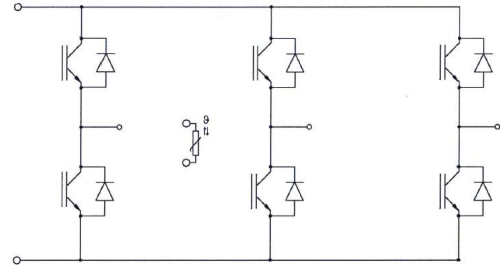
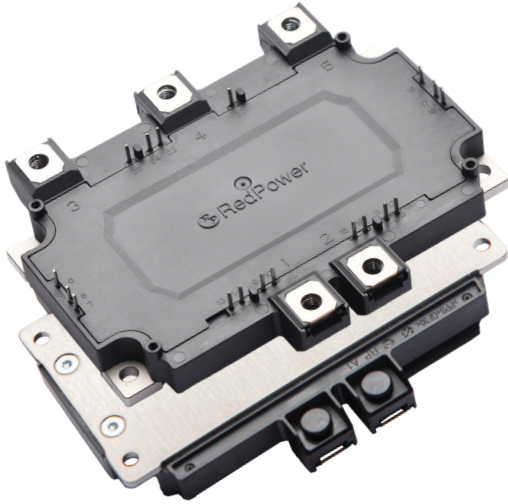


A1 package: 750V 400A IGBT module



等效电路图
Equivalent Circuit Schematic

Features:

- 750V 400A, $V_{CE(sat)} = 1.35V@25^{\circ}C$
- High RBSOA capability
- Micro pattern trench/FS technology
- Low switching losses
- High SC capability

产品特性:

- 750V 400A, $V_{CE(sat)} = 1.35V@25^{\circ}C$
- 高 RBSOA 能力
- 微沟槽/场终止技术
- 低开关损耗
- 高短路能力

Typical Applications:

- Automotive Applications
- Motor Drives

典型应用:

- 汽车应用
- 电机驱动

IGBT, Inverter / IGBT, 逆变部分
Maximum Rated Values / 最大标称参数

Collector-emitter voltage 集电极-发射极电压	$T_{vj}=25^{\circ}\text{C}$	V_{CES}	750	V
Continuous DC collector current 集电极连续直流电流		$I_{C\text{ nom}}$	400	A
	$T_C=65^{\circ}\text{C}, T_{vj\text{ max}}=175^{\circ}\text{C}$	I_C	460	A
Repetitive peak collector current 集电极可重复峰值电流	$t_p=1\text{ms}$	I_{CRM}	800	A
Total power dissipation 功率损耗	$T_C=25^{\circ}\text{C}, T_{vj\text{ max}}=175^{\circ}\text{C}$	P_{tot}	1200	W
Gate-emitter peak voltage 门极-发射极峰值电压		V_{GES}	± 20	V

Characteristic Values / 性能参数

min. typ. max.

