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74LCXH16374
Low Voltage 16-Bit D-Type Flip-Flop with Bushold

General Description

The LCXH16374 contains sixteen non-inverting D-type flip-flops with 3-STATE outputs and is intended for bus oriented applications. The device is byte controlled. A buffered clock (CP) and Output Enable ($\overline{OE}$) are common to each byte and can be shorted together for full 16-bit operation.

The LCXH16374 is designed for low voltage (2.5V or 3.3V) V_{CC} applications.

The LCXH16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

The LCXH16374 data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating data inputs at a valid logic level.

Features

- 5V tolerant control inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- 6.2 ns t_{PD} max (V_{CC} = 3.3V), 20 μA I_{CC} max
- Bushold on inputs eliminating the need for external pull-up/pull-down resistors
- Power down high impedance outputs
- ±24 mA output drive (V_{CC} = 3.0V)
- Implements proprietary noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  Human body model > 2000V
  Machine model > 200V
- Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

Ordering Code:

Order Number	Package Number	Package Description
74LCXH16374G (Note 1)(Note 3)	BGA54A	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
74LCXH16374MEA (Note 2)	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
74LCXH16374MTD (Note 2)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Note 1: Ordering code "G" indicates Trays.

Note 2: Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Logic Symbol
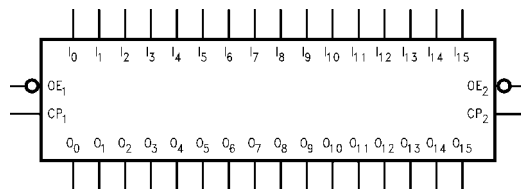
GTO™ is a trademark of Fairchild Semiconductor Corporation.

Connection Diagrams

Pin Assignment for SSOP and TSSOP

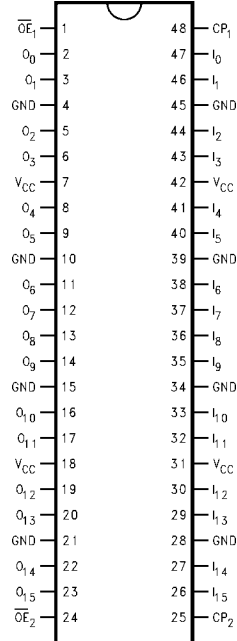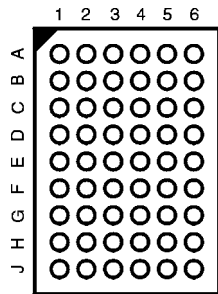|			
$\overline{OE}_1$	1	48	CP_1
O_0	2	47	I_0
O_1	3	46	I_1
GND	4	45	GND
O_2	5	44	I_2
O_3	6	43	I_3
V_{CC}	7	42	V_{CC}
O_4	8	41	I_4
O_5	9	40	I_5
GND	10	39	GND
O_6	11	38	I_6
O_7	12	37	I_7
O_8	13	36	I_8
O_9	14	35	I_9
GND	15	34	GND
O_{10}	16	33	I_{10}
O_{11}	17	32	I_{11}
V_{CC}	18	31	V_{CC}
O_{12}	19	30	I_{12}
O_{13}	20	29	I_{13}
GND	21	28	GND
O_{14}	22	27	I_{14}
O_{15}	23	26	I_{15}
$\overline{OE}_2$	24	25	CP_2

Pin Assignment for FBGA

1 2 3 4 5 6

A B C D E F G H J

(Top Thru View)

Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
CP_n	Clock Pulse Input
I_0–I_{15}	Bushold Inputs
O_0–O_{15}	Outputs
NC	No Connect

FBGA Pin Assignments

	1	2	3	4	5	6
A	O_0	NC	$\overline{OE}_1$	CP_1	NC	I_0
B	O_2	O_1	NC	NC	I_1	I_2
C	O_4	O_3	V_{CC}	V_{CC}	I_3	I_4
D	O_6	O_5	GND	GND	I_5	I_6
E	O_8	O_7	GND	GND	I_7	I_8
F	O_{10}	O_9	GND	GND	I_9	I_{10}
G	O_{12}	O_{11}	V_{CC}	V_{CC}	I_{11}	I_{12}
H	O_{14}	O_{13}	NC	NC	I_{13}	I_{14}
J	O_{15}	NC	$\overline{OE}_2$	CP_2	NC	I_{15}

