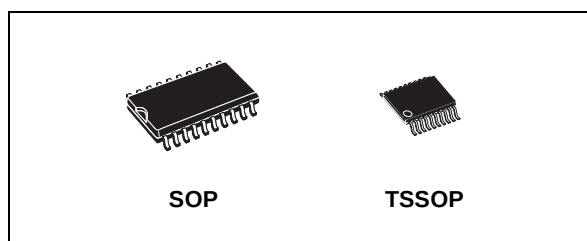




# 74LVC244A

## LOW VOLTAGE CMOS QUAD BUS BUFFERS (3-STATE) HIGH PERFORMANCE

- 5V TOLERANT INPUTS
- HIGH SPEED:  $t_{PD} = 5.9ns$  (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 244
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE:  
HBM > 2000V (MIL STD 883 method 3015);  
MM > 200V



### ORDER CODES

| PACKAGE | TUBE       | T & R        |
|---------|------------|--------------|
| SOP     | 74LVC244AM | 74LVC244AMTR |
| TSSOP   |            | 74LVC244ATTR |

It can be interfaced to 5V signal environment for inputs in mixed 3.3/5V system.

G control output governs four BUS BUFFERS.

This device is designed to be used with 3 state memory address drivers, etc.

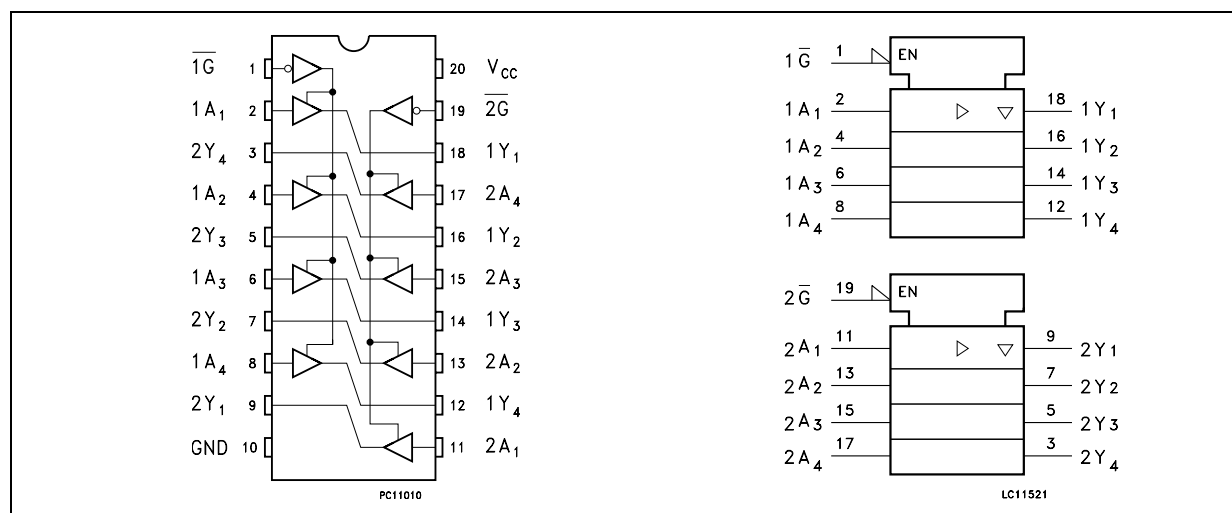
It has more speed performance at 3.3V than 5V AC/ACT family, combined with a lower power consumption.

