

## Advance Information

# Low-Voltage 1.65/2.5/3.3V 16-Bit D-Type Flip-Flop

## With 3.6V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The MC74VCX16374 is an advanced performance, non-inverting 16-bit D-type flip-flop. It is designed for very high-speed, very low-power operation in 1.65V, 2.5V or 3.3V systems. The VCX16374 is byte controlled, with each byte functioning identically, but independently. Each byte has separate Output Enable and Clock Pulse inputs. These control pins can be tied together for full 16-bit operation.

When operating at 2.5V (or 1.65V) the part is designed to tolerate voltages it may encounter on either inputs or outputs when interfacing to 3.3V busses. It is guaranteed to be over-voltage tolerant to 3.6V.

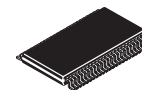
The MC74VCX16374 consists of 16 edge-triggered flip-flops with individual D-type inputs and 3.6V-tolerant 3-state outputs. The clocks (CPn) and Output Enables ( $\overline{OEn}$ ) are common to all flip-flops within the respective byte. The flip-flops will store the state of individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP) transition. With the  $\overline{OE}$  LOW, the contents of the flip-flops are available at the outputs. When the  $\overline{OE}$  is HIGH, the outputs go to the high impedance state. The  $\overline{OE}$  input level does not affect the operation of the flip-flops.

- Designed for Low Voltage Operation:  $V_{CC} = 1.65\text{--}3.6\text{V}$
- 3.6V Tolerant Inputs and Outputs
- High Speed Operation: 3.0ns max for 3.0 to 3.6V  
3.9ns max for 2.3 to 2.7V  
7.8ns max for 1.65 to 1.95V
- Static Drive:  $\pm 24\text{mA}$  Drive at 3.0V  
 $\pm 18\text{mA}$  Drive at 2.3V  
 $\pm 6\text{mA}$  Drive at 1.65V
- Supports Live Insertion and Withdrawal
- IOFF Specification Guarantees High Impedance When  $V_{CC} = 0\text{V}$
- Near Zero Static Supply Current in All Three Logic States (20 $\mu\text{A}$ )  
Substantially Reduces System Power Requirements
- Latchup Performance Exceeds  $\pm 300\text{mA}$  @ 125°C
- ESD Performance: Human Body Model >2000V; Machine Model >200V

# MC74VCX16374

# VCX

**LOW-VOLTAGE 1.65/2.5/3.3V  
16-BIT D-TYPE FLIP-FLOP**



**DT SUFFIX**  
48-LEAD PLASTIC TSSOP PACKAGE  
CASE 1201-01

### PIN NAMES

Pins	Function
$\overline{OEn}$	Output Enable Inputs
CPn	Clock Pulse Inputs
D0–D15	Inputs
O0–O15	Outputs

This document contains information on a new product. Specifications and information herein are subject to change without notice.



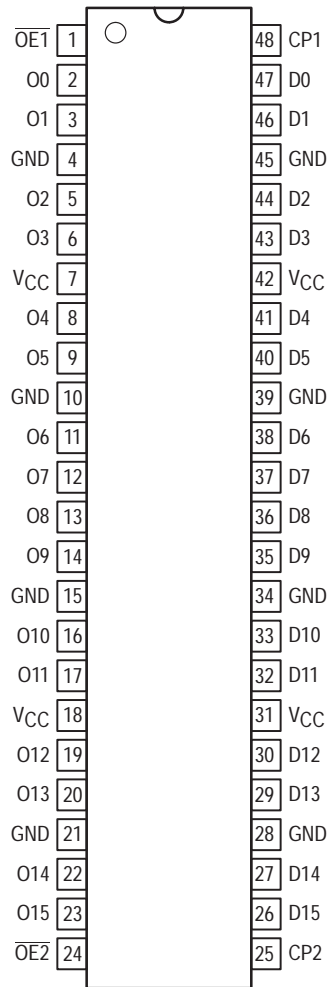


Figure 1. 48-Lead Pinout  
(Top View)

