WESTCODE

Phase Control Thyristor
Types N1351VC400 to N1351VC450

Absolute Maximum Ratings

	VOLTAGE RATINGS	MAXIMUM LIMITS	UNITS
V_{DRM}	Repetitive peak off-state voltage, (note 1)	4000-4500	V
V_{DSM}	Non-repetitive peak off-state voltage, (note 1)	4000-4500	V
V_{RRM}	Repetitive peak reverse voltage, (note 1)	4000-4500	V
V_{RSM}	Non-repetitive peak reverse voltage, (note 1)	4100-4600	V

	OTHER RATINGS	MAXIMUM LIMITS	UNITS
$I_{T(AV)}$	Mean on-state current. T_{sink}=55°C, (note 2)	1351	A
$I_{T(AV)}$	Mean on-state current. T_{sink}=85°C, (note 2)	944	A
$I_{T(AV)}$	Mean on-state current. T_{sink}=85°C, (note 3)	587	A
$I_{T(RMS)}$	Nominal RMS on-state current. T_{sink}=25°C, (note 2)	2641	A
$I_{T(d.c.)}$	D.C. on-state current. T_{sink}=25°C, (note 4)	2352	A
I_{TSM}	Peak non-repetitive surge t_p=10ms, V_{rm}=0.6V_{RRM}, (note 5)	17500	A
I_{TSM2}	Peak non-repetitive surge t_p=10ms, V_{rm}≤10V, (note 5)	20000	A
I^2t	I^2t capacity for fusing t_p=10ms, V_{rm}=0.6V_{RRM}, (note 5)	$1.53×10^6$	A^2s
I^2t	I^2t capacity for fusing t_p=10ms, V_{rm}≤10V, (note 5)	$2.00×10^6$	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) 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}=1000A, 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	-	-	3.0	I_{TM}=3220A	V
V_0	Threshold voltage	-	-	1.20		V
r_S	Slope resistance	-	-	0.553		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	-	0.7	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	-	1.5	2.0		
Q_{rr}	Recovered Charge	-	1500	-	I_{TM}=1000A, t_p=1000µs, di/dt=10A/µs, V_r=50V	µC
Q_{ra}	Recovered Charge, 50% chord	-	900	1200		µC
I_{rm}	Reverse recovery current	-	90	-		A
t_{rr}	Reverse recovery time, 50% chord	-	14.0	-		µs
t_q	Turn-off time	-	350	-	I_{TM}=1000A, t_p=1000µs, di/dt=10A/µs, V_r=50V, V_{dr}=80%V_{DRM}, dV_{dr}/dt=20V/µs	µs
		-	600	-	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
40	4000	4100	2000
42	4200	4300	2040
44	4400	4500	2080
45	4500	4600	2100

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

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

and:

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

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

Where V_0=1.20V, r_s=0.553mΩ,

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	0.017		
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 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.

125°C Coefficients	
A	2.195803659
B	-0.395248246
C	8.092×10^{-5}
D	$6.58800679 \times 10^{-2}$

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}	0.981×10^{-3}
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
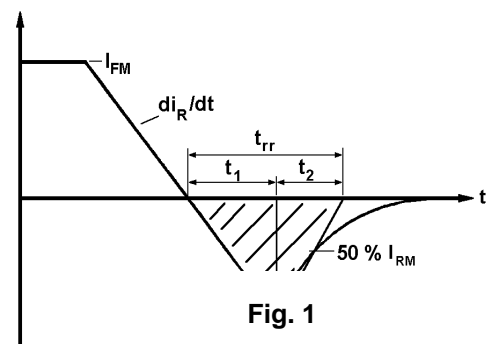
Curves

Figure 1 - On-state characteristics of Limit device

$T_J = 125°C$

N1351VC400-450
Issue 1

Instantaneous On-state current - I_{TM} (A)

Instantaneous On-state voltage - V_{TM} (V)
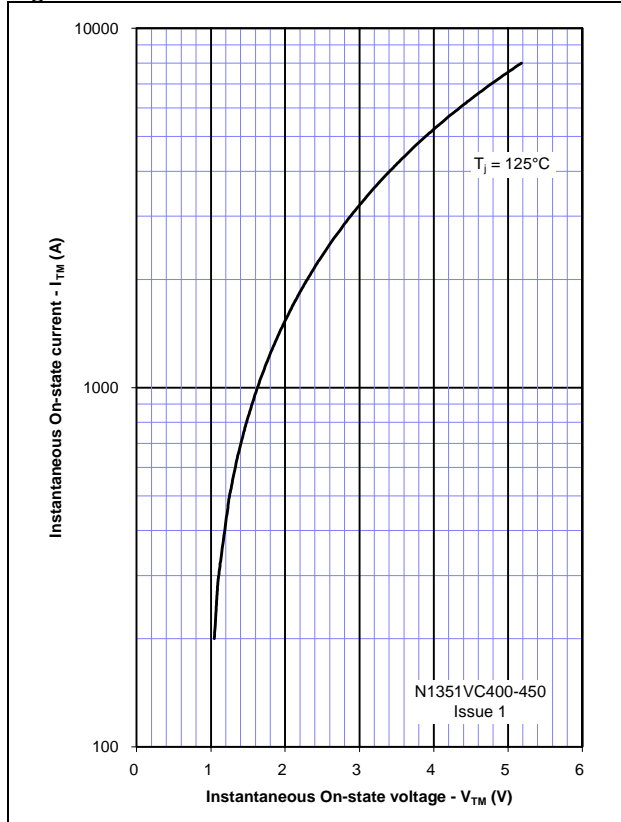
Figure 2 - Transient Thermal Impedance

