

## Rectifier Diode

### Types W4096Z#340 to W4096Z#450

Old Type No.: SW34-45CXC1870

#### Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
$V_{RRM}$	Repetitive peak reverse voltage, (note 1)	3400-4500	V
$V_{RSM}$	Non-repetitive peak reverse voltage, (note 1)	3500-4600	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Maximum average forward current, $T_{sink}=55^{\circ}C$ , (note 2)	4096	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=85^{\circ}C$ , (note 2)	3346	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=85^{\circ}C$ , (note 3)	2163	A
$I_{F(RMS)M}$	Nominal RMS forward current, $T_{sink}=25^{\circ}C$ , (note 2)	7460	A
$I_{F(d.c.)}$	D.C. forward current, $T_{sink}=25^{\circ}C$ , (note 4)	6801	A
$I_{FSM}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}=60\%V_{RRM}$ , (note 5)	41.7	kA
$I_{FSM2}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	45.9	kA
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}=60\%V_{RRM}$ , (note 5)	$8.7\times 10^6$	$A^2s$
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	$10.5\times 10^6$	$A^2s$
$T_{j\ op}$	Operating temperature range	-55 to +160	$^{\circ}C$
$T_{stg}$	Storage temperature range	-55 to +160	$^{\circ}C$

#### Notes:-

- 1) De-rating factor of 0.13% per  $^{\circ}C$  is applicable for  $T_j$  below  $25^{\circ}C$ .
- 2) Double side cooled, single phase; 50Hz,  $180^{\circ}$  half-sinewave.
- 3) Single side cooled, single phase; 50Hz,  $180^{\circ}$  half-sinewave.
- 4) Double side cooled.
- 5) Half-sinewave,  $160^{\circ}C$   $T_j$  initial.

**Characteristics**

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V <sub>FM</sub>	Maximum peak forward voltage	-	-	1.68	I <sub>TM</sub> =6000A	V
V <sub>FM</sub>	Maximum peak forward voltage	-	-	2.9	I <sub>TM</sub> =12300A	V
V <sub>T0</sub>	Threshold voltage	-	-	0.73		V
r <sub>T</sub>	Slope resistance	-	-	0.158		mΩ
I <sub>RRM</sub>	Peak reverse current	-	-	200	Rated V <sub>RRM</sub>	mA
I <sub>RRM</sub>	Peak reverse current	-	-	200	Rated V <sub>RRM</sub> , T <sub>j</sub> =25°C	mA
Q <sub>rr</sub>	Recovered charge	-	9500	-	I <sub>TM</sub> =1000A, t <sub>p</sub> =1000μs, di/dt=10A/μs, V <sub>F</sub> =50V	μC
Q <sub>ra</sub>	Recovered charge, 50% Chord	-	6000	6800		μC
I <sub>rr</sub>	Reverse recovery current	-	270	-		A
t <sub>rr</sub>	Reverse recovery time	-	45	-		μs
R <sub>thJK</sub>	Thermal resistance, junction to heatsink	-	-	0.011	Double side cooled	K/W
		-	-	0.022	Single side cooled	K/W
F	Mounting force	27	-	47		kN
W <sub>t</sub>	Weight	-	1.7	-	Outline Options ZC, ZT and ZY	kg
		-	1.2	-	Outline Options ZD and ZV	

Notes:-

- 1) Unless otherwise indicated T<sub>j</sub>=160°C.
- 2) For other clamp forces, please consult factory.

**Notes on rupture rated packages.**

This product is available with a non-rupture rated package.

For additional details on these products, please consult factory.

**Notes on Ratings and Characteristics**

1.0 Voltage Grade Table

Voltage Grade	$V_{DRM}$ $V_{DSM}$ $V_{RRM}$ V	$V_{RSM}$ V	$V_D$ $V_R$ DC V
34	3400	3500	1850
36	3600	3700	1900
38	3800	3900	1950
40	4000	4100	2000
42	4200	4300	2040
44	4400	4500	2080
45	4500	4600	2120

2.0 Extension of Voltage Grades

This report is applicable to other voltage grades when supply has been agreed by Sales/Production.

3.0 De-rating Factor

A blocking voltage de-rating factor of 0.13%/°C is applicable to this device for  $T_j$  below 25°C.

