



# PMN230ENE

60 V, N-channel Trench MOSFET

16 April 2018

Product data sheet

## 1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT457 (SC-74) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

## 2. Features and benefits

- Trench MOSFET technology
- Logic-level compatible
- Very fast switching
- ElectroStatic Discharge (ESD) protection > 2 kV HBM

## 3. Applications

- Relay driver
- High-speed line driver
- Low-side load switch
- Switching circuits

## 4. Quick reference data

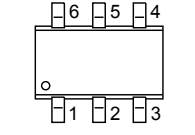
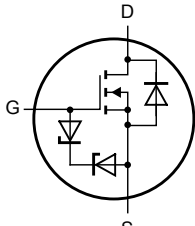
Table 1. Quick reference data

| Symbol                        | Parameter                        | Conditions                                                        | Min | Typ | Max | Unit |
|-------------------------------|----------------------------------|-------------------------------------------------------------------|-----|-----|-----|------|
| $V_{DS}$                      | drain-source voltage             | $T_j = 25\text{ °C}$                                              | -   | -   | 60  | V    |
| $V_{GS}$                      | gate-source voltage              |                                                                   | -20 | -   | 20  | V    |
| $I_D$                         | drain current                    | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}; t \leq 5\text{ s}$ | [1] | -   | 2   | A    |
| <b>Static characteristics</b> |                                  |                                                                   |     |     |     |      |
| $R_{DSon}$                    | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 1.6\text{ A}; T_j = 25\text{ °C}$    | -   | 176 | 222 | mΩ   |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 6 cm<sup>2</sup>.

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline                                                                                      | Graphic symbol                                                                                       |
|-----|--------|-------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 1   | D      | drain       |  <p>TSOP6 (SOT457)</p> |  <p>017aaa255</p> |
| 2   | D      | drain       |                                                                                                         |                                                                                                      |
| 3   | G      | gate        |                                                                                                         |                                                                                                      |
| 4   | S      | source      |                                                                                                         |                                                                                                      |
| 5   | D      | drain       |                                                                                                         |                                                                                                      |
| 6   | D      | drain       |                                                                                                         |                                                                                                      |

## 6. Ordering information

Table 3. Ordering information

| Type number | Package |                                                  |         |
|-------------|---------|--------------------------------------------------|---------|
|             | Name    | Description                                      | Version |
| PMN230ENE   | TSOP6   | plastic surface-mounted package (TSOP6); 6 leads | SOT457  |

## 7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| PMN230ENE   | 3E           |

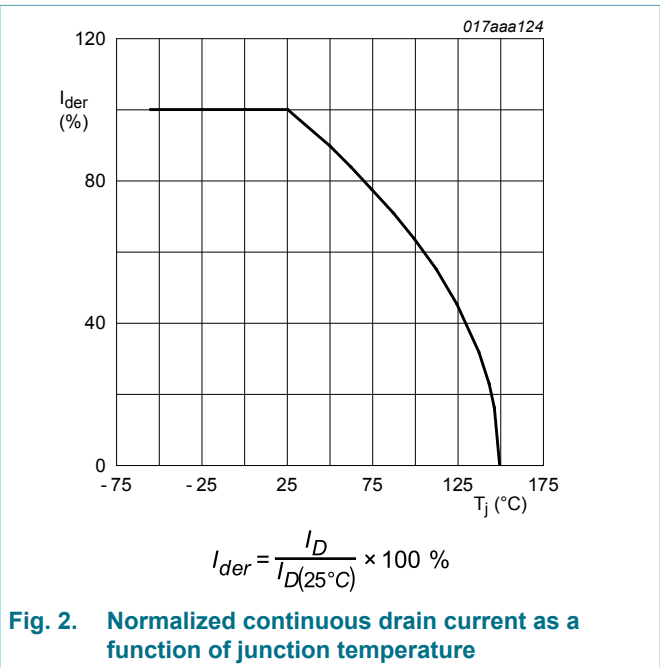
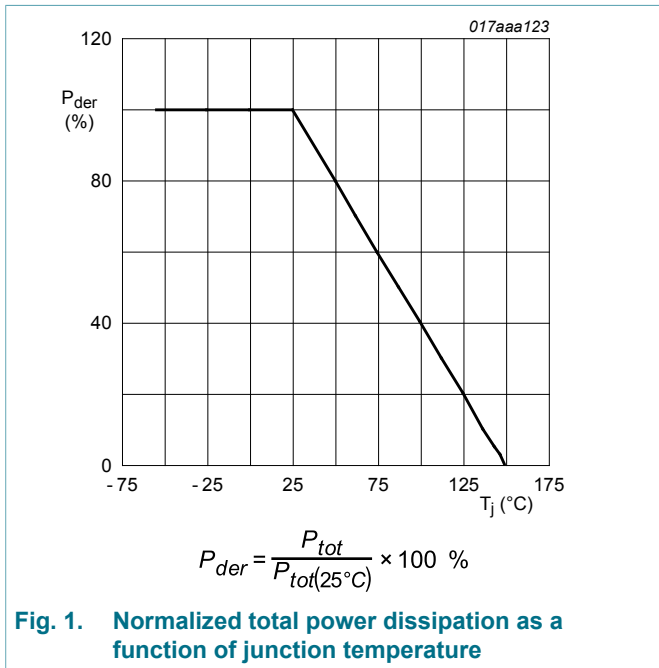
## 8. Limiting values

