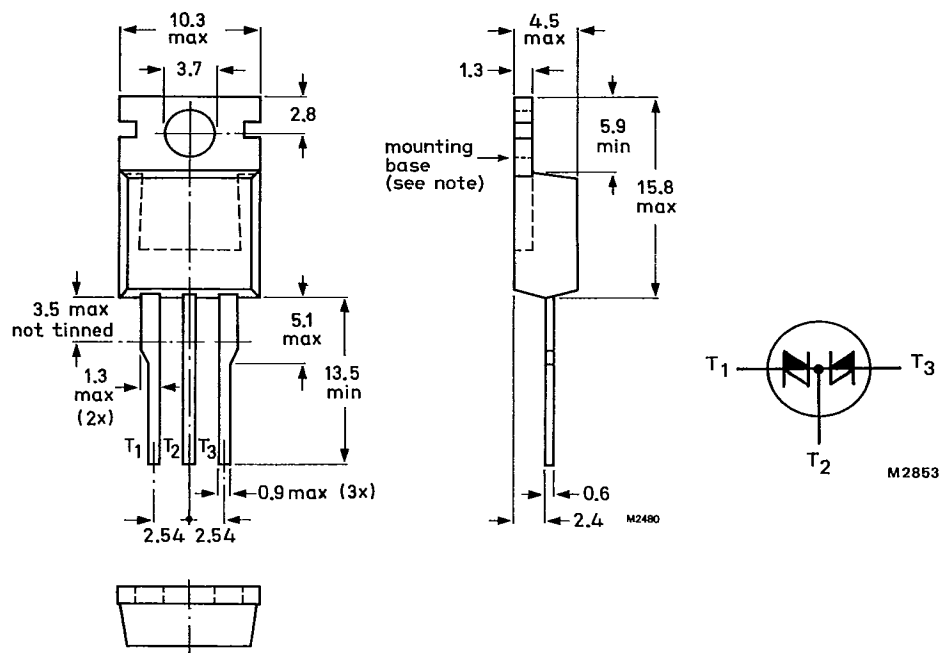
QUICK REFERENCE DATA

Breakover voltage per line	$V_{(BO)}$	<	78	V
Breakdown voltage per line	$V_{(BR)}$	>	58	V
Holding current	I_H	>	150	mA
Transient peak current (10/320 μs impulse)	I_{TSM}	max.	40	A

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB; centre lead connected to tab.

Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal T_2.

Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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Limiting values in accordance with the Absolute Maximum System (IEC 134).

Voltages

Continuous off-state voltage	V_D	max.	50	V

Currents

Transient peak current (8/20 μs impulse)	I_{TSM1}/I_{FSM1}	max.	150	A
Transient peak current (10/320 μs impulse) equivalent to 10/700 μs 1.6 kV voltage impulse (CCITT K17)	I_{TSM2}/I_{FSM2}	max.	40	A
Average on-state current	$I_{T(AV)}$	max.	5	A
Average forward current (averaged over any 20 ms period); up to T_{mb}= 75 ^oC	$I_{F(AV)}$	max.	5	A
RMS AC on-state current	$I_{T(RMS)}$	max.	8	A
Non-repetitive peak current; T_j = 100 ^oC prior to surge; t = 10 ms; half sinewave	I_{TSM3}/I_{FSM3}	max.	40	A
I^2t for fusing (t = 10 ms)	I^2t	max.	8	A^2s
Rate of rise of on-state current after $V_{(BO)}$ turn-on (t_p = 10 μs)	dI_T/dt	max.	50	A/μs

Power dissipation

Continuous dissipation; one line dissipating, unidirectional operation, device mounted on infinite heatsink	P_{tot}	max.	35	W
Peak dissipation; t = 1 ms, free-air mounting	P_{TM}	max.	110	W

Temperatures

Storage temperature	T_{stg}		−40 to +150	^oC
Operating temperature (off-state)	T_j	max.	125	^oC
Overload temperature (on-state)	T_{vj}	max.	150	^oC

