

|              |   |                    |
|--------------|---|--------------------|
| $V_{DM}$     | = | 5200 V             |
| $I_{T(AV)M}$ | = | 1800 A             |
| $I_{T(RMS)}$ | = | 2830 A             |
| $I_{TSM}$    | = | $29 \times 10^3$ A |
| $V_{T0}$     | = | 1.02 V             |
| $r_T$        | = | 0.32 mW            |

# Bi-Directional Control Thyristor

## 5STB 17N5200

Doc. No. 5SYA1036-04 May 07

- Two thyristors integrated into one wafer
- Patented free-floating silicon technology
- Designed for energy management and industrial applications
- Optimum power handling capability
- Interdigitated amplifying gate

The electrical and thermal data are valid for one-thyristor-half of the device (unless otherwise stated)

### Blocking

#### Maximum rated values<sup>1)</sup>

| Parameter                                    | Symbol         | Conditions  | 5STB 17N5200                                 | Unit |
|--|----------------|---|--|------|
| Max. surge peak forward blocking voltage     | $V_{SM}$       | $t_p = 10$ ms, $f = 5$ Hz<br>$T_{vj} = 5 \dots 125^\circ\text{C}$ , Note 1                                  | 5200   | V    |
| Max repetitive peak forward blocking voltage | $V_{RM}$       | $f = 50$ Hz, $t_p = 10$ ms, $t_{p1} = 250$ $\mu\text{s}$ ,<br>$T_{vj} = 5 \dots 125^\circ\text{C}$ , Note 1 | 5200   | V    |
| Max crest working forward voltages           | $V_{WM}$       |   | 2600   | V    |
| Critical rate of rise of off-state voltage   | $dv/dt_{crit}$ |   | Exp. to 2950 V, $T_{vj} = 125^\circ\text{C}$ | 2000 |

#### Characteristic values

| Parameter                   | Symbol   | Conditions                              | min | typ | max | Unit |
|-----------------------------|----------|---|-----|-----|-----|------|
| Max reverse leakage current | $I_{RM}$ | $V_{RM}$ , $T_{vj} = 125^\circ\text{C}$ |     |     | 400 | mA   |

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

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<sup>1)</sup>

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

#### Characteristic values

| Parameter                 | Symbol | Conditions                              | min  | typ | max  | Unit |
|---------------------------|--------|---|------|-----|------|------|
| Weight                    | $m$    |   |      |     | 2.9  | kg   |
| Housing thickness         | $H$    | $F_M = 90$ kN, $T_a = 25^\circ\text{C}$ | 34.8 |     | 35.4 | mm   |
| Surface creepage distance | $D_S$  |   | 53   |     |      | mm   |
| Air strike distance       | $D_a$  |   | 22   |     |      | mm   |

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

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## On-state

### Maximum rated values <sup>1)</sup>

| Parameter                         | Symbol       | Conditions   | min | typ | max                | Unit   |
|-----------------------------------|--------------|--|-----|-----|--------------------|--------|
| Average on-state current          | $I_{T(AV)M}$ | Half sine wave, $T_c = 70\text{ °C}$   |     |     | 1800               | A      |
| RMS on-state current              | $I_{T(RMS)}$ |  |     |     | 2830               | A      |
| RMS on-state current              | $I_{T(RMS)}$ | Full sine wave, $T_c = 70\text{ °C}$   |     |     | 4000               | A      |
| Peak non-repetitive surge current | $I_{TSM}$    | $t_p = 10\text{ ms}$ , $T_{vj} = 125\text{ °C}$ , sine wave after surge: $V_D = V_R = 0\text{ V}$  |     |     | $29.0 \times 10^3$ | A      |
| Limiting load integral            | $I^2t$       |  |     |     | $4.21 \times 10^6$ | $A^2s$ |
| Peak non-repetitive surge current | $I_{TSM}$    | $t_p = 8.3\text{ ms}$ , $T_{vj} = 125\text{ °C}$ , sine wave after surge: $V_D = V_R = 0\text{ V}$ |     |     | $31.0 \times 10^3$ | A      |
| Limiting load integral            | $I^2t$       |  |     |     | $3.99 \times 10^6$ | $A^2s$ |

