

$V_{DRM}$	=	4500 V
$I_{TGQM}$	=	3000 A
$I_{TSM}$	=	$24 \times 10^3$ A
$V_{T0}$	=	2.2 V
$r_T$	=	0.6 m $\Omega$
$V_{Dclink}$	=	2800 V

# Asymmetric Gate turn-off Thyristor 5SGA 30J4502

Doc. No. 5SYA1202-03 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 <sup>1)</sup>

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			60	mA
Repetitive peak reverse current	$I_{RRM}$	$V_R = V_{RRM}$ , $R_{GK} = \infty \Omega$			20	mA

## Mechanical data

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

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	$D_p$	$\pm 0.1$ mm		75		mm
Housing thickness	H	$\pm 0.5$ mm		26		mm
Weight	m			1.3		kg
Surface creepage distance	$D_s$	Anode to Gate	33			mm
Air strike distance	$D_a$	Anode to Gate	15			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 <sup>1)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. average on-state current	$I_{TAVM}$	Half sine wave, $T_C = 85^\circ\text{C}$			930	A
Max. RMS on-state current	$I_{TRMS}$				1460	A
Max. peak non-repetitive surge current	$I_{TSM}$	$t_p = 10\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ , sine wave After Surge: $V_D = V_R = 0\text{ V}$			$24 \times 10^3$	A
Limiting load integral	$I^2t$				$2.88 \times 10^6$	$\text{A}^2\text{s}$
Max. peak non-repetitive surge current	$I_{TSM}$	$t_p = 1\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ , sine wave After Surge: $V_D = V_R = 0\text{ V}$			$40 \times 10^3$	A
Limiting load integral	$I^2t$				$800 \times 10^3$	$\text{A}^2\text{s}$

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	$V_T$	$I_T = 3000\text{ A}$ , $T_{vj} = 125^\circ\text{C}$			4	V
Threshold voltage	$V_{(T0)}$	$T_{vj} = 125^\circ\text{C}$			2.2	V
Slope resistance	$r_T$	$I_T = 300 \dots 4000\text{ A}$			0.6	$\text{m}\Omega$
Holding current	$I_H$	$T_{vj} = 25^\circ\text{C}$			50	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	$di_T/dt_{cr}$	$T_{vj} = 125^\circ\text{C}$ , $f = 200\text{ Hz}$			400	$\text{A}/\mu\text{s}$
Critical rate of rise of on-state current	$di_T/dt_{cr}$	$I_T = 3000\text{ A}$ , $I_{GM} = 30\text{ A}$ , $di_G/dt = 20\text{ A}/\mu\text{s}$ , $f = 1\text{ Hz}$			800	$\text{A}/\mu\text{s}$
Min. on-time	$t_{on}$		100			$\mu\text{s}$

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-on delay time	$t_d$	$V_D = 0.5 V_{DRM}$ , $T_{vj} = 125^\circ\text{C}$			3	$\mu\text{s}$
Rise time	$t_r$	$I_T = 3000\text{ A}$ , $di/dt = 200\text{ A}/\mu\text{s}$ , $I_{GM} = 30\text{ A}$ , $di_G/dt = 20\text{ A}/\mu\text{s}$ , $C_S = 6\text{ }\mu\text{F}$			6	$\mu\text{s}$
Turn-on energy per pulse	$E_{on}$	$\mu\text{F}$ , $R_S = 5\text{ }\Omega$			3.6	J

## Turn-off switching

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

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. controllable turn-off current	$I_{TGQM}$	$V_{DM} \leq V_{DRM}$ , $di_{GQ}/dt = 40\text{ A}/\mu\text{s}$ , $C_S = 6\text{ }\mu\text{F}$ , $L_S \leq 0.3\text{ }\mu\text{H}$			3000	A
Min. off-time	$t_{off}$		80			$\mu\text{s}$

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Storage time	$t_s$	$V_D = 0.5 V_{DRM}$ , $T_{vj} = 125^\circ\text{C}$			25	$\mu\text{s}$
Fall time	$t_f$	$V_{DM} \leq V_{DRM}$ , $di_{GQ}/dt = 40\text{ A}/\mu\text{s}$ , $I_{TGQ} = I_{TGQM}$			3	$\mu\text{s}$
Turn-on energy per pulse	$E_{off}$	$R_S = 5\text{ }\Omega$ , $C_S = 6\text{ }\mu\text{F}$ , $L_S = 0.3\text{ }\mu\text{H}$			13	J
Peak turn-off gate current	$I_{GQM}$				900	A

### Gate

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

Parameter	Symbol	Conditions	min	typ	max	Unit
Repetitive peak reverse voltage	V <sub>GRM</sub>				17	V
Repetitive peak reverse current	I <sub>GRM</sub>	V <sub>GR</sub> = V <sub>GRM</sub>			20	mA

**Characteristic values**

Parameter	Symbol	Conditions	min	typ	max	Unit
Gate trigger voltage	V <sub>GT</sub>	T <sub>vj</sub> = 25°C,		1		V
Gate trigger current	I <sub>GT</sub>	V <sub>D</sub> = 24 V, R <sub>A</sub> = 0.1 Ω		3		A

