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.

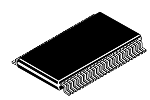
The MC74VCX16374 consists of 16 edge–triggered flip–flops with individual D–type inputs and 3.6V–tolerant 3–state outputs. The clocks (CPn) and Output Enables ($\overline{OEn}$) are common to all flip–flops within the respective byte. The flip–flops will store the state of individual D inputs that meet 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} = 1.65–3.6V
- 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: ±24mA Drive at 3.0V
  ±18mA Drive at 2.3V
  ±6mA Drive at 1.65V
- Supports Live Insertion and Withdrawal
- I_{OFF} Specification Guarantees High Impedance When V_{CC} = 0V
- Near Zero Static Supply Current in All Three Logic States (20µA) Substantially Reduces System Power Requirements
- Latchup Performance Exceeds ±300mA @ 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.

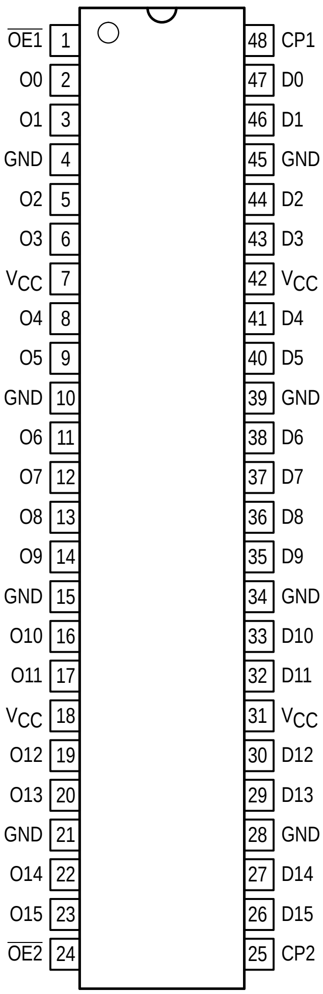


Figure 1. 48–Lead Pinout
(Top View)

