



74LVC04A

LOW VOLTAGE CMOS HEX INVERTER HIGH PERFORMANCE

- 5V TOLERANT INPUTS
- HIGH SPEED: $t_{PD} = 4.5ns$ (MAX.) at $V_{CC} = 3V$
- POWER DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 24mA$ (MIN) at $V_{CC} = 3V$
- PCI BUS LEVELS GUARANTEED AT 24 mA
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \cong t_{PHL}$
- OPERATING VOLTAGE RANGE:
 $V_{CC}(OPR) = 1.65V$ to $3.6V$ (1.2V Data Retention)
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 00
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE:
HBM > 2000V (MIL STD 883 method 3015);
MM > 200V

DESCRIPTION

The 74LVC04A is a low voltage CMOS HEX INVERTER fabricated with sub-micron silicon gate and double-layer metal wiring C²MOS technology. It is ideal for 1.65 to 3.6 V_{CC}



Table 1: Order Codes

| PACKAGE | T & R |
|---------|-------------|
| SOP | 74LVC04AMTR |
| TSSOP | 74LVC04ATTR |

operations and low power and low noise applications.

It can be interfaced to 5V signal environment for inputs in mixed 3.3/5V system.

It has more speed performance at 3.3V than 5V AC/ACT family, combined with a lower power consumption.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

