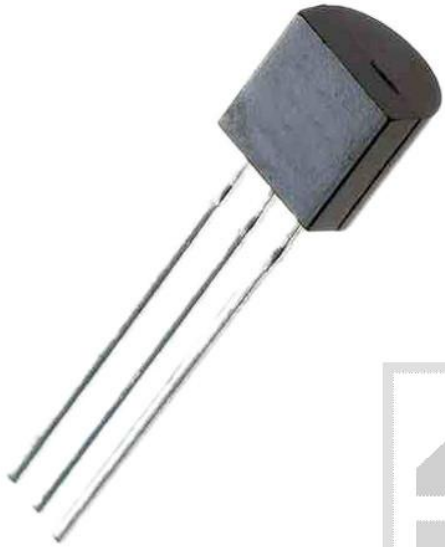
# TR 2N7000;TO92;tranzystor; N-MOSFET;200mA;60V;400mW



**Dane techniczne:**
Nazwa: 2N7000
Typ tranzystora: unipolarny N-MOSFET
Prąd kolektora: 200mA
Napięcie kolektor-emiter: 60V
Moc: 400mW
Obudowa: TO92
Montaż: przewlekany (THT)

# 2N7000

N-channel enhancement mode field-effect transistor

**Rev. 03 — 19 May 2000** **Product specification**

## 1. Description

N-channel enhancement mode field-effect transistor in a plastic package using TrenchMOS™[1] technology.

Product availability:

2N7000 in SOT54 (TO-92 variant).

## 2. Features

- TrenchMOS™ technology
- Very fast switching
- Logic level compatible.

## 3. Applications

- Relay driver
- High speed line driver
- Logic level translator.

## 4. Pinning information

**Table 1: Pinning - SOT54, simplified outline and symbol**

| Pin | Description | Simplified outline | Symbol |
|---|---|---|---|
| 1 | drain (d) | | |
| 2 | gate (g) | | |
| 3 | source (s) | | |
| | | 03ab40<br>3 2 1 | d<br>g<br>s<br>03ab30 |
| | | **SOT54 (TO-92 variant)** | **N-channel MOSFET** |

1. TrenchMOS is a trademark of Royal Philips Electronics.

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## 5. Quick reference data

**Table 2: Quick reference data**

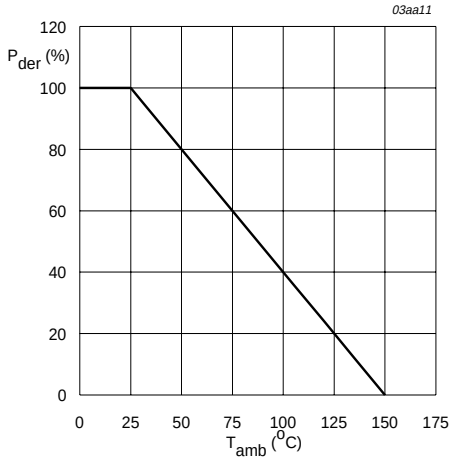
| Symbol | Parameter | Conditions | Typ | Max | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage (DC) | $T_j$ = 25 to 150 °C | – | 60 | V |
| $I_D$ | drain current (DC) | $T_{amb}$ = 25 °C; $V_{GS}$ = 10 V | – | 300 | mA |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | – | 0.83 | W |
| $T_j$ | junction temperature | | – | 150 | °C |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 500 mA | 2.8 | 5 | Ω |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 75 mA | 3.8 | 5.3 | Ω |

