

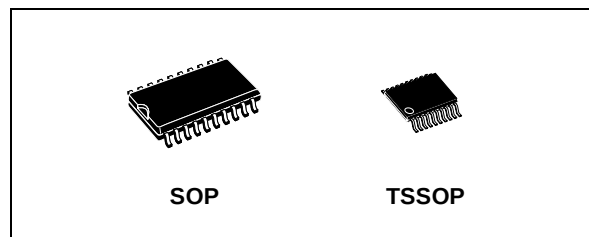
## LOW VOLTAGE CMOS OCTAL BUS TRANSCEIVER (NOT INVERTED) HIGH PERFORMANCE

- 5V TOLERANT INPUTS
- HIGH SPEED:  $t_{PD} = 6.3ns$  (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:  
 $t_{PLH} \approx t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC}(OPR) = 1.65V$  to  $3.6V$  (1.2V Data Retention)
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 245
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE:  
HBM > 2000V (MIL STD 883 method 3015);  
MM > 200V

### DESCRIPTION

The 74LVC245A is a low voltage CMOS OCTAL BUS TRANSCEIVER (3-STATE) fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology. It is ideal for 1.65 to 3.6 V<sub>CC</sub> operations and low power and low noise applications.

This IC is intended for two-way asynchronous communication between data buses and the



**Table 1: Order Codes**

| PACKAGE | T & R        |
|---------|--------------|
| SOP     | 74LVC245AMTR |
| TSSOP   | 74LVC245ATTR |

direction of data transmission is determined by DIR input. The enable input  $\bar{G}$  can be used to disable the device so that the buses are effectively isolated.

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

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

All floating bus terminals during High Z State must be held HIGH or LOW.

