Low switching losses
Low reverse recovery charge
Distributed amplified gate for high $di_T/dt$

# Fast Thyristor
# Type TFI573-2000-12

| | | | |
|---|---|---|---|
| Mean on-state current | | $I_{TAV}$ | 2000 A |
| Repetitive peak off-state voltage | | $V_{DRM}$ | 1000 ÷ 1200 V |
| Repetitive peak reverse voltage | | $V_{RRM}$ | |
| Turn-off time | | $t_q$ | 10.0; 12.5; 16.0; 20.0 μs |
| $V_{DRM}$, $V_{RRM}$, V | 1000 | | 1200 |
| Voltage code | 10 | | 12 |
| $T_j$, °C | – 60 ÷ 125 | | |

## MAXIMUM ALLOWABLE RATINGS

| Symbols and parameters | | Units | Values | Test conditions | |
|---|---|---|---|---|---|
| **ON-STATE** | | | | | |
| $I_{TAV}$ | Mean on-state current | A | 2000<br>3825 | $T_c$=94 °C; Double side cooled;<br>$T_c$=55 °C; Double side cooled;<br>180° half-sine wave; 50 Hz | |
| $I_{TRMS}$ | RMS on-state current | A | 3140 | $T_c$=94 °C; Double side cooled;<br>180° half-sine wave; 50 Hz | |
| $I_{TSM}$ | Surge on-state current | kA | 52.0<br>60.0 | $T_j$=$T_{j\,max}$<br>$T_j$=25 °C | 180° half-sine wave; 50 Hz ($t_p$=10 ms); single pulse;<br>$V_D$=$V_R$=0 V;<br>Gate pulse:$I_G$=$I_{FGM}$; $V_G$=20 V;<br>$t_{GP}$=50 μs; $di_G/dt$=2 A/μs |
| | | | 55.0<br>63.0 | $T_j$=$T_{j\,max}$<br>$T_j$=25 °C | 180° half-sine wave; 60 Hz ($t_p$=8.3 ms); single pulse;<br>$V_D$=$V_R$=0 V;<br>Gate pulse:$I_G$=$I_{FGM}$; $V_G$=20 V;<br>$t_{GP}$=50 μs; $di_G/dt$=2 A/μs |
| $I^2t$ | Safety factor | $A^2s{\cdot}10^3$ | 13520<br>18000 | $T_j$=$T_{j\,max}$<br>$T_j$=25 °C | 180° half-sine wave; 50 Hz ($t_p$=10 ms); single pulse;<br>$V_D$=$V_R$=0 V;<br>Gate pulse:$I_G$=$I_{FGM}$; $V_G$=20 V;<br>$t_{GP}$=50 μs; $di_G/dt$=2 A/μs |
| | | | 12550<br>16470 | $T_j$=$T_{j\,max}$<br>$T_j$=25 °C | 180° half-sine wave; 60 Hz ($t_p$=8.3 ms); single pulse;<br>$V_D$=$V_R$=0 V;<br>Gate pulse:$I_G$=$I_{FGM}$; $V_G$=20 V;<br>$t_{GP}$=50 μs; $di_G/dt$=2 A/μs |
| **BLOCKING** | | | | | |
| $V_{DRM}$, $V_{RRM}$ | Repetitive peak off-state and Repetitive peak reverse voltages | V | 1000÷1200 | $T_{j\,min}$< $T_j$ <$T_{j\,max}$;<br>180° half-sine wave; 50 Hz;<br>Gate open | |
| $V_{DSM}$, $V_{RSM}$ | Non-repetitive peak off-state and Non-repetitive peak reverse voltages | V | 1100÷1300 | $T_{j\,min}$< $T_j$ <$T_{j\,max}$;<br>180° half-sine wave; 50 Hz;single pulse;<br>Gate open | |
| $V_D$, $V_R$ | Direct off-state and Direct reverse voltages | V | 0.75·$V_{DRM}$<br>0.75·$V_{RRM}$ | $T_j$=$T_{j\,max}$;<br>Gate open | |

| | | | | |
|---|---|---|---|---|
| **TRIGGERING** | | | | |
| $I_{FGM}$ | Peak forward gate current | A | 10 | $T_j=T_{j\,max}$ |
| $V_{RGM}$ | Peak reverse gate voltage | V | 5 | |
| $P_G$ | Gate power dissipation | W | 8 | $T_j=T_{j\,max}$ for DC gate current |
| **SWITCHING** | | | | |
| $(di_T/dt)_{crit}$ | Critical rate of rise of on-state current non-repetitive (f=1 Hz) | A/μs | 2500 | $T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; $I_{TM}=2\ I_{TAV}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20$ V; $t_{GP}=50$ μs; $di_G/dt=2$ A/μs |
| **THERMAL** | | | | |
| $T_{stg}$ | Storage temperature | °C | -60 ÷ 125 | |
| $T_j$ | Operating junction temperature | °C | -60 ÷ 125 | |
| **MECHANICAL** | | | | |
| F | Mounting force | kN | 40.0 ÷ 50.0 | |
| a | Acceleration | $m/s^2$ | 50<br>100 | Device unclamped<br>Device clamped |

## CHARACTERISTICS

| Symbols and parameters | | Units | Values | Conditions | |
|---|---|---|---|---|---|
| **ON-STATE** | | | | | |
| $V_{TM}$ | Peak on-state voltage, max | V | 1.55<br>2.15 | $T_j=T_{j\,max}$; $I_{TM}=4000$ A<br>$T_j=25$ °C; $I_{TM}=6280$ A | |
| $V_{T(TO)}$ | On-state threshold voltage, max | V | 1.40 | $T_j=T_{j\,max}$; $0.5\ \pi\ I_{TAV} < I_T < 1.5\ \pi\ I_{TAV}$ | |
| $r_T$ | On-state slope resistance, max | mΩ | 0.080 | | |
| $I_H$ | Holding current, max | mA | 1000 | $T_j=25$ °C; $V_D=12$ V; Gate open | |
| **BLOCKING** | | | | | |
| $I_{DRM}$, $I_{RRM}$ | Repetitive peak off-state and Repetitive peak reverse currents, max | mA | 300 | $T_j=T_{j\,max}$; $V_D=V_{DRM}$; $V_R=V_{RRM}$ | |
| $(dv_D/dt)_{crit}$ | Critical rate of rise of off-state voltage[1], min | V/μs | 1000 | $T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; Gate open | |
| **TRIGGERING** | | | | | |
| $V_{GT}$ | Gate trigger direct voltage, max | V | 5.00<br>3.00<br>2.00 | $T_j=T_{j\,min}$<br>$T_j=25$ °C<br>$T_j=T_{j\,max}$ | $V_D=12$ V; $I_D=3$ A; Direct gate current |
| $I_{GT}$ | Gate trigger direct current, max | mA | 500<br>300<br>200 | $T_j=T_{j\,min}$<br>$T_j=25$ °C<br>$T_j=T_{j\,max}$ | |
| $V_{GD}$ | Gate non-trigger direct voltage, min | V | 0.35 | $T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; Direct gate current | |
| $I_{GD}$ | Gate non-trigger direct current, min | mA | 15.00 | | |
| **SWITCHING** | | | | | |
| $t_{gd}$ | Delay time | μs | 2.00 | $T_j=25$ °C; $V_D=0.4 \cdot V_{DRM}$; $I_{TM}=I_{TAV}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20$ V; $t_{GP}=50$ μs; $di_G/dt=2$ A/μs | |
| $t_q$ | Turn-off time[2], max | μs | 10.0; 12.5; 16.0; 20.0 | $dv_D/dt=50$ V/μs; | $T_j=T_{j\,max}$; $I_{TM}=I_{TAV}$; $di_R/dt=-10$ A/μs; $V_R=100$V; $V_D=0.67\ V_{DRM}$ |
| | | | 12.5; 16.0; 20.0; 25.0 | $dv_D/dt=200$ V/μs; | |
| $Q_{rr}$ | Total recovered charge(linear), max | μC | 220 | $T_j=T_{j\,max}$; $I_{TM}=2000$ A; $di_R/dt=-50$ A/μs; $V_R=100$ V | |
| $t_{rr}$ | Reverse recovery time, max | μs | 3.8 | | |
| $I_{rrM}$ | Peak reverse recovery current, max | A | 115 | | |

| THERMAL | | | | | |
|---|---|---|---|---|---|
| $R_{thjc}$ | Thermal resistance, junction to case, max | °C/W | 0.0085 | Direct current | Double side cooled |
| $R_{thjc-A}$ | | | 0.0187 | | Anode side cooled |
| $R_{thjc-K}$ | | | 0.0153 | | Cathode side cooled |
| $R_{thck}$ | Thermal resistance, case to heatsink, max | °C/W | 0.0020 | Direct current | |
| **MECHANICAL** | | | | | |
| w | Weight, typ | g | 1500 | | |
| $D_s$ | Surface creepage distance | mm (inch) | 36.60 (1.441) | | |
| $D_a$ | Air strike distance | mm (inch) | 16.20 (0.638) | | |

## NOTES

[1] Critical rate of rise of off-state voltage

| Symbol of group | A2 |
|---|---|
| $(dv_D/dt)_{crit}$, V/μs | 1000 |

[2] Turn-off time ($dv_D/dt$=50 V/μs)

| Symbol of group | A4 | X3 | T3 | P3 |
|---|---|---|---|---|
| $t_q$, μs | 10.0 | 12.5 | 16.0 | 20.0 |

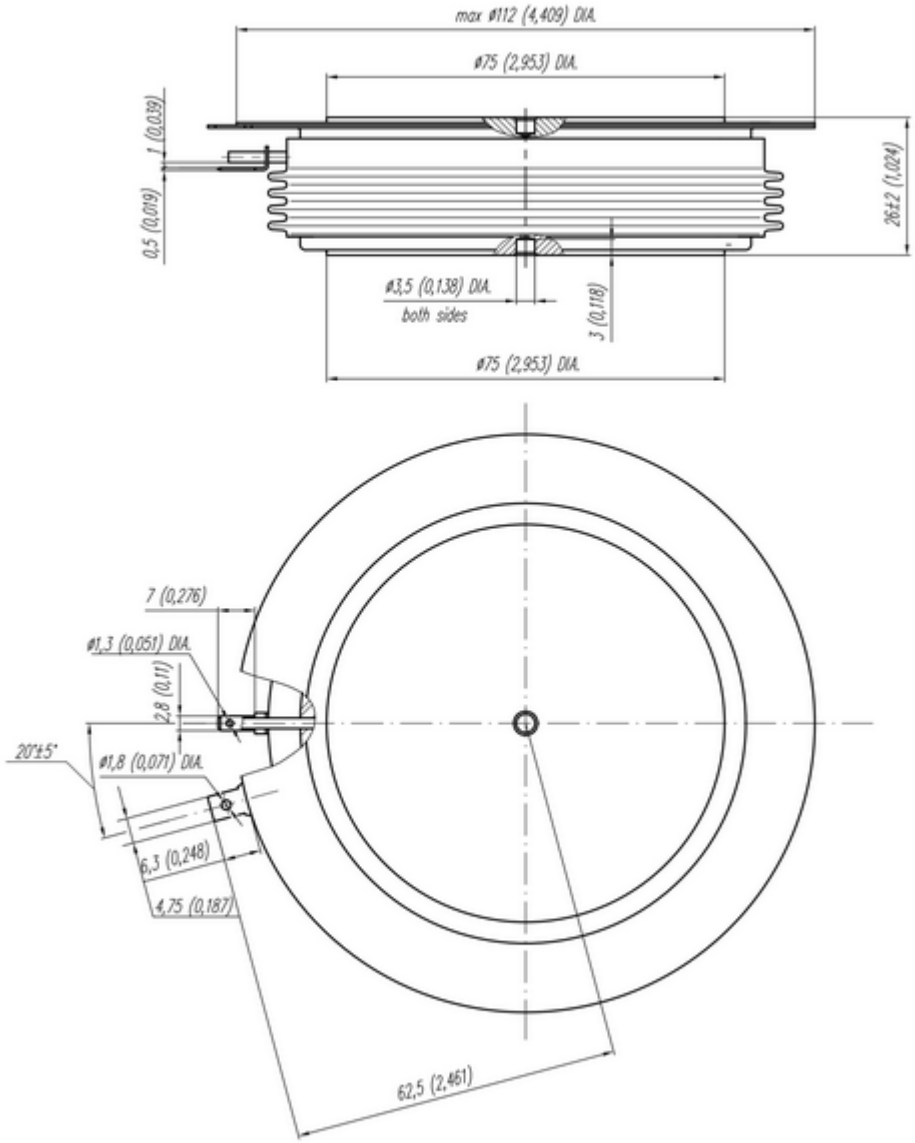
## PART NUMBERING GUIDE

| TFI | 573 | 2000 | 12 | A2 | A4 | N |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1. TFI — Fast Thyristor
   TFIS — Fast Thyristor with Distributed Amplified Gate
2. Design version
3. Mean on-state current, A
4. Voltage code
5. Critical rate of rise of off-state voltage
6. Group of turn-off time ($dv_D/dt$=50 V/μs)
7. Ambient conditions: N – normal; T – tropical

## OVERALL DIMENSIONS

**Package type: T.F2**




All dimensions in millimeters (inches)

**On-state characteristic model (see Fig. 1).**

Analytical function for On-state characteristic:

$$V_T = A + B \cdot i_T + C \cdot \ln(i_T + 1) + D \cdot \sqrt{i_T}$$

| | Coefficients | |
|---|---|---|
| | $T_j = 25^oC$ | $T_j = T_{j\,max}$ |
| **A** | 1.886396 | 1.150214 |
| **B** | 0.019465 | 0.062607 |
| **C** | 0.018317 | 0.024464 |
| **D** | 0.041506 | 0.055434 |

**Transient thermal impedance junction to case $Z_{thjc}$ model (see Fig. 2).**

Analytical function for Transient thermal impedance junction to case $Z_{thjc}$ for DC:

$$Z_{thjc} = \sum_{i=1}^{n} R_i \left( 1 - e^{-\frac{t}{\tau_i}} \right)$$

Where ***i*** = 1 to ***n***, ***n*** is the number of terms in the series.

