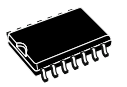
# HEX INVERTER (OPEN DRAIN)

- HIGH SPEED: $t_{PD}$ = 3.8ns (TYP.) at $V_{CC}$ = 5V
- LOW POWER DISSIPATION: $I_{CC}$ = 2 µA (MAX.) at $T_A$=25°C
- HIGH NOISE IMMUNITY: $V_{NIH} = V_{NIL}$ = 28% $V_{CC}$ (MIN.)
- POWER DOWN PROTECTION ON INPUTS
- OPERATING VOLTAGE RANGE: $V_{CC}$(OPR) = 2V to 5.5V
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 05
- IMPROVED LATCH-UP IMMUNITY
- LOW NOISE: $V_{OLP}$ = 0.8V (MAX.)



**SOP**

**TSSOP**

**Table 1: Order Codes**

| PACKAGE | T & R |
|---|---|
| SOP | 74VHC05MTR |
| TSSOP | 74VHC05TTR |

## DESCRIPTION

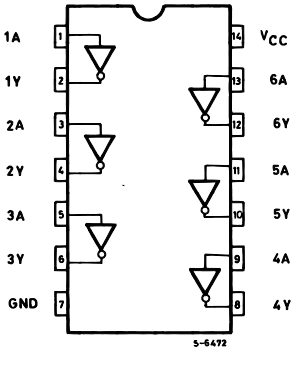
The 74VHC05 is an advanced high-speed CMOS OPEN DRAIN HEX INVERTER fabricated with sub-micron silicon gate and double-layer metal wiring $C^2MOS$ technology.

The internal circuit is composed of 3 stages including buffer output, which provides high noise immunity and stable output.

Power down protection is provided on all inputs and 0 to 7V can be accepted on inputs with no regard to the supply voltage. This device can be used to interface 5V to 3V.

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**



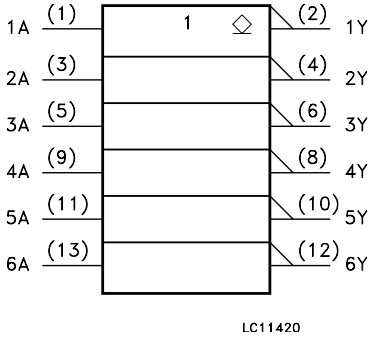



**Figure 2: Input Equivalent Circuit**

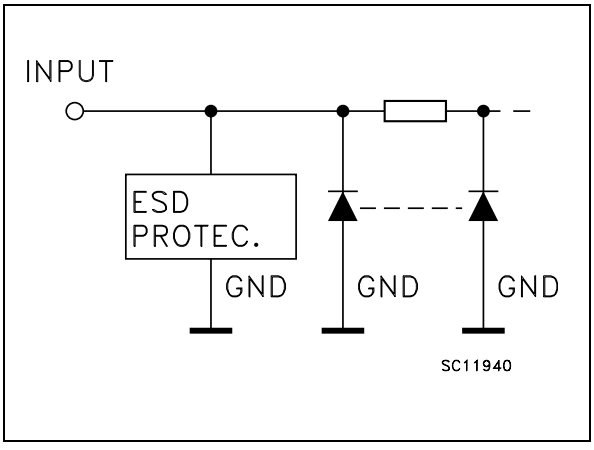



**Table 2: Pin Description**

| 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 | Z |
| H | L |

Z: High Impedance

**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 | -0.5 to $V_{CC}$ + 0.5 | V |
| $I_{IK}$ | DC Input Diode Current | - 20 | mA |
| $I_{OK}$ | DC Output Diode Current | ± 20 | mA |
| $I_O$ | DC Output Current | ± 25 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | ± 75 | 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

**Table 5: Recommended Operating Conditions**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 2 to 5.5 | V |
| $V_I$ | Input Voltage | 0 to 5.5 | V |
| $V_O$ | Output Voltage | 0 to $V_{CC}$ | V |
| $T_{op}$ | Operating Temperature | -55 to 125 | °C |
| dt/dv | Input Rise and Fall Time (note 1) ($V_{CC}$ = 3.3 ± 0.3V)<br>($V_{CC}$ = 5.0 ± 0.5V) | 0 to 100<br>0 to 20 | ns/V |

