

Provisional Data

## Rectifier Diode

### Types W5984T#360 and W5984T#400

Development Type No.: WX205T#400

#### Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
$V_{RRM}$	Repetitive peak reverse voltage, (note 1)	3600-4000	V
$V_{RSM}$	Non-repetitive peak reverse voltage, (note 1)	3700-4100	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Maximum average forward current, $T_{sink}=55^{\circ}C$ , (note 2)	5984	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=100^{\circ}C$ , (note 2)	4230	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=100^{\circ}C$ , (note 3)	2290	A
$I_{F(RMS)M}$	Nominal RMS forward current, $T_{sink}=25^{\circ}C$ , (note 2)	10930	A
$I_{F(d.c.)}$	D.C. forward current, $T_{sink}=25^{\circ}C$ , (note 4)	9850	A
$I_{FSM}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}=60\%V_{RRM}$ , (note 5)	62.0	kA
$I_{FSM2}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	68.0	kA
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}=60\%V_{RRM}$ , (note 5)	$19.2\times 10^6$	$A^2s$
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	$23.1\times 10^6$	$A^2s$
$T_{j\ op}$	Operating temperature range	-40 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) Cathode 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	-	-	1.25	I <sub>FM</sub> =5000A	V
V <sub>FM</sub>	Maximum peak forward voltage	-	-	2.12	I <sub>FM</sub> =15400A	V
V <sub>T0</sub>	Threshold voltage	-	-	0.758	Valid from 2000A to 6000A	V
r <sub>T</sub>	Slope resistance	-	-	0.097		mΩ
I <sub>R RM</sub>	Peak reverse current	-	-	100	Rated V <sub>R RM</sub>	mA
Q <sub>rr</sub>	Recovered charge	-	10000	11200		μC
Q <sub>ra</sub>	Recovered charge, 50% Chord	-	6700	-	I <sub>TM</sub> =2000A, t <sub>p</sub> =2000μs, di/dt=10A/μs, V <sub>r</sub> =100V	μC
I <sub>rm</sub>	Reverse recovery current	-	285	-		A
t <sub>rr</sub>	Reverse recovery time, 50% chord	-	47	-		μs
R <sub>thJK</sub>	Thermal resistance, junction to heatsink	-	-	0.008	Double side cooled	K/W
		-	-	0.013	Anode side cooled	K/W
		-	-	0.020	Cathode side cooled	K/W
F	Mounting force	60	-	70	Note 2	kN
W <sub>t</sub>	Weight	-	1.15	-	Outline option TJ	Kg
		-	1.70	-	Outline option TE	

Notes:-

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

## Notes on Ratings and Characteristics

### 1.0 Voltage Grade Table

Voltage Grade	$V_{RRM}$ V	$V_{RSM}$ V	$V_R$ DC V
36	3600	3700	1880
40	4000	4100	2100

### 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  $V_{T0}=0.758V$ ,  $r_T=0.097m\Omega$ ,

$R_{th}$  = 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	0.00866	0.00847	0.00832	0.00800
Square wave Cathode Side Cooled	0.02118	0.02101	0.02086	0.02000
Sine wave Double Side Cooled	0.00855	0.00837	0.00813	
Sine wave Cathode Side Cooled	0.02108	0.02091	0.02068	

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	1.701149	A	0.491657
B	-0.2152069	B	$2.050974 \times 10^{-3}$
C	$-8.51276 \times 10^{-5}$	C	$2.33397 \times 10^{-5}$
D	0.02609856	D	$8.878275 \times 10^{-3}$

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. Double Side Cooled				
Term	1	2	3	4
$r_p$	$3.81150 \times 10^{-3}$	$1.89558 \times 10^{-3}$	$1.71360 \times 10^{-3}$	$5.24282 \times 10^{-4}$
$\tau_p$	1.01434	0.34872	0.08992	0.01065

Term	1	2	3
$r_p$	0.01653	$3.37618 \times 10^{-3}$	$5.93598 \times 10^{-4}$
$\tau_p$	5.31595	0.15120	0.01207

