

## Rectifier Diode

### Types W1856NC400 to W1856NC500

Old Type No: SW40-50CXC815

#### Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
$V_{RRM}$	Repetitive peak reverse voltage, (note 1)	4000 - 5000	V
$V_{RSM}$	Non-repetitive peak reverse voltage, (note 1)	4100 - 5100	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{F(AV)M}$	Maximum average forward current, $T_{sink}=55^{\circ}C$ , (note 2)	1856	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=100^{\circ}C$ , (note 2)	1301	A
$I_{F(AV)M}$	Maximum average forward current. $T_{sink}=100^{\circ}C$ , (note 3)	814	A
$I_{F(RMS)}$	Nominal RMS forward current, $T_{sink}=25^{\circ}C$ , (note 2)	3399	A
$I_{F(d.c.)}$	D.C. forward current, $T_{sink}=25^{\circ}C$ , (note 4)	3026	A
$I_{FSM}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}=0.6V_{RRM}$ , (note 5)	16	kA
$I_{FSM2}$	Peak non-repetitive surge $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	21	kA
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}=0.6V_{RRM}$ , (note 5)	$1.28\times 10^6$	$A^2s$
$I^2t$	$I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)	$2.21\times 10^6$	$A^2s$
$T_{j\ op}$	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) 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	-	-	2.02	I <sub>FM</sub> =3000A	V
		-	-	2.95	I <sub>FM</sub> =5550A	
V <sub>T0</sub>	Threshold voltage	-	-	0.975		V
r <sub>T</sub>	Slope resistance	-	-	0.348		mΩ
I <sub>R<sub>RRM</sub></sub>	Peak reverse current	-	-	50	Rated V <sub>RRM</sub>	mA
		-	-	50	Rated V <sub>RRM</sub> , T <sub>j</sub> =25°C	
Q <sub>rr</sub>	Recovered charge	-	6200	-	I <sub>TM</sub> =1000A, t <sub>p</sub> =1000μs, di/dt=10A/μs, V <sub>r</sub> =50V	μC
Q <sub>ra</sub>	Recovered charge, 50% Chord	-	3000	3200		μC
I <sub>rr</sub>	Reverse recovery current	-	165	-		A
t <sub>rr</sub>	Reverse recovery time	-	36	-		μs
R <sub>thJK</sub>	Thermal resistance, junction to heatsink	-	-	0.022	Double side cooled	K/W
		-	-	0.044	Single side cooled	
F	Mounting force	19	-	26		kN
W <sub>t</sub>	Weight	-	480	-		g

Notes; -

 1) Unless otherwise indicated T<sub>j</sub>=160°C.

**Notes on Ratings and Characteristics**

1.0 Voltage Grade Table

Voltage Grade	V <sub>DRM</sub> V <sub>DSM</sub> V <sub>RRM</sub> V	V <sub>RSM</sub> V	V <sub>D</sub> V <sub>R</sub> DC V
40	4000	4100	2000
42	4200	4300	2040
44	4400	4500	2080
46	4600	4700	2120
48	4800	4900	2160
50	5000	5100	2200

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<sub>j</sub> 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<sub>T0</sub>=0.975V, r<sub>T</sub>=0.348mΩ,

R<sub>th</sub> = 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	0.022	
Sine wave Single Side Cooled	0.0482	0.0463	0.044	

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	0.641971348	A	0.326766748
B	0.0254553	B	0.05167461
C	$1.77411 \times 10^{-4}$	C	$2.926949 \times 10^{-4}$
D	$6.294207 \times 10^{-3}$	D	$7.328941 \times 10^{-3}$

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. Single Side Cooled					
Term	1	2	3	4	5
$r_p$	0.0291698	$4.295845 \times 10^{-3}$	$7.57109 \times 10^{-3}$	$2.195801 \times 10^{-3}$	$1.628753 \times 10^{-3}$
$\tau_p$	5.67822	1.123602	0.1407857	0.014381914	$1.272749 \times 10^{-3}$

D.C. Double Side Cooled				
Term	1	2	3	4
$r_p$	0.01177146	$6.485814 \times 10^{-3}$	$2.471007 \times 10^{-3}$	$1.607109 \times 10^{-3}$
$\tau_p$	0.9495346	0.1337950	0.01636628	$1.255571 \times 10^{-3}$

