中国中车 CRRC

TG600NP10U4B-S500

三电平 IGBT 模块 3-level IGBT Module

产品数据手册　Product Datasheet 版本 Ver 24.06

关键参数　Key Parameters

V_{CES}		1000	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

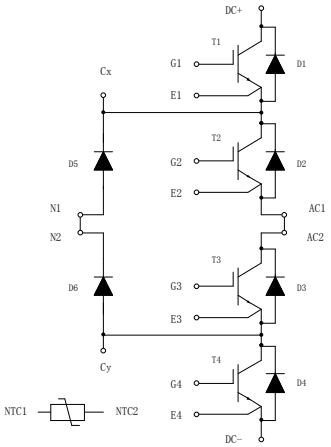


图 1. 电路结构

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= -40 °C	1000	V
		V_{GE} = 0V, T_C= 25 °C	1000	V
		V_{GE} = 0V, T_C= 150 °C	1000	V
V_{GES}	栅极-发射极电压 Gate-emitter voltage	T_C= 25 °C	+23/-20	V
I_C	额定电流 Rating Current	T_C = 75 °C, $T_{vj\ max}$=175°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 °C, $T_{vj\ max}$=175°C	1.7	kW
V_{RRM}	二极管重复峰值电压 Diode repetitive voltage		1000	V
I_F	二极管额定正向电流 Diode rating forward current	T_C = 75 °C, $T_{vj\ max}$=175°C	300	A

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
$R_{th(J-C)\ IGBT}$	IGBT 结壳热阻 Thermal resistance – IGBT				88.2	K / kW
$R_{th(J-C)\ Diode}$	二极管结壳热阻 Thermal resistance – Diode				206.8	K / kW
$R_{th(C-H)\ IGBT}$	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		
$R_{th(C-H)\ Diode}$	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		
$T_{vj\ op}$	工作结温 Operating junction temperature		-40		150	°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 °C　　T_C= 25 °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 °C			10	mA
		V_{GE} = 0V, V_{CE} = V_{CES}, T_{vj} =150 °C			20	mA
I_{GES}	栅极漏电流 Gate leakage current	V_{GE} = +23/-20V, V_{CE} = 0V			0.5	μA
$V_{GE\ (th)}$	栅极-发射极阈值电压 Gate threshold voltage	I_C = 15mA, V_{GE} = V_{CE}, T_{vj} =-40 °C		6.08		V
		I_C = 15mA, V_{GE} = V_{CE}	4.70	5.30	5.90	V
		I_C = 15mA, V_{GE} = V_{CE}, T_{vj} =150 °C		3.75		
$V_{CE\ (sat)}$(*1)	集电极-发射极饱和电压 Collector-emitter saturation voltage	V_{GE} =15V, I_C = 300A,T_{vj} = -40°C		1.30		
		V_{GE} =15V, I_C = 300A		1.40	1.80	V
		V_{GE} =15V, I_C = 300A,T_{vj} = 125 °C		1.60		V
		V_{GE} =15V, I_C = 300A,T_{vj} = 150 °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, T_{vj} = -40 °C		2.25		
		I_F = 300A, V_{GE} = 0V		2.30	2.70	V
		I_F = 300A, V_{GE} = 0V, T_{vj} = 125 °C		2.60		V
		I_F = 300A, V_{GE} = 0V, T_{vj} = 150 °C		2.55		V

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_F/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		

注意：
Note:

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)

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 °C	1000	V
I_F	二极管额定正向电流 Diode rating forward current	T_C= 50°C	400	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	t_P = 1ms	800	A
I_{FSM}	浪涌电流 Surge current	V_R =0V, t_P = 10ms, T_{vj} = 150 °C	1280	A
I^2t	二极管 I^2t 值 Diode I^2t	V_R =0V, t_P = 10ms, T_{vj} = 150 °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 = 400A, V_{GE} = 0V, T_{vj} = -40°C		2.05		
		I_F = 400A, V_{GE} = 0V		2.30	2.70	V
		I_F = 400A, V_{GE} = 0V, T_{vj} = 125 °C		2.60		V
		I_F = 400A, V_{GE} = 0V, T_{vj} = 150 °C		2.55		V
I_{RRM}	重复反向电流 Repetitive reverse current	T_{vj} = 150°C, V_R = 1000V			20	mA
$R_{th(J-C)\ Diode}$	二极管结壳热阻 Thermal resistance – Diode				177.4	K / kW
$R_{th(C-H)\ Diode}$	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

