



产品数据手册 Product Datasheet 版本 Ver 23.12

TH200D3B10U4-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.	1.23	V
I_C	Max.	100	A
$I_{C(RM)}$	Max.	200	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	
● SiC 二极管		Ultra-fast SiC Diode	
● 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

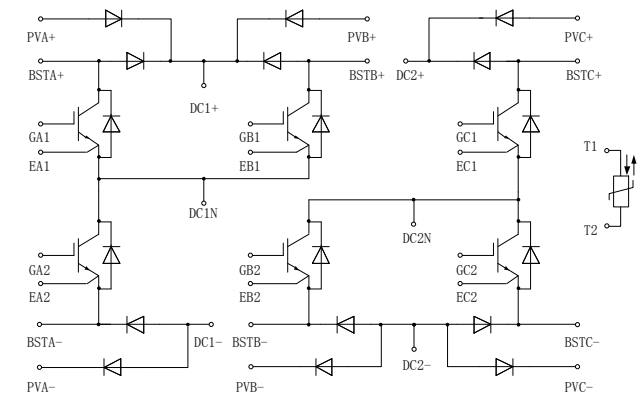


图 1. 电路结构

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	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 提升，二极管转换器
IGBT Boost, Diode Boost
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	集电极电流 Collector-emitter current	$T_H = 65\text{ }^{\circ}\text{C}, T_{vj\text{ max}} = 175\text{ }^{\circ}\text{C}$	70	A
	额定电流 Rating Current		100	A
$I_{C(PK)}$	集电极峰值电流 Peak collector current	$t_P = 1\text{ms}$	200	A
P_{max}	晶体管部分最大损耗 Max. transistor power dissipation	$T_C = 25\text{ }^{\circ}\text{C}, T_{vj\text{ max}} = 175\text{ }^{\circ}\text{C}$	339	W
V_{RRM}	二极管重复峰值电压 Diode repetitive voltage		1200	V
I_F	二极管正向直流电流 Diode forward current	DC	25	A
	二极管额定正向电流 Diode rating forward current		30	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_P = 1\text{ms}$	60	A
ρ_t	二极管 ρ_t 值 Diode ρ_t 值	$V_R = 0V, t_P = 10\text{ms}, T_{vj} = 150\text{ }^{\circ}\text{C}$	66	A^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				443	K / kW
$R_{th(J-C)}\text{ Diode}$	二极管结壳热阻 Thermal resistance – Diode				910	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		193		
$R_{th(C-H)}\text{ Diode}$	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		311		
$T_{vj\text{ op}}$	工作结温 Operating junction temperature		-40		150	$^{\circ}\text{C}$

IGBT 提升, 二极管转换器

IGBT Boost, Diode Boost

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
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_{vj} = 125\text{ }^{\circ}\text{C}$			3	mA
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_{vj} = 150\text{ }^{\circ}\text{C}$			5	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	$I_C = 1.67\text{mA}, V_{GE} = V_{CE}$	4.90	5.50	6.10	V
$V_{CE(sat)}^{(*1)}$	集电极-发射极饱和电压 Collector-emitter saturation voltage	$V_{GE} = 15V, I_C = 25A$		1.23	1.55	V
		$V_{GE} = 15V, I_C = 25A, T_{vj} = 125\text{ }^{\circ}\text{C}$		1.32		V
		$V_{GE} = 15V, I_C = 25A, T_{vj} = 150\text{ }^{\circ}\text{C}$		1.32		V
$V_F^{(*1)}$	二极管正向电压 Diode forward voltage	$I_F = 25A, V_{GE} = 0V$		1.35	1.70	V
		$I_F = 25A, V_{GE} = 0V, T_{vj} = 125\text{ }^{\circ}\text{C}$		1.60		V
		$I_F = 25A, V_{GE} = 0V, T_{vj} = 150\text{ }^{\circ}\text{C}$		1.70		V
C_{ies}	输入电容 Input capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		7.5		nF
Q_g	栅极电荷 Gate charge	-7.5/+15V		0.36		μC
C_{res}	反向传输电容 Reverse transfer capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		0.03		nF
R_{Gint}	内部栅极电阻 Internal gate resistor			2.4		Ω

注意: 1.(*1) 表示该参数的测试点为辅助母排端子 (*1) indicates it is measured at the auxiliary busbar terminal),

Note: 2.(*2) 表示 L 是电路杂散电感加上 L_{sCE} (*2) indicates L is the circuit stray inductance plus L_{sCE}).

