FAIRCHILD SEMICONDUCTOR™

June 2005
Revised August 2024

# 74LCXR162245
# Low Voltage 16-Bit Bidirectional Transceiver with 5V Tolerant Inputs/Outputs and 26Ω Series Resistors in the Outputs

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## General Description

The LCXR162245 contains sixteen non-inverting bidirectional buffers with 3-STATE outputs and is intended for bus oriented applications. The device is designed for low voltage (2.5V or 3.3V) $V_{CC}$ applications with capability of interfacing to a 5V signal environment. The device is byte controlled. Each byte has separate control inputs which could be shorted together for full 16-bit operation. The T/$\overline{R}$ inputs determine the direction of data flow through the device. The $\overline{OE}$ inputs disable both the A and B ports by placing them in a high impedance state.

In addition, all A and B outputs include equivalent 26Ω (nominal) series resistors to reduce overshoot and undershoot and are designed to sink/source up to 12 mA at $V_{CC}$ = 3.0V.

The LCXR162245 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
- A and B side outputs have equivalent 26Ω series resistors
- 5.3 ns $t_{PD}$ max ($V_{CC}$ = 3V), 10 µA $I_{CC}$ max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- Flow through pinout
- Implements proprietary noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

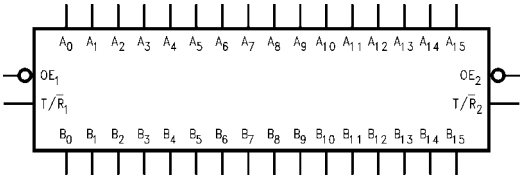
**Note 1:** To ensure the high-impedance state during power up or down $\overline{OE}$ should be tied to $V_{CC}$ through a pull-up resistor: the minimum value or the resistor is determined by the current-sourcing capability of the driver.

## Ordering Code:

| Order Number | Package Number | Package Description |
|---|---|---|
| 74LCXR162245MSA | MS48A | 48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide [RAIL] |
| 74LCXR162245MSX | MS48A | 48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide [TAPE and REEL] |
| 74LCXR162245MTD | MTD48 | 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide [RAIL] |
| 74LCXR162245MTX | MTD48 | 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide [TAPE and REEL] |

Devices also available in Tape and Reel. Specify by appending the suffix letter "x" to the ordering code.

## Logic Symbol



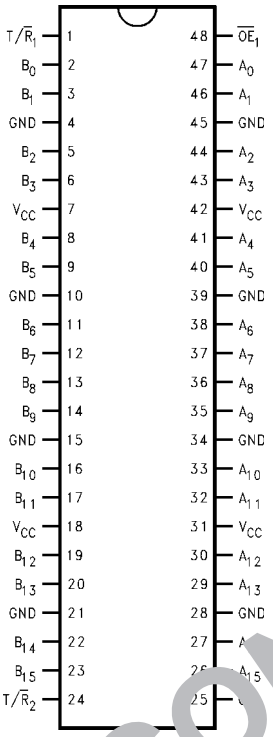

## Pin Descriptions

| Pin Names | Description |
|---|---|
| $\overline{OE}_n$ | Output Enable Input |
| T/$\overline{R}_n$ | Transmit/Receive Input |
| $A_0$–$A_{15}$ | Side A Inputs or 3-STATE Outputs |
| $B_0$–$B_{15}$ | Side B Inputs or 3-STATE Outputs |

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## Connection Diagram



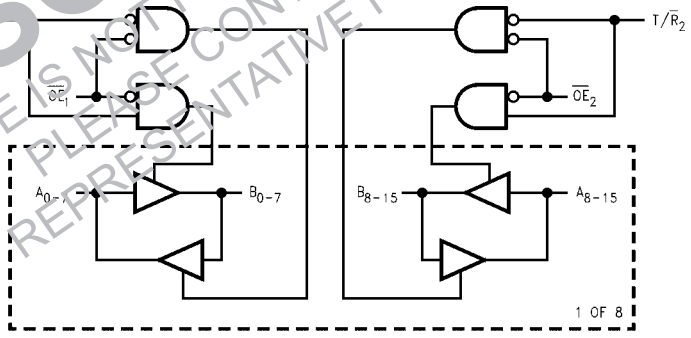

## Truth Tables

| Inputs | | Outputs |
|---|---|---|
| $\overline{OE}_1$ | $T/\overline{R}_1$ | |
| L | L | Bus $B_0$–$B_7$ Data to Bus $A_0$–$A_7$ |
| L | H | Bus $A_0$–$A_7$ Data to Bus $B_0$–$B_7$ |
| H | X | HIGH Z State on $A_0$–$A_7$, $B_0$–$B_7$ (Note 2) |

| Inputs | | Outputs |
|---|---|---|
| $\overline{OE}_2$ | $T/\overline{R}_2$ | |
| L | L | Bus $B_8$–$B_{15}$ Data to Bus $A_8$–$A_{15}$ |
| L | H | Bus $A_8$–$A_{15}$ Data to Bus $B_8$–$B_{15}$ |
| H | X | HIGH Z State on $A_8$–$A_{15}$, $B_8$–$B_{15}$ (Note 2) |