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 °C		5		kΩ
△R/R	R100 偏差 Deviation of R100	T_C = 100 °C, R_{100}=493Ω	-5		5	%
P_{25}	耗散功率 Power dissipation	T_C = 25 °C			20	mW
$B_{25/50}$	B-值 B-value	$R_2 = R_{25}\exp[B_{25/50}(1/T_2 - 1/(298.15\ K))]$		3375		K
$B_{25/80}$	B-值 B-value	$R_2 = R_{25}\exp[B_{25/80}(1/T_2 - 1/(298.15\ K))]$		3411		K
$B_{25/100}$	B-值 B-value	$R_2 = R_{25}\exp[B_{25/100}(1/T_2 - 1/(298.15\ K))]$		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	
相对温度指数 RTI（RTI Elec,housing）		130	°C
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 °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	°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

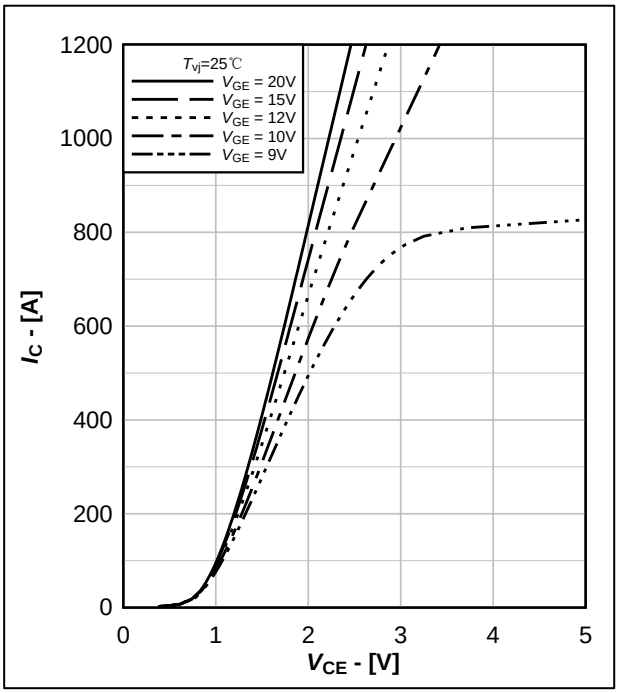


图 3. IGBT 输出特性典型曲线, I_C= f (V_{CE})

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

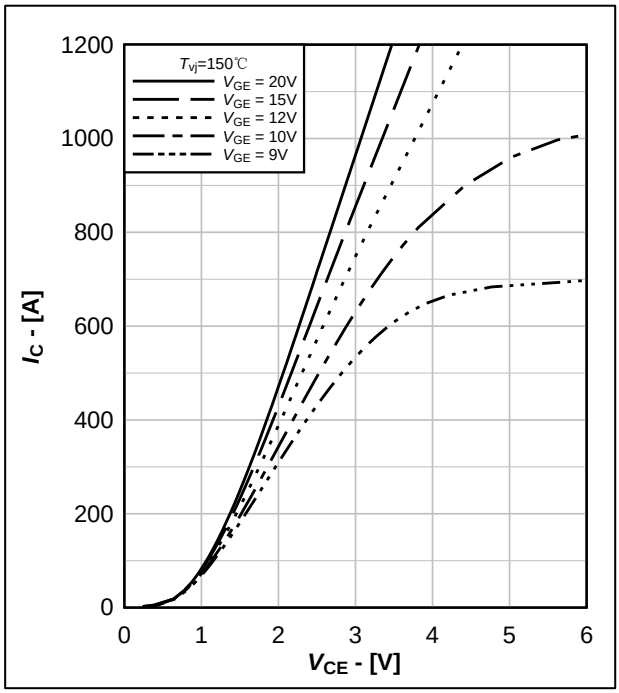


图 4. IGBT 输出特性典型曲线, I_C= f (V_{CE})

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

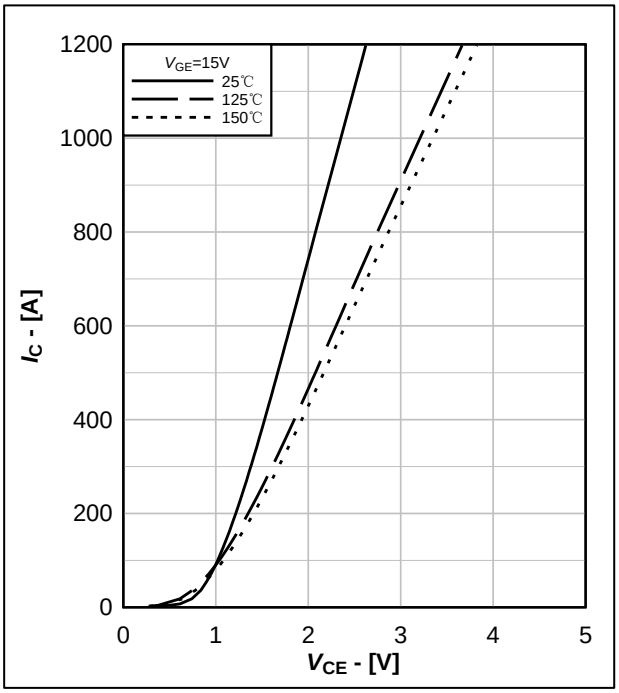


图 5. IGBT 输出特性典型曲线, I_C= f (V_{CE})

