

# 5SNA 2400E170305

## HiPak IGBT Module

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

Ultra low-loss, rugged SPT+ chip-set  
 Smooth switching SPT+ chip-set for good EMC  
 AlSiC base-plate for high power cycling capability  
 AlN substrate for low thermal resistance  
 Improved high reliability package



### 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	$I_C$	$T_C = 105 \text{ °C}$ , $T_{vj} = 150 \text{ °C}$		2400	A
Peak collector current	$I_{CM}$	$t_p = 1 \text{ ms}$		4800	A
Gate-emitter voltage	$V_{GES}$		-20	20	V
Total power dissipation	$P_{tot}$	$T_C = 25 \text{ °C}$ , $T_{vj} = 150 \text{ °C}$		17800	W
DC forward current	$I_F$			2400	A
Peak forward current	$I_{FRM}$	$t_p = 1 \text{ ms}$		4800	A
Surge current	$I_{FSM}$	$V_R = 0 \text{ V}$ , $T_{vj} = 150 \text{ °C}$ , $t_p = 10 \text{ ms}$ , half-sinewave		18000	A
IGBT short circuit SOA	$t_{psc}$	$V_{CC} = 1200 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 1700 \text{ V}$ $V_{GE} \leq 15 \text{ V}$ , $T_{vj} \leq 150 \text{ °C}$		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 ABB Document No. 5SYA 2039

### IGBT characteristic values <sup>3)</sup>

Parameter	Symbol	Conditions	min	typ	max	Unit	
Collector (-emitter) breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0 \text{ V}$ , $I_C = 10 \text{ mA}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$	1700			V	
Collector-emitter <sup>4)</sup> saturation voltage	$V_{CE \text{ sat}}$	$I_C = 2400 \text{ A}$ , $V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	1.8	2.05	2.3	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2.15	2.4	2.65	V
			$T_{vj} = 150 \text{ }^\circ\text{C}$		2.45		V
Collector cut-off current	$I_{CES}$	$V_{CE} = 1700 \text{ V}$ , $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		0.04	1	mA
			$T_{vj} = 125 \text{ }^\circ\text{C}$		30	60	mA
			$T_{vj} = 150 \text{ }^\circ\text{C}$		170		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	$V_{GE(TO)}$	$I_C = 240 \text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$	5.3		7.3	V	
Gate charge	$Q_{ge}$	$I_C = 2400 \text{ A}$ , $V_{CE} = 900 \text{ V}$ , $V_{GE} = -15 \text{ V} \dots 15 \text{ V}$		21		$\mu\text{C}$	
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$		239		nF	
Output capacitance	$C_{oes}$			20.9		nF	
Reverse transfer capacitance	$C_{res}$			9.24		nF	
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		450		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$		480		ns
			$T_{vj} = 150 \text{ }^\circ\text{C}$		490		ns
Rise time	$t_r$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		230		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$		240		ns
			$T_{vj} = 150 \text{ }^\circ\text{C}$		250		ns
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		1165		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1280		ns
			$T_{vj} = 150 \text{ }^\circ\text{C}$		1310		ns
Fall time	$t_f$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		220		ns
			$T_{vj} = 125 \text{ }^\circ\text{C}$		250		ns
			$T_{vj} = 150 \text{ }^\circ\text{C}$		260		ns
Turn-on switching energy	$E_{on}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		450		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		680		mJ
			$T_{vj} = 150 \text{ }^\circ\text{C}$		750		mJ
Turn-off switching energy	$E_{off}$	$V_{CC} = 900 \text{ V}$ , $I_C = 2400 \text{ A}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $V_{GE} = \pm 15 \text{ V}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$		750		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		980		mJ
			$T_{vj} = 150 \text{ }^\circ\text{C}$		1060		mJ
Short circuit current	$I_{SC}$	$t_{psc} \leq 10 \text{ } \mu\text{s}$ , $V_{GE} = 15 \text{ V}$ , $V_{CC} = 1200 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 1700 \text{ V}$	$T_{vj} = 150 \text{ }^\circ\text{C}$		10000	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>	$V_F$	$I_F = 2400 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	1.65	1.95	V	
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1.67	2.0	V
			$T_{vj} = 150 \text{ }^\circ\text{C}$		1.6		V
Reverse recovery current	$I_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	1920		A	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2180		A	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2350		A	
Recovered charge	$Q_{rr}$	$V_{CC} = 900 \text{ V}$ , $I_F = 2400 \text{ A}$ , $V_{GE} = \pm 15 \text{ V}$ , $R_G = 0.6 \text{ } \Omega$ , $C_{GE} = 0 \text{ nF}$ , $di/dt = 11.0 \text{ kA}/\mu\text{s}$ , $L_\sigma = 50 \text{ nH}$ , inductive load	$T_{vj} = 25 \text{ }^\circ\text{C}$	680		$\mu\text{C}$	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1220		$\mu\text{C}$	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1440		$\mu\text{C}$	
Reverse recovery time	$t_{rr}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	620		ns	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	990		ns	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1060		ns	
Reverse recovery energy	$E_{rec}$		$T_{vj} = 25 \text{ }^\circ\text{C}$	560		mJ	
			$T_{vj} = 125 \text{ }^\circ\text{C}$	870		mJ	
			$T_{vj} = 150 \text{ }^\circ\text{C}$	1030		mJ	