				min.	typ.	max.	
Collector-emitter saturation voltage 集电极-发射极饱和压降	$I_C=400\text{A}, V_{GE}=15\text{V}$ $I_C=400\text{A}, V_{GE}=15\text{V}$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	V_{CESat}	-	1.35 1.47	1.70	V
Gate threshold voltage 门极阈值电压	$V_{CE}=V_{GE}, I_C=6.4\text{mA}$	$T_{vj}=25^{\circ}\text{C}$	V_{GEth}	5.00	6.00	7.00	V
Internal gate resistor 内置门极电阻		$T_{vj}=25^{\circ}\text{C}$	R_{Gint}	-	0.55	-	Ω
Input capacitance 输入电容	$V_{CE}=25\text{V}, V_{GE}=0\text{V}, f=100\text{kHz}$	$T_{vj}=25^{\circ}\text{C}$	C_{ies}	-	58.4	-	nF
Reverse transfer capacitance 反向传输电容	$V_{CE}=25\text{V}, V_{GE}=0\text{V}, f=100\text{kHz}$	$T_{vj}=25^{\circ}\text{C}$	C_{res}	-	0.22	-	nF
Gate charge 门极电荷	$V_{GE}=\pm 15\text{V}$		Q_G	-	2.42	-	μC
Collector-emitter cut-off current 集电极-发射极关断漏电流	$V_{CE}=750\text{V}, V_{GE}=0\text{V}$	$T_{vj}=25^{\circ}\text{C}$	I_{CES}	-	-	1.0	mA
Gate-emitter leakage current 门极-发射极漏电流	$V_{CE}=0\text{V}, V_{GE}=20\text{V}$	$T_{vj}=25^{\circ}\text{C}$	I_{GES}	-	-	500	nA
Turn-on delay time, inductive load 开通延迟时间, 感性负载	$I_C=400\text{A}, V_{CE}=400\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Gon}=2.4\Omega$	$T_{vj}=25^{\circ}\text{C}$	t_{don}	-	158	-	ns
		$T_{vj}=125^{\circ}\text{C}$			165		
		$T_{vj}=150^{\circ}\text{C}$			171		
Rise time, inductive load 上升时间, 感性负载	$I_C=400\text{A}, V_{CE}=400\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Gon}=2.4\Omega$	$T_{vj}=25^{\circ}\text{C}$	t_r	-	63	-	ns
		$T_{vj}=125^{\circ}\text{C}$			71		
		$T_{vj}=150^{\circ}\text{C}$			72		
Turn-off delay time, inductive load 关断延迟时间, 感性负载	$I_C=400\text{A}, V_{CE}=400\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Goff}=7.5\Omega$	$T_{vj}=25^{\circ}\text{C}$	t_{doff}	-	729	-	ns
		$T_{vj}=125^{\circ}\text{C}$			786		
		$T_{vj}=150^{\circ}\text{C}$			813		
Fall time, inductive load 下降时间, 感性负载	$I_C=400\text{A}, V_{CE}=400\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Goff}=7.5\Omega$	$T_{vj}=25^{\circ}\text{C}$	t_f	-	62	-	ns
		$T_{vj}=125^{\circ}\text{C}$			121		
		$T_{vj}=150^{\circ}\text{C}$			136		
Turn-on energy loss per pulse 开通损耗	$I_C=400\text{A}, V_{CE}=400\text{V}, L_o=30\text{nH}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Gon}=2.4\Omega,$	$T_{vj}=25^{\circ}\text{C}$	E_{on}	-	10.9	-	mJ
		$T_{vj}=125^{\circ}\text{C}$			13.8		
		$T_{vj}=150^{\circ}\text{C}$			15.0		
Turn-off energy loss per pulse 关断损耗	$I_C=400\text{A}, V_{CE}=400\text{V}, L_o=30\text{nH}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Goff}=7.5\Omega$	$T_{vj}=25^{\circ}\text{C}$	E_{off}	-	20.0	-	mJ
		$T_{vj}=125^{\circ}\text{C}$			25.3		
		$T_{vj}=150^{\circ}\text{C}$			26.5		
SC data 短路耐量	$V_{CC}=400\text{V}, V_{GE}=-8\text{V}/15\text{V},$ $V_{CE\text{ max}}=V_{CES}-L_{s\text{ CE}} \cdot di/dt$	$T_{vj}=150^{\circ}\text{C}$	t_{psc}	6	-	-	μs
Thermal resistance, junction to case 结-壳热阻	Per IGBT/单个 IGBT		R_{thJC}	-	0.12	-	K/W

Temperature under switching conditions 工作温度	t_{op} continuous	$T_{vj\ op}$	-40	-	150	°C
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Diode, Inverter / 二极管, 逆变部分

Maximum Rated Values / 最大标称参数

Repetitive peak reverse voltage 可重复反向峰值电压	$T_{vj}=25^{\circ}\text{C}$	V_{RRM}	750	V
Continuous DC forward current 可连续正向直流电流		I_{Fnom}	400	A
Repetitive peak forward current 可重复正向峰值电流	$I_{FRM}=2\times I_F$	I_{FRM}	800	A