IGBT 提升，二极管转换器

IGBT Boost, Diode Boost

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	$I_C = 25A$, $V_{CE} = 500V$, $V_{GE} = -7.5/+15V$, $R_{G(OFF)} = 10\Omega$, $L_S = 35nH$, $dv/dt = 4300V/\mu s$ ($T_{vj} = 150\text{ }^{\circ}C$).	$T_{vj} = 25\text{ }^{\circ}C$		220		ns
			$T_{vj} = 125\text{ }^{\circ}C$		260		
			$T_{vj} = 150\text{ }^{\circ}C$		275		
t_f	下降时间 Fall time		$T_{vj} = 25\text{ }^{\circ}C$		65		ns
			$T_{vj} = 125\text{ }^{\circ}C$		65		
			$T_{vj} = 150\text{ }^{\circ}C$		85		
E_{OFF}	关断损耗 Turn-off energy loss		$T_{vj} = 25\text{ }^{\circ}C$		0.80		mJ
			$T_{vj} = 125\text{ }^{\circ}C$		1.05		
			$T_{vj} = 150\text{ }^{\circ}C$		1.10		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	$T_{vj} = 25\text{ }^{\circ}C$		85		ns	
		$T_{vj} = 125\text{ }^{\circ}C$		80			
		$T_{vj} = 150\text{ }^{\circ}C$		80			
t_r	上升时间 Rise time	$T_{vj} = 25\text{ }^{\circ}C$		14		ns	
		$T_{vj} = 125\text{ }^{\circ}C$		17			
		$T_{vj} = 150\text{ }^{\circ}C$		18			
E_{ON}	开通损耗 Turn-on energy loss	$T_{vj} = 25\text{ }^{\circ}C$		0.03		mJ	
		$T_{vj} = 125\text{ }^{\circ}C$		0.10			
		$T_{vj} = 150\text{ }^{\circ}C$		0.11			
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	$T_{vj} = 25\text{ }^{\circ}C$		0.15		μC	
		$T_{vj} = 125\text{ }^{\circ}C$		0.17			
		$T_{vj} = 150\text{ }^{\circ}C$		0.19			
I_{rr}	二极管反向恢复电流 Diode reverse recovery current	$T_{vj} = 25\text{ }^{\circ}C$		7		A	
		$T_{vj} = 125\text{ }^{\circ}C$		10			
		$T_{vj} = 150\text{ }^{\circ}C$		10			
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy	$T_{vj} = 25\text{ }^{\circ}C$		0.060		mJ	
		$T_{vj} = 125\text{ }^{\circ}C$		0.070			
		$T_{vj} = 150\text{ }^{\circ}C$		0.073			

旁路二极管

Bypass Diode

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	$T_C = 25\text{ }^{\circ}\text{C}$	1200	V
I_{FRMSM}	最大正向均方根电流（每芯片） Maximum RMS forward current per chip	$T_H = 75\text{ }^{\circ}\text{C}$	50	A
I_{RMSM}	最大整流器输出均方根电流 Maximum RMS current at rectifier output	$T_H = 75\text{ }^{\circ}\text{C}$	50	A
I_{FSM}	浪涌电流 Surge current	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 110\text{ }^{\circ}\text{C}$	832	A
I^2t	二极管 I^2t 值 Diode I^2t	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 110\text{ }^{\circ}\text{C}$	3461	A^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	$T_{vj} = 150\text{ }^{\circ}\text{C}$, $I_F = 45\text{A}$		1.00	1.35	V
I_{RRM}	重复反向电流 Repetitive reverse current	$T_{vj} = 150\text{ }^{\circ}\text{C}$, $V_R = 1200\text{V}$			5	mA
$R_{th(J-C) \text{ Diode}}$	二极管结壳热阻 Thermal resistance –Diode				415	K / kW
$R_{th(C-H) \text{ Diode}}$	接触热阻(Diode) Thermal resistance – case to heatsink (Diode)	安装力矩 1.3Nm, 导热脂 3.3W/m·K Mounting torque 1.3Nm, with mounting grease 3.3W/m·K		242		K / kW
$T_{vj \text{ op}}$	工作结温 Operating junction temperature		-40		110	$^{\circ}\text{C}$

反极性保护二极管
Inverse-polarity Protection Diode
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	$T_C = 25\text{ }^{\circ}\text{C}$	1200	V
I_{FRMSM}	最大正向均方根电流（每芯片） Maximum RMS forward current per chip	$T_H = 70\text{ }^{\circ}\text{C}$	30	A
I_{RMSM}	最大整流器输出均方根电流 Maximum RMS current at rectifier output	$T_H = 70\text{ }^{\circ}\text{C}$	30	A
I_{FSM}	浪涌电流 Surge current	$V_R = 0V, t_p = 10ms, T_{vj} = 150\text{ }^{\circ}\text{C}$	280	A
I^2t	二极管 I^2t 值 Diode I^2t	$V_R = 0V, t_p = 10ms, T_{vj} = 150\text{ }^{\circ}\text{C}$	392	A^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	$T_{vj} = 150\text{ }^{\circ}\text{C}, I_F = 15A$		1.00	1.35	V
I_{RRM}	重复反向电流 Repetitive reverse current	$T_{vj} = 150\text{ }^{\circ}\text{C}, V_R = 1200V$			5	mA
$R_{th(J-C) \text{ Diode}}$	二极管结壳热阻 Thermal resistance –Diode				1062	K / kW
$R_{th(C-H) \text{ Diode}}$	接触热阻(Diode) Thermal resistance – case to heatsink (Diode)	安装力矩 1.3Nm, 导热脂 3.3W/m·K Mounting torque 1.3Nm, with mounting grease 3.3W/m·K		208		K / kW
$T_{vj \text{ op}}$	工作结温 Operating junction temperature		-40		110	$^{\circ}\text{C}$

