

## Low-voltage CMOS quad bus buffer (3-state) with 5 V tolerant inputs and outputs

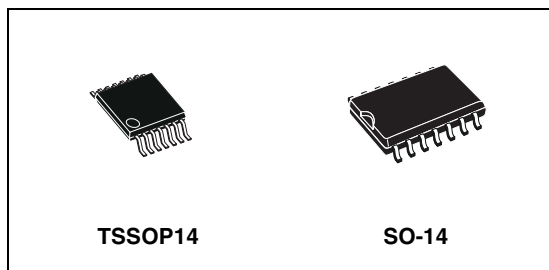
Datasheet – production data

### Features

- 5 V tolerant inputs and outputs
- High speed
  - $t_{PD} = 5.2 \text{ ns (max.)}$  at  $V_{CC} = 3 \text{ V}$
- Power-down protection on inputs and outputs
- Symmetrical output impedance
  - $|I_{OHL}| = I_{OL} = 24 \text{ mA (min.)}$  at  $V_{CC} = 3 \text{ V}$
- PCI bus levels guaranteed at 24 mA
- Balanced propagation delay
  - $t_{PLH} \cong t_{PHL}$
- Operating voltage range
  - $V_{CC} \text{ (opr.)} = 2.0 \text{ V to } 3.6 \text{ V}$
- Pin and function compatible with 74 series 125
- Latch-up performance exceeds 500 mA (JESD 17)
- ESD performance
  - HBM: 2000 V (MIL STD 883 method 3015)
  - MM: 200 V
  - CDM: 1000 V

### Applications

- Automotive
- Industrial
- Computer
- Consumer



### Description

The 74LCX125 device is a low-voltage CMOS quad bus buffer manufactured with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology. It is ideal for low-power and high-speed 3.3 V applications and can be interfaced to a 5 V signal environment for both inputs and outputs.

The device requires the 3-state control input  $\bar{G}$  to be set high to place the output in the high impedance state.

It has the same speed performance at 3.3 V as the 5 V AC/ACT family, combined with lower power consumption.

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

**Table 1. Device summary**

| Order code                  | Temperature range | Package                    | Packaging     | Marking   |
|-----------------------------|-------------------|----------------------------|---------------|-----------|
| 74LCX125TTR                 | -40/+85 °C        | TSSOP14                    | Tape and reel | LCX125    |
| 74LCX125YTTR <sup>(1)</sup> | -40/+85 °C        | TSSOP14 (automotive grade) | Tape and reel | LCX125Y   |
| 74LCX125MTR                 | -40/+85 °C        | SO-14                      | Tape and reel | 74LCX125  |
| 74LCX125YMTR <sup>(1)</sup> | -40/+85 °C        | SO-14 (automotive grade)   | Tape and reel | 74LCX125Y |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

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# 1 Logic symbols and I/O equivalent circuit