4.0 Snubber Components

When selecting snubber components, care must be taken not to use excessively large values of snubber capacitor or excessively small values of snubber resistor. Such excessive component values may lead to device damage due to the large resultant values of snubber discharge current. If required, please consult the factory for assistance.

5.0 Computer Modelling Parameters

5.1 Device Dissipation Calculations

$$I_{AV} = \frac{-V_{T0} + \sqrt{V_{T0}^2 + 4 \cdot ff^2 \cdot r_T \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_T} \quad \text{and:} \quad W_{AV} = \frac{\Delta T}{R_{th}}$$

$$\Delta T = T_{j\max} - T_K$$

Where  $V_{T0}=0.826V$ ,  $r_T=0.104m\Omega$ ,

$R_{th}$  = Supplementary thermal impedance, see table below and

$ff$  = Form factor, see table below.

Supplementary Thermal Impedance				
Conduction Angle	6 phase (60°)	3 phase (120°)	½ wave (180°)	d.c.
Square wave Double Side Cooled	0.0144	0.0132	0.0126	0.0116
Square wave Single Side Cooled	0.0262	0.0251	0.0244	0.0235
Sine wave Double Side Cooled	0.0133	0.0124	0.0115	
Sine wave Single Side Cooled	0.0253	0.0244	0.0234	

Form Factors				
Conduction Angle	6 phase (60°)	3 phase (120°)	½ wave (180°)	d.c.
Square wave	2.449	1.732	1.414	1
Sine wave	2.778	1.879	1.57	

## 5.2 Calculating $V_F$ using ABCD Coefficients

The on-state characteristic  $I_F$  vs.  $V_F$ , on page 6 is represented in two ways;

- (i) the well established  $V_{T0}$  and  $r_T$  tangent used for rating purposes and
- (ii) a set of constants A, B, C, D, forming the coefficients of the representative equation for  $V_F$  in terms of  $I_F$  given below:

$$V_F = A + B \cdot \ln(I_F) + C \cdot I_F + D \cdot \sqrt{I_F}$$

The constants, derived by curve fitting software, are given below for both hot and cold characteristics. The resulting values for  $V_F$  agree with the true device characteristic over a current range, which is limited to that plotted.

	25°C Coefficients	160°C Coefficients
A	0.61079656	0.615582755
B	0.0234119	-0.02994657
C	$6.6199 \times 10^{-5}$	$6.917 \times 10^{-5}$
D	$3.72241 \times 10^{-3}$	0.01174699

5.3 D.C. Thermal Impedance Calculation

$$r_t = \sum_{p=1}^{p=n} r_p \cdot \left( 1 - e^{-\frac{t}{\tau_p}} \right)$$

Where  $p = 1$  to  $n$ ,  $n$  is the number of terms in the series and:

- $t$  = Duration of heating pulse in seconds.
- $r_t$  = Thermal resistance at time  $t$ .
- $r_p$  = Amplitude of  $p$ th term.
- $\tau_p$  = Time Constant of  $r$ th term.

The coefficients for this device are shown in the tables below:

D.C. Single Side Cooled				
Term	1	2	3	4
$r_p$	0.01551	$2.7827 \times 10^{-3}$	$4.2105 \times 10^{-3}$	$0.9443 \times 10^{-3}$
$\tau_p$	10.04275	1.783567	0.2231307	$3.428 \times 10^{-3}$

D.C. Double Side Cooled					
Term	1	2	3	4	5
$r_p$	$6.4176 \times 10^{-3}$	$2.7472 \times 10^{-3}$	$1.2515 \times 10^{-3}$	$0.6336 \times 10^{-3}$	$0.59597 \times 10^{-3}$
$\tau_p$	1.785337	0.34595	0.099651	0.014214	$2.298151 \times 10^{-3}$

6.0 Reverse recovery ratings

(i)  $Q_{ra}$  is based on 50%  $I_{rm}$  chord as shown in Fig. 1

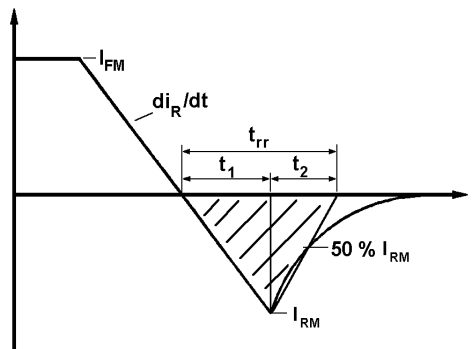


Fig. 1

(ii)  $Q_{rr}$  is based on a  $150\mu s$  integration time i.e.

