

|                     |                      |    |                                                        |
|---------------------|----------------------|----|--------------------------------------------------------|
| $V_{\text{DRM}}$    | = 4400               | V  | <h1>Phase Control Thyristor</h1> <h2>5STP 52U5200</h2> |
| $V_{\text{DSM}}$    | = 5200               | V  |                                                        |
| $I_{\text{T(AV)M}}$ | = 4120               | A  |                                                        |
| $I_{\text{T(RMS)}}$ | = 6470               | A  |                                                        |
| $I_{\text{TSM}}$    | = $85.2 \times 10^3$ | A  |                                                        |
| $V_{\text{(T0)}}$   | = 1.04               | V  |                                                        |
| $r_{\text{T}}$      | = 0.115              | mΩ |                                                        |

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- 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 52U5200 | 5STP 52U5000 | 5STP 52U4600 |
|----------------------------------|-------------------------------------------------------------------------|--------------|--------------|--------------|
| $V_{\text{DSM}}, V_{\text{RSM}}$ | $f = 5 \text{ Hz}, t_p = 10 \text{ ms}$                                 | 5200 V       | 5000 V       | 4600 V       |
| $V_{\text{DRM}}, V_{\text{RRM}}$ | $f = 50 \text{ Hz}, t_p = 10 \text{ ms}$                                | 4400 V       | 4200 V       | 4000 V       |
| $V_{\text{RSM}}$                 | $t_p = 5 \text{ ms}, \text{ single pulse}$                              | 5700 V       | 5500 V       | 5100 V       |
| $dV/dt_{\text{crit}}$            | Exp. to $0.67 \times V_{\text{DRM}}, T_{\text{vj}} = 110^\circ\text{C}$ | 2000 V/μs    |              |              |

Characteristic values

| Parameter               | Symbol           | Conditions                                          | min | typ | max | Unit |
|-------------------------|------------------|-----------------------------------------------------|-----|-----|-----|------|
| Forward leakage current | $I_{\text{DSM}}$ | $V_{\text{DSM}}, T_{\text{vj}} = 110^\circ\text{C}$ |     |     | 600 | mA   |
| Reverse leakage current | $I_{\text{RSM}}$ | $V_{\text{RSM}}, T_{\text{vj}} = 110^\circ\text{C}$ |     |     | 600 | mA   |

## Mechanical data

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

| Parameter      | Symbol         | Conditions       | min | typ | max | Unit             |
|----------------|----------------|------------------|-----|-----|-----|------------------|
| Mounting force | $F_{\text{M}}$ |                  | 120 | 135 | 160 | kN               |
| Acceleration   | $a$            | Device unclamped |     |     | 50  | m/s <sup>2</sup> |
| Acceleration   | $a$            | Device clamped   |     |     | 100 | m/s <sup>2</sup> |

Characteristic values

| Parameter                 | Symbol         | Conditions                                                       | min  | typ | max  | Unit |
|---------------------------|----------------|------------------------------------------------------------------|------|-----|------|------|
| Weight                    | $m$            |                                                                  |      |     | 3.6  | kg   |
| Housing thickness         | $H$            | $F_{\text{M}} = 135 \text{ kN}, T_{\text{a}} = 25^\circ\text{C}$ | 34.4 |     | 35.4 | mm   |
| Surface creepage distance | $D_{\text{S}}$ |                                                                  | 56   |     |      | mm   |
| Air strike distance       | $D_{\text{a}}$ |                                                                  | 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, $T_c = 70^\circ\text{C}$                                           |     |     | 4120                | A                    |
| RMS on-state current              | $I_{T(RMS)}$ |                                                                                    |     |     | 6470                | A                    |
| Peak non-repetitive surge current | $I_{TSM}$    | $t_p = 10\text{ ms}$ , $T_{vj} = 110^\circ\text{C}$ ,<br>$V_D = V_R = 0\text{ V}$  |     |     | $85.2 \times 10^3$  | A                    |
| Limiting load integral            | $I^2 t$      |                                                                                    |     |     | $36.28 \times 10^6$ | $\text{A}^2\text{s}$ |
| Peak non-repetitive surge current | $I_{TSM}$    | $t_p = 8.3\text{ ms}$ , $T_{vj} = 110^\circ\text{C}$ ,<br>$V_D = V_R = 0\text{ V}$ |     |     | $90.3 \times 10^3$  | A                    |
| Limiting load integral            | $I^2 t$      |                                                                                    |     |     | $33.85 \times 10^6$ | $\text{A}^2\text{s}$ |