Figure 1. IEC logic symbols

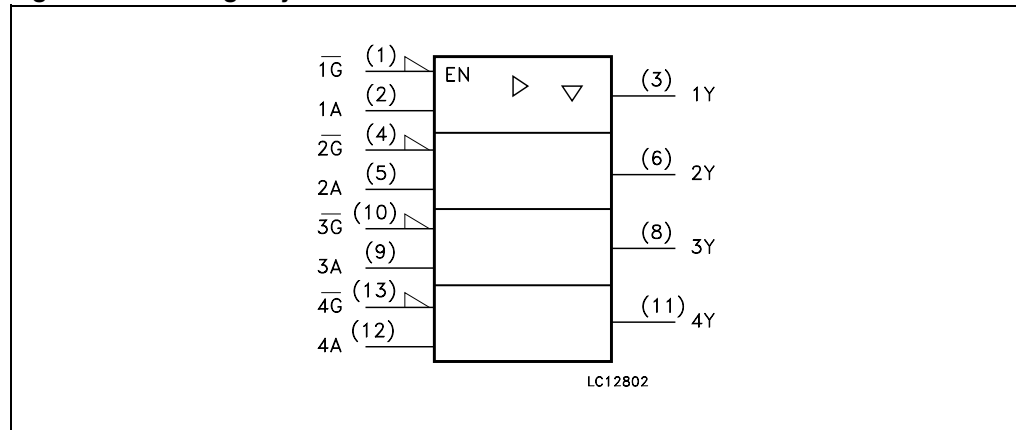
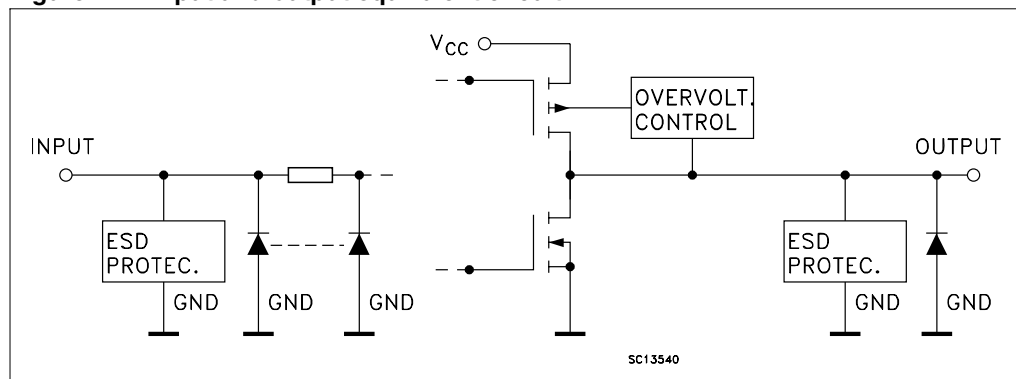


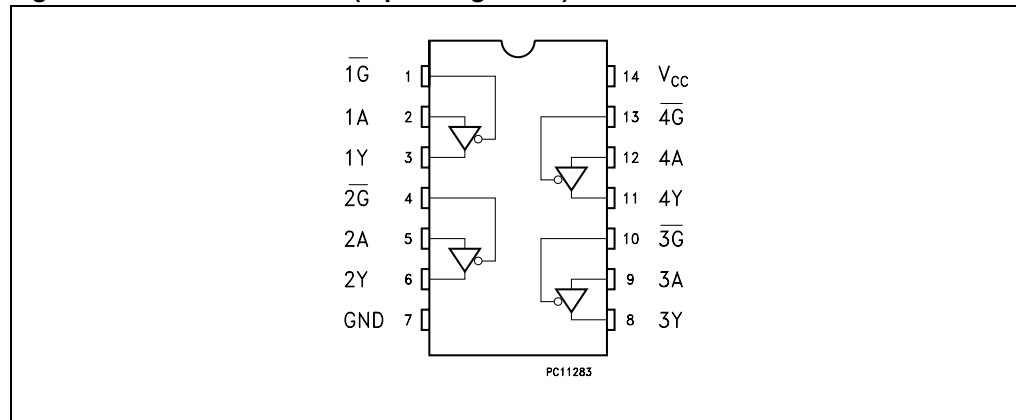
Figure 2. Input and output equivalent circuit



## 2 Pin settings

### 2.1 Pin connections

Figure 3. Pin connections (top through view)



### 2.2 Pin description

Table 2. Pin description

| Pin number   | Symbol                   | Name and function       |
|--------------|--------------------------|-------------------------|
| 1, 4, 10, 13 | $1\bar{G}$ TO $4\bar{G}$ | Output enable input     |
| 2, 5, 9, 12  | 1A TO 4A                 | Data inputs             |
| 3, 6, 8, 11  | 1Y TO 4Y                 | Data outputs            |
| 7            | GND                      | Ground (0 V)            |
| 14           | $V_{CC}$                 | Positive supply voltage |

### 2.3 Truth table

Table 3. Truth table

| Inputs    |           | Output    |
|-----------|-----------|-----------|
| A         | $\bar{G}$ | Y         |
| $X^{(1)}$ | H         | $Z^{(2)}$ |
| L         | L         | L         |
| H         | L         | H         |

1. "Do not care".