**t** = Duration of heating pulse in seconds.
**$Z_{thjc}$** = Thermal resistance at time t.
**$R_i$** = Amplitude of $p_{th}$ term.
$\tau_i$ = Time constatnt of $r_{th}$ term.

DC Double side cooled

| i | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **$R_i$, K/W** | 0.0003136 | 0.003279 | 0.0001485 | 0.0007865 | 0.0002694 | 0.003703 |
| **$\tau_i$, s** | 1.181 | 0.06771 | 0.003331 | 0.145 | 0.0004353 | 0.9499 |

DC Anode side cooled

| i | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **$R_i$, K/W** | 0.01013 | 0.004062 | 0.0009701 | 0.00306 | 0.000148 | 0.0002685 |
| **$\tau_i$, s** | 9.747 | 1.058 | 0.1302 | 0.06675 | 0.003276 | 0.0004342 |

DC Cathode side cooled

| i | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **$R_i$, K/W** | 0.006619 | 0.004032 | 0.0008219 | 0.003231 | 0.000147 | 0.0002716 |
| **$\tau_i$, s** | 9.745 | 1.026 | 0.143 | 0.06778 | 0.00342 | 0.0004396 |

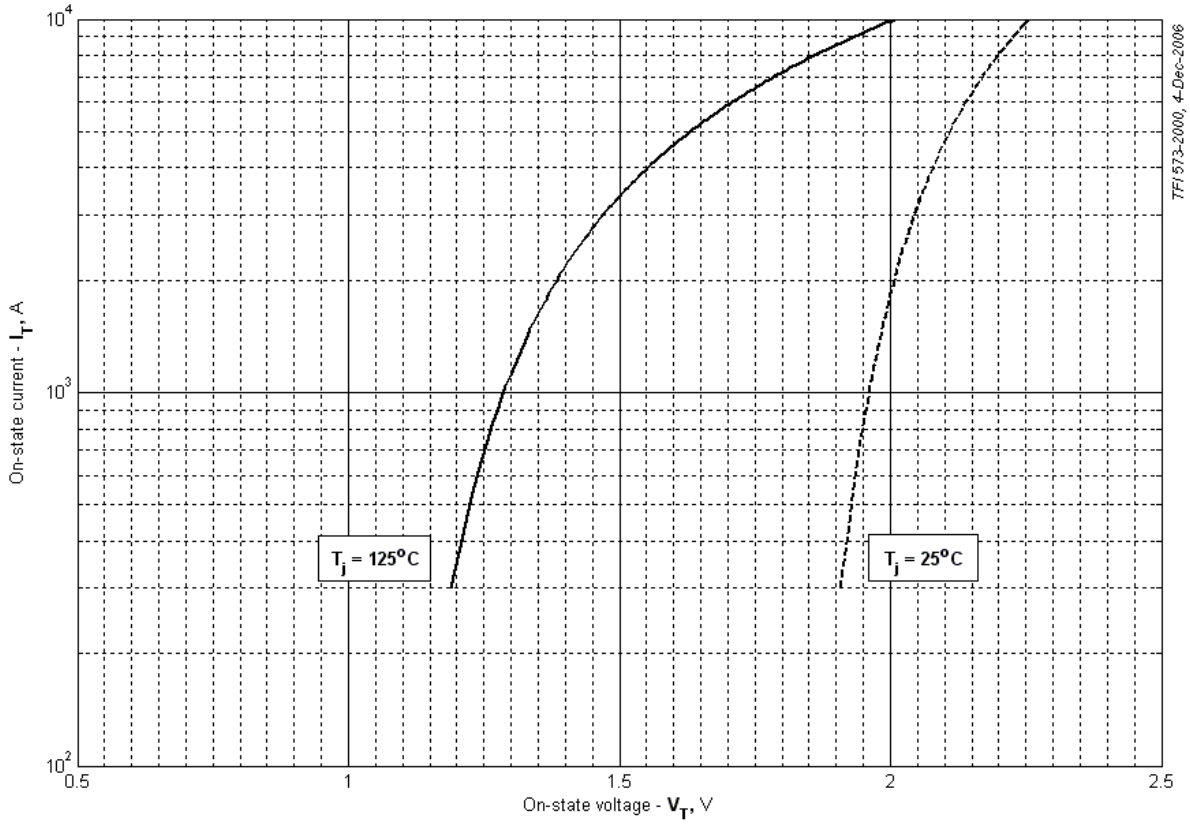



Fig 1 – On-state characteristics of Limit device

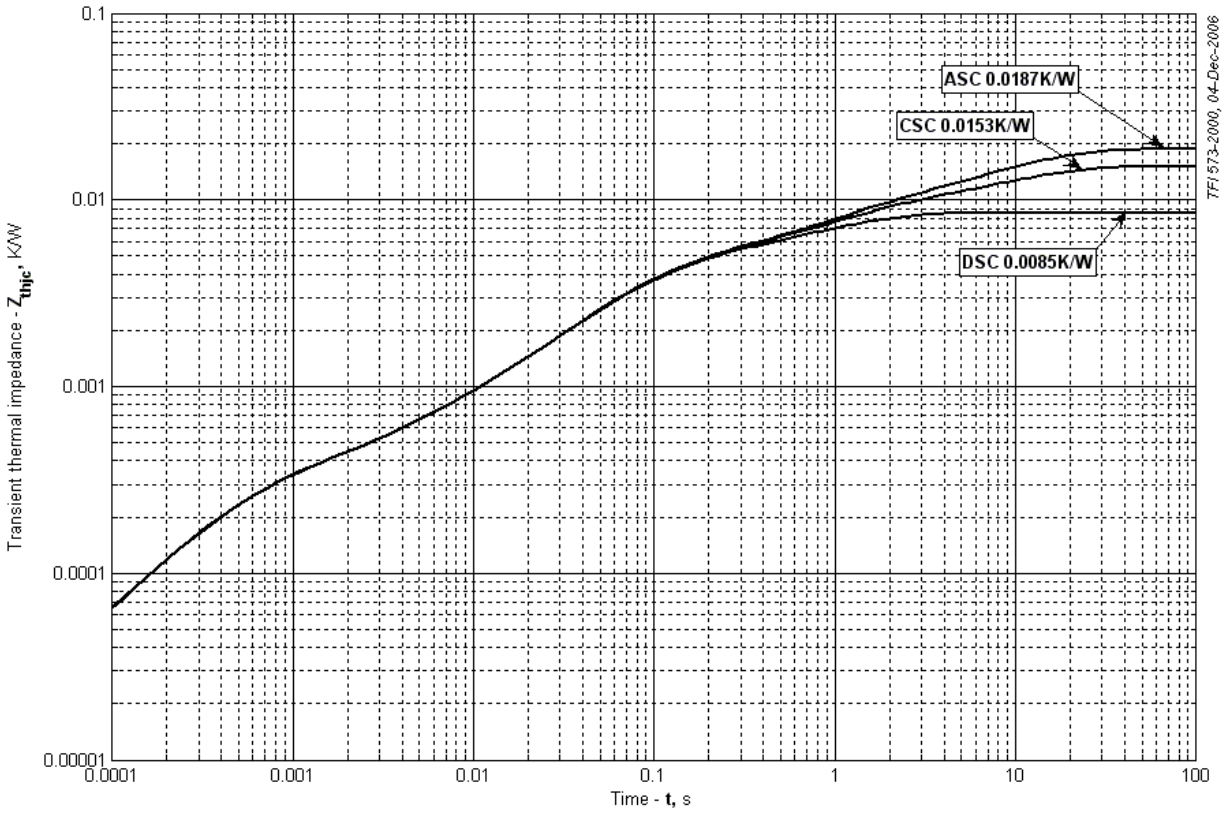



Fig 2 – Transient thermal impedance

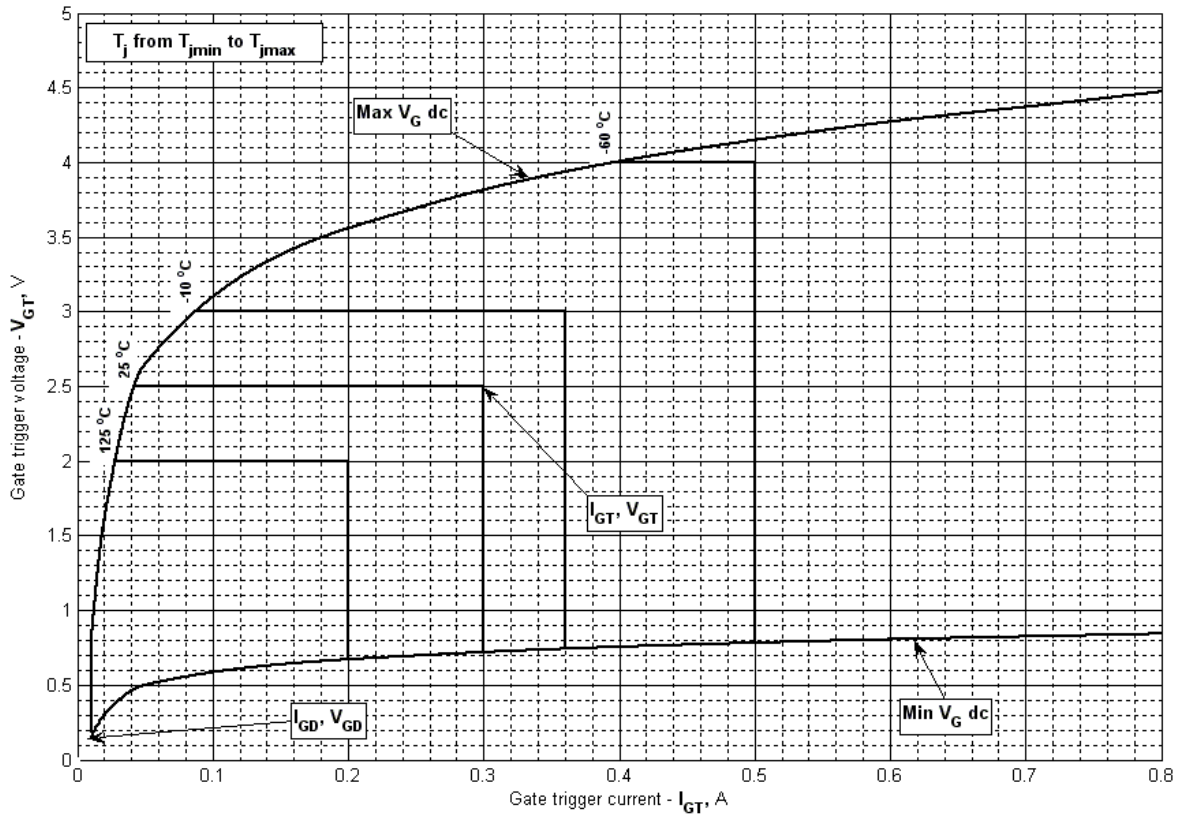



Fig 3 – Gate characteristics – Trigger limits

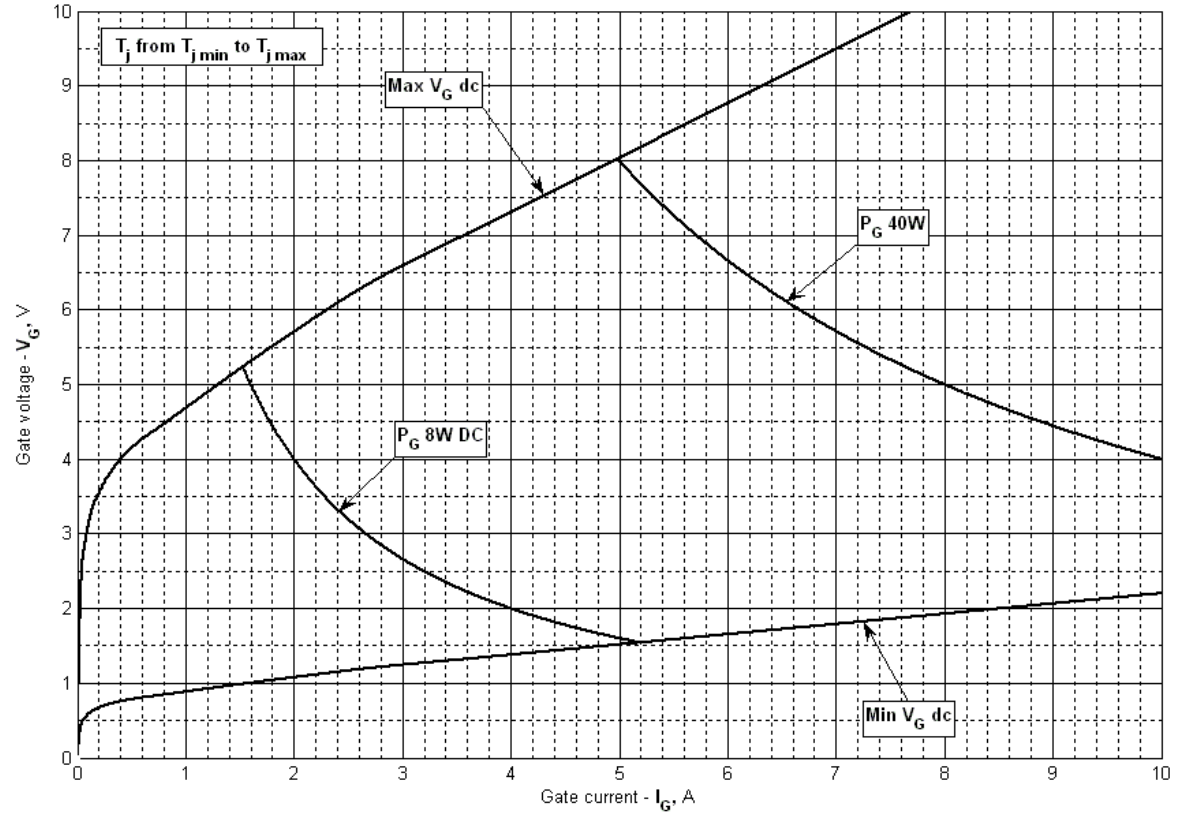



Fig 4 - Gate characteristics –Power curves

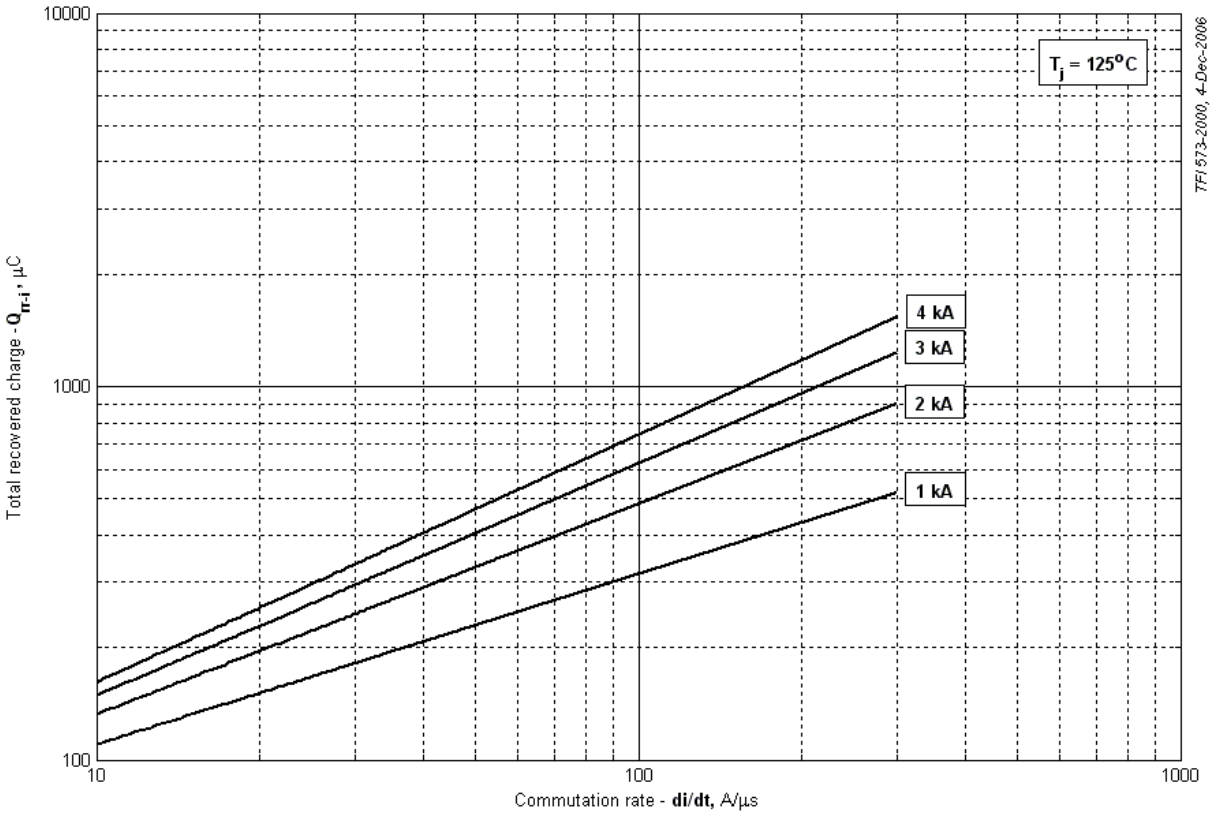



Fig 5 – Total recovered charge, $Q_{rr-i}$ (integral)

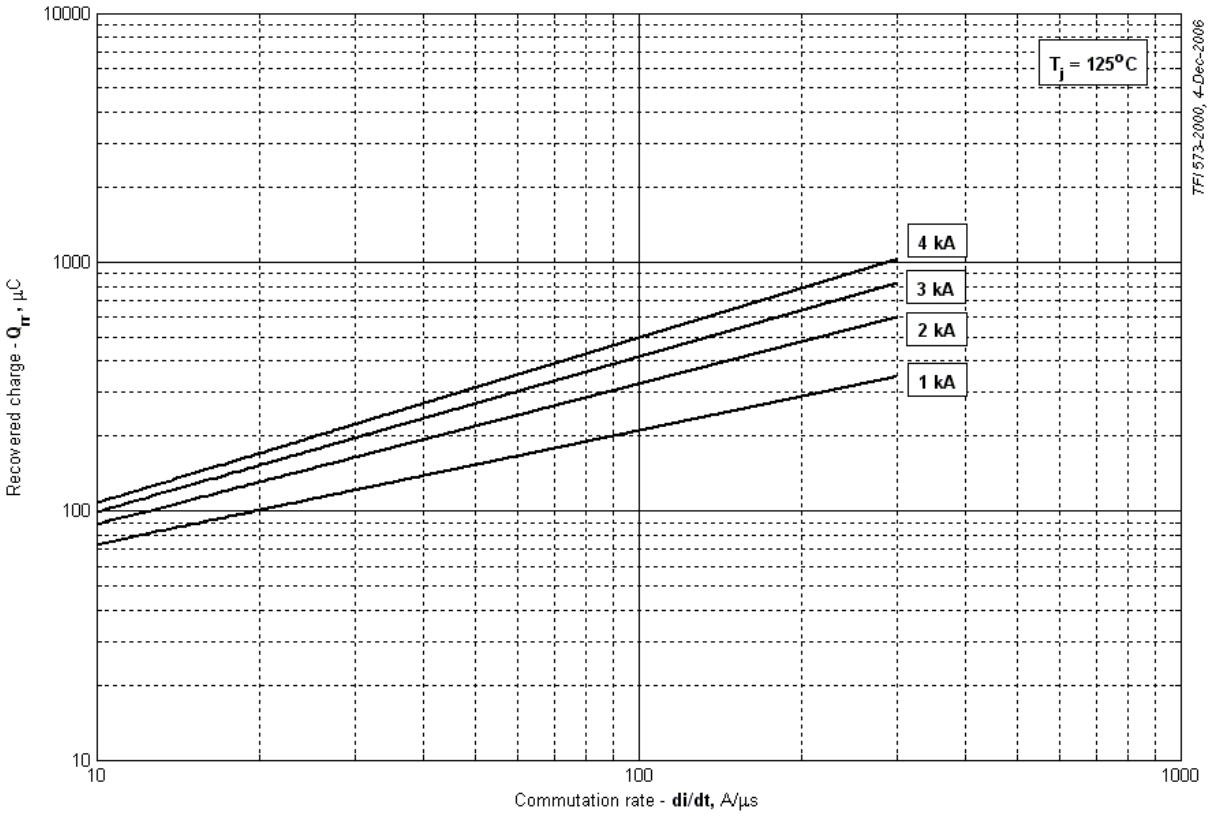



Fig 6 - Recovered charge, $Q_{rr}$ (linear)

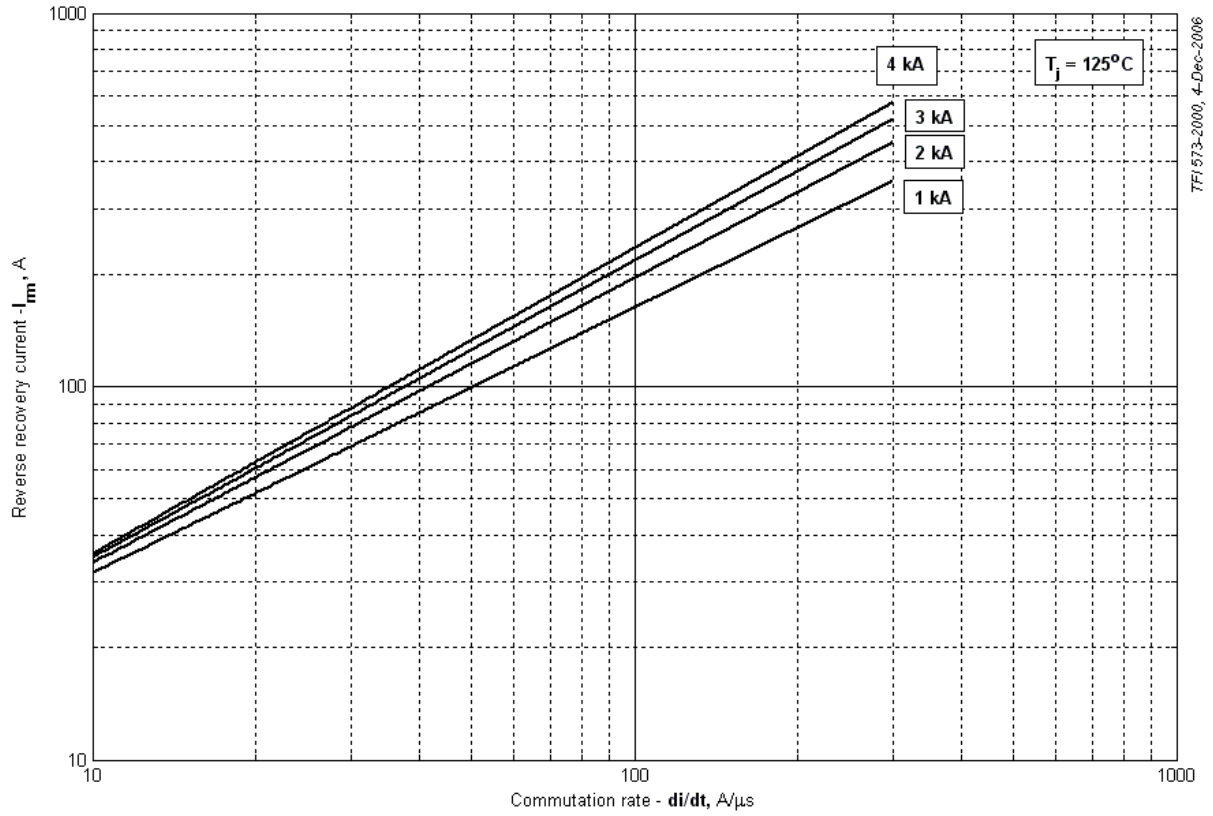



Fig 7 – Peak reverse recovery current, $I_{rm}$

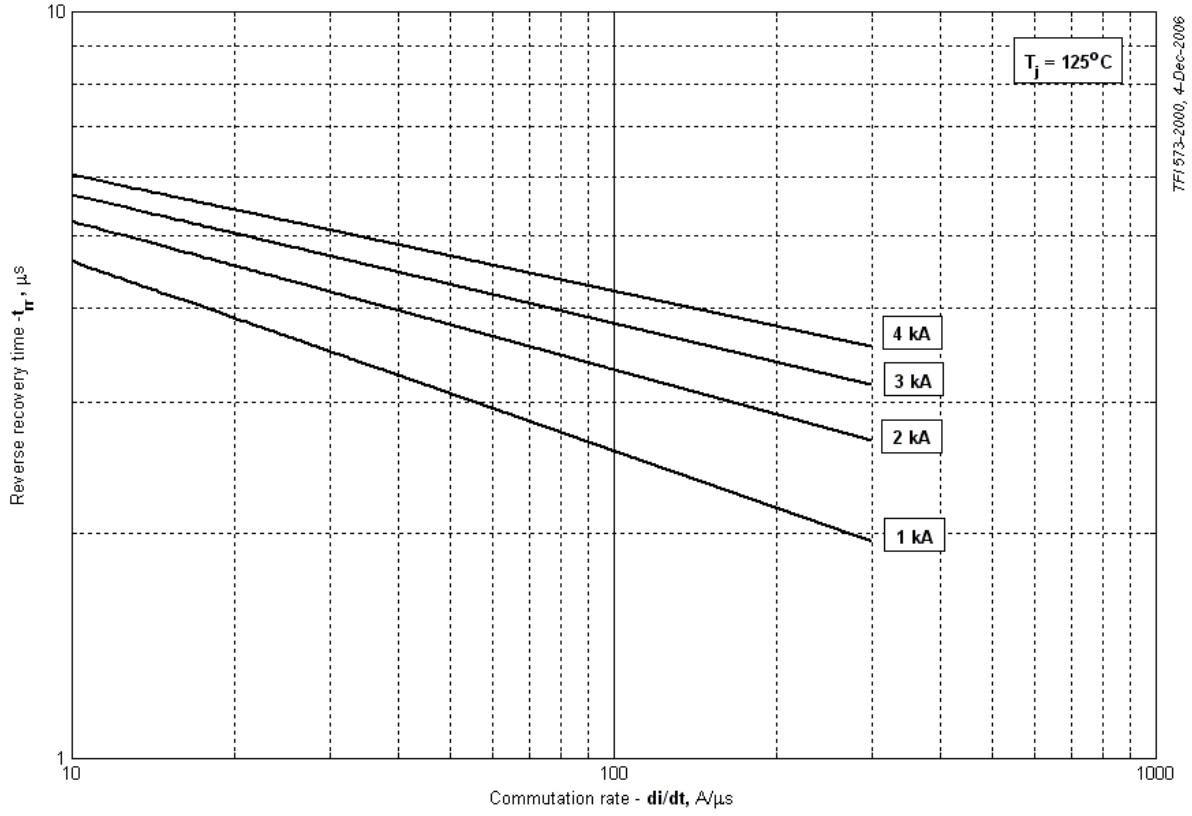



Fig 8 – Typical recovery time, $t_{rr}$ (linear)

