WESTCODE

An IXYS Company

**Date:- 5 Apr, 2006**

**Data Sheet Issue:- 2**

# Rectifier Diode

## Types W1520N#500 to W1520N#600

Old Part No.: SW46-58CXC620

**Absolute Maximum Ratings**

| | VOLTAGE RATINGS | MAXIMUM LIMITS | UNITS |
|---|---|---|---|
| $V_{RRM}$ | Repetitive peak reverse voltage, (note 1) | 5000-6000 | V |
| $V_{RSM}$ | Non-repetitive peak reverse voltage, (note 1) | 5100-6100 | V |

| | OTHER RATINGS | MAXIMUM LIMITS | UNITS |
|---|---|---|---|
| $I_{F(AV)M}$ | Maximum average forward current, $T_{sink}$=55°C, (note 2) | 1478 | A |
| $I_{F(AV)M}$ | Maximum average forward current. $T_{sink}$=100°C, (note 2) | 1001 | A |
| $I_{F(AV)M}$ | Maximum average forward current. $T_{sink}$=100°C, (note 3) | 639 | A |
| $I_{F(RMS)M}$ | Nominal RMS forward current, $T_{sink}$=25°C, (note 2) | 2727 | A |
| $I_{F(d.c.)}$ | D.C. forward current, $T_{sink}$=25°C, (note 4) | 2492 | A |
| $I_{FSM}$ | Peak non-repetitive surge $t_p$=10ms, $V_{rm}$=60%$V_{RRM}$, (note 5) | 12.0 | kA |
| $I_{FSM2}$ | Peak non-repetitive surge $t_p$=10ms, $V_{rm}$≤10V, (note 5) | 13.2 | kA |
| $I^2t$ | $I^2t$ capacity for fusing $t_p$=10ms, $V_{rm}$=60%$V_{RRM}$, (note 5) | $720\times10^3$ | $A^2s$ |
| $I^2t$ | $I^2t$ capacity for fusing $t_p$=10ms, $V_{rm}$≤10V, (note 5) | $871\times10^3$ | $A^2s$ |
| $T_{j\ op}$ | Operating temperature range | -40 to +150 | °C |
| $T_{stg}$ | Storage temperature range | -55 to +160 | °C |

Notes:-

1) De-rating factor of 0.13% per °C is applicable for $T_j$ below 25°C.
2) Double side cooled, single phase; 50Hz, 180° half-sinewave.
3) Single side cooled, single phase; 50Hz, 180° half-sinewave.
4) Double side cooled.
5) Half-sinewave, 150°C $T_j$ initial.

## Characteristics

| | PARAMETER | MIN. | TYP. | MAX. | TEST CONDITIONS (Note 1) | UNITS |
|---|---|---|---|---|---|---|
| $V_{FM}$ | Maximum peak forward voltage | - | - | 2.20 | $I_{TM}$=2340A | V |
| $V_{FM}$ | Maximum peak forward voltage | - | - | 3.33 | $I_{TM}$=4400A | V |
| $V_{T0}$ | Threshold voltage | - | - | 0.904 | | V |
| $r_T$ | Slope resistance | - | - | 0.552 | | mΩ |
| $I_{RRM}$ | Peak reverse current | - | - | 70 | Rated $V_{RRM}$ | mA |
| $Q_{rr}$ | Recovered charge | - | 7200 | - | $I_{TM}$=1000A, $t_p$=2000µs, di/dt=10A/µs, $V_r$=100V | µC |
| $Q_{ra}$ | Recovered charge, 50% Chord | - | 3350 | 3600 | | µC |
| $I_{rm}$ | Reverse recovery current | - | 160 | - | | A |
| $t_{rr}$ | Reverse recovery time | - | 42 | - | | µs |
| $R_{thJK}$ | Thermal resistance, junction to heatsink | - | - | 0.022 | Double side cooled | K/W |
| | | - | - | 0.044 | Single side cooled | K/W |
| F | Mounting force | 19 | - | 26 | | kN |
| $W_t$ | Weight | - | 480 | - | | g |

Notes:-
1) Unless otherwise indicated $T_j$=150°C.
2) For other clamp forces, please consult factory.

