

# 5SNA 2000K451300

## StakPak IGBT Module

$V_{CE} = 4500 \text{ V}$   
 $I_C = 2000 \text{ A}$

Low-loss, rugged SPT+ chip-set  
 Smooth switching SPT+ chip-set for good EMC  
 High tolerance to uneven mounting pressure  
 Explosion resistant package



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

Parameter	Symbol	Conditions	min	max	Unit
Collector-emitter voltage	$V_{CES}$	$V_{GE} = 0 \text{ V}$ , $T_{vj} \geq 25 \text{ °C}$		4500	V
DC collector current	$I_C$	$T_C = 85 \text{ °C}$ , $T_{vj} = 125 \text{ °C}$		2000	A
Peak collector current	$I_{CM}$	$t_p = 1 \text{ ms}$		4000	A
Gate-emitter voltage	$V_{GES}$		-20	20	V
Total power dissipation	$P_{tot}$	$T_C = 25 \text{ °C}$ , $T_{vj} = 125 \text{ °C}$		20800	W
DC forward current	$I_F$			2000	A
Peak forward current	$I_{FRM}$	$t_p = 1 \text{ ms}$		4000	A
Surge current	$I_{FSM}$	$V_R = 0 \text{ V}$ , $T_{vj} = 125 \text{ °C}$ , $t_p = 10 \text{ ms}$ , half-sinewave		14000	A
IGBT short circuit SOA	$t_{psc}$	$V_{CC} = 3400 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 4500 \text{ V}$ $V_{GE} \leq 15 \text{ V}$ , $T_{vj} \leq 125 \text{ °C}$		10	$\mu\text{s}$
Junction temperature	$T_{vj}$		-50	150	$^{\circ}\text{C}$
Junction operating temperature	$T_{vj(op)}$		-50	125	$^{\circ}\text{C}$
Case temperature	$T_C$		-50	125	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		-50	70	$^{\circ}\text{C}$
Mounting force <sup>2)3)</sup>	$F_M$		60	90	kN

<sup>1)</sup> Maximum rated values indicate limits beyond which damage to the device may occur per IEC 60747

<sup>2)</sup> For detailed mounting instructions refer to ABB document no. 5SYA 2037-02

<sup>3)</sup> All electrical characteristics are valid only when the module is clamped

## IGBT characteristic values <sup>4)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit	
Collector (-emitter) breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0 \text{ V}$ , $I_C = 10 \text{ mA}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$	4500			V	
Collector-emitter <sup>5)</sup> saturation voltage	$V_{CE \text{ sat}}$	$I_C = 2000 \text{ A}$ , $V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	2.55	2.85	3.15	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	3.35	3.65	3.95	V
Collector cut-off current	$I_{CES}$	$V_{CE} = 4500 \text{ V}$ , $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$			1	mA
			$T_{vj} = 125 \text{ }^\circ\text{C}$		50	100	mA
Gate leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}$ , $V_{GE} = \pm 20 \text{ V}$ , $T_{vj} = 125 \text{ }^\circ\text{C}$	-500		500	nA	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 320 \text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$	5.3		7.3	V	
Gate charge	$Q_G$	$I_C = 2000 \text{ A}$ , $V_{CE} = 2800 \text{ V}$ , $V_{GE} = -15 \text{ V} \dots 15 \text{ V}$		9.6		$\mu\text{C}$	
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$		186		nF	
Output capacitance	$C_{oes}$			13.4		nF	
Reverse transfer capacitance	$C_{res}$			3.7		nF	
Internal gate resistor	$R_{Gint}$			0.16		$\Omega$	
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 2000 \text{ A}$ , $R_G = 1.8 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	820		ns	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	690		ns	
Rise time	$t_r$	$V_{CC} = 2800 \text{ V}$ , $I_C = 2000 \text{ A}$ , $R_G = 1.8 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	530		ns	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	540		ns	
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 2000 \text{ A}$ , $R_G = 8.2 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	3990		ns	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	4410		ns	
Fall time	$t_f$	$V_{CC} = 2800 \text{ V}$ , $I_C = 2000 \text{ A}$ , $R_G = 8.2 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	710		ns	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	800		ns	
Turn-on switching energy	$E_{on}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 2000 \text{ A}$ , $R_G = 1.8 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	8110		mJ	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	9960		mJ	
Turn-off switching energy	$E_{off}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 2000 \text{ A}$ , $R_G = 8.2 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	7670		mJ	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	9790		mJ	
Short circuit current	$I_{sc}$	$t_{psc} \leq 10 \text{ } \mu\text{s}$ , $V_{GE} = 15 \text{ V}$ , $V_{CC} = 3400 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 4500 \text{ V}$	$T_{vj} = 125 \text{ }^\circ\text{C}$	7800		A	

<sup>4)</sup> Characteristic values according to IEC 60747 - 9

<sup>5)</sup> Collector-emitter saturation voltage is given at chip level

## Diode characteristic values <sup>6)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit
Forward voltage <sup>7)</sup>	$V_F$	$I_F = 2000 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	2.6	2.9	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	3.0	3.4	V
Peak reverse recovery current	$I_{RM}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	1670		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1950		A
Recovered charge	$Q_r$	$V_{CC} = 2800 \text{ V}$ , $I_F = 2000 \text{ A}$ , $V_{GE} = \pm 15 \text{ V}$ , $R_G = 1.8 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ , $di/dt = 3.8 \text{ kA}/\mu\text{s}$ $L_\sigma = 200 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	1770		$\mu\text{C}$
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2710		$\mu\text{C}$
Reverse recovery time	$t_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	2030		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2340		ns
Reverse recovery energy	$E_{rec}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	2930		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	4690		mJ

