FAST SOFT-RECOVERY RECTIFIER DIODES

- **With controlled avalanche**

Also available to BS9333-F002

Diffused silicon diodes in DO-4 metal envelopes, capable of absorbing transients. They are primarily intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX30-200 to BYX30-600
Reverse polarity (anode to stud): BYX30-200R to BYX30-600R.

QUICK REFERENCE DATA

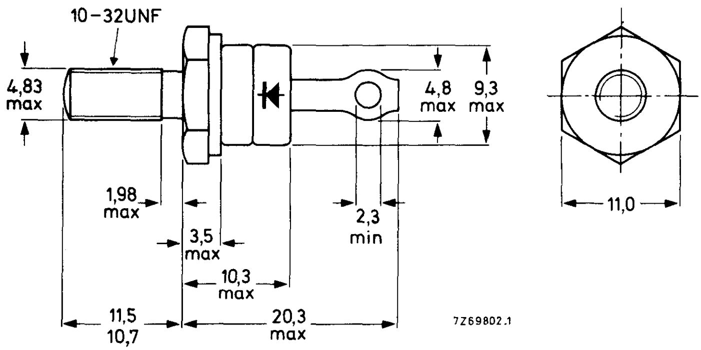
			BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	250	375	500	625	750	V

Average forward current	$I_{F(AV)}$	max.	14	A
Non-repetitive peak forward current	I_{FSM}	max.	250	A
Non-repetitive peak reverse power	P_{RSM}	max.	18	kW
Reverse recovery time	t_{rr}	<	200	ns

MECHANICAL DATA

Dimensions in mm

DO-4; Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 9.5 mm



Net mass: 7 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag)

Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)

The mark shown applies to the normal polarity types.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages [1]		BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max. 200	300	400	500	600	V
Continuous reverse voltage	V_R	max. 200	300	400	500	600	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	14	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	7.5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	22	A
Repetitive peak forward current	I_{FRM}	max.	310	A
Non-repetitive peak forward current (t = 10 ms; half-sinewave) T_j = 150 °C prior to surge; with reapplied V_{RWM}max.	I_{FSM}	max.	250	A
I^2t for fusing (t = 10 ms)	I^2t	max.	312	A^2s

Reverse power dissipation

Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 150 °C	P_{RRM}	max.	5.5	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave) T_j = 25 °C prior to surge	P_{RSM}	max.	18	kW
T_j = 150 °C prior to surge	P_{RSM}	max.	5.5	kW

Temperatures

Storage temperature	T_{stg}	-55 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

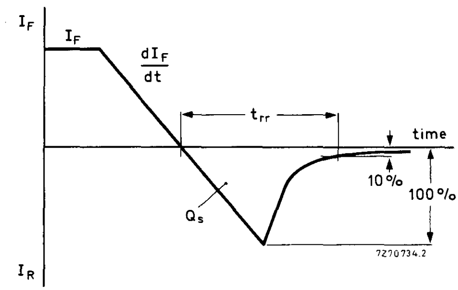
From junction to ambient in free air	$R_{th\ j-a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	°C/W

[1]) To ensure thermal stability: $R_{th\ j-a}$ < 2.5 °C/W (continuous reverse voltage) or < 5 °C/W (a.c.).
For smaller heatsinks T_j max should be derated. For a.c. see page 5.
For continuous reverse voltage: if $R_{th\ j-a}$ = 5 °C/W, then T_j max = 135 °C.
if $R_{th\ j-a}$ = 10 °C/W, then T_j max = 120 °C.

