| | | | |
|---|---|---|---|
| $V_{DRM}$ | = | 2500 | V |
| $I_{TGQM}$ | = | 1500 | A |
| $I_{TSM}$ | = | 10 | kA |
| $V_{T0}$ | = | 1.55 | V |
| $r_T$ | = | 0.63 | mΩ |
| $V_{DClin}$ | = | 1400 | V |

# Gate turn-off Thyristor

# 5SGA 15F2502

Doc. No. 5SYA 1214-01 Aug. 2000

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

## Blocking

| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{DRM}$ | Repetitive peak off-state voltage | | 2500 | V | $V_{GR} \geq 2V$ | |
| $V_{RRM}$ | Repetitive peak reverse voltage | | 17 | V | | |
| $I_{DRM}$ | Repetitive peak off-state current | ≤ | 100 | mA | $V_D = V_{DRM}$ | $V_{GR} \geq 2V$ |
| $I_{RRM}$ | Repetitive peak reverse current | ≤ | 50 | mA | $V_R = V_{RRM}$ | $R_{GK} = \infty$ |
| $V_{DClink}$ | Permanent DC voltage for 100 FIT failure rate | | 1400 | V | $0 \leq T_j \leq 125$ °C. Ambient cosmic radiation at sea level in open air. | |

## Mechanical data (see Fig. 19)

| | | | | | |
|---|---|---|---|---|---|
| $F_m$ | Mounting force | min. | | 14 | kN |
| | | max. | | 16 | kN |
| A | Acceleration:<br>Device unclamped<br>Device clamped | | | <br>50<br>200 | <br>$m/s^2$<br>$m/s^2$ |
| M | Weight | | | 0.6 | kg |
| $D_S$ | Surface creepage distance | | ≥ | 25 | mm |
| $D_a$ | Air strike distance | | ≥ | 15 | mm |

# GTO Data

## On-state

| | | | |
|---|---|---|---|
| $I_{TAVM}$ | Max. average on-state current | 550 A | Half sine wave, $T_C$ = 85 °C |
| $I_{TRMS}$ | Max. RMS on-state current | 870 A | |
| $I_{TSM}$ | Max. peak non-repetitive surge current | 10 kA | $t_P$ = 10 ms; $T_j$ = 125°C; After surge: $V_D = V_R$ = 0V |
| | | 20 kA | $t_P$ = 1 ms |
| $I^2t$ | Limiting load integral | $0.50 \cdot 10^6$ $A^2s$ | $t_P$ = 10 ms |
| | | $0.20 \cdot 10^6$ $A^2s$ | $t_P$ = 1 ms |
| $V_T$ | On-state voltage | 2.50 V | $I_T$ = 1500 A; $T_j$ = 125 °C |
| $V_{T0}$ | Threshold voltage | 1.55 V | $I_T$ = 300 - 2000 A |
| $r_T$ | Slope resistance | 0.63 mΩ | |
| $I_H$ | Holding current | 50 A | $T_j$ = 25 °C |

## Gate

| | | | |
|---|---|---|---|
| $V_{GT}$ | Gate trigger voltage | 1.5 V | $V_D$ = 24 V, $R_A$ = 0.1 Ω, $T_j$ = 25 °C |
| $I_{GT}$ | Gate trigger current | 1.5 A | |
| $V_{GRM}$ | Repetitive peak reverse voltage | 17 V | |
| $I_{GRM}$ | Repetitive peak reverse current | 20 mA | $V_{GR} = V_{GRM}$ |

## Turn-on switching

| | | | |
|---|---|---|---|
| $di/dt_{crit}$ | Max. rate of rise of on-state current | 400 A/µs | f = 200Hz; $I_T$ = 1500 A, $T_j$ = 125 °C, $I_{GM}$ = 30 A, $di_G/dt$ = 20 A/µs |
| | | 600 A/µs | f = 1Hz |
| $t_d$ | Delay time | 2.0 µs | $V_D$ = 0.5 $V_{DRM}$, $T_j$ = 125 °C, $I_T$ = 1500 A, di/dt = 200 A/µs, $I_{GM}$ = 30 A, $di_G/dt$ = 20 A/µs, $C_S$ = 3 µF, $R_S$ = 5 Ω |
| $t_r$ | Rise time | 4.0 µs | |
| $t_{on(min)}$ | Min. on-time | 80 µs | |
| $E_{on}$ | Turn-on energy per pulse | 0.50 Ws | |

## Turn-off switching

| | | | |
|---|---|---|---|
| $I_{TGQM}$ | Max controllable turn-off current | 1500 A | $V_{DM} = V_{DRM}$, $di_{GQ}/dt$ = 30 A/µs, $C_S$ = 3 µF, $L_S$ ≤ 0.3 µH |
| $t_s$ | Storage time | 15.0 µs | $V_D$ = ½ $V_{DRM}$, $V_{DM} = V_{DRM}$, $T_j$ = 125 °C, $di_{GQ}/dt$ = 30 A/µs, $I_{TGQ} = I_{TGQM}$, $C_S$ = 3 µF, $R_S$ = 5 Ω, $L_S$ ≤ 0.3 µH |
| $t_f$ | Fall time | 2.0 µs | |
| $t_{off(min)}$ | Min. off-time | 80 µs | |
| $E_{off}$ | Turn-off energy per pulse | 2.0 Ws | |
| $I_{GQM}$ | Peak turn-off gate current | 450 A | |

