

## 英飞凌 CoolMOS™ S7A

### 600V CoolMOS™ SJ S7A 功率器件

英飞凌IPQC60R010S7A是一款高压功率 MOSFET，根据英飞凌科技公司首创的超结（SJ）原理设计为静态开关。

IPQC60R010S7A 将领先的 SJ MOSFET 供应商的经验与一流的创新技术相结合，在 QDPAK 封装中实现了低  $R_{DS(on)}$ 。S7A 系列针对低频开关和断路器等大电流应用进行了优化。

### 特性

- 针对高端应用中的低开关频率进行了优化（断路器和桥式整流器中的二极管并联/替换）。
- S7A 技术以最小尺寸实现行业领先的  $R_{DS(on)}$ 。
- 开尔文源引脚可提高大电流时的开关性能。
- QDPAK (PG-HDSOP-22-1) 封装符合 MSL1 标准，完全无铅，易于目视检查的引线

### 优点

- S7A 支持低  $R_{DS(on)}$ ，以获得高恒流。
- 在应用中使用 MOSFET 代替二极管，从而提高性能（例如同步整流）。
- S7A 在 QDPAK 315mm<sup>2</sup> 的封装尺寸内能够达到 10mΩ。
- 开尔文源降低了寄生源电感，从而提高了极高电流处理的稳定性，并减少了振铃，方便使用。
- 改进的散热性能使 SMD QDPAK 封装可用于大电流设计。

### 潜在应用

断路器（高压电池隔离开关、DC 和 AC 低频开关、HV E-fuse）和二极管并联/替换，用于大功率/高性能应用。

### 产品验证

符合 AEC-Q101 标准

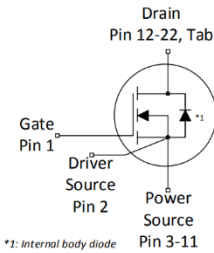
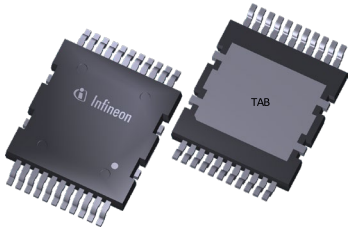
**需注意：**源极引脚和传感源极引脚不可互换。交换可能会导致故障。对于并联 4pin MOSFET 器件，通常建议将栅极电阻放置在驱动器源上而不是栅极上。对于生产部件批准程序（PPAP）的发布，我们建议在早期设计阶段共享与应用相关的信息，以避免 PPAP 发布的延误。可联系英飞凌销售办事处。

表 1 主要性能参数

| Parameter               | Value | Unit |
|-------------------------|-------|------|
| $R_{DS(on),max}$        | 10    | mΩ   |
| $Q_{g,typ}$             | 318   | nC   |
| $V_{SD}$                | 0.82  | V    |
| Pulsed $I_{SD}, I_{DS}$ | 801   | A    |

| Type/Ordering Code | Package     | Marking  | Related Links  |
|--------------------|-------------|----------|----------------|
| IPQC60R010S7A      | PG-HDSOP-22 | 60A010S7 | see Appendix A |

PG-HDSOP-22





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## 1 最大额定值

$T_j=25^\circ\text{C}$ , 除非另有规定

表 2 最大额定值

| Parameter                               | Symbol               | Values |      |      | Unit             | Note/ Test Condition                                                                                                                 |
|-----------------------------------------|----------------------|--------|------|------|------------------|--------------------------------------------------------------------------------------------------------------------------------------|
|                                         |                      | Min.   | Typ. | Max. |                  |                                                                                                                                      |
| Drain current rating                    | $I_D$                | -      | -    | 50   | A                | $T_c=140^\circ\text{C}$<br>Current is limited by $T_{j\max}=150^\circ\text{C}$ ;<br>Lower case temp does increase current capability |
| Pulsed drain current <sup>1)</sup>      | $I_{D,\text{pulse}}$ | -      | -    | 801  | A                | $T_c=25^\circ\text{C}$                                                                                                               |
| Avalanche energy, single pulse          | $E_{AS}$             | -      | -    | 616  | mJ               | $I_D=6.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                                                               |
| Avalanche current, single pulse         | $I_{AS}$             | -      | -    | 6.3  | A                | -                                                                                                                                    |
| MOSFET dv/dt ruggedness <sup>2)</sup>   | dv/dt                | -      | -    | 20   | V/ns             | $V_{DS}=0\text{V to }300\text{V}$                                                                                                    |
| Gate source voltage (static)            | $V_{GS}$             | -20    | -    | 20   | V                | static                                                                                                                               |
| Gate source voltage (dynamic)           | $V_{GS}$             | -30    | -    | 30   | V                | AC ( $f>1\text{ Hz}$ )                                                                                                               |
| Power dissipation                       | $P_{\text{tot}}$     | -      | -    | 694  | W                | $T_c=25^\circ\text{C}$                                                                                                               |
| Storage temperature                     | $T_{\text{stg}}$     | -55    | -    | 150  | $^\circ\text{C}$ | -                                                                                                                                    |
| Operating junction temperature          | $T_j$                | -40    | -    | 150  | $^\circ\text{C}$ | -                                                                                                                                    |
| Extended operating junction temperature | $T_j$                | 150    | -    | 175  | $^\circ\text{C}$ | $\leq 50\text{ h}$ in the application lifetime                                                                                       |
| Mounting torque                         | -                    | -      | -    | n.a. | Ncm              | -                                                                                                                                    |
| Diode forward current rating            | $I_S$                | -      | -    | 50   | A                | $T_c=140^\circ\text{C}$<br>Current is limited by $T_{j\max}=150^\circ\text{C}$ ;<br>Lower case temp does increase current capability |
| Diode pulse current <sup>1)</sup>       | $I_{S,\text{pulse}}$ | -      | -    | 801  | A                | $T_c=25^\circ\text{C}$                                                                                                               |
| Reverse diode dv/dt <sup>3)</sup>       | dv/dt                | -      | -    | 5    | V/ns             | $V_{DS}=0\text{ to }300\text{V}$ , $I_{SD}\leq 50\text{A}$ , $T_j=25^\circ\text{C}$ see table 8                                      |
| Maximum diode commutation speed         | di/dt                | -      | -    | 1000 | A/ $\mu\text{s}$ | $V_{DS}=0\text{ to }300\text{V}$ , $I_{SD}\leq 50\text{A}$ , $T_j=25^\circ\text{C}$ see table 8                                      |
| Insulation withstand voltage            | $V_{\text{ISO}}$     | -      | -    | n.a. | V                | $V_{\text{rms}}$ , $T_c=25^\circ\text{C}$ , $t=1\text{min}$                                                                          |

