V_{DRM}	=	4500 V
I_{TGQM}	=	4000 A
I_{TSM}	=	25×10^3 A
V_{T0}	=	1.2 V
r_T	=	0.65 mΩ
V_{Dclink}	=	2800 V

Asymmetric Gate turn-off Thyristor

5SGF 40L4502

Doc. No. 5SYA1209-04 Jan. 03

- **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 [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Repetitive peak off-state voltage	V_{DRM}	$V_{GR} \geq 2$ V			4500	V
Repetitive peak reverse voltage	V_{RRM}				17	V
Permanent DC voltage for 100 FIT failure rate	V_{Dclink}	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_{DRM}	$V_D = V_{DRM}$, $V_{GR} \geq 2$ V			100	mA
Repetitive peak reverse current	I_{RRM}	$V_R = V_{RRM}$, $R_{GK} = \infty\ \Omega$			50	mA

Mechanical data

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Mounting force	F_m		36	40	44	kN

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Pole-piece diameter	D_p	± 0.1 mm		75		mm
Housing thickness	H	± 0.5 mm		26		mm
Weight	m			1.5		kg
Surface creepage distance	D_s	Anode to Gate	33			mm
Air strike distance	D_a	Anode to Gate	14			mm

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

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GTO Data

On-state

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. average on-state current	I_{TAVM}	Half sine wave, T_C = 85 °C			1180	A
Max. RMS on-state current	I_{TRMS}				1850	A
Max. peak non-repetitive surge current	I_{TSM}	t_p = 10 ms, T_{vj} = 125°C, sine wave After Surge: $V_D = V_R$ = 0 V			25×10^3	A
Limiting load integral	I^2t				3.1×10^6	A^2s
Max. peak non-repetitive surge current	I_{TSM}	t_p = 1 ms, T_{vj} = 125°C, sine wave After Surge: $V_D = V_R$ = 0 V			40×10^3	A
Limiting load integral	I^2t				800×10^3	A^2s

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	V_T	I_T = 4000 A, T_{vj} = 125°C			3.8	V
Threshold voltage	$V_{(T0)}$	T_{vj} = 125°C I_T = 400...5000 A			1.2	V
Slope resistance	r_T				0.65	mΩ
Holding current	I_H	T_{vj} = 25°C			100	A

Turn-on switching

Maximum rated values [1)]

Parameter	Symbol	Conditions		min	typ	max	Unit
Critical rate of rise of on-state current	di_T/dt_{cr}	T_{vj} = 125°C, I_T = 4000 A, I_{GM} = 50 A, di_G/dt = 40 A/µs	f = 200 Hz			500	A/µs
Critical rate of rise of on-state current	di_T/dt_{cr}		f = 1 Hz			1000	A/µs
Min. on-time	t_{on}			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 °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			2.5	µs
Rise time	t_r				5	µs
Turn-on energy per pulse	E_{on}				3	J

Turn-off switching

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. controllable turn-off current	I_{TGQM}	$V_{DM} \le V_{DRM}$, di_{GQ}/dt = 40 A/µs, C_S = 6 µF, $L_S \le$ 0.2 µH			4000	A
Min. off-time	t_{off}		100			µs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Storage time	t_S	V_D = 0.5 V_{DRM}, T_{vj} = 125 °C $V_{DM} \le V_{DRM}$, di_{GQ}/dt = 40 A/µs, $I_{TGQ} = I_{TGQM}$, R_S = 5Ω, C_S = 6 µF, L_S = 0.2 µH			25	µs
Fall time	t_f				3	µs
Turn-on energy per pulse	E_{off}				10	J
Peak turn-off gate current	I_{GQM}				1100	A

Gate

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Repetetive peak reverse voltage	V_{GRM}				17	V
Repetetive peak reverse current	I_{GRM}	$V_{GR} = V_{GRM}$			20	mA

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Gate trigger voltage	V_{GT}	T_{vj} = 25°C, V_D = 24 V, R_A = 0.1 Ω		1.2		V
Gate trigger current	I_{GT}			4		A

Thermal

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Junction operating temperature	T_{vj}		-40		125	°C
Storage temperature range	T_{stg}		-40		125	°C

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Thermal resistance junction to case	$R_{th(jc)}$	Double side cooled			11	K/kW
	$R_{th(jc)A}$	Anode side cooled			20	K/kW
	$R_{th(jc)C}$	Cathode side cooled			25	K/kW
Thermal resistance case to heatsink (Double side cooled)	$R_{th(ch)}$	Single side cooled			6	K/kW
	$R_{th(ch)}$	Double 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)	7.766	1.728	1.064	0.450
τ_i(s)	0.5764	0.1258	0.0128	0.0031

