# BUK1M200-50SDLD
## Quad channel TOPFET™

Rev. 01 — 02 April 2003
**Product data**

## 1. Product profile

### 1.1 Description

Quad temperature and overload protected logic level power MOSFET in TOPFET™ technology in a 20-pin surface mount plastic package.

Product availability:

BUK1M200-50SDLD in SOT163-1 (SO20).

### 1.2 Features

- Power TrenchMOS™
- Overtemperature protection
- Overload protection
- Input-source voltage resets latched protection circuitry.
- Input used to control output stage and supply overload protection circuits

- 5 V logic compatible input level
- Current limiting
- ESD protection for all pins
- Overfatigue clamping for turn off of inductive loads
- Low operating input current permits direct drive by micro-controller.

### 1.3 Applications

- Low-side driver
- Low frequency Pulse Width Modulation

- DC switching
- General purpose switch for driving lamps, motors, solenoids and heaters.

### 1.4 Quick reference data

**Table 1:    Quick reference data**

| Symbol | Parameter | | Min | Max | Unit |
|---|---|---|---|---|---|
| $R_{DSon}$ | drain-source on-state resistance | | - | 200 | m$\Omega$ |
| $P_{tot}$ | total power dissipation | [1] | - | 9.4 | W |
| $T_j$ | junction temperature | | - | 150 | °C |
| $V_{DS}$ | drain-source voltage | | - | 50 | V |

[1]    All devices active
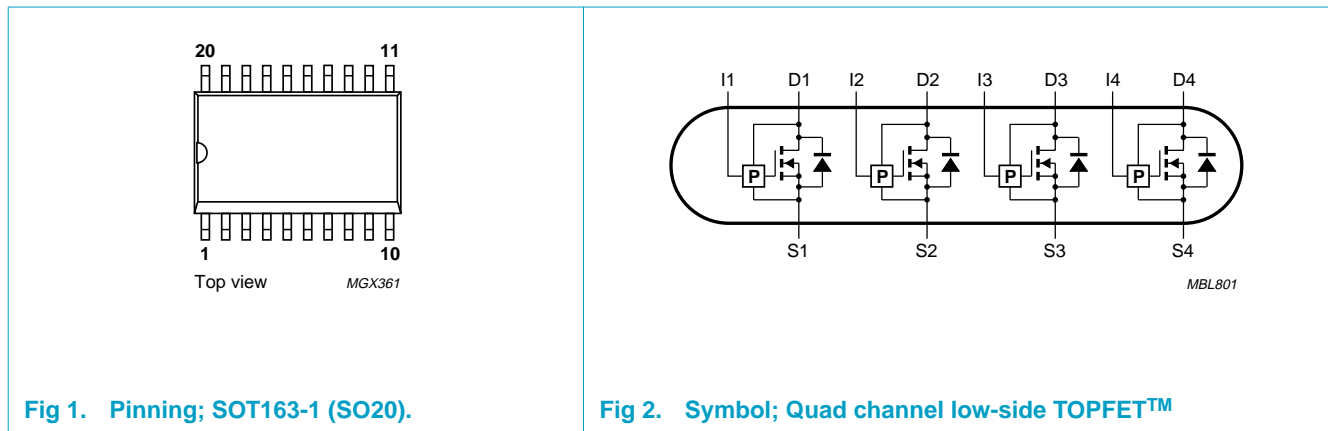
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## 2. Pinning information



**Fig 1. Pinning; SOT163-1 (SO20).**



**Fig 2. Symbol; Quad channel low-side TOPFET™**

### 2.1 Pin description

**Table 2: Pin description**

| Symbol | Pin | Description |
|---|---|---|
| n.c. | 1, 11, 10, 20 | not connected |
| D1 | 2,19 | drain 1 |
| I1 | 3 | input 1 |
| D2 | 4,17 | drain 2 |
| I2 | 5 | input 2 |
| D3 | 6,15 | drain 3 |
| I3 | 7 | input 3 |
| D4 | 8, 13 | drain 4 |
| I4 | 9 | input 4 |
| S4 | 12 | source 4 |
| S3 | 14 | source 3 |
| S2 | 16 | source 2 |
| S1 | 18 | source 1 |

