



# 74VCX16244

## 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  $V_{CC} = 3.0$  to  $3.6\text{V}$
  - $t_{PD} = 3.0 \text{ ns (MAX.)}$  at  $V_{CC} = 2.3$  to  $2.7\text{V}$
  - $t_{PD} = 5.0 \text{ ns (MAX.)}$  at  $V_{CC} = 1.8\text{V}$
- 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  $V_{CC} = 2.3\text{V}$
  - $|I_{OH}| = I_{OL} = 6 \text{ mA (MIN)}$  at  $V_{CC} = 1.8\text{V}$
- OPERATING VOLTAGE RANGE:
  - $V_{CC} \text{ (OPR)} = 1.8\text{V to } 3.6\text{V}$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 16244
- LATCH-UP PERFORMANCE EXCEEDS 300mA
- ESD PERFORMANCE:
  - HBM > 2000V; MM > 200V

### DESCRIPTION

The 74VCX16244 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 1.8 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.

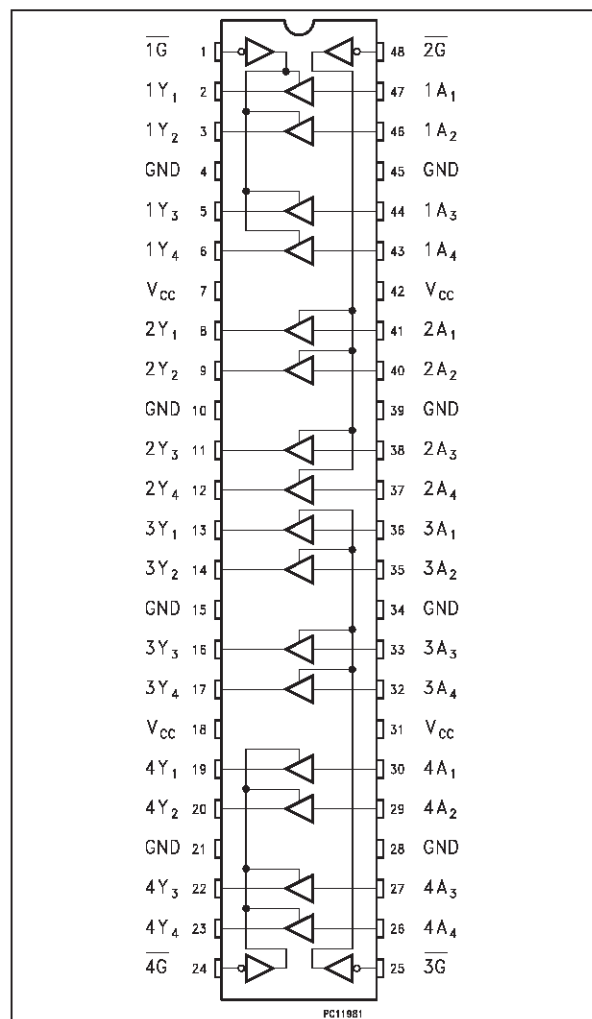
When  $\overline{nG}$  is LOW, the outputs are on. When  $\overline{nG}$  is HIGH, the output are in high impedance state.

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

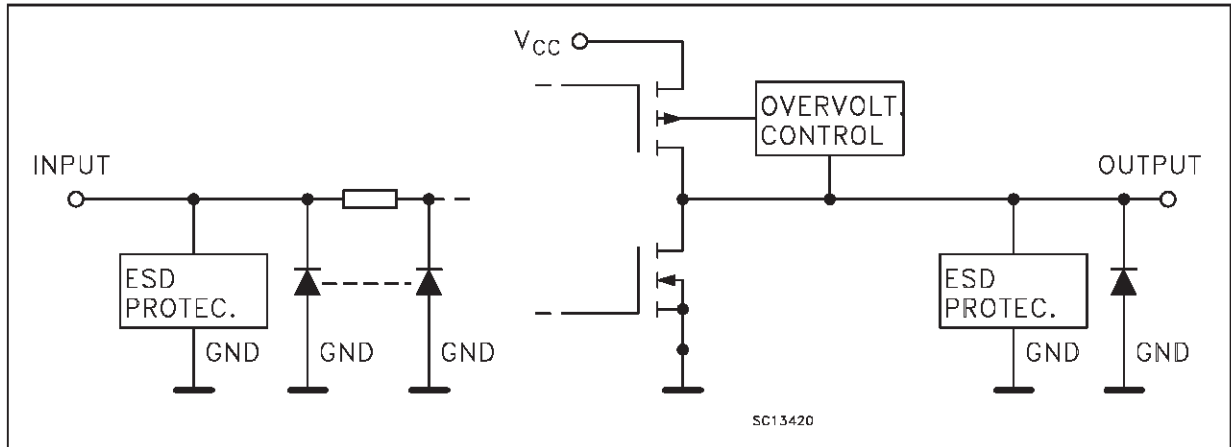
All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.



