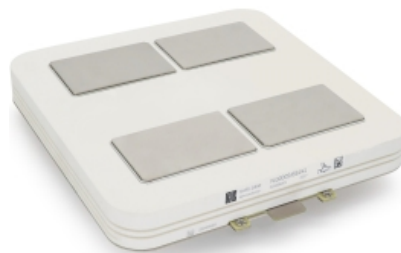


HCG2000S450S2K1

4500V 2000A IGBT 模块, 压接 封装, 内置续流二极管
4500V 2000A IGBT Module, Press Package, with FWD

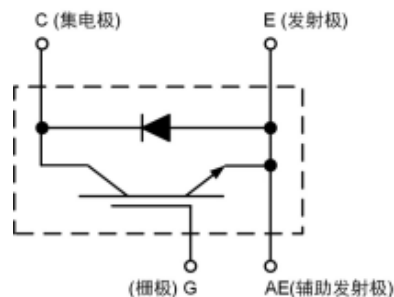
特点 Features

- 4500V 平面栅及场截止结构
4500V Planar Gate & Field Stop Structure
- 高鲁棒性
High Robustness
- 高可靠性
High Reliability
- 正温度系数
Positive Temperature Coefficient
- 高短路耐量
High Short Circuit Capability



应用 Applications

- 柔性直流输电
HVDC flexible system
- 海上风电
Offshore wind power generation



最大额定值 Maximum Rated Values*1

参数 Parameter	符号 Symbol	条件 Conditions	数值 Value	单位 Unit
集电极-发射极电压 Collector-Emitter Voltage	V_{CES}	$V_{GE}=0V, T_{vj}=25^{\circ}C$	4500	V
集电极直流电流 DC Collector Current	I_C	$T_C=100^{\circ}C, T_{vj}=125^{\circ}C$	2000	A
集电极峰值电流 Peak Collector Current	I_{CM}	$t_p=1ms$	4000	A
栅极-发射极电压 Gate-Emitter Voltage	V_{GES}		± 20	V
总功耗 Total Power Dissipation	P_{tot}	$T_C=25^{\circ}C, T_{vj}=125^{\circ}C$	20800	W
正向工作电流 DC Forward Current	I_F		2000	A
正向峰值电流 Peak Forward Current	I_{FRM}	$t_p=1ms$	4000	A
浪涌电流 Surge Current	I_{FSM}	$V_R=0V, T_{vj}=125^{\circ}C,$ $t_p=10ms, half-sinewave$	14000	A
IGBT短路耐量 IGBT Short Circuit SOA	t_{psc}	$V_{CC}=3400V, V_{CEM}$ $CHIP \leq 4500V$ $V_{GE} \leq 15V, T_{vj} \leq 125^{\circ}C$	10	μs
最高结温 Maximum Junction Temperature	$T_{vj(max)}$		125	$^{\circ}C$
工作结温 Junction Operating Temperature	$T_{vj(op)}$		-40~125	$^{\circ}C$
环境温度 Case temperature	T_C		-40~125	$^{\circ}C$
存储温度范围 Storage Temperature	T_{stg}		-40~70	$^{\circ}C$
安装压力 Mounting force	F_M		60~75	kN