6.0 Reverse recovery ratings

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

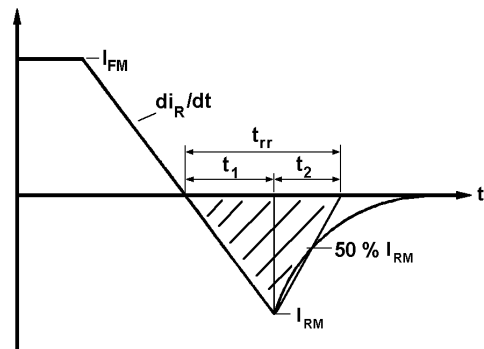


Fig. 1

(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

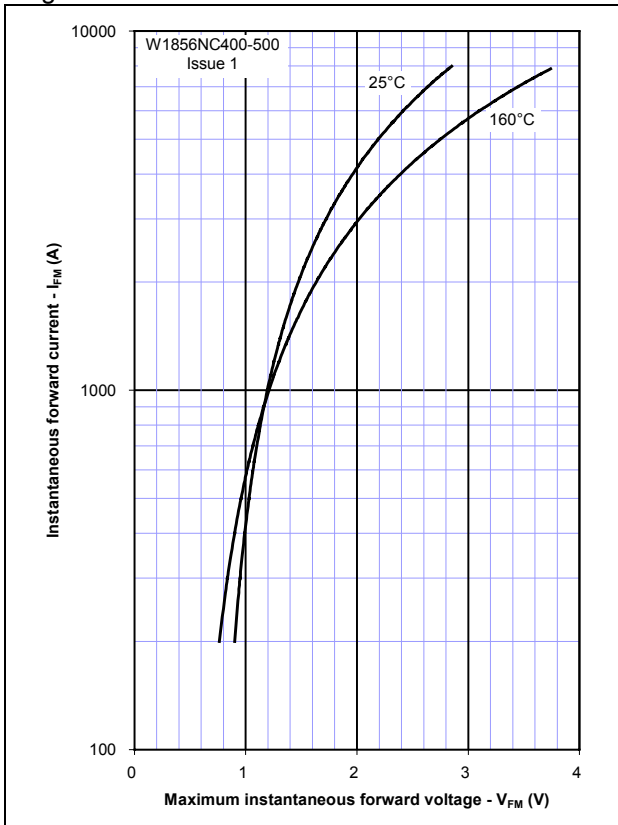


Figure 2 – Transient thermal impedance

