

$V_{\text{DRM}} = 4500 \text{ V}$
 $I_{\text{TGQM}} = 4000 \text{ A}$
 $I_{\text{TSM}} = 25 \text{ kA}$
 $V_{\text{T0}} = 1.20 \text{ V}$
 $r_{\text{T}} = 0.65 \text{ m}\Omega$
 $V_{\text{DClin}} = 2800 \text{ V}$

Gate turn-off Thyristor

5SGF 40L4502

Doc. No. 5SYA 1209-03 Aug. 2000

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

The 5SGF 40L4502 is a 91 mm buffered layer GTO with exceptionally low dynamic and static losses designed to retro-fit all former 4 kA GTOs of the same voltage. It offers optimal trade-off between on-state and switching losses and is encapsulated in an industry-standard press pack housing 120 mm wide and 26 mm thick.

Blocking

V_{DRM}	Repetitive peak off-state voltage	4500 V	$V_{\text{GR}} \geq 2\text{V}$
V_{RRM}	Repetitive peak reverse voltage	17 V	
I_{DRM}	Repetitive peak off-state current	$\leq 100 \text{ mA}$	$V_{\text{D}} = V_{\text{DRM}} \quad V_{\text{GR}} \geq 2\text{V}$
I_{RRM}	Repetitive peak reverse current	$\leq 50 \text{ mA}$	$V_{\text{R}} = V_{\text{RRM}} \quad R_{\text{GK}} = \infty$
V_{DClink}	Permanent DC voltage for 100 FIT failure rate	2800 V	$-40 \leq T_{\text{j}} \leq 125 \text{ }^{\circ}\text{C}$. Ambient cosmic radiation at sea level in open air.

Mechanical data (see Fig. 19)

F_{m}	Mounting force	min.	36	kN
		max.	44	kN
A	Acceleration:			
	Device unclamped		50	m/s^2
	Device clamped		200	m/s^2
M	Weight		1.5	kg
D_{S}	Surface creepage distance	$\geq$	33	mm
D_{a}	Air strike distance	$\geq$	14	mm

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GTO Data**On-state**

I _{TAVM}	Max. average on-state current	1180 A	Half sine wave, T _C = 85 °C	
I _{TRMS}	Max. RMS on-state current	1850 A		
I _{TSM}	Max. peak non-repetitive surge current	25 kA	t _P = 10 ms	T _j = 125°C
		40 kA	t _P = 1 ms	After surge:
I ² t	Limiting load integral	3.10·10 ⁶ A ² s	t _P = 10 ms	V _D = V _R = 0V
		0.80·10 ⁶ A ² s	t _P = 1 ms	
V _T	On-state voltage	3.80 V	I _T = 4000 A	T _j = 125 °C
V _{T0}	Threshold voltage	1.20 V	I _T = 400 - 5000 A	
r _T	Slope resistance	0.65 mΩ		
I _H	Holding current	100 A	T _j = 25 °C	

Gate

V_{GT}	Gate trigger voltage	1.2 V	$V_D = 24\text{ V}$ $T_j = 25\text{ }^{\circ}\text{C}$ $R_A = 0.1\text{ }\Omega$
I_{GT}	Gate trigger current	4.0 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	500 A/μs	f = 200Hz	I _T = 4000 A, T _j = 125 °C		
		1000 A/μs	f = 1Hz	I _{GM} = 50 A, di _G /dt = 40 A/μs		
t _d	Delay time	2.5 μs	V _D = 0.5 V _{DRM} T _j = 125 °C I _T = 4000 A di/dt = 300 A/μs I _{GM} = 50 A di _G /dt = 40 A/μs C _S = 6 μF R _S = 5 Ω			
t _r	Rise time	5.0 μs				
t _{on(min)}	Min. on-time	100 μs				
E _{on}	Turn-on energy per pulse	3.00 Ws				

Turn-off switching

I_{TGQM}	Max controllable turn-off current	4000 A	$V_{DM} = V_{DRM}$ $di_{GQ}/dt = 40\text{ A}/\mu\text{s}$ $C_S = 6\text{ }\mu\text{F}$ $L_S \leq 0.2\text{ }\mu\text{H}$	
t_s	Storage time	25.0 μs	$V_D = \frac{1}{2} V_{DRM}$ $V_{DM} = V_{DRM}$ $T_j = 125\text{ }^{\circ}\text{C}$ $di_{GQ}/dt = 40\text{ A}/\mu\text{s}$ $I_{TGQ} = I_{TGQM}$ $C_S = 6\text{ }\mu\text{F}$ $R_S = 5\text{ }\Omega$ $L_S \leq 0.2\text{ }\mu\text{H}$	
t_f	Fall time	3.0 μs		
$t_{off(min)}$	Min. off-time	100 μs		
E_{off}	Turn-off energy per pulse	10.0 Ws		
I_{GQM}	Peak turn-off gate current	1000 A		