Figure 1: Pin Connection And IEC Logic Symbols

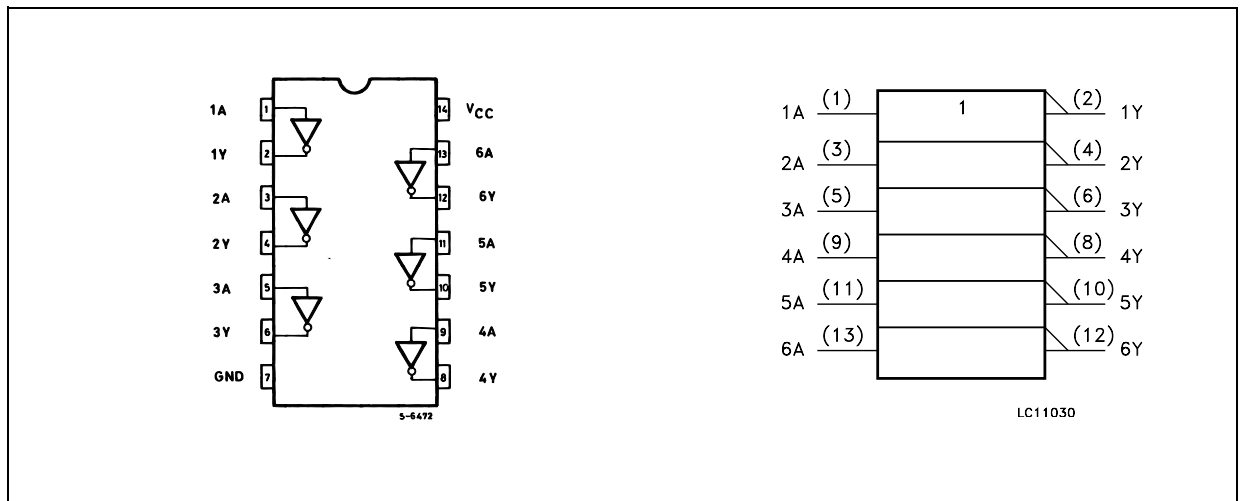


Figure 2: Input And Output Equivalent Circuit

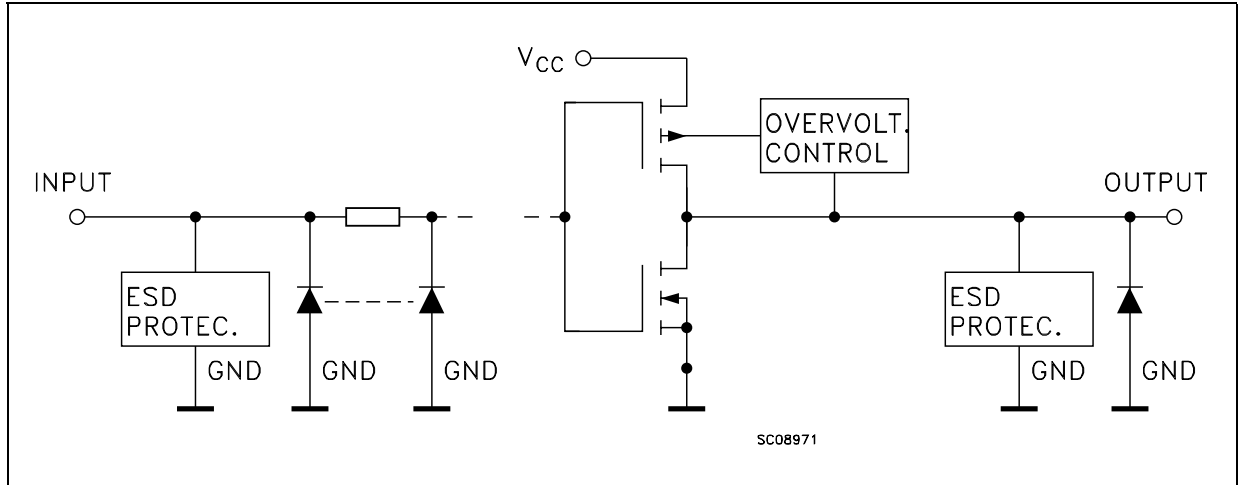


Table 2: Pin Description

| PIN N° | SYMBOL | NAME AND FUNCTION |
|--------------------|-----------------|-------------------------|
| 1,3,5,9,11,13 | 1A to 6A | Data Inputs |
| 2, 4, 6, 8, 10, 12 | 1Y to 6Y | Data Outputs |
| 7 | GND | Ground (0V) |
| 14 | V _{CC} | Positive Supply Voltage |

Table 3: Truth Table

| A | Y |
|---|---|
| L | H |
| H | L |

Table 4: Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|-------------------------------------|---|-------------------------------|------|
| V _{CC} | Supply Voltage | -0.5 to +7.0 | V |
| V _I | DC Input Voltage | -0.5 to +7.0 | V |
| V _O | DC Output Voltage (V _{CC} = 0V) | -0.5 to +7.0 | V |
| V _O | DC Output Voltage (High or Low State) (note 1) | -0.5 to V _{CC} + 0.5 | V |
| I _{IK} | DC Input Diode Current | - 50 | mA |
| I _{OK} | DC Output Diode Current (note 2) | - 50 | mA |
| I _O | DC Output Current | ± 50 | mA |
| I _{CC} or I _{GND} | DC V _{CC} or Ground Current per Supply Pin | ± 100 | mA |
| T _{stg} | Storage Temperature | -65 to +150 | °C |
| T _L | Lead Temperature (10 sec) | 300 | °C |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

1) I_O absolute maximum rating must be observed

2) V_O < GND

Table 5: Recommended Operating Conditions

| Symbol | Parameter | Value | Unit |
|------------------|--|---------------|-------------|
| V_{CC} | Supply Voltage (note 1) | 1.65 to 3.6 | V |
| V_I | Input Voltage | 0 to 5.5 | V |
| V_O | Output Voltage ($V_{CC} = 0V$) | 0 to 5.5 | V |
| V_O | Output Voltage (High or Low State) | 0 to V_{CC} | V |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 3.0$ to $3.6V$) | ± 24 | mA |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 2.7$ to $3.0V$) | ± 12 | mA |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 2.3$ to $2.7V$) | ± 8 | mA |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 1.65$ to $2.3V$) | ± 4 | mA |
| T_{op} | Operating Temperature | -55 to 125 | $^{\circ}C$ |
| dt/dv | Input Rise and Fall Time (note 2) | 0 to 10 | ns/V |

