比亚迪
半导体

BG450I07U13H6

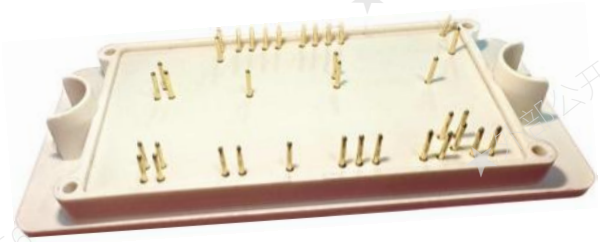
❒ 概述/General Description

这款 IGBT 模块采用 I 型 NPC 三电平拓扑，适用于光伏逆变器和 UPS 等。模块采用低导通损耗和低开关损耗的场终止 IGBT 和快恢复二极管芯片，使设计师能够实现高效率和卓越的可靠性能。

This IGBT module adopts I-type NPC three level topology, which is suitable for Solar inverter and UPS. The integrated field stop IGBT and fast recovery diode provide lower conduction losses and switching losses, enabling designers to achieve high efficiency and superior reliability.

❒ 封装/Package

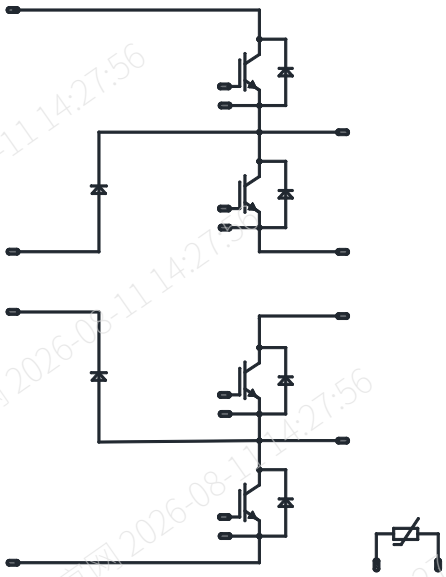
mic 2封装



❒ 产品特性/Features

- 低杂散电感设计
  Low inductive design
- 符合RoHS
  Pb−Free,Halogen Free/BFR Free

❒ 电路拓扑/Schematic



NPC1拓扑
650V,450A

❒ 应用/Applications

- 光伏应用
  Solar Applications
- 三电平应用
  3-Level-Applications

❒ 外管 IGBT(T1,T4)/Outer IGBT(T1,T4)

● 最大额定值 / Maximum Rated Values

(T_J=25°C,除非另外注明/unless otherwise noted)

参数 Parameter	符号 Symbol	工作条件 Conditions	额定值 Ratings	单位 Units
集电极-发射极电压 Collector-emitter voltage	V_{CES}	T_{vj}=25°C	650	V
连续集电极直流电流 Continuous DC collector current	$I_{C\ nom}$	T_C=80°C,$T_{vj\ max}$=175°C	416	A
集电极重复峰值电流 Repetitive peak collector current	I_{CRM}	t_p=1ms	832	
功耗 Total power dissipation	P_{tot}	T_C=80°C,$T_{vj\ max}$=175°C	748	W
栅极-发射极峰值电压 Gate-emitter peak voltage	V_{GE}		±20	V

● 电气特性 / Electrical Characteristics

参数 Parameter	符号 Symbol	工作条件 Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
集电极-发射极饱和电压 Collector-emitter saturation voltage	$V_{CE\ sat}$	V_{GE}=15V,I_C=450 A, T_{vj}=25°C	1.4	1.6	2.1	V
		T_{vj}=150°C	-	1.8	2.2	
栅极-发射极阈值电压 Gate-emitter threshold voltage	V_{GEth}	I_C=6mA,V_{CE}=V_{GE},T_{vj}=25°C	4	4.6	5.2	
栅极电荷 Gate charge	Q_G	V_{GE}=-9V~+15V	-	2.16	-	μC
内部栅极电阻 Internal gate resistor	R_{Gint}	T_{vj}=25°C	-	0.67	-	Ω
输入电容 Input capacitance	C_{ies}	f=10kHz,T_{vj}=25°C,V_{CE}=20V, V_{GE}=0V	-	20546	-	pF
输出电容 Output capacitance	C_{oss}		-	748	-	
反向传输电容 Reverse transfer capacitance	C_{res}		-	48	-	
集电极-发射极截止电流 Collector-emitter cut-off current	I_{CES}	V_{CE}=650V,V_{GE}=0V,T_{vj}=25°C	-	-	600	μA
栅极-发射极漏电流 Gate-emitter leakage current	I_{GES}	V_{CE}=0V,V_{GE}=±20V,T_{vj}=25°C	-	-	600	nA

参数 Parameter	符号 Symbol	工作条件 Conditions		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
开通延迟时间 Turn-on delay time	$t_{d\ on}$	V_{CE}=400V,I_C=100A,R_{on}=15Ω,R_{off}=15Ω,V_{GE}= -7 ~ +15V	T_{vj}=25°C	-	140	-	ns
			T_{vj}=150°C	-	118	-	
上升时间 Rise time	t_r		T_{vj}=25°C	-	62	-	
			T_{vj}=150°C	-	55	-	
关断延迟时间 Turn-off delay time	$t_{d\ off}$		T_{vj}=25°C	-	610	-	
			T_{vj}=150°C	-	646	-	
下降时间 Fall time	t_f		T_{vj}=25°C		41		
			T_{vj}=150°C	-	30	-	
开通损耗 Turn-on energy loss	E_{on}		T_{vj}=25°C	-	3.5	-	mJ
			T_{vj}=150°C	-	4.6	-	
关断损耗 Turn-off energy loss	E_{off}		T_{vj}=25°C	-	2.4	-	
			T_{vj}=150°C	-	3.4	-	
结－外壳热阻 Thermal resistance, junction to case	R_{thJC}	每个 IGBT / per IGBT		-	0.127	-	K/W
工作结温 Operating Junction Temperature	$T_{vj\ op}$			-40	-	150	°C
最大结温 Maximum Junction Temperature	$T_{vj\ max}$			-40	-	175	

❒ 内管 IGBT(T2,T3)/Inner IGBT(T2,T3)

● 最大额定值 / Maximum Rated Values

(T_J=25°C,除非另外注明/unless otherwise noted)

参数 Parameter	符号 Symbol	工作条件 Conditions	额定值 Ratings	单位 Units
集电极-发射极电压 Collector-emitter voltage	V_{CES}	T_{vj}=25°C	650	V
连续集电极直流电流 Continuous DC collector current	$I_{C\ nom}$	T_C=80°C,$T_{vj\ max}$=175°C	394	A
集电极重复峰值电流 Repetitive peak collector current	I_{CRM}	t_p=1ms	788	
功耗 Total power dissipation	P_{tot}	T_C=80°C,$T_{vj\ max}$=175°C	748	W
栅极-发射极峰值电压 Gate-emitter peak voltage	V_{GE}		±20	V

● 电气特性 / Electrical Characteristics

参数 Parameter	符号 Symbol	工作条件 Conditions		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
集电极-发射极饱和电压 Collector-emitter saturation voltage	$V_{CE\ sat}$	V_{GE}=15V,I_C=375 A	T_{vj}=25℃	1.4	1.6	2.1	V
			T_{vj}=150℃	-	1.8	2.2	
栅极-发射极阈值电压 Gate-emitter threshold voltage	V_{GEth}	I_C=5mA,V_{CE}=V_{GE},T_{vj}=25℃		4	4.6	5.2	
栅极电荷 Gate charge	Q_G	V_{GE}=-9V~+15V		-	1.8	-	μC
内部栅极电阻 Internal gate resistor	R_{Gint}	T_{vj}=25℃		-	0.72	-	Ω
输入电容 Input capacitance	C_{ies}	f=10kHz,T_{vj}=25℃,V_{CE}=20V, V_{GE}=0V		-	17174	-	pF
输出电容 Output capacitance	C_{oss}			-	630	-	
反向传输电容 Reverse transfer capacitance	C_{res}			-	41	-	
集电极-发射极截止电流 Collector-emitter cut-off current	I_{CES}	V_{CE}=650V,V_{GE}=0V,T_{vj}=25℃		-	-	500	μA
栅极-发射极漏电流 Gate-emitter leakage current	I_{GES}	V_{CE}=0V,V_{GE}=±20V,T_{vj}=25℃		-	-	500	nA
开通延迟时间 Turn-on delay time	$t_{d\ on}$	V_{CE}=400V,I_C=100A,R_{on}=15Ω,R_{off}=15Ω,V_{GE}= -7 ~ +15V	T_{vj}=25℃	-	168	-	ns
			T_{vj}=150℃	-	143	-	
上升时间 Rise time	t_r		T_{vj}=25℃	-	85	-	
			T_{vj}=150℃	-	75	-	
关断延迟时间 Turn-off delay time	$t_{d\ off}$		T_{vj}=25℃	-	764	-	
			T_{vj}=150℃	-	812	-	
下降时间 Fall time	t_f		T_{vj}=25℃		58		
			T_{vj}=150℃	-	43	-	
开通损耗 Turn-on energy loss	E_{on}		T_{vj}=25℃	-	4.2	-	mJ
			T_{vj}=150℃	-	5.8	-	
关断损耗 Turn-off energy loss	E_{off}		T_{vj}=25℃	-	2.9	-	
			T_{vj}=150℃	-	4.1	-	
结－外壳热阻 Thermal resistance, junction to case	R_{thJC}	每个 IGBT / per IGBT		-	0.127	-	K/W
工作结温 Operating Junction Temperature	$T_{vj\ op}$			-40	-	150	℃
最大结温 Maximum Junction Temperature	$T_{vj\ max}$			-40	-	175	

