

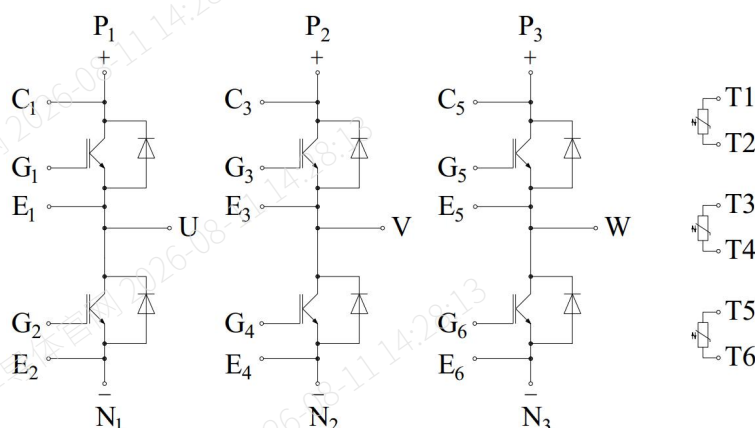
General Description

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

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IGBT/IGBT

Maximum Rated Values/最大额定值

Symbol	Parameter	Conditions	Values	Units
V_{CES}	Collector-emitter voltage 集电极-发射极电压	$T_{vj} = 25^{\circ}\text{C}$	750	V
I_{CN}	Implemented Collector current 集电极电流	$T_{vj} = 25^{\circ}\text{C}$	400	A
$I_{C\text{ nom}}$	Continuous DC Collector current 连续集电极直流电流	$T_F = 65^{\circ}\text{C}, T_{vj} = 150^{\circ}\text{C}$	315	A
V_{GES}	Gate-emitter peak voltage 栅极-发射极峰值电压	$T_{vj} = 25^{\circ}\text{C}$	+/- 20	V
I_{CRM}	Repetitive peak collector current 集电极重复峰值电流	Pulse, $t_p = 1\text{ms}$, $T_{vj} = 25^{\circ}\text{C}$	800	A
P_{tot}	Total power dissipation 总耗散功率	$T_F = 65^{\circ}\text{C}, T_{vj} = 150^{\circ}\text{C}$	433	W

Characteristics Values/特征值

Symbol	Items	Conditions		Values			Units
				Min.	Typ.	Max.	
$V_{CE\text{ sat}}$	Collector-emitter saturation voltage 集电极-发射极饱和电压	$I_C = 400\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 25^{\circ}\text{C}$		1.57		V
		$I_C = 400\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 125^{\circ}\text{C}$		1.79		V
		$I_C = 400\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 150^{\circ}\text{C}$		1.85		V
		$I_C = 600\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 25^{\circ}\text{C}$		1.71		V
		$I_C = 600\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 125^{\circ}\text{C}$		1.95		V
		$I_C = 600\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 150^{\circ}\text{C}$		2.02		V
$V_{GE\text{ th}}$	Gate threshold voltage 栅极阈值电压	$V_{CE} = V_{GE}, I_C = 8\text{mA}$	$T_{vj} = 25^{\circ}\text{C}$	5.0	5.67	7.0	V
Q_G	Gate charge 栅极电荷	$V_{GE} = -8\text{V} \dots +15\text{V}$			0.4		uC
$R_{G\text{int}}$	Internal gate resistance 内部栅极电阻		$T_{vj} = 25^{\circ}\text{C}$		5.0		Ω
C_{ies}	Input capacitance 输入电容	$f = 100\text{kHz},$ $V_{GE} = 0\text{V},$	$T_{vj} = 25^{\circ}\text{C}$		9		nF

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C _{oes}	Output capacitance 输出电容	V _{CE} = 100V			0.203	nF
C _{res}	Reverse capacitance 反向传输电容				0.038	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℃		600	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 = 30nH	T _{vj} = 25℃		154	ns
			T _{vj} = 125℃		177	ns
			T _{vj} = 150℃		177	ns
t _r	Rise time 上升时间		T _{vj} = 25℃		166	ns
			T _{vj} = 125℃		195	ns
			T _{vj} = 150℃		196	ns
E _{on}	Turn-on energy loss 开通损耗能量		T _{vj} = 25℃		35.4	mJ
			T _{vj} = 125℃		43.4	mJ
			T _{vj} = 150℃		46.7	mJ
t _{d off}	Turn-off delay time, 关断延迟时间		T _{vj} = 25℃		590	ns
			T _{vj} = 125℃		629	ns
			T _{vj} = 150℃		635	ns
t _f	Fall time 下降时间	T _{vj} = 25℃		103	ns	
		T _{vj} = 125℃		101	ns	
		T _{vj} = 150℃		106	ns	
E _{off}	Turn-off energy loss 关断损耗能量	T _{vj} = 25℃		22.2	mJ	
		T _{vj} = 125℃		29.7	mJ	
		T _{vj} = 150℃		30.3	mJ	
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 ≤ 6 μs T _{vj} = 25℃		1600	A
		T _P ≤ 6 μs T _{vj} = 150℃		1000	A	

