

关键参数		Key Parameters	
V_{CES}		950	V
$V_{CE(sat)}$	Typ.	1.40	V
I_C	Max.	200	A
$I_{C(RM)}$	Max.	400	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	

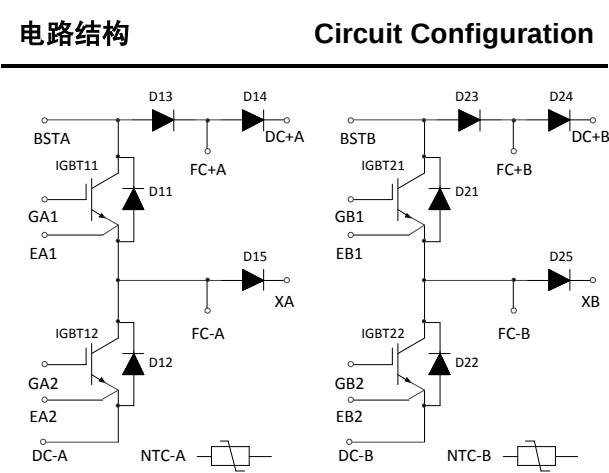


图 1. 电路结构

Fig. 1 Circuit configuration

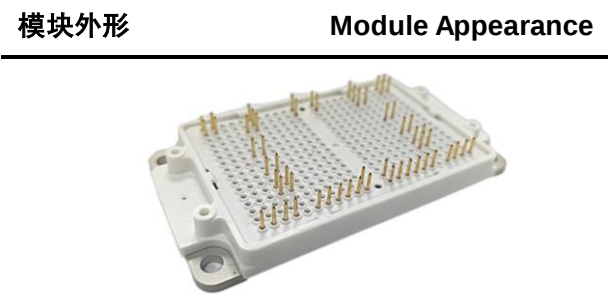


图 2. 模块外形

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 提升, 反并联二极管
 IGBT T11/12/21/22, 二极管 D11/12/21/22

IGBT Boost, Anti-parallel Diode
 IGBT T11/12/21/22, Diode D11/12/21/22

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	$T_H = 65^{\circ}\text{C}, T_{vj\text{ max}}=175^{\circ}\text{C}$	200	A
$I_{C(RM)}$	集电极峰值电流 Peak collector current	$t_P=1\text{ms}$	400	A
P_{max}	晶体管部分最大损耗 Max. transistor power dissipation	$T_C = 25\text{ }^{\circ}\text{C}, T_{vj\text{ max}}=175^{\circ}\text{C}$	732	W
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		100	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_P = 1\text{ms}$	200	A
t^2_t	二极管 t^2_t 值 Diode t^2_t	$V_R = 0V, t_P = 10\text{ms}, T_{vj} = 150\text{ }^{\circ}\text{C}$	1150	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				204.8	K / kW
$R_{th(J-C)} \text{ Diode}$	二极管结壳热阻 Thermal resistance – Diode				632.1	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		60		
$R_{th(C-H)} \text{ Diode}$	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		70		
$T_{vj\text{ op}}$	工作结温 Operating junction temperature		-40		150	$^{\circ}\text{C}$

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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	$I_C = 10\text{mA}, V_{GE} = V_{CE}$	4.60	5.20	5.80	V
$V_{CE(sat)}^{(*1)}$	集电极-发射极饱和电压 Collector-emitter saturation voltage	$V_{GE} = 15V, I_C = 70A$		1.40	1.70	V
		$V_{GE} = 15V, I_C = 70A, T_{vj} = 125\text{ }^{\circ}\text{C}$		1.60		V
		$V_{GE} = 15V, I_C = 70A, T_{vj} = 150\text{ }^{\circ}\text{C}$		1.60		V
$V_F^{(*1)}$	二极管正向电压 Diode forward voltage	$I_F = 70A, V_{GE} = 0V$		1.40	1.70	V
		$I_F = 70A, V_{GE} = 0V, T_{vj} = 125\text{ }^{\circ}\text{C}$		1.45		V
		$I_F = 70A, V_{GE} = 0V, T_{vj} = 150\text{ }^{\circ}\text{C}$		1.47		V
C_{ies}	输入电容 Input capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		15		nF
Q_g	栅极电荷 Gate charge	$\pm 15V$		0.74		μC
C_{res}	反向传输电容 Reverse transfer capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		0.06		nF
R_{Gint}	内部栅极电阻 Internal gate resistor			1.2		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.

T11&D13
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	$I_C = 70A$, $V_{CE} = 500V$, $V_{GE} = -7.5/+15V$, $R_{G(OFF)} = 30\Omega$, $L_S = 25nH$, $dv/dt = 8400V/\mu s$ ($T_{vj} = 150\text{ }^{\circ}C$).	$T_{vj} = 25\text{ }^{\circ}C$		595		ns
			$T_{vj} = 125\text{ }^{\circ}C$		620		
			$T_{vj} = 150\text{ }^{\circ}C$		640		
t_f	下降时间 Fall time		$T_{vj} = 25\text{ }^{\circ}C$		85		ns
			$T_{vj} = 125\text{ }^{\circ}C$		80		
			$T_{vj} = 150\text{ }^{\circ}C$		80		
E_{OFF}	关断损耗 Turn-off energy loss		$T_{vj} = 25\text{ }^{\circ}C$		2.5		mJ
			$T_{vj} = 125\text{ }^{\circ}C$		2.7		
			$T_{vj} = 150\text{ }^{\circ}C$		2.9		
$t_{d(on)}$	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	$T_{vj} = 25\text{ }^{\circ}C$		20		ns	
		$T_{vj} = 125\text{ }^{\circ}C$		21			
		$T_{vj} = 150\text{ }^{\circ}C$		23			
E_{ON}	开通损耗 Turn-on energy loss	$T_{vj} = 25\text{ }^{\circ}C$		1.10		mJ	
		$T_{vj} = 125\text{ }^{\circ}C$		1.20			
		$T_{vj} = 150\text{ }^{\circ}C$		1.25			
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	$T_{vj} = 25\text{ }^{\circ}C$		1.00		μC	
		$T_{vj} = 125\text{ }^{\circ}C$		0.99			
		$T_{vj} = 150\text{ }^{\circ}C$		0.98			
I_{rr}	二极管反向恢复电流 Diode reverse recovery current	$T_{vj} = 25\text{ }^{\circ}C$		31		A	
		$T_{vj} = 125\text{ }^{\circ}C$		30			
		$T_{vj} = 150\text{ }^{\circ}C$		29			
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy	$T_{vj} = 25\text{ }^{\circ}C$		0.33		mJ	
		$T_{vj} = 125\text{ }^{\circ}C$		0.28			
		$T_{vj} = 150\text{ }^{\circ}C$		0.22			