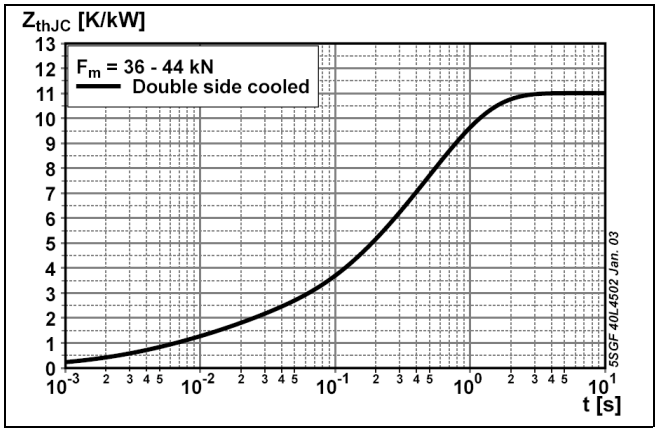

Fig. 1 Transient thermal impedance, junction to case.

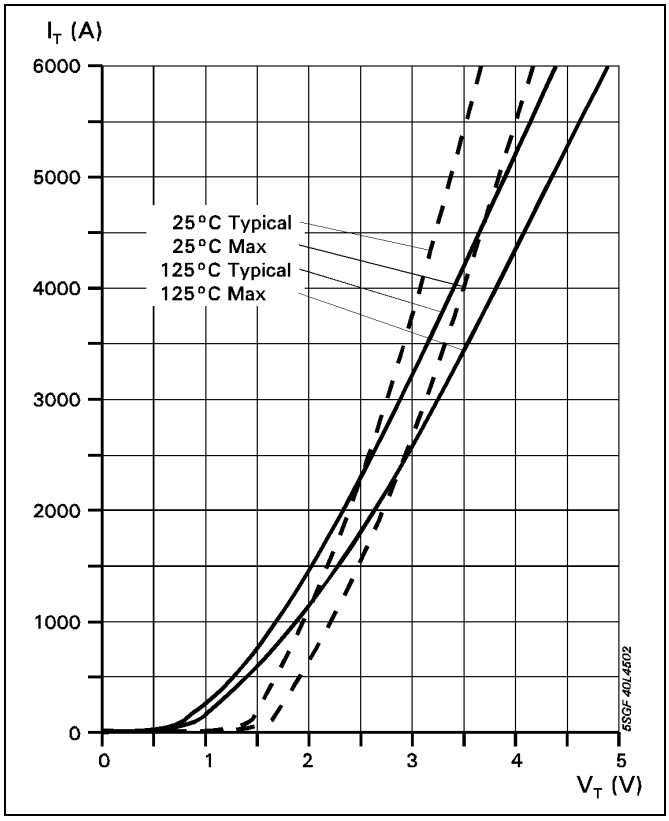

Fig. 2 On-state characteristics.

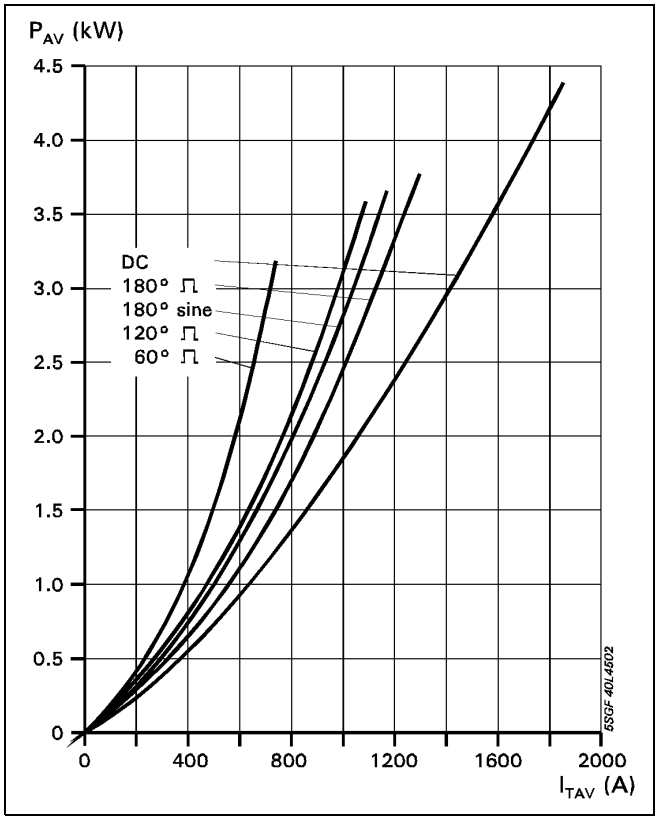

Fig. 3 Average on-state power dissipation vs. average on-state current.

