

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

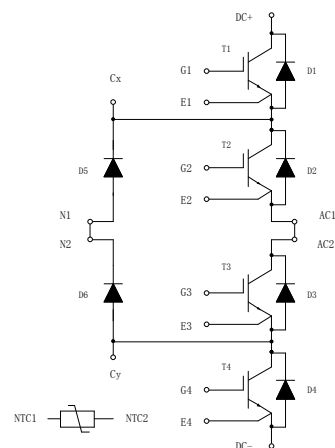
电路结构
Circuit Configuration


图 1. 电路结构

Fig. 1 Circuit configuration

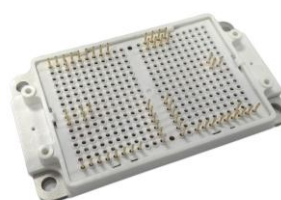
模块外形
Module Appearance


图 2. 模块外形

Fig. 2 Module appearance

模块标签说明
Module Label Code Instruction


数据位置 Data position	数据内容 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
I^2t	二极管 I^2t 值 Diode I^2t	$V_R = 0V, t_P = 10\text{ms}, T_{vj} = 150\text{ }^{\circ}\text{C}$	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				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		32.7		
$R_{th(C-H)} \text{ Diode}$	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		53.7		
$T_{vj\text{ op}}$	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	$I_C=300A$, $V_{CE}=500V$, $V_{GE}=-7.5/+15V$, $R_{G(OFF)}=15\Omega$, $L_S=25nH$, $dv/dt^{(*1)}=4500V/\mu s$ ($T_{vj}=150\text{ }^{\circ}C$).	$T_{vj}=25\text{ }^{\circ}C$		780		ns
			$T_{vj}=125\text{ }^{\circ}C$		800		
			$T_{vj}=150\text{ }^{\circ}C$		820		
t_f	下降时间 Fall time		$T_{vj}=25\text{ }^{\circ}C$		85		ns
			$T_{vj}=125\text{ }^{\circ}C$		82		
			$T_{vj}=150\text{ }^{\circ}C$		80		
E_{OFF}	关断损耗 Turn-off energy loss		$T_{vj}=25\text{ }^{\circ}C$		11.6		mJ
			$T_{vj}=125\text{ }^{\circ}C$		16.4		
			$T_{vj}=150\text{ }^{\circ}C$		16.8		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	$T_{vj}=25\text{ }^{\circ}C$		100		ns	
		$T_{vj}=125\text{ }^{\circ}C$		95			
		$T_{vj}=150\text{ }^{\circ}C$		95			
t_r	上升时间 Rise time	$T_{vj}=25\text{ }^{\circ}C$		32		ns	
		$T_{vj}=125\text{ }^{\circ}C$		38			
		$T_{vj}=150\text{ }^{\circ}C$		40			
E_{ON}	开通损耗 Turn-on energy loss	$T_{vj}=25\text{ }^{\circ}C$		4.8		mJ	
		$T_{vj}=125\text{ }^{\circ}C$		6.0			
		$T_{vj}=150\text{ }^{\circ}C$		6.3			
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	$T_{vj}=25\text{ }^{\circ}C$		10		μC	
		$T_{vj}=125\text{ }^{\circ}C$		20			
		$T_{vj}=150\text{ }^{\circ}C$		22			
I_{rr}	二极管反向恢复电流 Diode reverse recovery current	$T_{vj}=25\text{ }^{\circ}C$		180		A	
		$T_{vj}=125\text{ }^{\circ}C$		210			
		$T_{vj}=150\text{ }^{\circ}C$		215			
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy	$T_{vj}=25\text{ }^{\circ}C$		4.0		mJ	
		$T_{vj}=125\text{ }^{\circ}C$		8.0			
		$T_{vj}=150\text{ }^{\circ}C$		8.4			

1.(*1) dv/dt : 定义为关断波形电压 V_{CE} 上升段, 40% V_{CE} 至 60% V_{CE} 区间段的斜率(*1) dv/dt : Defined as the slope of waveform of 40% V_{CE} to 60% V_{CE} during turn off)

注意:
Note:

2.(*2) di/dt : 定义为开通波形电流 I_C 上升段, 40% I_C 至 60% I_C 区间段的斜率(*2) di/dt : Defined as the slope of waveform of 40% V_{CE} to 60% di/dt during turn on)

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
$V_F^{(*1)}$	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
$R_{th(J-C)} \text{ IGBT}$	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		39.6		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 =5000A/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