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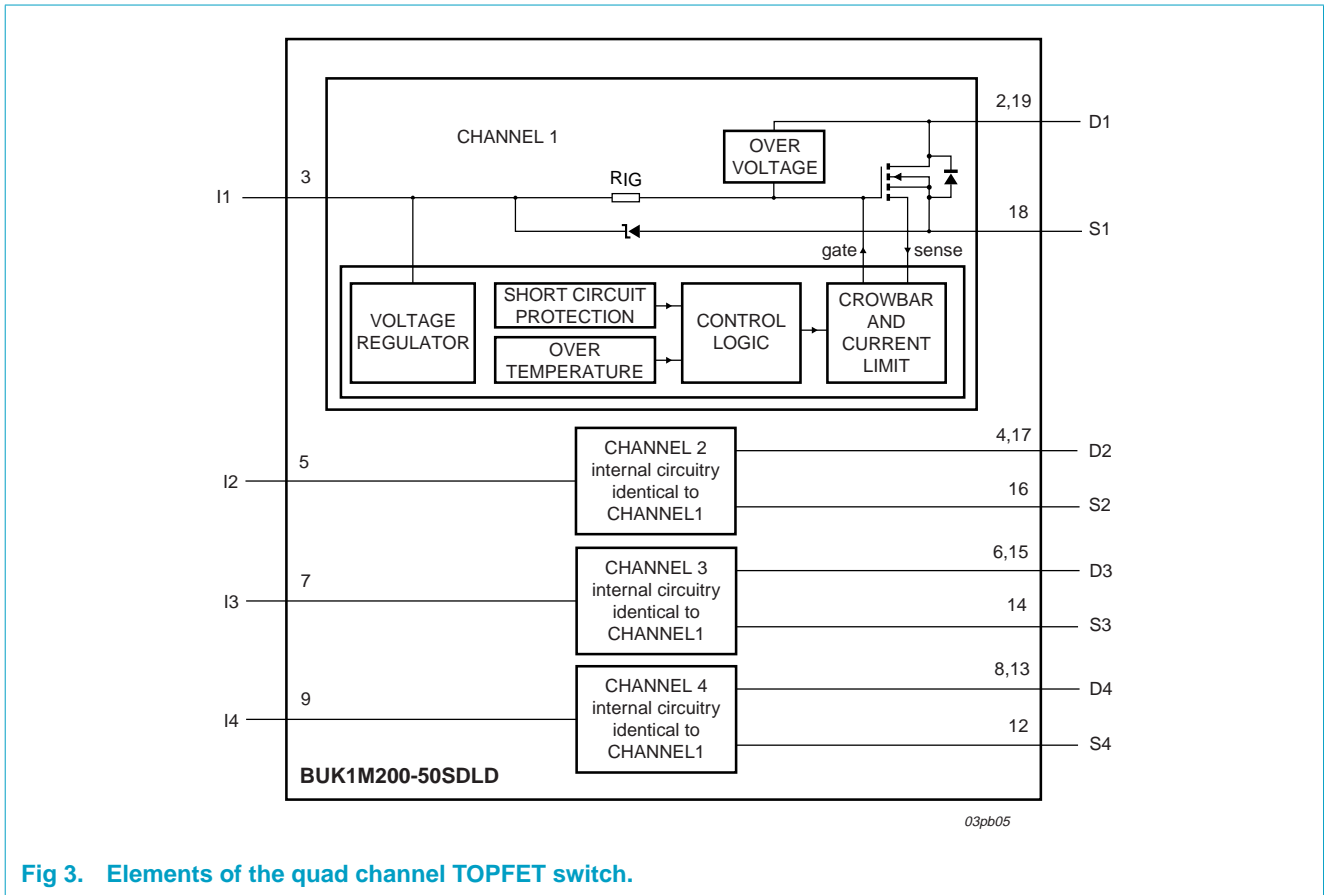
## 3. Block diagram



