英飞凌双面冷却模块

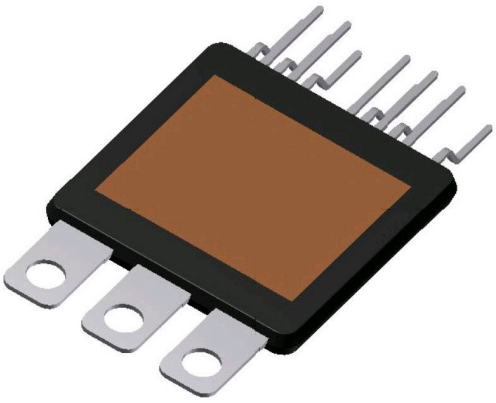
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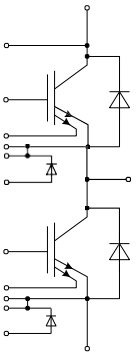
最终数据手册

V3.4，2020年4月15日

汽车高功率

1 特点/描述





V_{CES} = 700 V

I_C =400 A

典型应用

- 汽车应用
- 混合动力汽车

电气特性

- 阻断电压能力提升至700V
- 集成电流传感器
- 集成温度传感器
- 低杂散电感设计
- 低开关损耗
- $T_{vj\,op}$ = 150°C
- 短时延长工作温度
  $T_{vj\,op}$ = 175°C

机械特性

- 2.5kV AC 1min 绝缘
- 双面冷却
- 紧凑型设计
- 符合 RoHS 标准

描述

HybridPACK™ DSC S1 是一款非常紧凑的半桥模块,专为混合动力和电动汽车设计。

该模块基于英飞凌在开发IGBT功率模块和沟槽场截止型IGBT（包括具有增强软恢复特性的匹配二极管）方面的长期经验。此外，片上芯片集成的集成电流传感器和温度传感器可对IGBT的状态进行精确监测。这些功能可实现增强型短路保护，并实现系统的智能控制。

这款创新型小型封装专为双面冷却（DSC）设计，具有卓越的冷却性能。较低的杂散电感和更高的阻断电压，为设计高效率系统提供了支持。此外，新型材料组合和装配技术在确保最高可靠性和机械强度的同时，还能实现最佳的热性能和电性能。

Product Name	Ordering Code
FF400R07A01E3_S6	SP001661226

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2 IGBT、逆变器

2.1 最大额定值

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	700	V
Continuous DC collector current	T_C = 75°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$	400	A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	800	A
Total power dissipation	T_C = 25°C, $T_{vj\,max}$ = 175°C	P_{tot}	1500	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 特征值

			min.	typ.	max.	
Collector-emitter saturation voltage	I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$V_{CE\,sat}$		1.65 1.90 2.00	2.30	V
Gate threshold voltage	I_C = 4.85 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	5.00	5.80	6.50	V
Gate charge	V_{GE} = -15 V ... 15 V		Q_G		2.90		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		0.0		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		18.0		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.50		nF
Collector-emitter cut-off current	V_{CE} = 450 V, V_{GE} = 0 V	T_{vj} = 25°C	I_{CES}			0.1	mA
Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = 20 V	T_{vj} = 25°C	I_{GES}			400	nA
Turn-on delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,on}$		0.06 0.06 0.06		µs
Rise time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0.08 0.08 0.08		µs
Turn-off delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Goff} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,off}$		0.43 0.44 0.48		µs
Fall time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Goff} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0.04 0.04 0.05		µs
Turn-on energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω di/dt = 5.1 kA/µs (Tvj = 150°C)	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		5.70 7.40 7.90		mJ
Turn-off energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = -8/+15 V R_{Goff} = 3.6 Ω du/dt = 3.0 kV/µs (Tvj = 150°C)	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		14.5 16.5 18.0		mJ
SC data	$V_{GE} \leq$ 15 V, V_{CC} = 360 V $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq$ 6 µs, T_{vj} = 150°C	I_{SC}		1900		A
Thermal resistance, junction to case	per IGBT		R_{thJC}			0.100[1)]	K/W
Thermal resistance, case to heatsink	per IGBT λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K) Clamping Force F = 700N		R_{thCH}		0.140[1)]		K/W
Temperature under switching conditions	t_{op} continuous for 18s within a period of 600s, occurrence maximum 200 times over lifetime		$T_{vj\,op}$	-40 150		150 175	°C

