

HCG150FL065E2RB

650V/150A IGBT Module

ACP-2 IGBT 模块

ACP-2 IGBT Module

特性

Features

- 650V 沟槽栅/场终止工艺
650V Trench Gate/Field-Stop Process
- 低电磁干扰
Low EMI
- 低开关损耗
Low Switching Losses
- V_{CEsat} 正温度系数
 V_{CEsat} with Positive Temperature Coefficient
- 低热阻三氧化二铝 (Al_2O_3) 衬底
 Al_2O_3 Substrate with Low Thermal Resistance
- 紧凑型设计
Compact Design
- 集成的安装夹使安装坚固
Rugged Mounting Due to Integrated Mounting Clamps

应用

Application

- 三电平应用/3-Level-Applications
- 储能/PCS
- 不间断电源/UPS Systems
- 太阳能系统/Solar Applications

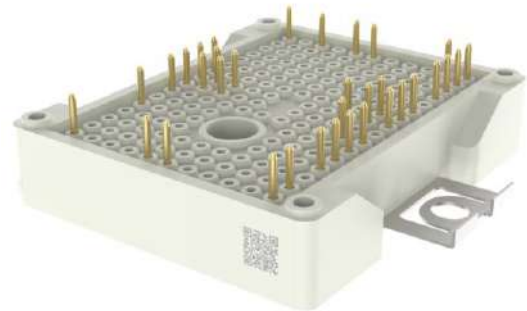
关键参数[T1&T4/D5&D6]

Key Parameters

Parameter	Symbol	Value	Unit
集电极-发射极电压 Collector-emitter voltage	V_{CES}	650	V
连续集电极直流电流 Continuous DC collector current	I_{Cnom}	150	A
集电极重复峰值电流 Repetitive peak collector current	I_{CRM}	300	A
集电极-发射极 饱和电压 Collector-Emitter saturation voltage	V_{CEsat}	$T_{vj}=25^{\circ}C$ 1.42	V
		$T_{vj}=125^{\circ}C$ 1.58	
IGBT结-散热器热阻 IGBT thermal resistance	R_{thJH}	0.55	K/W
Diode结-散热器热阻 Diode thermal resistance	R_{thJH}	0.70	K/W
开通损耗能量 Turn-on energy	E_{on}	$T_{vj}=25^{\circ}C$ 1.40	mJ
		$T_{vj}=125^{\circ}C$ 2.10	
关断损耗能量 Turn-off energy	E_{off}	$T_{vj}=25^{\circ}C$ 1.72	
		$T_{vj}=125^{\circ}C$ 1.98	

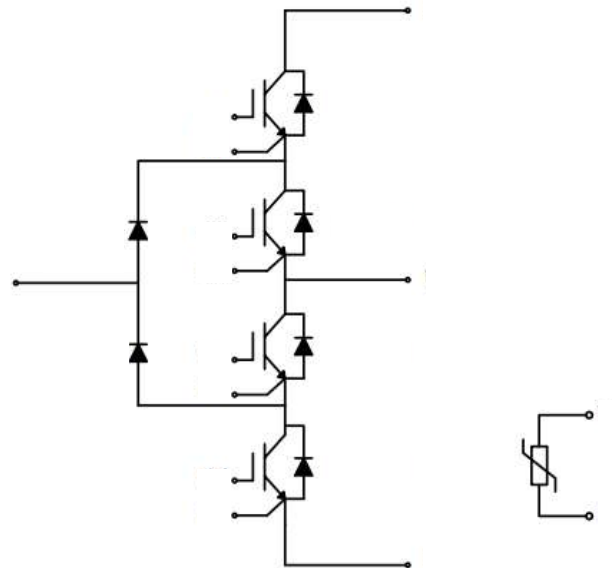
模块外观

Module Appearance



电路拓扑

Circuit Topology



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封装/ Package

表 1 绝缘参数/Insulation coordination

Parameter	Conditions	Symbol	Value	Unit
绝缘测试电压 Isolation test voltage	RMS, f = 50Hz, t = 60s	V_{ISOL}	3.0	kV
模块基板材料 Material of module baseplate			Cu	
内部绝缘 Internal isolation	基本绝缘 (class 1, IEC 61140) Basic insulation (class 1, IEC 61140)		Al_2O_3	
爬电距离 Creepage distance	端子至散热器 Terminal to heatsink	d_{Creep}	11.5	mm
爬电距离 Creepage distance	端子至端子 Terminal to terminal	d_{Creep}	6.3	mm
电气间隙 Clearance	端子至散热器 Terminal to heatsink	d_{Clear}	10.0	mm
电气间隙 Clearance	端子至端子 Terminal to terminal	d_{Clear}	5.0	mm
相对电痕指数 Comparative tracking index		CTI	> 200	

表 2 特征值/Characteristic values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
杂散电感, 模块 Stray inductance module			L_{sCE}		15		nH
储存温度 Storage temperature			T_{stg}	-40		125	°C
端子安装扭矩 Terminal connection torque	根据相应的应用手册进行安装 Mounting according to valid application note	M4, 螺丝 M4, Screw	M	2.0		2.3	Nm
重量 Weight			G		39		g

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表 3 最大标定值/Maximum rated values

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	$T_h = 80^{\circ}\text{C}, T_{vj\max} = 175^{\circ}\text{C}$	I_{CDC}	125	A
集电极重复峰值电流 Repetitive peak collector current	t_p limited by $T_{vj\max}$	I_{CRM}	300	A
总耗散功率 Total Power dissipation	$T_h = 80^{\circ}\text{C}, T_{vj} = T_{vj\max}$	P_{tot}	173	W
栅极-发射极电压 Gate-emitter peak voltage		V_{GES}	± 20	V

表 4 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	$I_C = 150\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 25^{\circ}\text{C}$	$V_{CE(sat)}$		1.42	1.92	V
		$T_{vj} = 125^{\circ}\text{C}$			1.58		
栅极阈值电压 Gate threshold voltage	$I_C = 1\text{mA}, V_{GE} = V_{CE}, T_{vj} = 25^{\circ}\text{C}$		V_{GEth}	4.35	4.85	5.35	V
栅极电荷 Gate charge	$V_{GE} = +15/-8\text{V}, V_{CE} = 400\text{V}$		Q_G		430		nC
输入电容 Input capacitance	$f = 1\text{MHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$		C_{ies}		12		nF
反向传输电容 Reverse transfer capacitance	$f = 1\text{MHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$		C_{res}		0.24		nF
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}			0.1	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}			500	nA
开通延迟时间（感性负载） Turn-on delay time (inductive load)	$V_{CE} = 300\text{V}$ $I_C = 150\text{A}$ $V_{GE} = +15/-8\text{V}$ $R_{Gon} = 5.1\Omega$ $R_{Goff} = 5.1\Omega$ $L_s = 50\text{nH}$ Inductive Load	$T_{vj} = 25^{\circ}\text{C}$	$t_{d(on)}$		24		ns
		$T_{vj} = 125^{\circ}\text{C}$			39		
上升时间（感性负载） Rise time (inductive load)		$T_{vj} = 25^{\circ}\text{C}$	t_r		37		ns
		$T_{vj} = 125^{\circ}\text{C}$			38		
关断延迟时间（感性负载） Turn-off delay time (inductive load)		$T_{vj} = 25^{\circ}\text{C}$	$t_{d(off)}$		205		ns
		$T_{vj} = 125^{\circ}\text{C}$			218		
下降时间（感性负载） Fall time (inductive load)		$T_{vj} = 25^{\circ}\text{C}$	t_f		60		ns
		$T_{vj} = 125^{\circ}\text{C}$			65		
开通损耗能量（每脉冲） Turn-on energy loss per pulse		$T_{vj} = 25^{\circ}\text{C}$	E_{on}		1.40		mJ
		$T_{vj} = 125^{\circ}\text{C}$			2.10		
关断损耗能量（每脉冲） Turn-off energy loss per pulse		$T_{vj} = 25^{\circ}\text{C}$	E_{off}		1.72		mJ
		$T_{vj} = 125^{\circ}\text{C}$			1.98		

