| | | |
|---|---|---|
| $V_{DRM}$ | = | 2800 V |
| $I_{T(AV)M}$ | = | 2780 A |
| $I_{T(RMS)}$ | = | 4360 A |
| $I_{TSM}$ | = | 43.0·10³ A |
| $V_{T0}$ | = | 0.928 V |
| $r_T$ | = | 0.141 mΩ |

# Phase Control Thyristor

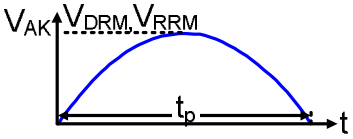
# 5STP 24H2800

Doc. No. 5SYA1047-04 May. 20

- **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 24H2800 | Unit |
|---|---|---|---|---|
| Max repetitive peak forward and reverse blocking voltage | $V_{DRM}$, $V_{RRM}$ | f = 50 Hz, $t_p$ = 10 ms, $T_{vj}$ = 5…125 °C, Note 1   | 2800 | V |
| Critical rate of rise of commutating voltage | $dv/dt_{crit}$ | Exp. to 0.67·$V_{DRM}$, $T_{vj}$ = 125 °C | 1000 | V/µs |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Forward leakage current | $I_{DRM}$ | $V_{DRM}$, $T_{vj}$ = 125 °C | | | 300 | mA |
| Reverse leakage current | $I_{RRM}$ | $V_{RRM}$, $T_{vj}$ = 125 °C | | | 300 | mA |

Note 1: Voltage de-rating factor of 0.11% per °C is applicable for $T_{vj}$ below +5 °C.

## Mechanical data

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

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Mounting force | $F_M$ | | 45 | 50 | 60 | 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 | | | | 0.9 | kg |
| Housing thickness | H | $F_M$ = 50 kN, $T_a$ = 25 °C | 25.75 | | 26.40 | 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 | | | 2780 | A |
| RMS on-state current | $I_{T(RMS)}$ | | | | 4360 | A |
| Peak non-repetitive surge current | $I_{TSM}$ | $t_p$ = 10 ms, $T_{vj}$ = 125 °C, sine half wave, $V_D = V_R$= 0 V, after surge | | | $43.0 \cdot 10^3$ | A |
| Limiting load integral | $I^2t$ | | | | $9.25 \cdot 10^6$ | $A^2s$ |
| Peak non-repetitive surge current | $I_{TSM}$ | $t_p$ = 10 ms, $T_{vj}$ = 125 °C, sine half wave, $V_R = 0.6 \cdot V_{RRM}$, after surge | | | $36.0 \cdot 10^3$ | A |
| Limiting load integral | $I^2t$ | | | | $6.48 \cdot 10^6$ | $A^2s$ |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| On-state voltage | $V_T$ | $I_T$ = 3000 A, $T_{vj}$ = 125 °C | | 1.26 | 1.35 | V |
| Threshold voltage | $V_{(T0)}$ | $I_T$ = 1500 A - 4500 A, $T_{vj}$ = 125 °C | | | 0.928 | V |
| Slope resistance | $r_T$ | | | | 0.141 | mΩ |
| Holding current | $I_H$ | Tvj = 25 °C | | | 75 | mA |
| | | Tvj = 125 °C | | | 60 | mA |
| Latching current | $I_L$ | Tvj = 25 °C | | | 600 | mA |
| | | Tvj = 125 °C | | | 200 | 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, $I_T$ = 3000 A, $V_D \leq 0.67 \cdot V_{DRM}$, $I_{GM}$ = 2 A, $t_r$ = 0.5 µs | Cont. f = 50 Hz | | | 150 | A/µs |
| | | | Cont. f = 1 Hz | | | 1000 | A/µs |
| Circuit-commutated turn-off time | $t_q$ | $T_{vj}$ = 125 °C, $I_T$ = 2000 A, $V_R$ = 200 V, $di_T/dt$ = -1.5 A/µs, $V_D \leq 0.67 \cdot V_{DRM}$, $dv_D/dt$ = 20 V/µs | | | | 400 | µs |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Reverse recovery charge | $Q_{rr}$ | $T_{vj}$ = 125 °C, $I_T$ = 2000 A, $V_R$ = 200 V, $di_T/dt$ = -1.5 A/µs | 650 | 1400 | 1700 | µAs |
| Reverse recovery current | $I_{RM}$ | | 30 | 44 | 50 | A |
| Gate turn-on delay time | $t_{gd}$ | $T_{vj}$ = 25 °C, $V_D = 0.4 \cdot V_{RM}$, $I_{GM}$ = 2 A, $t_r$ = 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. 7 | | | W |