❒ 快恢复二极管 D1-D4/FRD D1-D4

● 最大额定值 / Maximum Rated Values

(T_J=25°C,除非另外注明/unless otherwise noted)

参数 Parameter	符号 Symbol	工作条件 Conditions	额定值 Ratings	单位 Units
反向重复峰值电压 Repetitive peak reverse voltage	V_{RRM}	T_{vj}=25°C	650	V
正向电流 Implemented forward current	I_{FN}		200	A
正向重复峰值电流 Repetitive peak forward current	I_{FRM}	t_P=1ms	400	
功耗 Total power dissipation	P_{tot}	T_C=80°C,$T_{vj\ max}$=175°C	220	W

● 电气特性 / Electrical Characteristics

参数 Parameter	符号 Symbol	工作条件 Conditions		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
正向压降 Forward voltage	V_F	I_F=200A	T_{vj}=25°C	-	1.3	2.0	V
			T_{vj}=150°C	-	1.2	-	
反向恢复峰值电流 Peak reverse recovery current	I_{RM}	I_F=100A,V_R=400V,di/dt=1800A/us	T_{vj}=25°C	-	96	-	A
			T_{vj}=150°C	-	128	-	
反向恢复电荷 Recovered charge	Q_r		T_{vj}=25°C	-	3.4	-	μC
			T_{vj}=150°C	-	13.1	-	
反向恢复损耗 Reverse recovery energy	E_{rec}		T_{vj}=25°C	-	1.2	-	mJ
			T_{vj}=150°C	-	5.5	-	
结一外壳热阻 Thermal resistance, junction to case	R_{thJC}	每个二极管/per diode		-	0.318	-	K/W
工作结温 Operating Junction Temperature	$T_{vj\ op}$			-40	-	150	°C
最大结温 Maximum Junction Temperature	$T_{vj\ max}$			-40	-	175	

❒ 快恢复二极管 D5-D6/FRD D5-D6

● 最大额定值 / Maximum Rated Values

(T_J=25°C,除非另外注明/unless otherwise noted)

参数 Parameter	符号 Symbol	工作条件 Conditions	额定值 Ratings	单位 Units
反向重复峰值电压 Repetitive peak reverse voltage	V_{RRM}	T_{vj}=25°C	650	V
正向电流 Implemented forward current	I_{FN}		450	A
正向重复峰值电流 Repetitive peak forward current	I_{FRM}	t_P=1ms	900	
功耗 Total power dissipation	P_{tot}	T_C=80°C,$T_{vj\ max}$=175°C	370	W

● 电气特性 / Electrical Characteristics

参数 Parameter	符号 Symbol	工作条件 Conditions		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
正向压降 Forward voltage	V_F	I_F=450A	T_{vj}=25°C	1.5	1.7	1.9	V
			T_{vj}=150°C	-	1.8	-	
反向恢复峰值电流 Peak reverse recovery current	I_{RM}	I_F=450A,V_R=400V,di/dt=2200A/us	T_{vj}=25°C	-	176	-	A
			T_{vj}=150°C	-	248	-	
反向恢复电荷 Recovered charge	Q_r		T_{vj}=25°C	-	18	-	μC
			T_{vj}=150°C	-	34	-	
反向恢复损耗 Reverse recovery energy	E_{rec}		T_{vj}=25°C	-	4.2	-	mJ
			T_{vj}=150°C	-	9.2	-	
结一外壳热阻 Thermal resistance, junction to case	R_{thJC}	每个二极管/per diode		-	0.189	-	K/W
工作结温 Operating Junction Temperature	$T_{vj\ op}$			-40	-	150	°C
最大结温 Maximum Junction Temperature	$T_{vj\ max}$			-40	-	175	

❒ 负温度系数热敏电阻/NTC-Thermistor

参数 Parameter	符号 Symbol	工作条件 Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
额定电阻值 Rated resistance	R_{25}	T_{vj}=25°C	-	22.0	-	kΩ
	R_{100}	T_{vj}=100°C	-	1.446	-	
R_{100}偏差 Deviation of R_{100}	ΔR/R	T_C=100°C	-5		5	%
	P_{25}	T_{vj}=25°C	-	-	60	mW
B-值 B-value	$B_{25/50}$	$B_{(25/50)}$,tolerance±3%	-	3950	-	K
	$B_{25/100}$	$B_{(25/100)}$,tolerance±3%	-	4038	-	

- **电气特性 / Electrical Characteristics**

❒ 模块/Module

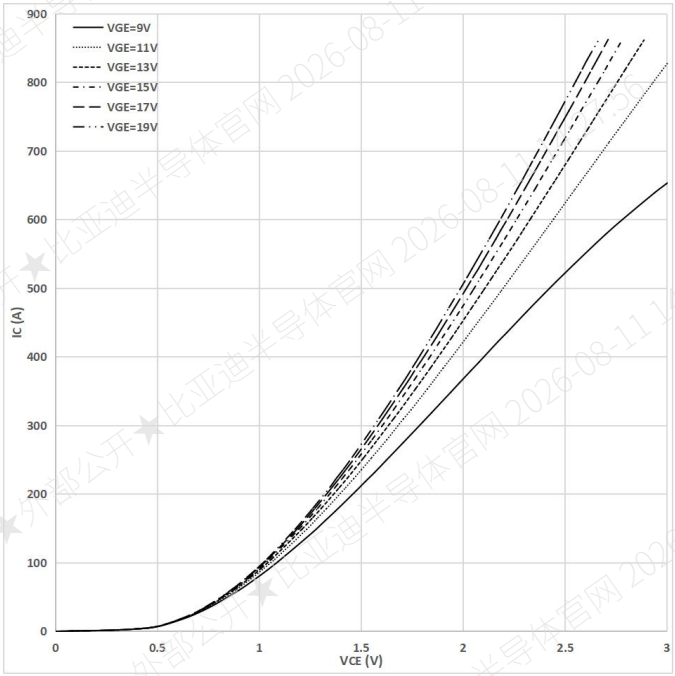
- **电气特性 / Electrical Characteristics**

参数 Parameter	符号 Symbol	工作条件 Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Units
内部绝缘 Internal isolation			Al_2O_3			
绝缘测试电压 Isolation test voltage	V_{ISOL}	RMS,f=50Hz,t=1min.	3			kV
爬电距离 Creepage distance	d_{Creep}			12.7		mm
电气间隙 Electrical clearance	d_{Clear}			12.7		
相对电痕指数 Comparative tracking index	CTI		600			V
相对温度指数 Relative thermal index	RTI		140			°C
杂散电感 Stray inductance	L_{SCE}		-	21	-	nH
储存温度 Storage temperature	T_{stg}		-40	-	125	°C
模块安装扭矩 Mounting torque for module mounting	M	M5,Screw	3		3.6	N·m
模块重量 Weight of module	G			178		g

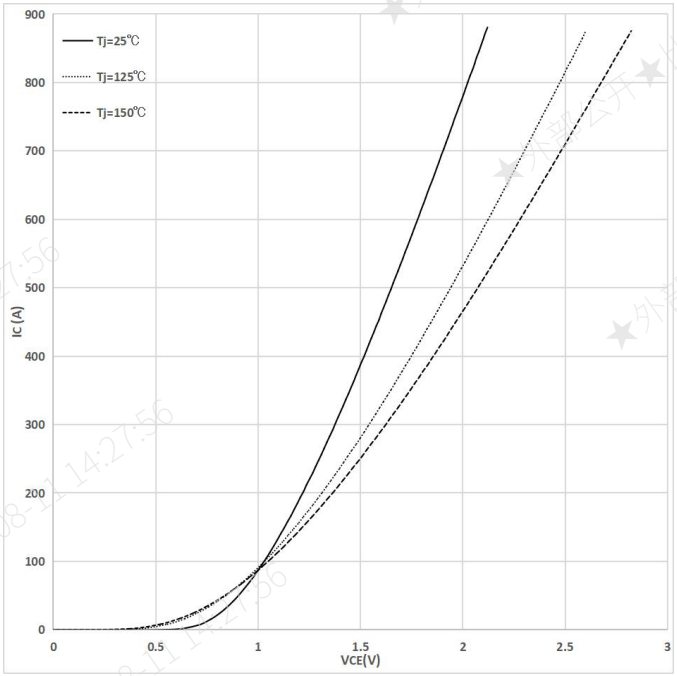
注：以上参数中的典型参考值基于封装条件下实验室测试数据得出，不作为生产测试验收依据。
Note: The typical reference values in the above parameters are based on laboratory test data under encapsulation conditions and are not to be used as a basis for production test acceptance.

