



# PSMN4R2-80YSE

N-channel 80 V, 4.2 mOhm MOSFET with enhanced SOA in LFAK56E

3 September 2021

Product data sheet

## 1. General description

N-channel enhancement mode MOSFET in a LFAK56E package qualified to 175 °C. Part of Nexperia's "ASFETs for hotswap" portfolio, the PSMN4R2-80YSE delivers very low  $R_{DS(on)}$  and a very strong linear-mode (SOA) performance in a high-reliability copper-clip LFAK56E package.

PSMN4R2-80YSE complements the latest "hot-swap" controllers – robust enough to withstand substantial inrush currents during turn-on, low  $R_{DS(on)}$  to minimize  $I^2R$  losses delivering optimum efficiency when turned fully ON and an 80% smaller footprint than existing D2PAK types.

## 2. Features and benefits

- Fully optimized Safe Operating Area (SOA) for superior linear mode operation
- Low  $R_{DS(on)}$  for low  $I^2R$  conduction losses
- LFAK56E package for applications that demand the highest performance and reliability in a 30 mm<sup>2</sup> footprint

## 3. Applications

- Hot swap
- Load switch
- Soft start
- E-fuse
- Telecommunication systems based on a 48 V backplane/supply rail

## 4. Quick reference data

Table 1. Quick reference data

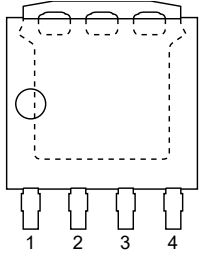
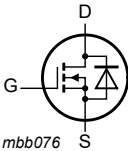
| Symbol                  | Parameter                        | Conditions                                                                                                                                       |  | Min | Typ | Max | Unit |
|-------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--|-----|-----|-----|------|
| V <sub>DS</sub>         | drain-source voltage             | 25 °C ≤ T <sub>j</sub> ≤ 175 °C                                                                                                                  |  | -   | -   | 80  | V    |
| I <sub>D</sub>          | drain current                    | V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 25 °C; <a href="#">Fig. 2</a>                                                                          |  | -   | -   | 170 | A    |
| P <sub>tot</sub>        | total power dissipation          | T <sub>mb</sub> = 25 °C; <a href="#">Fig. 1</a>                                                                                                  |  | -   | -   | 294 | W    |
| T <sub>j</sub>          | junction temperature             |                                                                                                                                                  |  | -55 | -   | 175 | °C   |
| Static characteristics  |                                  |                                                                                                                                                  |  |     |     |     |      |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 12</a>                                                   |  | -   | 3.2 | 4.2 | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 100 °C; <a href="#">Fig. 13</a>                                                  |  | -   | 4.6 | 6.4 | mΩ   |
| Dynamic characteristics |                                  |                                                                                                                                                  |  |     |     |     |      |
| Q <sub>GD</sub>         | gate-drain charge                | I <sub>D</sub> = 25 A; V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 10 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 14</a> ; <a href="#">Fig. 15</a> |  | 3   | 11  | 26  | nC   |
| Q <sub>G(tot)</sub>     | total gate charge                |                                                                                                                                                  |  | 37  | 73  | 110 | nC   |

| Symbol                      | Parameter                                    | Conditions                                                                                                                                                                                         |     | Min | Typ | Max | Unit |
|-----------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|------|
| <b>Avalanche ruggedness</b> |                                              |                                                                                                                                                                                                    |     |     |     |     |      |
| $E_{DS(AL)S}$               | non-repetitive drain-source avalanche energy | $I_D = 57\text{ A}$ ; $V_{sup} \leq 80\text{ V}$ ; $R_{GS} = 50\ \Omega$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ }^\circ\text{C}$ ; unclamped; $t_p = 126\ \mu\text{s}$ ; Fig. 4 | [1] | -   | -   | 374 | mJ   |
| <b>Source-drain diode</b>   |                                              |                                                                                                                                                                                                    |     |     |     |     |      |
| $Q_r$                       | recovered charge                             | $I_S = 25\text{ A}$ ; $dI_S/dt = -100\text{ A}/\mu\text{s}$ ; $V_{GS} = 0\text{ V}$ ; $V_{DS} = 40\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; Fig. 18                                          |     | -   | 35  | -   | nC   |

[1] Protected by 100% test

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline                                                                                                     | Graphic symbol                                                                                    |
|-----|--------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| 1   | S      | source                            |  <p>LPAK56E; 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            |                                                                                |         |
|---------------|--------------------|--------------------------------------------------------------------------------|---------|
|               | Name               | Description                                                                    | Version |
| PSMN4R2-80YSE | LPAK56E; Power-SO8 | plastic, single-ended surface-mounted package (LPAK56); 4 leads; 1.27 mm pitch | SOT1023 |

## 7. Marking

Table 4. Marking codes

| Type number   | Marking code |
|---------------|--------------|
| PSMN4R2-80YSE | 4E2S80J      |

