# TM40S12B1A-303B
# SiC MOSFET 器件 SiC MOSFET Device

## 关键参数 Key Parameters

| | | | |
|---|---|---|---|
| $V_{DSmax}$ | | 1200 | V |
| $R_{DS(on)}$ | Typ. | 34 | mΩ |
| $I_D$ | Max. | 62 | A |

## 典型应用 Typical Application

- OBC — On Board Charger
- DC-DC — DC-DC Converter
- 充电桩 — Battery Chargers
- 光伏逆变 — Solar Inverters

## 特点 Features

- 高开关频率 — High Switching Frequency
- 低开关损耗 — Low Switching Loss
- 软、快速开关 — Soft, fast Switching
- 易并联使用 — Easy Paralleling

## 电路结构 Circuit Configuration

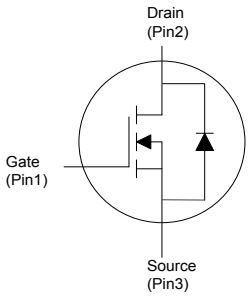



图 1. 电路结构

Fig. 1 Circuit configuration

## 器件外形 Device Appearance

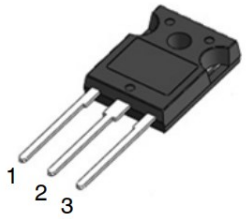



图 2. 模块外形

Fig. 2 Device appearance

## 最大额定值 Maximum Ratings

| 符号 Symbol | 参数名称 Parameter | 测试条件 Test Conditions | 数值 Value | 单位 Unit |
|---|---|---|---|---|
| $V_{DSS}$ | 漏源极电压 Drain-source voltage | $V_{GS}$=0V, $T_C$≥25℃ | 1200 | V |
| $V_{GSS}$ | 栅源电压 Gate-source voltage | $T_C$=25℃ | -8/+23 | V |
| $V_{GSop}$ | 栅源电压 Gate-source voltage | | -4/+18 | V |
| $I_D$ | 持续正向电流，由 $T_{vj\,max}$ 限制 Continuous forward current, limited by $T_{vj\,max}$ | $T_C$=25℃, $T_{vj\,max}$=175℃ | 62 | A |
| | | $T_C$=100℃, $T_{vj\,max}$=175℃ | 48 | A |
| $I_{DM}$ | 最大重复正向电流，由 $T_{vj\,max}$ 限制 Maximum repetitive forward current, limited by $T_{vj\,max}$ | $t_P$=1ms | 124 | A |
| $T_{vj\,max}$ | 最大允许结温 Max. Junction temperature | | 175 | °C |
| $T_{vj(op)}$ | 工作结温 Operation junction temperature | | -55...+175 | °C |

| | | | | |
|---|---|---|---|---|
| $T_{stg}$ | 存储温度<br>Storage temperature range | | -55...+150 | °C |
| $M$ | 安装力矩 - M3<br>Mounting Torque - M3 | | 0.6 | Nm |

## 电特性值 Electrical Characteristics

除非特别声明，否则 $T_{vj}$= 25 °C　　$T_{vj}$= 25 °C unless otherwise stated

| 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 |
|---|---|---|---|---|---|---|
| $I_{DSS}$ | 零栅压漏极电流<br>Zero gate voltage drain current | $V_{GS}$ = 0V, $V_{DS}$ = $V_{DSS}$ | | | 50 | μA |
| $I_{GSS}$ | 栅极漏电流<br>Gate leakage current | $V_{GS}$ = $V_{GSS}$, $V_{DS}$ = 0V | | | 250 | nA |
| $V_{GS(th)}$ (*1) | 栅极-源极阈值电压<br>Gate threshold voltage | $I_D$ = 10 mA, $V_{GS}$ = $V_{DS}$ | 2.1 | 2.8 | 3.5 | V |
| $R_{DS(on)}$ | 漏极-源极通态电阻<br>Drain-source on-state resistance | $V_{GS}$ =18V, $I_D$ = 33A | | 34 | 49 | mΩ |
| | | $V_{GS}$ =18V, $I_D$ =33A, $T_{vj}$ = 175 °C | | 55 | | mΩ |
| | | $V_{GS}$ =15V, $I_D$ = 33A | | 42 | | mΩ |
| | | $V_{GS}$ =15V, $I_D$ =33A, $T_{vj}$ = 175 °C | | 59 | | mΩ |
| $g_{fs}$ | 跨导<br>Forward transconductance | $V_{DS}$ =20V, $I_D$ = 33A | | 22 | | S |
| $C_{iss}$ | 输入电容<br>Input capacitance | $V_{DS}$ = 1000V, $V_{GS}$ = 0V, $f$ = 100kHz, $V_{AC}$ = 30mV | | 1854 | | pF |
| $C_{oss}$ | 输出电容<br>Output capacitance | | | 129 | | pF |
| $C_{rss}$ | 反向传输电容<br>Reverse transfer capacitance | | | 11 | | pF |
| $E_{oss}$ | 电容存储能量<br>$C_{oss}$ Stored Energy | | | 65 | | μJ |
| $R_{Gint}$ | 内部栅极电阻<br>Internal gate resistor | $V_{GS}$ =0V | | 3.2 | | Ω |
| $Q_{gs}$ | 栅源电荷<br>Gate to source charge | $I_D$ =33A, $V_{DS}$ = 800V, $V_{GS}$ = -4/+18V | | 27 | | nC |
| $Q_{gd}$ | 栅漏电荷<br>Gate to drain charge | | | 22 | | nC |
| $Q_g$ | 总栅极电荷<br>Total gate charge | | | 114 | | nC |
| $V_{SD}$ | 二极管正向电压<br>Diode forward voltage | $I_{SD}$ =33A, $V_{GS}$ = -4V | | 5.3 | | V |
| | | $I_{SD}$ =33A, $V_{GS}$ = -4V, $T_{vj}$ = 175 °C | | 4.8 | | V |