❒ 特性曲线/Characteristics Diagrams

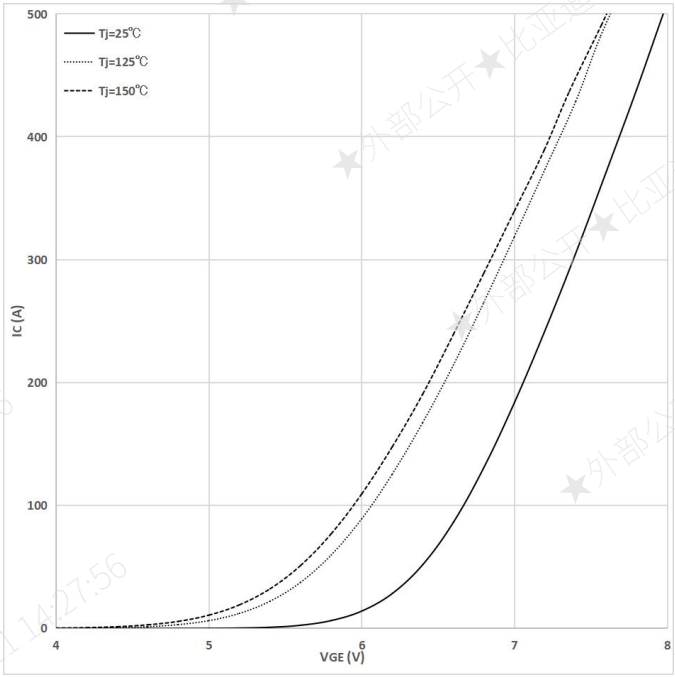
输出特性 IGBT,T1/T4 (典型)
output characteristic IGBT,T1/T4 (typical)
$I_C=f(V_{CE})$，$T_{vj}=150℃$



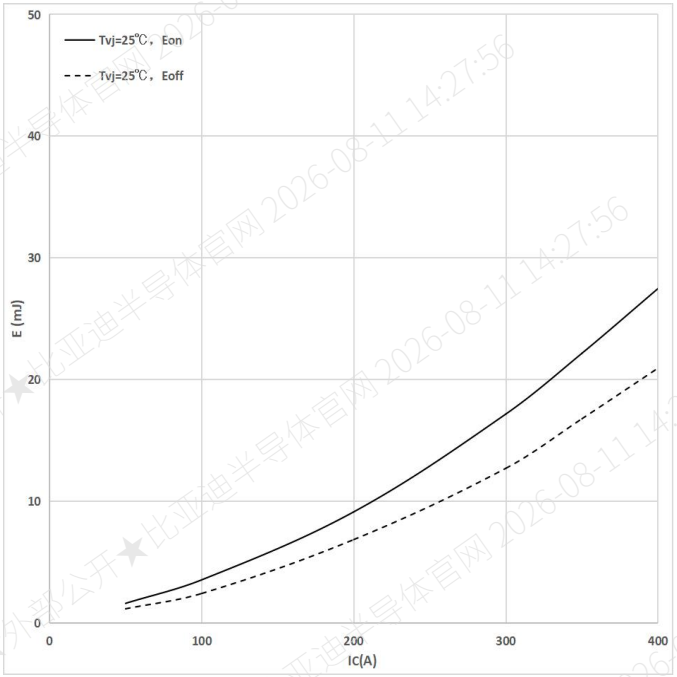
输出特性 IGBT,T1/T4 (典型)
output characteristic IGBT,T1/T4 (typical)
$I_C=f(V_{CE})$，$V_{GE}=15V$



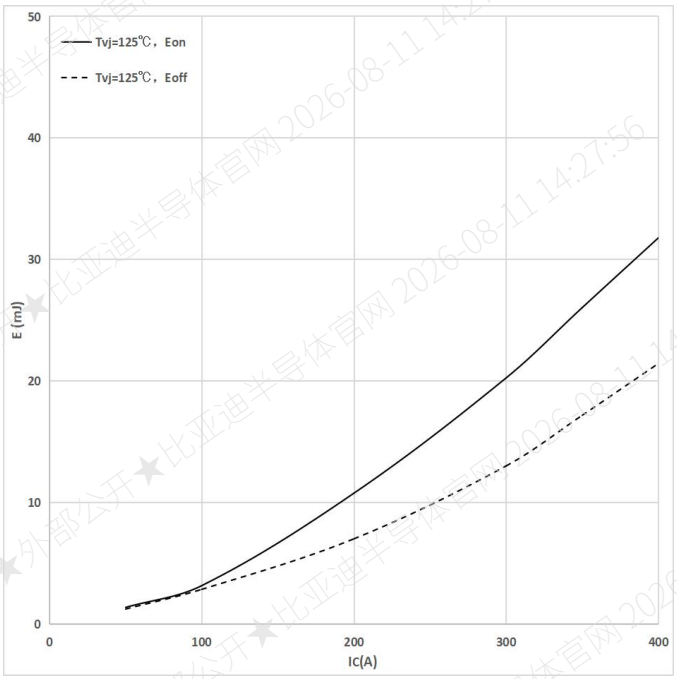
传输特性 IGBT,T1/T4 (典型)
output characteristic IGBT,T1/T4 (typical)
$I_C=f(V_{GE})$，$V_{CE}=20V$



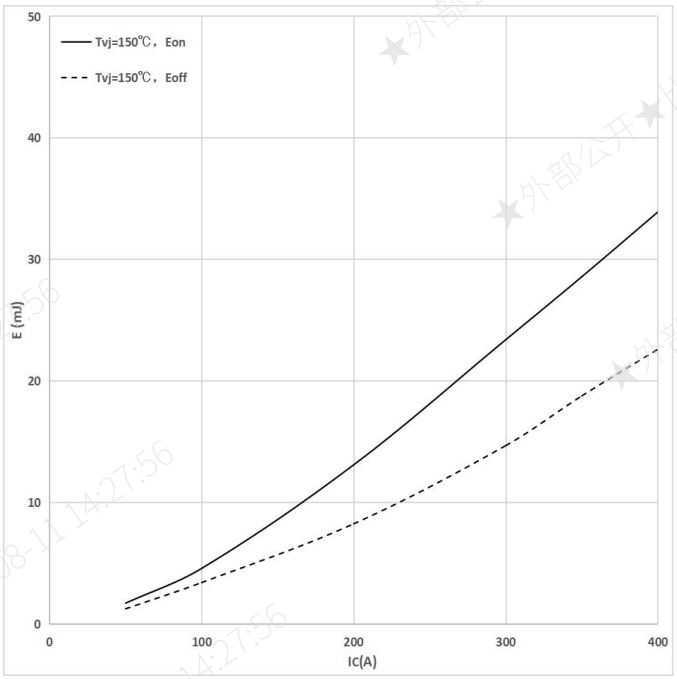
开关损耗 IGBT,T1/T4 (典型)
switching losses IGBT,T1/T4 (typical)
$E_{on}=f(I_C)$,$E_{off}=f(I_C)$
V_{GE}=-7～+15V,R_{Gon}=15Ω,R_{Goff}=15Ω
V_{CE}=400V,T_{Vj}=25℃



