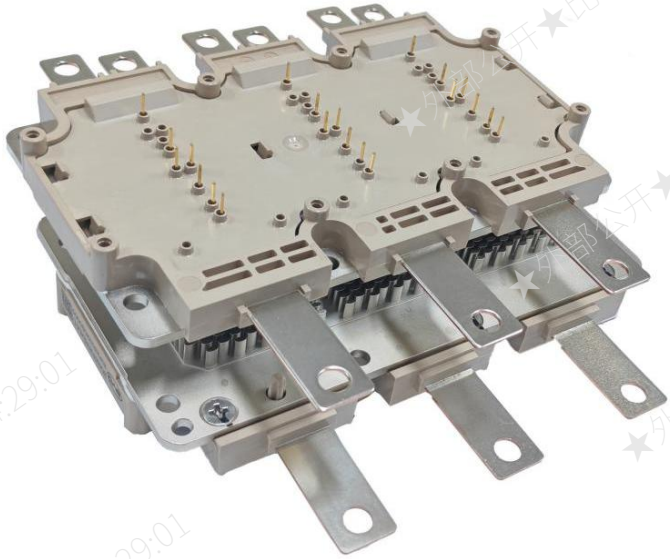
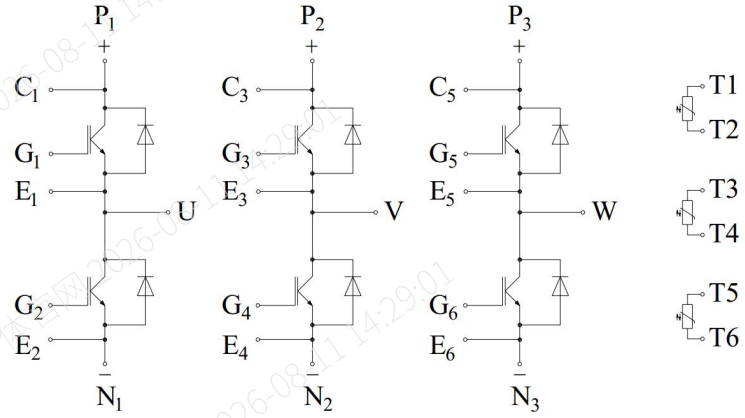
❒ General Description

This IGBT module, which adopts general packaging, can meet Auto-grade standards and is specially developed for new energy motor controller, also can be used for other applications. BYD module adopts DBC with additional elements, which has high strength. DBC can be made thin, less thermal resistance and better heat dissipation in the case of constant intensity requirements.



❒ 概述

这款 IGBT 模块采用了标准封装，可以满足汽车级标准，专为新能源汽车控制器设计，也可用于其他领域。BYD 模块采用了高强度、薄厚度的 DBC，具有更低的热阻，以及更好的热耗散能力。



❒ Key Features

- Full-bridge Module
- Low V_{CEsat}
- Ultra low conduction and switching Loss
- Integrated NTC temperature sensor
- Direct Cooled Base Plate

❒ 关键特性

- 全桥模块
- 低导通压降
- 低导通和开关损耗
- 集成温度传感器
- 直接水冷基板

❒ Applications

- Automotive Application
- Inverters
- Motor Drives

❒ 应用

- 汽车应用
- 逆变器
- 电机驱动

❒ IGBT/IGBT

● Maximum Rated Values/最大额定值

Symbol	Items	Conditions	Values	Units
V_{CES}	Collector-emitter voltage 集电极-发射极电压	T_{vj} = 25℃	750	V
I_{CN}	Implemented collector current 集电极电流	-	600	A
I_{C_nom}	Continuous DC Collector current 连续集电极直流电流	T_F = 65℃, T_{vj} = 175℃	400	A
V_{GES}	Gate-emitter peak voltage 栅极-发射极峰值电压	T_{vj} = 25℃	±20	V
I_{CRM}	Repetitive peak collector current 集电极重复峰值电流	Pluse, t_p = 1 ms, T_{vj} = 25℃	1200	A
P_{tot}	Total power dissipation 总耗散功率	T_F = 65℃,T_{vjmax} = 175℃	688	W

● Characteristics Values/特征值

Symbol	Items	Conditions		Values			Units
				Min.	Typ.	Max.	
$V_{CE\ sat}$	Collector-Emitter Saturation Voltage 集电极-发射极饱和电压	I_C = 400A, V_{GE} = 15V	T_{vj} = 25℃	-	1.7	-	V
		I_C = 400A, V_{GE} = 15V	T_{vj} = 150℃	-	2.08	-	V
		I_C = 400A, V_{GE} = 15V	T_{vj} = 175℃	-	2.15	-	V
		I_C = 600A, V_{GE} = 15V	T_{vj} = 25℃	-	2.11	-	V
		I_C = 600A, V_{GE} = 15V	T_{vj} = 150℃	-	2.82	-	V
		I_C = 600A, V_{GE} = 15V	T_{vj} = 175℃	-	3.00	-	V
V_{GEth}	Gate threshold voltage 栅极阈值电压	V_{CE} = V_{GE}, I_C = 3.2mA	T_{vj} = 25℃	4.9	5.8	6.5	V
Q_G	Gate charge 栅极电荷	V_{GE} = -8V…+15V	-	-	4.4	-	uC
R_{gint}	Internal gate resistance 内部栅极电阻	-	T_{vj} = 25℃	-	1.2	-	Ω
I_{SC}	SC data 短路数据	V_{GE} = 15 V, V_{CC} = 400 V V_{CEmax} = V_{CES} - L_{sCE} ·di/dt	$T_P \leq$ 8 μs T_{vj} = 25℃	-	3000	-	A
			$T_P \leq$ 6 μs T_{vj} = 150℃	-	2600	-	A