### Characteristic values

| Parameter         | Symbol   | Conditions   | min | typ | max  | Unit      |
|-------------------|----------|--|-----|-----|------|-----------|
| On-state voltage  | $V_T$    | $I_T = 2000\text{ A}$ , $T_{vj} = 125\text{ °C}$                 |     |     | 1.68 | V         |
| Threshold voltage | $V_{T0}$ | $I_T = 1000\text{ A} - 3000\text{ A}$ , $T_{vj} = 125\text{ °C}$ |     |     | 1.02 | V         |
| Slope resistance  | $r_T$    |  |     |     | 0.32 | $m\Omega$ |
| Holding current   | $I_H$    | $T_{vj} = 25\text{ °C}$  | 50  |     | 250  | mA        |
|                   |          | $T_{vj} = 125\text{ °C}$   |     |     | 150  | mA        |
| Latching current  | $I_L$    | $T_{vj} = 25\text{ °C}$  |     |     | 500  | mA        |
|                   |          | $T_{vj} = 125\text{ °C}$   |     |     | 300  | mA        |

## Switching

### Maximum rated values <sup>1)</sup>

| Parameter                                    | Symbol         | Conditions   | min | typ | max | Unit      |
|--|----------------|--|-----|-----|-----|-----------|
| Critical rate of rise of on-state current    | $di/dt_{crit}$ | $T_{vj} = 125\text{ °C}$ ,<br>$I_{TRM} = 3000\text{ A}$ ,<br>Cont. $f = 50\text{ Hz}$  |     |     | 250 | $A/\mu s$ |
| Critical rate of rise of on-state current    | $di/dt_{crit}$ | $V_D \leq 2950\text{ V}$ ,<br>$I_{FG} = 2\text{ A}$ , $t_r = 0.5\text{ }\mu s$<br>Cont. $f = 1\text{ Hz}$  |     |     | 500 | $A/\mu s$ |
| Circuit commutated turn-off time             | $t_q$          | $T_{vj} = 125\text{ °C}$ , $I_{TRM} = 2000\text{ A}$ ,<br>$V_R = 200\text{ V}$ , $di_T/dt = -1.5\text{ A}/\mu s$ ,<br>$V_D \leq 0.67 \cdot V_{RM}$ , $dv_D/dt = 20\text{ V}/\mu s$ , | 700 |     |     | $\mu s$   |
| Critical rate of rise of commutating voltage | $dv/dt_{com}$  | $T_{vj} = 125\text{ °C}$ , $V_R \leq 0.67 \cdot V_{RM}$  |     |     | 500 | $V/\mu s$ |

### Characteristic values

| Parameter                | Symbol   | Conditions   | min  | typ | max  | Unit     |
|--------------------------|----------|--|------|-----|------|----------|
| Reverse recovery charge  | $Q_{rr}$ | $T_{vj} = 125\text{ °C}$ , $I_{TRM} = 2000\text{ A}$ ,<br>$V_R = 200\text{ V}$ , $di_T/dt = -1.5\text{ A}/\mu s$ | 3500 |     | 6500 | $\mu As$ |
| Reverse recovery current | $I_{RM}$ |  | 65   |     | 90   | A        |
| Gate turn-on delay time  | $t_{gd}$ | $T_{vj} = 25\text{ °C}$ , $V_D = 0.4 \cdot V_{RM}$ , $I_{FG} = 2\text{ A}$ ,<br>$t_r = 0.5\text{ }\mu s$         |      |     | 3    | $\mu s$  |

## Triggering

Maximum rated values <sup>1)</sup>

| Parameter                            | Symbol       | Conditions          | min        | typ | max | Unit |
|--------------------------------------|--------------|---------------------|------------|-----|-----|------|
| Peak forward gate voltage            | $V_{FGM}$    |                     |            |     | 12  | V    |
| Max. rated peak forward gate current | $I_{FGM}$    |                     |            |     | 10  | A    |
| Peak reverse gate voltage            | $V_{RGM}$    |                     |            |     | 10  | V    |
| Max. rated gate power loss           | $P_G$        | For DC gate current |            |     | 3   | W    |
| Max. rated peak forward gate power   | $P_{GM(AV)}$ |                     | see Fig. 9 |     |     | W    |

Characteristic values

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

## Thermal

Maximum rated values <sup>1)</sup>

| 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<br>(Valid for one thyristor half no heat flow to the second half.) | $R_{th(j-c)}$ | Double-side cooled<br>$F_m = 81...108\text{ kN}$ |     |     | 11.4 | K/kW |
|  | $R_{th(j-c)}$ | Single-side cooled<br>$F_m = 81...108\text{ kN}$ |     |     | 22.8 | K/kW |
| Thermal resistance case to heatsink  | $R_{th(c-h)}$ | Double-side cooled<br>$F_m = 81...108\text{ kN}$ |     |     | 2    | K/kW |
|  | $R_{th(c-h)}$ | Single-side cooled<br>$F_m = 81...108\text{ kN}$ |     |     | 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) | 6.770  | 2.510  | 1.340  | 0.780  |
| $\tau_i$ (s) | 0.8651 | 0.1558 | 0.0212 | 0.0075 |