***Characteristic values***

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Gate-trigger voltage | $V_{GT}$ | Tvj = 25 °C | | | 2.6 | V |
| Gate-trigger current | $I_{GT}$ | Tvj = 25 °C | | | 400 | mA |
| Gate non-trigger voltage | $V_{GD}$ | $V_D = 0.4 \cdot V_{DRM}$, $T_{vjmax}$ = 125 °C | | | 0.3 | V |
| Gate non-trigger current | $I_{GD}$ | $V_D = 0.4 \cdot V_{DRM}$, $T_{vjmax}$ = 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>$F_m$ = 45... 60 kN | | | 10 | K/kW |
| | $R_{th(j-c)A}$ | Anode-side cooled<br>$F_m$ = 45... 60 kN | | | 20 | K/kW |
| | $R_{th(j-c)C}$ | Cathode-side cooled<br>$F_m$ = 45... 60 kN | | | 20 | K/kW |
| Thermal resistance case to heatsink, | $R_{th(c-h)}$ | Double-side cooled<br>$F_m$ = 45... 60 kN | | | 2 | K/kW |
| | $R_{th(c-h)}$ | Single-side cooled<br>$F_m$ = 45... 60 kN | | | 4 | 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) | 6.630 | 2.209 | 1.036 | 0.125 |
| $\tau_i$(s) | 0.4670 | 0.0485 | 0.0035 | 0.0006 |

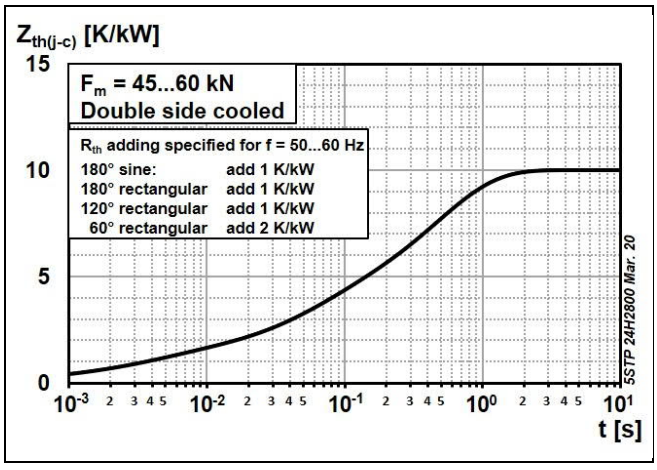



**Fig. 1** Transient thermal impedance (junction-to-case) vs. time

**Max. on-state characteristic model:**

$$V_{T25} = A_{Tvj} + B_{Tvj} \cdot I_T + C_{Tvj} \cdot \ln(I_T + 1) + D_{Tvj} \cdot \sqrt{I_T}$$

Valid for $I_T$ = 500 - 45000 A

| $A_{25}$ | $B_{25}$ | $C_{25}$ | $D_{25}$ |
|---|---|---|---|
| $288.2 \cdot 10^{-3}$ | $50.26 \cdot 10^{-6}$ | $103.5 \cdot 10^{-3}$ | $2.719 \cdot 10^{-3}$ |

