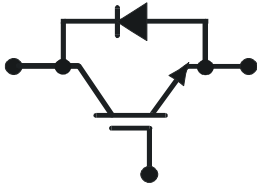


$V_{CE} = 1700\text{ V}$   
 $I_C = 2400\text{ A}$

**ABB HiPak™**

**IGBT Module**  
**5SNA 2400E170100**



Doc. No. 5SYA1555-03 Oct 06

- 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



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

Parameter	Symbol	Conditions	min	max	Unit
Collector-emitter voltage	$V_{CES}$	$V_{GE} = 0\text{ V}, T_{vj} \geq 25\text{ °C}$		1700	V
DC collector current	$I_C$	$T_c = 80\text{ °C}$		2400	A
Peak collector current	$I_{CM}$	$t_p = 1\text{ ms}, T_c = 80\text{ °C}$		4800	A
Gate-emitter voltage	$V_{GES}$		-20	20	V
Total power dissipation	$P_{tot}$	$T_c = 25\text{ °C}$ , per switch (IGBT)		14300	W
DC forward current	$I_F$			2400	A
Peak forward current	$I_{FRM}$			4800	A
Surge current	$I_{FSM}$	$V_R = 0\text{ V}, T_{vj} = 125\text{ °C}$ , $t_p = 10\text{ ms}$ , half-sinewave		20000	A
IGBT short circuit SOA	$t_{psc}$	$V_{CC} = 1200\text{ V}, V_{CEMCHIP} \leq 1700\text{ V}$ $V_{GE} \leq 15\text{ V}, T_{vj} \leq 125\text{ °C}$		10	$\mu\text{s}$
Isolation voltage	$V_{isol}$	1 min, $f = 50\text{ Hz}$		4000	V
Junction temperature	$T_{vj}$			150	$^{\circ}\text{C}$
Junction operating temperature	$T_{vj(op)}$		-40	125	$^{\circ}\text{C}$
Case temperature	$T_c$		-40	125	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		-40	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	$V_{(BR)CES}$	$V_{GE} = 0 \text{ V}$ , $I_C = 10 \text{ mA}$ , $T_{vj} = 25 \text{ °C}$	1700			V	
Collector-emitter <sup>4)</sup> saturation voltage	$V_{CE \text{ sat}}$	$I_C = 2400 \text{ A}$ , $V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ °C}$	2.0	2.3	2.6	V
			$T_{vj} = 125 \text{ °C}$	2.3	2.6	2.9	V
Collector cut-off current	$I_{CES}$	$V_{CE} = 1700 \text{ V}$ , $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$			12	mA
			$T_{vj} = 125 \text{ °C}$			120	mA
Gate leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}$ , $V_{GE} = \pm 20 \text{ V}$ , $T_{vj} = 125 \text{ °C}$	-500		500	nA	
Gate-emitter threshold voltage	$V_{GE(TO)}$	$I_C = 240 \text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25 \text{ °C}$	4.5		6.5	V	
Gate charge	$Q_{ge}$	$I_C = 2400 \text{ A}$ , $V_{CE} = 900 \text{ V}$ , $V_{GE} = -15 \text{ V} .. 15 \text{ V}$		22		$\mu\text{C}$	
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_{vj} = 25 \text{ °C}$		228		nF	
Output capacitance	$C_{oes}$			22.1			
Reverse transfer capacitance	$C_{res}$			9.6			
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.56 \text{ }\Omega$ ,	$T_{vj} = 25 \text{ °C}$	320		ns	
			$T_{vj} = 125 \text{ °C}$	320			
Rise time	$t_r$	$V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 60 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ °C}$	270		ns	
			$T_{vj} = 125 \text{ °C}$	275			
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.56 \text{ }\Omega$ ,	$T_{vj} = 25 \text{ °C}$	1000		ns	
			$T_{vj} = 125 \text{ °C}$	1090			
Fall time	$t_f$	$V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 60 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ °C}$	250		ns	
			$T_{vj} = 125 \text{ °C}$	265			
Turn-on switching energy	$E_{on}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $V_{GE} = \pm 15 \text{ V}$ , $R_G = 0.56 \text{ }\Omega$ , $L_\sigma = 60 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ °C}$	495		mJ	
			$T_{vj} = 125 \text{ °C}$	700			
Turn-off switching energy	$E_{off}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $V_{GE} = \pm 15 \text{ V}$ , $R_G = 0.56 \text{ }\Omega$ , $L_\sigma = 60 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ °C}$	850		mJ	
			$T_{vj} = 125 \text{ °C}$	1000			
Short circuit current	$I_{SC}$	$t_{psc} \leq 10 \text{ }\mu\text{s}$ , $V_{GE} = 15 \text{ V}$ , $T_{vj} = 125 \text{ °C}$ , $V_{CC} = 1200 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 1700 \text{ V}$		11100		A	
Module stray inductance	$L_{\sigma \text{ CE}}$			10		nH	
Resistance, terminal-chip	$R_{CC'+EE'}$		$T_C = 25 \text{ °C}$	0.06		m $\Omega$	
			$T_C = 125 \text{ °C}$	0.085			