Truth Tables

Inputs			Outputs
CP_1	$\overline{OE}_1$	I_0–I_7	O_0–O_7
⌐	L	H	H
⌐	L	L	L
L	L	X	O_0
X	H	X	Z

| Inputs			Outputs
CP_2	$\overline{OE}_2$	I_8–I_{15}	O_8–O_{15}
⌐	L	H	H
⌐	L	L	L
L	L	X	O_0
X	H	X	Z

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = High Impedance
O_0 = Previous O_0 before HIGH-to-LOW of CP

Functional Description

The LCXH16374 consists of sixteen edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The device is byte controlled with each byte functioning identically, but independent of the other. The control pins can be shorted together to obtain full 16-bit operation. Each byte has a buffered clock and buffered Output Enable common to all flip-flops within that byte. The description which follows applies to each byte. Each flip-flop will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP_n) transition. With the Output Enable ($\overline{OE}_n$) LOW, the contents of the flip-flops are available at the outputs. When $\overline{OE}_n$ is HIGH, the outputs go to the high impedance state. Operation of the $\overline{OE}_n$ input does not affect the state of the flip-flops.

Logic Diagrams

Byte 1 (0:7)

Byte 2 (8:15)
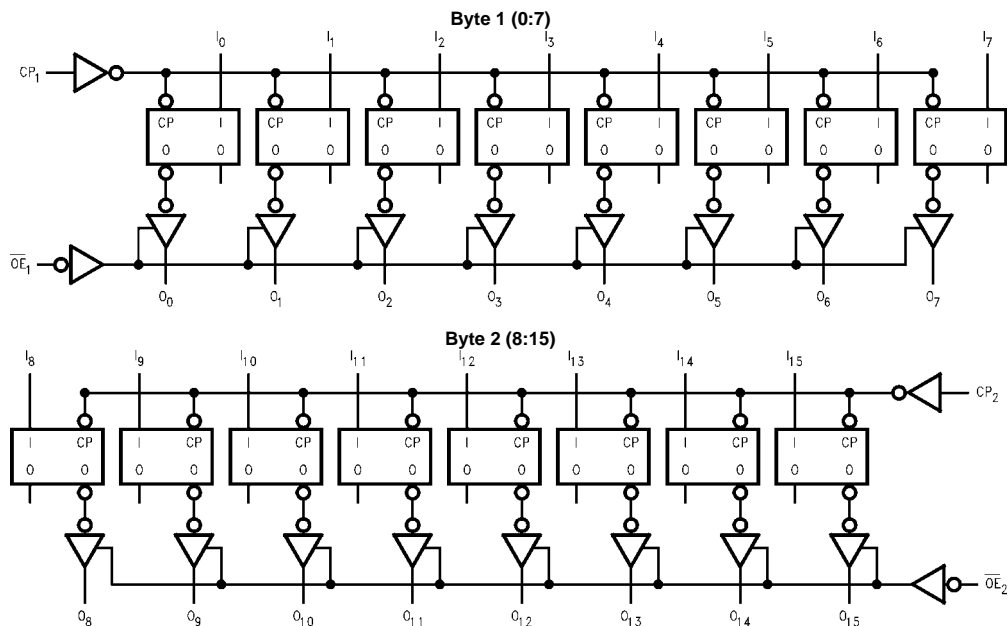
Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings(Note 3)

Symbol	Parameter		Value	Conditions	Units
V_{CC}	Supply Voltage		−0.5 to +7.0		V
V_I	DC Input Voltage	I_0 - I_{15}	−0.5 to V_{CC} + 0.5		V
		$\overline{OE}_1$, CP_n	−0.5V to 7.0V		
V_O	DC Output Voltage		−0.5 to +7.0	3-STATE	V
			−0.5 to V_{CC} + 0.5	Output in HIGH or LOW State (Note 4)	
I_{IK}	DC Input Diode Current		−50	$V_I < $ GND	mA
I_{OK}	DC Output Diode Current		−50	$V_O <$ GND	mA
			+50	$V_O > V_{CC}$	
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		−65 to +150		°C

