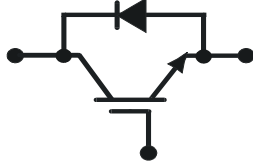


$V_{CE} = 4500\text{ V}$   
 $I_C = 650\text{ A}$

**ABB HiPak**

**IGBT Module**  
**5SNA 0650J450300**



Doc. No. 5SYA 1598-05 05-2016

- Ultra low-loss, rugged SPT+ chip-set
- Smooth switching SPT+ chip-set for good EMC
- Industry standard package
- High power density
- AlSiC base-plate for high power cycling capability
- AlN substrate for low thermal resistance
- Improved high reliability package
- Recognized under UL1557, File E196689



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

Parameter	Symbol	Conditions	min	max	Unit
Collector-emitter voltage	$V_{CES}$	$V_{GE} = 0\text{ V}$		4500	V
DC collector current	$I_C$	$T_c = 85\text{ °C}$		650	A
Peak collector current	$I_{CM}$	$t_p = 1\text{ ms}, T_c = 85\text{ °C}$		1300	A
Gate-emitter voltage	$V_{GES}$		-20	20	V
Total power dissipation	$P_{tot}$	$T_c = 25\text{ °C}$ , per switch (IGBT)		6670	W
DC forward current	$I_F$			650	A
Peak forward current	$I_{FRM}$			1300	A
Surge current	$I_{FSM}$	$V_R = 0\text{ V}, T_{vj} = 125\text{ °C}$ , $t_p = 10\text{ ms}$ , half-sinewave		5300	A
IGBT short circuit SOA	$t_{psc}$	$V_{CC} = 3400\text{ V}, V_{CEMCHIP} \leq 4500\text{ V}$ $V_{GE} \leq 15\text{ V}, T_{vj} \leq 125\text{ °C}$		10	$\mu\text{s}$
Isolation voltage	$V_{isol}$	1 min, $f = 50\text{ Hz}$		10.2	kV
Junction temperature	$T_{vj}$			125	$^{\circ}\text{C}$
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	125	$^{\circ}\text{C}$
Mounting torques <sup>2)</sup>	$M_s$	Base-heatsink, M6 screws	4	6	Nm
	$M_{t1}$	Main terminals, M8 screws	8	10	
	$M_{t2}$	Auxiliary terminals, M4 screws	2	3	

<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. 5SYA2039

**ABB Switzerland Ltd, Semiconductors reserves the right to change specifications without notice.**



IGBT characteristic values <sup>3)</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>4)</sup> saturation voltage	$V_{CE \text{ sat}}$	$I_C = 650 \text{ A}$ , $V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	2.9	3.3	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	3.7	4.2	V
Collector cut-off current	$I_{CES}$	$V_{CE} = 4500 \text{ V}$ , $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		8	mA
			$T_{vj} = 125 \text{ }^\circ\text{C}$		80	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	$V_{GE(TO)}$	$I_C = 160 \text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$	5.5		7.0	V
Gate charge	$Q_{ge}$	$I_C = 650 \text{ A}$ , $V_{CE} = 2800 \text{ V}$ , $V_{GE} = -15 \text{ V} \dots 15 \text{ V}$		5.4		$\mu\text{C}$
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$		71.4		nF
Output capacitance	$C_{oes}$			4.82		
Reverse transfer capacitance	$C_{res}$			1.28		
Internal gate resistance	$R_{Gint}$			0.81		$\Omega$
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 650 \text{ A}$ , $R_G = 2.2 \text{ } \Omega$ , $C_{GE} = 150 \text{ nF}$ ,	$T_{vj} = 25 \text{ }^\circ\text{C}$	700		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	700		
Rise time	$t_r$	$V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 150 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	160		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	170		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 650 \text{ A}$ , $R_G = 2.2 \text{ } \Omega$ , $C_{GE} = 150 \text{ nF}$ ,	$T_{vj} = 25 \text{ }^\circ\text{C}$	1670		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1920		
Fall time	$t_f$	$V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 150 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	420		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	540		
Turn-on switching energy	$E_{on}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 650 \text{ A}$ , $R_G = 2.2 \text{ } \Omega$ , $C_{GE} = 150 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 150 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	1500		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2100		
Turn-off switching energy	$E_{off}$	$V_{CC} = 2800 \text{ V}$ , $I_C = 650 \text{ A}$ , $R_G = 2.2 \text{ } \Omega$ , $C_{GE} = 150 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 150 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	2100		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2900		
Short circuit current	$I_{SC}$	$t_{psc} \leq 10 \text{ } \mu\text{s}$ , $V_{GE} = 15 \text{ V}$ , $T_{vj} = 125 \text{ }^\circ\text{C}$ , $V_{CC} = 3400 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 4500 \text{ V}$		2550		A
Module stray inductance	$L_{\sigma \text{ CE}}$			20		nH
Resistance, terminal-chip	$R_{CC'+EE'}$		$T_C = 25 \text{ }^\circ\text{C}$	0.1		m $\Omega$
			$T_C = 125 \text{ }^\circ\text{C}$	0.15		

<sup>3)</sup> Characteristic values according to IEC 60747 – 9<sup>4)</sup> Collector-emitter saturation voltage is given at chip level