CHARACTERISTICS

			BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage								
I_F = 50 A; T_j = 25 °C	V_F	<	3.2	3.2	3.2	3.2	3.2	V [1]
Reverse breakdown voltage								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	250	375	500	625	750	V
		<	1050	1050	1050	1050	1050	V
Reverse current								
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	4.0	4.0	4.0	4.0	4.0	mA

Reverse recovery charge when switched from				
I_F = 2 A to $V_R \geq$ 30 V; with $-dI_F/dt$ = 100 A/µs; T_j = 25 °C	Q_s	<	0.70	µC
Reverse recovery time when switched from				
I_F = 1 A to $V_R \geq$ 30 V; $-dI_F/dt$ = 50 A/µs; T_j = 25 °C	t_{rr}	<	200	ns



OPERATING NOTES

1. Square-wave operation

When I_F has been flowing sufficiently long for the steady state to be established, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a reverse transient (see figure above). The majority of the power dissipation due to the reverse transient occurs during fall time as the rectifier gradually becomes reverse biased, and the mean power will be proportional to the operating frequency. The mean value of this power loss can be derived from the graphs on page 10.

[1]) Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES (continued)

2. Sine wave operation

Power loss in sine wave operation will be considerably less owing to the much slower rate of change of the applied voltage (and consequently lower values of I_{RRM}), so that power loss due to reverse recovery may be safely ignored for frequencies up to 20 kHz.

3. Determination of the heatsink thermal resistance

Example:
Assume a diode, used in an inverter.

frequency	f	=	20	kHz
duty cycle	δ	=	0.5	
ambient temperature	T_{amb}	=	45	^oC
switched from	I_F	=	12	A
to	V_R	=	400	V
at a rate	$-\frac{dI}{dt}$	=	20	A/μs

At a duty cycle δ = 0.5 the average forward current I_{FAV} = 6 A.
From the upper graph on page 5 it follows, that at I_{FAV} = 6 A the average forward power + average leakage power = 15 W (point A).
The additional power losses due to switching-off can be read from the nomogram on page 10 (the example being based on optimum use, i.e. T_j = 150 ^oC). Starting from I_F = 12 A on the horizontal scale trace upwards until the appropriate line $-\frac{dI}{dt}$ = 20 A/μs. From the intersection trace horizontally to the right until the line for f = 20 kHz. Then trace downwards to the line V_R = 400 V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation P_{RAV} = 4 W.
Therefore the total power dissipation P_{tot} = 15 W + 4 W = 19 W (point B of the upper graph on page 5). From the right hand part follows the thermal resistance, required at T_{amb} = 45 ^oC.

$$R_{th\ mb\text{-}a} \approx 4\ ^oC/W$$

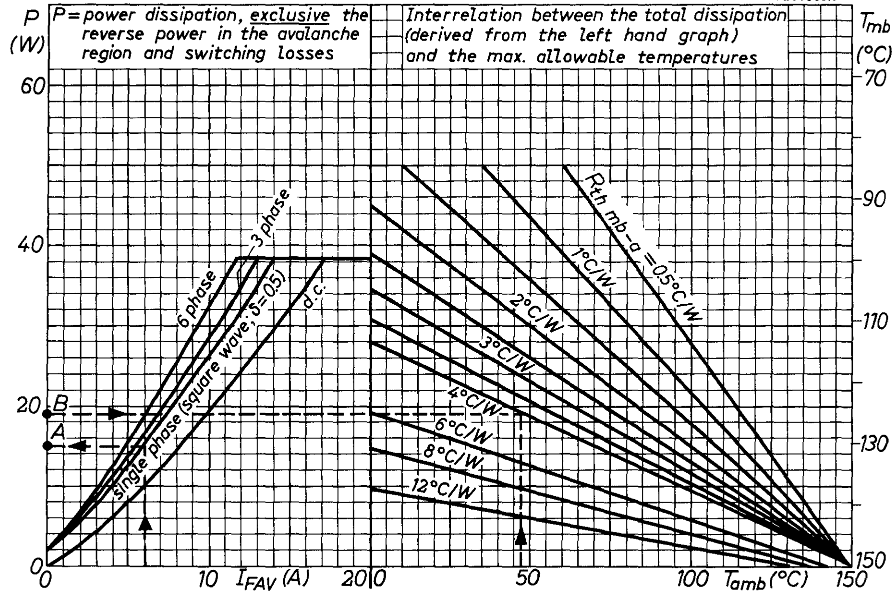
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.5 ^oC/W.