Recommended Operating Conditions (Note 5)

Symbol	Parameter		Min	Max	Units
V_{CC}	Supply Voltage	Operating	2.0	3.6	V
		Data Retention	1.5	3.6	
V_I	Input Voltage		0	V_{CC}	V
V_O	Output Voltage	HIGH or LOW State	0	V_{CC}	V
		3-STATE	0	5.5	
I_{OH}/I_{OL}	Output Current	V_{CC} = 3.0V – 3.6V		±24	mA
		V_{CC} = 2.7V – 3.0V		±12	
		V_{CC} = 2.3V – 2.7V		±8	
T_A	Free-Air Operating Temperature		−40	85	°C
$\Delta t/\Delta V$	Input Edge Rate, V_{IN} = 0.8V–2.0V, V_{CC} = 3.0V		0	10	ns/V

Note 3: The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Note 4: I_O Absolute Maximum Rating must be observed.

Note 5: Floating or unused control inputs must be HIGH or LOW.

DC Electrical Characteristics

Symbol	Parameter	Conditions		V_{CC} (V)	$T_A = $ −40°C to +85°C		Units
					Min	Max	
V_{IH}	HIGH Level Input Voltage			2.3 – 2.7	1.7		V
				2.7 – 3.6	2.0		
V_{IL}	LOW Level Input Voltage			2.3 – 2.7		0.7	V
				2.7 – 3.6		0.8	
V_{OH}	HIGH Level Output Voltage	I_{OH} = −100 μA		2.3 – 3.6	V_{CC} − 0.2		V
		I_{OH} = −8 mA		2.3	1.8		
		I_{OH} = −12 mA		2.7	2.2		
		I_{OH} = −18 mA		3.0	2.4		
		I_{OH} = −24 mA		3.0	2.2		
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 μA		2.3 – 3.6		0.2	V
		I_{OL} = 8 mA		2.3		0.6	
		I_{OL} = 12 mA		2.7		0.4	
		I_{OL} = 16 mA		3.0		0.4	
		I_{OL} = 24 mA		3.0		0.55	
I_I	Input Leakage Current	Data	$V_I = V_{CC}$ or GND	2.3 – 3.6		±5.0	μA
		Control	$0V \le V_I \le 5.5$	2.3 – 3.6		±5.0	

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_CC (V)	T_A = −40°C to +85°C Min	T_A = −40°C to +85°C Max	Units
$I_{I(HOLD)}$	Bushold Input Minimum Drive Hold Current	$V_{IN} = 0.7V$	2.3	45		μA
		$V_{IN} = 1.7V$	2.3	−45		
		$V_{IN} = 0.8V$	3.0	75		
		$V_{IN} = 2.0V$	3.0	−75		
$I_{I(OD)}$	Bushold Input Over-Drive Current to Change State	(Note 7)	2.7	300		μA
		(Note 8)	2.7	−300		
		(Note 7)	3.6	450		
		(Note 8)	3.6	−450		
I_{OZ}	3-STATE Output Leakage	$0 \leq V_O \leq 5.5V$	2.3 – 3.6		±5.0	μA
I_{OFF}	Power-Off Leakage Current	$V_O = V_{CC}$	0		10	μA
I_{CC}	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.3 – 3.6		20	μA
		$3.6V \leq V_O \leq 5.5V$ (Note 6)	2.3 – 3.6		±20	
ΔI_{CC}	Increase in I_{CC} per Input	$V_{IH} = V_{CC} - 0.6V$	2.3 – 3.6		500	μA

Note 6: Outputs disabled or 3-STATE only.