1) Truth Table guaranteed: 1.2V to 3.6V

2) V_{IN} from 0.8V to 2V at $V_{CC} = 3.0V$

Table 6: DC Specifications

| Symbol | Parameter | Test Condition | | Value | | | | Unit |
|-----------------|---------------------------|-----------------|--------------------------------|-----------------------|--------------|------------------------|--------------|---------|
| | | V_{CC} (V) | | -40 to 85 $^{\circ}C$ | | -55 to 125 $^{\circ}C$ | | |
| | | | | Min. | Max. | Min. | Max. | |
| V_{IH} | High Level Input Voltage | 1.65 to 1.95 | | $0.65V_{CC}$ | | $0.65V_{CC}$ | | V |
| | | 2.3 to 2.7 | | 1.7 | | 1.7 | | |
| | | 2.7 to 3.6 | | 2 | | 2 | | |
| V_{IL} | Low Level Input Voltage | 1.65 to 1.95 | | | $0.35V_{CC}$ | | $0.35V_{CC}$ | V |
| | | 2.3 to 2.7 | | | 0.7 | | 0.7 | |
| | | 2.7 to 3.6 | | | 0.8 | | 0.8 | |
| V_{OH} | High Level Output Voltage | 1.65 to 3.6 | $I_O = -100 \mu A$ | $V_{CC} - 0.2$ | | $V_{CC} - 0.2$ | | V |
| | | 1.65 | $I_O = -4 \text{ mA}$ | 1.2 | | 1.2 | | |
| | | 2.3 | $I_O = -8 \text{ mA}$ | 1.7 | | 1.7 | | |
| | | 2.7 | $I_O = -12 \text{ mA}$ | 2.2 | | 2.2 | | |
| | | 3.0 | $I_O = -18 \text{ mA}$ | 2.4 | | 2.4 | | |
| V_{OL} | Low Level Output Voltage | 1.65 to 3.6 | $I_O = 100 \mu A$ | | 0.2 | | 0.2 | V |
| | | 1.65 | $I_O = 4 \text{ mA}$ | | 0.45 | | 0.45 | |
| | | 2.3 | $I_O = 8 \text{ mA}$ | | 0.7 | | 0.7 | |
| | | 2.7 | $I_O = 12 \text{ mA}$ | | 0.4 | | 0.4 | |
| | | 3.0 | $I_O = 24 \text{ mA}$ | | 0.55 | | 0.55 | |
| I_I | Input Leakage Current | 3.6 | $V_I = 0$ to $5.5V$ | | ± 5 | | ± 5 | μA |
| I_{off} | Power Off Leakage Current | 0 | V_I or $V_O = 5.5V$ | | 100 | | 100 | μA |
| I_{CC} | Quiescent Supply Current | 3.6 | $V_I = V_{CC}$ or GND | | 10 | | 10 | μA |
| | | | V_I or $V_O = 3.6$ to $5.5V$ | | ± 10 | | ± 10 | |
| ΔI_{CC} | I_{CC} incr. per Input | 2.7 to 3.6 | $V_{IH} = V_{CC} - 0.6V$ | | 500 | | 500 | μA |

Table 7: Dynamic Switching Characteristics

| Symbol | Parameter | Test Condition | | Value | | | Unit |
|------------------|---|------------------------|---|------------------------|------|------|------|
| | | V _{CC} (V) | | T _A = 25 °C | | | |
| | | | | Min. | Typ. | Max. | |
| V _{OLP} | Dynamic Low Level Quiet Output (note 1) | 3.3 | C _L = 50pF V _{IL} = 0V, V _{IH} = 3.3V | | 0.8 | | V |
| V _{OLV} | | | | | -0.8 | | |

1) Number of output defined as "n". Measured with "n-1" outputs switching from HIGH to LOW or LOW to HIGH. The remaining output is measured in the LOW state.

