

英飞凌CoolSiC™ M1

PG-TO263-7

英飞凌CoolSiC™ MOSFET 650V G1

英飞凌650 V CoolSiC™基于英飞凌超过20 年的碳化硅技术积累构建。650V CoolSiC™ MOSFET 利用宽带隙 SiC 材料的特性，提供了性能、可靠性和易用性的独特组合。它适用于高温和恶劣的操作，能够以简化且经济高效的方式实现行业领先的系统效率。

特性

- 优化高电流下的开关行为
- 具有低  $Q_{fr}$  值的快速体二极管确保换向的稳健性
- 卓越的栅极氧化物可靠性
- $T_{j,max}=175^{\circ}\text{C}$  和优异的热性能
- 较低  $R_{DS(on)}$  和脉冲电流对温度的依赖性
- 增强雪崩能力
- 与标准驱动兼容
- 开尔文源可将开关损耗降低 4 倍

优点

- 高性能、高可靠性和易用性的独特组合
- 易于使用和集成
- 适用于连续硬换向拓扑
- 更高的稳健性和系统可靠性
- 提高效率
- 减小系统尺寸，提高功率密度

潜在的应用

- 通信和服务器 SMPS
- UPS（不间断电源）
- 太阳能逆变器
- 电动汽车充电基础设施
- 储能和电池化成
- D 类放大器

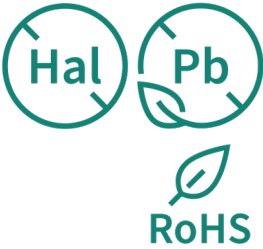
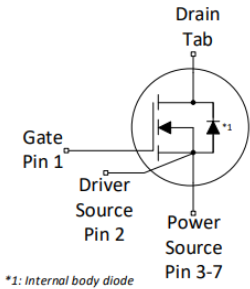
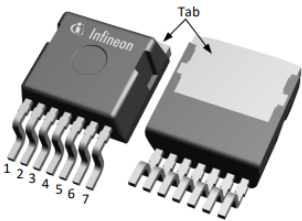
产品认证

完全符合 JEDEC 工业应用标准  
请注意：源和感测源引脚不可互换。 它们的交换可能会导致故障。

表 1 主要性能参数

| Parameter                       | Value | Unit |
|---------------------------------|-------|------|
| $V_{DS}@T_J=25^{\circ}\text{C}$ | 650   | V    |
| $R_{DS(on),typ}$                | 107   | mΩ   |
| $R_{DS(on),max}$                | 141   | mΩ   |
| $Q_{G,typ}$                     | 15    | nC   |
| $I_{DM,max}$                    | 47    | A    |
| $Q_{oss}@400\text{ V}$          | 35    | nC   |
| $E_{oss}@400\text{ V}$          | 5.3   | μJ   |

| Type/Ordering Code | Package    | Marking  | Related Links  |
|--------------------|------------|----------|----------------|
| IMBG65R107M1H      | PG-TO263-7 | 65R107M1 | see Appendix A |



本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。为确认准确性，请务必访问 [infineon.com](http://infineon.com) 参考最新的英文版本（控制文档）。



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## 1 最大额定值

除非另有规定， $T_j = 25\text{ }^{\circ}\text{C}$ 。

注意：为了获得最佳的使用寿命和可靠性，英飞凌建议工作条件不超过本数据表中所述最大额定值的80%。

**表 2 最大额定值**

| Parameter                                      | Symbol           | Values |      |          | Unit               | Note/ Test Condition                                                                                                                    |
|------------------------------------------------|------------------|--------|------|----------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
|                                                |                  | Min.   | Typ. | Max.     |                    |                                                                                                                                         |
| Continuous DC drain current <sup>1)</sup>      | $I_{\text{DDC}}$ | -      | -    | 24<br>17 | A                  | $T_c = 25\text{ }^{\circ}\text{C}$<br>$T_c = 100\text{ }^{\circ}\text{C}$                                                               |
| Peak drain current <sup>2)</sup>               | $I_{\text{DM}}$  | -      | -    | 47       | A                  | $T_c = 25\text{ }^{\circ}\text{C}$ , $V_{\text{GS}} = 18\text{ V}$                                                                      |
| Avalanche energy, single pulse                 | $E_{\text{AS}}$  | -      | -    | 76       | mJ                 | $I_D = 2.8\text{ A}$ , $V_{\text{DD}} = 50\text{ V}$ ; see table 11                                                                     |
| Avalanche energy, repetitive                   | $E_{\text{AR}}$  | -      | -    | 0.38     | mJ                 | $I_D = 2.8\text{ A}$ , $V_{\text{DD}} = 50\text{ V}$ ; see table 11                                                                     |
| Avalanche current, single pulse                | $I_{\text{AS}}$  | -      | -    | 2.8      | A                  | -                                                                                                                                       |
| MOSFET $dv/dt$ ruggedness                      | $dv/dt$          | -      | -    | 200      | V/ns               | $V_{\text{DS}} = 0\ldots 400\text{ V}$                                                                                                  |
| Gate source voltage (static) <sup>3)</sup>     | $V_{\text{GS}}$  | -5     | -    | 23       | V                  | -                                                                                                                                       |
| Gate source voltage (transient)                | $V_{\text{GS}}$  | -7     | -    | 25       | V                  | $t_{\text{pulse}} \leq 1\%$ duty cycle/ $f_{\text{sw}}$                                                                                 |
| Power dissipation                              | $P_{\text{tot}}$ | -      | -    | 110      | W                  | $T_c = 25\text{ }^{\circ}\text{C}$                                                                                                      |
| Storage temperature                            | $T_{\text{stg}}$ | -55    | -    | 150      | $^{\circ}\text{C}$ | -                                                                                                                                       |
| Operating junction temperature                 | $T_j$            | -55    | -    | 175      | $^{\circ}\text{C}$ | -                                                                                                                                       |
| Mounting torque                                | -                | -      | -    | n.a.     | Ncm                | -                                                                                                                                       |
| Continuous reverse drain current <sup>1)</sup> | $I_{\text{SDC}}$ | -      | -    | 24<br>16 | A                  | $V_{\text{GS}} = 18\text{ V}$ , $T_c = 25\text{ }^{\circ}\text{C}$<br>$V_{\text{GS}} = 0\text{ V}$ , $T_c = 25\text{ }^{\circ}\text{C}$ |
| Peak reverse drain current <sup>2)</sup>       | $I_{\text{SM}}$  | -      | -    | 47       | A                  | $T_c = 25\text{ }^{\circ}\text{C}$ , $t_p \leq 250\text{ ns}$                                                                           |
| Insulation withstand voltage                   | $V_{\text{ISO}}$ | -      | -    | n.a.     | V                  | $V_{\text{rms}}$ , $T_c = 25\text{ }^{\circ}\text{C}$ , $t = 1\text{ min}$                                                              |