1) 脉冲宽度  $t_p$  受限于  $T_{j\max}$

2) dv/dt 必须通过适当的栅极电阻来限制

3) 相同的低压侧和高压侧开关



2 热特性

表 3 热特性

| Parameter                                              | Symbol     | Values |      |      | Unit | Note/ Test Condition                                                                                                                                                   |
|--------------------------------------------------------|------------|--------|------|------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                        |            | Min.   | Typ. | Max. |      |                                                                                                                                                                        |
| Thermal resistance, junction - case                    | $R_{thJC}$ | -      | -    | 0.18 | °C/W | -                                                                                                                                                                      |
| Thermal resistance, junction - ambient                 | $R_{thJA}$ | -      | -    | 62   | °C/W | device on PCB, minimal footprint                                                                                                                                       |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$ | -      | 45   | 55   | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm <sup>2</sup> (one layer, 70μm thickness) copper area. Tap exposed to air. PCB is vertical without air stream cooling. |
| Soldering temperature, reflow soldering allowed        | $T_{sold}$ | -      | -    | 260  | °C   | reflow MSL1                                                                                                                                                            |

### 3 电气特性

$T_j=25^\circ\text{C}$ , 除非另有规定

**表 4 静态特性**

本数据手册中提到的 CoolMOS™ 不得在线性模式下运行。

如有任何疑问, 可联系英飞凌销售办事处。

对于施加阻断电压超过规定阻断电压 70% 的应用, 要求客户在早期设计阶段评估宇宙辐射效应的影响, 并联系英飞凌销售办事处以获得英飞凌必要的技术支持

| Parameter                        | Symbol        | Values |                |            | Unit     | Note/ Test Condition                                                                  |
|----------------------------------|---------------|--------|----------------|------------|----------|---------------------------------------------------------------------------------------|
|                                  |               | Min.   | Typ.           | Max.       |          |                                                                                       |
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | 600    | -              | -          | V        | $V_{GS}=0V, I_D=1mA$                                                                  |
| Gate threshold voltage           | $V_{(GS)th}$  | 3.5    | 4.0            | 4.5        | V        | $V_{DS}=V_{GS}, I_D=3.08mA$                                                           |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -<br>80        | 8<br>-     | $\mu A$  | $V_{DS}=600V, V_{GS}=0V, T_j=25^\circ C$<br>$V_{DS}=600V, V_{GS}=0V, T_j=150^\circ C$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -              | 100        | nA       | $V_{GS}=20V, V_{DS}=0V$                                                               |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.009<br>0.022 | 0.010<br>- | $\Omega$ | $V_{GS}=12V, I_D=50A, T_j=25^\circ C$<br>$V_{GS}=12V, I_D=50A, T_j=150^\circ C$       |
| Gate resistance                  | $R_G$         | -      | 0.45           | -          | $\Omega$ | $f=1MHz$ , open drain                                                                 |

**表 5 动态特性**

| Parameter                                                  | Symbol       | Values |       |      | Unit | Note/ Test Condition                                             |
|------------------------------------------------------------|--------------|--------|-------|------|------|------------------------------------------------------------------|
|                                                            |              | Min.   | Typ.  | Max. |      |                                                                  |
| Input capacitance                                          | $C_{iss}$    | -      | 11986 | -    | pF   | $V_{GS}=0V, V_{DS}=300V, f=250kHz$                               |
| Output capacitance                                         | $C_{oss}$    | -      | 188   | -    | pF   | $V_{GS}=0V, V_{DS}=300V, f=250kHz$                               |
| Effective output capacitance, energy related <sup>4)</sup> | $C_{o(er)}$  | -      | 644   | -    | pF   | $V_{GS}=0V, V_{DS}=0 \text{ to } 300V$                           |
| Effective output capacitance, time related <sup>5)</sup>   | $C_{o(tr)}$  | -      | 5717  | -    | pF   | $I_D=\text{constant}, V_{GS}=0V, V_{DS}=0 \text{ to } 300V$      |
| Output charge                                              | $Q_{oss}$    | -      | 1714  | -    | nC   | $V_{GS}=0V, V_{DS}=0 \text{ to } 300V$                           |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 50    | -    | ns   | $V_{DD}=300V, V_{GS}=13V, I_D=50A, R_G=3\Omega$ ;<br>see table 9 |
| Rise time                                                  | $t_r$        | -      | 5     | -    | ns   | $V_{DD}=300V, V_{GS}=13V, I_D=50A, R_G=3\Omega$ ;<br>see table 9 |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 180   | -    | ns   | $V_{DD}=300V, V_{GS}=13V, I_D=50A, R_G=3\Omega$ ;<br>see table 9 |
| Fall time                                                  | $t_f$        | -      | 9     | -    | ns   | $V_{DD}=300V, V_{GS}=13V, I_D=50A, R_G=3\Omega$ ;<br>see table 9 |

<sup>4)</sup>  $C_{o(er)}$  是一个固定电容, 当  $V_{DS}$  从 0 上升至 300V 时, 其储存能量同于  $C_{oss}$

<sup>5)</sup>  $C_{o(tr)}$  是一个固定电容, 当  $V_{DS}$  从 0 上升至 300V 时, 其充电时间同于  $C_{oss}$

表6 栅极电荷特性

| Parameter             | Symbol        | Values |      |      | Unit | Note/ Test Condition                             |
|-----------------------|---------------|--------|------|------|------|--------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                  |
| Gate to source charge | $Q_{gs}$      | -      | 69   | -    | nC   | $V_{DD}=300V, I_D=50A, V_{GS}=0 \text{ to } 12V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 105  | -    | nC   | $V_{DD}=300V, I_D=50A, V_{GS}=0 \text{ to } 12V$ |
| Gate charge total     | $Q_g$         | -      | 318  | -    | nC   | $V_{DD}=300V, I_D=50A, V_{GS}=0 \text{ to } 12V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.7  | -    | V    | $V_{DD}=300V, I_D=50A, V_{GS}=0 \text{ to } 12V$ |

表7 反向二极管特性

| Parameter                     | Symbol    | Values |      |      | Unit    | Note/ Test Condition                                  |
|-------------------------------|-----------|--------|------|------|---------|-------------------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                                       |
| Diode forward voltage         | $V_{SD}$  | -      | 0.82 | -    | V       | $V_{GS}=0V, I_F=50A, T_J=25^\circ C$                  |
| Reverse recovery time         | $t_{rr}$  | -      | 600  | -    | ns      | $V_R=300V, I_F=50A, di_F/dt=100A/\mu s$ ; see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 17   | -    | $\mu C$ | $V_R=300V, I_F=50A, di_F/dt=100A/\mu s$ ; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 55   | -    | A       | $V_R=300V, I_F=50A, di_F/dt=100A/\mu s$ ; see table 8 |

