



产品数据手册 Product Datasheet 版本 Ver 24.01

TG650NP10U4B-S501

三电平 IGBT 模块 3-level IGBT Module

关键参数		Key Parameters	
V_{CES}		950	V
$V_{CE(sat)}$	Typ.	1.40	V
I_C	Max.	600	A
$I_{C(RM)}$	Max.	1200	A

典型应用		Typical Applications	
● 三电平应用		3-level-applications	Converters
● 光伏应用		Solar	Applications
● UPS 系统		UPS	Systems

特点		Features	
● 低开关损耗		Low	Switching Losses
● 低感设计		Low	Inductive Design
● 集成 NTC		Integrated	NTC

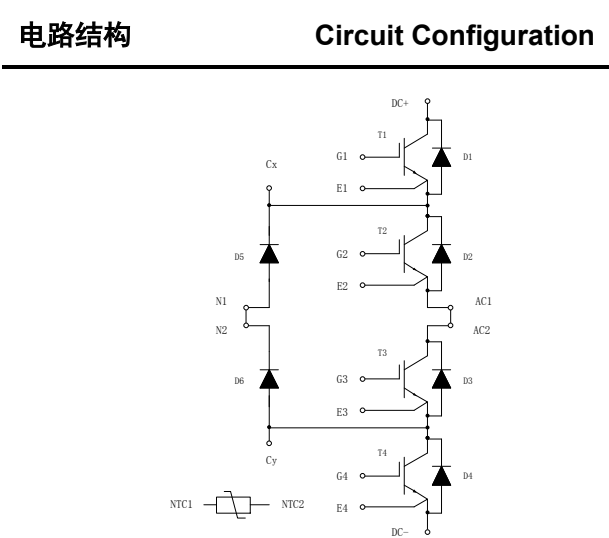


图 1. 电路结构

Fig. 1 Circuit configuration

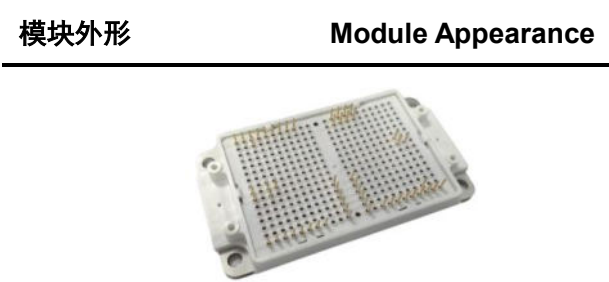


图 2. 模块外形

Fig. 2 Module appearance

模块标签说明		Module Label Code Instruction	
	数据位置	数据内容	
	Data position	Content of data	
	1--8	模块批次号	
		Module batch number	
	9--12	模块序列号	
		Module serial number	

IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4
最大额定值
Absolute Maximum Ratings

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions	数值 Value	单位 Unit
V_{CES}	集电极-发射极电压 Collector-emitter voltage	$V_{GE} = 0V, T_C = 25\text{ }^{\circ}C$	950	V
V_{GES}	栅极-发射极电压 Gate-emitter voltage	$T_C = 25\text{ }^{\circ}C$	± 20	V
I_C	额定电流 Rating Current	$T_C = 50\text{ }^{\circ}C, T_{vj\text{ max}} = 175\text{ }^{\circ}C$	600	A
$I_{C(RM)}$	集电极峰值电流 Peak collector current	$t_P = 1ms$	1200	A
P_{max}	晶体管部分最大损耗 Max. transistor power dissipation	$T_C = 25\text{ }^{\circ}C, T_{vj\text{ max}} = 175\text{ }^{\circ}C$	1.7	kW
V_{RRM}	二极管重复峰值电压 Diode repetitive voltage		950	V
I_F	二极管额定正向电流 Diode rating forward current		300	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_P = 1ms$	600	A
I^2t	二极管 I^2t 值 Diode I^2t	$V_R = 0V, t_P = 10ms, T_{vj} = 150\text{ }^{\circ}C$	4.6	kA^2s

热数据
Thermal Data

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
$R_{th(J-C)} \text{ IGBT}$	IGBT 结壳热阻 Thermal resistance – IGBT				70.1	K / kW
$R_{th(J-C)} \text{ Diode}$	二极管结壳热阻 Thermal resistance – Diode				170.6	K / kW
$R_{th(C-H)} \text{ IGBT}$	接触热阻(IGBT) Thermal resistance – case to heatsink (IGBT)	安装力矩 3.5Nm, 导热脂 3.3W/m·K Mounting torque 3.5Nm, with mounting grease 3.3W/m·K		80		
$R_{th(C-H)} \text{ Diode}$	接触热阻(Diode) Thermal resistance – case to heatsink (Diode)	安装力矩 3.5Nm, 导热脂 3.3W/m·K Mounting torque 3.5Nm, with mounting grease 3.3W/m·K		120		
$T_{vj\text{ op}}$	工作结温 Operating junction temperature		-40		150	$^{\circ}C$

IGBT T1/2/3/4, 二极管 D1/2/3/4

IGBT T1/2/3/4, Diode D1/2/3/4

电特性值

Electrical Characteristics

除非特别声明, 否则 $T_C = 25\text{ }^{\circ}\text{C}$ $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise stated

符号 Symbol	参数名称 Parameter	条件 Test Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
I_{CES}	集电极截止电流 Collector cut-off current	$V_{GE} = 0V, V_{CE} = V_{CES}$			1	mA
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_{vj} = 125\text{ }^{\circ}\text{C}$			10	mA
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_{vj} = 150\text{ }^{\circ}\text{C}$			20	mA
I_{GES}	栅极漏电流 Gate leakage current	$V_{GE} = \pm 20V, V_{CE} = 0V$			0.5	μA
$V_{GE(th)}$	栅极-发射极阈值电压 Gate threshold voltage	$I_C = 15\text{mA}, V_{GE} = V_{CE}$	4.70	5.30	5.90	V
$V_{CE(sat)}^{(*)1}$	集电极-发射极饱和电压 Collector-emitter saturation voltage	$V_{GE} = 15V, I_C = 300A$		1.40	1.80	V
		$V_{GE} = 15V, I_C = 300A, T_{vj} = 125\text{ }^{\circ}\text{C}$		1.60		V
		$V_{GE} = 15V, I_C = 300A, T_{vj} = 150\text{ }^{\circ}\text{C}$		1.70		V
		$V_{GE} = 15V, I_C = 600A$		1.80		V
$V_F^{(*)1}$	二极管正向电压 Diode forward voltage	$I_F = 300A, V_{GE} = 0V$		2.30	2.70	V
		$I_F = 300A, V_{GE} = 0V, T_{vj} = 125\text{ }^{\circ}\text{C}$		2.60		V
		$I_F = 300A, V_{GE} = 0V, T_{vj} = 150\text{ }^{\circ}\text{C}$		2.55		V
C_{ies}	输入电容 Input capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		37		nF
Q_g	栅极电荷 Gate charge	-7.5/+15V		1.74		μC
C_{res}	反向传输电容 Reverse transfer capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		0.1		nF
R_{Gint}	内部栅极电阻 Internal gate resistor			0.8		Ω