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(续) 特征值/ Characteristic values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
结—散热器热阻 Thermal resistance, junction to heatsink	每个IGBT, $\lambda_{grease} = 3.4W/(m^{\circ}K)$ Per IGBT, $\lambda_{grease} = 3.4W/(m^{\circ}K)$	R_{thJH}		0.55		K/W
最高结温 $T_{vj\ max}$		$T_{vj\ max}$	175			$^{\circ}C$

Diode/ D5&D6

表 5 最大标定值/Maximum rated values

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	$T_h = 80^{\circ}C, T_{vj\ max} = 175^{\circ}C$	I_F	108	A
总耗散功率 Total Power dissipation	$T_h = 80^{\circ}C, T_{vj} = T_{vj\ max}$	P_{tot}	135	W
正向重复峰值电流 Repetitive peak forward current	t_p limited by $T_{vj\ max}$	I_{FRM}	300	A

表 6 特征值/Characteristic values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	$I_F = 150A, V_{GE} = 0V$	$T_{vj} = 25^{\circ}C$	V_F		1.54	1.94	V
		$T_{vj} = 125^{\circ}C$			1.66		
反向恢复峰值电流 Peak reverse recovery current	$V_R = 300V$	$T_{vj} = 25^{\circ}C$	I_{RM}		90		A
		$T_{vj} = 125^{\circ}C$			110		
反向恢复电荷 Recovered charge	$I_F = 150A$ $R_{Gon} = 5.1\Omega$ $V_{GE} = -8V$ $L_s = 50nH$	$T_{vj} = 25^{\circ}C$	Q_r		3.3		μC
		$T_{vj} = 125^{\circ}C$			6.5		
反向恢复损耗（每脉冲） Reverse recovery energy	Inductive Load	$T_{vj} = 25^{\circ}C$	E_{rec}		0.83		mJ
		$T_{vj} = 125^{\circ}C$			1.37		
结—散热器热阻 Thermal resistance, junction to heatsink	每个二极管, $\lambda_{grease} = 3.4W/(m^{\circ}K)$ Per diode, $\lambda_{grease} = 3.4W/(m^{\circ}K)$	R_{thJH}			0.70		K/W
最高结温 $T_{vj\ max}$		$T_{vj\ max}$		175			$^{\circ}C$

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表 7 最大标定值/Maximum rated values

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	$T_h = 80^{\circ}\text{C}, T_{vj\max} = 175^{\circ}\text{C}$	I_{CDC}	125	A
集电极重复峰值电流 Repetitive peak collector current	t_p limited by $T_{vj\max}$	I_{CRM}	300	A
总耗散功率 Total Power dissipation	$T_h = 80^{\circ}\text{C}, T_{vj} = T_{vj\max}$	P_{Tot}	173	W
栅极-发射极电压 Gate-emitter peak voltage		V_{GES}	± 20	V

表 8 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	$I_C = 150\text{A}, V_{GE} = 15\text{V}$	$T_{vj} = 25^{\circ}\text{C}$	$V_{CE(\text{sat})}$		1.42	1.92	V	
		$T_{vj} = 125^{\circ}\text{C}$			1.58			
栅极阈值电压 Gate threshold voltage	$I_C = 1\text{mA}, V_{GE} = V_{CE}, T_{vj} = 25^{\circ}\text{C}$		V_{GEth}	4.35	4.85	5.35	V	
栅极电荷 Gate charge	$V_{GE} = +15/-8\text{V}, V_{CE} = 400\text{V}$		Q_G		430		nC	
输入电容 Input capacitance	$f = 1\text{MHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$		C_{ies}		12		nF	
反向传输电容 Reverse transfer capacitance	$f = 1\text{MHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$		C_{res}		0.24		nF	
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}			0.1	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}			500	nA	
开通延迟时间（感性负载） Turn-on delay time (inductive load)	$V_{CE} = 300\text{V}$ $I_C = 150\text{A}$ $V_{GE} = +15/-8\text{V}$ $R_{Gon} = 5.1\Omega$ $R_{Goff} = 5.1\Omega$ $L_s = 50\text{nH}$ Inductive Load	$T_{vj} = 25^{\circ}\text{C}$	$t_{d(\text{on})}$		32		ns	
		$T_{vj} = 125^{\circ}\text{C}$			39			
上升时间（感性负载） Rise time (inductive load)		$T_{vj} = 25^{\circ}\text{C}$	t_r		36		ns	
		$T_{vj} = 125^{\circ}\text{C}$			37			
关断延迟时间（感性负载） Turn-off delay time (inductive load)		$T_{vj} = 25^{\circ}\text{C}$	$t_{d(\text{off})}$		211		ns	
		$T_{vj} = 125^{\circ}\text{C}$			225			
下降时间（感性负载） Fall time (inductive load)		$T_{vj} = 25^{\circ}\text{C}$	t_f		55		ns	
		$T_{vj} = 125^{\circ}\text{C}$			79			
开通损耗能量（每脉冲） Turn-on energy loss per pulse			$T_{vj} = 25^{\circ}\text{C}$	E_{on}		0.83		mJ
			$T_{vj} = 125^{\circ}\text{C}$			0.97		
关断损耗能量（每脉冲） Turn-off energy loss per pulse			$T_{vj} = 25^{\circ}\text{C}$	E_{off}		1.71		mJ
			$T_{vj} = 125^{\circ}\text{C}$			2.20		

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（续）特征值/ Characteristic values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
结—散热器热阻 Thermal resistance, junction to heatsink	每个IGBT, $\lambda_{grease} = 3.4W/(m^{\circ}K)$ Per IGBT, $\lambda_{grease} = 3.4W/(m^{\circ}K)$	R_{thJH}		0.55		K/W
最高结温 $T_{vj\ max}$		$T_{vj\ max}$	175			$^{\circ}C$

Diode/ D1&D4

表 9 最大标定值/Maximum rated values

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	$T_h = 80^{\circ}C, T_{vj\ max} = 175^{\circ}C$	I_F	108	A
总耗散功率 Total Power dissipation	$T_h = 80^{\circ}C, T_{vj} = T_{vj\ max}$	P_{tot}	135	W
正向重复峰值电流 Repetitive peak forward current	t_p limited by $T_{vj\ max}$	I_{FRM}	300	A

