

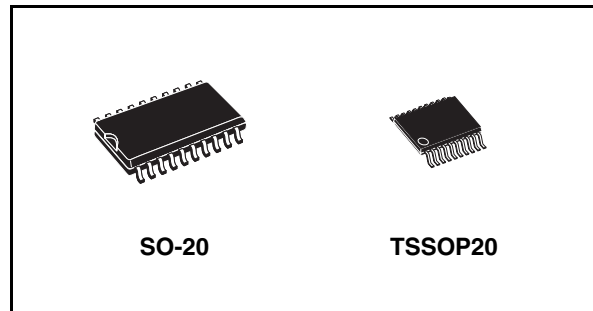


## 74LCX541

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

### Features

- 5V tolerant inputs and outputs
- High speed:
  - $t_{PD} = 8.0\text{ns}$  (Max) at  $V_{CC} = 3\text{V}$
- Power down protection on inputs and outputs
- Symmetrical output impedance:
  - $I_{OH} = I_{OL} = 24\text{mA}$  (Min) at  $V_{CC} = 3\text{V}$
- PCI bus levels guaranteed at 24mA
- Balanced propagation delays:
  - $t_{PLH} \cong t_{PHL}$
- Operating voltage range:
  - $V_{CC}(\text{Opr}) = 2.0\text{V}$  to  $3.6\text{V}$
- Pin and function compatible with 74 series 541
- Latch-up performance exceeds 500mA (JESD 17)
- ESD performance:
  - $\text{HBM} > 2000\text{V}$   
(MIL STD 883 method 3015);  $\text{MM} > 200\text{V}$



### Description

The 74LCX541 is a low voltage CMOS octal bus buffer (non-inverted) fabricated 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 3.3V applications; it can be interfaced to 5V signal environment for both inputs and outputs.

The 3 STATE control gate operates as two input AND such that if either G1 and G2 are high, all eight outputs are in the high impedance state. In order to enhance PC board layout the 74LCX541 offers a pinout having inputs and outputs on opposite sides of the package.

It has same 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.

### Order codes

| Part number | Package | Packaging     |
|-------------|---------|---------------|
| 74LCX541MTR | SO-20   | Tape and reel |
| 74LCX541TTR | TSSOP20 | Tape and reel |

# Contents

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# 1      Logic symbols and I/O equivalent circuit

Figure 1.    IEC logic symbols

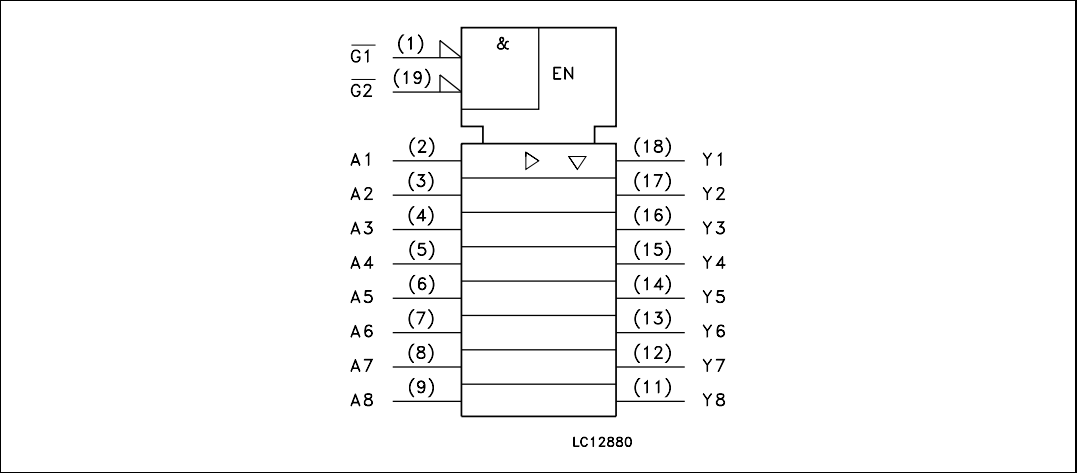
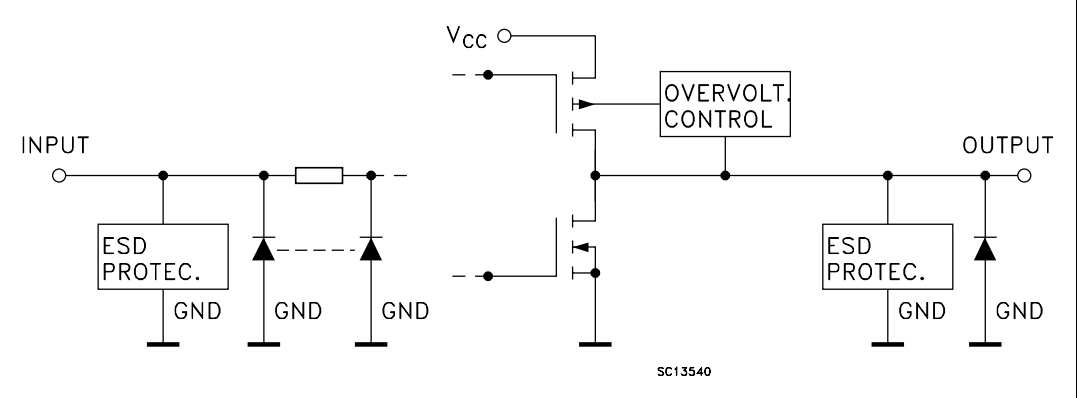


