

|                              |      |   |
|------------------------------|------|---|
| $V_{DRM} = 5600$             | $V$  | <h1>Phase Control Thyristor</h1><br><h2>5STP 12K6500</h2> |
| $V_{DSM} = 6500$             | $V$  |   |
| $I_{T(AV)M} = 1370$          | $A$  |   |
| $I_{T(RMS)} = 2160$          | $A$  |   |
| $I_{TSM} = 21.9 \times 10^3$ | $A$  |   |
| $V_{(T0)} = 1.18$            | $V$  |   |
| $r_T = 0.632$                | $mW$ |   |

Doc. No. 5SYA1069-01 May 04

- 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 <sup>1)</sup>

| Symbol             | Conditions                                   | 5STP 12K6500          | 5STP 12K6200 | 5STP 12K5800 |
|--------------------|--|-----------------------|--------------|--------------|
| $V_{DSM}, V_{RSM}$ | $f = 5 \text{ Hz}, t_p = 10 \text{ ms}$      | 6500 V                | 6200 V       | 5800 V       |
| $V_{DRM}, V_{RRM}$ | $f = 50 \text{ Hz}, t_p = 10 \text{ ms}$     | 5600 V                | 5300 V       | 4900 V       |
| $dV/dt_{crit}$     | Exp. to 3750 V, $T_{vj} = 125^\circ\text{C}$ | 2000 V/ $\mu\text{s}$ |              |              |

Characteristic values

| Parameter               | Symbol    | Conditions                            | min | typ | max | Unit |
|-------------------------|-----------|---------------------------------------|-----|-----|-----|------|
| Forward leakage current | $I_{DSM}$ | $V_{DSM}, T_{vj} = 125^\circ\text{C}$ |     |     | 600 | mA   |
| Reverse leakage current | $I_{RSM}$ | $V_{RSM}, T_{vj} = 125^\circ\text{C}$ |     |     | 600 | mA   |

$V_{DRM}/V_{RRM}$  are equal to  $V_{DSM}/V_{RSM}$  values up to  $T_{vj} = 110^\circ\text{C}$

## Mechanical data

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

| Parameter      | Symbol | Conditions       | min | typ | max | Unit           |
|----------------|--------|------------------|-----|-----|-----|----------------|
| Mounting force | $F_M$  |                  | 45  | 50  | 60  | 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      |   |     |     | 1.15 | kg   |
| Housing thickness         | H      | $F_M = 50 \text{ kN}, T_a = 25^\circ\text{C}$ |     |     |      | mm   |
| Surface creepage distance | $D_S$  |   | 45  |     |      | mm   |
| Air strike distance       | $D_a$  |   | 24  |     |      | 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, $T_c = 70^\circ\text{C}$   |     |     | 1370                | A                    |
| RMS on-state current              | $I_{T(RMS)}$ |  |     |     | 2160                | A                    |
| Peak non-repetitive surge current | $I_{TSM}$    | $t_p = 10\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ ,<br>$V_D = V_R = 0\text{ V}$  |     |     | $21.9 \times 10^3$  | A                    |
| Limiting load integral            | $I^2t$       |  |     |     | $2.4 \times 10^6$   | $\text{A}^2\text{s}$ |
| Peak non-repetitive surge current | $I_{TSM}$    | $t_p = 8.3\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ ,<br>$V_D = V_R = 0\text{ V}$ |     |     | $23.35 \times 10^3$ | A                    |
| Limiting load integral            | $I^2t$       |  |     |     | $2.26 \times 10^6$  | $\text{A}^2\text{s}$ |

### Characteristic values

| Parameter         | Symbol     | Conditions  | min | typ | max   | Unit             |
|-------------------|------------|---|-----|-----|-------|------------------|
| On-state voltage  | $V_T$      | $I_T = 1500\text{ A}$ , $T_{vj} = 125^\circ\text{C}$                |     |     | 2.12  | V                |
| Threshold voltage | $V_{(T0)}$ | $I_T = 800\text{ A} - 2000\text{ A}$ , $T_{vj} = 125^\circ\text{C}$ |     |     | 1.18  | V                |
| Slope resistance  | $r_T$      |   |     |     | 0.632 | $\text{m}\Omega$ |
| Holding current   | $I_H$      | $T_{vj} = 25^\circ\text{C}$   |     |     | 125   | mA               |
|                   |            | $T_{vj} = 125^\circ\text{C}$  |     |     | 75    | mA               |
| Latching current  | $I_L$      | $T_{vj} = 25^\circ\text{C}$   |     |     | 600   | mA               |
|                   |            | $T_{vj} = 125^\circ\text{C}$  |     |     | 200   | mA               |