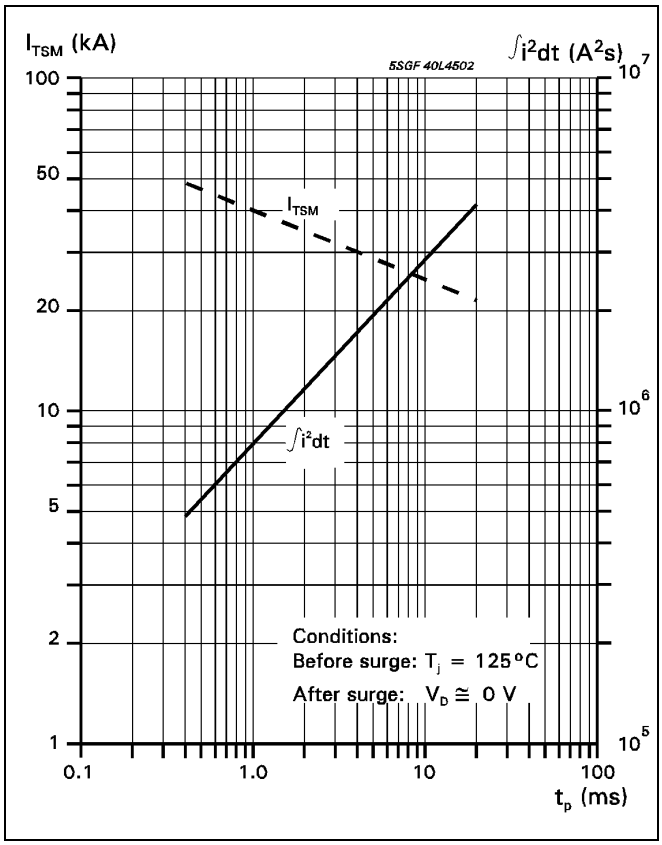

Fig. 4 Surge current and fusing integral vs. pulse width.

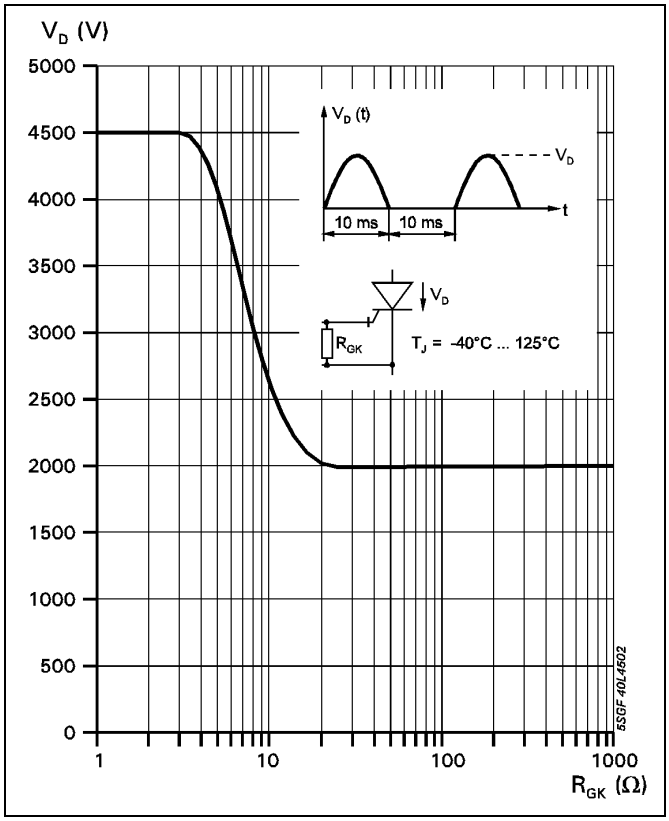

Fig. 5 Forward blocking voltage vs. gate-cathode resistance.

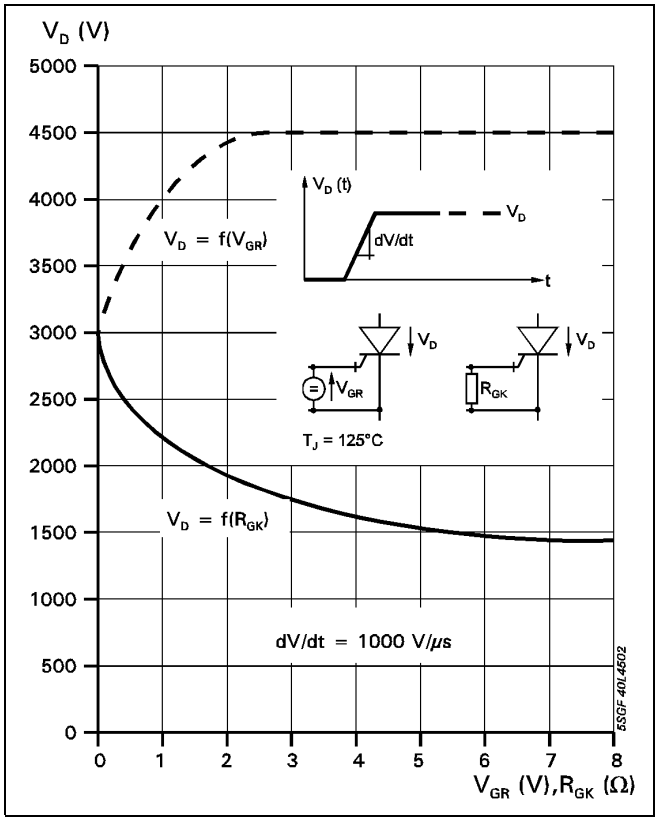

Fig. 6 Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.

