WESTCODE

Date:- 21 Jun, 2019

Data Sheet Issue:- 1

Phase Control Thyristor

Types N1661VC300 to N1661VC360

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{DRM}	Repetitive peak off-state voltage, (note 1)	3000-3600	V
V_{DSM}	Non-repetitive peak off-state voltage, (note 1)	3000-3600	V
V_{RRM}	Repetitive peak reverse voltage, (note 1)	3000-3600	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	3100-3700	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{T(AV)}$	Mean on-state current. T_{sink}=55°C, (note 2)	1661	A
$I_{T(AV)}$	Mean on-state current. T_{sink}=85°C, (note 2)	1154	A
$I_{T(AV)}$	Mean on-state current. T_{sink}=85°C, (note 3)	710	A
$I_{T(RMS)}$	Nominal RMS on-state current. T_{sink}=25°C, (note 2)	3259	A
$I_{T(d.c.)}$	D.C. on-state current. T_{sink}=25°C, (note 4)	2875	A
I_{TSM}	Peak non-repetitive surge t_p=10ms, V_{rm}=0.6V_{RRM}, (note 5)	23000	A
I_{TSM2}	Peak non-repetitive surge t_p=10ms, V_{rm}≤10V, (note 5)	25000	A
I^2t	I^2t capacity for fusing t_p=10ms, V_{rm}=0.6V_{RRM}, (note 5)	2.65×10^6	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, V_{rm}≤10V, (note 5)	3.13×10^6	A^2s
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) A 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}=2000A, 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	-	-	2.17	I_{TM}=3220A	V
V_0	Threshold voltage	-	-	1.04		V
r_S	Slope resistance	-	-	0.35		mΩ
dv/dt	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	-	-	150	Rated V_{DRM}	mA
I_{RRM}	Peak reverse current	-	-	150	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
I_H	Holding current	-	-	1000	T_j=25°C	mA
t_{gd}	Gate controlled turn-on delay time	-	0.5	1.0	V_D=67%V_{DRM}, I_{TM}=1000A, di/dt=10A/µs, I_{FG}=2A, t_r=0.5µs, T_j=25°C	µs
t_{gt}	Turn-on time	-	1.0	2.0		
Q_{rr}	Recovered Charge	-	5200	-	I_{TM}=1000A, t_p=1000µs, di/dt=10A/µs, V_r=50V	µC
Q_{ra}	Recovered Charge, 50% chord	-	2500	3200		µC
I_{rm}	Reverse recovery current	-	150	-		A
t_{rr}	Reverse recovery time, 50% chord	-	34	-		µs
t_q	Turn-off time	-	400	-	I_{TM}=1000A, t_p=1000µs, di/dt=10A/µs, V_r=50V, V_{dr}=80%V_{DRM}, dV_{dr}/dt=20V/µs	µs
		-	550	-	I_{TM}=1000A, t_p=1000µs, 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	-	-	0.017	Double side cooled	K/W
		-	-	0.034	Single side cooled	K/W
F	Mounting force	27	-	34		kN
W_t	Weight	-	1.0	-		kg

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
30	3000	3100	1750
32	3200	3300	1850
34	3400	3500	1950
36	3600	3700	2050

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 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.

6.0 Gate Drive
The recommended pulse gate drive is 30V, 15Ω with a short-circuit current rise time of not more than 0.5µs. This gate drive must be applied when using the full di/dt capability of the device.

The pulse duration may need to be configured according to the application but should be no shorter than 20µs, otherwise an increase in pulse current may be needed to supply the necessary charge to trigger.

7.0 Computer Modelling Parameters

7.1 Device Dissipation Calculations

$$I_{AV} = \frac{-V_0 + \sqrt{V_0^{\,2} + 4 \cdot ff \cdot r_s \cdot W_{AV}}}{2 \cdot ff \cdot r_s}$$

and:

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

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

Where V_0=1.04V, r_s=0.35mΩ,

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	0.027	0.0237	0.0218	0.0206	0.0192	0.0179	0.017
Square wave Single Side Cooled	0.0464	0.0428	0.0408	0.0395	0.038	0.0368	0.034
Sine wave Double Side Cooled	0.0233	0.0203	0.0191	0.0183	0.0177		
Sine wave Single Side Cooled	0.042	0.039	0.0377	0.037	0.0355		

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		

7.2 Calculating V_T using ABCD Coefficients

The on-state characteristic I_T vs. V_T, on page 5 is represented in two ways;

(i) the well established V_0 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 hot characteristics. The resulting values for V_T agree with the true device characteristic over a current range, which is limited to that plotted.

125°C Coefficients	
A	0.52543481
B	0.07119313
C	3.019143×10^{-4}
D	1.715824×10^{-3}

7.3 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	5
r_p	8.74×10^{-3}	4.03×10^{-3}	2.09×10^{-3}	1.38×10^{-3}	9.81×10^{-4}
τ_p	1.328	0.182	0.0601	8.05×10^{-3}	1.31×10^{-3}

D.C. Single Side Cooled					
Term	1	2	3	4	5
r_p	0.0204	5.29×10^{-3}	7.04×10^{-3}	2.2×10^{-3}	1.11×10^{-3}
τ_p	9.876	4.968	0.258	0.0137	1.33×10^{-3}

8.0 Reverse recovery ratings

(i) Q_{ra} is based on 50% I_{rm} chord as shown in 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) $$K\ Factor = \frac{t1}{t2}$$

