SCHOTTKY-BARRIER DOUBLE RECTIFIER DIODES

Low-leakage, platinum-barrier rectifier diodes in plastic envelopes, featuring low forward voltage drop, low capacitance and absence of stored charge. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are essential. Their single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. They can also withstand reverse voltage transients and have guaranteed reverse avalanche surge capability. The series consists of common-cathode types.

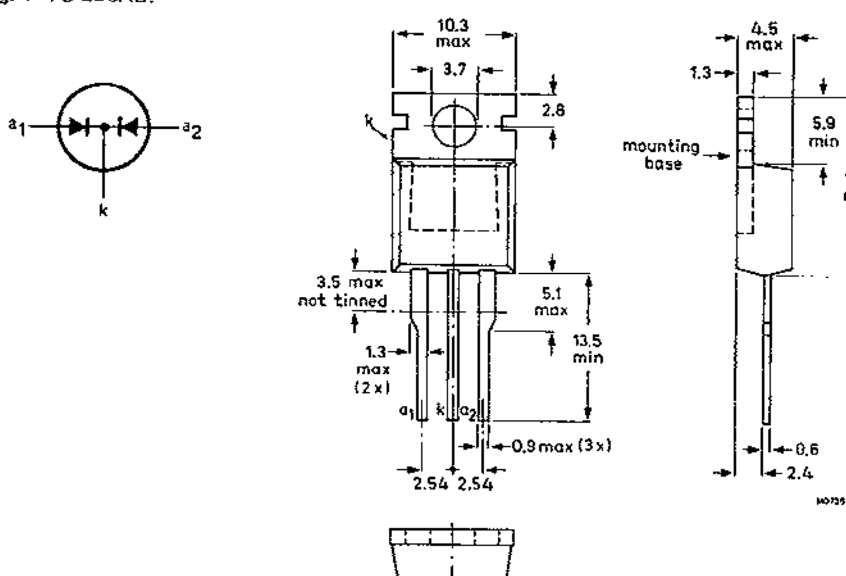
QUICK REFERENCE DATA

Per diode, unless otherwise stated			BYV133-35	40	45	
Repetitive peak reverse voltage	V_{RRM}	max.	35	40	45	V
Output current (both diodes conducting)	I_O	max.		20		A
Forward voltage	V_F	<		0.6		V
Junction temperature	T_j	max.		150		°C

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common cathode.

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

RATINGS

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

Voltages (per diode)			BYV133-35	40	45	
Repetitive peak reverse voltage	V_{RRM}	max.	35	40	45	V
Crest working reverse voltage	V_{RWM}	max.	35	40	45	V
Continuous reverse voltage	V_R	max.	35	40	45	V

Currents (both diodes conducting; note 1)				
Output current:				
square wave; δ = 0.5; up to T_{mb} = 121 °C (note 2)	I_O	max.	20	A
sinusoidal; up to T_{mb} = 124 °C (note 2)	I_O	max.	18	A
RMS forward current (note 3)	$I_{F(RMS)}$	max.	28	A
Repetitive peak forward current t_p = 20 µs; δ = 0.02 (per diode)	I_{FRM}	max.	200	A
Non-repetitive peak forward current (per diode) half sinewave; T_j = 125 °C prior to surge; with reapplied V_{RWM} max				
t = 10 ms	I_{FSM}	max.	100	A
t = 8.3 ms	I_{FSM}	max.	110	A
I^2t for fusing (t = 10 ms, per diode)	I^2t	max.	50	A^2s
Reverse surge current				
t_p = 2 µs; δ = 0.001	I_{RRM}	max.	1.0	A
t_p = 100 µs	I_{RSM}	max.	1.0	A
Temperatures				
Storage temperature	T_{stg}		−40 to +150	°C
Junction temperature	T_j	max.	150	°C

Notes:
1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
2. Assuming no reverse leakage current losses.
3. For output currents in excess of 20 A RMS, connection should be made to the exposed metal mounting base.

