WESTCODE SEMICONDUCTORS

Technical Publication
DFP174
Issue 1
February 1981

Fast Recovery Stud-Base Diode Type PHN/PHR174
150 amperes average: up to 2000 volts V_{RRM}

Ratings (Maximum values at Tj 125°C unless stated otherwise)

RATING	CONDITIONS	SYMBOL	
Average forward current	Half sine wave 100°C case temperature	$I_{F(AV)}$	150A
R.M.S. current		$I_{F(RMS)}$	400A
D.C forward current		I_F	400A
Peak one-cycle surge non-repetitive	10ms sine pulse, 60% V_{RRM} re-applied	$I_{FSM(1)}$	4500A
	10ms sine pulse, $V_{RM} \leq 10$ volts	$I_{FSM(2)}$	4950A
Maximum surge I^2t	10ms sine pulse, 60% V_{RRM} re-applied	$I^2t_{(1)}$	101000A²s
	10ms sine pulse, $V_{RM} \leq 10$ volts	$I^2t_{(2)}$	122000A²s
	3ms sine pulse $V_{RM} \leq 10$ volts	$I^2t_{(3)}$	91000A²s
Operating temperature range		T_{case}	−30 +125°C
Storage temperature range		T_{stg}	−40 +150°C

Characteristics (Maximum values at Tj 125°C unless stated otherwise)

CHARACTERISTIC	CONDITIONS	SYMBOL	
Peak forward voltage drop	At 470A I_{FM}	V_{FM}	1.35V
Forward conduction threshold voltage		V_O	1.0V
Forward conduction slope resistance		r	0.74mΩ
Peak reverse current	$V_{RM} = V_{RRM}$ (max.)	I_{RRM}	20mA
Thermal resistance	Junction to case	$R_{th\ (j\text{-}c)}$	0.13°C/W
	Case to heatsink	$R_{th\ (c\text{-}hs)}$	0.04°C/W
Reverse recovered charge	$I_{FM} = 550$A, di/dt = 40 A/μs, $V_{RM} = 50$V	Q_{rr}	160μC

VOLTAGE CODE		12	14	16	18	20	
Repetitive voltage	V_{RRM}	1200	1400	1600	1800	2000	
Non-repetitive voltage	V_{RSM}	1300	1500	1700	1900	2100	

Ordering Information (Please quote device code as explained below – 10 digits)

S M	● ●	P H	●	1 7 4
FIXED BASIC CODE	VOLTAGE CODE (see above)	FIXED OUTLINE CODE	BASE POLARITY N = cathode R = anode	FIXED TYPE CODE

Typical code: SM16PHN174 = 1600V_{RRM} stud-base diode with stud cathode

1. INTRODUCTION

The SM12-M20PHN/R174 diode series comprises fast recovery stud-based devices with 24mm all diffused silicon slices. All these diodes have controlled reverse recovery characteristics with good 'S' factors.

2. NOTES ON THE RATINGS

(a) **Square wave ratings**
These ratings are given for leading edge linear rates of rise of forward current of 100 and 200A/μs.

(b) **Energy per pulse characteristics**
These curves, when used in conjunction with those for the appropriate junction temperature rise, enable maximum operating frequencies and dissipations to be obtained.

(c) **Junction temperature rise per pulse**
Single pulse junction temperature rises are given for all rating conditions.

Let: Ep be the Energy per pulse for a given current and pulse width, in Joules

T be the appropriate junction temperature rise, in degrees Centigrade

R_θ be the steady-state thermal resistance (junction to sink)

and T_{SINK} be the heat sink temperature

the operating frequency may be obtained from

$$f = \frac{125 - T - t_{SINK}}{E_p R_\theta}$$

and the dissipation will be

$$W_{AV} = E_p f$$

3. REVERSE RECOVERY LOSS

On account of the number of circuit variables affecting reverse recovery voltage, no allowance for reverse recovery loss has been made in the forward ratings. The following procedure is suggested when it is necessary to include reverse recovery loss.

