



BUK7J1R4-40H

N-channel 40 V, 1.4 mΩ standard level MOSFET in LFPAK56E

5 July 2018

Product data sheet

1. General description

Automotive qualified N-channel MOSFET using the latest Trench 9 low ohmic superjunction technology, housed in an enhanced LFPAK56E package. This product has been fully designed and qualified to meet AEC-Q101 requirements delivering high performance and endurance.

2. Features and benefits

- Fully automotive qualified to AEC-Q101:
 - 175 °C rating suitable for thermally demanding environments
- Trench 9 Superjunction technology:
 - Reduced cell pitch enables enhanced power density and efficiency with lower R_{DSon} in same footprint
 - Improved SOA and avalanche capability compared to standard TrenchMOS
 - Tight $V_{GS(th)}$ limits enable easy paralleling of MOSFETs
- LFPAK Gull Wing leads:
 - High Board Level Reliability absorbing mechanical stress during thermal cycling, unlike traditional QFN packages
 - Visual (AOI) soldering inspection, no need for expensive x-ray equipment
 - Easy solder wetting for good mechanical solder joint
- LFPAK copper clip technology:
 - Improved reliability, with reduced R_{th} and R_{DSon}
 - Increases maximum current capability and improved current spreading

3. Applications

- 12 V automotive systems
- Motors, lamps and solenoid control
- Start-Stop micro-hybrid applications
- Transmission control
- Ultra high performance power switching

4. Quick reference data

Table 1. Quick reference data

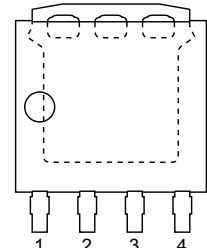
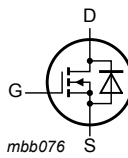
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|-----------|-------------------------|---|-----|-----|-----|-----|------|
| V_{DS} | drain-source voltage | $25\text{ °C} \leq T_j \leq 175\text{ °C}$ | | - | - | 40 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ Fig. 2 | [1] | - | - | 190 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C};$ Fig. 1 | | - | - | 395 | W |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|------|------|-----|------|
| Static characteristics | | | | | | |
| R _{DSon} | drain-source on-state resistance | V _{GS} = 10 V; I _D = 25 A; T _J = 25 °C; Fig. 11 | 0.74 | 1.06 | 1.4 | mΩ |
| Dynamic characteristics | | | | | | |
| Q _{GD} | gate-drain charge | I _D = 25 A; V _{DS} = 32 V; V _{GS} = 10 V; Fig. 13 ; Fig. 14 | - | 13 | 27 | nC |
| Source-drain diode | | | | | | |
| Q _r | recovered charge | I _S = 25 A; di _S /dt = -100 A/μs; V _{GS} = 0 V; V _{DS} = 20 V | - | 39 | - | nC |
| S | softness factor | I _S = 25 A; di _S /dt = -100 A/μs; V _{GS} = 0 V; V _{DS} = 20 V; T _J = 25 °C | - | 0.7 | - | |

[1] 190A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-----------------------------------|---|---|
| 1 | S | source |  <p>LFAK56E; Power-SO8 (SOT1023)</p> |  <p>mbb076</p> |
| 2 | S | source | | |
| 3 | S | source | | |
| 4 | G | gate | | |
| mb | D | mounting base; connected to drain | | |

6. Ordering information

Table 3. Ordering information

| Type number | Package | | Version |
|--------------|--------------------|--|---------|
| | Name | Description | |
| BUK7J1R4-40H | LFAK56E; Power-SO8 | plastic, single-ended surface-mounted package (LFAK56); 4 leads; 1.27 mm pitch | SOT1023 |

7. Marking

Table 4. Marking codes

| Type number | Marking code |
|--------------|--------------|
| BUK7J1R4-40H | 71H440 |

