| | | |
|---|---|---|
| $V_{DRM}$ | = | 5200 V |
| $I_{T(AV)M}$ | = | 3875 A |
| $I_{T(RMS)}$ | = | 6090 A |
| $I_{TSM}$ | = | $55\times10^3$ A |
| $V_{T0}$ | = | 1.03 V |
| $r_T$ | = | 0.16 mΩ |

# Phase Control Thyristor

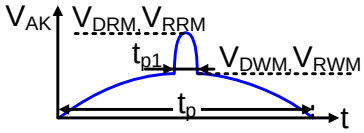
# 5STP 34Q5200

Doc. No. 5SYA1052-04 Jan. 11

- **Patented free-floating silicon technology**
- **Low on-state and switching losses**
- **Designed for traction, energy and industrial applications**
- **Optimum power handling capability**
- **Interdigitated amplifying gate**

## Blocking

***Maximum rated values*** [1)]

| Parameter | Symbol | Conditions | 5STP 34Q5200 | Unit |
|---|---|---|---|---|
| Max. surge peak forward and reverse blocking voltage | $V_{DSM}$, $V_{RSM}$ | $t_p$ = 10 ms, f = 5 Hz<br>$T_{vj}$ = 5…125°C, Note 1 | 5200 | V |
| Max repetitive peak forward and reverse blocking voltage | $V_{DRM}$, $V_{RRM}$ | f = 50 Hz, $t_p$ = 10 ms, $t_{p1}$ = 250 µs,<br>$T_{vj}$ = 5…125°C, Note 1, Note 2 | 5200 | V |
| Max crest working forward and reverse voltages | $V_{DWM}$, $V_{RWM}$ |  | 3470 | V |
| Critical rate of rise of commutating voltage | $dv/dt_{crit}$ | Exp. to 3470 V, $T_{vj}$ = 125°C | 2000 | V/µs |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Forward leakage current | $I_{DRM}$ | $V_{DRM}$, $T_{vj}$ = 125°C | | | 500 | mA |
| Reverse leakage current | $I_{RRM}$ | $V_{RRM}$, $T_{vj}$ = 125°C | | | 500 | mA |

Note 1: Voltage de-rating factor of 0.11% per °C is applicable for Tvj below +5 °C
Note 2: Recommended minimum ratio of $V_{DRM}$ / $V_{DWM}$ or $V_{RRM}$ / $V_{RWM}$ = 2. See App. Note 5SYA 2051.

## Mechanical data

***Maximum rated values*** [1)]

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Mounting force | $F_M$ | | 81 | 90 | 108 | kN |
| Acceleration | a | Device unclamped | | | 50 | $m/s^2$ |
| Acceleration | a | Device clamped | | | 100 | $m/s^2$ |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Weight | m | | | | 2.1 | kg |
| Housing thickness | H | $F_M$ = 90 kN, $T_a$ = 25 °C | 26.3 | | 26.7 | mm |
| Surface creepage distance | $D_S$ | | 36 | | | mm |
| Air strike distance | $D_a$ | | 15 | | | mm |

1) Maximum rated values indicate limits beyond which damage to the device may occur

## On-state

***Maximum rated values*** [1)]

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Average on-state current | $I_{T(AV)M}$ | Half sine wave, $T_c$ = 70 °C | | | 3875 | A |
| RMS on-state current | $I_{T(RMS)}$ | | | | 6090 | A |
| Peak non-repetitive surge current | $I_{TSM}$ | $t_p$ = 10 ms, $T_{vj}$ = 125 °C, sine wave after surge: $V_D = V_R$= 0 V | | | $55\times10^3$ | A |
| Limiting load integral | $I^2t$ | | | | $15.1\times10^6$ | $A^2s$ |
| Peak non-repetitive surge current | $I_{TSM}$ | $t_p$ = 8.3 ms, $T_{vj}$ = 125 °C, sine wave after surge: $V_D = V_R$= 0 V | | | $60\times10^3$ | A |
| Limiting load integral | $I^2t$ | | | | $14.94\times10^6$ | $A^2s$ |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| On-state voltage | $V_T$ | $I_T$ = 3000 A, $T_{vj}$ = 125 °C | | | 1.54 | V |
| Threshold voltage | $V_{(T0)}$ | $I_T$ = 2300 A - 7000 A, $T_{vj}$= 125 °C | | | 1.03 | V |
| Slope resistance | $r_T$ | | | | 0.16 | mΩ |
| Holding current | $I_H$ | $T_{vj}$ = 25 °C | | | 125 | mA |
| | | $T_{vj}$ = 125 °C | | | 75 | mA |
| Latching current | $I_L$ | $T_{vj}$ = 25 °C | | | 500 | mA |
| | | $T_{vj}$ = 125 °C | | | 250 | mA |

