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SEMICONDUCTOR®

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74LCX162374

Low Voltage 16-Bit D-Type Flip-Flop with 5V Tolerant Inputs and Outputs and 26Ω Series Resistors

General Description

The LCX162374 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 LCX162374 is designed for low voltage (2.5V or 3.3V) V_{CC} applications with capability of interfacing to a 5V signal environment. The 26Ω series resistor in the output helps reduce output overshoot and undershoot.

The LCX162374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- Equivalent 26Ω series resistor on outputs
- 7.0 ns t_{PD} max (V_{CC} = 3.3V), 20 μA I_{CC} max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- ±12 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) (Preliminary)

Note 1: To ensure the high-impedance state during power up or down, $\overline{OE}$ should be tied to V_{CC} through a pull-up resistor: the minimum value or the resistor is determined by the current-sourcing capability of the driver.

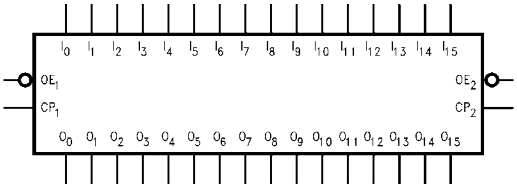
Ordering Code:

Order Number	Package Number	Package Description
74LCX162374GX (Note 2)	BGA54A (Preliminary)	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]
74LCX162374MEA (Note 3)	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
74LCX162374MTD (Note 3)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Note 2: BGA package available in Tape and Reel only.

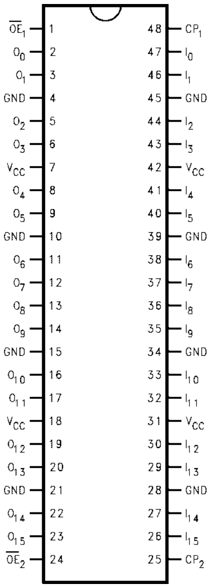
Note 3: Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Logic Symbol

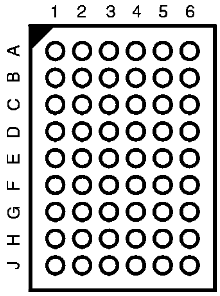


Connection Diagrams

Pin Assignment for SSOP and TSSOP



Pin Assignment for FBGA



(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}	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

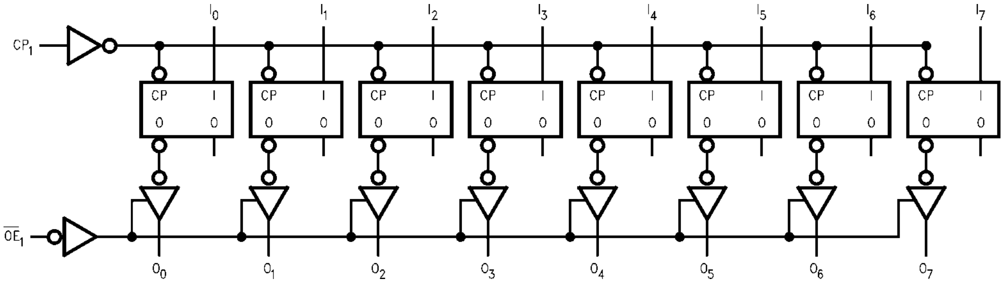
H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = High Impedance
O_0 = Previous O_0 before HIGH-to-LOW of CP

Functional Description

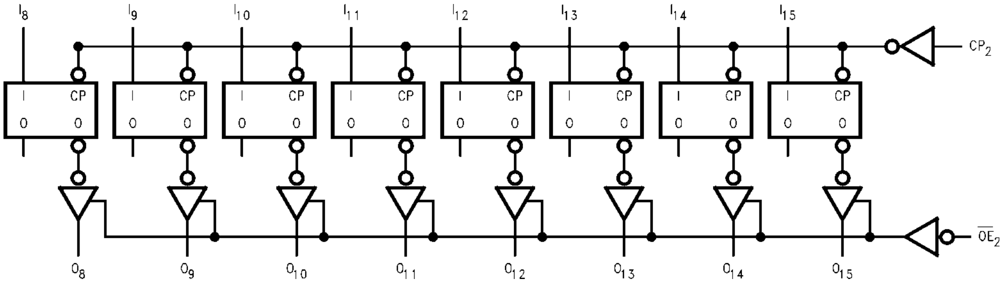
The LCX162374 consists of sixteen edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The device is byte controlled with each byte functioning identically, but independent of the other. The control pins can be shorted together to obtain full 16-bit operation. Each byte has 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 4)