T12&D14
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	$I_C=70A$, $V_{CE}=500V$, $V_{GE}=-7.5/+15V$, $R_{G(OFF)}=30\Omega$, $L_S=50nH$, $dv/dt=8400V/\mu s$ ($T_{vj}=150\text{ }^{\circ}C$).	$T_{vj}=25\text{ }^{\circ}C$		595		ns
			$T_{vj}=125\text{ }^{\circ}C$		600		
			$T_{vj}=150\text{ }^{\circ}C$		605		
t_f	下降时间 Fall time		$T_{vj}=25\text{ }^{\circ}C$		400		ns
			$T_{vj}=125\text{ }^{\circ}C$		390		
			$T_{vj}=150\text{ }^{\circ}C$		390		
E_{OFF}	关断损耗 Turn-off energy loss		$T_{vj}=25\text{ }^{\circ}C$		5.6		mJ
			$T_{vj}=125\text{ }^{\circ}C$		6.0		
			$T_{vj}=150\text{ }^{\circ}C$		6.5		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	$T_{vj}=25\text{ }^{\circ}C$		90		ns	
		$T_{vj}=125\text{ }^{\circ}C$		87			
		$T_{vj}=150\text{ }^{\circ}C$		87			
t_r	上升时间 Rise time	$T_{vj}=25\text{ }^{\circ}C$		22		ns	
		$T_{vj}=125\text{ }^{\circ}C$		25			
		$T_{vj}=150\text{ }^{\circ}C$		26			
E_{ON}	开通损耗 Turn-on energy loss	$T_{vj}=25\text{ }^{\circ}C$		1.00		mJ	
		$T_{vj}=125\text{ }^{\circ}C$		1.05			
		$T_{vj}=150\text{ }^{\circ}C$		1.10			
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	$T_{vj}=25\text{ }^{\circ}C$		0.47		μC	
		$T_{vj}=125\text{ }^{\circ}C$		0.45			
		$T_{vj}=150\text{ }^{\circ}C$		0.40			
I_{rr}	二极管反向恢复电流 Diode reverse recovery current	$T_{vj}=25\text{ }^{\circ}C$		27		A	
		$T_{vj}=125\text{ }^{\circ}C$		27			
		$T_{vj}=150\text{ }^{\circ}C$		27			
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy	$T_{vj}=25\text{ }^{\circ}C$		0.170		mJ	
		$T_{vj}=125\text{ }^{\circ}C$		0.165			
		$T_{vj}=150\text{ }^{\circ}C$		0.160			

二极管转换器
 二极管 D13/14/23/24

 Diode Boost
 Diode D13/14/23/24

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_F	二极管额定正向电流 Diode rating forward current	$T_H = 65\text{ }^{\circ}\text{C}$	100	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_P = 1\text{ms}$	200	A
I_{FSM}	浪涌电流 Surge current	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	830	A
t_t	二极管 t_t 值 Diode t_t	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	3445	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	$I_F = 70\text{A}$, $V_{GE} = 0\text{V}$		1.40	1.70	V
		$I_F = 70\text{A}$, $V_{GE} = 0\text{V}$, $T_{vj} = 125\text{ }^{\circ}\text{C}$		1.60		V
		$I_F = 70\text{A}$, $V_{GE} = 0\text{V}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$		1.70		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
$R_{th(J-C) \text{ Diode}}$	IGBT 结壳热阻 Thermal resistance – IGBT				291.9	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		50		K / kW
$T_{vj \text{ op}}$	工作结温 Operating junction temperature		-40		150	$^{\circ}\text{C}$

旁路二极管
 二极管 D15/25

 Bypass Diode
 Diode D15/25

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	$T_H = 65\text{ }^{\circ}\text{C}$	100	A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_P = 1\text{ms}$	200	A
I_{FSM}	浪涌电流 Surge current	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	480	A
t^2_t	二极管 t^2_t 值 Diode t^2_t	$V_R = 0\text{V}$, $t_P = 10\text{ms}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$	1150	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	$I_F = 70\text{A}$, $V_{GE} = 0\text{V}$		1.40	1.70	V
		$I_F = 70\text{A}$, $V_{GE} = 0\text{V}$, $T_{vj} = 125\text{ }^{\circ}\text{C}$		1.45		V
		$I_F = 70\text{A}$, $V_{GE} = 0\text{V}$, $T_{vj} = 150\text{ }^{\circ}\text{C}$		1.47		V
I_{RRM}	重复反向电流 Repetitive reverse current	$T_{vj} = 150\text{ }^{\circ}\text{C}$, $V_R = 950\text{V}$			5	mA
$R_{th(J-C)} \text{ Diode}$	IGBT 结壳热阻 Thermal resistance – IGBT				632.1	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		70		K / kW
$T_{vj\text{ op}}$	工作结温 Operating junction temperature		-40		150	$^{\circ}\text{C}$

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	11.5	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			16		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, 反并联二极管

