

关键参数
Key Parameters

V_{CES}		4500	V
$V_{CE(sat)}$	Typ.	2.35	V
I_C	Max.	2000	A
$I_{C(RM)}$	Max.	4000	A

典型应用
Typical Applications

- | | |
|----------|------------------------------|
| ● 柔直换流阀 | MMC-HVDC Valve |
| ● 直流断路器 | DC Breaker |
| ● 海上风电 | Off-shore Wind Power |
| ● 大型工业传动 | Large-scale Industrial Drive |

特点
Features

- | | |
|----------|---------------------------------|
| ● 双面散热 | Double-side Cooling |
| ● 失效短路 | Short-circuit Failure Mode |
| ● 高热循环能力 | High Thermal Cycling Capability |
| ● 低杂散电感 | Low Stray Inductance |

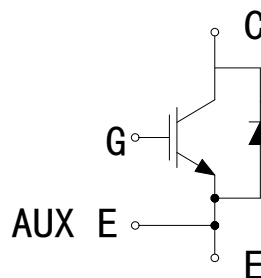
电路结构
Circuit Configuration


图 1. 电路结构

Fig. 1 Circuit configuration

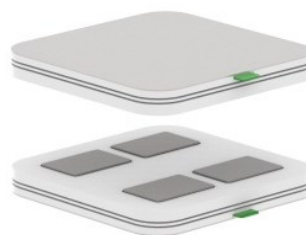
模块外形
Module Appearance


图 2. 模块外形

Fig. 2 Module appearance

模块标签说明
Module Label Code Instruction

 18BC00670027	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	$V_{GE} = 0V, T_C = 25\text{ }^{\circ}\text{C}$	4500	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	$T_C = 90\text{ }^{\circ}\text{C}$	2000	A
$I_{C(PK)}$	集电极峰值电流 Peak collector current	$t_P = 1\text{ms}$	4000	A
P_{max}	晶体管部分最大损耗 Max. transistor power dissipation	$T_{vj} = 135^{\circ}\text{C}, T_C = 25\text{ }^{\circ}\text{C}$	33.3	kW
I_{FSM}	二极管浪涌电流 Diode Surge Current	$V_R = 0V, t_P = 10\text{ms}, T_{vj} = 135\text{ }^{\circ}\text{C}$	26.0	kA

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
$R_{th(J-C)} \text{ IGBT}$	IGBT 结壳热阻 Thermal resistance – IGBT	双面散热 Double-side cooling			3.3	K / kW
$R_{th(J-C)} \text{ Diode}$	二极管结壳热阻 Thermal resistance – Diode	双面散热 Double-side cooling			6.6	K / kW
$R_{th(C-H)} \text{ IGBT}$	接触热阻(IGBT) Thermal resistance – case to heatsink (IGBT)	压装力 65kN Clamping Force 65kN		1.05		K / kW
$R_{th(C-H)} \text{ Diode}$	接触热阻(Diode) Thermal resistance – case to heatsink (Diode)	压装力 65kN Clamping Force 65kN		2.30		K / kW
T_{vj}	工作结温 Operating junction temperature	IGBT 部分 (IGBT)			135	°C
		二极管部分(Diode)			135	°C
T_{stg}	存储温度 Storage temperature range		-40		125	°C
M	压装力 Clamping Force		65		80	kN