$$Q_{rr} = \int_0^{150\mu s} i_{rr} \cdot dt$$

(iii)

$$K \text{ Factor} = \frac{t_1}{t_2}$$

**Curves**

Figure 1 - Forward characteristics of Limit device

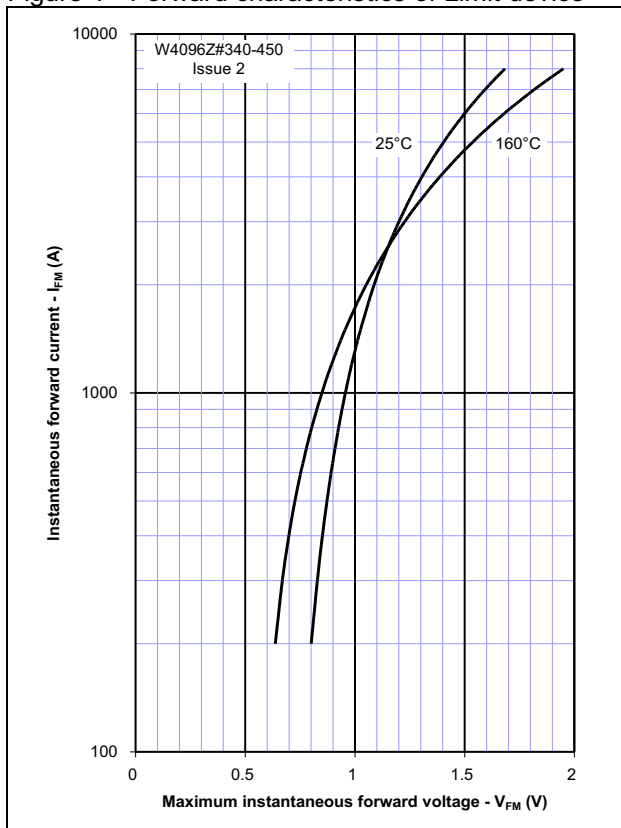


Figure 2 - Transient thermal impedance

