

# Rectifier Diode

## Types W3090HA520 to W3090HA600

Development Type No.: WX332HA520-600

### Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
$V_{RRM}$	Repetitive peak reverse voltage, (note 1)	5200-6000	V
$V_{RSM}$	Non-repetitive peak reverse voltage, (note 1)	5300-6100	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Maximum average forward current, $T_{sink}=55^{\circ}C$ , (note 2)	3110	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=100^{\circ}C$ , (note 2)	2105	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=100^{\circ}C$ , (note 3)	1120	A
$I_{F(RMS)M}$	Nominal RMS forward current, $T_{sink}=25^{\circ}C$ , (note 2)	5740	A
$I_{F(d.c.)}$	D.C. forward current, $T_{sink}=25^{\circ}C$ , (note 4)	5240	A
$I_{FSM}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}=60\%V_{RRM}$ , (note 5)	32	kA
$I_{FSM2}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	36	kA
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}=60\%V_{RRM}$ , (note 5)	$5.12\times 10^6$	$A^2s$
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	$6.48\times 10^6$	$A^2s$
$T_{j op}$	Operating temperature range	-40 to +150	$^{\circ}C$
$T_{stg}$	Storage temperature range	-55 to +150	$^{\circ}C$

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,  $150^{\circ}C$   $T_j$  initial.

**Characteristics**

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V <sub>FM</sub>	Maximum peak forward voltage	-	-	1.70	I <sub>FM</sub> =3000A	V
V <sub>FM</sub>	Maximum peak forward voltage	-	-	3.05	I <sub>FM</sub> =8450A	V
V <sub>T0</sub>	Threshold voltage	-	-	0.91	Valid from 2000A to 6000A	V
r <sub>T</sub>	Slope resistance	-	-	0.26		mΩ
I <sub>RRM</sub>	Peak reverse current	-	-	100	Rated V <sub>RRM</sub>	mA
Q <sub>rr</sub>	Recovered charge	-	8000	10000	I <sub>TM</sub> =3000A, t <sub>p</sub> =2000μs, di/dt=10A/μs, V <sub>r</sub> =100V	μC
Q <sub>ra</sub>	Recovered charge, 50% Chord	-	4300	-		μC
I <sub>rm</sub>	Reverse recovery current	-	210	-		A
t <sub>rr</sub>	Reverse recovery time, 50% chord	-	41	-		μs
R <sub>thJK</sub>	Thermal resistance, junction to heatsink	-	-	0.0105	Double side cooled	K/W
		-	-	0.0173	Anode side cooled	K/W
		-	-	0.0273	Cathode side cooled	K/W
F	Mounting force	32	-	40	Note 2	kN
W <sub>t</sub>	Weight		1.2			Kg

Notes:-

- 1) Unless otherwise indicated T<sub>j</sub>=150°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
52	5200	5300	3500
56	5600	5700	3750
60	6000	6100	4020

### 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  $V_{T0}=0.91V$ ,  $r_T=0.26m\Omega$ ,

$R_{th}$  = 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	0.0120	0.0116	0.0112	0.0105
Square wave Cathode Side Cooled	0.0288	0.0284	0.0280	0.0273
Sine wave Double Side Cooled	0.0117	0.0112	0.0107	
Sine wave Cathode Side Cooled	0.0285	0.0281	0.0276	

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		150°C Coefficients	
A	0.3624574	A	0.3072634
B	0.1017289	B	0.06905434
C	$1.62431 \times 10^{-4}$	C	$2.07622 \times 10^{-4}$
D	$-2.457541 \times 10^{-3}$	D	$3.928764 \times 10^{-3}$