1) 受 $T_{j,\text{max}}$ 限制。

2) 脉冲宽度 $t_{\text{pulse}}$ 受 $T_{j,\text{max}}$ 限制。

3) 应用设计中的最大栅极源电压应符合IPC-9592B的规定。

## 2 热特性

表3 热特性

| Parameter                                               | Symbol        | Values |      |      | Unit | Note/ Test Condition                                                                                                                                                                |
|---------------------------------------------------------|---------------|--------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                                                                                                                                                                                     |
| Thermal resistance, junction - case                     | $R_{th(j-c)}$ | -      | -    | 1.36 | °C/W | -                                                                                                                                                                                   |
| Thermal resistance, junction - ambient                  | $R_{th(j-a)}$ | -      | -    | 62   | °C/W | device on PCB, minimal footprint                                                                                                                                                    |
| Thermal resistance, junction - ambient, SMD version     | $R_{th(j-a)}$ | -      | 35   | 45   | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm <sup>2</sup> (one layer, 70μm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wave- & reflow soldering allowed | $T_{sold}$    | -      | -    | 260  | °C   | reflow MSL1                                                                                                                                                                         |



3 工作范围

表 4 工作范围

| Parameter                                                               | Symbol        | Values |      |      | Unit | Note/ Test Condition |
|-------------------------------------------------------------------------|---------------|--------|------|------|------|----------------------|
|                                                                         |               | Min.   | Typ. | Max. |      |                      |
| Gate-source voltage operating range including undershoots <sup>4)</sup> | $V_{GS}$      | -2     | -    | 20   | V    | -                    |
| Recommended turn-on voltage                                             | $V_{GS(on)}$  | -      | 18   | -    | V    | -                    |
| Recommended turn-off voltage                                            | $V_{GS(off)}$ | -      | 0    | -    | V    | -                    |

4)

重要提示：如果应用中器件的栅极源电压超出工作范围（表 4），则器件  $R_{DS(on)}$  和  $V_{GS(th)}$  可能会在器件使用寿命结束时超过数据表中规定的最大值。为了确保器件在计划使用寿命内正常运行，必须考虑最大额定值（表 2）和 CoolSiC™ MOSFET 650V M1 沟槽功率器件应用说明 AN\_1907\_PL52\_1911\_144109。

## 4 电气特性

除非另有规定,  $T_j = 25\text{ }^{\circ}\text{C}$

表 5 直流特性

| Parameter                            | Symbol              | Values |            |          | Unit          | Note/ Test Condition                                                                                                                                                                          |
|--------------------------------------|---------------------|--------|------------|----------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      |                     | Min.   | Typ.       | Max.     |               |                                                                                                                                                                                               |
| Drain-source voltage                 | $V_{\text{DSS}}$    | 650    | -          | -        | V             | $V_{\text{GS}} = 0\text{ V}, I_{\text{D}} = 0.26\text{ mA}$                                                                                                                                   |
| Gate threshold voltage <sup>5)</sup> | $V_{\text{GS(th)}}$ | 3.5    | 4.5        | 5.7      | V             | $V_{\text{DS}} = V_{\text{GS}}, I_{\text{D}} = 2.6\text{ mA}$                                                                                                                                 |
| Zero gate voltage drain current      | $I_{\text{DSS}}$    | -      | 1<br>3     | 100<br>- | $\mu\text{A}$ | $V_{\text{DS}} = 650\text{ V}, V_{\text{GS}} = 0\text{ V}, T_j = 25\text{ }^{\circ}\text{C}$<br>$V_{\text{DS}} = 650\text{ V}, V_{\text{GS}} = 0\text{ V}, T_j = 175\text{ }^{\circ}\text{C}$ |
| Gate-source leakage current          | $I_{\text{GSS}}$    | -      | -          | 100      | nA            | $V_{\text{GS}} = 20\text{ V}, V_{\text{DS}} = 0\text{ V}$                                                                                                                                     |
| Drain-source on-state resistance     | $R_{\text{DS(on)}}$ | -      | 107<br>150 | 141<br>- | m $\Omega$    | $V_{\text{GS}} = 18\text{ V}, I_{\text{D}} = 8.9\text{ A}, T_j = 25\text{ }^{\circ}\text{C}$<br>$V_{\text{GS}} = 18\text{ V}, I_{\text{D}} = 8.9\text{ A}, T_j = 175\text{ }^{\circ}\text{C}$ |
| Internal gate resistance             | $R_{\text{G,int}}$  | -      | 12.0       | -        | $\Omega$      | $f = 1\text{ MHz}$                                                                                                                                                                            |

<sup>5)</sup> 在  $V_{\text{GS}} = +20\text{ V}$  时 1 ms 脉冲之后进行测试。

表 6 直流特性

| Parameter                                                  | Symbol              | Values |      |      | Unit | Note/ Test Condition                                                                                                                                   |
|------------------------------------------------------------|---------------------|--------|------|------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                            |                     | Min.   | Typ. | Max. |      |                                                                                                                                                        |
| Input capacitance                                          | $C_{\text{iss}}$    | -      | 496  | -    | pF   | $V_{\text{GS}} = 0\text{ V}, V_{\text{DS}} = 400\text{ V}, f = 250\text{ kHz}$                                                                         |
| Reverse transfer capacitance                               | $C_{\text{rss}}$    | -      | 6.5  | -    | pF   | $V_{\text{GS}} = 0\text{ V}, V_{\text{DS}} = 400\text{ V}, f = 250\text{ kHz}$                                                                         |
| Output capacitance <sup>6)</sup>                           | $C_{\text{oss}}$    | -      | 58   | 75   | pF   | $V_{\text{GS}} = 0\text{ V}, V_{\text{DS}} = 400\text{ V}, f = 250\text{ kHz}$                                                                         |
| Output charge <sup>6)</sup>                                | $Q_{\text{oss}}$    | -      | 35   | 46   | nC   | calculation based on $C_{\text{oss}}$                                                                                                                  |
| Effective output capacitance, energy related <sup>7)</sup> | $C_{\text{o(er)}}$  | -      | 66   | -    | pF   | $V_{\text{GS}} = 0\text{ V},$<br>$V_{\text{DS}} = 0\ldots 400\text{ V}$                                                                                |
| Effective output capacitance, time related <sup>8)</sup>   | $C_{\text{o(tr)}}$  | -      | 87   | -    | pF   | $I_{\text{D}} = \text{constant}, V_{\text{GS}} = 0\text{ V}, V_{\text{DS}} = 0\ldots 400\text{ V}$                                                     |
| Turn-on delay time                                         | $t_{\text{d(on)}}$  | -      | 5.8  | -    | ns   | $V_{\text{DD}} = 400\text{ V}, V_{\text{GS}} = 0/18\text{ V},$<br>$I_{\text{D}} = 8.9\text{ A}, R_{\text{G,ext}} = 1.8\text{ }\Omega;$<br>see table 10 |
| Rise time                                                  | $t_{\text{r}}$      | -      | 6.7  | -    | ns   | $V_{\text{DD}} = 400\text{ V}, V_{\text{GS}} = 0/18\text{ V},$<br>$I_{\text{D}} = 8.9\text{ A}, R_{\text{G,ext}} = 1.8\text{ }\Omega;$<br>see table 10 |
| Turn-off delay time                                        | $t_{\text{d(off)}}$ | -      | 10.1 | -    | ns   | $V_{\text{DD}} = 400\text{ V}, V_{\text{GS}} = 0/18\text{ V},$<br>$I_{\text{D}} = 8.9\text{ A}, R_{\text{G,ext}} = 1.8\text{ }\Omega;$<br>see table 10 |
| Fall time                                                  | $t_{\text{f}}$      | -      | 7.0  | -    | ns   | $V_{\text{DD}} = 400\text{ V}, V_{\text{GS}} = 0/18\text{ V},$<br>$I_{\text{D}} = 8.9\text{ A}, R_{\text{G,ext}} = 1.8\text{ }\Omega;$<br>see table 10 |