Symbol	Parameter	Value	Conditions	Units
V_{CC}	Supply Voltage	−0.5 to +7.0		V
V_I	DC Input Voltage	−0.5 to +7.0		V
V_O	DC Output Voltage	−0.5 to +7.0 −0.5 to V_{CC} + 0.5	3-STATE Output in HIGH or LOW State (Note 5)	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
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 6)

Symbol	Parameter		Min	Max	Units
V_{CC}	Supply Voltage	Operating Data Retention	2.0 1.5	3.6 3.6	V
V_I	Input Voltage		0	5.5	V
V_O	Output Voltage	HIGH or LOW State 3-STATE	0 0	V_{CC} 5.5	V
I_{OH}/I_{OL}	Output Current	V_{CC} = 3.0V − 3.6V V_{CC} = 2.7V − 3.0V V_{CC} = 2.3V − 2.7V		±12 ±8 ±4	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 4: 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 5: I_O Absolute Maximum Rating must be observed.

Note 6: 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} = −4 mA	2.3	1.8		
		I_{OH} = −4 mA	2.7	2.2		
		I_{OH} = −6 mA	3.0	2.4		
		I_{OH} = −8 mA	2.7	2.0		
		I_{OH} = −12 mA	3.0	2.0		
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 μA	2.3 – 3.6		0.2	V
		I_{OL} = 4 mA	2.3		0.6	
		I_{OL} = 4 mA	2.7		0.4	
		I_{OL} = 6 mA	3.0		0.55	
		I_{OL} = 8 mA	2.7		0.6	
		I_{OL} = 12 mA	3.0		0.8	
I_I	Input Leakage Current	0 ≤ V_I ≤ 5.5V	2.3 – 3.6		±5.0	μA
I_{OZ}	3-STATE Output Leakage	0 ≤ V_O ≤ 5.5V V_I = V_{IH} or V_{IL}	2.3 – 3.6		±5.0	μA

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_{CC} (V)	T_A = −40°C to +85°C		Units
				Min	Max	
I_{OFF}	Power-Off Leakage Current	V_I or V_O = 5.5V	0		10	µA
I_{CC}	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.3 − 3.6		20	µA
		3.6V ≤ V_I, V_O ≤ 5.5V (Note 7)	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 7: Outputs disabled or 3-STATE only.

AC Electrical Characteristics

Symbol	Parameter	T_A = −40° to +85°C, R_L = 500Ω						Units
		V_{CC} = 3.3V ± 0.3V		V_{CC} = 2.7V		V_{CC} = 2.5V ± 0.2V		
		C_L = 50 pF		C_L = 50 pF		C_L = 30 pF		
		Min	Max	Min	Max	Min	Max	
f_{MAX}	Maximum Clock Frequency	170						MHz
t_{PHL}	Propagation Delay	1.5	7.0	1.5	7.3	1.5	8.4	ns
t_{PLH}	CP to O_n	1.5	7.0	1.5	7.3	1.5	8.4	
t_{PZL}	Output Enable time	1.5	6.9	1.5	7.1	1.5	9.0	ns
t_{PZH}		1.5	6.9	1.5	7.1	1.5	9.0	
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 8)		1.0					ns
t_{OSLH}			1.0					

Note 8: 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	Units
				Typical	
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	C_L = 50 pF, V_{IH} = 3.3V, V_{IL} = 0V	3.3	0.35	V
		C_L = 30 pF, V_{IH} = 2.5V, V_{IL} = 0V	2.5	0.25	
V_{OLV}	Quiet Output Dynamic Valley V_{OL}	C_L = 50 pF, V_{IH} = 3.3V, V_{IL} = 0V	3.3	−0.35	V
		C_L = 30 pF, V_{IH} = 2.5V, V_{IL} = 0V	2.5	−0.25	