### Thermal

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

Parameter	Symbol	Conditions	min	typ	max	Unit
Junction operating temperature	T <sub>vj</sub>		-40		125	°C
Storage temperature range	T <sub>stg</sub>		-40		125	°C

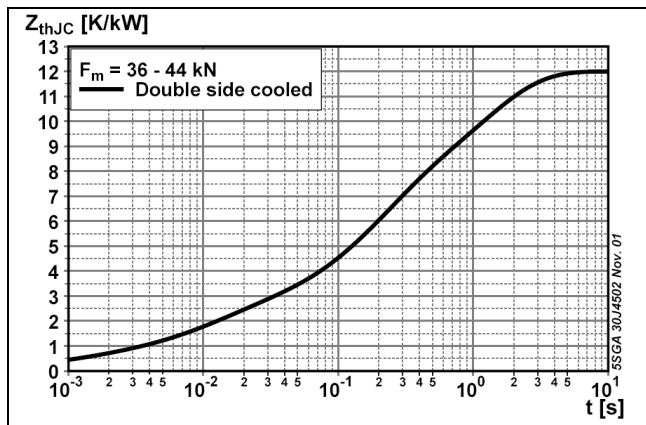
**Characteristic values**

Parameter	Symbol	Conditions	min	typ	max	Unit
Thermal resistance junction to case	R <sub>th(jc)</sub>	Double side cooled			12	K/kW
	R <sub>th(jc)A</sub>	Anode side cooled			22	K/kW
	R <sub>th(jc)C</sub>	Cathode side cooled			27	K/kW
Thermal resistance case to heatsink (Double side cooled)	R <sub>th(ch)</sub>	Single side cooled			6	K/kW
	R <sub>th(ch)</sub>	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 <sub>i</sub> (K/kW)	5.400	4.500	1.700	0.400
τ <sub>i</sub> (s)	1.2000	0.1700	0.0100	0.0010



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

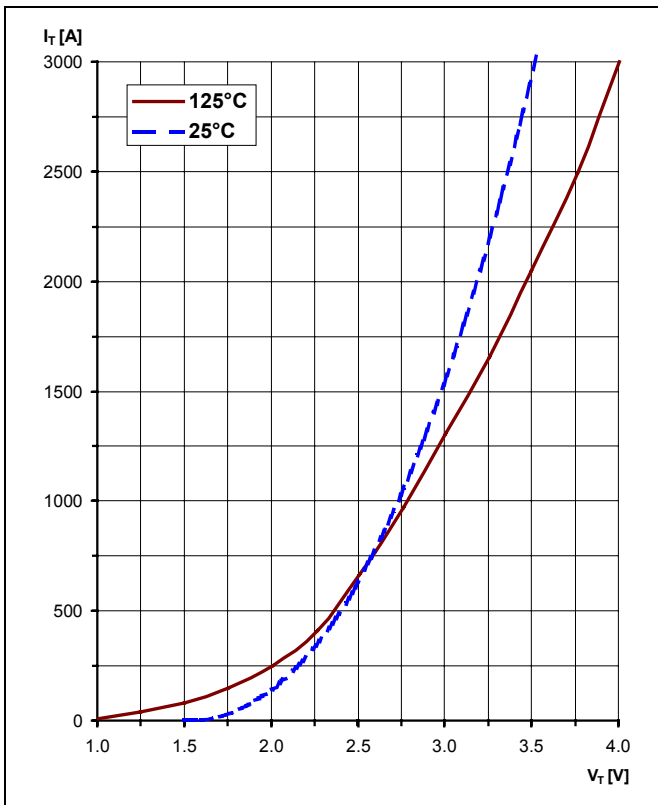


Fig. 2 On-state characteristics.

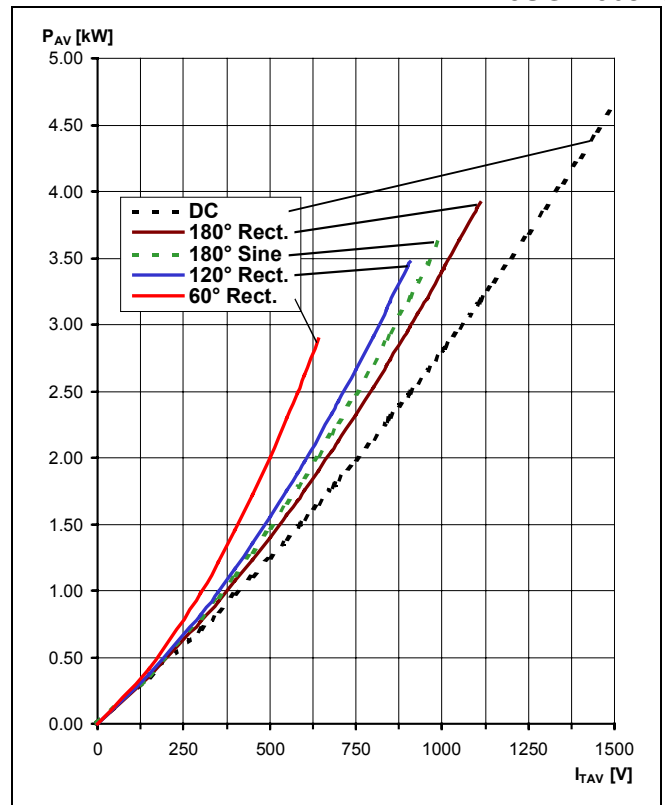


Fig. 3 Average on-state power dissipation vs. average on-state current..

