

Data sheet 5SYA 1473-01, May 2020

5SNA 1500G450300

HiPak IGBT Module - Preliminary



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

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	max	Unit
Collector-emitter voltage	V_{CES}	$V_{GE} = 0\text{ V}$	$T_{vj} \geq -40\text{ °C}$	4500	V
			$T_{vj} \geq 25\text{ °C}$	4500	V
DC collector current	I_C	$T_C = 110\text{ °C}, T_{vj} = 150\text{ °C}$		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}	$V_R = 0\text{ V}, T_{vj} = 150\text{ °C},$ $t_p = 10\text{ ms, half-sinewave}$		13200	A
IGBT short circuit SOA	t_{psc}	$V_{CC} = 3200\text{ V}, V_{CEM\text{ CHIP}} \leq 4500\text{ V}$ $V_{GE} \leq 15\text{ V}, T_{vj} \leq 150\text{ °C}$		10	μs
Isolation voltage	V_{isol}	1 min, $f = 50\text{ Hz}$		7400	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	

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

IGBT characteristic values ²⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Collector (-emitter) breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0 \text{ V}$, $I_C = 10 \text{ mA}$, $T_{vj} = 25 \text{ °C}$	4500			V
Collector-emitter ³⁾ saturation voltage	$V_{CE\text{sat}}$	$I_C = 1500 \text{ A}$, $V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ °C}$	2.70		V
			$T_{vj} = 125 \text{ °C}$	3.65		V
			$T_{vj} = 150 \text{ °C}$	3.85		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
			$T_{vj} = 150 \text{ °C}$	90		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}	$I_C = 1500 \text{ A}$, $V_{CE} = 2800 \text{ V}$, $V_{GE} = -15 \text{ V} \dots +15 \text{ V}$		tbd		μC
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 1 \text{ MHz}$, $T_{vj} = 25 \text{ °C}$		tbd		nF
Internal gate resistance	R_{Gint}			0.74		Ω
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 2800 \text{ V}$, $I_C = 1500 \text{ A}$, $R_G = 1.5 \text{ }\Omega$, $C_{GE} = 220 \text{ nF}$, $V_{GE} = \pm 15 \text{ V}$, $L_\sigma = 150 \text{ nH}$, inductive load	$T_{vj} = 25 \text{ °C}$	510		ns
			$T_{vj} = 125 \text{ °C}$	510		ns
			$T_{vj} = 150 \text{ °C}$	505		ns
Rise time	t_r	$V_{CC} = 2800 \text{ V}$, $I_C = 1500 \text{ A}$, $R_G = 1.5 \text{ }\Omega$, $C_{GE} = 220 \text{ nF}$, $V_{GE} = \pm 15 \text{ V}$, $L_\sigma = 150 \text{ nH}$, inductive load	$T_{vj} = 25 \text{ °C}$	220		ns
			$T_{vj} = 125 \text{ °C}$	235		ns
			$T_{vj} = 150 \text{ °C}$	245		ns
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 2800 \text{ V}$, $I_C = 1500 \text{ A}$, $R_G = 6.8 \text{ }\Omega$, $C_{GE} = 220 \text{ nF}$, $V_{GE} = \pm 15 \text{ V}$, $L_\sigma = 150 \text{ nH}$, inductive load	$T_{vj} = 25 \text{ °C}$	3170		ns
			$T_{vj} = 125 \text{ °C}$	3460		ns
			$T_{vj} = 150 \text{ °C}$	3550		ns
Fall time	t_f	$V_{CC} = 2800 \text{ V}$, $I_C = 1500 \text{ A}$, $R_G = 6.8 \text{ }\Omega$, $C_{GE} = 220 \text{ nF}$, $V_{GE} = \pm 15 \text{ V}$, $L_\sigma = 150 \text{ nH}$, inductive load	$T_{vj} = 25 \text{ °C}$	565		ns
			$T_{vj} = 125 \text{ °C}$	640		ns
			$T_{vj} = 150 \text{ °C}$	660		ns
Turn-on switching energy	E_{on}	$V_{CC} = 2800 \text{ V}$, $I_C = 1500 \text{ A}$, $R_G = 1.5 \text{ }\Omega$, $C_{GE} = 220 \text{ nF}$, $V_{GE} = \pm 15 \text{ V}$, $L_\sigma = 150 \text{ nH}$, inductive load	$T_{vj} = 25 \text{ °C}$	4360		mJ
			$T_{vj} = 125 \text{ °C}$	5750		mJ
			$T_{vj} = 150 \text{ °C}$	6380		mJ
Turn-off switching energy	E_{off}	$V_{CC} = 2800 \text{ V}$, $I_C = 1000 \text{ A}$, $R_G = 6.8 \text{ }\Omega$, $C_{GE} = 220 \text{ nF}$, $V_{GE} = \pm 15 \text{ V}$, $L_\sigma = 150 \text{ nH}$, inductive load	$T_{vj} = 25 \text{ °C}$	4610		mJ
			$T_{vj} = 125 \text{ °C}$	5480		mJ
			$T_{vj} = 150 \text{ °C}$	5710		mJ
Short circuit current	I_{SC}	$t_{psc} \leq 10 \text{ }\mu\text{s}$, $V_{GE} = 15 \text{ V}$, $V_{CC} = 3200 \text{ V}$, $V_{CEM\text{CHIP}} \leq 4500 \text{ V}$	$T_{vj} = 150 \text{ °C}$	7800		A

