

## 74LCXH16244

### Low Voltage 16-Bit Buffer/Line Driver with Bushold

#### General Description

The LCXH16244 contains sixteen non-inverting buffers with 3-STATE outputs designed to be employed as a memory or address driver, clock driver, or bus oriented transmitter/receiver. The device is nibble controlled. Each nibble has separate 3-STATE control inputs which can be shorted together for full 16-bit operation.

The LCXH16244 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.

The LCXH16244 is designed for low voltage (2.5V or 3.3V)  $V_{CC}$  applications with capability of interfacing to a 5V signal environment.

The LCXH16244 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

#### Features

- 5V tolerant control inputs and outputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 4.5 ns  $t_{PD}$  max ( $V_{CC} = 3.0V$ ), 20  $\mu A$   $I_{CC}$  max
- Bushold on inputs eliminates the need for external pull-up/pull-down resistors
- Power down high impedance inputs and outputs
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Implements patented 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)

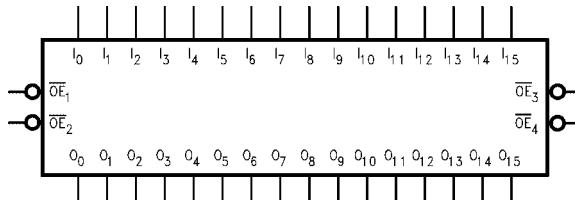
#### Ordering Code:

Order Number	Package Number	Package Description
74LCXH16244G (Note 1)(Note 2)	BGA54A	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
74LCXH16244MEA (Note 2)	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
74LCXH16244MTD (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.

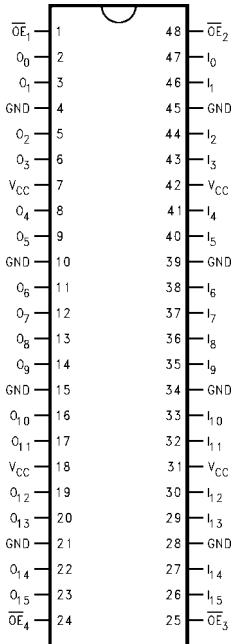
#### Logic Symbol



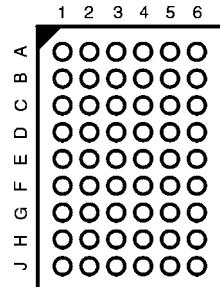
74LCXH16244 Low Voltage 16-Bit Buffer/Line Driver with Bushold

## Connection Diagrams

Pin Assignment for SSOP and TSSOP



Pin Assignment for FBGA



(Top Thru View)

## Pin Descriptions

Pin Names	Description
OE <sub>n</sub>	Output Enable Input (Active LOW)
I <sub>0</sub> –I <sub>15</sub>	Inputs
O <sub>0</sub> –O <sub>15</sub>	Outputs
NC	No Connect

## FBGA Pin Assignments

	1	2	3	4	5	6
<b>A</b>	O <sub>0</sub>	NC	OE <sub>1</sub>	OE <sub>2</sub>	NC	I <sub>0</sub>
<b>B</b>	O <sub>2</sub>	O <sub>1</sub>	NC	NC	I <sub>1</sub>	I <sub>2</sub>
<b>C</b>	O <sub>4</sub>	O <sub>3</sub>	V <sub>CC</sub>	V <sub>CC</sub>	I <sub>3</sub>	I <sub>4</sub>
<b>D</b>	O <sub>6</sub>	O <sub>5</sub>	GND	GND	I <sub>5</sub>	I <sub>6</sub>
<b>E</b>	O <sub>8</sub>	O <sub>7</sub>	GND	GND	I <sub>7</sub>	I <sub>8</sub>
<b>F</b>	O <sub>10</sub>	O <sub>9</sub>	GND	GND	I <sub>9</sub>	I <sub>10</sub>
<b>G</b>	O <sub>12</sub>	O <sub>11</sub>	V <sub>CC</sub>	V <sub>CC</sub>	I <sub>11</sub>	I <sub>12</sub>
<b>H</b>	O <sub>14</sub>	O <sub>13</sub>	NC	NC	I <sub>13</sub>	I <sub>14</sub>
<b>J</b>	O <sub>15</sub>	NC	OE <sub>4</sub>	OE <sub>3</sub>	NC	I <sub>15</sub>

