

关键参数 Key Parameters

|              |      |      |    |
|--------------|------|------|----|
| $V_{DS}$     |      | 1200 | V  |
| $R_{DS(on)}$ | Typ. | 3.31 | mΩ |
| $I_D$        | Max. | 400  | A  |
| $I_{DM}$     | Max. | 800  | A  |

典型应用 Typical Applications

- |             |                            |
|-------------|----------------------------|
| ● 电动汽车      | Automotive Applications    |
| ● 混合动力/纯电动车 | Hybrid/Electrical Vehicles |
| ● 电机驱动      | Motor Drives               |

特点 Features

- |                                     |                                              |
|-------------------------------------|----------------------------------------------|
| ● 低开关损耗                             | Low Switching Losses                         |
| ● 转模封装                              | Molded Package                               |
| ● 低感设计                              | Low Inductive Design                         |
| ● Si <sub>3</sub> N <sub>4</sub> 衬板 | Si <sub>3</sub> N <sub>4</sub> AMB Substrate |

电路结构 Circuit Configuration

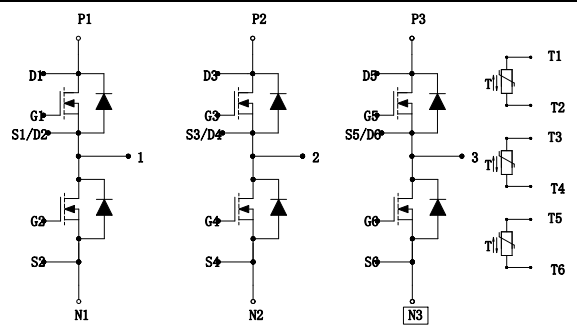


图 1. 电路结构

Fig. 1 Circuit configuration

模块外形 Module Appearance

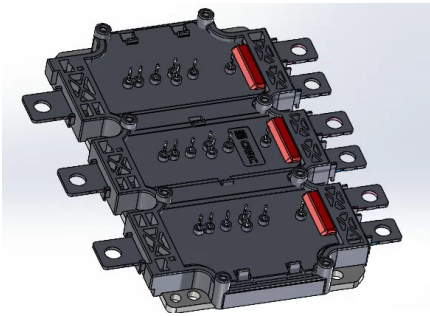


图 2. 模块外形

Fig. 2 Module appearance

模块标签说明

Module Label Code Instruction



| 数据位置<br>Data position | 数据内容<br>Content of data       |
|-----------------------|-------------------------------|
| 1--8                  | 模块批次号<br>Module batch number  |
| 9--12                 | 模块序列号<br>Module serial number |

**最大额定值**
**Absolute Maximum Ratings**

| 符号<br>Symbol | 参数名称<br>Parameter                              | 测试条件<br>Test Conditions                                                                                    | 数值<br>Value | 单位<br>Unit |
|--------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------|-------------|------------|
| $V_{DS}$     | 漏源极电压<br>Drain-source voltage                  | $V_{GS} = 0V, T_C = 25^\circ C$                                                                            | 1200        | V          |
| $V_{GSmax}$  | 栅源电压<br>Gate-source voltage                    | $T_C = 25^\circ C$                                                                                         | -8/+23      | V          |
| $V_{GSop}$   | 栅源电压<br>Gate-source voltage                    | $T_C = 25^\circ C$                                                                                         | -4/+18      | V          |
| $I_D$        | 额定漏极电流<br>Rating drain current                 | $T_F = 65^\circ C, T_{vj\ max} = 175^\circ C$                                                              | 400         | A          |
| $I_{DM}$     | 漏极峰值电流<br>Peak drain current                   | $t_p = 1ms$                                                                                                | 800         | A          |
| $P_{max}$    | 晶体管部分最大损耗<br>Max. transistor power dissipation | $T_F = 65^\circ C, T_{vj\ max} = 175^\circ C$                                                              | 887         | W          |
| $I^2t$       | 二极管 $I^2t$ 值<br>Diode $I^2t$                   | $V_R = 0V, t_p = 10ms, T_{vj} = 175^\circ C$                                                               | TBD         | $kA^2s$    |
| $V_{isol}$   | 绝缘电压(模块)<br>Isolation voltage – per module     | 短接所有端子，端子与基板间施加电压<br>(Connected terminals to baseplate),<br>RMS, $f = 0\ Hz, t = 1\ sec, T_C = 25^\circ C$ | 4200        | V          |

**热和机械数据**
**Thermal & Mechanical Data**

| 参数<br>Symbol                                 | 说明<br>Explanation              | 值<br>Value | 单位<br>Unit |
|----------------------------------------------|--------------------------------|------------|------------|
| 爬电距离<br>Creepage distance                    | 端子-散热器<br>Terminal to heatsink | 6.5        | mm         |
|                                              | 端子-端子<br>Terminal to terminal  | 10.5       | mm         |
| 绝缘间隙<br>Clearance                            | 端子-散热器<br>Terminal to heatsink | 4.5        | mm         |
|                                              | 端子-端子<br>Terminal to terminal  | 4.5        | mm         |
| 相对漏电起痕指数<br>CTI (Comparative tracking index) |                                | >600       |            |

