

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

Asymmetric Gate turn-off Thyristor 5SGF 40L4502

Doc. No. 5SYA1209-04 Feb. 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 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		26.0		26.5	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	$I_{T(AV)M}$	Half sine wave, $T_C = 85^\circ\text{C}$			1180	A
Max. RMS on-state current	$I_{T(RMS)}$				1850	A
Max. peak non-repetitive surge current	I_{TSM}	$t_p = 10\text{ ms}$, $T_{vj} = 125^\circ\text{C}$, sine wave After Surge: $V_D = V_R = 0\text{ V}$			25×10^3	A
Limiting load integral	I^2t				3.1×10^6	A^2s
Max. peak non-repetitive surge current	I_{TSM}	$t_p = 1\text{ ms}$, $T_{vj} = 125^\circ\text{C}$, sine wave After Surge: $V_D = V_R = 0\text{ V}$			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	$I_T = 4000\text{ A}$, $T_{vj} = 125^\circ\text{C}$			3.8	V
Threshold voltage	$V_{(T0)}$	$T_{vj} = 125^\circ\text{C}$ $I_T = 400 \dots 5000\text{ A}$			1.2	V
Slope resistance	r_T				0.65	$\text{m}\Omega$
Holding current	I_H	$T_{vj} = 25^\circ\text{C}$			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}	$T_{vj} = 125^\circ\text{C}$, $f = 200\text{ Hz}$ $I_T = 4000\text{ A}$, $I_{GM} = 50\text{ A}$, $di_G/dt = 40\text{ A}/\mu\text{s}$, $f = 1\text{ Hz}$			500	$\text{A}/\mu\text{s}$
Critical rate of rise of on-state current	di_T/dt_{cr}				1000	$\text{A}/\mu\text{s}$
Min. on-time	t_{on}		100			μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-on delay time	t_d	$V_D = 0.5 V_{DRM}$, $T_{vj} = 125^\circ\text{C}$ $I_T = 4000\text{ A}$, $di/dt = 300\text{ A}/\mu\text{s}$, $I_{GM} = 50\text{ A}$, $di_G/dt = 40\text{ A}/\mu\text{s}$, $C_S = 6\text{ }\mu\text{F}$, $R_S = 5\text{ }\Omega$			2.5	μs
Rise time	t_r				5	μs
Turn-on energy per pulse	E_{on}				3	J

Turn-off switching

Maximum rated values ¹⁾

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

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Storage time	t_s	$V_D = 0.5 V_{DRM}$, $T_{vj} = 125^\circ\text{C}$ $V_{DM} \leq V_{DRM}$, $di_{GQ}/dt = 40\text{ A}/\mu\text{s}$, $I_{TGQ} = I_{TGQM}$, $R_S = 5\text{ }\Omega$, $C_S = 6\text{ }\mu\text{F}$, $L_S = 0.2\text{ }\mu\text{H}$			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
Repetitive peak reverse voltage	V_{GRM}				17	V
Repetitive 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}	$T_{vj} = 25^{\circ}\text{C}$,		1.2		V
Gate trigger current	I_{GT}	$V_D = 24\text{ V}$, $R_A = 0.1\ \Omega$		4		A

Thermal

Maximum rated values ¹⁾

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	$R_{th(jc)}$	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

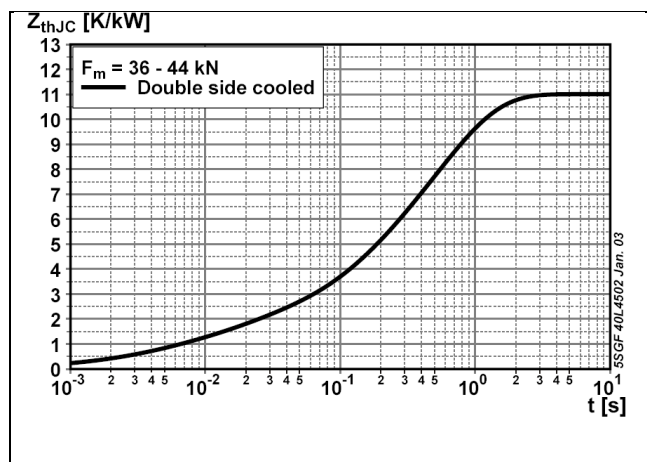


Fig. 1 Transient thermal impedance, junction to case.