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□ 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	$T_{vj} = 25^{\circ}\text{C}$	750	V
I_{FN}	Implemented forward current 正向直流电流		400	A
I_F	Continuous DC forward current 连续正向直流电流		315	A
I_{FRM}	Repetitive peak forward current 正向重复峰值电流	Pulse, $t_P = 1\text{ms}$, $T_{vj} = 25^{\circ}\text{C}$	800	A
I^2t	I^2t – value I^2t -值	$V_R=0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 125^{\circ}\text{C}$ $V_R=0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150^{\circ}\text{C}$	11250 9200	A^2s A^2s

● Characteristics Values/特征值

Symbol	Items	Conditions	Values			Units
			Min.	Typ.	Max.	
V_F	Forward voltage 正向电压	$I_F = 400\text{A}$, $V_{GE} = 0\text{V}$		1.5		V
		$I_F = 400\text{A}$, $V_{GE} = 0\text{V}$		1.59		V
		$I_F = 400\text{A}$, $V_{GE} = 0\text{V}$		1.63		V
		$I_F = 600\text{A}$, $V_{GE} = 0\text{V}$		1.75		V
		$I_F = 600\text{A}$, $V_{GE} = 0\text{V}$		1.87		V
		$I_F = 600\text{A}$, $V_{GE} = 0\text{V}$		1.91		V
I_{RM}	Peak reverse recovery current 反向恢复峰值电流	$T_{vj} = 25^{\circ}\text{C}$		57		A
		$T_{vj} = 125^{\circ}\text{C}$		77.2		A
		$T_{vj} = 150^{\circ}\text{C}$		85.4		A
Q_r	Recovered charge 恢复电荷	$V_{GE} = -8\text{V} \dots +15\text{V}$ $R_{Gon} = 2.5\ \Omega$, $R_{Goff} = 20\ \Omega$, $L_s = 30\text{nH}$	$T_{vj} = 25^{\circ}\text{C}$	8		μC
			$T_{vj} = 125^{\circ}\text{C}$	16.4		μC
			$T_{vj} = 150^{\circ}\text{C}$	18.1		μC
E_{rec}	Reverse recovery	$T_{vj} = 25^{\circ}\text{C}$		1.4		mJ

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energy 反向恢复损耗		$T_{vj} = 125^{\circ}\text{C}$		5.5		mJ
		$T_{vj} = 150^{\circ}\text{C}$		5.1		mJ

□ 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
ΔR/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}	C-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

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□ Module/模块

Symbol	Items	Conditions	Values			Units
			Min.	Typ.	Max.	
T_{vjmax}	Maximum junction temperature 最大结温				175	°C
T_{vjop}	Temperature under switching conditions 工作结温		-40		150	°C
T_{stg}	Storage temperature 储存温度		-40		125	°C
$R_{thJF\ IGBT}$	Thermal resistance, junction to cooling fluid 结-冷却液热阻	per IGBT; $\Delta V/\Delta t=10\text{dm}^3/\text{min}$; $T_F=45^\circ\text{C}$		0.20		K/W
$R_{thJF\ Diode}$	Thermal resistance, junction to cooling fluid 结-冷却液热阻	per diode; $\Delta V/\Delta t=10\text{dm}^3/\text{min}$; $T_F=45^\circ\text{C}$		0.33		K/W
Δp	Pressure drop in cooling circuit 冷却回路中的压降	$\Delta V/\Delta t=10\text{dm}^3/\text{min}$; $T_F=45^\circ\text{C}$		61		mbar
p	Maximum pressure in cooling circuit(relative pressure)	$T_{baseplate}<40^\circ\text{C}$ $T_{baseplate}\geq 40^\circ\text{C}$			2.5 2.0	bar
L_{sCE}	Stray inductance module 杂散电感,模块			17		nH
$R_{CC'+EE'}$	Module lead resistance, terminals - chip 模块引线电阻,端子-芯片	$T_{vj}=25^\circ\text{C}$, per switch		1		mΩ
V_{isol}	Isolation test voltage 绝缘测试电压	RMS, $f=50\text{Hz}$, $t=30\text{s}$	2.5			KV
d_{Creep}	Creepage distance 爬电距离	Terminal to terminal 端子到端子		15.4		mm
		Terminal to base 端子到底板		22.2		
d_{Clear}	Clearance 电气间隙	Terminal to terminal 端子到端子		9		
		Terminal to base 端子到底板		15		
M_1	Mounting torque for modul mounting 模块的安装扭距	Screw M5 M5 螺栓	3		6	N.m
M_2	Terminal connection torque 端子的连接扭距	Screw M6 M6 螺栓	3		6	N.m



