Longer HybridPACK™ Drive Module

电气特性/ Features and Benefits:

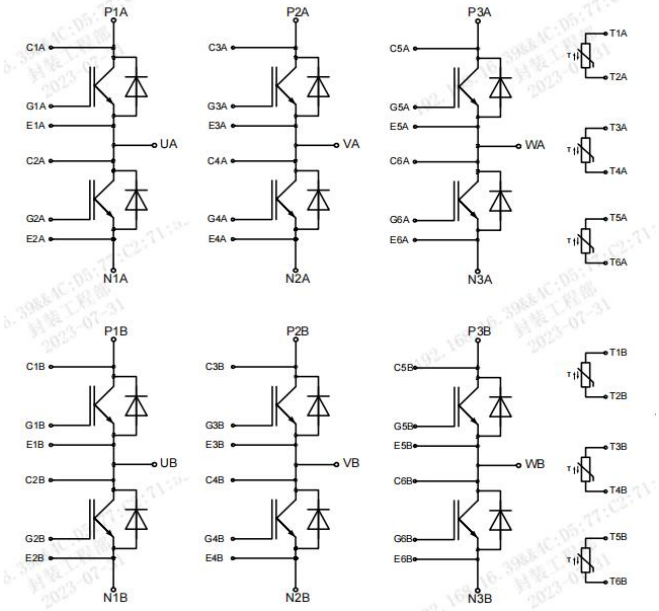
- 750V 沟槽栅/场终止工艺

  750V trench gate/field termination process
- 低开关损耗

  Low switching losses
- Vcesat 正温度系数

  Vcesat has a positive temperature coefficient
- 集成 NTC 温度传感器

  Integrated NTC temperature sensor



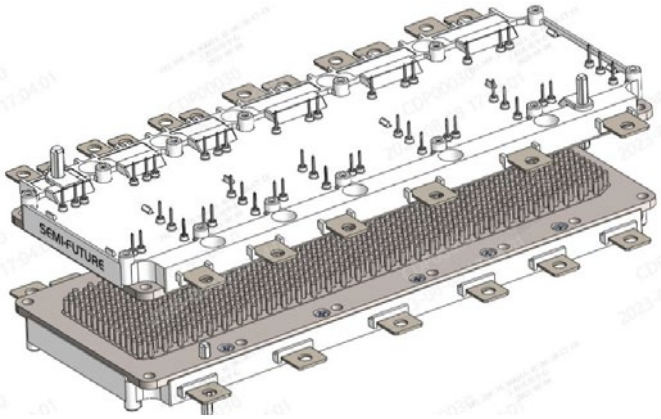
典型应用/Typical Applications：

- 混合动力汽车

  Hybrid Electrical Vehicles (H)EV
- 电机驱动

  Motor Drives
- 汽车应用

  Automotive Applications



A:V_{CES}=750V，$I_{C\ nom}$=550A / I_{CRM}=1100A

B:V_{CES}=750V，$I_{C\ nom}$=820A / I_{CRM}=1640A

IGBT, A

最大额定值 / Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
集电极-发射极电压 Collector-Emitter voltage	Tvj=25℃	V_{CES}	750	V
有效正向电流 Implemented forward current		I_{CN}	550	A
连续正向直流电流 Continuous DC forward current			250	A
集电极重复峰值电流 Repetitive peak collector current	T_P=1ms	I_{CRM}	1100	A
总功率损耗 Total power dissipation	T_F = 75°C, $T_{vj\ max}$ = 175°C	P_{tot}	760	W
栅极-发射极电压 Gate emitter voltage	Tvj=25℃	V_{GE}	±20	V

特征值 / Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
集电极-发射极饱和电压 Collector-Emitter saturation voltage	V_{GE}=15V, I_C=550A V_{GE}=15V, I_C=550A V_{GE}=15V, I_C=550A	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	V_{CEsat}		1.45 1.60 1.75	2.00	V
栅极-发射极阈值电压 Gate−Emitter Threshold Voltage	I_C=8.5mA, V_{GE}= V_{CE}	T_{vj}=25°C	$V_{GE(th)}$	5.10	5.70	6.30	
总栅电荷 Total Gate charge	V_{CE} = 400 V, I_C = 300 A, V_{GE} = ±15 V		Q_G		1580		nC
栅极电阻 Internal gate resistor	Tvj = 25°C		RGint		1.0		Ω
输入电容 Input capacitance	f=100KHz, V_{CE}=25 V, V_{GE}=0 V T_{vj}=25°C		Cies		30.0		nF
输出电容 Output capacitance			Coes		2.00		
反向传输电容 Reverse transfer capacitance			Cres		0.54		
集电极-发射极截止电流 Collector-emitter cut-off current	V_{CE}=750V , V_{GE}= 0 V	T_{vj}=25°C T_{vj}=175°C	I_{CES}		4.5	1.0	mA
栅极-发射极漏电流 Gate-emitter leakage current	V_{CE}=0 V, V_{GE}= 20 V	T_{vj}=25°C	I_{GES}			300	nA
开通延迟时间 Turn-on delay time	I_C=300A, V_{CE}=400 V V_{GE}=±15 V, R_G=4Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	$t_{d\ on}$		125 122 126		ns

