

Phase Control Thyristor Types N2046NS120 to N2046NS160

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V _{DRM}	Repetitive peak off-state voltage, (note 1)	1200-1600	V
V _{DSM}	Non-repetitive peak off-state voltage, (note 1)	1200-1600	V
V _{RRM}	Repetitive peak reverse voltage, (note 1)	1200-1600	V
V _{RSM}	Non-repetitive peak reverse voltage, (note 1)	1300-1700	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
I _{T(AV)}	Mean on-state current. T _{sink} =55°C, (note 2)	2046	A
I _{T(AV)}	Mean on-state current. T _{sink} =85°C, (note 2)	1338	A
I _{T(AV)}	Mean on-state current. T _{sink} =85°C, (note 3)	760	A
I _{T(RMS)}	Nominal RMS on-state current. T _{sink} =25°C, (note 2)	4141	A
I _{T(d.c.)}	D.C. on-state current. T _{sink} =25°C, (note 4)	3340	A
I _{TSM}	Peak non-repetitive surge t _p =10ms, V _{RM} =0.6V _{RRM} , (note 5)	29.2	kA
I _{TSM2}	Peak non-repetitive surge t _p =10ms, V _{RM} ≤10V, (note 5)	32.2	kA
I ² t	I ² t capacity for fusing t _p =10ms, V _{RM} =0.6V _{RRM} , (note 5)	4.26×10 ⁶	A ² s
I ² t	I ² t capacity for fusing t _p =10ms, V _{RM} ≤10V, (note 5)	5.18×10 ⁶	A ² s
di _T /dt	Maximum rate of rise of on-state current (repetitive), (Note 6)	150	A/μs
	Maximum 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	4	W
P _{GM}	Peak forward gate power	30	W
V _{GD}	Non-trigger gate voltage, (Note 7)	0.25	V
T _{HS}	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_{TM}=1500A, I_{FG}=2A, t_r≤0.5μs, T_{case}=125°C.
- 7) Rated V_{DRM}.

Characteristics

	PARAMETER	MIN.	TYP.	MAX.	TEST CONDITIONS (Note 1)	UNITS
V _{TM}	Maximum peak on-state voltage	-	-	1.27	I _{TM} =2550A	V
V ₀	Threshold voltage	-	-	0.98		V
r _s	Slope resistance	-	-	0.114		mΩ
dv/dt	Critical rate of rise of off-state voltage	1000	-	-	V _D =80% V _{DRM} , linear ramp	V/μs
I _{DRM}	Peak off-state current	-	-	100	Rated V _{DRM}	mA
I _{RDM}	Peak reverse current	-	-	100	Rated V _{RDM}	mA
V _{GT}	Gate trigger voltage	-	-	3.0	T _j =25°C, V _D =10V, I _T =2A	V
I _{GT}	Gate trigger current	-	-	300		mA
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	-	1.2	3.0		
Q _{rr}	Recovered Charge	-	-	2930		μC
Q _{ra}	Recovered Charge, 50% chord	-	-	1950		μC
I _{rm}	Reverse recovery current	-	-	165	I _{TM} =1000A, t _p =1ms, di/dt=10A/μs, V _r =50V	A
t _{rr}	Reverse recovery time, 50% chord	-	-	19		μs
t _q	Turn-off time	-	-	250	I _{TM} =1000A, t _p =1ms, di/dt=10A/μs, V _r =50V, V _{dr} =80%V _{DRM} , dV _{dr} /dt=20V/μs	μs
		-	-	350	I _{TM} =1000A, t _p =1ms, di/dt=10A/μs, V _r =50V, V _{dr} =80%V _{DRM} , dV _{dr} /dt=200V/μs	
R _{th(j-hs)}	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	-	510	-		g

Notes: -

1) Unless otherwise indicated T_j=125°C.

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
12	1200	1300	810
14	1400	1500	930
16	1600	1700	1040

2.0 Extension of Voltage Grades

This report is applicable to other and higher 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 Computer Modelling Parameters

5.1 Device Dissipation Calculations

$$I_{AV} = \frac{-V_0 + \sqrt{V_0^2 + 4 \cdot ff^2 \cdot r_s \cdot W_{AV}}}{2 \cdot ff^2 \cdot r_s} \quad \text{and:} \quad W_{AV} = \frac{\Delta T}{R_{th}}$$

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

Where $V_0=0.98V$, $r_s=0.114m\Omega$,

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

ff = Form factor, see table below.

Supplementary Thermal Impedance							
Conduction Angle	30°	60°	90°	120°	180°	270°	d.c.
Square wave Double Side Cooled	0.0312	0.0285	0.0267	0.0255	0.0240	0.0228	0.0220
Square wave Single Side Cooled	0.0543	0.0513	0.0496	0.0484	0.0469	0.0455	0.0440
Sine wave Double Side Cooled	0.0286	0.0276	0.0269	0.0263	0.022		
Sine wave Single Side Cooled	0.0509	0.0482	0.0471	0.0463	0.044		

Form Factors							
Conduction Angle	30°	60°	90°	120°	180°	270°	d.c.
Square wave	3.464	2.449	2	1.732	1.414	1.149	1
Sine wave	3.98	2.778	2.22	1.879	1.57		

5.2 Calculating V_T using ABCD Coefficients

The on-state characteristic I_T vs. V_T , on page 7 is represented in two ways;

- (i) the well established V_o and r_s 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	0.9954351	A	0.696021633
B	-0.01263431	B	0.02945267
C	6.61716×10^{-5}	C	9.57308×10^{-5}
D	1.957375×10^{-3}	D	1.957375×10^{-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.
- τ_p = Time Constant of r_{th} term.