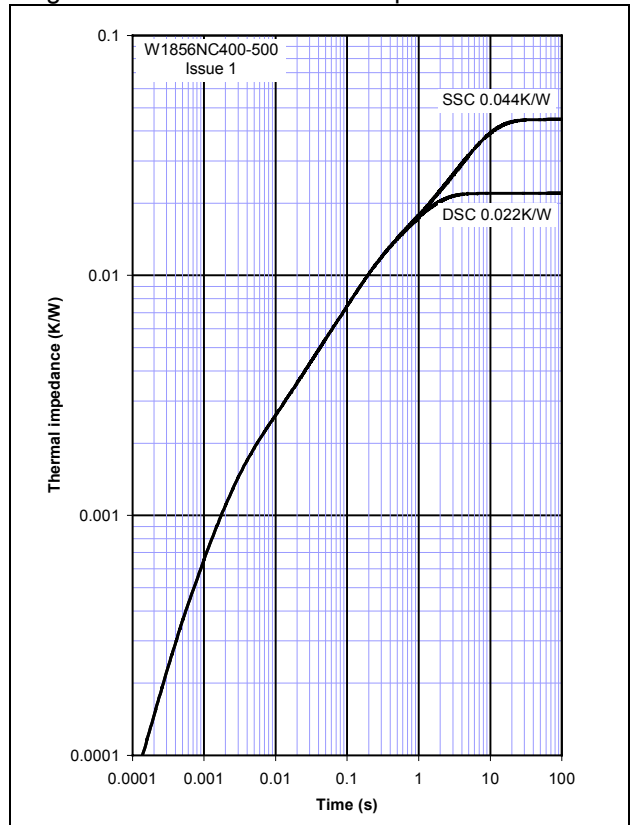


Figure 3 – Maximum Surge and  $I^2t$  Ratings

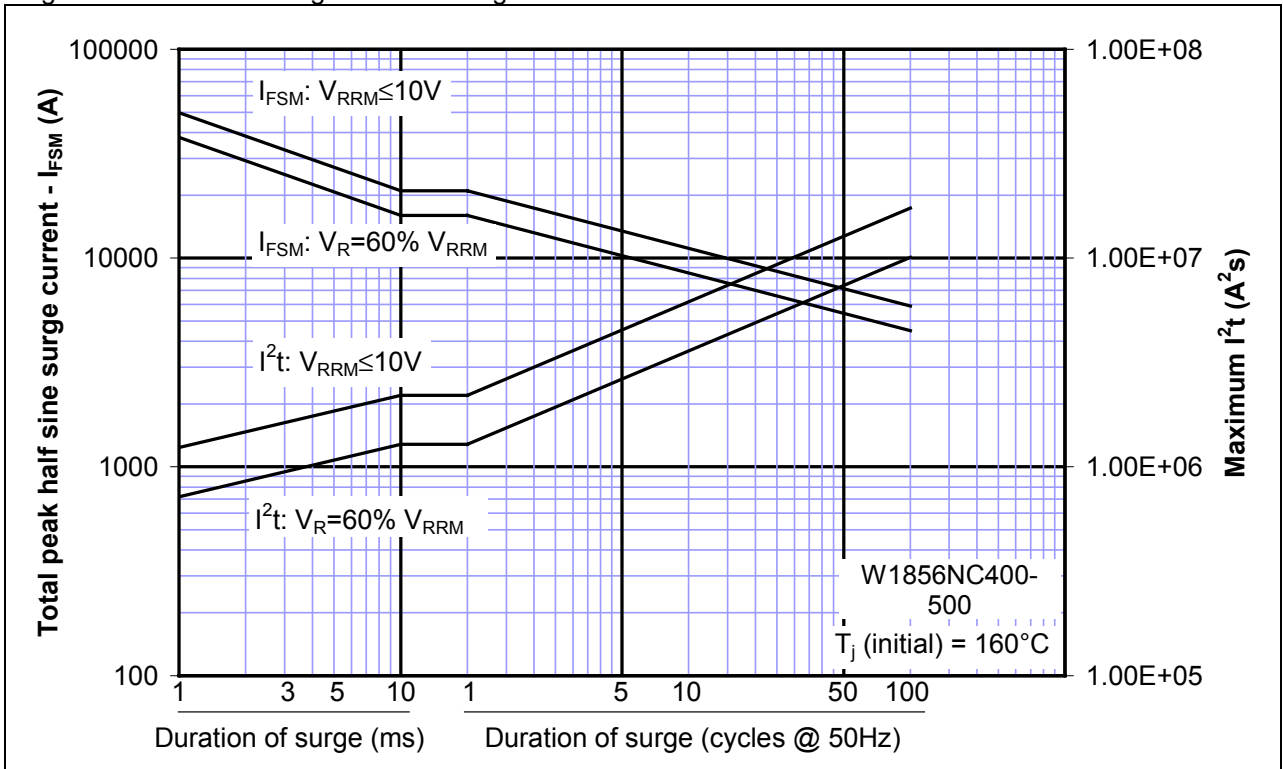


Figure 4 – Total recovered charge,  $Q_{rr}$

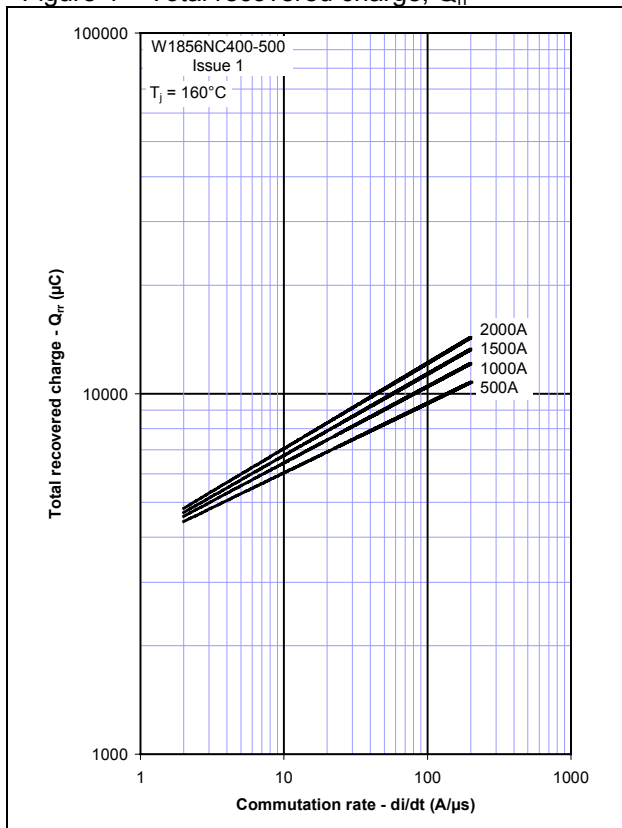


Figure 5 – Recovered charge,  $Q_{ra}$  (50% chord)

