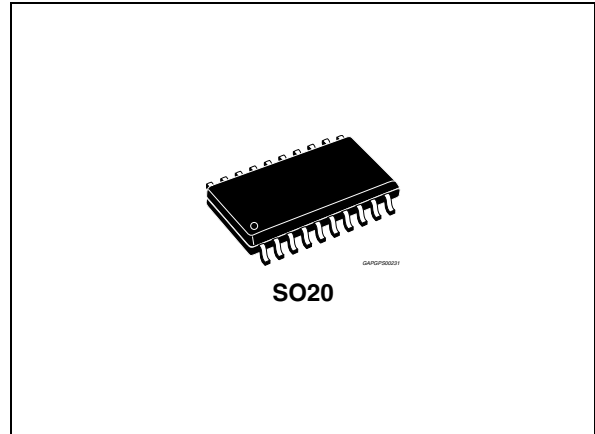


## Quad low side driver

Datasheet — production data

### Features

- Wide input voltage range from -24 V up to +45 V
- Wide operating supply voltage range from 4.5 V up to 32 V
- Reverse biasing protected ( $V_S = -24$  V)
- Very low standby quiescent current  $< 2 \mu\text{A}$
- Programmable signal transfer polarity
- TTL and CMOS compatible inputs
- Defined output off state off for open inputs
- Three open drain DMOS outputs, with  $R_{DSon} = 1.5 \Omega$  at 25 °C and  $V_S > 6$  V
- Output current limitation
- Controlled output slope for low EMI
- Over temperature shut-down
- Integrated output clamping for fast inductive recirculation  $V_{FB} > 45$  V
- Status monitoring for:
  - Over temperature
  - Disconnected ground or supply voltage



- ESD: all pins are guaranteed till 2 kV human body mode

### Description

The L9338 is a monolithic integrated quad low side driver realized in advanced Multipower-BCD technology. It is intended to drive lines, lamps or relays in automotive or industrial applications.

**Table 1. Device summary**

| Order code   | Package | Packing       |
|--------------|---------|---------------|
| E-L9338MD    | SO20    | Tube          |
| E-L9338MD/TR | SO20    | Tape and reel |

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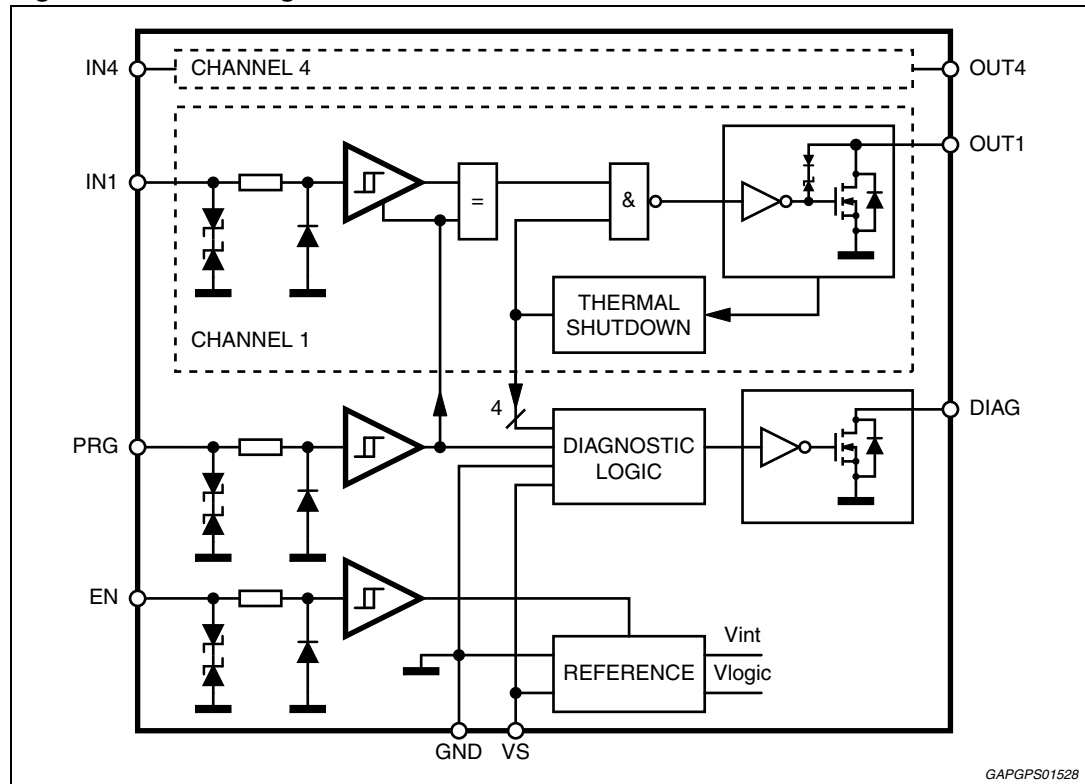
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## 1 Block diagram