D.C. Double Side Cooled				
Term	1	2	3	4
r_p	0.01259616	6.104048×10^{-3}	1.892873×10^{-3}	1.36883×10^{-3}
τ_p	0.9703361	0.1463832	0.02065504	2.03018×10^{-3}

D.C. Single Side Cooled					
Term	1	2	3	4	5
r_p	0.02920339	4.632284×10^{-3}	8.442641×10^{-3}	1.88397×10^{-3}	4.92672×10^{-4}
τ_p	5.887762	1.311024	0.1602293	4.93716×10^{-3}	9.83965×10^{-4}

Curves

Figure 1 – On-state characteristics of Limit device

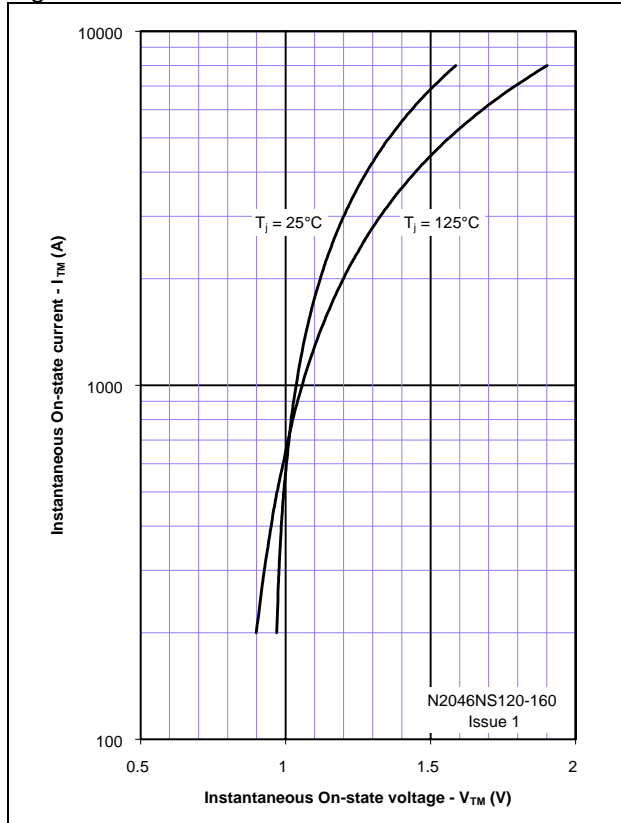


Figure 2 - Transient Thermal Impedance

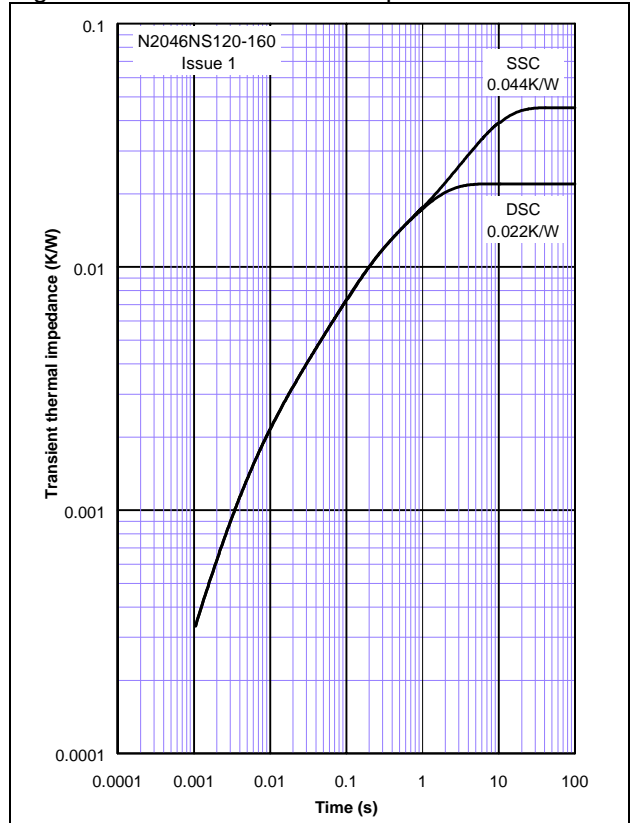


Figure 3 – Gate Characteristics - Trigger Limits

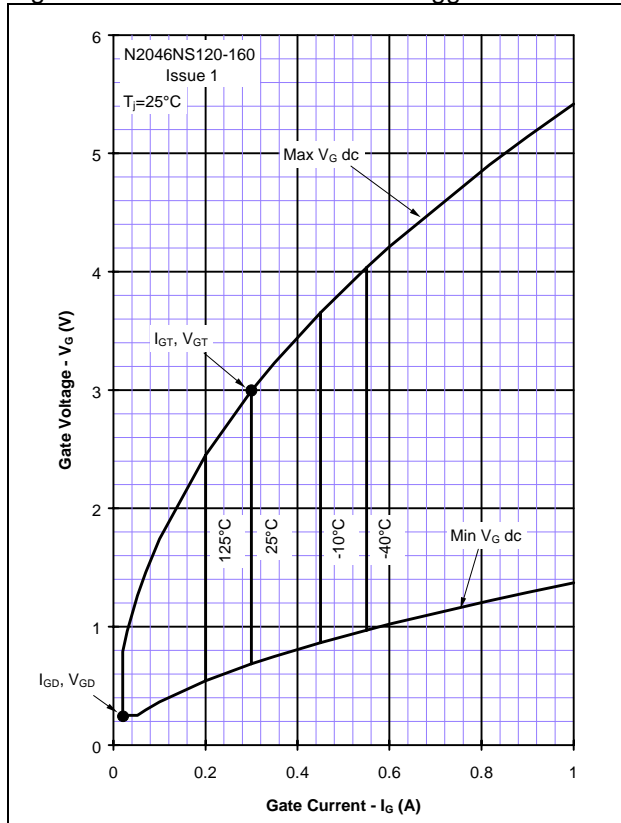


Figure 4 - Gate Characteristics - Power Curves

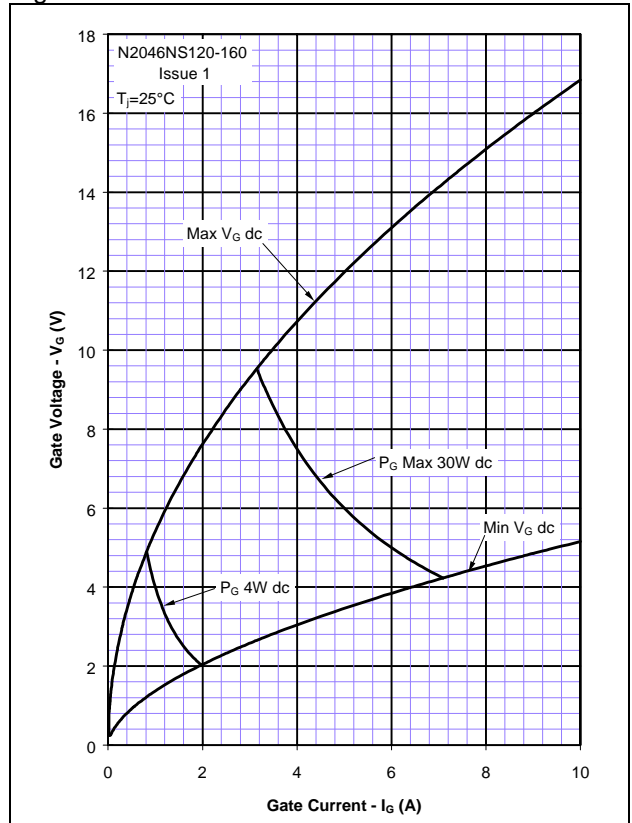


Figure 5 – Recovered Charge, Q_{rr}

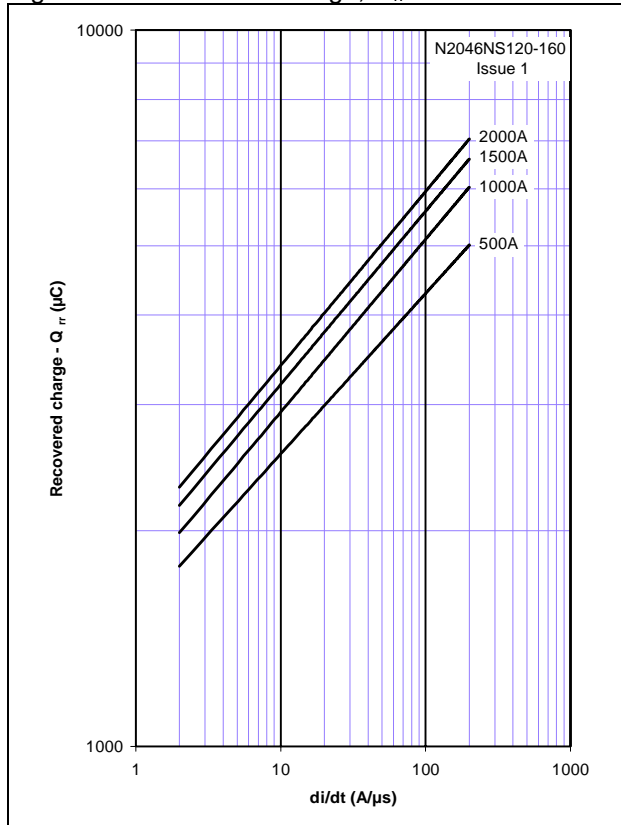


Figure 6 – Recovered charge, Q_{ra} (50% chord)