N1351VC400-450
Issue 1

SSC
0.034K/W

DSC
0.017K/W

Transient thermal impedance (K/W)

Time (s)
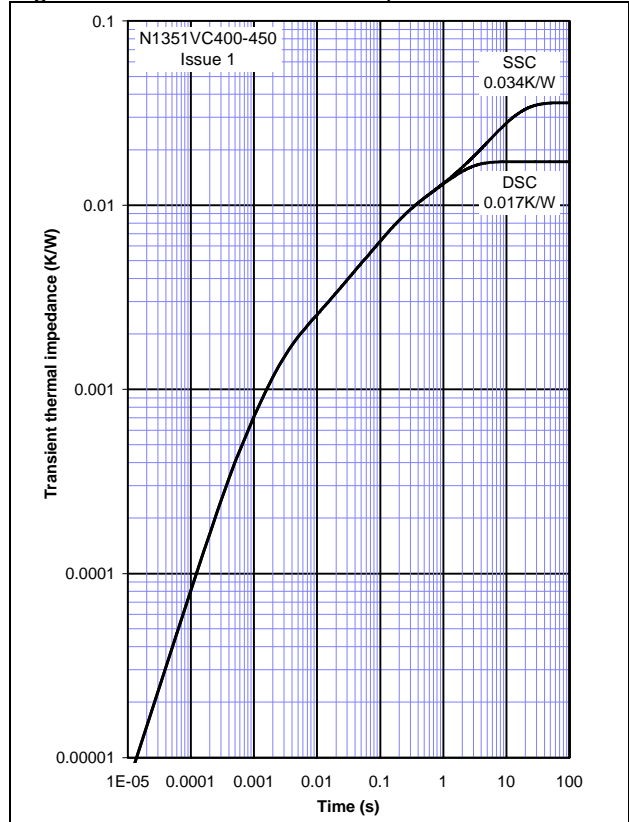
Figure 3 - Gate Characteristics - Trigger Limits

N1351VC400-450
Issue 1

$T_j=25°C$

Max V_G dc

I_{GT}, V_{GT}

125°C   25°C   -10°C   -40°C

Min V_G dc

I_{GD}, V_{GD}

Gate Voltage - V_G (V)
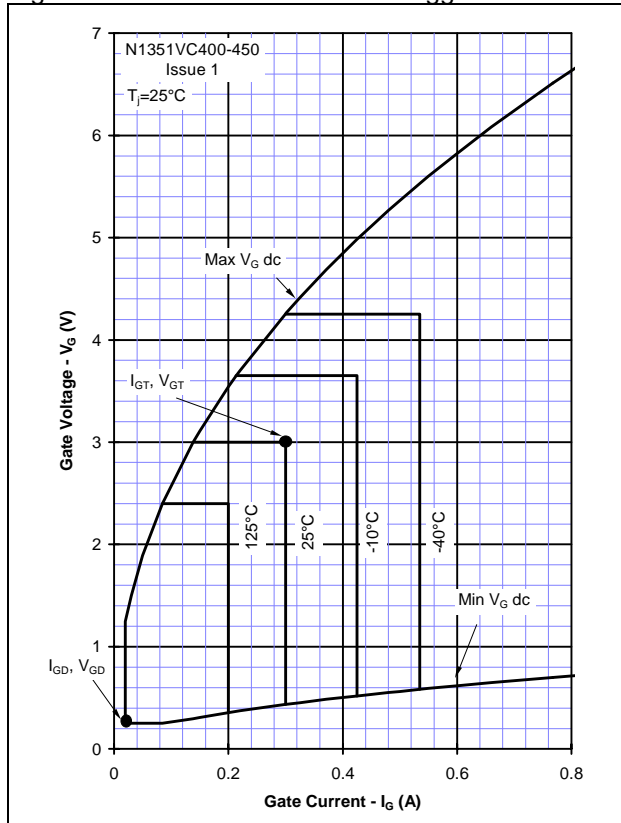
Gate Current - I_G (A)

