

DATA SHEET

74HC04; 74HCT04 Hex inverter

Product specification
Supersedes data of 1993 Sep 01

2003 Jul 23

Hex inverter

74HC04; 74HCT04

FEATURES

- Complies with JEDEC standard no. 8-1A
- ESD protection:
HBM EIA/JESD22-A114-A exceeds 2000 V
MM EIA/JESD22-A115-A exceeds 200 V.
- Specified from -40 to $+85$ °C and -40 to $+125$ °C.

DESCRIPTION

The 74HC/HCT04 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 74HC/HCT04 provide six inverting buffers.

QUICK REFERENCE DATA

GND = 0 V; $T_{amb} = 25$ °C; $t_r = t_f \leq 6.0$ ns.

| SYMBOL | PARAMETER | CONDITIONS | TYPICAL | | UNIT |
|-------------------|--|-------------------------------|---------|-------|------|
| | | | HC04 | HCT04 | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | $C_L = 15$ pF; $V_{CC} = 5$ V | 7 | 8 | ns |
| C_I | input capacitance | | 3.5 | 3.5 | pF |
| C_{PD} | power dissipation capacitance per gate | notes 1 and 2 | 21 | 24 | pF |

Notes

- C_{PD} is used to determine the dynamic power dissipation (P_D in μ W).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$$
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;
 N = total load switching outputs;
 $\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.
- For 74HC04: the condition is $V_I = \text{GND}$ to V_{CC} .
For 74HCT04: the condition is $V_I = \text{GND}$ to $V_{CC} - 1.5$ V.

FUNCTION TABLE

See note 1.

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

Note

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

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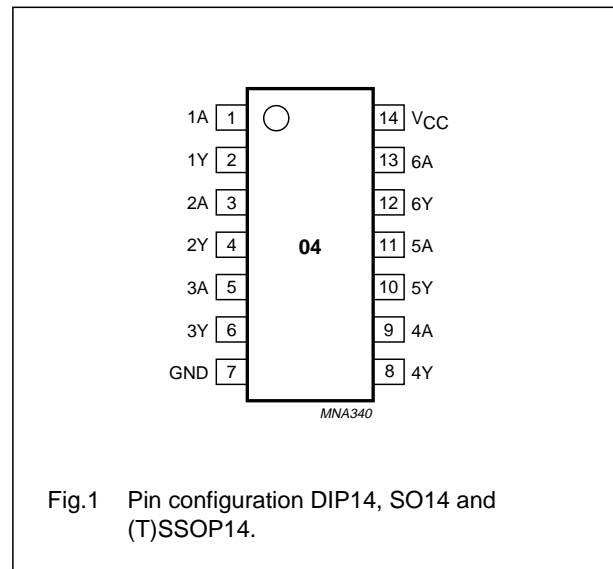
74HC04; 74HCT04

ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | | | |
|-------------|-------------------|------|----------|----------|----------|
| | TEMPERATURE RANGE | PINS | PACKAGE | MATERIAL | CODE |
| 74HC04N | -40 to +125 °C | 14 | DIP14 | plastic | SOT27-1 |
| 74HCT04N | -40 to +125 °C | 14 | DIP14 | plastic | SOT27-1 |
| 74HC04D | -40 to +125 °C | 14 | SO14 | plastic | SOT108-1 |
| 74HCT04D | -40 to +125 °C | 14 | SO14 | plastic | SOT108-1 |
| 74HC04DB | -40 to +125 °C | 14 | SSOP14 | plastic | SOT337-1 |
| 74HCT04DB | -40 to +125 °C | 14 | SSOP14 | plastic | SOT337-1 |
| 74HC04PW | -40 to +125 °C | 14 | TSSOP14 | plastic | SOT402-1 |
| 74HCT04PW | -40 to +125 °C | 14 | TSSOP14 | plastic | SOT402-1 |
| 74HC04BQ | -40 to +125 °C | 14 | DHVQFN14 | plastic | SOT762-1 |
| 74HCT04BQ | -40 to +125 °C | 14 | DHVQFN14 | plastic | SOT762-1 |

