# 74LVT04-Q100

## 3.3 V Hex inverter

Rev. 1 — 26 May 2014 Product data sheet

## 1. General description

The 74LVT04-Q100 is a high-performance product designed for $V_{CC}$ operation at 3.3 V.

The 74LVT04-Q100 provides six inverting buffers.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 3) and is suitable for use in automotive applications.

## 2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 3)
  - Specified from −40 °C to +85 °C
- TTL input and output switching levels
- Latch-up protection
  - JESD78 class II exceeds 500 mA
- ESD protection:
  - MIL-STD-883, method 3015 exceeds 2000 V
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)
- Specified from −40 °C to +85 °C

## 3. Ordering information

**Table 1. Ordering information**

| Type number | Package | | | |
|---|---|---|---|---|
| | Temperature range | Name | Description | Version |
| 74LVT04D-Q100 | −40 °C to +85 °C | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |
| 74LVT04DB-Q100 | −40 °C to +85 °C | SSOP14 | plastic shrink small outline package; 14 leads; body width 5.3 mm | SOT337-1 |
| 74LVT04PW-Q100 | −40 °C to +85 °C | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |

## 4. Functional diagram

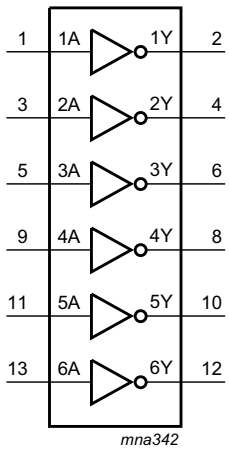



Fig 1. Logic symbol

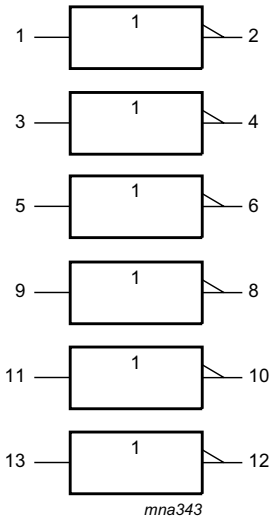



Fig 2. IEC logic symbol

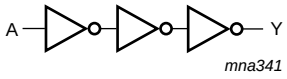



Fig 3. Logic diagram for one gate

## 5. Pinning information

### 5.1 Pinning

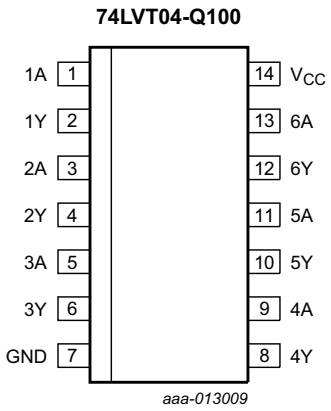



Fig 4. Pin configuration SOT108-1 (SO14), SOT337-1 (SSOP14) and SOT402-1 (TSSOP14)

### 5.2 Pin description

**Table 2. Pin description**

| Symbol | Pin | Description |
|---|---|---|
| nA | 1, 3, 5, 9, 11, 13 | data input |
| nY | 2, 4, 6, 8, 10, 12 | data output |
| GND | 7 | ground (0 V) |
| $V_{CC}$ | 14 | supply voltage |

## 6. Functional description

**Table 3. Function table[1]**

| Input | Output |
|---|---|
| **nA** | **nY** |
| L | H |
| H | L |

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

## 7. Limiting values

**Table 4. 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 | +4.6 | V |
| $V_I$ | input voltage | [1] | –0.5 | +7.0 | V |
| $V_O$ | output voltage | output in OFF-state or HIGH-state [1] | –0.5 | +7.0 | V |
| $I_{IK}$ | input clamping current | $V_I < 0$ V | –50 | - | mA |
| $I_{OK}$ | output clamping current | $V_O < 0$ V | –50 | - | mA |
| $I_O$ | output current | output in LOW-state | - | 64 | mA |
| | | output in HIGH-state | - | –32 | mA |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_j$ | junction temperature | [2] | - | 150 | °C |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = –40 °C to +85 °C [3] | - | 500 | mW |

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

[2] The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability.

[3] 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.