**Fig 3. Elements of the quad channel TOPFET switch.**
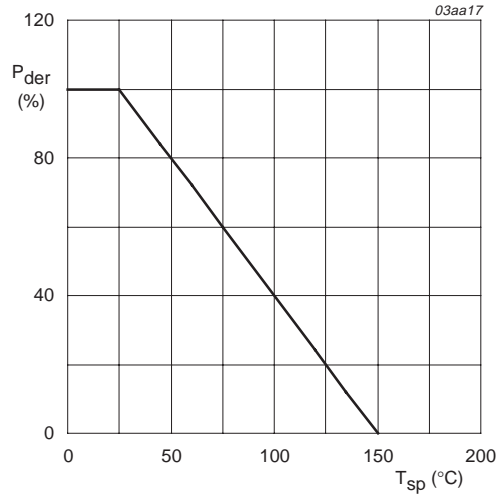
## 4. Limiting values

**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 | | [1] | - | 50 | V |
| $I_I$ | input current | clamping | | - | 3 | mA |
| $P_{tot}$ | total power dissipation | $T_{sp} \leq 25\ ^\circ C$; Figure 4 | [2] | - | 9.4 | W |
| $I_{IMS}$ | non-repetitive peak input current | $t_p \leq 1$ ms | | - | 10 | mA |
| $T_{stg}$ | storage temperature | | | −55 | +150 | °C |
| $T_j$ | junction temperature | normal operation | [3] | - | 150 | °C |
| **Overvoltage clamping** [4] | | | | | | |
| $E_{DS(CL)S}$ | non-repetitive drain-source clamping energy | $T_{amb} = 25\ ^\circ C$; $I_{DM} \leq I_{D(lim)}$ (refer to Table 5); inductive load | [5] | - | 100 | mJ |
| $E_{DS(CL)R}$ | repetitive drain-source clamping energy | $T_{sp} \leq 125\ ^\circ C$; $I_{DM} = 50$ mA; f = 250 Hz | [5] | - | 5 | mJ |
| **Overload protection** [6] | | | | | | |
| $V_{DS(prot)}$ | protected drain-source voltage | $V_{IS} \geq 4$ V | | - | 35 | V |
| **Reverse diode** | | | | | | |
| $I_S$ | source (diode forward) current | $T_{sp} \leq 25\ ^\circ C$; $V_{IS} = 0$ V | | - | 2 | A |
| **Electrostatic discharge** | | | | | | |
| $V_{esd}$ | electrostatic discharge voltage | C = 250 pF; R = 1.5 kΩ | | - | 2 | kV |

[1] Prior to the onset of overvoltage clamping. For voltages above this value, safe operation is limited by the overvoltage clamping energy.

[2] For all devices active.

[3] Not in an overload condition with drain current limiting.

[4] At a drain-source voltage above 50 V the power MOSFET is actively turned on to clamp overvoltage transients.

[5] Single active device.

[6] With the protection supply provided via the input pin, the TOPFET is protected from short circuit loads. Overload protection operates by means of drain current limiting and by activating the overtemperature protection.

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

**Fig 4.   Normalized total power dissipation as a function of solder point temperature.**

## 5.   Thermal characteristics

**Table 4:**      **Thermal characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point. | mounted on thermo clad board | | | | |
| | | one device active | - | - | 45 | K/W |
| | | all devices active | - | - | 13.3 | K/W |