注意: 1. (*) 表示该参数基于芯片水平给出。**Note:** 1. (*) indicates it is given at chip level.

IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4
电特性值
Electrical Characteristics

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
$t_{d(off)}$	关断延迟时间 Turn-off delay time	$I_C = 300A$, $V_{CE} = 500V$, $V_{GE} = -7.5/+15V$, $R_{G(OFF)} = 30\Omega$, $L_S = 25nH$, $dv/dt = 4000V/\mu s$ ($T_{vj} = 150^\circ C$).	$T_{vj} = 25^\circ C$		1380		ns
			$T_{vj} = 125^\circ C$		1440		
			$T_{vj} = 150^\circ C$		1480		
t_f	下降时间 Fall time		$T_{vj} = 25^\circ C$		75		ns
			$T_{vj} = 125^\circ C$		72		
			$T_{vj} = 150^\circ C$		70		
E_{OFF}	关断损耗 Turn-off energy loss		$T_{vj} = 25^\circ C$		22.0		mJ
			$T_{vj} = 125^\circ C$		23.4		
			$T_{vj} = 150^\circ C$		23.6		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	$I_C = 300A$, $V_{CE} = 500V$, $V_{GE} = -7.5/+15V$, $R_{G(ON)} = 2.5\Omega$, $L_S = 25nH$, $di/dt = 7000A/\mu s$ ($T_{vj} = 150^\circ C$).	$T_{vj} = 25^\circ C$		100		ns
			$T_{vj} = 125^\circ C$		95		
			$T_{vj} = 150^\circ C$		95		
t_r	上升时间 Rise time		$T_{vj} = 25^\circ C$		32		ns
			$T_{vj} = 125^\circ C$		38		
			$T_{vj} = 150^\circ C$		40		
E_{ON}	开通损耗 Turn-on energy loss		$T_{vj} = 25^\circ C$		4.8		mJ
			$T_{vj} = 125^\circ C$		6.0		
			$T_{vj} = 150^\circ C$		6.3		
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	$I_F = 300A$, $V_{CE} = 500V$, $R_{G(ON)} = 2.5\Omega$, - $di_F/dt = 7000A/\mu s$ ($T_{vj} = 150^\circ C$).	$T_{vj} = 25^\circ C$		10		μC
			$T_{vj} = 125^\circ C$		20		
			$T_{vj} = 150^\circ C$		22		
I_{rr}	二极管反向恢复电流 Diode reverse recovery current		$T_{vj} = 25^\circ C$		180		A
			$T_{vj} = 125^\circ C$		210		
			$T_{vj} = 150^\circ C$		215		
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy		$T_{vj} = 25^\circ C$		4.0		mJ
			$T_{vj} = 125^\circ C$		8.0		
			$T_{vj} = 150^\circ C$		8.4		

二极管 D5/6

Diode D5/6

最大额定值

Absolute Maximum Ratings

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions	数值 Value	单位 Unit
V_{RRM}	反向重复峰值电压 Repetitive peak reverse voltage	$T_C = 25\text{ }^{\circ}\text{C}$	950	V
I_F	二极管额定正向电流 Diode rating forward current	$T_C = 50\text{ }^{\circ}\text{C}$	400	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_P = 1\text{ms}$	800	A
I_{FSM}	浪涌电流 Surge current	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	1280	A
I^2t	二极管 I^2t 值 Diode I^2t	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	8.2	kA^2s

特征值

Characteristic Values

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
$V_F^{(*)}$	正向电压 Forward voltage	$I_F = 400\text{A}$, $V_{GE} = 0\text{V}$		2.30	2.70	V
		$I_F = 400\text{A}$, $V_{GE} = 0\text{V}$, $T_{vj} = 125\text{ }^{\circ}\text{C}$		2.60		V
		$I_F = 400\text{A}$, $V_{GE} = 0\text{V}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$		2.55		V
I_{RRM}	重复反向电流 Repetitive reverse current	$T_{vj} = 150\text{ }^{\circ}\text{C}$, $V_R = 950\text{V}$			20	mA
$R_{th(J-C)} \text{ IGBT}$	IGBT 结壳热阻 Thermal resistance – IGBT				134.6	K / kW
$R_{th(C-H)} \text{ Diode}$	接触热阻(Diode) Thermal resistance – case to heatsink (Diode)	安装力矩 3.5Nm, 导热脂 3.3W/m·K Mounting torque 3.5Nm, with mounting grease 3.3W/m·K		100		K / kW
$T_{vj\text{ op}}$	工作结温 Operating junction temperature		-40		150	$^{\circ}\text{C}$

注意: 1.(*) 表示该参数基于芯片水平给出。

Note: 1. (*) indicates it is given at chip level.