**Note 2:** A and B port inputs are still active

## Logic Diagram




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## 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 | −0.5 to +7.0 | | V |
| $V_O$ | DC Output Voltage | −0.5 to +7.0<br>−0.5 to $V_{CC}$ + 0.5 | Output in 3-STATE<br>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<br>+50 | $V_O$ < GND<br>$V_O$ > $V_{CC}$ | 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 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 | 5.5 | 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 | | ±12 | mA |
| | | $V_{CC}$ = 2.7V – 3.0V | | ±8 | |
| | | $V_{CC}$ = 2.3V – 2.7V | | ±4 | |
| $T_A$ | 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:** Unused pins (Inputs and I/O's) must be held HIGH or LOW. They may not Float.

## 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 I/O Leakage | 0 ≤ $V_O$ ≤ 5.5V | 2.3 – 3.6 | | ±5.0 | μA |
| | | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | |

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## 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 6) | 2.3 – 3.6 | | ±20 | |
| $\Delta I_{CC}$ | 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.

## AC Electrical Characteristics

| Symbol | Parameter | $T_A = -40°C$ to $+85°C$, $R_L = 500\Omega$ | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | $V_{CC} = 3.3V \pm 0.3V$ | | $V_{CC} = 2.7V$ | | $V_{CC} = 2.5V \pm 0.2$ | | |
| | | $C_L = 50$ pF | | $C_L = 50$ pF | | $C_L = 30$ pF | | |
| | | Min | Max | Min | Max | Min | Max | |
| $t_{PHL}$ | Propagation Delay | 1.5 | 5.3 | 1.5 | 6.0 | 1.5 | 6.4 | ns |
| $t_{PLH}$ | $A_n$ to $B_n$ or $B_n$ to $A_n$ | 1.5 | 5.3 | 1.5 | 6.0 | 1.5 | 6.4 | |
| $t_{PZL}$ | Output Enable Time | 1.5 | 7.3 | 1.5 | 8.0 | 1.5 | 9.5 | ns |
| $t_{PZH}$ | | 1.5 | 7.3 | 1.5 | 8.0 | 1.5 | 9.5 | |
| $t_{PLZ}$ | Output Disable Time | 1.5 | 6.4 | 1.5 | 6.9 | 1.5 | 7.7 | ns |
| $t_{PHZ}$ | | 1.5 | 6.4 | 1.5 | 6.9 | 1.5 | 7.7 | |
| $t_{OSHL}$ | Output to Output Skew (Note 7) | | 1.0 | | | | | ns |
| $t_{OSLH}$ | | | 1.0 | | | | | |

**Note 7:** 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 ($t_{OSLH}$). 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 | 0.35 | 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 |
| $C_{I/O}$ | Input/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 |

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## AC LOADING and WAVEFORMS Generic for LCX Family

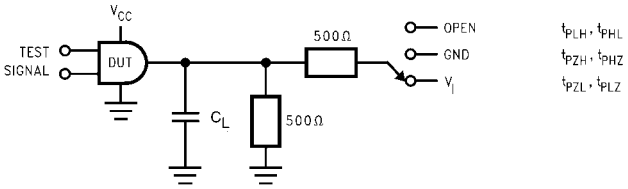
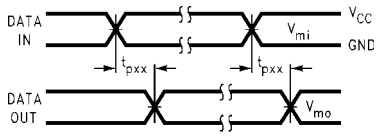
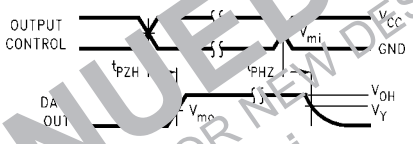



**FIGURE 1. AC Test Circuit ($C_L$ includes probe and jig capacitance)**

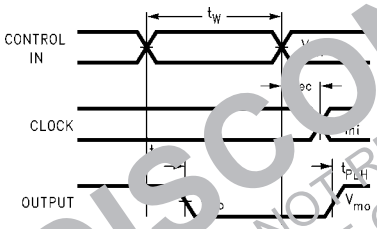
| Test | Switch |
|---|---|
| $t_{PLH}$, $t_{PHL}$ | Open |
| $t_{PZL}$, $t_{PLZ}$ | 6V at $V_{CC}$ = 3.3 ± 0.3V<br>$V_{CC}$ x 2 at $V_{CC}$ = 2.5 ± 0.2V |
| $t_{PZH}$,$t_{PHZ}$ | GND |



