

# 5SNA 1500E450300

## HiPak IGBT Module



- $V_{CE} = 4500\text{ V}$
- $I_C = 1500\text{ A}$
- Ultra-low loss SPT++ technology
- Very soft switching FCE diode with increased diode area
- Exceptional ruggedness and highest current rating
- AISiC base-plate for high power cycling capability
- AlN substrate for low thermal resistance
- Recognized under UL1557, File E 196689

### 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	$I_C$	$T_C = 95\text{ °C}, T_{vj} = 150\text{ °C}$		1500	A
Peak collector current	$I_{CM}$	$t_p = 1\text{ ms}$		3000	A
Gate-emitter voltage	$V_{GES}$		-20	20	V
DC forward current	$I_F$			1500	A
Peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$		3000	A
Surge current	$I_{FSM}$	$V_R = 0\text{ V}, T_{vj\text{ Start}} = 150\text{ °C},$ $t_p = 10\text{ ms, half-sinewave}$		13200	A
IGBT short circuit SOA	$t_{psc}$	$V_{CC} = 3200\text{ V}, V_{CEM\text{ CHIP}} \leq 4500\text{ V}$ $V_{GE} \leq 15\text{ V}, T_{vj\text{ Start}} \leq 150\text{ °C}$		10	$\mu\text{s}$
Isolation voltage	$V_{isol}$	1 min, $f = 50\text{ Hz}$		6000	V
Junction temperature	$T_{vj}$			175	$^{\circ}\text{C}$
Junction operating temperature	$T_{vj(op)}$		-40	150	$^{\circ}\text{C}$
Case temperature	$T_C$		-50	125	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		-50	125	$^{\circ}\text{C}$
Mounting torques	$M_s$	Base-heatsink, M6 screws	4	6	Nm
	$M_{t1}$	Main terminals, M8 screws	8	10	
	$M_{t1}$	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

IGBT characteristic values <sup>2)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit
Collector (-emitter) breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}$ , $I_C = 10\text{ mA}$ , $T_{vj} \geq -40\text{ °C}$	4500			V
Collector-emitter <sup>3)</sup> saturation voltage	$V_{CE\text{sat}}$	$I_C = 1500\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	2.7		V
			$T_{vj} = 125\text{ °C}$	3.55		V
			$T_{vj} = 150\text{ °C}$	3.80		V
Collector cut-off current	$I_{CES}$	$V_{CE} = 4500\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		1	mA
			$T_{vj} = 125\text{ °C}$	20		mA
			$T_{vj} = 150\text{ °C}$	105		mA
Gate leakage current	$I_{GES}$	$V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$ , $T_{vj} = 150\text{ °C}$	-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	$Q_{ge}$	$I_C = 1500\text{ A}$ , $V_{CE} = 2800\text{ V}$ , $V_{GE} = -15\text{ V} \dots +15\text{ V}$		10.85		$\mu\text{C}$
Input capacitance	$C_{ies}$			305		nF
Internal gate resistance	$R_{Gint}$			0.74		$\Omega$
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 2800\text{ V}$ , $I_C = 1500\text{ A}$ , $R_G = 1.5\ \Omega$ , $C_{GE} = 220\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 150\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$	510		ns
			$T_{vj} = 125\text{ °C}$	510		ns
			$T_{vj} = 150\text{ °C}$	510		ns
Rise time	$t_r$	$V_{CC} = 2800\text{ V}$ , $I_C = 1500\text{ A}$ , $R_G = 1.5\ \Omega$ , $C_{GE} = 220\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 150\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$	200		ns
			$T_{vj} = 125\text{ °C}$	220		ns
			$T_{vj} = 150\text{ °C}$	230		ns
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 2800\text{ V}$ , $I_C = 1500\text{ A}$ , $R_G = 6.8\ \Omega$ , $C_{GE} = 220\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 150\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$	3260		ns
			$T_{vj} = 125\text{ °C}$	3550		ns
			$T_{vj} = 150\text{ °C}$	3650		ns
Fall time	$t_f$	$V_{CC} = 2800\text{ V}$ , $I_C = 1500\text{ A}$ , $R_G = 6.8\ \Omega$ , $C_{GE} = 220\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 150\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$	560		ns
			$T_{vj} = 125\text{ °C}$	590		ns
			$T_{vj} = 150\text{ °C}$	650		ns
Turn-on switching energy	$E_{on}$	$V_{CC} = 2800\text{ V}$ , $I_C = 1500\text{ A}$ , $R_G = 1.5\ \Omega$ , $C_{GE} = 220\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 150\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$	4000		mJ
			$T_{vj} = 125\text{ °C}$	5330		mJ
			$T_{vj} = 150\text{ °C}$	5860		mJ
Turn-off switching energy	$E_{off}$	$V_{CC} = 2800\text{ V}$ , $I_C = 1500\text{ A}$ , $R_G = 6.8\ \Omega$ , $C_{GE} = 220\text{ nF}$ , $V_{GE} = \pm 15\text{ V}$ , $L_\sigma = 150\text{ nH}$ , inductive load	$T_{vj} = 25\text{ °C}$	4820		mJ
			$T_{vj} = 125\text{ °C}$	5620		mJ
			$T_{vj} = 150\text{ °C}$	5900		mJ
Short circuit current	$I_{SC}$	$t_{psc} \leq 10\ \mu\text{s}$ , $V_{GE} = 15\text{ V}$ , $V_{CC} = 3200\text{ V}$ , $V_{CEM\text{CHIP}} \leq 4500\text{ V}$	$T_{vj\text{Start}} = 150\text{ °C}$	7800		A