THERMAL RESISTANCE

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From junction to ambient in free air mounted on a printed circuit board at any lead length	$R_{th\ j\text{-}amb}$	=	60	K/W
From junction to mounting base				
One line conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	2.7	K/W
unidirectional operation	$R_{th\ j\text{-}mb}$	=	3.5	K/W
Both lines conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	1.85	K/W
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.9	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

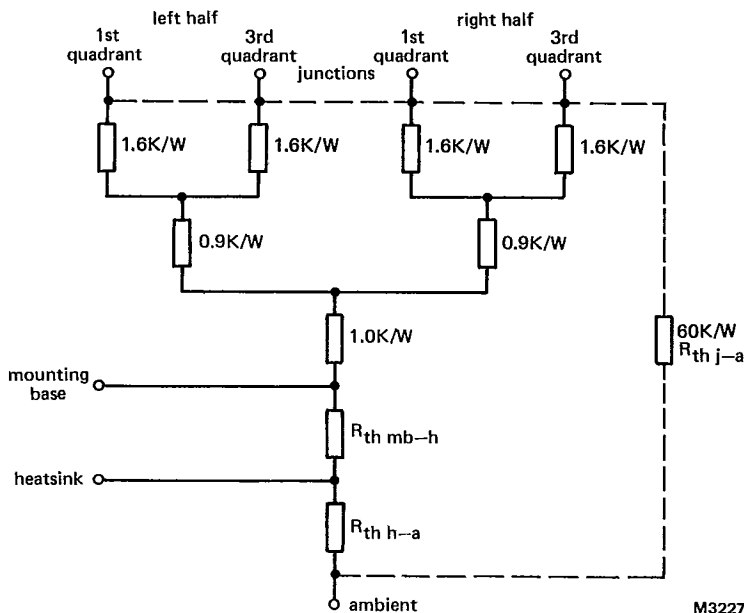|				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm max. mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm max. alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

Fig.2 Components of thermal resistance (junction to ambient).

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CHARACTERISTICS

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T_j = 25 °C unless otherwise stated; each line to centre lead.

On-state voltage (note 1)				
I_{TM} = 5 A	V_{TM}	<	3.0	V
Forward voltage (note 1)				
I_{FM} = 5 A	V_{FM}	<	3.0	V
Avalanche voltage				
$I_{(BR)}$ = 10 mA	$V_{(BR)}$	>	58	V
Breakover voltage				
100 μs pulsed; $I = I_S$	$V_{(BO)}$	<	78	V
Temperature coefficient of $V_{(BR)}$	$S_{(br)}$	typ.	+0.1	%/K
Holding current (note 2)				
T_j = 25 °C	I_H	>	150	mA
T_j = 70 °C	I_H	>	100	mA
Switching current (note 3)	I_S	>	10	mA
	I_S	typ.	400	mA
	I_S	<	1000	mA
Off-state current; V_D = 50 V (note 4)				
T_j = 70 °C	I_D	<	50	μA
T_j = 125 °C	I_D	<	250	μA
Linear rate of rise of off-state voltage				
that will not trigger any device;				
T_j = 70 °C; V_{DM} = 50 V	dV_D/dt	<	2000	V/μs
Off-state capacitance				
V_D = 0; f = 1 kHz to 1 MHz	C_j	<	500	pF
Forward recovery of diode when switched				
to I_F = 1 A with dI_F/dt = 10 A/μs	V_{fr}	typ.	2.2	V

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.