<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	$R_{th(j-c)IGBT}$				0.007	K/W
Diode thermal resistance junction to case	$R_{th(j-c)DIODE}$				0.012	K/W
IGBT thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-s)IGBT}$	IGBT per switch, $\lambda$ grease = $1\text{W}/\text{m} \times \text{K}$		0.009		K/W
Diode thermal resistance <sup>2)</sup> case to heatsink	$R_{th(c-s)DIODE}$	Diode per switch, $\lambda$ grease = $1\text{W}/\text{m} \times \text{K}$		0.018		K/W
Comparative tracking index	CTI		600			
Module stray inductance	$L_{\sigma CE}$			8		nH
Resistance, terminal-chip	$R_{CC' \rightarrow EE'}$		$T_C = 25 \text{ }^\circ\text{C}$	0.055		m $\Omega$
			$T_C = 125 \text{ }^\circ\text{C}$	0.075		
			$T_C = 150 \text{ }^\circ\text{C}$	0.080		

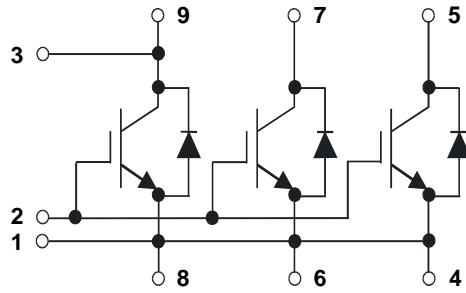
<sup>2)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA 2039

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

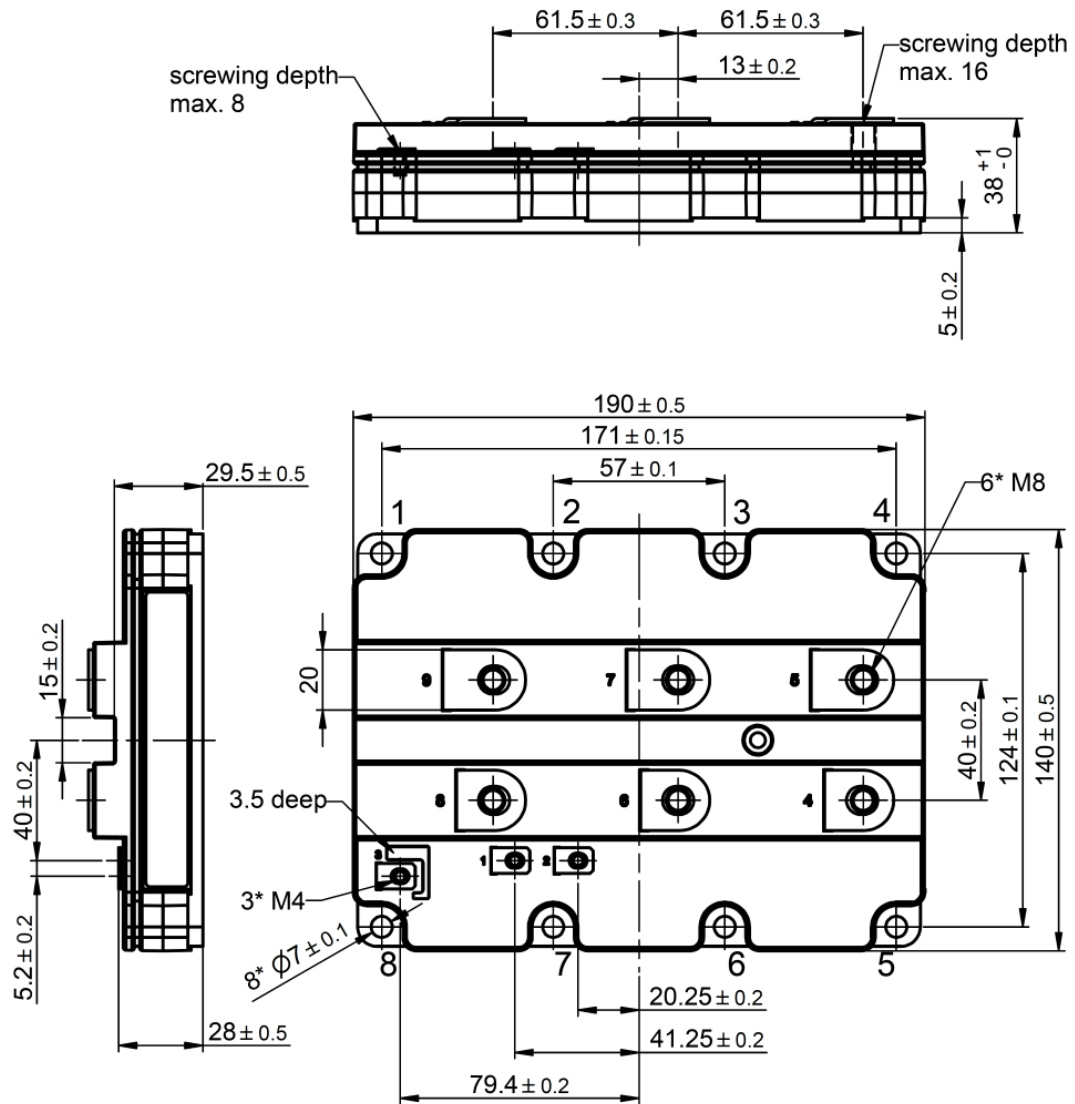
Parameter	Symbol	Conditions	min	typ	max	Unit
Dimensions	L x W x H	Typical		190 x 140 x 38		mm
Clearance distance in air	$d_a$	according to IEC 60664-1 and EN 50124-1	Term. to base:	23		mm
			Term. to term:	19		
Surface creepage distance	$d_s$	according to IEC 60664-1 and EN 50124-1	Term. to base:	28.2		mm
			Term. to term:	28.2		
Mass	m			1210		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 ABB Document No. 5SYA 2039