**Diode characteristic values** <sup>5)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit	
Forward voltage <sup>6)</sup>	$V_F$	$I_F = 650 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		3.1	3.7	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$		3.4	4	
Reverse recovery current	$I_{rr}$	$V_{CC} = 2800 \text{ V},$ $I_F = 650 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 2.2 \text{ } \Omega,$	$T_{vj} = 25 \text{ }^\circ\text{C}$		830		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$		930		
Recovered charge	$Q_{rr}$	$C_{GE} = 150 \text{ nF},$ $L_\sigma = 150 \text{ nH}$ inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		560		$\mu\text{C}$
			$T_{vj} = 125 \text{ }^\circ\text{C}$		930		
Reverse recovery time	$t_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$		1180		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1700		
Reverse recovery energy	$E_{rec}$		$T_{vj} = 25 \text{ }^\circ\text{C}$		910		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1610		

<sup>5)</sup> Characteristic values according to IEC 60747 – 2

<sup>6)</sup> Forward voltage is given at chip level

**Package properties** <sup>7)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit
IGBT thermal resistance junction to case	$R_{th(j-c)IGBT}$				0.015	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.030	K/W
IGBT thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-s)IGBT}$	IGBT per switch, $\lambda$ grease = $1\text{W/m} \times \text{K}$		0.013		K/W
Diode thermal resistance <sup>7)</sup> case to heatsink	$R_{th(c-s)DIODE}$	Diode per switch, $\lambda$ grease = $1\text{W/m} \times \text{K}$		0.027		K/W
Partial discharge extinction voltage	$V_e$	$f = 50 \text{ Hz}, Q_{PD} \leq 10\text{pC}$ (acc. to IEC 61287)	5100			V
Comparative tracking index	CTI			$\geq 600$		

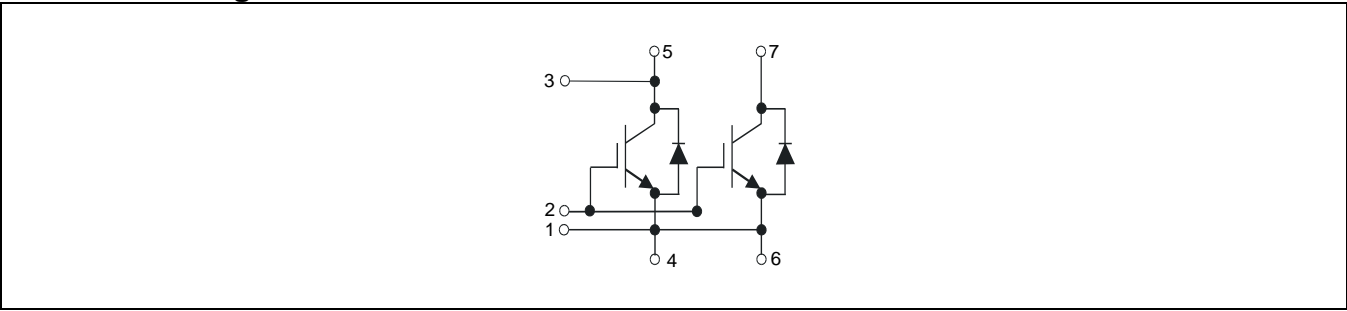
<sup>2)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA2039

**Mechanical properties** <sup>7)</sup>

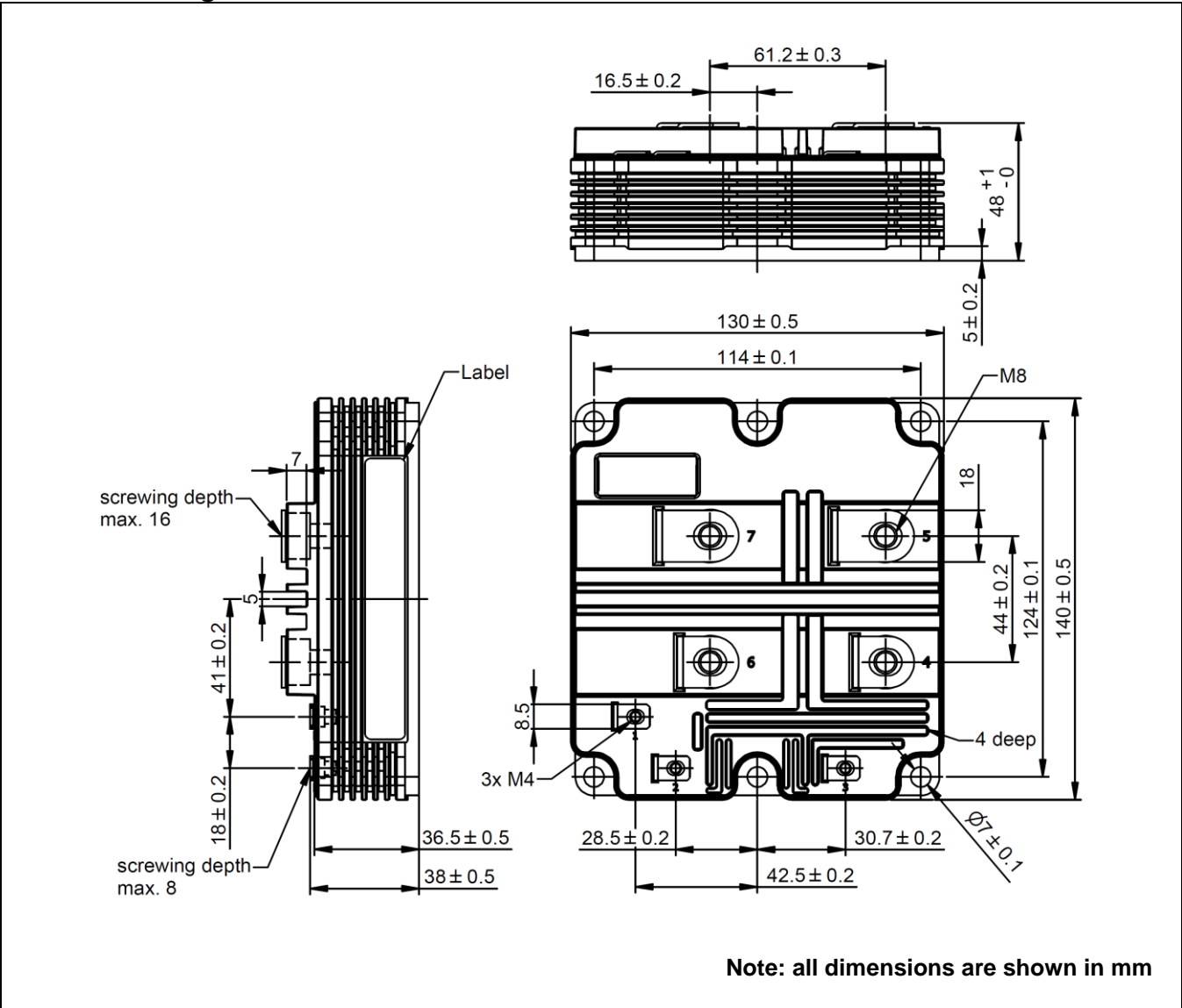
Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	$L \times W \times H$	Typical , see outline drawing		130 x 140 x 48		mm
Clearance distance in air	$d_a$	according to IEC 60664-1 and EN 50124-1	Term. to base:	40		mm
			Term. to term:	26		
Surface creepage distance	$d_s$	according to IEC 60664-1 and EN 50124-1	Term. to base:	64		mm
			Term. to term:	56		
Mass	$m$			1010		g