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	11.2	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			22		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 提升，二极管转换器

IGBT Boost, Diode Boost

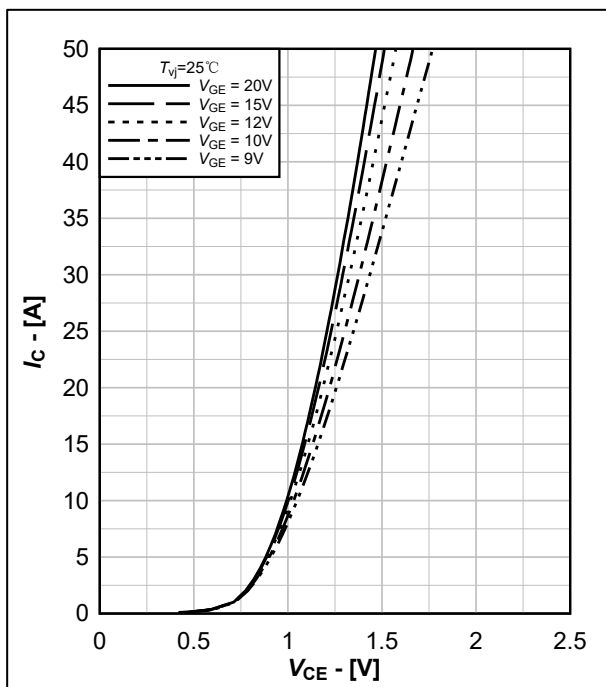


图 3. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

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

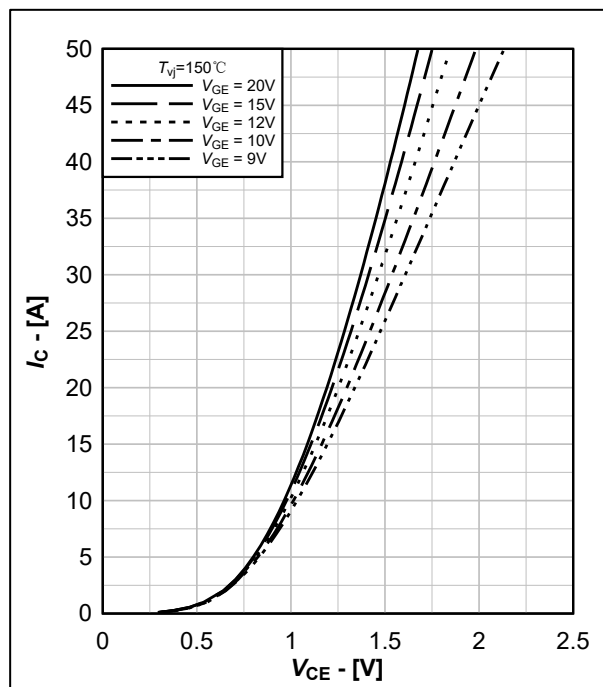


