

# 5SNA 1600N170300

## HiPak IGBT Module

$$V_{CE} = 1700 \text{ V}$$

$$I_C = 1600 \text{ A}$$

Ultra low-loss, rugged SPT+ chip-set  
 Smooth switching SPT+ chip-set for good EMC  
 AISiC 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	$V_{CES}$	$V_{GE} = 0 \text{ V}$ , $T_{vj} \geq 25 \text{ }^\circ\text{C}$		1700	V
DC collector current	$I_C$	$T_C = 70 \text{ }^\circ\text{C}$ , $T_{vj} = 150 \text{ }^\circ\text{C}$		1600	A
Peak collector current	$I_{CM}$	$t_p = 1 \text{ ms}$		3200	A
Gate-emitter voltage	$V_{GES}$		-20	20	V
Total power dissipation	$P_{tot}$	$T_C = 25 \text{ }^\circ\text{C}$ , $T_{vj} = 150 \text{ }^\circ\text{C}$		11900	W
DC forward current	$I_F$			1600	A
Peak forward current	$I_{FRM}$	$t_p = 1 \text{ ms}$		3200	A
Surge current	$I_{FSM}$	$V_R = 0 \text{ V}$ , $T_{vj} = 150 \text{ }^\circ\text{C}$ , $t_p = 10 \text{ ms}$ , half-sinewave		12000	A
IGBT short circuit SOA	$t_{psc}$	$V_{CC} = 1200 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 1700 \text{ V}$ $V_{GE} \leq 15 \text{ V}$ , $T_{vj \text{ start}} \leq 150 \text{ }^\circ\text{C}$		10	$\mu\text{s}$
Isolation voltage	$V_{ISOL}$	1 min, $f = 50 \text{ Hz}$		4000	V
Junction temperature	$T_{vj}$			175	$^\circ\text{C}$
Junction operating temperature	$T_{vj(op)}$		-50	150	$^\circ\text{C}$
Case temperature	$T_C$		-50	150	$^\circ\text{C}$
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 Document No. 5SYA 2039

**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	$V_{CE\text{ sat}}$	$I_C = 1600\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.8	2.05	2.3	V
			$T_{vj} = 125\text{ °C}$	2.15	2.4	2.65	V
			$T_{vj} = 150\text{ °C}$		2.45		V
Collector cut-off current	$I_{CES}$	$V_{CE} = 1700\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		0.02	1	mA
			$T_{vj} = 125\text{ °C}$		20	40	mA
			$T_{vj} = 150\text{ °C}$		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	$V_{GE(TO)}$	$I_C = 160\text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25\text{ °C}$	5.3		7.3	V	
Gate charge	$Q_{ge}$	$I_C = 1600\text{ A}$ , $V_{CE} = 900\text{ V}$ , $V_{GE} = -15\text{ V} \dots 15\text{ V}$		14		$\mu\text{C}$	
Internal gate resistance	$R_{Gint}$			0.8		$\Omega$	
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 900\text{ V}$ , $I_C = 1600\text{ A}$ , $R_G = 0.9\text{ }\Omega$ , $C_{GE} = 0\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 75\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$		570		ns
			$T_{vj} = 125\text{ °C}$		630		ns
			$T_{vj} = 150\text{ °C}$		650		ns
Rise time	$t_r$	$V_{CC} = 900\text{ V}$ , $I_C = 1600\text{ A}$ , $R_G = 0.9\text{ }\Omega$ , $C_{GE} = 0\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 75\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$		250		ns
			$T_{vj} = 125\text{ °C}$		260		ns
			$T_{vj} = 150\text{ °C}$		260		ns
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 900\text{ V}$ , $I_C = 1600\text{ A}$ , $R_G = 0.9\text{ }\Omega$ , $C_{GE} = 0\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 75\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$		950		ns
			$T_{vj} = 125\text{ °C}$		1060		ns
			$T_{vj} = 150\text{ °C}$		1100		ns
Fall time	$t_f$	$V_{CC} = 900\text{ V}$ , $I_C = 1600\text{ A}$ , $R_G = 0.9\text{ }\Omega$ , $C_{GE} = 0\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 75\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$		200		ns
			$T_{vj} = 125\text{ °C}$		240		ns
			$T_{vj} = 150\text{ °C}$		260		ns
Turn-on switching energy	$E_{on}$	$V_{CC} = 900\text{ V}$ , $I_C = 1600\text{ A}$ , $R_G = 0.9\text{ }\Omega$ , $C_{GE} = 0\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 75\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$		430		mJ
			$T_{vj} = 125\text{ °C}$		590		mJ
			$T_{vj} = 150\text{ °C}$		650		mJ
Turn-off switching energy	$E_{off}$	$V_{CC} = 900\text{ V}$ , $I_C = 1600\text{ A}$ , $R_G = 0.9\text{ }\Omega$ , $C_{GE} = 0\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 75\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$		420		mJ
			$T_{vj} = 125\text{ °C}$		570		mJ
			$T_{vj} = 150\text{ °C}$		640		mJ
Short circuit current	$I_{SC}$	$t_{psc} \leq 10\text{ }\mu\text{s}$ , $V_{GE} = 15\text{ V}$ , $V_{CE} = 1200\text{ V}$ , $V_{CEM\text{ CHIP}} \leq 1700\text{ V}$	$T_{vj} = 150\text{ °C}$	6600		A	