上升时间 Rise time	I_C=300A, V_{CE}=400 V V_{GE}=±15 V, R_G=4Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	t_r		77 77 80		ns
关断延迟时间 Turn-off delay time	I_C=300A, V_{CE}=400 V V_{GE}=±15 V, R_G=4Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	$t_{d\ off}$		265 297 315		ns
下降时间 Fall time	I_C=300A, V_{CE}=400 V V_{GE}=±15 V, R_G=4Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	t_f		275 346 300		ns
开通损耗能量（每脉冲） Turn-on energy loss per pulse	I_C=300A, V_{CE}=400 V V_{GE}=±15 V, R_G=4Ω di/dt=3200A/us(T_{vj}=150°C) (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	E_{on}		8.05 10.1 11.5		mJ
关断损耗能量（每脉冲） Turn-off energy loss per pulse	I_C=300A, V_{CE}=400 V V_{GE}=±15 V, R_G=4Ω dv/dt=3900V/us(T_{vj}=150°C) (电感负载) / (inductive load)	T T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	E_{off}		17.0 21.0 22.5		mJ
结-外壳热阻 Thermal resistance, junction to case	每个 IGBT / per IGBT		R_{thJC}		0.134		K/W
在开关条件下的温度 Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

二极管，A

最大额定值 / Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
反向重复峰值电压 Repetitive peak reverse voltage	T_{vj}=25°C	V_{RRM}	750	V
有效正向电流 Implemented forward current		I_{FN}	550	A
连续正向直流电流 Continuous DC forward current		IF	230	A
正向重复峰值电流 Repetitive peak forward current	t_p=1ms	I_{FRM}	1100	A

特征值 / Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	I_F=550A, V_{GE}=0V I_F=550A, V_{GE}=0V I_F=550A, V_{GE}=0V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	V_F		1.81 1.95 1.98	2.20	V

反向恢复峰值电流 Peak reverse recovery current	I_F =300A, -diF/dt=3200A/μs(T_{vj}=150°C) V_R =400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	I_{RM}		135 190 300		A
反向恢复时间 Reverse Recovery Time	IF=300A, -diF/dt=3200A/μs(T_{vj}=150°C) V_R =400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	Trr		110 225 255		ns
恢复电荷 Recovered charge	IF=300A, -diF/dt=3200A/μs(T_{vj}=150°C) V_R =400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	Q_{rr}		8.38 20.1 22.7		μC
反向恢复损耗（每脉冲） Reverse recovered energy	IF=300A, -diF/dt=3200A/μs(T_{vj}=150°C) V_R =400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	E_{rec}		1.87 5.63 6.03		mJ
结-外壳热阻 Thermal resistance, junction to case	每个二极管 / per diode		R_{thJC}		0.178		K/W
在开关状态下温度 Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

IGBT, B

最大额定值 / Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
集电极-发射极电压 Collector-Emitter voltage	Tvj=25℃	V_{CES}	750	V
有效正向电流 Implemented forward current		I_{CN}	820	A
连续正向直流电流 Continuous DC forward current	T_F = 80°C, $T_{vj\ max}$ = 175°C	IC nom	450	A
集电极重复峰值电流 Repetitive peak collector current	T_P=1ms	I_{CRM}	1640	A
总功率损耗 Total power dissipation	T_F = 75°C, $T_{vj\ max}$ = 175°C	P_{tot}	760	W
栅极-发射极电压 Gate emitter voltage	Tvj=25℃	V_{GE}	±20	V

特征值 / Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	

集电极-发射极饱和电压 Collector-Emitter saturation voltage	V_{GE}=15V, I_C=820A V_{GE}=15V, I_C=820A V_{GE}=15V, I_C=820A	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	V_{CEsat}		1.45 1.60 1.75	2.00	V
栅极-发射极阈值电压 Gate−Emitter Threshold Voltage	I_C=9.6mA, V_{GE}= V_{CE}	T_{vj}=25°C	$V_{GE(th)}$	5.15	5.75	6.35	
总栅电荷 Total Gate charge	V_{CE} = 400 V, I_C = 450 A, V_{GE} = ±15 V		Q_G		2300		nC
栅极电阻 Internal gate resistor	Tvj=25℃		Rgint		0.7		Ω
输入电容 Input capacitance	f=100KHz, V_{CE}=25 V, V_{GE}=0 V T_{vj}=25°C		Cies		44.1		nF
输出电容 Output capacitance			Coes		3.03		
反向传输电容 Reverse transfer capacitance			Cres		0.80		
集电极-发射极截止电流 Collector-emitter cut-off current	V_{CE}=750V_{GE}= 0 V	T_{vj}=25°C T_{vj}=175°C	I_{CES}		10	1.0	mA
栅极-发射极漏电流 Gate-emitter leakage current	V_{CE}=0 V, V_{GE}= 20 V	T_{vj}=25°C	I_{GES}			400	nA
开通延迟时间 Turn-on delay time	I_C=450A, V_{CE}=400 V V_{GE}=±15 V, R_G=5Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	$t_{d\,on}$		180 184 170		ns
上升时间 Rise time	I_C=450A, V_{CE}=400 V V_{GE}=±15 V, R_G=5Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	t_r		114 115 118		ns
关断延迟时间 Turn-off delay time	I_C=450A, V_{CE}=400 V V_{GE}=±15 V, R_G=5Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	$t_{d\,off}$		382 418 426		ns
下降时间 Fall time	I_C=450A, V_{CE}=400 V V_{GE}=±15 V, R_G=5Ω (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	t_f		215 321 358		ns
开通损耗能量（每脉冲） Turn-on energy loss per pulse	I_C=450A, V_{CE}=400 V V_{GE}=±15 V, R_G=5Ω di/dt=3100A/us(T_{vj}=150°C) (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{on}		16.3 22.4 23.0		mJ
关断损耗能量（每脉冲） Turn-off energy loss per pulse	I_C=450A, V_{CE}=400 V V_{GE}=±15 V, R_G=5Ω dv/dt=3000V/us(T_{vj}=150°C) (电感负载) / (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{off}		26.5 34.5 35.8		mJ
结-外壳热阻 Thermal resistance, junction to case	每个 IGBT / per IGBT		R_{thJC}		0.134		K/W

