

MC74LCX16374

Low-Voltage CMOS 16-Bit D-Type Flip-Flop

With 5 V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The MC74LCX16374 is a high performance, non-inverting 16-bit D-type flip-flop operating from a 2.3 V to 3.6 V supply. The device is byte controlled. Each byte has separate Output Enable and Clock Pulse inputs. These control pins can be tied together for full 16-bit operation. High impedance TTL compatible inputs significantly reduce current loading to input drivers while TTL compatible outputs offer improved switching noise performance. A V_I specification of 5.5 V allows MC74LCX16374 inputs to be safely driven from 5.0 V devices.

The MC74LCX16374 consists of 16 edge-triggered flip-flops with individual D-type inputs and 5.0 V-tolerant 3-state true outputs. The buffered clocks (CPn) and buffered Output Enables ($\overline{OE}n$) 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.

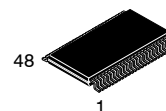
Features

- Designed for 2.3 to 3.6 V V_{CC} Operation
- 6.2 ns Maximum t_{pd}
- 5.0 V Tolerant – Interface Capability With 5.0 V TTL Logic
- Supports Live Insertion and Withdrawal
- I_{OFF} Specification Guarantees High Impedance When $V_{CC} = 0$ V
- LVTTL Compatible
- LVCMOS Compatible
- 24 mA Balanced Output Sink and Source Capability
- Near Zero Static Supply Current in All Three Logic States (20 μ A) Substantially Reduces System Power Requirements
- Latchup Performance Exceeds 500 mA
- ESD Performance:
 - ◆ Human Body Model >2000 V
 - ◆ Machine Model >200 V
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



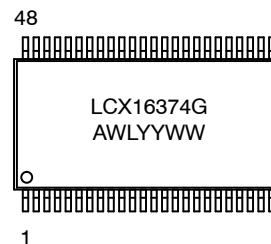
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TSSOP-48
DT SUFFIX
CASE 1201

MARKING DIAGRAM



A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb-Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

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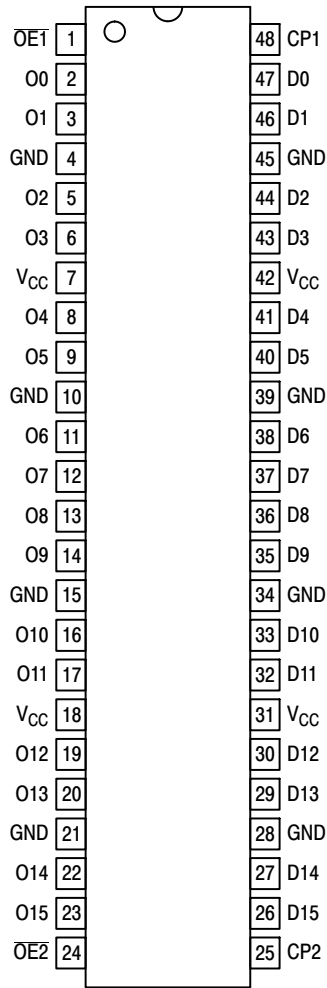


Figure 1. Pinout: 48-Lead (Top View)

