# BUK9Y1R3-40H

N-channel 40 V, 1.3 mΩ logic level MOSFET in LFPAK56

10 January 2025 Product data sheet

## 1. General description

Automotive qualified N-channel MOSFET using the latest Trench 9 low ohmic superjunction technology, housed in a robust LFPAK56 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**

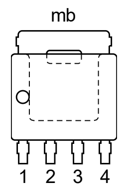
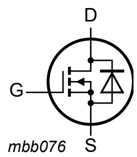
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | 25 °C ≤ $T_j$ ≤ 175 °C | | - | - | 40 | V |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{mb}$ = 25 °C; Fig. 2 | [1] | - | - | 190 | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; Fig. 1 | | - | - | 395 | W |
| **Static characteristics** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 25 °C; Fig. 11 | | 0.67 | 0.96 | 1.3 | mΩ |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Dynamic characteristics** | | | | | | | |
| $Q_{GD}$ | gate-drain charge | $I_D$ = 25 A; $V_{DS}$ = 20 V; $V_{GS}$ = 4.5 V; Fig. 13; Fig. 14 | | - | 11.2 | 22.4 | 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; $T_j$ = 25 °C | | - | 38.8 | - | nC |
| S | softness factor | | | - | 0.8 | - | |

[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 | <br>**LFPAK56; Power-SO8 (SOT669)** |  |
| 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 |
| BUK9Y1R3-40H | LFPAK56; Power-SO8 | plastic, single-ended surface-mounted package; 4 terminals | SOT669 |

## 7. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| BUK9Y1R3-40H | 91H340 |

## 8. Limiting values

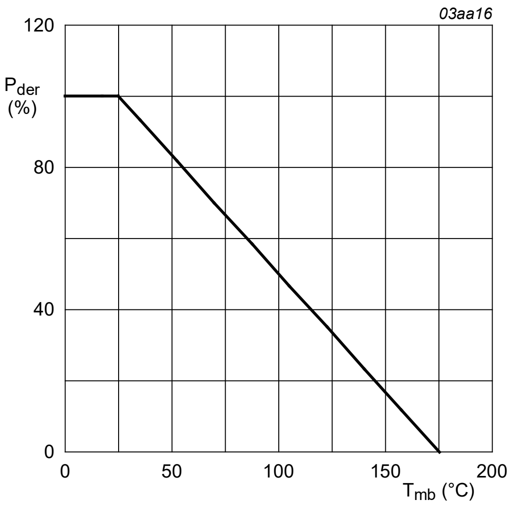
**Table 5. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).Tj = 25 °C unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | 25 °C ≤ $T_j$ ≤ 175 °C | | - | 40 | V |
| $V_{GS}$ | gate-source voltage | | [1] | -20 | 20 | V |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; Fig. 1 | | - | 395 | W |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{mb}$ = 25 °C; Fig. 2 | [2] | - | 190 | A |
| | | $V_{GS}$ = 10 V; $T_{mb}$ = 100 °C; Fig. 2 | [2] | - | 190 | A |
| $I_{DM}$ | peak drain current | pulsed; $t_p$ ≤ 10 µs; $T_{mb}$ = 25 °C; Fig. 3 | | - | 600 | A |

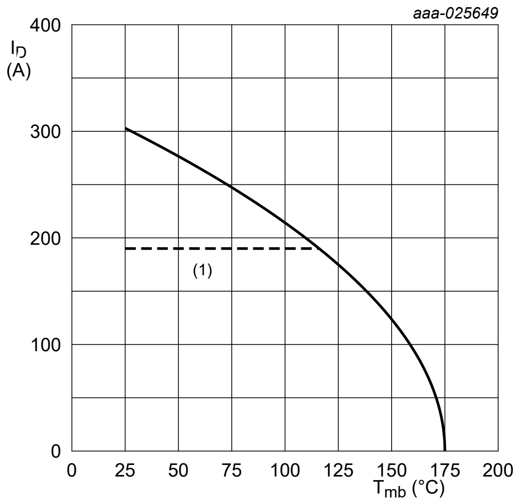
| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $T_{stg}$ | storage temperature | | | -55 | 175 | °C |
| $T_j$ | junction temperature | | | -55 | 175 | °C |
| **Source-drain diode** | | | | | | |
| $I_S$ | source current | $T_{mb}$ = 25 °C | [3] | - | 145 | A |
| $I_{SM}$ | peak source current | pulsed; $t_p \leq$ 10 µs; $T_{mb}$ = 25 °C | | - | 600 | A |
| **Avalanche ruggedness** | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D$ = 190 A; $V_{sup} \leq$ 40 V; $R_{GS}$ = 50 Ω; $V_{GS}$ = 10 V; $T_{j(init)}$ = 25 °C; unclamped; Fig. 4 | [4] [5] | - | 154 | mJ |

[1] Refer to application note AN90001 for further information.
[2] 190A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature
[3] 145A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature
[4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
[5] Refer to application note AN10273 for further information.