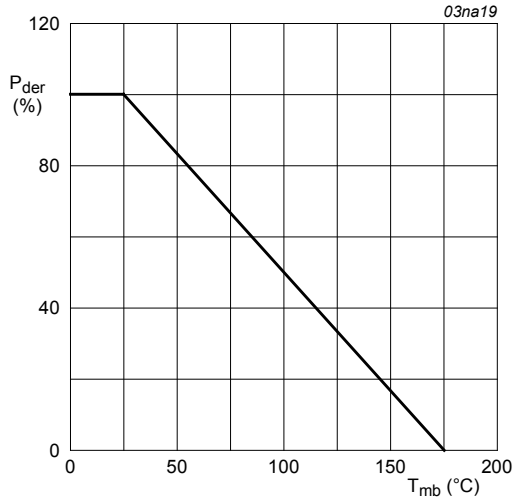
8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

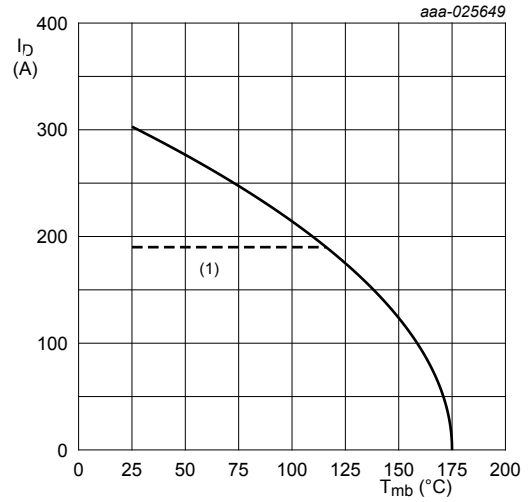
| Symbol | Parameter | Conditions | | Min | Max | Unit |
|-----------------------------|--|---|---------|-----|-----|------|
| V_{DS} | drain-source voltage | $25\text{ °C} \leq T_j \leq 175\text{ °C}$ | | - | 40 | V |
| V_{GS} | gate-source voltage | DC; $T_j \leq 175\text{ °C}$ | | -10 | 20 | V |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C}$; Fig. 1 | | - | 395 | W |
| I_D | drain current | $V_{GS} = 10\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2 | [1] | - | 190 | A |
| | | $V_{GS} = 10\text{ V}$; $T_{mb} = 100\text{ °C}$; Fig. 2 | [1] | - | 190 | A |
| I_{DM} | peak drain current | pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$; Fig. 3 | | - | 600 | A |
| T_{stg} | storage temperature | | | -55 | 175 | °C |
| T_j | junction temperature | | | -55 | 175 | °C |
| Source-drain diode | | | | | | |
| I_S | source current | $T_{mb} = 25\text{ °C}$ | [2] | - | 145 | A |
| I_{SM} | peak source current | pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$ | | - | 600 | A |
| Avalanche ruggedness | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 190\text{ A}$; $V_{sup} \leq 40\text{ V}$; $R_{GS} = 50\text{ }\Omega$; $V_{GS} = 10\text{ V}$; $T_{j(init)} = 25\text{ °C}$; unclamped; Fig. 4 | [3] [4] | - | 154 | mJ |

- [1] 190A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
- [2] 145A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
- [3] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [4] Refer to application note AN10273 for further information.