²⁾ Characteristic values according to IEC 60747 - 9³⁾ Collector-emitter saturation voltage is given at chip level

Diode characteristic values ⁴⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Forward voltage ⁵⁾	V_F	$I_F = 1500 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	2.60		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}		$T_{vj} = 25 \text{ }^\circ\text{C}$	2150		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2370		A
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2480		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	$T_{vj} = 25 \text{ }^\circ\text{C}$	1870		μC
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2850		μC
			$T_{vj} = 150 \text{ }^\circ\text{C}$	3300		μC
Reverse recovery time	t_{rr}		$T_{vj} = 25 \text{ }^\circ\text{C}$	1440		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1890		ns
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2040		ns
Reverse recovery energy	E_{rec}		$T_{vj} = 25 \text{ }^\circ\text{C}$	3370		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	5250		mJ
			$T_{vj} = 150 \text{ }^\circ\text{C}$	6100		mJ

⁴⁾ Characteristic values according to IEC 60747 – 2⁵⁾ Forward voltage is given at chip levelPackage properties ⁶⁾

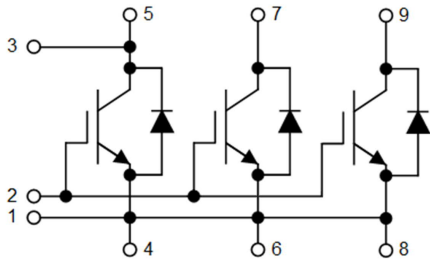
Parameter	Symbol	Conditions	min	typ	max	Unit
IGBT thermal resistance junction to case	$R_{th(j-c)IGBT}$				0.0098	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.016	K/W
IGBT thermal resistance ²⁾ case to heatsink	$R_{th(c-s)IGBT}$	IGBT per switch, λ grease = 1W/m x K		0.008		K/W
Diode thermal resistance ²⁾ case to heatsink	$R_{th(c-s)DIODE}$	Diode per switch, λ 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}		$T_C = 25 \text{ }^\circ\text{C}$	0.07		m Ω
			$T_C = 125 \text{ }^\circ\text{C}$	0.1		
			$T_C = 150 \text{ }^\circ\text{C}$	0.11		

