

## Phase Control Thyristor

### Type N4803FC300-350

Old Type No.: N1683CH29-35

#### Absolute Maximum Ratings

|           | VOLTAGE RATINGS                                 | MAXIMUM LIMITS | UNITS |
|-----------|-------------------------------------------------|----------------|-------|
| $V_{DRM}$ | Repetitive peak off-state voltage, (note 1)     | 3000-3500      | V     |
| $V_{DSM}$ | Non-repetitive peak off-state voltage, (note 1) | 3000-3500      | V     |
| $V_{RRM}$ | Repetitive peak reverse voltage, (note 1)       | 3000-3500      | V     |
| $V_{RSM}$ | Non-repetitive peak reverse voltage, (note 1)   | 3100-3600      | V     |

|               | OTHER RATINGS                                                          | MAXIMUM LIMITS    | UNITS       |
|---------------|------------------------------------------------------------------------|-------------------|-------------|
| $I_{T(AV)}$   | Mean on-state current. $T_{sink}=55^{\circ}C$ , (note 2)               | 4803              | A           |
| $I_{T(AV)}$   | Mean on-state current. $T_{sink}=85^{\circ}C$ , (note 2)               | 3356              | A           |
| $I_{T(AV)}$   | Mean on-state current. $T_{sink}=85^{\circ}C$ , (note 3)               | 2072              | A           |
| $I_{T(RMS)}$  | Nominal RMS on-state current. $T_{sink}=25^{\circ}C$ , (note 2)        | 9453              | A           |
| $I_{T(d.c.)}$ | D.C. on-state current. $T_{sink}=25^{\circ}C$ , (note 4)               | 8362              | A           |
| $I_{TSM}$     | Peak non-repetitive surge $t_p=10ms$ , $V_{rm}=0.6V_{RRM}$ , (note 5)  | 60                | kA          |
| $I_{TSM2}$    | Peak non-repetitive surge $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)     | 67                | kA          |
| $I^2t$        | $I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}=0.6V_{RRM}$ , (note 5) | $18.0\times 10^6$ | $A^2s$      |
| $I^2t$        | $I^2t$ capacity for fusing $t_p=10ms$ , $V_{rm}\leq 10V$ , (note 5)    | $22.5\times 10^6$ | $A^2s$      |
| $di_T/dt$     | Maximum rate of rise of on-state current (repetitive), (Note 6)        | 150               | $A/\mu s$   |
|               | Maximum rate of rise of on-state current (non-repetitive), (Note 6)    | 300               | $A/\mu s$   |
| $V_{RGM}$     | Peak reverse gate voltage                                              | 5                 | V           |
| $P_{G(AV)}$   | Mean forward gate power                                                | 5                 | W           |
| $P_{GM}$      | Peak forward gate power                                                | 50                | W           |
| $V_{GD}$      | Non-trigger gate voltage, (Note 7)                                     | 0.25              | V           |
| $T_{HS}$      | Operating temperature range                                            | -40 to +125       | $^{\circ}C$ |
| $T_{stg}$     | Storage temperature range                                              | -40 to +150       | $^{\circ}C$ |

Notes: -

- 1) De-rating factor of 0.13% per  $^{\circ}C$  is applicable for  $T_j$  below  $25^{\circ}C$ .
- 2) Double side cooled, single phase; 50Hz,  $180^{\circ}$  half-sinewave.
- 3) Single side cooled, single phase; 50Hz,  $180^{\circ}$  half-sinewave.
- 4) Double side cooled.
- 5) Half-sinewave,  $125^{\circ}C$   $T_j$  initial.
- 6)  $V_D=67\% V_{DRM}$ ,  $I_{TM}=1000A$ ,  $I_{FG}=2A$ ,  $t_r\leq 0.5\mu s$ ,  $T_{case}=125^{\circ}C$ .
- 7) Rated  $V_{DRM}$ .

**Characteristics**

|                  | PARAMETER                                  | MIN. | TYP.  | MAX.   | TEST CONDITIONS (Note 1)                                                                                                                            | UNITS |
|------------------|--------------------------------------------|------|-------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| V <sub>TM</sub>  | Maximum peak on-state voltage              | -    | -     | 1.6    | I <sub>TM</sub> =6000A                                                                                                                              | V     |
| V <sub>0</sub>   | Threshold voltage                          | -    | -     | 0.92   |                                                                                                                                                     | V     |
| r <sub>s</sub>   | Slope resistance                           | -    | -     | 0.11   |                                                                                                                                                     | mΩ    |
| dv/dt            | Critical rate of rise of off-state voltage | 1000 | -     | -      | V <sub>D</sub> =80% V <sub>DRM</sub> , Linear ramp, gate o/c                                                                                        | V/μs  |
| I <sub>DRM</sub> | Peak off-state current                     | -    | -     | 300    | Rated V <sub>DRM</sub>                                                                                                                              | mA    |
| I <sub>RRM</sub> | Peak reverse current                       | -    | -     | 300    | Rated V <sub>RRM</sub>                                                                                                                              | mA    |
| V <sub>GT</sub>  | Gate trigger voltage                       | -    | -     | 3.0    | T <sub>J</sub> =25°C, V <sub>D</sub> =10V, I <sub>T</sub> =3A                                                                                       | V     |
| I <sub>GT</sub>  | Gate trigger current                       | -    | -     | 300    |                                                                                                                                                     | mA    |
| I <sub>H</sub>   | Holding current                            | -    | -     | 1000   | T <sub>J</sub> =25°C                                                                                                                                | mA    |
| t <sub>gd</sub>  | Gate controlled turn-on delay time         | -    | 1.0   | 2.0    | I <sub>FG</sub> =2A, t <sub>r</sub> =0.5μs, V <sub>D</sub> =67%V <sub>DRM</sub> , T <sub>J</sub> =25°C                                              | μs    |
| t <sub>gt</sub>  | Turn-on time                               | -    | 2.0   | 3.0    | I <sub>TM</sub> =2000A, di/dt=10A/μs, T <sub>J</sub> =25°C                                                                                          | μs    |
| Q <sub>rr</sub>  | Recovered Charge                           | -    | 12000 | -      | I <sub>TM</sub> =4000A, t <sub>p</sub> =2ms, di/dt=10A/μs, V <sub>r</sub> =50V                                                                      | μC    |
| Q <sub>ra</sub>  | Recovered Charge, 50% chord                | -    | 7000  | 10500  |                                                                                                                                                     | μC    |
| I <sub>rm</sub>  | Reverse recovery current                   | -    | 280   | -      |                                                                                                                                                     | A     |
| t <sub>rr</sub>  | Reverse recovery time, 50% chord           | -    | 50    | -      |                                                                                                                                                     | μs    |
| t <sub>q</sub>   | Turn-off time                              | -    | 620   | -      | I <sub>TM</sub> =4000A, t <sub>p</sub> =2ms, di/dt=10A/μs, V <sub>r</sub> =50V, V <sub>dr</sub> =67%V <sub>DRM</sub> , dV <sub>dr</sub> /dt=20V/μs  | μs    |
|                  |                                            | -    | 850   | -      | I <sub>TM</sub> =4000A, t <sub>p</sub> =2ms, di/dt=10A/μs, V <sub>r</sub> =50V, V <sub>dr</sub> =67%V <sub>DRM</sub> , dV <sub>dr</sub> /dt=200V/μs |       |
| R <sub>θ</sub>   | Thermal resistance, junction to heatsink   | -    | -     | 0.0065 | Double side cooled                                                                                                                                  | K/W   |
|                  |                                            | -    | -     | 0.013  | Single side cooled                                                                                                                                  | K/W   |
| F                | Mounting force                             | 81   | -     | 99     |                                                                                                                                                     | kN    |
| W <sub>t</sub>   | Weight                                     | -    | 2.8   | -      |                                                                                                                                                     | kg    |