**Figure 1: Pin Connection And IEC Logic Symbols**

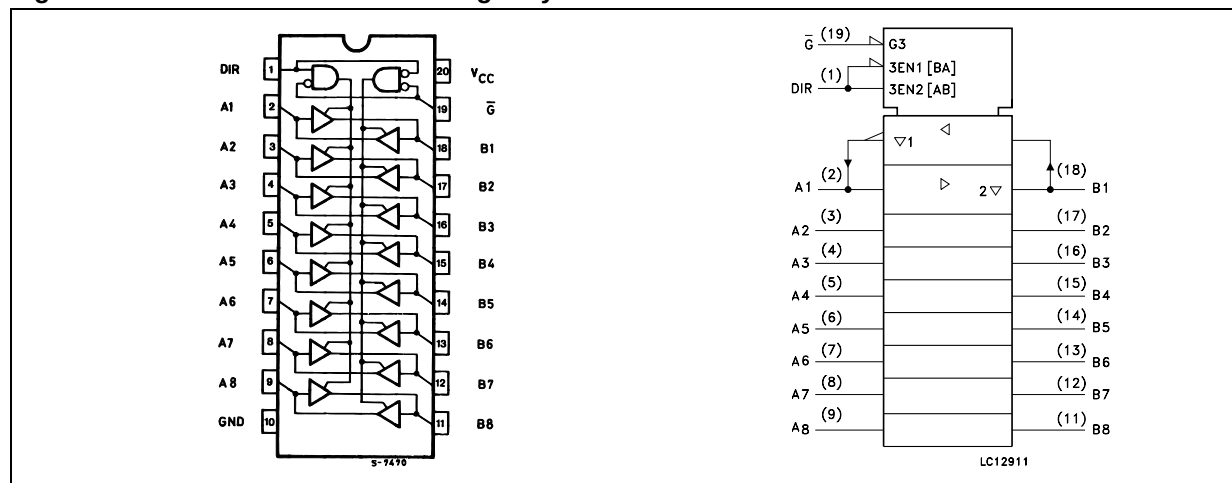


Figure 2: Input And Output Equivalent Circuit

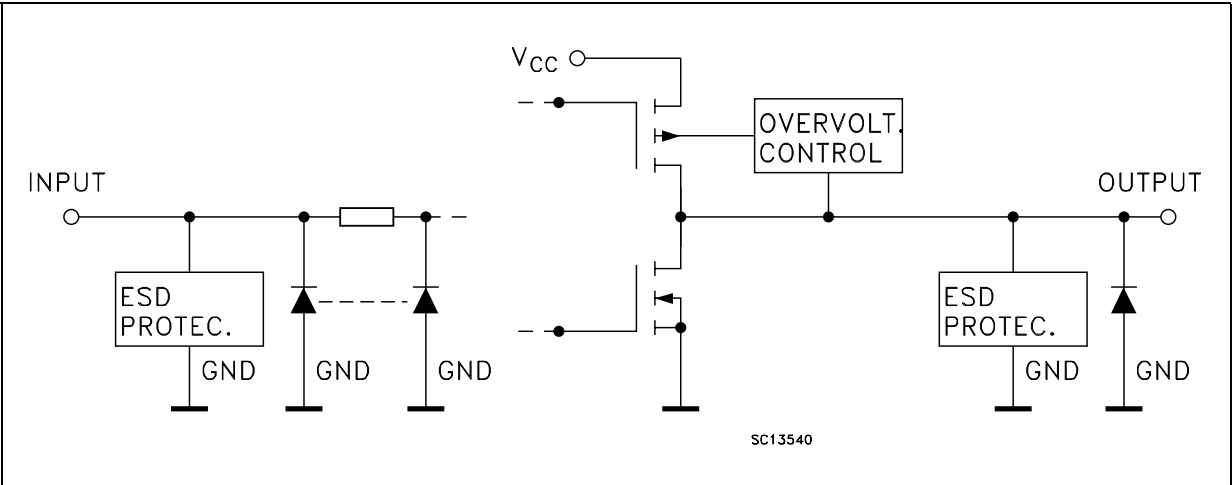


Table 2: Pin Description

| PIN N°                         | SYMBOL          | NAME AND FUNCTION       |
|--------------------------------|-----------------|-------------------------|
| 1                              | DIR             | Directional Control     |
| 2, 3, 4, 5, 6, 7, 8, 9         | A1 to A8        | Data Inputs/Outputs     |
| 18, 17, 16, 15, 14, 13, 12, 11 | B1 to B8        | Data Inputs/Outputs     |
| 19                             | $\overline{G}$  | Output Enable Input     |
| 10                             | GND             | Ground (0V)             |
| 20                             | V <sub>CC</sub> | Positive Supply Voltage |

Table 3: Truth Table

| INPUTS         |     | FUNCTION |        | OUTPUT         |
|----------------|-----|----------|--------|----------------|
| $\overline{G}$ | DIR | A BUS    | B BUS  | Y <sub>n</sub> |
| L              | L   | OUTPUT   | INPUT  | A = B          |
| L              | H   | INPUT    | OUTPUT | B = A          |
| H              | X   | Z        | Z      | Z              |