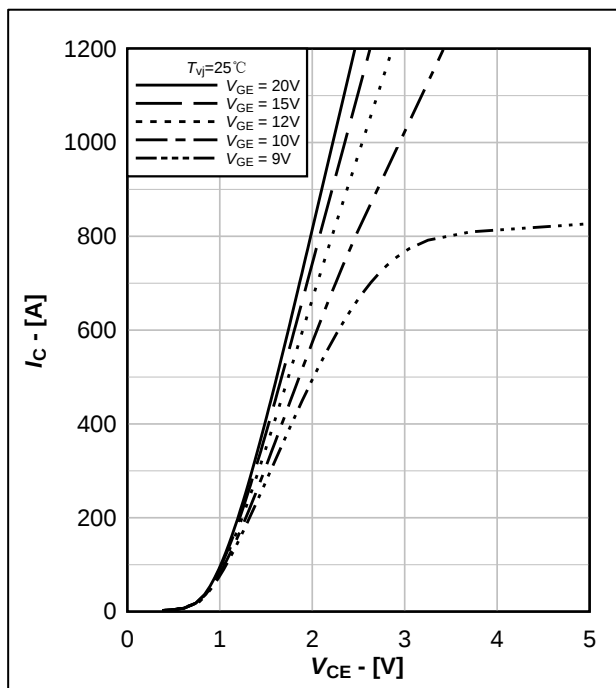
IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4

图 3. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

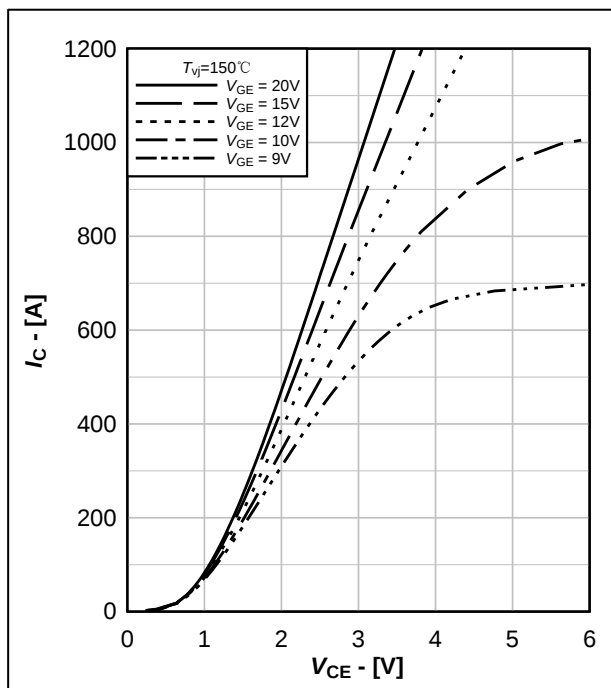
Fig.3 Typical IGBT output characteristic, $I_C = f(V_{CE})$

图 4. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

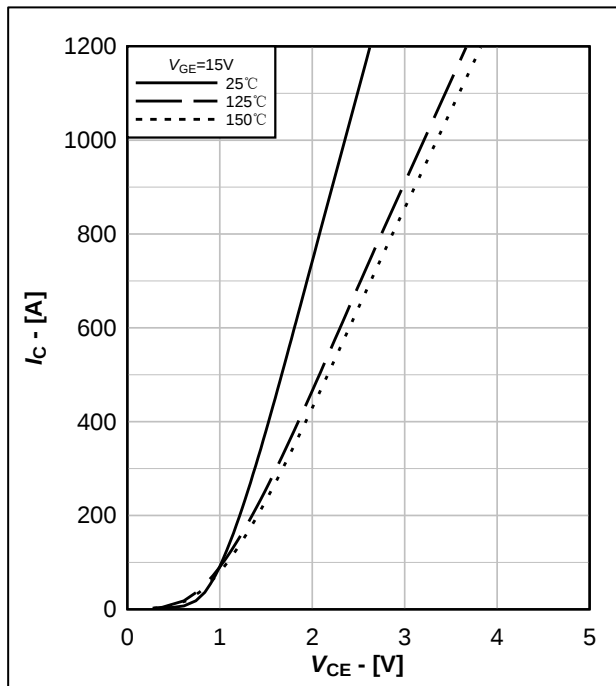
Fig.4 Typical IGBT output characteristic, $I_C = f(V_{CE})$