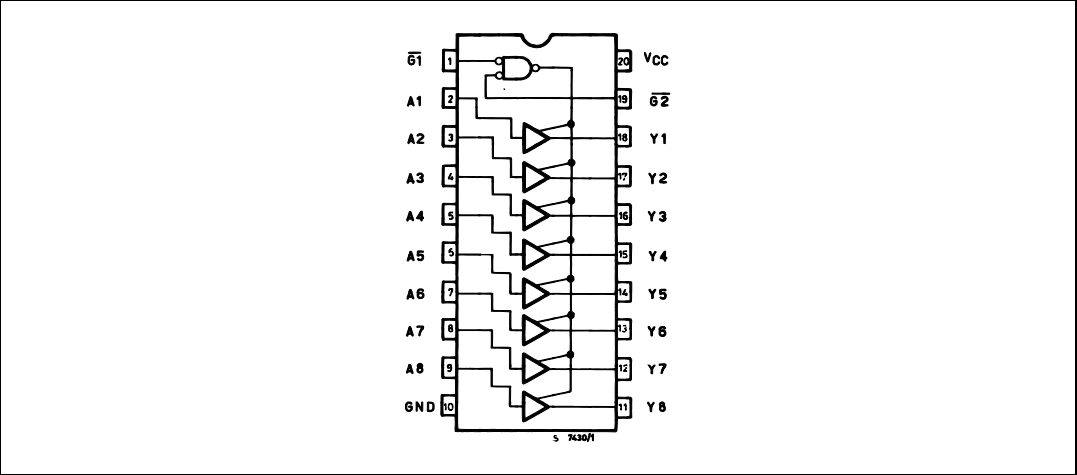
Figure 2.    Input and output equivalent circuit



## 2 Pin settings

### 2.1 Pin connection

Figure 3. Pin connection (top through view)



### 2.2 Pin description

Table 1. Pin description

| Pin N°                            | Symbol                             | Name and function       |
|-----------------------------------|------------------------------------|-------------------------|
| 1, 19                             | $\overline{G1}, \overline{G2}$     | Output enable inputs    |
| 2, 3, 4, 5,<br>6, 7, 8, 9         | A1 to A8                           | Data inputs             |
| 18, 17, 16, 15,<br>14, 13, 12, 11 | $\overline{Y1}$ to $\overline{Y8}$ | Data outputs            |
| 10                                | GND                                | Ground (0V)             |
| 20                                | V <sub>CC</sub>                    | Positive supply voltage |

