

英飞凌HybridPACK™ DC6 模块

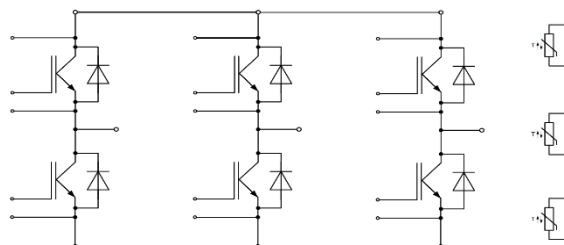
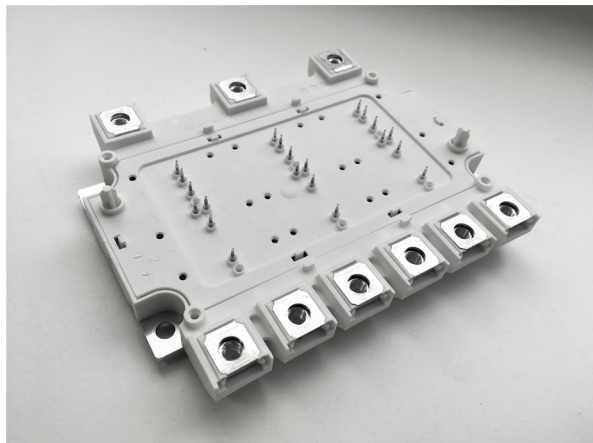
FS650R08A4P2

DC6i 变体

最终数据手册

V3.0, 2020-05-06

## 1 特点/描述


 $V_{CES} = 750 \text{ V}$ 
 $I_C = 650 \text{ A}$ 

### 典型应用

- 汽车应用
- (混合) 电动汽车 (H)EV
- 电机驱动
- 商业性农用车辆
- 针对带DC母线的汽车应用进行了优化  
最高电压达470 V

### 电气特性

- 阻断电压 750V
- 低  $V_{CESat}$
- 低开关损耗
- 低Qg和Crss
- 低杂散电感设计
- $T_{vj op} = 150^\circ\text{C}$
- 短时延长工作温度  
 $T_{vj op} = 175^\circ\text{C}$

### 机械特性

- 2.5kV AC 1min 绝缘
- 高爬电距离和电气间隙
- 紧凑型设计
- 高功率密度
- 带状直接冷却底板
- PCB和冷却器组装的安装指导
- 集成NTC温度传感器
- PressFit 技术
- 符合 RoHS 要求

### 描述

英飞凌 HybridPACK™DC6i 是一款专为混合动力和电动汽车优化的、结构极为紧凑的六相全桥模块

(750V/650A)。该功率模块采用了新一代 EDT2 IGBT，这是一种针对电力传动系统应用进行优化的汽车级微模式沟槽场截止单元设计。该芯片组兼具基准电流密度、短路耐受性以及更高的阻断电压，可在恶劣的环境条件下确保逆变器可靠运行。EDT2 IGBT 还具有出色的轻载功率损耗表现，有助于在实际驾驶周期中提高系统效率。EDT2 IGBT 针对开关频率在 10 kHz 范围内的应用进行了优化。

全新 HybridPACK™DC6i 功率模块系列配备机械安装指导，方便客户轻松装配。此外，信号端子采用压接引脚，避免了额外耗时的选择性焊接工艺，从而节省了系统成本并提高了系统可靠性。FS650R08A4P2 产品采用带PinFin结构的直冷底板，最大程度地利用了所采用的芯片组并展现出卓越的了冷却性能。由于电气间隙和爬电距离较大，该模块系列非常适合更高的系统工作电压，并支持模块化逆变器方案

| Product Name | Ordering Code |
|--------------|---------------|
| FS650R08A4P2 | SP001714512   |

## 2 IGBT、逆变器

### 2.1 最大额定值

| Parameter                         | Conditions                                                      | Symbol             | Value             | Unit |
|-----------------------------------|-----------------------------------------------------------------|--------------------|-------------------|------|
| Collector-emitter voltage         | $T_{vj} = 25^{\circ}\text{C}$                                   | $V_{CES}$          | 750               | V    |
| Implemented collector current     |                                                                 | $I_{CN}$           | 650               | A    |
| Continuous DC collector current   | $T_F = 65^{\circ}\text{C}$ , $T_{vj\max} = 175^{\circ}\text{C}$ | $I_{C\text{ nom}}$ | 375 <sup>1)</sup> | A    |
| Repetitive peak collector current | $t_P = 1\text{ ms}$                                             | $I_{CRM}$          | 1300              | A    |
| Total power dissipation           | $T_F = 75^{\circ}\text{C}$ , $T_{vj\max} = 175^{\circ}\text{C}$ | $P_{\text{tot}}$   | 488 <sup>1)</sup> | W    |
| Gate-emitter peak voltage         |                                                                 | $V_{GES}$          | +/-20             | V    |