*1 根据IEC 60747, 最大额定值表明会使器件造成损伤的条件边界

IGBT特征值 IGBT Characteristic Values*2

参数 Parameter	符号 Symbol	条件 Conditions		数 □ Value			□ 位 Unit	
				Min.	Typ.	Max.		
集 □ 极-□ 射极反向 □ 穿 □ □ Collector-Emitter Breakdown Voltage	$V_{(BR)CE\ S}$	$V_{GE}=0V, I_C=10mA, T_{vj}=25^{\circ}C$		4500			V	
集 □ 极-□ 射极 □ 和 □ □ *3 Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C=2000A, V_{GE}=15V$	$T_{vj}=25^{\circ}C$		2.70	3.05	V	
			$T_{vj}=125^{\circ}C$		3.35	3.85	V	
集 □ 极-□ 射极截止 □ 流 Collector-Emitter Cut-off Current	I_{CES}	$V_{CE}=4500V, V_{GE}=0V$	$T_{vj}=25^{\circ}C$			1	mA	
			$T_{vj}=125^{\circ}C$		15	100	mA	
□ 极-□ 射极漏 □ 流 Gate-Emitter Leakage Current	I_{GES}	$V_{CE}=0V, V_{GE}=\pm 20V, T_{vj}=125^{\circ}C$		-500		500	nA	
□ 极-□ 射极开启 □ □ Gate-Emitter Threshold Voltage	$V_{GE(th)}$	$I_C=320mA, V_{CE}=V_{GE}, T_{vj}=25^{\circ}C$		6.7		7.7	V	
□ 极 □ 荷 Gate Charge	Q_G	$I_C=2000A, V_{CE}=2800V, V_{GE}=-15V\sim+15V$			10		μC	
□ 入 □ 容 Input Capacitance	C_{ies}	$V_{CE}=25V, V_{GE}=0V, f=500kHz, T_{vj}=25^{\circ}C$			213		nF	
□ 出 □ 容 Output Capacitance	C_{oes}				15.3		nF	
反向 □ □ □ 容 Reverse Transfer Capacitance	C_{res}				4.7		nF	
内置 □ 极 □ 阻 Internal Gate Resistance	R_{Gint}				0		Ω	
开通延 □ □ □ □ Turn-on Delay Time	$t_{d(on)}$	$I_C=2000A, V_{CE}=2800V, V_{GE}=\pm 15V, R_{Gon}=1.8\Omega, R_{Goff}=8.2\Omega, C_{ge}=330nF, L_S=140nH, Inductive Load$	$T_{vj}=25^{\circ}C$		1100		ns	
			$T_{vj}=125^{\circ}C$		900		ns	
上升 □ □ Rise Time	t_r		$T_{vj}=25^{\circ}C$		400		ns	
			$T_{vj}=125^{\circ}C$		450		ns	
关断延 □ □ □ □ Turn-off Delay Time	$t_{d(off)}$		$T_{vj}=25^{\circ}C$		3800		ns	
			$T_{vj}=125^{\circ}C$		4100		ns	
下降 □ □ Fall Time	t_f		$T_{vj}=25^{\circ}C$		1200		ns	
			$T_{vj}=125^{\circ}C$		1400		ns	
开通 □ 耗 Turn-on Switching Energy	E_{on}		$T_{vj}=25^{\circ}C$		14240		mJ	
			$T_{vj}=125^{\circ}C$		15730		mJ	
关断 □ 耗 Turn-off Switching Energy	E_{off}		$T_{vj}=25^{\circ}C$		6960		mJ	
			$T_{vj}=125^{\circ}C$		8180		mJ	
短路 □ 流 Short Circuit Current	I_{SC}	$V_{GE}\leq 15V, t_{psc}\leq 10\mu s, V_{CC}=3400V, T_{vj}=125^{\circ}C, V_{CEM\ CHIP}\leq 4500V$			8400		A	

*2 IGBT特征值遵从IEC 60747-9

*2 IGBT特征值遵从IEC 60747-9

*3 $V_{CE(sat)}$ 值为芯片值

二极管特征值 Diode Characteristic Values*3

参数 Parameter	符号 Symbol	条件 Conditions		数□ Value			□位 Unit	
				Min.	Typ.	Ma x.		
正向□□ *4 Forward Voltage	V _F	I _F =2000A	T _{vj} =25°C		2.60		V	
			T _{vj} =125°C		2.85		V	
反向恢复□流 Reverse Recovery Current	I _{rr}	I _F =2000A, V _R =2800V, V _{GE} =15V, R _{Gon} =1.8Ω, L _S =140nH, Inductive load	T _{vj} =25°C		1620		A	
			T _{vj} =125°C		1970		A	
反向恢复□荷 Reverse Recovery Charge	Q _{rr}		T _{vj} =25°C		1750		uC	
			T _{vj} =125°C		2700		uC	
反向恢复□□ Reverse Recovery Time	t _{rr}		T _{vj} =25°C		4.0		us	
			T _{vj} =125°C		5.1		us	
反向恢复□耗 Reverse Recovery Energy Loss	E _{rec}		T _{vj} =25°C		2350		mJ	
			T _{vj} =125°C		3860		mJ	