2. The minimum current at which the BOD will remain in the on-state.

3. The avalanche current required to switch the BOD to the on-state.
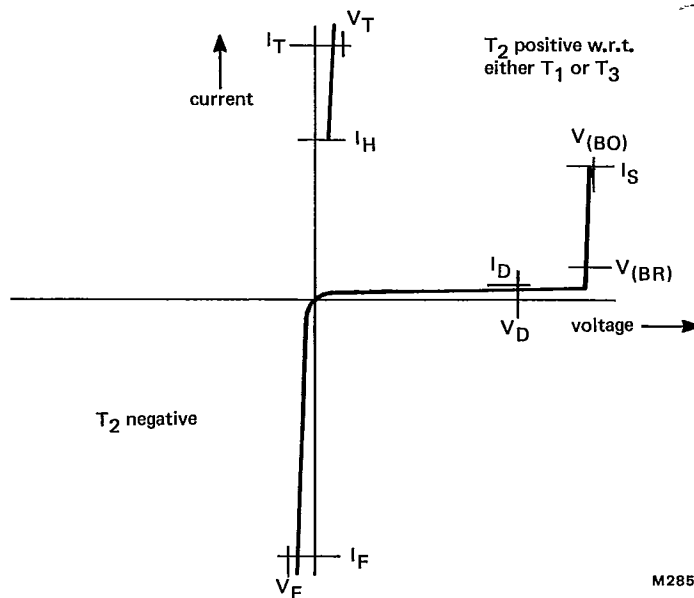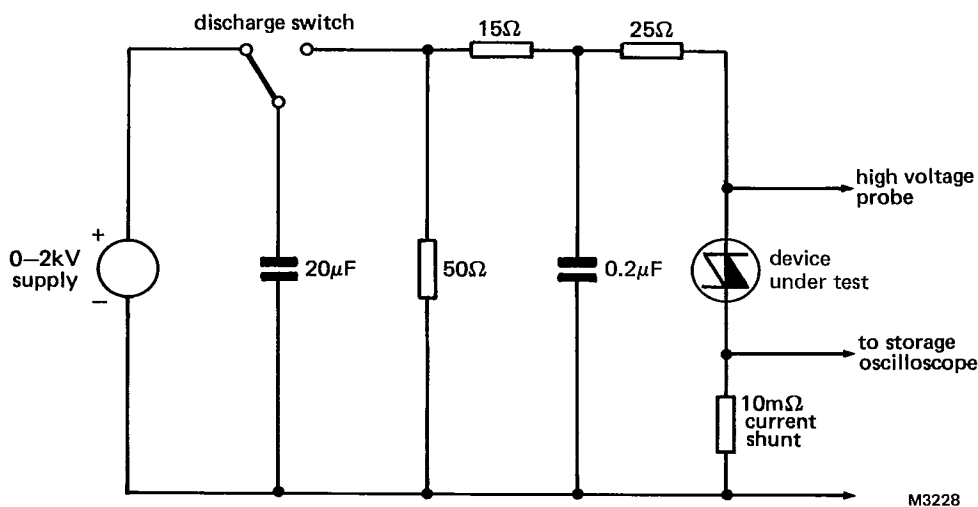
4. i.e., at maximum recommended continuous voltage.

Dual asymmetrical breakover diode

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V_T

I_T

current

T_2 positive w.r.t.
either T_1 or T_3

I_H

$V_{(BO)}$

I_S

I_D

$V_{(BR)}$

V_D voltage ➝

T_2 negative

I_F

V_F

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Fig.3 Breakover diode characteristics.

discharge switch

15Ω

25Ω

high voltage
probe

0–2kV
supply

+

–

20μF

50Ω

0.2μF

device
under test

to storage
oscilloscope

10mΩ
current
shunt

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Fig.4 Test circuit for high-voltage impulse (I_{TSM2}/I_{FSM2}).
(according to CCITT vol IX-Rec. K17).

Notes:
The 10/700 μs Impulse Waveform is defined for the voltage across the test fixture when the device
under test is replaced with an open circuit. Clearly, once a breakover device has switched on to a low
voltage, the current waveform will have a shorter fall-time, since the 15 Ω + 25 Ω output impedance
becomes effectively in parallel with the 50 Ω.

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MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit. The maximum permissible soldering temperature is 275 ^{o}C. Heat must not be applied for more than 5 seconds. Soldered joints must be at least 4.7 mm from the body of the device.

2. The leads must not be bent less than 2.4 mm from the body of the device and should be supported during bending. The leads can be bent twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.

3. Any heatsink used must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

4. For good thermal contact a metallic-oxide loaded heatsink compound must be used between the mounting base and heatsink. Ordinary silicone grease is not recommended.

5. The preferred mounting method is with the use of a spring clip. This ensures good thermal contact under the crystal area and safe isolation. However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to plastic body of the device during mounting.