### 热和机械数据

### Thermal & Mechanical Data

| 符号<br>Symbol         | 参数名称<br>Parameter                              | 测试条件<br>Test Conditions                                                                                                                                                                                                             | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit       |
|----------------------|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------------|------------------|
| $R_{th(J-F)}$ MOSFET | MOSFET 热阻<br>Thermal resistance –MOSFET        | 冷却液: 50%乙二醇溶液; $\Delta V/\Delta t=10\text{ dm}^3/\text{min}$ ; $T_F = 65\text{ }^\circ\text{C}$<br>Cooling Fluid: 50% water / 50% ethylene glycol; $\Delta V/\Delta t=10\text{ dm}^3/\text{min}$ ; $T_F = 65\text{ }^\circ\text{C}$ |             | 124         | 136         | K / kW           |
| $\Delta P$           | 冷却液流阻<br>Pressure drop in cooling circuit      | 冷却液: 50%乙二醇溶液; $\Delta V/\Delta t=10\text{ dm}^3/\text{min}$ ; $T_F = 25\text{ }^\circ\text{C}$<br>Cooling Fluid: 50% water / 50% ethylenglycol; $\Delta V/\Delta t=10\text{ dm}^3/\text{min}$ ; $T_F = 25\text{ }^\circ\text{C}$   |             | 50          |             | mbar             |
| $P$                  | 冷却液最大压力<br>Maximum pressure in cooling circuit |                                                                                                                                                                                                                                     |             |             | 2.5         | bar              |
| $T_{vj\text{ op}}$   | 工作结温<br>Operating junction temperature         |                                                                                                                                                                                                                                     | -40         |             | 175         | $^\circ\text{C}$ |
| $T_{\text{stg}}$     | 存储温度<br>Storage temperature range              |                                                                                                                                                                                                                                     | -40         |             | 125         | $^\circ\text{C}$ |
| $M$                  | 安装力矩<br>Screw torque                           | 电路互连用– M4<br>Electrical connections – M5                                                                                                                                                                                            | 1.8         | 2.0         | 2.2         | Nm               |
|                      |                                                | PCB 安装用<br>PCB Mounting                                                                                                                                                                                                             | 0.80        | 0.85        | 0.90        | Nm               |

### 热敏电阻数据

### NTC-Thermistor Data

| 符号<br>Symbol | 参数名称<br>Parameter                      | 测试条件<br>Test Conditions                                       | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|--------------|----------------------------------------|---------------------------------------------------------------|-------------|-------------|-------------|------------|
| $R_{25}$     | 额定电阻值<br>Rated resistance              | $T_C = 25\text{ }^\circ\text{C}$                              |             | 5           |             | k $\Omega$ |
| $\Delta R/R$ | $R_{100}$ 偏差<br>Deviation of $R_{100}$ | $T_C = 100\text{ }^\circ\text{C}$ , $R_{100}=493\Omega$       | -5          |             | 5           | %          |
| $P_{25}$     | 耗散功率<br>Power dissipation              | $T_C = 25\text{ }^\circ\text{C}$                              |             |             | 20          | mW         |
| $B_{25/50}$  | B -值<br>B -value                       | $R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298.15\text{ K}))]$  |             | 3375        |             | K          |
| $B_{25/80}$  | B -值<br>B -value                       | $R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298.15\text{ K}))]$  |             | 3411        |             | K          |
| $B_{25/100}$ | B -值<br>B -value                       | $R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298.15\text{ K}))]$ |             | 3433        |             | K          |

**电特性值**
**Electrical Characteristics**

除非特别声明，否则  $T_C = 25\text{ }^{\circ}\text{C}$ 
 $T_C = 25\text{ }^{\circ}\text{C}$  unless otherwise stated

| 符号<br>Symbol        | 参数名称<br>Parameter                             | 条件<br>Test Conditions                                                                                                                                              | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|---------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------------|------------|
| $I_{DSS}$           | 零栅压漏极电流<br>Zero gate voltage drain current    | $V_{GS} = 0V, V_{DS} = V_{DSS}$                                                                                                                                    |             |             | 100         | $\mu A$    |
|                     |                                               | $V_{GS} = 0V, V_{DS} = V_{DSS}, T_{vj} = 150\text{ }^{\circ}\text{C}$                                                                                              |             |             | 500         | $\mu A$    |
|                     |                                               | $V_{GS} = 0V, V_{DS} = V_{DSS}, T_{vj} = 175\text{ }^{\circ}\text{C}$                                                                                              |             |             | 1000        | $\mu A$    |
| $I_{GSS}$           | 栅极漏电流<br>Gate leakage current                 | $V_{GS} = -8/+23V, V_{DS} = 0V$                                                                                                                                    |             |             | 500         | nA         |
| $V_{GS(th)}$        | 栅极-源极阈值电压<br>Gate threshold voltage           | $I_D = 40mA, V_{GS} = V_{DS}$                                                                                                                                      | 2.2         | 2.8         | 3.4         | V          |
| $R_{DS(on)}^{(*1)}$ | 漏极-源极通态电阻<br>Drain-source on-state resistance | $V_{GS} = 18V, I_D = 400A$                                                                                                                                         |             | 3.31        |             | m $\Omega$ |
|                     |                                               | $V_{GS} = 18V, I_D = 400A, T_{vj} = 150\text{ }^{\circ}\text{C}$                                                                                                   |             | 4.68        |             | m $\Omega$ |
|                     |                                               | $V_{GS} = 18V, I_D = 400A, T_{vj} = 175\text{ }^{\circ}\text{C}$                                                                                                   |             | 5.26        |             | m $\Omega$ |
| $g_{fs}$            | 跨导<br>Forward transconductance                | $V_{DS} = 20V, I_D = 400A$                                                                                                                                         |             | 381         |             | S          |
| $V_{SD}^{(*1)}$     | 二极管正向电压<br>Diode forward voltage              | $I_{SD} = 400A, V_{GS} = -4V$                                                                                                                                      |             | 4.3         |             | V          |
|                     |                                               | $I_{SD} = 400A, V_{GS} = -4V, T_{vj} = 150\text{ }^{\circ}\text{C}$                                                                                                |             | 3.9         |             | V          |
|                     |                                               | $I_{SD} = 400A, V_{GS} = -4V, T_{vj} = 175\text{ }^{\circ}\text{C}$                                                                                                |             | 3.8         |             | V          |
| $I_{SC}$            | 短路电流<br>Short circuit current                 | $T_{vj} = 175\text{ }^{\circ}\text{C}, V_{DD} = 800V,$<br>$V_{GS} \leq 18V, t_p \leq TBD\mu s,$<br>$V_{DS(max)} = V_{DSS} - L^{(*2)} \times di/dt,$<br>IEC 60747-8 |             | TBD         |             | A          |

**注意:** 1. (\*1) 表示该参数的测试点为辅助母排端子 (\*1) indicates it is measured at the auxiliary busbar terminal),  
**Note:** 2. (\*2) 表示  $L$  是电路杂散电感加上  $L_{SDS}$  (\*3) indicates  $L$  is the circuit stray inductance plus  $L_{SDS}$ ).