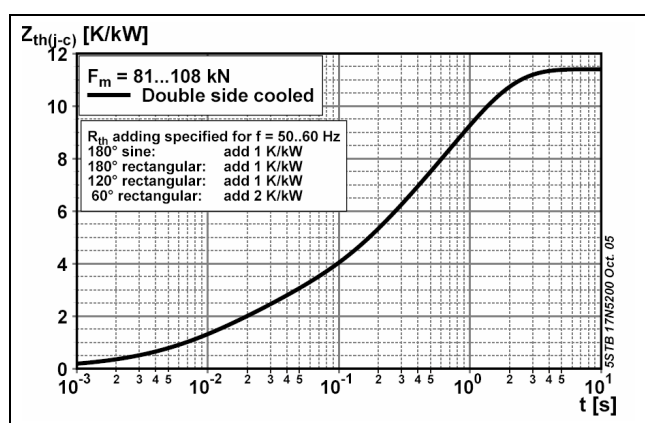
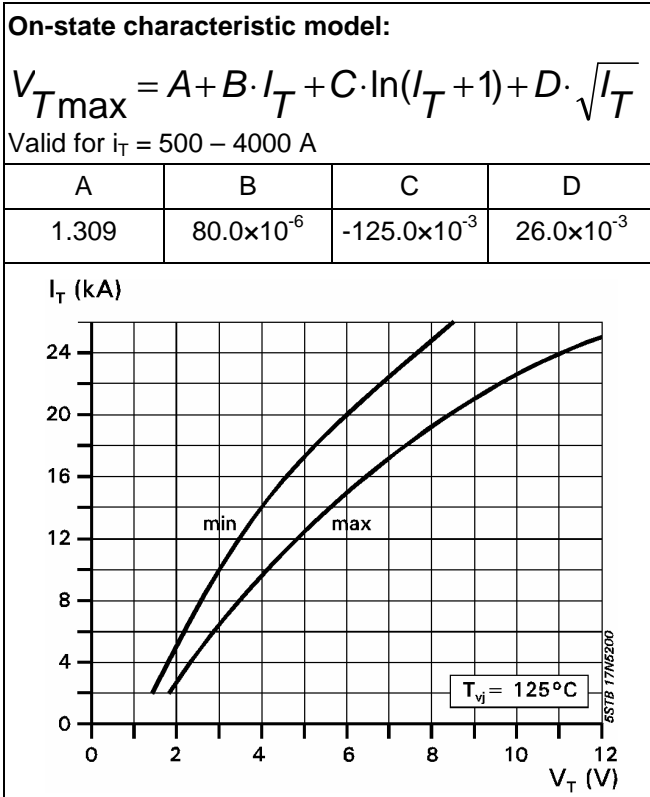
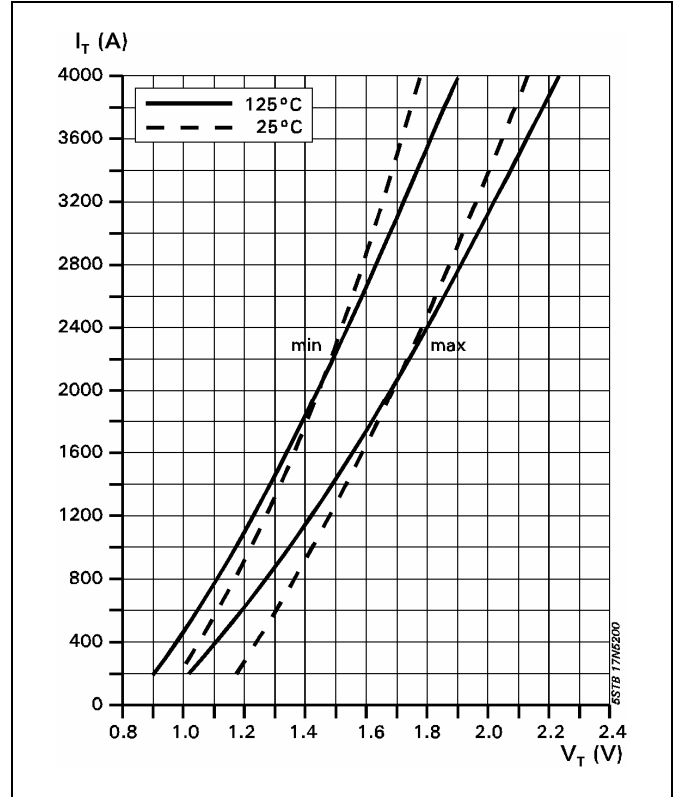


