

DATA SHEET

74AHC14; 74AHCT14 **Hex inverting Schmitt trigger**

Product specification
Supersedes data of 1999 Jan 11
File under Integrated Circuits, IC06

1999 Sep 27

Hex inverting Schmitt trigger

74AHC14; 74AHCT14

FEATURES

- ESD protection:
HBM EIA/JESD22-A114-A exceeds 2000 V
MM EIA/JESD22-A115-A exceeds 200 V
CDM EIA/JESD22-C101 exceeds 1000 V
- Balanced propagation delays
- Inputs accepts voltages higher than V_{CC}
- For AHC only:
operates with CMOS input levels
- For AHCT only:
operates with TTL input levels
- Specified from
-40 to +85 and +125 °C.

DESCRIPTION

The 74AHC/AHCT14 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard No. 7A.

The 74AHC/AHCT14 provide six inverting buffers with Schmitt-trigger action. They are capable of transforming slowly changing input signals into sharply defined, jitter-free output signals.

FUNCTION TABLE

See note 1.

| INPUTS | OUTPUTS |
|--------|---------|
| nA | nY |
| L | H |
| H | L |

Note

1. H = HIGH voltage level;
L = LOW voltage level.

QUICK REFERENCE DATA

GND = 0 V; $T_{amb} = 25\text{ °C}$; $t_r = t_f \leq 3.0\text{ ns}$.

| SYMBOL | PARAMETER | CONDITIONS | TYPICAL | | UNIT |
|-------------------|----------------------------------|---|---------|------|------|
| | | | AHC | AHCT | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | $C_L = 15\text{ pF}$; $V_{CC} = 5\text{ V}$ | 3.2 | 4.0 | ns |
| C_I | input capacitance | $V_I = V_{CC}$ or GND | 3.0 | 3.0 | pF |
| C_O | output capacitance | | 4.0 | 4.0 | pF |
| C_{PD} | power dissipation capacitance | $C_L = 50\text{ pF}$; $f = 1\text{ MHz}$; notes 1 and 2 | 10 | 12 | pF |

Notes

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

PINNING

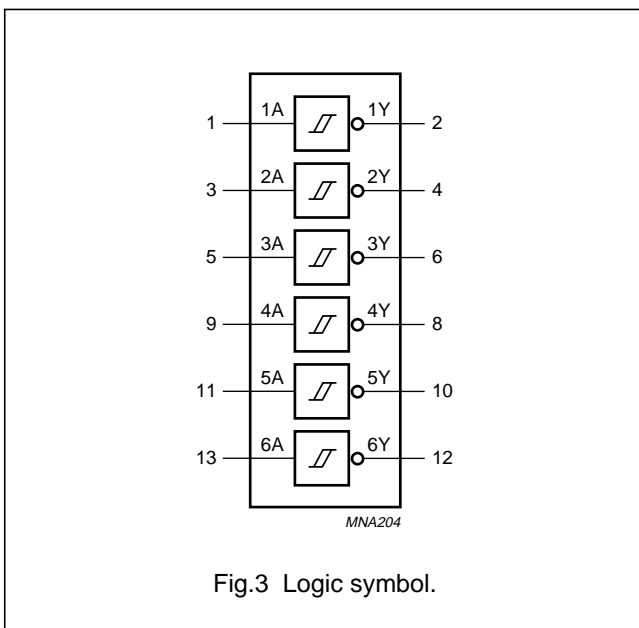
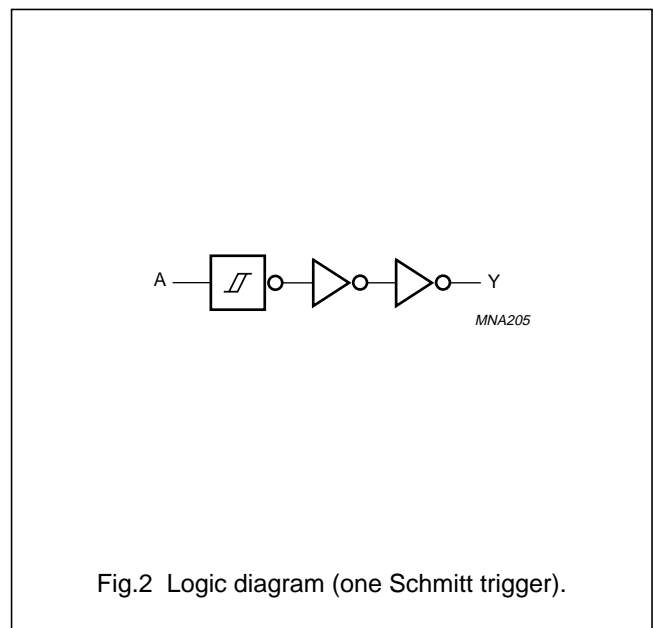
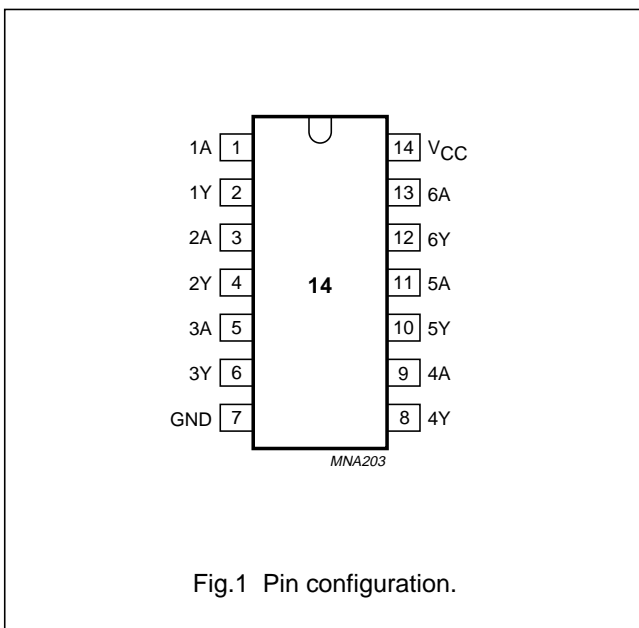
| PIN | SYMBOL | DESCRIPTION |
|-----------------------|----------|-------------------|
| 1, 3, 5, 9, 11 and 13 | 1A to 6A | data inputs |
| 2, 4, 6, 8, 10 and 12 | 1Y to 6Y | data outputs |
| 7 | GND | ground (0 V) |
| 14 | V_{CC} | DC supply voltage |