Thermal

T_j	Storage and operating junction temperature range	-40...125°C	
R_{thJC}	Thermal resistance junction to case	20 K/kW	Anode side cooled
		25 K/kW	Cathode side cooled
		11 K/kW	Double side cooled
R_{thCH}	Thermal resistance case to heat sink	6 K/kW	Single side cooled
		3 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)	6.89	3.49	0.61	0.0001
τ_i (s)	2.01	0.26	0.003	0.0001

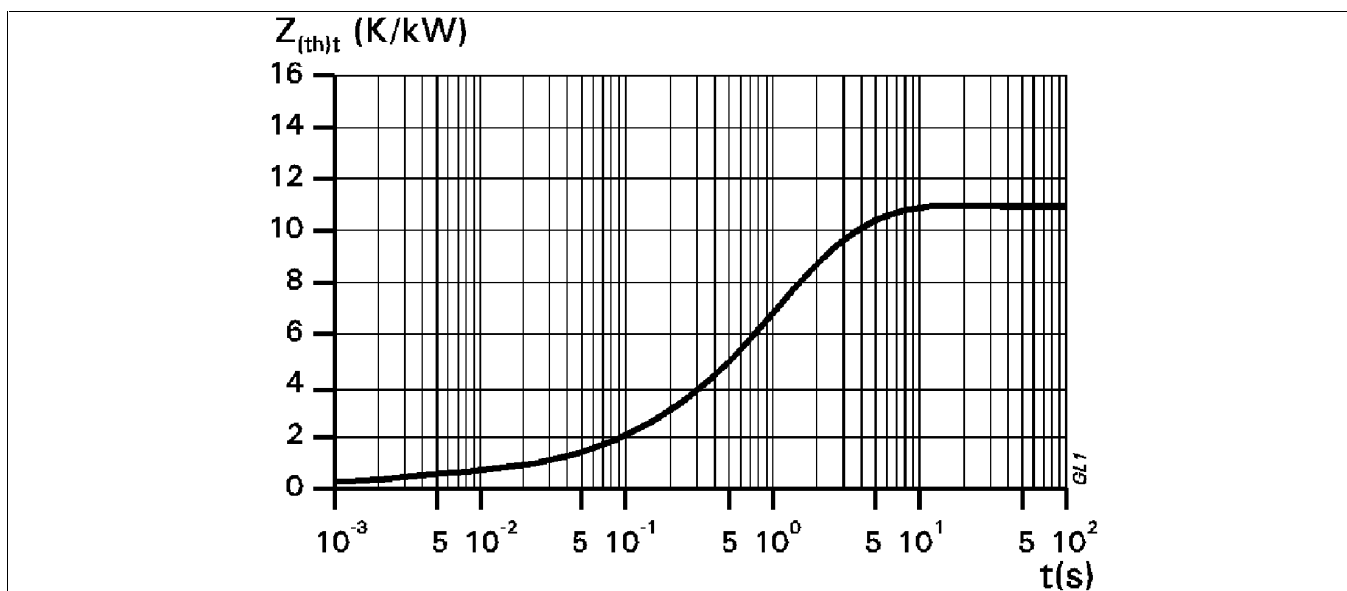


Fig. 1 Transient thermal impedance, junction to case.