### PIN CONNECTION



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

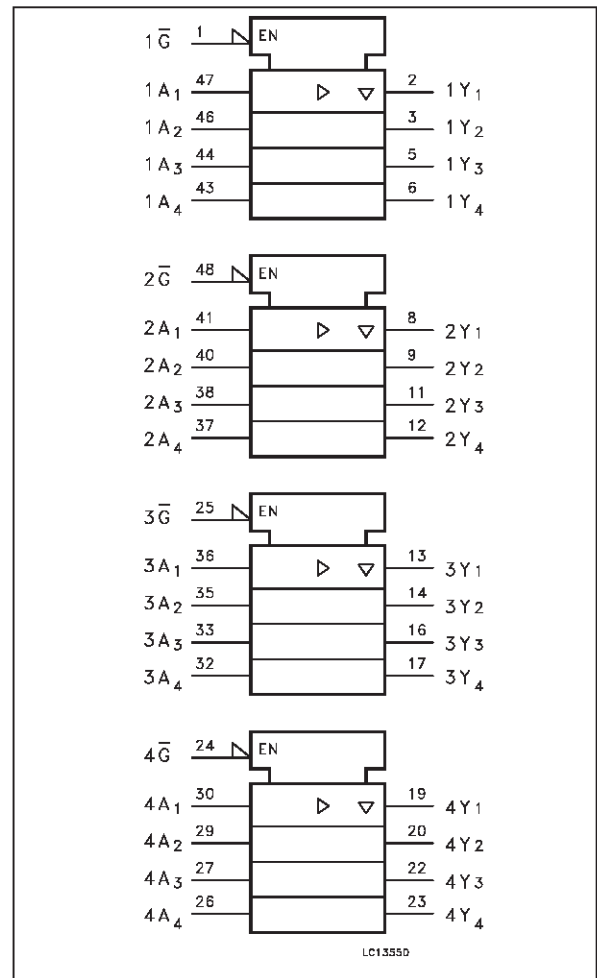
PIN No	SYMBOL	NAME AND FUNCTION
1	$\overline{1G}$	Output Enable Input
2, 3, 5, 6	1Y1 to 1Y4	Data Outputs
8, 9, 11, 12	2Y1 to 2Y4	Data Outputs
13, 14, 16, 17	3Y1 to 3Y4	Data Outputs
19, 20, 22, 23	4Y1 to 4Y4	Data Outputs
24	$\overline{4G}$	Output Enable Input
25	$\overline{3G}$	Output Enable Input
30, 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 <sub>CC</sub>	Supply Voltage	-0.5 to + 4.6	V
V <sub>I</sub>	DC Input Voltage	-0.5 to + 4.6	V
V <sub>O</sub>	DC Output Voltage (OFF state)	-0.5 to + 4.6	V
V <sub>O</sub>	DC Output Voltage (High or Low State) (note1)	-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 (note2)	± 50	mA
I <sub>O</sub>	DC Output Source/Sink 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
P <sub>D</sub>	Power Dissipation	400	mW
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 condition is not implied.