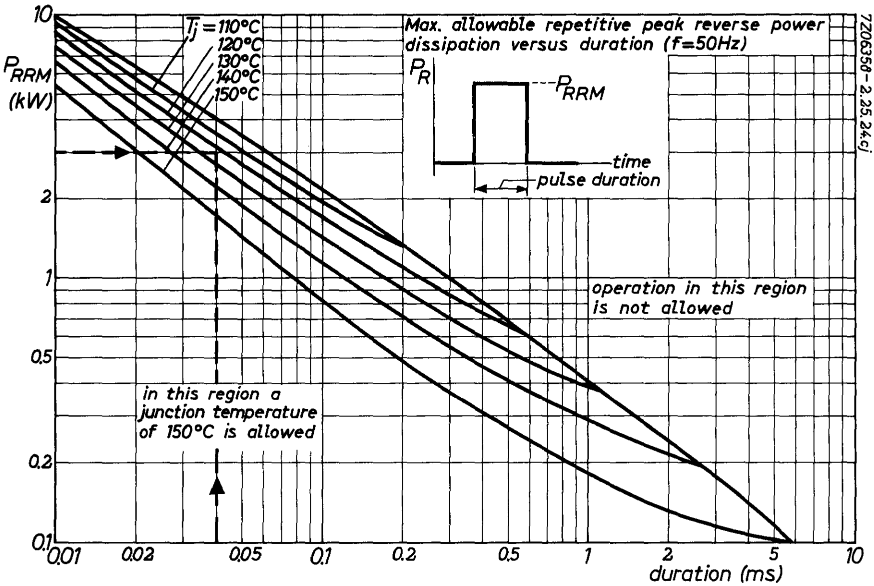
Hence the heatsink thermal resistance should be:

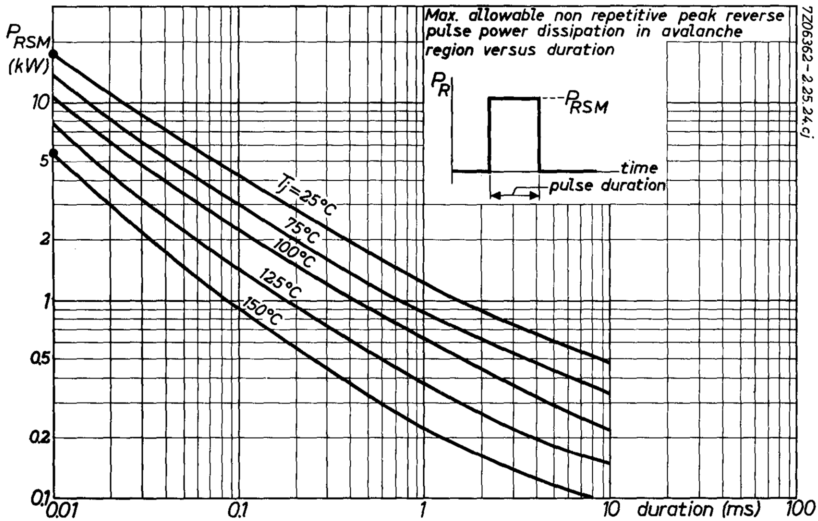
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (4 - 0.5)\ ^oC/W = 3.5\ ^oC/W.$$

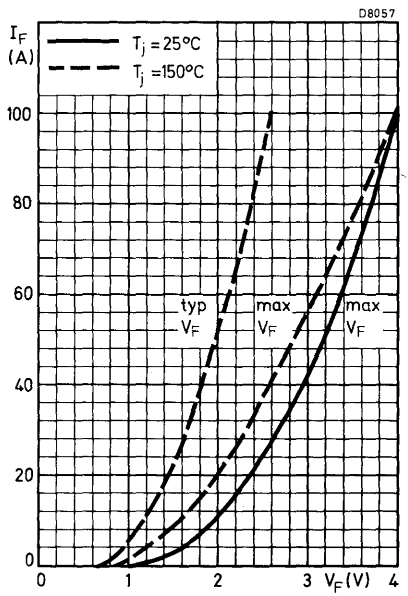
The applicable heatsink(s) may then be found in the Section HEATSINKS.