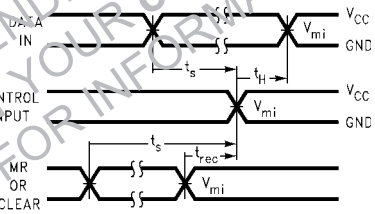

**Waveform for Inverting and Non-Inverting Functions**



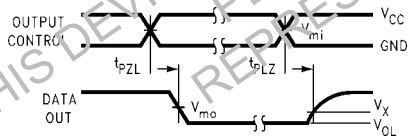

**3-STATE Output High Enable and Disable Times for Logic**



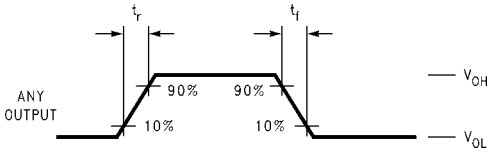

**Propagation Delay, Pulse Width and $t_{rec}$ Waveforms**




**Setup Time, Hold Time and Recovery Time for Logic**




**3-STATE Output Low Enable and Disable Times for Logic**



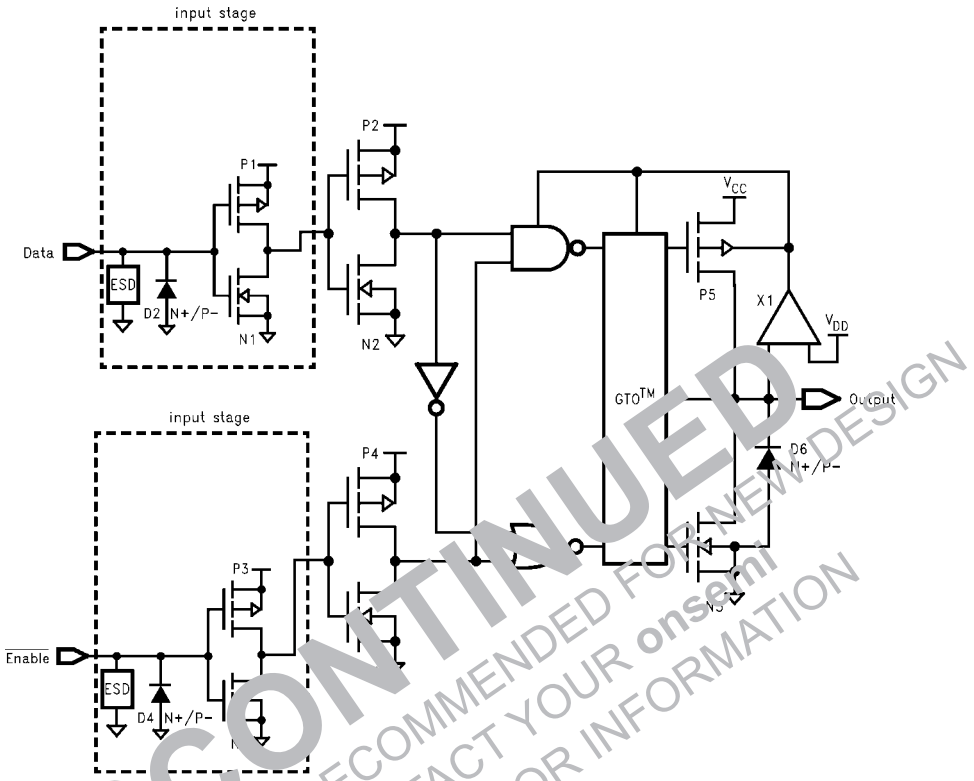

**$t_{rise}$ and $t_{fall}$**

**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 |

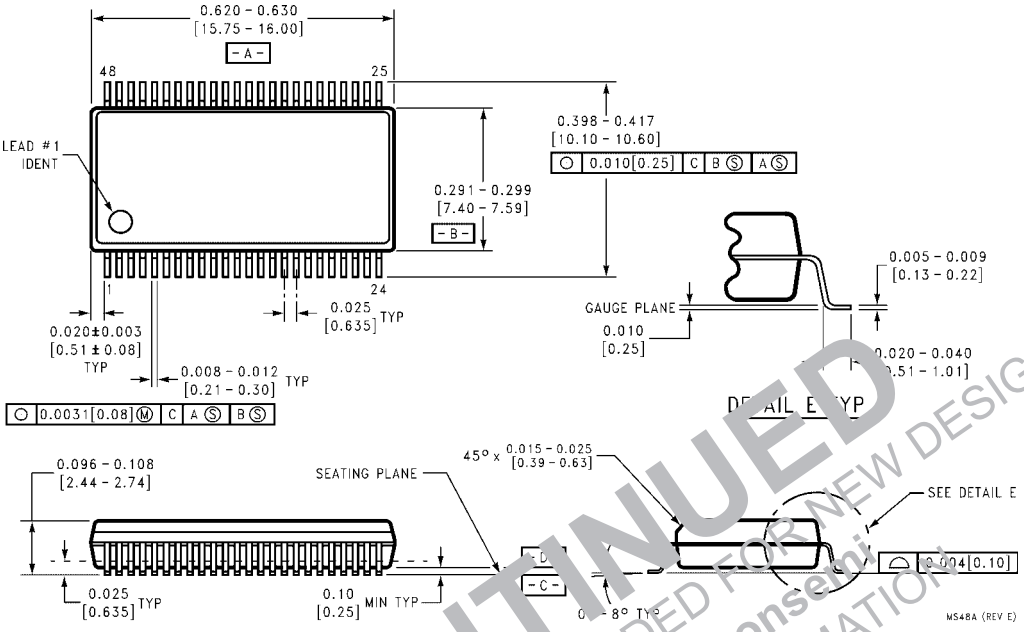