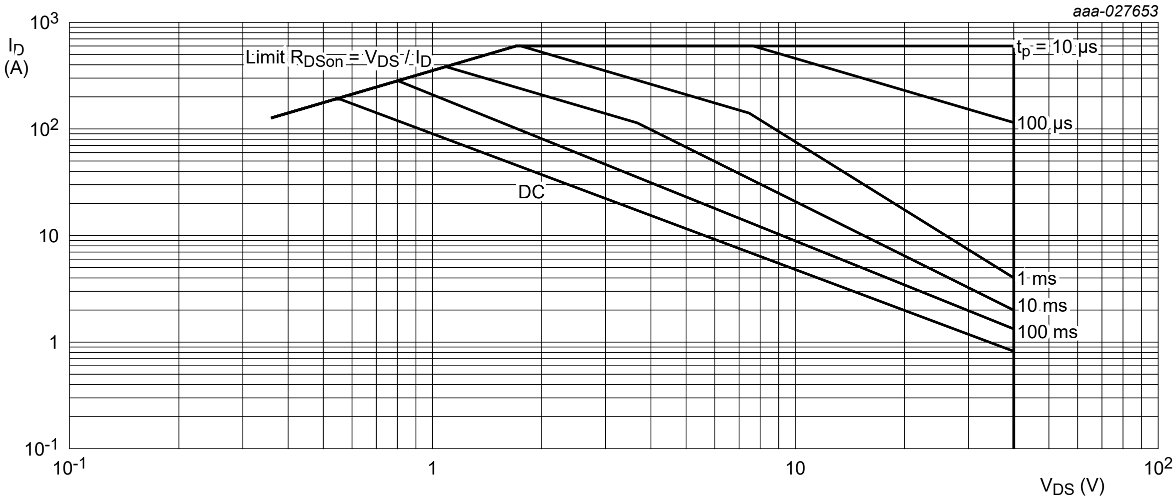

$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$

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



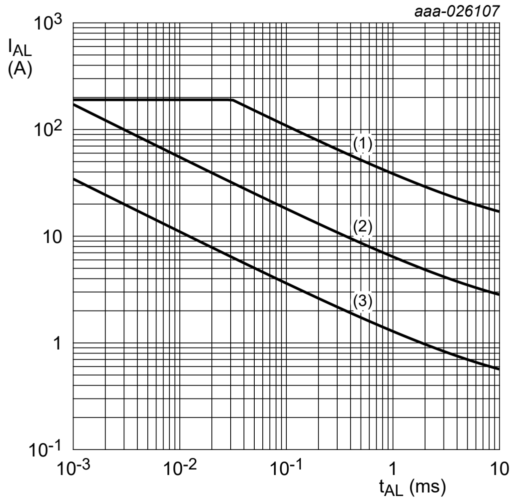

$V_{GS} \geq 10$ V
(1) 190A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

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




$T_{mb}$ = 25 °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) $T_{j\ (init)}$ = 25 °C; (2) $T_{j\ (init)}$ = 150 °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 |