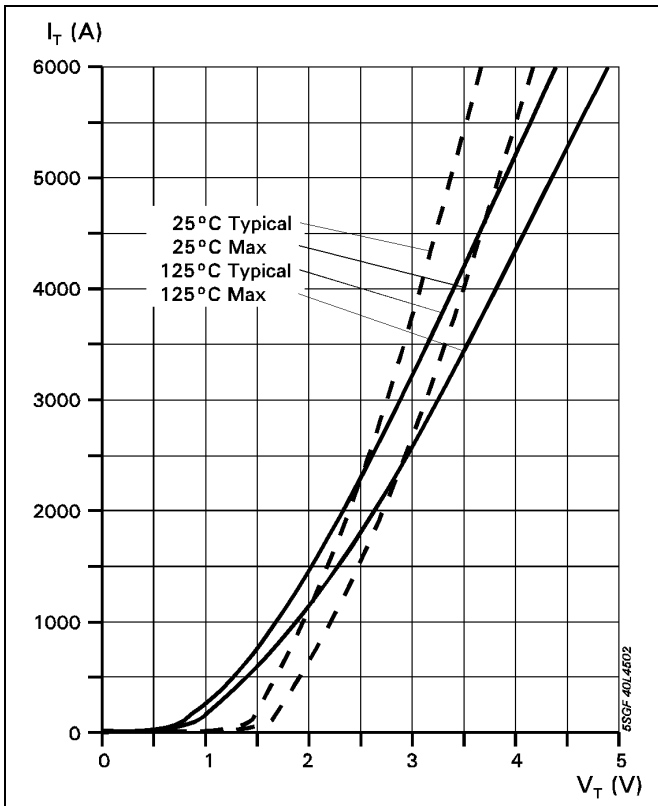


Fig. 2 On-state characteristics.

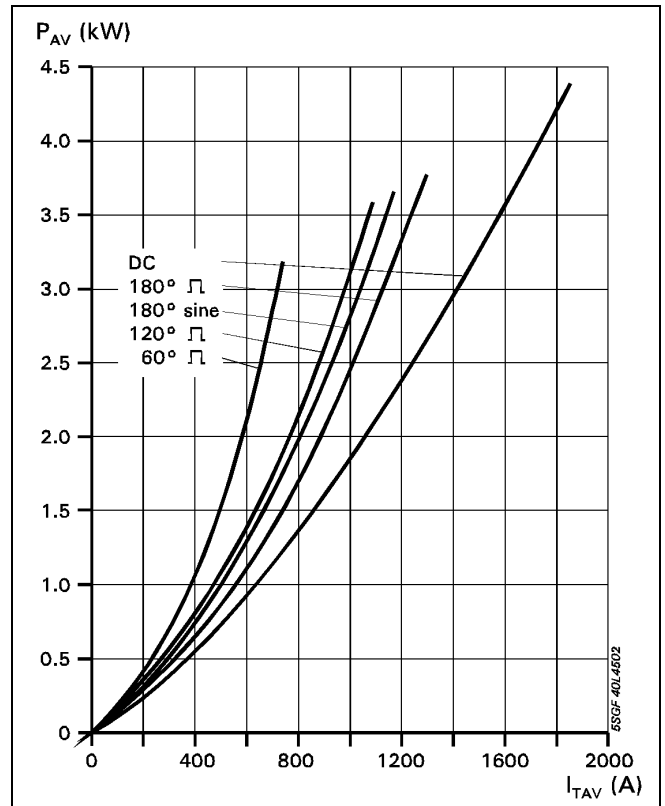


Fig. 3 Average on-state power dissipation vs. average on-state current.

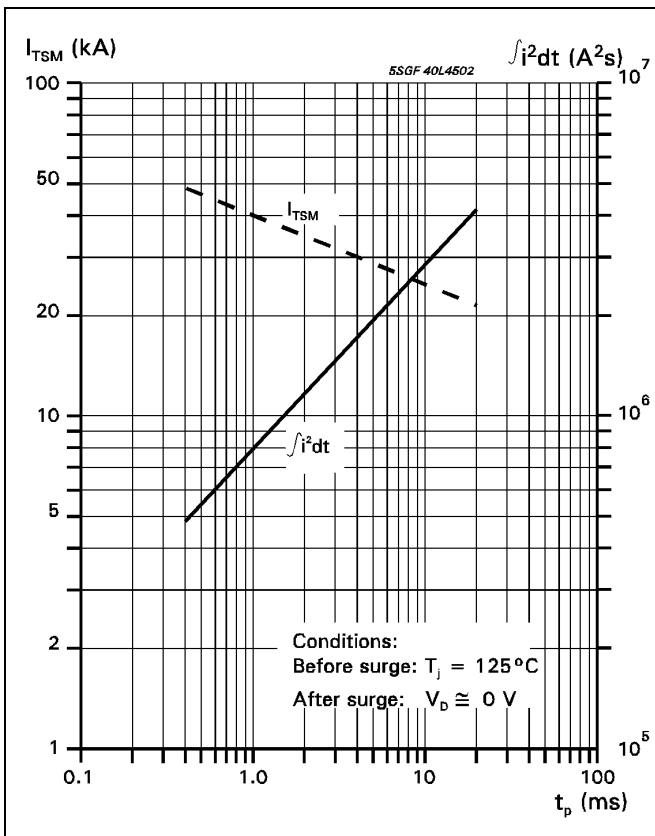


Fig. 4 Surge current and fusing integral vs. pulse width.

