

NI2000S45S2K1

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

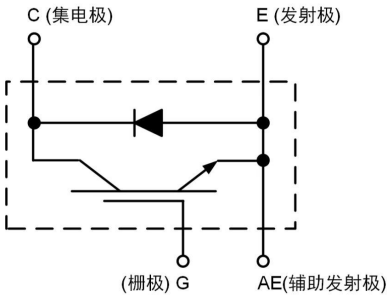
特点 Features

- 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
总耗散功耗 Total Power Dissipation	P_{tot}	$T_C=25^{\circ}C, T_{vj}=125^{\circ}C$	20800	W
额定正向工作电流 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}	$V_R=0V, T_{vj}=125^{\circ}C,$ $t_p=10ms, half\text{-}sinewave$	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		数值 Value			单位 Unit
				Min.	Typ.	Max.	
集电极-发射极反向击穿电压 Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=10mA, T_{vj}=25^{\circ}C$		4500			V
集电极-发射极饱和电压*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
集电极-发射极截止电流 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
栅极-发射极漏电流 Gate-Emitter Leakage Current	I_{GES}	$V_{CE}=0V, V_{GE}=\pm 20V, T_{vj}=125^{\circ}C$		-500		500	nA
栅极-发射极开启电压 Gate-Emitter Threshold Voltage	$V_{GE(th)}$	$I_C=320mA, V_{CE}=V_{GE}, T_{vj}=25^{\circ}C$		6.7		7.7	V
栅极电荷 Gate Charge	Q_G	$I_C=2000A, V_{CE}=2800V, V_{GE}=-15V\sim+15V$			10		μC
输入电容 Input Capacitance	C_{ies}	$V_{CE}=25V, V_{GE}=0V, f=500kHz, T_{vj}=25^{\circ}C$			213		nF
输出电容 Output Capacitance	C_{oes}				15.3		nF
反向传输电容 Reverse Transfer Capacitance	C_{res}				4.7		nF
内置栅极电阻 Internal Gate Resistance	R_{Gint}				0		Ω
开通延迟时间 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
上升时间 Rise Time	t_r		$T_{vj}=25^{\circ}C$		400		ns
			$T_{vj}=125^{\circ}C$		450		ns
关断延迟时间 Turn-off Delay Time	$t_{d(off)}$		$T_{vj}=25^{\circ}C$		3800		ns
			$T_{vj}=125^{\circ}C$		4100		ns
下降时间 Fall Time	t_f		$T_{vj}=25^{\circ}C$		1200		ns
			$T_{vj}=125^{\circ}C$		1400		ns
开通损耗 Turn-on Switching Energy	E_{on}		$T_{vj}=25^{\circ}C$		14240		mJ
			$T_{vj}=125^{\circ}C$		15730		mJ
关断损耗 Turn-off Switching Energy	E_{off}		$T_{vj}=25^{\circ}C$		6960		mJ
			$T_{vj}=125^{\circ}C$		8180		mJ
短路电流 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

*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		数值 Value			单位 Unit	
				Min.	Typ.	Max.		
正向电压*4 Forward Voltage	V _F	I _F =2000A	T _{vj} =25°C		2.60		V	
			T _{vj} =125°C		2.85		V	
反向恢复电流 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	
反向恢复电荷 Reverse Recovery Charge	Q _{rr}		T _{vj} =25°C		1750		uC	
			T _{vj} =125°C		2700		uC	
反向恢复时间 Reverse Recovery Time	t _{rr}		T _{vj} =25°C		4.0		us	
			T _{vj} =125°C		5.1		us	
反向恢复损耗 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-壳热阻 IGBT Thermal Resistance: Junction to Case	R _{th(J-C)}				0.0048	K/W
二极管 结-壳热阻 Diode Thermal Resistance: Junction to Case	R _{th(J-C)}				0.0091	K/W
IGBT接触热阻 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
二极管接触热阻 Diode Thermal Resistance: Case to Heatsink	R _{th(C-H)}			0.0023		K/W
相对漏电起痕指数 Comparative Tracking Index	CTI		600			

