PHILIPS INTERNATIONAL 56E D ■ 7110826 0041630 532 ■PHIN

T-03-19

FAST SOFT-RECOVERY RECTIFIER DIODES

- With controlled avalanche

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): BYX46-200 to BYX46-600.
Reverse polarity (anode to stud): BYX46-200R to BYX46-600R

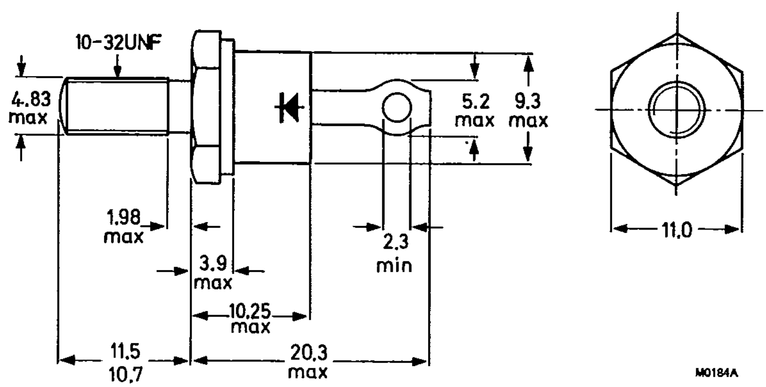
QUICK REFERENCE DATA

			BYX46-200(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.			22			A
Non-repetitive peak forward current	I_{FSM}	max.			300			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:
see ACCESSORIES section

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 (IEC 134)

Voltages *			BYX46-200(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.	22	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	15	A
R.M.S. forward current	$I_{F(RMS)}$	max.	35	A
Repetitive peak forward current	I_{FRM}	max.	400	A
Non-repetitive peak forward current (t = 10 ms; half-sinewave) T_j = 165 °C prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	300	A
I^2t for fusing (t = 10 ms)	I^2t	max.	450	A^2s
Reverse power dissipation				
Repetitive peak reverse power dissipation t = 10 μs (square wave; f = 50 Hz) T_j = 100 °C	P_{RRM}	max.	9,5	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 = 165 °C prior to surge	P_{RSM}	max.	4	kW
Temperatures				
Storage temperature	T_{stg}		−55 to +165	°C
Junction temperature	T_j	max.	165	°C

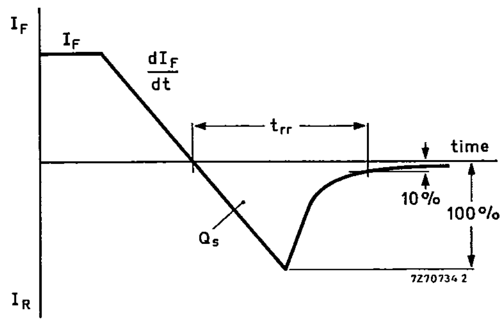
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,3	°C/W
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	0,5	°C/W

* To ensure thermal stability: $R_{th\,j\text{-}a} < 2,5$ °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 $R_{th\,j\text{-}a}$ = 5 °C/W, then $T_{j\,max}$ = 135 °C; if $R_{th\,j\text{-}a}$ = 10 °C/W, then $T_{j\,max}$ = 125 °C.

CHARACTERISTICS

			BYX46-200(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage I_F = 50 A; T_j = 25 °C	V_F	<	2,0	2,0	2,0	2,0	2,0	V *
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 $V_R \geqslant$ 30 V; $-dI_F/dt$ = 100 A/µs; T_j = 25 °C	Q_s	<			0,70			µC
Reverse recovery time when switched from I_F = 1 A to $V_R \geqslant$ 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.

* 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 50 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}	=	40	^oC
switched from	I_F	=	12	A
to	V_R	=	300	V
at a rate	$-\frac{dI}{dt}$	=	50	A/µs

At a duty cycle $\delta = 0.5$ 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 = 13 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. $T_j = 165\ ^oC$). Starting from $I_F = 12$ A on the horizontal scale trace upwards until the appropriate line $-\frac{dI}{dt} = 50$ A/µs. From the intersection trace horizontally to the right until the line for f = 20 kHz. Then trace downwards to the line $V_R = 300$ V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation $P_{RAV} = 6$ W.
Therefore the total power dissipation $P_{tot} = 13\ W + 6\ W = 19\ W$ (point B of the upper graph on page 5).