## 8. Limiting values

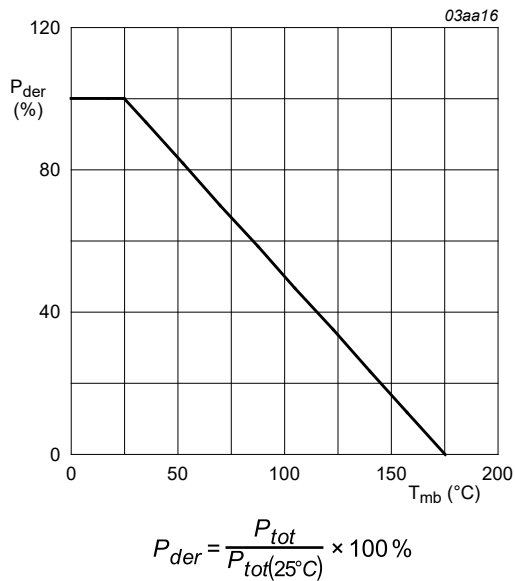
Table 5. Limiting values

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

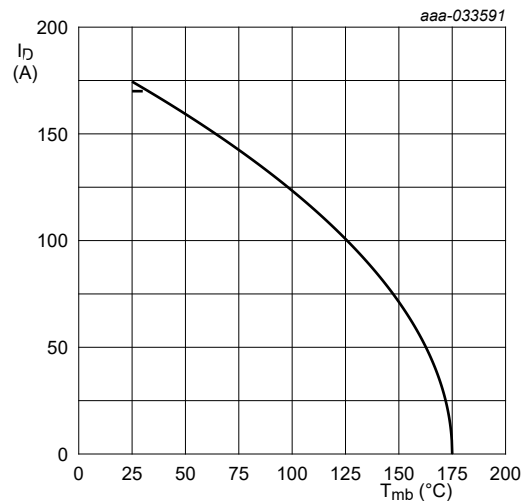
| Symbol    | Parameter               | Conditions                                                                                        |  | Min | Max | Unit |
|-----------|-------------------------|---------------------------------------------------------------------------------------------------|--|-----|-----|------|
| $V_{DS}$  | drain-source voltage    | $25\text{ }^\circ\text{C} \leq T_j \leq 175\text{ }^\circ\text{C}$                                |  | -   | 80  | V    |
| $V_{DGR}$ | drain-gate voltage      | $25\text{ }^\circ\text{C} \leq T_j \leq 175\text{ }^\circ\text{C}$ ; $R_{GS} = 20\text{ k}\Omega$ |  | -   | 80  | V    |
| $V_{GS}$  | gate-source voltage     |                                                                                                   |  | -20 | 20  | V    |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25\text{ }^\circ\text{C}$ ; Fig. 1                                                      |  | -   | 294 | W    |

| Symbol                      | Parameter                                    | Conditions                                                                                                                                                                                         | Min | Max | Unit   |
|-----------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|--------|
| $I_D$                       | drain current                                | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 2                                                                                                                                          | -   | 170 | A      |
|                             |                                              | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 100\text{ °C}$ ; Fig. 2                                                                                                                                         | -   | 123 | A      |
| $I_{DM}$                    | peak drain current                           | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 3                                                                                                                        | -   | 698 | A      |
| $T_{stg}$                   | storage temperature                          |                                                                                                                                                                                                    | -55 | 175 | °C     |
| $T_j$                       | junction temperature                         |                                                                                                                                                                                                    | -55 | 175 | °C     |
| $T_{sld(M)}$                | peak soldering temperature                   |                                                                                                                                                                                                    | -   | 260 | °C     |
| <b>Source-drain diode</b>   |                                              |                                                                                                                                                                                                    |     |     |        |
| $I_S$                       | source current                               | $T_{mb} = 25\text{ °C}$                                                                                                                                                                            | -   | 170 | A      |
| $I_{SM}$                    | peak source current                          | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$                                                                                                                                 | -   | 698 | A      |
| <b>Avalanche ruggedness</b> |                                              |                                                                                                                                                                                                    |     |     |        |
| $E_{DS(AL)S}$               | non-repetitive drain-source avalanche energy | $I_D = 57\text{ A}$ ; $V_{sup} \leq 80\text{ V}$ ; $R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ; unclamped; $t_p = 126\text{ }\mu\text{s}$ ; Fig. 4 | [1] | -   | 374 mJ |
| $I_{AS}$                    | non-repetitive avalanche current             | $V_{sup} = 80\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ; $R_{GS} = 50\text{ }\Omega$                                                                               | [1] | -   | 57 A   |