IGBT T11/12/21/22, 二极管 D11/12/21/22

IGBT Boost, Anti-parallel Diode

IGBT T11/12/21/22, Diode D11/12/21/22

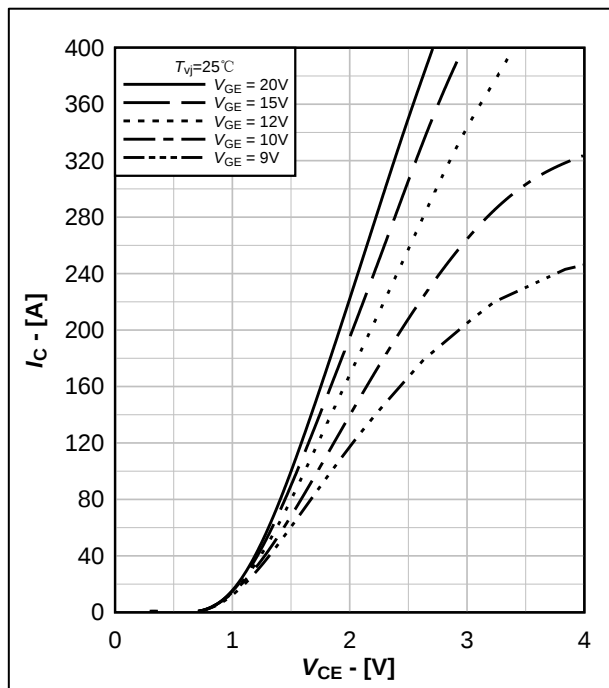


图 3. IGBT 输出特性典型曲线, $I_c = f(V_{ce})$

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

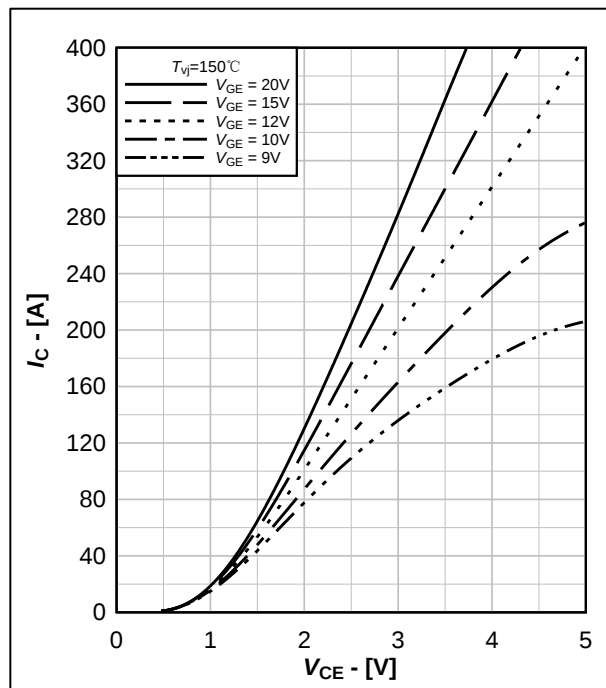


图 4. IGBT 输出特性典型曲线, $I_c = f(V_{ce})$

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

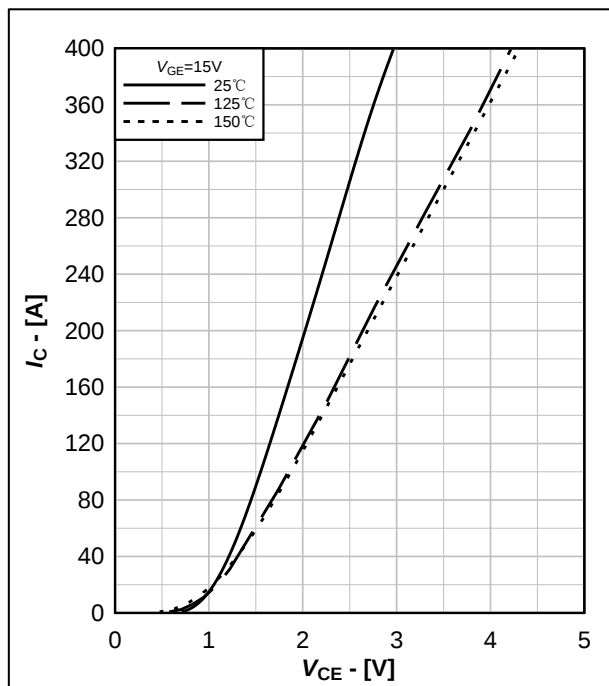


图 5. IGBT 输出特性典型曲线, $I_c = f(V_{ce})$

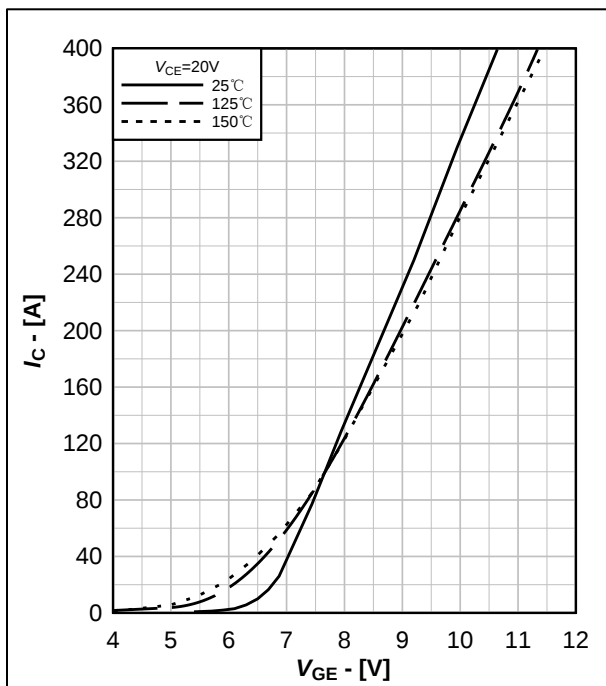


图 6. IGBT 传输特性典型曲线, $I_c = f(V_{ge})$

IGBT 提升, 反并联二极管

IGBT T11/12/21/22, 二极管 D11/12/21/22