6. Rivet mounting (only possible for non-insulated mounting)
    Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole. The maximum recommended hole size for rivet mounting is 3.5 mm. The pre-formed head of the rivet should be on the device side and any rivet tool used should not damage the plastic body of the device.

OPERATING NOTES

1. For most applications involving transient overvoltage protection only, the device is not normally mounted on a heatsink. The free-air rating of the device is normally adequate for non-repetitive transients.

2. Circuit connections to the common (T_2) terminal should be made to the centre lead not the mounting tab.

3. During a mains contact fault, excessive dissipation can occur with the device held in its avalanche state. The following figures illustrate how power dissipation can be calculated during a mains contact fault. In general, if the fault resistance is about 500 — 5 kΩ, there may be excessive dissipation.

MAINS CONTACT

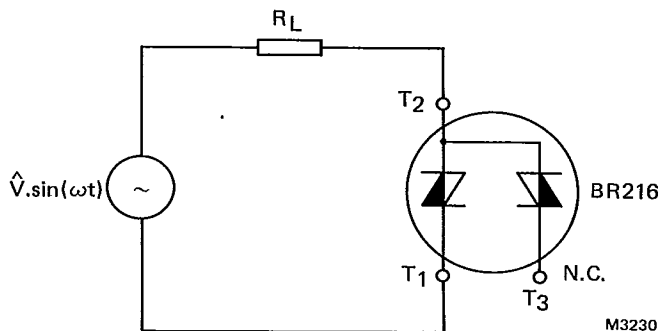Calculation of power dissipation during mains contact fault.

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Fig.5 Equivalent circuit of BOD during mains contact fault;
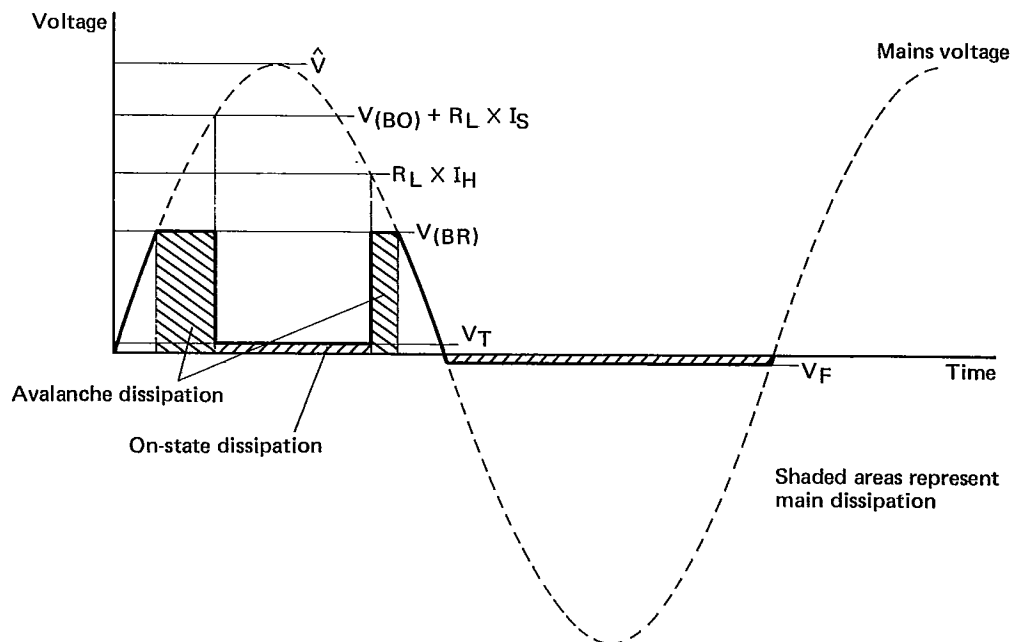R_L = total fault resistance.

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Fig.6 Dissipation during mains contact fault.

Solid line shows voltage across BOD.

