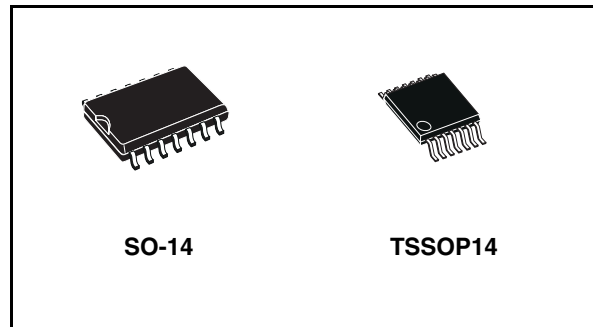


## HEX SCHMITT inverter

### Features

- High speed:  $t_{PD} = 5.5\text{ns}$  (typ.) at  $V_{CC} = 5\text{V}$
- Low power dissipation:  
 $I_{CC} = 2\ \mu\text{A}$  (Max.) at  $T_A = 25^\circ\text{C}$
- Typical hysteresis:  $V_h = 0.7\text{V}$  at  $V_{CC} = 4.5\text{V}$
- Power down protection on inputs & outputs
- Symmetrical output impedance:  
 $|I_{OH}| = I_{OL} = 8\ \text{mA}$  (Min)
- Balanced propagation delays:  
 $t_{PLH} \cong t_{PHL}$
- Operating voltage range:  
 $V_{CC}(\text{Opr}) = 4.5\text{V}$  to  $5.5\text{V}$
- Pin and function compatible with 74 series 14
- Improved latch-up immunity
- Low noise:  $V_{OLP} = 0.8\text{V}$  (Max.)



### Description

The 74VHCT14A is an advanced high-speed CMOS HEX SCHMITT inverter fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS 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 outputs 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 since all inputs are equipped with TTL threshold.

Pin configuration and function are the same as those of the 74VHC04 but the 74VHC14 has hysteresis.

This together with its schmitt trigger function allows it to be used on line receivers with slow rise/fall input signals.

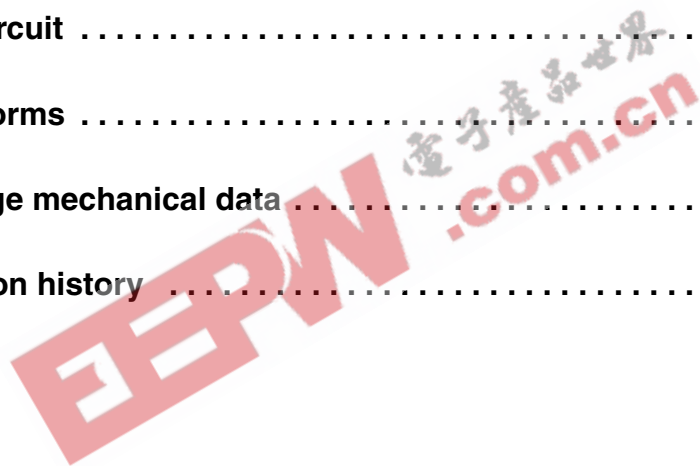
All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

**Table 1. Device summary**

| Part number  | Package | Packaging     |
|--------------|---------|---------------|
| 74VHCT14AMTR | SO-14   | Tape and reel |
| 74VHCT14ATTR | TSSOP14 | Tape and reel |

# Contents

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# 1 Logic symbols and I/O equivalent circuit