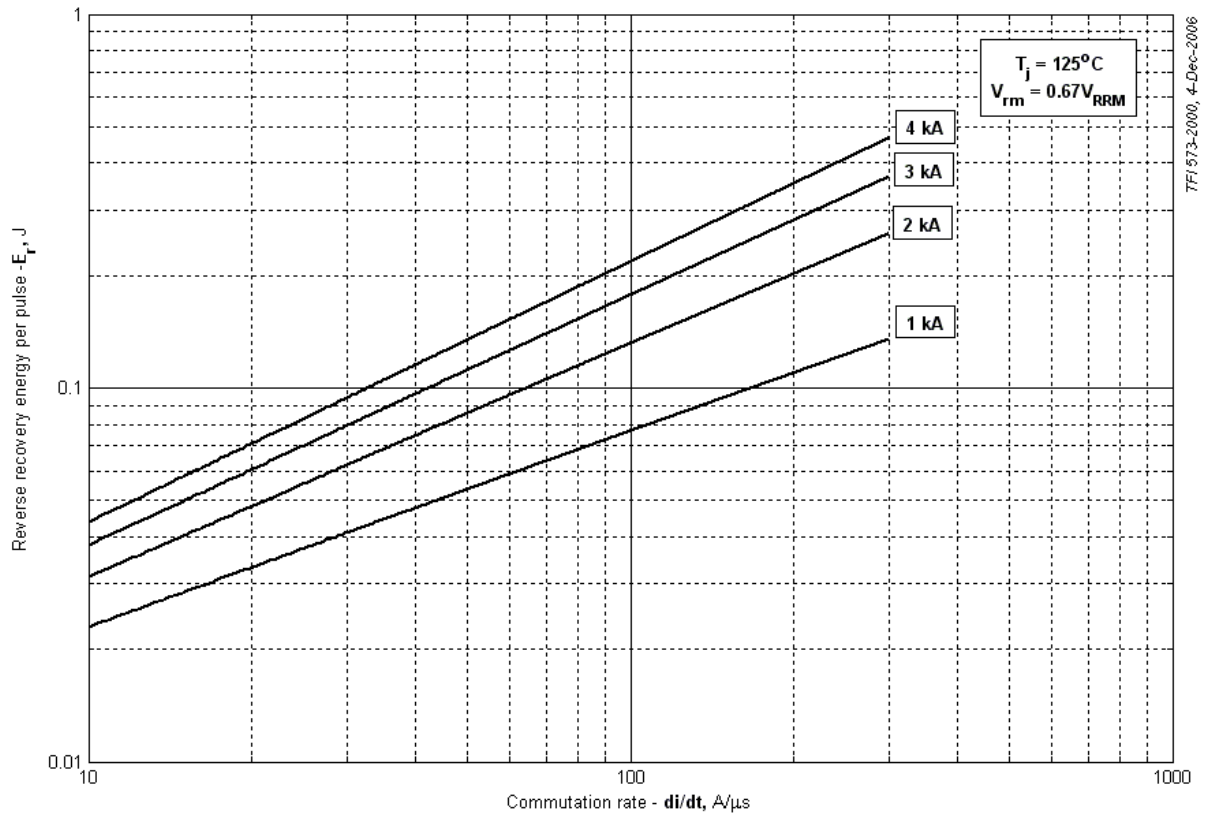



Fig 9 – Reverse recovery energy per pulse

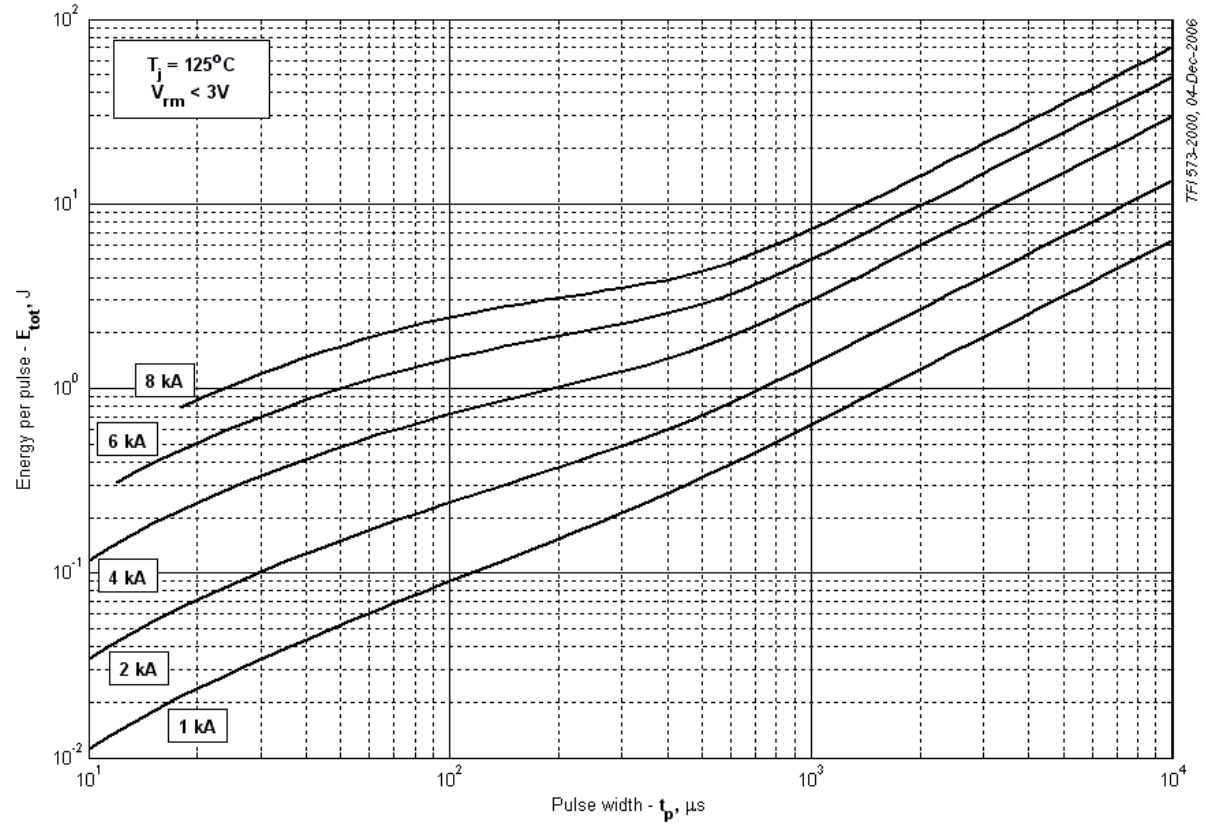



Fig 10 – Sine wave energy per pulse

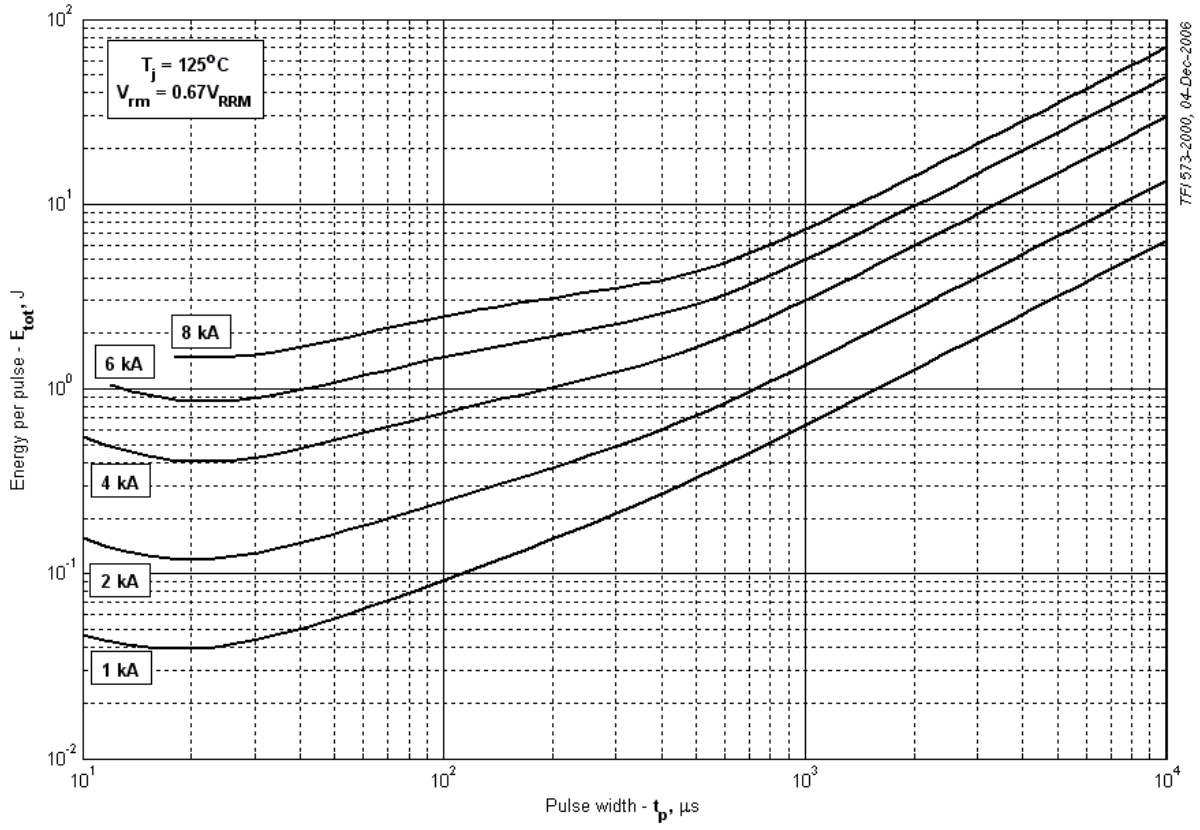



Fig 11 – Sine wave energy per pulse

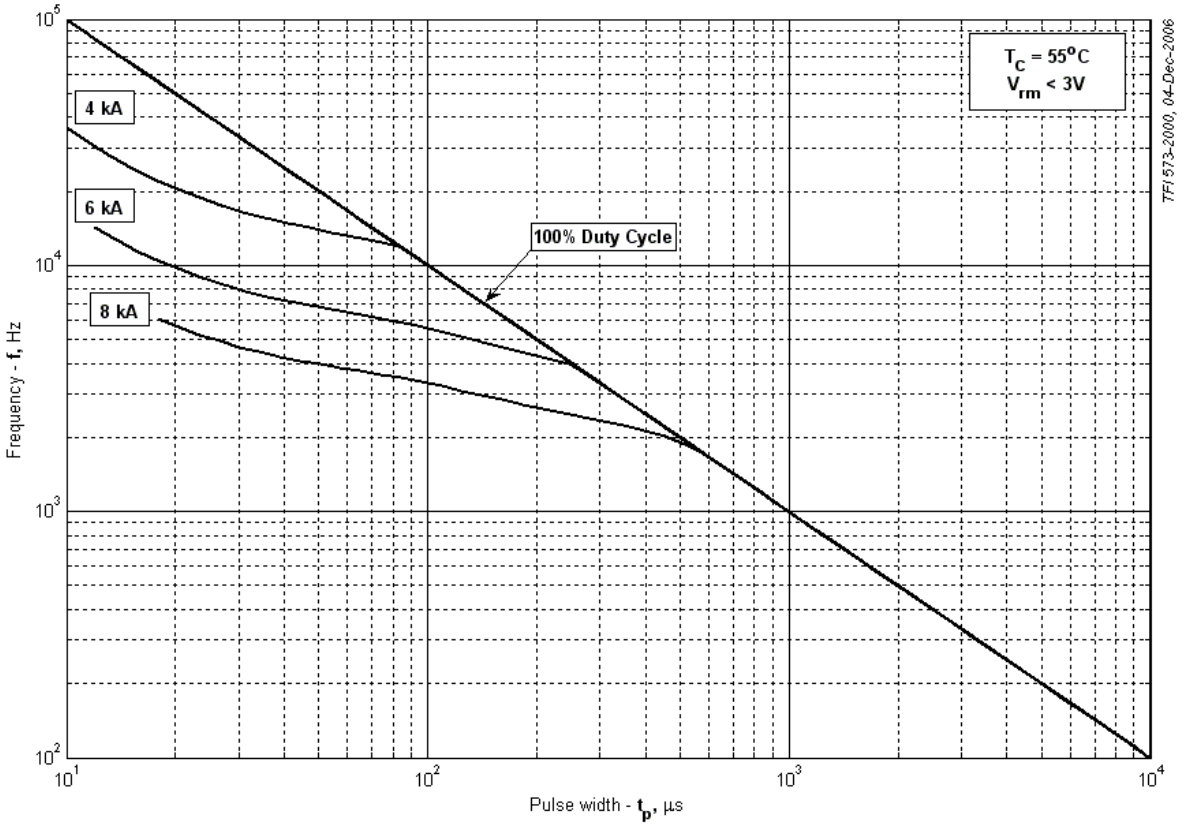



Fig 12 – Sine wave frequency ratings