## 6. Static characteristics

**Table 5:    Static characteristics**

*Limits are valid for $-40\,°C \le T_{sp} \le +150\,°C$ and typical values for $T_{sp} = 25\,°C$ unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Off-state output characteristics** | | | | | | | |
| $V_{DS(CL)}$ | drain-source clamping voltage | $V_{IS} = 0$ V; $I_D = 10$ mA | | 50 | - | - | V |
| | | $V_{IS} = 0$ V; $I_D = 200$ mA; $t_p \le 300$ µs; $\delta \le 0.01$; Figure 16 | | 50 | 62 | 70 | V |
| $I_{DSS}$ | drain-source leakage current | $V_{IS} = 0$ V; $V_{DS} = 40$ V | | - | - | 100 | µA |
| | | $T_{sp} = 25\,°C$; Figure 17 | | - | 0.05 | 10 | µA |
| **On-state output characteristic** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{IS} \ge 4$ V; $t_p \le 300$ µs; $\delta \le 0.01$; $I_D = 100$ mA; Figure 5 and 6 | | - | - | 380 | mΩ |
| | | $T_{sp} = 25\,°C$ | | - | 150 | 200 | mΩ |
| **Input characteristics** [1] | | | | | | | |
| $V_{IS(th)}$ | input-source threshold voltage | $V_{DS} = 5$ V; $I_D = 1$ mA | | 0.6 | - | 2.4 | V |
| | | $T_{sp} = 25$ C; Figure 10 | | 1.1 | 1.6 | 2.1 | V |
| $I_{IS}$ | input-source current | normal operation | | | | | |
| | | $V_{IS} = 5$ V | | 100 | 220 | 400 | µA |
| | | $V_{IS} = 4$ V | | 80 | 195 | 330 | µA |
| | | protection latched | | | | | |
| | | $V_{IS} = 5$ V | | 200 | 400 | 650 | µA |
| | | $V_{IS} = 3$ V; Figure 11 and 12 | | 130 | 250 | 430 | µA |
| $V_{IS(rst)}$ | input-source reset voltage | $t_{rst} \ge 100$ µs; Figure 15 | [2] | 1.5 | 2 | 2.9 | V |
| $t_{rst(latch)}$ | latch reset time | | [6] | 10 | 40 | 100 | µs |
| $V_{IS(CL)}$ | input-source clamping voltage | $I_I = 1.5$ mA; Figure 16 | | 5.5 | - | 8.5 | V |
| $R_{IG}$ | input-gate resistance | | [3] | - | 33 | - | kΩ |
| **Overload protection characteristic** [4] | | | | | | | |
| $I_{D(lim)}$ | drain current limiting | $V_{IS} = 5$ V; Figure 18 | | 0.8 | 1.3 | 1.7 | A |
| | | $V_{IS} = 4.5$ V | | 0.7 | - | - | A |
| | | $4$ V $\le V_{IS} \le 5.5$ V; | | 0.6 | - | 1.8 | A |
| **Short circuit load protection characteristics** | | | | | | | |
| $P_{OV(th)}$ | overload power threshold | $V_{IS} = 5$ V | [5] | - | 17 | - | W |
| $T_{d(sc)}$ | short circuit response time | $V_{IS} = 5$ V; Figure 14 | [7] | - | 1.6 | - | ms |
| **Overtemperature protection characteristic** | | | | | | | |
| $T_{j(th)}$ | threshold junction temperature | $4$ V $\le V_{IS} \le 5.5$ V; $I_D \ge 280$ mA or $V_{DS} \ge 100$ mV; Figure 9 | | 150 | 165 | - | °C |
| **Source-drain diode characteristic** | | | | | | | |
| $V_{SD}$ | source-drain (diode forward) voltage | $I_S = 2$ A; $V_{IS} = 0$ V; $t_p = 300$ µs | | - | 0.83 | 1.1 | V |

[1]    The supply for the logic and overload protection is taken from the input.

[2]    The input voltage below which the overload protection circuits will be reset.
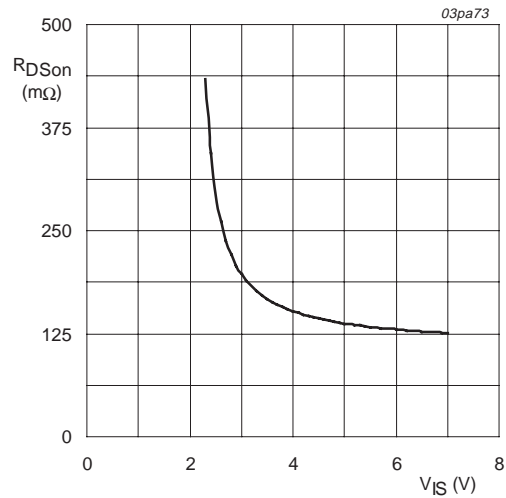
[3]    Not directly measurable from the device terminals.

[4] The TOPFET switches off to protect itself when one of the overload thresholds is exceeded. It remains latched off until reset by the input.

[5] Power threshold for protection to operate.

[6] To reset the latched state, the input-source voltage is reduced from 5 V to 1 V.

[7] Trip time $t_{(trip)}$ varies with overload dissipation $P_{OV}$ according to the formula $t_{(trip)} = t_{d(sc)} / [P_{OV} / P_{OV(th)} - 1]$
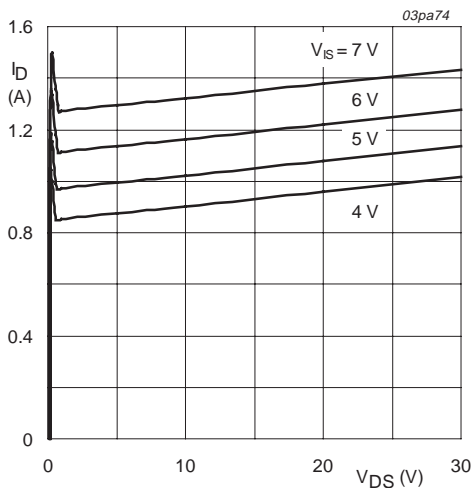


