



产品数据手册 Product Datasheet 版本 Ver 24.02

TG600NP10U4-S500
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

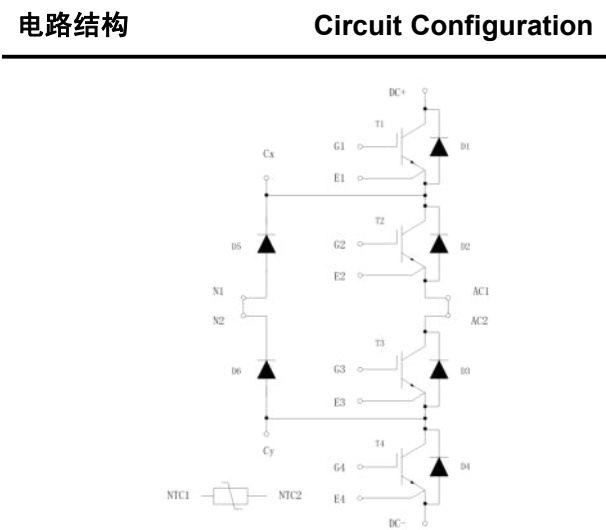


图 1. 电路结构
Fig. 1 Circuit configuration

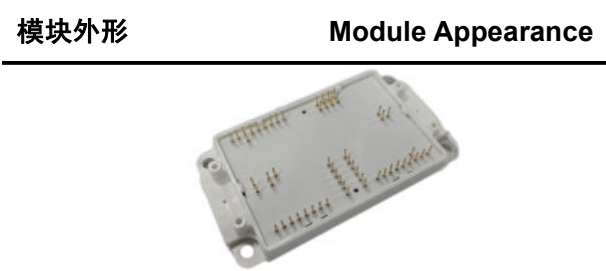


图 2. 模块外形
Fig. 2 Module appearance

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	$V_{GE} = 0V, T_C = 25\text{ }^{\circ}\text{C}$	950	V
V_{GES}	栅极-发射极电压 Gate-emitter voltage	$T_C = 25\text{ }^{\circ}\text{C}$	± 20	V
I_C	额定电流 Rating Current	$T_C = 50\text{ }^{\circ}\text{C}, T_{vj\text{ max}}=175^{\circ}\text{C}$	600	A
$I_{C(RM)}$	集电极峰值电流 Peak collector current	$t_P=1\text{ms}$	1200	A
P_{max}	晶体管部分最大损耗 Max. transistor power dissipation	$T_C = 25\text{ }^{\circ}\text{C}, T_{vj\text{ max}}=175^{\circ}\text{C}$	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	$t_P = 1\text{ms}$	600	A
ρ_t	二极管 ρ_t 值 Diode ρ_t	$V_R = 0V, t_P = 10\text{ms}, T_{vj} = 150\text{ }^{\circ}\text{C}$	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				88.2	K / kW
$R_{th(J-C)} \text{ Diode}$	二极管结壳热阻 Thermal resistance – Diode				206.8	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	$^{\circ}\text{C}$

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. (*1) 表示该参数基于芯片水平给出。**Note:** 1. (*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, $R_{G(OFF)}$ = 30Ω, L_S = 25nH, dv/dt =4000V/μs (T_{vj} = 150 °C).	T_{vj} = 25 °C		1380		ns
			T_{vj} = 125 °C		1440		
			T_{vj} = 150 °C		1480		
t_f	下降时间 Fall time		T_{vj} = 25 °C		75		ns
			T_{vj} = 125 °C		72		
			T_{vj} = 150 °C		70		
E_{OFF}	关断损耗 Turn-off energy loss		T_{vj} = 25 °C		22.0		mJ
			T_{vj} = 125 °C		23.4		
			T_{vj} = 150 °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, $R_{G(ON)}$ = 2.5Ω, L_S = 25nH, di/dt =7000A/μs (T_{vj} = 150 °C).	T_{vj} = 25 °C		100		ns
			T_{vj} = 125 °C		95		
			T_{vj} = 150 °C		95		
t_r	上升时间 Rise time		T_{vj} = 25 °C		32		ns
			T_{vj} = 125 °C		38		
			T_{vj} = 150 °C		40		
E_{ON}	开通损耗 Turn-on energy loss		T_{vj} = 25 °C		4.8		mJ
			T_{vj} = 125 °C		6.0		
			T_{vj} = 150 °C		6.3		
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	I_F =300A, V_{CE} = 500V, $R_{G(ON)}$ = 2.5Ω, - di _r /dt =7000A/μs (T_{vj} = 150 °C).	T_{vj} = 25 °C		10		μC
			T_{vj} = 125 °C		20		
			T_{vj} = 150 °C		22		
I_{rr}	二极管反向恢复电流 Diode reverse recovery current		T_{vj} = 25 °C		180		A
			T_{vj} = 125 °C		210		
			T_{vj} = 150 °C		215		
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy		T_{vj} = 25 °C		4.0		mJ
			T_{vj} = 125 °C		8.0		
			T_{vj} = 150 °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
ρt	二极管 ρt 值 Diode ρt	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	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
$V_F^{(*1)}$	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
$R_{th(J-C)} \text{ Diode}$	二极管结壳热阻 Thermal resistance – Diode				177.4	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. (*1) 表示该参数基于芯片水平给出。