1) I<sub>O</sub> absolute maximum rating must be observed

2) V<sub>O</sub> < GND, V<sub>O</sub> > V<sub>CC</sub>

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	1.8 to 3.6	V
V <sub>I</sub>	Input Voltage	-0.3 to 3.6	V
V <sub>O</sub>	Output Voltage (OFF state)	0 to 3.6	V
V <sub>O</sub>	Output Voltage (High or Low State)	0 to V <sub>CC</sub>	V
I <sub>OH</sub> , I <sub>OL</sub>	High or Low Level Output Current (V <sub>CC</sub> = 3.0 to 3.6V)	± 24	mA
I <sub>OH</sub> , I <sub>OL</sub>	High or Low Level Output Current (V <sub>CC</sub> = 2.3 to 2.7V)	± 18	mA
I <sub>OH</sub> , I <sub>OL</sub>	High or Low Level Output Current (V <sub>CC</sub> = 1.8V)	± 6	mA
T <sub>op</sub>	Operating Temperature:	-40 to +85	°C
dt/dv	Input Transition Rise or Fall Rate (V <sub>CC</sub> = 3.0V) (note 1)	0 to 10	ns/V

1) V<sub>IN</sub> from 0.8V to 2.0V, V<sub>CC</sub> = 3.0V

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

Symbol	Parameter	Test Conditions		Value		Unit
		V <sub>CC</sub> (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	V <sub>I</sub> = V <sub>IH</sub> 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> 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> = 0 to 3.6 V		±5	μA
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> 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> (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
V <sub>OH</sub>	High Level Output Voltage	2.3 to 2.7	V <sub>I</sub> = V <sub>IH</sub> 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> 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> = 0 to 3.6 V		±5	μA
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> 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	

**DC SPECIFICATIONS** ( $1.8V \leq V_{CC} \leq 2.3V$  unless otherwise specified)

Symbol	Parameter	Test Conditions		Value		Unit	
		V <sub>CC</sub> (V)		-40 to 85 °C			
				Min.	Max.		
V <sub>IH</sub>	High Level Input Voltage	1.8 to 2.3		0.7V <sub>CC</sub>		V	
V <sub>IL</sub>	Low Level Input Voltage				0.2V <sub>CC</sub>		V
V <sub>OH</sub>	High Level Output Voltage	1.8	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>O</sub> = -100 μA	V <sub>CC</sub> - 0.2	V	
		1.8		I <sub>O</sub> = -6 mA	1.4		
V <sub>OL</sub>	Low Level Output Voltage	1.8	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>O</sub> = 100 μA	0.2	V	
		1.8		I <sub>O</sub> = 6 mA	0.3		
I <sub>I</sub>	Input Leakage Current	1.8	V <sub>I</sub> = 0 to 3.6V			±5	μA
I <sub>OZ</sub>	3 State Output Leakage Current	1.8	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>O</sub> = 0 to 3.6V			±10	μA
I <sub>off</sub>	Power Off Leakage Current	0	V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6V			10	μA
I <sub>CC</sub>	Quiescent Supply Current	1.8	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 3.6V			±20	

**DYNAMIC SWITCHING CHARACTERISTICS** (T<sub>a</sub> = 25°C, Input t<sub>r</sub> = t<sub>f</sub> = 2.0ns, C<sub>L</sub> = 30pF, R<sub>L</sub> = 500Ω)

Symbol	Parameter	Test Conditions		Value			Unit
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C			
				Min.	Typ.	Max.	
V <sub>OLP</sub>	Dynamic Low Voltage Quiet Output (note 1, 3)	1.8	V <sub>IL</sub> = 0 V V <sub>IH</sub> = V <sub>CC</sub>		0.25		V
		2.5			0.6		
		3.3			0.8		
V <sub>OLV</sub>	Dynamic Low Voltage Quiet Output (note 1, 3)	1.8	V <sub>IL</sub> = 0 V V <sub>IH</sub> = V <sub>CC</sub>		-0.25		V
		2.5			-0.6		
		3.3			-0.8		
V <sub>OHV</sub>	Dynamic High Voltage Quiet Output (note 2, 3)	1.8	V <sub>IL</sub> = 0 V V <sub>IH</sub> = V <sub>CC</sub>		1.5		V
		2.5			1.9		
		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
		$V_{CC}$ (V)	Waveform	-40 to 85 °C		
				Min.	Max.	
$t_{PLH}$ $t_{PHL}$	Propagation Delay Time	1.8	1	1.5	5.0	ns
		2.3 to 2.7		1.0	3.0	
		3.0 to 3.6		0.8	2.5	
$t_{PZL}$ $t_{PZH}$	Output Enable Time	1.8	2	1.5	6.5	ns
		2.3 to 2.7		1.0	4.1	
		3.0 to 3.6		0.8	3.5	
$t_{PLZ}$ $t_{PHZ}$	Output Disable Time	1.8	2	1.5	5.0	ns
		2.3 to 2.7		1.0	3.8	
		3.0 to 3.6		0.8	3.5	
$t_{OSLH}$ $t_{OSHL}$	Output to Output Skew Time (note 1, 2)	1.8			0.5	ns
		2.3 to 2.7			0.5	
		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 ( $t_{OSLH} = |t_{PLHm} - t_{PLHl}|$ ,  $t_{OSHL} = |t_{PHLm} - t_{PHLl}|$ )