Characteristic Values / 性能参数

			min.	typ.	max.		
Forward voltage ¹⁾ 正向通态压降	$I_F=400\text{A}, V_{GE}=0\text{V}$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	V_F	-	1.40 1.33	-	V
Peak reverse recovery current 反向恢复峰值电流	$I_F=400\text{A}, V_R=400\text{V}$ $-di_F/dt=5500\text{A}/\mu\text{s}(T_{vj}=150^{\circ}\text{C})$ $V_{GE}=-8\text{V}$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	I_{RM}	-	216 248 260	-	A
Recovery charge 反向恢复电荷	$I_F=400\text{A}, V_R=400\text{V}$ $-di_F/dt=5500\text{A}/\mu\text{s}(T_{vj}=150^{\circ}\text{C})$ $V_{GE}=-8\text{V}$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	Q_R	-	17.1 28.0 33.0	-	μC
Reverse recovery energy 反向恢复损耗	$I_F=400\text{A}, V_R=400\text{V}$ $-di_F/dt=5500\text{A}/\mu\text{s}(T_{vj}=150^{\circ}\text{C})$ $V_{GE}=-8\text{V}$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	E_{rec}	-	4.6 7.9 9.6	-	mJ
Thermal resistance, junction to case 结-壳热阻	Per FRD/单个 FRD		R_{thJC}	-	0.20	-	K/W
Temperature under switching conditions 工作温度	t_{op} continuous		$T_{vj\ op}$	-40	-	150	°C

NTC-Thermistor/ NTC-热敏电阻

Characteristic Values / 性能参数

			min.	typ.	max.		
Rated resistance 标称电阻	$T_{NTC}=25^{\circ}\text{C}$		R_{25}	-	5	-	K Ω
Deviation of R100 R100 偏移值	$T_{NTC}=100^{\circ}\text{C}, R_{100}=493.3\Omega$		$\Delta R/R$	-5	-	5	%
Power dissipation 功率耗散	$T_{NTC}=25^{\circ}\text{C}$		P_{25}	-	-	20	mW
B-value B 值	$R_2=R_{25} \exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$		$B_{25/50}$	-	3375	-	K
	$R_2=R_{25} \exp[B_{25/80}(1/T_2-1/(298.15\text{K}))]$		$B_{25/80}$	-	3414	-	K
	$R_2=R_{25} \exp[B_{25/100}(1/T_2-1/(298.15\text{K}))]$		$B_{25/100}$	-	3436	-	K