$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

**Fig 5.** Normalized drain-source on-state resistance factor as a function of junction temperature.



$T_j = 25 °C; I_D = 100 mA; t_p = 300 µs$

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



$T_j = 25 °C; t_p = 300 µs$

**Fig 7.** Output characteristics; drain current as a function of drain-source voltage; typical values.



$T_j = 25 °C; V_{DS} = 10 V; t_p = 300 µs$

**Fig 8.** Transfer characteristics; drain current as a function of input-source voltage; typical values.
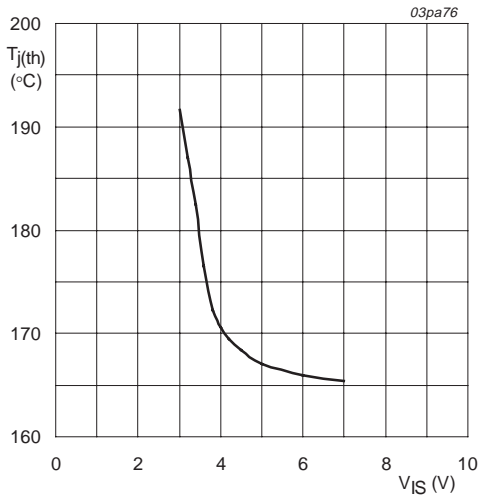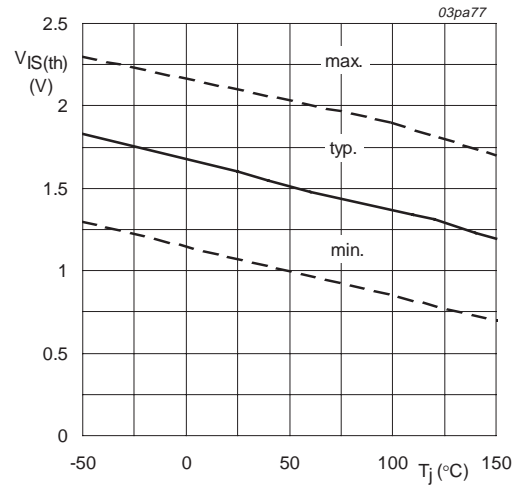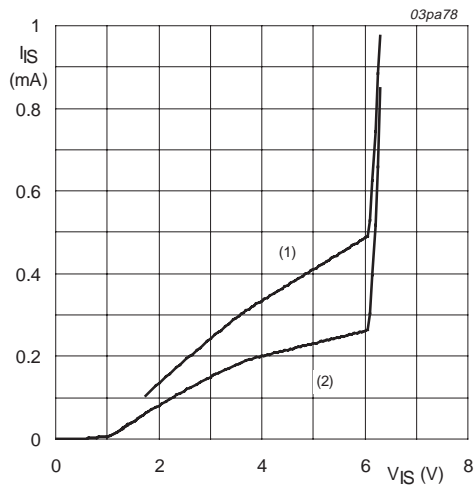
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**Fig 9.** Overtemperature protection characteristic; threshold junction temperature as a function of input-source voltage; typical values.

$I_D$ = mA; $V_{DS}$ = 5 V

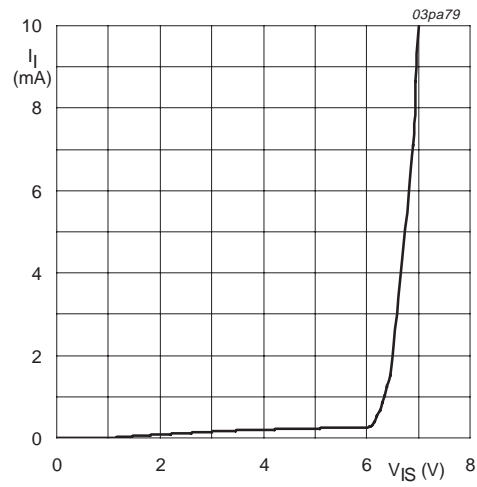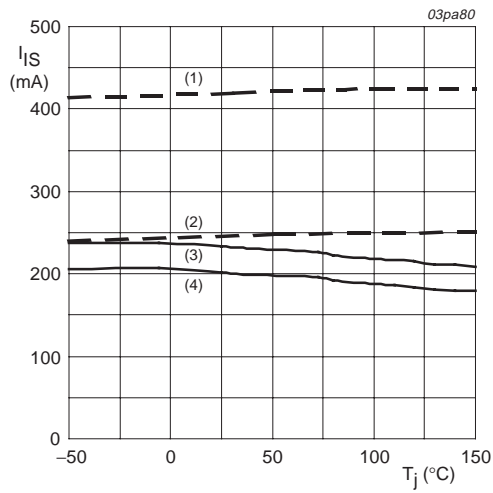**Fig 10.** Input-source threshold voltage as a function of junction temperature.