4 电气特性图

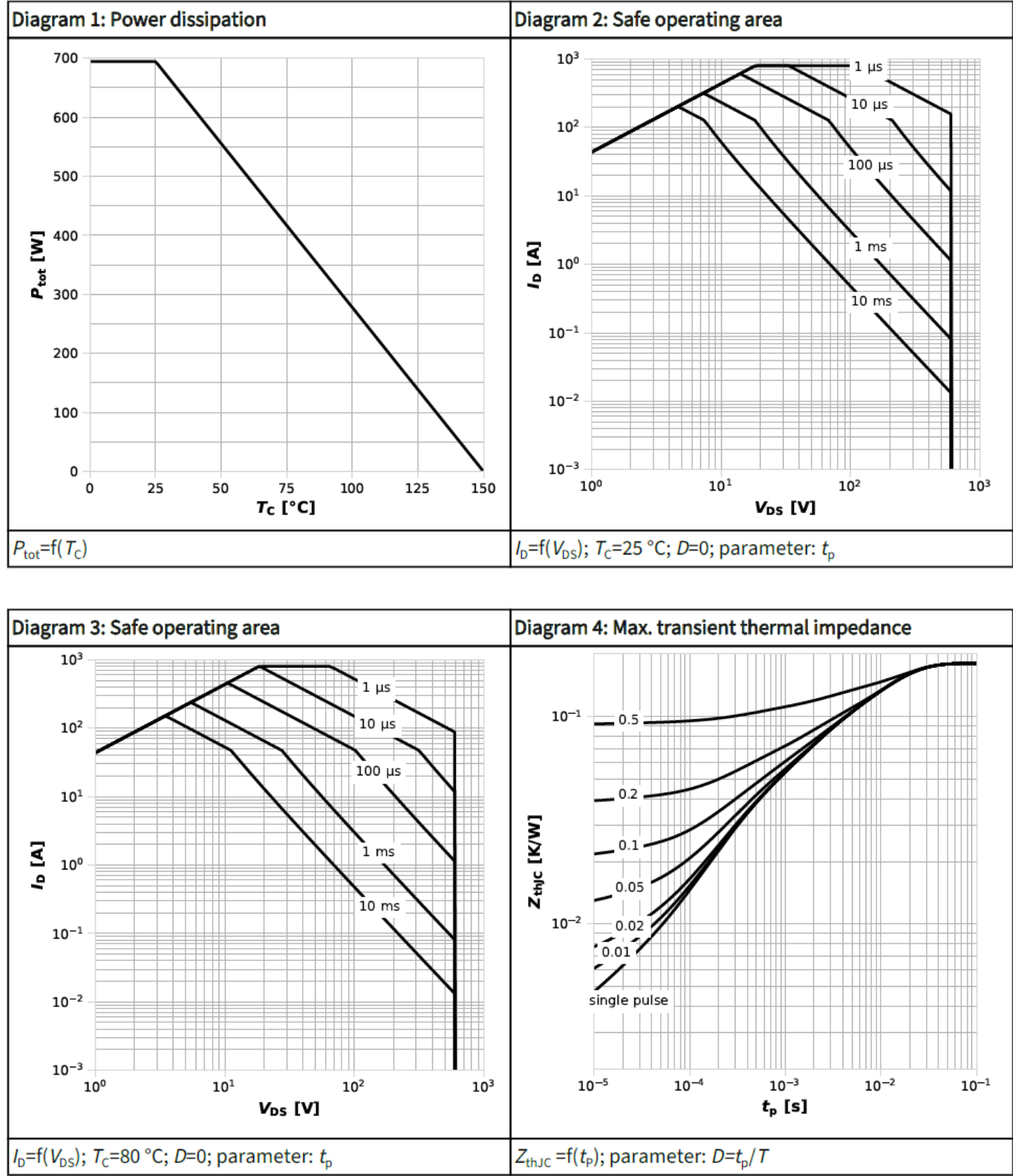
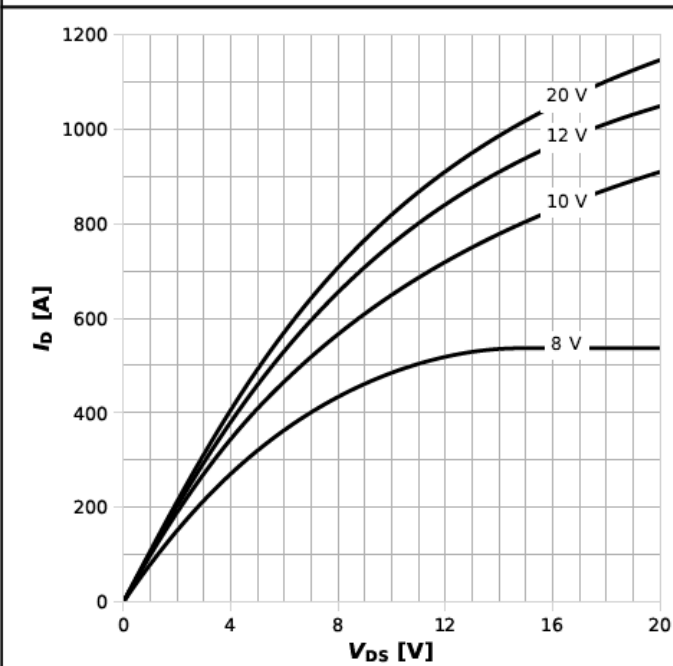
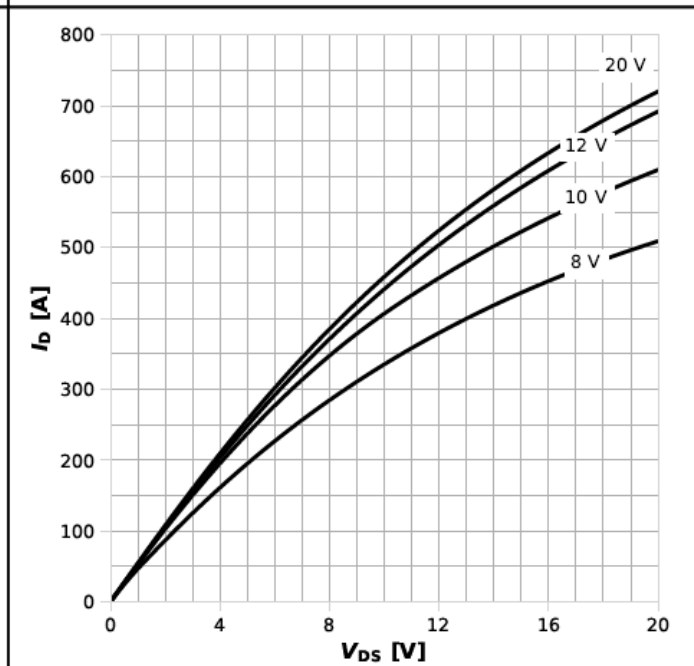


