中国中车 CRRC

产品数据手册 Product Datasheet 版本 Ver 23.02

TIM3600E2SM17-TSA000

单管型 IGBT 模块 Single Switch IGBT Module

关键参数 Key Parameters

V_{CES}		1700	V
$V_{CE(sat)}$	Typ.	1.95	V
I_C	Max.	3600	A
$I_{C(RM)}$	Max.	7200	A

典型应用 Typical Applications

- 牵引传动 Traction Drives
- 电机控制 Motor Controllers
- 智能电网 Smart Grid
- 高可靠性逆变器 High Reliability Inverters

特点 Features

- AlSiC 基板 AlSiC Baseplate
- AlN 衬板 AlN Substrates
- 高热循环能力 High Thermal Cycling Capability
- 10μs 短路承受能力 10μs Short Circuit Withstand

电路结构 Circuit Configuration

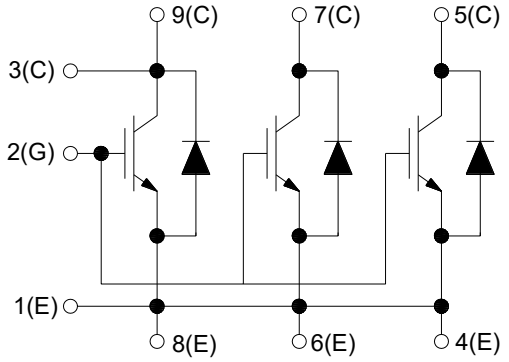


图 1. 电路结构

Fig. 1 Circuit configuration

模块外形 Module Appearance

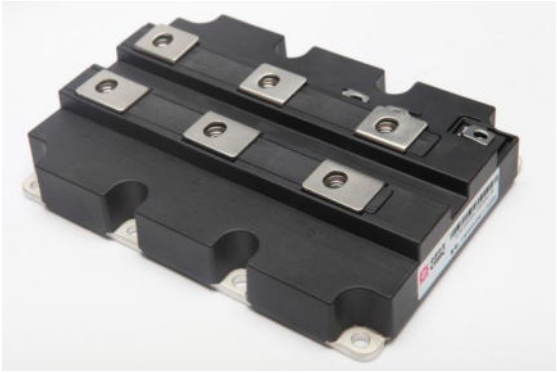


图 2. 模块外形

Fig. 2 Module appearance

模块标签说明 Module Label Code Instruction

ab1234567890

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

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 °C	1700	V
V_{GES}	栅极-发射极电压 Gate-emitter voltage	T_C= 25 °C	± 20	V
I_C	集电极电流 Collector-emitter current	T_C = 95 °C, T_{vj} max= 175°C	3600	A
$I_{C(RM)}$	集电极峰值电流 Peak collector current	t_P=1ms	7200	A
P_{max}	晶体管部分最大损耗 Max. transistor power dissipation	T_{vj} = 175°C, T_C = 25 °C	20	kW
I^2t	二极管 I^2t 值 Diode I^2t	V_R =0V, t_P = 10ms, T_{vj} = 150 °C	2200	kA^2s
V_{isol}	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	4000	V
Q_{PD}	局部放电电荷(模块) Partial discharge – per module	IEC1287.V_1=1800V,V_2=1300V,50Hz RMS	10	pC

热和机械数据 Thermal & Mechanical Data

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	33.0	mm
	端子-端子 Terminal to terminal	34.0	mm
绝缘间隙 Clearance	端子-散热器 Terminal to heatsink	20.0	mm
	端子-端子 Terminal to terminal	20.0	mm
相对漏电起痕指数 CTI (Comparative Tracking Index)		>600	

热和机械数据 Thermal & Mechanical 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				7.5	K / kW
$R_{th(J-C)\ Diode}$	二极管结壳热阻 Thermal resistance – Diode				9.5	K / kW
$R_{th(C-H)\ IGBT}$	接触热阻(IGBT) Thermal resistance – case to heatsink (IGBT)	安装力矩 5Nm，导热脂 1W/m·K Mounting torque 5Nm, with mounting grease 1W/m·K		9.7		K / kW
$R_{th(C-H)\ Diode}$	接触热阻(Diode) Thermal resistance – case to heatsink (Diode)	安装力矩 5Nm，导热脂 1W/m·K Mounting torque 5Nm, with mounting grease 1W/m·K		10.5		K / kW
$T_{vj\ op}$	工作结温 Operating junction temperature	IGBT 芯片（IGBT）	-40		150	°C
		二极管芯片(Diode)	-40		150	°C
T_{stg}	存储温度 Storage temperature range		-40		150	°C
M	安装力矩 Screw torque	安装紧固用 – M6 Mounting – M6			5	Nm
		电路互连用 – M4 Electrical connections – M4			2	Nm
		电路互连用 - M8 Electrical connections – M8			10	Nm