<sup>7)</sup> Package and mechanical properties according to IEC 60747 – 15

Electrical configuration



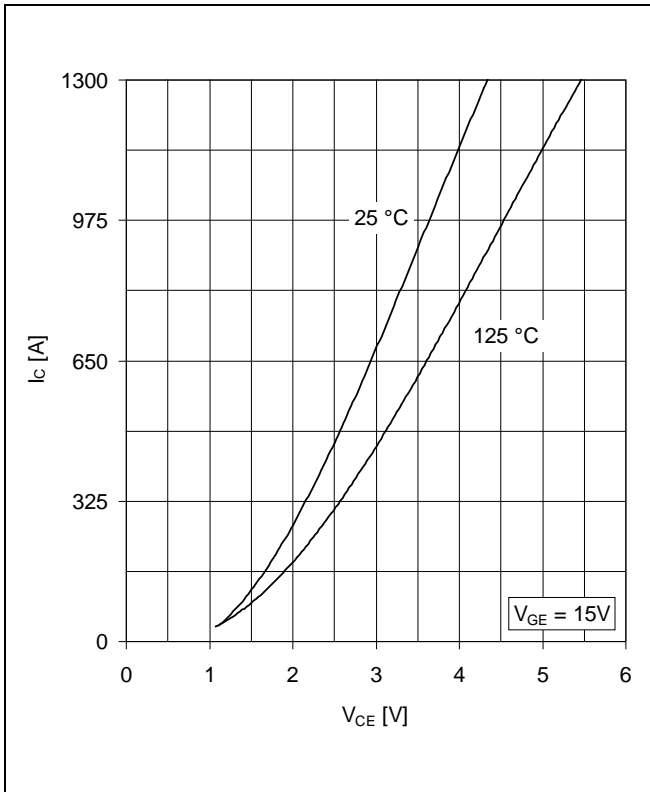
Outline drawing <sup>2)</sup>



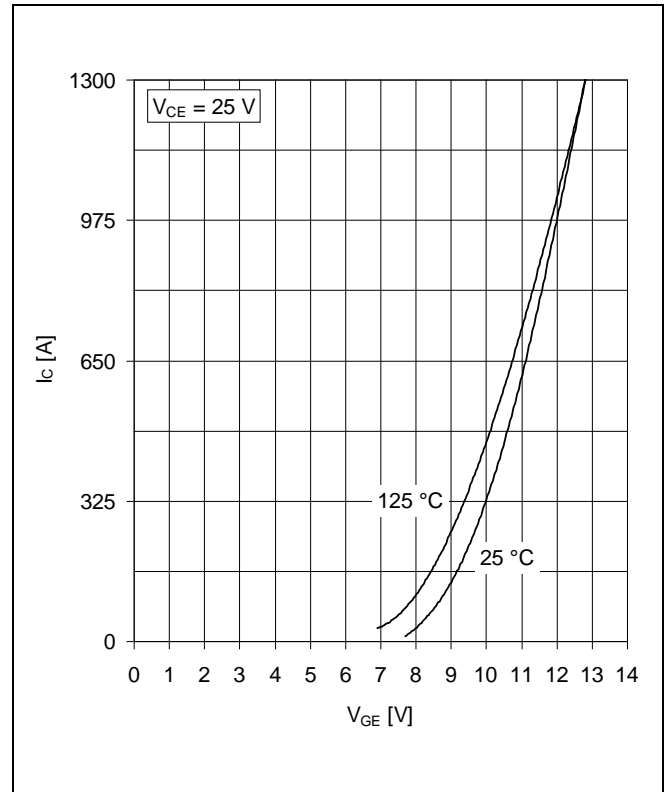
<sup>2)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA2039

This is an electrostatic sensitive device, please observe the international standard IEC 60747-1, chap. IX.