**Figure 1. Block diagram**



## 2 Pins description

Figure 2. Pins connection diagram

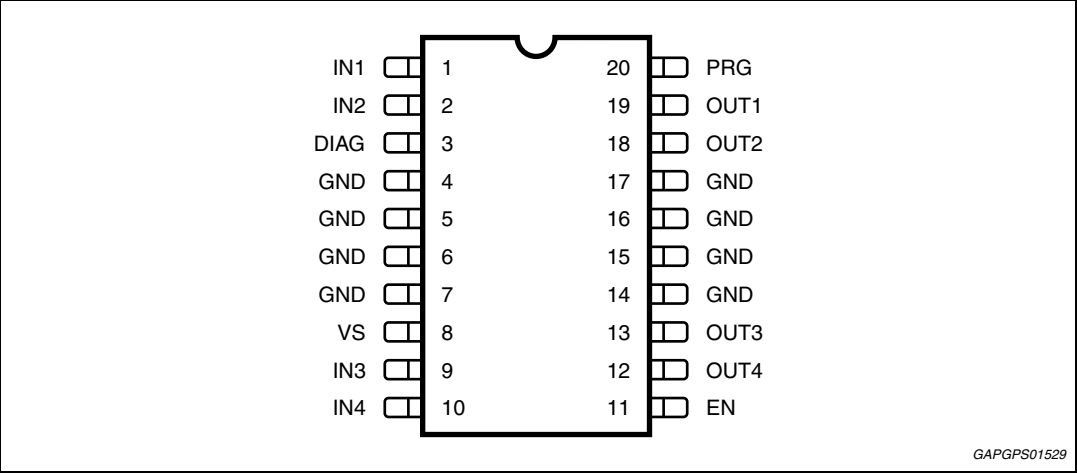


Table 2. Pins function

| Pin #                | Pin name | Function       |
|----------------------|----------|----------------|
| 1                    | IN1      | Input 1        |
| 2                    | IN2      | Input 2        |
| 3                    | DIAG     | Diagnostics    |
| 4,5,6,7,14, 15,16,17 | GND      | Ground         |
| 8                    | VS       | Supply voltage |
| 9                    | IN3      | Input 3        |
| 10                   | IN4      | Input 4        |
| 11                   | EN       | Enable         |
| 12                   | OUT 4    | Output 4       |
| 13                   | OUT 3    | Output 3       |
| 18                   | OUT 2    | Output 2       |
| 19                   | OUT 1    | Output 1       |
| 20                   | PRG      | Program        |

## 3 Electrical specifications

### 3.1 Absolute maximum ratings

**Table 3. Absolute maximum ratings (no damage or latch)**

| Symbol              | Parameter              | Value      | Unit |
|---------------------|------------------------|------------|------|
| $V_S$               | Supply voltage         | -24 to 45  | V    |
| <b>Pin voltages</b> |                        |            |      |
| $V_{IN}$            | Input, enable, program | -24 to 45  | V    |
| $V_{OUT}$           | Output                 | -0.3 to 45 | V    |
| $V_{DIAG}$          | Diagnostic output      | -0.3 to 45 | V    |

### 3.2 Thermal data

**Table 4. Thermal data**

| Symbol           | Parameter                          | Value      | Unit |
|------------------|------------------------------------|------------|------|
| $R_{th(j-pins)}$ | Thermal resistance junction-to-pin | 14 (Typ.)  | °C/W |
| $T_{jMon}$       | Temperature-monitoring             |            |      |
|                  | Switch-off-level                   | 160 to 190 | °C   |
|                  | Switch-on-level                    | 140 to 170 | °C   |

### 3.3 Operating condition

The electrical characteristics are valid within the below defined operating ranges, unless otherwise specified. The function will be guaranteed by design until  $T_{jMon}$  switch-OFF-level.