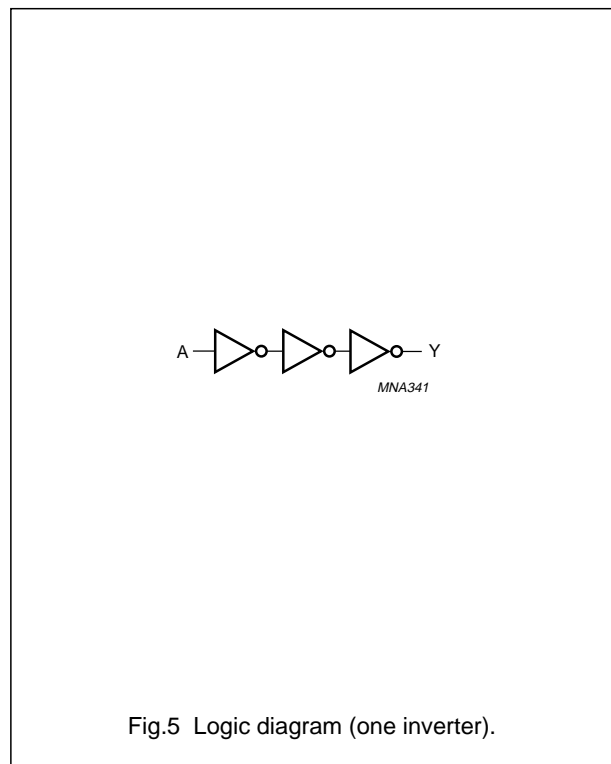
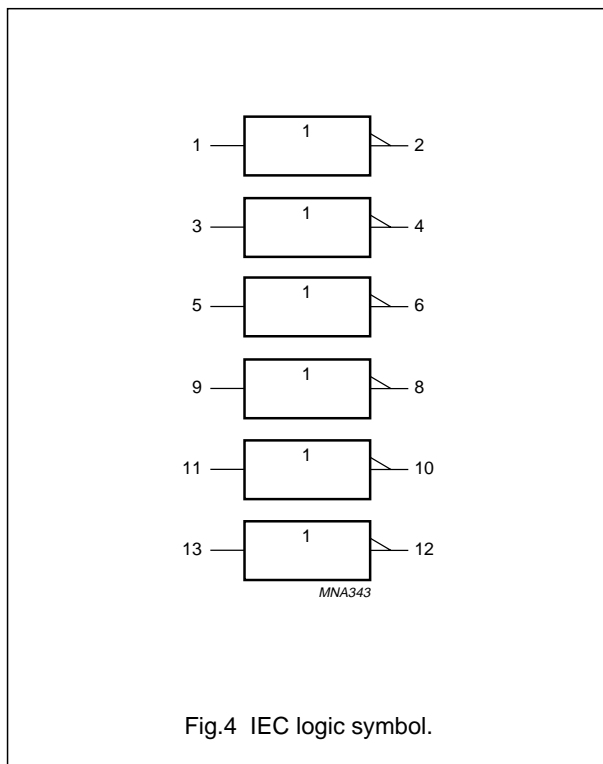
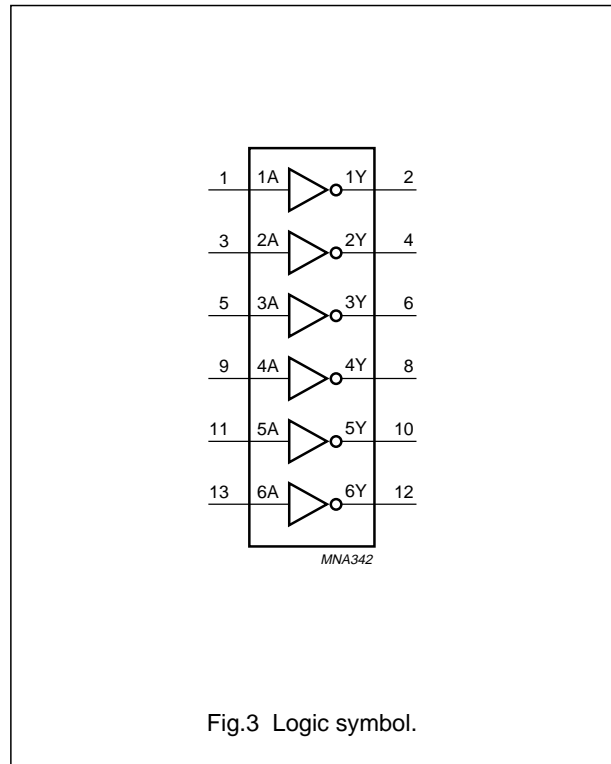
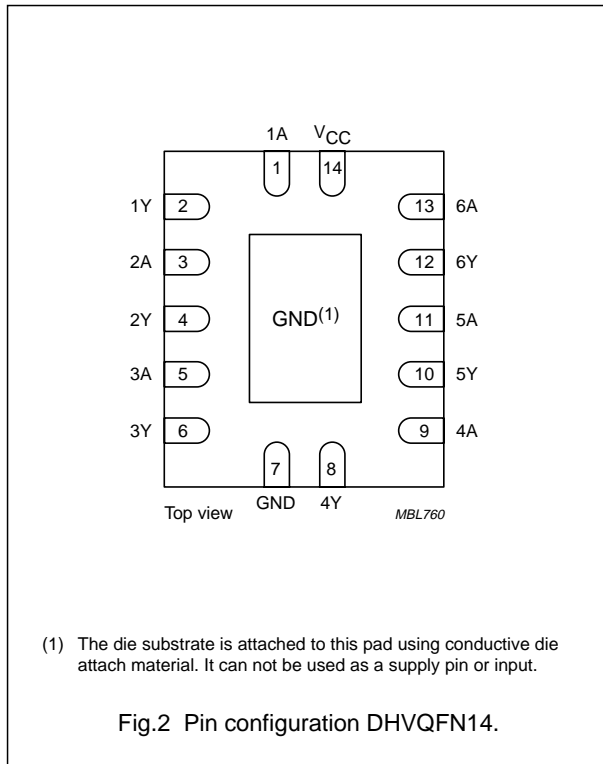
PINNING

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



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RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | 74HC04 | | | 74HCT04 | | | UNIT |
|------------|---------------------------|--|--------|------|----------|---------|------|----------|------|
| | | | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. | |
| V_{CC} | supply voltage | | 2.0 | 5.0 | 6.0 | 4.5 | 5.0 | 5.5 | V |
| V_I | input voltage | | 0 | – | V_{CC} | 0 | – | V_{CC} | V |
| V_O | output voltage | | 0 | – | V_{CC} | 0 | – | V_{CC} | V |
| T_{amb} | ambient temperature | see DC and AC characteristics per device | –40 | +25 | +125 | –40 | +25 | +125 | °C |
| t_r, t_f | input rise and fall times | $V_{CC} = 2.0\text{ V}$ | – | – | 1000 | – | – | – | ns |
| | | $V_{CC} = 4.5\text{ V}$ | – | 6.0 | 500 | – | 6.0 | 500 | ns |
| | | $V_{CC} = 6.0\text{ V}$ | – | – | 400 | – | – | – | ns |

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} | supply voltage | | –0.5 | +7.0 | V |
| I_{IK} | input diode current | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ | – | ±20 | mA |
| I_{OK} | output diode current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ | – | ±20 | mA |
| I_O | output source or sink current | $-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$ | – | ±25 | mA |
| I_{CC}, I_{GND} | V_{CC} or GND current | | – | ±50 | mA |
| T_{stg} | storage temperature | | –65 | +150 | °C |
| P_{tot} | power dissipation | | – | – | – |
| | DIP14 package | $T_{amb} = -40\text{ to }+125\text{ °C}$; note 1 | – | 750 | mW |
| | other packages | $T_{amb} = -40\text{ to }+125\text{ °C}$; note 2 | – | 500 | mW |

Notes

- For DIP14 packages: above 70 °C derate linearly with 12 mW/K.
- For SO14 packages: above 70 °C derate linearly with 8 mW/K.
For SSOP14 and TSSOP14 packages: above 60 °C derate linearly with 5.5 mW/K.
For DHVQFN14 packages: above 60 °C derate linearly with 4.5 mW/K.

