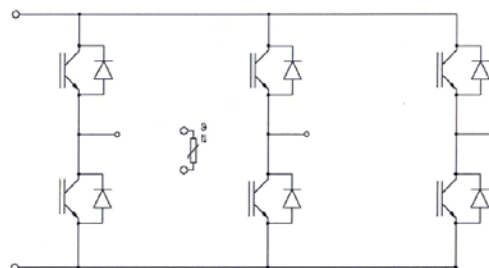


A1 package: 650V 400A IGBT module



等效电路图

Equivalent Circuit Schematic

Features:

- 650V 400A, $V_{CE(sat)} = 1.55 \text{ V}@25^{\circ}\text{C}$
- High RBSOA capability
- Trench/FS Technology
- Low switching losses
- High SC capability

产品特性:

- 650V 400A, $V_{CE(sat)} = 1.55\text{V}@25^{\circ}\text{C}$
- 高 RBSOA 能力
- 沟槽栅/场终止技术
- 低开关损耗
- 高短路能力

Typical Applications:

- E-Mobility

典型应用:

- 电动汽车电机驱动

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}	650	V
Continuous DC collector current 集电极连续直流电流	$T_C=80^{\circ}\text{C}, T_{vjmax}=175^{\circ}\text{C}$	$I_{C\ nom}$	400	A
Repetitive Peak collector current 集电极可重复峰值电流	$I_{CRM}=2 \times I_{C\ nom}$	I_{CRM}	800	A
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.

Collector-emitter saturation Voltage 集电极-发射极饱和压降	$I_C=400\text{A}, V_{GE}=15\text{V}$ $I_C=400\text{A}, V_{GE}=15\text{V}$ $I_C=400\text{A}, V_{GE}=15\text{V}$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	V_{CESat}	-	1.55 1.82 1.89	2.10	V
Gate Threshold Voltage 门极阈值电压	$V_{CE}=10\text{V}, I_C=3.2\text{mA}, T_{vj}=25^{\circ}\text{C}$		V_{GETh}	5.0	5.8	6.8	V
Internal Gate Resistor 内置门极电阻	$T_{vj}=25^{\circ}\text{C}$		R_{Gint}	-	1	-	Ω
Input Capacitance 输入电容	$V_{CE}=25\text{V}, V_{GE}=0\text{V}, f=100\text{kHz}$		C_{ies}	-	30	-	nF
Reverse Transfer Capacitance 反向传输电容	$V_{CE}=25\text{V}, V_{GE}=0\text{V}, f=100\text{kHz}$		C_{res}	-	560	-	pF
Gate Charge 门极电荷	$V_{GE}=-15\text{V}/15\text{V}$		Q_G	-	0.9	-	μC
Collector-emitter Cutoff Current 集电极-发射极关断漏电流	$V_{CE}=650\text{V}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$		I_{CES}	-	-	1	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	$I_C=400\text{A}, V_{CE}=300\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Gon}=1.8\Omega$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	t_{don}	-	105 115 120	-	ns
Rise Time, Inductive Load 上升时间, 感性负载	$I_C=400\text{A}, V_{CE}=300\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Gon}=1.8\Omega$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	t_r	-	60 62 65	-	ns
Turn-off Delay Time, Inductive Load 关断延迟时间, 感性负载	$I_C=400\text{A}, V_{CE}=300\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Goff}=3.3\Omega$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	t_{doff}	-	325 345 355	-	ns
Fall Time, Inductive Load 下降时间, 感性负载	$I_C=400\text{A}, V_{CE}=300\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Goff}=3.3\Omega$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	t_f	-	90 210 220	-	ns
Turn-on energy loss per pulse 开通损耗	$I_C=400\text{A}, V_{CE}=300\text{V}$ $V_{GE}=-8\text{V}/15\text{V}$ $R_{Gon}=1.8\Omega$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	E_{on}	-	1.73 3.80 4.30	-	mJ
Turn-off energy loss per pulse 关断损耗	$I_C=400\text{A}, V_{CE}=300\text{V},$ $V_{GE}=-8\text{V} / 15\text{V}, L_c=25\text{nH}$ $V_{GE}=-8\text{V}/15\text{V}, R_{Goff}=3.3\Omega$	$T_{vj}=25^{\circ}\text{C}$ $T_{vj}=125^{\circ}\text{C}$ $T_{vj}=150^{\circ}\text{C}$	E_{off}	-	14.8 17.8 18.2	-	mJ