图 5. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

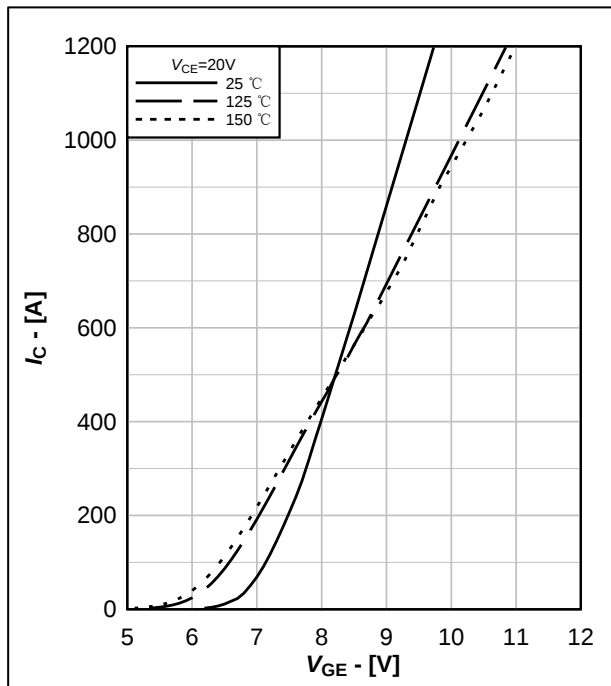
Fig.5 Typical IGBT output characteristic, $I_C = f(V_{CE})$

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

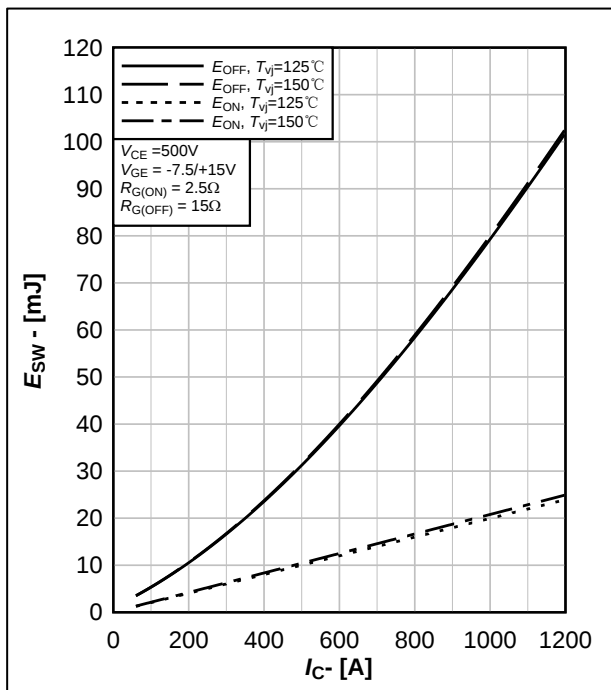

图 7. IGBT 开关损耗典型曲线, $E_{on}=f(I_C)$, $E_{off}=f(I_C)$

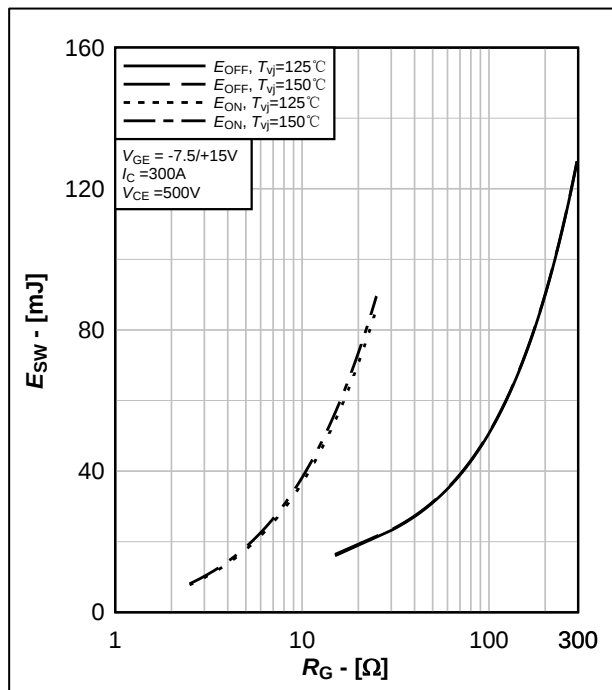
Fig.7 Typical IGBT switching energy, $E_{on}=f(I_C)$, $E_{off}=f(I_C)$

图 8. IGBT 开关损耗典型曲线, $E_{on}=f(R_G)$, $E_{off}=f(R_G)$

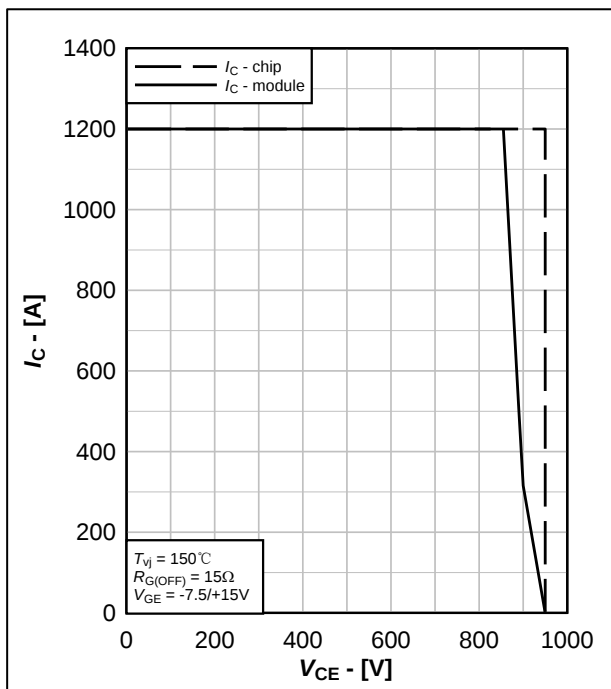
Fig.8 Typical IGBT switching energy, $E_{on}=f(R_G)$, $E_{off}=f(R_G)$

