



# 74VCXH16244

## LOW VOLTAGE CMOS 16-BIT BUFFER (3-STATE) WITH 3.6V TOLERANT INPUTS AND OUTPUTS

PRELIMINARY DATA

- 3.6V TOLERANT INPUTS AND OUTPUTS
- HIGH SPEED:  
 $t_{PD} = 2.5 \text{ ns (MAX.)}$  at  $V_{CC} = 3.0 \text{ to } 3.6\text{V}$   
 $t_{PD} = 3.0 \text{ ns (MAX.)}$  at  $V_{CC} = 2.3 \text{ to } 2.7\text{V}$
- POWER-DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 24 \text{ mA (MIN)}$  at  $V_{CC} = 3.0\text{V}$   
 $|I_{OH}| = I_{OL} = 18 \text{ mA (MIN)}$  at  $V_{CC} = 2.3\text{V}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC} \text{ (OPR)} = 1.8\text{V to } 3.6\text{V}$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 16244
- BUS HOLD PROVIDED ON DATA INPUTS
- LATCH-UP PERFORMANCE EXCEEDS 300mA
- ESD PERFORMANCE:  
 $\text{HBM} > 2000\text{V}; \text{MM} > 200\text{V}$

### DESCRIPTION

The 74VCXH16244 is a low voltage CMOS 16-BIT BUS BUFFER (NON-INVERTED) fabricated with sub-micron silicon gate and five layer metal wiring C<sup>2</sup>MOS technology. It is ideal for low power and very high speed 2.3 to 3.6V applications; it can be interfaced to 3.6V signal environment for both inputs and outputs.

Any  $\overline{nG}$  control output governs four BUS BUFFERS. Output Enable input ( $\overline{nG}$ ) tied together gives full 16-bit operation.

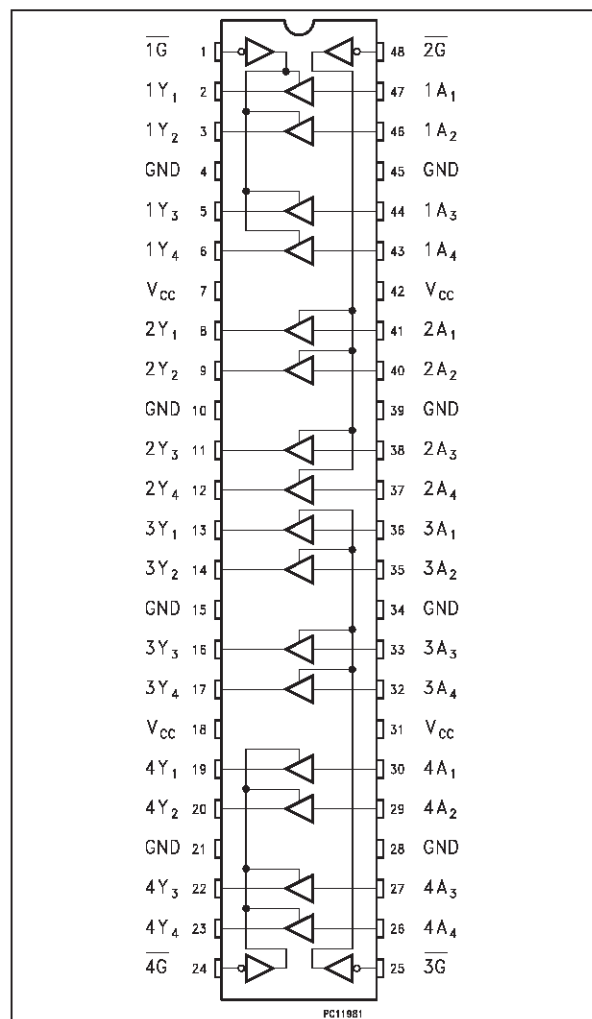
When  $\overline{nG}$  is LOW, the outputs are on. When  $\overline{nG}$  is HIGH, the output are in high impedance state.

This device is designed to be used with 3 state memory address drivers, etc. Bus hold on data inputs is provided in order to eliminate the need for external pull-up or pull-down resistor.