CHARACTERISTICS (per diode)

Forward voltage				
$I_F = 7$ A; $T_j = 150$ °C	V_F	<	0.6	V*
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	0.94	V*
Reverse current				
$V_R = V_{RWM\ max}$; $T_j = 125$ °C	I_R	<	15	mA
$V_R = V_{RWM\ max}$; $T_j = 25$ °C	I_R	<	0.1	mA
Junction capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	300	pF

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.6	K/W

Influence of mounting method

1. Heatsink mounted with clip

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	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 maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum 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

2. Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at any device lead length and with copper laminate on the board.	$R_{th\ j\text{-}a}$	=	60	K/W

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. 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 holes.

OPERATING NOTES

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.

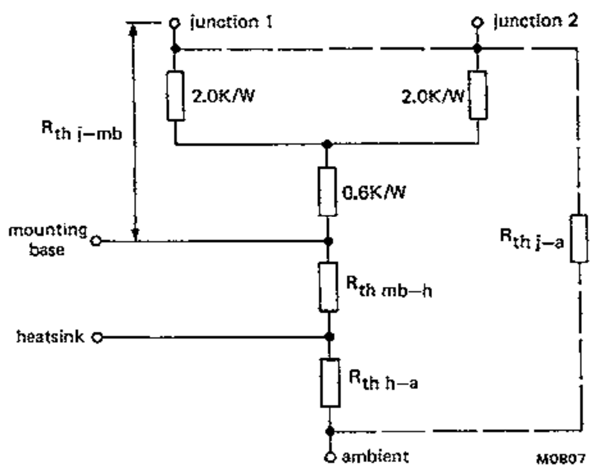


Fig.2

OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation

P_F – forward conduction dissipation

$$P_{tot} = P_R + P_F \quad \text{......... 1).}$$

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{.............. 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3, (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
From this calculation, $P_R = P_R$ (diode 1) + P_R (diode 2) .... 3).
Foward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).
Similarly, $P_F = P_F$ (diode 1) + P_F (diode 2) .... 4).
Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:– If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}mb}$ = 1.6 K/W. If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}mb}$ of 2.6 K/W.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV133-35 and heatsink compound;
T_{amb} = 50 °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 7 A; $I_{F(AV)}$ (diode 2) = 7 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}mb}$ = 1.6 K/W and $R_{th\ mb\text{-}h}$ = 0.2 K/W.
For each diode from Fig.4, it is found that P_F = 5.75 W;
hence total P_F = 2 x 5.75 = 11.5 W (from equation 4)
If the desired T_{jmax} is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.06 W
Therefore total P_R = 2 x 0.06 = 0.12 W (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^\circ C - 50\ ^\circ C}{11.5\ W + 0.12\ W} - (1.6 + 0.2) = 5.1\ K/W$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (1.6 + 0.2 + 5.1) \times 0.12 = 0.8\ ^\circ C.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE WAVE OPERATION (Fig.3 and 4)