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

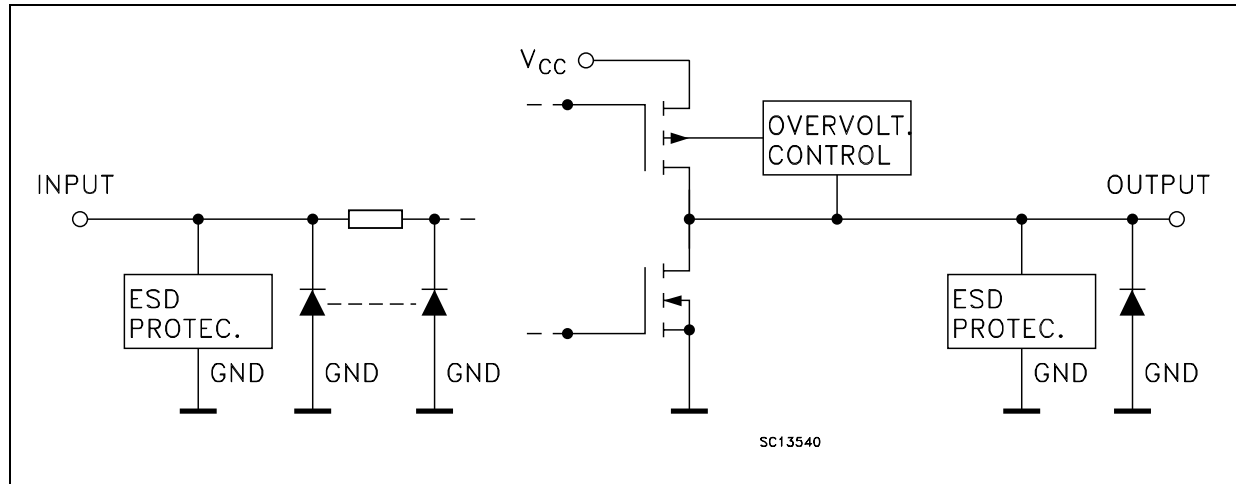
### DESCRIPTION

The 74LVC244A is a low voltage CMOS OCTAL BUS BUFFER (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.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

| PIN No         | SYMBOL          | NAME AND FUNCTION       |
|----------------|-----------------|-------------------------|
| 1              | 1G              | Output Enable Input     |
| 2, 4, 6, 8     | 1A1 to 1A4      | Data Inputs             |
| 9, 7, 5, 3     | 2Y1 to 2Y4      | Data Outputs            |
| 11, 13, 15, 17 | 2A1 to 2A4      | Data Inputs             |
| 18, 16, 14, 12 | 1Y1 to 1Y4      | Data Outputs            |
| 19             | 2G              | Output Enable Input     |
| 10             | GND             | Ground (0V)             |
| 20             | V <sub>CC</sub> | Positive Supply Voltage |

## TRUTH TABLE

| INPUTS         |                | OUTPUT         |
|----------------|----------------|----------------|
| $\overline{G}$ | A <sub>n</sub> | Y <sub>n</sub> |
| L              | L              | L              |
| L              | H              | H              |
| H              | X              | Z              |

X : Don't care  
Z : High Impedance

## 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

## 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  $V_{CC} = 3.0V$ 

## 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 |                      | ± 5                 |                      | ± 5                 | 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   |

## 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.

## 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                                     |              | 9.0  |               | 12   | ns   |
|                                        |                                       | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     |              | 7.9  |               | 10.5 |      |
|                                        |                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 1.5          | 6.9  |               | 8.3  |      |
|                                        |                                       | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1            | 5.9  |               | 7.1  |      |
| t <sub>PZL</sub> t <sub>PZH</sub>      | Output Enable Time                    | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     |              | 11   |               | 14.3 | ns   |
|                                        |                                       | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     |              | 9.6  |               | 12.5 |      |
|                                        |                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 1            | 8.6  |               | 10.3 |      |
|                                        |                                       | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 1            | 7.6  |               | 9.1  |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | Output Disable Time                   | 1.65 to 1.95           | 30                     | 1000                  | 2.0                                     |              | 9.0  |               | 11.7 | ns   |
|                                        |                                       | 2.3 to 2.7             | 30                     | 500                   | 2.0                                     |              | 7.8  |               | 10.1 |      |
|                                        |                                       | 2.7                    | 50                     | 500                   | 2.5                                     | 2            | 6.8  |               | 8.2  |      |
|                                        |                                       | 3.0 to 3.6             | 50                     | 500                   | 2.5                                     | 2            | 6.5  |               | 7.8  |      |
| 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>|)