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

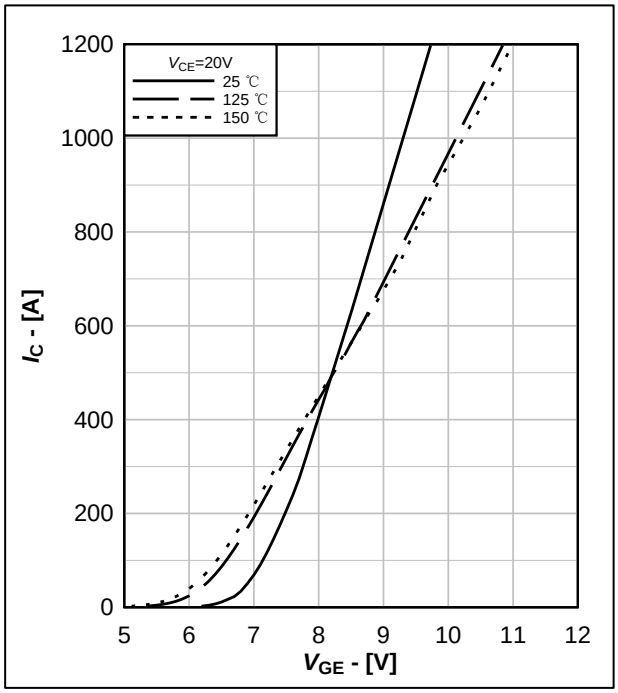


图 6. IGBT 传输特性典型曲线, I_C= f (V_{GE})

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

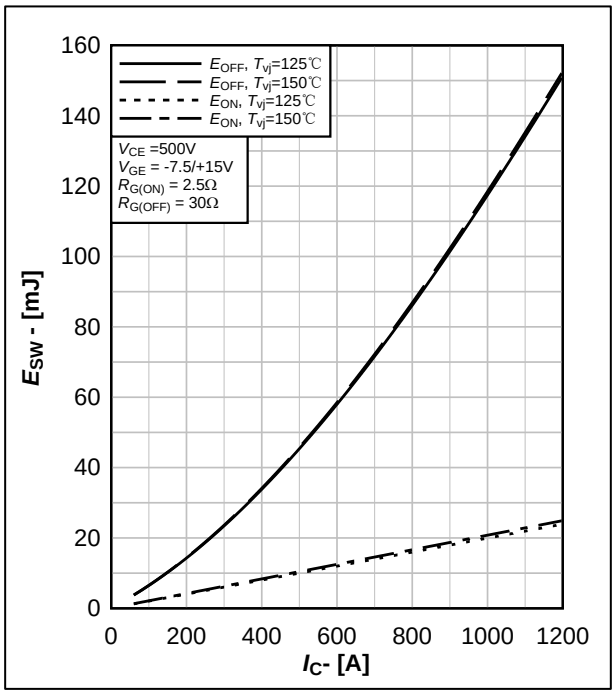


图 7. IGBT 开关损耗典型曲线, E_{on}= f (I_C), E_{off}= f (I_C)

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

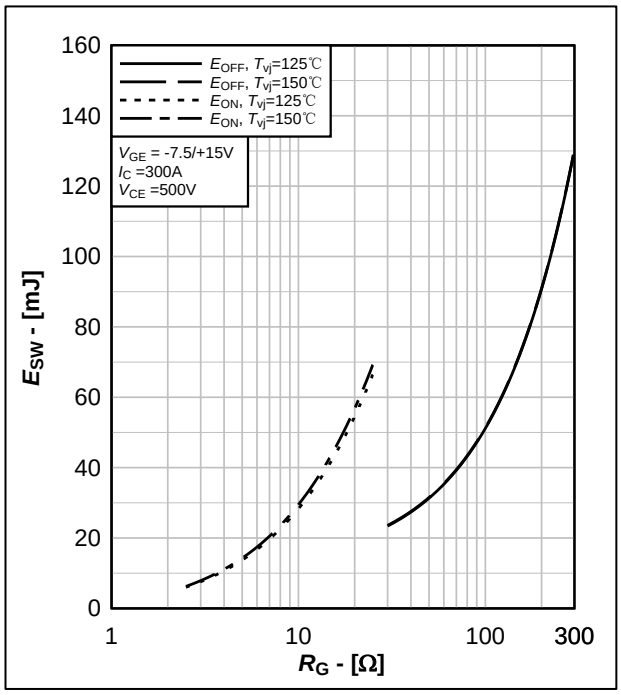


图 8. IGBT 开关损耗典型曲线, E_{on}= f (R_G), E_{off}= f (R_G)

