



Phase Control Thyristor Types N4845E#320 & N4845E#360

Absolute Maximum Ratings

| | VOLTAGE RATINGS | MAXIMUM LIMITS | UNITS |
|------------------|---|----------------|-------|
| V _{DRM} | Repetitive peak off-state voltage, (note 1) | 3200-3600 | V |
| V _{DSM} | Non-repetitive peak off-state voltage, (note 1) | 3200-3600 | V |
| V _{RRM} | Repetitive peak reverse voltage, (note 1) | 3200-3600 | V |
| V _{RSM} | Non-repetitive peak reverse voltage, (note 1) | 3300-3700 | V |

| | OTHER RATINGS | MAXIMUM LIMITS | UNITS |
|----------------------|--|----------------------|------------------|
| I _{T(AV)} | Mean on-state current. T _{sink} =55°C, (note 2) | 4865 | A |
| I _{T(AV)} | Mean on-state current. T _{sink} =85°C, (note 2) | 3405 | A |
| I _{T(AV)} | Mean on-state current. T _{sink} =85°C, (note 3) | 2060 | A |
| I _{T(RMS)} | Nominal RMS on-state current. T _{sink} =25°C, (note 2) | 9505 | A |
| I _{T(d.c.)} | D.C. on-state current. T _{sink} =25°C, (note 4) | 8480 | A |
| I _{TSM} | Peak non-repetitive surge t _p =10ms, V _{RM} =0.6V _{RRM} , (note 5) | 65 | kA |
| I _{TSM2} | Peak non-repetitive surge t _p =10ms, V _{RM} ≤10V, (note 5) | 72 | kA |
| I ² t | I ² t capacity for fusing t _p =10ms, V _{RM} =0.6V _{RRM} , (note 5) | 21.1×10 ⁶ | A ² s |
| I ² t | I ² t capacity for fusing t _p =10ms, V _{RM} ≤10V, (note 5) | 25.9×10 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 | 5 | 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) Cathode 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}=5000A, 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 | - | - | 1.55 | $I_{TM}=5000A$ | V |
| V_0 | Threshold voltage | - | - | 0.93 | | V |
| r_T | Slope resistance | - | - | 0.122 | | m Ω |
| dv/dt | Critical rate of rise of off-state voltage | 1000 | - | - | $V_D=80\% V_{DRM}$, Linear ramp, gate o/c | V/ μ s |
| I_{DRM} | Peak off-state current | - | - | 200 | Rated V_{DRM} | mA |
| I_{RRM} | Peak reverse current | - | - | 200 | Rated V_{RRM} | mA |
| V_{GT} | Gate trigger voltage | - | - | 3.0 | $T_j=25^\circ C$, $V_D=10V$, $I_T=3A$ | V |
| I_{GT} | Gate trigger current | - | - | 300 | | mA |
| I_H | Holding current | - | - | 1000 | $T_j=25^\circ C$ | mA |
| t_{gd} | Gate controlled turn-on delay time | - | 0.9 | 1.3 | $I_{FG}=2A$, $t_r=0.5\mu s$, $V_D=67\% V_{DRM}$, $I_{TM}=2000A$, $di/dt=10A/\mu s$, $T_j=25^\circ C$ | μ s |
| t_{gt} | Turn-on time | - | 2.4 | 4.0 | | μ s |
| Q_{rr} | Recovered Charge | - | 10000 | 11000 | $I_{TM}=2000A$, $t_p=2000\mu s$, $di/dt=10A/\mu s$, $V_r=100V$ | μ C |
| Q_{ra} | Recovered Charge, 50% chord | - | 6625 | - | | μ C |
| I_{rrm} | Reverse recovery current | - | 265 | - | | A |
| t_{rr} | Reverse recovery time, 50% chord | - | 50 | - | | μ s |
| t_q | Turn-off time | - | 530 | - | $I_{TM}=2000A$, $t_p=2000\mu s$, $di/dt=10A/\mu s$, $V_r=100V$, $V_{dr}=80\% V_{DRM}$, $dV_{dr}/dt=20V/\mu s$ | μ s |
| | | - | 850 | - | $I_{TM}=2000A$, $t_p=2000\mu s$, $di/dt=10A/\mu s$, $V_r=100V$, $V_{dr}=80\% V_{DRM}$, $dV_{dr}/dt=200V/\mu s$ | |
| R_{thJK} | Thermal resistance, junction to heatsink | - | - | 0.0060 | Double side cooled | K/W |
| | | - | - | 0.0118 | Anode side cooled | K/W |
| | | - | - | 0.0125 | Cathode side cooled | K/W |
| F | Mounting force | 76 | - | 93 | Note 2 | kN |
| W_t | Weight | - | 2.0 | - | | kg |

Notes:-

- 1) Unless otherwise indicated $T_j=125^\circ C$.
- 2) For other clamp forces, please consult factory.