Total power generated = avalanche dissipation prior to switching
  (per half-cycle)   + on-state dissipation
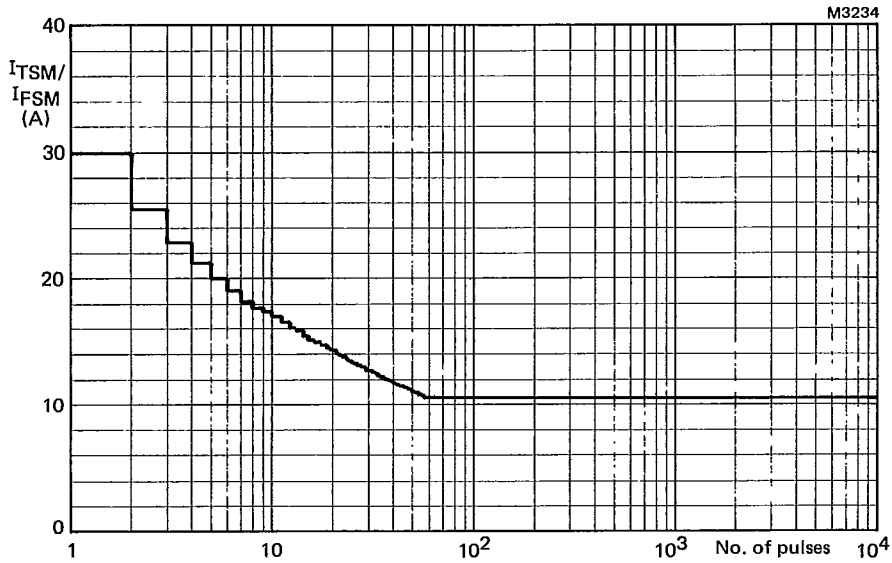   + avalanche dissipation after on-state.

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Fig.7 Maximum permissible non-repetitive on-state current based on sinusoidal currents (f = 50 Hz; device triggered at the start of each pulse). T_j = 125 °C prior to surge.

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exponential pulse duration (time to 50% of peak)
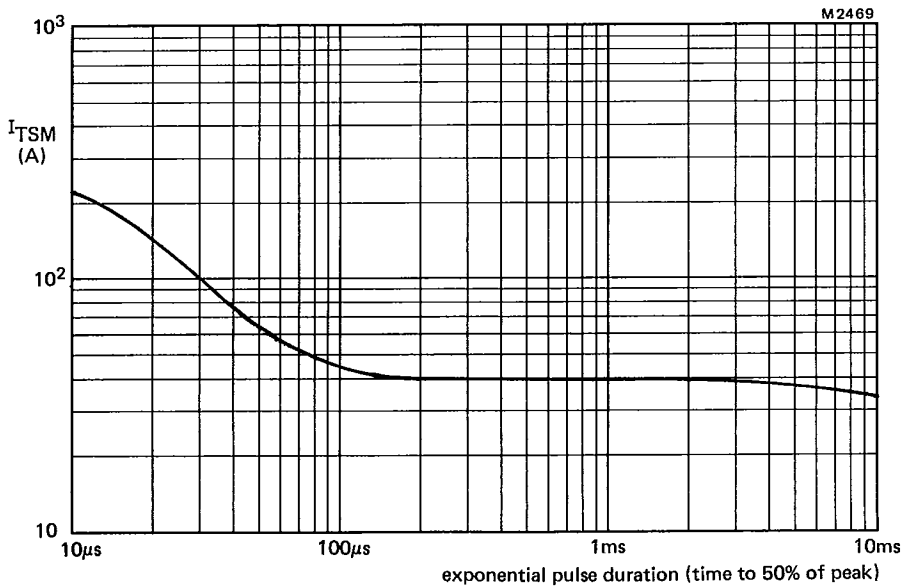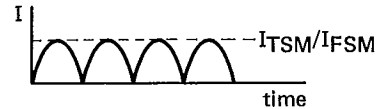
Fig.8 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration (virtual front-time 10 μs).