[1)] 采用双面冷却，评估参考HybridPACK™ DSC应用说明

3 二极管、逆变器

3.1 最大额定值

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj} = 25°C	V_{RRM}	700	V
Continuous DC forward current		I_F	400	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	800	A
I^2t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C	I^2t	9000	A^2s

3.2 特征值

			min.	typ.	max.	
Forward voltage	I_F = 400 A, V_{GE} = 0 V T_{vj} = 25°C I_F = 400 A, V_{GE} = 0 V T_{vj} = 125°C I_F = 400 A, V_{GE} = 0 V T_{vj} = 150°C	V_F		1.95 1.84 1.80	2.55	V
Peak reverse recovery current	I_F = 400 A, - di_F/dt = 5000 A/µs (T_{vj} = 150°C) T_{vj} = 25°C V_R = 300 V T_{vj} = 125°C V_{GE} = -8 V T_{vj} = 150°C	I_{RM}		135 210 220		A
Recovered charge	I_F = 400 A, - di_F/dt = 5000 A/µs (T_{vj} = 150°C) T_{vj} = 25°C V_R = 300 V T_{vj} = 125°C V_{GE} = -8 V T_{vj} = 150°C	Q_r		12.0 23.0 27.0		µC
Reverse recovery energy	I_F = 400 A, - di_F/dt = 5000 A/µs (T_{vj} = 150°C) T_{vj} = 25°C V_R = 300 V T_{vj} = 125°C V_{GE} = -8 V T_{vj} = 150°C	E_{rec}		2.80 5.80 6.60		mJ
Thermal resistance, junction to case	per diode	R_{thJC}			0.150[1)]	K/W
Thermal resistance, case to heatsink	per diode λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K) Clamping Force F = 700N	R_{thCH}		0.200[1)]		K/W
Temperature under switching conditions	t_{op} continuous for 18s within a period of 600s, occurrence maximum 200 times over lifetime	$T_{vj\,op}$	-40 150		150 175	°C

4 模块

Parameter	Conditions	Symbol	Value	Unit
Isolation test voltage	RMS, f = 50 Hz, t = 1 min.	V_{ISOL}	2.5	kV
Material of module baseplate			Cu	
Internal isolation	basic insulation (class 1, IEC 61140)		Al_2O_3	
Creepage distance	terminal to heatsink terminal to terminal	d_{Creep}	3.5	mm
Clearance	terminal to heatsink terminal to terminal	d_{Clear}	3.5	mm
Comperative tracking index		CTI	> 600	

			min.	typ.	max.	
Stray inductance module		L_{sCE}		15		nH
Storage temperature		T_{stg}	-40		125	°C
Terminal connection torque	Screw M5	M		-		Nm
Mounting force per clamp		F		-	900	N
Weight		G		30		g

5 温度传感器

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Forward voltage	I_{TS} = 1.00 mA, T_{vj} = 150°C I_{TS} = 1.00 mA, T_{vj} = 25°C	V_{TS}		2.120 2.910		V