**电特性值**
**Electrical Characteristics**

 除非特别声明，否则  $T_C = 25\text{ }^{\circ}\text{C}$ 
 $T_C = 25\text{ }^{\circ}\text{C}$  unless otherwise stated

| 符号<br>Symbol  | 参数名称<br>Parameter                                     | 条件<br>Test Conditions                                         | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit    |
|---------------|-------------------------------------------------------|---------------------------------------------------------------|-------------|-------------|-------------|---------------|
| $C_{iss}$     | 输入电容<br>Input capacitance                             | $V_{DS} = 600\text{V}, V_{GS} = 0\text{V}, f = 100\text{kHz}$ |             | 24          |             | nF            |
| $Q_g$         | 栅极电荷<br>Gate charge                                   | -4/+18V                                                       |             | 1.1         |             | $\mu\text{C}$ |
| $C_{rss}$     | 反向传输电容<br>Reverse transfer capacitance                | $V_{DS} = 600\text{V}, V_{GS} = 0\text{V}, f = 100\text{kHz}$ |             | 0.07        |             | nF            |
| $L_{sDS}$     | 模块电感<br>Module inductance                             |                                                               |             | 11          |             | nH            |
| $R_{DD'+SS'}$ | 模块引线电阻，端子-芯片<br>Module lead resistance, terminal-chip |                                                               |             | 0.7         |             | m $\Omega$    |
| $R_{Gint}$    | 内部栅极电阻<br>Internal gate resistor                      |                                                               |             | 1.9         |             | $\Omega$      |

## 电特性值

## Electrical Characteristics

| 符号<br>Symbol | 参数名称<br>Parameter                           | 测试条件<br>Test Conditions                                                                                                                       |                   | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|--------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|-------------|-------------|------------|
| $t_{d(off)}$ | 关断延迟时间<br>Turn-off delay time               | $I_D$ =500A,<br>$V_{DS}$ = 950V,<br>$V_{GS}$ = -4/+18V,<br>$R_{G(OFF)}$ = 7.7Ω,<br>$L_S$ = 25nH,<br>dv/dt =10100V/μs<br>( $T_{vj}$ = 175 °C). | $T_{vj}$ = 25 °C  |             | 405         |             | ns         |
|              |                                             |                                                                                                                                               | $T_{vj}$ = 150 °C |             | 499         |             |            |
|              |                                             |                                                                                                                                               | $T_{vj}$ = 175 °C |             | 512         |             |            |
| $t_f$        | 下降时间<br>Fall time                           |                                                                                                                                               | $T_{vj}$ = 25 °C  |             | 81          |             | ns         |
|              |                                             |                                                                                                                                               | $T_{vj}$ = 150 °C |             | 83          |             |            |
|              |                                             |                                                                                                                                               | $T_{vj}$ = 175 °C |             | 87          |             |            |
| $E_{OFF}$    | 关断损耗<br>Turn-off energy loss                |                                                                                                                                               | $T_{vj}$ = 25 °C  |             | 39.06       |             | mJ         |
|              |                                             |                                                                                                                                               | $T_{vj}$ = 150 °C |             | 41.18       |             |            |
|              |                                             |                                                                                                                                               | $T_{vj}$ = 175 °C |             | 41.70       |             |            |
| $t_{d(on)}$  | 开通延迟时间<br>Turn-on delay time                | $T_{vj}$ = 25 °C                                                                                                                              |                   | 116         |             | ns          |            |
|              |                                             | $T_{vj}$ = 150 °C                                                                                                                             |                   | 90          |             |             |            |
|              |                                             | $T_{vj}$ = 175 °C                                                                                                                             |                   | 86          |             |             |            |
| $t_r$        | 上升时间<br>Rise time                           | $T_{vj}$ = 25 °C                                                                                                                              |                   | 130         |             | ns          |            |
|              |                                             | $T_{vj}$ = 150 °C                                                                                                                             |                   | 114         |             |             |            |
|              |                                             | $T_{vj}$ = 175 °C                                                                                                                             |                   | 113         |             |             |            |
| $E_{ON}$     | 开通损耗<br>Turn-on energy loss                 | $T_{vj}$ = 25 °C                                                                                                                              |                   | 64.66       |             | mJ          |            |
|              |                                             | $T_{vj}$ = 150 °C                                                                                                                             |                   | 59.05       |             |             |            |
|              |                                             | $T_{vj}$ = 175 °C                                                                                                                             |                   | 59.74       |             |             |            |
| $Q_{rr}$     | 二极管反向恢复电荷<br>Diode reverse recovery charge  | $T_{vj}$ = 25 °C                                                                                                                              |                   | 2           |             | μC          |            |
|              |                                             | $T_{vj}$ = 150 °C                                                                                                                             |                   | 7           |             |             |            |
|              |                                             | $T_{vj}$ = 175 °C                                                                                                                             |                   | 8           |             |             |            |
| $I_{rr}$     | 二极管反向恢复电流<br>Diode reverse recovery current | $T_{vj}$ = 25 °C                                                                                                                              |                   | 85          |             | A           |            |
|              |                                             | $T_{vj}$ = 150 °C                                                                                                                             |                   | 167         |             |             |            |
|              |                                             | $T_{vj}$ = 175 °C                                                                                                                             |                   | 186         |             |             |            |
| $E_{rec}$    | 二极管反向恢复损耗<br>Diode reverse recovery energy  | $T_{vj}$ = 25 °C                                                                                                                              |                   | 0.07        |             | mJ          |            |
|              |                                             | $T_{vj}$ = 150 °C                                                                                                                             |                   | 0.32        |             |             |            |
|              |                                             | $T_{vj}$ = 175 °C                                                                                                                             |                   | 0.37        |             |             |            |

