

BUK71/7907-40ATC

TrenchPLUS standard level FET

Rev. 01 — 9 August 2002

Product data

1. Product profile

1.1 Description

N-channel enhancement mode field-effect power transistor in a plastic package using TrenchMOS™ technology, featuring very low on-state resistance, TrenchPLUS diodes for clamping, (ESD) protection and temperature sensing.

Product availability:

BUK7107-40ATC in SOT426 (D²-PAK)

BUK7907-40ATC in SOT263B (TO-220AB).

1.2 Features

- Integrated temperature sensor
- ESD and overvoltage protection
- Q101 compliant
- $R_{DSon} = 5.8 \text{ m}\Omega$ (typ).

1.3 Applications

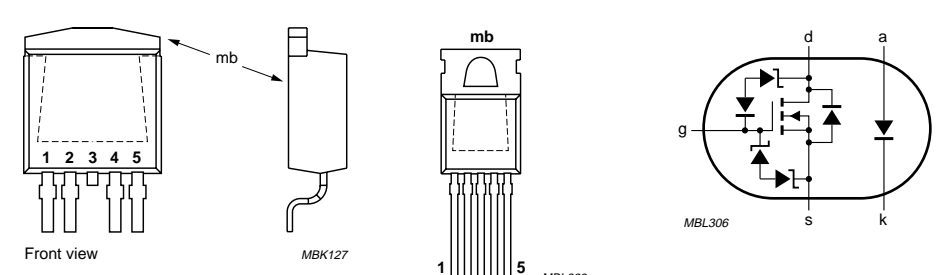
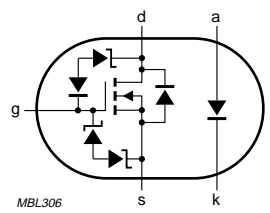
- Variable Valve Timing for engines
- Electrical Power Assisted Steering.

1.4 Quick reference data

- $V_{DS} \leq 40 \text{ V}$
- $I_D \leq 75 \text{ A}$
- $V_F = 658 \text{ mV}$ (typ)
- $S_F = -1.54 \text{ mV/K}$ (typ).

2. Pinning information

Table 1: Pinning - SOT426 and SOT263B, simplified outline and symbol

| Pin | Description | Simplified outline | Symbol |
|-----|--|--|---|
| 1 | gate (g) |  |  |
| 2 | anode (a) | | |
| 3 | drain (d) | | |
| 4 | cathode (k) | | |
| 5 | source (s) | | |
| mb | mounting base; connected to drain (d) | | |
| | | SOT426 (D ² -PAK) | SOT263B (TO-220AB) |

3. Limiting values

Table 2: Limiting values

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

| Symbol | Parameter | Conditions | Min | Max | Unit |
|--------------------------------|--|--|-------|-----------|------------------|
| V_{DS} | drain-source voltage (DC) | | [1] - | 40 | V |
| V_{DGS} | drain-gate voltage (DC) | $I_{DG} = 250 \mu\text{A}$ | [1] - | 40 | V |
| V_{GS} | gate-source voltage (DC) | | - | ± 20 | V |
| I_D | drain current (DC) | $T_{mb} = 25 \text{ }^\circ\text{C}$; $V_{GS} = 10 \text{ V}$; Figure 2 and 3 | [2] - | 140 | A |
| | | | [3] - | 75 | A |
| | | $T_{mb} = 100 \text{ }^\circ\text{C}$; $V_{GS} = 10 \text{ V}$; Figure 2 | [3] - | 75 | A |
| I_{DM} | peak drain current | $T_{mb} = 25 \text{ }^\circ\text{C}$; pulsed; $t_p \leq 10 \mu\text{s}$; Figure 3 | - | 560 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25 \text{ }^\circ\text{C}$; Figure 1 | - | 272 | W |
| $I_{DG(CL)}$ | drain-gate clamping current | $t_p = 5 \text{ ms}$; $\delta = 0.01$ | - | 50 | mA |
| $I_{GS(CL)}$ | gate-source clamping current | continuous | - | 10 | mA |
| | | $t_p = 5 \text{ ms}$; $\delta = 0.01$ | - | 50 | mA |
| $V_{isol(FET-TSD)}$ | FET to temperature sense diode isolation voltage | | - | ± 100 | V |
| T_{stg} | storage temperature | | -55 | +175 | $^\circ\text{C}$ |
| T_j | junction temperature | | -55 | +175 | $^\circ\text{C}$ |
| Source-drain diode | | | | | |
| I_{DR} | reverse drain current | $T_{mb} = 25 \text{ }^\circ\text{C}$ | [2] - | 140 | A |
| | | | [3] - | 75 | A |
| I_{DRM} | peak reverse drain current | $T_{mb} = 25 \text{ }^\circ\text{C}$; pulsed; $t_p \leq 10 \mu\text{s}$ | - | 560 | A |
| Clamping | | | | | |
| $E_{DS(CL)S}$ | non-repetitive drain-source clamping energy | unclamped inductive load; $I_D = 75 \text{ A}$; $V_{DS} \leq 40 \text{ V}$; $V_{GS} = 10 \text{ V}$; $R_{GS} = 10 \text{ k}\Omega$; starting $T_j = 25 \text{ }^\circ\text{C}$ | - | 1.4 | J |
| Electrostatic Discharge | | | | | |
| V_{esd} | electrostatic discharge voltage; pins 1,3,5 | Human Body Model; $C = 100 \text{ pF}$; $R = 1.5 \text{ k}\Omega$ | | 6 | kV |