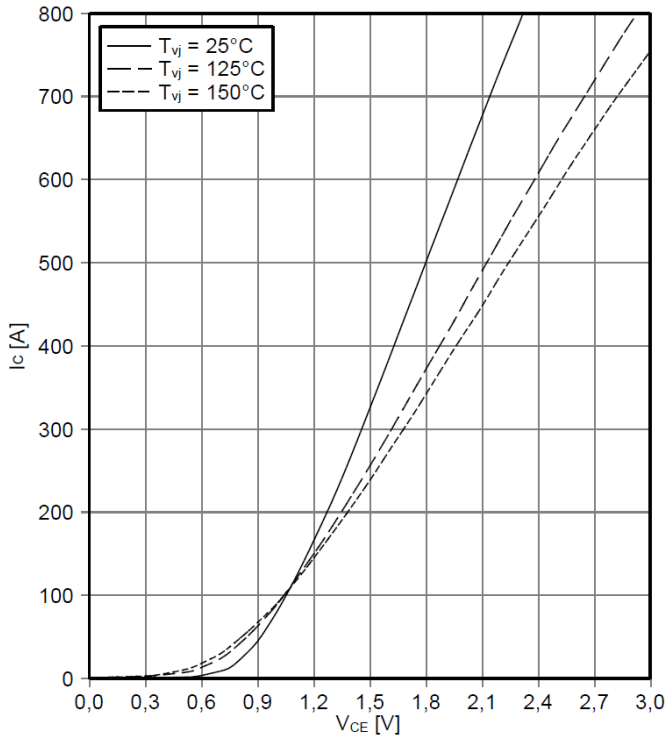
[1)] 采用双面冷却，评估参考HybridPACK™ DSC应用说明

6 电流传感器

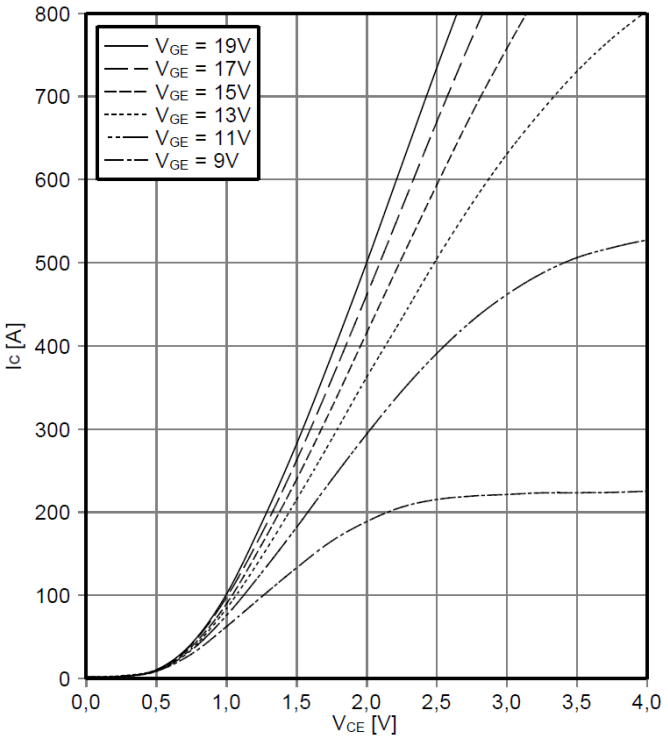
Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output voltage	V_{CE} = 2.35 V, I_C = 800 A R_{sense} = 1.60 Ω, T_{vj} = 25°C VGE = 15 V	V_{sense}		0.64		V

7 特性图

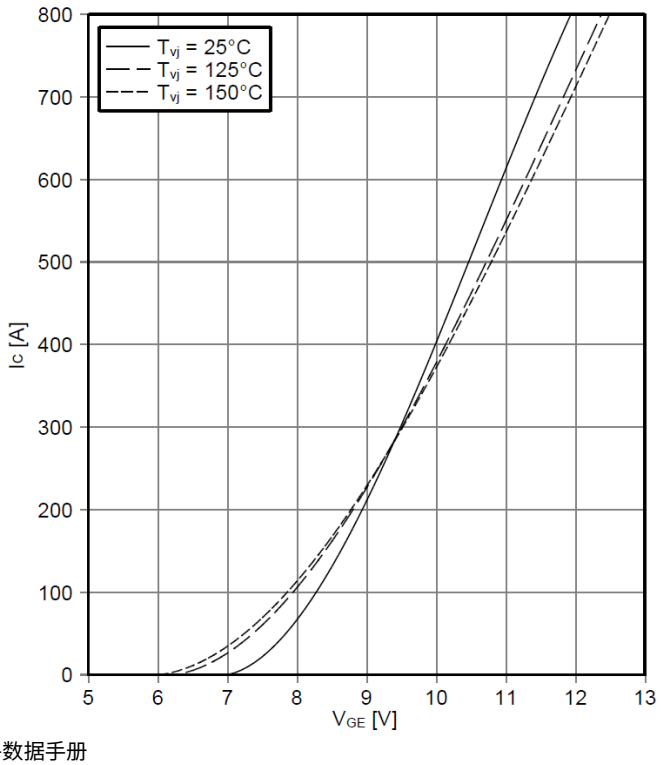
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
V_{GE} = 15 V