## Thermal

| | | | |
|---|---|---|---|
| $T_j$ | Storage and operating junction temperature range | 0...125°C | |
| $R_{thJC}$ | Thermal resistance junction to case | 49 K/kW | Anode side cooled |
| | | 60 K/kW | Cathode side cooled |
| | | 27 K/kW | Double side cooled |
| $R_{thCH}$ | Thermal resistance case to heat sink | 16 K/kW | Single side cooled |
| | | 8 K/kW | Double side cooled |

**Analytical function for transient thermal impedance:**

$$Z_{thJC}(t) = \sum_{i=1}^{4} R_i (1 - e^{-t/\tau_i})$$

| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $R_I$ (K/kW) | 15 | 5.2 | 7.5 | 0.1 |
| $\tau_i$ (s) | 0.461 | 0.095 | 0.012 | 0.001 |

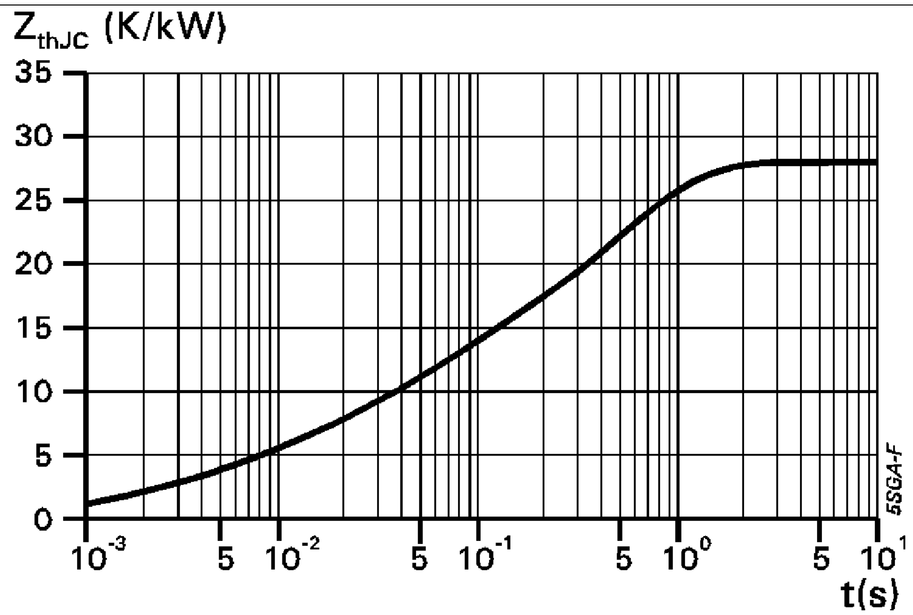


**Fig. 1** Transient thermal impedance, junction to case.

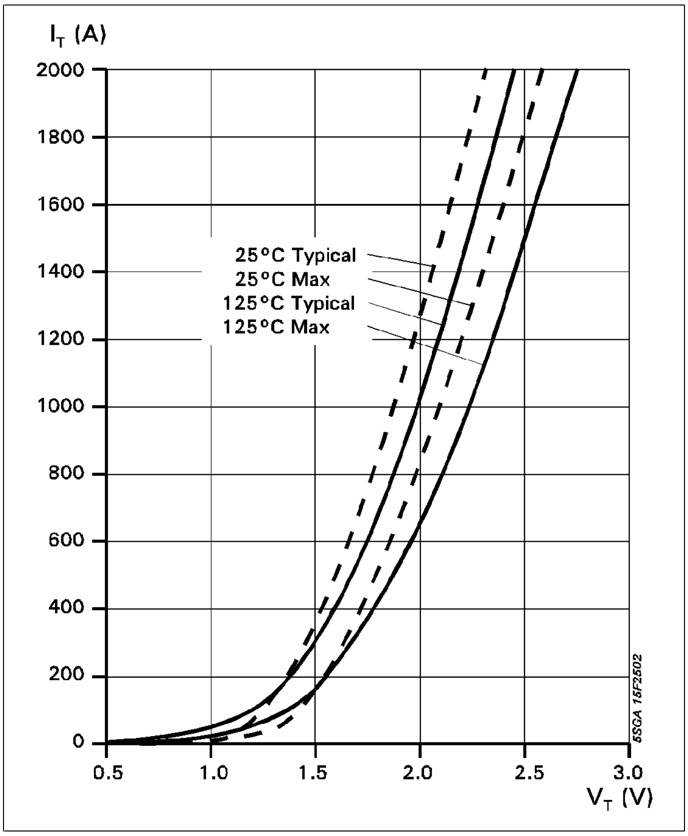


**Fig. 2** On-state characteristics

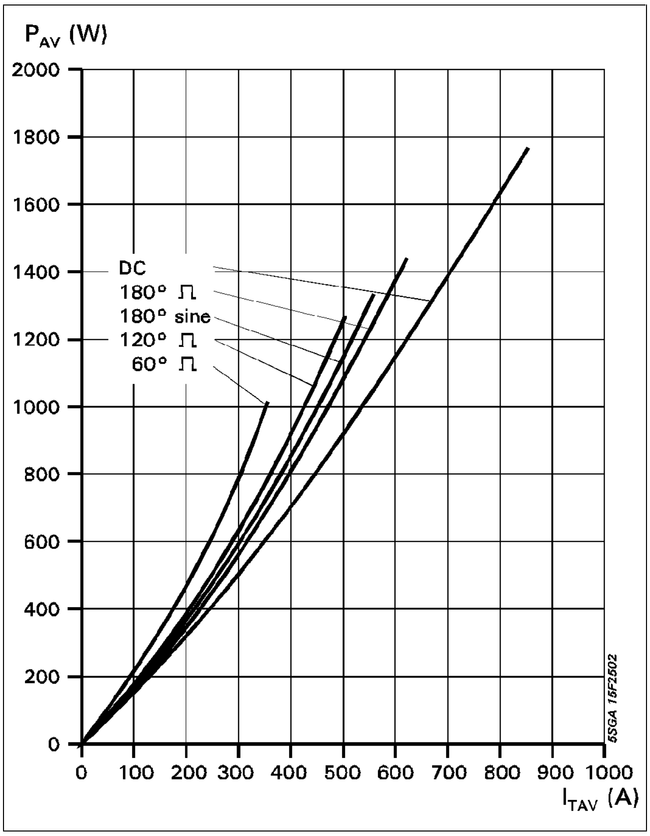


**Fig. 3** Average on-state power dissipation vs. average on-state current.

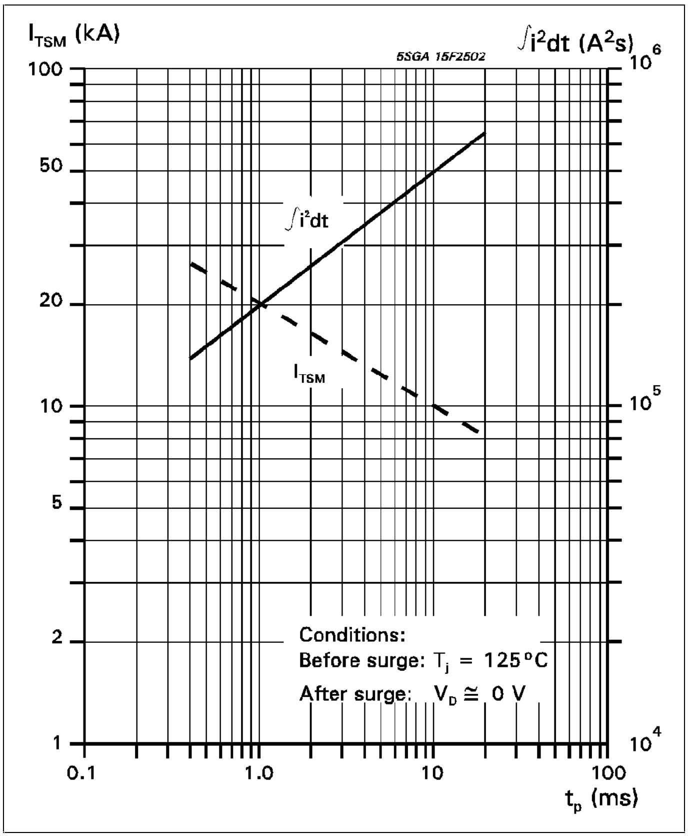