Notes: -

1) Unless otherwise indicated T<sub>J</sub>=125°C.

**Notes on Ratings and Characteristics****1.0 Voltage Grade Table**

| Voltage Grade | $V_{DRM}$ $V_{DSM}$ $V_{RRM}$<br>V | $V_{RSM}$<br>V | $V_D$ $V_R$<br>DC V |
|---------------|------------------------------------|----------------|---------------------|
| 30            | 3000                               | 3100           | 1860                |
| 31            | 3100                               | 3200           | 1920                |
| 32            | 3200                               | 3300           | 1980                |
| 33            | 3300                               | 3400           | 2040                |
| 34            | 3400                               | 3500           | 2100                |
| 35            | 3500                               | 3600           | 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**

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

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

Where  $V_0=0.92V$ ,  $r_s=0.11m\Omega$ ,

$R_{th}$  = 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  | 0.00717 | 0.00707 | 0.00698 | 0.00689 | 0.00673 | 0.00652 | 0.0065 |
| Square wave Single Side Cooled  | 0.0137  | 0.01359 | 0.01349 | 0.0134  | 0.01323 | 0.01301 | 0.013  |
| Sine wave Double Side Cooled    | 0.00709 | 0.00697 | 0.00687 | 0.00678 | 0.00654 |         |        |
| Sine wave Single Side Cooled    | 0.0136  | 0.01348 | 0.01337 | 0.01328 | 0.01303 |         |        |

| 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 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                  | 0.861185                   |
| B                  | 0.02416985                 |
| C                  | $1.342070 \times 10^{-4}$  |
| D                  | $-3.560819 \times 10^{-3}$ |

## 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.

$\tau_p$  = Time Constant of  $r_{th}$  term.

| D.C. Double Side Cooled |                           |                           |                           |                           |
|-------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Term                    | 1                         | 2                         | 4                         | 5                         |
| $r_p$                   | $3.424745 \times 10^{-3}$ | $1.745273 \times 10^{-3}$ | $8.532017 \times 10^{-4}$ | $3.457329 \times 10^{-4}$ |
| $\tau_p$                | 1.125391                  | 0.1878348                 | 0.02788979                | $8.430889 \times 10^{-3}$ |

| D.C. Single Side Cooled |                           |                           |                           |                          |
|-------------------------|---------------------------|---------------------------|---------------------------|--------------------------|
| Term                    | 1                         | 2                         | 5                         | 6                        |
| $r_p$                   | $8.375269 \times 10^{-3}$ | $2.518437 \times 10^{-3}$ | $1.193758 \times 10^{-3}$ | $7.45432 \times 10^{-4}$ |
| $\tau_p$                | 8.929845                  | 0.4711304                 | 0.08221244                | 0.01221961               |