**注意：** 1.(*1)表示做过预处理后的测试值

**Note:** 1.(*1)Indicates $V_{GS(th)}$ is pre-processed).

## 电特性值 Electrical Characteristics

| 符号 Symbol | 参数名称 Parameter | 测试条件 Test Conditions | | 最小值 Min. | 典型值 Typ. | 最大值 Max. | 单位 Unit |
|---|---|---|---|---|---|---|---|
| $t_{d(off)}$ | 关断延迟时间 Turn-off delay time | $I_D$ =25A, $V_{DS}$ = 800V, $V_{GS}$ = -4/+15V, $R_{G(OFF)}$ =0.0Ω, d$v$/dt =59160V/μs ($T_{vj}$= 175 °C) | $T_{vj}$= 25 °C | | 25 | | ns |
| | | | $T_{vj}$= 175 °C | | 28 | | |
| $t_f$ | 下降时间 Fall time | | $T_{vj}$= 25 °C | | 18 | | ns |
| | | | $T_{vj}$= 175 °C | | 18 | | |
| $E_{OFF}$ | 关断损耗 Turn-off energy loss | | $T_{vj}$= 25 °C | | 68 | | μJ |
| | | | $T_{vj}$= 175 °C | | 88 | | |
| $t_{d(on)}$ | 开通延迟时间 Turn-on delay time | $I_D$ =25A, $V_{DS}$ = 800V, $V_{GS}$ = -4/+15V, $R_{G(ON)}$ =3.9Ω, d$i$/dt =1500A/μs ($T_{vj}$= 175 °C) | $T_{vj}$= 25 °C | | 11 | | ns |
| | | | $T_{vj}$= 175 °C | | 10 | | |
| $t_r$ | 上升时间 Rise time | | $T_{vj}$= 25 °C | | 12 | | ns |
| | | | $T_{vj}$= 175 °C | | 10 | | |
| $E_{ON}$ | 开通损耗 Turn-on energy loss | | $T_{vj}$= 25 °C | | 215 | | μJ |
| | | | $T_{vj}$= 175 °C | | 259 | | |
| $Q_{rr}$ | 二极管反向恢复电荷 Diode reverse recovery charge | $I_D$ =25A, $V_{DS}$ = 800V, - d$i_{SD}$/dt =1500A/μs ($T_{vj}$= 175 °C) | $T_{vj}$= 25 °C | | 113 | | nC |
| | | | $T_{vj}$= 175 °C | | 150 | | |
| $I_{rr}$ | 二极管反向恢复电流 Diode reverse recovery current | | $T_{vj}$= 25 °C | | 11 | | A |
| | | | $T_{vj}$= 175 °C | | 13 | | |

## 电特性值 Electrical Characteristics

| 符号 Symbol | 参数名称 Parameter | 测试条件 Test Conditions | | 最小值 Min. | 典型值 Typ. | 最大值 Max. | 单位 Unit |
|---|---|---|---|---|---|---|---|
| $t_{d(off)}$ | 关断延迟时间 Turn-off delay time | $I_D$ =25A, $V_{DS}$ = 800V, $V_{GS}$ = -4/+18V, $R_{G(OFF)}$ =0.0Ω, d$v$/dt =59200V/μs ($T_{vj}$= 175 °C) | $T_{vj}$= 25 °C | | 26 | | ns |
| | | | $T_{vj}$= 175 °C | | 32 | | |
| $t_f$ | 下降时间 Fall time | | $T_{vj}$= 25 °C | | 18 | | ns |
| | | | $T_{vj}$= 175 °C | | 18 | | |
| $E_{OFF}$ | 关断损耗 Turn-off energy loss | | $T_{vj}$= 25 °C | | 80 | | μJ |
| | | | $T_{vj}$= 175 °C | | 92 | | |
| $t_{d(on)}$ | 开通延迟时间 Turn-on delay time | $I_D$ =25A, $V_{DS}$ = 800V, $V_{GS}$ = -4/+18V, $R_{G(ON)}$ =1.8Ω, d$i$/dt =1500A/μs ($T_{vj}$= 175 °C) | $T_{vj}$= 25 °C | | 11 | | ns |
| | | | $T_{vj}$= 175 °C | | 11 | | |
| $t_r$ | 上升时间 Rise time | | $T_{vj}$= 25 °C | | 10 | | ns |
| | | | $T_{vj}$= 175 °C | | 10 | | |
| $E_{ON}$ | 开通损耗 Turn-on energy loss | | $T_{vj}$= 25 °C | | 224 | | μJ |
| | | | $T_{vj}$= 175 °C | | 271 | | |
| $Q_{rr}$ | 二极管反向恢复电荷 Diode reverse recovery charge | $I_D$ =25A, $V_{DS}$ = 800V, - d$i_{SD}$/dt =1500A/μs ($T_{vj}$= 175 °C) | $T_{vj}$= 25 °C | | 113 | | nC |
| | | | $T_{vj}$= 175 °C | | 150 | | |
| $I_{rr}$ | 二极管反向恢复电流 Diode reverse recovery current | | $T_{vj}$= 25 °C | | 11 | | A |
| | | | $T_{vj}$= 175 °C | | 13 | | |

## 热学特性 Thermal Characristics

| 符号 (Symbol) | 参数名称 (Parameter) | 条件 (Test Conditions) | 最小值 (Min) | 典型值 (Typ) | 最大值 (Max) | 单位 (Unit) |
|---|---|---|---|---|---|---|
| $R_{\theta VJ-C}$ | 结到壳热阻 Thermal resistance, junction – case | $T_C$ = 25°C, $T_{vj}$ = 175°C | | 0.47 | | K/W |