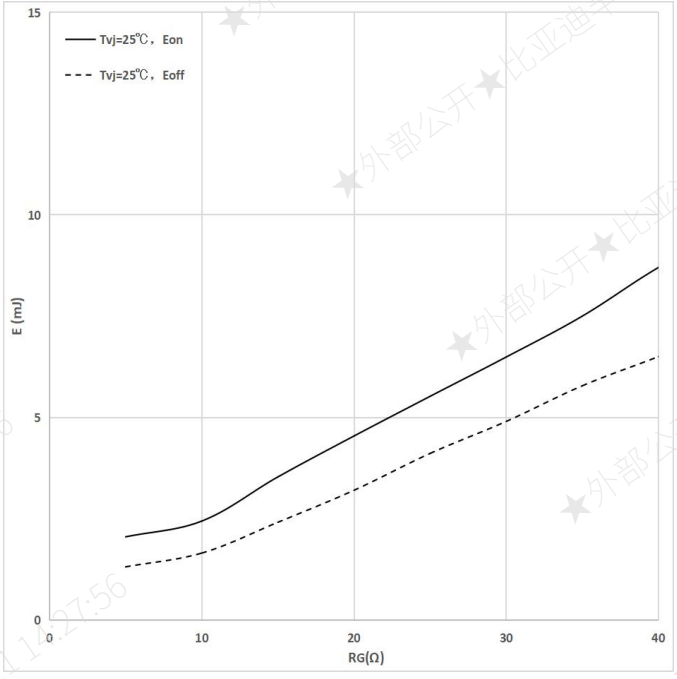
开关损耗 IGBT,T1/T4 (典型)
switching losses IGBT,T1/T4 (typical)
$E_{on}=f(I_C),E_{off}=f(I_C)$
V_{GE}=-7～+15V,R_{Gon}=15Ω,R_{Goff}=15Ω
V_{CE}=400V,T_{vj}=125℃



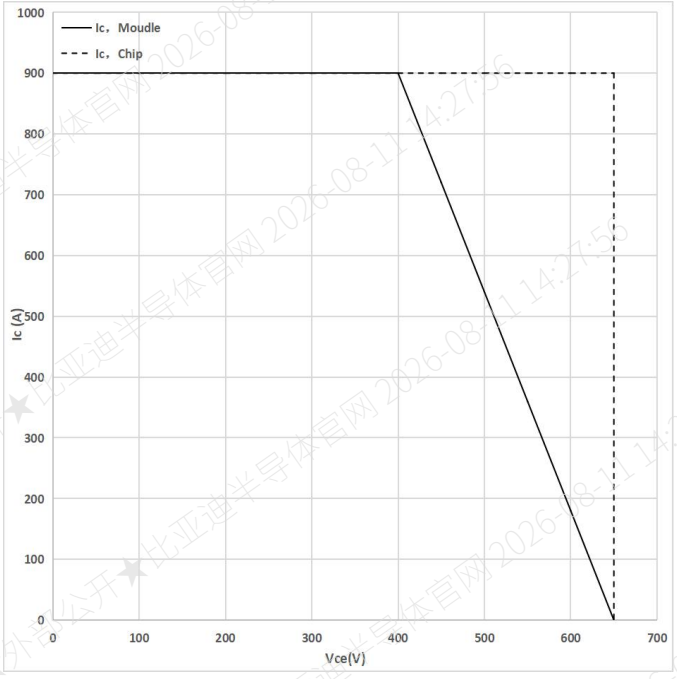
开关损耗 IGBT,T1/T4 (典型)
switching losses IGBT,T1/T4 (typical)
$E_{on}=f(I_C),E_{off}=f(I_C)$
V_{GE}=-7～+15V,R_{Gon}=15Ω,R_{Goff}=15Ω
V_{CE}=400V,T_{vj}=150℃



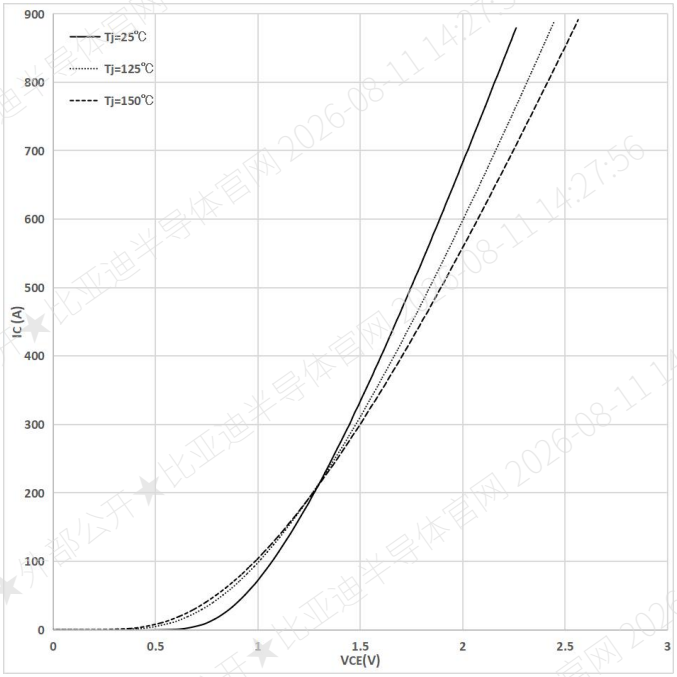
开关损耗 IGBT,T1/T4 (典型)
switching losses IGBT,T1/T4 (typical)
$E_{on}=f(R_G),E_{off}=f(R_G)$
V_{GE}=-7～+15V,T_{vj}=25℃,V_{CE}=400V，I_C=100A



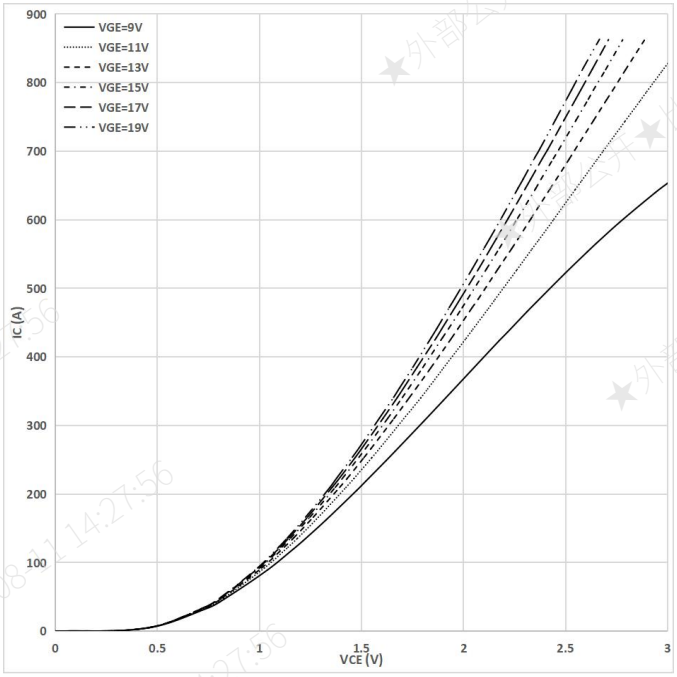
反偏安全工作区 IGBT, T1/T4（RBSOA）
reverse bias safe operating area IGBT,T1/T4 (RBSOA)
$I_C=f(V_{CE}),V_{GE}$=±15V,R_{Goff}=47Ω,T_{vj}=150℃



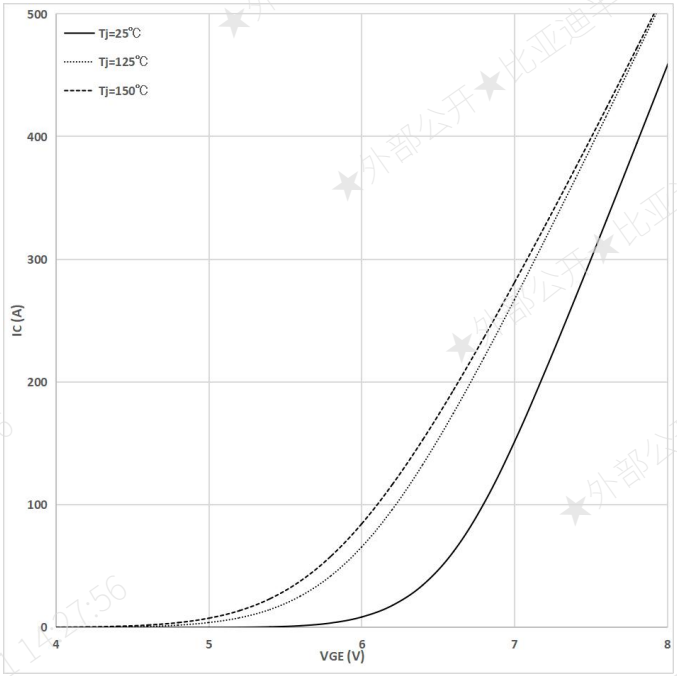
输出特性 IGBT,T2/T3 (典型)
output characteristic IGBT,T2/T3 (typical)
$I_C=f(V_{CE})$，$V_{GE}=15V$