<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>	$V_F$	$I_F = 2400 \text{ A}$	$T_{vj} = 25 \text{ °C}$	1.65	2.0	V
			$T_{vj} = 125 \text{ °C}$		1.7	
Reverse recovery current	$I_{rr}$	$V_{CC} = 900 \text{ V},$ $I_F = 2400 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 0.56 \text{ } \Omega$ $L_\sigma = 60 \text{ nH}$ inductive load	$T_{vj} = 25 \text{ °C}$	1520		A
			$T_{vj} = 125 \text{ °C}$	1880		
Recovered charge	$Q_{rr}$	$V_{CC} = 900 \text{ V},$ $I_F = 2400 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 0.56 \text{ } \Omega$ $L_\sigma = 60 \text{ nH}$ inductive load	$T_{vj} = 25 \text{ °C}$	590		$\mu\text{C}$
			$T_{vj} = 125 \text{ °C}$	1025		
Reverse recovery time	$t_{rr}$	$V_{CC} = 900 \text{ V},$ $I_F = 2400 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 0.56 \text{ } \Omega$ $L_\sigma = 60 \text{ nH}$ inductive load	$T_{vj} = 25 \text{ °C}$	580		ns
			$T_{vj} = 125 \text{ °C}$	870		
Reverse recovery energy	$E_{rec}$	$V_{CC} = 900 \text{ V},$ $I_F = 2400 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 0.56 \text{ } \Omega$ $L_\sigma = 60 \text{ nH}$ inductive load	$T_{vj} = 25 \text{ °C}$	420		mJ
			$T_{vj} = 125 \text{ °C}$	720		

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

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

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

Parameter	Symbol	Conditions	min	typ	max	Unit
IGBT thermal resistance junction to case	$R_{th(j-c)IGBT}$				0.007	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.012	K/W
IGBT thermal resistance case to heatsink <sup>2)</sup>	$R_{th(c-s)IGBT}$	IGBT per switch, $\lambda$ grease = $1\text{W/m}^2 \text{ K}$		0.009		K/W
Diode thermal resistance case to heatsink <sup>7)</sup>	$R_{th(c-s)DIODE}$	Diode per switch, $\lambda$ grease = $1\text{W/m}^2 \text{ K}$		0.018		K/W

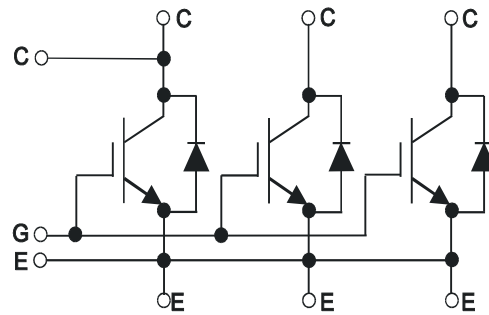
<sup>2)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA2039

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

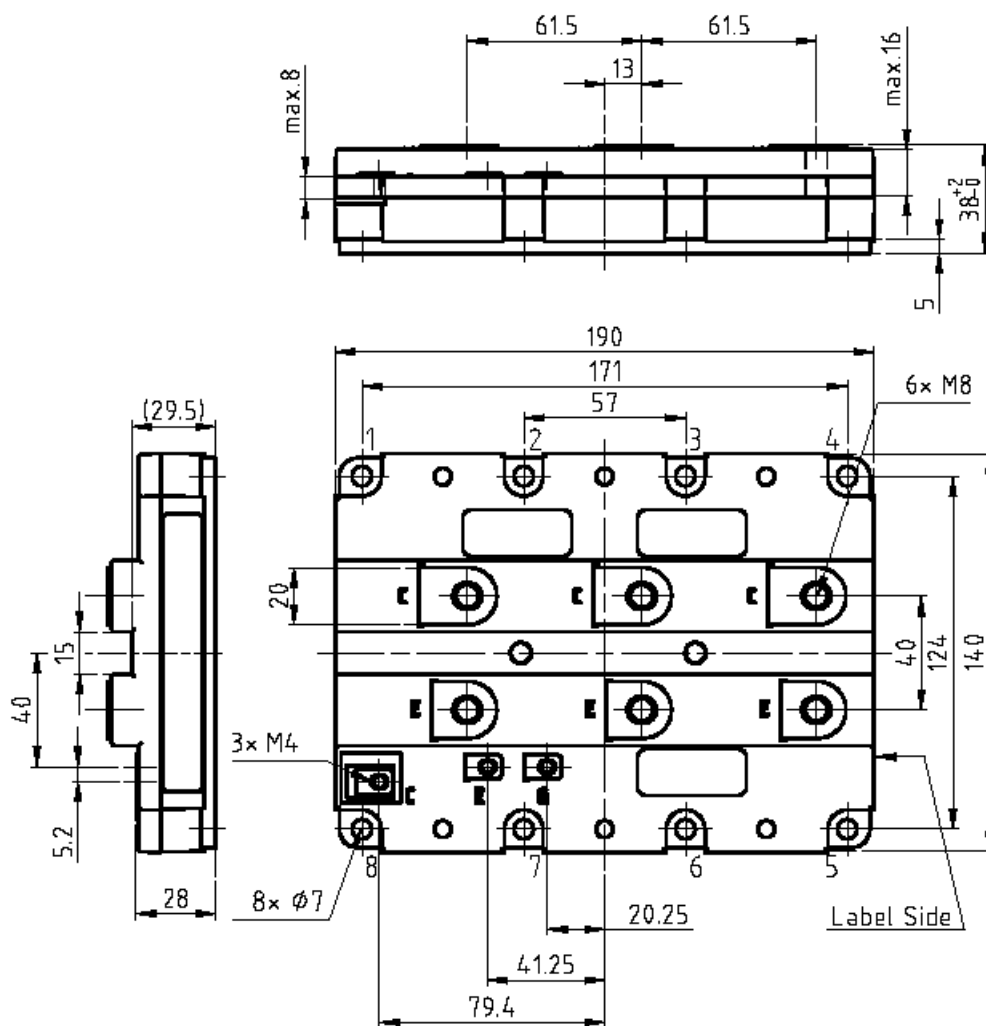
Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	$L \times W \times H$	Typical , see outline drawing	190 x 140 x 38			mm
Clearance distance in air	$d_a$	according to IEC 60664-1 and EN 50124-1	Term. to base:	23		mm
			Term. to term:	19		
Surface creepage distance	$d_s$	according to IEC 60664-1 and EN 50124-1	Term. to base:	33		mm
			Term. to term:	32		
Mass	$m$			1500		g