### Characteristic values

| Parameter         | Symbol     | Conditions                                                           | min | typ | max   | Unit             |
|-------------------|------------|----------------------------------------------------------------------|-----|-----|-------|------------------|
| On-state voltage  | $V_T$      | $I_T = 3000\text{ A}$ , $T_{vj} = 110^\circ\text{C}$                 |     |     | 1.38  | V                |
| Threshold voltage | $V_{(T0)}$ | $I_T = 2000\text{ A} - 6000\text{ A}$ , $T_{vj} = 110^\circ\text{C}$ |     |     | 1.04  | V                |
| Slope resistance  | $r_T$      |                                                                      |     |     | 0.115 | $\text{m}\Omega$ |
| Holding current   | $I_H$      | $T_{vj} = 25^\circ\text{C}$                                          |     |     | 200   | mA               |
|                   |            | $T_{vj} = 110^\circ\text{C}$                                         |     |     | 100   | mA               |
| Latching current  | $I_L$      | $T_{vj} = 25^\circ\text{C}$                                          |     |     | 900   | mA               |
|                   |            | $T_{vj} = 110^\circ\text{C}$                                         |     |     | 700   | mA               |

## Switching

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

| Parameter                                 | Symbol         | Conditions                                                                                                                                                                                        | min | typ | max  | Unit                   |
|-------------------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------------------------|
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $T_{vj} = 110^\circ\text{C}$ , Cont.<br>$I_{TRM} = 3000\text{ A}$ , $f = 50\text{ Hz}$                                                                                                            |     |     | 250  | $\text{A}/\mu\text{s}$ |
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $V_D \leq 0.67 V_{DRM}$ , Cont.<br>$I_{FG} = 2\text{ A}$ , $t_r = 0.5\text{ }\mu\text{s}$ , $f = 1\text{ Hz}$                                                                                     |     |     | 1000 | $\text{A}/\mu\text{s}$ |
| Circuit-commutated turn-off time          | $t_q$          | $T_{vj} = 110^\circ\text{C}$ , $I_{TRM} = 3000\text{ A}$ ,<br>$V_R = 200\text{ V}$ , $di_T/dt = -5\text{ A}/\mu\text{s}$ ,<br>$V_D \leq 0.67 \cdot V_{DRM}$ , $dv_D/dt = 20\text{ V}/\mu\text{s}$ | 700 |     |      | $\mu\text{s}$          |

### Characteristic values

| Parameter               | Symbol   | Conditions                                                                                                                  | min | typ | max   | Unit           |
|-------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------|-----|-----|-------|----------------|
| Recovery charge         | $Q_{rr}$ | $T_{vj} = 110^\circ\text{C}$ , $I_{TRM} = 3000\text{ A}$ ,<br>$V_R = 200\text{ V}$ ,<br>$di_T/dt = -5\text{ A}/\mu\text{s}$ |     |     | 12500 | $\mu\text{As}$ |
| Gate turn-on delay time | $t_{gd}$ | $V_D = 0.4 \cdot V_{RM}$ , $I_{FG} = 2\text{ A}$ ,<br>$t_r = 0.5\text{ }\mu\text{s}$ , $T_{vj} = 25^\circ\text{C}$          |     |     | 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 | $V_{GD}$ | $V_D = 0.4 \times V_{DRM}$ , $T_{vj} = 110\text{ °C}$ | 0.3 |     |     | V    |
| Gate non-trigger current | $I_{GD}$ | $V_D = 0.4 \times V_{DRM}$ , $T_{vj} = 110\text{ °C}$ | 10  |     |     | mA   |