Figure 4 - Gate Characteristics - Power Curves

N1351VC400-450
Issue 1

$T_j=25°C$

Max V_G dc

P_G Max 30W dc

P_G 4W dc

Min V_G dc

Gate Voltage - V_G (V)
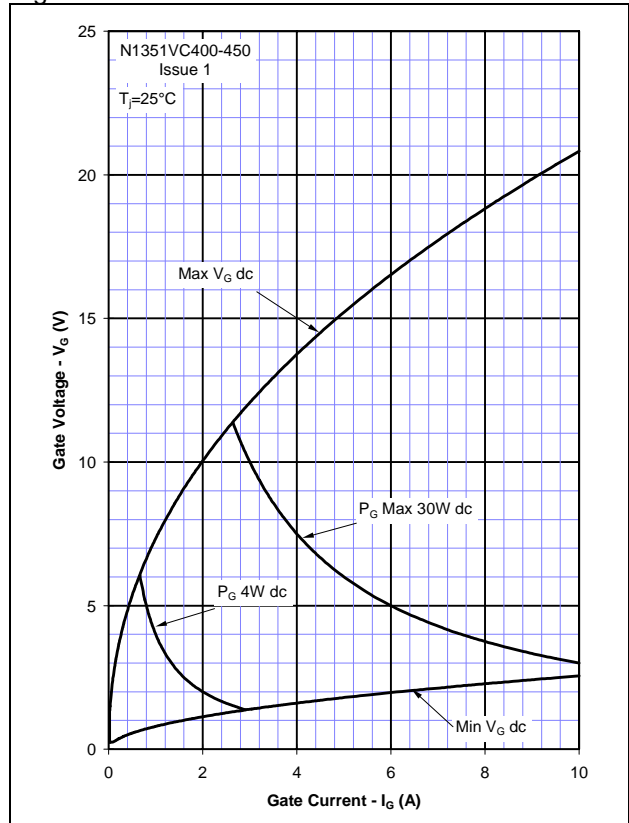
Gate Current - I_G (A)

