

|                         |                   |   |
|-------------------------|-------------------|---|
| <b>V<sub>DSM</sub></b>  | <b>= 4200 V</b>   | <h1>Phase Control Thyristor</h1><br><h2>5STP 28L4200</h2> |
| <b>I<sub>TAVM</sub></b> | <b>= 3170 A</b>   |   |
| <b>I<sub>TRMS</sub></b> | <b>= 4980 A</b>   |   |
| <b>I<sub>TSM</sub></b>  | <b>= 52000 A</b>  |   |
| <b>V<sub>T0</sub></b>   | <b>= 0.97 V</b>   |   |
| <b>r<sub>T</sub></b>    | <b>= 0.158 mΩ</b> |   |

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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 28L4200 | 5STP 28L4000 | 5STP 28L3600 |
|-------------------------------------|--|--------------|--------------|--------------|
| V <sub>DRM</sub> , V <sub>RRM</sub> | f = 50 Hz, t <sub>p</sub> = 10ms                         | 4200 V       | 4000 V       | 3600 V       |
| V <sub>RSM1</sub>                   | t <sub>p</sub> = 5ms, single pulse                       | 4600 V       | 4400 V       | 4000 V       |
| dV/dt <sub>crit</sub>               | Exp. to 0.67 x V <sub>DRM</sub> , T <sub>j</sub> = 125°C | 2000 V/μs    |              |              |

*Characteristic values*

| Parameter               | Symbol           | Conditions                                | min | typ | max | Unit |
|-------------------------|------------------|---|-----|-----|-----|------|
| Forward leakage current | I <sub>DRM</sub> | V <sub>DRM</sub> , T <sub>j</sub> = 125°C |     |     | 400 | mA   |
| Reverse leakage current | I <sub>RRM</sub> | V <sub>RRM</sub> , T <sub>j</sub> = 125°C |     |     | 400 | mA   |

### Mechanical data

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

| Parameter      | Symbol         | Conditions       | min | typ | max | Unit             |
|----------------|----------------|------------------|-----|-----|-----|------------------|
| Mounting force | F <sub>M</sub> |                  | 63  | 70  | 84  | 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              |            |     | 1.45 |     | kg   |
| Surface creepage distance | D <sub>s</sub> |            | 36  |      |     | mm   |
| Air strike distance       | D <sub>a</sub> |            | 15  |      |     | mm   |

<sup>1)</sup> Maximum Ratings are those values 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                  |
|--|------------|---|-----|-----|-------|-----------------------|
| Max. average on-state current          | $I_{TAVM}$ | Half sine wave, $T_c = 70^\circ\text{C}$  |     |     | 3170  | A                     |
| RMS on-state current                   | $I_{TRMS}$ |   |     |     | 4980  | A                     |
| Max. peak non-repetitive surge current | $I_{TSM}$  | $t_p = 10\text{ ms}$ , $T_j = 125^\circ\text{C}$ ,<br>$V_D = V_R = 0\text{ V}$  |     |     | 52000 | A                     |
| Limiting load integral                 | $I^2t$     |   |     |     | 13520 | $\text{kA}^2\text{s}$ |
| Max. peak non-repetitive surge current | $I_{TSM}$  | $t_p = 8.3\text{ ms}$ , $T_j = 125^\circ\text{C}$ ,<br>$V_D = V_R = 0\text{ V}$ |     |     | 56000 | A                     |
| Limiting load integral                 | $I^2t$     |   |     |     | 13014 | $\text{kA}^2\text{s}$ |