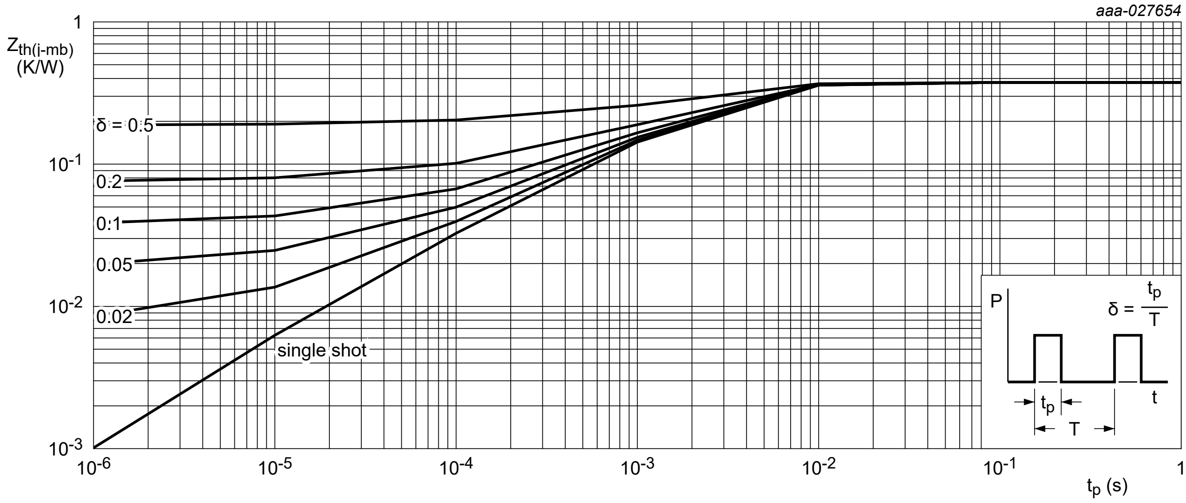


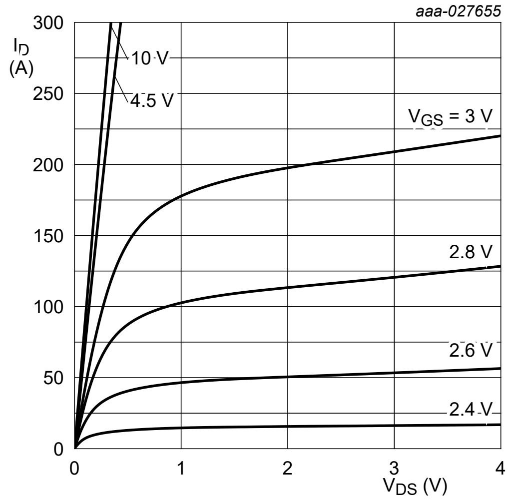

**Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration**

## 10. Characteristics

**Table 7. Characteristics**

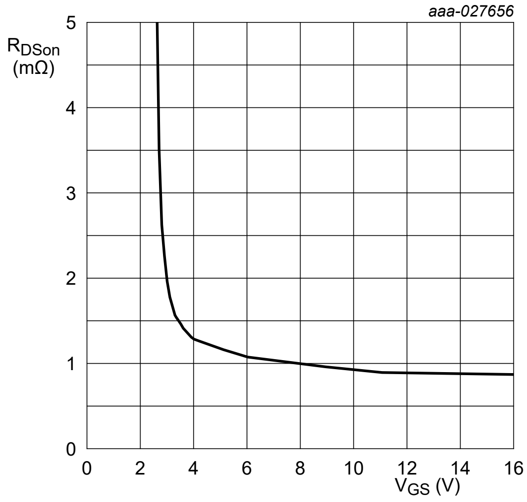
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | 40 | 43 | - | V |
| | | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = -40 °C | | - | 40.5 | - | V |
| | | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | | 36 | 40 | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$=$V_{GS}$; $T_j$ = 25 °C; Fig. 9; Fig. 10 | | 1.35 | 1.62 | 2.05 | V |
| | | $I_D$ = 1 mA; $V_{DS}$=$V_{GS}$; $T_j$ = 175 °C; Fig. 10 | | 0.6 | - | - | V |
| | | $I_D$ = 1 mA; $V_{DS}$=$V_{GS}$; $T_j$ = -55 °C; Fig. 10 | | - | - | 2.5 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 40 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | - | 0.4 | 1 | µA |
| | | $V_{DS}$ = 16 V; $V_{GS}$ = 0 V; $T_j$ = 125 °C | | - | 2.4 | 10 | µA |
| | | $V_{DS}$ = 40 V; $V_{GS}$ = 0 V; $T_j$ = 175 °C | | - | 0.34 | 1 | mA |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 16 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | | - | 2 | 100 | nA |
| | | $V_{GS}$ = -16 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | | - | 2 | 100 | nA |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 25 °C; Fig. 11 | | 0.67 | 0.96 | 1.3 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 105 °C; Fig. 12 | | 1 | 1.47 | 2.1 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 125 °C; Fig. 12 | | 1.1 | 1.6 | 2.3 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 175 °C; Fig. 12 | | 1.4 | 2.04 | 2.8 | mΩ |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 25 A; $T_j$ = 25 °C; Fig. 11 | | 0.85 | 1.21 | 1.8 | mΩ |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 25 A; $T_j$ = 105 °C; Fig. 12 | | 1.26 | 1.82 | 2.8 | mΩ |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 25 A; $T_j$ = 125 °C; Fig. 12 | | 1.4 | 1.97 | 3.1 | mΩ |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 25 A; $T_j$ = 175 °C; Fig. 12 | | 1.76 | 2.5 | 3.9 | mΩ |
| $R_G$ | gate resistance | f = 1 MHz; $T_j$ = 25 °C | | 0.58 | 1.46 | 3.65 | Ω |
| **Dynamic characteristics** | | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 25 A; $V_{DS}$ = 20 V; $V_{GS}$ = 10 V; Fig. 13; Fig. 14 | | - | 99 | 139 | nC |
| | | $I_D$ = 25 A; $V_{DS}$ = 20 V; $V_{GS}$ = 4.5 V; Fig. 13; Fig. 14 | | - | 45.3 | 63.4 | nC |
| $Q_{GS}$ | gate-source charge | | | - | 16.1 | 24.2 | nC |
| $Q_{GD}$ | gate-drain charge | | | - | 11.2 | 22.4 | nC |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 25 V; $V_{GS}$ = 0 V; f = 1 MHz; $T_j$ = 25 °C; Fig. 15 | | - | 6978 | 9769 | pF |
| $C_{oss}$ | output capacitance | | | - | 1244 | 1742 | pF |
| $C_{rss}$ | reverse transfer capacitance | | | - | 269 | 592 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 20 V; $R_L$ = 0.8 Ω; $V_{GS}$ = 4.5 V; $R_{G(ext)}$ = 5 Ω | | - | 36.3 | - | ns |
| $t_r$ | rise time | | | - | 42.5 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | | - | 51.8 | - | ns |
| $t_f$ | fall time | | | - | 30.7 | - | ns |
| **Source-drain diode** | | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = 25 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; Fig. 16 | | - | 0.8 | 1.2 | V |
| $t_{rr}$ | reverse recovery time | $I_S$ = 25 A; $dI_S/dt$ = -100 A/µs; $V_{GS}$ = 0 V; $V_{DS}$ = 20 V; $T_j$ = 25 °C | | - | 38.7 | - | ns |
| $Q_r$ | recovered charge | | | - | 38.8 | - | nC |
| S | softness factor | | | - | 0.8 | - | |
| | | $I_S$ = 25 A; $dI_S/dt$ = -500 A/µs; $V_{GS}$ = 0 V; $V_{DS}$ = 20 V; $T_j$ = 25 °C | | - | 0.72 | - | |