(a) **Determination by Measurement**
From waveforms of recovery current obtained from a high frequency shunt (see Note 1) and reverse voltage present during recovery, an instantaneous reverse recovery loss waveform must be constructed. Let the area under this waveform be A microjoules per pulse. An additional junction temperature rise per pulse can then be evaluated from:

$$\text{Total } T_J \text{ rise per pulse} = \text{Forward } T_J \text{ rise per pulse} + \frac{A}{t} r_t$$

where $r_t = 1.64 \times 10^{-4} \sqrt{t}$

where t = duration of reverse recovery loss per pulse in microseconds

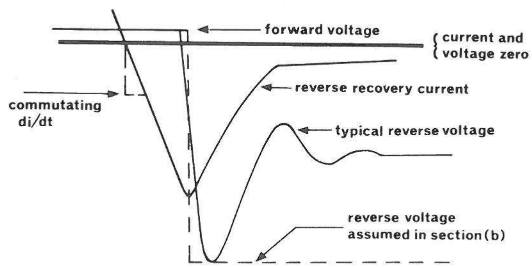
where A = Area under reverse loss waveform per pulse in microjoules

The Energy per pulse must also be modified to include the reverse recovery loss by adding

$A \times 10^{-6}$ Joules

to the forward energy per pulse values.

(b) **Determination without measurement**
Junction temperature rise per pulse per volt and Reverse Recovery Energy per pulse per volt curves are given for cases where it is not possible to measure the voltage and current conditions during reverse recovery. The Figure below shows the idealised situation during reverse recovery. In practice the reverse voltage has an initial overshoot (by an amount inversely proportional to the 'S' Factor) and then settles to a steady state during the recovery 'tail'. This method assumes that full voltage is present throughout the recovery.



The values obtained from these curves must be multiplied by the reverse voltage.

4. NOTE 1

REVERSE RECOVERY LOSS BY MEASUREMENT

When measuring the reverse recovered charge care must be taken to ensure that:

(a) a.c. coupled devices such as current transformers are avoided, as they tend to exaggerate the apparent charge (due to the prior passage of forward current).

(b) The measuring oscilloscope has adequate dynamic range – typically 100 screen heights – to cope with the initial forward current without overload.

NOTE 2

HOUSING LOSS

The loss caused by coupling between housing and anode current (which gives rise to additional heating at high frequency) has been incorporated into the curves of forward energy loss per pulse.