Symbol	Items	Conditions		Values			Units
				Min.	Typ.	Max.	
C_{ies}	Input capacitance 输入电容	f = 100KHz, V_{CE} = 50V, V_{GE} = 0V	T_{vj} = 25℃	-	26.25	-	nF
C_{oes}	Output capacitance 输出电容			-	0.91	-	nF
C_{res}	Reverse capacitance 反向传输电容			-	0.13	-	nF
I_{CES}	C-E cut-off current 集电极-发射极截止电流	V_{CE} = 750V, V_{GE} = 0V,	T_{vj} = 25℃	-	-	1.0	mA
I_{GES}	G-E leakage current 栅极-发射极漏电流	V_{CE} = 0V, V_{GE} = 20V,	T_{vj} = 25℃	-	-	400	nA
$t_{d\ on}$	Turn-on delay time 开通延迟时间	I_C = 400 A, V_{CE} = 450 V V_{GE} = -8V…+15 V R_{Gon} = 2.5 Ω, R_{Goff} = 20 Ω, L_s = 30 nH	T_{vj} = 25℃	-	177.7	-	ns
			T_{vj} = 150℃	-	206.4	-	ns
			T_{vj} = 175℃	-	212.1	-	ns
t_r	Rise time 上升时间		T_{vj} = 25℃	-	68	-	ns
			T_{vj} = 150℃	-	85.2	-	ns
			T_{vj} = 175℃	-	88.6	-	ns
E_{on}	Turn-on energy loss 开通损耗能量		T_{vj} = 25℃	-	13.69	-	mJ
			T_{vj} = 150℃	-	16.72	-	mJ
			T_{vj} = 175℃	-	17.32	-	mJ
$t_{d\ off}$	Turn-off delay time, 关断延迟时间		T_{vj} = 25℃	-	807	-	ns
			T_{vj} = 150℃	-	897	-	ns
			T_{vj} = 175℃	-	915	-	ns
t_f	Fall time 下降时间		T_{vj} = 25℃	-	63.2	-	ns
			T_{vj} = 150℃	-	139.5	-	ns
			T_{vj} = 175℃	-	154.8	-	ns
E_{off}	Turn-off energy loss 关断损耗能量		T_{vj} = 25℃	-	20.12	-	mJ
			T_{vj} = 150℃	-	31.91	-	mJ
			T_{vj} = 175℃	-	34.26	-	mJ

❒ FRD/二极管

● Maximum Rated Values/最大额定值

Symbol	Items	Conditions	Values	Units
V_{RRM}	Repetitive peak reverse voltage 反向重复峰值电压	T_{vj} = 25℃	750	V
I_{FN}	Implemented forward current 正向直流电流	-	600	A
I_F	Continuous DC Forward current 连续正向直流电流	-	400	A

I_{FRM}	Repetitive peak forward current 正向重复峰值电流	Pluse, t_P = 1ms, T_{vj} = 25℃	1200	A
I^2t	I^2t – value I^2t -值	V_R=0V； t_P = 10 ms, T_{vj} = 125°C	18000	A^2s
		V_R=0V； t_P = 10 ms, T_{vj} = 150°C	16000	A^2s

● Characteristics Values/特征值

Symbol	Items	Conditions		Values			Units
				Min.	Typ.	Max.	
V_F	Forward voltage 正向电压	I_F =400A, V_{GE} = 0V	T_{vj} = 25℃	-	1.28	-	V
			T_{vj} = 150℃	-	1.17	-	V
			T_{vj} = 175℃	-	1.12	-	V
I_{RM}	Peak reverse recovery current 反向恢复峰值电流	I_F = 400 A, V_R = 450 V, -di/dt = 4500 A/us, V_{GE} = -8V…+15V, L_s =30nH	T_{vj} = 25℃	-	215.3	-	A
			T_{vj} = 150℃	-	219.8	-	A
			T_{vj} = 175℃	-	220.7	-	A
Q_r	Recovered charge 恢复电荷		T_{vj} = 25℃	-	17.09	-	uC
			T_{vj} = 150℃	-	28.35	-	uC
			T_{vj} = 175℃	-	30.6	-	uC
E_{rec}	Reverse recovery energy 反向恢复损耗		T_{vj} = 25℃	-	5.48	-	mJ
			T_{vj} = 150℃	-	9.98	-	mJ
			T_{vj} = 175℃	-	10.88	-	mJ