表 10 特征值/Characteristic values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	$I_F = 150A, V_{GE} = 0V$	$T_{vj} = 25^{\circ}C$	V_F		1.54	1.94	V
		$T_{vj} = 125^{\circ}C$			1.66		
反向恢复峰值电流 Peak reverse recovery current	$V_R = 300V$	$T_{vj} = 25^{\circ}C$	I_{RM}		96		A
		$T_{vj} = 125^{\circ}C$			118		
反向恢复电荷 Recovered charge	$I_F = 150A$ $R_{Gon} = 5.1\Omega$ $V_{GE} = -8V$ $L_s = 50nH$	$T_{vj} = 25^{\circ}C$	Q_r		4.5		μC
		$T_{vj} = 125^{\circ}C$			7.3		
反向恢复损耗（每脉冲） Reverse recovery energy	Inductive Load	$T_{vj} = 25^{\circ}C$	E_{rec}		1.05		mJ
		$T_{vj} = 125^{\circ}C$			1.90		
结—散热器热阻 Thermal resistance, junction to heatsink	每个二极管, $\lambda_{grease} = 3.4W/(m^{\circ}K)$ Per diode, $\lambda_{grease} = 3.4W/(m^{\circ}K)$	R_{thJH}			0.70		K/W
最高结温 $T_{vj\ max}$		$T_{vj\ max}$		175			$^{\circ}C$

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Diode/ D2&D3

表 11 最大标定值/Maximum rated values

Parameter	Conditions	Symbol	Value	Unit
反向重复峰值电压 Repetitive peak reverse voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{RRM}	650	V
连续正向直流电流 Continuous DC forward current	$T_C = 80^{\circ}\text{C}$, $T_{vj\max} = 175^{\circ}\text{C}$	I_F	108	A
总耗散功率 Total Power dissipation	$T_C = 80^{\circ}\text{C}$, $T_{vj} = T_{vj\max}$	P_{tot}	135	W
正向重复峰值电流 Repetitive peak forward current	t_p limited by $T_{vj\max}$	I_{FRM}	300	A

表 12 特征值/Characteristic values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
正向电压 Forward voltage	$I_F = 150\text{A}$, $V_{GE} = 0\text{V}$	V_F		1.54	1.94	V
	$T_{vj} = 125^{\circ}\text{C}$			1.66		
结-散热器热阻 Thermal resistance, junction to heatsink	每个二极管, $\lambda_{grease} = 3.4\text{W}/(\text{m}^{\circ}\text{K})$ Per diode, $\lambda_{grease} = 3.4\text{W}/(\text{m}^{\circ}\text{K})$	R_{thJH}		0.70		K/W
最高结温 $T_{vj\max}$		$T_{vj\max}$		175		$^{\circ}\text{C}$

负温度系数热敏电阻/ NTC-Thermistor

表 13 特征值/Characteristic values

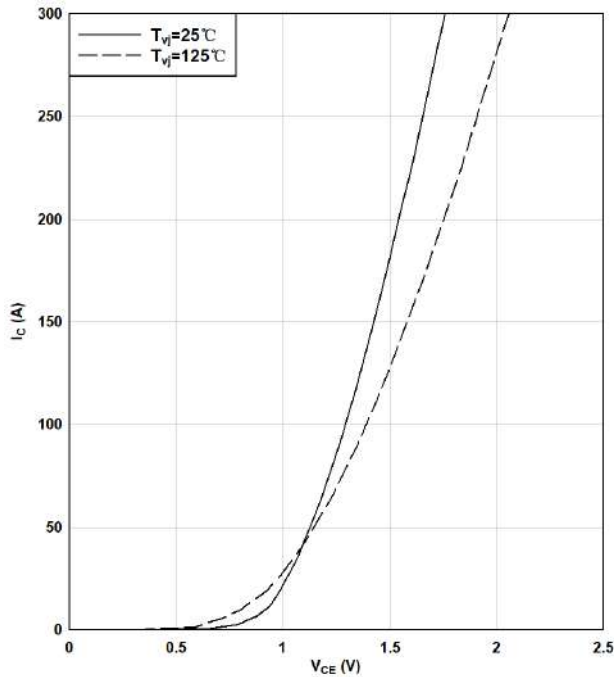
Parameter	Conditions	Symbol	Value	Unit
额定电阻值 Rated resistance	$T_{NTC} = 25^{\circ}\text{C}$	R_{25}	5	k Ω
R_{100} 偏差 Deviation of R_{100}	$T_{NTC} = 100^{\circ}\text{C}$, $R_{100} = 493\Omega$	$\Delta R/R$	± 5	%
B-值 B-value	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\text{K}))]$	$B_{25/50}$	3375	K
B-值 B-value	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\text{K}))]$	$B_{25/100}$	3433	K

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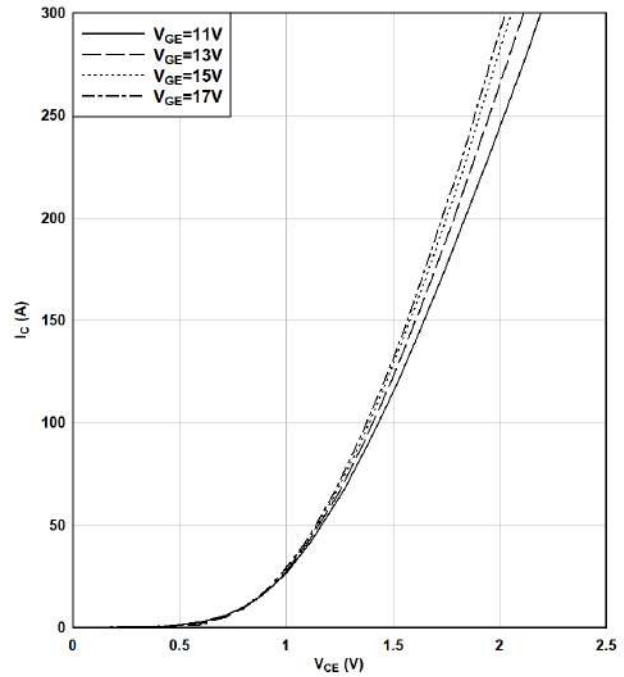
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特征参数图表/ Characteristics Diagrams

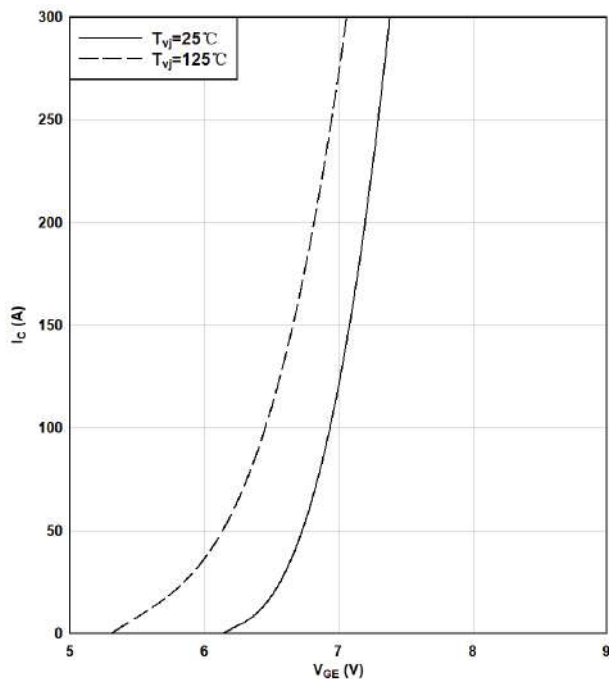
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Output characteristic (typical), IGBT(T1/T4), Inverter $I_C = f(V_{CE})$
 $V_{GE} = 15V$