[1] Protected by 100% test



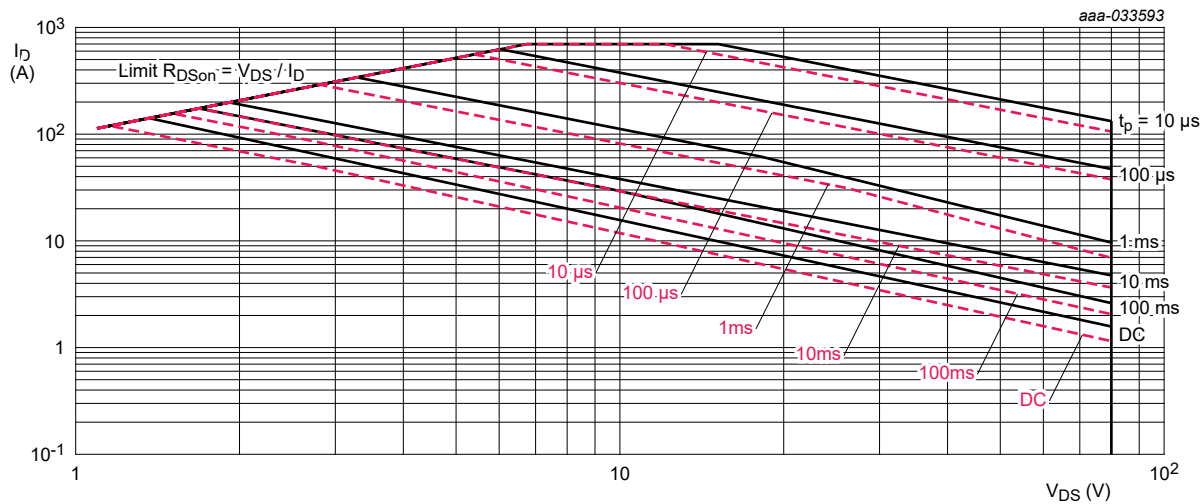
**Fig. 1. Normalized total power dissipation as a function of mounting base temperature**



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

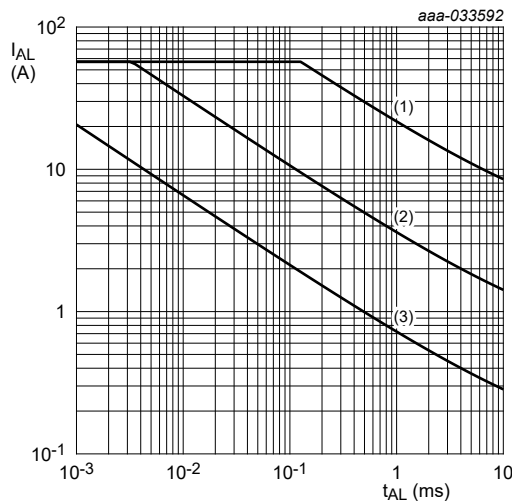
(1) 170A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

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



$T_{mb} = 25\text{ }^{\circ}\text{C}$  (Solid black line);  $T_{mb} = 125\text{ }^{\circ}\text{C}$  (red dashed line);  $I_{DM}$  is a single pulse

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



(1)  $T_{j\text{ (init)}} = 25\text{ }^{\circ}\text{C}$ ; (2)  $T_{j\text{ (init)}} = 150\text{ }^{\circ}\text{C}$ ; (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     | -   | 0.45 | 0.51 | K/W  |
| $R_{th(j-a)}$  | thermal resistance from junction to ambient       | Fig. 6     | -   | 42   | -    | K/W  |
|                |                                                   | Fig. 7     | -   | 85   | -    | K/W  |

