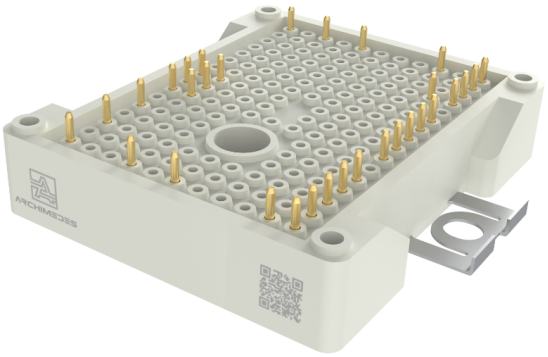
ACP-2 IGBT 模块
ACP-2 IGBT Module

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

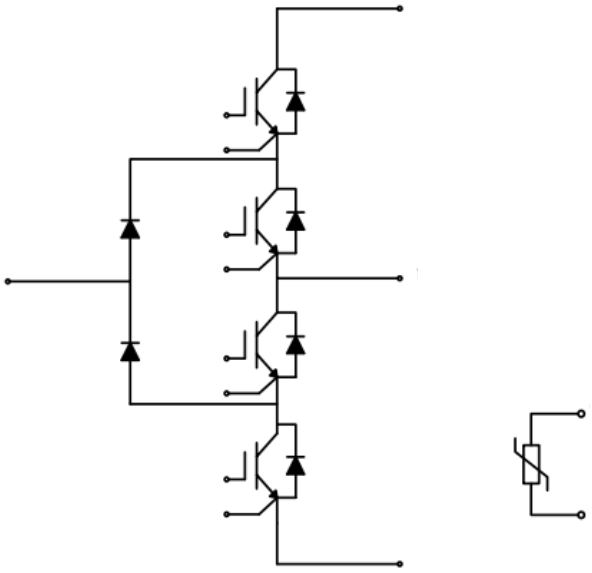
模块外观 Module Appearance



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

电路拓扑 Circuit Topology



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}	200	A
集电极重复峰值电流 Repetitive peak collector current		I_{CRM}	400	A
集电极－发射极饱和电压 Collector-Emitter saturation voltage	T_{vj}=25℃	V_{CEsat}	1.36	V
	T_{vj}=125℃		1.48	
IGBT结－散热器热阻 IGBT thermal resistance		R_{thJH}	0.469	K/W
Diode结－散热器热阻 Diode thermal resistance		R_{thJH}	0.829	K/W
开通损耗能量 Turn-on energy	T_{vj}=25℃	E_{on}	3.05	mJ
	T_{vj}=125℃		3.83	
关断损耗能量 Turn-off energy	T_{vj}=25℃	E_{off}	3.37	
	T_{vj}=125℃		4.59	

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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	℃
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

IGBT/ T1&T4

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℃	V_{CES}	650	V
连续集电极直流电流 Continuous DC collector current	T_H = 80℃, $T_{vj\,max}$ = 175℃	I_{CDC}	162	A
集电极重复峰值电流 Repetitive peak collector current	t_p limited by $T_{vj\,max}$	I_{CRM}	400	A
总耗散功率 Total Power dissipation	T_H = 80℃, T_{vj} = $T_{vj\,max}$	P_{tot}	203	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 = 200A, V_{GE} = 15V	T_{vj} = 25℃	$V_{CE(sat)}$		1.36		V
		T_{vj} = 125℃			1.48		
栅极阈值电压 Gate threshold voltage	I_C = 1.0mA, V_{GE} = V_{CE}, T_{vj} = 25℃		V_{GEth}	3.0	3.8	4.6	V
栅极电荷 Gate charge	V_{GE} = +15/-8V, V_{CE} = 400V		Q_G		777		nC
输入电容 Input capacitance	f = 100KHz, T_{vj} = 25℃, V_{CE} = 25V, V_{GE} = 0V		C_{ies}		27.5		nF
输出电容 Output capacitance	f = 100KHz, T_{vj} = 25℃, V_{CE} = 25V, V_{GE} = 0V		C_{oes}		1.87		nF
反向传输电容 Reverse transfer capacitance	f = 100KHz, T_{vj} = 25℃, V_{CE} = 25V, V_{GE} = 0V		C_{res}		0.017		nF
集电极－发射极截止电流 Collector-emitter cut-off current	V_{CE} = 650V, V_{GE} = 0V, T_{vj} = 25℃		I_{CES}			0.5	mA
栅极－发射极漏电流 Gate-emitter leakage current	V_{CE} = 0V, V_{GE} = 20V, T_{vj} = 25℃		I_{GES}			200	nA
开通延迟时间（感性负载） Turn-on delay time (inductive load)	V_{CE} = 400V I_C = 200A V_{GE} = +15/-8V R_{Gon} = 7.5Ω R_{Goff} = 20Ω Ls = 15nH *I*nductive *L*oad	T_{vj} = 25℃	$t_{d(on)}$		100		ns
		T_{vj} = 125℃			97		
上升时间（感性负载） Rise time (inductive load)		T_{vj} = 25℃	t_r		45		ns
		T_{vj} = 125℃			50		
关断延迟时间（感性负载） Turn-off delay time (inductive load)		T_{vj} = 25℃	$t_{d(off)}$		450		ns
		T_{vj} = 125℃			490		
下降时间（感性负载） Fall time (inductive load)		T_{vj} = 25℃	t_f		45		ns
		T_{vj} = 125℃			65		
开通耗损能量（每脉冲） Turn-on energy loss per pulse		T_{vj} = 25℃	E_{on}		3.05		mJ
		T_{vj} = 125℃			3.83		
关断损耗能量（每脉冲） Turn-off energy loss per pulse		T_{vj} = 25℃	E_{off}		3.37		mJ
		T_{vj} = 125℃			4.59		

（续）特征值/ Characteristic values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
结－壳热阻 Thermal resistance, junction to case		R_{thJC}		0.198		K/W
壳－散热器热阻 Thermal resistance, case to heatsink	每个IGBT，λgrease = 3.3W/(m*K) Per IGBT，λgrease = 3.3W/(m*K)	R_{thCH}		0.271		K/W
最高结温 $T_{vj\ max}$		$T_{vj\ max}$		175		℃

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℃	V_{RRM}	650	V
连续正向直流电流 Continuous DC forward current	T_h = 80℃, $T_{vj\ max}$ = 175℃	I_F	90	A
总耗散功率 Total Power dissipation	T_h = 80℃, T_{vj} = $T_{vj\ max}$	P_{tot}	115	W
正向重复峰值电流 Repetitive peak forward current	t_p limited by $T_{vj\ max}$	I_{FRM}	400	A

表 6　特征值/Characteristic values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	I_F = 200A, V_{GE} = 0V	T_{vj} = 25℃	V_F		1.77		V
		T_{vj} = 125℃			2.17		
反向恢复峰值电流 Peak reverse recovery current	V_R= 400V I_F = 200A R_{Gon} = 7.5Ω V_{GE} = -8V *Ls* = 15nH *I*nductive *L*oad	T_{vj} = 25℃	I_{RM}		19		A
		T_{vj} = 125℃			21		
反向恢复电荷 Recovered charge		T_{vj} = 25℃	Q_r		0.2		μC
		T_{vj} = 125℃			0.3		
反向恢复损耗（每脉冲） Reverse recovery energy		T_{vj} = 25℃	*E*rec		0.027		mJ
		T_{vj} = 125℃			0.031		
结－壳热阻 Thermal resistance, junction to case			R_{thJC}		0.405		K/W
壳－散热器热阻 Thermal resistance, case to heatsink	每个IGBT，λgrease = 3.3W/(m*K) Per IGBT，λgrease = 3.3W/(m*K)		R_{thCH}		0.424		K/W
最高结温 $T_{vj\ max}$			$T_{vj\ max}$		175		℃