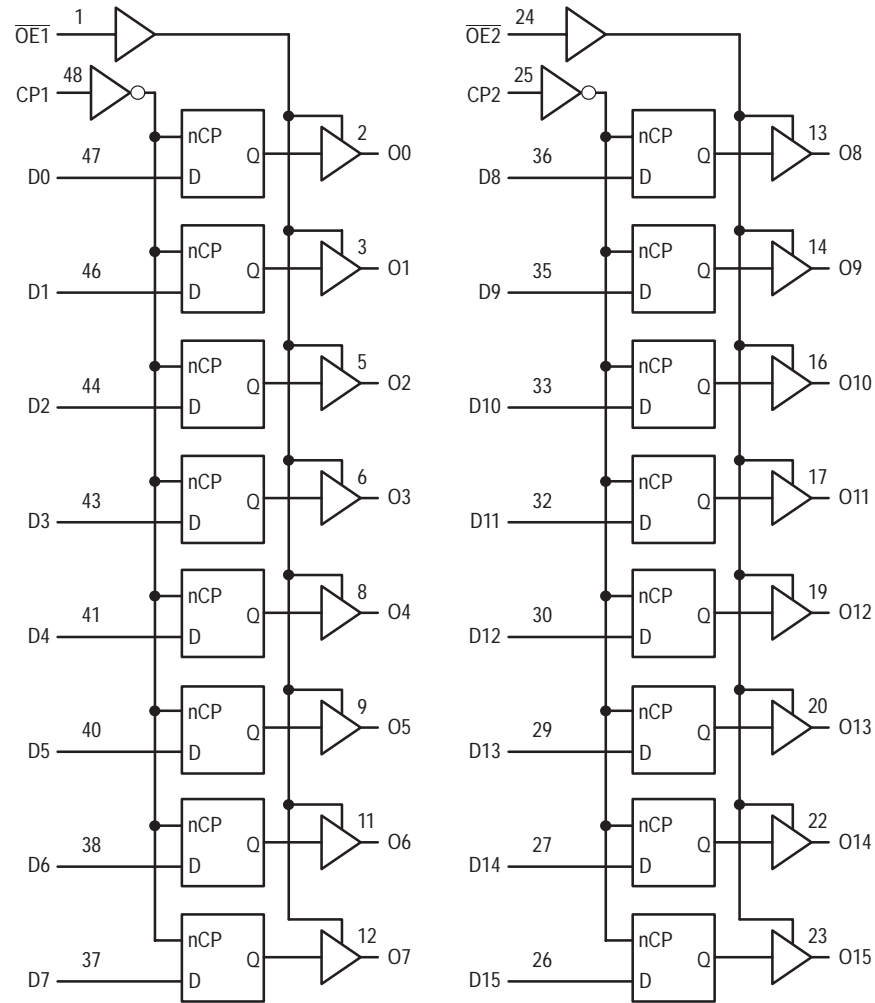


Figure 2. Logic Diagram

Inputs			Outputs	Inputs			Outputs
CP1	OE1	D0:7	O0:7	CP2	OE2	D8:15	O8:15
↑	L	H	H	↑	L	H	H
↑	L	L	L	↑	L	L	L
X	L	X	O0	X	L	X	O0
X	H	X	Z	X	H	X	Z

H = High Voltage Level; L = Low Voltage Level; Z = High Impedance State; ↑ = Low-to-High Transition; X = High or Low Voltage Level and Transitions Are Acceptable, for I<sub>CC</sub> reasons, DO NOT FLOAT Inputs. O0 = No Change.

**ABSOLUTE MAXIMUM RATINGS\***

Symbol	Parameter	Value	Condition	Unit
$V_{CC}$	DC Supply Voltage	$-0.5$ to $+4.6$		V
$V_I$	DC Input Voltage	$-0.5 \leq V_I \leq +4.6$		V
$V_O$	DC Output Voltage	$-0.5 \leq V_O \leq +4.6$	Output in 3-State	V
		$-0.5 \leq V_O \leq V_{CC} + 0.5$	Note 1.; Outputs Active	V
$I_{IK}$	DC Input Diode Current	$-50$	$V_I < GND$	mA
$I_{OK}$	DC Output Diode Current	$-50$	$V_O < GND$	mA
		$+50$	$V_O > V_{CC}$	mA
$I_O$	DC Output Source/Sink Current	$\pm 50$		mA
$I_{CC}$	DC Supply Current Per Supply Pin	$\pm 100$		mA
$I_{GND}$	DC Ground Current Per Ground Pin	$\pm 100$		mA
$T_{STG}$	Storage Temperature Range	$-65$ to $+150$		°C

\* Absolute maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute-maximum-rated conditions is not implied.