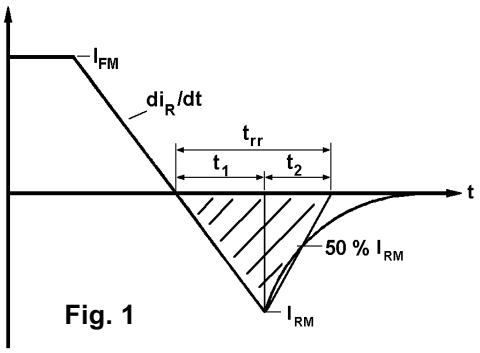


Fig. 1

Curves

Figure 1 - On-state characteristics of Limit device

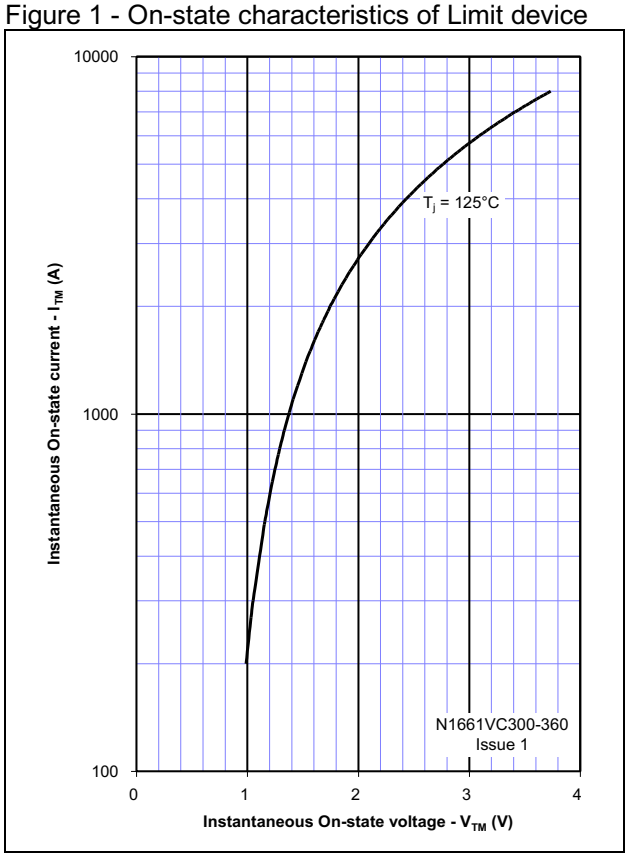


Figure 2 - Transient Thermal Impedance

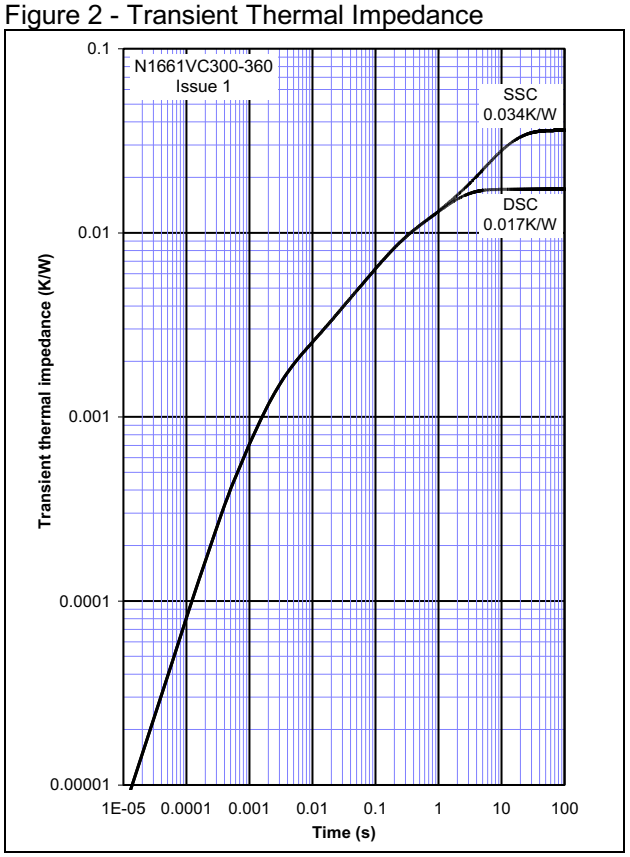


Figure 3 - Gate Characteristics - Trigger Limits