$T_j$ = 25 °C

(1) Protection latched.

(2) Normal operation.

**Fig 11.** Input-source current as a function of input-source voltage; typical values.

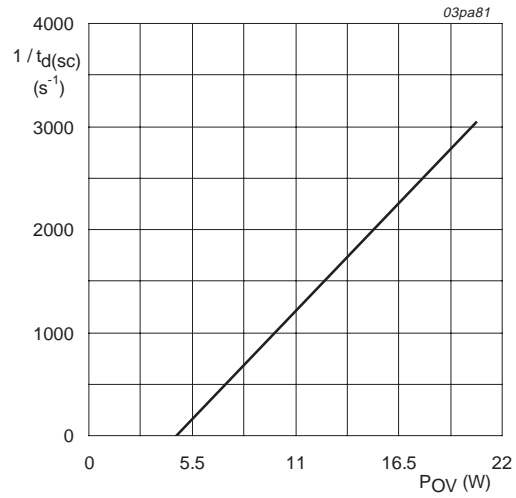$T_j$ = 25 °C

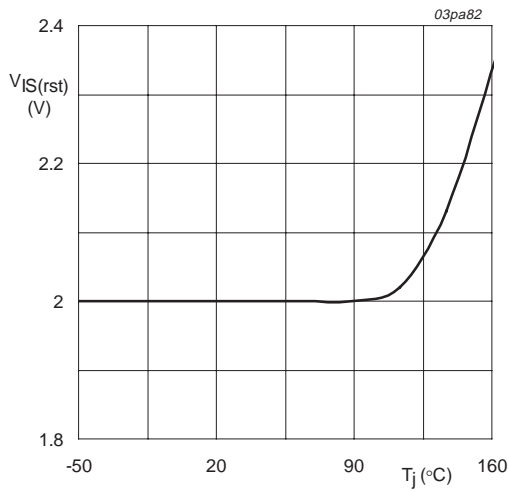**Fig 12.** Input clamping characteristic; input current as a function of input-source voltage; typical values.

(1) $V_{IS}$ = 5 V; device in latched mode.
(2) $V_{IS}$ = 3 V; device in latched mode.
(3) $V_{IS}$ = 5 V; device in normal mode.
(4) $V_{IS}$ = 4 V; device in normal mode.

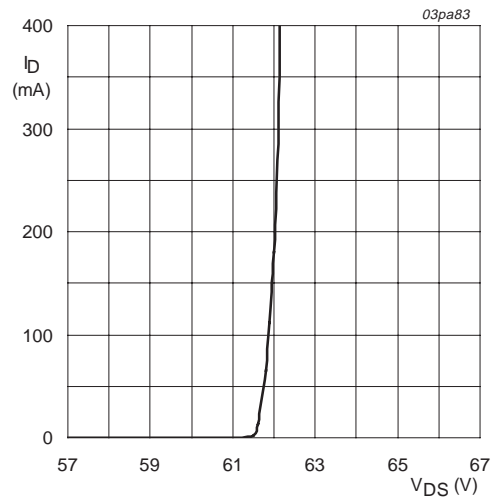**Fig 13. Input-source current as a function of junction temperature; typical values.**



$V_{IS} \geq 4$ V; $T_j \leq 125$ °C

**Fig 14. Reciprocal of short circuit response time as a function of total overload power; single device dissipating; typical values**



