

DATA SHEET

74LVC06A

Hex inverter with open-drain
outputs

Product specification
File under Integrated Circuits, IC24

2000 Mar 07

Hex inverter with open-drain outputs

74LVC06A

FEATURES

- 5 V tolerant inputs and outputs (open drain) for interfacing with 5 V logic
- Wide supply voltage range from 1.65 to 5.5 V
- CMOS low power consumption
- Direct interface with TTL levels
- Inputs accept voltages up to 5 V
- Complies with JEDEC standard no. 8-1A.

DESCRIPTION

The 74LVC06A 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 3.3 or 5 V devices. This feature allows the use of these devices as translators in a mixed 3.3 to 5 V environment.

The 74LVC06A provides six inverting buffers.

The outputs of the 74LVC06A devices are open drain and can be connected to other open-drain outputs to implement active-LOW wired-OR or active-HIGH wired-AND functions.

QUICK REFERENCE DATA

GND = 0 V; $T_{amb} = 25\text{ }^{\circ}\text{C}$; $t_r = t_f \leq 2.5\text{ ns}$.

| SYMBOL | PARAMETER | CONDITIONS | TYP. | UNIT |
|-------------------|--|--|------|------|
| t_{PLZ}/t_{PZL} | propagation delay nA to nY | $C_L = 50\text{ pF}$; $V_{CC} = 3.3\text{ V}$ | 2.3 | ns |
| C_I | input capacitance | | 5.0 | pF |
| C_{PD} | power dissipation capacitance per gate | $V_I = \text{GND to } V_{CC}$; note 1 | 8.0 | pF |

Note

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz;

f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in Volts;

$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.

FUNCTION TABLE

See note 1.

| INPUT | OUTPUT |
|-------|--------|
| nA | nY |
| L | Z |
| H | L |

Note

1. H = HIGH voltage level;
L = LOW voltage level;
Z = high impedance OFF-state.

Hex inverter with open-drain outputs

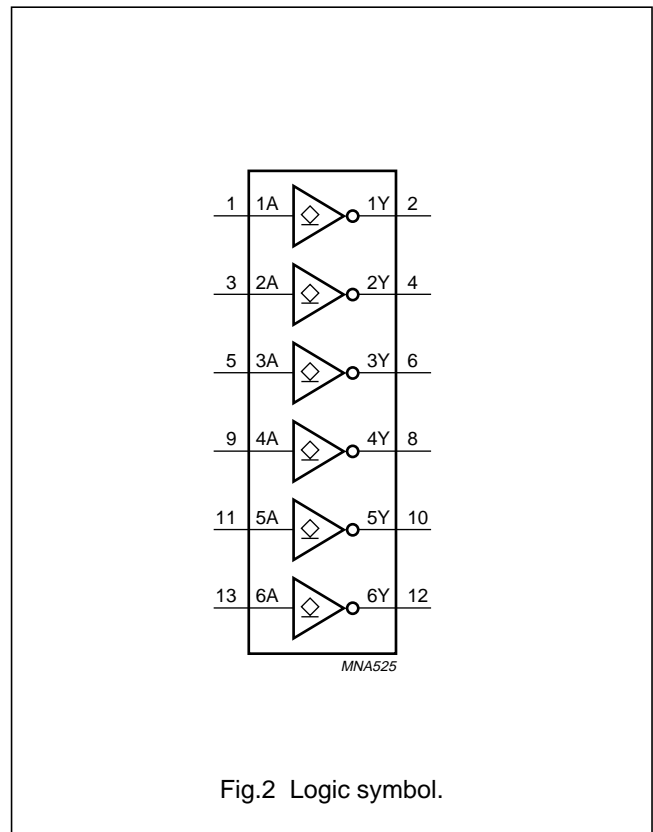
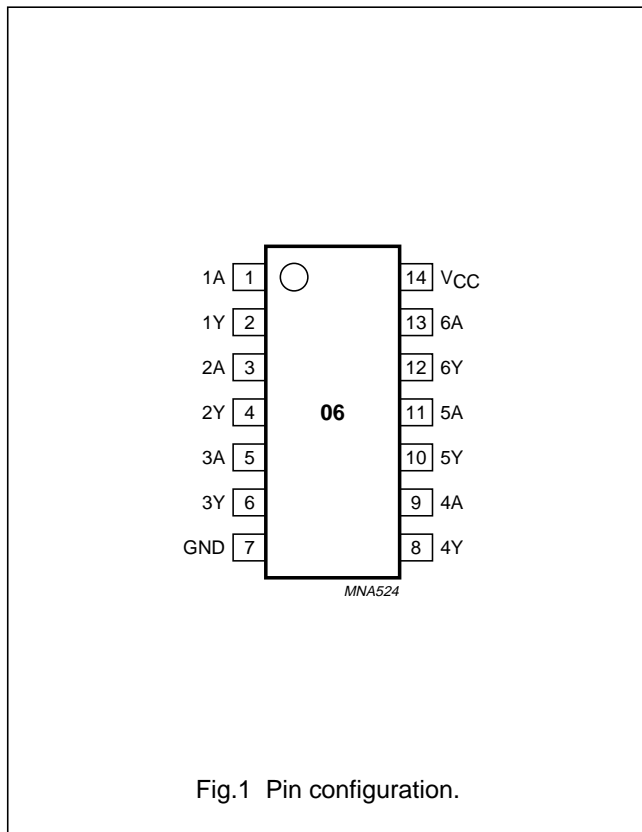
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ORDERING INFORMATION