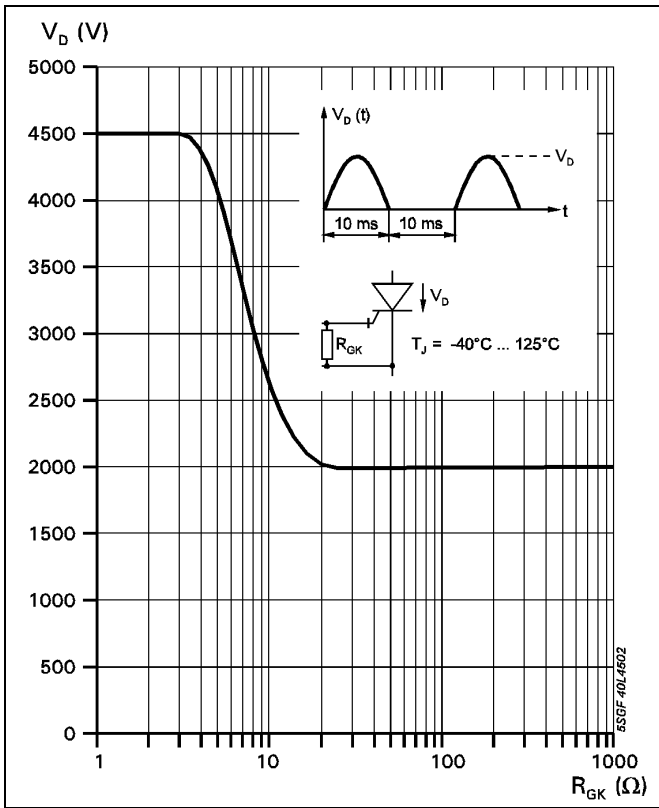


Fig. 5 Forward blocking voltage vs. gate-cathode resistance.

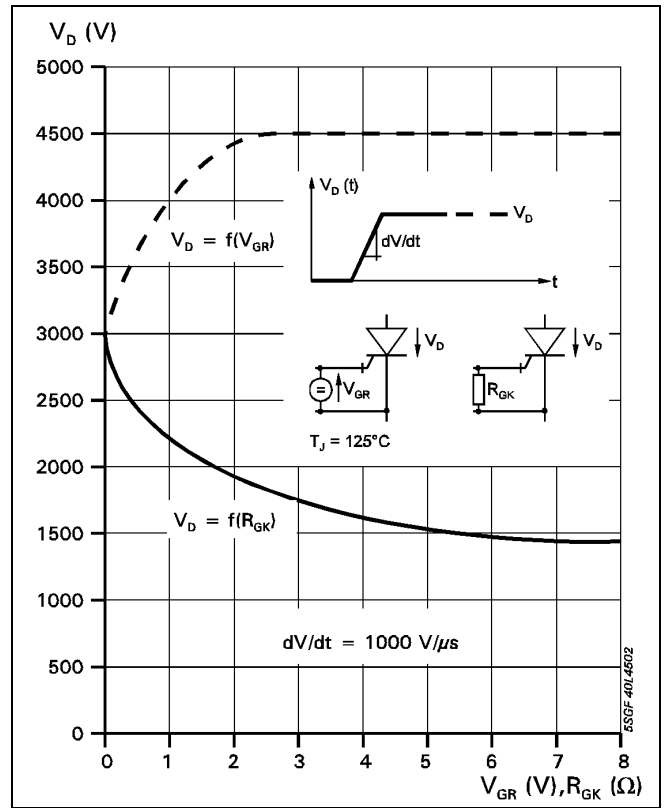


Fig. 6 Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.