## Thermal

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

| Parameter                            | Symbol    | Conditions | min | typ | max | Unit |
|--------------------------------------|-----------|------------|-----|-----|-----|------|
| Operating junction temperature range | $T_{vj}$  |            |     |     | 110 | °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>$F_m = 120...160\text{ kN}$  |     |     | 4   | K/kW |
|                                     | $R_{th(j-c)A}$ | Anode-side cooled<br>$F_m = 120...160\text{ kN}$   |     |     | 8   | K/kW |
|                                     | $R_{th(j-c)C}$ | Cathode-side cooled<br>$F_m = 120...160\text{ kN}$ |     |     | 8   | K/kW |
| Thermal resistance case to heatsink | $R_{th(c-h)}$  | Double-side cooled<br>$F_m = 120...160\text{ kN}$  |     |     | 0.8 | K/kW |
|                                     | $R_{th(c-h)}$  | Single-side cooled<br>$F_m = 120...160\text{ kN}$  |     |     | 1.6 | K/kW |

Analytical function for transient thermal impedance:

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

| i                       | 1      | 2      | 3      | 4      |
|-------------------------|--------|--------|--------|--------|
| $R_{th i}(\text{K/kW})$ | 2.701  | 0.816  | 0.326  | 0.160  |
| $\tau_i(\text{s})$      | 0.9478 | 0.1249 | 0.0146 | 0.0032 |

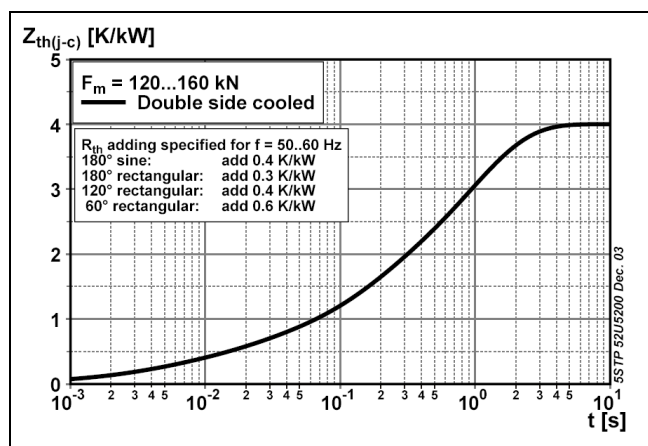


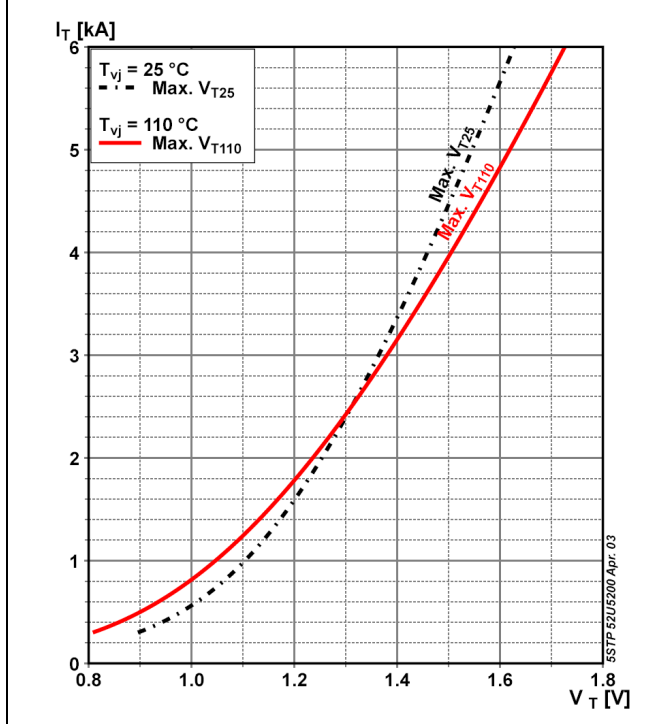
Fig. 1 Transient thermal impedance junction-to case.