## 6. Limiting values

**Table 3: Limiting values**

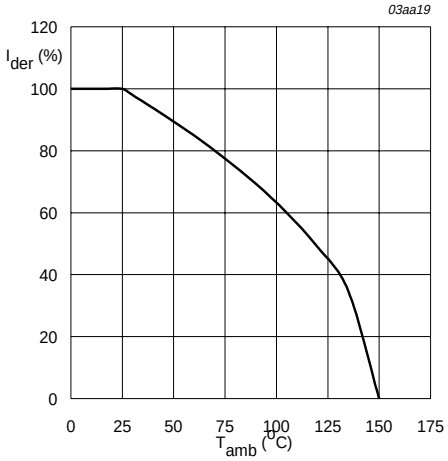
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage (DC) | $T_j$ = 25 to 150 °C | – | 60 | V |
| $V_{DGR}$ | drain-gate voltage (DC) | $T_j$ = 25 to 150 °C; $R_{GS}$ = 20 kΩ | – | 60 | V |
| $V_{GS}$ | gate-source voltage (DC) | | – | ±30 | V |
| $V_{GSM}$ | peak gate-source voltage | $t_p \leq 50$ µs; pulsed; duty cycle = 25% | – | ±40 | V |
| $I_D$ | drain current (DC) | $T_{amb}$ = 25 °C; $V_{GS}$ = 10 V; Figure 2 and 3 | – | 300 | mA |
| | | $T_{amb}$ = 100 °C; $V_{GS}$ = 10 V; Figure 2 | – | 190 | mA |
| $I_{DM}$ | peak drain current | $T_{amb}$ = 25 °C; pulsed; $t_p \leq 10$ µs; Figure 3 | – | 1.3 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C; Figure 1 | – | 0.83 | W |
| $T_{stg}$ | storage temperature | | –55 | +150 | °C |
| $T_j$ | operating junction temperature | | –55 | +150 | °C |
| **Source-drain diode** | | | | | |
| $I_S$ | source (diode forward) current (DC) | $T_{amb}$ = 25 °C | – | 300 | mA |
| $I_{SM}$ | peak source (diode forward) current | $T_{amb}$ = 25 °C; pulsed; $t_p \leq 10$ µs | – | 1.3 | A |




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

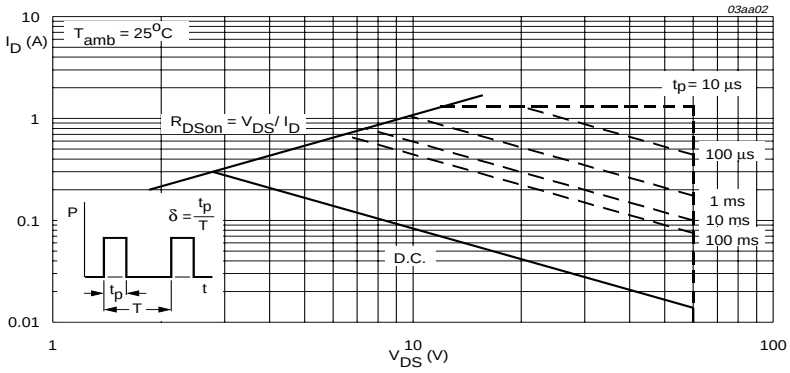
**Fig 1. Normalized total power dissipation as a function of ambient temperature.**




$V_{GS} \geq 4.5$ V

$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

**Fig 2. Normalized continuous drain current as a function of ambient temperature.**




$T_{amb}$ = 25 °C; $I_{DM}$ is single pulse.

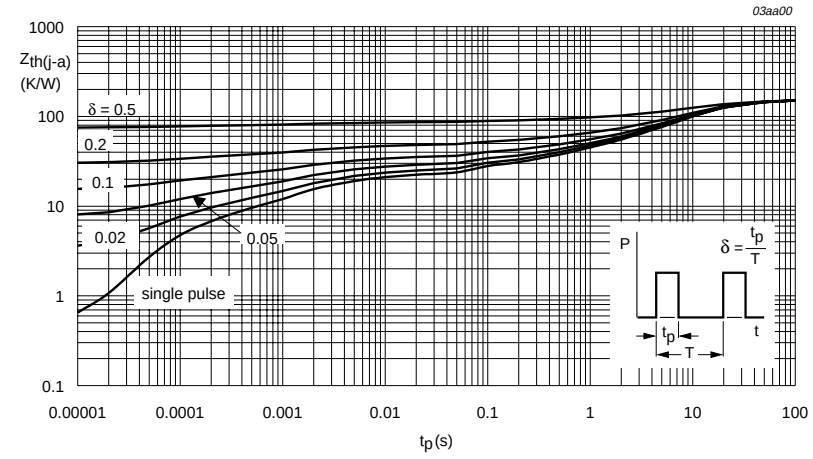
**Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.**