## Switching

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

| Parameter                                 | Symbol         | Conditions  | min | typ | max  | Unit                   |
|---|----------------|---|-----|-----|------|------------------------|
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $T_{vj} = 125^\circ\text{C}$ ,<br>$I_{TRM} = 1300\text{ A}$ ,<br>Cont.<br>$f = 50\text{ Hz}$  |     |     | 250  | $\text{A}/\mu\text{s}$ |
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $V_D \leq 3750\text{ V}$ ,<br>$I_{FG} = 2\text{ A}$ , $t_r = 0.5\ \mu\text{s}$<br>Cont.<br>$f = 1\text{ Hz}$  |     |     | 1000 | $\text{A}/\mu\text{s}$ |
| Circuit-commutated turn-off time          | $t_q$          | $T_{vj} = 125^\circ\text{C}$ , $I_{TRM} = 800\text{ A}$ ,<br>$V_R = 200\text{ V}$ , $di_T/dt = -1\ \text{A}/\mu\text{s}$ ,<br>$V_D \leq 0.67 \cdot V_{DRM}$ , $dV_D/dt = 20\text{ V}/\mu\text{s}$ | 800 |     |      | $\mu\text{s}$          |

### Characteristic values

| Parameter               | Symbol   | Conditions   | min  | typ | max  | Unit           |
|-------------------------|----------|--|------|-----|------|----------------|
| Recovery charge         | $Q_{rr}$ | $T_{vj} = 125^\circ\text{C}$ , $I_{TRM} = 2000\text{ A}$ ,<br>$V_R = 200\text{ V}$ ,<br>$di_T/dt = -1\ \text{A}/\mu\text{s}$ | 1600 |     | 2600 | $\mu\text{As}$ |
| Gate turn-on delay time | $t_{gd}$ | $V_D = 0.4 \cdot V_{RM}$ , $I_{FG} = 2\text{ A}$ ,<br>$t_r = 0.5\ \mu\text{s}$ , $T_{vj} = 25^\circ\text{C}$                 |      |     | 3    | $\mu\text{s}$  |

## Triggering

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

| 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 |     |     |      |

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 | $V_{GD}$ | $V_D = 0.4 \times V_{DRM}, T_{vjmax} = 125\text{ °C}$ | 0.3 |     |     | V    |
| Gate non-trigger current | $I_{GD}$ | $V_D = 0.4 \times V_{DRM}, T_{vjmax} = 125\text{ °C}$ | 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 | $R_{th(j-c)}$  | Double-side cooled<br>$F_m = 45...60\text{ kN}$  |     |     | 11  | K/kW |
|                                     | $R_{th(j-c)A}$ | Anode-side cooled<br>$F_m = 45...60\text{ kN}$   |     |     | 22  | K/kW |
|                                     | $R_{th(j-c)C}$ | Cathode-side cooled<br>$F_m = 45...60\text{ kN}$ |     |     | 22  | K/kW |
| Thermal resistance case to heatsink | $R_{th(c-h)}$  | Double-side cooled<br>$F_m = 45...60\text{ kN}$  |     |     | 2   | K/kW |
|                                     | $R_{th(c-h)}$  | Single-side cooled<br>$F_m = 45...60\text{ kN}$  |     |     | 4   | K/kW |

Analytical function for transient thermal impedance:

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

| i                       | 1      | 2      | 3      | 4      |
|-------------------------|--------|--------|--------|--------|
| $R_{th i}(\text{K/kW})$ | 7.347  | 2.414  | 0.797  | 0.447  |
| $\tau_i(\text{s})$      | 0.9879 | 0.0995 | 0.0157 | 0.0040 |