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

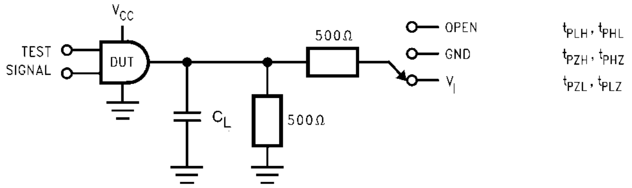
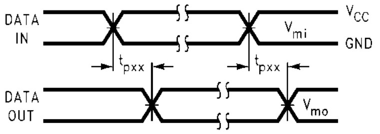
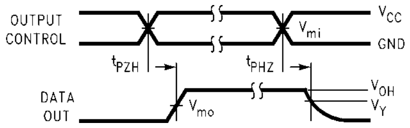


FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)

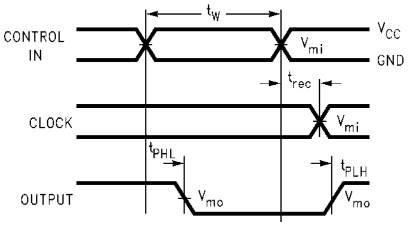
Test	Switch
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6V at V_{CC} = 3.3 ± 0.3V, and 2.7V V_{CC} x 2 at V_{CC} = 2.5 ± 0.2V
t_{PZH}, t_{PHZ}	GND



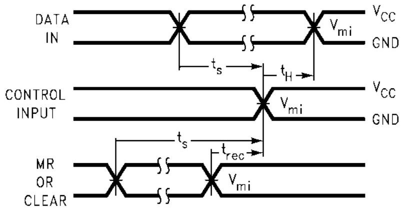
Waveform for Inverting and Non-Inverting Functions



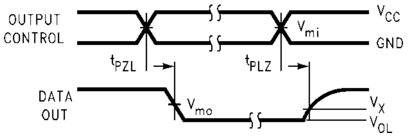
3-STATE Output High Enable and Disable Times for Logic



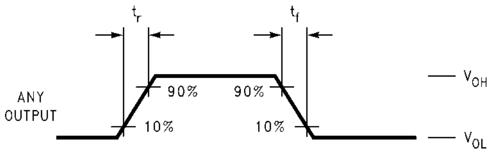
Propagation Delay. Pulse Width and t_{rec} Waveforms