$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

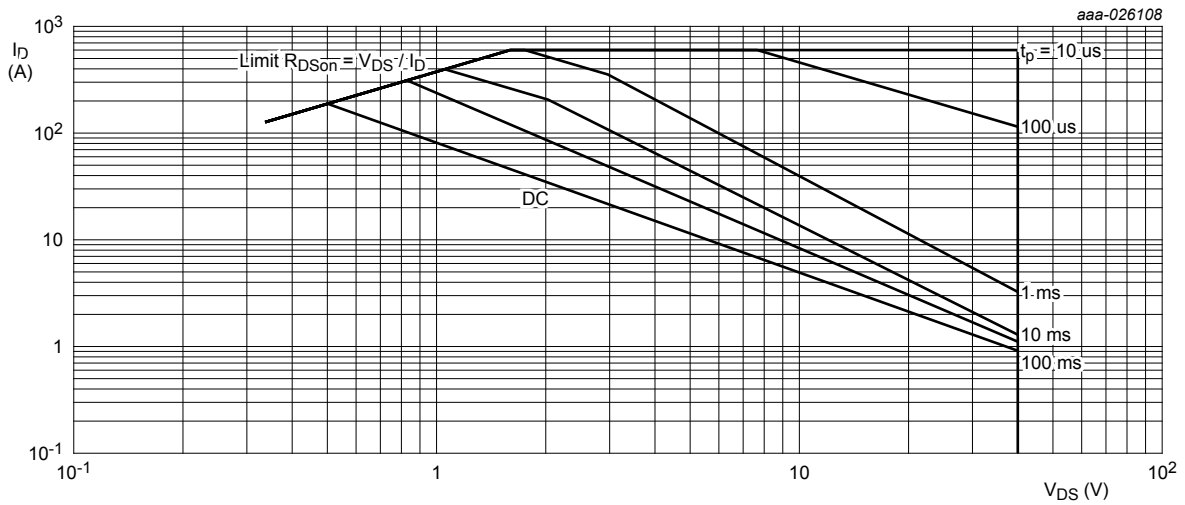
Fig. 1. Normalized total power dissipation as a function of mounting base temperature



$V_{GS} \geq 10\text{ V}$

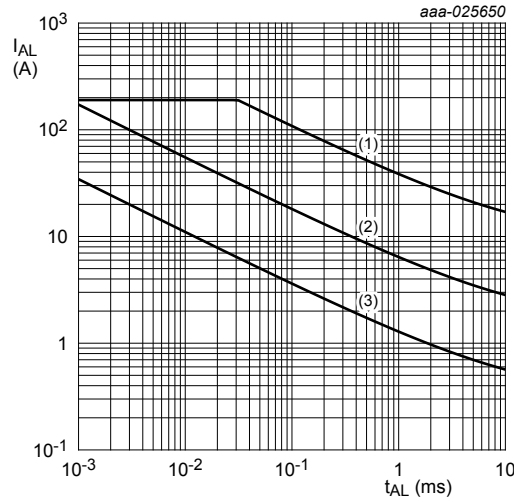
(1) 190A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

Fig. 2. Continuous drain current as a function of mounting base temperature



$T_{mb} = 25^{\circ}C$; I_{DM} is a single pulse

Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage



(1) $T_{j\text{ (init)}} = 25\text{ °C}$; (2) $T_{j\text{ (init)}} = 150\text{ °C}$; (3) Repetitive Avalanche

Fig. 4. Avalanche rating; avalanche current as a function of avalanche time

9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------|---|------------------------|-----|------|------|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Fig. 5 | - | 0.29 | 0.38 | K/W |