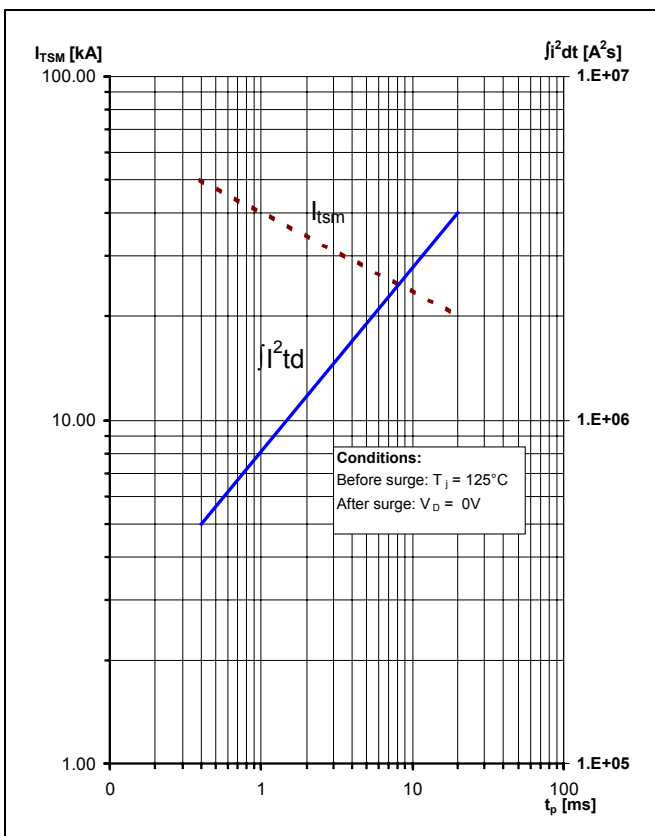


Fig. 4 Surge current and fusing integral vs. pulse width.

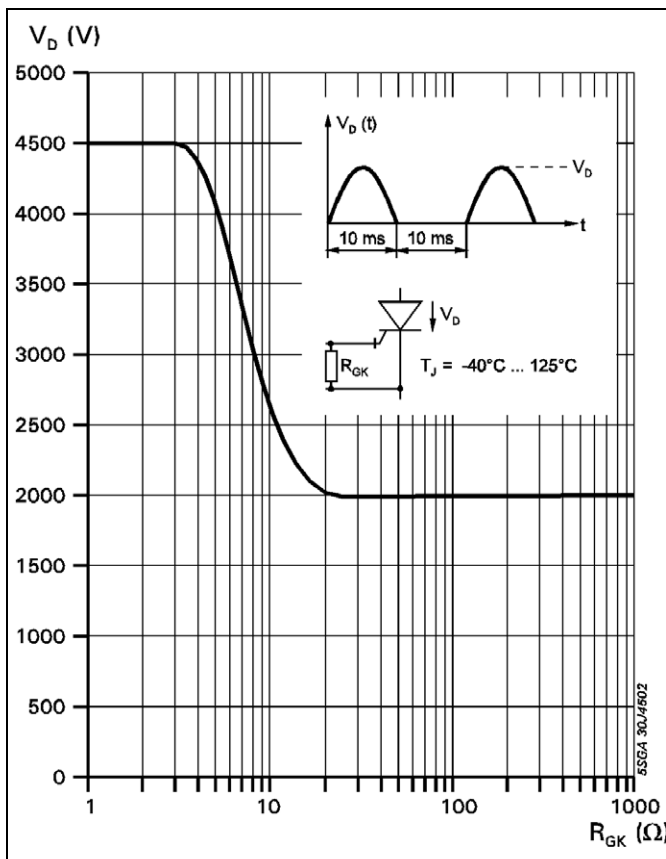


Fig. 5 Forward blocking voltage vs. gate-cathode resistance..