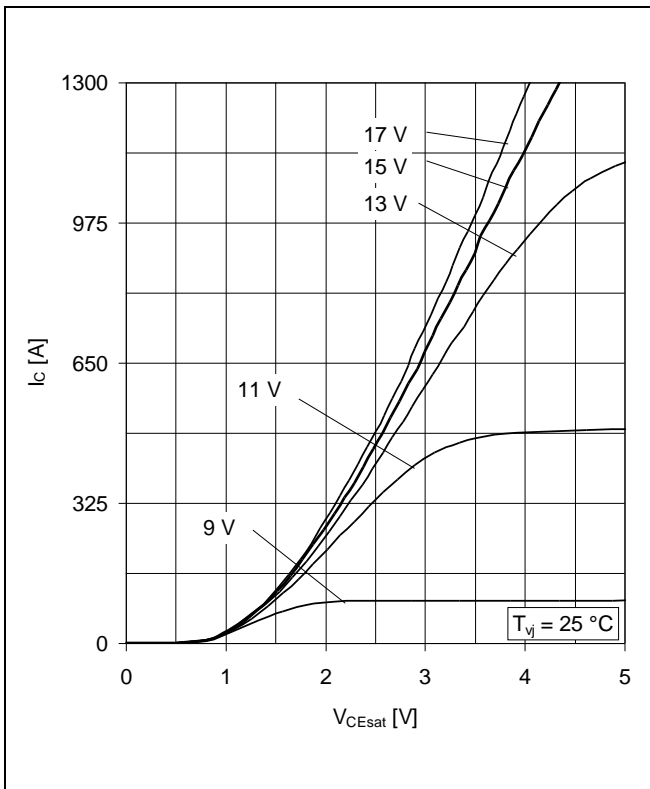
This product has been designed and qualified for Industrial Level.



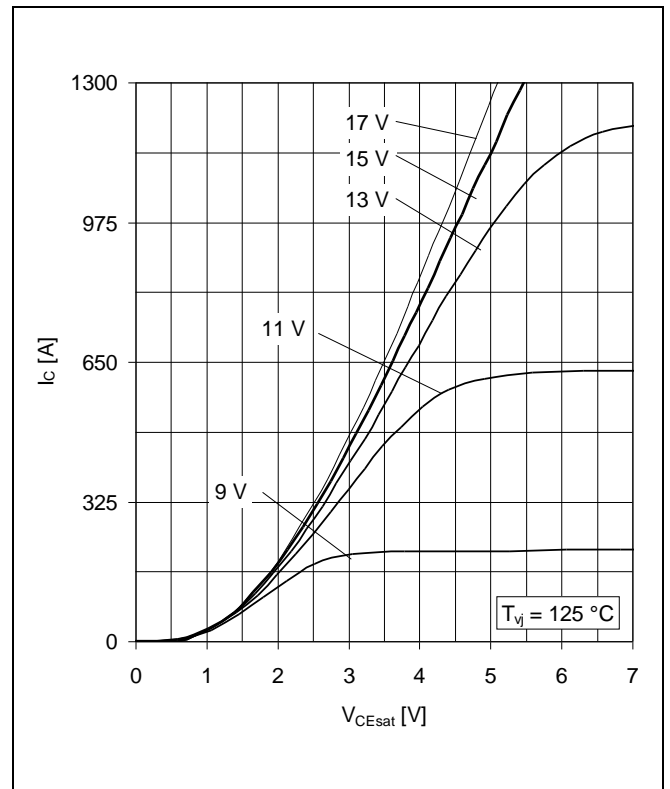
**Fig. 1** Typical on-state characteristics, chip level



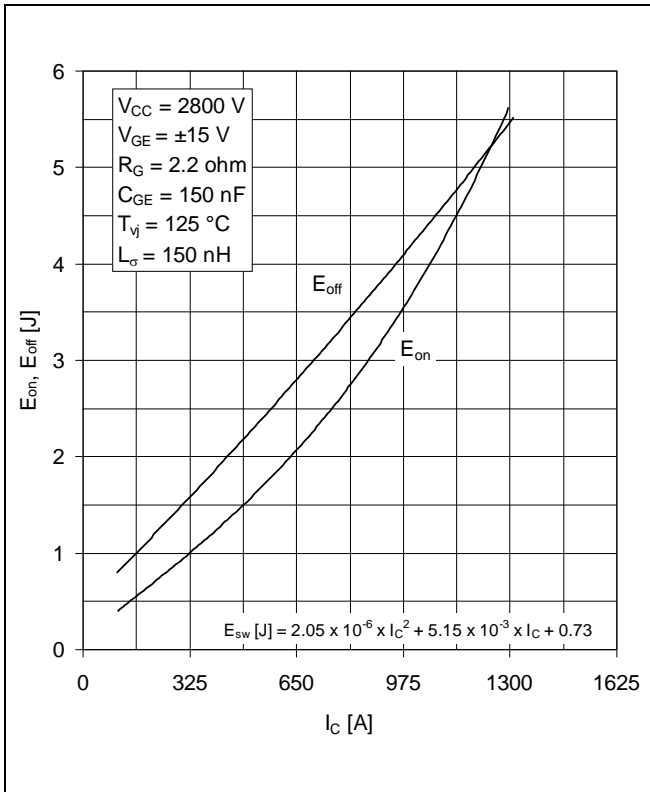
**Fig. 2** Typical transfer characteristics, chip level



