July 2007

74LVTH162374
Low Voltage 16-Bit D-Type Flip-Flop with 3-STATE Outputs and 25Ω Series Resistors in the Outputs

Features

- Input and output interface capability to systems at 5V V_{CC}
- Bushold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion/extraction permitted
- Power Up/Power Down high impedance provides glitch-free bus loading
- Outputs include equivalent series resistance of 25Ω to make external termination resistors unnecessary and reduce overshoot and undershoot
- Functionally compatible with the 74 series 16374
- Latch-up performance exceeds 500mA
- ESD performance:
  - Human-body model > 2000V
  - Machine model > 200V
  - Charged-device model > 1000V
- Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA) (Preliminary)

General Description

The LVTH162374 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 LVTH162374 is designed with equivalent 25Ω series resistance in both the HIGH and LOW states of the output. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus transceivers/transmitters.

The LVTH162374 data inputs include bushold, eliminating the need for external pull-up resistors to hold unused inputs.

These flip-flops are designed for low-voltage (3.3V) V_{CC} applications, but with the capability to provide a TTL interface to a 5V environment. The LVTH162374 is fabricated with an advanced BiCMOS technology to achieve high speed operation similar to 5V ABT while maintaining a low power dissipation.

Ordering Information

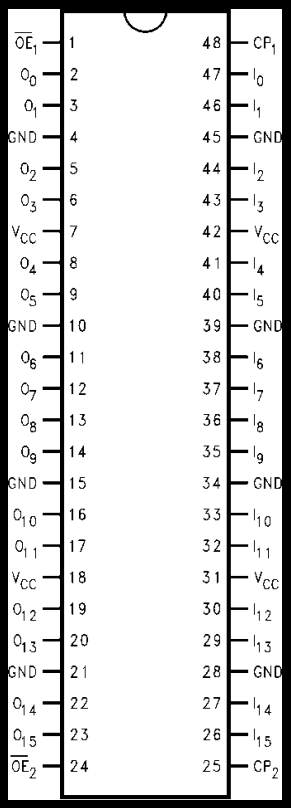
Order Number	Package Number	Pb-Free	Package Description	Supplied As
74LVTH162374GX(1)	BGA54A (Preliminary)	Yes	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide	Tape and Reel
74LVTH162374MEA	MS48A	Yes	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide	Tubes
74LVTH162374MEX	MS48A	Yes	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide	Tape and Reel
74LVTH162374MTD	MTD48	Yes	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide	Tubes
74LVTH162374MTX	MTD48	Yes	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide	Tape and Reel

Notes:

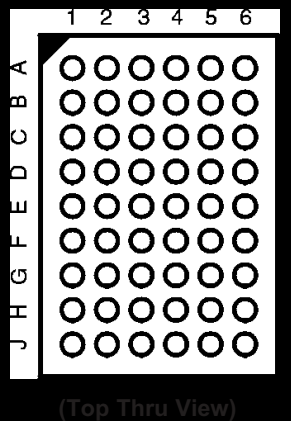
1. BGA package available in Tape and Reel only.

Connection Diagrams

Pin Assignments for SSOP and TSSOP



Pin Assignment for FPGA



(Top Thru View)

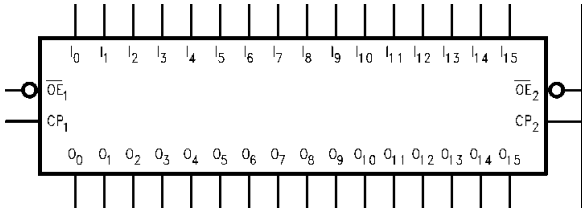
Pin Description

Pin Name	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
CP_n	Clock Pulse Input
I_0–I_{15}	Inputs
O_0–O_{15}	3-STATE 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}

Logic Symbol



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_o
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_o
X	H	X	Z

