# PH6030AL

## N-channel TrenchMOS logic level FET

**Rev. 05 — 12 January 2010** **Product data sheet**

## 1. Product profile

### 1.1 General description

Logic level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product is designed and qualified for use in computing and consumer applications.

### 1.2 Features and benefits

- High efficiency due to low switching and conduction losses
- Suitable for logic level gate drive sources

### 1.3 Applications

- Consumer applications
- Desktop Voltage Regulator Module (VRM)
- Notebook Voltage Regulator Module (VRM)

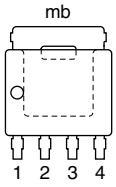
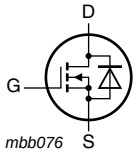
### 1.4 Quick reference data

**Table 1. Quick reference**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | - | - | 30 | V |
| $I_D$ | drain current | $T_{mb}$ = 25 °C; $V_{GS}$ = 10 V; see Figure 1 | - | - | 79 | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; see Figure 2 | - | - | 55 | W |
| **Dynamic characteristics** | | | | | | |
| $Q_{GD}$ | gate-drain charge | $V_{GS}$ = 4.5 V; $I_D$ = 10 A; $V_{DS}$ = 12 V; see Figure 14 and 15 | - | 3.08 | - | nC |
| $Q_{G(tot)}$ | total gate charge | | - | 11 | - | nC |
| **Static characteristics** | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 4.5 V; $I_D$ = 15 A; $T_j$ = 25 °C | - | 6.18 | 7.87 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 15 A; $T_j$ = 25 °C | - | 4.2 | 6 | mΩ |

## 2. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | S | source |  |  |
| 2 | S | source | | |
| 3 | S | source | | |
| 4 | G | gate | | |
| mb | D | mounting base; connected to drain | | |



**SOT669 (LFPAK)**

## 3. Ordering information

**Table 3. Ordering information**

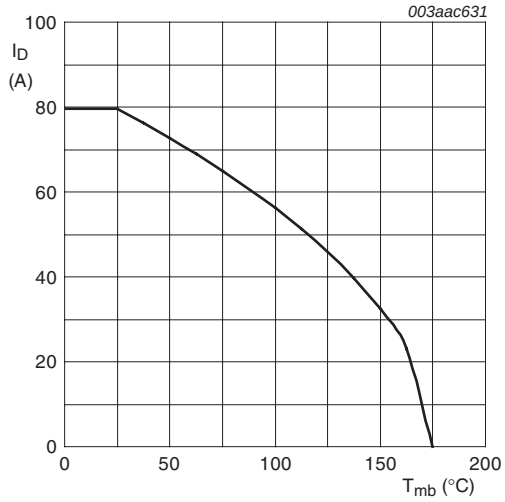
| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| PH6030AL | LFPAK | plastic single-ended surface-mounted package (LFPAK); 4 leads | SOT669 |

## 4. Limiting values

**Table 4. Limiting values**

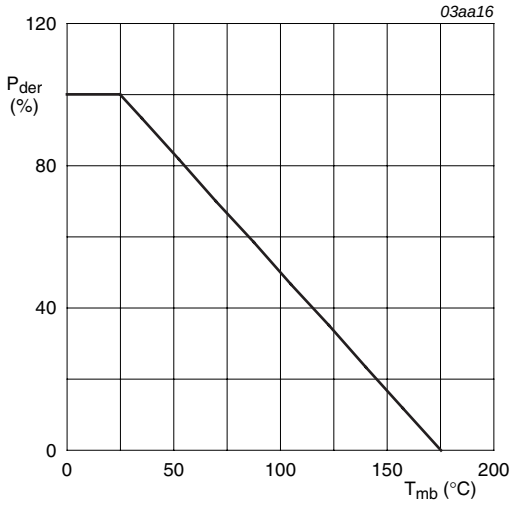
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | - | 30 | V |
| $V_{DGR}$ | drain-gate voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C; $R_{GS} = 20$ kΩ | - | 30 | V |
| $V_{GS}$ | gate-source voltage | | -20 | 20 | V |
| $I_D$ | drain current | $V_{GS} = 10$ V; $T_{mb} = 100$ °C; see Figure 1 | - | 56 | A |
| | | $V_{GS} = 10$ V; $T_{mb} = 25$ °C; see Figure 1 | - | 79 | A |
| $I_{DM}$ | peak drain current | $t_p \leq 10$ µs; pulsed; $T_{mb} = 25$ °C; see Figure 3 | - | 292 | A |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25$ °C; see Figure 2 | - | 55 | W |
| $T_{stg}$ | storage temperature | | -55 | 175 | °C |
| $T_j$ | junction temperature | | -55 | 175 | °C |
| **Source-drain diode** | | | | | |
| $I_S$ | source current | $T_{mb} = 25$ °C | - | 73 | A |
| $I_{SM}$ | peak source current | $t_p \leq 10$ µs; pulsed; $T_{mb} = 25$ °C | - | 292 | A |
| **Avalanche ruggedness** | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $V_{GS} = 10$ V; $T_{j(init)} = 25$ °C; $I_D = 73$ A; $V_{sup} \leq 30$ V; $R_{GS} = 50$ Ω; unclamped | - | 26 | mJ |