2. High impedance.

### 3 Maximum ratings

Stressing the device above the rating listed in [Table 4: Absolute maximum ratings](#) 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 [Table 5: Recommended operating conditions](#) of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**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 ( $V_{CC} = 0$ V)                  | -0.5 to +7.0           | V    |
| $V_O$     | DC output voltage (high or low state) <sup>(1)</sup> | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$  | DC input diode current                               | -50                    | mA   |
| $I_{OK}$  | DC output diode current <sup>(2)</sup>               | -50                    | mA   |
| $I_O$     | DC output current                                    | $\pm 50$               | mA   |
| $I_{CC}$  | DC supply current per supply pin                     | $\pm 100$              | mA   |
| $I_{GND}$ | DC ground current per supply pin                     | $\pm 100$              | mA   |
| $T_{stg}$ | Storage temperature                                  | -65 to +150            | °C   |
| $T_L$     | Lead temperature (10 sec.)                           | 300                    | °C   |

1.  $I_O$  absolute maximum rating must be observed.
2.  $V_O < GND$ .

### Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol           | Parameter   | Value         | Unit |
|------------------|---|---------------|------|
| $V_{CC}$         | Supply voltage <sup>(1)</sup>                               | 2.0 to 3.6    | V    |
| $V_I$            | Input voltage   | 0 to 5.5      | V    |
| $V_O$            | Output voltage ( $V_{CC} = 0$ V)                            | 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 3.6 V) | $\pm 24$      | mA   |
| $I_{OH}, I_{OL}$ | High or low level output current ( $V_{CC} = 2.7$ V)        | $\pm 12$      | mA   |
| dt/dv            | Input rise and fall time <sup>(2)</sup>                     | 0 to 10       | ns/V |

1. Truth table guaranteed: 1.5 V to 3.6 V.
2.  $V_{IN}$  from 0.8 V to 2 V at  $V_{CC} = 3.0$  V.

## 4 Electrical characteristics

Table 6. DC specifications

| Symbol           | Parameter                             | Test condition         |  | Value                 |      | Unit |
|------------------|---------------------------------------|------------------------|--|-----------------------|------|------|
|                  |                                       | V <sub>CC</sub><br>(V) |  | -40 to 85 °C          |      |      |
|                  |                                       |                        |  | Min.                  | Max. |      |
| V <sub>IH</sub>  | High level input voltage              | 2.7 to 3.6             |  | 2.0                   |      | V    |
| V <sub>IL</sub>  | Low level input voltage               |                        |  |                       |      | 0.8  |
| V <sub>OH</sub>  | High level output voltage             | 2.7 to 3.6             | I <sub>O</sub> = -100 μA   | V <sub>CC</sub> - 0.2 |      | V    |
|                  |                                       | 2.7                    | I <sub>O</sub> = -12 mA  | 2.2                   |      |      |
|                  |                                       | 3.0                    | I <sub>O</sub> = -18 mA  | 2.4                   |      |      |
|                  |                                       |                        | I <sub>O</sub> = -24 mA  | 2.2                   |      |      |
| V <sub>OL</sub>  | Low level output voltage              | 2.7 to 3.6             | I <sub>O</sub> = 100 μA  |                       | 0.2  | V    |
|                  |                                       | 2.7                    | I <sub>O</sub> = 12 mA   |                       | 0.4  |      |
|                  |                                       | 3.0                    | I <sub>O</sub> = 16 mA   |                       | 0.4  |      |
|                  |                                       |                        | I <sub>O</sub> = 24 mA   |                       | 0.55 |      |
| I <sub>I</sub>   | Input leakage current                 | 2.7 to 3.6             | V <sub>I</sub> = 0 to 5.5 V  |                       | ±5   | μA   |
| I <sub>off</sub> | Power OFF leakage current             | 0                      | V <sub>I</sub> or V <sub>O</sub> = 5.5 V   |                       | 10   | μA   |
| I <sub>OZ</sub>  | High Impedance output leakage current | 2.7 to 3.6             | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = 0 to V <sub>CC</sub> |                       | ±5   | μA   |
| I <sub>CC</sub>  | Quiescent supply current              | 2.7 to 3.6             | V <sub>I</sub> = V <sub>CC</sub> or GND  |                       | 10   | μA   |
|                  |                                       |                        | V <sub>I</sub> or V <sub>O</sub> = 3.6 to 5.5 V  |                       | ±10  |      |
| ΔI <sub>CC</sub> | I incr. per input                     | 2.7 to 3.6             | V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V  |                       | 500  | μA   |