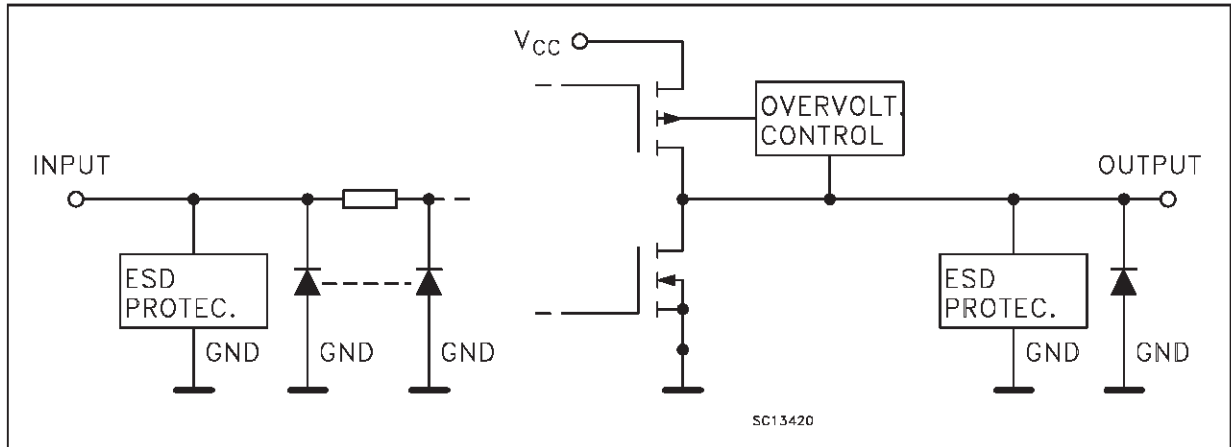
All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.



### PIN CONNECTION



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

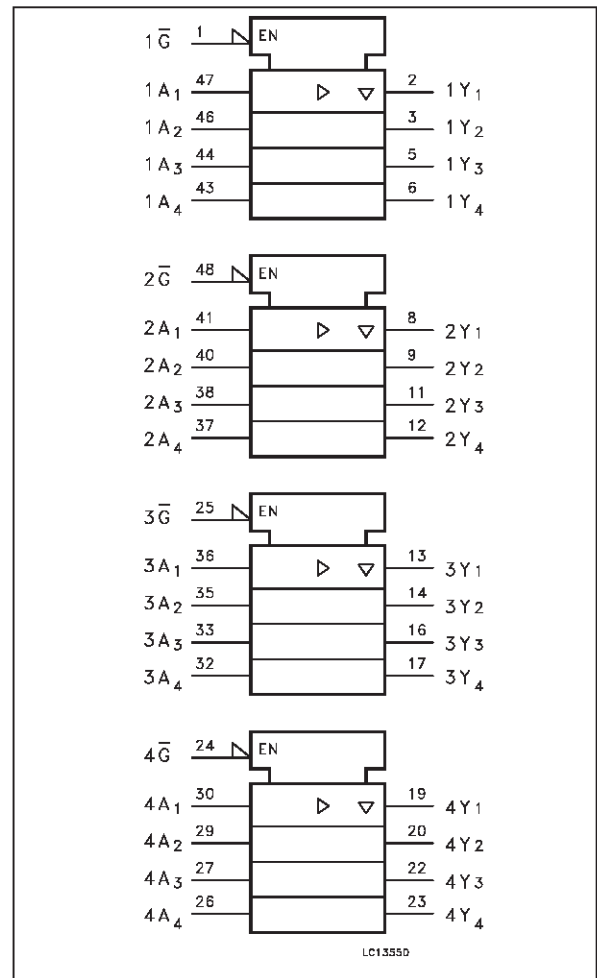
| PIN No                        | SYMBOL          | NAME AND FUNCTION       |
|-------------------------------|-----------------|-------------------------|
| 1                             | $\overline{1G}$ | Output Enable Input     |
| 2, 3, 5, 6                    | 1Y1 to 1Y4      | Data Outputs            |
| 8, 9, 11, 12                  | 2Y1 to 2Y4      | Data Outputs            |
| 13, 14, 16, 17                | 3Y1 to 3Y4      | Data Outputs            |
| 19, 20, 22, 23                | 4Y1 to 4Y4      | Data Outputs            |
| 24                            | $\overline{4G}$ | Output Enable Input     |
| 25                            | $\overline{3G}$ | Output Enable Input     |
| 30, 29, 27, 26                | 4A1 to 4A4      | Data Inputs             |
| 36, 35, 33, 32                | 3A1 to 3A4      | Data Inputs             |
| 41, 40, 38, 37                | 2A1 to 2A4      | Data Inputs             |
| 47, 46, 44, 43                | 1A1 to 1A4      | Data Inputs             |
| 48                            | $\overline{2G}$ | Output Enable Input     |
| 4, 10, 15, 21, 28, 34, 39, 45 | GND             | Ground (0V)             |
| 7, 18, 31, 42                 | V <sub>CC</sub> | Positive Supply Voltage |