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 |
|---------------|------------------------------------|----------------|---------------------|
| 32 | 3200 | 3300 | 1920 |
| 36 | 3600 | 3700 | 2160 |

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 $V_0=0.93V$, $r_T=0.122m\Omega$,

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 | 0.00661 | 0.00653 | 0.00645 | 0.00639 | 0.00627 | 0.00613 | 0.00600 |
| Square wave Anode Side Cooled | 0.01242 | 0.01234 | 0.01226 | 0.01220 | 0.01208 | 0.01194 | 0.01180 |
| Square wave Cathode Side Cooled | 0.01314 | 0.01307 | 0.01300 | 0.01295 | 0.01285 | 0.01271 | 0.01250 |
| Sine wave Double Side Cooled | 0.00654 | 0.00644 | 0.00637 | 0.00630 | 0.00613 | | |
| Sine wave Anode Side Cooled | 0.01235 | 0.01225 | 0.01218 | 0.01212 | 0.01194 | | |
| Sine wave Cathode Side Cooled | 0.01308 | 0.01300 | 0.01294 | 0.01288 | 0.01272 | | |

| 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 | | |

5.2 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_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 | 1.197091 | A | 0.8600505 |
| B | -0.03714521 | B | -0.02173266 |
| C | 5.2376×10^{-5} | C | 6.36509×10^{-5} |
| D | 4.888255×10^{-3} | D | 7.866687×10^{-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 | 3.543719×10^{-3} | 1.677583×10^{-3} | 6.679909×10^{-4} | 1.256405×10^{-4} |
| τ_p | 1.365469 | 0.1841105 | 0.02837475 | 6.118678×10^{-3} |

| D.C. Anode Side Cooled | | | | |
|------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Term | 1 | 2 | 3 | 4 |
| r_p | 8.378160×10^{-3} | 2.441365×10^{-3} | 8.566744×10^{-4} | 1.497242×10^{-4} |
| τ_p | 6.749137 | 0.3199177 | 0.03601898 | 6.471704×10^{-3} |

| D.C. Cathode Side Cooled | | | | |
|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Term | 1 | 2 | 3 | 4 |
| r_p | 9.319408×10^{-3} | 2.558027×10^{-3} | 6.224641×10^{-4} | 9.787425×10^{-5} |
| τ_p | 7.197878 | 0.2406578 | 0.02322995 | 7.393157×10^{-3} |