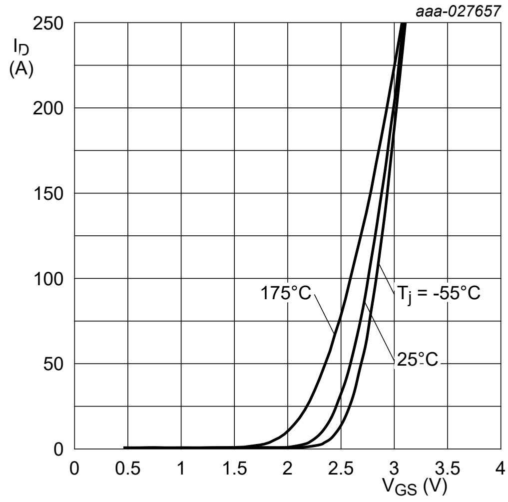

$T_j$ = 25 °C

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



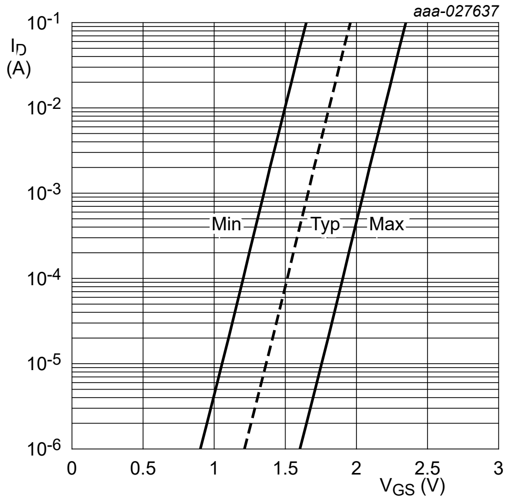

$T_j$ = 25 °C; $I_D$ = 25 A

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



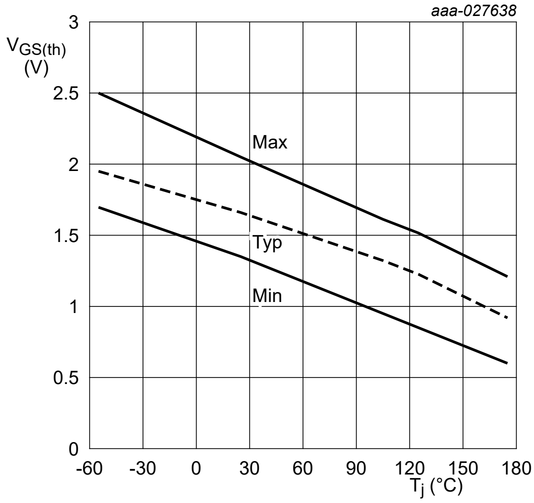

$V_{DS}$ = 8 V

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



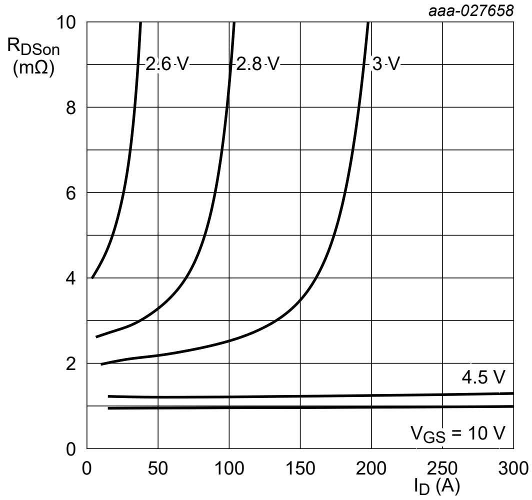

$T_j$ = 25 °C; $V_{DS}$ = 5 V

**Fig. 9. Sub-threshold drain current as a function of gate-source voltage**



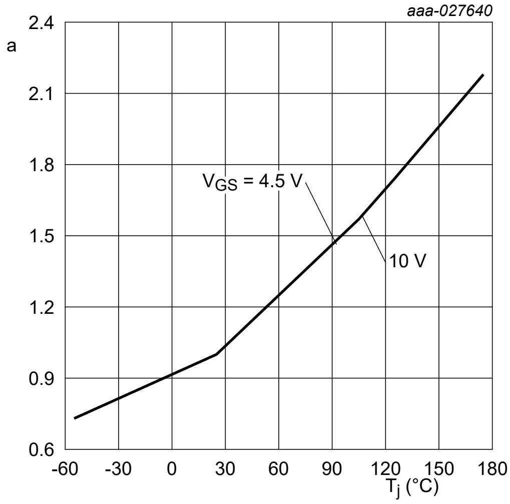