<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>	$V_F$	$I_F = 1600 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	1.65	1.95	V	
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1.67	2	V
			$T_{vj} = 150 \text{ }^\circ\text{C}$		1.6		V
Peak reverse recovery current	$I_{RM}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	1190		A	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1400		A	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1490		A	
Recovered charge	$Q_{rr}$	$V_{CC} = 900 \text{ V},$ $I_F = 1600 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 0.9 \text{ }^\Omega, C_{GE} = 0 \text{ nF},$ $L_\sigma = 75 \text{ nH},$ inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	490		$\mu\text{C}$	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	840		$\mu\text{C}$	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1000		$\mu\text{C}$	
Reverse recovery time	$t_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	720		ns	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1120		ns	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1220		ns	
Reverse recovery energy	$E_{rec}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	310		mJ	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	540		mJ	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	640		mJ	

<sup>5)</sup> Characteristic values according to IEC 60747 - 15

<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	$R_{th(j-c)IGBT}$				0.011	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.018	K/W
IGBT thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-s)IGBT}$	IGBT per switch, $\lambda$ grease = 1W/m x K		0.012		K/W
Diode thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-s)DIODE}$	Diode per switch, $\lambda$ grease = 1W/m x K		0.024		K/W
Comparative tracking index	CTI		600			
Module stray inductance	$L_{\sigma CE}$			12		nH
Resistance, terminal-chip	$R_{CC'+EE'}$		$T_C = 25 \text{ }^\circ\text{C}$	0.082		m $\Omega$
			$T_C = 125 \text{ }^\circ\text{C}$	0.113		
			$T_C = 150 \text{ }^\circ\text{C}$	0.120		

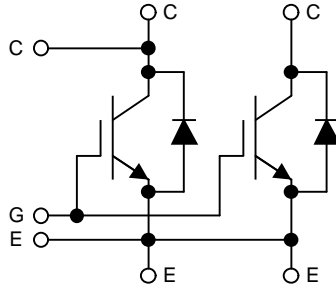
<sup>2)</sup> For detailed mounting instructions refer to Document No. 5SYA 2039

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

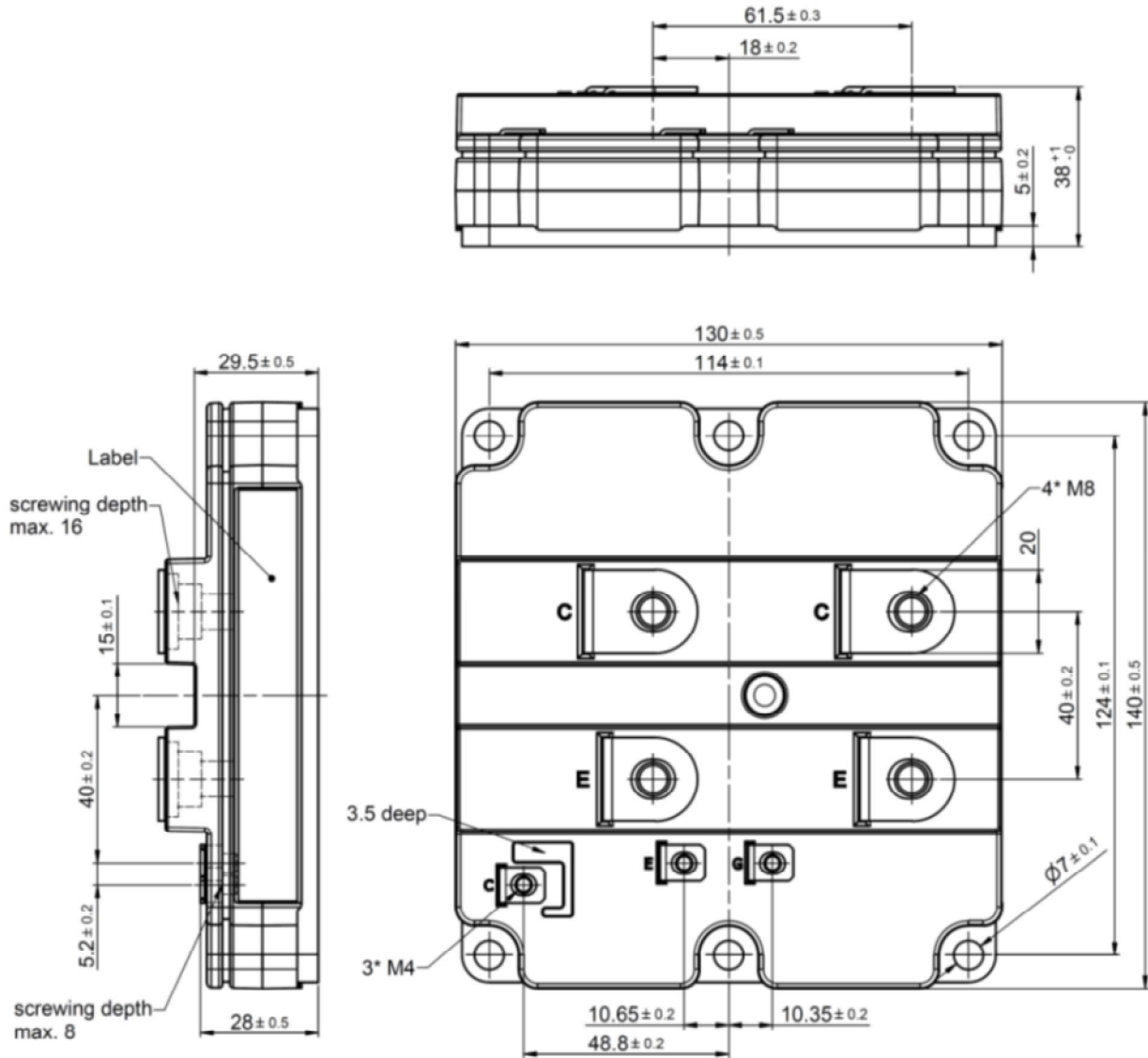
Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	L x W x H	Typical		130 x 140 x 38		mm
Clearance distance in air	$d_a$	according to IEC 60664-1 and EN 50124-1	Term. to base:	19		mm
			Term. to term:	19		
Surface creepage distance	$d_s$	according to IEC 60664-1 and EN 50124-1	Term. to base:	28.2		mm
			Term. to term:	28.2		
Mass	m			820		g