二极管 D5/6
Diode D5/6
电特性值
Electrical Characteristics

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
Q _{rr}	二极管反向恢复电荷 Diode reverse recovery charge	I _F =300A, V _{CE} = 500V, R _{G(ON)} = 3Ω, - di _F /dt =7000A/μs (T _{vj} = 150 °C).	T _{vj} = 25 °C		15		μC
			T _{vj} = 125 °C		22		
			T _{vj} = 150 °C		25		
I _{rr}	二极管反向恢复电流 Diode reverse recovery current		T _{vj} = 25 °C		195		A
			T _{vj} = 125 °C		230		
			T _{vj} = 150 °C		240		
E _{rec}	二极管反向恢复损耗 Diode reverse recovery energy		T _{vj} = 25 °C		4.8		mJ
			T _{vj} = 125 °C		9.0		
			T _{vj} = 150 °C		9.4		

热敏电阻数据

NTC-Thermistor Data

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
R_{25}	额定电阻值 Rated resistance	$T_C = 25\text{ }^{\circ}\text{C}$		5		k Ω
$\Delta R/R$	R100 偏差 Deviation of R100	$T_C = 100\text{ }^{\circ}\text{C}$, $R_{100}=493\Omega$	-5		5	%
P_{25}	耗散功率 Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$			20	mW
$B_{25/50}$	B-值 B-value	$R_2 = R_{25}\exp [B_{25/50}(1/T_2 - 1/(298.15\text{ K}))]$		3375		K
$B_{25/80}$	B-值 B-value	$R_2 = R_{25}\exp [B_{25/80}(1/T_2 - 1/(298.15\text{ K}))]$		3411		K
$B_{25/100}$	B-值 B-value	$R_2 = R_{25}\exp [B_{25/100}(1/T_2 - 1/(298.15\text{ K}))]$		3433		K

模块

Module

参数 Symbol	说明 Explanation	值 Value	单位 Unit
爬电距离 Creepage distance	端子-散热器 Terminal to heatsink	11.5	mm
	端子-端子 Terminal to terminal	6.8	mm
绝缘间隙 Clearance	端子-散热器 Terminal to heatsink	9.4	mm
	端子-端子 Terminal to terminal	5.5	mm
相对漏电起痕指数 CTI (Comparative Tracking Index)		>400	
绝缘电压(模块) Isolation voltage – per module	短接所有端子，端子与基板间施加电压 (Connected terminals to base plate), AC RMS,1 min, 50Hz, $T_C= 25\text{ }^{\circ}\text{C}$	3200	V

模块

Module

符号 Symbol	参数名称 Parameter	测试条件 Test Conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
L_{sCE}	模块电感 Module inductance			14		nH
T_{stg}	存储温度 Storage temperature range		-40		125	$^{\circ}\text{C}$
M	安装力矩 Screw torque	安装紧固用 Mounting	3		5	Nm

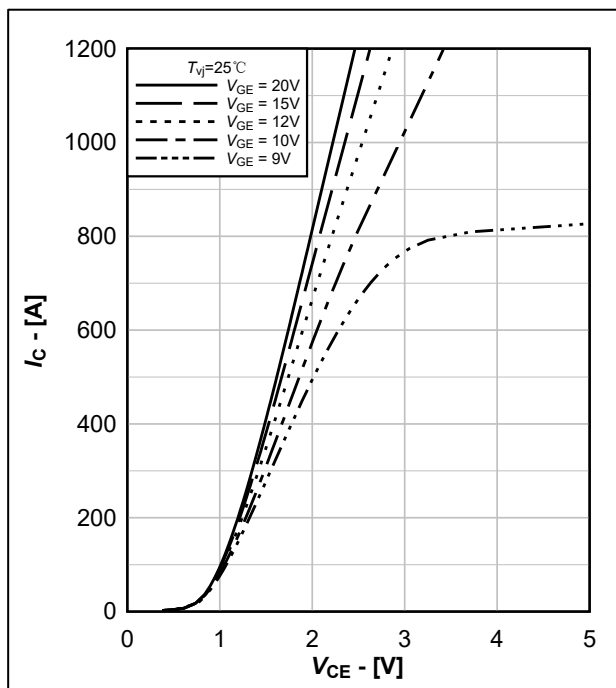
IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4

图 3. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

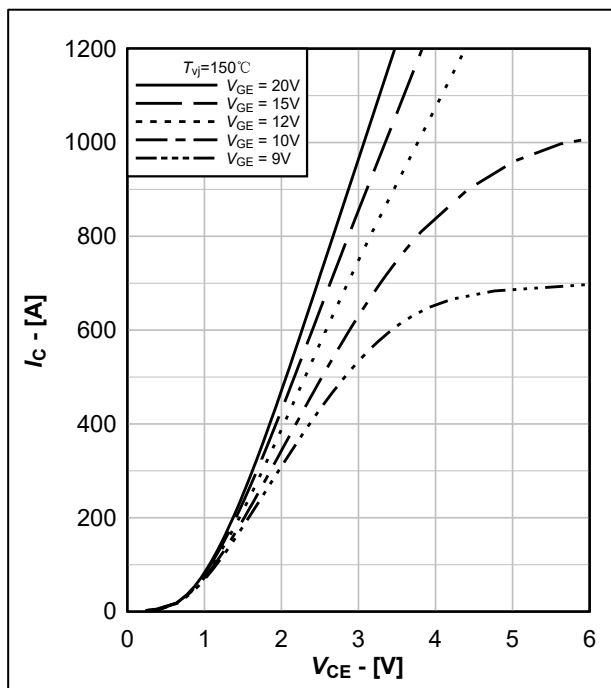
Fig.3 Typical IGBT output characteristic, $I_C = f(V_{CE})$

图 4. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

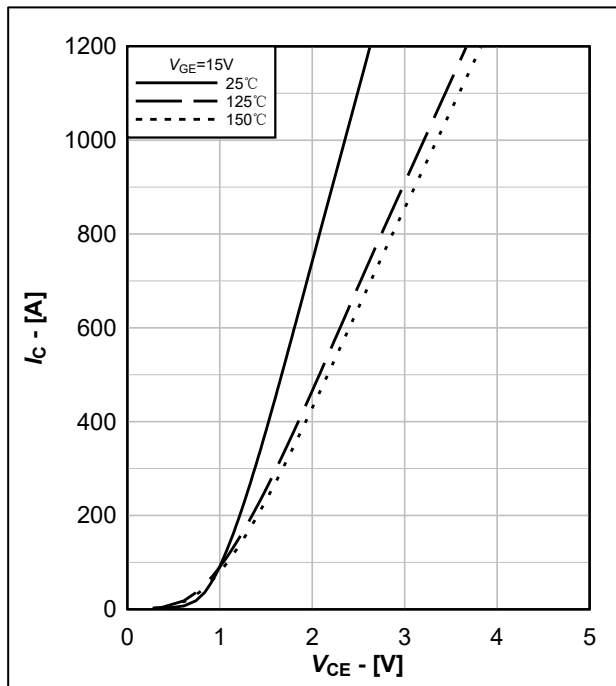
Fig.4 Typical IGBT output characteristic, $I_C = f(V_{CE})$