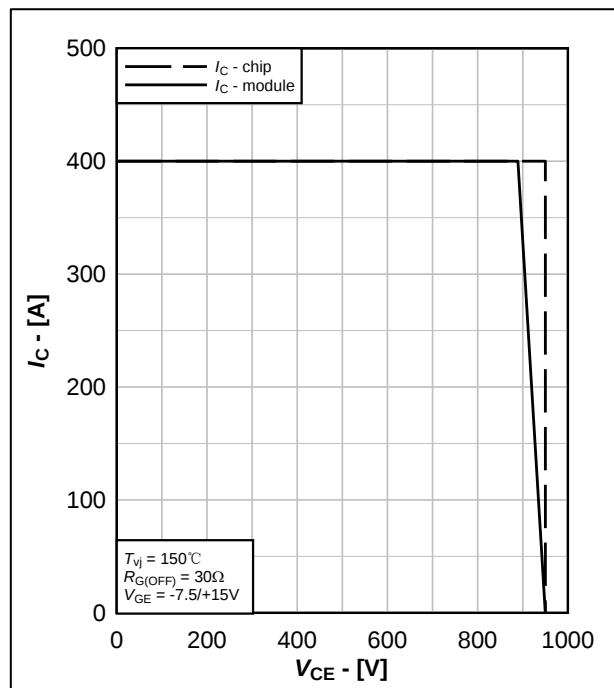


图 7. IGBT 反偏安全工作区, $I_C = f(V_{CE})$

Fig.7 Reverse bias safe operating area of IGBT, $I_C = f(V_{CE})$

IGBT Boost, Anti-parallel Diode
IGBT T11/12/21/22, Diode D11/12/21/22

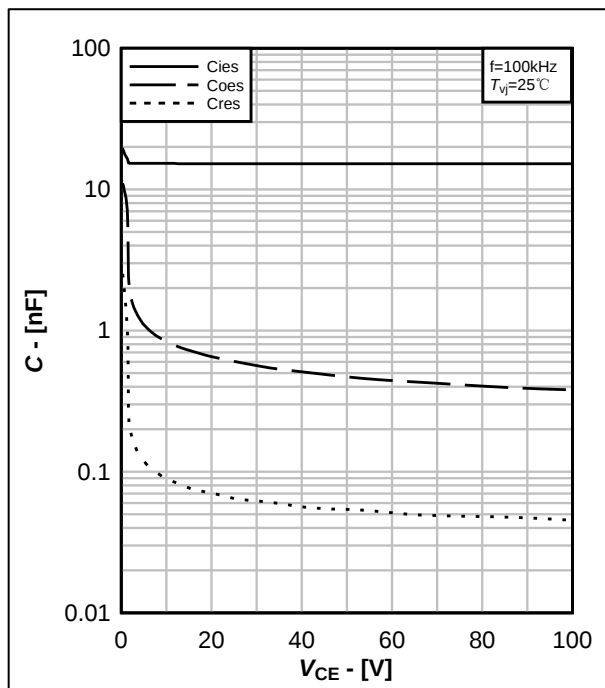


图 8. 电容特性典型曲线, $C = f(V_{CE})$

Fig.8 Typical capacity characteristic, $C = f(V_{CE})$

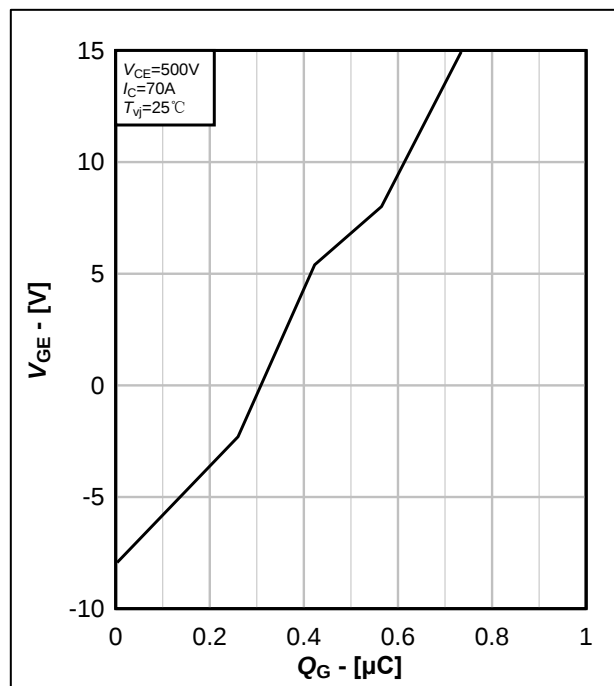


图 9. 栅极电荷特性典型曲线, $V_{GE} = f(Q_G)$

Fig.9 Typical gate charge characteristic, $V_{GE} = f(Q_G)$

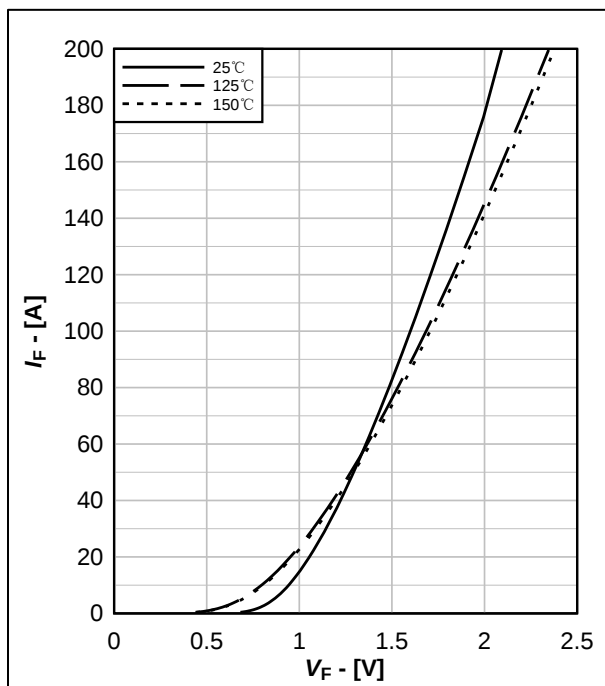


图 10. FRD 输出特性典型曲线, $I_F = f(V_F)$

Fig.10 Typical FRD output characteristic, $I_F = f(V_F)$