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DC CHARACTERISTICS

Type 74HC04

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

| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|--------------------------------|----------------------------|--|---------------------|------|------|------|------|
| | | OTHER | V _{CC} (V) | | | | |
| T_{amb} = 25 °C | | | | | | | |
| V _{IH} | HIGH-level input voltage | | 2.0 | 1.5 | 1.2 | – | V |
| | | | 4.5 | 3.15 | 2.4 | – | V |
| | | | 6.0 | 4.2 | 3.2 | – | V |
| V _{IL} | LOW-level input voltage | | 2.0 | – | 0.8 | 0.5 | V |
| | | | 4.5 | – | 2.1 | 1.35 | V |
| | | | 6.0 | – | 2.8 | 1.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} I _O = –20 µA | 2.0 | 1.9 | 2.0 | – | V |
| | | I _O = –20 µA | 4.5 | 4.4 | 4.5 | – | V |
| | | I _O = –4.0 mA | 4.5 | 3.98 | 4.32 | – | V |
| | | I _O = –20 µA | 6.0 | 5.9 | 6.0 | – | V |
| | | I _O = –5.2 mA | 6.0 | 5.48 | 5.81 | – | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 20 µA | 2.0 | – | 0 | 0.1 | V |
| | | I _O = 20 µA | 4.5 | – | 0 | 0.1 | V |
| | | I _O = 4.0 mA | 4.5 | – | 0.15 | 0.26 | V |
| | | I _O = 20 µA | 6.0 | – | 0 | 0.1 | V |
| | | I _O = 5.2 mA | 6.0 | – | 0.16 | 0.26 | V |
| I _{LI} | input leakage current | V _I = V _{CC} or GND | 6.0 | – | 0.1 | ±0.1 | µA |
| I _{oz} | 3-state output OFF current | V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND | 6.0 | – | – | ±0.5 | µA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 6.0 | – | – | 2 | µA |

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| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|--|----------------------------|--|---------------------|------|------|------|------|
| | | OTHER | V _{CC} (V) | | | | |
| T_{amb} = -40 to +85 °C | | | | | | | |
| V _{IH} | HIGH-level input voltage | | 2.0 | 1.5 | - | - | V |
| | | | 4.5 | 3.15 | - | - | V |
| | | | 6.0 | 4.2 | - | - | V |
| V _{IL} | LOW-level input voltage | | 2.0 | - | - | 0.5 | V |
| | | | 4.5 | - | - | 1.35 | V |
| | | | 6.0 | - | - | 1.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} I _O = -20 µA | 2.0 | 1.9 | - | - | V |
| | | I _O = -20 µA | 4.5 | 4.4 | - | - | V |
| | | I _O = -4.0 mA | 4.5 | 3.84 | - | - | V |
| | | I _O = -20 µA | 6.0 | 5.9 | - | - | V |
| | | I _O = -5.2 mA | 6.0 | 5.34 | - | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 20 µA | 2.0 | - | - | 0.1 | V |
| | | I _O = 20 µA | 4.5 | - | - | 0.1 | V |
| | | I _O = 4.0 mA | 4.5 | - | - | 0.33 | V |
| | | I _O = 20 µA | 6.0 | - | - | 0.1 | V |
| | | I _O = 5.2 mA | 6.0 | - | - | 0.33 | V |
| I _{LI} | input leakage current | V _I = V _{CC} or GND | 6.0 | - | - | ±1.0 | µA |
| I _{OZ} | 3-state output OFF current | V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND | 6.0 | - | - | ±5.0 | µA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 6.0 | - | - | 20 | µA |

Hex inverter

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| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|----------------------------|--|---------------------|------|------|-------|------|
| | | OTHER | V _{CC} (V) | | | | |
| T_{amb} = -40 to +125 °C | | | | | | | |
| V _{IH} | HIGH-level input voltage | | 2.0 | 1.5 | – | – | V |
| | | | 4.5 | 3.15 | – | – | V |
| | | | 6.0 | 4.2 | – | – | V |
| V _{IL} | LOW-level input voltage | | 2.0 | – | – | 0.5 | V |
| | | | 4.5 | – | – | 1.35 | V |
| | | | 6.0 | – | – | 1.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} I _O = –20 µA | 2.0 | 1.9 | – | – | V |
| | | I _O = –20 µA | 4.5 | 4.4 | – | – | V |
| | | I _O = –20 µA | 6.0 | 5.9 | – | – | V |
| | | I _O = –4.0 mA | 4.5 | 3.7 | – | – | V |
| | | I _O = –5.2 mA | 6.0 | 5.2 | – | – | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 20 µA | 2.0 | – | – | 0.1 | V |
| | | I _O = 20 µA | 4.5 | – | – | 0.1 | V |
| | | I _O = 20 µA | 6.0 | – | – | 0.1 | V |
| | | I _O = 4.0 mA | 4.5 | – | – | 0.4 | V |
| | | I _O = 5.2 mA | 6.0 | – | – | 0.4 | V |
| I _{LI} | input leakage current | V _I = V _{CC} or GND | 6.0 | – | – | ±1.0 | µA |
| I _{OZ} | 3-state output OFF current | V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND | 6.0 | – | – | ±10.0 | µA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 6.0 | – | – | 40 | µA |