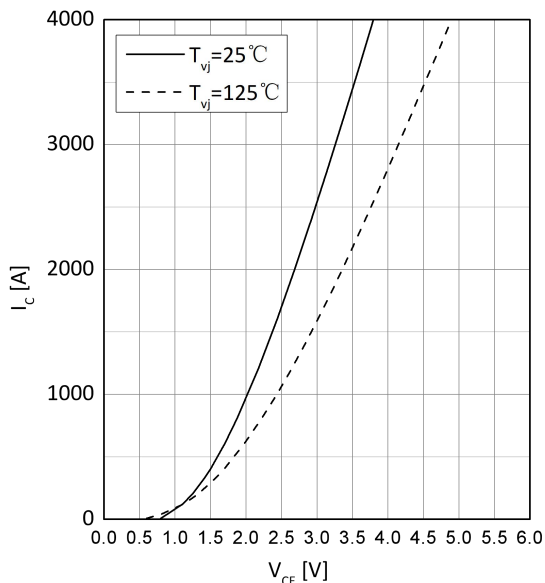
*5 封装特性遵从IEC 60747-15、IEC 60270

机械特性 Mechanical Properties

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
空气电气间隙 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

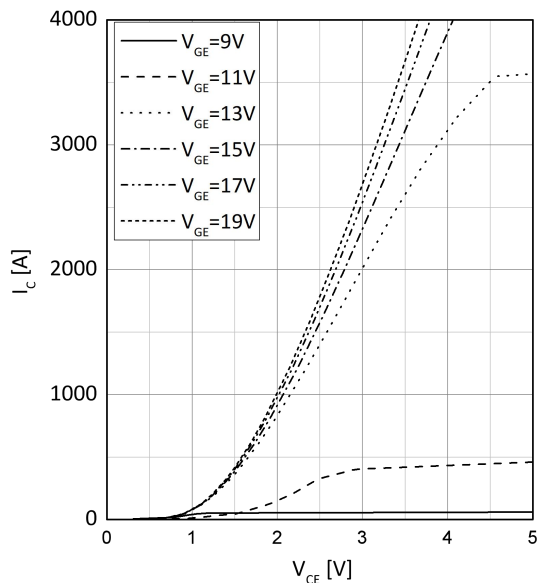
Typical output characteristics,chip level



输出特性典型曲线

Typical output characteristics,chip level

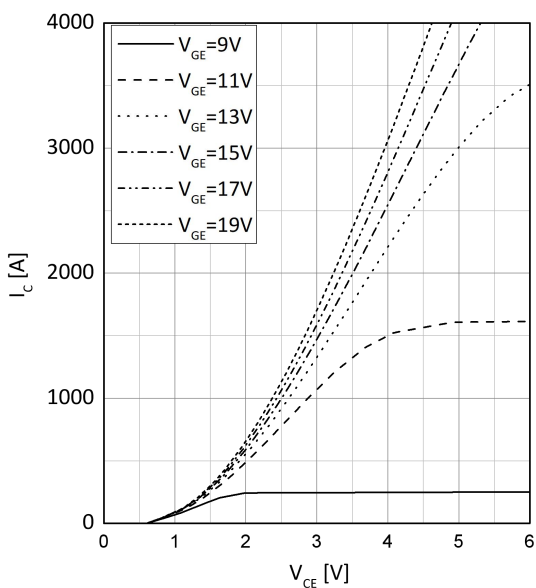
$$I_c = f(V_{CE}), T_{vj} = 25^\circ\text{C}$$



输出特性典型曲线

Typical output characteristics,chip level

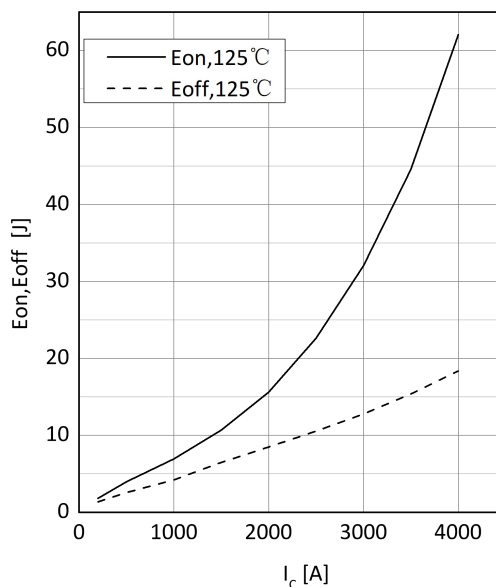
$$I_c = f(V_{CE}), T_{vj} = 125^\circ\text{C}$$