1) $V_{IN}$ from 30% to 70% of $V_{CC}$

**Table 6: DC Specifications**

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $V_{IH}$ | High Level Input Voltage | 2.0 | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 3.0 to 5.5 | | $0.7V_{CC}$ | | | $0.7V_{CC}$ | | $0.7V_{CC}$ | | |
| $V_{IL}$ | Low Level Input Voltage | 2.0 | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 3.0 to 5.5 | | | | $0.3V_{CC}$ | | $0.3V_{CC}$ | | $0.3V_{CC}$ | |
| $V_{OL}$ | Low Level Output Voltage | 2.0 | $I_O$=50 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 3.0 | $I_O$=50 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | $I_O$=50 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 3.0 | $I_O$=4 mA | | | 0.36 | | 0.44 | | 0.55 | |
| | | 4.5 | $I_O$=8 mA | | | 0.36 | | 0.44 | | 0.55 | |
| $I_{OZ}$ | High Impedance Output Leakage Current | 5.5 | $V_I = V_{IH}$ or $V_{IL}$<br>$V_O = V_{CC}$ or GND | | | ±0.25 | | ± 2.5 | | ± 2.5 | µA |
| $I_I$ | Input Leakage Current | 0 to 5.5 | $V_I$ = 5.5V or GND | | | ± 0.1 | | ± 1 | | ± 1 | µA |
| $I_{CC}$ | Quiescent Supply Current | 5.5 | $V_I = V_{CC}$ or GND | | | 2 | | 20 | | 20 | µA |

**Table 7: AC Electrical Characteristics** (Input $t_r = t_f$ = 3ns)

| Symbol | Parameter | Test Condition | | | Value | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | $C_L$ (pF) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | |
| | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_{PZL}$ | Output Enable Time | 3.3(*) | 15 | $R_L$ = 1 KΩ | | 5.0 | 7.1 | 1.0 | 8.5 | 1.0 | 8.5 | ns |
| | | 3.3(*) | 50 | $R_L$ = 1 KΩ | | 7.5 | 10.6 | 1.0 | 12.0 | 1.0 | 12.0 | |
| | | 5.0(**) | 15 | $R_L$ = 1 KΩ | | 3.8 | 5.5 | 1.0 | 6.5 | 1.0 | 6.5 | |
| | | 5.0(**) | 50 | $R_L$ = 1 KΩ | | 5.3 | 7.5 | 1.0 | 8.5 | 1.0 | 8.5 | |
| $t_{PLZ}$ | Output Disable Time | 3.3(*) | 50 | $R_L$ = 1 KΩ | | 7.5 | 10.6 | 1.0 | 12.0 | 1.0 | 12.0 | ns |
| | | 5.0(**) | 50 | $R_L$ = 1 KΩ | | 5.3 | 7.5 | 1.0 | 8.5 | 1.0 | 8.5 | |

(*) Voltage range is 3.3V ± 0.3V
(**) Voltage range is 5.0V ± 0.5V

### Table 8: Capacitive Characteristics

| Symbol | Parameter | Test Condition | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $C_{IN}$ | Input Capacitance | | | 6 | 10 | | 10 | | 10 | pF |
| $C_{OUT}$ | Output Capacitance | | | 8 | | | | | | pF |
| $C_{PD}$ | Power Dissipation Capacitance (note 1) | | | 3 | | | | | | pF |