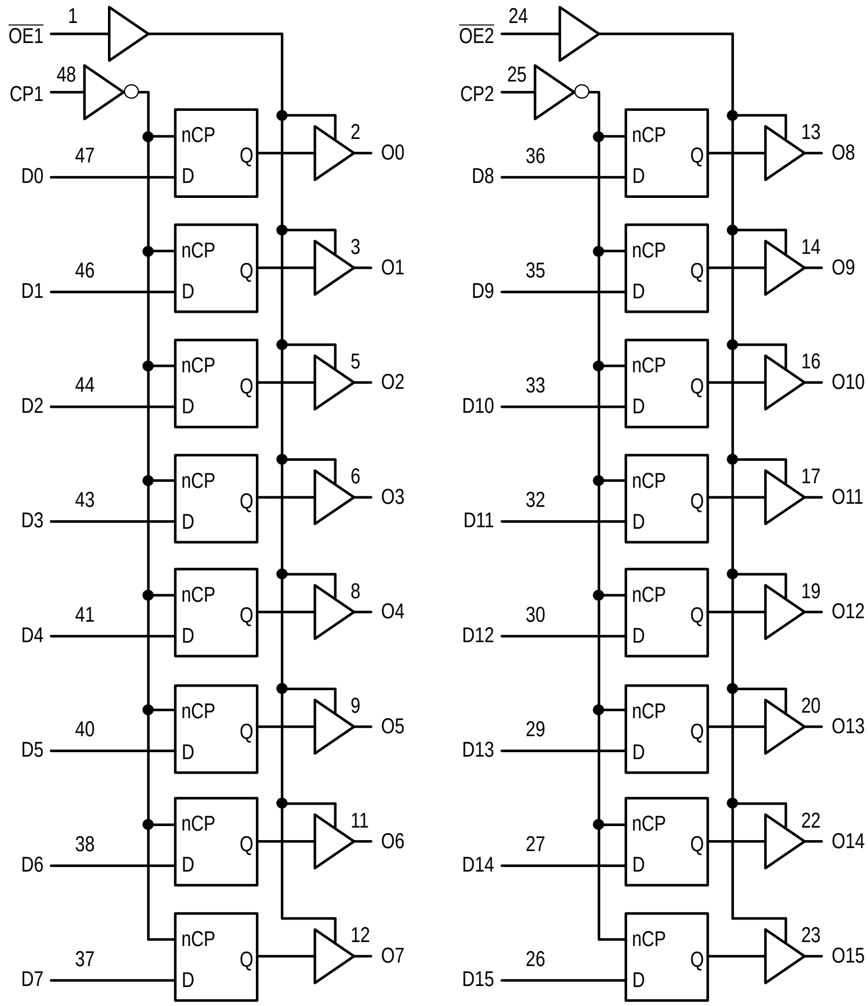


Figure 2. Logic Diagram

Inputs			Outputs	Inputs			Outputs
CP1	**$\overline{OE1}$**	**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	$-0.5 \leq V_I \leq +4.6$		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	±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

* 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} ≤ 3.6V)

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

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

DC ELECTRICAL CHARACTERISTICS (2.3V ≤ V_{CC} ≤ 2.7V)

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

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

DC ELECTRICAL CHARACTERISTICS (1.65V ≤ V_{CC} < 1.95V)

Symbol	Characteristic	Condition	T_A = –40°C to +85°C Min	Max	Unit
V_{IH}	HIGH Level Input Voltage	1.65V ≤ V_{CC} < 1.95V	0.7 × V_{CC}		V
V_{IL}	LOW Level Input Voltage	1.65V ≤ V_{CC} < 1.95V		0.2 × V_{CC}	V
V_{OH}	HIGH Level Output Voltage	V_{CC} = 1.65 – 1.95V; I_{OH} = –100µA	V_{CC} – 0.2		V
		V_{CC} = 1.65V; I_{OH} = –6mA	1.25		
V_{OL}	LOW Level Output Voltage	V_{CC} = 1.65 – 1.95V; I_{OL} = 100µA		0.2	V
		V_{CC} = 1.65V; I_{OL} = 6mA		0.3	
I_I	Input Leakage Current	V_{CC} = 1.65V; 0 ≤ V_I ≤ 3.6V		±5.0	µA
I_{OZ}	3–State Output Current	V_{CC} = 1.65 – 1.95V; 0 ≤ V_O ≤ 3.6V; V_I = V_{IH} or V_{IL}		±10	µA
I_{OFF}	Power–Off Leakage Current	V_{CC} = 0V; 0V ≤ (V_I, V_O) ≤ 3.6V		10	µA
I_{CC}	Quiescent Supply Current	V_{CC} = 1.65 – 1.95V; V_I = V_{CC} or GND		20	µA
		V_{CC} = 1.65 – 1.95V; V_{CC} ≤ (V_I, V_O) ≤ 3.6V		±20	

AC CHARACTERISTICS (Note 4.; t_R = t_F = 2.0ns; C_L = 30pF; R_L = 500Ω)

Symbol	Parameter	Waveform	Limits T_A = –40°C to +85°C V_{CC} = 3.0V to 3.6V Min	Max	V_{CC} = 2.3V to 2.7V Min	Max	V_{CC} = 1.65 – 1.95V Min	Max	Unit
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		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		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		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 5.)			0.5 0.5		0.5 0.5		0.5 0.5	ns

4. These AC parameters are preliminary and may be modified prior to release. For C_L = 50pF, 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