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

## Electrical configuration



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

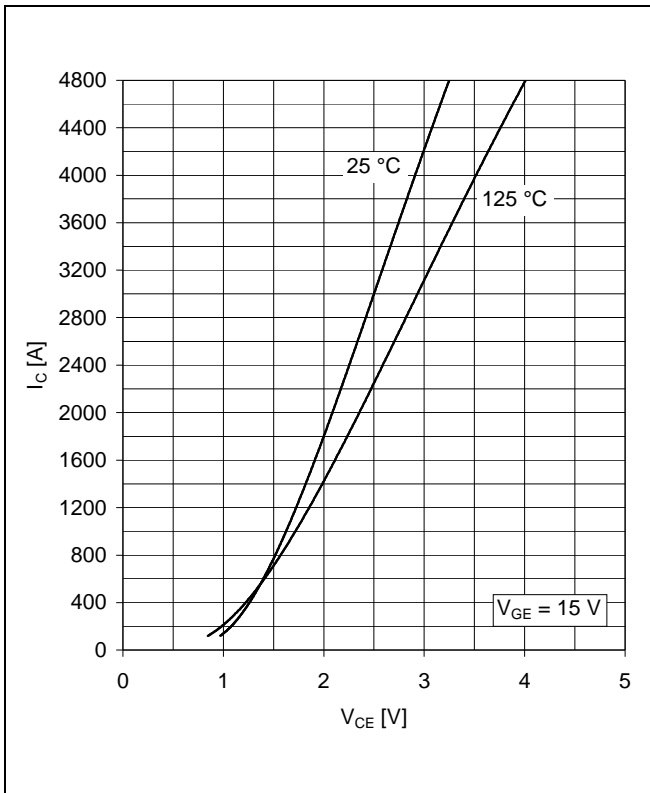


Note: all dimensions are shown in mm

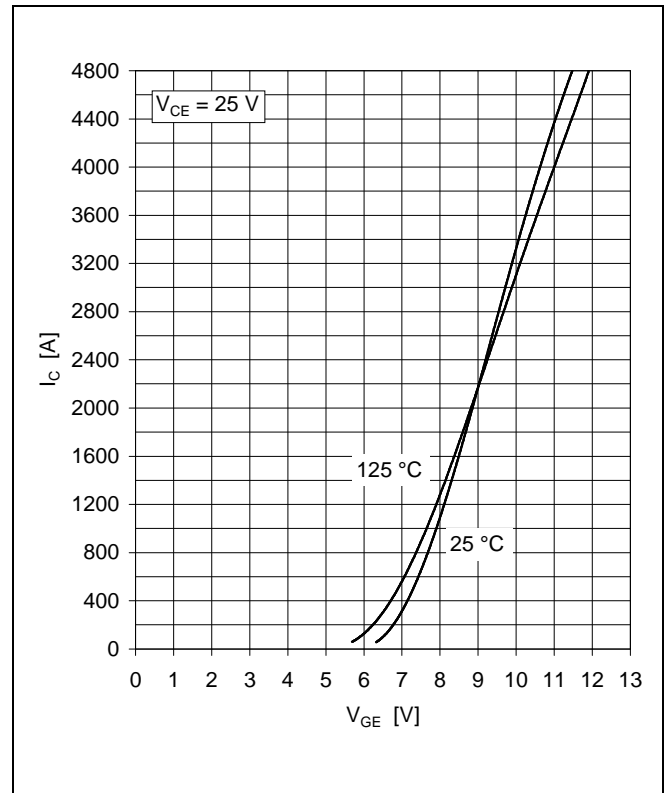
<sup>2)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA2039