Curves

Figure 1 - On-state characteristics of Limit device

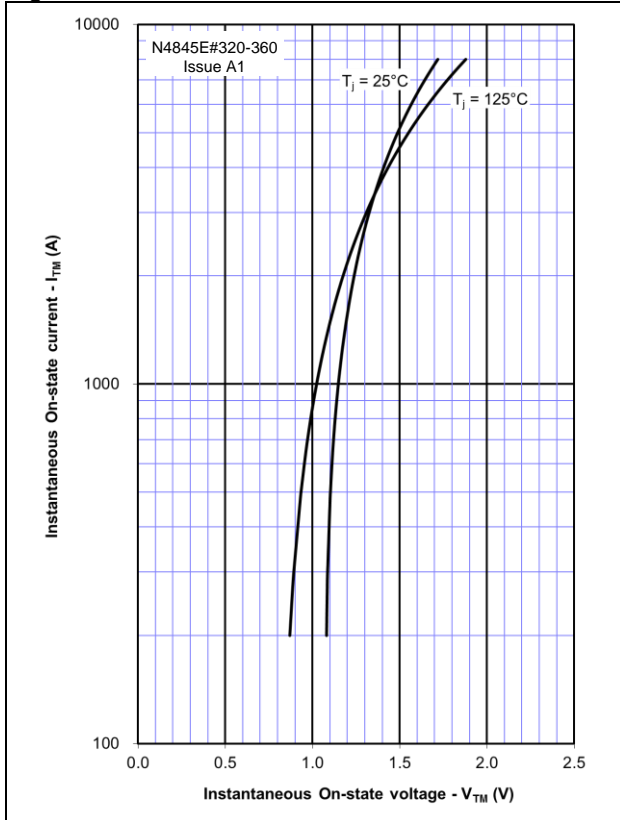


Figure 2 - Transient Thermal Impedance

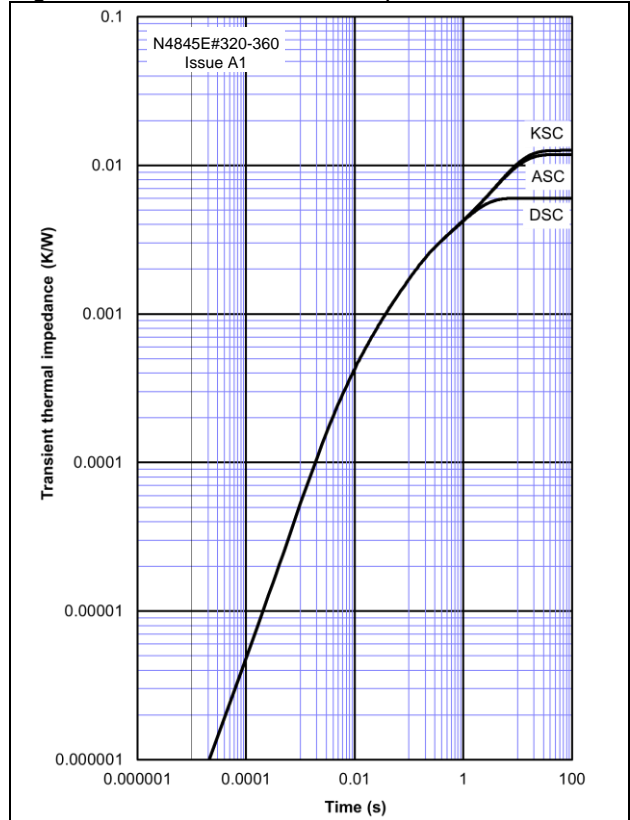


Figure 3 - Gate Characteristics - Trigger Limits

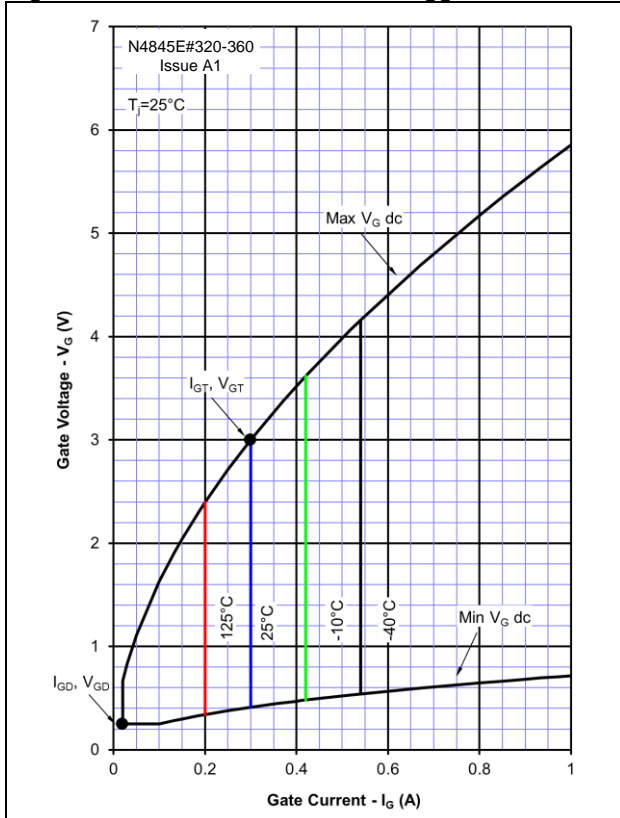


Figure 4 - Gate Characteristics - Power Curves

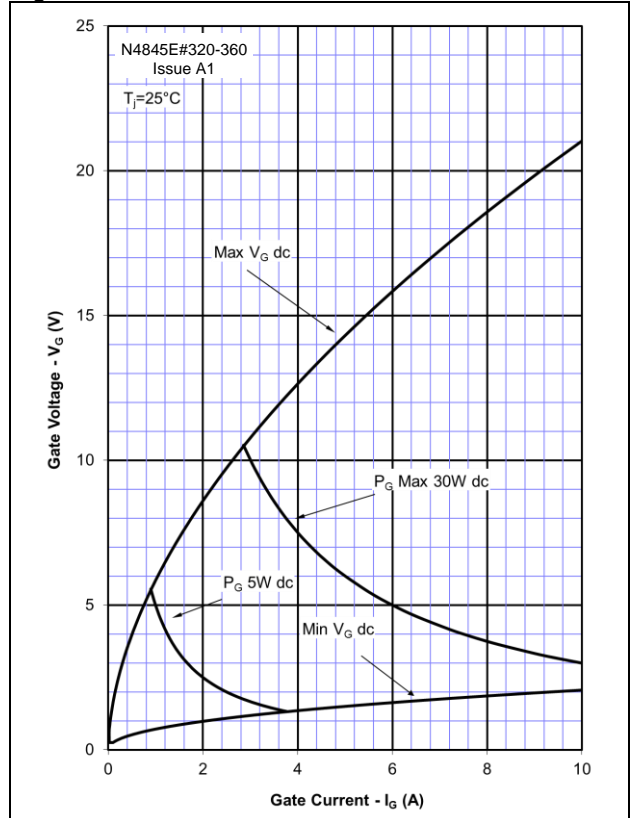


Figure 5 – Recovered Charge, Q_{rr}

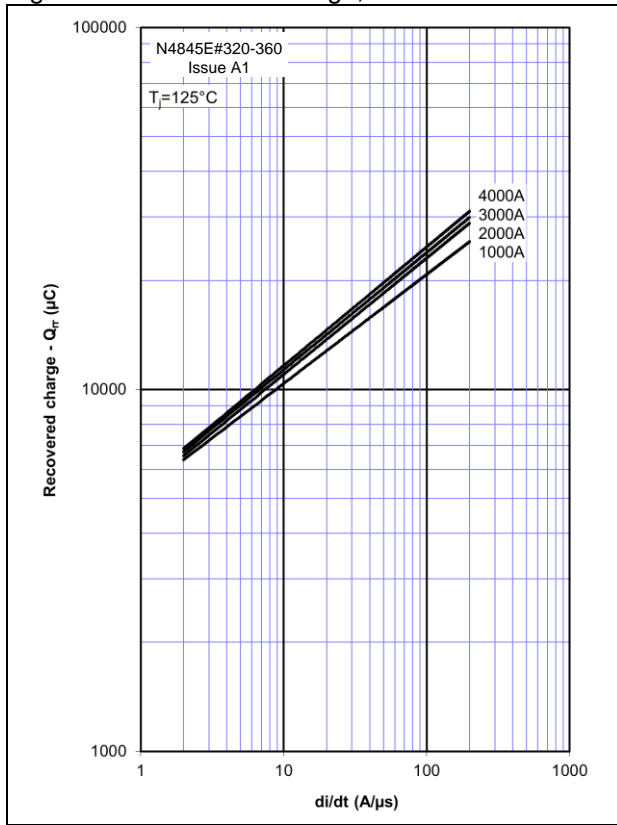


Figure 6 – Recovered charge, Q_{ra} (50% chord)