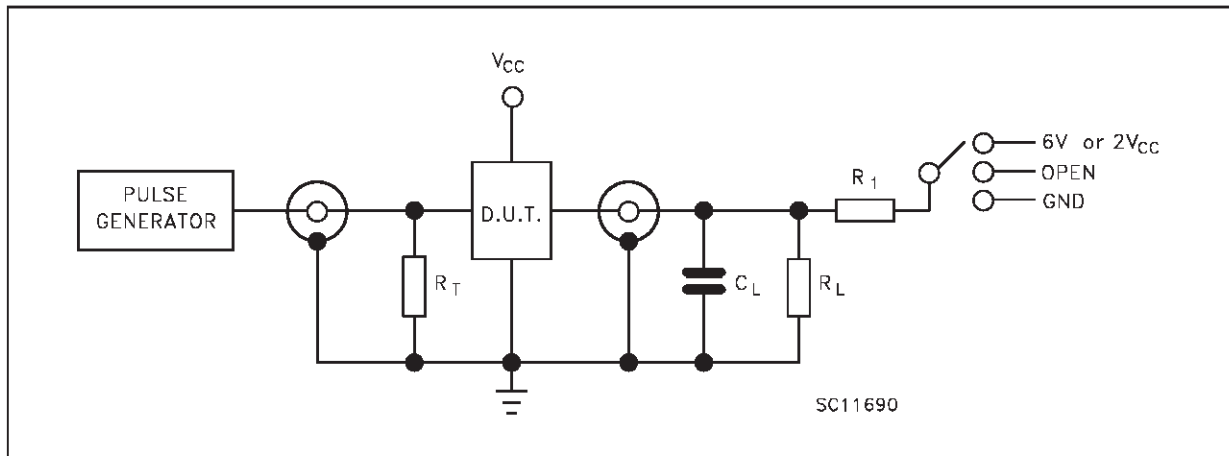
2) Parameter guaranteed by design

**CAPACITIVE CHARACTERISTICS**

Symbol	Parameter	Test Conditions		Value			Unit
		$V_{CC}$ (V)		$T_A = 25 \text{ °C}$			
				Min.	Typ.	Max.	
$C_{IN}$	Input Capacitance	1.8, 2.5 or 3.3	$V_{IN} = 0V \text{ or } V_{CC}$		6		pF
$C_{OUT}$	Output Capacitance	1.8, 2.5 or 3.3	$V_{IN} = 0V \text{ or } V_{CC}$		7		pF
$C_{PD}$	Power Dissipation Capacitance (note 1)	1.8, 2.5 or 3.3	$f_{IN} = 10\text{MHz}$ $V_{IN} = 0V \text{ or } V_{CC}$		20		pF

1)  $C_{PD}$  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 $2.7V$ or $1.8V$ )	$2V_{CC}$
$t_{PZH}$ , $t_{PHZ}$	GND