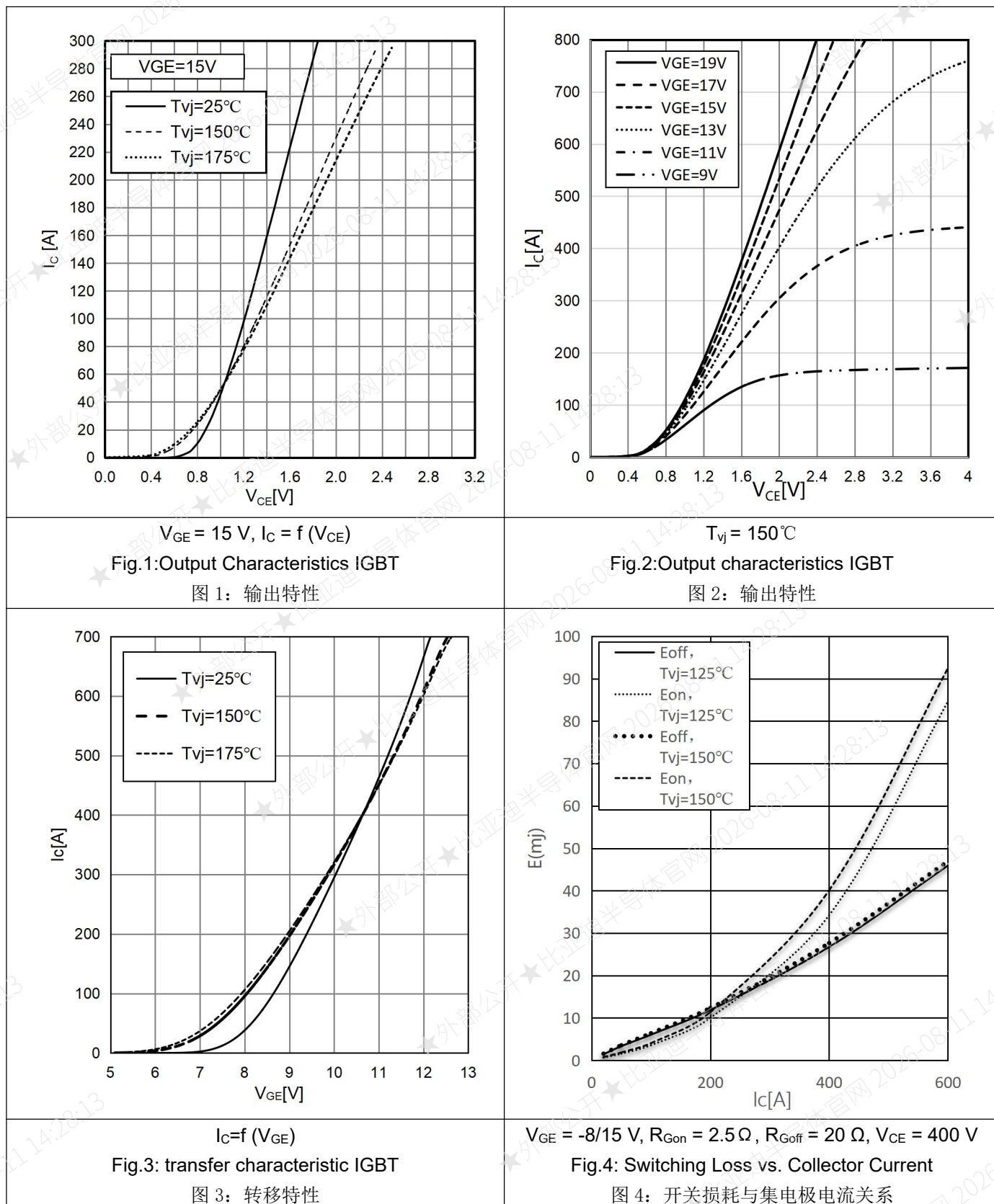
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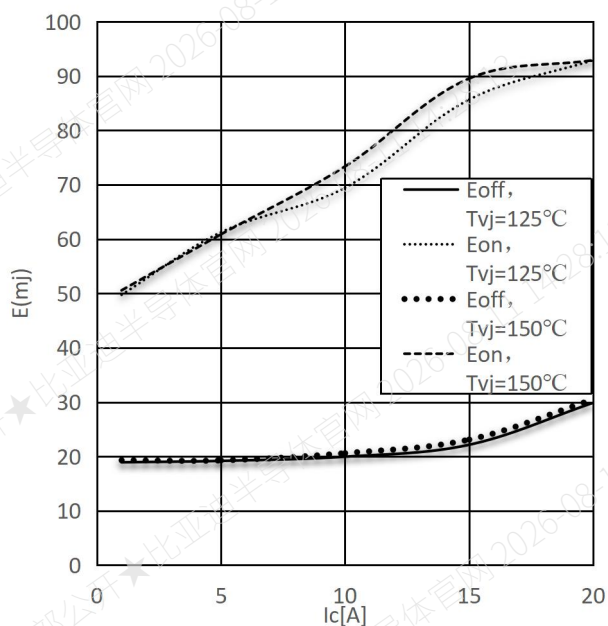
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	Internal isolation 内部绝缘	ceramics 陶瓷	Al ₂ O ₃	
	Material of module baseplate 模块基板材料		Cu+Ni	
L x W x H	Dimensions 尺寸		140×112.6×30.6	mm
m	Weight 重量		728	g
CTI	Comparative tracking index 相对电痕指数		>200	