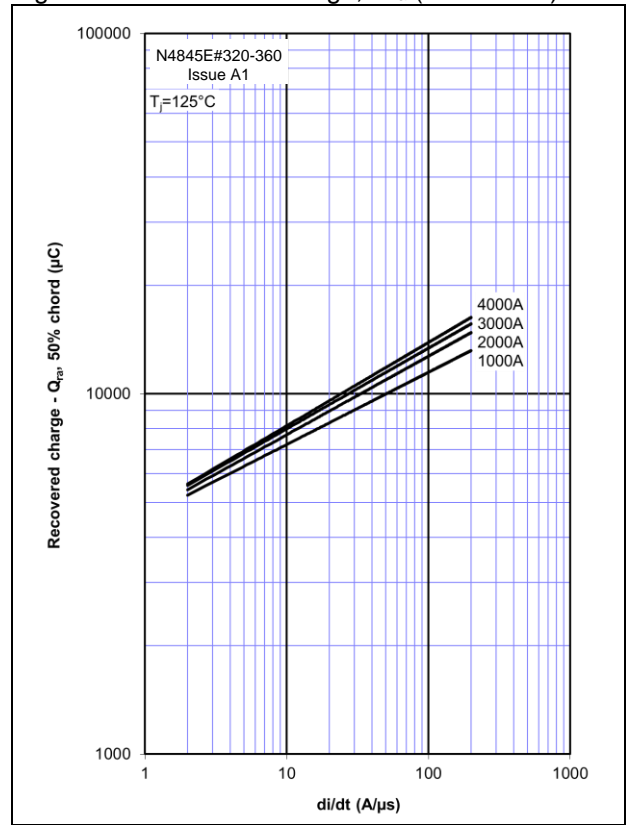


Figure 7 – Reverse recovery current, I_{rm}

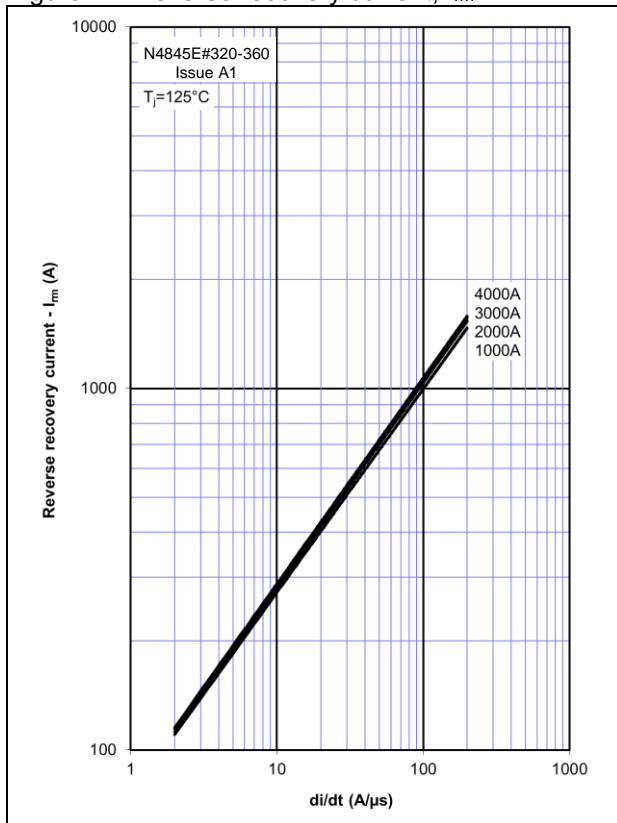


Figure 8 – Reverse recovery time, t_{rr}

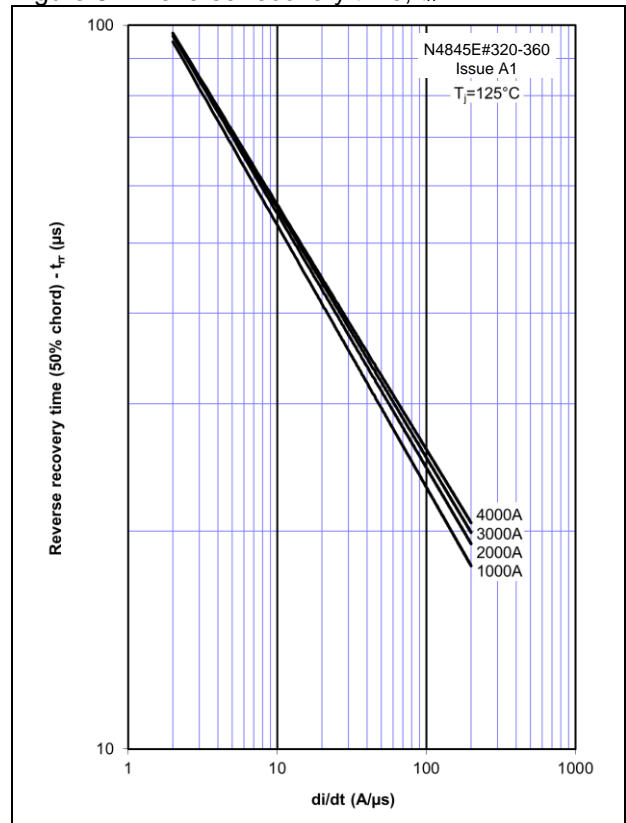


Figure 9 – On-state current vs. Power dissipation – Double Side Cooled (Sine wave)

