

|                     |   |                    |
|---------------------|---|--------------------|
| $V_{\text{DRM}}$    | = | 4500 V             |
| $I_{\text{TGQM}}$   | = | 4000 A             |
| $I_{\text{TSM}}$    | = | $25 \times 10^3$ A |
| $V_{\text{T0}}$     | = | 2.1 V              |
| $r_{\text{T}}$      | = | 0.58 mW            |
| $V_{\text{Dclink}}$ | = | 2800 V             |

# Asymmetric Gate turn-off Thyristor 5SGA 40L4501

Doc. No. 5SYA1208-02 March 05

- Patented free-floating silicon technology
- Low on-state and switching losses
- Annular gate electrode
- Industry standard housing
- Cosmic radiation withstand rating

## Blocking

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

| Parameter                                     | Symbol               | Conditions                                         | min | typ | max  | Unit |
|-----------------------------------------------|----------------------|----------------------------------------------------|-----|-----|------|------|
| Repetitive peak off-state voltage             | $V_{\text{DRM}}$     | $V_{\text{GR}} \geq 2 \text{ V}$                   |     |     | 4500 | V    |
| Repetitive peak reverse voltage               | $V_{\text{RRM}}$     |                                                    |     |     | 17   | V    |
| Permanent DC voltage for 100 FIT failure rate | $V_{\text{DC-link}}$ | Ambient cosmic radiation at sea level in open air. |     |     | 2800 | V    |

Characteristic values

| Parameter                         | Symbol           | Conditions                                                      | min | typ | max | Unit |
|-----------------------------------|------------------|-----------------------------------------------------------------|-----|-----|-----|------|
| Repetitive peak off-state current | $I_{\text{DRM}}$ | $V_{\text{D}} = V_{\text{DRM}}, V_{\text{GR}} \geq 2 \text{ V}$ |     |     | 100 | mA   |
| Repetitive peak reverse current   | $I_{\text{RRM}}$ | $V_{\text{R}} = V_{\text{RRM}}, R_{\text{GK}} = \infty \Omega$  |     |     | 50  | mA   |

## Mechanical data

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

| Parameter      | Symbol         | Conditions | min | typ | max | Unit |
|----------------|----------------|------------|-----|-----|-----|------|
| Mounting force | $F_{\text{m}}$ |            | 36  | 40  | 44  | kN   |

Characteristic values

| Parameter                 | Symbol         | Conditions           | min  | typ | max  | Unit |
|---------------------------|----------------|----------------------|------|-----|------|------|
| Pole-piece diameter       | $D_{\text{p}}$ | $\pm 0.1 \text{ mm}$ |      | 85  |      | mm   |
| Housing thickness         | $H$            |                      | 25.6 |     | 26.1 | mm   |
| Weight                    | $m$            |                      |      |     | 1.5  | kg   |
| Surface creepage distance | $D_{\text{s}}$ | Anode to Gate        | 33   |     |      | mm   |
| Air strike distance       | $D_{\text{a}}$ | Anode to Gate        | 14   |     |      | mm   |

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

ABB Switzerland Ltd, Semiconductors reserves the right to change specifications without notice.



# GTO Data

## On-state

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

| Parameter                              | Symbol       | Conditions                                                                                           | min | typ | max               | Unit             |
|----------------------------------------|--------------|------------------------------------------------------------------------------------------------------|-----|-----|-------------------|------------------|
| Max. average on-state current          | $I_{T(AV)M}$ | Half sine wave, $T_C = 85\text{ °C}$                                                                 |     |     | 1000              | A                |
| Max. RMS on-state current              | $I_{T(RMS)}$ |                                                                                                      |     |     | 1570              | A                |
| Max. peak non-repetitive surge current | $I_{TSM}$    | $t_p = 10\text{ ms}$ , $T_{vj} = 125\text{ °C}$ , sine wave<br>After Surge: $V_D = V_R = 0\text{ V}$ |     |     | $25 \times 10^3$  | A                |
| Limiting load integral                 | $I^2 t$      |                                                                                                      |     |     | $3.1 \times 10^6$ | A <sup>2</sup> s |
| Max. peak non-repetitive surge current | $I_{TSM}$    | $t_p = 1\text{ ms}$ , $T_{vj} = 125\text{ °C}$ , sine wave<br>After Surge: $V_D = V_R = 0\text{ V}$  |     |     | $40 \times 10^3$  | A                |
| Limiting load integral                 | $I^2 t$      |                                                                                                      |     |     | $800 \times 10^3$ | A <sup>2</sup> s |

Characteristic values

| Parameter         | Symbol     | Conditions                                                  | min | typ | max  | Unit |
|-------------------|------------|-------------------------------------------------------------|-----|-----|------|------|
| On-state voltage  | $V_T$      | $I_T = 4000\text{ A}$ , $T_{vj} = 125\text{ °C}$            |     |     | 4.4  | V    |
| Threshold voltage | $V_{(T0)}$ | $T_{vj} = 125\text{ °C}$<br>$I_T = 400 \dots 5000\text{ A}$ |     |     | 2.1  | V    |
| Slope resistance  | $r_T$      |                                                             |     |     | 0.58 | mΩ   |
| Holding current   | $I_H$      | $T_{vj} = 25\text{ °C}$                                     |     |     | 100  | A    |

## Turn-on switching

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

| Parameter                                 | Symbol         | Conditions                                                                                                                                                                                                                                 | min | typ | max  | Unit |
|-------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------|
| Critical rate of rise of on-state current | $di_T/dt_{cr}$ | $T_{vj} = 125\text{ °C}$ , $f = 200\text{ Hz}$<br>$I_T = 4000\text{ A}$ , $I_{GM} = 50\text{ A}$ ,<br>$di_G/dt = 40\text{ A/}\mu\text{s}$ , $f = 1\text{ Hz}$                                                                              |     |     | 500  | A/μs |
| Critical rate of rise of on-state current | $di_T/dt_{cr}$ |                                                                                                                                                                                                                                            |     |     | 1000 | A/μs |
| Min. on-time                              | $t_{on}$       | $V_D = 0.5 V_{DRM}$ , $T_{vj} = 125\text{ °C}$<br>$I_T = 4000\text{ A}$ , $di/dt = 300\text{ A/}\mu\text{s}$ ,<br>$I_{GM} = 50\text{ A}$ , $di_G/dt = 40\text{ A/}\mu\text{s}$ ,<br>$C_S = 6\text{ }\mu\text{F}$ , $R_S = 5\text{ }\Omega$ | 100 |     |      | μs   |