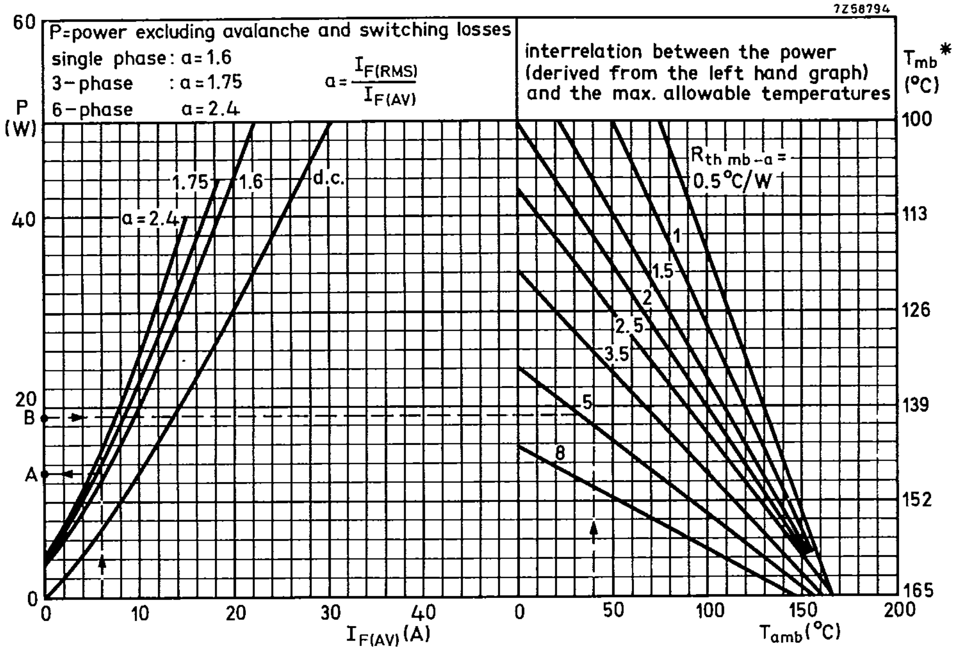
From the right hand part of the upper graph on page 5 follows the thermal resistance, required at $T_{amb} = 40\ ^oC$.

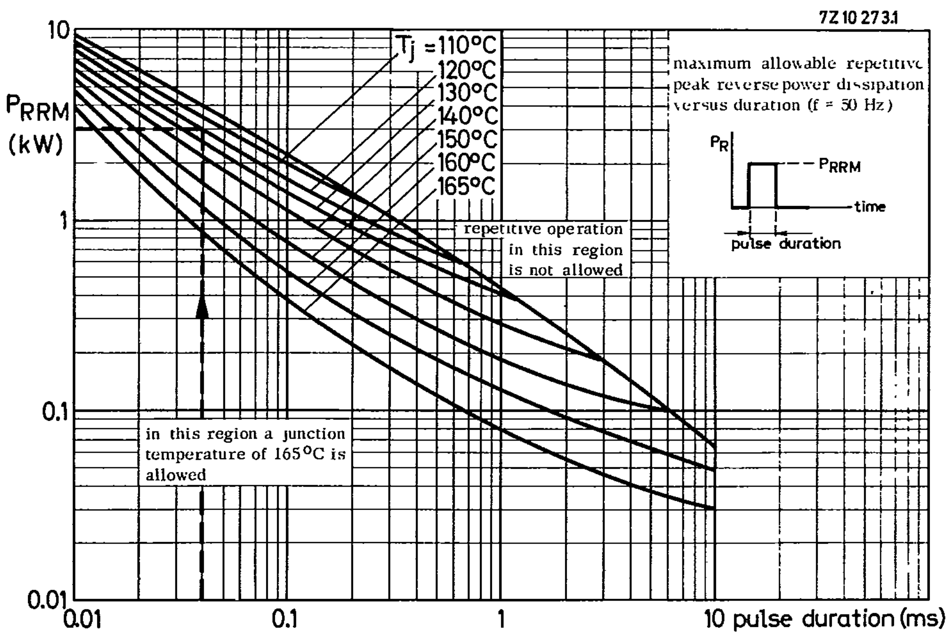
$$R_{th\ mb\text{-}a} \approx 5\ ^oC/W$$