图 4. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

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

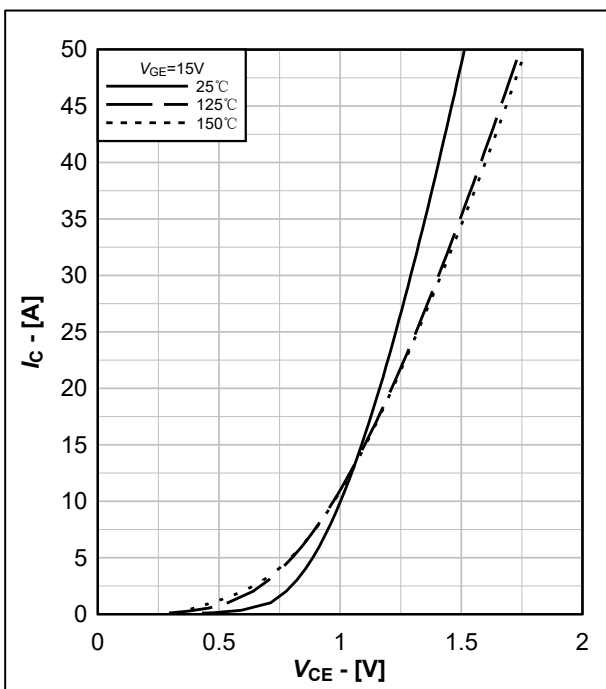


图 5. IGBT 输出特性典型曲线, $I_C = f(V_{CE})$

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

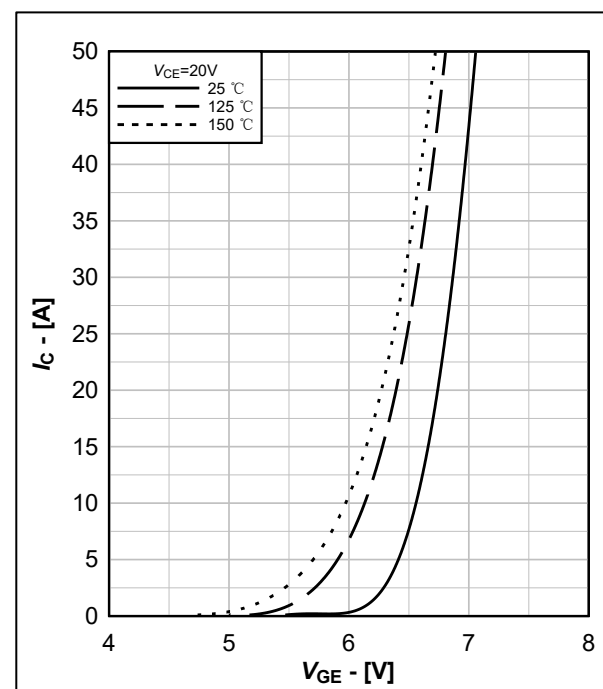
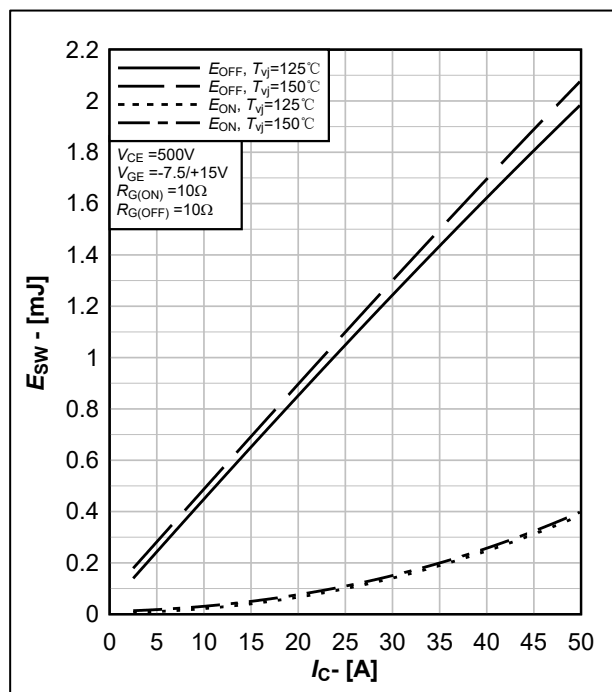
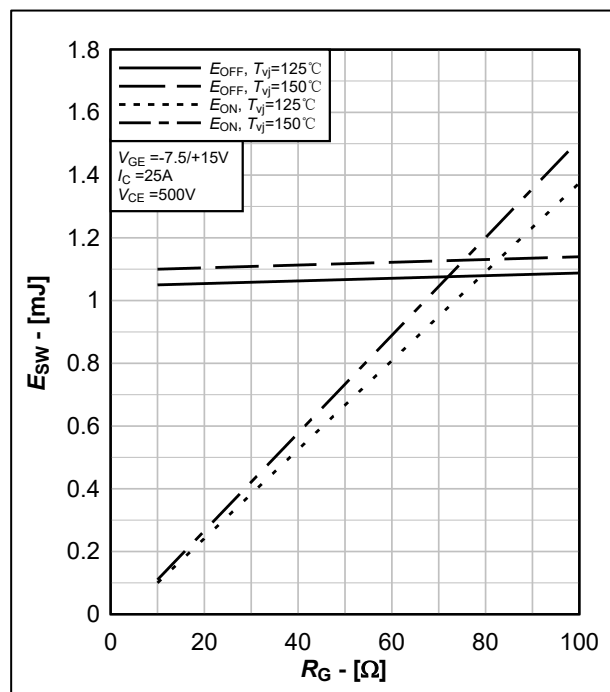
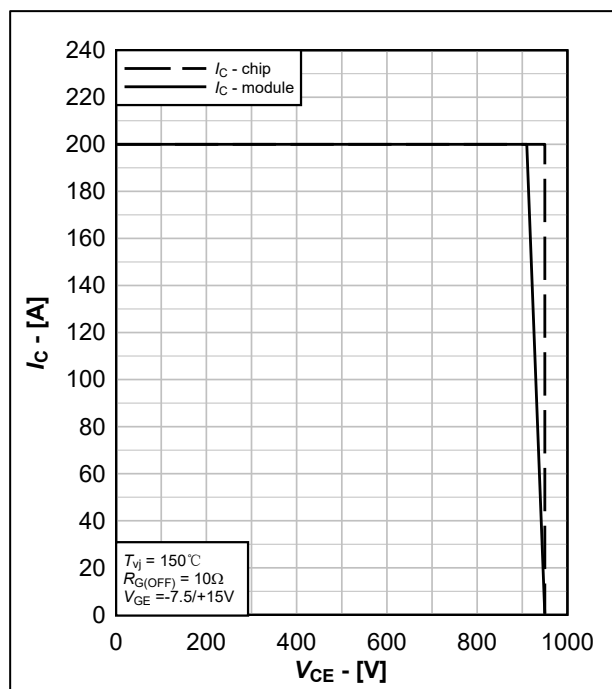
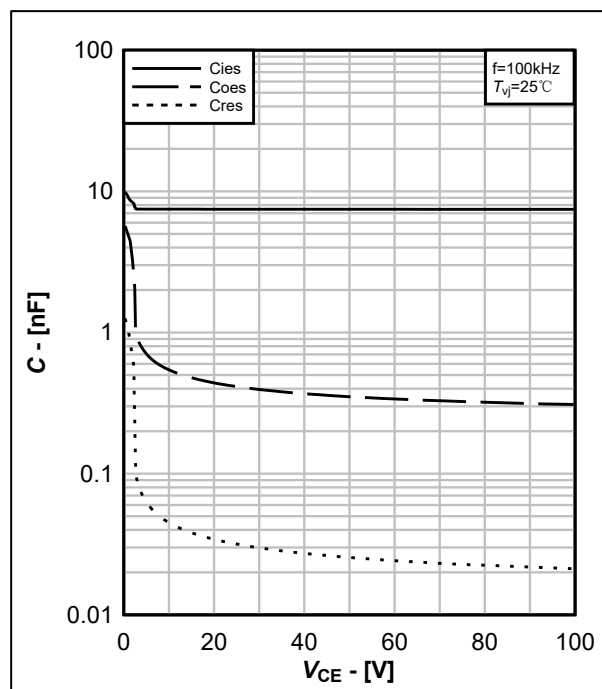