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ORDERING INFORMATION

| OUTSIDE NORTH AMERICA | NORTH AMERICA | PACKAGES | | | |
|-----------------------|---------------|----------|---------|----------|----------|
| | | PINS | PACKAGE | MATERIAL | CODE |
| 74AHC14D | 74AHC14D | 14 | SO | plastic | SOT108-1 |
| 74AHC14PW | 74AHC14PW DH | 14 | TSSOP | plastic | SOT402-1 |
| 74AHCT14D | 74AHCT14D | 14 | SO | plastic | SOT108-1 |
| 74AHCT14PW | 74AHCT14PW DH | 14 | TSSOP | plastic | SOT402-1 |



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RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | 74AHC | | | 74AHCT | | | UNIT |
|-----------|-------------------------------------|--|-------|------|----------|--------|------|----------|------|
| | | | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. | |
| V_{CC} | DC supply voltage | | 2.0 | 5.0 | 5.5 | 4.5 | 5.0 | 5.5 | V |
| V_I | input voltage | | 0 | – | 5.5 | 0 | – | 5.5 | V |
| V_O | output voltage | | 0 | – | V_{CC} | 0 | – | V_{CC} | V |
| T_{amb} | operating ambient temperature range | see DC and AC characteristics per device | –40 | +25 | +85 | –40 | +25 | +85 | °C |
| | | | –40 | +25 | +125 | –40 | +25 | +125 | °C |

LIMITING VALUES

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

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|-----------|----------------------------------|--|------|------|------|
| V_{CC} | DC supply voltage | | –0.5 | +7.0 | V |
| V_I | input voltage range | | –0.5 | +7.0 | V |
| I_{IK} | DC input diode current | $V_I < -0.5$ V; note 1 | – | –20 | mA |
| I_{OK} | DC output diode current | $V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V; note 1 | – | ±20 | mA |
| I_O | DC output source or sink current | -0.5 V < V_O < $V_{CC} + 0.5$ V | – | ±25 | mA |
| I_{CC} | DC V_{CC} or GND current | | – | ±75 | mA |
| T_{stg} | storage temperature range | | –65 | +150 | °C |
| P_D | power dissipation per package | for temperature range: –40 to +125 °C; note 2 | – | 500 | mW |

Notes

1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. For SO packages: above 70 °C the value of P_D derates linearly with 8 mW/K.
For TSSOP packages: above 60 °C the value of P_D derates linearly with 5.5 mW/K.