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

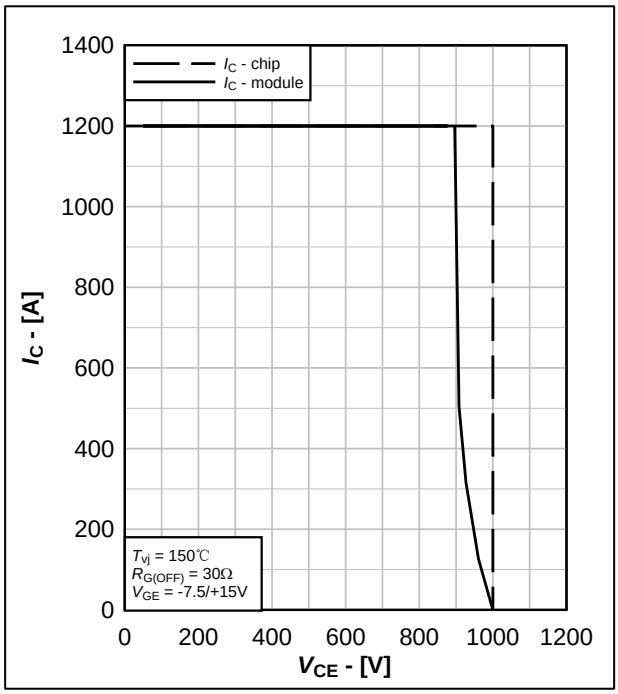


图 9. IGBT 反偏安全工作区, I_C = f (V_{CE})

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

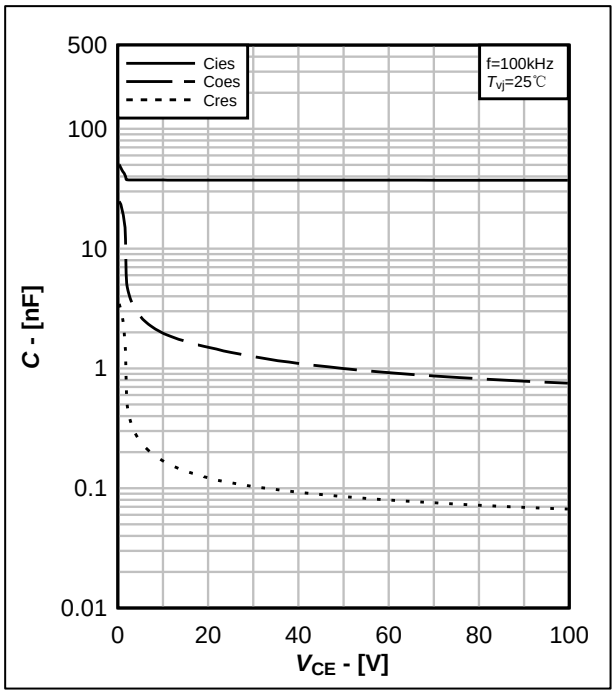


图 10. 电容特性典型曲线, C= f (V_{CE})

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

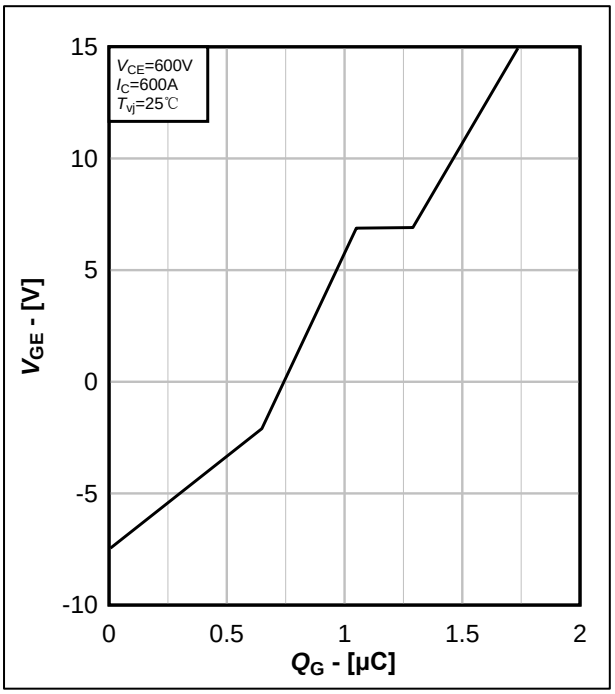


图 11. 栅极电荷特性典型曲线, V_{GE} = f (Q_G)