IGBT/ T2&T3

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℃	V_{CES}	650	V
连续集电极直流电流 Continuous DC collector current	T_h = 80℃, $T_{vj\,max}$ = 175℃	I_{CDC}	162	A
集电极重复峰值电流 Repetitive peak collector current	t_p limited by $T_{vj\,max}$	I_{CRM}	400	A
总耗散功率 Total Power dissipation	T_h = 80℃, T_{vj} = $T_{vj\,max}$	P_{tot}	203	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 = 200A, V_{GE} = 15V	T_{vj} = 25℃	$V_{CE(sat)}$		1.36		V
		T_{vj} = 125℃			1.48		
栅极阈值电压 Gate threshold voltage	I_C = 1.0mA, V_{GE} = V_{CE}, T_{vj} = 25℃		V_{GEth}	3.0	3.8	4.6	V
栅极电荷 Gate charge	V_{GE} = +15/-8V, V_{CE} = 400V		Q_G		777		nC
输入电容 Input capacitance	f = 100KHz, T_{vj} = 25℃, V_{CE} = 25V, V_{GE} = 0V		C_{ies}		27.5		nF
输出电容 Output capacitance	f = 100KHz, T_{vj} = 25℃, V_{CE} = 25V, V_{GE} = 0V		C_{oes}		1.87		nF
反向传输电容 Reverse transfer capacitance	f = 100KHz, T_{vj} = 25℃, V_{CE} = 25V, V_{GE} = 0V		C_{res}		0.017		nF
集电极－发射极截止电流 Collector-emitter cut-off current	V_{CE} = 650V, V_{GE} = 0V, T_{vj} = 25℃		I_{CES}			0.5	mA
栅极－发射极漏电流 Gate-emitter leakage current	V_{CE} = 0V, V_{GE} =20V, T_{vj} = 25℃		I_{GES}			200	nA
开通延迟时间（感性负载） Turn-on delay time (inductive load)	V_{CE} = 400V I_C = 200A V_{GE} = +15/-8V R_{Gon} = 7.5Ω R_{Goff} = 30Ω Ls = 20nH *Inductive Load*	T_{vj} = 25℃	$t_{d(on)}$		102		ns
		T_{vj} = 125℃			97		
上升时间（感性负载） Rise time (inductive load)		T_{vj} = 25℃	t_r		43		ns
		T_{vj} = 125℃			47		
关断延迟时间（感性负载） Turn-off delay time (inductive load)		T_{vj} = 25℃	$t_{d(off)}$		715		ns
		T_{vj} = 125℃			755		
下降时间（感性负载） Fall time (inductive load)		T_{vj} = 25℃	t_f		64		ns
		T_{vj} = 125℃			68		
开通耗损能量（每脉冲） Turn-on energy loss per pulse		T_{vj} = 25℃	E_{on}		2.89		mJ
		T_{vj} = 125℃			3.52		
关断损耗能量（每脉冲） Turn-off energy loss per pulse		T_{vj} = 25℃	E_{off}		4.25		mJ
		T_{vj} = 125℃			5.17		

（续）特征值/ Characteristic values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
结－壳热阻 Thermal resistance, junction to case		R_{thJC}		0.198		K/W
壳－散热器热阻 Thermal resistance, case to heatsink	每个IGBT，λgrease = 3.3W/(m*K) Per IGBT，λgrease = 3.3W/(m*K)	R_{thCH}		0.271		K/W
最高结温 $T_{vj\ max}$		$T_{vj\ max}$		175		℃

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℃	V_{RRM}	650	V
连续正向直流电流 Continuous DC forward current	T_h = 80℃, $T_{vj\ max}$ = 175℃	I_F	90	A
总耗散功率 Total Power dissipation	T_h = 80℃, T_{vj} = $T_{vj\ max}$	P_{tot}	115	W
正向重复峰值电流 Repetitive peak forward current	t_p limited by $T_{vj\ max}$	I_{FRM}	400	A

表 10　特征值/Characteristic values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	I_F = 200A, V_{GE} = 0V	T_{vj} = 25℃	V_F		1.77		V
		T_{vj} = 125℃			2.17		
反向恢复峰值电流 Peak reverse recovery current	V_R= 400V I_F = 200A R_{Gon} = 7.5Ω V_{GE} = -8V Ls = 20nH Inductive Load	T_{vj} = 25℃	I_{RM}		46		A
		T_{vj} = 125℃			48		
反向恢复电荷 Recovered charge		T_{vj} = 25℃	Qr		0.8		μC
		T_{vj} = 125℃			1.1		
反向恢复损耗（每脉冲） Reverse recovery energy		T_{vj} = 25℃	Erec		0.15		mJ
		T_{vj} = 125℃			0.23		
结－壳热阻 Thermal resistance, junction to case			R_{thJC}		0.405		K/W
壳－散热器热阻 Thermal resistance, case to heatsink	每个IGBT，λgrease = 3.3W/(m*K) Per IGBT，λgrease = 3.3W/(m*K)		R_{thCH}		0.424		K/W
最高结温 $T_{vj\ max}$			$T_{vj\ max}$		175		℃

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℃	V_{RRM}	650	V
连续正向直流电流 Continuous DC forward current	T_C = 80℃, $T_{vj\ max}$ = 175℃	I_F	108	A
总耗散功率 Total Power dissipation	T_C = 80℃, T_{vj} = $T_{vj\ max}$	P_{tot}	117	W
正向重复峰值电流 Repetitive peak forward current	t_p limited by $T_{vj\ max}$	I_{FRM}	400	A

表 12　特征值/Characteristic values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
正向电压 Forward voltage	I_F = 200A, V_{GE} = 0V	T_{vj} = 25℃	V_F		1.54		V
		T_{vj} = 125℃			1.63		
结－壳热阻 Thermal resistance, junction to case			R_{thJC}		0.295		K/W
壳－散热器热阻 Thermal resistance, case to heatsink	每个IGBT，λgrease = 3.3W/(m*K) Per IGBT，λgrease = 3.3W/(m*K)		R_{thCH}		0.515		K/W
最高结温 $T_{vj\ max}$			$T_{vj\ max}$		175		℃