**Fig. 4** Surge current and fusing integral vs. pulse width

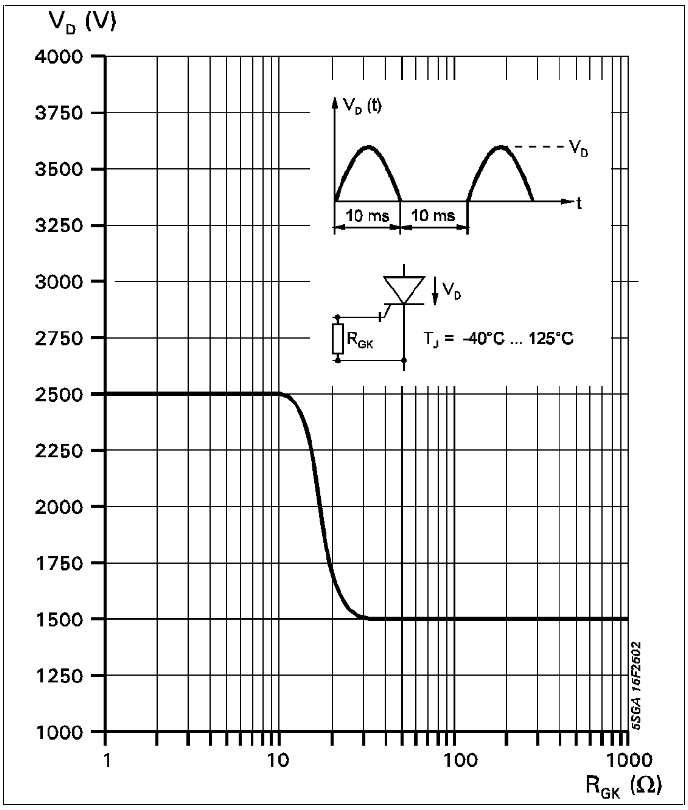


**Fig. 5** Forward blocking voltage vs. gate-cathode resistance.

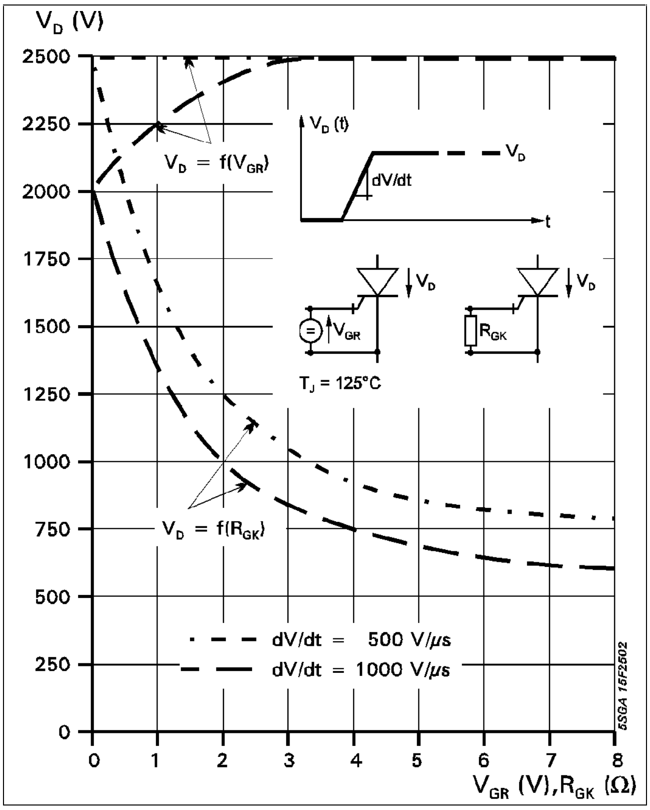


**Fig. 6** Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.

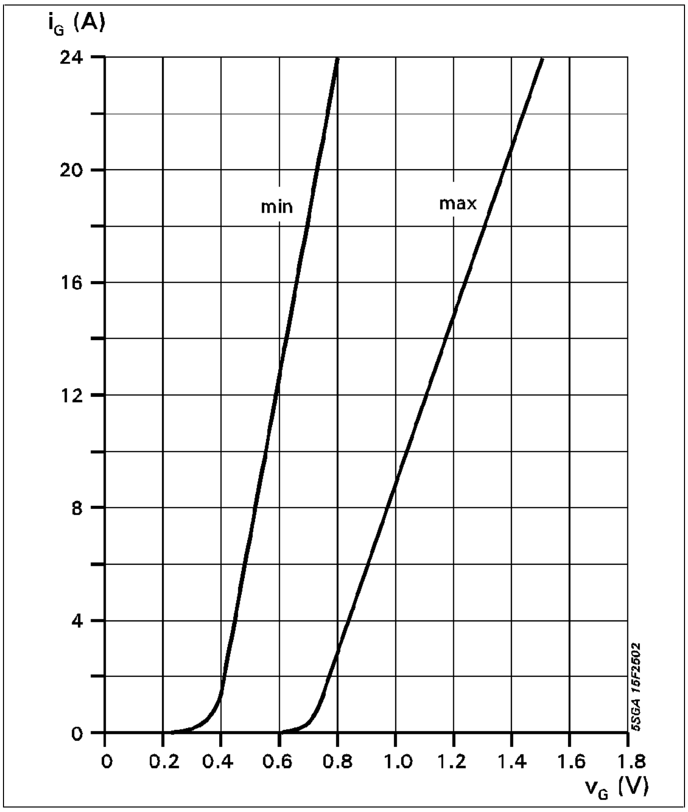


**Fig. 7** Forwarde gate current vs. forard gate voltage.

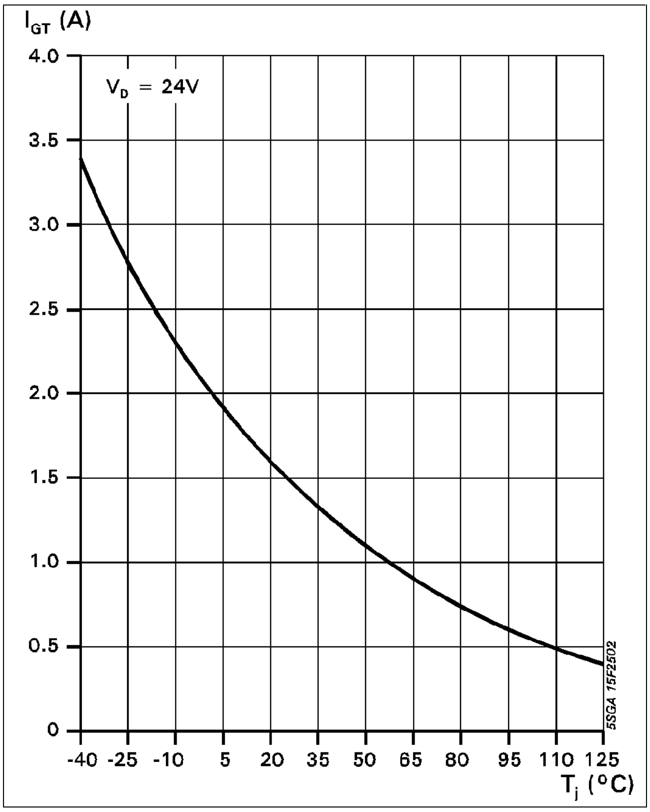


