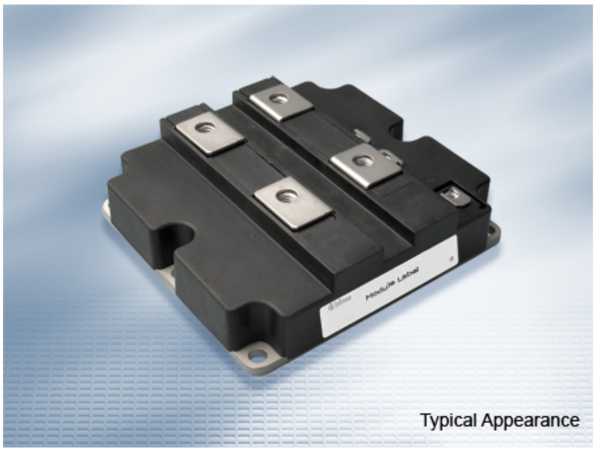
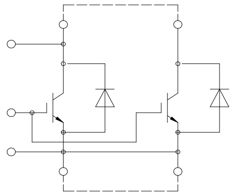
# 技术信息 / Technical Information

IGBT-模块
IGBT-Module

# FZ1600R17HP4_B2

IHM-B 模块 采用第四代沟槽栅/场终止IGBT4和发射极控制二极管
IHM-B module with Trench/Fieldstop IGBT4 and Emitter Controlled diode


Typical Appearance



external connection
(to be done)

$V_{CES}$ = 1700V
$I_{C\ nom}$ = 1600A / $I_{CRM}$ = 3200A

### 典型应用
- 谐振逆变器应用
- 大功率变流器
- 牵引变流器
- 风力发电机

### Typical Applications
- Resonant inverter applications
- High power converters
- Traction drives
- Wind turbines

### 电气特性
- 提高工作结温 $T_{vj\ op}$
- 低 $V_{CEsat}$
- 增大的二极管针对反馈运行模式

### Electrical Features
- Extended operating temperature $T_{vj\ op}$
- Low $V_{CEsat}$
- Enlarged diode for regenerative operation

### 机械特性
- 4 kV 交流 1分钟 绝缘
- 碳化硅铝（AlSiC）基板提供更高的温度循环能力
- 封装的 CTI > 400
- 高爬电距离和电气间隙
- 高功率循环和温度循环能力
- 高功率密度
- IHM B 封装

### Mechanical Features
- 4 kV AC 1min insulation
- AlSiC base plate for increased thermal cycling capability
- Package with CTI > 400
- High creepage and clearance distances
- High power and thermal cycling capability
- High power density
- IHM B housing

## Module Label Code

**Barcode Code 128**

00000123456000000000000

**DMX - Code**

| Content of the Code | Digit |
|---|---|
| Module Serial Number | 1 - 5 |
| Module Material Number | 6 - 11 |
| Production Order Number | 12 - 19 |
| Datecode (Production Year) | 20 - 21 |
| Datecode (Production Week) | 22 - 23 |

| | | |
|---|---|---|
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# 技术信息 / Technical Information

IGBT-模块
IGBT-Module

**FZ1600R17HP4_B2**

## IGBT, 逆变器 / IGBT,Inverter

### 最大额定值 / Maximum Rated Values

| | | | | |
|---|---|---|---|---|
| 集电极 - 发射极电压<br>Collector-emitter voltage | $T_{vj}$ = 25°C | $V_{CES}$ | 1700 | V |
| 连续集电极直流电流<br>Continuous DC collector current | $T_C$ = 100°C, $T_{vj\,max}$ = 175°C | $I_{C\,nom}$ | 1600 | A |
| 集电极重复峰值电流<br>Repetitive peak collector current | $t_P$ = 1 ms | $I_{CRM}$ | 3200 | A |
| 总功率损耗<br>Total power dissipation | $T_C$ = 25°C, $T_{vj\,max}$ = 175°C | $P_{tot}$ | 10,5 | kW |
| 栅极 - 发射极峰值电压<br>Gate-emitter peak voltage | | $V_{GES}$ | +/-20 | V |