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DC CHARACTERISTICS

Type 74AHC14

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

| SYMBOL | PARAMETER | TEST CONDITIONS | | T_{amb} (°C) | | | | | | UNIT | |
|----------|--|---|--------------|----------------|------|------|------------|------|-------------|------|---------|
| | | OTHER | V_{CC} (V) | 25 | | | -40 to +85 | | -40 to +125 | | |
| | | | | MIN. | TYP. | MAX. | MIN. | MAX. | MIN. | | MAX. |
| V_{T+} | positive going threshold | | 3.0 | – | – | 2.2 | – | 2.2 | – | 2.2 | V |
| | | | 4.5 | – | – | 3.15 | – | 3.15 | – | 3.15 | |
| | | | 5.5 | – | – | 3.85 | – | 3.85 | – | 3.85 | |
| V_{T-} | negative going threshold | | 3.0 | 0.9 | – | – | 0.9 | – | 0.9 | – | V |
| | | | 4.5 | 1.35 | – | – | 1.35 | – | 1.35 | – | |
| | | | 5.5 | 1.65 | – | – | 1.65 | – | 1.65 | – | |
| V_H | hysteresis ($V_{T+} - V_{T-}$) | | 3.0 | 0.3 | – | 1.2 | 0.3 | 1.2 | 0.25 | 1.2 | V |
| | | | 4.5 | 0.4 | – | 1.4 | 0.4 | 1.4 | 0.35 | 1.4 | |
| | | | 5.5 | 0.5 | – | 1.6 | 0.5 | 1.6 | 0.45 | 1.6 | |
| V_{OH} | HIGH-level output voltage; all outputs | $V_I = V_{IH}$ or V_{IL} ; $I_O = -50 \mu A$ | 2.0 | 1.9 | 2.0 | – | 1.9 | – | 1.9 | – | V |
| | | | 3.0 | 2.9 | 3.0 | – | 2.9 | – | 2.9 | – | |
| | | | 4.5 | 4.4 | 4.5 | – | 4.4 | – | 4.4 | – | |
| | HIGH-level output voltage | $V_I = V_{IH}$ or V_{IL} ; $I_O = -4.0 mA$ | 3.0 | 2.58 | – | – | 2.48 | – | 2.40 | – | V |
| 4.5 | | | 3.94 | – | – | 3.8 | – | 3.70 | – | | |
| V_{OL} | LOW-level output voltage; all outputs | $V_I = V_{IH}$ or V_{IL} ; $I_O = 50 \mu A$ | 2.0 | – | 0 | 0.1 | – | 0.1 | – | 0.1 | V |
| | | | 3.0 | – | 0 | 0.1 | – | 0.1 | – | 0.1 | |
| | | | 4.5 | – | 0 | 0.1 | – | 0.1 | – | 0.1 | |
| | LOW-level output voltage | $V_I = V_{IH}$ or V_{IL} ; $I_O = 4 mA$ | 3.0 | – | – | 0.36 | – | 0.44 | – | 0.55 | V |
| | | | 4.5 | – | – | 0.36 | – | 0.44 | – | 0.55 | |
| I_I | input leakage current | $V_I = V_{CC}$ or GND | 5.5 | – | – | 0.1 | – | 1.0 | – | 2.0 | μA |
| I_{CC} | quiescent supply current | $V_I = V_{CC}$ or GND; $I_O = 0$ | 5.5 | – | – | 2.0 | – | 20 | – | 40 | μA |
| C_I | input capacitance | | | – | 3 | 10 | – | 10 | – | 10 | pF |

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Type 74AHCT14

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

| SYMBOL | PARAMETER | TEST CONDITIONS | | T _{amb} (°C) | | | | | | UNIT | |
|------------------|---|---|---------------------|-----------------------|------|------|------------|------|-------------|------|------|
| | | OTHER | V _{CC} (V) | 25 | | | -40 to +85 | | -40 to +125 | | |
| | | | | MIN. | TYP. | MAX. | MIN. | MAX. | MIN. | | MAX. |
| V _{T+} | positive going threshold | | 4.5 | – | – | 1.9 | – | 1.9 | – | 1.9 | V |
| | | | 5.5 | – | – | 2.1 | – | 2.1 | – | 2.1 | V |
| V _{T-} | negative going threshold | | 4.5 | 0.5 | – | – | 0.5 | – | 0.5 | – | V |
| | | | 5.5 | 0.6 | – | – | 0.6 | – | 0.6 | – | V |
| V _H | hysteresis (V _{T+} – V _{T-}) | | 4.5 | 0.4 | – | 1.4 | 0.4 | 1.4 | 0.35 | 1.4 | V |
| | | | 5.5 | 0.4 | – | 1.5 | 0.4 | 1.5 | 0.35 | 1.5 | V |
| V _{OH} | HIGH-level output voltage; all outputs | V _I = V _{IH} or V _{IL} ; I _O = –50 μA | 4.5 | 4.4 | 4.5 | – | 4.4 | – | 4.4 | – | V |
| | HIGH-level output voltage | V _I = V _{IH} or V _{IL} ; I _O = –8.0 mA | 4.5 | 3.94 | – | – | 3.8 | – | 3.7 | – | V |
| V _{OL} | LOW-level output voltage; all outputs | V _I = V _{IH} or V _{IL} ; I _O = 50 μA | 4.5 | – | 0 | 0.1 | – | 0.1 | – | 0.1 | V |
| | LOW-level output voltage | V _I = V _{IH} or V _{IL} ; I _O = 8 mA | 4.5 | – | – | 0.36 | – | 0.44 | – | 0.55 | V |
| I _I | input leakage current | V _I = V _{CC} or GND | 5.5 | – | – | 0.1 | – | 1.0 | – | 2.0 | μA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 5.5 | – | – | 2.0 | – | 20 | – | 40 | μA |
| ΔI _{CC} | additional quiescent supply current per input pin | V _I = V _{CC} – 2.1 V other inputs at V _{CC} or GND; I _O = 0 | 4.5 to 5.5 | – | – | 1.35 | – | 1.5 | – | 1.5 | mA |
| C _I | input capacitance | | | – | 3 | 10 | – | 10 | – | 10 | pF |