**Curves**

Figure 1 – On-state characteristics of Limit device

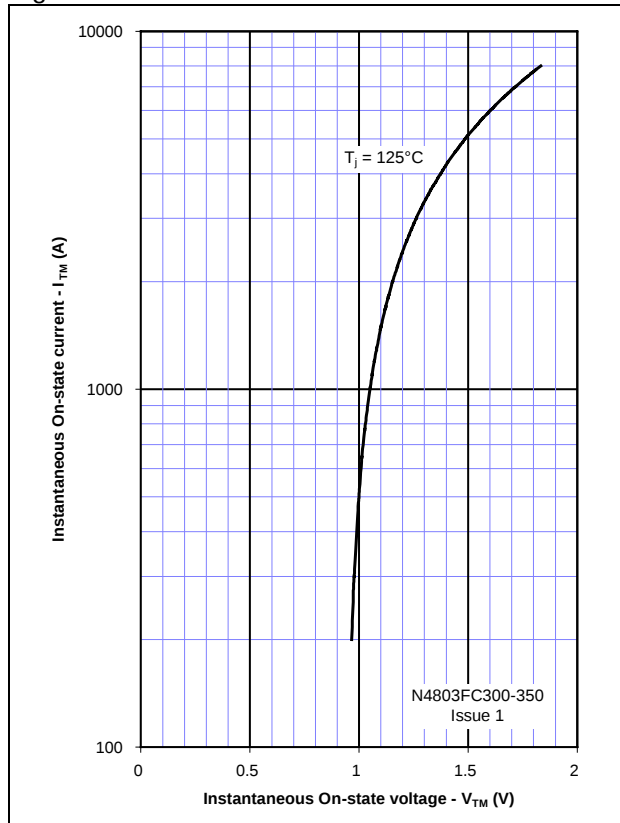


Figure 2 – Transient Thermal Impedance

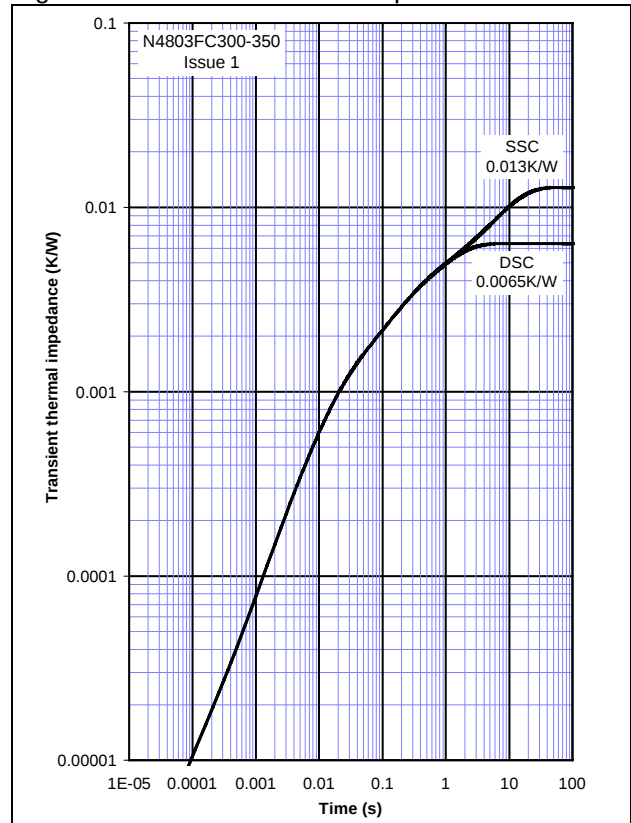


Figure 3 – Gate Characteristics - Trigger Limits

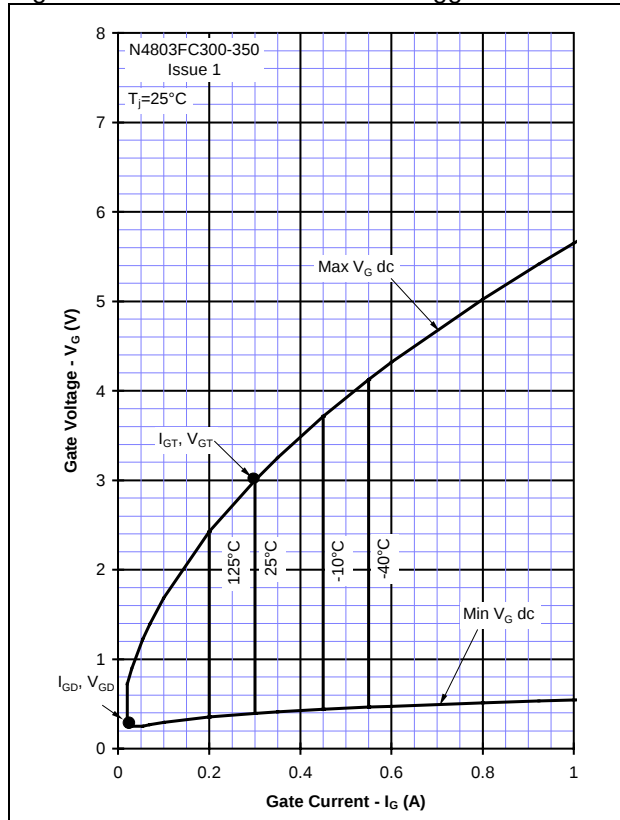


Figure 4 – Gate Characteristics - Power Curves

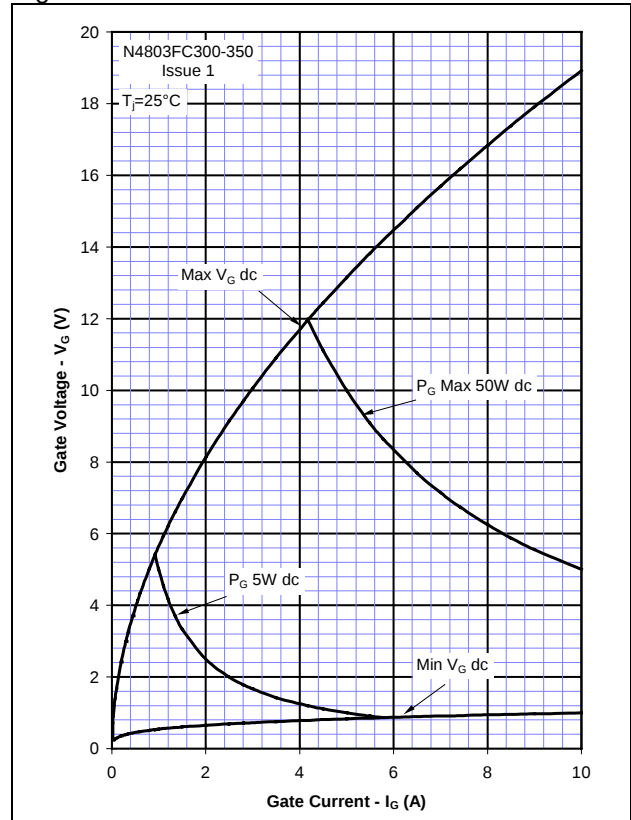


Figure 5 – Recovered Charge,  $Q_{rr}$

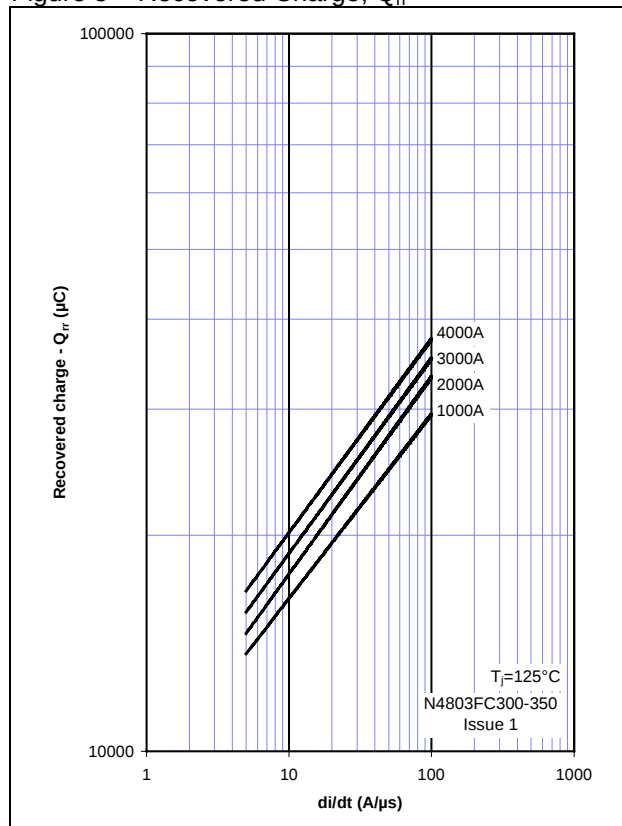


Figure 6 – Recovered charge,  $Q_{ra}$  (50% chord)