**Table 5. Limiting values**

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

| Symbol                    | Parameter               | Conditions                                                     |     | Min | Max  | Unit |
|---------------------------|-------------------------|----------------------------------------------------------------|-----|-----|------|------|
| V <sub>DS</sub>           | drain-source voltage    | T <sub>j</sub> = 25 °C                                         |     | -   | 60   | V    |
| V <sub>GS</sub>           | gate-source voltage     |                                                                |     | -20 | 20   | V    |
| I <sub>D</sub>            | drain current           | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C; t ≤ 5 s      | [1] | -   | 2    | A    |
|                           |                         | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C               | [1] | -   | 1.6  | A    |
|                           |                         | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 100 °C              | [1] | -   | 1    | A    |
| I <sub>DM</sub>           | peak drain current      | T <sub>amb</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs |     | -   | 7    | A    |
| P <sub>tot</sub>          | total power dissipation | T <sub>amb</sub> = 25 °C                                       | [2] | -   | 475  | mW   |
|                           |                         |                                                                | [1] | -   | 1.14 | W    |
|                           |                         | T <sub>sp</sub> = 25 °C                                        |     | -   | 3.9  | W    |
| T <sub>j</sub>            | junction temperature    |                                                                |     | -55 | 150  | °C   |
| T <sub>amb</sub>          | ambient temperature     |                                                                |     | -55 | 150  | °C   |
| T <sub>stg</sub>          | storage temperature     |                                                                |     | -65 | 150  | °C   |
| <b>Source-drain diode</b> |                         |                                                                |     |     |      |      |
| I <sub>S</sub>            | source current          | T <sub>amb</sub> = 25 °C                                       | [1] | -   | 1.1  | A    |

- [1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 6 cm<sup>2</sup>.
- [2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.



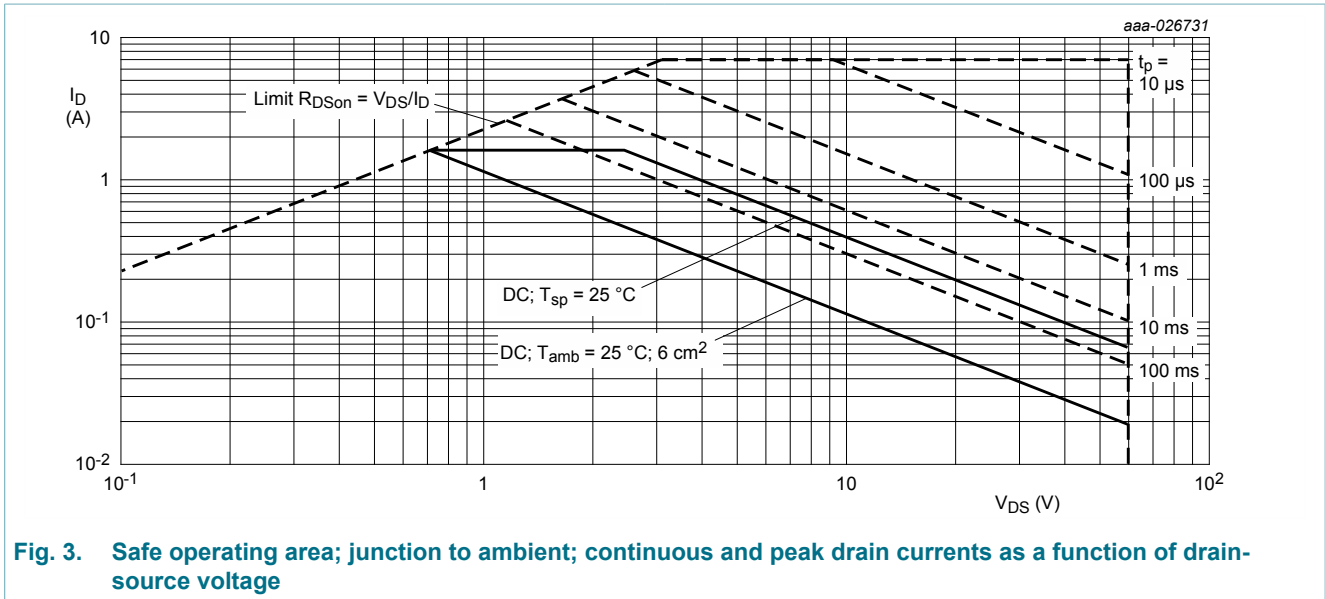


Fig. 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

## 9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol                | Parameter                                        | Conditions           |     | Min | Typ | Max | Unit |
|-----------------------|--------------------------------------------------|----------------------|-----|-----|-----|-----|------|
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air          | [1] | -   | 230 | 265 | K/W  |
|                       |                                                  |                      | [2] | -   | 95  | 110 | K/W  |
|                       |                                                  | in free air; t ≤ 5 s | [2] | -   | 55  | 63  | K/W  |
| R <sub>th(j-sp)</sub> | thermal resistance from junction to solder point |                      |     | -   | 28  | 32  | K/W  |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 6 cm<sup>2</sup>.

