

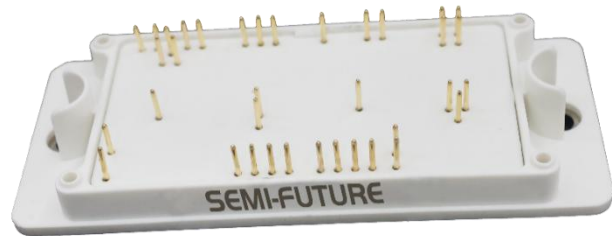
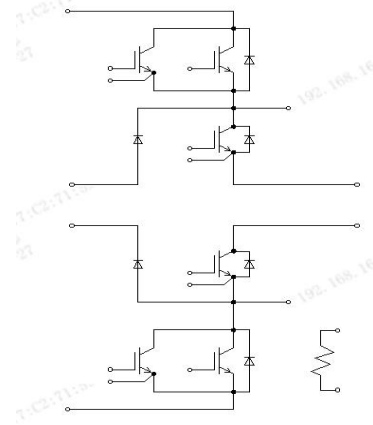
3-Level NPC Inverter Module

电气特性/ Features and Benefits:

- 650V 沟槽栅/场终止工艺
650V 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:

- 三电平应用
3-level-applications
- 光伏逆变器
Solar Inverters
- 不间断电源
Uninterruptable Power Supplies Systems



$V_{CES} = 650V$, $I_{C\text{nom}} = 450A$

IGBT, Q1.1/Q1.2/Q4.1/Q4.2

最大额定值 / Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
集电极-发射极电压 Collector-Emitter voltage	$T_{vj} = 25^\circ\text{C}$	V_{CES}	650	V
连续集电极直流电流 Continuous DC collector current	$T_c = 80^\circ\text{C}$, $T_{vj\text{ max}} = 175^\circ\text{C}$	$I_{C\text{nom}}$	167	A
脉冲集电极电流 Pulsed Collector Current	$T_c = 175^\circ\text{C}$	$I_{C\text{pulse}}$	500	A
栅极-发射极电压 Gate emitter voltage	$T_{vj} = 25^\circ\text{C}$	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	$V_{GE}=15V, I_C=225A$ $V_{GE}=15V, I_C=225A$ $V_{GE}=15V, I_C=225A$	$T_{vj}=25^{\circ}C$ $T_{vj}=125^{\circ}C$ $T_{vj}=150^{\circ}C$	V_{CEsat}		1.65 1.90 2.12	2.20	V
栅极-发射极阈值电压 Gate-Emitter Threshold Voltage	$I_C=2.75mA, V_{GE}=V_{CE}$	$T_{vj}=25^{\circ}C$	$V_{GE(th)}$	3.70	4.30	4.90	
总栅电荷 Total Gate charge	$V_{CE}=400V, I_C=225A, V_{GE}=\pm 15V$		Q_G		750		nC
输入电容 Input capacitance	$f=100KHz, V_{CE}=25V, V_{GE}=0V$	$T_{vj}=25^{\circ}C$	C_{ies}		12.80		nF
反向传输电容 Reverse transfer capacitance			C_{res}		0.06		
集电极-发射极截止电流 Collector-emitter cut-off current	$V_{CE}=650V, V_{GE}=0V$	$T_{vj}=25^{\circ}C$	I_{CES}			1	mA
栅极-发射极漏电流 Gate-emitter leakage current	$V_{CE}=0V, V_{GE}=20V$	$T_{vj}=25^{\circ}C$	I_{GES}			200	nA
开通延迟时间 Turn-on delay time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=10\Omega$ (电感负载) / (inductive load)	$T_{vj}=25^{\circ}C$	$t_{d on}$		60		ns
上升时间 Rise time		$T_{vj}=125^{\circ}C$			52		
		$T_{vj}=150^{\circ}C$			54		
关断延迟时间 Turn-off delay time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=10\Omega$ (电感负载) / (inductive load)	$T_{vj}=25^{\circ}C$	$t_{d off}$		186		
		$T_{vj}=125^{\circ}C$			203		
		$T_{vj}=150^{\circ}C$			210		
下降时间 Fall time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=10\Omega$ (电感负载) / (inductive load)	$T_{vj}=25^{\circ}C$	t_f		43		
		$T_{vj}=125^{\circ}C$			58		
		$T_{vj}=150^{\circ}C$			64		
开通损耗能量 (每脉冲) Turn-on energy loss per pulse	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=10\Omega$ $di/dt=2000A/us(T_{vj}=150^{\circ}C)$ (电感负载) / (inductive load)	$T_{vj}=25^{\circ}C$	E_{on}		9.82		mJ
$T_{vj}=125^{\circ}C$				11.60			
$T_{vj}=150^{\circ}C$				12.43			
关断损耗能量 (每脉冲) Turn-off energy loss per pulse	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=10\Omega$ $dv/dt=8500V/us(T_{vj}=150^{\circ}C)$ (电感负载) / (inductive load)	$T_{vj}=25^{\circ}C$	E_{off}		2.70		
$T_{vj}=125^{\circ}C$				3.73			
$T_{vj}=150^{\circ}C$				4.07			
结-外壳热阻 Thermal resistance, junction to case	每个 IGBT / per IGBT		R_{thJC}		0.25		K/W
在开关状态下温度 Temperature under switching conditions			$T_{vj op}$	-40		150	$^{\circ}C$

