$V_{DRM} = 4500 V$ 

 $I_{TGQM} = 3000 A$ 

 $I_{TSM} = 24 \text{ kA}$ 

 $V_{T0} = 1.80 V$ 

 $r_T = 0.70 \text{ m}\Omega$ 

 $V_{DClin} = 3000 V$ 

## **Gate turn-off Thyristor**

5SGF 30J4502

## **PRELIMINARY**

Doc. No. 5SYA 1211-04 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 30J4502 is a 85 mm buffered layer GTO with exceptionally low dynamic and static losses designed to retro-fit all former 3 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 108 mm wide and 26 mm thick.

**Blocking** 

	<u> </u>					
$V_{DRM}$	Repetitive peak off-state voltage		4500	V	$V_{GR} \ge 2V$	
$V_{RRM}$	Repetitive peak reverse voltage		17	V		
I <sub>DRM</sub>	Repetitive peak off-state current	<b>≤</b>	100	mΑ	$V_D = V_{DRM}$ $V_{GR} \ge 2V$	
I <sub>RRM</sub>	Repetitive peak reverse current	<	50	mΑ	$V_R = V_{RRM}$ $R_{GK} = \infty$	
$V_{DClink}$	Permanent DC voltage for 100 FIT failure rate		3000	V	$-40 \le T_j \le 125$ °C. Ambient cosmic radiation at sea level in open air.	
	1 11 Idilato tato				'	

#### Mechanical data (see Fig. 19)

F <sub>m</sub>	Mounting force	min.		28	kN
	Mounting force	max.		38	kN
Α	Acceleration:				
	Device unclamped			50	m/s <sup>2</sup> m/s <sup>2</sup>
	Device clamped			200	m/s <sup>2</sup>
М	Weight			1.3	kg
Ds	Surface creepage distance		2	33	mm
Da	Air strike distance			15	mm



### **GTO Data**

#### On-state

$I_{TAVM}$	Max. average on-state current	960 A	Half sine wave, T <sub>C</sub> = 85 °C			
I <sub>TRMS</sub>	Max. RMS on-state current	1510 A				
I <sub>TSM</sub>	Max. peak non-repetitive	24 kA	$t_P = 10 \text{ ms}  T_j = 125^{\circ}\text{C}$			
	surge current	40 kA	$t_P = 1 \text{ ms}$ After surge:			
l <sup>2</sup> t	Limiting load integral	2.88·10 <sup>6</sup> A <sup>2</sup> s	$t_P = 10 \text{ ms}$ $V_D = V_R = 0V$			
		0.80·10 <sup>6</sup> A <sup>2</sup> s	t <sub>P</sub> = 1 ms			
V <sub>T</sub>	On-state voltage	3.90 V	I <sub>T</sub> = 3000 A			
V <sub>T0</sub>	Threshold voltage	1.80 V	I <sub>T</sub> = 400 - 4000 A T <sub>j</sub> = 125 °C			
r <sub>T</sub>	Slope resistance	0.70 mΩ				
I <sub>H</sub>	Holding current	100 A	T <sub>j</sub> = 25 °C			

#### Gate

$V_{GT}$	Gate trigger voltage	1.2 V	V	D	= 24 V	T <sub>j</sub> =	25 °C	
I <sub>GT</sub>	Gate trigger current	2.5 A	F	RA	= $0.1 \Omega$			
$V_{GRM}$	Repetitive peak reverse voltage	17 V						
I <sub>GRM</sub>	Repetitive peak reverse current	20 m	A V	GR	= V <sub>GRM</sub>			

**Turn-on switching** 

	un on switching						
di/dt <sub>crit</sub>	Max. rate of rise of on-state	500 A/μs	f = 200Hz	$I_T = 3000$	Α,	$T_j =$	125 °C
	current	1000 A/µs	f = 1Hz	$I_{GM} = 25$	$A, di_G$	/dt =	= 20 A/μs
t <sub>d</sub>	Delay time	2.5 µs	V <sub>D</sub> =	0.5 V <sub>DRM</sub>	Tj	=	125 °C
t <sub>r</sub>	Rise time	5.0 µs	I <sub>T</sub> = 30	000 A	di/dt	=	300 A/μs
t <sub>on(min)</sub>	Min. on-time	100 µs	I <sub>GM</sub> =	25 A	di <sub>G</sub> /dt	=	20 A/μs
E <sub>on</sub>	Turn-on energy per pulse	2.50 Ws	C <sub>S</sub> =	3 µF	$R_s$	=	5 Ω