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

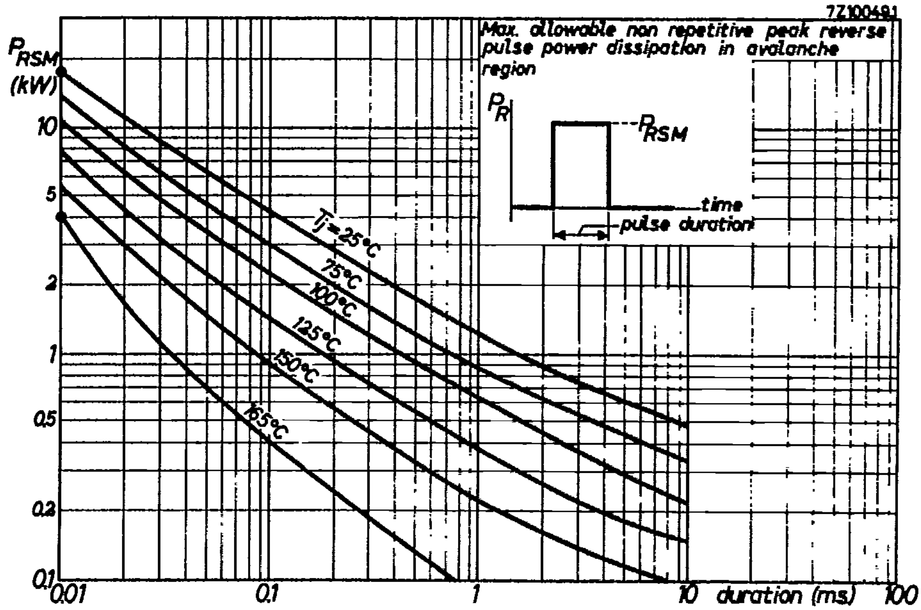
Hence the heatsink thermal resistance should be:

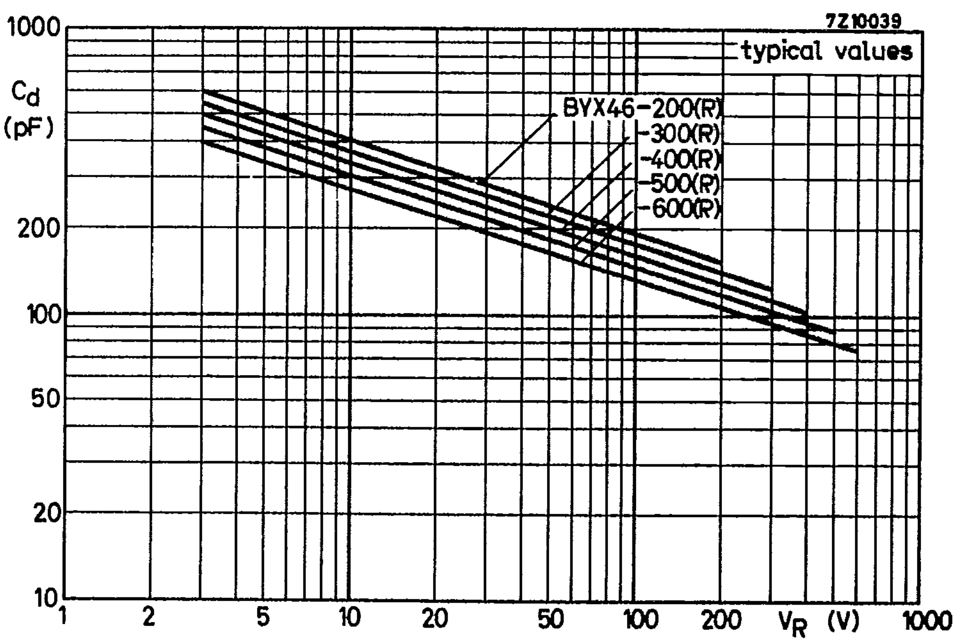
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (5 - 0.5)\ ^oC/W = 4.5\ ^oC/W.$$


7Z58794
P=power excluding avalanche and switching losses
single phase: a = 1.6
3-phase : a = 1.75
6-phase a = 2.4
a = $\frac{I_{F(RMS)}}{I_{F(AV)}}$
interrelation between the power
(derived from the left hand graph)
and the max. allowable temperatures
P (W)
T_{mb} *) (°C)
a = 2.4
1.75
1.6
d.c.
$R_{th\ mb-a}$ = 0.5 °C/W
1
1.5
2
2.5
3.5
5
8
B
A
$I_{F(AV)}$ (A)
T_{amb} (°C)