## 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 on page 5:

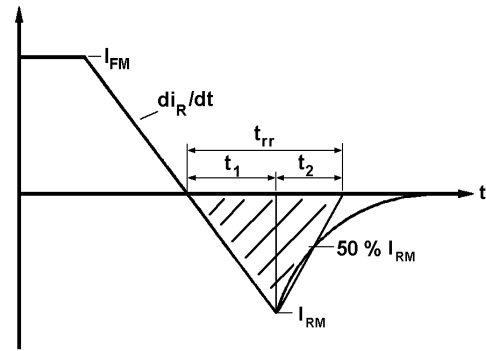
D.C. Double Side Cooled				
Term	1	2	3	4
$r_p$	$4.833386 \times 10^{-3}$	$2.428484 \times 10^{-3}$	$2.556565 \times 10^{-3}$	$6.778151 \times 10^{-4}$
$\tau_p$	0.9049929	0.3059693	0.07882910	$5.760647 \times 10^{-3}$

D.C. Anode Side Cooled					
Term	1	2	3	4	5
$r_p$	$9.389648 \times 10^{-3}$	$3.552906 \times 10^{-3}$	$2.867635 \times 10^{-3}$	$6.065886 \times 10^{-4}$	$1.081806 \times 10^{-3}$
$\tau_p$	6.032949	0.5244182	0.1316295	0.05328786	$9.747228 \times 10^{-3}$

D.C. Cathode Side Cooled				
Term	1	2	3	4
$r_p$	0.02178216	$3.548018 \times 10^{-3}$	$1.319715 \times 10^{-3}$	$7.056416 \times 10^{-4}$
$\tau_p$	5.035878	0.1905190	0.05133230	$6.802442 \times 10^{-3}$