Hex inverter

74HC04; 74HCT04

Type 74HCT04

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

| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|--|-------------------------------------|---|---------------------|------|------|------|------|
| | | OTHER | V _{CC} (V) | | | | |
| T_{amb} = 25 °C | | | | | | | |
| V _{IH} | HIGH-level input voltage | | 4.5 to 5.5 | 2.0 | 1.6 | – | V |
| V _{IL} | LOW-level input voltage | | 4.5 to 5.5 | – | 1.2 | 0.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} I _O = –20 µA | 4.5 | 4.4 | 4.5 | – | V |
| | | I _O = –4.0 mA | 4.5 | 3.84 | 4.32 | – | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 20 µA | 4.5 | – | 0 | 0.1 | V |
| | | I _O = 4.0 mA | 4.5 | – | 0.15 | 0.26 | V |
| I _{LI} | input leakage current | V _I = V _{CC} or GND | 5.5 | – | – | ±0.1 | µA |
| I _{OZ} | 3-state output OFF current | V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND; I _O = 0 | 5.5 | – | – | ±0.5 | µA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 5.5 | – | – | 2 | µA |
| ΔI _{CC} | additional supply current per input | V _I = V _{CC} – 2.1 V; I _O = 0 | 4.5 to 5.5 | – | 120 | 432 | µA |
| T_{amb} = –40 to +85 °C | | | | | | | |
| V _{IH} | HIGH-level input voltage | | 4.5 to 5.5 | 2.0 | – | – | V |
| V _{IL} | LOW-level input voltage | | 4.5 to 5.5 | – | – | 0.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} I _O = –20 µA | 4.5 | 4.4 | – | – | V |
| | | I _O = –4.0 mA | 4.5 | 3.84 | – | – | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 20 µA | 4.5 | – | – | 0.1 | V |
| | | I _O = 4.0 mA | 4.5 | – | – | 0.33 | V |
| I _{LI} | input leakage current | V _I = V _{CC} or GND | 5.5 | – | – | ±1.0 | µA |
| I _{OZ} | 3-state output OFF current | V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND; I _O = 0 | 5.5 | – | – | ±5.0 | µA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 5.5 | – | – | 20 | µA |
| ΔI _{CC} | additional supply current per input | V _I = V _{CC} – 2.1 V; I _O = 0 | 4.5 to 5.5 | – | – | 540 | µA |

Hex inverter

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| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|-------------------------------------|---|---------------------|------|------|------|------|
| | | OTHER | V _{CC} (V) | | | | |
| T_{amb} = -40 to +125 °C | | | | | | | |
| V _{IH} | HIGH-level input voltage | | 4.5 to 5.5 | 2.0 | – | – | V |
| V _{IL} | LOW-level input voltage | | 4.5 to 5.5 | – | – | 0.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} I _O = -20 µA | 4.5 | 4.4 | – | – | V |
| | | I _O = -4.0 mA | 4.5 | 3.7 | – | – | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} I _O = 20 µA | 4.5 | – | – | 0.1 | V |
| | | I _O = 4.0 mA | 4.5 | – | – | 0.4 | V |
| I _{LI} | input leakage current | V _I = V _{CC} or GND | 5.5 | – | – | ±1.0 | µA |
| I _{OZ} | 3-state output OFF current | V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND; I _O = 0 | 5.5 | – | – | ±10 | µA |
| I _{CC} | quiescent supply current | V _I = V _{CC} or GND; I _O = 0 | 5.5 | – | – | 40 | µA |
| ΔI _{CC} | additional supply current per input | V _I = V _{CC} - 2.1 V; I _O = 0 | 4.5 to 5.5 | – | – | 590 | µA |

Hex inverter

74HC04; 74HCT04

AC CHARACTERISTICS

Family 74HC04

GND = 0 V; $t_r = t_f \leq 6.0$ ns; $C_L = 50$ pF.

| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|-------------------------------|------------------|--------------|------|------|------|------|
| | | WAVEFORMS | V_{CC} (V) | | | | |
| $T_{amb} = 25$ °C | | | | | | | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | see Figs 6 and 7 | 2.0 | – | 25 | 85 | ns |
| | | | 4.5 | – | 9 | 17 | ns |
| | | | 6.0 | – | 7 | 14 | ns |
| t_{THL}/t_{TLH} | output transition time | see Figs 6 and 7 | 2.0 | – | 19 | 75 | ns |
| | | | 4.5 | – | 7 | 15 | ns |
| | | | 6.0 | – | 6 | 13 | ns |
| $T_{amb} = -40$ to $+85$ °C | | | | | | | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | see Figs 6 and 7 | 2.0 | – | – | 105 | ns |
| | | | 4.5 | – | – | 21 | ns |
| | | | 6.0 | – | – | 18 | ns |
| t_{THL}/t_{TLH} | output transition time | see Figs 6 and 7 | 2.0 | – | – | 95 | ns |
| | | | 4.5 | – | – | 19 | ns |
| | | | 6.0 | – | – | 16 | ns |
| $T_{amb} = -40$ to $+125$ °C | | | | | | | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | see Figs 6 and 7 | 2.0 | – | – | 130 | ns |
| | | | 4.5 | – | – | 26 | ns |
| | | | 6.0 | – | – | 22 | ns |
| t_{THL}/t_{TLH} | output transition time | see Figs 6 and 7 | 2.0 | – | – | 110 | ns |
| | | | 4.5 | – | – | 22 | ns |
| | | | 6.0 | – | – | 19 | ns |