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

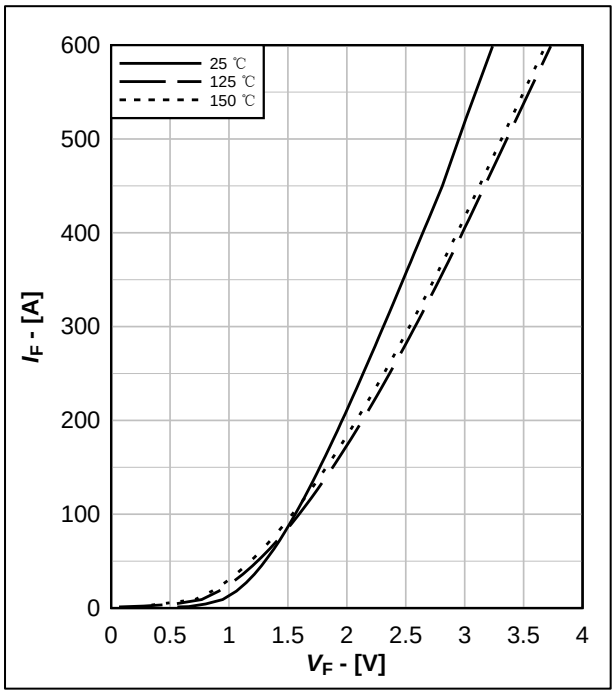


图 12. FRD 输出特性典型曲线, I_F = f (V_F)

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

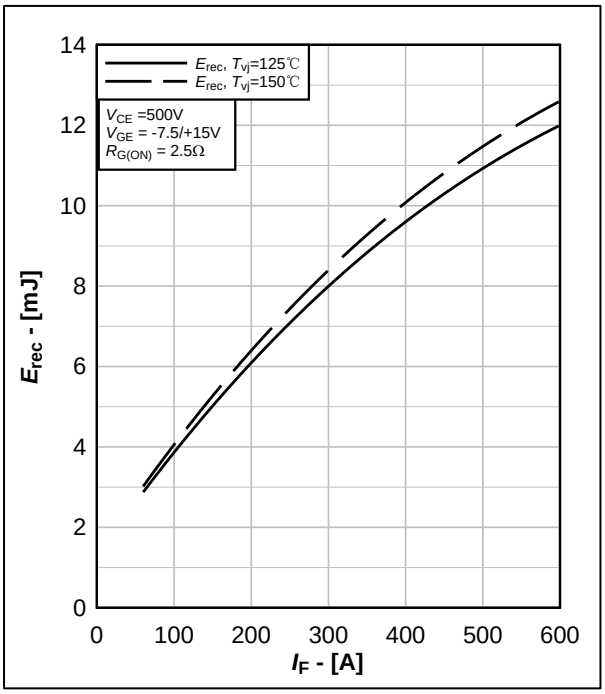


图 13. FRD 反向恢复损耗典型曲线, E_{rec}=f(I_F)

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

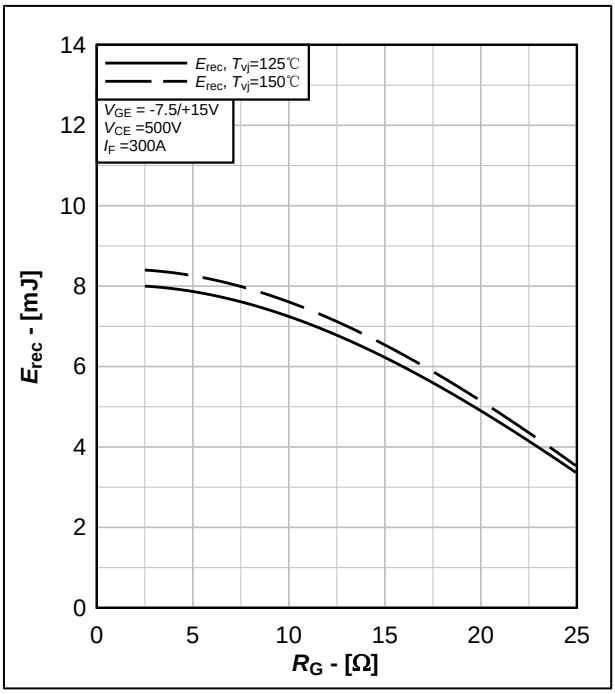


图 14. FRD 反向恢复损耗典型曲线, E_{rec}=f(R_G)

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

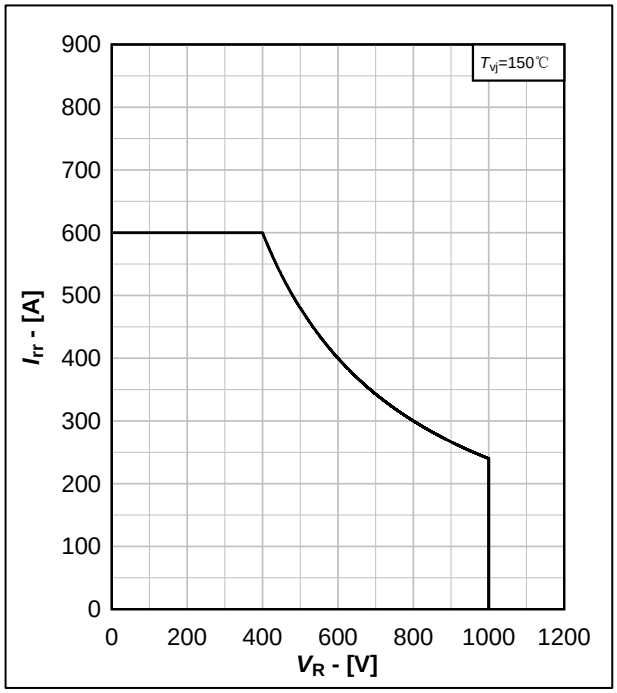


图 15. FRD 反偏安全工作区, I_{rr} = f (V_R)