在开关条件下的温度 Temperature under switching conditions		$T_{vj\ op}$	-40		175	°C

二极管，B

最大额定值 / Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
反向重复峰值电压 Repetitive peak reverse voltage	T_{vj}=25°C	V_{RRM}	750	V
有效正向电流 Implemented forward current		I_{FN}	820	A
连续正向直流电流 Continuous DC forward current		IF	450	A
正向重复峰值电流 Repetitive peak forward current	t_p=1ms	I_{FRM}	1640	A

特征值 / Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	I_F=820A, V_{GE}=0V I_F=820A, V_{GE}=0V I_F=820A, V_{GE}=0V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	V_F		1.85 1.98 2.05	2.20	V
反向恢复峰值电流 Peak reverse recovery current	IF=450A, -diF/dt=3100A/μs VR=400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	I_{RM}		135 190 300		A
反向恢复时间 Reverse Recovery Time	IF=450A, -diF/dt=3100A/μs VR=400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	Trr		115 230 292		ns
恢复电荷 Recovered charge	IF=450A, -diF/dt=3100A/μs VR=400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	Q_{rr}		8.38 20.0 22.7		μC
反向恢复损耗（每脉冲） Reverse recovered energy	IF=450A, -diF/dt=3100A/μs VR=400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=150°C T_{vj}=175°C	E_{rec}		2.38 7.42 8.76		mJ
结-外壳热阻 Thermal resistance, junction to case	每个二极管 / per diode		R_{thJC}		0.178		K/W
在开关状态下温度 Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

负温度系数热敏电阻/NTC-Thermistor

特征值/Characteristic Values

Parameter	Conditions	Value			Unit
R25	T=25℃		5.00		KΩ
△R/R	Tc=100℃, R100=493.3Ω	−5		5	%
B−value	B (25/50), tolerance ±3%		3380		K
B−value	B (25/85), tolerance ±3%		3476		K
B−value	B (25/100), tolerance ±3%		3485		K

模块 / Module

Parameter	Conditions	Symbol	Value			Unit
绝缘测试电压 Isolation test voltage	RMS, f=0Hz, t=1sec	V_{ISOL}		4.2		kV
内部绝缘 Internal isolation				Al_2O_3		
储存温度 Storage temperature		Tstg	-40		125	°C
爬电距离 Creepage distance	terminal to heatsink terminal to terminal	dCreep		9.0 9.0		mm
电器间隙 Clearance	terminal to heatsink terminal to terminal	dClear		4.5 4.5		mm
Comperative tracking index		CTI		> 200		
			Min.	**Typ.**	**Max.**	
模块安装的扭矩 Mounting torque for modul mounting	Screw M4 baseplate to heatsink Screw EJOT Delta PCB to frame	M	1.8 0.45		2.2 0.55	Nm
重量 Weight		G		1270		g

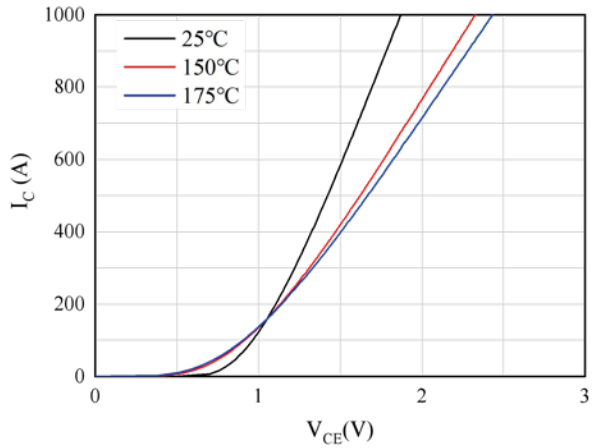


图 1. 典型输出特性 (V_{GE}=15V),IGBT A

Figure 1.Typical output characteristics (V_{GE}=15V)

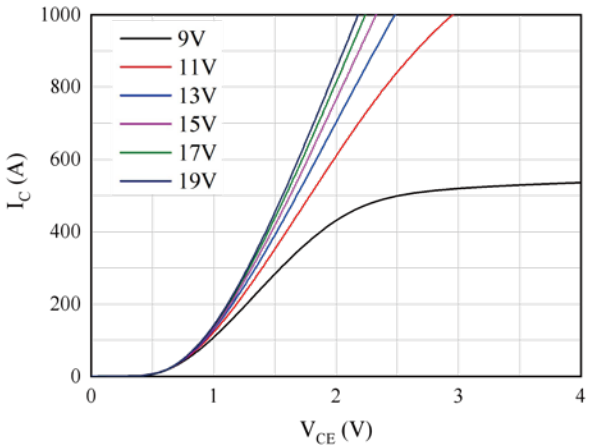


图 2. 典型输出特性 (T_{vj}=150℃),IGBT A

Figure 2.Typical output characteristics (T_{vj}=150℃)