### Characteristic values

| Parameter         | Symbol   | Conditions  | min | typ | max   | Unit             |
|-------------------|----------|---|-----|-----|-------|------------------|
| On-state voltage  | $V_T$    | $I_T = 3000\text{ A}$ , $T_j = 125^\circ\text{C}$                 |     |     | 1.45  | V                |
| Threshold voltage | $V_{T0}$ | $I_T = 2000\text{ A} - 6000\text{ A}$ , $T_j = 125^\circ\text{C}$ |     |     | 0.97  | V                |
| Slope resistance  | $r_T$    | $T_j = 125^\circ\text{C}$   |     |     | 0.158 | $\text{m}\Omega$ |
| Holding current   | $I_H$    | $T_j = 25^\circ\text{C}$  |     |     | 100   | mA               |
|                   |          | $T_j = 125^\circ\text{C}$   |     |     | 60    | mA               |
| Latching current  | $I_L$    | $T_j = 25^\circ\text{C}$  |     |     | 500   | mA               |
|                   |          | $T_j = 125^\circ\text{C}$   |     |     | 300   | mA               |

## Switching

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

| Parameter                                 | Symbol         | Conditions   | min | typ                         | max  | Unit                   |
|---|----------------|--|-----|-----------------------------|------|------------------------|
| Critical rate of rise of on-state current | $di/dt_{crit}$ | $T_j = 125^\circ\text{C}$ , $I_{TRM} = 4000\text{ A}$ ,<br>$V_D \leq 0.67 \cdot V_{DRM}$ ,<br>$I_{FG} = 2\text{ A}$ , $t_r = 0.5\ \mu\text{s}$   |     | Cont.<br>$f = 50\text{ Hz}$ | 250  | $\text{A}/\mu\text{s}$ |
| Critical rate of rise of on-state current | $di/dt_{crit}$ |  |     | Cont.<br>$f = 1\text{ Hz}$  | 1000 | $\text{A}/\mu\text{s}$ |
| Circuit-commutated turn-off time          | $t_q$          | $T_j = 125^\circ\text{C}$ , $I_{TRM} = 4000\text{ A}$ ,<br>$V_R = 200\text{ V}$ , $di_T/dt = -5\text{ A}/\mu\text{s}$ ,<br>$V_D \leq 0.67 \cdot V_{DRM}$ , $dv_D/dt = 20\text{ V}/\mu\text{s}$ , | 600 |                             |      | $\mu\text{s}$          |

### Characteristic values

| Parameter       | Symbol   | Conditions  | min  | typ | max  | Unit           |
|-----------------|----------|---|------|-----|------|----------------|
| Recovery charge | $Q_{rr}$ | $T_j = 125^\circ\text{C}$ , $I_{TRM} = 4000\text{ A}$ ,<br>$V_R = 200\text{ V}$ , $di_T/dt = -5\text{ A}/\mu\text{s}$ | 5500 |     | 7500 | $\mu\text{As}$ |
| Delay time      | $t_d$    | $V_D = 0.4 \cdot V_{DRM}$ , $I_{FG} = 2\text{ A}$ , $t_r = 0.5\ \mu\text{s}$  |      |     | 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    |
| Gate power loss           | $P_G$     | For DC gate current |            |     | 3   | W    |
| Average gate power loss   | $P_{GAV}$ |                     | see Fig. 9 |     |     |      |

Characteristic values

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

## Thermal

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

| Parameter                            | Symbol    | Conditions | min | typ | max | Unit             |
|--------------------------------------|-----------|------------|-----|-----|-----|------------------|
| Operating junction temperature range | $T_j$     |            |     |     | 125 | $^\circ\text{C}$ |
| Storage temperature range            | $T_{stg}$ |            | -40 |     | 140 | $^\circ\text{C}$ |

Characteristic values

| Parameter                           | Symbol         | Conditions          | min | typ | max | Unit |
|-------------------------------------|----------------|---------------------|-----|-----|-----|------|
| Thermal resistance junction to case | $R_{th(j-c)}$  | Double side cooled  |     |     | 7   | K/kW |
|                                     | $R_{th(j-c)A}$ | Anode side cooled   |     |     | 14  | K/kW |
|                                     | $R_{th(j-c)C}$ | Cathode side cooled |     |     | 14  | K/kW |
| Thermal resistance case to heatsink | $R_{th(c-h)}$  | Double side cooled  |     |     | 1.5 | K/kW |
|                                     | $R_{th(c-h)}$  | Single side cooled  |     |     | 3   | K/kW |

Analytical function for transient thermal impedance:

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

|              |        |        |        |        |
|--------------|--------|--------|--------|--------|
| i            | 1      | 2      | 3      | 4      |
| $R_i$ (K/kW) | 4.7    | 0.853  | 1.07   | 0.49   |
| $\tau_i$ (s) | 0.4787 | 0.0824 | 0.0104 | 0.0041 |

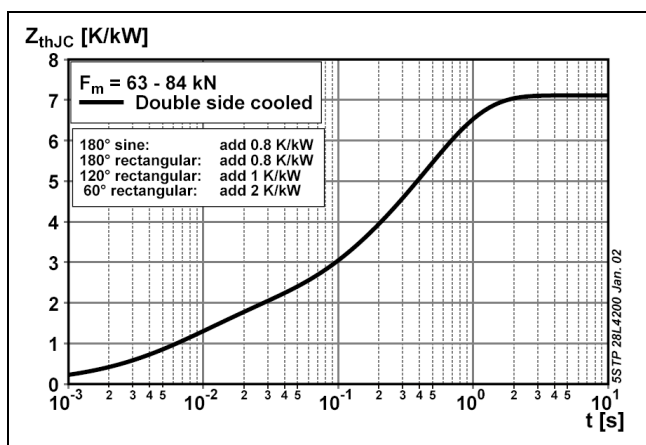
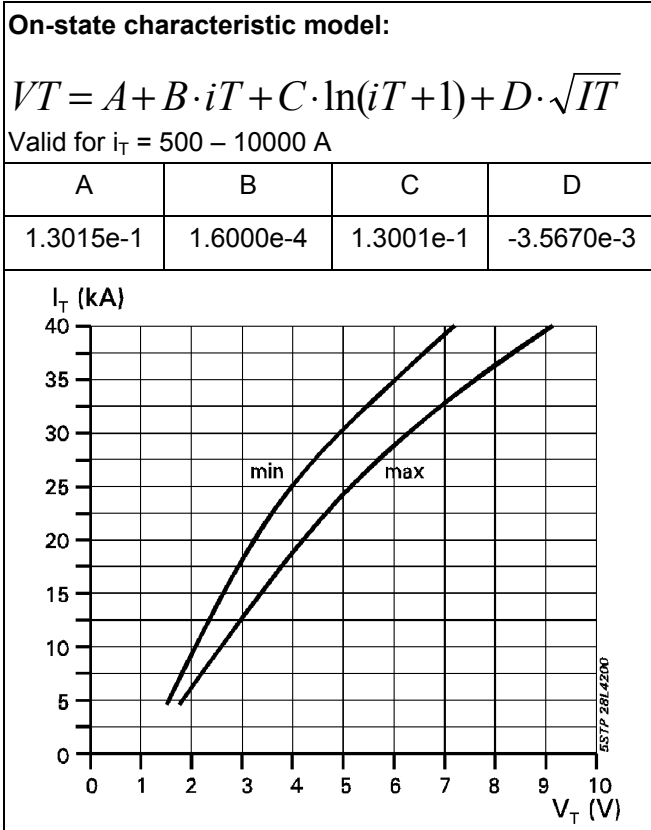
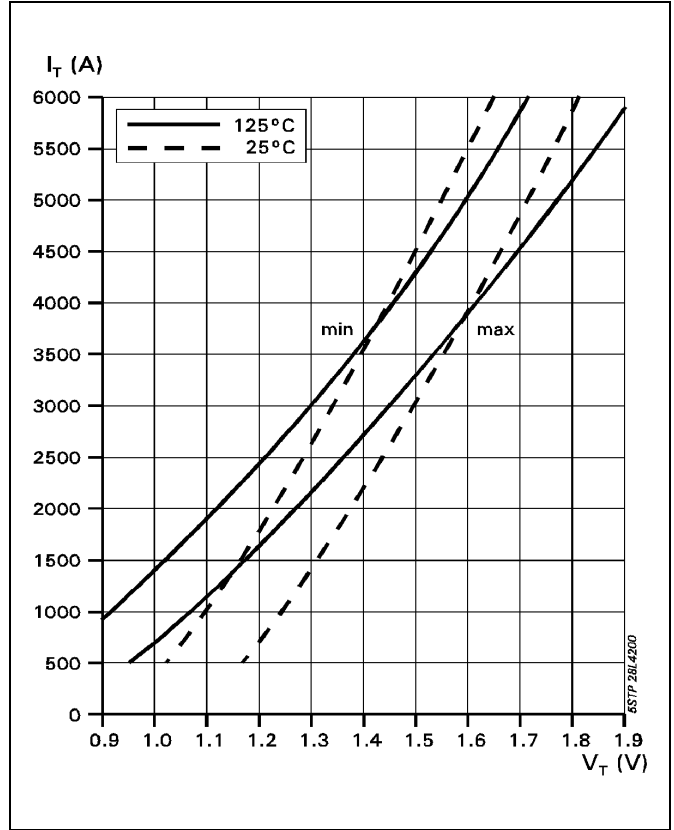