<sup>2)</sup> Characteristic values according to IEC 60747 – 9<sup>3)</sup> Collector-emitter saturation voltage is given at chip level

Diode characteristic values <sup>4)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit
Forward voltage <sup>5)</sup>	$V_F$	$I_F = 1500 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	2.55		V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2.80		V
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2.75		V
Reverse recovery current	$I_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	1900		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2250		A
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2370		A
Recovered charge	$Q_{rr}$	$V_{CC} = 2800 \text{ V},$ $I_F = 1500 \text{ A},$ $V_{GE} = \pm 15 \text{ V},$ $R_G = 1.5 \text{ }^\Omega,$ $C_{GE} = 220 \text{ nF},$ $L_\sigma = 150 \text{ nH}$ inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	1570		$\mu\text{C}$
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2480		$\mu\text{C}$
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2880		$\mu\text{C}$
Reverse recovery time	$t_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	1320		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1780		ns
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1930		ns
Reverse recovery energy	$E_{rec}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	2730		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	4500		mJ
			$T_{vj} = 150 \text{ }^\circ\text{C}$	5350		mJ

<sup>4)</sup> Characteristic values according to IEC 60747 – 2<sup>5)</sup> Forward voltage is given at chip levelPackage properties <sup>6)</sup>

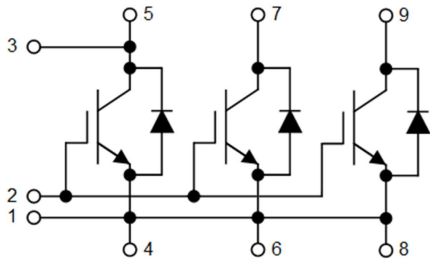
Parameter	Symbol	Conditions	min	typ	max	Unit
IGBT thermal resistance junction to case	$R_{th(j-c)IGBT}$				0.0098	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.016	K/W
IGBT thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-s)IGBT}$	IGBT per switch, $\lambda$ grease = 1W/m x K		0.008		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		0.011		K/W
Partial discharge voltage	$V_e$	$f = 50 \text{ Hz}, Q_{PD} \leq 10\text{pC}$ (acc. to IEC 61287)	3500			V
Comparative tracking index	CTI		600			V
Module stray inductance	$L_{\sigma CE}$			18		nH
Resistance, terminal-chip	$R_{CC+EE}$		$T_C = 25 \text{ }^\circ\text{C}$	0.055		m $\Omega$
			$T_C = 125 \text{ }^\circ\text{C}$	0.075		
			$T_C = 150 \text{ }^\circ\text{C}$	0.080		