Characteristic values

| Parameter                | Symbol   | Conditions                                                                                                                                                                                                                                 | min | typ | max | Unit |
|--------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| Turn-on delay time       | $t_d$    | $V_D = 0.5 V_{DRM}$ , $T_{vj} = 125\text{ °C}$<br>$I_T = 4000\text{ A}$ , $di/dt = 300\text{ A/}\mu\text{s}$ ,<br>$I_{GM} = 50\text{ A}$ , $di_G/dt = 40\text{ A/}\mu\text{s}$ ,<br>$C_S = 6\text{ }\mu\text{F}$ , $R_S = 5\text{ }\Omega$ |     |     | 2.5 | μs   |
| Rise time                | $t_r$    |                                                                                                                                                                                                                                            |     |     | 5   | μs   |
| Turn-on energy per pulse | $E_{on}$ |                                                                                                                                                                                                                                            |     |     | 3.3 | J    |

## Turn-off switching

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

| Parameter                          | Symbol     | Conditions                                                                                                                                                                                                                              | min | typ | max  | Unit |
|------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------|
| Max. controllable turn-off current | $I_{TGQM}$ | $V_{DM} \leq V_{DRM}$ , $di_{GQ}/dt = 40\text{ A/}\mu\text{s}$ ,<br>$C_S = 6\text{ }\mu\text{F}$ , $L_S \leq 0.3\text{ }\mu\text{H}$                                                                                                    |     |     | 4000 | A    |
| Min. off-time                      | $t_{off}$  | $V_D = 0.5 V_{DRM}$ , $T_{vj} = 125\text{ °C}$<br>$V_{DM} \leq V_{DRM}$ , $di_{GQ}/dt = 40\text{ A/}\mu\text{s}$ ,<br>$I_{TGQ} = I_{TGQM}$ ,<br>$R_S = 5\text{ }\Omega$ , $C_S = 6\text{ }\mu\text{F}$ , $L_S = 0.3\text{ }\mu\text{H}$ | 100 |     |      | μs   |

Characteristic values

| Parameter                  | Symbol    | Conditions                                                                                                                                                                                                                              | min | typ | max  | Unit |
|----------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------|
| Storage time               | $t_S$     | $V_D = 0.5 V_{DRM}$ , $T_{vj} = 125\text{ °C}$<br>$V_{DM} \leq V_{DRM}$ , $di_{GQ}/dt = 40\text{ A/}\mu\text{s}$ ,<br>$I_{TGQ} = I_{TGQM}$ ,<br>$R_S = 5\text{ }\Omega$ , $C_S = 6\text{ }\mu\text{F}$ , $L_S = 0.3\text{ }\mu\text{H}$ |     |     | 27   | μs   |
| Fall time                  | $t_f$     |                                                                                                                                                                                                                                         |     |     | 3    | μs   |
| Turn-on energy per pulse   | $E_{off}$ |                                                                                                                                                                                                                                         |     |     | 14   | J    |
| Peak turn-off gate current | $I_{GQM}$ |                                                                                                                                                                                                                                         |     |     | 1100 | A    |

## Gate

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

| Parameter                       | Symbol    | Conditions         | min | typ | max | Unit |
|---------------------------------|-----------|--------------------|-----|-----|-----|------|
| Repetitive peak reverse voltage | $V_{GRM}$ |                    |     |     | 17  | V    |
| Repetitive peak reverse current | $I_{GRM}$ | $V_{GR} = V_{GRM}$ |     |     | 50  | mA   |

Characteristic values

| Parameter            | Symbol   | Conditions                                                                   | min | typ | max | Unit |
|----------------------|----------|------------------------------------------------------------------------------|-----|-----|-----|------|
| Gate trigger voltage | $V_{GT}$ | $T_{vj} = 25^{\circ}\text{C}$ ,<br>$V_D = 24\text{ V}$ , $R_A = 0.1\ \Omega$ |     | 1.2 |     | V    |
| Gate trigger current | $I_{GT}$ |                                                                              |     | 4   |     | A    |

## Thermal

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

| Parameter                      | Symbol    | Conditions | min | typ | max | Unit               |
|--------------------------------|-----------|------------|-----|-----|-----|--------------------|
| Junction operating temperature | $T_{vj}$  |            | -40 |     | 125 | $^{\circ}\text{C}$ |
| Storage temperature range      | $T_{stg}$ |            | -40 |     | 125 | $^{\circ}\text{C}$ |

Characteristic values

| Parameter                                                | Symbol         | Conditions          | min | typ | max | Unit |
|----------------------------------------------------------|----------------|---------------------|-----|-----|-----|------|
| Thermal resistance junction to case                      | $R_{th(j-c)}$  | Double side cooled  |     |     | 11  | K/kW |
|                                                          | $R_{th(j-c)A}$ | Anode side cooled   |     |     | 20  | K/kW |
|                                                          | $R_{th(j-c)C}$ | Cathode side cooled |     |     | 25  | K/kW |
| Thermal resistance case to heatsink (Double side cooled) | $R_{th(c-h)}$  | Single side cooled  |     |     | 6   | K/kW |
|                                                          | $R_{th(c-h)}$  | Double side cooled  |     |     | 3   | 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      |
|--------------------|--------|--------|--------|--------|
| $R_i(\text{K/kW})$ | 7.313  | 1.974  | 1.218  | 0.501  |
| $\tau_i(\text{s})$ | 0.5400 | 0.0939 | 0.0117 | 0.0036 |