□ Characteristics Diagrams/特性曲线

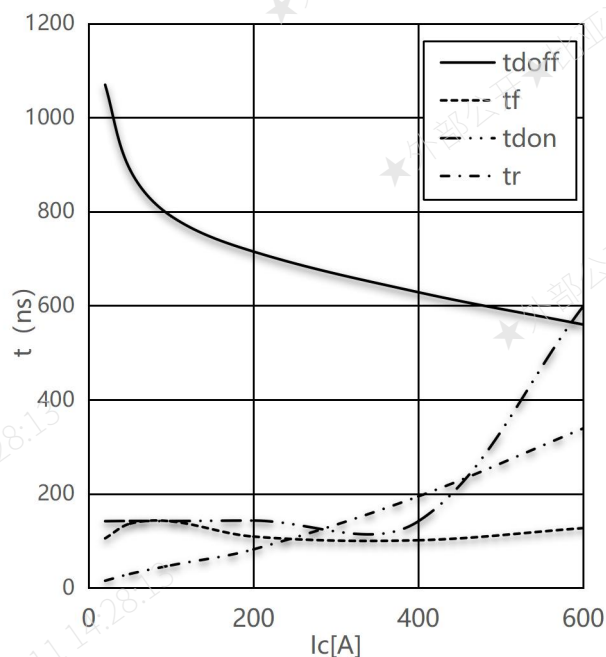


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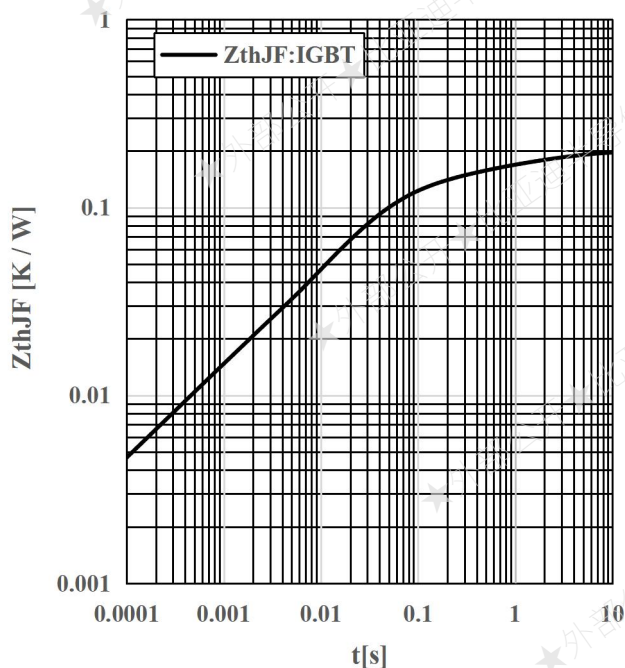
$V_{GE} = -8/15 \text{ V}$, $I_C = 400 \text{ A}$, $V_{CE} = 450 \text{ V}$
Fig.5: Switching Loss vs. Gate Resistor

图 5：开关损耗与门极电阻关系



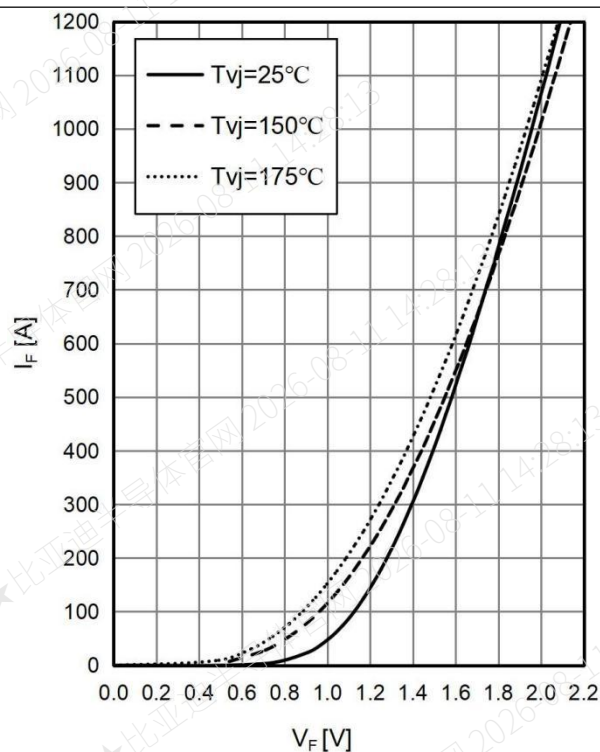
$V_{CE} = 450 \text{ V}$, $V_{GE} = -8/15 \text{ V}$, $R_G = 2.5/20 \Omega$, $T_{vj} = 125^\circ\text{C}$
Fig.6: Switching Times vs. I_C