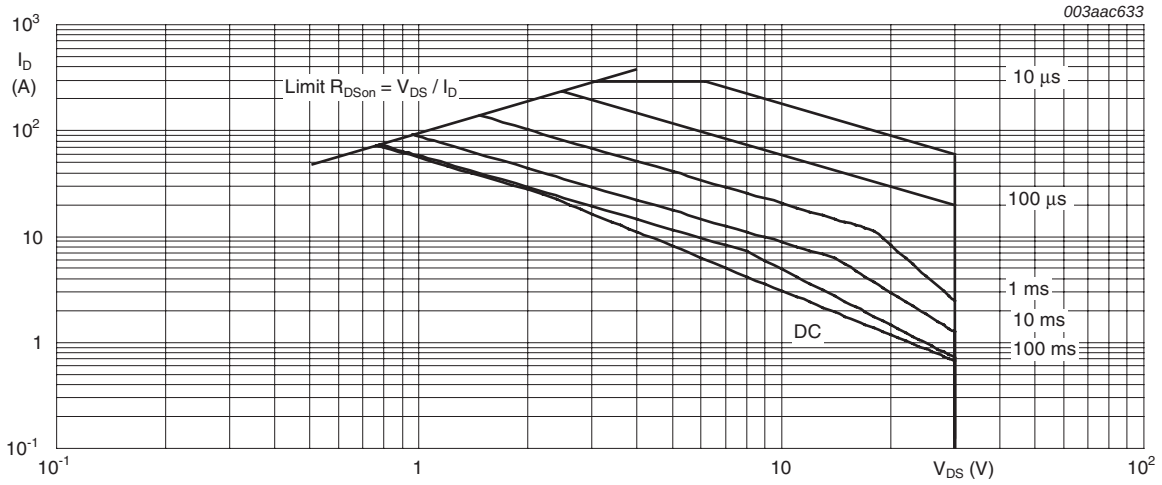

$V_{GS} \geq 10\ V$

**Fig 1. Continuous drain current as a function of mounting base temperature**




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

**Fig 2. Normalized total power dissipation as a function of mounting base temperature**




$T_{mb} = 25\,°C; I_{DM}$ is single pulse

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

## 5. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{th(j\text{-}mb)}$ | thermal resistance from junction to mounting base | see Figure 4 | - | 1.4 | 2.25 | K/W |