Figure 1. IEC logic symbols

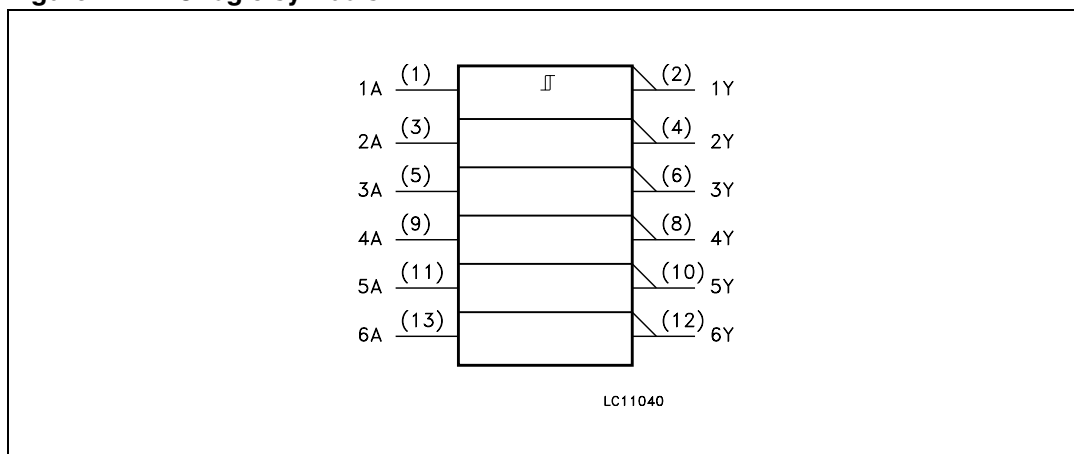
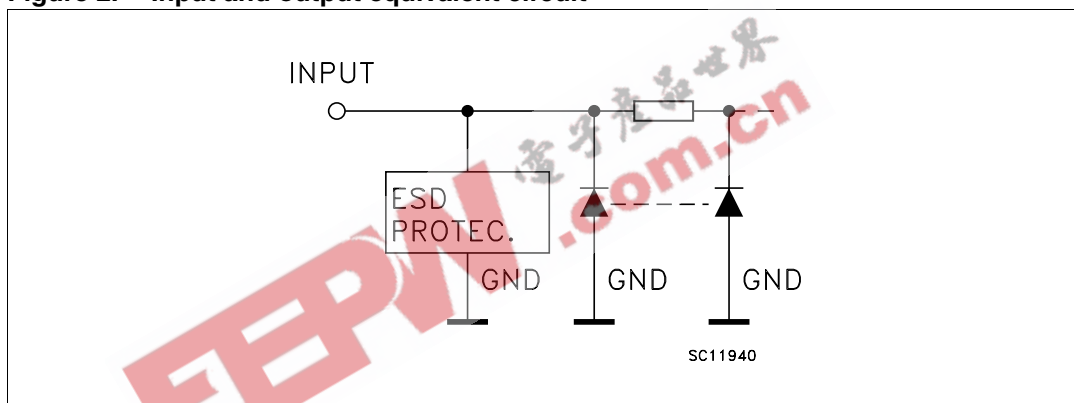


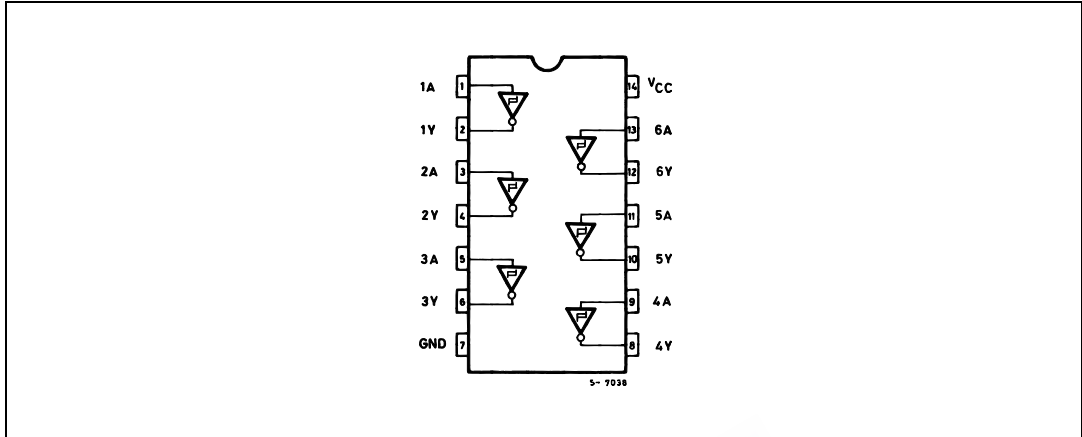
Figure 2. Input and output equivalent circuit



## 2 Pin settings

### 2.1 Pin connection

Figure 3. Pin connection (top through view)



### 2.2 Pin description

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 <sub>CC</sub> | Positive supply voltage |

### 2.3 Truth table

Table 3. Truth table

| Inputs   | Output   |
|----------|----------|
| <b>A</b> | <b>Y</b> |
| L        | H        |
| H        | L        |

### 3 Maximum rating

stressing the device above the rating listed in the “absolute maximum ratings” table may cause permanent damage to the device. these are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. exposure to absolute maximum rating conditions for extended periods may affect device reliability. refer also to the STMicroelectronics sure program and other relevant quality documents.