*3 二极管特征值遵从IEC 60747-2

*4 V_F值为芯片值

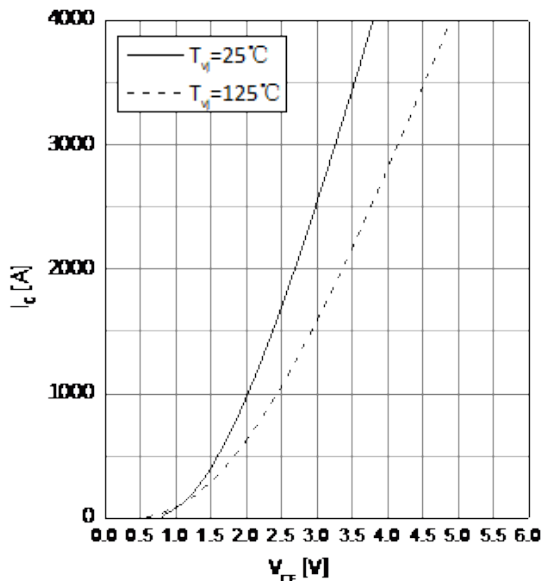
封装特性 Package Properties*5

参数 Parameter	符号 Symbol	条件 Condition	数值 Value			单位 Unit
			Min	Typ.	Max	
IGBT 结-壳电阻 IGBT Thermal Resistance: Junction to Case	R _{th(J-C)}				0.0048	K/W
二极管 结-壳电阻 Diode Thermal Resistance: Junction to Case	R _{th(J-C)}				0.0091	K/W
IGBT接触电阻 IGBT Thermal Resistance: Case to Heatsink	R _{th(C-H)}	Heatsink flatness : Complete module area < 100 μm Each submodule area < 20 μm Roughness : < 1.6 μm		0.0011		K/W
二极管接触电阻 Diode Thermal Resistance: Case to Heatsink	R _{th(C-H)}			0.0023		K/W
机械特性追踪指数 Comparative Tracking Index	CTI		600			

参数 Parameter	符号 Symbol	条件 Condition	Min	Typ.	Max	单位 Unit
尺寸 Dimensions	L x W x H	Typical device clamped	237.3 x 235.1 x 28.7			mm
		device unclamped	237.3 x 235.1 x 31.5			mm
表面爬电距离 Surface creepage distance	d _a	according to IEC 60664-1 and EN 50124-1	40			mm
空气间隙 Clearance distance in air	d _s	according to IEC 60664-1 and EN 50124-1	23			mm
模块重量 Module Weight	G			3440		g

输出特性典型曲线

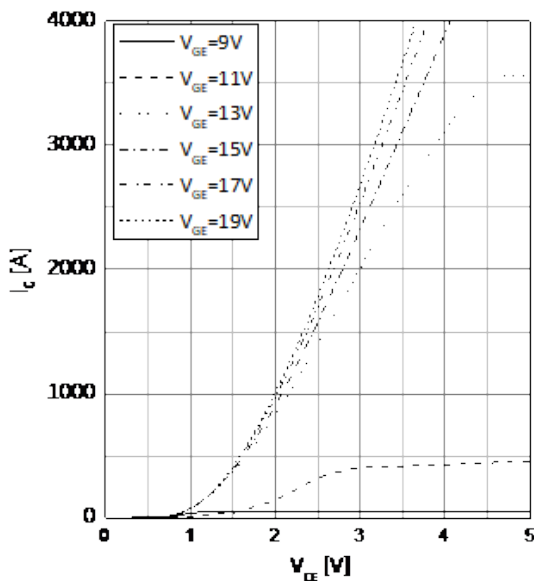
Typical output characteristics,chip level