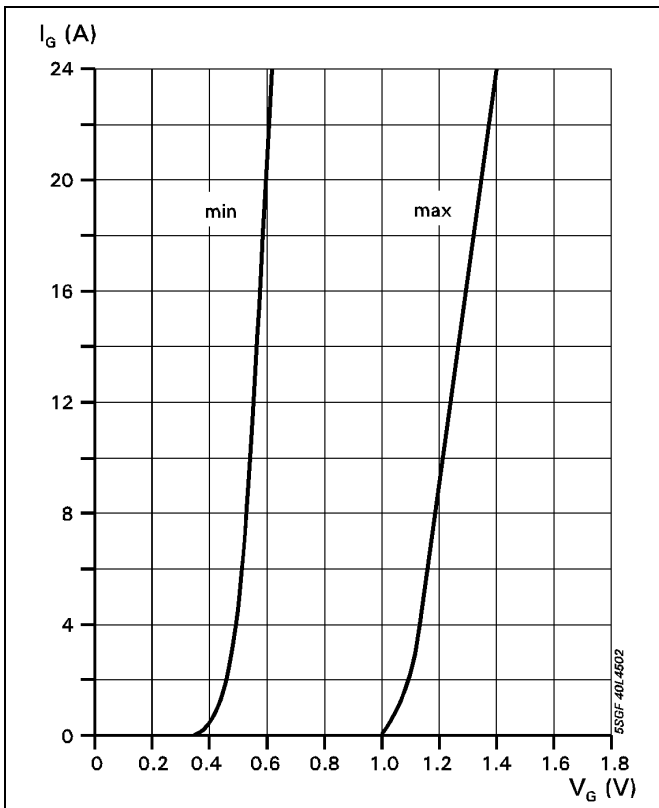


Fig. 7 Forward gate current vs. forward gate voltage.

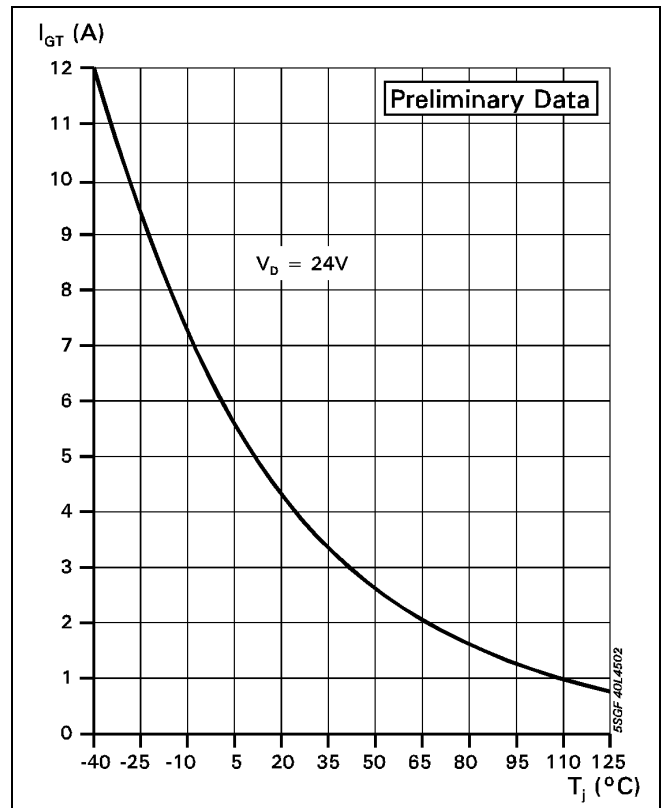


Fig. 8 Gate trigger current vs. junction temperature

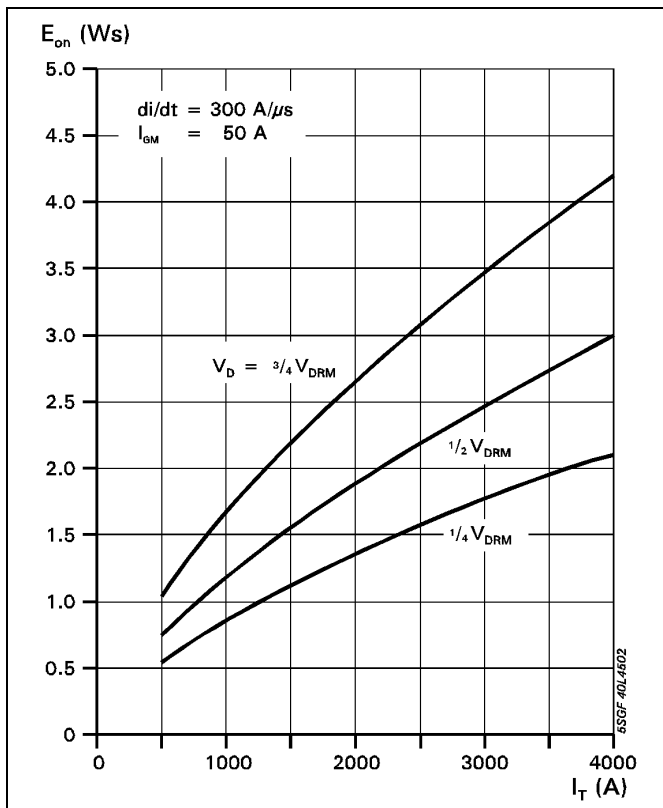


Fig. 9 Turn-on energy per pulse vs. on-state current and turn-on voltage.