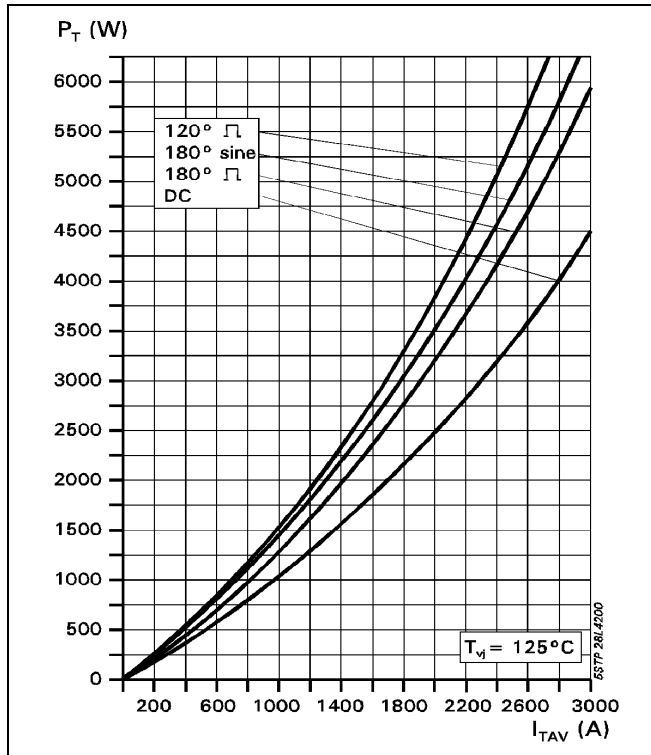
Fig. 1 Transient thermal impedance junction-to case.



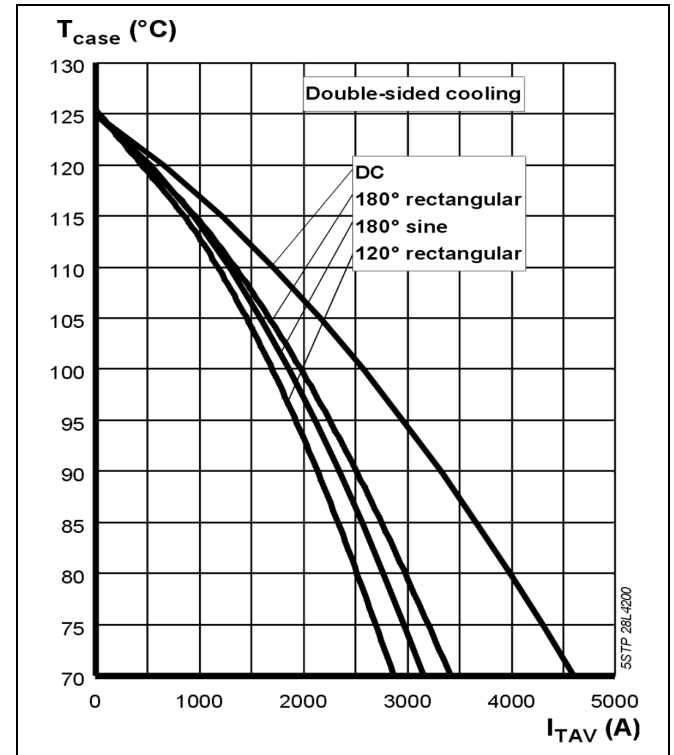
**Fig. 2** On-state characteristics.  
 $T_j = 125^\circ\text{C}$ , 10ms half sine