<sup>6)</sup> Characteristic values according to IEC 60747 - 2

<sup>7)</sup> Forward voltage is given at chip level

## Package properties

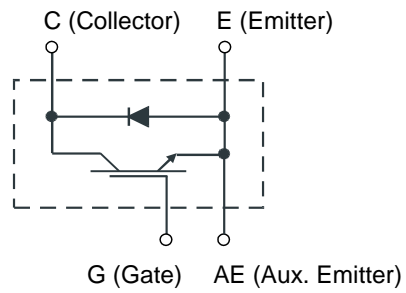
Parameter	Symbol	Conditions	min	typ	max	Unit
IGBT thermal resistance junction to case	$R_{th(j-c)IGBT}$				0.0048	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.0091	K/W
IGBT thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-h)IGBT}$	Heatsink flatness : Complete module area < 100 $\mu\text{m}$ Each submodule area < 20 $\mu\text{m}$ Roughness : < 1.6 $\mu\text{m}$		0.0011		K/W
Diode thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-h)DIODE}$			0.0023		K/W
Comparative tracking index	CTI		600			

<sup>2)</sup> for detailed mounting instructions refer to ABB Document No. 5SYA 2037-02

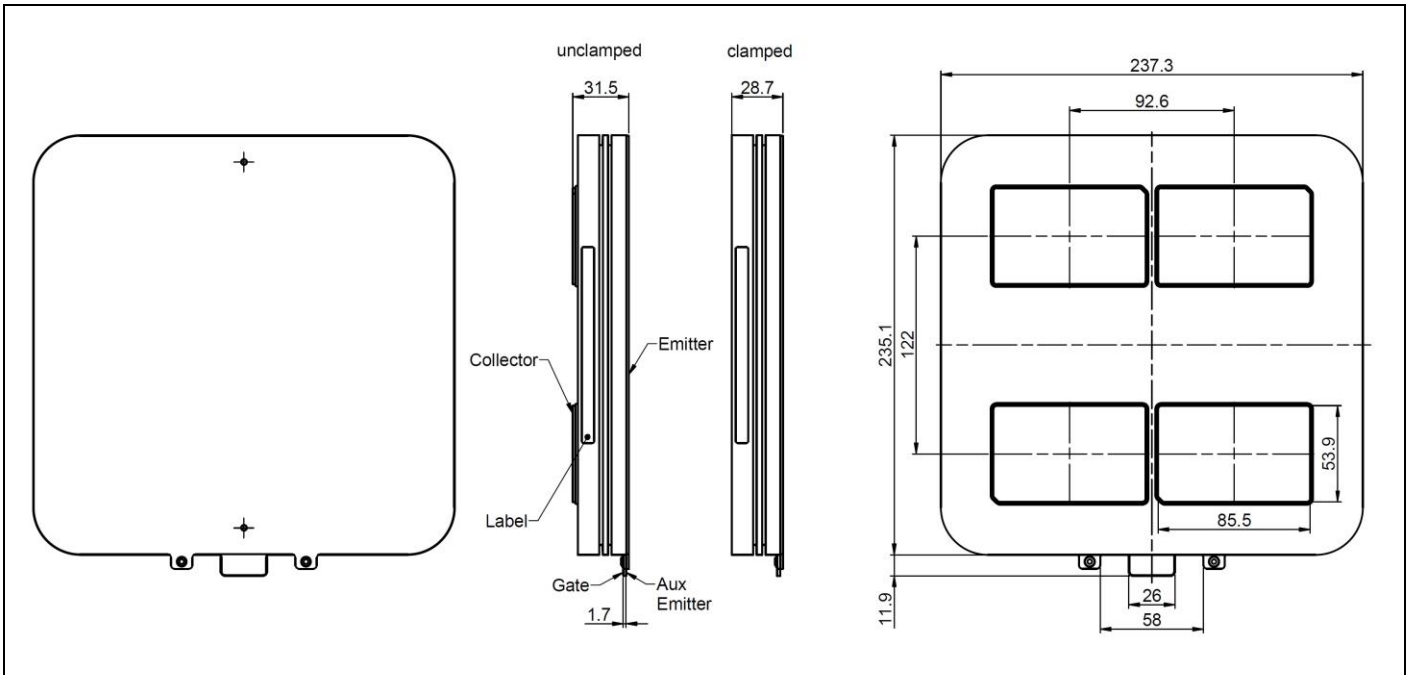
## Mechanical properties

Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	L x W x H	Typical	device clamped	246.95 x 237.3 x 28.75		mm
			device unclamped	246.95 x 237.3 x 31.5		
Clearance distance in air	$d_a$	according to IEC 60664-1 and EN 50124-1	23			mm
Surface creepage distance	$d_s$	according to IEC 60664-1 and EN 50124-1	40			mm
Mass	m			3745		g

## Electrical configuration



## Outline drawing <sup>2)</sup>



Note: all dimensions are shown in millimeters

<sup>2)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA 2039

This is an electrostatic sensitive device; please observe the international standard IEC 60747-1, chap. VIII.  
This product has been designed and qualified for Industrial Level.