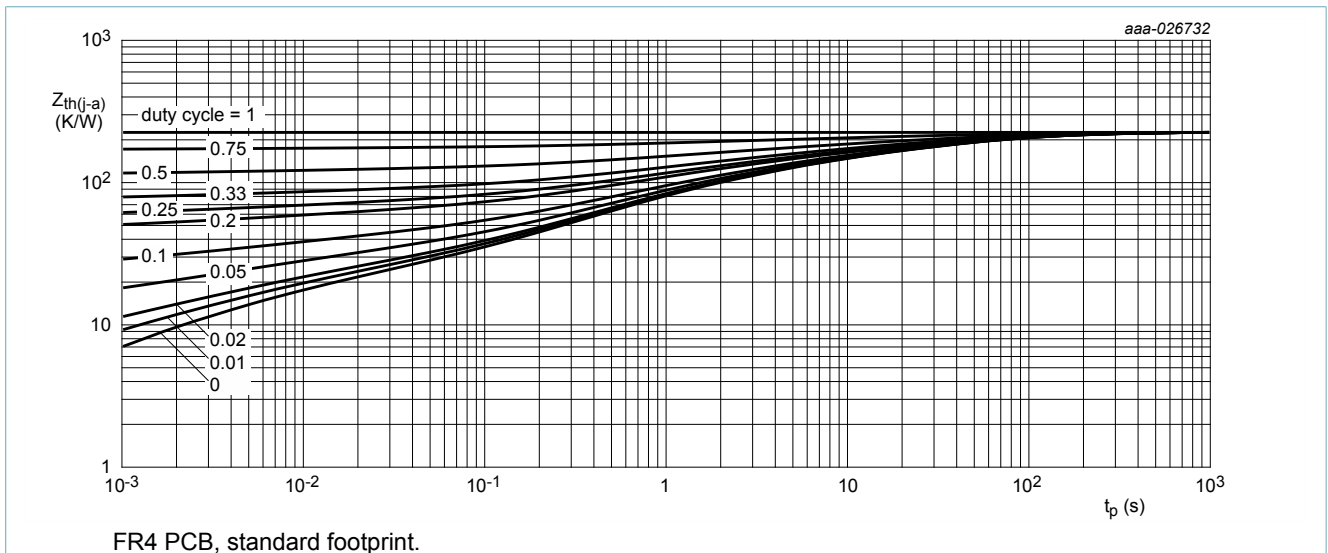


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

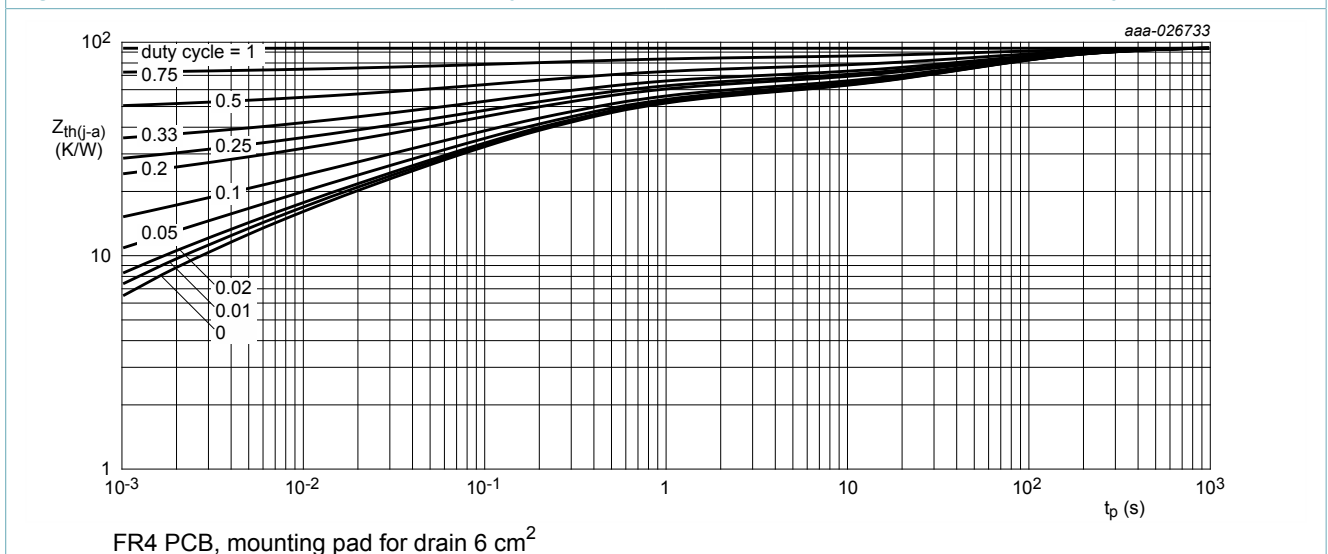
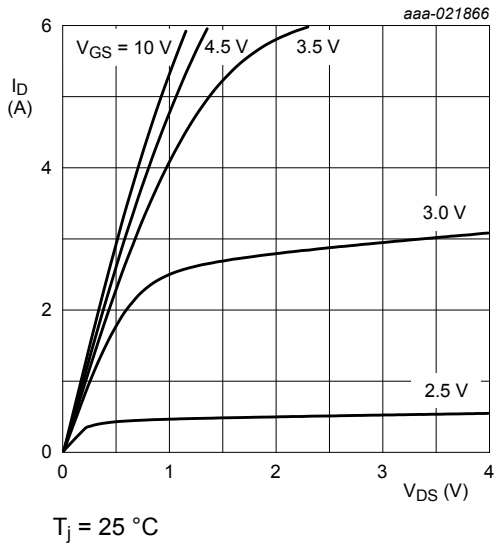