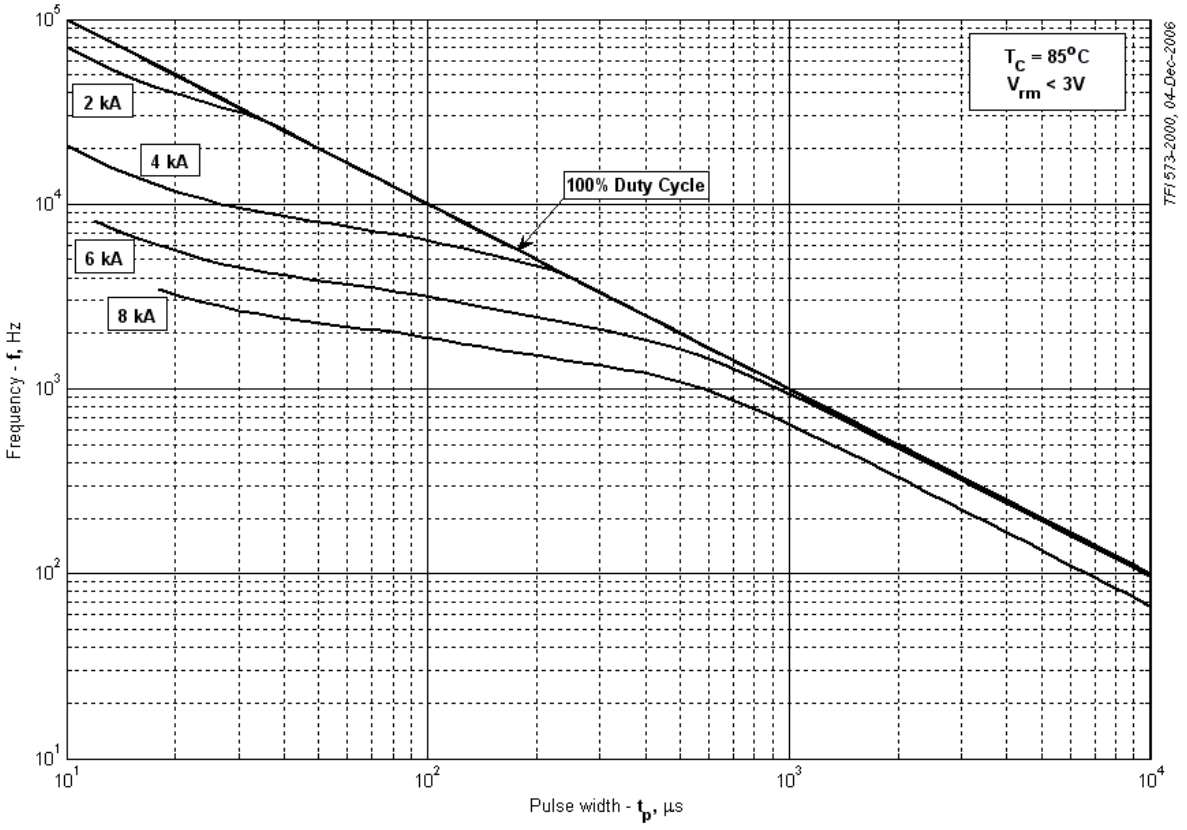



Fig 13 – Sine wave frequency ratings

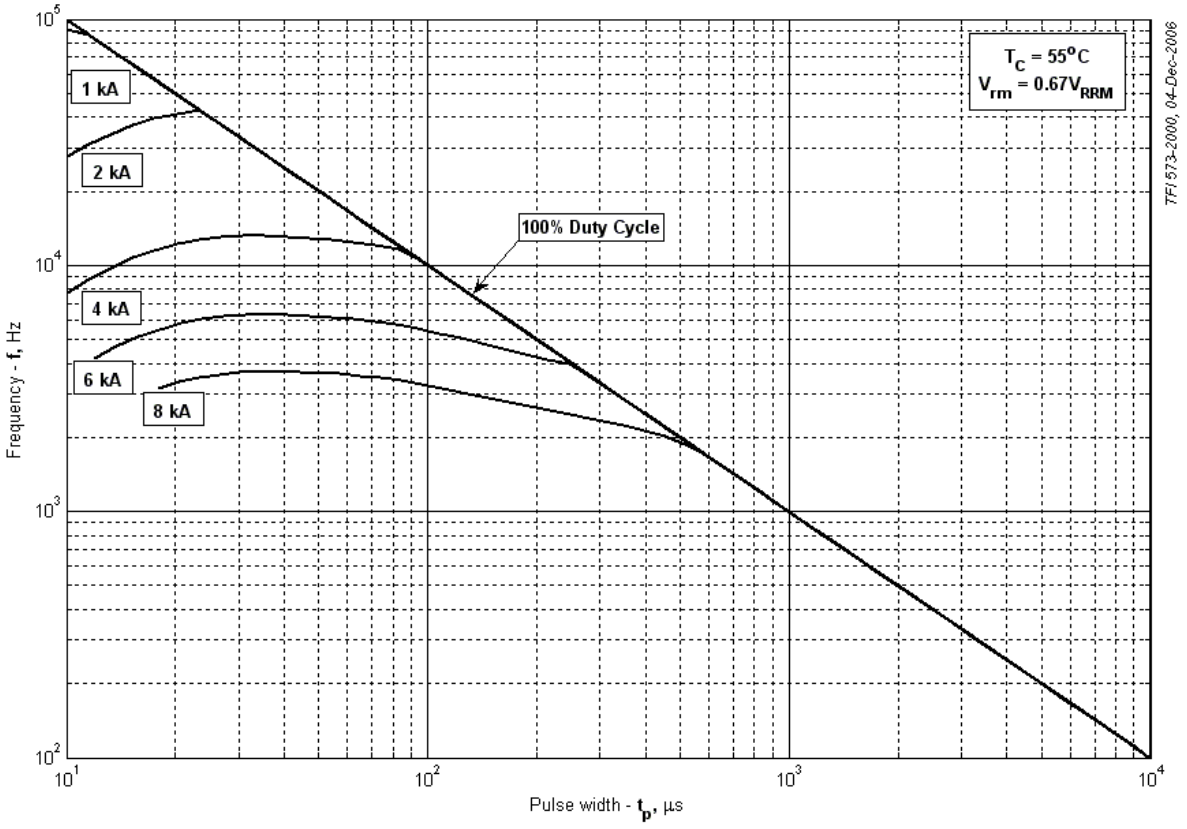



Fig 14 – Sine wave frequency ratings

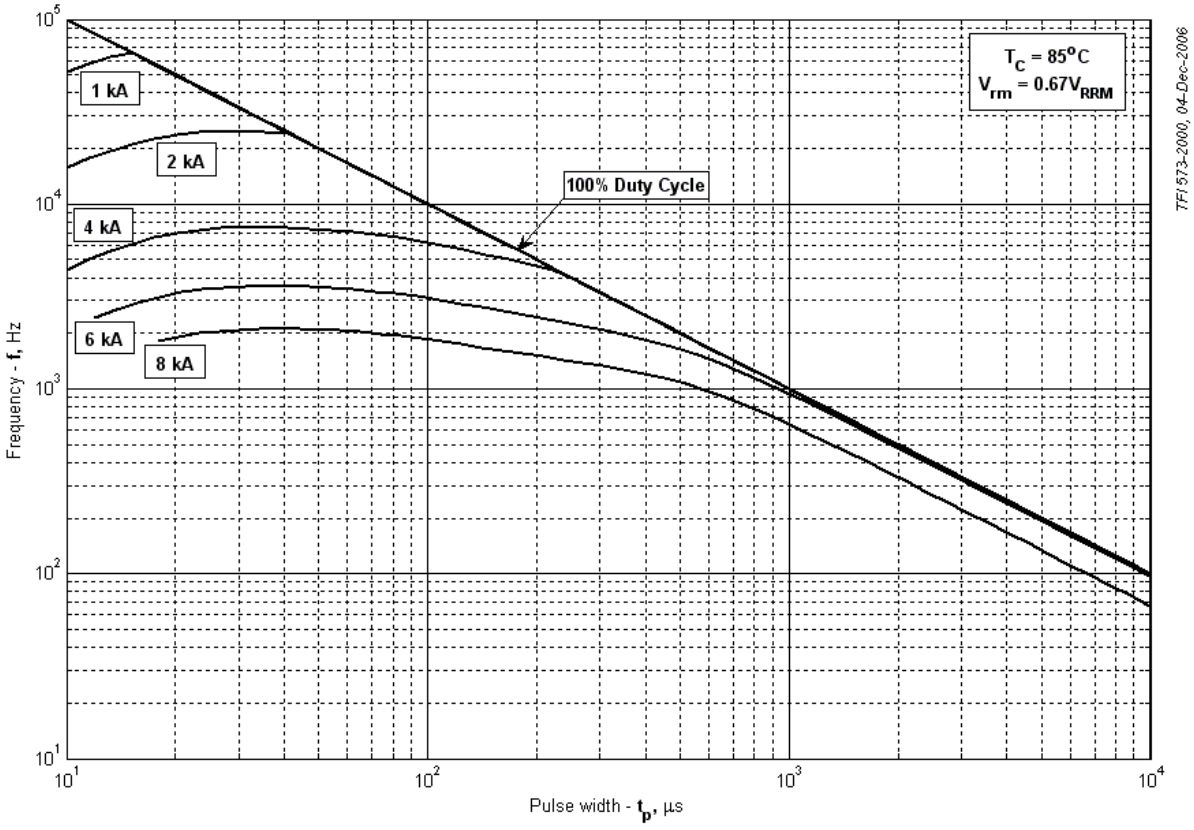



Fig 15 – Sine wave frequency ratings

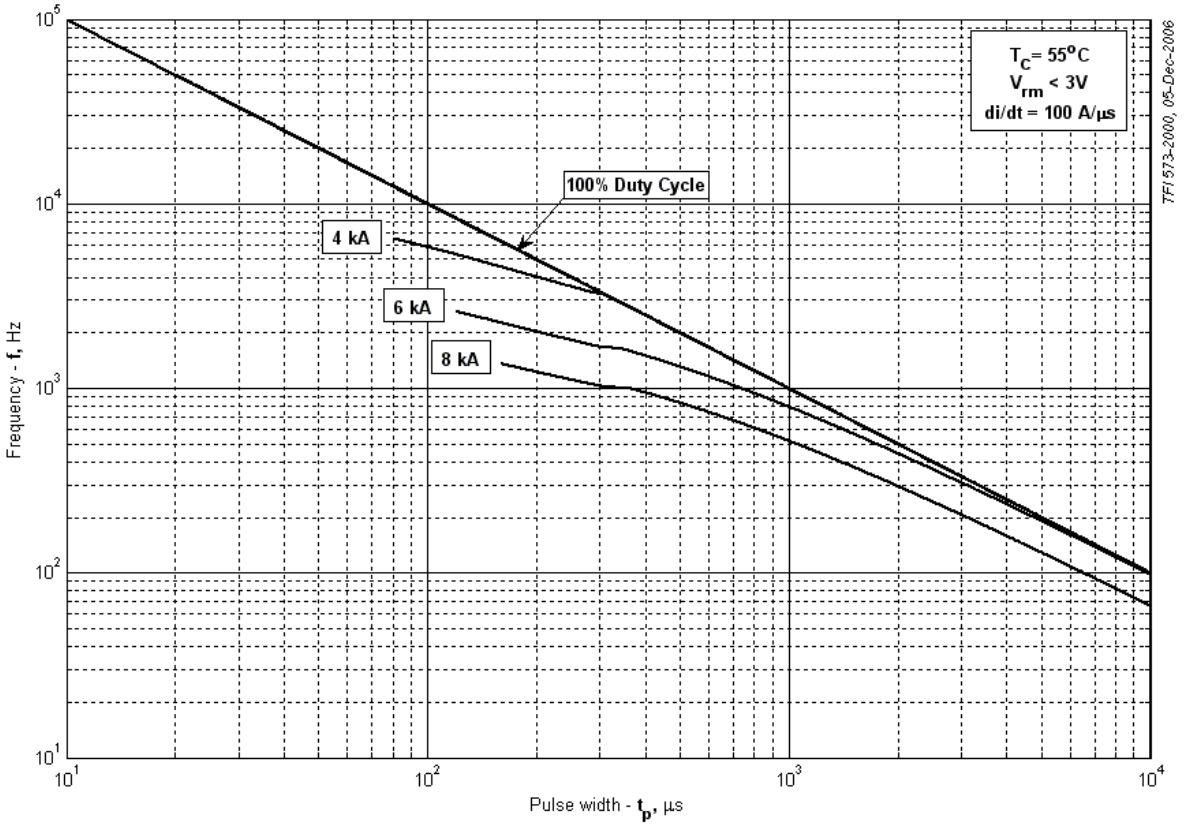



Fig 16 – Square wave frequency ratings

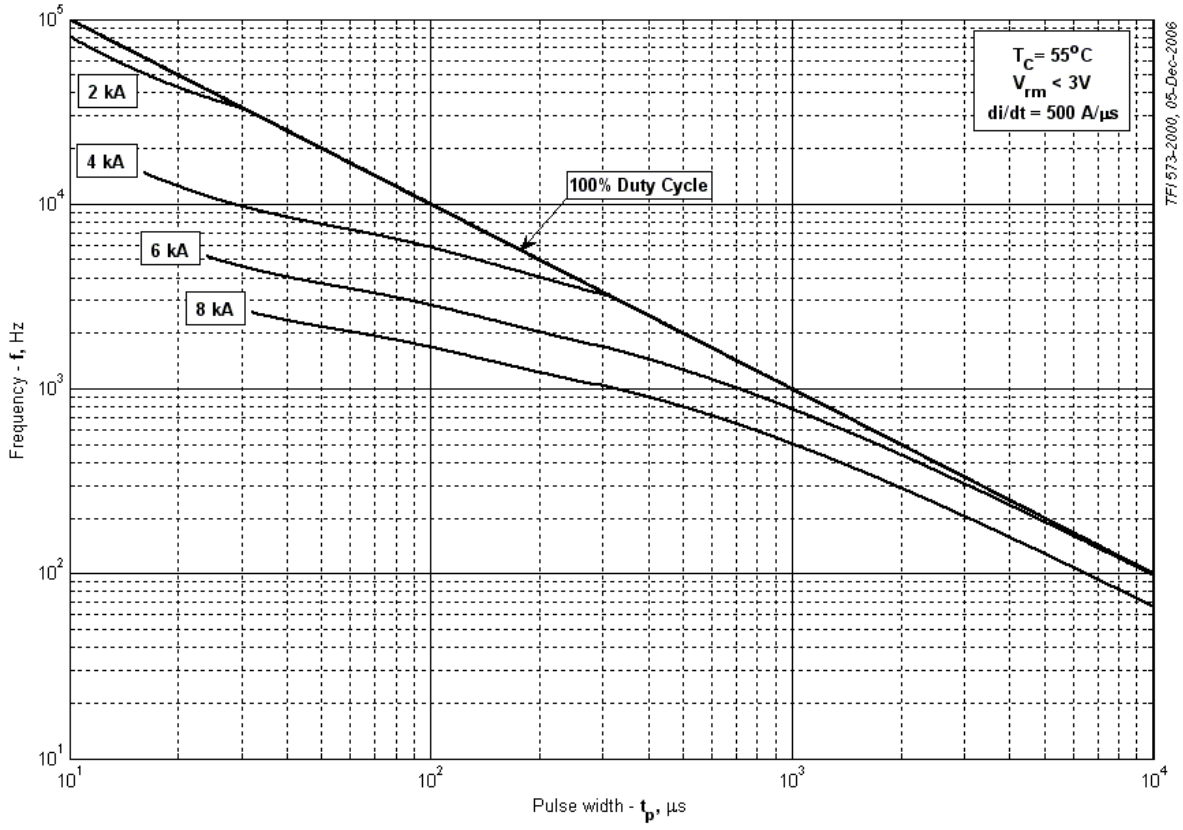