$t_r$ = 100 µs
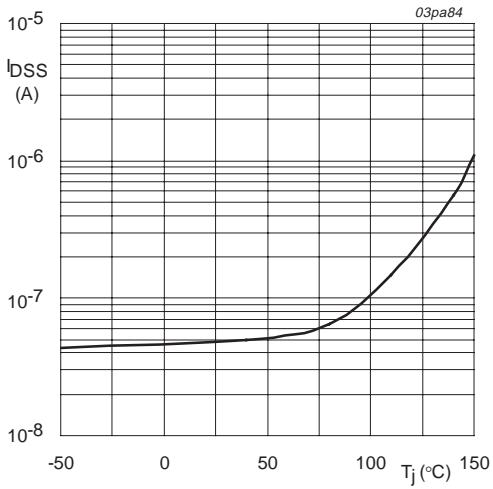
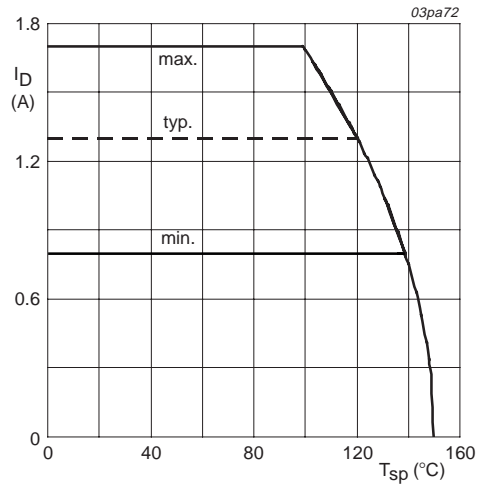**Fig 15. Input-source reset voltage as a function of junction temperature; typical values.**



$V_{IS}$ = 0 V; $t_p$ = 300 µs

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

$V_{DS}$ = 40 V; $V_{IS}$ = 0 V

**Fig 17. Drain-source leakage current as a function of junction temperature; typical values.**



$V_{IS}$ = 5 V

**Fig 18. Drain current limiting as a function of solder point temperature.**

# 7. Dynamic characteristics

**Table 6:    Switching characteristics**

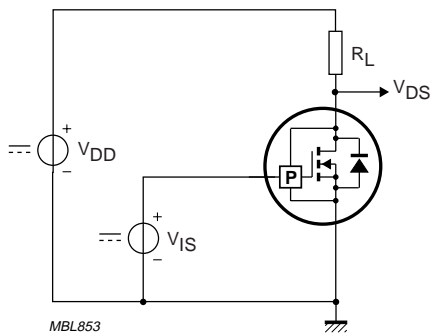| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Turn-on measured from the input going HIGH** | | | | | | |
| $t_{d(on)}$ | turn-on delay time | $R_L$ = 50 Ω; $I_D$ = 250 mA; $V_{IS}$ = 5 V; Figure 19 and 20; $T_{sp}$ = 25 °C | - | 5 | 12 | µs |
| $t_r$ | rise time | | - | 11 | 30 | µs |
| $t_{d(off)}$ | turn-off delay time | | - | 25 | 65 | µs |
| $t_f$ | fall time | | - | 14 | 35 | µs |



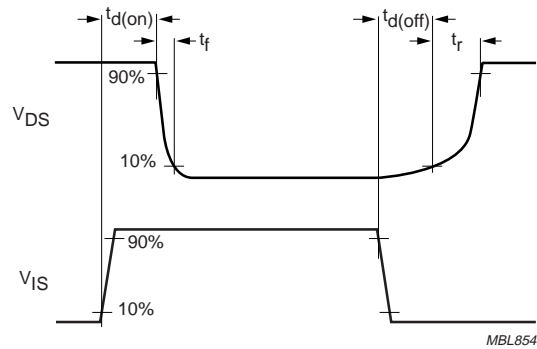**Fig 19. Test circuit for resistive load switching times.**