**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  $I_T = 300 - 100000$  A

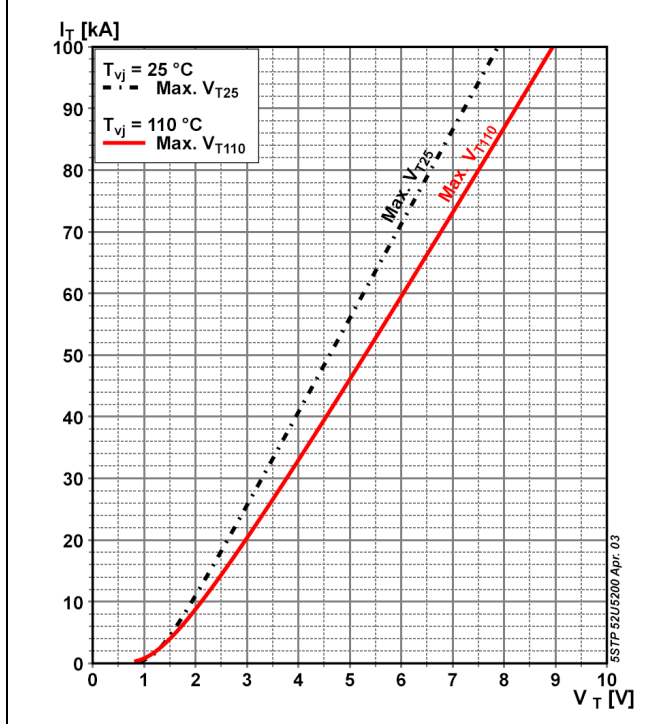
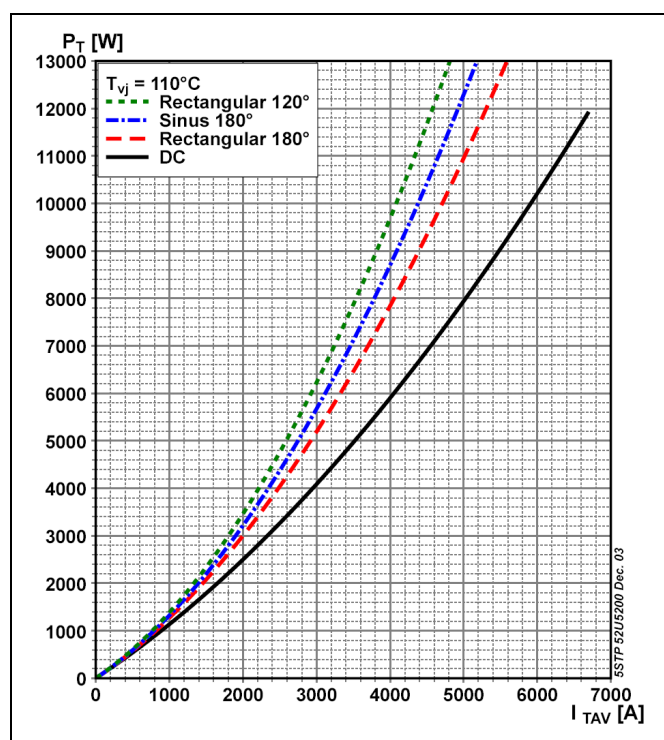
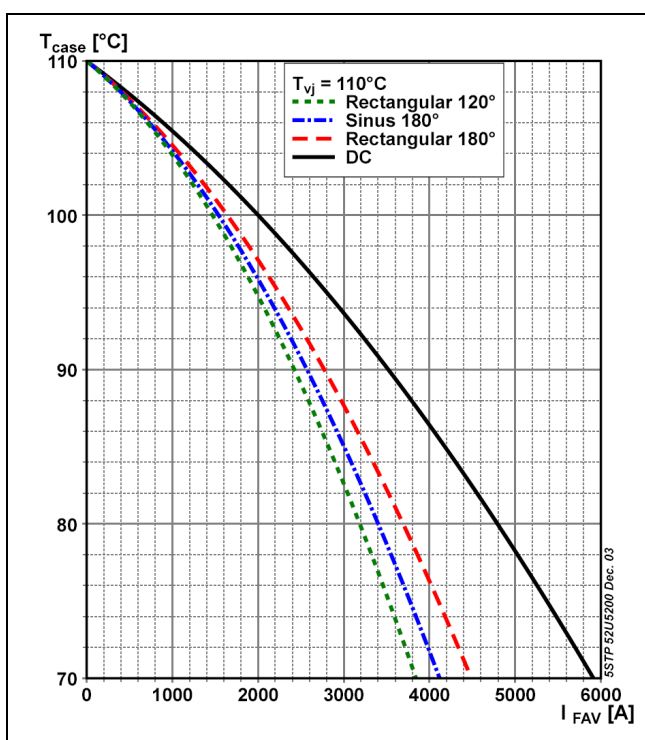
| $A_{25}$               | $B_{25}$               | $C_{25}$             | $D_{25}$               |
|------------------------|------------------------|----------------------|------------------------|
| $69.79 \times 10^{-6}$ | $67.25 \times 10^{-6}$ | $160 \times 10^{-3}$ | $-2.17 \times 10^{-3}$ |