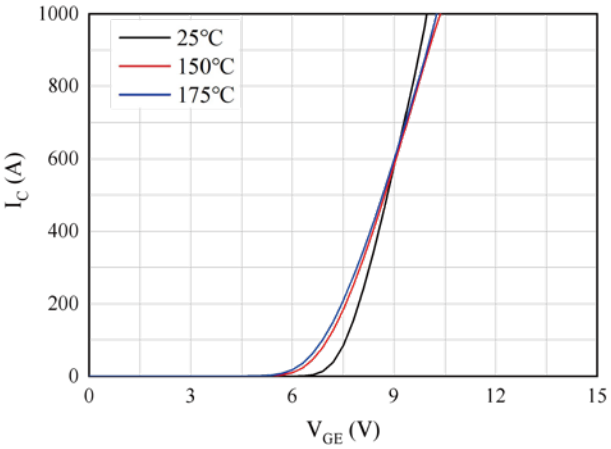


图 3. 典型传输特性(V_{CE}=20V),IGBT A

Figure 3.Typical transfer characteristic(V_{CE}=20V)

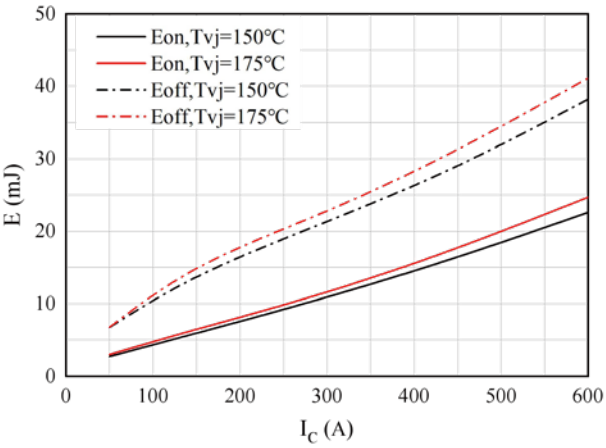


图 4. 开关损耗 逆变器,,IGBT A

Figure 4. Switching losses of IGBT

V_{GE}=±15V, R_G=4Ω, V_{CE}=400V

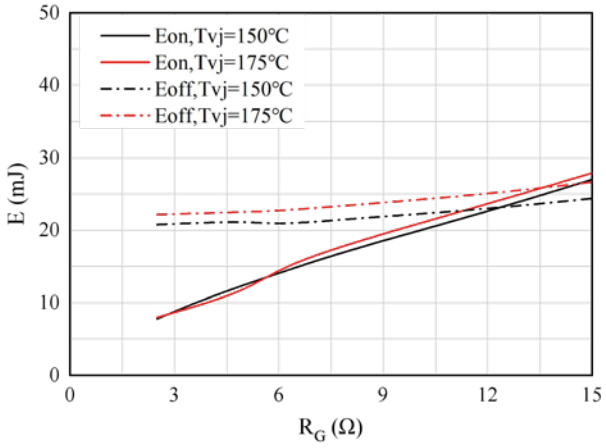


图 5. 开关损耗 逆变器,IGBT A

Figure 5. Switching losses of IGBT

V_{GE}=±15V, I_C=300A, V_{CE}=400V

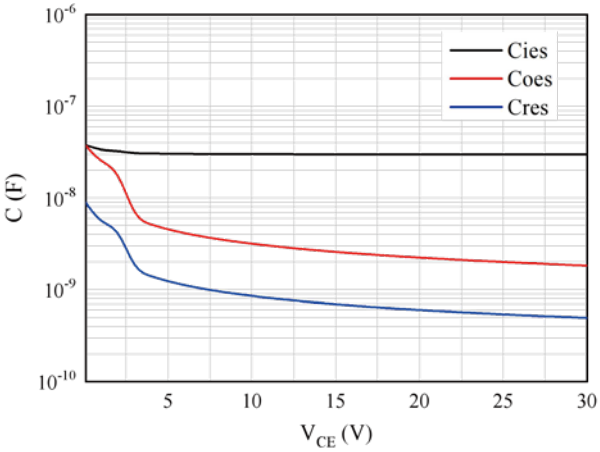


图 6. 电容特性,IGBT A

Figure 6. Capacitance characteristic

f=100 kHz, V_{GE}=0 V, Tvj=25 °C

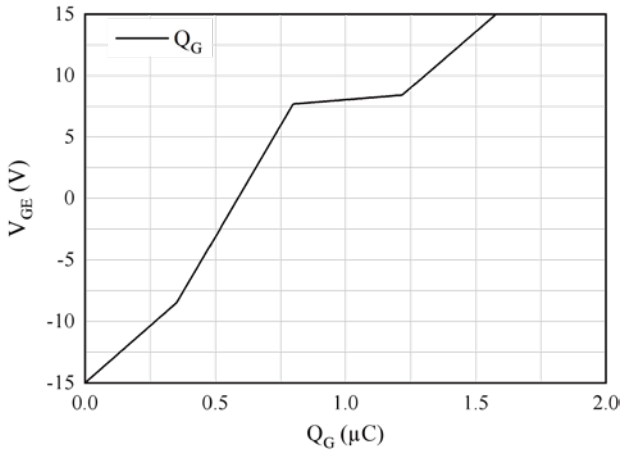