| Notes on rupture rated packages. |
|---|
| This product is available with a non-rupture rated package.<br>For additional details on these products, 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 |
|---|---|---|---|
| 50 | 5000 | 5100 | 2200 |
| 52 | 5200 | 5300 | 2240 |
| 54 | 5400 | 5500 | 2280 |
| 56 | 5600 | 5700 | 2320 |
| 58 | 5800 | 5900 | 2360 |
| 60 | 6000 | 6100 | 2400 |

### 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

$$I_{AV} = \frac{-V_{T0} + \sqrt{V_{T0}^{\,2} + 4 \cdot ff^2 \cdot r_T \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_T}$$

and:

$$W_{AV} = \frac{\Delta T}{R_{th}}$$

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

Where $V_{T0}$=0.904V, $r_T$=0.552mΩ,

$R_{th}$ = 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 | 0.0285 | 0.0255 | 0.0240 | 0.0220 |
| Square wave Single Side Cooled | 0.0513 | 0.0484 | 0.0469 | 0.0440 |
| Sine wave Double Side Cooled | 0.0257 | 0.0233 | 0.0220 | |
| Sine wave Single Side Cooled | 0.0482 | 0.0463 | 0.0440 | |

| 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 | 0.2752955 | -0.5382763 |
| B | 0.1242329 | 0.2918416 |
| C | $3.472\times10^{-4}$ | $6.499\times10^{-4}$ |
| D | $-4.4595\times10^{-3}$ | -0.0216334 |

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 | 5 |
| $r_p$ | 0.0291698 | $4.295845\times10^{-3}$ | $7.57109\times10^{-3}$ | $2.195801\times10^{-3}$ | $1.628753\times10^{-3}$ |
| $\tau_p$ | 5.67822 | 1.123602 | 0.1407857 | 0.014381914 | $1.272749\times10^{-3}$ |

| D.C. Double Side Cooled | | | | |
|---|---|---|---|---|
| Term | 1 | 2 | 3 | 4 |
| $r_p$ | 0.01177146 | $6.485814\times10^{-3}$ | $2.471007\times10^{-3}$ | $1.607109\times10^{-3}$ |
| $\tau_p$ | 0.9495346 | 0.1337950 | 0.01636628 | $1.255571\times10^{-3}$ |

6.0 Reverse recovery ratings

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

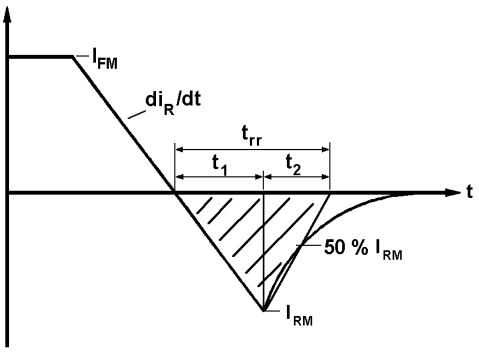



**Fig. 1**

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

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

(iii)