### 2.2 特征值

|                                               |                                                                                                                                                                                                                                                                                   |                                                                                                                                                                      | min.                | typ.       | max.                                 |                          |                    |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|--------------------------------------|--------------------------|--------------------|
| Collector-emitter saturation voltage          | $I_C = 375\text{ A}$ , $V_{GE} = 15\text{ V}$<br>$I_C = 375\text{ A}$ , $V_{GE} = 15\text{ V}$<br>$I_C = 375\text{ A}$ , $V_{GE} = 15\text{ V}$<br>$I_C = 650\text{ A}$ , $V_{GE} = 15\text{ V}$<br>$I_C = 650\text{ A}$ , $V_{GE} = 15\text{ V}$                                 | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$ | $V_{CE\text{ sat}}$ |            | 1.10<br>1.15<br>1.15<br>1.30<br>1.45 | 1.35                     | V                  |
| Gate threshold voltage                        | $I_C = 11.5\text{ mA}$ , $V_{CE} = V_{GE}$                                                                                                                                                                                                                                        | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                                                      | $V_{GEth}$          | 4.90       | 5.80<br>4.10                         | 6.50                     | V                  |
| Gate charge                                   | $V_{GE} = -8\text{ V} \dots 15\text{ V}$ , $V_{CE} = 400\text{ V}$                                                                                                                                                                                                                |                                                                                                                                                                      | $Q_G$               |            | 3.55                                 |                          | $\mu\text{C}$      |
| Internal gate resistor                        |                                                                                                                                                                                                                                                                                   | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                        | $R_{Gint}$          |            | 1.0                                  |                          | $\Omega$           |
| Input capacitance                             | $f = 1\text{ MHz}$ , $V_{CE} = 50\text{ V}$ , $V_{GE} = 0\text{ V}$                                                                                                                                                                                                               | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                        | $C_{ies}$           |            | 65.0                                 |                          | nF                 |
| Output capacitance                            | $f = 1\text{ MHz}$ , $V_{CE} = 50\text{ V}$ , $V_{GE} = 0\text{ V}$                                                                                                                                                                                                               | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                        | $C_{oes}$           |            | 0.83                                 |                          | nF                 |
| Reverse transfer capacitance                  | $f = 1\text{ MHz}$ , $V_{CE} = 50\text{ V}$ , $V_{GE} = 0\text{ V}$                                                                                                                                                                                                               | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                        | $C_{res}$           |            | 0.25                                 |                          | nF                 |
| Collector-emitter cut-off current             | $V_{CE} = 750\text{ V}$ , $V_{GE} = 0\text{ V}$                                                                                                                                                                                                                                   | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                        | $I_{CES}$           |            |                                      | 1.0                      | mA                 |
| Gate-emitter leakage current                  | $V_{CE} = 0\text{ V}$ , $V_{GE} = 20\text{ V}$                                                                                                                                                                                                                                    | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                                        | $I_{GES}$           |            |                                      | 400                      | nA                 |
| Turn-on delay time, inductive load            | $I_C = 375\text{ A}$ , $V_{CE} = 400\text{ V}$<br>$V_{GE} = -8\text{ V} / +15\text{ V}$<br>$R_{Gon} = 2.4\ \Omega$                                                                                                                                                                | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $t_{don}$           |            | 0.30<br>0.32<br>0.33                 |                          | $\mu\text{s}$      |
| Rise time, inductive load                     | $I_C = 375\text{ A}$ , $V_{CE} = 400\text{ V}$<br>$V_{GE} = -8\text{ V} / +15\text{ V}$<br>$R_{Gon} = 2.4\ \Omega$                                                                                                                                                                | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $t_r$               |            | 0.07<br>0.08<br>0.08                 |                          | $\mu\text{s}$      |
| Turn-off delay time, inductive load           | $I_C = 375\text{ A}$ , $V_{CE} = 400\text{ V}$<br>$V_{GE} = -8\text{ V} / +15\text{ V}$<br>$R_{Goff} = 5.1\ \Omega$                                                                                                                                                               | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $t_{doff}$          |            | 0.80<br>0.88<br>0.92                 |                          | $\mu\text{s}$      |
| Fall time, inductive load                     | $I_C = 375\text{ A}$ , $V_{CE} = 400\text{ V}$<br>$V_{GE} = -8\text{ V} / +15\text{ V}$<br>$R_{Goff} = 5.1\ \Omega$                                                                                                                                                               | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $t_f$               |            | 0.06<br>0.07<br>0.08                 |                          | $\mu\text{s}$      |
| Turn-on energy loss per pulse                 | $I_C = 375\text{ A}$ , $V_{CE} = 400\text{ V}$ , $L_S = 20\text{ nH}$<br>$V_{GE} = -8\text{ V} / +15\text{ V}$<br>$R_{Gon} = 2.4\ \Omega$<br>$di/dt (T_{vj} 25^{\circ}\text{C}) = 7000\text{ A}/\mu\text{s}$<br>$di/dt (T_{vj} 175^{\circ}\text{C}) = 4000\text{ A}/\mu\text{s}$  | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $E_{on}$            |            | 8.00<br>11.5<br>13.0                 |                          | mJ                 |
| Turn-off energy loss per pulse                | $I_C = 375\text{ A}$ , $V_{CE} = 400\text{ V}$ , $L_S = 20\text{ nH}$<br>$V_{GE} = -8\text{ V} / +15\text{ V}$<br>$R_{Goff} = 5.1\ \Omega$<br>$dv/dt (T_{vj} 25^{\circ}\text{C}) = 3800\text{ V}/\mu\text{s}$<br>$dv/dt (T_{vj} 175^{\circ}\text{C}) = 3300\text{ V}/\mu\text{s}$ | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $E_{off}$           |            | 18.0<br>23.5<br>24.5                 |                          | mJ                 |
| SC data                                       | $V_{GE} \leq 15\text{ V}$ , $V_{CC} = 400\text{ V}$<br>$V_{CE\max} = V_{CES} - L_{SCE} \cdot di/dt$                                                                                                                                                                               | $t_P \leq 6\ \mu\text{s}$ , $T_{vj} = 25^{\circ}\text{C}$<br>$t_P \leq 3\ \mu\text{s}$ , $T_{vj} = 175^{\circ}\text{C}$                                              | $I_{sc}$            |            | 3900<br>3200                         |                          | A                  |
| Thermal resistance, junction to cooling fluid | per IGBT; $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$ , $T_F = 75^{\circ}\text{C}$                                                                                                                                                                                            |                                                                                                                                                                      | $R_{thJF}$          |            | 0.170 <sup>2)</sup>                  | 0.205 <sup>2)</sup>      | K/W                |
| Temperature under switching conditions        | $t_{op}$ continuous<br>for 10s within a period of 30s, occurrence maximum 3000 times<br>over lifetime                                                                                                                                                                             |                                                                                                                                                                      | $T_{vj\text{ op}}$  | -40<br>150 |                                      | 150 <sup>3)</sup><br>175 | $^{\circ}\text{C}$ |

<sup>1)</sup>通过特性/设计验证，而不是通过测试。

<sup>2)</sup>根据应用笔记 AN-HPDC6i-AN-HP1-DC6i-Assembly-Instructions 设计冷却器并确定流向。冷却液为 50% 水 / 50% 乙二醇。

<sup>3)</sup>当  $T_{vj\text{ op}} > 150^{\circ}\text{C}$  时：底板温度必须限制在  $125^{\circ}\text{C}$ 。

### 3 二极管、逆变器

#### 3.1 最大额定值

| Parameter                       | Conditions                                                                                                                                       | Symbol    | Value             | Unit                                         |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------|----------------------------------------------|
| Repetitive peak reverse voltage | $T_{vj} = 25^{\circ}\text{C}$                                                                                                                    | $V_{RRM}$ | 750               | V                                            |
| Implemented forward current     |                                                                                                                                                  | $I_{FN}$  | 650               | A                                            |
| Continuous DC forward current   |                                                                                                                                                  | $I_F$     | 375 <sup>1)</sup> | A                                            |
| Repetitive peak forward current | $t_P = 1 \text{ ms}$                                                                                                                             | $I_{FRM}$ | 1300              | A                                            |
| $I^2t$ - value                  | $V_R = 0 \text{ V}, t_P = 10 \text{ ms}, T_{vj} = 150^{\circ}\text{C}$<br>$V_R = 0 \text{ V}, t_P = 10 \text{ ms}, T_{vj} = 175^{\circ}\text{C}$ | $I^2t$    | 16500<br>14000    | $\text{A}^2\text{s}$<br>$\text{A}^2\text{s}$ |

#### 3.2 特征值

|                                               |                                                                                                                                                                                                                                         |                                                                                                                                                                      | min.       | typ.                                 | max.                     |                    |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------|--------------------------|--------------------|
| Forward voltage                               | $I_F = 375 \text{ A}, V_{GE} = 0 \text{ V}$<br>$I_F = 375 \text{ A}, V_{GE} = 0 \text{ V}$<br>$I_F = 375 \text{ A}, V_{GE} = 0 \text{ V}$<br>$I_F = 650 \text{ A}, V_{GE} = 0 \text{ V}$<br>$I_F = 650 \text{ A}, V_{GE} = 0 \text{ V}$ | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$ | $V_F$      | 1.45<br>1.35<br>1.30<br>1.70<br>1.60 | 1.65                     | V                  |
| Peak reverse recovery current                 | $I_F = 375 \text{ A}, -di_F/dt = 4000 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$<br>$V_R = 400 \text{ V}$<br>$V_{GE} = -8 \text{ V}$                                                                                         | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $I_{RM}$   | 205<br>320<br>345                    |                          | A                  |
| Recovered charge                              | $I_F = 375 \text{ A}, -di_F/dt = 4000 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$<br>$V_R = 400 \text{ V}$<br>$V_{GE} = -8 \text{ V}$                                                                                         | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $Q_r$      | 24.5<br>47.5<br>56.0                 |                          | $\mu\text{C}$      |
| Reverse recovery energy                       | $I_F = 375 \text{ A}, -di_F/dt = 4000 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$<br>$V_R = 400 \text{ V}$<br>$V_{GE} = -8 \text{ V}$                                                                                         | $T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 150^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                                                    | $E_{rec}$  | 8.60<br>16.0<br>19.0                 |                          | mJ                 |
| Thermal resistance, junction to cooling fluid | per diode; $\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}, T_F = 75^{\circ}\text{C}$                                                                                                                                                   | $R_{thJF}$                                                                                                                                                           |            | 0.230 <sup>2)</sup>                  | 0.275 <sup>2)</sup>      | K/W                |
| Temperature under switching conditions        | $t_{op}$ continuous<br>for 10s within a period of 30s, occurrence maximum 3000 times<br>over lifetime                                                                                                                                   | $T_{vj op}$                                                                                                                                                          | -40<br>150 |                                      | 150 <sup>3)</sup><br>175 | $^{\circ}\text{C}$ |