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AC CHARACTERISTICS

Type 74AHC14

GND = 0 V; $t_r = t_f \leq 3.0$ ns.

| SYMBOL | PARAMETER | TEST CONDITIONS | | T _{amb} (°C) | | | | | | UNIT | |
|--|-------------------------------|------------------|----------------|-----------------------|------|------|------------|------|-------------|------|------|
| | | WAVEFORMS | C _L | 25 | | | -40 to +85 | | -40 to +125 | | |
| | | | | MIN. | TYP. | MAX. | MIN. | MAX. | MIN. | | MAX. |
| V_{CC} = 3.0 to 3.6 V; note 1 | | | | | | | | | | | |
| t _{PHL} /t _{PLH} | propagation delay nA to nY | see Figs 4 and 5 | 15 pF | – | 4.3 | 12.8 | 1.0 | 15.0 | 1.0 | 16.0 | ns |
| | propagation delay nA to nY | | 50 pF | – | 5.8 | 16.3 | 1.0 | 18.0 | 1.0 | 20.5 | ns |
| V_{CC} = 4.5 to 5.5 V; note 2 | | | | | | | | | | | |
| t _{PHL} /t _{PLH} | propagation delay nA to nY | see Figs 4 and 5 | 15 pF | – | 3.2 | 8.6 | 1.0 | 10.0 | 1.0 | 11.0 | ns |
| | propagation delay nA to nY | | 50 pF | – | 4.2 | 10.6 | 1.0 | 12.0 | 1.0 | 13.5 | ns |

Notes

1. Typical values at V_{CC} = 3.3 V.
2. Typical values at V_{CC} = 5.0 V.

Type 74AHCT14

GND = 0 V; $t_r = t_f \leq 3.0$ ns.

| SYMBOL | PARAMETER | TEST CONDITIONS | | T _{amb} (°C) | | | | | | UNIT | |
|--|-------------------------------|------------------|----------------|-----------------------|------|------|------------|------|-------------|------|------|
| | | WAVEFORMS | C _L | 25 | | | -40 to +85 | | -40 to +125 | | |
| | | | | MIN. | TYP. | MAX. | MIN. | MAX. | MIN. | | MAX. |
| V_{CC} = 4.5 to 5.5 V; note 1 | | | | | | | | | | | |
| t _{PHL} /t _{PLH} | propagation delay nA to nY | see Figs 4 and 5 | 15 pF | – | 4.0 | 7.0 | 1.0 | 8.0 | 1.0 | 9.0 | ns |
| | propagation delay nA to nY | | 50 pF | – | 5.4 | 8.0 | 1.0 | 9.0 | 1.0 | 10.0 | ns |

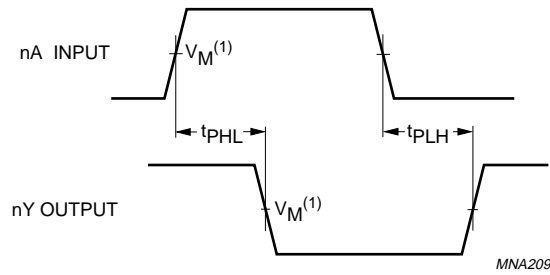
Note

1. Typical values at V_{CC} = 5.0 V.

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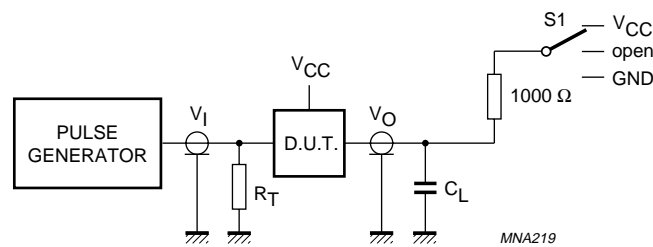
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AC WAVEFORMS



| FAMILY | V _I INPUT REQUIREMENTS | V _M ⁽¹⁾ INPUT | V _M ⁽¹⁾ OUTPUT |
|--------|-----------------------------------|-------------------------------------|--------------------------------------|
| AHC | GND to V _{CC} | 50% V _{CC} | 50% V _{CC} |
| AHCT | GND to 3.0 V | 1.5 V | 50% V _{CC} |

Fig.4 The input (nA) to output (nY) propagation delays.