图 6. IGBT 传输特性典型曲线, $I_C = f(V_{GE})$

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

IGBT 提升, 二极管转换器

IGBT Boost, Diode Boost

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

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。

IGBT 提升，二极管转换器

IGBT Boost, Diode Boost

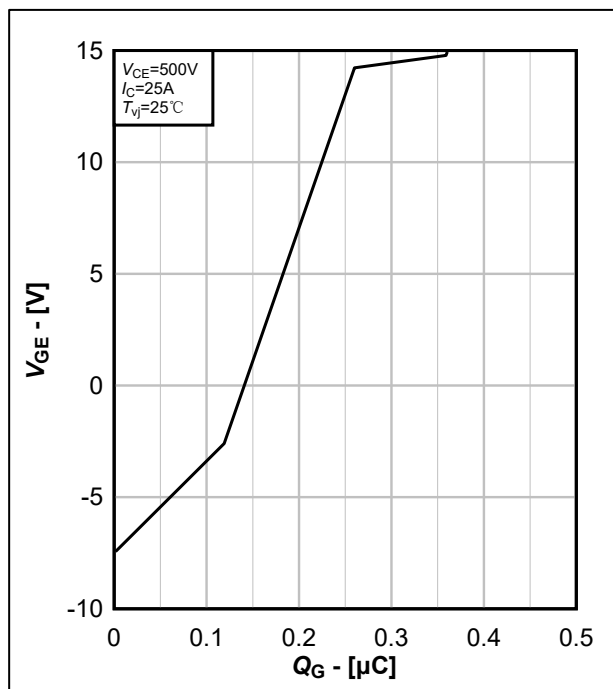

图 11. 栅极电荷特性典型曲线, $V_{GE} = f(Q_G)$

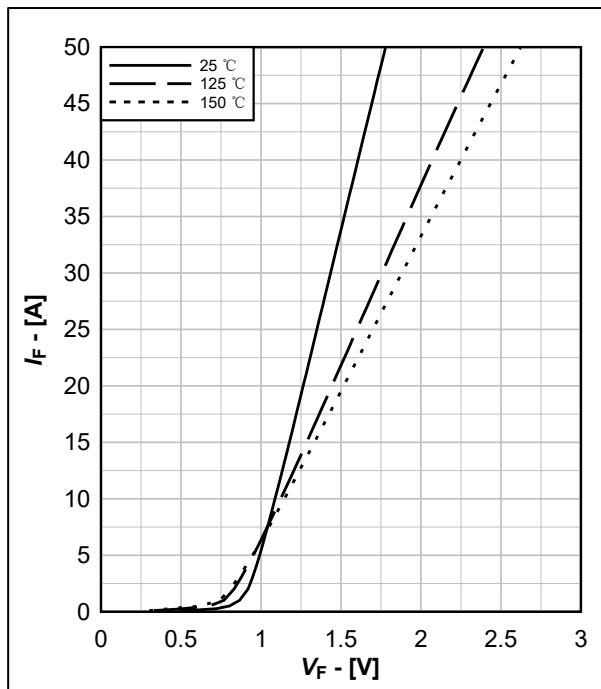
Fig.11 Typical gate charge characteristic, $V_{GE} = f(Q_G)$