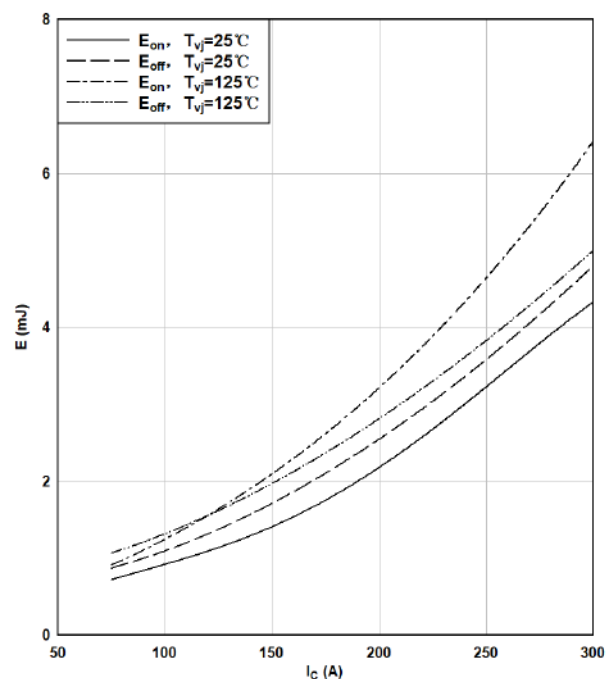
输出特性（典型），IGBT(T1/T4)，逆变器
Output characteristic (typical), IGBT(T1/T4), Inverter $I_C = f(V_{CE})$
 $T_{vj} = 125^\circ C$



传输特性（典型），IGBT(T1/T4)，逆变器
Transfer characteristic (typical), IGBT(T1/T4),
Inverter $I_C = f(V_{GE})$
 $V_{CE} = 20V$



开关损耗（典型），IGBT(T1/T4)，逆变器
Switching losses (typical), IGBT(T1/T4),
Inverter $E = f(I_C)$
 $V_{CE} = 300V$, $R_{Gon} = R_{Goff} = 5.1\Omega$, $V_{GE} = +15/-8V$

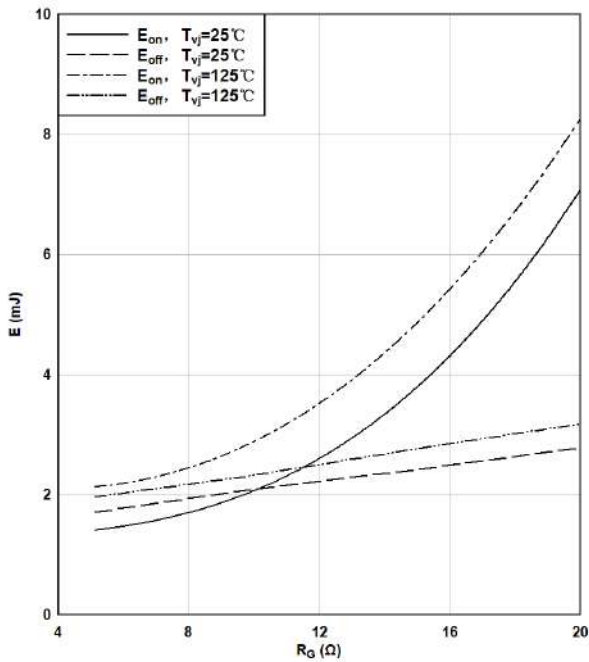


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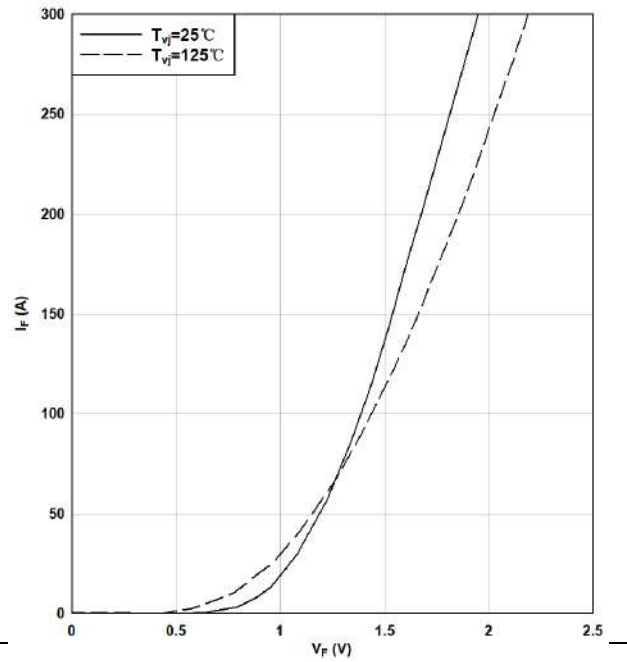
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(续) 特征参数图表/Characteristics Diagrams

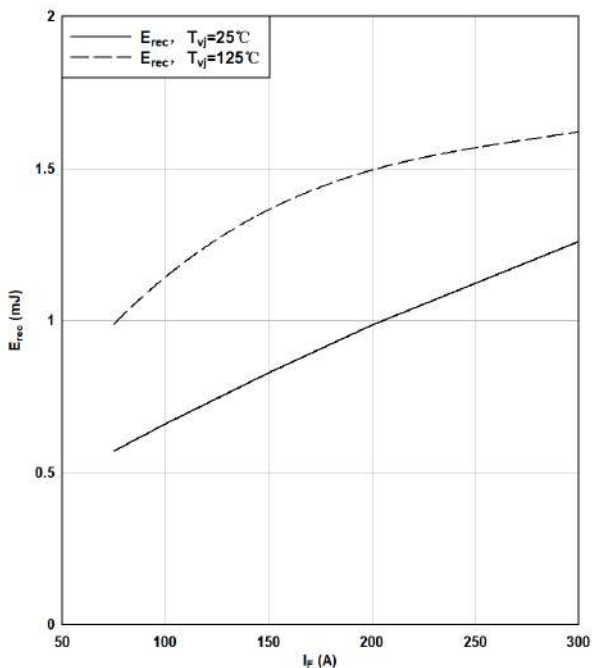
开关损耗 (典型), IGBT(T1/T4), 逆变器
Switching losses (typical), IGBT(T1/T4),
Inverter $E = f(R_G)$
 $I_C = 150A$, $V_{CE} = 300V$, $V_{GE} = +15/-8V$