[1] Voltage is limited by clamping

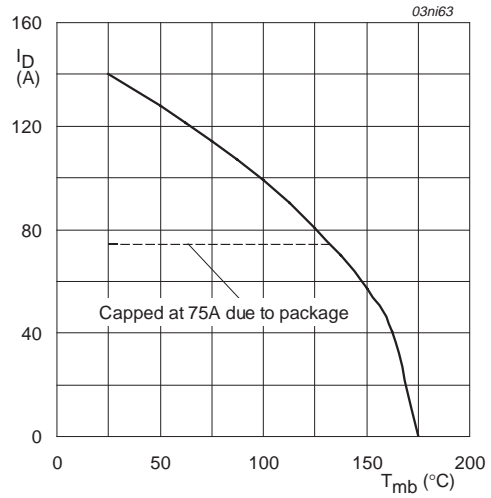
[2] Current is limited by power dissipation chip rating

[3] Continuous current is limited by package.



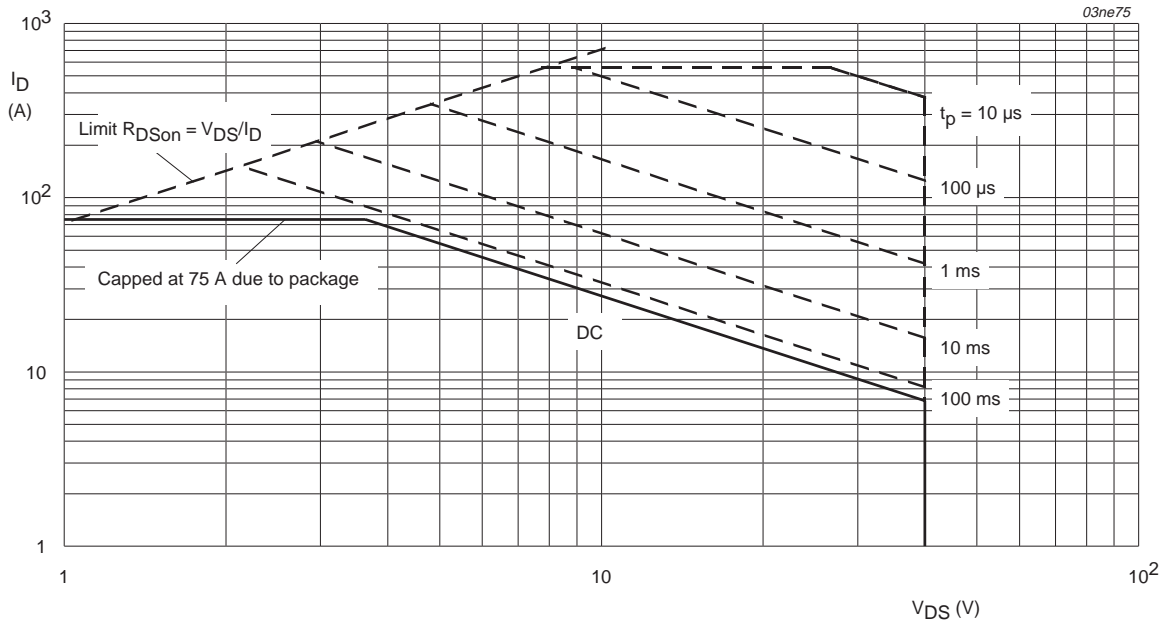
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



$V_{GS} \geq 10$ V

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



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

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

4. Thermal characteristics

Table 3: Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------|---|-------------------------------------|-----|-----|------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | | | | | |
| | SOT263B | vertical in still air | - | 60 | - | K/W |
| | SOT426 | minimum footprint; mounted on a PCB | - | 50 | - | K/W |
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Figure 4 | - | - | 0.55 | K/W |