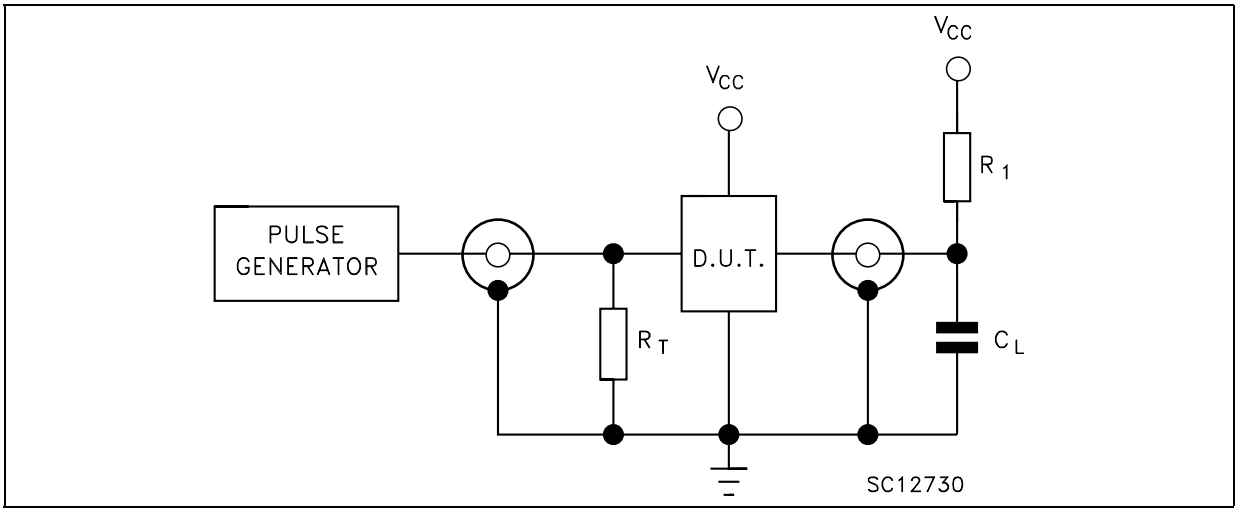
1) $C_{PD}$ is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/6$ (per gate)

### Table 9: Dynamic Switching Characteristics

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $V_{OLP}$ | Dynamic Low Voltage Quiet Output (note 1, 2) | 5.0 | $C_L$ = 50 pF | | 0.4 | 0.8 | | | | | V |
| $V_{OLV}$ | | | | -0.8 | -0.4 | | | | | | |
| $V_{IHD}$ | Dynamic High Voltage Input (note 1, 3) | 5.0 | | 3.5 | | | | | | | V |
| $V_{ILD}$ | Dynamic Low Voltage Input (note 1, 3) | 5.0 | | | | 1.5 | | | | | V |

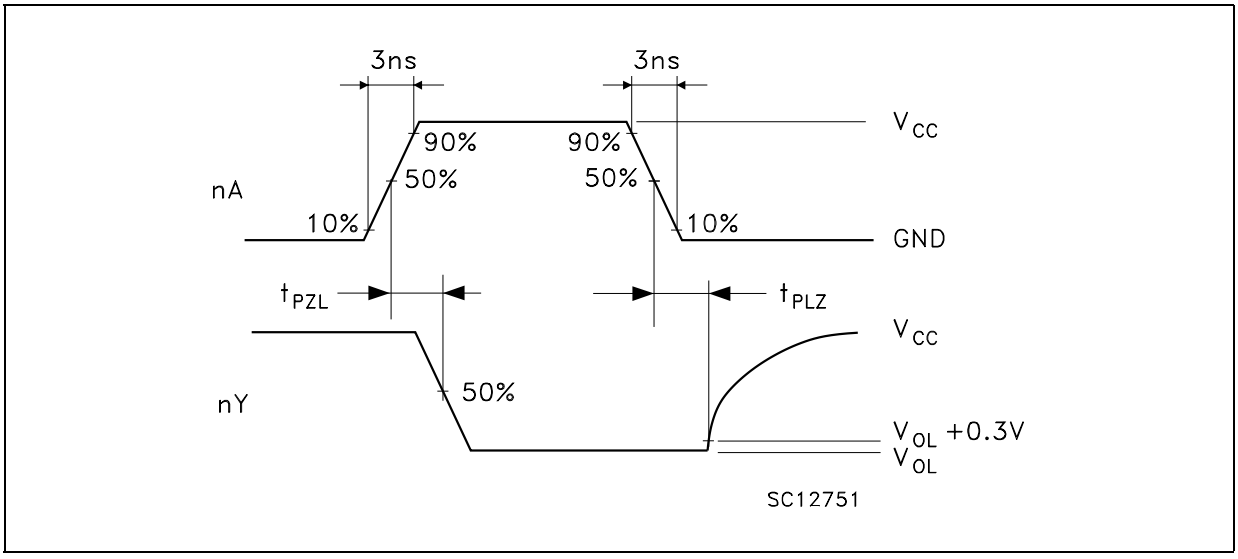
1) Worst case package.
2) Max number of outputs defined as (n). Data inputs are driven 0V to 5.0V, (n-1) outputs switching and one output at GND.
3) Max number of data inputs (n) switching. (n-1) switching 0V to 5.0V. Inputs under test switching: 5.0V to threshold ($V_{ILD}$), 0V to threshold ($V_{IHD}$), f=1MHz.