**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 <sup>(1)</sup> | -0.5 to +7.0           | V    |
| $V_O$     | DC output voltage <sup>(2)</sup> | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$  | DC input diode current           | - 20                   | mA   |
| $I_{OK}$  | DC output diode current          | $\pm 20$               | mA   |
| $I_O$     | DC output current                | $\pm 25$               | mA   |
| $I_{CC}$  | DC supply current per supply pin | $\pm 50$               | mA   |
| $I_{GND}$ | DC ground current per supply pin | $\pm 50$               | mA   |
| $T_{stg}$ | Storage temperature              | -65 to +150            | °C   |
| $T_L$     | Lead temperature (10 sec)        | 300                    | °C   |

1.  $V_{CC} = 0V$

2. High or low state

#### 3.1 Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol   | Parameter                     | Value         | Unit |
|----------|-------------------------------|---------------|------|
| $V_{CC}$ | Supply voltage                | 4.5 to 5.5    | V    |
| $V_I$    | Input voltage                 | 0 to 5.5      | V    |
| $V_O$    | Output voltage <sup>(1)</sup> | 0 to 5.5      | V    |
| $V_O$    | Output voltage <sup>(2)</sup> | 0 to $V_{CC}$ | V    |
| $T_{op}$ | Operating temperature         | -55 to 125    | °C   |

1.  $V_{CC} = 0V$

2. High or low state

## 4 Electrical characteristics

Table 6. DC specifications

| Symbol           | Parameter                            | Test condition         |  | Value                 |      |       |             |       |              | Unit  |      |
|------------------|--------------------------------------|------------------------|--|-----------------------|------|-------|-------------|-------|--------------|-------|------|
|                  |                                      | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |       | -40 to 85°C |       | -55 to 125°C |       |      |
|                  |                                      |                        |  | Min.                  | Typ. | Max.  | Min.        | Max.  | Min.         |       | Max. |
| V <sub>t+</sub>  | High level threshold voltage         | 4.5                    |  |                       |      | 2.0   |             | 2.0   |              | 2.0   | V    |
|                  |                                      | 5.5                    |  |                       |      | 2.0   |             | 2.0   |              | 2.0   |      |
| V <sub>t-</sub>  | Low level threshold voltage          | 4.5                    |  | 0.6                   |      |       | 0.6         |       | 0.6          |       | V    |
|                  |                                      | 5.5                    |  | 0.6                   |      |       | 0.6         |       | 0.6          |       |      |
| V <sub>h</sub>   | Hysteresis voltage                   | 4.5                    |  | 0.4                   |      | 1.4   | 0.4         | 1.4   | 0.4          | 1.4   | V    |
|                  |                                      | 5.5                    |  | 0.4                   |      | 1.5   | 0.4         | 1.5   | 0.4          | 1.5   |      |
| V <sub>OH</sub>  | High level output voltage            | 4.5                    | I <sub>O</sub> =-50 μA                                   | 4.4                   | 4.5  |       | 4.4         |       | 4.4          |       | V    |
|                  |                                      | 4.5                    | I <sub>O</sub> =-8 mA                                    | 3.94                  |      |       | 3.8         |       | 3.7          |       |      |
| V <sub>OL</sub>  | Low level output voltage             | 4.5                    | I <sub>O</sub> =50 μA                                    |                       | 0.0  | 0.1   |             | 0.1   |              | 0.1   | V    |
|                  |                                      | 4.5                    | I <sub>O</sub> =8 mA                                     |                       |      | 0.36  |             | 0.44  |              | 0.55  |      |
| I <sub>I</sub>   | Input leakage current                | 0 to 5.5               | V <sub>I</sub> = 5.5V or GND                             |                       |      | ± 0.1 |             | ± 1.0 |              | ± 1.0 | μA   |
| I <sub>CC</sub>  | Quiescent supply current             | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND                  |                       |      | 2     |             | 20    |              | 20    | μA   |
| +I <sub>CC</sub> | Additional worst case supply current | 5.5                    | One Input at 3.4V, other input at V <sub>CC</sub> or GND |                       |      | 1.35  |             | 1.5   |              | 1.5   | mA   |
| I <sub>OPD</sub> | Output leakage current               | 0                      | V <sub>OUT</sub> = 5.5V                                  |                       |      | 0.5   |             | 5.0   |              | 5.0   | μA   |