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

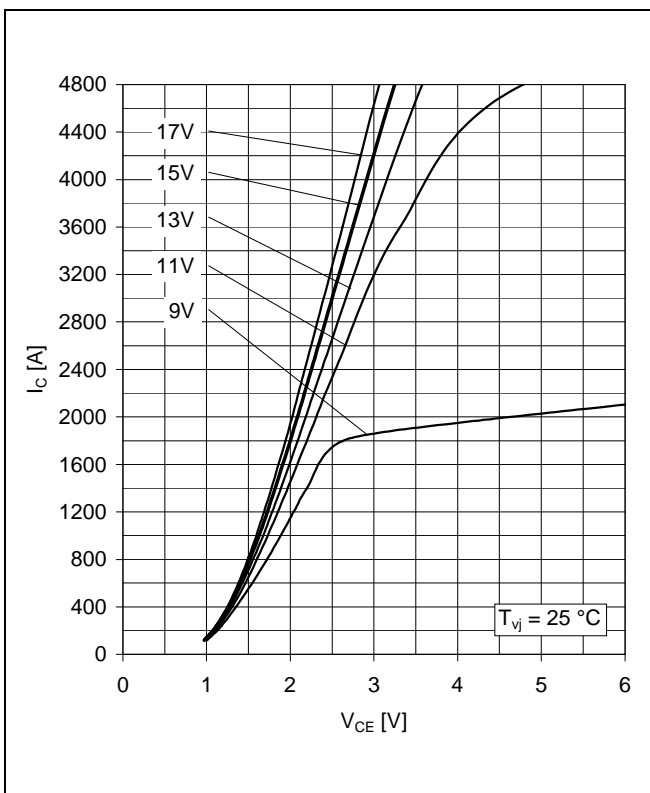
This product has been designed and qualified for Industrial Level.



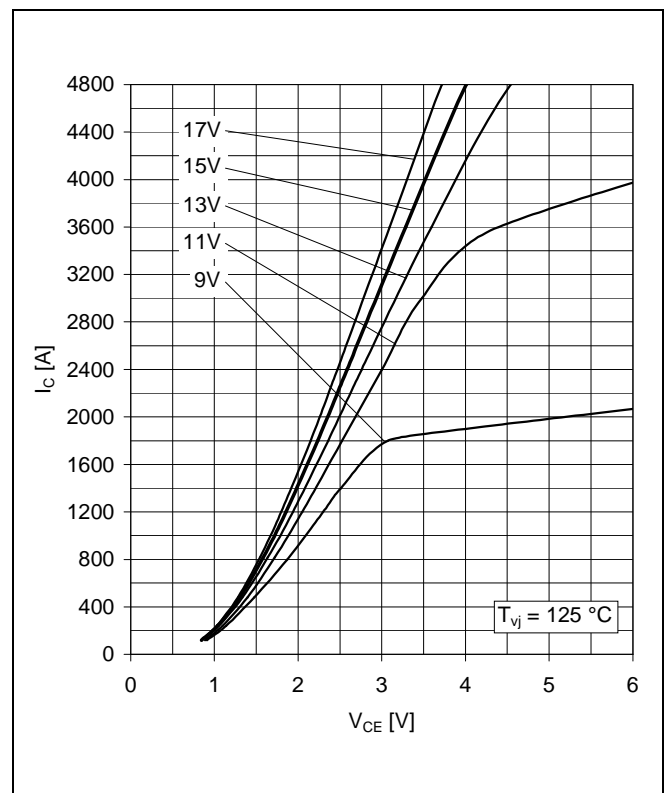
**Fig. 1** Typical on-state characteristics, chip level



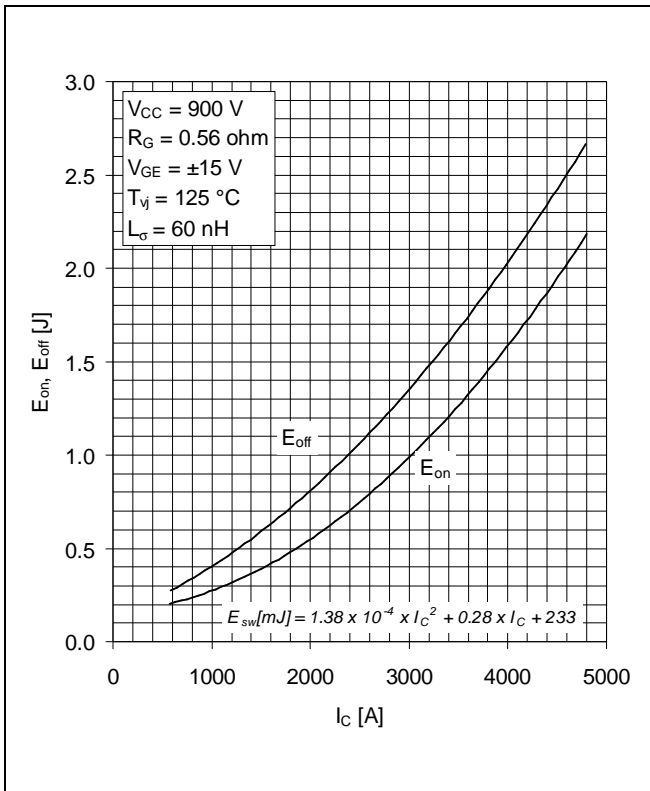
**Fig. 2** Typical transfer characteristics, chip level