## Switching

***Maximum rated values*** [1)]

| Parameter | Symbol | Conditions | | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $T_{vj}$ = 125 °C,<br>$I_{TRM}$ = 3000 A, | Cont.<br>f = 50 Hz | | | 250 | A/µs |
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $V_D \le 0.67\ V_{DRM}$,<br>$I_{FG}$ = 2 A, $t_r$ = 0.5 µs | Cont.<br>f = 1Hz | | | 1000 | A/µs |
| Circuit-commutated turn-off time | $t_q$ | $T_{vj}$ = 125°C, $I_{TRM}$ = 2000 A,<br>$V_R$ = 200 V, $di_T/dt$ = -1.5 A/µs,<br>$V_D \le 0.67 \cdot V_{DRM}$, $dv_D/dt$ = 20 V/µs | | 700 | | | µs |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Reverse recovery charge | $Q_{rr}$ | $T_{vj}$ = 125°C, $I_{TRM}$ = 2000 A,<br>$V_R$ = 200 V,<br>$di_T/dt$ = -1.5 A/µs | 3400 | | 5200 | µAs |
| Reverse recovery current | $I_{RM}$ | | 60 | | 95 | A |
| Gate turn-on delay time | $t_{gd}$ | $T_{vj}$ = 25 °C, $V_D = 0.4 \cdot V_{RM}$, $I_{FG}$ = 2 A,<br>$t_r$ = 0.5 µs | | | 3 | µs |

# Triggering

***Maximum rated values*** [1)]

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Peak forward gate voltage | $V_{FGM}$ | | | | 12 | V |
| Peak forward gate current | $I_{FGM}$ | | | | 10 | A |
| Peak reverse gate voltage | $V_{RGM}$ | | | | 10 | V |
| Average gate power loss | $P_{G(AV)}$ | | | see Fig. 9 | | W |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Gate-trigger voltage | $V_{GT}$ | $T_{vj}$ = 25 °C | | | 2.6 | V |
| Gate-trigger current | $I_{GT}$ | $T_{vj}$ = 25 °C | | | 400 | mA |
| Gate non-trigger voltage | $V_{GD}$ | $V_D$ = 0.4 x $V_{DRM}$, $T_{vjmax}$ = 125 °C | 0.3 | | | V |
| Gate non-trigger current | $I_{GD}$ | $V_D$ = 0.4 x $V_{DRM}$, $T_{vjmax}$ = 125°C | 10 | | | mA |

# Thermal

***Maximum rated values*** [1)]

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Operating junction temperature range | $T_{vj}$ | | | | 125 | °C |
| Storage temperature range | $T_{stg}$ | | -40 | | 140 | °C |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Thermal resistance junction to case | $R_{th(j-c)}$ | Double-side cooled<br>$F_m$ = 81...108 kN | | | 5 | K/kW |
| | $R_{th(j-c)A}$ | Anode-side cooled<br>$F_m$ = 81...108 kN | | | 10 | K/kW |
| | $R_{th(j-c)C}$ | Cathode-side cooled<br>$F_m$ = 81...108 kN | | | 10 | K/kW |
| Thermal resistance case to heatsink | $R_{th(c-h)}$ | Double-side cooled<br>$F_m$ = 81...108 kN | | | 1 | K/kW |
| | $R_{th(c-h)}$ | Single-side cooled<br>$F_m$ = 81...108 kN | | | 2 | K/kW |

**Analytical function for transient thermal impedance:**

$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i(1 - e^{-t/\tau_i})$$

| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $R_i$(K/kW) | 3.359 | 0.936 | 0.481 | 0.224 |
| $\tau_i$(s) | 0.4924 | 0.0854 | 0.0118 | 0.0030 |