Figure 5 – Recovered Charge, Q_{rr}
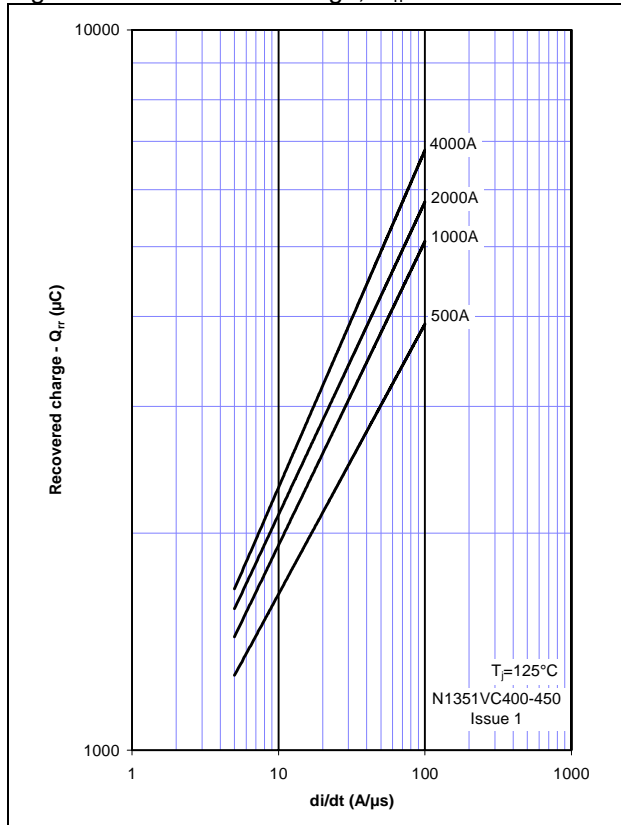
Figure 6 – Recovered charge, Q_{ra} (50% chord)
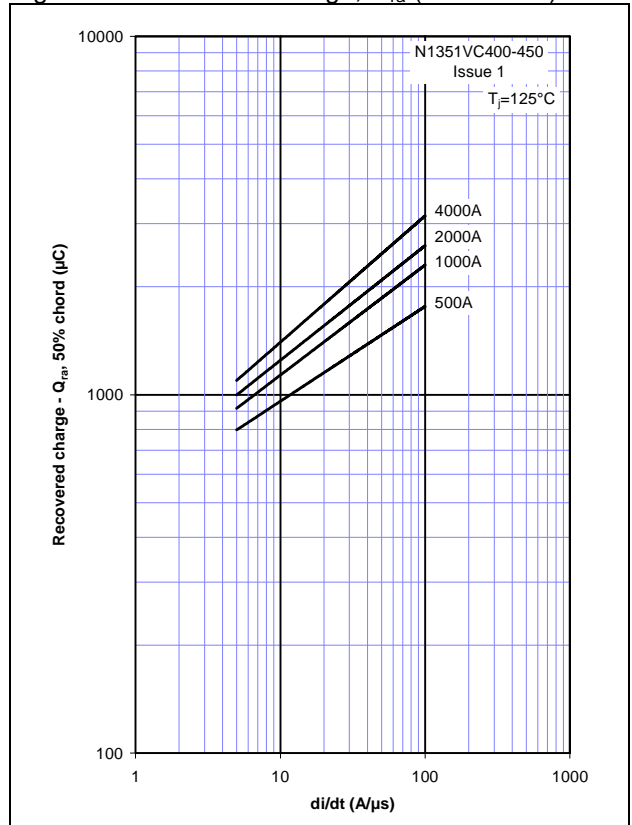
Figure 7 – Reverse recovery current, I_{rm}
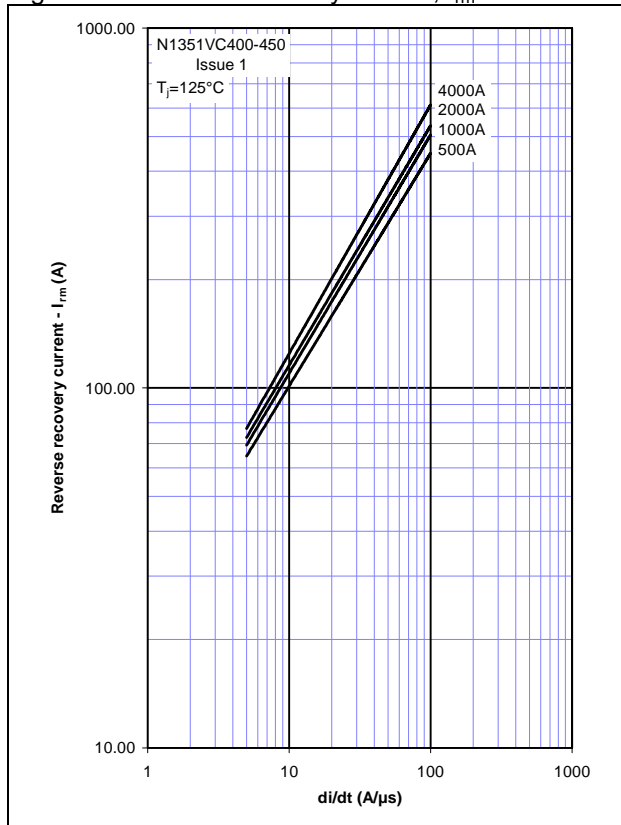
Figure 8 – Reverse recovery time, t_{rr} (50% chord)
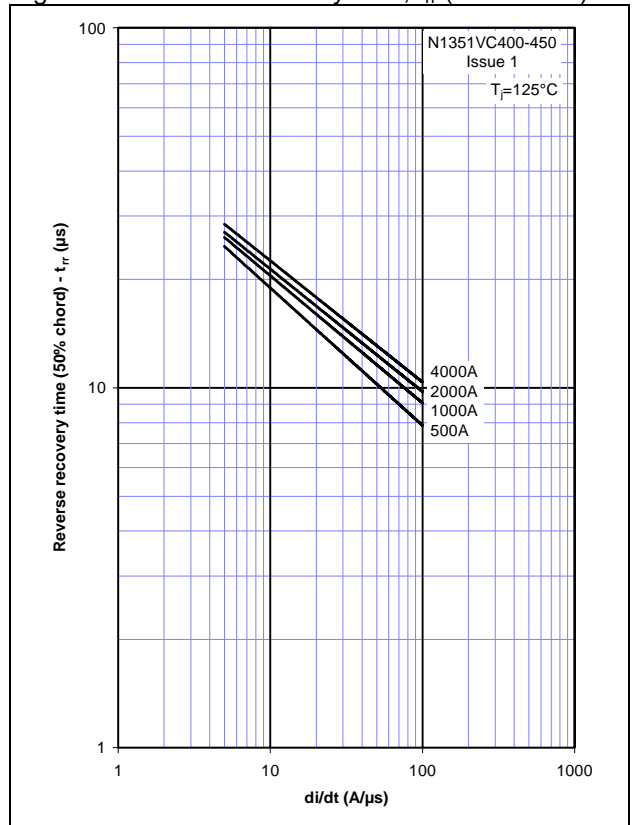