## Truth Tables

Inputs		Outputs
OE <sub>1</sub>	I <sub>0</sub> –I <sub>3</sub>	O <sub>0</sub> –O <sub>3</sub>
L	L	L
L	H	H
H	X	Z

Inputs		Outputs
OE <sub>2</sub>	I <sub>4</sub> –I <sub>7</sub>	O <sub>4</sub> –O <sub>7</sub>
L	L	L
L	H	H
H	X	Z

Inputs		Outputs
OE <sub>3</sub>	I <sub>8</sub> –I <sub>11</sub>	O <sub>8</sub> –O <sub>11</sub>
L	L	L
L	H	H
H	X	Z

Inputs		Outputs
OE <sub>4</sub>	I <sub>12</sub> –I <sub>15</sub>	O <sub>12</sub> –O <sub>15</sub>
L	L	L
L	H	H
H	X	Z

H = HIGH Voltage Level  
L = LOW Voltage Level

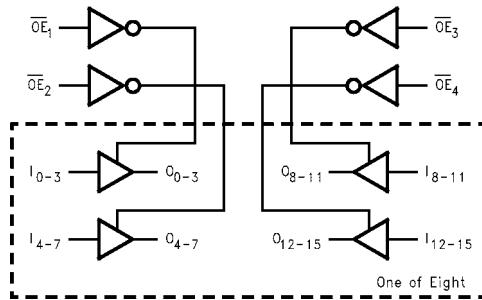
X = Immaterial  
Z = High Impedance

## Functional Description

The LCXH16244 contains sixteen non-inverting buffers with 3-STATE standard outputs. The device is nibble (4 bits) controlled with each nibble functioning identically, but independent of the other. The control pins can be shorted together to obtain full 16-bit operation. The

3-STATE outputs are controlled by an Output Enable ( $\overline{OE}_n$ ) input for each nibble. When  $\overline{OE}_n$  is LOW, the outputs are in 2-state mode. When  $\overline{OE}_n$  is HIGH, the outputs are in the high impedance mode, but this does not interfere with entering new data into the inputs.

## Logic Diagram



### 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	OE	−0.5 to +7.0			V
		$I_O - I_{15}$	−0.5 to $V_{CC} + 0.5$			
$V_O$	DC Output Voltage		−0.5 to +7.0 −0.5 to $V_{CC} + 0.5$	Output in 3-STATE Output in HIGH or LOW State (Note 4)		V
$I_{IK}$	DC Input Diode Current		−50	$V_I < GND$		mA
$I_{OK}$	DC Output Diode Current		−50 +50	$V_O < GND$ $V_O > V_{CC}$		mA
	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	Operating	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	$V_{CC} = 3.0V - 3.6V$ $V_{CC} = 2.7V - 3.0V$ $V_{CC} = 2.3V - 2.7V$		±24 ±12 ±8	mA
$T_A$	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 held HIGH or LOW.

### DC Electrical Characteristics

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$		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	$I_{OH} = -100 \mu\text{A}$	2.3 – 3.6	$V_{CC} - 0.2$		V
		$I_{OH} = -8 \text{ mA}$	2.3	1.8		
		$I_{OH} = -12 \text{ mA}$	2.7	2.2		
		$I_{OH} = -18 \text{ mA}$	3.0	2.4		
		$I_{OH} = -24 \text{ mA}$	3.0	2.2		
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu\text{A}$	2.3 – 3.6		0.2	V
		$I_{OL} = 8 \text{ mA}$	2.3		0.6	
		$I_{OL} = 12 \text{ mA}$	2.7		0.4	
		$I_{OL} = 16 \text{ mA}$	3.0		0.4	
		$I_{OL} = 24 \text{ mA}$	3.0		0.55	
$I_I$	Input Leakage Current	Data	$V_I = V_{CC}$ or GND	2.3 – 3.6	±5.0	$\mu\text{A}$
		Control	$0 \leq V_I \leq 5.5$	2.3 – 3.6	±5.0	

## DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C		Units
				Min	Max	
I <sub>I(HOLD)</sub>	Bushold Input Minimum Drive Hold Current	V <sub>IN</sub> = 0.7V	2.3	45		μA
		V <sub>IN</sub> = 1.7V		-45		
		V <sub>IN</sub> = 0.8V	3.0	75		
		V <sub>IN</sub> = 2.0V		-75		
I <sub>I(OD)</sub>	Bushold Input Over-Drive Current to Change State	(Note 6)	2.7	300		μA
		(Note 7)		-300		
		(Note 6)	3.6	450		
		(Note 7)		-450		
I <sub>OZ</sub>	3-STATE Output Leakage	0 ≤ V <sub>O</sub> ≤ 5.5V V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	2.3 – 3.6		±5.0	μA
I <sub>OFF</sub>	Power-Off Leakage Current	V <sub>O</sub> = 5.5V	0		10	μA
I <sub>CC</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND	2.3 – 3.6		20	μA
ΔI <sub>CC</sub>	Increase in I <sub>CC</sub> per Input	V <sub>IH</sub> = V <sub>CC</sub> – 0.6V	2.3 – 3.6		500	μA

**Note 6:** An external driver must source at least the specified current to switch from LOW-to-HIGH.

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

## AC Electrical Characteristics

Symbol	Parameter	T <sub>A</sub> = -40°C to +85°C, R <sub>L</sub> = 500 Ω						Units	
		V <sub>CC</sub> = 3.3V ± 0.3V		V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 2.5V ± 0.2V			
		C <sub>L</sub> = 50 pF		C <sub>L</sub> = 50 pF		C <sub>L</sub> = 30 pF			
		Min	Max	Min	Max	Min	Max		
		1.0	4.5	1.0	5.2	1.0	5.4		
t <sub>PHL</sub>	Propagation Delay Data to Output	1.0	4.5	1.0	5.2	1.0	5.4	ns	
t <sub>PZL</sub>	Output Enable Time	1.0	5.5	1.0	6.3	1.0	7.2	ns	
t <sub>PZH</sub>		1.0	5.5	1.0	6.3	1.0	7.2	ns	
t <sub>PLZ</sub>	Output Disable Time	1.0	5.4	1.0	5.7	1.0	6.5	ns	
t <sub>PHZ</sub>		1.0	5.4	1.0	5.7	1.0	6.5	ns	
t <sub>OShL</sub>	Output to Output Skew (Note 8)		1.0					ns	
t <sub>OSLH</sub>			1.0					ns	

**Note 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<sub>OShL</sub>) or LOW-to-HIGH (t<sub>OSLH</sub>). Parameter guaranteed by design.

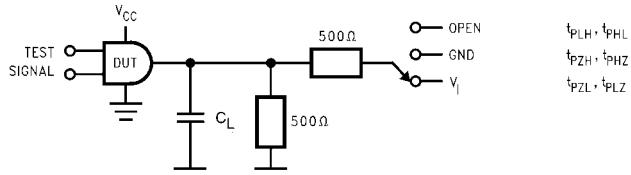
## Dynamic Switching Characteristics

Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C		Units
				Typical		
V <sub>OLP</sub>	Quiet Output Dynamic Peak V <sub>OL</sub>	C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V	3.3	0.8		V
		C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V		2.5	0.6	
V <sub>OVL</sub>	Quiet Output Dynamic Valley V <sub>OL</sub>	C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V	3.3	-0.8		V
		C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V		2.5	-0.6	

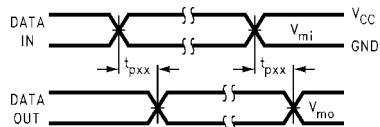
## Capacitance

Symbol	Parameter	Conditions	Typical	Units
C <sub>IN</sub>	Input Capacitance	V <sub>CC</sub> = Open, V <sub>I</sub> = 0V or V <sub>CC</sub>	7	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub>	8	pF
C <sub>PD</sub>	Power Dissipation Capacitance	V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub> , f = 10 MHz	20	pF