Table 8: AC Electrical Characteristics

| Symbol | Parameter | Test Condition | | | | Value | | | | Unit |
|--|---------------------------------------|------------------------|------------------------|-----------------------|---|--------------|------|---------------|------|------|
| | | V _{CC} (V) | C _L (pF) | R _L (Ω) | t _s = t _r (ns) | -40 to 85 °C | | -55 to 125 °C | | |
| | | | | | | Min. | Max. | Min. | Max. | |
| t _{PLH} t _{PHL} | Propagation Delay Time | 1.65 to 1.95 | 30 | 1000 | 2.0 | | 9.5 | | 12.5 | ns |
| | | 2.3 to 2.7 | 30 | 500 | 2.0 | | 7.0 | | 10 | |
| | | 2.7 | 50 | 500 | 2.5 | | 5.5 | | 6.6 | |
| | | 3.0 to 3.6 | 50 | 500 | 2.5 | 1 | 4.5 | 1 | 5.4 | |
| t _{OSLH} t _{OSSL} | Output To Output Skew Time (note1, 2) | 2.7 to 3.6 | | | | | 1 | | 1 | ns |

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW (t_{OSLH} = |t_{PLHm} - t_{PLHn}|, t_{OSSL} = |t_{PHLm} - t_{PHLn}|)

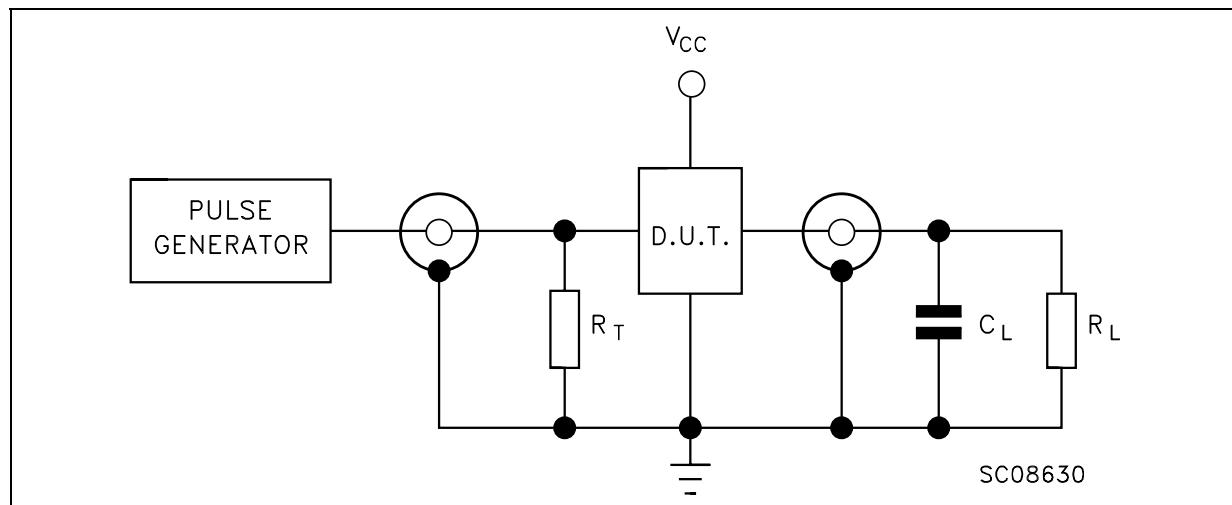
2) Parameter guaranteed by design

Table 9: Capacitive Characteristics

| Symbol | Parameter | Test Condition | | Value | | | Unit |
|-----------------|--|------------------------|-------------------------|------------------------|------|------|------|
| | | V _{CC} (V) | | T _A = 25 °C | | | |
| | | | | Min. | Typ. | Max. | |
| C _{IN} | Input Capacitance | | | | 4 | | pF |
| C _{PD} | Power Dissipation Capacitance (note 1) | 1.8 | f _{IN} = 10MHz | | 37 | | pF |
| | | 2.5 | | | 37 | | |
| | | 3.3 | | | 41 | | |