SC Data 短路耐量	$V_{CE}=300V$, $V_{GE}=15V/-8V$, $T_{vj}=150^{\circ}C$	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		$T_{vj op}$	-40	-	150	$^{\circ}C$

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	$T_{vj}=25^{\circ}C$	V_{RRM}	750	V
Continuous DC Forward Current 可连续正向直流电流		I_F	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 正向通态压降	$I_F=400A$, $V_{GE}=0V$ $I_F=400A$, $V_{GE}=0V$ $I_F=400A$, $V_{GE}=0V$	$T_{vj}=25^{\circ}C$ $T_{vj}=125^{\circ}C$ $T_{vj}=150^{\circ}C$	V_F	-	1.55 1.52 1.50	2.2 V
Peak Reverse Recovery Current 反向恢复峰值电流	$I_F=400A$, $V_R=300V$ $-di_F/dt=4800A/\mu s(T_{vj}=150^{\circ}C)$ $V_{GE}=-8V$	$T_{vj}=25^{\circ}C$ $T_{vj}=150^{\circ}C$ $T_{vj}=150^{\circ}C$	I_{RM}	-	250 280 300	- A
Recovery Charge 反向恢复电荷	$I_F=400A$, $V_R=300V$ $-di_F/dt=4800A/\mu s(T_{vj}=150^{\circ}C)$ $V_{GE}=-8V$	$T_{vj}=25^{\circ}C$ $T_{vj}=150^{\circ}C$ $T_{vj}=150^{\circ}C$	Q_R	-	15.0 23.1 27.0	- μC
Reverse Recovery Energy 反向恢复损耗	$I_F=400A$, $V_R=300V$ $-di_F/dt=4800A/\mu s(T_{vj}=150^{\circ}C)$ $V_{GE}=-8V$	$T_{vj}=25^{\circ}C$ $T_{vj}=150^{\circ}C$ $T_{vj}=150^{\circ}C$	E_{rec}	-	4.2 6.9 8.1	- mJ
Thermal Resistance, Junction to Case 结-壳热阻	Per FRD/单个 FRD	R_{thJC}	-	-	0.19	K/W
Temperature under switching conditions 工作温度		$T_{vj op}$	-40	-	150	$^{\circ}C$

NTC-Thermistor/ NTC-热敏电阻

Characteristic Values / 性能参数

			min.	typ.	max.	
Rated Resistance 标称电阻	$T_{vj}=25^{\circ}\text{C}$	R_{25}	-	5	-	K Ω
Deviation of R100 R100 偏移值	$T_c=100^{\circ}\text{C}$, $R_{100}=481\Omega$	$\Delta R/R$	-5	-	5	%
Power Dissipation 功率耗散	$T_c=25^{\circ}\text{C}$	P_{25}	-	-	10	mW
B-Value B 值	$R_2=R_{25} \exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$	$B_{25/50}$	-	3380	-	K
B-Value B 值	$R_2=R_{25} \exp[B_{25/80}(1/T_2-1/(298.15\text{K}))]$	$B_{25/80}$	-	3440	-	