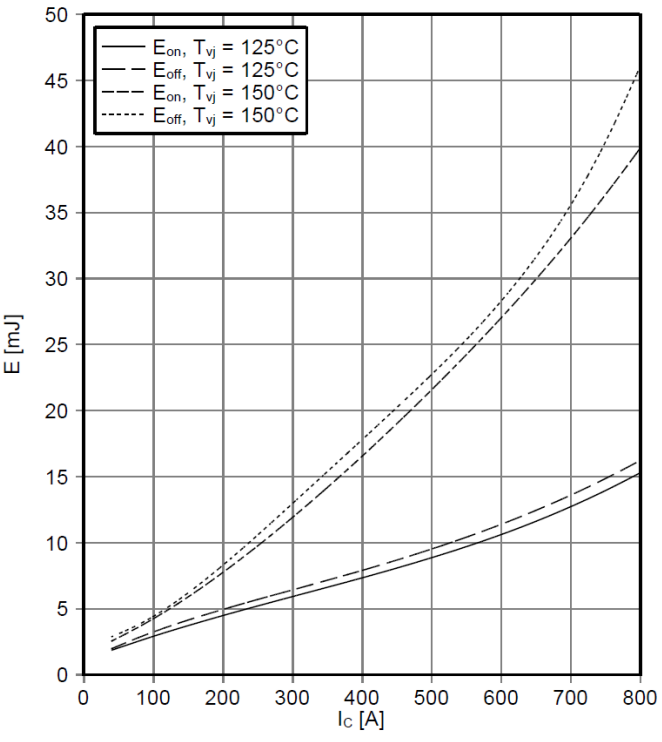
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
T_{vj} = 150°C



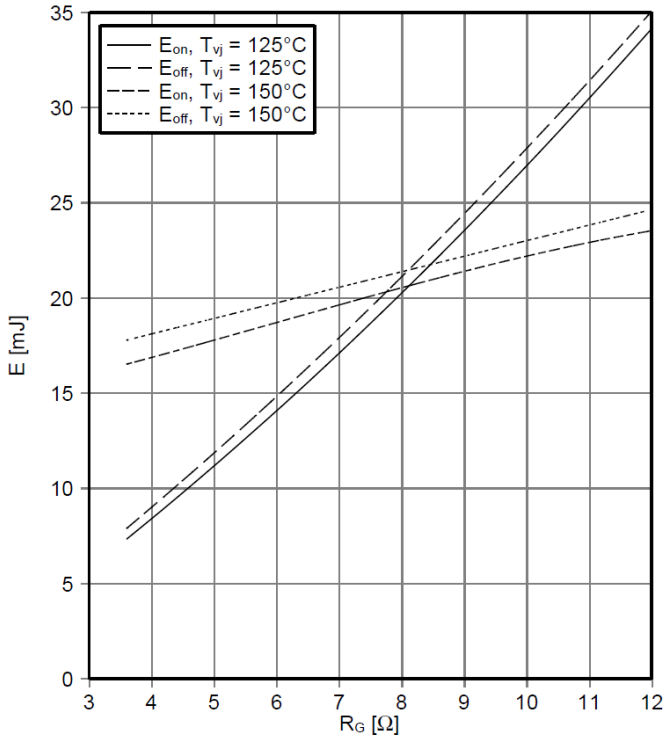
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
V_{CE} = 20 V