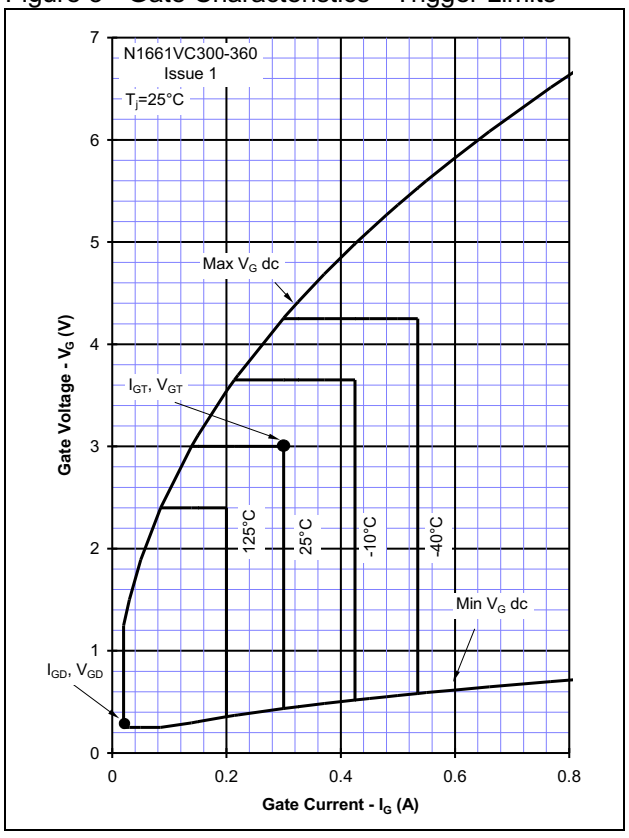


Figure 4 - Gate Characteristics - Power Curves

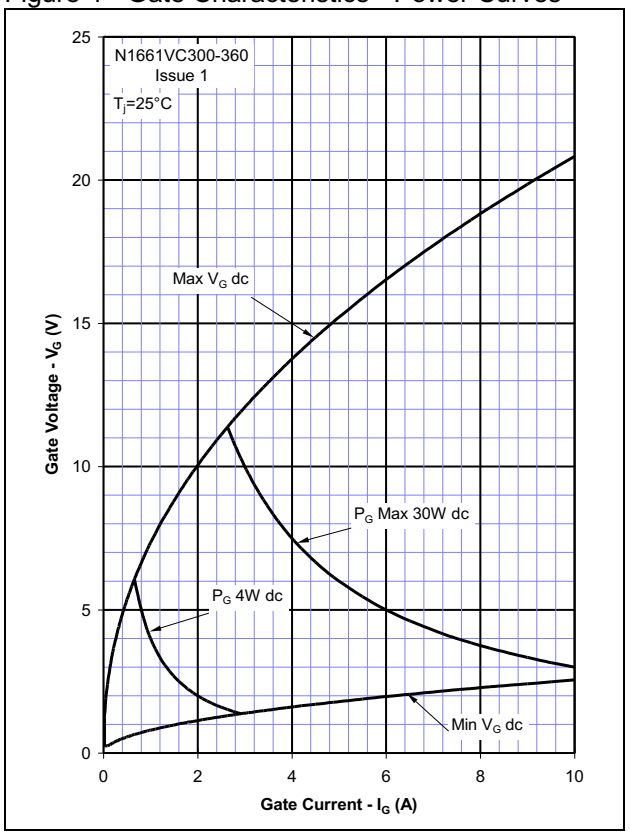


Figure 5 – Recovered Charge, Q_{rr}

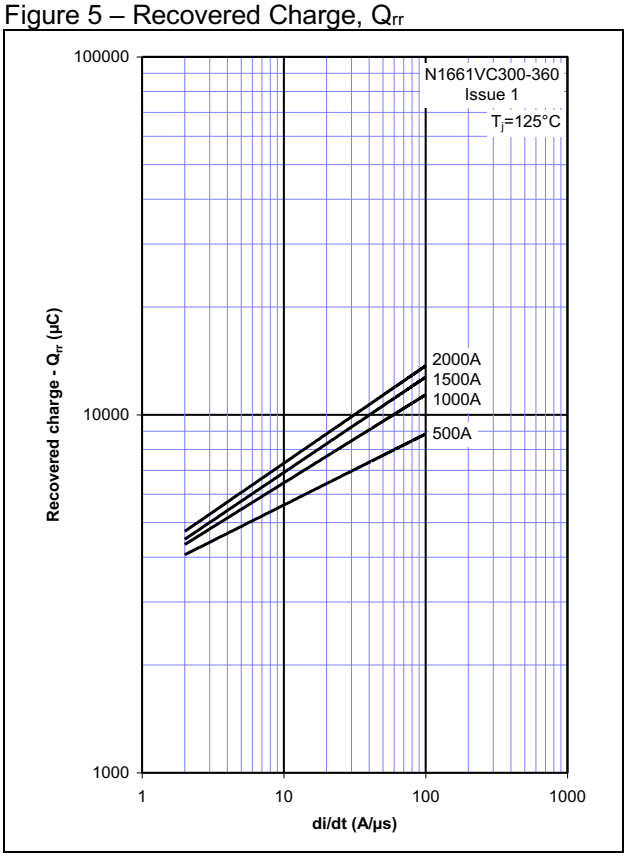


Figure 6 – Recovered charge, Q_{ra} (50% chord)