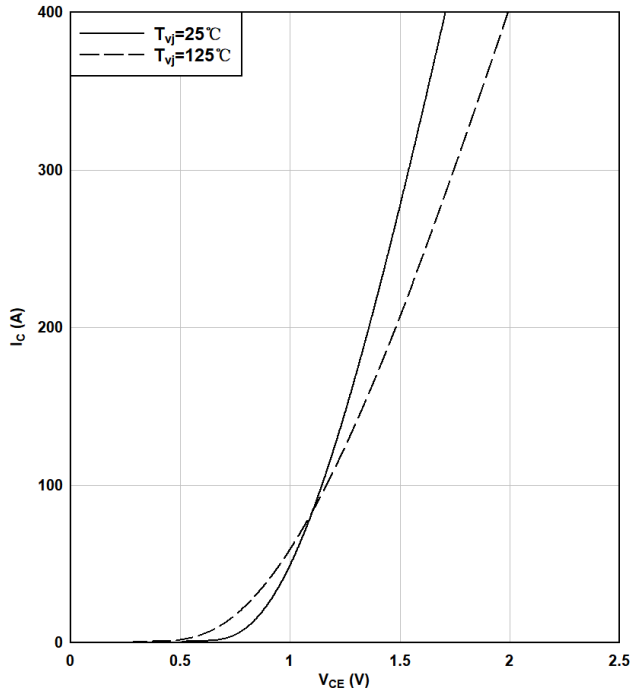
负温度系数热敏电阻/ NTC-Thermistor

表 13　特征值/Characteristic values

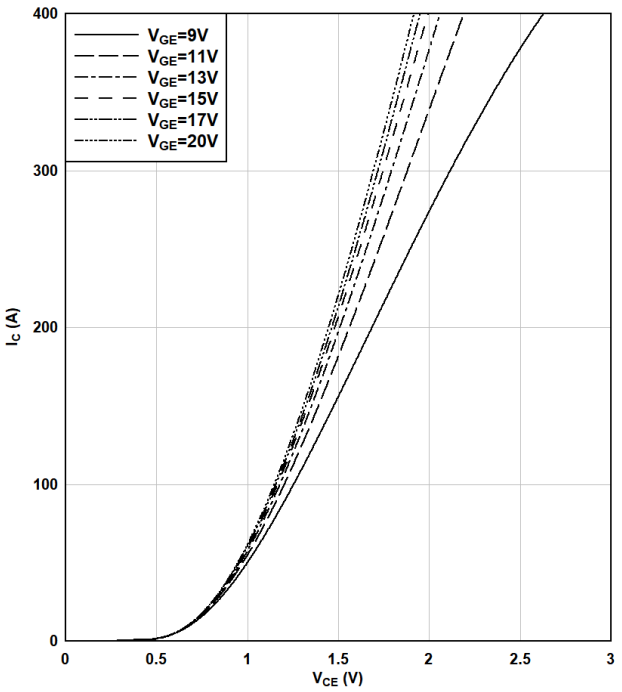
Parameter	Conditions	Symbol	Value	Unit
额定电阻值 Rated resistance	T_{NTC} = 25 ℃	R_{25}	5	kΩ
R_{100}偏差 Deviation of R_{100}	T_{NTC} = 100 ℃, R_{100} = 493 Ω	$\Delta R/R$	±5	%
B-值 B-value	$R_2 = R_{25} \exp[B_{25/50}(1/T2-1/(298{,}15\ K))]$	$B_{25/50}$	3375	K
B-值 B-value	$R_2 = R_{25} \exp[B_{25/100}(1/T_2-1/(298{,}15\ K))]$	$B_{25/100}$	3433	K

特征参数图表/ Characteristics Diagrams

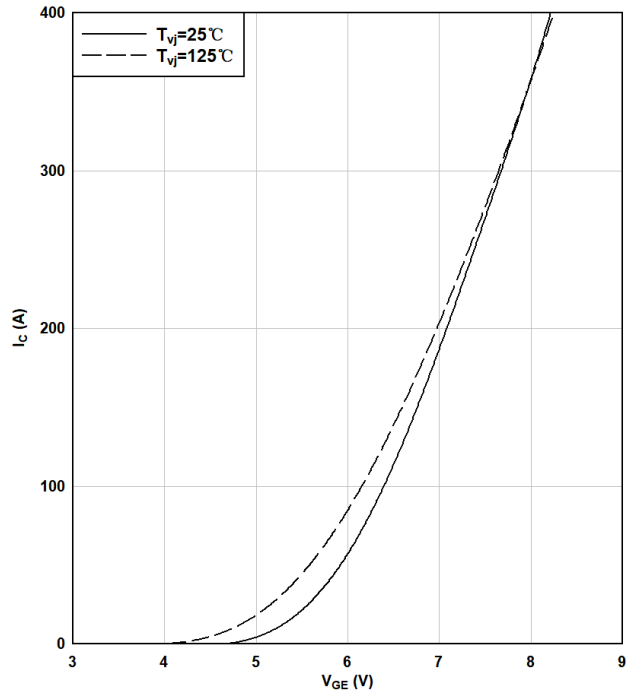
输出特性（典型）, IGBT (T1/T4)，逆变器
Output characteristic (typical), IGBT(T1/T4), Inverter
$I_C = f(V_{CE})$
V_{GE} = 15V



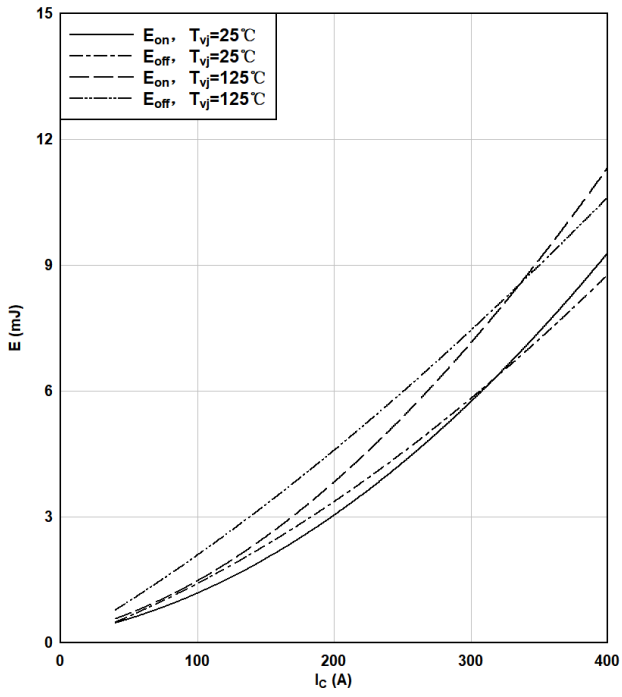
输出特性（典型）, IGBT(T1/T4)，逆变器
Output characteristic (typical), IGBT(T1/T4), Inverter
$I_C = f(V_{CE})$
T_{vj}=125℃



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

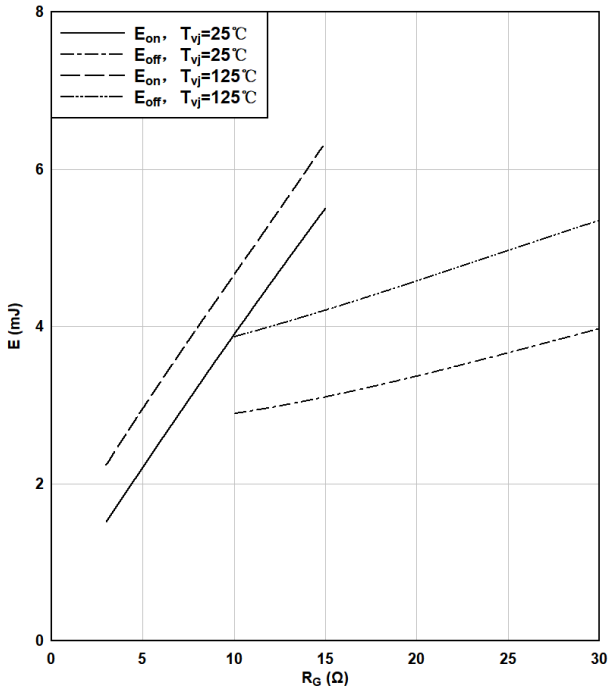


开关损耗（典型），IGBT(T1/T4)，逆变器
Switching losses (typical), IGBT(T1/T4), Inverter
$E = f(I_C)$
V_{CE} = 400V, R_{Gon} = 7.5Ω, R_{Goff} = 20Ω,V_{GE} = +15/-8V