Mechanical properties <sup>6)</sup>

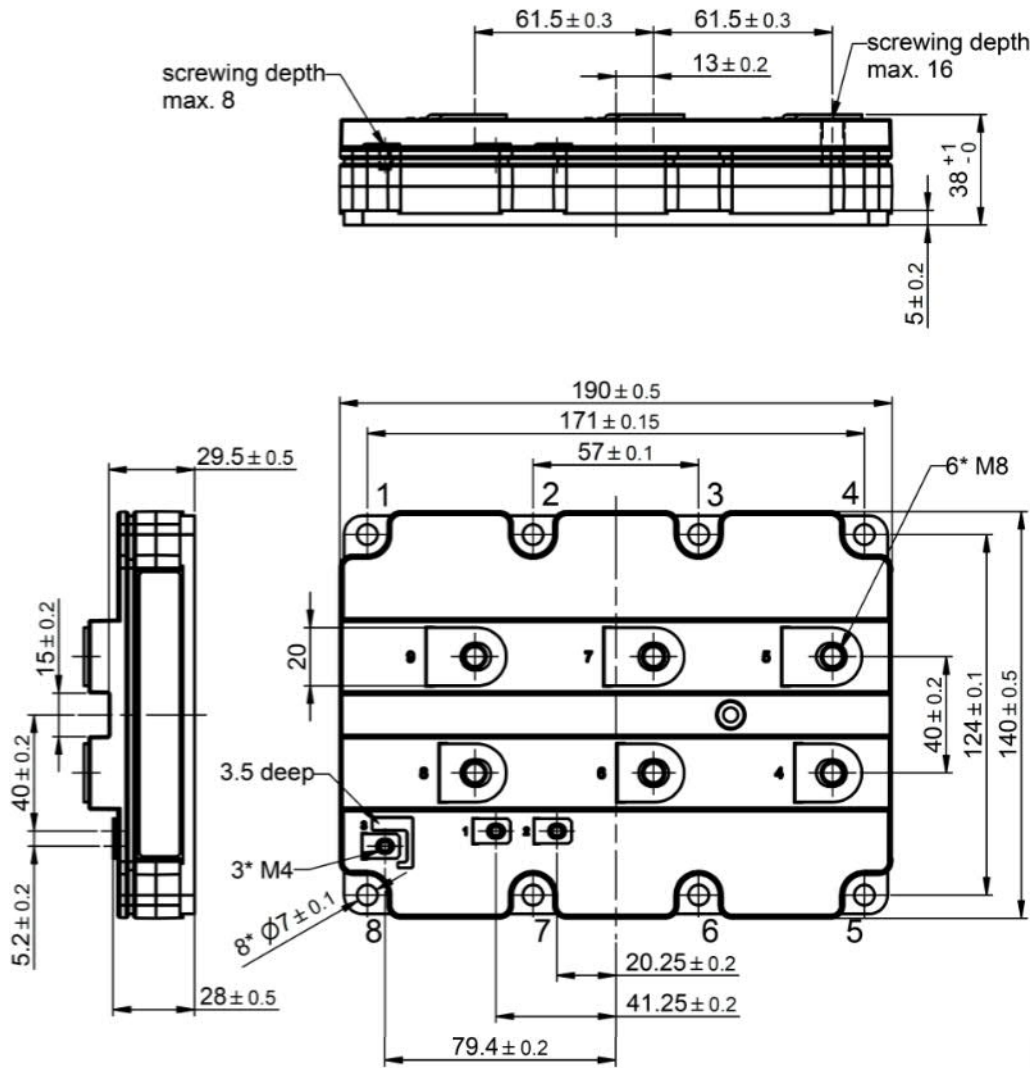
Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	L x W x H	Typical		190 x 140 x 38		mm
Clearance distance in air	$d_a$	According to IEC 60664-1 and EN 50124-1	Term. to base:	23		mm
			Term. to term:	19		
Surface creepage distance	$d_s$	According to IEC 60664-1 and EN 50124-1	Term. to base:	28.2		mm
			Term. to term:	28.2		
Mass	m			1190		g