# 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | 2.7 | 3.6 | V |
| $V_I$ | input voltage | | 0 | 5.5 | V |
| $V_{IH}$ | HIGH-level input voltage | | 2.0 | - | V |
| $V_{IL}$ | LOW-level input voltage | | - | 0.8 | V |
| $I_{OH}$ | HIGH-level output current | | - | –20 | mA |
| $I_{OL}$ | LOW-level output current | | - | 32 | mA |
| $T_{amb}$ | ambient temperature | in free air | –40 | +85 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | outputs enabled | - | 10 | ns/V |

# 9. Static characteristics

**Table 6. Static characteristics**

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

| Symbol | Parameter | Conditions | –40 °C to +85 °C | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ[1] | Max | |
| $V_{IK}$ | input clamping voltage | $V_{CC}$ = 2.7 V; $I_{IK}$ = –18 mA | - | - | –1.2 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_{CC}$ = 2.7 V to 3.6 V; $I_{OH}$ = –100 µA | $V_{CC}$ – 0.2 | - | - | V |
| | | $V_{CC}$ = 2.7 V; $I_{OH}$ = –6 mA | 2.4 | - | - | V |
| | | $V_{CC}$ = 3.0 V; $I_{OH}$ = –20 mA | 2.0 | - | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_{CC}$ = 2.7 V; $I_{OL}$ = –100 µA | - | - | 0.2 | V |
| | | $V_{CC}$ = 2.7 V; $I_{OL}$ = 24 mA | - | - | 0.5 | V |
| | | $V_{CC}$ = 3.0 V; $I_{OL}$ = 32 mA | - | - | 0.5 | V |
| $I_I$ | input leakage current | $V_{CC}$ = 0 V or 3.6 V; $V_I$ = 5.5 V | - | - | 10 | µA |
| | | $V_{CC}$ = 3.6 V; $V_I$ = $V_{CC}$ or GND | - | - | ±1 | µA |
| $I_{OFF}$ | power-off leakage current | $V_{CC}$ = 0 V; $V_I$ or $V_O$ = 0 V to 4.5 V | - | - | ±100 | µA |
| $I_{CCH}$ | HIGH-level supply current | $V_{CC}$ = 3.6 V; outputs HIGH; $V_I$ = GND or $V_{CC}$, $I_O$ = 0 V | - | - | 0.02 | mA |
| $I_{CCL}$ | LOW-level supply current | $V_{CC}$ = 3.6 V; outputs LOW; $V_I$ = GND or $V_{CC}$; $I_O$ = 0 V | - | 1.5 | 3 | mA |
| $\Delta I_{CC}$ | additional supply current | per input pin [2] $V_{CC}$ = 3 V to 3.6 V; one input at $V_{CC}$ – 0.6 V; other inputs at $V_{CC}$ or GND | - | - | 0.2 | µA |
| $C_I$ | input capacitance | $V_I$ = 3 V or 0 V | - | 3 | - | pF |

[1] All typical values are at $V_{CC}$ = 3.3 V and $T_{amb}$ = 25°C.

[2] This is the increase in supply current for each input at the specified voltage level other than $V_{CC}$ or GND.

## 10. Dynamic characteristics

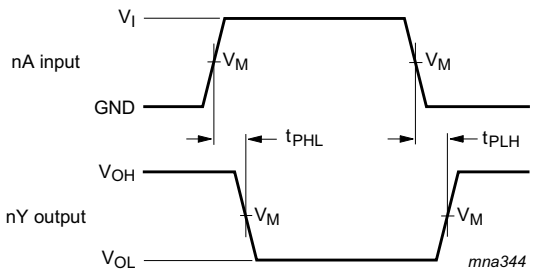
**Table 7. Dynamic characteristics**

*GND = 0 V; for test circuit, see Figure 6.*

| Symbol | Parameter | Conditions | –40 °C to +85 °C | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ[1] | Max | |
| $t_{PLH}$ | LOW to HIGH propagation delay | nA to nY; see Figure 5 | | | | |
| | | $V_{CC}$ = 2.7 V | - | - | 4.7 | ns |
| | | $V_{CC}$ = 3.3 V ± 0.3 V | 1.0 | 2.6 | 3.9 | ns |
| $t_{PHL}$ | HIGH to LOW propagation delay | nA to nY; see Figure 5 | | | | |
| | | $V_{CC}$ = 2.7 V | - | - | 3.2 | ns |
| | | $V_{CC}$ = 3.3 V ± 0.3 V | 1.0 | 2.5 | 3.5 | ns |

[1] All typical values are at $V_{CC}$ = 3.3 V and $T_{amb}$ = 25°C.