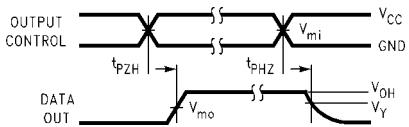
## AC LOADING and WAVEFORMS Generic for LCX Family

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

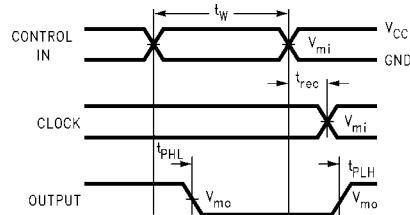
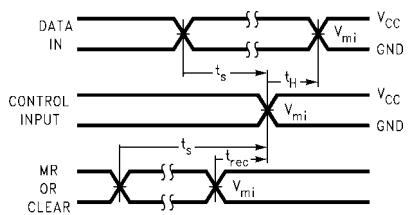
$V_I$	$C_L$
6V for $V_{CC} = 3.3V, 2.7V$	50 pF
$V_{CC} * 2$ for $V_{CC} = 2.5V$	30 pF



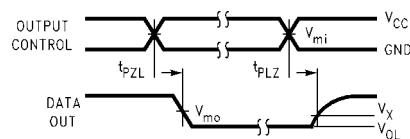
Waveform for Inverting and Non-Inverting Functions



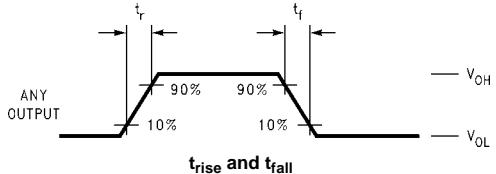
3-STATE Output High Enable and Disable Times for Logic

Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms

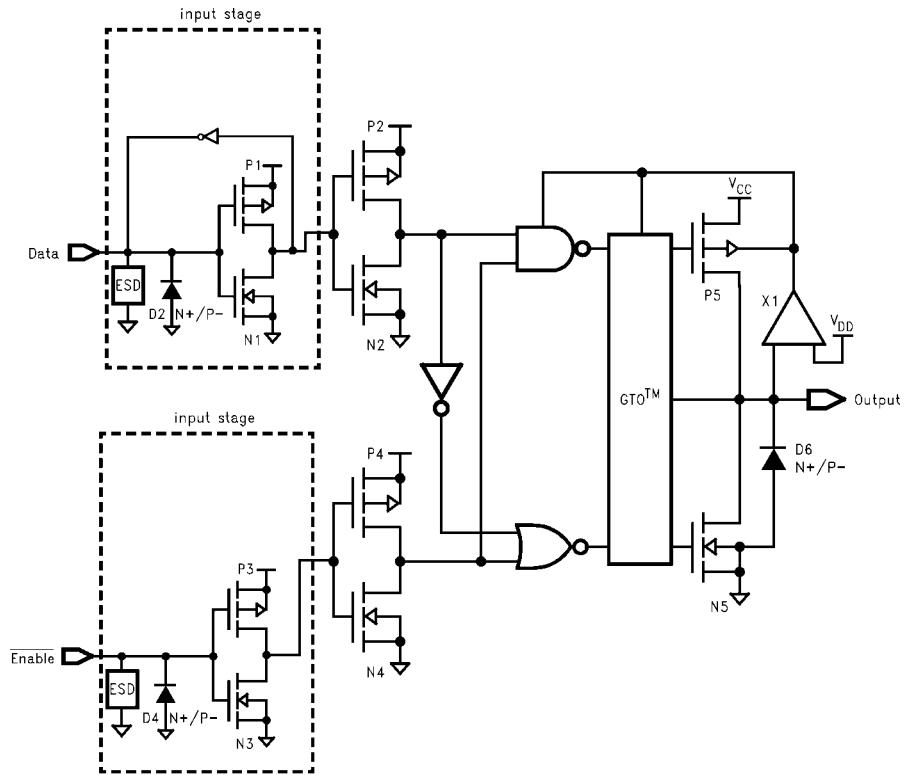
Setup Time, Hold Time and Recovery Time for Logic