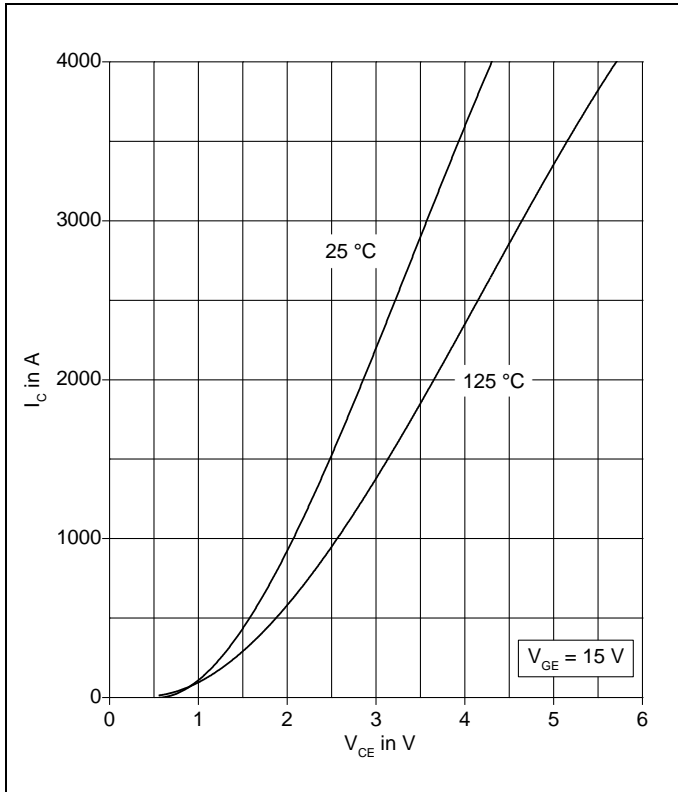


Fig. 1 Typical on-state characteristics, chip level

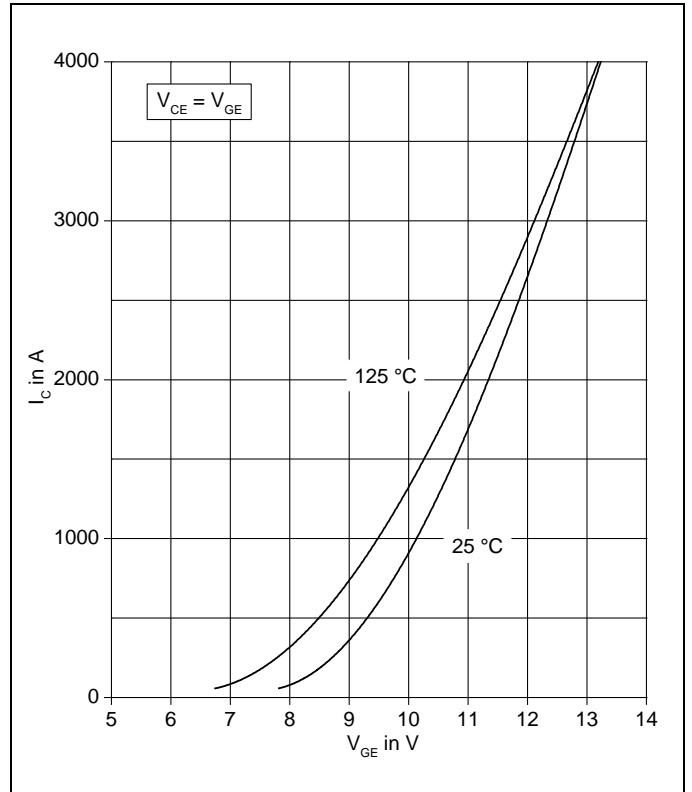


Fig. 2 Typical transfer characteristics, chip level

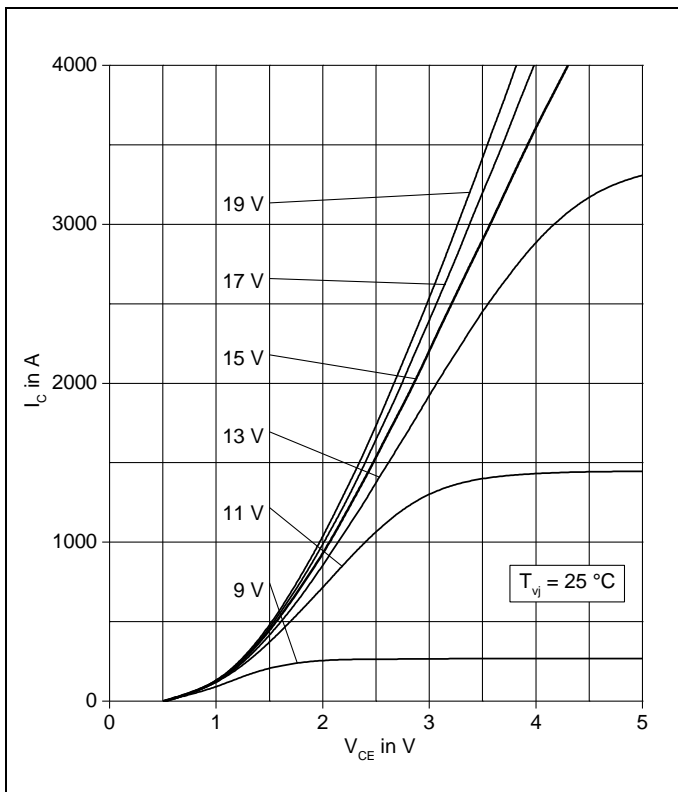


Fig. 3 Typical output characteristics, chip level