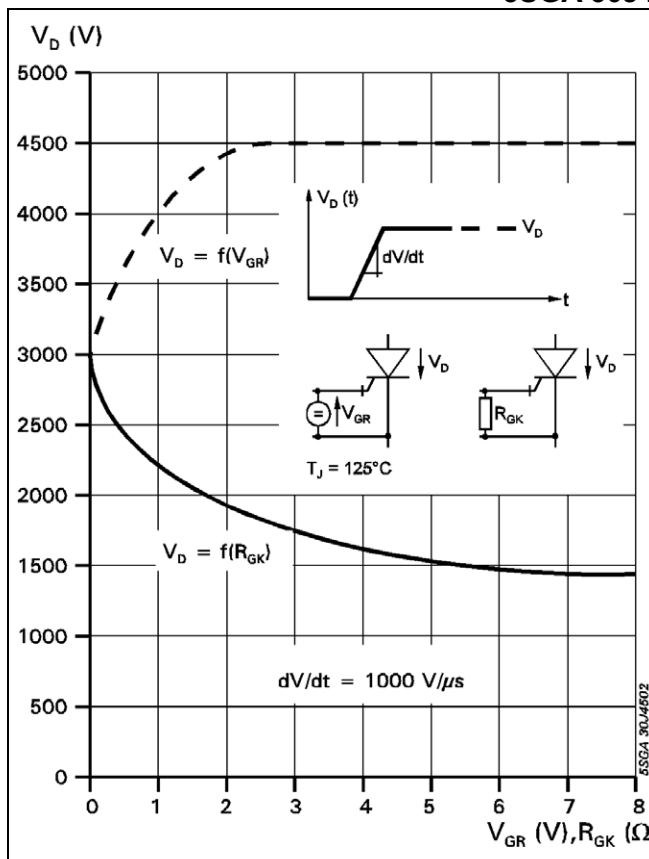


Fig. 6 Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.

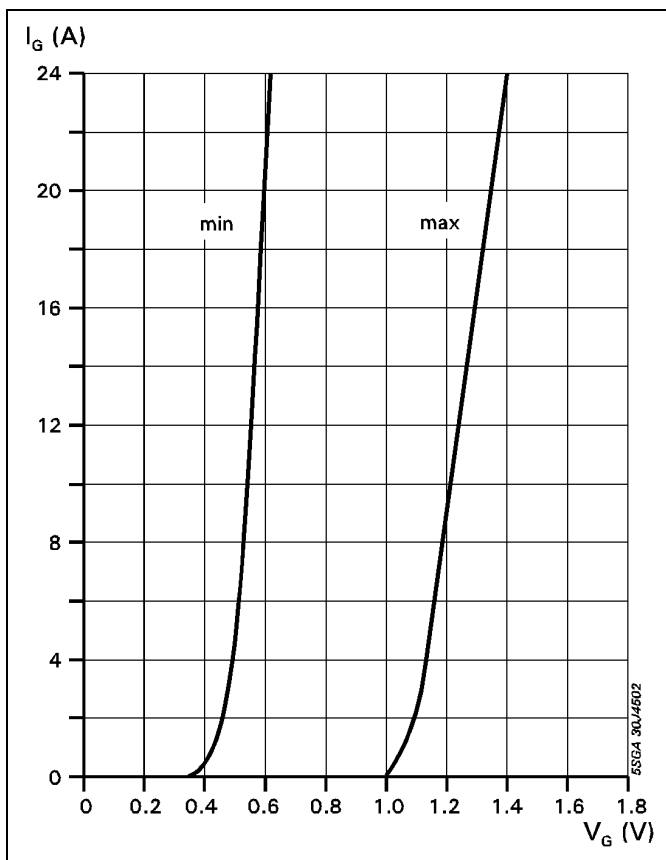


Fig. 7 Forward gate current vs. forward gate voltage.