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			60	mA
		V_{GE} = 0V, V_{CE} = V_{CES}, T_{vj} =150 °C			100	mA
I_{GES}	栅极漏电流 Gate leakage current	V_{GE} = ±20V, V_{CE} = 0V			1	μA
$V_{GE\ (th)}$	栅极-发射极阈值电压 Gate threshold voltage	I_C = 120mA, V_{GE} = V_{CE}	5.5	6.1	6.7	V
$V_{CE\ (sat)}$ (*1)	集电极-发射极饱和电压 Collector-emitter saturation voltage	V_{GE} =15V, I_C = 3600A		1.95	2.35	V
		V_{GE} =15V, I_C = 3600A, T_{vj} = 125 °C		2.20		V
		V_{GE} =15V, I_C = 3600A, T_{vj} = 150 °C		2.25		V
I_F	二极管正向直流电流 Diode forward current	DC		3600		A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	t_P = 1ms		7200		A
V_F (*1)	二极管正向电压 Diode forward voltage	I_F = 3600A, V_{GE} = 0V		1.80	2.20	V
		I_F = 3600A, V_{GE} = 0V, T_{vj} = 125 °C		1.85		V
		I_F = 3600A, V_{GE} = 0V, T_{vj} = 150 °C		1.85		V
I_{SC}	短路电流 Short circuit current	T_{vj} = 150° C, V_{CC} = 1000V, V_{GE}≤15V, t_p≤10μs, $V_{CE(max)}$ = V_{CES} – $L^{(*2)}$×di/dt, IEC 60747-9		14400		A

注意：
Note:

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),

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}).

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
C_{ies}	输入电容 Input capacitance	V_{CE} = 25V, V_{GE} = 0V, f = 100kHz		601		nF
Q_g	栅极电荷 Gate charge	±15V		37.8		μC
C_{res}	反向传输电容 Reverse transfer capacitance	V_{CE} = 25V, V_{GE} = 0V, f = 100kHz		0.4		nF
L_{sCE}	模块杂散电感 Module stray inductance			6		nH
$R_{CC'+EE'}$	模块引线电阻，端子-芯片 Module lead resistance, terminal-chip			85		μΩ

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 =3600A, V_{CE} =900V, V_{GE} = ±15V, $R_{G(OFF)}$ = 0.5Ω, L_S = 60 nH, dv/dt =3100V/μs (T_{vj}= 150 °C)	T_{vj}= 25 °C		2175		ns
			T_{vj}= 125 °C		2280		
			T_{vj}= 150 °C		2310		
t_f	下降时间 Fall time		T_{vj}= 25 °C		245		ns
			T_{vj}= 125 °C		300		
			T_{vj}= 150 °C		315		
E_{OFF}	关断损耗 Turn-off energy loss		T_{vj}= 25 °C		1585		mJ
			T_{vj}= 125 °C		1760		
			T_{vj}= 150 °C		1790		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	I_C =3600A V_{CE} = 900V, V_{GE} = ±15V, $R_{G(ON)}$ = 0.5Ω, L_S = 60nH, di/dt =11000A/μs (T_{vj}= 150 °C)	T_{vj}= 25 °C		970		ns
			T_{vj}= 125 °C		970		
			T_{vj}= 150 °C		970		
t_r	上升时间 Rise time		T_{vj}= 25 °C		310		ns
			T_{vj}= 125 °C		320		
			T_{vj}= 150 °C		330		
E_{ON}	开通损耗 Turn-on energy loss		T_{vj}= 25 °C		370		mJ
			T_{vj}= 125 °C		600		
			T_{vj}= 150 °C		650		
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	I_F =3600A, V_{CE} =900V, - di_F/dt =11000A/μs (T_{vj}= 150°C)	T_{vj}= 25 °C		845		μC
			T_{vj}= 125 °C		1410		
			T_{vj}= 150 °C		1660		
I_{rr}	二极管反向恢复电流 Diode reverse recovery current		T_{vj}= 25 °C		1960		A
			T_{vj}= 125 °C		2390		
			T_{vj}= 150 °C		2550		
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy		T_{vj}= 25 °C		650		mJ
			T_{vj}= 125 °C		1120		
			T_{vj}= 150 °C		1240		