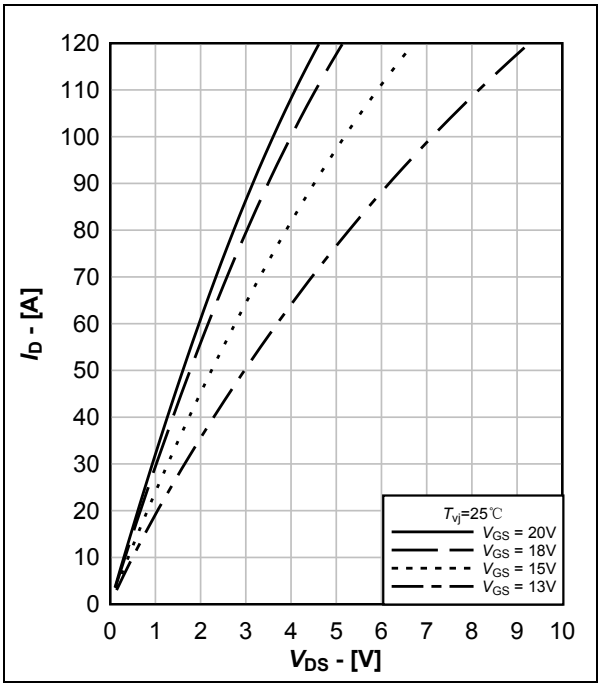



图 3. 输出特性典型曲线, $I_D$= f ($V_{DS}$), $T_{vj}$ = 25 °C

Fig.3 Typical output characteristics, $I_D$= f ($V_{DS}$), $T_{vj}$ = 25 °C

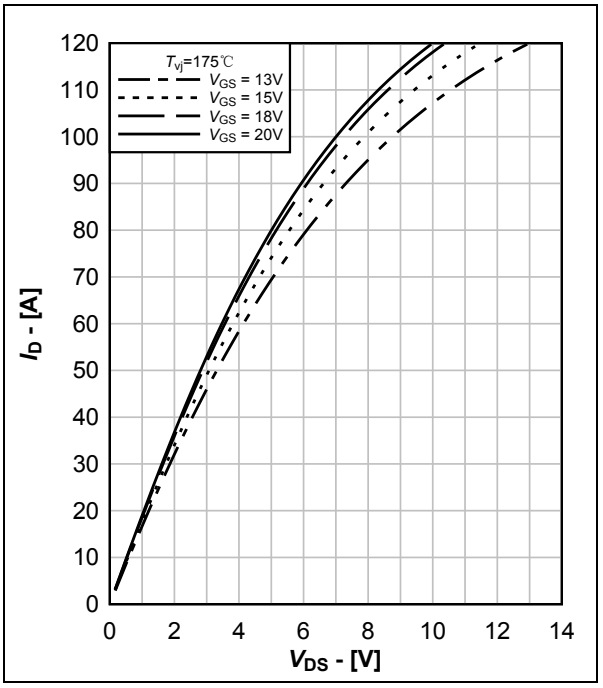



图 4. 输出特性典型曲线, $I_D$= f ($V_{DS}$), $T_{vj}$ = 175 °C

Fig.4 Typical output characteristics, $I_D$= f ($V_{DS}$), $T_{vj}$ = 175 °C

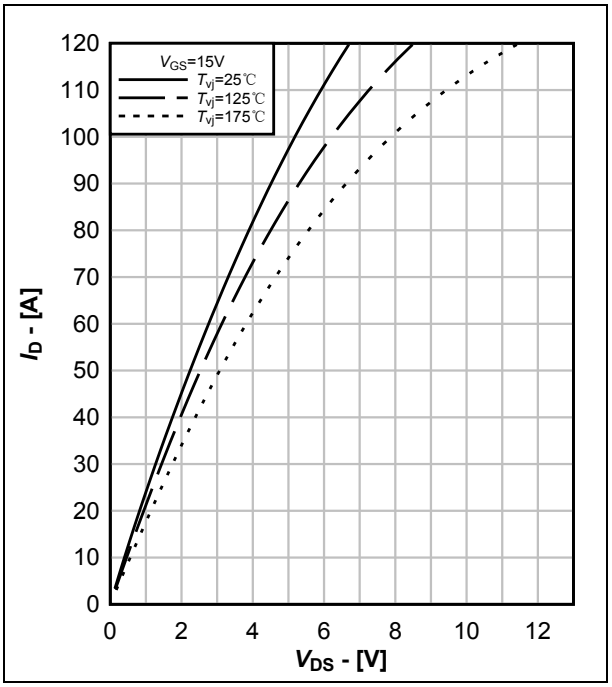



图 5. 输出特性典型曲线, $I_D$= f ($V_{DS}$)

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

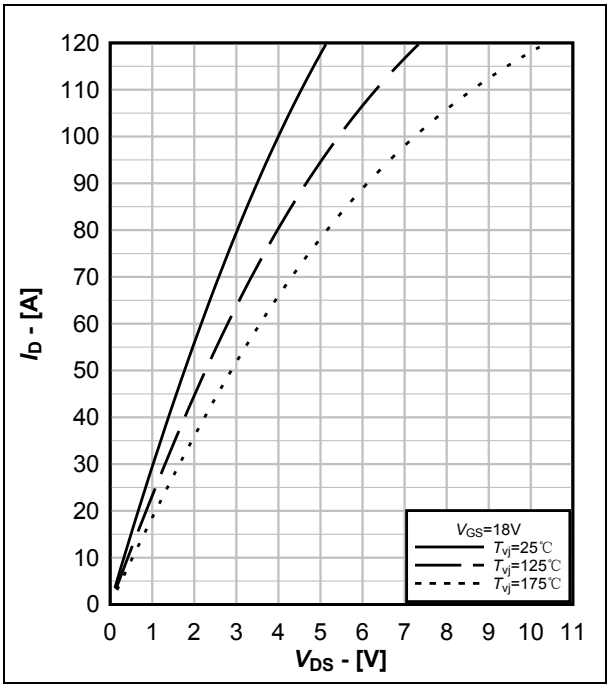



图 6. 输出特性典型曲线, $I_D$= f ($V_{DS}$)

Fig.6 Typical output characteristics, $I_D$= f ($V_{DS}$)

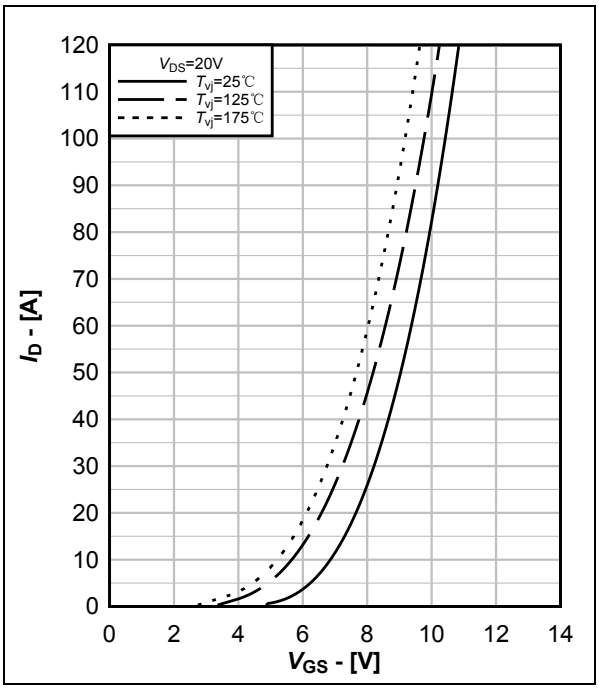



图 7.传输特性典型曲线,$I_D$= f ($V_{GS}$)