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

## Curves

Figure 1 - Forward characteristics of Limit device

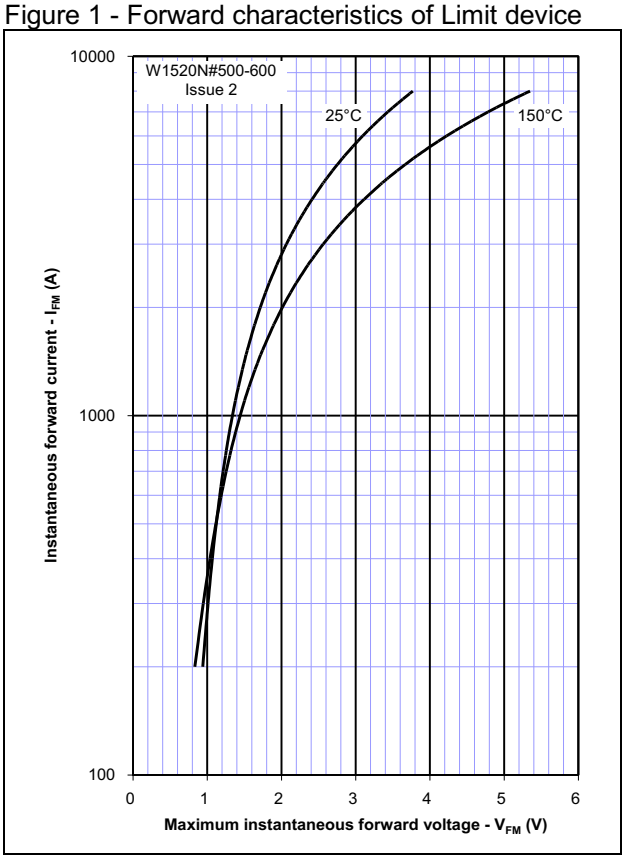



Figure 2 - Transient thermal impedance

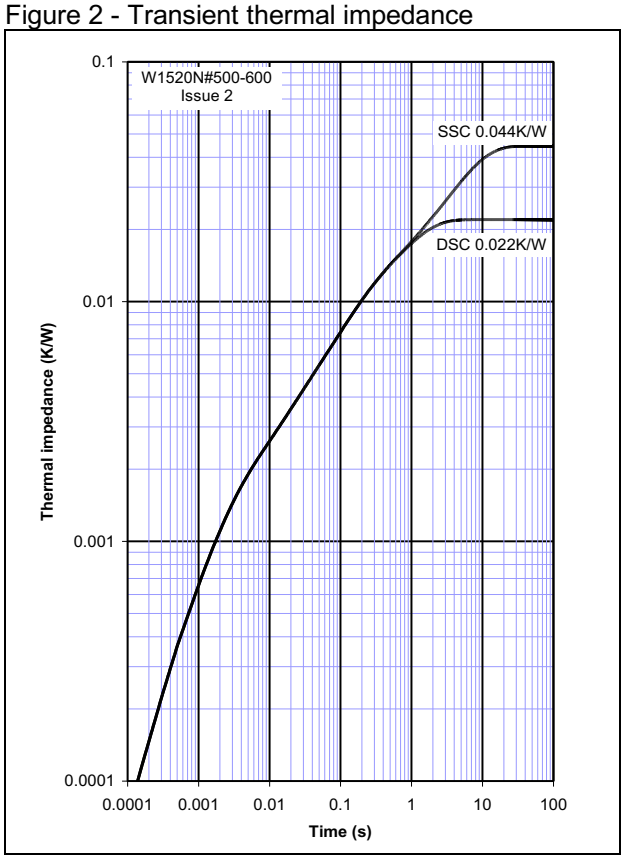