图 5. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

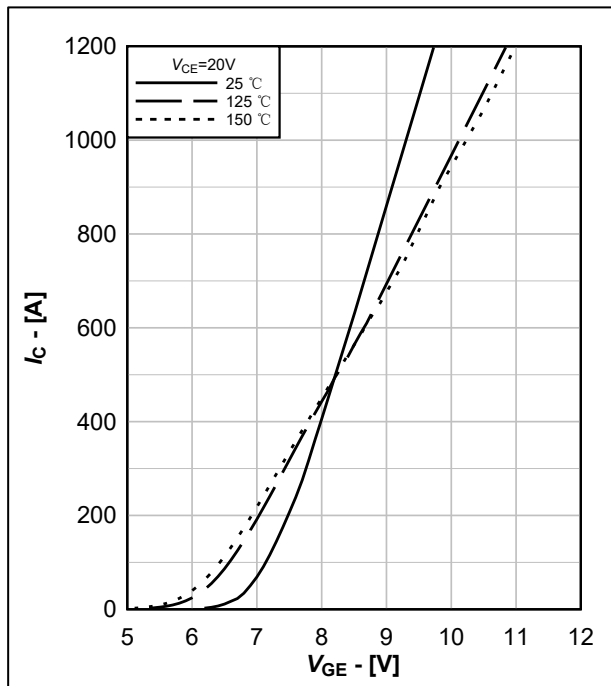
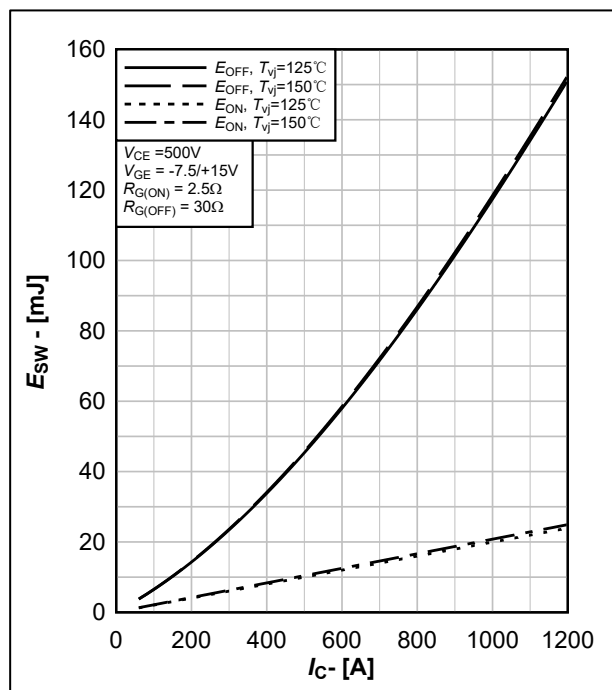
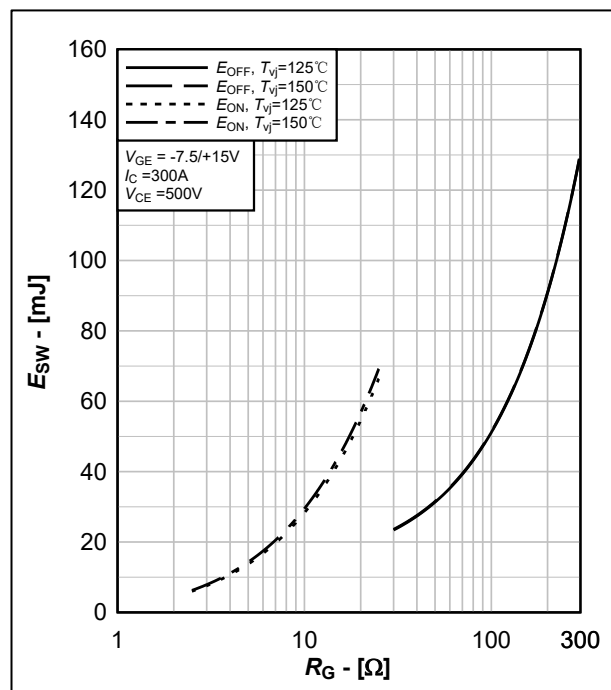
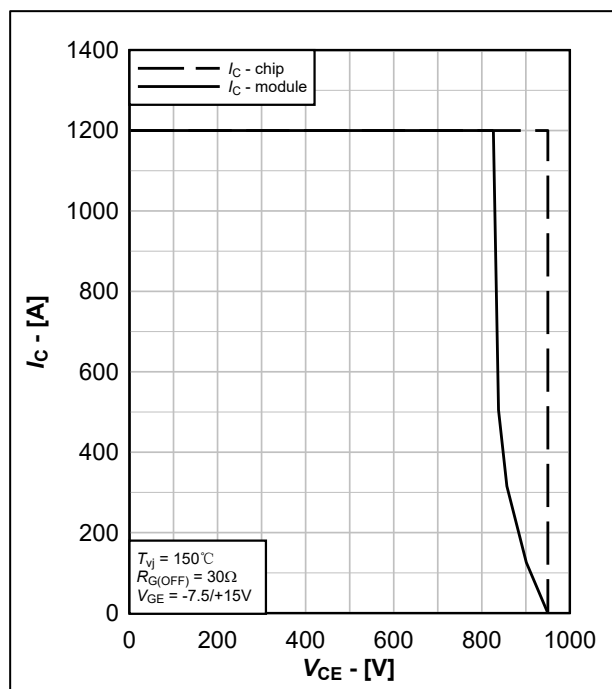
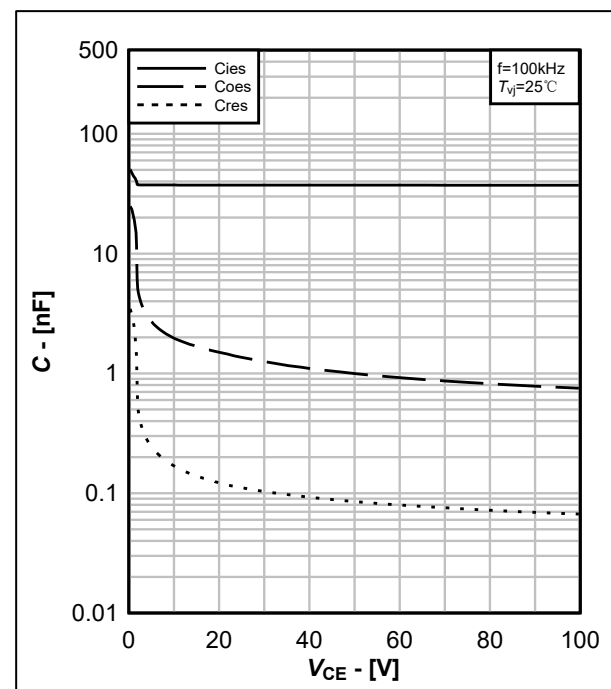
Fig.5 Typical IGBT output characteristic, $I_C = f(V_{CE})$