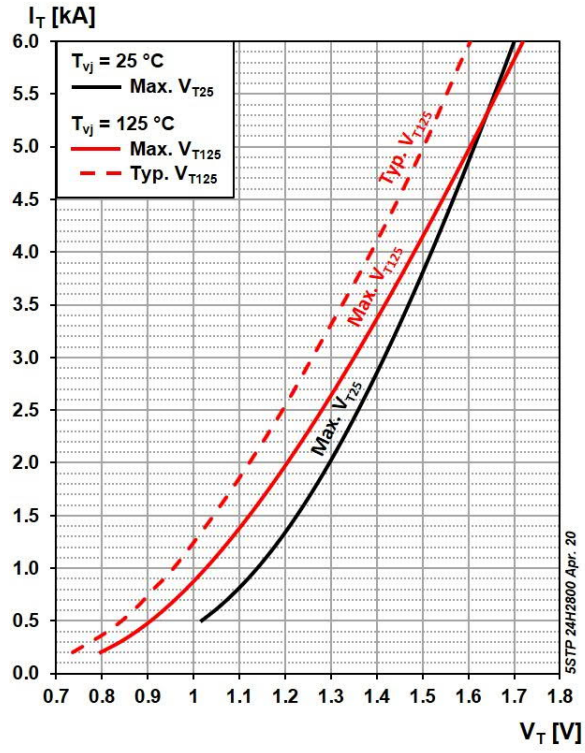



**Fig. 2** On-state voltage characteristics

**Max. on-state characteristic model:**

$$V_{T125} = A_{Tvj} + B_{Tvj} \cdot I_T + C_{Tvj} \cdot \ln(I_T + 1) + D_{Tvj} \cdot \sqrt{I_T}$$

Valid for $I_T$ = 200 - 45000 A

| $A_{125}$ | $B_{125}$ | $C_{125}$ | $D_{125}$ |
|---|---|---|---|
| $477.1 \cdot 10^{-3}$ | $64.63 \cdot 10^{-6}$ | $40.55 \cdot 10^{-3}$ | $6.471 \cdot 10^{-3}$ |