X : Don't Care  
Z : High Impedance

Table 4: Absolute Maximum Ratings

| Symbol                              | Parameter                                                  | Value                         | Unit |
|-------------------------------------|------------------------------------------------------------|-------------------------------|------|
| V <sub>CC</sub>                     | Supply Voltage                                             | -0.5 to +7.0                  | V    |
| V <sub>I</sub>                      | DC Input Voltage                                           | -0.5 to +7.0                  | V    |
| V <sub>O</sub>                      | DC Output Voltage (High Impedance or V <sub>CC</sub> = 0V) | -0.5 to +7.0                  | V    |
| V <sub>O</sub>                      | DC Output Voltage (High or Low State) (note 1)             | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| I <sub>IK</sub>                     | DC Input Diode Current                                     | - 50                          | mA   |
| I <sub>OK</sub>                     | DC Output Diode Current (note 2)                           | - 50                          | mA   |
| I <sub>O</sub>                      | DC Output Current                                          | ± 50                          | mA   |
| I <sub>CC</sub> or I <sub>GND</sub> | DC V <sub>CC</sub> or Ground Current per Supply Pin        | ± 100                         | mA   |
| T <sub>stg</sub>                    | Storage Temperature                                        | -65 to +150                   | °C   |
| T <sub>L</sub>                      | 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<sub>O</sub> absolute maximum rating must be observed  
2) V<sub>O</sub> < 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 (High Impedance or $V_{CC} = 0V$ )              | 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 $3.6V$ )  | $\pm 24$      | mA   |
| $I_{OH}, I_{OL}$ | High or Low Level Output Current ( $V_{CC} = 2.7$ to $3.0V$ )  | $\pm 12$      | mA   |
| $I_{OH}, I_{OL}$ | High or Low Level Output Current ( $V_{CC} = 2.3$ to $2.7V$ )  | $\pm 8$       | mA   |
| $I_{OH}, I_{OL}$ | High or Low Level Output Current ( $V_{CC} = 1.65$ to $2.3V$ ) | $\pm 4$       | mA   |
| $T_{op}$         | Operating Temperature                                          | -55 to 125    | °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 <sub>CC</sub><br>(V) |                                                                                   | -40 to 85 °C         |                     | -55 to 125 °C        |                     |      |
|                  |                                       |                        |                                                                                   | Min.                 | Max.                | Min.                 | Max.                |      |
| V <sub>IH</sub>  | High Level Input Voltage              | 1.65 to 1.95           |                                                                                   | 0.65V <sub>CC</sub>  |                     | 0.65V <sub>CC</sub>  |                     | V    |
|                  |                                       | 2.3 to 2.7             |                                                                                   | 1.7                  |                     | 1.7                  |                     |      |
|                  |                                       | 2.7 to 3.6             |                                                                                   | 2                    |                     | 2                    |                     |      |
| V <sub>IL</sub>  | Low Level Input Voltage               | 1.65 to 1.95           |                                                                                   |                      | 0.35V <sub>CC</sub> |                      | 0.35V <sub>CC</sub> | V    |
|                  |                                       | 2.3 to 2.7             |                                                                                   |                      | 0.7                 |                      | 0.7                 |      |
|                  |                                       | 2.7 to 3.6             |                                                                                   |                      | 0.8                 |                      | 0.8                 |      |
| V <sub>OH</sub>  | High Level Output Voltage             | 1.65 to 3.6            | I <sub>O</sub> =-100 μA                                                           | V <sub>CC</sub> -0.2 |                     | V <sub>CC</sub> -0.2 |                     | V    |
|                  |                                       | 1.65                   | I <sub>O</sub> =-4 mA                                                             | 1.2                  |                     | 1.2                  |                     |      |
|                  |                                       | 2.3                    | I <sub>O</sub> =-8 mA                                                             | 1.7                  |                     | 1.7                  |                     |      |
|                  |                                       | 2.7                    | I <sub>O</sub> =-12 mA                                                            | 2.2                  |                     | 2.2                  |                     |      |
|                  |                                       | 3.0                    | I <sub>O</sub> =-18 mA                                                            | 2.4                  |                     | 2.4                  |                     |      |