**6.0 Reverse recovery ratings**

(i)  $Q_{rr}$  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

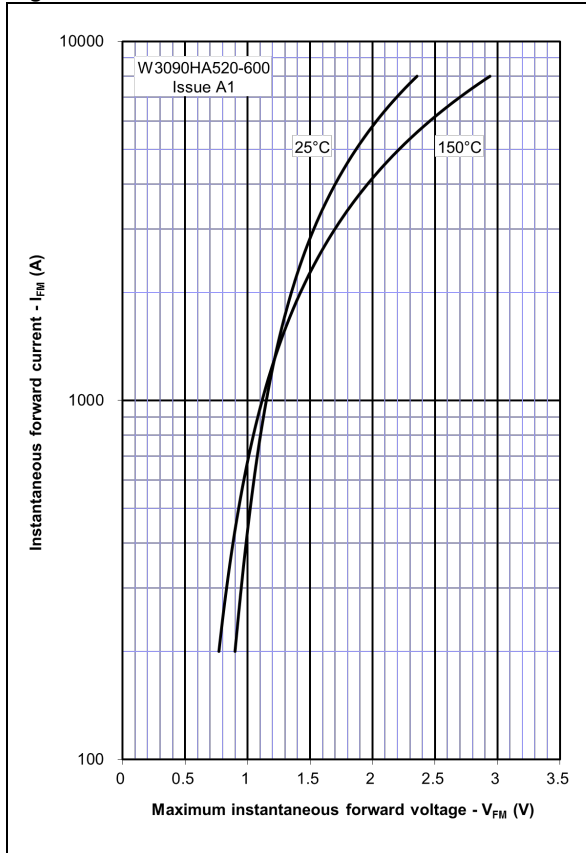


Figure 2 – Transient thermal impedance

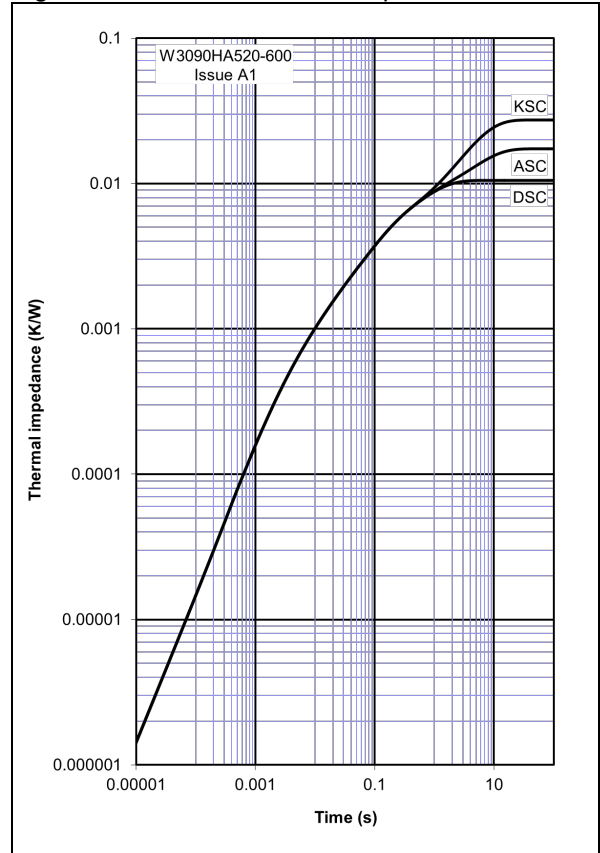