Note: 1. (*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

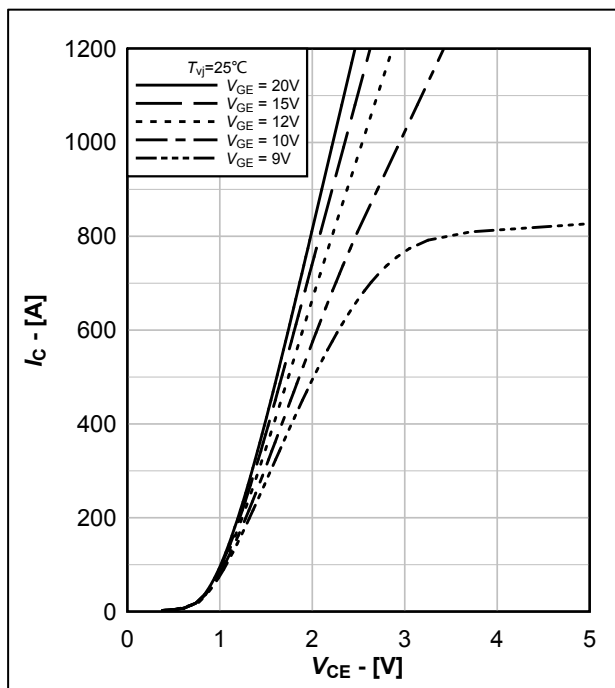


图 3. IGBT 输出特性典型曲线, $I_c = f(V_{CE})$

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

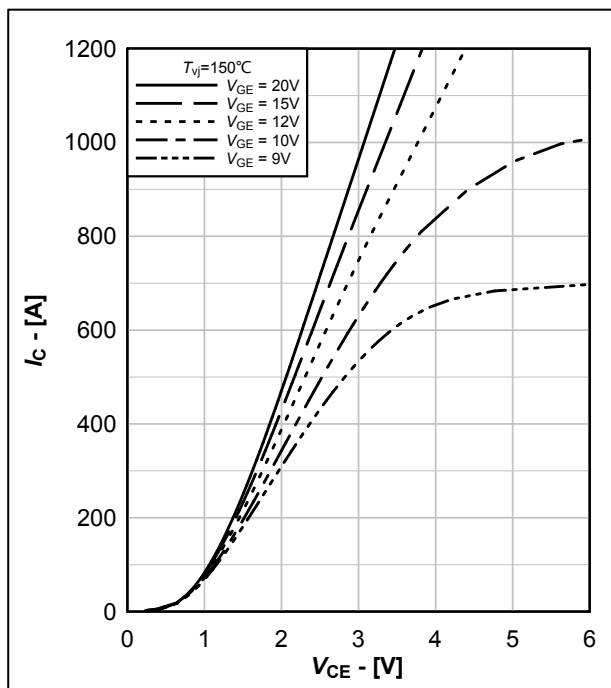


图 4. IGBT 输出特性典型曲线, $I_c = f(V_{CE})$