**Turn-off switching** 

1 4111 01	i switching			
I <sub>TGQM</sub>	Max controllable turn-off	3000 A	$V_{DM} = V_{DRM}$ $di_{GQ}/dt = 4$	40 A/µs
	current		$C_S = 3  \mu F$ $L_S \leq$	0.2 µH
ts	Storage time	25.0 µs	$V_D = \frac{1}{2} V_{DRM} V_{DM} = \frac{1}{2} V_{DRM} V_{DM} = \frac{1}{2} V_{DRM} V_{DM} = \frac{1}{2} V_{DRM} V_{DM} V$	$V_{DRM}$
t <sub>f</sub>	Fall time	3.0 µs	$T_j = 125  ^{\circ}C  di_{GQ}/dt =$	40 A/μs
t <sub>off(min)</sub>	Min. off-time	100 µs	$I_{TGQ} = I_{TGQM}$	
E <sub>off</sub>	Turn-off energy per pulse	10.0 Ws	$C_S$ = 3 $\mu F$ $R_S$ =	5 Ω
I <sub>GQM</sub>	Peak turn-off gate current	800 A	$L_S \leq 0.2 \ \mu H$	

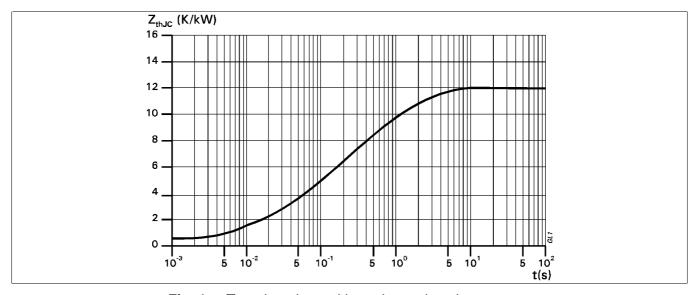
#### **Thermal**

T <sub>j</sub>	Storage and operating	-40125°C	
	junction temperature range		
R <sub>thJC</sub>	Thermal resistance	22 K/kW	Anode side cooled
	junction to case	27 K/kW	Cathode side cooled
		12 K/kW	Double side cooled
R <sub>thCH</sub>	Thermal resistance case to	6 K/kW	Single side cooled
	heat sink	3 K/kW	Double side cooled

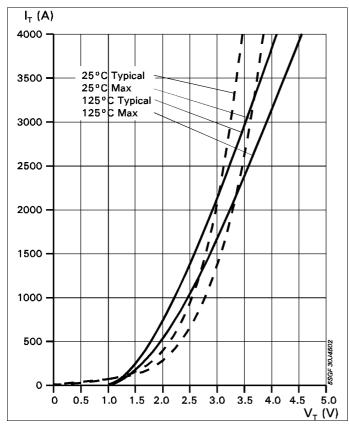
# Analytical function for transient thermal impedance:

$$Z_{thJC}(t) = \sum_{i=1}^{4} R_i(1 - e^{-t/\tau_i})$$

i	1	2	3	4
R <sub>I</sub> (K/kW)	5.4	4.5	1.7	0.4
τ <sub>i</sub> (s)	1.2	0.17	0.01	0.001



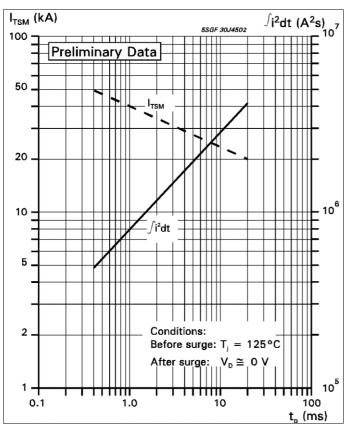
**Fig. 1** Transient thermal impedance, junction to case.