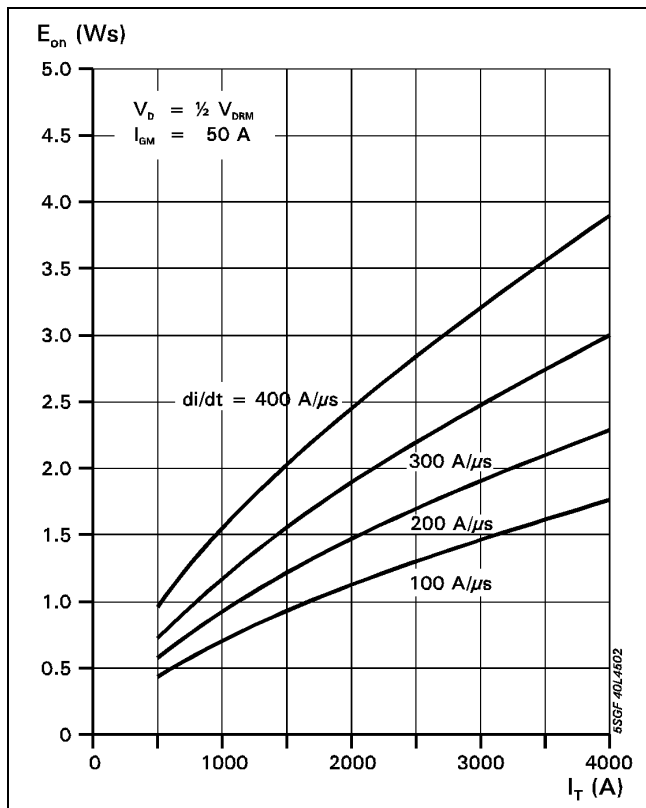


Fig. 10 Turn-on energy per pulse vs. on-state current and current rise rate

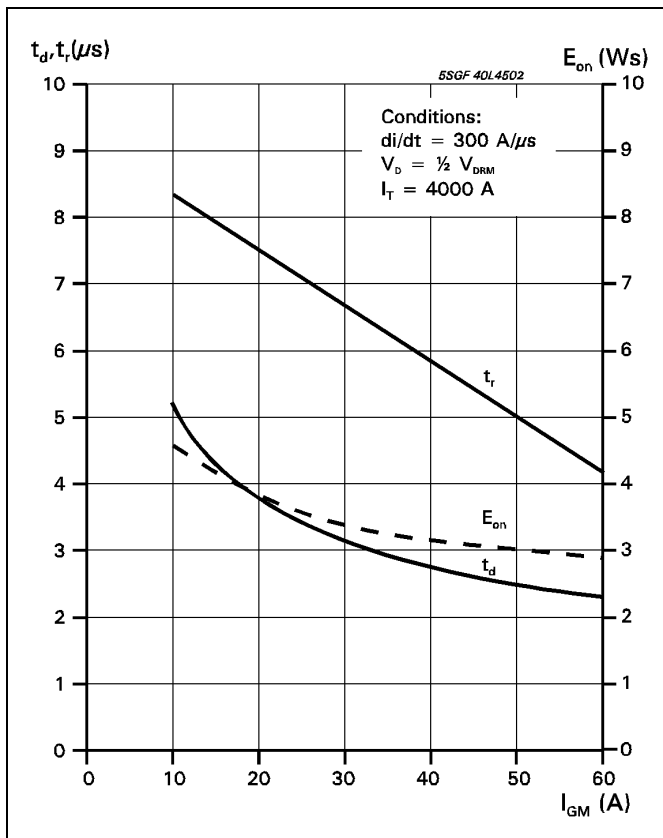


Fig. 11 Turn-on energy per pulse vs. on-state current and turn-on voltage.

Common Test conditions for figures 9, 10 and 11:

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

Definition of Turn-on energy:

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

Common Test conditions for figures 12, 13 and 15:

Definition of Turn-off energy:

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

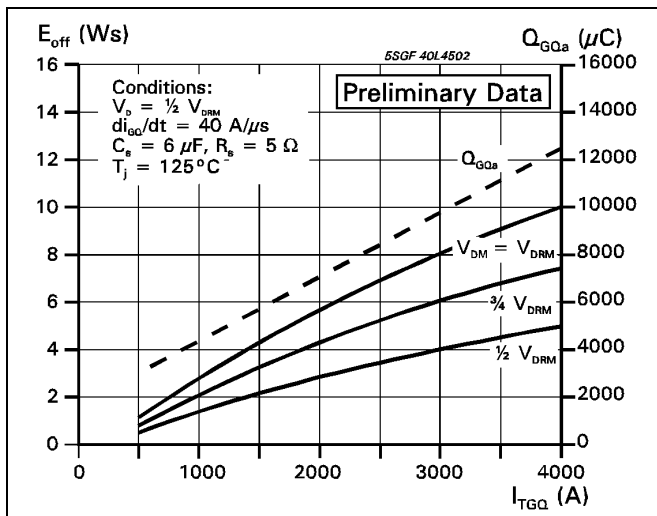


Fig. 12 Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.