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

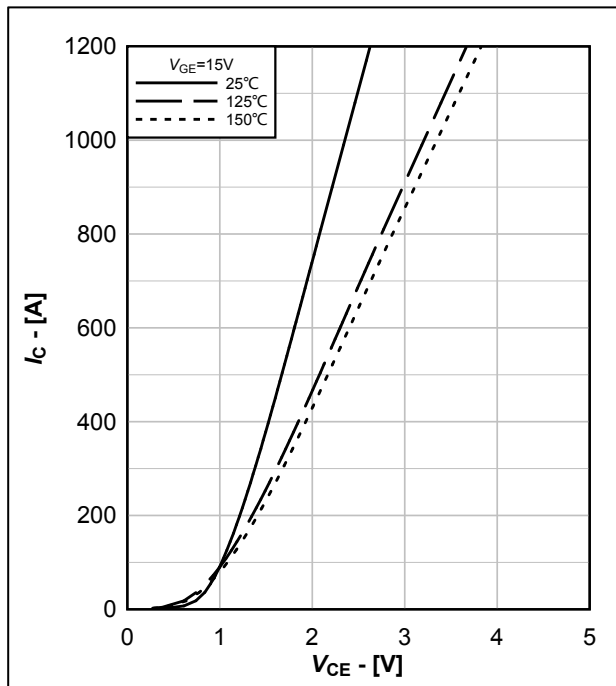


图 5. IGBT 输出特性典型曲线, $I_c = f(V_{CE})$

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

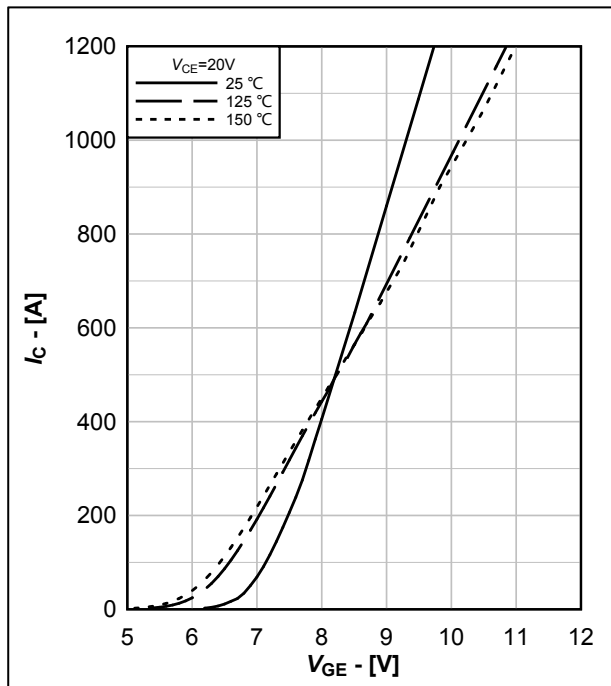
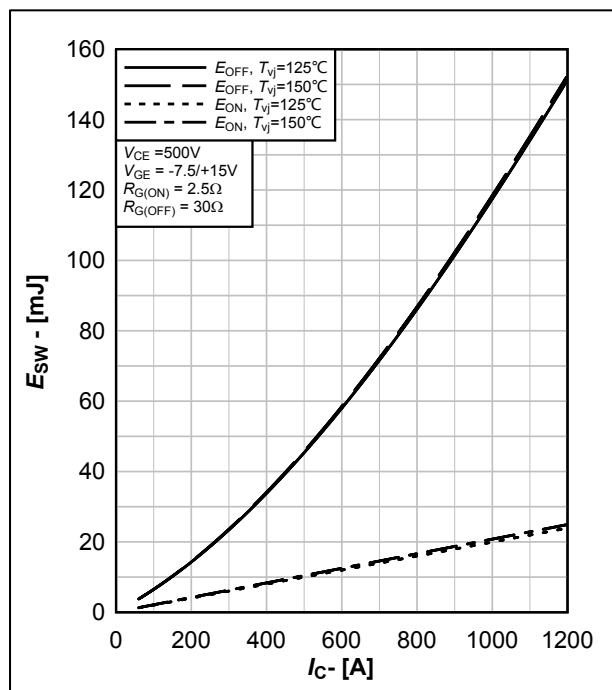