- 6) 最大规格由计算出的六西格玛置信上限定义。
- 7)  $C_{o(er)}$  是一个固定电容，当  $V_{DS}$  从 0 上升至 400 V 时，其提供与  $C_{oss}$  相同的储存能量。
- 8)  $C_{o(tr)}$  是一个固定电容，当  $V_{DS}$  从 0 上升至 400 V 时，其充电时间与  $C_{oss}$  相同。

表7 栅极电荷特性

| Parameter                     | Symbol       | Values |      |      | Unit | Note/ Test Condition                                                                   |
|-------------------------------|--------------|--------|------|------|------|----------------------------------------------------------------------------------------|
|                               |              | Min.   | Typ. | Max. |      |                                                                                        |
| Plateau gate to source charge | $Q_{GS(pl)}$ | -      | 4    | -    | nC   | $V_{DD} = 400\text{ V}$ , $I_D = 8.9\text{ A}$ ,<br>$V_{GS} = 0\text{ to }18\text{ V}$ |
| Gate to drain charge          | $Q_{GD}$     | -      | 3    | -    | nC   | $V_{DD} = 400\text{ V}$ , $I_D = 8.9\text{ A}$ ,<br>$V_{GS} = 0\text{ to }18\text{ V}$ |
| Total gate charge             | $Q_G$        | -      | 15   | -    | nC   | $V_{DD} = 400\text{ V}$ , $I_D = 8.9\text{ A}$ ,<br>$V_{GS} = 0\text{ to }18\text{ V}$ |

表8 反向二极管特性

| Parameter                                    | Symbol    | Values |      |      | Unit | Note/ Test Condition                                                                                    |
|----------------------------------------------|-----------|--------|------|------|------|---------------------------------------------------------------------------------------------------------|
|                                              |           | Min.   | Typ. | Max. |      |                                                                                                         |
| Drain-source reverse voltage                 | $V_{SD}$  | -      | 4.0  | -    | V    | $V_{GS} = 0\text{ V}$ , $I_S = 8.9\text{ A}$ , $T_J = 25\text{ °C}$                                     |
| MOSFET forward recovery time                 | $t_{fr}$  | -      | 17.7 | -    | ns   | $V_{DD} = 400\text{ V}$ , $I_S = 8.9\text{ A}$ ,<br>$di_S/dt = 1000\text{ A}/\mu\text{s}$ ; see table 9 |
| MOSFET forward recovery charge <sup>9)</sup> | $Q_{fr}$  | -      | 47   | -    | nC   | $V_{DD} = 400\text{ V}$ , $I_S = 8.9\text{ A}$ ,<br>$di_S/dt = 1000\text{ A}/\mu\text{s}$ ; see table 9 |
| MOSFET peak forward recovery current         | $I_{frm}$ | -      | 5.2  | -    | A    | $V_{DD} = 400\text{ V}$ , $I_S = 8.9\text{ A}$ ,<br>$di_S/dt = 1000\text{ A}/\mu\text{s}$ ; see table 9 |

- 9)  $Q_{fr}$  包括  $Q_{oss}$ 。

5 电气特性图

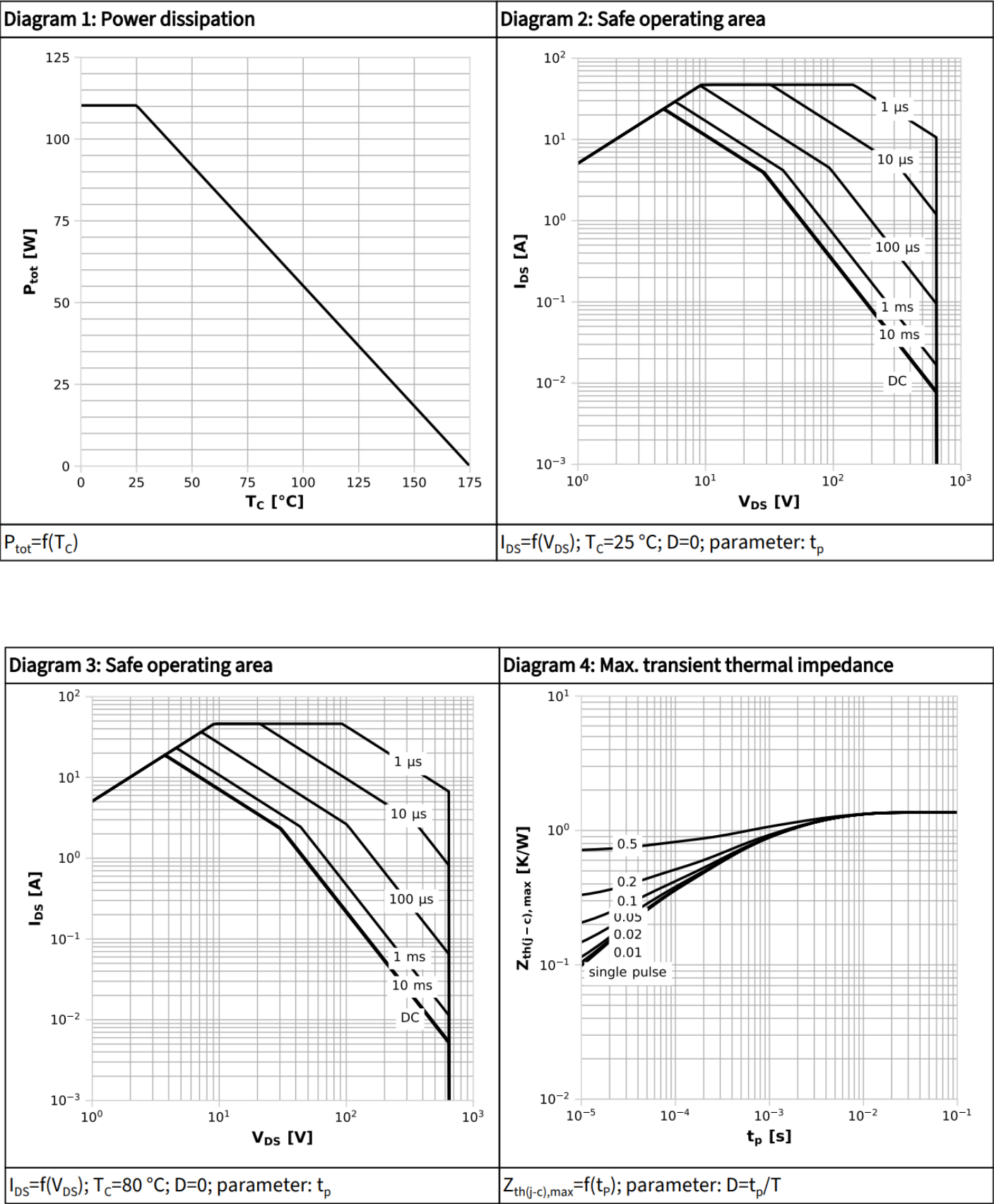
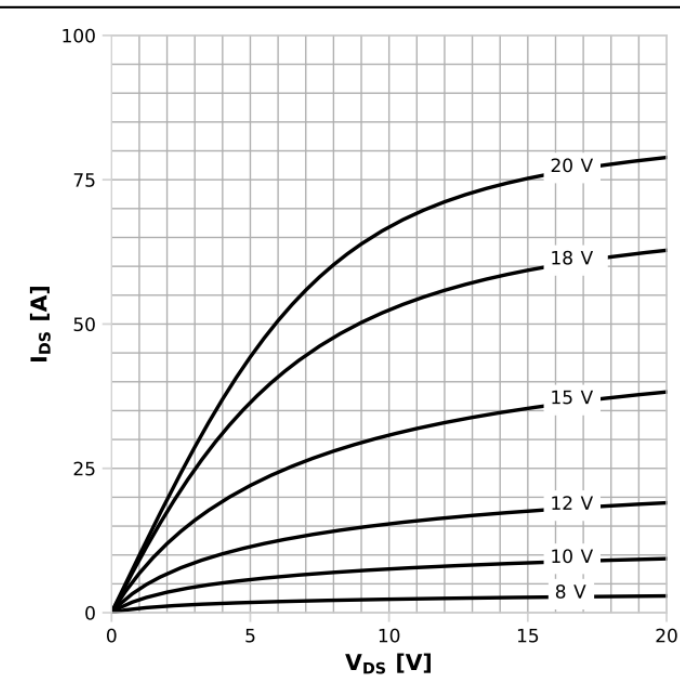