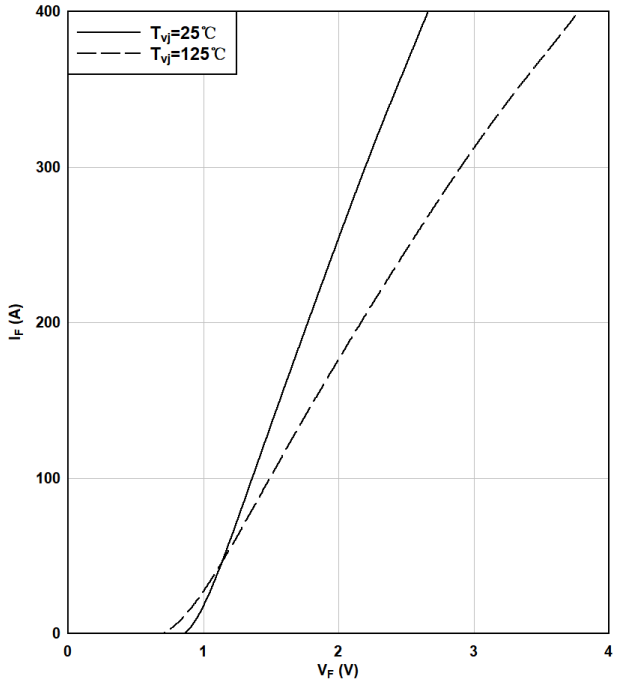


（续）特征参数图表/Characteristics Diagrams

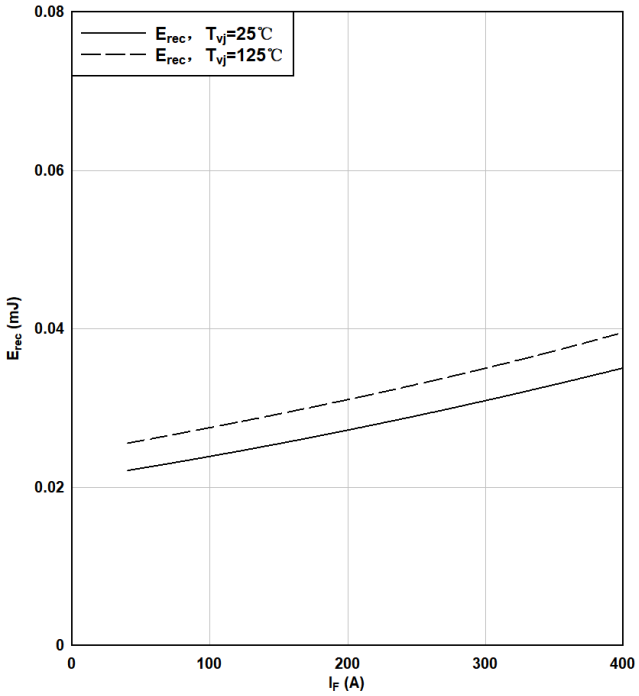
开关损耗 （典型），IGBT(T1/T4)，逆变器
Switching losses (typical), IGBT(T1/T4), Inverter
$E = f(R_G)$
I_C= 200A, V_{CE} = 400V, V_{GE} = +15/-8V



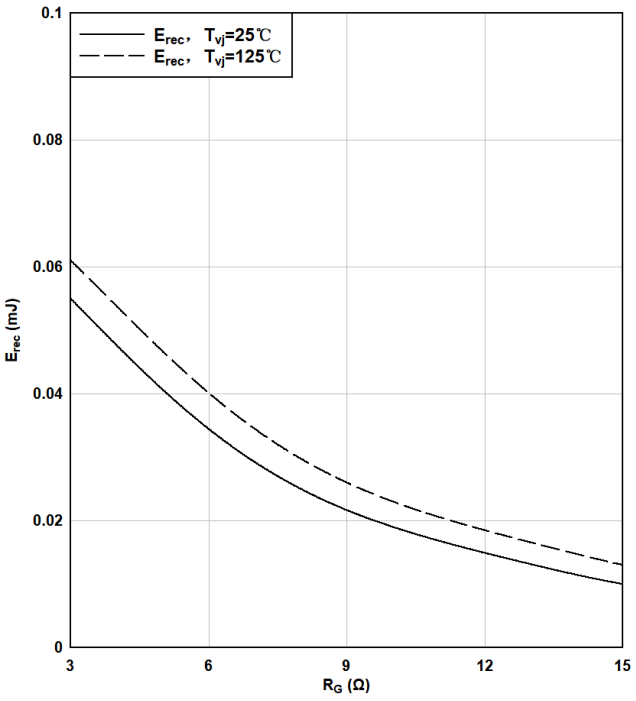
正向特性（典型），二极管(D5/D6)
Forward characteristic (typical), Diode(D5/D6)
$I_F = f(V_F)$



开关损耗（典型）， 二极管(D5/D6)
Switching losses (typical), Diode(D5/D6)
$E_{rec} = f(I_F)$
V_{CE} = 400V, R_{Gon} = 7.5Ω

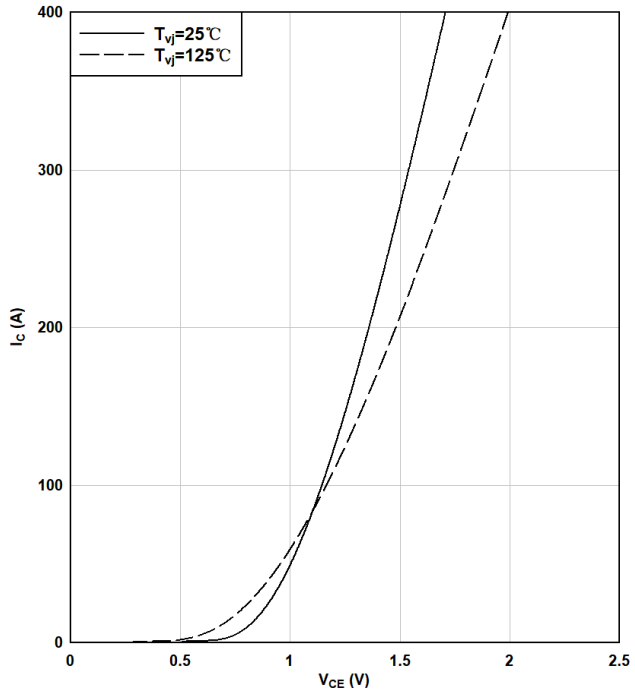


开关损耗（典型），二极管(D5/D6)
Switching losses (typical), Diode(D5/D6)
$E_{rec} = f(R_G)$
I_F = 200A, V_{CE} = 400V