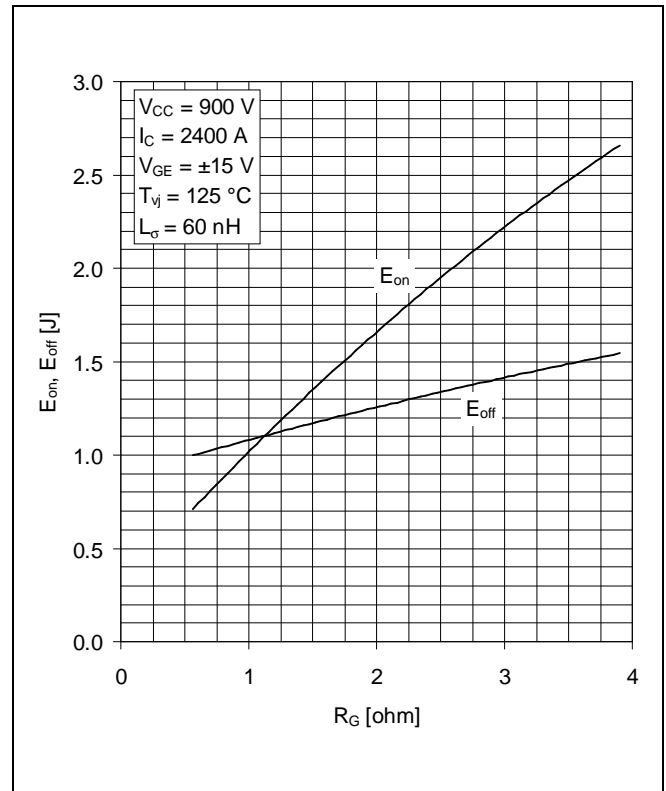
**Fig. 3** Typical output characteristics, chip level



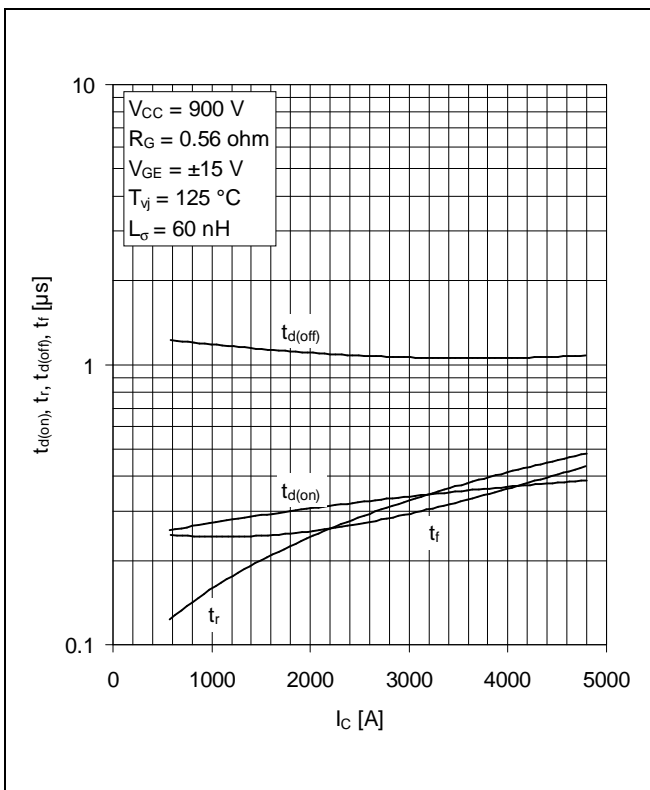
**Fig. 4** Typical output characteristics, chip level



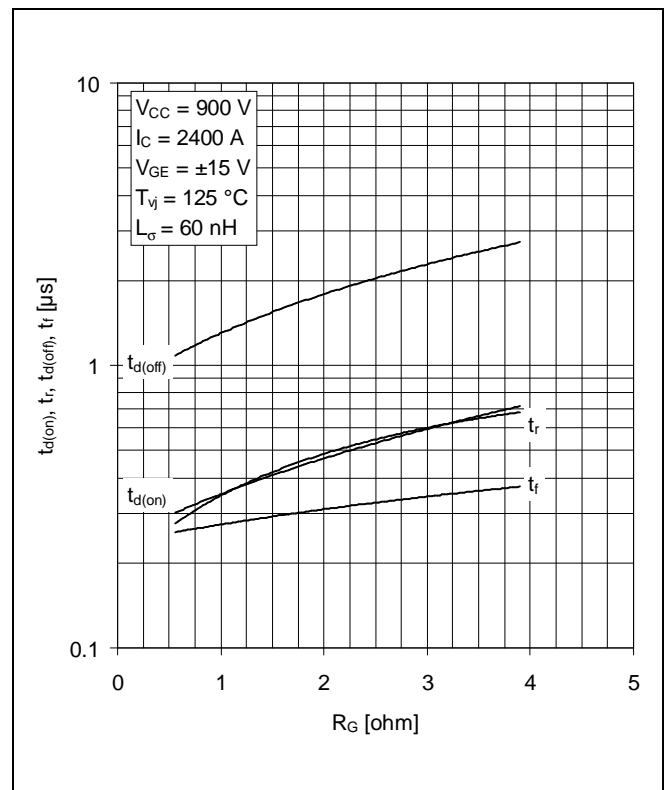
**Fig. 5** Typical switching energies per pulse vs collector current