1.  $I_O$  absolute maximum rating must be observed.

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	Supply Voltage Operating Data Retention Only	1.65 1.2	3.6 3.6	V
$V_I$	Input Voltage	$-0.3$	3.6	V
$V_O$	Output Voltage (Active State) (3-State)	0 0	$V_{CC}$ 3.6	V
$I_{OH}$	HIGH Level Output Current, $V_{CC} = 3.0V - 3.6V$		$-24$	mA
$I_{OL}$	LOW Level Output Current, $V_{CC} = 3.0V - 3.6V$		24	mA
$I_{OH}$	HIGH Level Output Current, $V_{CC} = 2.3V - 2.7V$		$-18$	mA
$I_{OL}$	LOW Level Output Current, $V_{CC} = 2.3V - 2.7V$		18	mA
$I_{OH}$	HIGH Level Output Current, $V_{CC} = 1.65 - 1.95V$		$-6$	mA
$I_{OL}$	LOW Level Output Current, $V_{CC} = 1.65 - 1.95V$		6	mA
$T_A$	Operating Free-Air Temperature	$-40$	$+85$	°C
$\Delta t/\Delta V$	Input Transition Rise or Fall Rate, $V_{IN}$ from 0.8V to 2.0V, $V_{CC} = 3.0V$	0	10	ns/V

**DC ELECTRICAL CHARACTERISTICS** ( $2.7V < V_{CC} \leq 3.6V$ )

Symbol	Characteristic	Condition	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$		Unit
			Min	Max	
$V_{IH}$	HIGH Level Input Voltage (Note 2.)	$2.7V < V_{CC} \leq 3.6V$	2.0		V
$V_{IL}$	LOW Level Input Voltage (Note 2.)	$2.7V < V_{CC} \leq 3.6V$		0.8	V
$V_{OH}$	HIGH Level Output Voltage	$2.7V < V_{CC} \leq 3.6V$ ; $I_{OH} = -100\mu\text{A}$	$V_{CC} - 0.2$		V
		$V_{CC} = 2.7V$ ; $I_{OH} = -12\text{mA}$	2.2		
		$V_{CC} = 3.0V$ ; $I_{OH} = -18\text{mA}$	2.4		
		$V_{CC} = 3.0V$ ; $I_{OH} = -24\text{mA}$	2.2		
$V_{OL}$	LOW Level Output Voltage	$2.7V < V_{CC} \leq 3.6V$ ; $I_{OL} = 100\mu\text{A}$		0.2	V
		$V_{CC} = 2.7V$ ; $I_{OL} = 12\text{mA}$		0.4	
		$V_{CC} = 3.0V$ ; $I_{OL} = 18\text{mA}$		0.4	
		$V_{CC} = 3.0V$ ; $I_{OL} = 24\text{mA}$		0.55	
$I_I$	Input Leakage Current	$2.7V < V_{CC} \leq 3.6V$ ; $0V \leq V_I \leq 3.6V$		$\pm 5.0$	$\mu\text{A}$
$I_{OZ}$	3-State Output Current	$2.7V < V_{CC} \leq 3.6V$ ; $0V \leq V_O \leq 3.6V$ ; $V_I = V_{IH}$ or $V_{IL}$		$\pm 10$	$\mu\text{A}$
$I_{OFF}$	Power-Off Leakage Current	$V_{CC} = 0V$ ; $0V \leq (V_I, V_O) \leq 3.6V$		10	$\mu\text{A}$
$I_{CC}$	Quiescent Supply Current	$2.7V < V_{CC} \leq 3.6V$ ; $V_I = \text{GND}$ or $V_{CC}$		20	$\mu\text{A}$
		$2.7V < V_{CC} \leq 3.6V$ ; $V_{CC} \leq (V_I, V_O) \leq 3.6V$		$\pm 20$	$\mu\text{A}$
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$2.7V < V_{CC} \leq 3.6V$ ; $V_{IH} = V_{CC} - 0.6V$		750	$\mu\text{A}$