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.

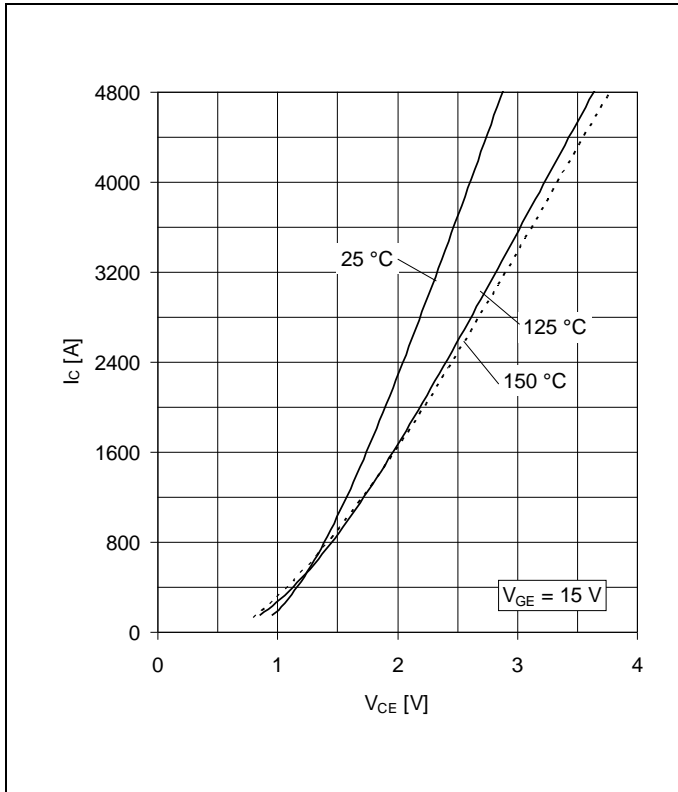


Fig. 1 Typical on-state characteristics, chip level

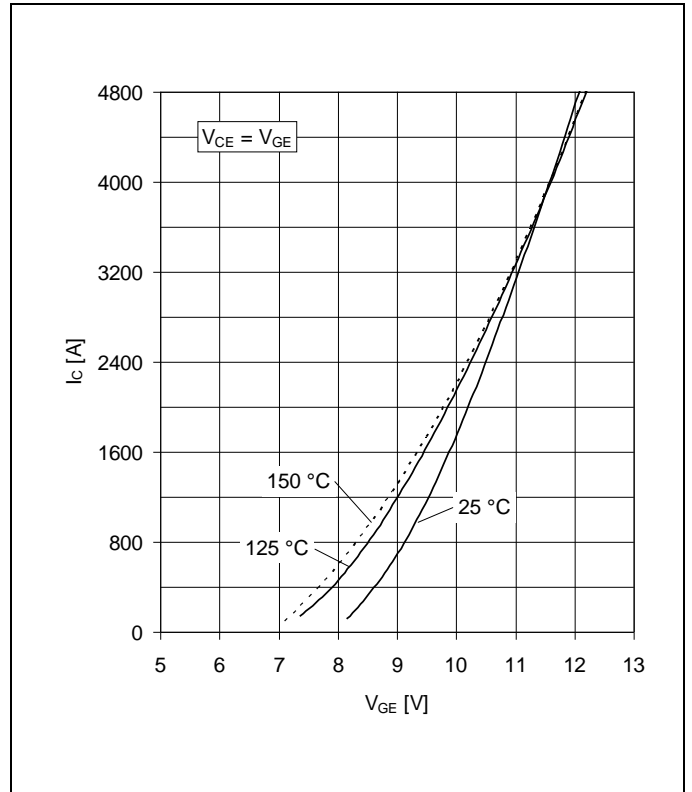


Fig. 2 Typical transfer characteristics, chip level

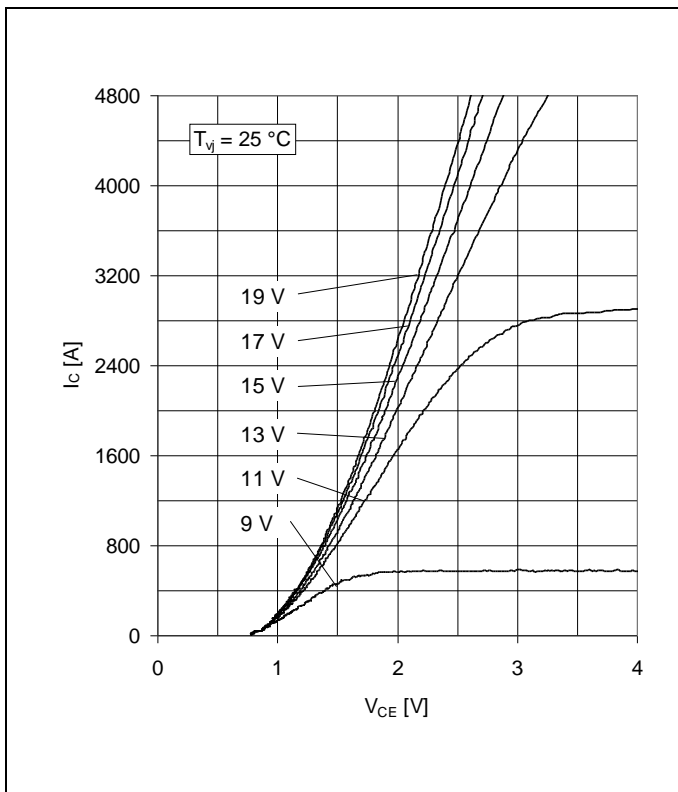


