WESTCODE
An IXYS Company

Date:- 27 May, 2004

Data Sheet Issue:- 1

Phase Control Thyristor

Types N3476T#360 to N3476T#420

Old Type No.: N1463C/DH36-42

Absolute Maximum Ratings

	VOLTAGE RATINGS	**MAXIMUM LIMITS**	**UNITS**
V_{DRM}	Repetitive peak off-state voltage, (note 1)	3600-4200	V
V_{DSM}	Non-repetitive peak off-state voltage, (note 1)	3600-4200	V
V_{RRM}	Repetitive peak reverse voltage, (note 1)	3600-4200	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	3700-4300	V

	OTHER RATINGS	**MAXIMUM LIMITS**	**UNITS**
$I_{T(AV)M}$	Maximum average on-state current, T_{sink}=55°C, (note 2)	3476	A
$I_{T(AV)M}$	Maximum average on-state current. T_{sink}=85°C, (note 2)	2434	A
$I_{T(AV)M}$	Maximum average on-state current. T_{sink}=85°C, (note 3)	1518	A
$I_{T(RMS)M}$	Nominal RMS on-state current, T_{sink}=25°C, (note 2)	6787	A
$I_{T(d.c.)}$	D.C. on-state current, T_{sink}=25°C, (note 4)	6063	A
I_{TSM}	Peak non-repetitive surge t_p=10ms, $V_{rm}=0.6V_{RRM}$, (note 5)	46.8	A
I_{TSM2}	Peak non-repetitive surge t_p=10ms, $V_{rm}\leq10$V, (note 5)	52.0	A
I^2t	I^2t capacity for fusing t_p=10ms, $V_{rm}=0.6V_{RRM}$, (note 5)	10.95×10^6	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, $V_{rm}\leq10$V, (note 5)	13.52×10^6	A^2s
$(di/dt)_{cr}$	Critical rate of rise of on-state current (repetitive), (Note 6)	150	A/µs
	Critical rate of rise of on-state current (non-repetitive), (Note 6)	300	A/µs
V_{RGM}	Peak reverse gate voltage	5	V
$P_{G(AV)}$	Mean forward gate power	5	W
P_{GM}	Peak forward gate power	50	W
$T_{j\ op}$	Operating temperature range	-40 to +125	°C
T_{stg}	Storage temperature range	-40 to +150	°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, 125°C T_j initial.
6) V_D=67% V_{DRM}, I_{FG}=2A, $t_r\leq0.5$µs, T_{case}=125°C.

Characteristics

	PARAMETER	**MIN.**	**TYP.**	**MAX.**	**TEST CONDITIONS** (Note 1)	**UNITS**
V_{TM}	Maximum peak on-state voltage	-	-	1.87	I_{TM}=5000A	V
V_{T0}	Threshold voltage	-	-	0.97		V
r_T	Slope resistance	-	-	0.18		mΩ
$(dv/dt)_{cr}$	Critical rate of rise of off-state voltage	1000	-	-	V_D=80% V_{DRM}, linear ramp, gate o/c	V/µs
I_{DRM}	Peak off-state current	-	-	250	Rated V_{DRM}	mA
I_{RRM}	Peak reverse current	-	-	250	Rated V_{RRM}	mA
V_{GT}	Gate trigger voltage	-	-	3.0	T_j=25°C V_D=10V, I_T=3A	V
I_{GT}	Gate trigger current	-	-	300		mA
V_{GD}	Gate non-trigger voltage	-	-	0.25	Rated V_{DRM}	V
I_H	Holding current	-	-	1000	T_j=25°C	mA
t_{gd}	Gate-controlled turn-on delay time	-	0.7	1.5	I_{FG}=2A, t_r=0.5µs, V_D=67%V_{DRM}, I_{TM}=2000A, di/dt=10A/µs, T_j=25°C	µs
t_{gt}	Turn-on time	-	3.0	5.0		µs
Q_{rr}	Recovered charge	-	15000	-	I_{TM}=4000A, t_p=2ms, di/dt=10A/µs, V_r=50V	µC
Q_{ra}	Recovered charge, 50% Chord	-	7500	10000		µC
I_{rr}	Reverse recovery current	-	300	-		A
t_{rr}	Reverse recovery time	-	50	-		µs
t_q	Turn-off time	-	550	-	I_{TM}=4000A, t_p=2ms, di/dt=10A/µs, V_r=50V, V_{dr}=80%V_{DRM}, dV_{dr}/dt=20V/µs	µs
		-	950	-	I_{TM}=4000A, t_p=2ms, di/dt=10A/µs, V_r=50V, V_{dr}=80%V_{DRM}, dV_{dr}/dt=200V/µs	
R_{thJK}	Thermal resistance, junction to heatsink	-	-	0.008	Double side cooled	K/W
		-	-	0.016	Single side cooled	K/W
F	Mounting force	63	-	77		kN
W_t	Weight	-	1.3	-	Housing option TC & TT	kg
		-	1.7	-	Housing option TD & TV	

Notes:-

1) Unless otherwise indicated T_j=125°C.

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
36	3600	3700	2160
37	3700	3800	2220
38	8800	3900	2280
40	4000	4100	2400
42	4200	4300	2520

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 Repetitive dv/dt

Standard dv/dt is 1000V/µs.