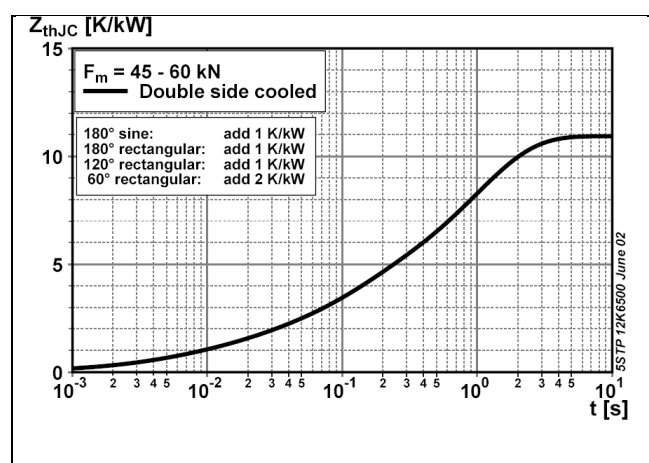
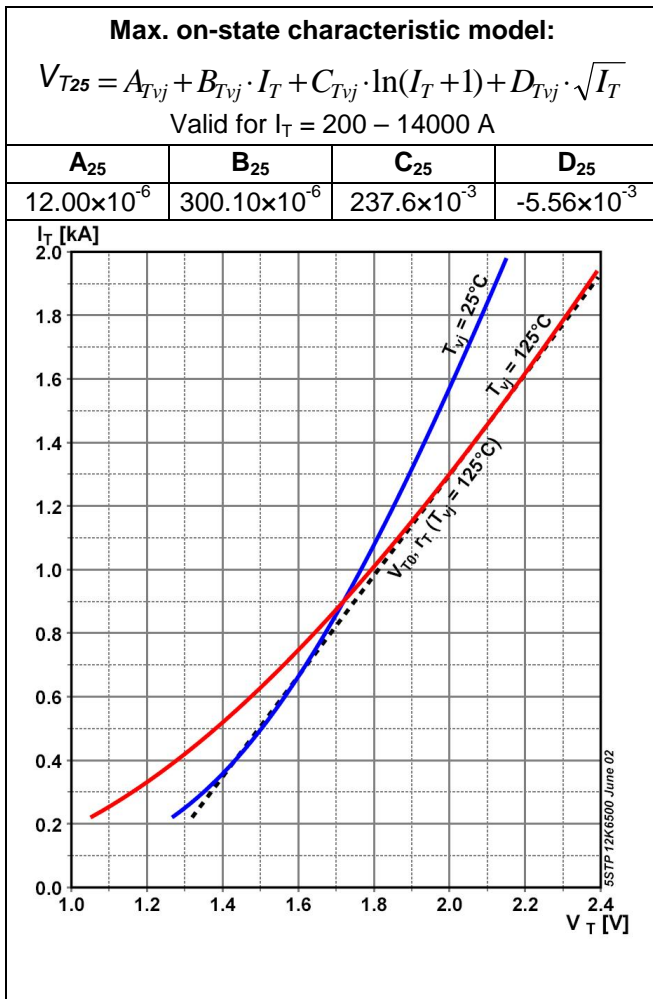
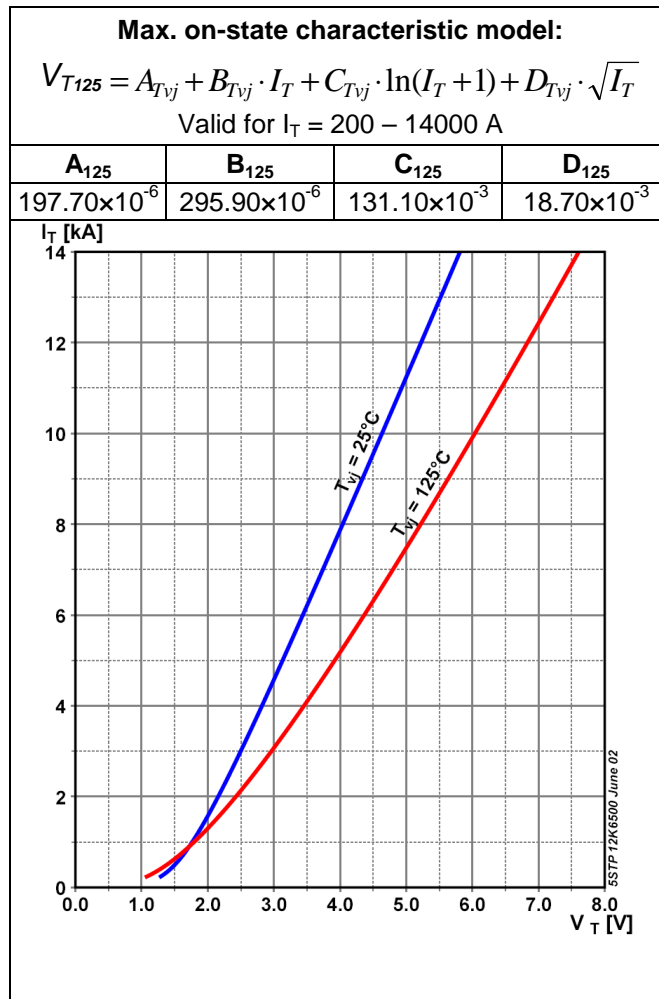