H = HIGH Voltage Level

L = LOW Voltage Level

X = Immaterial

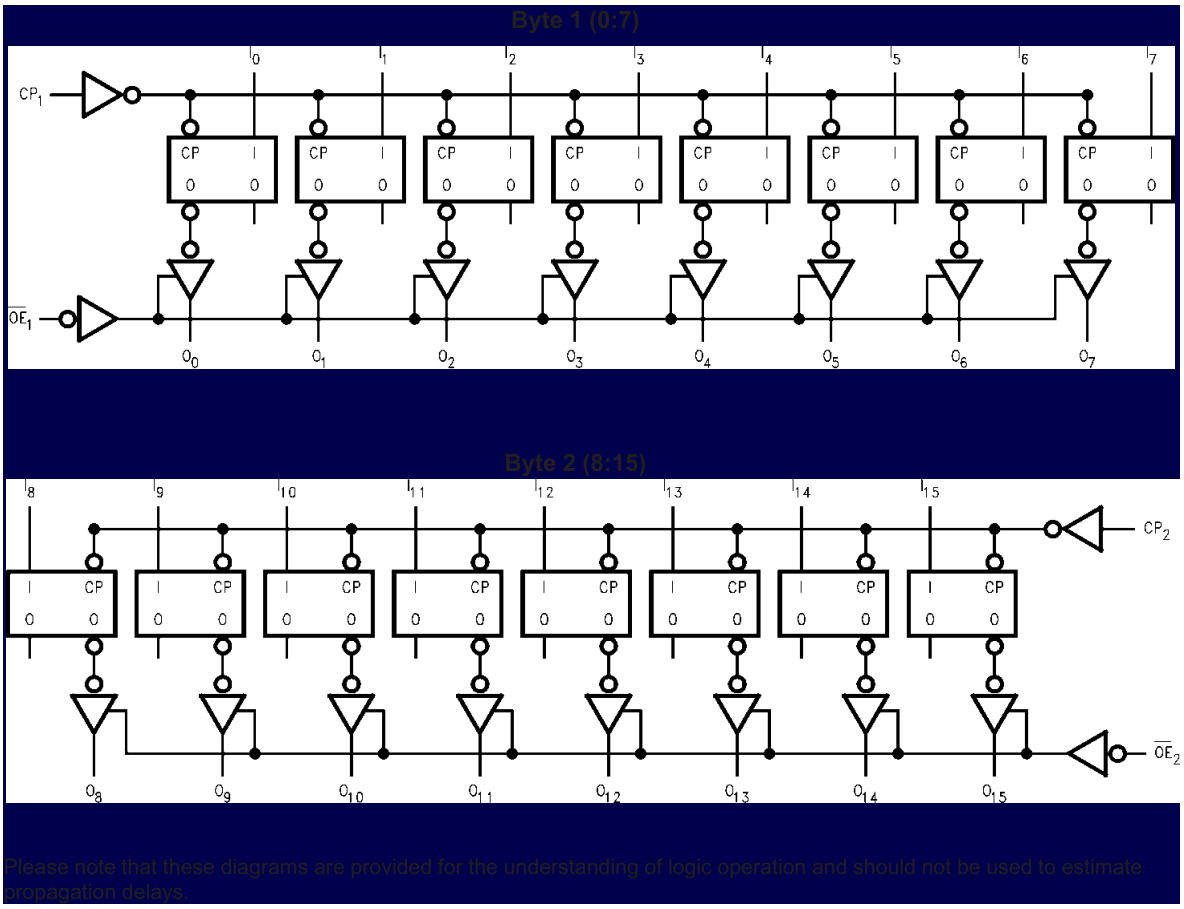
Z = HIGH Impedance

O_o = Previous O_o before LOW-to-HIGH of CP

Functional Description

The LVTH162374 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 indi-vidual D-type 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



Please note that these diagrams are provided for the understanding of logic operation and should not be used to estimate propagation delays.

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Conditions	Value	Units
V_{CC}	Supply Voltage		-0.5 to +4.6	V
V_I	DC Input Voltage		-0.5 to +7.0	V
V_O	DC Output Voltage	Output in 3-STATE	-0.5 to +7.0	V
		Output in HIGH or LOW State(2)	-0.5 to +7.0	
I_{IK}	DC Input Diode Current	V_I < GND	-50	mA
I_{OK}	DC Output Diode Current	V_O < GND	-50	mA
I_O	DC Output Current	V_O > V_{CC} Output at HIGH State	64	mA
		V_O > V_{CC} Output at LOW State	128	
I_{CC}	DC Supply Current per Supply Pin		±64	mA
I_{GND}	DC Ground Current per Ground Pin		±128	mA
T_{STG}	Storage Temperature		-65 to +150	°C