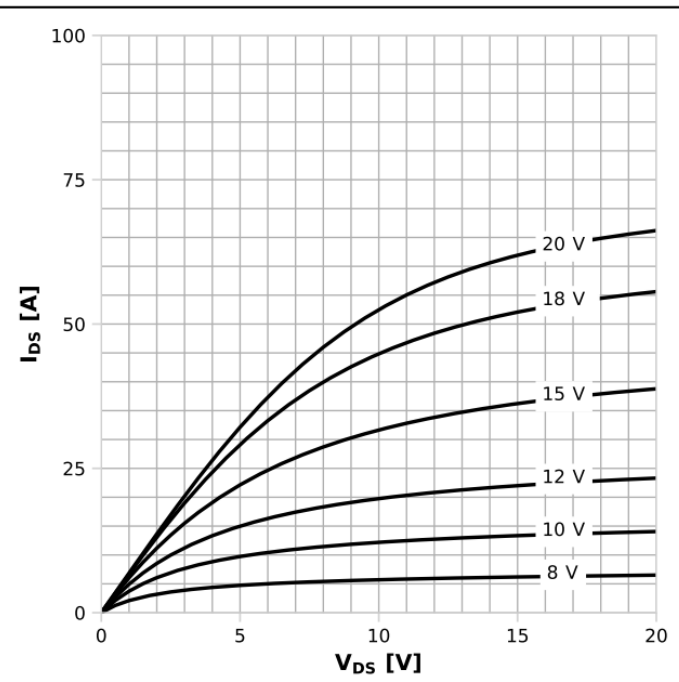


Diagram 5: Typ. output characteristics



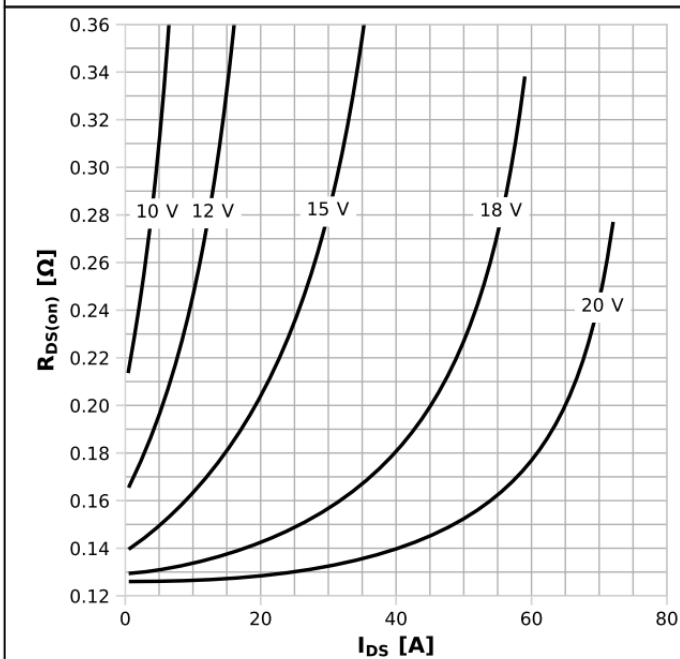
$I_{DS}=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



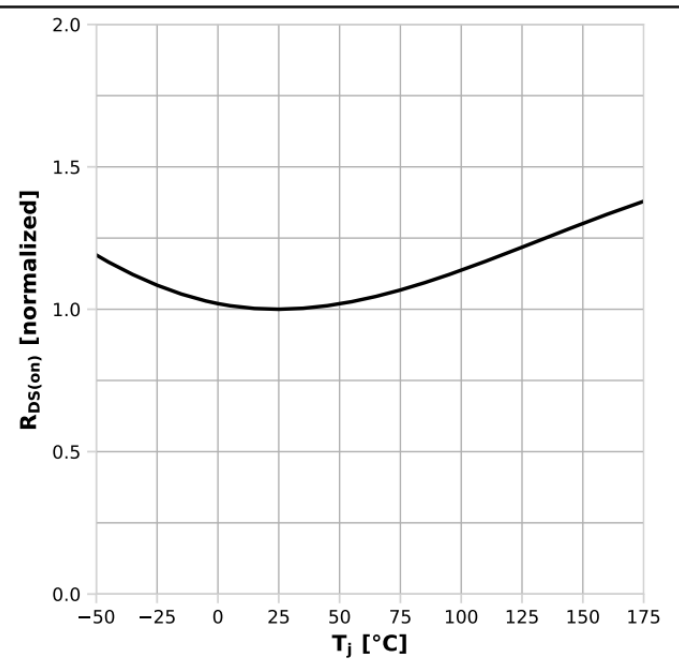
$I_{DS}=f(V_{DS}); T_j=175\text{ °C}; \text{parameter: } V_{GS}$