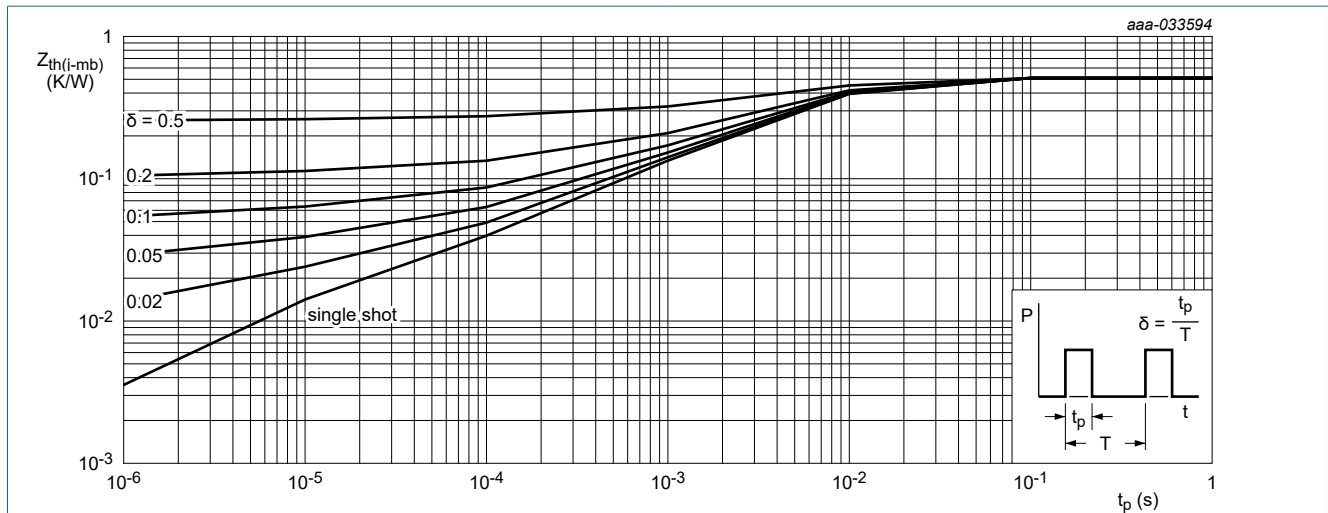
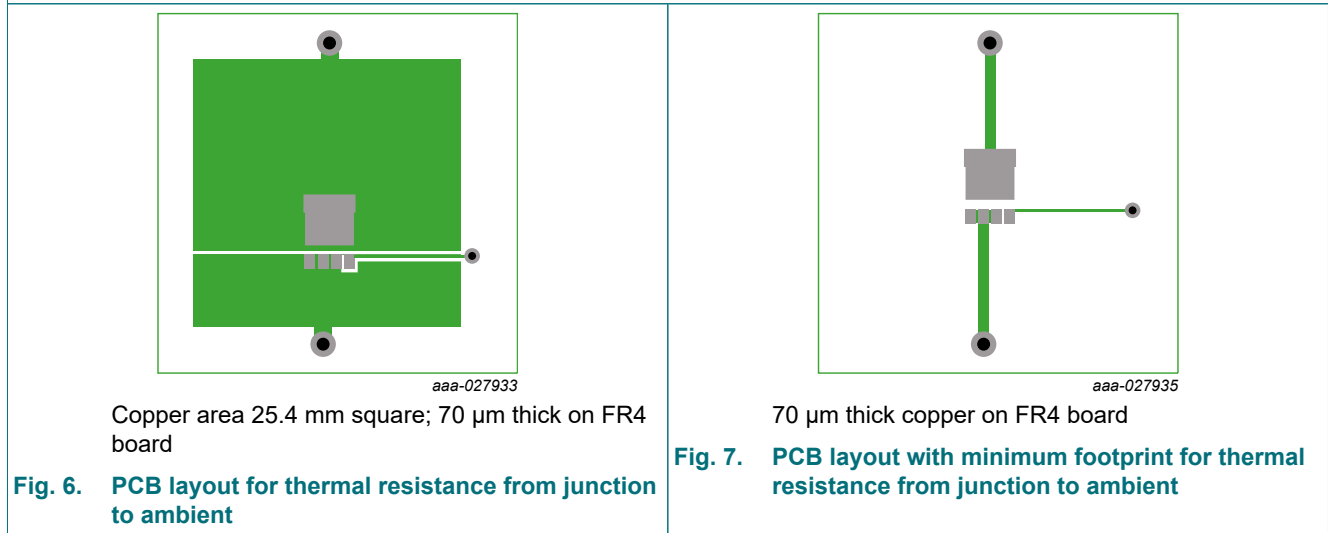


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration



## 10. Characteristics

Table 7. Characteristics

| Symbol                        | Parameter                                                | Conditions                                                     | Min | Typ  | Max | Unit    |
|-------------------------------|----------------------------------------------------------|----------------------------------------------------------------|-----|------|-----|---------|
| <b>Static characteristics</b> |                                                          |                                                                |     |      |     |         |
| $V_{(BR)DSS}$                 | drain-source breakdown voltage                           | $I_D = 250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 ^\circ C$       | 80  | -    | -   | V       |
|                               |                                                          | $I_D = 250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = -55 ^\circ C$      | 72  | -    | -   | V       |
| $V_{GS(th)}$                  | gate-source threshold voltage                            | $I_D = 1 mA$ ; $V_{DS}=V_{GS}$ ; $T_j = 25 ^\circ C$ ; Fig. 11 | 2   | 2.6  | 3.6 | V       |
|                               |                                                          | $I_D = 1 mA$ ; $V_{DS}=V_{GS}$ ; $T_j = 175 ^\circ C$          | -   | 1.6  | -   | V       |
|                               |                                                          | $I_D = 1 mA$ ; $V_{DS}=V_{GS}$ ; $T_j = -55 ^\circ C$          | -   | 3    | -   | V       |
| $\Delta V_{GS(th)}/\Delta T$  | gate-source threshold voltage variation with temperature | $25 ^\circ C \leq T_j \leq 150 ^\circ C$                       | -   | -6.1 | -   | mV/K    |
| $I_{DSS}$                     | drain leakage current                                    | $V_{DS} = 80 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 ^\circ C$         | -   | 0.02 | 1   | $\mu A$ |
|                               |                                                          | $V_{DS} = 80 V$ ; $V_{GS} = 0 V$ ; $T_j = 125 ^\circ C$        | -   | 5.5  | 100 | $\mu A$ |
| $I_{GSS}$                     | gate leakage current                                     | $V_{GS} = 20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 ^\circ C$         | -   | 2    | 100 | nA      |
|                               |                                                          | $V_{GS} = -20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 ^\circ C$        | -   | 2    | 100 | nA      |

