

$V_{DRM}$	=	4500 V
$I_{TGQM}$	=	600 A
$I_{TSM}$	=	$3 \times 10^3$ A
$V_{T0}$	=	1.9 V
$r_T$	=	3.5 m $\Omega$
$V_{Dclink}$	=	2800 V

# Asymmetric Gate turn-off Thyristor 5SGA 06D4502 PRELIMINARY

Doc. No. 5SYA1236-00 Jun. 04

- Patented free-floating silicon technology
- Low on-state and switching losses
- Central 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			20	mA
Repetitive peak reverse current	$I_{RRM}$	$V_R = V_{RRM}, R_{GK} = \infty \Omega$			50	mA

## Mechanical data

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

Parameter	Symbol	Conditions	min	typ	max	Unit
Mounting force	$F_m$		10	11	12	kN

*Characteristic values*

Parameter	Symbol	Conditions	min	typ	max	Unit
Pole-piece diameter	$D_p$	$\pm 0.1$ mm		34		mm
Housing thickness	H			26		mm
Weight	m				0.25	kg
Surface creepage distance	$D_s$	Anode to Gate	30			mm
Air strike distance	$D_a$	Anode to Gate	20.5			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	$I_{T(AV)M}$	Half sine wave, $T_C = 85^\circ\text{C}$			210	A
Max. RMS on-state current	$I_{T(RMS)}$				330	A
Max. peak non-repetitive surge current	$I_{TSM}$	$t_p = 8.3\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ , sine wave After Surge: $V_D = V_R = 0\text{ V}$			$3.1 \times 10^3$	A
Limiting load integral	$I^2t$				$40 \times 10^3$	$\text{A}^2\text{s}$
Max. peak non-repetitive surge current	$I_{TSM}$	$t_p = 10\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ , sine wave After Surge: $V_D = V_R = 0\text{ V}$			$3 \times 10^3$	A
Limiting load integral	$I^2t$				$45 \times 10^3$	$\text{A}^2\text{s}$
Max. peak non-repetitive surge current	$I_{TSM}$	$t_p = 1\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$ , sine wave After Surge: $V_D = V_R = 0\text{ V}$			$6 \times 10^3$	A
Limiting load integral	$I^2t$				$18 \times 10^3$	$\text{A}^2\text{s}$

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	$V_T$	$I_T = 600\text{ A}$ , $T_{vj} = 125^\circ\text{C}$			4	V
Threshold voltage	$V_{(T0)}$	$T_{vj} = 125^\circ\text{C}$ $I_T = 200 \dots 600\text{ A}$			1.9	V
Slope resistance	$r_T$				3.5	$\text{m}\Omega$
Holding current	$I_H$	$T_{vj} = 25^\circ\text{C}$			20	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	$di_T/dt_{cr}$	$T_{vj} = 125^\circ\text{C}$ , $f = 200\text{ Hz}$ $I_T = 600\text{ A}$ , $I_{GM} = 20\text{ A}$ , $di_G/dt = 20\text{ A}/\mu\text{s}$ , $f = 1\text{ Hz}$			400	$\text{A}/\mu\text{s}$
Critical rate of rise of on-state current	$di_T/dt_{cr}$				600	$\text{A}/\mu\text{s}$
Min. on-time	$t_{on}$		80			$\mu\text{s}$

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-on delay time	$t_d$	$V_D = 0.5 V_{DRM}$ , $T_{vj} = 125^\circ\text{C}$ $I_T = 600\text{ A}$ , $di/dt = 200\text{ A}/\mu\text{s}$ , $I_{GM} = 20\text{ A}$ , $di_G/dt = 20\text{ A}/\mu\text{s}$ , $C_S = 1\text{ }\mu\text{F}$ , $R_S = 10\text{ }\Omega$			1.5	$\mu\text{s}$
Rise time	$t_r$				3	$\mu\text{s}$
Turn-on energy per pulse	$E_{on}$				0.8	J

## Turn-off switching

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

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. controllable turn-off current	$I_{TGQM}$	$V_{DM} \leq V_{DRM}$ , $V_D = 0.5 V_{DRM}$ $di_{GQ}/dt = 20\text{ A}/\mu\text{s}$ , $C_S = 1\text{ }\mu\text{F}$ , $L_S \leq 0.15\text{ }\mu\text{H}$ , RCD Snubber			600	A
Spike Voltage	$V_{DSP}$				$\leq 650$	V
Min. off-time	$t_{off}$		80			$\mu\text{s}$

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Storage time	$t_S$	$V_D = 0.5 V_{DRM}$ , $T_{vj} = 125^\circ\text{C}$ $V_{DM} \leq V_{DRM}$ , $di_{GQ}/dt = 20\text{ A}/\mu\text{s}$ , $I_{TGQ} = I_{TGQM}$ , $R_S = 10\text{ }\Omega$ , $C_S = 1\text{ }\mu\text{F}$ , $L_S = 0.15\text{ }\mu\text{H}$ RCD Snubber			15	$\mu\text{s}$
Fall time	$t_f$				5	$\mu\text{s}$
Turn-on energy per pulse	$E_{off}$				1.9	J
Peak turn-off gate current	$I_{GQM}$				300	A