**Table 5. Operating condition**

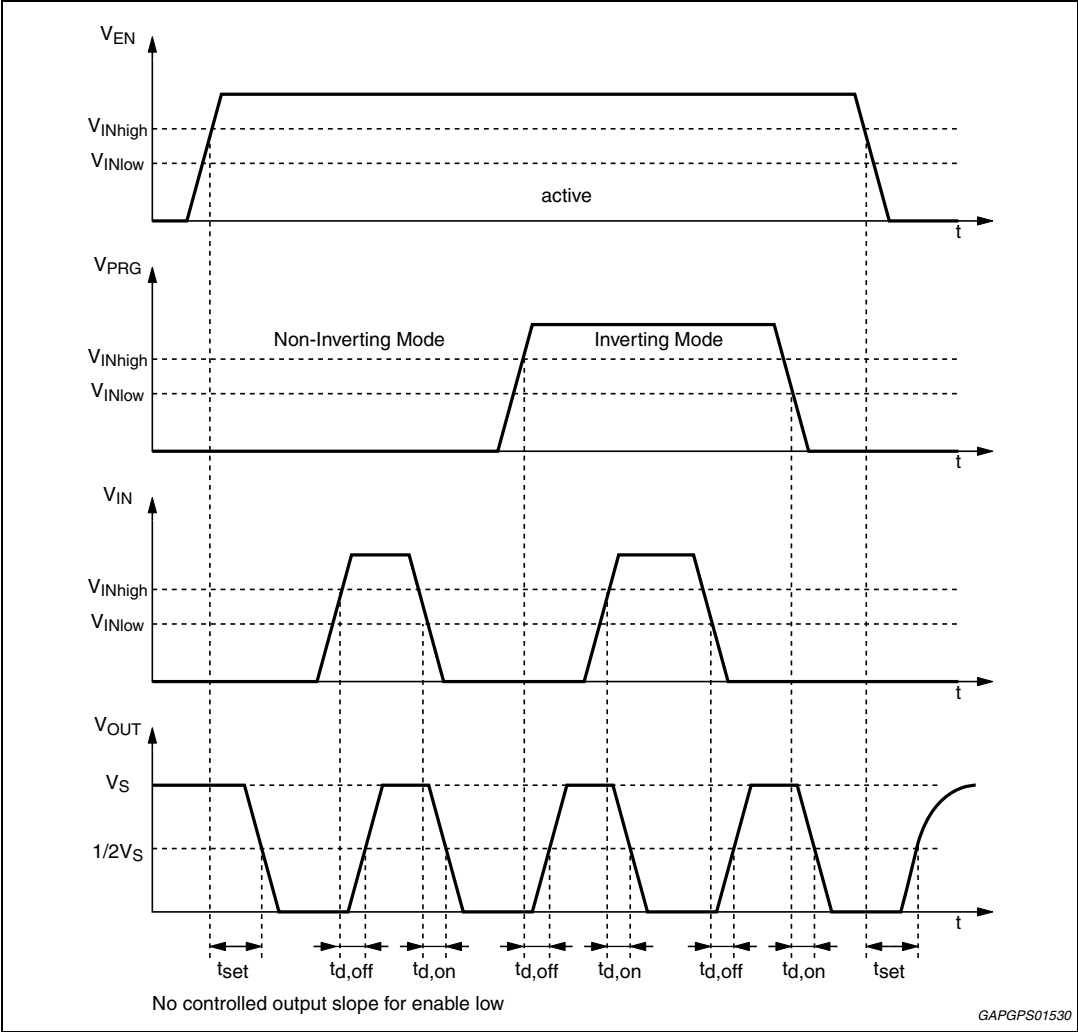
| Symbol         | Parameter            | Value      | Unit |
|----------------|----------------------|------------|------|
| $V_S$          | Supply voltage       | 4.5 to 32  | V    |
| $V_{IN}$       | Input pin voltage    | -24 to 45  | V    |
| $V_{EN}$       | Enable pin voltage   | -24 to 45  | V    |
| $V_{OUT}, V_D$ | Output pin voltage   | -0.3 to 45 | V    |
| $T_j$          | Junction temperature | -40 to 150 | °C   |