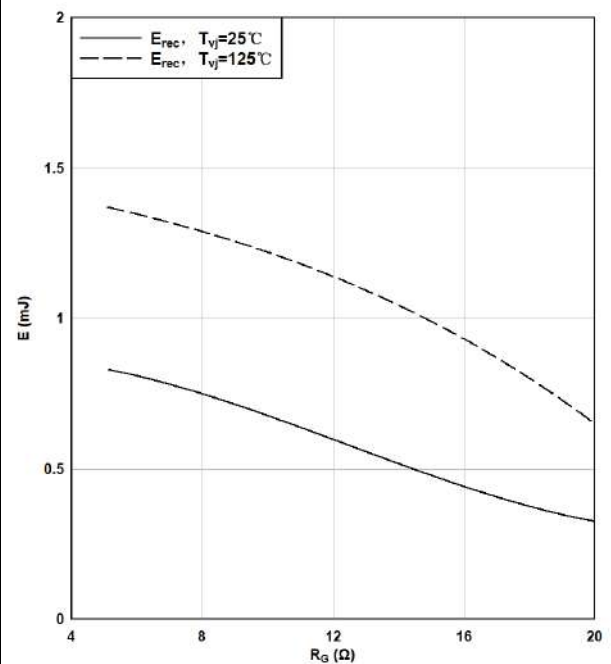
正向特性 (典型), 二极管(D5/D6) Forward
characteristic (typical), Diode(D5/D6) $I_F = f$
(V_F)



开关损耗 (典型), 二极管(D5/D6)
Switching losses (typical), Diode(D5/
D6) $E_{rec} = f(I_F)$
 $V_{CE} = 300V$, $R_{Gon} = 5.1Ω$



开关损耗 (典型), 二极管(D5/D6)
Switching losses (typical), Diode(D5/
D6) $E_{rec} = f(R_G)$
 $I_F = 150A$, $V_{CE} = 300V$



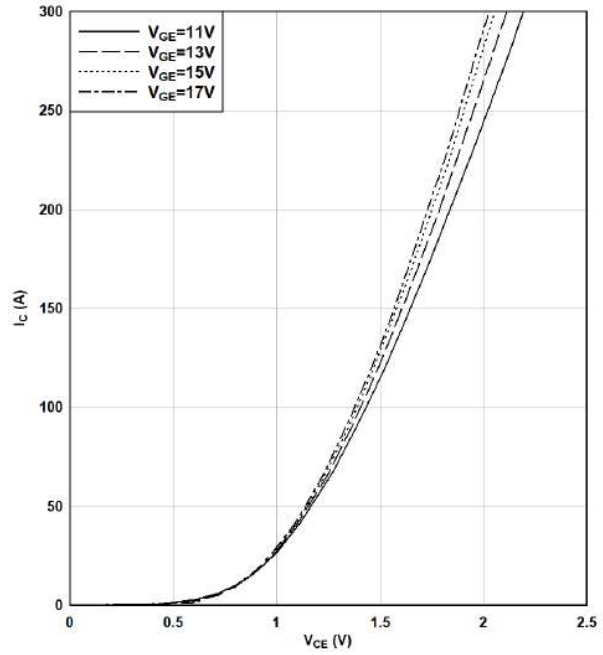
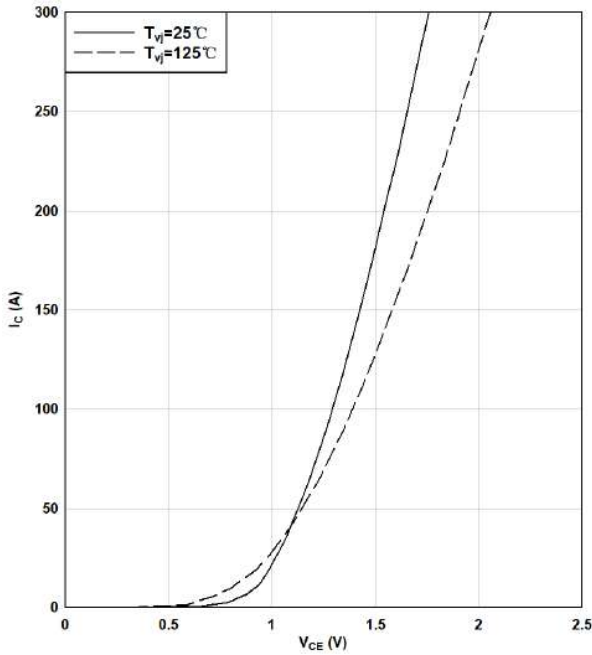
HCG150FL065E2RB

650V/150A IGBT Module

(续) 特征参数图表/Characteristics Diagrams

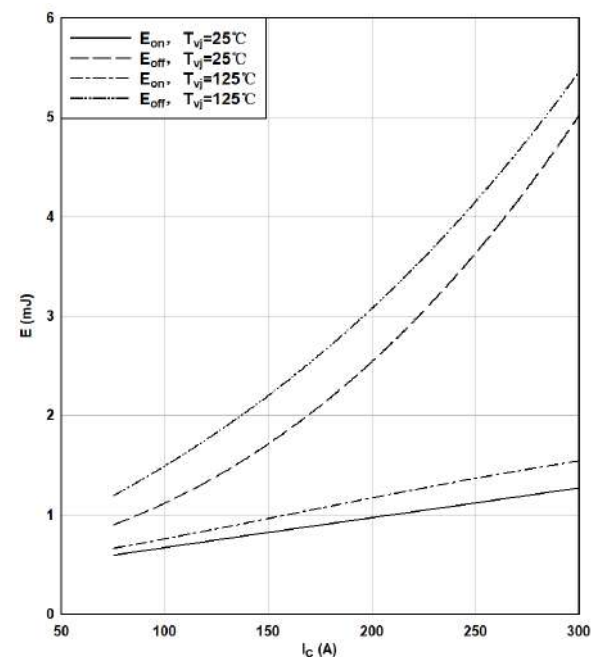
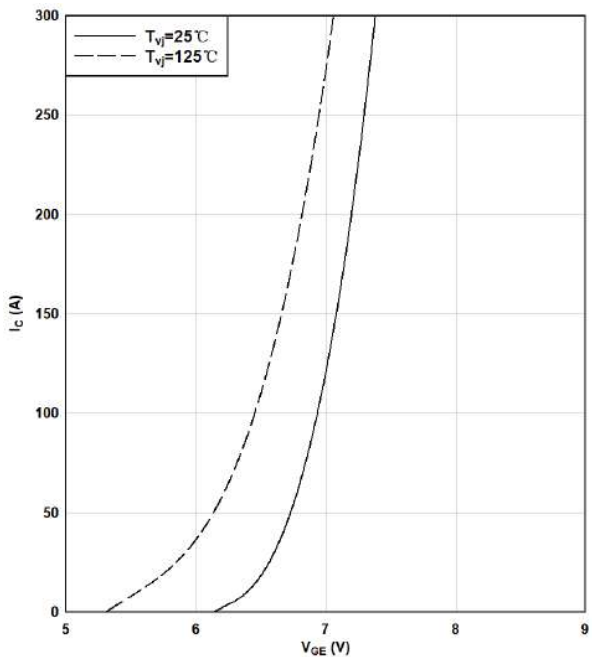
输出特性 (典型), IGBT(T2/T3), 逆变器 Output characteristic (typical), IGBT(T2/T3), Inverter $I_C = f(V_{CE})$
 $V_{GE} = 15V$