Table 7. AC electrical characteristics (Input  $t_r = t_f = 3\text{ns}$ )

| Symbol                 | Parameter                 | Test condition     |               |  | Value                    |      |      |                             |      |                              | Unit |      |
|------------------------|---------------------------|--------------------|---------------|--|--------------------------|------|------|-----------------------------|------|------------------------------|------|------|
|                        |                           | $V_{CC}$<br>(1)(V) | $C_L$<br>(pF) |  | $T_A = 25^\circ\text{C}$ |      |      | $-40$ to $85^\circ\text{C}$ |      | $-55$ to $125^\circ\text{C}$ |      |      |
|                        |                           |                    |               |  | Min.                     | Typ. | Max. | Min.                        | Max. | Min.                         |      | Max. |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation delay<br>time | 5.0                | 15            |  |                          | 5.5  | 7.6  | 1.0                         | 8.5  | 1.0                          | 9.5  | ns   |
|                        |                           | 5.0                | 50            |  |                          | 6.7  | 8.0  | 1.0                         | 9.5  | 1.0                          | 10.5 |      |

1. Voltage range is  $5.0\text{V} \pm 0.5\text{V}$

Table 8. Capacitive characteristics

| Symbol   | Parameter                            | Test condition |  |  | Value                    |      |      |                             |      |                              | Unit |      |
|----------|--------------------------------------|----------------|--|--|--------------------------|------|------|-----------------------------|------|------------------------------|------|------|
|          |                                      |                |  |  | $T_A = 25^\circ\text{C}$ |      |      | $-40$ to $85^\circ\text{C}$ |      | $-55$ to $125^\circ\text{C}$ |      |      |
|          |                                      |                |  |  | Min.                     | Typ. | Max. | Min.                        | Max. | Min.                         |      | Max. |
| $C_{IN}$ | Input capacitance                    |                |  |  |                          | 6    | 10   |                             | 10   |                              | 10   | pF   |
| $C_{PD}$ | Power dissipation<br>capacitance (1) |                |  |  |                          | 20   |      |                             |      |                              |      | 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)

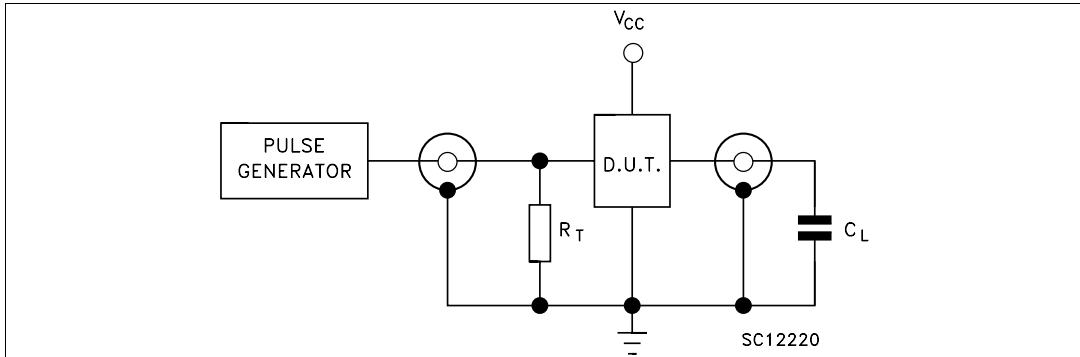
Table 9. Dynamic switching characteristics

| Symbol    | Parameter                                      | Test condition  |                      |      | Value                    |      |      |                             |      |                              | Unit |      |
|-----------|--|-----------------|----------------------|------|--------------------------|------|------|-----------------------------|------|------------------------------|------|------|
|           |  | $V_{CC}$<br>(V) |                      |      | $T_A = 25^\circ\text{C}$ |      |      | $-40$ to $85^\circ\text{C}$ |      | $-55$ to $125^\circ\text{C}$ |      |      |
|           |  |                 |                      |      | Min.                     | Typ. | Max. | Min.                        | Max. | Min.                         |      | Max. |
| $V_{OLP}$ | Dynamic low<br>voltage quiet<br>output (1) (2) | 5.0             | $C_L = 50\text{ pF}$ |      | 0.3                      | 0.8  |      |                             |      |                              |      | V    |
| $V_{OLV}$ |  |                 |                      | -0.8 | -0.3                     |      |      |                             |      |                              |      |      |
| $V_{IHD}$ | Dynamic high<br>voltage input (1) (3)          | 5.0             |                      |      |                          |      |      |                             |      |                              | V    |      |
| $V_{ILD}$ | Dynamic low<br>voltage input (1) (3)           | 5.0             |                      |      |                          |      | 0.6  |                             |      |                              |      | 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 ( $V_{IHD}$ ),  $f = 1\text{MHz}$ .