Fig.7 Typical transfer characteristics, $I_D$= f ($V_{GS}$)

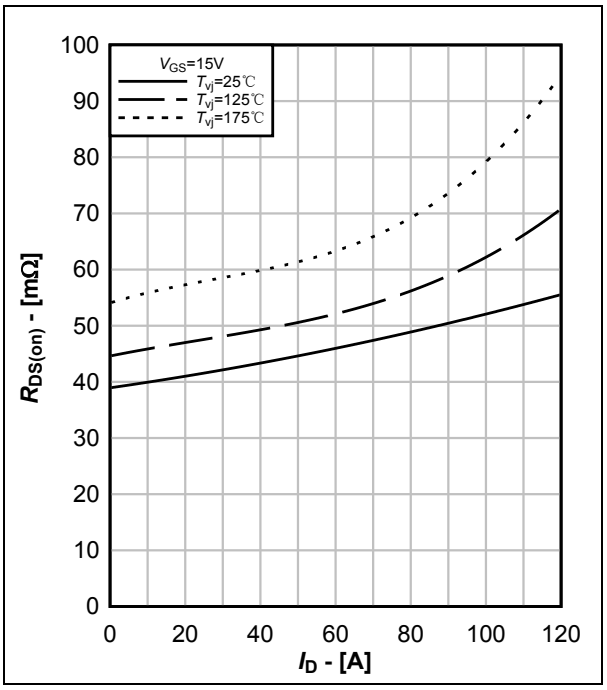



图 8. 导通电阻典型曲线, $R_{DS(on)}$ = f ($I_D$)

Fig.8 Typical On-Resistance characteristics, $R_{DS(on)}$ = f ($I_D$)

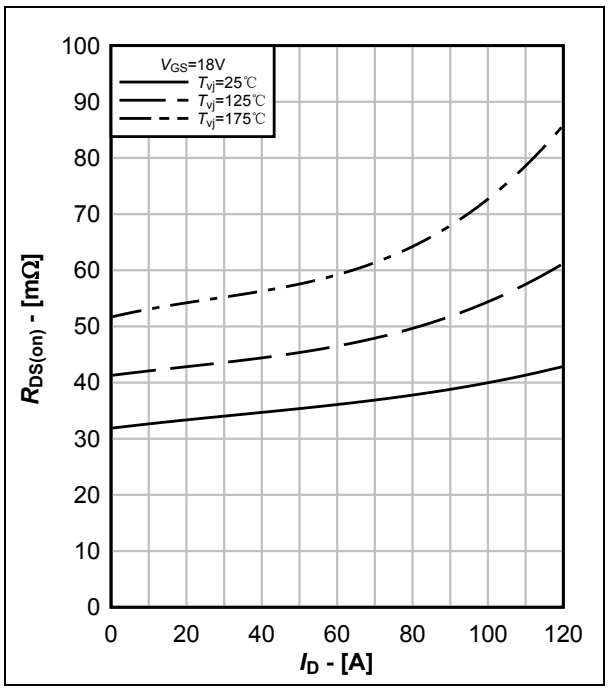



图 9. 导通电阻典型曲线, $R_{DS(on)}$ = f ($I_D$)

Fig.9 Typical On-Resistance characteristics, $R_{DS(on)}$ = f ($I_D$)

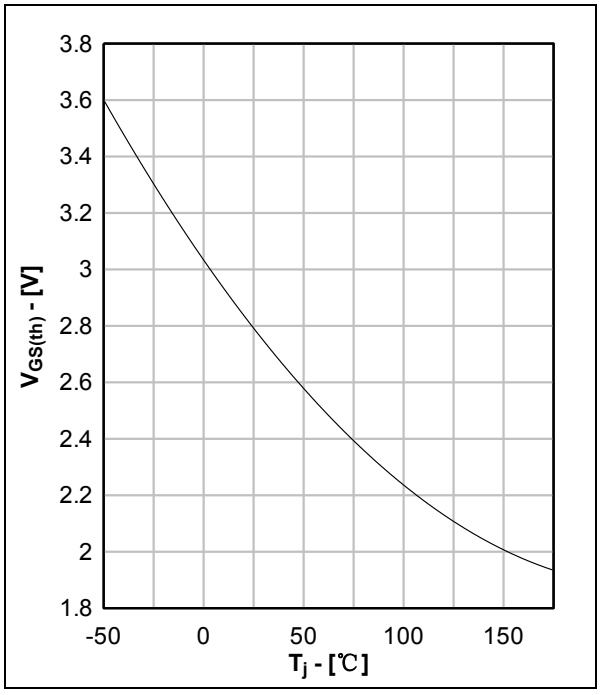



图 10. 阈值电压典型曲线, $V_{GS(th)}$ = f ($T_j$)

Fig.10 Typical $V_{GS(th)}$ characteristics, $V_{GS(th)}$ = f ($T_j$)

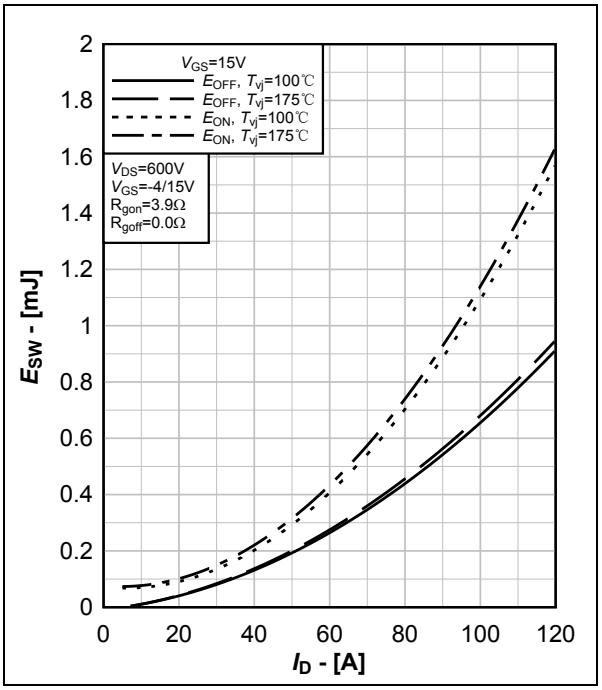



图 11. MOSFET 开关损耗典型曲线, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

Fig.12 Typical MOSFET switching energy, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