### 特征值 / Characteristic Values

| | | | | min. | typ. | max. | |
|---|---|---|---|---|---|---|---|
| 集电极 - 发射极饱和电压<br>Collector-emitter saturation voltage | $I_C$ = 1600 A, $V_{GE}$ = 15 V<br>$I_C$ = 1600 A, $V_{GE}$ = 15 V<br>$I_C$ = 1600 A, $V_{GE}$ = 15 V | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $V_{CE\,sat}$ | | 1,90<br>2,30<br>2,40 | 2,25 | V<br>V<br>V |
| 栅极阈值电压<br>Gate threshold voltage | $I_C$ = 64,0 mA, $V_{CE}$ = $V_{GE}$, $T_{vj}$ = 25°C | | $V_{GEth}$ | 5,20 | 5,80 | 6,40 | V |
| 栅极电荷<br>Gate charge | $V_{GE}$ = -15 V ... +15 V | | $Q_G$ | | 17,0 | | µC |
| 内部栅极电阻<br>Internal gate resistor | $T_{vj}$ = 25°C | | $R_{Gint}$ | | 0,97 | | Ω |
| 输入电容<br>Input capacitance | f = 1 MHz, $T_{vj}$ = 25°C, $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | | $C_{ies}$ | | 130 | | nF |
| 反向传输电容<br>Reverse transfer capacitance | f = 1 MHz, $T_{vj}$ = 25°C, $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | | $C_{res}$ | | 4,20 | | nF |
| 集电极-发射极截止电流<br>Collector-emitter cut-off current | $V_{CE}$ = 1700 V, $V_{GE}$ = 0 V, $T_{vj}$ = 25°C | | $I_{CES}$ | | | 5,0 | mA |
| 栅极-发射极漏电流<br>Gate-emitter leakage current | $V_{CE}$ = 0 V, $V_{GE}$ = 20 V, $T_{vj}$ = 25°C | | $I_{GES}$ | | | 400 | nA |
| 开通延迟时间(电感负载)<br>Turn-on delay time, inductive load | $I_C$ = 1600 A, $V_{CE}$ = 900 V<br>$V_{GE}$ = ±15 V<br>$R_{Gon}$ = 0,6 Ω | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $t_{d\,on}$ | | 0,52<br>0,59<br>0,65 | | µs<br>µs<br>µs |
| 上升时间(电感负载)<br>Rise time, inductive load | $I_C$ = 1600 A, $V_{CE}$ = 900 V<br>$V_{GE}$ = ±15 V<br>$R_{Gon}$ = 0,6 Ω | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $t_r$ | | 0,14<br>0,15<br>0,155 | | µs<br>µs<br>µs |
| 关断延迟时间(电感负载)<br>Turn-off delay time, inductive load | $I_C$ = 1600 A, $V_{CE}$ = 900 V<br>$V_{GE}$ = ±15 V<br>$R_{Goff}$ = 0,6 Ω | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $t_{d\,off}$ | | 1,05<br>1,20<br>1,20 | | µs<br>µs<br>µs |
| 下降时间(电感负载)<br>Fall time, inductive load | $I_C$ = 1600 A, $V_{CE}$ = 900 V<br>$V_{GE}$ = ±15 V<br>$R_{Goff}$ = 0,6 Ω | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $t_f$ | | 0,30<br>0,46<br>0,51 | | µs<br>µs<br>µs |
| 开通损耗能量 (每脉冲)<br>Turn-on energy loss per pulse | $I_C$ = 1600 A, $V_{CE}$ = 900 V, $L_S$ = 50 nH<br>$V_{GE}$ = ±15 V, di/dt = 11000 A/µs ($T_{vj}$ = 150°C)<br>$R_{Gon}$ = 0,6 Ω | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $E_{on}$ | | 240<br>330<br>370 | | mJ<br>mJ<br>mJ |
| 关断损耗能量 (每脉冲 )<br>Turn-off energy loss per pulse | $I_C$ = 1600 A, $V_{CE}$ = 900 V, $L_S$ = 50 nH<br>$V_{GE}$ = ±15 V, du/dt = 3250 V/µs ($T_{vj}$ = 150°C)<br>$R_{Goff}$ = 0,6 Ω | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $E_{off}$ | | 420<br>570<br>600 | | mJ<br>mJ<br>mJ |
| 短路数据<br>SC data | $V_{GE}$ ≤ 15 V, $V_{CC}$ = 1000 V<br>$V_{CEmax}$ = $V_{CES}$ -$L_{sCE}$ ·di/dt | $t_P$ ≤ 10 µs, $T_{vj}$ = 150°C | $I_{SC}$ | | 7500 | | A |
| 结 - 外壳热阻<br>Thermal resistance, junction to case | 每个 IGBT / per IGBT | | $R_{thJC}$ | | | 11,6 | K/kW |
| 外壳 - 散热器热阻<br>Thermal resistance, case to heatsink | 每个 IGBT / per IGBT<br>$\lambda_{Paste}$ = 1 W/(m·K) / $\lambda_{grease}$ = 1 W/(m·K) | | $R_{thCH}$ | | 15,0 | | K/kW |
| 在开关状态下温度<br>Temperature under switching conditions | | | $T_{vj\,op}$ | -40 | | 150 | °C |

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## 二极管,逆变器 / Diode, Inverter

### 最大额定值 / Maximum Rated Values

| | | | | |
|---|---|---|---|---|
| 反向重复峰值电压<br>Repetitive peak reverse voltage | $T_{vj}$ = 25°C | $V_{RRM}$ | 1700 | V |
| 连续正向直流电流<br>Continuous DC forward current | | $I_F$ | 1600 | A |
| 正向重复峰值电流<br>Repetitive peak forward current | $t_P$ = 1 ms | $I_{FRM}$ | 3200 | A |
| I2t-值<br>I²t - value | $V_R$ = 0 V, $t_P$ = 10 ms, $T_{vj}$ = 125°C<br>$V_R$ = 0 V, $t_P$ = 10 ms, $T_{vj}$ = 150°C | $I^2t$ | 630<br>595 | kA²s<br>kA²s |
| 最大损耗功率<br>Maximum power dissipation | $T_{vj}$ = 125°C | $P_{RQM}$ | 2400 | kW |
| 最小开通时间<br>Minimum turn-on time | | $t_{on\ min}$ | 10,0 | µs |