图 12. FRD 输出特性典型曲线, $I_F = f(V_F)$

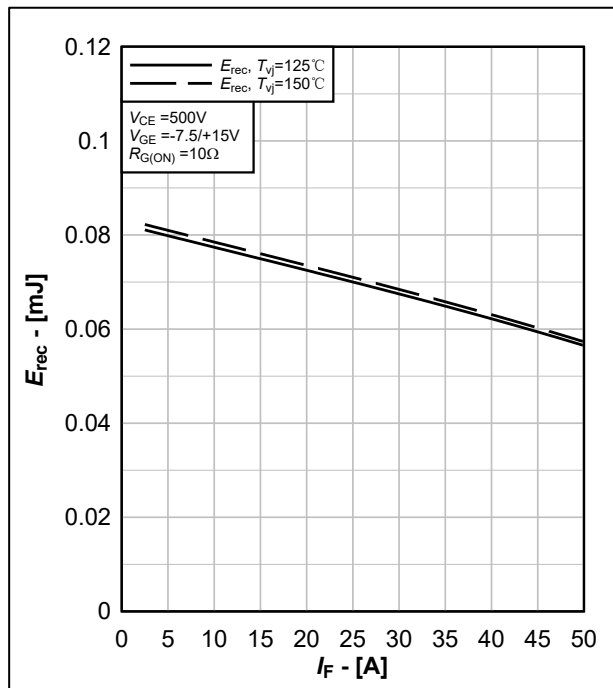
Fig.12 Typical FRD output characteristic, $I_F = f(V_F)$

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

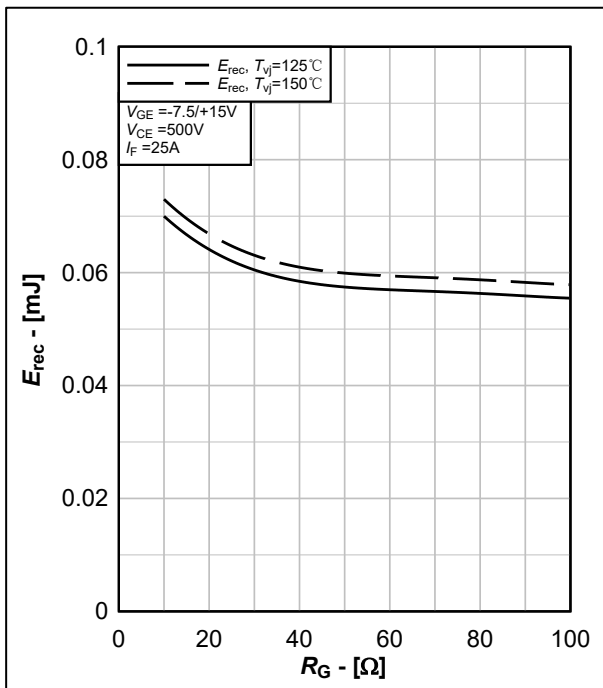
Fig.13 Typical FRD switching loss E_{rev} $E_{rec}=f(I_F)$

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_{rev} $E_{rec}=f(R_G)$

IGBT 提升，二极管转换器

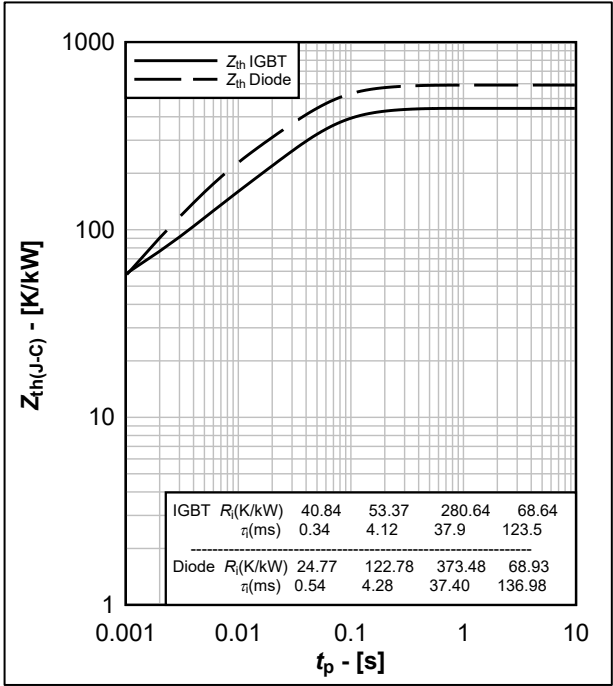


图 15. 瞬态热阻抗曲线, $Z_{th(j-c)} = f(t_p)$
Fig.15 Transient thermal impedance, $Z_{th(j-c)} = f(t_p)$