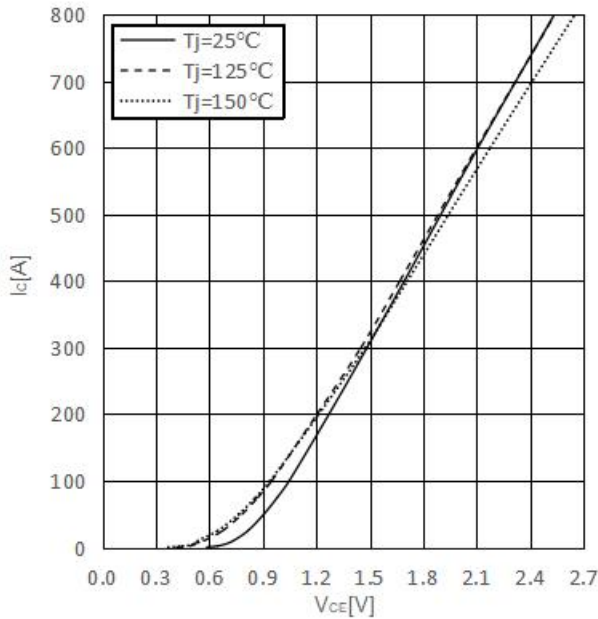
Module / 模块

Isolation test voltage 绝缘测试电压	RMS, f=50Hz, t=1min	V_{ISOL}	3			KV
Material of module baseplate 模块底板材料			Cu			
Internal isolation 内部绝缘			Al_2O_3/ZrO_2			
Creepage distance 爬电距离	Terminal to heatsink Terminal to terminal		12.0 6.1			mm
Clearance 电气间隙	Terminal to heatsink Terminal to terminal		12.0 6.1			mm
Comparative tracking index 相对漏电起痕指数		CTI	200 ²⁾			
			min.	typ.	max.	
Stray inductance module 模块杂散电感		L_{sCE}	-	20	-	nH
Module lead resistance, terminals- chip 模块引脚电阻, 端子-芯片	$T_c=25^\circ C$, Per Switch	$R_{CC'+EE'}$	-	1.0	-	m Ω
Storage temperature 贮存温度		T_{stg}	-40	-	125	$^\circ C$
Mounting torque for module mounting 模块安装力矩	Screw M5 / M5 螺丝 Baseplate to heatsink	M	3.0	-	6.0	Nm
Terminal connection torque 功率端子连接力矩	Screw M6 / M6 螺丝	M	3.0	-	6.0	Nm
Weight 重量		G	-	470	-	g

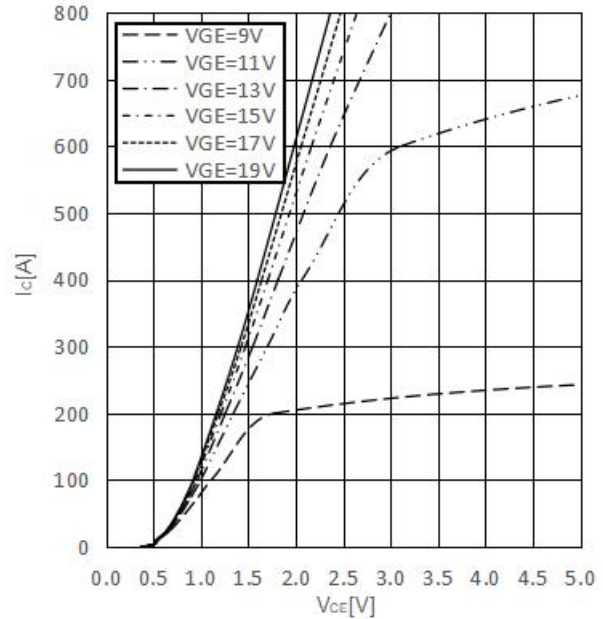
- 1) Terminal impedance is not included.
不包含端子阻抗。
- 2) CTI is about 200.
CTI 约等于 200。

Circuit Diagram / 曲线图

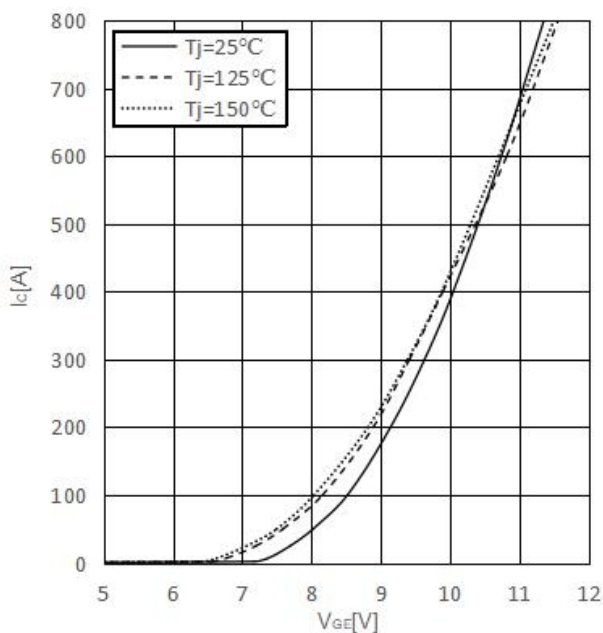
Output characteristic IGBT, Inverter (typical), Inclusive R_{CC+EE}
IGBT 输出特性, 逆变 (典型值), 包含 R_{CC+EE}
 $I_c = f(V_{CE}), V_{GE} = 15V$