### 4 NTC-热敏电阻

|                        |                                                                |              | min. | typ.  | max. |                  |
|------------------------|----------------------------------------------------------------|--------------|------|-------|------|------------------|
| Parameter              | Conditions                                                     | Symbol       |      | Value |      | Unit             |
| Rated resistance       | $T_C = 25^{\circ}\text{C}$                                     | $R_{25}$     |      | 5.00  |      | $\text{k}\Omega$ |
| Deviation of $R_{100}$ | $T_C = 100^{\circ}\text{C}, R_{100} = 493 \Omega$              | $\Delta R/R$ | -5   |       | 5    | %                |
| Power dissipation      | $T_C = 25^{\circ}\text{C}$                                     | $P_{25}$     |      |       | 20.0 | mW               |
| B-value                | $R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$  | $B_{25/50}$  |      | 3375  |      | K                |
| B-value                | $R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298,15 \text{ K}))]$  | $B_{25/80}$  |      | 3411  |      | K                |
| B-value                | $R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298,15 \text{ K}))]$ | $B_{25/100}$ |      | 3433  |      | K                |

根据应用手册标定

<sup>1)</sup>通过特性/设计验证，而不是通过测试。

<sup>2)</sup>根据应用笔记 AN-HPDC6i-AN-HP1-DC6i-Assembly-Instructions 设计冷却器并确定流向。冷却液为 50% 水 / 50% 乙二醇。

<sup>3)</sup>当  $T_{vj op} > 150^{\circ}\text{C}$  时：底板温度必须限制在  $125^{\circ}\text{C}$ 。

## 5 模块

| Parameter                           | Conditions                                                                            | Symbol             | Value                                        |                  | Unit              |
|-------------------------------------|---------------------------------------------------------------------------------------|--------------------|----------------------------------------------|------------------|-------------------|
| Isolation test voltage              | RMS, f = 50 Hz, t = 1 min                                                             | V <sub>ISOL</sub>  | 2.5                                          |                  | kV                |
| Material of module baseplate        |                                                                                       |                    | Cu/Ni/Al <sup>1)</sup>                       |                  |                   |
| Internal isolation                  | basic insulation (class 1, IEC 61140)                                                 |                    | Al <sub>2</sub> O <sub>3</sub> <sup>2)</sup> |                  |                   |
| Creepage distance                   | terminal to heatsink<br>terminal to terminal                                          | d <sub>Creep</sub> | 18.2<br>8.2                                  |                  | mm                |
| Clearance                           | terminal to heatsink<br>terminal to terminal                                          | d <sub>Clear</sub> | 18.2<br>5.9                                  |                  | mm                |
| Comperative tracking index          |                                                                                       | CTI                | > 200                                        |                  |                   |
|                                     |                                                                                       |                    | Min.                                         | typ.             | max.              |
| Pressure drop in cooling circuit    | ΔV/Δt = 10.0 dm <sup>3</sup> /min; T <sub>F</sub> = 75°C                              | Δp                 |                                              | 90 <sup>3)</sup> | mbar              |
| Maximum pressure in cooling circuit | T <sub>baseplate</sub> < 40°C<br>T <sub>baseplate</sub> ≥ 40°C<br>(relative pressure) | p                  |                                              |                  | 2.5<br>2.0<br>bar |
| Stray inductance module             |                                                                                       | L <sub>sCE</sub>   |                                              | 15               | nH                |
| Storage temperature                 |                                                                                       | T <sub>stg</sub>   | -40                                          |                  | 125<br>°C         |
| Mounting torque for modul mounting  | Screw M5 baseplate to heatsink                                                        | M                  | 3.00                                         |                  | 6.00<br>Nm        |
| Terminal connection torque          | Screw M5                                                                              | M                  | 3.0                                          | -                | 6.0<br>Nm         |
| Weight                              |                                                                                       | G                  |                                              | 490              | g                 |

<sup>1)</sup> 铜基底板，表面镀镍，并采用铝带键合。

<sup>2)</sup> 改进的Al<sub>2</sub>O<sub>3</sub>陶瓷。

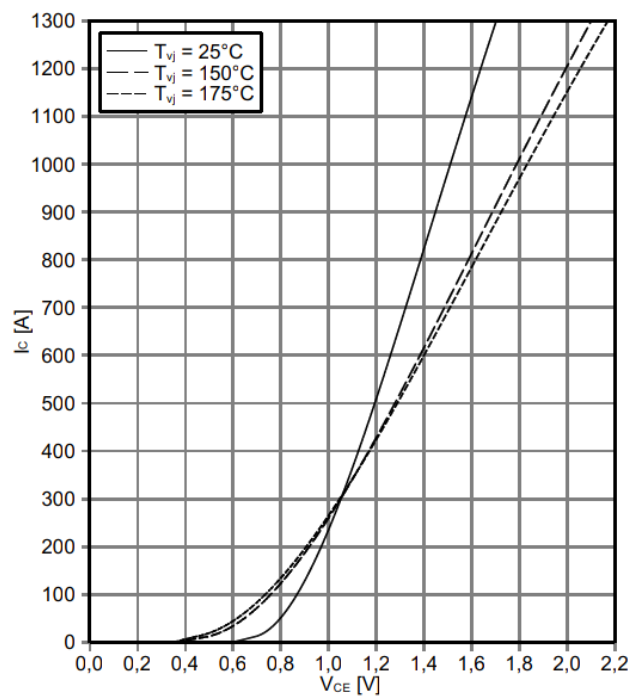
<sup>3)</sup> 根据应用笔记 AN-HPDC6i-AN-HP1-DC6i-Assembly-Instructions 设计冷却器并确定流向。冷却液为 50% 水 / 50% 乙二醇。

## 6 特性图

output characteristic IGBT, Inverter (typical)

$$I_C = f(V_{CE})$$

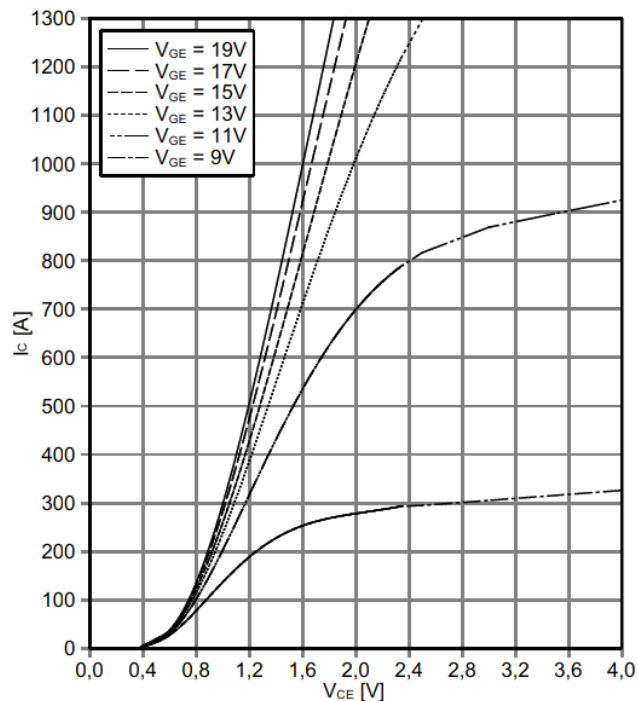
$$V_{GE} = 15 \text{ V}$$



output characteristic IGBT, Inverter (typical)