|                  |                                       | 3.0                    | I <sub>O</sub> =-24 mA                                                            | 2.2                  |                     | 2.2                  |                     |      |
| V <sub>OL</sub>  | Low Level Output Voltage              | 1.65 to 3.6            | I <sub>O</sub> =100 μA                                                            |                      | 0.2                 |                      | 0.2                 | V    |
|                  |                                       | 1.65                   | I <sub>O</sub> =4 mA                                                              |                      | 0.45                |                      | 0.45                |      |
|                  |                                       | 2.3                    | I <sub>O</sub> =8 mA                                                              |                      | 0.7                 |                      | 0.7                 |      |
|                  |                                       | 2.7                    | I <sub>O</sub> =12 mA                                                             |                      | 0.4                 |                      | 0.4                 |      |
|                  |                                       | 3.0                    | I <sub>O</sub> =24 mA                                                             |                      | 0.55                |                      | 0.55                |      |
| I <sub>I</sub>   | Input Leakage Current                 | 3.6                    | V <sub>I</sub> = 0 to 5.5V                                                        |                      | ± 5                 |                      | ± 5                 | μA   |
| I <sub>off</sub> | Power Off Leakage Current             | 0                      | V <sub>I</sub> or V <sub>O</sub> = 5.5V                                           |                      | 10                  |                      | 10                  | μA   |
| I <sub>OZ</sub>  | High Impedance Output Leakage Current | 3.6                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = 0 to 5.5V |                      | ± 10                |                      | ± 10                | μA   |
| I <sub>CC</sub>  | Quiescent Supply Current              | 3.6                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                           |                      | 10                  |                      | 10                  | μA   |
|                  |                                       |                        | V <sub>I</sub> or V <sub>O</sub> = 3.6 to 5.5V                                    |                      | ± 10                |                      | ± 10                |      |
| ΔI <sub>CC</sub> | I <sub>CC</sub> incr. per Input       | 2.7 to 3.6             | V <sub>IH</sub> = V <sub>CC</sub> -0.6V                                           |                      | 500                 |                      | 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 (note 1) | 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 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 <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 |      | -55 to 125 °C |      |      |
|                                        |                                       |                        |                        |                       |                                         | Min.         | Max. | Min.          | Max. |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time                | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 2.0          | 9.0  | 2.0           | 12   | ns   |
|                                        |                                       | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 2.0          | 8.0  | 2.0           | 10.5 |      |
|                                        |                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 1.5          | 7.3  | 1.5           | 8.8  |      |
|                                        |                                       | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1.0          | 6.3  | 1.0           | 7.6  |      |
| t <sub>PZL</sub> t <sub>PZH</sub>      | Output Enable Time                    | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 2.0          | 12   | 2.0           | 16   | ns   |
|                                        |                                       | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 2.0          | 9.5  | 2.0           | 12.5 |      |
|                                        |                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 1.0          | 9.0  | 1.0           | 11   |      |
|                                        |                                       | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1.0          | 8.5  | 1.0           | 10   |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | Output Disable Time                   | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     | 2.0          | 11   | 2.0           | 14   | ns   |
|                                        |                                       | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     | 2.0          | 9.0  | 2.0           | 12   |      |
|                                        |                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 2.0          | 8.5  | 2.0           | 10   |      |
|                                        |                                       | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 2.0          | 7.5  | 2.0           | 9.0  |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | 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<sub>OSLH</sub> = |t<sub>PLHm</sub> - t<sub>PLHn</sub>|, t<sub>OSHL</sub> = |t<sub>PHLm</sub> - t<sub>PHLn</sub>|)