Fig. 3 Typical output characteristics, chip level

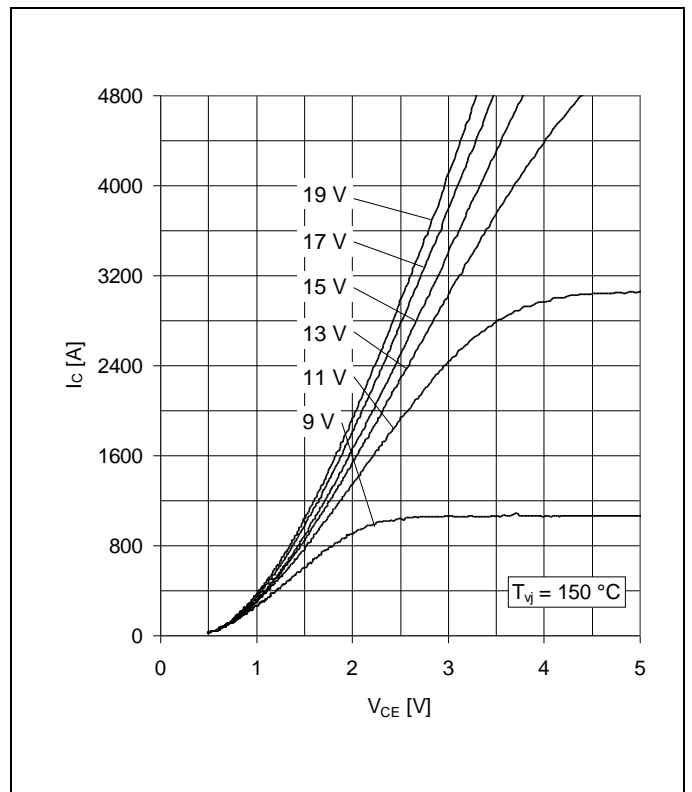


Fig. 4 Typical output characteristics, chip level

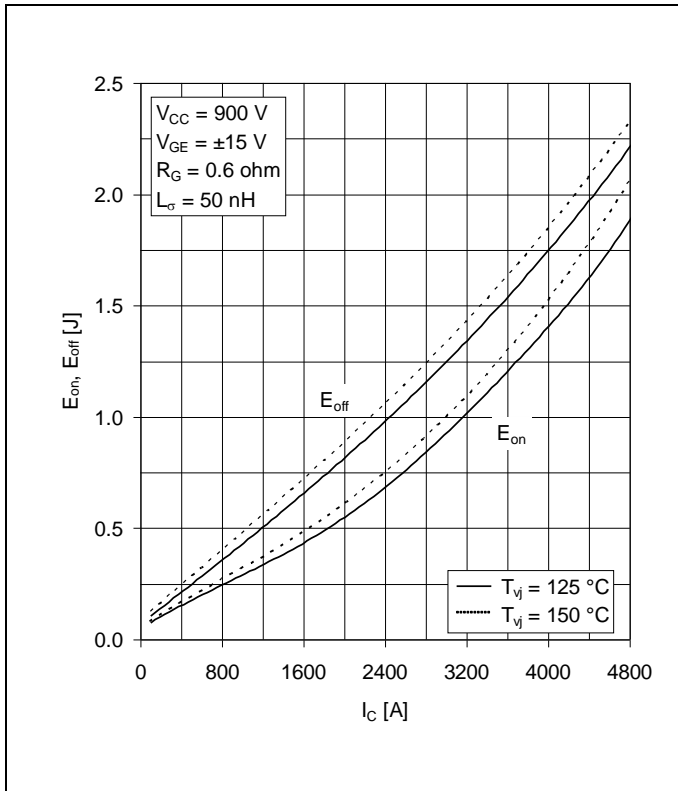


Fig. 5 Typical switching energies per pulse vs. collector current