7Z10273.1
P_{RRM} (kW)
Tj = 110°C
120°C
130°C
140°C
150°C
160°C
165°C
maximum allowable repetitive peak reverse power dissipation versus duration (f = 50 Hz)
P_R
P_{RRM}
time
pulse duration
repetitive operation in this region is not allowed
in this region a junction temperature of 165°C is allowed
pulse duration (ms)

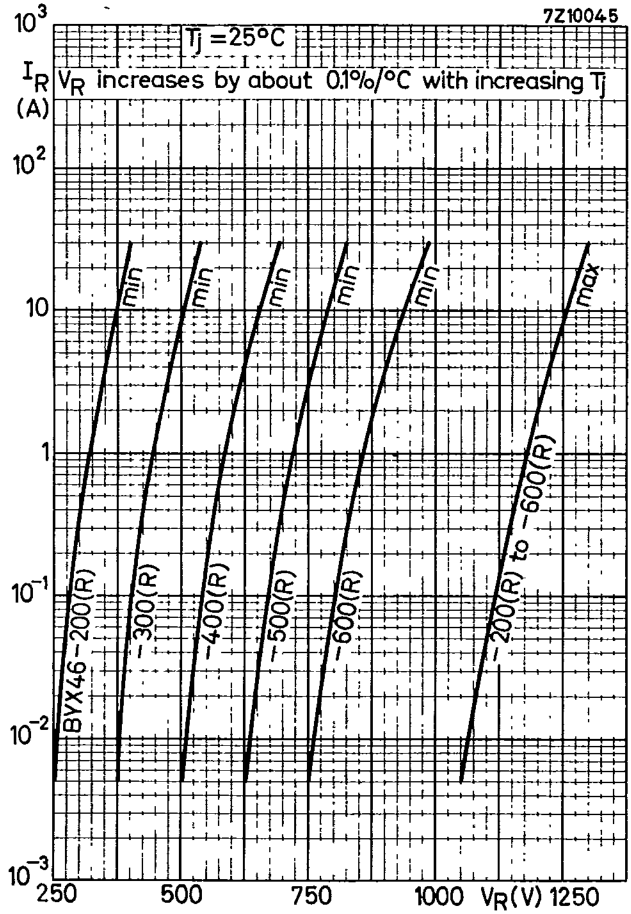
T-03-19

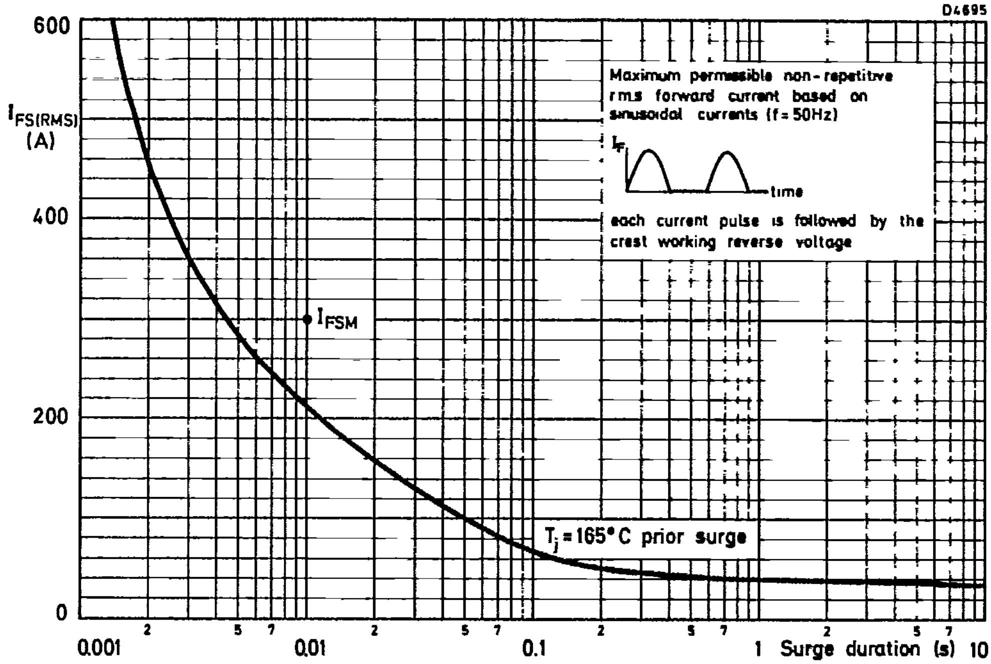

7Z100491
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region
P_{RSM} (kW)
P_R
P_{RSM}
time
pulse duration
T_j = 25 °C
75 °C
100 °C
125 °C
150 °C
165 °C
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100