IGBT 提升, 反并联二极管

IGBT T11/12/21/22, 二极管 D11/12/21/22

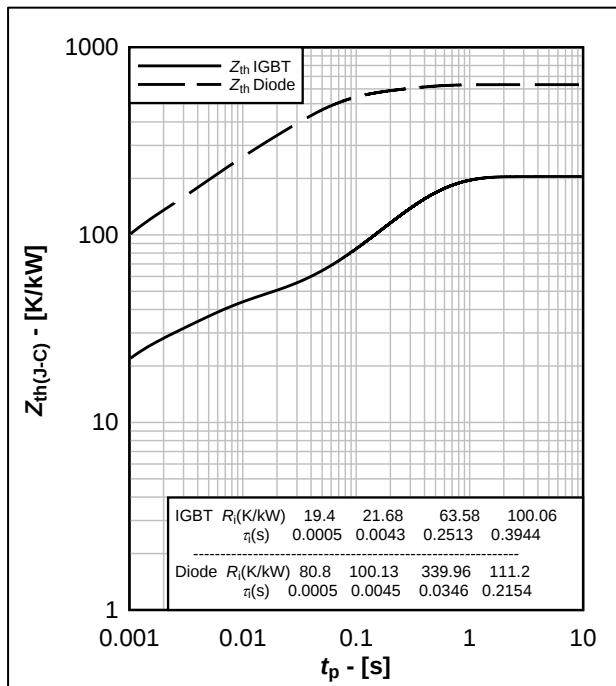


图 11. 瞬态热阻抗曲线, $Z_{th(j-c)} = f(t_p)$

Fig.11 Transient thermal impedance, $Z_{th(j-c)} = f(t_p)$

IGBT Boost, Anti-parallel Diode

IGBT T11/12/21/22, Diode D11/12/21/22

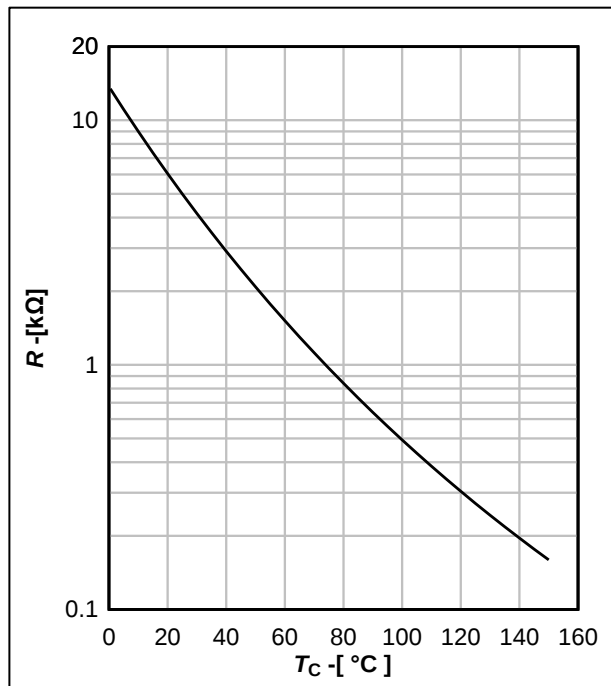


图 12. 热敏电阻典型特性曲线, $R = f(T_c)$

Fig.12 Typical NTC thermistor characteristic, $R = f(T_c)$

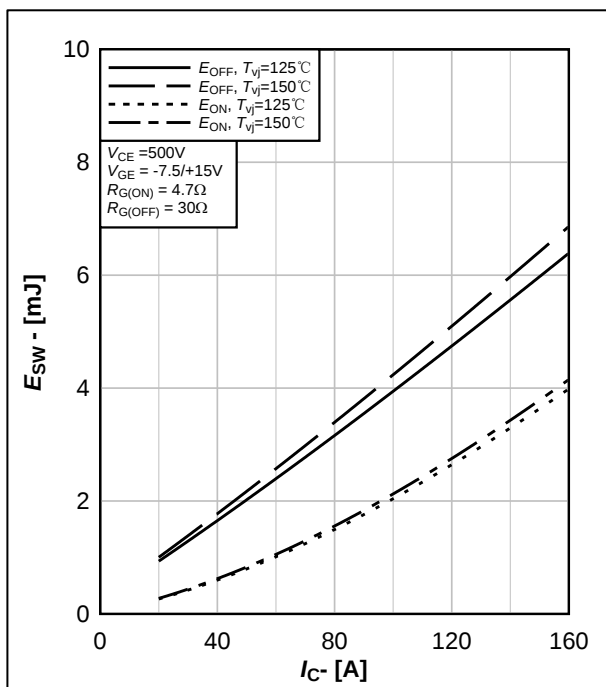
T11&D13

图 13. IGBT 开关损耗典型曲线, $E_{on}=f(I_C)$, $E_{off}=f(I_C)$

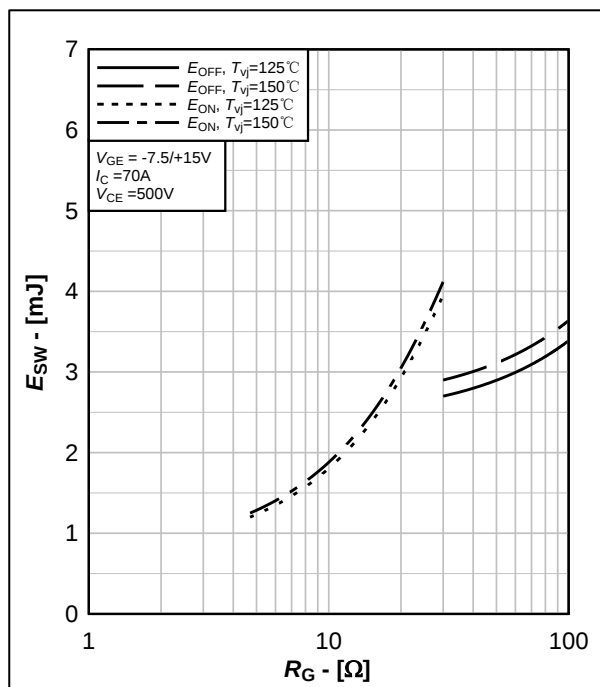
Fig.13 Typical IGBT switching energy, $E_{on}=f(I_C)$, $E_{off}=f(I_C)$