Diagram 5: Typ. output characteristics



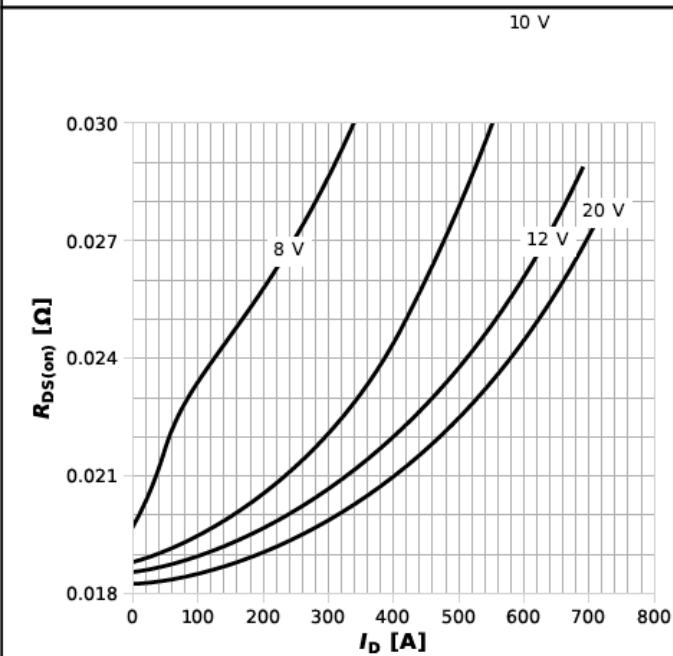
$I_D = f(V_{DS})$ ;  $T_J = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



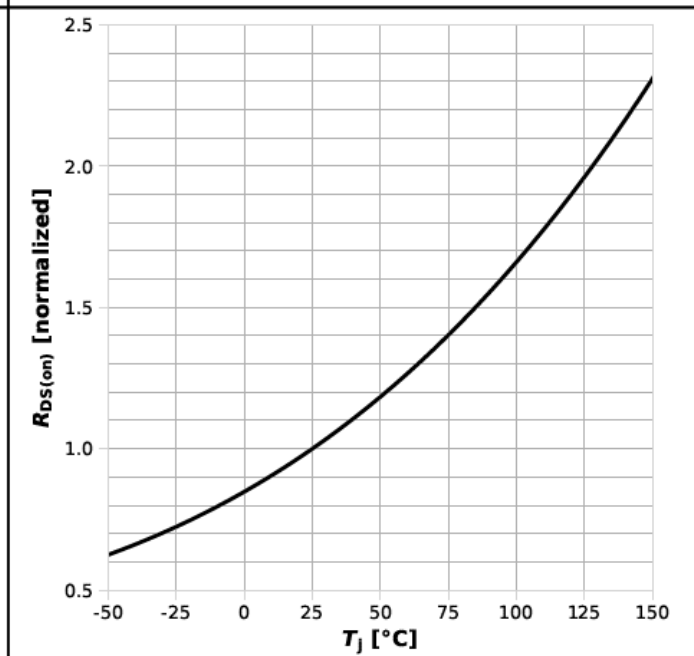
$I_D = f(V_{DS})$ ;  $T_J = 125\text{ °C}$ ; parameter:  $V_{GS}$

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



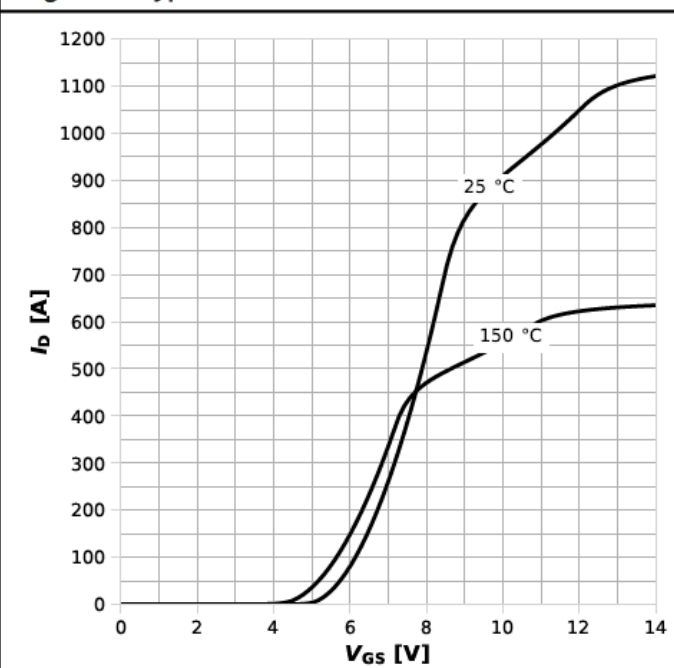
$R_{DS(on)} = f(I_D)$ ;  $T_J = 125\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



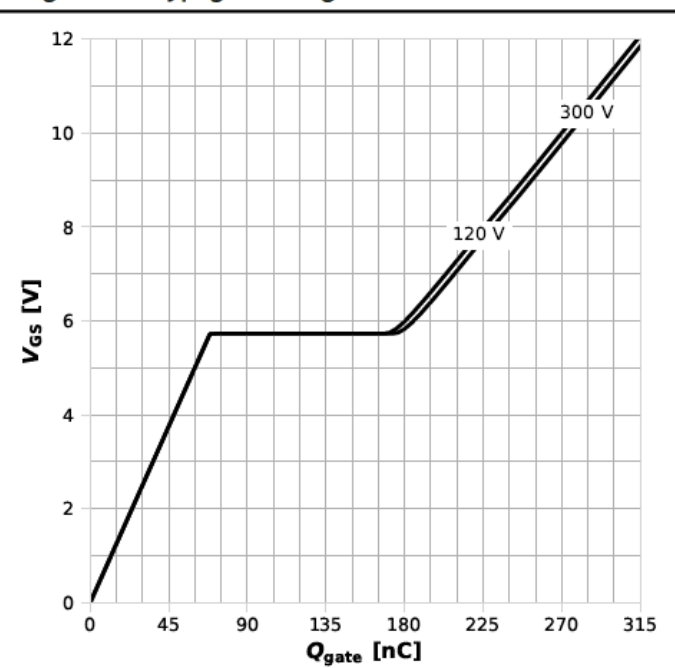
$R_{DS(on)} = f(T_J)$ ;  $I_D = 50\text{ A}$ ;  $V_{GS} = 12\text{ V}$

