# DATA SHEET



## 74LVC240A

Octal buffer/line driver with 5-volt tolerant inputs/outputs; inverting (3-State)

Product specification
IC24 Data Handbook

1998 May 20

Philips
Semiconductors

PHILIPS

# Octal buffer/line driver with 5-volt tolerant inputs/outputs; inverting (3-State)

# 74LVC240A

## FEATURES

- 5-volt tolerant inputs/outputs, for interfacing with 5-volt logic
- Supply voltage range of 1.2V to 3.6V
- Complies with JEDEC standard no. 8-1A
- CMOS low power consumption
- Direct interface with TTL levels
- High impedance when $V_{CC}$ = 0V

## DESCRIPTION

The 74LVC240A is a high-performance, low-power, low-voltage, Si-gate CMOS device, superior to most advanced CMOS compatible TTL families.

Inputs can be driven from either 3.3V or 5V devices. In 3-State operation, outputs can handle 5V. These features allow the use of these devices as translators in a mixed 3.3V/5V environment.

The ‘240A is an octal non-inverting buffer/line driver with 3-State outputs. The 3-State outputs are controlled by the output enable inputs $1\overline{OE}$ and $2\overline{OE}$. A HIGH on $n\overline{OE}$ causes the outputs to assume a high impedance OFF-state. Schmitt-trigger action at all inputs makes the circuit highly tolerant for slower input rise and fall times.

The ’240’ is functionally identical to the ’244’, but the ’244’ has inverting outputs.

## QUICK REFERENCE DATA

GND = 0 V; $T_{amb}$ = 25°C; $t_r = t_f \leq 2.5$ ns

| SYMBOL | PARAMETER | CONDITIONS | TYPICAL | UNIT |
|---|---|---|---|---|
| $t_{PHL}/t_{PLH}$ | Propagation delay<br>$1A_n$ to $1Y_n$;<br>$2A_n$ to $2Y_n$ | $C_L$ = 50pF<br>$V_{CC}$ = 3.3V | 3.5 | ns |
| $C_I$ | Input capacitance | | 5.0 | pF |
| $C_{PD}$ | Power dissipation capacitance per buffer | Notes 1 and 2 | 20 | pF |

**NOTE:**

1. $C_{PD}$ is used to determine the dynamic power dissipation ($P_D$ in µW):
   $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o)$ where:
   $f_i$ = input frequency in MHz; $C_L$ = output load capacity in pF;
   $f_o$ = output frequency in MHz; $V_{CC}$ = supply voltage in V;
   $\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.
2. The condition is $V_I$ = GND to $V_{CC}$

## ORDERING INFORMATION

| PACKAGES | TEMPERATURE RANGE | OUTSIDE NORTH AMERICA | NORTH AMERICA | PKG. DWG. # |
|---|---|---|---|---|
| 20-Pin Plastic Small Outline (SO) | –40°C to +85°C | 74LVC240A D | 74LVC240A D | SOT163-1 |
| 20-Pin Plastic Shrink Small Outline (SSOP) Type II | –40°C to +85°C | 74LVC240A DB | 74LVC240A DB | SOT339-1 |
| 20-Pin Plastic Thin Shrink Small Outline (TSSOP) Type I | –40°C to +85°C | 74LVC240A PW | 7LVC240APW DH | SOT360-1 |

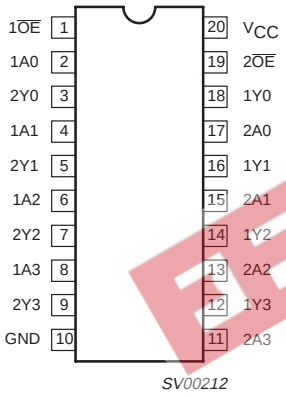
# Octal buffer/line driver with 5-volt tolerant inputs/outputs; inverting (3-State)