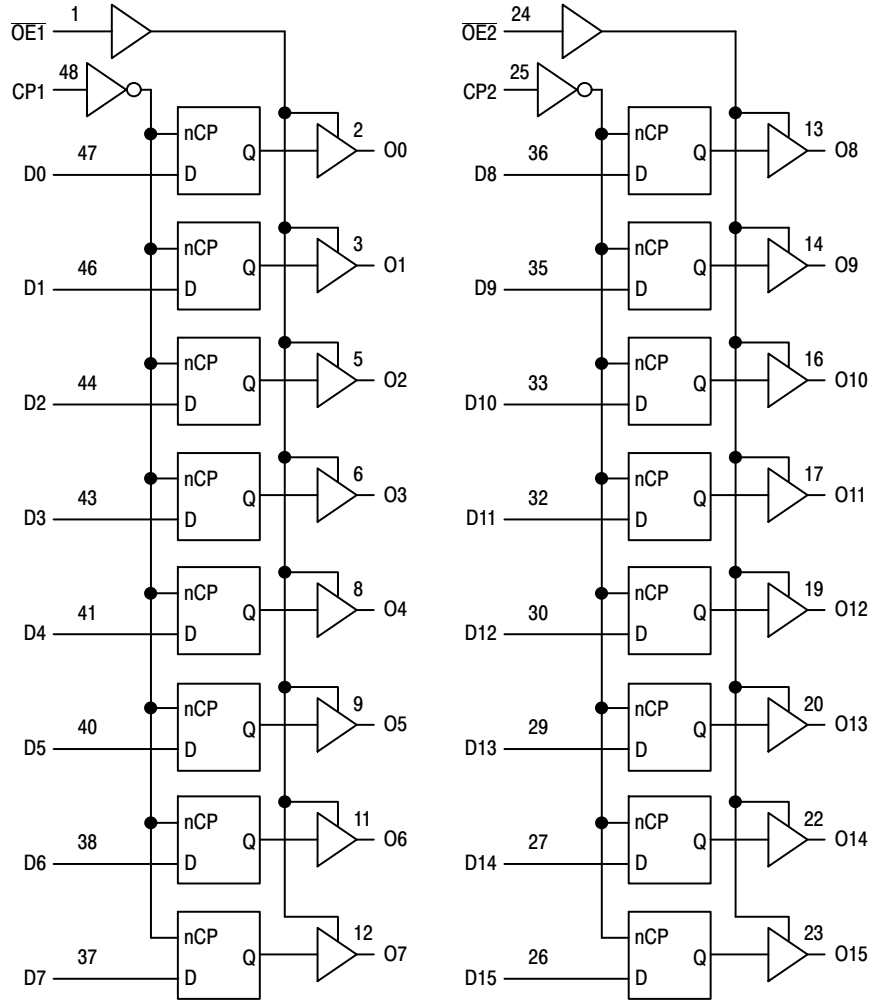


Figure 2. Logic Diagram

Table 1. PIN NAMES

Pins	Function
$\overline{OE}n$	Output Enable Inputs
CPn	Clock Pulse Inputs
D0-D15	Inputs
O0-O15	Outputs

TRUTH TABLE

Inputs			Outputs	Inputs			Outputs
CP1	$\overline{OE}1$	D0:7	O0:7	CP2	$\overline{OE}2$	D8:15	O8:15
↑	L	H	H	↑	L	H	H
↑	L	L	L	↑	L	L	L
L	L	X	O0	L	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

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ORDERING INFORMATION

Device	Package	Shipping†
MC74LCX16374DTG	TSSOP-48 (Pb-Free)	39 Units / Rail
M74LCX16374DTR2G	TSSOP-48 (Pb-Free)	2500 / Tape & Reel

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

MAXIMUM RATINGS

Symbol	Parameter	Value	Condition	Units
V_{CC}	DC Supply Voltage	-0.5 to +7.0		V
V_I	DC Input Voltage	$-0.5 \leq V_I \leq +7.0$		V
V_O	DC Output Voltage	$-0.5 \leq V_O \leq +7.0$	Output in 3-State	V
		$-0.5 \leq V_O \leq V_{CC} + 0.5$	Output in HIGH or LOW State. (Note 1)	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
MSL	Moisture Sensitivity		Level 1	

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. I_O absolute maximum rating must be observed.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Units
V_{CC}	Supply Voltage Operating Data Retention Only	2.0	2.5, 3.3	3.6	V
		1.5	2.5, 3.3	3.6	
V_I	Input Voltage	0		5.5	V
V_O	Output Voltage (HIGH or LOW State) (3-State)	0		V_{CC}	V
		0		5.5	
I_{OH}	HIGH Level Output Current $V_{CC} = 3.0\text{ V} - 3.6\text{ V}$ $V_{CC} = 2.7\text{ V} - 3.0\text{ V}$ $V_{CC} = 2.3\text{ V} - 2.7\text{ V}$			-24	mA
				-12	
				-8	
I_{OL}	LOW Level Output Current $V_{CC} = 3.0\text{ V} - 3.6\text{ V}$ $V_{CC} = 2.7\text{ V} - 3.0\text{ V}$ $V_{CC} = 2.3\text{ V} - 2.7\text{ V}$			+24	mA
				+12	
				+8	
T_A	Operating Free-Air Temperature	-55		+125	°C
$\Delta t/\Delta V$	Input Transition Rise or Fall Rate, V_{IN} from 0.8 V to 2.0 V, $V_{CC} = 3.0\text{ V}$	0		10	ns/V