### 特征值 / Characteristic Values

| | | | | min. | typ. | max. | |
|---|---|---|---|---|---|---|---|
| 正向电压<br>Forward voltage | $I_F$ = 1600 A, $V_{GE}$ = 0 V<br>$I_F$ = 1600 A, $V_{GE}$ = 0 V<br>$I_F$ = 1600 A, $V_{GE}$ = 0 V | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $V_F$ | | 1,65<br>1,65<br>1,65 | 2,10 | V<br>V<br>V |
| 反向恢复峰值电流<br>Peak reverse recovery current | $I_F$ = 1600 A, - $di_F/dt$ = 11000 A/µs ($T_{vj}$=150°C)<br>$V_R$ = 900 V<br>$V_{GE}$ = -15 V | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $I_{RM}$ | | 2000<br>2350<br>2400 | | A<br>A<br>A |
| 恢复电荷<br>Recovered charge | $I_F$ = 1600 A, - $di_F/dt$ = 11000 A/µs ($T_{vj}$=150°C)<br>$V_R$ = 900 V<br>$V_{GE}$ = -15 V | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $Q_r$ | | 450<br>740<br>840 | | µC<br>µC<br>µC |
| 反向恢复损耗（每脉冲）<br>Reverse recovery energy | $I_F$ = 1600 A, - $di_F/dt$ = 11000 A/µs ($T_{vj}$=150°C)<br>$V_R$ = 900 V<br>$V_{GE}$ = -15 V | $T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 150°C | $E_{rec}$ | | 300<br>520<br>590 | | mJ<br>mJ<br>mJ |
| 结 - 外壳热阻<br>Thermal resistance, junction to case | 每个二极管 / per diode | | $R_{thJC}$ | | | 15,9 | K/kW |
| 外壳 - 散热器热阻<br>Thermal resistance, case to heatsink | 每个二极管 / per diode<br>$\lambda_{Paste}$ = 1 W/(m·K) / $\lambda_{grease}$ = 1 W/(m·K) | | $R_{thCH}$ | | 16,0 | | K/kW |
| 在开关状态下温度<br>Temperature under switching conditions | | | $T_{vj\ op}$ | -40 | | 150 | °C |

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## 模块 / Module

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 绝缘测试电压<br>Isolation test voltage | RMS, f = 50 Hz, t = 1 min. | $V_{ISOL}$ | | 4,0 | | kV |
| 模块基板材料<br>Material of module baseplate | | | | AlSiC | | |
| 爬电距离<br>Creepage distance | 端子至散热器 / terminal to heatsink<br>端子至端子 / terminal to terminal | | | 32,2<br>32,2 | | mm |
| 电气间隙<br>Clearance | 端子至散热器 / terminal to heatsink<br>端子至端子 / terminal to terminal | | | 19,1<br>19,1 | | mm |
| 相对电痕指数<br>Comperative tracking index | | CTI | | > 400 | | |
| | | | min. | typ. | max. | |
| 杂散电感,模块<br>Stray inductance module | | $L_{sCE}$ | | 9,0 | | nH |
| 模块引线电阻,端子-芯片<br>Module lead resistance, terminals - chip | $T_C$ = 25°C, 每个开关 / per switch | $R_{CC'+EE'}$ | | 0,15 | | mΩ |
| 储存温度<br>Storage temperature | | $T_{stg}$ | -40 | | 150 | °C |
| 模块安装的安装扭距<br>Mounting torque for modul mounting | 螺丝 M6 根据相应的应用手册进行安装<br>Screw M6 - Mounting according to valid application note | M | 4,25 | | 5,75 | Nm |
| 端子联接扭距<br>Terminal connection torque | 螺丝 M4 根据相应的应用手册进行安装<br>Screw M4 - Mounting according to valid application note<br>螺丝 M8 根据相应的应用手册进行安装<br>Screw M8 - Mounting according to valid application note | M | 1,8<br>8,0 | -<br>- | 2,1<br>10 | Nm<br>Nm |
| 重量<br>Weight | | G | | 800 | | g |