| TYPE NUMBER | PACKAGES | | | | |
|-------------|-------------------|------|---------|----------|----------|
| | TEMPERATURE RANGE | PINS | PACKAGE | MATERIAL | CODE |
| 74LVC06AD | -40 to +85 °C | 14 | SO | plastic | SOT108-1 |
| 74LVC06APW | | 14 | TSSOP | plastic | SOT402-1 |

PINNING

| PIN | SYMBOL | DESCRIPTION |
|-----------------------|-----------------|-------------------|
| 1, 3, 5, 9, 11 and 13 | 1A to 6A | data inputs |
| 2, 4, 6, 8, 10 and 12 | 1Y to 6Y | data outputs |
| 7 | GND | ground (0 V) |
| 14 | V _{CC} | DC supply voltage |



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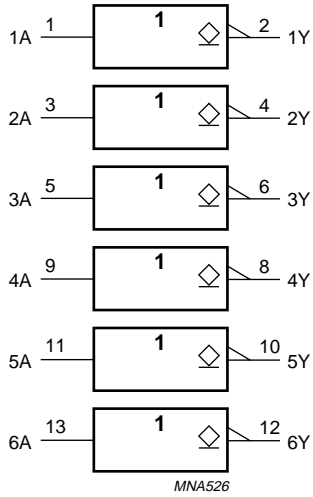


Fig.3 IEC logic symbol.

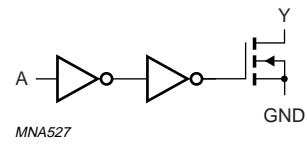


Fig.4 Logic diagram (one gate).

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RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | LIMITS | | UNIT |
|------------|-------------------------------|----------------------------|--------|----------|------|
| | | | MIN. | MAX. | |
| V_{CC} | DC supply voltage | | 1.65 | 5.5 | V |
| V_I | DC input voltage | | 0 | 5.5 | V |
| V_O | DC output voltage | active mode | 0 | V_{CC} | V |
| | | high-impedance mode | 0 | 5.5 | V |
| T_{amb} | operating ambient temperature | | -40 | +85 | °C |
| t_r, t_f | input rise and fall ratios | $V_{CC} = 1.65$ to 2.7 V | 0 | 20 | ns/V |
| | | $V_{CC} = 2.7$ to 5.5 V | 0 | 10 | ns/V |

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134); voltages are referenced to GND (ground = 0 V).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|-------------------|----------------------------------|---|------|----------------|------|
| V_{CC} | DC supply voltage | | -0.5 | +6.5 | V |
| I_{IK} | DC input diode current | $V_I < 0$ | - | -50 | mA |
| V_I | DC input voltage | note 1 | -0.5 | +6.5 | V |
| I_{OK} | DC output clamping diode current | $V_O < 0$ | - | -50 | mA |
| V_O | DC output voltage | active mode; note 1 | -0.5 | $V_{CC} + 0.5$ | V |
| | | high-impedance mode; note 1 | -0.5 | +6.5 | V |
| I_O | DC output sink current | $V_O = 0$ to V_{CC} | - | 50 | mA |
| I_{CC}, I_{GND} | DC V_{CC} or GND current | | - | ±100 | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_{tot} | power dissipation per package | | | | |
| | SO package | above 70 °C derate linearly with 8 mW/K | - | 500 | mW |
| | TSSOP package | above 60 °C derate linearly with 5.5 mW/K | - | 500 | mW |