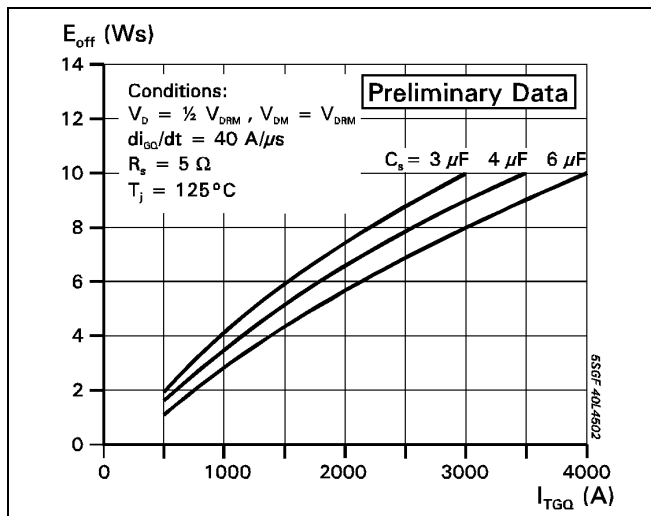


Fig. 13 Turn-off energy per pulse vs. turn-off current and snubber capacitance.

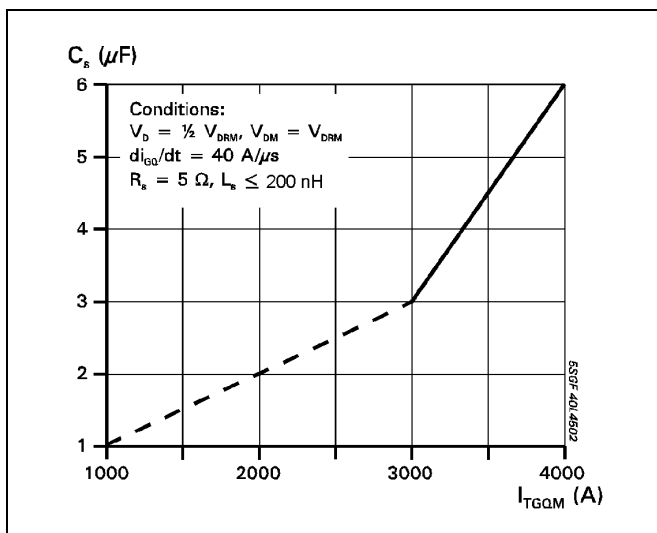


Fig. 14 Required snubber capacitor vs. max allowable turn-off current.

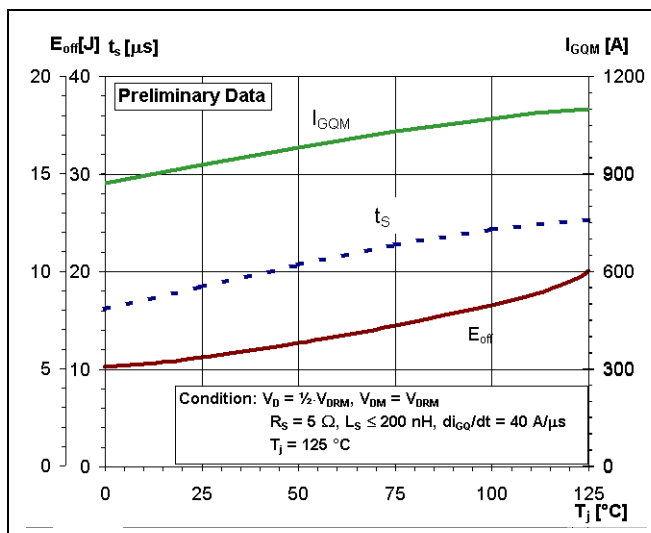


Fig. 15 Turn-off energy per pulse, storage time and peak turn-off gate current vs. junction temperature.

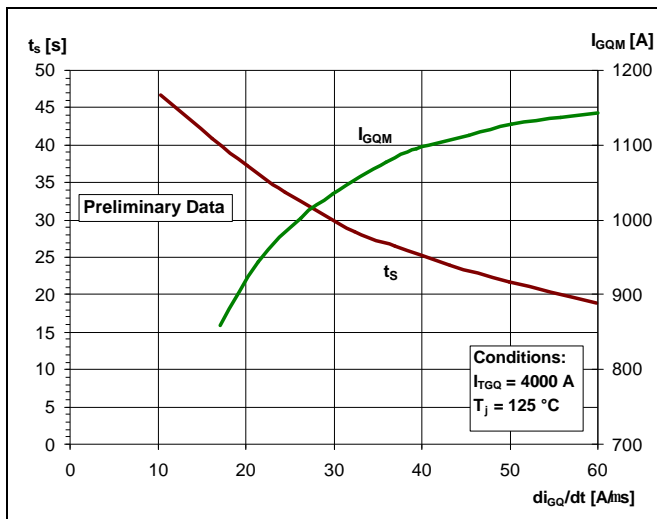


Fig. 16 Storage time and peak turn-off gate current vs. neg. gate current rise rate.