Fig 17 – Square wave frequency ratings

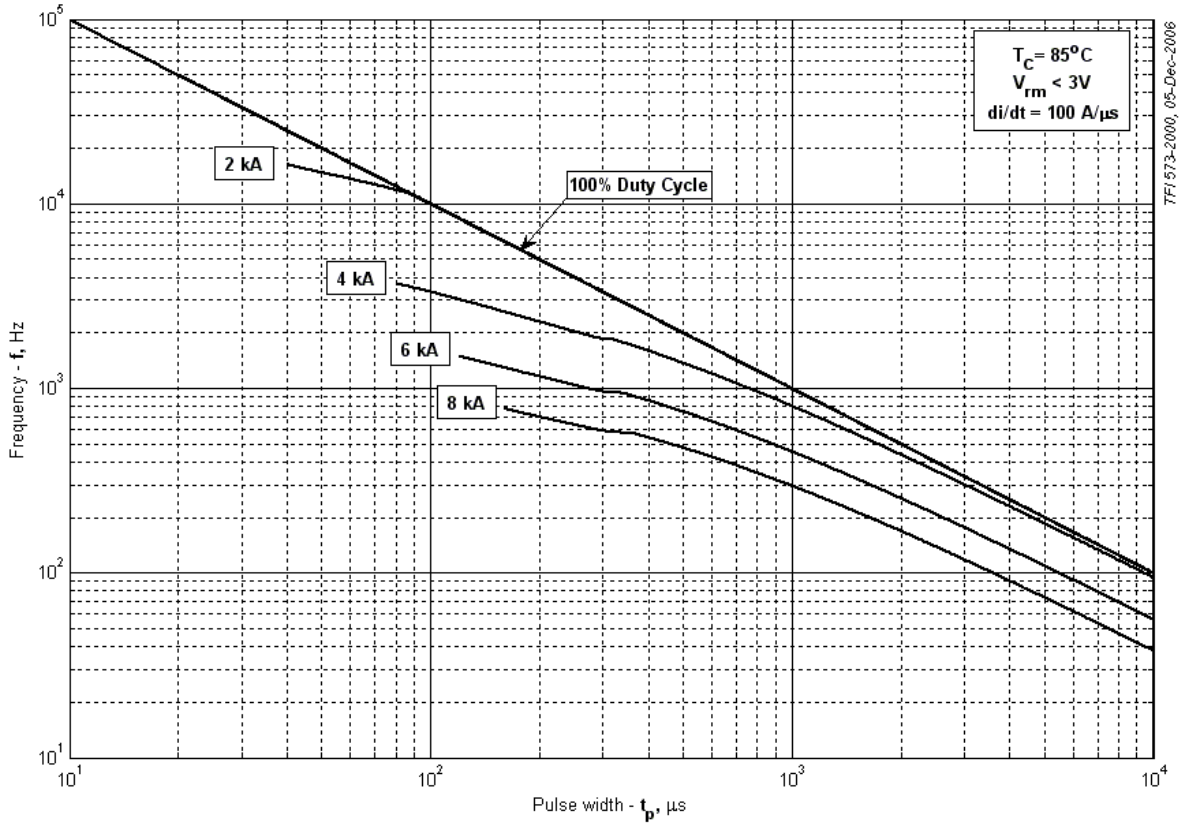



Fig 18 – Square wave frequency ratings

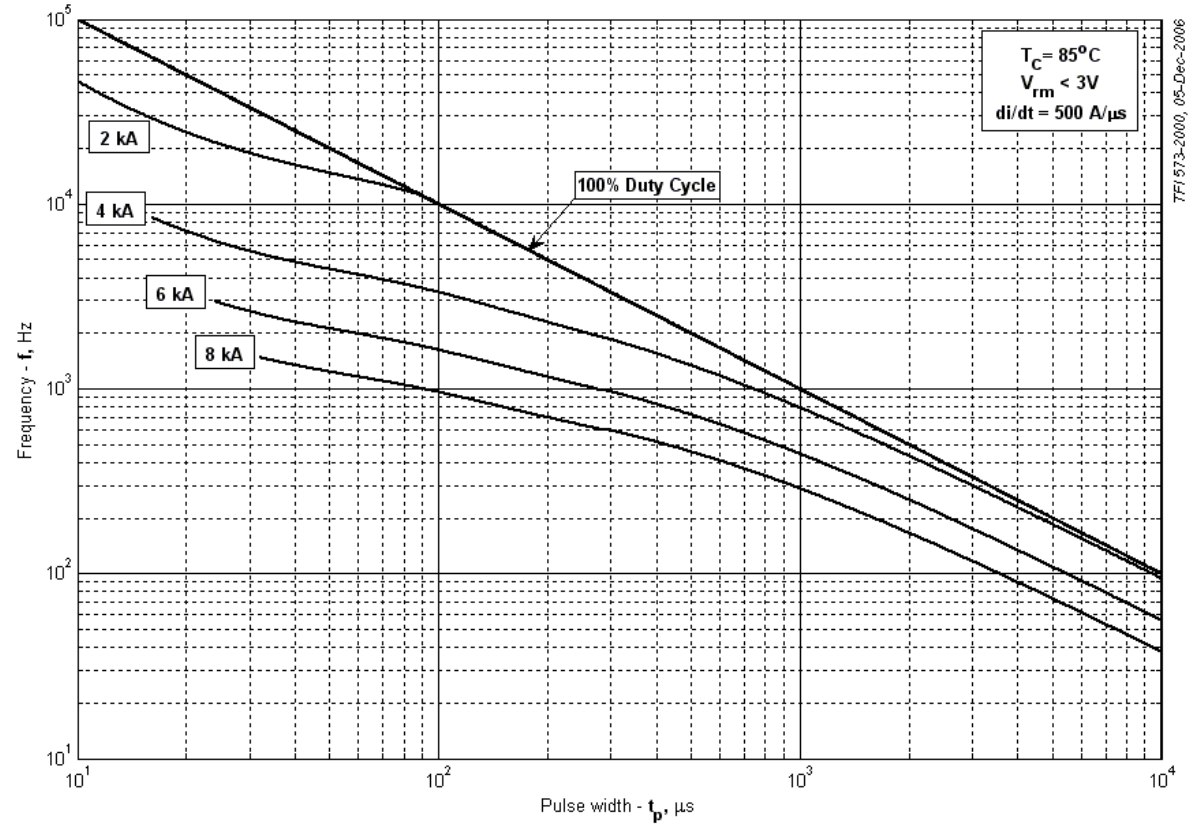



Fig 19 – Square wave frequency ratings

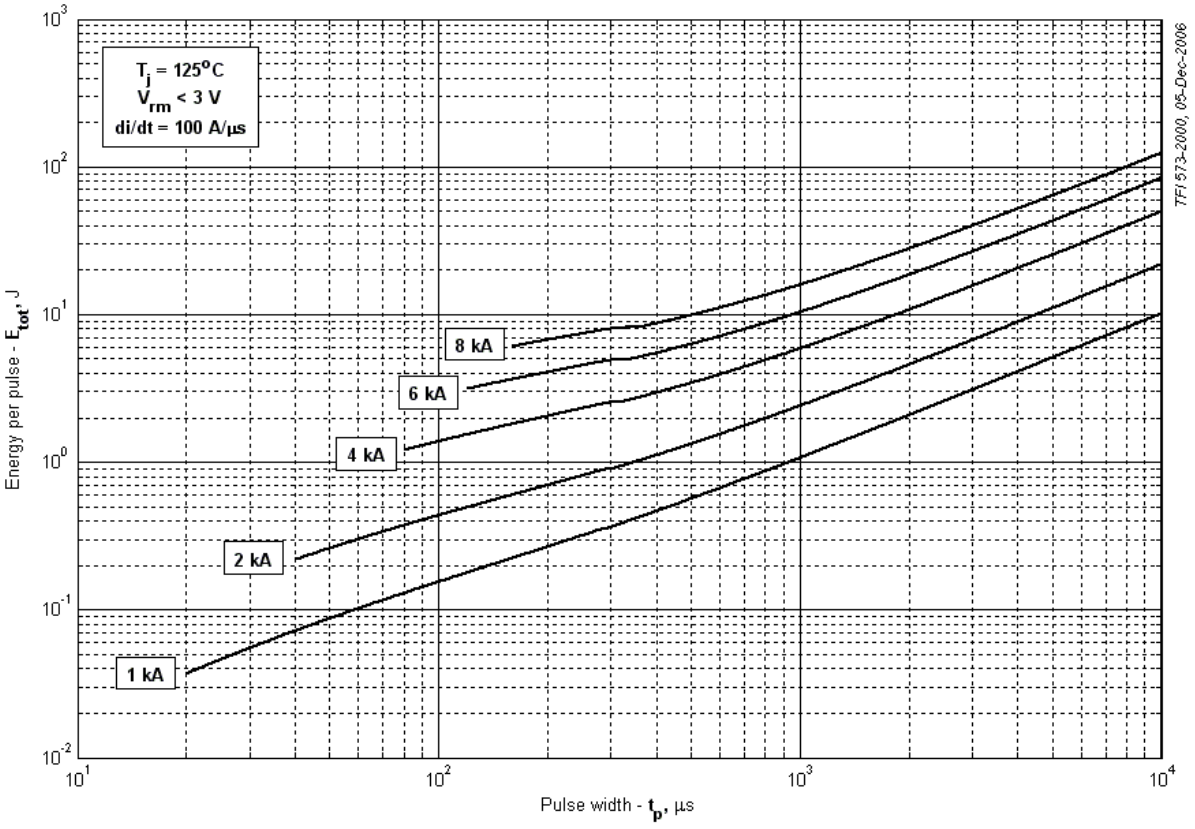



Fig 20 – Square wave energy per pulse

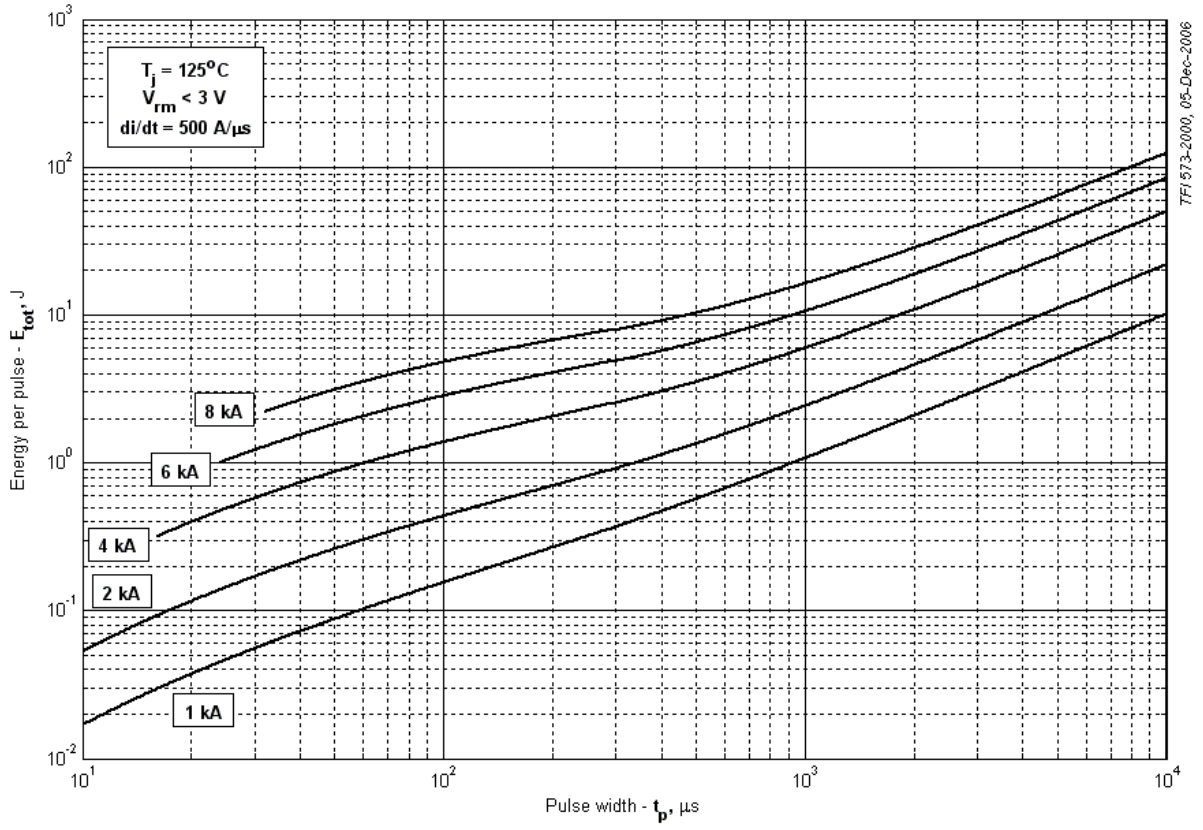