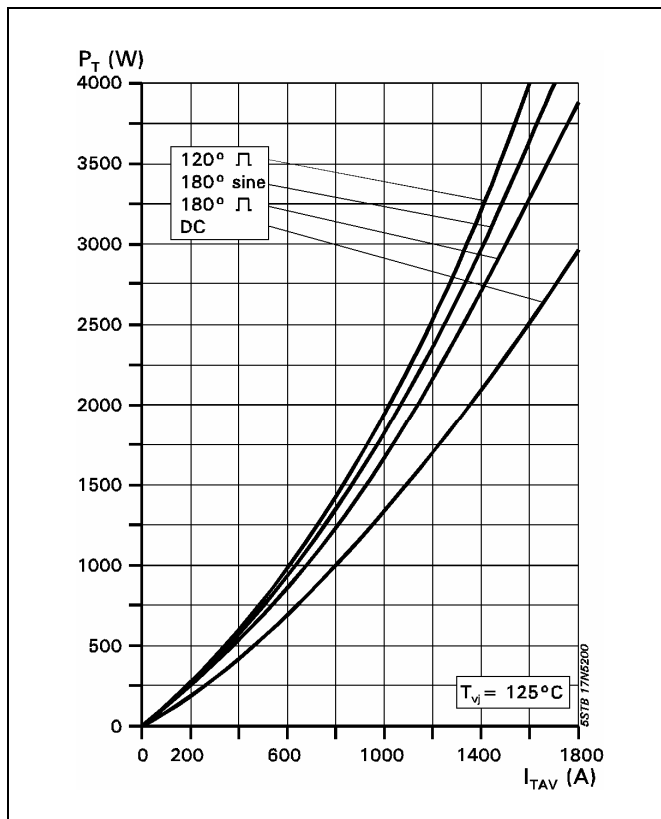
Fig. 1 Transient thermal impedance (junction-to-case) vs. time



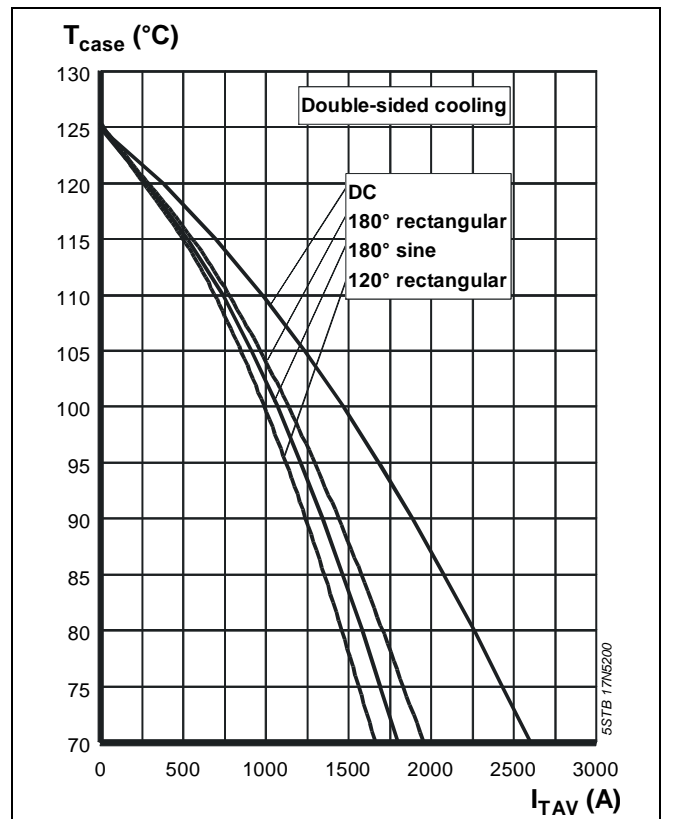
**Fig. 2** On-state characteristics,  $T_j = 125^\circ\text{C}$ , 10ms half sine