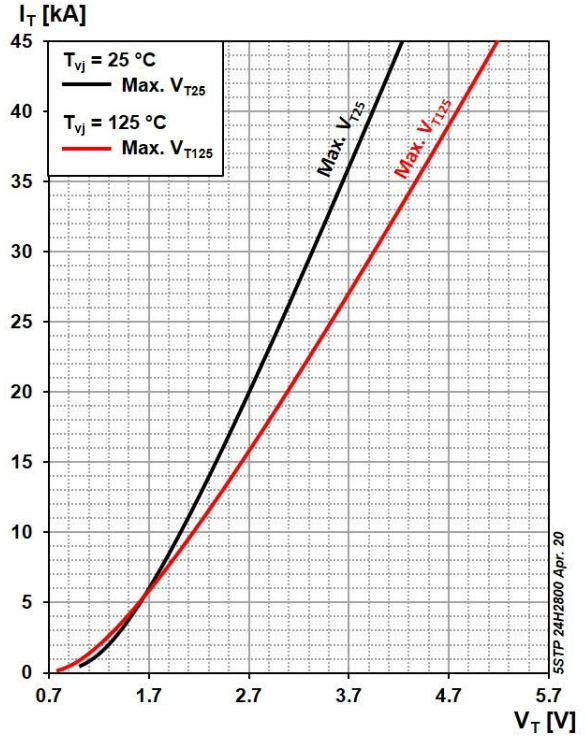



**Fig. 3** On-state voltage characteristics

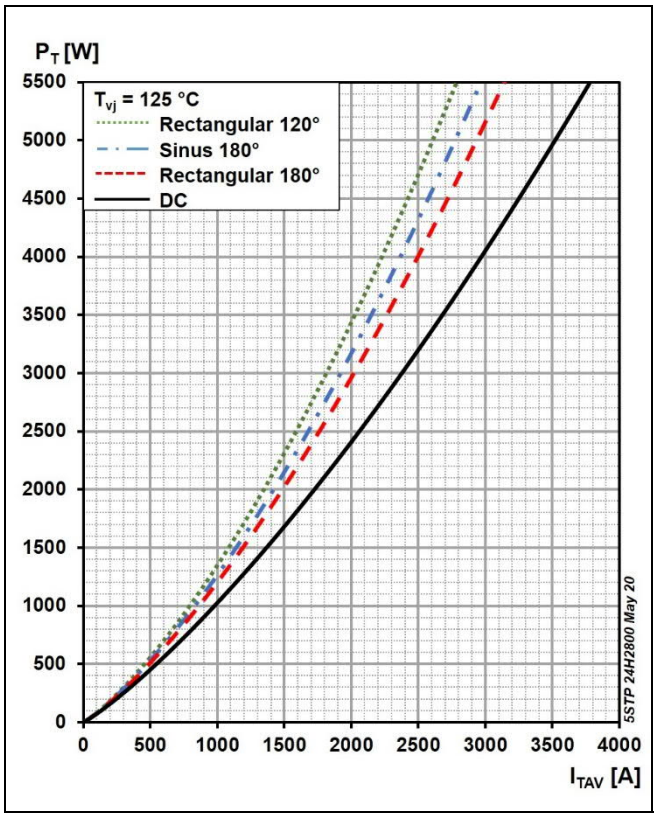



**Fig. 4** On-state power dissipation vs. mean on-state current, turn-on losses excluded

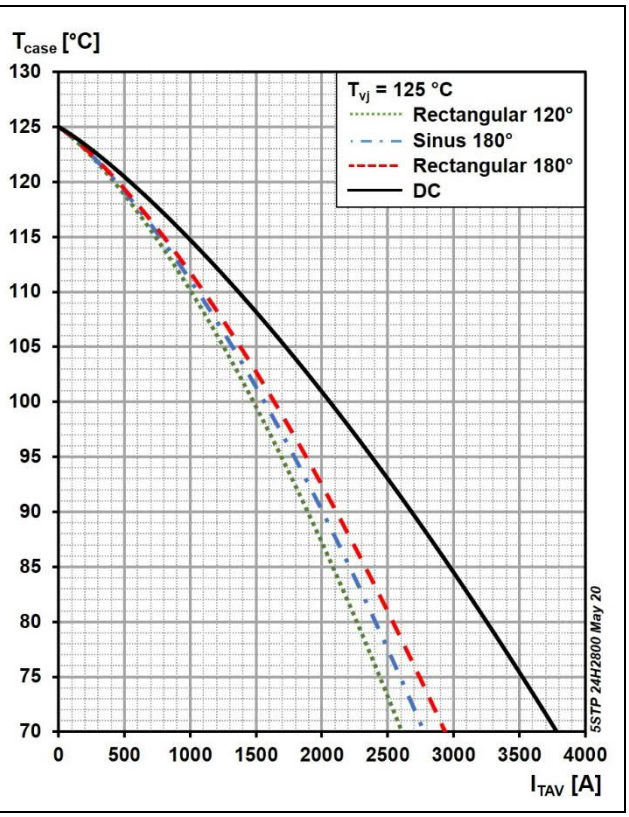



**Fig. 5** Max. permissible case temperature vs. mean on-state current, switching losses ignored

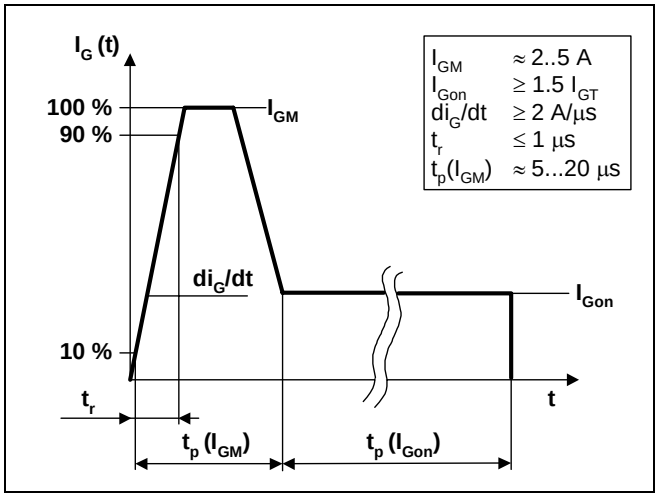



**Fig. 6** Recommended gate current waveform

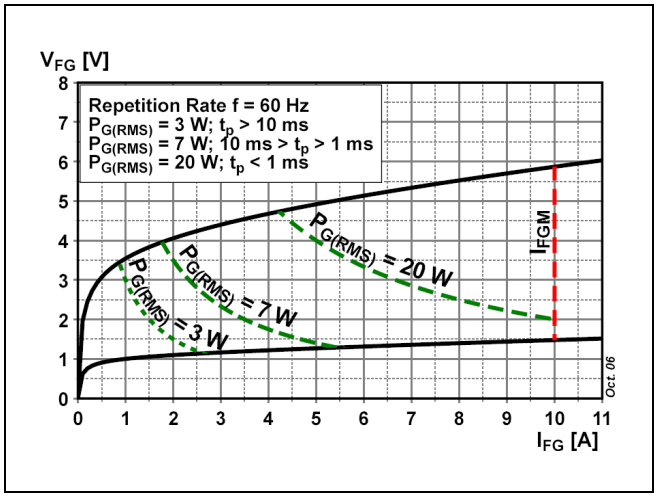