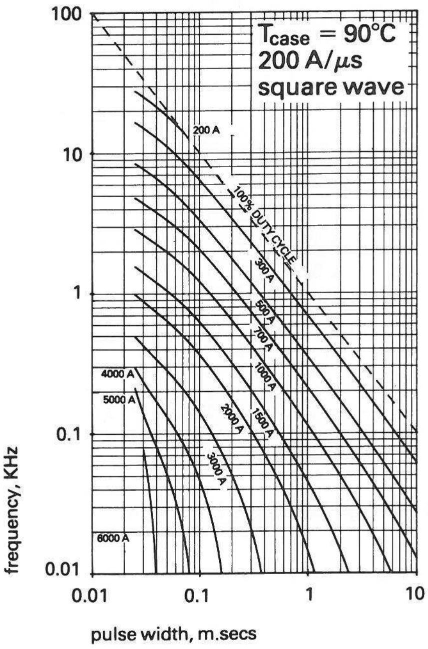


Figure 1 **Frequency v. pulse width**

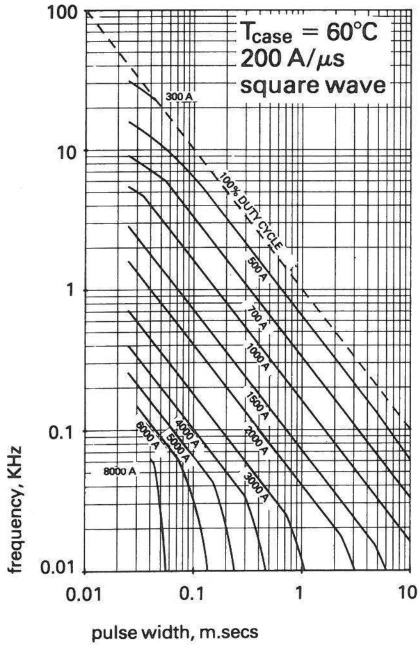


Figure 2 **Frequency v. pulse width**

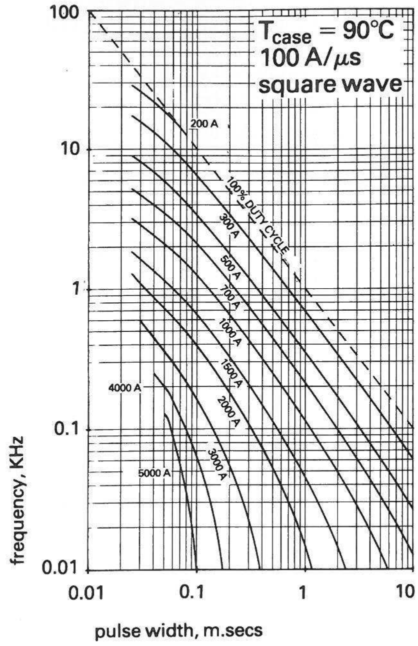


Figure 5 **Frequency v. pulse width**

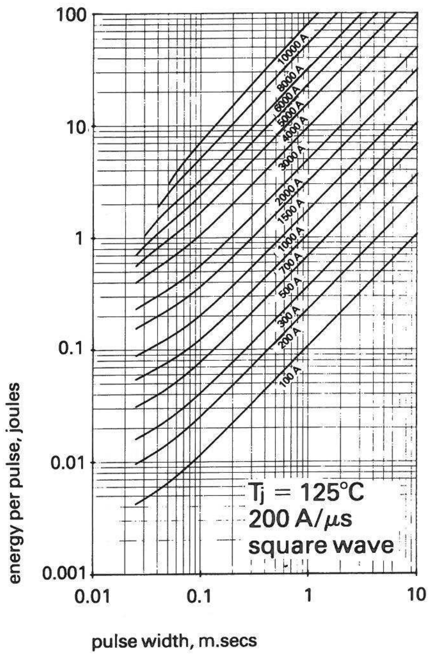


Figure 3 **Energy per pulse v. pulse width**

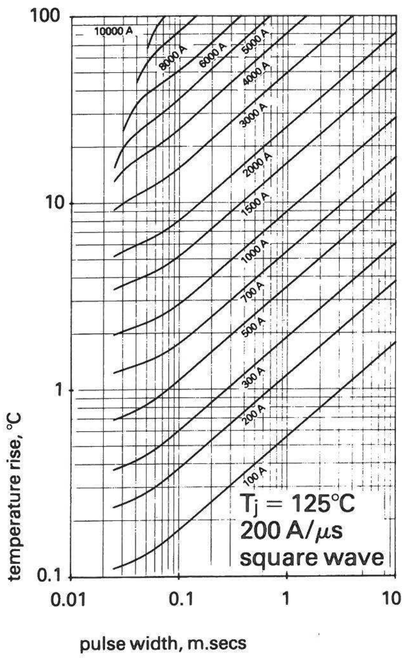


Figure 4 **Temperature rise per pulse v. pulse width**