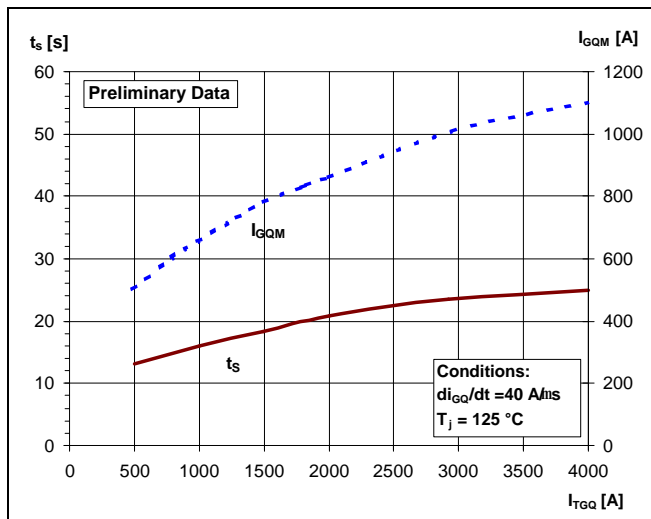


Fig. 17 Storage time and peak turn-off gate current vs. turn-off current.

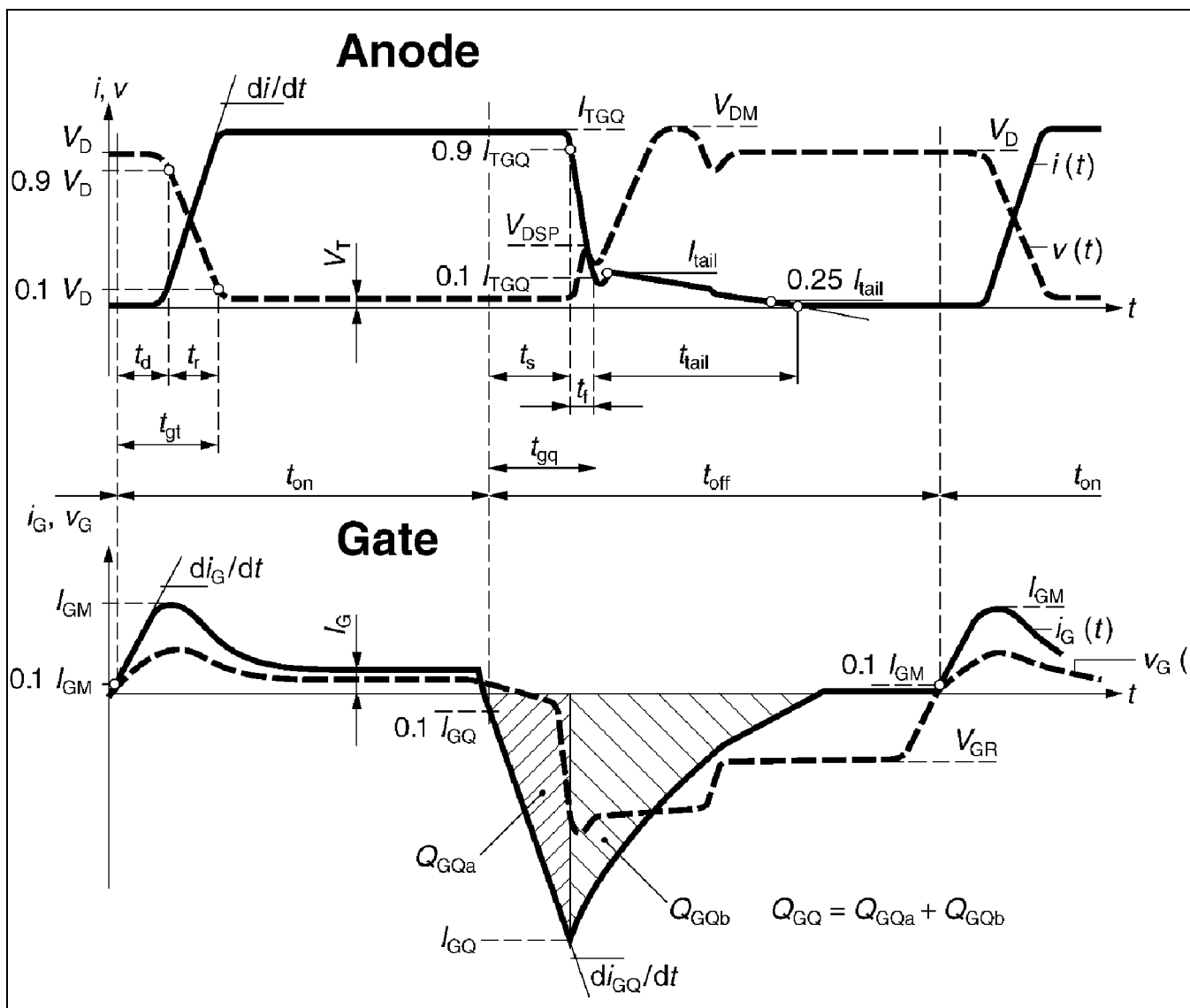


Fig. 18 General current and voltage waveforms with GTO-specific symbols.