1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. I_{CC(OPR)} = C_{PD} × V_{CC} × f_{IN} + I_{CC}/n (per circuit)

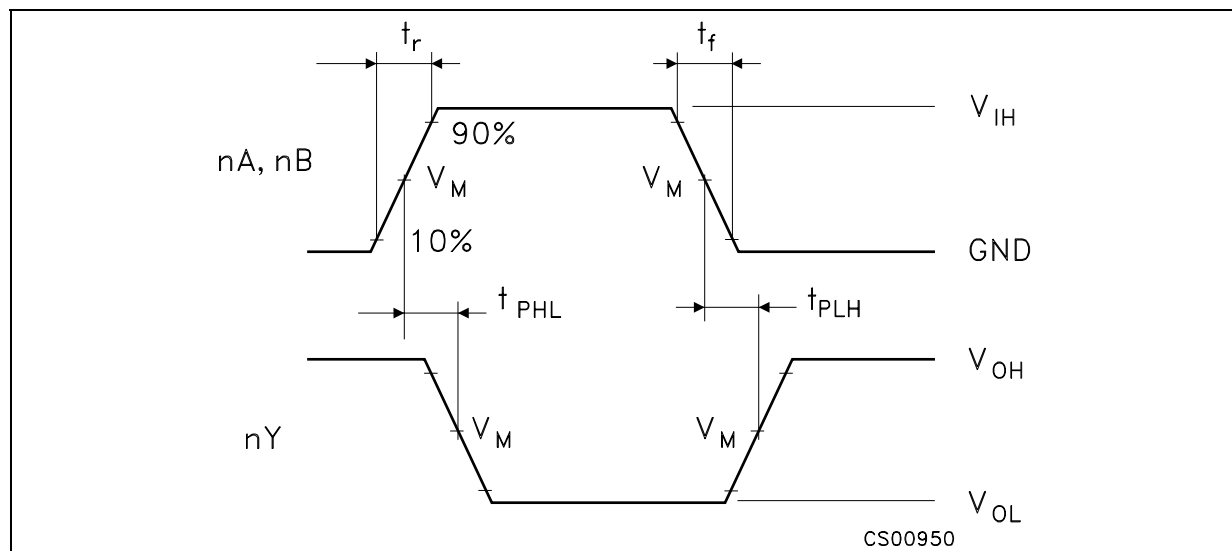
Figure 3: Test Circuit



$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

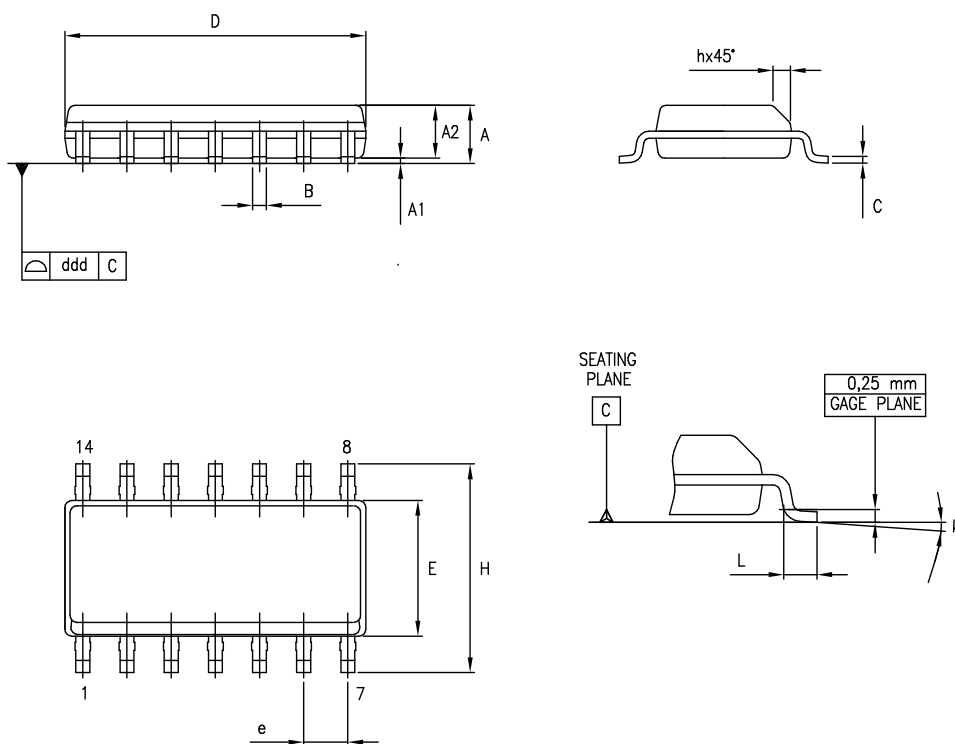
Table 10: Test Circuit And Waveform Symbol Value