IGBT Boost, Diode Boost

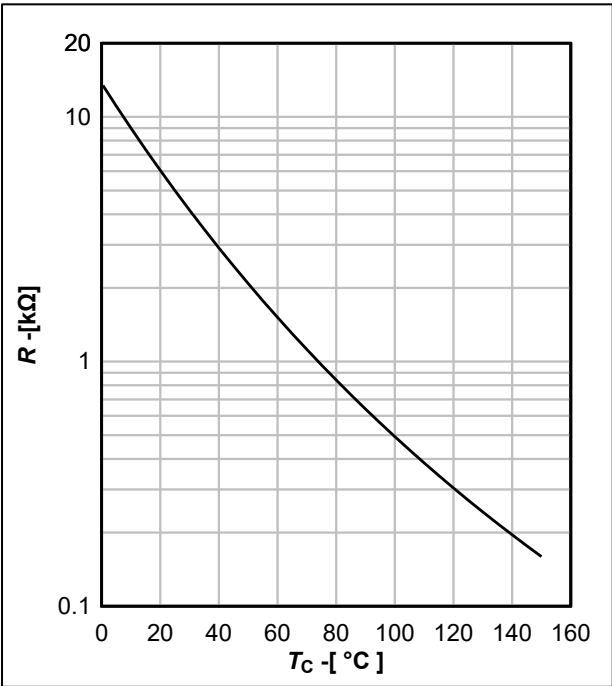


图 16. 热敏电阻典型特性曲线, $R = f(T_c)$
Fig.16 Typical NTC thermistor characteristic, $R = f(T_c)$