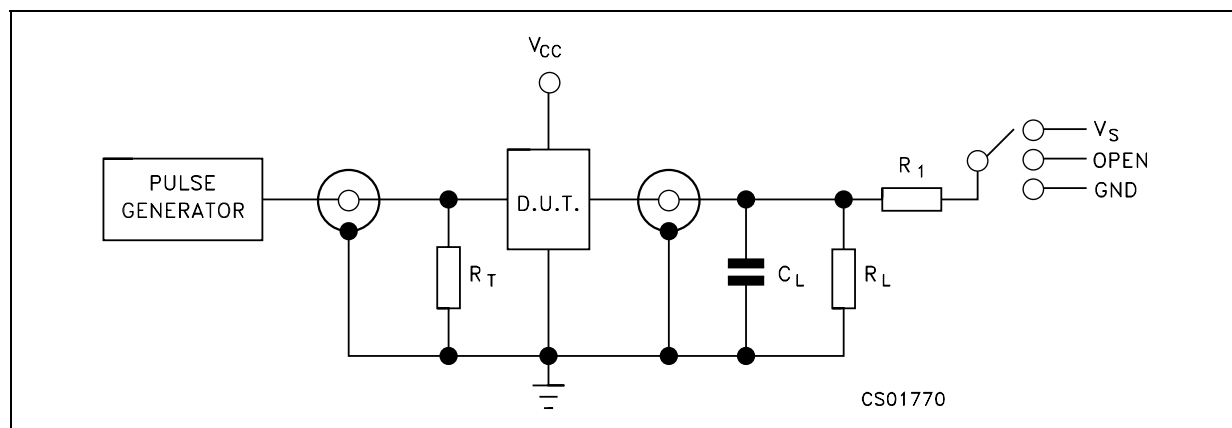
2) Parameter guaranteed by design

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                         |                        |                         |                        | 4    |      | pF   |
| C <sub>PD</sub> | Power Dissipation Capacitance<br>(note 1) | 1.8                    | f <sub>IN</sub> = 10MHz |                        | 28   |      | pF   |
|                 |                                           | 2.5                    |                         |                        | 30   |      |      |
|                 |                                           | 3.3                    |                         |                        | 34   |      |      |

1) 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>/n (per circuit)

Figure 3: Test Circuit



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

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            |
| $R_L = R_1$ | 1000 $\Omega$     | 500 $\Omega$      | 500 $\Omega$    | 500 $\Omega$    |
| $V_S$       | $2 \times V_{CC}$ | $2 \times V_{CC}$ | 6V              | 6V              |
| $V_{IH}$    | $V_{CC}$          | $V_{CC}$          | 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            |
| $V_X$       | $V_{OL} + 0.15V$  | $V_{OL} + 0.15V$  | $V_{OL} + 0.3V$ | $V_{OL} + 0.3V$ |
| $V_Y$       | $V_{OH} - 0.15V$  | $V_{OH} - 0.15V$  | $V_{OH} - 0.3V$ | $V_{OH} - 0.3V$ |
| $t_r = t_f$ | <2.0ns            | <2.0ns            | <2.5ns          | <2.5ns          |