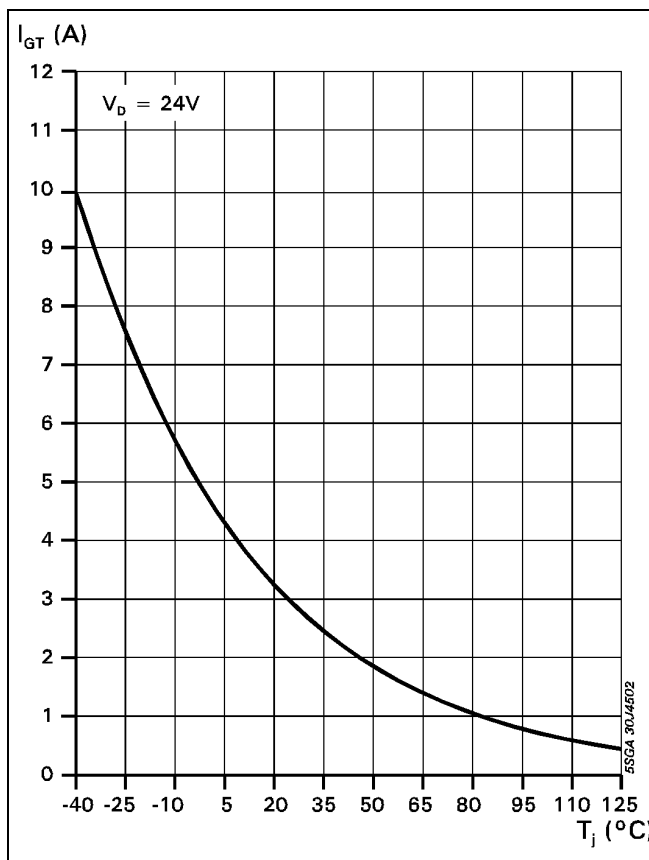


Fig. 8 Gate trigger current vs. junction temperature

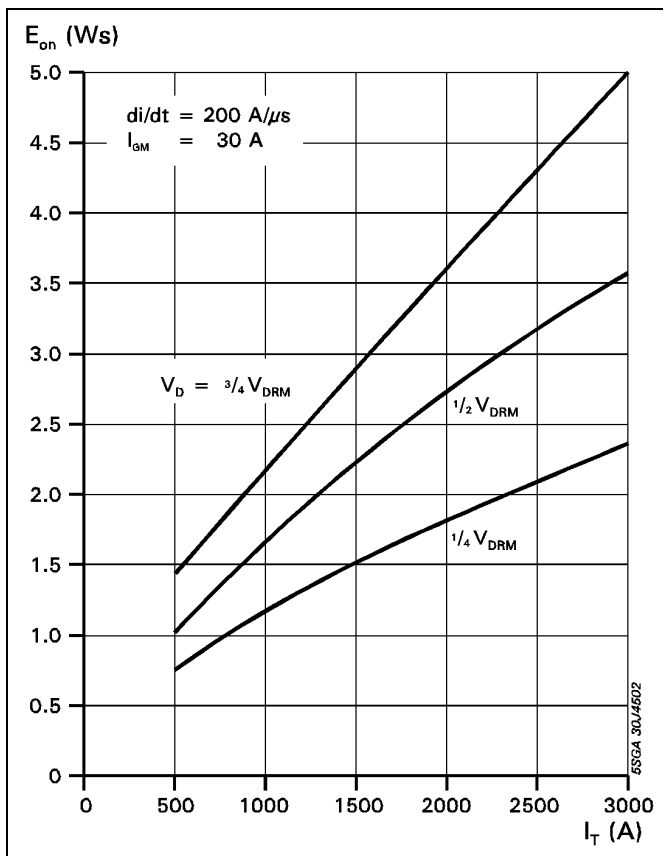


Fig. 9 Turn-on energy per pulse vs. on-state current and turn-on voltage.

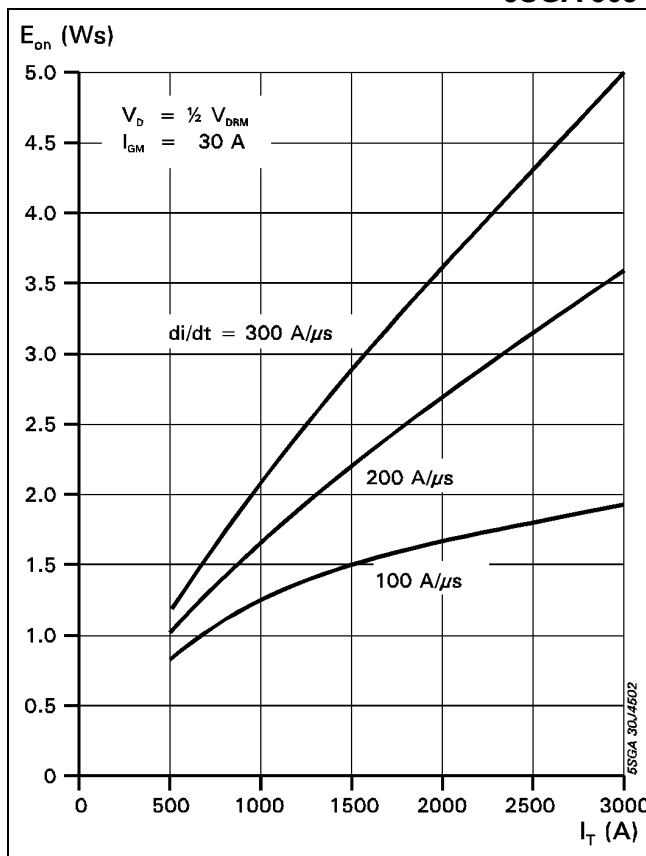


Fig. 10 Turn-on energy per pulse vs. on-state current and current rise rate

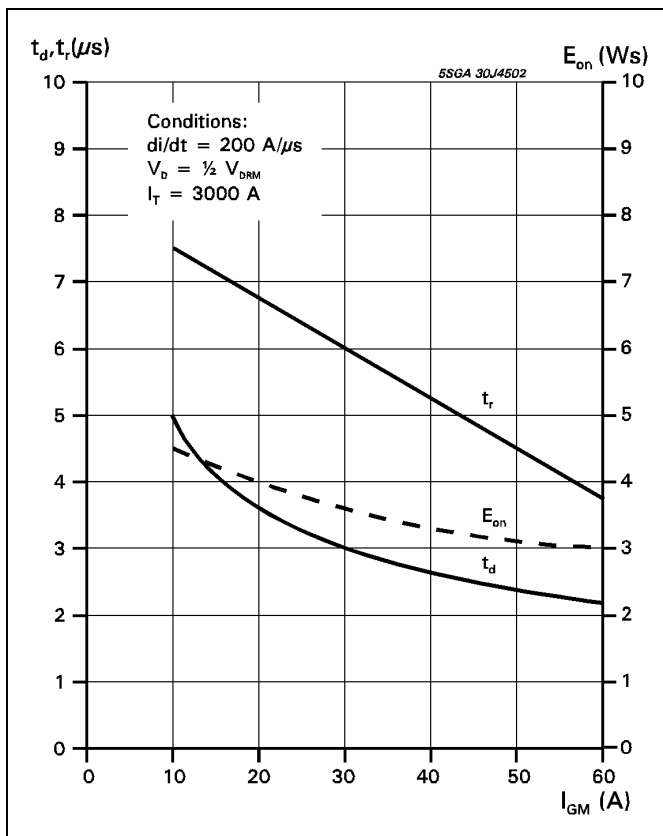


Fig. 11 Turn-on energy per pulse vs. on-state current and turn-on voltage.