❒ Module/模块

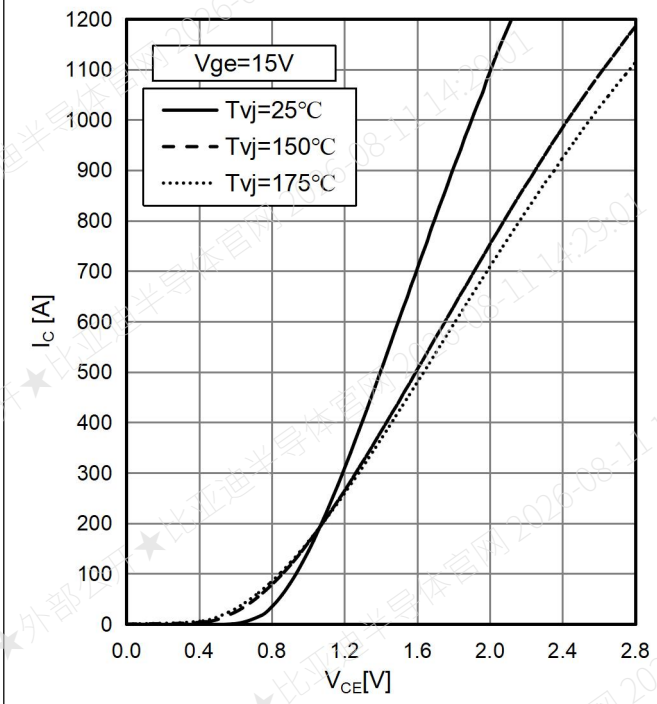
Symbol	Items	Conditions	Values			Units
			Min.	Typ.	Max.	
T_{vjmax}	Maximum junction temperature 最大结温	-	-	-	175	℃
T_{vjop}	Temperature under switching conditions 工作结温	-	-40	-	150	℃
T_{stg}	Storage temperature 储存温度	-	-40	-	125	℃
$R_{thjF\ IGBT}$	Thermal resistance, junction to cooling fluid 结-冷却液热阻	per IGBT $\Delta V/\Delta t$=10dm^3/min; T_F=45℃	-	0.16	-	K/W
$R_{thjF\ Diode}$	Thermal resistance, junction to cooling fluid 结-冷却液热阻	per diode $\Delta V/\Delta t$=10dm^3/min; T_F=45℃	-	0.25	-	K/W
L_{sCE}	Stray inductance module 杂散电感,模块	-	-	8.3	-	nH

$R_{CC'+EE'}$	Module lead resistance, terminals - chip 模块引线电阻,端子-芯片	T_{vj} = 25℃， per switch	-	1	-	mΩ
V_{isol}	Isolation test voltage 绝缘测试电压	RMS, f = 50Hz, t = 30s.	3.8	-	-	KV
d_{Creep}	Creepage distance 爬电距离	Terminal to terminal 端子到端子	-	11.6	-	mm
		Terminal to heatsink 端子到底板	-	10.3	-	
d_{Clear}	Clearance 电气间隙	Terminal to terminal 端子到端子	-	5.2	-	
		Terminal to heatsink 端子到底板	-	6.8	-	
M_1	Mounting torque for module mounting 模块的安装扭距	Screw M4 baseplate to heatsink M4 螺栓固定底板	1.8	2.0	2.2	N.m
		Screw EJOT Delta PCB to frame EJOT 螺栓固定 PCB	0.45	0.50	0.55	
M_2	Terminal connection torque 端子的连接扭距	Screw M5 M5 螺栓	3	-	6	N.m
	Internal isolation 内部绝缘	ceramics 陶瓷	Al_2O_3			-
	Material of module baseplate 模块基板材料	-	Cu+Ni			-
L x W x H	Dimensions 尺寸	-	143.5×132.8×21.8			mm
m	Weight 重量	-	588			g
CTI	Comparative tracking index 相对电痕指数	-	≥175			-

❒ NTC-Thermistor/负温度系数热敏电阻

Symbol	Items	Conditions	Values			Units
			Min.	Typ.	Max.	
R_{25}	Rated resistance 额定电阻值	T_C = 25℃	-	5.0	-	KΩ
△R/R	Deviation of R100 R100 偏差	T_C = 100℃，R_{100} = 493Ω	-5	-	5	%
P_{25}	Power dissipation 耗散功率	T_C = 25℃	-	-	20	mW
$B_{25/50}$	B-value/B-值	$R_2 = R_{25}\exp[B_{25/50}(1/T_2-1/(298.15K))]$	-	3375	-	K
$B_{25/80}$	B-value/ B-值	$R_2 = R_{25}\exp[B_{25/80}(1/T_2-1/(298.15K))]$	-	3411	-	K
$B_{25/100}$	B-value/ B-值	$R_2 = R_{25}\exp[B_{25/100}(1/T_2-1/(298.15K))]$	-	3433	-	K

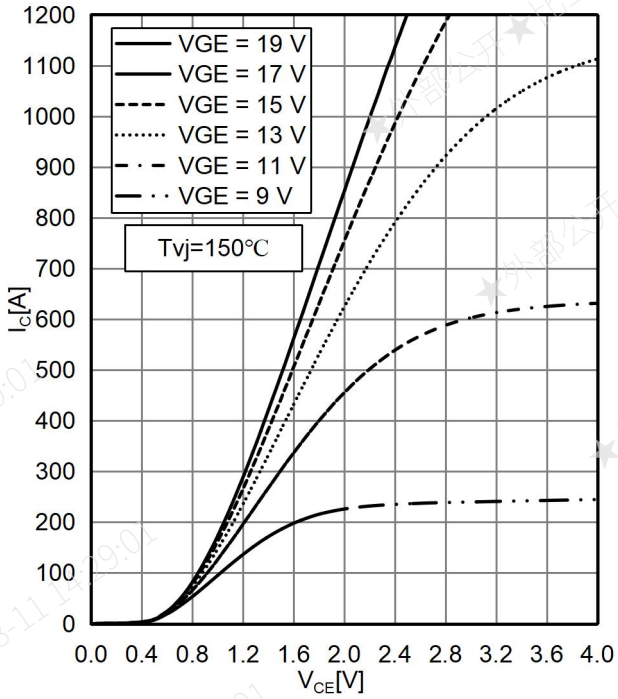
❒ Characteristics Diagrams/特性曲线



V_{GE} = 15V, I_C = f (V_{CE})