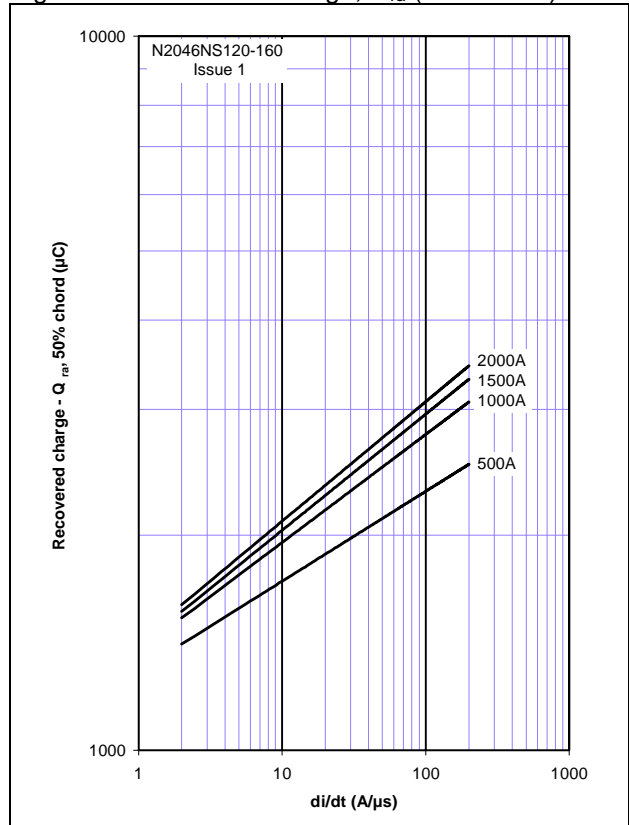


Figure 7 – Reverse recovery current, I_{rm}

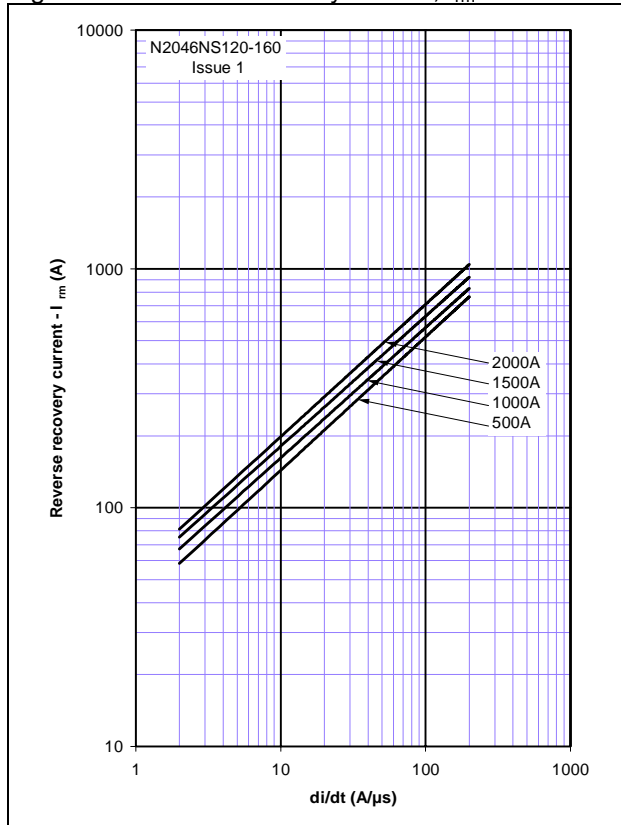


Figure 8 – Reverse recovery time, t_{rr}

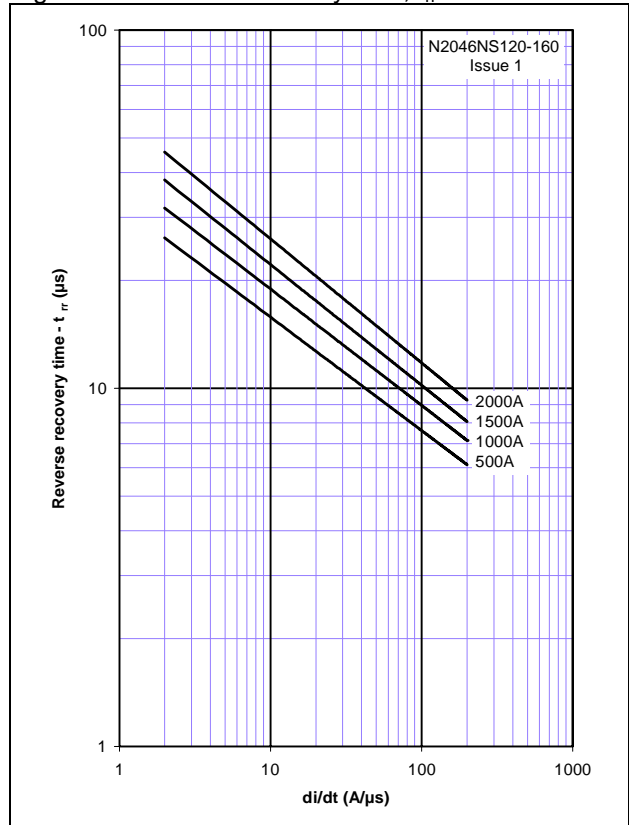


Figure 9 – On-state current vs. Power dissipation – Double Side Cooled (Sine wave)