2. These values of  $V_I$  are used to test DC electrical characteristics only.

**DC ELECTRICAL CHARACTERISTICS** ( $2.3V \leq V_{CC} \leq 2.7V$ )

Symbol	Characteristic	Condition	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$		Unit
			Min	Max	
$V_{IH}$	HIGH Level Input Voltage (Note 3.)	$2.3V \leq V_{CC} \leq 2.7V$	1.6		V
$V_{IL}$	LOW Level Input Voltage (Note 3.)	$2.3V \leq V_{CC} \leq 2.7V$		0.7	V
$V_{OH}$	HIGH Level Output Voltage	$2.3V \leq V_{CC} \leq 2.7V$ ; $I_{OH} = -100\mu\text{A}$	$V_{CC} - 0.2$		V
		$V_{CC} = 2.3V$ ; $I_{OH} = -6\text{mA}$	2.0		
		$V_{CC} = 2.3V$ ; $I_{OH} = -12\text{mA}$	1.8		
		$V_{CC} = 2.3V$ ; $I_{OH} = -18\text{mA}$	1.7		
$V_{OL}$	LOW Level Output Voltage	$2.3V \leq V_{CC} \leq 2.7V$ ; $I_{OL} = 100\mu\text{A}$		0.2	V
		$V_{CC} = 2.3V$ ; $I_{OL} = 12\text{mA}$		0.4	
		$V_{CC} = 2.3V$ ; $I_{OL} = 18\text{mA}$		0.6	
$I_I$	Input Leakage Current	$2.3V \leq V_{CC} \leq 2.7V$ ; $0V \leq V_I \leq 3.6V$		$\pm 5.0$	$\mu\text{A}$
$I_{OZ}$	3-State Output Current	$2.3V \leq V_{CC} \leq 2.7V$ ; $0V \leq V_O \leq 3.6V$ ; $V_I = V_{IH}$ or $V_{IL}$		$\pm 10$	$\mu\text{A}$
$I_{OFF}$	Power-Off Leakage Current	$V_{CC} = 0V$ ; $0V \leq (V_I, V_O) \leq 3.6V$		10	$\mu\text{A}$
$I_{CC}$	Quiescent Supply Current	$2.3V \leq V_{CC} \leq 2.7V$ ; $V_I = \text{GND}$ or $V_{CC}$		20	$\mu\text{A}$
		$2.3V \leq V_{CC} \leq 2.7V$ ; $V_{CC} \leq (V_I, V_O) \leq 3.6V$		$\pm 20$	$\mu\text{A}$

3. These values of  $V_I$  are used to test DC electrical characteristics only.

**DC ELECTRICAL CHARACTERISTICS** ( $1.65\text{V} \leq V_{CC} < 1.95\text{V}$ )

Symbol	Characteristic	Condition	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$		Unit
			Min	Max	
$V_{IH}$	HIGH Level Input Voltage	$1.65\text{V} \leq V_{CC} < 1.95\text{V}$	$0.7 \times V_{CC}$		V
$V_{IL}$	LOW Level Input Voltage	$1.65\text{V} \leq V_{CC} < 1.95\text{V}$		$0.2 \times V_{CC}$	V
$V_{OH}$	HIGH Level Output Voltage	$V_{CC} = 1.65 - 1.95\text{V}; I_{OH} = -100\mu\text{A}$	$V_{CC} - 0.2$		V
		$V_{CC} = 1.65\text{V}; I_{OH} = -6\text{mA}$	1.25		
$V_{OL}$	LOW Level Output Voltage	$V_{CC} = 1.65 - 1.95\text{V}; I_{OL} = 100\mu\text{A}$		0.2	V
		$V_{CC} = 1.65\text{V}; I_{OL} = 6\text{mA}$		0.3	
$I_I$	Input Leakage Current	$V_{CC} = 1.65\text{V}; 0 \leq V_I \leq 3.6\text{V}$		$\pm 5.0$	$\mu\text{A}$
$I_{OZ}$	3-State Output Current	$V_{CC} = 1.65 - 1.95\text{V}; 0 \leq V_O \leq 3.6\text{V}; V_I = V_{IH} \text{ or } V_{IL}$		$\pm 10$	$\mu\text{A}$
$I_{OFF}$	Power-Off Leakage Current	$V_{CC} = 0\text{V}; 0\text{V} \leq (V_I, V_O) \leq 3.6\text{V}$		10	$\mu\text{A}$
$I_{CC}$	Quiescent Supply Current	$V_{CC} = 1.65 - 1.95\text{V}; V_I = V_{CC} \text{ or } \text{GND}$		20	$\mu\text{A}$
		$V_{CC} = 1.65 - 1.95\text{V}; V_{CC} \leq (V_I, V_O) \leq 3.6\text{V}$		$\pm 20$	