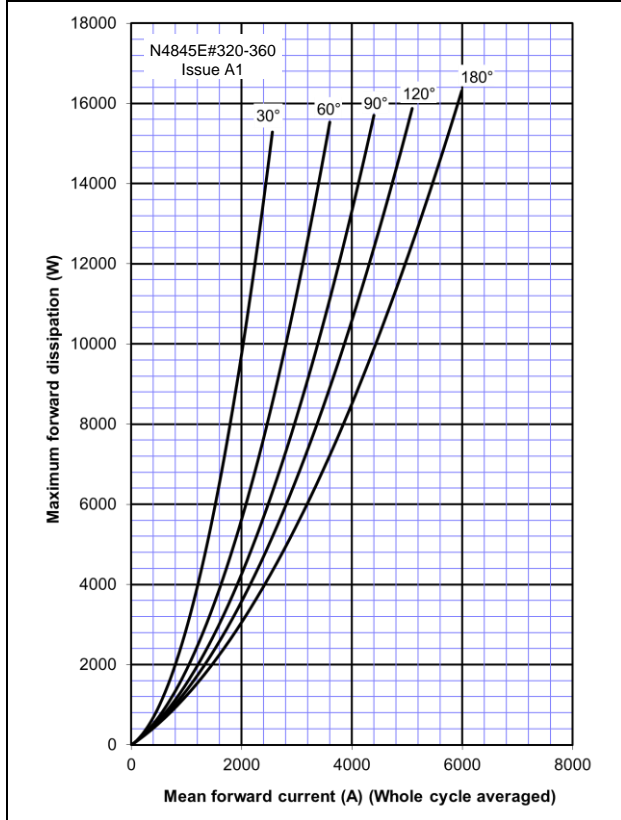


Figure 10 – On-state current vs. Heatsink temperature - Double Side Cooled (Sine wave)

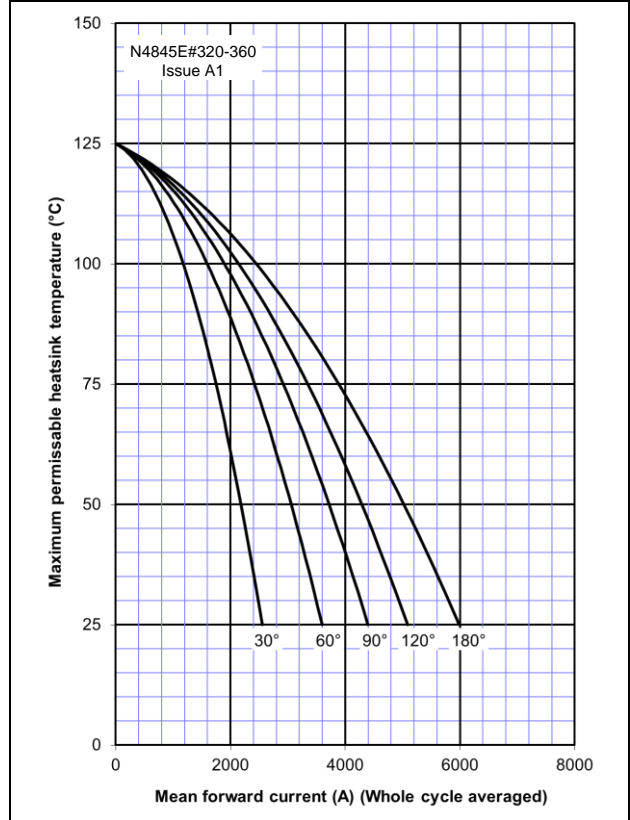


Figure 11 – On-state current vs. Power dissipation – Double Side Cooled (Square wave)

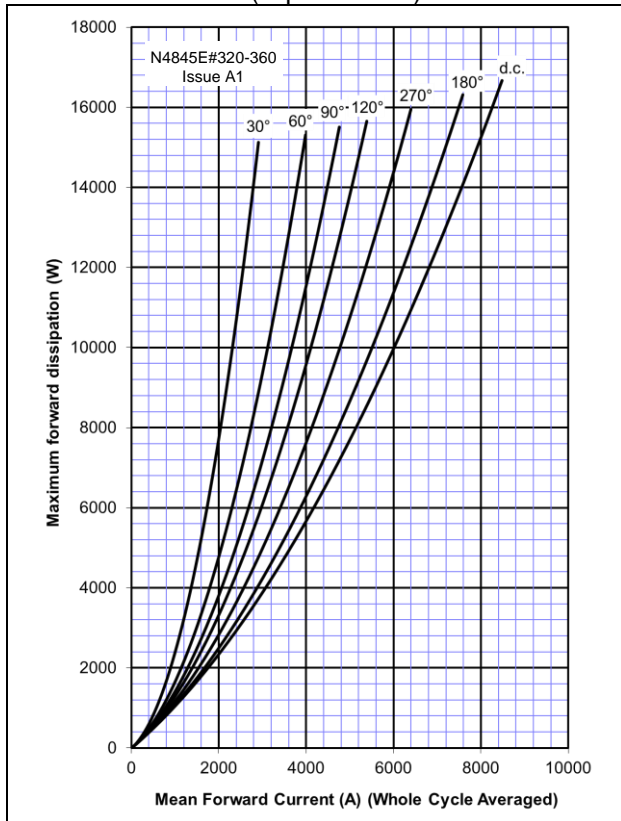


Figure 12 – On-state current vs. Heatsink temperature - Double Side Cooled (Square wave)