| | |
|---|---|
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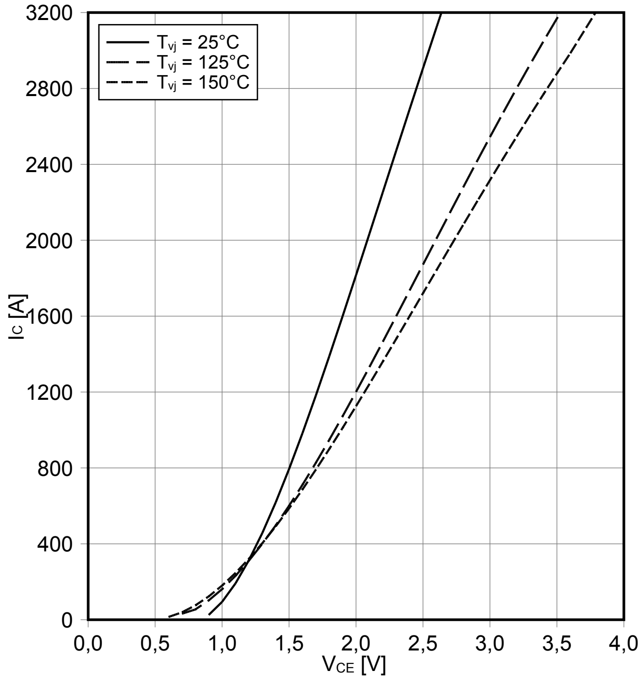
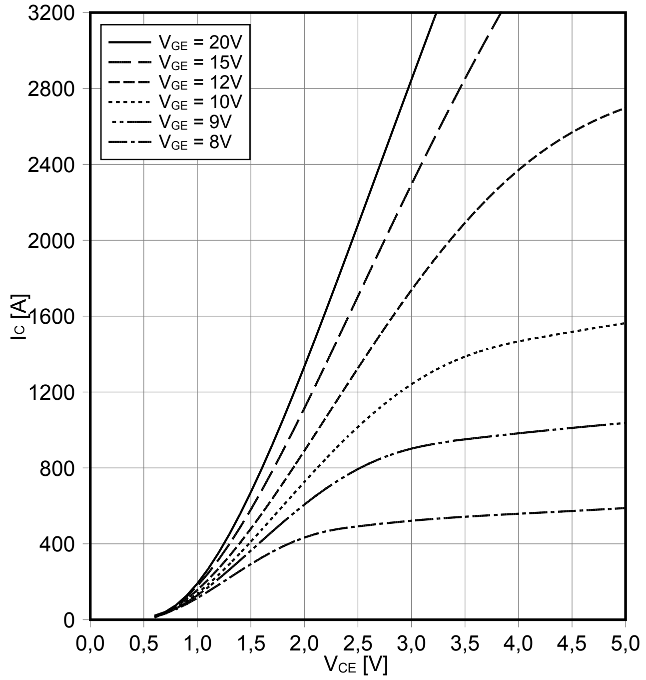
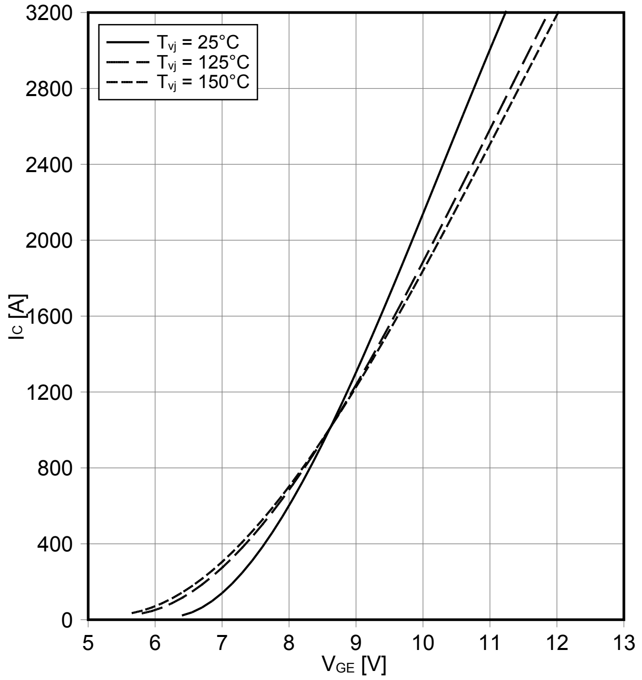
**输出特性 IGBT, 逆变器 （典型)**
**output characteristic IGBT,Inverter (typical)**
$I_C = f(V_{CE})$
$V_{GE} = 15\ V$