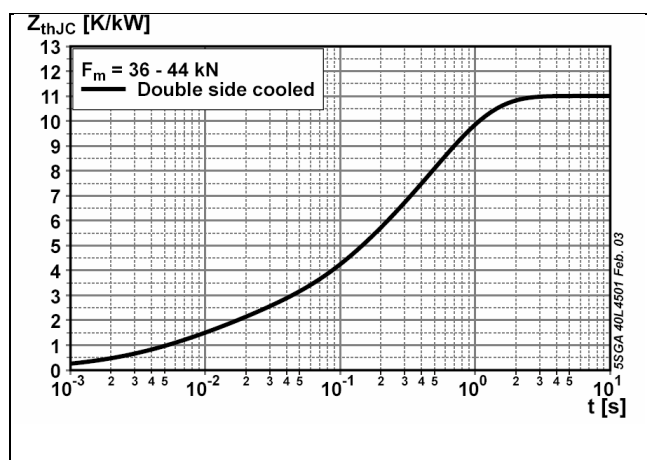


Fig. 1 Transient thermal impedance, junction to case

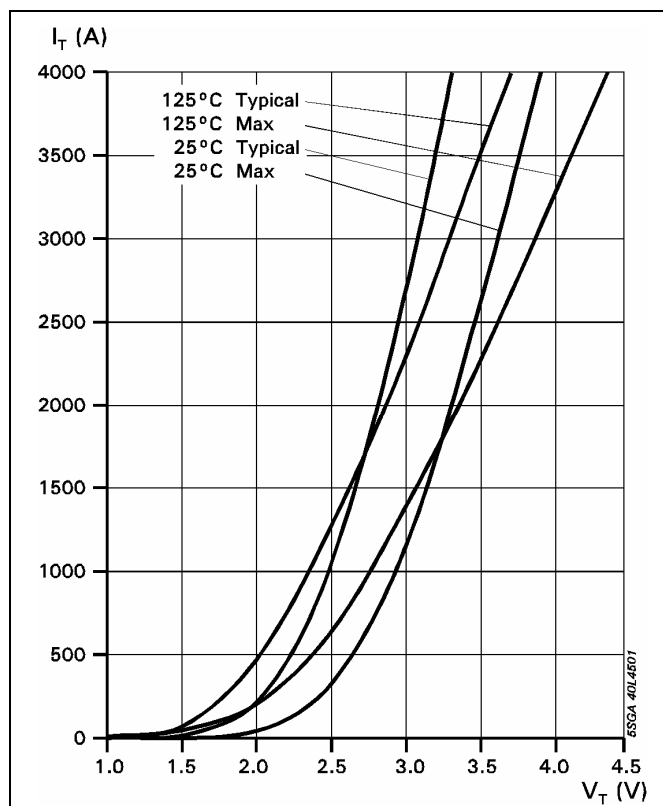


Fig. 2 On-state characteristics

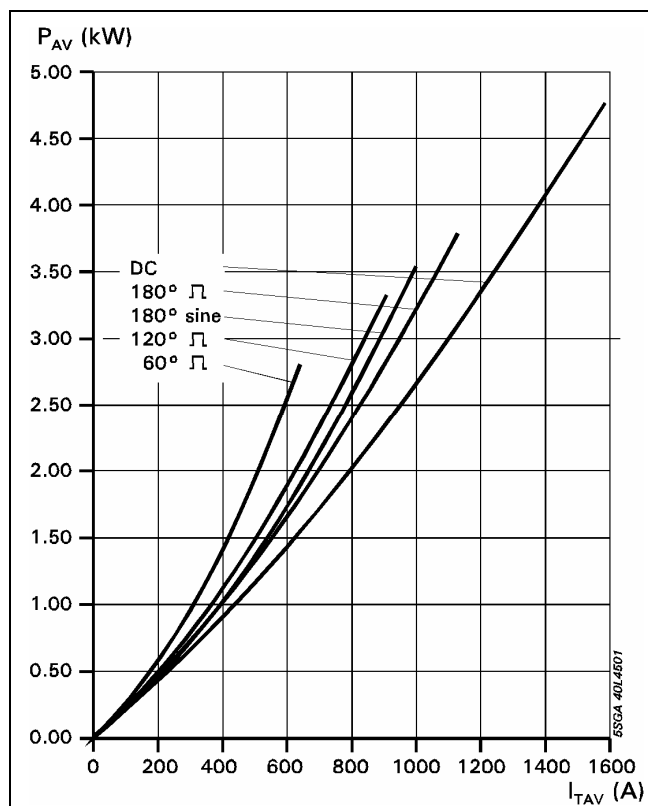


Fig. 3 Average on-state power dissipation vs. average on-state current