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

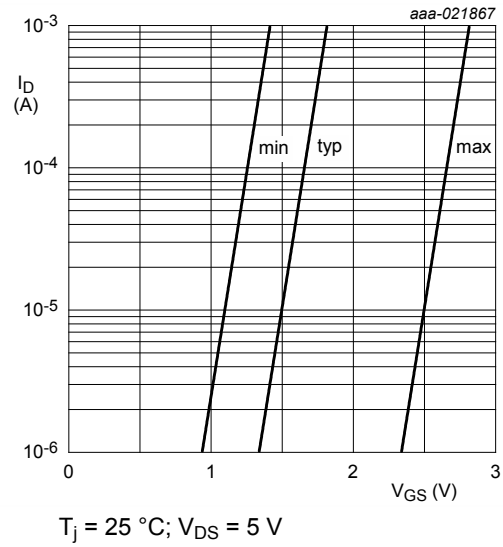
## 10. Characteristics

Table 7. Characteristics

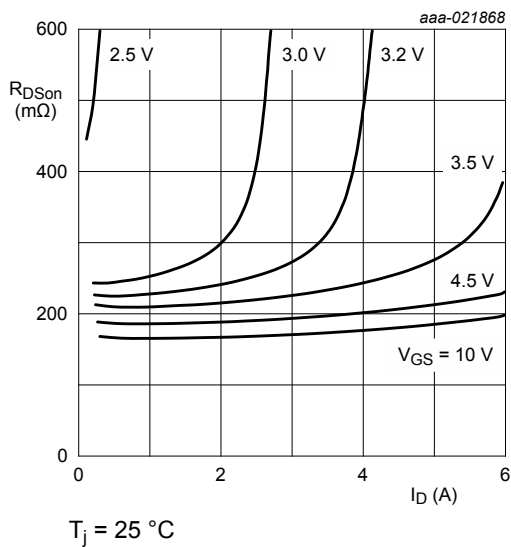
| Symbol                         | Parameter                        | Conditions                                                                              | Min                                                                                                                   | Typ  | Max | Unit       |
|--------------------------------|----------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------|-----|------------|
| <b>Static characteristics</b>  |                                  |                                                                                         |                                                                                                                       |      |     |            |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                        | 60                                                                                                                    | -    | -   | V          |
| $V_{GSth}$                     | gate-source threshold voltage    | $I_D = 250 \mu A$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ C$                     | 1.3                                                                                                                   | 1.7  | 2.7 | V          |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                          | -                                                                                                                     | -    | 1   | $\mu A$    |
| $I_{GSS}$                      | gate leakage current             | $V_{GS} = 20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                          | -                                                                                                                     | -    | 10  | $\mu A$    |
|                                |                                  | $V_{GS} = -20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                         | -                                                                                                                     | -    | -10 | $\mu A$    |
|                                |                                  | $V_{GS} = 10 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                          | -                                                                                                                     | -    | 1   | $\mu A$    |
|                                |                                  | $V_{GS} = -10 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                         | -                                                                                                                     | -    | -1  | $\mu A$    |
| $R_{DSon}$                     | drain-source on-state resistance | $V_{GS} = 10 V$ ; $I_D = 1.6 A$ ; $T_j = 25 \text{ }^\circ C$                           | -                                                                                                                     | 176  | 222 | m $\Omega$ |
|                                |                                  | $V_{GS} = 10 V$ ; $I_D = 1.6 A$ ; $T_j = 150 \text{ }^\circ C$                          | -                                                                                                                     | 352  | 444 | m $\Omega$ |
|                                |                                  | $V_{GS} = 4.5 V$ ; $I_D = 1.5 A$ ; $T_j = 25 \text{ }^\circ C$                          | -                                                                                                                     | 196  | 262 | m $\Omega$ |
| $g_{fs}$                       | forward transconductance         | $V_{DS} = 10 V$ ; $I_D = 1.5 A$ ; $T_j = 25 \text{ }^\circ C$                           | -                                                                                                                     | 6.2  | -   | S          |
| $R_G$                          | gate resistance                  | $f = 1 \text{ MHz}$                                                                     | -                                                                                                                     | 9    | -   | $\Omega$   |