$I_D$ = 1 mA ; $V_{DS}$ = $V_{GS}$

**Fig. 10. Gate-source threshold voltage as a function of junction temperature**



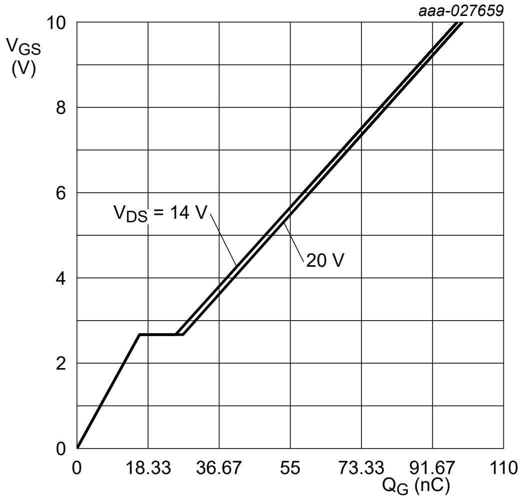

$T_j$ = 25 °C

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




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

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




$T_j$ = 25 °C; $I_D$ = 25 A

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

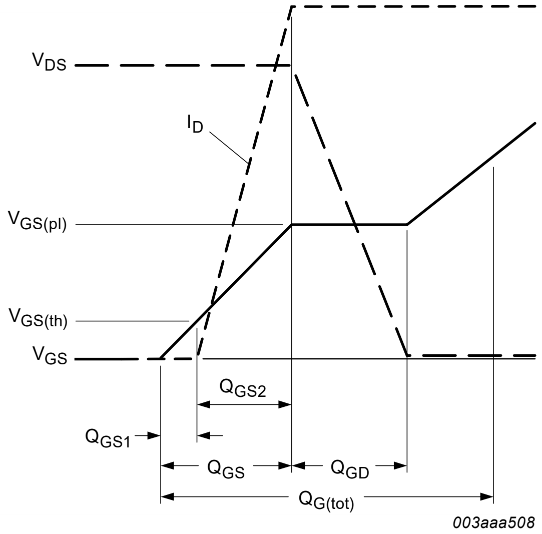
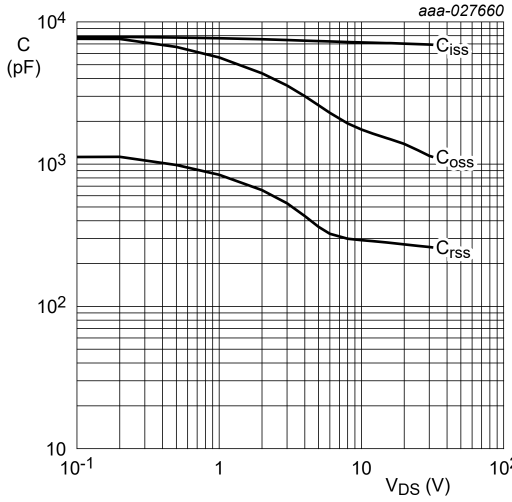
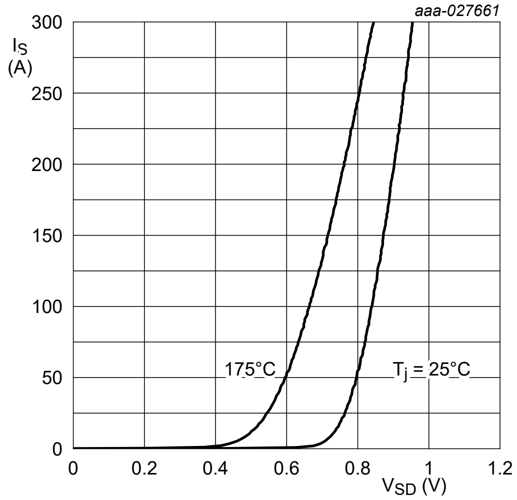