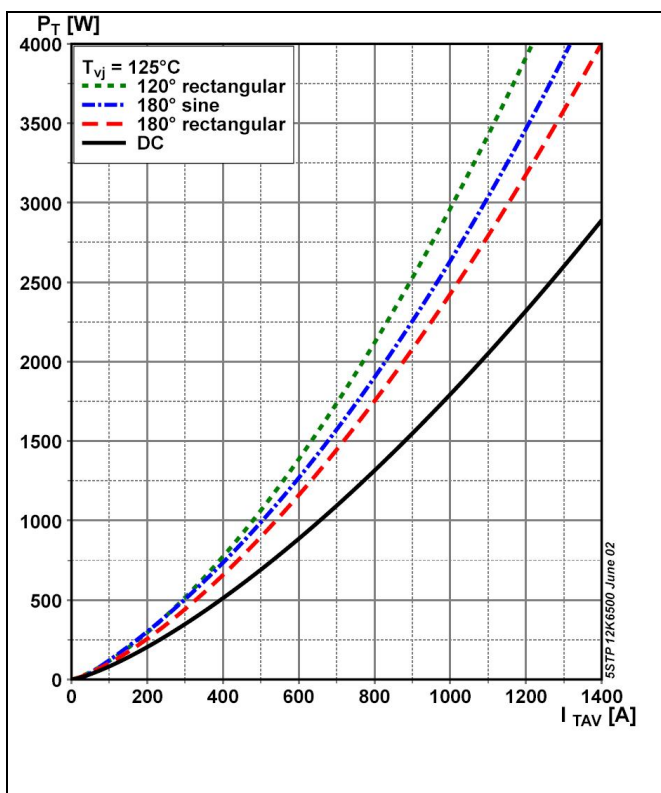
Fig. 1 Transient thermal impedance junction-to case.



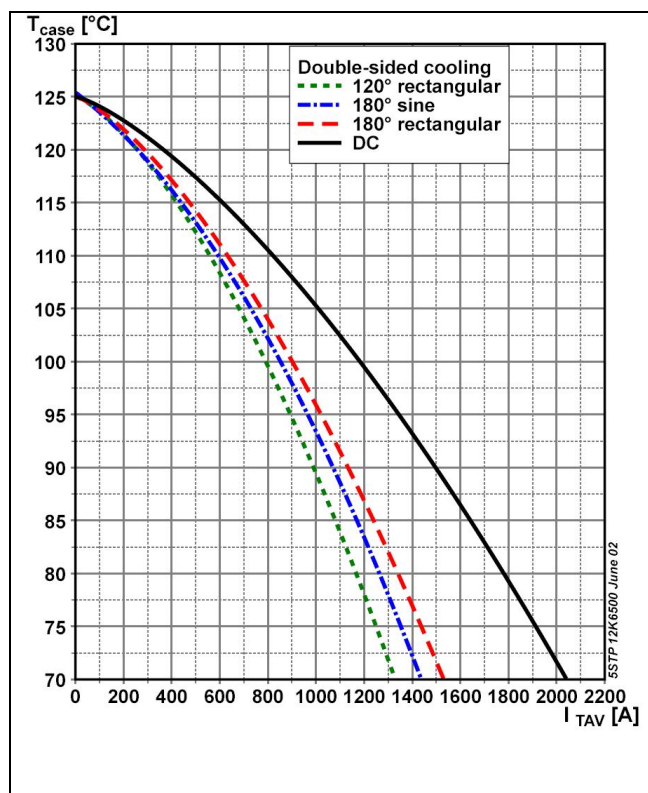
**Fig. 2** Max. on-state voltage characteristics