### Figure 3: Test Circuit



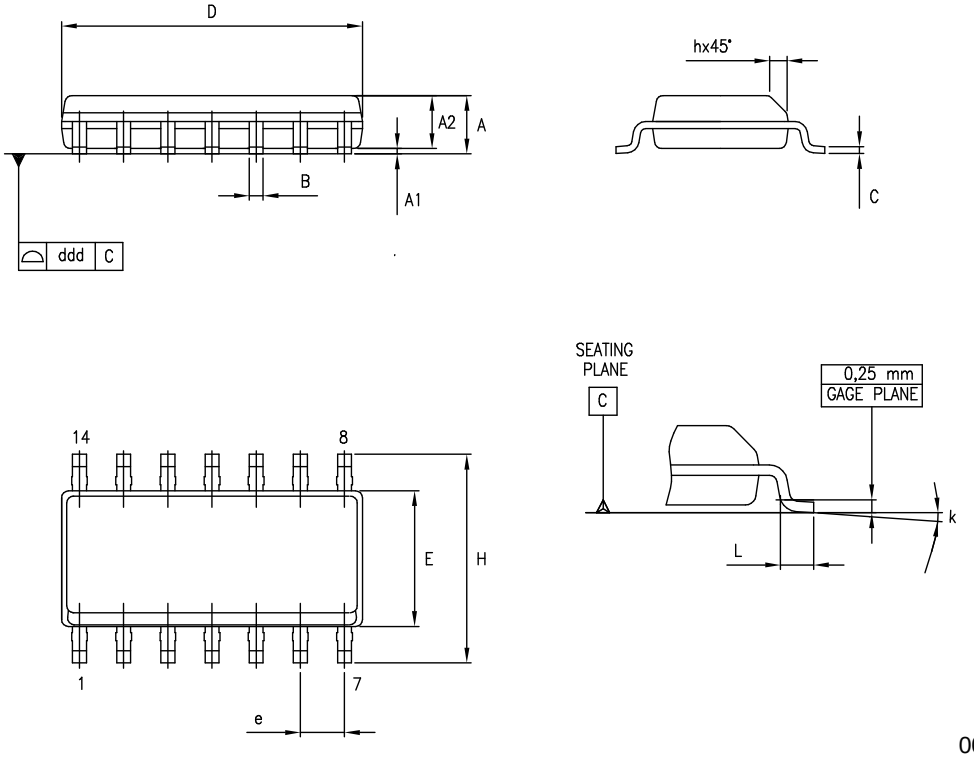

$C_L$ = 15/50pF or equivalent (includes jig and probe capacitance)
$R_L$ = R1 = 1KΩ or equivalent
$R_T$ = $Z_{OUT}$ of pulse generator (typically 50Ω)