Hex inverter

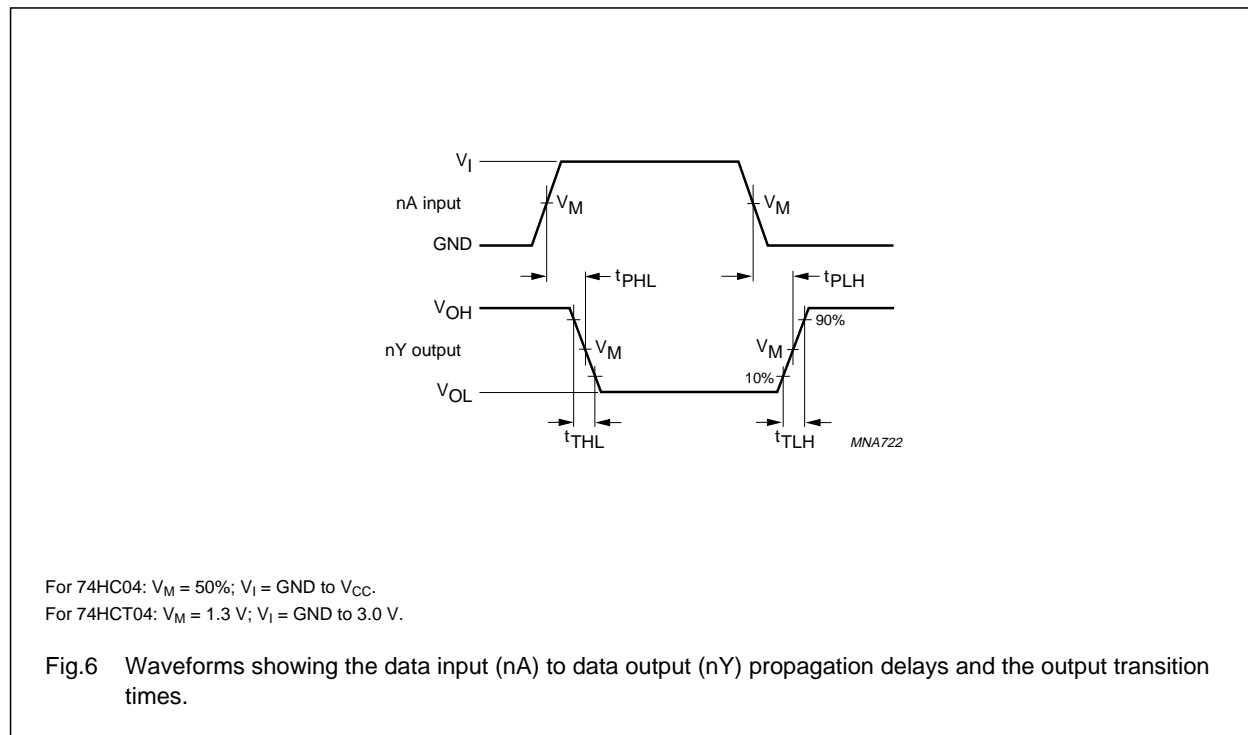
74HC04; 74HCT04

Family 74HCT04

GND = 0 V; $t_r = t_f \leq 6.0$ ns; $C_L = 50$ pF.

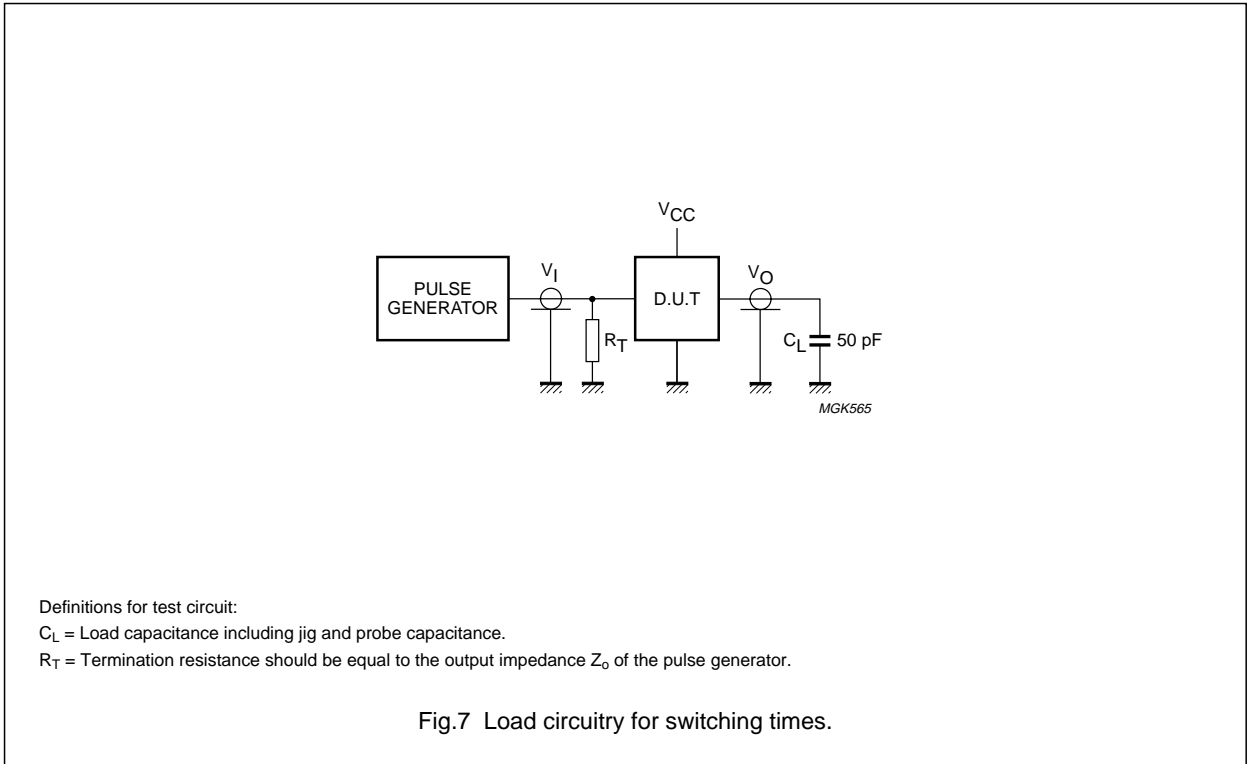
| SYMBOL | PARAMETER | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|-------------------------------|------------------|--------------|------|------|------|------|
| | | WAVEFORMS | V_{CC} (V) | | | | |
| $T_{amb} = 25$ °C | | | | | | | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | see Figs 6 and 7 | 4.5 | – | 10 | 19 | ns |
| t_{THL}/t_{TLH} | output transition time | see Figs 6 and 7 | 4.5 | – | 7 | 15 | ns |
| $T_{amb} = -40$ to $+85$ °C | | | | | | | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | see Figs 6 and 7 | 4.5 | – | – | 24 | ns |
| t_{THL}/t_{TLH} | output transition time | see Figs 6 and 7 | 4.5 | – | – | 19 | ns |
| $T_{amb} = -40$ to $+125$ °C | | | | | | | |
| t_{PHL}/t_{PLH} | propagation delay nA to nY | see Figs 6 and 7 | 4.5 | – | – | 29 | ns |
| t_{THL}/t_{TLH} | output transition time | see Figs 6 and 7 | 4.5 | – | – | 22 | ns |