**AC CHARACTERISTICS** (Note 4.;  $t_R = t_F = 2.0\text{ns}$ ;  $C_L = 30\text{pF}$ ;  $R_L = 500\Omega$ )

Symbol	Parameter	Waveform	Limits						Unit
			T <sub>A</sub> = −40°C to +85°C						
			V <sub>CC</sub> = 3.0V to 3.6V		V <sub>CC</sub> = 2.3V to 2.7V		V <sub>CC</sub> = 1.65 – 1.95V		
			Min	Max	Min	Max	Min	Max	
f <sub>max</sub>	Clock Pulse Frequency	1	250		200		100		MHz
t <sub>PLH</sub>	Propagation Delay	1	0.8	3.0	1.0	3.9		7.8	ns
t <sub>PHL</sub>	CP to On		0.8	3.0	1.0	3.9		7.8	
t <sub>PZH</sub>	Output Enable Time to	2	0.8	3.5	1.0	4.6		9.2	ns
t <sub>PZL</sub>	High and Low Level		0.8	3.5	1.0	4.6		9.2	
t <sub>PHZ</sub>	Output Disable Time From	2	0.8	3.5	1.0	3.8		6.8	ns
t <sub>PLZ</sub>	High and Low Level		0.8	3.5	1.0	3.8		6.8	
t <sub>s</sub>	Setup Time, High or Low Dn to CP	3	1.5		1.5		2.5		ns
t <sub>h</sub>	Hold Time, High or Low Dn to CP	3	1.0		1.0		1.0		ns
t <sub>w</sub>	CP Pulse Width, High	3	1.5		1.5		4.0		ns
t <sub>OSHL</sub>	Output-to-Output Skew			0.5		0.5		0.5	ns
t <sub>OSLH</sub>	(Note 5.)			0.5		0.5		0.5	

4. These AC parameters are preliminary and may be modified prior to release. For  $C_L = 50\text{pF}$ , add approximately 300ps to the AC maximum specification.

5. Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW ( $t_{OSHL}$ ) or LOW-to-HIGH ( $t_{OSLH}$ ); parameter guaranteed by design.

## DYNAMIC SWITCHING CHARACTERISTICS

Symbol	Characteristic	Condition	$T_A = +25^\circ\text{C}$	Unit
			Typ	
V <sub>OLP</sub>	Dynamic LOW Peak Voltage (Note 6.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	0.25	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	0.6	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	0.8	
V <sub>OLV</sub>	Dynamic LOW Valley Voltage (Note 6.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	-0.25	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	-0.6	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	-0.8	
V <sub>OHV</sub>	Dynamic HIGH Valley Voltage (Note 7.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.5	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.9	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	2.2	

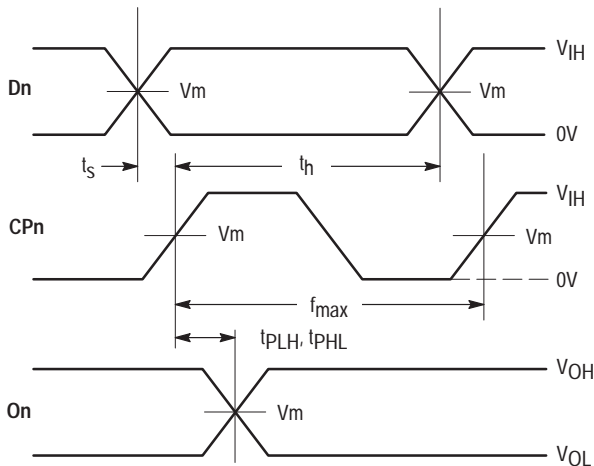
6. Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the LOW state.