图 6：开关时间与集电极电流关系



$Z_{thJF} = f(t)$, $\Delta V/\Delta t = 8 \text{ dm}^3/\text{min}$, $T_f = 45^\circ\text{C}$
Fig.7: Transient thermal impedance (IGBT) Z_{thJF}

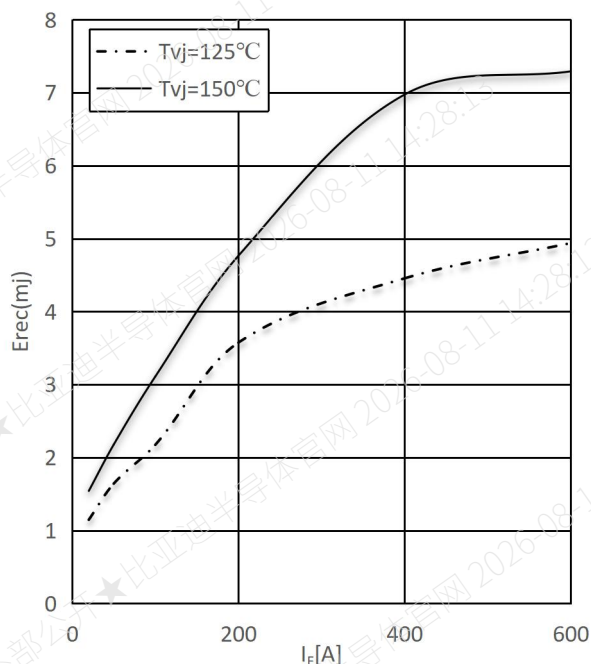
图 7：瞬态热阻抗(IGBT) Z_{thJF}



$I_F = f(V_F)$
Fig.8: Forward characteristic

图 8：正向特性

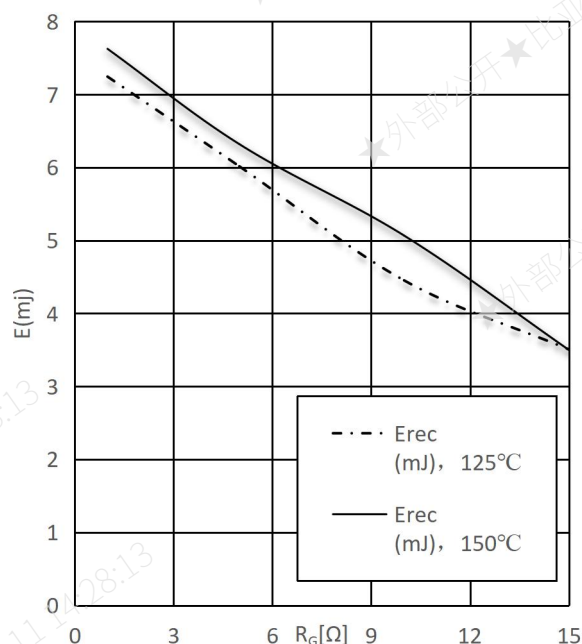
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$R_{Gon} = 2.5 \Omega$, $V_{CE} = 450 V$