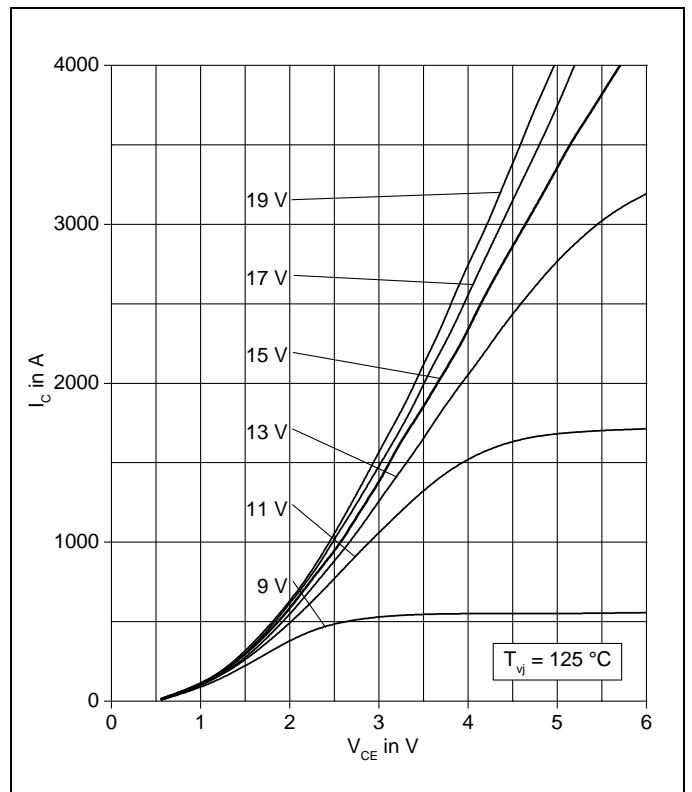


Fig. 4 Typical output characteristics, chip level

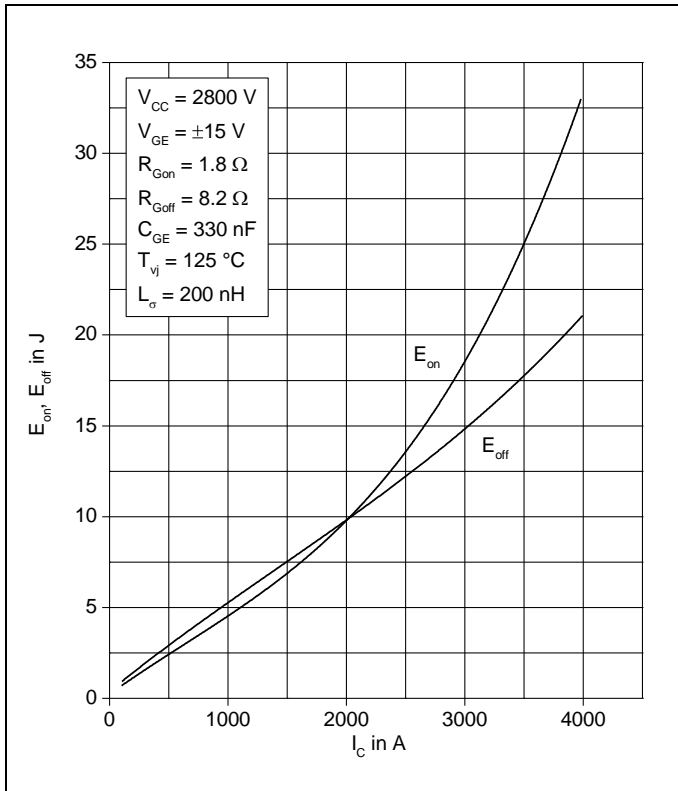


Fig. 5 Typical switching energies per pulse vs. collector current

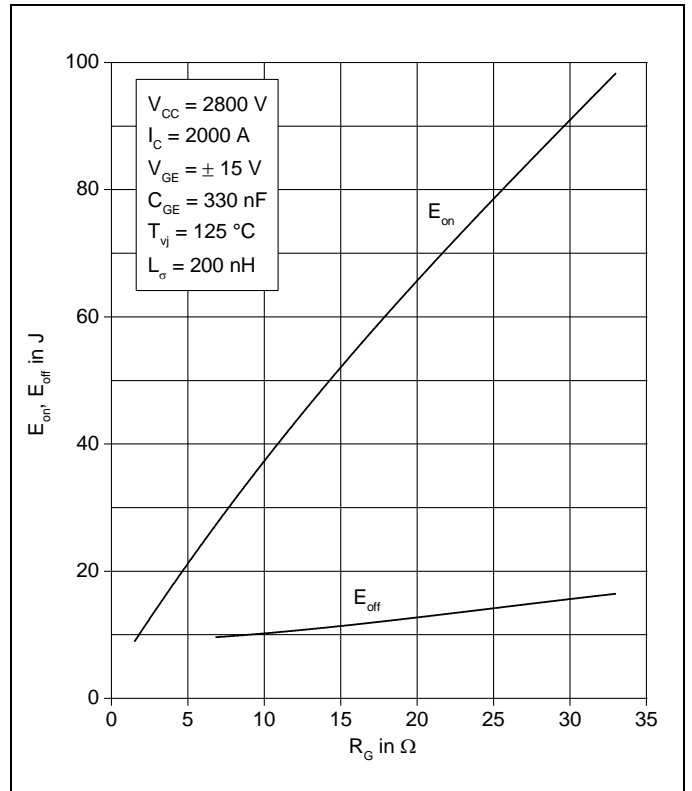