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

## Electrical configuration



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



Note: all dimensions are shown in millimeters

<sup>2)</sup> For detailed mounting instructions refer to 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.

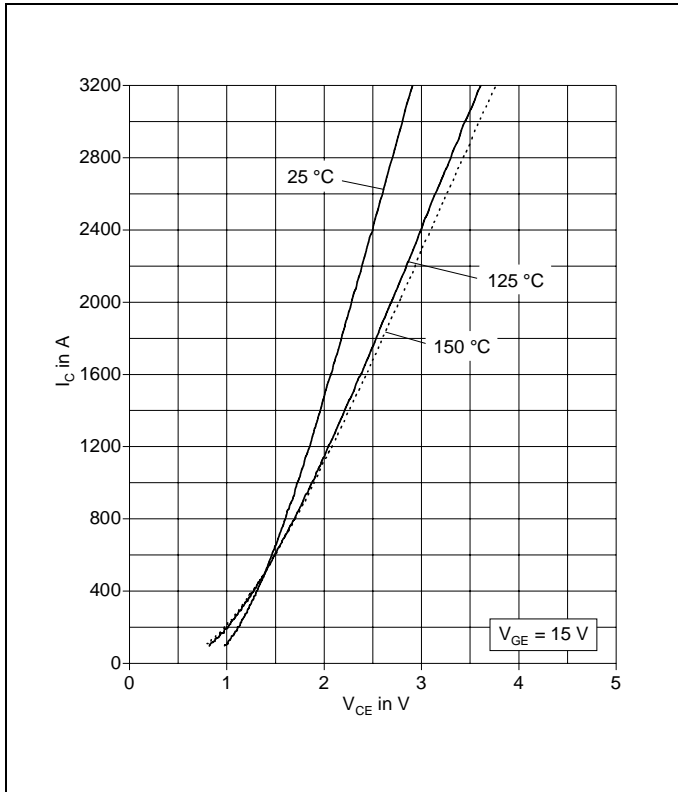


Fig. 1 Typical on-state characteristics, chip level

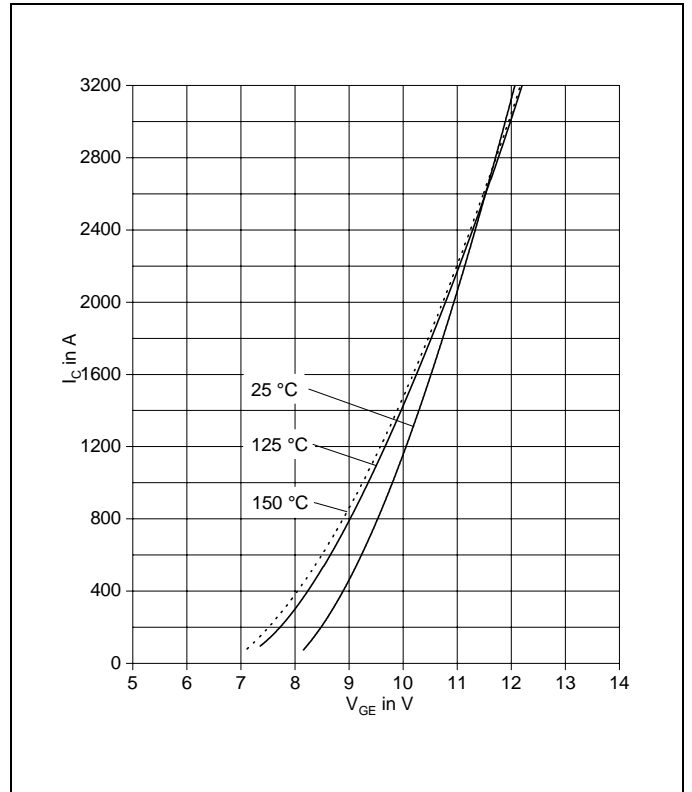


Fig. 2 Typical transfer characteristics, chip level

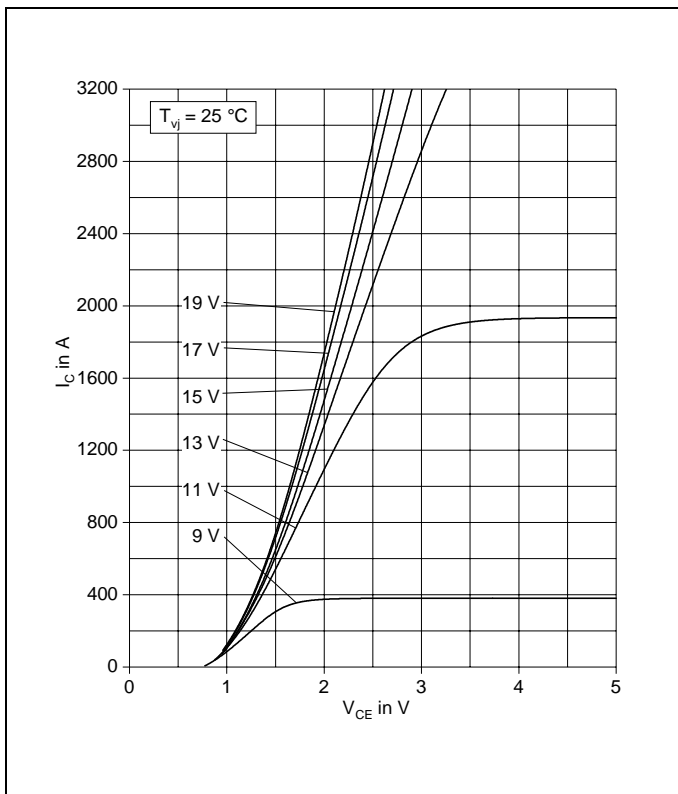


Fig. 3 Typical output characteristics, chip level

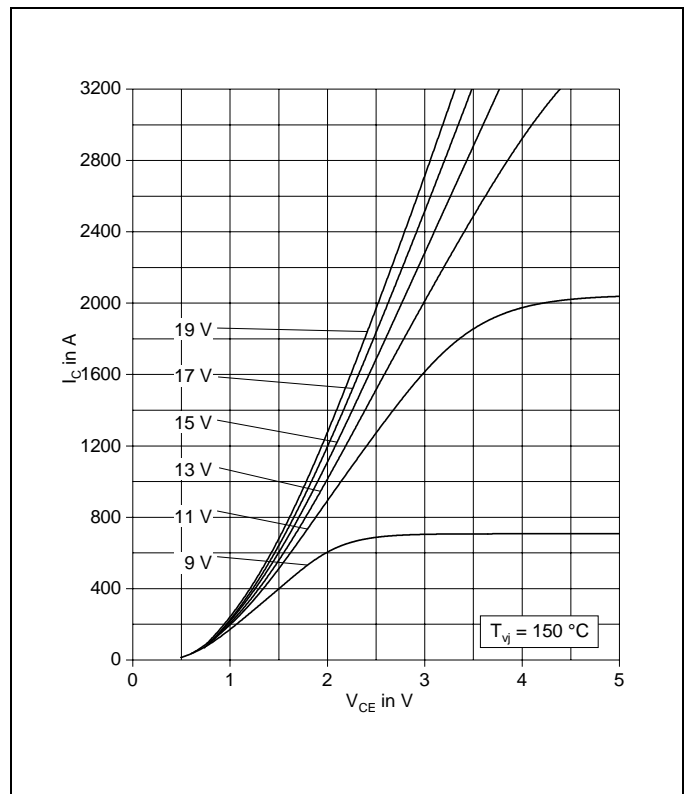