**Fig. 3** Max. 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.

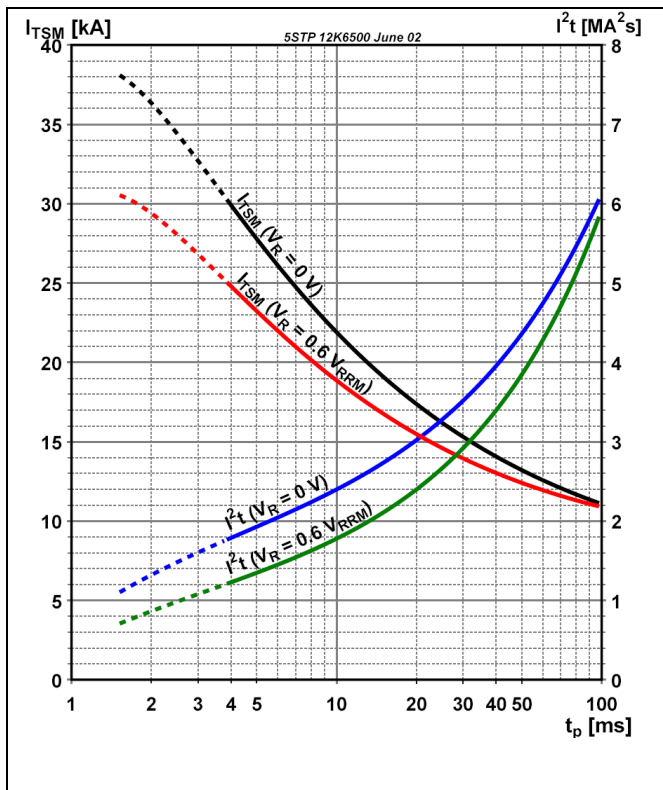


Fig. 6 Surge on-state current vs. pulse length. Half-sine wave.

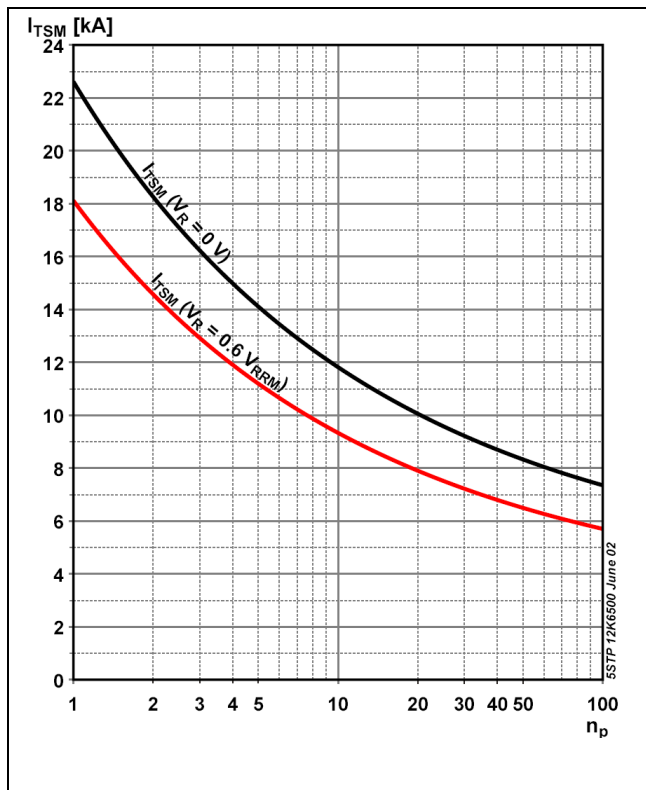


Fig. 7 Surge on-state current vs. number of pulses. Half-sine wave, 10 ms, 50Hz.