Fig.1:On-state Characteristics

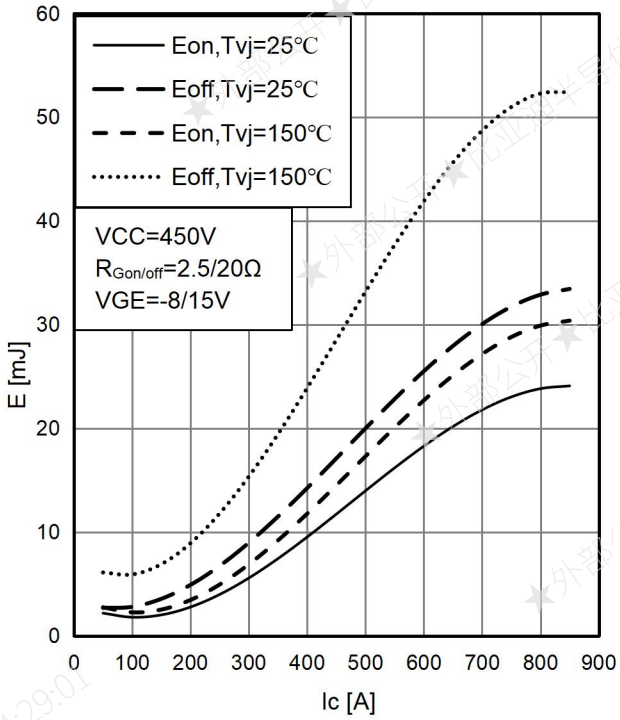
图 1：通态特性



T_{vj} = 150℃

Fig.2:Output characteristics

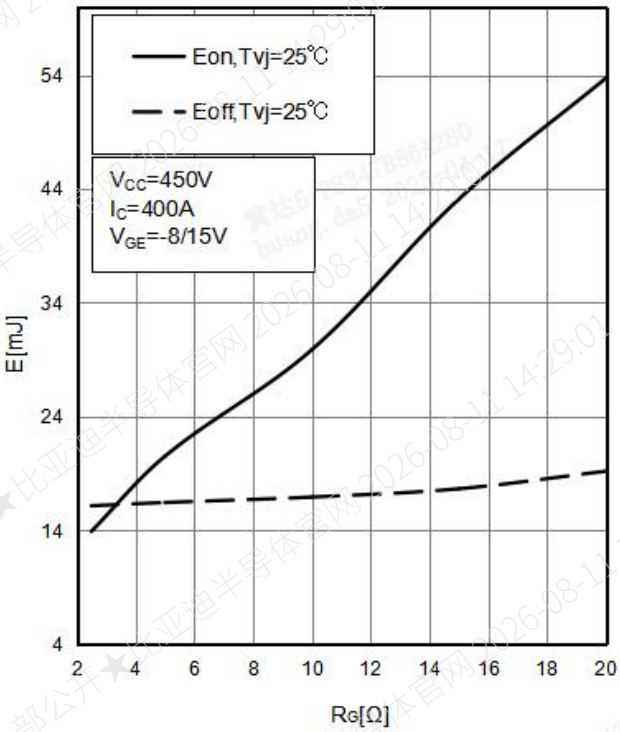
图 2：输出特性



V_{GE} = 15 V, R_{Gon} /R_{Goff} =2.5/20 Ω, V_{CE} = 450V

Fig.3: Switching Loss vs. Collector Current

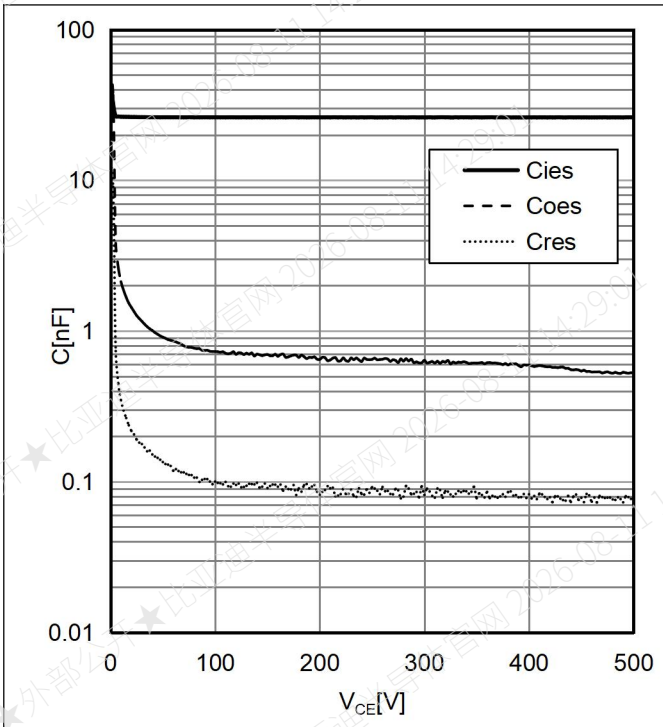
图 3：开关损耗与集电极电流关系



V_{GE} = 15 V, I_C =400 A, V_{CE} =450 V, T_{vj} = 25℃

Fig.4: Switching Loss vs. Gate Resistor