Fig. 4 Typical output characteristics, chip level

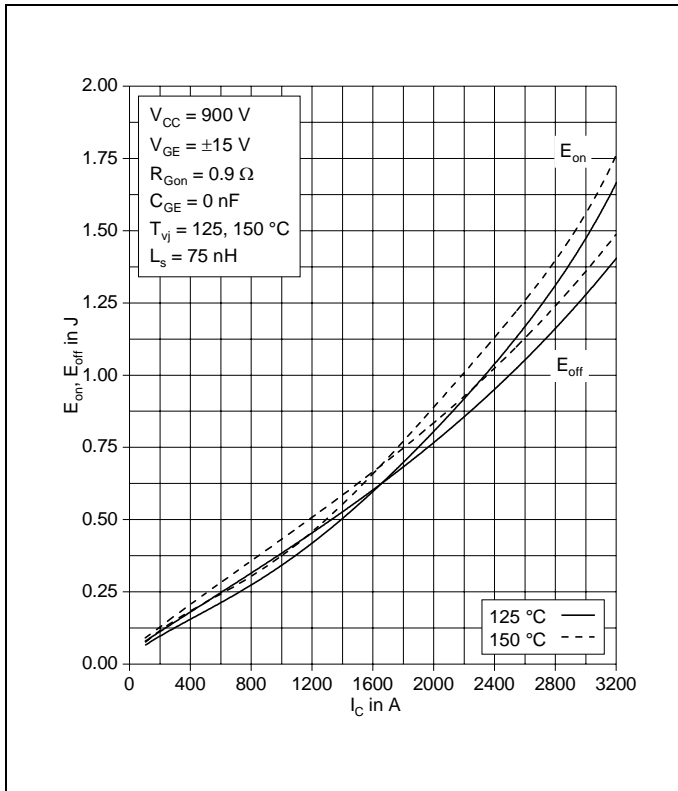


Fig. 5 Typical switching energies per pulse vs. collector current

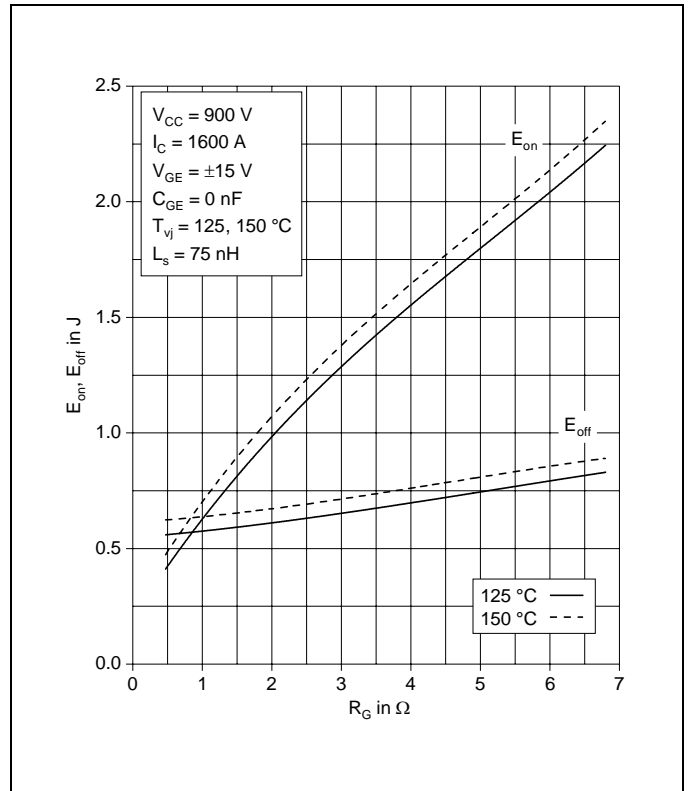


Fig. 6 Typical switching energies per pulse vs. gate resistor

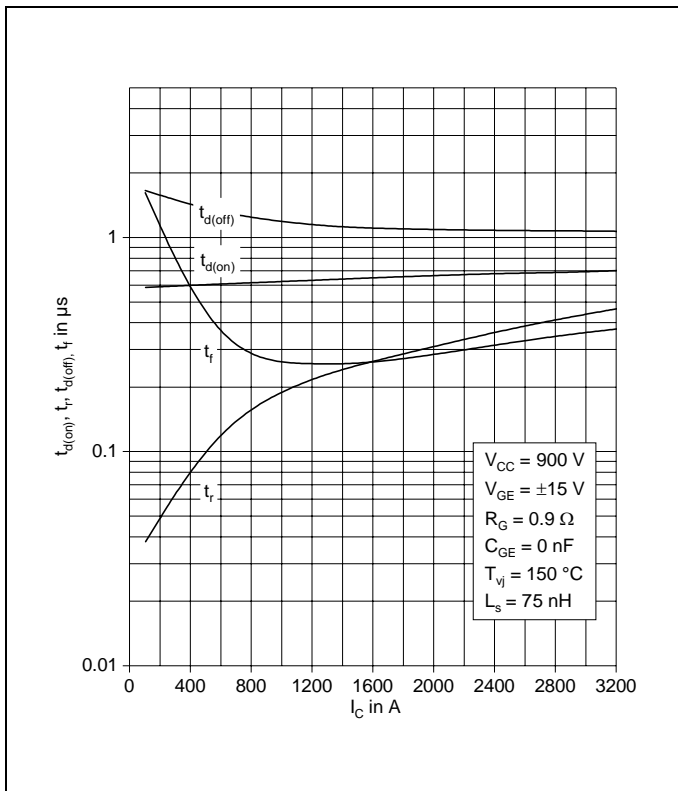