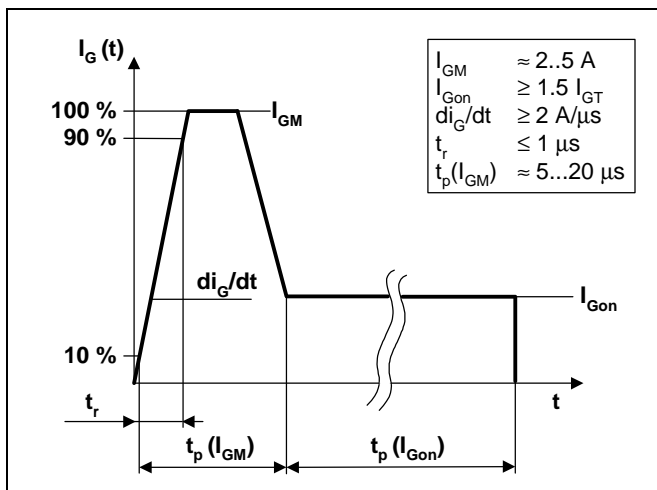


Fig. 8 Recommended gate current waveform.

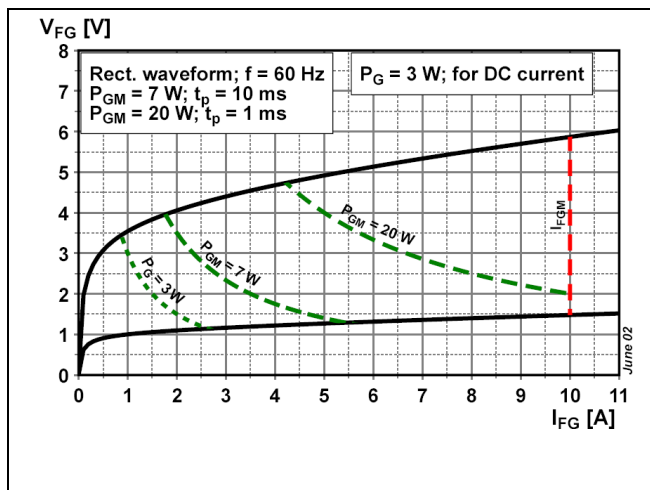


Fig. 9 Max. peak gate power loss.

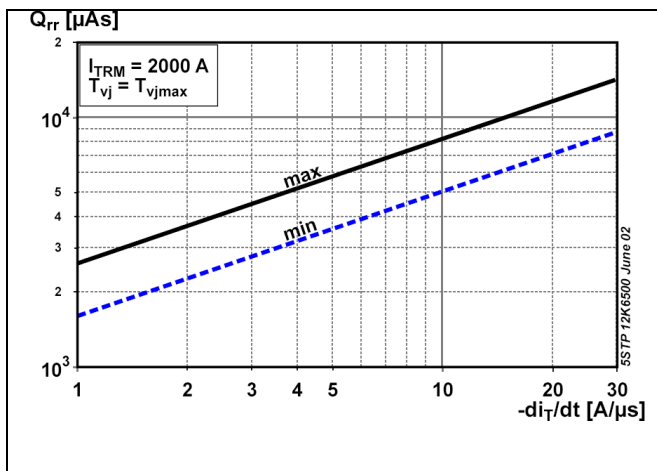


Fig. 10 Recovery charge vs. decay rate of on-state current.

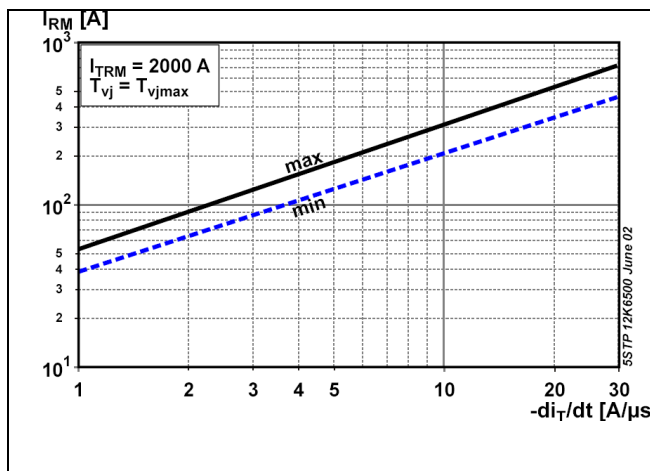


Fig. 11 Peak reverse recovery current vs. decay rate of on-state current.