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 =3600A, V_{CE} =900V, V_{GE} = ±15V, $R_{G(OFF)}$ = 2.0Ω, L_S = 60 nH, dv/dt =2100V/μs (T_{vj}= 150 °C)	T_{vj}= 25 °C		2810		ns
			T_{vj}= 125 °C		2970		
			T_{vj}= 150 °C		3010		
t_f	下降时间 Fall time		T_{vj}= 25 °C		300		ns
			T_{vj}= 125 °C		330		
			T_{vj}= 150 °C		345		
E_{OFF}	关断损耗 Turn-off energy loss		T_{vj}= 25 °C		1925		mJ
			T_{vj}= 125 °C		2120		
			T_{vj}= 150 °C		2170		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	I_C =3600A V_{CE} = 900V, V_{GE} = ±15V, $R_{G(ON)}$ = 2.0Ω, L_S = 60nH, di/dt =8100A/μs (T_{vj}= 150 °C)	T_{vj}= 25 °C		1205		ns
			T_{vj}= 125 °C		1100		
			T_{vj}= 150 °C		1100		
t_r	上升时间 Rise time		T_{vj}= 25 °C		500		ns
			T_{vj}= 125 °C		505		
			T_{vj}= 150 °C		510		
E_{ON}	开通损耗 Turn-on energy loss		T_{vj}= 25 °C		1680		mJ
			T_{vj}= 125 °C		2200		
			T_{vj}= 150 °C		2400		
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	I_F =3600A, V_{CE} =900V, - di_F/dt =8100A/μs (T_{vj}= 150°C)	T_{vj}= 25 °C		770		μC
			T_{vj}= 125 °C		1300		
			T_{vj}= 150 °C		1530		
I_{rr}	二极管反向恢复电流 Diode reverse recovery current		T_{vj}= 25 °C		1570		A
			T_{vj}= 125 °C		1950		
			T_{vj}= 150 °C		2060		
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy		T_{vj}= 25 °C		535		mJ
			T_{vj}= 125 °C		890		
			T_{vj}= 150 °C		975		

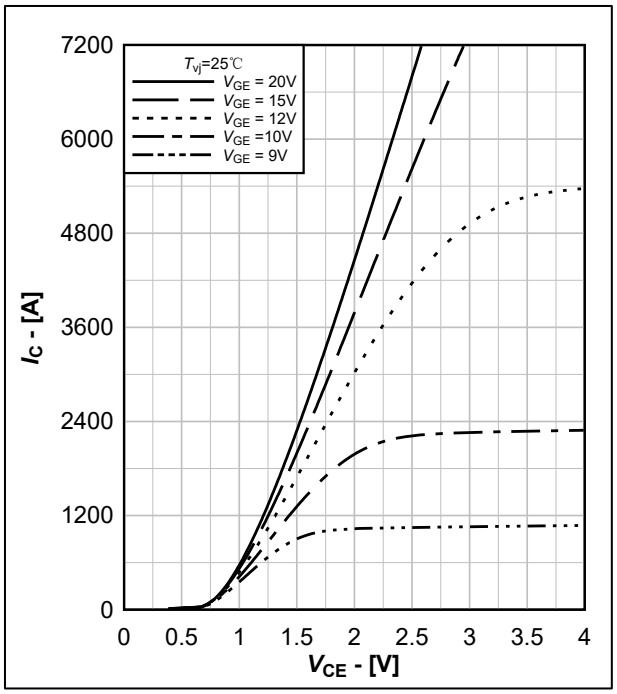


图 3. IGBT 输出特性典型曲线, I_C= f (V_{CE})

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

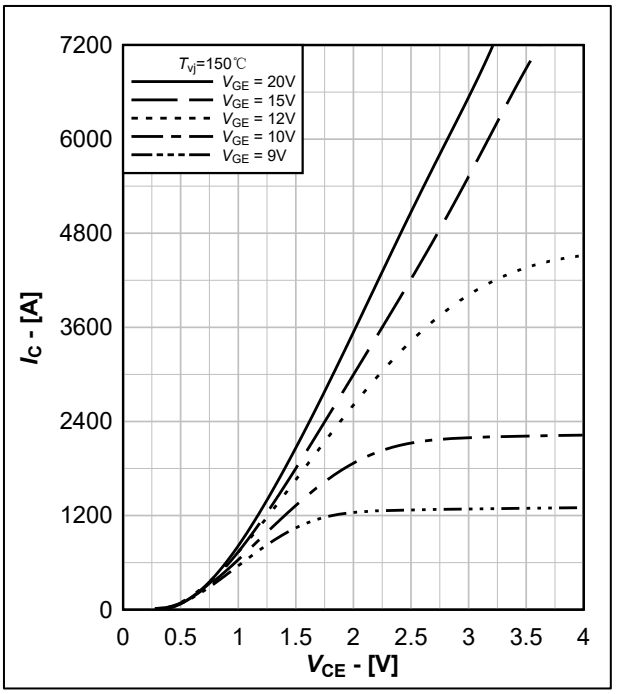


图 4. IGBT 输出特性典型曲线, I_C= f (V_{CE})