Note

1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

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DC CHARACTERISTICS

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

| SYMBOL | PARAMETER | TEST CONDITIONS | | T _{amb} (°C) | | | UNIT |
|------------------|---|--|---------------------|-----------------------|---------------------|------------------------|------|
| | | OTHER | V _{CC} (V) | -40 to +85 | | | |
| | | | | MIN. | TYP. ⁽¹⁾ | MAX. | |
| V _{IH} | HIGH-level input voltage | | 1.65 to 1.95 | V _{CC} | – | – | V |
| | | | 2.3 to 2.7 | 1.7 | – | – | V |
| | | | 2.7 to 3.6 | 2.0 | – | – | V |
| | | | 4.5 to 5.5 | 0.7 × V _{CC} | – | – | V |
| V _{IL} | LOW-level input voltage | | 1.65 to 1.95 | – | – | GND | V |
| | | | 2.3 to 2.7 | – | – | 0.7 | V |
| | | | 2.7 to 3.6 | – | – | 0.8 | V |
| | | | 4.5 to 5.5 | – | – | 0.30 × V _{CC} | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 100 μA I _O = 4 mA I _O = 8 mA I _O = 12 mA I _O = 24 mA I _O = 32 mA | 1.65 to 5.5 | – | – | 0.20 | V |
| | | | 1.65 | – | – | 0.45 | V |
| | | | 2.3 | – | – | 0.3 | V |
| | | | 2.7 | – | – | 0.4 | V |
| | | | 3.0 | – | – | 0.55 | V |
| | | | 4.5 | – | – | 0.55 | V |
| I _I | input leakage current | V _I = 5.5 V or GND | 3.6 | – | ±0.1 | ±5 | μA |
| I _{OZ} | 3-state output OFF-state current | V _I = V _{IH} or V _{IL} ; V _O = 5.5 V or GND | 3.6 | – | 0.1 | ±10 | μA |
| I _{off} | power-off leakage current | V _I or V _O = 6.5 V | 0.0 | – | ±0.1 | ±10 | μA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 5.5 | – | 0.1 | 10 | μA |
| ΔI _{CC} | additional quiescent supply current per input pin | V _I = V _{CC} – 0.6 V; I _O = 0 | 2.3 to 5.5 | – | 5 | 500 | μA |

Note1. All typical values are at V_{CC} = 3.3 V and T_{amb} = 25 °C.

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AC CHARACTERISTICS

GND = 0 V; $V_{CC} \leq 2.7$ V and $t_r = t_f \leq 2$ ns; $V_{CC} \geq 2.7$ V and $t_r = t_f \leq 2.5$ ns.

| SYMBOL | PARAMETER | TEST CONDITIONS | | T _{amb} (°C) | | | UNIT |
|------------------------------------|----------------------------|------------------|---------------------|-----------------------|---------------------|------|------|
| | | WAVEFORMS | V _{CC} (V) | -40 to +85 | | | |
| | | | | MIN. | TYP. ⁽¹⁾ | MAX. | |
| t _{PLZ} /t _{PZL} | propagation delay nA to nY | see Figs 5 and 6 | 1.65 to 1.95 | – | 2.9 | – | ns |
| | | | 2.3 to 2.7 | 0.5 | 1.8 | 3.1 | ns |
| | | | 2.7 | 0.5 | 2.5 | 3.9 | ns |
| | | | 3.0 to 3.6 | 0.5 | 2.3 | 3.7 | ns |
| | | | 4.5 to 5.5 | 0.5 | 1.7 | 3.4 | ns |