# 74LVC240A

## PIN DESCRIPTION

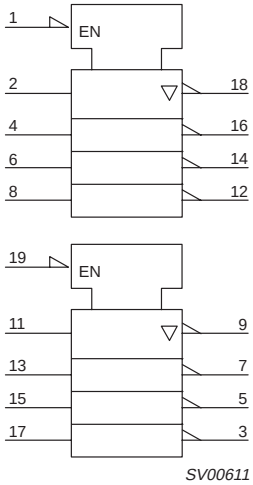
| PIN NUMBER | SYMBOL | FUNCTION |
|---|---|---|
| 1 | $1\overline{OE}$ | Output enable input (active LOW) |
| 2, 4, 6, 8 | $1A_0$ to $1A_3$ | Data inputs |
| 3, 5, 7, 9 | $2Y_0$ to $2Y_3$ | Bus outputs |
| 10 | GND | Ground (0V) |
| 17, 15, 13, 11 | $2A_0$ to $2A_3$ | Bus inputs |
| 18, 16, 14, 12 | $1Y_0$ to $1Y_3$ | Bus outputs |
| 19 | $\overline{2OE}$ | Output enable input (active-LOW) |
| 20 | $V_{CC}$ | Positive power supply |

## PIN CONFIGURATION



SV00212

## LOGIC SYMBOL (IEEE/IEC)



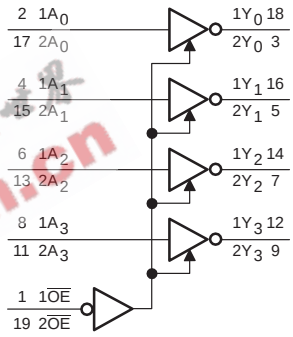
SV00611

## FUNCTION TABLE

| INPUTS | | OUTPUT |
|---|---|---|
| $n\overline{OE}$ | $nA_n$ | $nY_n$ |
| L | L | H |
| L | H | L |
| H | X | Z |

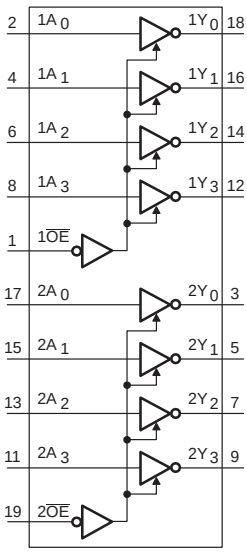
H = HIGH voltage level
L = LOW voltage level
X = Don't care
Z = High impedance OFF-state

## LOGIC SYMBOL



SV00608

## FUNCTIONAL DIAGRAM



SV00610

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | LIMITS | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| $V_{CC}$ | DC supply voltage (for max. speed performance) | | 2.7 | 3.6 | V |
| $V_{CC}$ | DC supply voltage (for low-voltage applications) | | 1.2 | 3.6 | V |
| $V_I$ | DC Input voltage range | | 0 | 5.5 | V |
| $V_O$ | DC Output voltage range; output HIGH or LOW state | | 0 | $V_{CC}$ | V |
| | DC output voltage range; output 3-State | | 0 | 5.5 | |
| $T_{amb}$ | Operating ambient temperature range in free-air | | –40 | +85 | °C |
| $t_r$, $t_f$ | Input rise and fall times | $V_{CC}$ = 1.2 to 2.7V<br>$V_{CC}$ = 2.7 to 3.6V | 0<br>0 | 20<br>10 | ns/V |

## ABSOLUTE MAXIMUM RATINGS[1]

In accordance with the Absolute Maximum Rating System (IEC 134)
Voltages are referenced to GND (ground = 0V)

| SYMBOL | PARAMETER | CONDITIONS | RATING | UNIT |
|---|---|---|---|---|
| $V_{CC}$ | DC supply voltage | | –0.5 to +6.5 | V |
| $I_{IK}$ | DC input diode current | $V_I < 0$ | –50 | mA |
| $V_I$ | DC input voltage | Note 2 | –0.5 to +6.5 | V |
| $I_{OK}$ | DC output diode current | $V_O > V_{CC}$ or $V_O < 0$ | ±50 | mA |
| $V_O$ | DC output voltage; output HIGH or LOW state | Note 2 | –0.5 to $V_{CC}$ +0.5 | V |
| | DC output voltage; output 3-State | Note 2 | –0.5 to 6.5 | |
| $I_O$ | DC output source or sink current | $V_O$ = 0 to $V_{CC}$ | ±50 | mA |
| $I_{GND}$, $I_{CC}$ | DC $V_{CC}$ or GND current | | ±100 | mA |
| $T_{stg}$ | Storage temperature range | | –65 to +150 | °C |
| $P_{TOT}$ | Power dissipation per package<br>– plastic mini-pack (SO)<br>– plastic shrink mini-pack (SSOP and TSSOP) | <br>above +70°C derate linearly with 8 mW/K<br>above +60°C derate linearly with 5.5 mW/K | <br>500<br>500 | mW |