5.0 Snubber Components

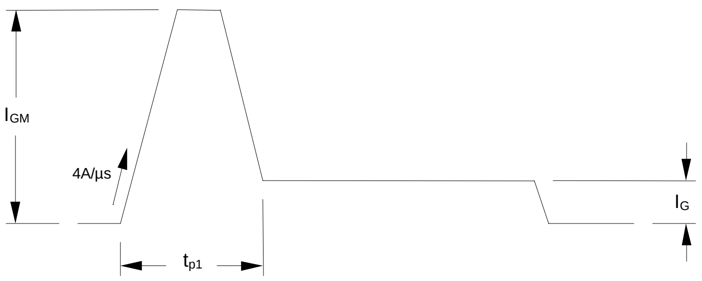
When selecting snubber components, care must be taken not to use excessively large values of snubber capacitor or excessively small values of snubber resistor. Such excessive component values may lead to device damage due to the large resultant values of snubber discharge current. If required, please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

6.0 Rate of rise of on-state current

The maximum un-primed rate of rise of on-state current must not exceed 300A/µs at any time during turn-on on a non-repetitive basis. For repetitive performance, the on-state rate of rise of current must not exceed 150A/µs at any time during turn-on. Note that these values of rate of rise of current apply to the total device current including that from any local snubber network.

7.0 Gate Drive

The nominal requirement for a typical gate drive is illustrated below. An open circuit voltage of at least 30V is assumed. This gate drive must be applied when using the full di/dt capability of the device.



The magnitude of I_{GM} should be between five and ten times I_{GT}, which is shown on page 2. Its duration (t_{p1}) should be 20µs or sufficient to allow the anode current to reach ten times I_L, whichever is greater. Otherwise, an increase in pulse current could be needed to supply the necessary charge to trigger. The 'back-porch' current I_G should remain flowing for the same duration as the anode current and have a magnitude in the order of 1.5 times I_{GT}.

8.0 Computer Modelling Parameters

8.1 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_0=0.97V, r_s=0.180mΩ,

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

ff = Form factor, see table below.

Supplementary Thermal Impedance							
Conduction Angle	30°	60°	90°	120°	180°	270°	d.c.
Square wave Double Side Cooled	0.00915	0.00907	0.00898	0.00891	0.00878	0.00864	0.008
Square wave Single Side Cooled	0.01795	0.01781	0.01772	0.01759	0.01731	0.01678	0.016
Sine wave Double Side Cooled	0.00911	0.00903	0.00895	0.00884	0.00867		
Sine wave Single Side Cooled	0.01784	0.01775	0.01763	0.01735	0.01682		

Form Factors							
Conduction Angle	30°	60°	90°	120°	180°	270°	d.c.
Square wave	3.46	2.45	2	1.73	1.41	1.15	1
Sine wave	3.98	2.78	2.22	1.88	1.57		

8.2 Calculating V_T using ABCD Coefficients

The on-state characteristic I_T vs. V_T, 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_T in terms of I_T given below:

$$V_T = A + B \cdot \ln(I_T) + C \cdot I_T + D \cdot \sqrt{I_T}$$

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

25°C Coefficients		125°C Coefficients	
A	1.256165	A	0.888777947
B	-0.02203001	B	0.0235943
C	$0.128423\text{x}10^{-3}$	C	$0.19641\text{x}10^{-3}$
D	$1.797903\text{x}10^{-3}$	D	$-2.853666\text{x}10^{-3}$

8.3 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.
τ_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
r_p	4.293445×10^{-3}	2.542182×10^{-3}	1.167986×10^{-3}
τ_p	0.8365194	0.176198	0.02000819

D.C. Single Side Cooled				
Term	1	2	3	4
r_p	9.899658×10^{-3}	2.731068×10^{-3}	2.619106×10^{-3}	1.049687×10^{-3}
τ_p	5.623142	1.132481	0.1461472	0.01849926

9.0 Reverse recovery ratings

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

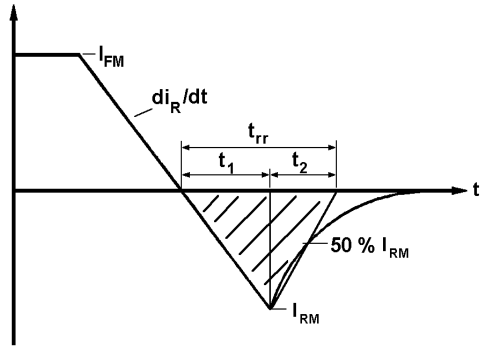


Fig. 1

(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 - On-state characteristics of Limit device