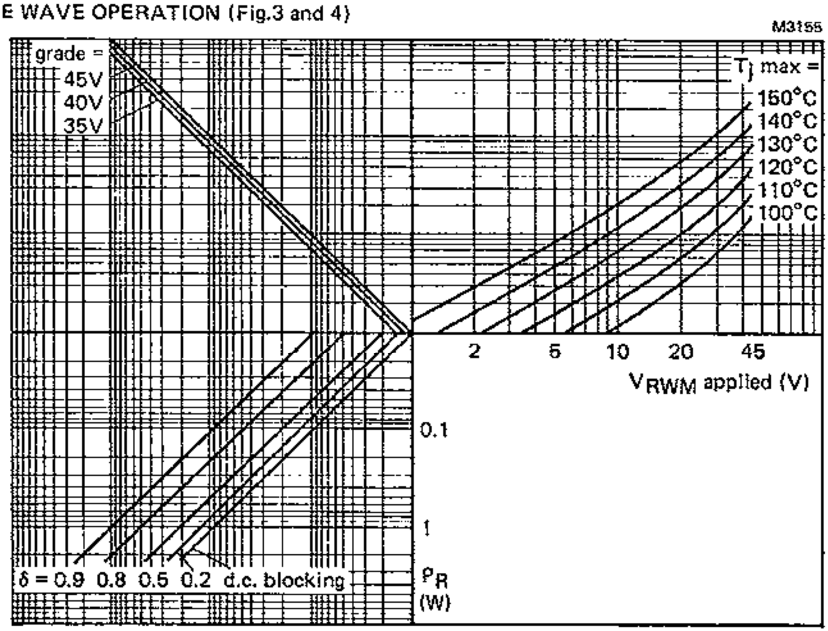
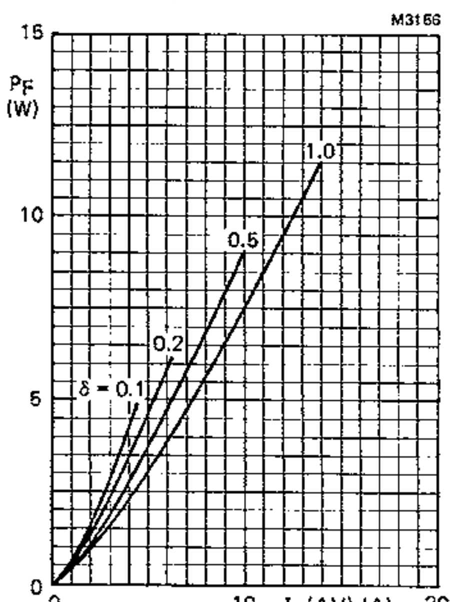
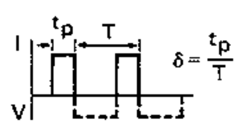


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and duty cycle; per diode.





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4 Forward current power rating; per diode.

SINUSOIDAL OPERATION (Figs. 5 and 6)

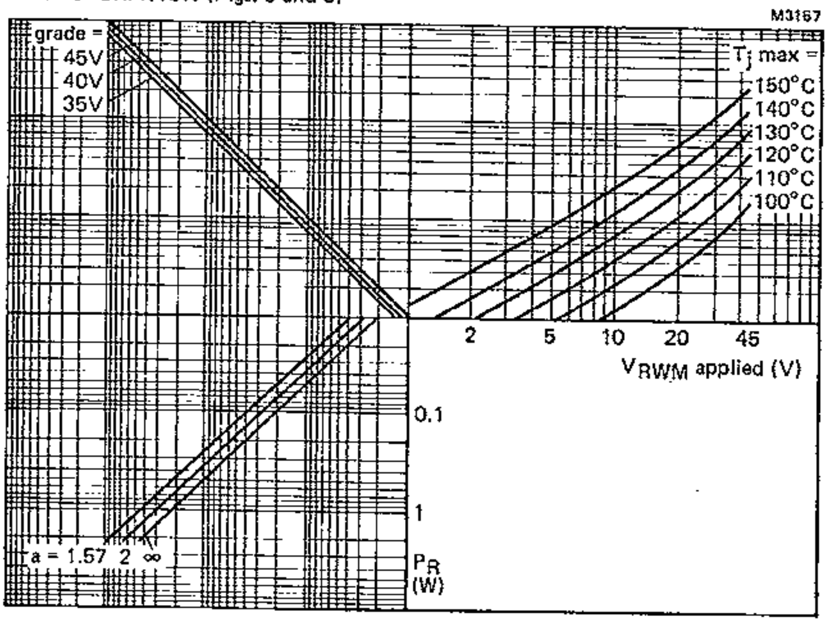


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and form factor; per diode.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

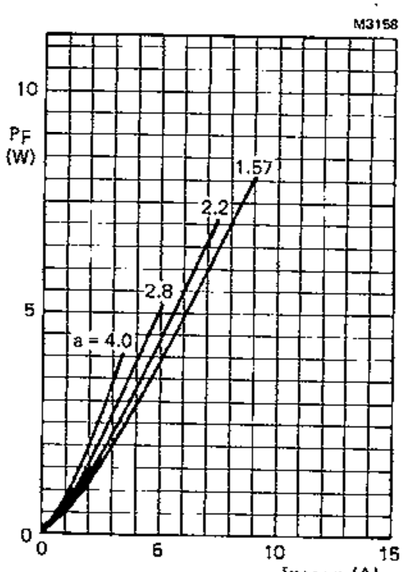


Fig.6 Forward current power rating; per diode.