IGBT, Q2/Q3**最大额定值 / Maximum Ratings**

Parameter	Conditions	Symbol	Value	Unit
集电极-发射极电压 Collector-Emitter voltage	$T_{vj}=25^{\circ}\text{C}$	V_{CES}	650	V
连续集电极直流电流 Continuous DC collector current	$T_c=80^{\circ}\text{C}$, $T_{vj\text{ max}}=175^{\circ}\text{C}$	I_{cnom}	280	A
脉冲集电极电流 Pulsed Collector Current	$T_c=175^{\circ}\text{C}$	I_{cpulse}	840	A
栅极-发射极电压 Gate emitter voltage	$T_{vj}=25^{\circ}\text{C}$	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	$V_{GE}=15\text{V}$, $I_C=375\text{A}$ $T_{vj}=25^{\circ}\text{C}$ $V_{GE}=15\text{V}$, $I_C=375\text{A}$ $T_{vj}=125^{\circ}\text{C}$ $V_{GE}=15\text{V}$, $I_C=375\text{A}$ $T_{vj}=150^{\circ}\text{C}$	V_{CESat}		1.62 1.90 1.97	2.20	V
栅极-发射极阈值电压 Gate-Emitter threshold voltage	$I_C=3.75\text{mA}$, $V_{GE}=V_{CE}$ $T_{vj}=25^{\circ}\text{C}$	$V_{GE(th)}$	3.70	4.30	4.90	
栅电荷 Gate charge	$V_{CE}=400\text{V}$, $I_C=375\text{A}$, $V_{GE}=\pm 15\text{V}$	Q_G		1230		nC
输入电容 Input capacitance	$f=100\text{KHz}$, $V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$ $T_{vj}=25^{\circ}\text{C}$	C_{ies}		21.2		nF
反向传输电容 Reverse transfer capacitance		C_{res}		0.10		
集电极-发射极截止电流 Collector-emitter cut-off current	$V_{CE}=650\text{V}$, $V_{GE}=0\text{V}$ $T_{vj}=25^{\circ}\text{C}$	I_{CES}			1	mA
栅极-发射极漏电流 Gate-emitter leakage current	$V_{CE}=0\text{V}$, $V_{GE}=20\text{V}$ $T_{vj}=25^{\circ}\text{C}$	I_{GES}			200	nA
开通延迟时间 Turn-on delay time	$I_C=200\text{A}$, $V_{CE}=400\text{V}$ $T_{vj}=25^{\circ}\text{C}$ $V_{GE}=\pm 15\text{V}$, $R_G=30\Omega$ $T_{vj}=125^{\circ}\text{C}$ (电感负载) / (inductive load) $T_{vj}=150^{\circ}\text{C}$	t_{don}		278 236 215		ns
上升时间 Rise time	$I_C=200\text{A}$, $V_{CE}=400\text{V}$ $T_{vj}=25^{\circ}\text{C}$ $V_{GE}=\pm 15\text{V}$, $R_G=30\Omega$ $T_{vj}=125^{\circ}\text{C}$ (电感负载) / (inductive load) $T_{vj}=150^{\circ}\text{C}$	t_r		150 154 157		

关断延迟时间 Turn-off delay time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ (电感负载) / (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	$t_{d\ off}$		726 774 788		
下降时间 Fall time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ (电感负载) / (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	t_f		70 73 75		
开通损耗能量 (每脉冲) Turn-on energy loss per pulse	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ $di/dt=1000A/\mu s(T_{vj}=150^\circ C)$ (电感负载) / (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	E_{on}		14.10 15.00 15.30		mJ
关断损耗能量 (每脉冲) Turn-off energy loss per pulse	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ $dv/dt=3800V/\mu s(T_{vj}=150^\circ C)$ (电感负载) / (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	E_{off}		6.00 6.40 6.78		
结-外壳热阻 Thermal resistance, junction to case	每个 IGBT / per IGBT		R_{thJC}		0.15		K/W
在开关状态下温度 Temperature under switching conditions			$T_{vj\ op}$	-40		150	$^\circ C$

二极管, D1/D2/D3/D4

最大额定值 / Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
反向重复峰值电压 Repetitive peak reverse voltage	$T_{vj}=25^\circ C$	V_{RRM}	650	V
连续正向直流电流 Continuous DC forward current	$TC=80^\circ C, T_{vj\ max}=175^\circ C$	I_F	93	A
正向重复峰值电流 Repetitive peak forward current	$t_p=1ms$	I_{FRM}	280	A
I^2t 值 I^2t -value	$V_R = 0V, t_p = 10ms, T_{vj} = 125^\circ C$	I^2t	1900	A^2S

特征值 / Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
正向电压 Forward voltage	$I_F=120A, V_{GE}=0V$ $I_F=120A, V_{GE}=0V$ $I_F=120A, V_{GE}=0V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	V_F		1.60 1.70 1.75	2.00 V
反向恢复峰值电流 Peak reverse recovery current	$I_F=200A,$ $-di_F/dt=1000A/\mu s$ $V_R=400V, V_{GE}=-15V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	I_{RM}		45 51 58	A