输出特性 (典型), IGBT(T2/T3), 逆变器 Output characteristic (typical), IGBT(T2/T3), Inverter $I_C = f(V_{CE})$
 $T_{vj}=125^{\circ}C$



传输特性 (典型), IGBT(T2/T3), 逆变器 Transfer characteristic (typical), IGBT(T2/T3), Inverter $I_C = f(V_{GE})$
 $V_{CE} = 20V$

开关损耗 (典型), IGBT(T2/T3), 逆变器 Switching losses (typical), IGBT(T2/T3), Inverter $E = f(I_C)$
 $V_{CE} = 300V$, $R_{Gon}=R_{Goff}=5.1\Omega$, $V_{GE} = +15/-8V$

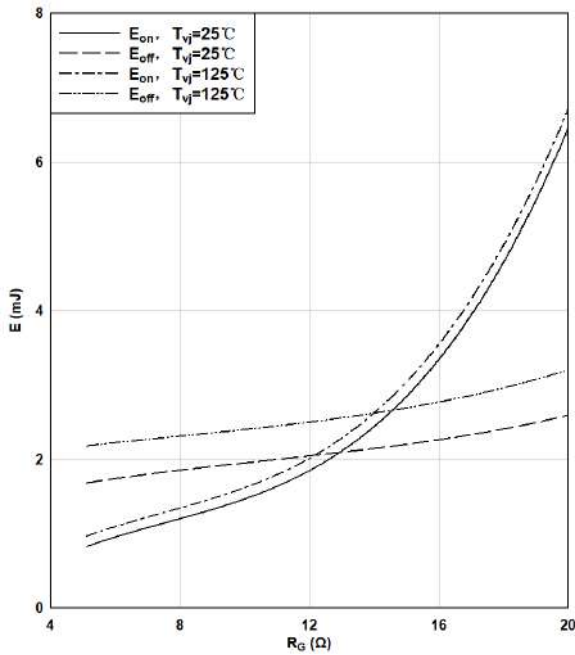


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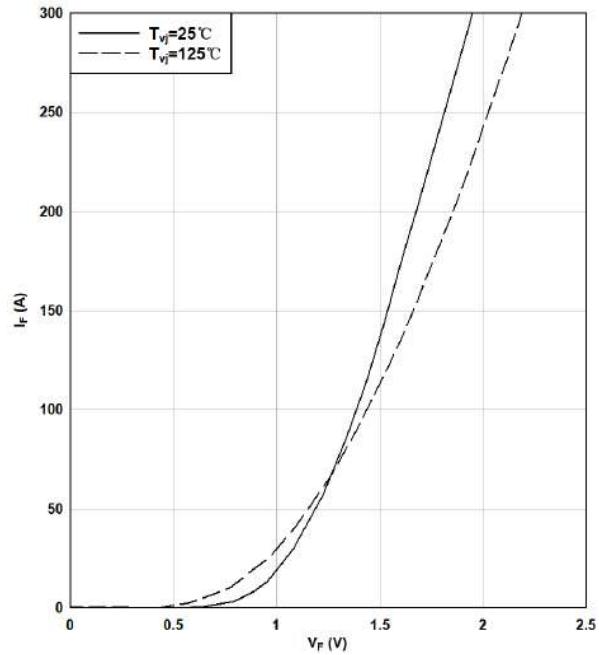
650V/150A IGBT Module

(续) 特征参数图表/Characteristics Diagrams

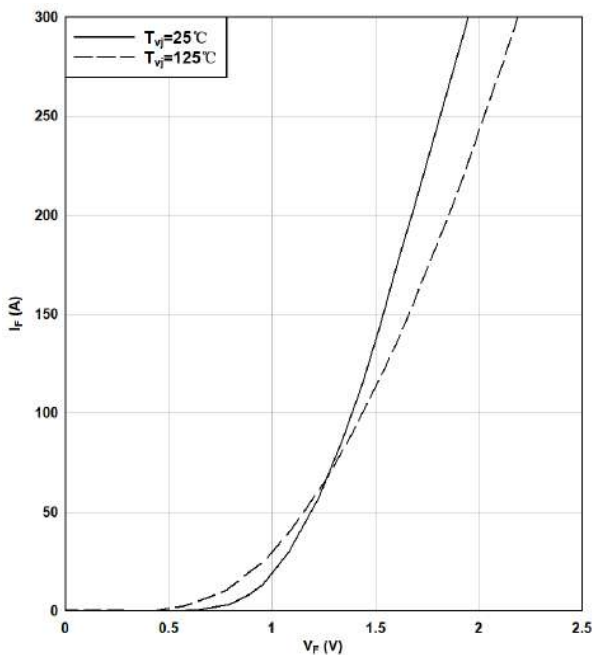
开关损耗 (典型), IGBT(T2/T3), 逆变器
Switching losses (typical), IGBT(T2/T3),
Inverter $E = f(R_G)$
 $I_C = 150A$, $V_{CE} = 300V$, $V_{GE} = +15/-8V$



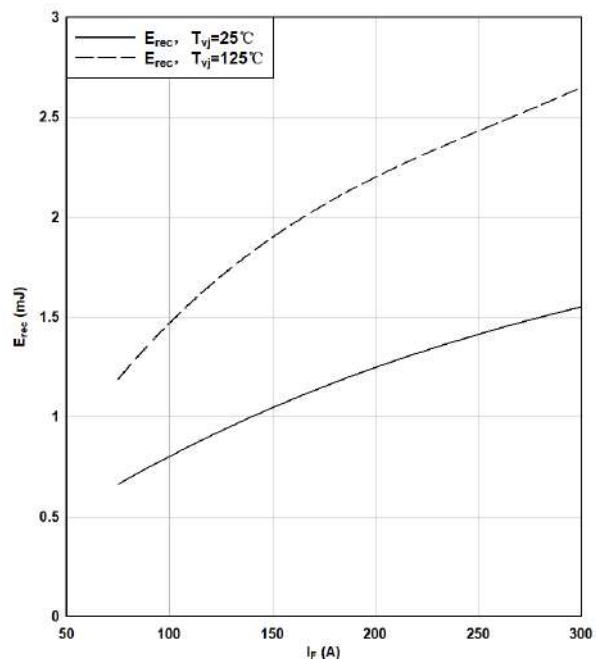
正向特性 (典型), 二极管(D1/D4)
Forward characteristic (typical), Diode(D1/
D4) $I_F = f(V_F)$



正向特性 (典型), 二极管(D2/D3)
Forward characteristic (typical), Diode(D2/
D3) $I_F = f(V_F)$



开关损耗 (典型), 二极管(D1/D4)
Switching losses (typical), Diode(D1/
D4) $E_{rec} = f(I_F)$
 $V_{CE} = 300V$, $R_{Gon} = 5.1\Omega$