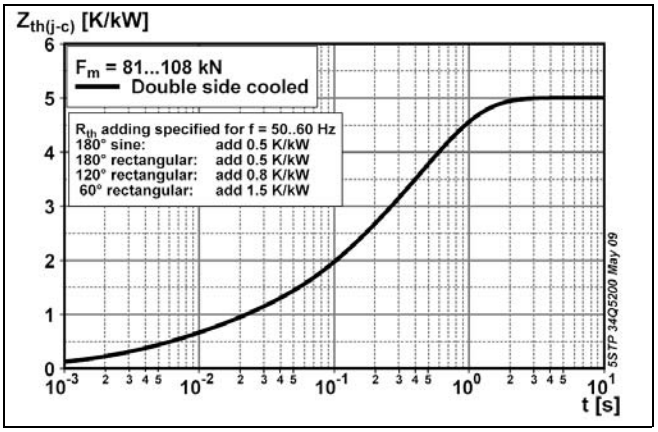



**Fig. 1** Transient thermal impedance (junction-to-case) vs. time

**On-state characteristic model:**

$$V_{T\max} = A + B \cdot I_T + C \cdot \ln(I_T + 1) + D \cdot \sqrt{I_T}$$

Valid for $i_T$ = 500 – 14000 A

| A | B | C | D |
|---|---|---|---|
| 1.065 | $105.0\times10^{-6}$ | $-38.88\times10^{-3}$ | $8.155\times10^{-3}$ |