反向恢复时间 Reverse Recovery Time	IF=200A, -diF/dt=1000A/μs(Tvj=150°C) VR=400V, VGE=-15 V	Tvj=125°C Tvj=150°C	Trr		148 210 223		ns
恢复电荷 Recovered charge	IF=200A, -diF/dt=1000A/μs(Tvj=150°C) VR=400V, VGE=-15 V	Tvj=125°C Tvj=150°C	Qrr		3.30 5.78 6.90		μC
反向恢复损耗（每脉冲） Reverse recovered energy	IF=200A, -diF/dt=1000A/μs(Tvj=150°C) VR=400V, VGE=-15 V	Tvj=125°C Tvj=150°C	Erec		0.46 0.94 1.16		mJ
结-外壳热阻 Thermal resistance, junction to case	每个二极管 / per diode		RthJC		0.39		K/W
在开关状态下温度 Temperature under switching conditions			Tvj op	-40		150	°C

二极管，D5/D6**最大额定值 / Maximum Ratings**

Parameter	Conditions	Symbol	Value	Unit
反向重复峰值电压 Repetitive peak reverse voltage	Tvj=25°C	VRRM	650	V
连续正向直流电流 Continuous DC forward current	Tc=80°C, Tvj max=175°C	IF	220	A
正向重复峰值电流 Repetitive peak forward current	tp=1ms	IFRM	630	A
I²t 值 I²t-value	VR = 0 V, tp = 10 ms, Tvj = 125°C	I²t	7000	A²S

特征值 / Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
正向电压 Forward voltage	IF=375A, VGE=0V IF=375A VGE=0V IF=375A, VGE=0V	Tvj=25°C Tvj=125°C Tvj=150°C	VF	1.60 1.70 1.75	2.00	V
反向恢复峰值电流 Peak reverse recovery current	IF=200A, -diF/dt=2000A/μs(Tvj=150°C) VR=400V, VGE=-15V	Tvj=25°C Tvj=125°C Tvj=150°C	IRM	58 77 90		A
反向恢复时间 Reverse Recovery Time	IF=200A, -diF/dt=2000A/μs(Tvj=150°C) VR=400V, VGE=-15V	Tvj=25°C Tvj=125°C Tvj=150°C	Trr	142 174 180		ns

恢复电荷 Recovered charge	$I_F=200A$, $-di_F/dt=2000A/\mu s(T_{vj}=150^\circ C)$ $V_R=400V, V_{GE}=-15V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	Q_{rr}		4.08 8.12 9.90		μC
反向恢复损耗（每脉冲） Reverse recovered energy	$I_F=200A$, $-di_F/dt=2000A/\mu s(T_{vj}=150^\circ C)$ $V_R=400V, V_{GE}=-15V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	E_{rec}		0.53 1.21 1.52		mJ
结-外壳热阻 Thermal resistance, junction to case	每个二极管 / per diode		R_{thJC}		0.19		K/W
在开关状态下温度 Temperature under switching conditions			$T_{vj op}$	-40		150	$^\circ C$

负温度系数热敏电阻/NTC-Thermistor

特征值/Characteristic Values

Parameter	Conditions	Value			Unit
R25	T=25 $^\circ C$		22		K Ω
$\Delta R/R$		-5		5	%
B-value	B (25/50), tolerance $\pm 3\%$		3950		K
B-value	B (25/100), tolerance $\pm 3\%$		3998		K

模块 / Module

Parameter	Conditions	Symbol	Value			Unit
绝缘测试电压 Isolation test voltage	RMS, f=50Hz, t=1min	V_{ISOL}	3200			V
内部绝缘 Internal isolation			Al ₂ O ₃			
储存温度 Storage temperature		T_{stg}	-40		125	$^\circ C$
模块安装的扭矩 Mounting torque for modul mounting		M	2.0		5.0	Nm
重量 Weight		W		177		g

IGBT, Q1.1/Q1.2/Q4.1/Q4.2

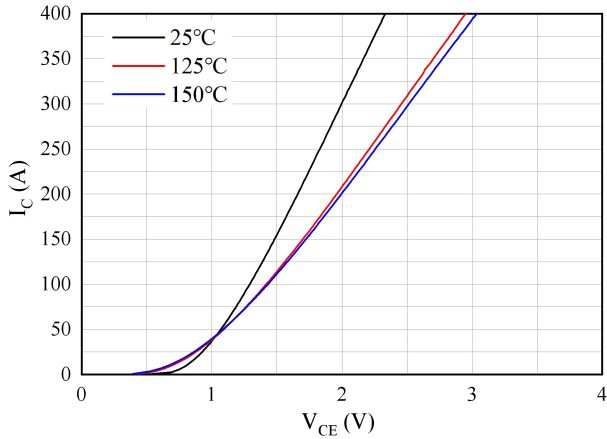


图 1. 典型输出特性 ($V_{GE}=15V$)

Figure1. Typical output characteristics ($V_{GE}=15V$)