**Figure 4: Waveform - Propagation Delays** (f=1MHz; 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 |

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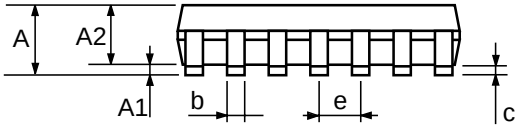
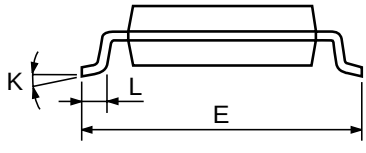
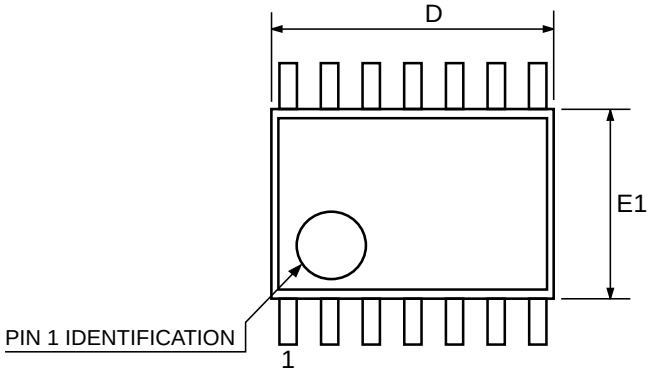
# TSSOP14 MECHANICAL DATA