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DC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic	Condition	T _A = -55°C to +125°C		Units
			Min	Max	
V _{IH}	HIGH Level Input Voltage (Note 2)	2.3 V ≤ V _{CC} ≤ 2.7 V	1.7		V
		2.7 V ≤ V _{CC} ≤ 3.6 V	2.0		
V _{IL}	LOW Level Input Voltage (Note 2)	2.3 V ≤ V _{CC} ≤ 2.7 V		0.7	V
		2.7 V ≤ V _{CC} ≤ 3.6 V		0.8	
V _{OH}	HIGH Level Output Voltage	2.3 V ≤ V _{CC} ≤ 3.6 V; I _{OL} = 100 μA	V _{CC} - 0.2		V
		V _{CC} = 2.3 V; I _{OH} = -8 mA	1.8		
		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	2.3 V ≤ V _{CC} ≤ 3.6 V; I _{OL} = 100 μA		0.2	V
		V _{CC} = 2.3 V; I _{OL} = 8 mA		0.6	
		V _{CC} = 2.7 V; I _{OL} = 12 mA		0.4	
		V _{CC} = 3.0 V; I _{OL} = 16 mA		0.4	
		V _{CC} = 3.0 V; I _{OL} = 24 mA		0.55	
I _{OZ}	3-State Output Current	V _{CC} = 3.6 V, V _{IN} = V _{IH} or V _{IL} , V _{OUT} = 0 to 5.5 V		±5	μA
I _{OFF}	Power Off Leakage Current	V _{CC} = 0, V _{IN} = 5.5 V or V _{OUT} = 5.5 V		10	μA
I _{IN}	Input Leakage Current	V _{CC} = 3.6 V, V _{IN} = 5.5 V or GND		±5	μA
I _{CC}	Quiescent Supply Current	V _{CC} = 3.6 V, V _{IN} = 5.5 V or GND		10	μA
ΔI _{CC}	Increase in I _{CC} per Input	2.3 ≤ V _{CC} ≤ 3.6 V; V _{IH} = V _{CC} - 0.6 V		500	μA

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

AC CHARACTERISTICS (t_R = t_F = 2.5 ns; C_L = 50 pF; R_L = 500 Ω)

Symbol	Parameter	Waveform	T _A = -55°C to +125°C						Units
			V _{CC} = 3.3 V ± 0.3 V C _L = 50 pF		V _{CC} = 2.7 V C _L = 50 pF		V _{CC} = 2.5 V ± 0.2 V C _L = 30 pF		
			Min	Max	Min	Max	Min	Max	
f _{max}	Clock Pulse Frequency	1	170						MHz
t _{PLH} t _{PHL}	Propagation Delay CP to O _n	1	1.5	6.2	1.5	6.5	1.5	7.4	ns
			1.5	6.2	1.5	6.5	1.5	7.4	
t _{PZH} t _{PZL}	Output Enable Time to High and Low Level	2	1.5	6.1	1.5	6.3	1.5	7.9	ns
			1.5	6.1	1.5	6.3	1.5	7.9	
t _{PHZ} t _{PLZ}	Output Disable Time From High and Low Level	2	1.5	6.0	1.5	6.2	1.5	7.2	ns
			1.5	6.0	1.5	6.2	1.5	7.2	
t _s	Setup Time, HIGH or LOW D ⁿ to CP	1	2.5		2.5		3.0		ns
t _h	Hold Time, HIGH or LOW D ⁿ to CP	1	1.5		1.5		2.0		ns
t _w	CP Pulse Width, HIGH	3	3.0		3.0		3.5		ns
t _{OSSL} t _{OSLH}	Output-to-Output Skew (Note 3)			1.0					ns
				1.0					

3. 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_{OSSL}) or LOW-to-HIGH (t_{OSLH}); parameter guaranteed by design.