7. 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.

## CAPACITIVE CHARACTERISTICS

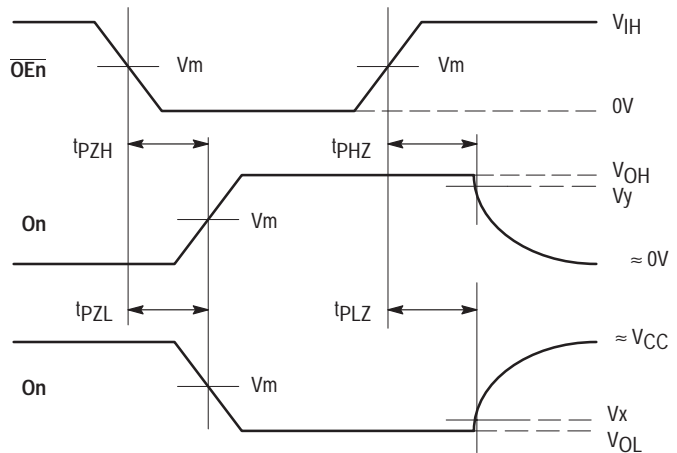
Symbol	Parameter	Condition	Typical	Unit
C <sub>IN</sub>	Input Capacitance	Note 8.	6	pF
C <sub>OUT</sub>	Output Capacitance	Note 8.	7	pF
C <sub>PD</sub>	Power Dissipation Capacitance	Note 8., 10MHz	20	pF

8.  $V_{CC} = 1.8, 2.5$  or  $3.3\text{V}$ ;  $V_I = 0\text{V}$  or  $V_{CC}$ .



WAVEFORM 1 – PROPAGATION DELAYS, SETUP AND HOLD TIMES

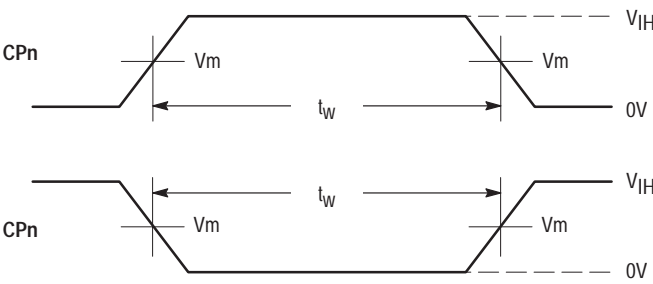
$t_R = t_F = 2.0\text{ns}$ , 10% to 90%;  $f = 1\text{MHz}$ ;  $t_W = 500\text{ns}$



WAVEFORM 2 – OUTPUT ENABLE AND DISABLE TIMES

$t_R = t_F = 2.0\text{ns}$ , 10% to 90%;  $f = 1\text{MHz}$ ;  $t_W = 500\text{ns}$