## N-channel 80 V, 4.2 mOhm MOSFET with enhanced SOA in LPAK56E

| Symbol                  | Parameter                         | Conditions                                                                                                                                             |  | Min  | Typ  | Max  | Unit |
|-------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--|------|------|------|------|
| R <sub>DSon</sub>       | drain-source on-state resistance  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 12</a>                                                         |  | -    | 3.2  | 4.2  | mΩ   |
|                         |                                   | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 100 °C; <a href="#">Fig. 13</a>                                                        |  | -    | 4.6  | 6.4  | mΩ   |
|                         |                                   | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 175 °C; <a href="#">Fig. 13</a>                                                        |  | -    | 6.3  | 9.3  | mΩ   |
| R <sub>G</sub>          | gate resistance                   | f = 1 MHz; T <sub>j</sub> = 25 °C                                                                                                                      |  | 0.52 | 1.04 | 2.08 | Ω    |
| Dynamic characteristics |                                   |                                                                                                                                                        |  |      |      |      |      |
| Q <sub>G(tot)</sub>     | total gate charge                 | I <sub>D</sub> = 25 A; V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 10 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 14</a> ; <a href="#">Fig. 15</a>       |  | 37   | 73   | 110  | nC   |
|                         |                                   | I <sub>D</sub> = 0 A; V <sub>DS</sub> = 0 V; V <sub>GS</sub> = 10 V; T <sub>j</sub> = 25 °C                                                            |  | -    | 40   | -    | nC   |
| Q <sub>GS</sub>         | gate-source charge                | I <sub>D</sub> = 25 A; V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 10 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 14</a> ; <a href="#">Fig. 15</a>       |  | 18   | 31   | 43   | nC   |
| Q <sub>GS(th)</sub>     | pre-threshold gate-source charge  |                                                                                                                                                        |  | -    | 16.2 | -    | nC   |
| Q <sub>GS(th-pl)</sub>  | post-threshold gate-source charge |                                                                                                                                                        |  | -    | 14.8 | -    | nC   |
| Q <sub>GD</sub>         | gate-drain charge                 |                                                                                                                                                        |  | 3    | 11   | 26   | nC   |
| V <sub>GS(pl)</sub>     | gate-source plateau voltage       | I <sub>D</sub> = 25 A; V <sub>DS</sub> = 40 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 14</a> ; <a href="#">Fig. 15</a>                               |  | -    | 5.6  | -    | V    |
| C <sub>iss</sub>        | input capacitance                 | V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 0 V; f = 0.5 MHz; T <sub>j</sub> = 25 °C; <a href="#">Fig. 16</a>                                            |  | 3429 | 5714 | 8000 | pF   |
| C <sub>oss</sub>        | output capacitance                |                                                                                                                                                        |  | 893  | 1488 | 2381 | pF   |
| C <sub>rss</sub>        | reverse transfer capacitance      |                                                                                                                                                        |  | 5    | 55   | 164  | pF   |
| t <sub>d(on)</sub>      | turn-on delay time                | V <sub>DS</sub> = 40 V; R <sub>L</sub> = 1.6 Ω; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 5 Ω; T <sub>j</sub> = 25 °C                              |  | -    | 23   | -    | ns   |
| t <sub>r</sub>          | rise time                         |                                                                                                                                                        |  | -    | 25   | -    | ns   |
| t <sub>d(off)</sub>     | turn-off delay time               |                                                                                                                                                        |  | -    | 32   | -    | ns   |
| t <sub>f</sub>          | fall time                         |                                                                                                                                                        |  | -    | 24   | -    | ns   |
| Source-drain diode      |                                   |                                                                                                                                                        |  |      |      |      |      |
| V <sub>SD</sub>         | source-drain voltage              | I <sub>S</sub> = 25 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 17</a>                                                          |  | -    | 0.81 | 1    | V    |
| t <sub>rr</sub>         | reverse recovery time             | I <sub>S</sub> = 25 A; dI <sub>S</sub> /dt = -100 A/μs; V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 40 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 18</a> |  | -    | 38   | -    | ns   |
| Q <sub>r</sub>          | recovered charge                  |                                                                                                                                                        |  | -    | 35   | -    | nC   |