输出特性典型曲线

Typical output characteristics,chip level

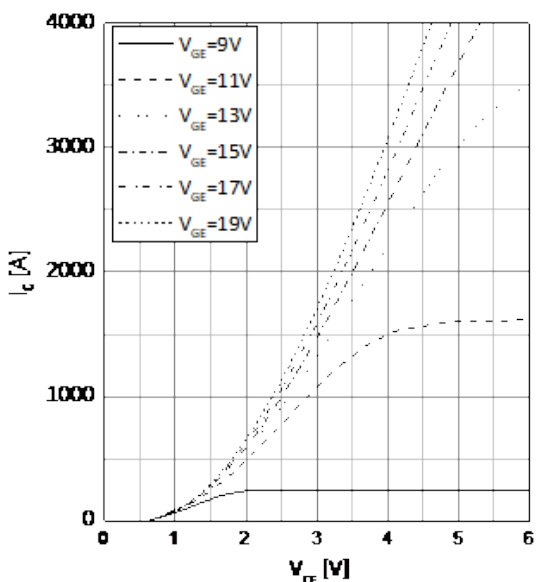
$$I_c = f(V_{ce}), T_{vj} = 25^{\circ}\text{C}$$



输出特性典型曲线

Typical output characteristics,chip level

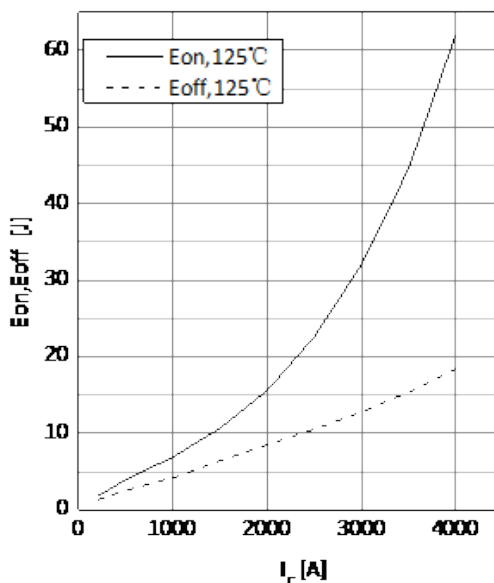
$$I_c = f(V_{ce}), T_{vj} = 125^{\circ}\text{C}$$



开关损耗 IGBT

Switching losses IGBT

$$E = f(I_c), V_{GE} = \pm 15\text{V}, R_{Gon} = 1.8\Omega, R_{Goff} = 8.2\Omega, C_{ge} = 330\text{nF}, V_{ce} = 2800\text{V}$$