### 3.4 Electrical characteristics

**Table 6. Electrical characteristics**

| Symbol                                 | Parameter                       | Test Condition                                                                                    | Min. | Typ. | Max.           | Unit   |
|----------------------------------------|---------------------------------|---------------------------------------------------------------------------------------------------|------|------|----------------|--------|
| I <sub>Q</sub>                         | Quiescent current               | -0.3V ≤ V <sub>EN</sub> ≤ 0.5V;<br>V <sub>S</sub> = 14V; T <sub>j</sub> = 85°C                    | -    | < 2  | 10             | μA     |
|                                        |                                 | EN = high; V <sub>S</sub> ≤ 14V                                                                   | -    | 1.5  | 2              | mA     |
| Inputs IN1 - IN3, PRG                  |                                 |                                                                                                   |      |      |                |        |
| V <sub>INlow</sub>                     | Input voltage low               | -                                                                                                 | -24  | -    | 2.0            | V      |
| V <sub>INhigh</sub>                    | Input voltage high              | -                                                                                                 | 2.8  | -    | 45             | V      |
| I <sub>IN</sub>                        | Input current                   | -24 V ≤ V <sub>i</sub> ≤ 10 V                                                                     | -10  | -    | 15             | μA     |
| Enable input EN                        |                                 |                                                                                                   |      |      |                |        |
| V <sub>ENlow</sub>                     | Input voltage low               | -                                                                                                 | -24  | -    | 1              | V      |
| V <sub>ENhigh</sub>                    | Input voltage high              | -                                                                                                 | 3.2  | -    | V <sub>S</sub> | V      |
| R <sub>EN</sub>                        | Input impedance                 | -24V < V <sub>i</sub> < 2.5V                                                                      | 10   | -    | -              | kΩ     |
| I <sub>EN</sub>                        | Input current                   | 2.5V ≤ V <sub>i</sub> ≤ 25V                                                                       | -    | 20   | 50             | μA     |
| Outputs OUT1-OUT3                      |                                 |                                                                                                   |      |      |                |        |
| R <sub>DSon</sub>                      | Output on-resistor to ground    | V <sub>S</sub> ≥ 6 V, I <sub>O</sub> = 0.3 A<br>T <sub>j</sub> = 25 °C<br>T <sub>j</sub> = 125 °C | -    | 1.7  | 2.3<br>3.5     | Ω<br>Ω |
| I <sub>OLeak</sub>                     | Leakage current                 | V <sub>O</sub> = V <sub>S</sub> = 14 V; T <sub>j</sub> = 85 °C                                    | -    | ≤1   | 5              | μA     |
| V <sub>OClamp</sub>                    | Output voltage during clamping  | time < 200 μs; 10 mA ≤ I <sub>O</sub> ≤ 0.3 A                                                     | 45   | 52   | 60             | V      |
| I <sub>OSC</sub>                       | Short-circuit current           | -                                                                                                 | 400  | 700  | 1200           | mA     |
| C <sub>O</sub>                         | Internal output capacities      | V <sub>O</sub> ≥ 4.5V                                                                             | -    | -    | 100            | pF     |
| Diagnostic output DIAG                 |                                 |                                                                                                   |      |      |                |        |
| V <sub>Dlow</sub>                      | Output voltage low              | I <sub>DL</sub> ≤ 1 mA                                                                            | -    | 0.3  | 0.5            | V      |
| I <sub>Dmax</sub>                      | Max. Output current             | Internal current limitation                                                                       | 1    | 5    | 15             | mA     |
| I <sub>Dleak</sub>                     | Leakage current                 | V <sub>S</sub> = 14 V; T <sub>J</sub> = 85 °C                                                     | -    | ≤0.1 | 1              | μA     |
| Timing (see <a href="#">Figure 3</a> ) |                                 |                                                                                                   |      |      |                |        |
| t <sub>d,on</sub>                      | On delay time                   | V <sub>S</sub> = 14 V, C <sub>ext</sub> = 0 pF<br>10 mA ≤ I <sub>O</sub> ≤ 200m A                 | -    | 2.5  | 3.5            | μs     |
| t <sub>d,off</sub>                     | Off delay time                  |                                                                                                   | -    | 3    | 4.5            | μs     |
| t <sub>set</sub>                       | Enable settling time            |                                                                                                   | -    | -    | 10             | μs     |
| t <sub>d,DIAG</sub>                    | On or off diagnostic delay time |                                                                                                   | -    | -    | 10             | μs     |
| S <sub>out</sub>                       | Output slopes                   |                                                                                                   | 2.5  | 9    | 16             | V/μs   |

Figure 3. Timing diagram



## 4 Circuit description

The L9338 is a quad low side driver for lines, lamps or inductive loads in automotive and industrial applications.

All inputs are TTL or CMOS compatible. This allows the device to be driven directly by a microcontroller. For the noise immunity, all inputs have a Schmitt-trigger with a hysteresis of typ. 100 mV.