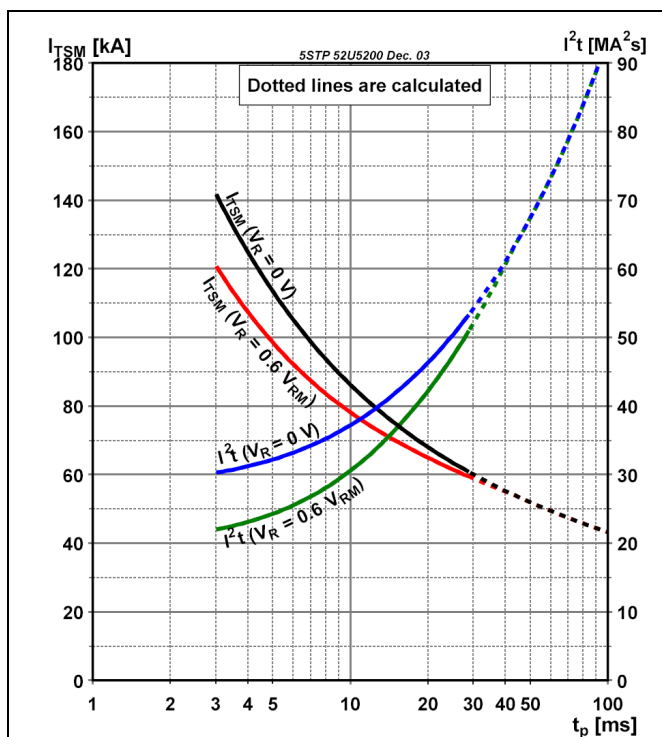
**Fig. 2** Max. on-state voltage characteristics**Max. on-state characteristic model:**

$$V_{T110} = A_{Tvj} + B_{Tvj} \cdot I_T + C_{Tvj} \cdot \ln(I_T + 1) + D_{Tvj} \cdot \sqrt{I_T}$$

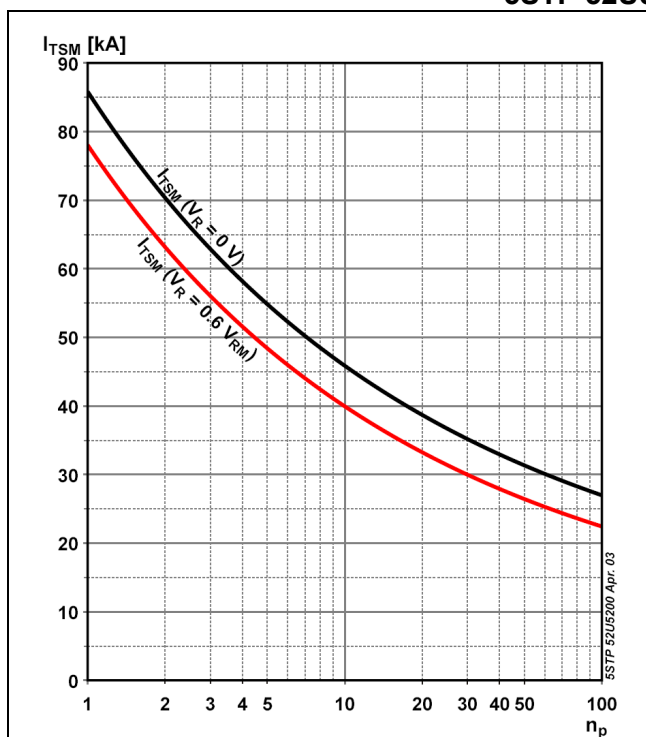
Valid for  $I_T = 300 - 100000$  A

| $A_{110}$              | $B_{110}$              | $C_{110}$               | $D_{110}$             |
|------------------------|------------------------|-------------------------|-----------------------|
| $20.86 \times 10^{-6}$ | $66.73 \times 10^{-6}$ | $130.70 \times 10^{-3}$ | $2.43 \times 10^{-3}$ |