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

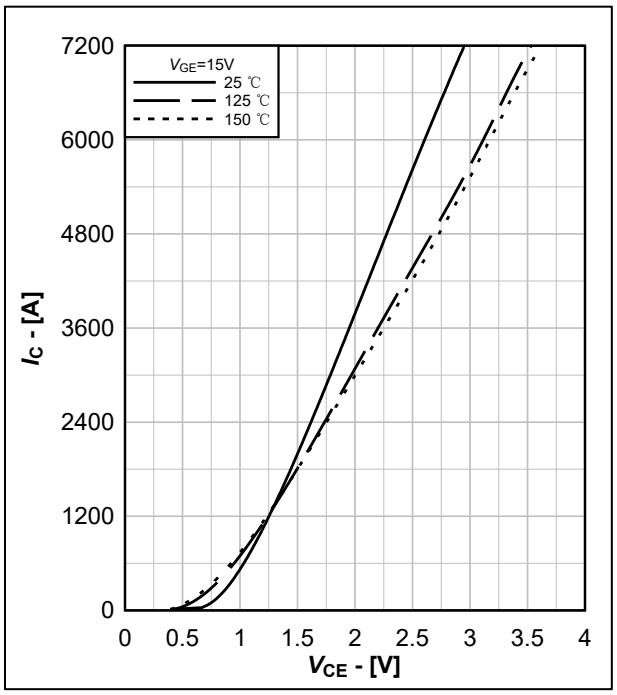


图 5. IGBT 输出特性典型曲线, I_C= f (V_{CE})

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

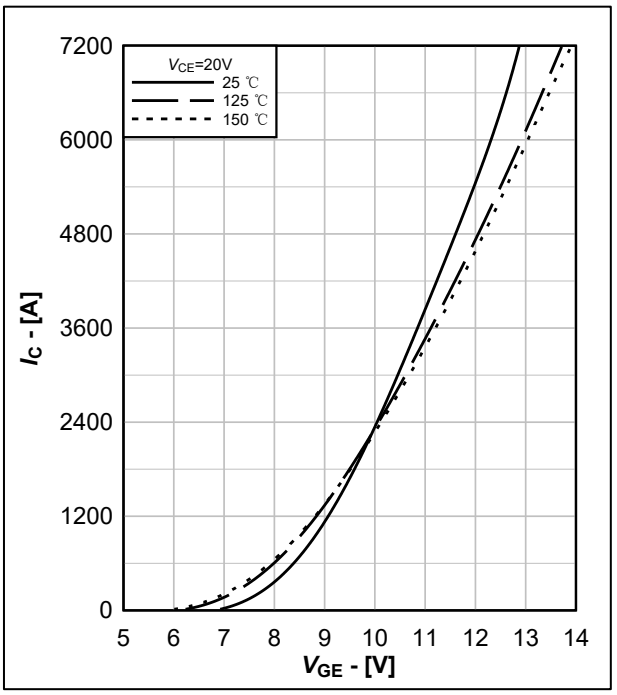


图 6. IGBT 传输特性典型曲线, I_C= f (V_{GE})