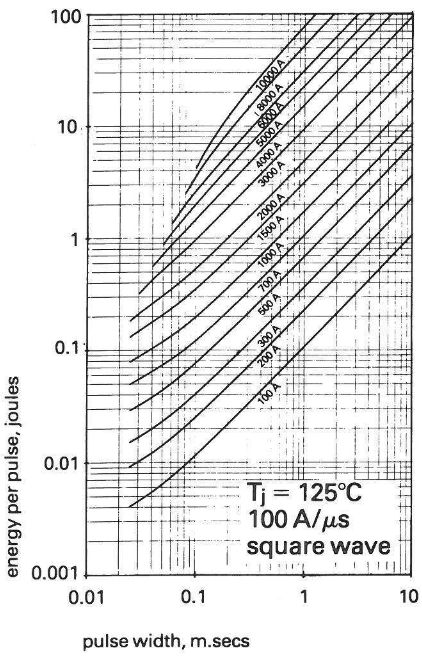


Figure 7 **Frequency per pulse v. pulse width**

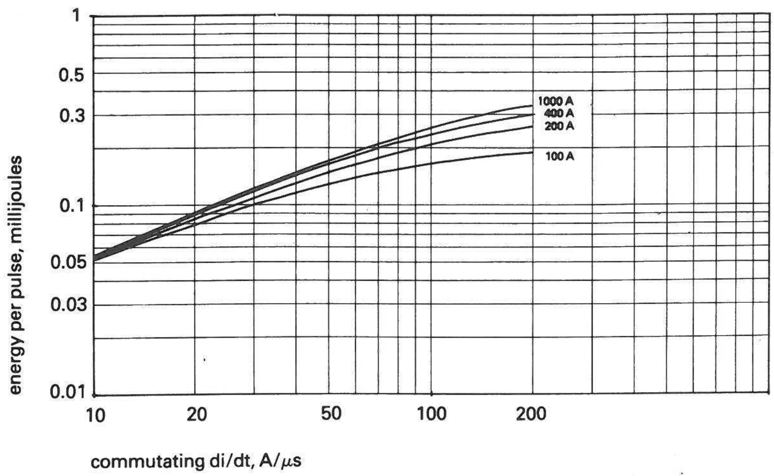


Figure 13 **Max. reverse energy loss per pulse per recovery volt at T_j 125°C**

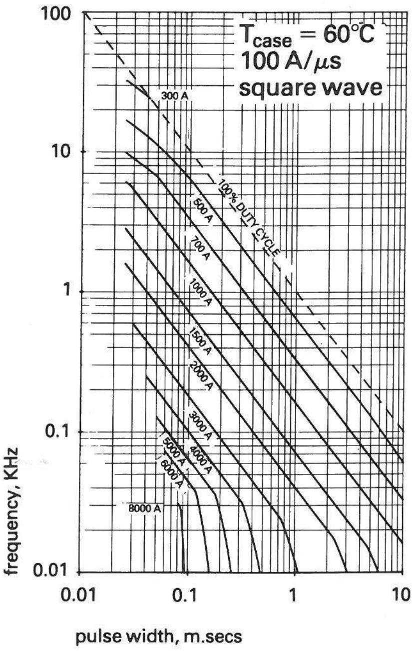


Figure 6 Frequency v. pulse width

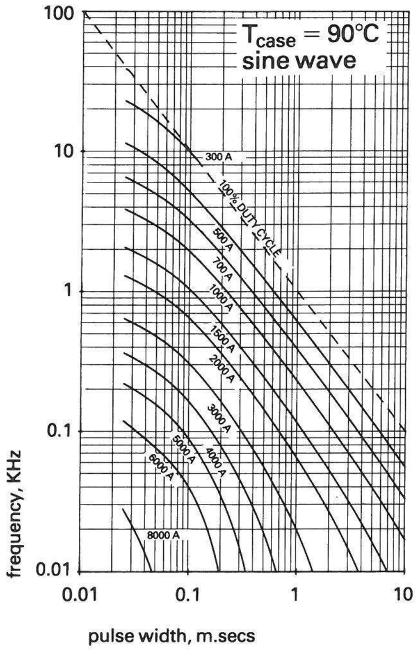


Figure 9 Frequency v. pulse width

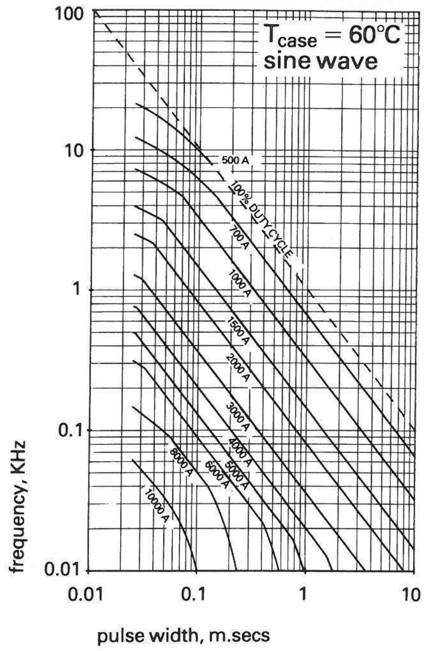