**Fig. 3** On-state 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.

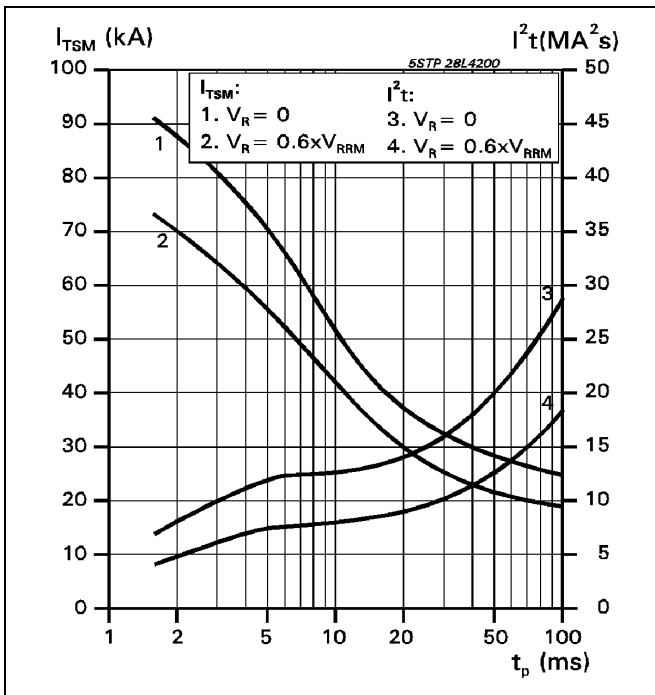


Fig. 6 Surge on-state current vs. pulse length. Half-sine wave.

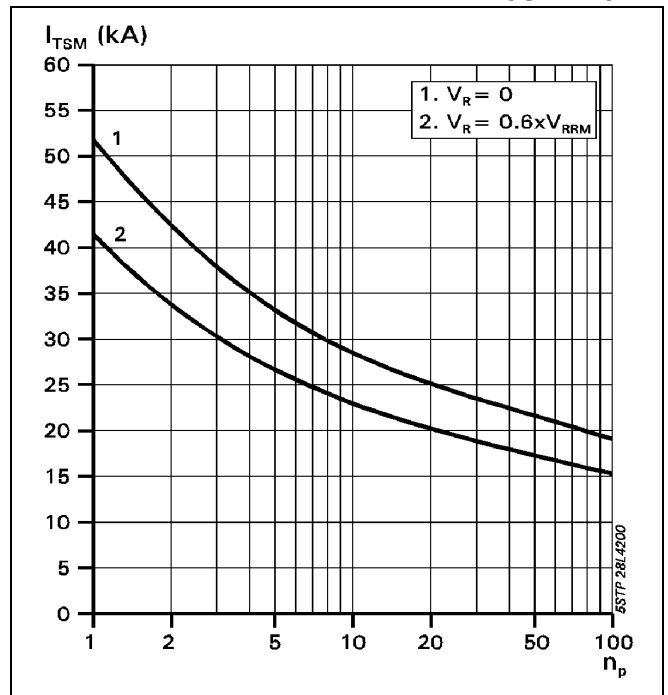


Fig. 7 Surge on-state current vs. number of pulses. Half-sine wave, 10 ms, 50Hz.