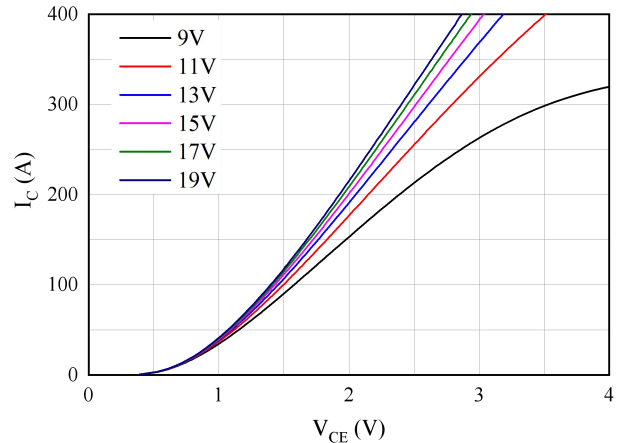


图 2. 典型输出特性 ($T_{vj}=150^{\circ}C$)

Figure2. Typical output characteristics ($T_{vj}=150^{\circ}C$)

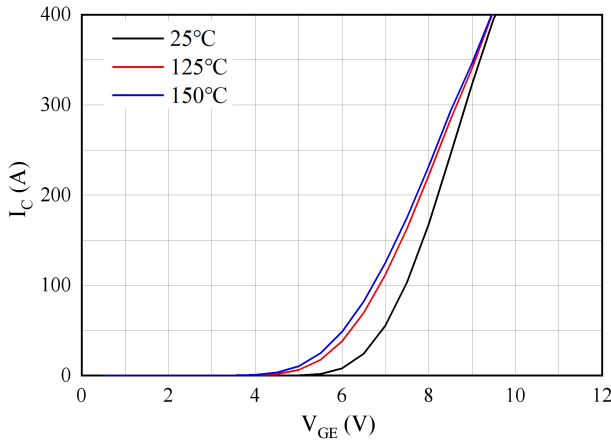


图 3. 典型传输特性 ($V_{CE}=20V$)

Figure3. Typical transfer characteristic ($V_{CE}=20V$)

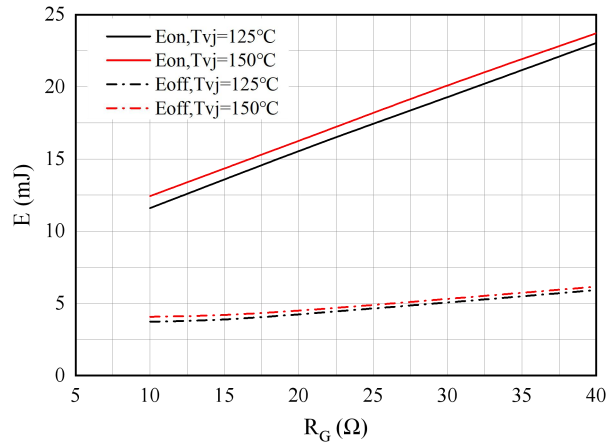


图 4. 开关损耗

Figure4. Switching losses of IGBT

$V_{GE} = \pm 15V, I_C = 200A, V_{CE} = 400V$

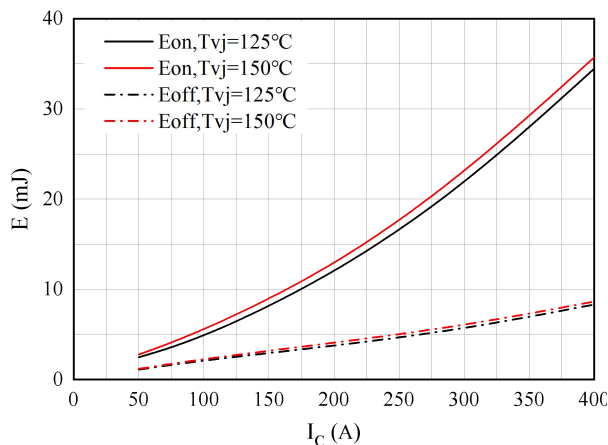


图 5. 典型开关损耗

Figure5. Switching losses of IGBT s

$V_{GE} = \pm 15V, R_g = 10\Omega, V_{CE} = 400V$

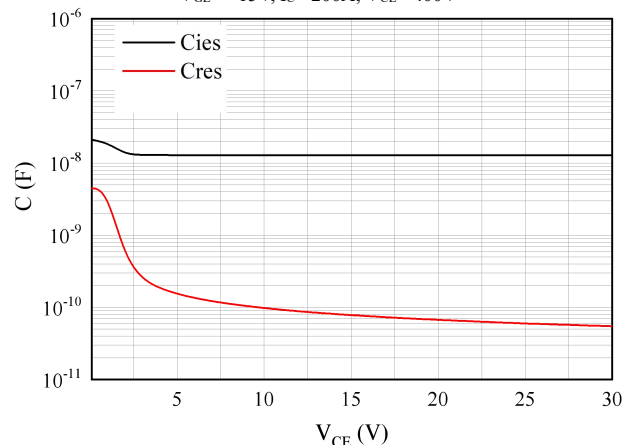


图 6. 电容特性

Figure6. Capacitance characteristic

$f = 100\text{ kHz}, V_{GE} = 0V, T_{vj} = 25^{\circ}C$

IGBT, Q2/Q3

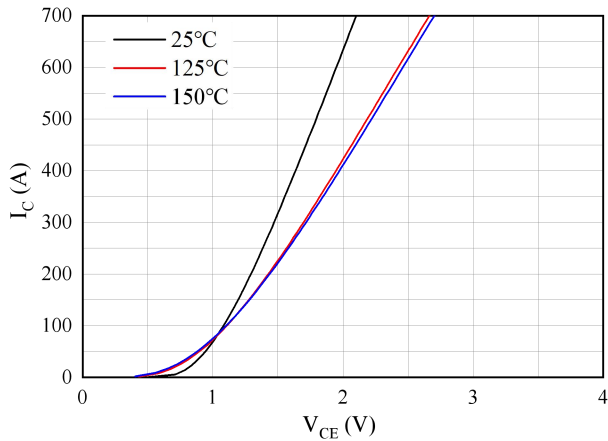


图 7. 典型输出特性 ($V_{GE}=15V$)