Fig.9: Reverse recovery Energy

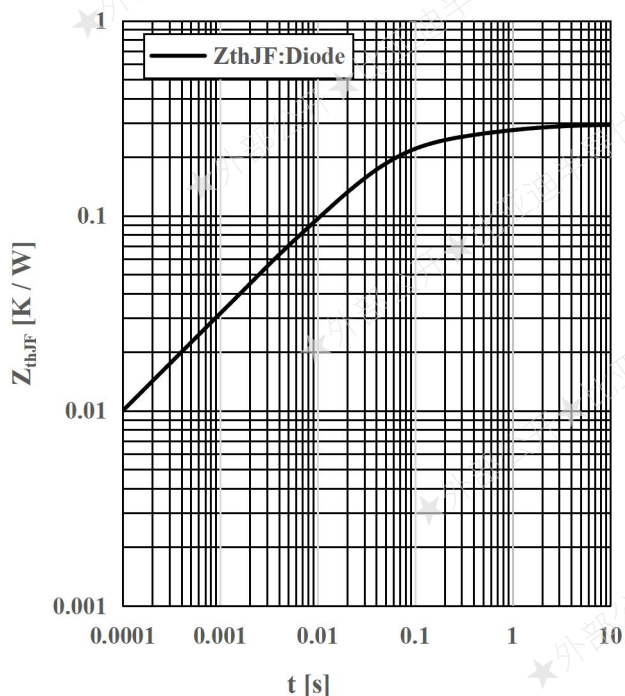
图 9: 反向恢复损耗



$I_F = 400A$, $V_{CE} = 450 V$

Fig.10: Reverse recovery Energy vs. Gate Resistor

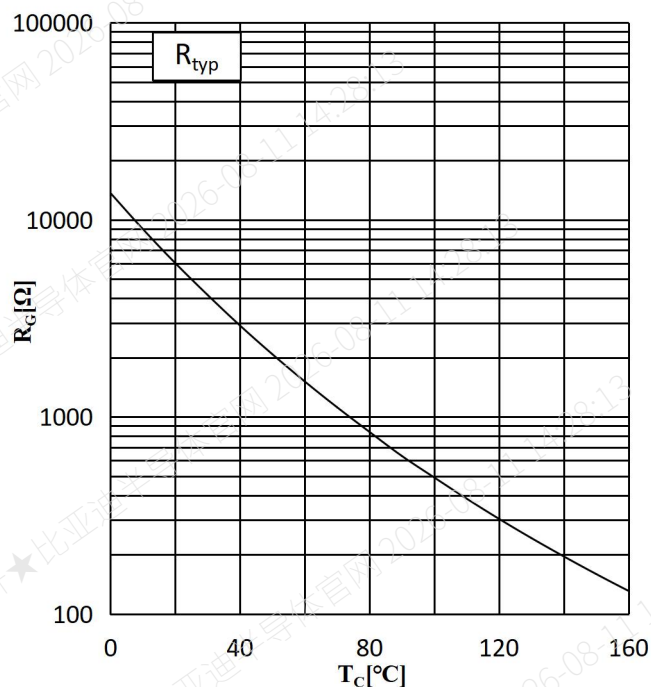
图 10: 反向恢复损耗与门极电阻的关系



$Z_{thJF} = f(t)$, $\Delta V/\Delta t = 8 \text{ dm}^3/\text{min}$, $T_f = 45^\circ\text{C}$