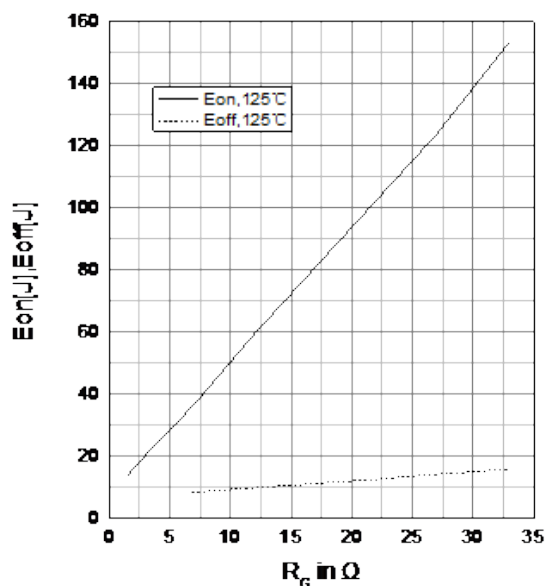


开关损耗IGBT

Switching losses IGBT

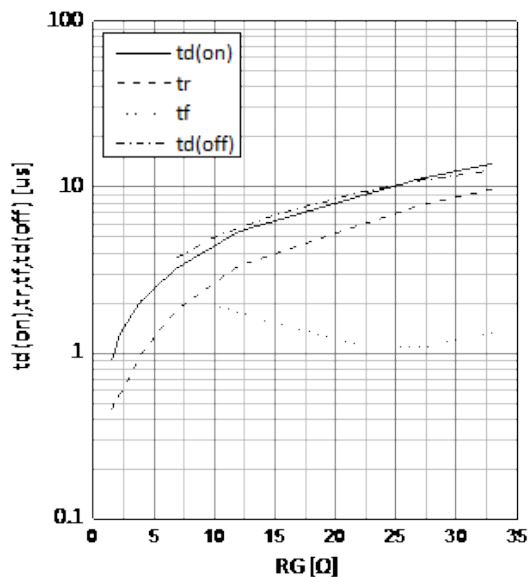
$V_{GE} = \pm 15V$,

$I_C = 2000A$, $C_{ge} = 330nF$, $V_{CE} = 2800V$



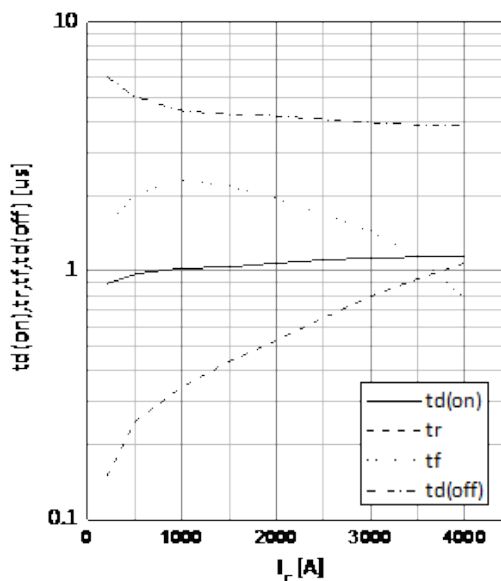
开关时间与门极电阻关系曲线

Typical switching time per pulse vs. gate resistor



开关时间与集电极电流关系曲线

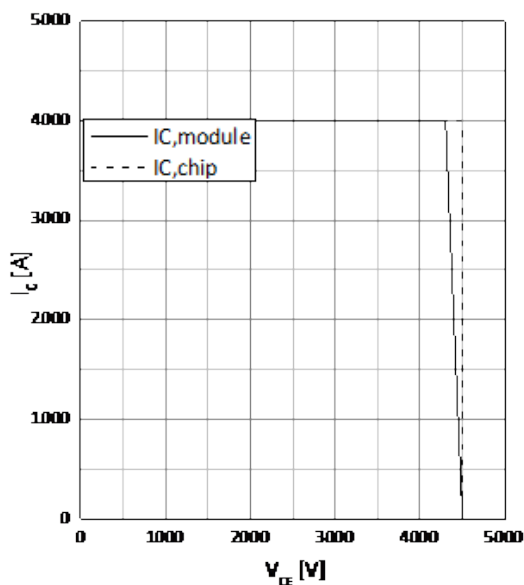
Typical switching time per pulse vs. collector current



反偏安全工作区

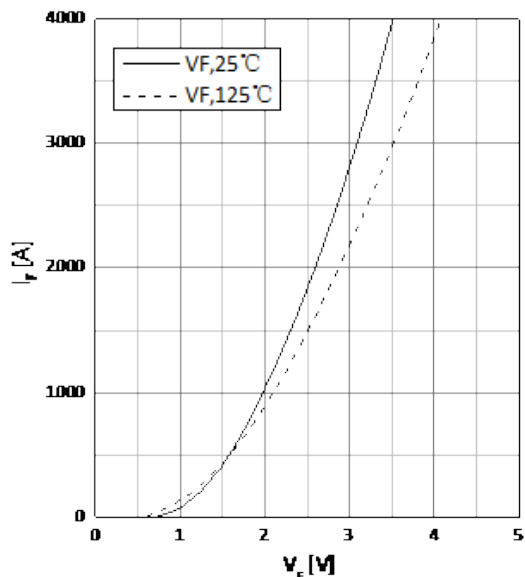
Turn-off safe operating area (RBSOA)