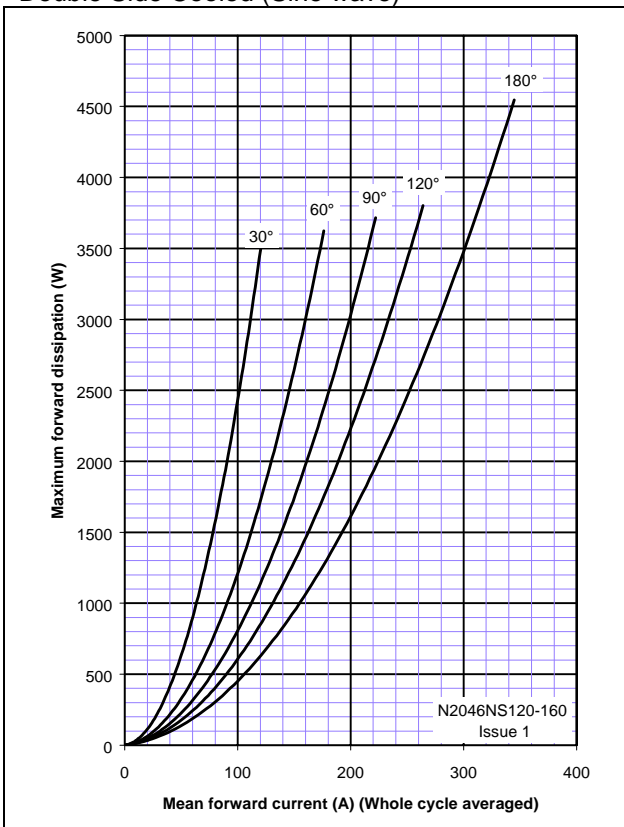


Figure 10 – On-state current vs. Heatsink temperature - Double Side Cooled (Sine wave)

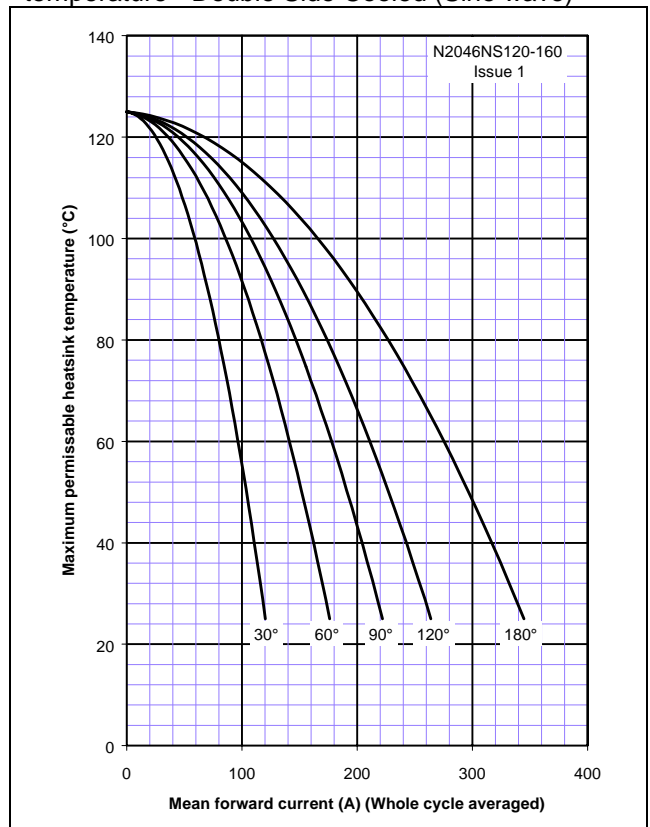


Figure 11 – On-state current vs. Power dissipation – Double Side Cooled (Square wave)

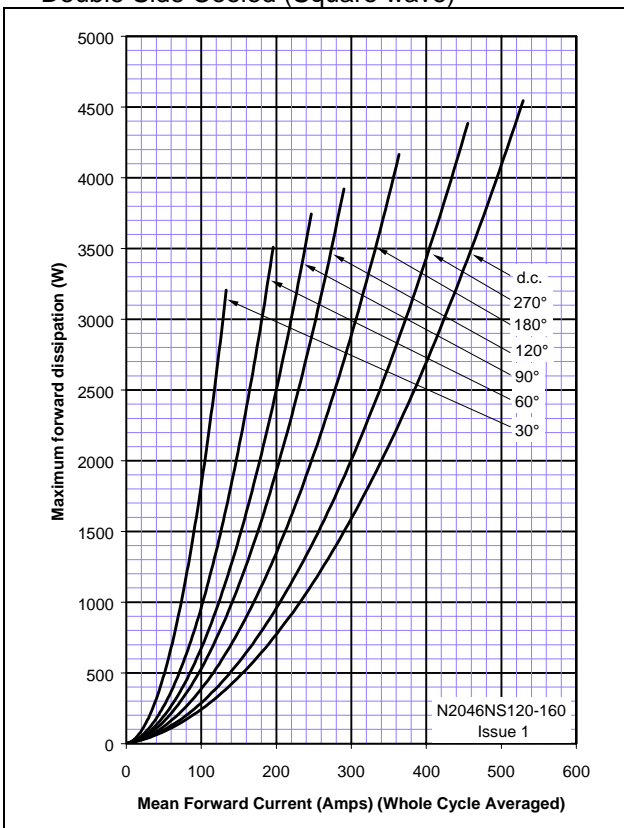


Figure 12 – On-state current vs. Heatsink temperature – Double Side Cooled (Square wave)