旁路二极管

Bypass Diode

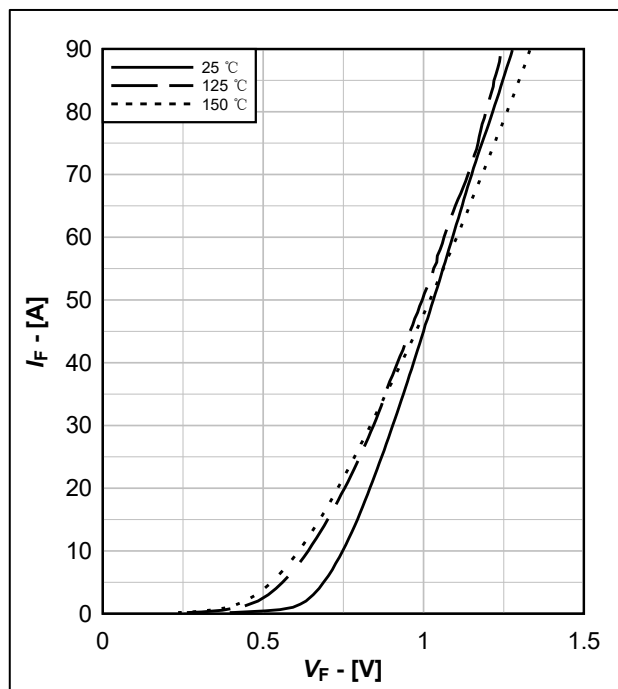


图 17. FRD 输出特性典型曲线, $I_F = f(V_F)$

Fig.17 Typical FRD output characteristic, $I_F = f(V_F)$

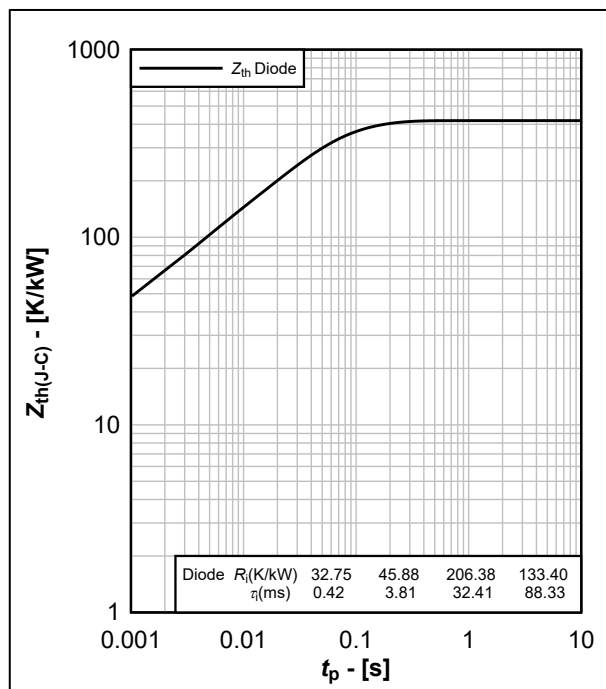
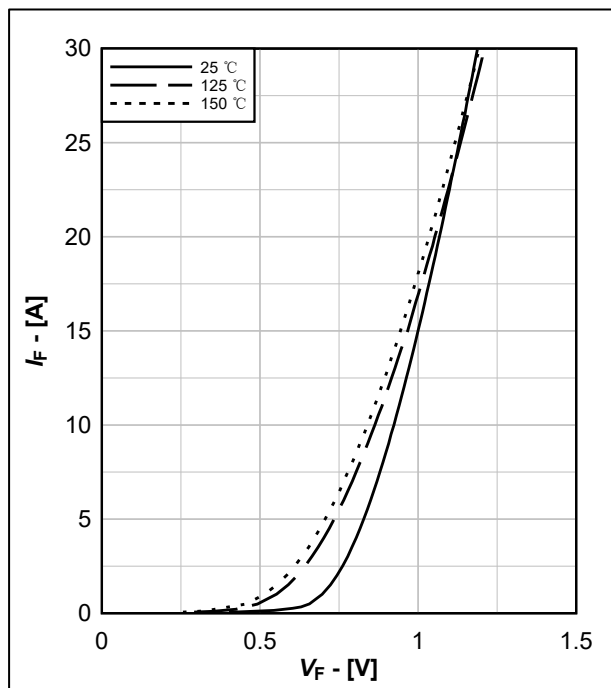
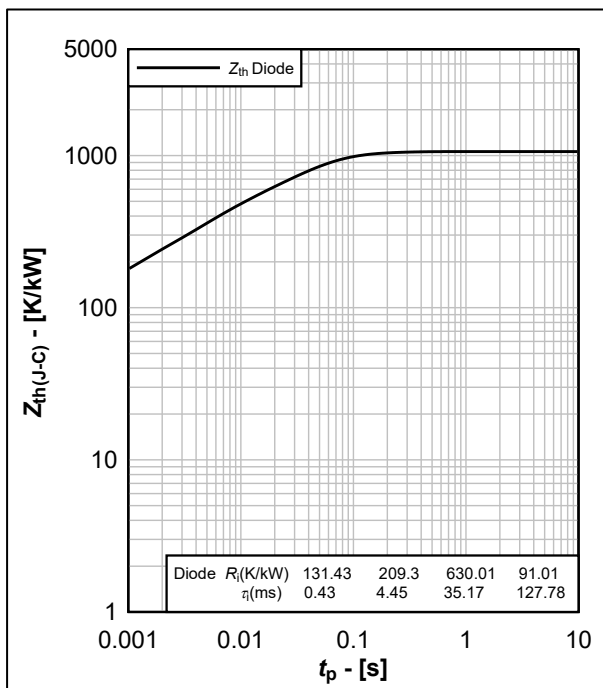


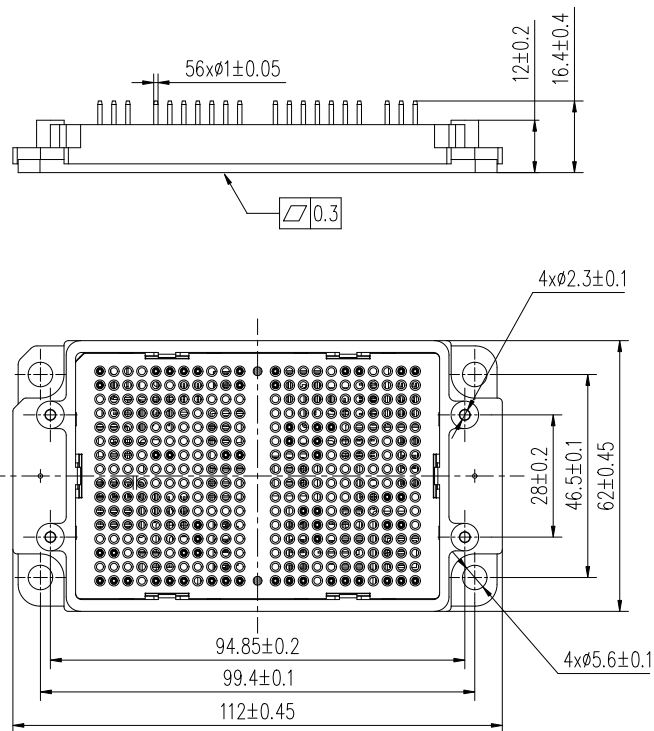
图 18. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$

Fig.18 Transient thermal impedance, $Z_{th(J-C)} = f(t_p)$

反极性保护二极管

Inverse-polarity Protection Diode

图 19. FRD 输出特性典型曲线, $I_F = f(V_F)$ Fig.19 Typical FRD output characteristic, $I_F = f(V_F)$ 图 20. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$ Fig.20 Transient thermal impedance, $Z_{th(J-C)} = f(t_p)$



重量 Weight: 104g 模块外观类型 Module outline code: U3

图 21. 模块外观尺寸

Fig. 21 Module outlines

株洲中车时代半导体有限公司

ZHUZHOU CRRC TIMES SEMICONDUCTOR CO., LTD

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产品数据手册 Product Datasheet 版本 Ver 23.12

TH200D3B10U4-S500

三电平 IGBT 模块 3-level IGBT Module

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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。