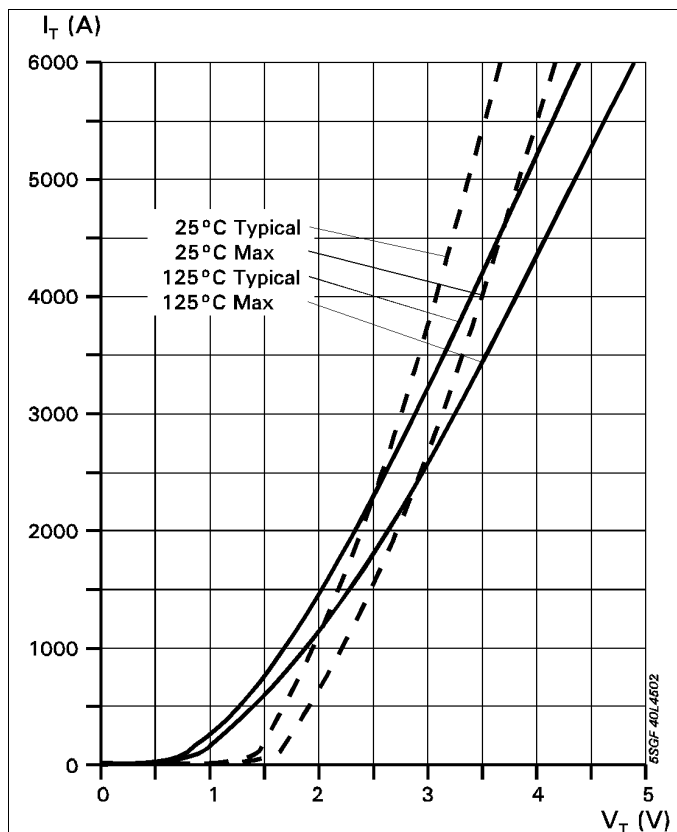


Fig. 2 On-state characteristics

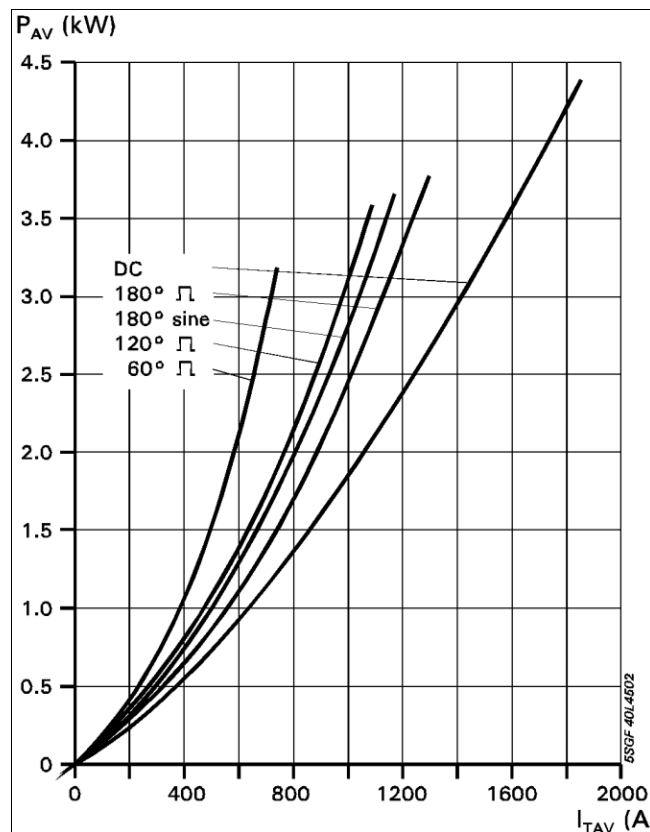


Fig. 3 Average on-state power dissipation vs. average on-state current.

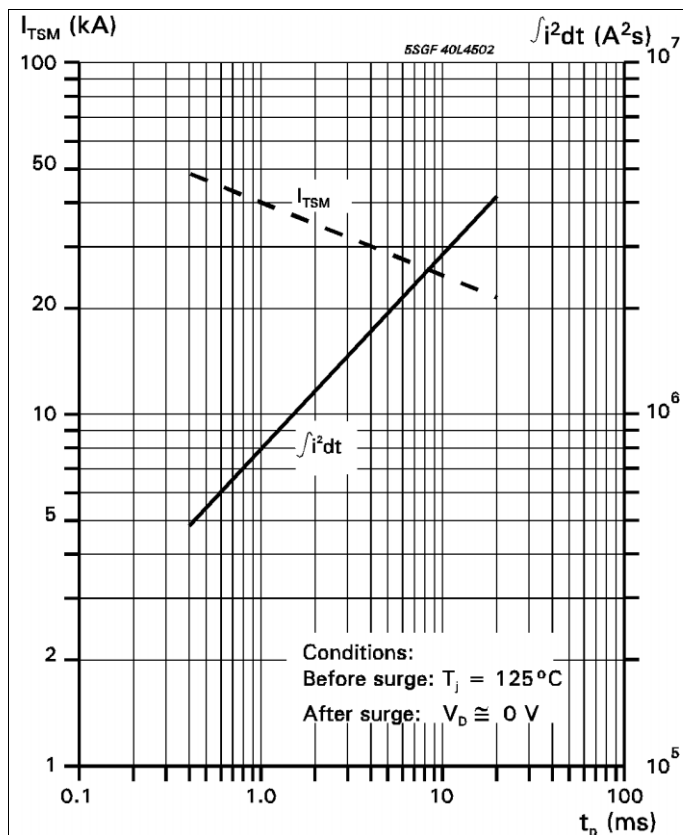


Fig. 4 Surge current and fusing integral vs. pulse width

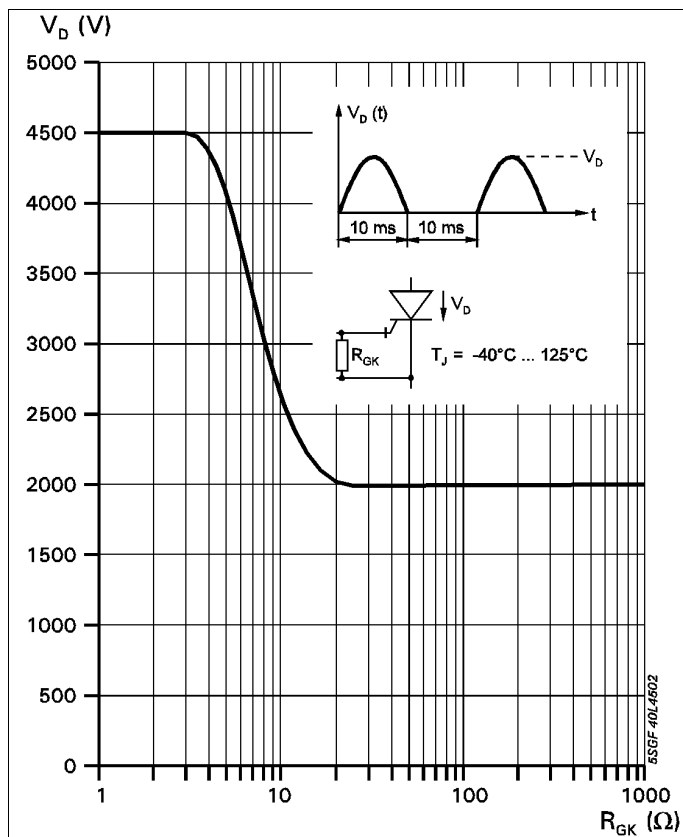


Fig. 5 Forward blocking voltage vs. gate-cathode resistance.