**NOTES:**

1. Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

## DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions voltages are referenced to GND (ground = 0V)

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|---|---|---|---|---|---|---|
| | | | Temp = -40°C to +85°C | | | |
| | | | MIN | TYP[1] | MAX | |
| $V_{IH}$ | HIGH level Input voltage | $V_{CC}$ = 1.2V | $V_{CC}$ | | | V |
| | | $V_{CC}$ = 2.7 to 3.6V | 2.0 | | | |
| $V_{IL}$ | LOW level Input voltage | $V_{CC}$ = 1.2V | | | GND | V |
| | | $V_{CC}$ = 2.7 to 3.6V | | | 0.8 | |
| $V_{OH}$ | HIGH level output voltage | $V_{CC}$ = 2.7V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = –12mA | $V_{CC}$ – 0.5 | | | V |
| | | $V_{CC}$ = 3.0V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = –100µA | $V_{CC}$ – 0.2 | $V_{CC}$ | | |
| | | $V_{CC}$ = 3.0V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = –18mA | $V_{CC}$ – 0.6 | | | |
| | | $V_{CC}$ = 3.0V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = –24mA | $V_{CC}$ – 0.8 | | | |
| $V_{OL}$ | LOW level output voltage | $V_{CC}$ = 2.7V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 12mA | | | 0.40 | V |
| | | $V_{CC}$ = 3.0V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 100µA | | GND | 0.20 | |
| | | $V_{CC}$ = 3.0V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 24mA | | | 0.55 | |
| $I_I$ | Input leakage current[2] | $V_{CC}$ = 3.6V; $V_I$ = 5.5V or GND | | ±0.1 | ±5 | µA |
| $I_{OZ}$ | 3-State output OFF-state current | $V_{CC}$ = 3.6V; $V_I$ = $V_{IH}$ or $V_{IL}$; $V_O$ = 5.5V or GND | | 0.1 | ±10 | µA |
| $I_{off}$ | Power off leakage current | $V_{CC}$ = 0.0V; $V_I$ or $V_O$ = 5.5V | | 0.1 | ±10 | µA |
| $I_{CC}$ | Quiescent supply current | $V_{CC}$ = 3.6V; $V_I$ = $V_{CC}$ or GND; $I_O$ = 0 | | 0.1 | 10 | µA |
| $\Delta I_{CC}$ | Additional quiescent supply current per input pin | $V_{CC}$ = 2.7V to 3.6V; $V_I$ = $V_{CC}$ –0.6V; $I_O$ = 0 | | 5 | 500 | µA |

**NOTES:**
1. All typical values are at $V_{CC}$ = 3.3V and $T_{amb}$ = 25°C.
2. The specified overdrive current at the data input forces the data input to the opposite logic input state.

## AC CHARACTERISTICS

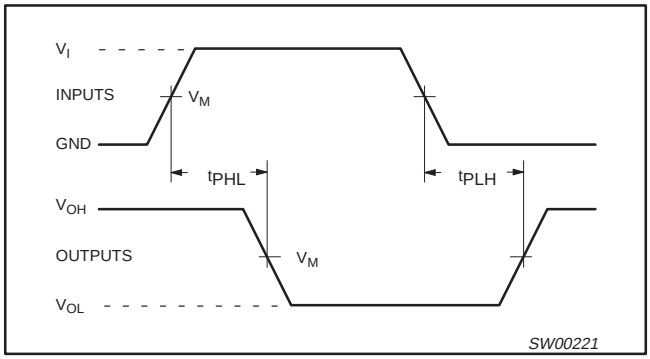
GND = 0V; $t_r = t_f \leq$ 2.5ns; $C_L$ = 50pF; $R_L$ = 500Ω; $T_{amb}$ = –40°C to +85°C.