# 7. Thermal characteristics

**Table 4: Thermal characteristics**

| Symbol | Parameter | Conditions | Value | Unit |
|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | vertical in still air; lead length ≤ 5 mm; Figure 4 | 150 | K/W |

## 7.1 Transient thermal impedance




Vertical in still air.

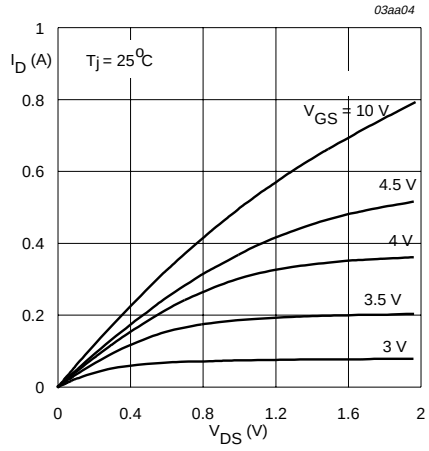
**Fig 4. Transient thermal impedance from junction to ambient as a function of pulse duration.**

# 8. Characteristics

**Table 5: Characteristics**

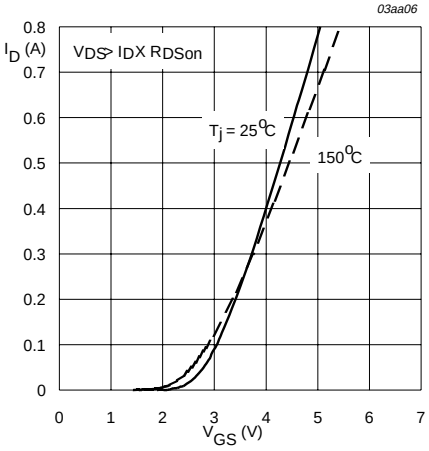
*$T_j$ = 25 °C unless otherwise specified*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 10 µA; $V_{GS}$ = 0 V | | | | |
| | | $T_j$ = 25 °C | 60 | 75 | – | V |
| | | $T_j$ = –55 °C | 55 | – | – | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; Figure 9 | | | | |
| | | $T_j$ = 25 °C | 1 | 2 | – | V |
| | | $T_j$ = 150 °C | 0.6 | – | – | V |
| | | $T_j$ = –55 °C | – | – | 3.5 | V |
| $I_{DSS}$ | drain-source leakage current | $V_{DS}$ = 48 V; $V_{GS}$ = 0 V | | | | |
| | | $T_j$ = 25 °C | – | 0.01 | 1.0 | µA |
| | | $T_j$ = 150 °C | – | – | 10 | µA |
| $I_{GSS}$ | gate-source leakage current | $V_{GS}$ = ±15 V; $V_{DS}$ = 0 V | – | 10 | 100 | nA |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 500 mA; Figure 7 and 8 | | | | |
| | | $T_j$ = 25 °C | – | 2.8 | 5 | Ω |
| | | $T_j$ = 150 °C | – | – | 9.25 | Ω |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 75 mA; Figure 7 and 8 | | | | |
| | | $T_j$ = 25 °C | – | 3.8 | 5.3 | Ω |
| **Dynamic characteristics** | | | | | | |
| $g_{fs}$ | forward transconductance | $V_{DS}$ = 10 V; $I_D$ = 200 mA; Figure 11 | 100 | 300 | – | mS |
| $C_{iss}$ | input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 10 V; f = 1 MHz; Figure 12 | – | 25 | 40 | pF |
| $C_{oss}$ | output capacitance | | – | 18 | 30 | pF |
| $C_{rss}$ | reverse transfer capacitance | | – | 7.5 | 10 | pF |
| $t_{on}$ | turn-on time | $V_{DD}$ = 50 V; $R_D$ = 250 Ω; $V_{GS}$ = 10 V; $R_G$ = 50 Ω; $R_{GS}$ = 50 Ω | – | 3 | 10 | ns |
| $t_{off}$ | turn-off time | | – | 12 | 15 | ns |
| **Source-drain diode** | | | | | | |
| $V_{SD}$ | source-drain (diode forward) voltage | $I_S$ = 300 mA; $V_{GS}$ = 0 V; Figure 13 | – | 0.85 | 1.5 | V |
| $t_{rr}$ | reverse recovery time | $I_S$ = 300 mA; $dI_S/dt$ = –100 A/µs; $V_{GS}$ = 0 V; $V_{DS}$ = 25 V | – | 30 | – | ns |
| $Q_r$ | recovered charge | | – | 30 | – | nC |