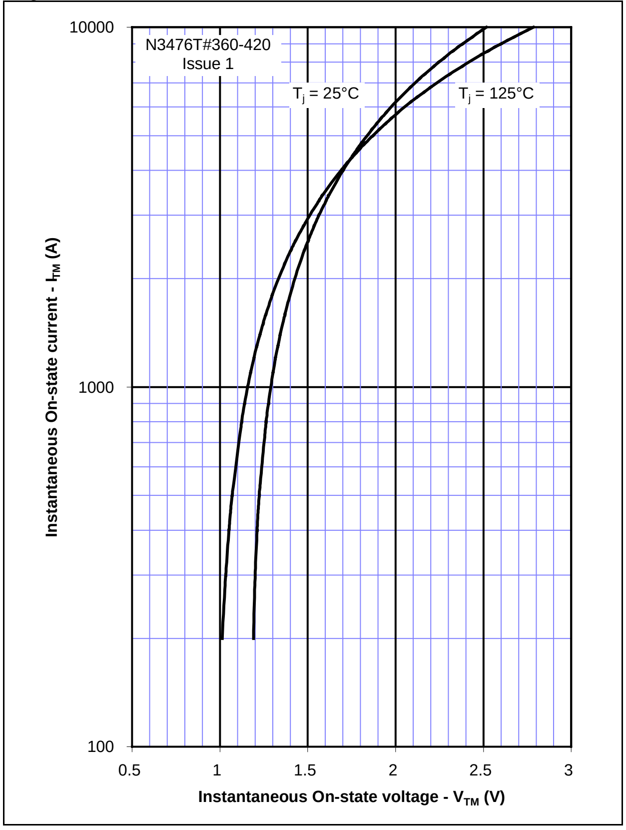


Figure 2 - Transient thermal impedance

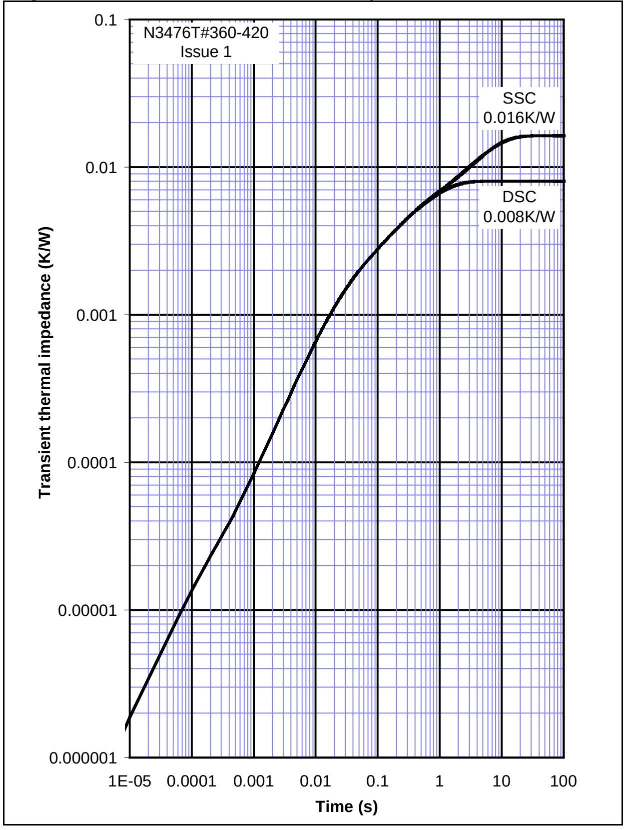


Figure 3 - Gate characteristics - Trigger limits

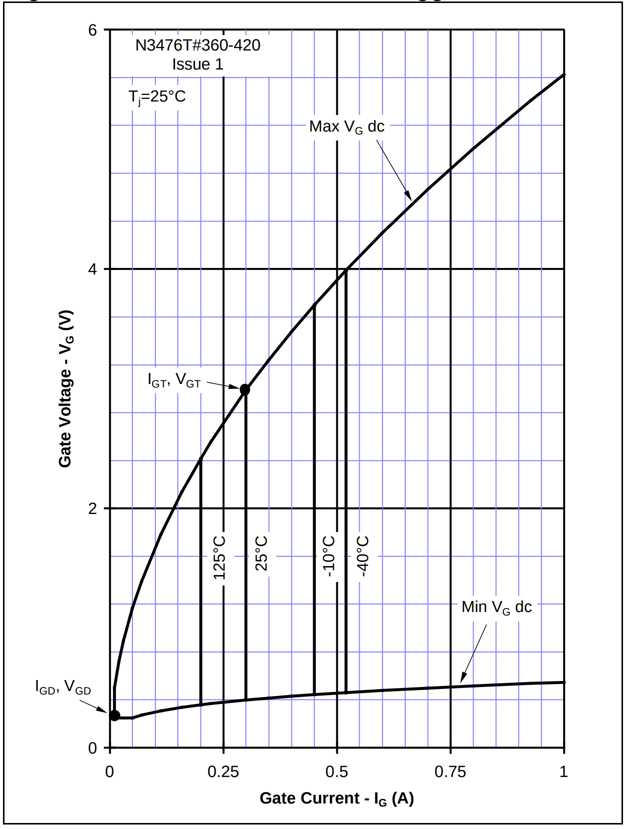


Figure 4 - Gate characteristics - Power curves

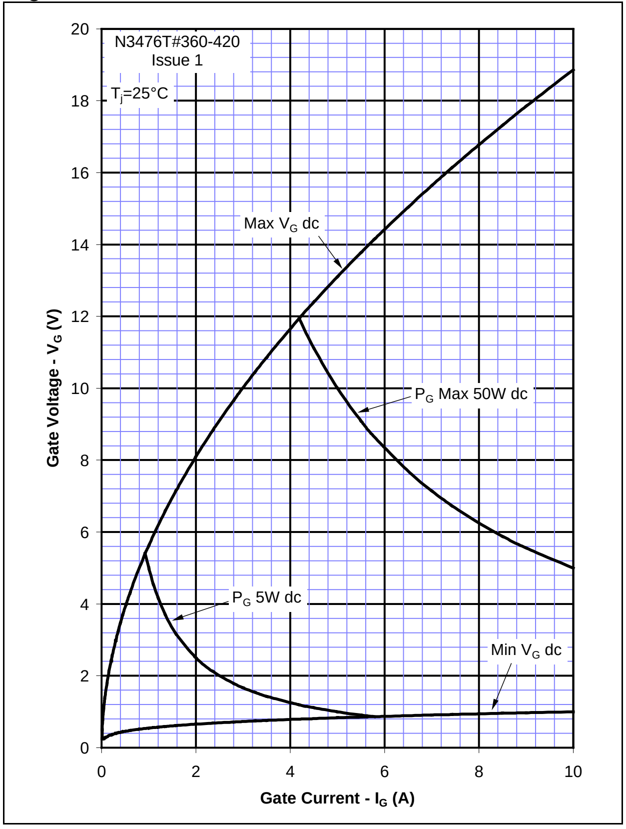