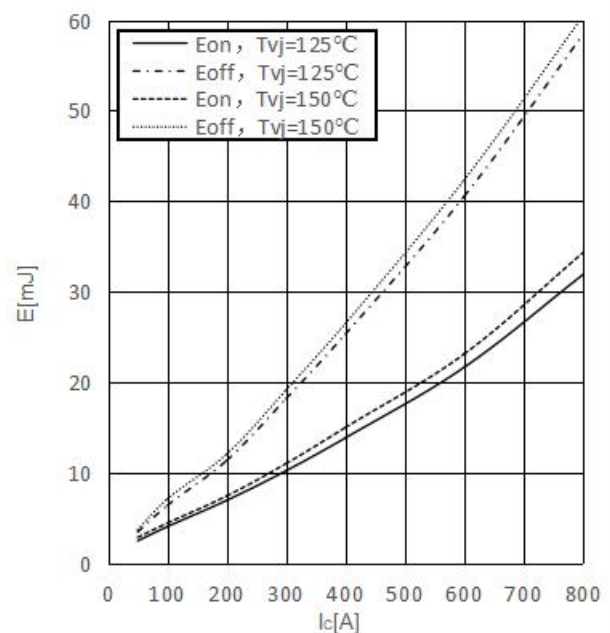
Output characteristic IGBT, Inverter (typical), Inclusive R_{CC+EE}
IGBT 输出特性, 逆变 (典型值), 包含 R_{CC+EE}
 $I_c = f(V_{CE}), T_j = 150^\circ\text{C}$



Transfer characteristic IGBT, Inverter (typical), Inclusive R_{CC+EE}
IGBT 传输特性, 逆变 (典型值), 包含 R_{CC+EE}
 $I_c = f(V_{GE}), V_{CE} = 20V$

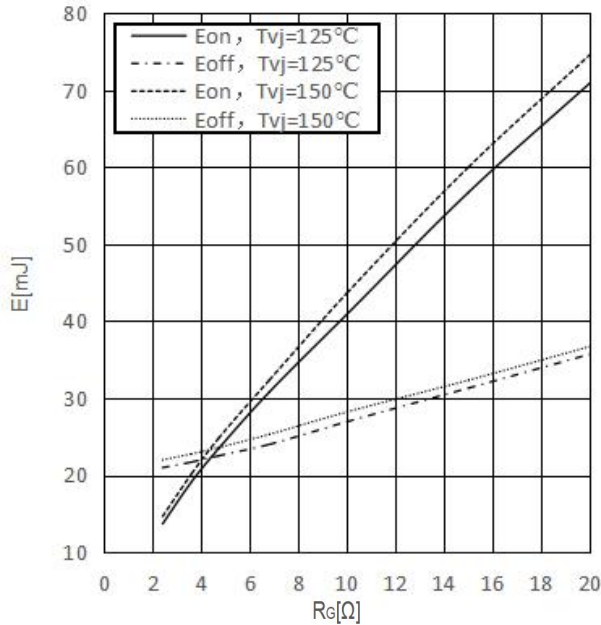


Switching losses IGBT, Inverter (typical), Inclusive R_{CC+EE}
IGBT 开关损耗, 逆变 (典型值), 包含 R_{CC+EE}
 $E = f(I_c), V_{GE} = +15V/-8V,$
 $R_{Gon} = 2.4\Omega, R_{Goff} = 7.5\Omega, V_{CE} = 400V$



Switching losses IGBT, Inverter (typical), Inclusive $R_{CC} + EE$

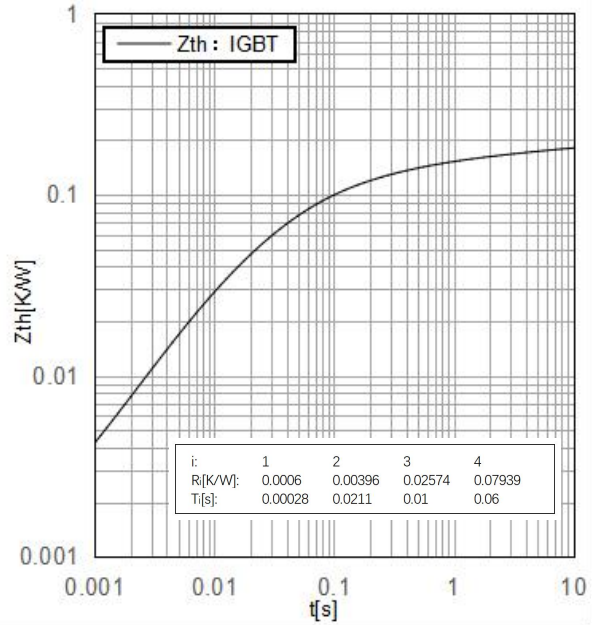
IGBT 开关损耗, 逆变 (典型值), 包含 $R_{CC} + EE$
 $E = f(R_G), V_{GE} = +15V/-8V, I_C = 400A, V_{CE} = 400V$