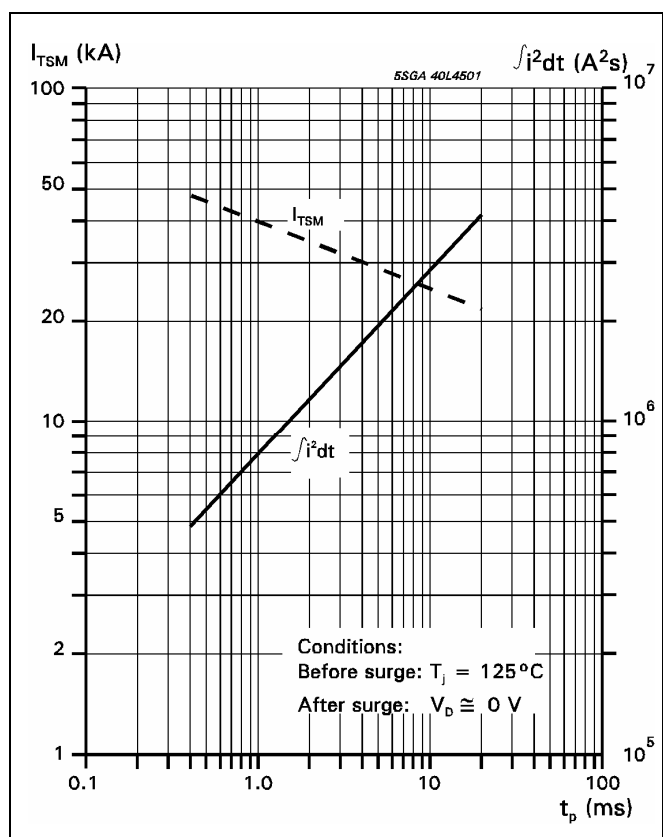
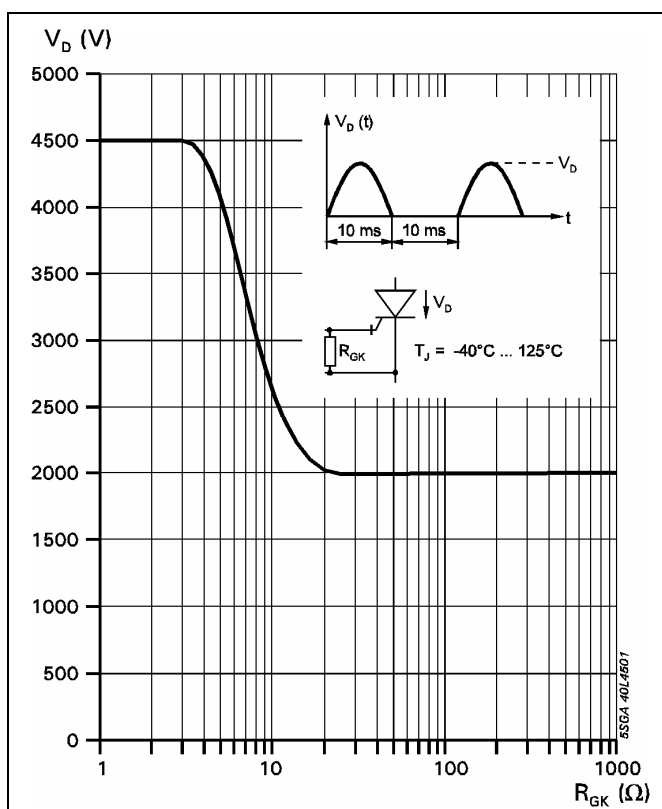
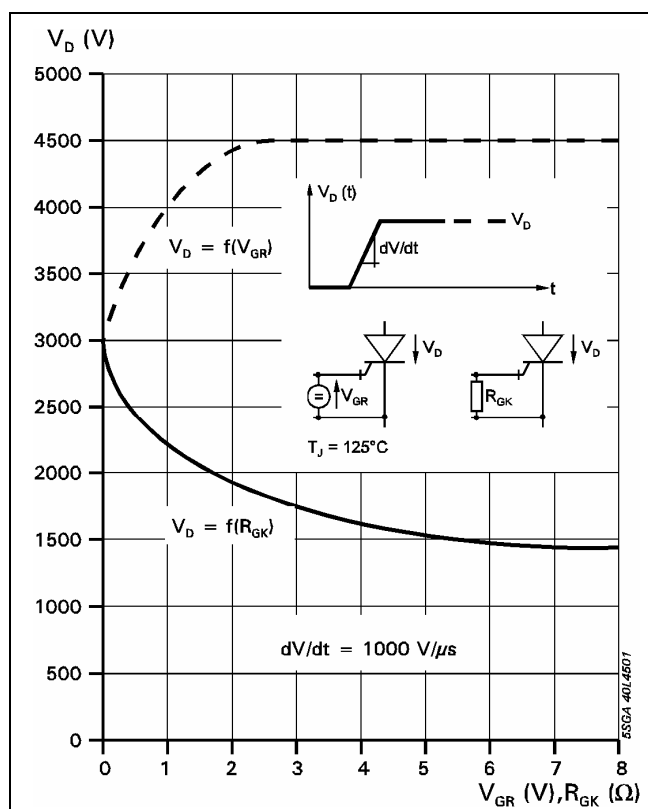


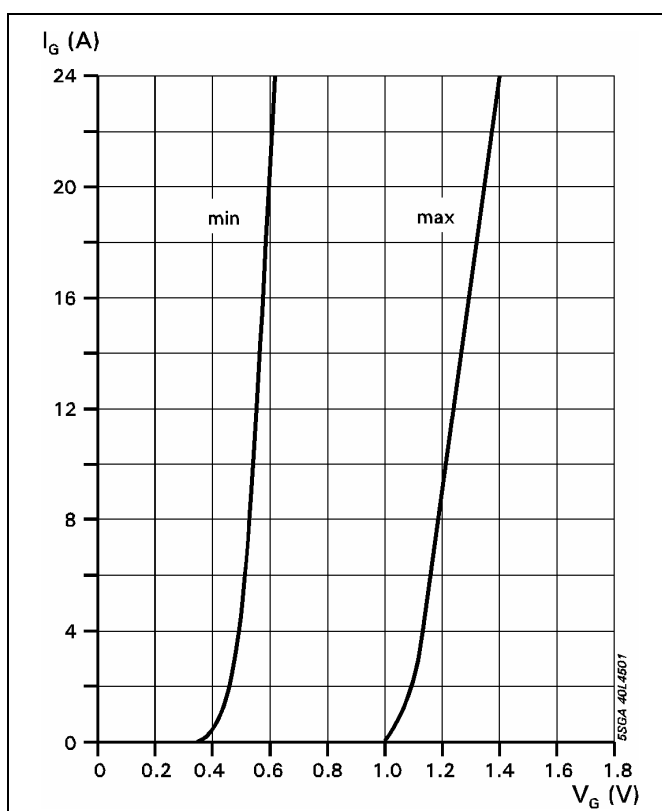
Fig. 4 Surge current and fusing integral vs. pulse width