Diagram 7: Typ. drain-source on-state resistance



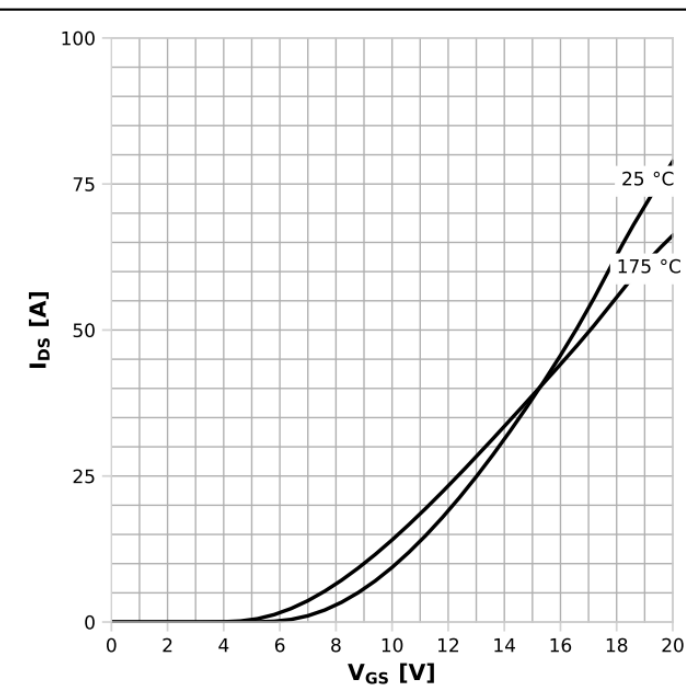
$R_{DS(on)}=f(I_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



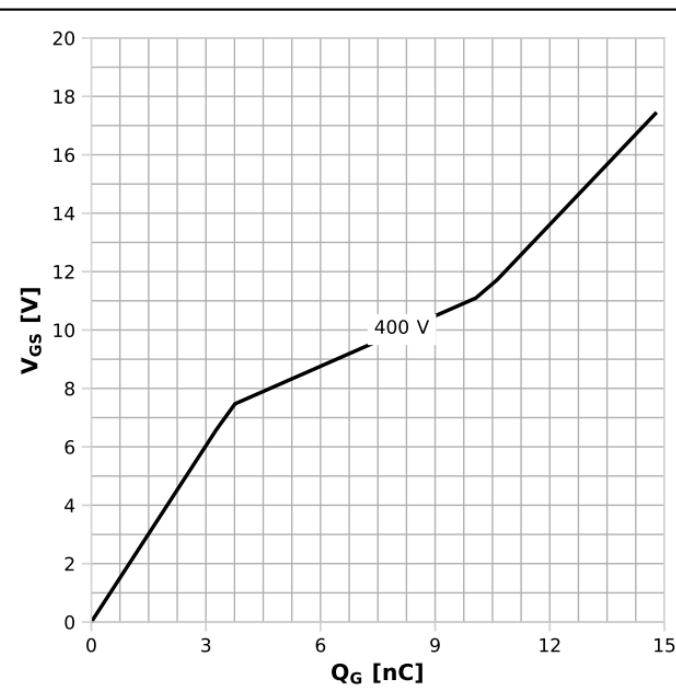
$R_{DS(on)}=f(T_j); I_D=8.9\text{ A}; V_{GS}=18\text{ V}$

Diagram 9: Typ. transfer characteristics



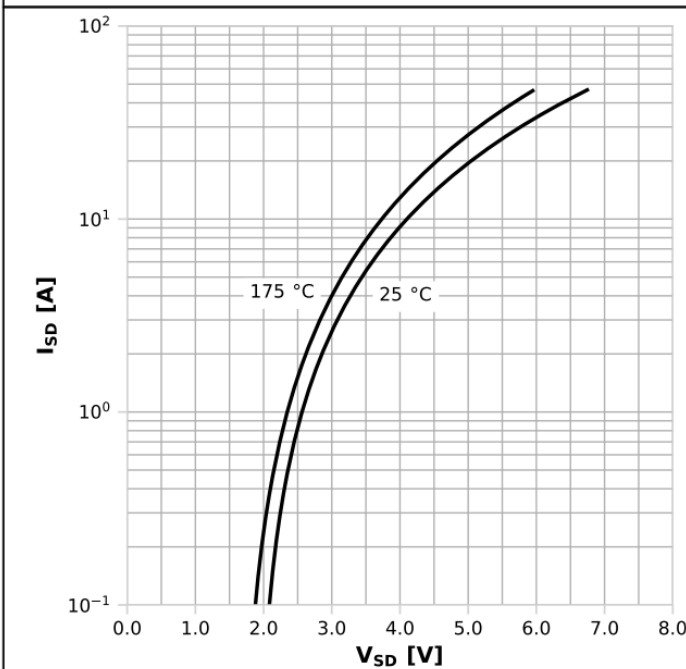
$I_{DS}=f(V_{GS}); V_{DS}=20V$ ; parameter:  $T_j$

Diagram 10: Typ. gate charge



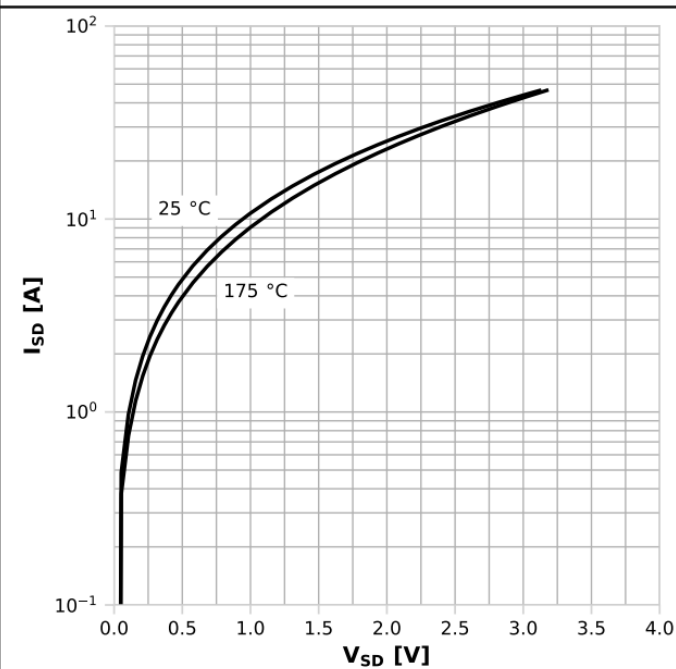
$V_{GS}=f(Q_G); I_D=8.9$  A pulsed; parameter:  $V_{DD}$