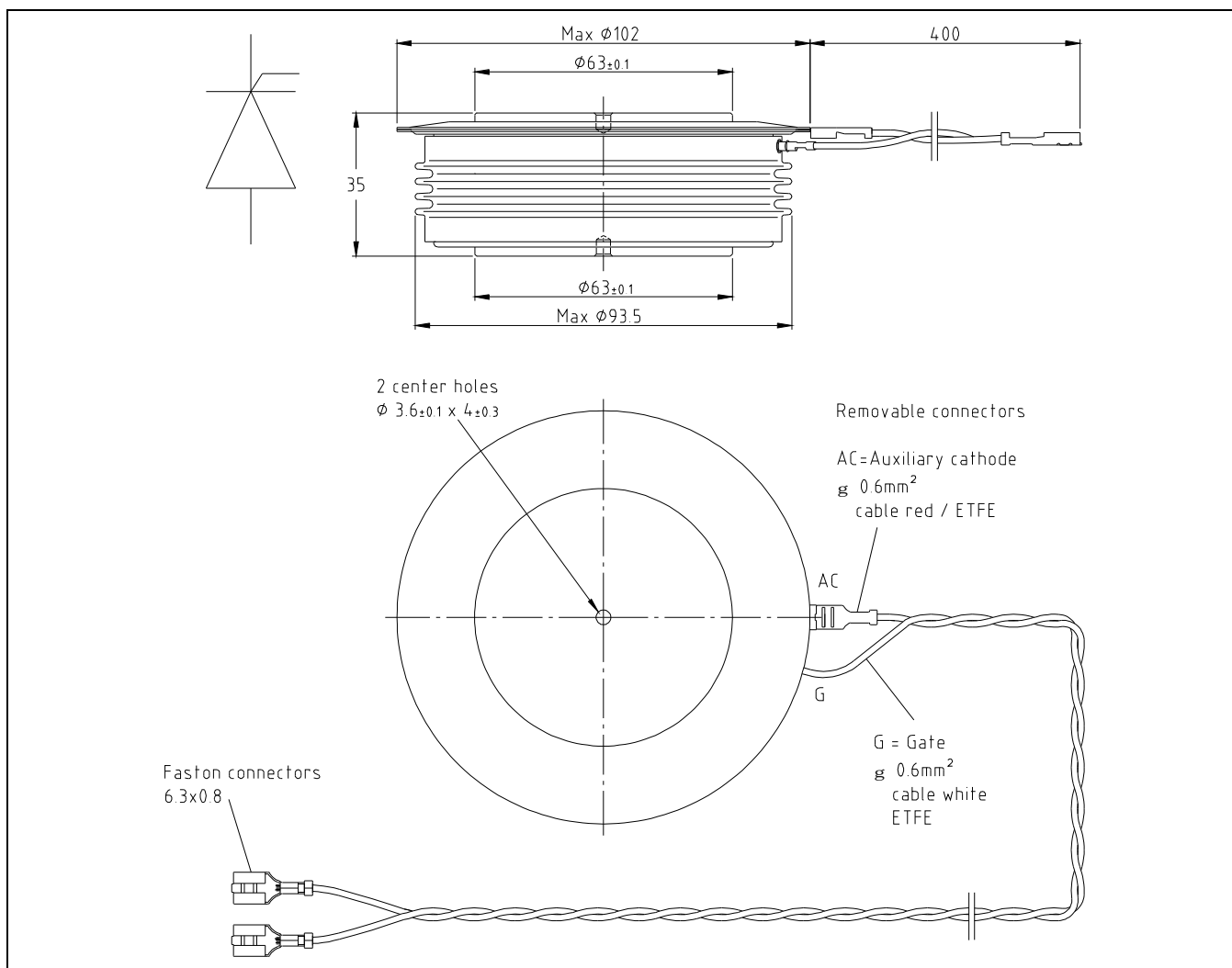


Fig. 12 Device Outline Drawing.

### Related application notes:

| Doc. Nr   | Titel   |
|-----------|---|
| 5SYA2020  | Design of RC-Snubber for Phase Control Applications                                   |
| 5SYA2034  | Gate-drive Recommendations for PCT's  |
| 5SYA 2036 | Recommendations regarding mechanical clamping of Press Pack High Power Semiconductors |

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