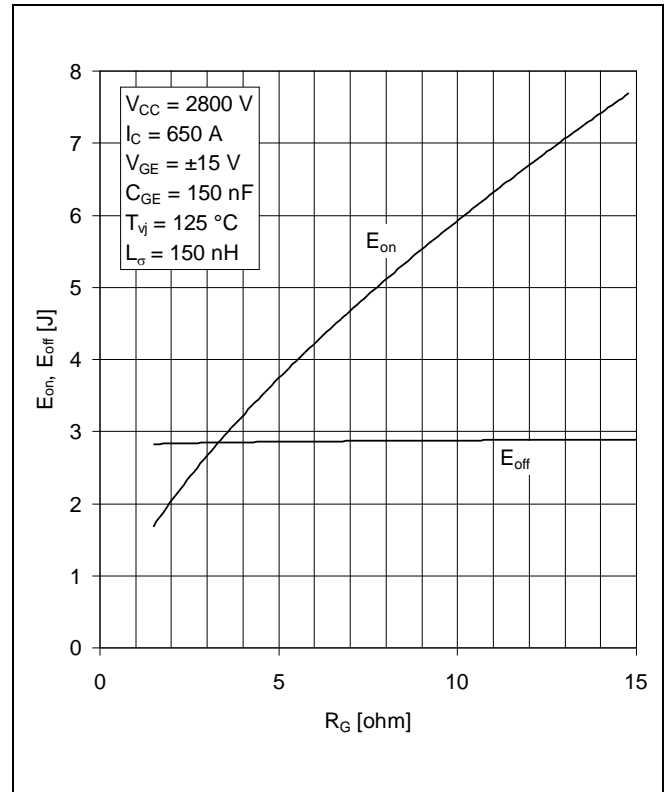
**Fig. 3** Typical output characteristics, chip level



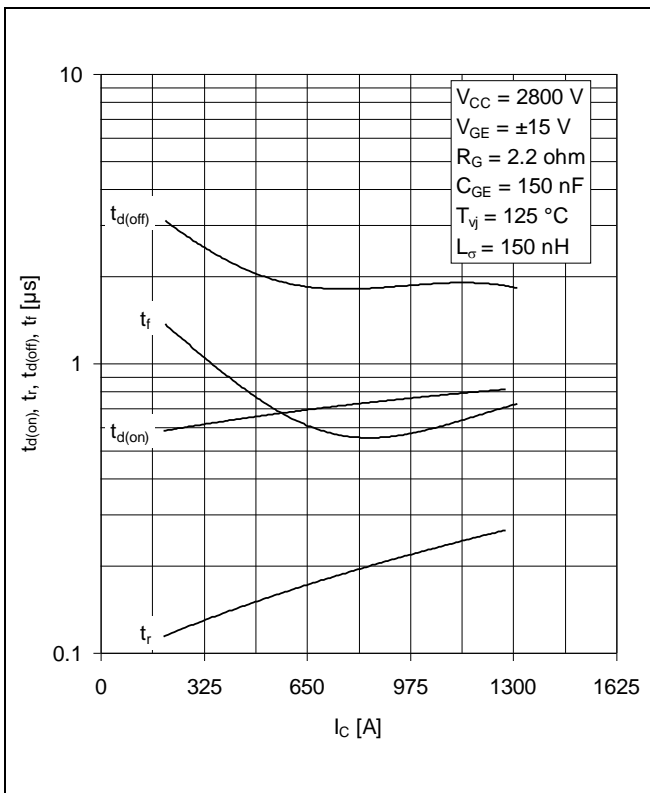
**Fig. 4** Typical output characteristics, chip level



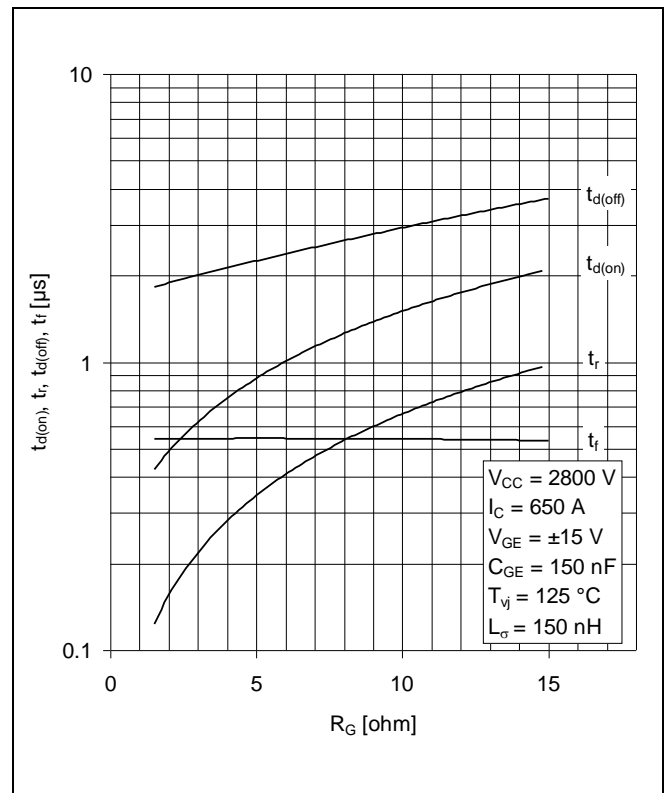
**Fig. 5** Typical switching energies per pulse vs collector current