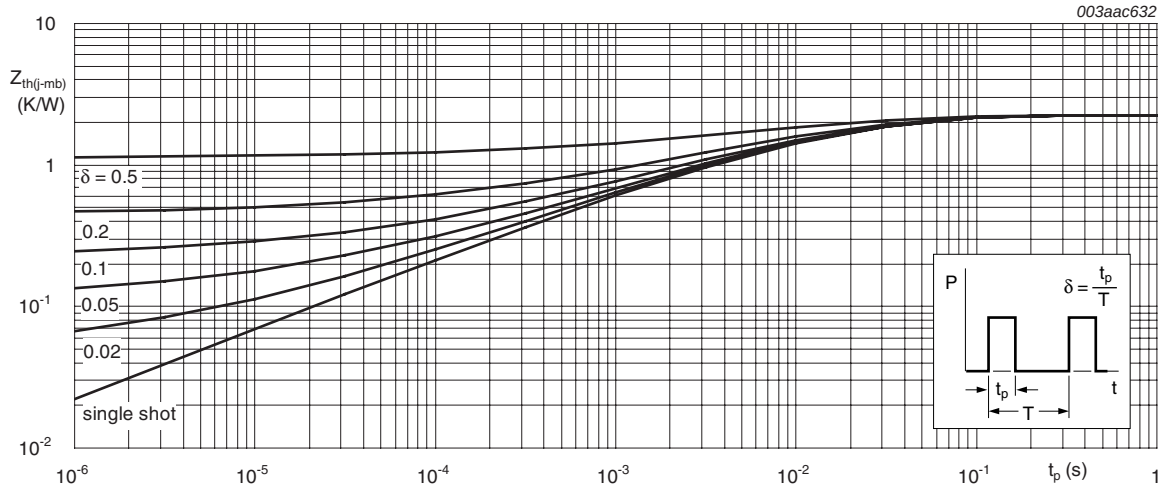



**Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration**

# 6. Characteristics

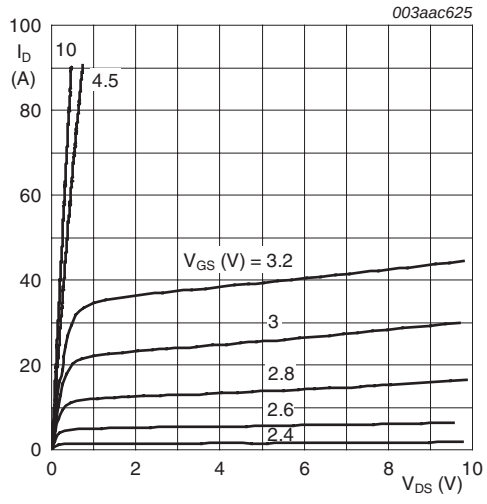
**Table 6. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 20 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; $t_{av}$ = 100 ns | 35 | - | - | V |
| | | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | 30 | - | - | V |
| | | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | 27 | - | - | V |
| | | $I_D$ = 25 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; $t_{AV}$ = 100 ns | 35 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 25 °C; see Figure 11 and 12 | 1.3 | 1.7 | 2.15 | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 150 °C; see Figure 12 | 0.65 | - | - | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = -55 °C; see Figure 12 | - | - | 2.45 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 30 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | - | 1 | µA |
| | | $V_{DS}$ = 30 V; $V_{GS}$ = 0 V; $T_j$ = 150 °C | - | - | 100 | µA |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 16 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | - | - | 100 | nA |
| | | $V_{GS}$ = -16 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | - | - | 100 | nA |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 4.5 V; $I_D$ = 15 A; $T_j$ = 25 °C | - | 6.18 | 7.87 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 15 A; $T_j$ = 150 °C; see Figure 13 | - | - | 10.5 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 15 A; $T_j$ = 25 °C | - | 4.2 | 6 | mΩ |
| $R_G$ | gate resistance | f = 1 MHz | - | 0.63 | 1.5 | Ω |
| **Dynamic characteristics** | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 10 A; $V_{DS}$ = 12 V; $V_{GS}$ = 4.5 V; see Figure 14 and 15 | - | 11 | - | nC |
| | | $I_D$ = 10 A; $V_{DS}$ = 12 V; $V_{GS}$ = 10 V; see Figure 14 and 15 | - | 24 | - | nC |
| | | $I_D$ = 0 A; $V_{DS}$ = 0 V; $V_{GS}$ = 10 V | - | 22 | - | nC |
| $Q_{GS}$ | gate-source charge | $I_D$ = 10 A; $V_{DS}$ = 12 V; $V_{GS}$ = 4.5 V; see Figure 14 and 15 | - | 4.2 | - | nC |
| $Q_{GS(th)}$ | pre-threshold gate-source charge | | - | 2.4 | - | nC |
| $Q_{GS(th-pl)}$ | post-threshold gate-source charge | | - | 1.8 | - | nC |
| $Q_{GD}$ | gate-drain charge | | - | 3.08 | - | nC |
| $V_{GS(pl)}$ | gate-source plateau voltage | $V_{DS}$ = 12 V; see Figure 14 and 15 | - | 2.6 | - | V |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 12 V; $V_{GS}$ = 0 V; f = 1 MHz; $T_j$ = 25 °C; see Figure 16 | - | 1425 | - | pF |
| $C_{oss}$ | output capacitance | | - | 313 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 155 | - | pF |