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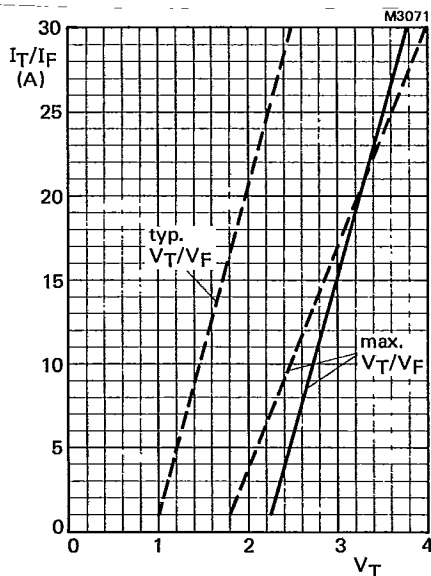
Fig.9 On-state voltage (V_T) and forward voltage (V_F) versus current. (200 μs pulsed condition to avoid excessive dissipation) —— T_j = 25, – – – T_j = 125 °C.
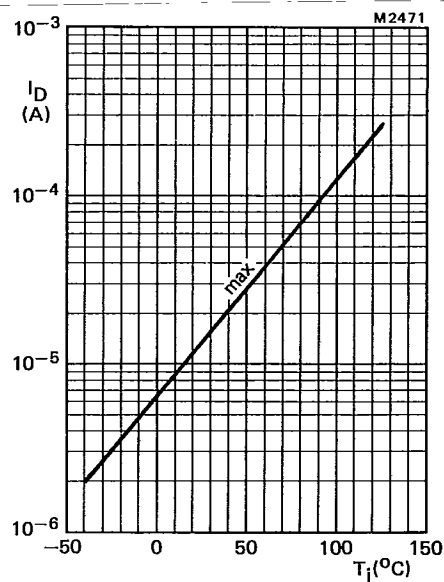
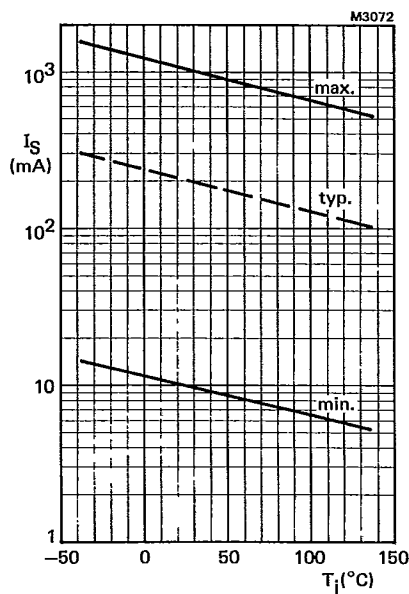Fig.10 Maximum off-state current as a function of temperature.

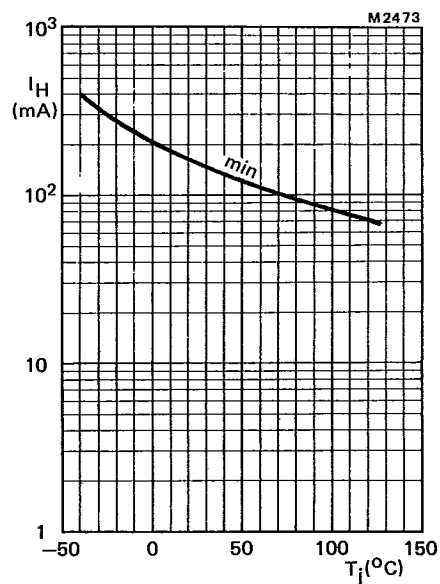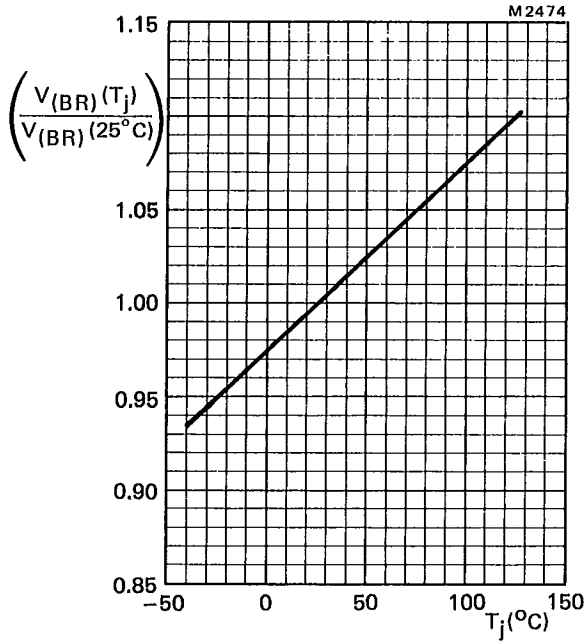Fig.11 Switching current as a function of junction temperature

Fig.12 Minimum holding current as a function of temperature.