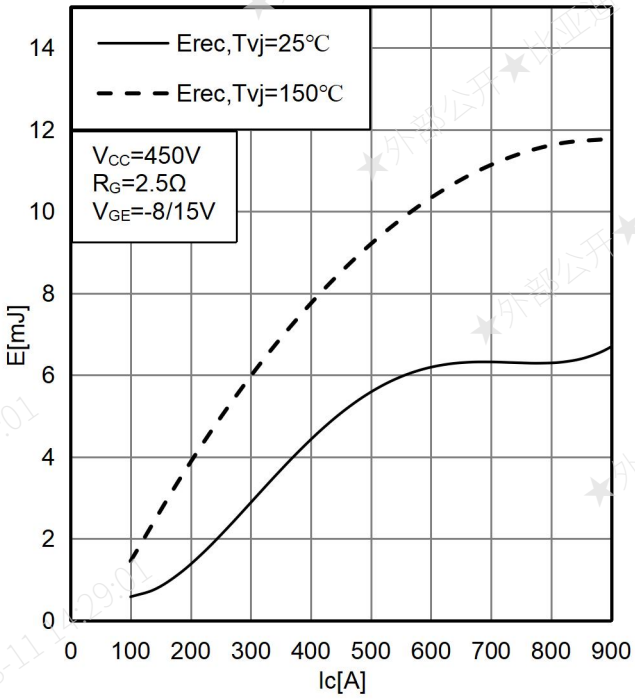
图 4：开关损耗与门极电阻关系



V_{CC}= V, I_C = A, V_{GE} = V, T_{vj} = ℃

Fig.5: Parasitic Capacitance vs. Vce

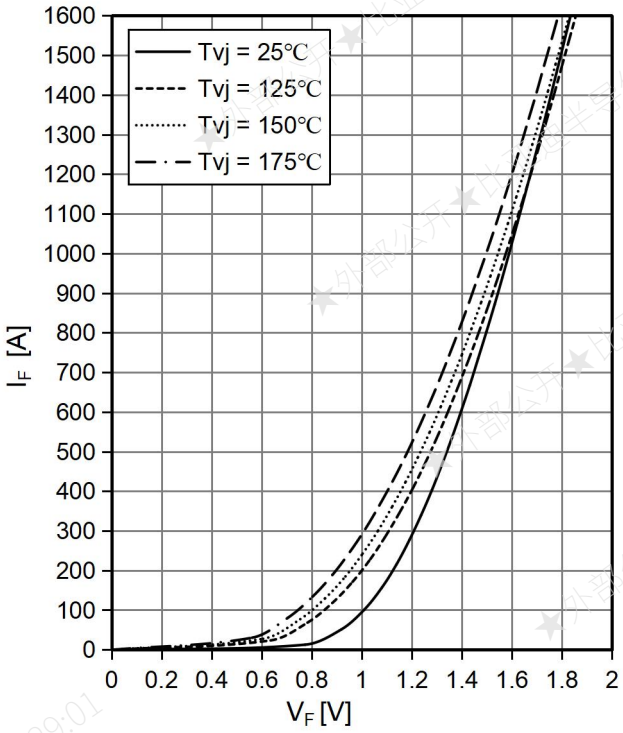
图 5：寄生电容随 Vce 变化曲线



R_{Gon} = 2.5Ω , V_{CE} = 450V

Fig.6: Reverse recovery Energy

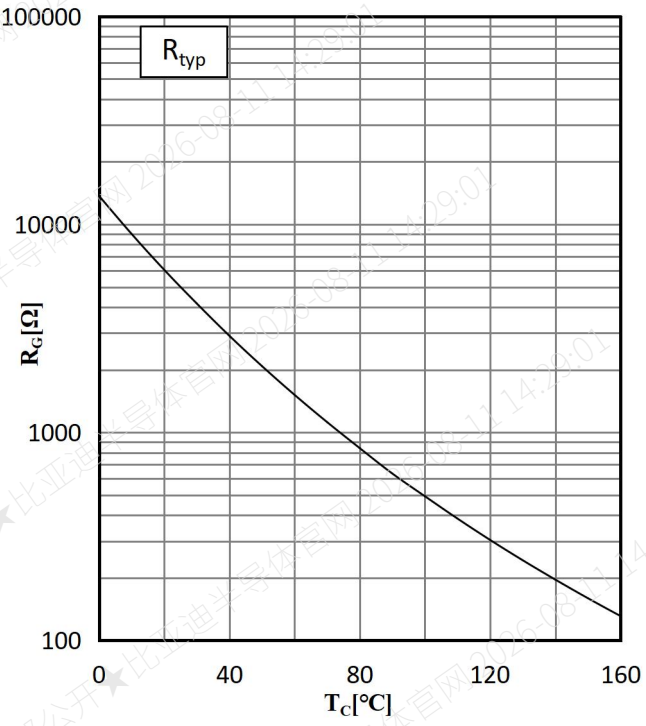
图 6：反向恢复损耗



$I_F = f(V_F)$

Fig.7: Forward characteristic

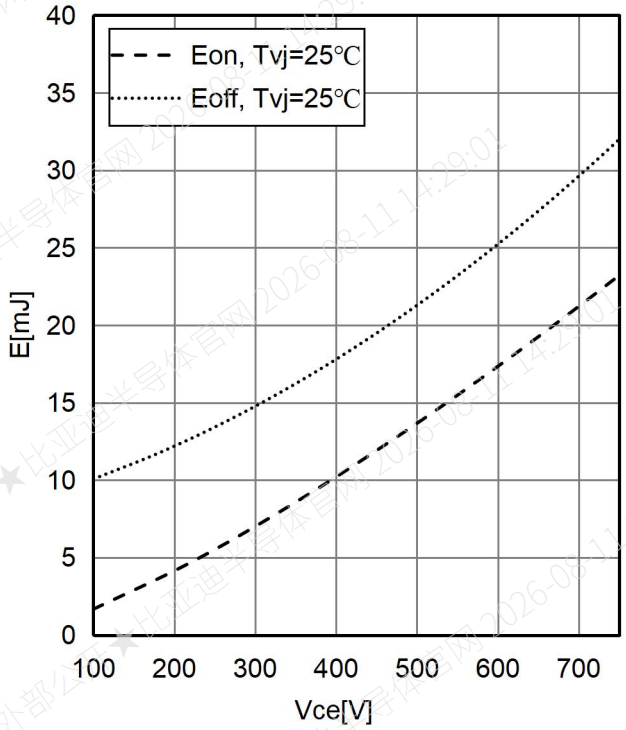
图 7：正向特性



R = f (T)