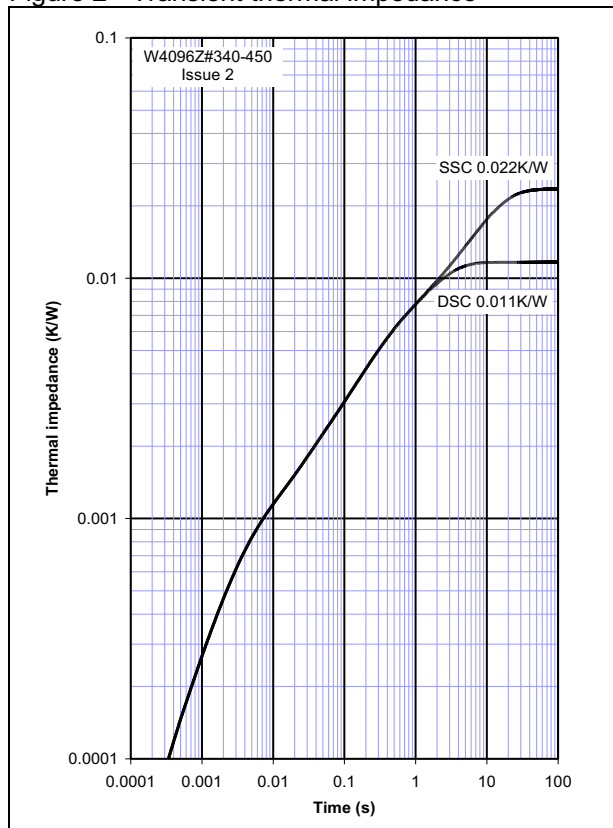


Figure 3 - Maximum surge Rating

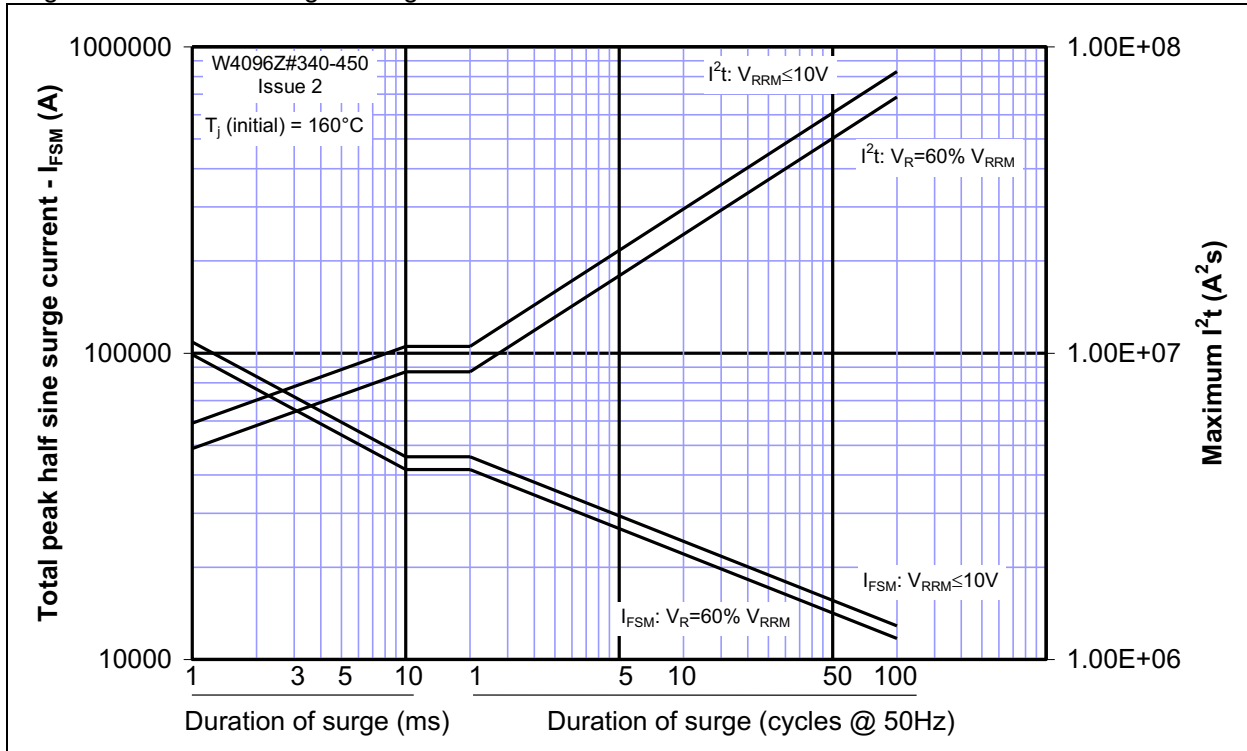


Figure 4 - Total recovered charge,  $Q_{rr}$

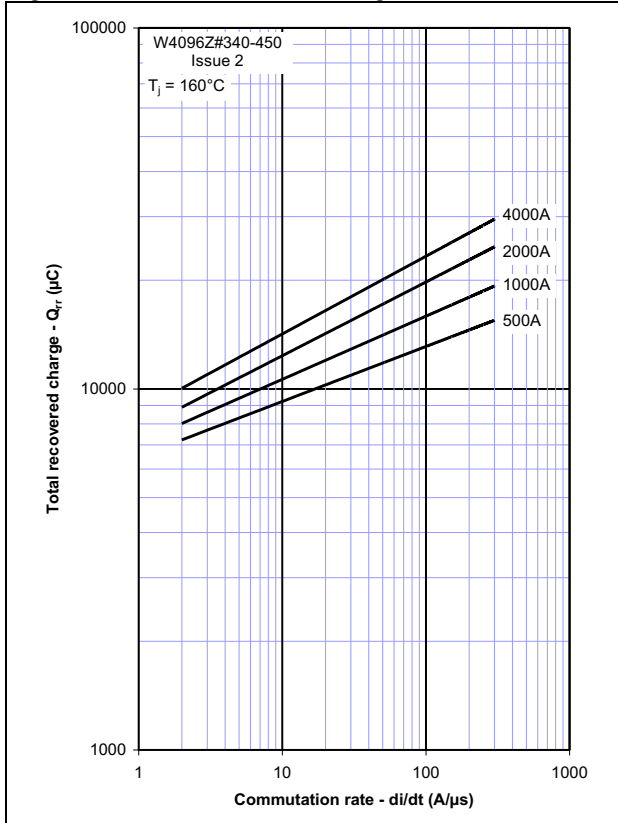


Figure 5 - Recovered charge,  $Q_{ra}$  (50% chord)