Each input stage has an input voltage protection from -24 V to 45 V. The device can be activated with a 'high' signal on Enable (EN) input. Enable 'low' switches the device into the sleep mode. In this mode the quiescent current is less than 10 mA. A high signal on programming (PRG) input changes the signal transfer polarity from non inverting into the inverting mode. Normally this pin is connected to  $V_S$  or GND. These pins (PRG and EN) are internally fixed at low status by open input condition.

Independent of the programming input, the output (OUT) switches off, if the signal input (IN) pin is not connected.

Each output driver has a current limitation of min. 0.4 A and a separate thermal shut-down. The thermal shut-down deactivates that output which exceeds temperature switch off level. About 20K below this temperature threshold the output will be activated again. This means, that each output is able to sink continuously 285 mA without activating thermal shut-down at 85 °C ambient temperature. The slew rate of the output is limited to max. 14 V/ms to reduce the electromagnetic interference, but not for the enable transfer characteristic (see [Figure 3](#)). An integrated active flyback voltage limitation clamps the output voltage during the flyback phase of inductive loads to typ. 50 V. The power DMOS switches ON, if the device is enabled and the output swings below ground. This protection avoids the activation of parasitic inside the power DMOS.

The diagnostic (DIAG) is an open drain output. The logic status depends on the programming pin. If the PRG pin is 'low' the DIAG output becomes low, if the device works correctly.

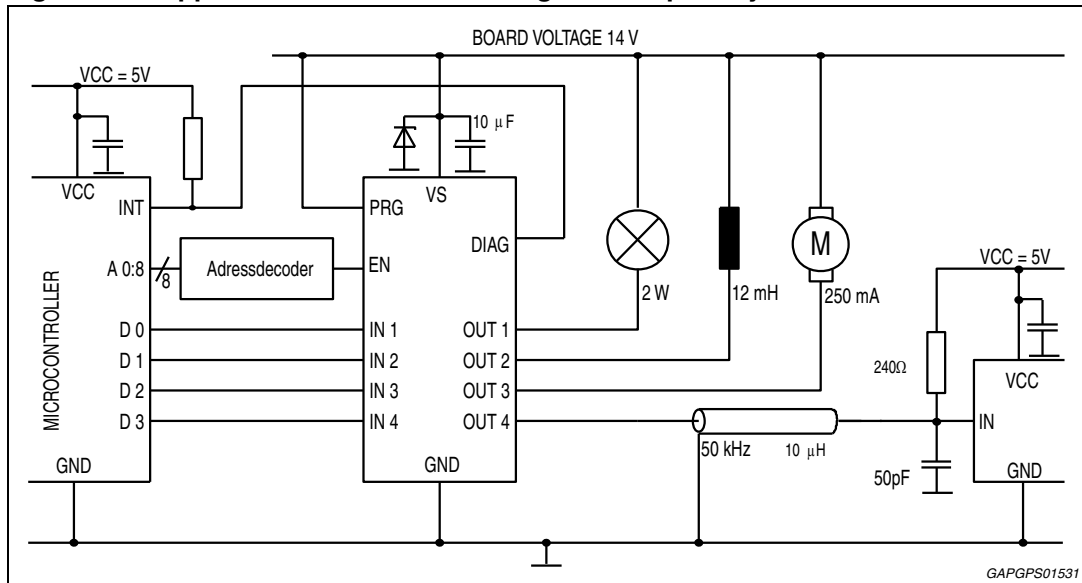
At thermal shut-down of one channel, disconnected ground or supply voltage the diagnostic output becomes high. If the PRG pin is 'high' this output is switched off at normal function and switched on at over temperature.

**Table 7. Diagnostic**

| Pins                                                    | EN | PRG | IN | OUT                    | DIAG    |
|---------------------------------------------------------|----|-----|----|------------------------|---------|
| Normal function                                         | H  | L   | L  | L (on)                 | L (on)  |
|                                                         | H  | L   | H  | H (off)                | L (on)  |
|                                                         | H  | H   | L  | H (off)                | H(off)  |
|                                                         | H  | H   | H  | L (on)                 | H(off)  |
|                                                         | L  | X   | X  | H (off)                | H(off)  |
| Over temperature, disconnected ground or supply voltage | H  | L   | X  | H (off) <sup>(1)</sup> | H (off) |
| Over temperature                                        | H  | H   | X  | H (off) <sup>(1)</sup> | L (on)  |

1. Selective for each channel at over temperature.

X = not relevant.