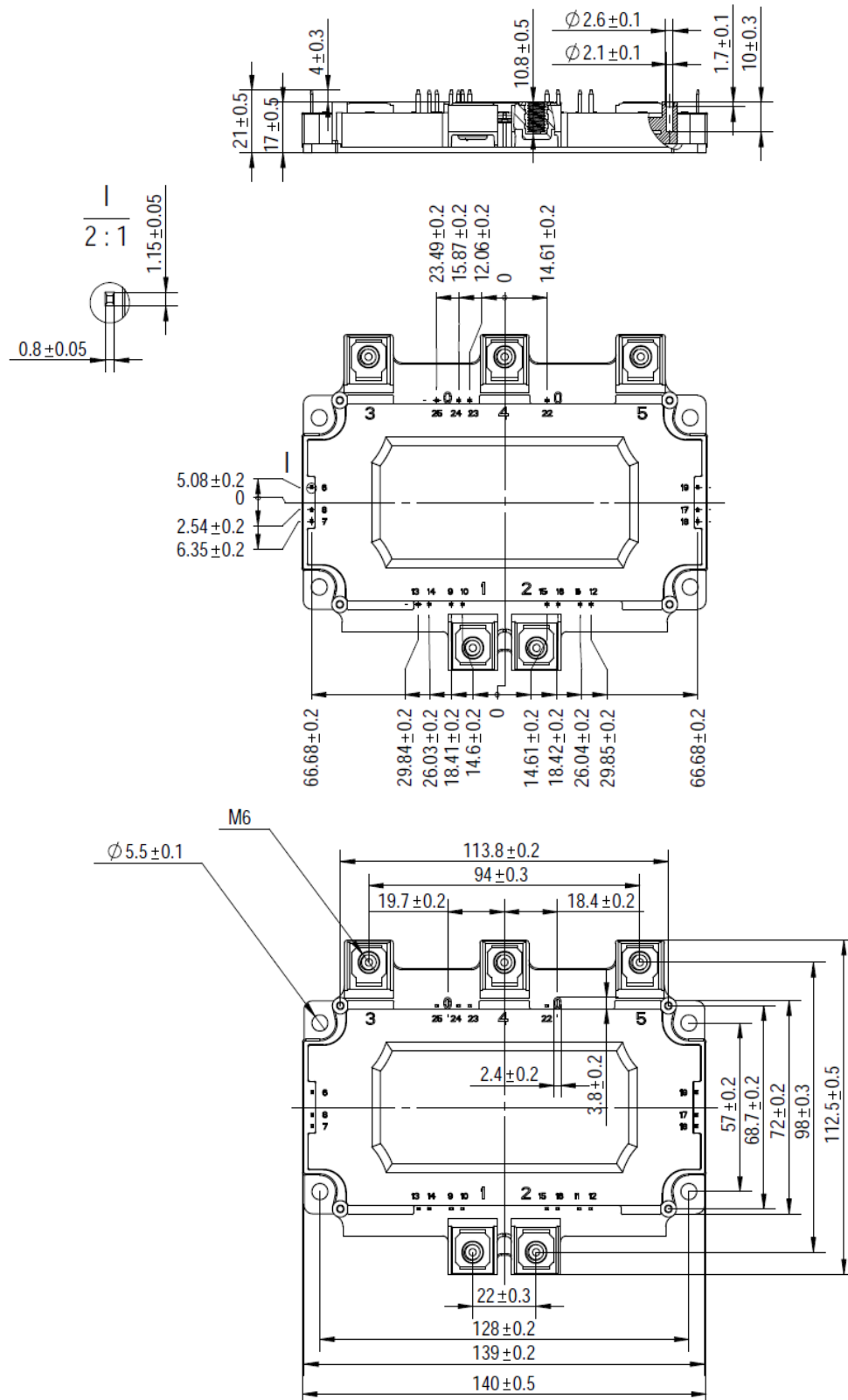
Module / 模块

Isolation Test Voltage 绝缘测试电压	RMS, f=50Hz, t=3s	V_{ISOL}	3.0	KV
Material of Module Baseplate 模块底板材料			Cu	
Internal Isolation 内部绝缘			Al_2O_3	
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	