Note:

2. I_O Absolute Maximum Rating must be observed.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Min.	Max.	Units
V_{CC}	Supply Voltage	2.7	3.6	V
V_I	Input Voltage	0	5.5	V
I_{OH}	HIGH Level Output Current		-12	mA
I_{OL}	LOW Level Output Current		12	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

DC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	Conditions	T_A = -40°C to +85°C		Units
				Min.	Max.	
V_{IK}	Input Clamp Diode Voltage	2.7	I_I = -18mA		-1.2	V
V_{IH}	Input HIGH Voltage	2.7–3.6	$V_O \le 0.1V$ or $V_O \ge V_{CC} - 0.1V$	2.0		V
V_{IL}	Input LOW Voltage	2.7–3.6			0.8	V
V_{OH}	Output HIGH Voltage	2.7–3.6	I_{OH} = -100µA	V_{CC} – 0.2V		V
		3.0	I_{OH} = -12mA	2.0		
V_{OL}	Output LOW Voltage	2.7	I_{OL} = 100µA		0.2	V
		3.0	I_{OL} = 12mA		0.8	
$I_{I(HOLD)}$	Bushold Input Minimum Drive	3.0	V_I = 0.8V	75		µA
			V_I = 2.0V	-75		
$I_{I(OD)}$	Bushold Input Over-Drive Current to Change State	3.0	(3)	500		µA
			(4)	-500		
I_I	Input Current	3.6	V_I = 5.5V		10	µA
	Control Pins		V_I = 0V or V_{CC}		±1	
	Data Pins		V_I = 0V		-5	
			V_I = V_{CC}		1	
I_{OFF}	Power Off Leakage Current	0	$0V \le V_I$ or $V_O \le 5.5V$		±100	µA
$I_{PU/PD}$	Power Up/Down 3-STATE Output Current	0–1.5	V_O = 0.5V to 3.0V, V_I = GND or V_{CC}		±100	µA
I_{OZL}	3-STATE Output Leakage Current	3.6	V_O = 0.5V		-5	µA
I_{OZH}	3-STATE Output Leakage Current	3.6	V_O = 3.0V		5	µA
I_{OZH}+	3-STATE Output Leakage Current	3.6	$V_{CC} < V_O \le 5.5V$		10	µA
I_{CCH}	Power Supply Current	3.6	Outputs HIGH		0.19	mA
I_{CCL}	Power Supply Current	3.6	Outputs LOW		5	mA
I_{CCZ}	Power Supply Current	3.6	Outputs Disabled		0.19	mA
I_{CCZ}+	Power Supply Current	3.6	$V_{CC} \le V_O \le 5.5V$, Outputs Disabled		0.19	mA
ΔI_{CC}	Increase in Power Supply Current(5)	3.6	One Input at V_{CC} – 0.6V Other Inputs at V_{CC} or GND		0.2	mA

Notes:

3. An external driver must source at least the specified current to switch from LOW-to-HIGH.
4. An external driver must sink at least the specified current to switch from HIGH-to-LOW.
5. This is the increase in supply current for each input that is at the specified voltage level rather than V_{CC} or GND.

Dynamic Switching Characteristics[6]

Symbol	Parameter	V_{CC} (V)	Conditions C_L = 50pF, R_L = 500Ω	T_A = -40°C to +85°C			Units
				Min.	Typ.	Max	
V_{OLP}	Quiet Output Maximum Dynamic V_{OL}	3.3	[7]		0.8		V
V_{OLV}	Quiet Output Minimum Dynamic V_{OL}	3.3	[7]		-0.8		V

Note:

6. Characterized in SSOP package. Guaranteed parameter, but not tested.

7. Max number of outputs defined as (n). n–1 data inputs are driven 0V to 3V. Output under test held LOW.

AC Electrical Characteristics

Symbol	Parameter	T_A = -40°C to +85°C, C_L = 50pF, R_L = 500Ω				Units
		V_{CC} = 3.3V ±0.3V		V_{CC} = 2.7V		
		Min.	Max.	Min.	Max.	
f_{MAX}	Maximum Clock Frequency	160		150		MHz
t_{PHL}	Propagation Delay, CP to On	2.0	5.1	2.0	5.3	ns
t_{PLH}		1.6	5.3	1.6	6.2	
t_{PZL}	Output Enable Time	1.8	5.0	1.8	6.0	ns
t_{PZH}		1.2	5.6	1.2	6.9	
t_{PLZ}	Output Disable Time	1.9	5.0	1.9 2.0	5.1	ns
t_{PHZ}		2.0	5.4		5.7	
t_S	Setup Time	1.8		2.0		ns
t_H	Hold Time	0.8		0.1		ns
t_W	Pulse Width	3.0		3.0		ns
t_{OSHL}	Output to Output Skew[8]		1.0		1.0	ns
t_{OSLH}			1.0		1.0	

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_{OSHL}) or LOW-to-HIGH (t_{OSLH}).

Capacitance[9]

Symbol	Parameter	Conditions	Typ.	Units
C_{IN}	Input Capacitance	V_{CC} = OPEN, V_I = 0V or V_{CC}	4	pF
C_{PD}	Power Dissipation Capacitance	V_{CC} = 3.0V, V_O = 0V or V_{CC}	8	pF

Note:

9. Capcitance is measured at frequency f = 1MHz, per MIL-STD-883, Method 3012.

Physical Dimensions

Dimensions are in millimeters unless otherwise noted.