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

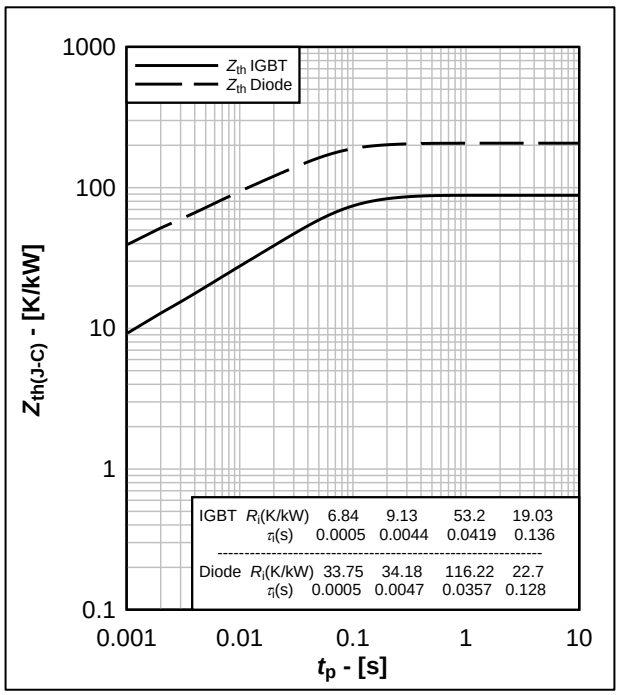


图 16. 瞬态热阻抗曲线, $Z_{th(J-C)}$ = f (t_p)

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

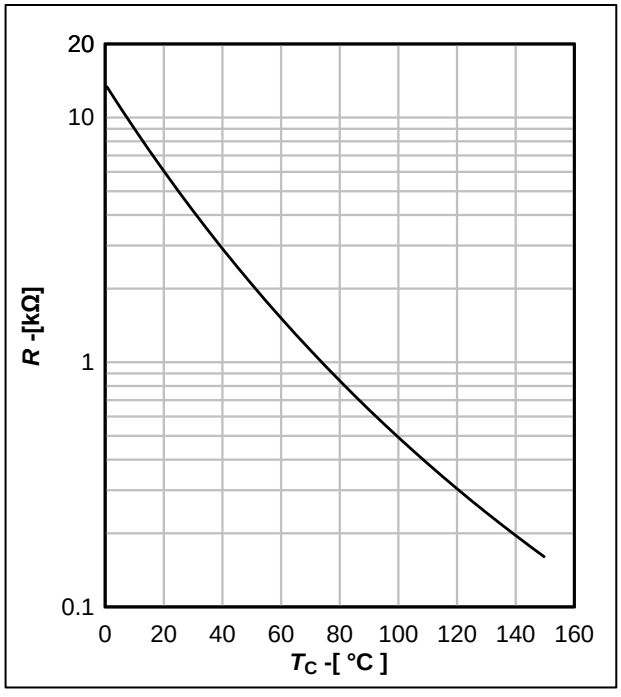


图 17. 热敏电阻典型特性曲线, R= f (T_C)