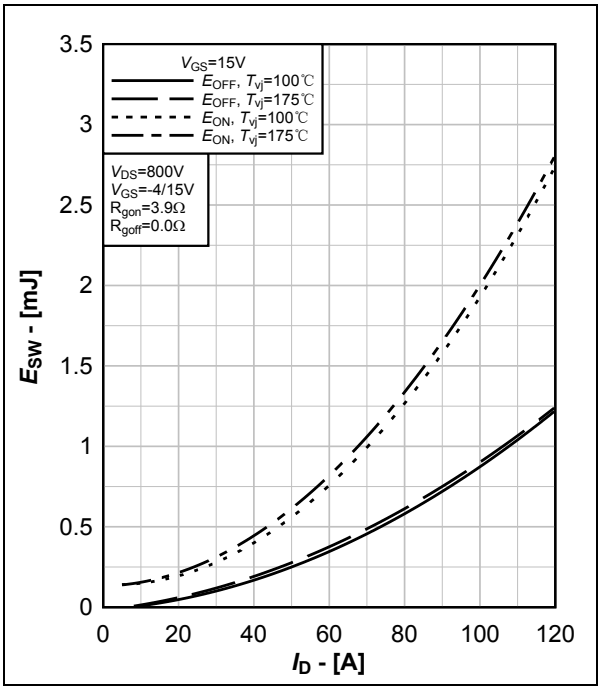



图 12. MOSFET 开关损耗典型曲线, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

Fig.12 Typical MOSFET switching energy, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

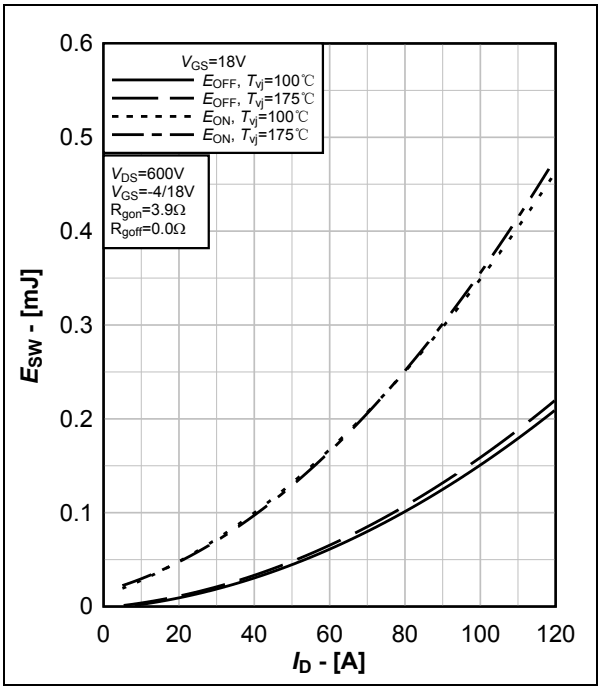



图 13. MOSFET 开关损耗典型曲线, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

Fig.13 Typical MOSFET switching energy, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

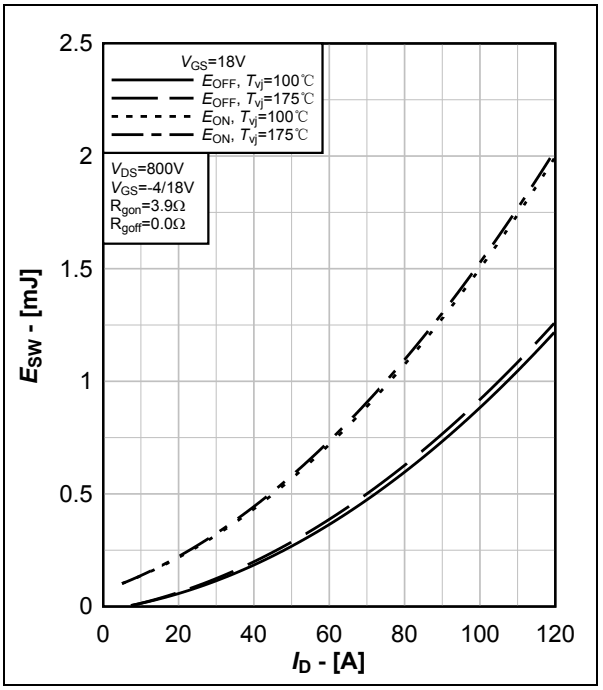



图 14. MOSFET 开关损耗典型曲线, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

Fig.14 Typical MOSFET switching energy, $E_{off}$= f ($I_D$), $E_{on}$= f ($I_D$)

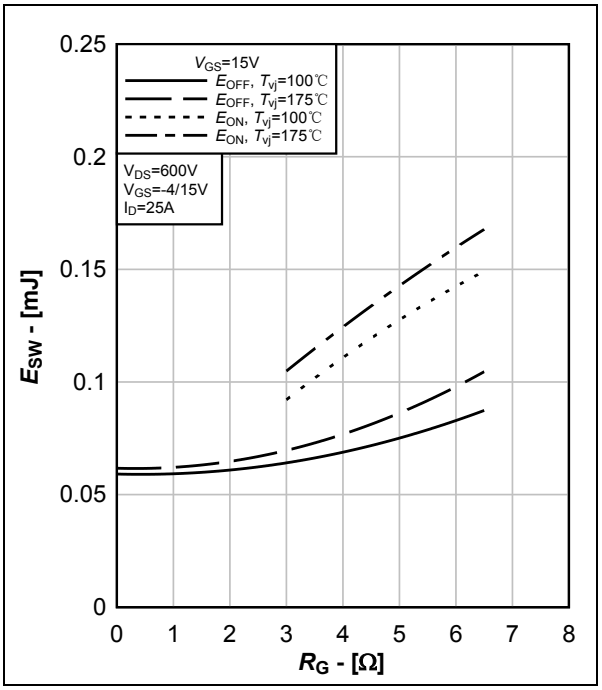



图 15. MOSFET 开关损耗典型曲线, $E_{on}$= f ($R_G$), $E_{off}$= f ($R_G$)