| Symbol | V_{CC} | | | |
|-------------|---------------|-------------|-------------|-------------|
| | 1.65 to 1.95V | 2.3 to 2.7V | 2.7V | 3.0 to 3.6V |
| C_L | 30pF | 30pF | 50pF | 50pF |
| R_L | 1000Ω | 500Ω | 500Ω | 500Ω |
| V_{IH} | V_{CC} | V_{CC} | 2.7V | 2.7V |
| V_M | $V_{CC}/2$ | $V_{CC}/2$ | 1.5V | 1.5V |
| V_{OH} | V_{CC} | V_{CC} | 3.0V | 3.0V |
| $t_r = t_f$ | <2.0ns | <2.0ns | <2.5ns | <2.5ns |

Figure 4: Waveform - Propagation Delay ($f=1\text{MHz}$; 50% duty cycle)

SO-14 MECHANICAL DATA

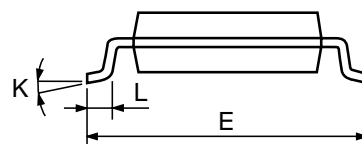
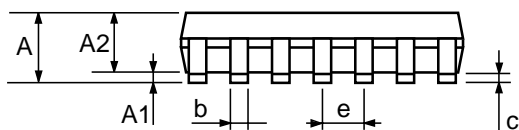
| DIM. | mm. | | | inch | | |
|------|------|------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 1.35 | | 1.75 | 0.053 | | 0.069 |
| A1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| A2 | 1.10 | | 1.65 | 0.043 | | 0.065 |
| B | 0.33 | | 0.51 | 0.013 | | 0.020 |
| C | 0.19 | | 0.25 | 0.007 | | 0.010 |
| D | 8.55 | | 8.75 | 0.337 | | 0.344 |
| E | 3.8 | | 4.0 | 0.150 | | 0.157 |
| e | | 1.27 | | | 0.050 | |
| H | 5.8 | | 6.2 | 0.228 | | 0.244 |
| h | 0.25 | | 0.50 | 0.010 | | 0.020 |
| L | 0.4 | | 1.27 | 0.016 | | 0.050 |
| k | 0° | | 8° | 0° | | 8° |
| ddd | | | 0.100 | | | 0.004 |