TRUTH TABLE

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

X: "H" or "L"  
Z: High impedance

IEC LOGIC SYMBOLS



**ABSOLUTE MAXIMUM RATINGS**

| Symbol                | Parameter                                     | Value                  | Unit        |
|-----------------------|---|------------------------|-------------|
| $V_{CC}$              | Supply Voltage                                | -0.5 to + 4.6          | V           |
| $V_I$                 | DC Input Voltage                              | -0.5 to + 4.6          | V           |
| $V_O$                 | DC Output Voltage (OFF state)                 | -0.5 to + 4.6          | V           |
| $V_O$                 | DC Output Voltage (High or Low State) (note1) | -0.5 to $V_{CC} + 0.5$ | V           |
| $I_{IK}$              | DC Input Diode Current                        | - 50                   | mA          |
| $I_{OK}$              | DC Output Diode Current (note2)               | $\pm 50$               | mA          |
| $I_O$                 | DC Output Source/Sink Current                 | $\pm 50$               | mA          |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current Per Supply Pin  | $\pm 100$              | mA          |
| $P_D$                 | Power Dissipation                             | 400                    | mW          |
| $T_{stg}$             | Storage Temperature                           | -65 to +150            | $^{\circ}C$ |
| $T_L$                 | Lead Temperature (10 sec)                     | 300                    | $^{\circ}C$ |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

1)  $I_O$  absolute maximum rating must be observed

2)  $V_O < GND$ ,  $V_O > V_{CC}$

**RECOMMENDED OPERATING CONDITIONS**

| Symbol              | Parameter   | Value         | Unit        |
|---------------------|---|---------------|-------------|
| $V_{CC}$            | Supply Voltage  | 2.3 to 3.6    | V           |
| $V_I$               | Input Voltage   | -0.3 to 3.6   | V           |
| $V_O$               | Output Voltage (OFF state)                                      | 0 to 3.6      | 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 ( $V_{CC} = 2.3$ to $2.7V$ )   | $\pm 18$      | mA          |
| $T_{op}$            | Operating Temperature:  | -40 to +85    | $^{\circ}C$ |
| dt/dv               | Input Transition Rise or Fall Rate ( $V_{CC} = 3.0V$ ) (note 1) | 0 to 10       | ns/V        |

1)  $V_{IN}$  from 0.8V to 2.0V,  $V_{CC} = 3.0V$

**DC SPECIFICATIONS** ( $2.7V < V_{CC} \leq 3.6V$  unless otherwise specified)

| Symbol               | Parameter                      | Test Conditions        |  | 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             | V <sub>I</sub> = V <sub>IH</sub><br>or V <sub>IL</sub>                             | 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                   |      |
|                      |                                | 3.0                    |  | I <sub>O</sub> = -24 mA  | 2.2                   |      |
| V <sub>OL</sub>      | Low Level Output Voltage       | 2.7 to 3.6             | V <sub>I</sub> = V <sub>IH</sub><br>or V <sub>IL</sub>                             | 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> = 18 mA   | 0.4                   |      |
|                      |                                | 3.0                    |  | I <sub>O</sub> = 24 mA   | 0.55                  |      |
| I <sub>I</sub>       | Input Leakage Current          | 2.7 to 3.6             | V <sub>I</sub> = V <sub>CC</sub> or GND  |                          | ±5                    | μA   |
| I <sub>I(HOLD)</sub> | Input Hold Current             | 3                      | V <sub>I</sub> = 0.8 V   | 75                       |                       | μA   |
|                      |                                |                        | V <sub>I</sub> = 2 V   | -75                      |                       |      |
|                      |                                | 3.6                    | V <sub>I</sub> = 0 to 3.6 V  |                          | ±500                  |      |
| I <sub>OZ</sub>      | 3 State 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 3.6 V |                          | ±10                   | μA   |
| I <sub>off</sub>     | Power Off Leakage Current      | 0                      | V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V                                      |                          | 10                    | μA   |
| I <sub>CC</sub>      | Quiescent Supply Current       | 2.7 to 3.6             | V <sub>I</sub> = V <sub>CC</sub> or GND  |                          | 20                    | μA   |
|                      |                                |                        | V <sub>I</sub> or V <sub>O</sub> = V <sub>CC</sub> to 3.6 V                        |                          | ±20                   |      |
| ΔI <sub>CC</sub>     | ICC incr. per input            | 2.7 to 3.6             | V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V  |                          | 750                   | μA   |