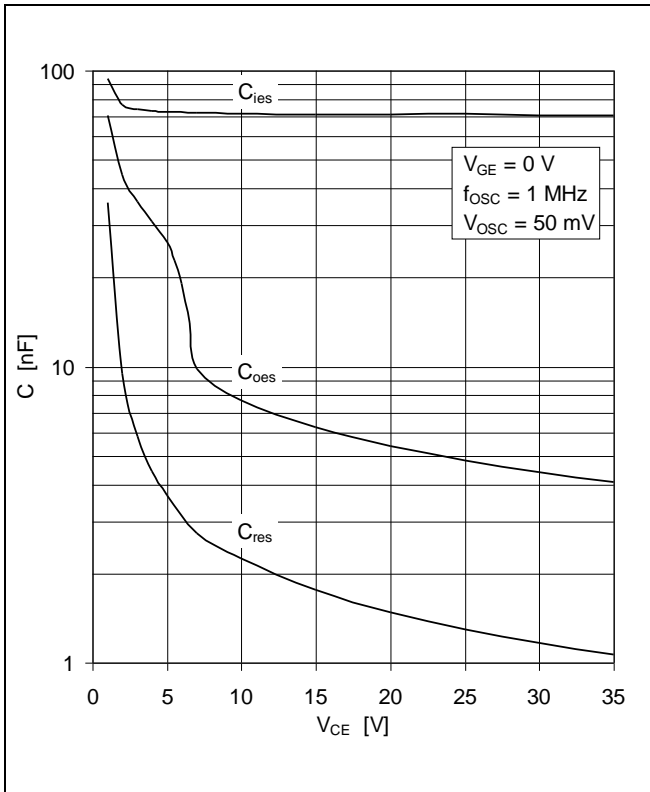
**Fig. 6** Typical switching energies per pulse vs gate resistor



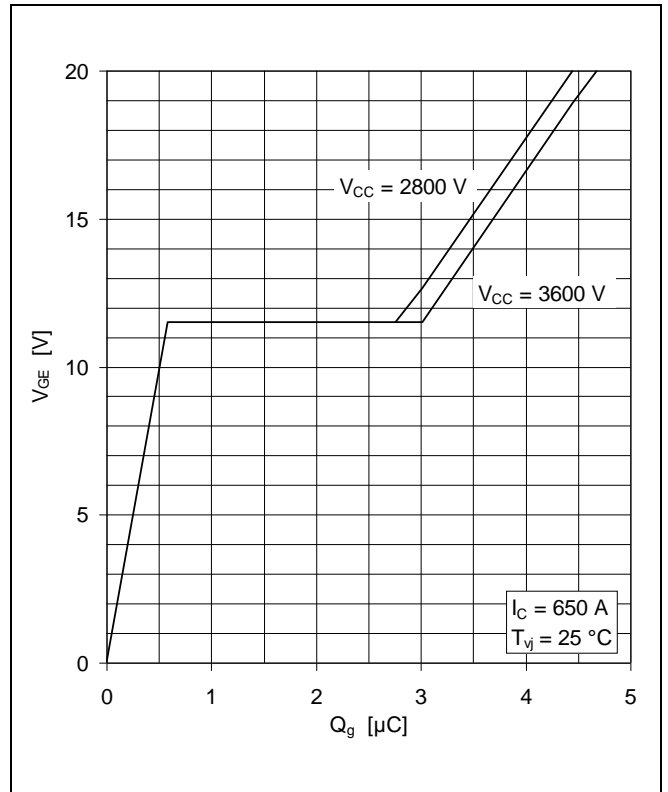
**Fig. 7** Typical switching times vs collector current



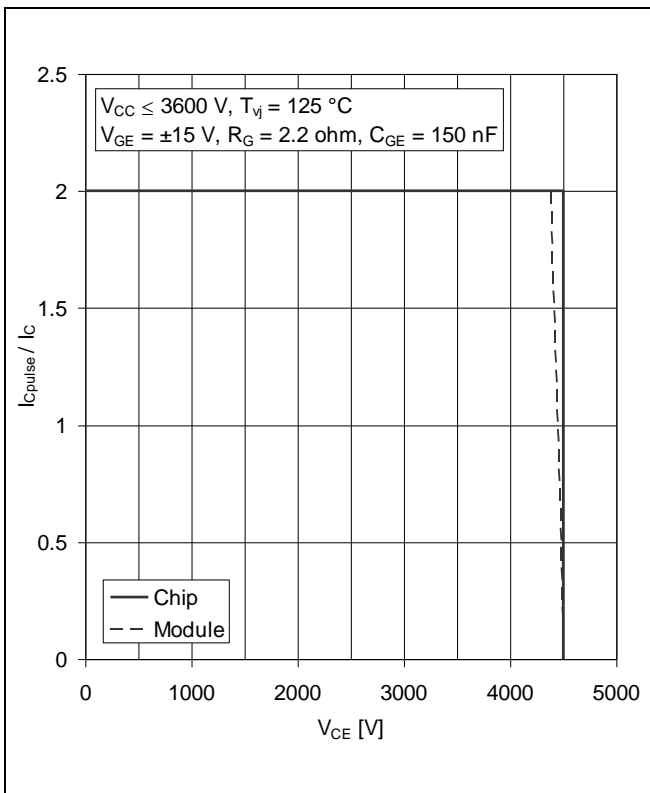
**Fig. 8** Typical switching times vs gate resistor