Note 7: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 8: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

AC Electrical Characteristics

Symbol	Parameter	$V_{CC} = 3.3V \pm 0.3V$ $C_L = 50 pF$ Min	$V_{CC} = 3.3V \pm 0.3V$ $C_L = 50 pF$ Max	$V_{CC} = 2.7V$ $C_L = 50 pF$ Min	$V_{CC} = 2.7V$ $C_L = 50 pF$ Max	$V_{CC} = 2.5V \pm 0.2V$ $C_L = 30 pF$ Min	$V_{CC} = 2.5V \pm 0.2V$ $C_L = 30 pF$ Max	Units
f_{MAX}	Maximum Clock Frequency	170						MHz
t_{PHL}	Propagation Delay	1.5	6.2	1.5	6.5	1.5	7.4	ns
t_{PLH}	CP to O_n	1.5	6.2	1.5	6.5	1.5	7.4	
t_{PZL}	Output Enable time	1.5	6.1	1.5	6.3	1.5	7.9	ns
t_{PZH}		1.5	6.1	1.5	6.3	1.5	7.9	
t_{PLZ}	Output Disable Time	1.5	6.0	1.5	6.2	1.5	7.2	ns
t_{PHZ}		1.5	6.0	1.5	6.2	1.5	7.2	
t_S	Setup Time	2.5		2.5		3.0		ns
t_H	Hold Time	1.5		1.5		2.0		ns
t_W	Pulse Width	3.0		3.0		3.5		ns
t_{OSHL}	Output to Output Skew (Note 9)		1.0					ns
t_{OSLH}			1.0					

T_A = −40° to +85°C, R_L = 500Ω

Note 9: Skew is defined as the absolute value of the differences 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	Parameter	Conditions	V_CC (V)	T_A = 25°C Typical	Units
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	$C_L = 50 pF$, $V_{IH} = 3.3V$, $V_{IL} = 0V$	3.3	0.8	V
		$C_L = 30 pF$, $V_{IH} = 2.5V$, $V_{IL} = 0V$	2.5	0.6	
V_{OLV}	Quiet Output Dynamic Valley V_{OL}	$C_L = 50 pF$, $V_{IH} = 3.3V$, $V_{IL} = 0V$	3.3	−0.8	V
		$C_L = 30 pF$, $V_{IH} = 2.5V$, $V_{IL} = 0V$	2.5	0.6	

Capacitance

Symbol	Parameter	Conditions	Typical	Units
C_{IN}	Input Capacitance	V_{CC} = Open, $V_I = 0V$ or V_{CC}	7	pF
C_{OUT}	Output Capacitance	$V_{CC} = 3.3V$, $V_I = 0V$ or V_{CC}	8	pF
C_{PD}	Power Dissipation Capacitance	$V_{CC} = 3.3V$, $V_I = 0V$ or V_{CC}, f = 10 MHz	20	pF

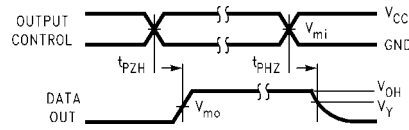# AC LOADING and WAVEFORMS Generic for LCX Family

FIGURE 1. AC Test Circuit (C$_L$ includes probe and jig capacitance)

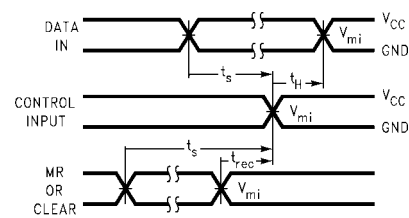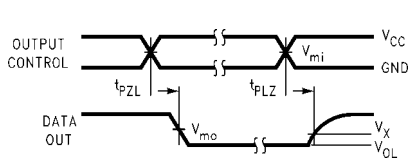| Test	Switch
t$_{PLH}$, t$_{PHL}$	Open
t$_{PZL}$, t$_{PLZ}$	6V at V$_{CC}$ = 3.3 ± 0.3V, and 2.7V V$_{CC}$ x 2 at V$_{CC}$ = 2.5 ± 0.2V
t$_{PZH}$, t$_{PHZ}$	GND

