74VCXH16374

Low-Voltage 1.8/2.5/3.3V 16-Bit D-Type Flip-Flop

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

The 74VCXH16374 is an advanced performance, non−inverting 16−bit D−type flip−flop. It is designed for very high−speed, very low−power operation in 1.8 V, 2.5 V or 3.3 V systems. The VCXH16374 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 2.5 V (or 1.8 V) the part is designed to tolerate voltages it may encounter on either inputs or outputs when interfacing to 3.3 V busses. It is guaranteed to be overvoltage tolerant to 3.6V.

The 74VCXH16374 consists of 16 edge−triggered flip−flops with individual D−type inputs and 3.6 V−tolerant 3−state outputs. The clocks (CPn) and Output Enables ($\overline{\text{OEn}}$) 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 $\overline{\text{OE}}$ LOW, the contents of the flip−flops are available at the outputs. When the $\overline{\text{OE}}$ is HIGH, the outputs go to the high impedance state. The $\overline{\text{OE}}$ input level does not affect the operation of the flip−flops. The data inputs include active bushold circuitry, eliminating the need for external pullup resistors to hold unused or floating inputs at a valid logic state.

Features

- Designed for Low Voltage Operation: V_{CC} = 1.65 V − 3.6 V
- 3.6 V Tolerant Inputs and Outputs
- High Speed Operation: 3.0 ns max for 3.0 V to 3.6V
  3.9 ns max for 2.3 V to 2.7V
  7.8 ns max for 1.65 V to 1.95V
- Static Drive: ±24 mA Drive at 3.0 V
  ±18 mA Drive at 2.3 V
  ±6 mA Drive at 1.65 V
- Supports Live Insertion and Withdrawal
- Includes Active Bushold to Hold Unused or Floating Inputs at a Valid Logic State
- I_{OFF} Specification Guarantees High Impedance When V_{CC} = 0 V*
- Near Zero Static Supply Current in All Three Logic States (20 μA) Substantially Reduces System Power Requirements
- Latchup Performance Exceeds ±250 mA @ 125°C
- ESD Performance: Human Body Model >2000 V
  Machine Model >200 V
- All Devices in Package TSSOP are Inherently Pb−Free**

*To ensure the outputs activate in the 3−state condition, the output enable pins should be connected to V_{CC} through a pullup resistor. The value of the resistor is determined by the current sinking capability of the output connected to the $\overline{\text{OE}}$ pin.

**For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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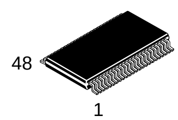
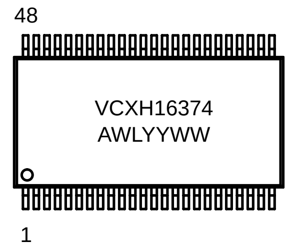
MARKING DIAGRAM



TSSOP−48
DT SUFFIX
CASE 1201



A	= Assembly Location
WL	= Wafer Lot
YY	= Year
WW	= Work Week

PIN NAMES

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

ORDERING INFORMATION

Device	Package	Shipping†
74VCXH16374DT	TSSOP (Pb−Free)	39 / Rail
74VCXH16374DTR	TSSOP (Pb−Free)	2500 / Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

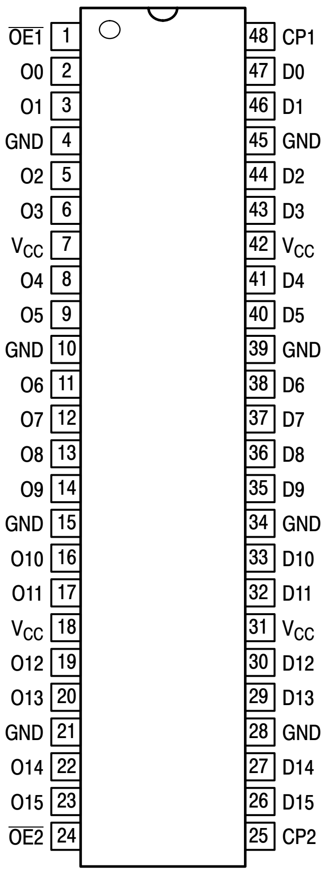


Figure 1. 48−Lead Pinout
(Top View)