**Fig. 7** Max. peak gate power loss

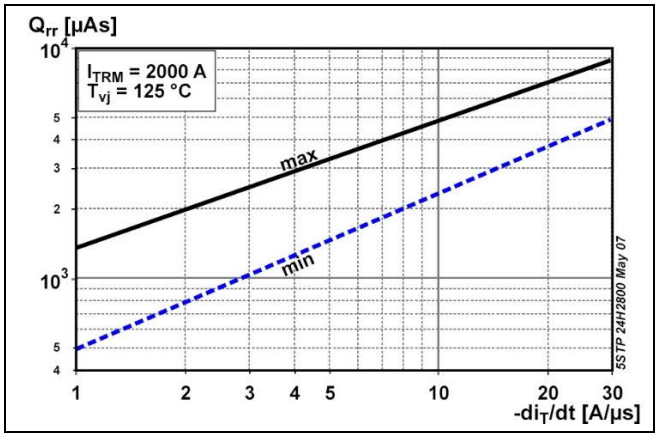



**Fig. 8** Reverse recovery charge vs. decay rate of on-state current

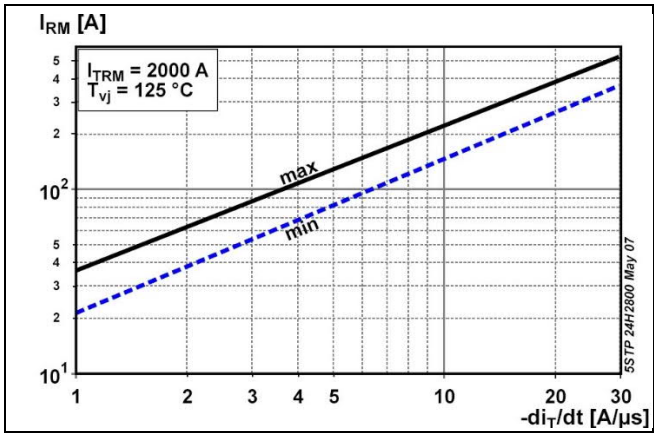



**Fig. 9** Peak reverse recovery current vs. decay rate of on-state current

# Turn-on and Turn-off losses

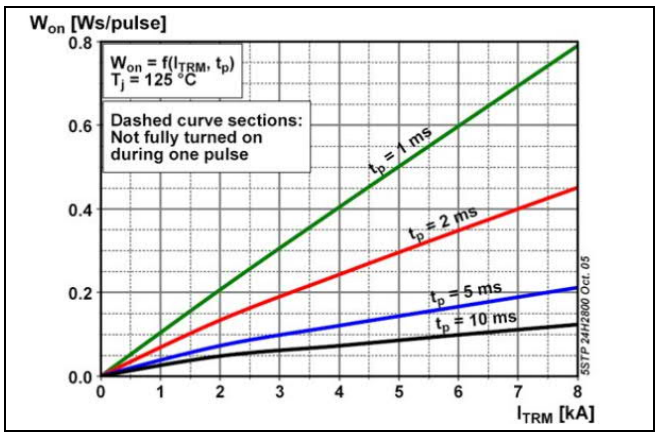



**Fig. 10** Turn-on energy, half sinusoidal waves

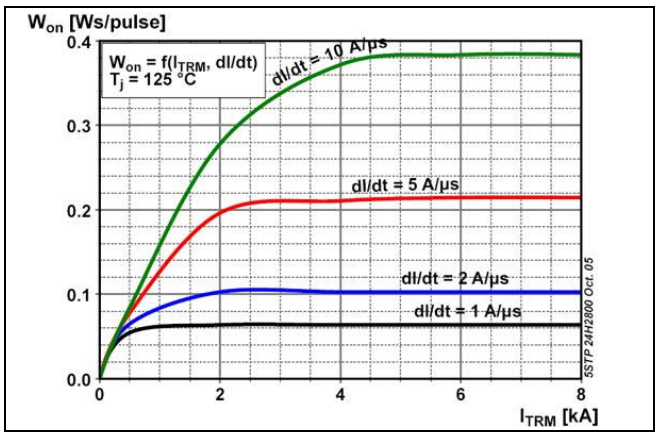



**Fig. 11** Turn-on energy, rectangular waves

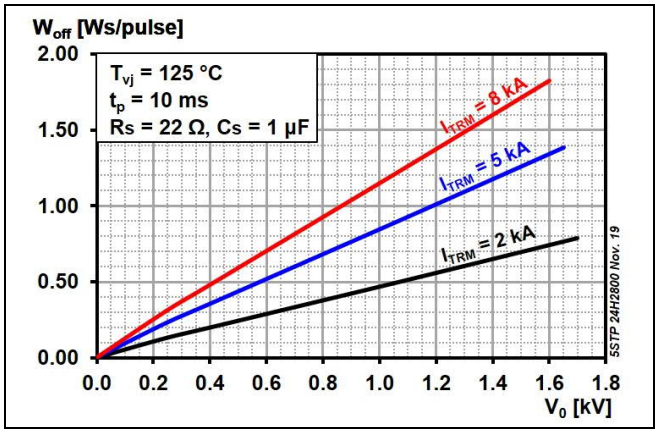