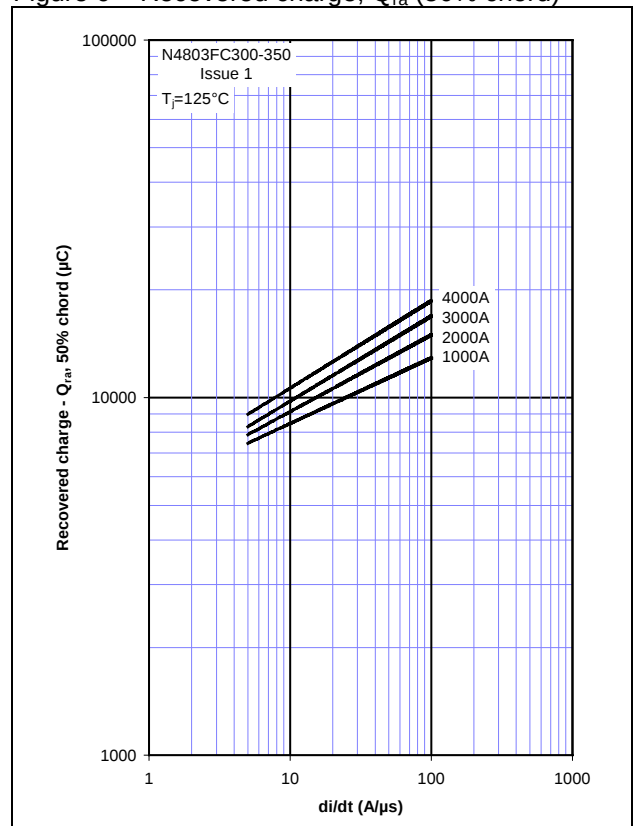


Figure 7 – Reverse recovery current,  $I_{rm}$

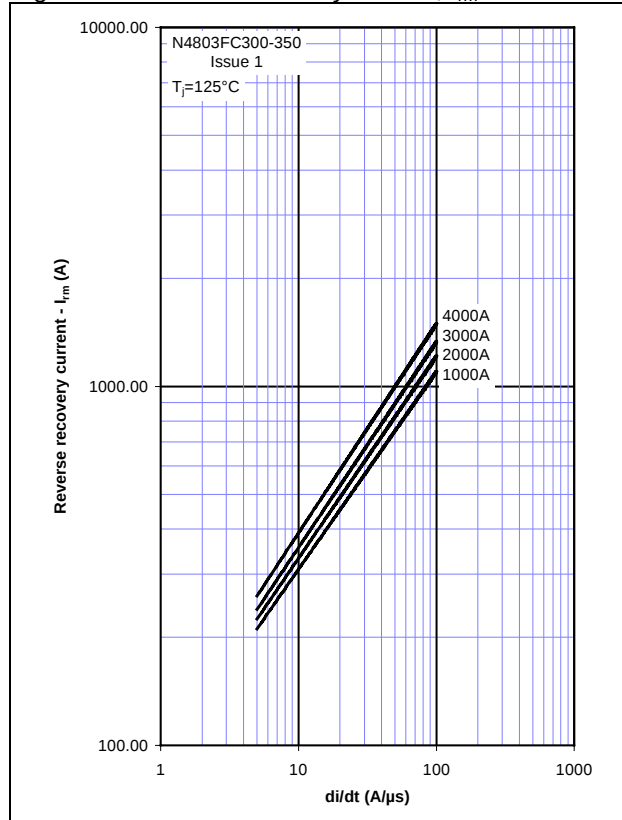


Figure 8 – Reverse recovery time,  $t_{rr}$

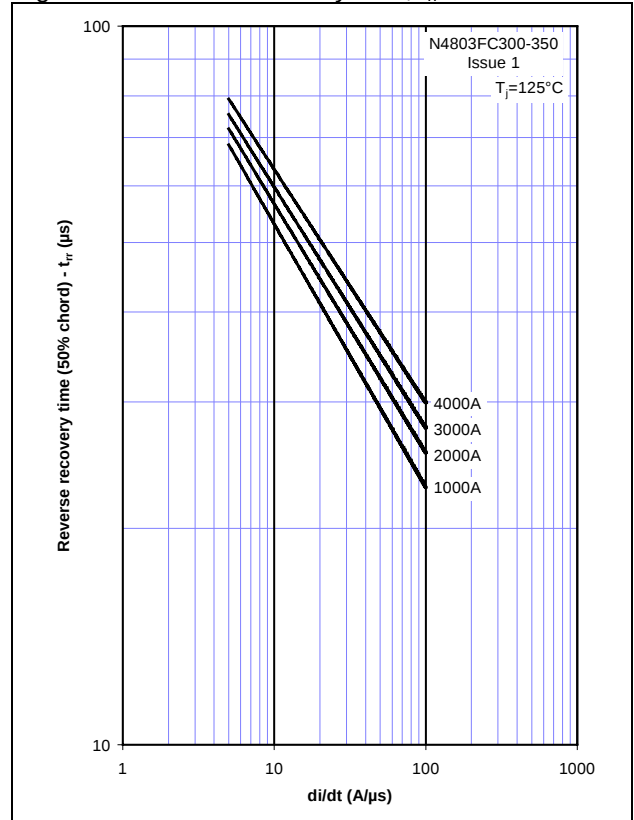


Figure 9 – On-state current vs. Power dissipation – Double Side Cooled (Sine wave)

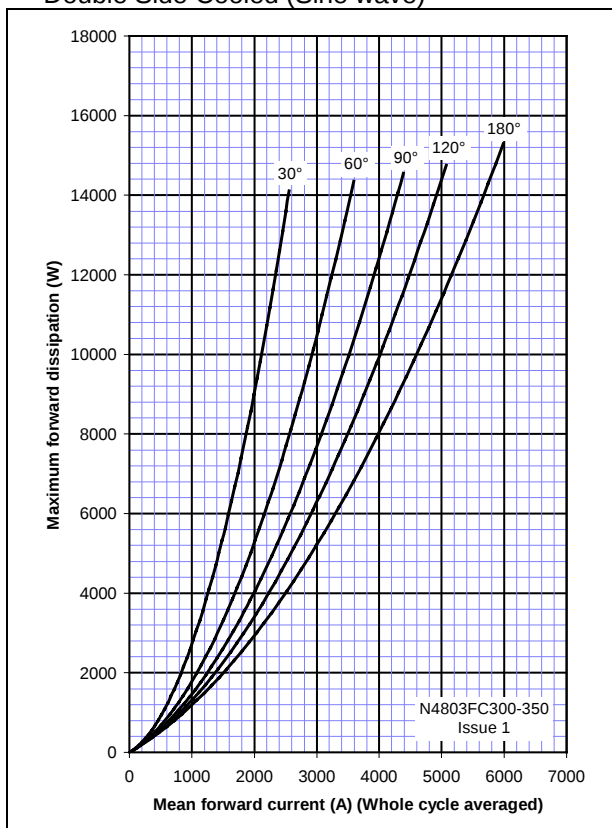


Figure 10 – On-state current vs. Heatsink temperature - Double Side Cooled (Sine wave)

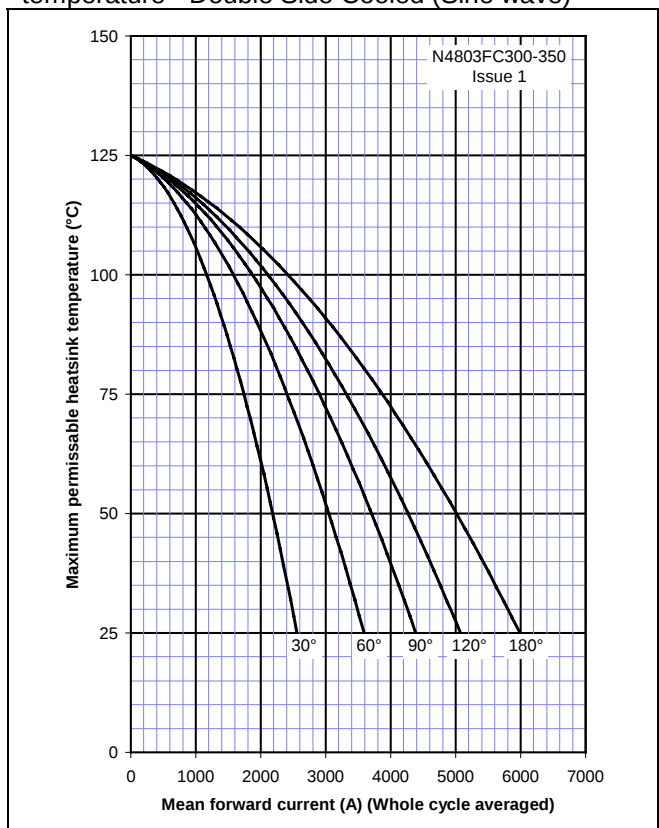


Figure 11 – On-state current vs. Power dissipation – Double Side Cooled (Square wave)