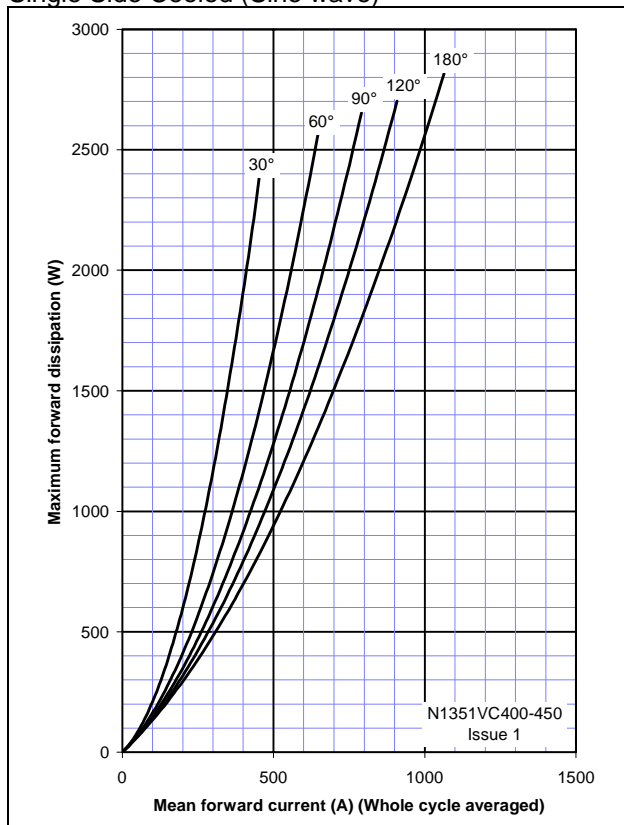Figure 9 – On-state current vs. Power dissipation – Double Side Cooled (Sine wave)
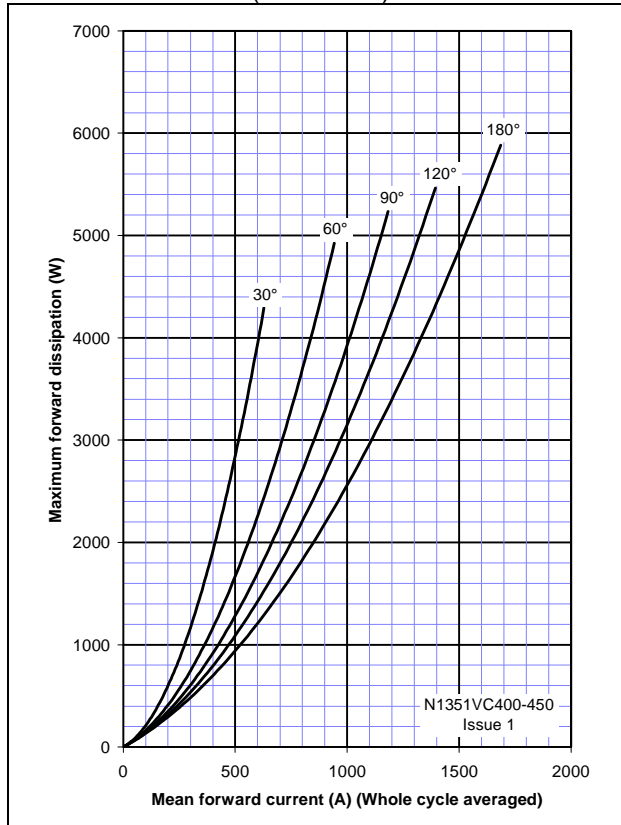
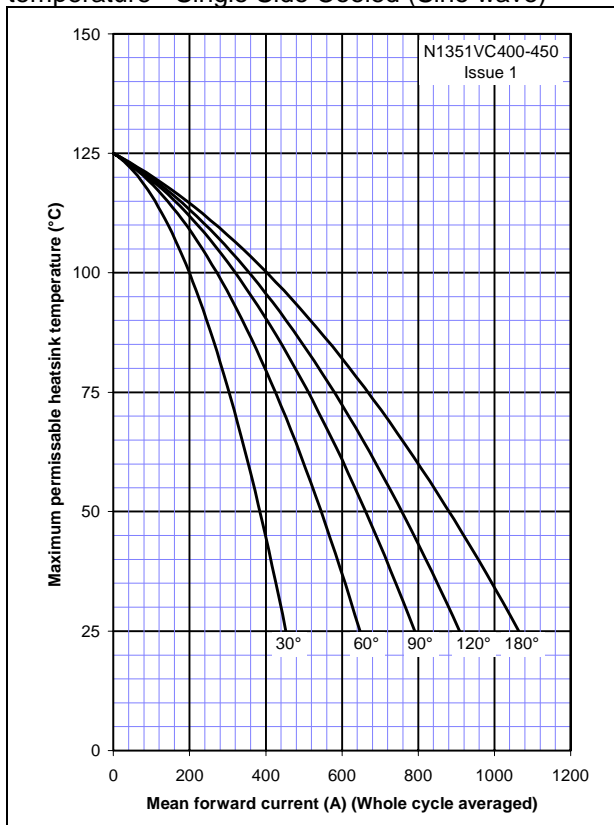Figure 10 – On-state current vs. Heatsink temperature - Double Side Cooled (Sine wave)
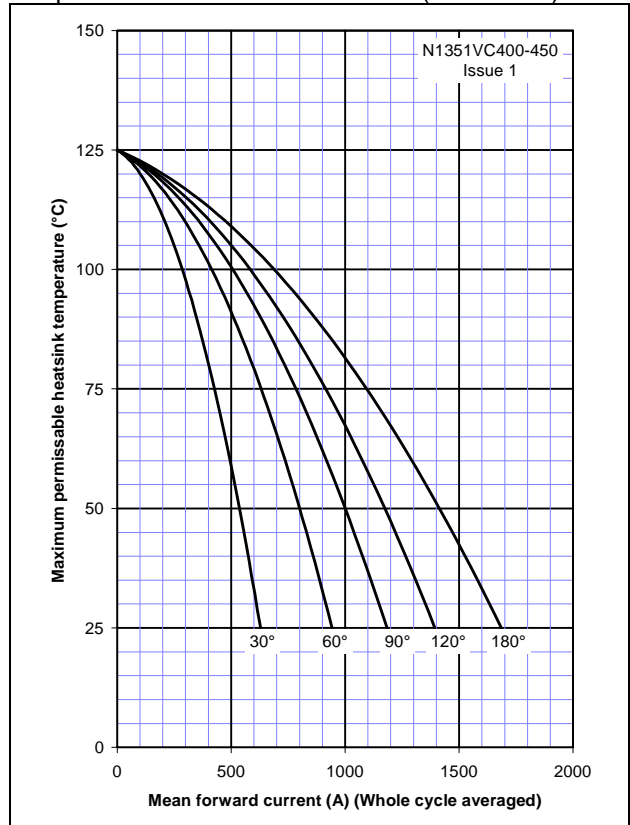