Figure7. Typical output characteristics ($V_{GE}=15V$)

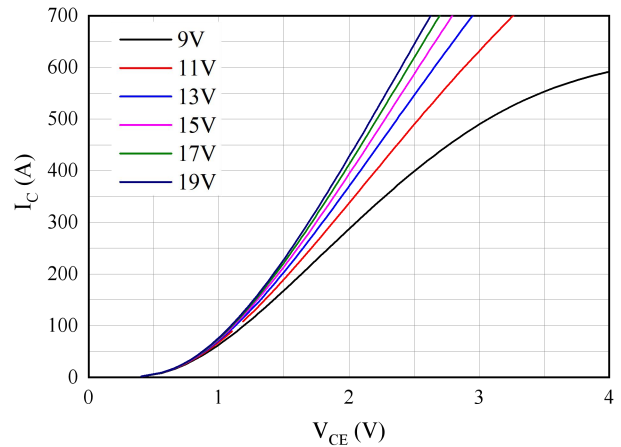


图 8. 典型输出特性 ($T_{vj}=150^{\circ}C$)

Figure8. Typical output characteristics ($T_{vj}=150^{\circ}C$)

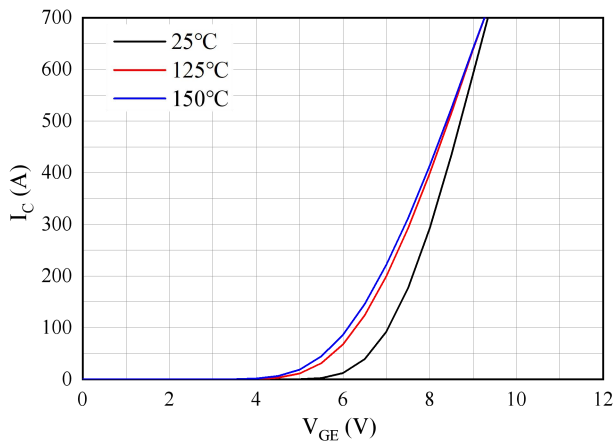


图 9. 典型传输特性($V_{CE}=20V$)

Figure9. Typical transfer characteristic($V_{CE}=20V$)