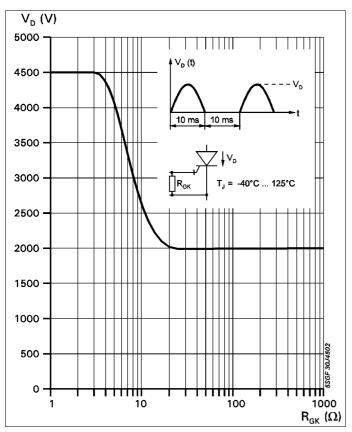
P<sub>AV</sub> (kW) 4.50 4.00 3.50 DC 180° Л 3.00 180° sine 120° Л 60° Л 2.50 2.00 1.50 1.00 0.50 0.00 200 400 600 800 1000 1200 1400 1600 0

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.

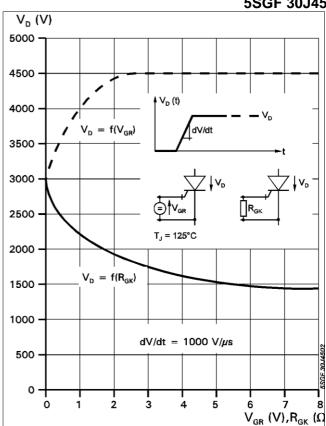
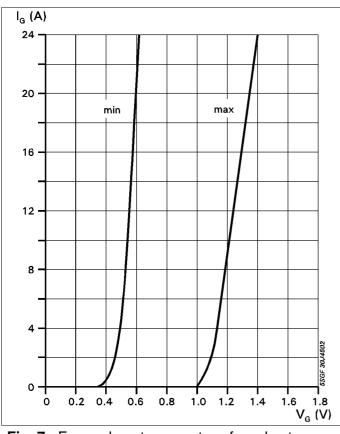


Fig. 6 Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.



**Fig. 7** Forwarde gate current vs. forard gate voltage.

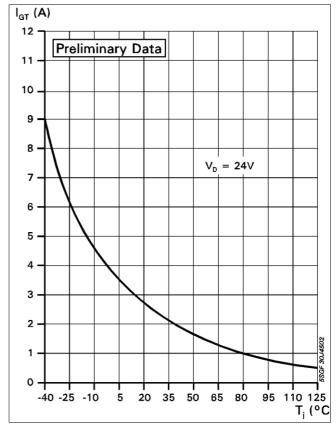
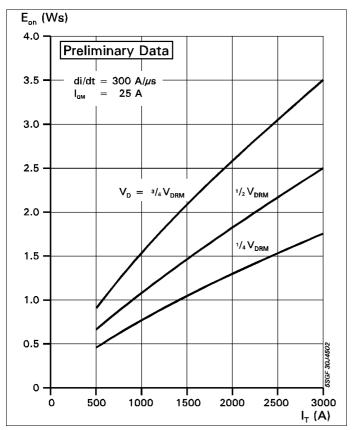
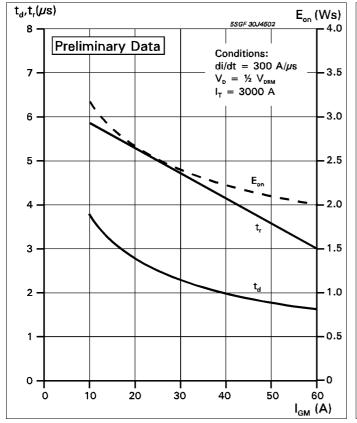


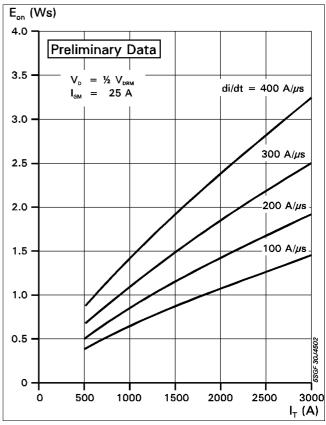
Fig. 8 Gate trigger current vs. junction temperature



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



**Fig. 11** 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

Common Test conditions for figures 9, 10 and 11:

$$di_G/dt = 20 \text{ A/}\mu\text{s}$$
 $C_S = 3 \mu\text{F}$ 
 $R_S = 5 \Omega$ 
 $Tj = 125 ^{\circ}\text{C}$ 