$$I_C = f(V_{CE})$$

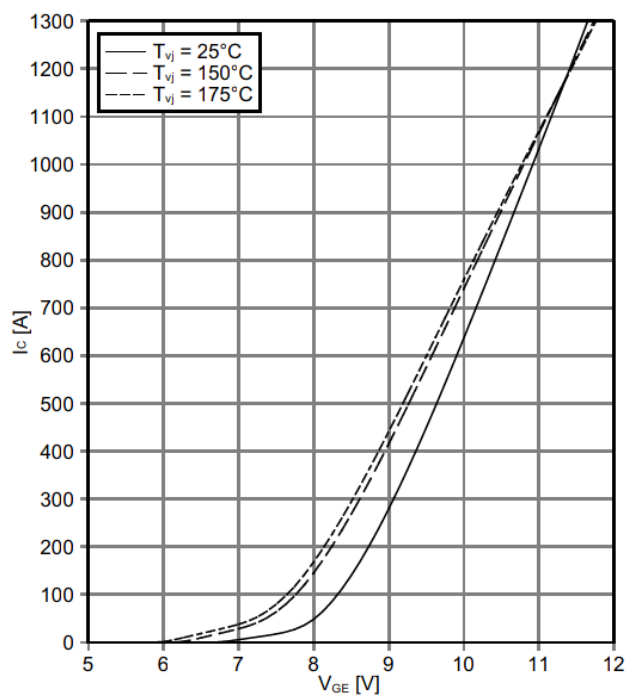
$$T_{vj} = 150^\circ\text{C}$$



transfer characteristic IGBT, Inverter (typical)

$$I_C = f(V_{GE})$$

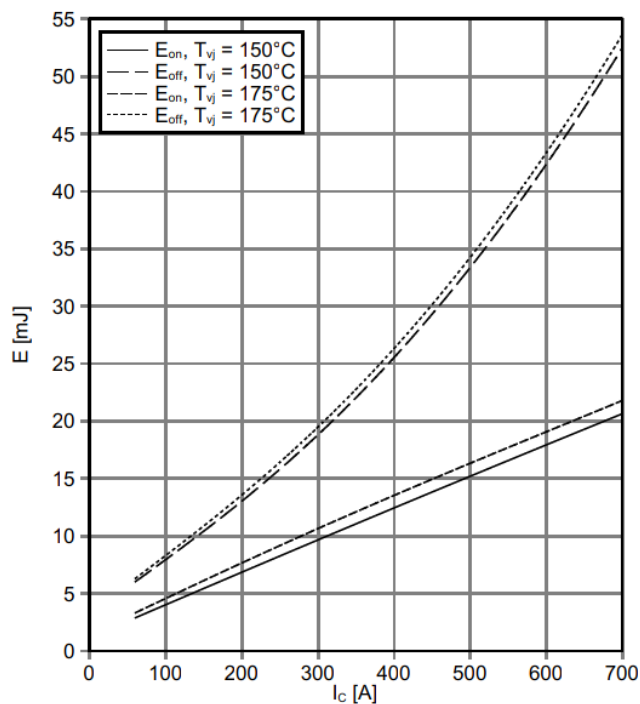
$$V_{CE} = 20 \text{ V}$$



switching losses IGBT, Inverter (typical)

$$E_{on} = f(I_C), E_{off} = f(I_C)$$

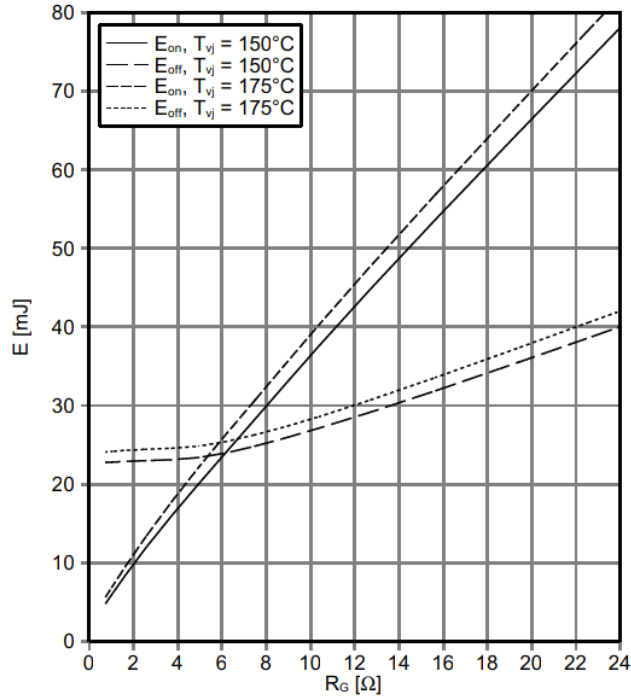
$$V_{GE} = +15 \text{ V} / -8 \text{ V}, R_{Gon} = 2.4 \Omega, R_{Goff} = 5.1 \Omega, V_{CE} = 400 \text{ V}$$



switching losses IGBT, Inverter (typical)

$E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$ ,

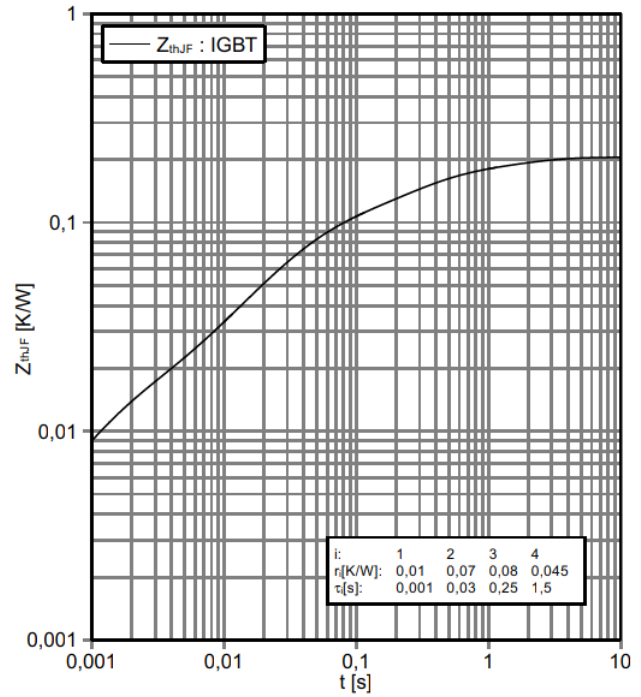
$V_{GE} = +15V / -8V$ ,  $I_C = 450 A$ ,  $V_{CE} = 400 V$