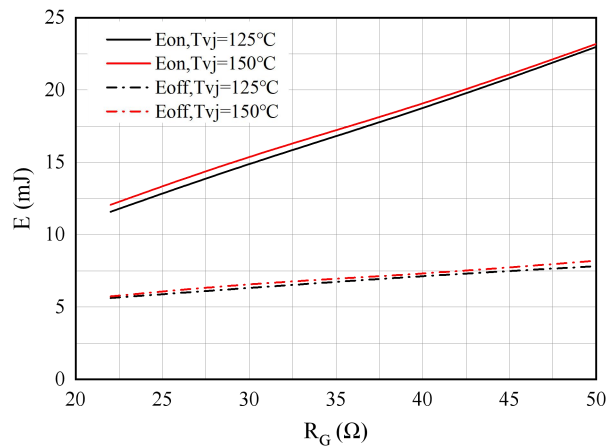


图 10. 开关损耗

Figure10. Switching losses of IGBT

$V_{GE} = \pm 15V, I_C = 200A, V_{CE} = 400V$

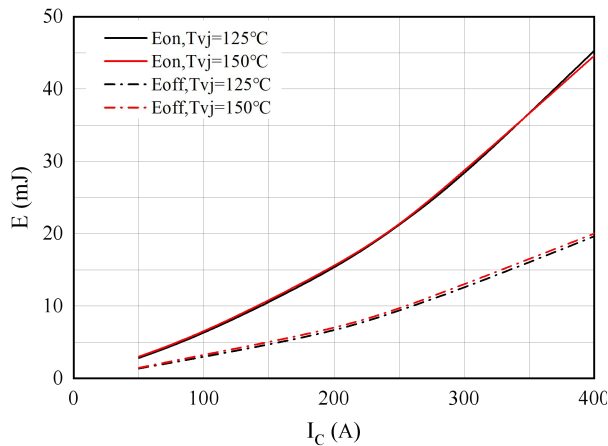


图 11. 开关损耗

Figure11. Switching losses of IGBT

$V_{GE} = \pm 15V, R_g = 30\Omega, V_{CE} = 400V$

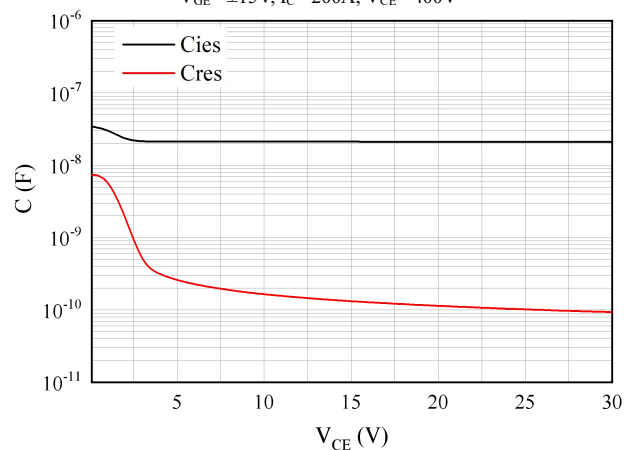


图 12. 电容特性

Figure12. Capacitance characteristic

$f = 100\text{ kHz}, V_{GE} = 0V, T_{vj} = 25^{\circ}C$

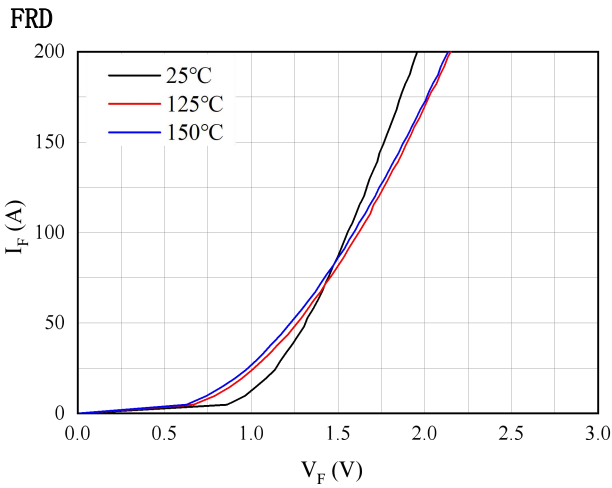


图 13 正向偏压特性二极管 (D1/D2/D3/D4)
Figure 13 Forward characteristic of Diode

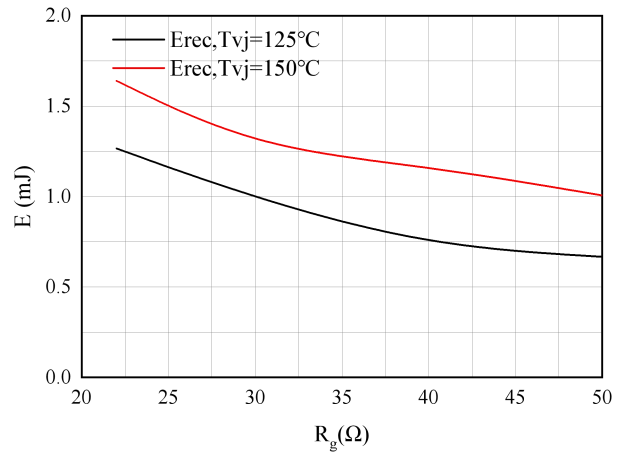


图 14. 反向恢复损耗 (D1/D2/D3/D4)
Figure 14. Reverse Recovery Energy
 $I_F = 200A, V_{CE} = 400V$

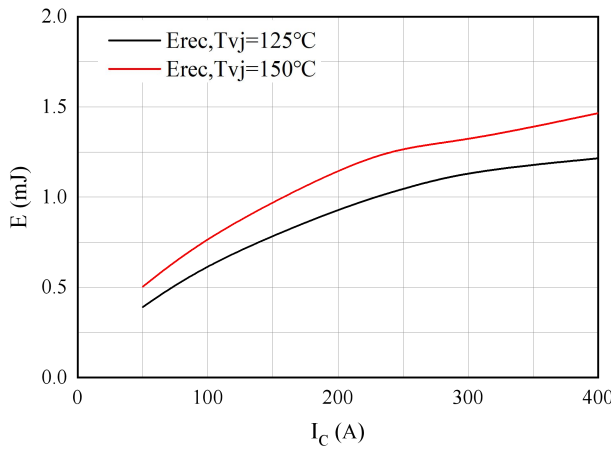


图 15. 反向恢复损耗 (D1/D2/D3/D4)
Figure 15. Reverse Recovery Energy
 $R_g = 30 \Omega, V_{CE} = 400V$