Waveform for Inverting and Non-Inverting Functions

3-STATE Output High Enable and Disable Times for Logic

Propagation Delay. Pulse Width and t$_{rec}$ Waveforms

Setup Time, Hold Time and Recovery Time for Logic

3-STATE Output Low Enable and Disable Times for Logic

t$_{rise}$ and t$_{fall}$
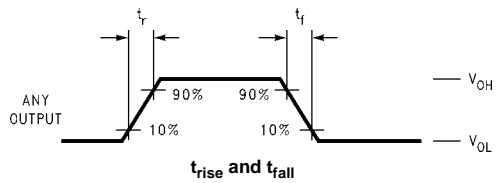
FIGURE 2. Waveforms
(Input Characteristics; f =1MHz, t$_r$ = t$_f$ = 3ns)

Symbol	V$_{CC}$		
	3.3V ± 0.3V	**2.7V**	**2.5V ± 0.2V**
V$_{mi}$	1.5V	1.5V	V$_{CC}$/2
V$_{mo}$	1.5V	1.5V	V$_{CC}$/2
V$_x$	V$_{OL}$ + 0.3V	V$_{OL}$ + 0.3V	V$_{OL}$ + 0.15V
V$_y$	V$_{OH}$ − 0.3V	V$_{OH}$ − 0.3V	V$_{OH}$ − 0.15V

Schematic Diagram Generic for LCXH Family (with Bushold)
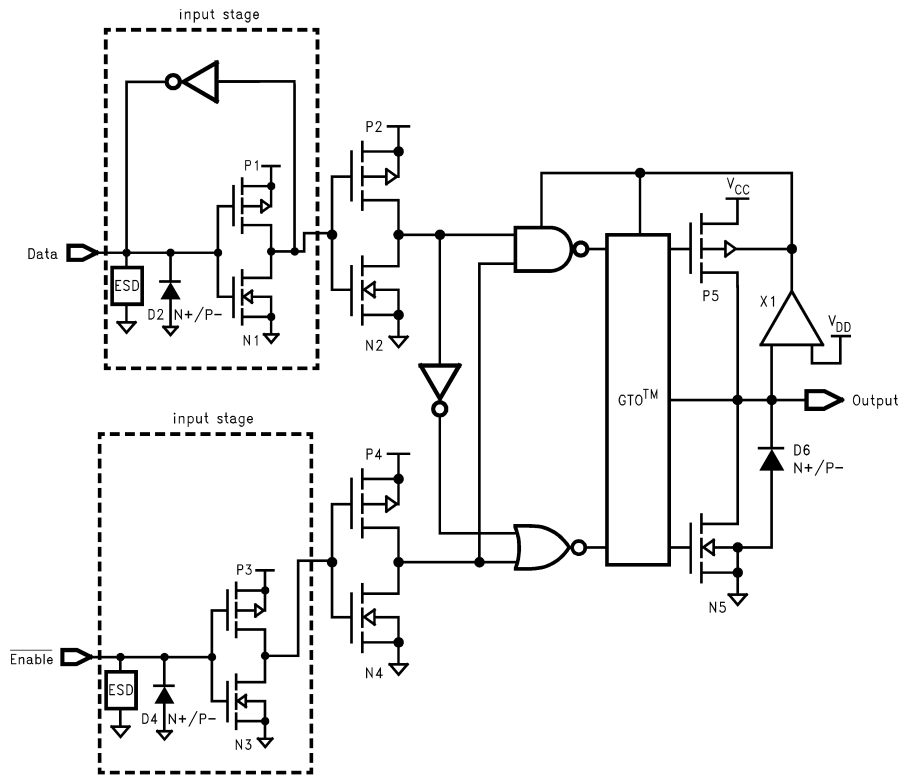
Physical Dimensions inches (millimeters) unless otherwise noted