Fig. 7 Typical switching times vs. collector current

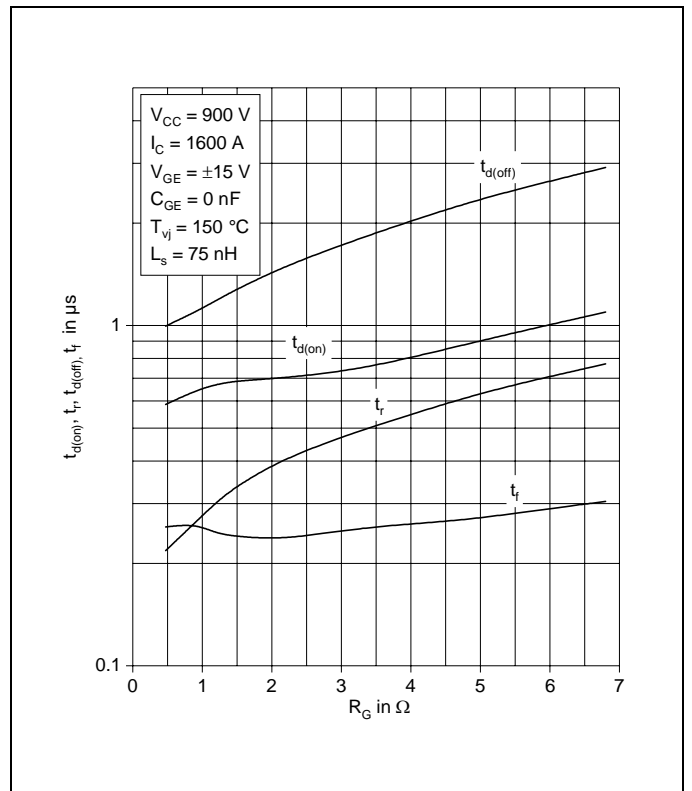


Fig. 8 Typical switching times vs. gate resistor

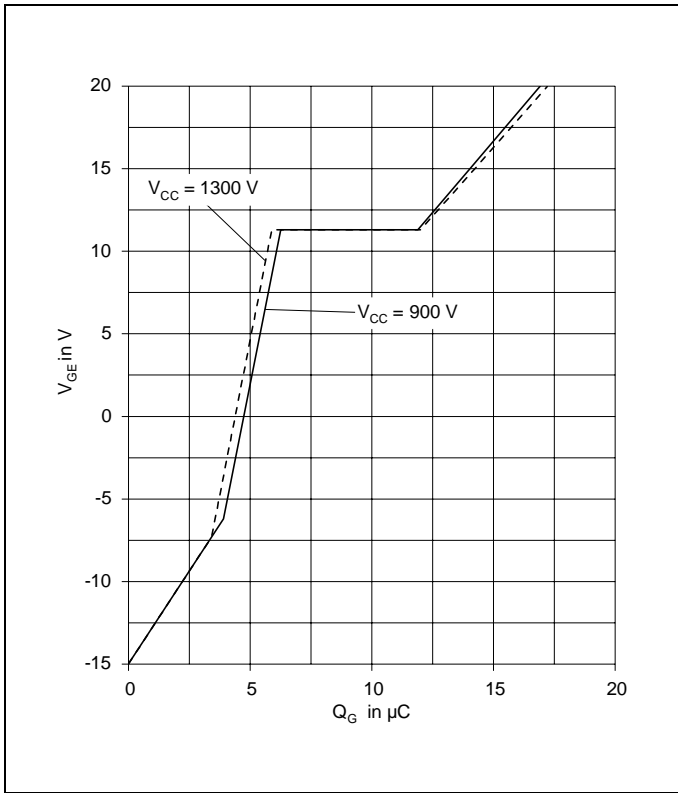


Fig. 9 Typical gate charge characteristics

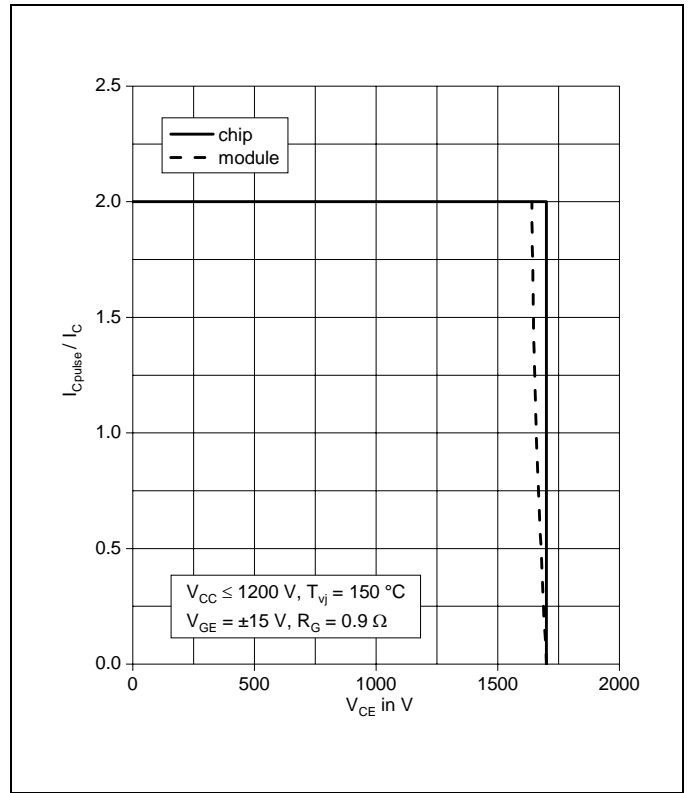


Fig. 10 Turn-off safe operating area (RBSOA)