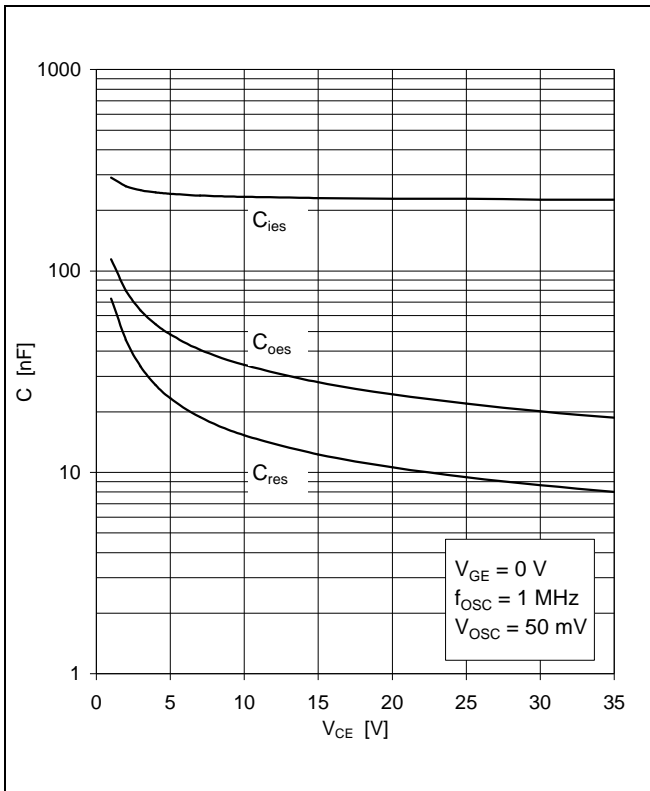
**Fig. 6** Typical switching energies per pulse vs gate resistor



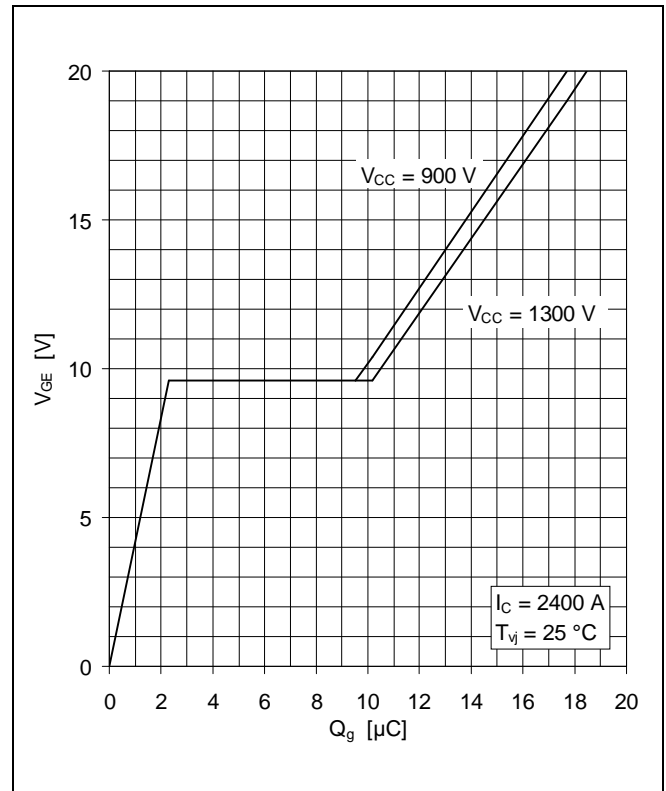
**Fig. 7** Typical switching times vs collector current



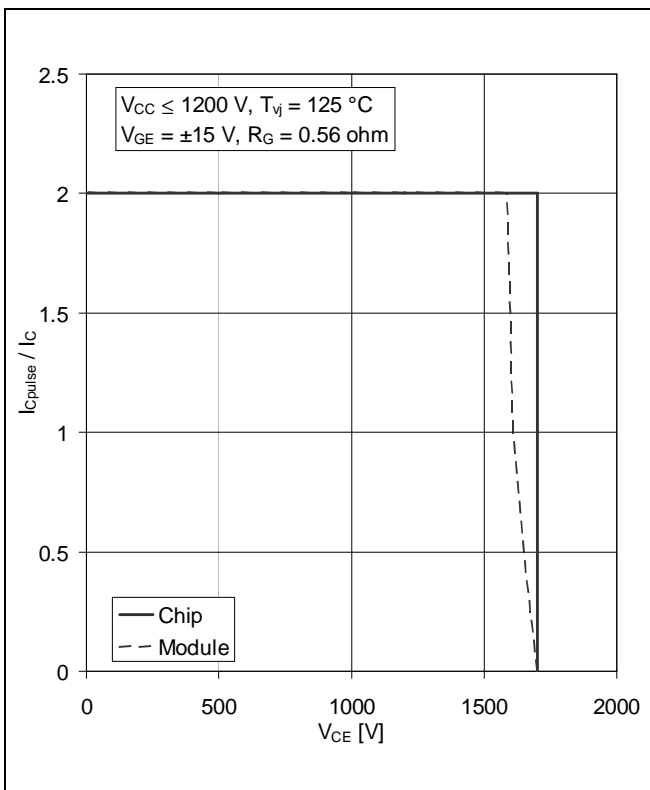
**Fig. 8** Typical switching times vs gate resistor