**DC SPECIFICATIONS** ( $2.3V < V_{CC} \leq 2.7V$  unless otherwise specified)

| Symbol               | Parameter                      | Test Conditions        |  | Value                    |                       | Unit |
|----------------------|--------------------------------|------------------------|--|--------------------------|-----------------------|------|
|                      |                                | V <sub>CC</sub><br>(V) |  | -40 to 85 °C             |                       |      |
|                      |                                |                        |  | Min.                     | Max.                  |      |
| V <sub>IH</sub>      | High Level Input Voltage       | 2.3 to 2.7             |  | 1.6                      |                       | V    |
| V <sub>IL</sub>      | Low Level Input Voltage        |                        |  |                          | 0.7                   |      |
| V <sub>OH</sub>      | High Level Output Voltage      | 2.3 to 2.7             | V <sub>I</sub> = V <sub>IH</sub><br>or V <sub>IL</sub>                             | I <sub>O</sub> = -100 μA | V <sub>CC</sub> - 0.2 | V    |
|                      |                                | 2.3                    |  | I <sub>O</sub> = -6 mA   | 2.0                   |      |
|                      |                                | 2.3                    |  | I <sub>O</sub> = -12 mA  | 1.8                   |      |
|                      |                                | 2.3                    |  | I <sub>O</sub> = -18 mA  | 1.7                   |      |
| V <sub>OL</sub>      | Low Level Output Voltage       | 2.3 to 2.7             | V <sub>I</sub> = V <sub>IH</sub><br>or V <sub>IL</sub>                             | I <sub>O</sub> = 100 μA  | 0.2                   | V    |
|                      |                                | 2.3                    |  | I <sub>O</sub> = 12 mA   | 0.4                   |      |
|                      |                                | 2.3                    |  | I <sub>O</sub> = 18 mA   | 0.6                   |      |
| I <sub>I</sub>       | Input Leakage Current          | 2.3 to 2.7             | V <sub>I</sub> = V <sub>CC</sub> or GND  |                          | ±5                    | μA   |
| I <sub>I(HOLD)</sub> | Input Hold Current             | 2.3                    | V <sub>I</sub> = 0.7 V   | 45                       |                       | μA   |
|                      |                                |                        | V <sub>I</sub> = 1.7 V   | -45                      |                       |      |
| I <sub>OZ</sub>      | 3 State Output Leakage Current | 2.3 to 2.7             | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = 0 to 3.6 V |                          | ±10                   | μA   |
| I <sub>off</sub>     | Power Off Leakage Current      | 0                      | V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V                                      |                          | 10                    | μA   |
| I <sub>CC</sub>      | Quiescent Supply Current       | 2.3 to 2.7             | V <sub>I</sub> = V <sub>CC</sub> or GND  |                          | 20                    | μA   |
|                      |                                |                        | V <sub>I</sub> or V <sub>O</sub> = V <sub>CC</sub> to 3.6 V                        |                          | ±20                   |      |