| <b>Dynamic characteristics</b> |                                  |                                                                                         |                                                                                                                       |      |     |            |
| $Q_{G(tot)}$                   | total gate charge                | $V_{DS} = 30 V$ ; $I_D = 1.5 A$ ; $V_{GS} = 10 V$ ;<br>$T_j = 25 \text{ }^\circ C$      | -                                                                                                                     | 3.9  | 5   | nC         |
| $Q_{GS}$                       | gate-source charge               |                                                                                         | -                                                                                                                     | 0.4  | -   | nC         |
| $Q_{GD}$                       | gate-drain charge                |                                                                                         | -                                                                                                                     | 0.7  | -   | nC         |
| $C_{iss}$                      | input capacitance                | $V_{DS} = 30 V$ ; $f = 1 \text{ MHz}$ ; $V_{GS} = 0 V$ ;<br>$T_j = 25 \text{ }^\circ C$ | -                                                                                                                     | 177  | -   | pF         |
| $C_{oss}$                      | output capacitance               |                                                                                         | -                                                                                                                     | 15   | -   | pF         |
| $C_{rss}$                      | reverse transfer capacitance     |                                                                                         | -                                                                                                                     | 11   | -   | pF         |
| $t_{d(on)}$                    | turn-on delay time               |                                                                                         | $V_{DS} = 30 V$ ; $I_D = 1.5 A$ ; $V_{GS} = 10 V$ ;<br>$R_{G(ext)} = 6 \text{ } \Omega$ ; $T_j = 25 \text{ }^\circ C$ | -    | 6   | -          |
| $t_r$                          | rise time                        | -                                                                                       |                                                                                                                       | 8    | -   | ns         |
| $t_{d(off)}$                   | turn-off delay time              | -                                                                                       |                                                                                                                       | 13   | -   | ns         |
| $t_f$                          | fall time                        | -                                                                                       |                                                                                                                       | 5    | -   | ns         |
| <b>Source-drain diode</b>      |                                  |                                                                                         |                                                                                                                       |      |     |            |
| $V_{SD}$                       | source-drain voltage             | $I_S = 1.1 A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$                            | -                                                                                                                     | 0.85 | 1.2 | V          |



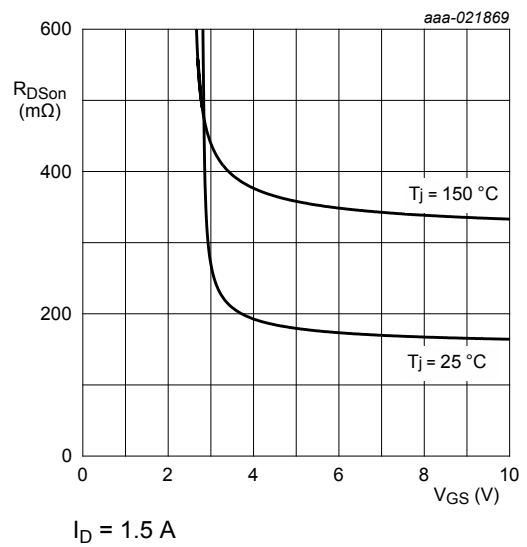
**Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



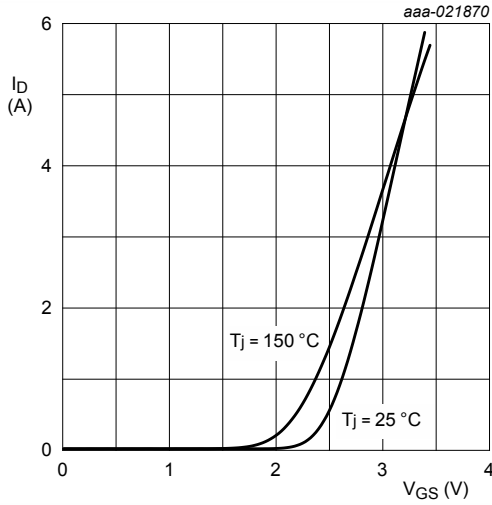
**Fig. 7. Sub-threshold drain current as a function of gate-source voltage**