Fig. 6 Typical switching energies per pulse vs. gate resistor

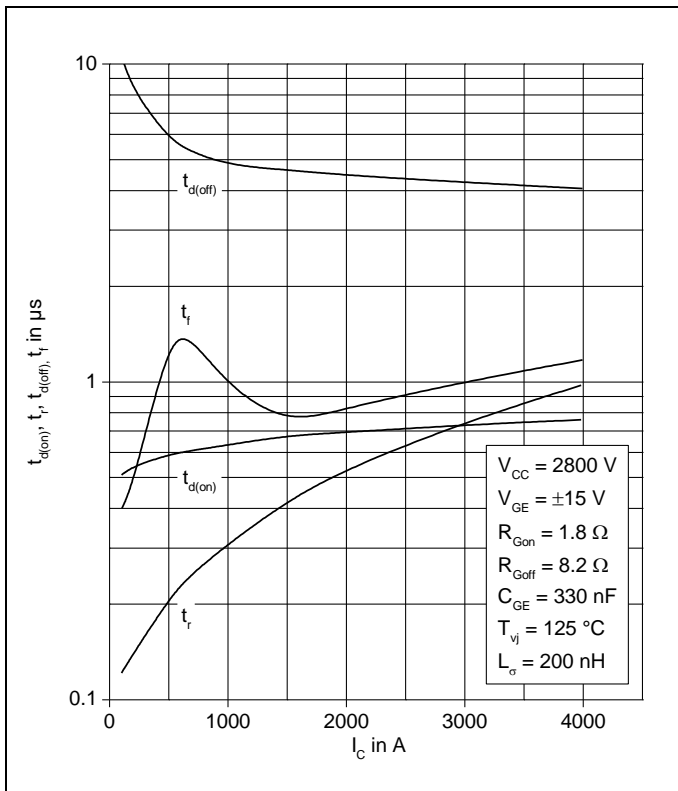


Fig. 7 Typical switching times vs. collector current

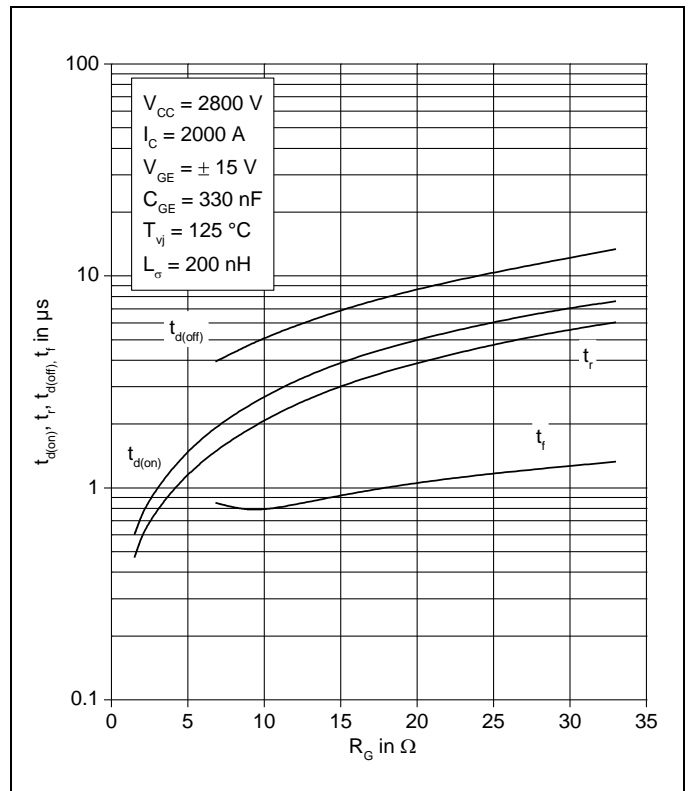


Fig. 8 Typical switching times vs. gate resistor