| SYMBOL | PARAMETER | WAVEFORM | LIMITS | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ = 3.3V ±0.3V | | | $V_{CC}$ = 2.7V | | $V_{CC}$ = 1.2V | |
| | | | MIN | TYP[1] | MAX | MIN | MAX | TYP | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation delay<br>$1A_n$ to $1Y_n$;<br>$2A_n$ to $2Y_n$ | 1, 3 | 1.5 | 3.5 | 6.5 | 1.5 | 7.5 | 16.0 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | 3-State output enable time<br>$\overline{1OE}$ to $1Y_n$;<br>$\overline{2OE}$ to $2Y_n$ | 2, 3 | 1.5 | 4.3 | 8.0 | 1.5 | 9.0 | 19.0 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | 3-State output disable time<br>$\overline{1OE}$ to $1Y_n$;<br>$\overline{2OE}$ to $2Y_n$ | 2, 3 | 1.5 | 3.7 | 7.0 | 1.5 | 8.0 | 17.0 | ns |

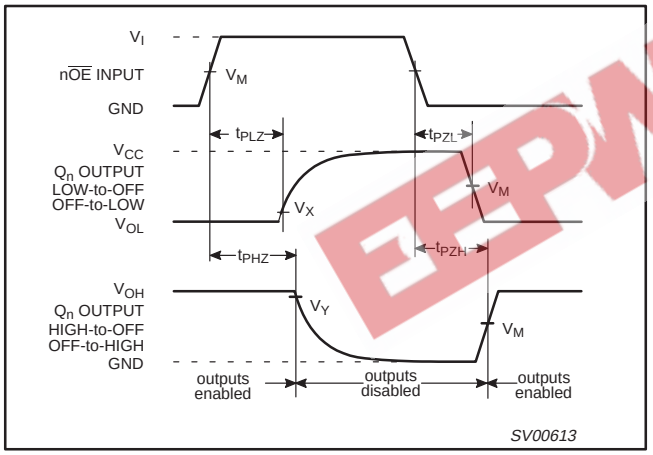
**NOTE:**
1. Unless otherwise stated, all typical values are at $V_{CC}$ = 3.3V and $T_{amb}$ = 25°C.

## AC WAVEFORMS

$V_M$ = 1.5V at $V_{CC} \geq$ 2.7V; $V_M$ = 0.5 $V_{CC}$ at $V_{CC}$ < 2.7V.
$V_{OL}$ and $V_{OH}$ are the typical output voltage drop that occur with the output load.
$V_X = V_{OL}$ + 0.3V at $V_{CC} \geq$ 2.7V; $V_X = V_{OL}$ + 0.1 $V_{CC}$ at $V_{CC}$ < 2.7V
$V_Y = V_{OH}$ –0.3V at $V_{CC} \geq$ 2.7V; $V_Y = V_{OH}$ – 0.1 $V_{CC}$ at $V_{CC}$ < 2.7V

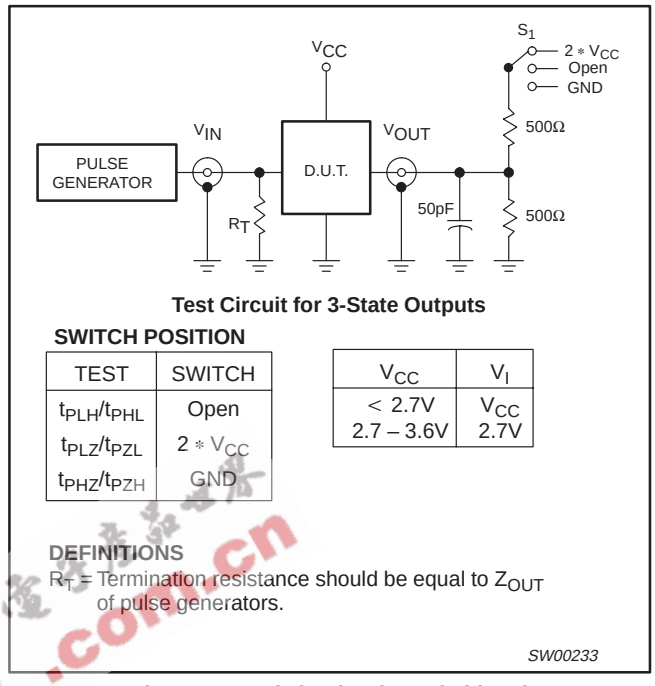



**Waveform 1. Inputs ($1A_n$, $2A_n$) to outputs ($1Y_n$, $2Y_n$) propagation delays.**




**Waveform 2. 3-State enable and disable times.**

## TEST CIRCUIT




**Test Circuit for 3-State Outputs**

**SWITCH POSITION**

| TEST | SWITCH |
|---|---|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | 2 * $V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND |

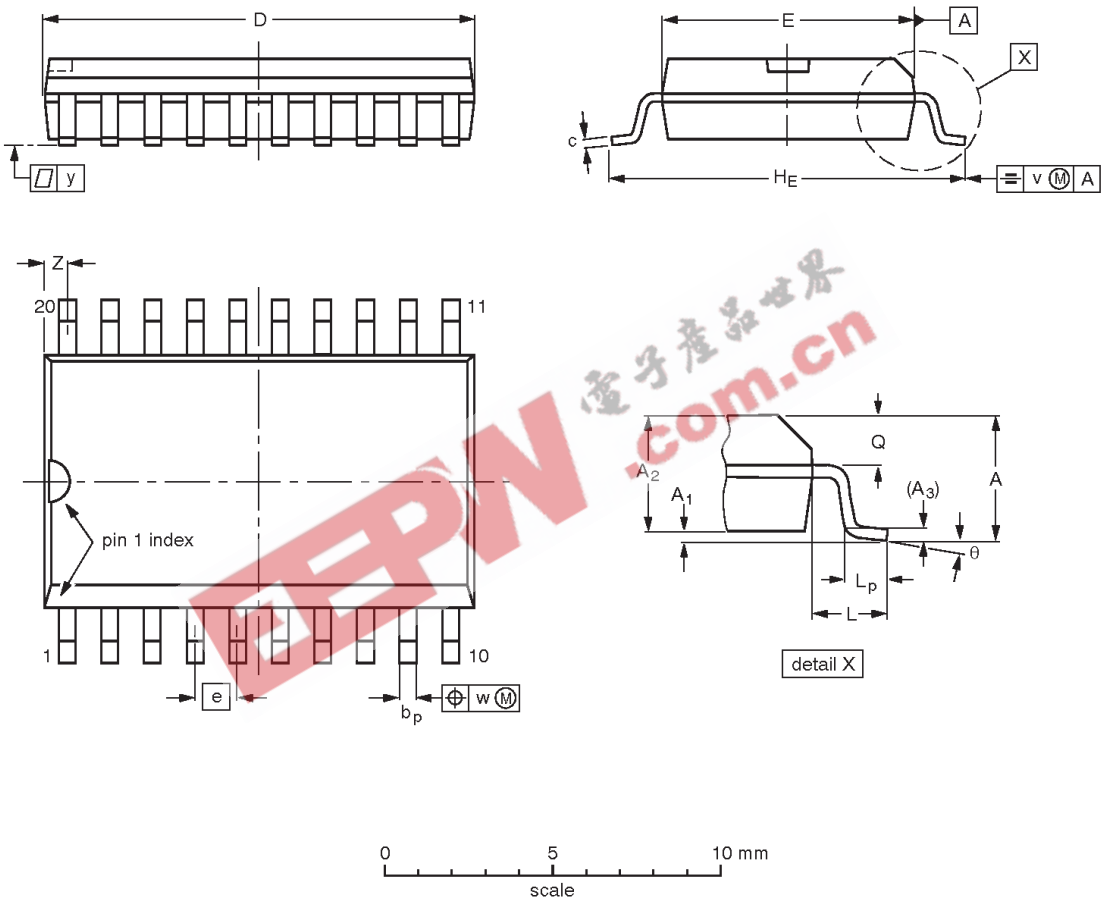
| $V_{CC}$ | $V_I$ |
|---|---|
| < 2.7V | $V_{CC}$ |
| 2.7 – 3.6V | 2.7V |

**DEFINITIONS**

$R_T$ = Termination resistance should be equal to $Z_{OUT}$ of pulse generators.