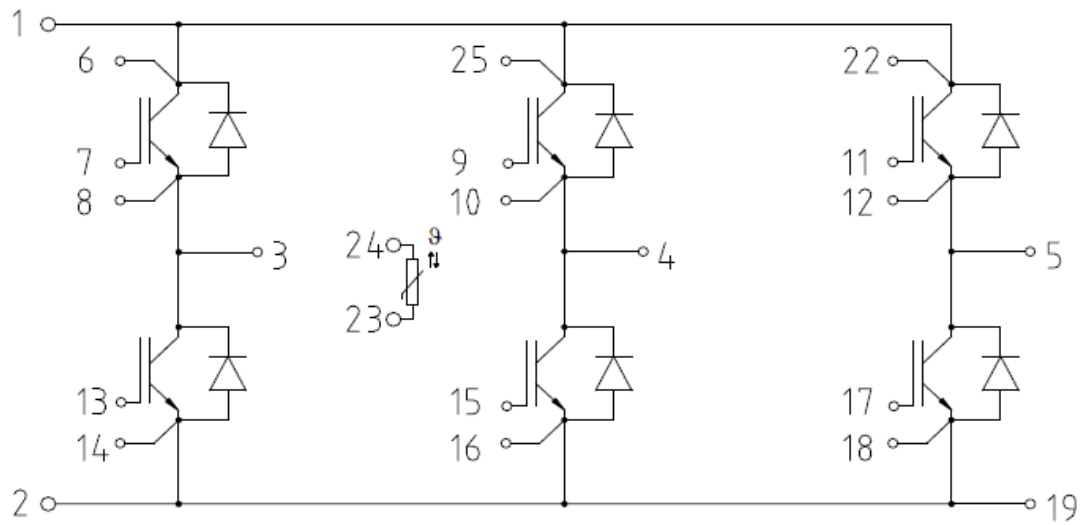
			min.	typ.	max.	
Stray Inductance Module 模块杂散电感		L_{sCE}	-	30	-	nH
Module Lead Resistance, Terminals-Chip 模块引脚电阻, 端子-芯片	$T_c=25^{\circ}\text{C}$, Per Switch	R_{CC+EE}	-	1.00	-	m Ω
Storage Temperature 贮存温度		T_{stg}	-40	-	125	$^{\circ}\text{C}$
Mounting Torque for Module Mounting 模块安装力矩	Screw M5 / M5 螺丝	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	-	460	-	g

Package Dimension / 封装尺寸

Dimensions in Millimeters / 毫米为单位



Internal Circuit / 内部电路

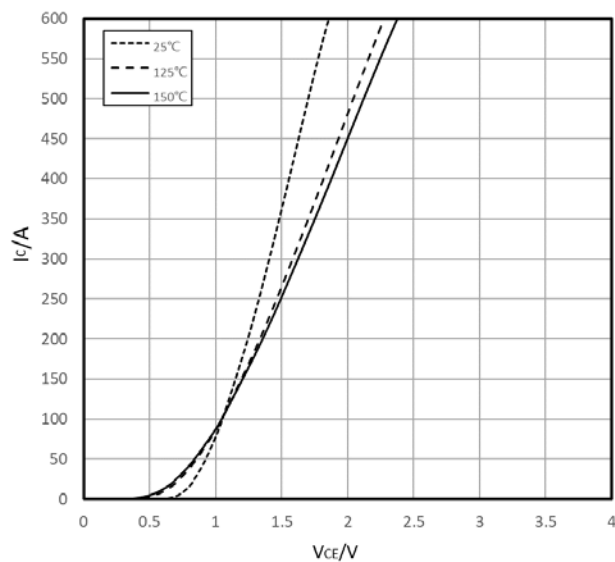


Circuit Diagram / 曲线图

Output characteristic IGBT, Inverter(typical)

输出特性, 逆变IGBT

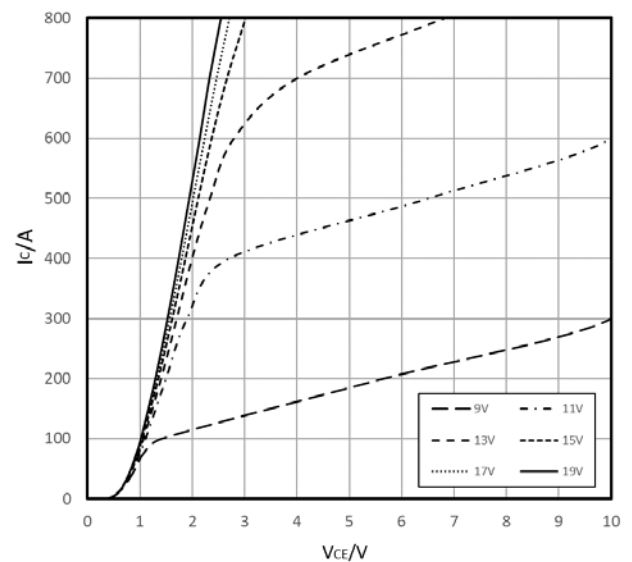
$I_c = f(V_{CE})$, $V_{GE} = 15V$



Output characteristic IGBT, Inverter(typical)