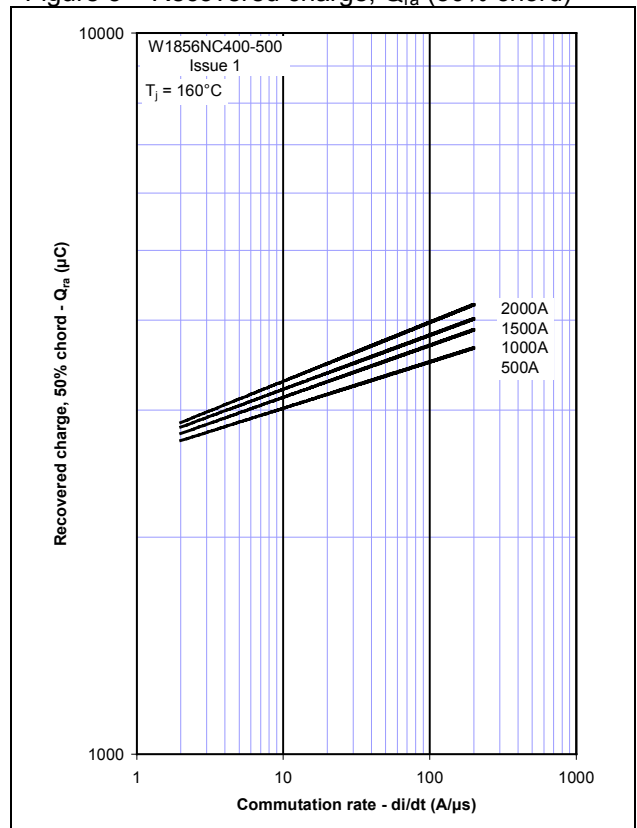


Figure 6 – Peak reverse recovery current,  $I_{rm}$

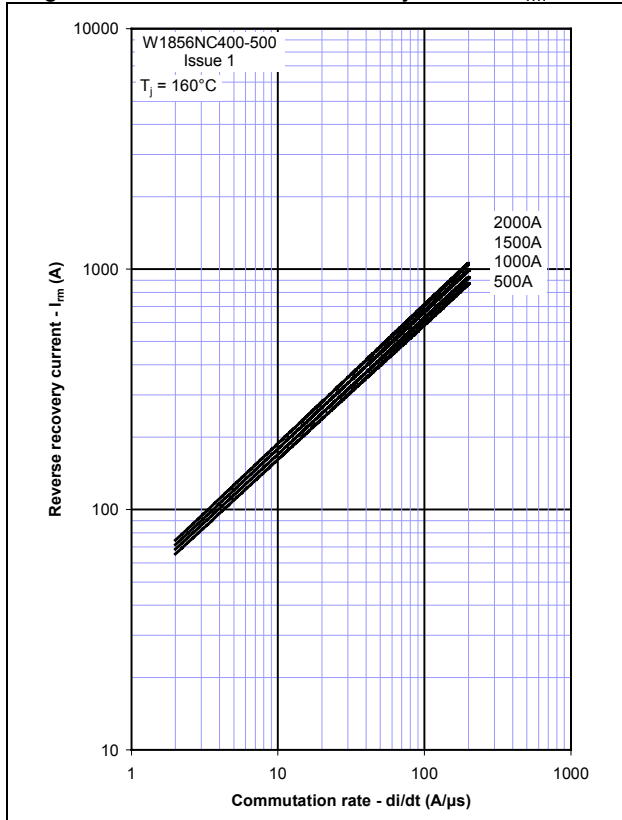


Figure 7 – Maximum recovery time,  $t_{rr}$  (50% chord)