Common Test conditions for figures 9, 10 and 11:

- $di_G/dt = 20 \text{ A}/\mu\text{s}$
- $C_S = 6 \mu\text{F}$
- $R_S = 5 \Omega$
- $T_j = 125 \text{ }^\circ\text{C}$

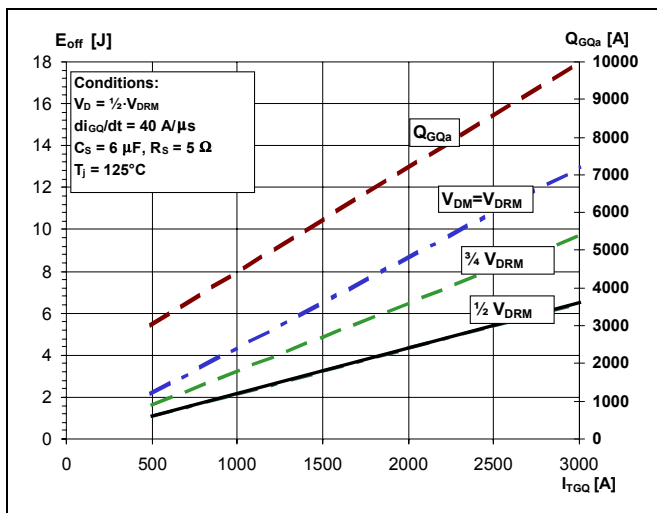
Definition of Turn-on energy:

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

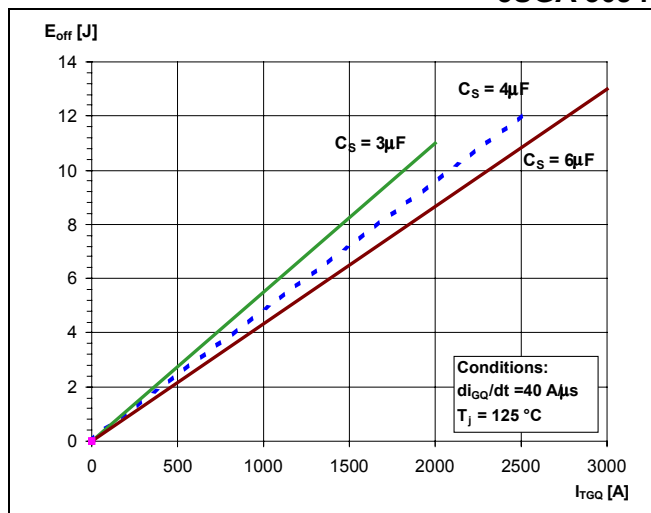
Common Test conditions for figures 12, 13 and 15:

Definition of Turn-off energy:

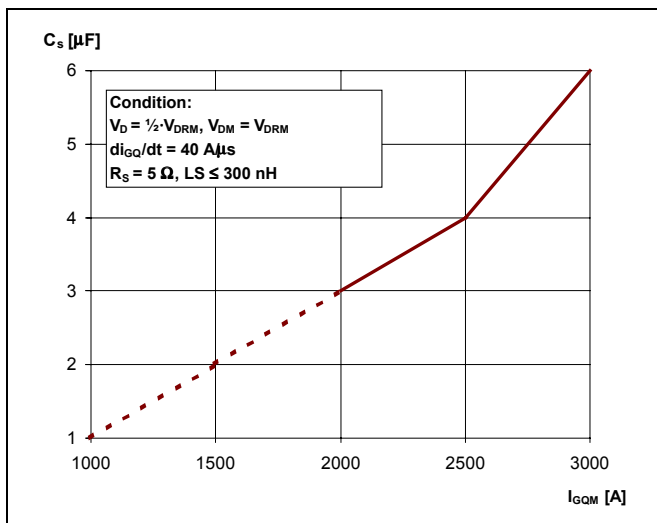
$$E_{off} = \int_0^{40 \mu\text{s}} V_D \cdot I_T dt \quad (t = 0, I_T = 0.9 \cdot I_{TGO})$$



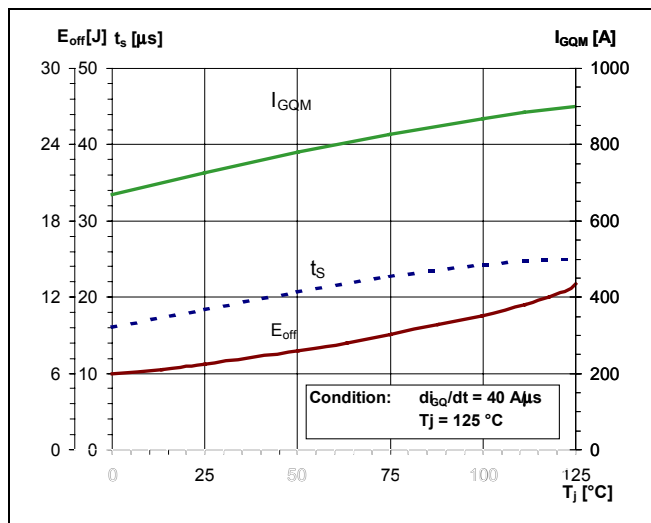
**Fig. 12** Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.