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
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_C = 135\text{ }^{\circ}\text{C}$		45	150	mA
I_{GES}	栅极漏电流 Gate leakage current	$V_{GE} = \pm 20V, V_{CE} = 0V$			500	nA
$V_{GE(TH)}$	栅极-发射极阈值电压 Gate threshold voltage	$I_C = 200mA, V_{GE} = V_{CE}$	5.5	6.0	6.5	V
$V_{CE(sat)}$	集电极-发射极饱和电压 Collector-emitter saturation voltage	$V_{GE} = 15V, I_C = 1500A$		2.35	2.75	V
		$V_{GE} = 15V, I_C = 1500A, T_{vj} = 135\text{ }^{\circ}\text{C}$		2.95	3.35	V
I_F	二极管正向直流电流 Diode forward current	DC		2000		A
I_{FRM}	二极管正向重复峰值电流 Diode peak forward current	$t_p = 1ms$		4000		A
V_F	二极管正向电压 Diode forward voltage	$I_F = 2000A, V_{GE} = 0$		2.59	2.99	V
		$I_F = 2000A, V_{GE} = 0, T_{vj} = 135\text{ }^{\circ}\text{C}$		2.75	3.15	V
I_{SC}	短路电流 Short circuit current	$T_{vj} = 135\text{ }^{\circ}\text{C}, V_{CC} = 3600V,$ $V_{GE} \leq 15V, t_p \leq 10\mu s,$ $V_{CE(max)} = V_{CES} - L \times di/dt,$ IEC 60747-9		7800		A

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
C_{ies}	输入电容 Input capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100kHz$		306		nF
Q_g	栅极电荷 Gate charge	$\pm 15V$		24		μC
C_{res}	反向传输电容 Reverse transfer capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100kHz$		6		nF
C_{oes}	输出电容 Output capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100kHz$		20		nF
L_M	模块杂散电感 Module stray inductance			6		nH
R_{Gint}	内部栅极电阻 Internal gate resistor			0.9		Ω

电特性值
Electrical Characteristics

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
$t_{d(off)}$	关断延迟时间 Turn-off delay time	$I_C = 2000A,$ $V_{CE} = 2800V,$ $V_{GE} = \pm 15V,$ $R_{G(OFF)} = 8.2\Omega,$ $C_{GE} = 330nF,$ $L_S = 150nH$	$T_{vj} = 25^\circ C$	6488		ns
			$T_{vj} = 135^\circ C$	6823		
t_f	下降时间 Fall time		$T_{vj} = 25^\circ C$	2003		ns
			$T_{vj} = 135^\circ C$	3430		
E_{OFF}	关断损耗 Turn-off energy loss		$T_{vj} = 25^\circ C$	10.5		J
			$T_{vj} = 135^\circ C$	12.2		
$t_{d(on)}$	开通延迟时间 Turn-on delay time	$I_C = 2000A,$ $V_{CE} = 2800V,$ $V_{GE} = \pm 15V,$ $R_{G(ON)} = 1.8\Omega,$ $C_{GE} = 330nF,$ $L_S = 150nH,$ $di/dt = 2922A/us,$ $(T_{vj} = 135^\circ C)$	$T_{vj} = 25^\circ C$	814		ns
			$T_{vj} = 135^\circ C$	761		
t_r	上升时间 Rise time		$T_{vj} = 25^\circ C$	498		ns
			$T_{vj} = 135^\circ C$	597		
E_{ON}	开通损耗 Turn-on energy loss		$T_{vj} = 25^\circ C$	9.8		J
			$T_{vj} = 135^\circ C$	13.9		
Q_{rr}	二极管反向恢复电荷 Diode reverse recovery charge	$I_F = 2000A,$ $V_{CE} = 2800V,$ $-di_F/dt = 2922A/us,$ $(T_{vj} = 135^\circ C)$	$T_{vj} = 25^\circ C$	1598		μC
			$T_{vj} = 135^\circ C$	3064		
I_{rr}	二极管反向恢复电流 Diode reverse recovery current		$T_{vj} = 25^\circ C$	1505		A
			$T_{vj} = 135^\circ C$	1657		
E_{rec}	二极管反向恢复损耗 Diode reverse recovery energy		$T_{vj} = 25^\circ C$	2.3		J
			$T_{vj} = 135^\circ C$	4.9		