## 5 Test circuit

Figure 4. Test circuit

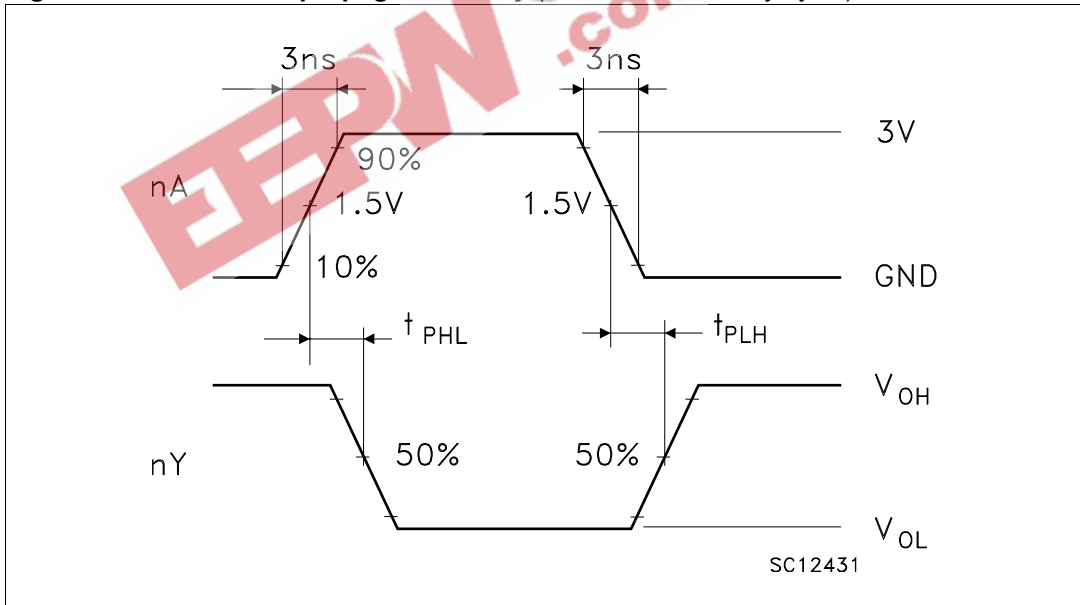


$C_L = 15/50\text{pF}$  or equivalent (includes jig and probe capacitance)

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

## 6 Waveforms

Figure 5. Waveform - propagation delay ( $f = 1\text{MHz}$ ; 50% duty cycle)