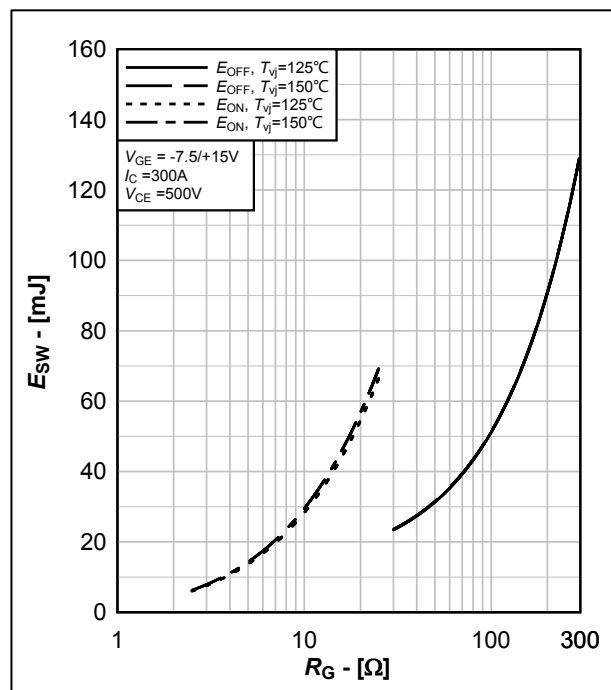
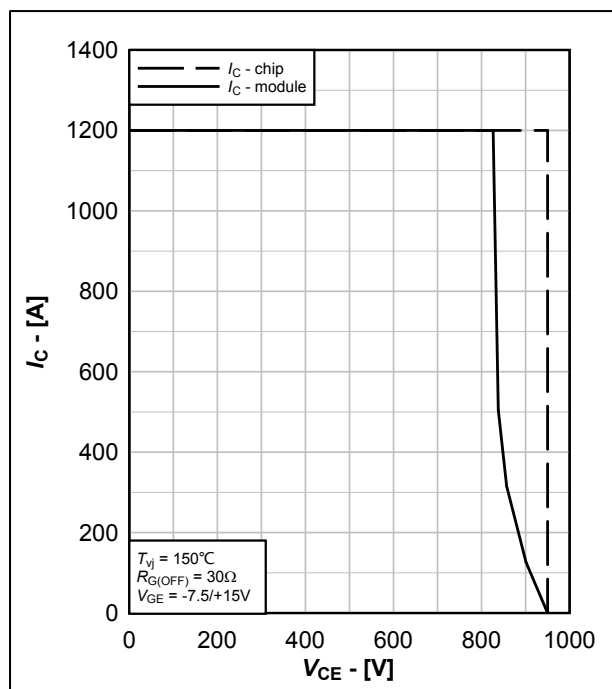
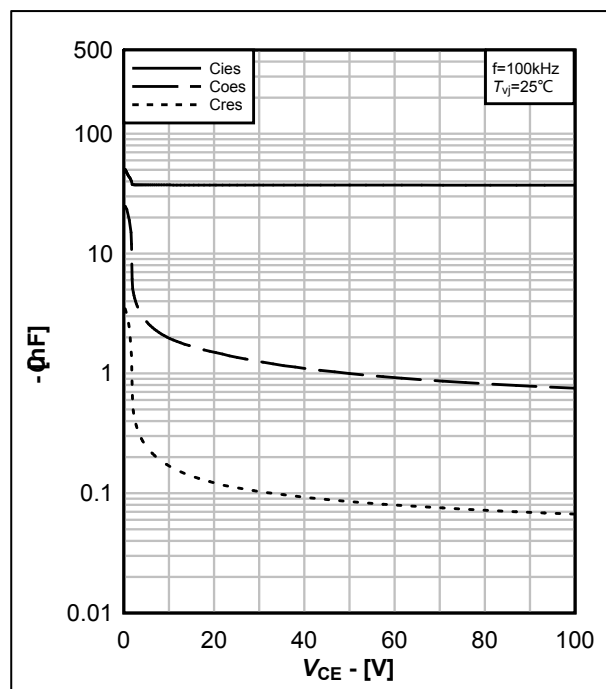
图 6. IGBT 传输特性典型曲线, $I_c = f(V_{GE})$

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

IGBT T1/2/3/4, 二极管 D1/2/3/4

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, $E_{on}=f(I_c)$, $E_{off}=f(I_c)$

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

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, $C=f(V_{ce})$

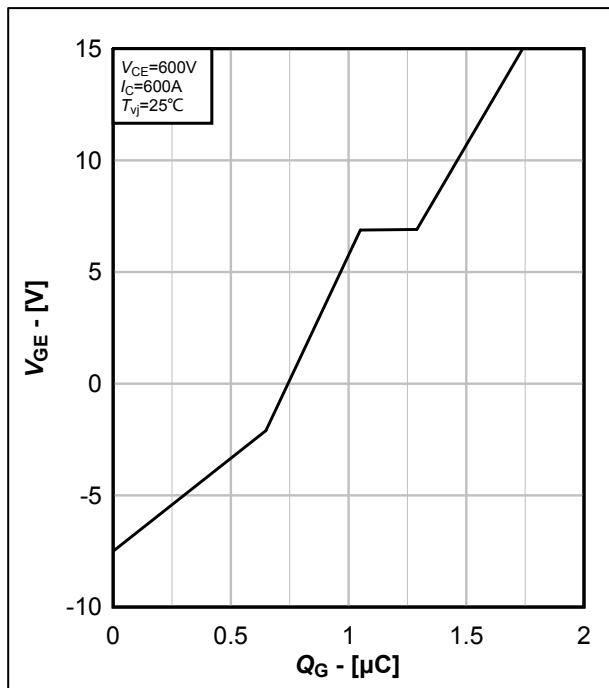
IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4