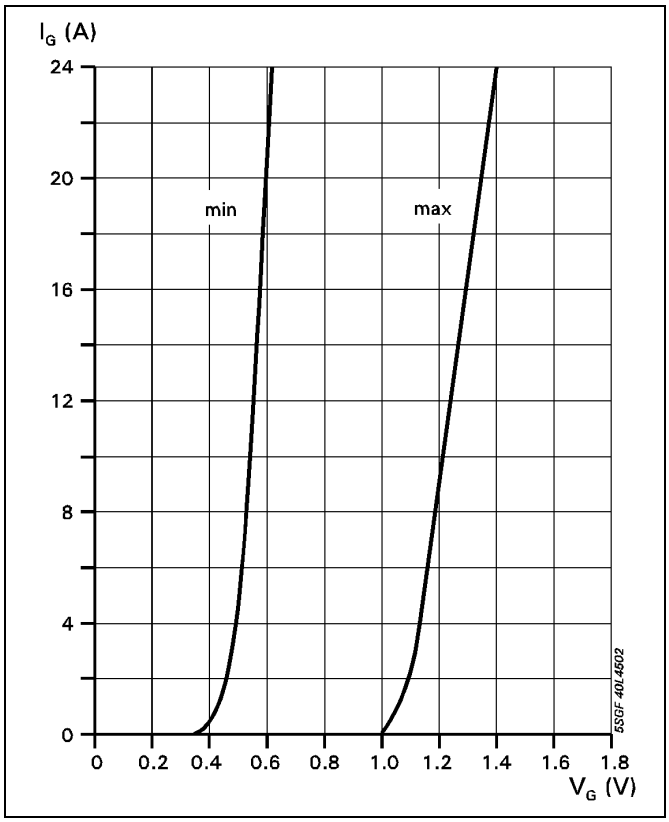

Fig. 7 Forward gate current vs. forard gate voltage.