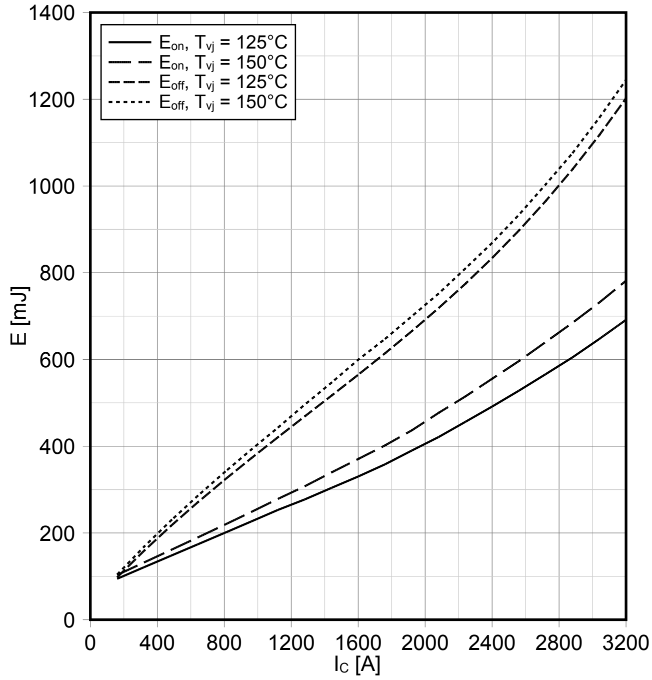

**输出特性 IGBT, 逆变器 （典型)**
**output characteristic IGBT,Inverter (typical)**
$I_C = f(V_{CE})$
$T_{vj} = 150°C$




**传输特性 IGBT, 逆变器 (典型)**
**transfer characteristic IGBT,Inverter (typical)**
$I_C = f(V_{GE})$
$V_{CE} = 20\ V$




**开关损耗 IGBT, 逆变器 （典型)**
**switching losses IGBT,Inverter (typical)**
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
$V_{GE} = \pm 15\ V$, $R_{Gon} = 0.6\ \Omega$, $R_{Goff} = 0.6\ \Omega$, $V_{CE} = 900\ V$

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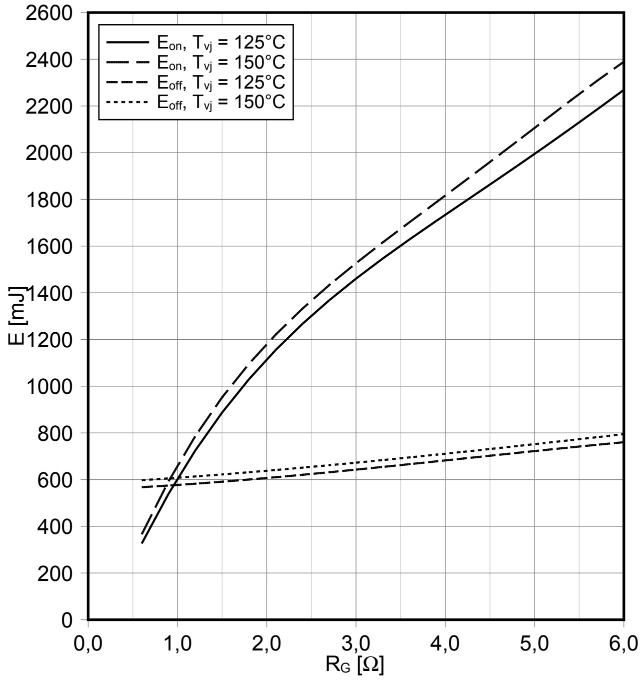
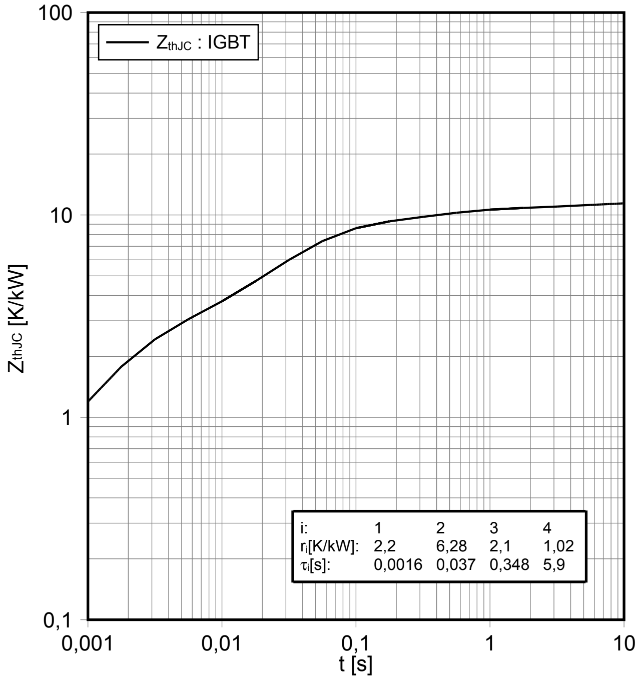
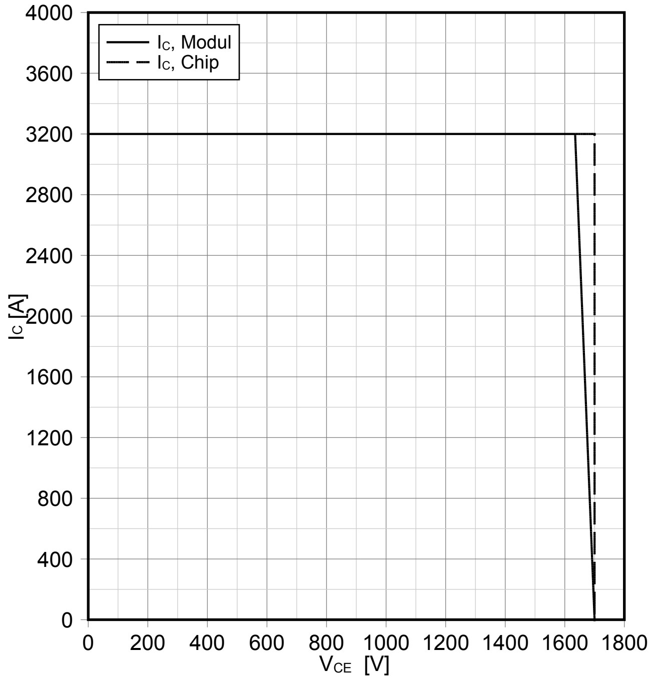
**开关损耗 IGBT, 逆变器 （典型）**
**switching losses IGBT,Inverter (typical)**
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$
$V_{GE} = \pm 15$ V, $I_C = 1600$ A, $V_{CE} = 900$ V