| 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 |



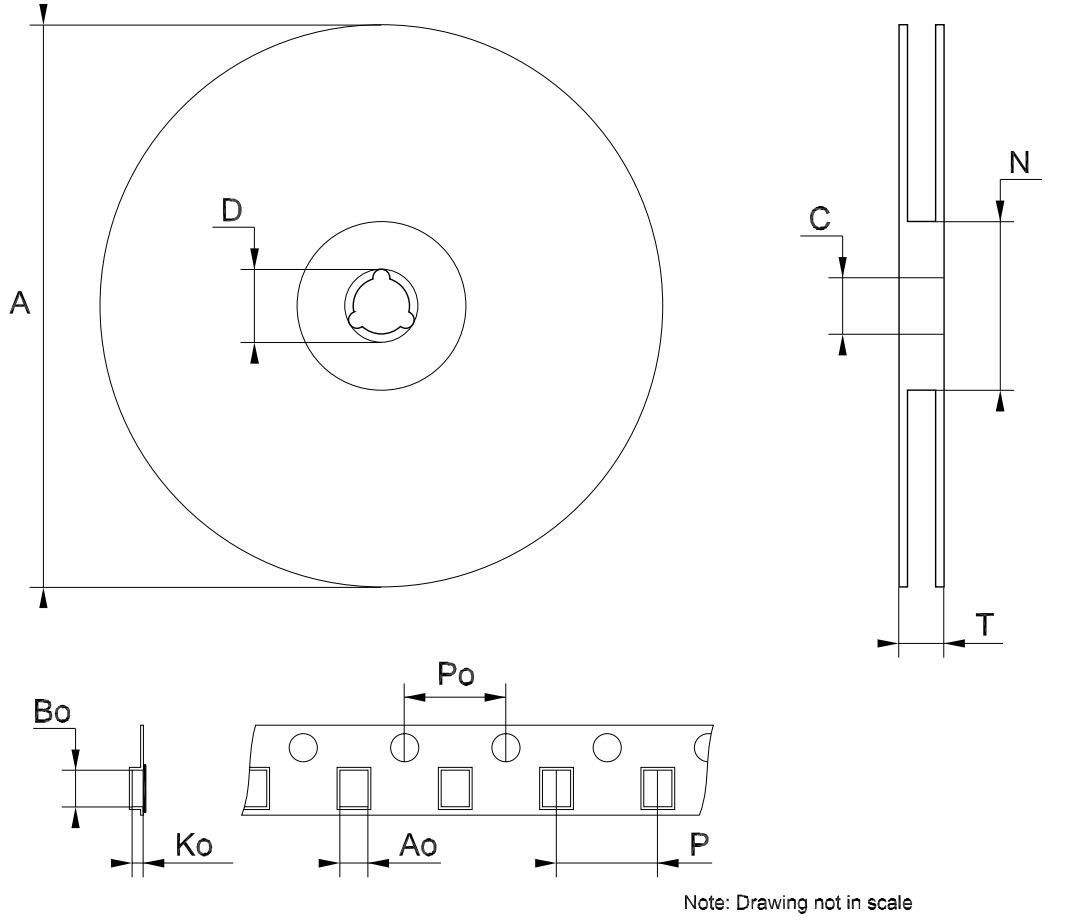




0080337D

## Tape & Reel SO-14 MECHANICAL DATA

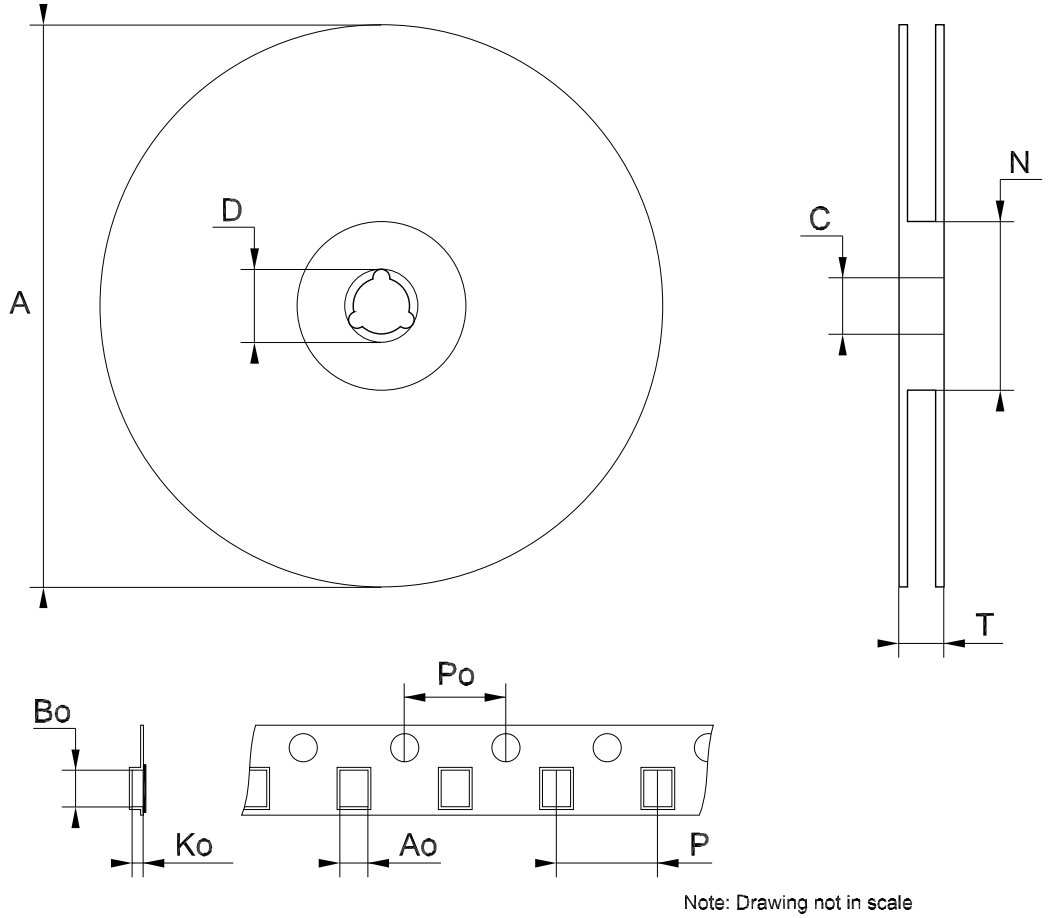
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.4 | | 6.6 | 0.252 | | 0.260 |
| Bo | 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 |




Note: Drawing not in scale

## 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 |




Note: Drawing not in scale

**Table 10: Revision History**

| Date | Revision | Description of Changes |
|---|---|---|
| 12-Nov-2004 | 5 | Order Codes Revision - pag. 1. |