**Fig. 8. Drain-source on-state resistance as a function of drain current; typical values**

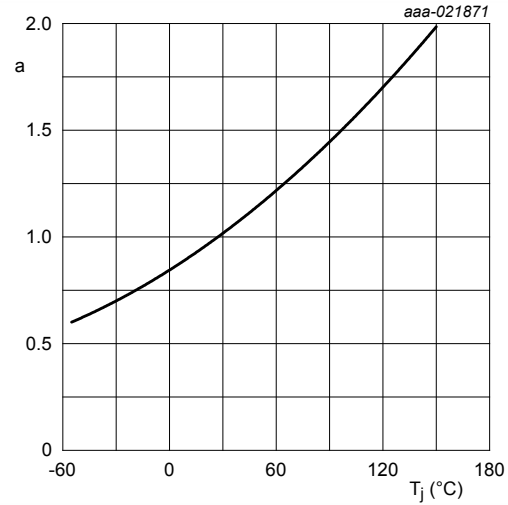


**Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values**



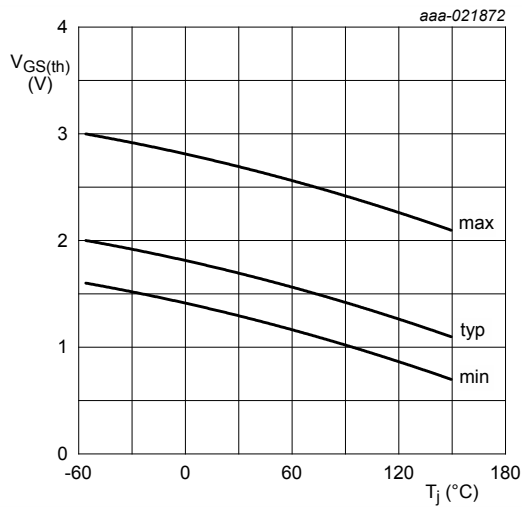
$$V_{DS} > I_D \times R_{DSon}$$

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



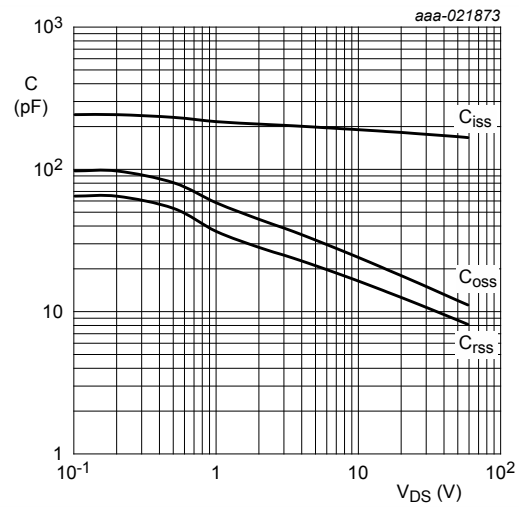
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

**Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values**



$$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}$$

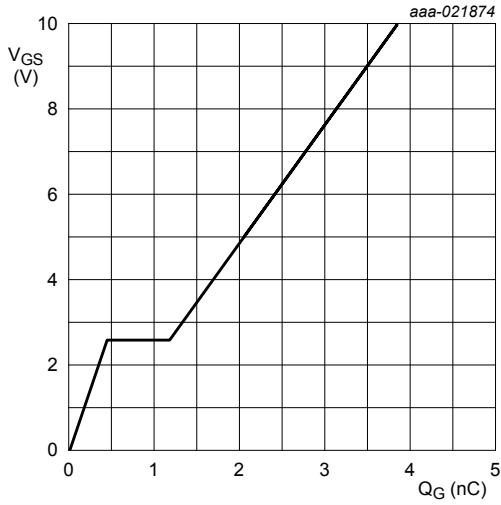
**Fig. 12. Gate-source threshold voltage as a function of junction temperature**



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

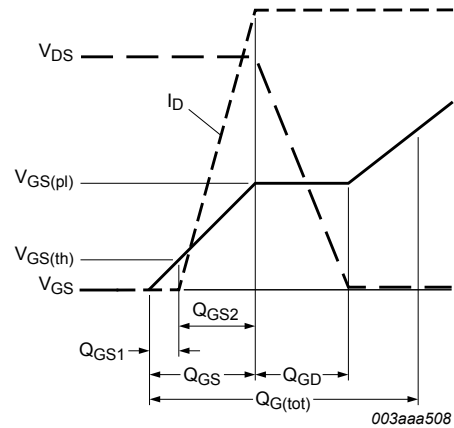
**Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



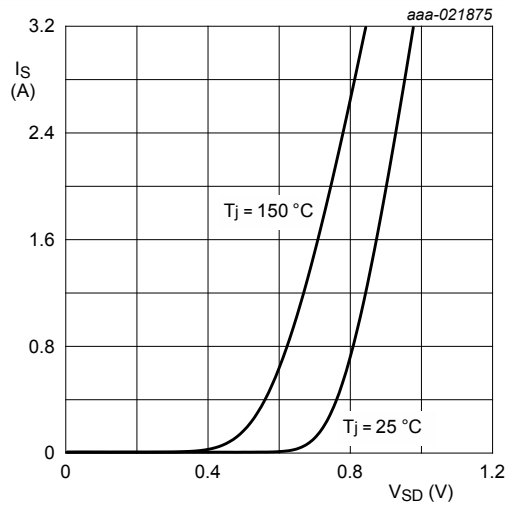


$I_D = 1.6 \text{ A}; V_{DS} = 30 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