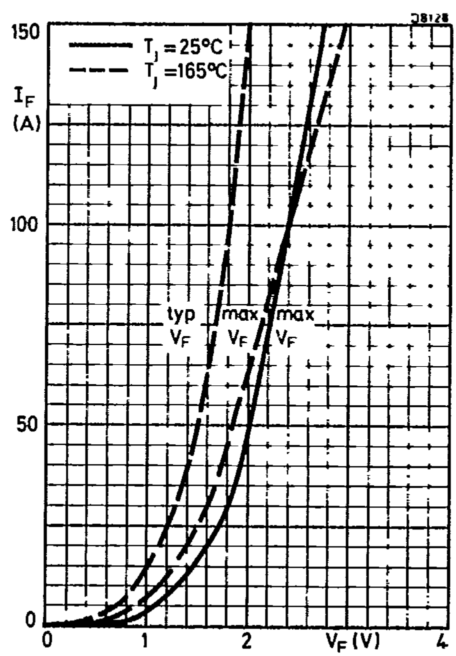

7Z10039
typical values
C_d (pF)
BYX46-200(R)
-300(R)
-400(R)
-500(R)
-600(R)
1000
200
100
50
20
10
1
2
5
10
20
50
100
200
V_R (V)
1000

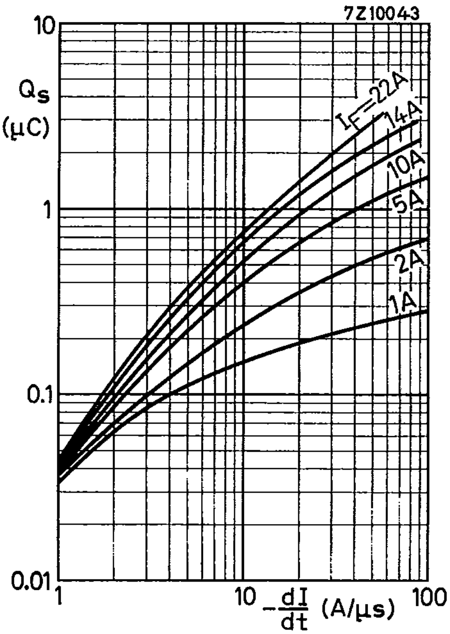
PHILIPS INTERNATIONAL 56E D ■ 7110826 0041636 T50 ■PHIN