图 6. IGBT 传输特性典型曲线, $I_C = f(V_{GE})$

Fig.6 Typical IGBT transfer characteristic, $I_C = f(V_{GE})$

IGBT T1/2/3/4, 二极管 D1/2/3/4

IGBT T1/2/3/4, Diode D1/2/3/4

图 7. IGBT 开关损耗典型曲线, $E_{on}=f(I_c)$, $E_{off}=f(I_c)$ Fig.7 Typical IGBT switching energy, $E_{on}=f(I_c)$, $E_{off}=f(I_c)$ 图 8. IGBT 开关损耗典型曲线, $E_{on}=f(R_g)$, $E_{off}=f(R_g)$ Fig.8 Typical IGBT switching energy, $E_{on}=f(R_g)$, $E_{off}=f(R_g)$ 图 9. IGBT 反偏安全工作区, $I_c=f(V_{ce})$ Fig.9 Reverse bias safe operating area of IGBT, $I_c=f(V_{ce})$ 图 10. 电容特性典型曲线, $C=f(V_{ce})$ Fig.10 Typical capacity characteristic, $C=f(V_{ce})$

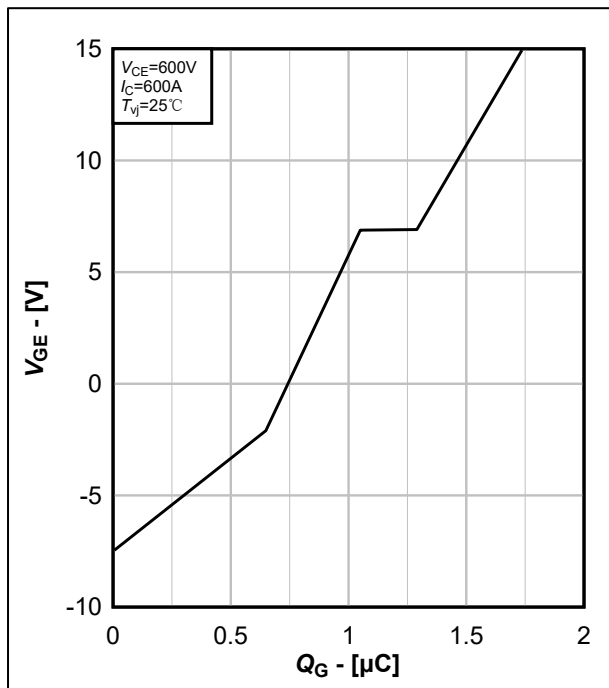
IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4

图 11. 栅极电荷特性典型曲线, $V_{GE} = f(Q_G)$

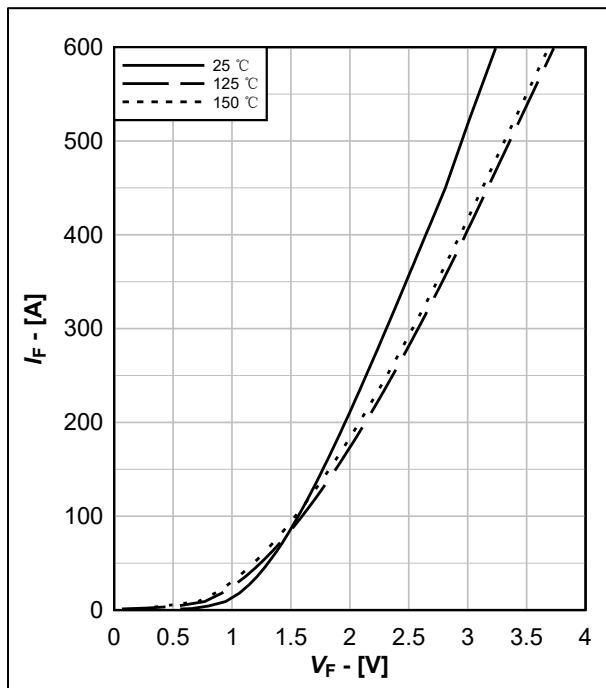
Fig.11 Typical gate charge characteristic, $V_{GE} = f(Q_G)$

图 12. FRD 输出特性典型曲线, $I_F = f(V_F)$

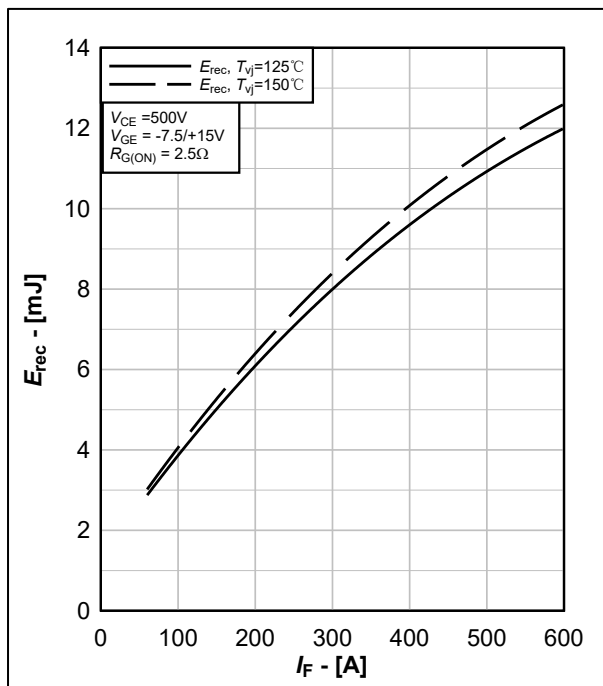
Fig.12 Typical FRD output characteristic, $I_F = f(V_F)$