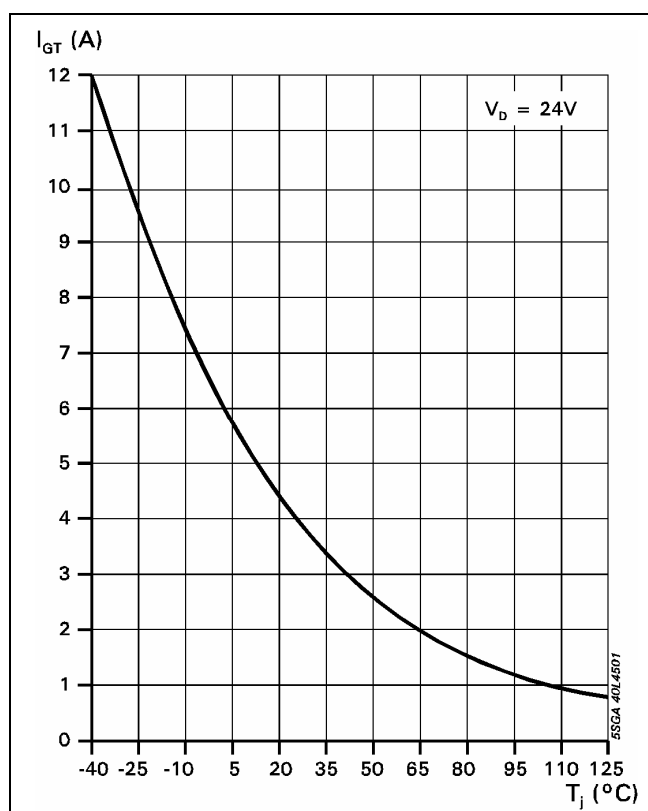
**Fig. 5** Forward blocking voltage vs. gate-cathode resistance



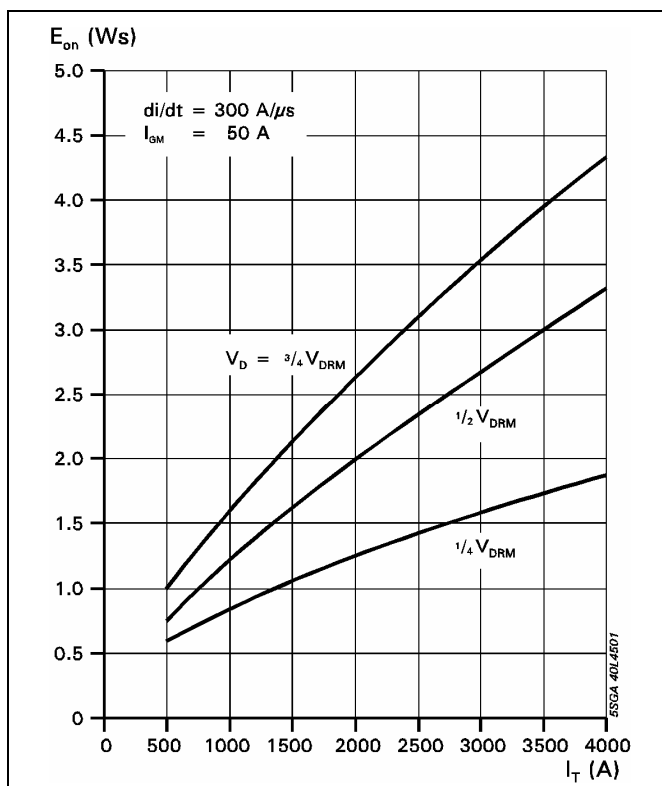
**Fig. 6** Static dv/dt capability; forward blocking voltage vs. neg. gate voltage or gate cathode resistance



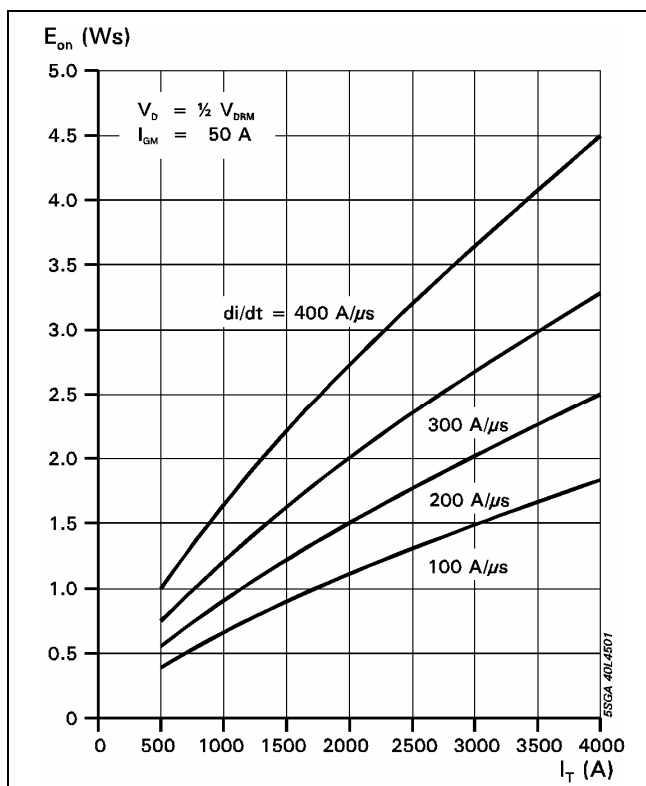
**Fig. 7** Forward gate current vs. forward gate voltage



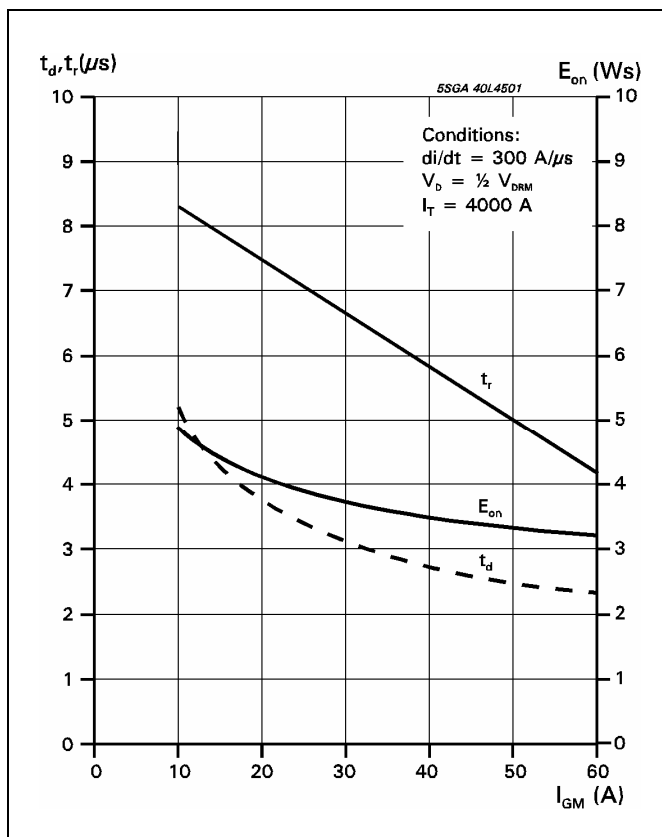
**Fig. 8** Gate trigger current vs. junction temperature