图 7 栅极电荷特性 逆变器,IGBT A

Figure 7. Gate charge characteristic of IGBT

V_{CE}= 400 V, I =300A, Tvj = 25°C

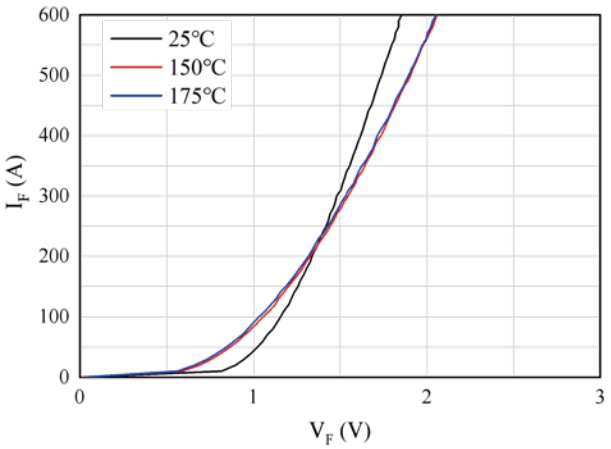


图 8 正向偏压特性 二极管,FRD A

Figure 8. Forward characteristic of Diode

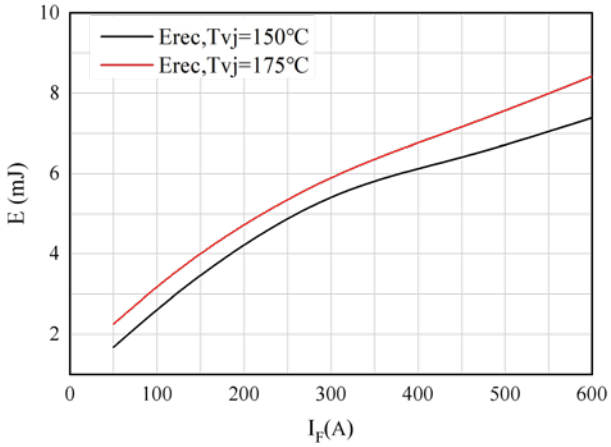


图 9. 开关损耗 二极管,FRD A

Figure 9. Switching losses of Diode

R_G=4Ω，V_{CE}=400V

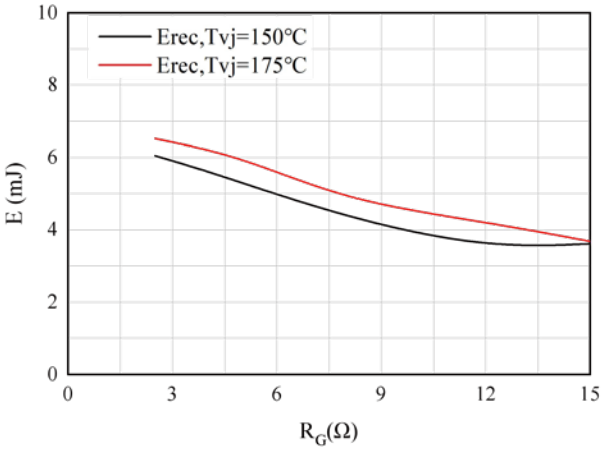


图 10. 开关损耗 二极管,FRD A

Figure 10. Switching losses of Diode

I_C=300A，V_{CE}=400V

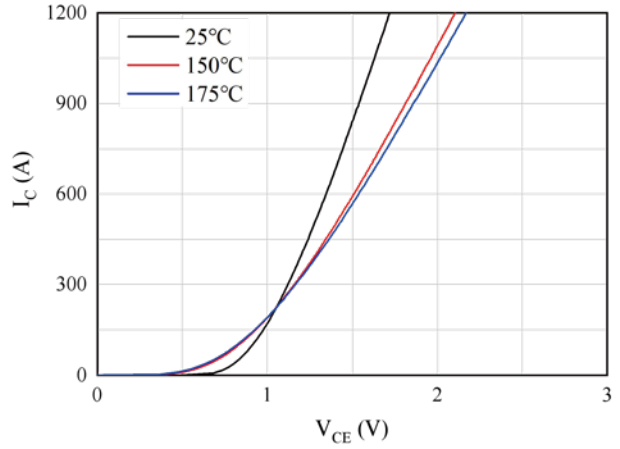


图 11. 典型输出特性 (V_{GE}=15V),IGBT B

Figure 11.Typical output characteristics (V_{GE}=15V)