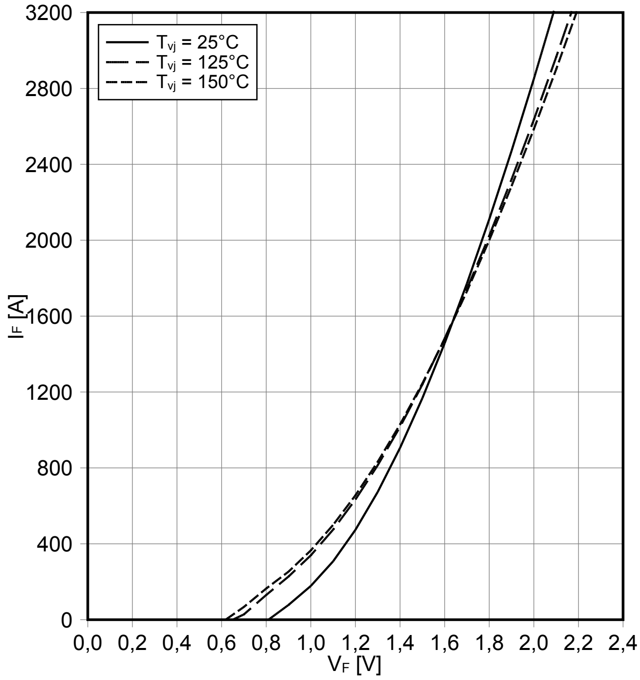

**瞬态热阻抗 IGBT, 逆变器**
**transient thermal impedance IGBT,Inverter**
$Z_{thJC} = f(t)$



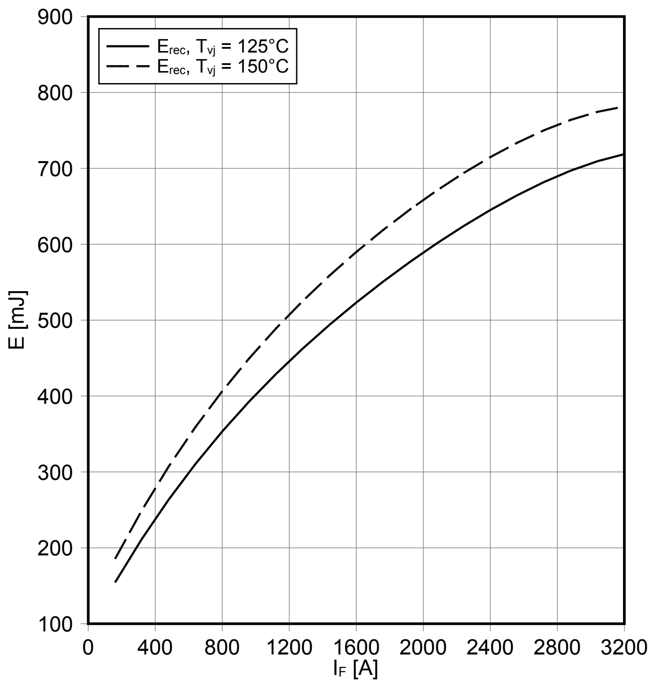

**反偏安全工作区 IGBT, 逆变器 （RBSOA）**
**reverse bias safe operating area IGBT,Inverter (RBSOA)**
$I_C = f(V_{CE})$
$V_{GE} = \pm 15$ V, $R_{Goff} = 0.6\ \Omega$, $T_{vj} = 150°C$