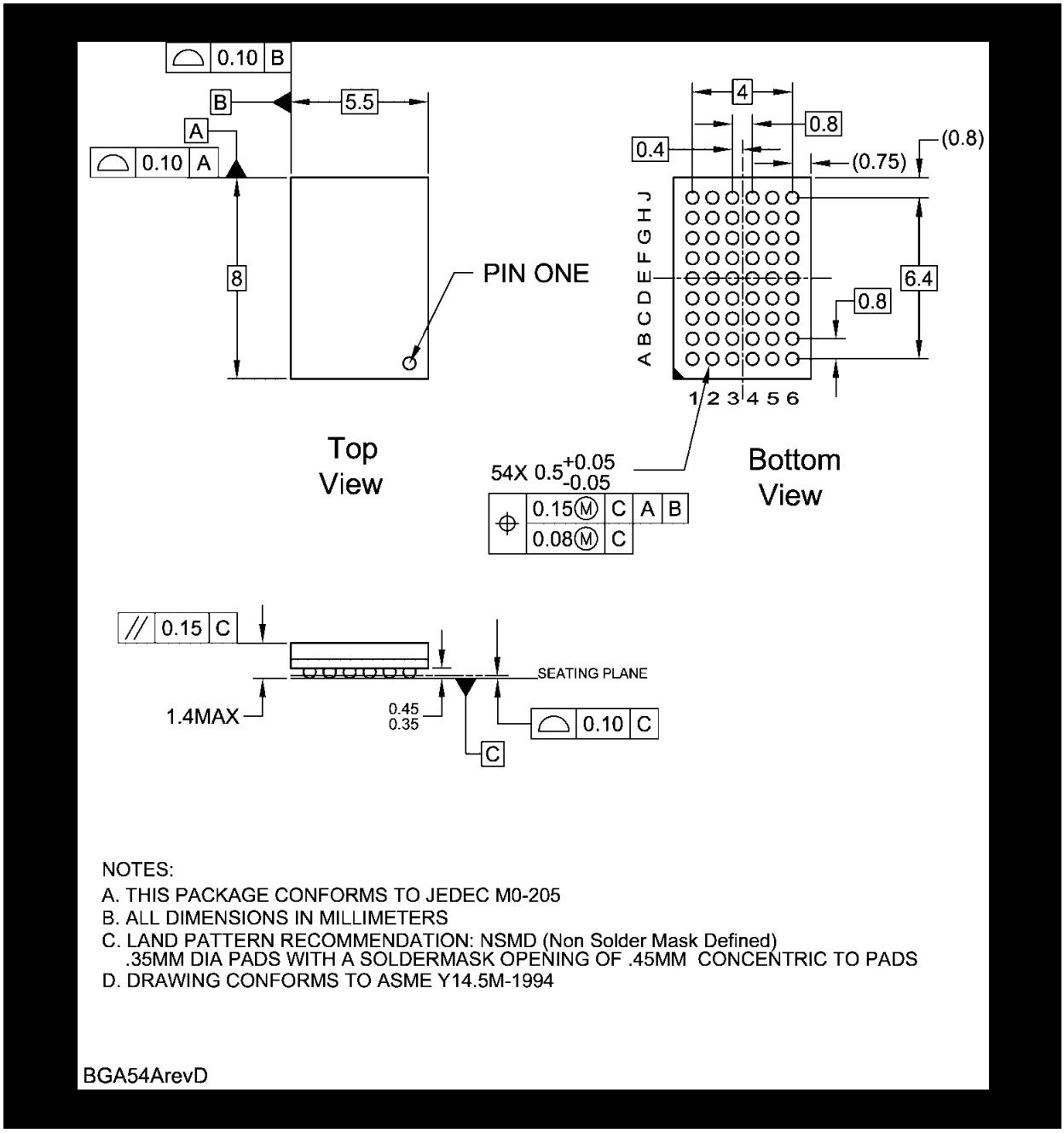


Figure 1. 54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
Package Number BGA54A
(Preliminary)

Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.

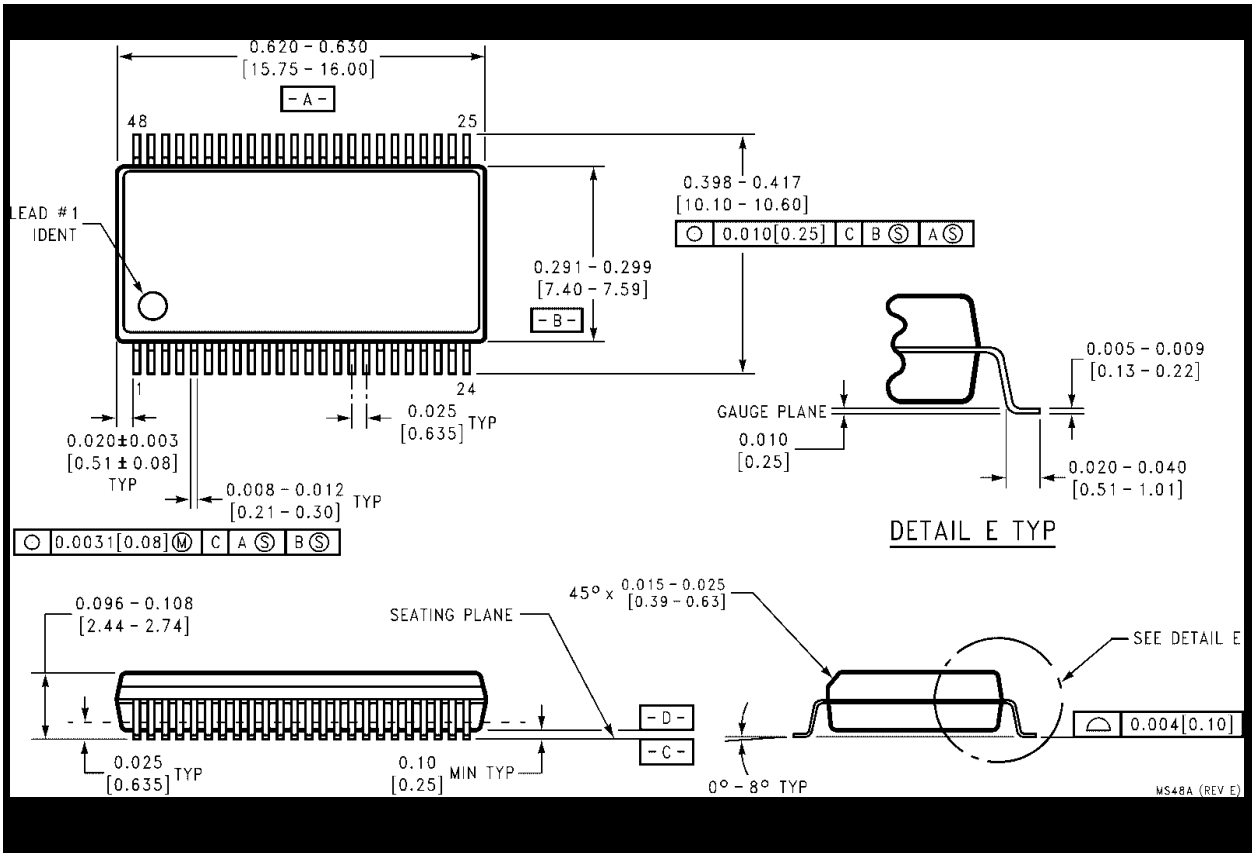


Figure 2. 48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
Package Number MS48A