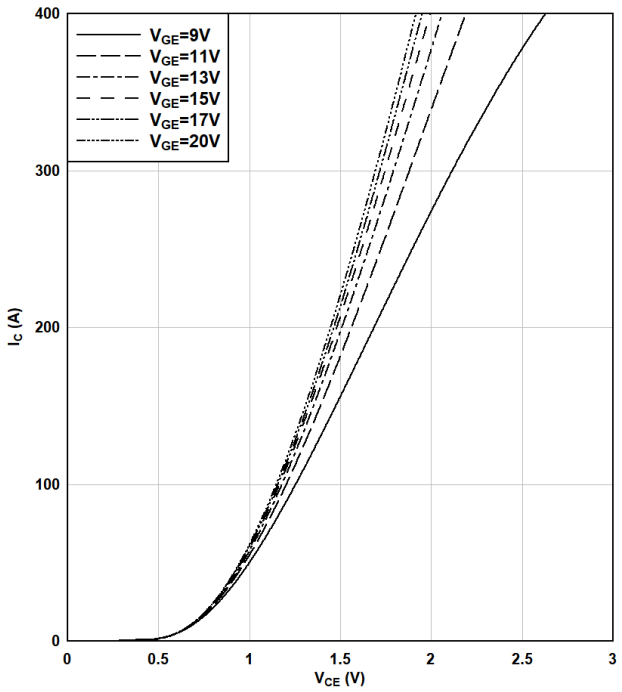


（续）特征参数图表/Characteristics Diagrams

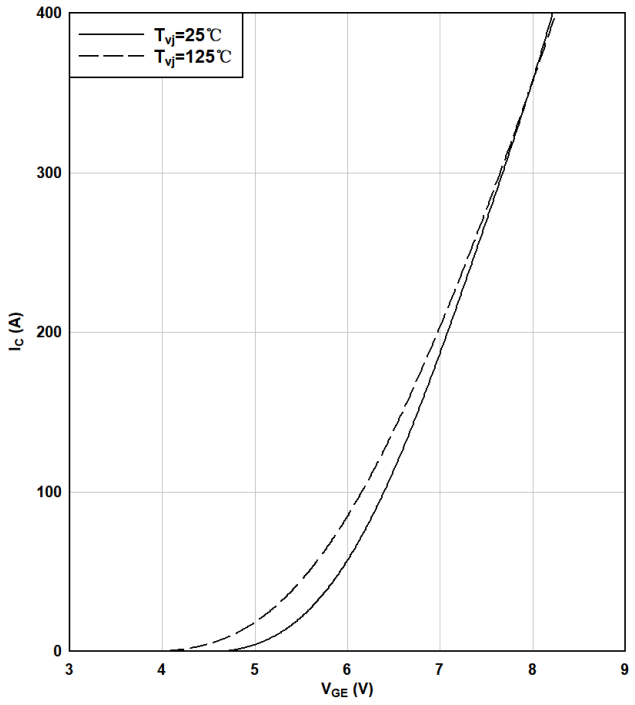
输出特性（典型）, IGBT(T2/T3)，逆变器
Output characteristic (typical), IGBT(T2/T3), Inverter
$I_C = f(V_{CE})$
V_{GE} = 15V



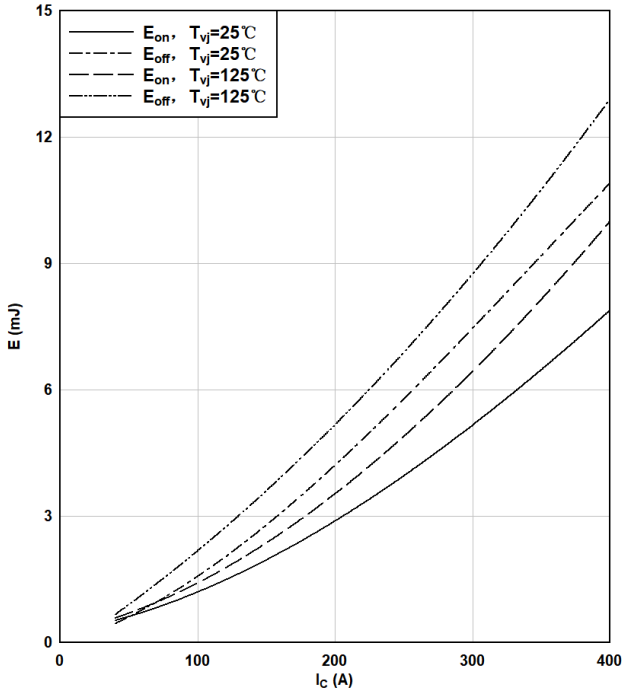
输出特性（典型）, IGBT(T2/T3)，逆变器
Output characteristic (typical), IGBT(T2/T3), Inverter
$I_C = f(V_{CE})$
T_{vj}=125℃



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

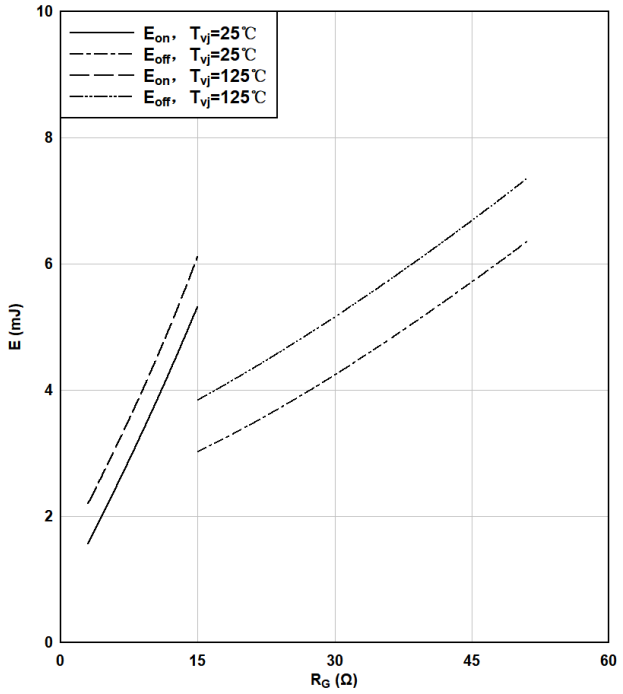


开关损耗（典型）, IGBT(T2/T3)，逆变器
Switching losses (typical), IGBT(T2/T3), Inverter
$E = f(I_C)$
V_{CE} = 400V, R_{Gon}= 7.5Ω, R_{Goff} = 30Ω,V_{GE} = +15/-8V

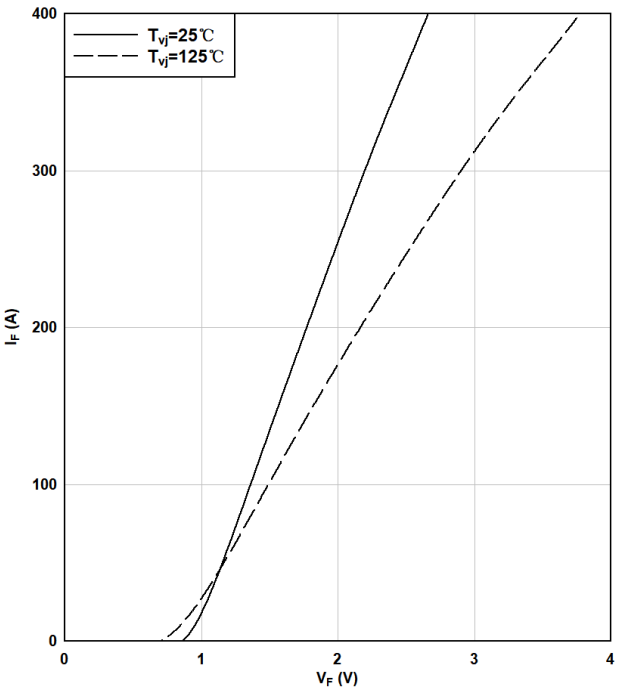


（续）特征参数图表/Characteristics Diagrams

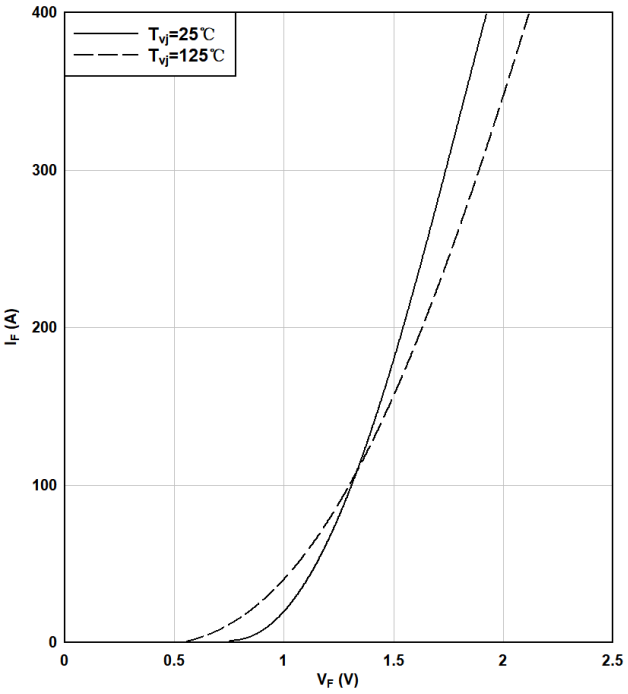
开关损耗 （典型），IGBT(T2/T3)，逆变器
Switching losses (typical), IGBT(T2/T3), Inverter
$E = f(R_G)$
I_C= 200A, V_{CE} = 400V, V_{GE} = +15/-8V