**Fig. 8** Gate trigger current vs. junction temperature

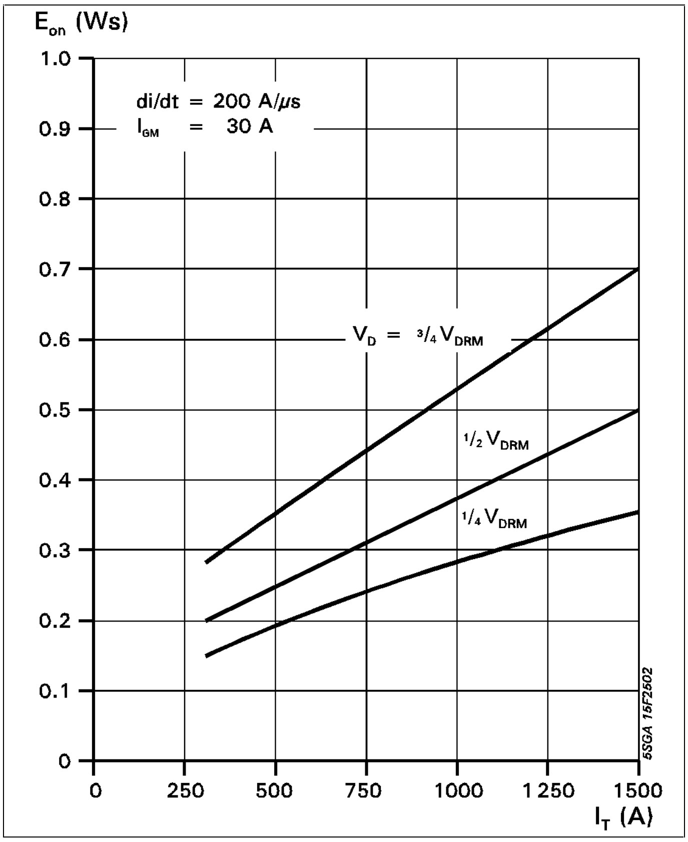


**Fig. 9** Turn-on energy per pulse vs. on-state current and turn-on voltage.

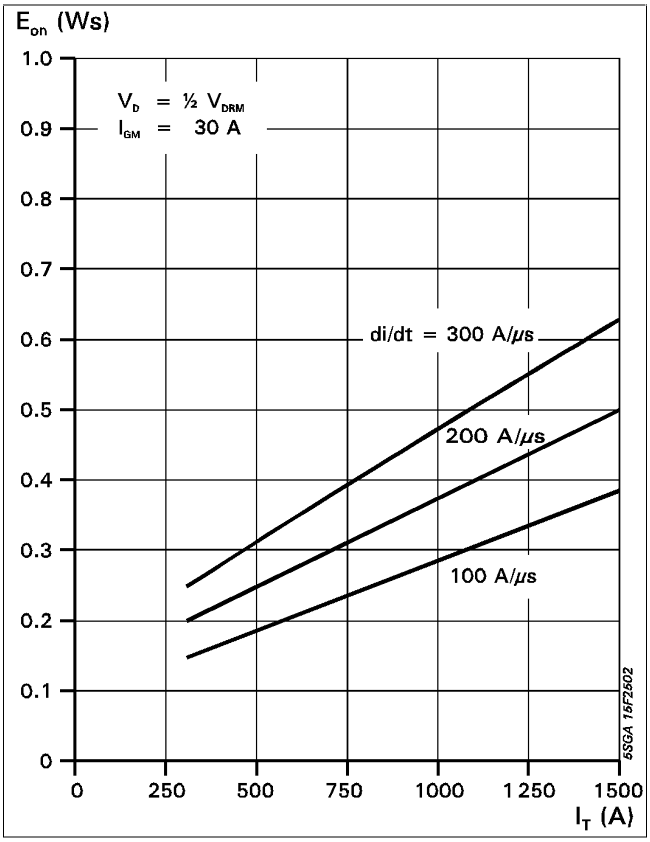


**Fig. 10** Turn-on energy per pulse vs. on.-state current and current rise rate

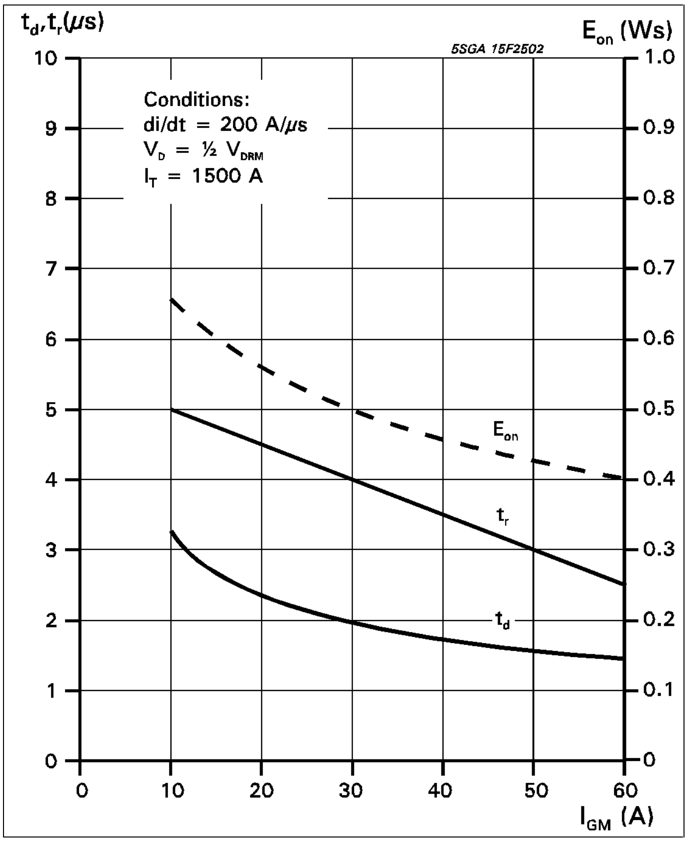


**Fig. 11** Turn-on energy per pulse vs. on-state current and turn-on voltage.

Common Test conditions for figures 9, 10 and 11:

| | |
|---|---|
| $di_G/dt$ | = 20 A/µs |
| $C_S$ | = 3 µF |
| $R_S$ | = 5 Ω |
| Tj | = 125 °C |

Definition of Turn-on energy:

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

Common Test conditions for figures 12, 13 and 15:

Definition of Turn-off energy:

$$E_{off} = \int_0^{40\mu s} V_D \cdot I_T dt \quad (t = 0, I_T = 0.9 \cdot I_{TGQ})$$

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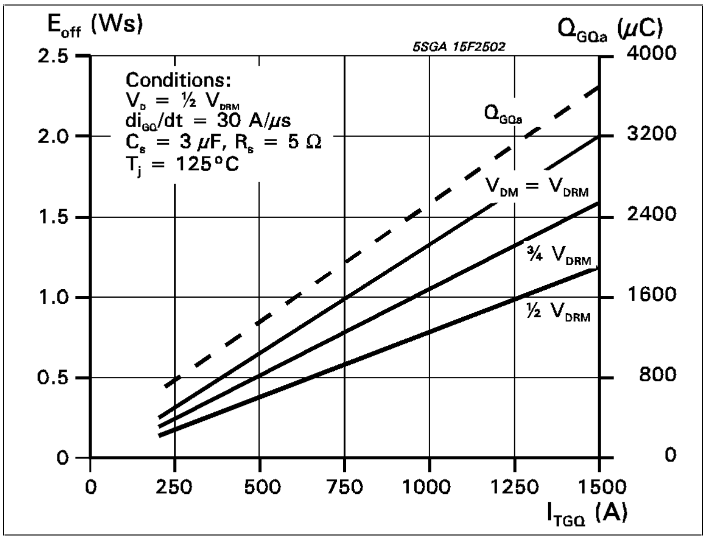