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

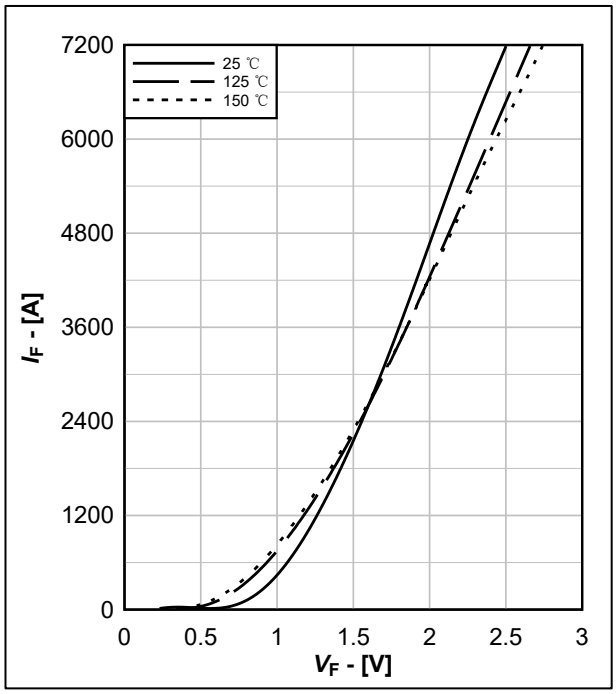


图 7. FRD 输出特性典型曲线, $I_F = f(V_F)$

Fig.7 Typical FRD output characteristics, $I_F = f(V_F)$

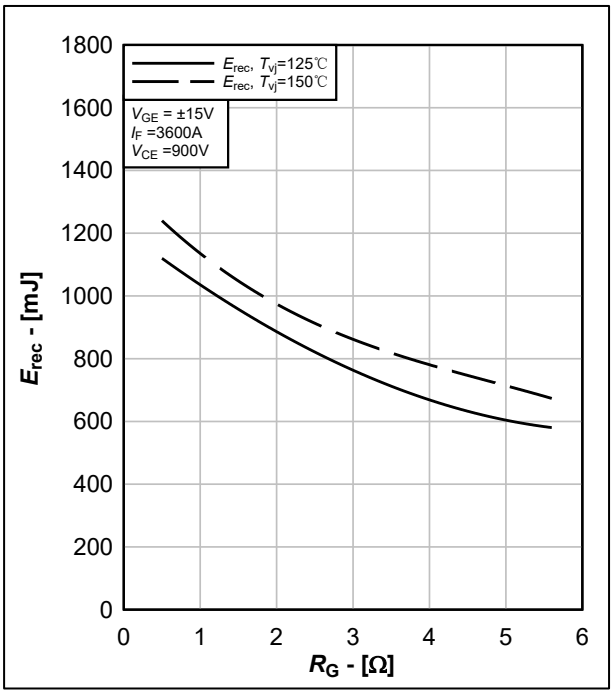


图 8. FRD 反向恢复损耗典型曲线, $E_{rec}=f(R_G)$

Fig.8 Typical FRD switching loss E_{rec}, $E_{rec}=f(R_G)$

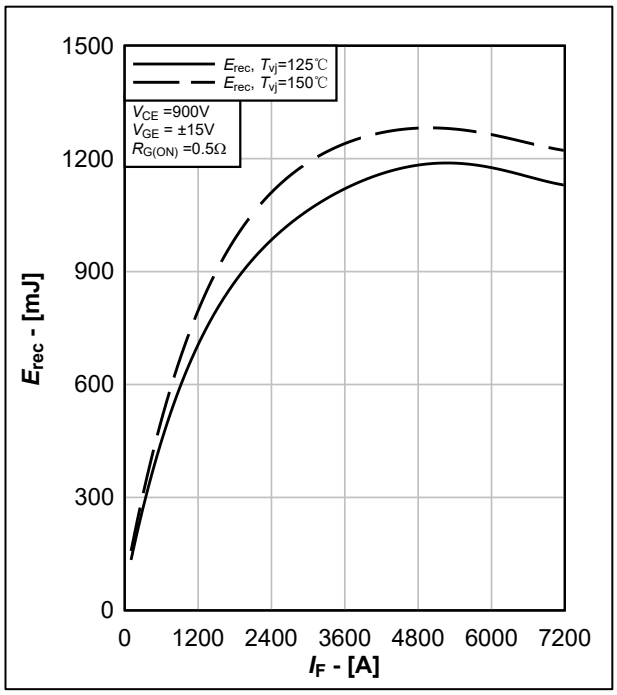


图 9. FRD 反向恢复损耗典型曲线, $E_{rec}=f(I_F)$

Fig.9 Typical FRD switching loss E_{rec}, $E_{rec}=f(I_F)$

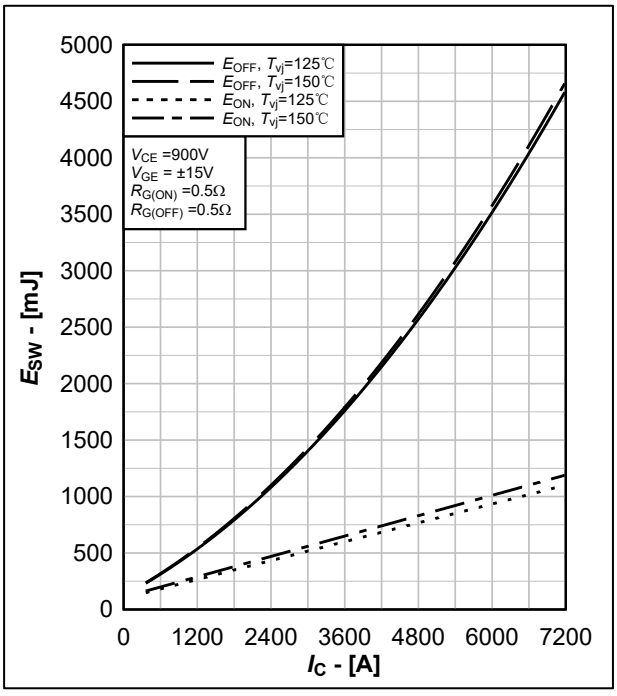


图 10. IGBT 开关损耗典型曲线, $E_{on}= f(I_C)$, $E_{off}= f(I_C)$