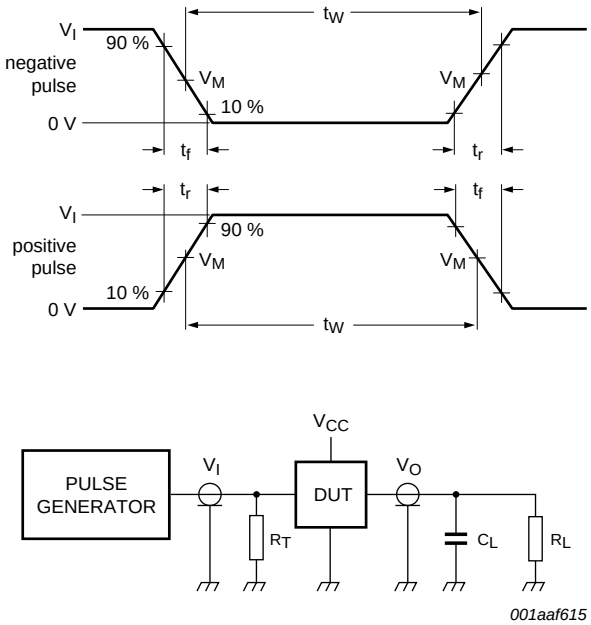
## 11. Waveforms




$V_M$ = 50%; $V_I$ = GND to $V_{CC}$.

$V_M$ = 1.5 V; $V_I$ = GND to 2.7 V

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




Test data is given in Table 8.

Definitions test circuit:

$R_T$ = termination resistance should be equal to output impedance $Z_o$ of the pulse generator.

$C_L$ = load capacitance including jig and probe capacitance.

$R_L$ = Load resistance.

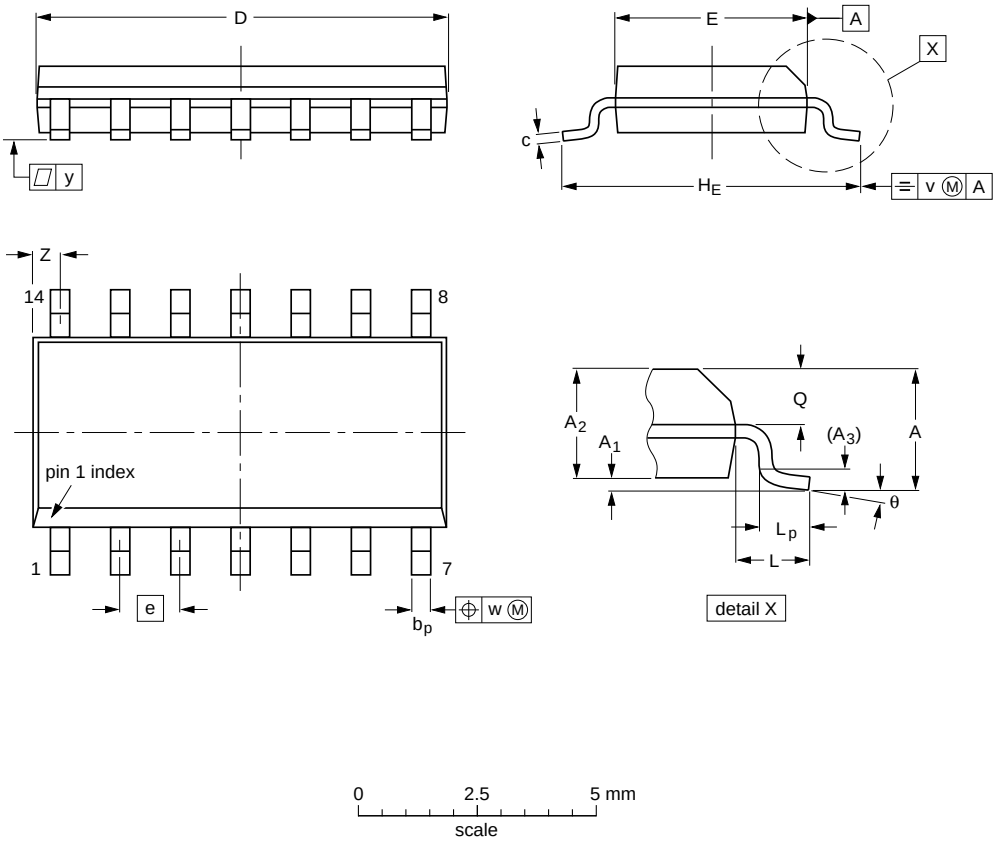
**Fig 6. Test circuit for measuring switching times**