<sup>6)</sup> Package and mechanical properties according to IEC 60747 – 15

Electrical configuration



Outline drawing (mm)



Note: 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

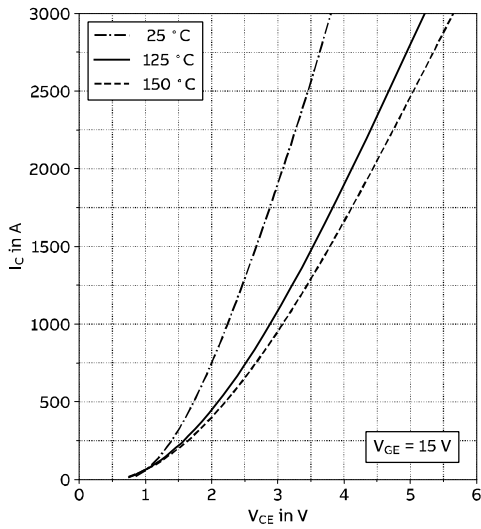


Fig. 2 Typical transfer characteristics, chip level

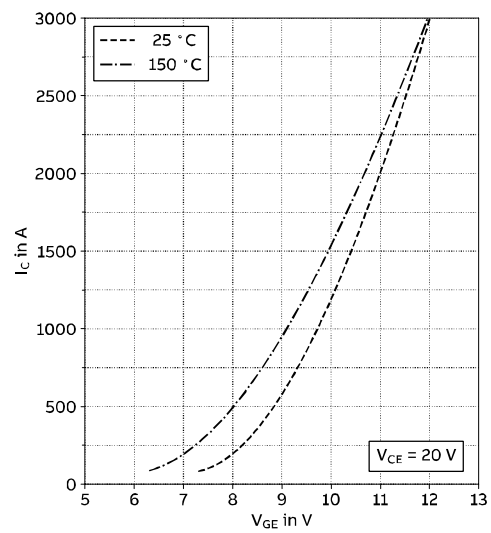


Fig. 3 Typical output characteristics, chip level,  $V_{GE} = 15\text{ V}$

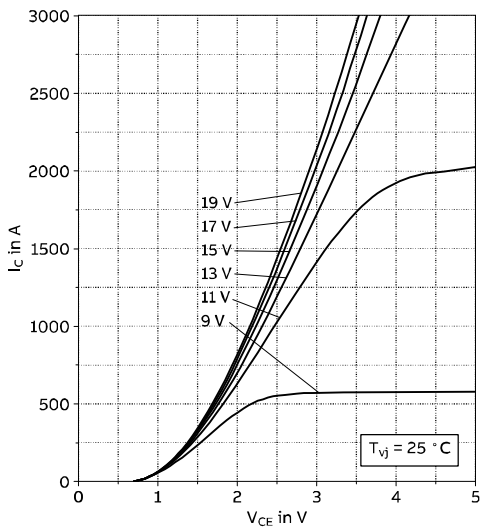


Fig. 4 Typical output characteristics, chip level,  $V_{GE} = 15\text{ V}$

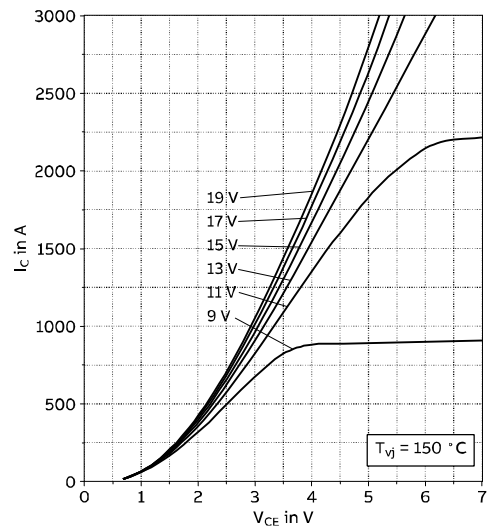