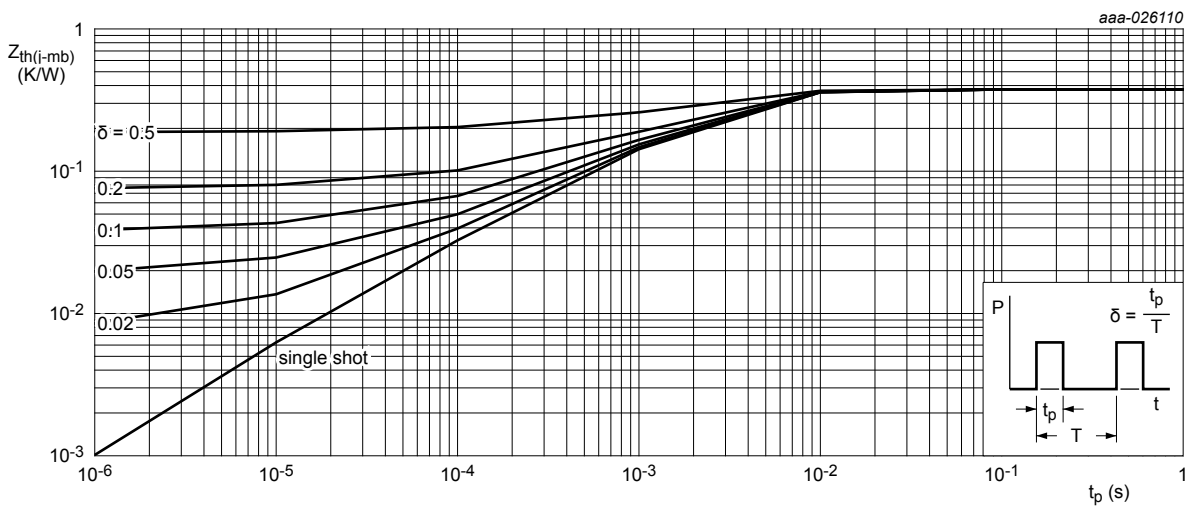


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

10. Characteristics

Table 7. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|--|------|------|------|---------------|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | 40 | 42 | - | V |
| | | $I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = -40 \text{ }^\circ\text{C}$ | - | 39.6 | - | V |
| | | $I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$ | 36 | 38.9 | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ Fig. 9 ; Fig. 10 | 2.4 | 3 | 3.6 | V |
| | | $I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ Fig. 9 | - | - | 4.3 | V |
| | | $I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 \text{ }^\circ\text{C};$ Fig. 9 | 1 | - | - | V |
| I_{DSS} | drain leakage current | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | 0.1 | 1 | μA |
| | | $V_{DS} = 16 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 125 \text{ }^\circ\text{C}$ | - | 2.4 | 10 | μA |
| | | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$ | - | 240 | 500 | μA |
| I_{GSS} | gate leakage current | $V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | 2 | 100 | nA |
| | | $V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | 2 | 100 | nA |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ Fig. 11 | 0.74 | 1.06 | 1.4 | mΩ |
| | | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 105 \text{ }^\circ\text{C};$ Fig. 12 | 1.05 | 1.57 | 2.23 | mΩ |
| | | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 125 \text{ }^\circ\text{C};$ Fig. 12 | 1.16 | 1.74 | 2.45 | mΩ |
| | | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ Fig. 12 | 1.46 | 2.18 | 3.05 | mΩ |
| R_G | gate resistance | $f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}$ | 0.4 | 1 | 2.5 | Ω |
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V};$ Fig. 13 ; Fig. 14 | - | 73 | 103 | nC |
| Q_{GS} | gate-source charge | | - | 21 | 32 | nC |
| Q_{GD} | gate-drain charge | | - | 13 | 27 | nC |
| C_{iss} | input capacitance | $V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz};$ $T_j = 25 \text{ }^\circ\text{C};$ Fig. 15 | - | 5436 | 7610 | pF |
| C_{oss} | output capacitance | | - | 1314 | 1840 | pF |
| C_{rss} | reverse transfer capacitance | | - | 238 | 524 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ } \Omega; V_{GS} = 10 \text{ V};$ $R_{G(ext)} = 5 \text{ } \Omega$ | - | 19 | - | ns |
| t_r | rise time | | - | 17 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 43 | - | ns |
| t_f | fall time | | - | 21 | - | ns |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 25 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C};$ Fig. 16 | - | 0.8 | 1.2 | V |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------|-----------------------|--|-----|------|-----|------|
| t_{rr} | reverse recovery time | $I_S = 25\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; $V_{DS} = 20\text{ V}$ | - | 37 | - | ns |
| Q_r | recovered charge | | - | 39 | - | nC |
| S | softness factor | $I_S = 25\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; $V_{DS} = 20\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$ | - | 0.7 | - | |
| | | $I_S = 25\text{ A}$; $dI_S/dt = -500\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; $V_{DS} = 20\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$ | - | 0.56 | - | |