**Fig 20. Resistive load switching waveforms.**

## 8. Package outline

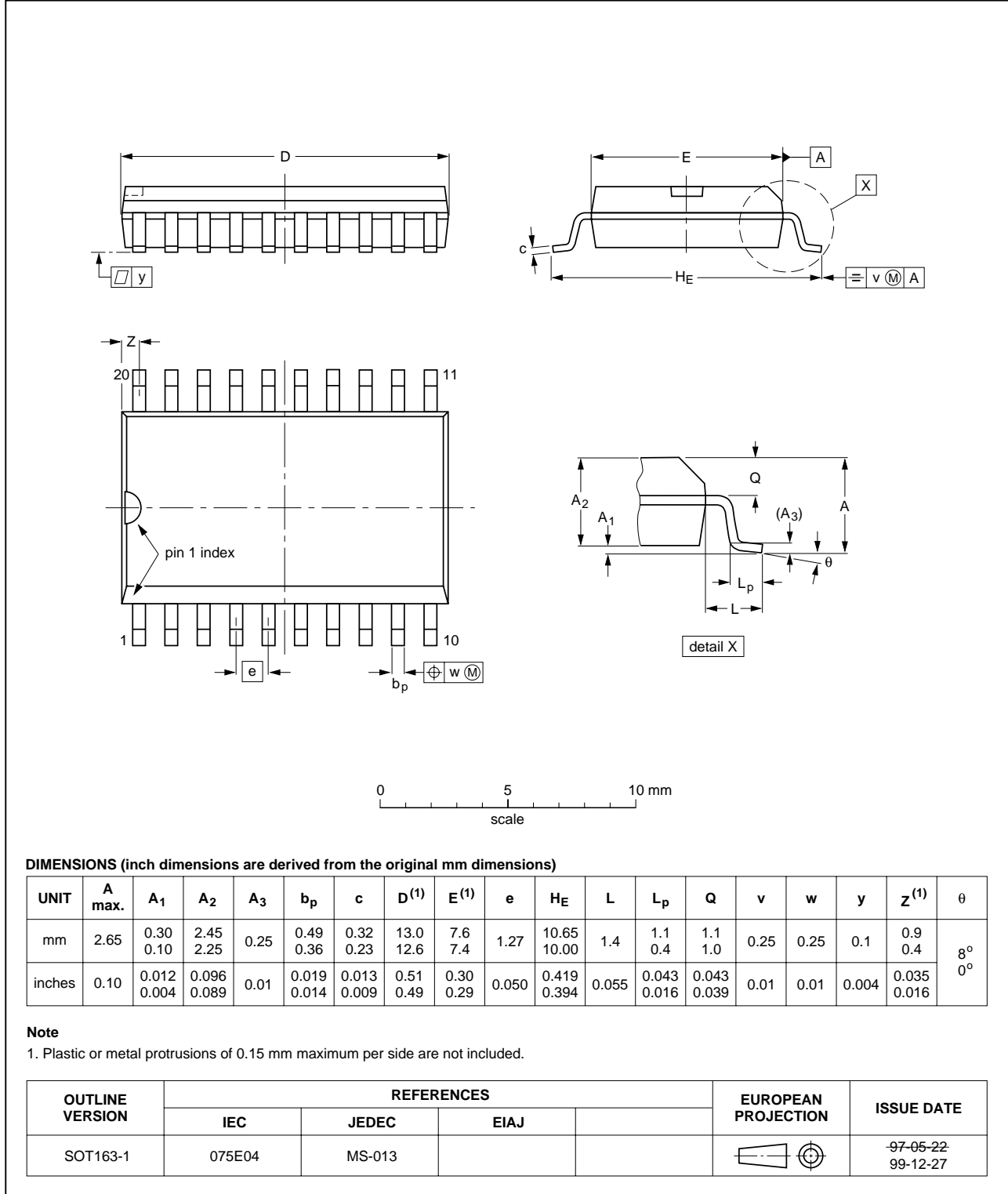**SO20: plastic small outline package; 20 leads; body width 7.5 mm**

**SOT163-1**



**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|------|--------|-------|-------|-------|-------|---|-----------|-----------|---|-------|---|-------|---|---|---|---|-----------|---|
| mm | 2.65 | 0.30 0.10 | 2.45 2.25 | 0.25 | 0.49 0.36 | 0.32 0.23 | 13.0 12.6 | 7.6 7.4 | 1.27 | 10.65 10.00 | 1.4 | 1.1 0.4 | 1.1 1.0 | 0.25 | 0.25 | 0.1 | 0.9 0.4 | 8° 0° |
| inches | 0.10 | 0.012 0.004 | 0.096 0.089 | 0.01 | 0.019 0.014 | 0.013 0.009 | 0.51 0.49 | 0.30 0.29 | 0.050 | 0.419 0.394 | 0.055 | 0.043 0.016 | 0.043 0.039 | 0.01 | 0.01 | 0.004 | 0.035 0.016 | |

**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 | EIAJ | | | |
| SOT163-1 | 075E04 | MS-013 | | | | ~~97-05-22~~ 99-12-27 |

**Fig 21. SOT163-1.**

# 9. Revision history

**Table 7:** Revision history

| Rev | Date | CPCN | Description |
|-----|------|------|-------------|
| 01 | 20030402 | - | Product datasheet (9397 750 10956) |

## 10. Data sheet status

| Level | Data sheet status[1] | Product status[2][3] | Definition |
|---|---|---|---|
| I | 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. |
| II | 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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[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.

[3]    For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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**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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# Contents

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