Figure 10 Frequency v. pulse width

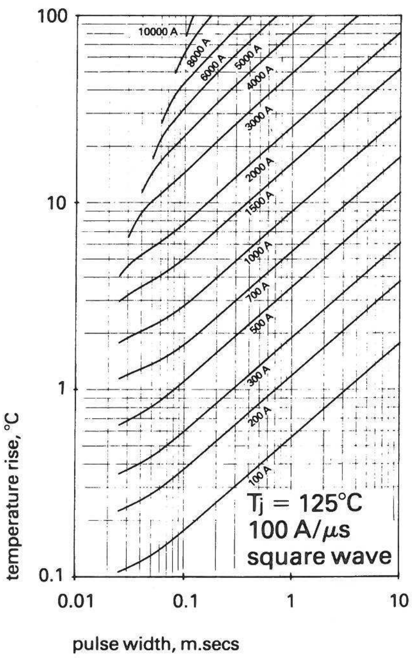


Figure 8 Temperature rise per pulse v. pulse width

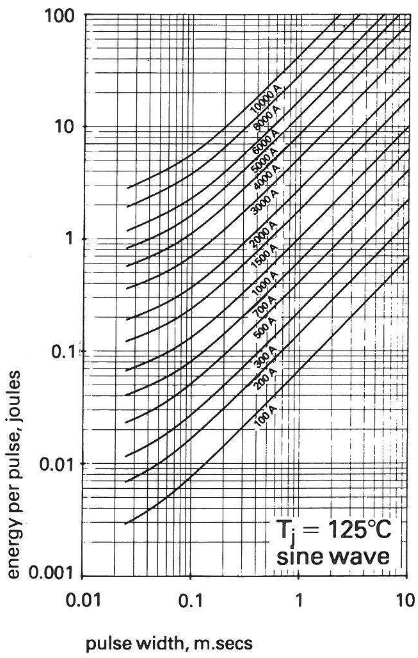


Figure 11 Energy per pulse v. pulse width

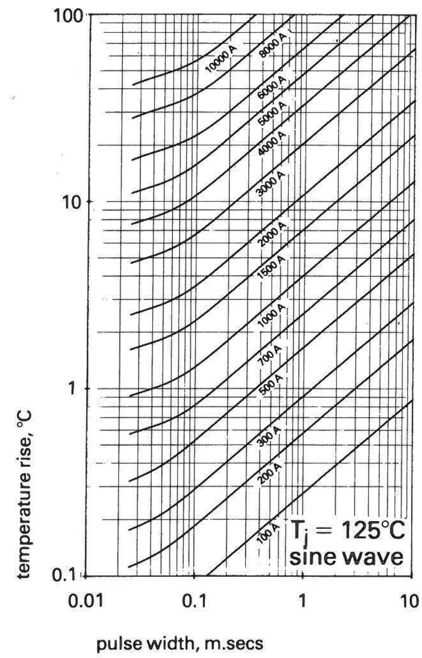


Figure 12 Temperature rise per pulse v. pulse width

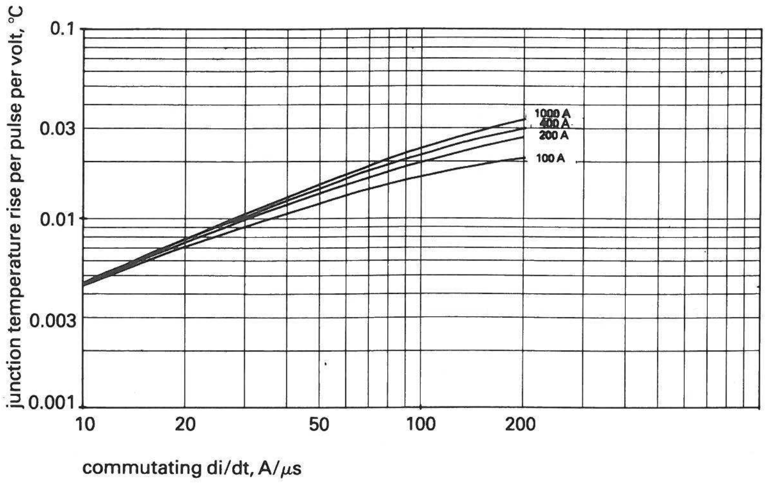


Figure 14 Max. junction temperature rise per pulse per recovery volt at T_j 125°C