**DYNAMIC SWITCHING CHARACTERISTICS** ( $T_a = 25^\circ\text{C}$ , Input  $t_r = t_f = 2.0\text{ns}$ ,  $C_L = 30\text{pF}$ ,  $R_L = 500\Omega$ )

| Symbol           | Parameter  | Test Conditions        |  | Value                  |      |      | Unit |
|------------------|--|------------------------|--|------------------------|------|------|------|
|                  |  | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25 °C |      |      |      |
|                  |  |                        |  | Min.                   | Typ. | Max. |      |
| V <sub>OLP</sub> | Dynamic Low Voltage Quiet Output<br>(note 1, 3)  | 2.5                    | V <sub>IL</sub> = 0 V<br>V <sub>IH</sub> = V <sub>CC</sub> |                        | 0.6  |      | V    |
|                  |  | 3.3                    |  |                        | 0.8  |      |      |
| V <sub>OLV</sub> | Dynamic Low Voltage Quiet Output<br>(note 1, 3)  | 2.5                    | V <sub>IL</sub> = 0 V<br>V <sub>IH</sub> = V <sub>CC</sub> |                        | -0.6 |      | V    |
|                  |  | 3.3                    |  |                        | -0.8 |      |      |
| V <sub>OHV</sub> | Dynamic High Voltage Quiet Output<br>(note 2, 3) | 2.5                    | V <sub>IL</sub> = 0 V<br>V <sub>IH</sub> = V <sub>CC</sub> |                        | 1.9  |      | V    |
|                  |  | 3.3                    |  |                        | 2.2  |      |      |

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.

2) 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 HIGH state.

3) Parameters guaranteed by design.

**AC ELECTRICAL CHARACTERISTICS** ( $C_L = 30\text{ pF}$ ,  $R_L = 500\Omega$ , Input  $t_r = t_f = 2.0\text{ ns}$ )

| Symbol                                 | Parameter                              | Test Condition         |          | Value        |      | Unit |
|--|--|------------------------|----------|--------------|------|------|
|  |  | V <sub>CC</sub><br>(V) | Waveform | -40 to 85 °C |      |      |
|  |  |                        |          | Min.         | Max. |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time                 | 2.3 to 2.7             | 1        | 1.0          | 3.0  | ns   |
|  |  | 3.0 to 3.6             |          | 0.8          | 2.5  |      |
| t <sub>PZL</sub><br>t <sub>PZH</sub>   | Output Enable Time                     | 2.3 to 2.7             | 2        | 1.0          | 4.1  | ns   |
|  |  | 3.0 to 3.6             |          | 0.8          | 3.5  |      |
| t <sub>PLZ</sub><br>t <sub>PHZ</sub>   | Output Disable Time                    | 2.3 to 2.7             | 2        | 1.0          | 3.8  | ns   |
|  |  | 3.0 to 3.6             |          | 0.8          | 3.5  |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output to Output Skew Time (note 1, 2) | 2.3 to 2.7             |          |              | 0.5  | ns   |
|  |  | 3.0 to 3.6             |          |              | 0.5  |      |

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 ( $t_{OSLH} = |t_{PLHm} - t_{PLHr}|$ ,  $t_{OSHL} = |t_{PHLm} - t_{PHLr}|$ )