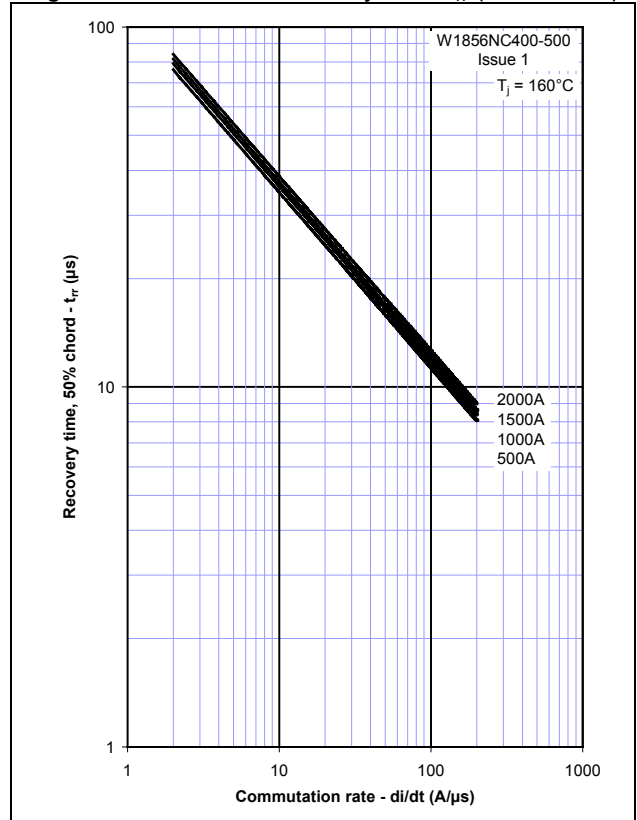


Figure 8 – Forward current vs. Power dissipation - Double Side Cooled

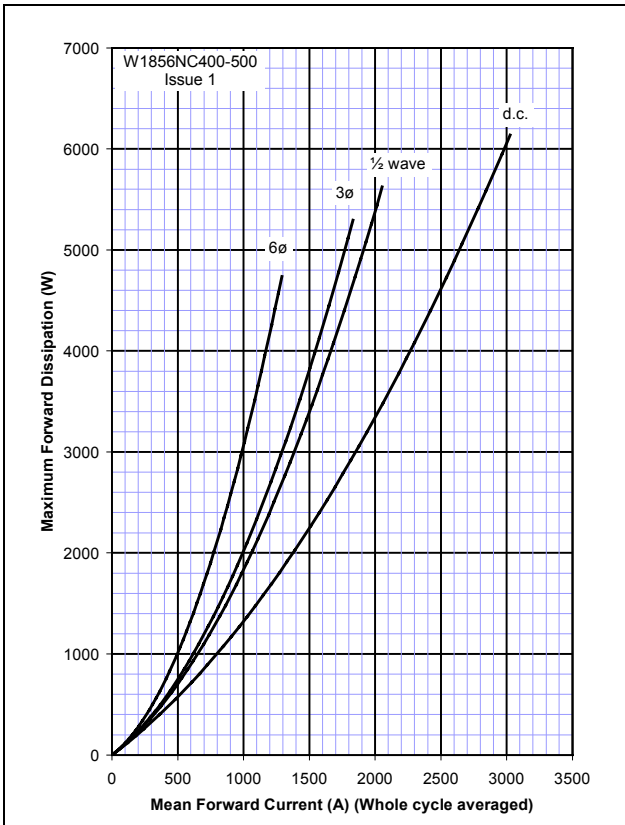


Figure 9 – Forward current vs. Heatsink temperature - Double Side Cooled

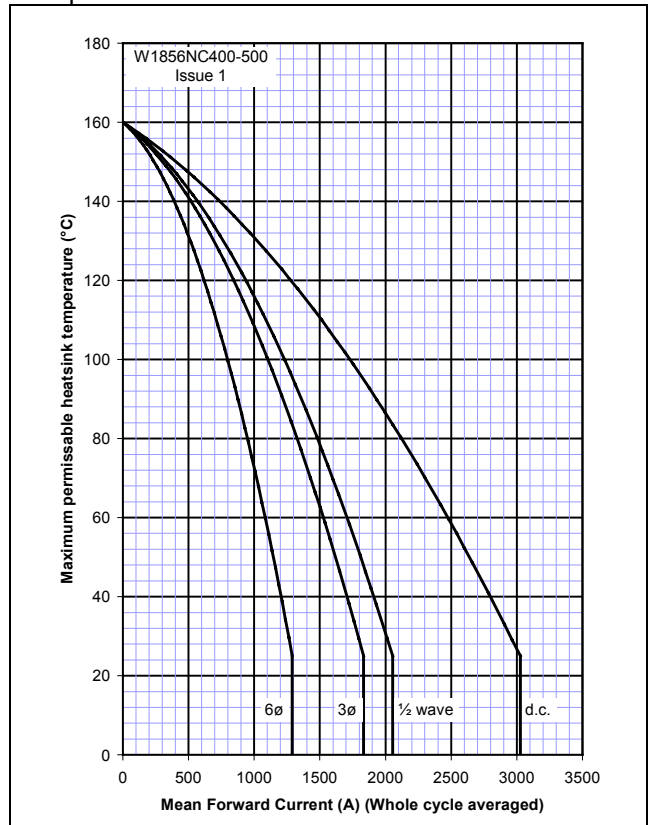