Figure 5 - Total recovered charge, Q_{rr}

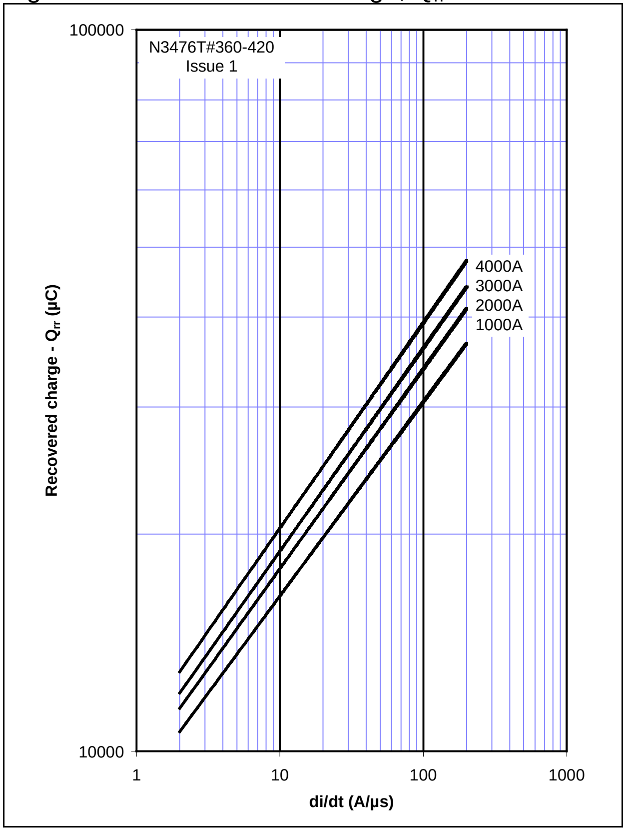


Figure 6 - Recovered charge, Q_{ra} (50% chord)

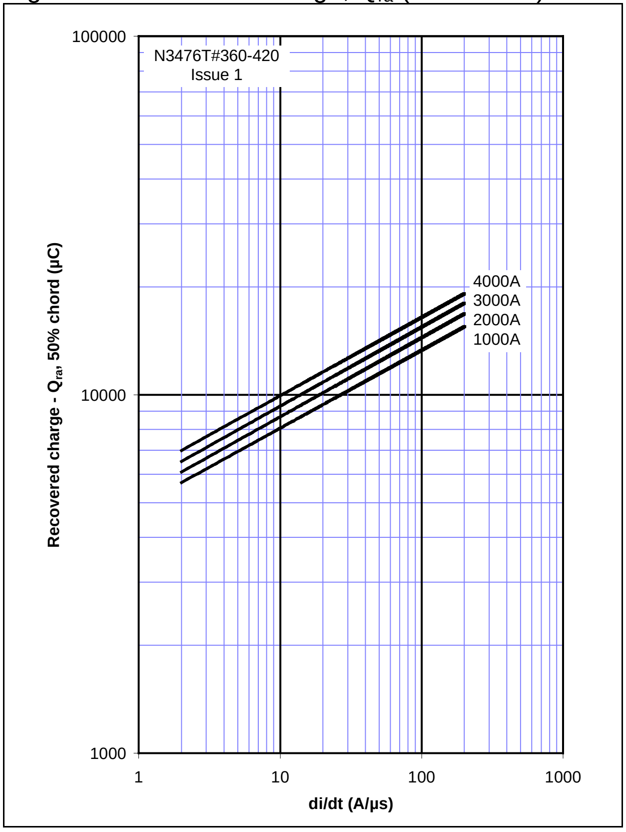


Figure 7 - Peak reverse recovery current, I_{rm}

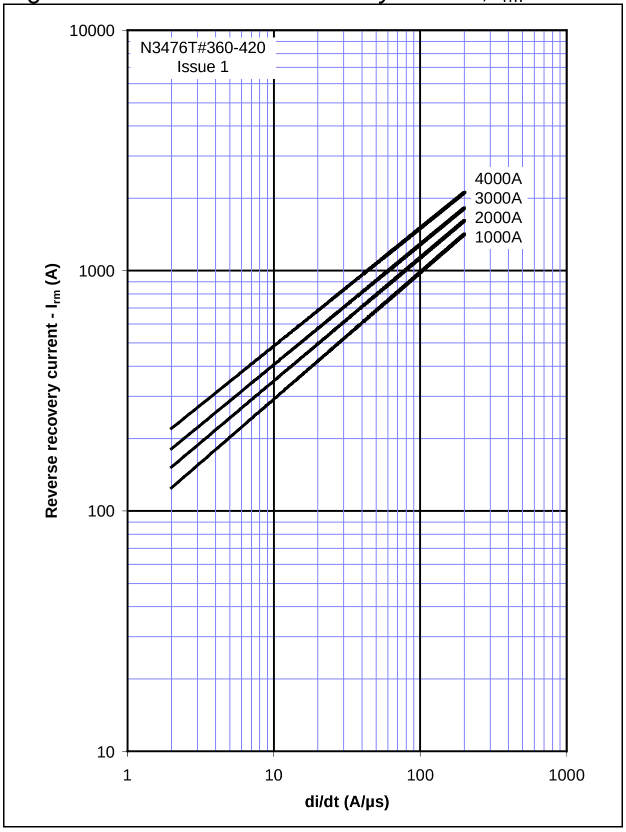


Figure 8 - Maximum recovery time, t_{rr} (50% chord)