Fig. 5 Typical switching energies per pulse vs. collector current

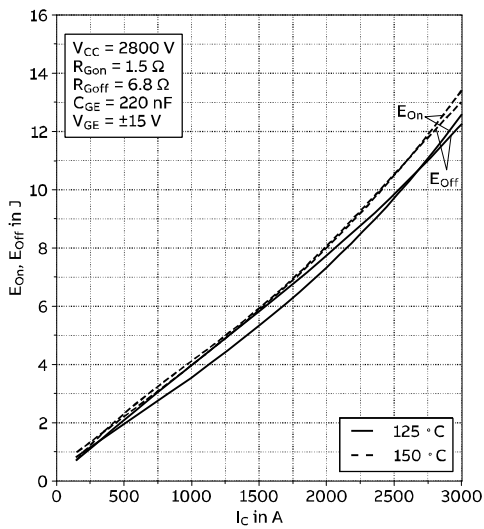


Fig. 6 Typical switching energies per pulse vs. gate resistor

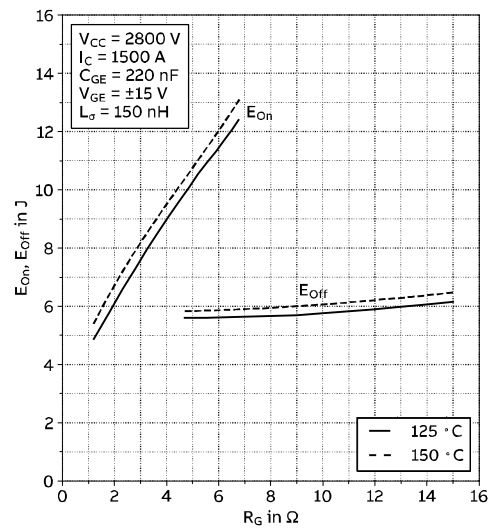


Fig. 7 Typical switching times vs. collector current

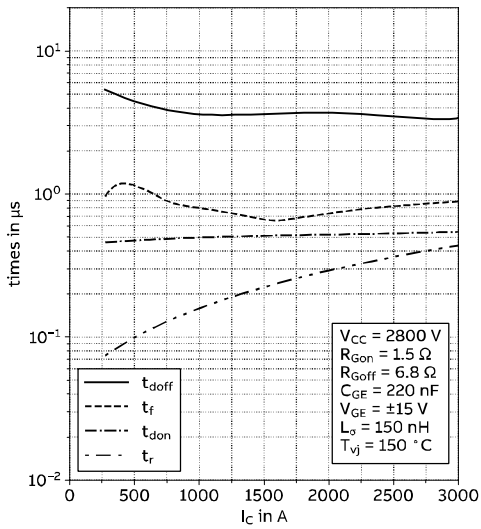


Fig. 8 Typical switching times vs. gate resistor

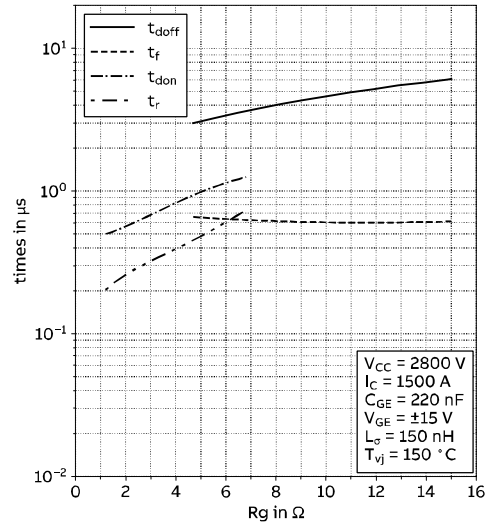


Fig. 9 Typical gate charge characteristics

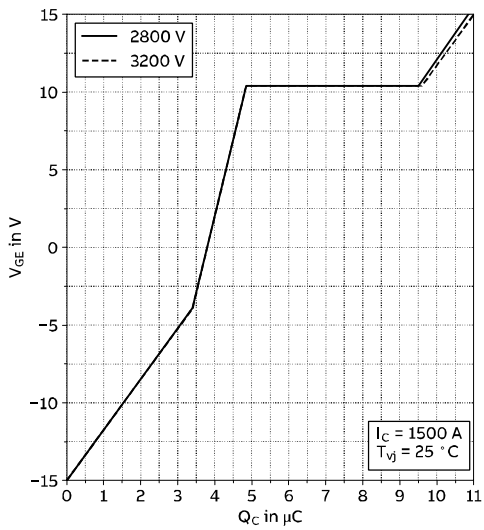


Fig. 10 Turn-off safe operating area (RBSOA)