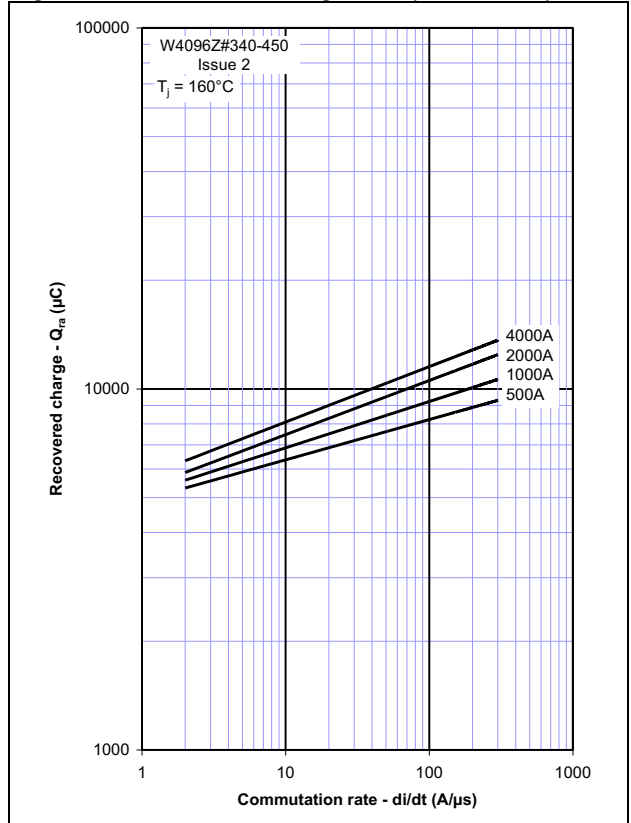


Figure 6 - Peak reverse recovery current,  $I_{rm}$

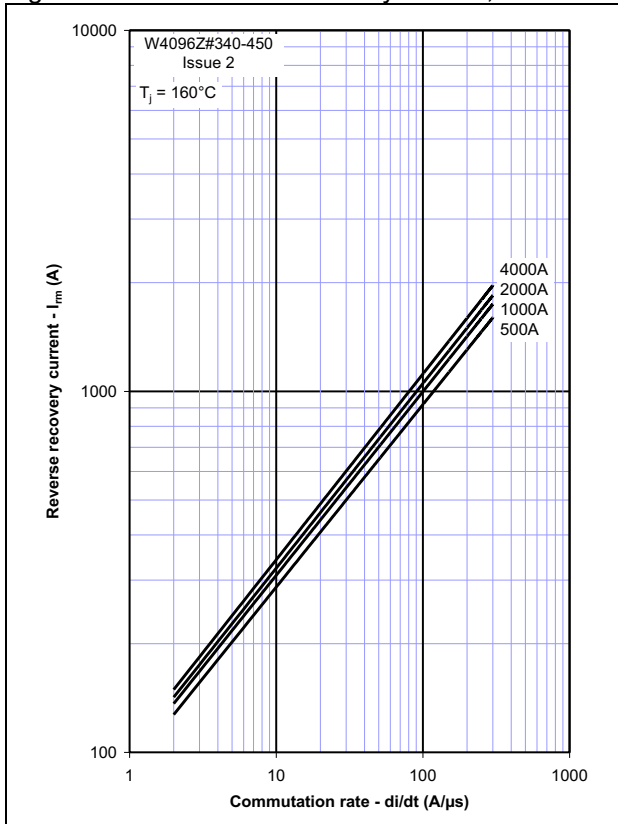


Figure 7 - Maximum recovery time,  $t_{rr}$  (50% chord)