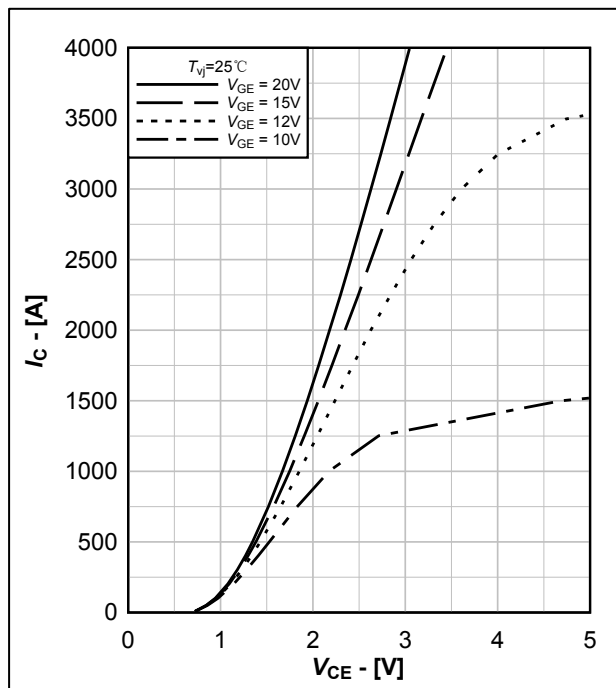

图 3. IGBT 输出特性典型曲线, $I_c = f(V_{CE})$

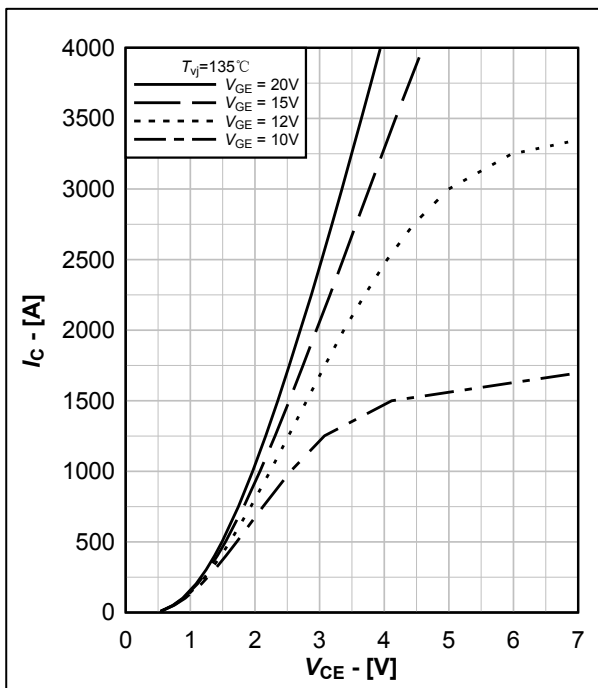
Fig.3 Typical IGBT output characteristics, $I_c = f(V_{CE})$

图 4. IGBT 输出特性典型曲线, $I_c = f(V_{CE})$

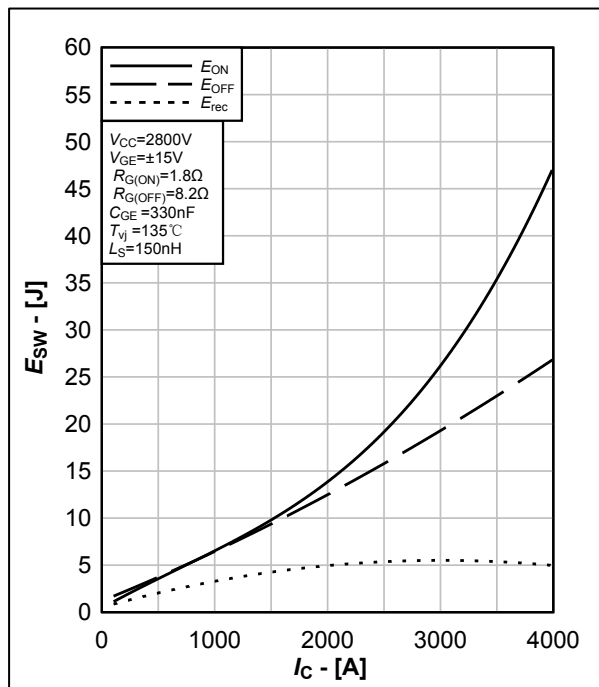
Fig.4 Typical IGBT output characteristics, $I_c = f(V_{CE})$