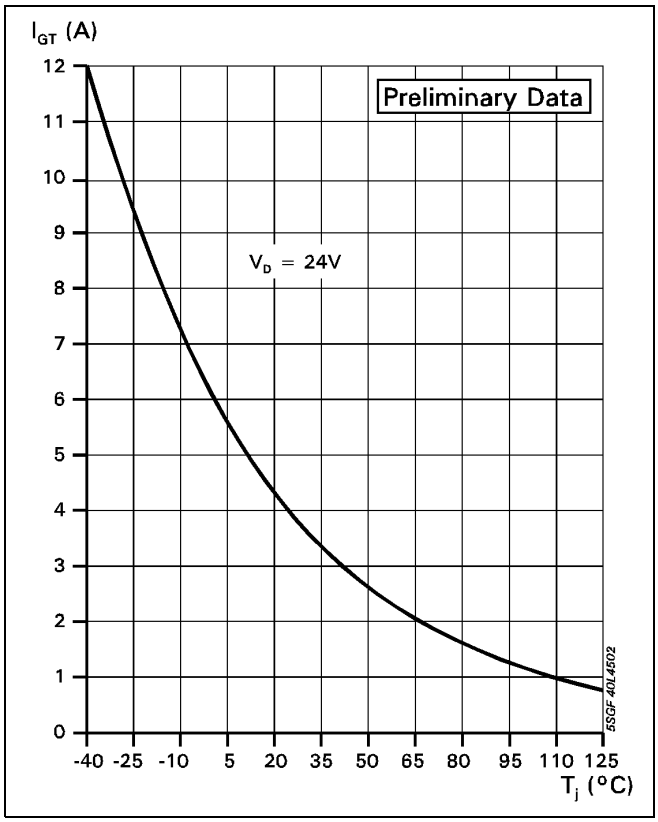

Fig. 8 Gate trigger current vs. junction temperature

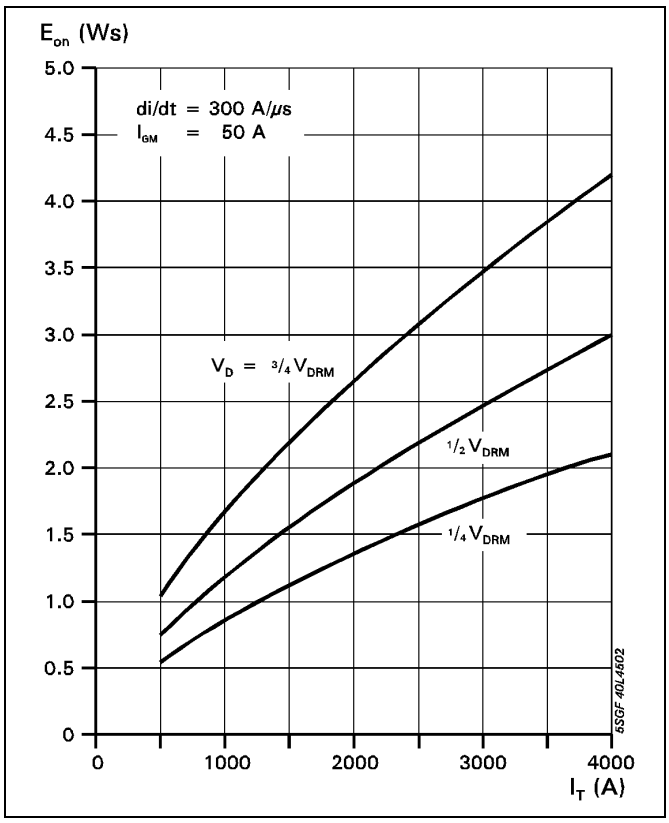

Fig. 9 Turn-on energy per pulse vs. on-state current and turn-on voltage.

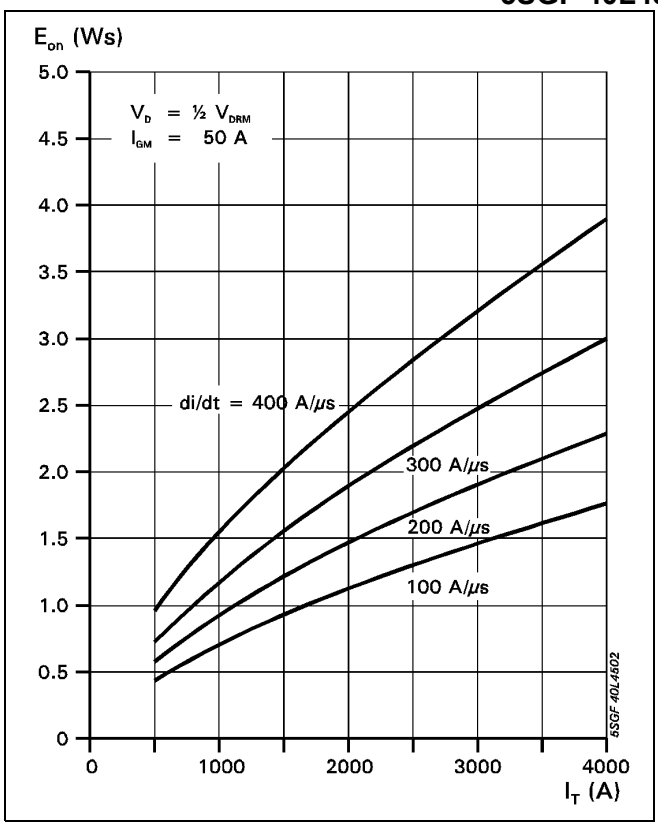

Fig. 10 Turn-on energy per pulse vs. on.-state current and current rise rate

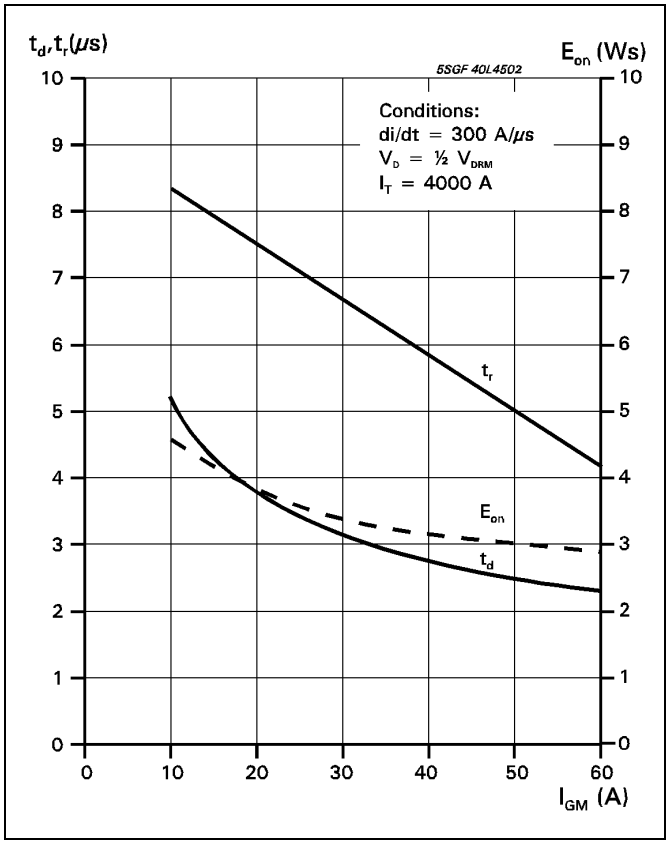

Fig. 11 Turn-on energy per pulse vs. on-state current and turn-on voltage.