图 9. IGBT 反偏安全工作区, $I_C=f(V_{CE})$

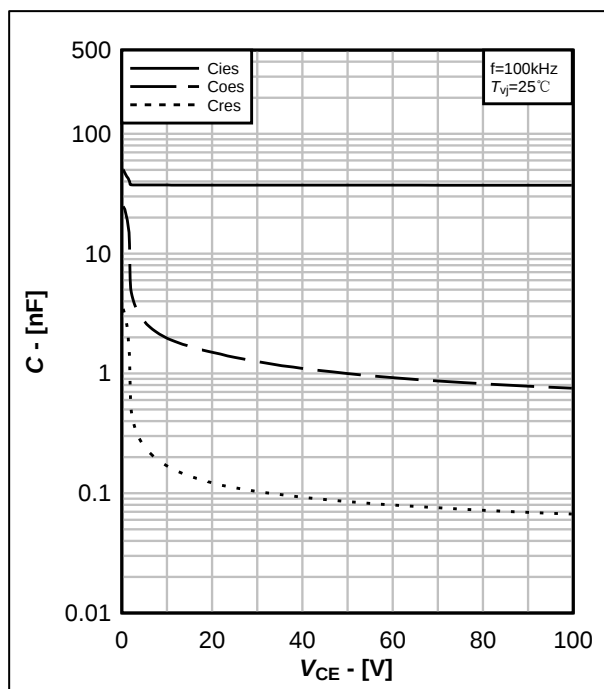
Fig.9 Reverse bias safe operating area of IGBT, $I_C=f(V_{CE})$

图 10. 电容特性典型曲线, $C=f(V_{CE})$

Fig.10 Typical capacity characteristic, $C=f(V_{CE})$

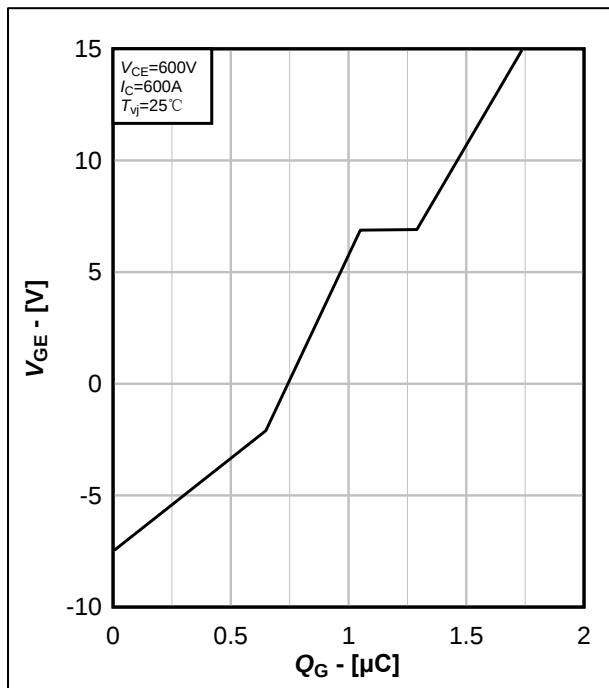
IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4

图 11. 栅极电荷特性典型曲线, $V_{GE} = f(Q_G)$

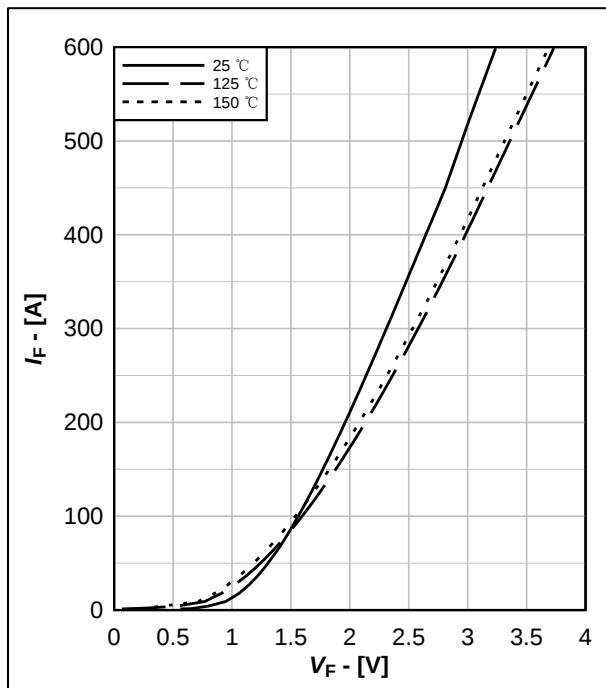
Fig.11 Typical gate charge characteristic, $V_{GE} = f(Q_G)$