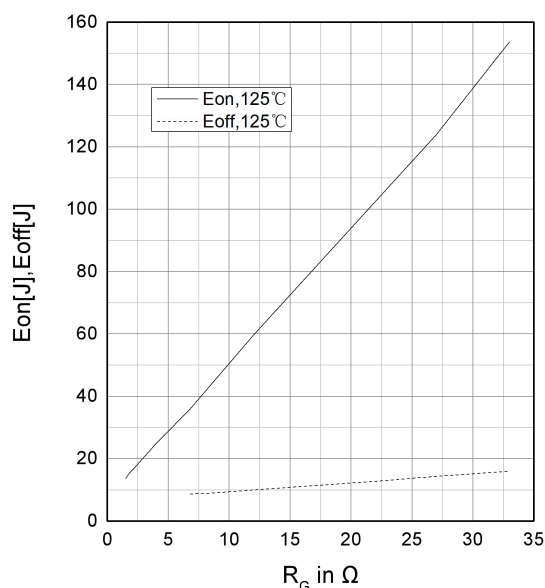
开关损耗 IGBT

Switching losses IGBT

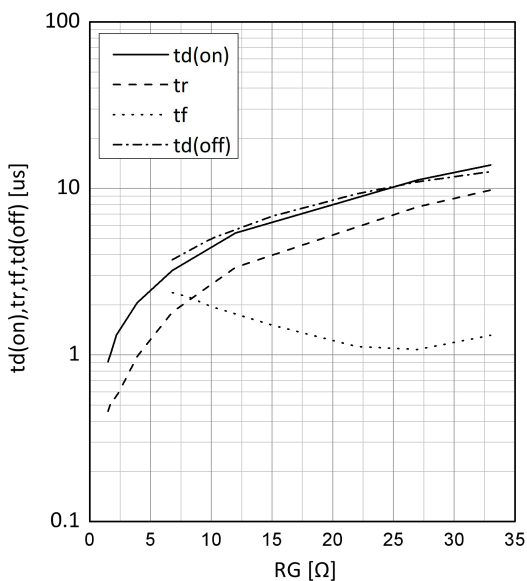
$$E = f(I_c), V_{GE} = \pm 15\text{V}, R_{Gon} = 1.8\Omega, R_{Goff} = 8.2\Omega, C_{ge} = 330\text{nF}, V_{CE} = 2800\text{V}$$



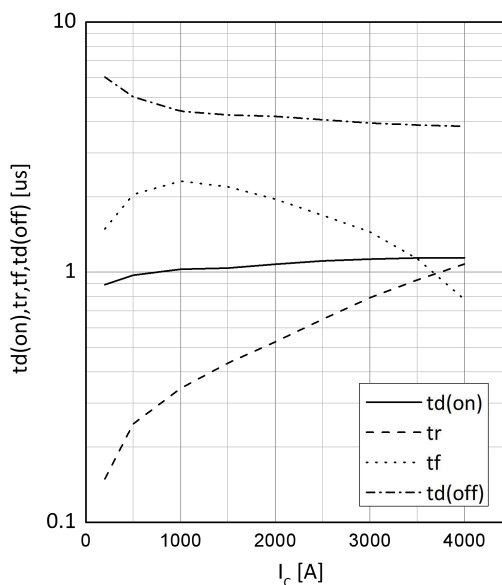
开关损耗IGBT
Switching losses IGBT
VGE=±15V, IC=2000A,Cge=330nF,VCE=2800V



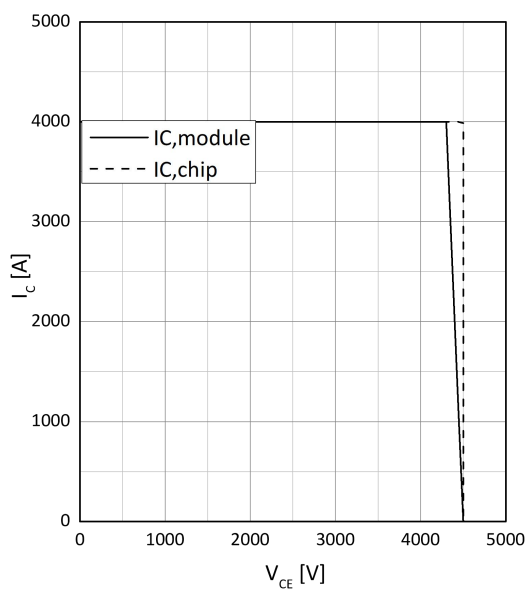
开关时间与门极电阻关系曲线
Typical switching time per pulse vs. gate resistor