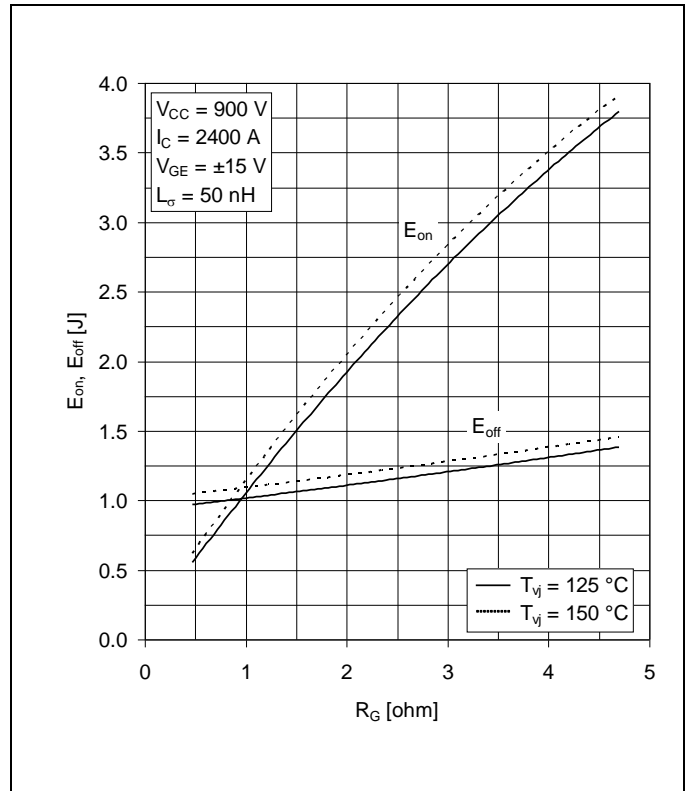


Fig. 6 Typical switching energies per pulse vs. gate resistor

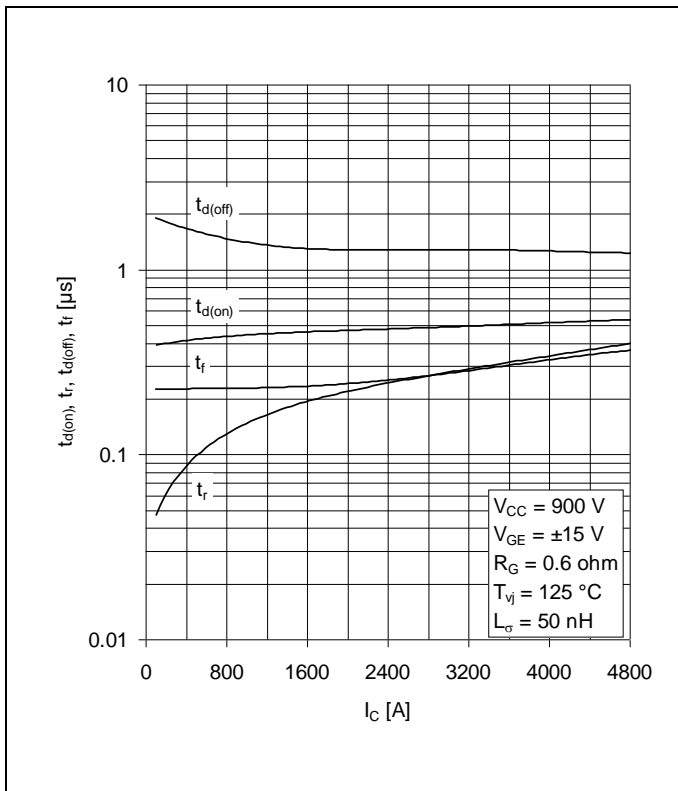


Fig. 7 Typical switching times vs. collector current

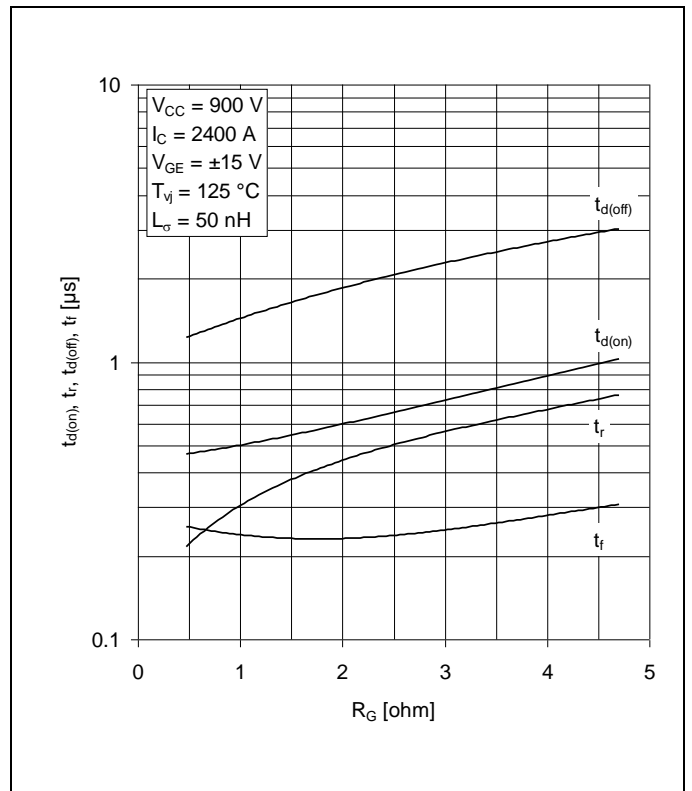


Fig. 8 Typical switching times vs. gate resistor