Diagram 9: Typ. transfer characteristics



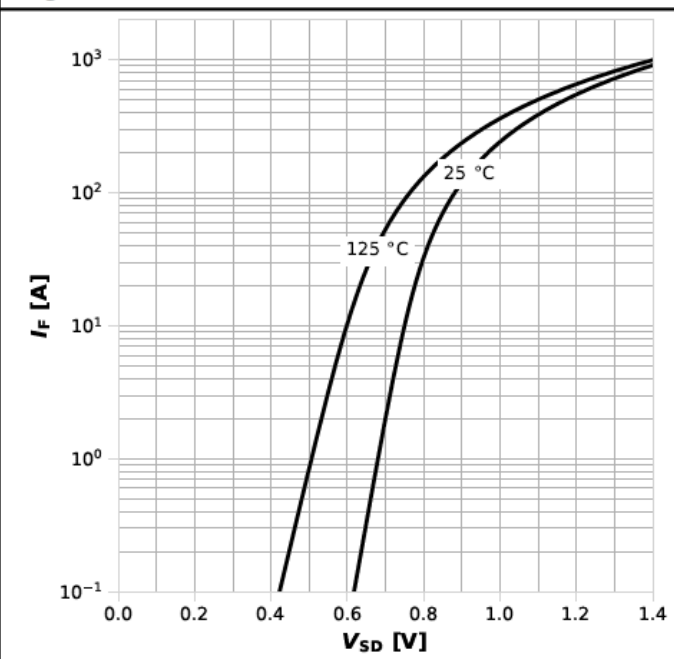
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

Diagram 10: Typ. gate charge



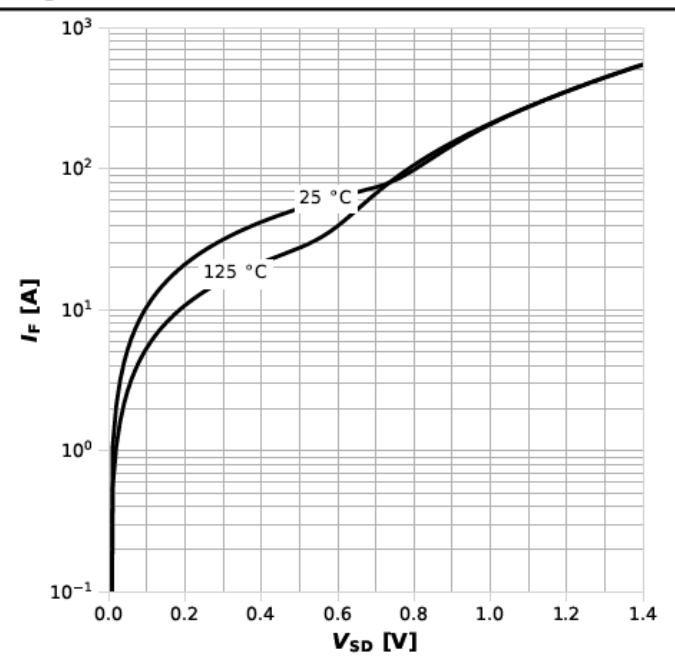
$V_{GS} = f(Q_{gate})$ ;  $I_D = 50 A$  pulsed; parameter:  $V_{DD}$

Diagram 11: Forward characteristics of reverse diode



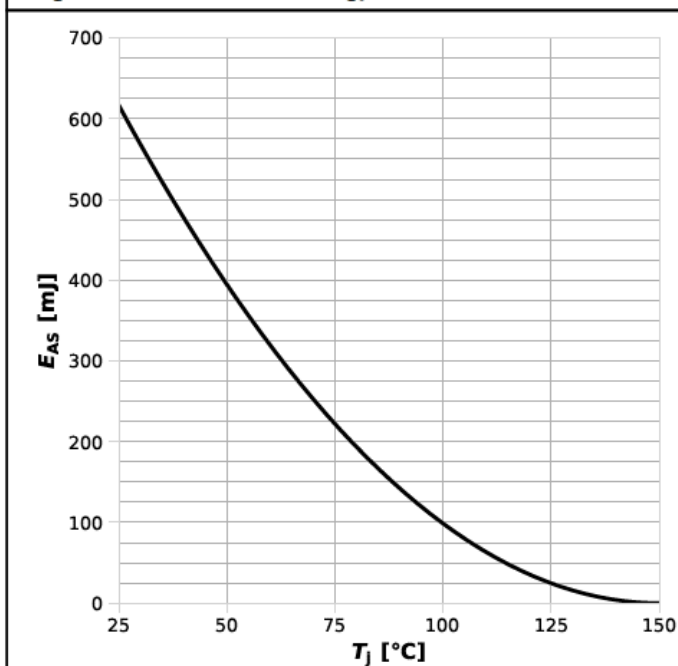
$I_F = f(V_{SD})$ ;  $V_{GS} = 0 V$ ; parameter:  $T_j$

Diagram 12: Forward characteristics of reverse diode



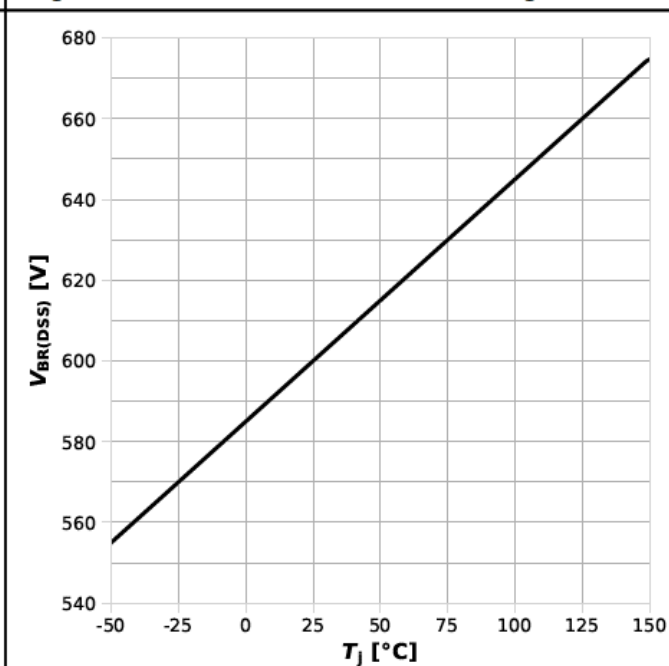
$I_F = f(V_{SD})$ ;  $V_{GS} = 12 V$ ; parameter:  $T_j$