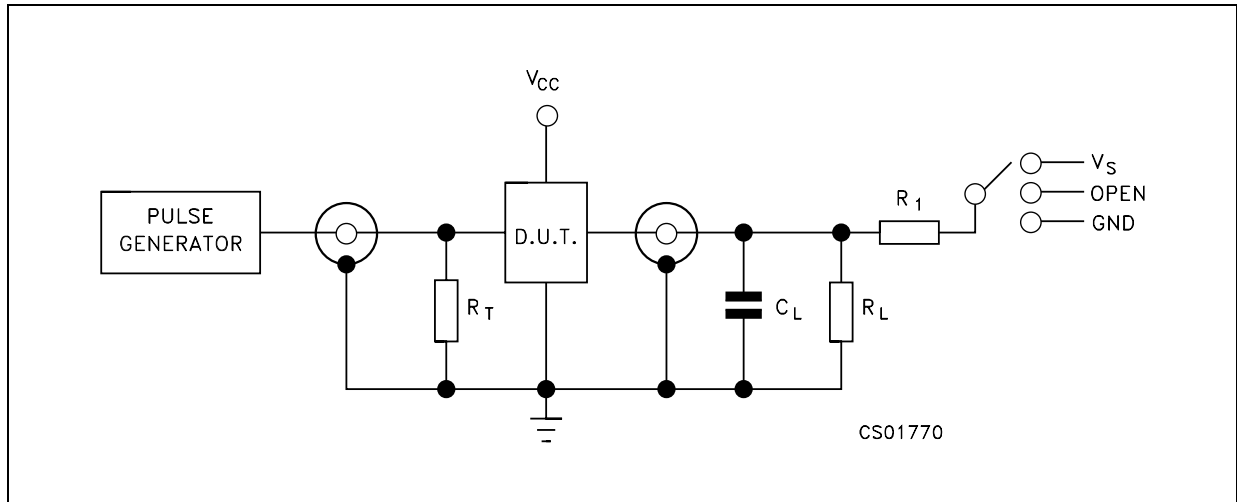
2) Parameter guaranteed by design

## 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)

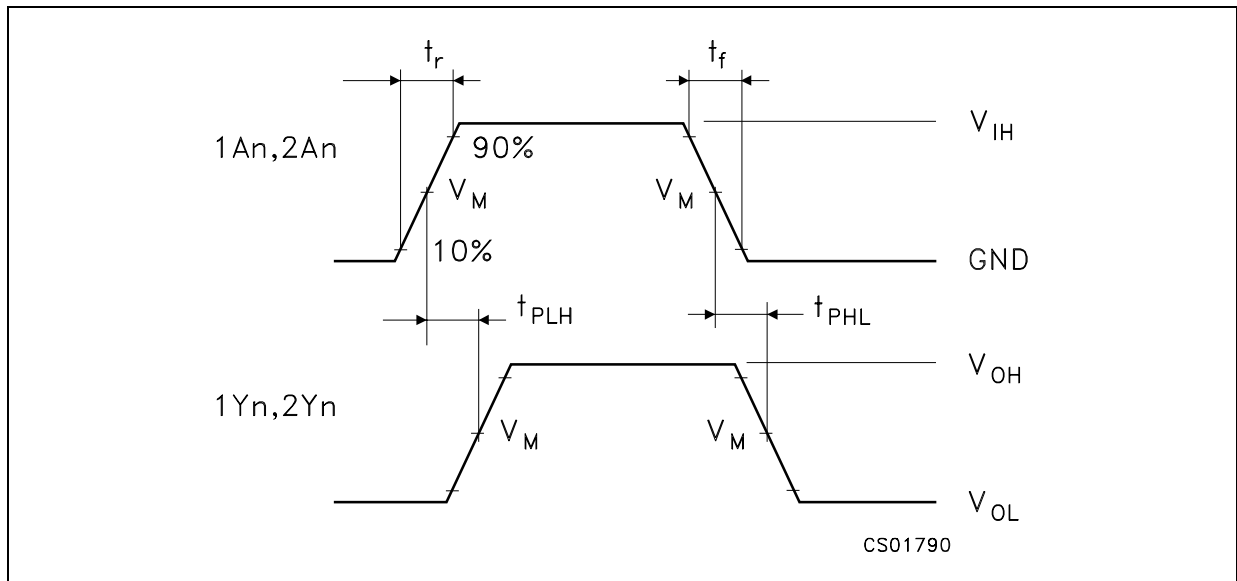
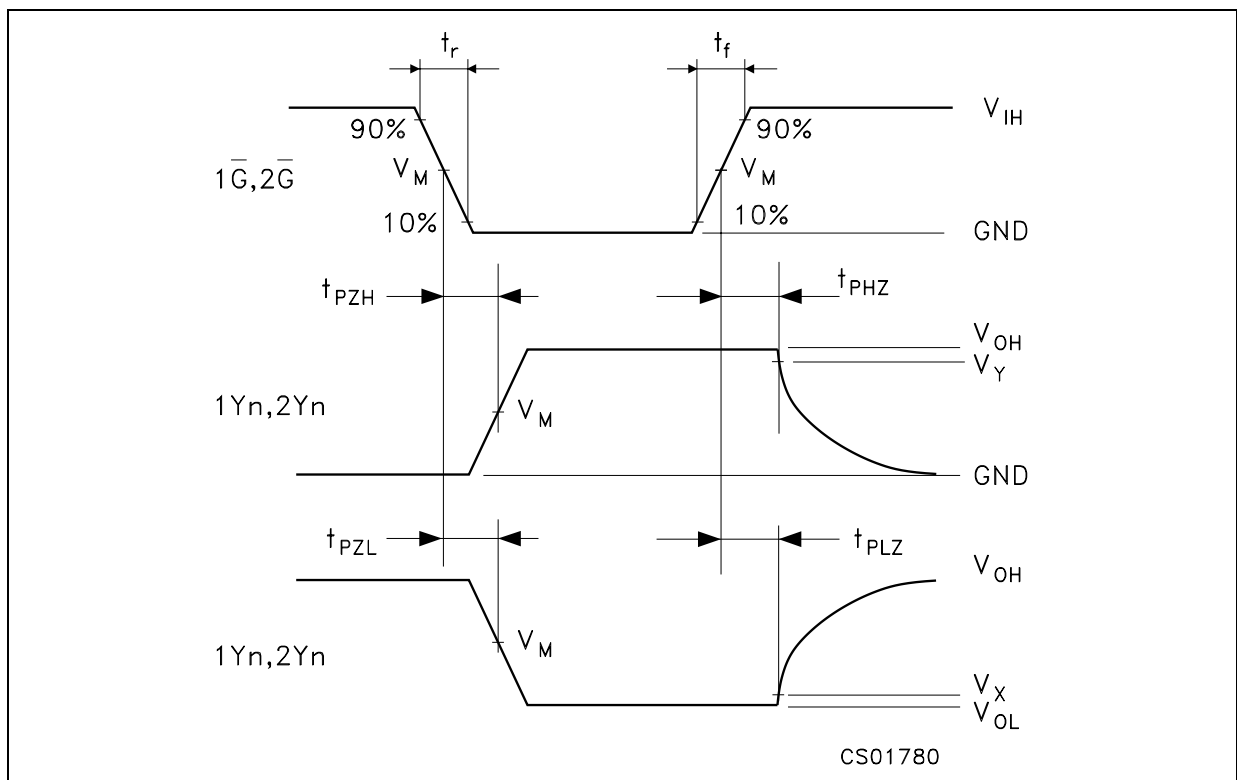
## TEST CIRCUIT