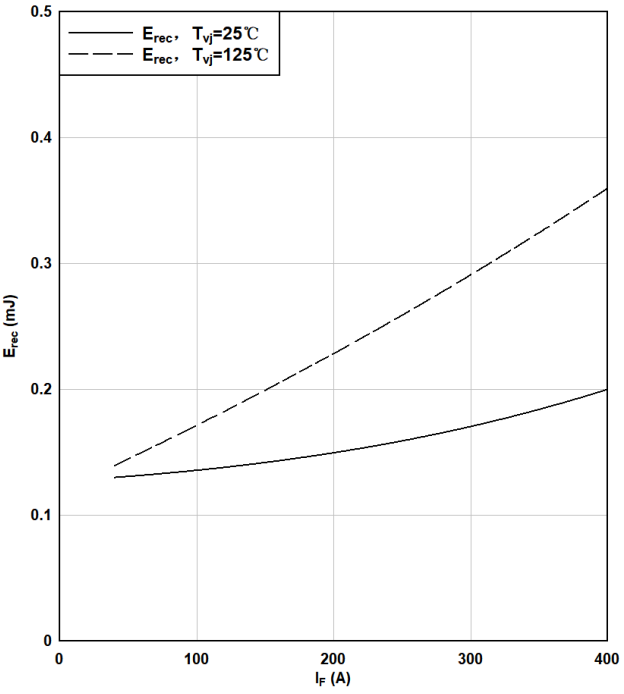
正向特性（典型），二极管(D1/D4)
Forward characteristic (typical), Diode(D1/D4)
$I_F = f(V_F)$



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

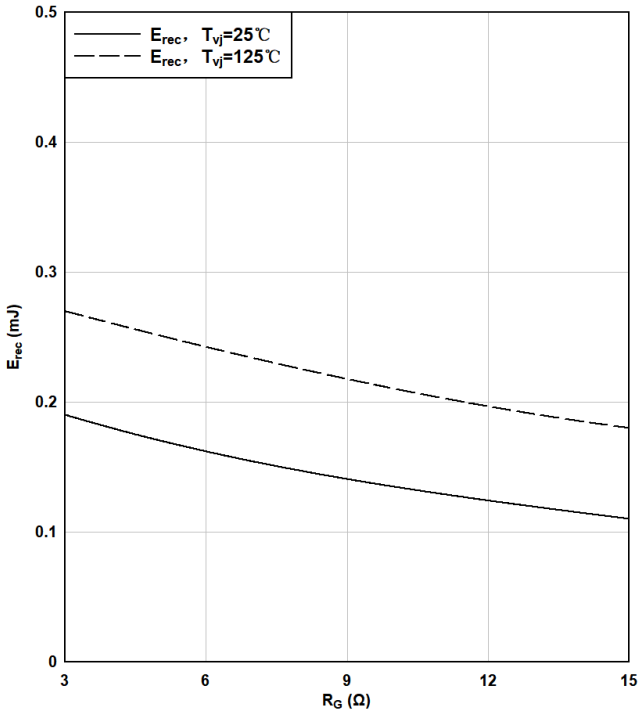


开关损耗（典型), 二极管(D1/D4)
Switching losses (typical), Diode(D1/D4)
$E_{rec} = f(I_F)$
V_{CE} = 400V, R_{Gon} = 7.5Ω

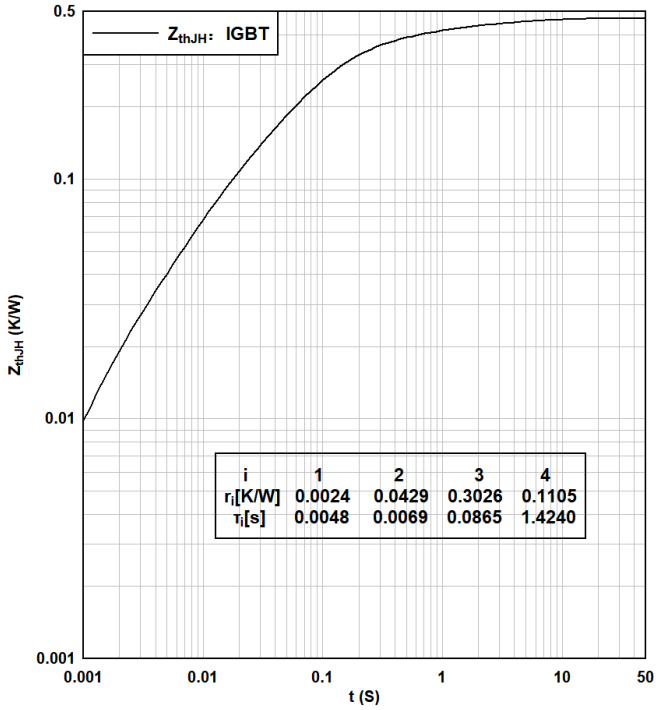


（续）特征参数图表/Characteristics Diagrams

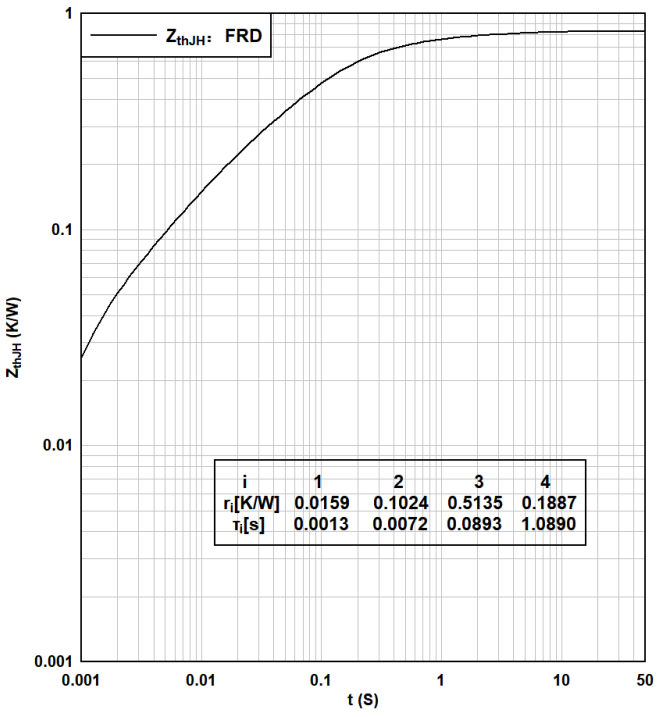
开关损耗（典型）, 二极管(D1/D4)
Switching losses (typical), Diode(D1/D4)
$E_{rec} = f(R_G)$
I_F= 200A, V_{CE} = 400V