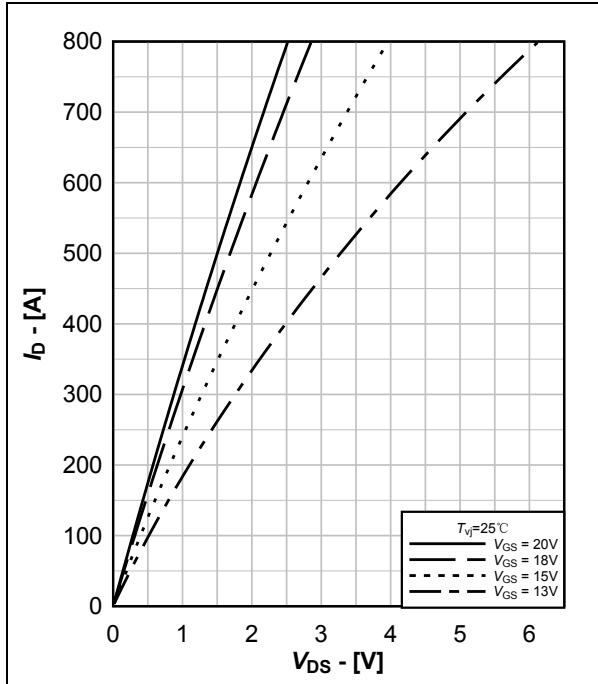


图 3. MOSFET 输出特性典型曲线,  $I_D = f(V_{DS})$

Fig.3 Typical MOSFET output characteristics,  $I_D = f(V_{DS})$

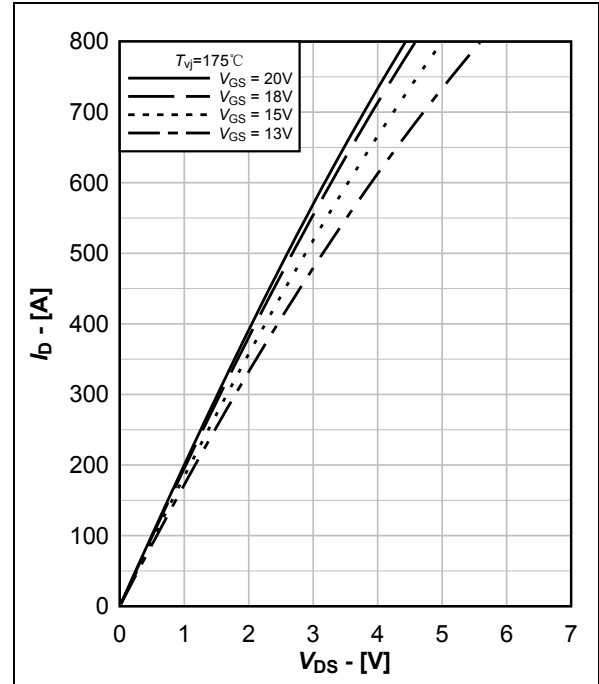


图 4. MOSFET 输出特性典型曲线,  $I_D = f(V_{DS})$

Fig.4 Typical MOSFET output characteristics,  $I_D = f(V_{DS})$

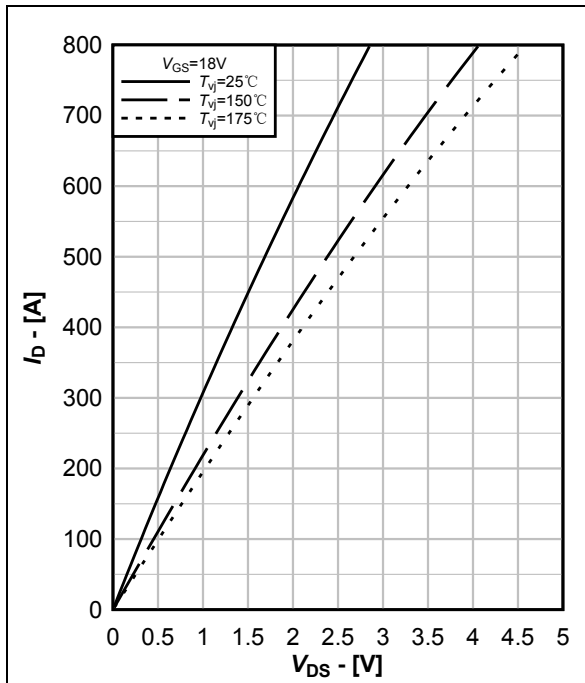


图 5. MOSFET 输出特性典型曲线,  $I_D = f(V_{DS})$

Fig.5 Typical MOSFET output characteristics,  $I_D = f(V_{DS})$

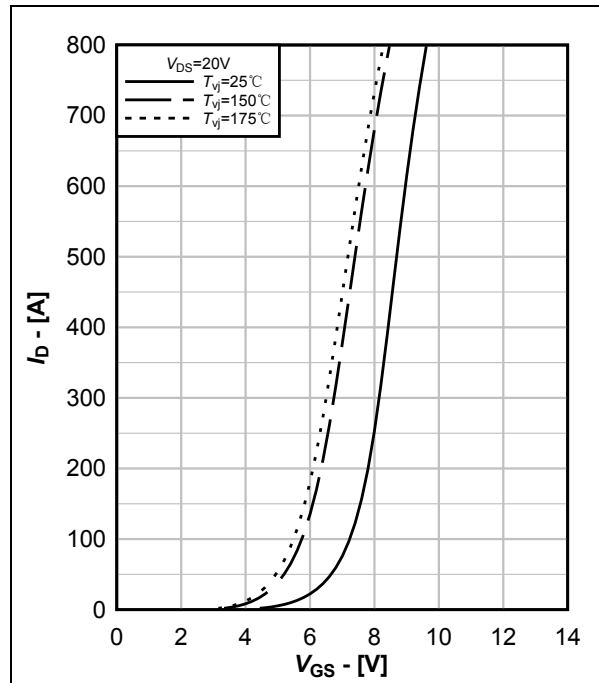