transient thermal impedance IGBT, Inverter

$Z_{thJF} = f(t)$ , cooler design according to AN-HPDC6i

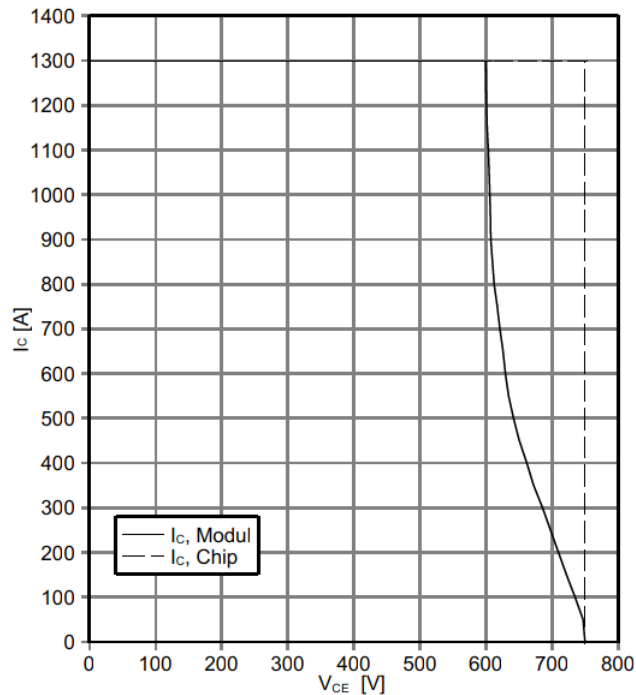
$\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}$ ;  $T_f = 75^\circ C$ ; 50% water / 50% ethylenglycol



reverse bias safe operating area IGBT, Inverter (RBSOA)

$I_C = f(V_{CE})$

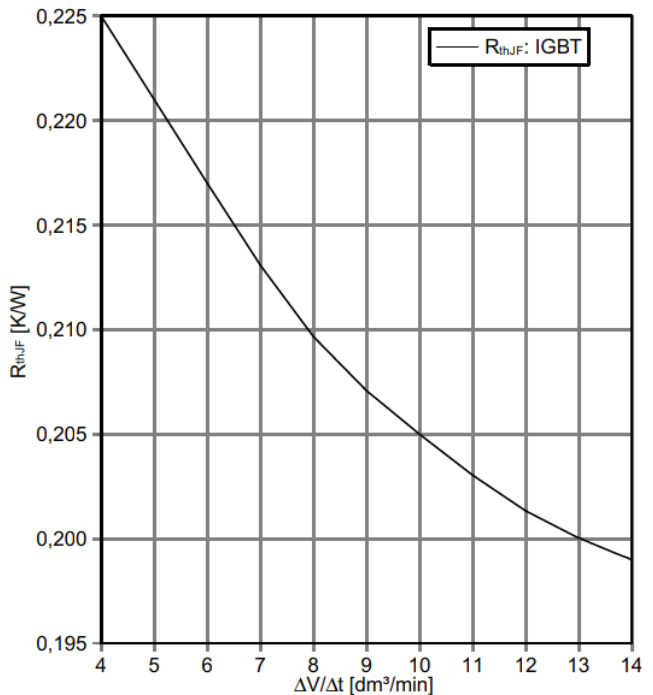
$V_{GE} = +15V / -8V$ ,  $R_{Goff} = 5,1 \Omega$ ,  $T_{vj} = 175^\circ C$



thermal impedance IGBT, Inverter

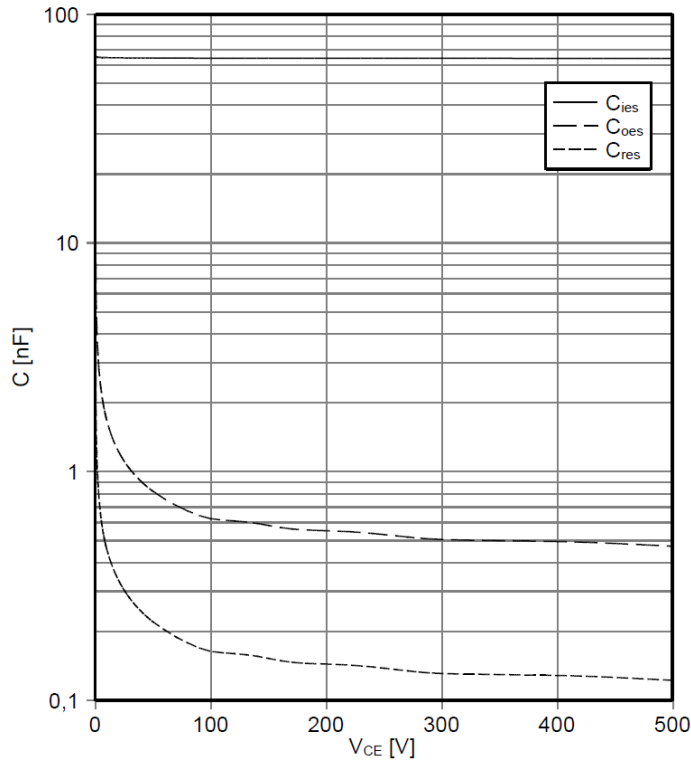
$R_{thJF} = f(\Delta V/\Delta t)$ , cooler design according to AN-HPDC6i

$T_f = 75^\circ C$ ; 50% water / 50% ethylenglycol



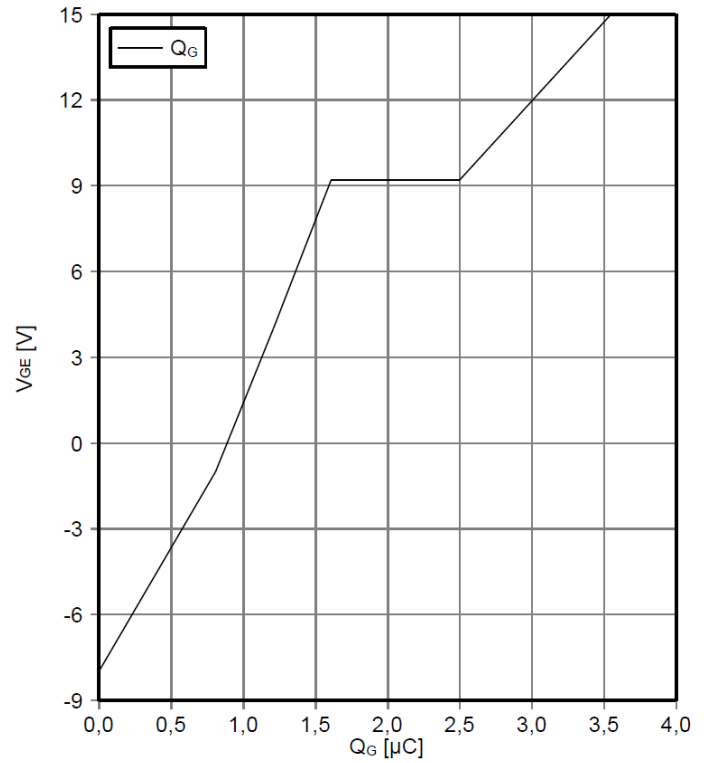
capacity characteristic IGBT, Inverter (typical)