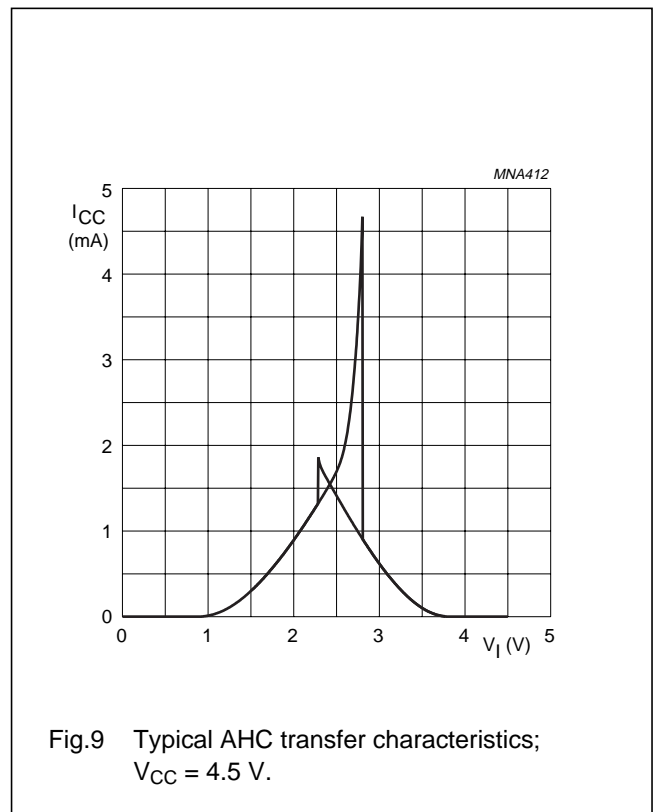
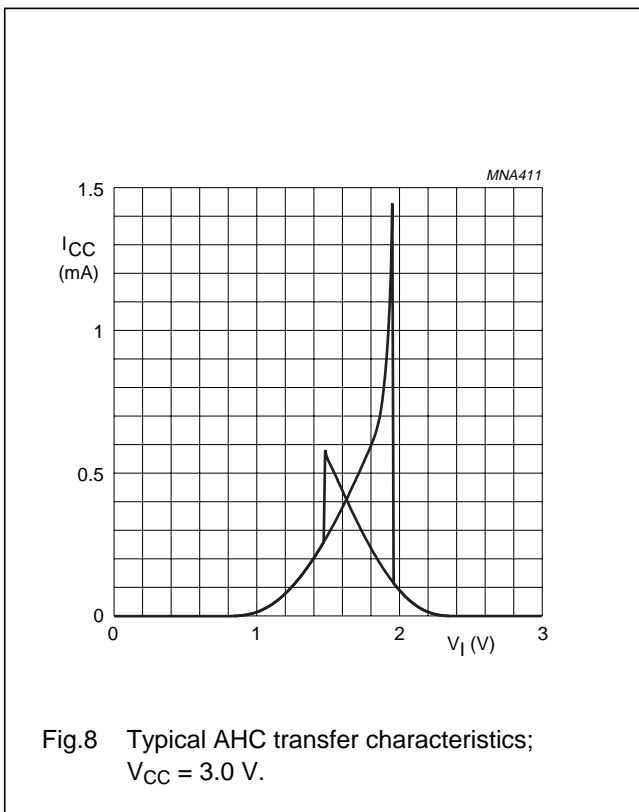
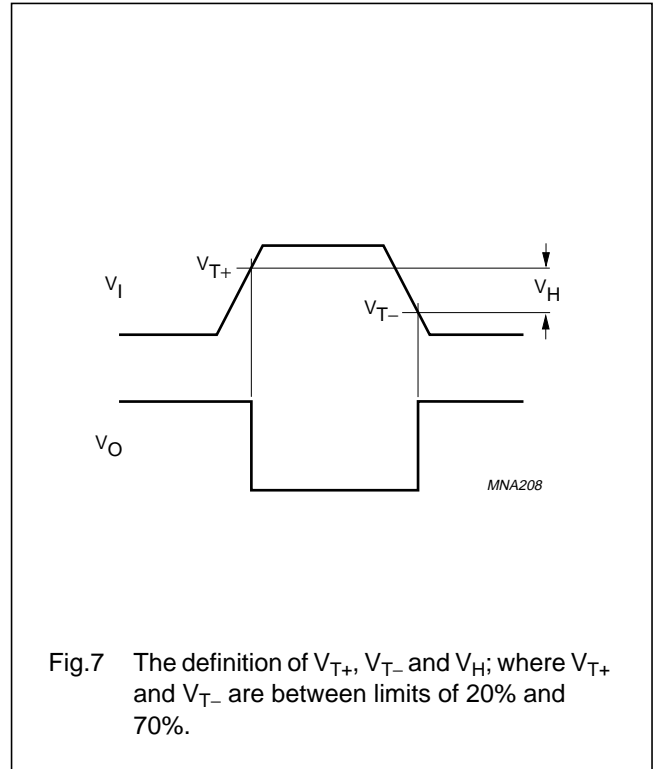
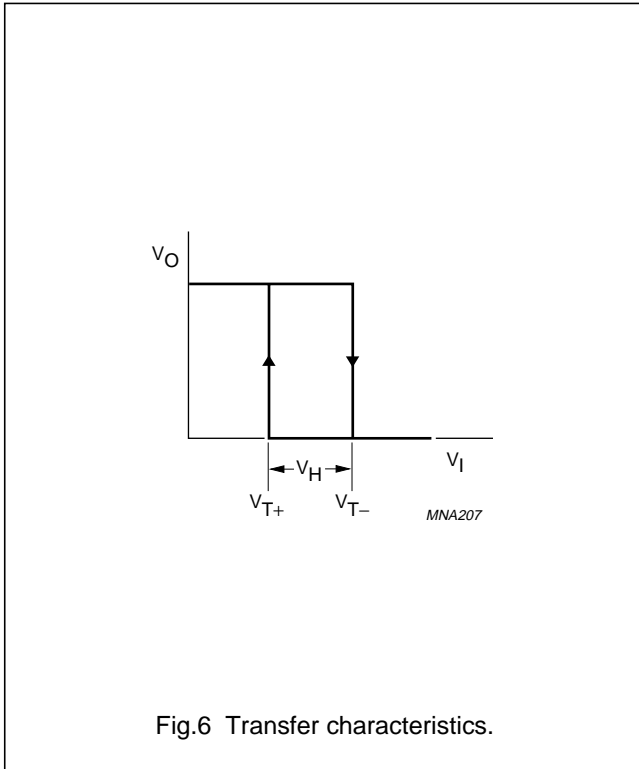
| TEST | S ₁ |
|------------------------------------|-----------------|
| t _{PLH} /t _{PHL} | open |
| t _{PLZ} /t _{PZL} | V _{CC} |
| t _{PHZ} /t _{PZH} | GND |