AC WAVEFORMS



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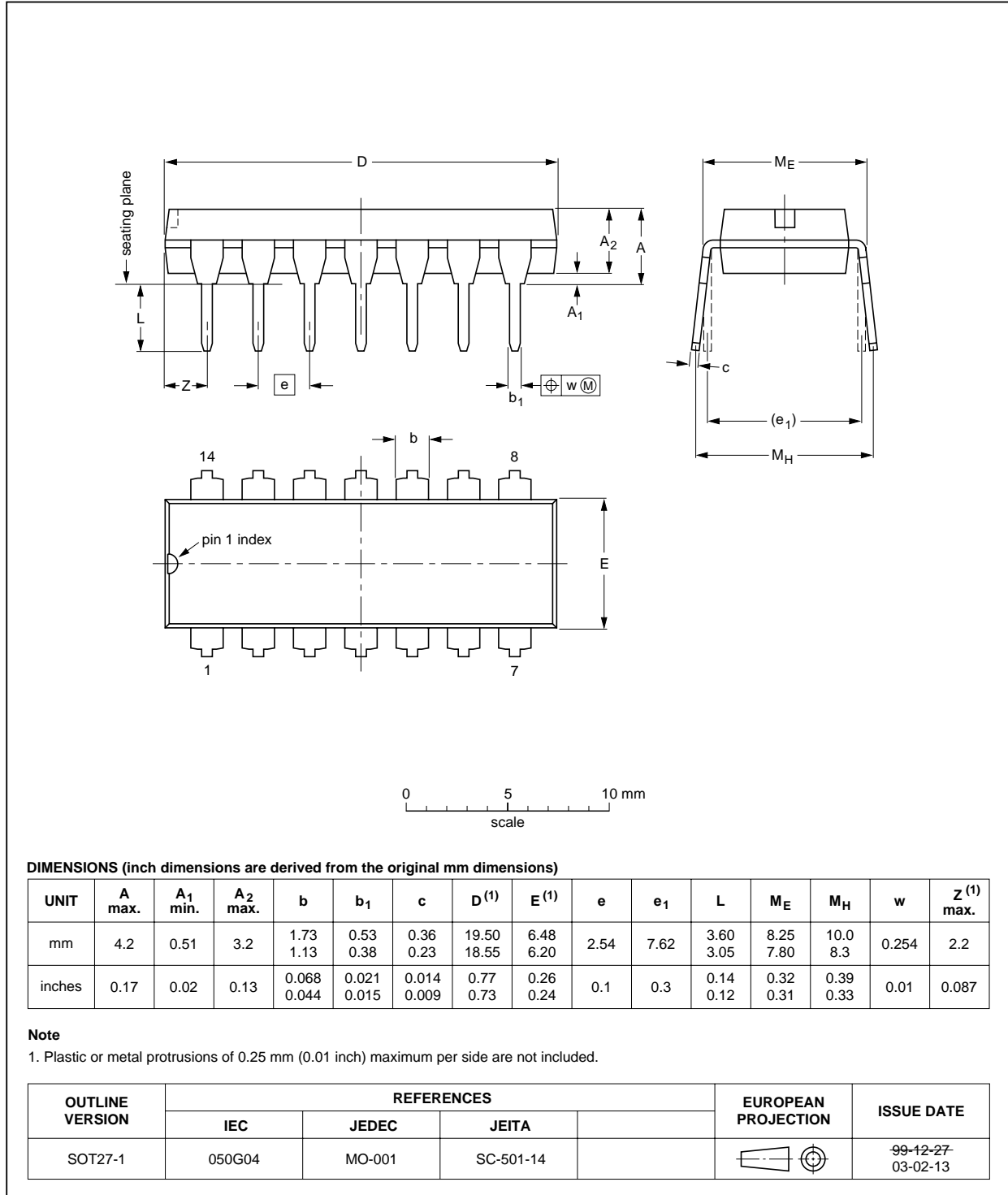
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PACKAGE OUTLINES

DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1

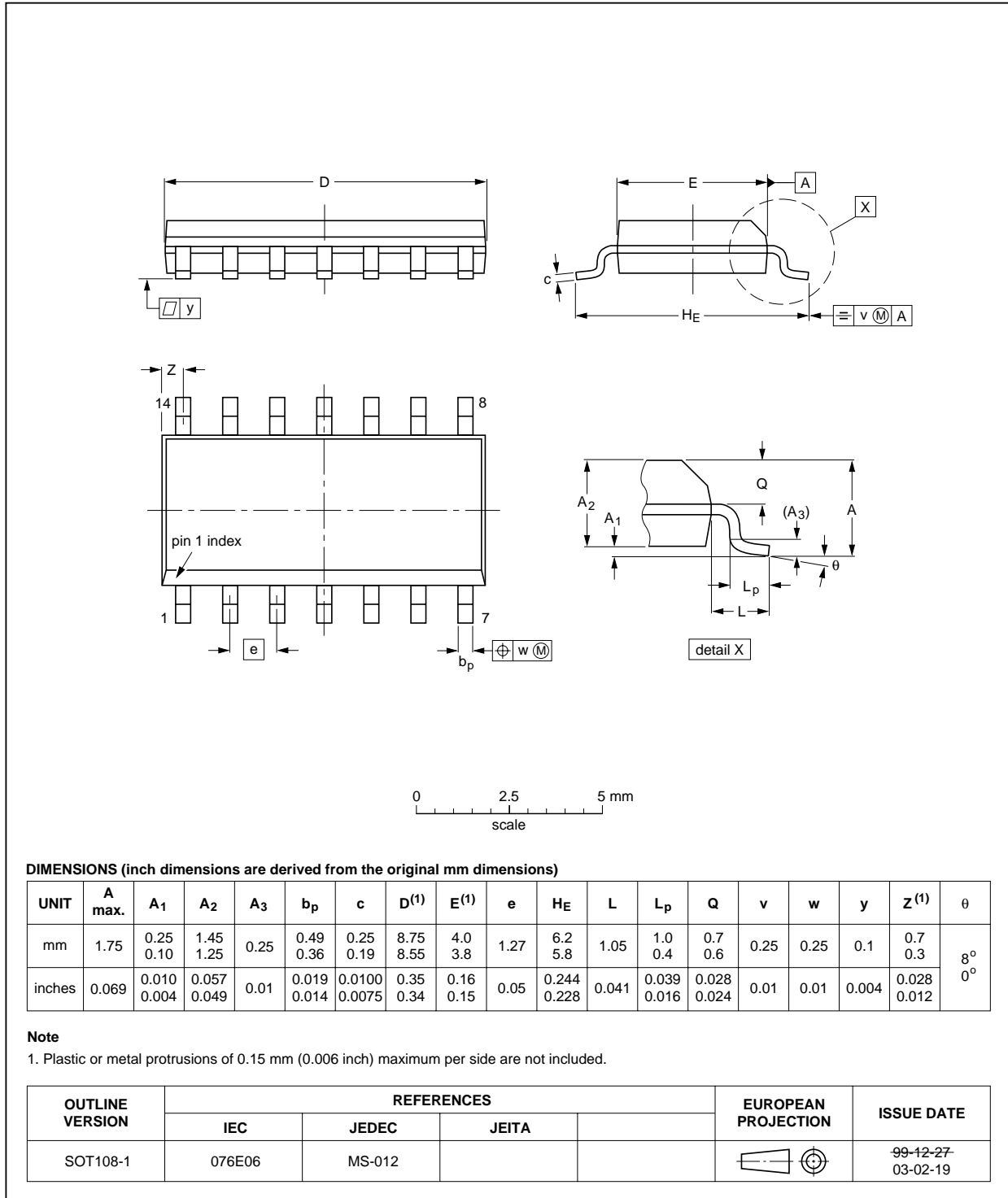


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SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