**Table 6. Characteristics** *…continued*

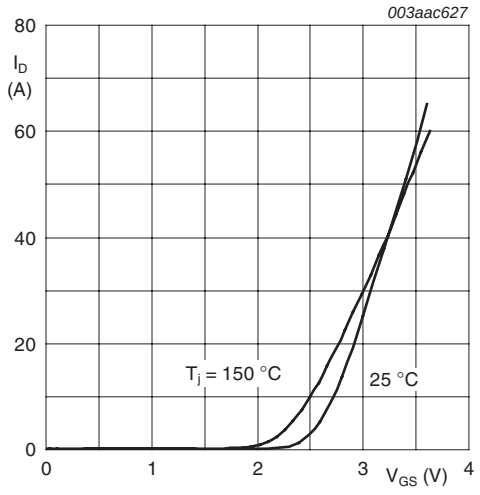
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 12 V; $R_L$ = 0.5 Ω; $V_{GS}$ = 4.5 V; $R_{G(ext)}$ = 4.7 Ω | - | 25 | - | ns |
| $t_r$ | rise time | | - | 43 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 31 | - | ns |
| $t_f$ | fall time | | - | 11 | - | ns |
| **Source-drain diode** | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = 25 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; see Figure 17 | - | 0.88 | 1.2 | V |
| $t_{rr}$ | reverse recovery time | $I_S$ = 20 A; $dI_S/dt$ = -100 A/µs; $V_{GS}$ = 0 V; $V_{DS}$ = 20 V | - | 32 | - | ns |
| $Q_r$ | recovered charge | | - | 25 | - | nC |

[1] Tested to JEDEC standards where applicable.