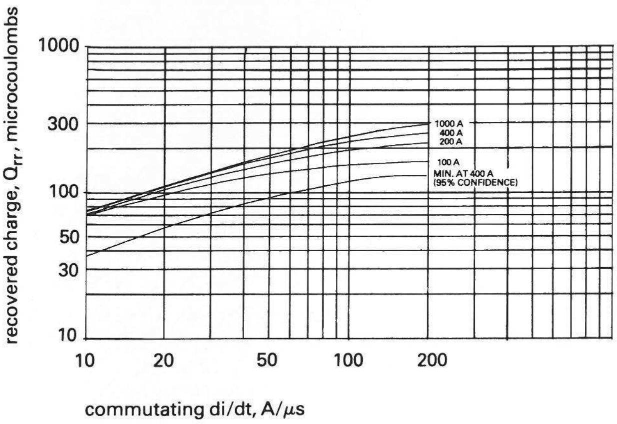


Figure 15 Maximum recovered charge at T_j 125°C

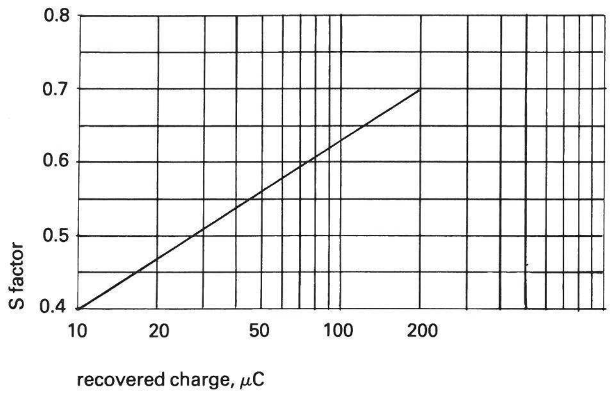


Figure 16 Minimum S factor at T_j 125°C

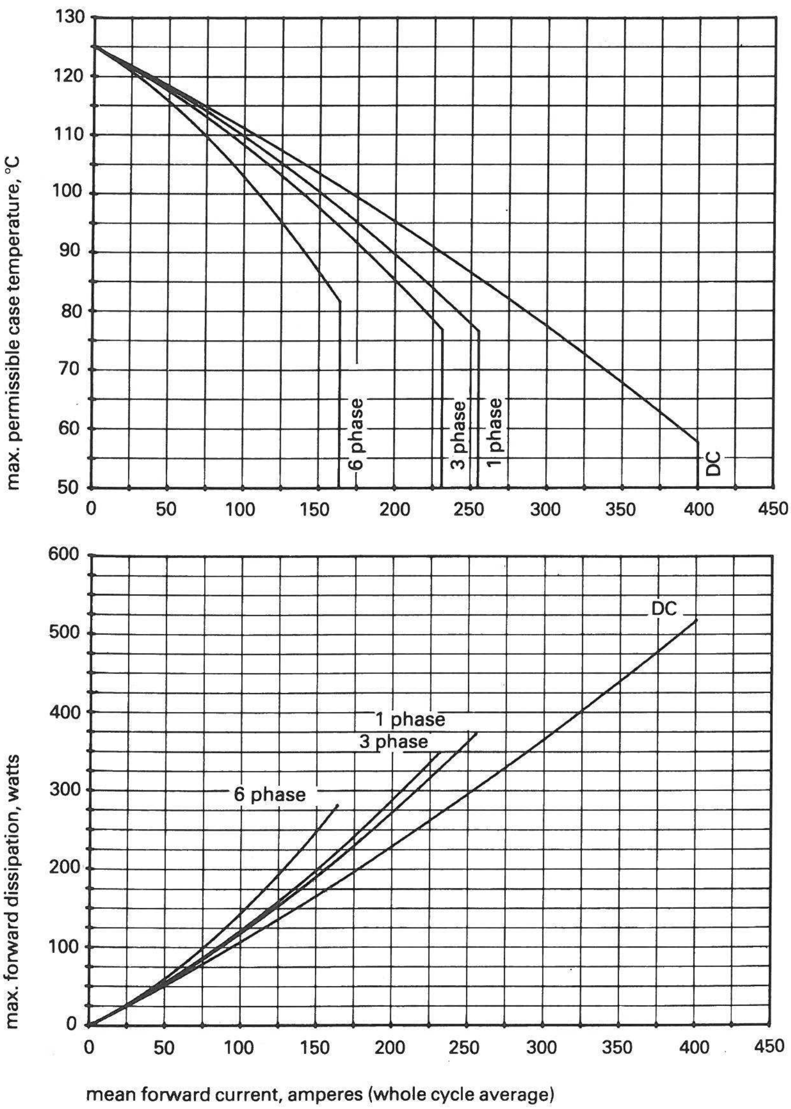


Figure 17 Dissipation and case temperature v. current, 50Hz

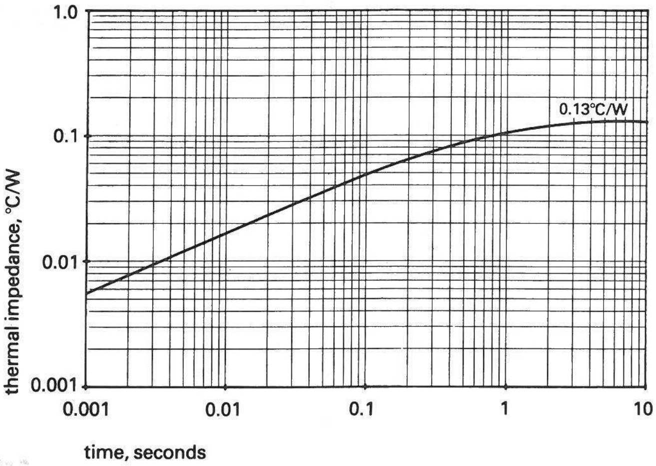


Figure 18 Junction to case transient thermal impedance

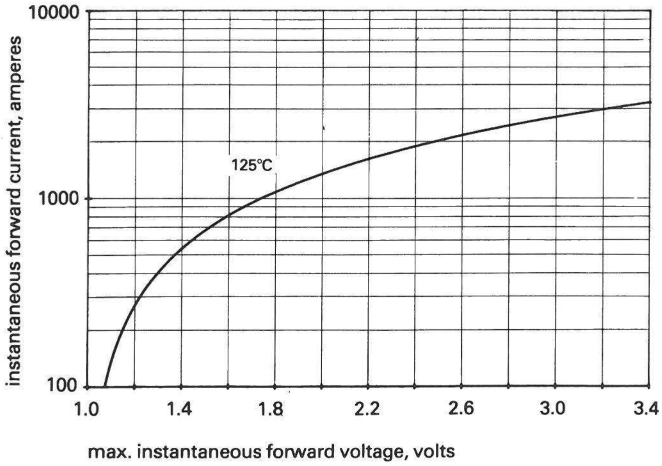


Figure 19 Forward voltage characteristic of limit diode