Figure 3 - Maximum Surge Rating

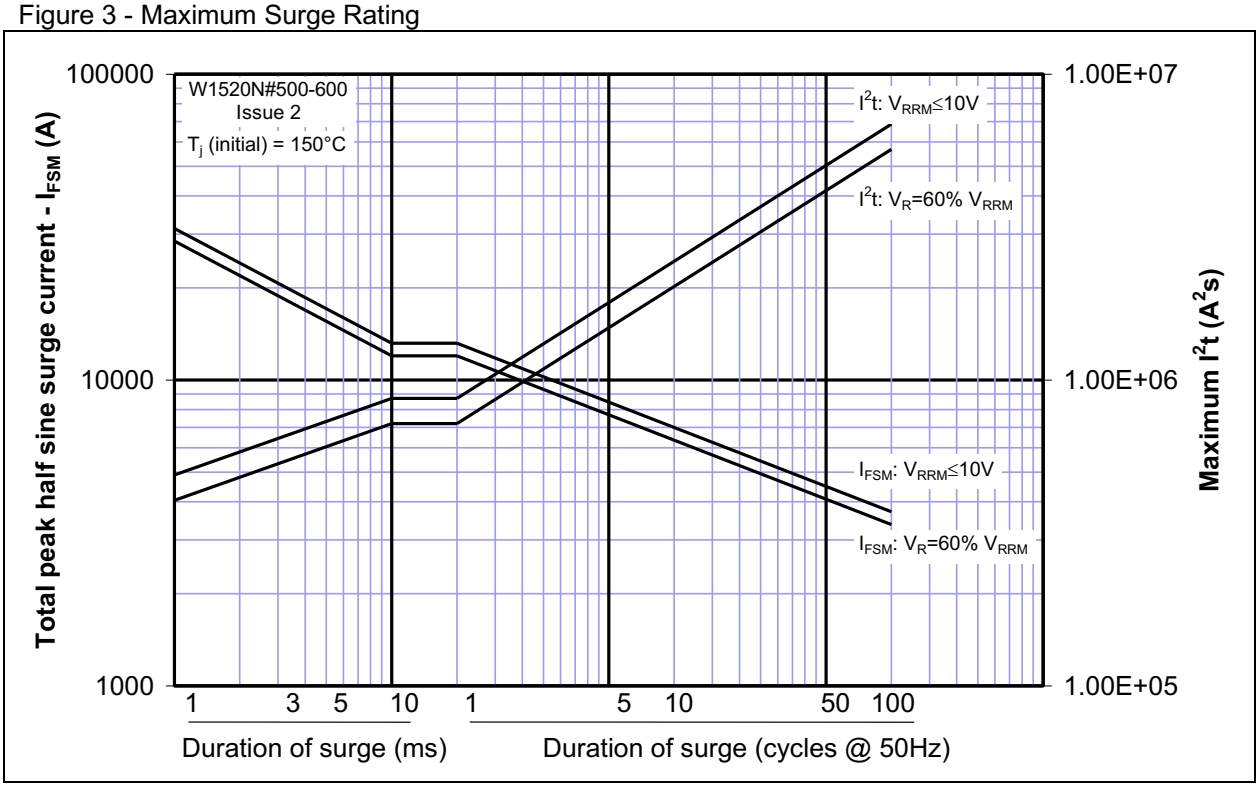


Figure 4 - Total recovered charge, $Q_{rr}$

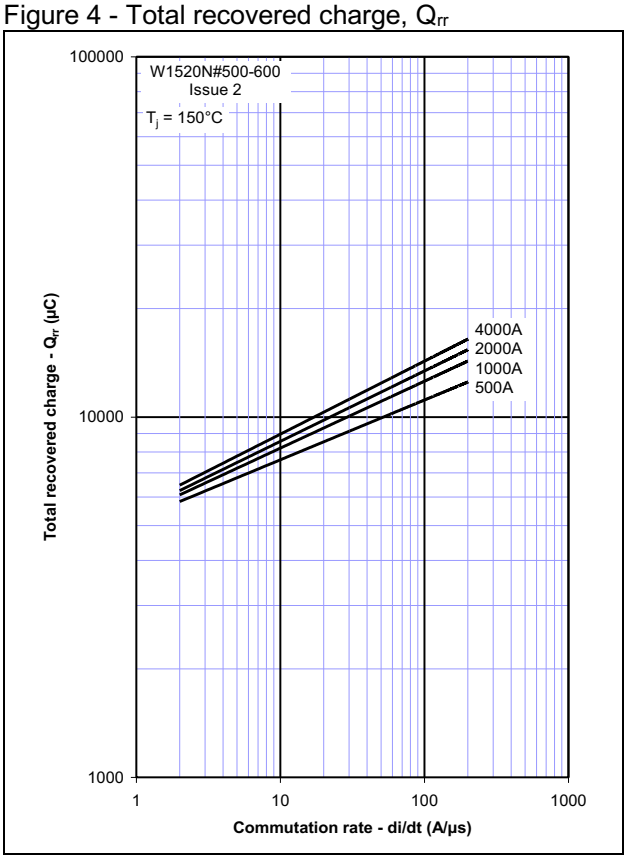



Figure 5 - Recovered charge, $Q_{ra}$ (50% chord)