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



**Fig. 15. Gate charge waveform definitions**



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

**Fig. 16. Source current as a function of source-drain voltage; typical values**

### 11. Test information

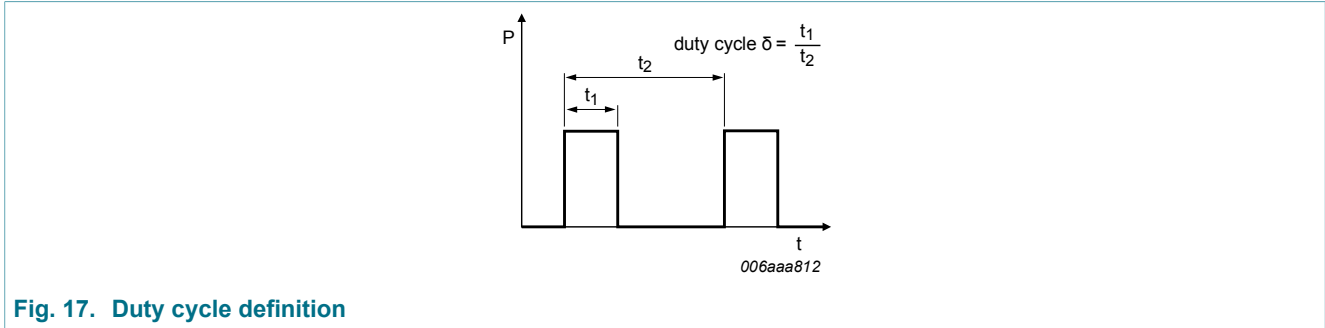


Fig. 17. Duty cycle definition

### 12. Package outline

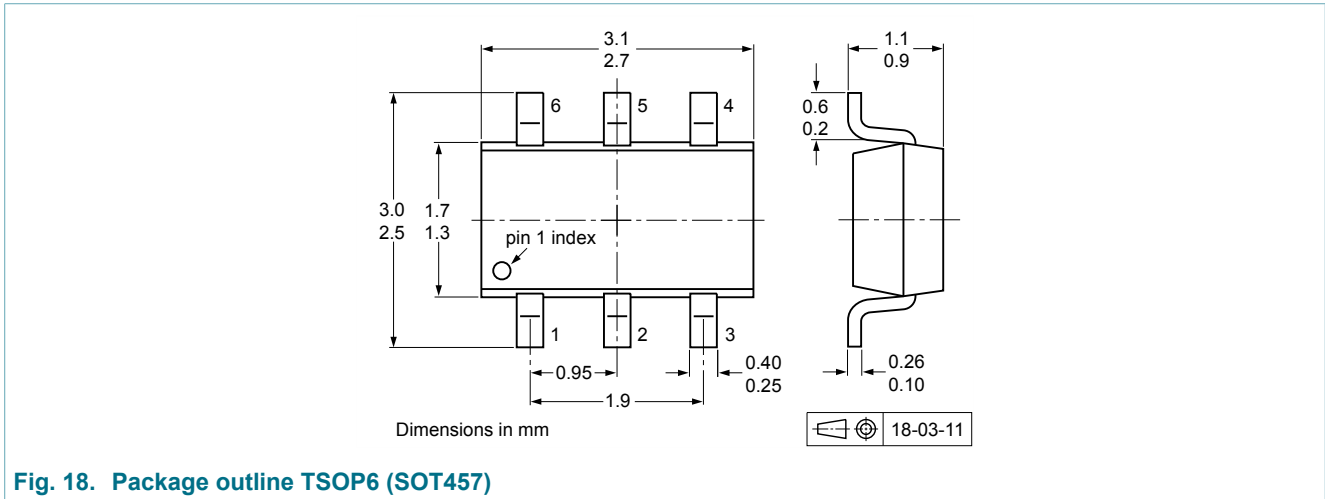


Fig. 18. Package outline TSOP6 (SOT457)