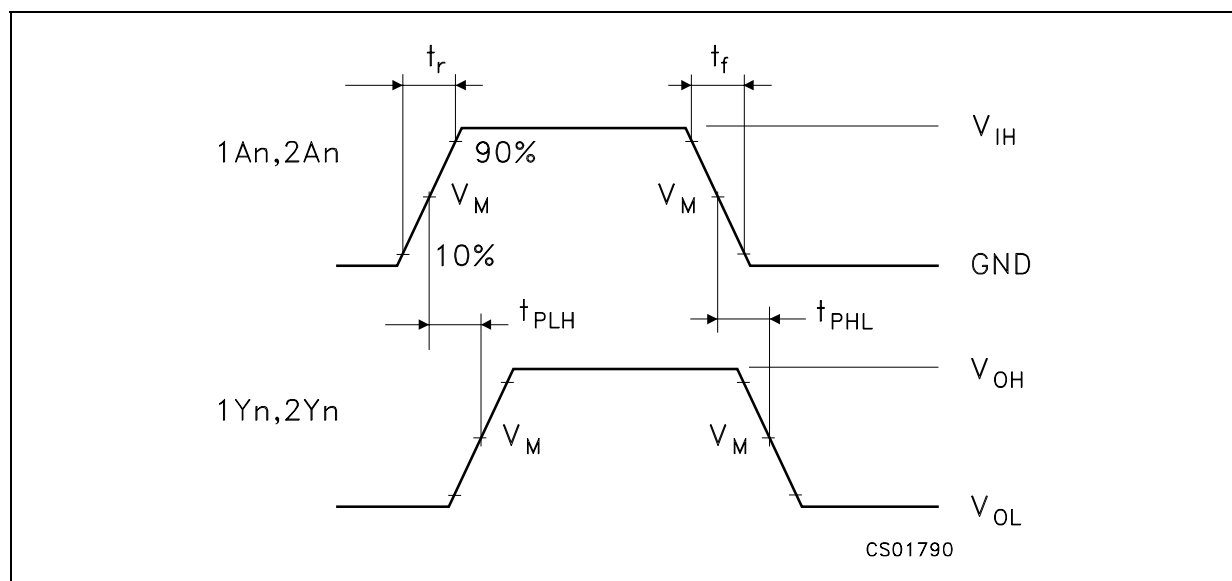
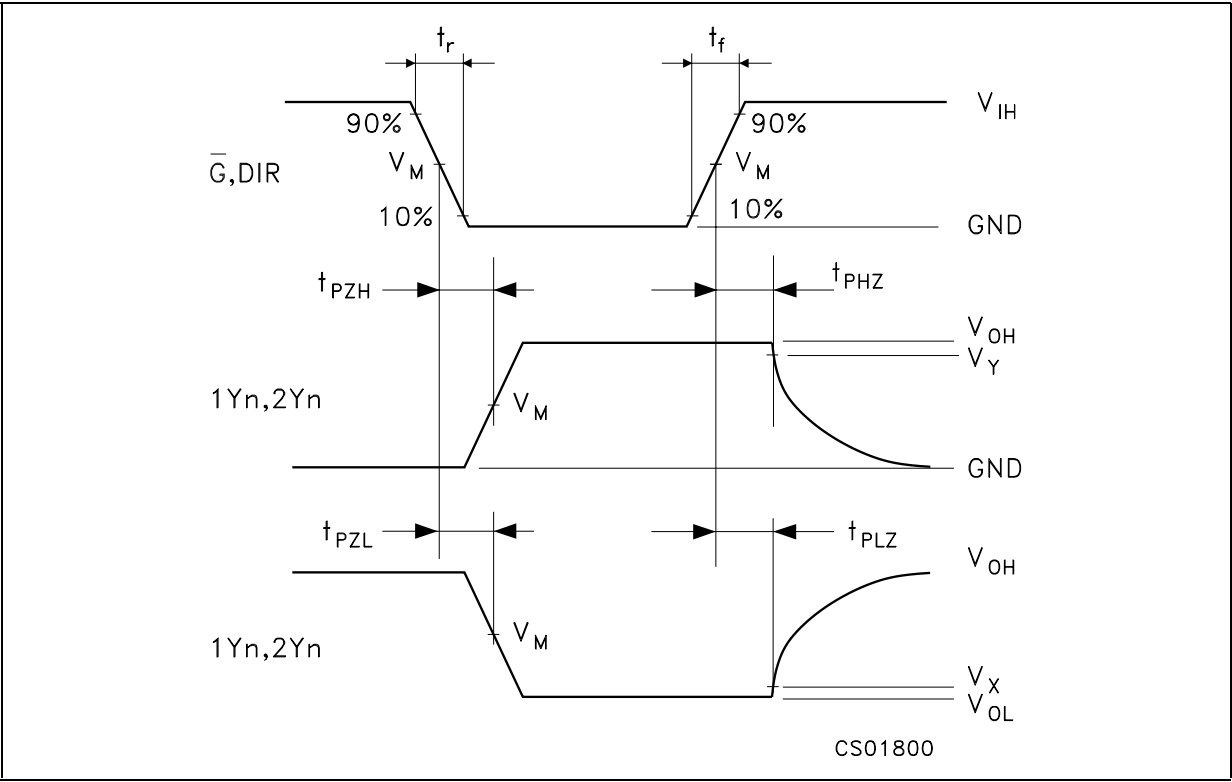