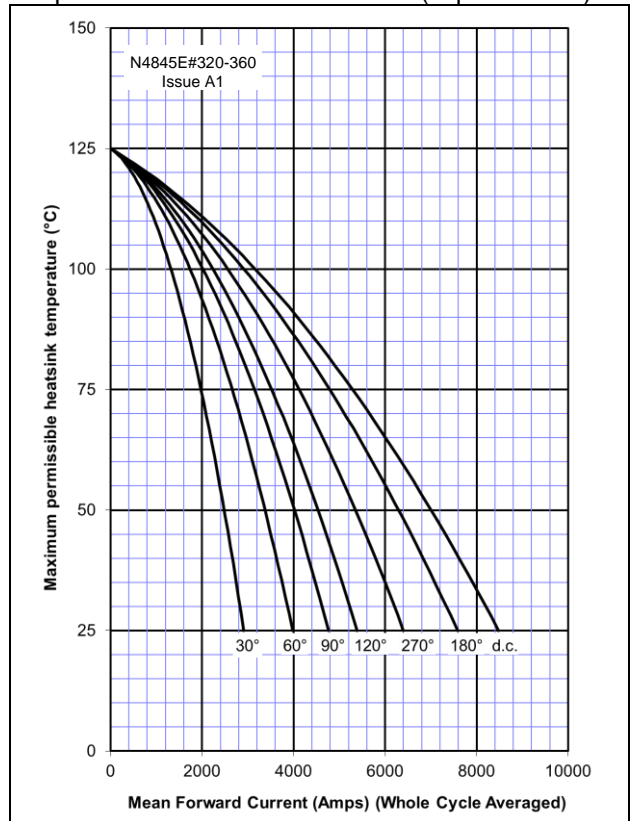


Figure 13 – On-state current vs. Power dissipation – Cathode Side Cooled (Sine wave)

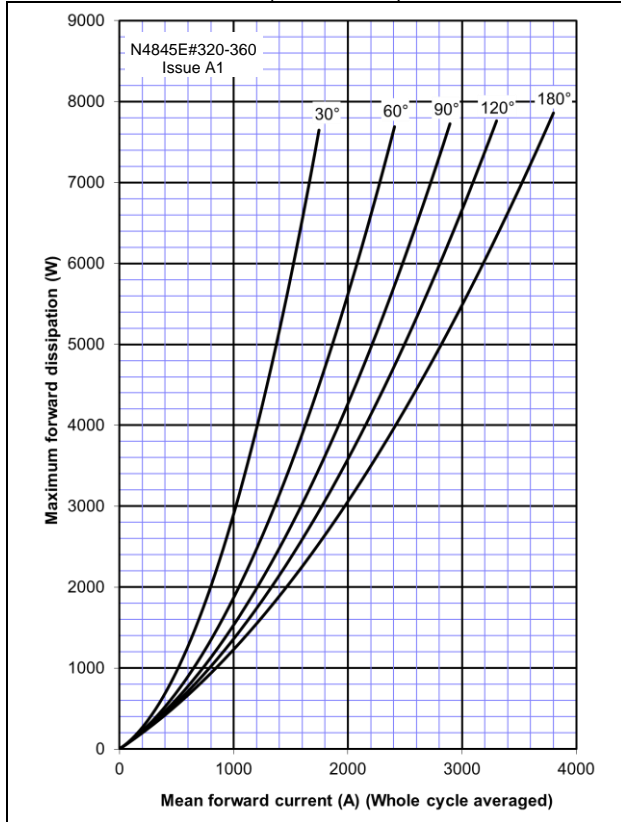


Figure 14 – On-state current vs. Heatsink temperature - Cathode Side Cooled (Sine wave)

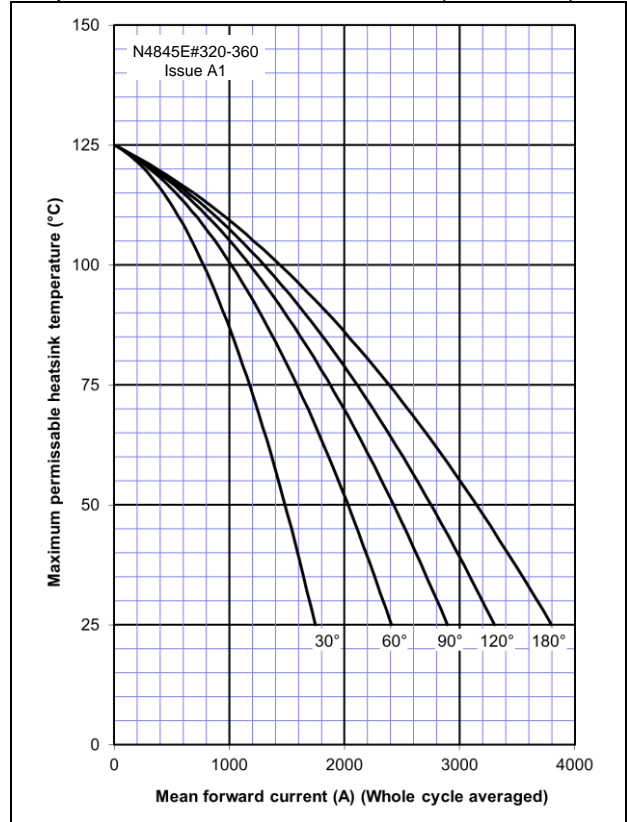


Figure 15 – On-state current vs. Power dissipation – Cathode Side Cooled (Square wave)