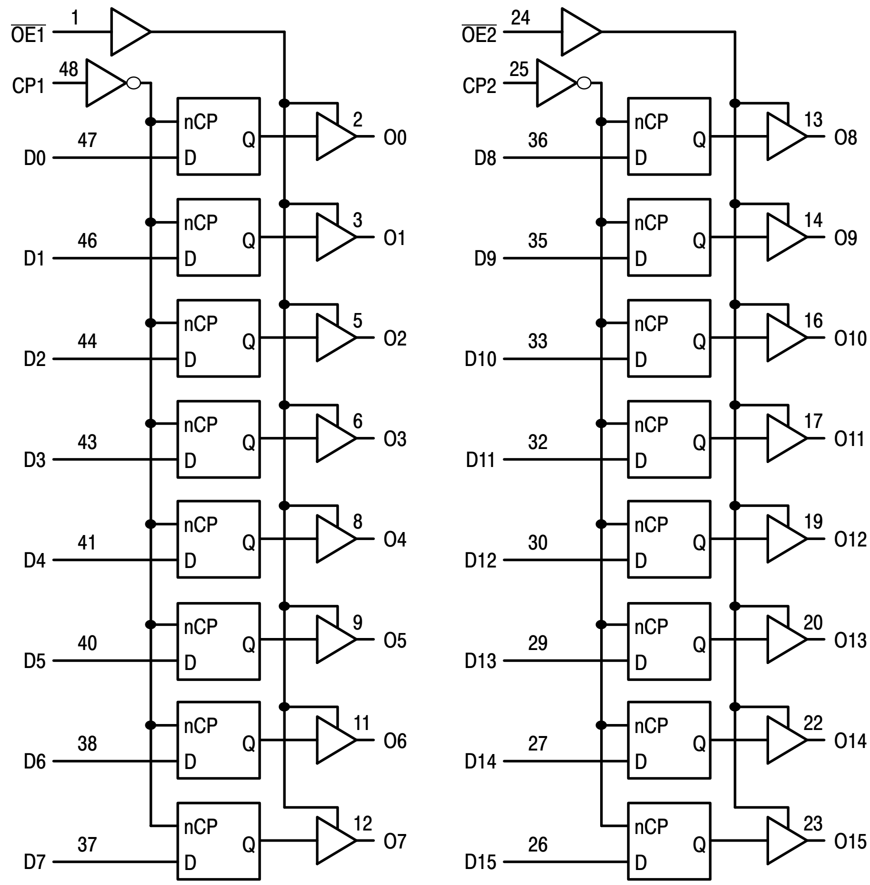


Figure 2. Logic Diagram

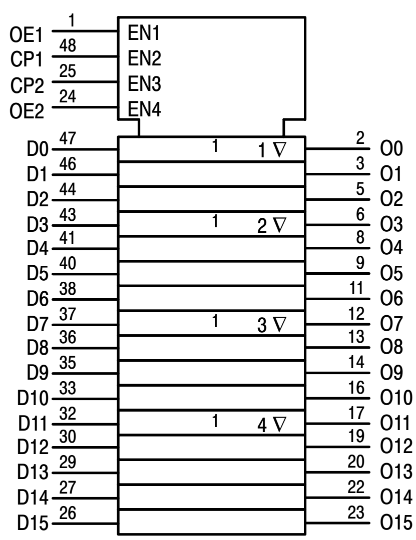


Figure 3. IEC Logic Diagram

TRUTH TABLE

Inputs			Outputs	Inputs			Outputs
CP1	$\overline{OE1}$	D0:7	O0:7	CP2	$\overline{OE2}$	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_{CC} 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	$-0.5 \le V_I \le +4.6$		V
V_O	DC Output Voltage	$-0.5 \le V_O \le +4.6$	Output in 3−State	V
		$-0.5 \le V_O \le V_{CC} + 0.5$	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	±50		mA
I_{CC}	DC Supply Current Per Supply Pin	±100		mA
I_{GND}	DC Ground Current Per Ground Pin	±100		mA
T_{STG}	Storage Temperature Range	−65 to +150		°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.
1. I_O absolute maximum rating must be observed.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Unit
V_{CC}	Supply Voltage Operating Data Retention Only	1.65 1.2	3.3 3.3	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} = 3.0 V − 3.6 V			−24	mA
I_{OL}	LOW Level Output Current, V_{CC} = 3.0 V − 3.6 V			24	mA
I_{OH}	HIGH Level Output Current, V_{CC} = 2.3 V − 2.7 V			−18	mA
I_{OL}	LOW Level Output Current, V_{CC} = 2.3 V − 2.7 V			18	mA
I_{OH}	HIGH Level Output Current, V_{CC} = 1.65 V − 1.95 V			−6	mA
I_{OL}	LOW Level Output Current, V_{CC} = 1.65 V − 1.95 V			6	mA
T_A	Operating Free−Air Temperature	−40		+85	°C
$\Delta t/\Delta V$	Input Transition Rise or Fall Rate, V_{IN} from 0.8 V to 2.0 V, V_{CC} = 3.0 V	0		10	ns/V