## Gate

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

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		V
Gate trigger current	$I_{GT}$	$V_D = 24\text{ V}$ , $R_A = 0.1\ \Omega$		2		A

## Thermal

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

Parameter	Symbol	Conditions	min	typ	max	Unit
Junction operating temperature	$T_{vj}$		0		125	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$		0		125	$^{\circ}\text{C}$

### Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Thermal resistance junction to case	$R_{th(jc)}$	Double side cooled			50	K/kW
	$R_{th(jc)A}$	Anode side cooled			85	K/kW
	$R_{th(jc)C}$	Cathode side cooled			122	K/kW
Thermal resistance case to heatsink (Double side cooled)	$R_{th(ch)}$	Single side cooled			16	K/kW
	$R_{th(ch)}$	Double side cooled			8	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)	15.000	5.200	7.500	0.100
$\tau_i$ (s)	0.4610	0.0950	0.0120	0.0010

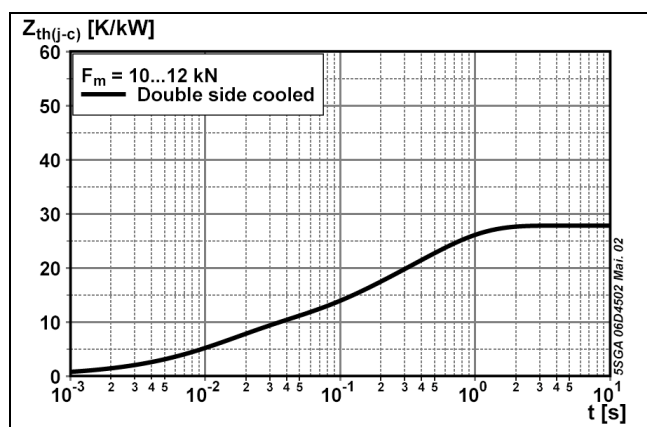


Fig. 1 Transient thermal impedance, junction to case.