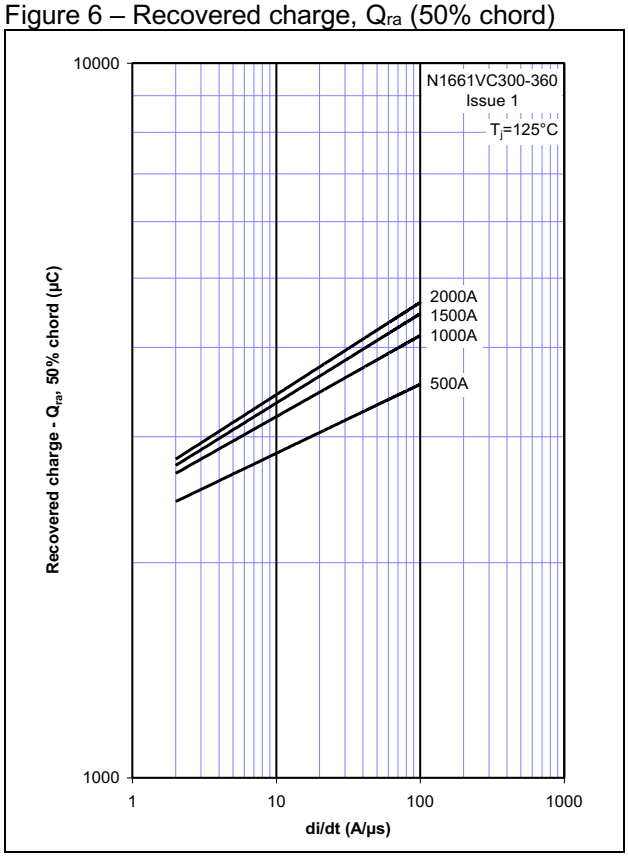


Figure 7 – Reverse recovery current, I_{rm}

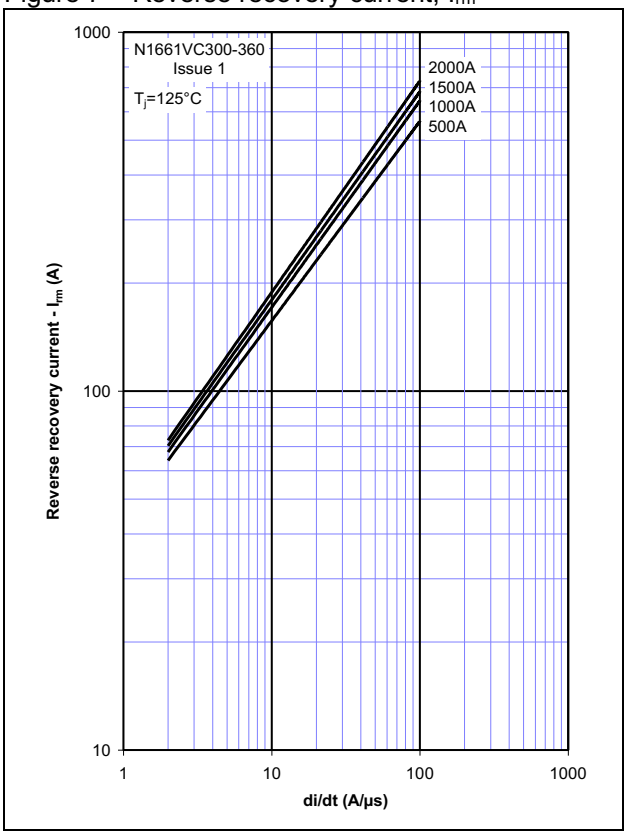


Figure 8 – Reverse recovery time, t_{rr} (50% chord)

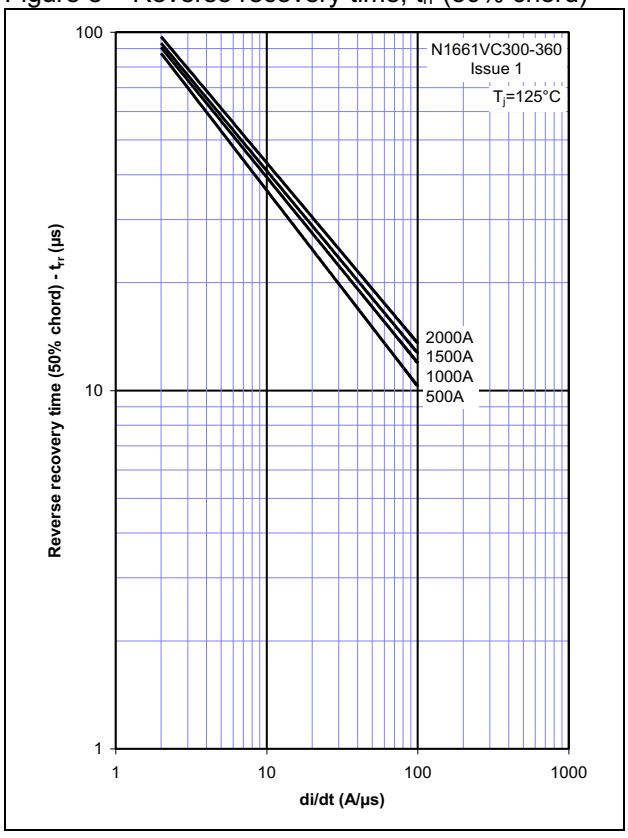


Figure 9 – On-state current vs. Power dissipation – Double Side Cooled (Sine wave)

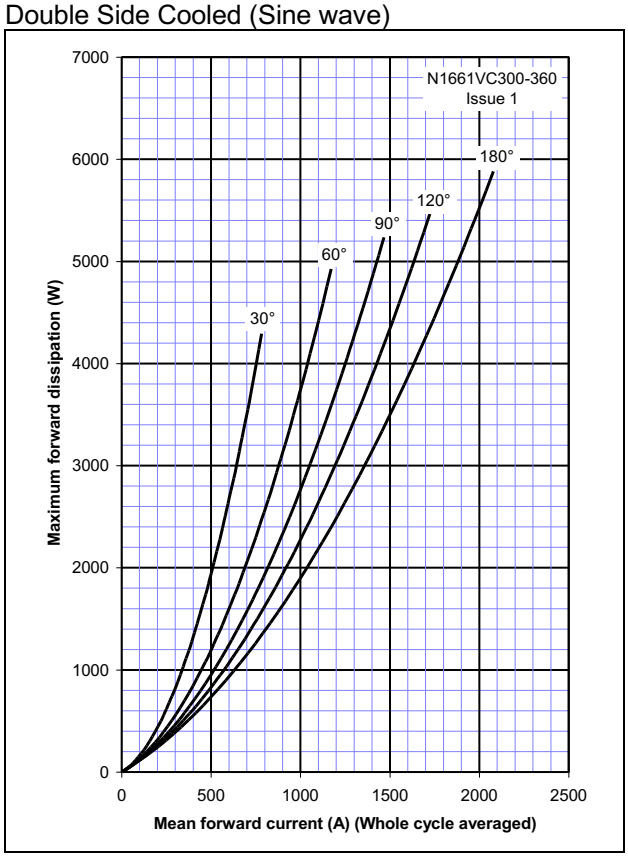


Figure 10 – On-state current vs. Heatsink temperature - Double Side Cooled (Sine wave)