## 3 Logic states

### 3.1 Truth table

Table 2. Truth table

| Input           |                 |    | Output          |
|-----------------|-----------------|----|-----------------|
| $\overline{G1}$ | $\overline{G2}$ | An | $\overline{Yn}$ |
| H               | X               | X  | Z               |
| X               | H               | X  | Z               |
| L               | L               | H  | L               |
| L               | L               | L  | H               |

Note:

*X : Do not care*

*Z : High impedance*

## 4 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 3. 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 (OFF state)                        | -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                                    | ±50                    | mA   |
| $I_{CC}$  | DC supply current per supply pin                     | ± 100                  | mA   |
| $I_{GND}$ | DC ground current per supply pin                     | ± 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.  $V_O < GND$

### 4.1 Recommended operating conditions

**Table 4. 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 (OFF state)                                    | 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 ( $V_{CC} = 2.7V$ )          | ± 12          | mA   |
| $T_{op}$         | Operating temperature                                         | -40 to 85     | °C   |
| dt/dv            | Input rise and fall time <sup>(2)</sup>                       | 0 to 10       | ns/V |

1. Truth table guaranteed: 1.5V to 3.6V

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

## 5 Electrical characteristics

**Table 5. 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    |
| V <sub>OH</sub>  | High level output voltage             | 2.7 to 3.6             | I <sub>O</sub> = -100μA                                                                      | V <sub>CC</sub> -0.2 |      | V    |
|                  |                                       | 2.7                    | I <sub>O</sub> = -12mA                                                                       | 2.2                  |      |      |
|                  |                                       | 3.0                    | I <sub>O</sub> = -18mA                                                                       | 2.4                  |      |      |
|                  |                                       |                        | I <sub>O</sub> = -24mA                                                                       | 2.2                  |      |      |
| V <sub>OL</sub>  | Low level output voltage              | 2.7 to 3.6             | I <sub>O</sub> = 100μA                                                                       |                      | 0.2  | V    |
|                  |                                       | 2.7                    | I <sub>O</sub> = 12mA                                                                        |                      | 0.4  |      |
|                  |                                       | 3.0                    | I <sub>O</sub> = 16mA                                                                        |                      | 0.4  |      |
|                  |                                       |                        | I <sub>O</sub> = 24mA                                                                        |                      | 0.55 |      |
| I <sub>I</sub>   | Input leakage current                 | 2.7 to 3.6             | V <sub>I</sub> = 0 to 5.5V                                                                   |                      | ± 5  | μA   |
| I <sub>off</sub> | Power OFF leakage current             | 0                      | V <sub>I</sub> or V <sub>O</sub> = 5.5V                                                      |                      | 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 5.5V                                               |                      | ± 10 |      |
| ΔI <sub>CC</sub> | I incr. per Input                     | 2.7 to 3.6             | V <sub>IH</sub> = V <sub>CC</sub> - 0.6V                                                     |                      | 500  | μA   |

**Table 6. 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> = 50pF<br>V <sub>IL</sub> = 0V, V <sub>IH</sub> = 3.3V |                        | 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 7. 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                                     | 1.5          | 9.0 | ns   |
|                                        |                                                          | 3.0 to 3.6             |                        |                       |                                         | 1.5          | 8.0 |      |
| t <sub>PZL</sub> t <sub>PZH</sub>      | Output enable time                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 1.5          | 9.5 | ns   |
|                                        |                                                          | 3.0 to 3.6             |                        |                       |                                         | 1.5          | 8.5 |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | Output disable time                                      | 2.7                    | 50                     | 500                   | 2.5                                     | 1.5          | 8.5 | ns   |
|                                        |                                                          | 3.0 to 3.6             |                        |                       |                                         | 1.5          | 7.5 |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | output to output skew time <sup>(1)</sup> <sup>(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<sub>OSLH</sub> = |t<sub>PLHm</sub> - t<sub>PLHn</sub>|, t<sub>OSHL</sub> = |t<sub>PHLm</sub> - t<sub>PHLn</sub>|)
- Parameter guaranteed by design