图 5. IGBT 及 FRD 开关能耗典型曲线,

Fig.5 Typical IGBT & FRD switching energy,

$$E_{ON} = f(I_C), E_{OFF} = f(I_C), E_{rec} = f(I_C)$$

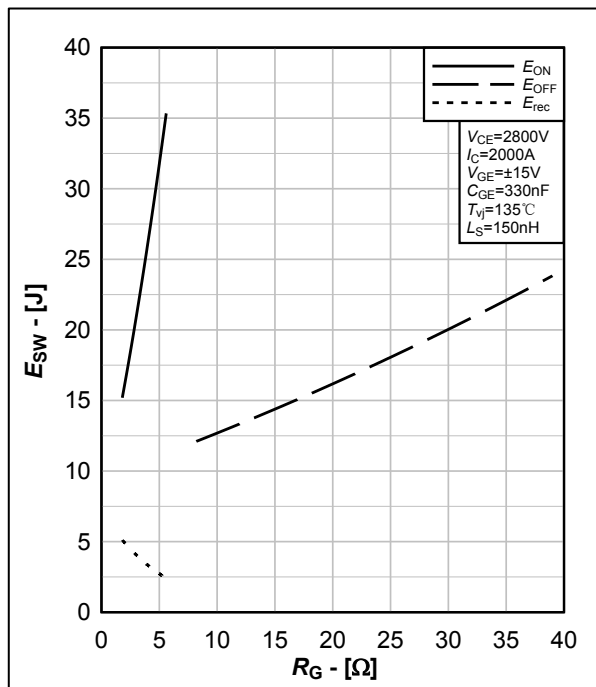


图 6. IGBT 及 FRD 开关能耗典型曲线,

Fig.6 Typical IGBT & FRD switching energy,

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