**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.

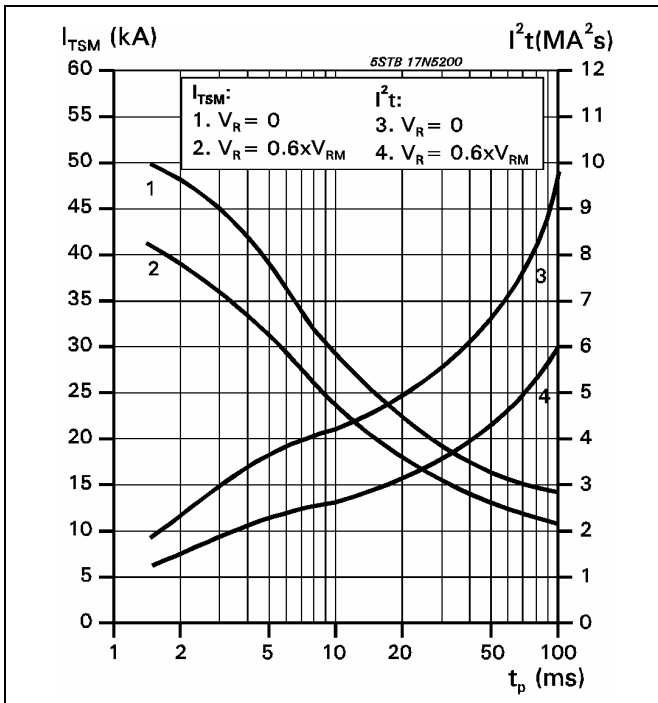


Fig. 6 Surge on-state current vs. pulse length. Half-sine wave.

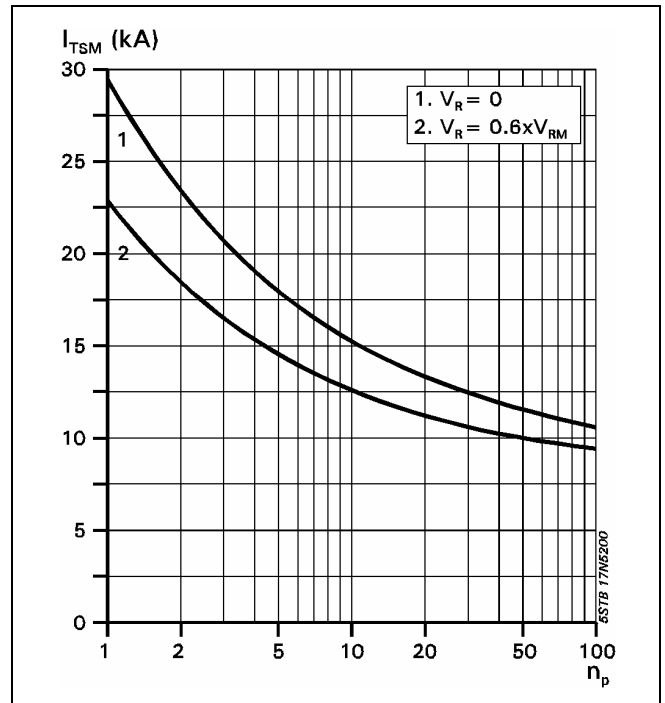


Fig. 7 Surge on-state current vs. number of pulses. Half-sine wave, 10 ms, 50Hz.