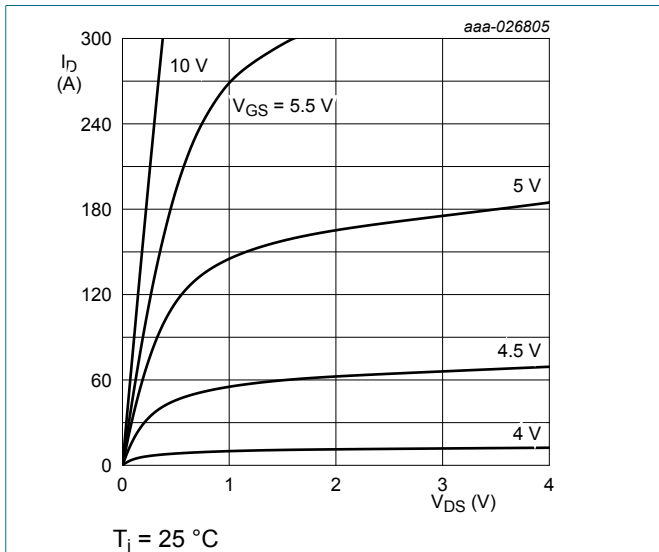


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

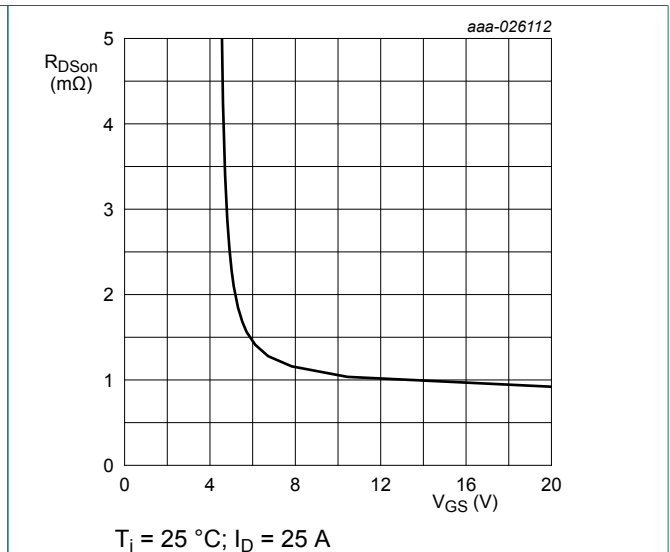


Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values

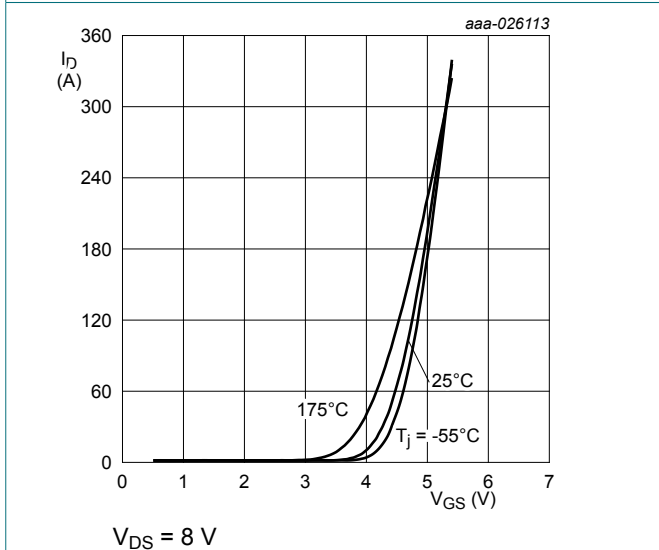


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

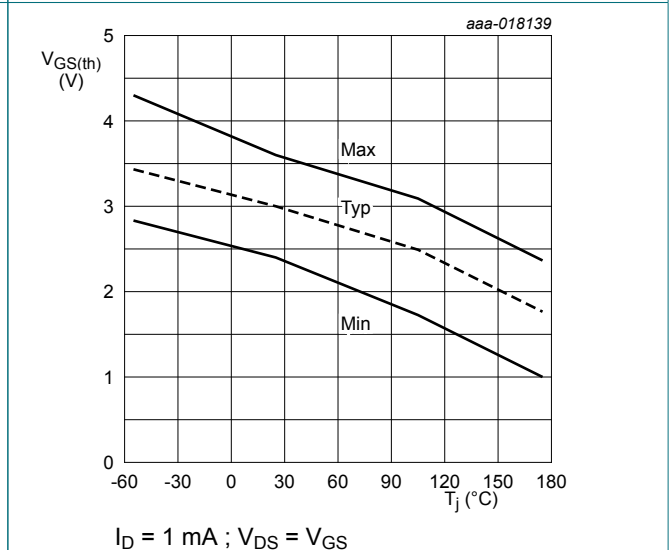