Top View

PIN ONE

Bottom View

54X 0.5 +0.05 / -0.05

⊕	0.15(M)	C	A	B
	0.08(M)	C		

// 0.15 C

SEATING PLANE

1.4MAX

0.45 / 0.35

△ 0.10 C
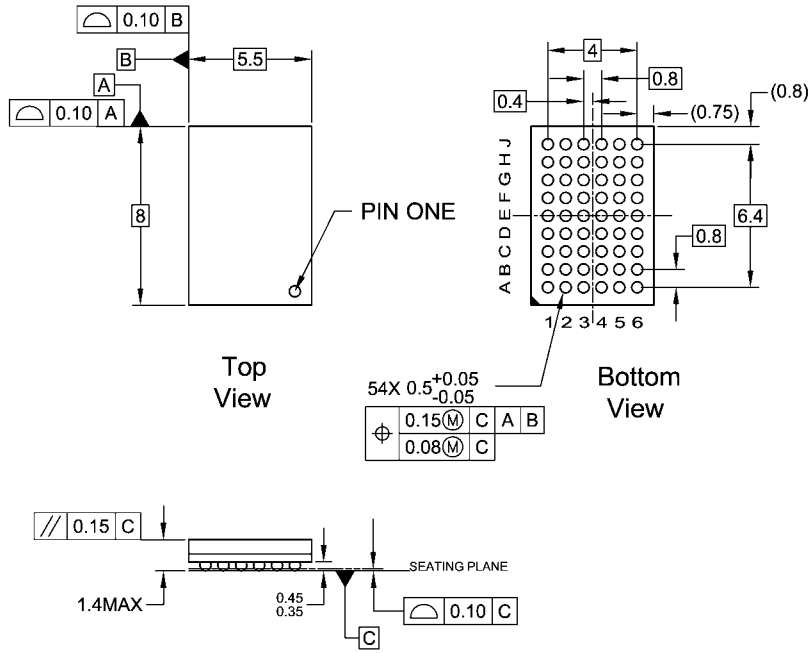
NOTES:
A. THIS PACKAGE CONFORMS TO JEDEC M0-205
B. ALL DIMENSIONS IN MILLIMETERS
C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)
   .35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS
D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA54ArevD

54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
Package Number BGA54A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)
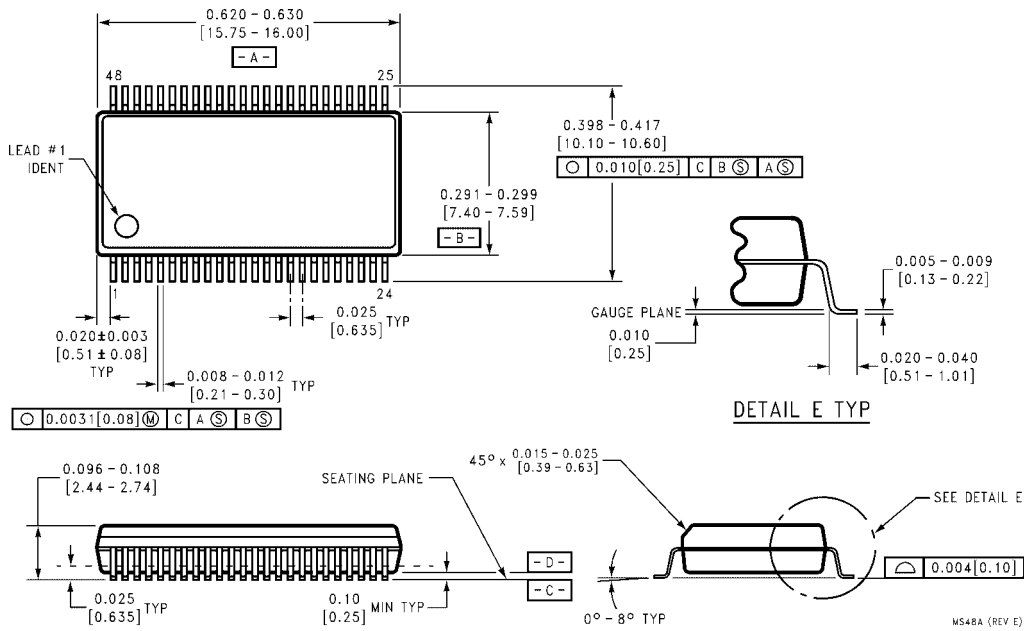
48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
Package Number MS48A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

NOTES:
A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION ED, DATE 4/97.
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTD48REVC

48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide
Package Number MTD48

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PUBLICATION ORDERING INFORMATION

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