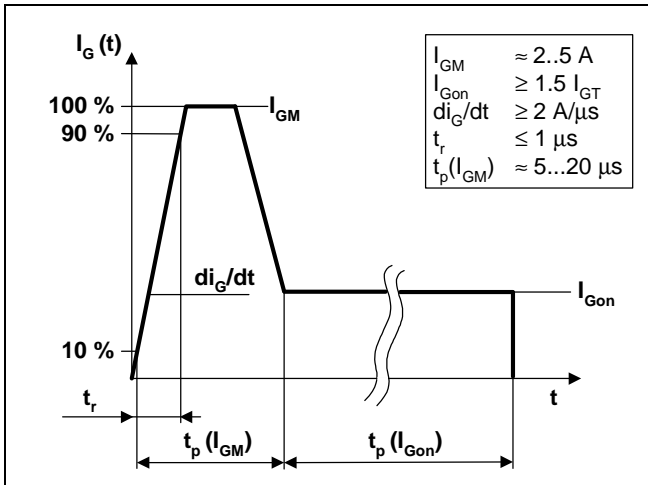


Fig. 8 Recommended gate current waveform

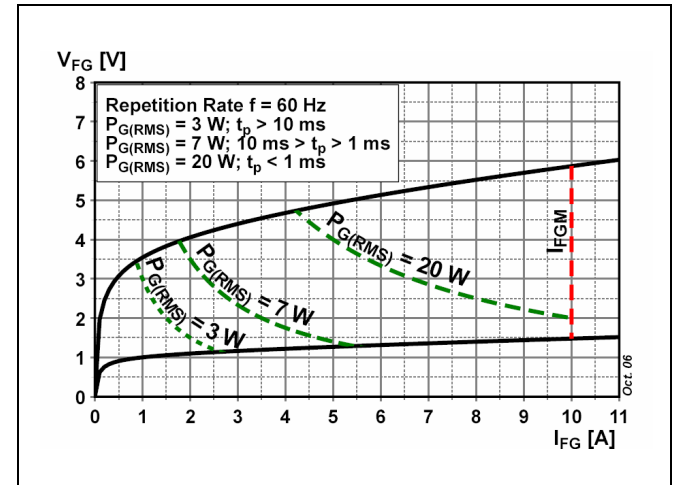


Fig. 9 Max. peak gate power loss

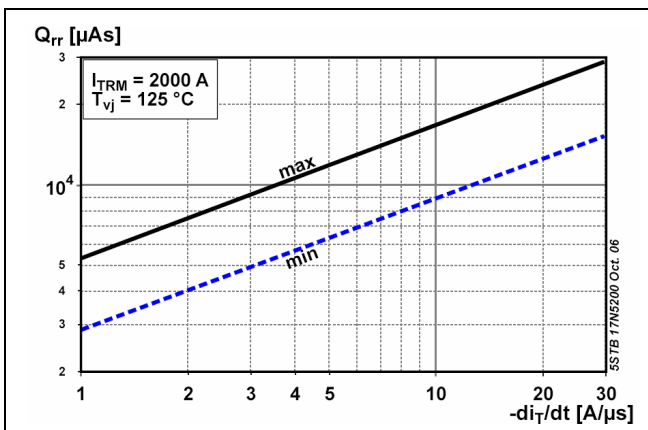


Fig. 10 Reverse recovery charge vs. decay rate of on-state current

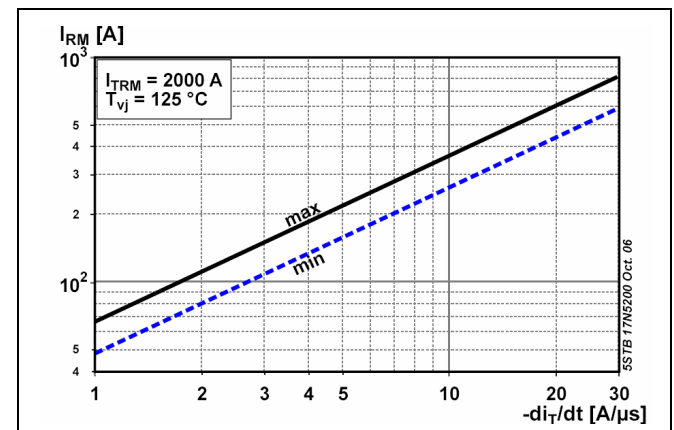


Fig. 11 Peak reverse recovery current vs. decay rate of on-state current

# Turn-on and Turn-off losses

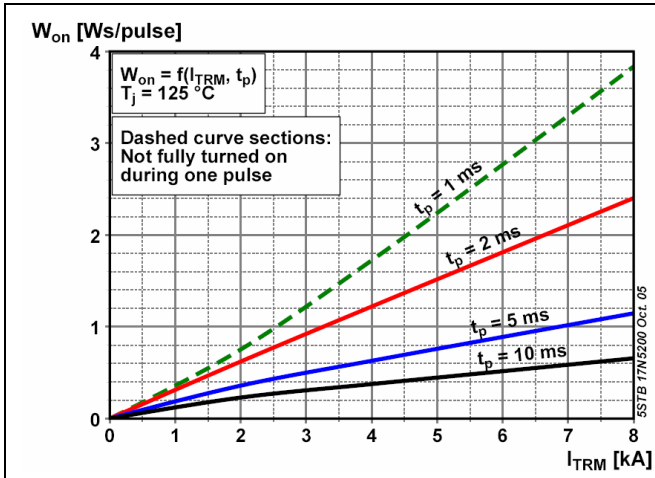


Fig. 12 Turn-on energy, half sinusoidal waves