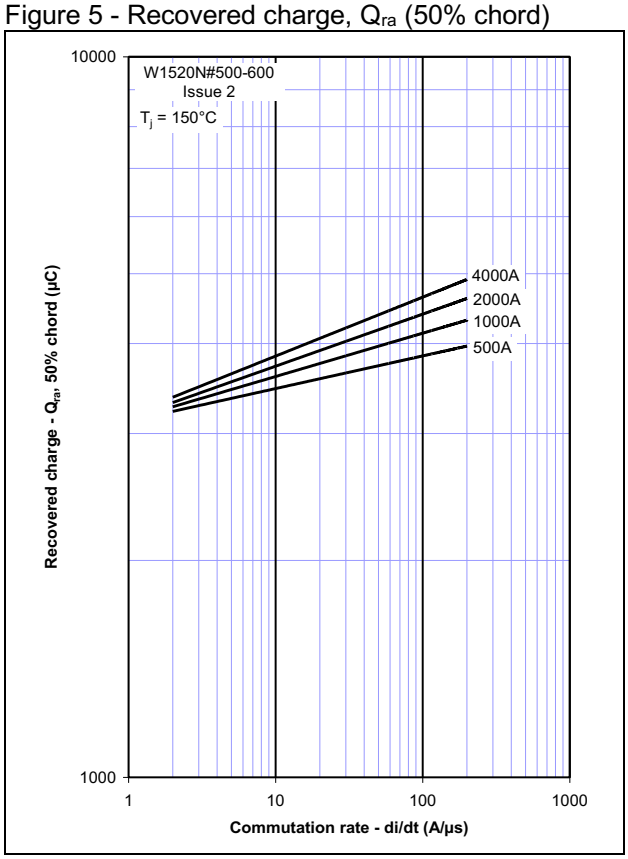



Figure 6 - Peak reverse recovery current, $I_{rm}$

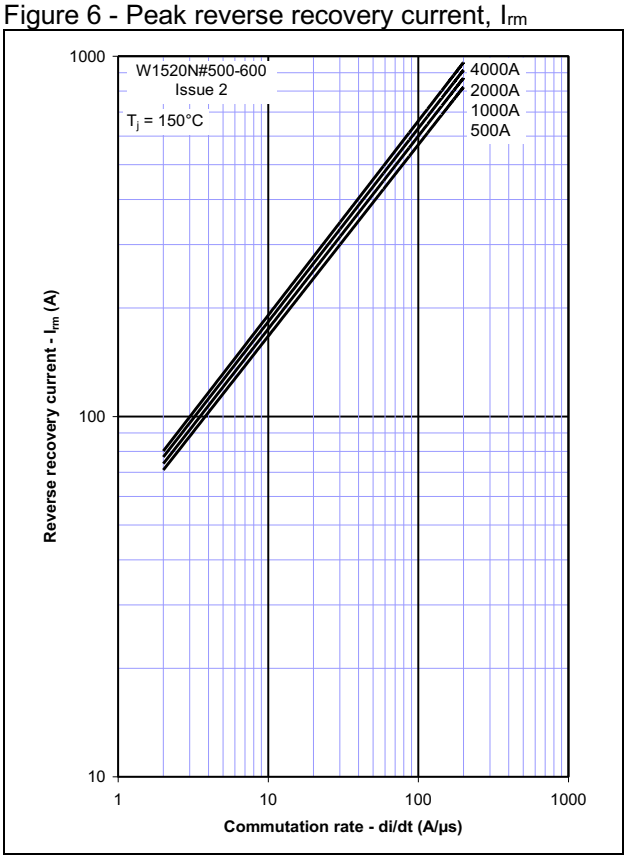



Figure 7 - Maximum recovery time, $t_{rr}$ (50% chord)