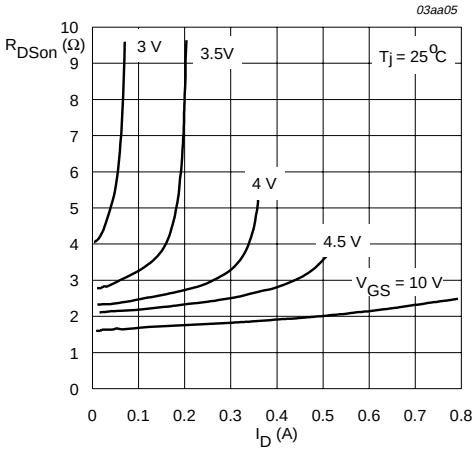

$T_j$ = 25 °C

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



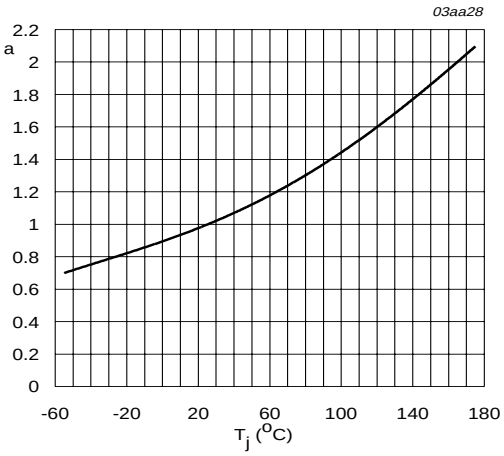

$T_j$ = 25 °C and 150 °C; $V_{DS} \geq I_D \times R_{DSon}$

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



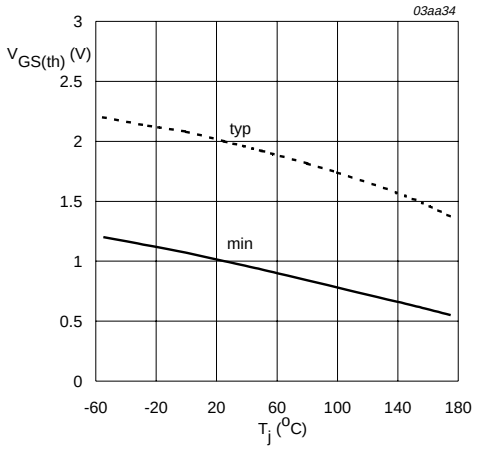

$T_j$ = 25 °C

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



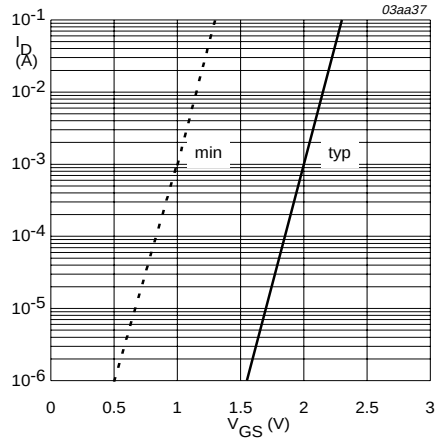

$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

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



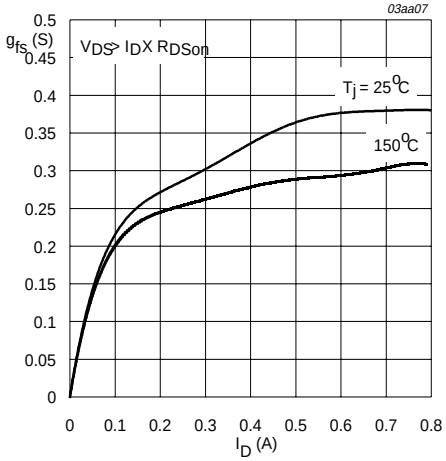

$I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$

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



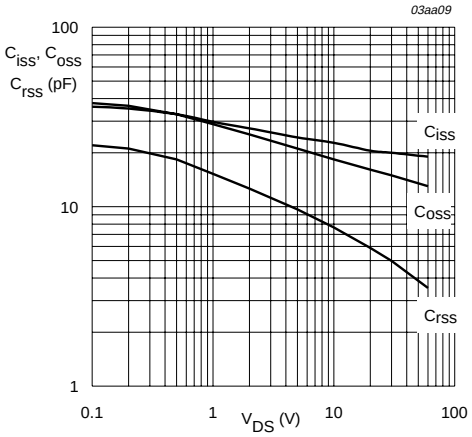

$T_j$ = 25 °C; $V_{DS}$ = 5 V

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



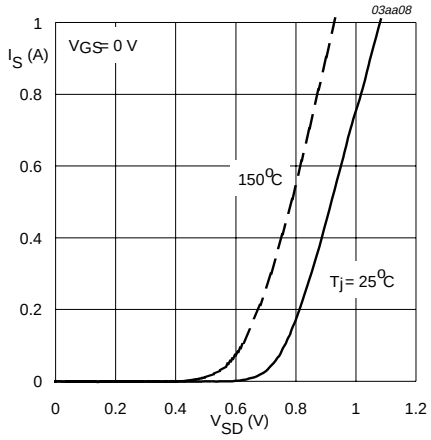

$T_j$ = 25 °C and 150 °C; $V_{DS} \geq I_D \times R_{DSon}$

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




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