Common Test conditions for figures 9, 10 and 11:

di_G/dt	= 40 A/µs
C_S	= 6 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:

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

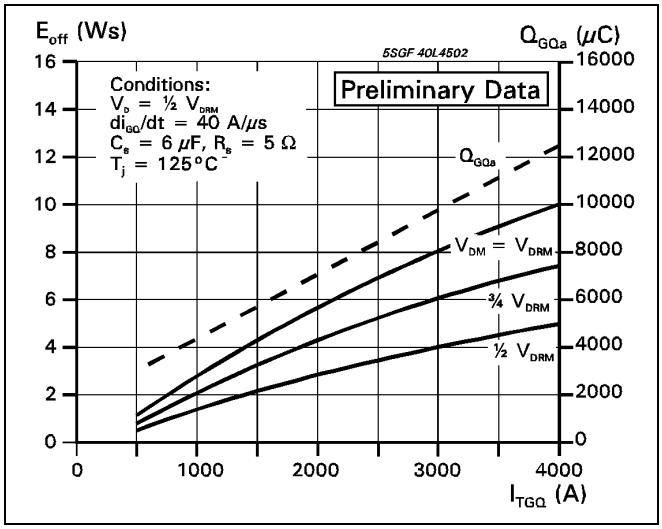

Fig. 12 Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.

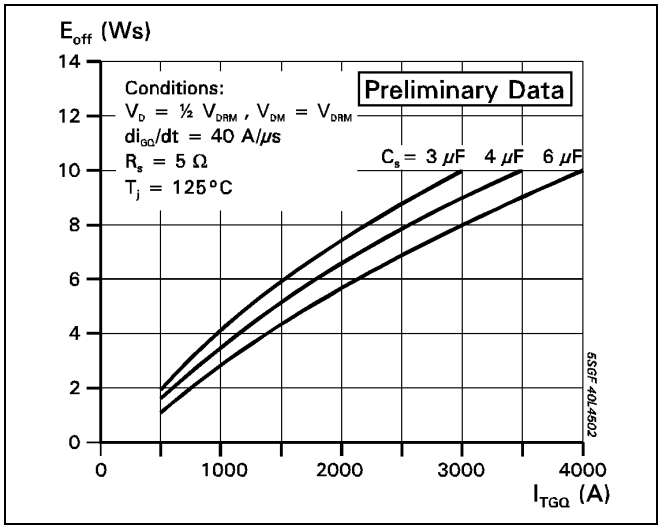

Fig. 13 Turn-off energy per pulse vs. turn-off current and snubber capacitance.

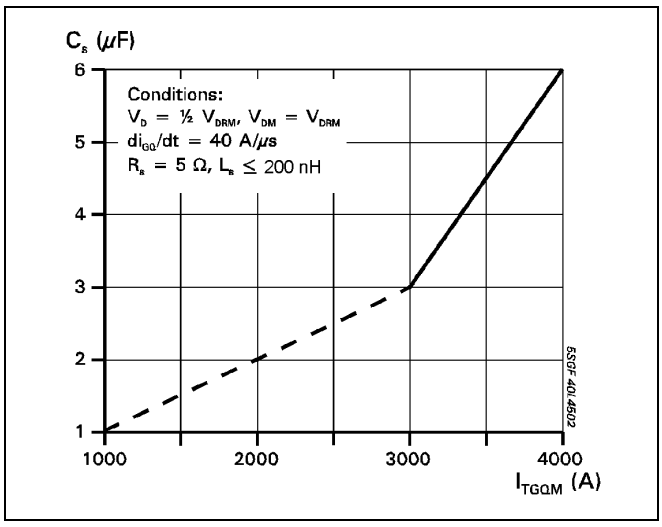

Fig. 14 Required snubber capacitor vs. max allowable turn-off current.

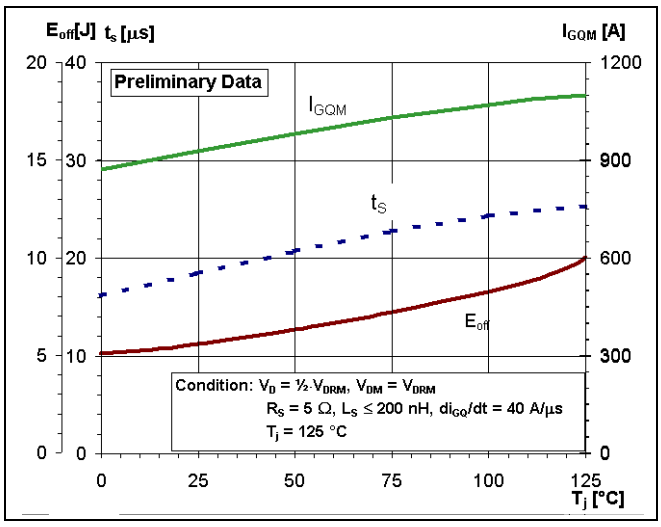

Fig. 15 Turn-off energy per pulse, storage time and peak turn-off gate current vs. junction temperature.