Fig.15 Typical MOSFET switching energy, $E_{on}$= f($R_G$), $E_{off}$= f ($R_G$)

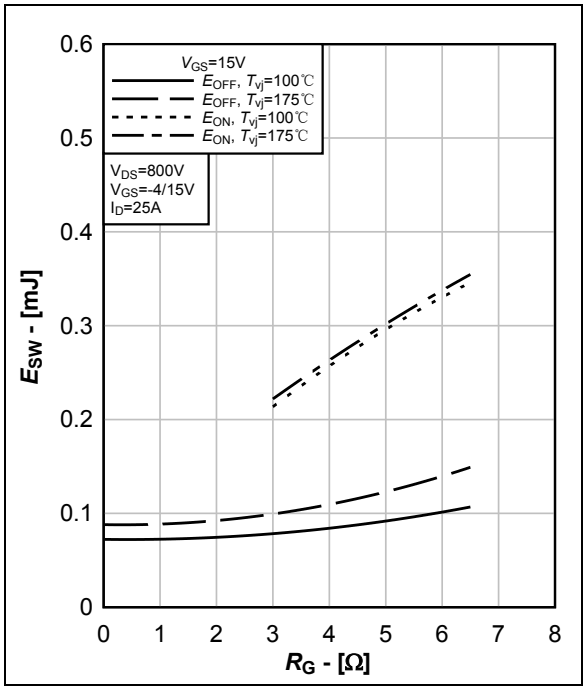



图 16. MOSFET 开关损耗典型曲线, $E_{on}$= f ($R_G$), $E_{off}$= f ($R_G$)

Fig.16 Typical MOSFET switching energy, $E_{on}$= f($R_G$), $E_{off}$= f ($R_G$)

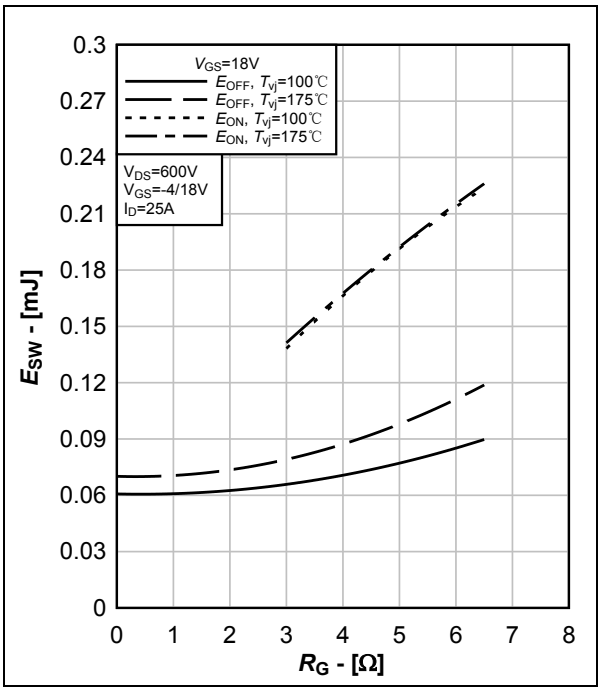



图 17. MOSFET 开关损耗典型曲线, $E_{on}$= f ($R_G$), $E_{off}$= f ($R_G$)

Fig.17 Typical MOSFET switching energy, $E_{on}$= f($R_G$), $E_{off}$= f ($R_G$)

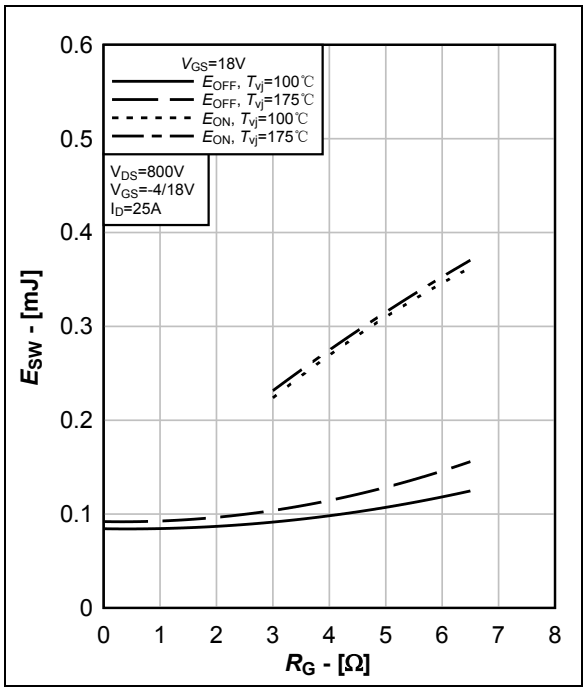



图 18. MOSFET 开关损耗典型曲线, $E_{on}$= f ($R_G$), $E_{off}$= f ($R_G$)

Fig.18 Typical MOSFET switching energy, $E_{on}$= f($R_G$), $E_{off}$= f ($R_G$)

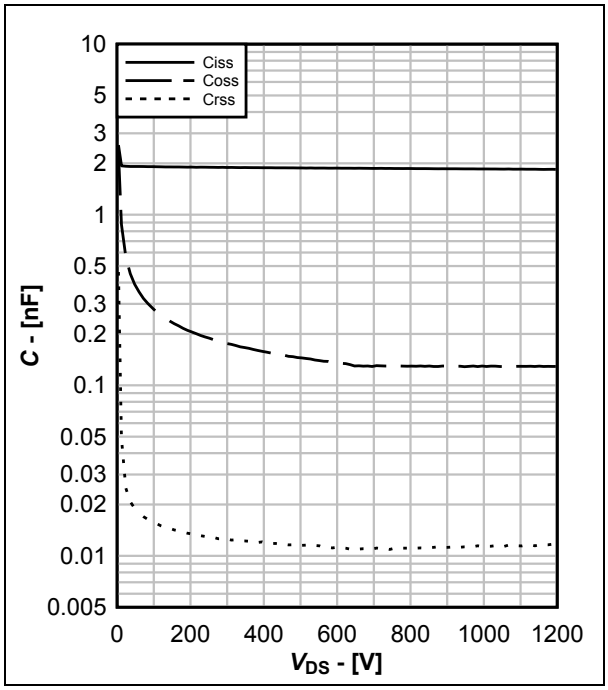



图 19. 电容特性典型曲线, $C$= f ($V_{DS}$)