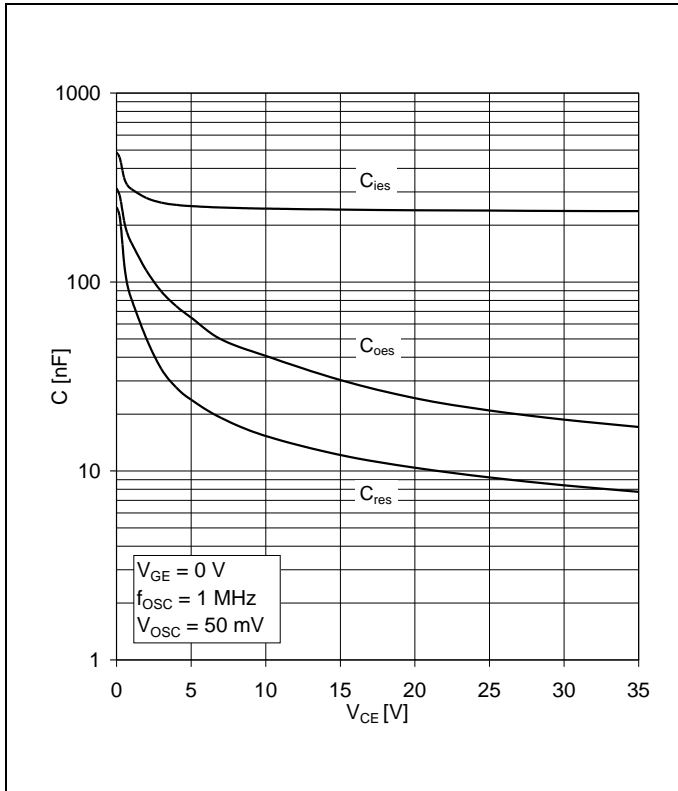


Fig. 9 Typical capacitances vs. collector-emitter voltage

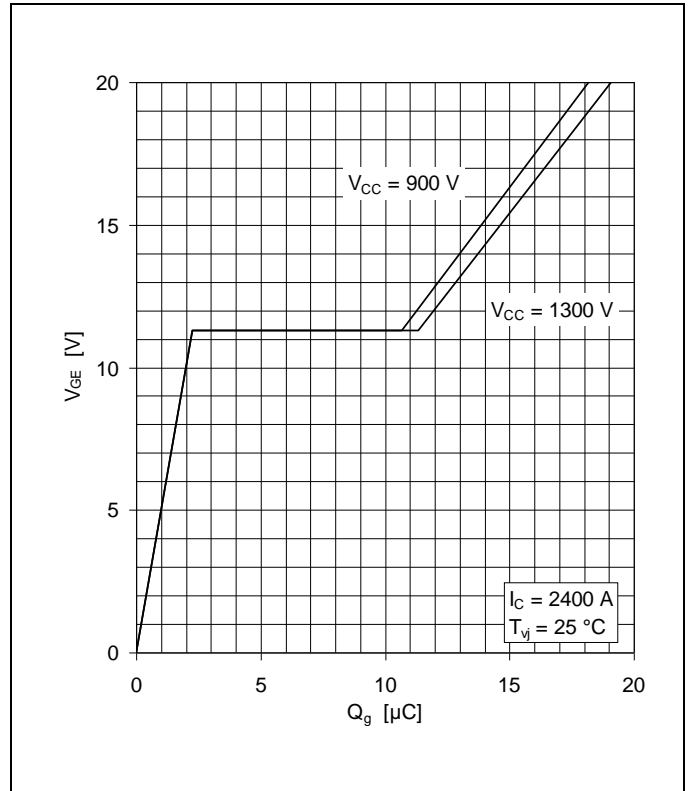


Fig. 10 Typical gate charge characteristics

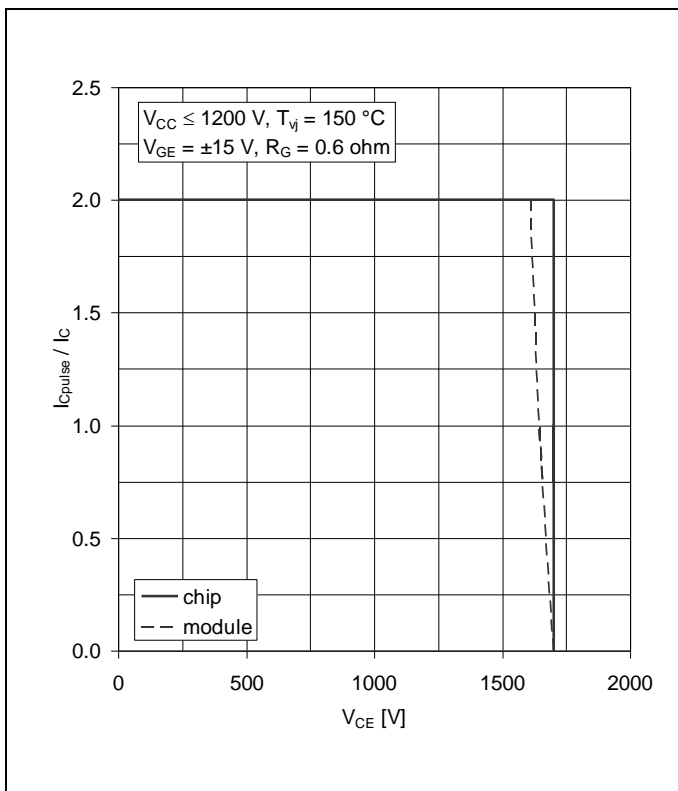


Fig. 11 Turn-off safe operating area (RBSOA)