**Waveform 3. Load circuitry for switching times.**

**SO20: plastic small outline package; 20 leads; body width 7.5 mm** **SOT163-1**




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

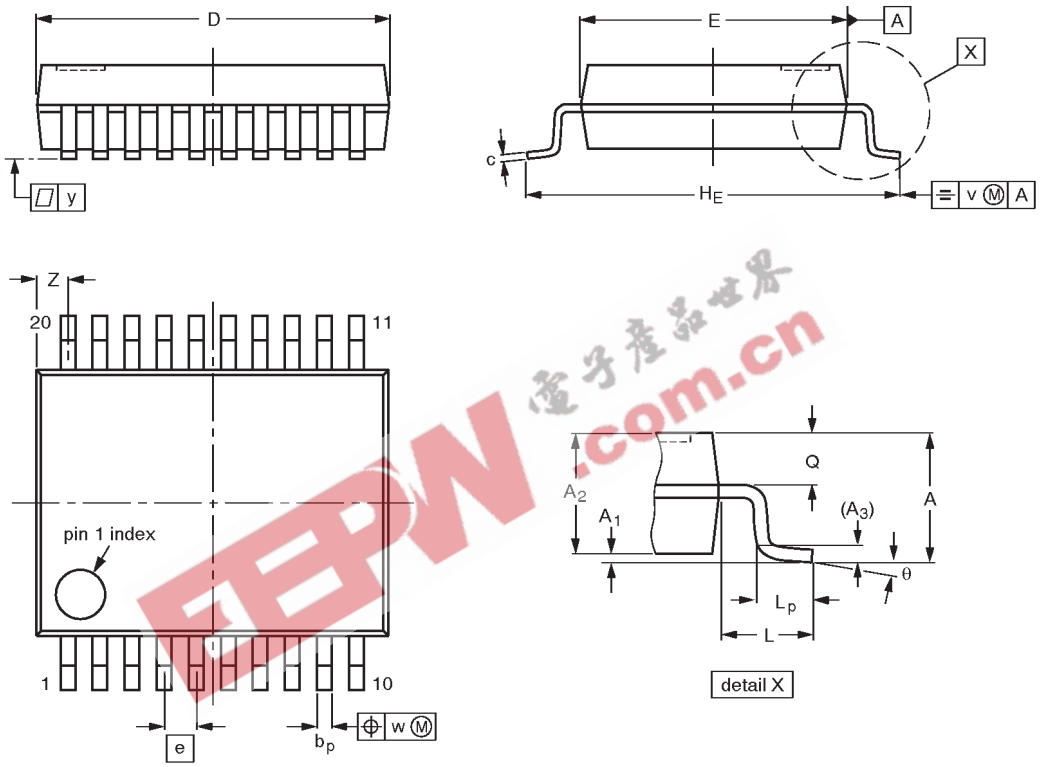
| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.65 | 0.30<br>0.10 | 2.45<br>2.25 | 0.25 | 0.49<br>0.36 | 0.32<br>0.23 | 13.0<br>12.6 | 7.6<br>7.4 | 1.27 | 10.65<br>10.00 | 1.4 | 1.1<br>0.4 | 1.1<br>1.0 | 0.25 | 0.25 | 0.1 | 0.9<br>0.4 | $8^o$<br>$0^o$ |
| inches | 0.10 | 0.012<br>0.004 | 0.096<br>0.089 | 0.01 | 0.019<br>0.014 | 0.013<br>0.009 | 0.51<br>0.49 | 0.30<br>0.29 | 0.050 | 0.42<br>0.39 | 0.055 | 0.043<br>0.016 | 0.043<br>0.039 | 0.01 | 0.01 | 0.004 | 0.035<br>0.016 | |

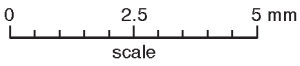
**Note**

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-013AC | | | | ~~92-11-17~~<br>95-01-24 |