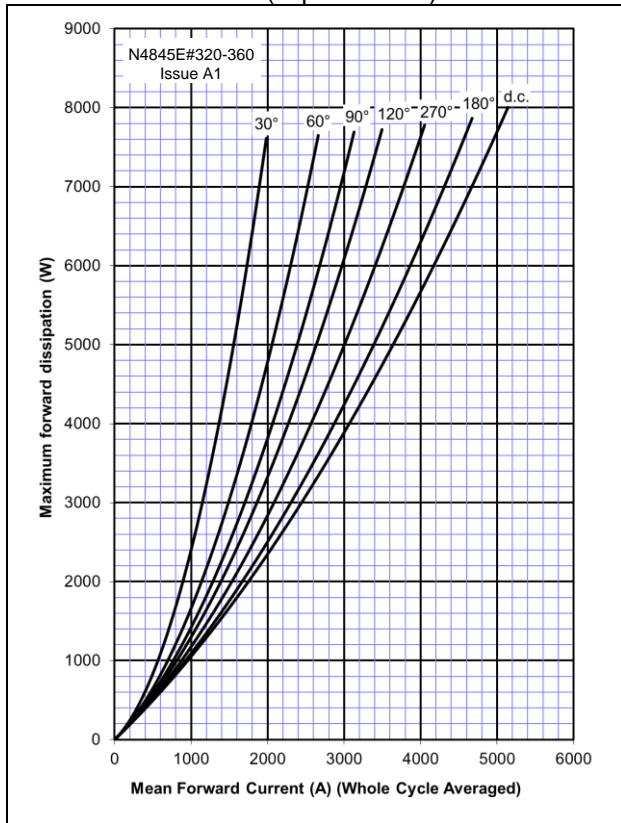


Figure 16 – On-state current vs. Heatsink temperature - Cathode Side Cooled (Square wave)