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

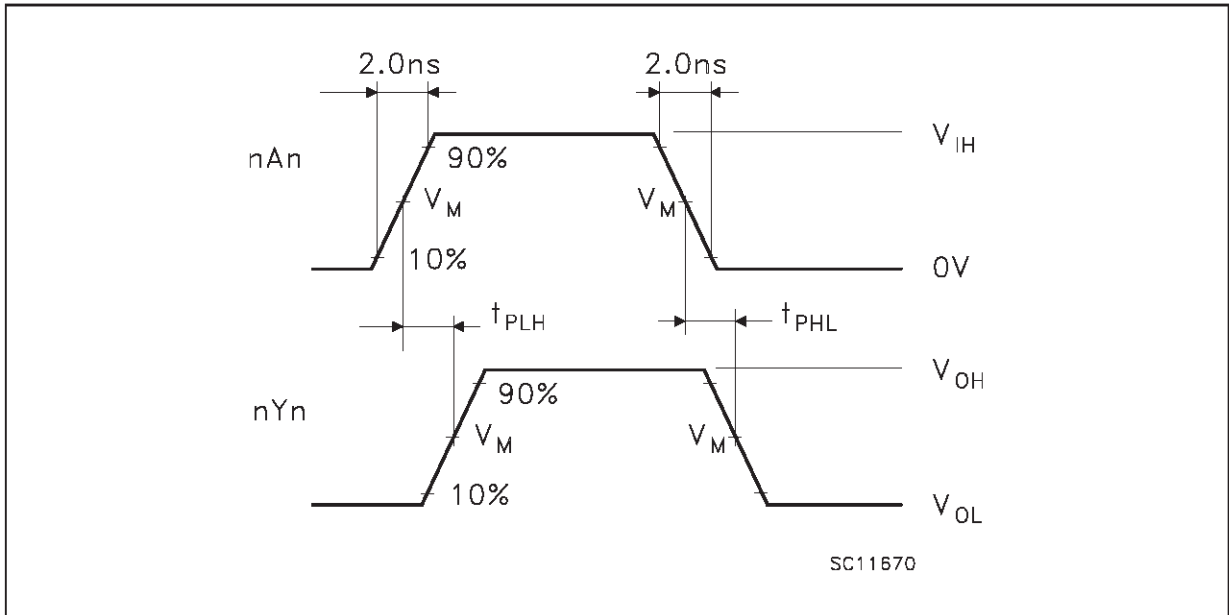
$R_L = R_1 = 500\Omega$  or equivalent

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

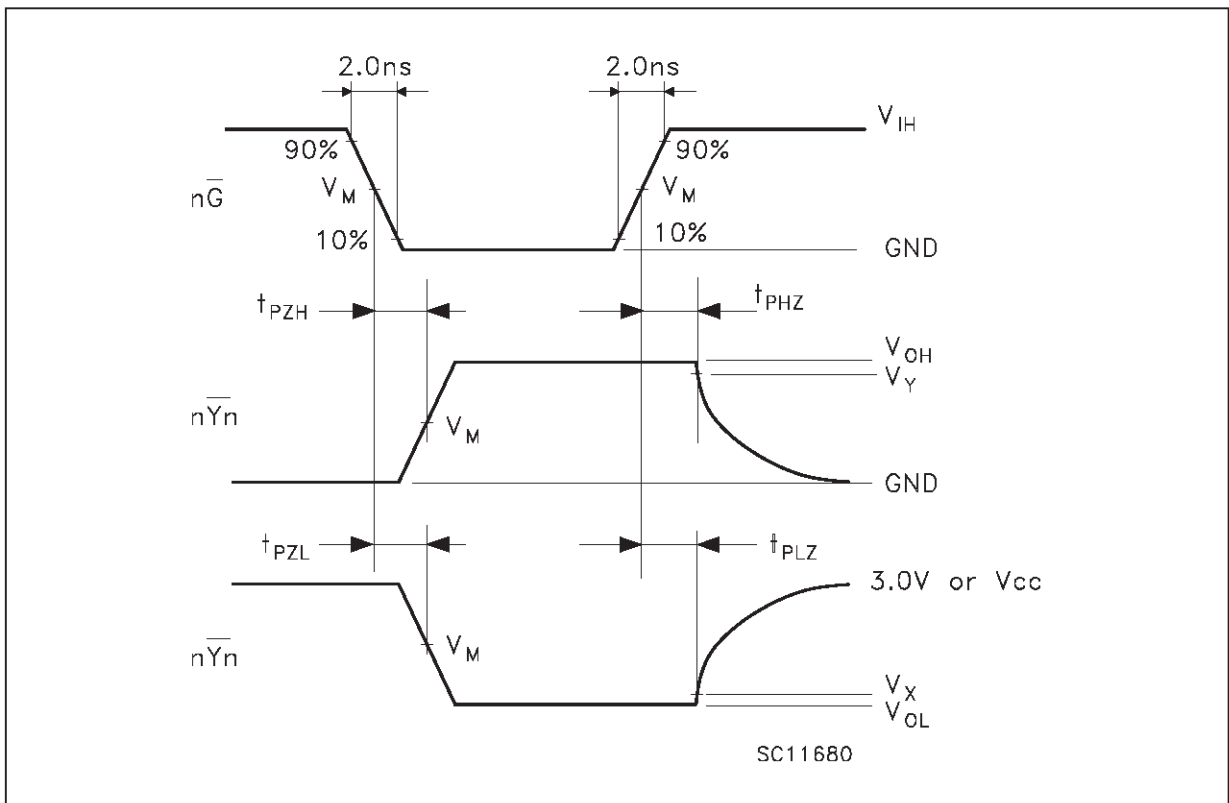
## WAVEFORM SYMBOL VALUES

Symbol	$V_{CC}$		
	3.0 to 3.6V	2.3 to 2.7V	1.8V
$V_{IH}$	2.7V	$V_{CC}$	$V_{CC}$
$V_M$	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$	$V_{OL} + 0.15V$