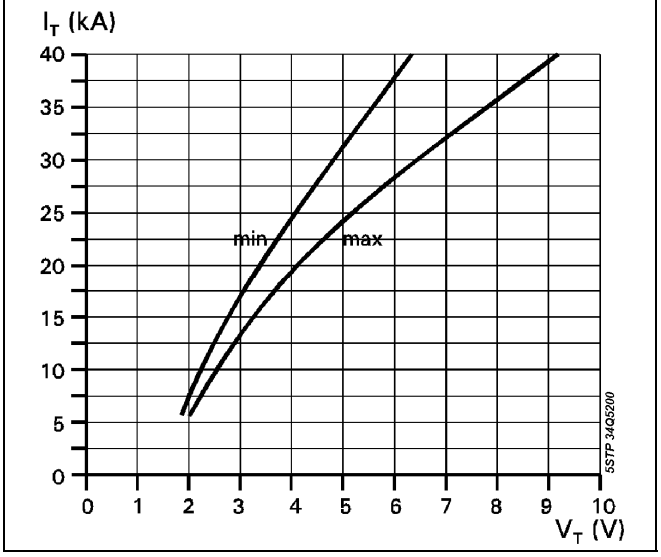



**Fig. 2** On-state characteristics, $T_j$=125°C, 10ms half sine

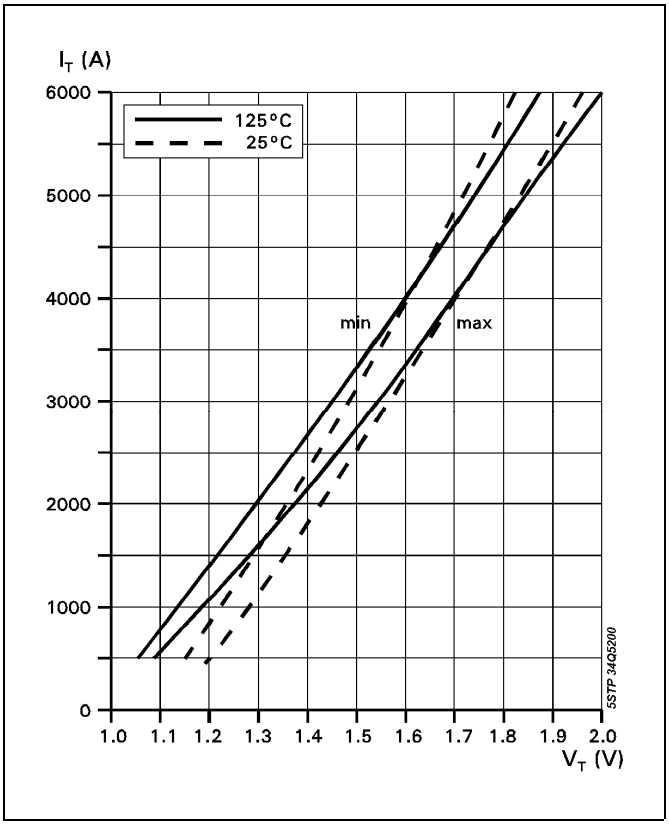



**Fig. 3** On-state voltage characteristics

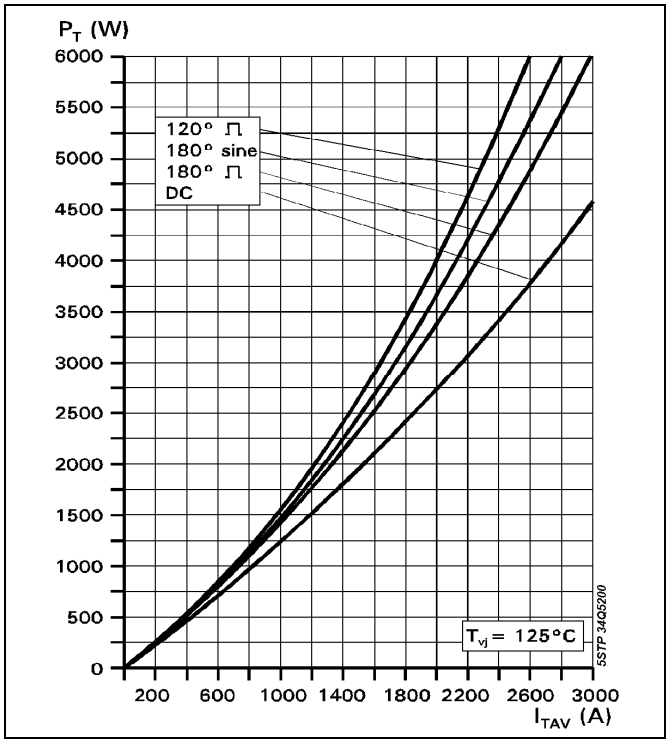



**Fig. 4** On-state power dissipation vs. mean on-state current, turn-on losses excluded

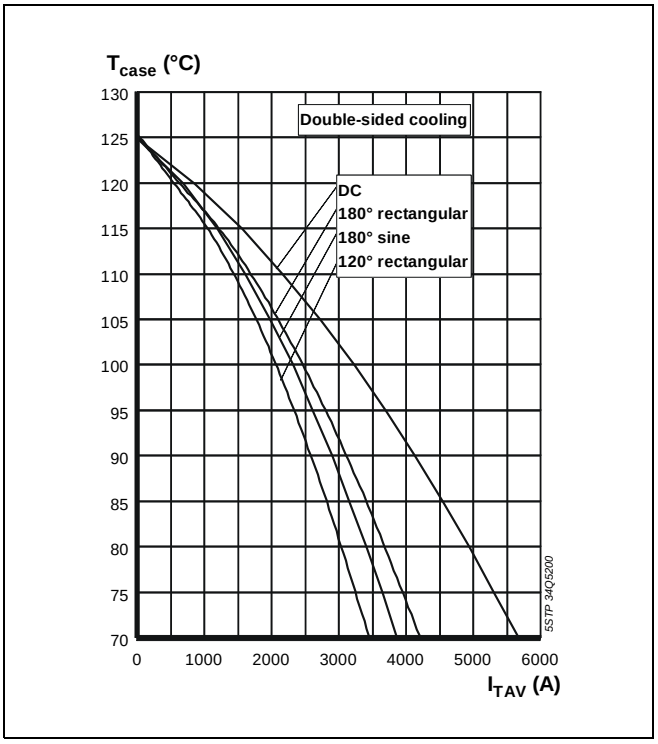



**Fig. 5** Max. permissible case temperature vs. mean on-state current, switching losses ignored

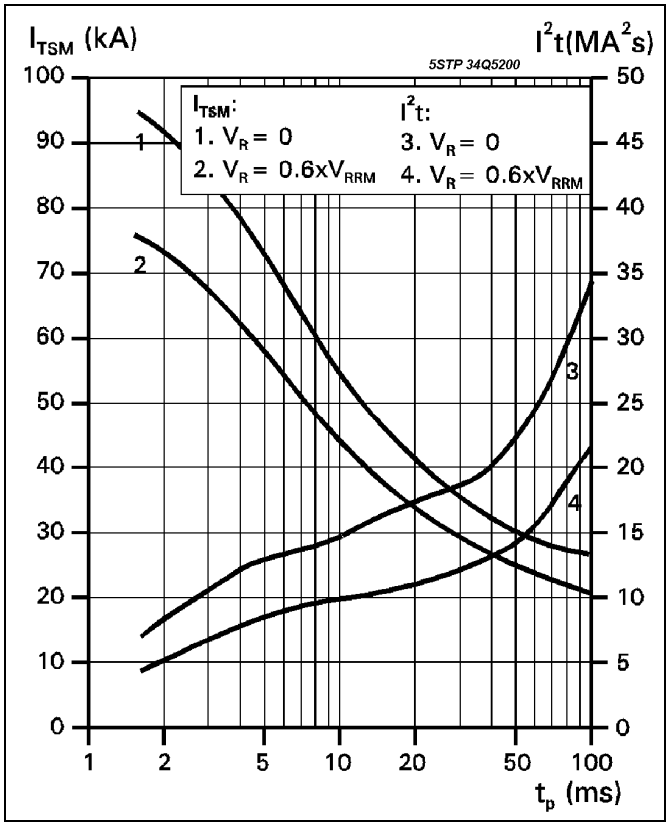