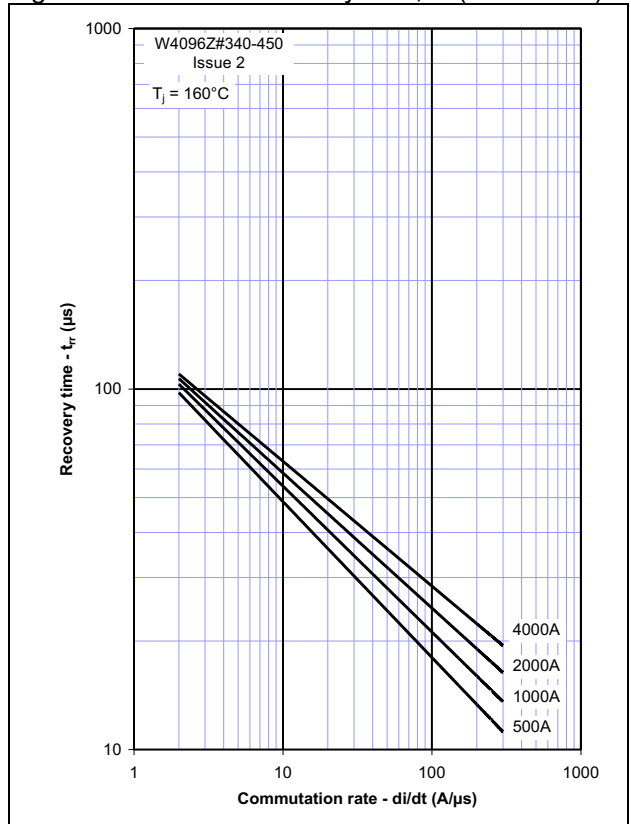


Figure 8 – Forward current vs. Power dissipation – Double Side Cooled

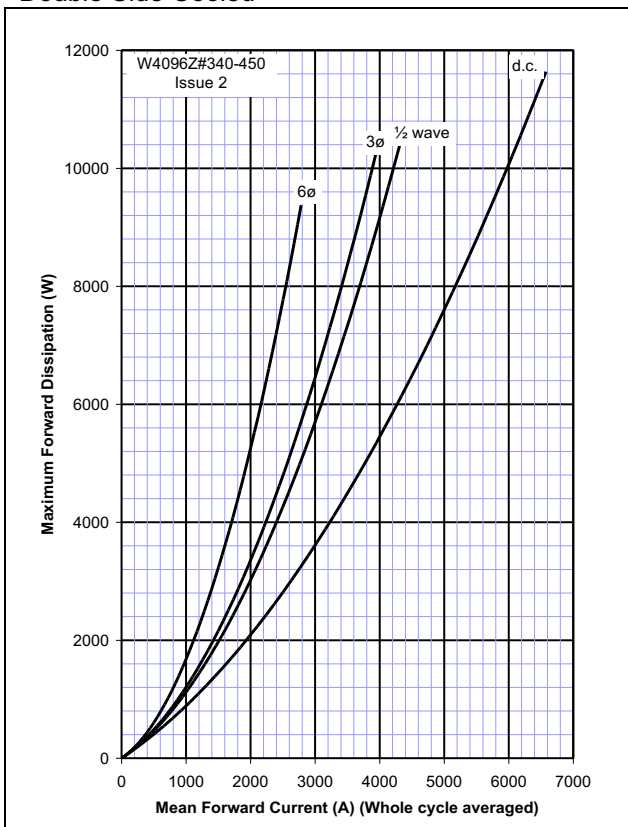


Figure 9 – Forward current vs. Heatsink temperature - Double Side Cooled

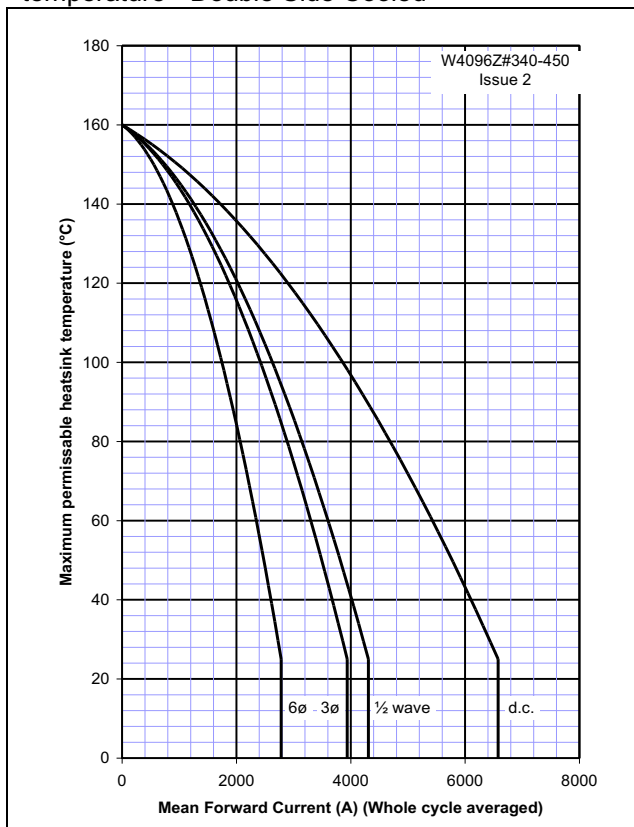


Figure 10 – Forward current vs. Power dissipation – Single Side Cooled

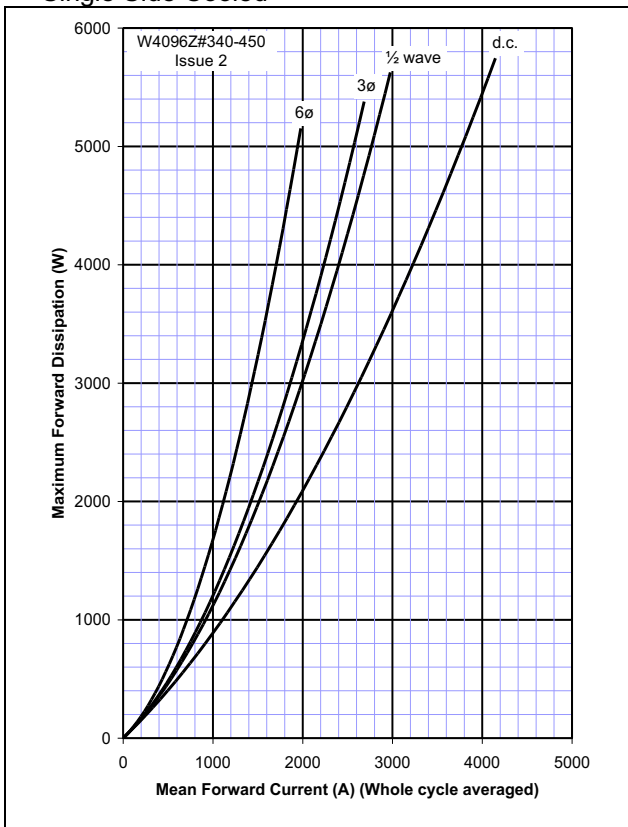