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

二极管 D5/6

Diode D5/6

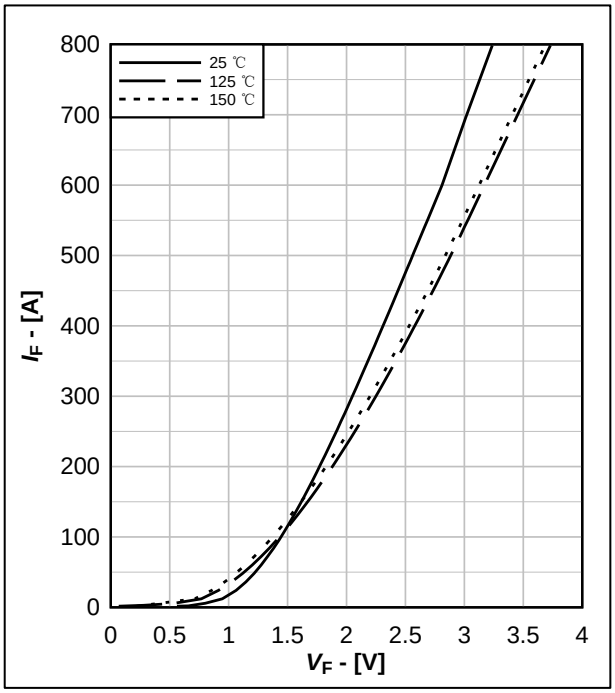


图 18. FRD 输出特性典型曲线, $I_F = f(V_F)$

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

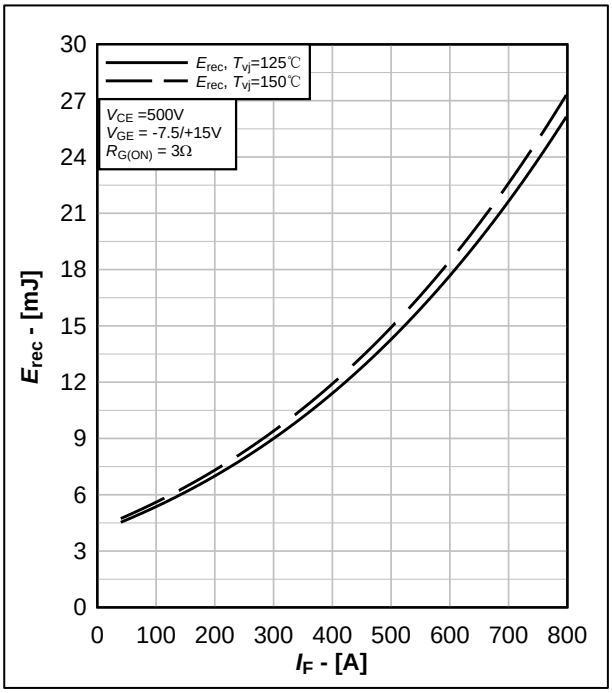


图 19. FRD 反向恢复损耗典型曲线, $E_{rec}=f(I_F)$

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

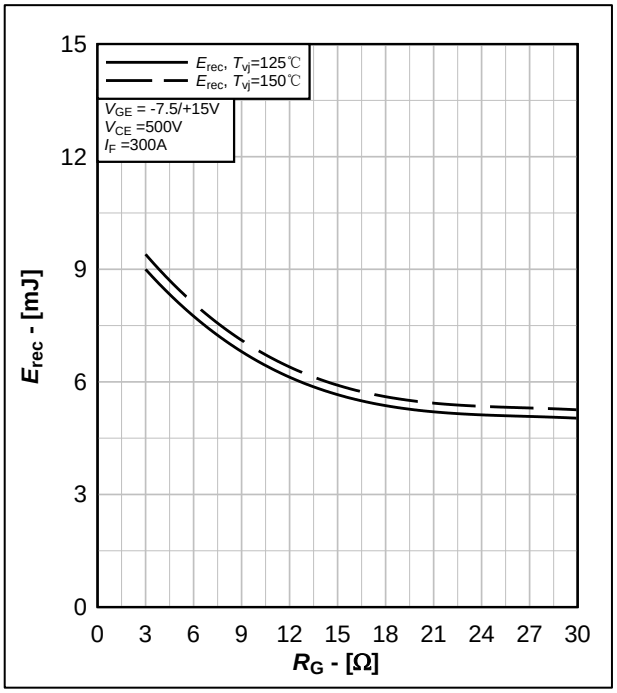


图 20. FRD 反向恢复损耗典型曲线, $E_{rec}=f(R_G)$