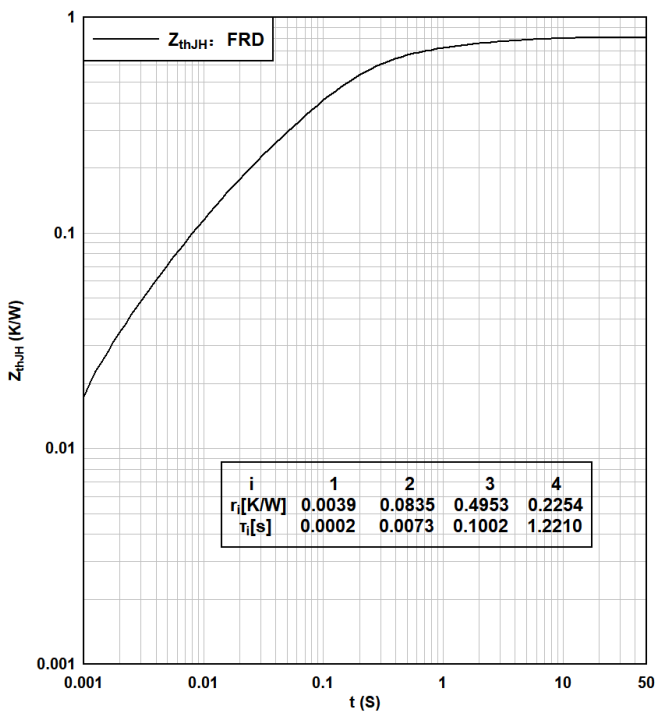
瞬态热阻抗, IGBT(T1/T2/T3/T4)
Transient thermal impedance, IGBT(T1/T2/T3/T4)
$Z_{thJH} = f(t)$



瞬态热阻抗, FRD(D1/D4/D5/D6)
Transient thermal impedance, IGBT(D1/D4/D5/D6)
$Z_{thJH} = f(t)$

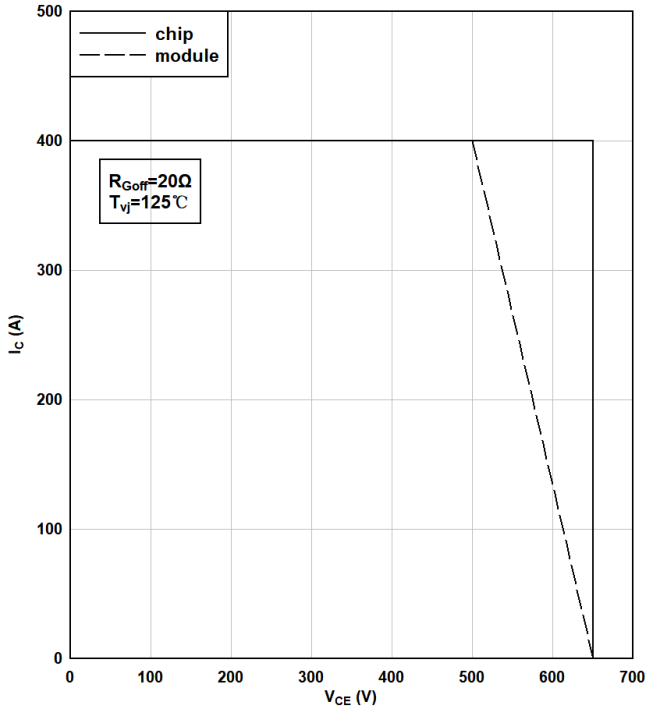


瞬态热阻抗, FRD(D2/D3)
Transient thermal impedance, IGBT(D2/D3)
$Z_{thJH} = f(t)$

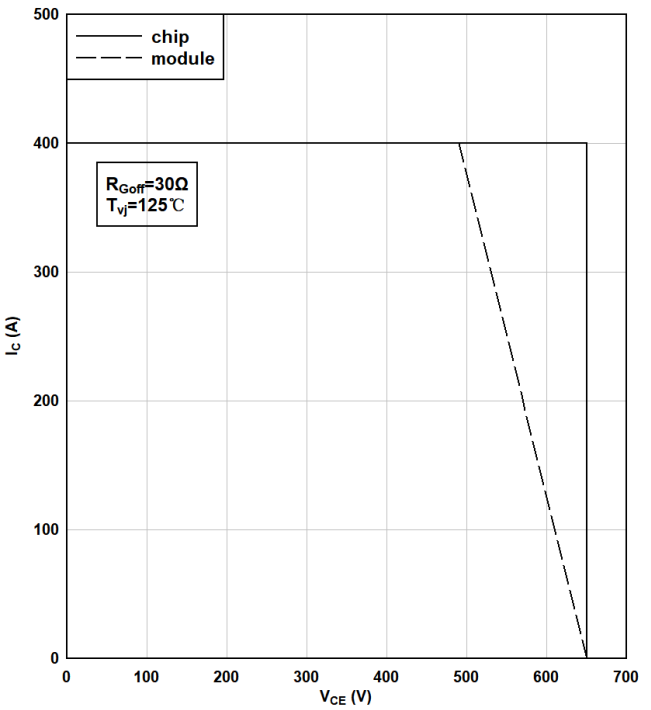


（续）特征参数图表/Characteristics Diagrams

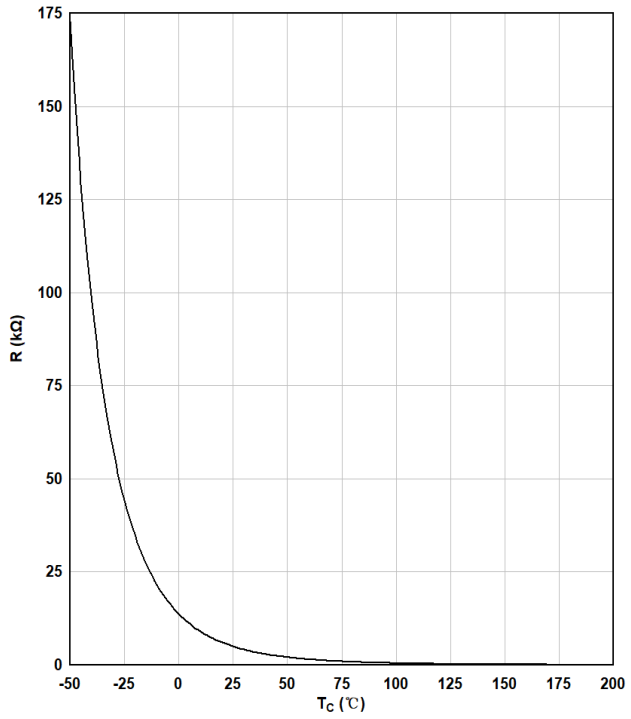
反偏安全工作区 IGBT, 逆变器 (T1/T4)
Reverse bias safe operating area IGBT, Inverter(T1/T4)
$I_C = f(V_{CE})$
T_{vj}=125℃, R_{Goff} = 20Ω