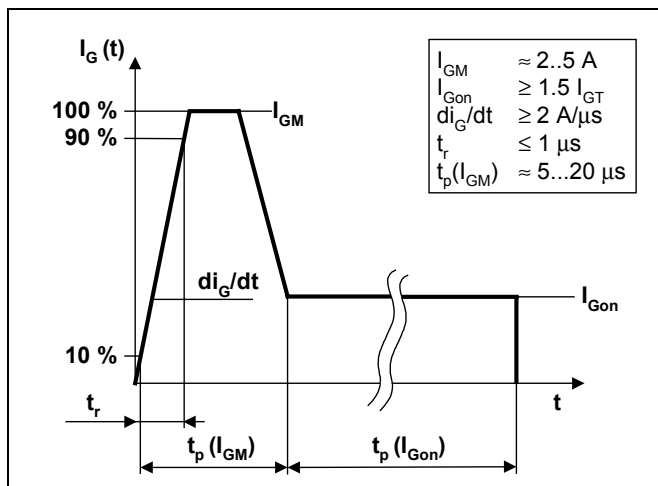
**Fig. 3** Max. on-state voltage characteristics**Fig. 4** On-state power dissipation vs. mean on-state current. Turn-on losses excluded.**Fig. 5** Max. permissible case temperature vs. mean on-state current.



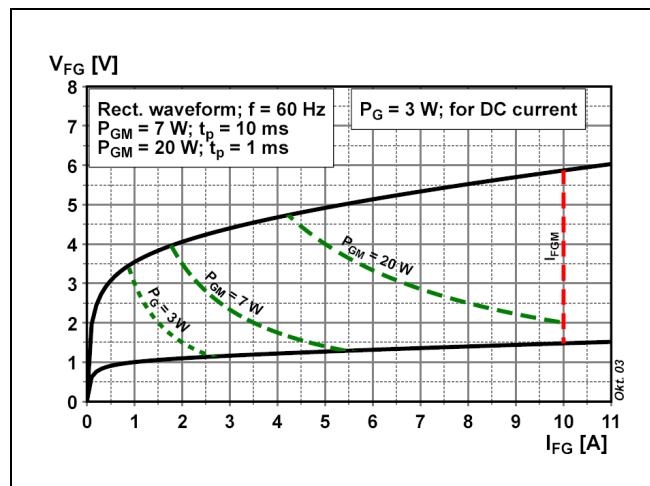
**Fig. 6** Surge on-state current vs. pulse length. Half-sine wave.



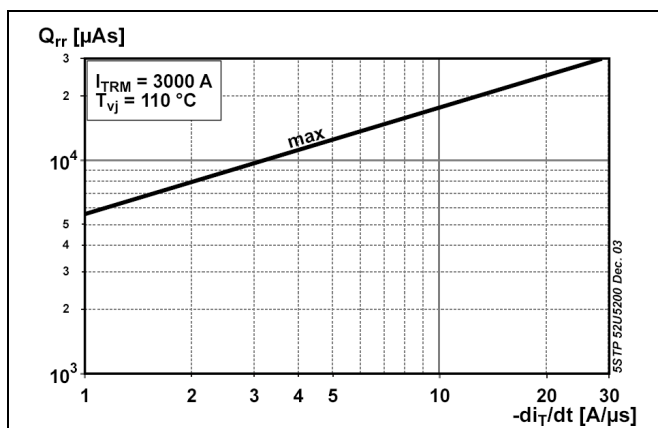
**Fig. 7** Surge on-state current vs. number of pulses. Half-sine wave, 10 ms, 50Hz.



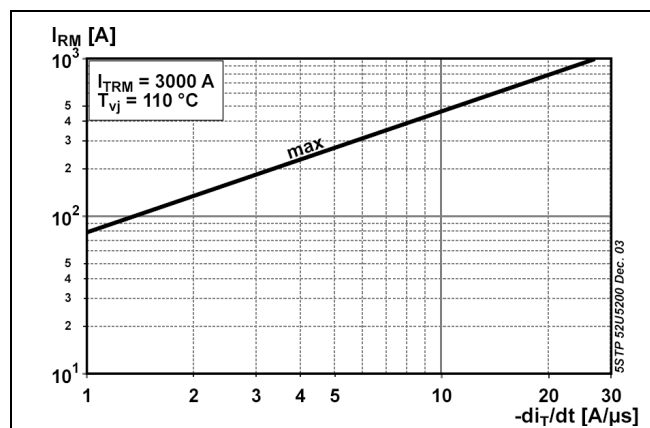
**Fig. 8** Recommended gate current waveform.