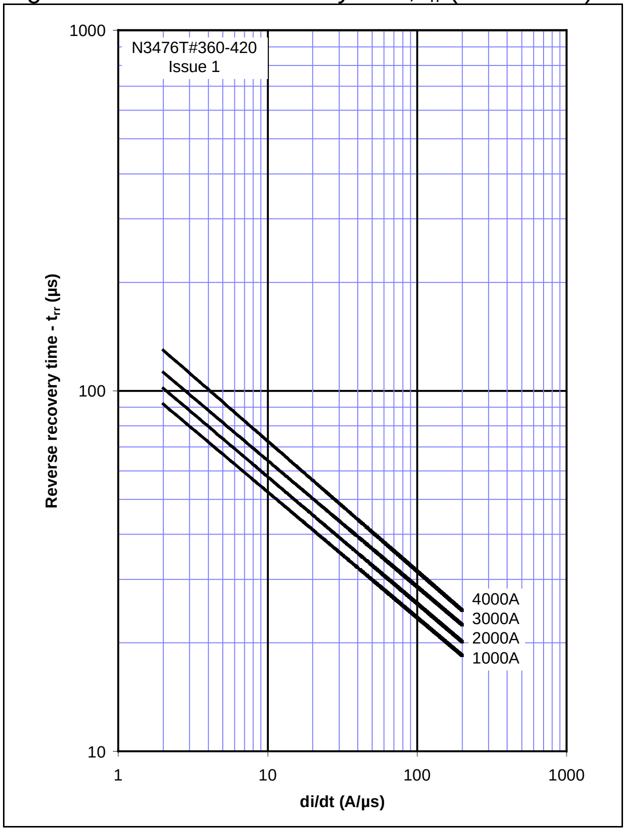


Figure 9 – On-state current vs. Power dissipation – Double Side Cooled (Sine wave)

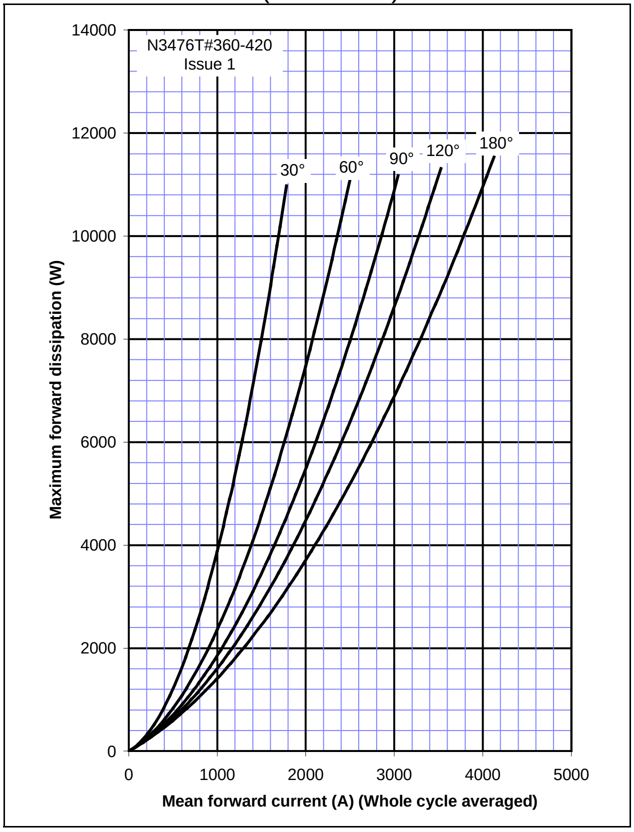


Figure 10 – On-state current vs. Heatsink temperature - Double Side Cooled (Sine wave)

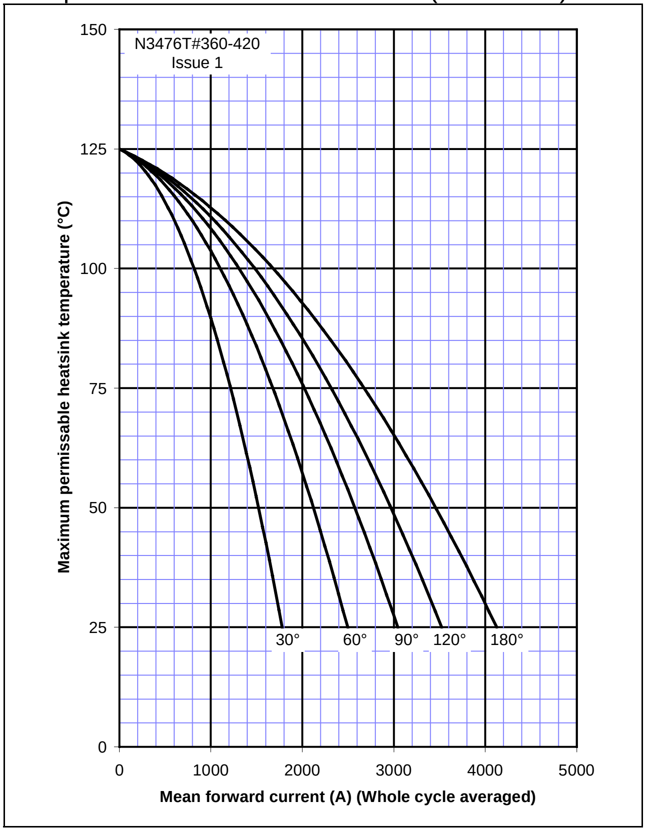


Figure 11 – On-state current vs. Power dissipation – Double Side Cooled (Square wave)