图 13. FRD 反向恢复损耗典型曲线, $E_{rec}=f(I_F)$

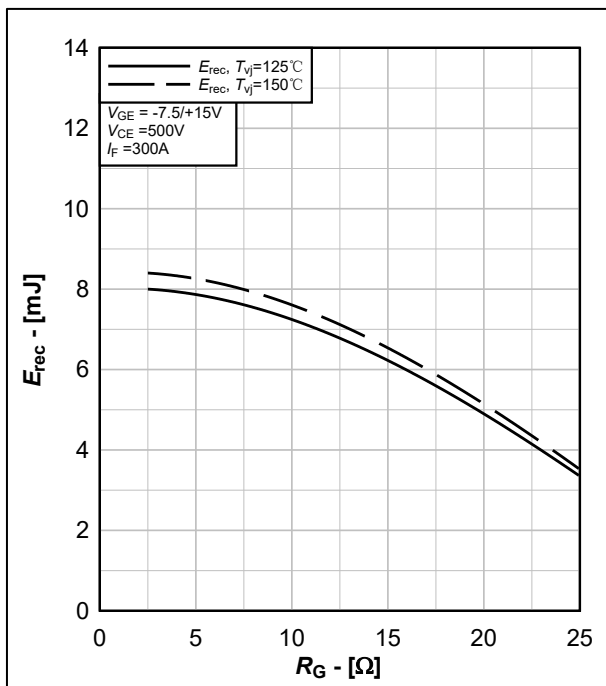
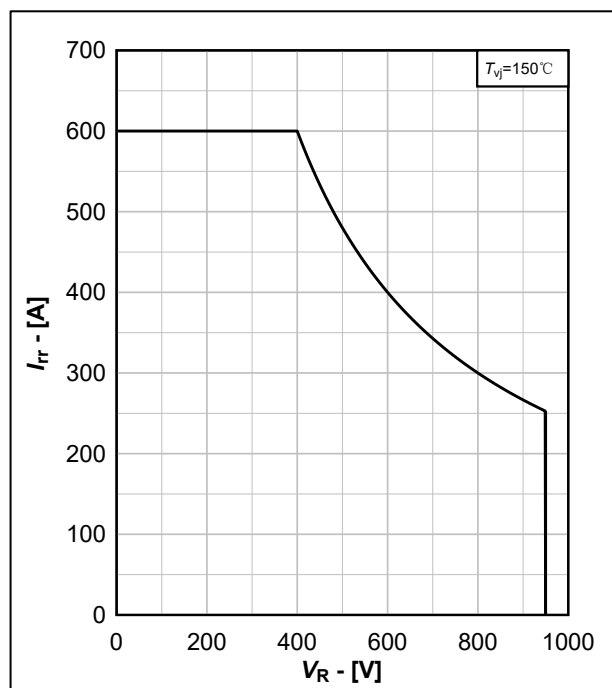
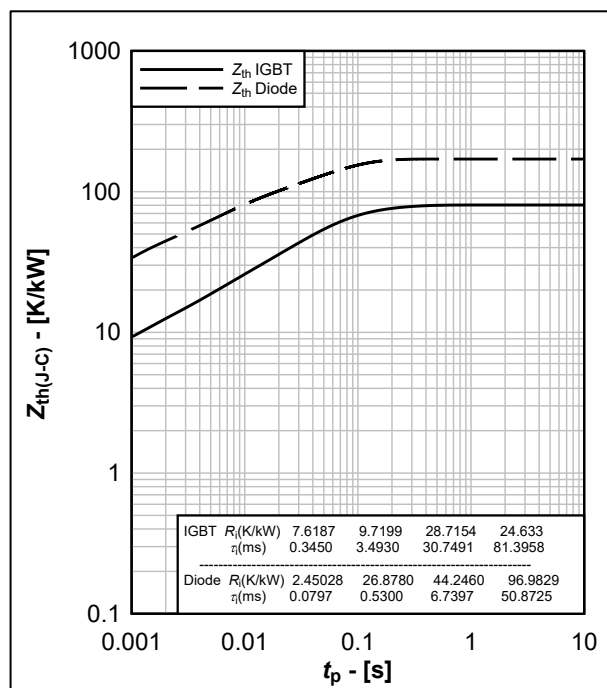
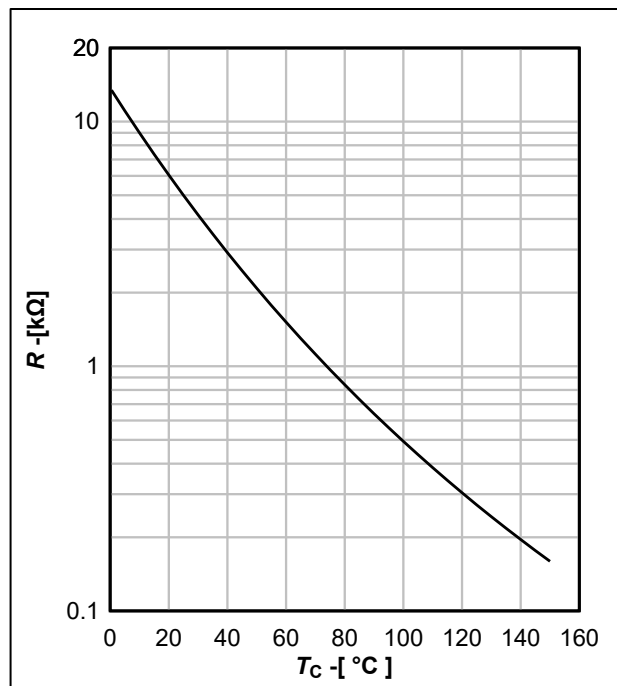
Fig.13 Typical FRD switching loss E_{rec} , $E_{rec}=f(I_F)$