Fig.19 Typical capacity characteristic, $C$= f ($V_{DS}$)

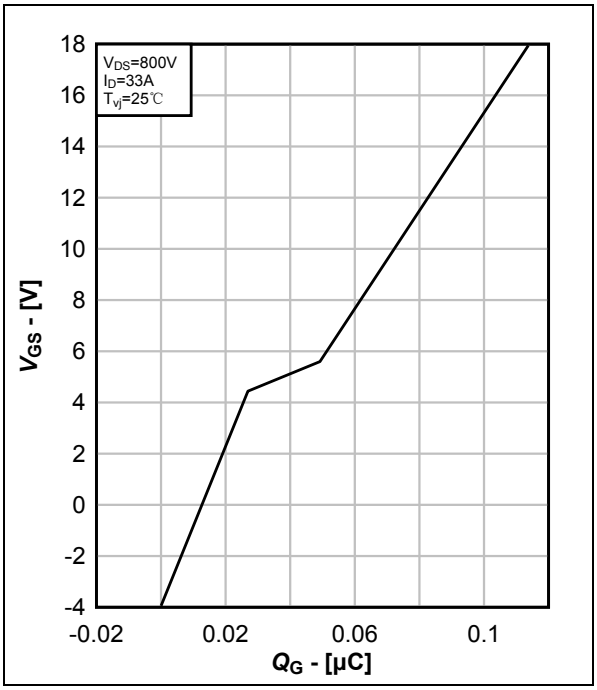



图 20. 栅极电荷特性典型曲线, $V_{GS}$ = f ($Q_G$)

Fig.20 Typical gate charge characteristic, $V_{GS}$= f ($Q_G$)

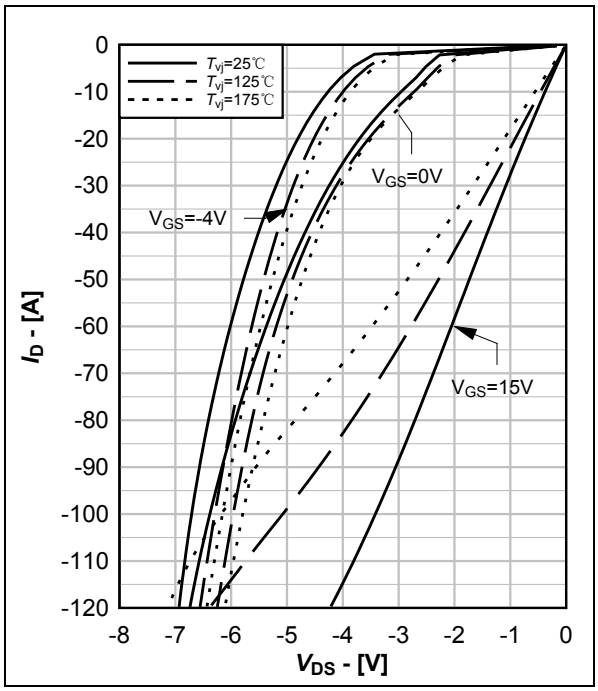



图 21. 体二极管及第三象限输出特性典型曲线, $I_D$ = f ($V_{DS}$)

Fig.21 Typical body diode output and 3rd quadrant characteristic, $I_D$ = f ($V_{DS}$)

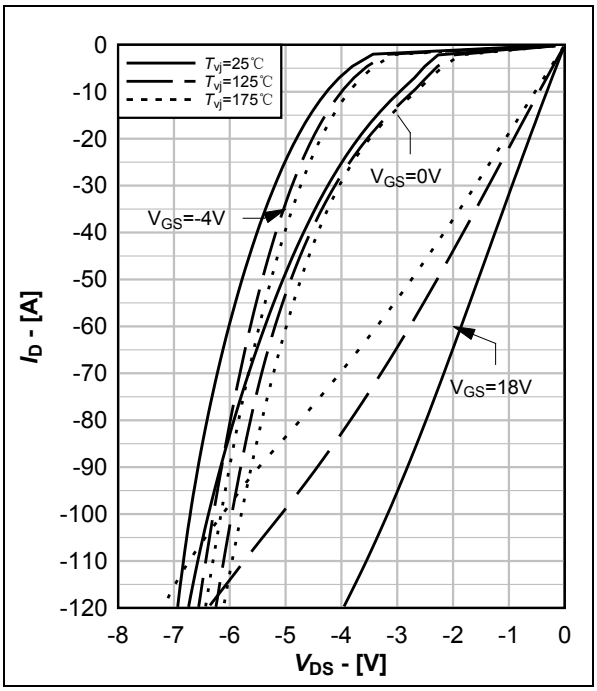



图 22. 体二极管及第三象限输出特性典型曲线, $I_D$ = f ($V_{DS}$)

Fig.22 Typical body diode output and 3rd quadrant characteristic, $I_D$ = f ($V_{DS}$)

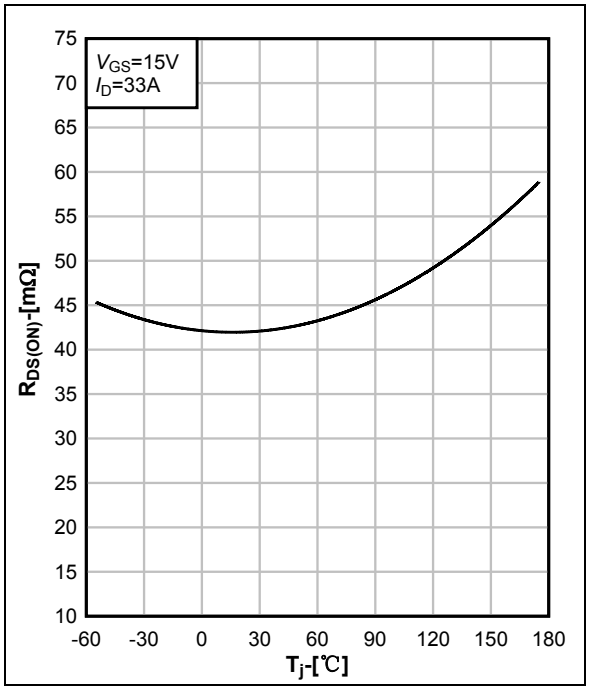



图 23. 导通电阻典型曲线, $R_{DS(on)}$ = f ($T_j$)