Note

1. All typical values are measured at T_{amb} = 25 °C and at V_{CC} respectively 1.8, 2.5, 2.7, 3.3 and 5.0 V.

AC WAVEFORMS

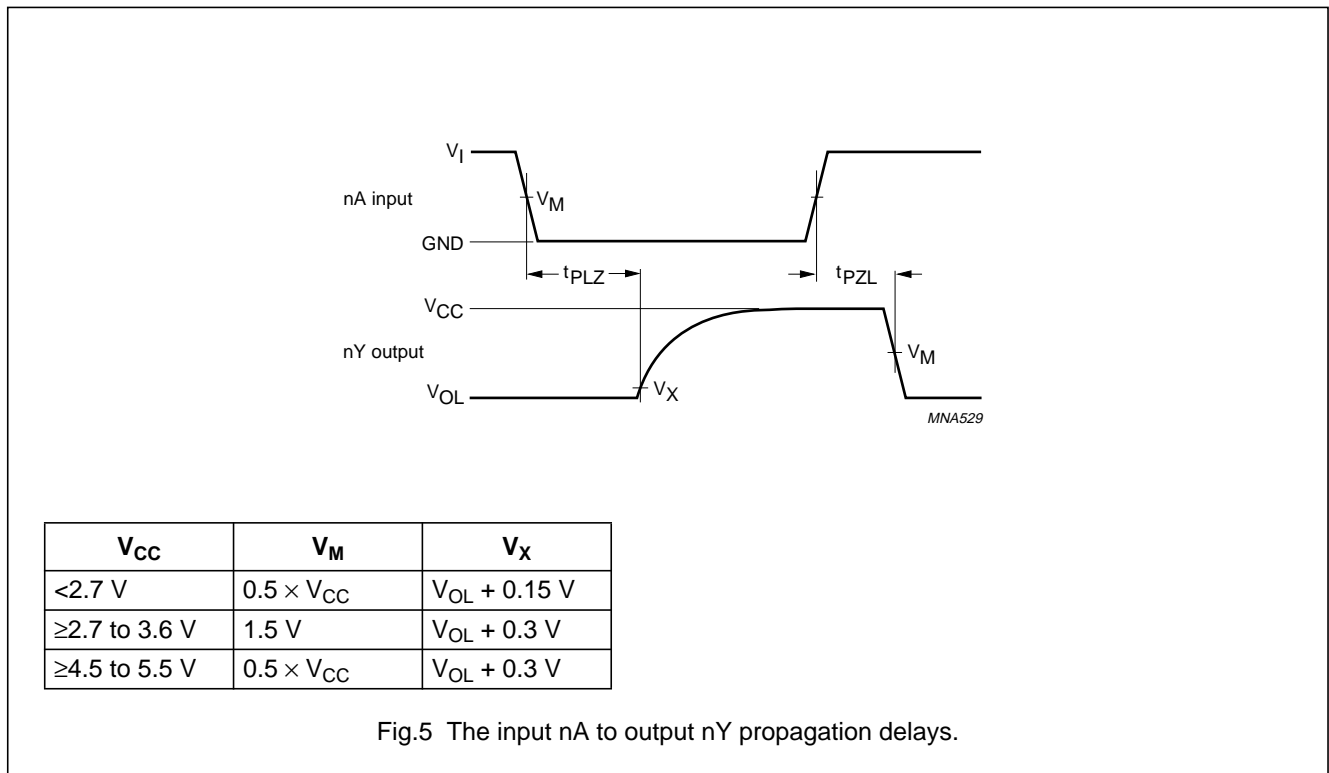
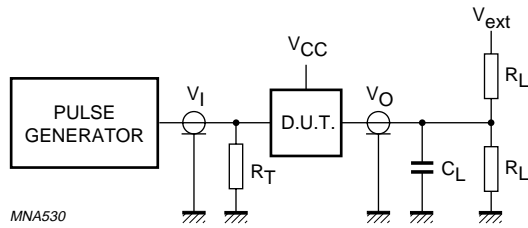


Fig.5 The input nA to output nY propagation delays.

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| V_{CC} | V_{ext} | V_I | C_L | R_L |
|----------------|-------------------|----------|-------|--------------|
| 1.65 to 1.95 V | $2 \times V_{CC}$ | V_{CC} | 30 pF | 1 k Ω |
| 2.3 to 2.7 V | $2 \times V_{CC}$ | V_{CC} | 30 pF | 500 Ω |
| 2.7 V | 6 V | 2.7 V | 50 pF | 500 Ω |
| 3.3 to 3.6 V | 6 V | 2.7 V | 50 pF | 500 Ω |
| 4.5 to 5.5 V | $2 \times V_{CC}$ | V_{CC} | 50 pF | 500 Ω |

Fig.6 Load circuitry for switching times.