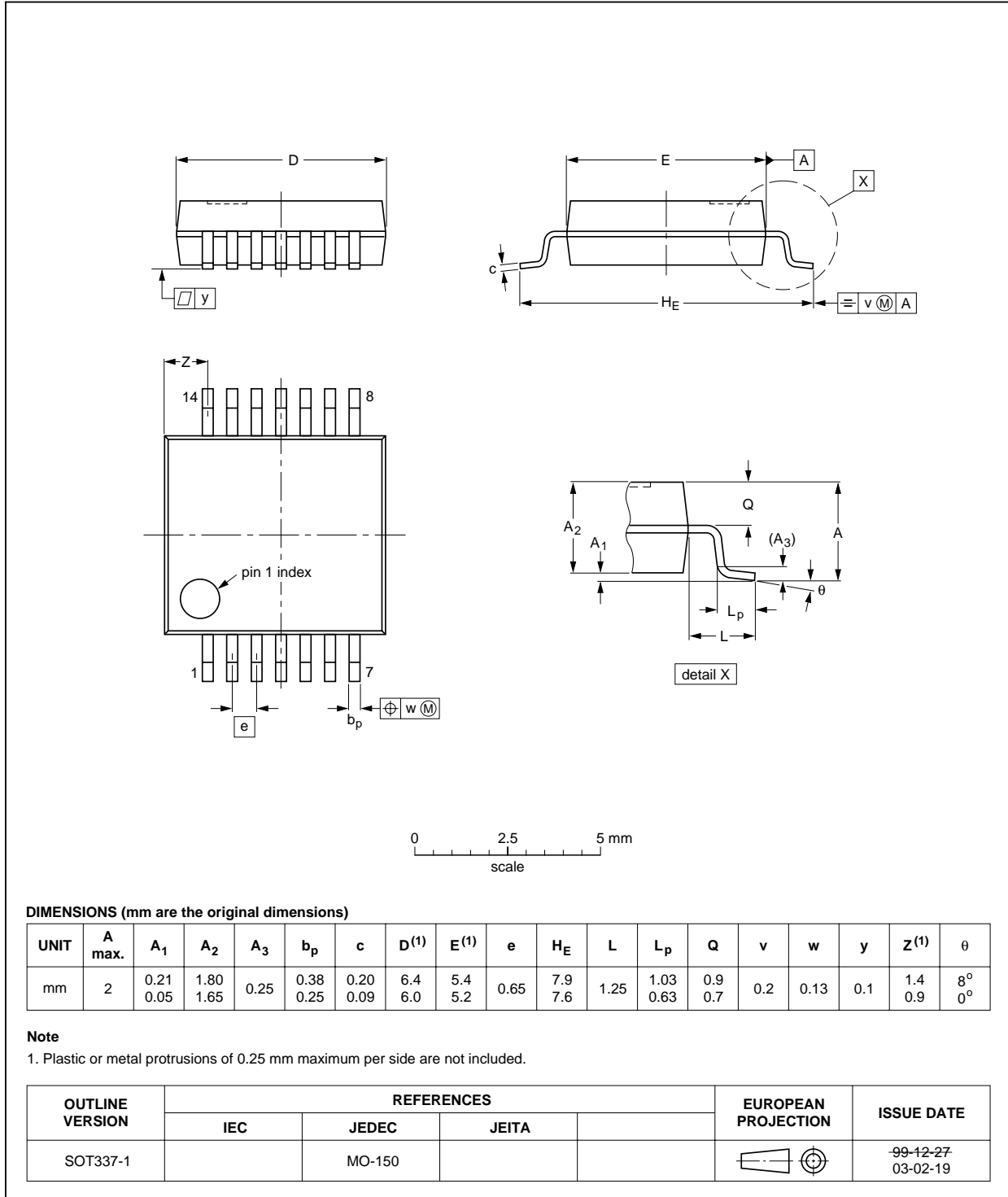


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SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1