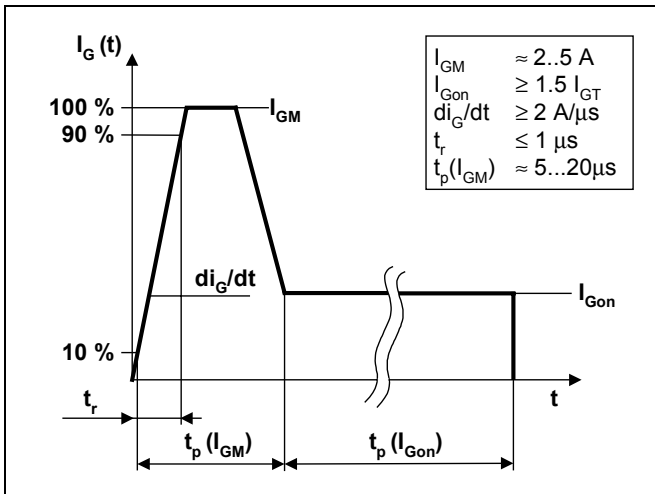


Fig. 8 Recommended gate current waveform.

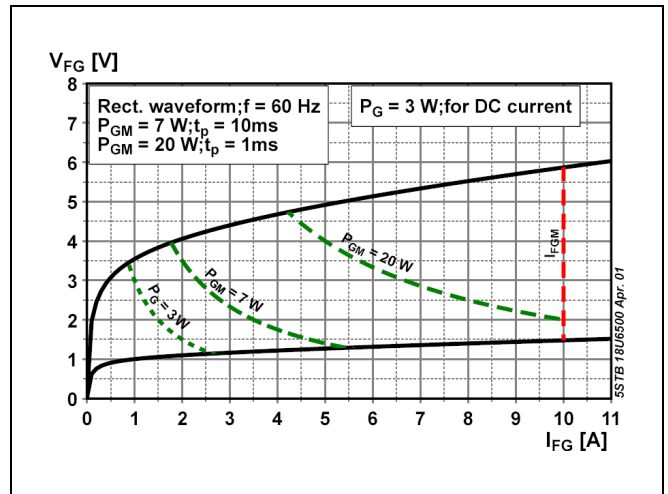


Fig. 9 Max. peak gate power loss.

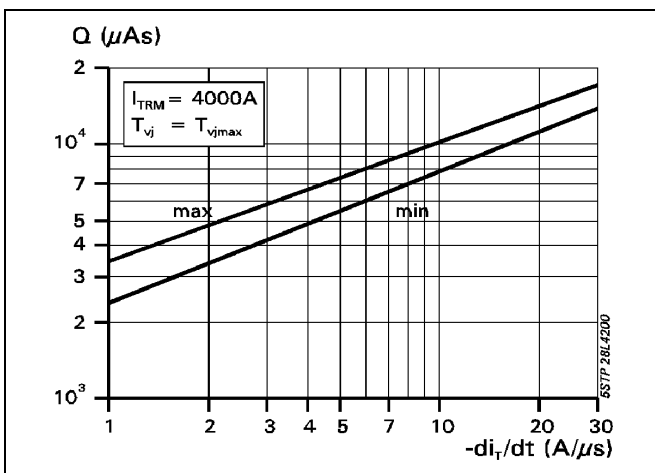


Fig. 10 Recovery charge vs. decay rate of on-state current.

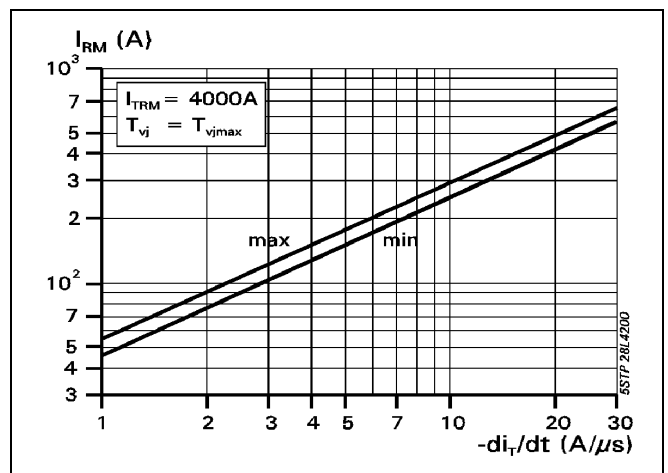


Fig. 11 Peak reverse recovery current vs. decay rate of on-state current.