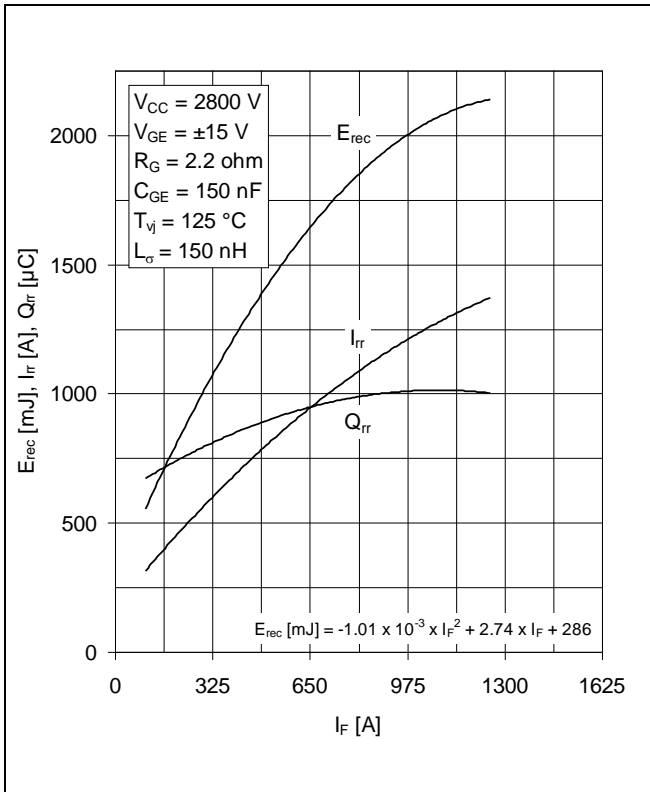
**Fig. 9** Typical capacitances vs collector-emitter voltage



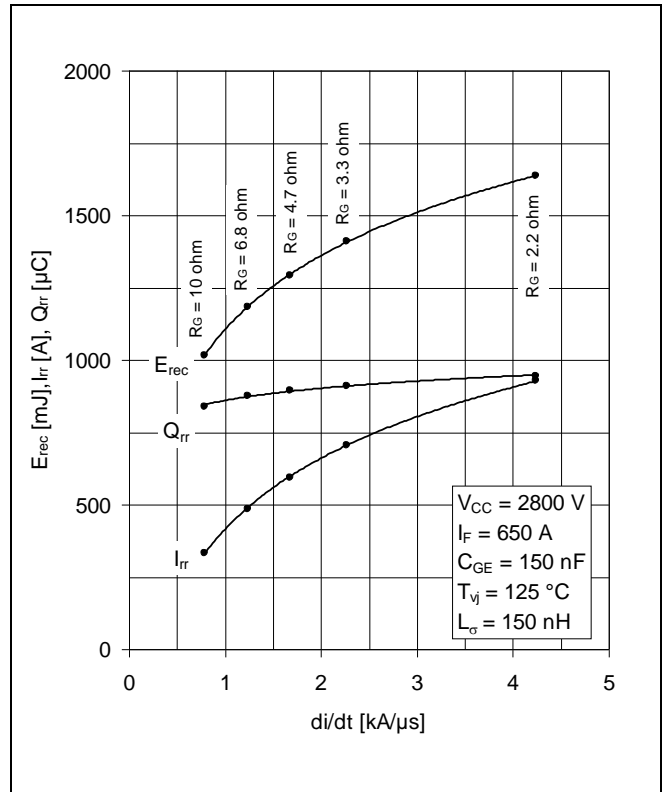
**Fig. 10** Typical gate charge characteristics



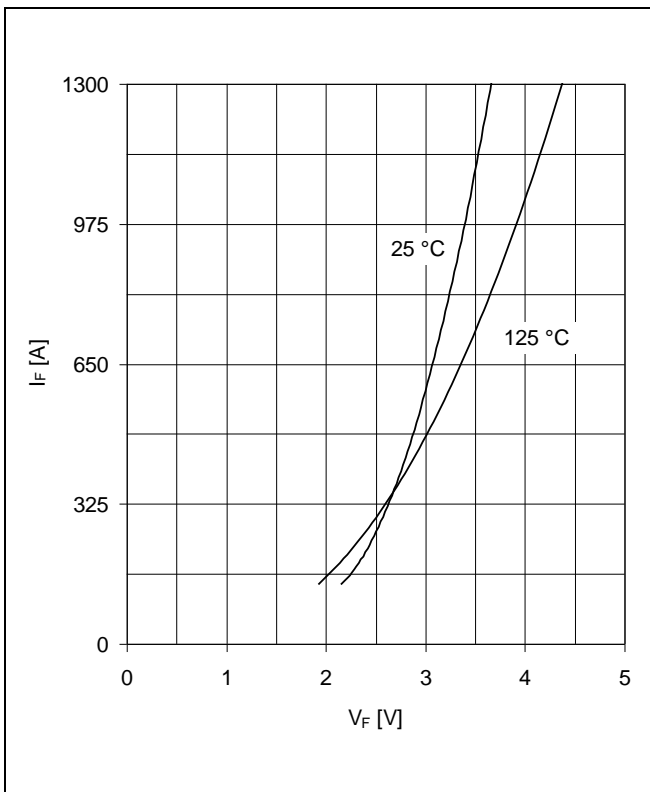
**Fig. 11** Turn-off safe operating area (RBSOA)