Diagram 11: Typ. reverse drain current characteristics



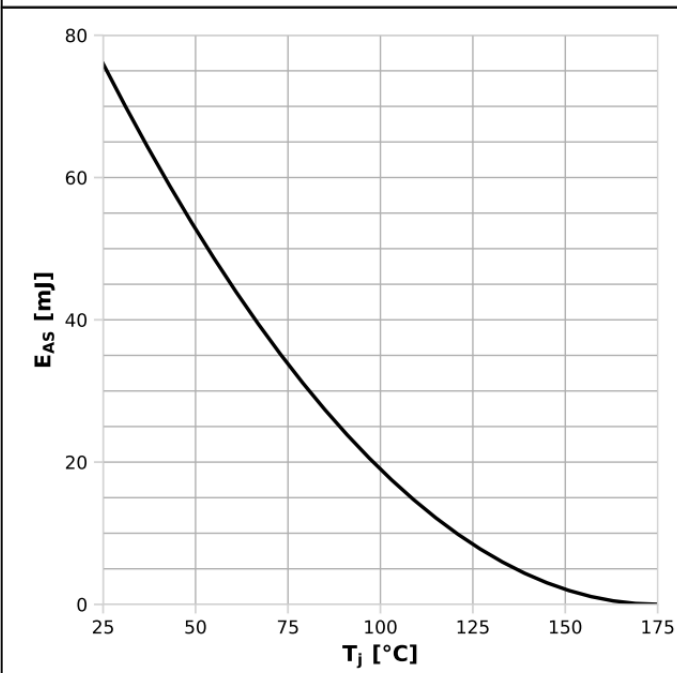
$I_{SD}=f(V_{SD}); V_{GS}=0$  V; parameter:  $T_j$

Diagram 12: Typ. reverse drain current characteristics



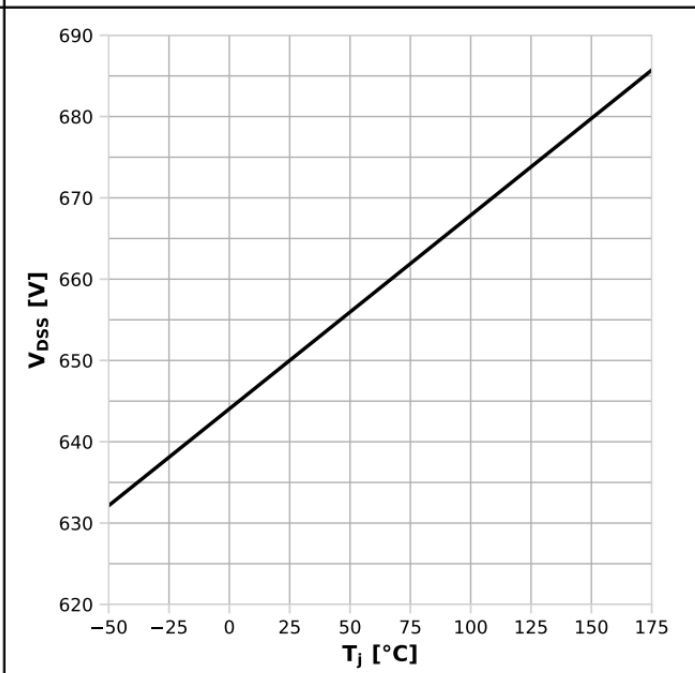
$I_{SD}=f(V_{SD}); V_{GS}=18$  V; parameter:  $T_j$

Diagram 13: Avalanche energy



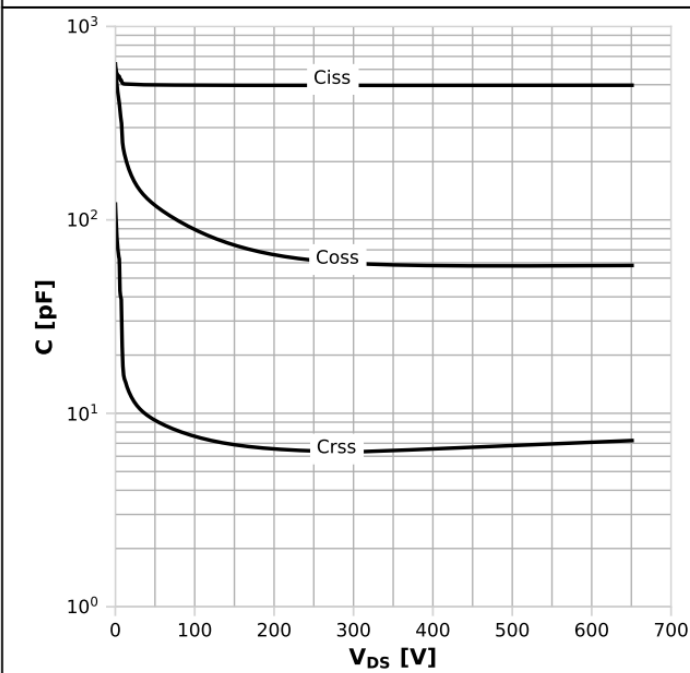
$E_{AS}=f(T_j); I_D=2.8\text{ A}; V_{DD}=50\text{ V}$

Diagram 14: Drain-source breakdown voltage



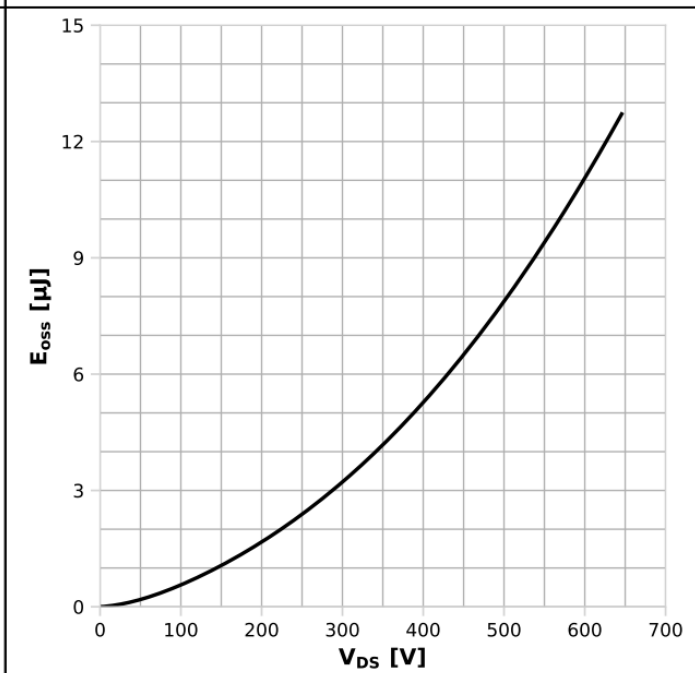
$V_{DSS}=f(T_j); I_D=0.26\text{ mA}$

Diagram 15: Typ. capacitances



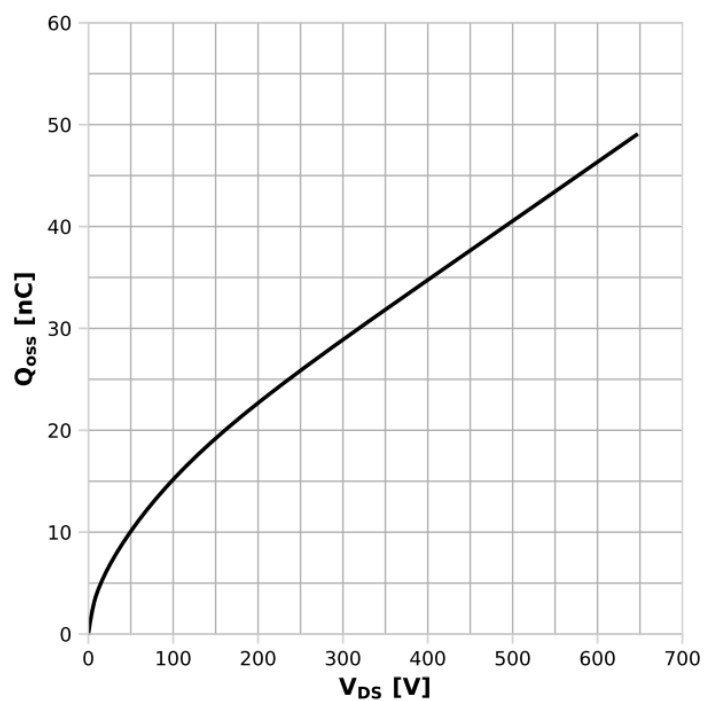
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=250\text{ kHz}$