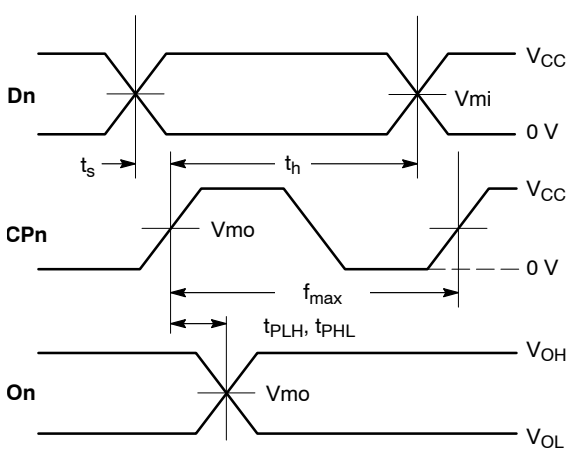
DYNAMIC SWITCHING CHARACTERISTICS

Symbol	Characteristic	Condition	T _A = +25°C			Units
			Min	Typ	Max	
V _{OLP}	Dynamic LOW Peak Voltage (Note 4)	V _{CC} = 3.3 V, C _L = 50 pF, V _{IH} = 3.3 V, V _{IL} = 0 V V _{CC} = 2.5 V, C _L = 30 pF, V _{IH} = 2.5 V, V _{IL} = 0 V		0.8 0.6		V
V _{OLV}	Dynamic LOW Valley Voltage (Note 4)	V _{CC} = 3.3 V, C _L = 50 pF, V _{IH} = 3.3 V, V _{IL} = 0 V V _{CC} = 2.5 V, C _L = 30 pF, V _{IH} = 2.5 V, V _{IL} = 0 V		-0.8 -0.6		V

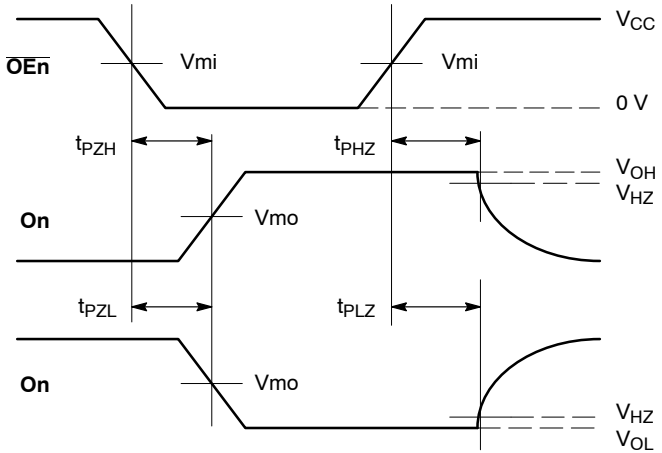
4. Number of outputs defined as “n”. Measured with “n-1” outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the LOW state.

CAPACITIVE CHARACTERISTICS

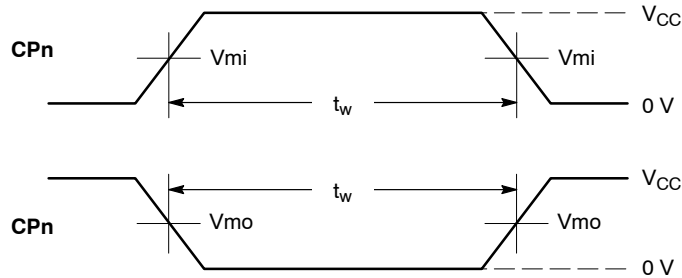
Symbol	Parameter	Condition	Typical	Units
C _{IN}	Input Capacitance	V _{CC} = 3.3 V, V _I = 0 V or V _{CC}	7	pF
C _{OUT}	Output Capacitance	V _{CC} = 3.3 V, V _I = 0 V or V _{CC}	8	pF
C _{PD}	Power Dissipation Capacitance	10 MHz, V _{CC} = 3.3 V, V _I = 0 V or V _{CC}	20	pF



WAVEFORM 1 - PROPAGATION DELAYS, SETUP AND HOLD TIMES
 $t_R = t_F = 2.5 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$



WAVEFORM 2 - OUTPUT ENABLE AND DISABLE TIMES
 $t_R = t_F = 2.5 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$



WAVEFORM 3 - PULSE WIDTH
 $t_R = t_F = 2.5 \text{ ns}$ (or fast as required) from 10% to 90%;
 Output requirements: $V_{OL} \leq 0.8 \text{ V}$, $V_{OH} \geq 2.0 \text{ V}$

Figure 3. AC Waveforms

Table 2. AC WAVEFORMS

Symbol	V _{CC}		
	3.3 V ± 0.3 V	2.7 V	2.5 V ± 0.2 V
V _{mi}	1.5 V	1.5 V	V _{CC} / 2
V _{mo}	1.5 V	1.5 V	V _{CC} / 2
V _{HZ}	V _{OL} + 0.3 V	V _{OL} + 0.3 V	V _{OL} + 0.15 V
V _{LZ}	V _{OH} - 0.3 V	V _{OH} - 0.3 V	V _{OH} - 0.15 V