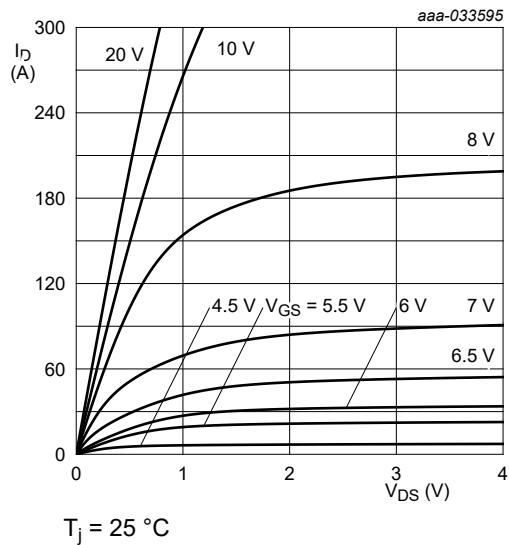


Fig. 8. Output characteristics; drain current as a function of drain-source voltage; typical values

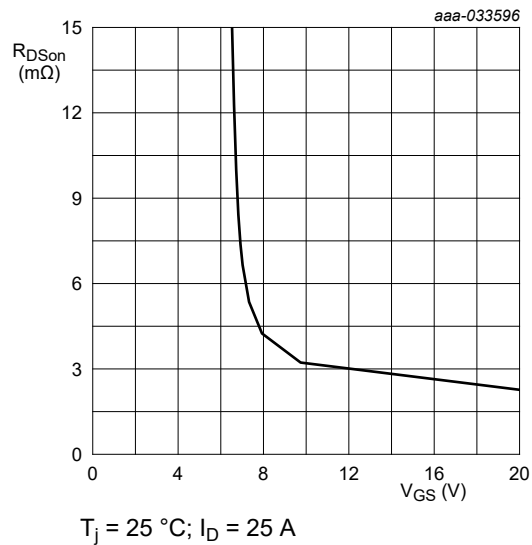


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

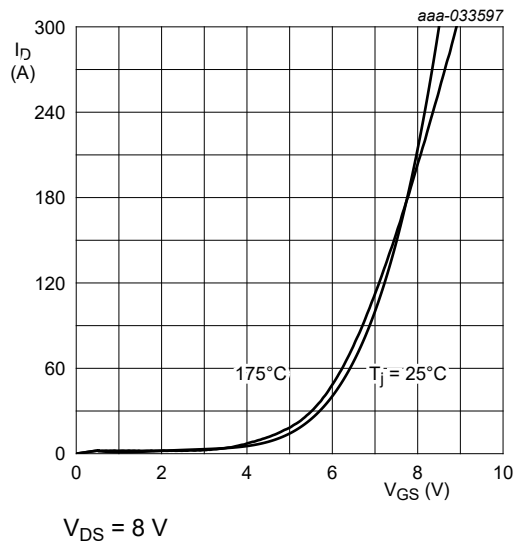


Fig. 10. Transfer characteristics; drain current as a function of gate-source voltage; typical values

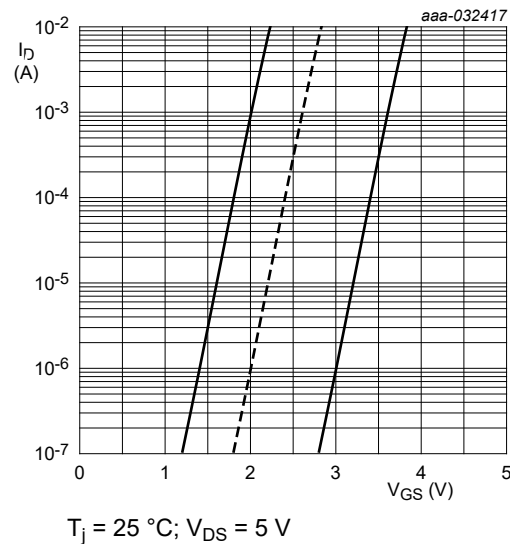


Fig. 11. Sub-threshold drain current as a function of gate-source voltage

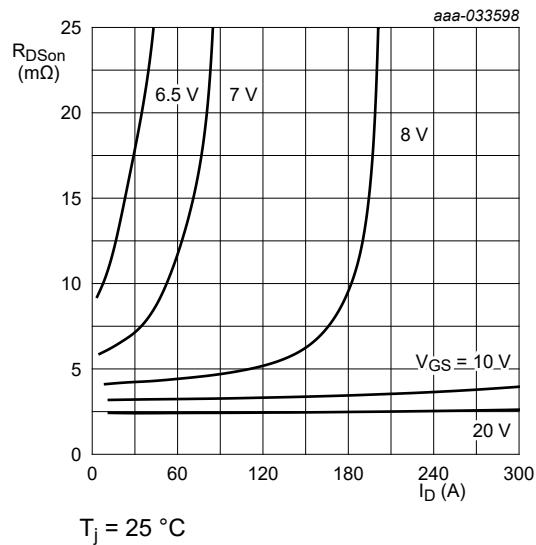


Fig. 12. Drain-source on-state resistance as a function of drain current; typical values