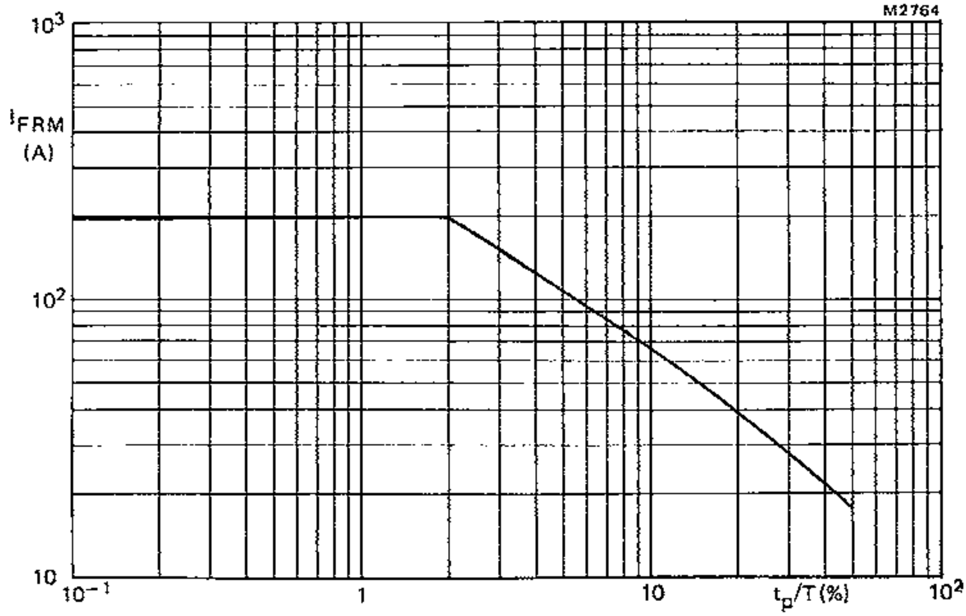
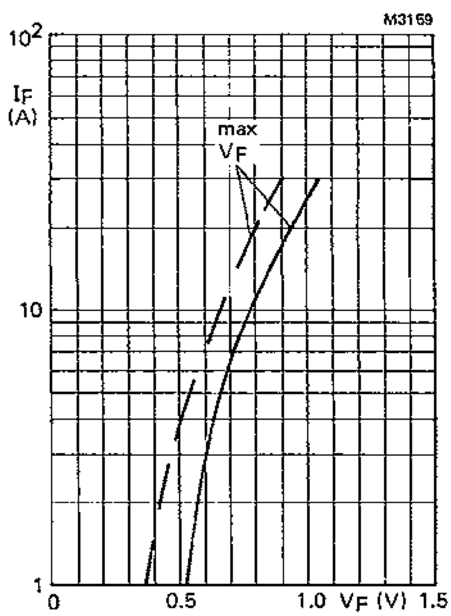
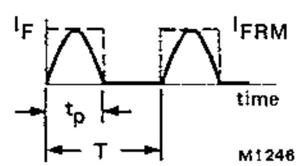


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for $1\ \mu s < t_p < 1$ ms; per diode.





Definition of I_{FRM} and t_p/T.

Fig.8 —— $T_j = 25\ ^oC$; – – – $T_j = 150\ ^oC$; per diode.