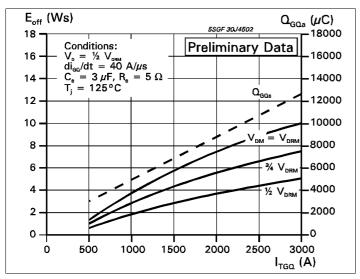
Definition of Turn-on energy:

$$Eon = \int_{0}^{20 \,\mu s} V_D \cdot I \tau dt \quad (t = 0, I_G = 0.1 \cdot I_{GM})$$

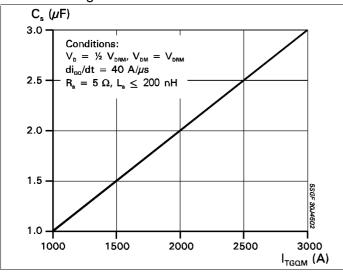
Common Test conditions for figures 12, 13 and 15:

Definition of Turn-off energy:

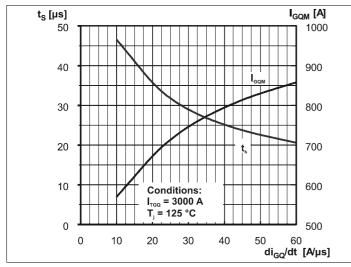
$$E_{off} = \int_{0}^{40 \,\mu s} V_D \cdot I_T dt \quad \text{(t = 0, I_T = 0.9 · I_{TGQ})}$$



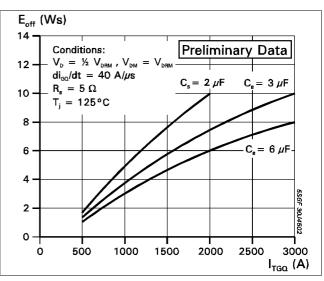
**Fig. 12** Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.



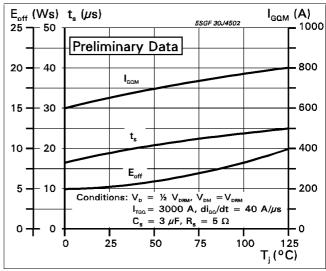
**Fig. 14** Required snubber capacitor vs. max allowable turn-off current.



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



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



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

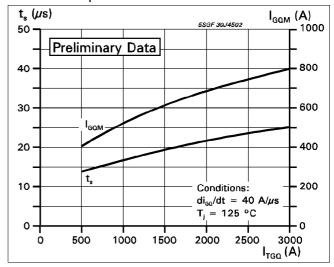


Fig. 17 Storage time and peak turn-off gate current vs. turn-off current

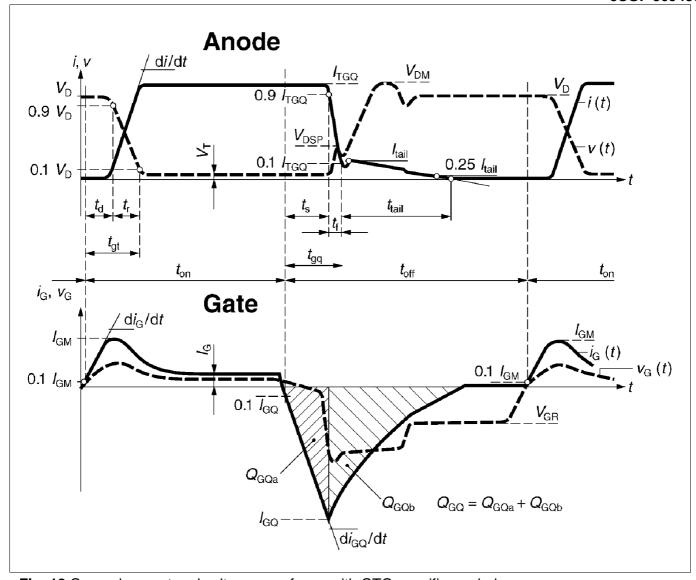
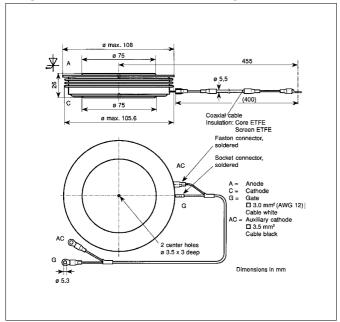


Fig. 18 General current and voltage waveforms with GTO-specific symbols



**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.

ABB Semiconductors AG reserves the right to change specifications without notice.



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