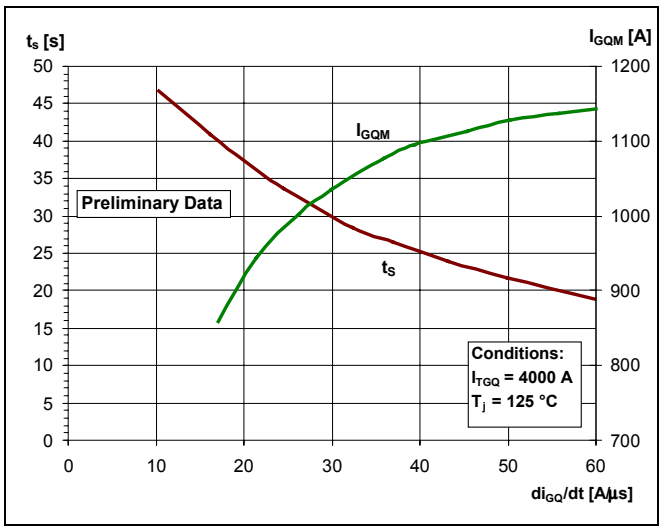

Fig. 16 Storage time and peak turn-off gate current vs. neg. gate current rise rate.

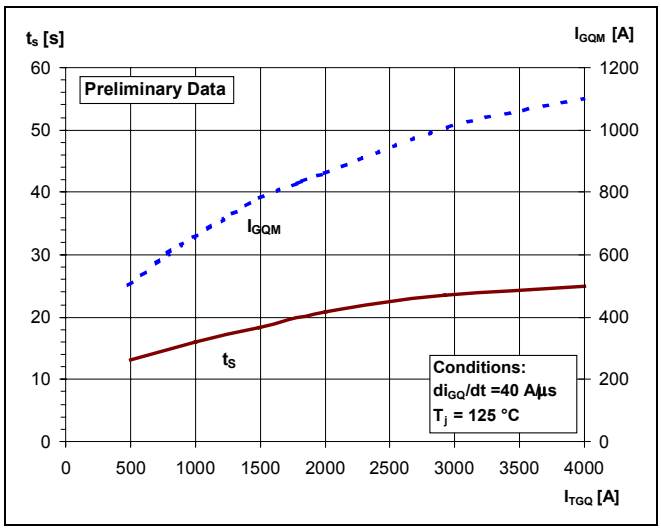

Fig. 17 Storage time and peak turn-off gate current vs. turn-off current.