6.0 Reverse recovery ratings

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

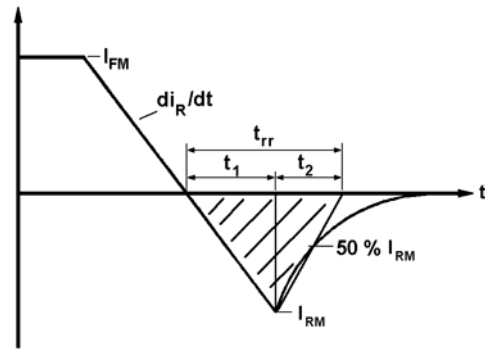


Fig. 1

(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

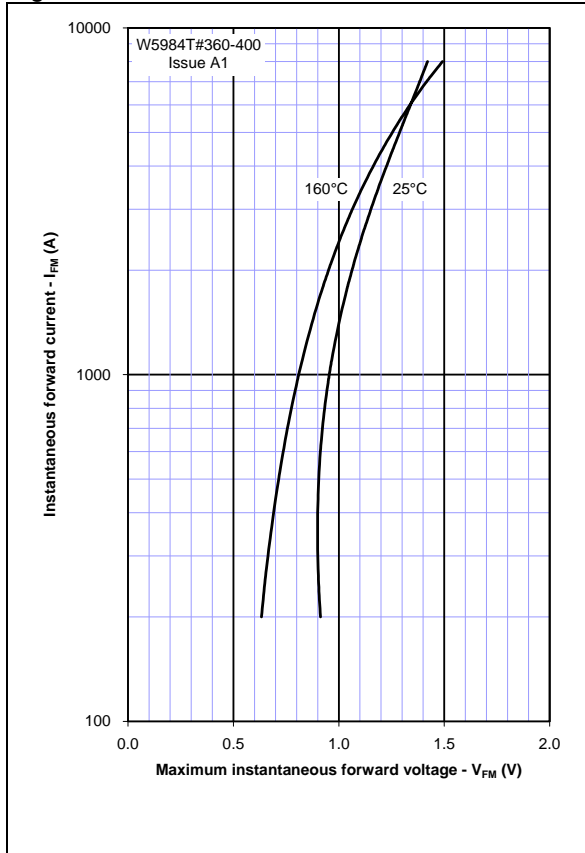