Figure 3 – Maximum Surge Rating

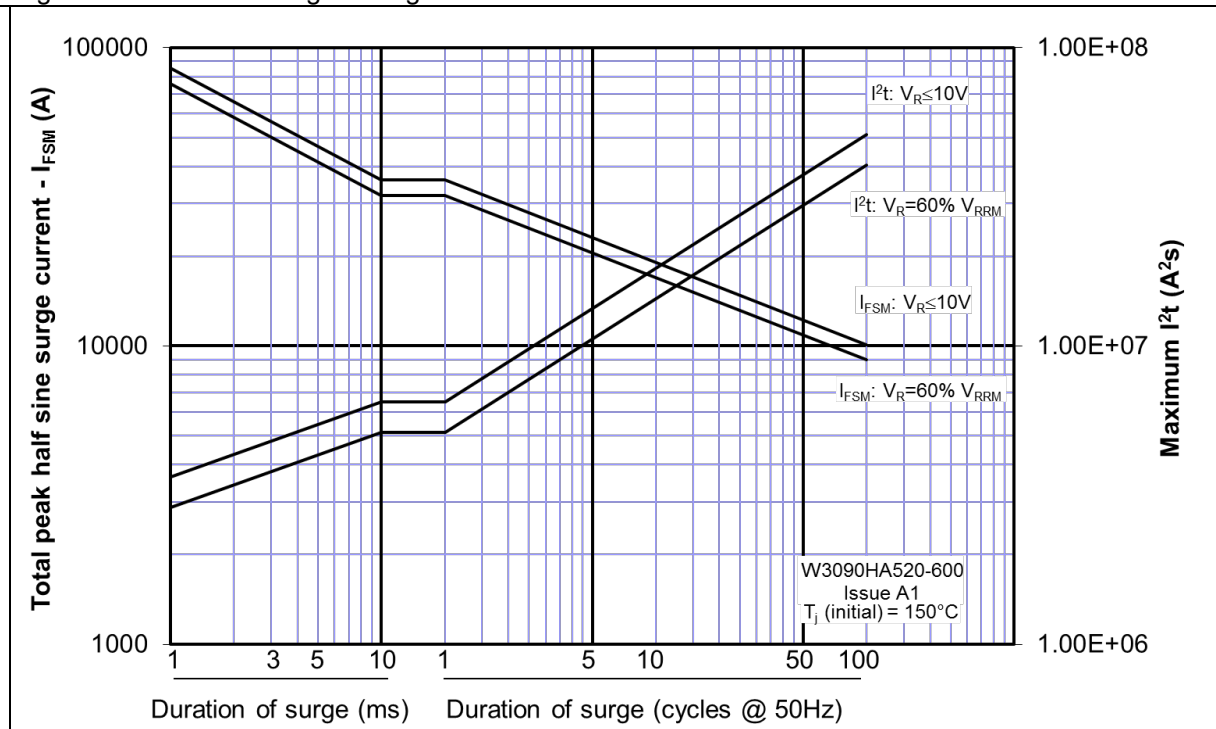


Figure 4 – Total recovered charge,  $Q_{rr}$

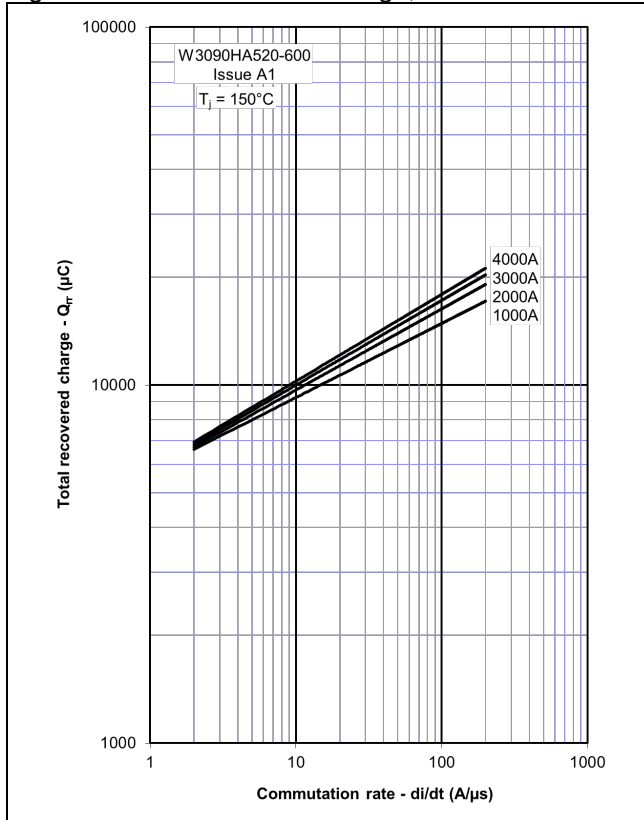


Figure 5 – Recovered charge,  $Q_{ra}$  (50% chord)