Diagram 16: Typ. Coss stored energy



$E_{OSS}=f(V_{DS})$

Diagram 17: Typ. Qoss output charge



$$Q_{oss}=f(V_{DS})$$

6 测试电路

表 9 体二极管特性 (CoolSiC)

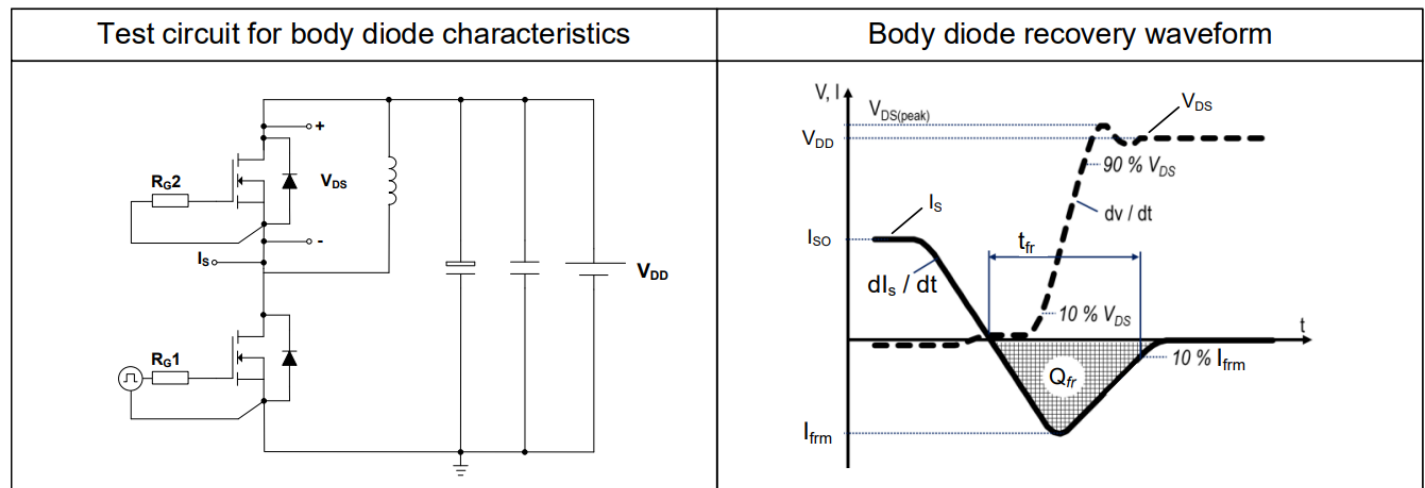


表 10 开关时间 (CoolSiC)