开关时间与集电极电流关系曲线
Typical switching time per pulse vs. collector current

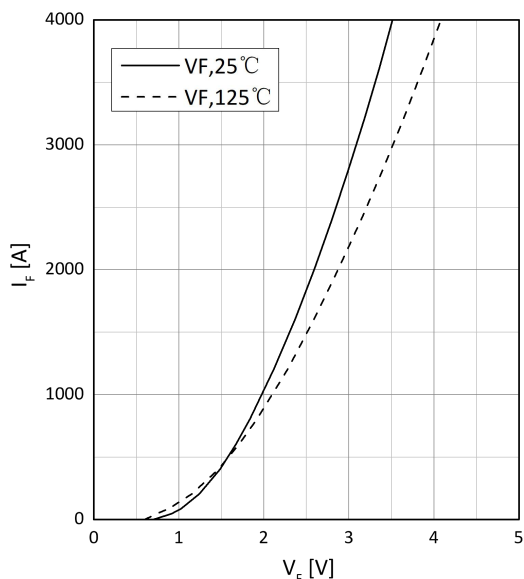


反偏安全工作区
Turn-off safe operating area (RBSOA)
VGE=±15V,RGoff=8.2 Ω ,Tvj=125 $^\circ\text{C}$



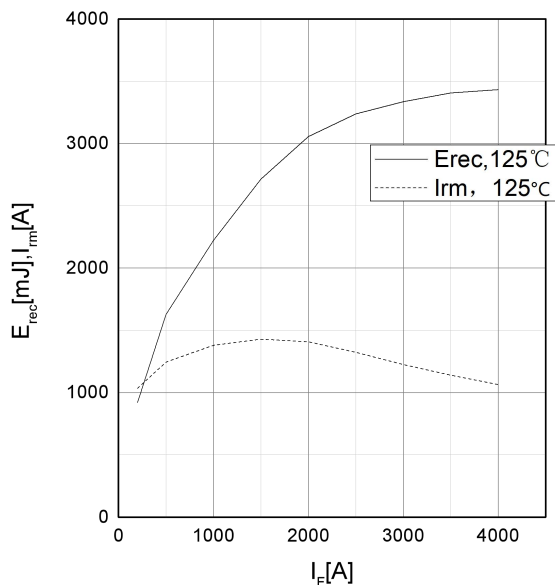
二极管正向偏压特性曲线

Typical diode forward characteristic, chip level



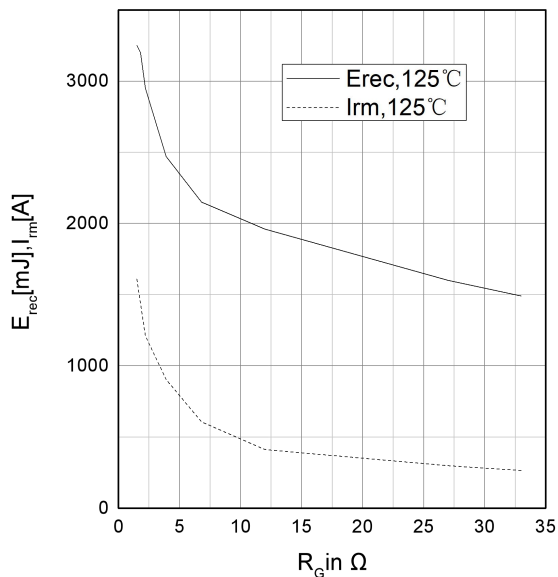
反向恢复损耗与二极管电流关系曲线

Typical reverse recovery characteristics vs. forward current



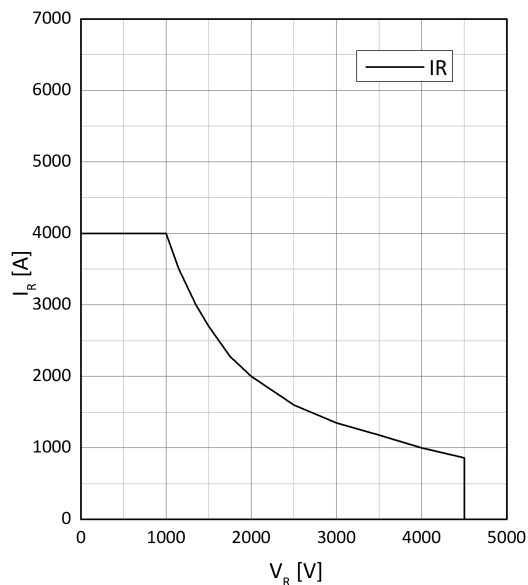
反向恢复损耗与门极电阻的关系曲线