Table 7. Dynamic switching characteristics

| Symbol           | Parameter                                     | Test condition         |  | Value                  |      |      | Unit |
|------------------|---|------------------------|--|------------------------|------|------|------|
|                  |   | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25 °C |      |      |      |
|                  |   |                        |  | Min.                   | Typ. | Max. |      |
| V <sub>OLP</sub> | Dynamic low level quiet output <sup>(1)</sup> | 3.3                    | C <sub>L</sub> = 50 pF<br>V <sub>IL</sub> = 0 V, V <sub>IH</sub> = 3.3 V |                        | 0.8  |      | V    |
| V <sub>OLV</sub> |   |                        |  |                        | -0.8 |      |      |

1. Number of outputs 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 <sub>CC</sub><br>(V) | C <sub>L</sub><br>(pF) | R <sub>L</sub><br>(Ω) | t <sub>s</sub> = t <sub>r</sub><br>(ns) | -40 to 85 °C |      |      |
|  |   |                        |                        |                       |   | Min.         | Max. |      |
| t <sub>PLH</sub> , t <sub>PHL</sub>    | Propagation delay time                        | 2.7                    | 50                     | 500                   | 2.5                                     |              | 6.0  | ns   |
|  |   | 3.0 to 3.6             |                        |                       |   | 1.0          | 5.2  |      |
| t <sub>PZL</sub> , t <sub>PZH</sub>    | Output enable time to HIGH and LOW level      | 2.7                    | 50                     | 500                   | 2.5                                     | 1.0          | 6.0  | ns   |
|  |   | 3.0 to 3.6             |                        |                       |   | 1.0          | 5.0  |      |
| t <sub>PLZ</sub> , t <sub>PHZ</sub>    | Output disable time to HIGH and LOW level     | 2.7                    | 50                     | 500                   | 2.5                                     | 1.0          | 6.0  | ns   |
|  |   | 3.0 to 3.6             |                        |                       |   | 1.0          | 5.0  |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output to output skew time <sup>(1) (2)</sup> | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     |              | 1.0  | ns   |

- 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 ( $t_{OSLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{OSHL} = |t_{PLHm} - t_{PLHn}|$ ).
- Parameter guaranteed by design.

**Table 9. Capacitive characteristics**

| Symbol           | Parameter                                    | Test condition         |  | Value                  |      |      | Unit |
|------------------|--|------------------------|--|------------------------|------|------|------|
|                  |  | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25 °C |      |      |      |
|                  |  |                        |  | Min.                   | Typ. | Max. |      |
| C <sub>IN</sub>  | Input capacitance                            | 3.3                    | V <sub>IN</sub> = 0 to V <sub>CC</sub>                             |                        | 5    |      | pF   |
| C <sub>OUT</sub> | Output capacitance                           | 3.3                    | V <sub>IN</sub> = 0 to V <sub>CC</sub>                             |                        | 10   |      | pF   |
| C <sub>PD</sub>  | Power dissipation capacitance <sup>(1)</sup> | 3.3                    | f <sub>IN</sub> = 10 MHz<br>V <sub>IN</sub> = 0 or V <sub>CC</sub> |                        | 37   |      | pF   |

- C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to [Table 10: Test circuit](#). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/4$  (per gate).