Figure 2 – Transient thermal impedance

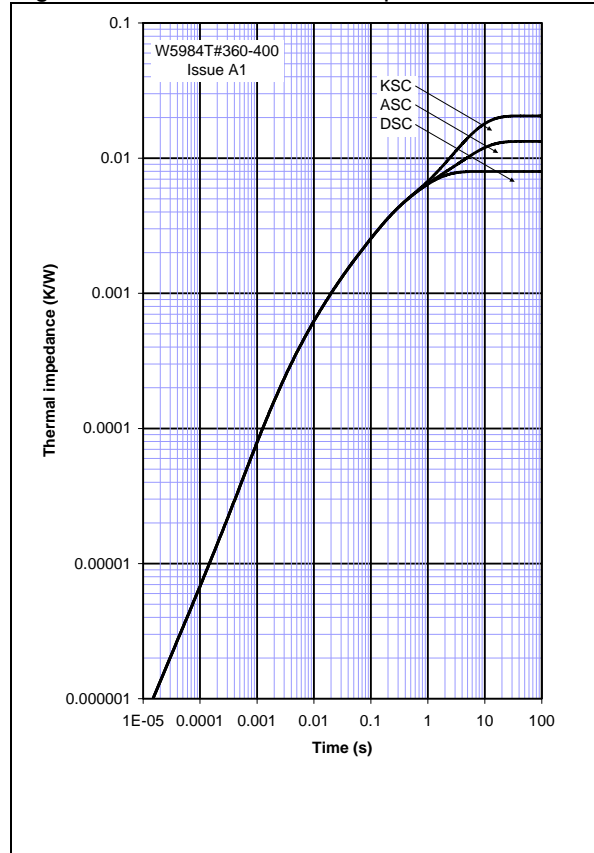


Figure 3 – Maximum Surge Rating

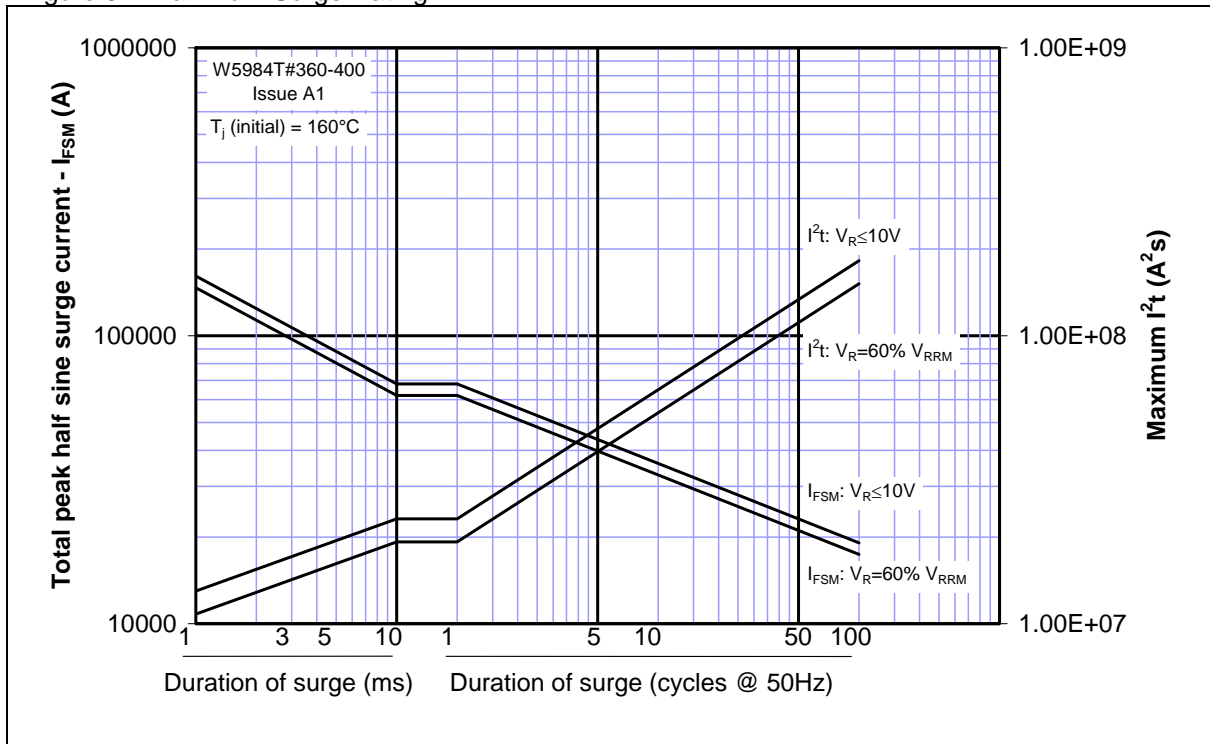


Figure 4 – Total recovered charge,  $Q_{rr}$

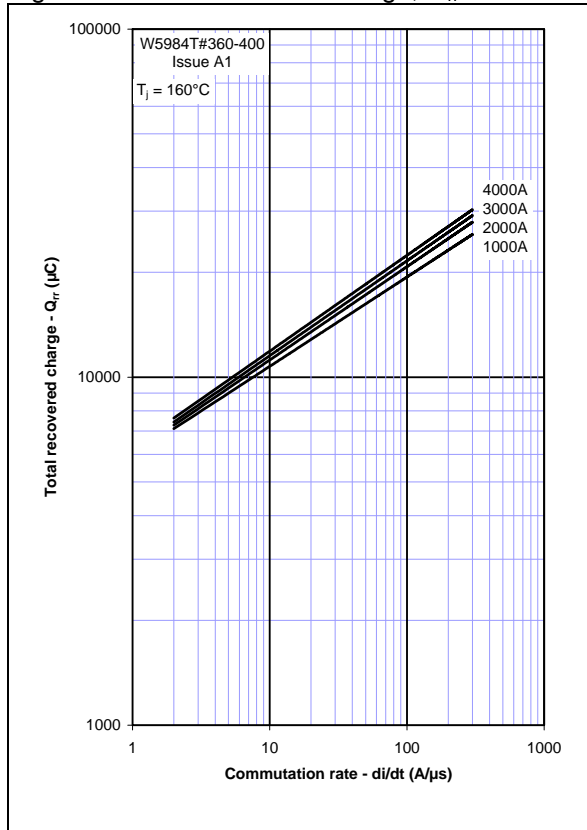