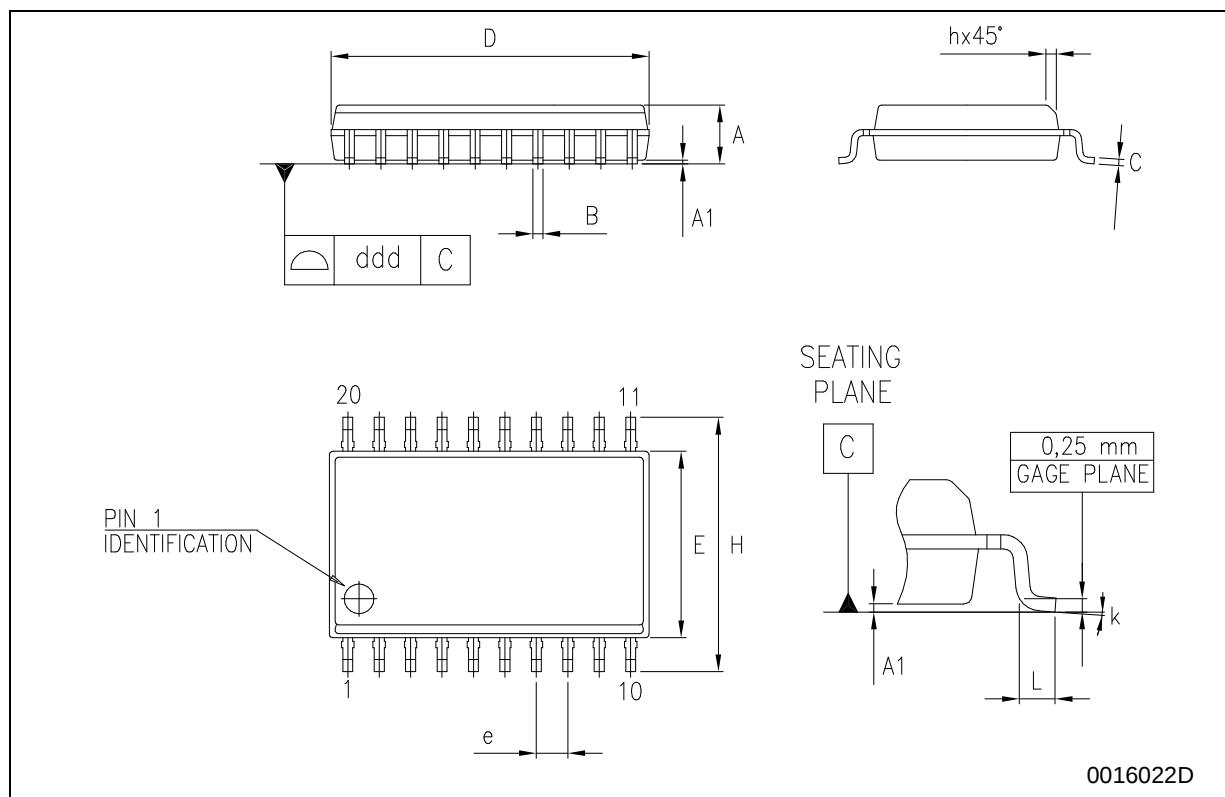
Figure 4: Waveform - Propagation Delays ( $f=1\text{MHz}$ ; 50% duty cycle)