图 14. IGBT 开关损耗典型曲线, $E_{on}=f(R_G)$, $E_{off}=f(R_G)$

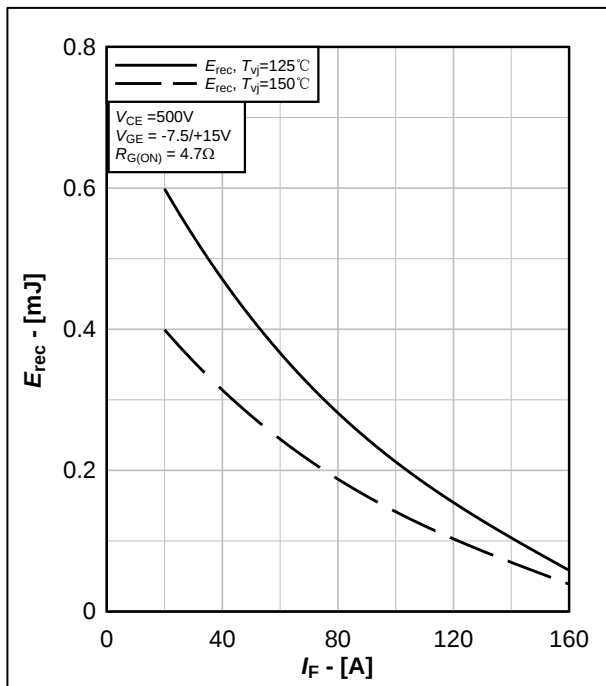
Fig.14 Typical IGBT switching energy, $E_{on}=f(R_G)$, $E_{off}=f(R_G)$

图 15. FRD 反向恢复损耗典型曲线, $E_{rec}=f(I_F)$

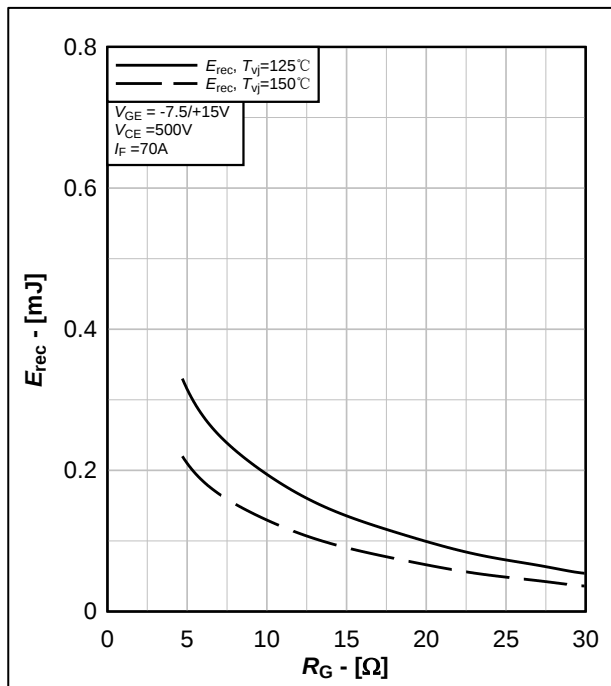
Fig.15 Typical FRD switching loss E_{rec} , $E_{rec}=f(I_F)$

图 16. FRD 反向恢复损耗典型曲线, $E_{rec}=f(R_G)$

Fig.16 Typical FRD switching loss E_{rec} , $E_{rec}=f(R_G)$

T12&D14

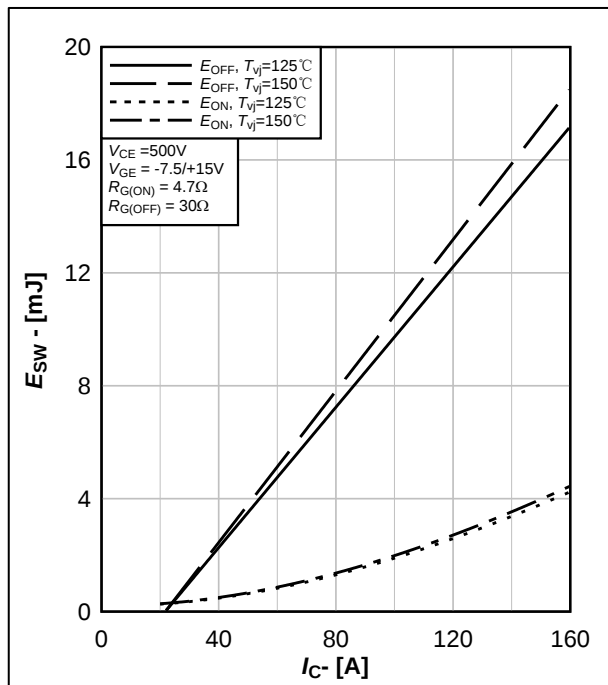

 图 17. IGBT 开关损耗典型曲线, $E_{on}=f(I_C)$, $E_{off}=f(I_C)$

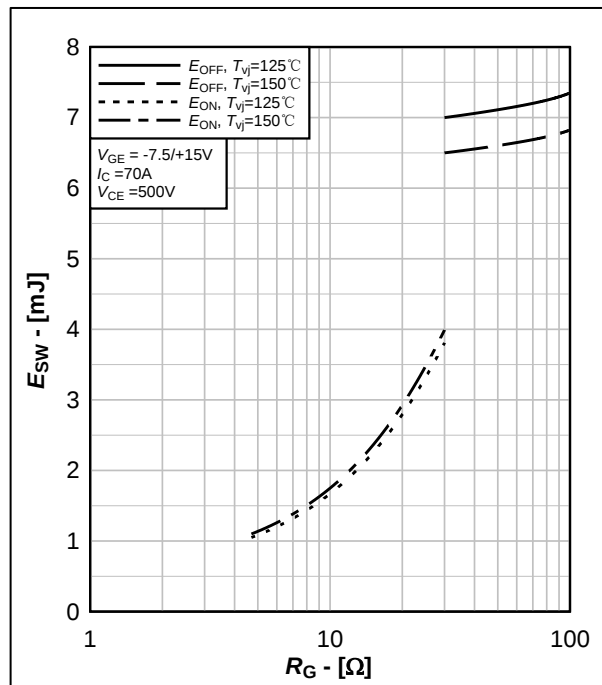
 Fig.17 Typical IGBT switching energy, $E_{on}=f(I_C)$, $E_{off}=f(I_C)$