**Fig. 6** Surge on-state current vs. pulse length, half-sine wave

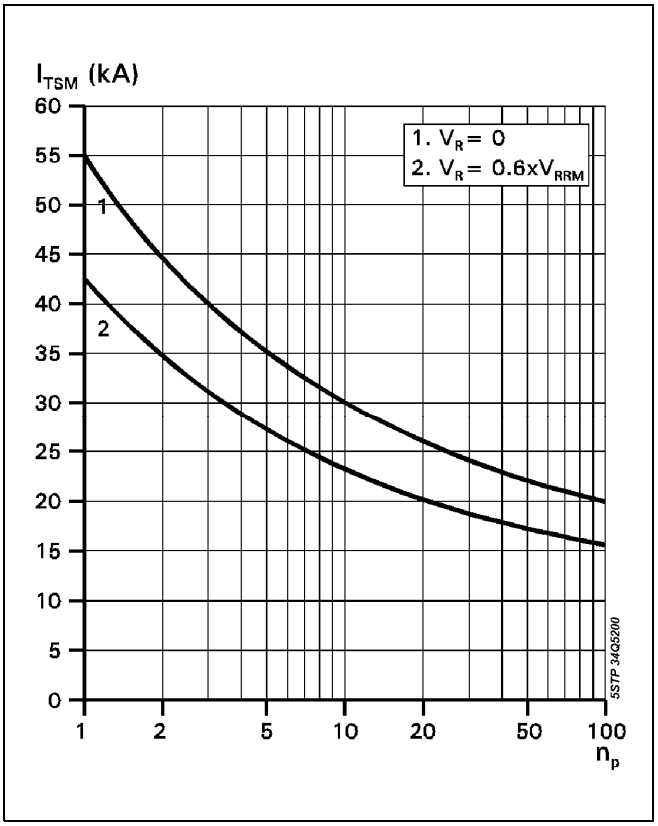



**Fig. 7** Surge on-state current vs. number of pulses, half-sine wave, 10 ms, 50Hz

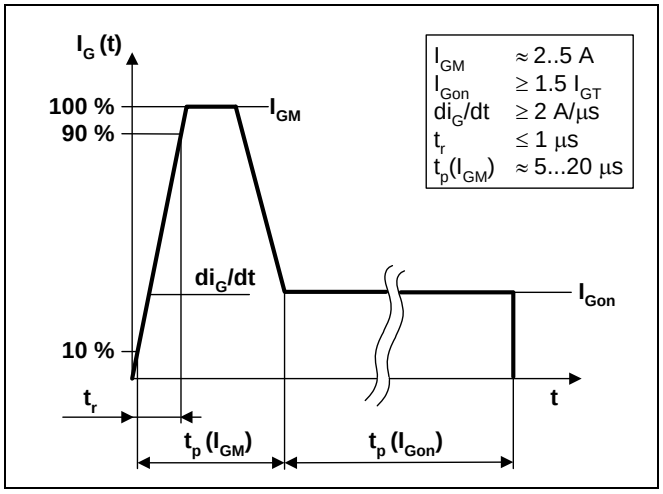



**Fig. 8** Recommended gate current waveform

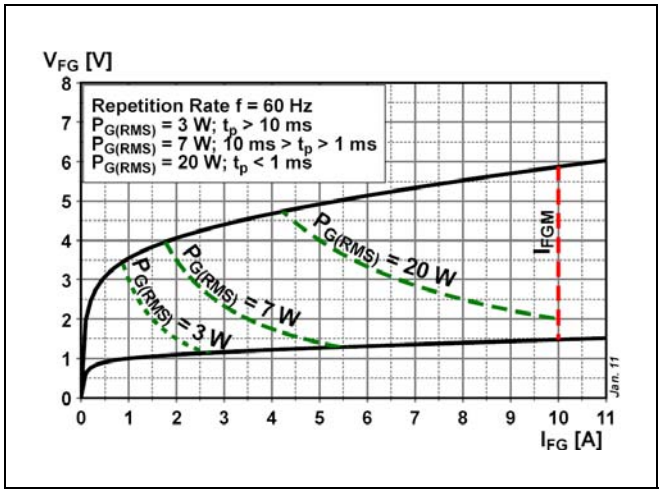



**Fig. 9** Max. peak gate power loss

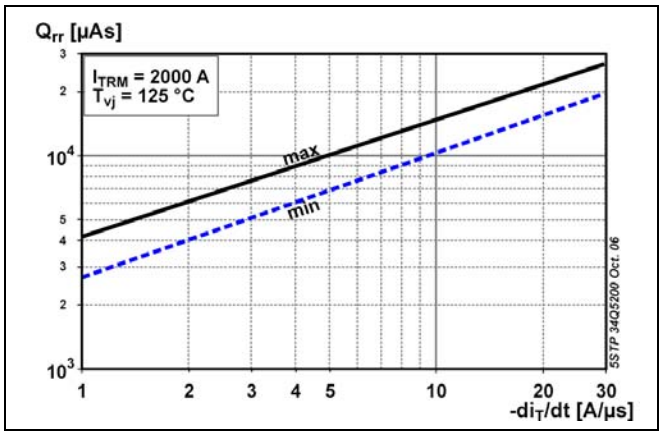



**Fig. 10** Reverse recovery charge vs. decay rate of on-state current

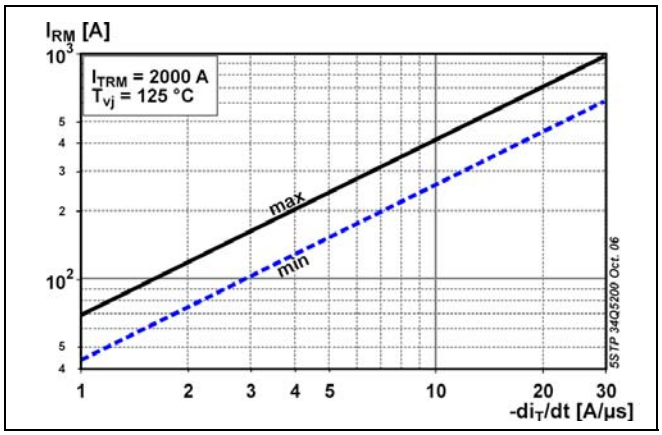