## 5 Test circuit

Figure 4. Test circuit

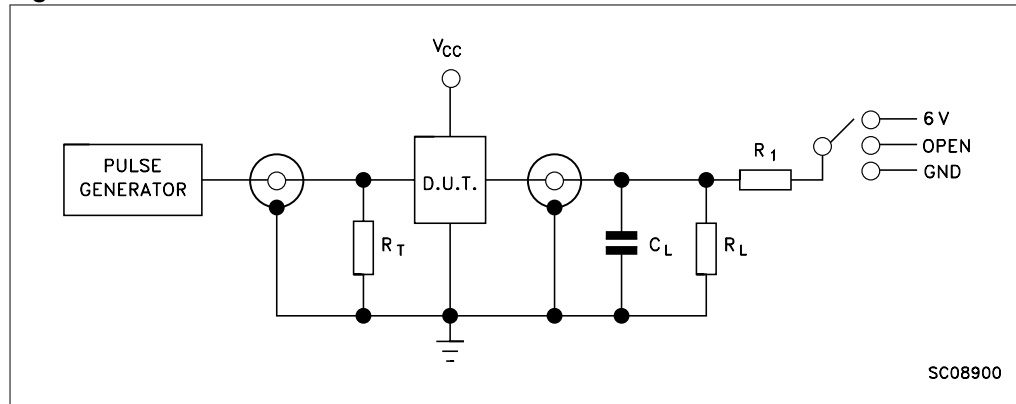


Table 10. Test circuit

| Test                  | Switch |
|-----------------------|--------|
| $t_{PLH}$ , $t_{PHL}$ | Open   |
| $t_{PZL}$ , $t_{PLZ}$ | 6 V    |
| $t_{PZH}$ , $t_{PHZ}$ | GND    |

Note:  $C_L = 50 \text{ pF}$  or equivalent (includes jig and probe capacitance)  
 $R_L = 500 \text{ } \Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50 \text{ } \Omega$ ).



## 6 Waveforms

Figure 5. Propagation delay (f = 1 MHz; 50% duty cycle)

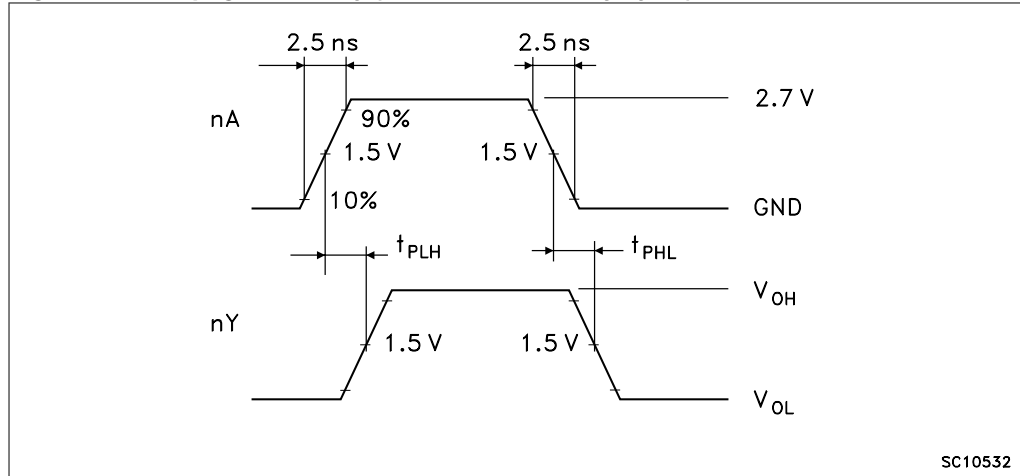
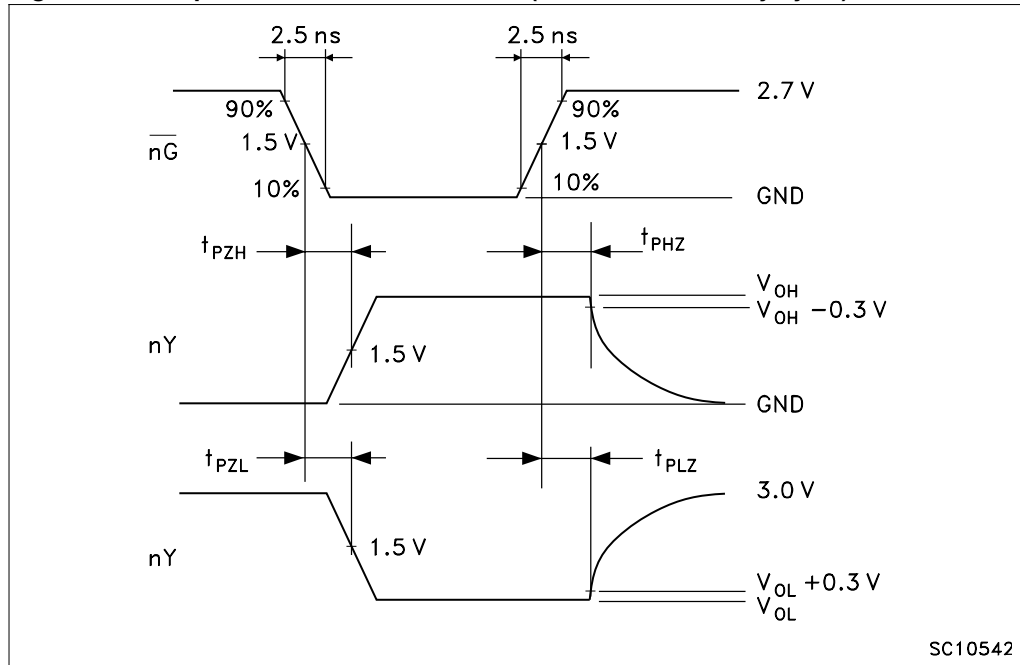