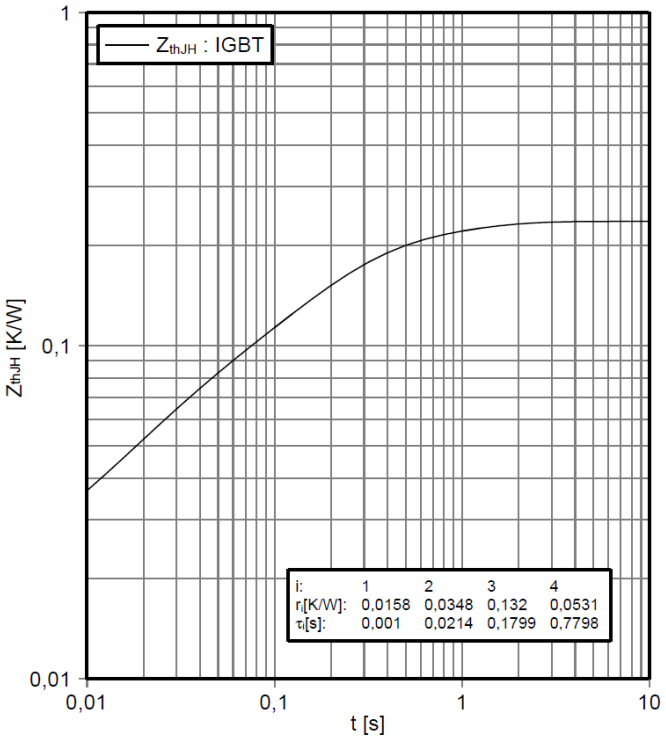
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
V_{GE} = -8 / +15 V, R_{Gon} = 3.6 Ω, R_{Goff} = 3.6 Ω, V_{CE} = 300 V



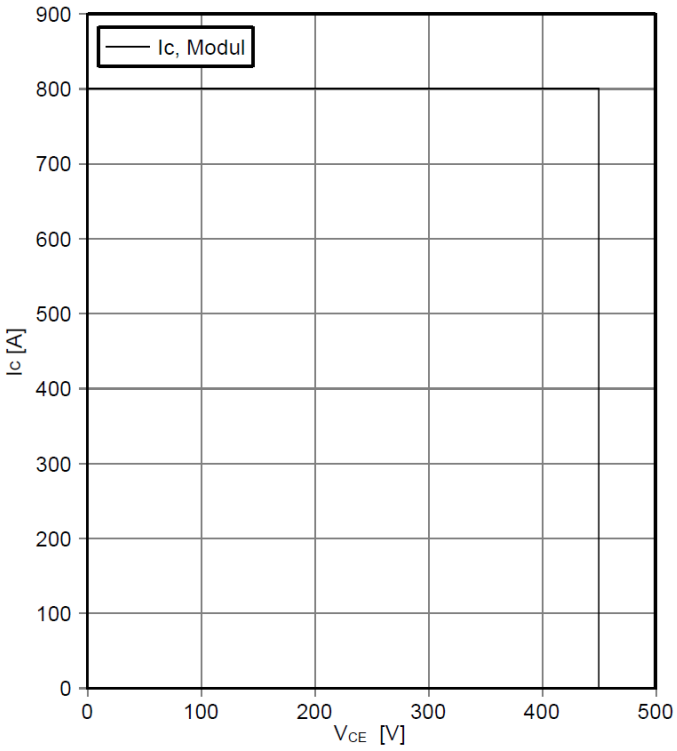
switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$
V_{GE} = -8 / +15 V, I_C = 400 A, V_{CE} = 300 V



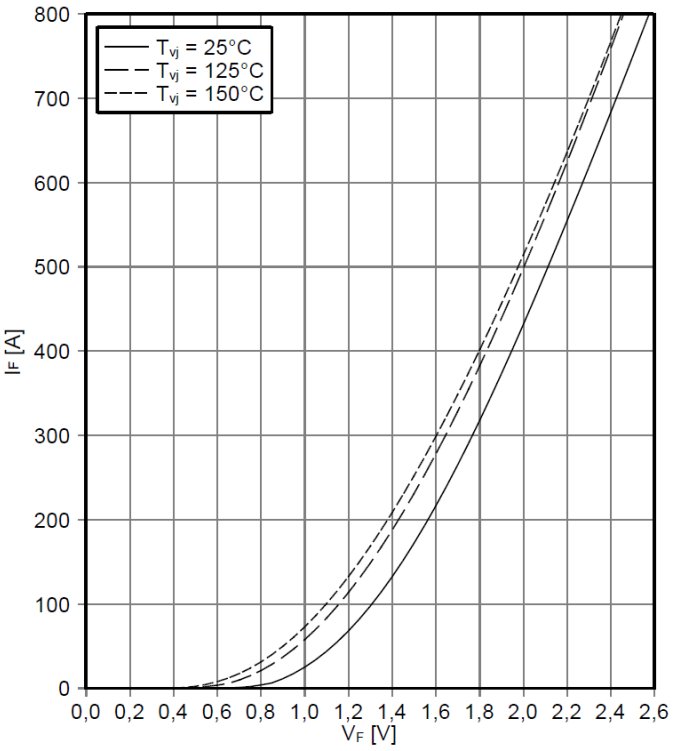
transient thermal impedance IGBT,Inverter
$Z_{thJH} = f(t)$