**Fig. 11** Peak reverse recovery current vs. decay rate of on-state current

# Turn-on and Turn-off losses

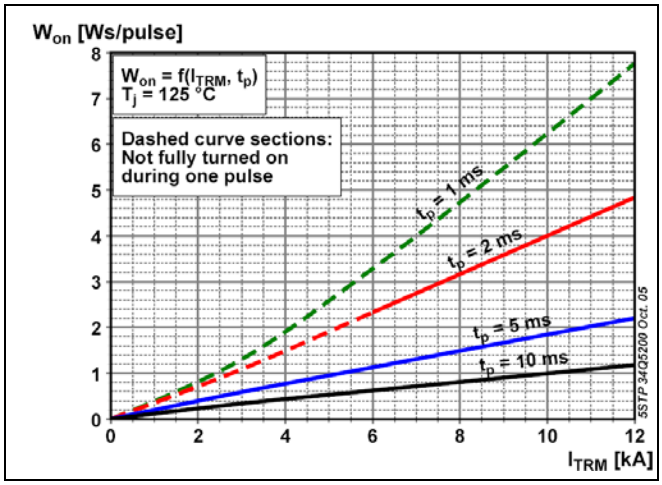



**Fig. 12** Turn-on energy, half sinusoidal waves

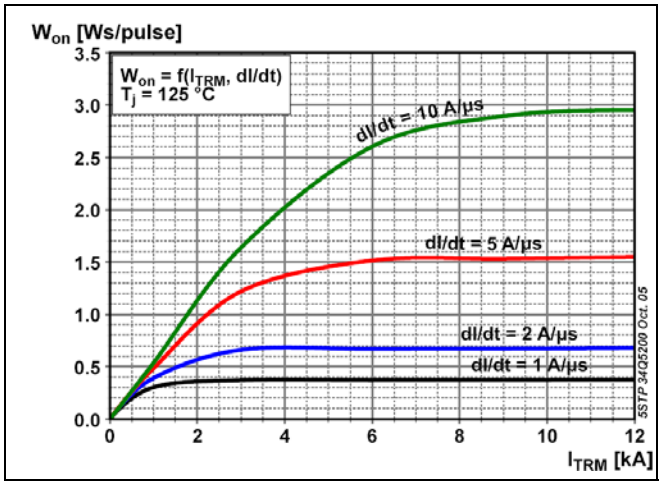



**Fig. 13** Turn-on energy, rectangular waves

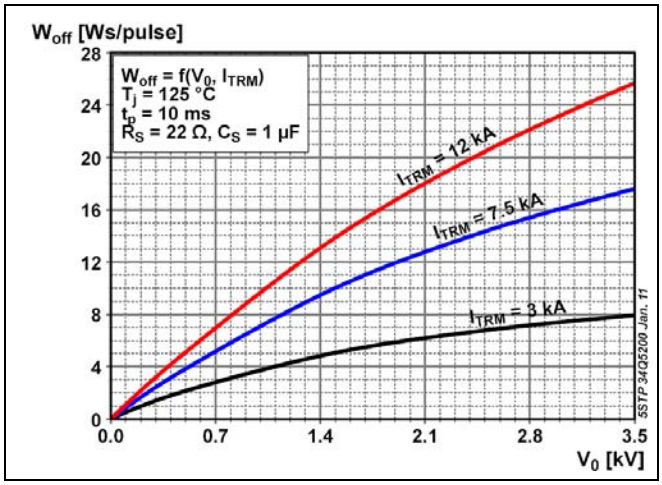



**Fig. 14** Turn-off energy, half sinusoidal waves

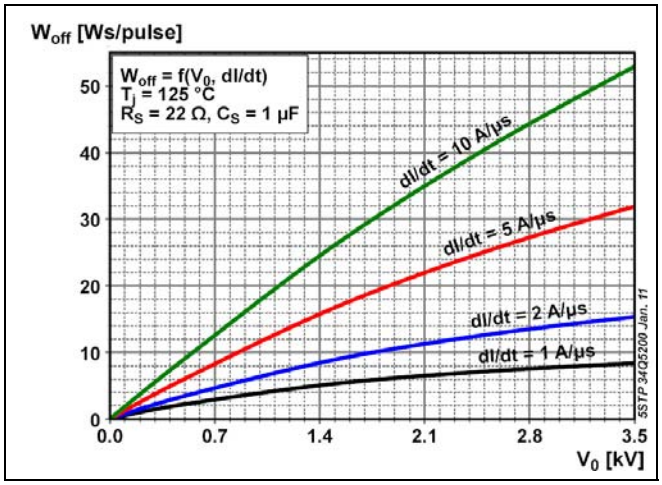



**Fig. 15** Turn-off energy, rectangular waves

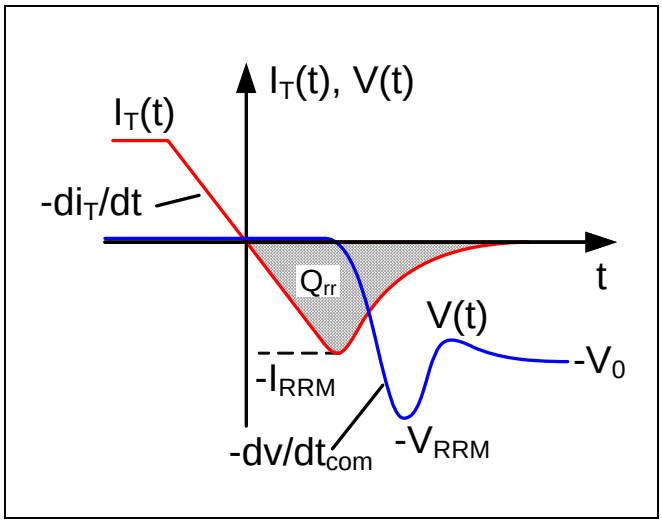