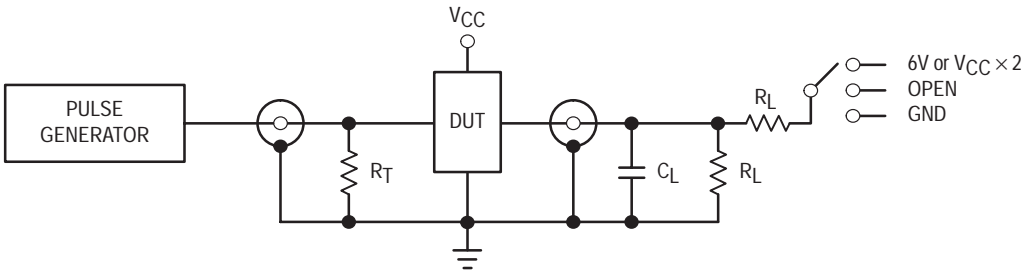
Figure 3. AC Waveforms



**WAVEFORM 3 – PULSE WIDTH**  
 $t_R = t_F = 2.0\text{ns}$  (or fast as required) from 10% to 90%

**Figure 4. AC Waveforms**

Symbol	V <sub>CC</sub>		
	3.3V ±0.3V	2.5V ±0.2V	1.8V ±0.15V
V <sub>IH</sub>	2.7V	V <sub>CC</sub>	V <sub>CC</sub>
V <sub>m</sub>	1.5V	V <sub>CC</sub> /2	V <sub>CC</sub> /2
V <sub>x</sub>	V <sub>OL</sub> + 0.3V	V <sub>OL</sub> + 0.15V	V <sub>OL</sub> + 0.15V
V <sub>y</sub>	V <sub>OH</sub> – 0.3V	V <sub>OH</sub> – 0.15V	V <sub>OH</sub> – 0.15V



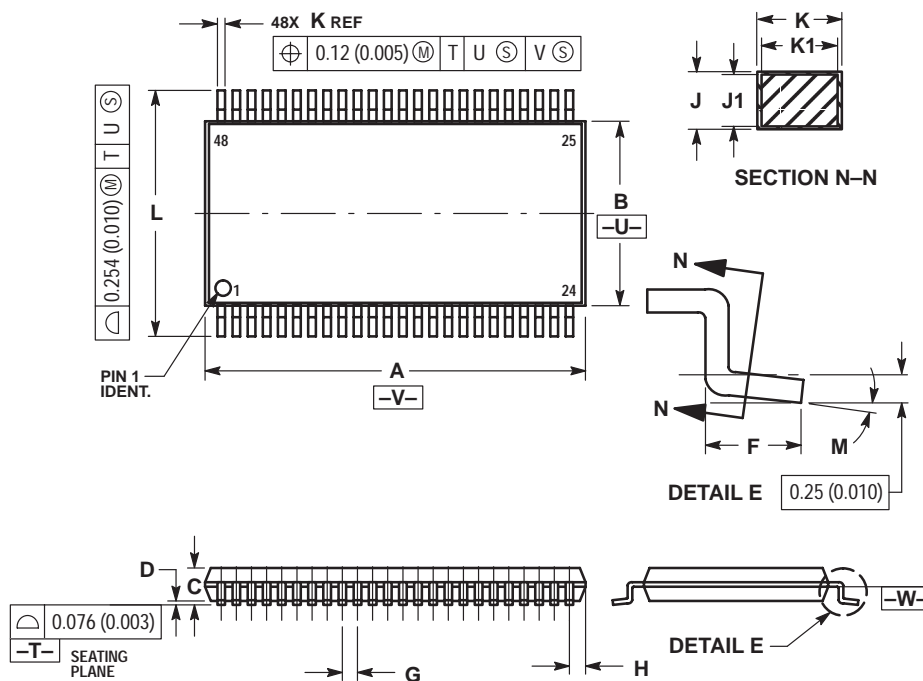
TEST	SWITCH
t <sub>PLH</sub> , t <sub>PHL</sub>	Open
t <sub>PZL</sub> , t <sub>PLZ</sub>	6V at V <sub>CC</sub> = 3.3 ±0.3V; V <sub>CC</sub> × 2 at V <sub>CC</sub> = 2.5 ±0.2V; 1.8V ±0.15V
t <sub>PZH</sub> , t <sub>PHZ</sub>	GND

C<sub>L</sub> = 30pF or equivalent (Includes jig and probe capacitance)  
R<sub>L</sub> = 500Ω or equivalent  
R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

**Figure 5. Test Circuit**

## OUTLINE DIMENSIONS


DT SUFFIX  
PLASTIC TSSOP PACKAGE  
CASE 1201-01  
ISSUE A



## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
5. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
6. DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	12.40	12.60	0.488	0.496
B	6.00	6.20	0.236	0.244
C	—	1.10	—	0.043
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.50 BSC	—	0.0197 BSC	—
H	0.37	—	0.015	—
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.17	0.27	0.007	0.011
K1	0.17	0.23	0.007	0.009
L	7.95	8.25	0.313	0.325
M	0°	8°	0°	8°

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