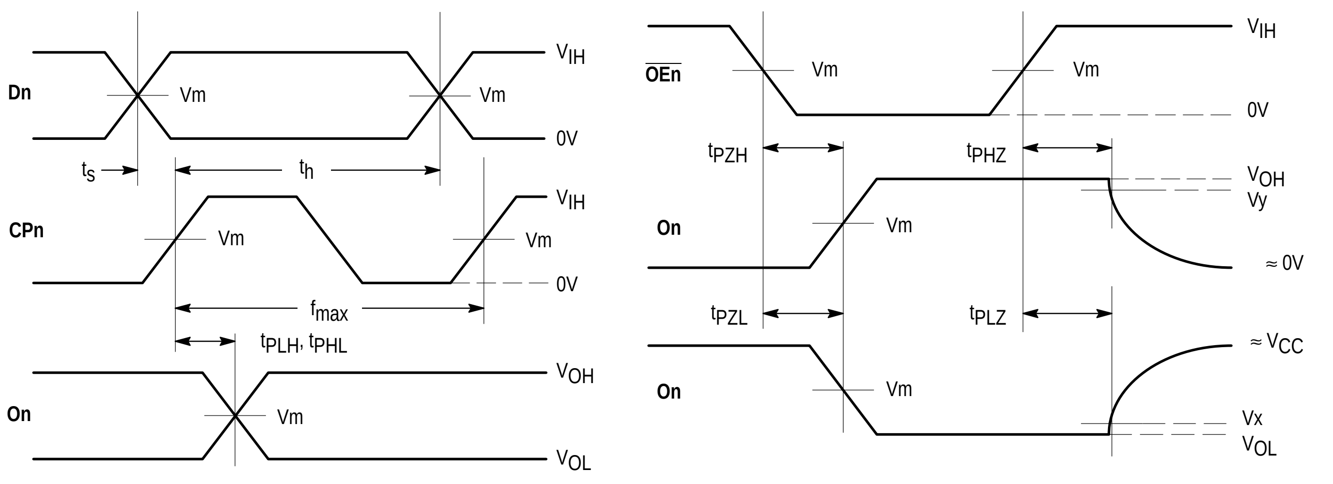
Symbol	Characteristic	Condition	$T_A = +25°C$ Typ	Unit
V_{OLP}	Dynamic LOW Peak Voltage (Note 6.)	$V_{CC} = 1.8V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	0.25	V
		$V_{CC} = 2.5V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	0.6	
		$V_{CC} = 3.3V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	0.8	
V_{OLV}	Dynamic LOW Valley Voltage (Note 6.)	$V_{CC} = 1.8V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	–0.25	V
		$V_{CC} = 2.5V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	–0.6	
		$V_{CC} = 3.3V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	–0.8	
V_{OHV}	Dynamic HIGH Valley Voltage (Note 7.)	$V_{CC} = 1.8V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.5	V
		$V_{CC} = 2.5V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.9	
		$V_{CC} = 3.3V$, $C_L = 30pF$, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	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_{IN}	Input Capacitance	Note 8.	6	pF
C_{OUT}	Output Capacitance	Note 8.	7	pF
C_{PD}	Power Dissipation Capacitance	Note 8., 10MHz	20	pF

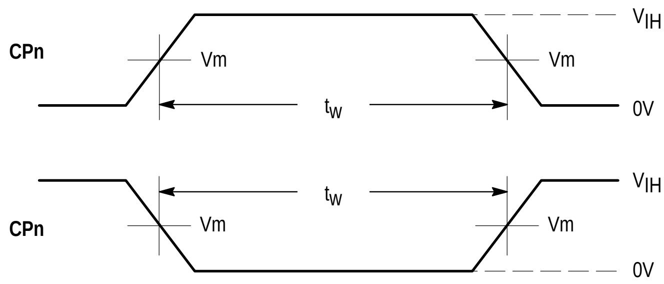
8. V_{CC} = 1.8, 2.5 or 3.3V; V_I = 0V or V_{CC}.