Fig.10 Typical IGBT switching energy, $E_{on}= f(I_C)$, $E_{off}= f(I_C)$

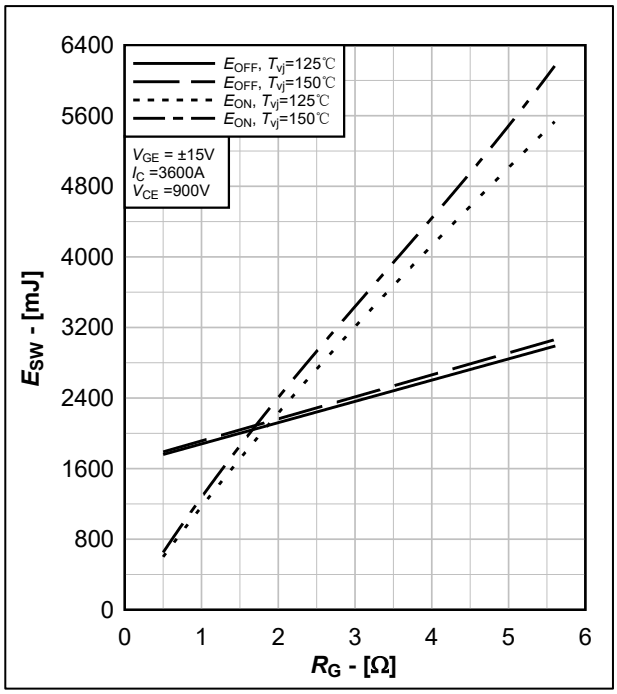


图 11. IGBT 开关损耗典型曲线, E_{on}= f (R_G), E_{off}= f (R_G)

Fig.11 Typical IGBT switching energy, E_{on}= f(R_G), E_{off}= f (R_G)

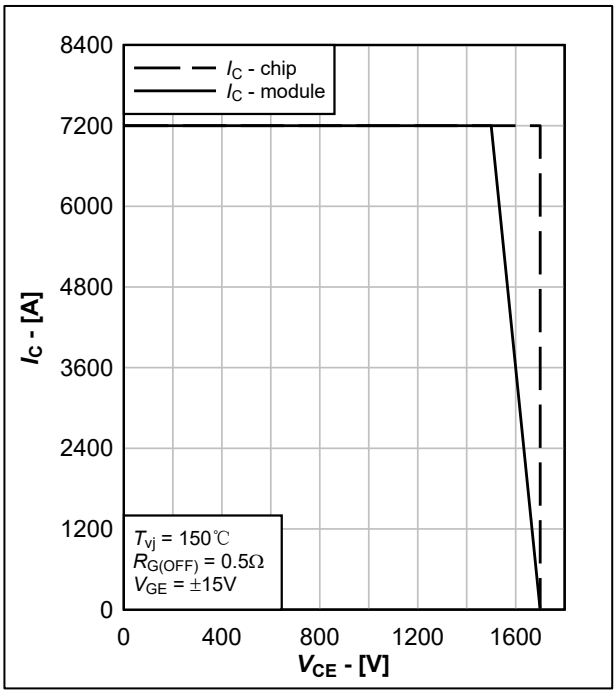


图 12. IGBT 反偏安全工作区, I_C = f (V_{CE})

Fig.12 Reverse bias safe operating area of IGBT, I_C = f (V_{CE})

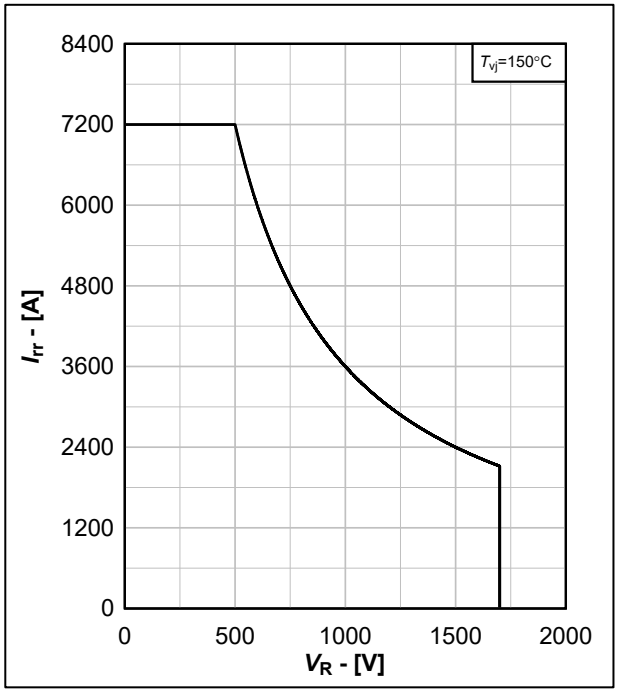


图 13. FRD 反偏安全工作区, I_{rr} = f (V_R)

Fig.13 Reverse bias safe operating area of FRD, I_{rr} = f (V_R)