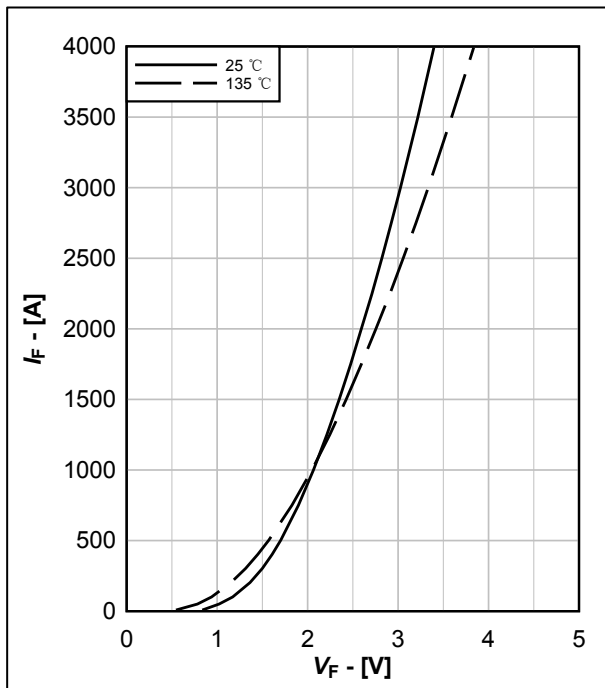

图 7. FRD 输出特性典型曲线, $I_F = f(V_F)$

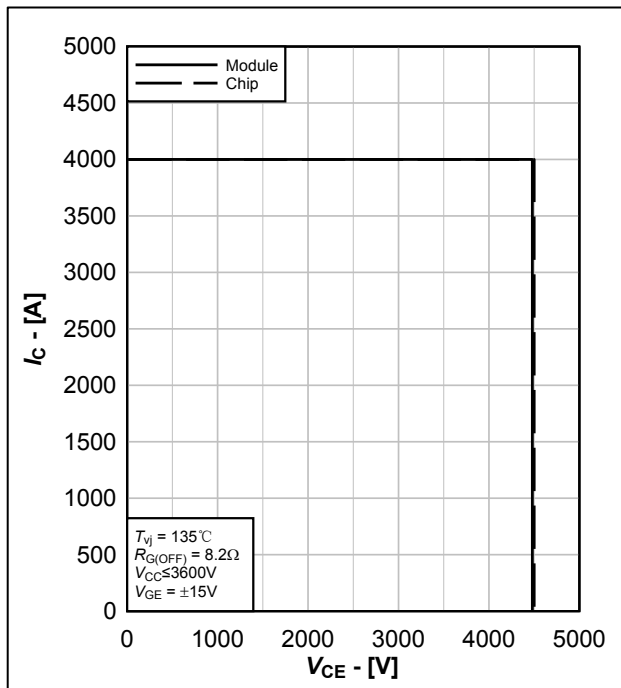
Fig.7 Typical FRD output characteristics, $I_F = f(V_F)$

图 8. IGBT 反偏安全工作区 $I_C = f(V_{CE})$

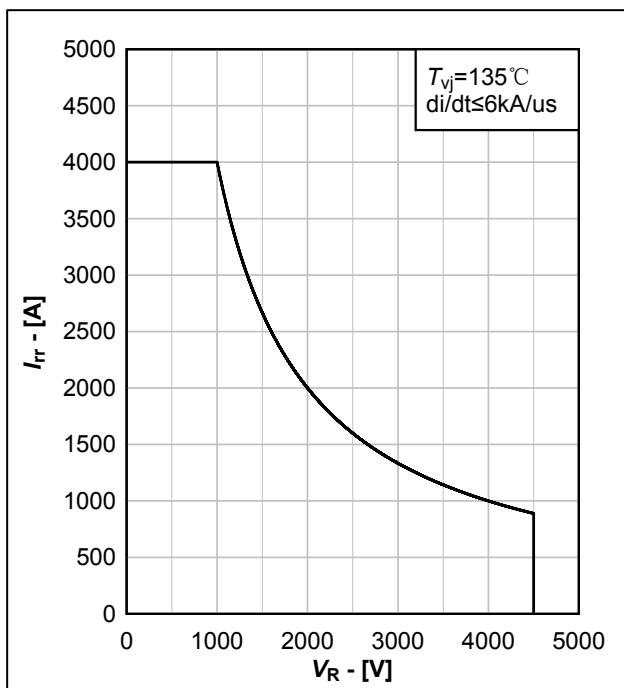
Fig.8 Reverse bias safe operating area of IGBT $I_C = f(V_{CE})$