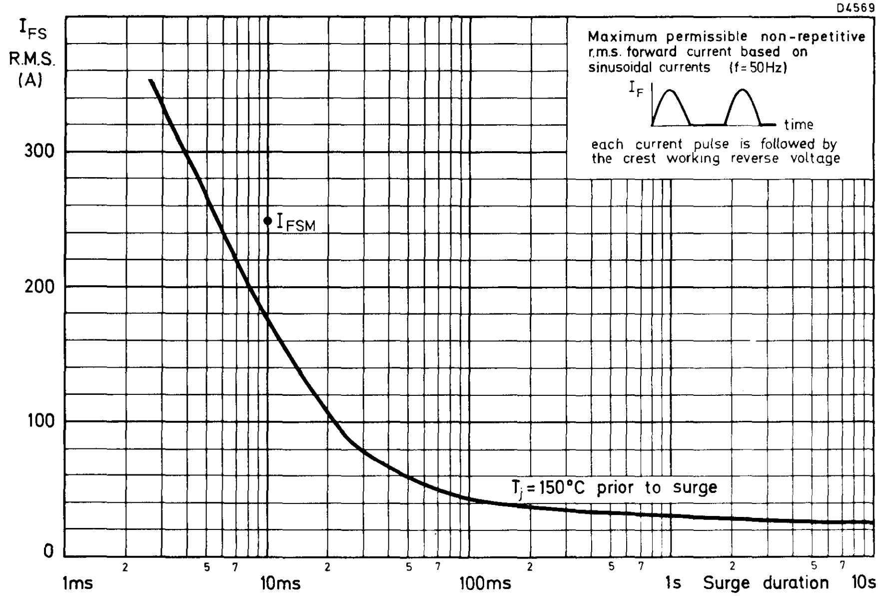
7Z06363.3

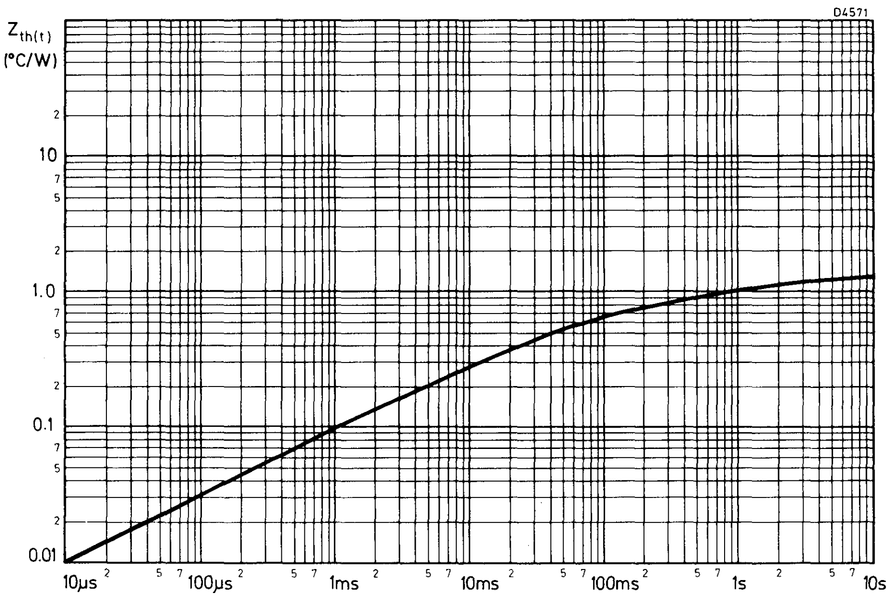

P (W)
P = power dissipation, exclusive the reverse power in the avalanche region and switching losses
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures
T_{mb} (°C)
6 phase
3 phase
single phase (square wave; δ=0.5)
d.c.
B
A
$R_{th\ mb-a}$ = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
12°C/W
I_{FAV} (A)
T_{amb} (°C)