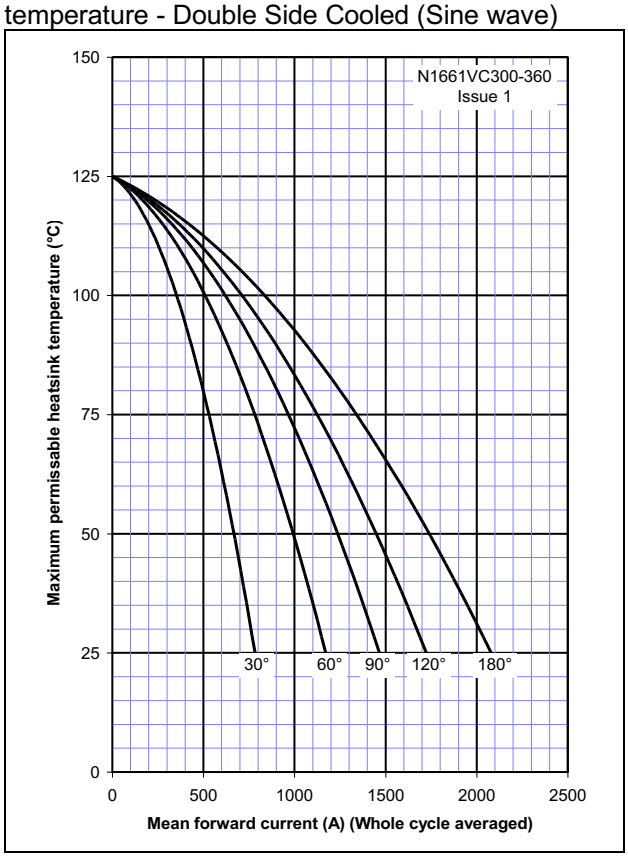


Figure 11 – On-state current vs. Power dissipation – Double Side Cooled (Square wave)

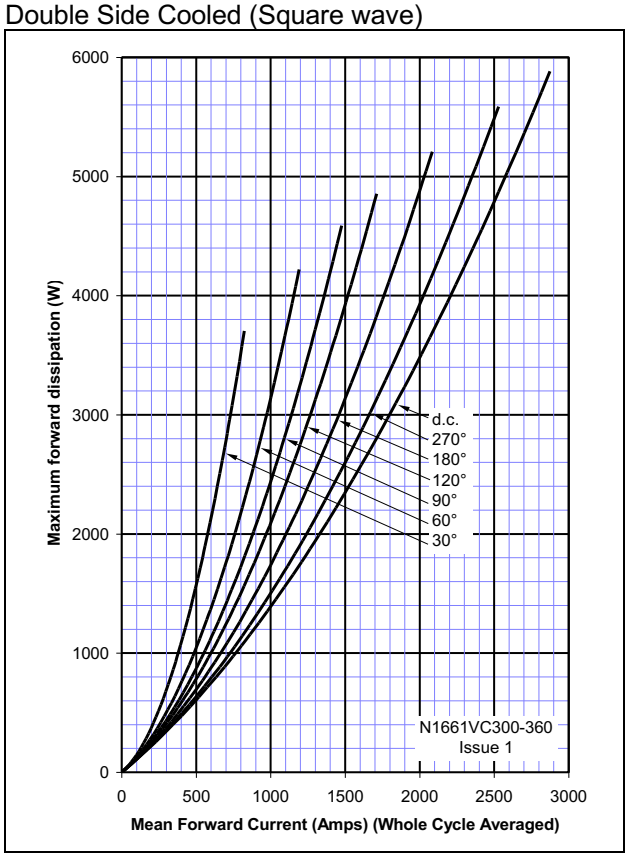


Figure 12 – On-state current vs. Heatsink temperature - Double Side Cooled (Square wave)

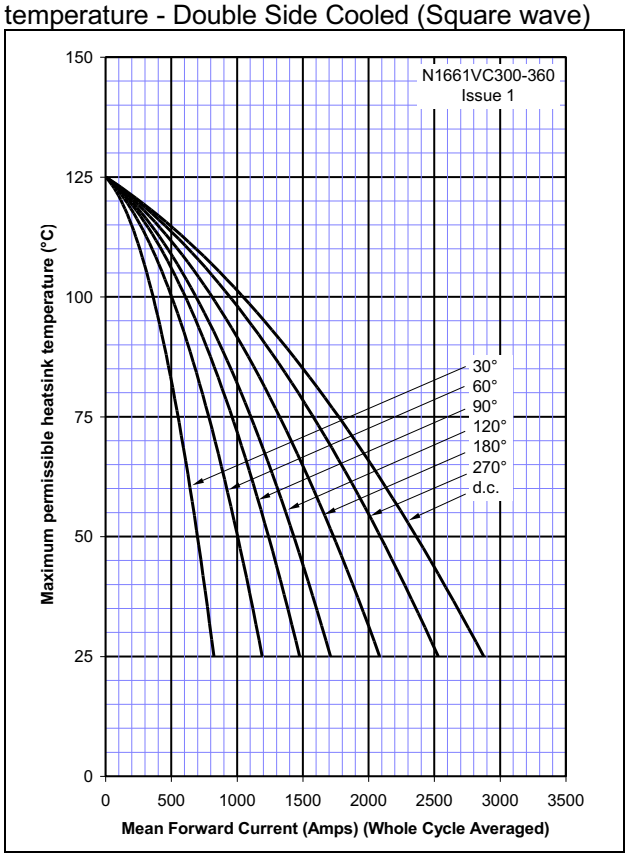


Figure 13 – On-state current vs. Power dissipation – Single Side Cooled (Sine wave)