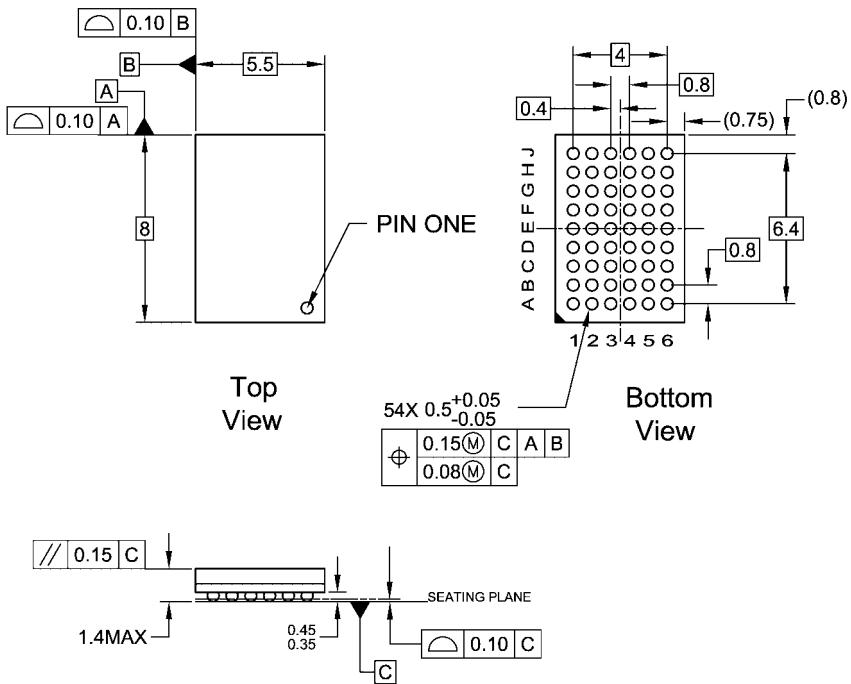


3-STATE Output Low Enable and Disable Times for Logic

FIGURE 2. Waveforms  
(Input Characteristics;  $f = 1\text{MHz}$ ,  $t_r = t_f = 3\text{ns}$ )

Symbol	$V_{CC}$		
	$3.3V \pm 0.3V$	$2.7V$	$2.5V \pm 0.2V$
$V_{mi}$	1.5V	1.5V	$V_{CC}/2$
$V_{mo}$	1.5V	1.5V	$V_{CC}/2$
$V_x$	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$
$V_y$	$V_{OH} - 0.3V$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$

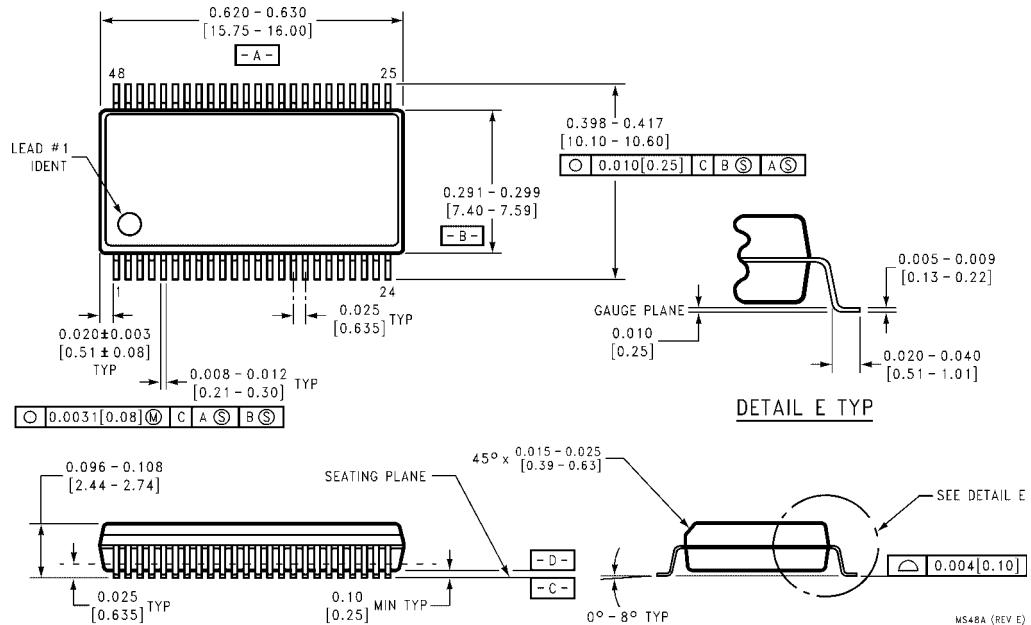
**Schematic Diagram** Generic for LCXH Family