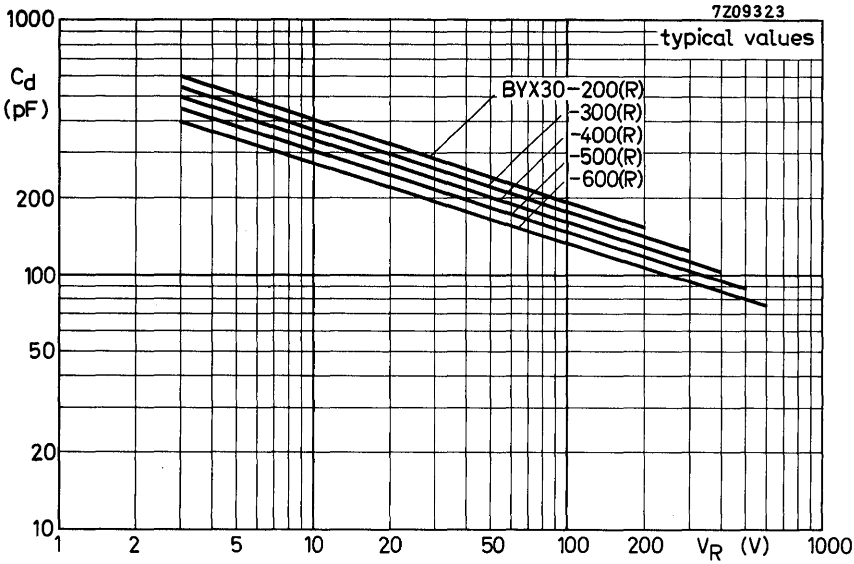

P_{RRM} (kW)
T_j = 110°C
120°C
130°C
140°C
150°C
Max. allowable repetitive peak reverse power dissipation versus duration (f=50Hz)
P_R
P_{RRM}
time
pulse duration
operation in this region is not allowed
in this region a junction temperature of 150°C is allowed
duration (ms)
7Z06356-2.25.24.c)

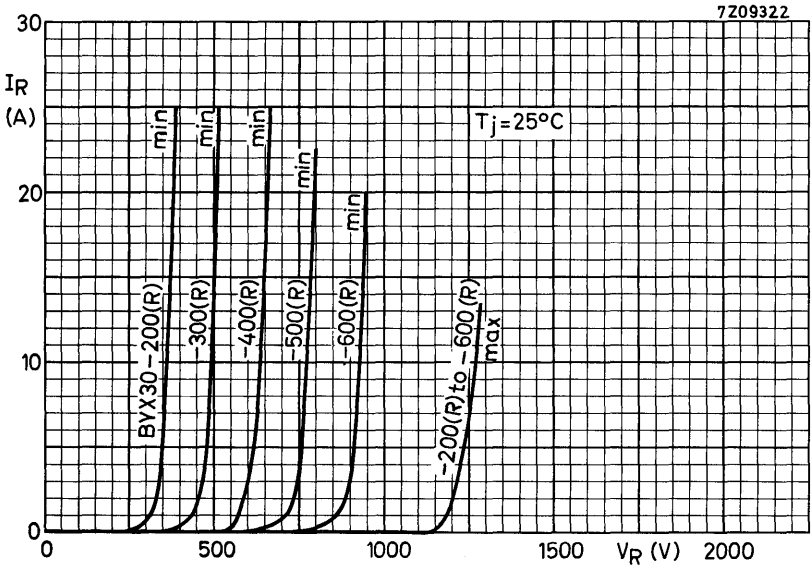

7Z06362-2.25.24.cj
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
P_RSM (kW)
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100
Tj = 25 °C
75 °C
100 °C
125 °C
150 °C
P_R
P_RSM
time
pulse duration