Figure 5 – Recovered charge,  $Q_{ra}$  (50% chord)

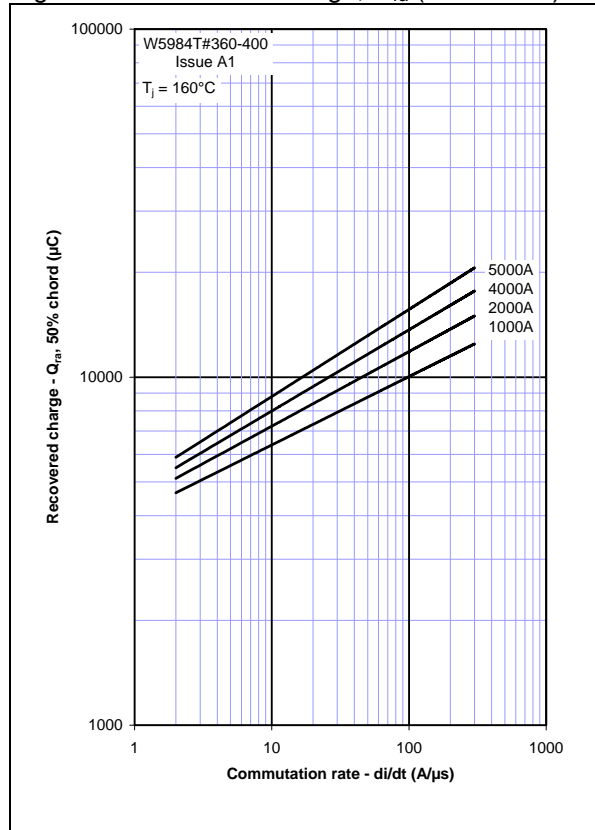


Figure 6 – Peak reverse recovery current,  $I_{rm}$

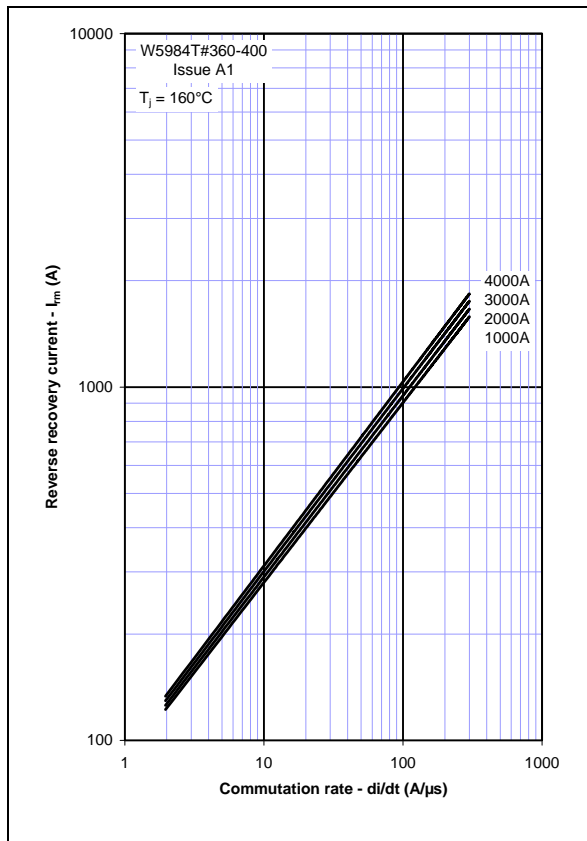


Figure 7 – Maximum recovery time,  $t_{rr}$  (50% chord)