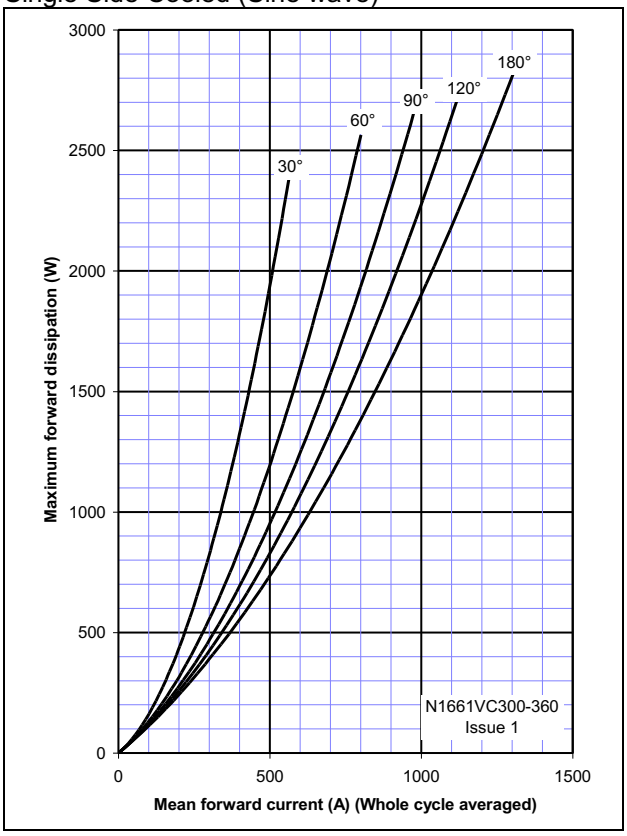


Figure 14 – On-state current vs. Heatsink temperature - Single Side Cooled (Sine wave)

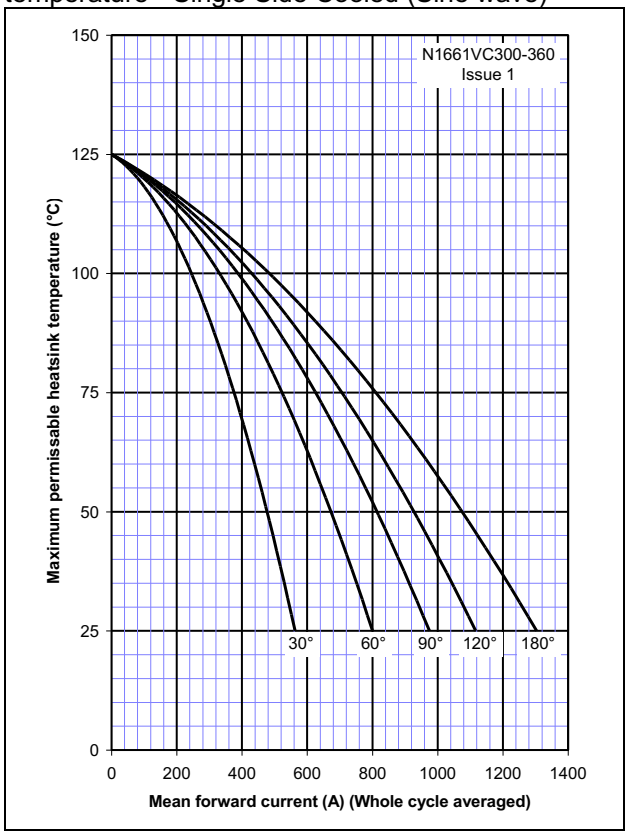


Figure 15 – On-state current vs. Power dissipation – Single Side Cooled (Square wave)

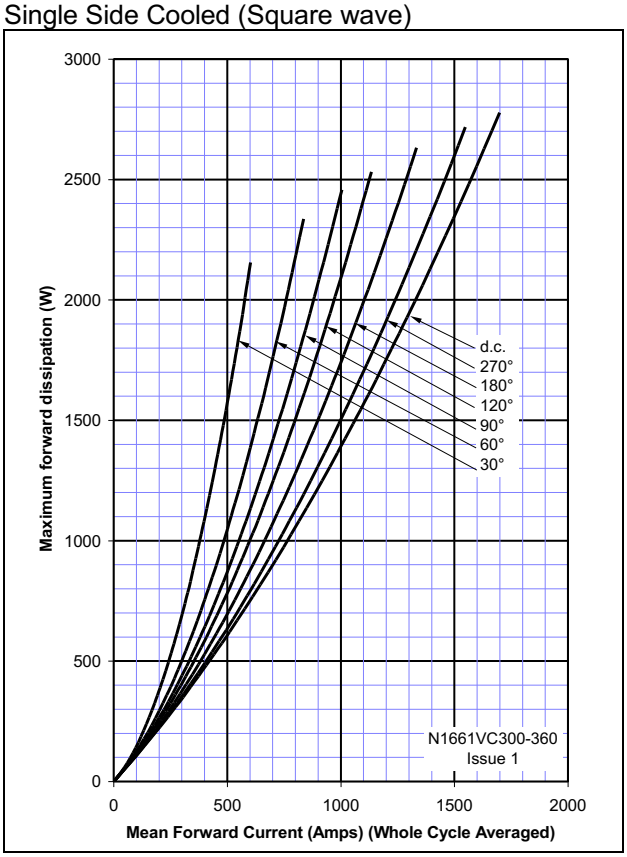


Figure 16 – On-state current vs. Heatsink temperature - Single Side Cooled (Square wave)