图 14. FRD 反向恢复损耗典型曲线, $E_{rec}=f(R_G)$

Fig.14 Typical FRD switching loss E_{rec} , $E_{rec}=f(R_G)$

IGBT T1/2/3/4, 二极管 D1/2/3/4

图 15. FRD 反偏安全工作区, $I_{rr} = f(V_R)$ Fig.15 Reverse bias safe operating area of FRD, $I_{rr} = f(V_R)$

IGBT T1/2/3/4, Diode D1/2/3/4

图 16. 瞬态热阻抗曲线, $Z_{th(j-c)} = f(t_p)$ Fig.16 Transient thermal impedance, $Z_{th(j-c)} = f(t_p)$ 图 17. 热敏电阻典型特性曲线, $R = f(T_c)$ Fig.17 Typical NTC thermistor characteristic, $R = f(T_c)$

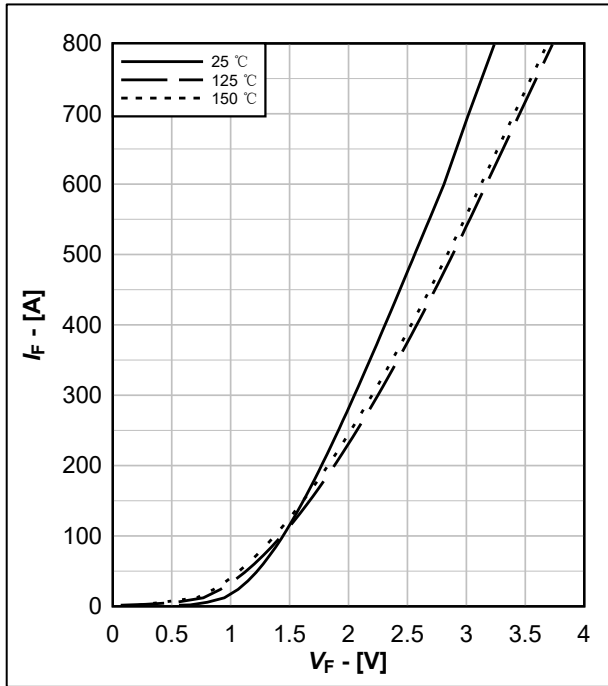
二极管 D5/6
Diode D5/6

图 18. FRD 输出特性典型曲线, $I_F = f(V_F)$

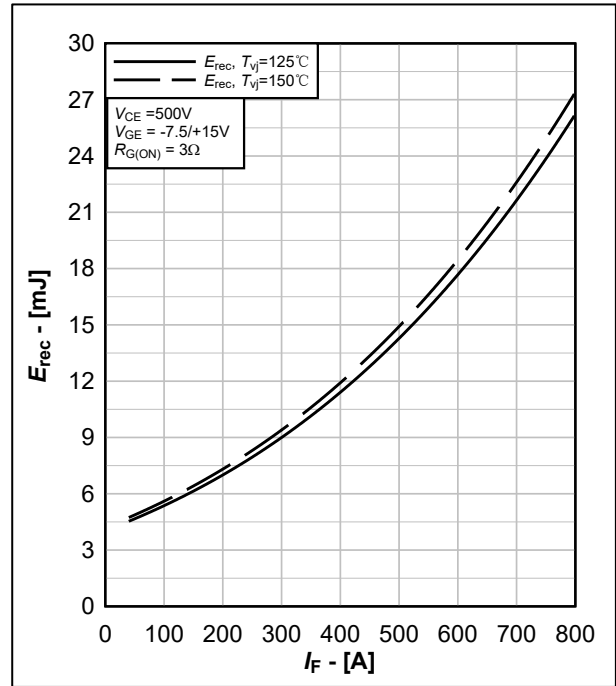
Fig.18 Typical FRD output characteristic, $I_F = f(V_F)$

图 19. FRD 反向恢复损耗典型曲线, $E_{rec} = f(I_F)$

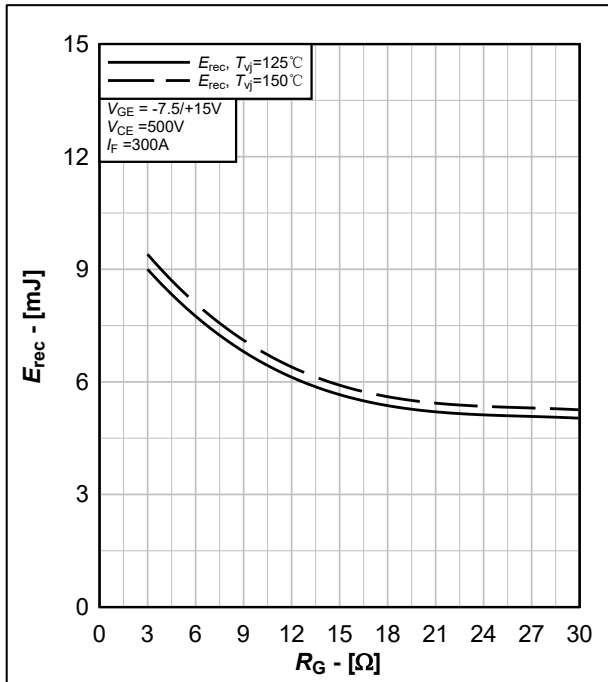
Fig.19 Typical FRD switching loss E_{rec} , $E_{rec} = f(I_F)$