Setup Time, Hold Time and Recovery Time for Logic



3-STATE Output Low Enable and Disable Times for Logic

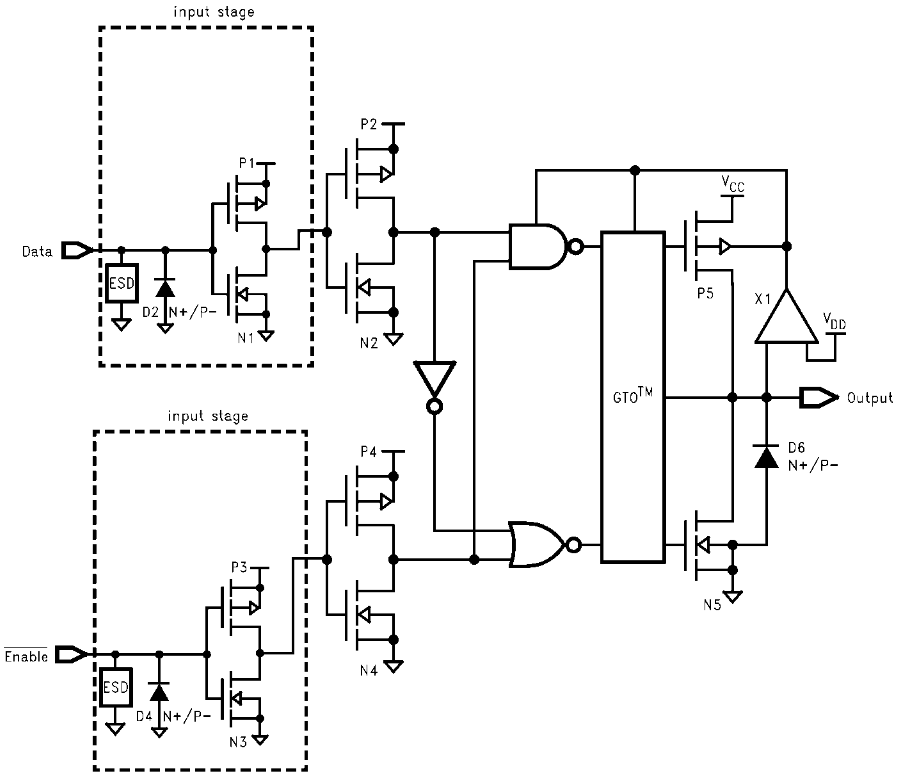


t_{rise} and t_{fall}

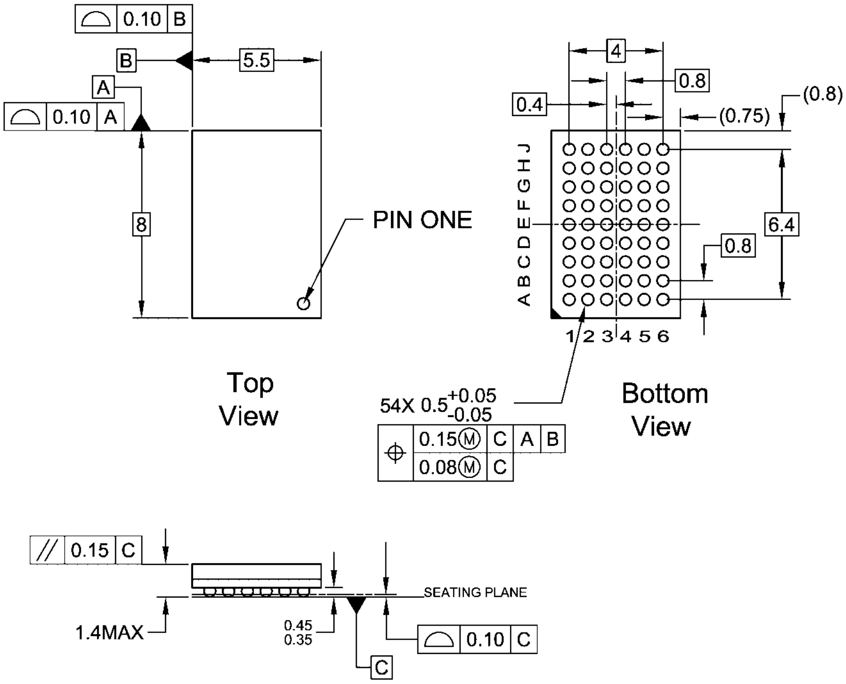
FIGURE 2. Waveforms
(Input Characteristics; f =1MHz, t_r = t_f = 3ns)

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 LCX Family



Physical Dimensions inches (millimeters) unless otherwise noted



NOTES:

A. THIS PACKAGE CONFORMS TO JEDEC M0-205

B. ALL DIMENSIONS IN MILLIMETERS

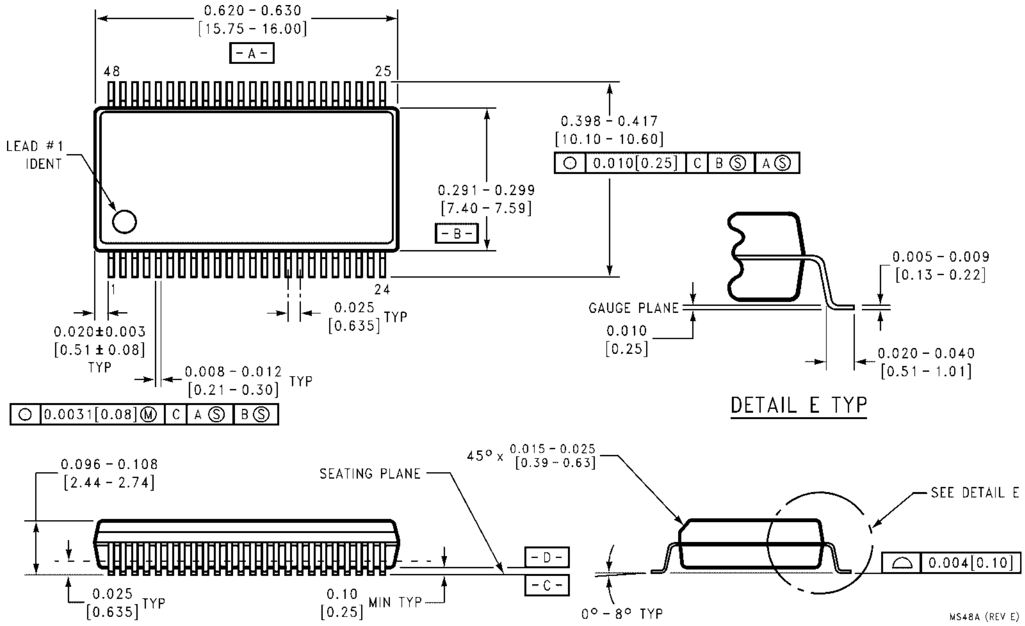
C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)
.35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS

D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA54ArevD

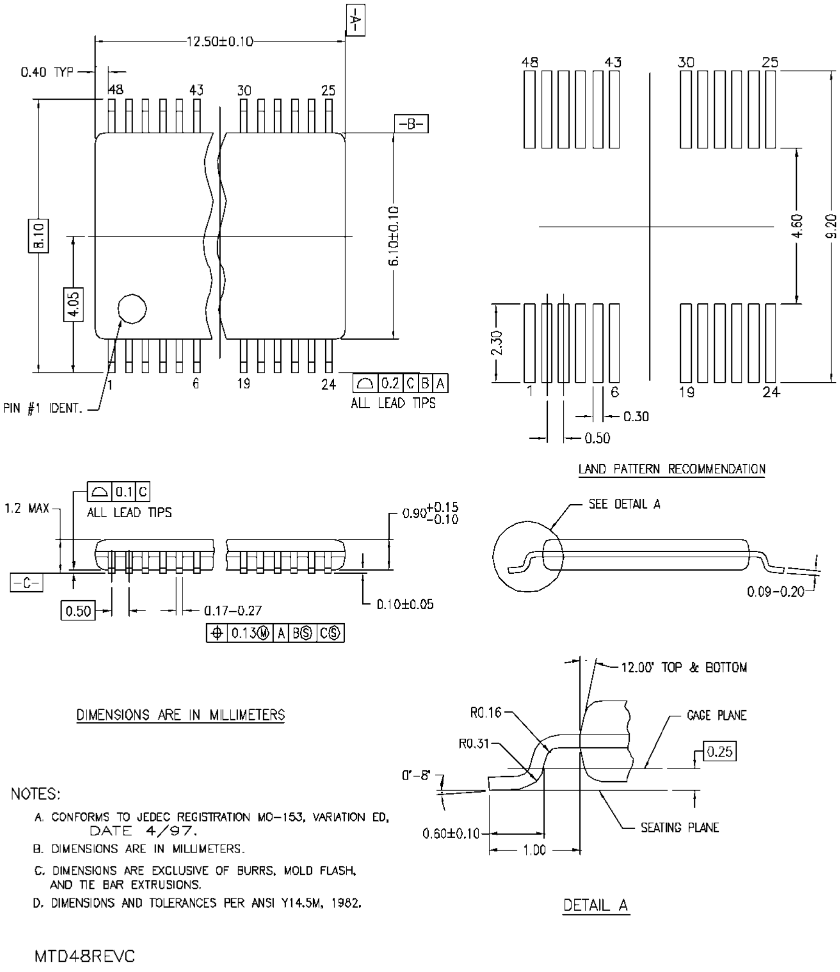
54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
Package Number BGA54A
Preliminary

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)



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

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