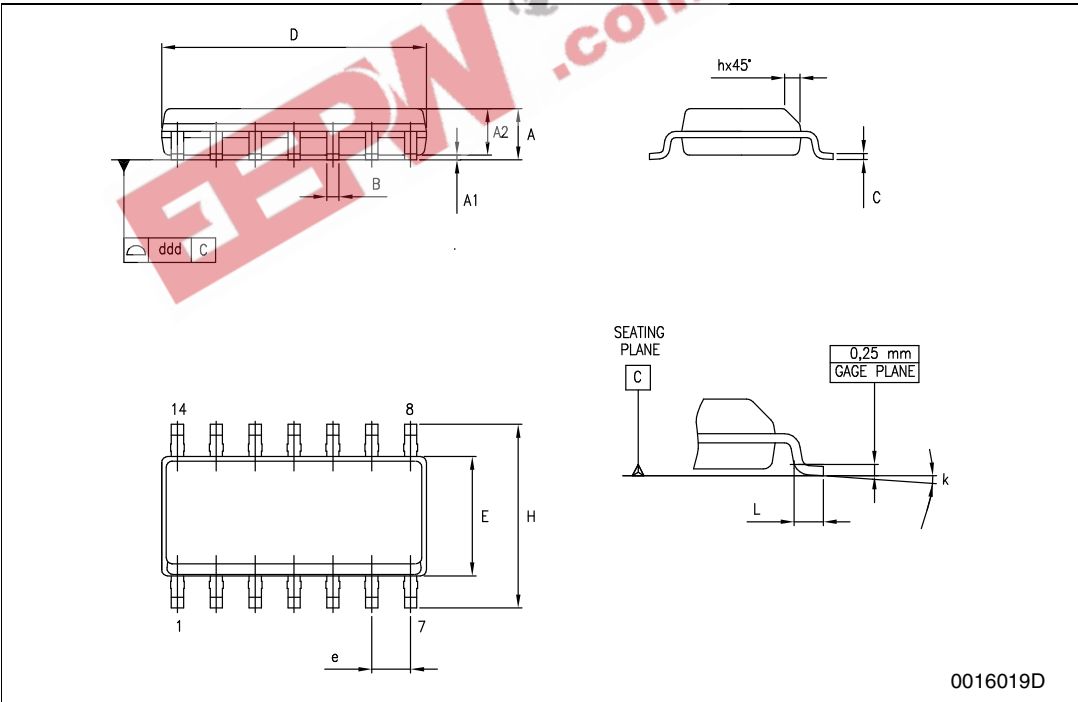
## 7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

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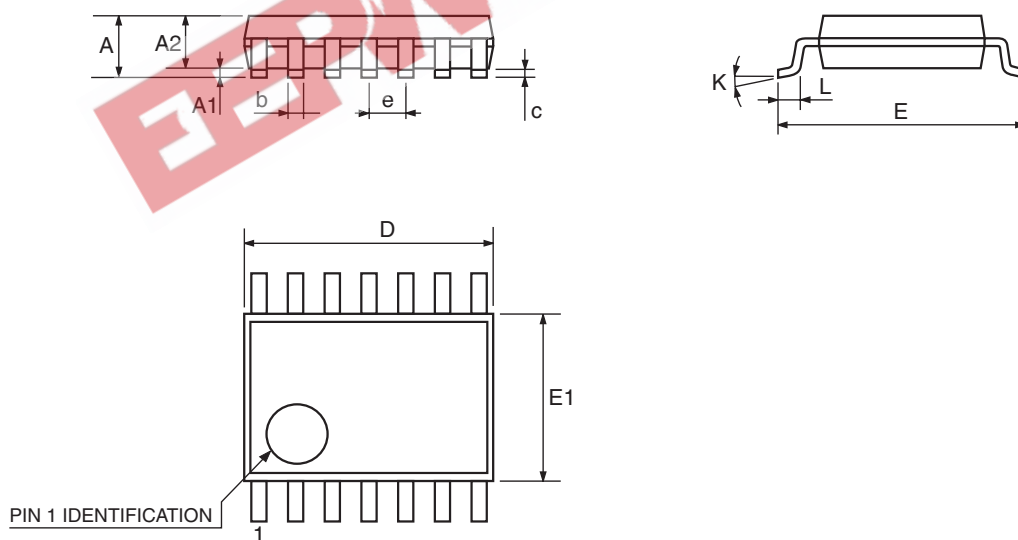
**SO-14 MECHANICAL DATA**