Physical Dimensions (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

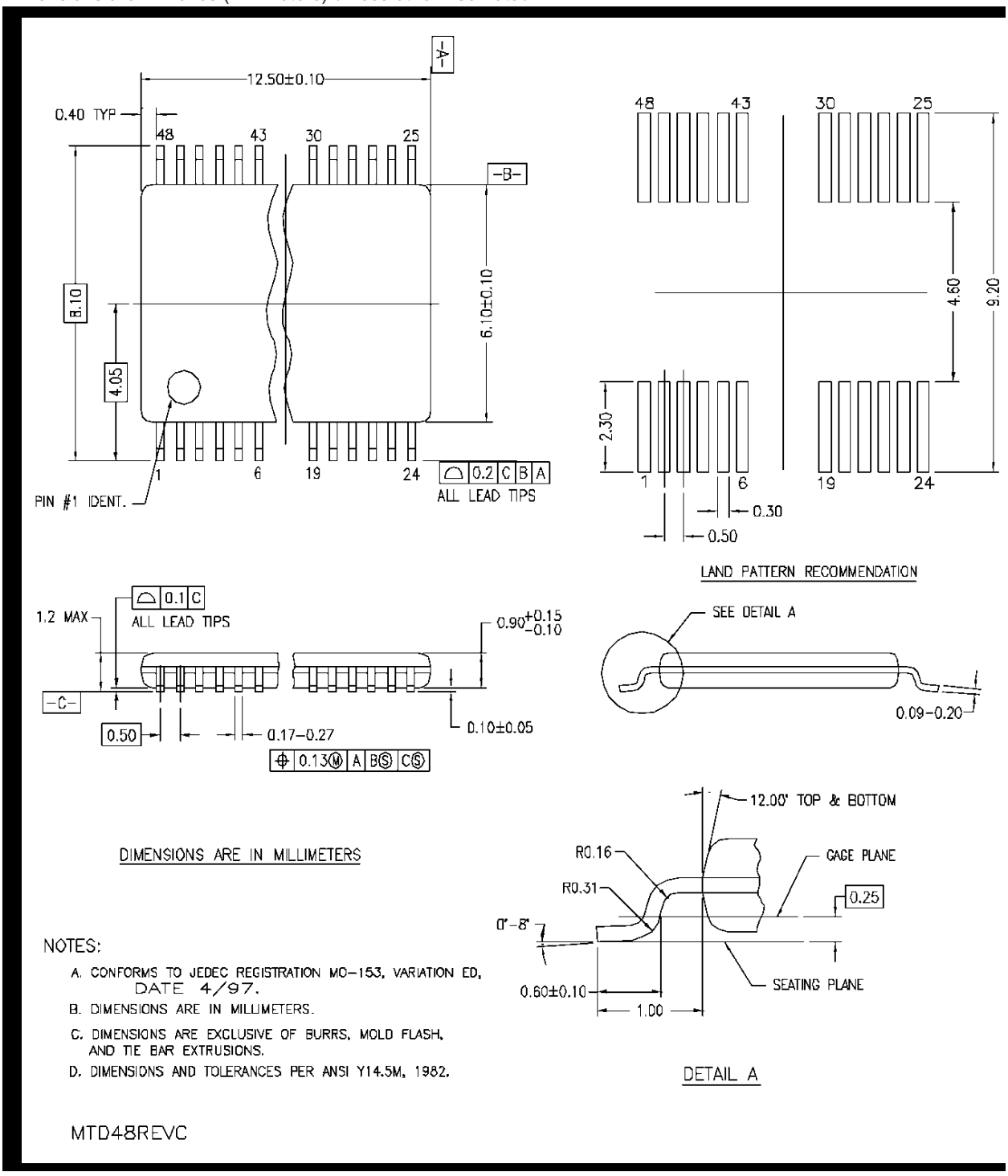


Figure 3. 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide
Package Number MDT48

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