**Fig. 14. Gate charge waveform definitions**




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

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

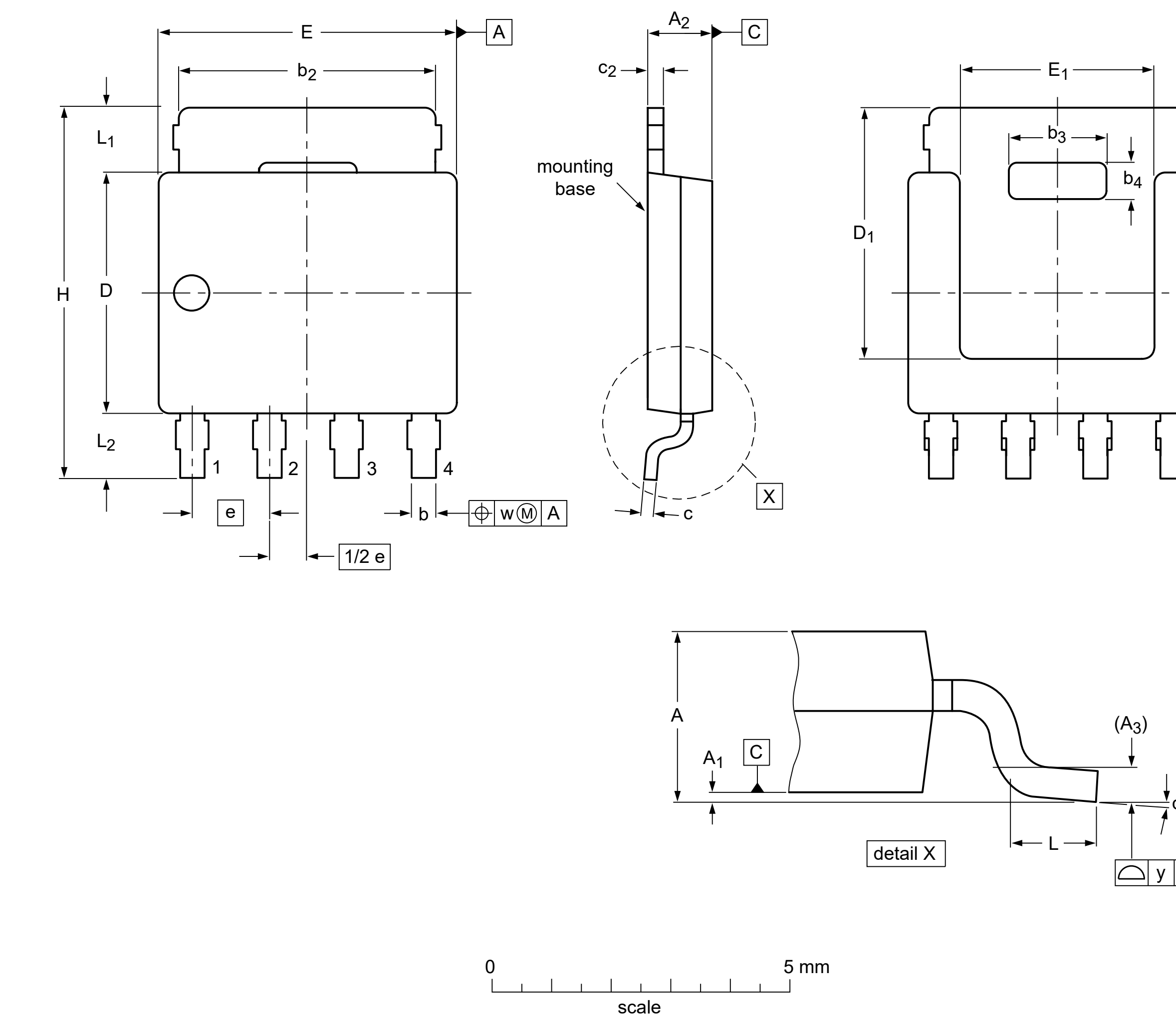



$V_{GS}$ = 0 V

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

# 11. Package outline

**Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads** **SOT669**




Dimensions (mm are the original dimensions)

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

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

*sot669_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT669 | | MO-235 | | | | ~~11-03-25~~ 13-02-27 |