Transient thermal impedance IGBT, Inverter

IGBT 瞬态热阻, 逆变

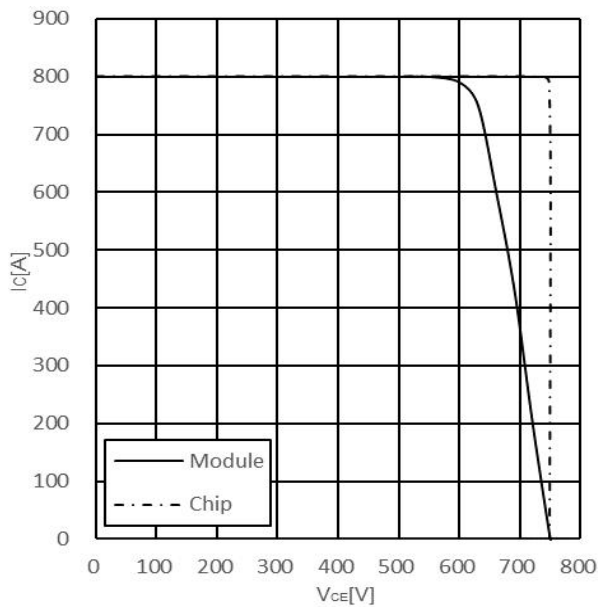
$Z_{thJC} = f(t)$



Reverse bias safe operating area IGBT, Inverter (RBSOA)

IGBT 反向安全工作区, 逆变 (RBSOA)

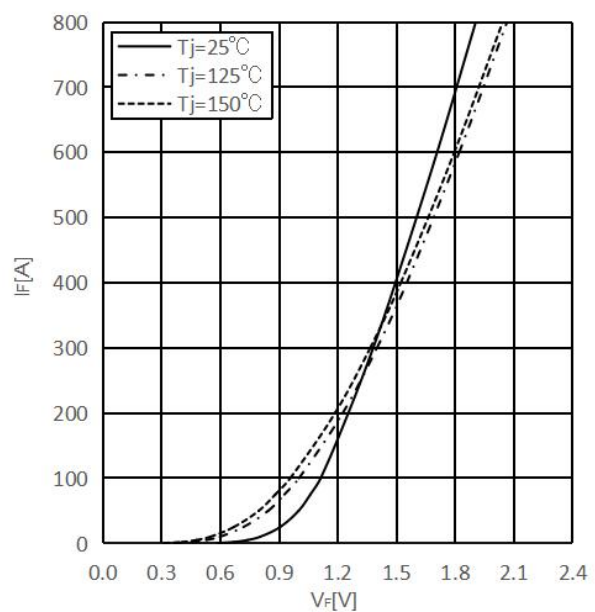
$I_C = f(V_{CE}), V_{CE} = +15V/-8V, R_{Goff} = 7.5\Omega, T_j = 150^\circ C$



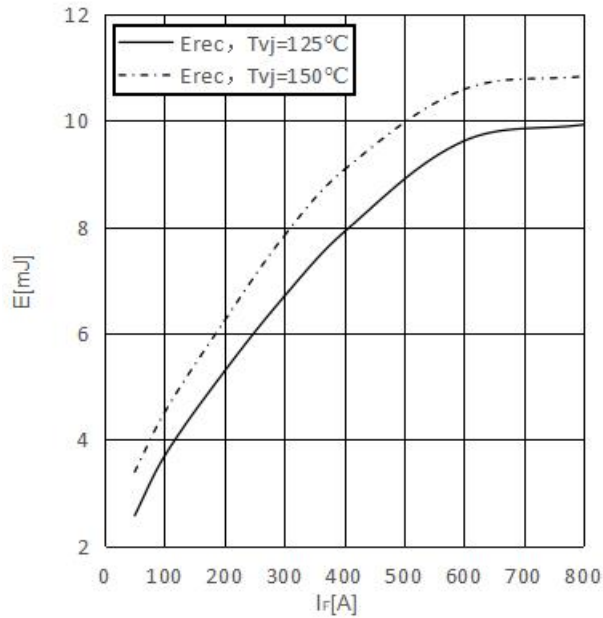
Forward characteristic FRD, Inverter (typical), Inclusive $R_{CC} + EE$