图 9. 二极管反偏安全工作区

Fig.9 Reverse bias safe operating area of Diode

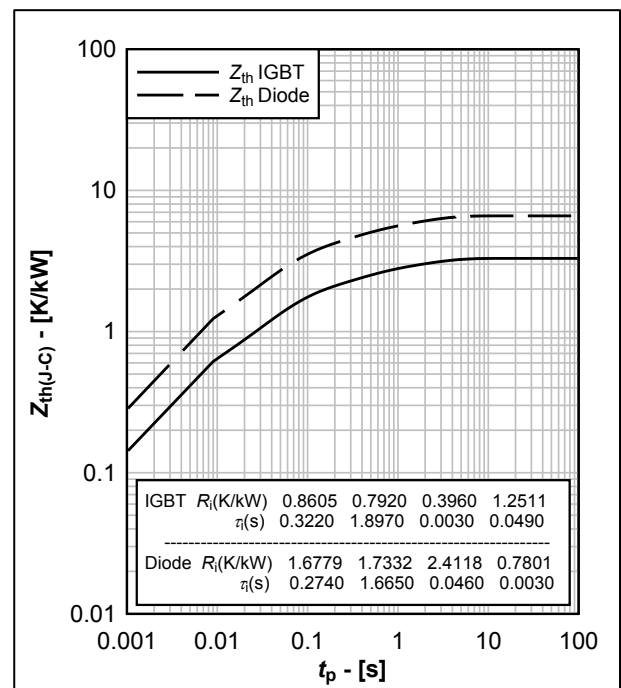
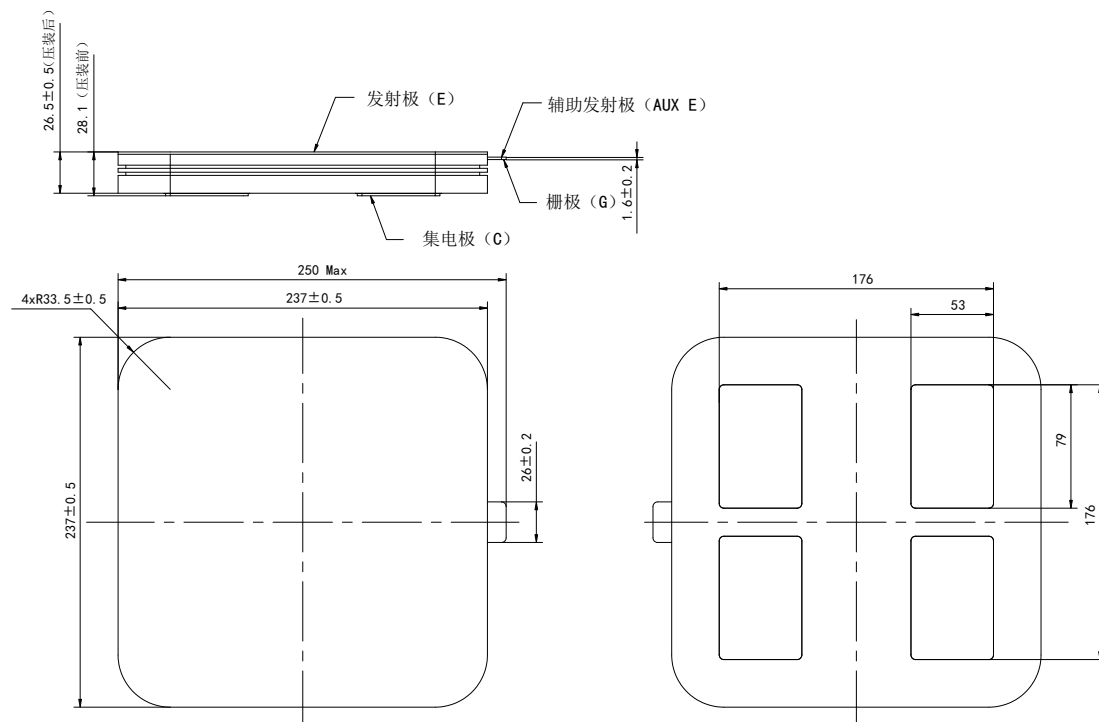

图 10. 瞬态热阻抗曲线, $Z_{th(j-c)} = f(t_p)$

Fig.10 Transient thermal impedance, $Z_{th(j-c)} = f(t_p)$



- 1、压接式 IGBT 单管，功率等级为 4500V/2000A；
- 2、管壳材质为聚酯树脂+玻纤复合材料，CTI ≥ 600；
- 3、CE 最小爬电距离 40mm，CE 最小电气间隙 21mm；
- 4、使用压力范围 65~80kN。

重量 Weight: 4100g

模块外观类型 Module outline code: ZF

图 11. 模块外观尺寸

Fig. 11 Module outlines

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