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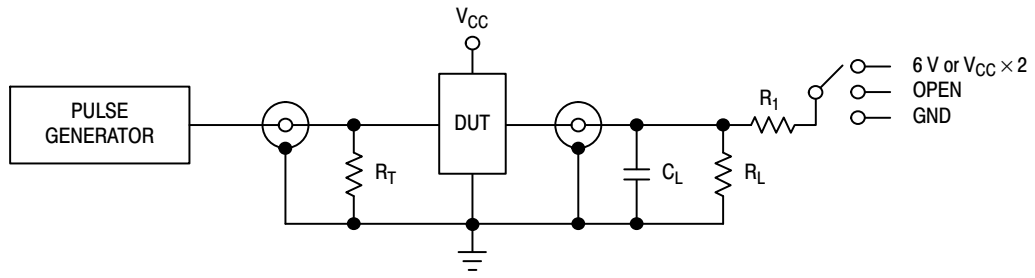


Figure 4. Test Circuit

Table 3. TEST CIRCUIT

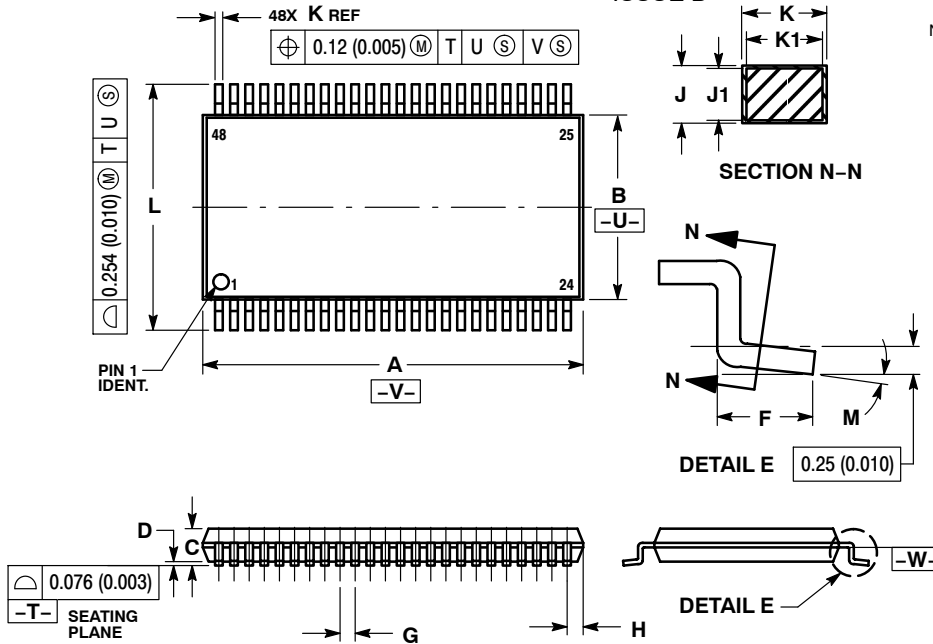
Test	Switch
t_{PLH} , t_{PHL}	Open
t_{PZL} , t_{PLZ}	6 V at $V_{CC} = 3.3 \pm 0.3$ V 6 V at $V_{CC} = 2.5 \pm 0.2$ V
Open Collector/Drain t_{PLH} and t_{PHL}	6 V
t_{PZH} , t_{PHZ}	GND

$C_L = 50$ pF at $V_{CC} = 3.3 \pm 0.3$ V or equivalent (includes jig and probe capacitance)
 $C_L = 30$ pF at $V_{CC} = 2.5 \pm 0.2$ V or equivalent (includes jig and probe capacitance)
 $R_L = R_1 = 500 \Omega$ or equivalent
 $R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

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PACKAGE DIMENSIONS

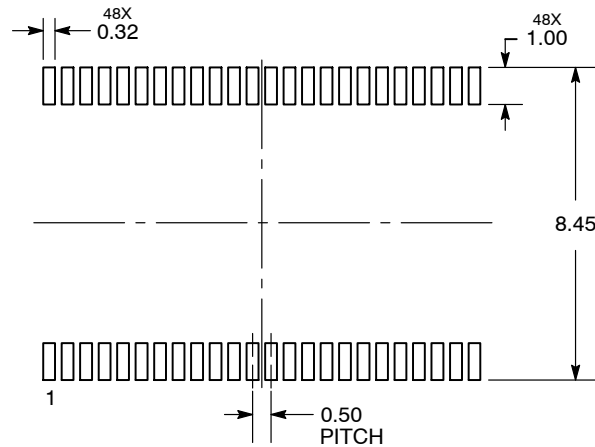
TSSOP-48
DT SUFFIX
CASE 1201-01
ISSUE B



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-.

RECOMMENDED SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

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