### 13. Soldering

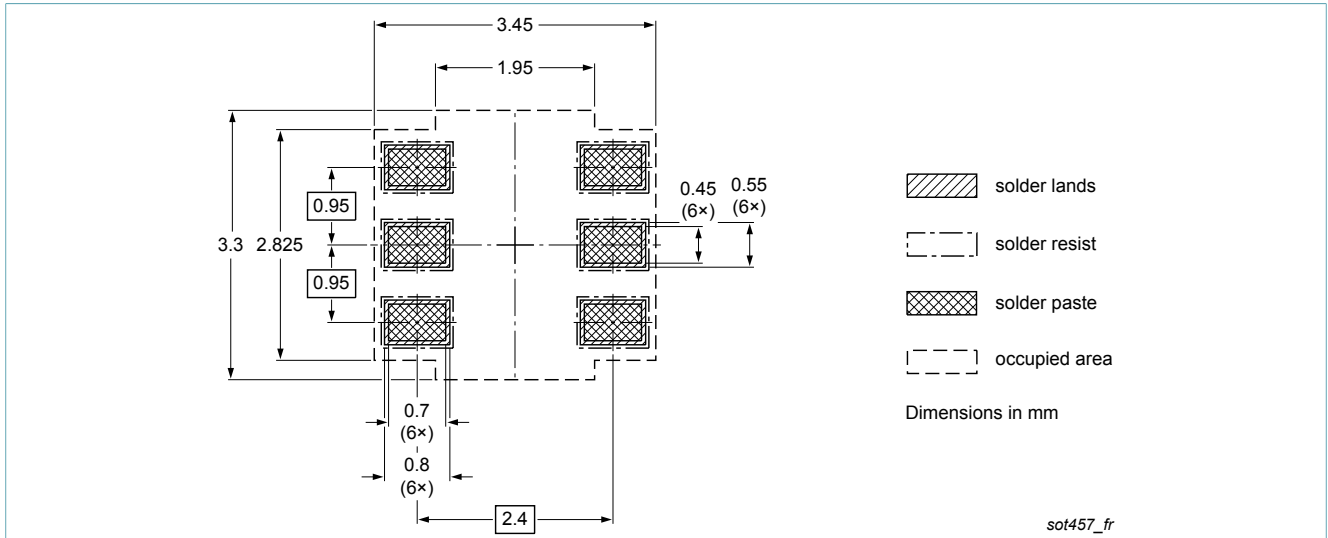


Fig. 19. Reflow soldering footprint for TSOP6 (SOT457)

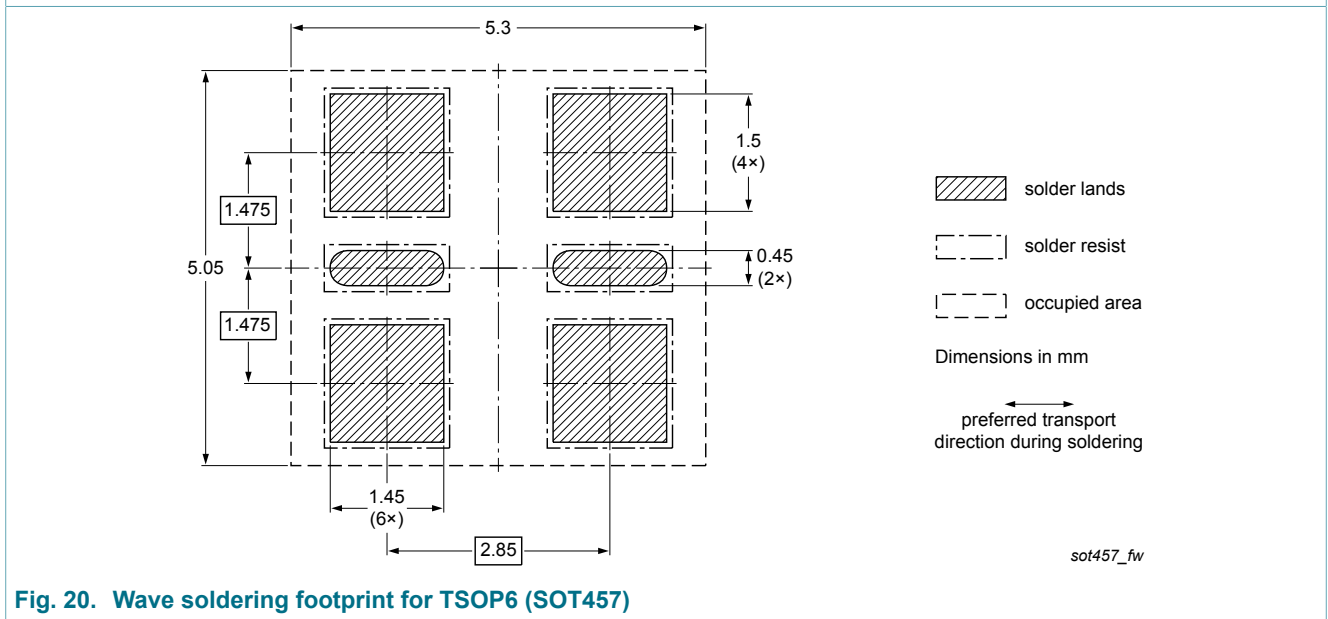


Fig. 20. Wave soldering footprint for TSOP6 (SOT457)

## 14. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status  | Change notice | Supersedes |
|---------------|--------------|--------------------|---------------|------------|
| PMN230ENE v.1 | 20180416     | Product data sheet | -             | -          |

## 15. 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.
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Date of release: 16 April 2018

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