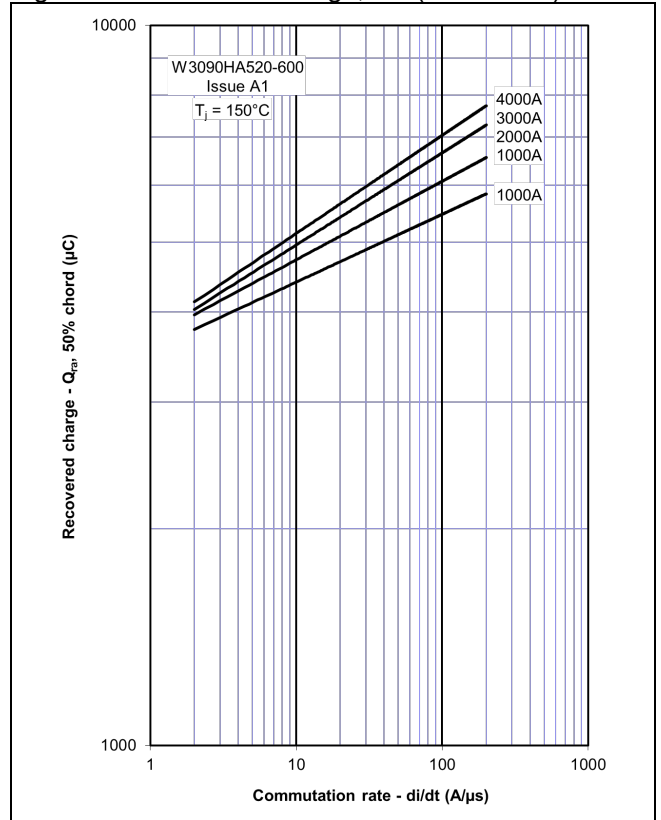


Figure 6 – Peak reverse recovery current,  $I_{rm}$

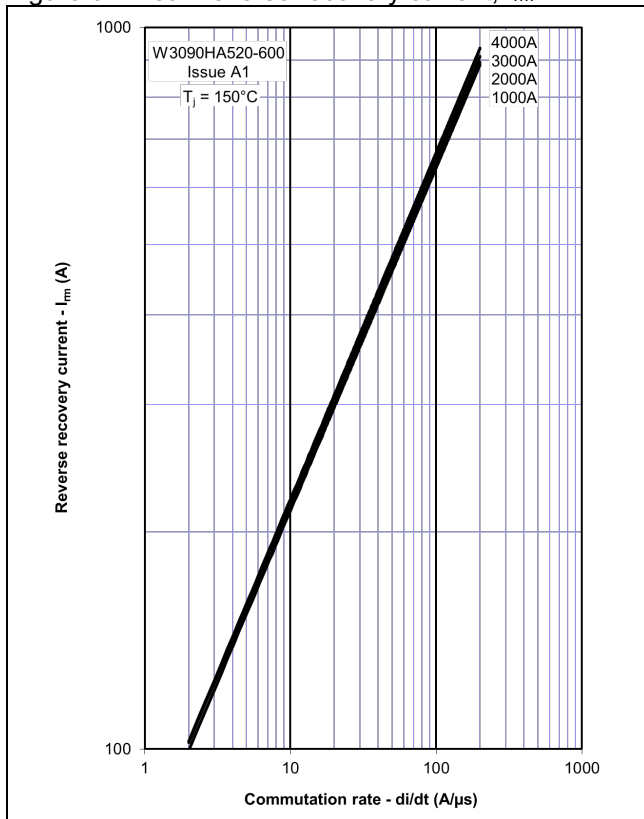


Figure 7 – Maximum recovery time,  $t_{rr}$  (50% chord)