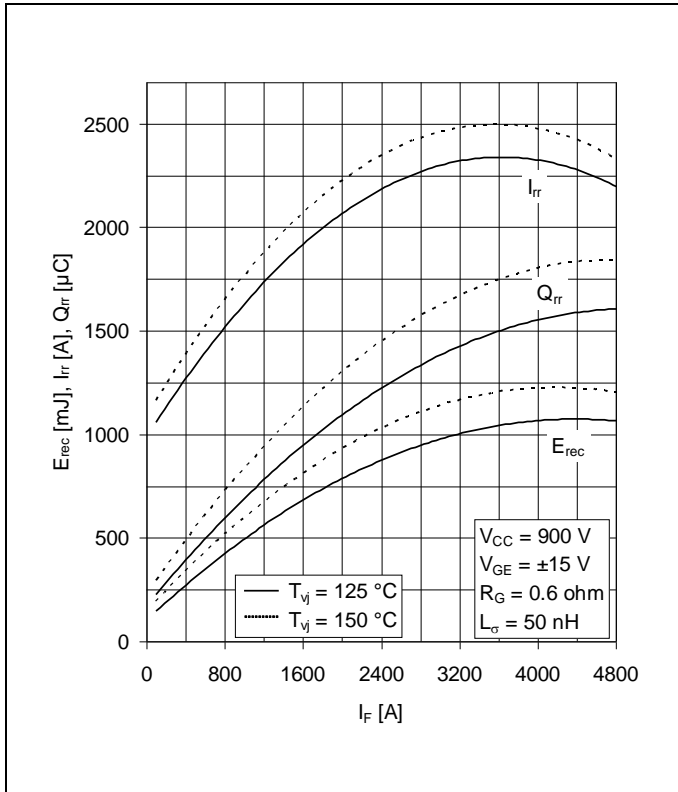


Fig. 12 Typical reverse recovery characteristics vs. forward current

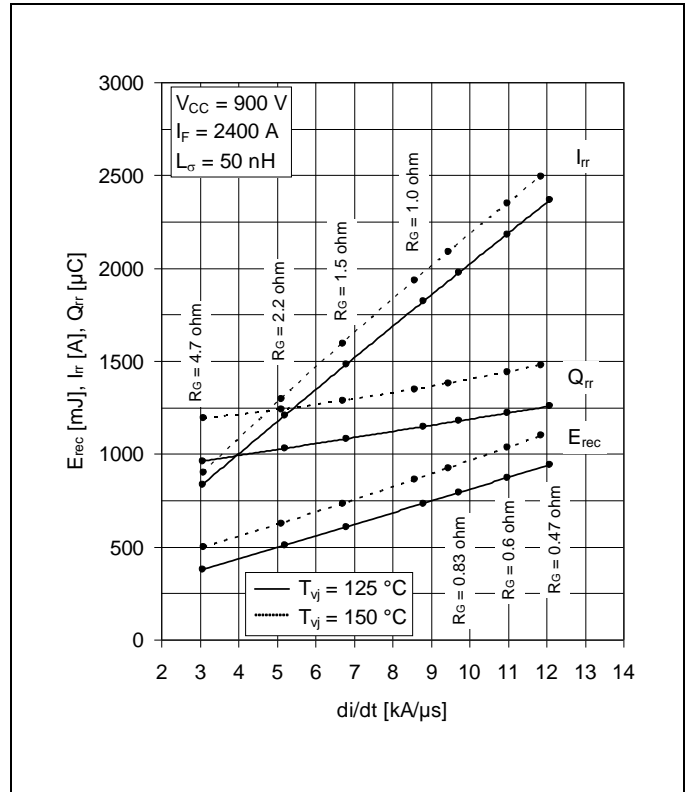


Fig. 13 Typical reverse recovery characteristics vs. di/dt

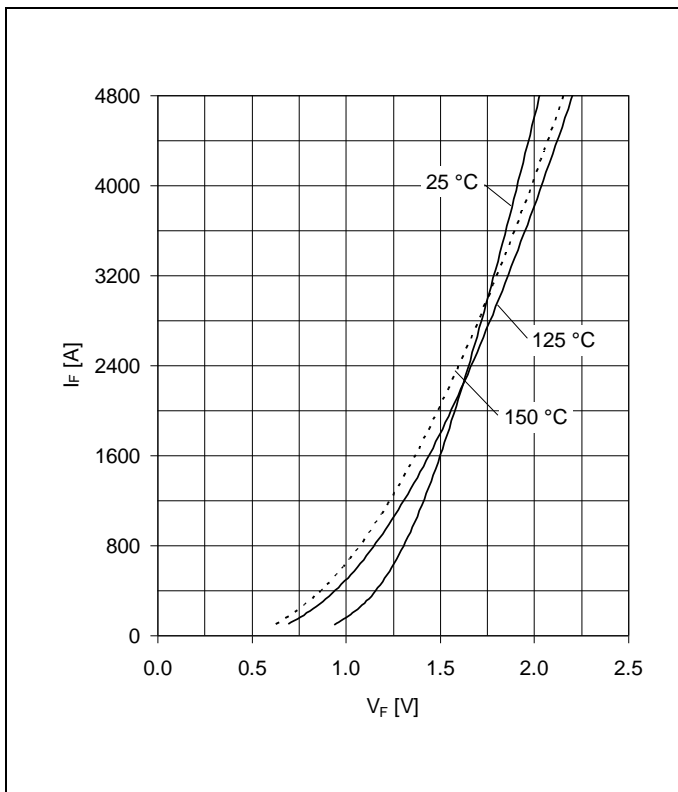


Fig. 14 Typical diode forward characteristics chip level

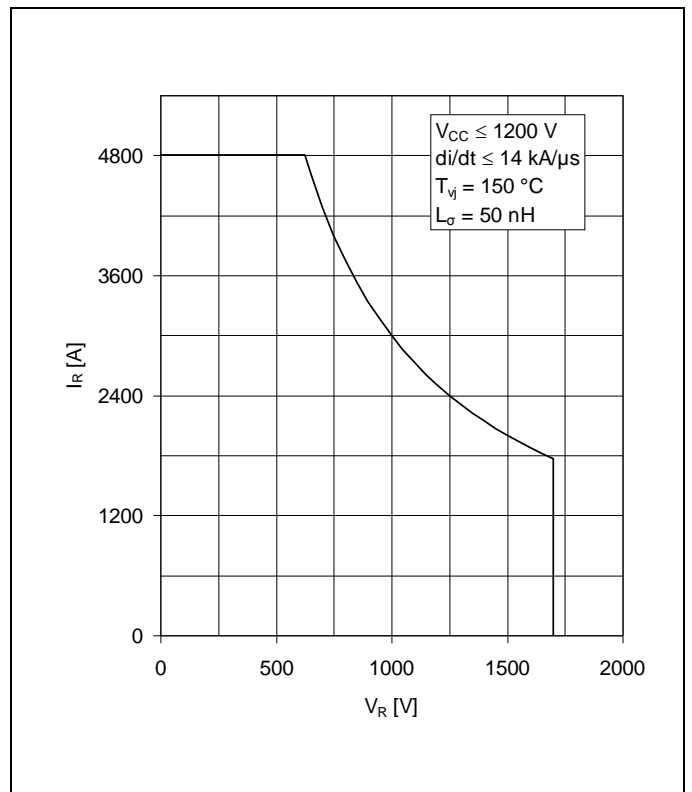


Fig. 15 Safe operating area diode (SOA)