Table 8. 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>                            |                        | 6   |     | pF   |
| C <sub>OUT</sub> | Output capacitance                           | 3.3                    | V <sub>IN</sub> = 0 to V <sub>CC</sub>                            |                        | 12  |     | pF   |
| C <sub>PD</sub>  | Power dissipation capacitance <sup>(1)</sup> | 3.3                    | f <sub>IN</sub> = 10MHz<br>V <sub>IN</sub> = 0 or V <sub>CC</sub> |                        | 25  |     | 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 Test Circuit). Average operating current can be obtained by the following equation. I<sub>CC(opr)</sub> = C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> + I<sub>CC</sub>/8 (per buffer)



6 Test circuit

Figure 4. Test circuit

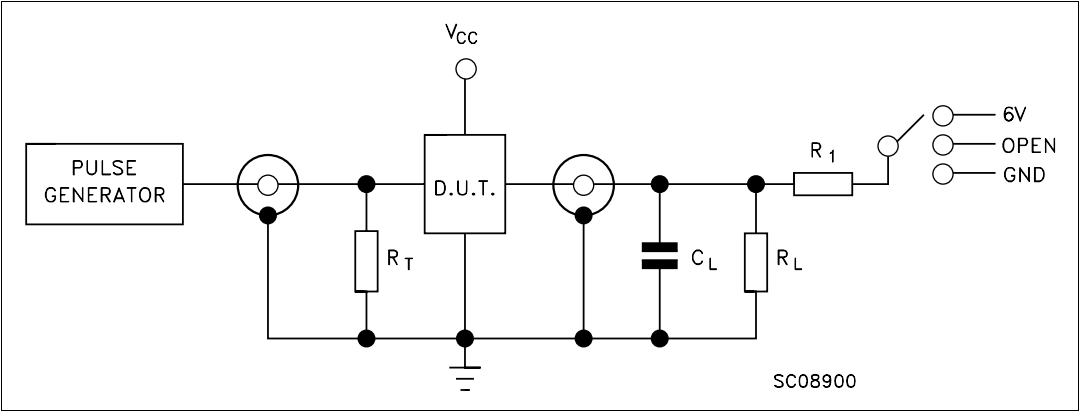


Figure 5. Test circuit

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

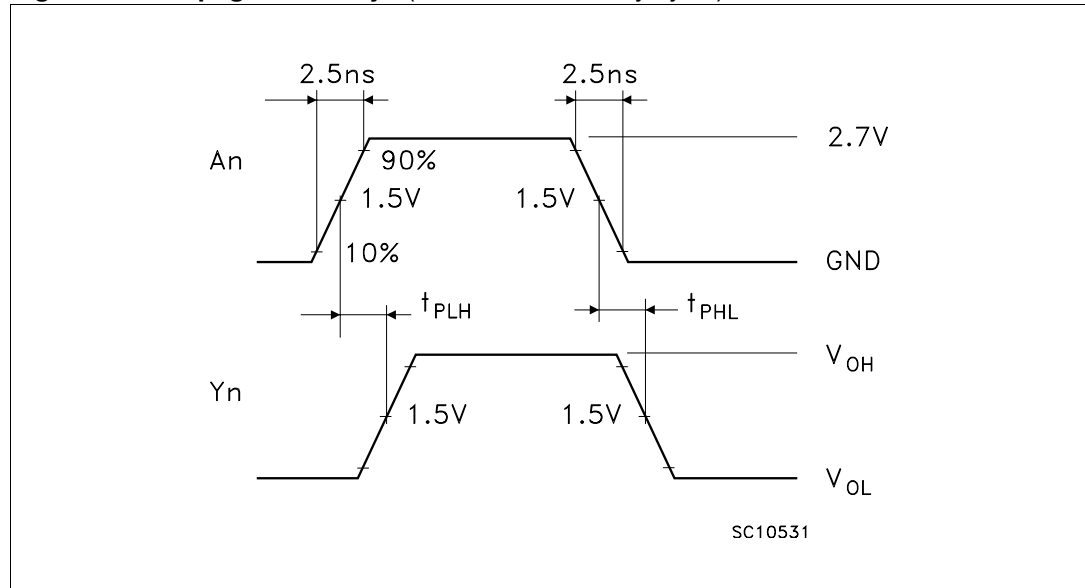
$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)