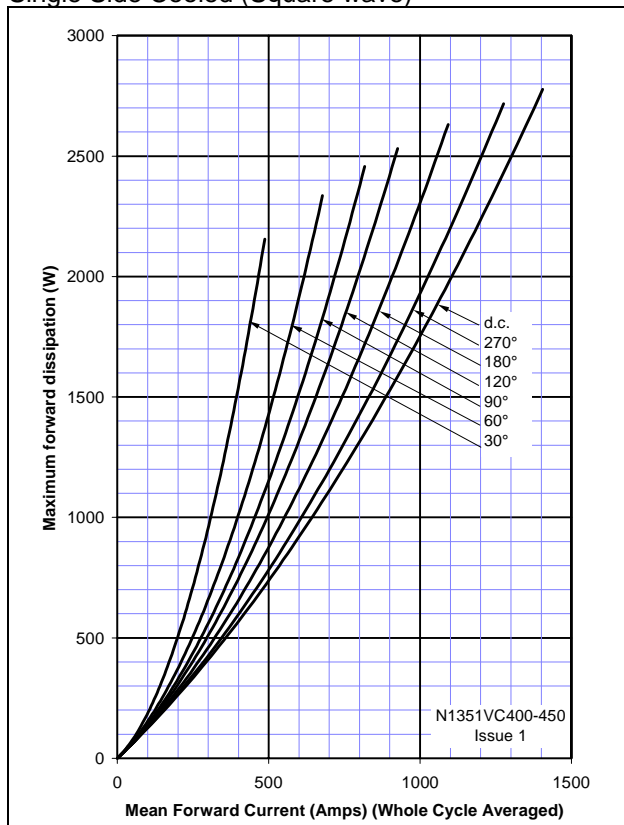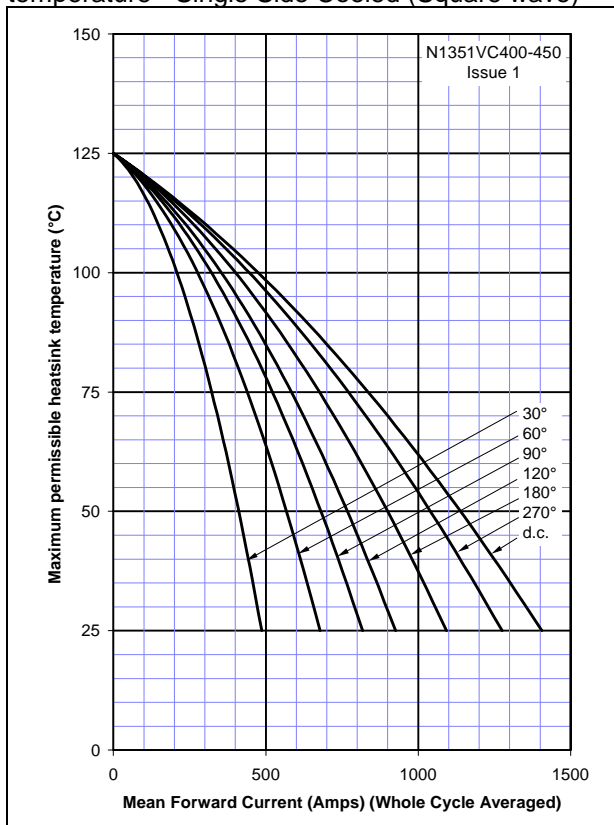Figure 11 – On-state current vs. Power dissipation – Double Side Cooled (Square wave)
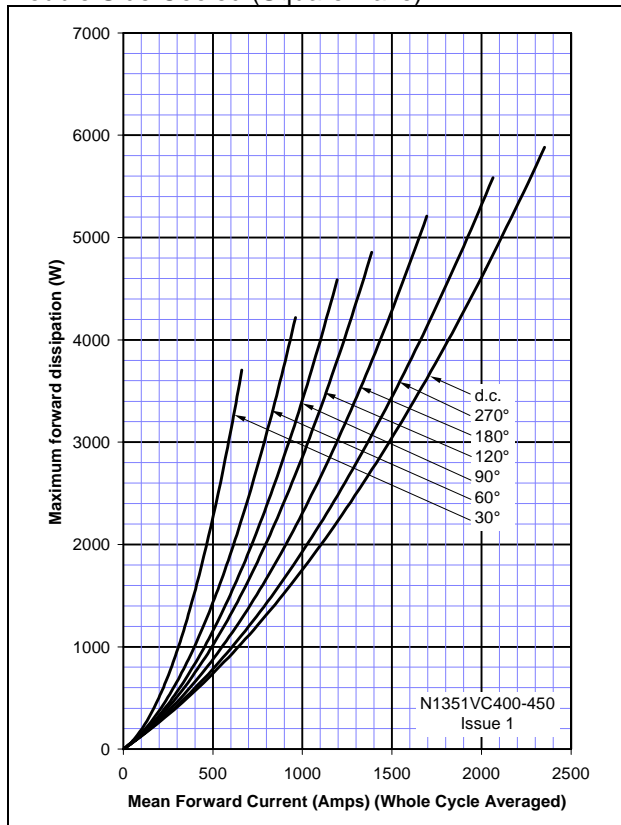
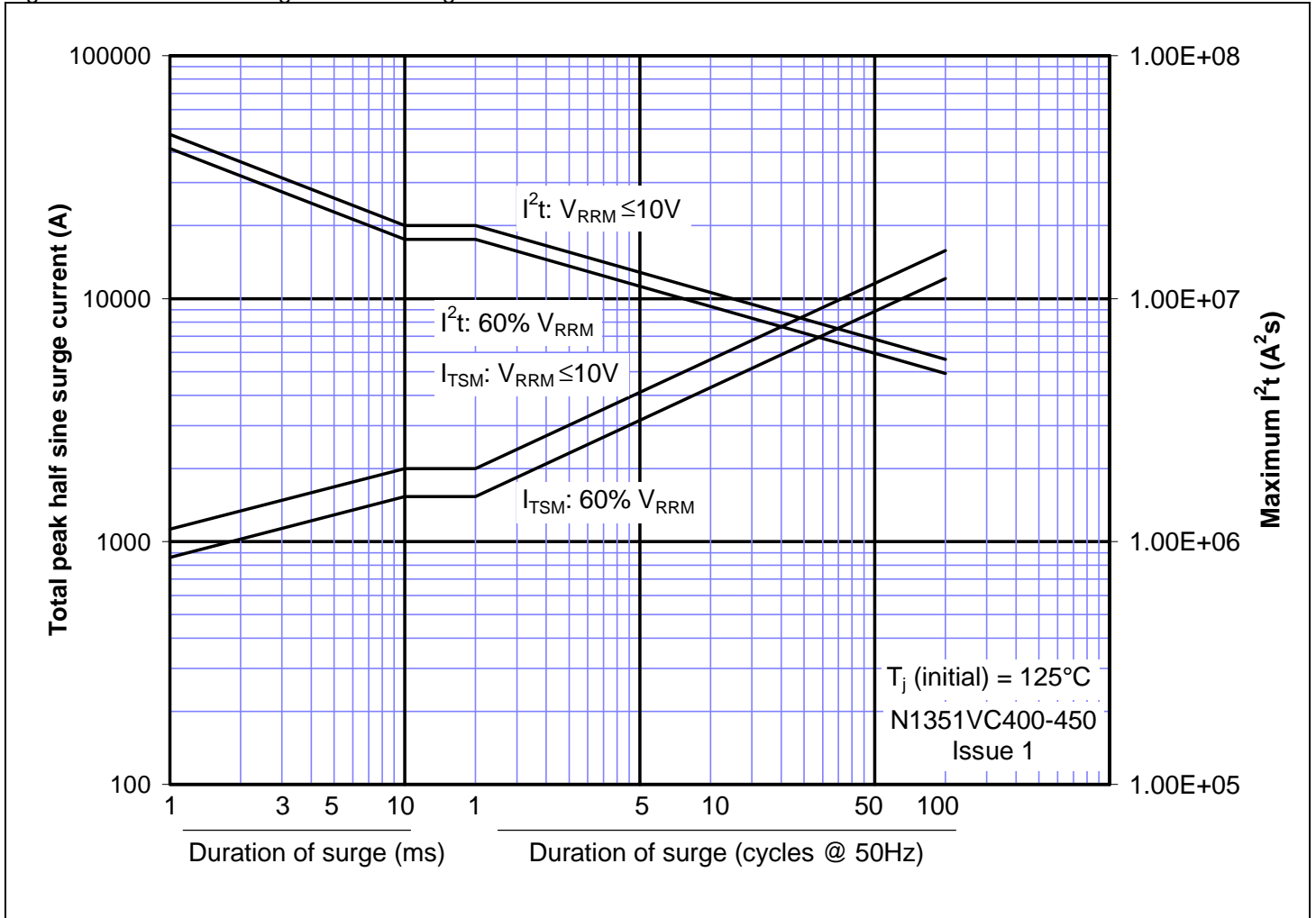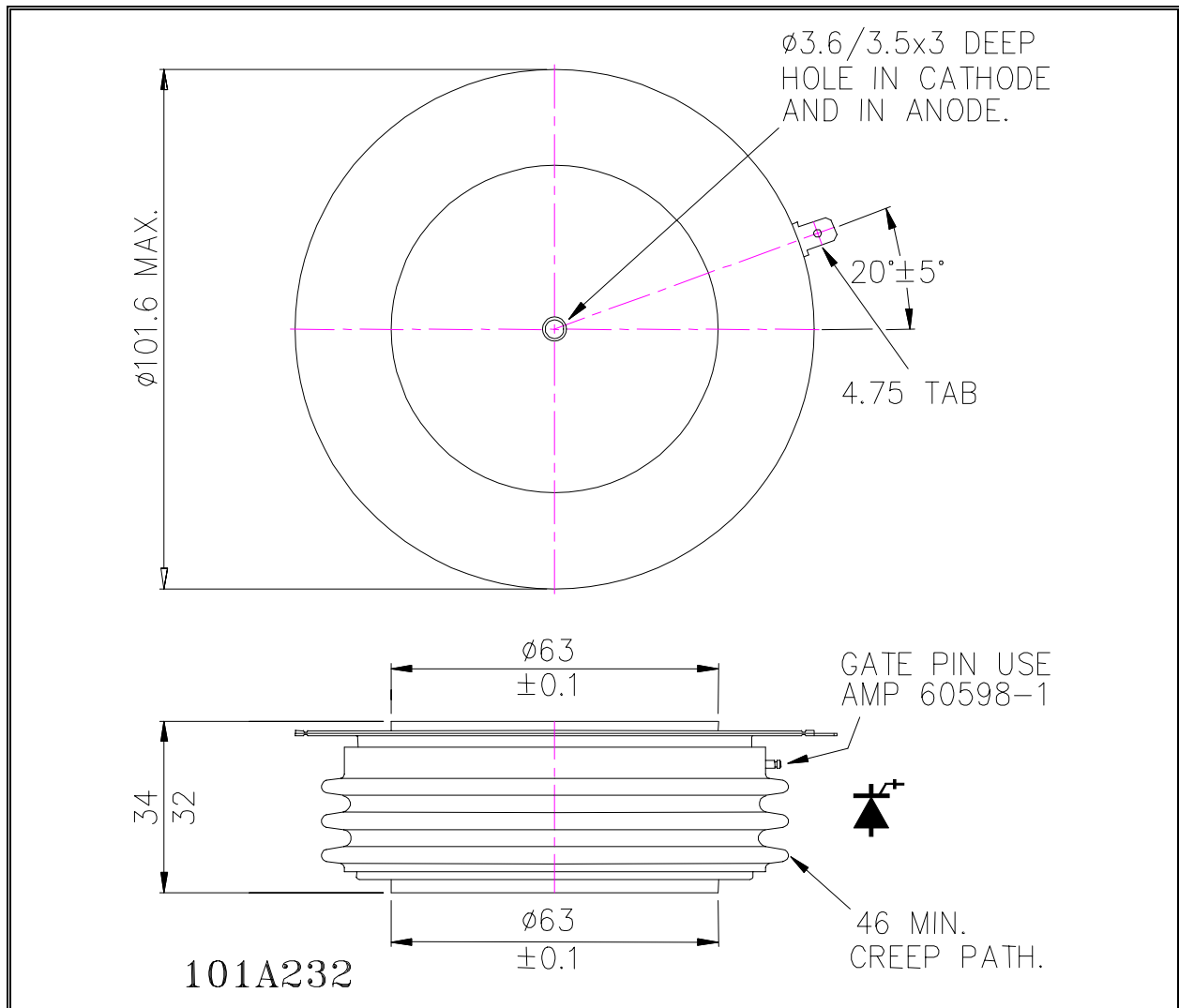Figure 12 – On-state