Fig.5 Load circuitry for switching times.

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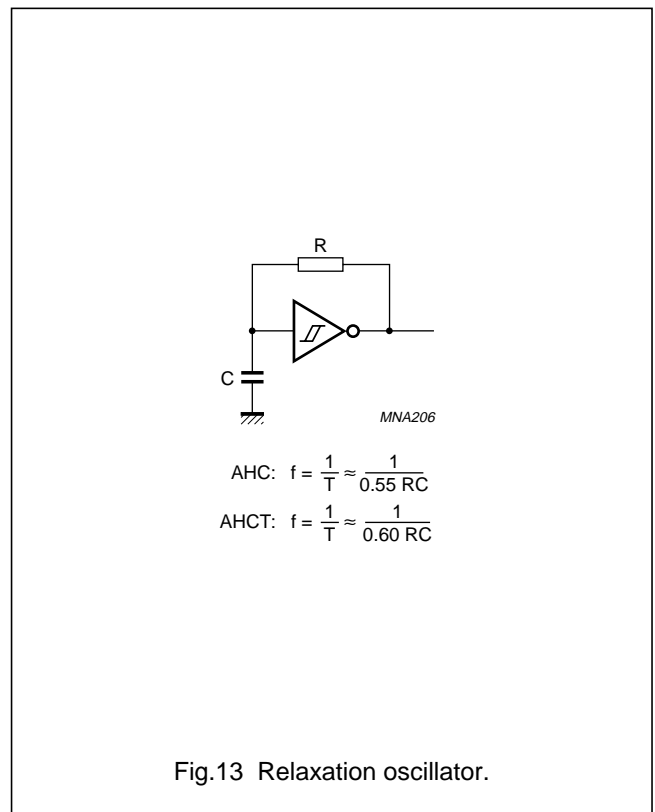
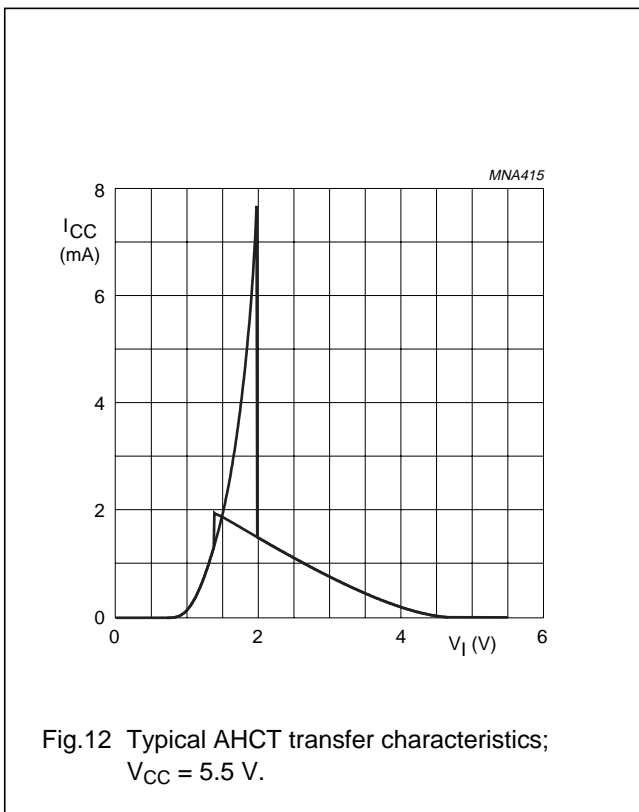