Diagram 13: Avalanche energy



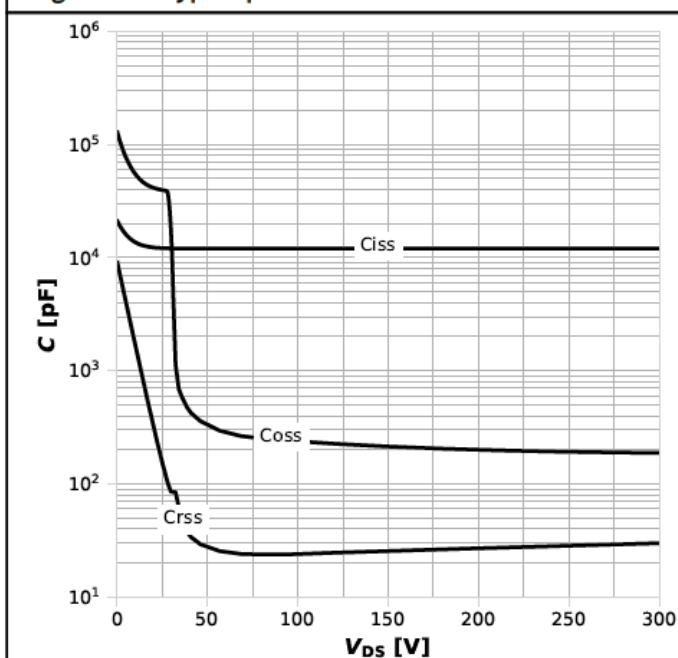
$$E_{AS}=f(T_J); I_D=6.3\text{ A}; V_{DD}=50\text{ V}$$

Diagram 14: Drain-source breakdown voltage



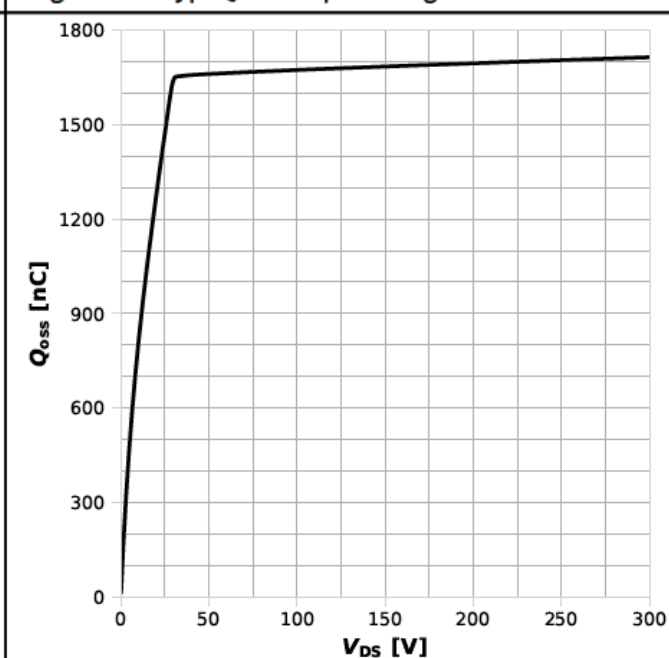
$$V_{BR(DSS)}=f(T_J); I_D=1\text{ mA}$$

Diagram 15: Typ. capacitances



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

Diagram 17: Typ. Qoss output charge



$$Q_{oss}=f(V_{DS}); V_{GS}=0\text{ V}$$

5 测试电路

表 8 二极管特性

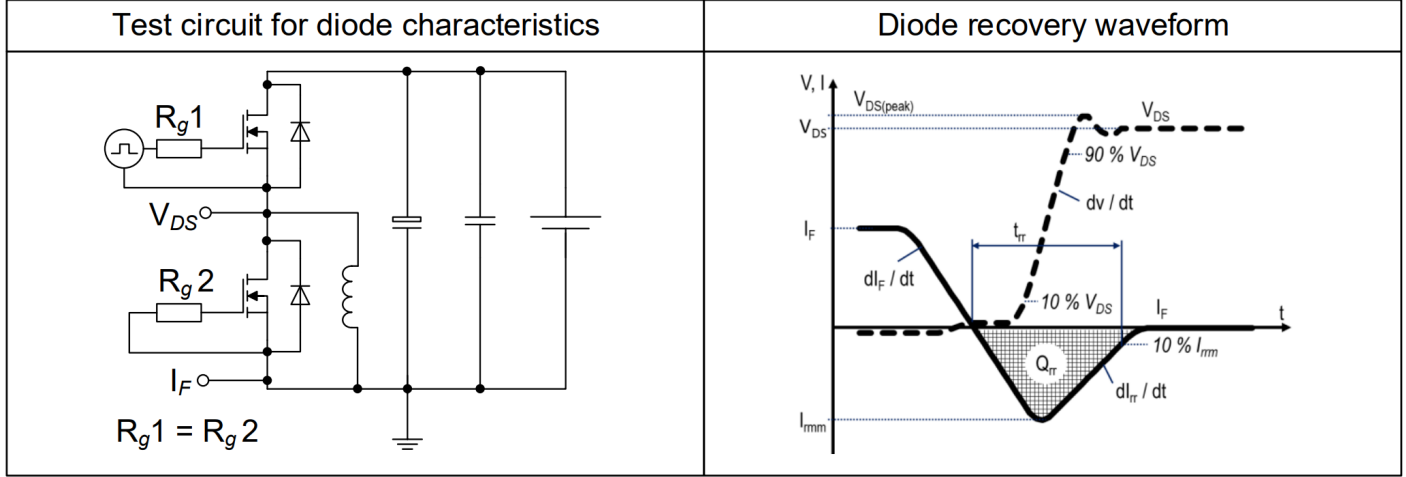


表 9 开关时间(ss)