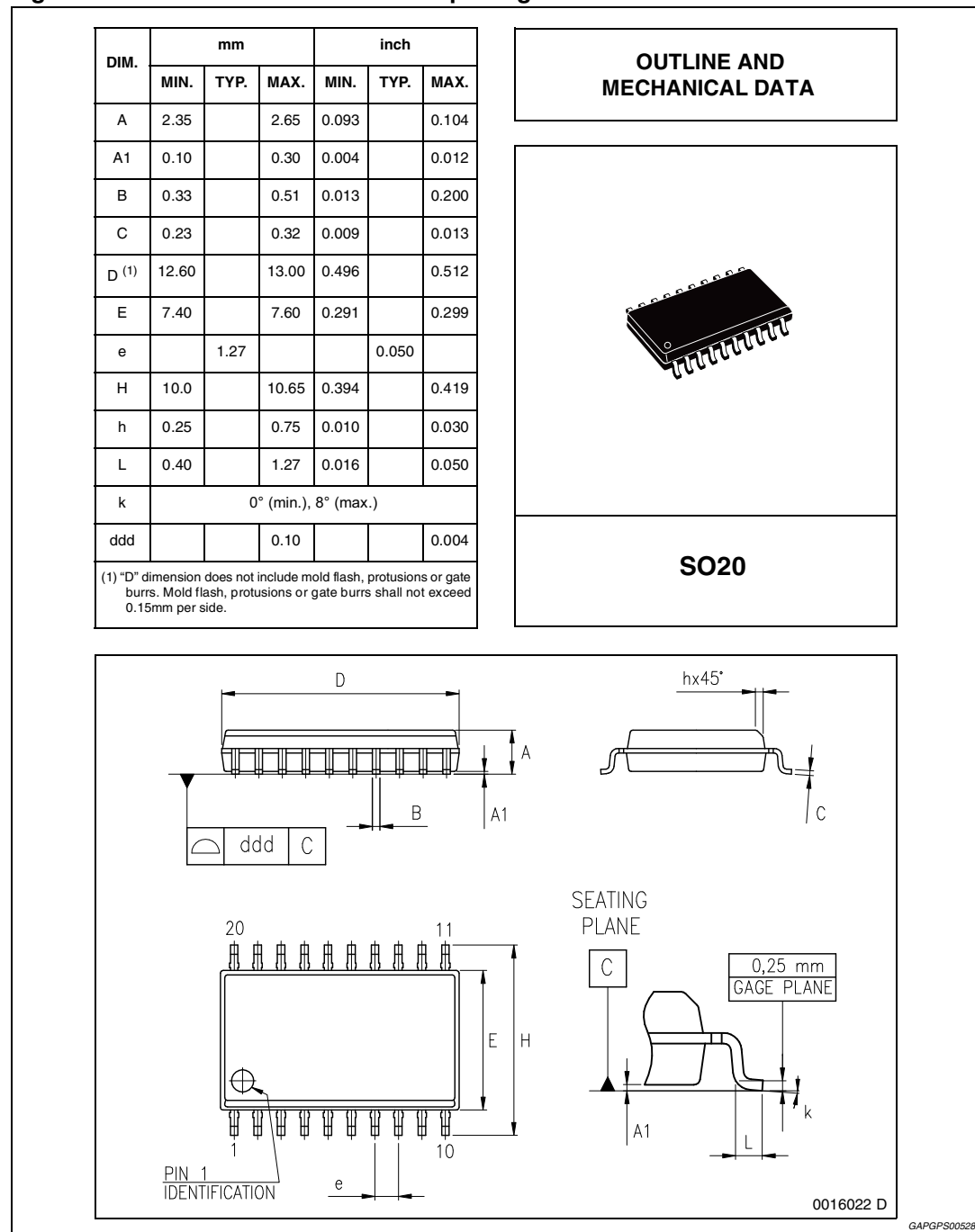
**Figure 4. Application circuit for inverting transfer polarity**

## 5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

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**Figure 5. SO20 mechanical data and package dimensions**



## 6 Revision history

**Table 8. Document revision history**

| Date         | Revision | Changes                                                                                                    |
|--------------|----------|------------------------------------------------------------------------------------------------------------|
| March 2000   | 3        |                                                                                                            |
| 10-Apr-2012  | 4        | Document reformatted.<br>Updated ordering numbers, see <a href="#">Table 1: Device summary on page 1</a> . |
| 16-Sept-2013 | 5        | Updated Disclaimer                                                                                         |

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