DC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic	Condition	$T_A = -40°C$ to $+85°C$ Min	Max	Unit
V_{IH}	HIGH Level Input Voltage (Note 2)	$1.65\ V \le V_{CC} < 2.3\ V$	$0.65 \times V_{CC}$		V
		$2.3\ V \le V_{CC} \le 2.7\ V$	1.6		
		$2.7\ V < V_{CC} \le 3.6\ V$	2.0		
V_{IL}	LOW Level Input Voltage (Note 2)	$1.65\ V \le V_{CC} < 2.3\ V$		$0.35 \times V_{CC}$	V
		$2.3\ V \le V_{CC} \le 2.7\ V$		0.7	
		$2.7\ V < V_{CC} \le 3.6\ V$		0.8	
V_{OH}	HIGH Level Output Voltage	$1.65\ V \le V_{CC} \le 3.6\ V$; $I_{OH} = -100\ \mu A$	$V_{CC} - 0.2$		V
		$V_{CC} = 1.65\ V$; $I_{OH} = -6\ mA$	1.25		
		$V_{CC} = 2.3\ V$; $I_{OH} = -6\ mA$	2.0		
		$V_{CC} = 2.3\ V$; $I_{OH} = -12\ mA$	1.8		
		$V_{CC} = 2.3\ V$; $I_{OH} = -18\ mA$	1.7		
		$V_{CC} = 2.7\ V$; $I_{OH} = -12\ mA$	2.2		
		$V_{CC} = 3.0\ V$; $I_{OH} = -18\ mA$	2.4		
		$V_{CC} = 3.0\ V$; $I_{OH} = -24\ mA$	2.2		
V_{OL}	LOW Level Output Voltage	$1.65\ V \le V_{CC} \le 3.6\ V$; $I_{OL} = 100\ \mu A$		0.2	V
		$V_{CC} = 1.65\ V$; $I_{OL} = 6\ mA$		0.3	
		$V_{CC} = 2.3\ V$; $I_{OL} = 12\ mA$		0.4	
		$V_{CC} = 2.3\ V$; $I_{OL} = 18\ mA$		0.6	
		$V_{CC} = 2.7\ V$; $I_{OL} = 12\ mA$		0.4	
		$V_{CC} = 3.0\ V$; $I_{OL} = 18\ mA$		0.4	
		$V_{CC} = 3.0\ V$; $I_{OL} = 24\ mA$		0.55	
I_I	Input Leakage Current	$1.65\ V \le V_{CC} \le 3.6\ V$; $0\ V \le V_I \le 3.6\ V$		±5.0	μA
$I_{I(HOLD)}$	Minimum Bushold Input Current	$V_{CC} = 3.0\ V$, $V_{IN} = 0.8\ V$	75		μA
		$V_{CC} = 3.0\ V$, $V_{IN} = 2.0\ V$	−75		
		$V_{CC} = 2.3\ V$, $V_{IN} = 0.7\ V$	45		
		$V_{CC} = 2.3\ V$, $V_{IN} = 1.6\ V$	−45		
		$V_{CC} = 1.65\ V$, $V_{IN} = 0.57\ V$	25		
		$V_{CC} = 1.65\ V$, $V_{IN} = 1.07\ V$	−25		
$I_{I\ (OD)}$	Minimum Bushold Over−Drive Current Needed to Change State	$V_{CC} = 3.6\ V$, (Note 3)	450		μA
		$V_{CC} = 3.6\ V$, (Note 4)	−450		
		$V_{CC} = 2.7\ V$, (Note 3)	300		
		$V_{CC} = 2.7\ V$, (Note 4)	−300		