**Fig. 9** Turn-on energy per pulse vs. on-state current and turn-on voltage



**Fig. 10** Turn-on energy per pulse vs. on-state current and current rise rate



**Fig. 11** Turn-on energy per pulse vs. on-state current and turn-on voltage

#### Common Test conditions:

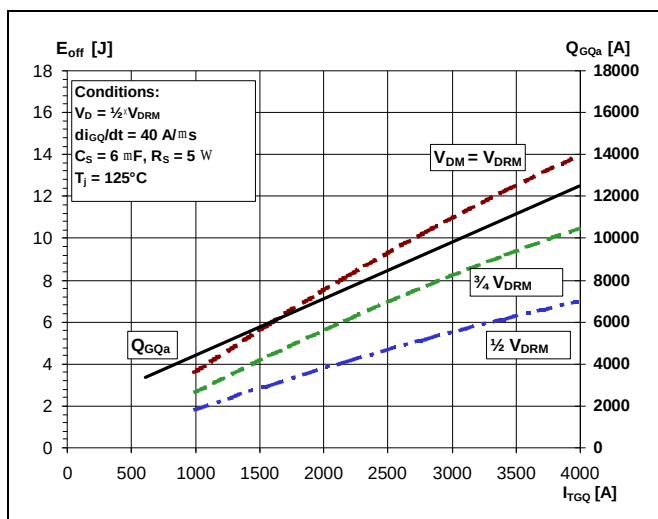
$$\begin{aligned} di_G/dt &= 40 \text{ A}/\mu\text{s} \\ C_S &= 6 \mu\text{F} \\ R_S &= 5 \Omega \\ T_j &= 125^\circ\text{C} \end{aligned}$$

#### Definition of Turn-on energy:

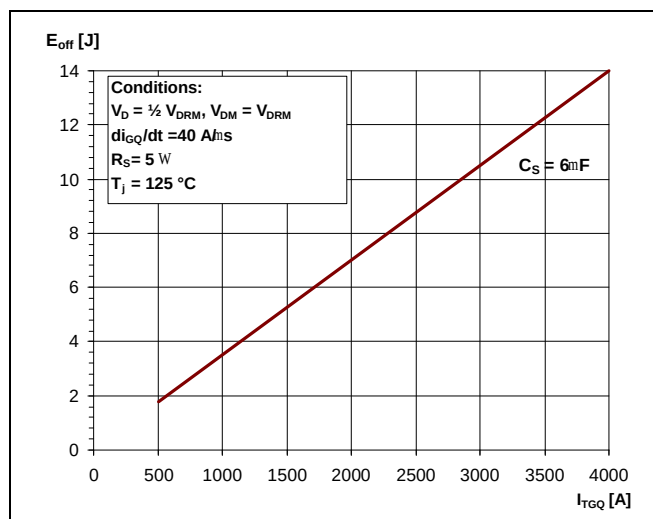
$$E_{on} = \int_0^{20 \text{ ms}} V_D \cdot I_T dt \quad (t = 0, I_G = 0.1 \cdot I_{GM})$$

#### Definition of Turn-off energy:

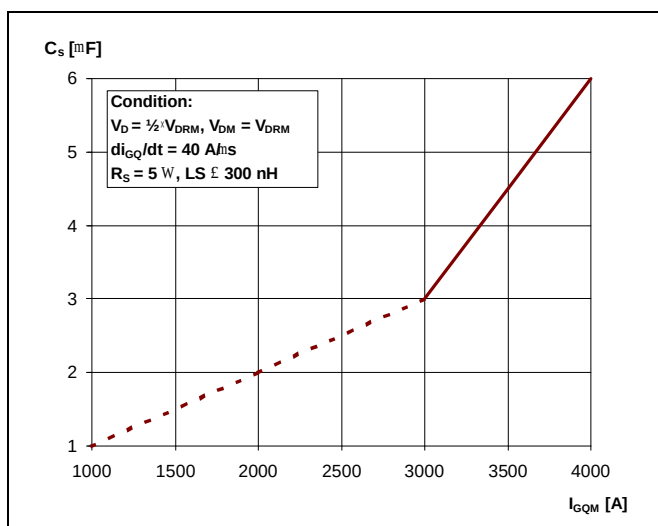
$$E_{off} = \int_0^{40 \text{ ms}} V_D \cdot I_T dt \quad (t = 0, I_T = 0.9 \cdot I_{TQ})$$



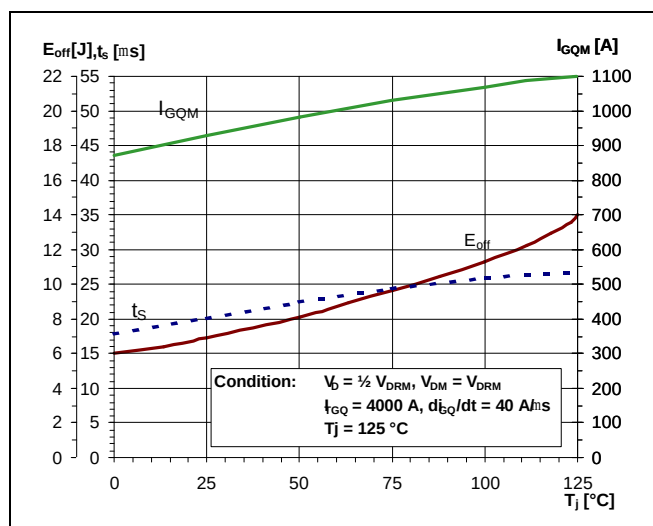
**Fig. 12** Turn-off energy per pulse vs. turn-off current and peak turn-off voltage, extracted gate charge vs. turn-off current