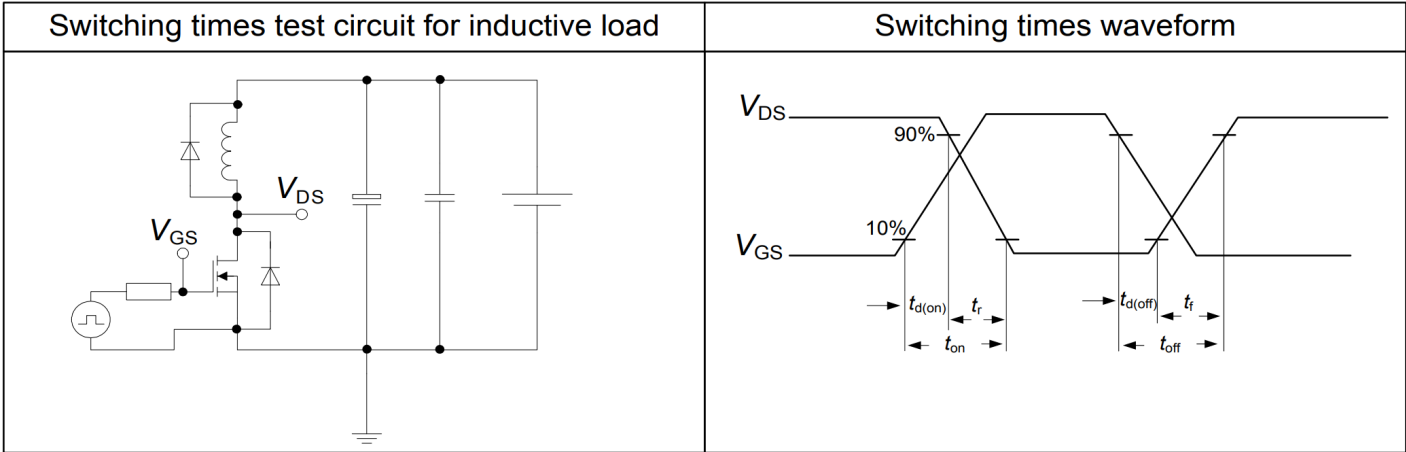
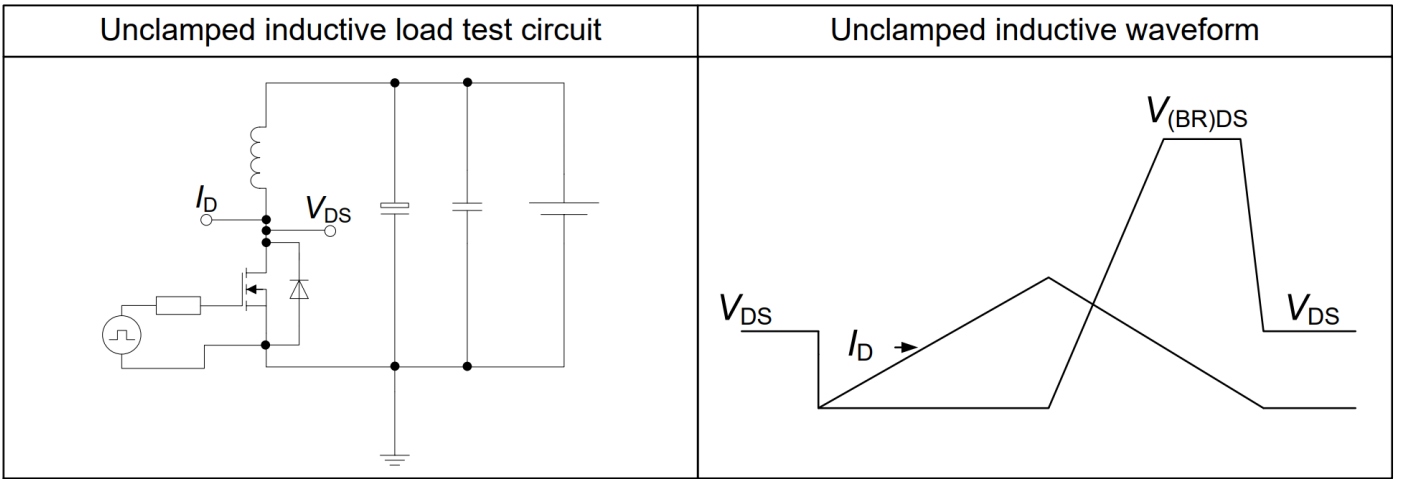


表 10 非钳位感性负载(ss)