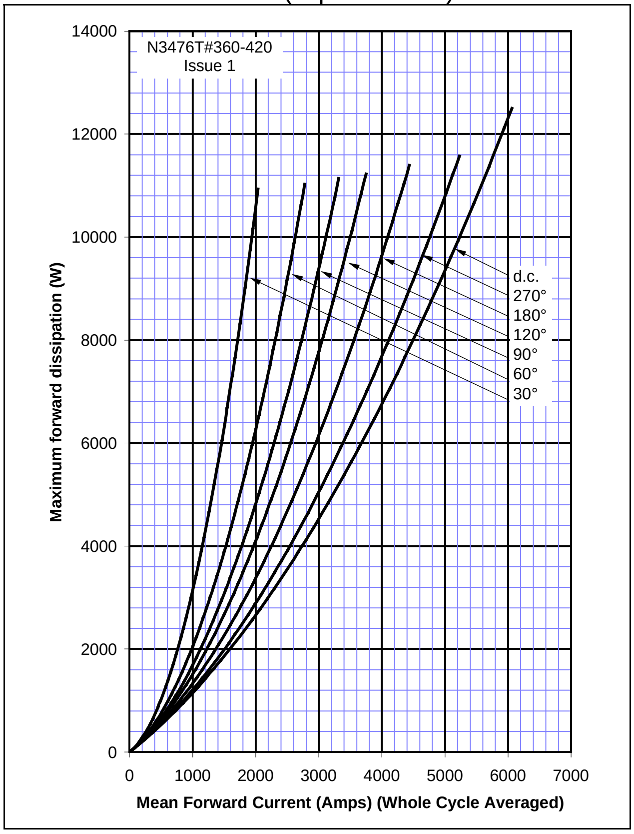


Figure 12 – On-state current vs. Heatsink temperature – Double Side Cooled (Square wave)

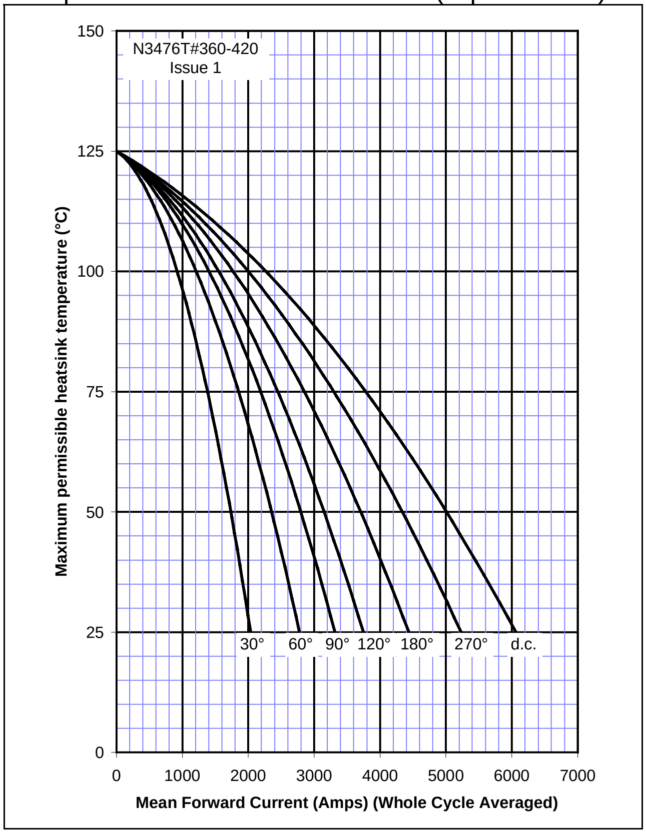


Figure 13 – On-state current vs. Power dissipation – Single Side Cooled (Sine wave)

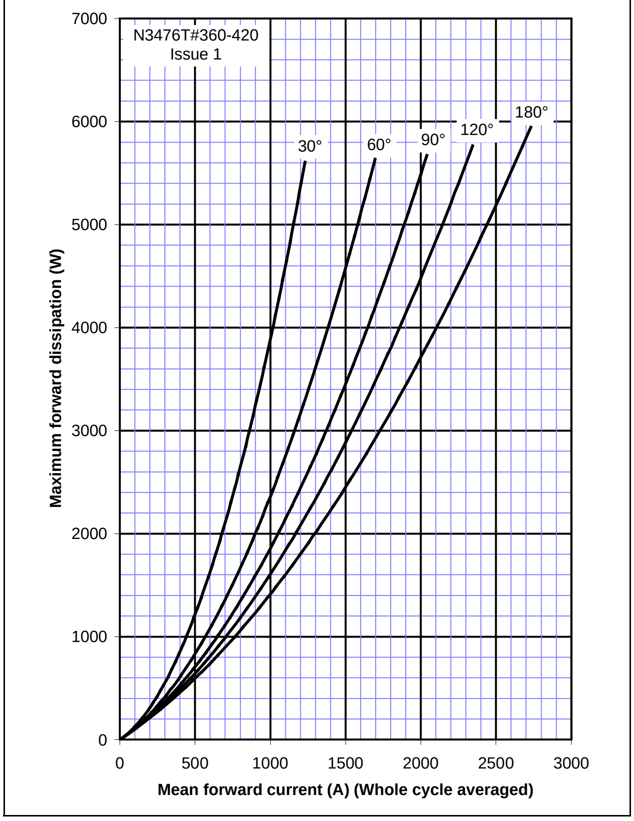


Figure 14 – On-state current vs. Heatsink temperature – Single Side Cooled (Sine wave)