		$V_{CC} = 1.95\ V$, (Note 3)	200		
		$V_{CC} = 1.95\ V$, (Note 4)	−200		
I_{OZ}	3−State Output Current	$1.65\ V \le V_{CC} \le 3.6\ V$; $0\ V \le V_O \le 3.6\ V$; $V_I = V_{IH}$ or V_{IL}		±10	μA
I_{OFF}	Power−Off Leakage Current	$V_{CC} = 0\ V$; V_I or $V_O = 3.6\ V$		10	μA
I_{CC}	Quiescent Supply Current (Note 5)	$1.65\ V \le V_{CC} \le 3.6\ V$; $V_I = GND$ or V_{CC}		20	μA
		$1.65\ V \le V_{CC} \le 3.6\ V$; $3.6\ V \le V_I, V_O \le 3.6\ V$		±20	μA
ΔI_{CC}	Increase in I_{CC} per Input	$2.7\ V < V_{CC} \le 3.6\ V$; $V_{IH} = V_{CC} - 0.6\ V$		750	μA

2. These values of V_I are used to test DC electrical characteristics only.
3. An external driver must source at least the specified current to switch from LOW−to−HIGH.
4. An external driver must source at least the specified current to switch from HIGH−to−LOW.
5. Outputs disabled or 3−state only.

AC CHARACTERISTICS (Note 6; $t_R = t_F = 2.0$ ns; $C_L = 30$ pF; $R_L = 500\ \Omega$)

Symbol	Parameter	Waveform	$T_A = -40°C$ to $+85°C$						Unit
			$V_{CC} = 3.0$ V to 3.6 V		$V_{CC} = 2.3$ V to 2.7 V		$V_{CC} = 1.65$ V to 1.95 V		
			Min	Max	Min	Max	Min	Max	
f_{max}	Clock Pulse Frequency	1	250		200		100		MHz
t_{PLH} t_{PHL}	Propagation Delay CP−to−On	1	0.8 0.8	3.0 3.0	1.0 1.0	3.9 3.9	1.5 1.5	7.8 7.8	ns
t_{PZH} t_{PZL}	Output Enable Time to High and Low Level	2	0.8 0.8	3.5 3.5	1.0 1.0	4.6 4.6	1.5 1.5	9.2 9.2	ns
t_{PHZ} t_{PLZ}	Output Disable Time From High and Low Level	2	0.8 0.8	3.5 3.5	1.0 1.0	3.8 3.8	1.5 1.5	6.8 6.8	ns
t_s	Setup Time, High or Low Dn−to−CP	3	1.5		1.5		2.5		ns
t_h	Hold Time, High or Low Dn−to−CP	3	1.0		1.0		1.0		ns
t_w	CP Pulse Width, High	3	1.5		1.5		4.0		ns
t_{OSHL} t_{OSLH}	Output−to−Output Skew (Note 7)			0.5 0.5		0.5 0.5		0.75 0.75	ns

6. For $C_L = 50$ pF, add approximately 300 ps to the AC maximum specification.
7. 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.