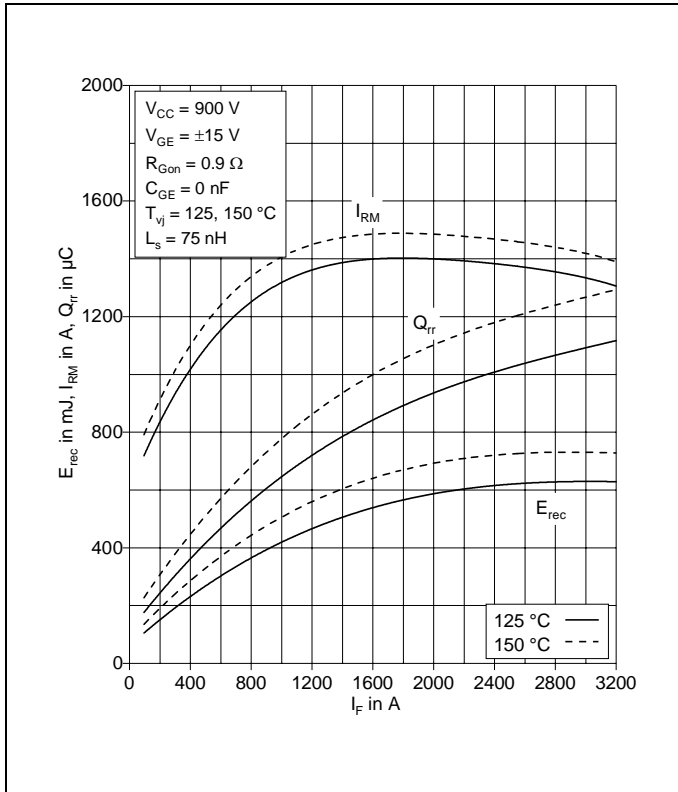


Fig. 11 Typical reverse recovery characteristics vs. forward current

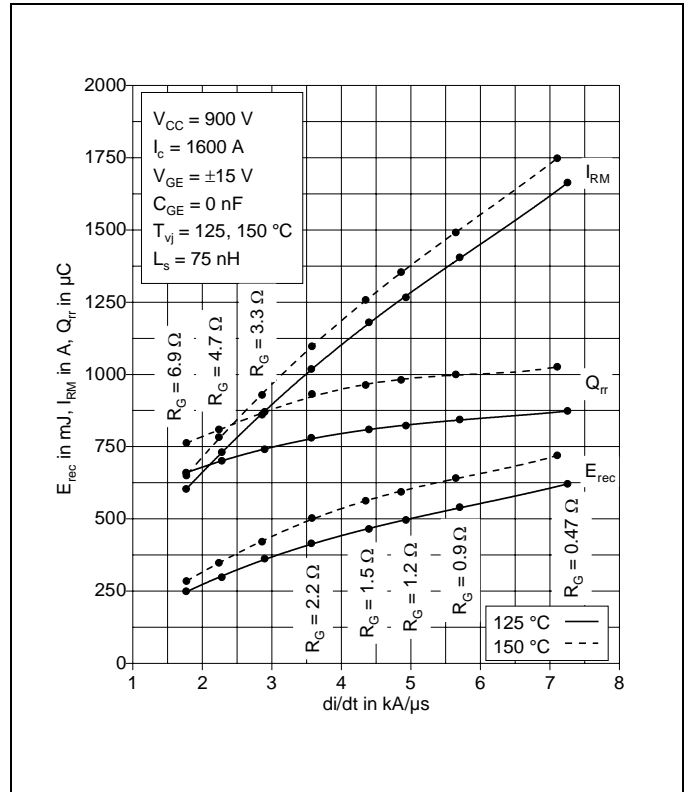


Fig. 12 Typical reverse recovery characteristics vs.  $di/dt$

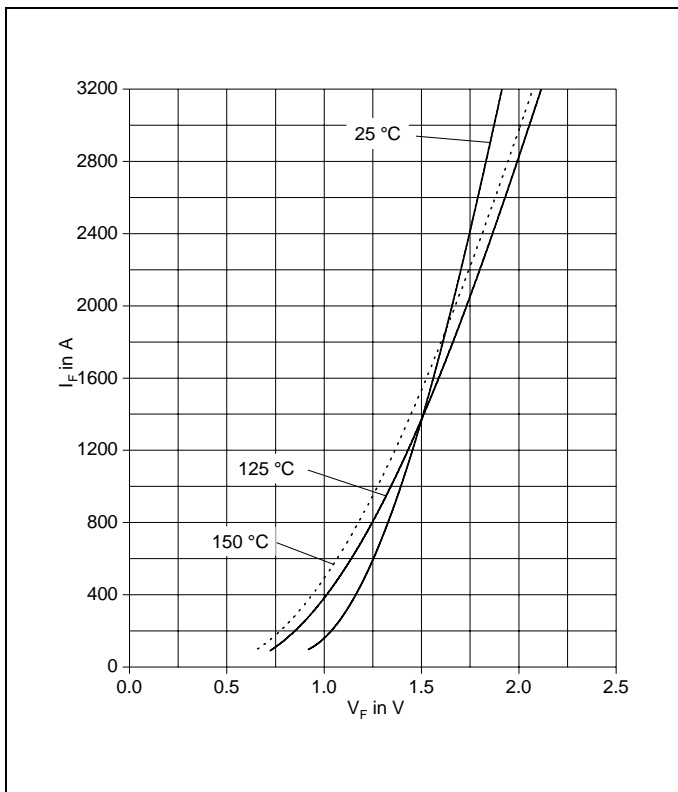


Fig. 13 Typical diode forward characteristics chip level

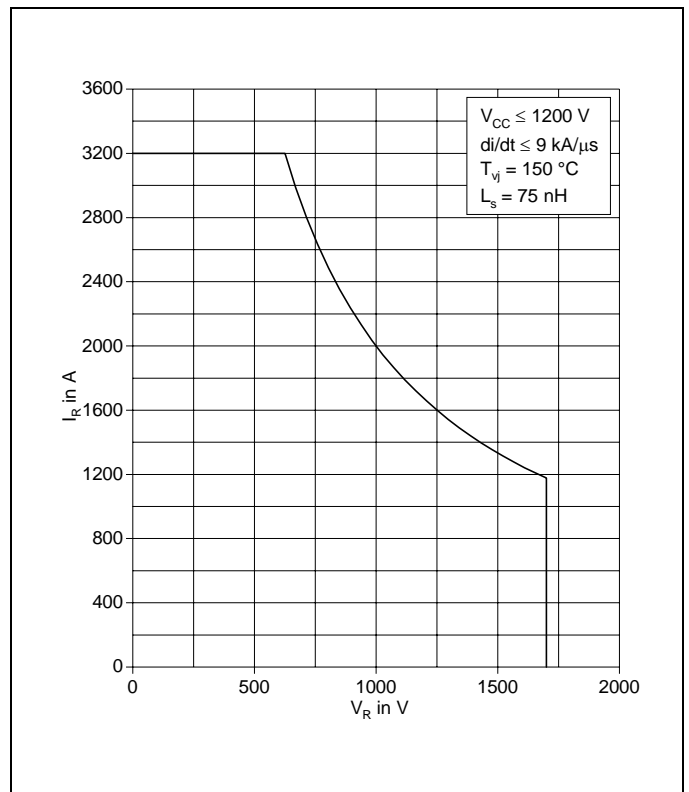


Fig. 14 Safe operating area diode (SOA)



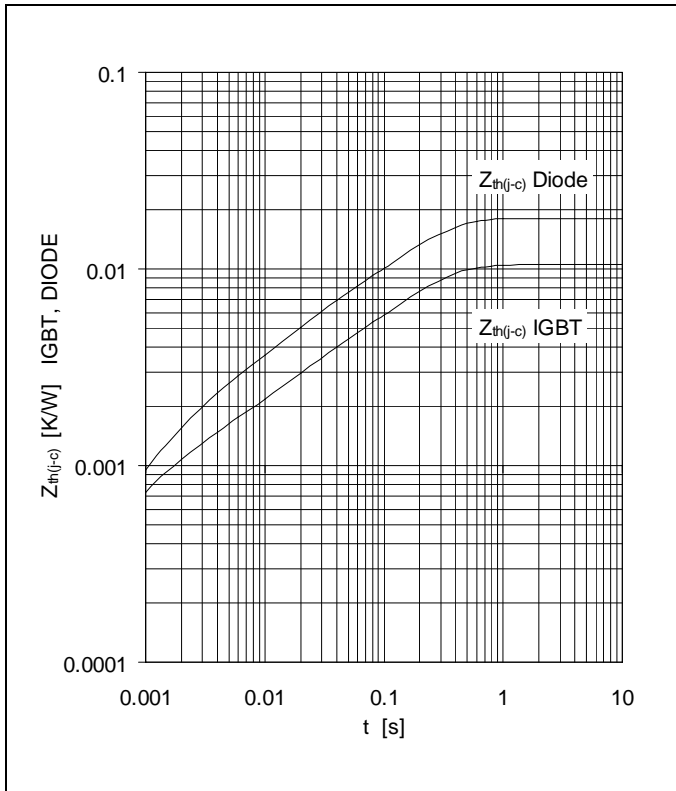


Fig. 15 Thermal impedance vs. time

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	Ri(K/kW)	7.59	1.8	0.743	0.369	
	τi(ms)	202	20.3	2.01	0.52	
DIODE	Ri(K/kW)	12.6	2.89	1.3	1.26	
	τi(ms)	210	29.6	7.01	1.49	

**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 2057 IGBT diode safe operating area (SOA)
- 5SYA 2058 Surge currents for IGBT diodes
- 5SYA 2093 Thermal design of IGBT modules
- 5SYA 2098 Paralleling of IGBT modules
- 5SYA 2039 Mounting Instructions for HiPak 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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[FF900R12IP4D](#) [FF900R12IP4DV](#) [FP30R06W1E3\\_B11](#) [FP50R07N2E4\\_B11](#) [FS100R07PE4](#) [FS150R07N3E4\\_B11](#) [FS150R17N3E4](#)  
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