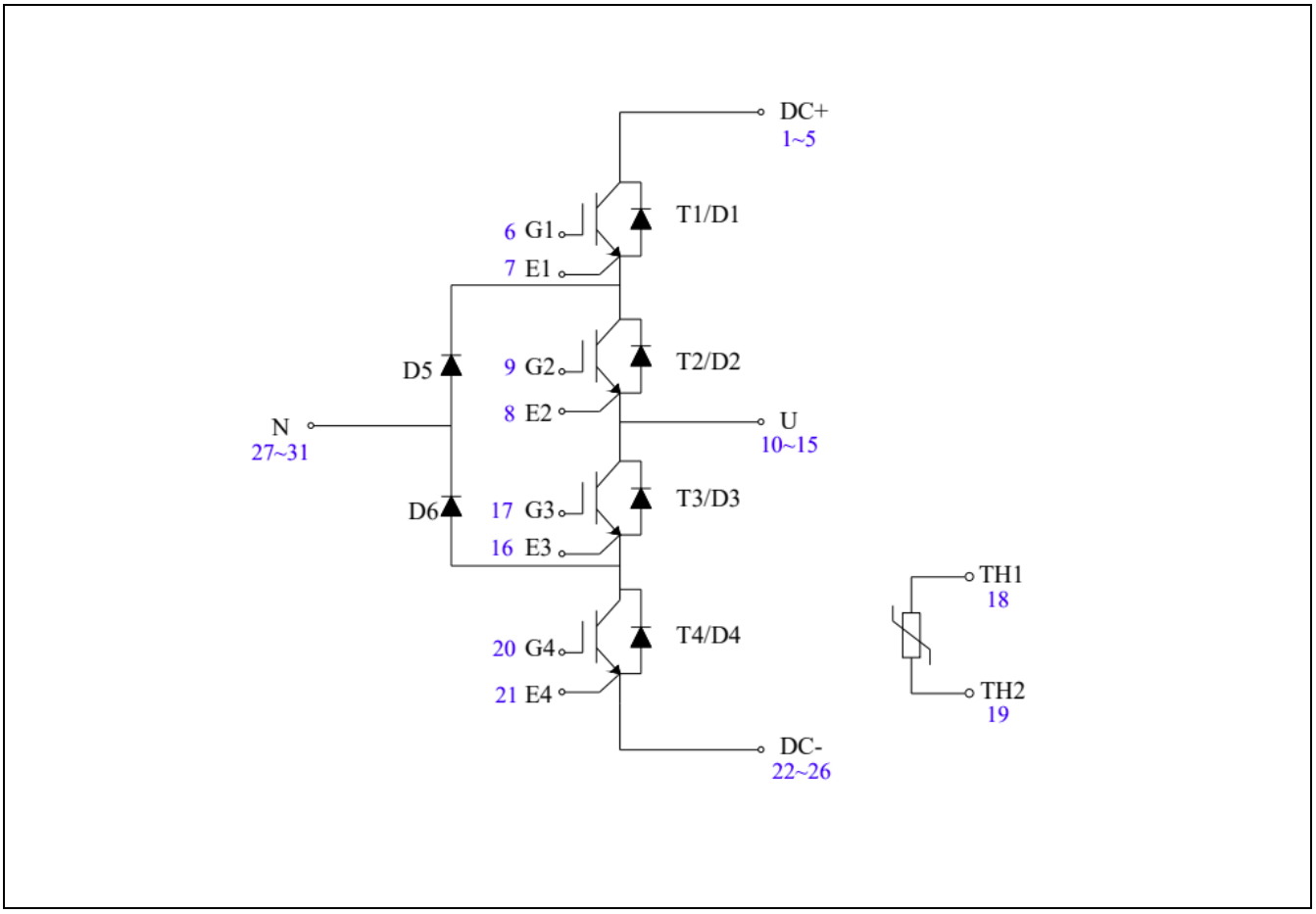
反偏安全工作区 IGBT, 逆变器 (T2/T3)
Reverse bias safe operating area IGBT, Inverter(T2/T3)
$I_C = f(V_{CE})$
T_{vj}=125℃, R_{Goff} = 30Ω



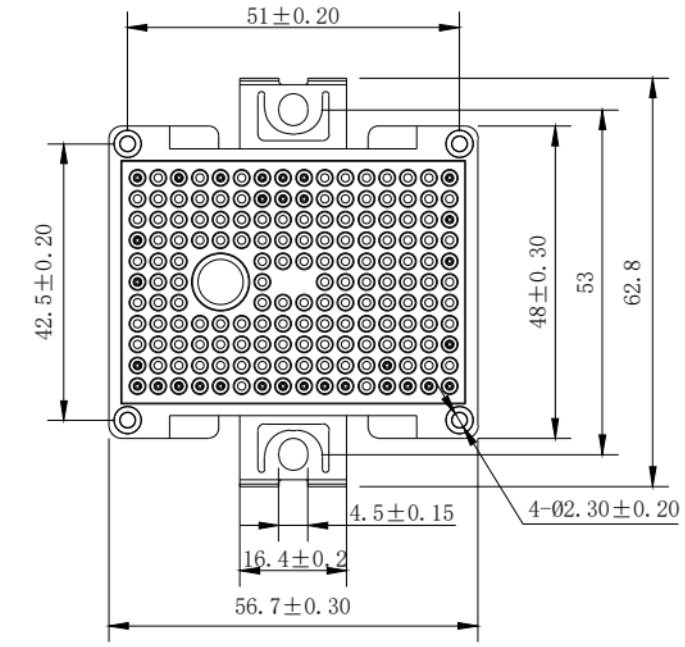
负温度系数热敏电阻温度特性（典型）
NTC-Thermistor-temperature characteristic(typical)
$R = f(T_C)$

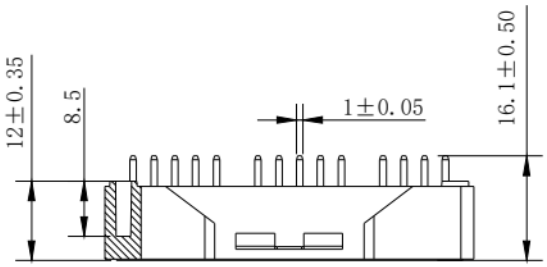


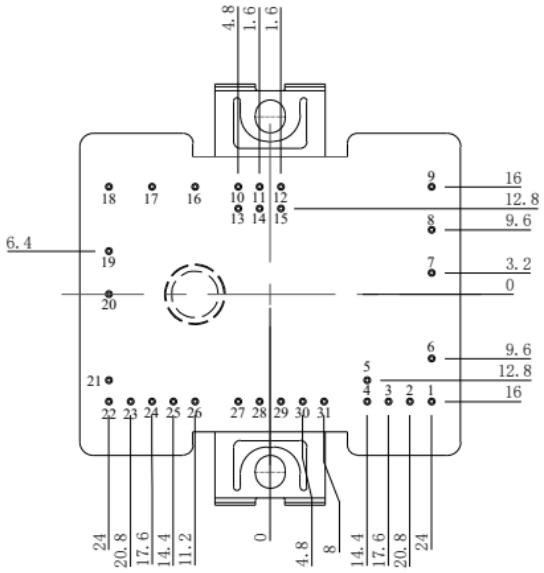
电路拓扑图/ Circuit Diagram



封装尺寸/ Package Outlines







模块标签信息/ Module Marking Information

Marking Diagram
AMG200L65P2H3FS = Specific Device Code
P2CQ26150010001= Lot Traceability
ACP-2 = Package Type

声明与使用条件/ Notices and conditions of use

1. 阿基米德保留手册的更改权；

   Archimedes reserves the right to change the manual；

2. 本手册中提供的数据一部分为产品的典型值，实际出厂测试的数据与典型值略有差异，但我司保证这些差异不会影响产品的正常使用，如果产品信息发生变更，我司会及时更新手册，请随时关注；

   Part of the data provided in this manual is the typical value of the product, the actual factory test data and the typical value are slightly different, but our company guarantees that these differences will not affect the normal use of the product, if the product information changes, our company will update the manual in time, please pay attention at any time；

3. 在应用我司产品时请不要超过产品的最大额定值，否则我司无法保证产品应用的可靠性；

   When applying our products, please do not exceed the maximum rating of the product, otherwise our company can not guarantee the reliability of the product application；

4. 产品在使用时，严禁触碰，断电后确认无残余电荷且产品已完全冷却后，才可以在有静电防护措施下触碰产品；

   When the product is in use, it is strictly forbidden to touch the product. After power off, it is confirmed that there is no residual charge and the product has been completely cooled, and it can only be touched under electrostatic protection measures；

5. 购买产品时请认准我司商标，如有疑问请与本司联系。

   Please look for our trademark when purchasing products. If you have any questions, please contact us.