Mechanical properties ⁶⁾

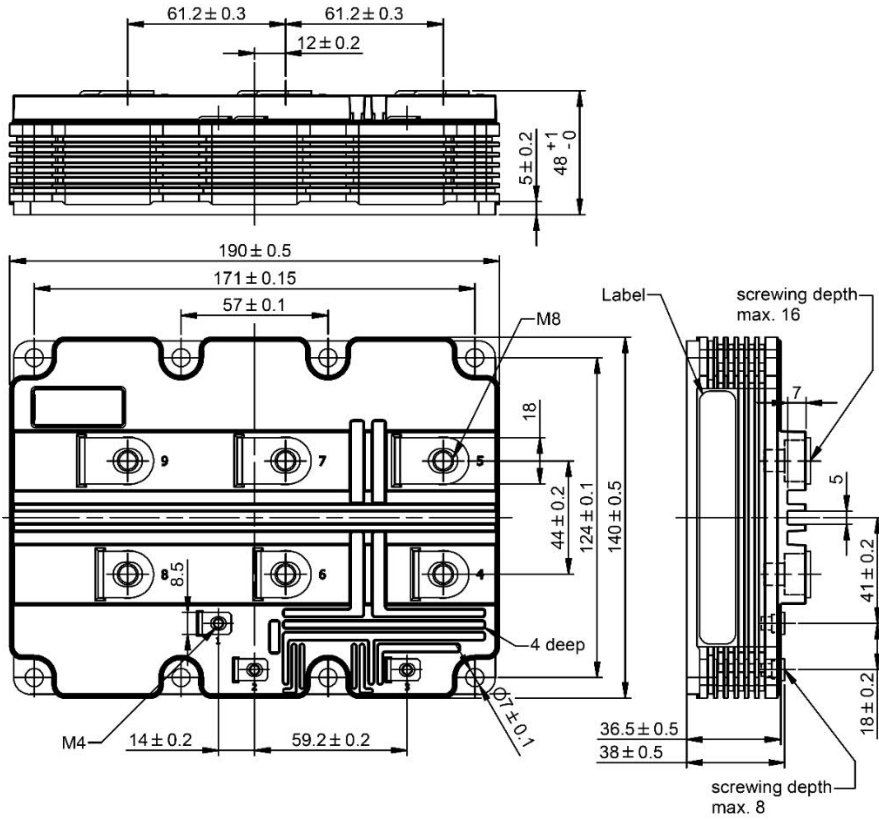
Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	L x W x H	Typical		190 x 140 x 48		mm
Clearance distance in air	d_a	According to IEC 60664-1 and EN 50124-1	Term. to base:	40		mm
			Term. to term:	26		
Surface creepage distance	d_s	According to IEC 60664-1 and EN 50124-1	Term. to base:	64		mm
			Term. to term:	56		
Mass	m			1330		g