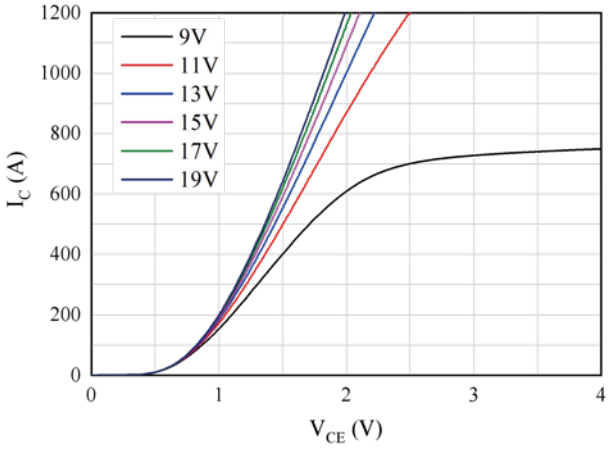


图 12. 典型输出特性 (T_{vj}=150℃),IGBT B

Figure12.Typical output characteristics (T_{vj}=150℃)

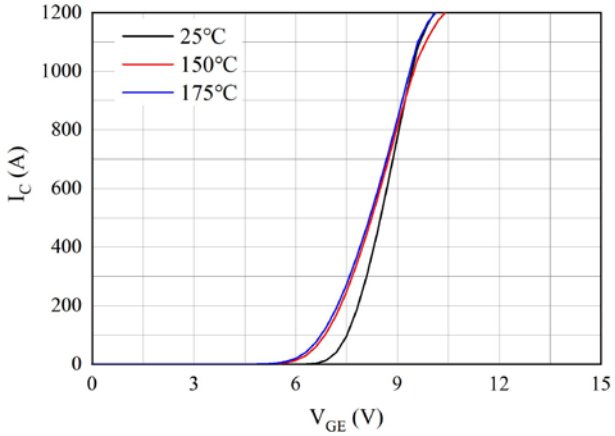


图 13. 典型传输特性(V_{CE}=20V),IGBT B

Figure 13.Typical transfer characteristic(V_{CE}=20V)