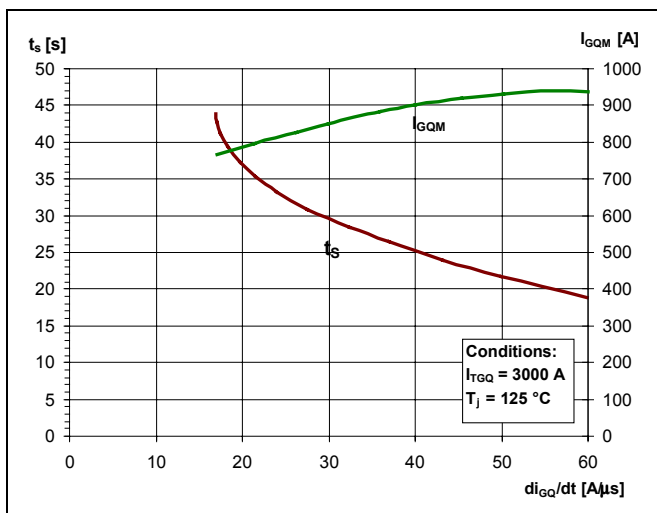
**Fig. 13** Turn-off energy per pulse vs. turn-off current and snubber capacitance.



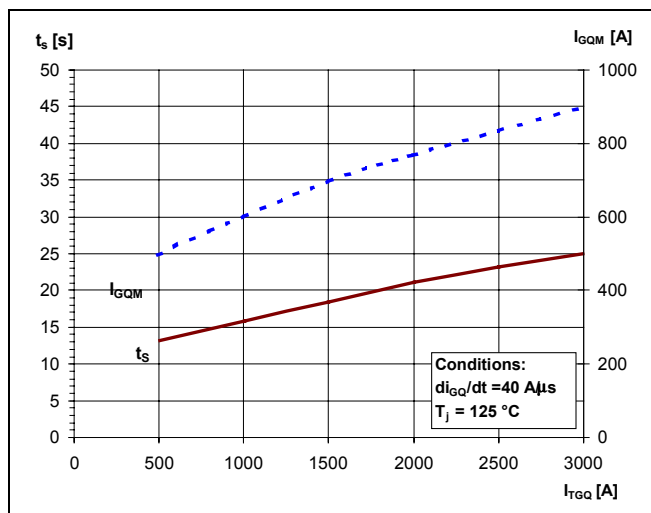
**Fig. 14** Required snubber capacitor vs. max allowable turn-off current.