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## Schematic Diagram Generic for LCX Family




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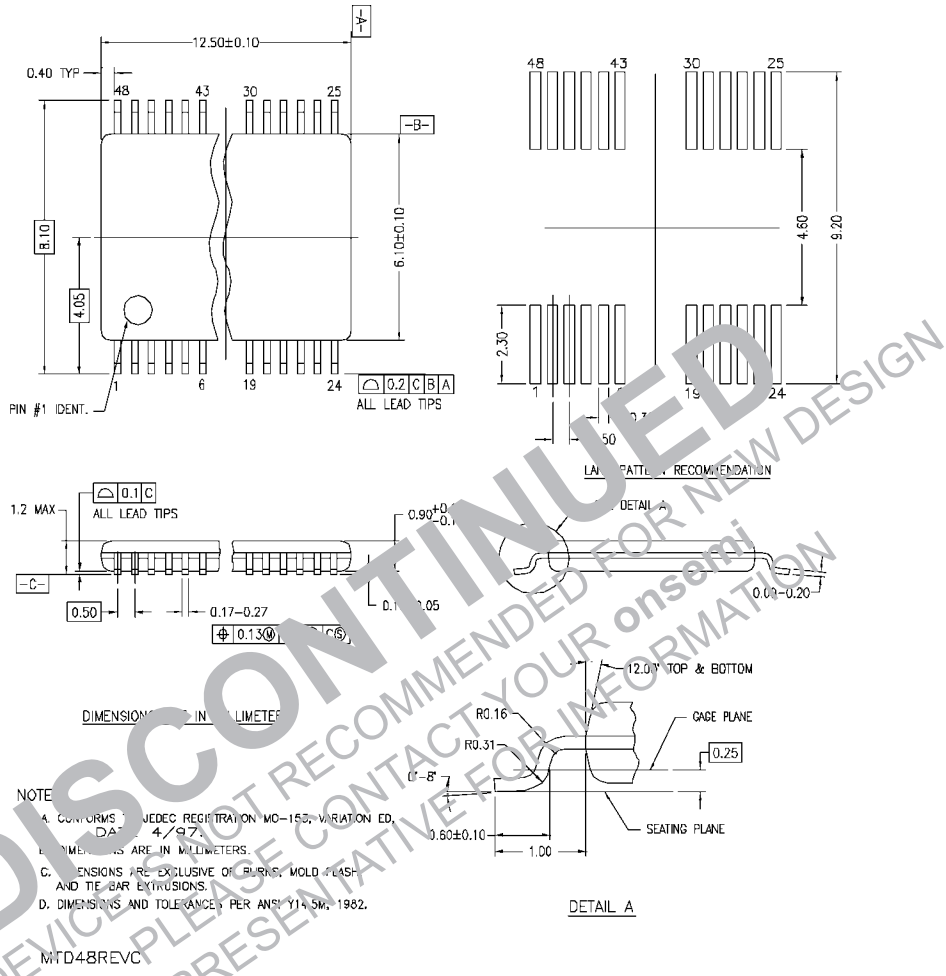
## Physical Dimensions inches (millimeters) unless otherwise noted




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

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## 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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