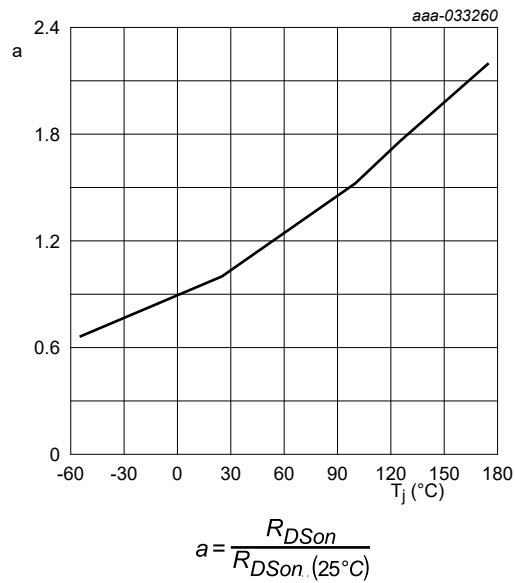


Fig. 13. Normalized drain-source on-state resistance factor as a function of junction temperature

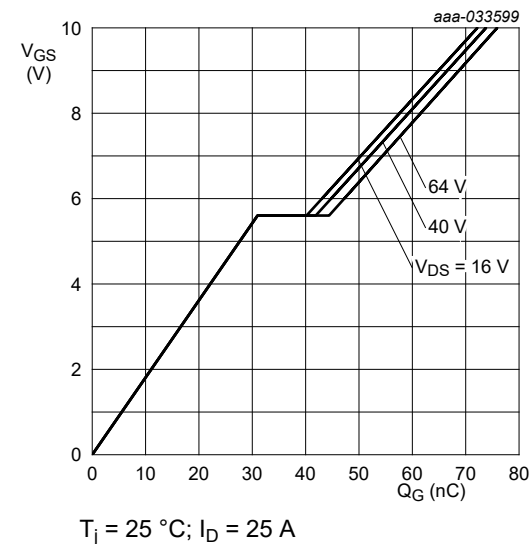


Fig. 14. Gate-source voltage as a function of gate charge; typical values

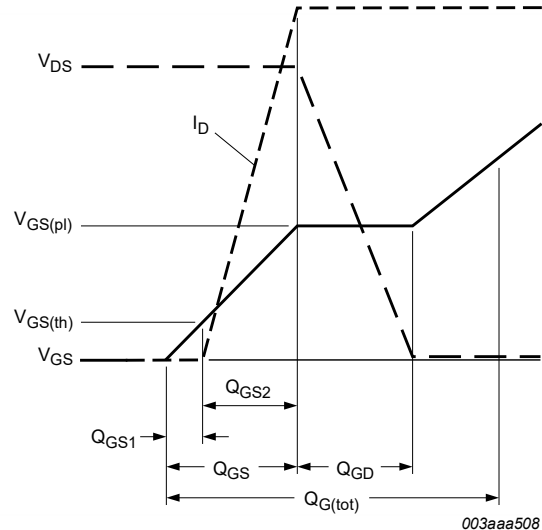
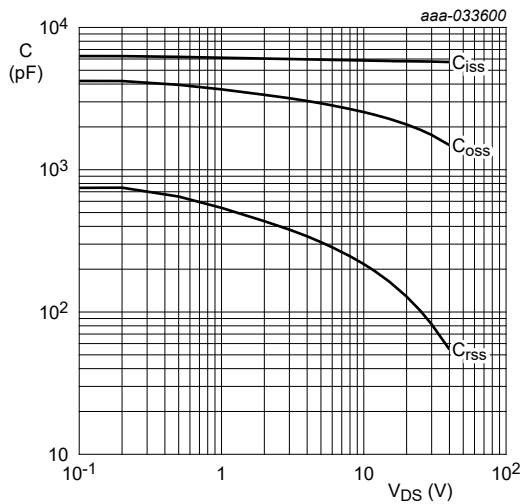


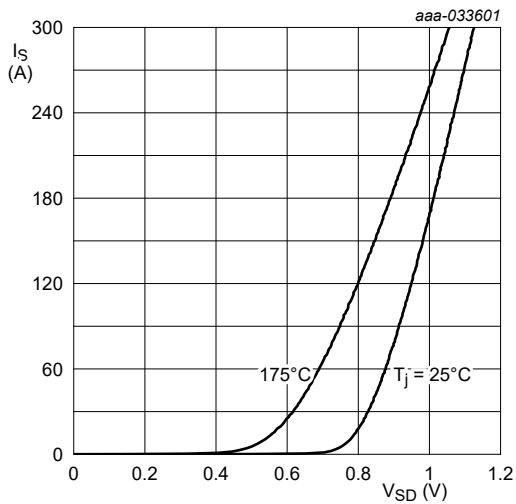
Fig. 15. Gate charge waveform definitions