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

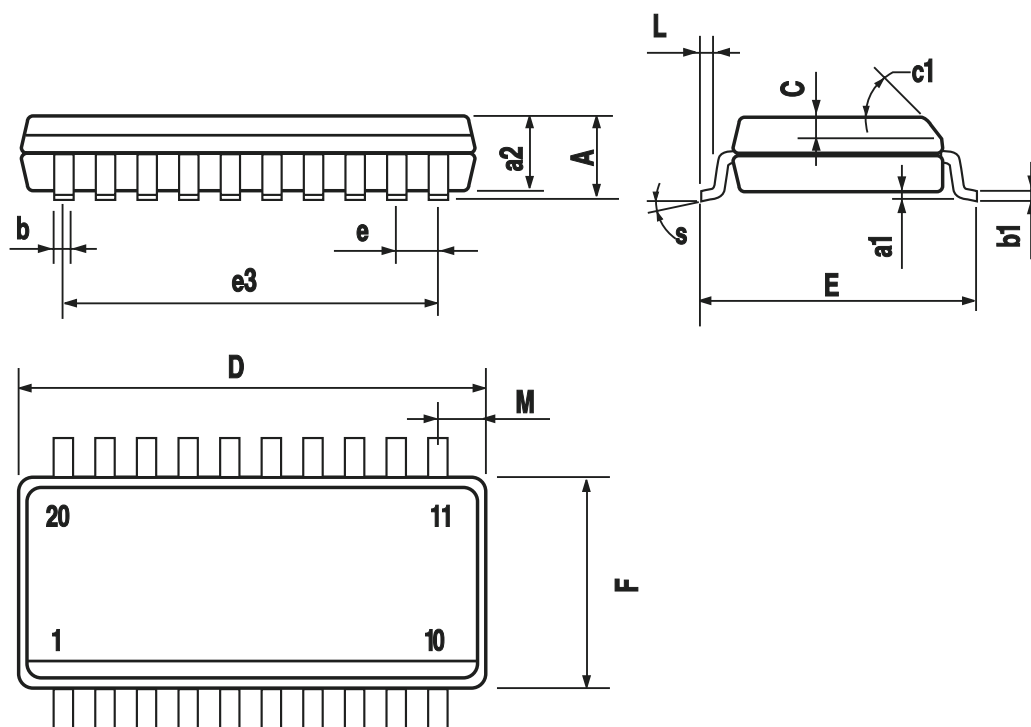
## TEST CIRCUIT AND WAVEFORM SYMBOL VALUE