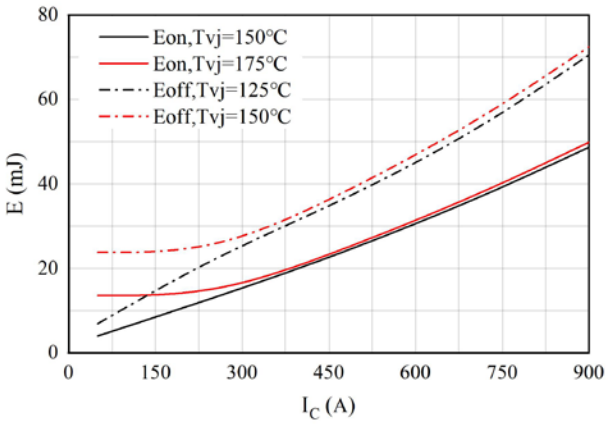


图 14. 开关损耗 逆变器,IGBT B

Figure 14. Switching losses of IGBT

V_{GE} =±15V, R =5 Ω , V_{CE}=400V

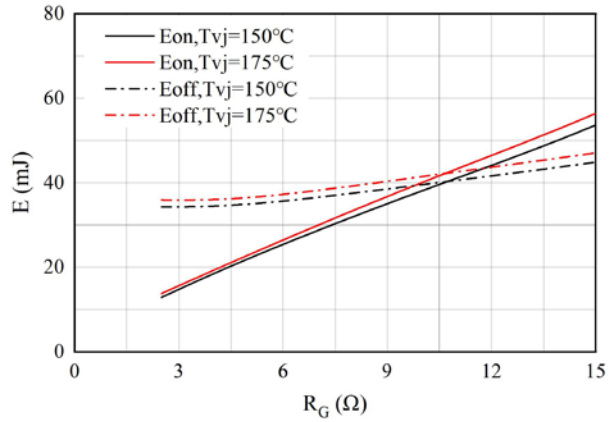


图 15. 开关损耗 逆变器,IGBT B

Figure 15. Switching losses of IGBT

V_{GE}=±15V, IC=450A, V_{CE}=400V

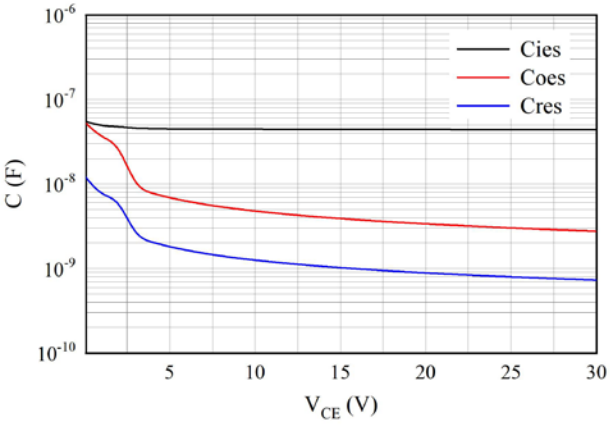


图 16. 电容特性,IGBT B

Figure 16. Capacitance characteristic

f=100 kHz,V_G =0 V,Tvj=25 °C

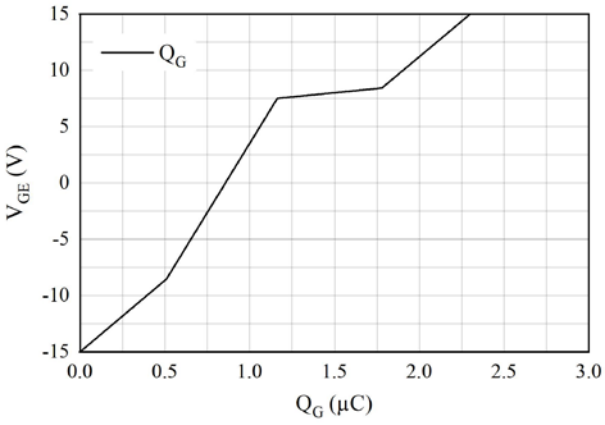


图 17 栅极电荷特性 逆变器,IGBT B

Figure 17. Gate charge characteristic of IGBT

V_{CE}=400 V, I_C=300A, Tvj=25°C

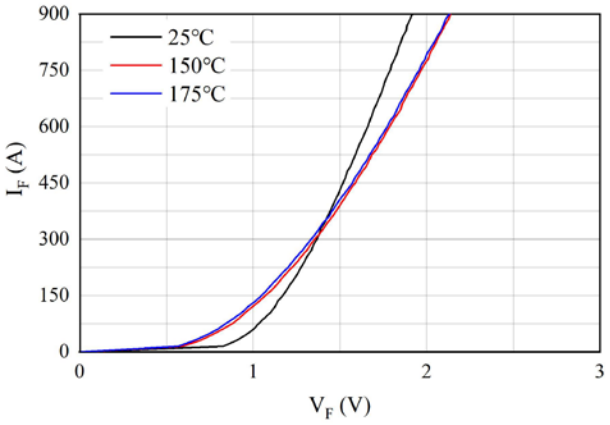


图 18 正向偏压特性 二极管,FRD B

Figure 18. Forward characteristic of Diode