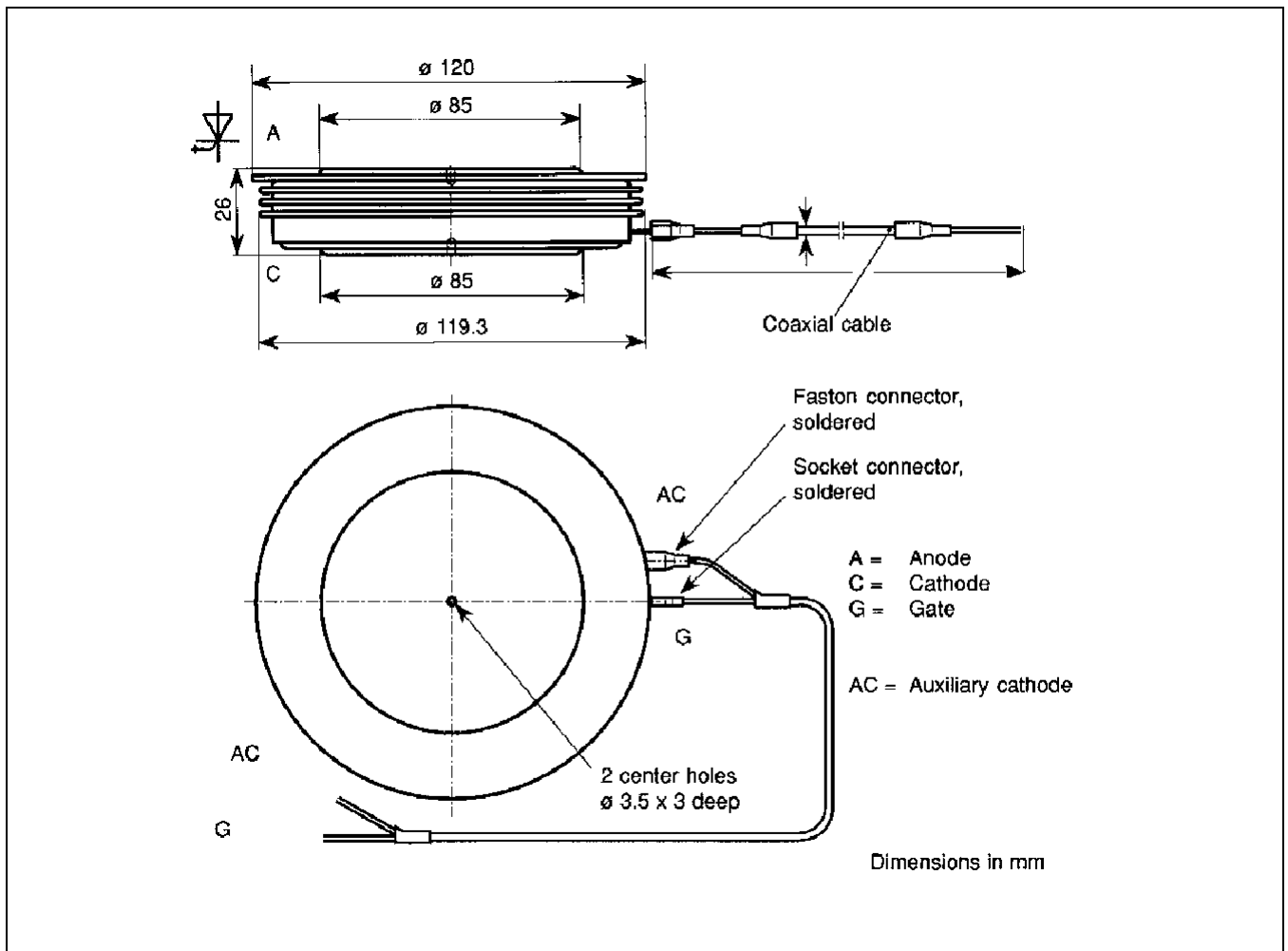


Fig. 19 Outline drawing. All dimensions are in millimeters and represent nominal values unless stated otherwise.

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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