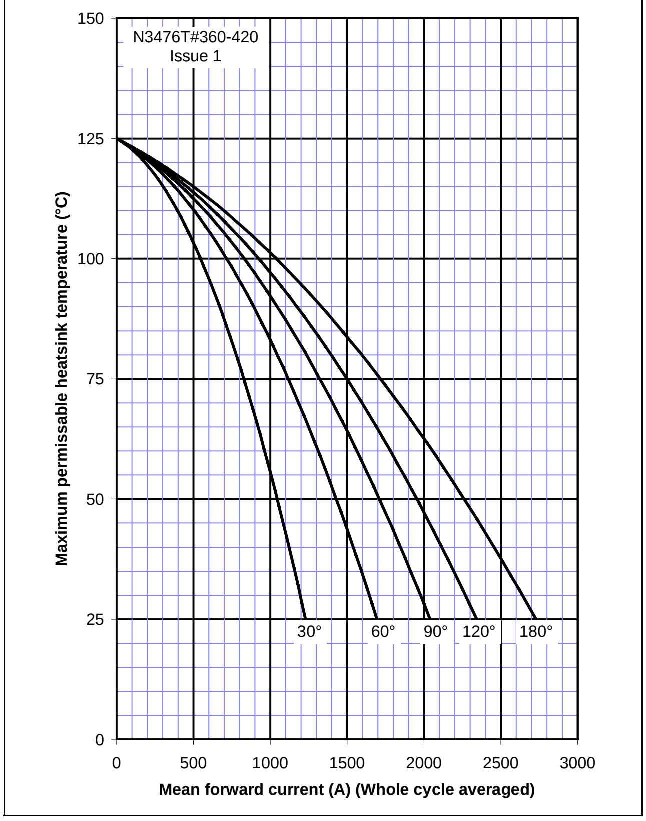


Figure 15 – On-state current vs. Power dissipation – Single Side Cooled (Square wave)

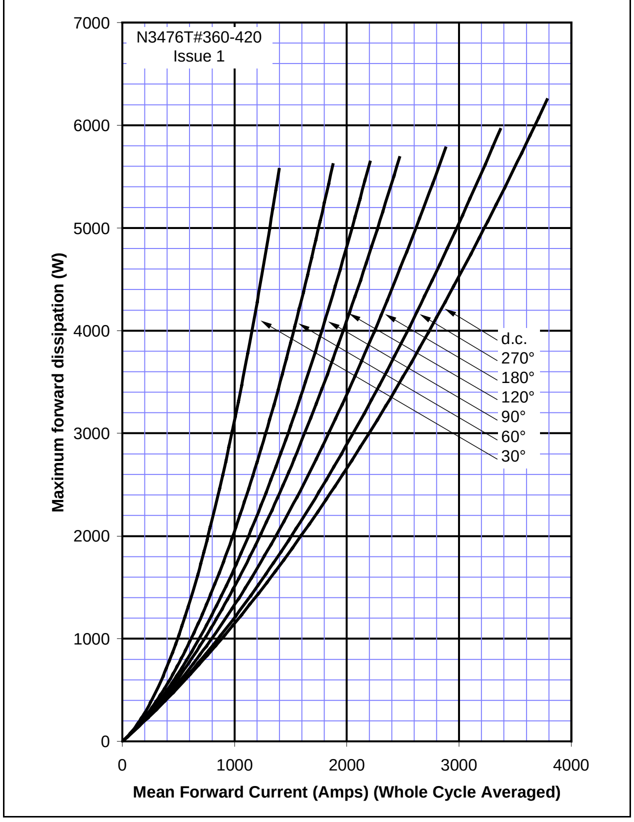


Figure 16 – On-state current vs. Heatsink temperature – Single Side Cooled (Square wave)