$V_{GE} = \pm 15V$, $R_{Goff} = 8.2\Omega$, $T_j = 125^\circ C$



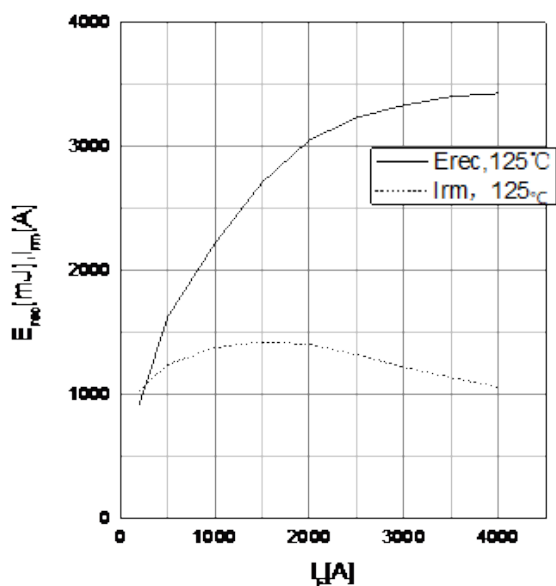
二极管正向偏压特性曲线

Typical diode forward characteristic, chip level



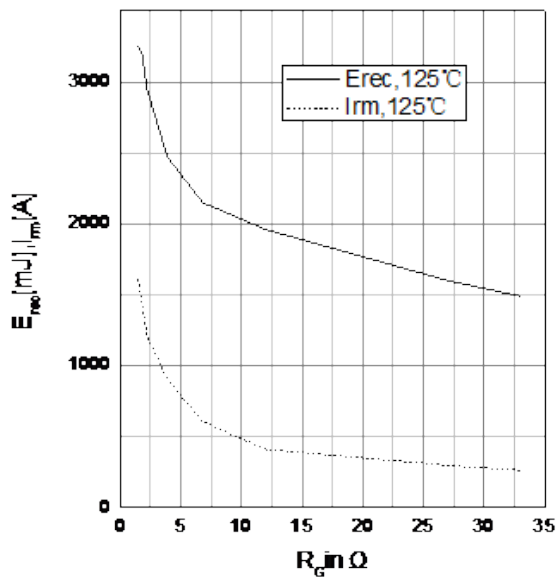
反向恢复损耗与二极管电流关系曲线

Typical reverse recovery characteristics vs. forward current



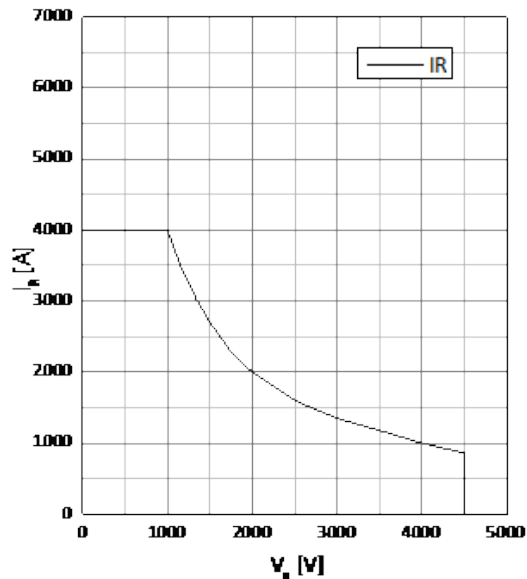
反向恢复损耗与门极电阻的关系曲线

Typical switching energies per pulse vs. gate resistor

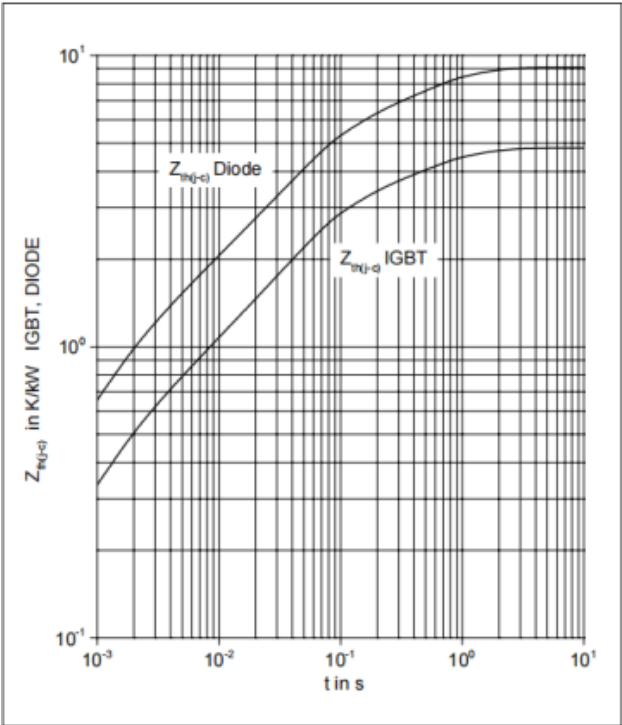


二极管安全工作区

safe operating area diode (RRSOA)



瞬态热阻抗