**Fig. 17. Package outline LFPAK56; Power-SO8 (SOT669)**

# 12. Soldering

**Footprint information for reflow soldering** **SOT669**

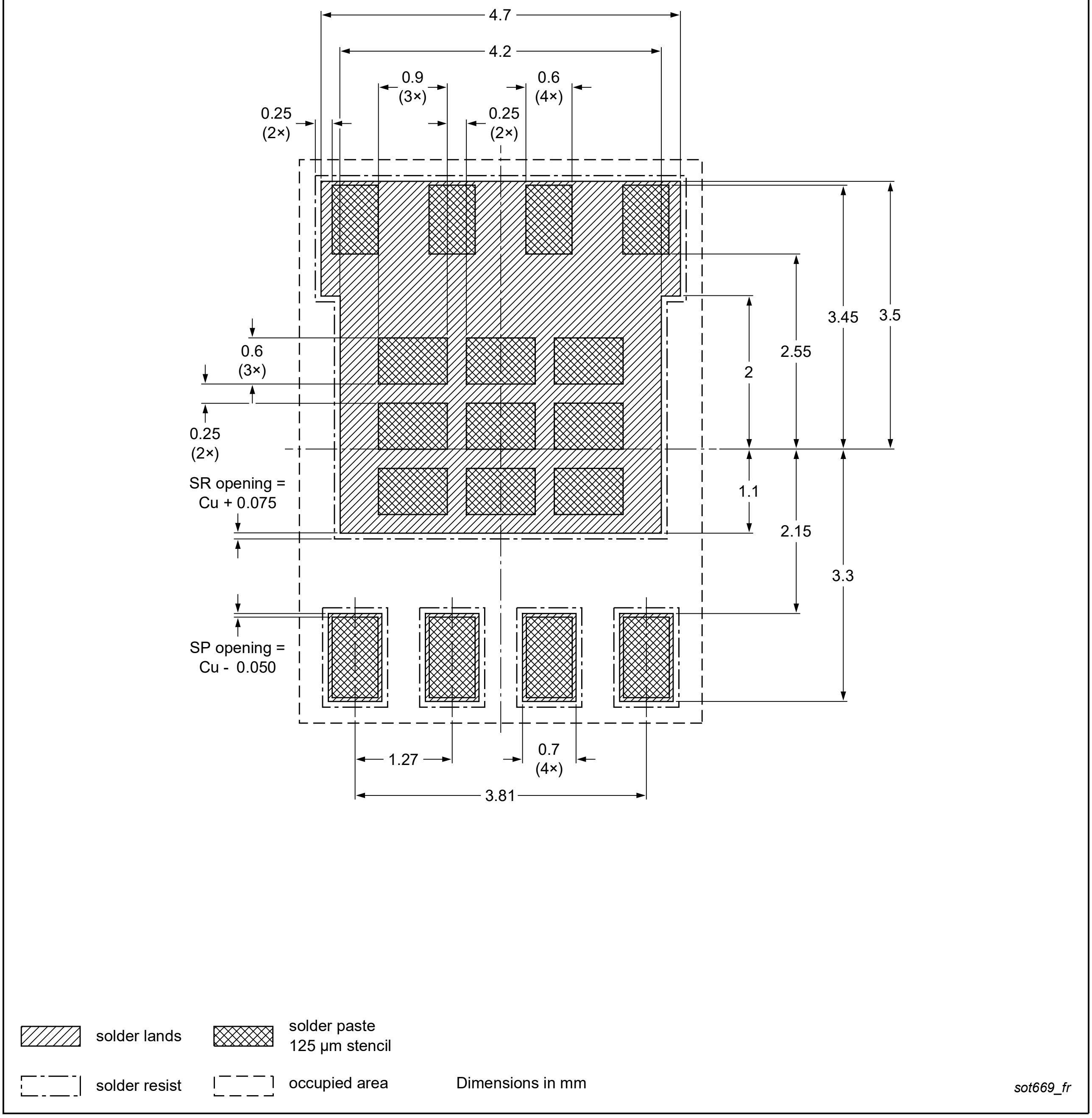



**Fig. 18. Reflow soldering footprint for LFPAK56; Power-SO8 (SOT669)**

**Wave soldering footprint