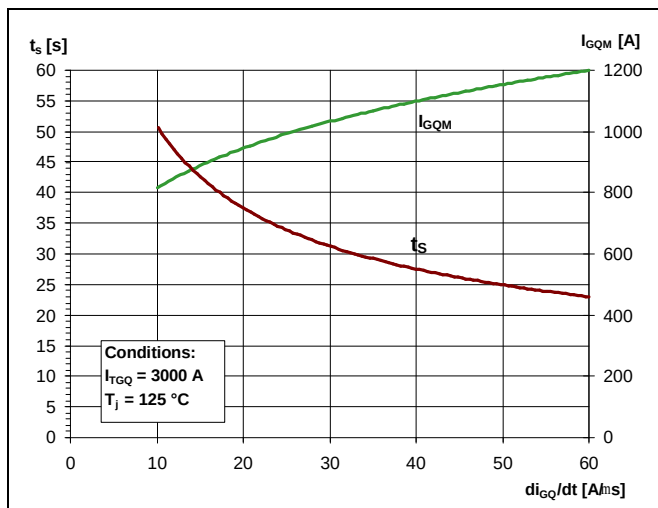
**Fig. 13** Turn-off energy per pulse vs. turn-off current and snubber capacitance



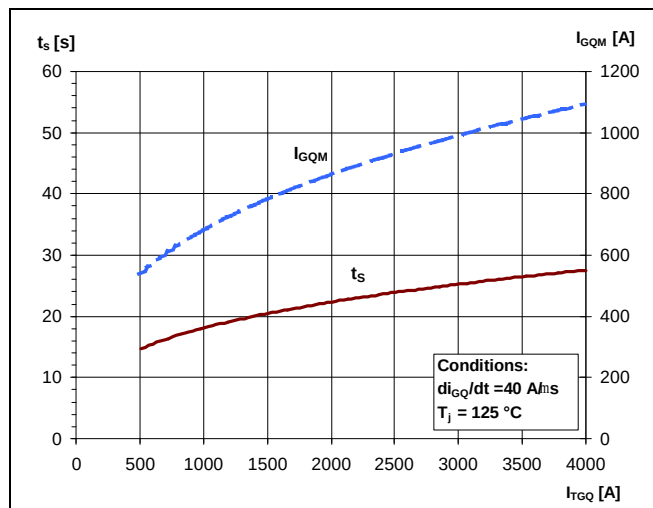
**Fig. 14** Required snubber capacitor vs. max allowable turn-off current