**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.

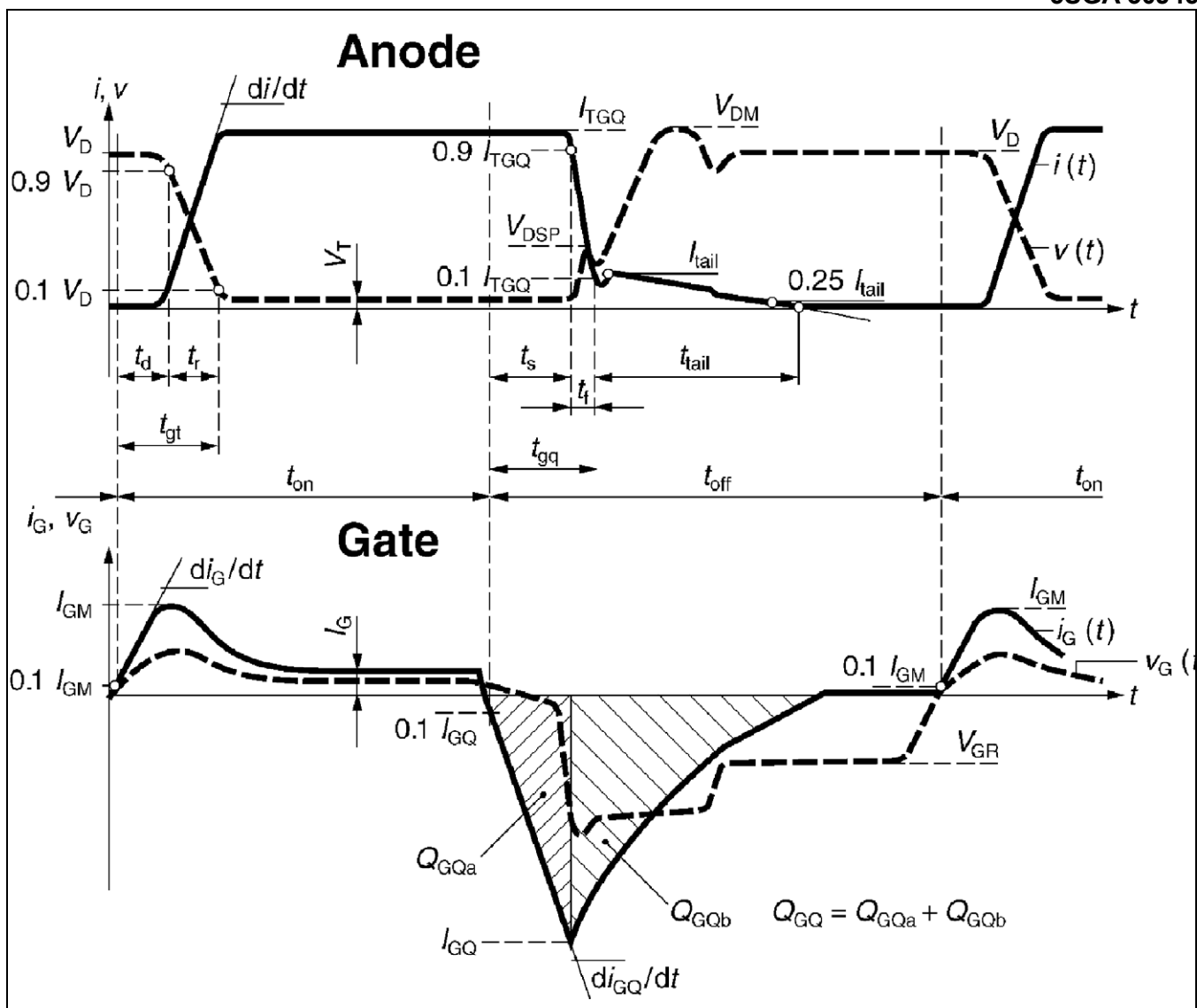


Fig. 18 General current and voltage waveforms with GTO-specific symbols.

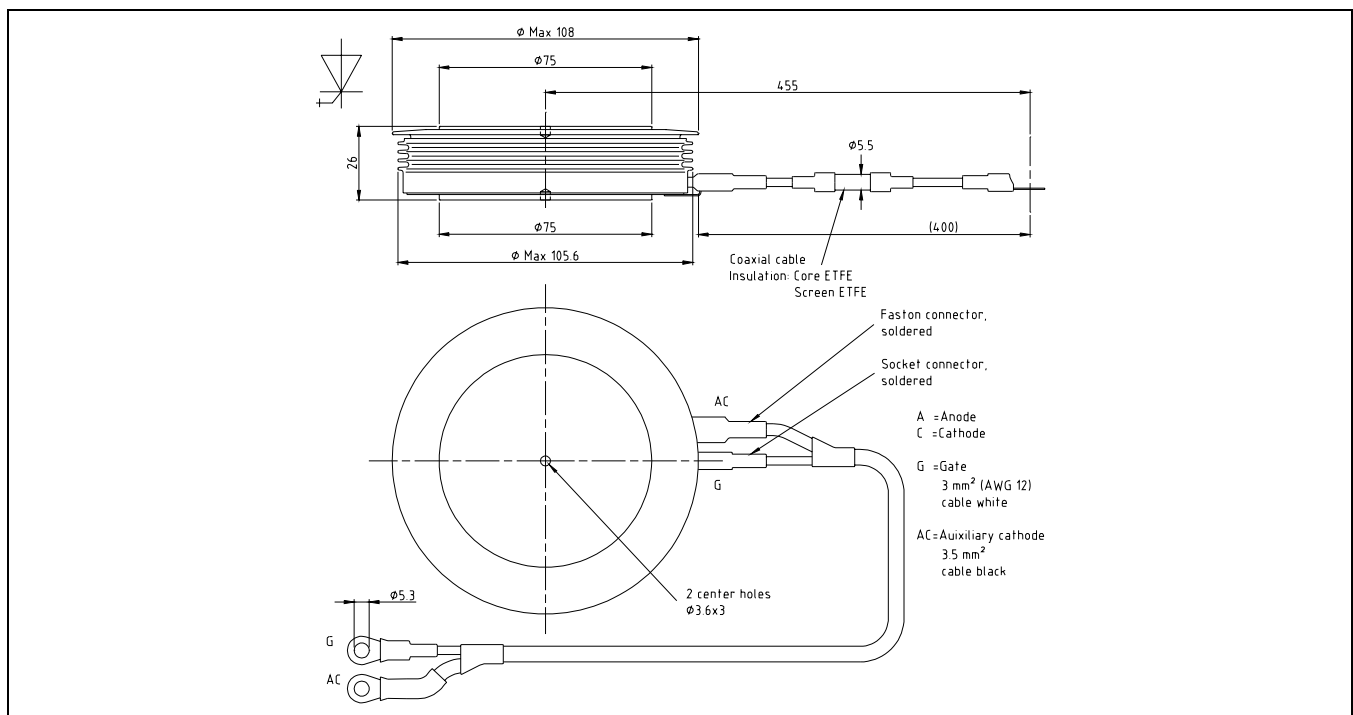


Fig. 19 Outline drawing. All dimensions are in millimeters and represent nominal values unless stated otherwise.



**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 :  $V_{GR} = 10... 15$  V.

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Doc. No. 5SYA1202-03 Jan. 03

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