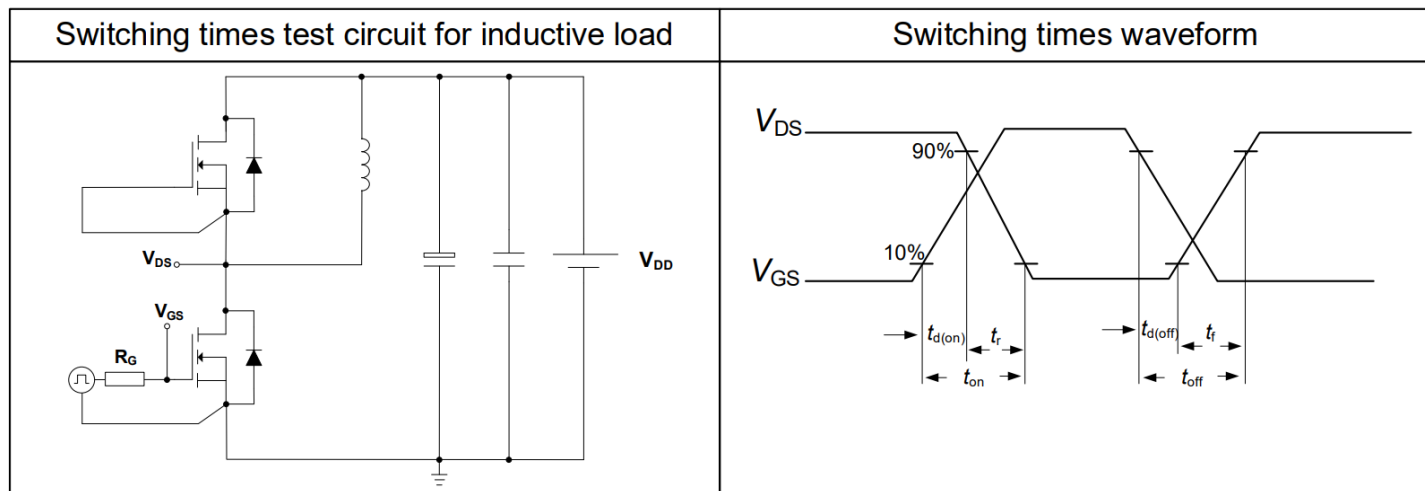
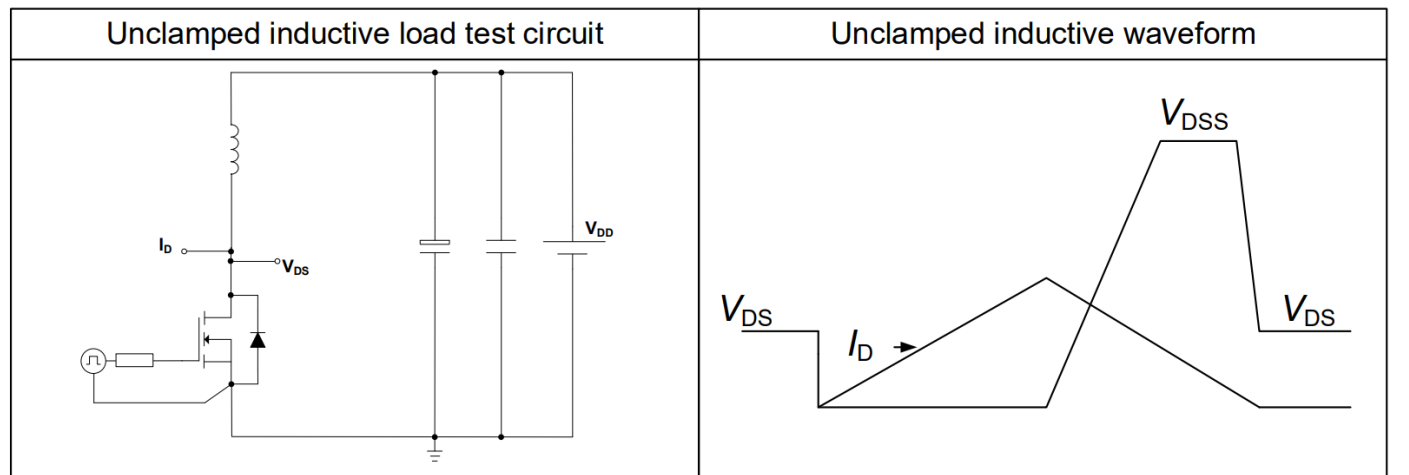
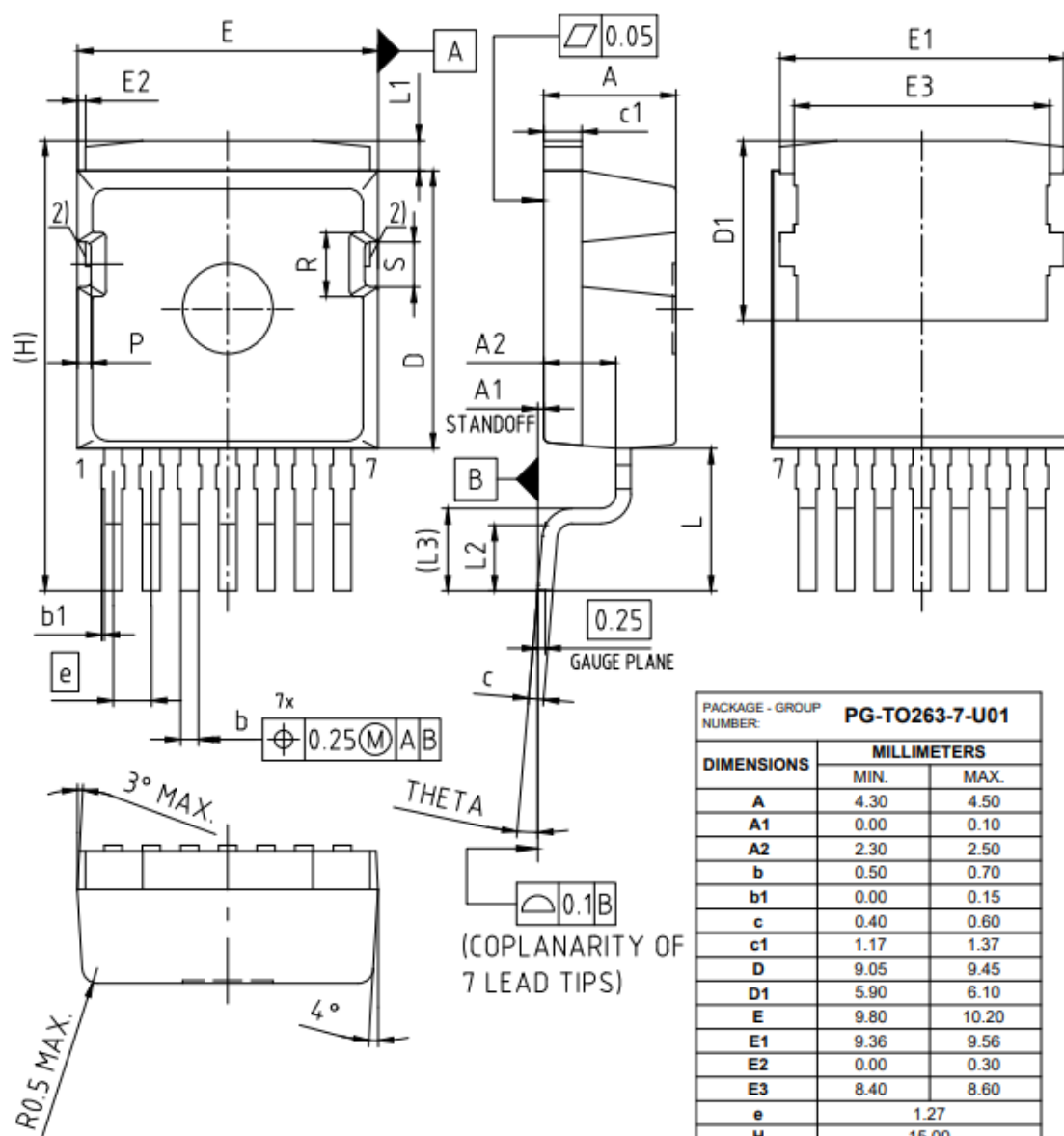


表 11 非钳位感性负载



## 7 封装外形



NOTES:

- 1) ALL METAL SURFACES TIN PLATED EXCEPT AREA OF CUT  
2) MOLD FILLING IS ACCEPTABLE AT THIS AREA

|                            |             |                |  |
|----------------------------|-------------|----------------|--|
| PACKAGE - GROUP<br>NUMBER: |             | PG-TO263-7-U01 |  |
| DIMENSIONS                 | MILLIMETERS |                |  |
|                            | MIN.        | MAX.           |  |
| A                          | 4.30        | 4.50           |  |
| A1                         | 0.00        | 0.10           |  |
| A2                         | 2.30        | 2.50           |  |
| b                          | 0.50        | 0.70           |  |
| b1                         | 0.00        | 0.15           |  |
| c                          | 0.40        | 0.60           |  |
| c1                         | 1.17        | 1.37           |  |
| D                          | 9.05        | 9.45           |  |
| D1                         | 5.90        | 6.10           |  |
| E                          | 9.80        | 10.20          |  |
| E1                         | 9.36        | 9.56           |  |
| E2                         | 0.00        | 0.30           |  |
| E3                         | 8.40        | 8.60           |  |
| e                          | 1.27        |                |  |
| H                          | 15.00       |                |  |
| L                          | 4.20        | 5.20           |  |
| L1                         | 0.70        | 1.30           |  |
| L2                         | 1.70        | 2.30           |  |
| L3                         | 2.70        |                |  |
| P                          | 0.35        | 0.55           |  |
| R                          | 2.03        | 2.23           |  |
| S                          | 1.40        | 1.60           |  |
| THETA                      | 0.00°       | 8.00°          |  |

**图 1** PG- T0263 - 7外形图，尺寸单位为毫米

## 8 附录 A

表 12 相关链接

- [英飞凌 CoolSiC CoolSiC™ MOSFET 650 V G1 网页](#)
- [英飞凌 CoolSiC CoolSiC™ MOSFET 650 V G1 应用笔记](#)
- [英飞凌 CoolSiC CoolSiC™ MOSFET 650 V G1 仿真模型](#)
- [英飞凌设计工具](#)

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## 修订记录

IMBG65R107M1H

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修订 2024 - 08 - 26 , Rev. 2 . 1

## 历史修订版本

| Revision | Date       | Subjects (major changes since last revision)              |
|----------|------------|-----------------------------------------------------------|
| 2.0      | 2021-12-10 | Release of final version                                  |
| 2.1      | 2024-08-26 | IDSS update, nomenclature update, datasheet layout update |

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**Edition 2025-04-21**

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