$V_Y$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$	$V_{OH} - 0.15V$

WAVEFORM 1: PROPAGATION DELAYS (f=1MHz; 50% duty cycle)



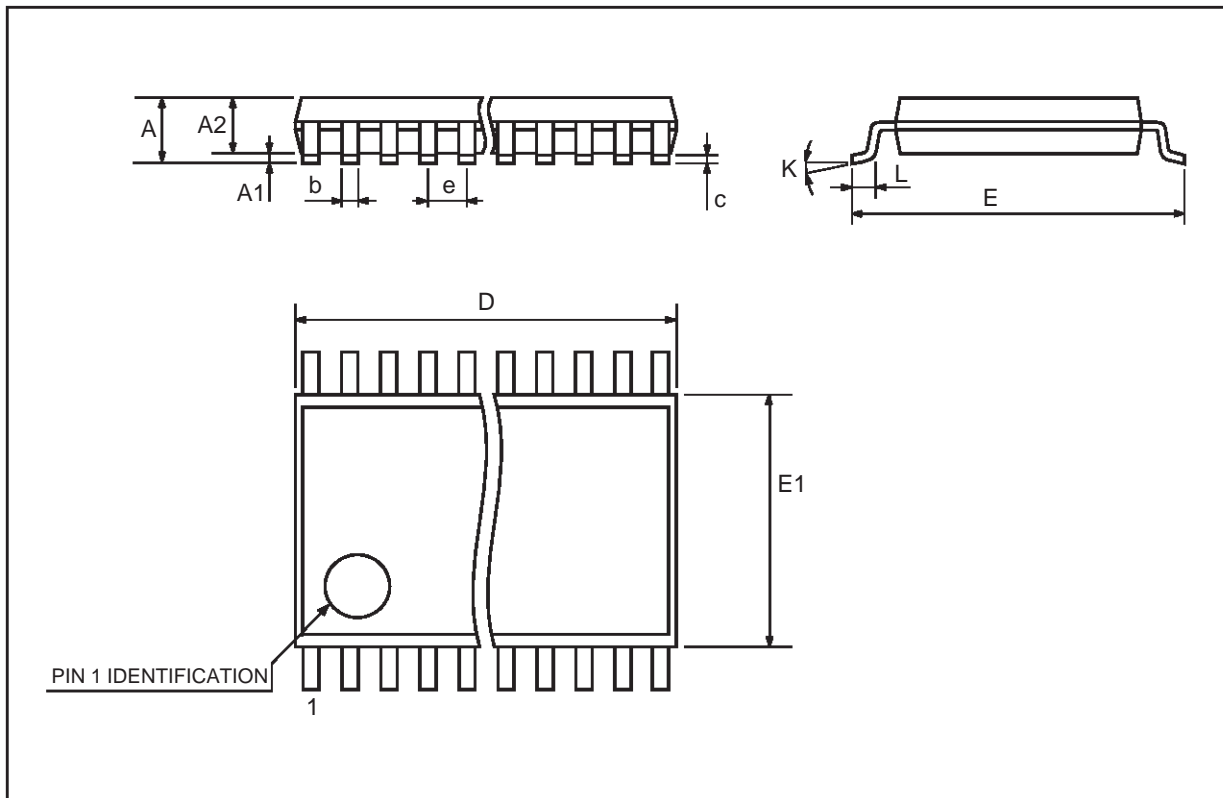
WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIME (f=1MHz; 50% duty cycle)





## 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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