图 20. FRD 反向恢复损耗典型曲线, $E_{rec} = f(R_G)$

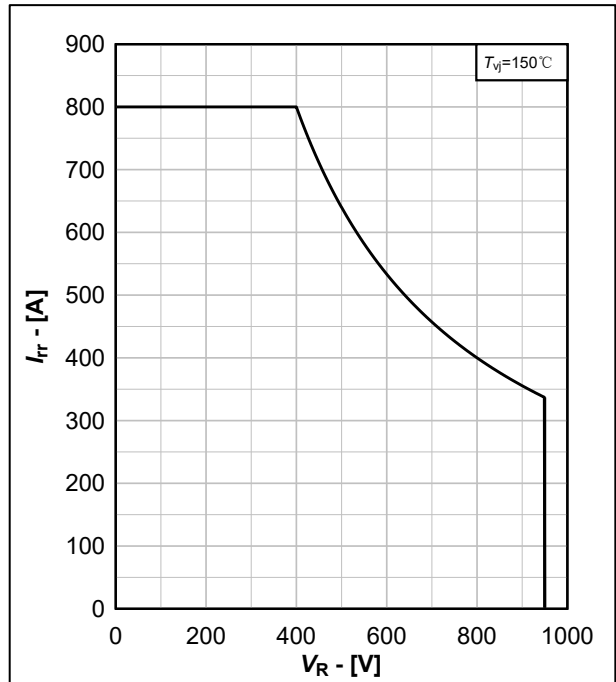
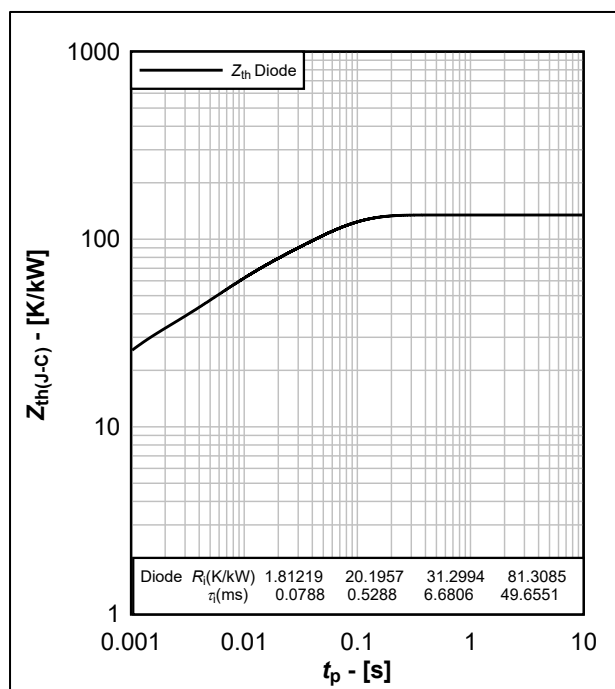
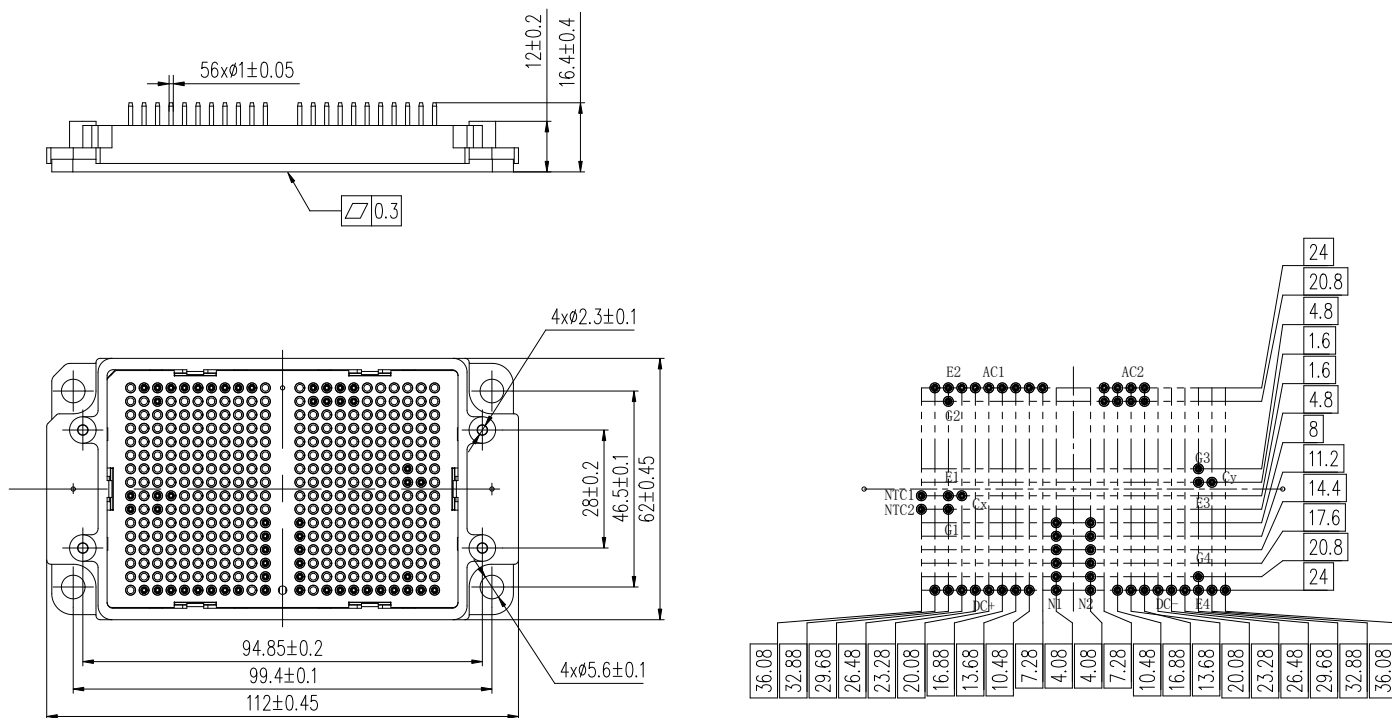
Fig.20 Typical FRD switching loss E_{rec} , $E_{rec} = f(R_G)$

图 21. FRD 反偏安全工作区, $I_{rr} = f(V_R)$

Fig.21 Reverse bias safe operating area of FRD, $I_{rr} = f(V_R)$

二极管 D5/6

Diode D5/6

图 22. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$ Fig.22 Transient thermal impedance, $Z_{th(J-C)} = f(t_p)$



重量 Weight: 240 g 模块外观类型 Module outline code: U4B

图 23. 模块外观尺寸

Fig. 23 Module outlines

株洲中车时代半导体有限公司

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产品数据手册 Product Datasheet 版本 Ver 24.01

TG650NP10U4B-S501

三电平 IGBT 模块 3-level IGBT Module

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(6) We annotate datasheet in the top right hand corner of the front page, to indicate product status. The annotation “Preliminary” indicates the product design is complete and final characterization for volume production is in progress, the product information in the datasheet is currently can be referenced, but some details may change in the future. There is no annotation indicates the product is capable to produce in batch quantity.

Caution: This device is sensitive to electrostatic discharge. Users should follow ESD handling procedures.

注意：该器件对静电敏感，用户须采取 ESD 防护措施。