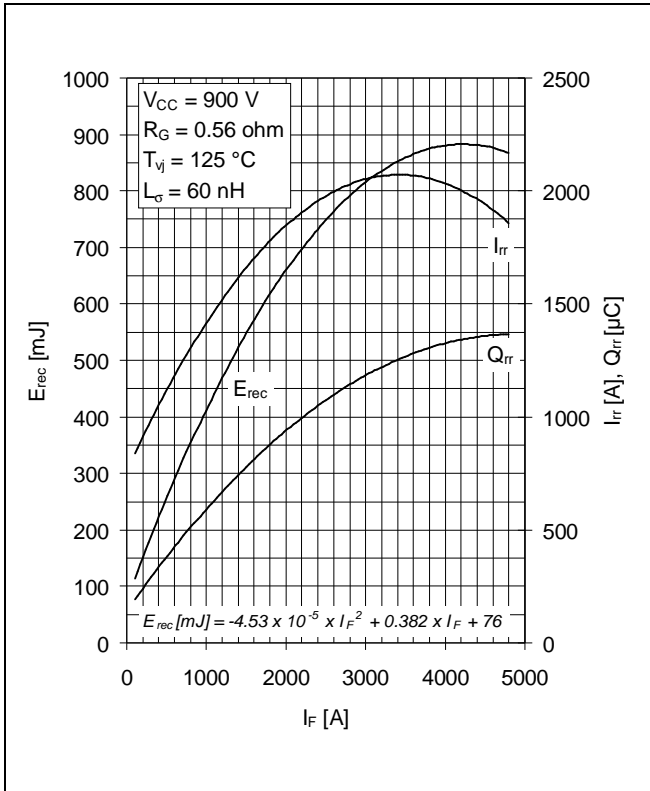
**Fig. 9** Typical capacitances vs collector-emitter voltage



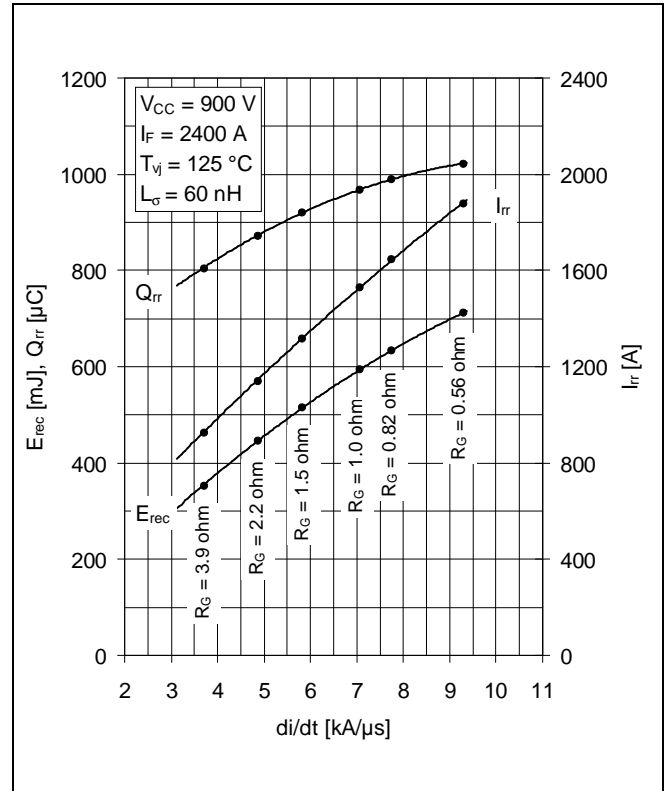
**Fig. 10** Typical gate charge characteristics