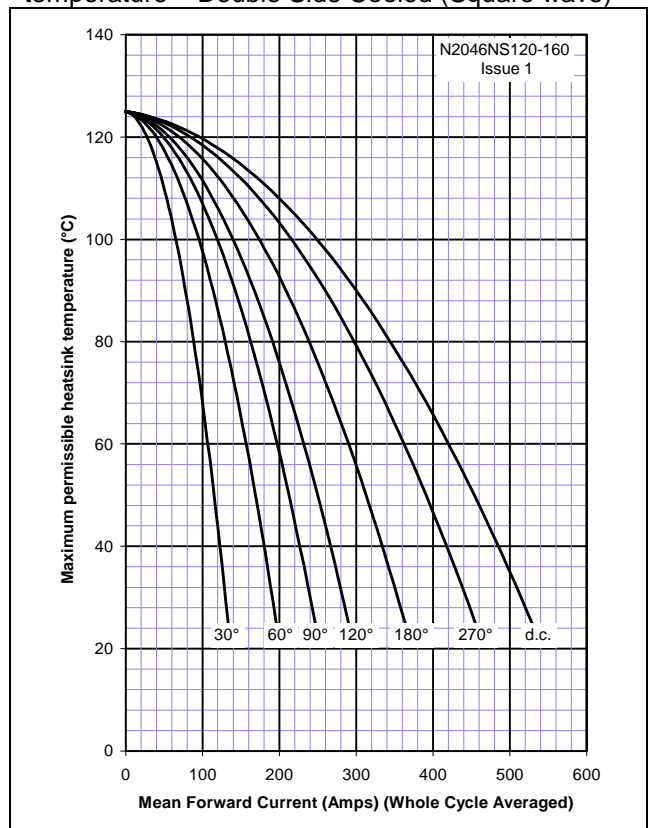


Figure 13 – On-state current vs. Power dissipation – Single Side Cooled (Sine wave)

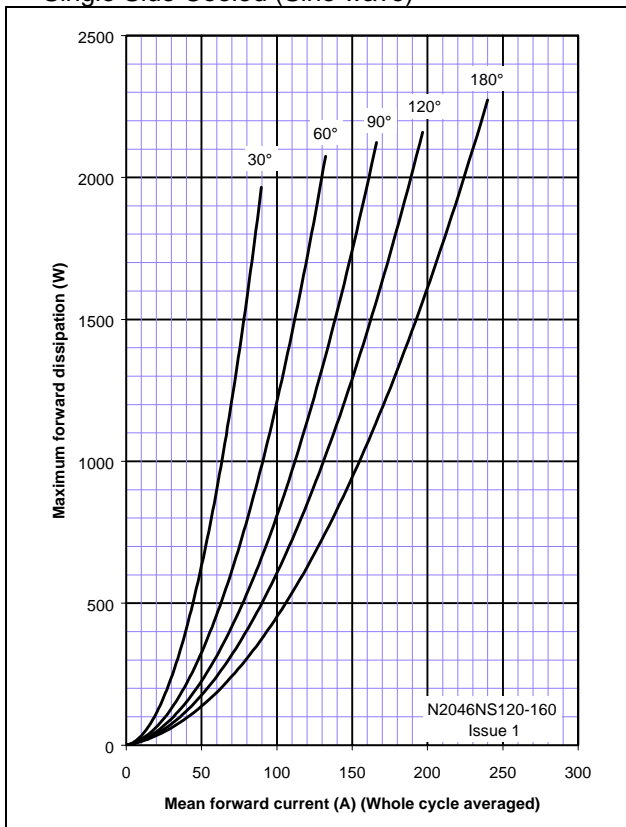


Figure 14 – On-state current vs. Heatsink temperature – Single Side Cooled (Sine wave)

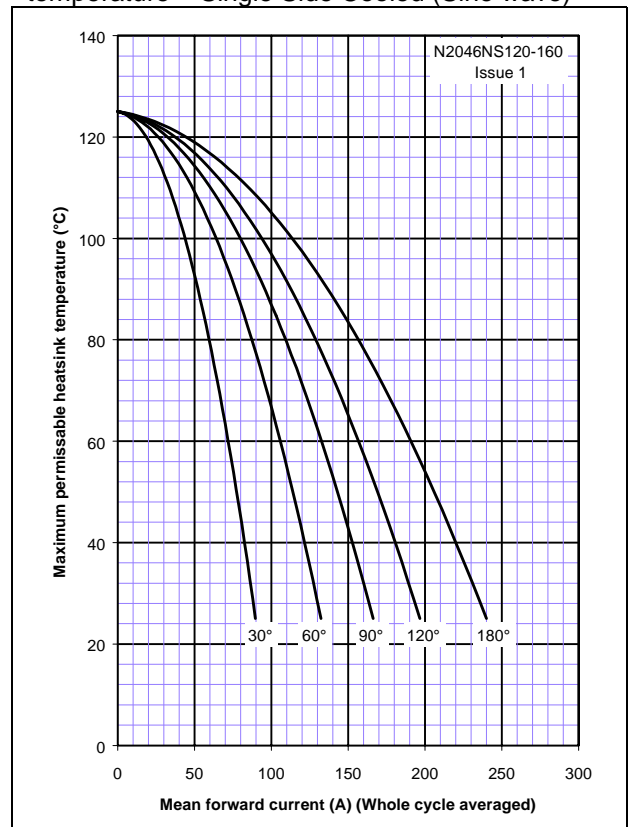


Figure 15 – On-state current vs. Power dissipation – Single Side Cooled (Square wave)