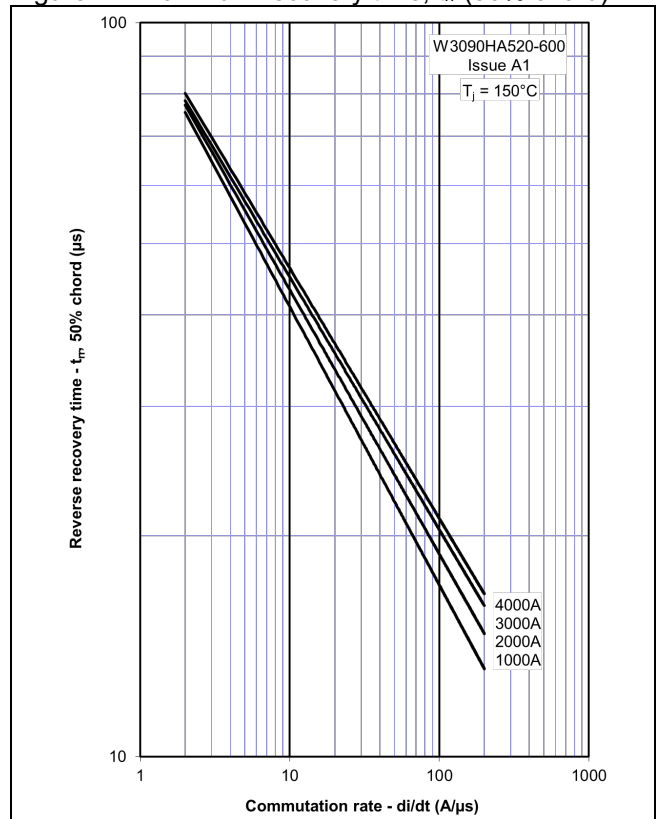


Figure 8 – Forward current vs. Power dissipation – Double Side Cooled

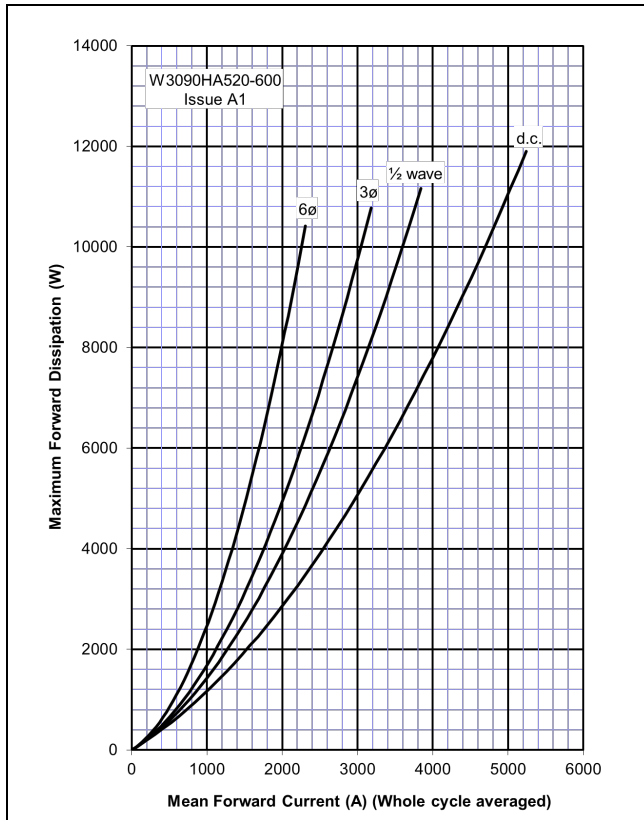


Figure 9 – Forward current vs. Heatsink temperature – Double Side Cooled

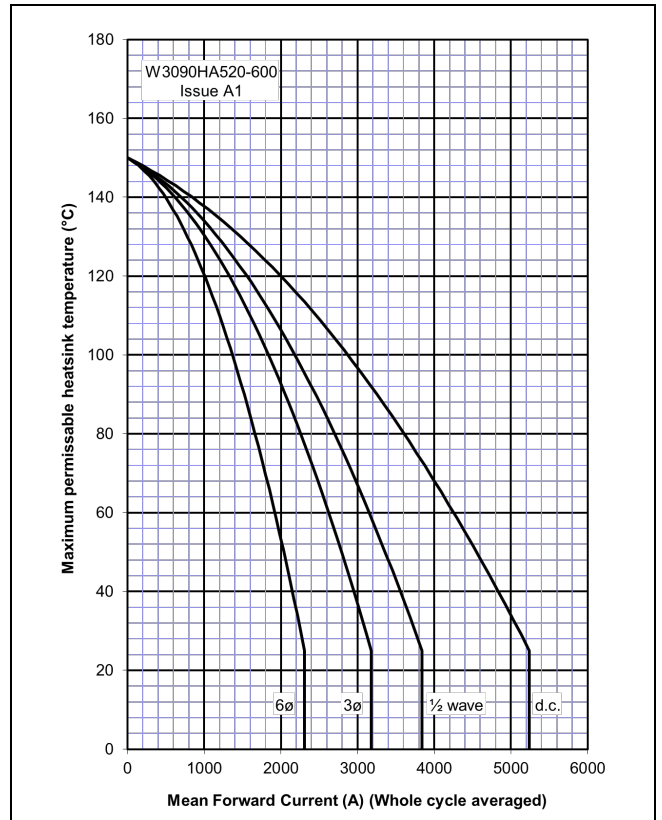