4.1 Transient thermal impedance

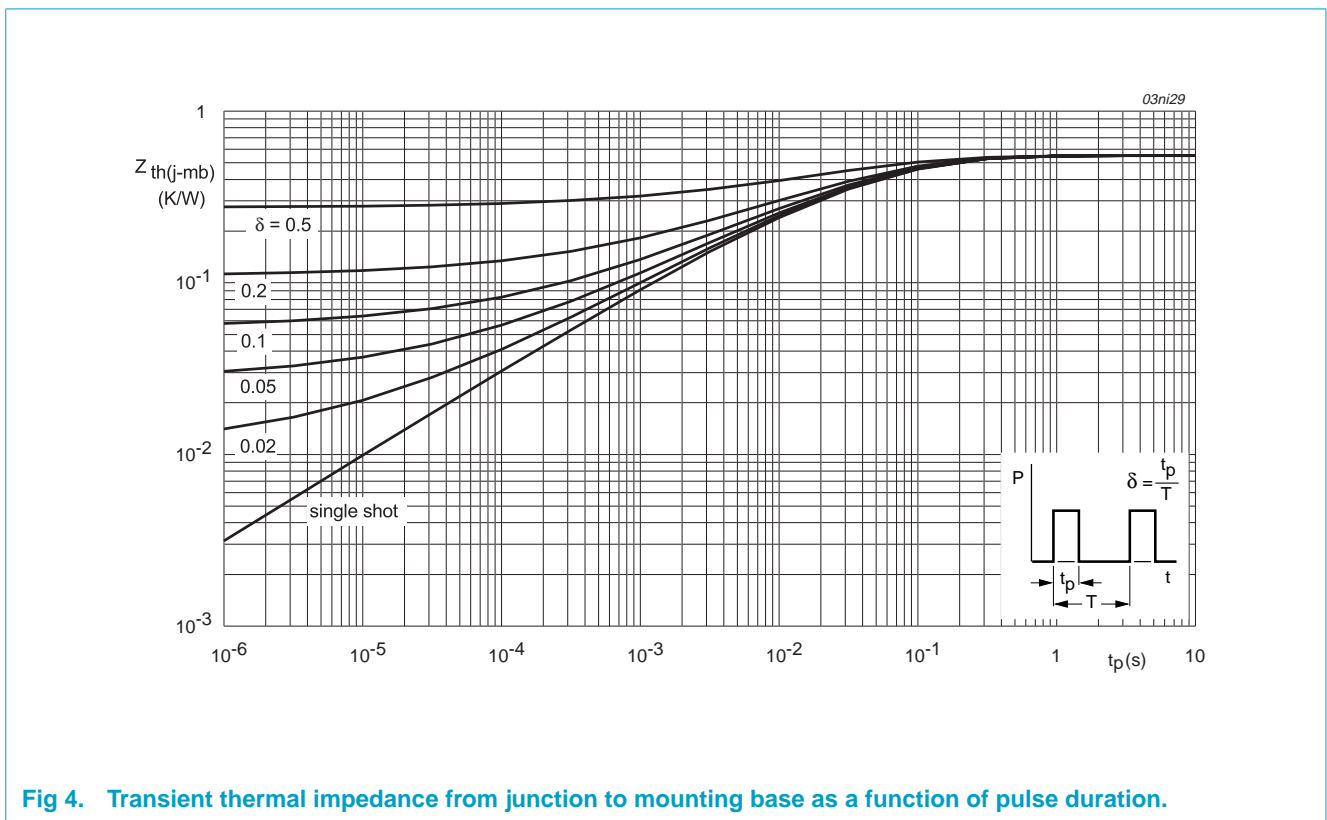


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration.