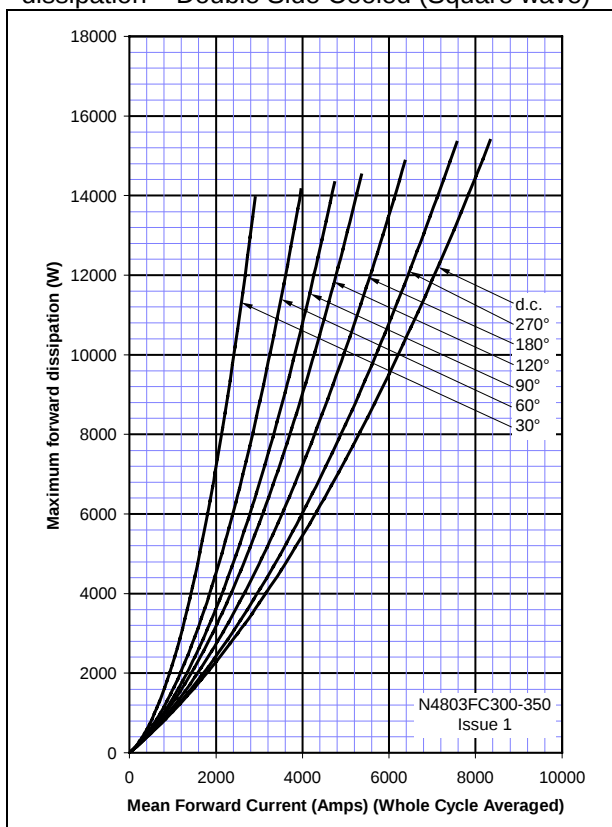


Figure 12 – On-state current vs. Heatsink temperature - Double Side Cooled (Square wave)

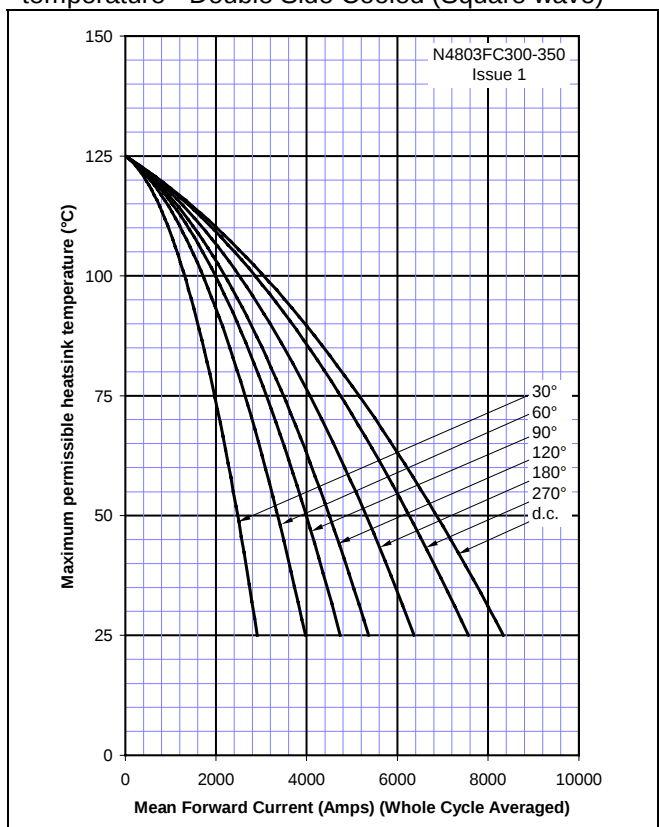


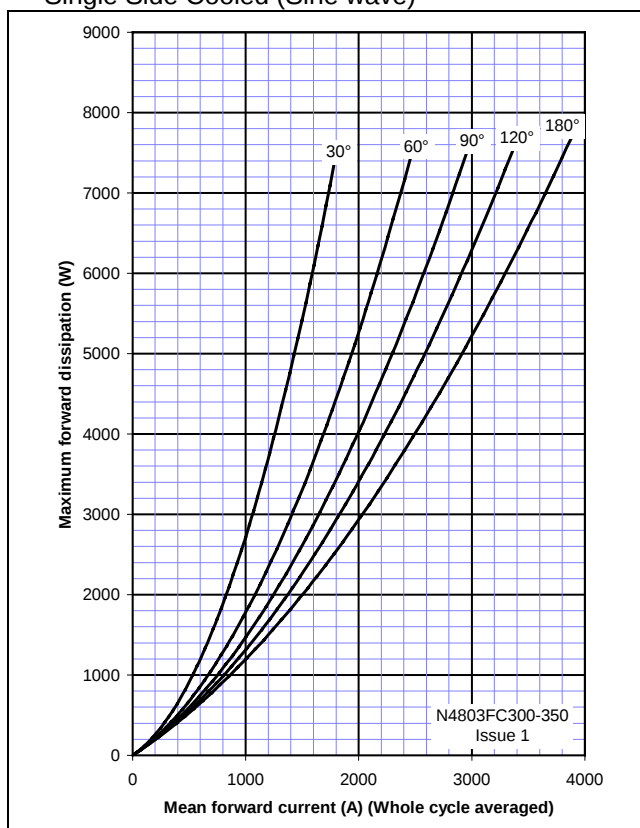
Figure 13 – On-state current vs. Power dissipation  
– Single Side Cooled (Sine wave)