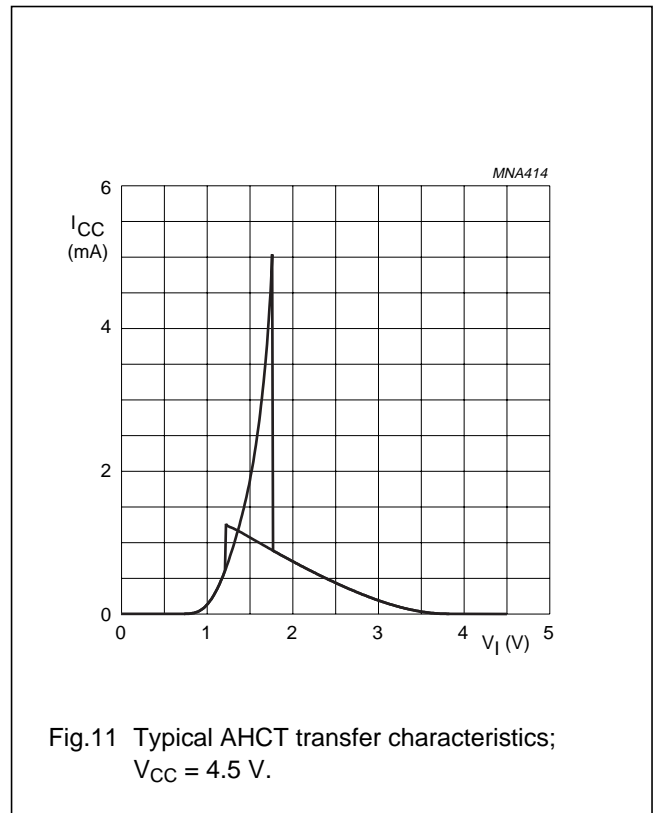
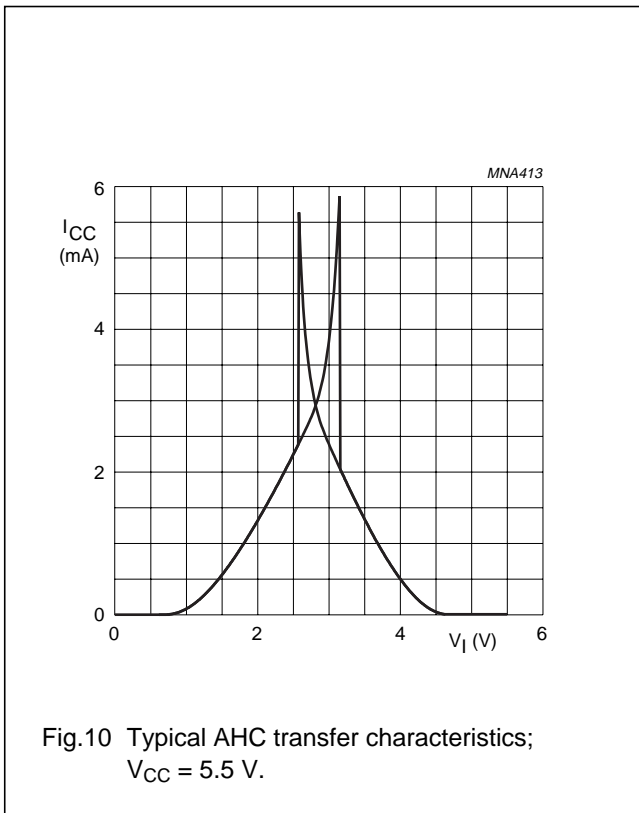
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TRANSFER CHARACTERISTICS WAVEFORMS