current vs. Heatsink temperature - Double Side Cooled (Square wave)
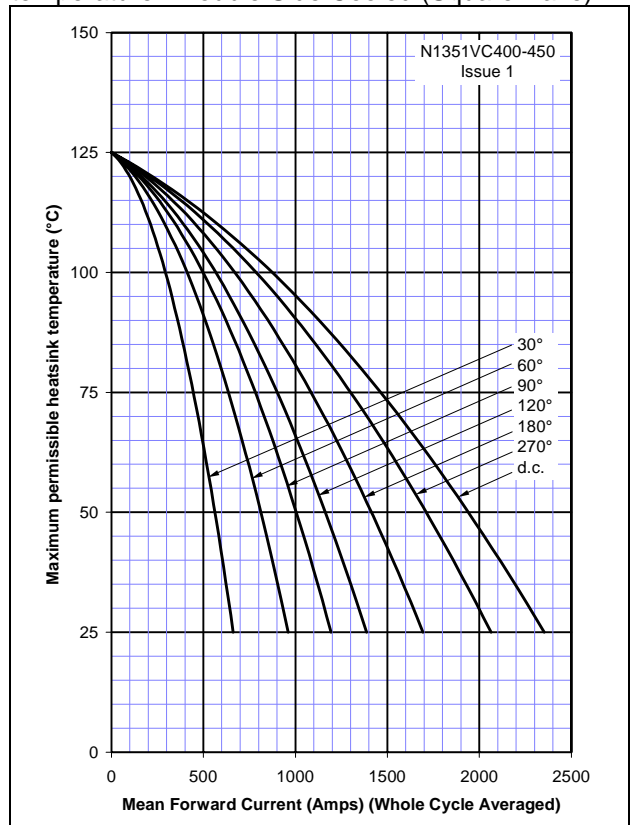
Figure 13 – On-state current vs. Power dissipation –
Single Side Cooled (Sine wave)

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

ø3.6/3.5x3 DEEP HOLE IN CATHODE AND IN ANODE.

ø101.6 MAX.

20°±5°

4.75 TAB

ø63 ±0.1

GATE PIN USE AMP 60598-1

34
32

ø63 ±0.1

46 MIN. CREEP PATH.

101A232

ORDERING INFORMATION		(Please quote 10 digit code as below)	
N1351	**VC**	**♦ ♦**	**0**
Fixed Type Code	Fixed Outline Code	Voltage Code 40-45	Fixed turn-off time code

Typical order code: N1351VC400 – 4000V V_{DRM}/V_{RRM}, 34mm clamp height capsule.