Fig 21 – Square wave energy per pulse

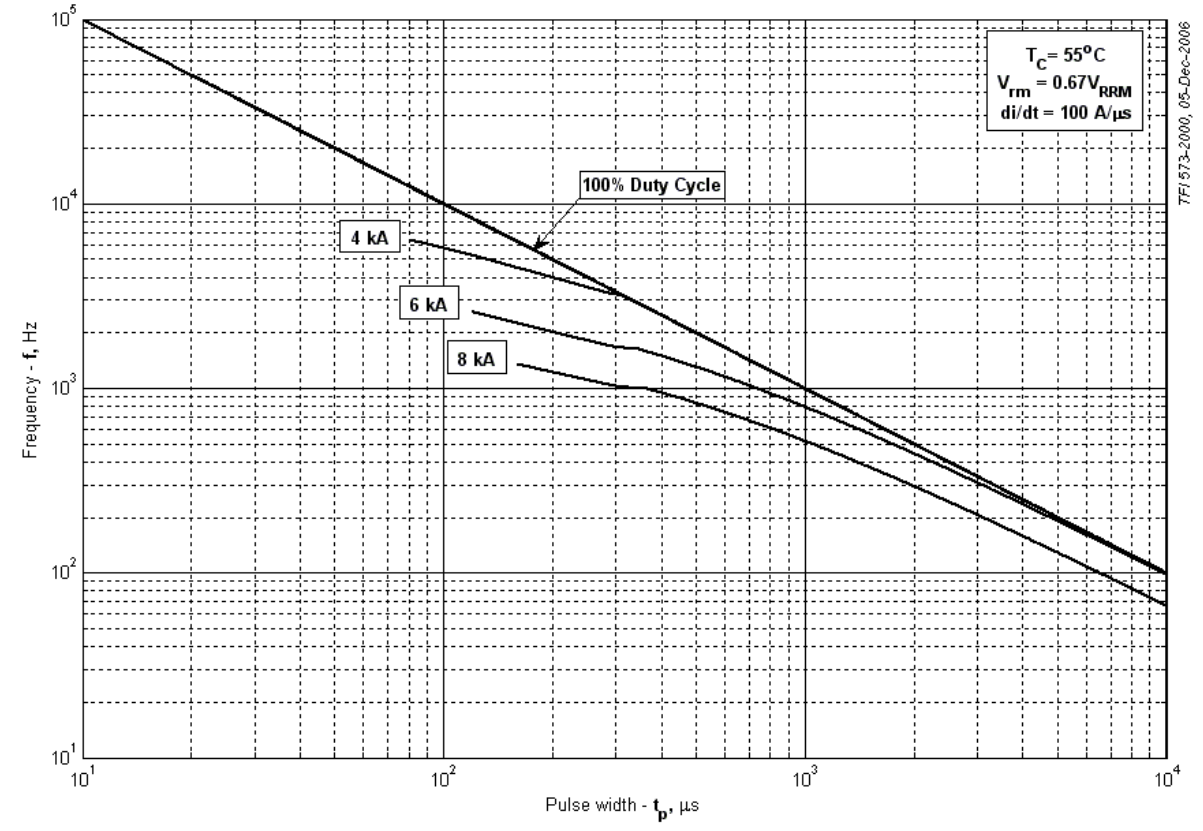



Fig 22 – Square wave frequency ratings

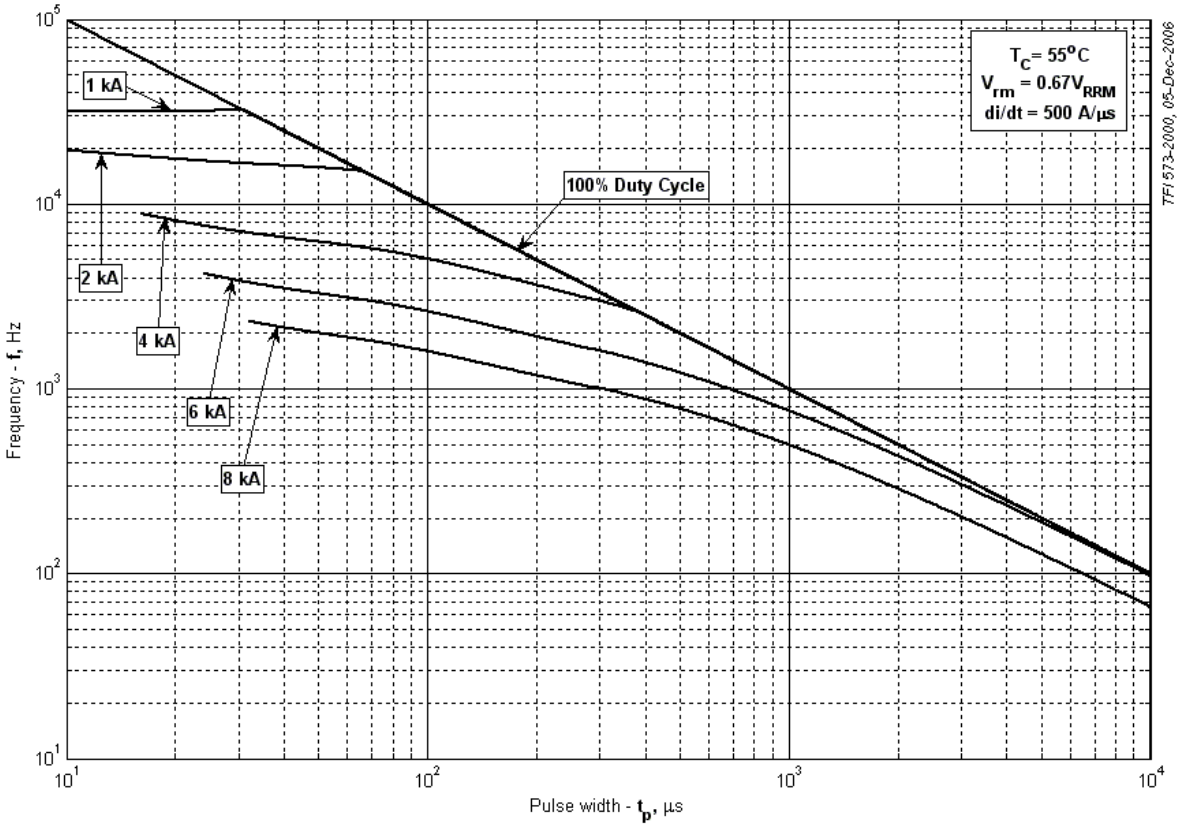



Fig 23 – Square wave frequency ratings

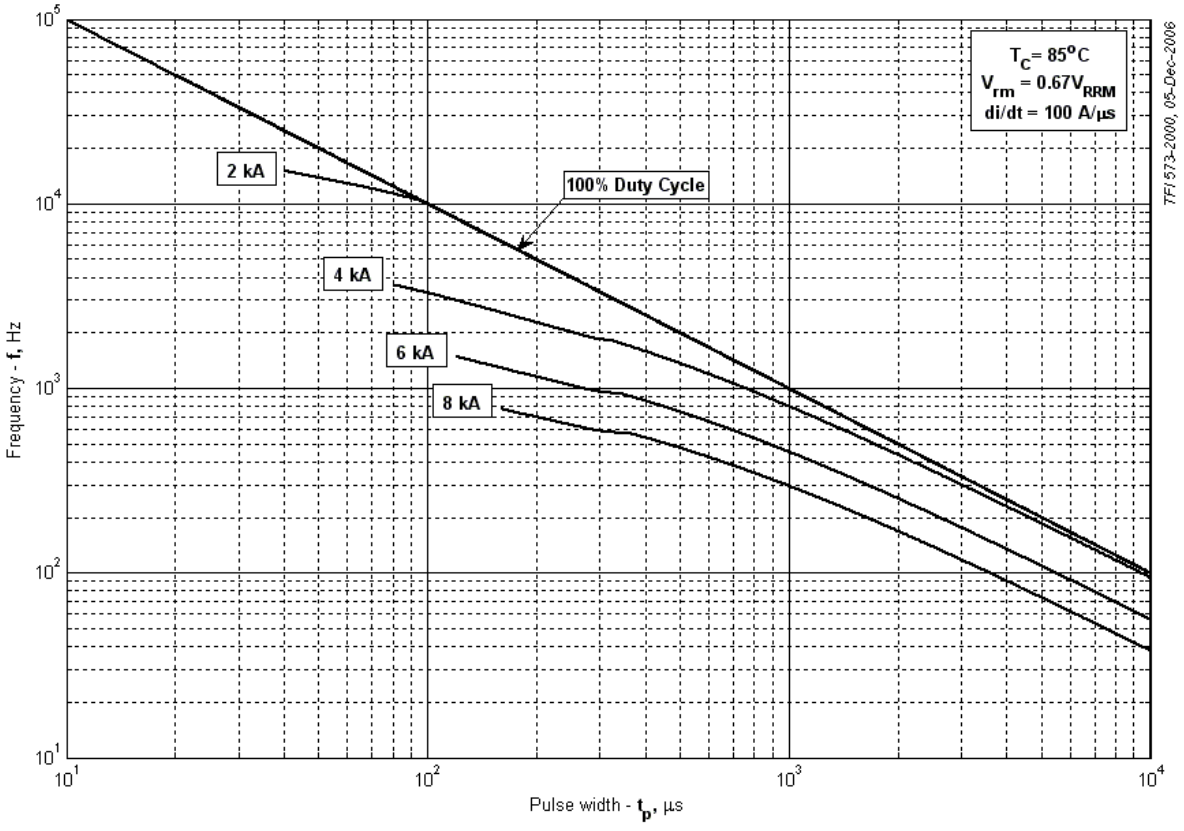



Fig 24 – Square wave frequency ratings

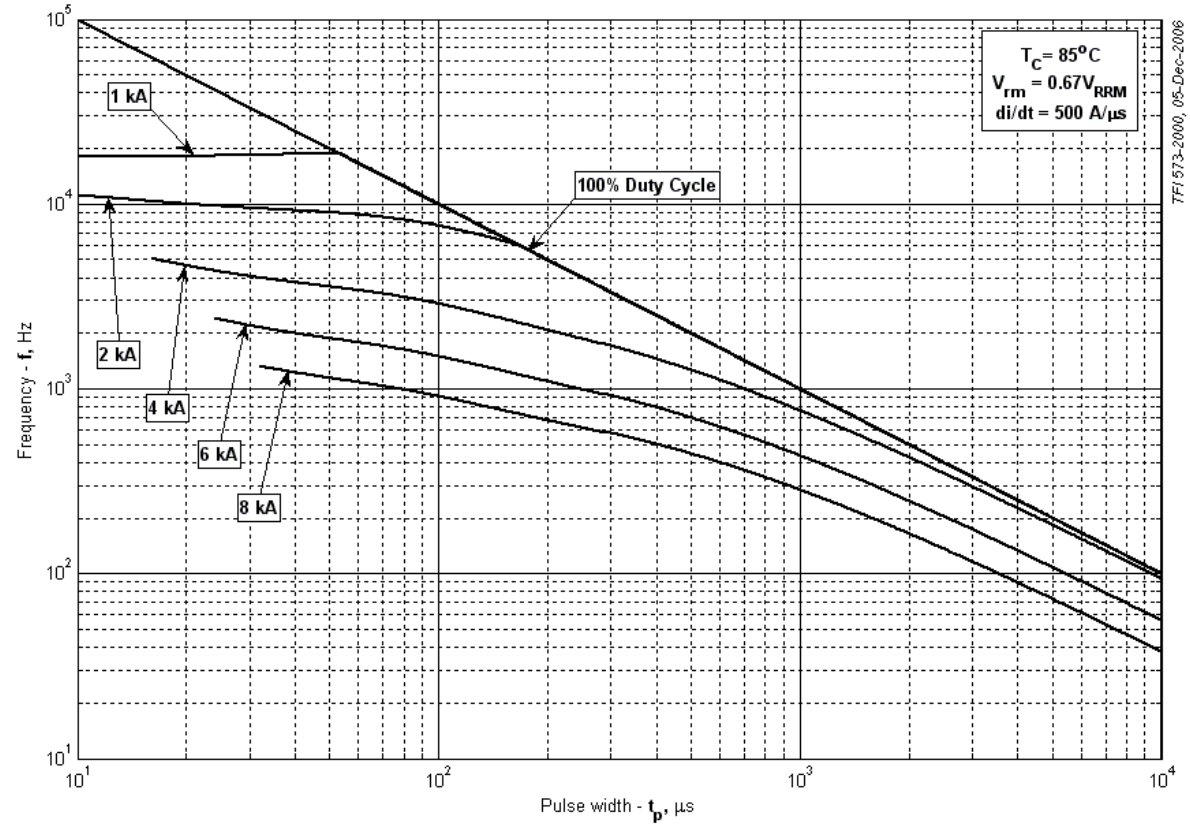