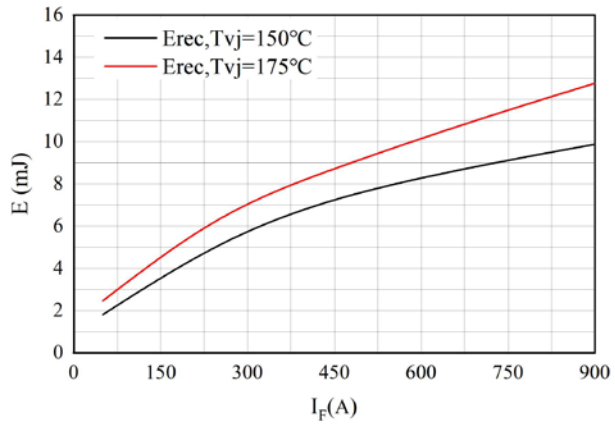


图 19. 开关损耗 二极管,FRD B

Figure 19. Switching losses of Diode

R_G =5Ω, V_{CE}=400V

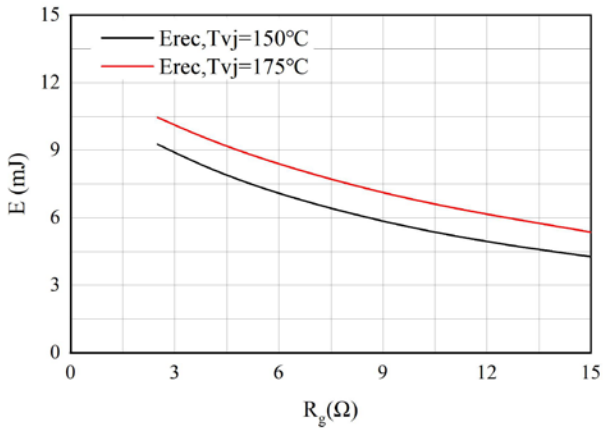


图 20. 开关损耗 二极管,FRD B

Figure 20. Switching losses of Diode

I_C=450A, V_{CE}=400V

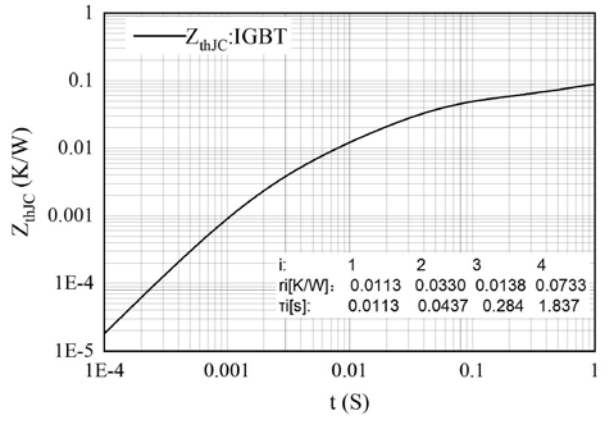


图 21. 瞬态热阻抗 IGBT，逆变器

Figure21. Transient thermal impedance IGBT, Inverter

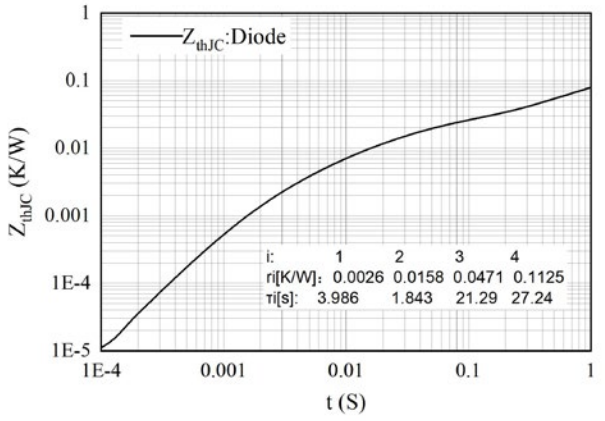


图 22. 瞬态热阻抗 二极管

Figure22. Transient thermal impedance Diode

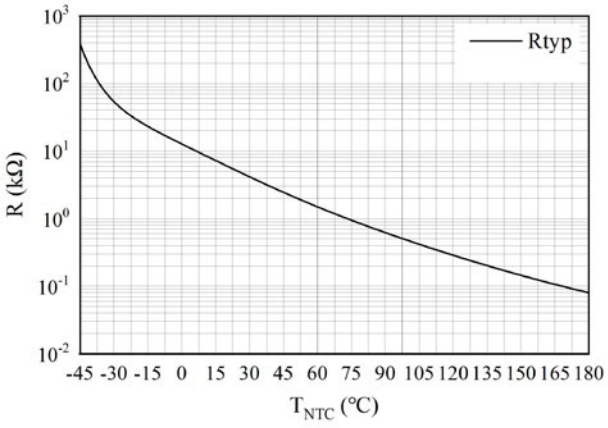
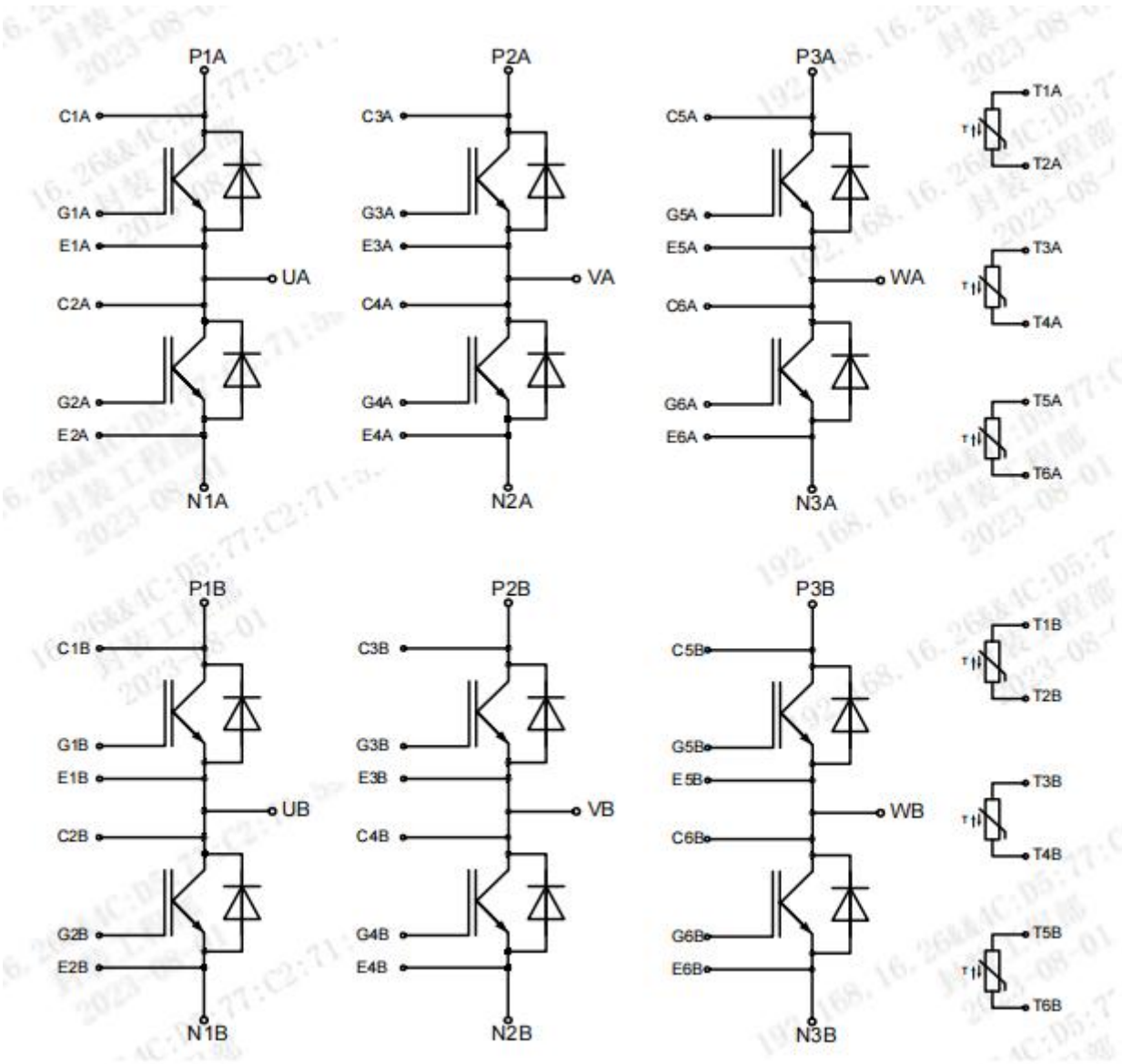


图 23. 负温系数热敏电阻 温度特性

Figure 23. NTC-Themistor-temperature characteristic

接线图 / Circuit diagram



封装尺寸 / Package outlines