Fig.8: Typ. NTC-Temperature Characteristics

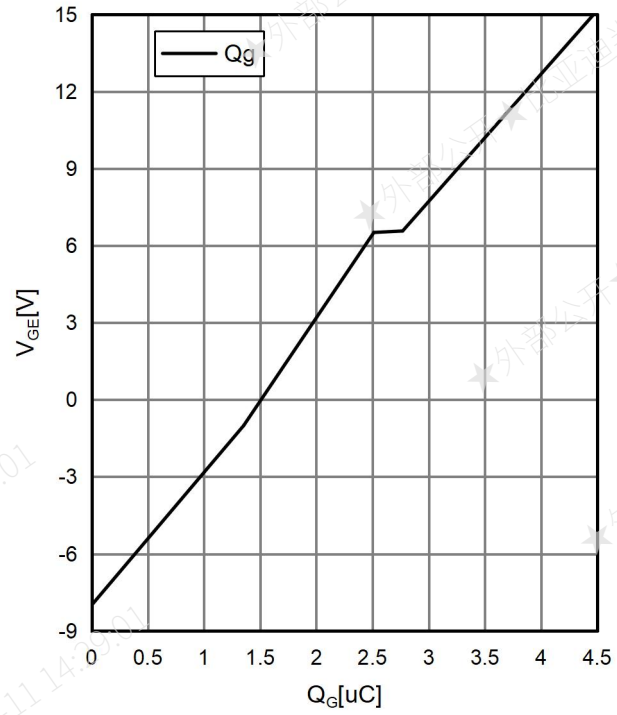
图 8：典型的 NTC 电阻-温度特性



V_{GE} =-8/15 V,I_C = 400A, V_{GE} = 15 V, R_{Gon} /R_{Goff} = 2.5/20Ω

Fig.9: Switching L vs. V_{CC}

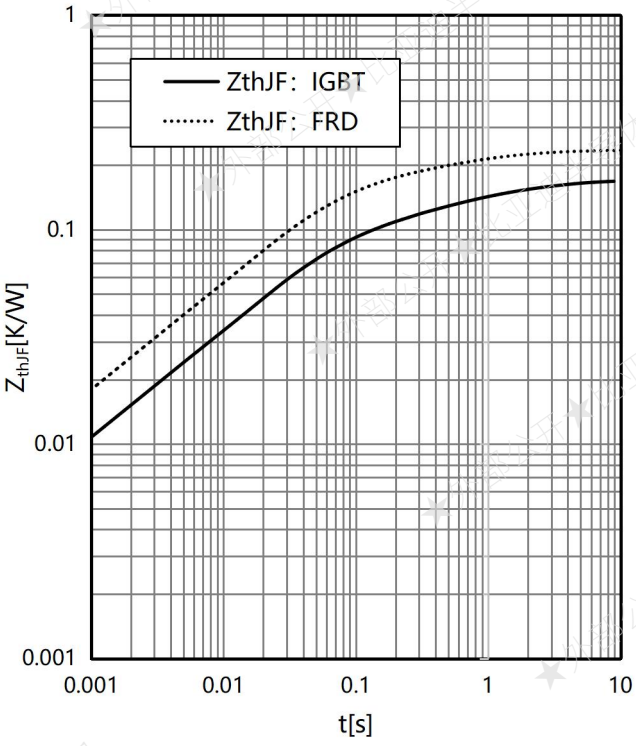
图 9：开关损耗随母线电压曲线.



R_G = 20Ω, T_{vj} =25℃

Fig.10: Gate Charge vs. Gate Voltage

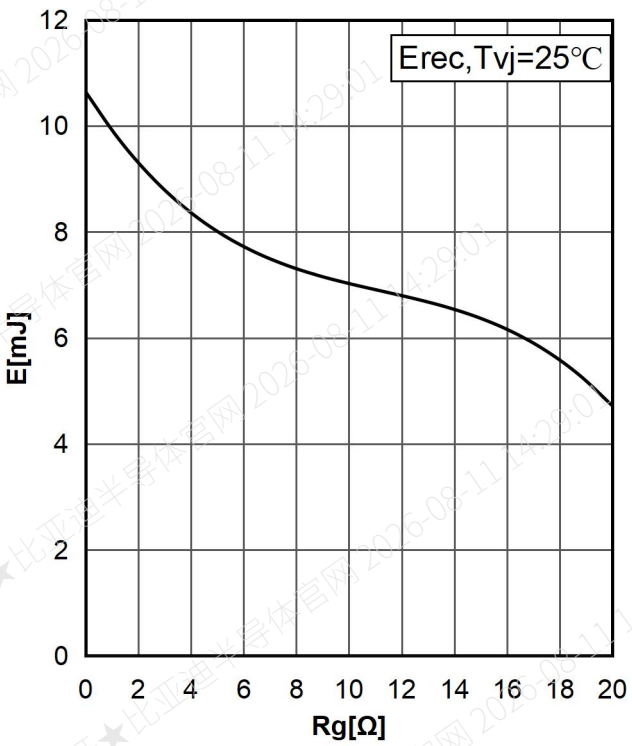
图 10：门极电荷与门极电压曲线



Z_{thJF} = f (t)