⁶⁾ 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

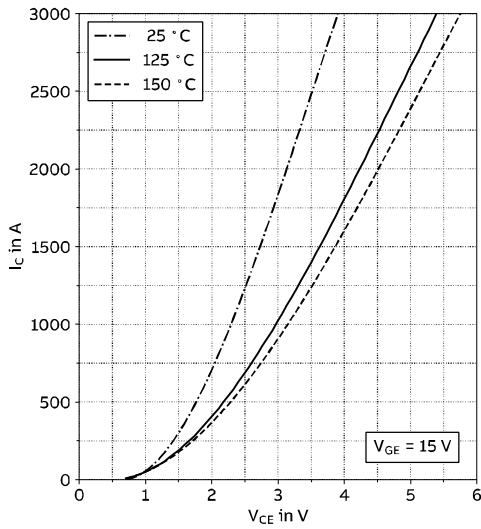


Fig. 2 Typical transfer characteristics, chip level

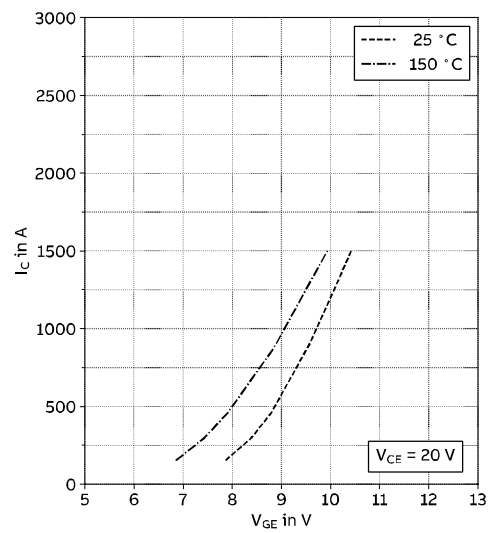


Fig. 3 Typical output characteristics, chip level, VGE = 15 V

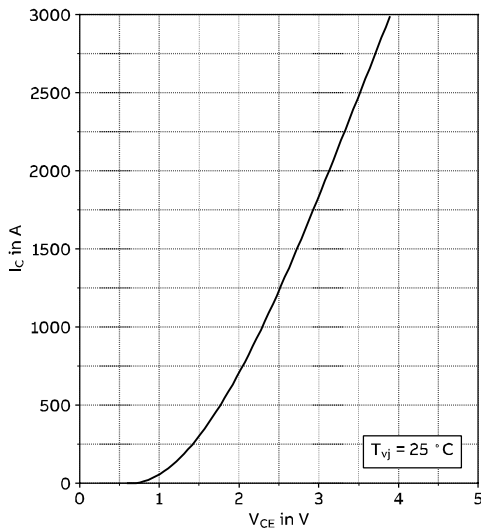


Fig. 4 Typical output characteristics, chip level, VGE = 15 V

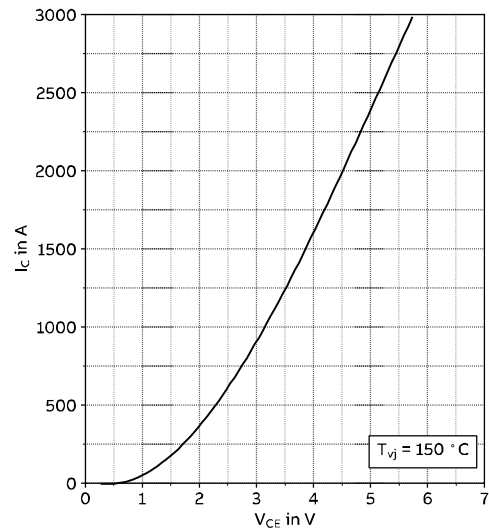


Fig. 5 Typical switching energies per pulse vs. collector current