图 11. 栅极电荷特性典型曲线, $V_{GE} = f(Q_G)$

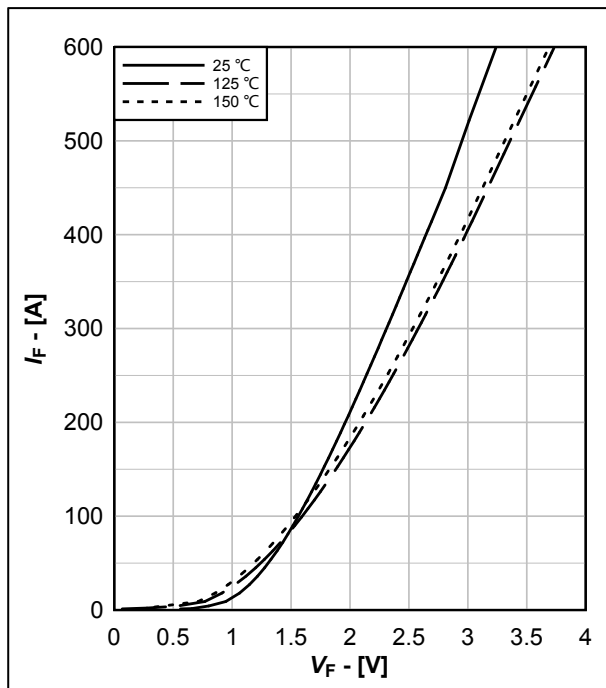
Fig.11 Typical gate charge characteristic, $V_{GE} = f(Q_G)$

图 12. FRD 输出特性典型曲线, $I_F = f(V_F)$

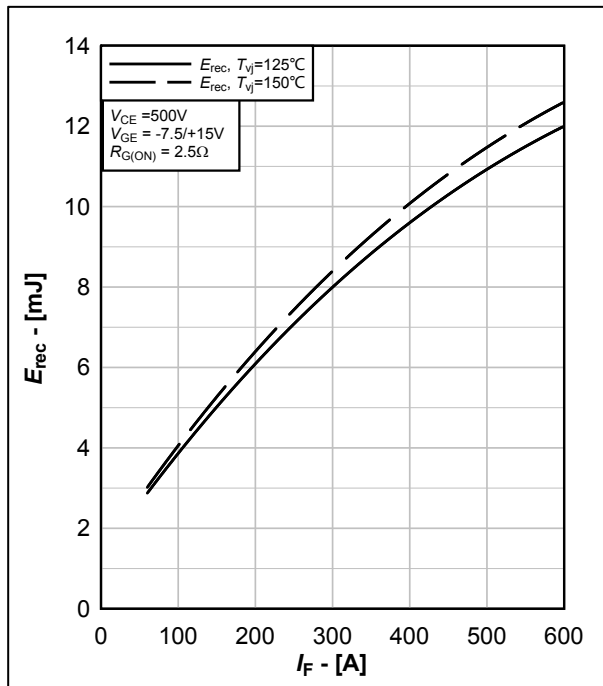
Fig.12 Typical FRD output characteristic, $I_F = f(V_F)$