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

BGA54ArevD

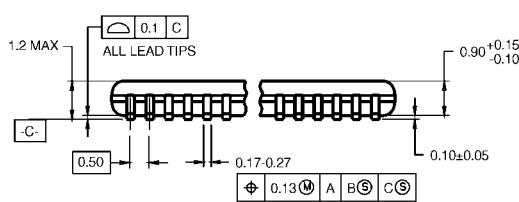
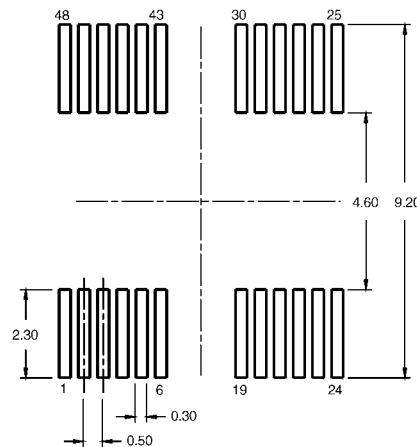
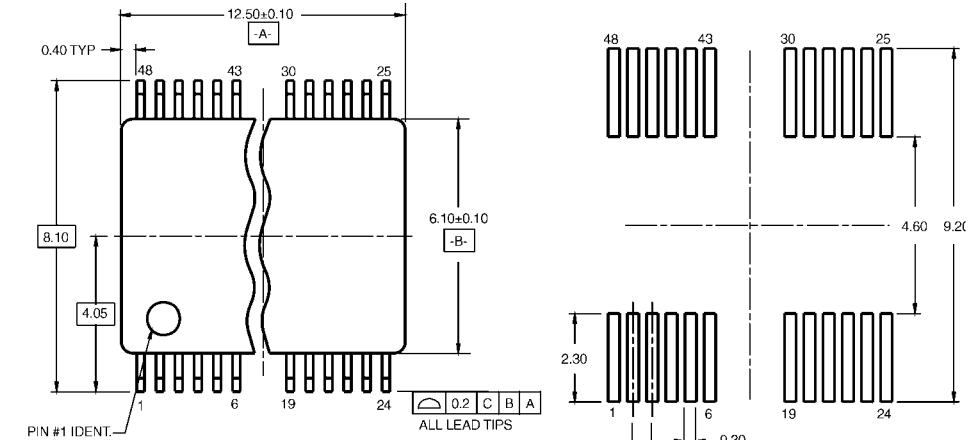
54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC M0-205, 5.5mm Wide  
Package Number BGA54A

**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)



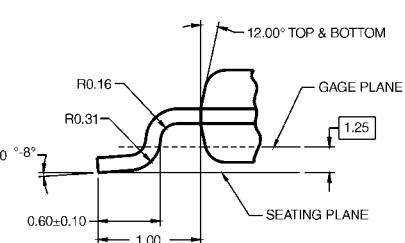
DIMENSIONS ARE IN MILLIMETERS

NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6, DATE 7/93.
- 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.

MTD48RevB1

LAND PATTERN RECOMMENDATION



DETAIL A

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

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