AC CHARACTERISTICS ($t_R = t_F = 2.0$ ns; $C_L = 50$ pF; $R_L = 500\ \Omega$)

Symbol	Parameter	Waveform	$T_A = -40°C$ to $+85°C$				Unit
			$V_{CC} = 3.0$ V to 3.6 V		$V_{CC} = 2.7$ V		
			Min	Max	Min	Max	
f_{max}	Clock Pulse Frequency	4	150		150		MHz
t_{PLH} t_{PHL}	Propagation Delay CP−to−On	4	1.0 1.0	4.2 4.2		4.9 4.9	ns
t_{PZH} t_{PZL}	Output Enable Time to High and Low Level	5	1.0 1.0	4.8 4.8		5.9 5.9	ns
t_{PHZ} t_{PLZ}	Output Disable Time From High and Low Level	5	1.0 1.0	4.3 4.3		4.7 4.7	ns
t_{OSHL} t_{OSLH}	Output−to−Output Skew (Note 8)			0.5 0.5		0.5 0.5	ns

8. 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

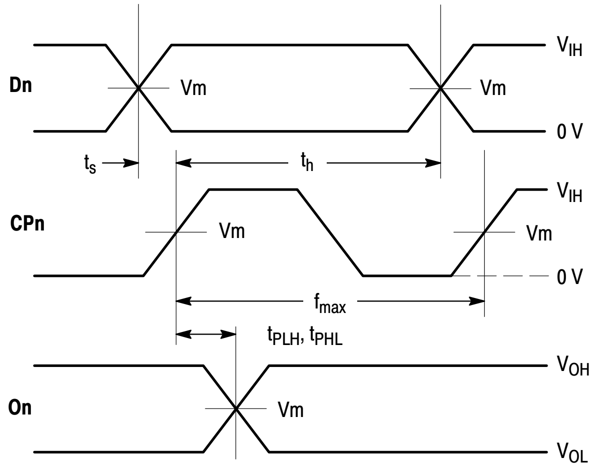
Symbol	Characteristic	Condition	T_A = +25°C Typ	Unit
V_{OLP}	Dynamic LOW Peak Voltage (Note 9)	V_{CC} = 1.8 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	0.25	V
		V_{CC} = 2.5 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	0.6	
		V_{CC} = 3.3 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	0.8	
V_{OLV}	Dynamic LOW Valley Voltage (Note 9)	V_{CC} = 1.8 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	−0.25	V
		V_{CC} = 2.5 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	−0.6	
		V_{CC} = 3.3 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	−0.8	
V_{OHV}	Dynamic HIGH Valley Voltage (Note 10)	V_{CC} = 1.8 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	1.5	V
		V_{CC} = 2.5 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	1.9	
		V_{CC} = 3.3 V, C_L = 30 pF, V_{IH} = V_{CC}, V_{IL} = 0 V	2.2	

9. 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.
10. 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.