Figure 10 – Forward current vs. Power dissipation - Single Side Cooled

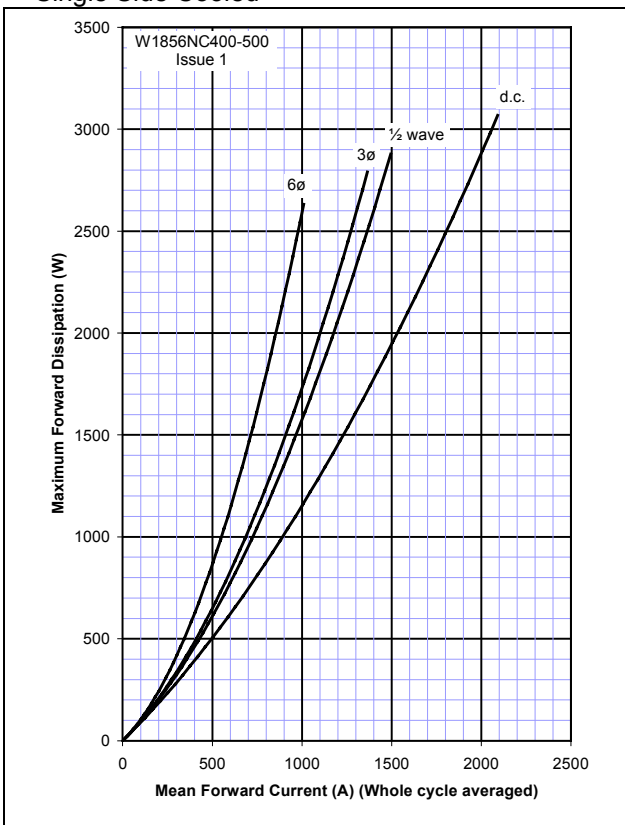
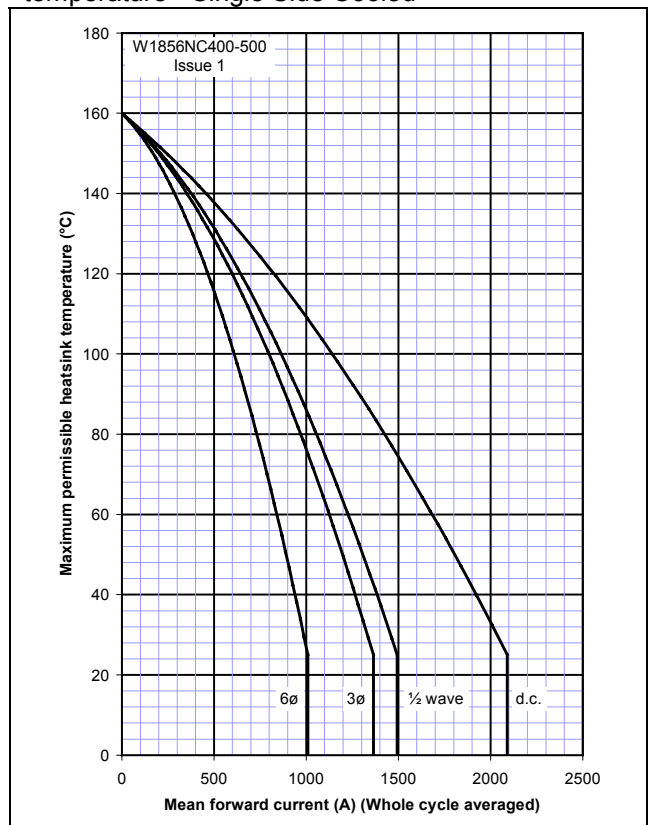
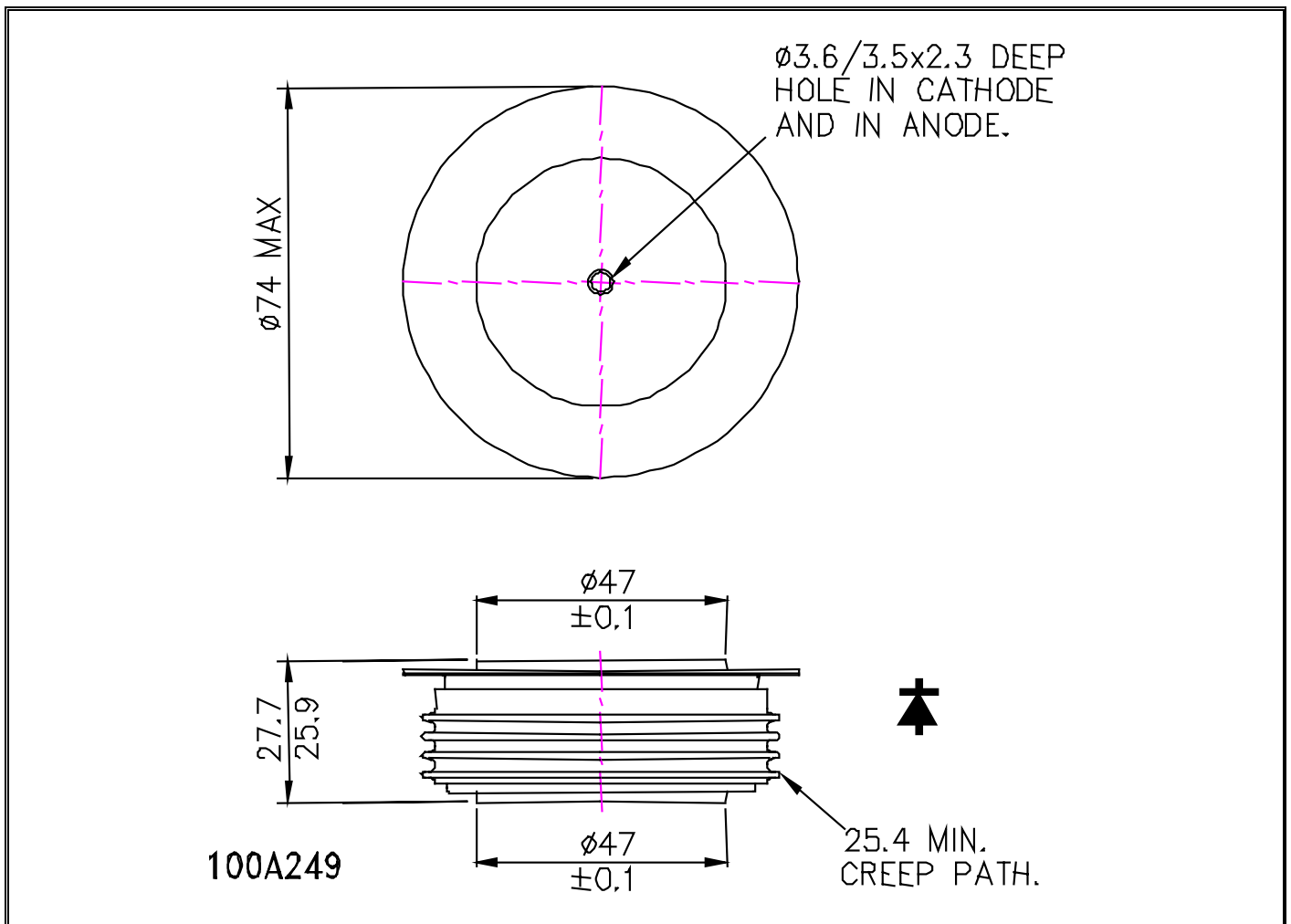


Figure 11 – Forward current vs. Heatsink temperature - Single Side Cooled





**Outline Drawing & Ordering Information**



**ORDERING INFORMATION**

(Please quote 10 digit code as below)

<b>W1856</b>	<b>NC</b>	<b>◆◆</b>	<b>0</b>
Fixed Type Code	Fixed outline code	Voltage code $V_{DRM}/100$ 40-50	Fixed code

Typical order code: W1856NC400 – 4000V  $V_{RRM}$ , 27.7mm clamp height capsule.

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