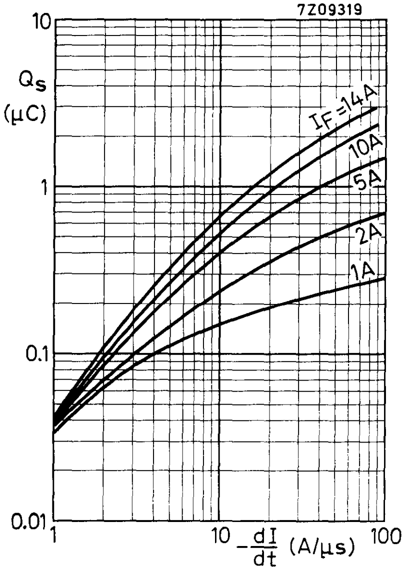

D8057
I_F (A)
Tj = 25 °C
Tj = 150 °C
100
80
60
40
20
0
0
1
2
3
V_F (V)
4
typ V_F
max V_F
max V_F


D4569
I_{FS}
R.M.S.
(A)
300
200
100
0
Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
I_{FSM}
T_j = 150°C prior to surge
1ms
10ms
100ms
1s
Surge duration
10s

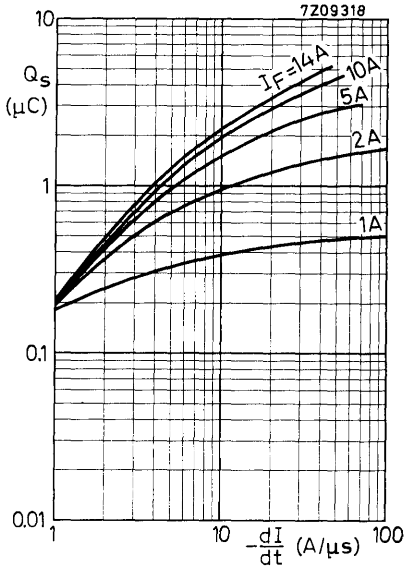

D4571
$Z_{th(t)}$
(°C/W)
10
1.0
0.1
0.01
10μs
100μs
1ms
10ms
100ms
1s
10s


7Z09323
typical values
1000
C_d
(pF)
200
100
50
20
10
1
2
5
10
20
50
100
200
V_R (V)
1000
BYX30−200(R)
−300(R)
−400(R)
−500(R)
−600(R)

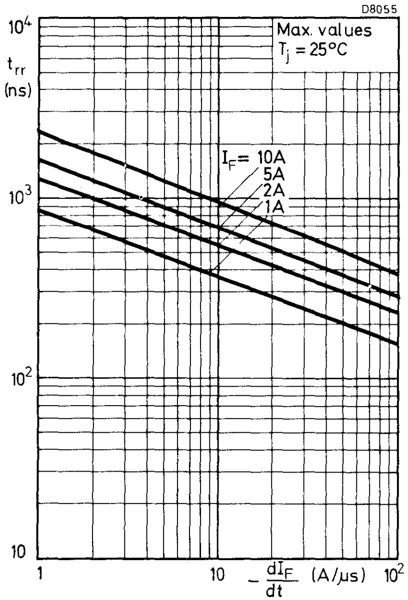

7Z09322
30
I_R
(A)
20
10
0
0
500
1000
1500
V_R (V)
2000
T_j=25°C
min
min
min
min
min
BYX30−200(R)
−300(R)
−400(R)
−500(R)
−600(R)
−200(R) to −600(R)
max