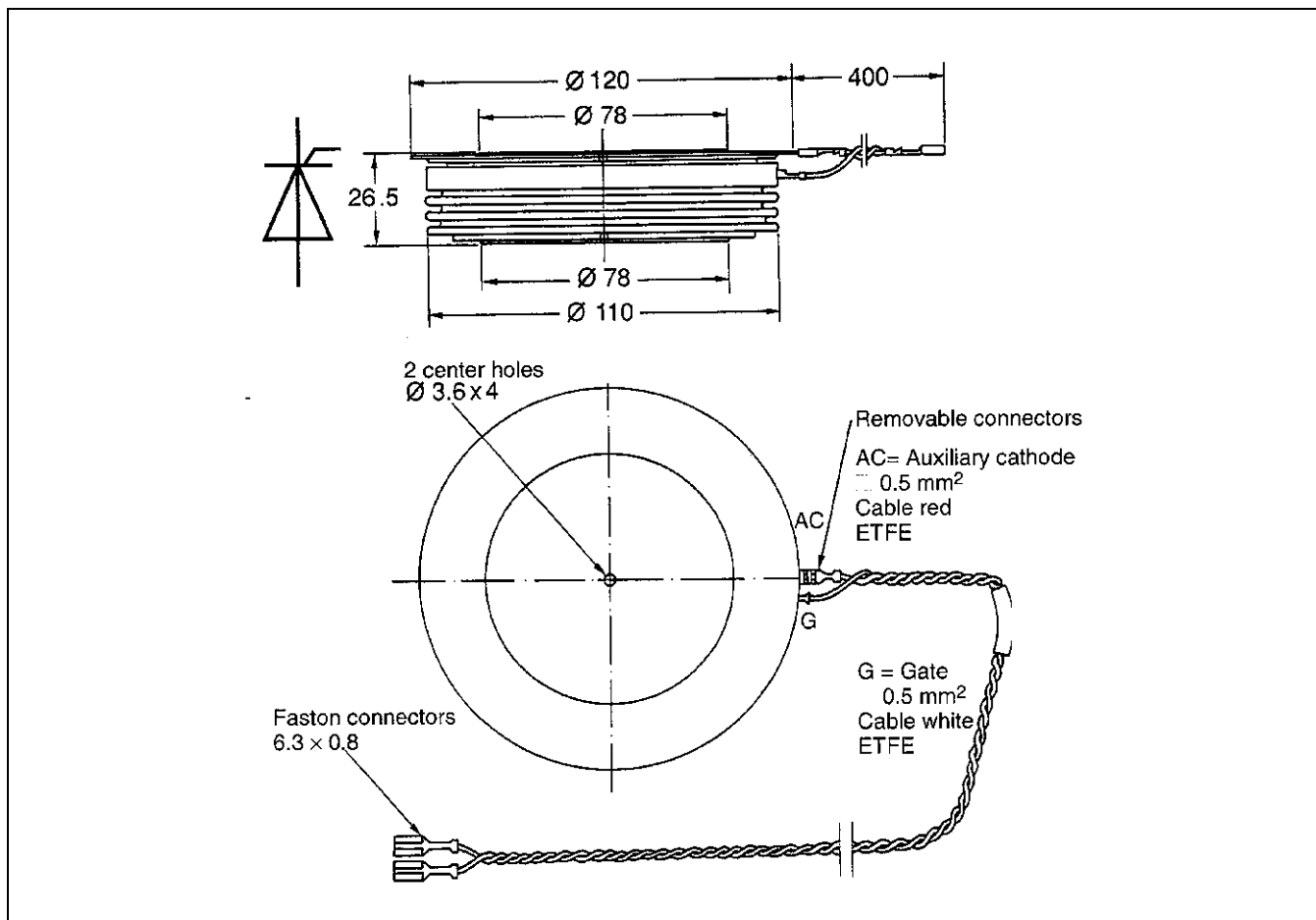


Fig. 12 Device Outline Drawing.

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