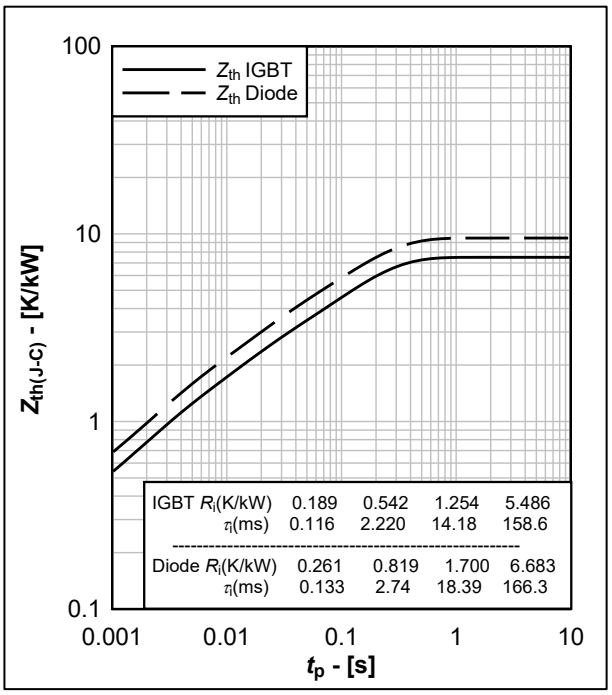


图 14. 瞬态热阻抗曲线, $Z_{th(J-C)}$ = f (t_p)

Fig.14 Transient thermal impedance, $Z_{th(J-C)}$ = f (t_p)

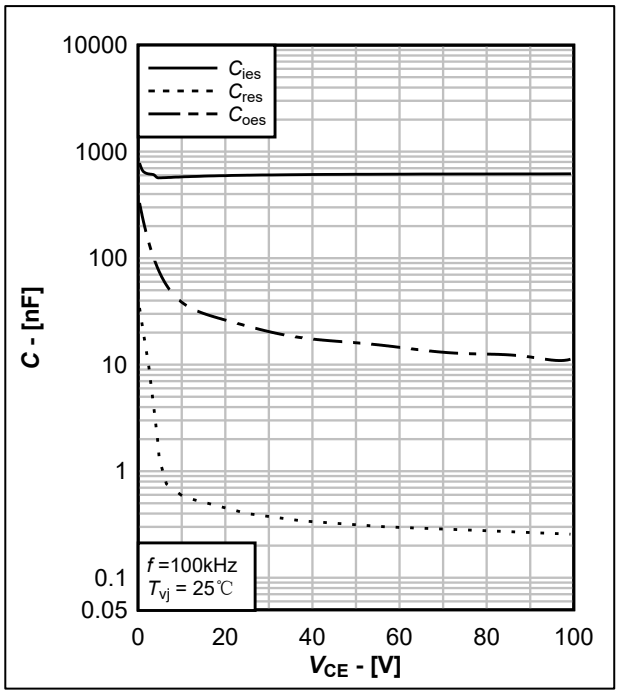


图 15. 电容特性典型曲线, C= f (V_{CE})

Fig.15 Typical capacity characteristic, C= f (V_{CE})