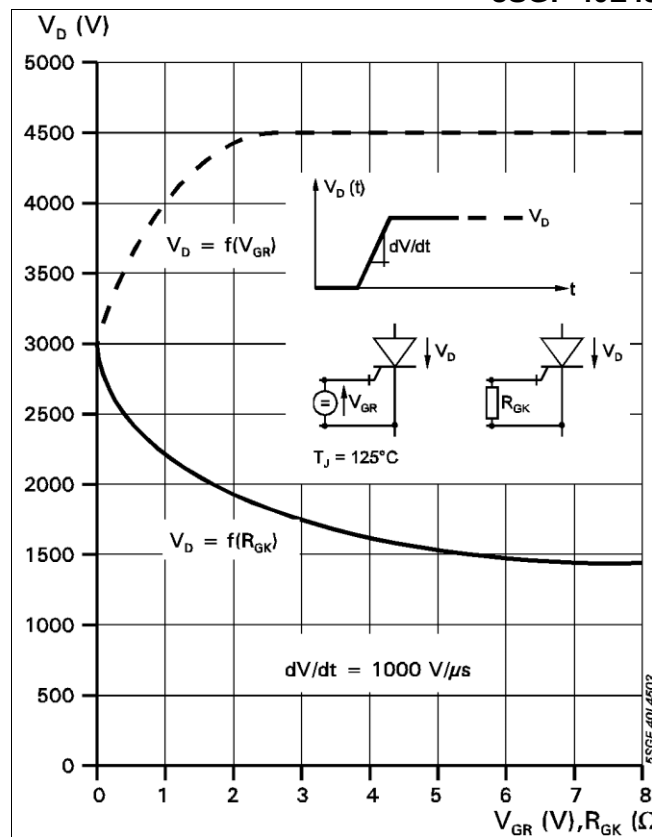


Fig. 6 Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.

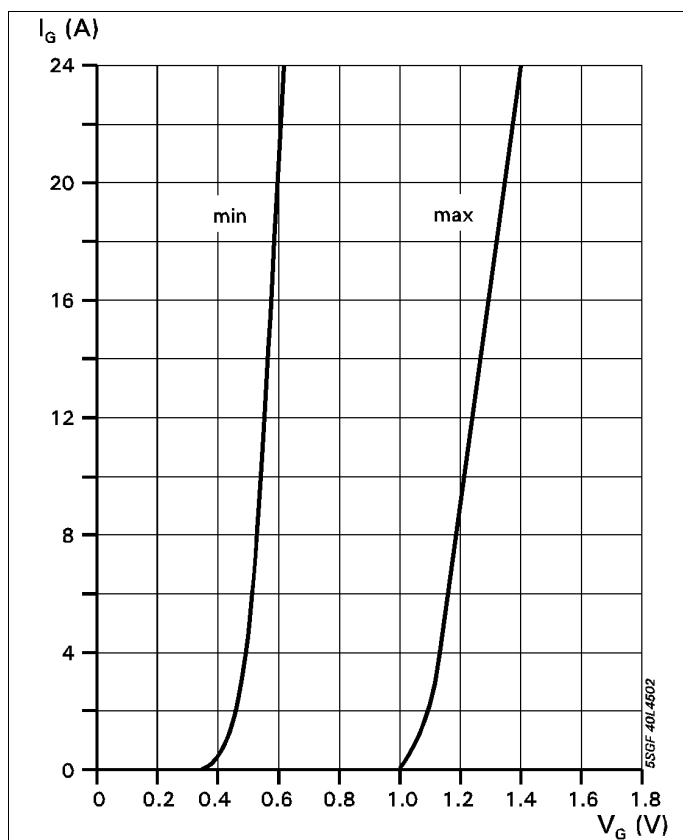


Fig. 7 Forward gate current vs. forward gate voltage.