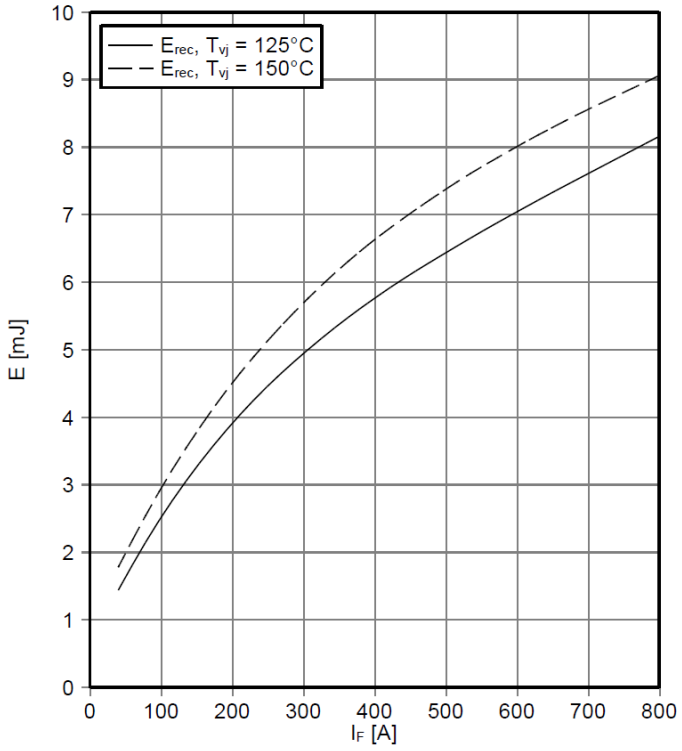
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$
V_{GE} = ±15 V, R_{Goff} = 3.6 Ω, T_{vj} = 150°C



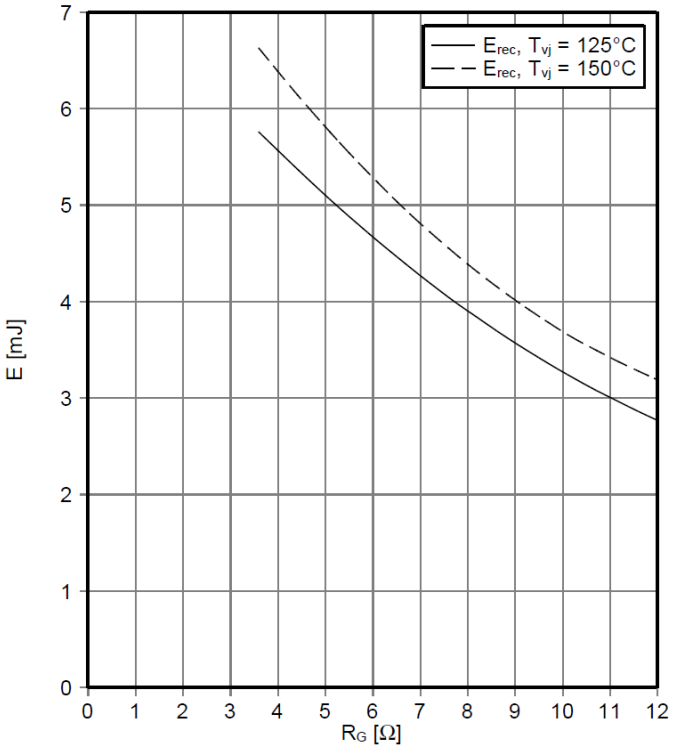
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