6 封装外形

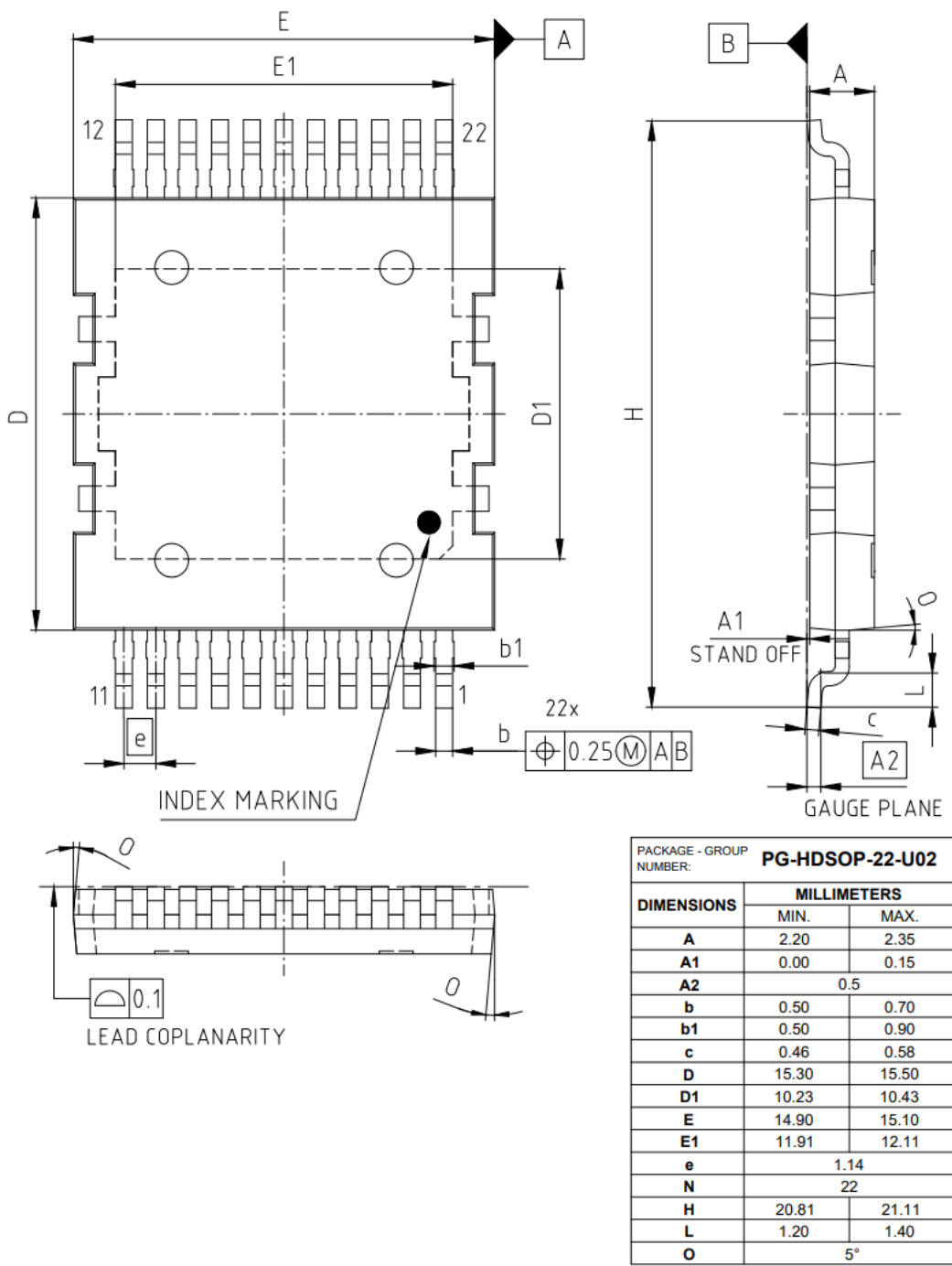


图 1 PG-HDSOP- 22 外形图，尺寸单位为mm

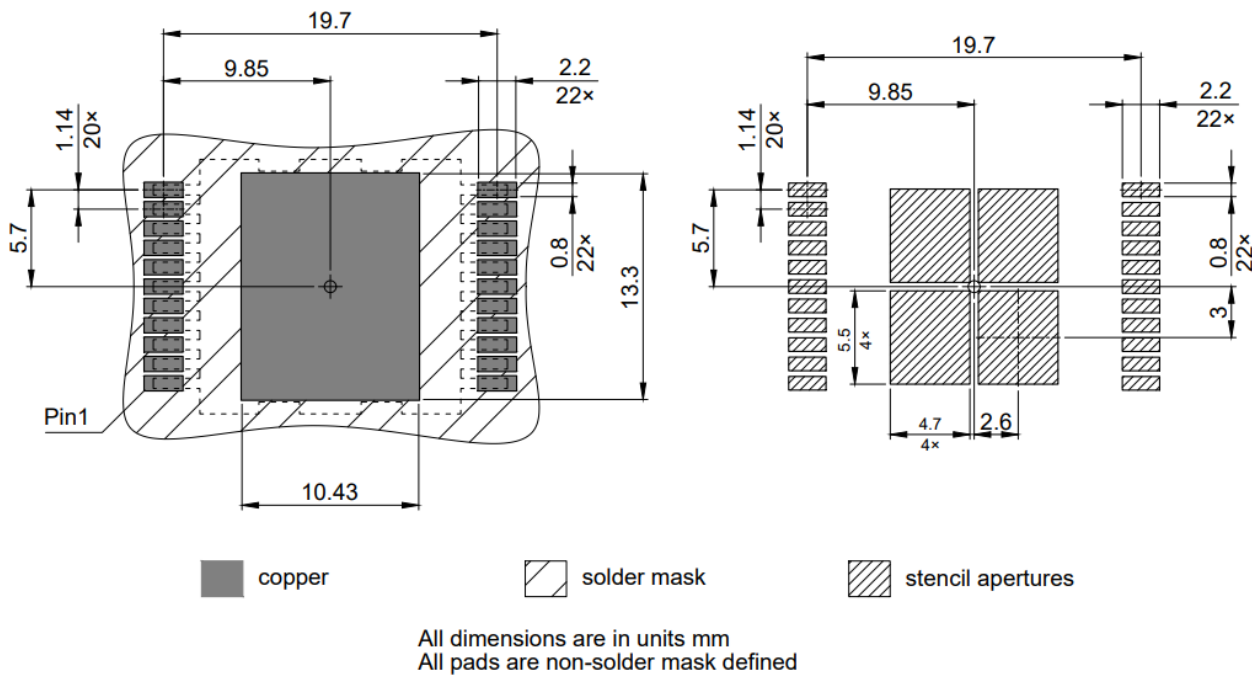
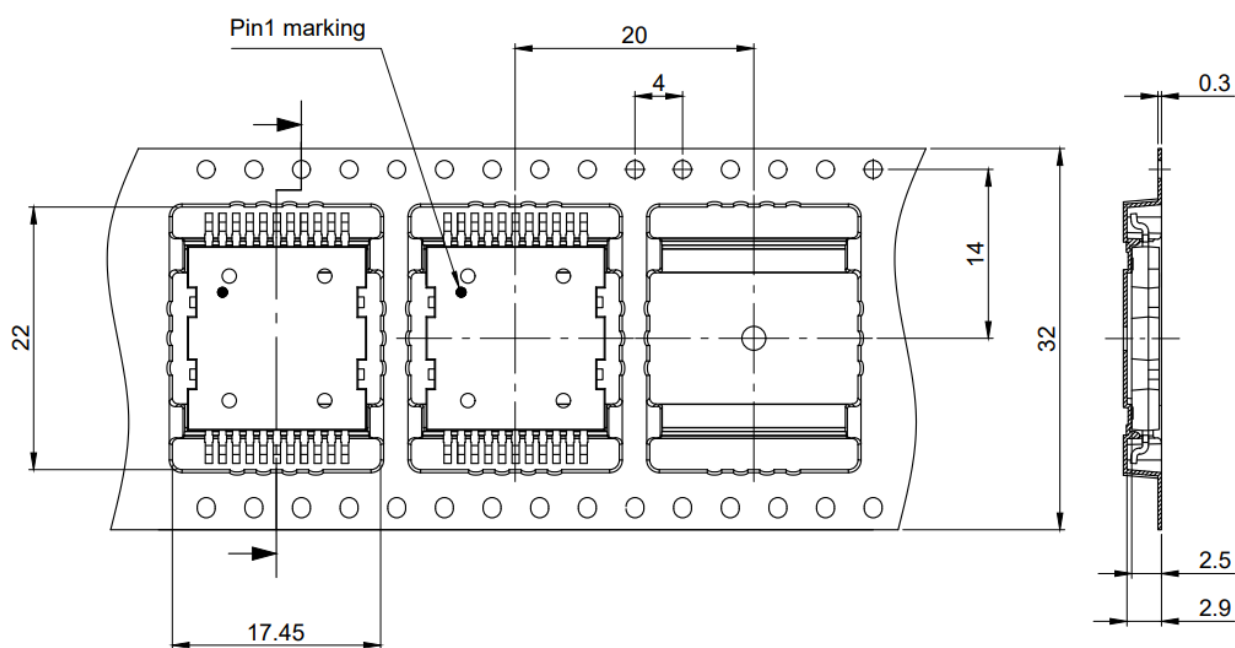


图 2 PG-HDSOP- 22 外形图，尺寸单位为mm



All dimensions are in units mm

The drawing is in compliance with ISO 128-30, Projection Method 1 [  ]

图 3 PG-HDSOP-22 外形图，尺寸单位为mm

## 7 附录 A

表 11 相关链接

- [IFX CoolMOS S7 网页](#)
- [IFX CoolMOS S7 应用笔记](#)
- [IFX CoolMOS S7 仿真模型](#)
- [IFX 设计工具](#)

## 修订记录

IPQC60R010S7A

### Revision 2024-05-24, Rev. 2.3

Previous Revision

| Revision | Date       | Subjects (major changes since last revision)                                                                                                                     |
|----------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.0      | 2022-11-23 | Release of final version                                                                                                                                         |
| 2.1      | 2023-10-30 | Added footnote for pulsed drain current                                                                                                                          |
| 2.2      | 2023-11-22 | Additional maximum parameter for high current turn off added to datasheet for SSCB, SSR and motor start applications; Removed footmark from pulsed drain current |
| 2.3      | 2024-05-24 | Removed high current turn-off parameter limitation, Adaption of Transfer curve, Output characteristics and drain-source on-state resistance                      |

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