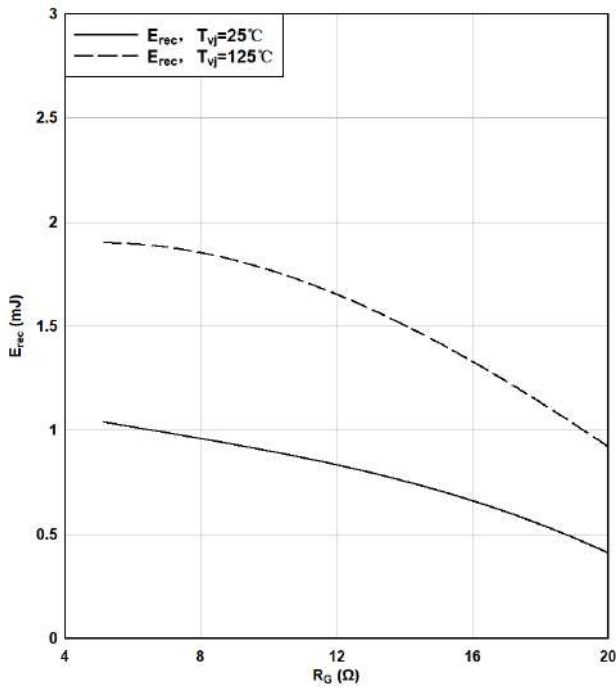


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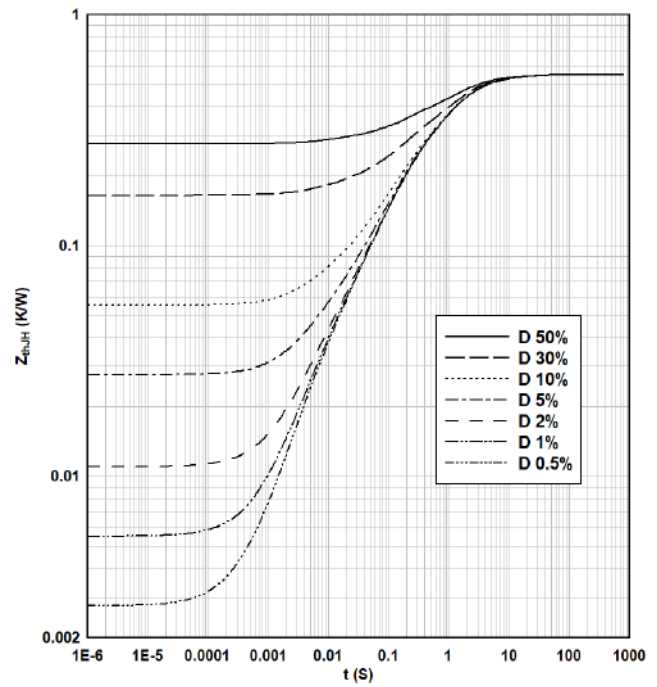
650V/150A IGBT Module

(续) 特征参数图表/Characteristics Diagrams

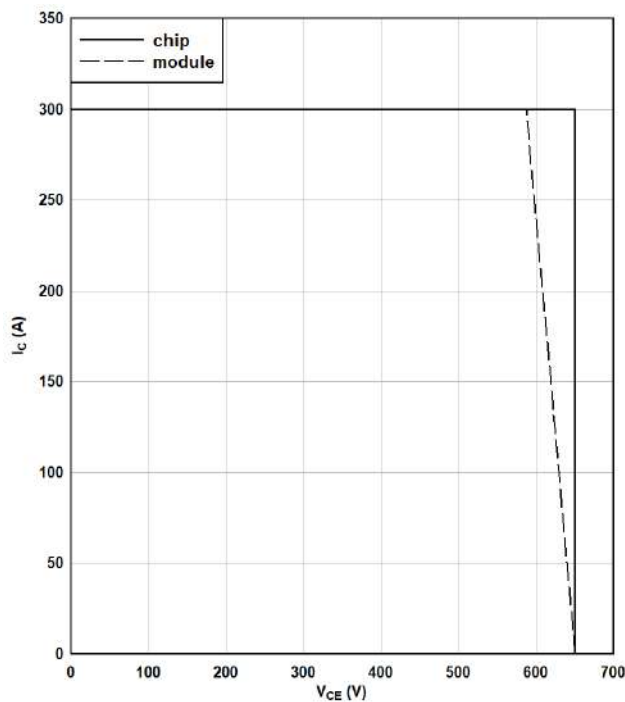
开关损耗 (典型), 二极管(D1/D4)
Switching losses (typical), Diode(D1/D4)
 $E_{rec} = f(R_G)$
 $I_F = 150A, V_{CE} = 300V$



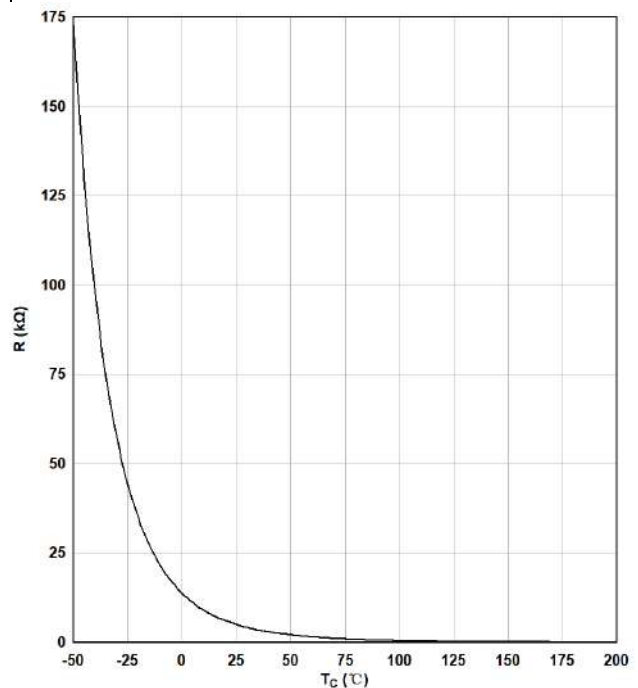
瞬态热阻抗, IGBT(T1/T2/T3/T4)
Transient thermal impedance, IGBT(T1/T2/T3/T4)
 $Z_{thJH} = f(t)$



反偏安全工作区 IGBT, 逆变器 (T1/T2/T3/T4)
Reverse bias safe operating area IGBT, Inverter(T1/T2/T3/T4)
 $I_C = f(V_{CE})$
 $T_{vj} = 125°C, R_{Goff} = 5.1Ω$