$R_L = R_1 = 500\Omega$  or equivalent

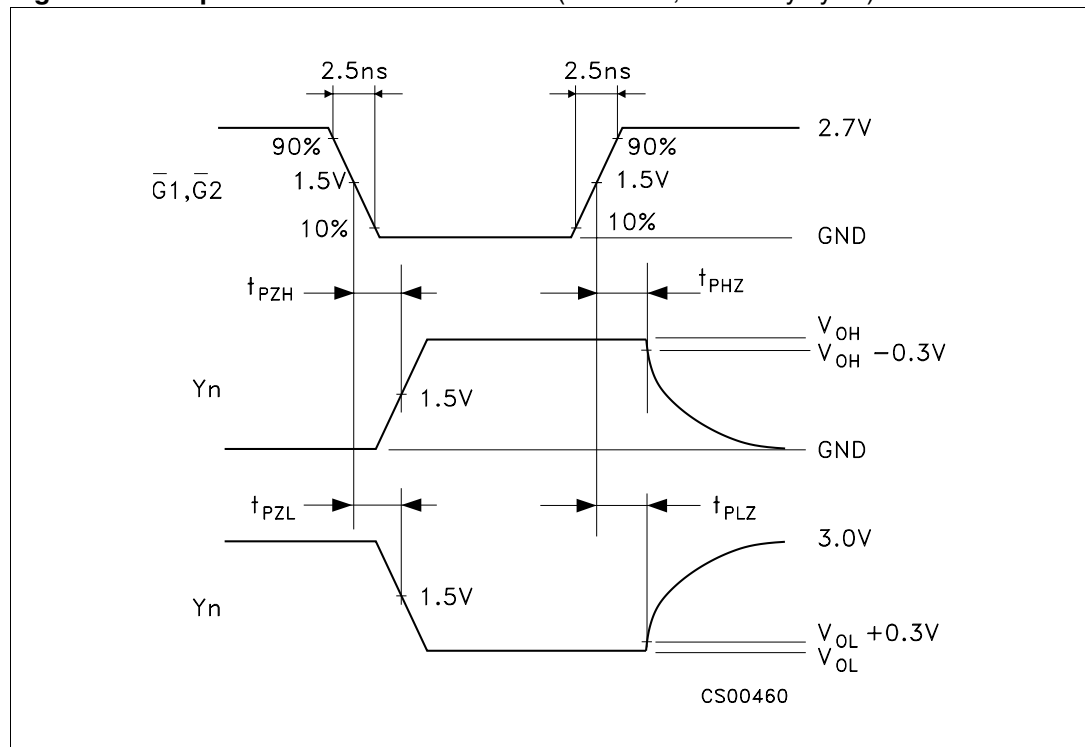
$R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