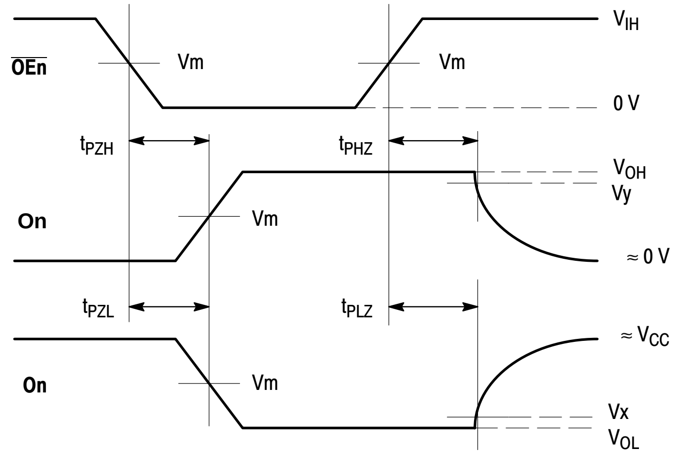
CAPACITIVE CHARACTERISTICS

Symbol	Parameter	Condition	Typical	Unit
C_{IN}	Input Capacitance	Note 11	6	pF
C_{OUT}	Output Capacitance	Note 11	7	pF
C_{PD}	Power Dissipation Capacitance	Note 11, 10 MHz	20	pF

11. V_{CC} = 1.8 V, 2.5 V or 3.3 V; V_I = 0 V or V_{CC}.

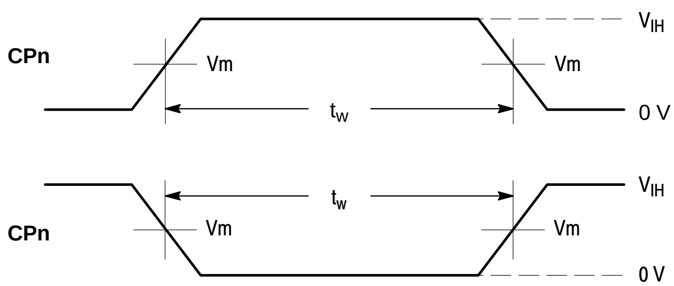


WAVEFORM 1 – PROPAGATION DELAYS, SETUP AND HOLD TIMES
$t_R = t_F = 2.0$ ns, 10% to 90%; f = 1 MHz; $t_W = 500$ ns



WAVEFORM 2 – OUTPUT ENABLE AND DISABLE TIMES
$t_R = t_F = 2.0$ ns, 10% to 90%; f = 1 MHz; $t_W = 500$ ns

Figure 4. AC Waveforms



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

Figure 5. AC Waveforms

Table 1. AC WAVEFORMS

Symbol	V_{CC}		
	3.3 V ± 0.3 V	**2.5 V ± 0.2 V**	**1.8 V ± 0.15 V**
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_m	1.5 V	$V_{CC}/2$	$V_{CC}/2$
V_x	V_{OL} + 0.3 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V
V_y	V_{OH} − 0.3 V	V_{OH} − 0.15 V	V_{OH} − 0.15 V

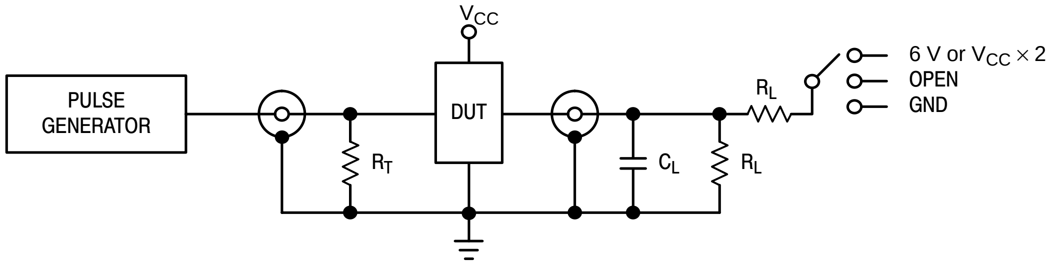
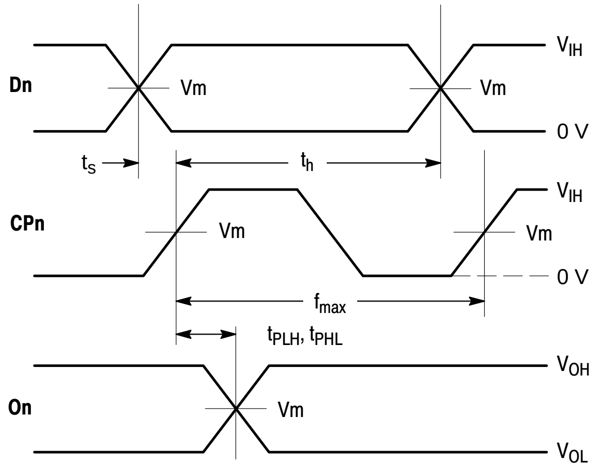