FRD 正向特性, 逆变 (典型值), 包含 $R_{CC} + EE$

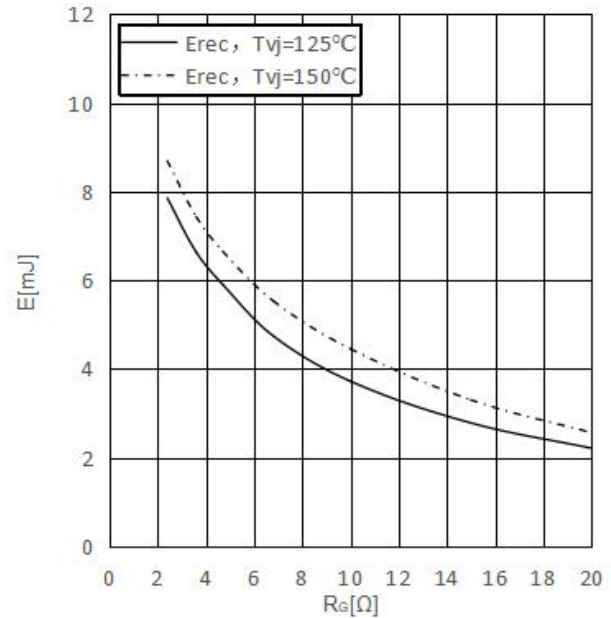
$I_F = f(V_F)$



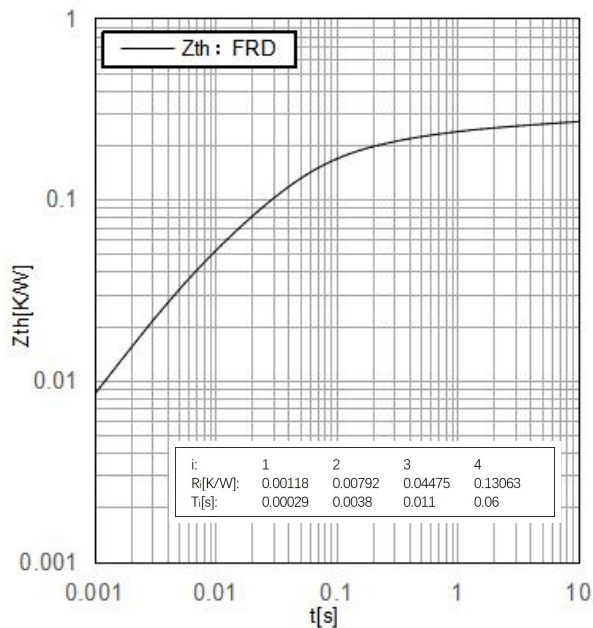
Switching Losses FRD, Inverter (typical), Inclusive $R_{CC}+EE'$
 FRD 开关损耗, 逆变 (典型值), 包含 $R_{CC}+EE'$
 $E_{rec}=f(I_F), R_{Gon}=2.4\Omega, V_{CE}=400V$