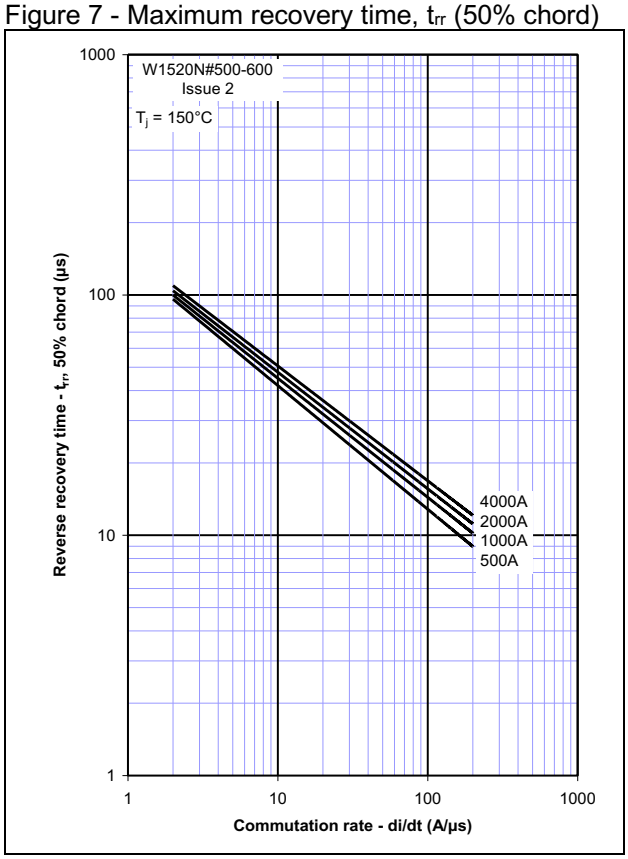


Figure 8 – Forward current vs. Power dissipation – Double Side Cooled

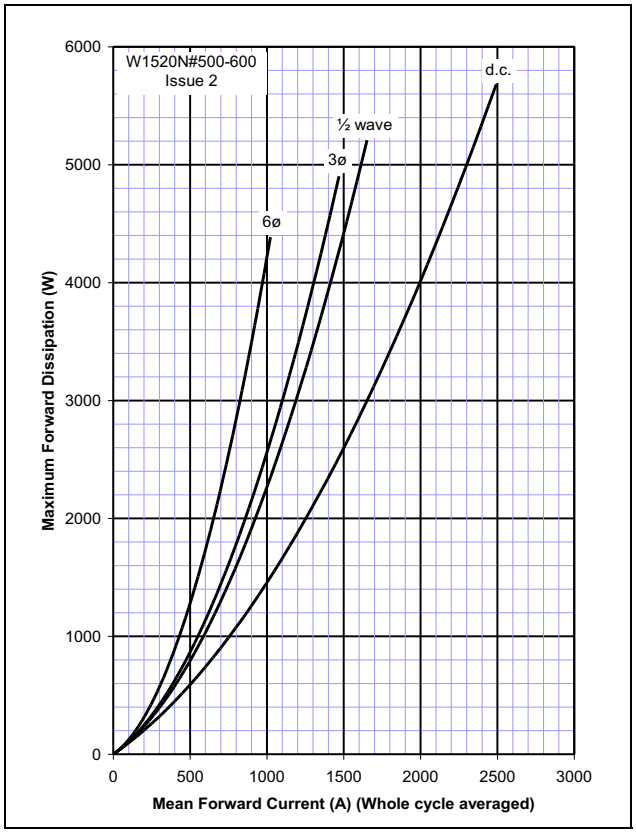



Figure 9 – Forward current vs. Heatsink temperature - Double Side Cooled

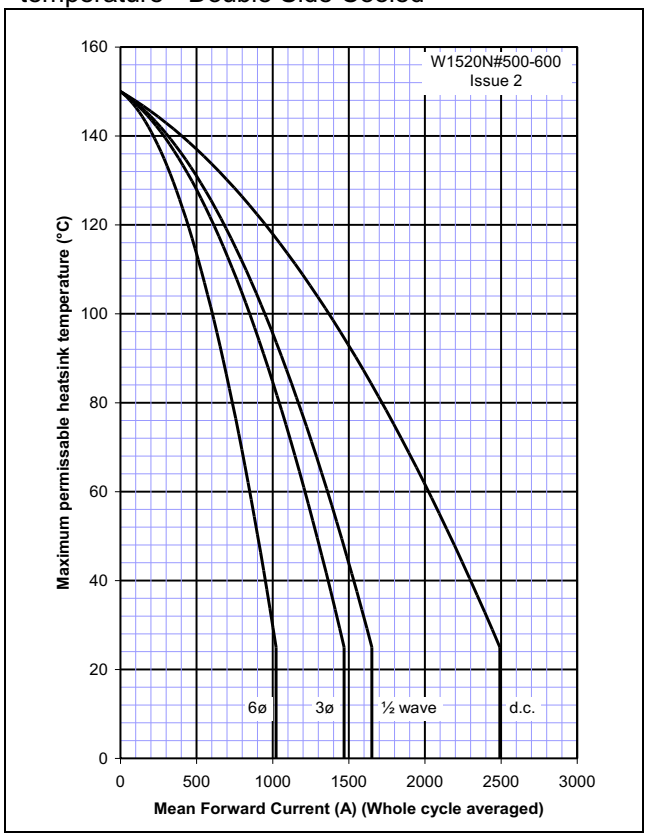



Figure 10 – Forward current vs. Power dissipation – Single Side Cooled