**Fig. 12** Typical turn-off energy, half sinusoidal waves

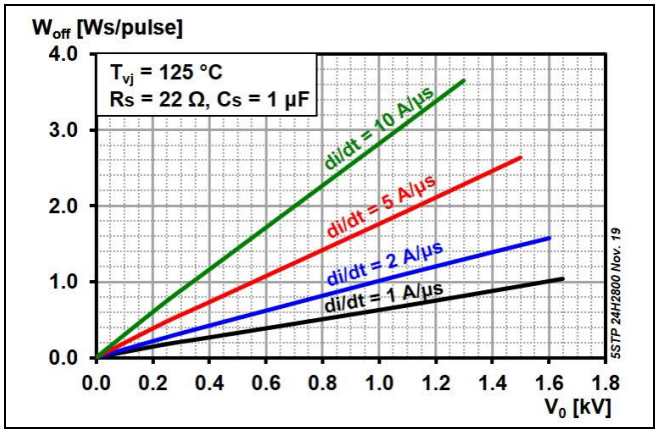



**Fig. 13** Typical turn-off energy, rectangular waves

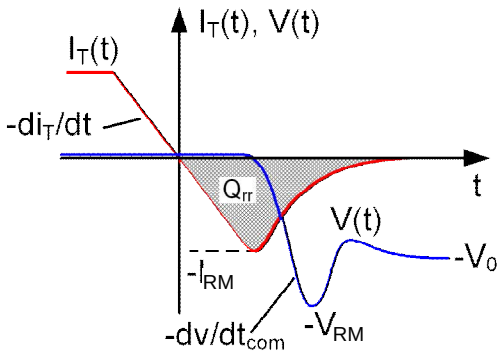



**Fig. 14** Current and voltage waveforms at turn-off

**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. 15** Relationships for power loss

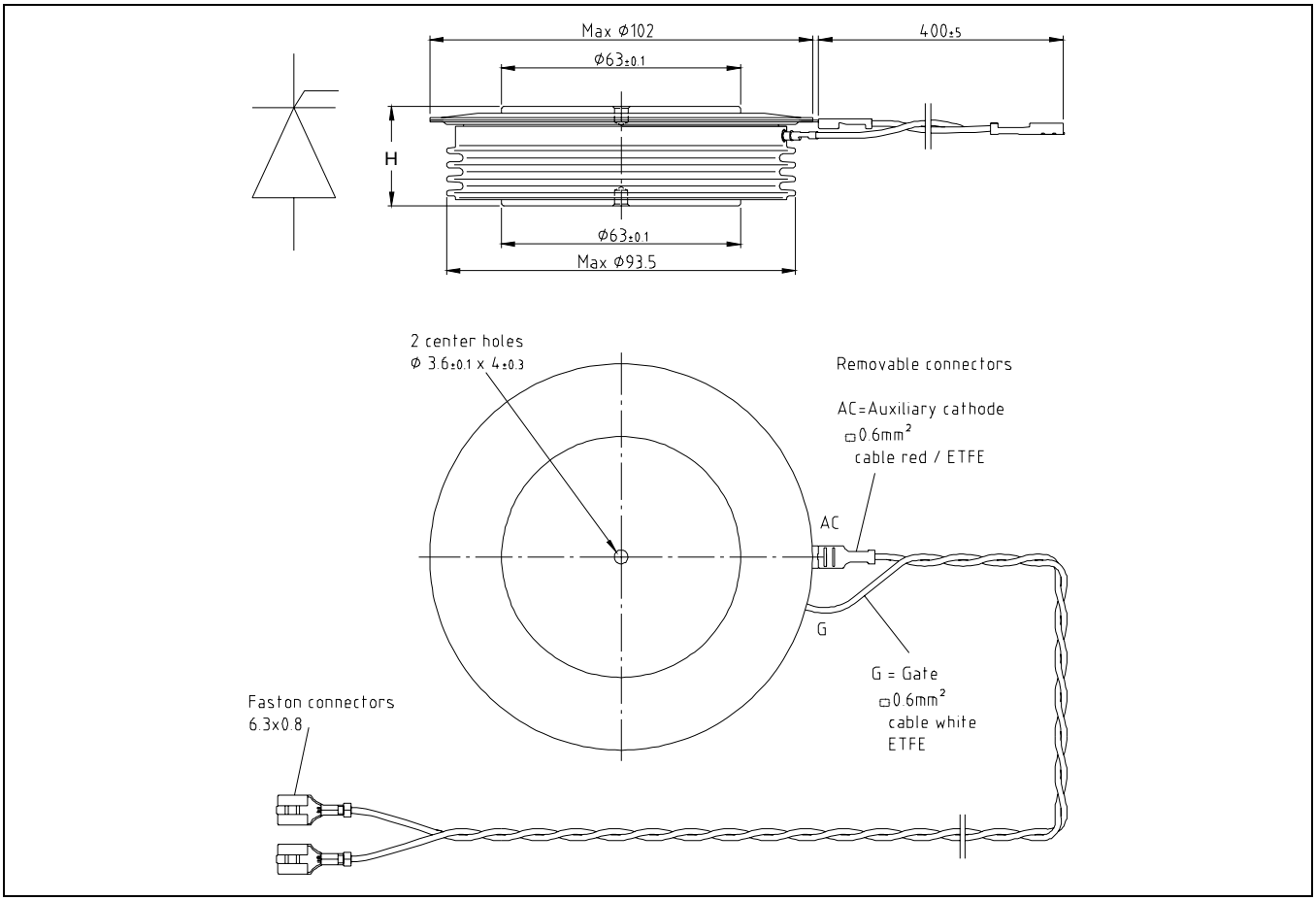



**Fig. 16** Device Outline Drawing

## Related documents:

| | |
|---|---|
| 5SYA 2020 | Design of RC-Snubbers for Phase Control Applications |
| 5SYA 2049 | Voltage definitions for phase control and bi-directionally controlled thyristors |
| 5SYA 2051 | Voltage ratings of high power semiconductors |
| 5SYA 2034 | Gate-drive recommendations for phase control and bi-directionally controlled thyristors |
| 5SYA 2036 | Recommendations regarding mechanical clamping of Press-Pack High Power Semiconductors |
| 5SZK 9118 | General Environmental Conditions for High Power Semiconductors |

Please refer to http://www.abb.com/semiconductors for current version of documents.



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