Fig.11: Transient thermal impedance (FRD) Z_{thJF}

图 11: 瞬态热阻抗(FRD) Z_{thJF}

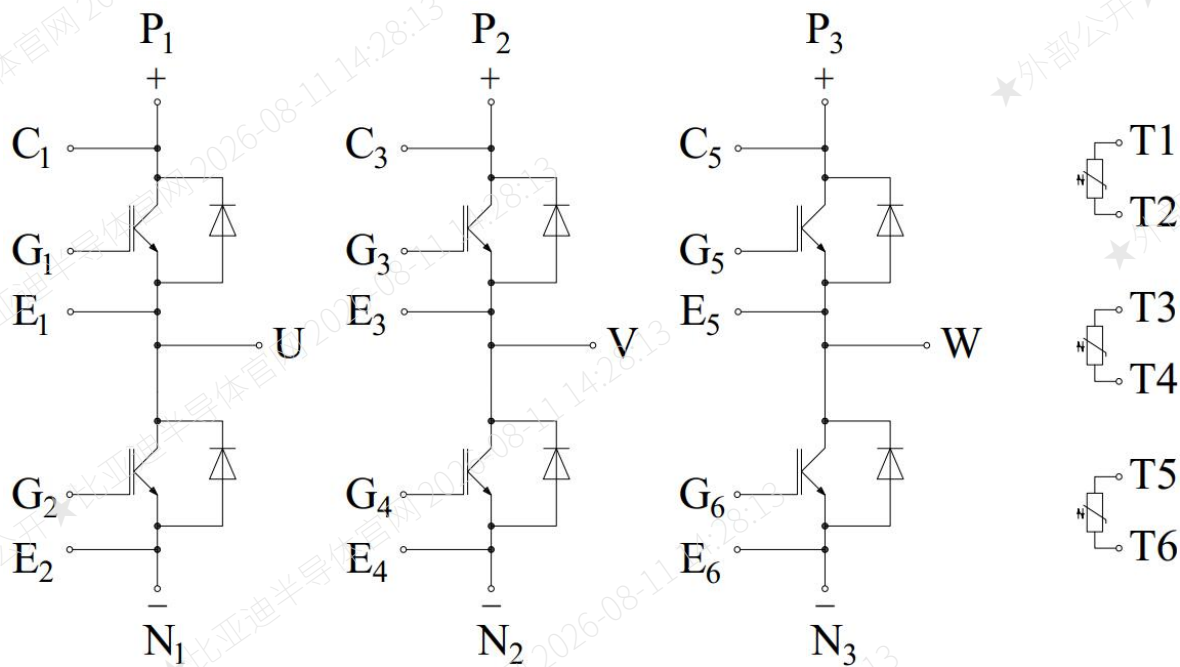


$R = f(T)$

Fig.12: Typ. NTC-Temperature Characteristics

图 12: 典型的 NTC 电阻-温度特性

□ **Circuit Diagram/接线图**



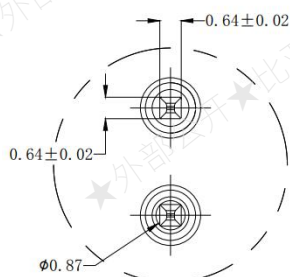
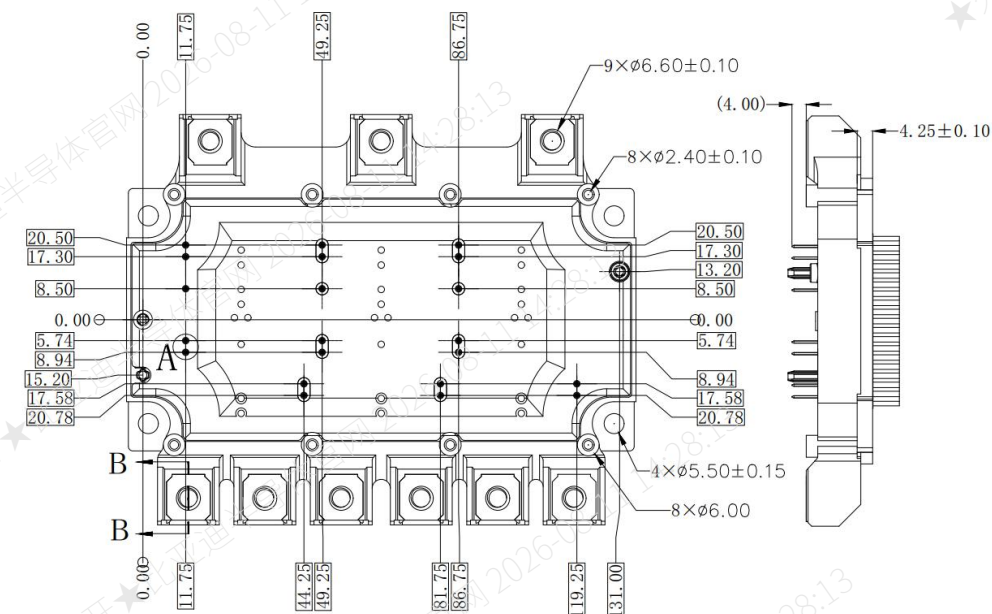
□ **Package outlines/封装尺寸**



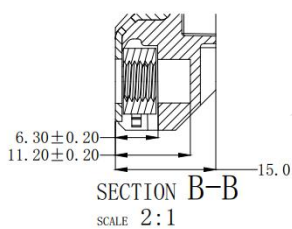
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DETAIL A
SCALE 10:1