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

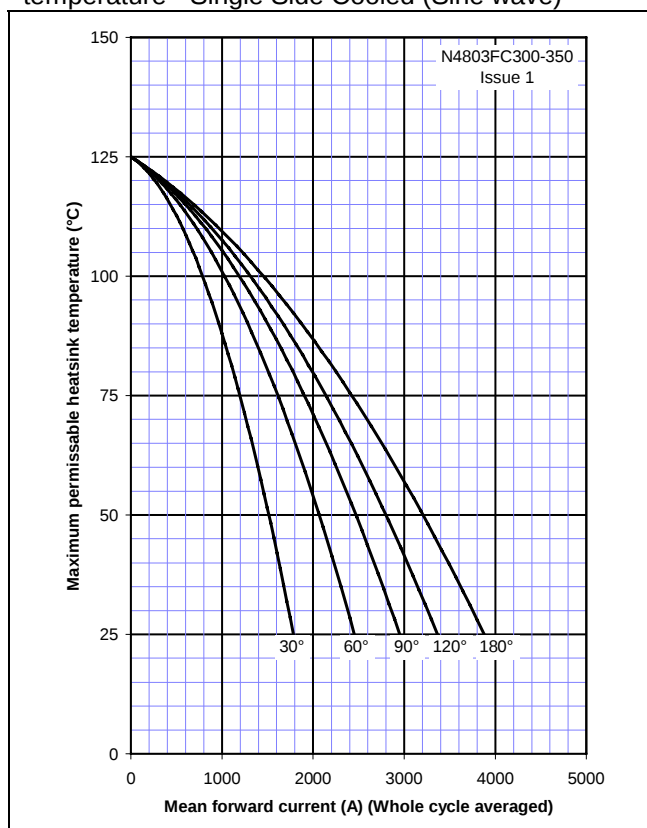
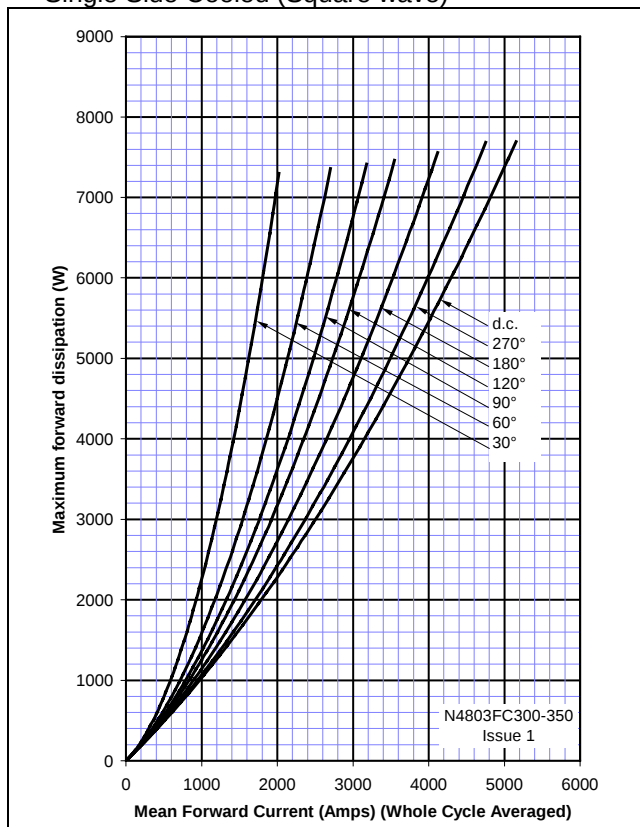
Figure 15 – On-state current vs. Power dissipation  
– Single Side Cooled (Square wave)