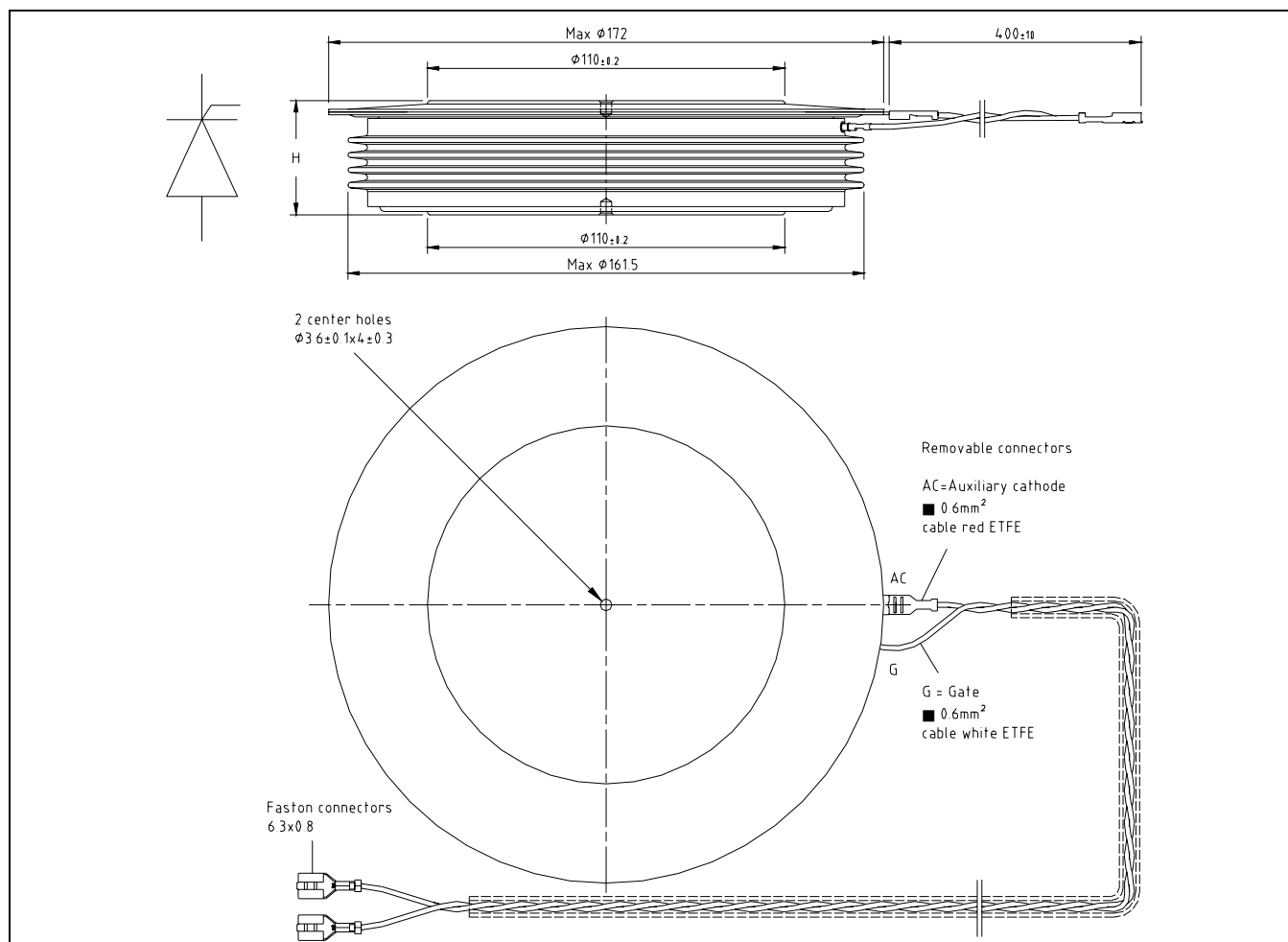
**Fig. 9** Max. peak gate power loss.



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

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)