Fig. 13 Normalised avalanche breakdown voltage as a function of temperature. Note: this figure may also be used to derive normalised $V_{(BO)}$.
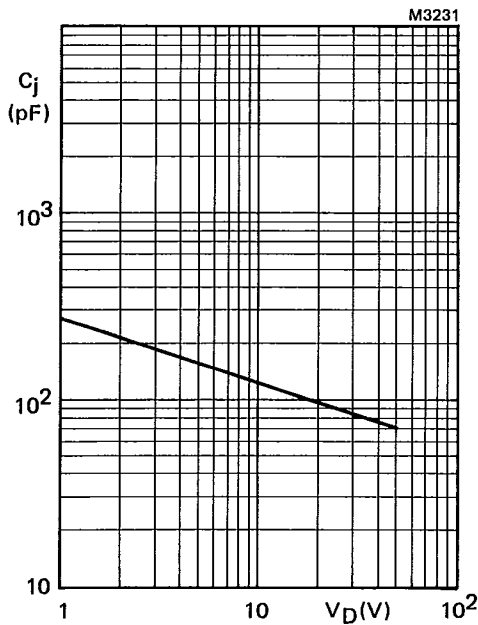

Fig. 14 Typical junction capacitance as a function of off-state voltage; $T_j = 25\,^{\circ}C$; f = 1 MHz.
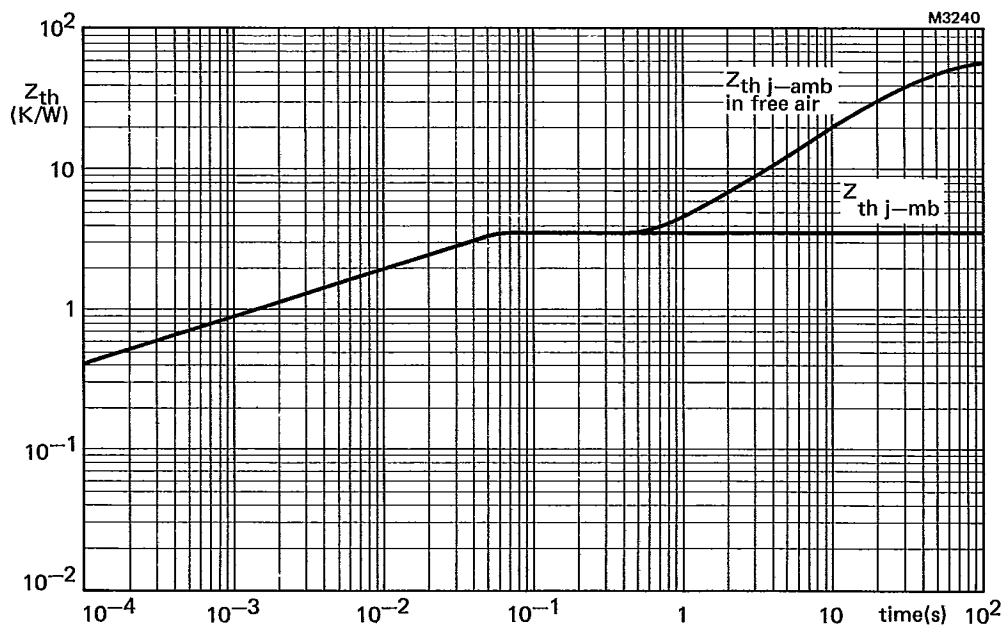
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Fig.15 Transient thermal impedance as a function of time (rectangular pulse duration).