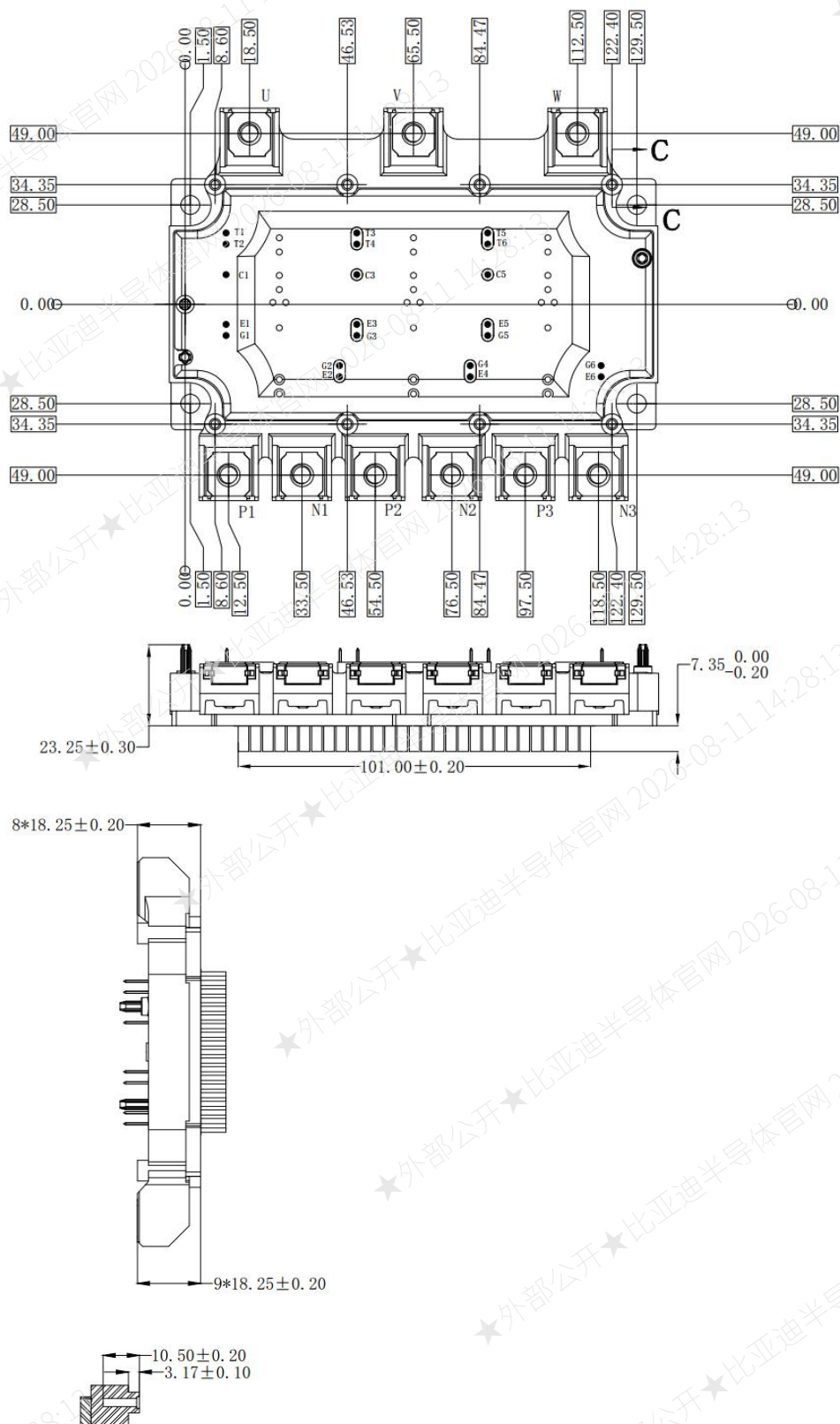
SECTION B-B
SCALE 2:1



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SECTION C-C

□ Attention / 警示

Correct and Safety Use of Power Module / 功率模块安全正确的使用方法:

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.

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。

During Transit / 运输过程:

- Tossing or dropping of a carton may damage devices inside.

包装箱颠簸或坠落可能导致内部器件损毁。

- 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.

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。

Storage / 存储:

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

贮存地点温度与湿度应分别控制在5~35°C和45~75%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。

Prolonged Storage / 长期存储:

- 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.

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。

Operating Environment / 应用环境:

- 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.

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。

Anti-electrostatic Measures / 防静电措施:

- Following precautions should be taken for gated devices to prevent static buildup which could damage the devices.

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。

(1) Precautions against the device rupture caused by static electricity

预防措施可以防止静电击穿器件

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.

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

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损毁。防静电地板可以抑制电荷生成并快速耗散。

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

不要用易受静电影响的容器运输或贮存器件。

* 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.

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。

* 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.

安装过程中始终保持设备和操作人员的身體接触地面（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。

* Use soldering irons with grounded tips.

使用接地的烙铁头。

BYD Semiconductor Company Limited exerts the greatest possible effort to ensure high quality and reliability. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing BYD Semiconductor Company Limited products, to comply with the standards of safety in making a safe design for the entire system, including redundancy, fire-prevention measures, and malfunction prevention, to prevent any accidents, fires, or community damage that may ensue. In developing your designs, please ensure that BYD Semiconductor Company Limited products are used within specified operating ranges as set forth in the most recent BYD Semiconductor Company Limited products specifications.

比亚迪半导体股份有限公司致力于产品的高性能和高可靠性。然而，半导体器件一般会因为其固有的对电荷敏感性和易受物理应力损坏的特点，而发生故障和失效。当用户购买比亚迪半导体股份有限公司的产品时，用户有责任按照安全标准来为整个系统做出安全的设计来防止任何事故，火灾或继而引起的危害公共安全，包括设计的冗余，防火措施，故障预防。请改善您的设计，确保比亚迪半导体股份有限公司的产品在额定范围内使用并参考最新的比亚迪半导体股份有限公司产品规格书。

DISCLAIMER 免责声明

- **Warranty Period:** Unless otherwise agreed in the COOPERATION AGREEMENT or other WRITTEN DOCUMENTS, the Warranty Period for products specified in this specification shall be 1 year from the date of shipment.

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厂之日起 1 年。

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

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。

- **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.**

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。

- **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.**

本文件所载内容，不应视为对本公司或他人所有的专利、商标（标识）及版权等知识产权做出的任何明示、默示或以其他方式的转让及/或许可；本公司对本文件所列产品知识产权的承诺，仅限于与客户另行达成书面合作约定中示明的内容。未经本公司书面许可，禁止客户对产品进行任何形式的拆解和逆向工程分析。

- **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**

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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.

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。

- 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。

- 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。

- This specification is written in both Chinese and English, and in case of any conflict between the Chinese and English versions, the Chinese version shall prevail.

本文件以中英文双语书就，如有不同之处，以中文内容为准。