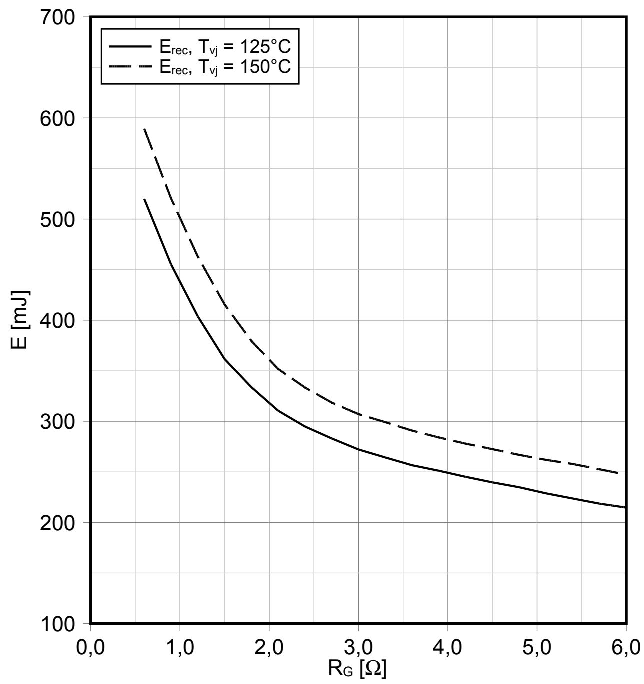

**正向偏压特性 二极管,逆变器 （典型）**
**forward characteristic of Diode, Inverter (typical)**
$I_F = f(V_F)$



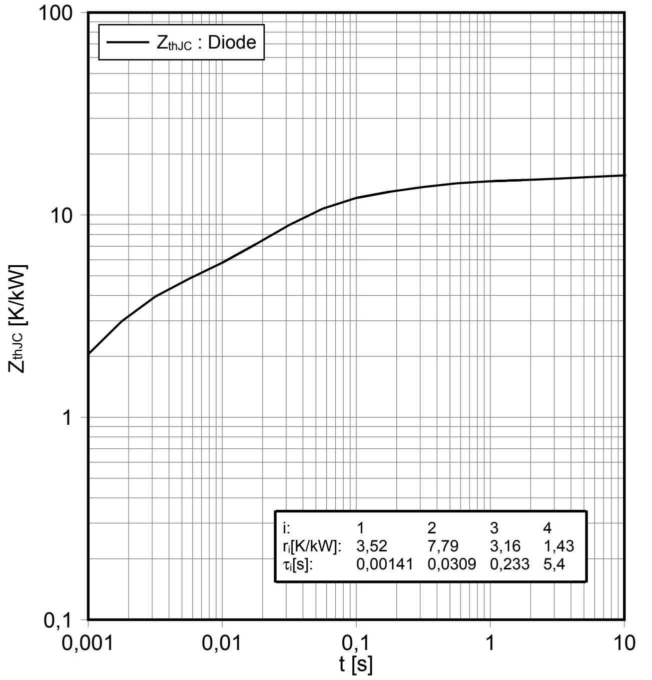
**开关损耗 二极管,逆变器 ( 典型)**
**switching losses Diode, Inverter (typical)**
$E_{rec} = f(I_F)$
$R_{Gon} = 0.6\ \Omega$, $V_{CE} = 900$ V




**开关损耗 二极管,逆变器 ( 典型)**
**switching losses Diode, Inverter (typical)**
$E_{rec} = f(R_G)$
$I_F = 1600$ A, $V_{CE} = 900$ V

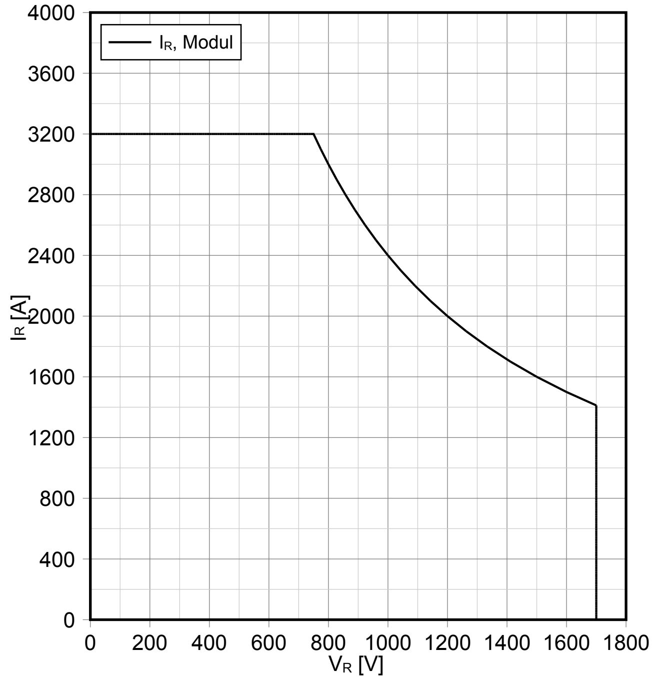



**瞬态热阻抗 二极管,逆变器**
**transient thermal impedance Diode, Inverter**
$Z_{thJC} = f(t)$




| i: | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $r_i$[K/kW]: | 3,52 | 7,79 | 3,16 | 1,43 |
| $\tau_i$[s]: | 0,00141 | 0,0309 | 0,233 | 5,4 |