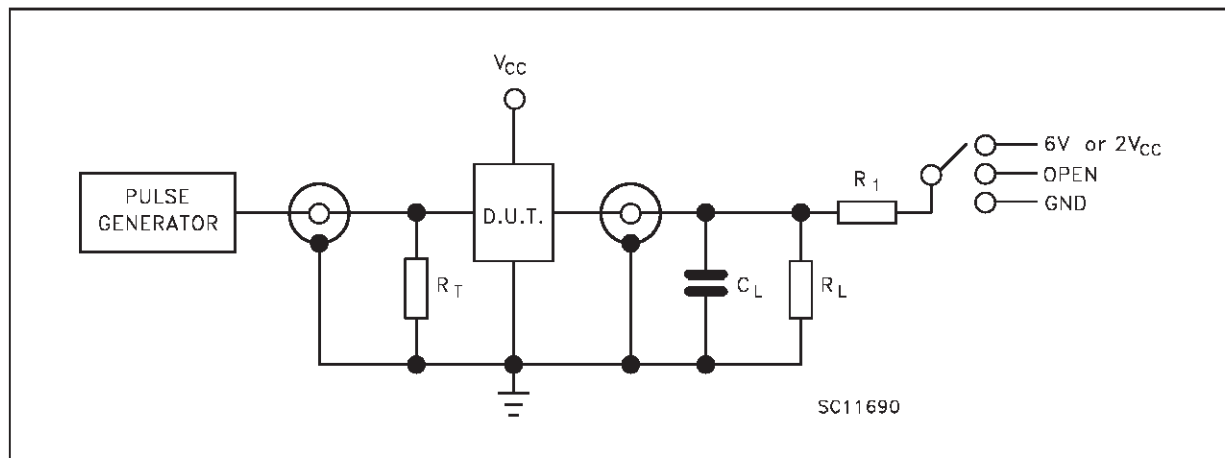
2) Parameter guaranteed by design

**CAPACITIVE CHARACTERISTICS**

| Symbol           | Parameter                              | Test Conditions        |  | Value                  |      |      | Unit |
|------------------|--|------------------------|--|------------------------|------|------|------|
|                  |  | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25 °C |      |      |      |
|                  |  |                        |  | Min.                   | Typ. | Max. |      |
| C <sub>IN</sub>  | Input Capacitance                      | 2.5 or 3.3             | V <sub>IN</sub> = 0V or V <sub>CC</sub>                            |                        | 6    |      | pF   |
| C <sub>OUT</sub> | Output Capacitance                     | 2.5 or 3.3             | V <sub>IN</sub> = 0V or V <sub>CC</sub>                            |                        | 7    |      | pF   |
| C <sub>PD</sub>  | Power Dissipation Capacitance (note 1) | 2.5 or 3.3             | f <sub>IN</sub> = 10MHz<br>V <sub>IN</sub> = 0V or V <sub>CC</sub> |                        | 20   |      | pF   |

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. Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/16$  (per circuit)

TEST CIRCUIT



| TEST   | SWITCH    |
|--|-----------|
| $t_{PLH}$ , $t_{PHL}$                              | Open      |
| $t_{PZL}$ , $t_{PLZ}$ ( $V_{CC} = 3.0$ to $3.6V$ ) | 6V        |
| $t_{PZL}$ , $t_{PLZ}$ ( $V_{CC} = 2.3$ to $2.7V$ ) | $2V_{CC}$ |
| $t_{PZH}$ , $t_{PHZ}$                              | GND       |