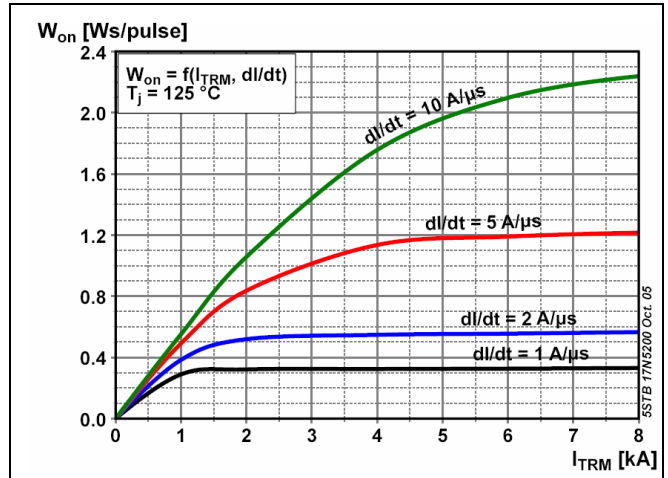


Fig. 13 Turn-on energy, rectangular waves

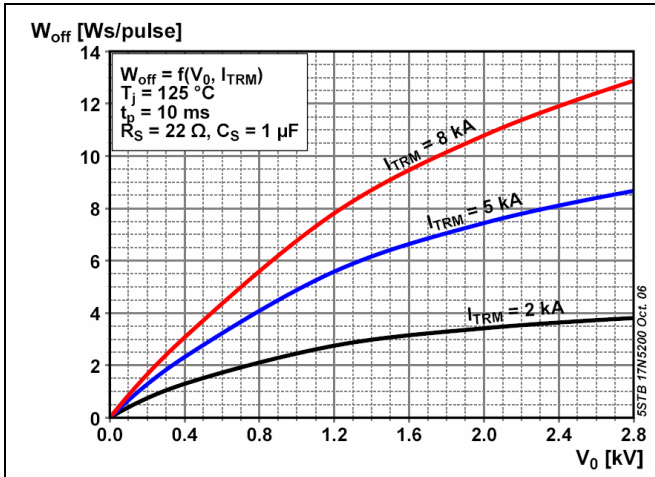


Fig. 14 Turn-off energy, half sinusoidal waves

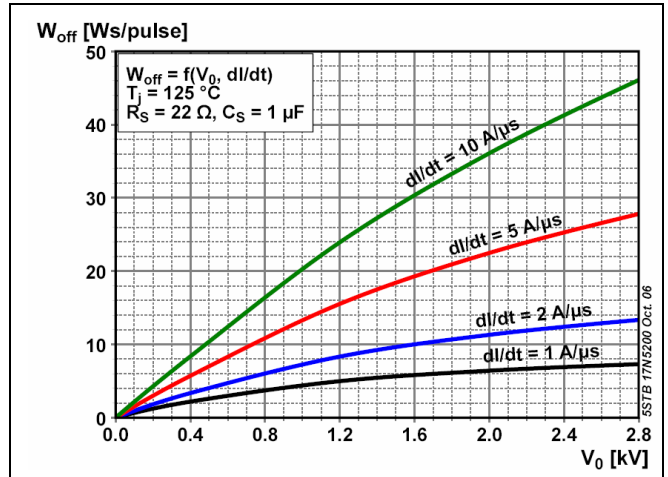


Fig. 15 Turn-off energy, rectangular waves

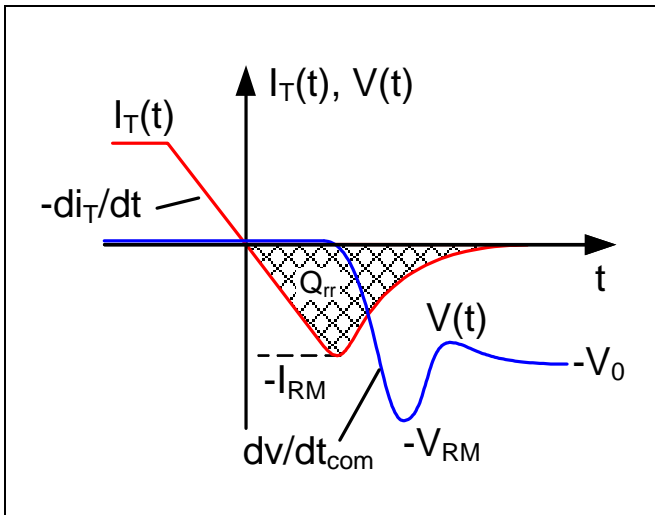


Fig. 16 Current and voltage waveforms at turn-off

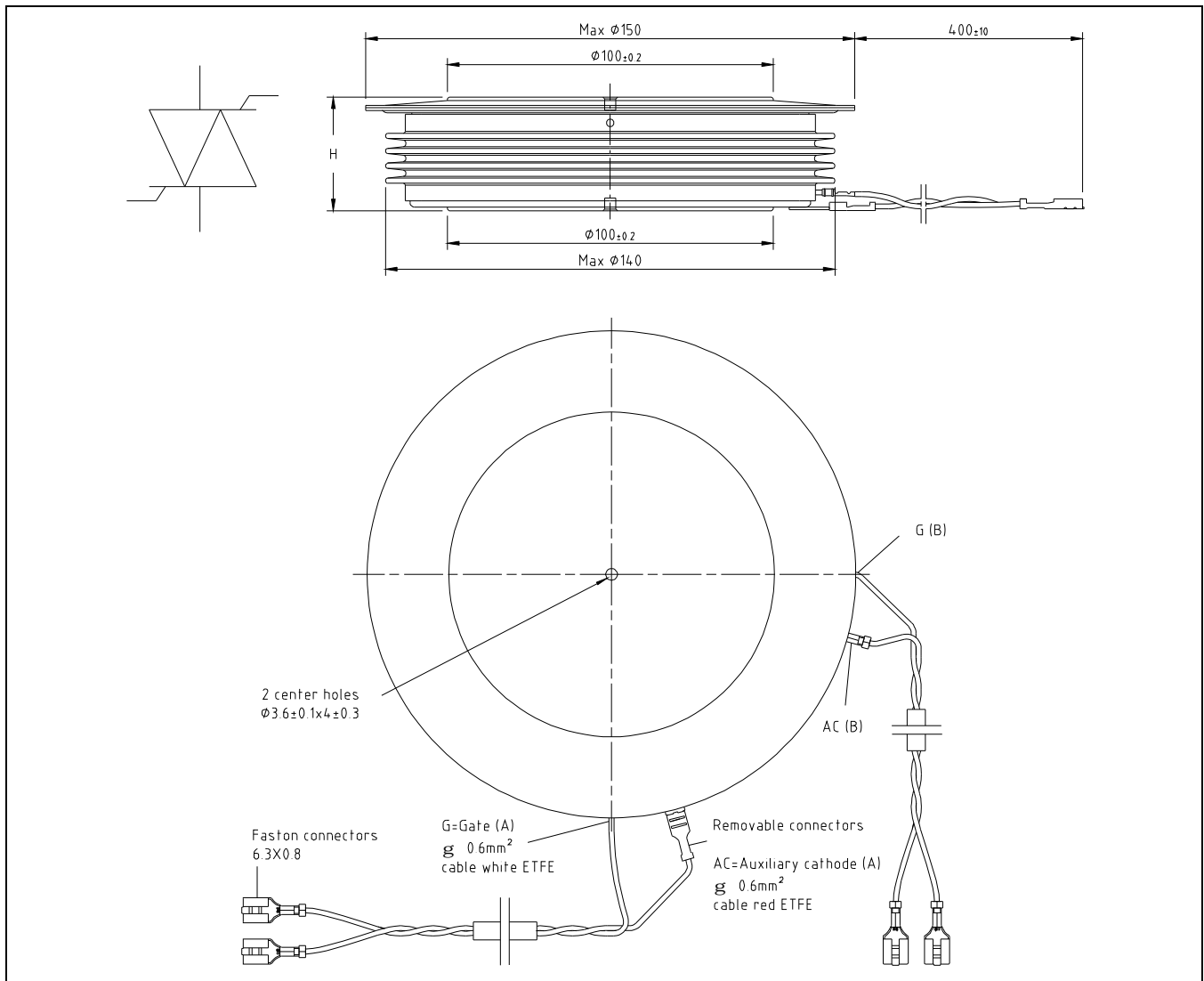
**Total power loss for repetitive waveforms:**

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

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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**ABB Switzerland Ltd**  
**Semiconductors**  
 Fabrikstrasse 3  
 CH-5600 Lenzburg, Switzerland

Doc. No. 5SYA1036-04 May 07

Telephone +41 (0)58 586 1419  
 Fax +41 (0)58 586 1306  
 Email [abbsem@ch.abb.com](mailto:abbsem@ch.abb.com)  
 Internet [www.abb.com/semiconductors](http://www.abb.com/semiconductors)

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