| 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            |
| $R_L = R_1$ | 1000Ω             | 500Ω              | 500Ω            | 500Ω            |
| $V_S$       | $2 \times V_{CC}$ | $2 \times V_{CC}$ | 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          |

**WAVEFORM 1: PROPAGATION DELAYS** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIME** ( $f=1\text{MHz}$ ; 50% duty cycle)

## SO-20 MECHANICAL DATA

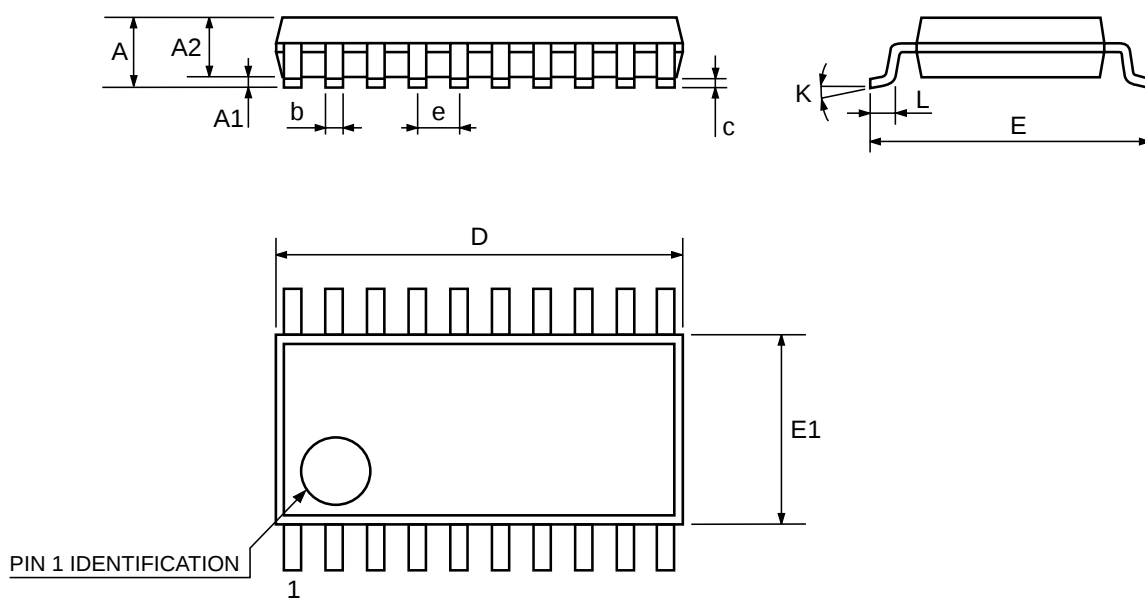
| DIM. | mm.        |       |       | inch  |       |       |
|------|------------|-------|-------|-------|-------|-------|
|      | MIN.       | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |            |       | 2.65  |       |       | 0.104 |
| a1   | 0.1        |       | 0.2   | 0.004 |       | 0.008 |
| a2   |            |       | 2.45  |       |       | 0.096 |
| b    | 0.35       |       | 0.49  | 0.014 |       | 0.019 |
| b1   | 0.23       |       | 0.32  | 0.009 |       | 0.012 |
| C    |            | 0.5   |       |       | 0.020 |       |
| c1   | 45° (typ.) |       |       |       |       |       |
| D    | 12.60      |       | 13.00 | 0.496 |       | 0.512 |
| E    | 10.00      |       | 10.65 | 0.393 |       | 0.419 |
| e    |            | 1.27  |       |       | 0.050 |       |
| e3   |            | 11.43 |       |       | 0.450 |       |
| F    | 7.40       |       | 7.60  | 0.291 |       | 0.300 |
| L    | 0.50       |       | 1.27  | 0.020 |       | 0.050 |
| M    |            |       | 0.75  |       |       | 0.029 |
| S    | 8° (max.)  |       |       |       |       |       |



PO13L

## 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 |            | 0.0089 |
| 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  |



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