Typical switching energies per pulse vs. gate resistor



二极管安全工作区

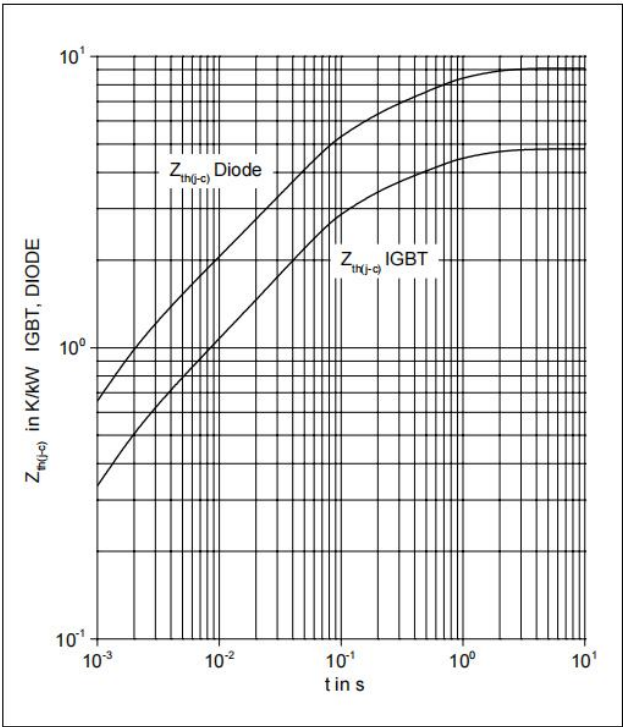
safe operating area diode (RROSA)



瞬态热阻抗

Transient thermal impedance

ZthJC = f (t)



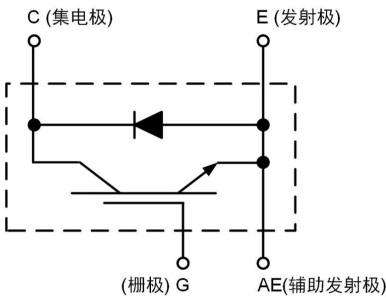
Analytical function for transient thermal impedance:

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

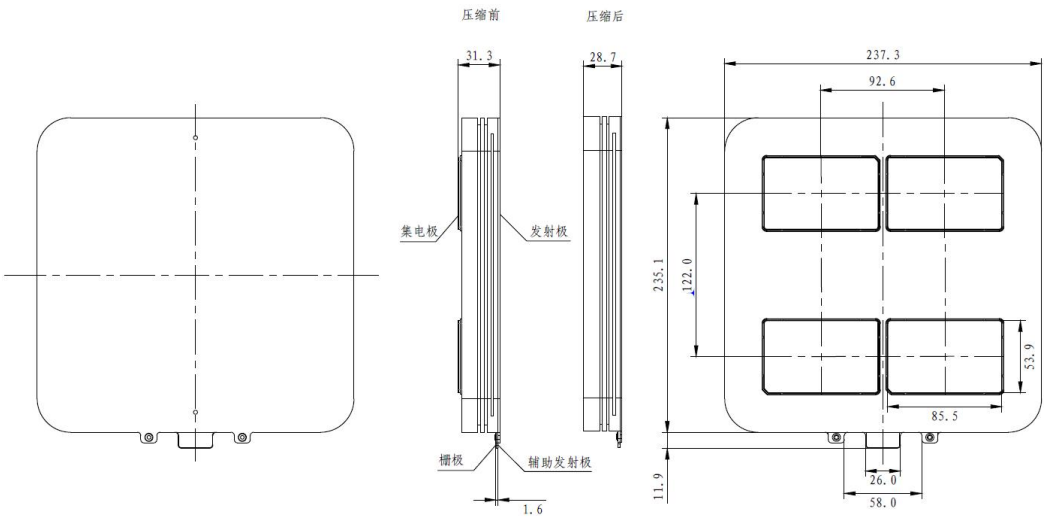
i	1	2	3	4	5
R _i in K/kW	1.801	2.234	0.403	0.369	
τ _i in s	0.581	0.059	0.006	0.001	

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