Figure 6. Output enable and disable time (f = 1 MHz; 50% duty cycle)



## 7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Figure 7. SO-14 package outline

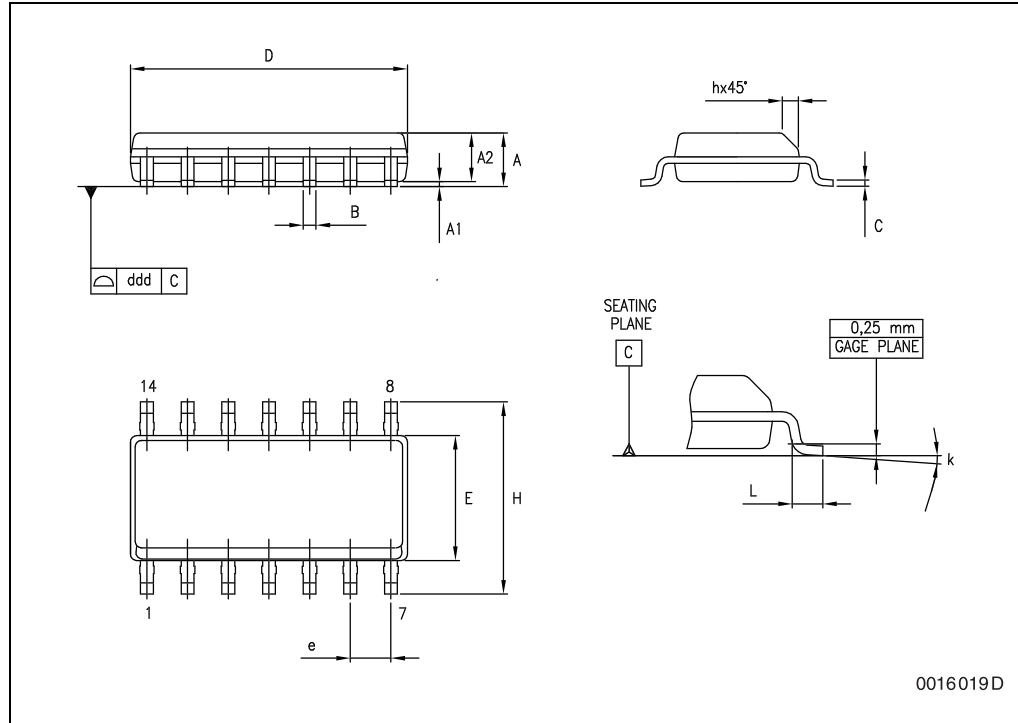


Table 11. SO-14 package mechanical data

| Symbol | Dimensions |      |       |       |       |       |
|--------|------------|------|-------|-------|-------|-------|
|        | 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 |