**Table 8. Test data**

| Input | | | | Load | |
|---|---|---|---|---|---|
| $V_I$ | $f_i$ | $t_W$ | $t_r$, $t_f$ | $C_L$ | $R_L$ |
| 2.7 V | ≤ 10 MHz | 500 ns | ≤2.5 ns | 50 pF | 500 Ω |

## 12. Package outline

**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<br>0.10 | 1.45<br>1.25 | 0.25 | 0.49<br>0.36 | 0.25<br>0.19 | 8.75<br>8.55 | 4.0<br>3.8 | 1.27 | 6.2<br>5.8 | 1.05 | 1.0<br>0.4 | 0.7<br>0.6 | 0.25 | 0.25 | 0.1 | 0.7<br>0.3 | $8^o$<br>$0^o$ |
| inches | 0.069 | 0.010<br>0.004 | 0.057<br>0.049 | 0.01 | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.35<br>0.34 | 0.16<br>0.15 | 0.05 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.024 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012 | |

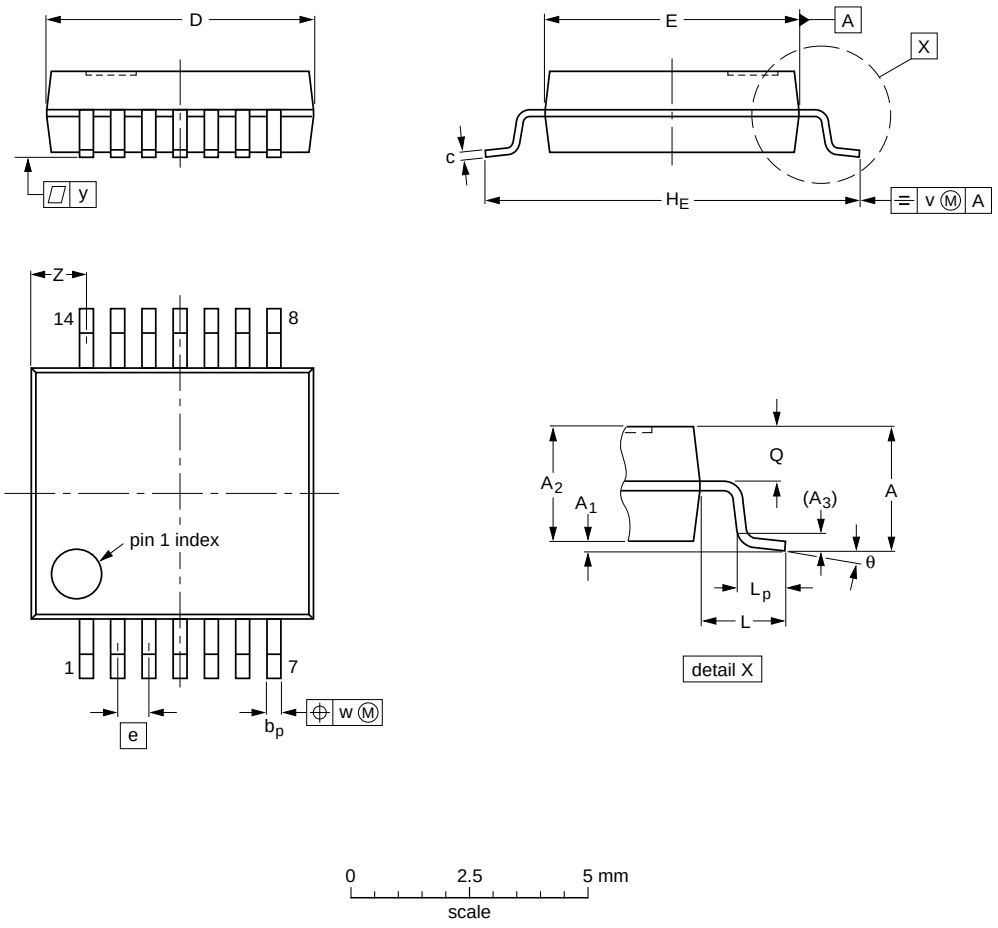
**Note**

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT108-1 | 076E06 | MS-012 | | | | ~~99-12-27~~<br>03-02-19 |