**Fig. 15** Turn-off energy per pulse, storage time and peak turn-off gate current vs. junction temperature



**Fig. 16** Storage time and peak turn-off gate current vs. neg. gate current rise rate



**Fig. 17** Storage time and peak turn-off gate current vs. turn-off current

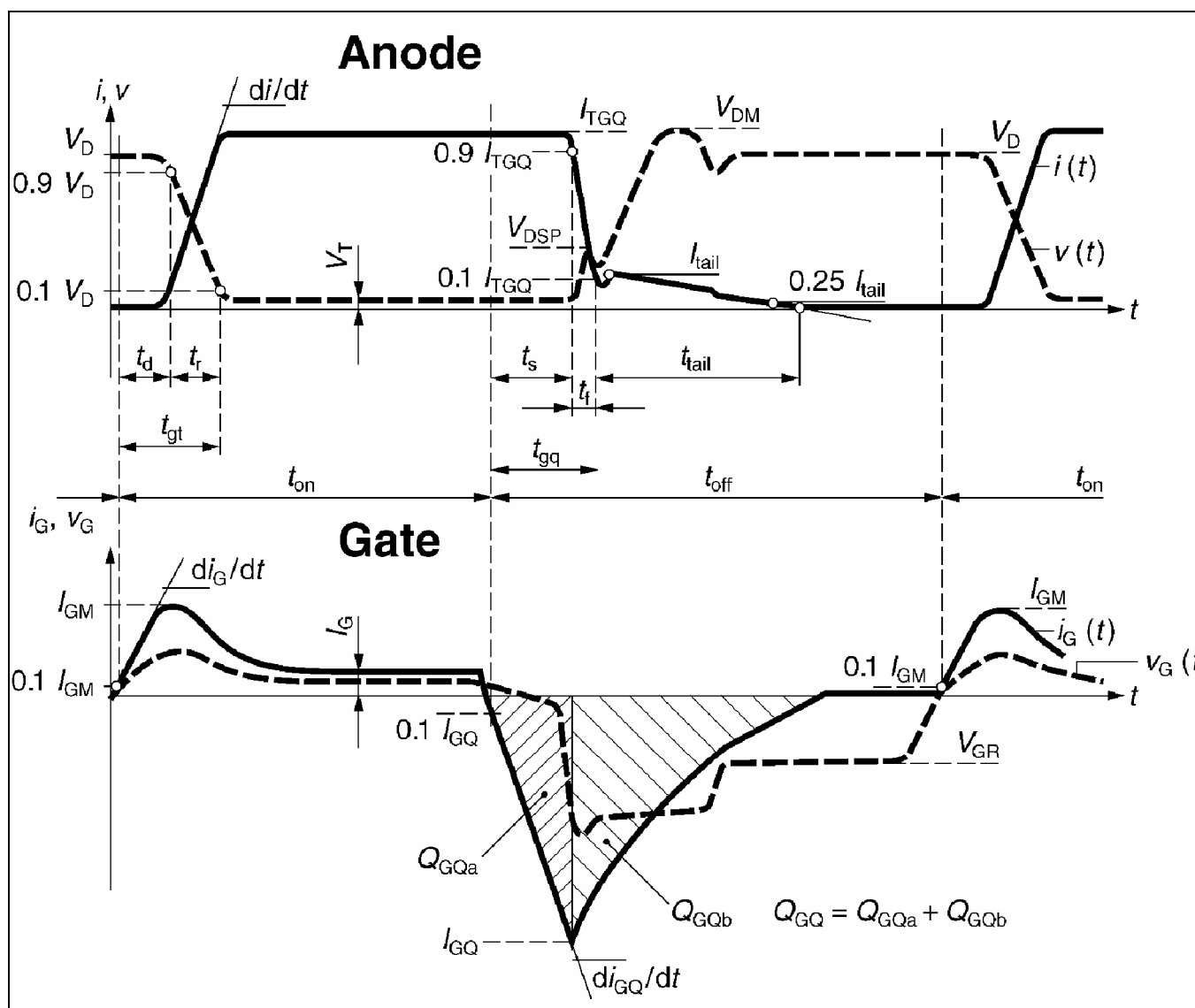
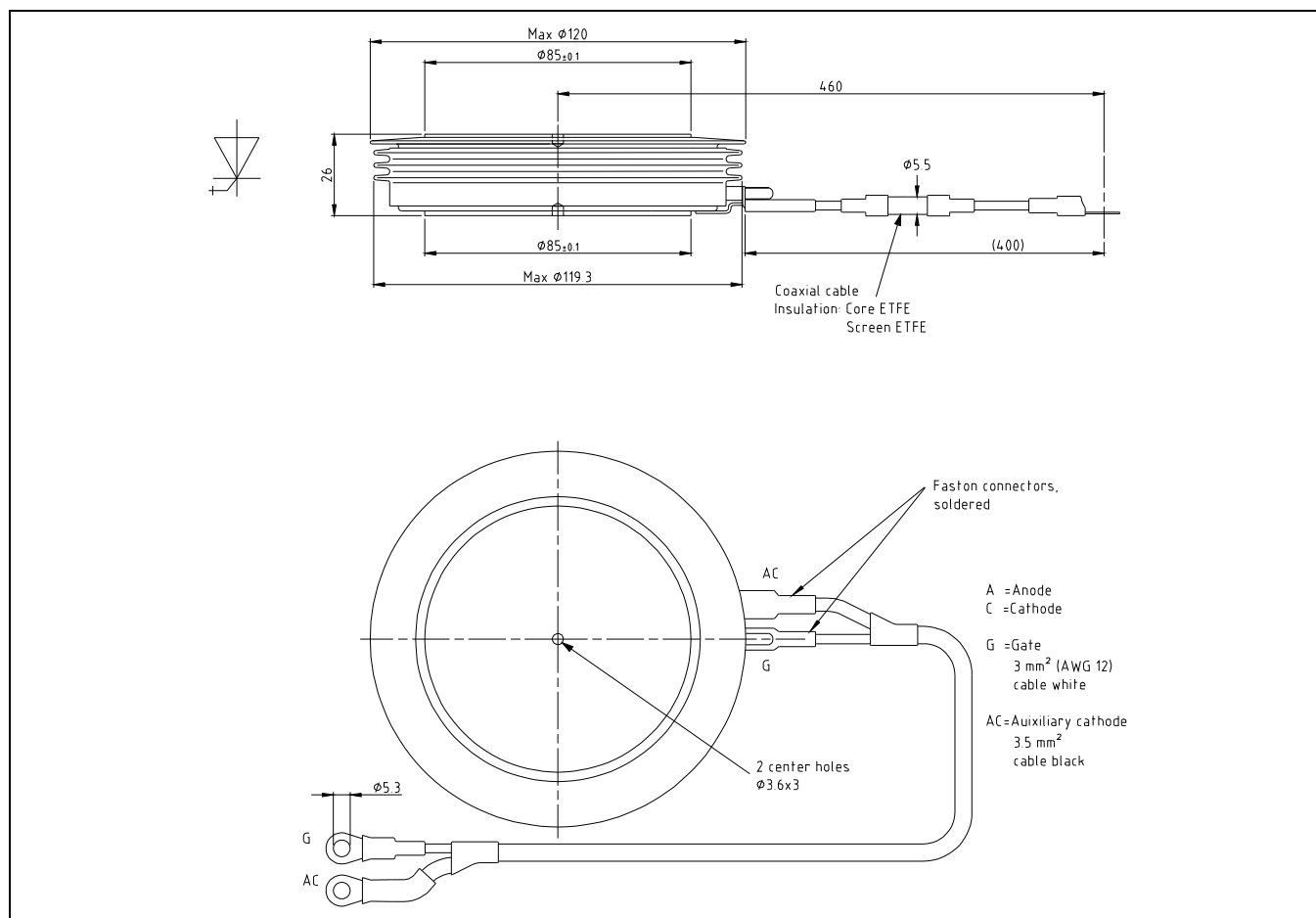


Fig. 18 General current and voltage waveforms with GTO-specific symbols





**Fig. 19** Outline drawing; all dimensions are in millimeters and represent nominal values unless stated otherwise

### Reverse avalanche capability

In operation with an antiparallel freewheeling diode, the GTO reverse voltage  $V_R$  may exceed the rate value  $V_{RRM}$  due to stray inductance and diode turn-on voltage spike at high  $di/dt$ . The GTO is then driven into reverse avalanche. This condition is not dangerous for the GTO provided avalanche time and current are below 10  $\mu s$  and 1000 A respectively. However, gate voltage must remain negative during this time. Recommendation :  $V_{GR} = 10 \dots 15$  V.

### Related documents:

|           |                                                                                                                           |
|-----------|---------------------------------------------------------------------------------------------------------------------------|
| 5SYA 2036 | Recommendations regarding mechanical clamping of Press Pack High Power Semiconductors                                     |
| 5SYA 2046 | Cosmic Ray                                                                                                                |
| 5SZK 9104 | Specification of enviromental class for pressure contact GTO, STORAGE available on request, please contact factory        |
| 5SZK 9105 | Specification of enviromental class for pressure contact GTO, TRANSPORTATION available on request, please contact factory |

Please refer to <http://www.abb.com/semiconductors> for actual versions.

**ABB Switzerland Ltd, Semiconductors reserves the right to change specifications without notice.**



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

Doc. No. 5SYA1208-02 March 05

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)