**Fig. 12** Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.

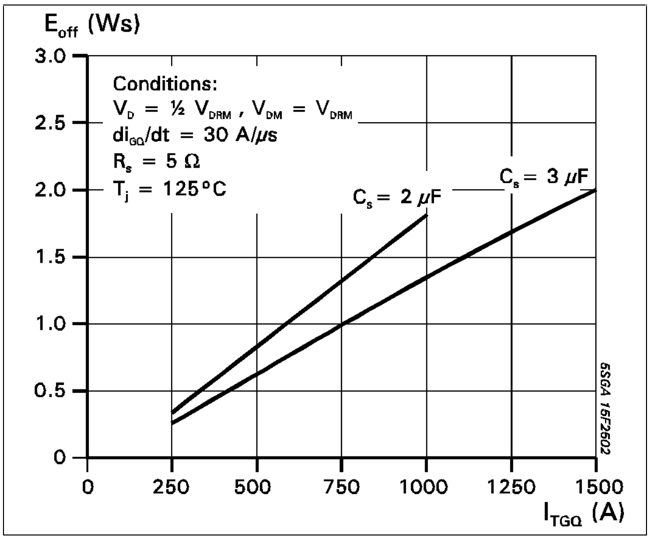


**Fig. 13** Turn-off energy per pulse vs. turn-off current and snubber capacitance.

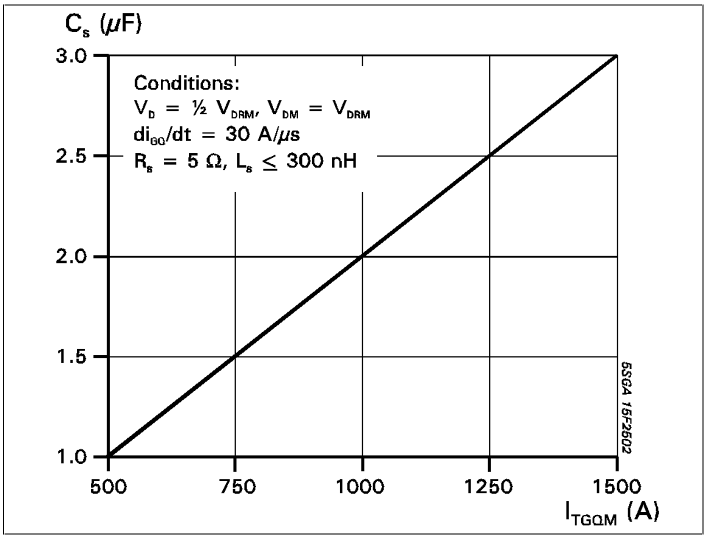


**Fig. 14** Required snubber capacitor vs. max allowable turn-off current.

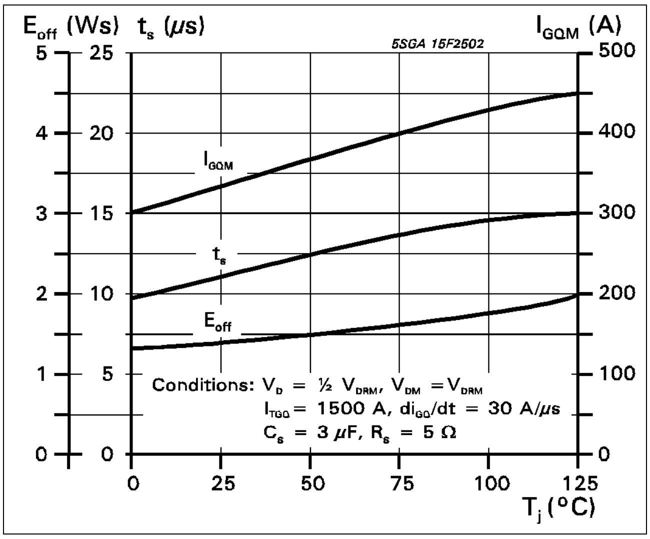


**Fig. 15** Turn-off energy per pulse, storage time and peak turn-off gate current vs. junction temperature

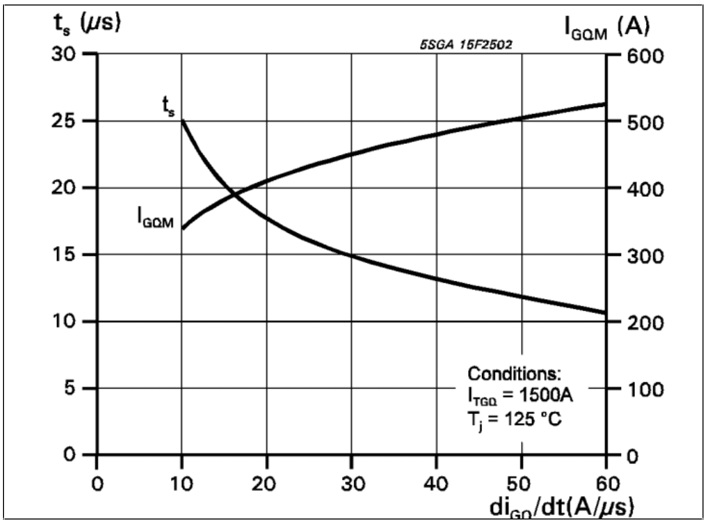


**Fig. 16** Storage time and peak turn-off gate current vs. neg. gate current rise rate.

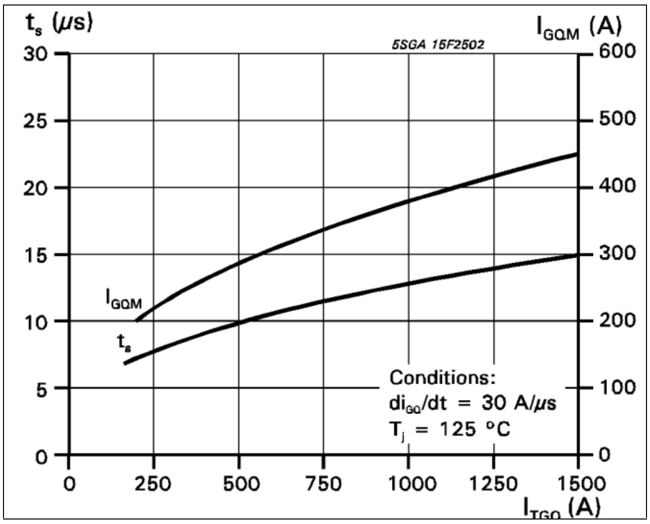