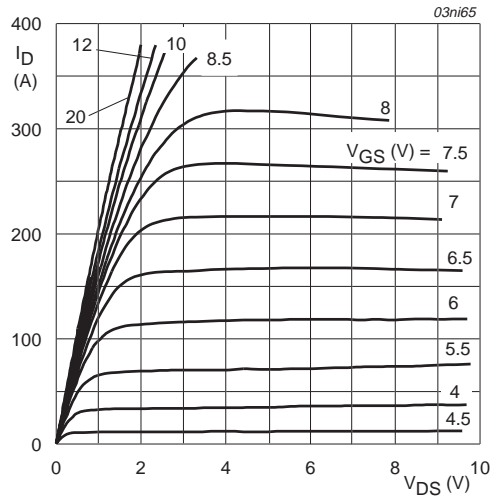
5. Characteristics

Table 4: Characteristics
 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|--|---|------|-------|-------|---------------|
| Static characteristics | | | | | | |
| $V_{(BR)DG}$ | drain-gate zener breakdown voltage | $I_D = 0.25\text{ mA}; V_{GS} = 0\text{ V}$ | | | | |
| | | $T_j = 25\text{ }^\circ\text{C}$ | 40 | - | - | V |
| | | $T_j = -55\text{ }^\circ\text{C}$ | 40 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1\text{ mA}; V_{DS} = V_{GS};$ Figure 9 | | | | |
| | | $T_j = 25\text{ }^\circ\text{C}$ | 2 | 3 | 4 | V |
| | | $T_j = 175\text{ }^\circ\text{C}$ | 1 | - | - | V |
| | | $T_j = -55\text{ }^\circ\text{C}$ | - | - | 4.4 | V |
| I_{DSS} | drain-source leakage current | $V_{DS} = 40\text{ V}; V_{GS} = 0\text{ V}$ | | | | |
| | | $T_j = 25\text{ }^\circ\text{C}$ | - | 0.1 | 10 | μA |
| | | $T_j = 175\text{ }^\circ\text{C}$ | - | - | 250 | μA |
| $V_{(BR)GSS}$ | gate-source breakdown voltage | $I_G = \pm 1\text{ mA};$ $-55\text{ }^\circ\text{C} < T_j < 175\text{ }^\circ\text{C}$ | 20 | 22 | - | V |
| I_{GSS} | gate-source leakage current | $V_{GS} = \pm 10\text{ V}; V_{DS} = 0\text{ V}$ | | | | |
| | | $T_j = 25\text{ }^\circ\text{C}$ | - | 5 | 1000 | nA |
| | | $T_j = 175\text{ }^\circ\text{C}$ | - | - | 10 | μA |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 50\text{ A};$ Figure 7 and 8 | | | | |
| | | $T_j = 25\text{ }^\circ\text{C}$ | - | 5.8 | 7 | m Ω |
| | | $T_j = 175\text{ }^\circ\text{C}$ | - | - | 14 | m Ω |
| V_F | temperature sense diode forward voltage | $I_F = 250\text{ } \mu\text{A}$ | 648 | 658 | 668 | mV |
| S_F | temperature sense diode temperature coefficient | $I_F = 250\text{ } \mu\text{A};$ $-55\text{ }^\circ\text{C} < T_j < 175\text{ }^\circ\text{C}$ | -1.4 | -1.54 | -1.68 | mV/K |
| V_{hys} | temperature sense diode forward voltage hysteresis | $125\text{ } \mu\text{A} < I_F < 250\text{ } \mu\text{A}$ | 25 | 32 | 50 | mV |
| Dynamic characteristics | | | | | | |
| $Q_{g(tot)}$ | total gate charge | $V_{GS} = 10\text{ V}; V_{DS} = 32\text{ V};$ $I_D = 25\text{ A};$ Figure 14 | - | 108 | - | nC |
| Q_{gs} | gate-source charge | | - | 21 | - | nC |
| Q_{gd} | gate-to-drain (Miller) charge | | - | 42 | - | nC |
| C_{iss} | input capacitance | $V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V};$ $f = 1\text{ MHz};$ Figure 12 | - | 4500 | - | pF |
| C_{oss} | output capacitance | | - | 960 | - | pF |
| C_{rss} | reverse transfer capacitance | | - | 510 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DD} = 30\text{ V}; R_L = 1.2\text{ } \Omega;$ $V_{GS} = 10\text{ V}; R_G = 1\text{ k}\Omega$ | - | 2 | - | μs |
| t_r | rise time | | - | 5.7 | - | μs |
| $t_{d(off)}$ | turn-off delay time | | - | 8.9 | - | μs |
| t_f | fall time | | - | 6.8 | - | μs |

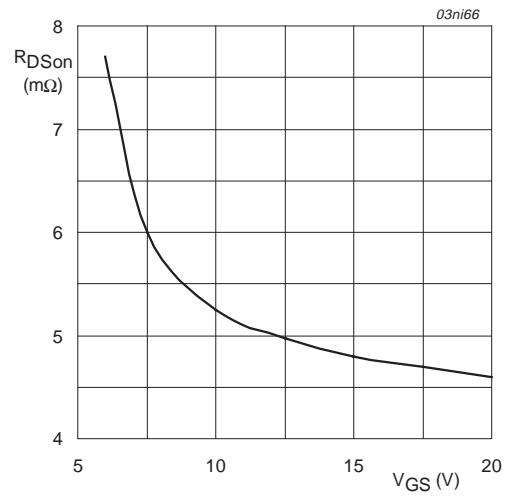
Table 4: Characteristics...continued*T_j = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------------|--------------------------------------|--|-----|------|-----|------|
| L _d | internal drain inductance | from upper edge of drain mounting base to center of die | - | 2.5 | - | nH |
| L _s | internal source inductance | from source lead to source bond pad | - | 7.5 | - | nH |
| Source-drain diode | | | | | | |
| V _{SD} | source-drain (diode forward) voltage | I _S = 25 A; V _{GS} = 0 V; Figure 19 | - | 0.85 | 1.2 | V |
| t _{rr} | reverse recovery time | I _S = 20 A; dI _S /dt = -100 A/μs | - | 80 | - | ns |
| Q _r | recovered charge | V _{GS} = -10 V; V _{DS} = 30 V | - | 200 | - | nC |



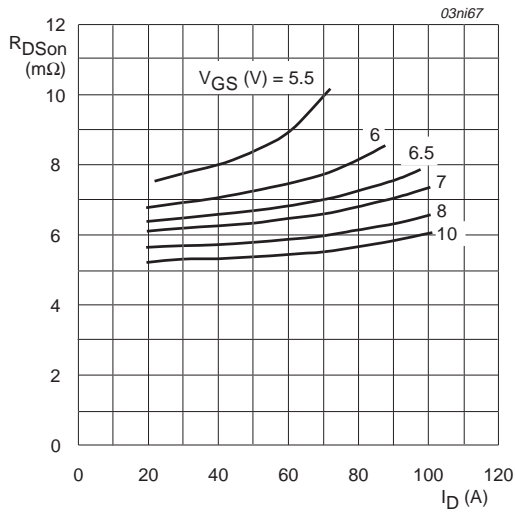
$T_j = 25\text{ }^\circ\text{C}$; $t_p = 300\text{ }\mu\text{s}$

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



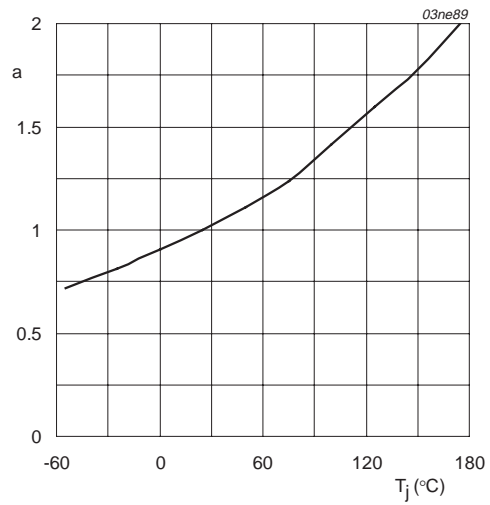
$T_j = 25\text{ }^\circ\text{C}$; $I_D = 50\text{ A}$

Fig 6. Drain-source on-state resistance as a function of gate-source voltage; typical values.