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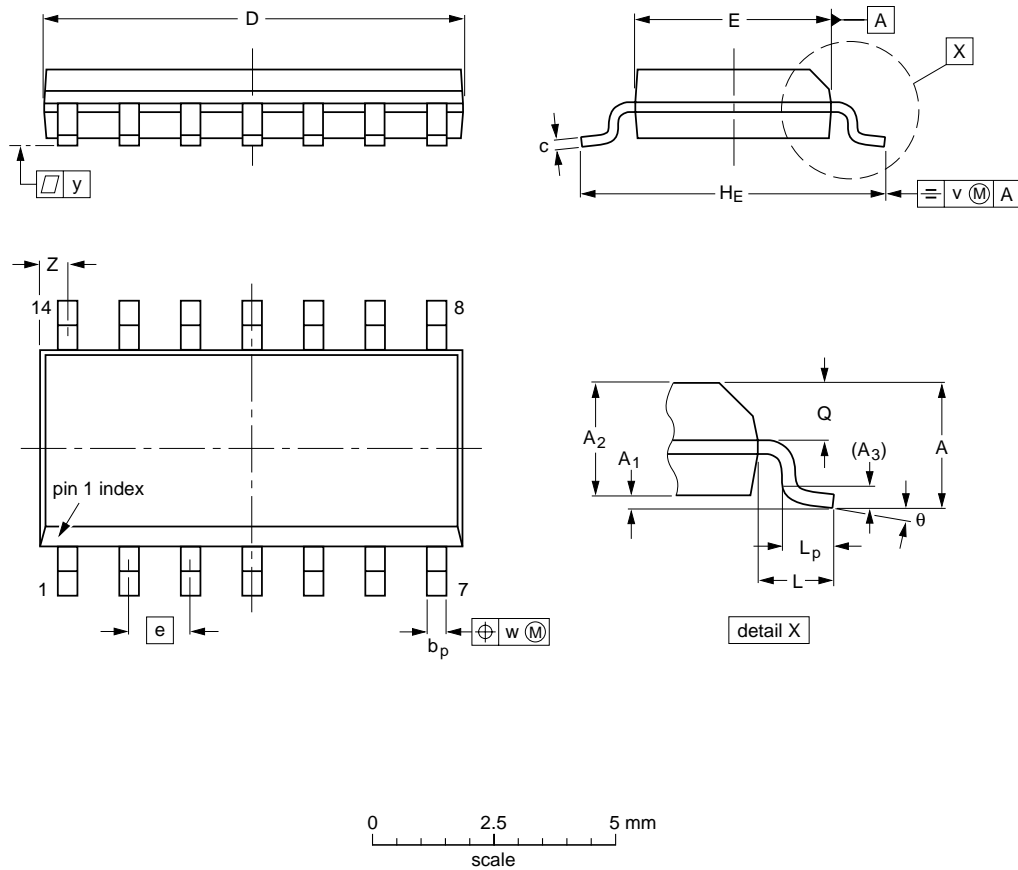
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PACKAGE OUTLINES

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.

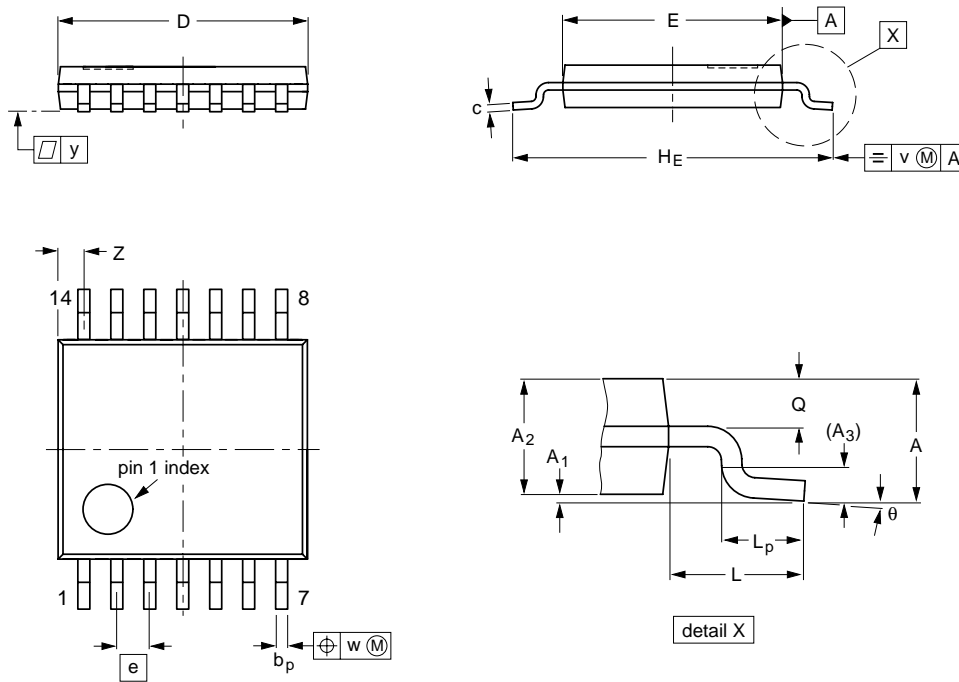
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT108-1 | 076E06S | MS-012AB | | | | 95-01-23 97-05-22 |

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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 | | | | 94-07-12 95-04-04 |

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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 |
| 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 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 | |
| Where application information is given, it is advisory and does not form part of the specification. | |

LIFE SUPPORT APPLICATIONS

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 customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

Hex inverting Schmitt trigger

74AHC14; 74AHCT14

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