Fig. 9. Gate-source threshold voltage as a function of junction temperature

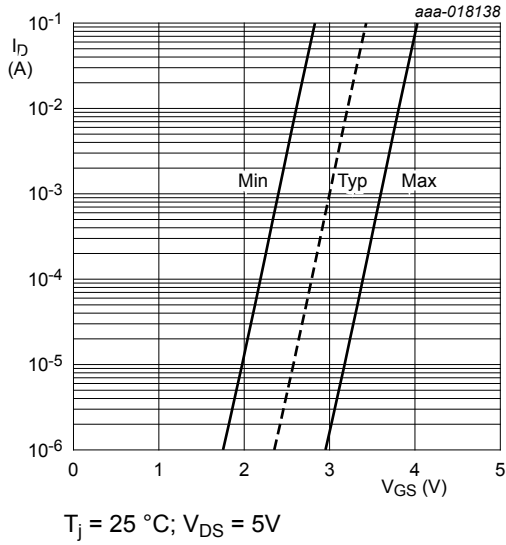


Fig. 10. Sub-threshold drain current as a function of gate-source voltage

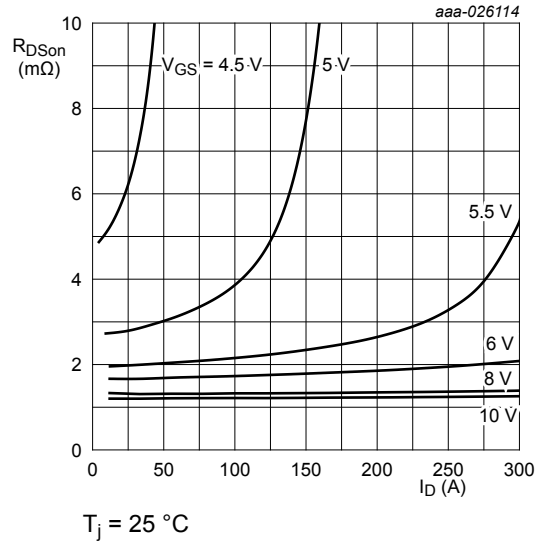


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