输出特性, 逆变IGBT

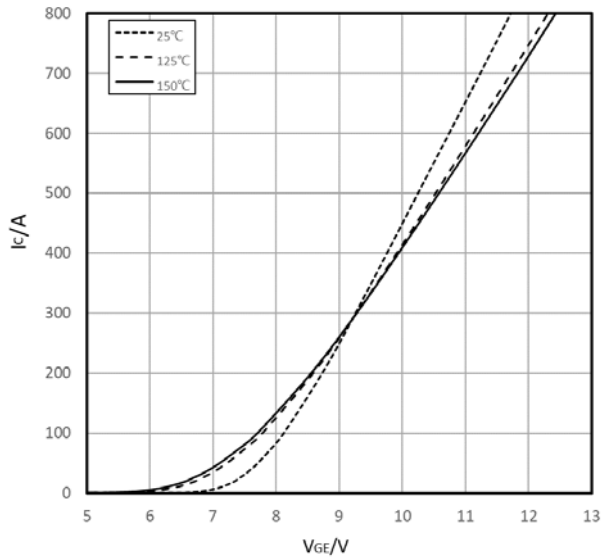
$I_c = f(V_{CE})$, $T_{vj} = 150^\circ C$



Transfer characteristic IGBT, Inverter(typical)

转移特性, 逆变IGBT

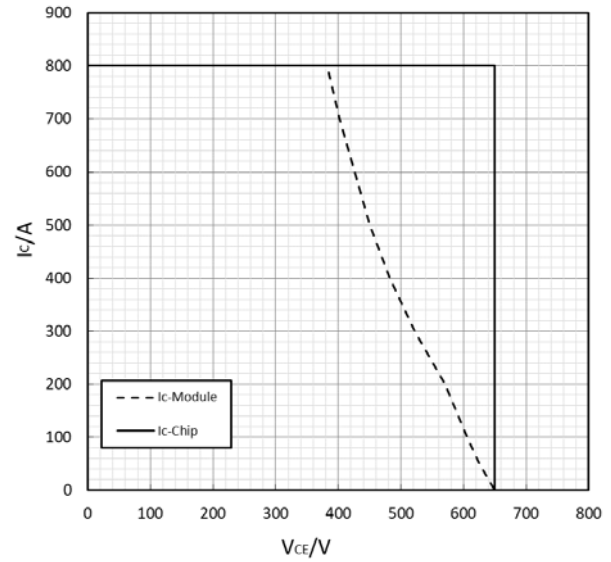
$I_C = f(V_{GE})$, $V_{CE} = 20V$



Reverse bias safe operating area IGBT, Inverter, (RBSOA)

RBSOA, 逆变IGBT

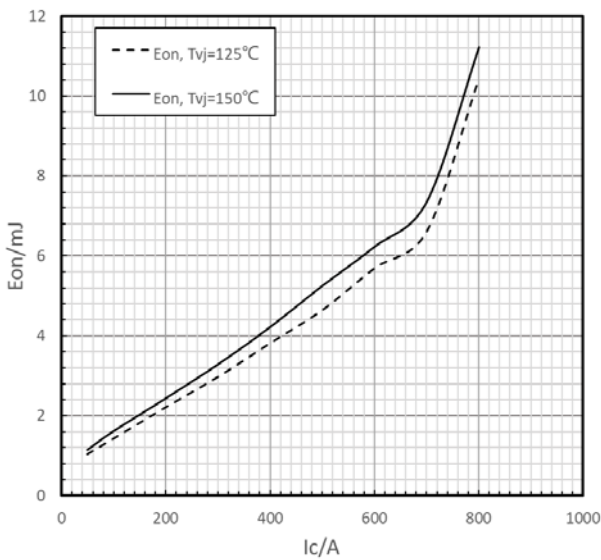
$I_C = f(V_{CE})$, $T_{vj} = 150^\circ\text{C}$, $V_{GE} = +15V/-8V$



Turn-on loss IGBT, Inverter,(typical)