图 6. MOSFET 传输特性典型曲线,  $I_D = f(V_{GS})$

Fig.6 Typical MOSFET transfer characteristics,  $I_D = f(V_{GS})$

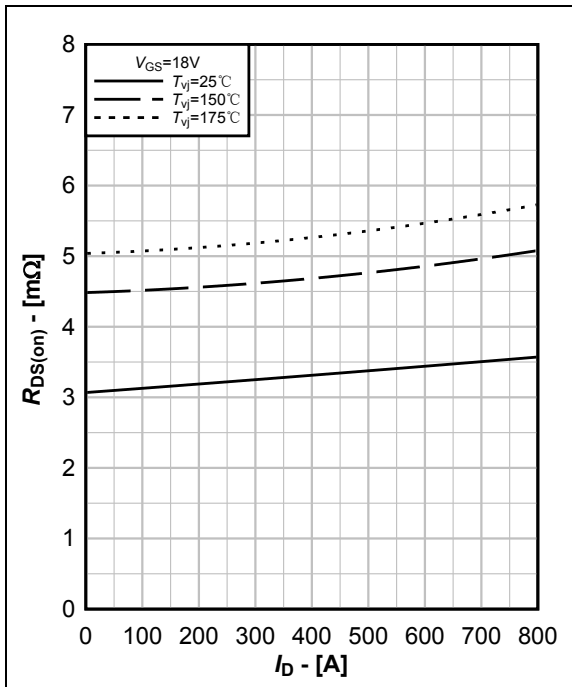

图 7. 导通电阻典型曲线,  $R_{DS(on)} = f(I_D)$ 

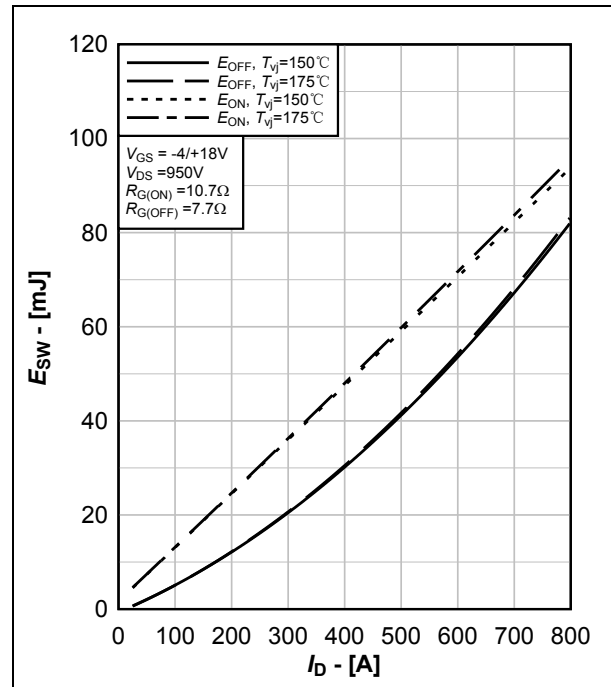
Fig.7 Typical On-Resistance characteristics,  $R_{DS(on)} = f(I_D)$ 

图 8. MOSFET 开关损耗典型曲线,  $E_{on} = f(I_C)$ ,  $E_{off} = f(I_C)$ 

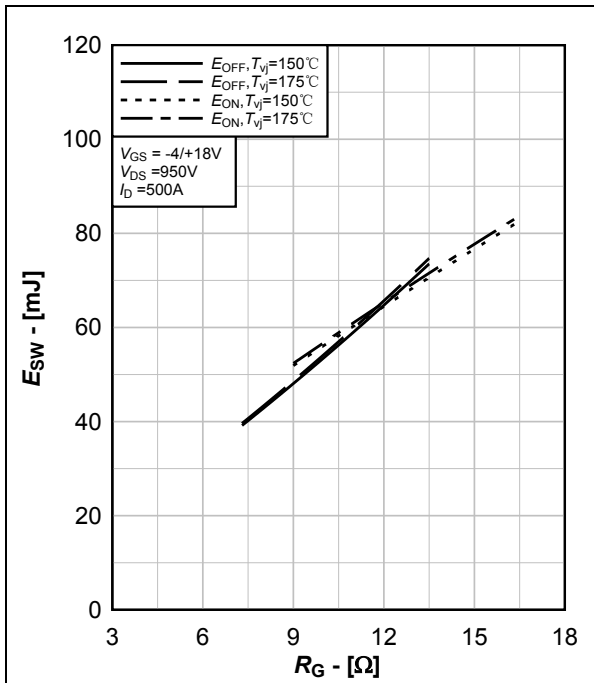
Fig.8 Typical MOSFET switching energy,  $E_{on} = f(I_C)$ ,  $E_{off} = f(I_C)$ 