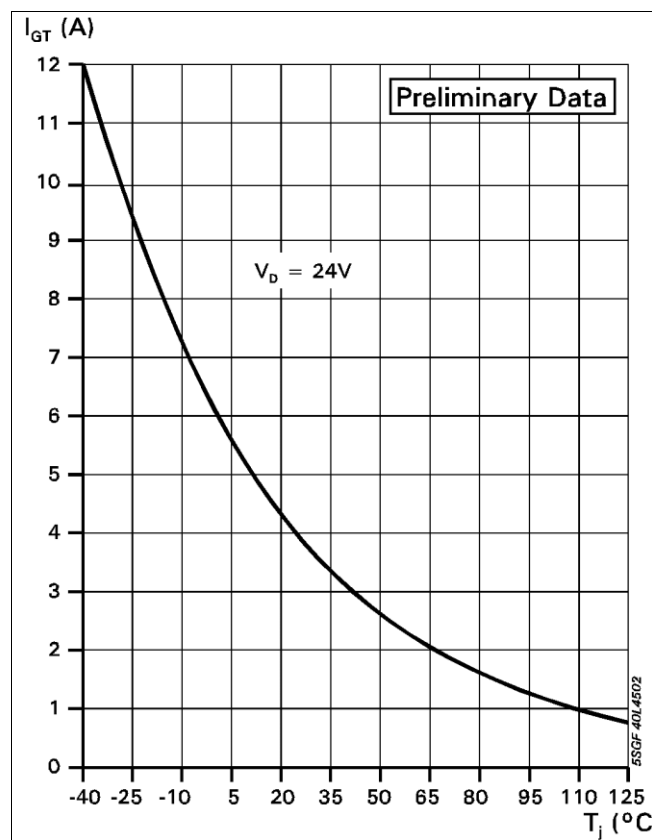


Fig. 8 Gate trigger current vs. junction temperature

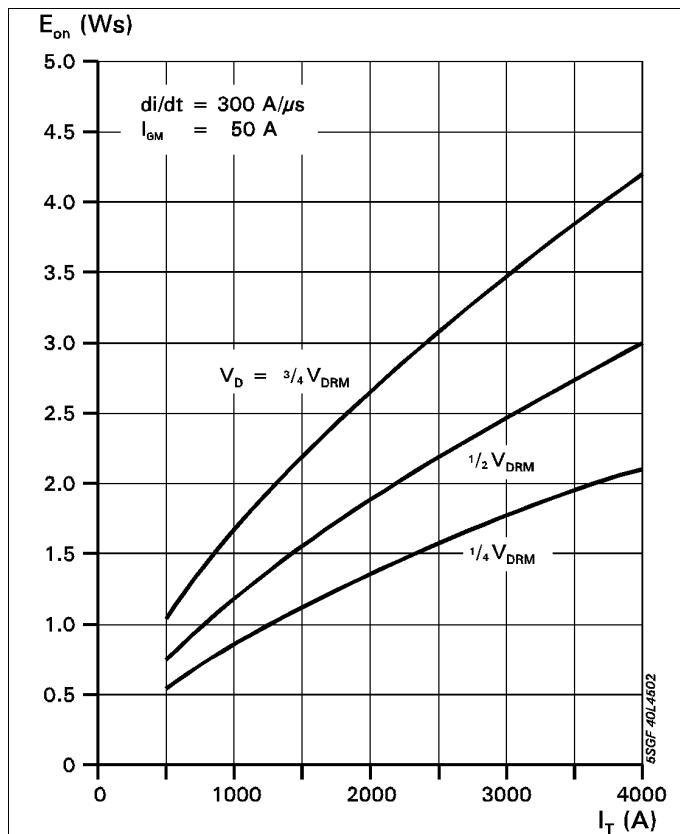


Fig. 9 Turn-on energy per pulse vs. on-state current and turn-on voltage.