$$C = f(V_{CE})$$

 $V_{GE} = 0 \text{ V}, T_{vj} = 25^\circ\text{C}, f = 1\text{MHz}$ 


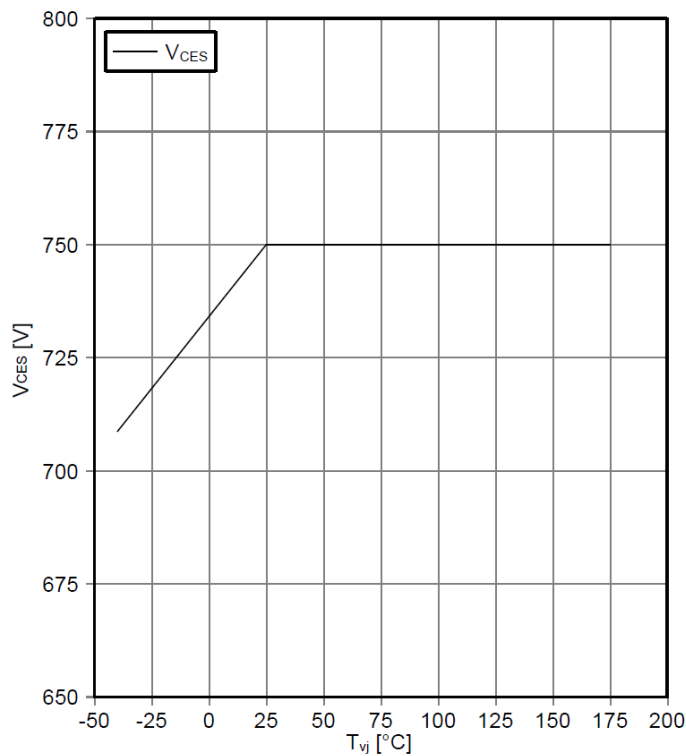
gate charge characteristic IGBT, Inverter (typical)

$$V_{GE} = f(Q_G)$$

 $V_{CE} = 400 \text{ V}, I_C = 450 \text{ A}, T_{vj} = 25^\circ\text{C}$ 


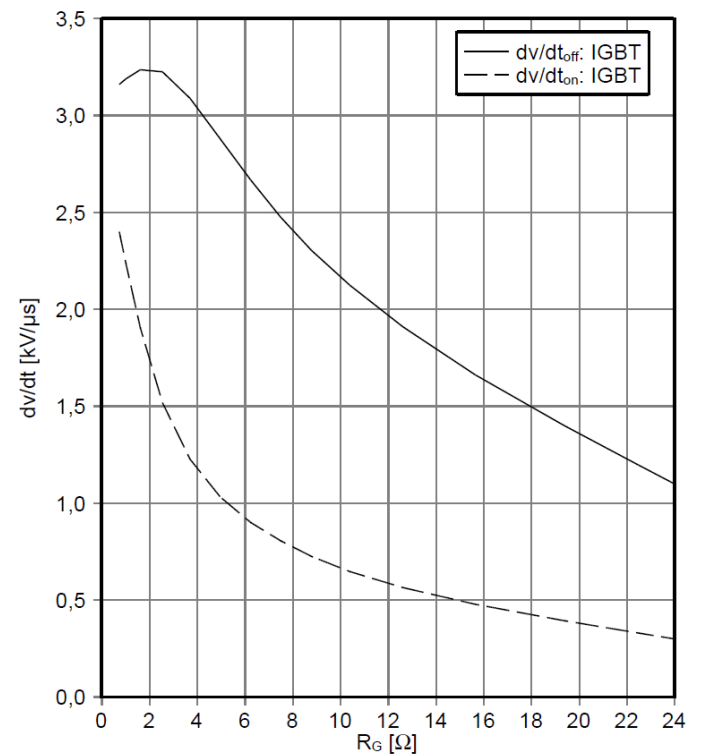
maximum allowed collector-emitter voltage

 $V_{CES} = f(T_{vj})$ , verified by characterization / design not by test

 $I_{CES} = 1 \text{ mA for } T_{vj} \leq 25^\circ\text{C}; I_{CES} = 30 \text{ mA for } T_{vj} > 25^\circ\text{C}$ 


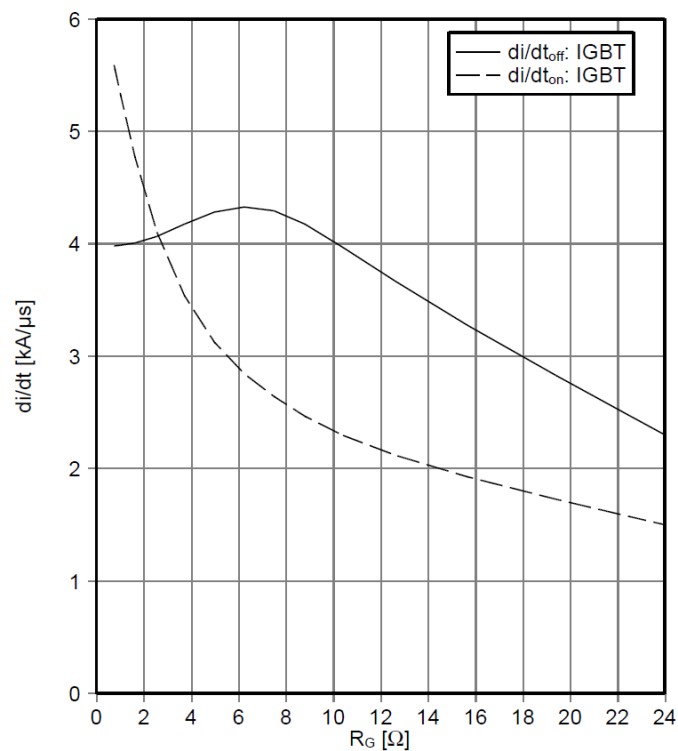
voltage slope IGBT, Inverter (typical)

$$dv/dt = f(R_G)$$

 $V_{GE} = +15\text{V} / -8\text{V}, I_C = 375 \text{ A}, V_{CE} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}$ 


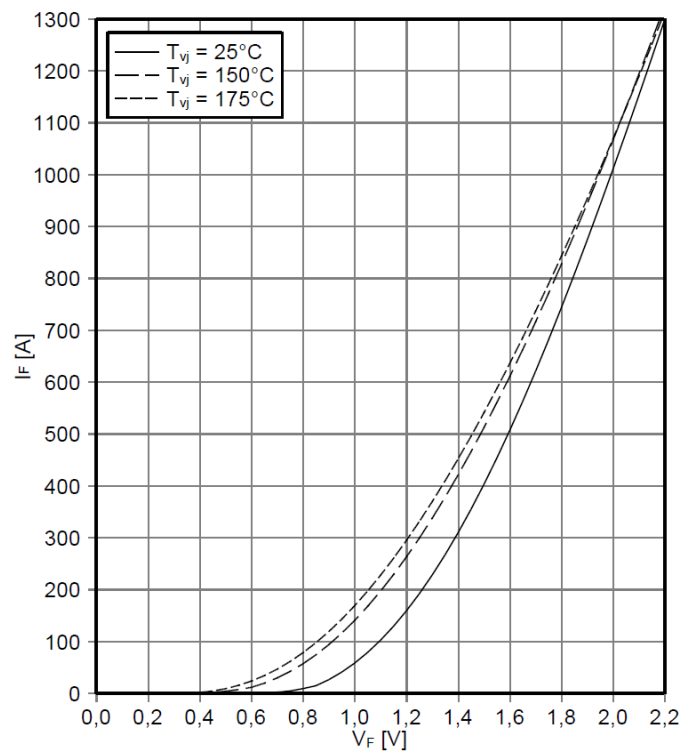
current slope IGBT, Inverter (typical)