$T_j = 25\text{ }^\circ\text{C}$; $t_p = 300\text{ }\mu\text{s}$

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



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

Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature.



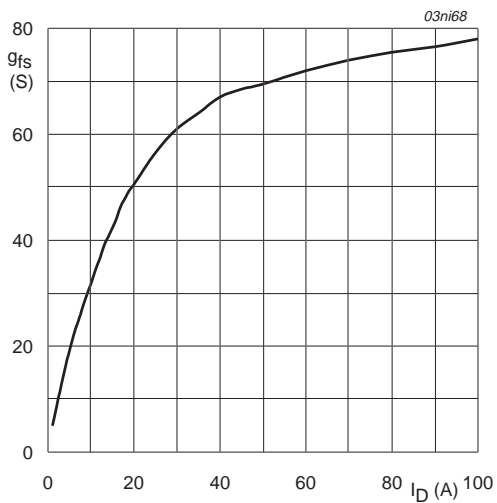
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



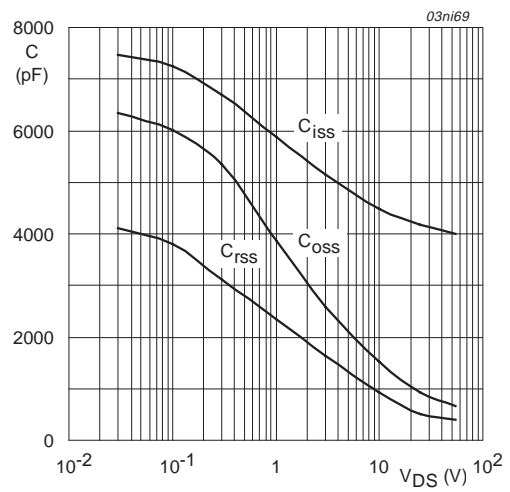
$T_j = 25 \text{ °C}; V_{DS} = V_{GS}$

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



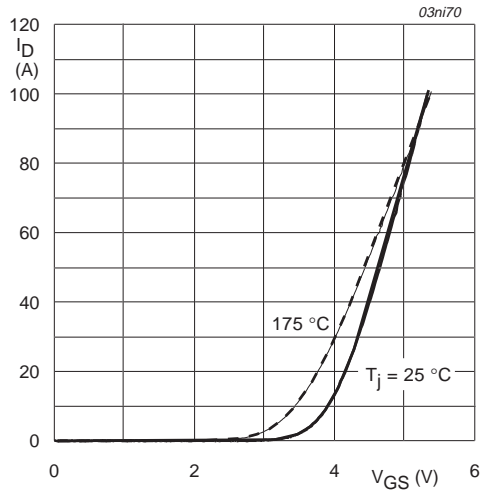
$T_j = 25 \text{ °C}; V_{DS} = 25 \text{ V}$

Fig 11. Forward transconductance as a function of drain current; typical values.



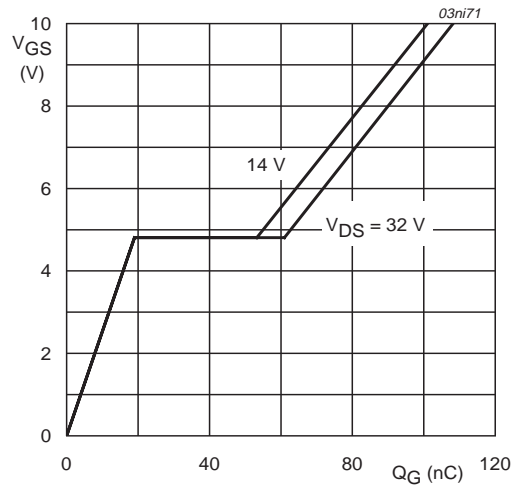
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