**Fig 7. Package outline SOT108-1 (SO14)**

**SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm** **SOT337-1**




**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 | 0.21<br>0.05 | 1.80<br>1.65 | 0.25 | 0.38<br>0.25 | 0.20<br>0.09 | 6.4<br>6.0 | 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 | 1.4<br>0.9 | $8^o$<br>$0^o$ |

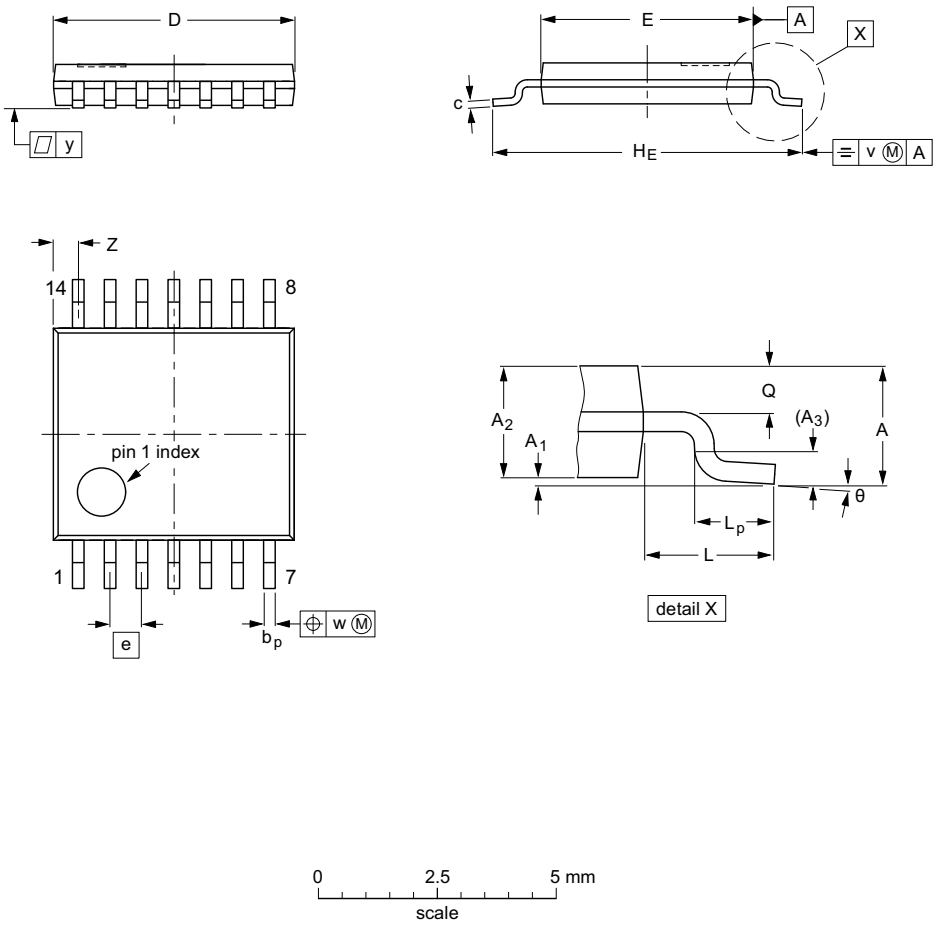
**Note**

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

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT337-1 | | MO-150 | | | | ~~99-12-27~~<br>03-02-19 |

**Fig 8. Package outline SOT337-1 (SSOP14)**

**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 | 1.1 | 0.15<br>0.05 | 0.95<br>0.80 | 0.25 | 0.30<br>0.19 | 0.2<br>0.1 | 5.1<br>4.9 | 4.5<br>4.3 | 0.65 | 6.6<br>6.2 | 1 | 0.75<br>0.50 | 0.4<br>0.3 | 0.2 | 0.13 | 0.1 | 0.72<br>0.38 | 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 | JEITA | | | |
| SOT402-1 | | MO-153 | | | | ~~99-12-27~~<br>03-02-18 |

**Fig 9. Package outline SOT402-1 (TSSOP14)**

## 13. Abbreviations

**Table 9. Abbreviations**

| Acronym | Description |
|---|---|
| HBM | Human Body Model |
| ESD | ElectroStatic Discharge |
| MM | Machine Model |
| MIL | Military |

## 14. Revision history

**Table 10. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| 74LVT04_Q100 v.1 | 20140526 | Product data sheet | - | - |

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| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
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