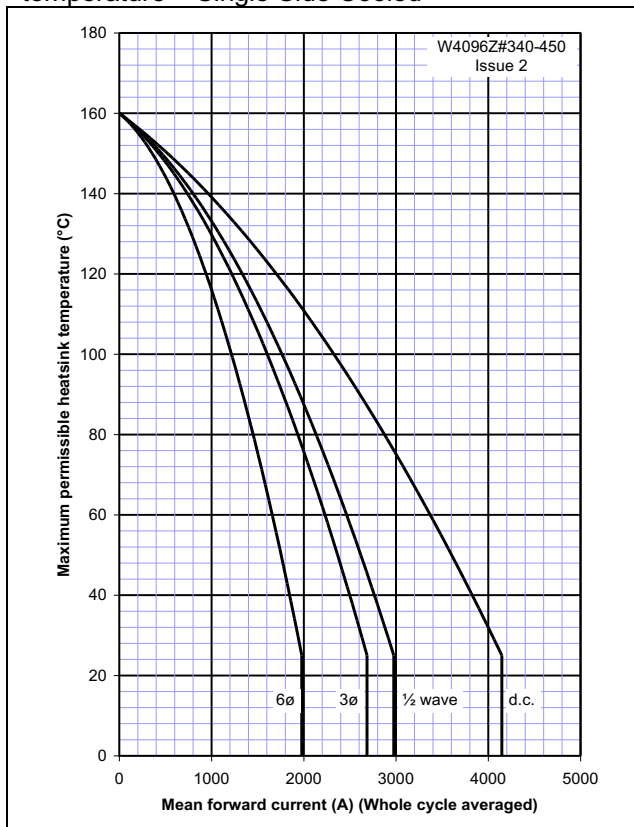
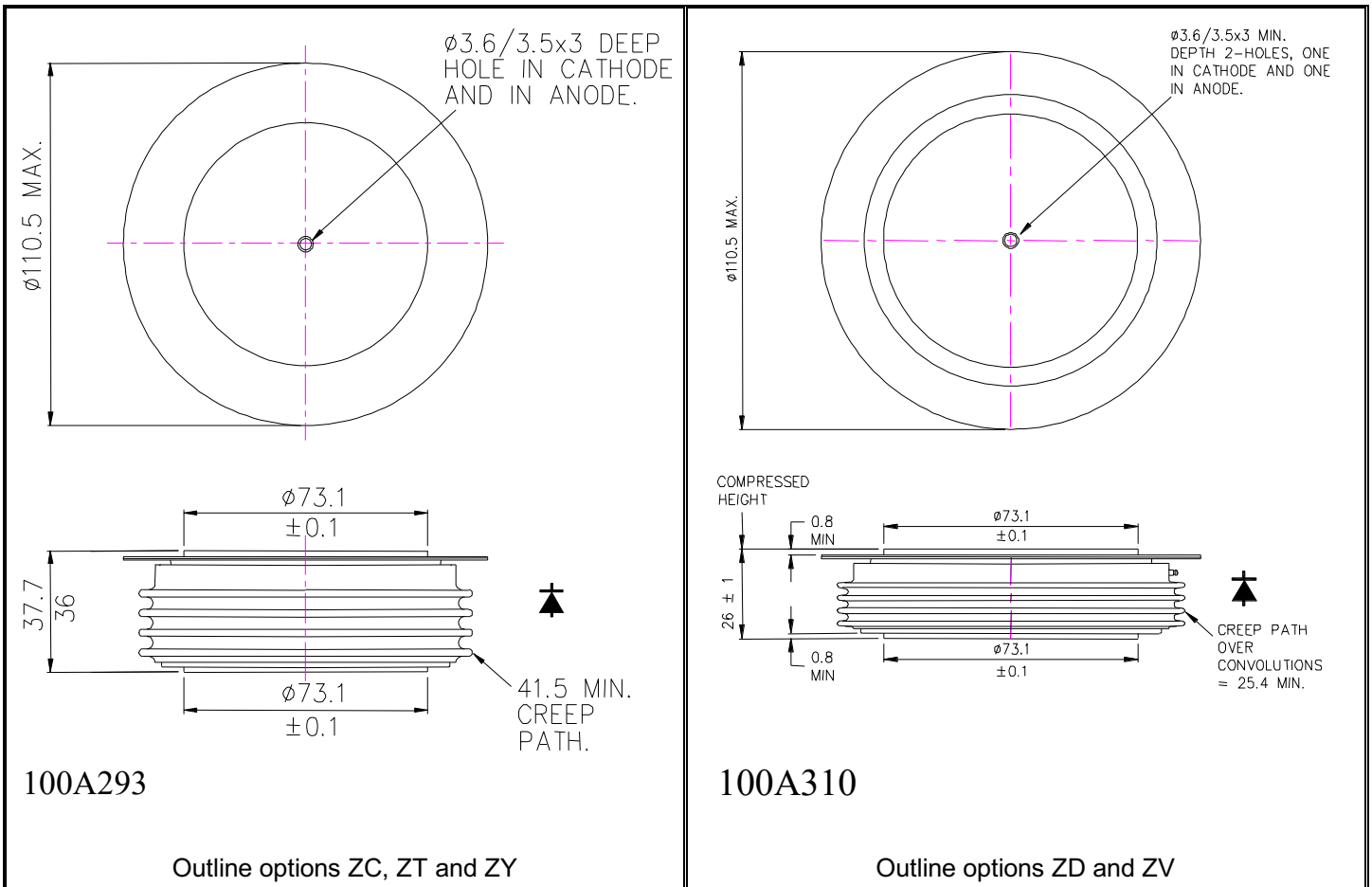


Figure 11 – Forward current vs. Heatsink temperature – Single Side Cooled





**Outline Drawing & Ordering Information**



Outline options ZC, ZT and ZY

Outline options ZD and ZV

**ORDERING INFORMATION**

(Please quote 10 digit code as below)

<b>W4096</b>	<b>Z#</b>	<b>◆◆</b>	<b>0</b>
Fixed Type Code	Fixed outline code ZC = 37.7mm Clamp height, ZT = 37.7mm rupture rated capsule, ZY = 37.7mm extended rupture rated capsule ZD = 26mm Clamp height, ZV = 26mm rupture rated capsule	Voltage code V <sub>RRM</sub> /100 34-45	Fixed turn-off time code

Order code: W4096ZC380 – 3800V V<sub>RRM</sub>, 37.7mm clamp height capsule.

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