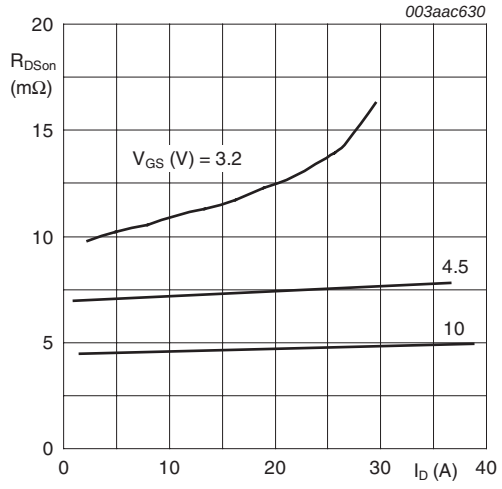

$T_j = 25\,°C; t_p = 300\,\mu s$

**Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values**



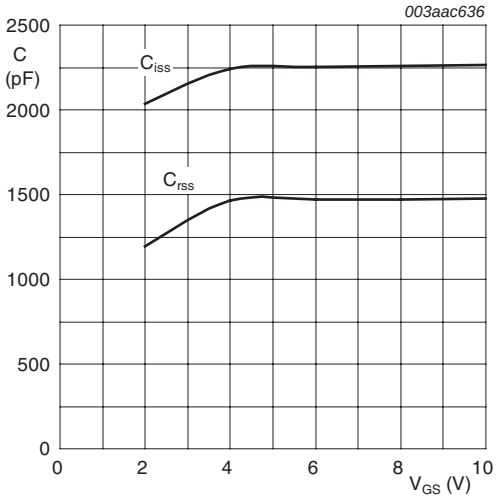

$V_{DS} = 10\,V$

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



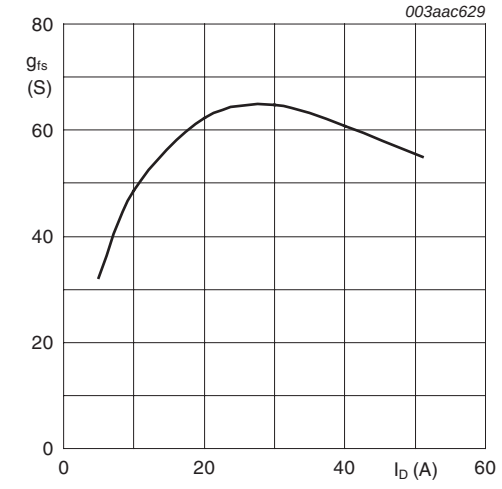

$T_j = 25\,°C$

**Fig 7. Drain-source on-state resistance as a function of drain current; typical values**



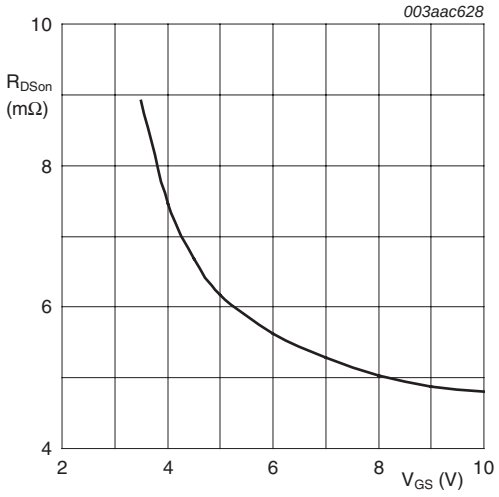

$V_{DS} = 0\,V; f = 1\,MHz$

**Fig 8. Input and reverse transfer capacitances as a function of gate-source voltage; typical values**



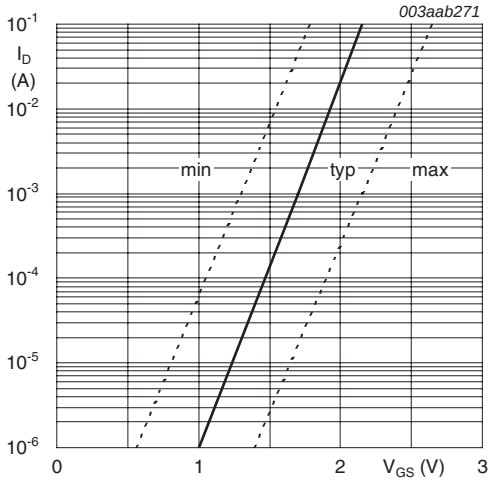

$T_j = 25\,°C; V_{DS} = 15\,V$