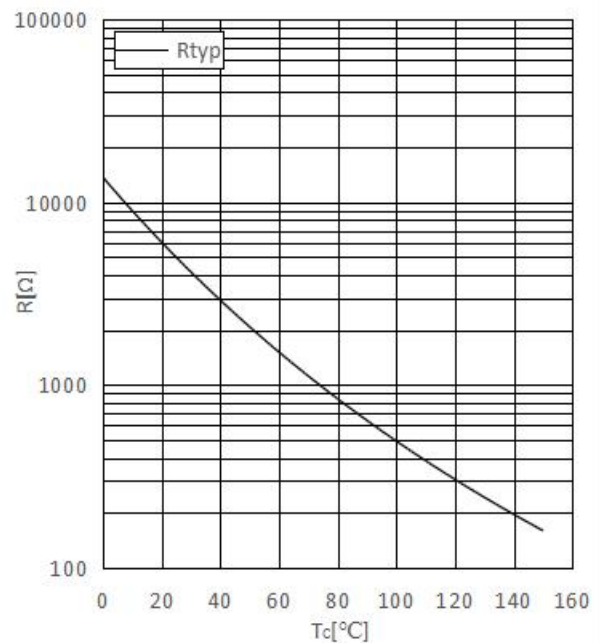
Output characteristic E_{rec} , Inverter (typical), Inclusive $R_{CC}+EE'$
 FRD 输出特性, 逆变 (典型值), 包含 $R_{CC}+EE'$
 $E_{rec}=f(R_g)$



Transient thermal impedance FRD, Inverter
 FRD 瞬态热阻, 逆变
 $Z_{thJC}=f(t)$

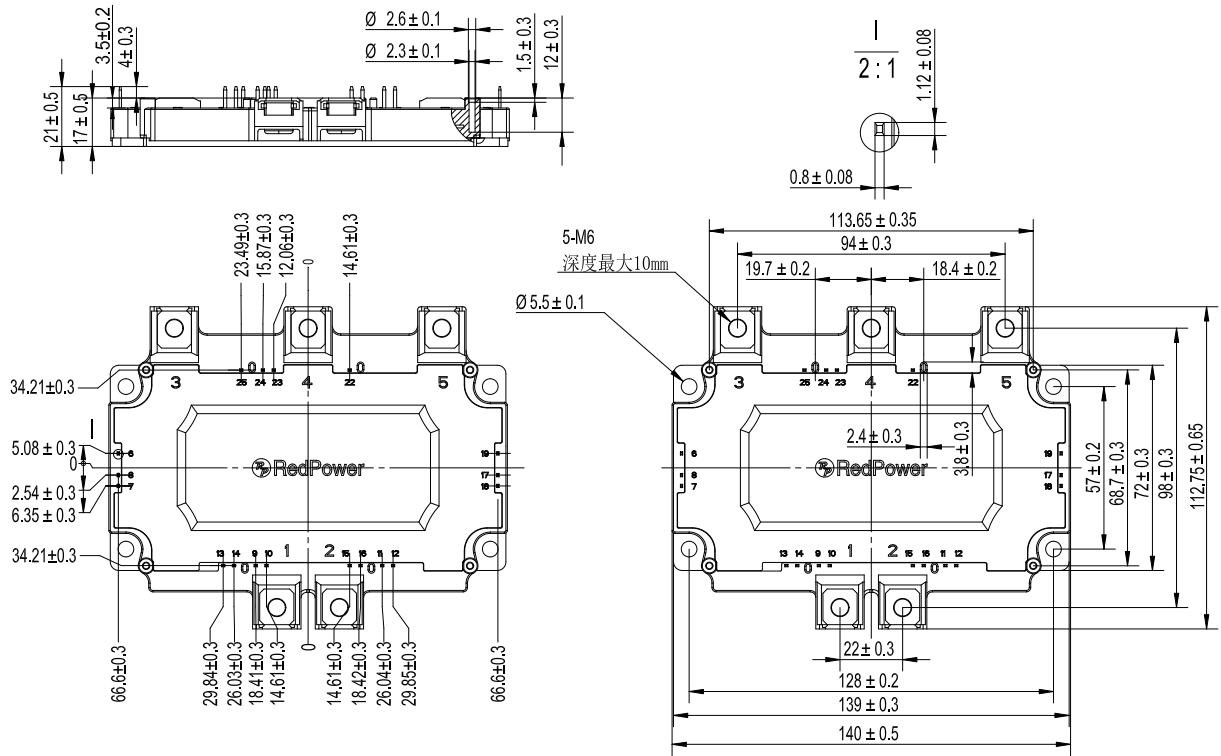


NTC Thermistor temperature characteristic (typical)
 NTC 热敏电阻
 $R=f(T)$



Package Dimension / 封装尺寸

Dimensions in Millimeters / 毫米为单位



Internal Circuit / 内部电路