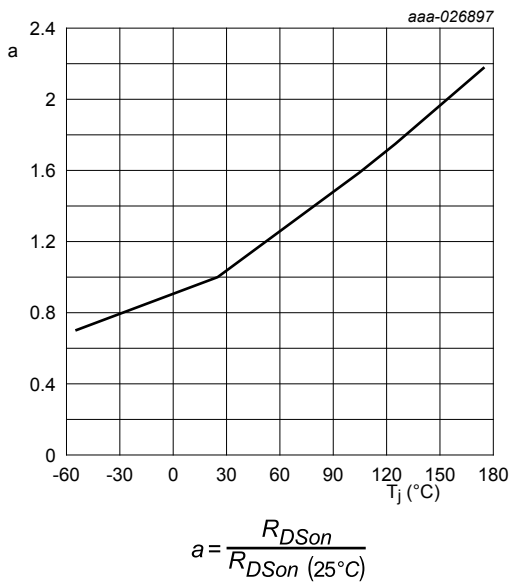


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

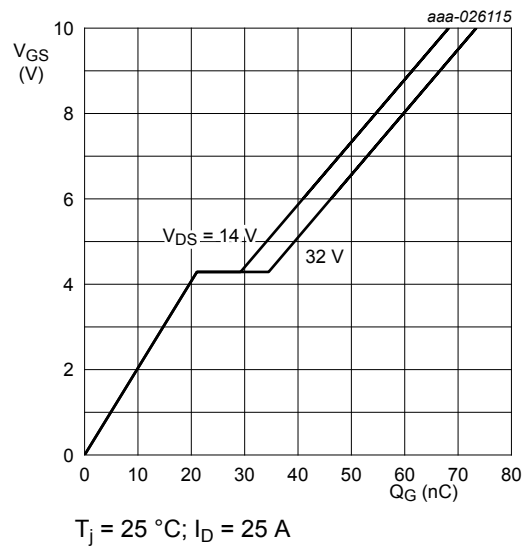


Fig. 13. Gate-source voltage as a function of gate charge; typical values

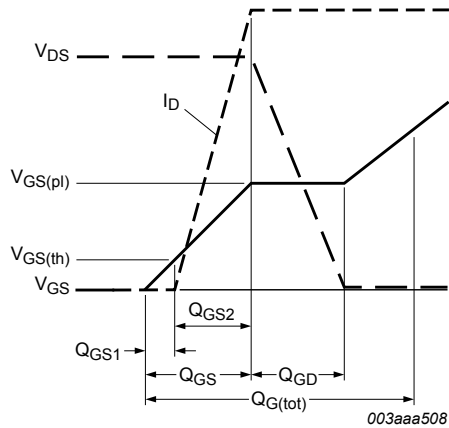
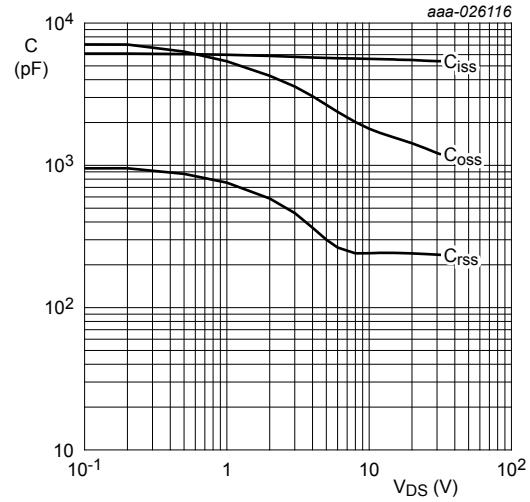
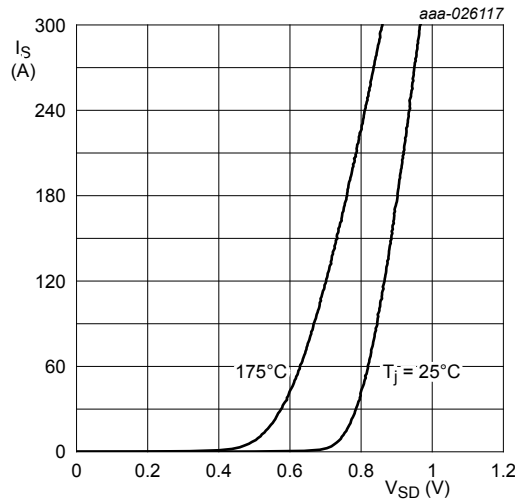