图 12. FRD 输出特性典型曲线, $I_F = f(V_F)$

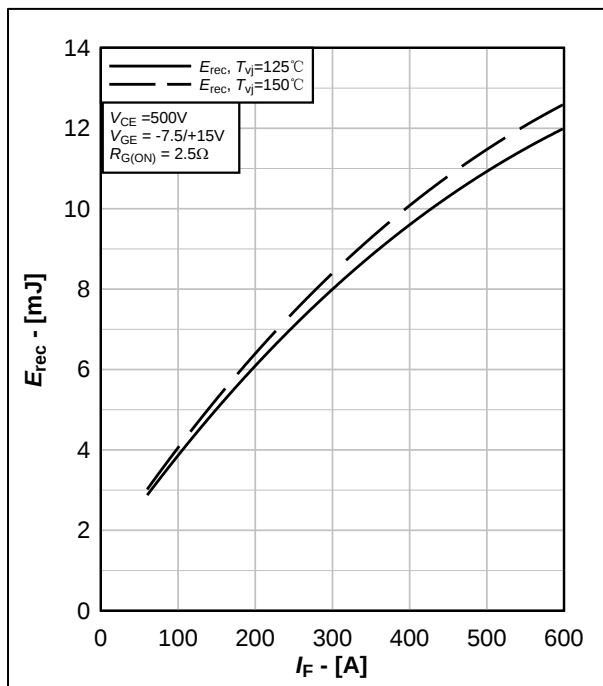
Fig.12 Typical FRD output characteristic, $I_F = f(V_F)$

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

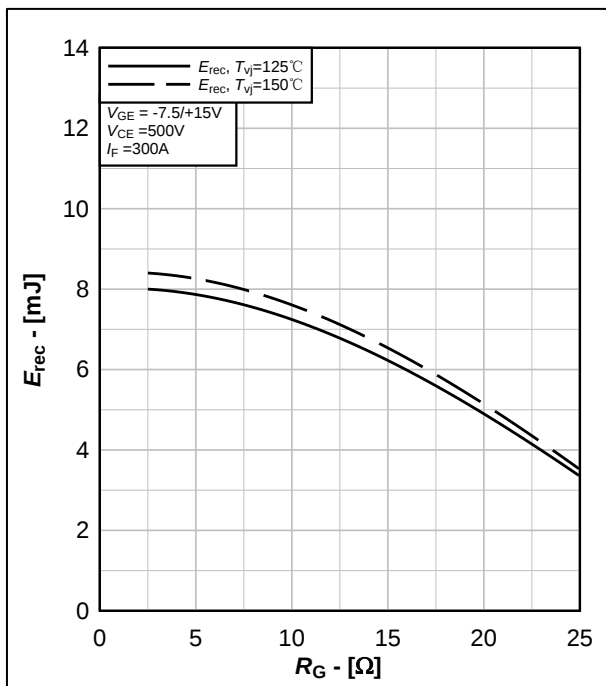
Fig.13 Typical FRD switching loss E_{rec} , $E_{rec} = f(I_F)$

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} , $E_{rec} = f(R_G)$

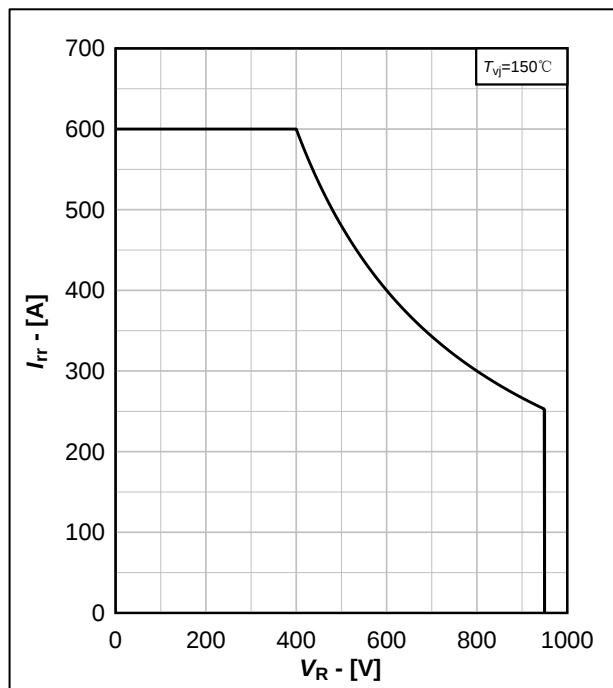
IGBT T1/2/3/4, 二极管 D1/2/3/4
IGBT T1/2/3/4, Diode D1/2/3/4