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

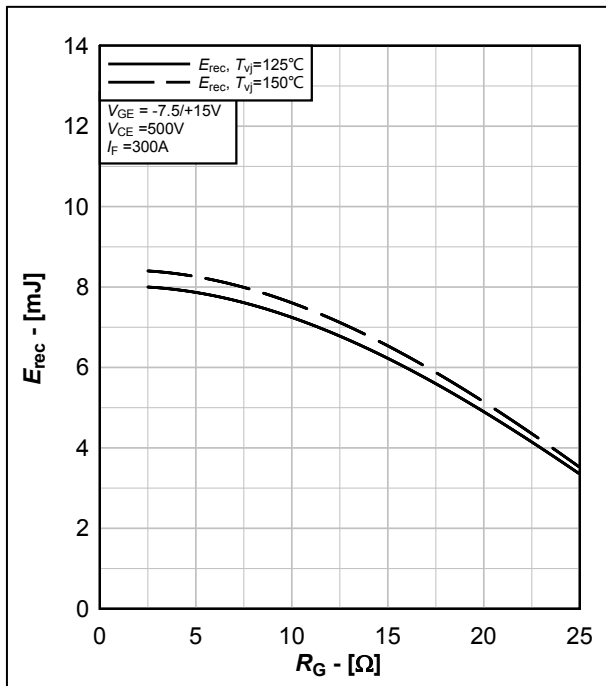
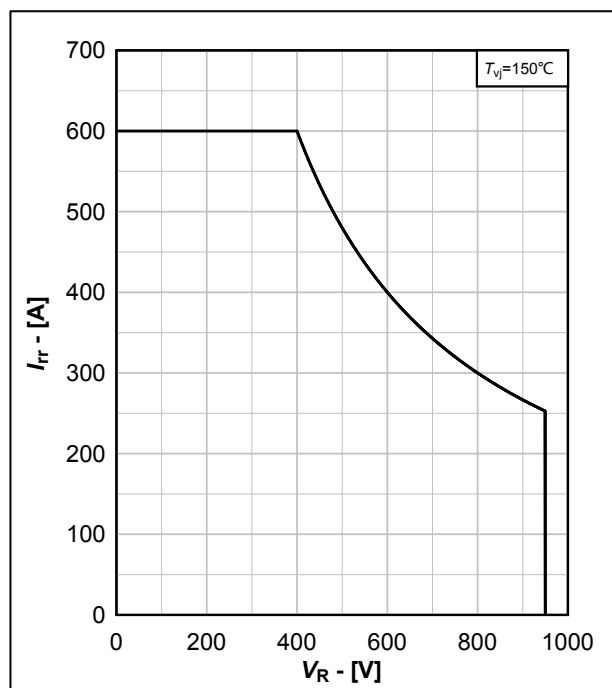
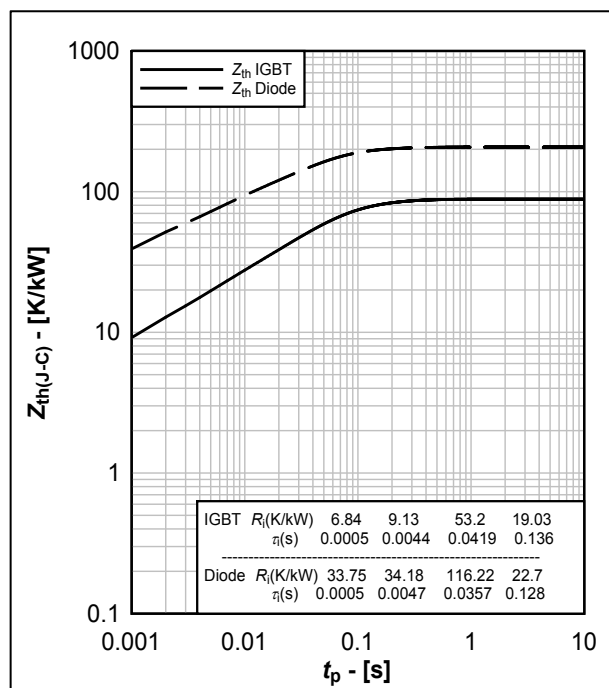
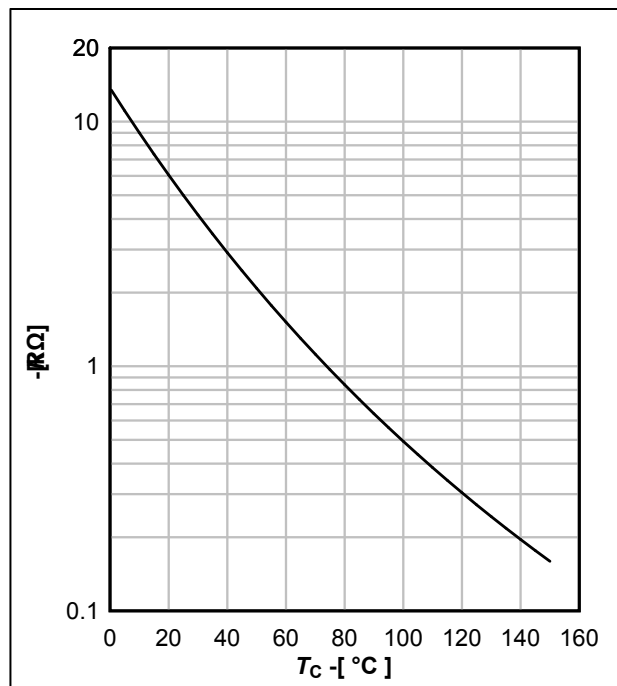
Fig.13 Typical FRD switching loss E_{rec} , $E_{rec} = f(I_F)$