Figure 10 – Forward current vs. Power dissipation – Cathode Side Cooled

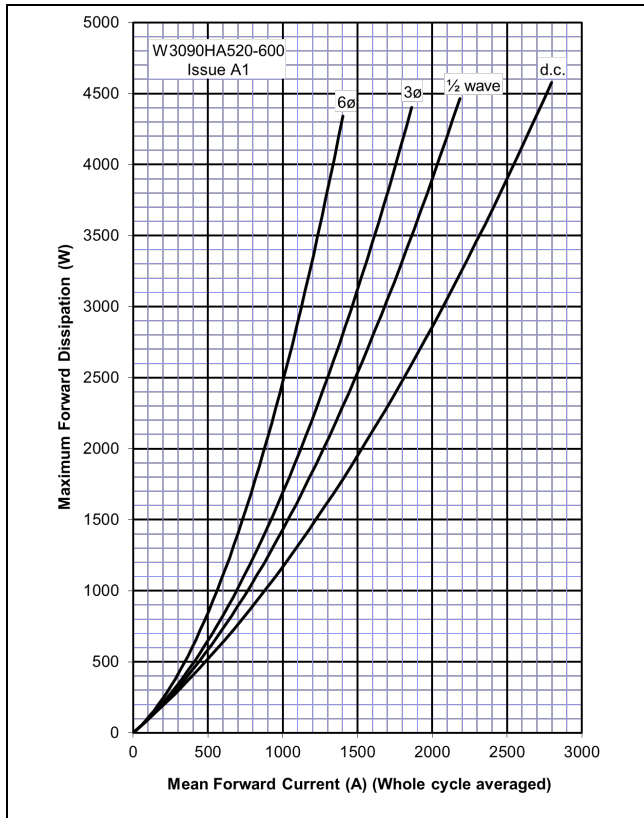
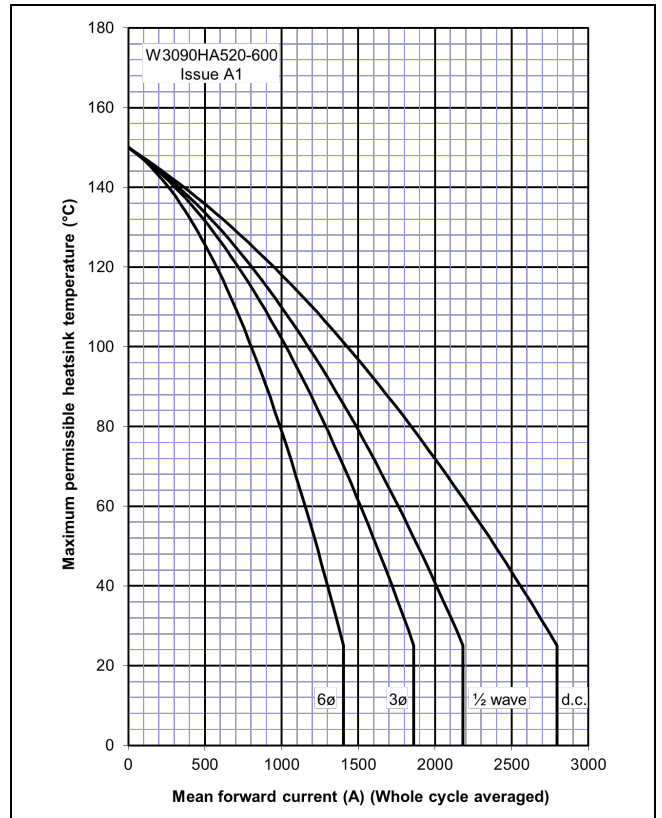
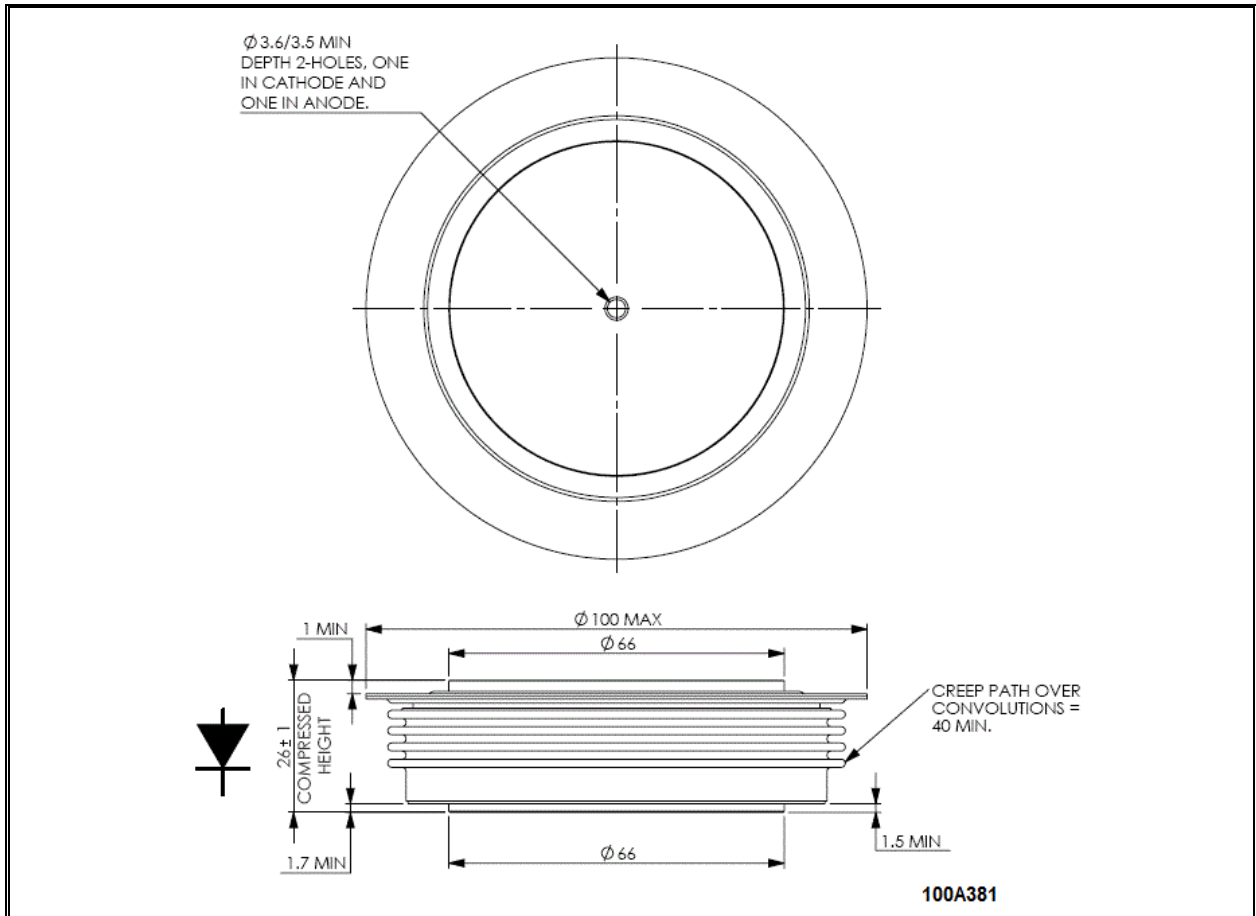


Figure 11 – Forward current vs. Heatsink temperature – Cathode Side Cooled





**Outline Drawing & Ordering Information**



<b>ORDERING INFORMATION</b> (Please quote 10 digit code as below)			
<b>W3090</b>	<b>HA</b>	<b>◆◆</b>	<b>0</b>
Fixed Type Code	Fixed Outline Code	Voltage code $V_{RRM}/100$ 52-60	Fixed code

Order code: W3090HA600 – 6000V  $V_{RRM}$ , 26mm clamp height capsule.

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