**Fig 9. Forward transconductance as a function of drain current; typical values**



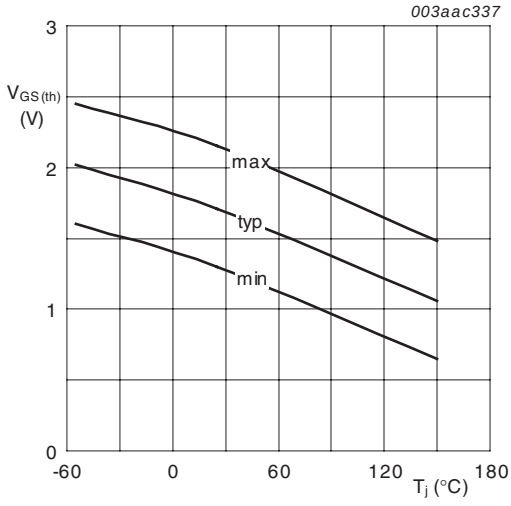

$T_j = 25\,°C; I_D = 15\,A$

**Fig 10. Drain-source on-state resistance as a function of gate-source voltage; typical values**



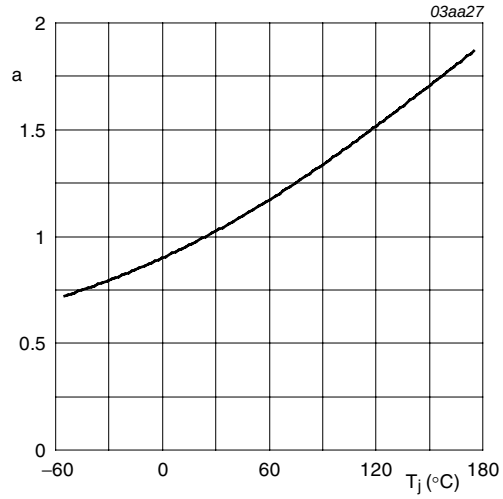

$T_j = 25\,°C; V_{DS} = 5\,V$

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




$I_D = 1\,mA; V_{DS} = V_{GS}$

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




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

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

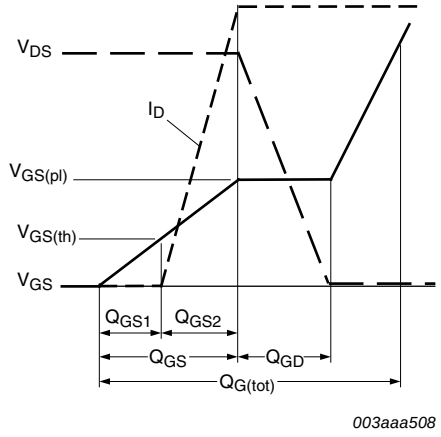
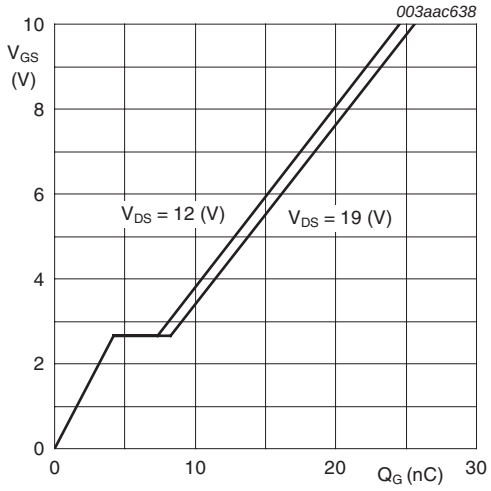
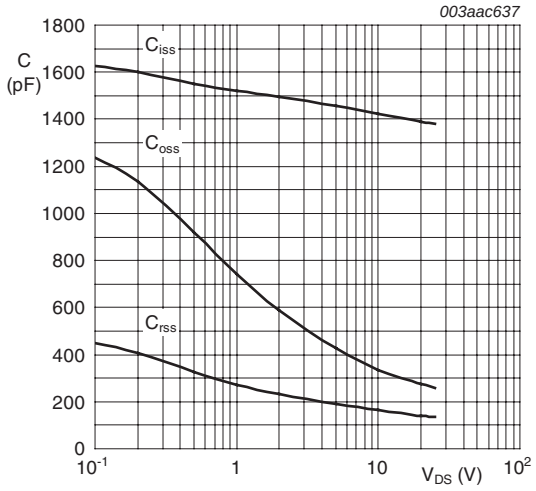