开通损耗, 逆变IGBT

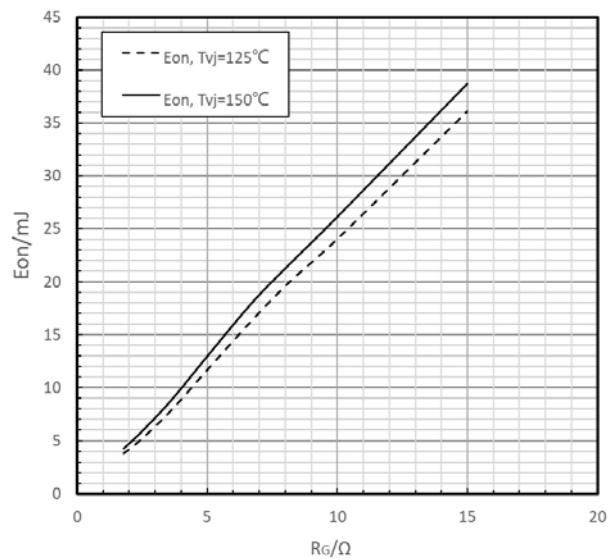
$E_{on} = f(I_C)$, $V_{GE} = +15V/-8V$, $R_{gon} = 1.8\Omega$, $V_{CE} = 300V$



Turn-on loss IGBT, Inverter,(typical)

开通损耗, 逆变IGBT

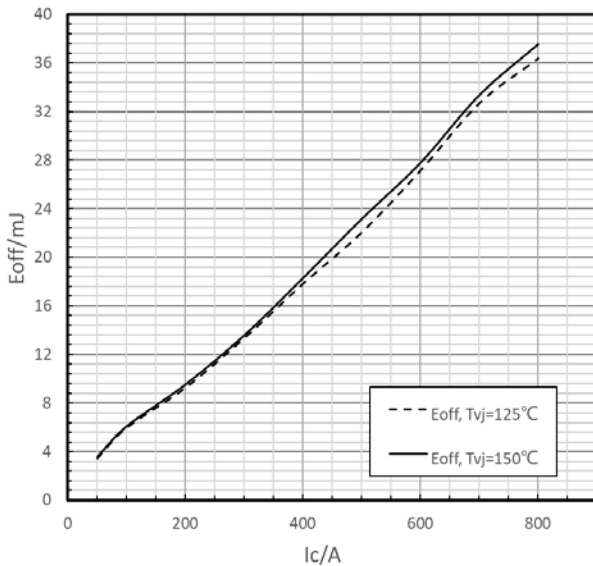
$E_{on} = f(R_g)$, $V_{GE} = +15V/-8V$, $I_C = 400A$, $V_{CE} = 300V$



Turn-off loss IGBT, Inverter,(typical)

关断损耗, 逆变IGBT

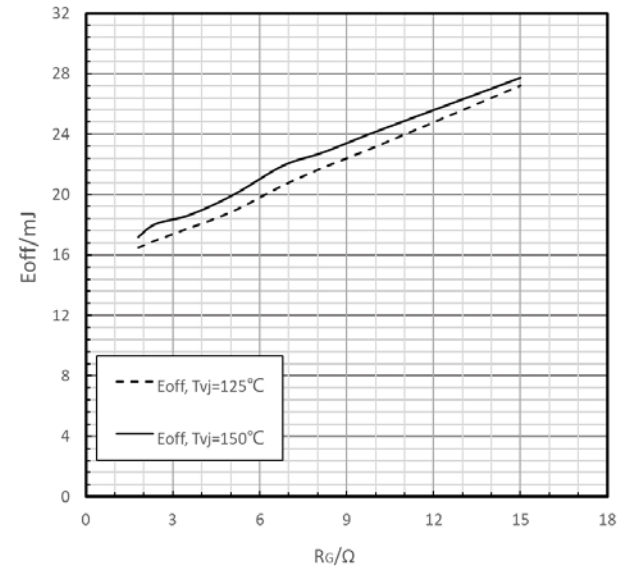
$$E_{off}=f(I_C), V_{GE}=+15V/-8V, R_{goff}=3.3\Omega, V_{CE}=300V$$



Turn-off loss IGBT, Inverter,(typical)