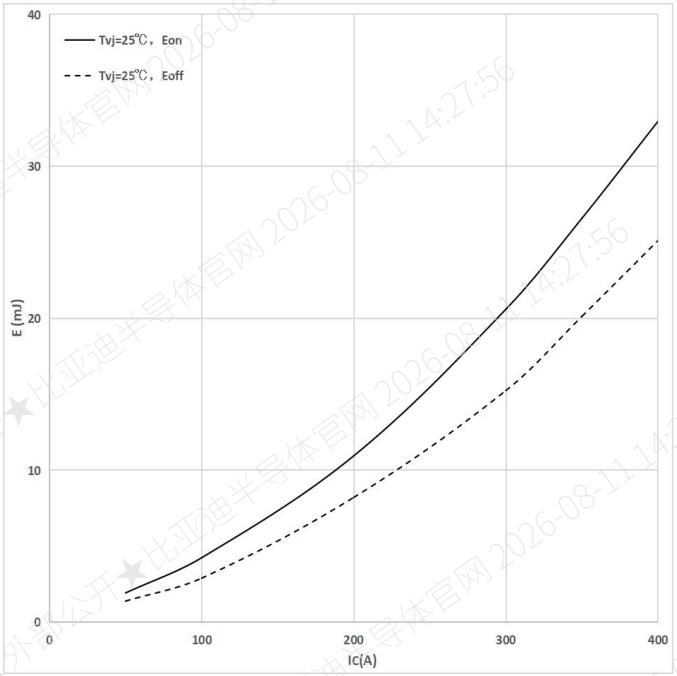
输出特性 IGBT,T2/T3 (典型)
output characteristic IGBT,T2/T3 (typical)
$I_C=f(V_{CE})$，$T_{vj}=150℃$



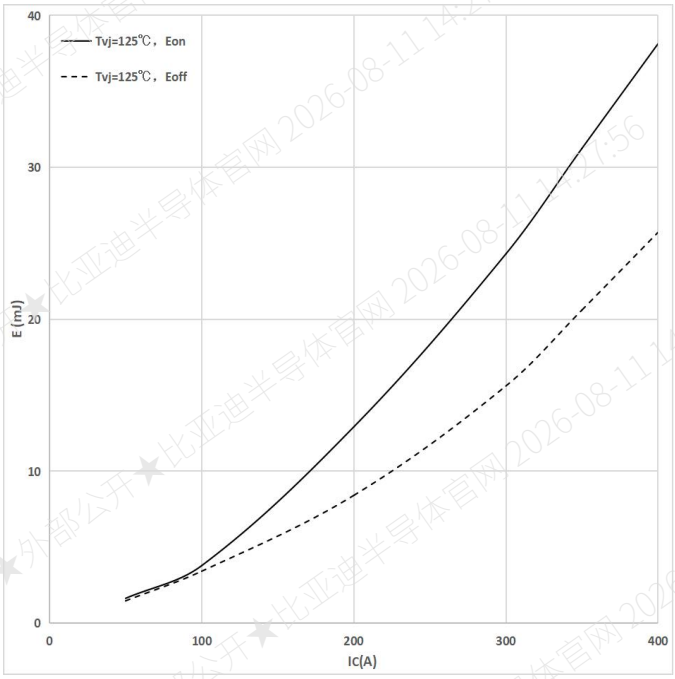
传输特性 IGBT,T2/T3 (典型)
output characteristic IGBT,T2/T3 (typical)
$I_C=f(V_{GE})$，$V_{GE}=20V$



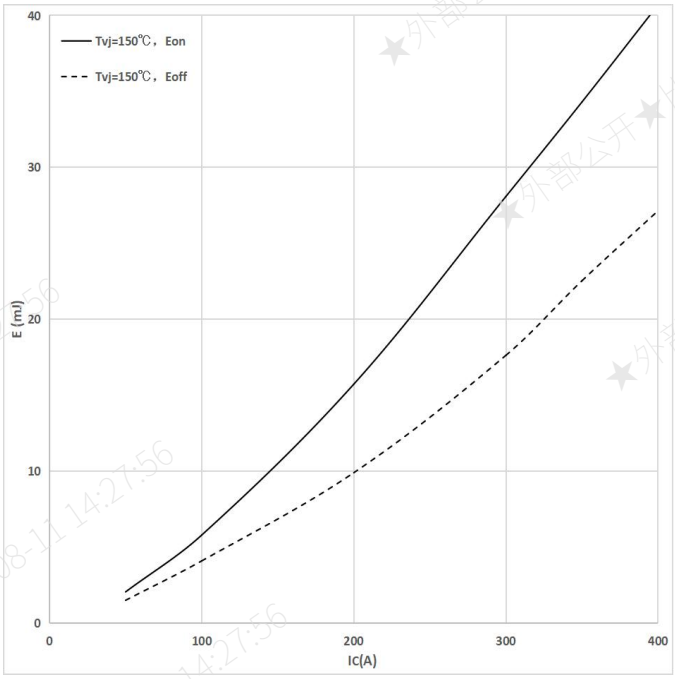
开关损耗 IGBT,T2/T3 (典型)
switching losses IGBT,T2/T3 (typical)
$E_{on}=f(I_C)$,$E_{off}=f(I_C)$
V_{GE}=-7～+15V,R_{Gon}=15Ω,R_{Goff}=15Ω
V_{CE}=400V，T_{vj}=25℃



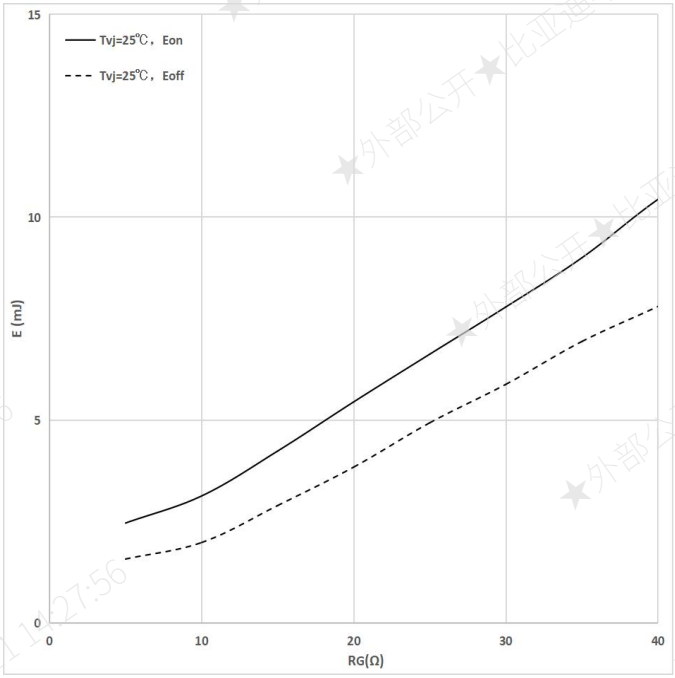
开关损耗 IGBT,T2/T3 (典型)
switching losses IGBT,T2/T3 (typical)
$E_{on}=f(I_C),E_{off}=f(I_C)$
V_{GE}=-7～+15V,R_{Gon}=15Ω,R_{Goff}=15Ω
V_{CE}=400V，T_{vj}=125℃



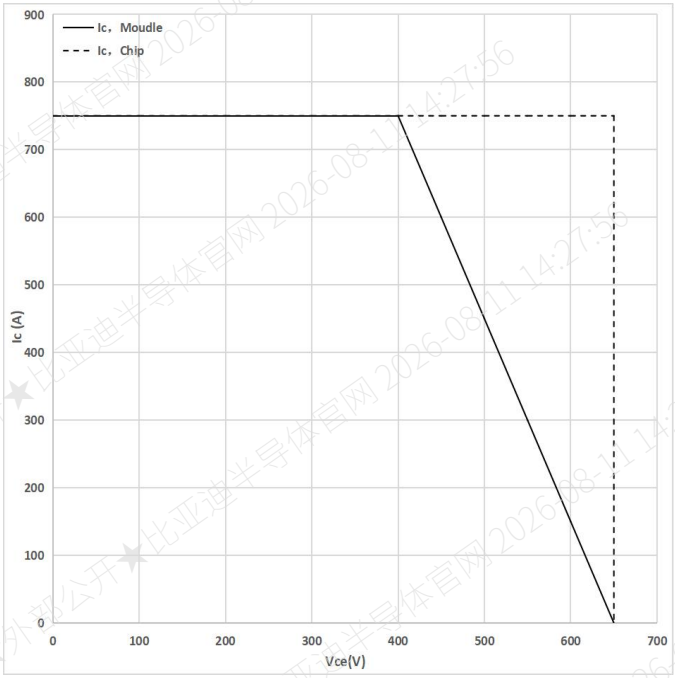
开关损耗 IGBT,T2/T3 (典型)
switching losses IGBT,T2/T3 (typical)
$E_{on}=f(I_C),E_{off}=f(I_C)$
V_{GE}=-7～+15V,R_{Gon}=15Ω,R_{Goff}=15Ω
V_{CE}=400V，T_{vj}=150℃