Figure 8. TSSOP14 package outline

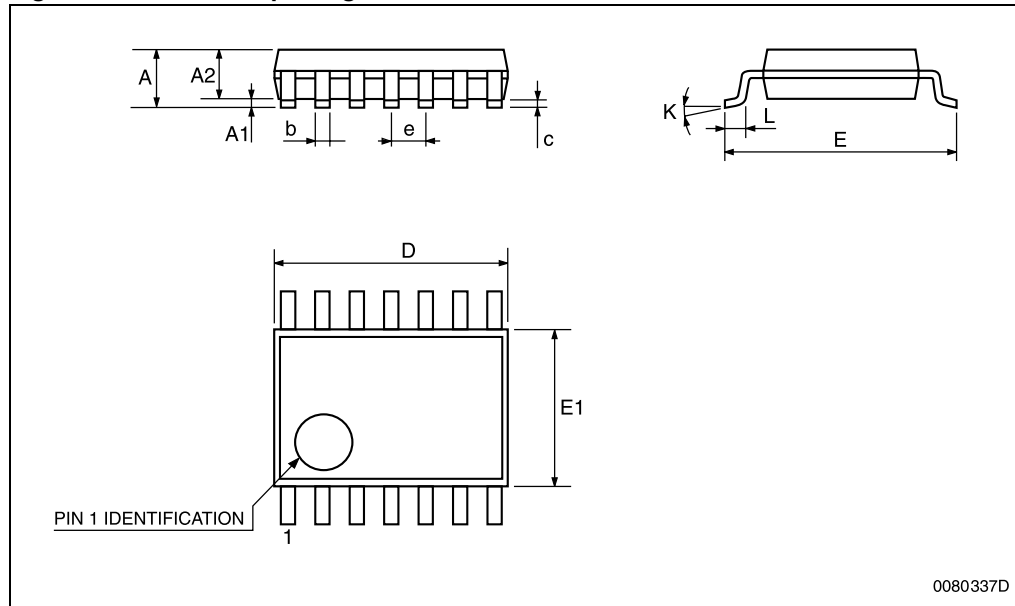
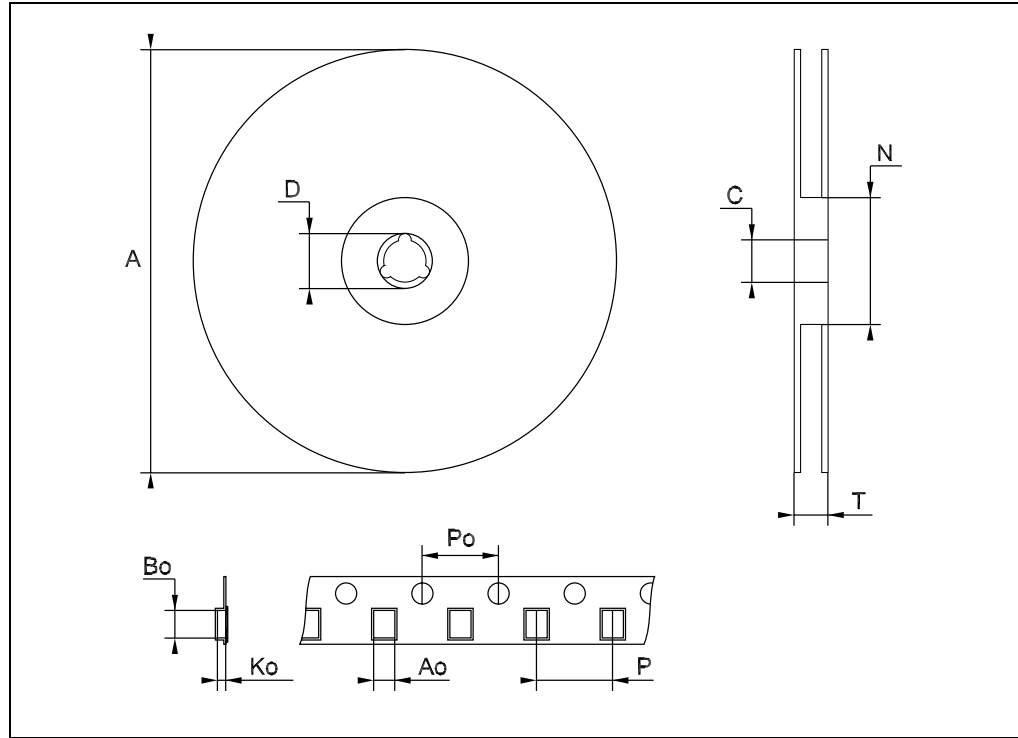


Table 12. TSSOP14 package mechanical data

| Symbol | Dimensions |          |      |       |            |        |
|--------|------------|----------|------|-------|------------|--------|
|        | 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  |