 图 18. IGBT 开关损耗典型曲线, $E_{on}=f(R_G)$, $E_{off}=f(R_G)$

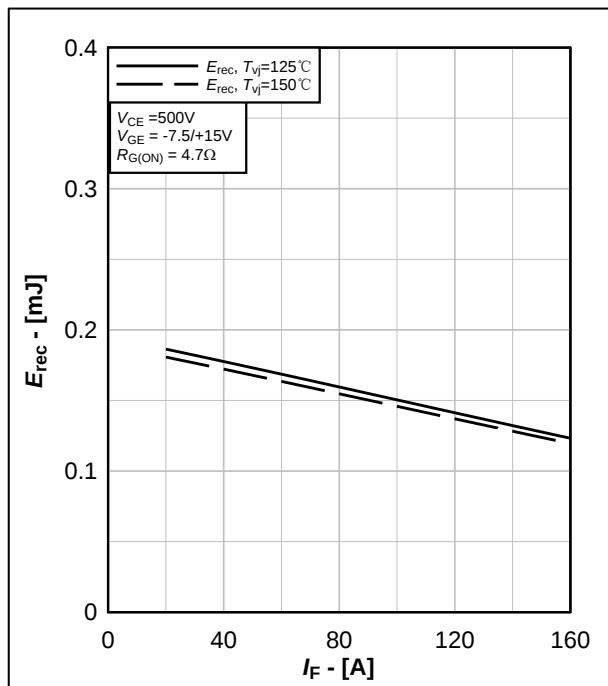
 Fig.18 Typical IGBT switching energy, $E_{on}=f(R_G)$, $E_{off}=f(R_G)$

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

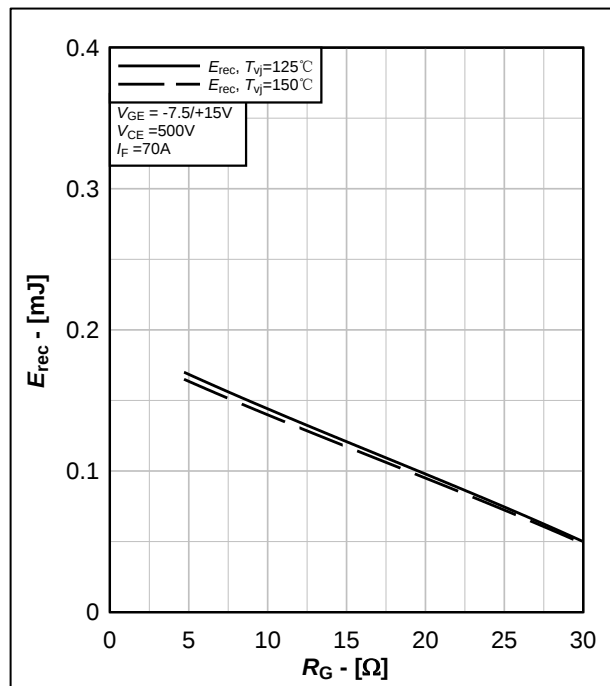
 Fig.19 Typical FRD switching loss E_{rec} , $E_{rec}=f(I_F)$