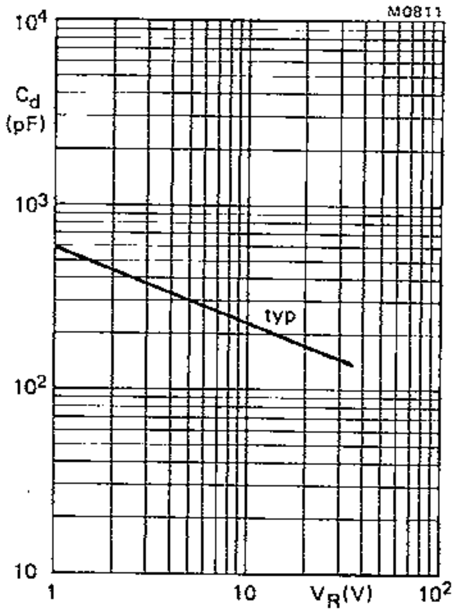


Fig.9 f = 1 MHz; T_j = 25 to 125 °C; per diode.

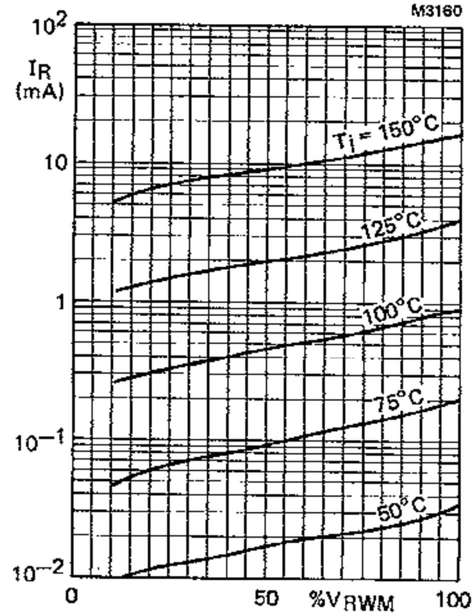


Fig.10 Typical values; per diode.

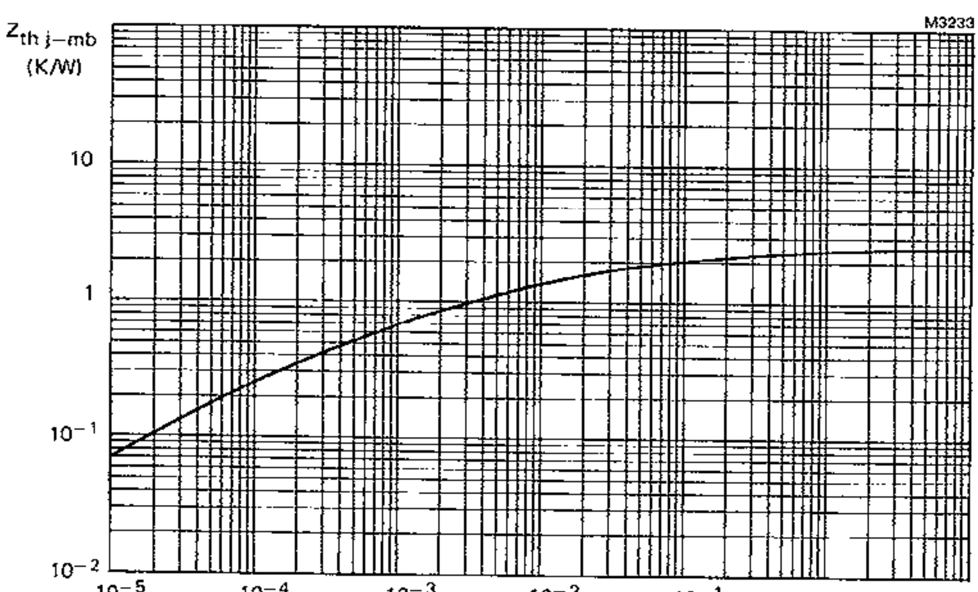


Fig.11 Transient thermal impedance; one diode conducting.