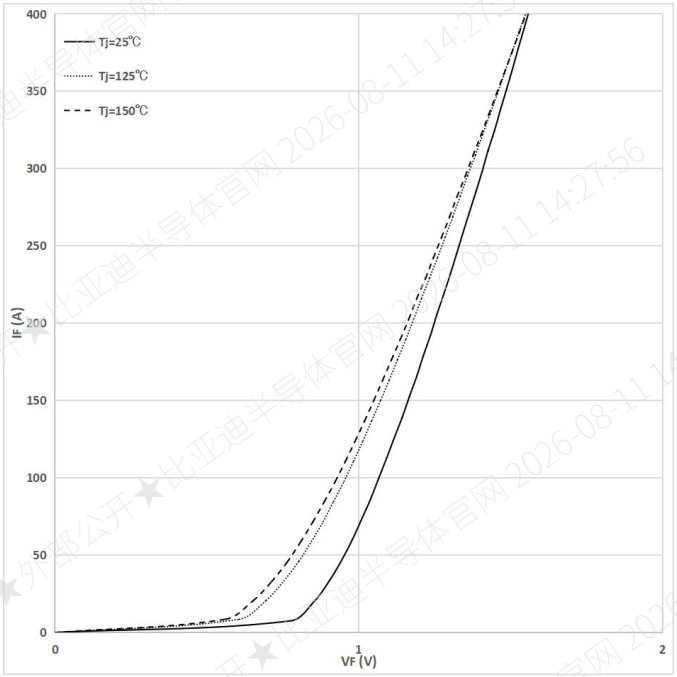
开关损耗 IGBT,T2/T3 (典型)
switching losses IGBT,T2/T3 (typical)
$E_{on}=f(R_G),E_{off}=f(R_G)$
V_{GE}=-7～+15V,T_{vj}=25℃,V_{CE}=400V，I_C=100A



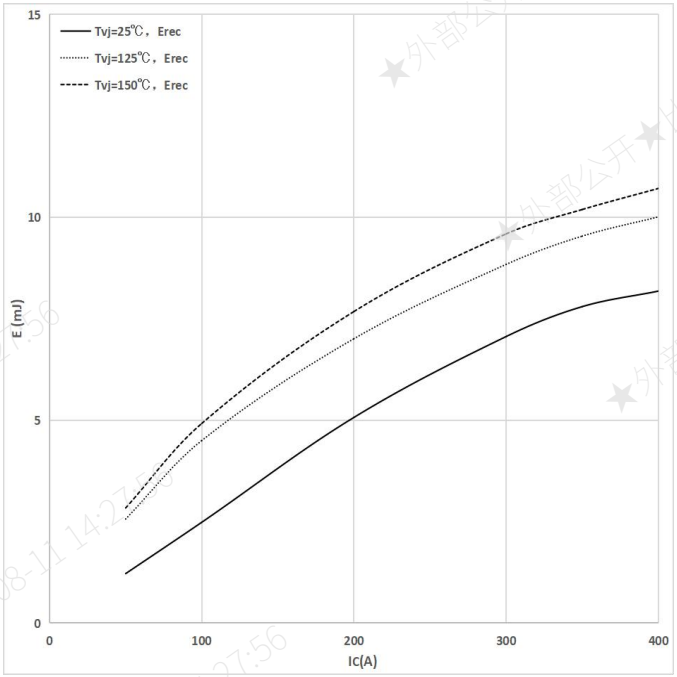
反偏安全工作区 IGBT, T2/T3（RBSOA）
reverse bias safe operating area IGBT,T2/T3 (RBSOA)
$I_C=f(V_{CE})$
V_{GE}=±15V,R_{Goff}=47Ω,T_{vj}=150℃



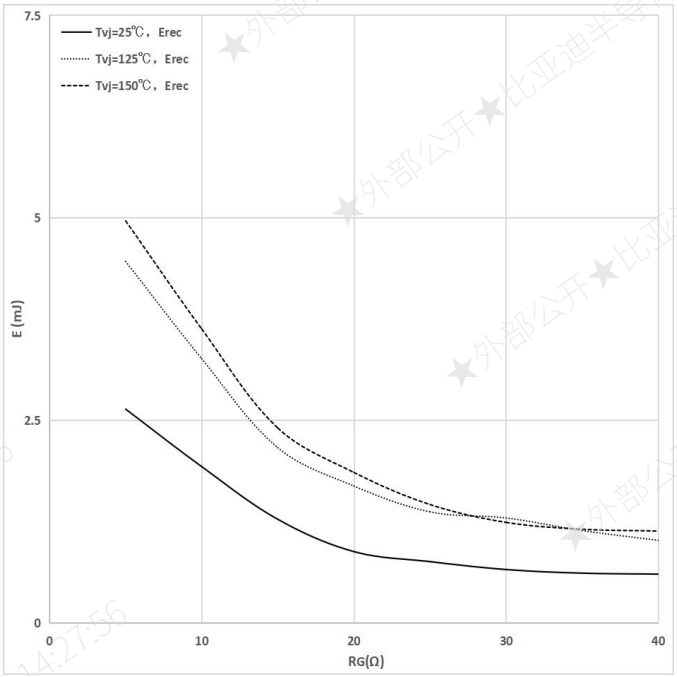
正向偏压特性 二极管,D1～D4 (典型)
forward characteristic Diode,D1～D4 (typical)
$I_F=f(V_F)$



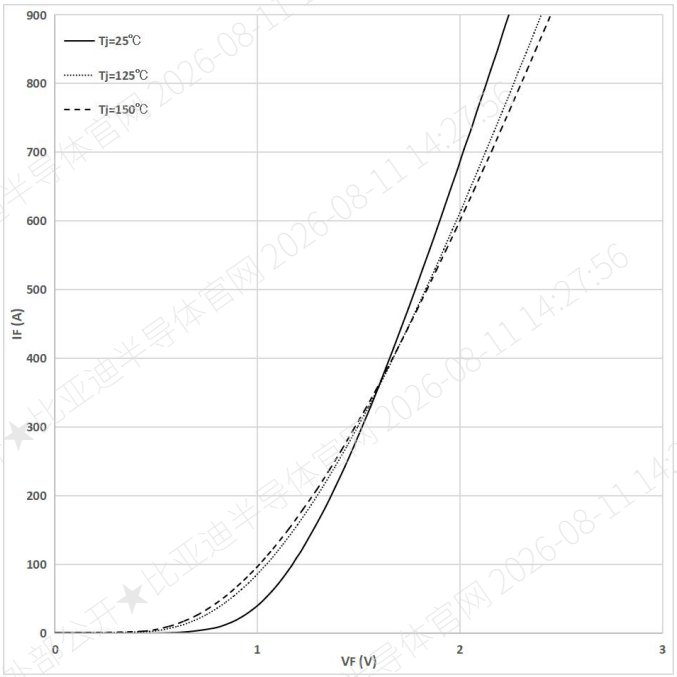
开关损耗 二极管,D1～D4 (典型)
switching losses Diode,D1～D4 (typical)
$E_{rec}=f(I_F)$
$R_{Gon}=15\Omega, V_{CE}=400V$