$$di/dt = f(R_G)$$

 $V_{GE} = +15V / -8V, I_C = 375 A, V_{CE} = 400 V, T_{vj} = 150^\circ C$ 


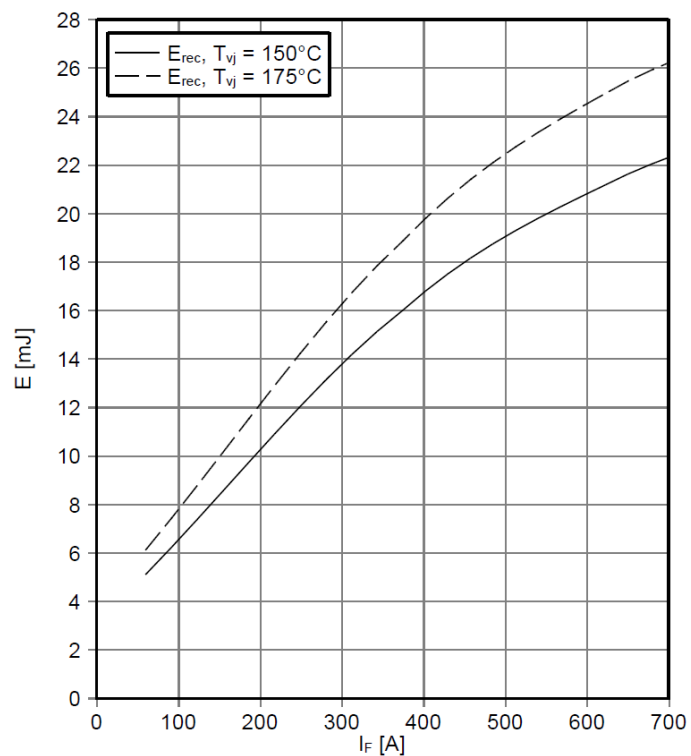
forward characteristic of Diode, Inverter (typical)

$$I_F = f(V_F)$$



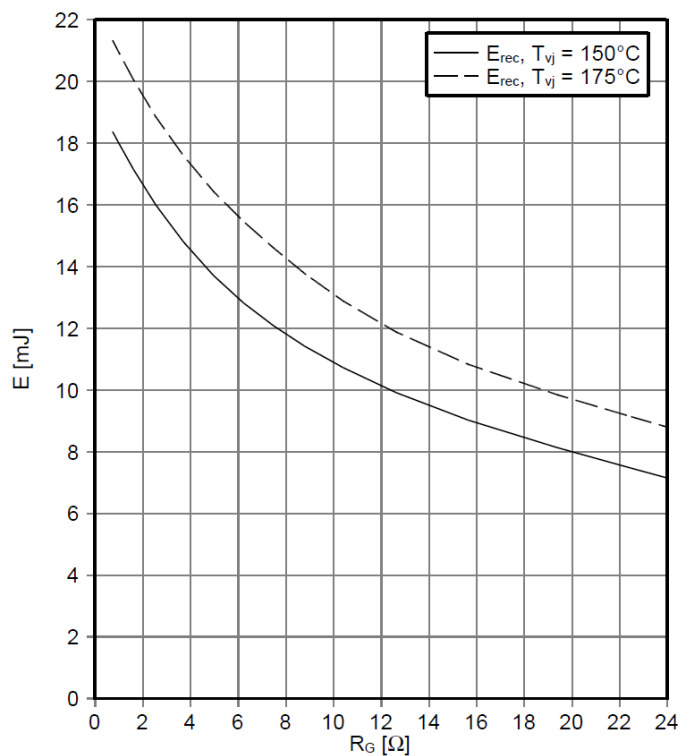
switching losses Diode, Inverter (typical)

$$E_{rec} = f(I_F)$$

 $R_{Gon} = 2.4 \Omega, V_{CE} = 400 V$ 


switching losses Diode, Inverter (typical)

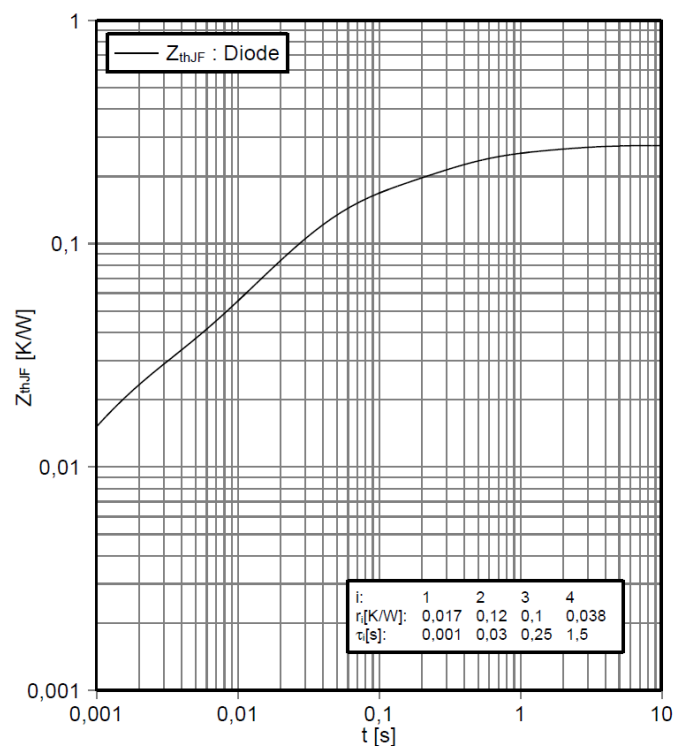
$$E_{rec} = f(R_G)$$

 $I_F = 375 A, V_{CE} = 400 V$ 


transient thermal impedance Diode, Inverter

$Z_{thJF} = f(t)$ , cooler design according to AN-HPDC6i

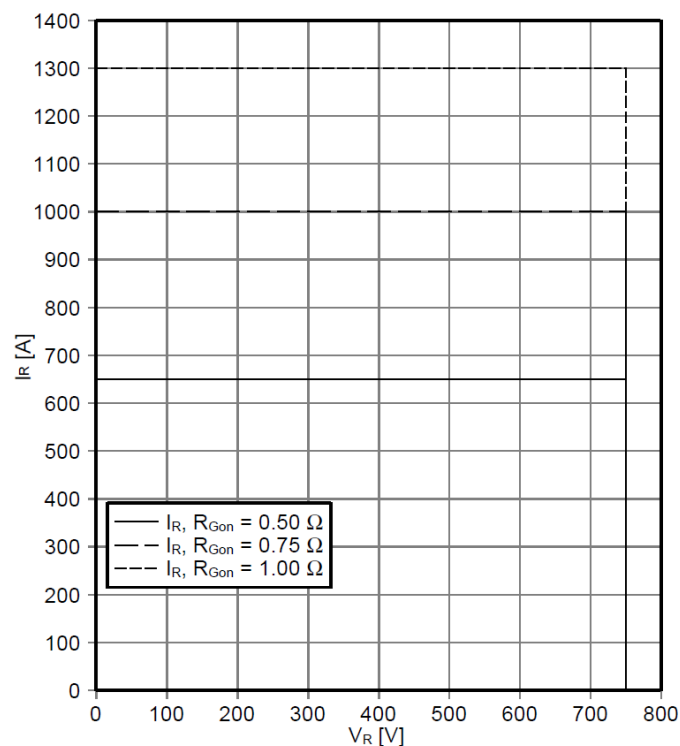
$\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}$ ;  $T_f = 75^\circ\text{C}$ ; 50% water / 50% ethylenglycol



safe operation area Diode, Inverter (SOA)