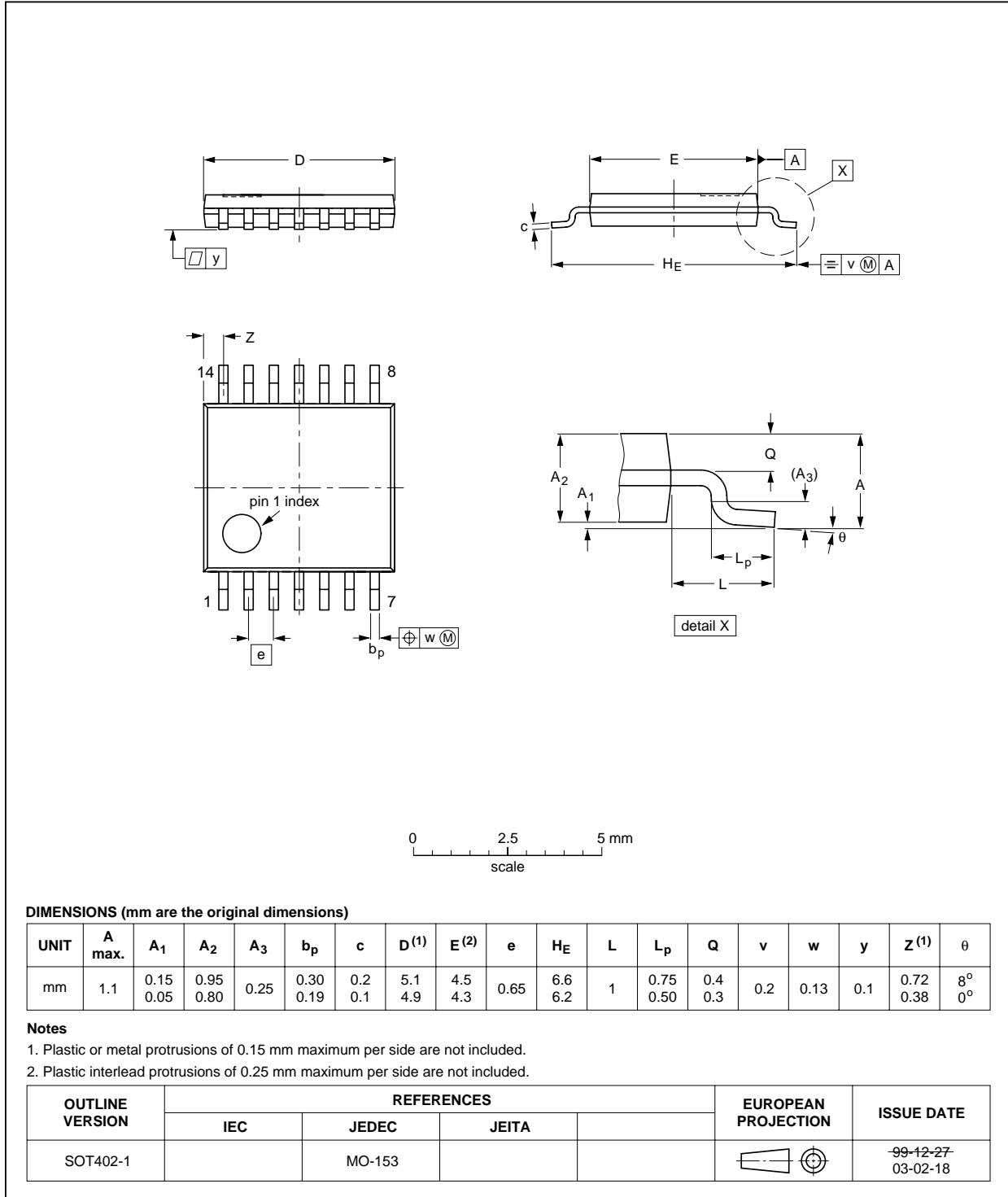


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TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

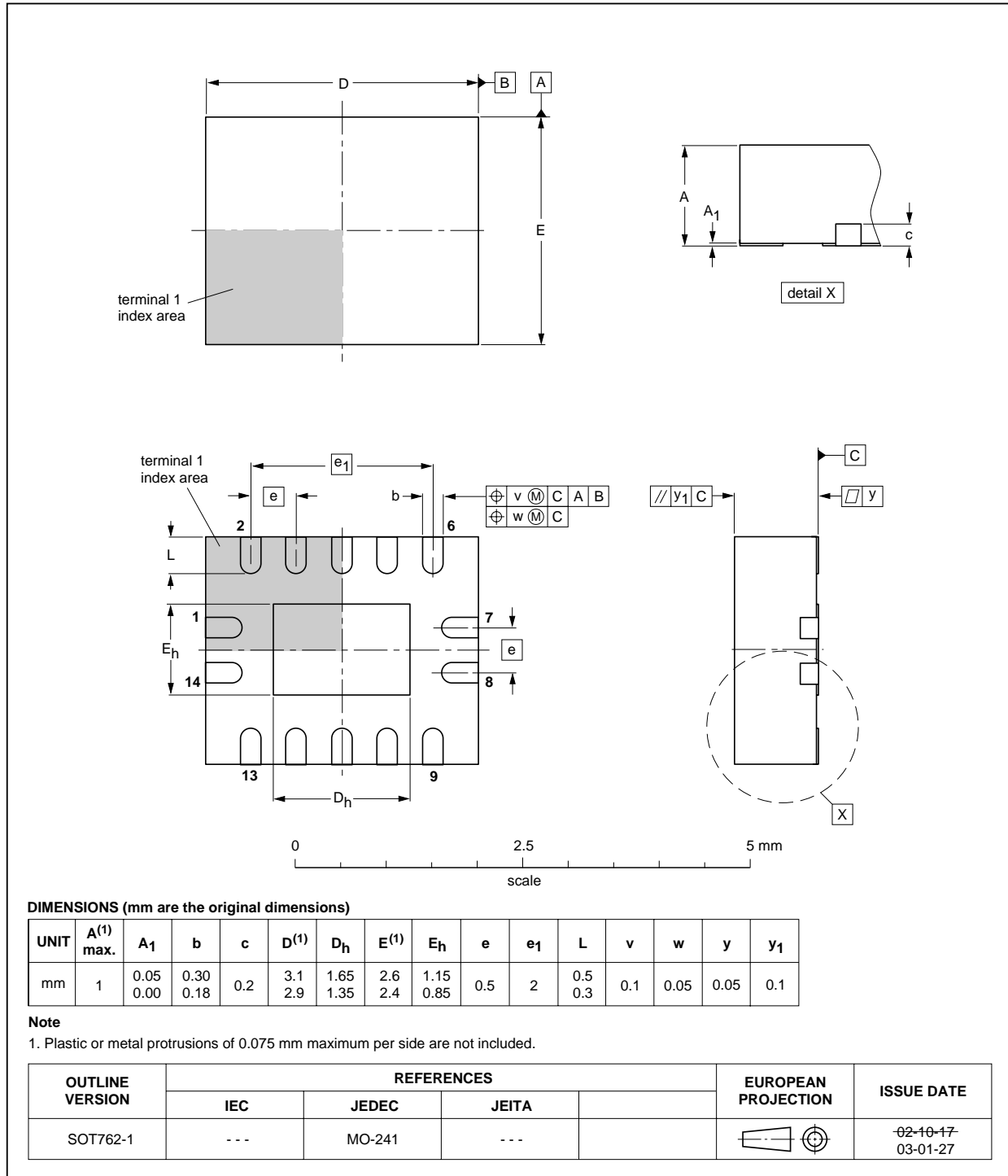


Hex inverter

74HC04; 74HCT04

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1



Hex inverter

74HC04; 74HCT04

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. |
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| III | Product data | Production | This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN). |

Notes

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

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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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