关断损耗, 逆变IGBT

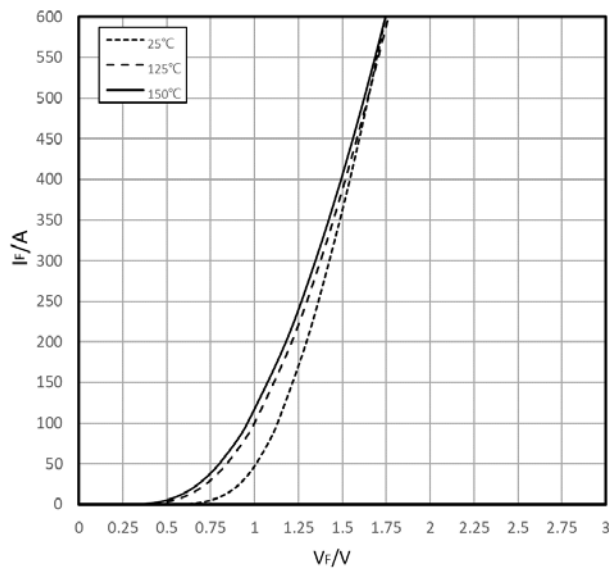
$$E_{off}=f(R_g), V_{GE}=+15V/-8V, I_C=400A, V_{CE}=300V$$



Output characteristic FRD, Inverter(typical)

输出特性, 逆变FRD

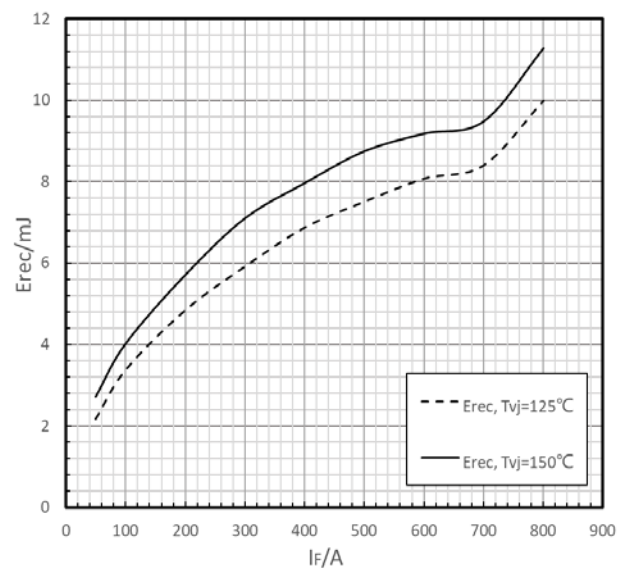
$$I_F=f(V_F)$$



Switching loss FRD, Inverter, (typical)

反向恢复损耗, 逆变FRD

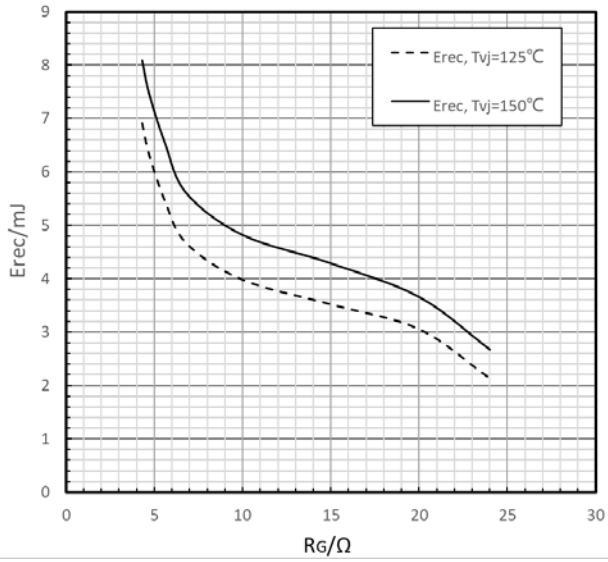
$$E_{rec}=f(I_F), R_{gon}=1.8\Omega, V_{CE}=300V$$



Switching loss FRD, Inverter, (typical)

反向恢复损耗，逆变FRD

$$E_{rec}=f(R_G), I_F=400A, V_{CE}=300V$$



NTC Thermistor

NTC 热敏电阻

$$R=f(T)$$