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

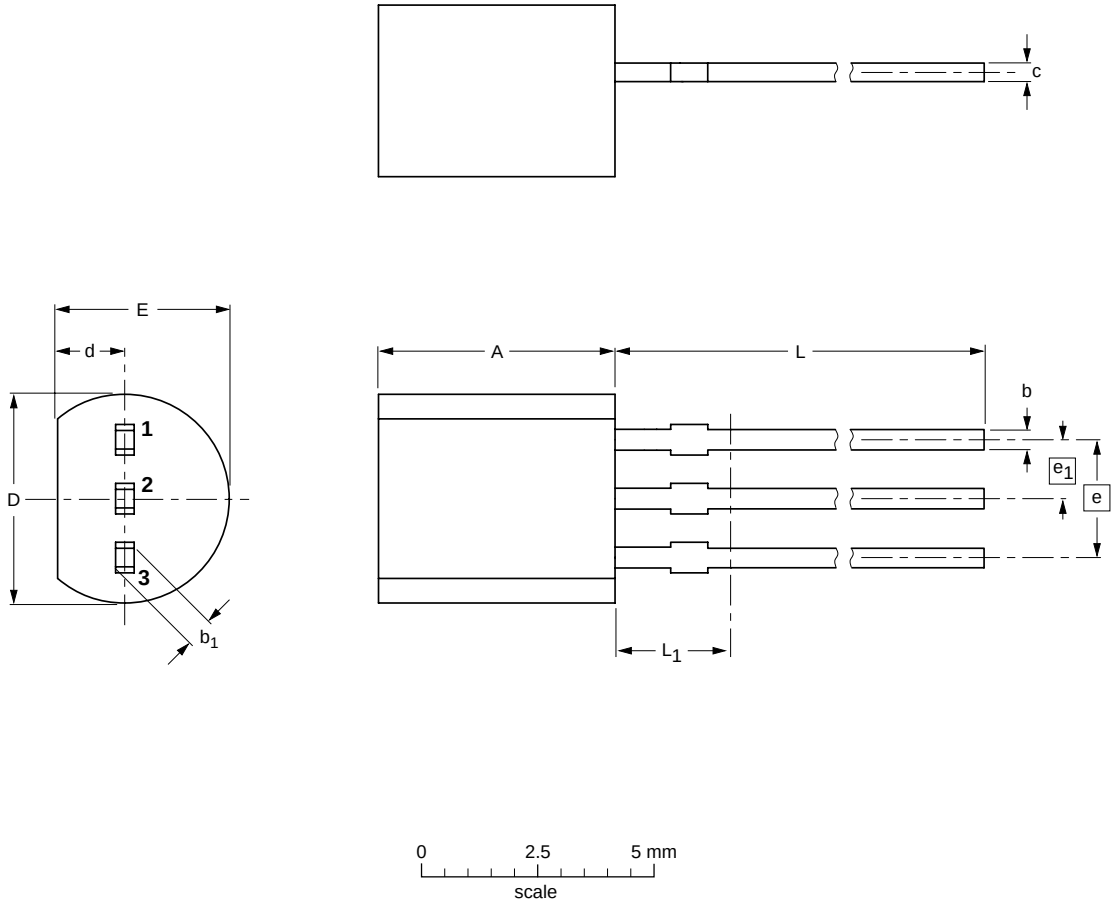



$T_j$ = 25 °C and 150 °C; $V_{GS}$ = 0 V

**Fig 13. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.**

## 9. Package outline

**Plastic single-ended leaded (through hole) package; 3 leads** **SOT54**




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

| UNIT | A | b | $b_1$ | c | D | d | E | e | $e_1$ | L | $L_1$ (1) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 5.2<br>5.0 | 0.48<br>0.40 | 0.66<br>0.56 | 0.45<br>0.40 | 4.8<br>4.4 | 1.7<br>1.4 | 4.2<br>3.6 | 2.54 | 1.27 | 14.5<br>12.7 | 2.5 |

**Note**

1. Terminal dimensions within this zone are uncontrolled to allow for flow of plastic and terminal irregularities.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT54 | | TO-92 | SC-43 | | | 97-02-28 |

**Fig 14. SOT54 (TO-92 variant).**

## 10. Revision history

Table 6: Revision history

| Rev | Date | CPCN | Description |
|---|---|---|---|
| 03 | 20000519 | HZG336 | **Product specification; third version.**<br>Converted to TrenchMOS™ technology. |
| 02 | 19970617 | - | **Product specification; second version.** |
| 01 | 19901031 | - | **Product specification; initial version.** |

## 11. Data sheet status

| Datasheet status | Product status | Definition [1] |
|---|---|---|
| Objective specification | Development | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice. |
| Preliminary specification | Qualification | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Product specification | Production | This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |

[1] Please consult the most recently issued data sheet before initiating or completing a design.

## 12. Definitions

**Short-form specification —** The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**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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**Date of release: 19 May 2000** **Document order number: 9397 750 07153**

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