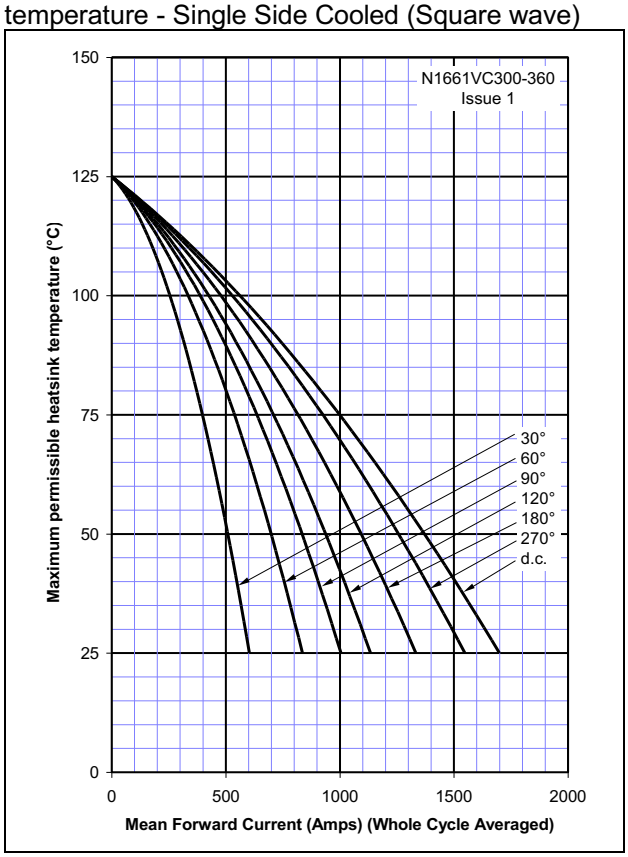
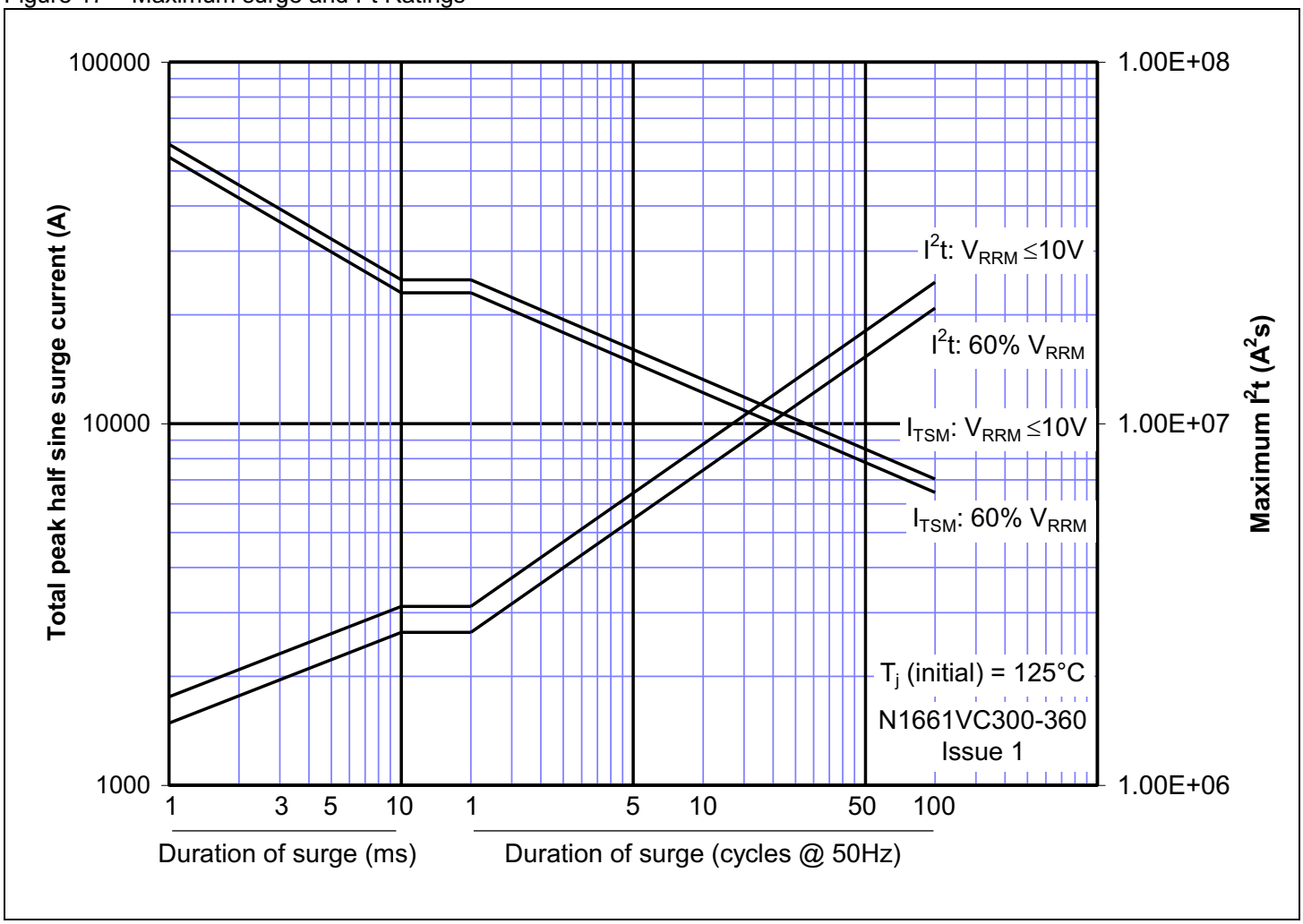
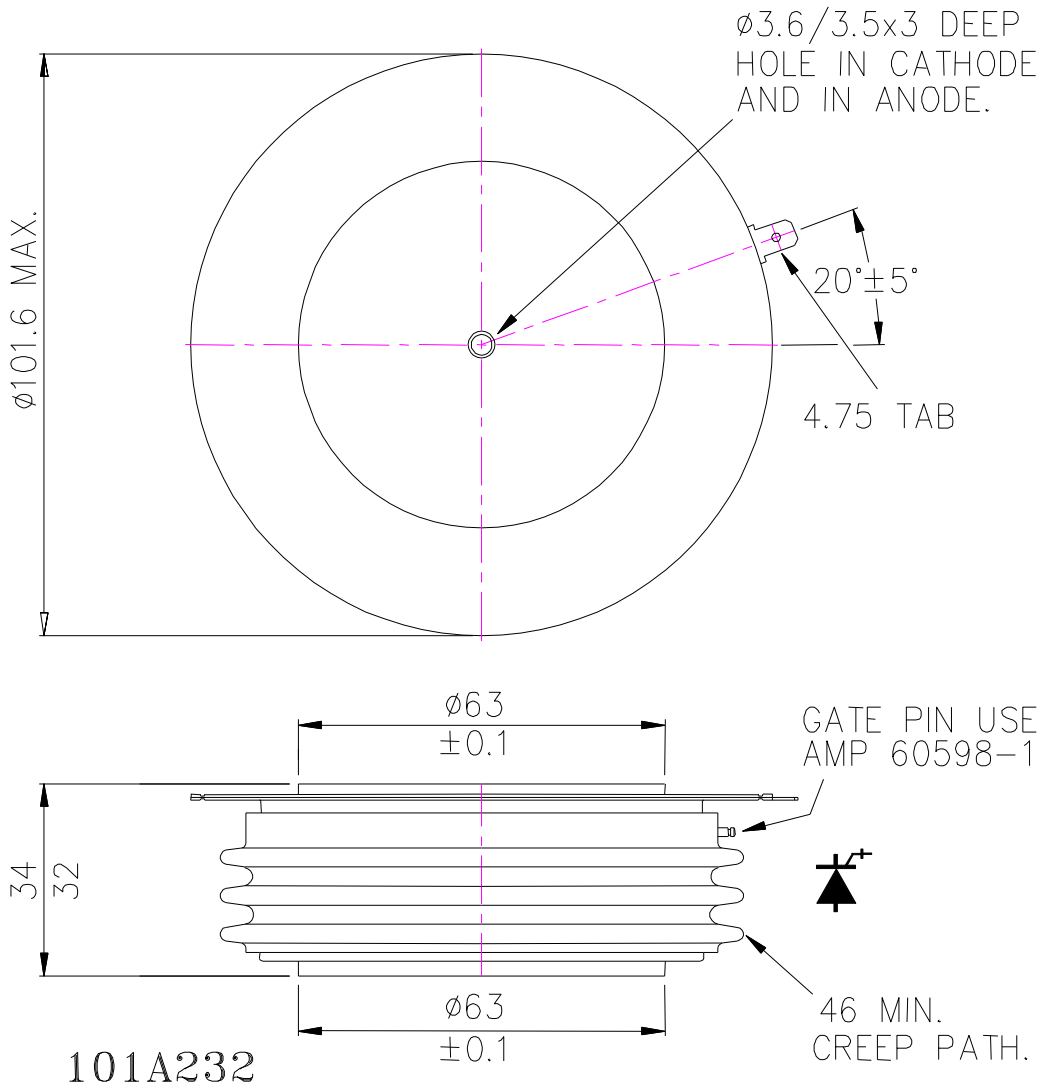


Figure 17 – Maximum surge and I^2t Ratings



Outline Drawing & Ordering Information



ORDERING INFORMATION (Please quote 10 digit code as below)

N1661	VC	♦ ♦	0
Fixed Type Code	Fixed Outline Code	Voltage Code 30-36	Fixed turn-off time code

Typical order code: N1661VC320 – 3200V V_{DRM}/V_{RRM}, 34mm clamp height capsule.

WESTCODE

UK: Westcode Semiconductors Ltd.
P.O. Box 57, Chippenham, Wiltshire, England. SN15 1JL.
Tel: +44 (0) 1249 444524 Fax: +44 (0) 1249 659448
E-Mail: WSL.sales@westcode.com

USA: Westcode Semiconductors Inc.
3270 Cherry Avenue, Long Beach, California 90807
Tel: +1 (562) 595 6971 Fax: +1 (562) 595 8182
E-Mail: WSI.sales@westcode.com

Internet: http://www.westcode.com

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