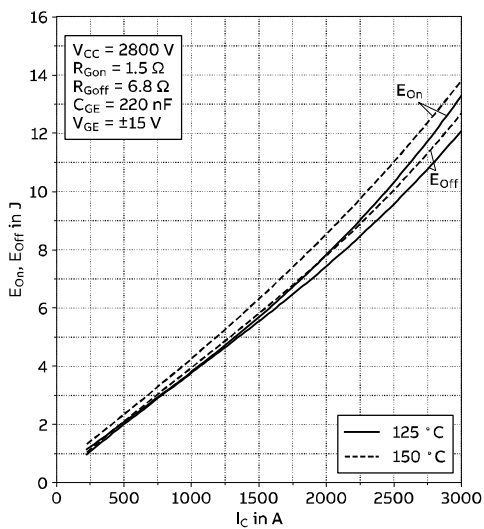


Fig. 6 Typical switching energies per pulse vs. gate resistor

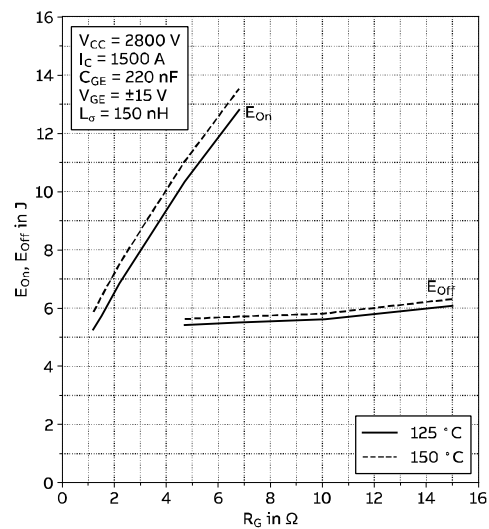


Fig. 7 Typical switching times vs. collector current

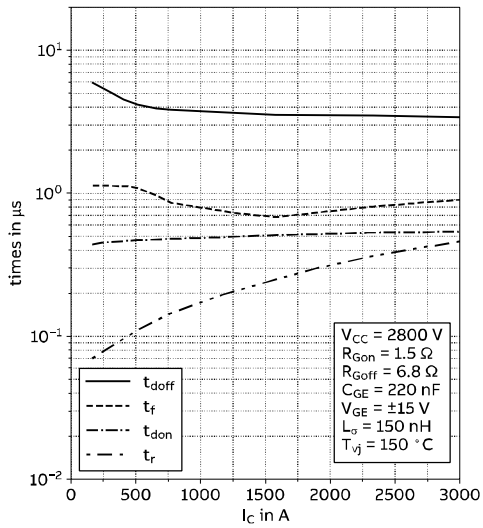


Fig. 8 Typical switching times vs. gate resistor

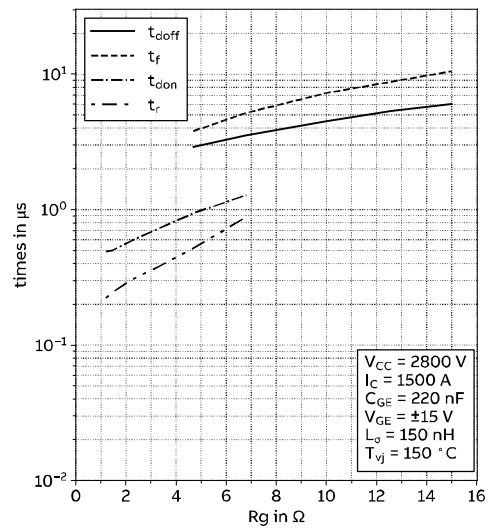


Fig. 9 Typical gate charge characteristics, tbd

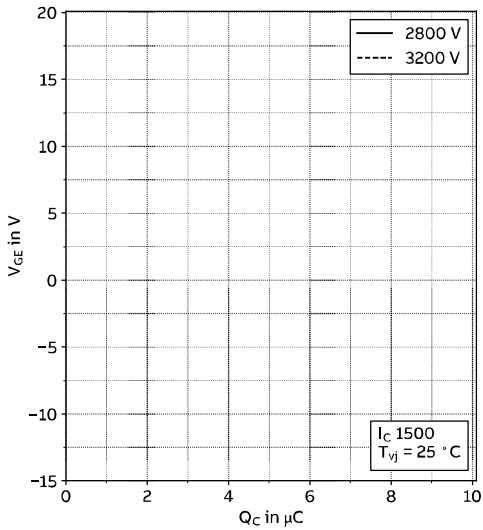


Fig. 10 Turn-off safe operating area (RBSOA)