Transient thermal impedance
 $Z_{thJC} = f(t)$

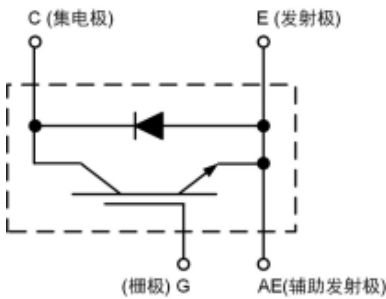


Analytical function for transient thermal impedance:

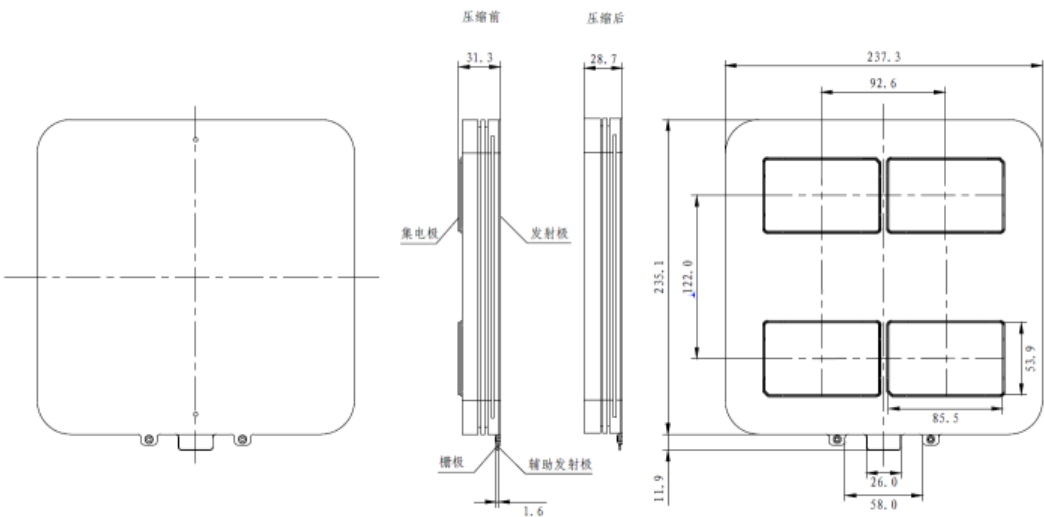
$$Z_{th(j-c)}(t) = \sum_{i=1}^n R_i (1 - e^{-t/\tau_i})$$

	i					
		1	2	3	4	5
IGBT	R_i in K/kW	1.801	2.234	0.403	0.369	
	τ_i in s	0.581	0.059	0.006	0.001	
DIODE	R_i in K/kW	3.614	3.958	0.803	0.727	
	τ_i in s	0.584	0.059	0.006	0.001	

接线图



封装尺寸



修订记录Revision History

版本Version	日期Date	描述Description
A0	2023-04-11	初版
A1	2024-01-31	正式版