Fig 25 – Square wave frequency ratings

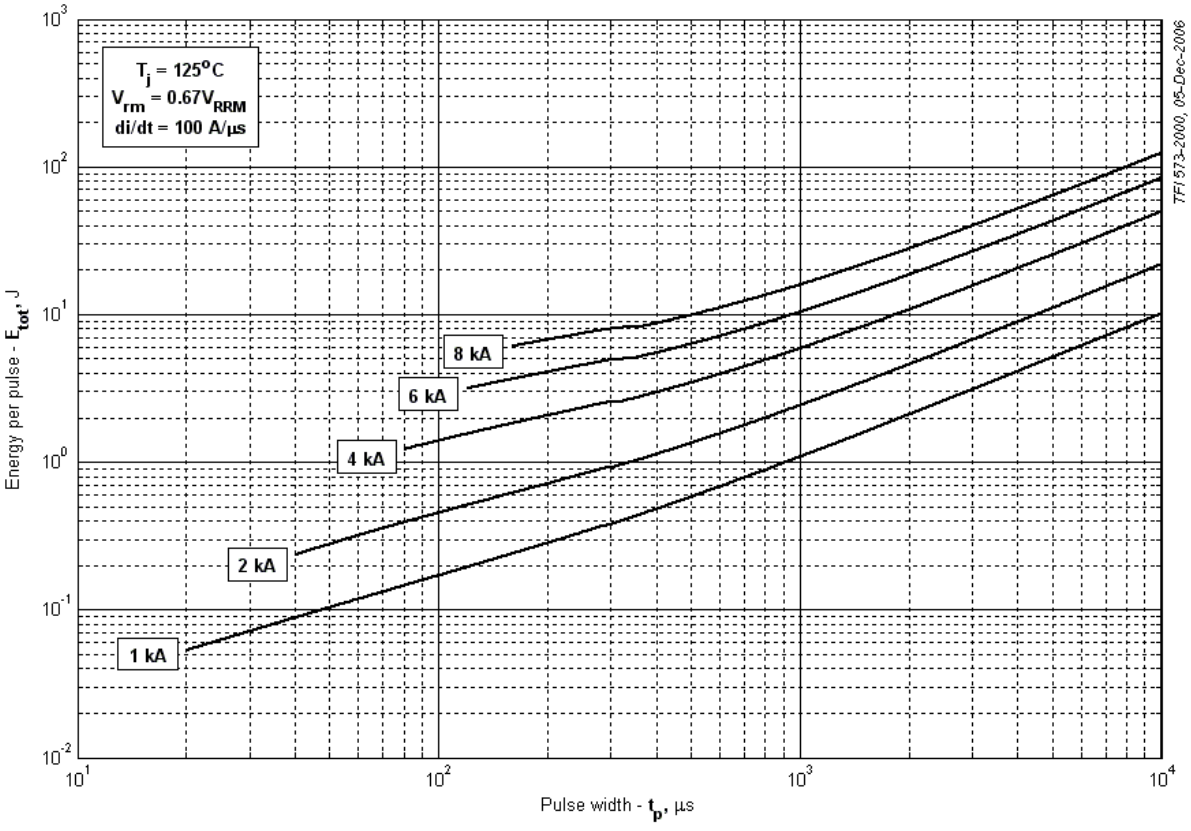



Fig 26 – Square wave energy per pulse

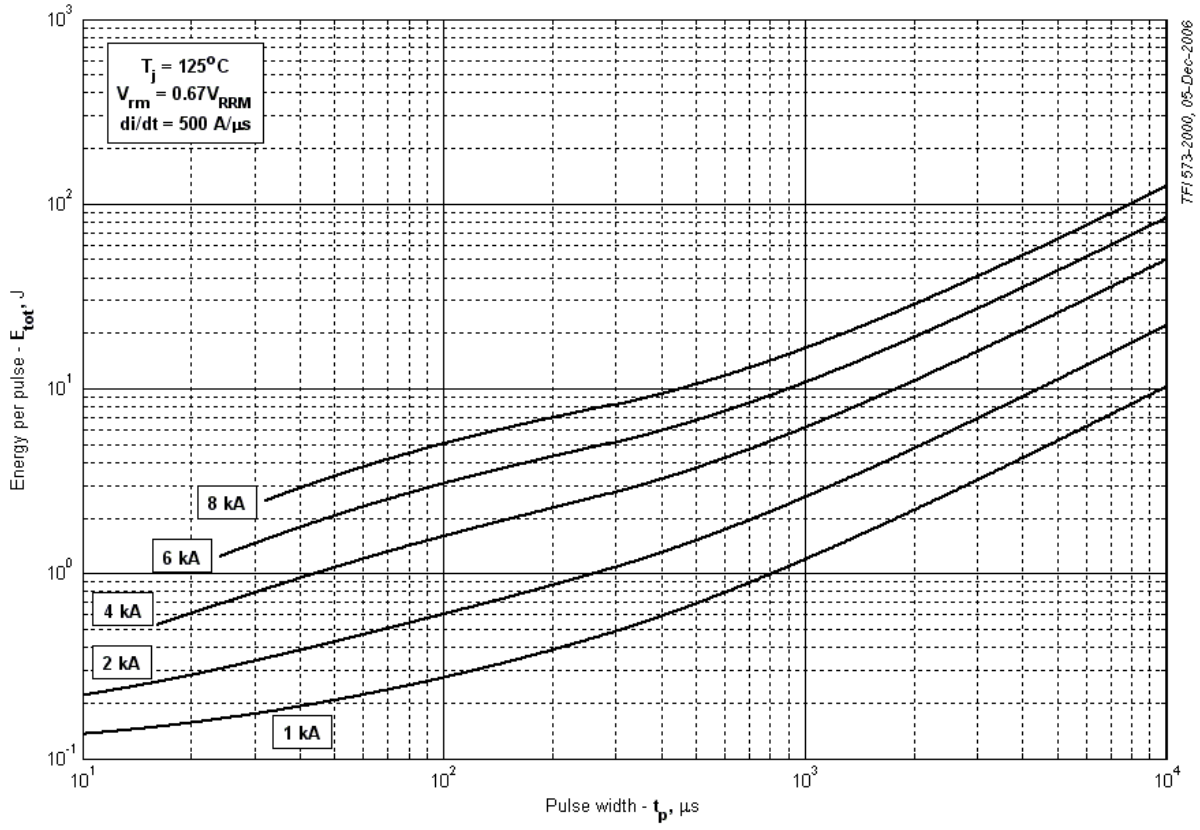



Fig 27 – Square wave energy per pulse

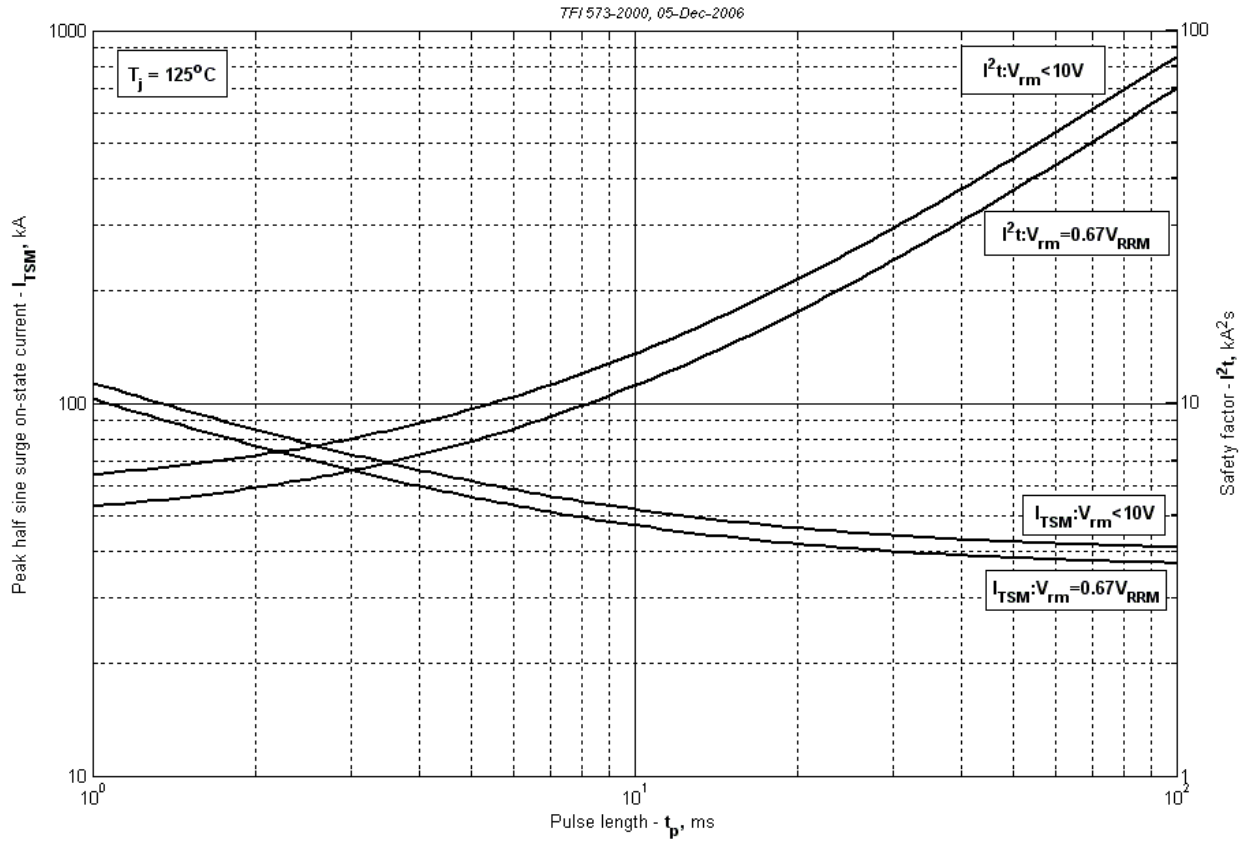



Fig 29 – Maximum surge and $I^2t$ ratings

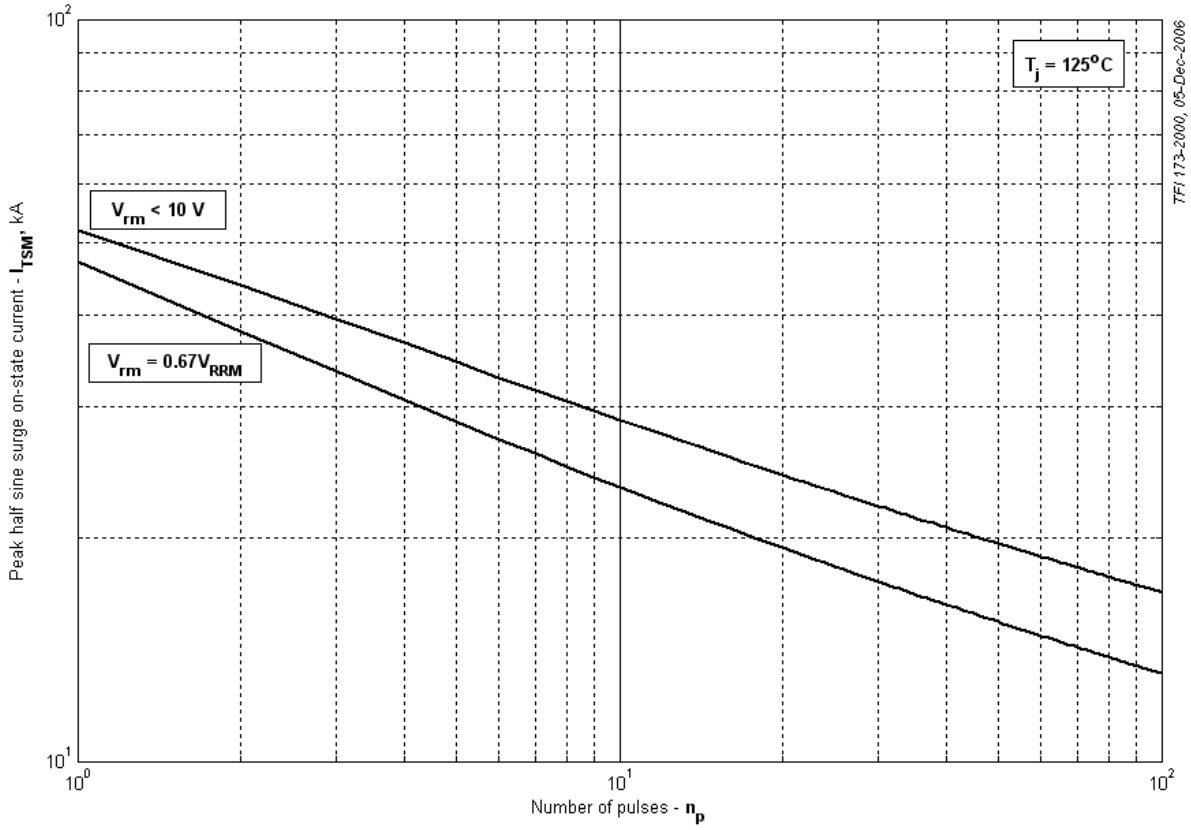



Fig 30 – Maximum surge ratings