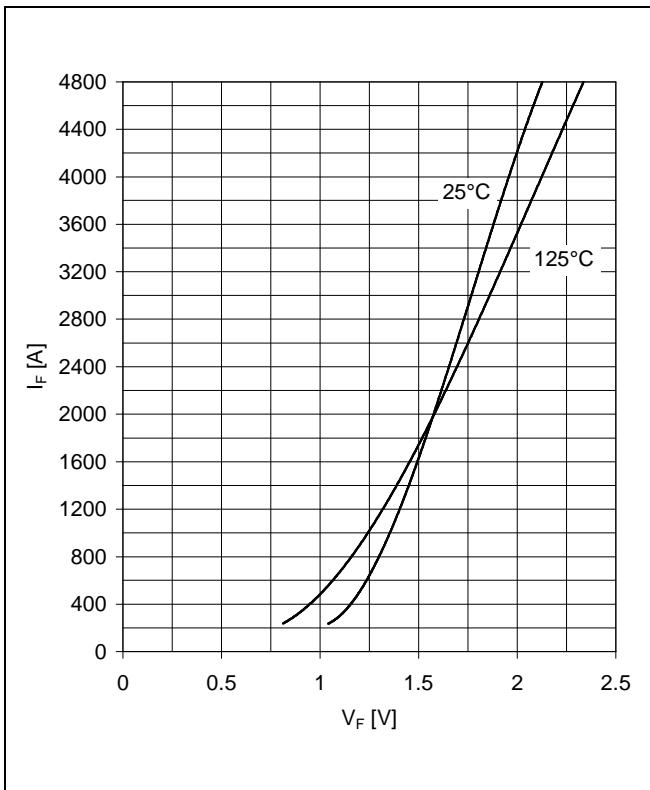
**Fig. 11** Turn-off safe operating area (RBSOA)



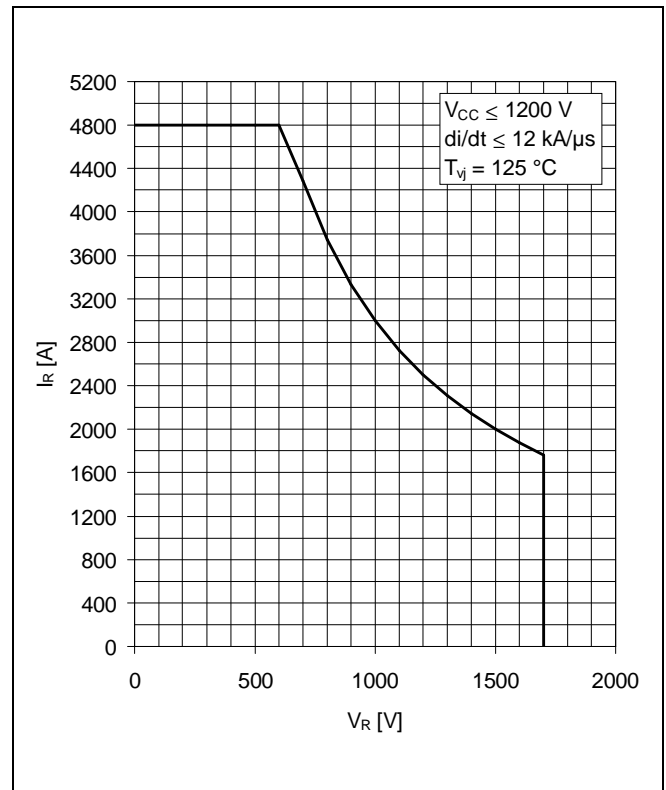
**Fig. 12** Typical reverse recovery characteristics vs forward current



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



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



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



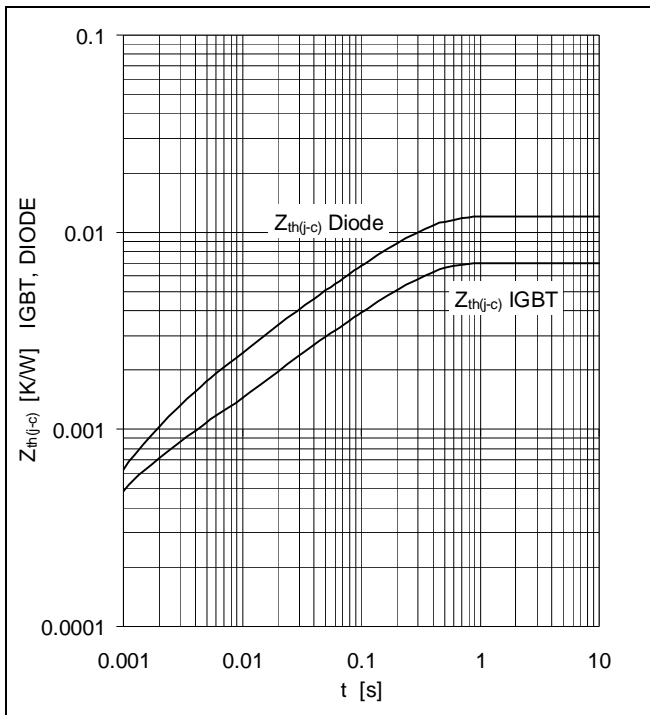


Fig. 16 Thermal impedance vs time

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	
IGBT	R <sub>i</sub> (K/kW)	5.059	1.201	0.495	0.246	
	τ <sub>i</sub> (ms)	202.9	20.3	2.01	0.52	
DIODE	R <sub>i</sub> (K/kW)	8.432	1.928	0.866	0.839	
	τ <sub>i</sub> (ms)	210	29.6	7.01	1.49	

For detailed information refer to:

- 5SYA 2042-02 Failure rates of HiPak modules due to cosmic rays
- 5SYA 2043-01 Load – cycle capability of HiPaks
- 5SZK 9120-00 Specification of environmental class for HiPak (available upon request)

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