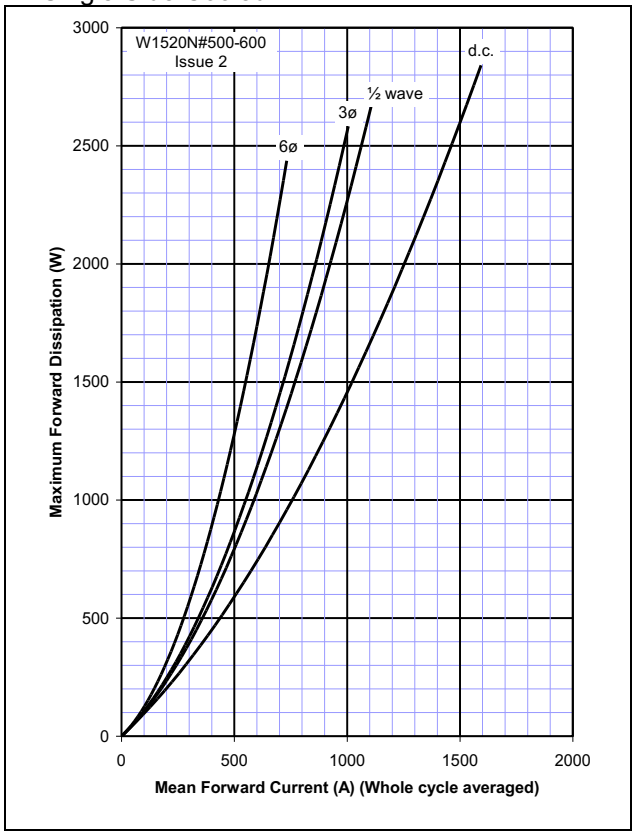
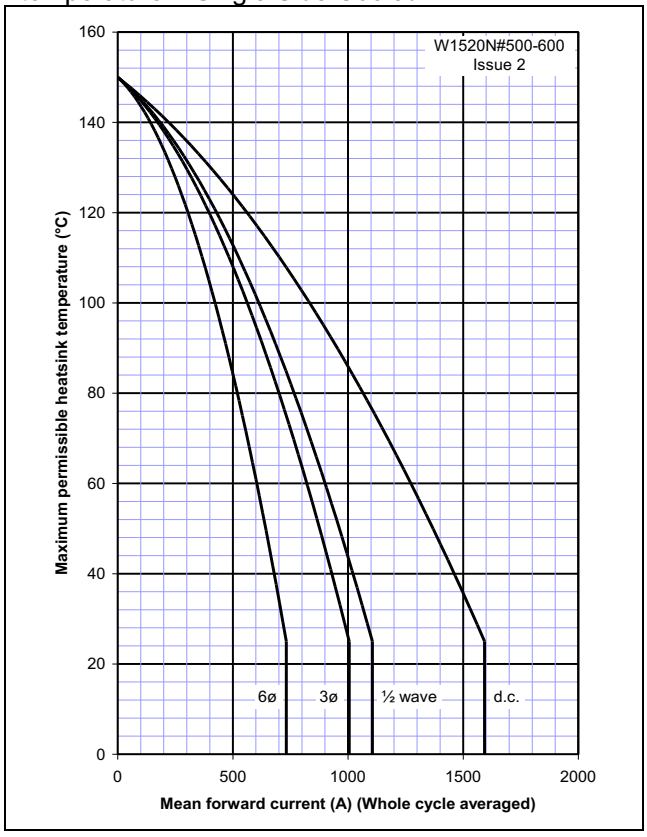
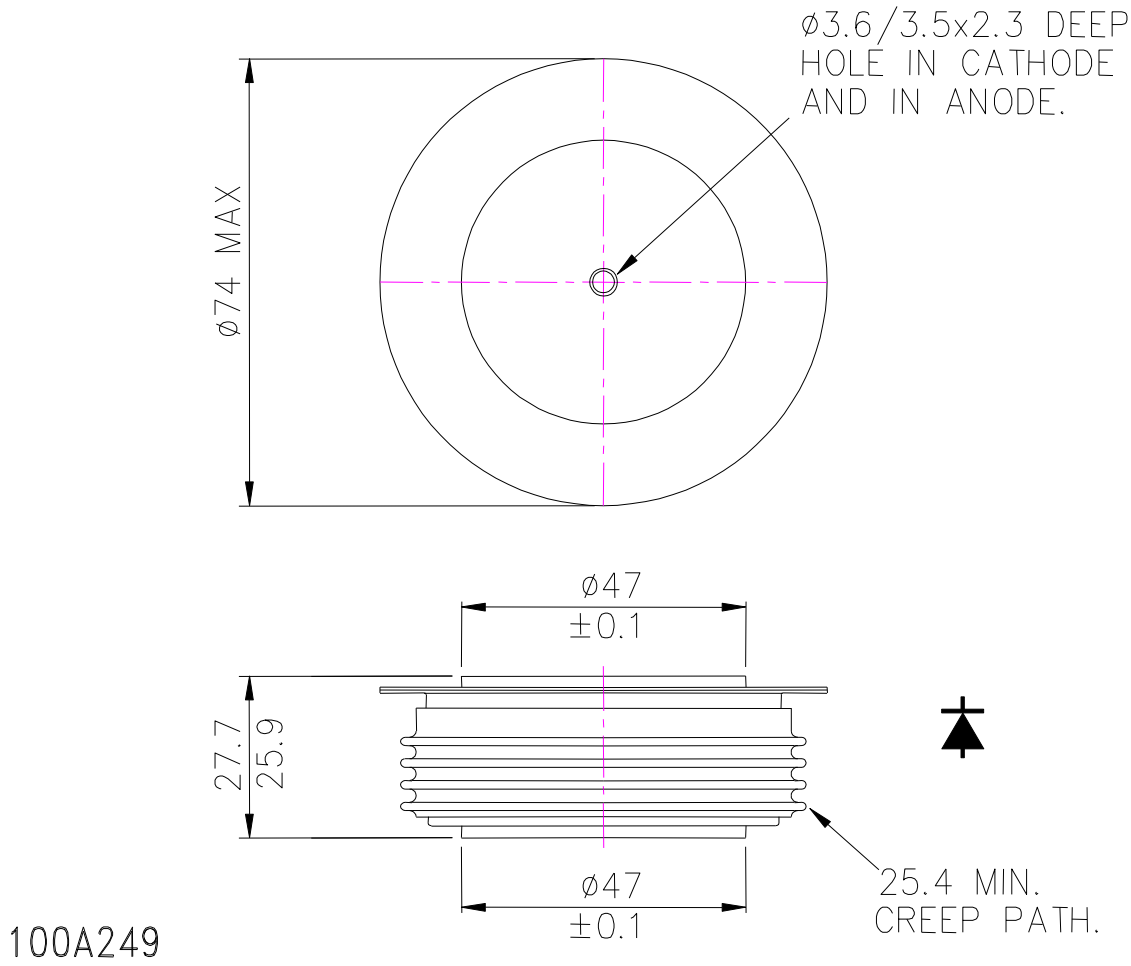



Figure 11 – Forward current vs. Heatsink temperature – Single Side Cooled



## Outline Drawing & Ordering Information




| ORDERING INFORMATION (Please quote 10 digit code as below) | | | |
|---|---|---|---|
| **W1520** | **N#** | **♦♦** | **0** |
| Fixed Type Code | Outline code<br>NC = 27.7mm Clamp height capsule<br>NT = 27.7mm Clamp height, rupture rated capsule | Voltage code<br>$V_{RRM}$/100<br>50-60 | Fixed code |

Typical order code: W1520NT500 – 5000V $V_{RRM}$, 27.7mm clamp height.

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