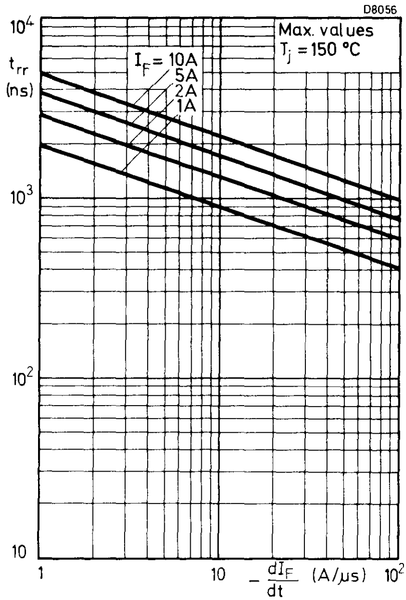


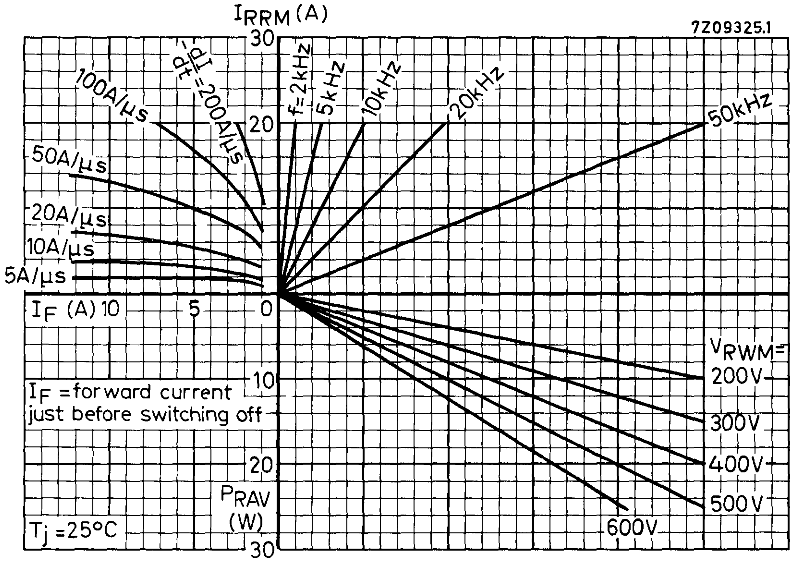
Maximum values; T_j = 25 °C; switched from I_F to $V_R \geqslant 30$ V.

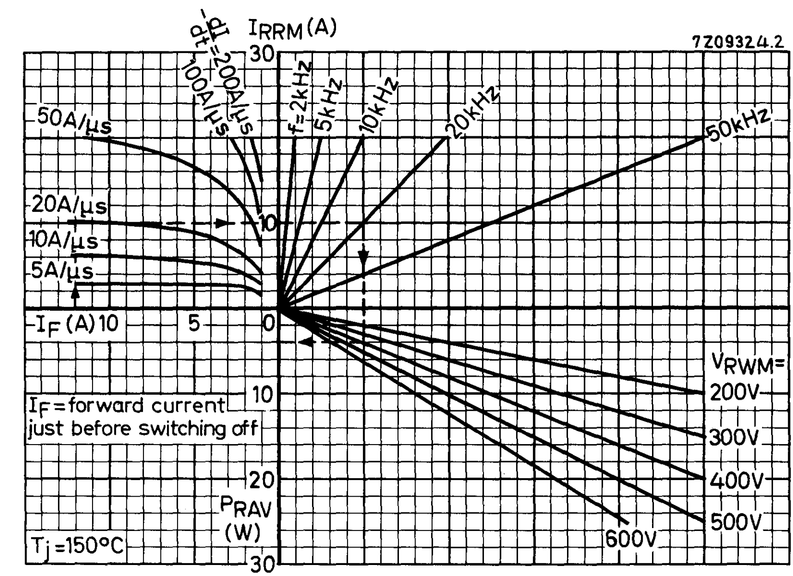


Maximum values; T_j = 150 °C; switched from I_F to $V_R \geqslant 30$ V.









Nomogram: Power loss P_{RAV} due to switching only (square wave operation)