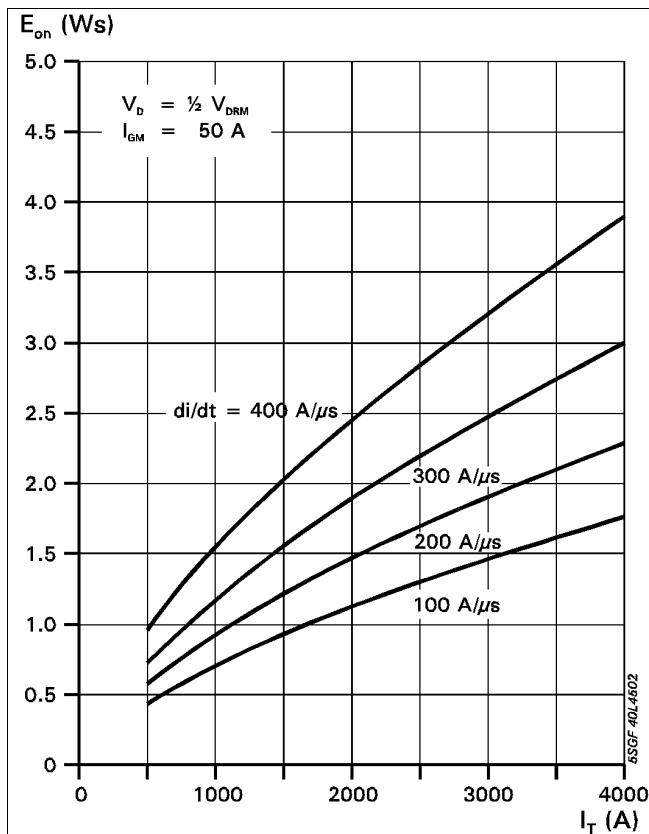


Fig. 10 Turn-on energy per pulse vs. on-state current and current rise rate

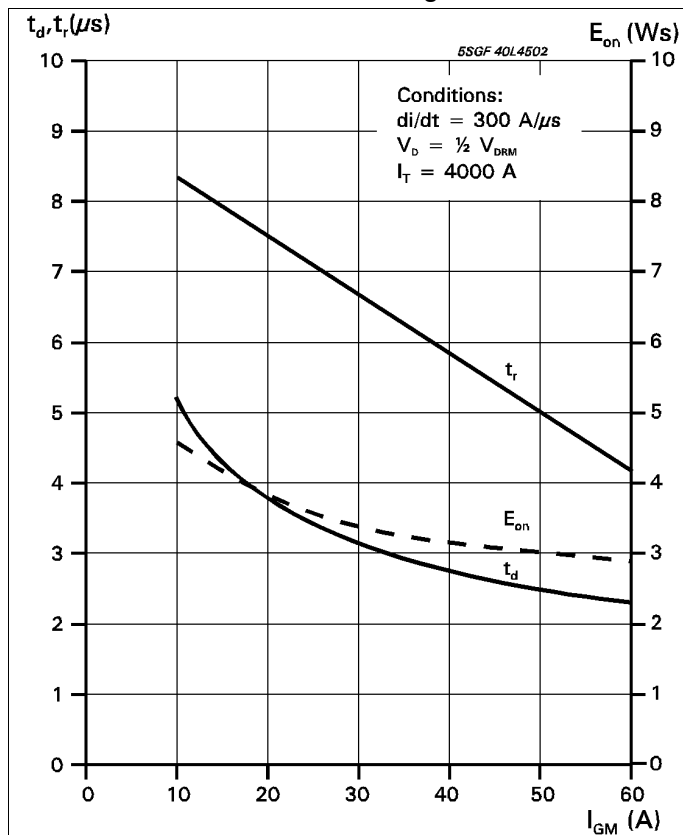


Fig. 11 Turn-on energy per pulse vs. on-state current and turn-on voltage.

Common Test conditions for figures 9, 10 and 11:

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

Definition of Turn-on energy:

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

Common Test conditions for figures 12, 13 and 15:

Definition of Turn-off energy:

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

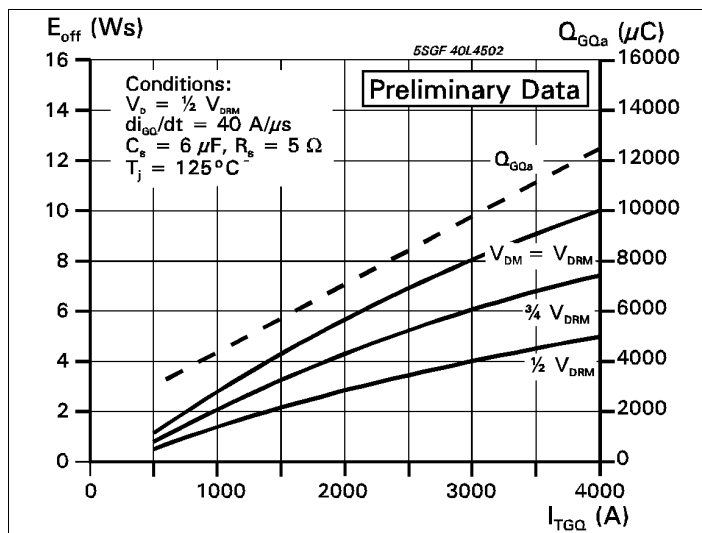


Fig. 12 Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.

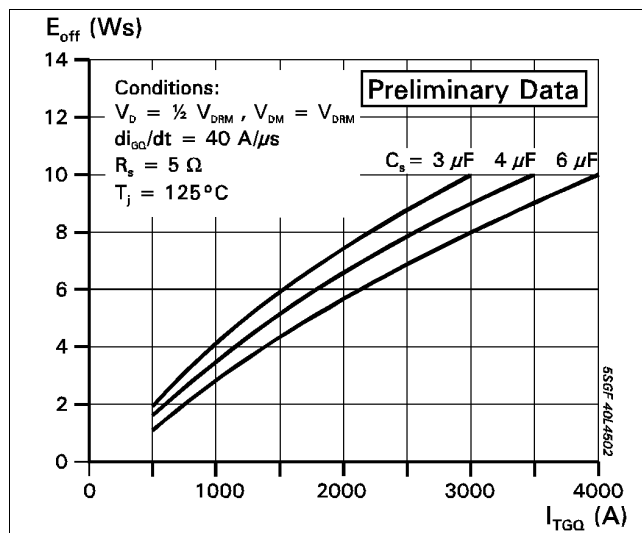


Fig. 13 Turn-off energy per pulse vs. turn-off current and snubber capacitance.