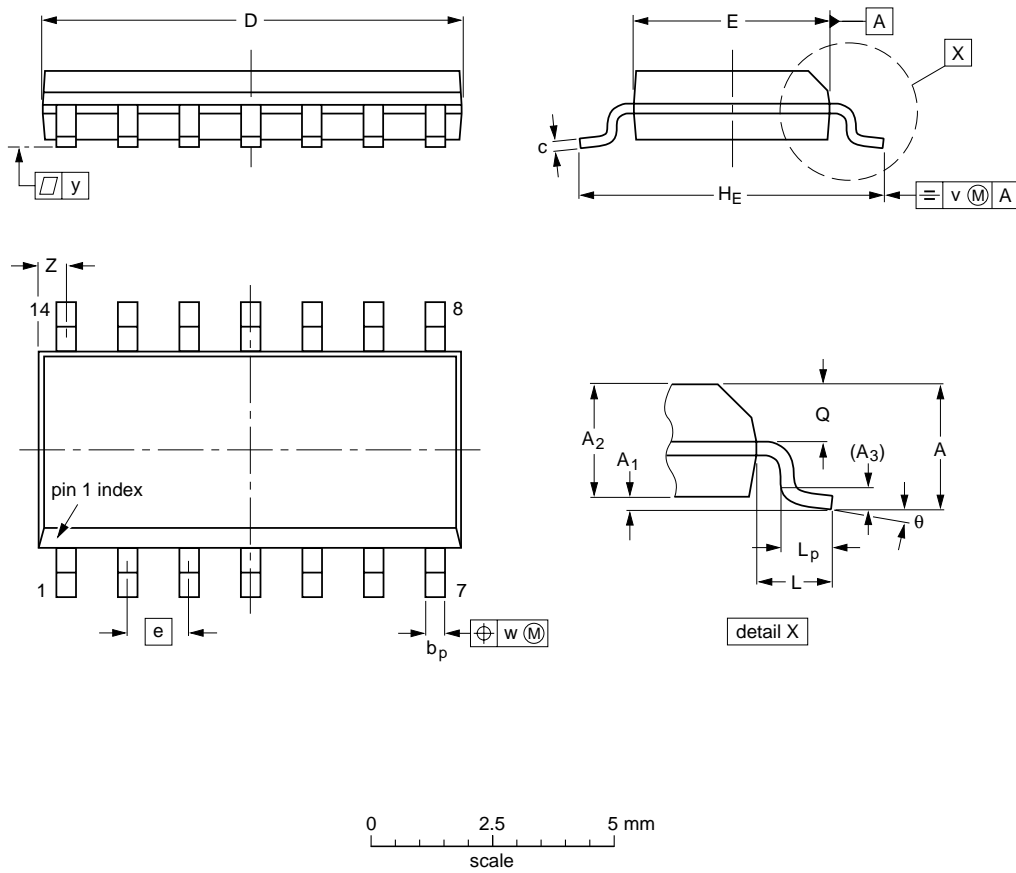
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PACKAGE OUTLINES

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



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 | 1.75 | 0.25 0.10 | 1.45 1.25 | 0.25 | 0.49 0.36 | 0.25 0.19 | 8.75 8.55 | 4.0 3.8 | 1.27 | 6.2 5.8 | 1.05 | 1.0 0.4 | 0.7 0.6 | 0.25 | 0.25 | 0.1 | 0.7 0.3 | 8° 0° |
| inches | 0.069 | 0.010 0.004 | 0.057 0.049 | 0.01 | 0.019 0.014 | 0.0100 0.0075 | 0.35 0.34 | 0.16 0.15 | 0.050 | 0.244 0.228 | 0.041 | 0.039 0.016 | 0.028 0.024 | 0.01 | 0.01 | 0.004 | 0.028 0.012 | |