$V_{GS} = 0\text{ V}$ ;  $f = 0.5\text{ MHz}$

Fig. 16. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



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

Fig. 17. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

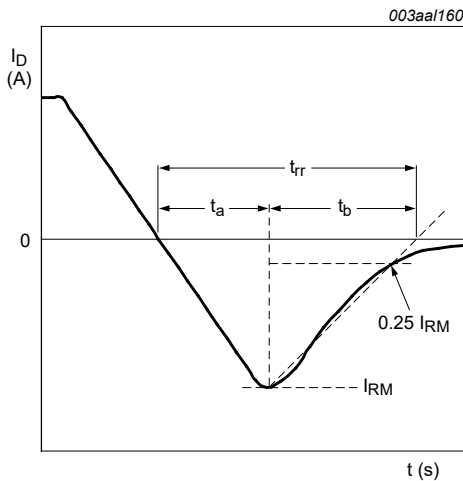


Fig. 18. Reverse recovery timing definition

11. Package outline

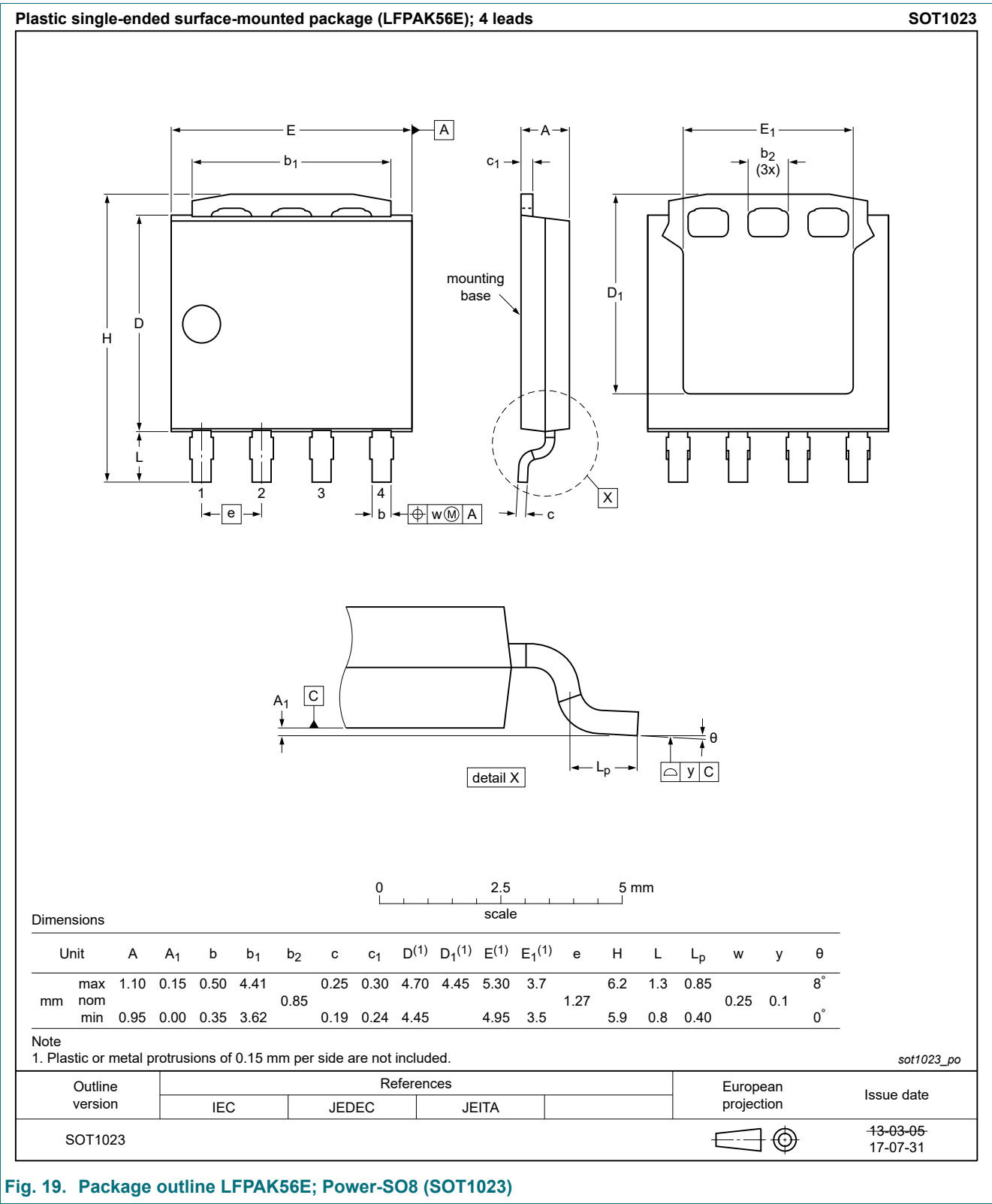


Fig. 19. Package outline LPAK56E; Power-SO8 (SOT1023)



## 13. Legal information

### Data sheet status

| 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.                       |
| Product [short] data sheet     | Production         | This document contains the product specification.                                     |

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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