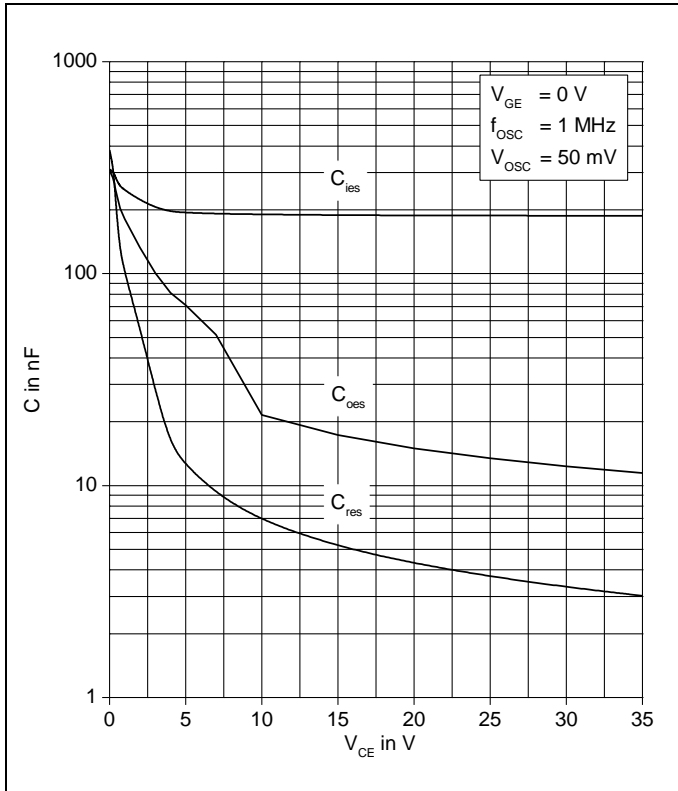


Fig. 9 Typical capacitances vs. collector-emitter voltage

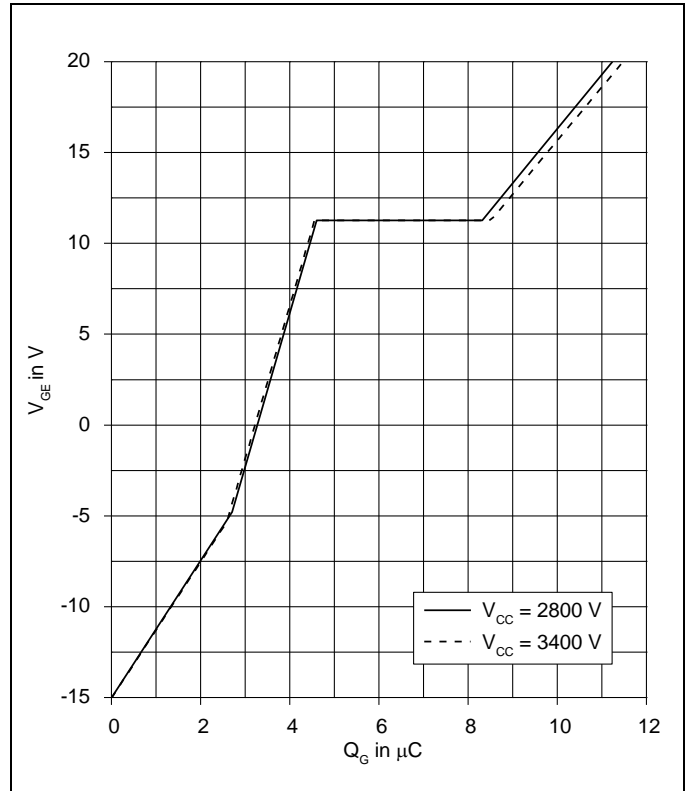


Fig. 10 Typical gate charge characteristics

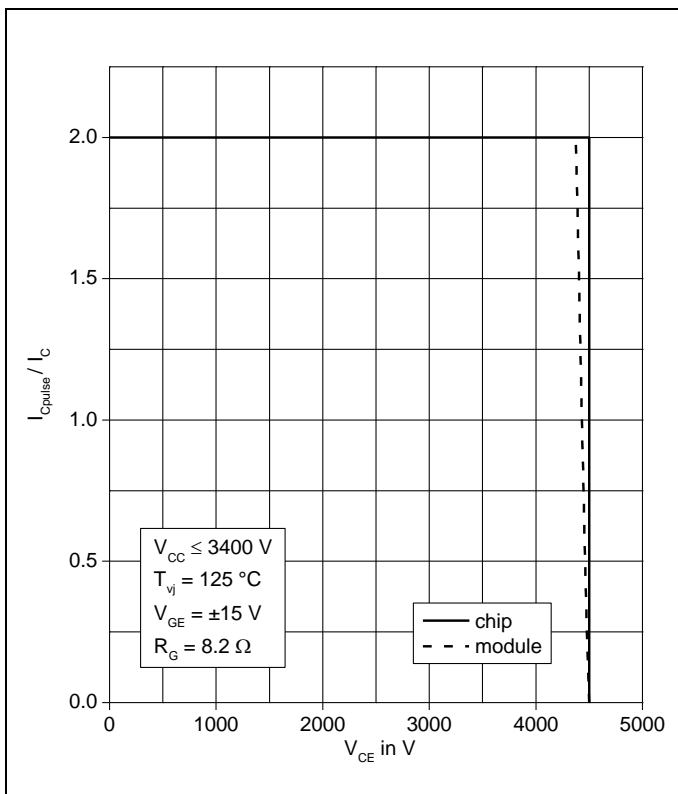


Fig. 11 Turn-off safe operating area (RBSOA)