图 15. FRD 反偏安全工作区, $I_{rr} = f(V_R)$

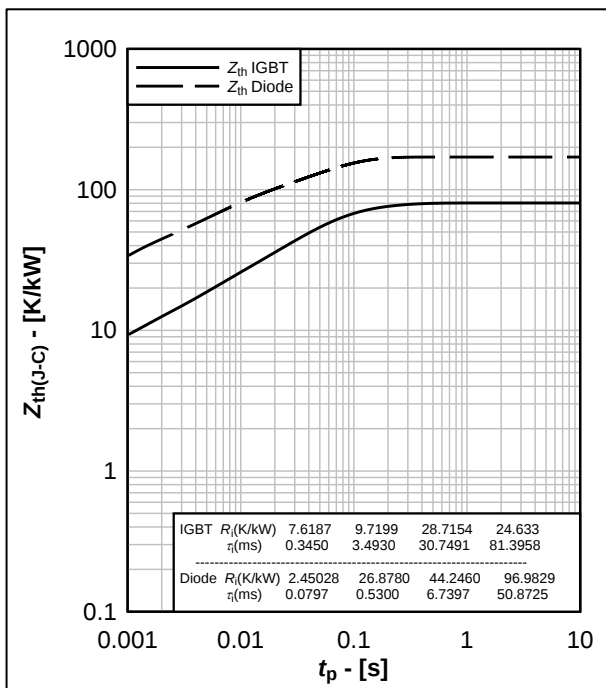
Fig.15 Reverse bias safe operating area of FRD, $I_{rr} = f(V_R)$

图 16. 瞬态热阻抗曲线, $Z_{th(j-c)} = f(t_p)$

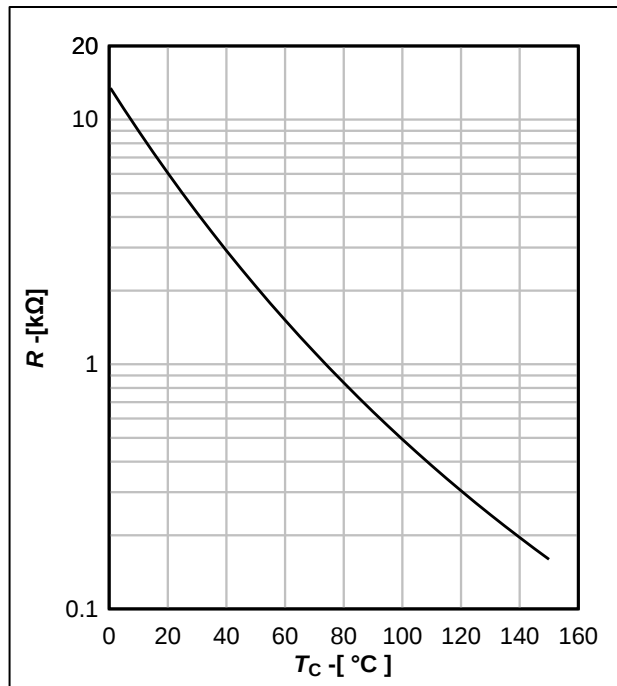
Fig.16 Transient thermal impedance, $Z_{th(j-c)} = f(t_p)$