**Fig. 17** Storage time and peak turn-off gate current vs. turn-off current

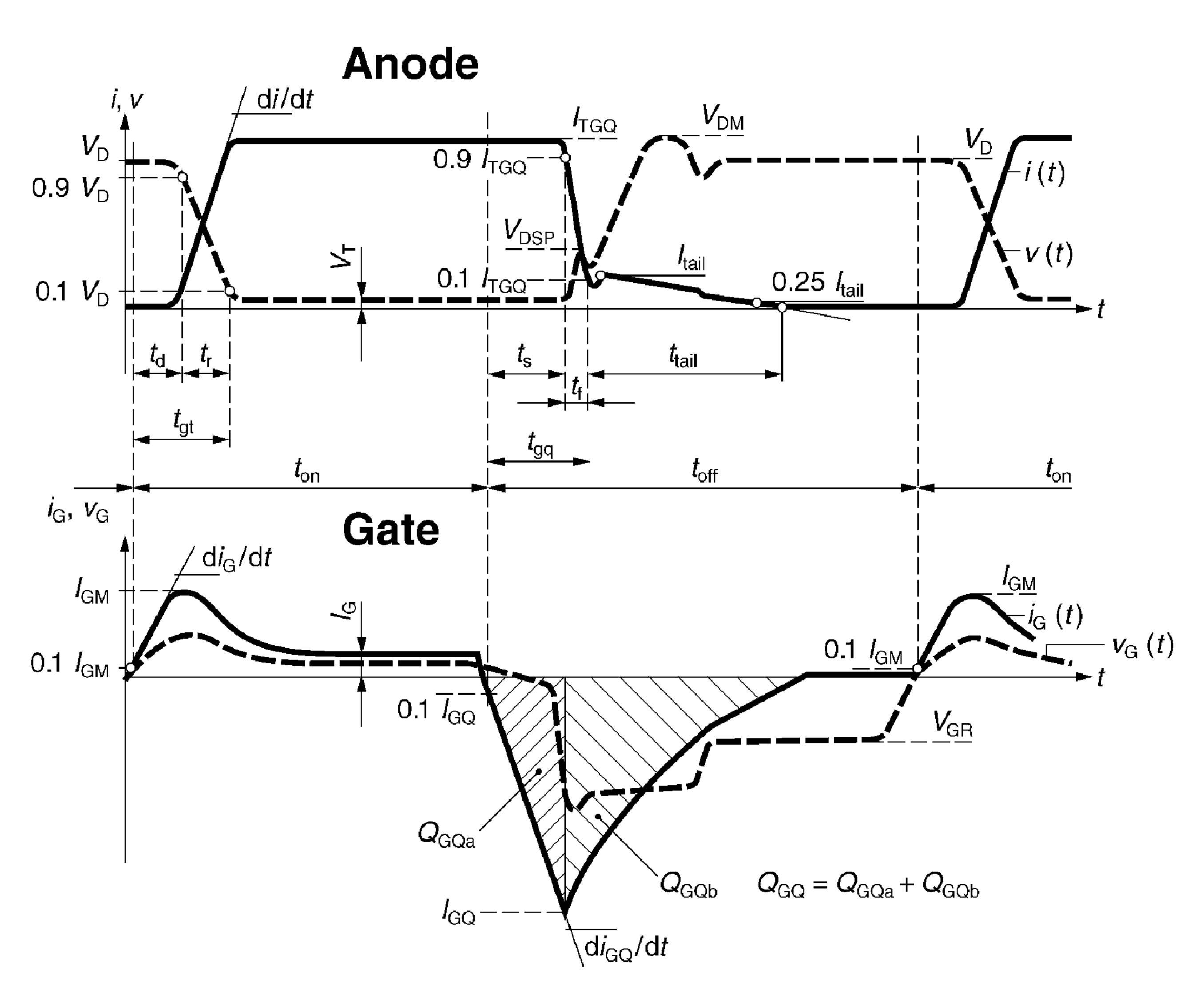


**Fig. 18** General current and voltage waveforms with GTO-specific symbols

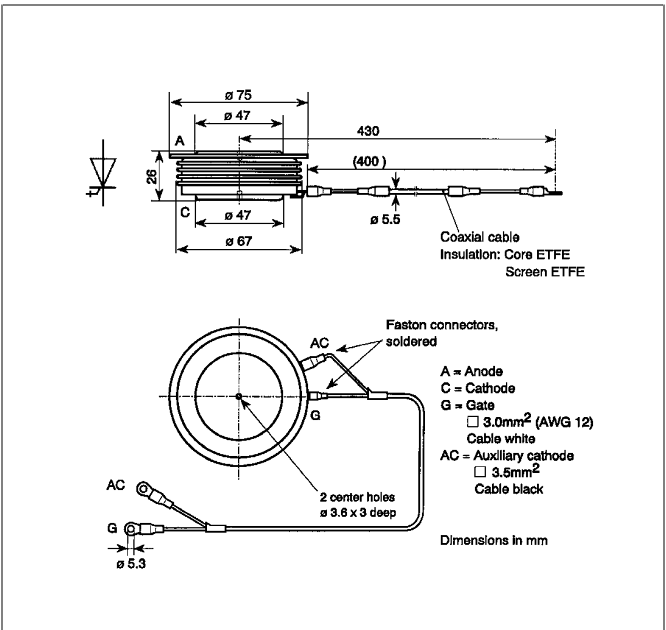


**Fig. 19** Outline drawing. All dimensions are in millimeters and represent nominal values unless stated otherwise.

**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 µs and 1000 A respectively. However, gate voltage must remain negative during this time. Recommendation : $V_{GR}$ = 10… 15 V.



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