Fig. 14. Gate charge waveform definitions



$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$V_{GS} = 0 \text{ V}$

Fig. 16. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

11. Package outline

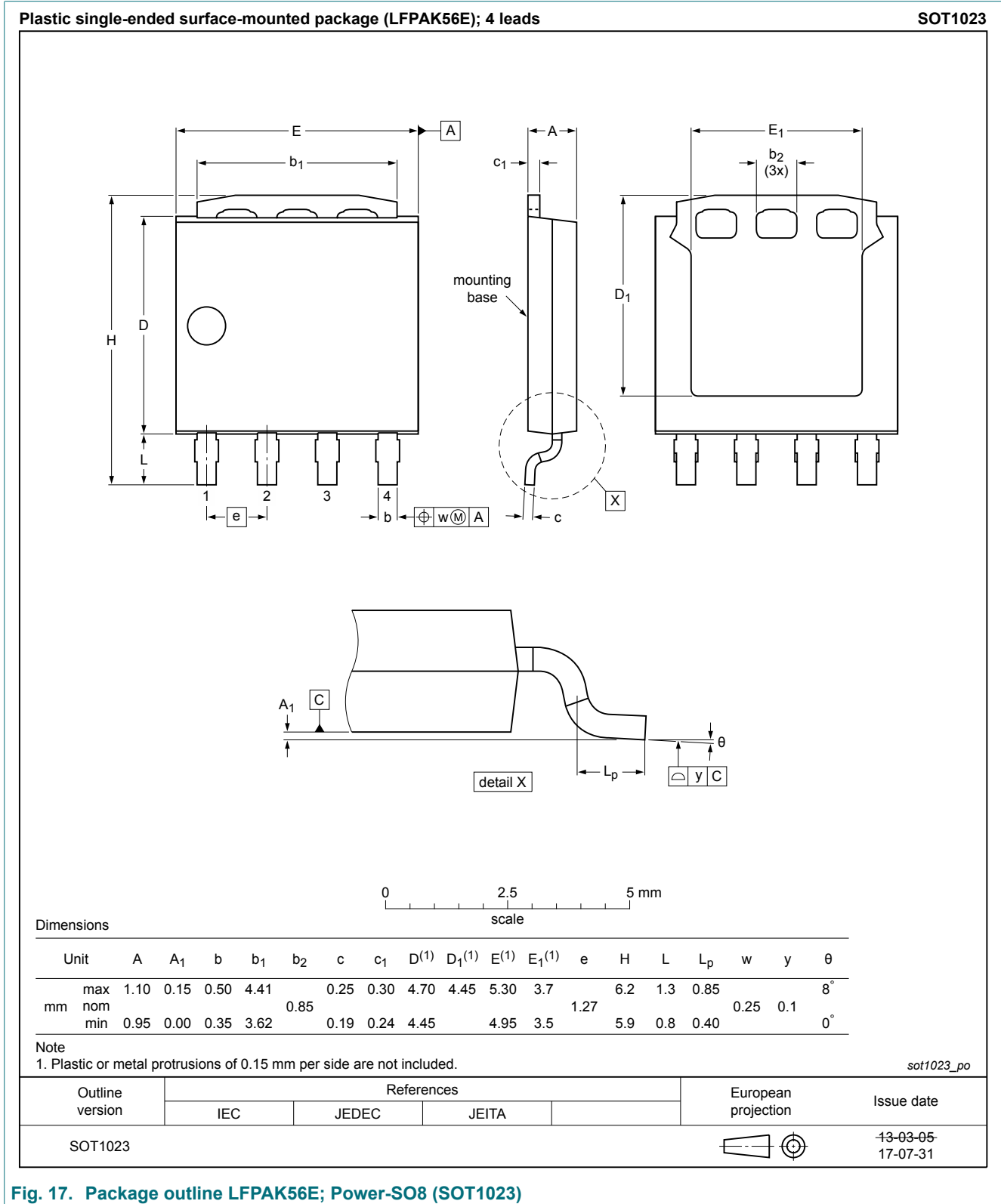


Fig. 17. Package outline LPAK56E; Power-SO8 (SOT1023)

12. Legal information

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| Document status [1][2] | Product status [3] | Definition |
|--------------------------------|--------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
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