Figure 6. Test Circuit

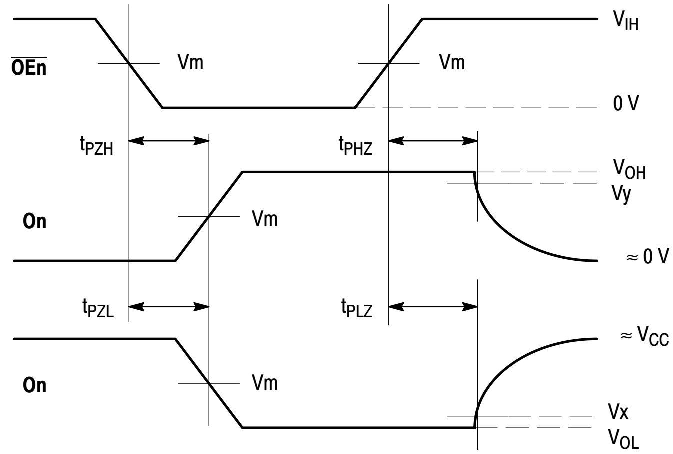
Table 2. TEST CIRCUIT

TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6 V at V_{CC} = 3.3 ± 0.3 V; V_{CC} × 2 at V_{CC} = 2.5 ± 0.2 V; 1.8 ± 0.15 V
t_{PZH}, t_{PHZ}	GND

C_L = 30 pF or equivalent (Includes jig and probe capacitance)
R_L = 500 Ω or equivalent
R_T = Z_{OUT} of pulse generator (typically 50 Ω)

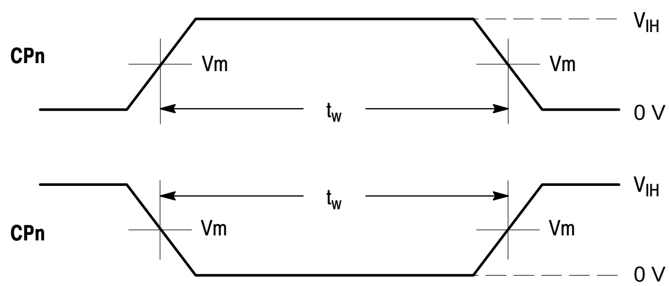


WAVEFORM 4 – PROPAGATION DELAYS, SETUP AND HOLD TIMES
$t_R = t_F = 2.0$ ns, 10% to 90%; f = 1 MHz; $t_W = 500$ ns



WAVEFORM 5 – OUTPUT ENABLE AND DISABLE TIMES
$t_R = t_F = 2.0$ ns, 10% to 90%; f = 1 MHz; $t_W = 500$ ns

Figure 7. AC Waveforms



WAVEFORM 6 − PULSE WIDTH
$t_R = t_F = 2.0$ ns (or fast as required) from 10% to 90%

Figure 8. AC Waveforms

Table 3. AC WAVEFORMS

Symbol	V_{CC}	
	3.3 V ± 0.3 V	**2.7 V**
V_{IH}	2.7 V	2.7 V
V_m	1.5 V	1.5 V
V_x	V_{OL} + 0.3 V	V_{OL} + 0.3 V
V_y	V_{OH} − 0.3 V	V_{OH} − 0.3 V