Note

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

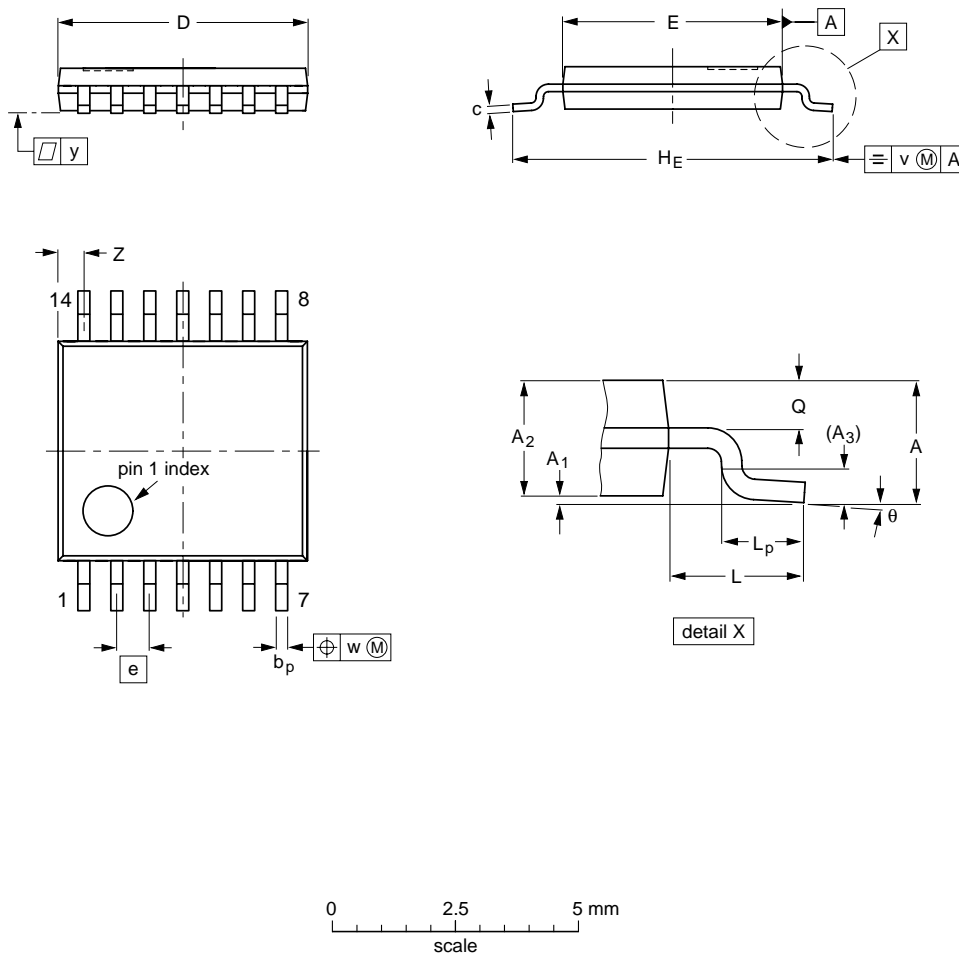
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|--------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT108-1 | 076E06 | MS-012 | | | | 97-05-22 99-12-27 |

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TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1



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 0.05 | 0.95 0.80 | 0.25 | 0.30 0.19 | 0.2 0.1 | 5.1 4.9 | 4.5 4.3 | 0.65 | 6.6 6.2 | 1.0 | 0.75 0.50 | 0.4 0.3 | 0.2 | 0.13 | 0.1 | 0.72 0.38 | 8° 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 | | | |
| SOT402-1 | | MO-153 | | | | 95-04-04 99-12-27 |

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SOLDERING**Introduction to soldering surface mount packages**

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

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Suitability of surface mount IC packages for wave and reflow soldering methods

| PACKAGE | SOLDERING METHOD | |
|--|-----------------------------------|-----------------------|
| | WAVE | REFLOW ⁽¹⁾ |
| BGA, LFBGA, SQFP, TFBGA | not suitable | suitable |
| HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS | not suitable ⁽²⁾ | suitable |
| PLCC ⁽³⁾ , SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended ⁽³⁾⁽⁴⁾ | suitable |
| SSOP, TSSOP, VSO | not recommended ⁽⁵⁾ | suitable |

Notes

- All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the "Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods".
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
- Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DEFINITIONS

| Data sheet status | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| 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. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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NOTES

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