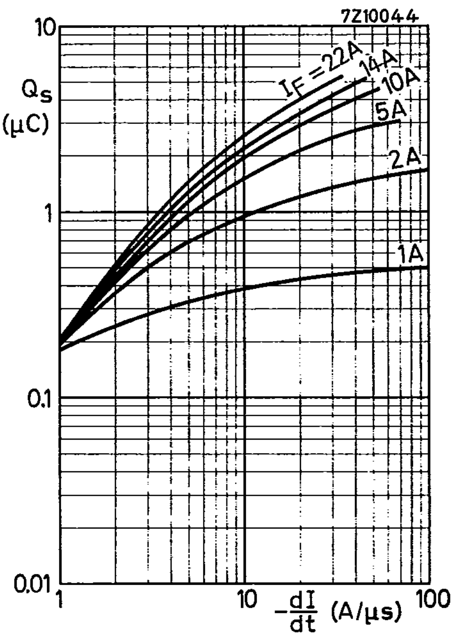
T-03-19

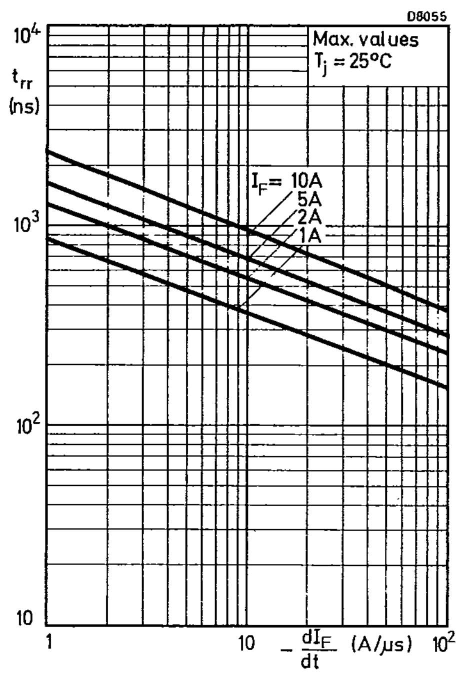


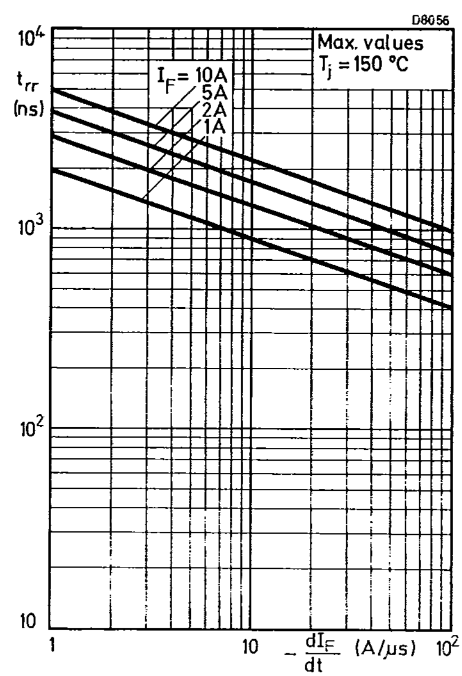

D4695
600
$I_{FS(RMS)}$
(A)
400
200
0
Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
I_{FSM}
T_j = 165°C prior surge
0.001
0.01
0.1
1 Surge duration (s) 10