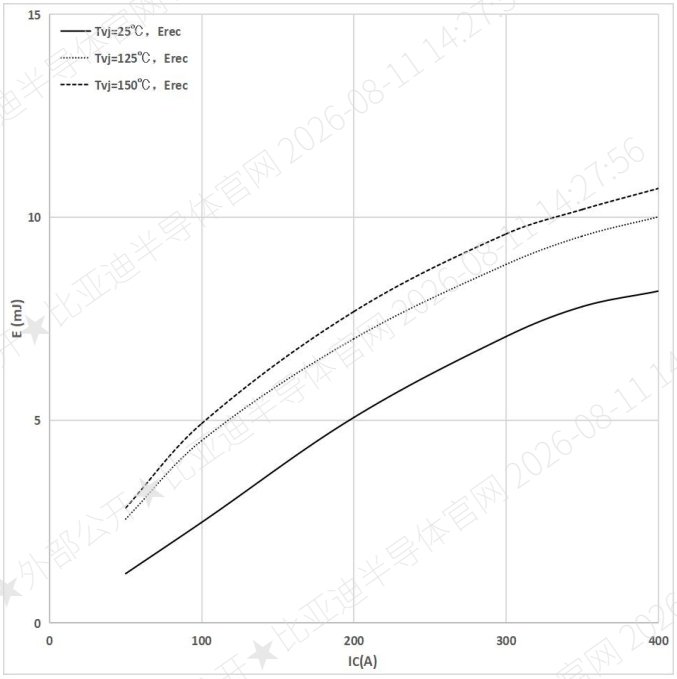
开关损耗 二极管,D1～D4 (典型)
switching losses Diode,D1～D4 (typical)
$E_{rec}=f(R_G)$
$I_F=100A, V_{CE}=400V$



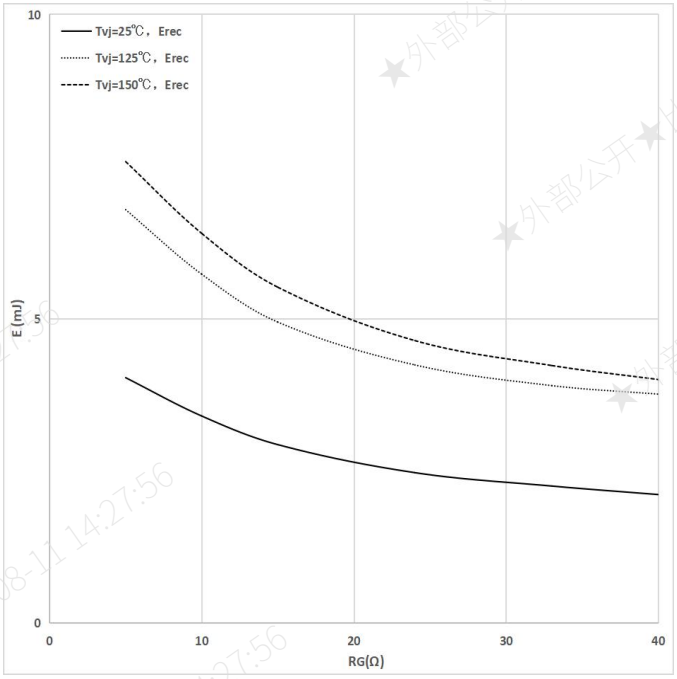
正向偏压特性 二极管,D5/D6 (典型)
forward characteristic Diode,D5/D6 (typical)
$I_F=f(V_F)$



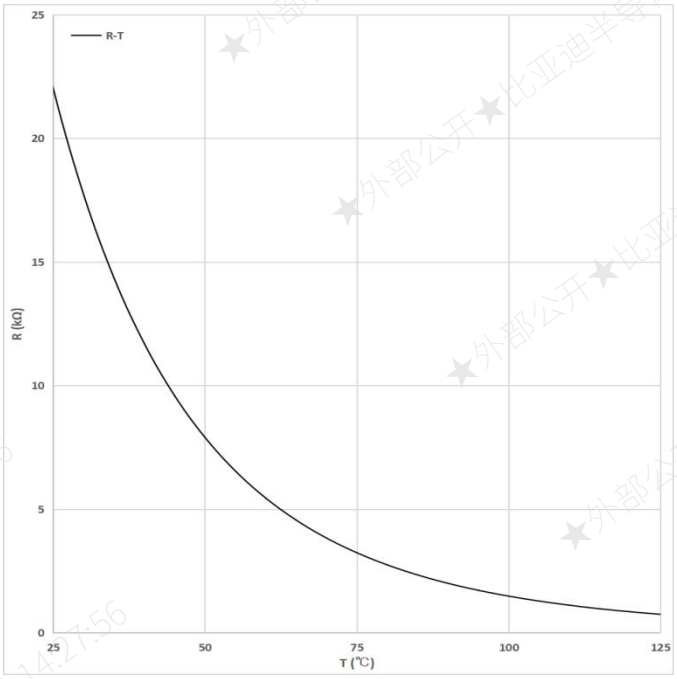
开关损耗 二极管,D5/D6 (典型)
switching losses Diode,D1～D4 (typical)
$E_{rec}=f(I_F)$
$R_{Gon}=15\Omega, V_{CE}=400V$



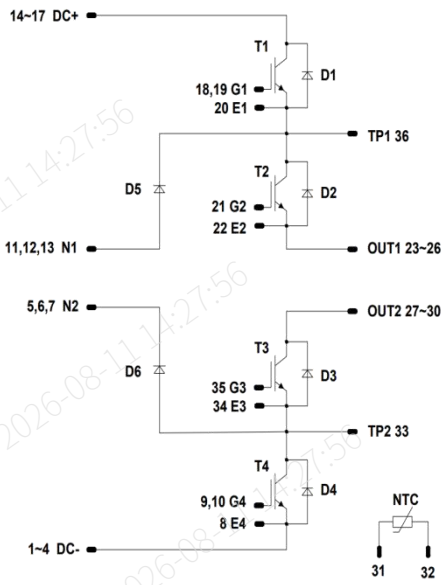
开关损耗 二极管,D5/D6 (典型)
switching losses Diode,D1～D4 (typical)
$Erec=f(R_G)$
$I_F=100A, V_{CE}=400V$



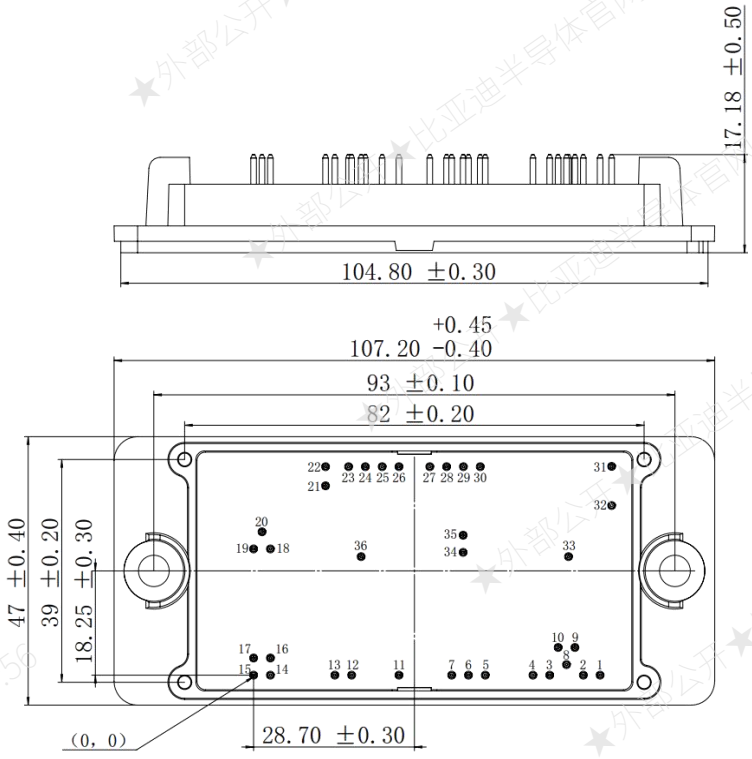
负温度系数热敏电阻 温度特性
NTC-Thermistor-temperature characteristic (typical)
R=f(T)



❒ 接线图/circuit diagram headline



❒ 封装尺寸/package outlines



PIN	PIN POSITION		PIN	PIN POSITION	
	X	Y		X	Y
1	61.85	0.0	19	0.0	22.1
2	58.85	0.0	20	1.5	25.1
3	52.85	0.0	21	12.85	33.15
4	49.85	0.0	22	12.85	36.5
5	41.35	0.0	23	16.95	36.5
6	38.35	0.0	24	19.95	36.5
7	35.35	0.0	25	22.95	36.5
8	55.85	1.85	26	25.95	36.5
9	57.35	4.85	27	31.45	36.5
10	54.35	4.85	28	34.45	36.5
11	25.95	0.0	29	37.45	36.5
12	17.5	0.0	30	40.45	36.5
13	14.5	0.0	31	63.9	36.55
14	3.0	0.0	32	63.9	29.7
15	0.0	0.0	33	56.2	20.75
16	3.0	3.0	34	37.4	21.5
17	0.0	3.0	35	37.4	24.5
18	3.0	22.1	36	19.2	20.75

❒ 免责声明 DISCLAIMER

■ 使用范围：本产品适用于工业级电气应用（包括但不限于：工业电机驱动、变频器、不间断电源（UPS）、光伏逆变器、储能变流器、工业焊接设备、电能质量设备（如SVG、APF）等）。

Applications: This product is suitable for industrial electrical applications (including but not limited to: industrial motor drives, frequency converters, UPS, photovoltaic inverters, energy storage converters, industrial welding equipment, power quality devices (SVG, APF), etc.)