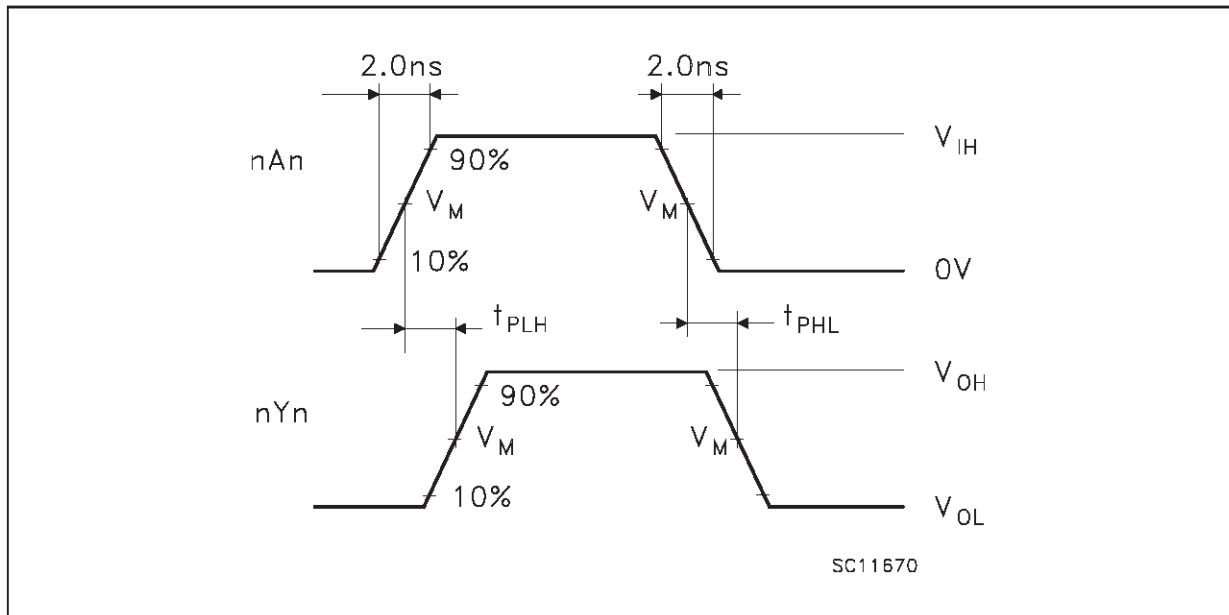
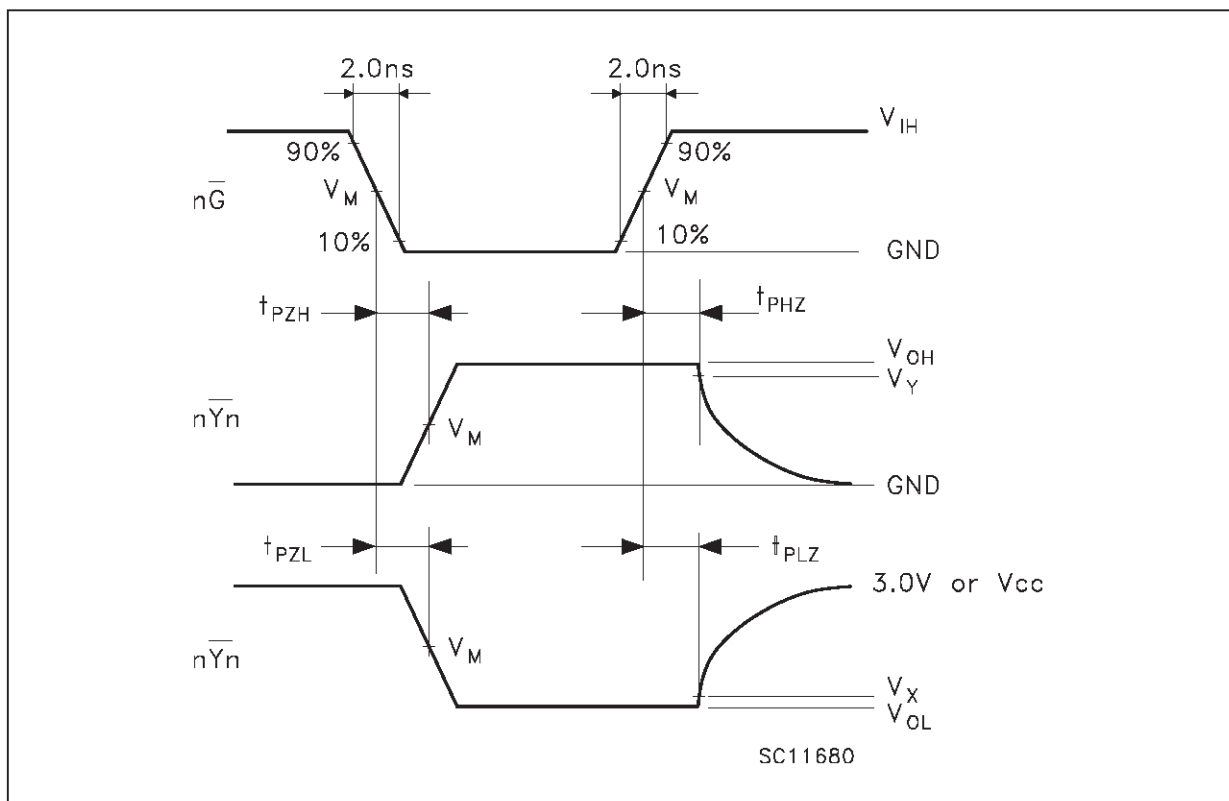
$C_L = 30$  pF or equivalent (includes jig and probe capacitance)