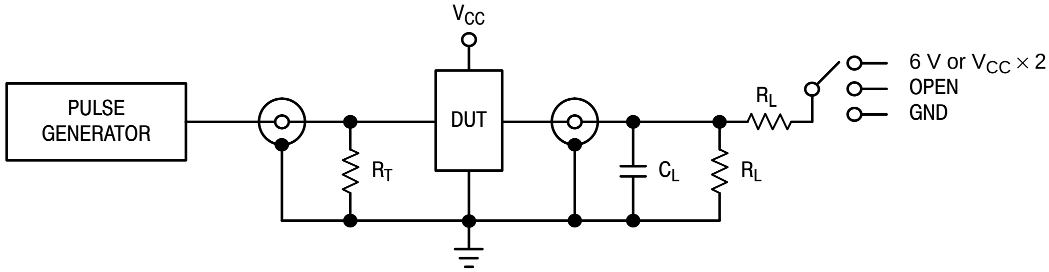


Figure 9. Test Circuit

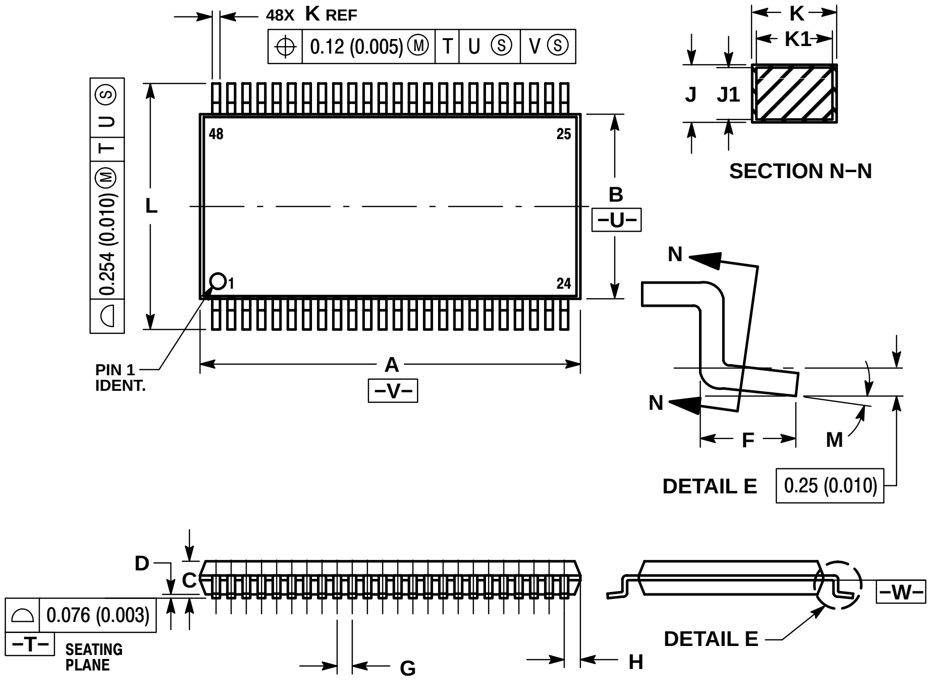
Table 4. TEST CIRCUIT

TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6 V at V_{CC} = 3.3 ± 0.3 V; V_{CC} × 2 at V_{CC} = 2.5 ± 0.2 V; 1.8 ± 0.15 V
t_{PZH}, t_{PHZ}	GND

C_L = 50 pF or equivalent (Includes jig and probe capacitance)
R_L = 500 Ω or equivalent
R_T = Z_{OUT} of pulse generator (typically 50 Ω)

PACKAGE DIMENSIONS

TSSOP
DT SUFFIX
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−.

	MILLIMETERS		INCHES	
DIM	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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