**安全工作区 二极管,逆变器 (SOA)**
**safe operation area Diode, Inverter (SOA)**
$I_R = f(V_R)$
$T_{vj} = 150$°C

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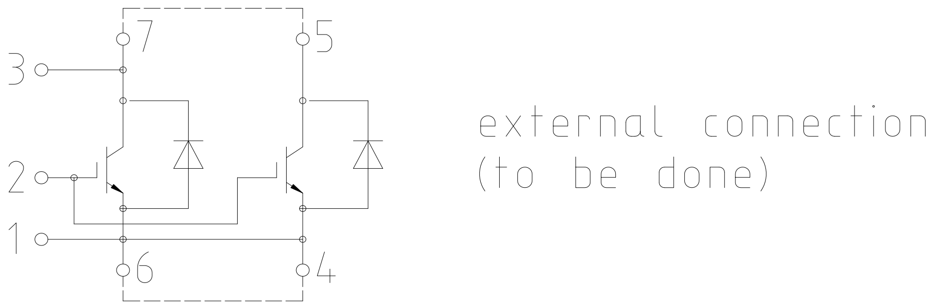
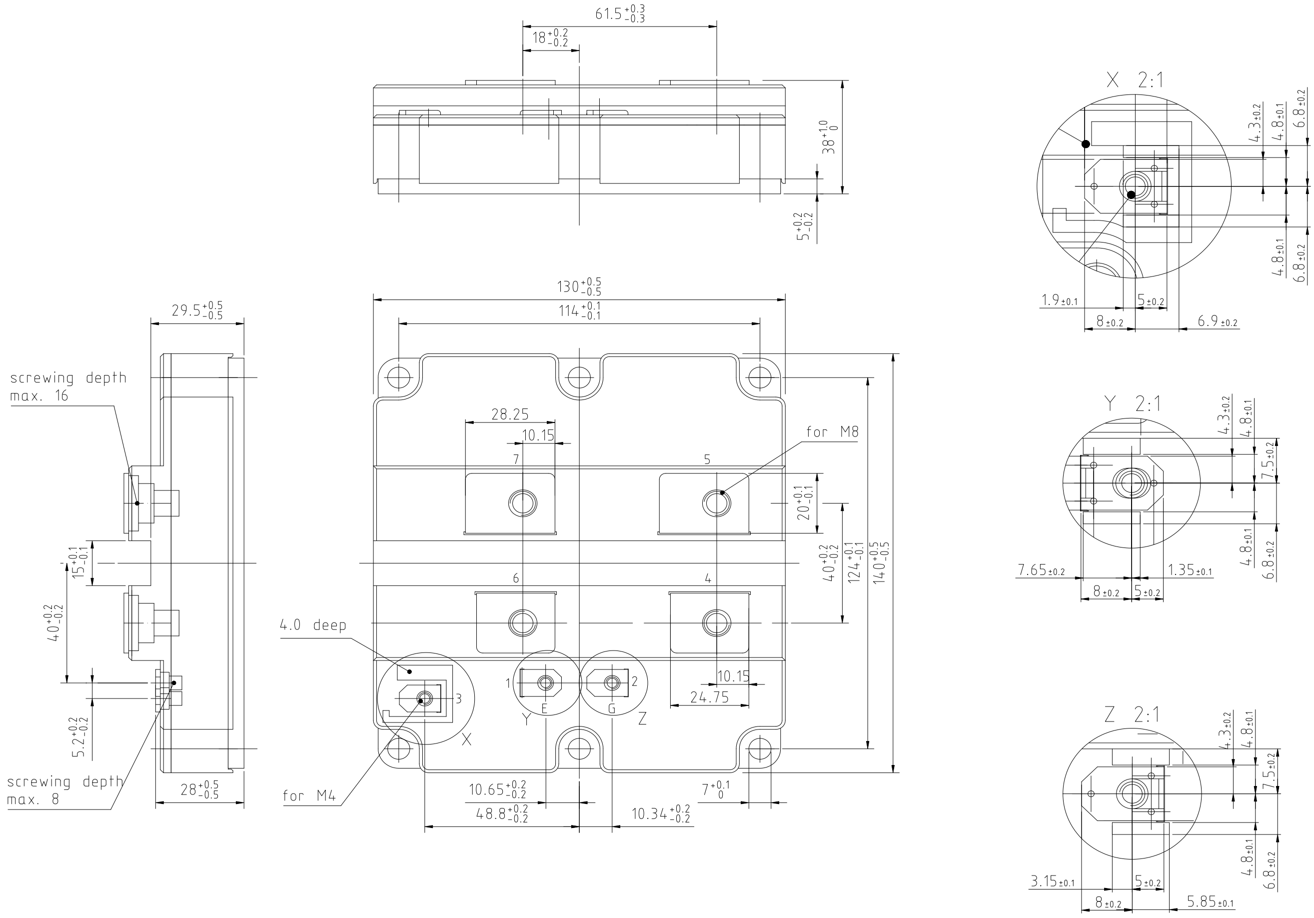
## 接线图 / Circuit diagram




## 封装尺寸 / Package outlines

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## 使用条件和条款

### 重要提示

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