图 17. 热敏电阻典型特性曲线, $R = f(T_c)$

Fig.17 Typical NTC thermistor characteristic, $R = f(T_c)$

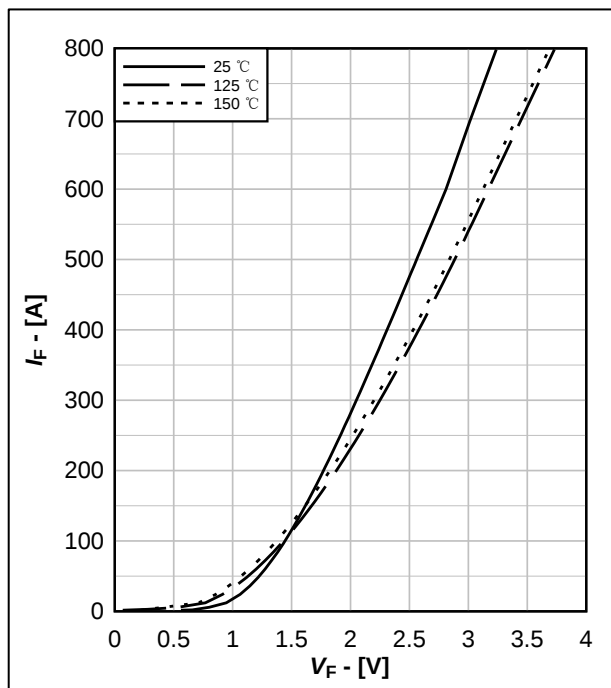
二极管 D5/6
Diode D5/6

图 18. FRD 输出特性典型曲线, $I_F = f(V_F)$

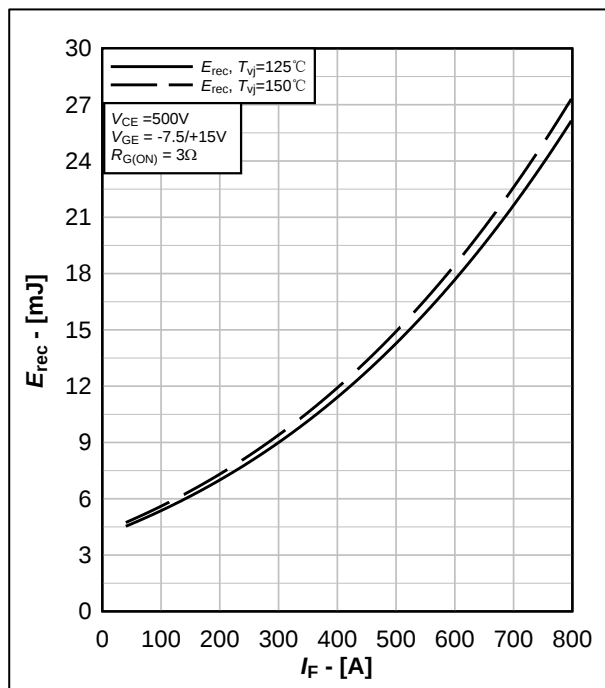
Fig.18 Typical FRD output characteristic, $I_F = f(V_F)$

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

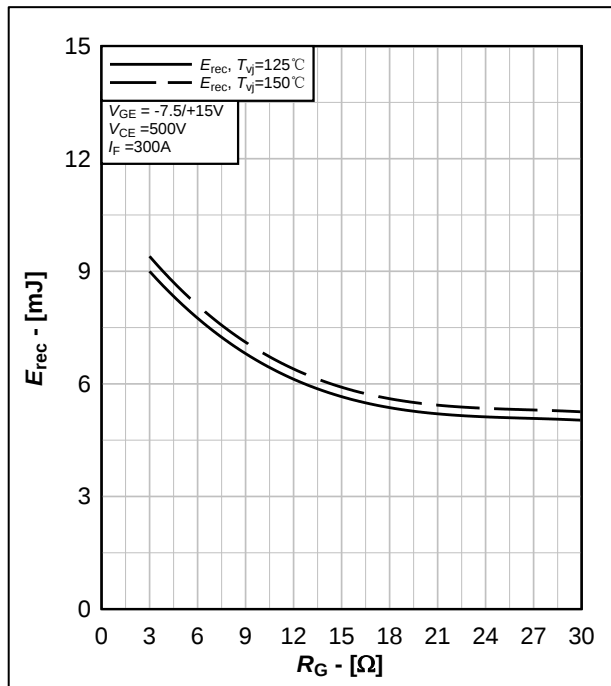
Fig.19 Typical FRD switching loss E_{rec} , $E_{rec} = f(I_F)$

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

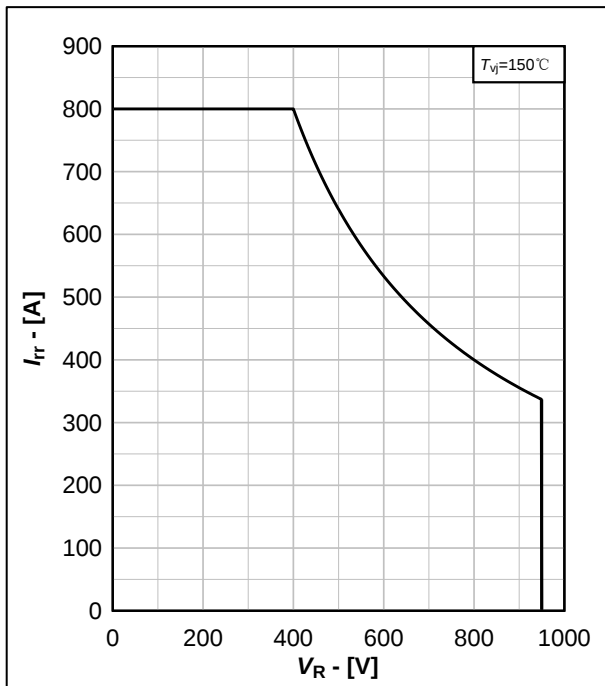
Fig.20 Typical FRD switching loss E_{rec} , $E_{rec} = f(R_G)$