| 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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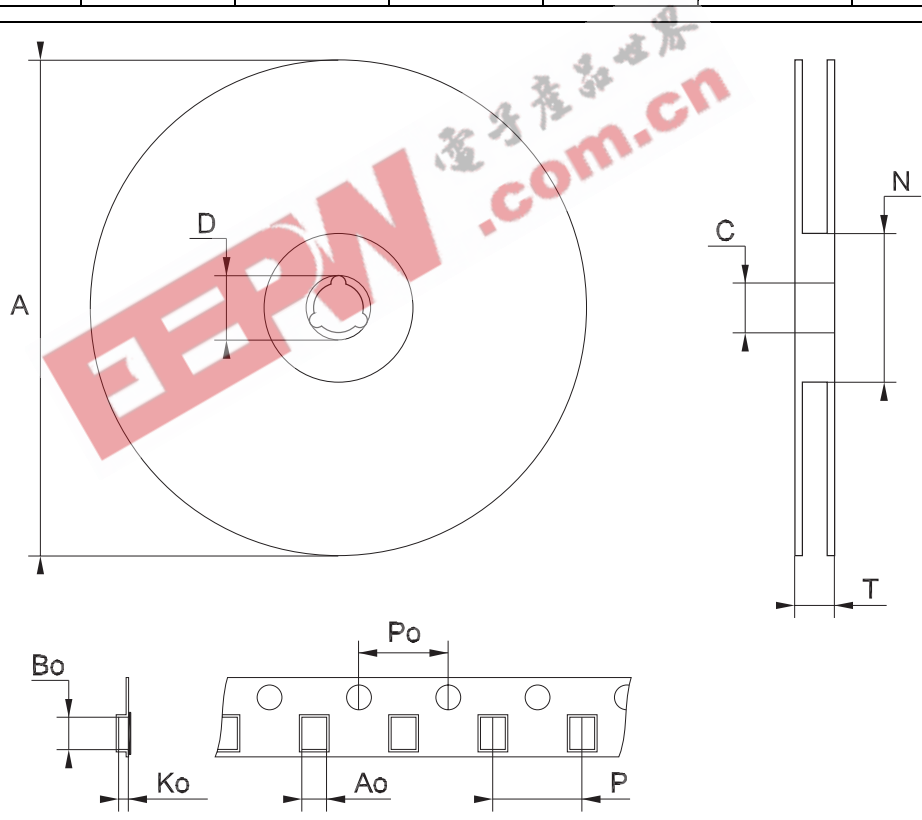
| TSSOP14 MECHANICAL DATA |      |          |      |       |            |        |
|-------------------------|------|----------|------|-------|------------|--------|
| DIM.                    | mm.  |          |      | inch  |            |        |
|                         | MIN. | TYP      | MAX. | 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  |



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**Tape & Reel SO-14 MECHANICAL DATA**

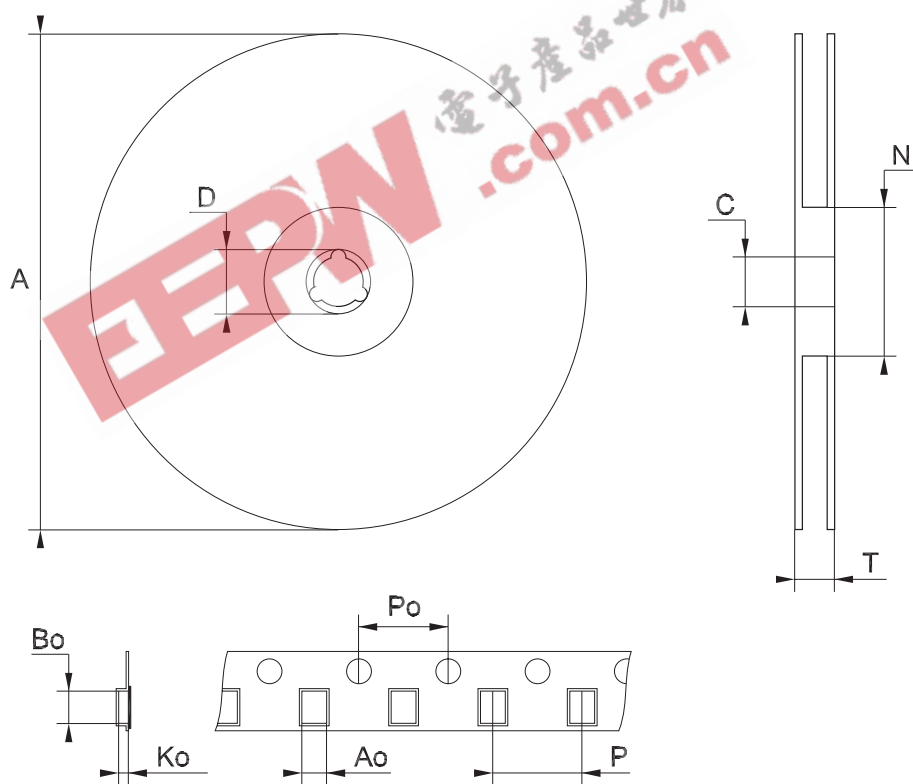
| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| 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 &amp; 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

## 8 Revision history

Table 10. Revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 12-Nov-2004 | 1        | First release   |
| 03-May-2007 | 2        | Document reformatted, updated <a href="#">Table 6 on page 6</a> |

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