■ 质保期：除双方在合作协议或其他书面文件中另行约定外，本规格书所述产品质保期自出货起12个月。

Warranty Period: Unless otherwise agreed in the COOPERATION AGREEMENT Or Other WRITTEN DOCUMENTS, The warranty period for the product described in this specification is 12 months from the date of shipment.

■ **特别说明 Special Instructions:**

功率模块安全正确的使用方法：不当的操作（如电应力、机械应力等）可能导致模块损毁。请注意以下介绍，并根据指导来使用使用本产品。

Correct and Safety Use of Power Module: Unsuitable operation (such as electrical, mechanical stress and so on) may lead to damage of power modules. Please pay attention to the following descriptions and use this product according to the guidance.

- 运输过程中：包装箱颠簸或坠落可能导致内部器件损毁；器件遇水受潮将导致故障失效。在雨雪天气尤其要注意保护器件防止淋湿。

  During Transit: Tossing or dropping of a carton may damage devices inside. Devices exposed to moisture may result in failure. Special care should be taken during rainy or snowy weather to implement protective measures preventing the device from getting wet.
- 贮存：贮存地点温度与湿度应分别控制在20±5℃和30%～60%RH。如果贮存环境远高于或低于指示的变化范围，将危害器件的性能与可靠性。

  Storage: The temperature and humidity of the storage place should be 20±5℃ and 30%～60%RH respectively. The performance and reliability of devices may be jeopardized if devices are stored in an environment far above or below the range indicated above.
- 长期贮存：当存储器件时间超过一年，贮存地点应当采取去湿措施。器件经过长期存放使用时，检查器件确保外观没有刮伤，灰尘，锈迹等。

  Prolonged Storage: When storing devices more than one year, dehumidifying measures should be provided for the storage place. When using devices after a long period of storage, please inspect them to ensure there are no scratches, dust, rust, or other defects on the surface.
- 应用环境：器件不应当暴露在水，有机溶剂，腐蚀性气体、易燃易爆性气体，微尘，腐蚀性药剂中，上述任何一种情况都会导致严重事故。

  Operating Environment: Devices should not be exposed to water, organic solvents, corrosive gases, explosive gases, fine particles, or corrosive agents, since any of those can lead to a serious accident.
- 防静电措施：带栅极器件应采取以下预警来防止可以损毁器件的静电生成：

  Anti-electrostatic Measures: Following precautions should be taken for gated devices to prevent static buildup which could damage the devices:

  1.门极与发射(源)极间产生的人体静电、包装箱静电和过电压将损毁或击穿器件。采样发射(源)极和温度传感器同样容易受到过压损毁。防静电底板可以抑制电荷生成并快速耗散。

  Static electricity of human bodies and cartons and/or excessive voltage applied across the gate to emitter(source) may damage and rupture devices. Sense-emitter(source) and temperature-sensor are also vulnerable to excessive voltage. The basis of anti-electrostatic is suppression of build-up and quick dissipation of the charged electricity.

  2.不要用易受静电影响的容器运输或贮存器件。

  Containers that are susceptible to static electricity should not be used for transit or for storage.

3.发射(源)极信号端子应一直用碳纤维布或类似物短接直到模块使用前。任何情况下不要徒手碰触信号端子。

Signal terminals to emitter(source) should be always shorted with a carbon cloth or the like until right before a module is used. Never touch the signal terminals with bare hands.

4.安装过程中始终保持设备和操作人员的身体接触地面（移除碳纤维布或类似物后）。用导电垫覆盖工作地点及周围地板并使其接地。

During the installation process, it is necessary to always maintain the equipment and the operator's body in contact with the ground after removing carbon fiber cloth or similar materials. It is advisable to cover the workstation and its surrounding floor with conductive mats and ground them.

5.使用接地的烙铁头。

Use soldering irons with grounded tips.

- 本公司致力于提高产品质量与稳定性。本文件之目的，仅在于陈述产品相关技术信息。

  Our Company is committed to enhancing product quality and stability. This specification serves solely to delineate technical product details.

- **尽管本公司已尽合理努力及注意，但由于产品本身敏感特性以及测试环境、系统的差异，存在一定的故障发生率以及可能在某些情况下出现故障或失效。因此，本公司不承诺本文件中所列信息准确性及产品适配、适销性。本文件所载信息不应被视为本公司对产品功能、条件或质量的保证与承诺。**

  Notwithstanding the Company's reasonable efforts and due diligence, the sensitive nature of the products and variations in testing environments and systems may result in a certain failure rate, including potential malfunctions or failures under specific conditions. Consequently, the Company does not warrant the accuracy of the information contained in this specification, nor the fitness for a particular purpose or merchantability of the products. The information in this specification shall not be construed as a guarantee or commitment regarding product functionality, condition, or quality.

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  The content contained in this specification shall not be construed as any express, implied, or otherwise grant and/or license to patents, trademarks, copyrights, or other intellectual property rights owned by the Company or third parties. The Company's commitments regarding product intellectual property are strictly limited to the terms expressly stated in SEPARATE WRITTEN AGREEMENTS with Customers. Reverse-engineering, disassembly, or any form of analysis of the product is strictly prohibited without the Company's prior written consent.

- 任何超出本文件中建议存储条件、使用条件及绝对最大额定参数条件（或部分明确值）使用，造成的产品损坏或连带事故发生，本公司不承担相关责任。当客户在使用产品时，应根据最新版本文件上规定的操作步骤或示明条件进行使用或测试。客户有责任遵从安全规则（包括冗余设计、防火措施、故障预防等）设计安全及稳定的系统环境，在实际应用前、或实际应用中验证本文件所述的任何功能，以确保适用性、安全性（预防可能发生的任何事故、火灾或社会伤害等）及可靠性。建议客户在测试前可咨询本公司，以验证产品信息是否可以涵盖应用需求。

  The Company shall not be held liable for any product damage or consequential incidents resulting from usage beyond the recommended storage conditions, operating parameters, or absolute maximum ratings (or other explicitly stated limits) specified in this specification. Customers must strictly adhere to the operational procedures and conditions outlined in the latest version of the specification when utilizing or testing the product. Customers are responsible for complying with safety standards, including but not limited to redundant design, fire prevention measures, and fault prevention, to design and maintain a safe and stable system environment. Customers must verify all functionalities described in this specification before or during actual application to ensure product suitability, safety (preventing potential accidents, fires, or public harm etc.), and reliability. It is recommended that Customers consult our company prior to testing to confirm whether the product information adequately covers the application requirements.

- 本产品不能且禁止应用在一些需要更高稳定性及质量的特殊设备上，以免导致人员伤亡等意外发生，包括原子能控制设备，飞机及航空器件，船舶、轨道等运输设备，交通信号设备，燃烧控制设备，医药设备以及所有安全性设备等。客户应通过本公司或经本公司授权的渠道购买正品，并应在法律约束范围内及本文件明确条件下合法、合理使用，否则造成损失与伤害的，本公司概不负责。

  This product shall not be used in any equipment or applications requiring higher reliability or quality standards where failure could result in personal injury, death, or catastrophic events, including but not limited to nuclear control systems, aircraft/aviation components, maritime/rail transport equipment, traffic signaling devices, combustion control systems, medical equipment, or other safety-critical applications. Customers must procure genuine products exclusively through the Company or authorized channels, and utilize them strictly within legally permitted boundaries and under conditions expressly defined in this specification. The Company disclaims all liability for losses, damages, or injuries arising from non-compliance with these requirements.

- 本文件示明信息，均为发布时本公司尽合理努力整理并记录的产品最新信息。为提供更加准确的信息，本公司保留对本文件不定期勘误修改及版本更新的权利。客户在使用或参阅时，请使用最新版本。

  The information presented in this specification constitutes the latest product details compiled and recorded by our Company with reasonable efforts at the time of publication. To ensure greater accuracy, our Company reserves the right to make periodic corrections, modifications, and version updates to this specification without prior notice. Customers should always refer to the latest version when using or consulting this document.

- 本文件以中英文双语书就，如有不同之处，以中文内容为准。

  The information presented in this specification constitutes the latest product details compiled and recorded by our Company with reasonable efforts at the time of publication. To ensure greater accuracy, our Company reserves the right to make periodic corrections, modifications, and version updates to this specification without prior notice. Customers should always refer to the latest version when using or consulting this document.