Fig.23 Typical On-Resistance characteristics, $R_{DS(on)}$ = f ($T_j$)

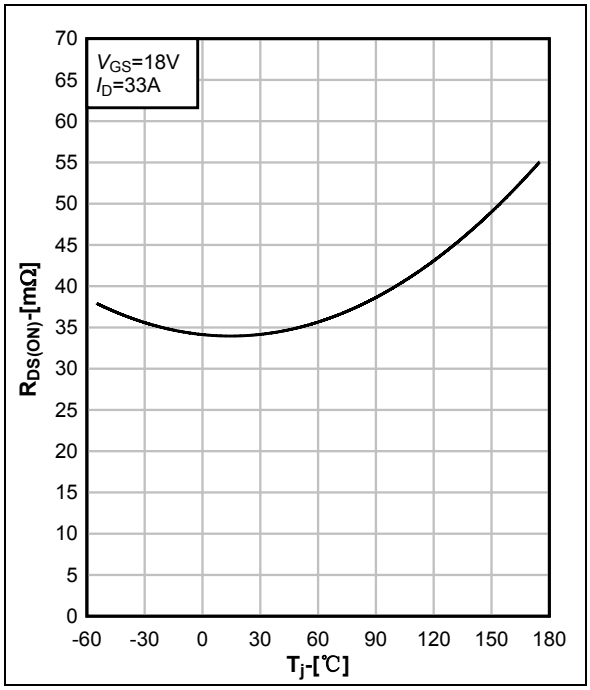



图 24. 导通电阻典型曲线, $R_{DS(on)}$ = f ($T_j$)

Fig.24 Typical On-Resistance characteristics, $R_{DS(on)}$ = f ($T_j$)

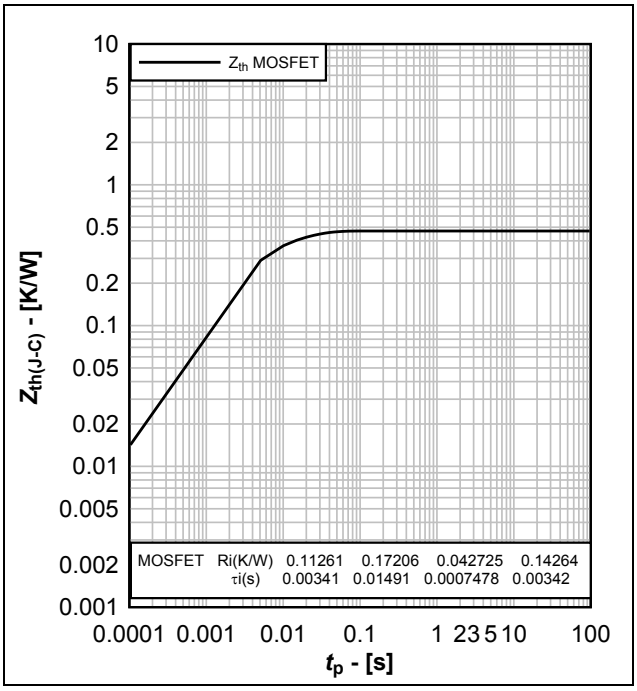
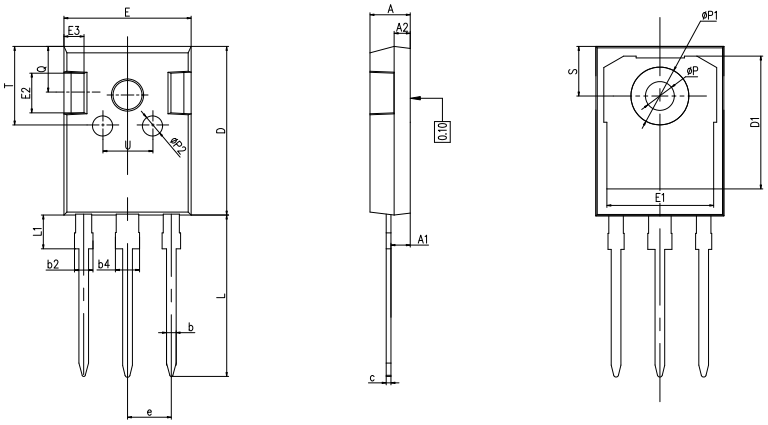



图 25. 瞬态热阻抗曲线, $Z_{th(J-C)}$ = f ($t_p$)

Fig.25 Transient thermal impedance, $Z_{th(J-C)}$ = f ($t_p$)




| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.21 | 2.41 | 2.59 |
| A2 | 1.85 | 2.00 | 2.15 |
| b | 1.11 | 1.21 | 1.36 |
| b2 | 1.91 | 2.01 | 2.21 |
| b4 | 2.91 | 3.01 | 3.21 |
| c | 0.51 | 0.61 | 0.75 |
| D | 20.70 | 21.00 | 21.30 |
| D1 | 16.25 | 16.55 | 16.85 |
| E | 15.50 | 15.80 | 16.10 |
| E1 | 13.00 | 13.30 | 13.60 |
| E2 | 4.80 | 5.00 | 5.20 |
| E3 | 2.30 | 2.50 | 2.70 |
| e | 5.44BSC | | |
| L | 19.62 | 19.92 | 20.22 |
| L1 | - | - | 4.30 |
| M | 0.35 | - | 0.95 |
| P | 3.40 | 3.60 | 3.80 |
| P1 | 7.00 | - | 7.40 |
| S | 6.05 | 6.15 | 6.25 |

图 26. 封装尺寸

Fig. 26 Package Dimensions

**株洲中车时代半导体有限公司**

**ZHUZHOU CRRC TIMES SEMICONDUCTOR CO., LTD**

| | | |
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