**Fig 14. Gate charge waveform definitions**



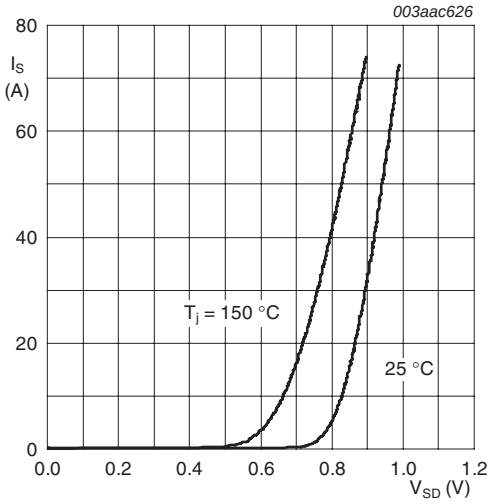

$T_j = 25\,°C; I_D = 10\,A$

**Fig 15. Gate-source voltage as a function of gate charge; typical values**




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

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

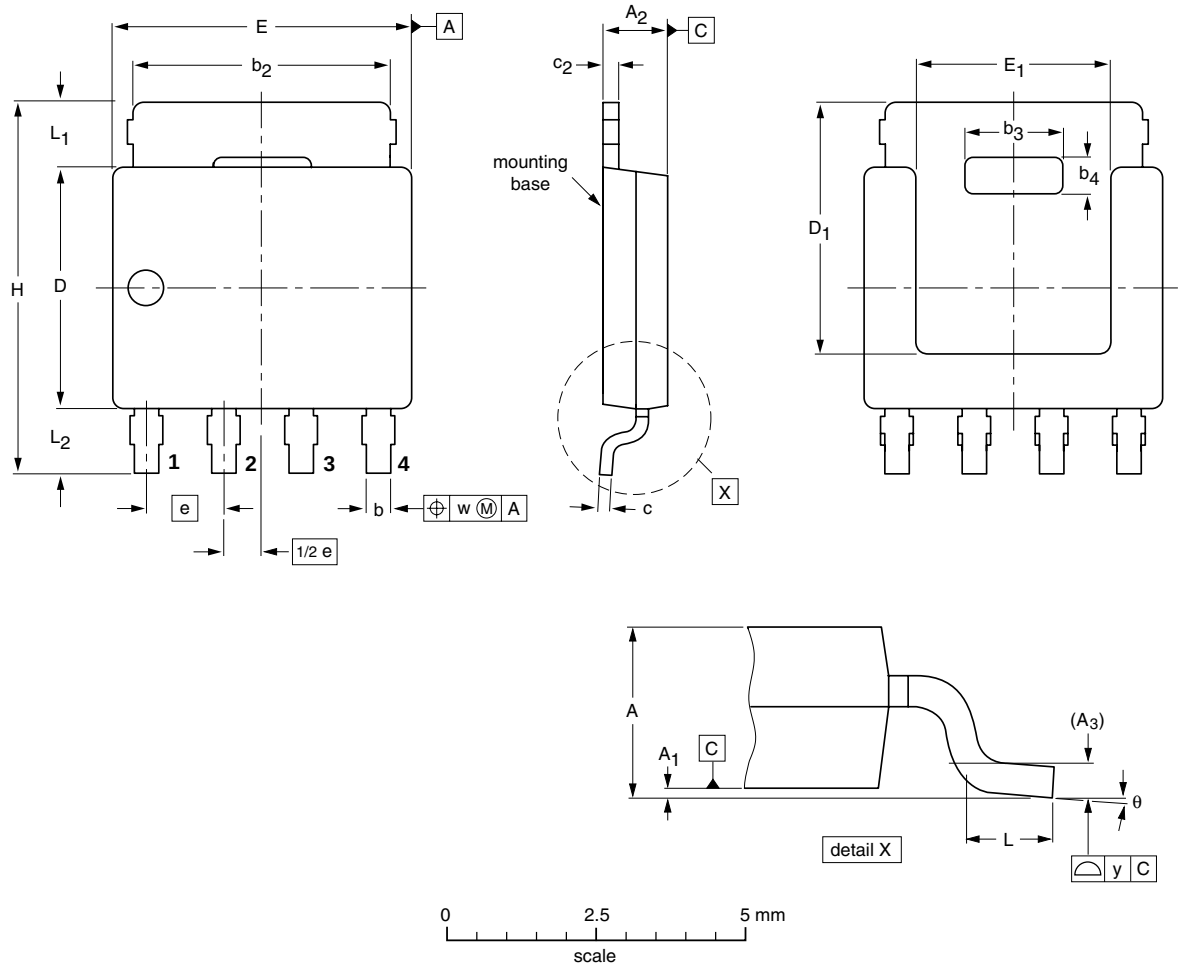



$V_{GS} = 0\,V$

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

# 7. Package outline

**Plastic single-ended surface-mounted package (LFPAK); 4 leads** **SOT669**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ | $A_2$ | $A_3$ | b | $b_2$ | $b_3$ | $b_4$ | c | $c_2$ | $D^{(1)}$ | $D_1^{(1)}$ max | $E^{(1)}$ | $E_1^{(1)}$ | e | H | L | $L_1$ | $L_2$ | w | y | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.20<br>1.01 | 0.15<br>0.00 | 1.10<br>0.95 | 0.25 | 0.50<br>0.35 | 4.41<br>3.62 | 2.2<br>2.0 | 0.9<br>0.7 | 0.25<br>0.19 | 0.30<br>0.24 | 4.10<br>3.80 | 4.20 | 5.0<br>4.8 | 3.3<br>3.1 | 1.27 | 6.2<br>5.8 | 0.85<br>0.40 | 1.3<br>0.8 | 1.3<br>0.8 | 0.25 | 0.1 | 8°<br>0° |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT669 | | MO-235 | | | | ~~04-10-13~~<br>06-03-16 |

**Fig 18. Package outline SOT669 (LFPAK)**

## 8. Revision history

**Table 7. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| PH6030AL_5 | 20100112 | Product data sheet | - | PH6030AL_4 |
| Modifications: | • Various changes to content. | | | |
| PH6030AL_4 | 20091014 | Product data sheet | - | PH6030AL_3 |
| PH6030AL_3 | 20090121 | Product data sheet | - | PH6030AL_2 |
| PH6030AL_2 | 20081030 | Preliminary data sheet | - | PH6030AL_1 |
| PH6030AL_1 | 20080909 | Preliminary data sheet | - | - |

# 9. Legal information

## 9.1 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 URL http://www.nxp.com.

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**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

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## 10. Contact information

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## 11. Contents





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