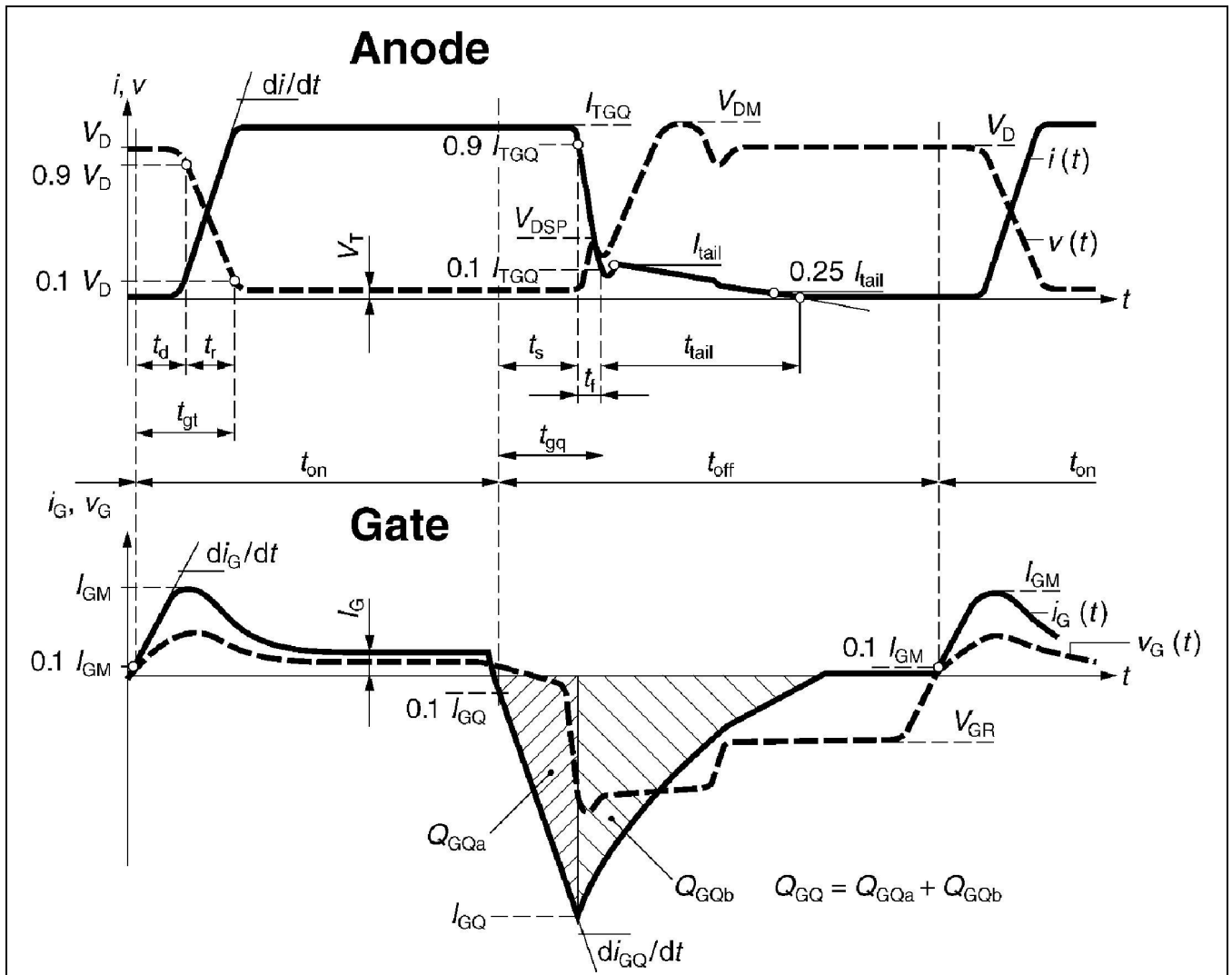
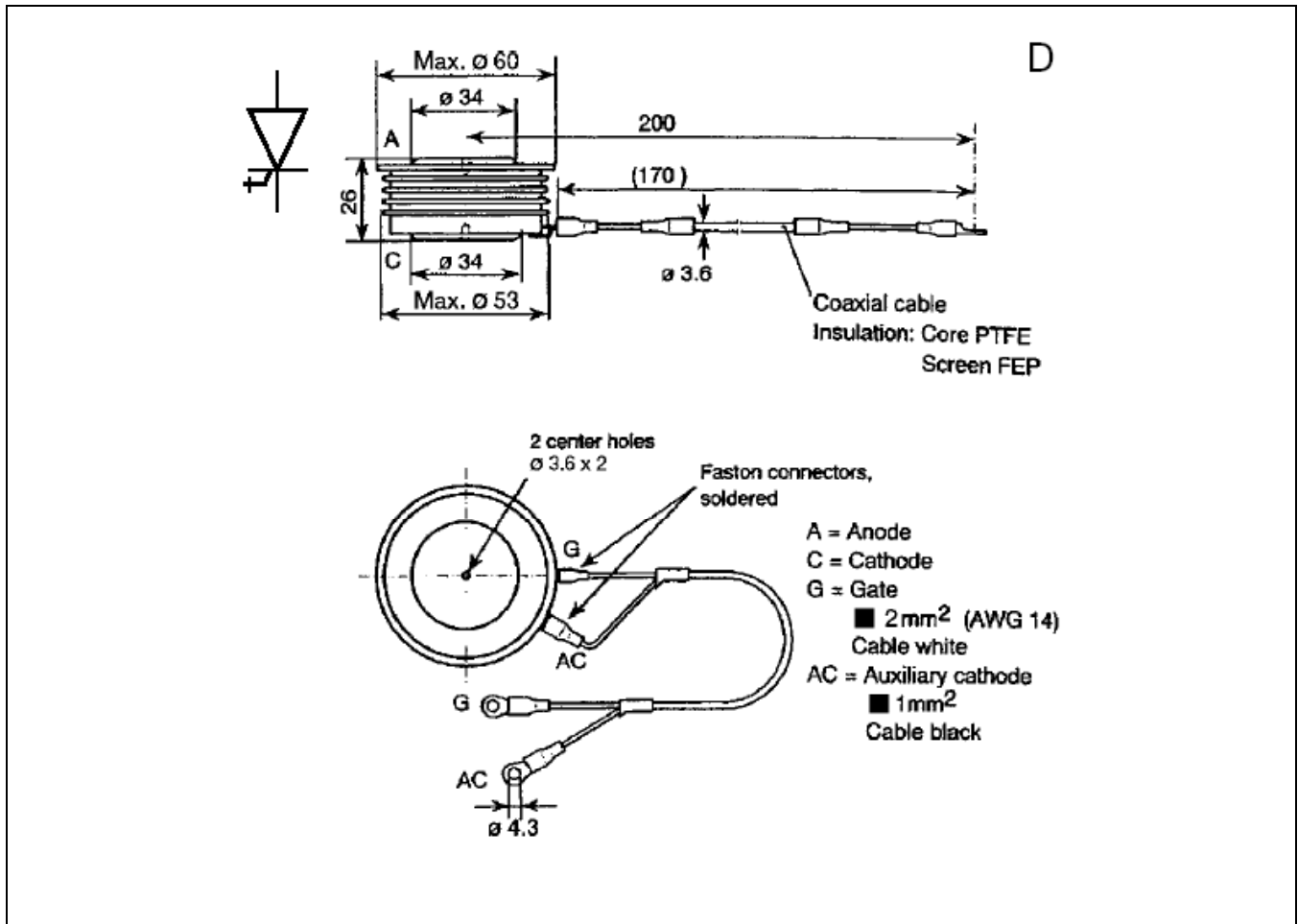


Fig. 2 General current and voltage waveforms with GTO-specific symbols.



**Fig. 3** 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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