Fig.11: IGBT transient thermal impedance

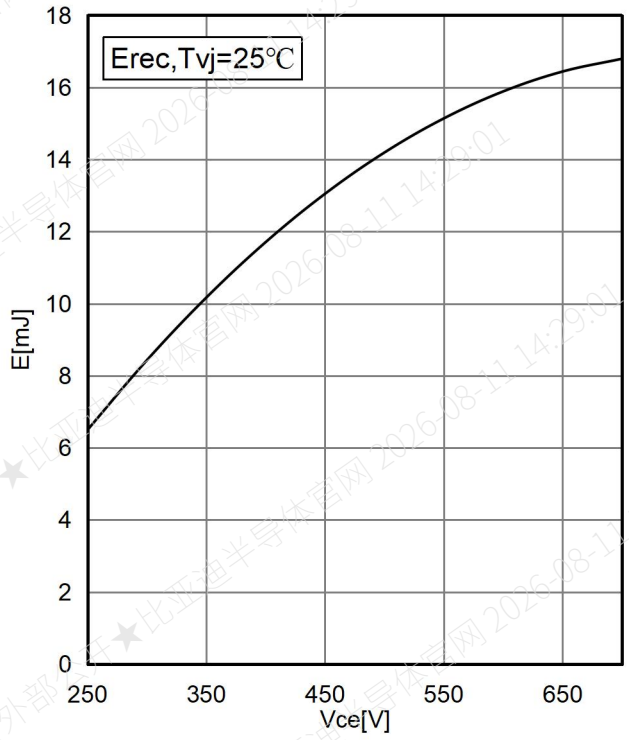
图 11：瞬态热阻抗



V_{CE} = 450V

Fig.12: Reverse recovery Energy vs. Gate Resistance

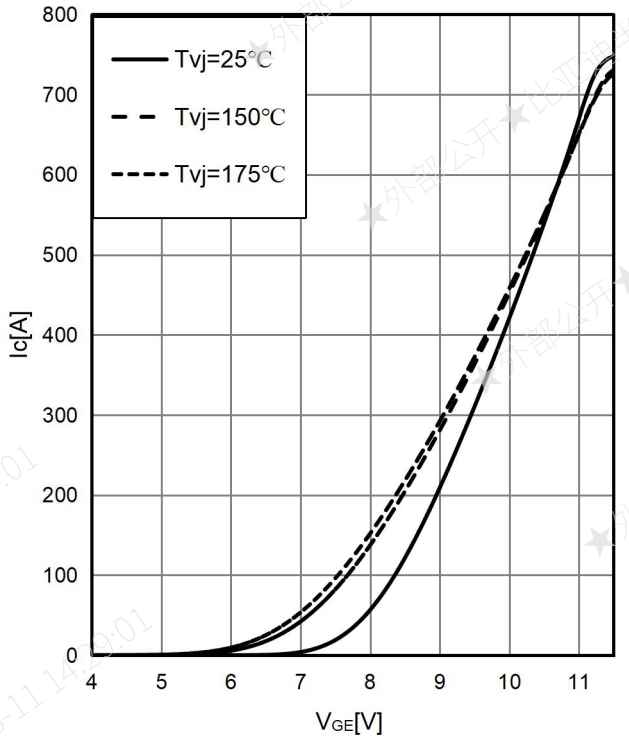
图 12：反向恢复损耗随门极电阻变化曲线



I_F=400A,

Fig.13: Reverse recovery Energy vs. V_{cc}

图 13：反向恢复损耗随母线电压变化曲线

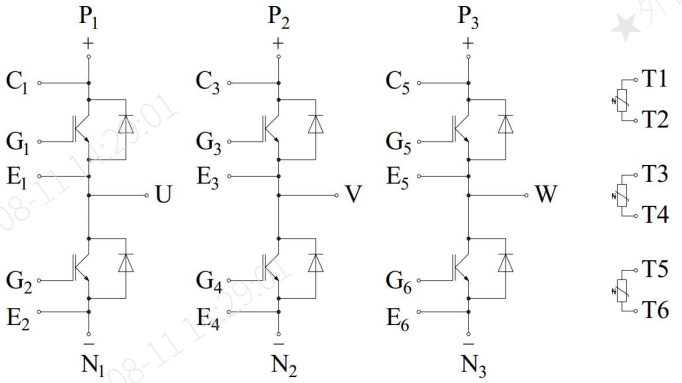


$I_C = f(V_{GE})$

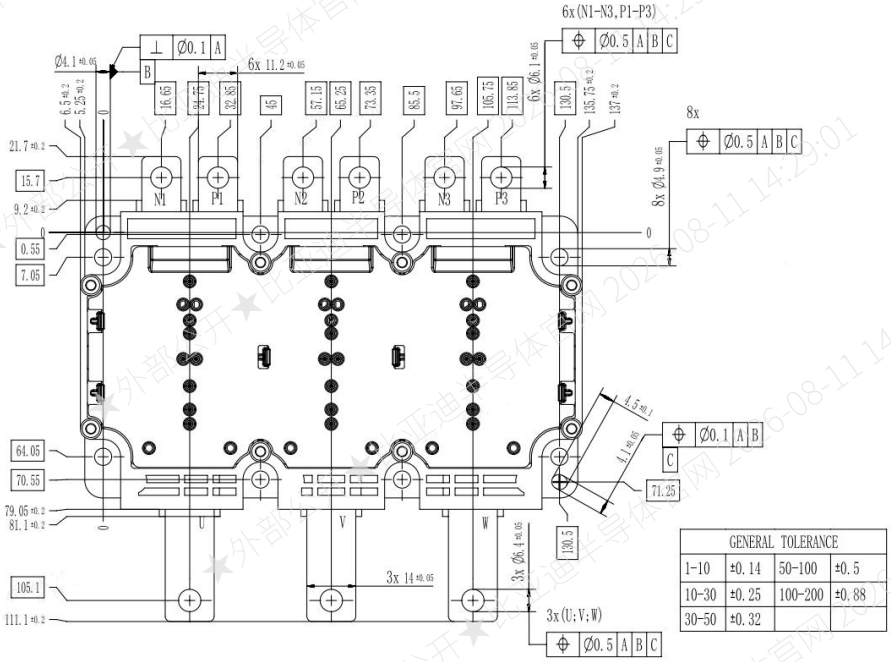
Fig.14: IGBT Transfer Characteristics

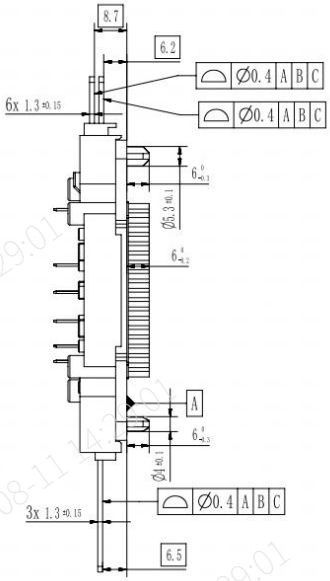
图 14：转移特性曲线

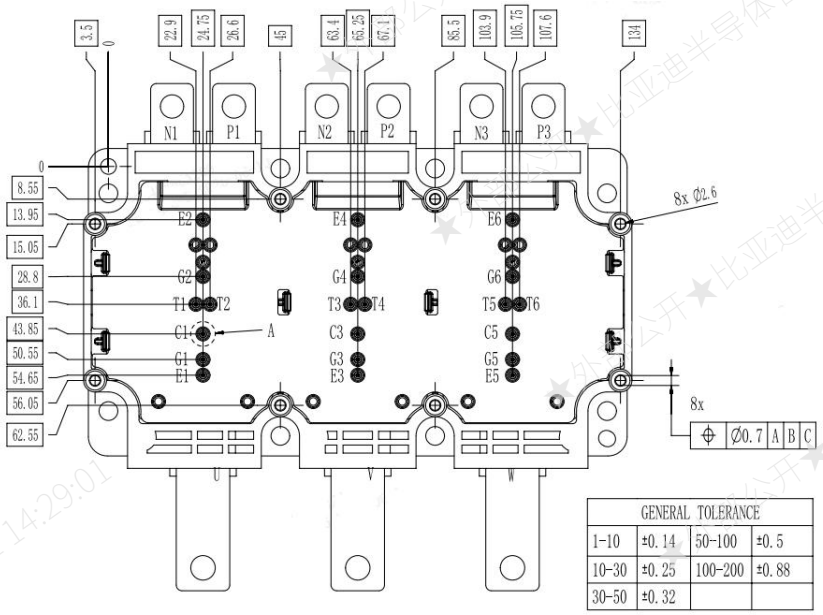
❒ Circuit Diagram/接线图

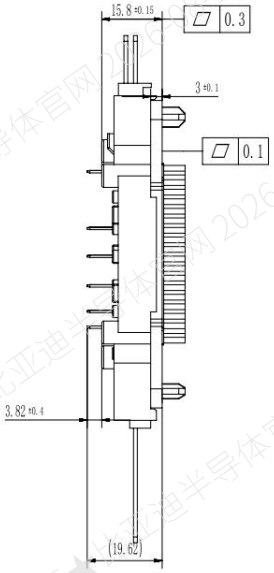


❒ Package outlines/封装尺寸









❒ Attention

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 BYD's IGBT modules according to the guidance.

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.

Storage:

• The temperature and humidity of the storage place should be 5~35°C and 45~75% 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.

Prolonged Storage:

• When using devices after prolonged storage, dehumidifying measures should be provided for the storage place,please inspect them to ensure there are no scratches, dust, rust, or other defects on the surface.

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.

Anti-electrostatic Measures:

• Following precautions should be taken for gated devices to prevent static buildup which could damage the devices. Precautions against the device rupture caused by static electricity

* Static electricity of human bodies and cartons and/or excessive voltage applied across the gate to emitter may damage and rupture devices. Sense-emitter 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.

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

* Signal terminals to emitter 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.

* Always ground the equipment and your body during installation (after removing a carbon cloth or the like). It is advisable to cover the workstation and its surrounding floor with conductive mats and ground them.

* Use soldering irons with grounded tips.

❒ 警示

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比亚迪IGBT模块。

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。

贮存：

• 贮存地点温度与湿度应分别控制在5~35° C和45~75%。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。

长期贮存：

• 器件经过长期存放使用时，贮存地点应当采取去湿措施，检查器件确保外观没有刮伤，灰尘，锈迹等。

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。

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，预防措施可以防止静电击穿器件。

* 门极与发射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。

* 不要用易受静电影响的容器运输或贮存器件。

* 发射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。

* 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触地面。

* 使用接地的烙铁头。

免责声明

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