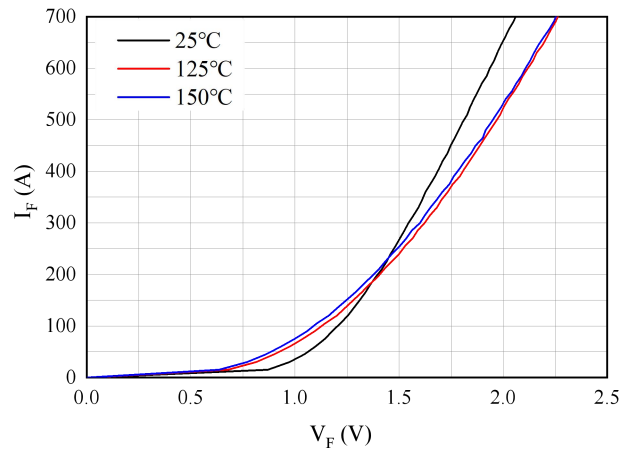


图 16 正向偏压特性二极管 (D5/D6)
Figure 16 Forward characteristic of Diode

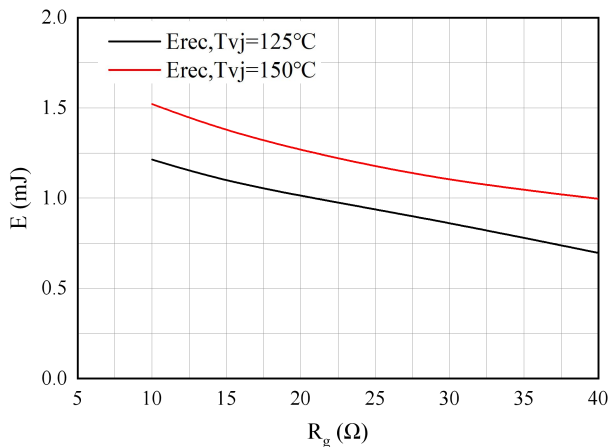


图 16. 反向恢复损耗 (D5/D6)
Figure 16. Reverse Recovery Energy
 $I_F = 200A, V_{CE} = 400V$

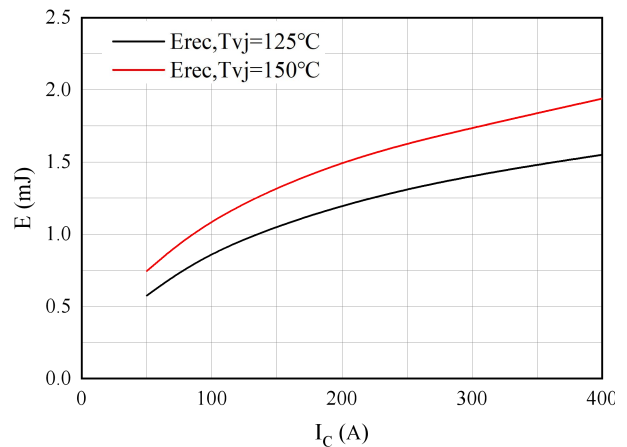


图 17. 反向恢复损耗 (D5/D6)
Figure 17. Reverse Recovery Energy
 $R_g = 10 \Omega, V_{CE} = 400V$

NTC

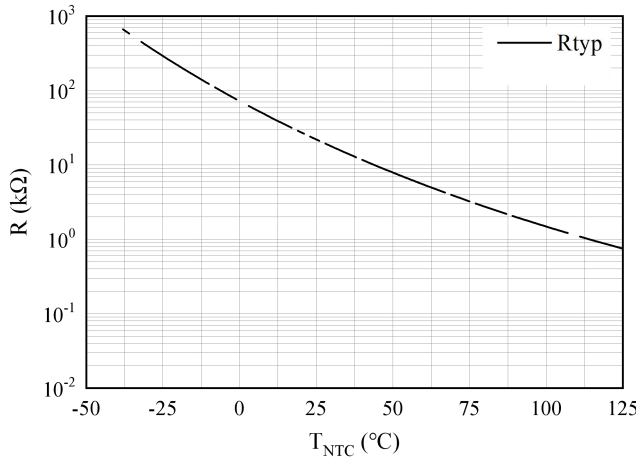
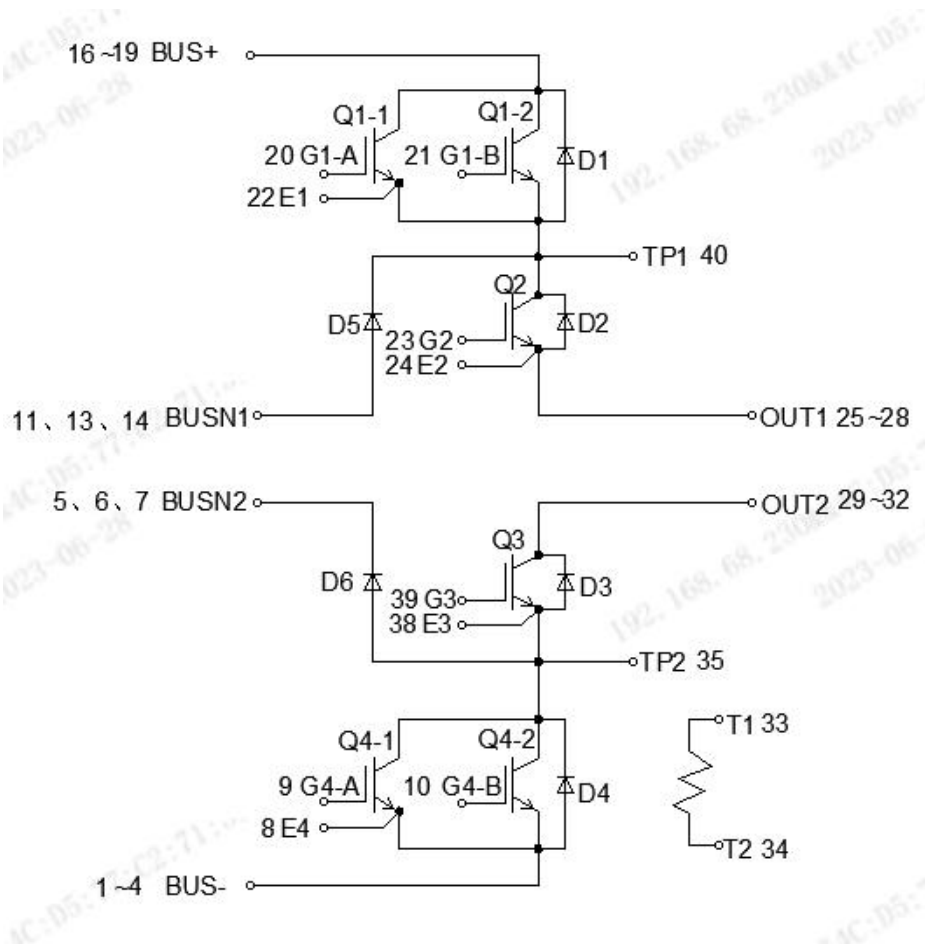