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

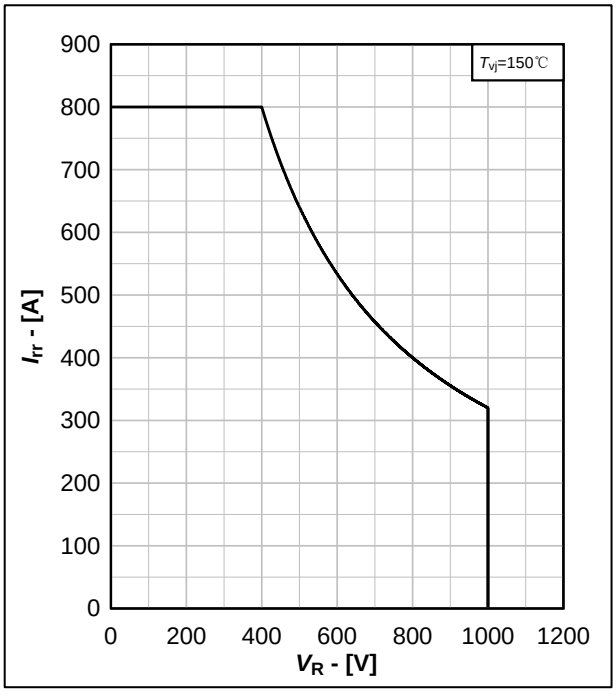


图 21. FRD 反偏安全工作区, $I_{rr} = f(V_R)$

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

二极管 D5/6

Diode D5/6

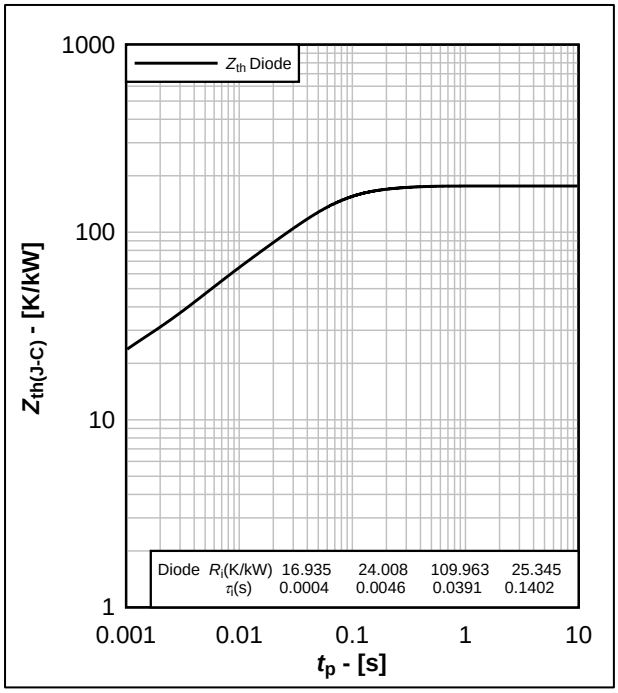
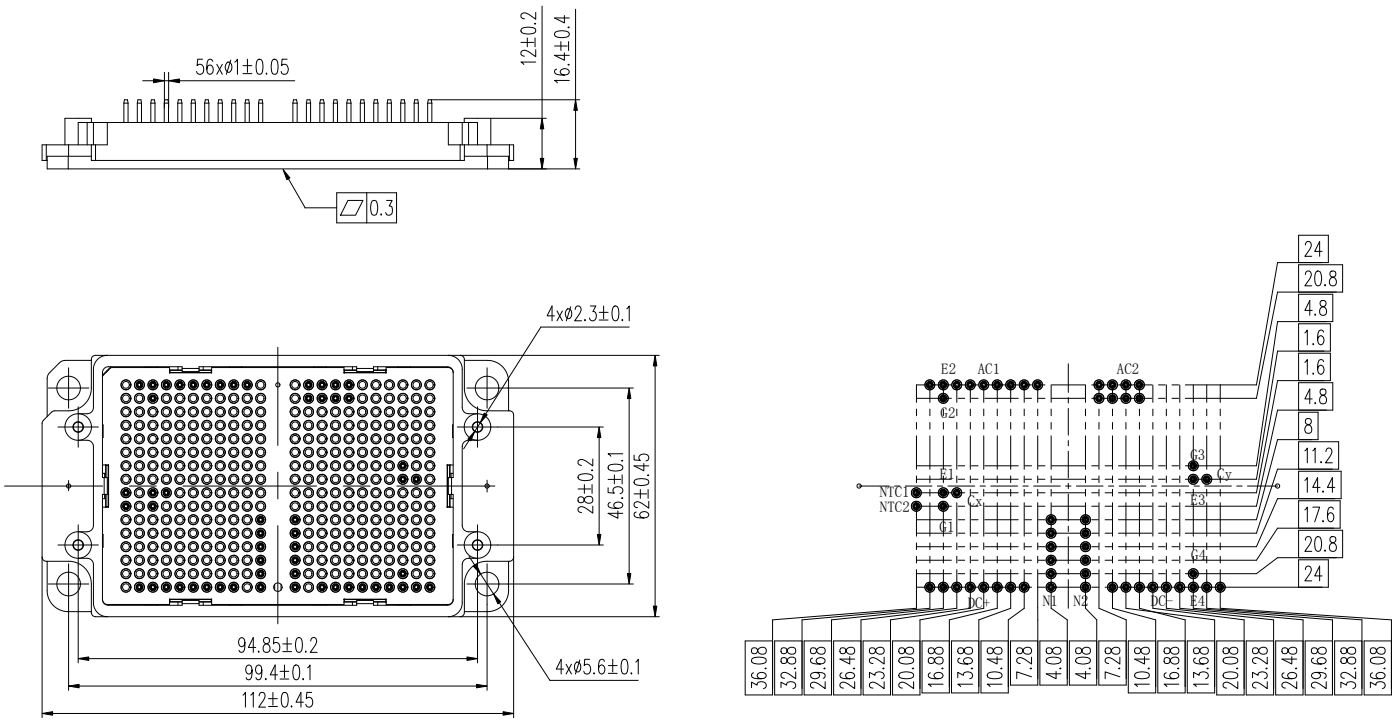


图 22. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$

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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