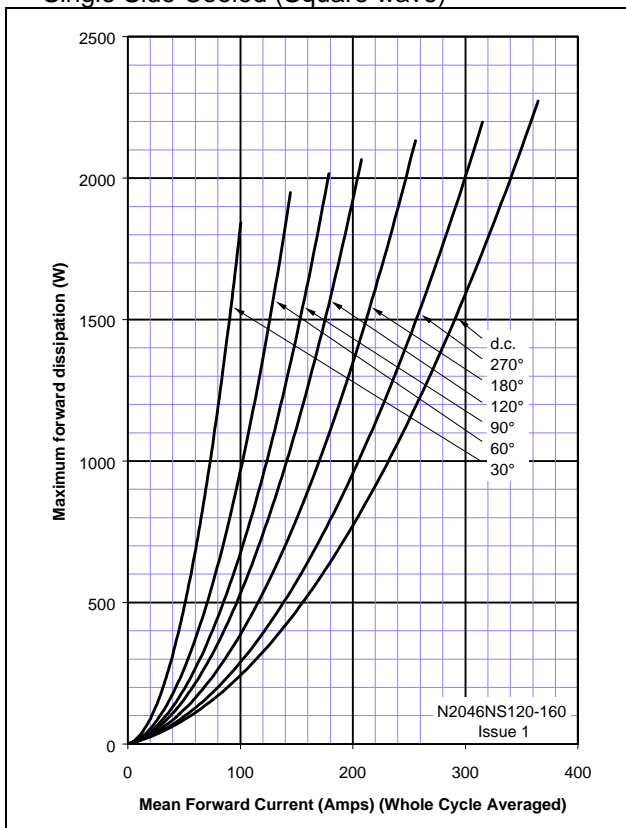


Figure 16 – On-state current vs. Heatsink temperature – Single Side Cooled (Square wave)