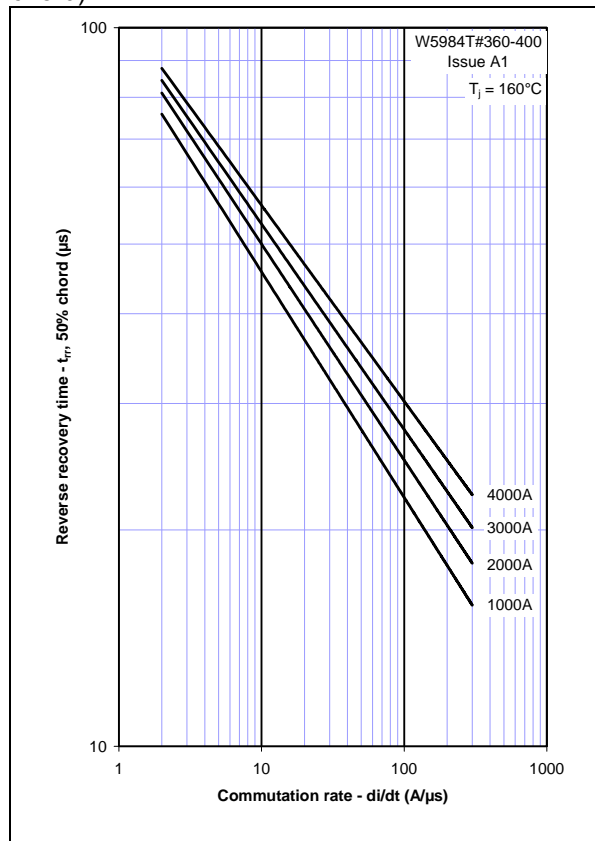


Figure 8 – Forward current vs. Power dissipation – Double Side Cooled

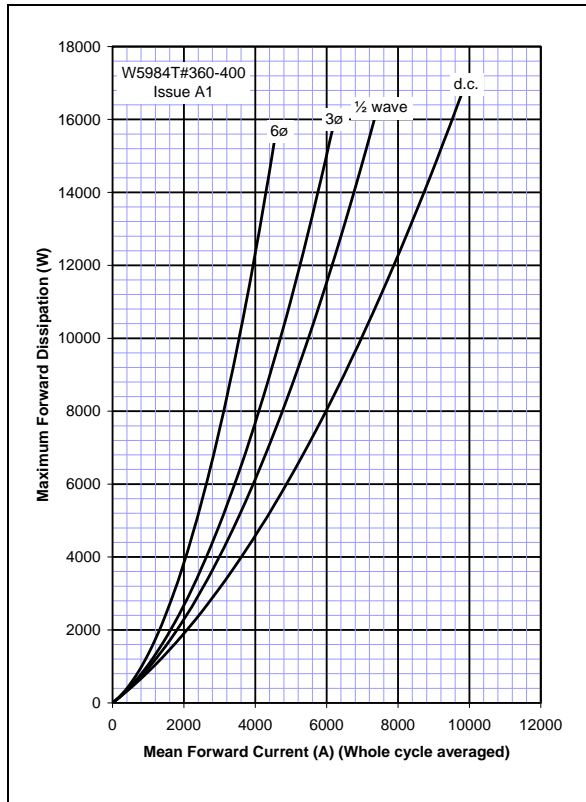


Figure 9 – Forward current vs. Heatsink temperature – Double Side Cooled

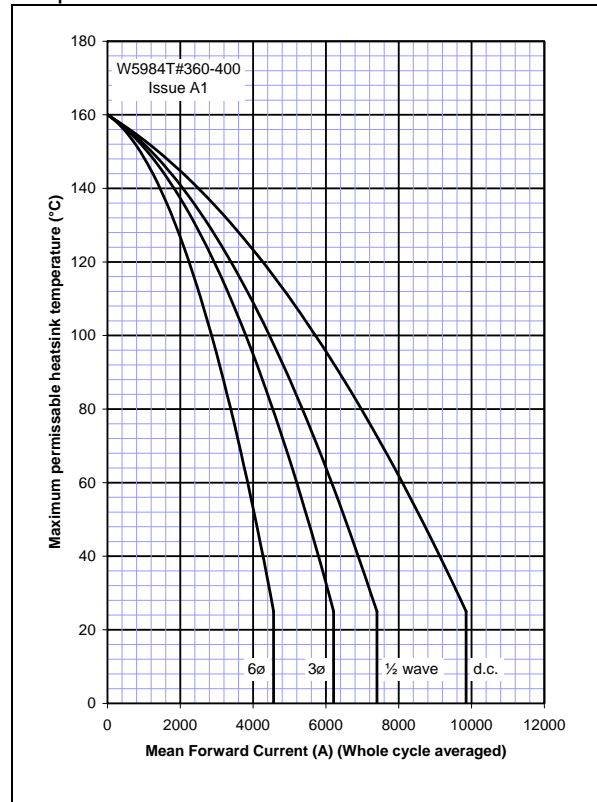


Figure 10 – Forward current vs. Power dissipation – Cathode Side Cooled