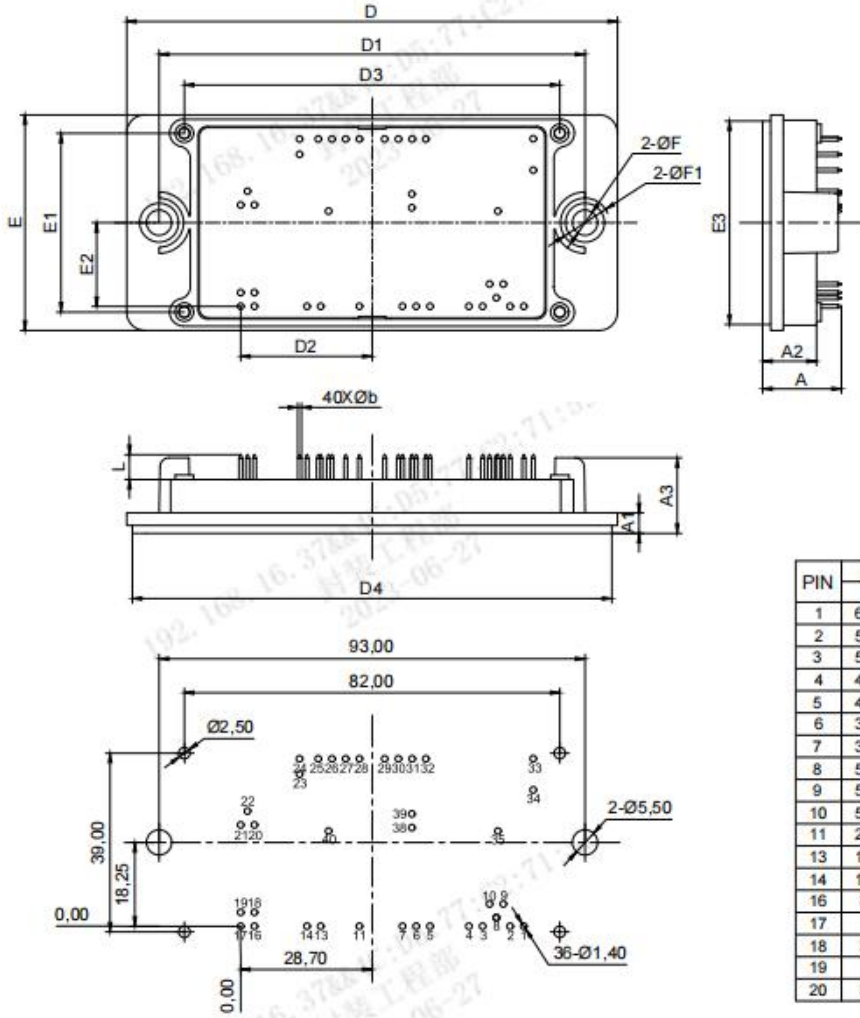
图 18. 负温系数热敏电阻 温度特性

Figure 18. NTC-Thermistor-temperature characteristic

接线图 / Circuit diagram



封装尺寸 / Package outlines



DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	16.63	17.23	17.83
A1	4.60	4.70	4.80
A2	11.90	12.00	12.10
A3	16.40	16.70	17.00
b	0.95	1.00	1.05
D	106.80	107.20	107.60
D1	92.90	93.00	93.10
D2	28.40	28.70	29.00
D3	81.80	82.00	82.20
D4	104.35	104.75	105.15
E	46.60	47.00	47.40
E1	38.80	39.00	39.20
E2	17.95	18.25	18.55
E3	44.30	44.40	44.50
F	5.40	5.50	5.60
F1	10.70REF		
L	5.03	5.23	5.43

PIN	PIN POSITION	
	X	Y
1	61.85	0
2	58.85	0
3	52.85	0
4	49.85	0
5	41.35	0
6	38.35	0
7	35.35	0
8	55.85	1.85
9	57.35	4.85
10	54.35	4.85
11	25.95	0
13	17.50	0
14	14.50	0
16	3.00	0
17	0	0
18	3.00	3.00
19	0	3.00
20	3.00	22.10

PIN	PIN POSITION	
	X	Y
21	0.00	22.10
22	1.50	25.10
23	12.85	33.15
24	12.85	36.50
25	16.95	36.50
26	19.95	36.50
27	22.95	36.50
28	25.95	36.50
29	31.45	36.50
30	34.45	36.50
31	37.45	36.50
32	40.45	36.50
33	63.90	36.50
34	63.90	29.70
35	56.20	20.75
38	37.40	21.50
39	37.40	24.50
40	19.20	20.75