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, $R = f(T_c)$

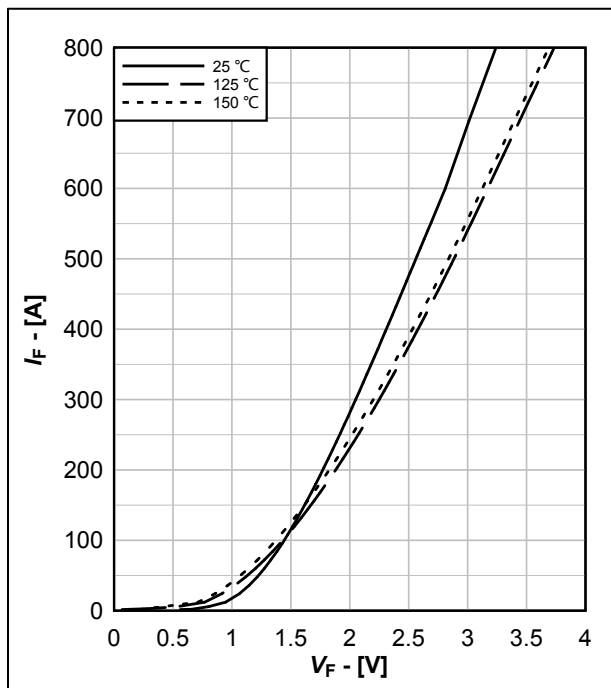
二极管 D5/6
Diode D5/6

图 18. FRD 输出特性典型曲线, $I_F = f(V_F)$

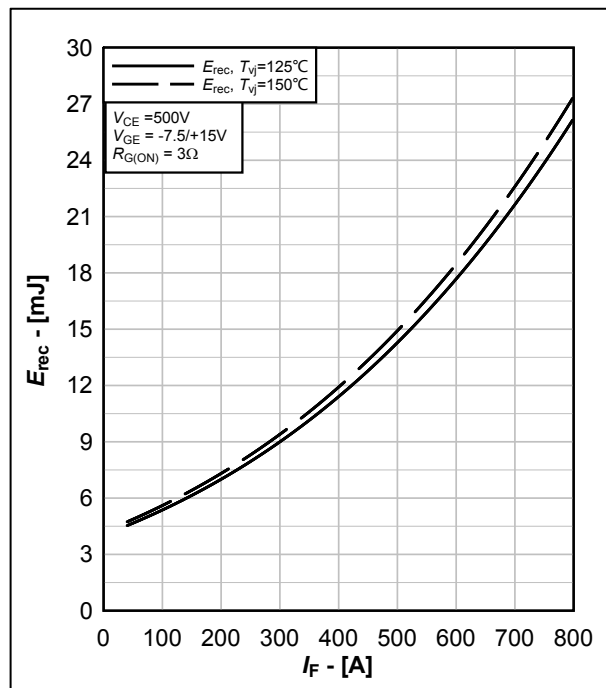
Fig.18 Typical FRD output characteristic, $I_F = f(V_F)$

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

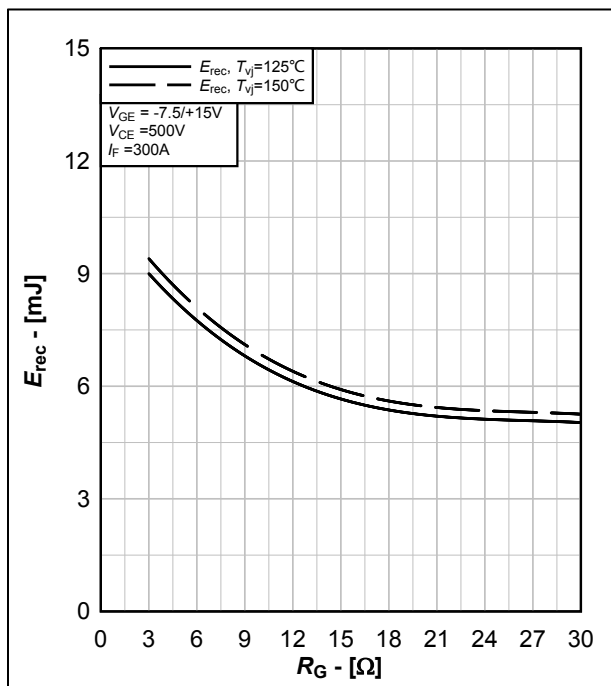
Fig.19 Typical FRD switching loss E_{rec} , $E_{rec} = f(I_F)$

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

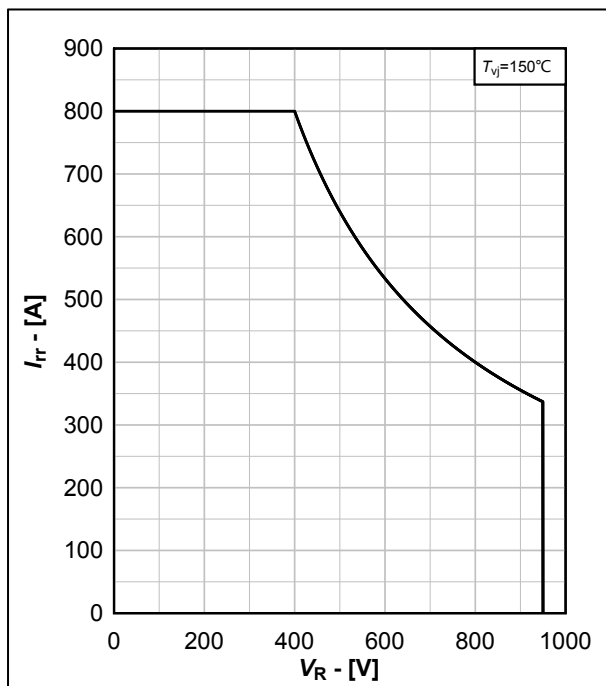
Fig.20 Typical FRD switching loss E_{rec} , $E_{rec} = f(R_G)$