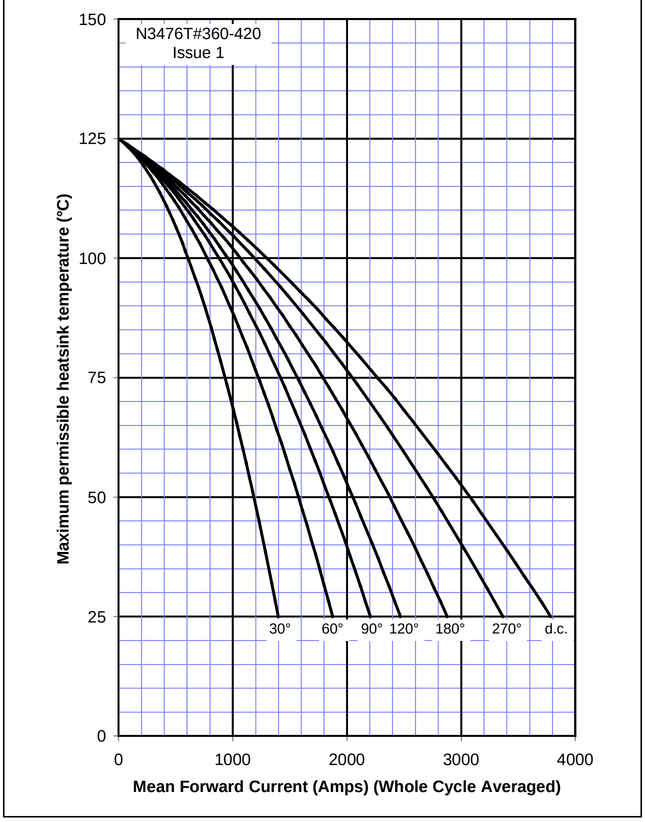
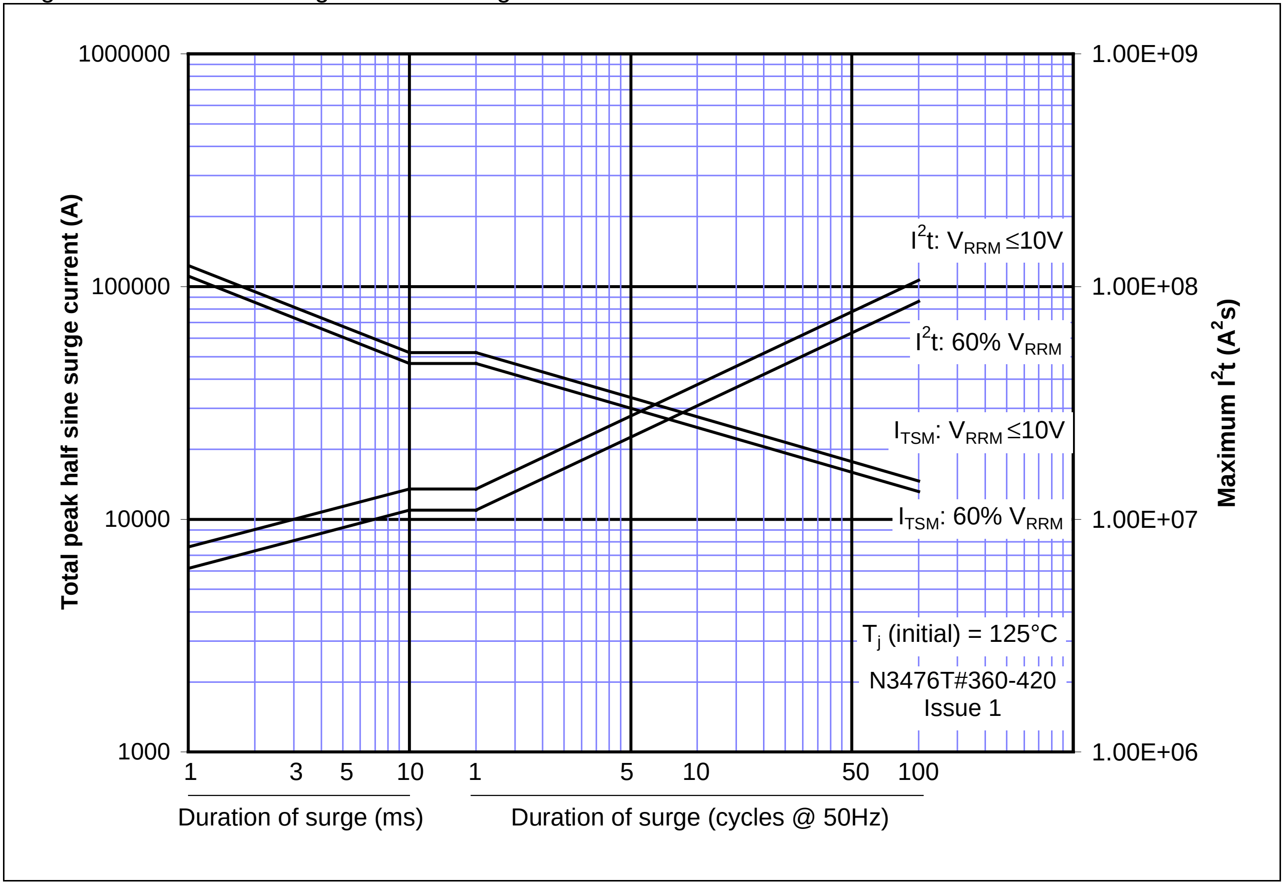
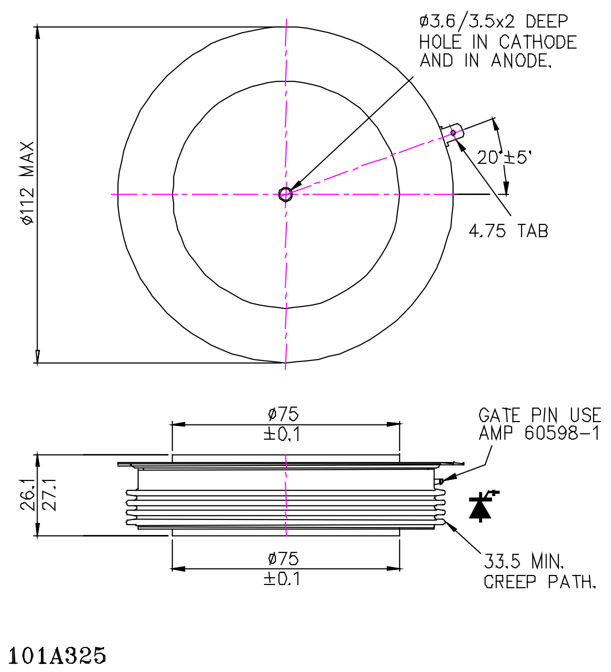


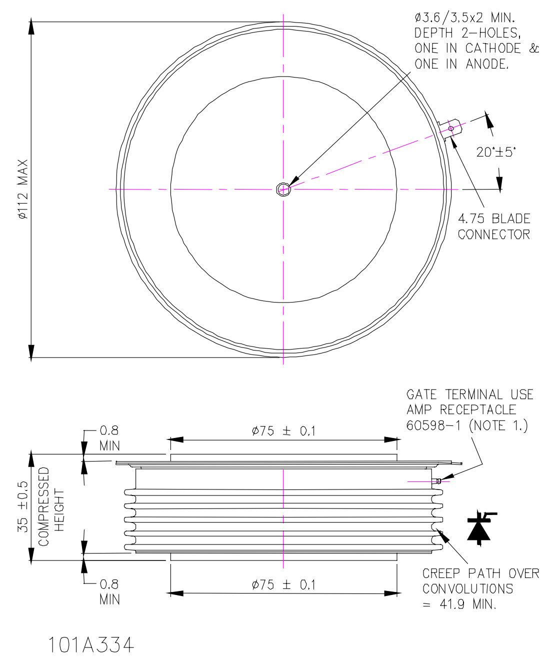
Figure 17 - Maximum surge and I^2t Ratings



Outline Drawing & Ordering Information



Outline options TC and TT



Outline options TD and TV

ORDERING INFORMATION	(Please quote 10 digit code as below)		
N3476	**♦♦**	**♦♦**	**0**
Fixed Type Code	Outline Code TC=26.1mm height, TT=26.1mm height, rupture rated TD=33.1mm height, TV=33.1mm height, rupture rated	Voltage code V_{DRM}/100 36-42	Fixed turn-off time code
Typical order code: N3476TD420 – 4200V V_{DRM}, V_{RRM}, 33.1mm clamp height.			

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