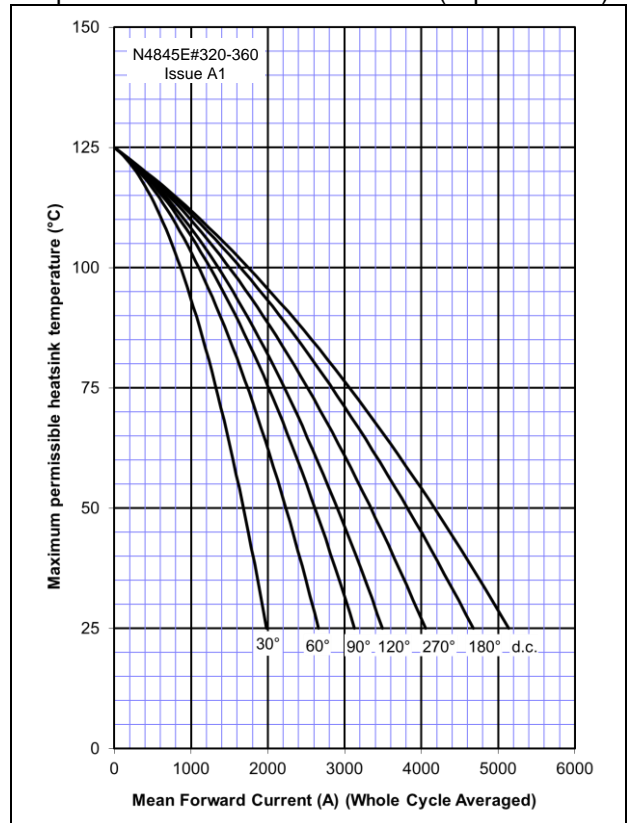
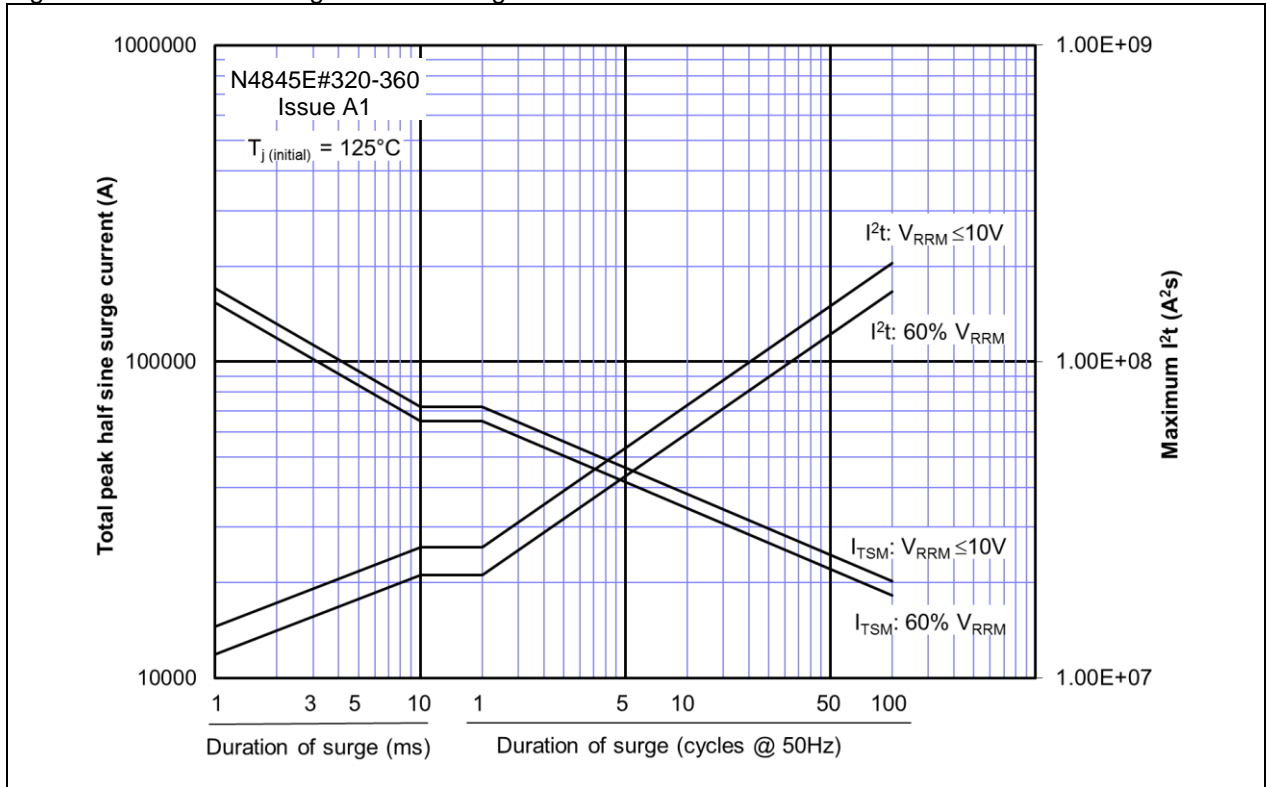
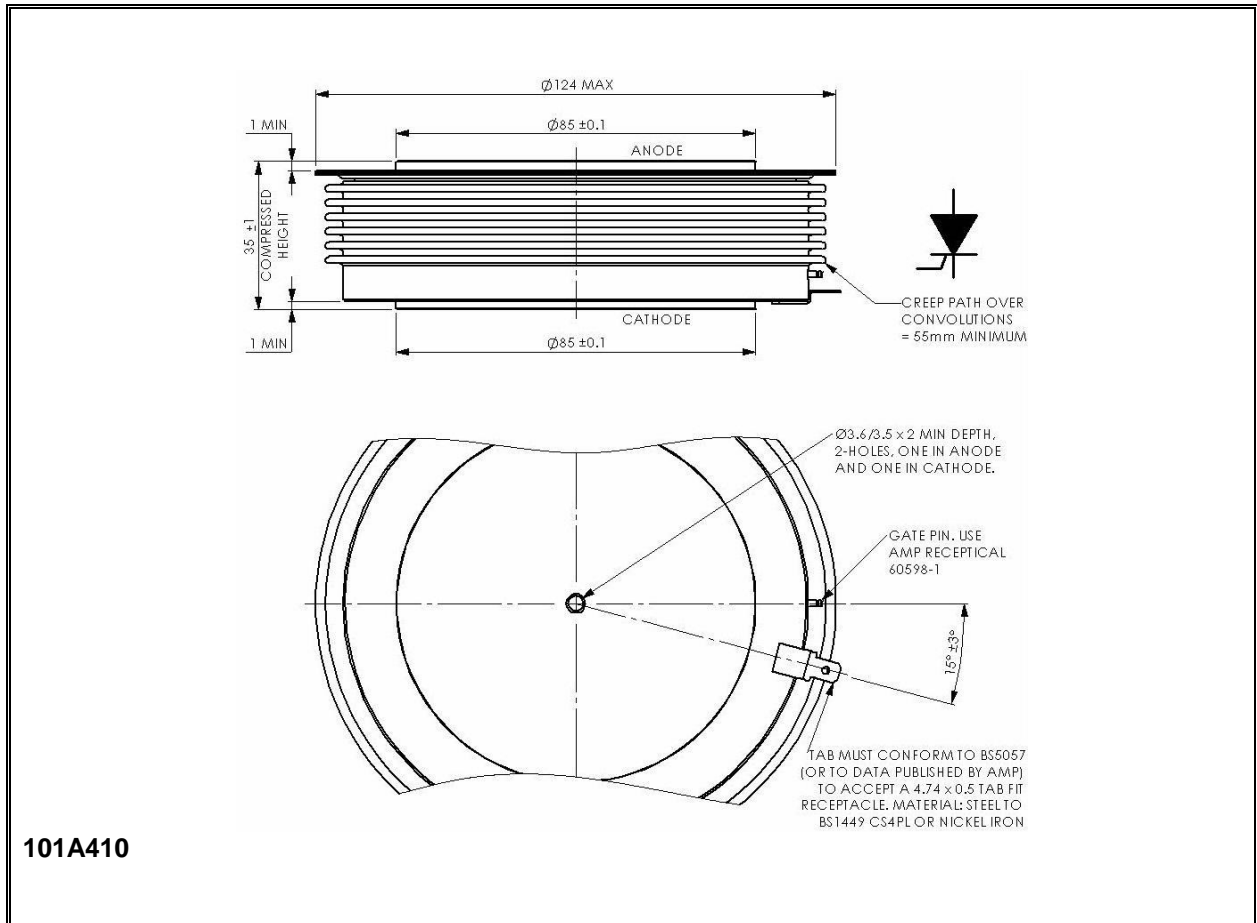


Figure 17 – Maximum surge and I²t Ratings



Outline Drawing & Ordering Information

ORDERING INFORMATION

(Please quote 10 digit code as below)

| N4845 | E# | ◆ ◆ | 0 |
|-----------------|--|-------------------------|--------------------------|
| Fixed Type Code | Fixed Outline Code EE 35mm clamp height capsule EY 35mm clamp height non-rupture rated capsule | Voltage Code 32 & 36 | Fixed turn-off time code |

 Typical order code: N4845EE360 – 3600V V_{DRM} , V_{RRM} , 1000V/ μ s dv/dt, 35mm clamp height capsule.

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