information for LFPAK56 package** **SOT669**

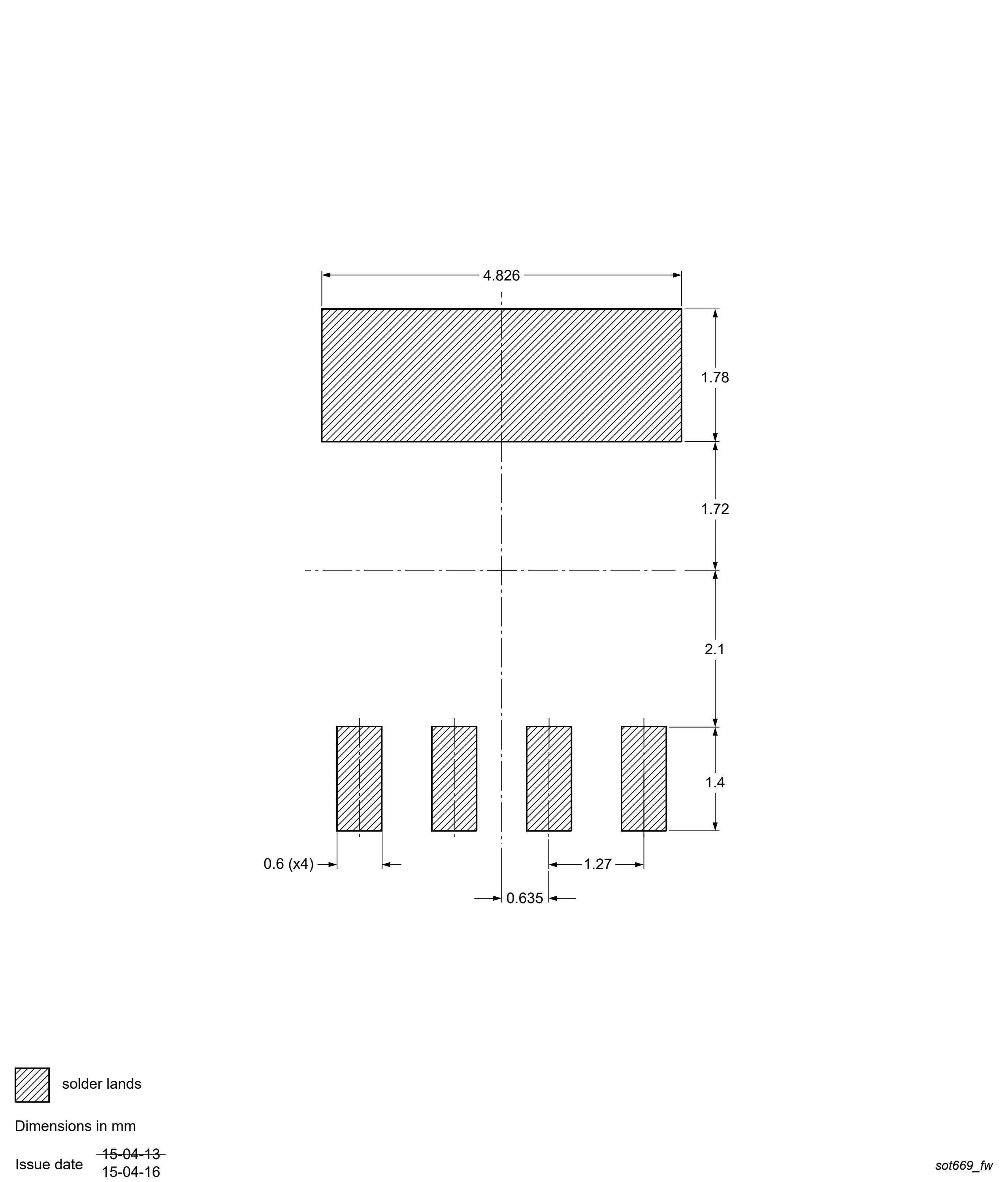



**Fig. 19. Wave soldering footprint for LFPAK56; Power-SO8 (SOT669)**

# 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".
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