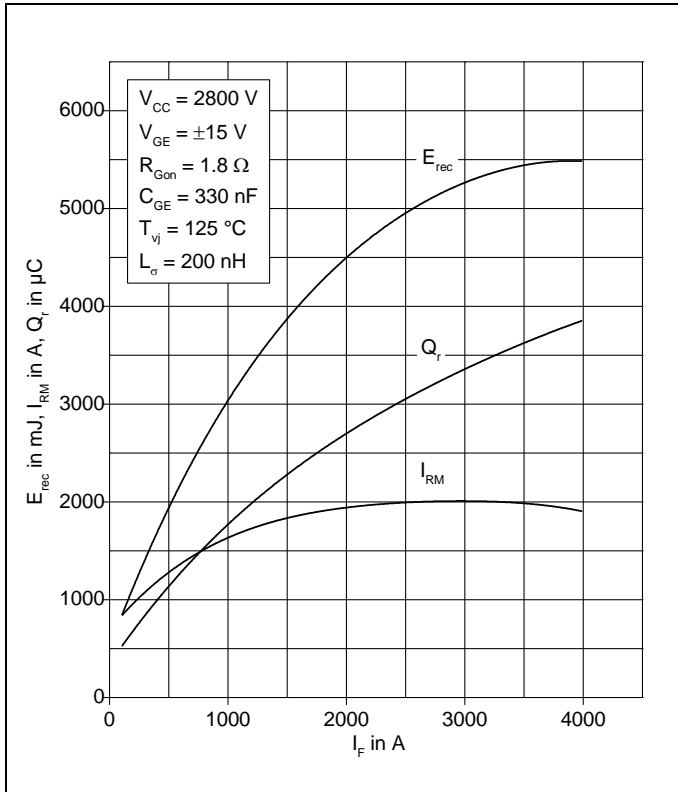


Fig. 12 Typical reverse recovery characteristics vs. forward current

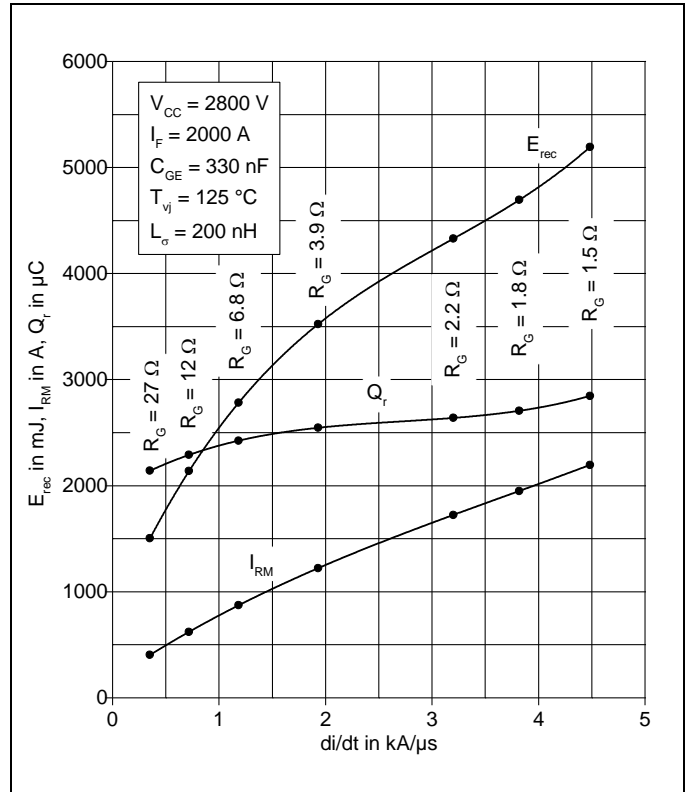


Fig. 13 Typical reverse recovery characteristics vs. di/dt

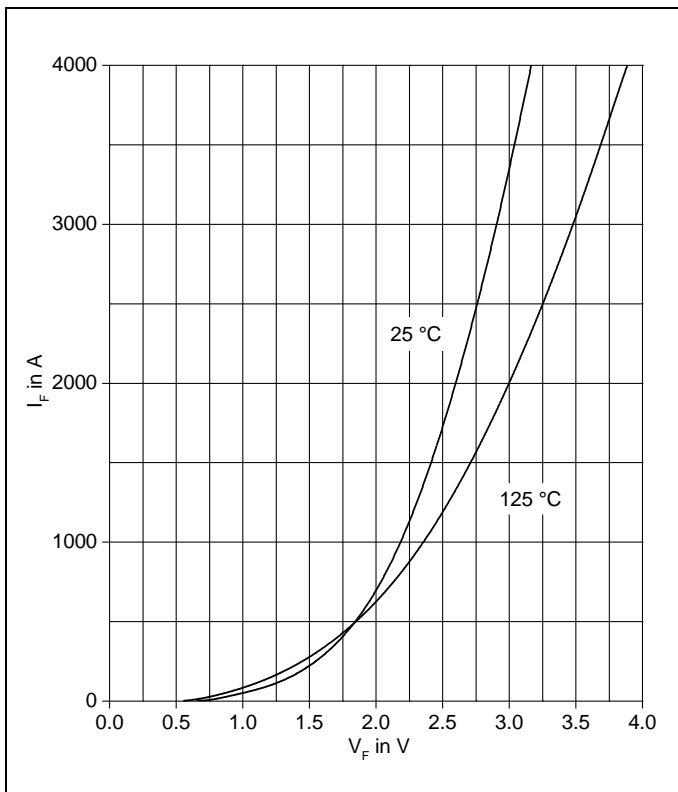


Fig. 14 Typical diode forward characteristics chip level

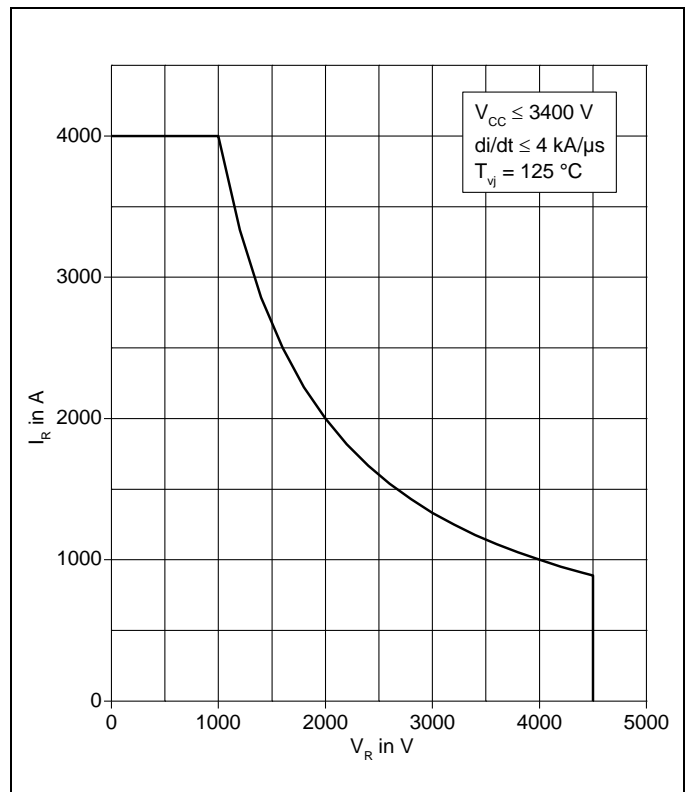


Fig. 15 Safe operating area diode (SOA)



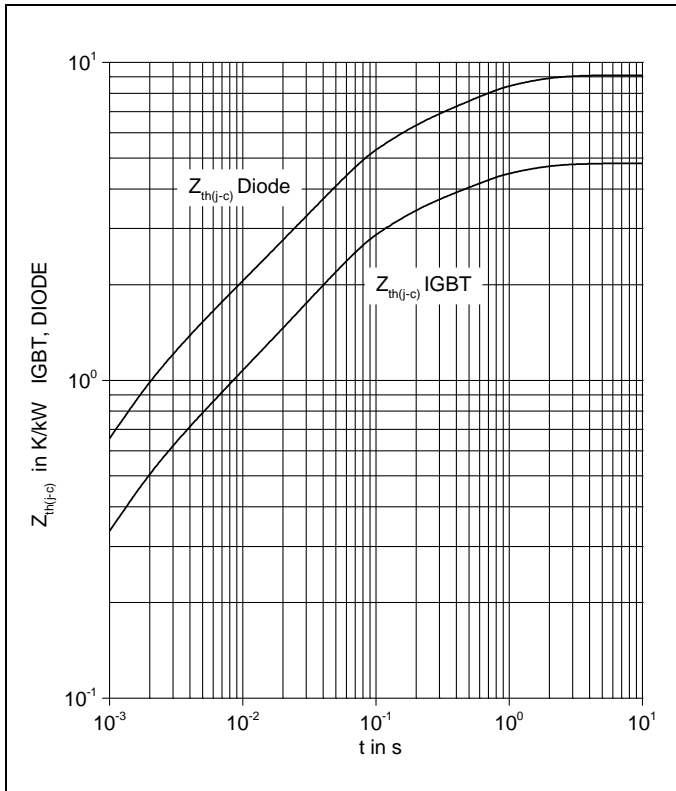


Fig. 16 Thermal impedance vs. time

Analytical function for transient thermal impedance:

$$Z_{th(j-c)}(t) = \sum_{i=1}^n R_i (1 - e^{-t/\tau_i})$$

i	1	2	3	4	5
<b>IGBT</b> R <sub>i</sub> in K/kW	1.801	2.234	0.403	0.369	
<b>IGBT</b> τ <sub>i</sub> in s	0.581	0.059	0.006	0.001	
<b>DIODE</b> R <sub>i</sub> in K/kW	3.614	3.958	0.803	0.727	
<b>DIODE</b> τ <sub>i</sub> in s	0.584	0.059	0.006	0.001	

ABB Switzerland Ltd.  
Semiconductors  
Fabrikstrasse 3  
CH-5600 Lenzburg  
Switzerland

Phone: +41 58 586 1419  
Fax: +41 58 586 1306  
E-Mail: [abbsem@ch.abb.com](mailto:abbsem@ch.abb.com)  
Internet: [www.abb.com/semiconductors](http://www.abb.com/semiconductors)

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