图 9. MOSFET 开关损耗典型曲线,  $E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$ 

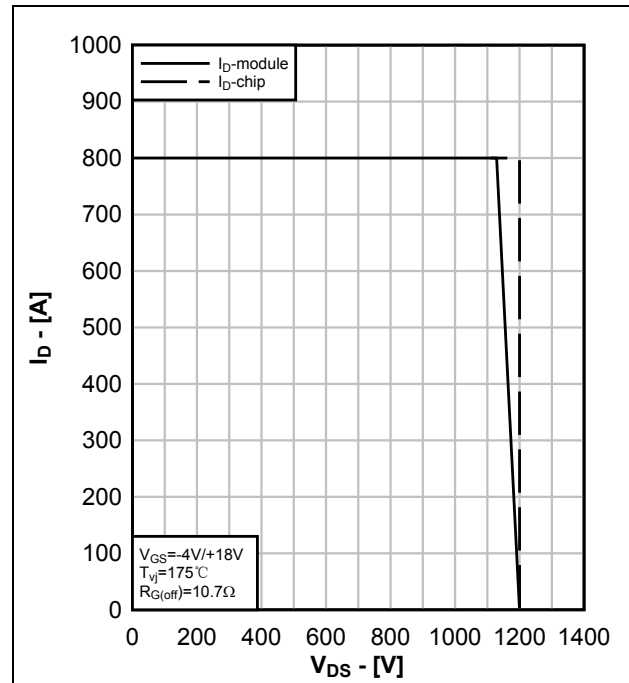
Fig.9 Typical MOSFET switching energy,  $E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$ 

图 10. MOSFET 反偏安全工作区,  $I_D = f(V_{DS})$ 

Fig.10 Reverse bias safe operating area of MOSFET,  $I_D = f(V_{DS})$

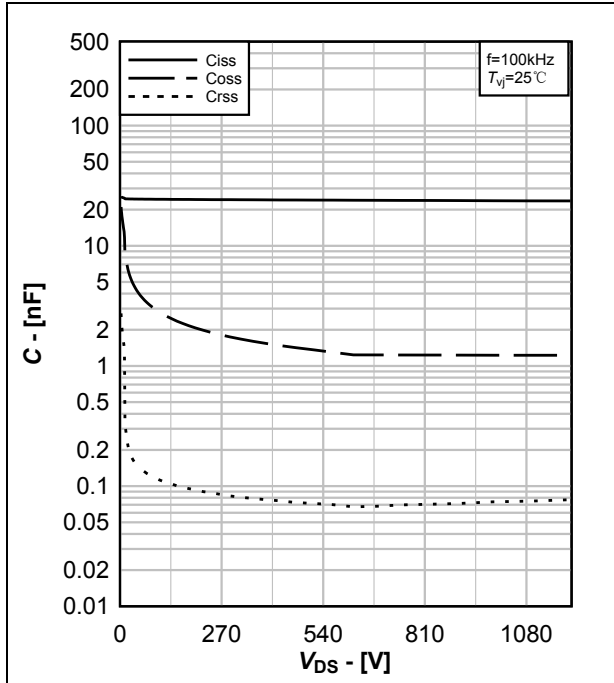


图 11. 电容特性典型曲线,  $C = f(V_{DS})$

Fig.11 Typical capacity characteristic,  $C = f(V_{DS})$

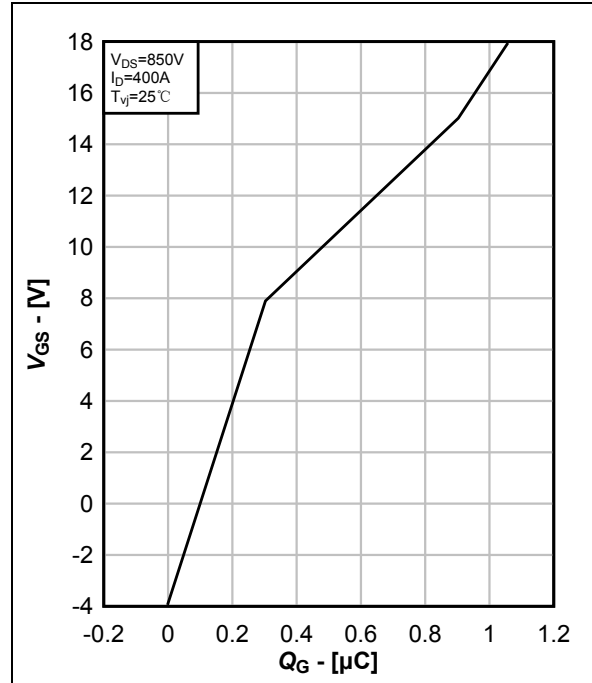


图 12. 栅极电荷特性典型曲线,  $V_{GS} = f(Q_G)$

Fig.12 Typical gate charge characteristic,  $V_{GS} = f(Q_G)$

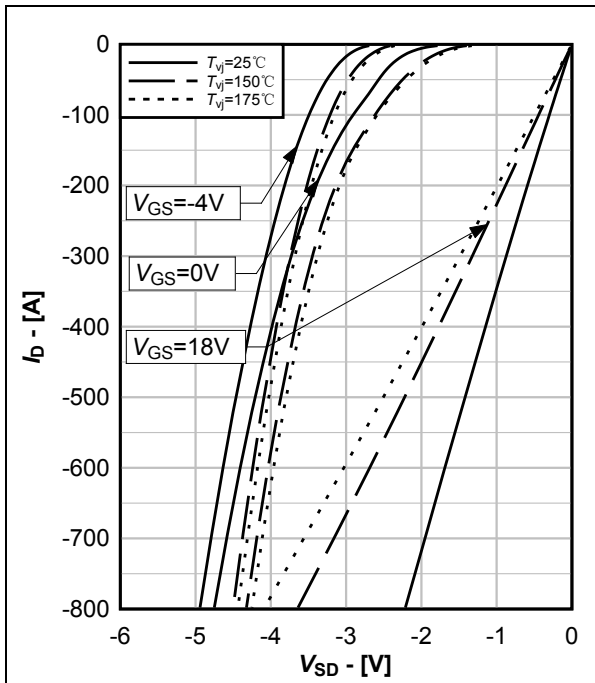


图 13. 体二极管及第三象限输出特性典型曲线,  $I_D = f(V_{DS})$

Fig.13 Typical body diode output and 3rd quadrant characteristic,  
 $I_D = f(V_{DS})$