Fig 12. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



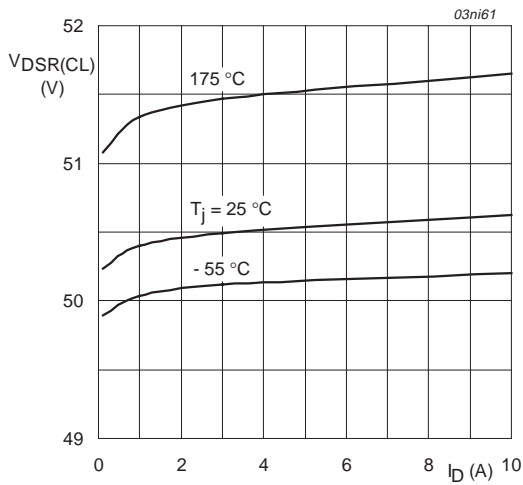
$V_{DS} = 25 \text{ V}$

Fig 13. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



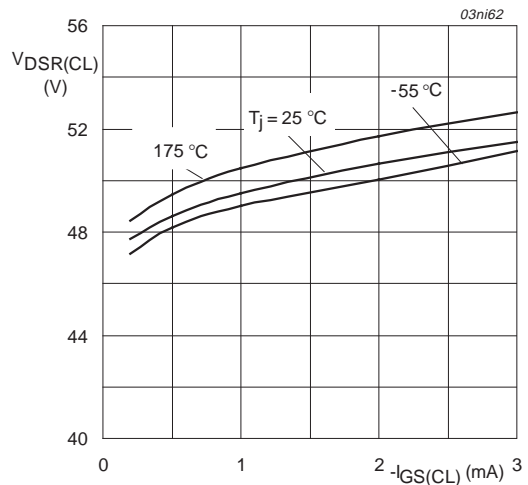
$T_j = 25 \text{ °C}; I_D = 25 \text{ A}$

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



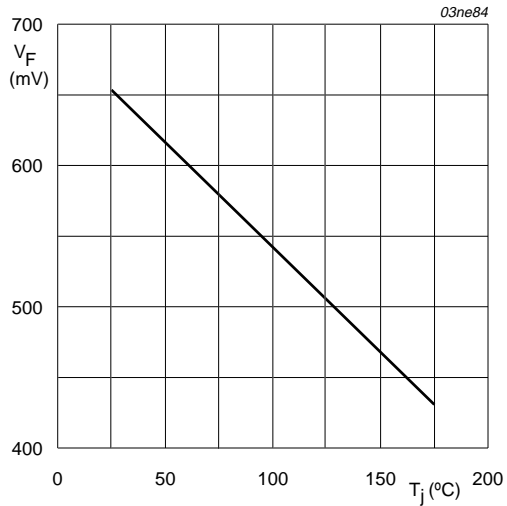
$I_{GS(CL)} = -2 \text{ mA}$

Fig 15. Drain-source clamping voltage as a function of drain current; typical values.



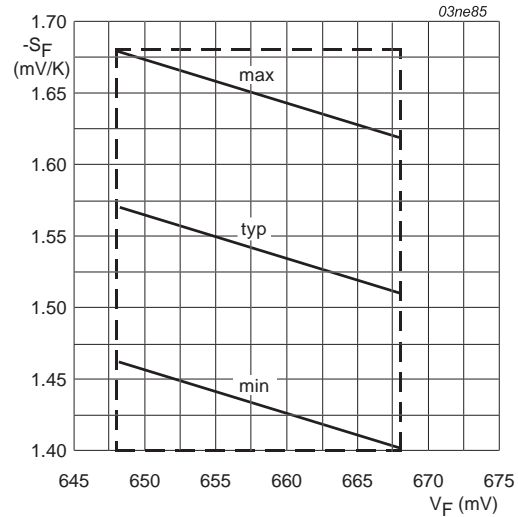
$I_D = 10 \text{ A}$

Fig 16. Drain-source clamping voltage as a function of gate-source current; typical values.



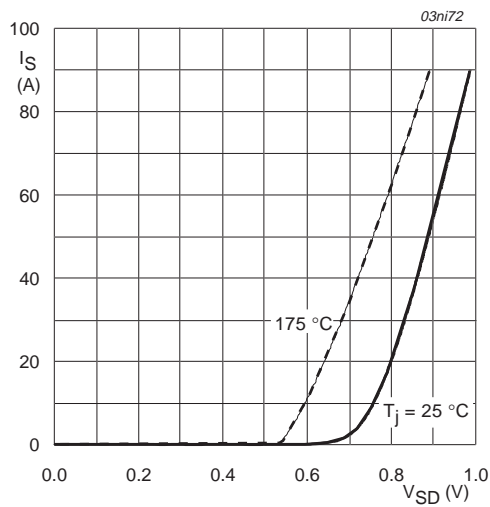
$I_F = 250 \mu A$

Fig 17. Forward voltage of temperature sense diode as a function of junction temperature; typical values.



V_F at $T_j = 25 \text{ C}$; $I_F = 250 \mu A$

Fig 18. Temperature coefficient of temperature sense diode as a function of forward voltage; typical values.



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

Fig 19. Reverse diode current as a function of reverse diode voltage; typical values.