Figure 5: Waveform - Output Enable And Disable Time (f=1MHz; 50% duty cycle)



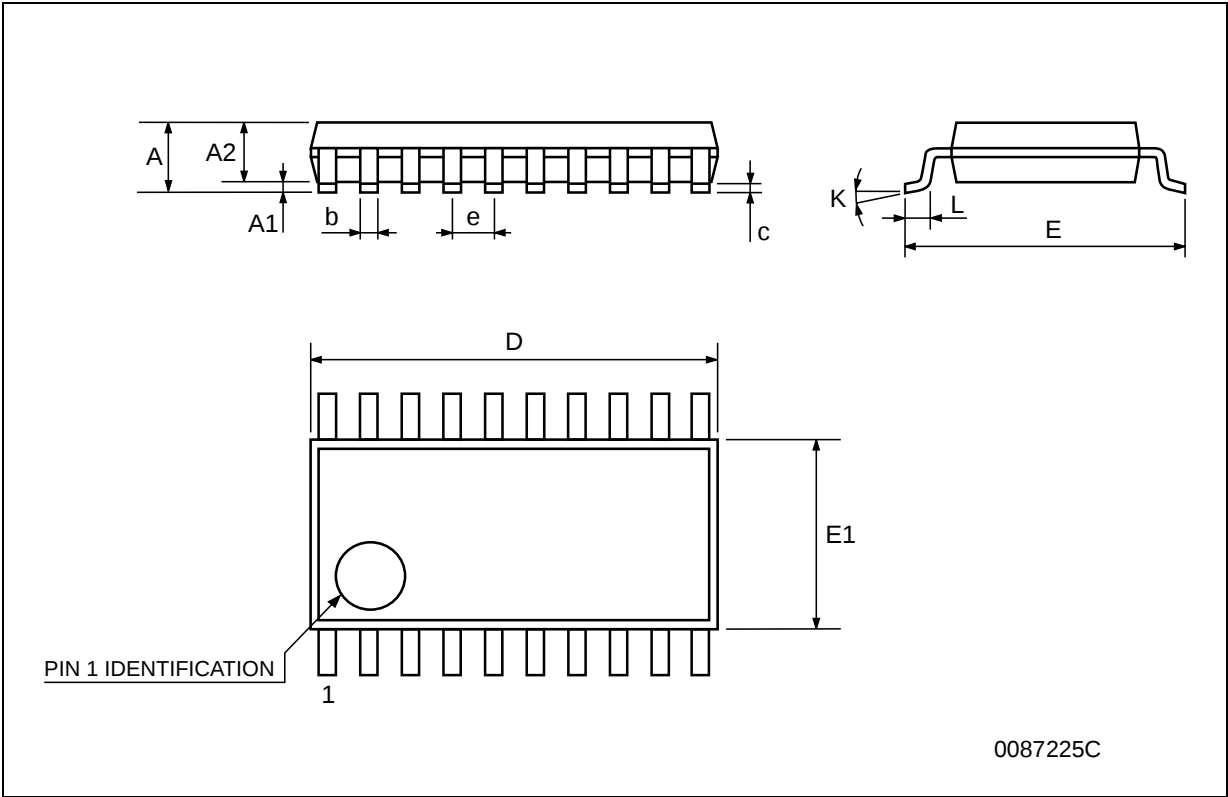
## SO-20 MECHANICAL DATA

| DIM. | mm.   |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.35  |      | 2.65  | 0.093 |       | 0.104 |
| A1   | 0.1   |      | 0.30  | 0.004 |       | 0.012 |
| B    | 0.33  |      | 0.51  | 0.013 |       | 0.020 |
| C    | 0.23  |      | 0.32  | 0.009 |       | 0.013 |
| D    | 12.60 |      | 13.00 | 0.496 |       | 0.512 |
| E    | 7.4   |      | 7.6   | 0.291 |       | 0.299 |
| e    |       | 1.27 |       |       | 0.050 |       |
| H    | 10.00 |      | 10.65 | 0.394 |       | 0.419 |
| h    | 0.25  |      | 0.75  | 0.010 |       | 0.030 |
| L    | 0.4   |      | 1.27  | 0.016 |       | 0.050 |
| k    | 0°    |      | 8°    | 0°    |       | 8°    |
| ddd  |       |      | 0.100 |       |       | 0.004 |



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  |



# Tape & Reel SO-20 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    |      |     | 30.4 |       |      | 1.197  |
| Ao   | 10.8 |     | 11   | 0.425 |      | 0.433  |
| Bo   | 13.2 |     | 13.4 | 0.520 |      | 0.528  |
| Ko   | 3.1  |     | 3.3  | 0.122 |      | 0.130  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 11.9 |     | 12.1 | 0.468 |      | 0.476  |



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  |



**Table 11: Revision History**

| Date        | Revision | Description of Changes            |
|-------------|----------|-----------------------------------|
| 26-Jul-2004 | 4        | Ordering Codes Revision - pag. 1. |

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