0016019D

TSSOP14 MECHANICAL DATA

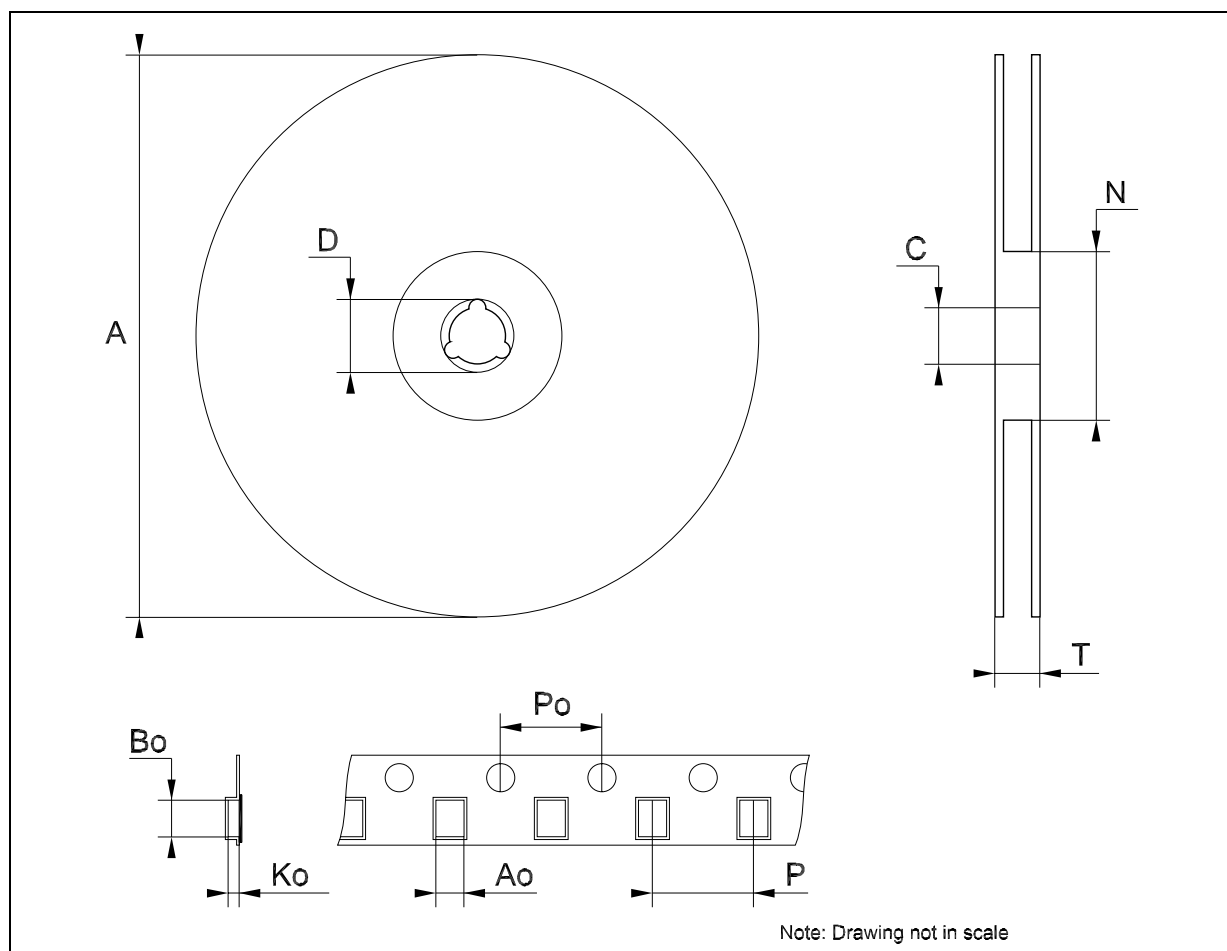
| DIM. | mm. | | | inch | | |
|------|------|----------|------|-------|------------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



0080337D

Tape & Reel SO-14 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-----|------|-------|------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.4 | | 6.6 | 0.252 | | 0.260 |
| Bo | 9 | | 9.2 | 0.354 | | 0.362 |
| Ko | 2.1 | | 2.3 | 0.082 | | 0.090 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |



Tape & Reel TSSOP14 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-----|------|-------|------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.7 | | 6.9 | 0.264 | | 0.272 |
| Bo | 5.3 | | 5.5 | 0.209 | | 0.217 |
| Ko | 1.6 | | 1.8 | 0.063 | | 0.071 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |



Table 11: Revision History

| Date | Revision | Description of Changes |
|-------------|-----------------|-----------------------------------|
| 26-Jul-2004 | 6 | Ordering Codes Revision - pag. 1. |

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