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

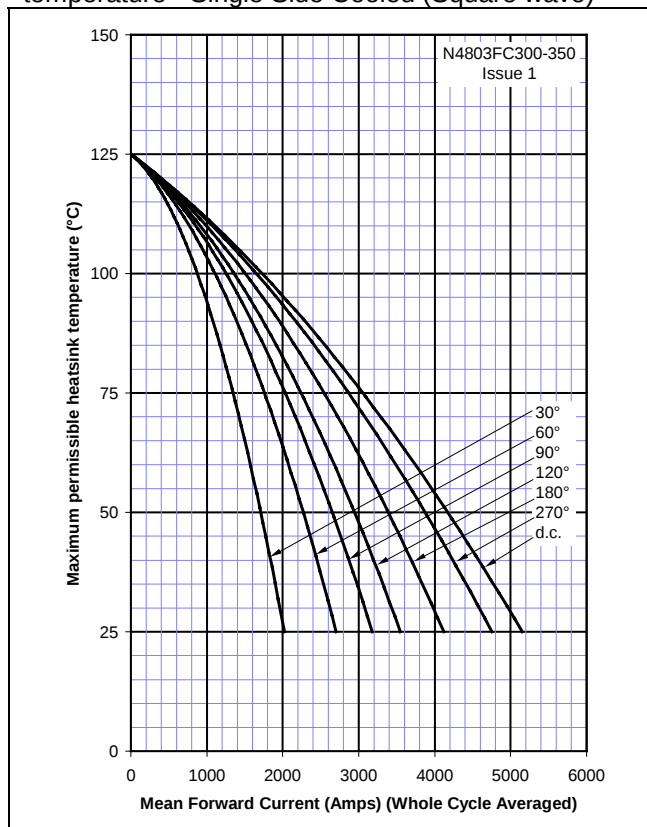
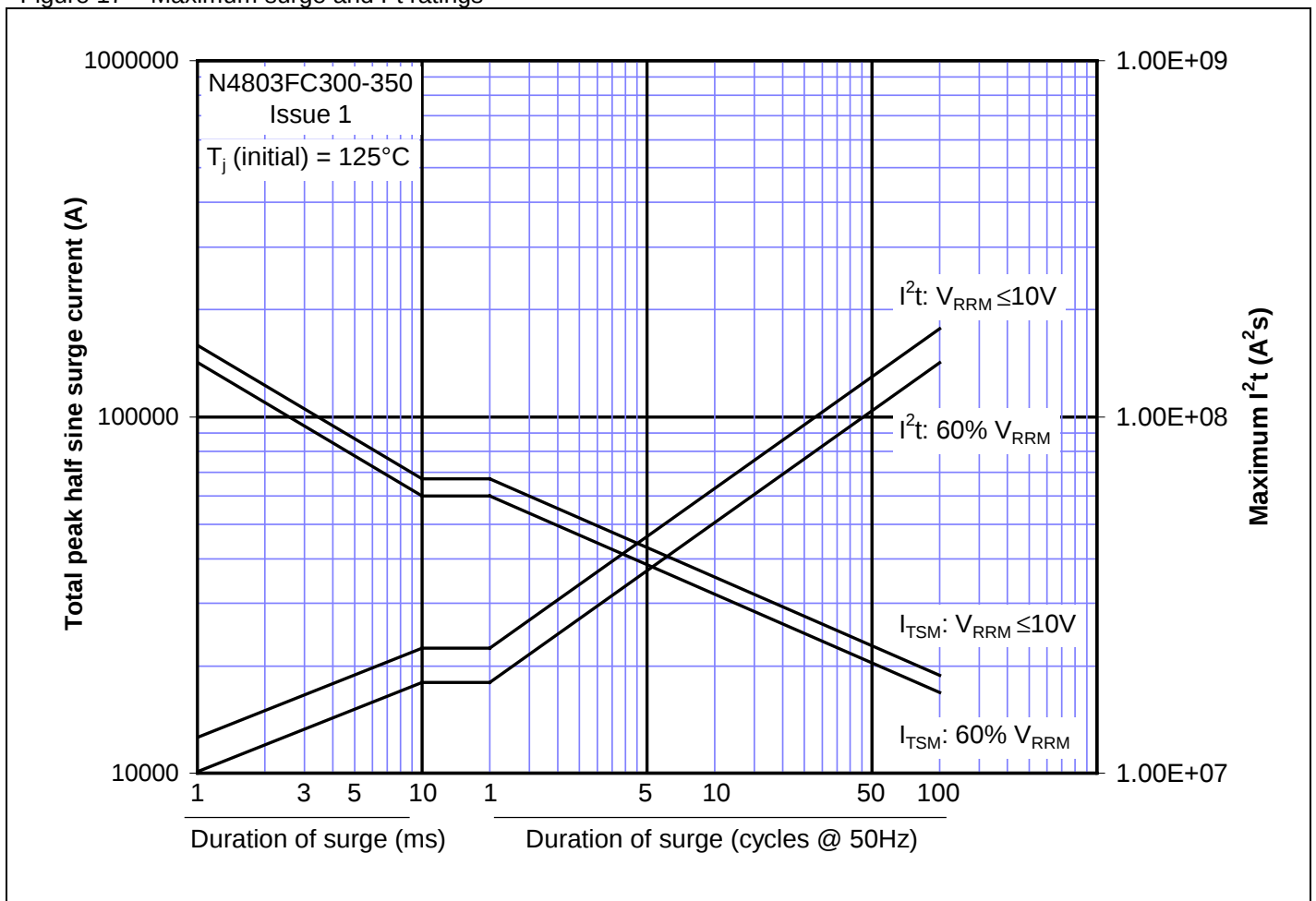
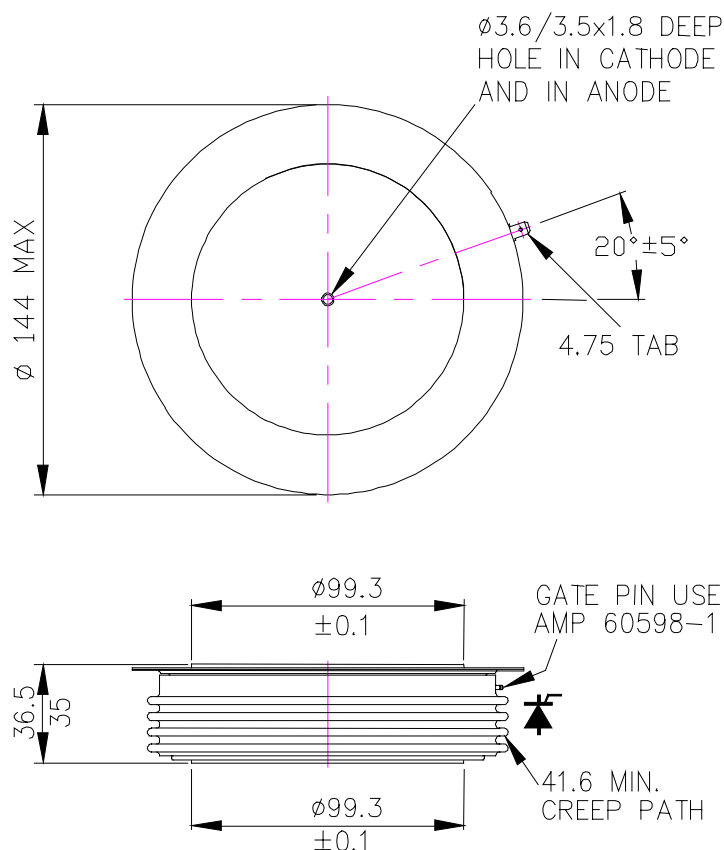


Figure 17 – Maximum surge and  $I^2t$  ratings

**Outline Drawing & Ordering Information**

101A322

**ORDERING INFORMATION**

(Please quote 10 digit code as below)

| N4803              | FC                    | ◆◆                                     | 0          |
|--------------------|-----------------------|----------------------------------------|------------|
| Fixed<br>Type Code | Fixed<br>outline code | Voltage code<br>$V_{DRM}/100$<br>30-35 | Fixed code |

Order code: N4803FC320 – 3200V  $V_{RRM}$ , 36.5mm clamp height capsule.

**IXYS Semiconductor GmbH**  
 Edisonstraße 15  
 D-68623 Lampertheim  
 Tel: +49 6206 503-0  
 Fax: +49 6206 503-627  
 E-mail: [marcom@ixys.de](mailto:marcom@ixys.de)

**IXYS Corporation**  
 3540 Bassett Street  
 Santa Clara CA 95054 USA  
 Tel: +1 (408) 982 0700  
 Fax: +1 (408) 496 0670  
 E-mail: [sales@ixys.net](mailto:sales@ixys.net)

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**Westcode Semiconductors Ltd**  
 PO Box 57 Chippenham  
 Wiltshire SN15 1JL  
 Tel: +44 (0)1249 444524  
 Fax: +44 (0)1249 659448  
 E-mail: [WSL.sales@westcode.com](mailto:WSL.sales@westcode.com)

**Westcode Semiconductors Inc**  
 3270 Cherry Avenue  
 Long Beach CA 90807 USA  
 Tel: +1 (562) 595 6971  
 Fax: +1 (562) 595 8182  
 E-mail: [WSI.sales@westcode.com](mailto:WSI.sales@westcode.com)

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