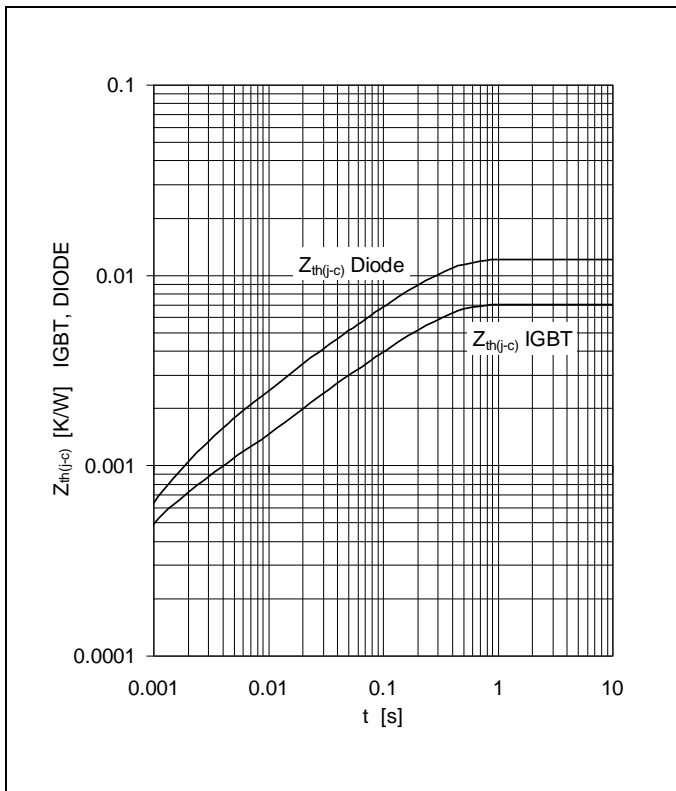


Fig. 16 Thermal impedance vs. time

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	Ri(K/kW)	5.059	1.201	0.495	0.246	
	$\tau_i$ (ms)	202.9	20.3	2.01	0.52	
DIODE	Ri(K/kW)	8.432	1.928	0.866	0.839	
	$\tau_i$ (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 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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