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

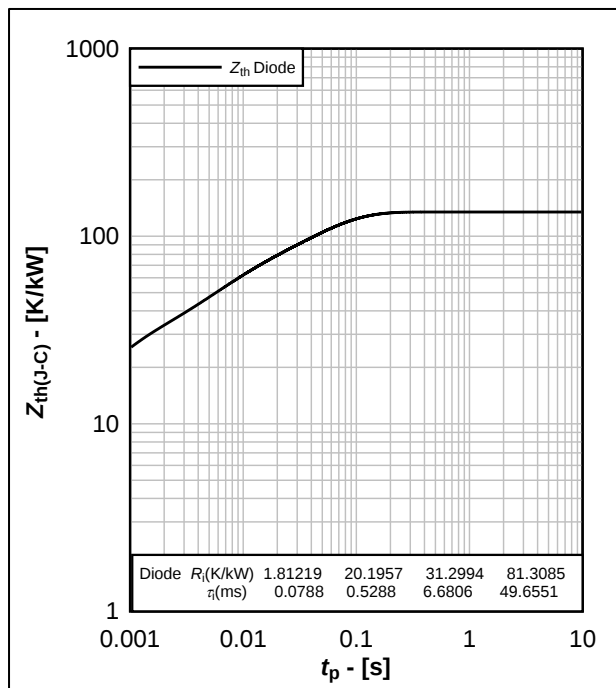
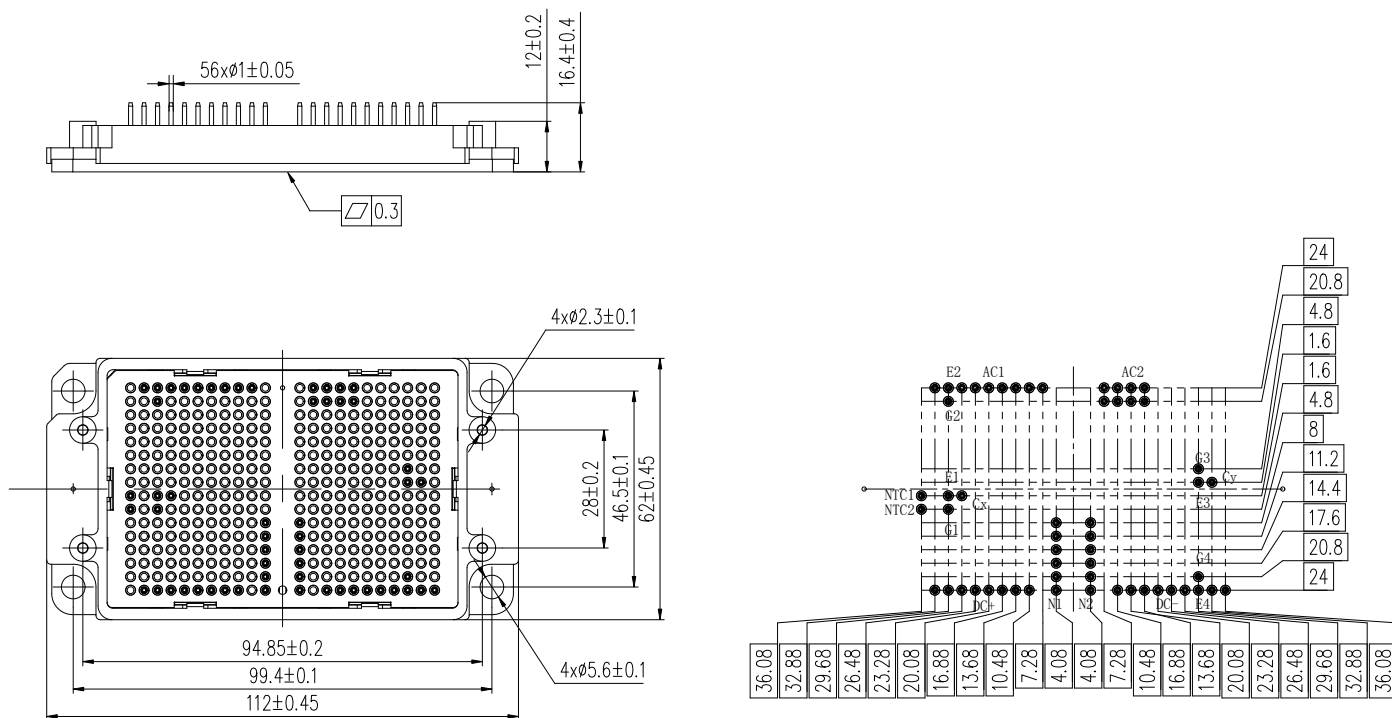


图 22. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$

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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