Figure 9. Tape and reel SO-14 outline

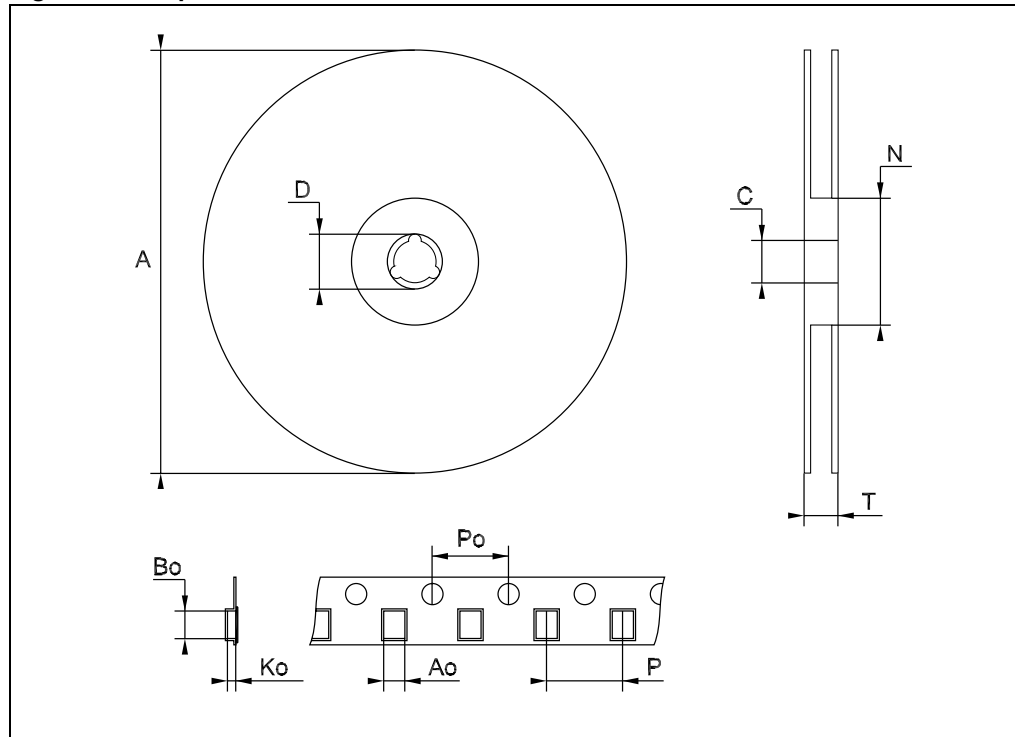


Drawing is not in scale.

Table 13. Tape and reel SO-14 mechanical data

| Symbol | Dimensions |      |      |       |      |        |
|--------|------------|------|------|-------|------|--------|
|        | 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  |

Figure 10. Tape and reel TSSOP14 outline



Drawing is not in scale.

Table 14. Tape and reel TSSOP14 mechanical data

| Symbol | Dimensions |      |      |       |      |        |
|--------|------------|------|------|-------|------|--------|
|        | 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  |

## 8 Revision history

Table 15. Document revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 15-Sep-2004 | 5        | Ordering codes revision - pag. 1  |
| 13-Jul-2006 | 6        | New template, temperature ranges updated  |
| 20-Jun-2012 | 7        | Added <i>Applications on page 1</i><br>Updated <i>Table 1: Device summary on page 1</i><br>Updated $T_{op}$ in <i>Table 5: Recommended operating conditions</i><br>Updated ECOPACK <sup>®</sup> text in <i>Section 7: Package information</i><br>Minor textual updates  |
| 02-Oct-2012 | 8        | Updated ESD performance in <i>Features</i> (updated HBM and MM, added CDM).<br>Added 74LCX125YMTR device and "Marking" to <i>Table 1</i> , updated temperature range and note <i>1</i> .<br>Updated <i>Section 3: Maximum ratings</i> (added cross-references).<br>Removed "Operating temperature" from <i>Table 5</i> .<br>Reformatted <i>Section 7: Package information</i> .<br>Minor corrections throughout document. |

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