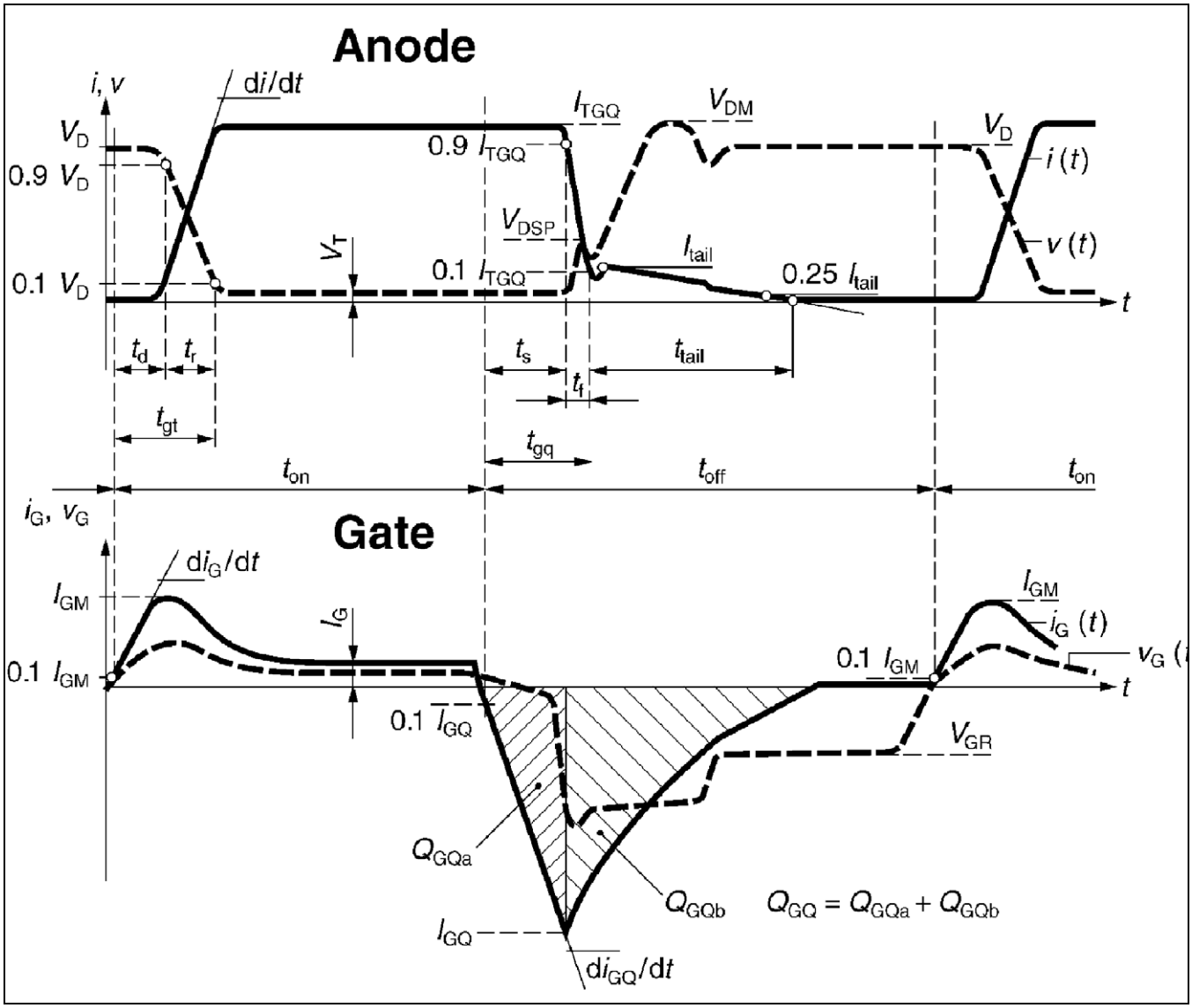

Fig. 18 General current and voltage waveforms with GTO-specific symbols.

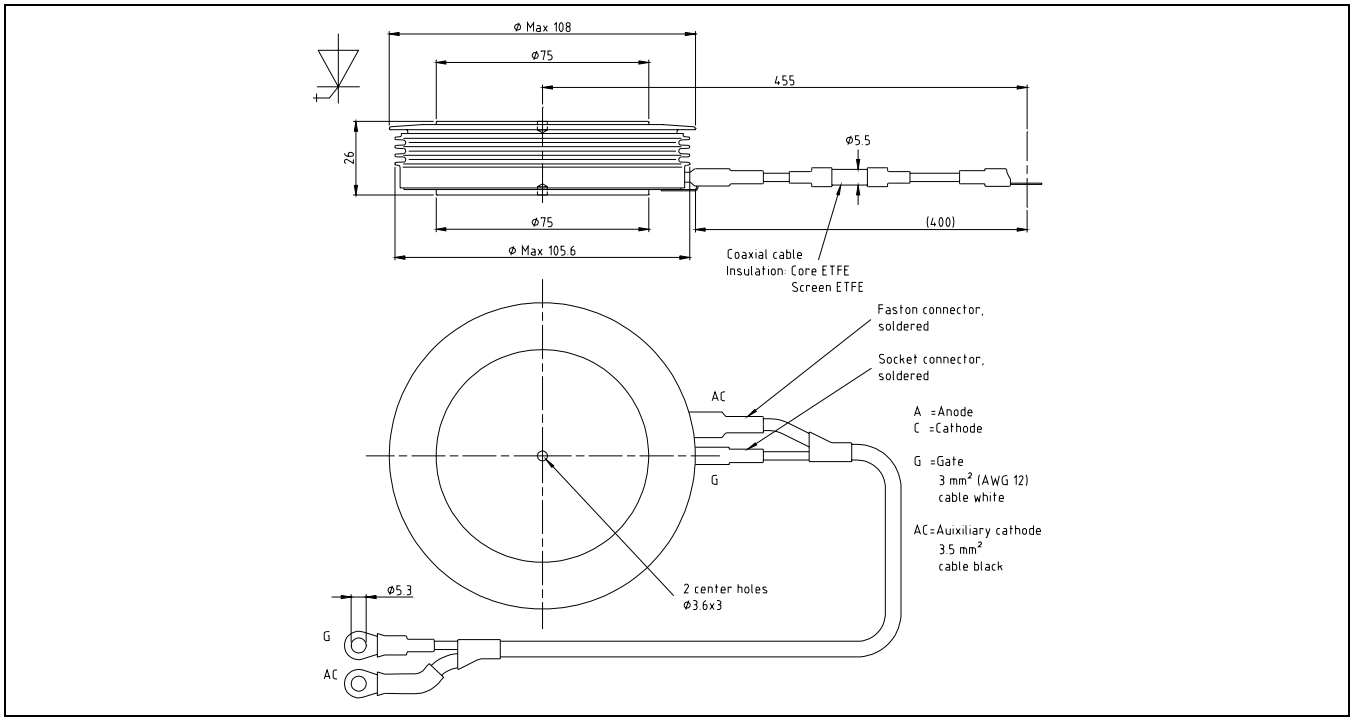

Fig. 19 Outline drawing. All dimensions are in millimeters and represent nominal values unless stated otherwise.

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.

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Doc. No. 5SYA1209-04 Jan. 03