**SSOP20: plastic shrink small outline package; 20 leads; body width 5.3 mm** **SOT339-1**




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

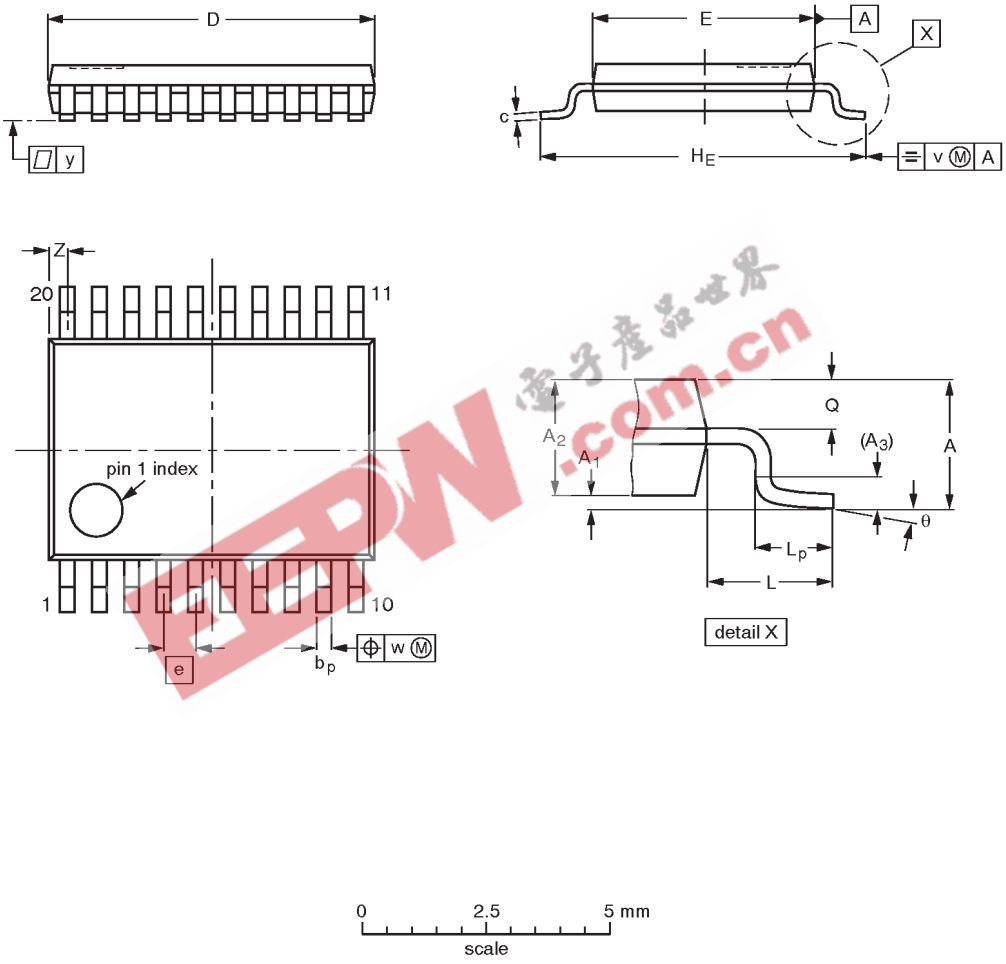
| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.0 | 0.21<br>0.05 | 1.80<br>1.65 | 0.25 | 0.38<br>0.25 | 0.20<br>0.09 | 7.4<br>7.0 | 5.4<br>5.2 | 0.65 | 7.9<br>7.6 | 1.25 | 1.03<br>0.63 | 0.9<br>0.7 | 0.2 | 0.13 | 0.1 | 0.9<br>0.5 | 8°<br>0° |

**Note**

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT339-1 | | MO-150AE | | | | ~~93-09-08~~<br>95-02-04 |

**TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm** **SOT360-1**




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

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | D (1) | E (2) | e | $H_E$ | L | $L_p$ | Q | v | w | y | Z (1) | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.10 | 0.15<br>0.05 | 0.95<br>0.80 | 0.25 | 0.30<br>0.19 | 0.2<br>0.1 | 6.6<br>6.4 | 4.5<br>4.3 | 0.65 | 6.6<br>6.2 | 1.0 | 0.75<br>0.50 | 0.4<br>0.3 | 0.2 | 0.13 | 0.1 | 0.5<br>0.2 | 8°<br>0° |

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT360-1 | | MO-153AC | | | | ~~93-06-16~~<br>95-02-04 |

**NOTES**

## Data sheet status

| Data sheet 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 chages 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 datasheet before initiating or completing a design.

## 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 134). 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.

**Application information —** Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

## Disclaimers

**Life support —** These products are not designed for use in life support appliances, devices or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips Semiconductors customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

**Right to make changes —** Philips Semiconductors reserves the right to make changes, without notice, in the products, including circuits, standard cells, and/or software, described or contained herein in order to improve design and/or performance. Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

**Philips Semiconductors**
**811 East Arques Avenue**
**P.O. Box 3409**
**Sunnyvale, California 94088–3409**
**Telephone 800-234-7381**



print code Date of release: 05-96

Document order number: 9397-750-04499

Let's make things better.

**Philips Semiconductors**

PHILIPS