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

二极管转换器
二极管 D13/14/23/24

Diode Boost
Diode D13/14/23/24

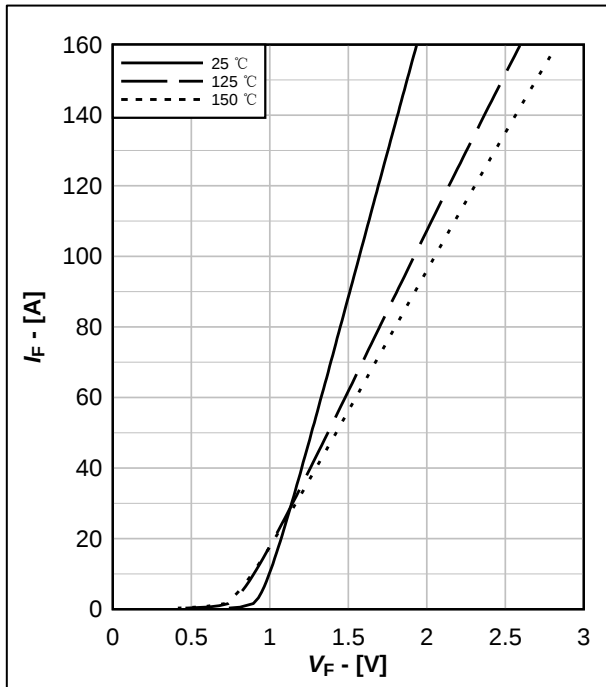


图 21. FRD 输出特性典型曲线, $I_F = f(V_F)$

Fig.21 Typical FRD output characteristic, $I_F = f(V_F)$

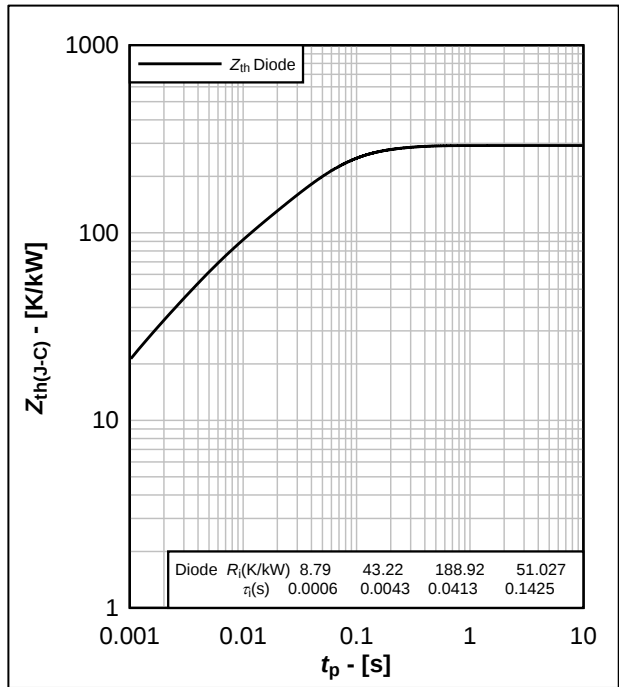


图 22. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$

Fig.22 Transient thermal impedance, $Z_{th(J-C)} = f(t_p)$

旁路二极管
二极管 D15/25

Bypass Diode
Diode D15/25

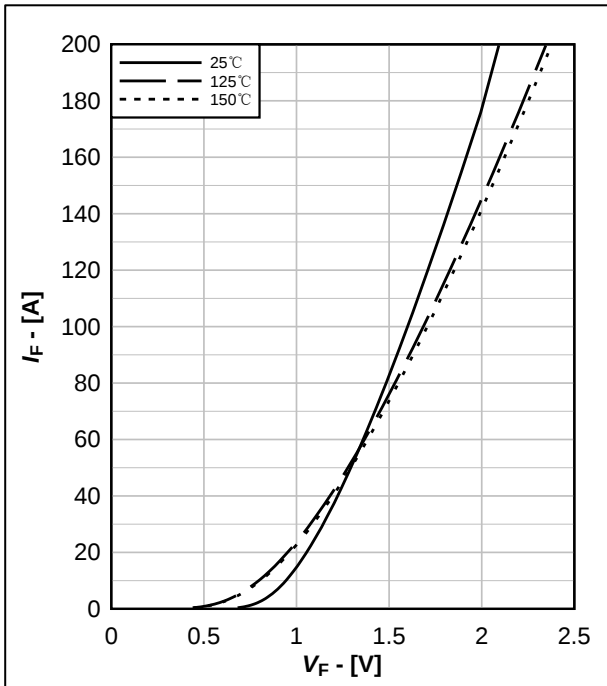


图 23. FRD 输出特性典型曲线, $I_F = f(V_F)$

Fig.23 Typical FRD output characteristic, $I_F = f(V_F)$

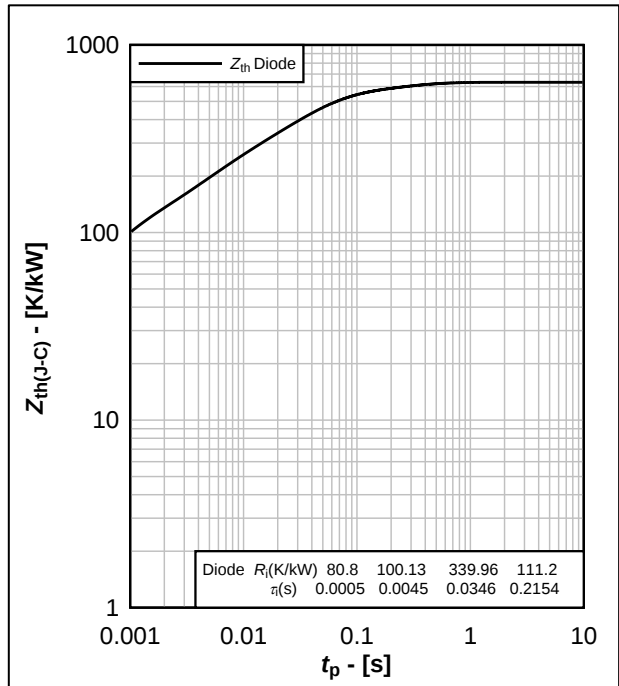
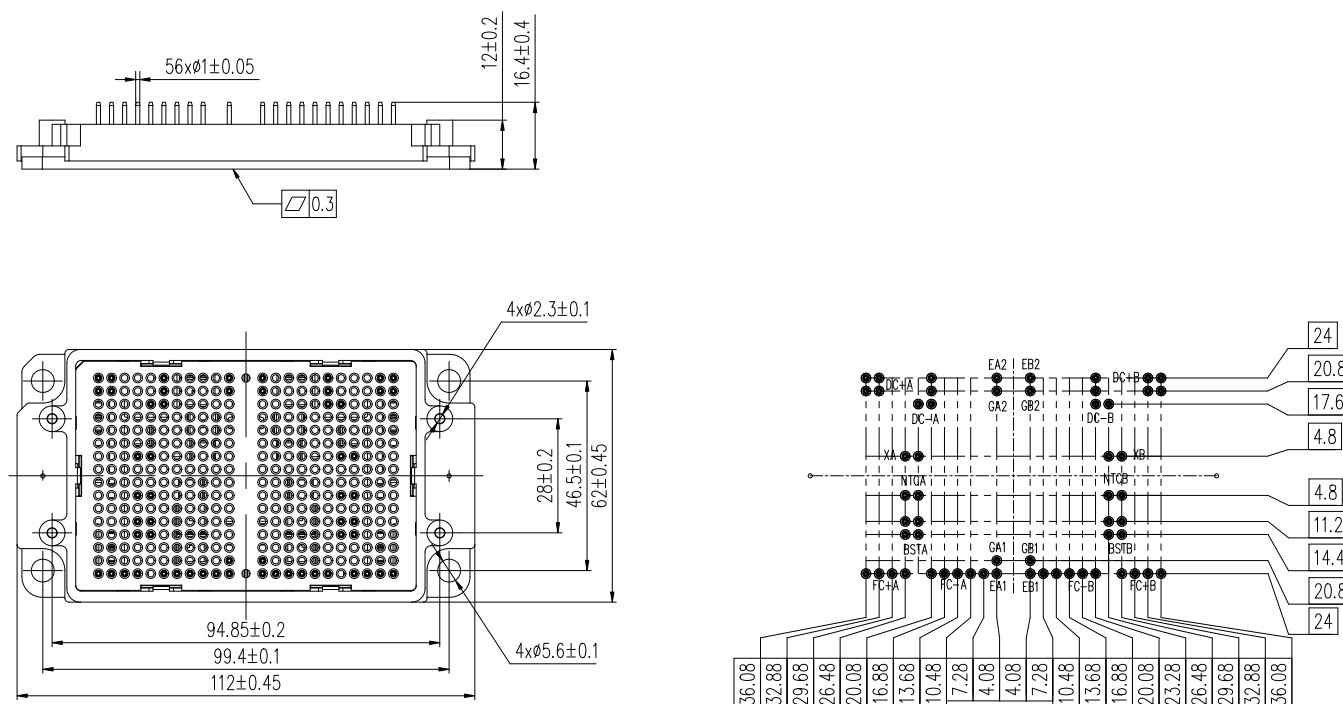


图 24. 瞬态热阻抗曲线, $Z_{th(J-C)} = f(t_p)$

Fig.24 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 25. 模块外观尺寸

Fig. 25 Module outlines

株洲中车时代半导体有限公司

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