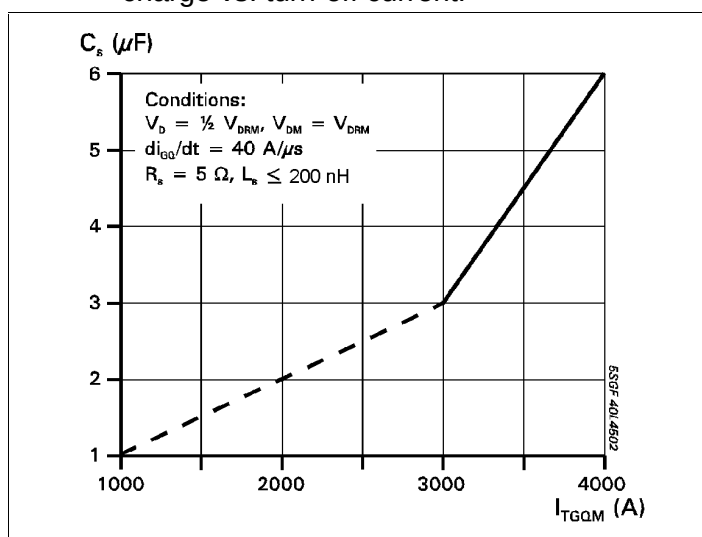


Fig. 14 Required snubber capacitor vs. max allowable turn-off current.

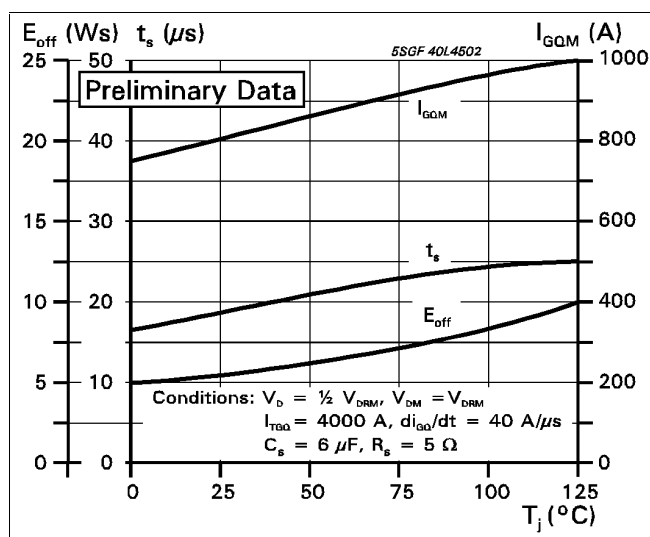


Fig. 15 Turn-off energy per pulse, storage time and peak turn-off gate current vs. junction temperature

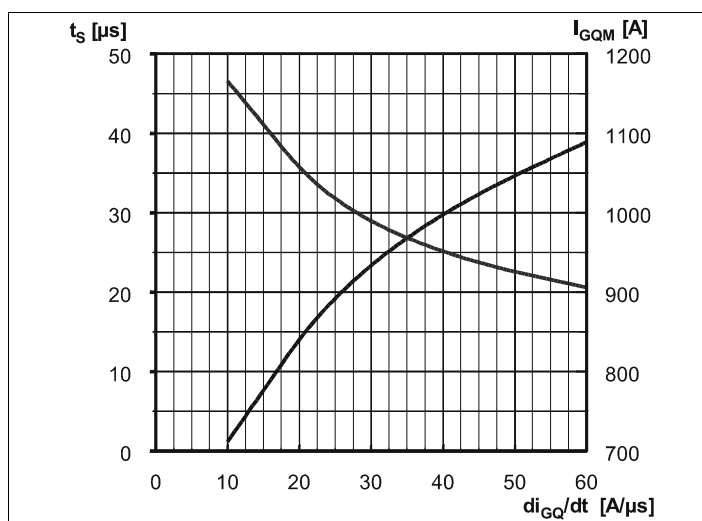


Fig. 16 Storage time and peak turn-off gate current vs. neg. gate current rise rate.