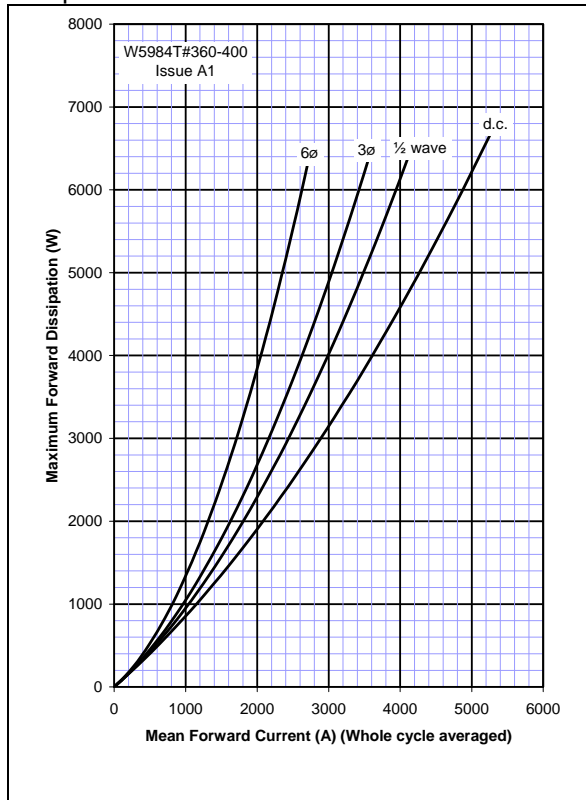
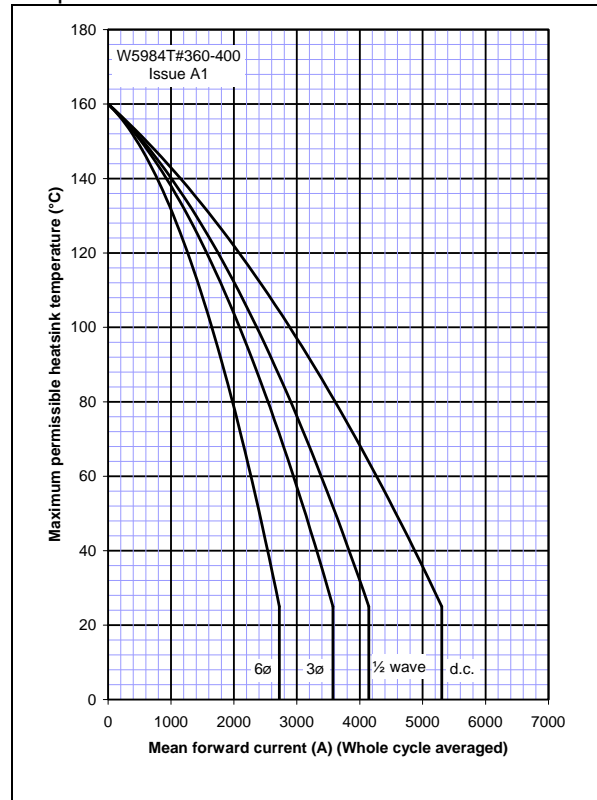
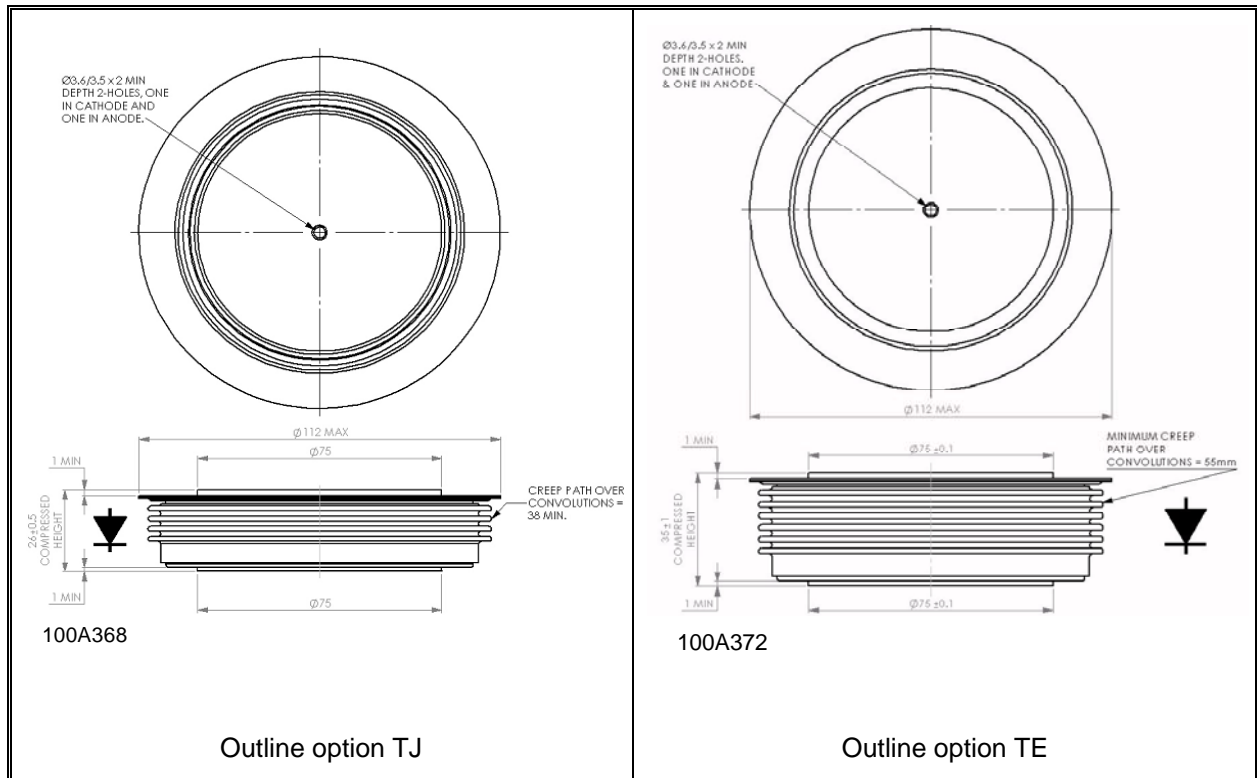


Figure 11 – Forward current vs. Heatsink temperature – Cathode Side Cooled





**Outline Drawing & Ordering Information**



**ORDERING INFORMATION**

(Please quote 10 digit code as below)

<b>W5984</b>	<b>T#</b>	<b>◆◆</b>	<b>0</b>
Fixed Type Code	Outline Code TJ = 26mm Clamp height TE = 35mm Clamp height	Voltage code $V_{RRM}/100$ 36 & 40	Fixed code

Order code: W5984T#400 – 4000V  $V_{RRM}$ , 26mm clamp height capsule.

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