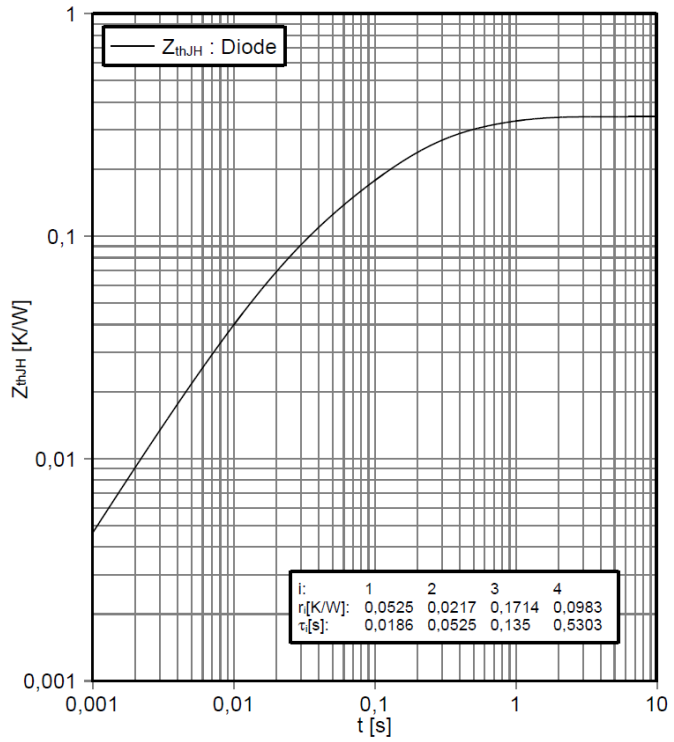
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$
$R_{Gon} = 3.6\ \Omega$, $V_{CE} = 300\ V$



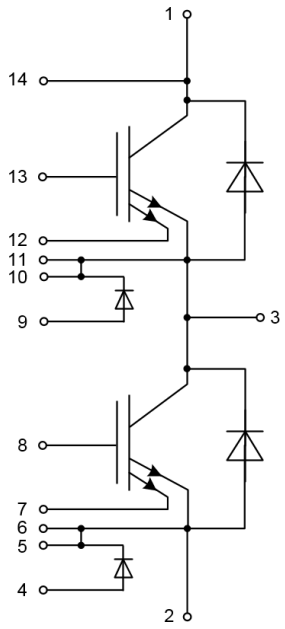
switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$
$I_F = 400\ A$, $V_{CE} = 300\ V$