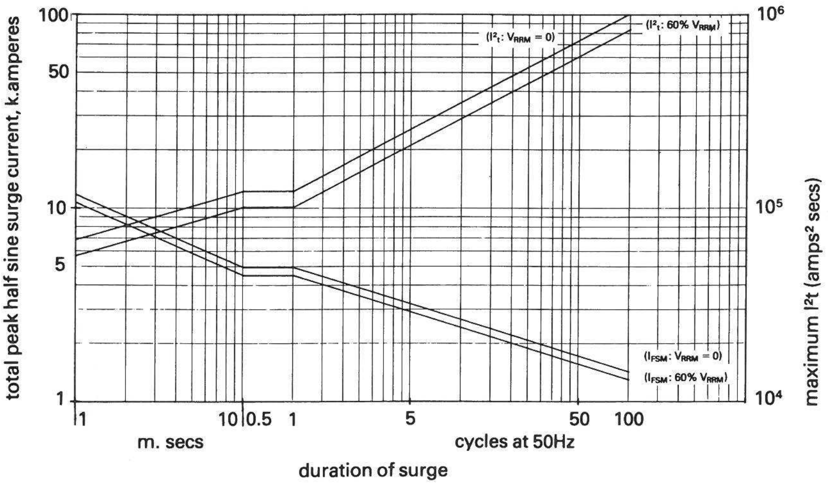
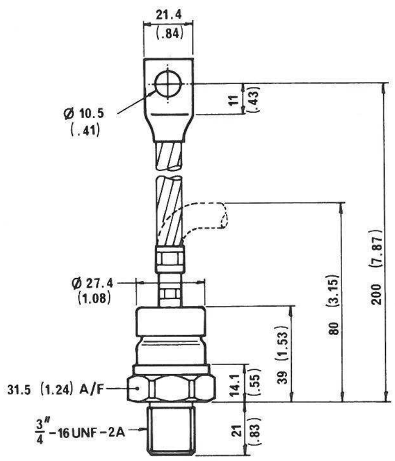


Figure 20 Max. non-repetitive surge current at initial junction temperature 125°C



dimensions in mm (inches)
mounting torque: 27-24.5 Nm
(2.77-2.5 kgf m)
thread must not be lubricated
weight: 250 grams

In the interest of product improvement, Westcode reserves the right to change specifications at any time without notice.

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