6. Package outline

Plastic single-ended surface mounted package (Philips version of D²-PAK); 5 leads
(one lead cropped)

SOT426

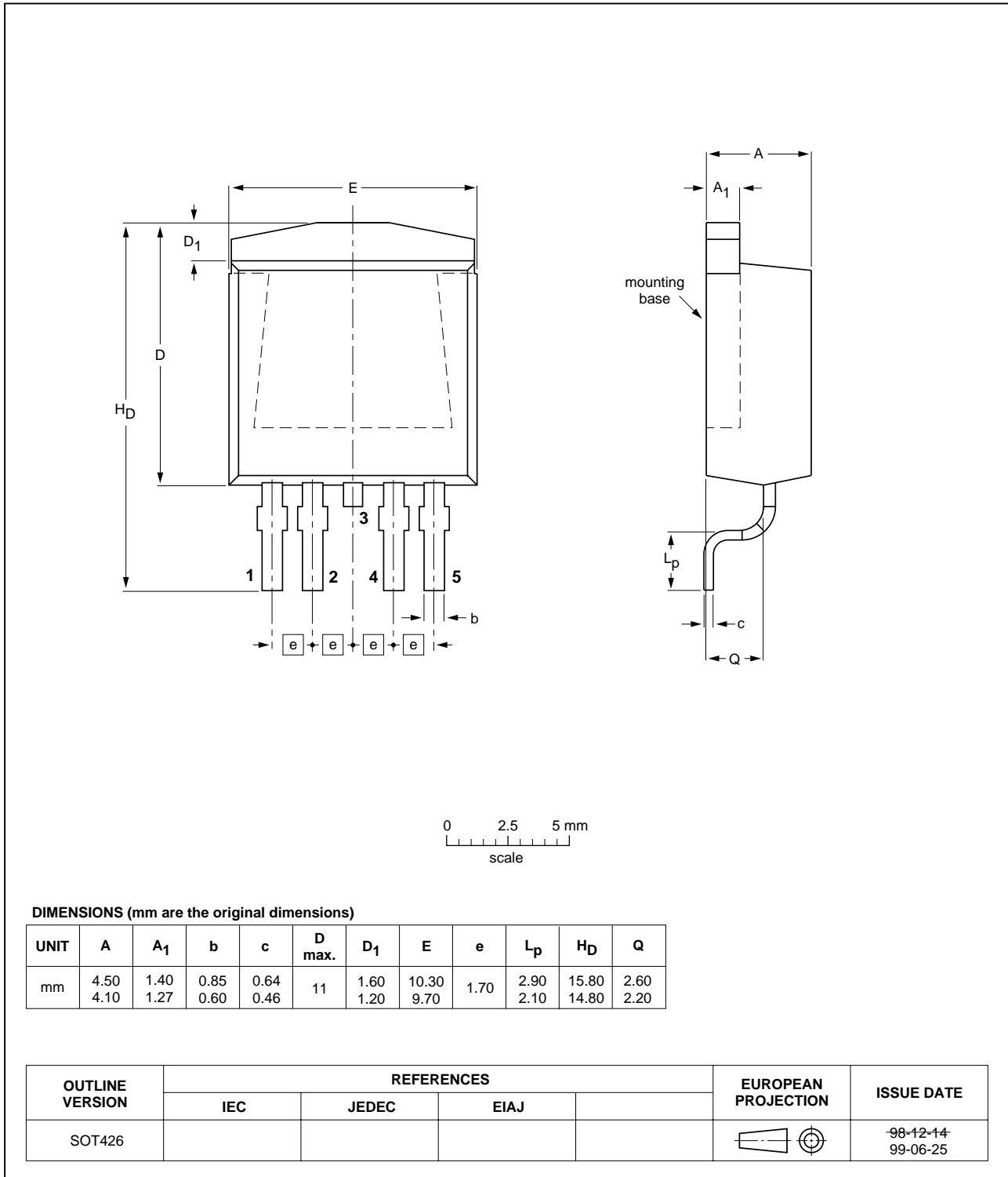


Fig 20. SOT426 (D²-PAK).

Plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220

SOT263B

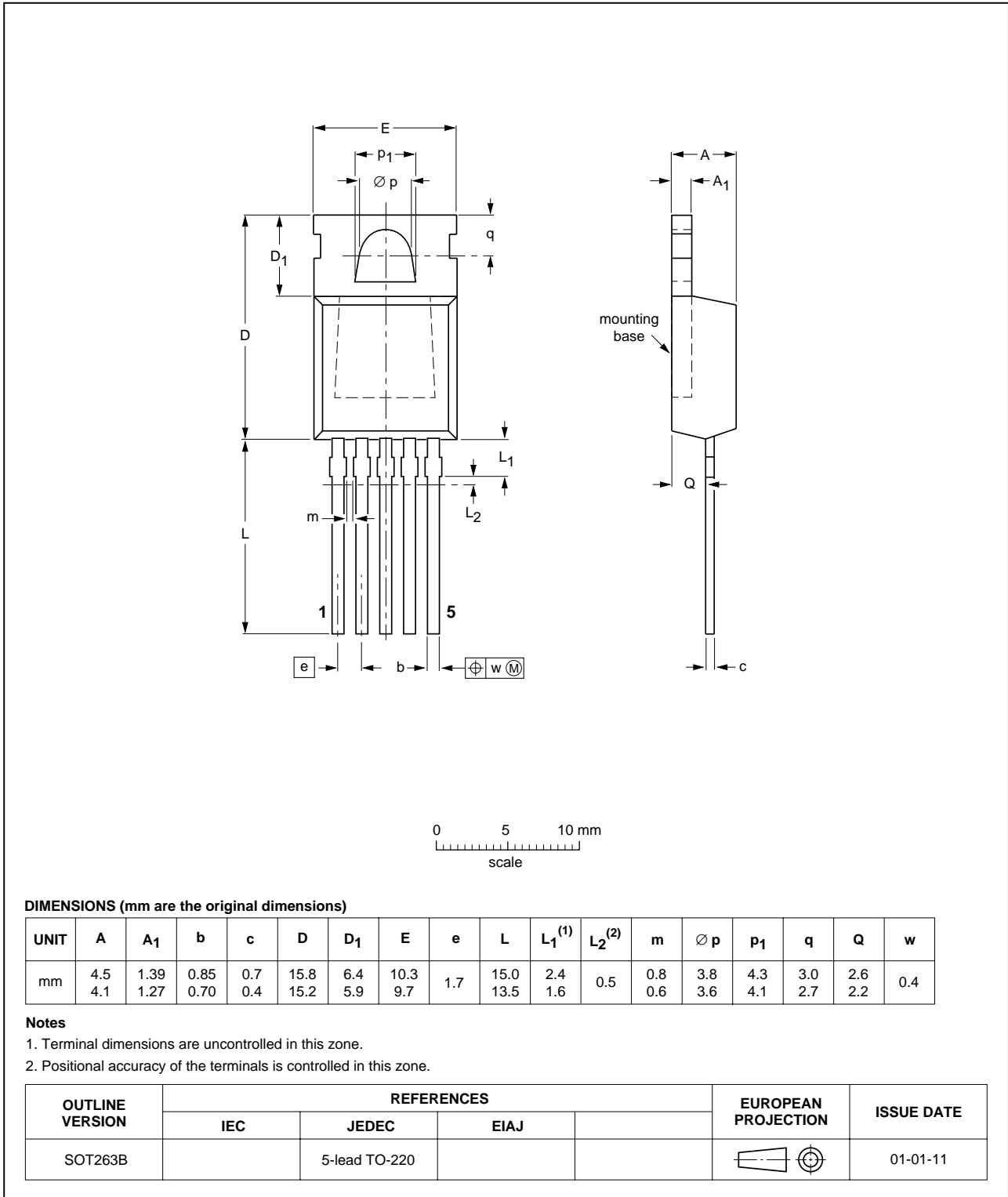
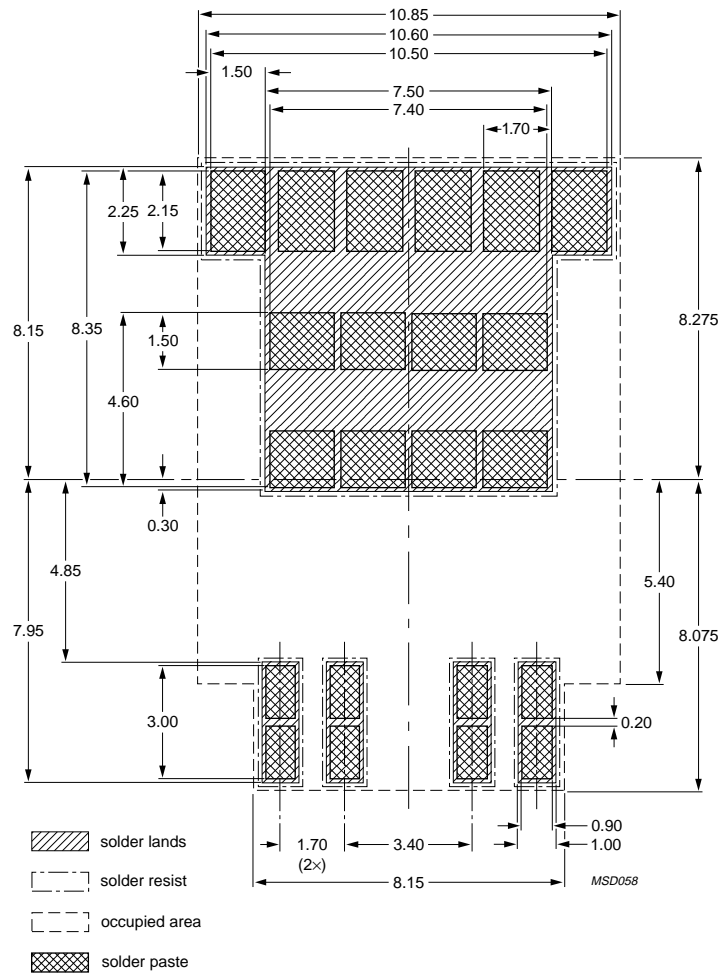


Fig 21. SOT263B (TO-220AB).

7. Soldering



Dimensions in mm.

Fig 22. Reflow soldering footprint for SOT426.

8. Revision history

Table 5: Revision history

| Rev | Date | CPCN | Description |
|-----|----------|------|-------------------------------|
| 01 | 20020809 | - | Product data; initial version |

9. Data sheet status

| Data sheet status ^[1] | Product status ^[2] | Definition |
|----------------------------------|-------------------------------|--|
| Objective data | Development | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice. |
| Preliminary data | Qualification | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product. |
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[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

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Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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