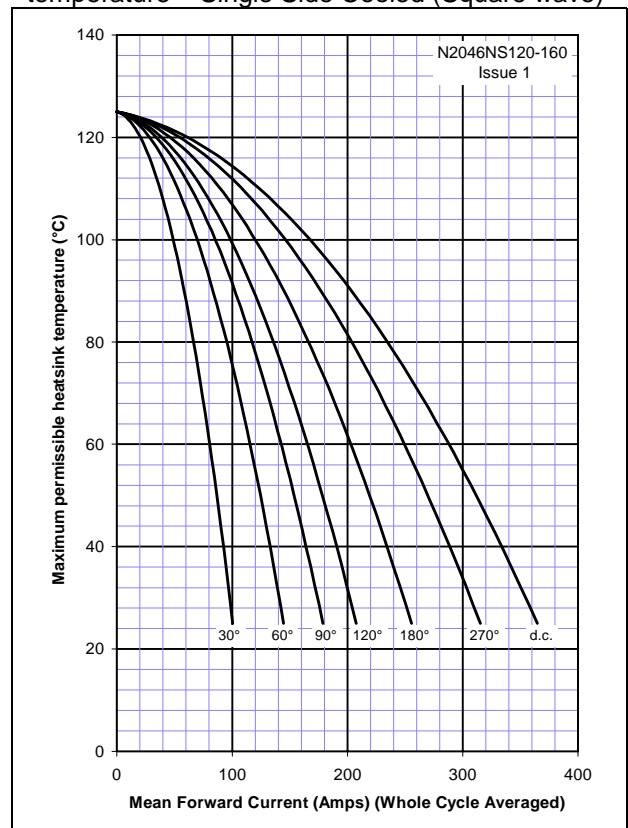
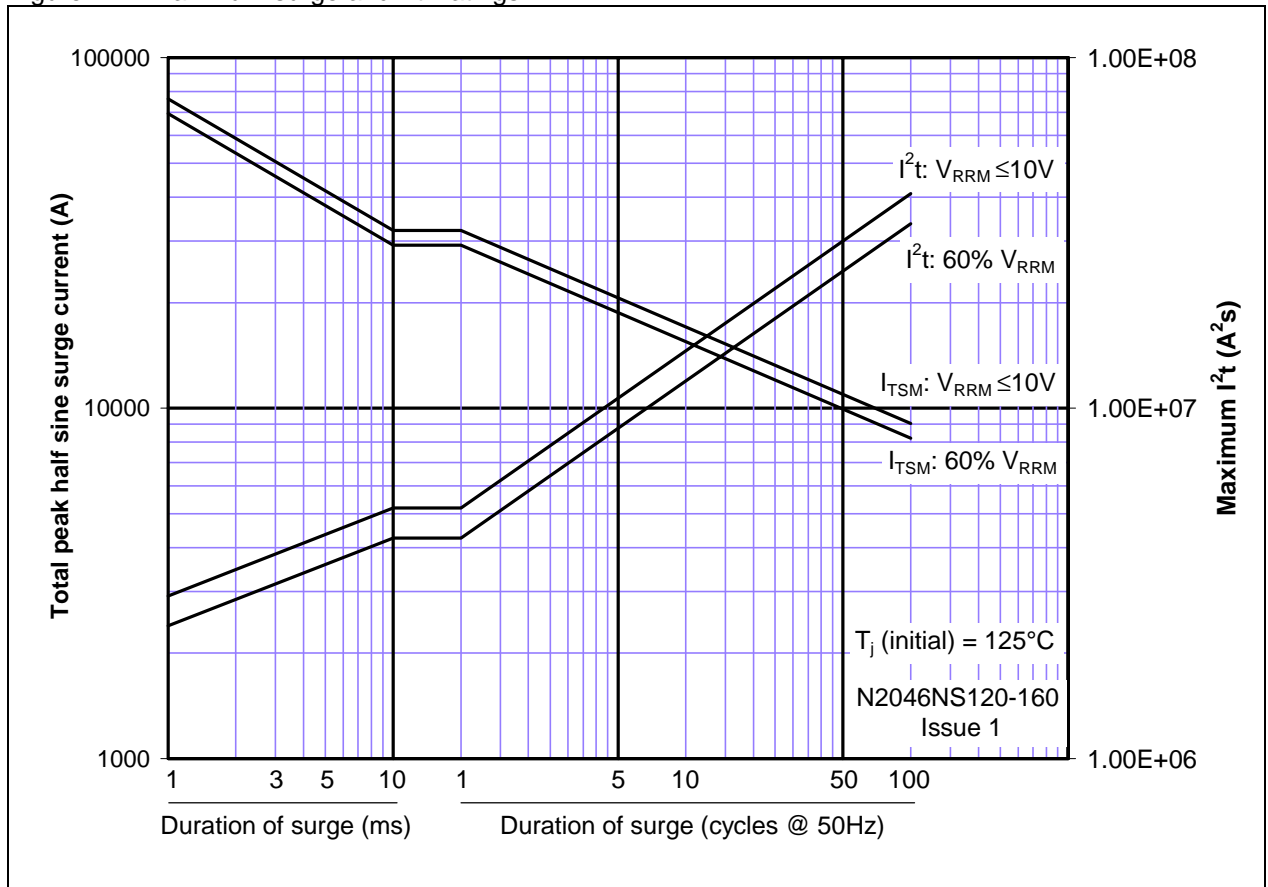
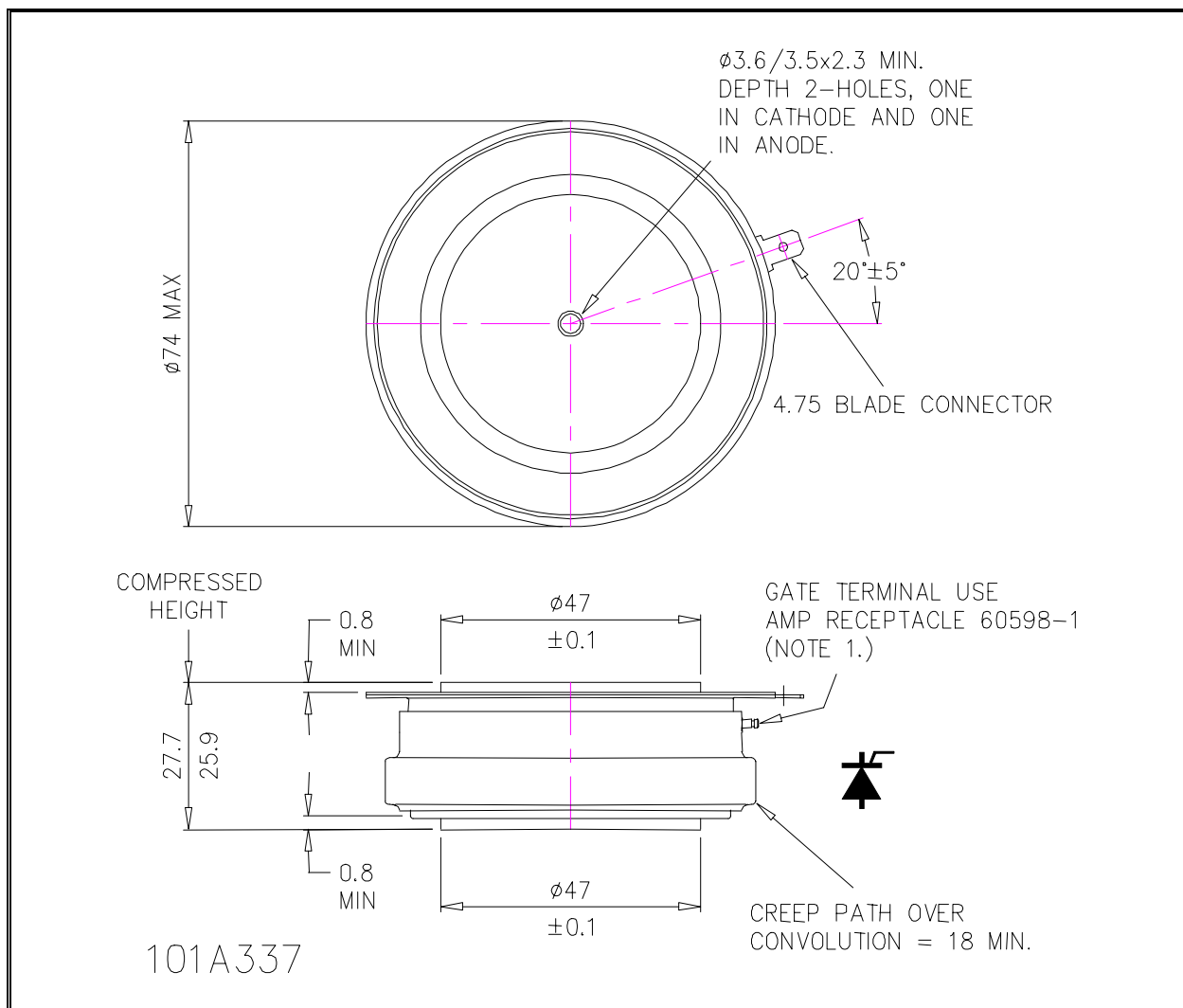


Figure 17 – Maximum surge and I^2t Ratings



Outline Drawing & Ordering Information



ORDERING INFORMATION		(Please quote 10 digit code as below)	
N2046	NS	◆◆	0
Fixed Type Code	Fixed Outline Code	Voltage Code 12-16	Fixed turn-off time code

Typical order code: N2046NS120 – 1200V V_{DRM} , V_{RRM} , 27mm clamp height capsule.

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