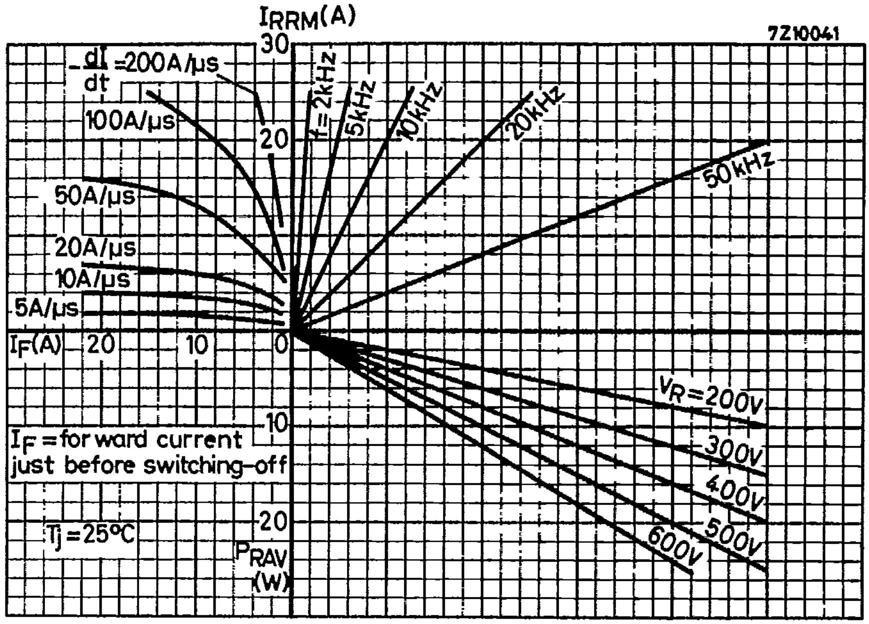

150
I_F
(A)
100
50
0
T_j = 25°C
T_j = 165°C
typ V_F
max V_F
max V_F
0
1
2
V_F (V)
4

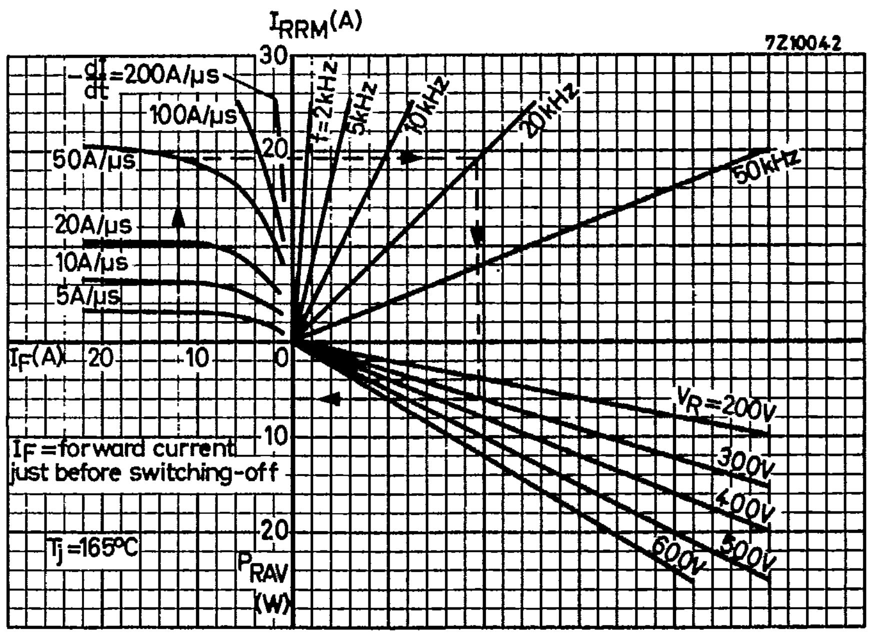

7Z10043
Q_s (μC)
I_F = 22A
14A
10A
5A
2A
1A
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/μs)


7Z10044
Q_s (μC)
I_F = 22A
14A
10A
5A
2A
1A
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/μs)

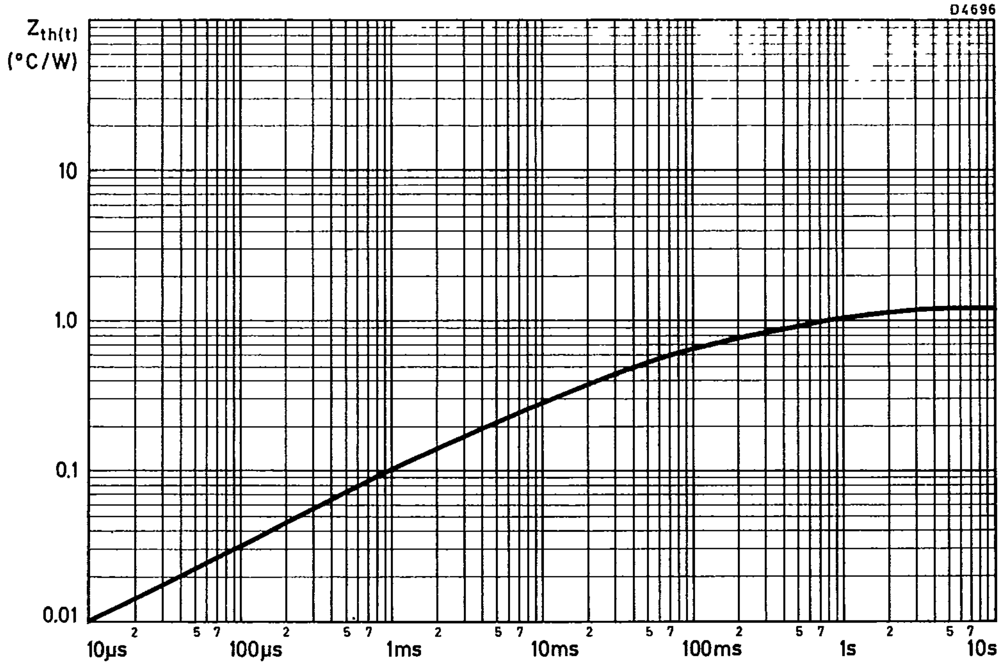

D8055
Max. values
T_j = 25°C
t_{rr} (ns)
I_F = 10A
5A
2A
1A
10^4
10^3
10^2
10
1
10
10^2
$-\frac{dI_F}{dt}$ (A/μs)


D8056
Max. values
T_j = 150 °C
t_{rr} (ns)
I_F = 10A
5A
2A
1A
10^4
10^3
10^2
10
1
10
10^2
$-\frac{dI_F}{dt}$ (A/μs)





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


D4696
$Z_{th(t)}$ (°C/W)
10
1.0
0.1
0.01
10μs
100μs
1ms
10ms
100ms
1s
10s
2
5
7