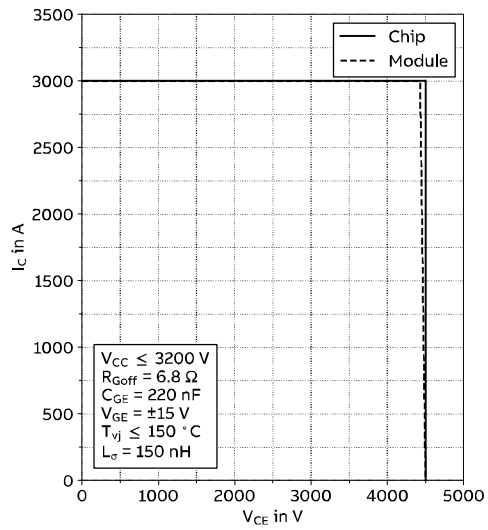


Fig. 11 Typical diode forward characteristics chip level

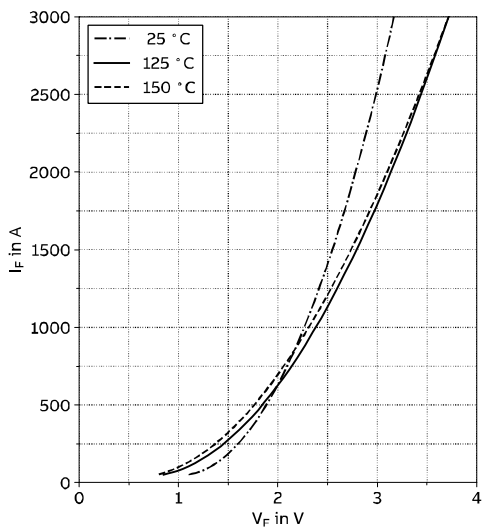


Fig. 12 Typical reverse recovery characteristics vs. forward current

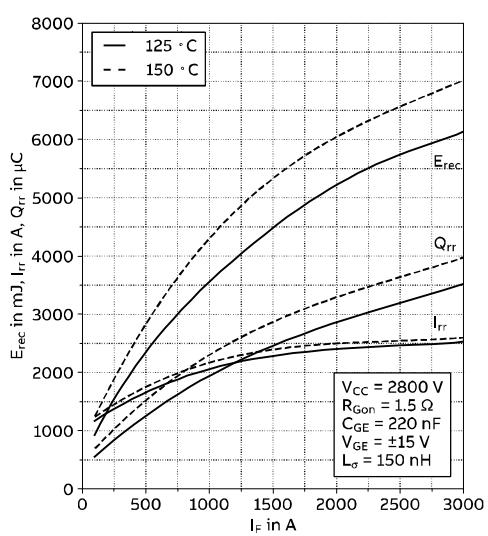


Fig. 13 Typical reverse recovery characteristics vs. di/dt

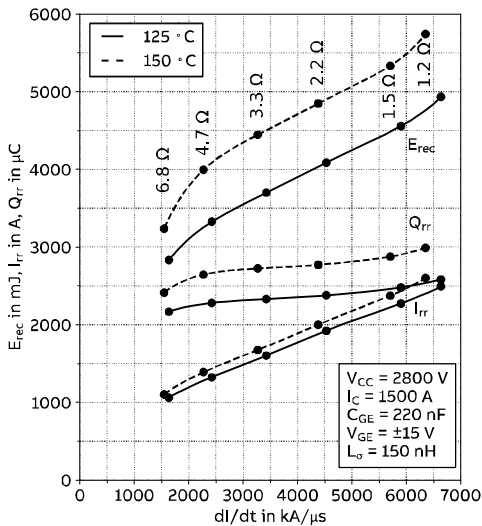


Fig. 14 Safe operating area diode (SOA)

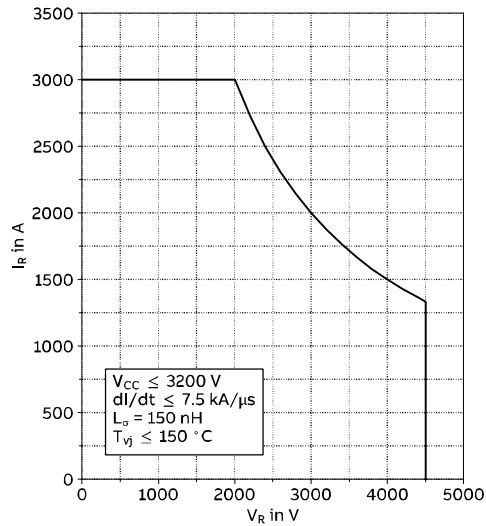
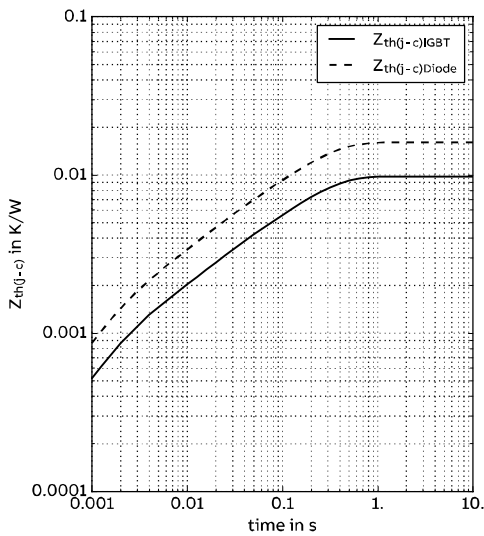


Fig. 15 Thermal impedance vs. time



Analytical function of the transient thermal resistance

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

i	1	2	3	4	5	
IGBT	R <sub>i</sub> (K/kW)	0.9	2.35	4.84	1.68	
	τ <sub>i</sub> (ms)	3609	364	51	3.7	
DIODE	R <sub>i</sub> (K/kW)	1.95	6.11	5.9	2.06	
	τ <sub>i</sub> (ms)	2283	160	32	2.7	

Related documents:

- 5SYA 2039 Mounting Instructions for HiPak modules
- 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 9118 General Environmental Conditions For High Power Semiconductors
- 5SZK 9120 Specification of environmental class for HiPak

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