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

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

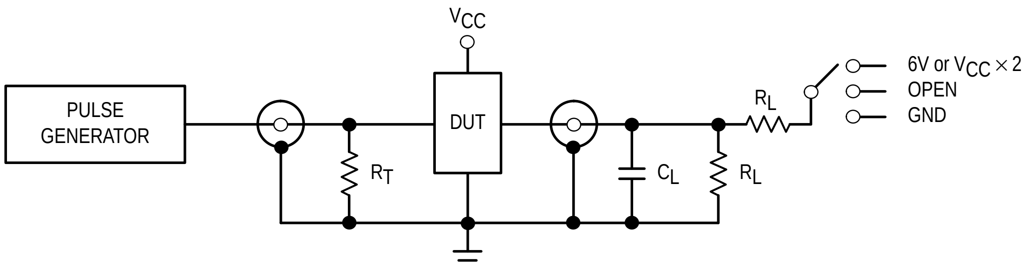
Figure 3. AC Waveforms



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

Figure 4. AC Waveforms

Symbol	V_{CC}		
	3.3V ±0.3V	**2.5V ±0.2V**	**1.8V ±0.15V**
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



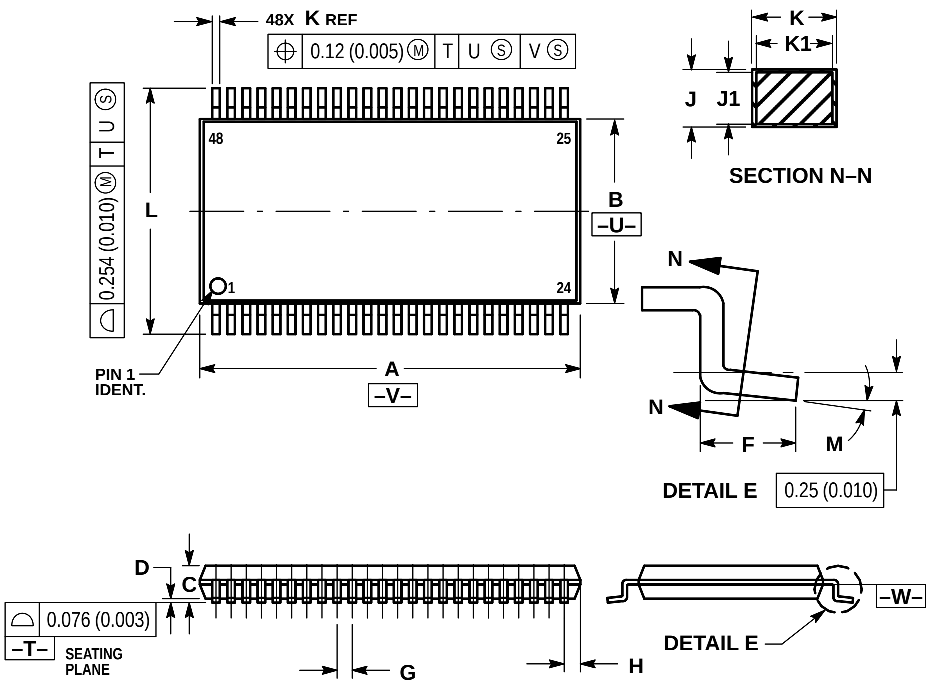
TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6V at V_{CC} = 3.3 ±0.3V; $V_{CC} \times 2$ at V_{CC} = 2.5 ±0.2V; 1.8V ±0.15V
t_{PZH}, t_{PHZ}	GND

C_L = 30pF or equivalent (Includes jig and probe capacitance)
R_L = 500Ω or equivalent
$R_T = Z_{OUT}$ 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–.

	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 °

How to reach us:
USA / EUROPE / Locations Not Listed: Motorola Literature Distribution; P.O. Box 5405, Denver, Colorado 80217. 1–303–675–2140 or 1–800–441–2447

Customer Focus Center: 1–800–521–6274

Mfax™: RMFAX0@email.sps.mot.com – TOUCHTONE 1–602–244–6609
Motorola Fax Back System – US & Canada ONLY 1–800–774–1848
– http://sps.motorola.com/mfax/

HOME PAGE: http://motorola.com/sps/

JAPAN: Motorola Japan Ltd.; SPD, Strategic Planning Office, 141, 4–32–1 Nishi–Gotanda, Shinagawa–ku, Tokyo, Japan. 81–3–5487–8488

ASIA / PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Centre, 2, Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong. 852–26629298