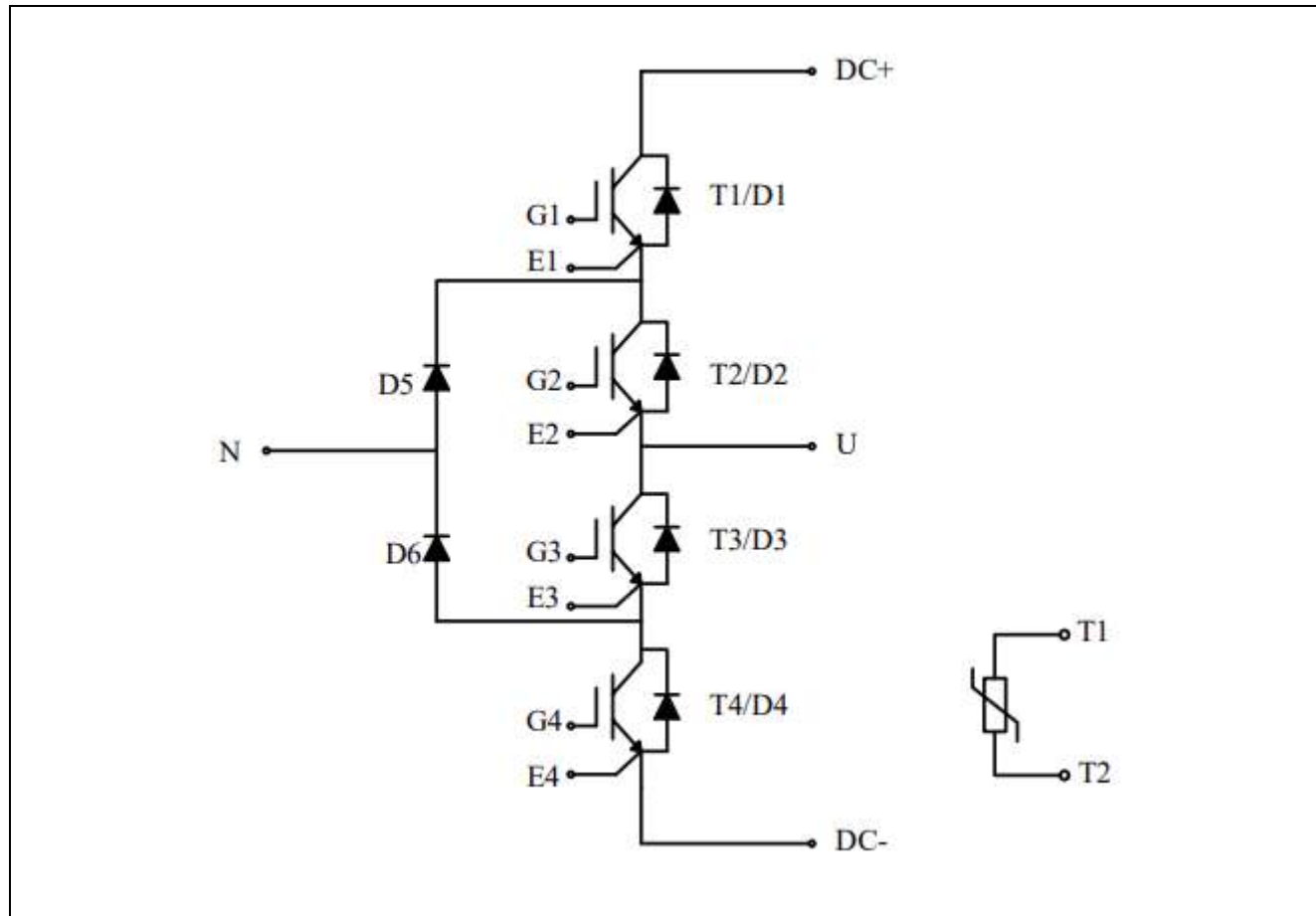
负温度系数热敏电阻温度特性 (典型)
NTC-Thermistor-temperature characteristic(typical)
 $R = f(T_C)$



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650V/150A IGBT Module

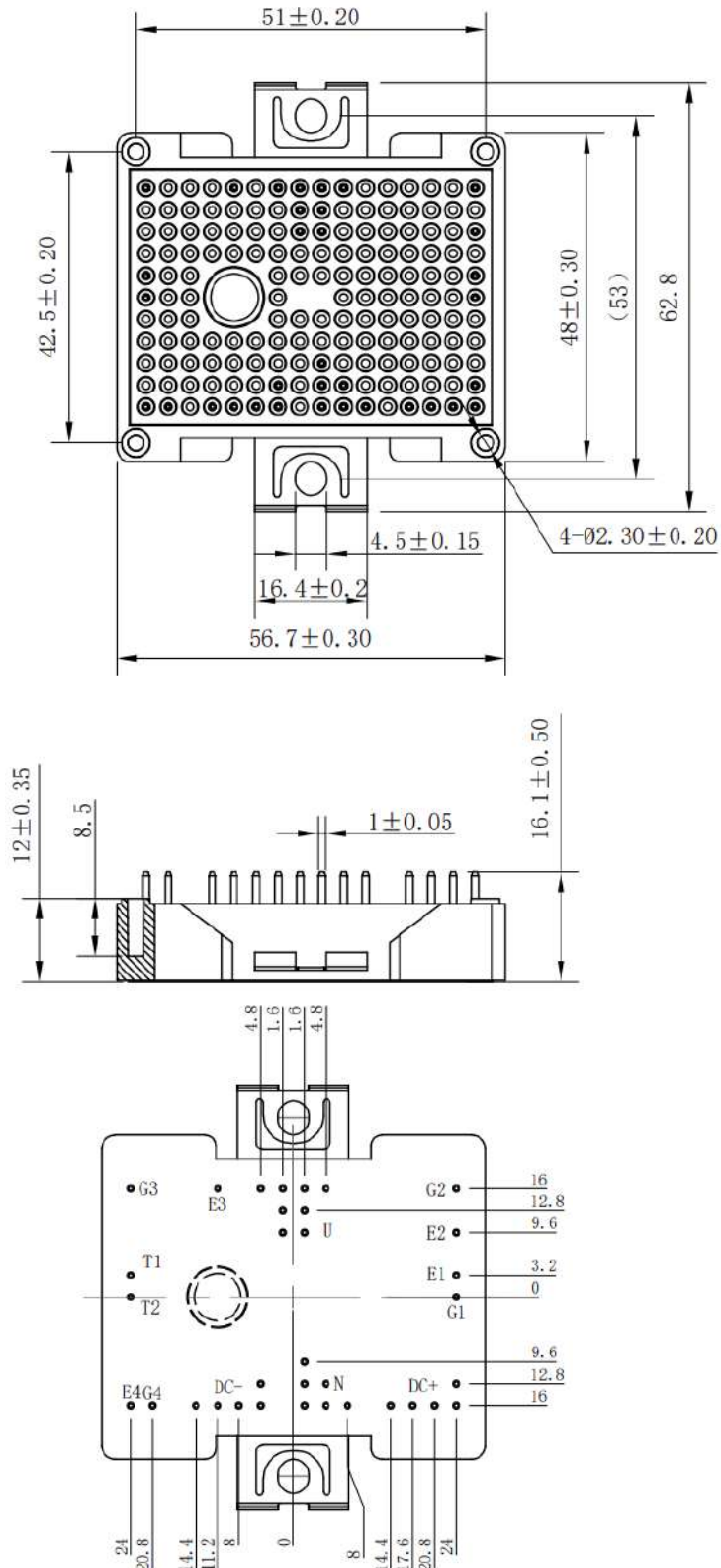
电路拓扑图/ Circuit Diagram



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650V/150A IGBT Module

封装尺寸/ Package Outlines



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