transient thermal impedance Diode, Inverter
$Z_{thJH} = f(t)$

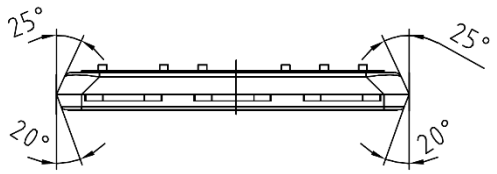


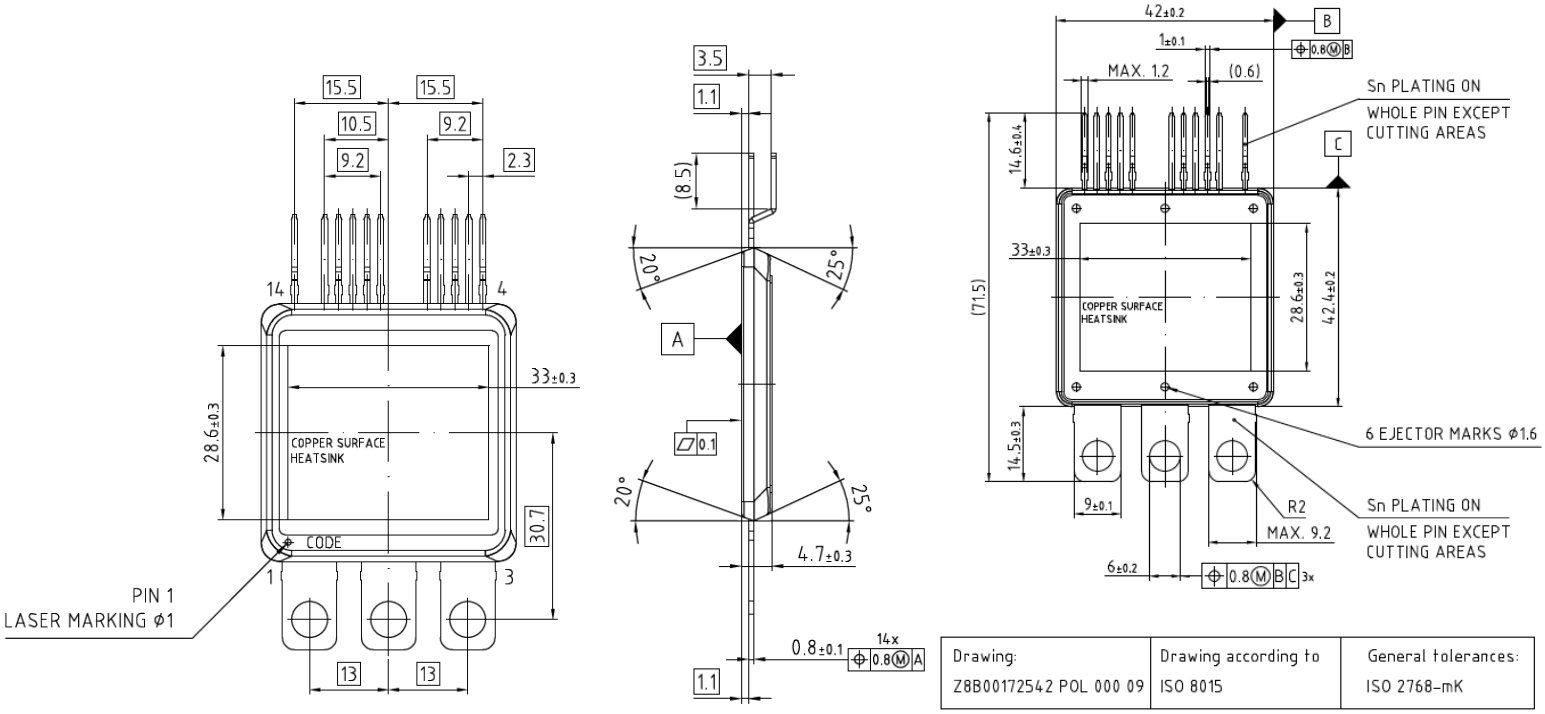
8 电路图



Pin Number	Symbol	I/O	Function
1	P	DC Supply (+)	Positive Supply
2	N	DC Supply (-)	Negative Supply
3	U	AC Output	U Phase Output
4	T+L	Input	Temperature Sensor Plus Low Side
5	T-L	Output	Temperature Sensor Minus Low Side
6	EL	Output	IGBT Emitter Output Low Side
7	CSL	Output	IGBT Current Sensor Output Low Side
8	GL	Input	Gate Input Low Side
9	T+H	Input	Temperature Sensor Plus High Side
10	T-H	Output	Temperature Sensor Minus High Side
11	EH	Output	IGBT Emitter Output High Side
12	CSH	Output	IGBT Current Sensor output High Side
13	GH	Input	Gate Input High Side
14	PS	Output	P-Terminal Voltage Sensing / IGBT Collector Output

9 封装外形





Drawing:	Drawing according to	General tolerances:
Z8B00172542 POL 000 09	ISO 8015	ISO 2768-mK

修订记录

自上次修订以来的主要变化

修订记录

Reference	Date	Description
V1.0	2015-03-26	Initial Version
V1.1	2015-04-07	Extension of target data
V2.0	2016-02-02	Update of target data
V3.0	2016-11-07	Final Datasheet
V3.1	2016-11-08	Change of product name in description
V3.2	2016-12-13	Changes in description
V3.3	2017-07-28	Update mechanical drawing
V3.4	2020-04-15	Correction of package outlines

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