**Fig. 16** Current and voltage waveforms at turn-off

**Total power loss for repetitive waveforms:**

$$P_{TOT} = P_T + W_{on} \cdot f + W_{off} \cdot f$$

where

$$P_T = \frac{1}{T}\int_0^T I_T \cdot V_T(I_T)\ dt$$

**Fig. 17** Relationships for power loss

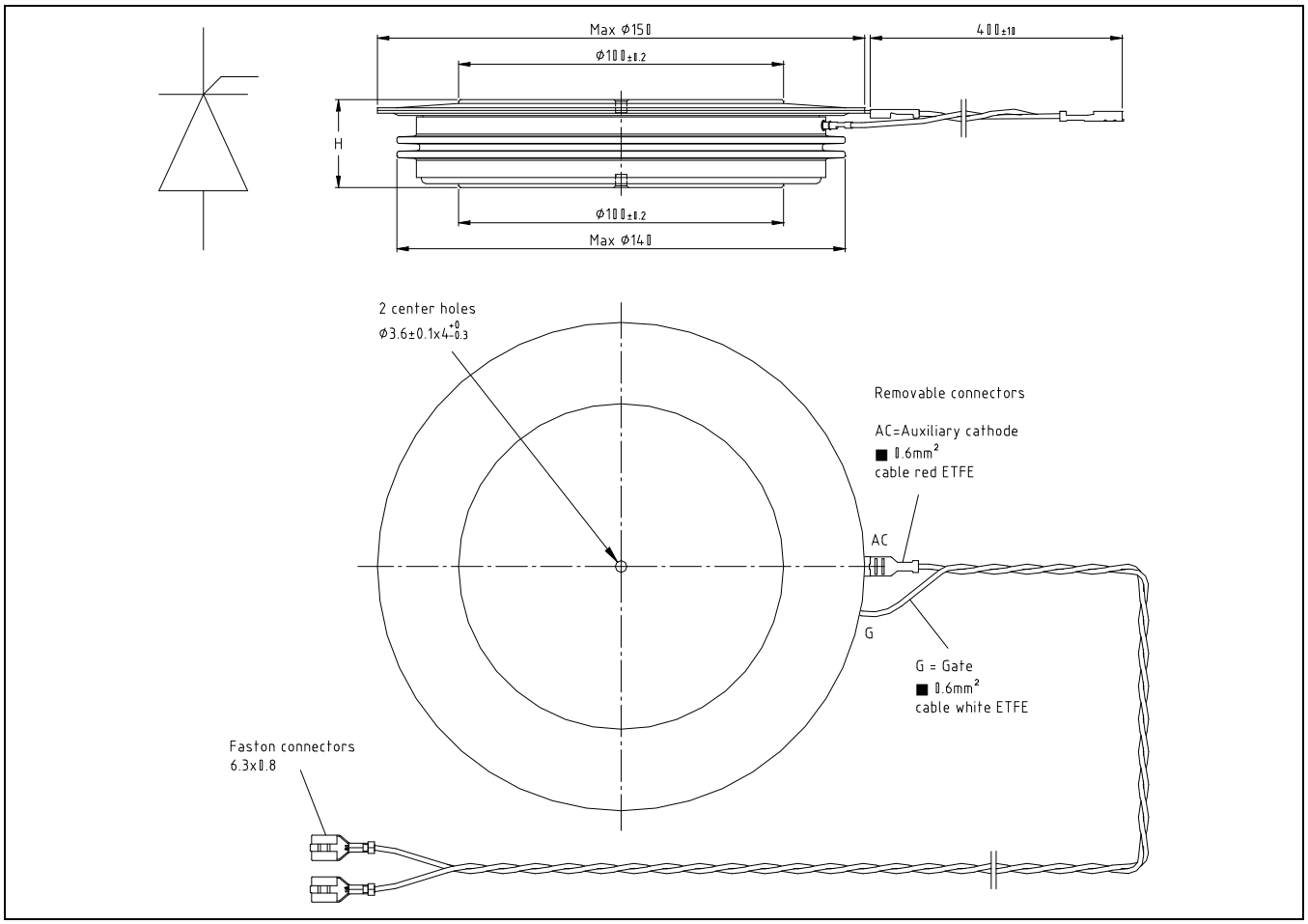



**Fig. 18** Device Outline Drawing

## Related documents:

| | |
|---|---|
| 5SYA 2020 | Design of RC-Snubber for Phase Control Applications |
| 5SYA 2049 | Voltage definitions for phase control thyristors and diodes |
| 5SYA 2051 | Voltage ratings of high power semiconductors |
| 5SYA 2034 | Gate-Drive Recommendations for PCT's |
| 5SYA 2036 | Recommendations regarding mechanical clamping of Press Pack High Power Semiconductors |
| 5SZK 9104 | Specification of environmental class for pressure contact diodes, PCTs and GTO, STORAGE available on request, please contact factory |
| 5SZK 9105 | Specification of environmental class for pressure contact diodes, PCTs and GTO, TRANSPORTATION available on request, please contact factory |

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