## 7 Waveforms

**Figure 6. Propagation delays ( $f = 1\text{MHz}$ ; 50% duty cycle)**

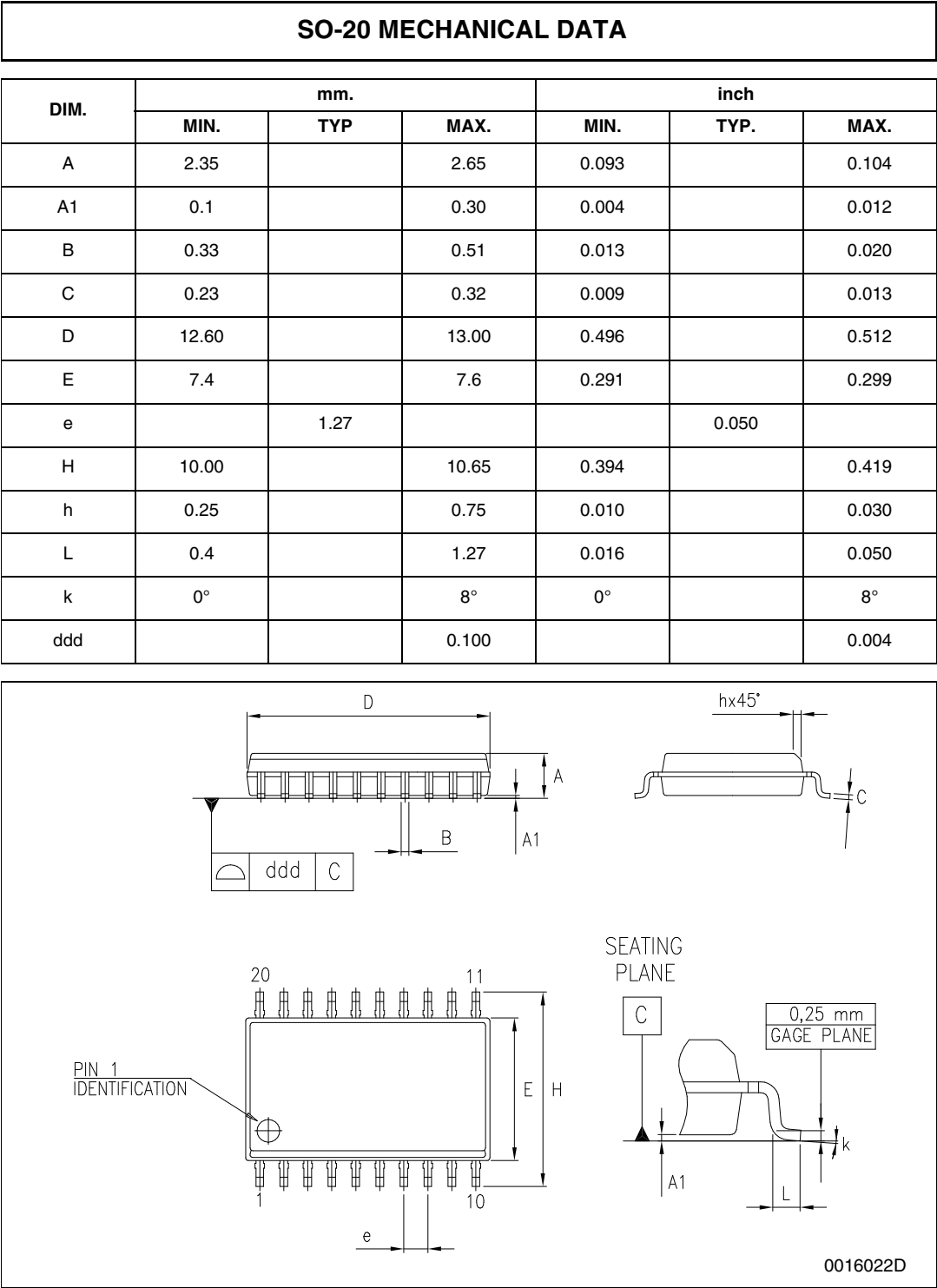


**Figure 7. Output enable and disable time ( $f = 1\text{MHz}$ ; 50% duty cycle)**



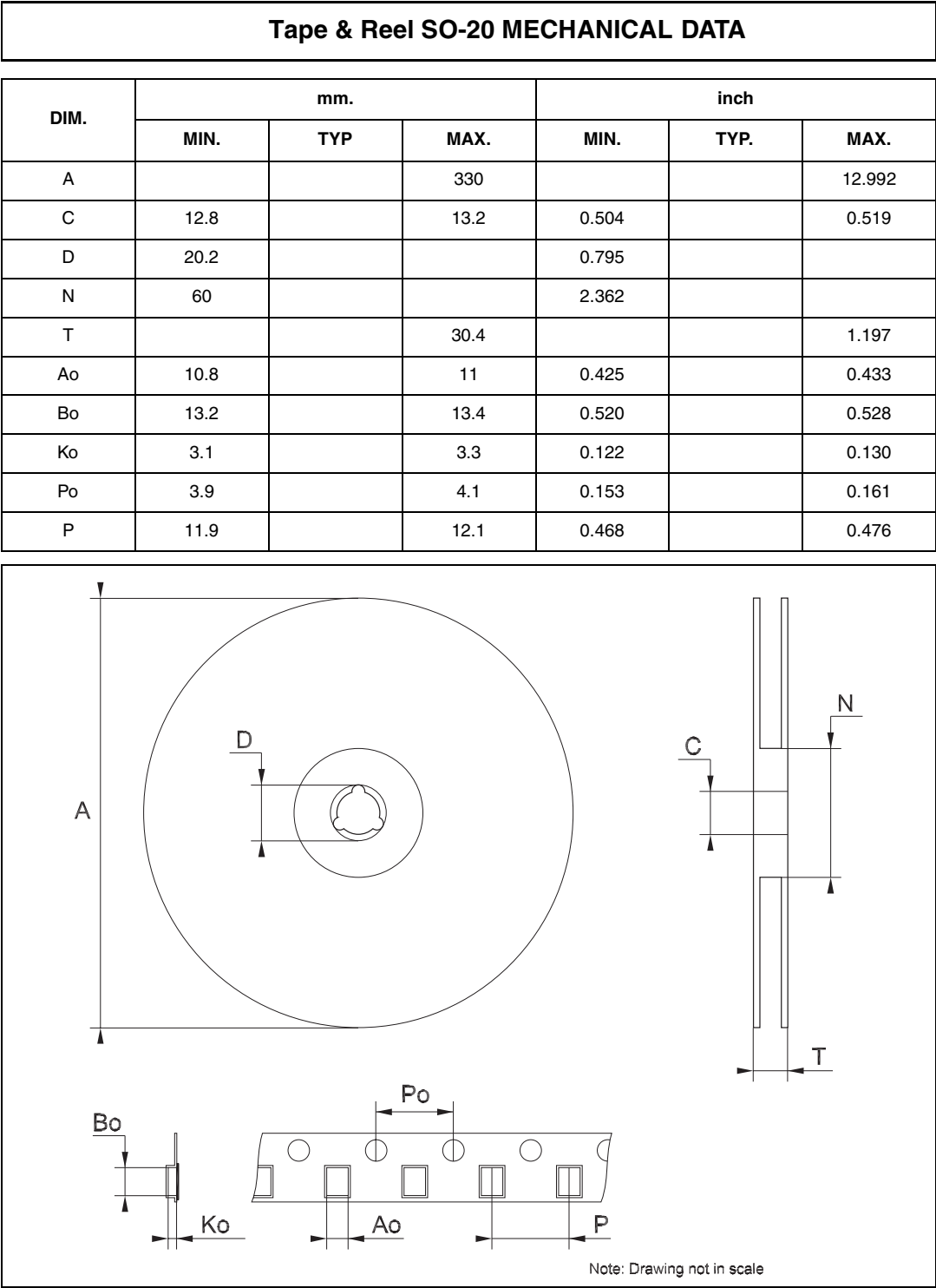
## 8 Package mechanical data

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)