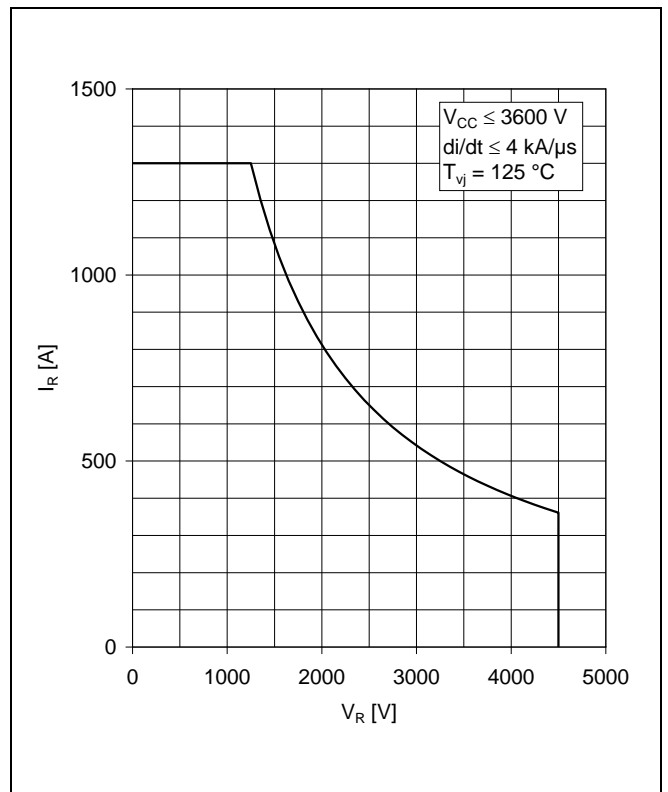
**Fig. 12** Typical reverse recovery characteristics vs forward current



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



**Fig. 14** Typical diode forward characteristics, chip level



**Fig. 15** Safe operating area diode (SOA)



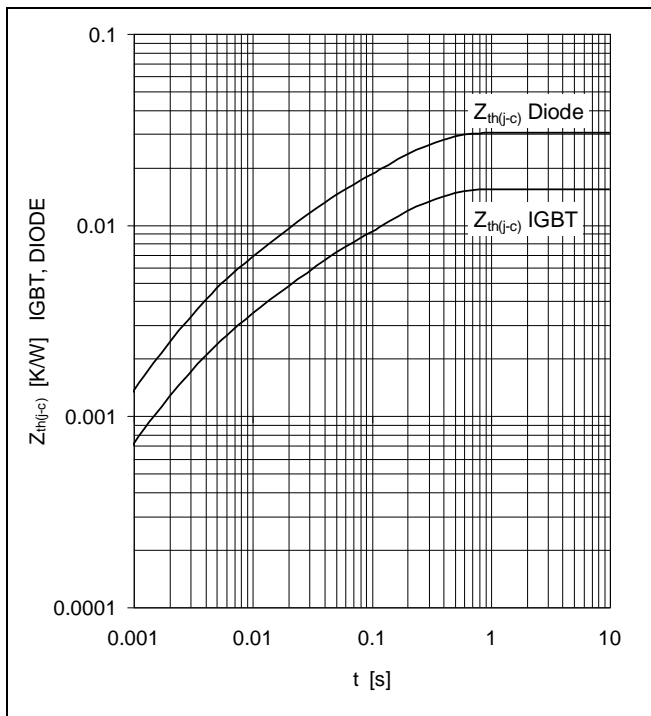


Fig. 16 Thermal impedance vs time

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
IGBT	R <sub>i</sub> (K/kW)	10.3	3.42	1.68		
	τ <sub>i</sub> (ms)	192.6	21.4	2.78		
DIODE	R <sub>i</sub> (K/kW)	20	7.01	3.46		
	τ <sub>i</sub> (ms)	191.5	22.6	3.1		

**Related documents:**

- 5SYA 2042 Failure rates of HiPak modules due to cosmic rays
- 5SYA 2043 Load - cycle capability of HiPaks
- 5SYA 2045 Thermal runaway during blocking
- 5SYA 2053 Applying IGBT
- 5SYA 2058 Surge currents for IGBT diodes
- 5SYA 2093 Thermal design of IGBT modules
- 5SYA 2098 Paralleling of IGBT modules
- 5SZK 9111 Specification of environmental class for HiPak Storage
- 5SZK 9112 Specification of environmental class for HiPak Transportation
- 5SZK 9113 Specification of environmental class for HiPak Operation (Industry)
- 5SZK 9120 Specification of environmental class for HiPak

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