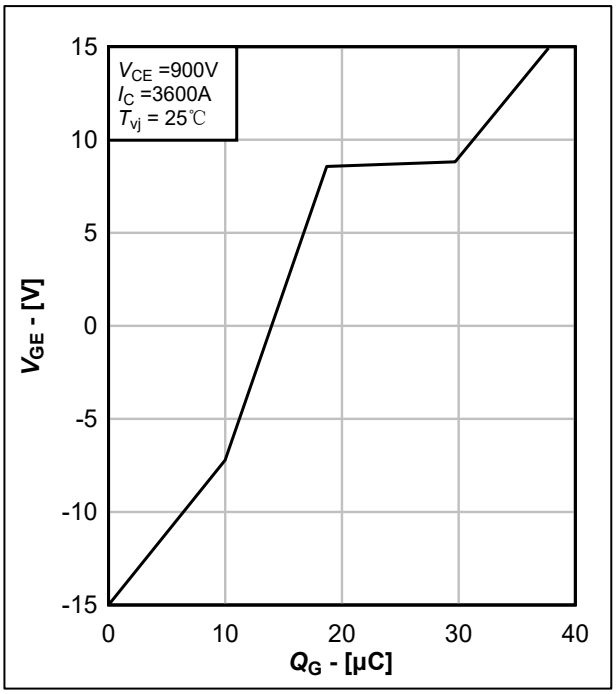
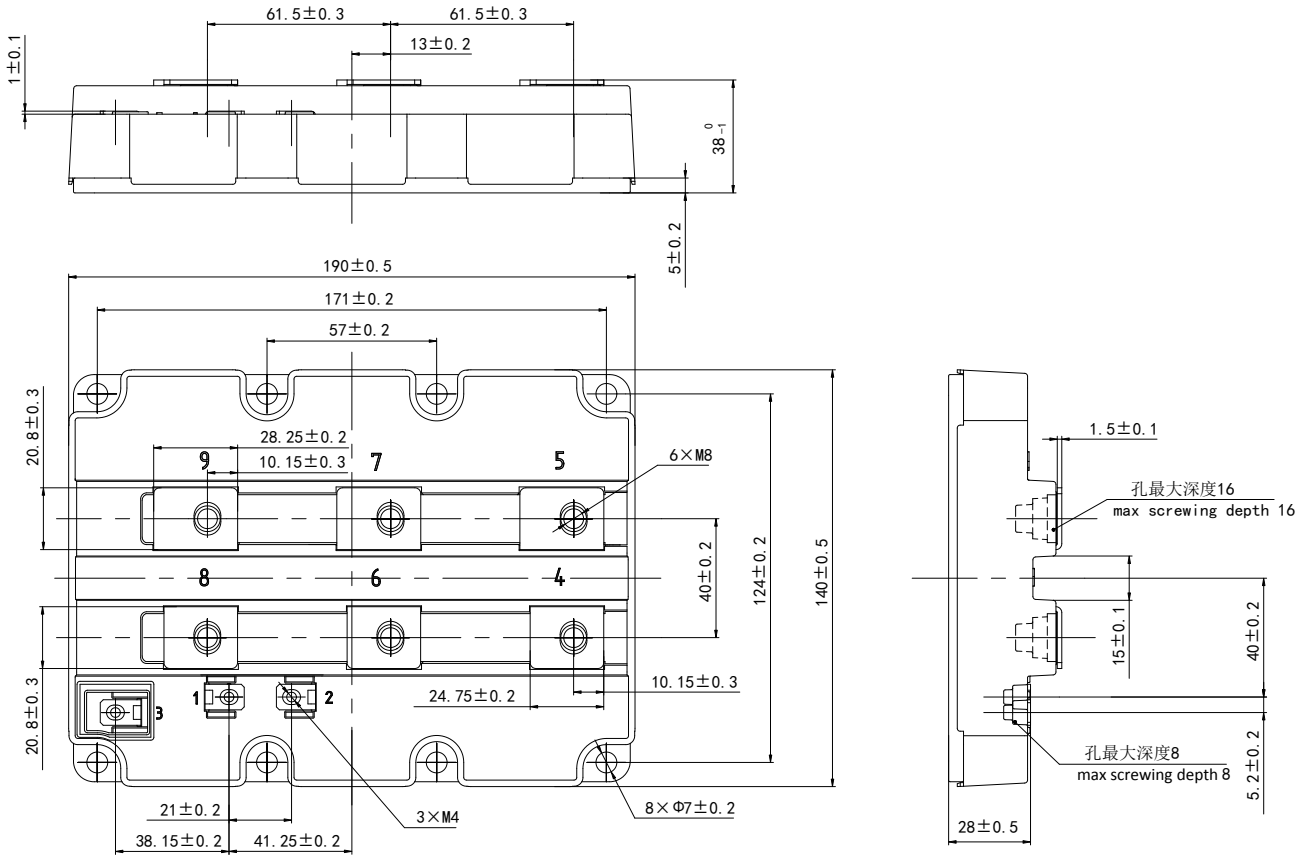


图 16. 栅极电荷特性典型曲线, V_{GE} = f (Q_G)

Fig.16 Typical gate charge characteristic, V_{GE} = f (Q_G)



重量 Weight：1100g　　模块外观类型 Module outline code：E2

图 17.　模块外观尺寸

Fig. 17　Module outlines

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（5）产品在使用时，严禁触碰。产品断电后，在确保无电荷残留、产品已冷却后，才可以在有静电防护措施的情况下触碰产品。

（6）产品数据手册首页的右上角，会显示产品的状态。如果它尚未完全批准，会标示**初版（preliminary）**，该标示意味着该产品已完成设计，量产的产品参数正在确定中，数据手册中的产品信息目前是可以参考的，但将来某些细节可能会发生变化。如果产品数据手册首页的右上角没有标注，则表示该产品已可以批量生产。

Terms and conditions of usage

(1) The product information in this datasheet are intended for use by technical personnel. Due to the diversity of product applications, the information contained in this document can only be used as a general guide, the application applicability cannot be guaranteed in some special applications. It is recommended that users do the assessment of the application applicability before applied. If users need additional product information and help, please contact our sales or technical support.

(2) Some product data in the datasheet of this product are the typical values, the actual factory testing data may deviate slightly from typical values, but our company guarantees that these deviations will not affect the normal use of the product. If the product information changes, our company will promptly amend the datasheet, please keeps your attention to product information changing in our company website.

(3) If there are special requirements for the product, or apply it in special industries (such as aerospace, medical, life support, etc.), we strongly recommend that to perform joint application risk and quality assessments, get the quality agreements.

(4) During the application, if the working conditions are beyond the limitation of temperature, voltage, current or safe operating area of the product defined in the product datasheet, our company cannot guarantee the reliability of the product.

(5) When the products are in use, it is strictly prohibited to touch. After power off, to ensure that there is no residual charge and the products have been cooled before they can be touched. And all operations must be under ESD protection measures.

(6) We annotate datasheet in the top right hand corner of the front page, to indicate product status. The annotation“Preliminary” indicates the product design is complete and final characterization for volume production is in progress，the product information in the datasheet is currently can be referenced, but some details may change in the future. There is no annotation indicates the product is capable to produce in batch quantity.