$R_L = R_1 = 500\Omega$  or equivalent

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

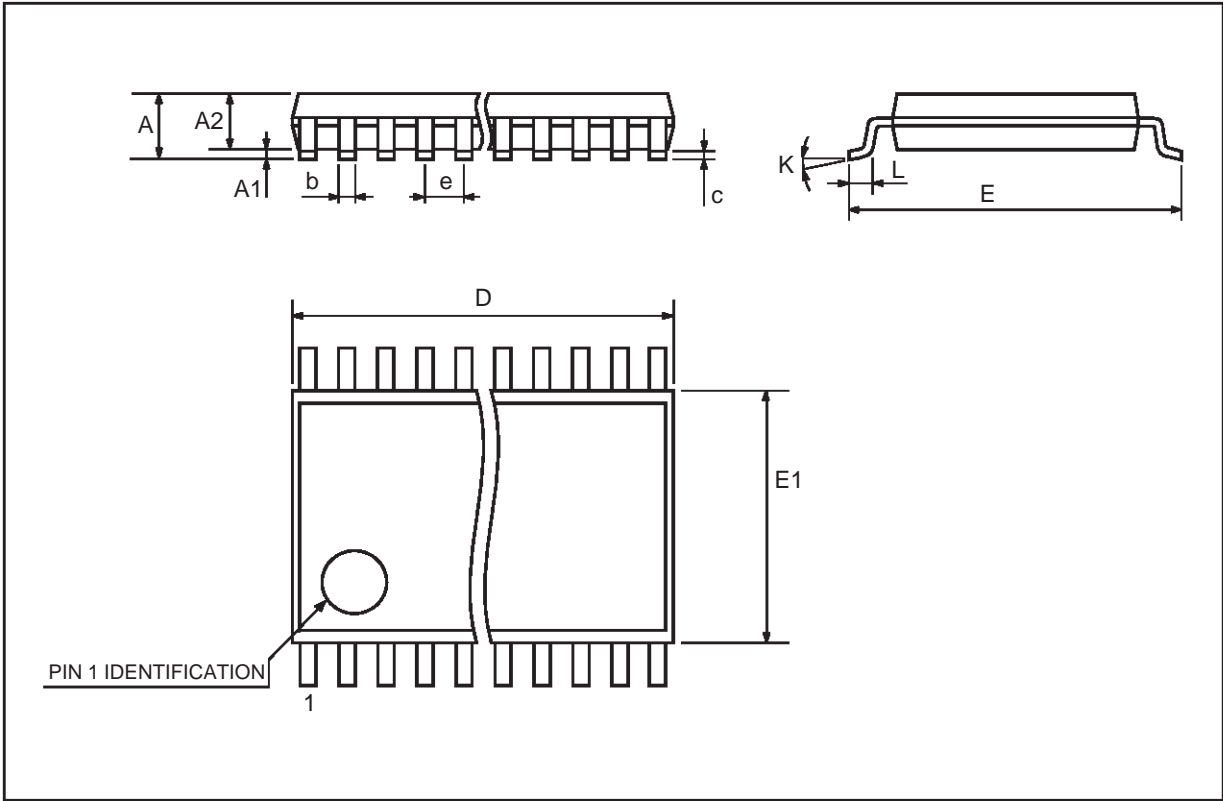
WAVEFORM SYMBOL VALUES

| Symbol   | $V_{CC}$        |                  |
|----------|-----------------|------------------|
|          | 3.0 to 3.6V     | 2.3 to 2.7V      |
| $V_{IH}$ | 2.7V            | $V_{CC}$         |
| $V_M$    | 1.5V            | $V_{CC}/2$       |
| $V_X$    | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ |
| $V_Y$    | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ |

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

**TSSOP48 MECHANICAL DATA**

| DIM. | mm   |         |      | inch   |            |        |
|------|------|---------|------|--------|------------|--------|
|      | MIN. | TYP.    | MAX. | MIN.   | TYP.       | MAX.   |
| A    |      |         | 1.1  |        |            | 0.433  |
| A1   | 0.05 | 0.10    | 0.15 | 0.002  | 0.004      | 0.006  |
| A2   | 0.85 | 0.9     | 0.95 | 0.335  | 0.354      | 0.374  |
| b    | 0.17 |         | 0.27 | 0.0067 |            | 0.011  |
| c    | 0.09 |         | 0.20 | 0.0035 |            | 0.0079 |
| D    | 12.4 | 12.5    | 12.6 | 0.408  | 0.492      | 0.496  |
| E    | 7.95 | 8.1     | 8.25 | 0.313  | 0.319      | 0.325  |
| E1   | 6.0  | 6.1     | 6.2  | 0.236  | 0.240      | 0.244  |
| e    |      | 0.5 BSC |      |        | 0.0197 BSC |        |
| K    | 0°   | 4°      | 8°   | 0°     | 4°         | 8°     |
| L    | 0.50 | 0.60    | 0.70 | 0.020  | 0.024      | 0.028  |





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