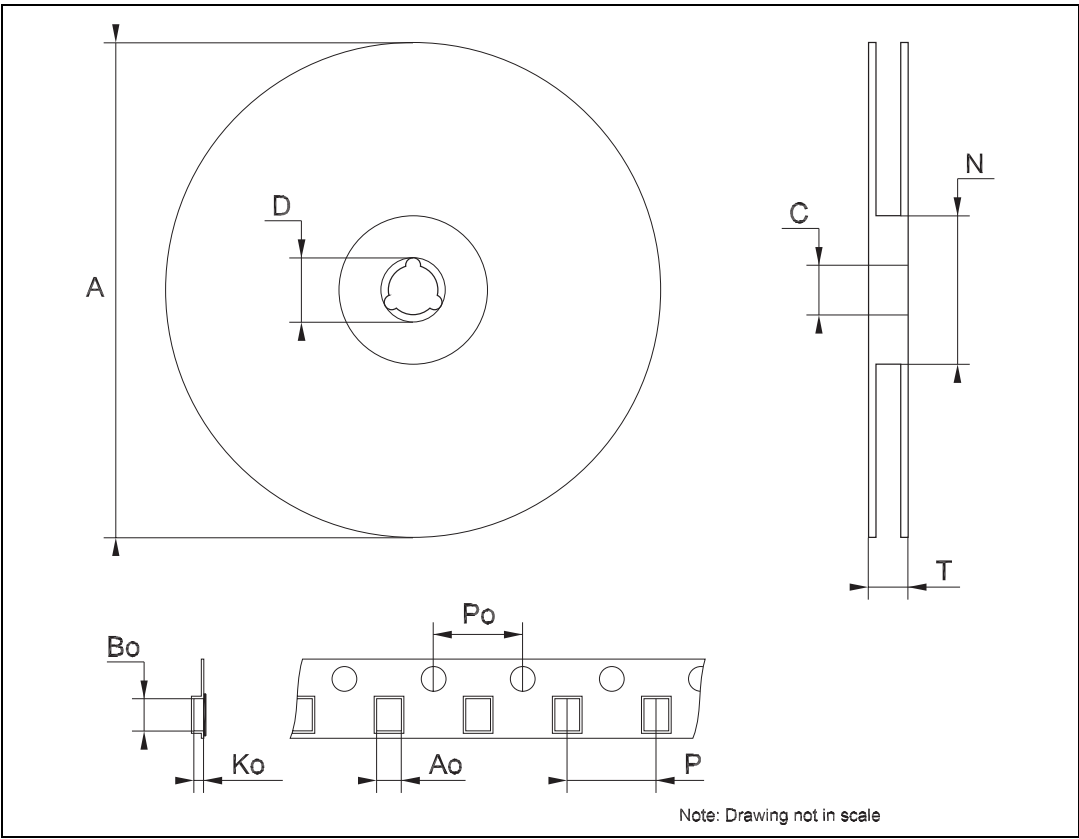
| TSSOP20 MECHANICAL DATA |      |          |      |       |            |        |
|-------------------------|------|----------|------|-------|------------|--------|
| DIM.                    | mm.  |          |      | inch  |            |        |
|                         | MIN. | TYP      | MAX. | 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 |            | 0.0079 |
| D                       | 6.4  | 6.5      | 6.6  | 0.252 | 0.256      | 0.260  |
| 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  |

The diagram illustrates the mechanical specifications of the TSSOP20 package through three views: top, side, and front. The top view shows a rectangular package with pins along all four edges, with dimensions D (width) and E1 (height) indicated. A circle marks the 'PIN 1 IDENTIFICATION' point. The side view shows the package profile with dimensions A (total height), A1 (lead height), A2 (body height), b (lead thickness), c (lead width), and K (lead angle). The front view shows the package with pins on the bottom edge, with dimensions E (total width), L (lead length), and E1 (height) indicated. The text '0087225C' is located in the bottom right corner of the diagram area.



Tape & Reel TSSOP20 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   | 6.8  |     | 7    | 0.268 |      | 0.276  |
| Bo   | 6.9  |     | 7.1  | 0.272 |      | 0.280  |
| Ko   | 1.7  |     | 1.9  | 0.067 |      | 0.075  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 11.9 |     | 12.1 | 0.468 |      | 0.476  |



## 9 Revision history

**Table 9. Revision history**

| Date        | Revision | Changes                                                       |
|-------------|----------|---------------------------------------------------------------|
| 15-Sep-2004 | 4        | Ordering Codes Revision - pag. 1.                             |
| 24-Jan-2007 | 5        | The document has been reformatted, temperature ranges updated |



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