$I_R = f(V_R)$

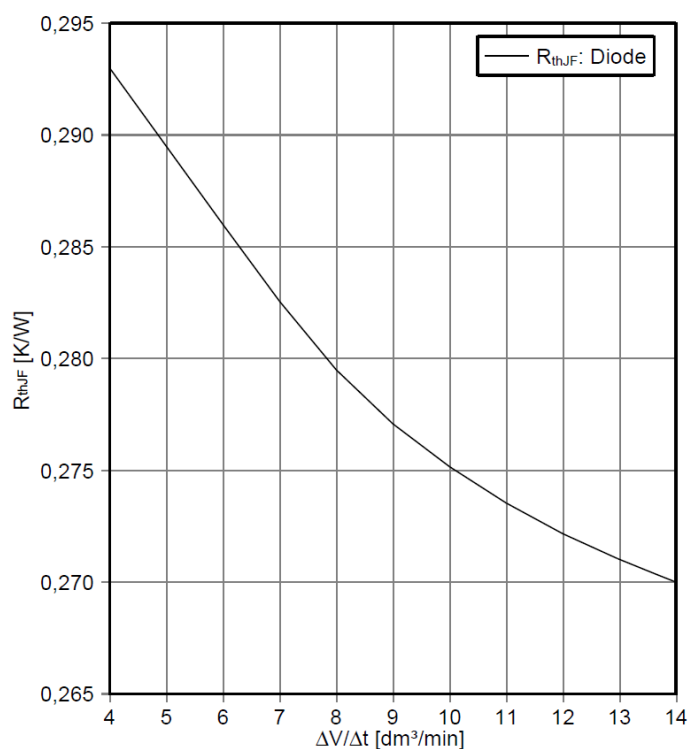
$T_{vj} = 150^\circ\text{C}$



thermal impedance Diode, Inverter

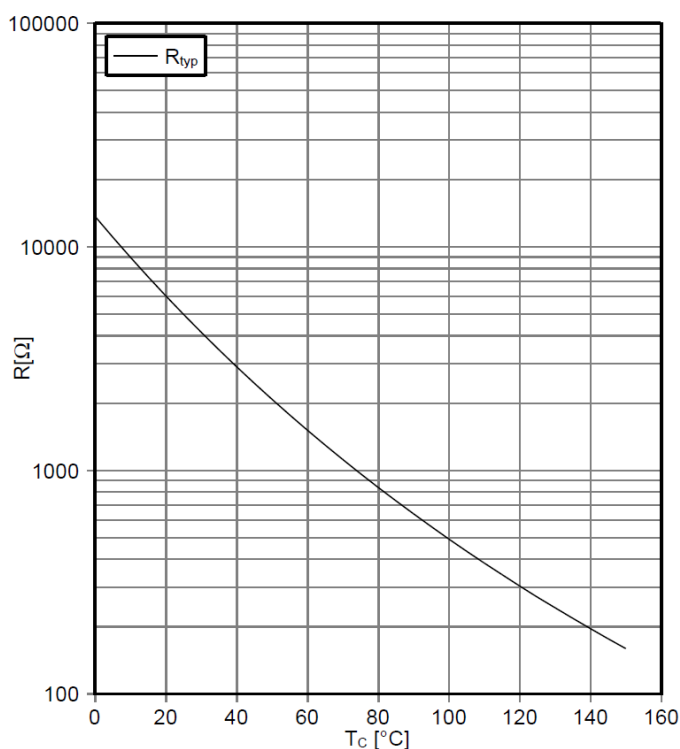
$R_{thJF} = f(\Delta V/\Delta t)$ , cooler design according to AN-HPDC6i

$T_f = 75^\circ\text{C}$ ; 50% water / 50% ethylenglycol



NTC-Thermistor-temperature characteristic (typical)

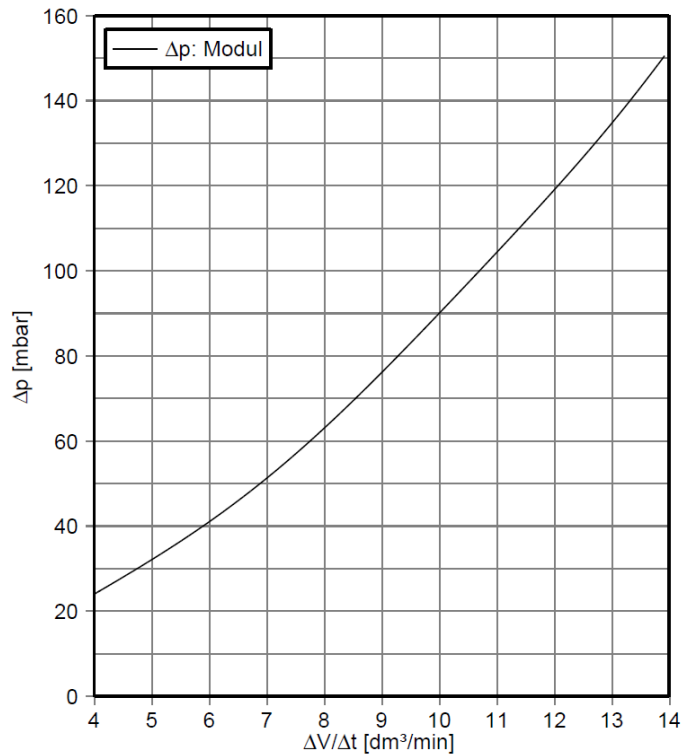
$R = f(T)$



pressure drop in cooling circuit

$\Delta p = f(\Delta V/\Delta t)$ , cooler design according to AN-HPDC6i

Tf = 75°C; 50% water / 50% ethylenglycol

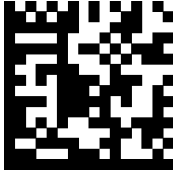




[illegible]

## 9 标签代码

### 9.1 模块代码

|              |                                                                                                                                                  |                                                           |                                                            |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------|
| Code Format  | Data Matrix                                                                                                                                      |                                                           |                                                            |
| Encoding     | ASCII Text                                                                                                                                       |                                                           |                                                            |
| Symbol Size  | 16x16                                                                                                                                            |                                                           |                                                            |
| Standard     | IEC24720 and IEC16022                                                                                                                            |                                                           |                                                            |
| Code Content | Content<br>Module Serial Number<br>Module Material Number<br>Production Order Number<br>Datecode (Production Year)<br>Datecode (Production Week) | Digit<br>1 - 5<br>6 - 11<br>12 - 19<br>20 - 21<br>22 - 23 | Example (below)<br>71549<br>142846<br>55054991<br>15<br>30 |
| Example      | <br>71549142846550549911530                                    |                                                           |                                                            |

### 9.2 包装代码

|              |                                                                                                                            |                                       |                                                            |                                                                 |
|--------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------|
| Code Format  | Code128                                                                                                                    |                                       |                                                            |                                                                 |
| Encoding     | Code Set A                                                                                                                 |                                       |                                                            |                                                                 |
| Symbol Size  | 34 digits                                                                                                                  |                                       |                                                            |                                                                 |
| Standard     | IEC8859-1                                                                                                                  |                                       |                                                            |                                                                 |
| Code Content | Content<br>Backend Construction Number<br>Production Lot Number<br>Serial Number<br>Date Code<br>Box Quantity              | Identifier<br>X<br>1T<br>S<br>9D<br>Q | Digit<br>2 - 9<br>12 - 19<br>21 - 25<br>28 - 31<br>33 - 34 | Example (below)<br>95056609<br>2X0003E0<br>754389<br>1139<br>15 |
| Example      | <br>X950566091T2X0003E0S754389D1139Q15 |                                       |                                                            |                                                                 |

## 修订记录

自上次修订以来的主要变化

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### 修订记录

| Reference | Date       | Description                            |
|-----------|------------|----------------------------------------|
| V1.0      | 2017-08-31 | Target datasheet                       |
| V1.1      | 2018-01-18 | Change of package designation          |
| V1.2      | 2018-06-25 | Extention of target data (E, Rth, ...) |
| V1.3      | 2019-02-12 | New package outlines / pinning         |
| V2.0      | 2019-10-30 | Preliminary datasheet                  |
| V3.0      | 2020-05-06 | Final datasheet                        |

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