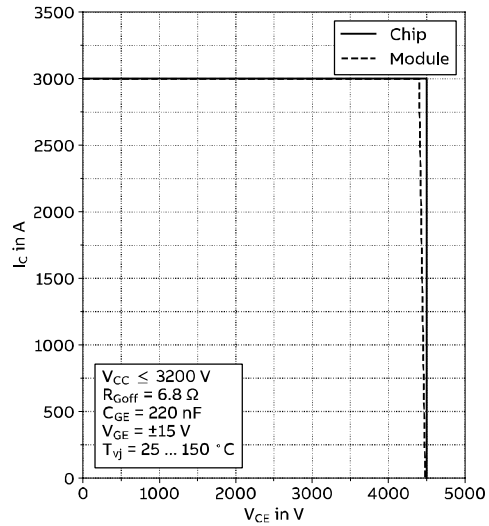


Fig. 11 Typical diode forward characteristics chip level

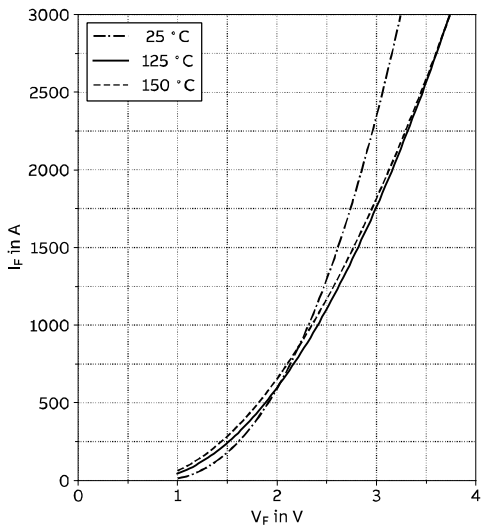


Fig. 12 Typical reverse recovery characteristics vs. forward current

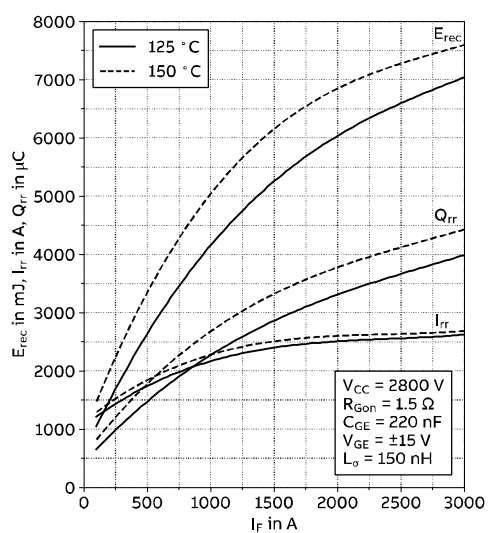


Fig. 13 Typical reverse recovery characteristics vs. di/dt

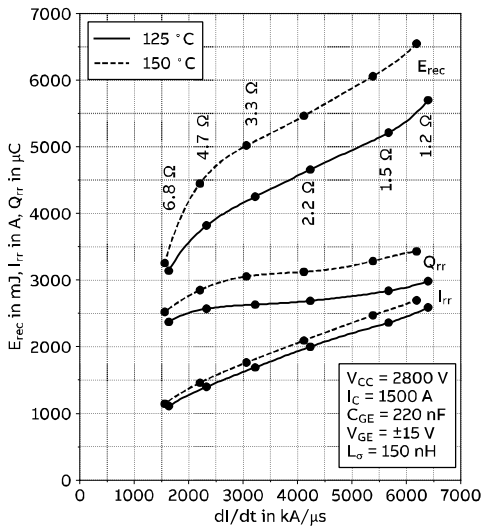


Fig. 14 Safe operating area diode (SOA)

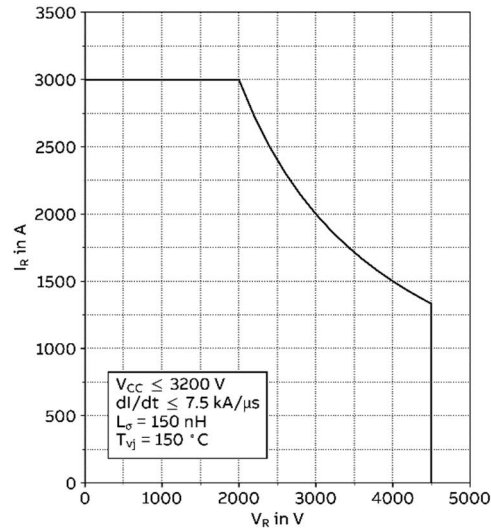
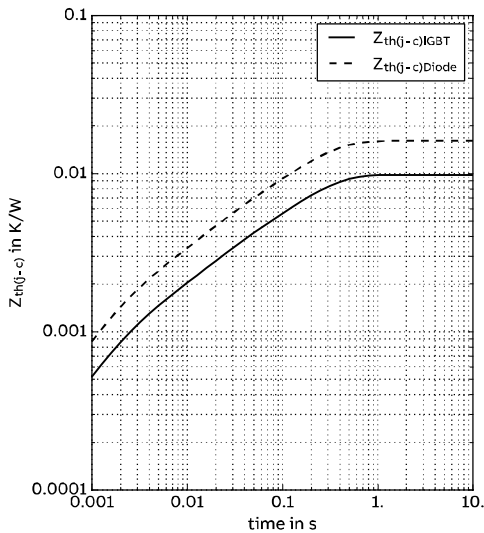


Fig. 15 Thermal impedance vs. time



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 _i (K/kW)	0.9	2.35	4.84	1.68	
	τ _i (ms)	3609	364	51	3.7	
DIODE	R _i (K/kW)	1.95	6.11	5.9	2.06	
	τ _i (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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