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

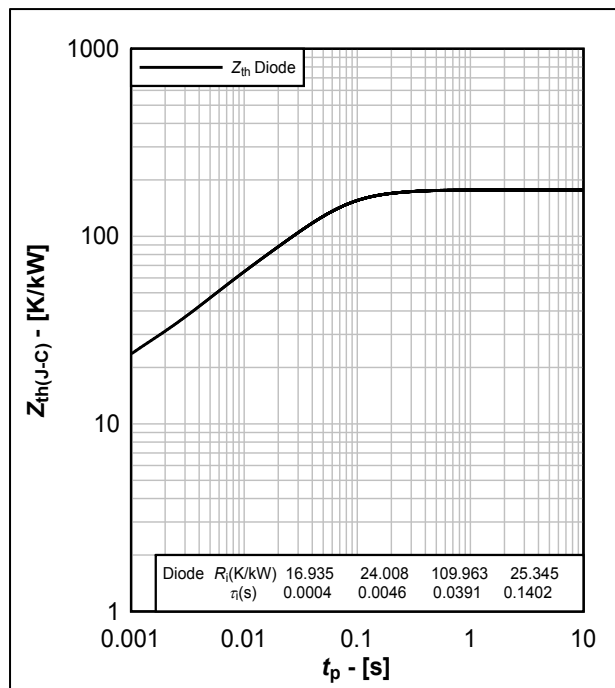
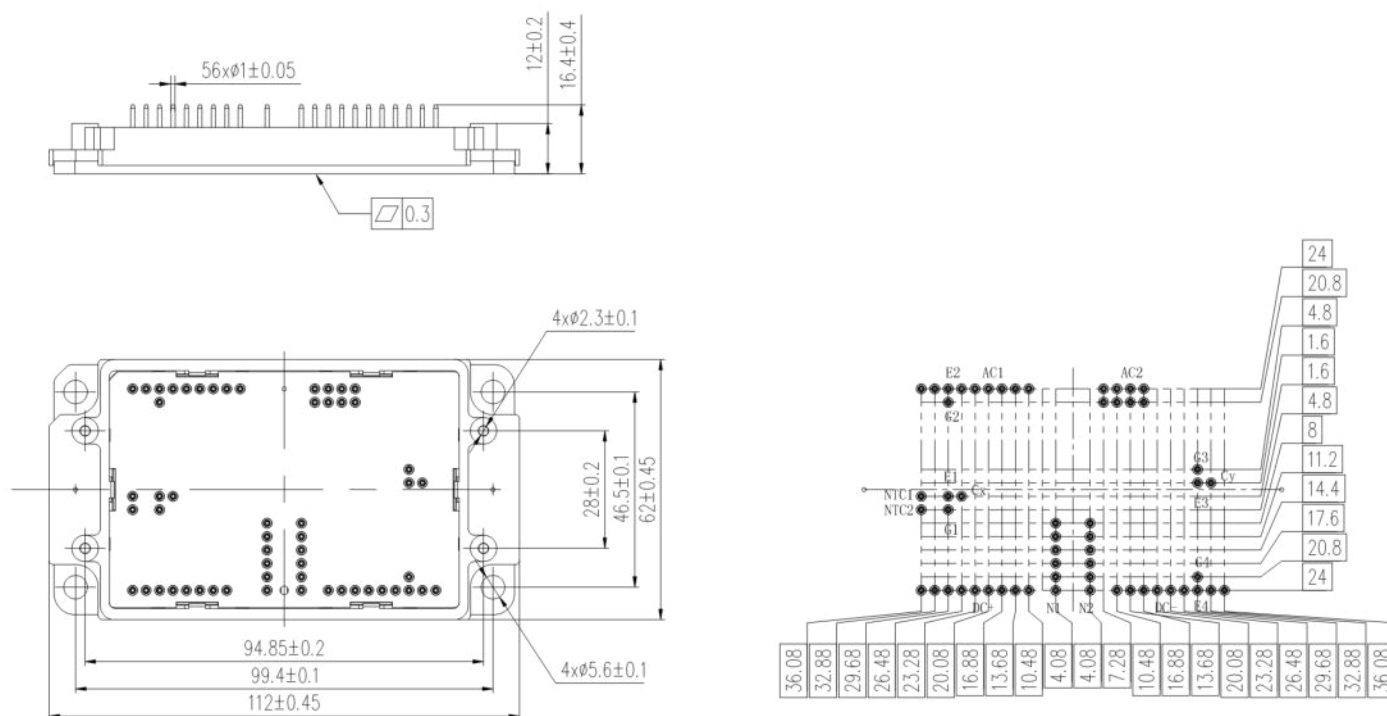


图 22. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$

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: U4

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 24.02

TG600NP10U4-S500

三电平 IGBT 模块 3-level IGBT Module

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