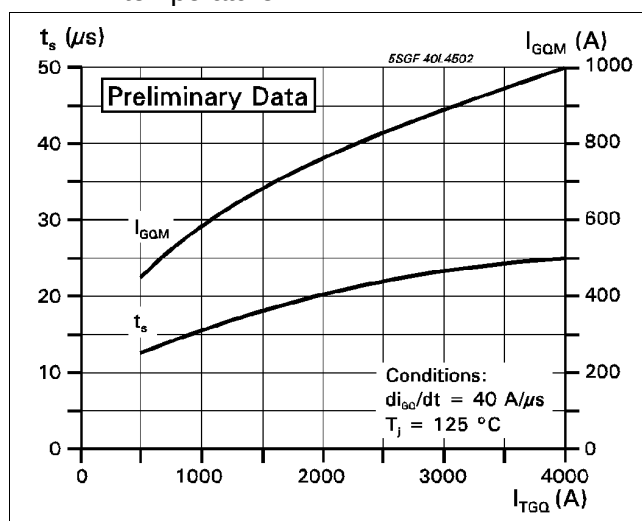


Fig. 17 Storage time and peak turn-off gate current vs. turn-off current

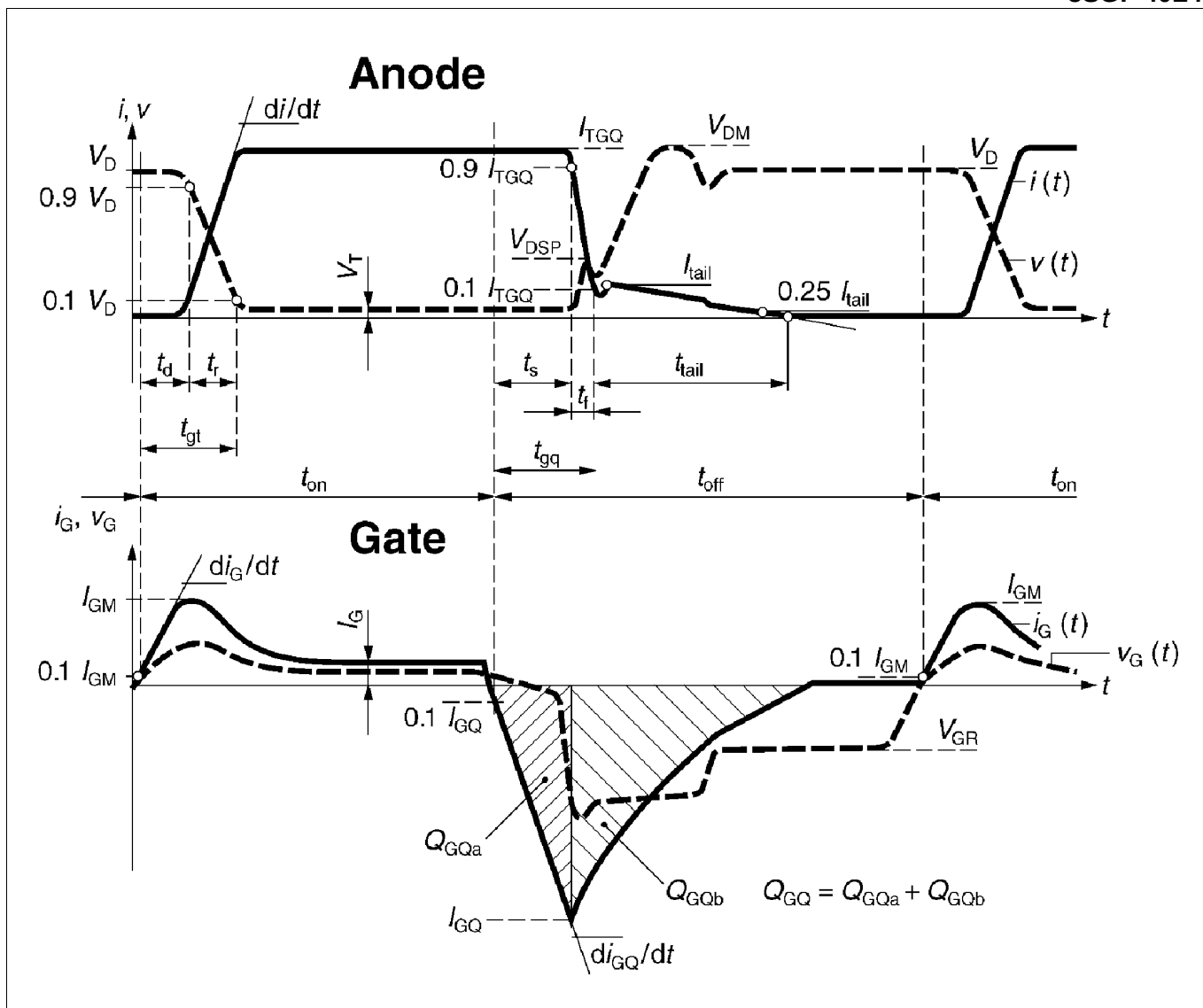


Fig. 18 General current and voltage waveforms with GTO-specific symbols

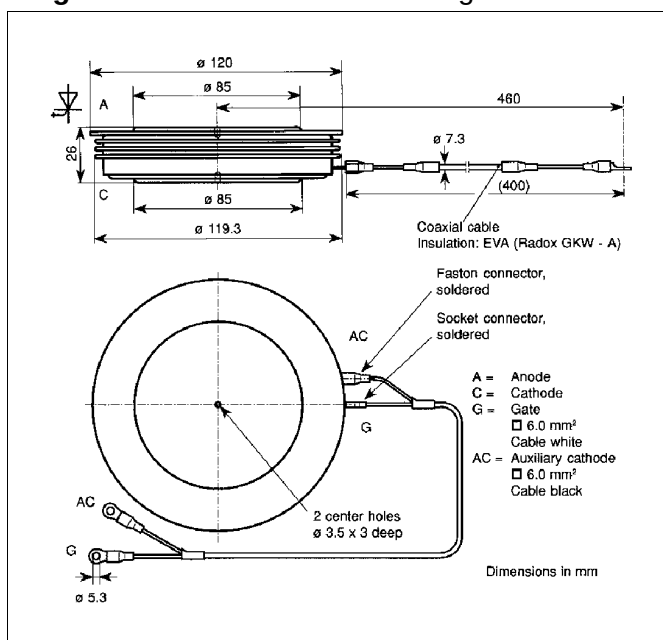


Fig. 19 Outline drawing. All dimensions are in millimeters and represent nominal values unless stated otherwise.

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 : $V_{GR} = 10 \dots 15 \text{ V}$.

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