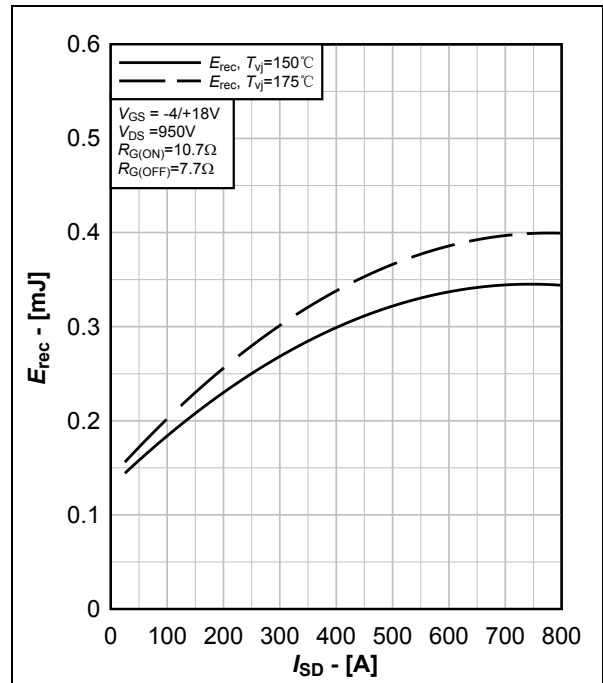


图 14. 体二极管反向恢复损耗典型曲线,  $E_{rec} = f(I_F)$

Fig.14 Typical body diode switching loss  $E_{rec}$ ,  $E_{rec} = f(I_F)$

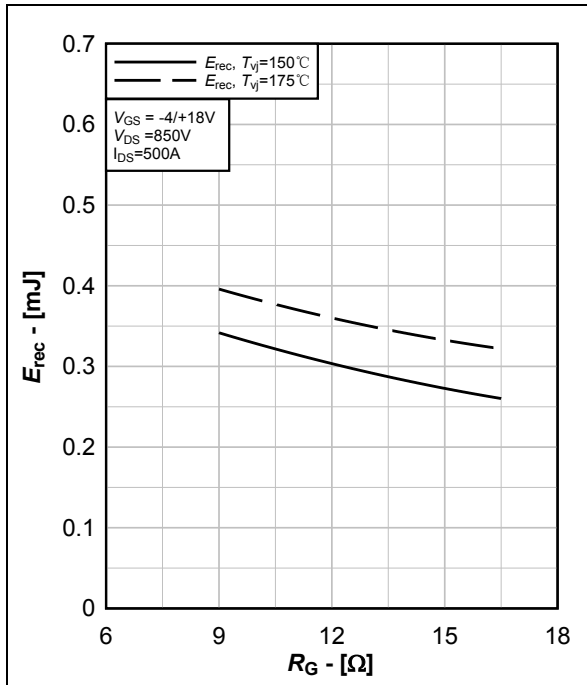


图 15. 体二极管反向恢复损耗典型曲线,  $E_{rec}=f(R_G)$

Fig.15 Typical body diode switching loss  $E_{rec}$ ,  $E_{rec}=f(R_G)$

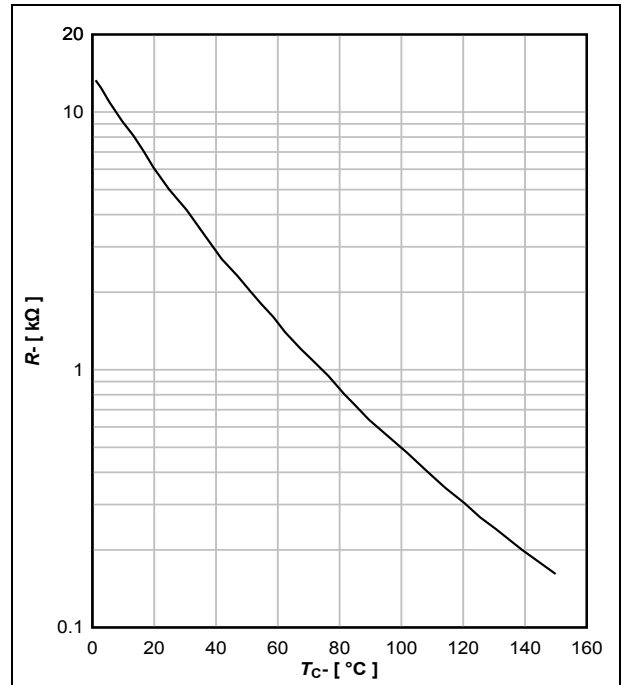


图 16. 热敏电阻典型特性曲线,  $R=f(T_C)$

Fig.16 Typical NTC thermistor characteristic,  $R=f(T_C)$

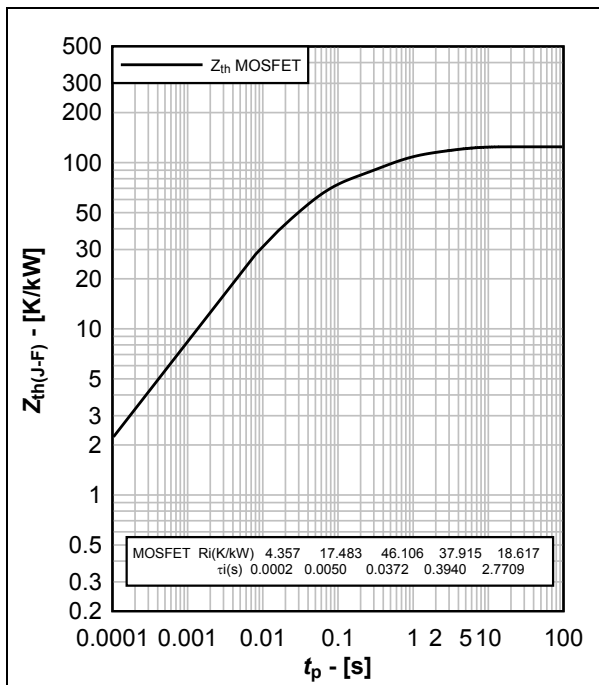
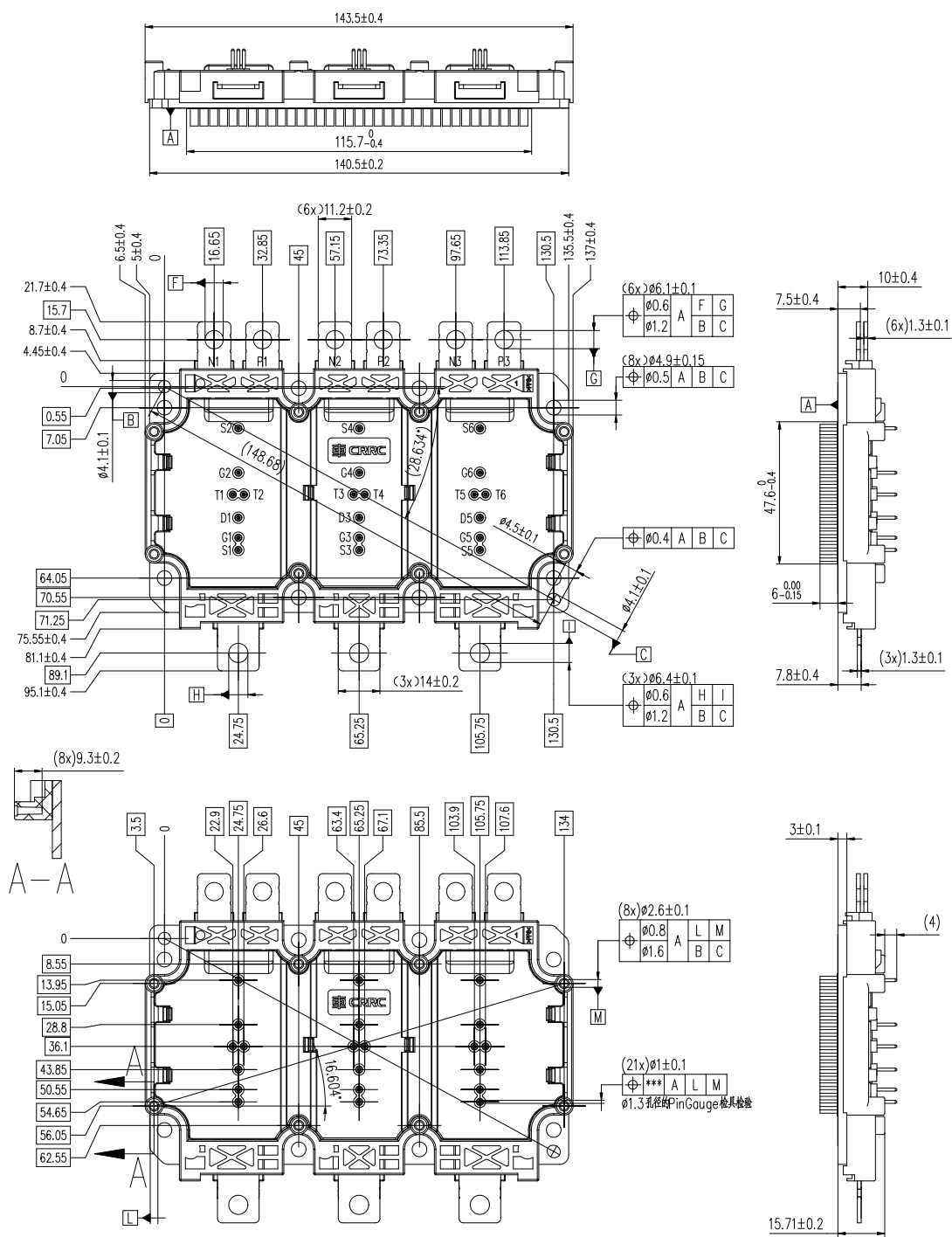


图 17. 瞬态热阻抗曲线,  $Z_{th(J-F)}=f(t_p)$

Fig.17 Transient thermal impedance,  $Z_{th(J-F)}=f(t_p)$



重量 Weight: 600g 模块外观类型 Module outline code: S7

图 18. 模块外观尺寸

Fig. 18 Module outlines

Caution: This device is sensitive to electrostatic discharge. Users should follow ESD handling procedures.

注意: 该器件对静电敏感, 用户须采取 ESD 防护措施。

株洲中车时代半导体有限公司

ZHUZHOU CRRC TIMES SEMICONDUCTOR CO., LTD.

|      |           |                                                           |                                                                                   |
|------|-----------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|
| 地 址  | Address   | 湖南省株洲市石峰区田心工业园                                            | Tianxin Industrial Park, Shifeng District,<br>ZhuZhou City, Hunan Province, China |
| 邮 编  | Zipcode   | 412001                                                    |                                                                                   |
| 电 话  | Telephone | +86 (0)731-28498268, 28498238, 28493472                   |                                                                                   |
| 传 真  | Fax       | +86 (0)731-28498851, 28498494                             |                                                                                   |
| 电子邮箱 | Email     | ctsc@csrzc.com                                            |                                                                                   |
| 网 址  | Web Site  | <a href="http://ctsc.csrzc.com">http://ctsc.csrzc.com</a> |                                                                                   |

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