

**FAIRCHILD**  
SEMICONDUCTOR™

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## 74VCXH16240

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

#### General Description

The VCXH16240 contains sixteen inverting buffers with 3-STATE outputs to be employed as a memory and address driver, clock driver, or bus oriented transmitter/receiver. The device is nibble (4-bit) controlled. Each nibble has separate 3-STATE control inputs which can be shorted together for full 16-bit operation.

The VCXH16240 data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating inputs at a valid logic level.

The 74VCXH16240 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications with output capability up to 3.6V.

The 74VCXH16240 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

#### Features

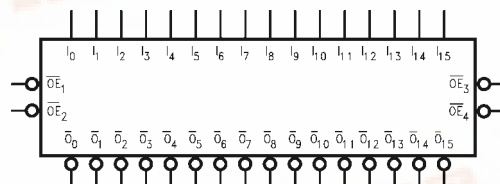
- 1.65V–3.6V  $V_{CC}$  supply operation
- 3.6V tolerant control inputs and outputs
- Bushold on data inputs eliminates the need for external pull-up/pull-down resistors
- $t_{PD}$ 
  - 2.5 ns max for 3.0V to 3.6V  $V_{CC}$
  - 3.0 ns max for 2.3V to 2.7V  $V_{CC}$
  - 6.0 ns max for 1.65V to 1.95V  $V_{CC}$
- Static Drive ( $I_{OH}/I_{OL}$ )
  - ±24 mA @ 3.0V  $V_{CC}$
  - ±18 mA @ 2.3V  $V_{CC}$
  - ±6 mA @ 1.65V  $V_{CC}$
- Uses patented noise/EMI reduction circuitry
- Latch-up performance exceeds 300 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

#### Ordering Code:

| Order Number   | Package Number | Package Descriptions                                                        |
|----------------|----------------|-----------------------------------------------------------------------------|
| 74VCXH16240MTD | MTD48          | 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

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

#### Logic Symbol



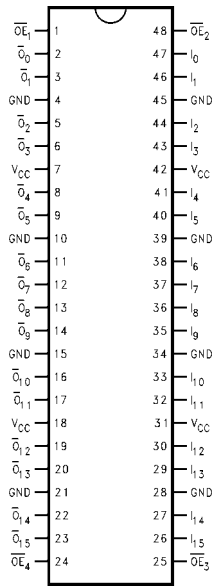
#### Pin Descriptions

| Pin Names                              | Description                      |
|----------------------------------------|----------------------------------|
| $\overline{OE}_n$                      | Output Enable Input (Active LOW) |
| $I_0$ – $I_{15}$                       | Bushold Inputs                   |
| $\overline{O}_0$ – $\overline{O}_{15}$ | Outputs                          |

74VCXH16240 Low Voltage 16-Bit Inverting Buffer/Line Driver



### Connection Diagram



### Truth Tables

| Inputs            |           | Outputs                         |
|-------------------|-----------|---------------------------------|
| $\overline{OE_1}$ | $I_0-I_3$ | $\overline{O_0}-\overline{O_3}$ |
| L                 | L         | H                               |
| L                 | H         | L                               |
| H                 | X         | Z                               |

| Inputs            |           | Outputs                         |
|-------------------|-----------|---------------------------------|
| $\overline{OE_2}$ | $I_4-I_7$ | $\overline{O_4}-\overline{O_7}$ |
| L                 | L         | H                               |
| L                 | H         | L                               |
| H                 | X         | Z                               |

| Inputs            |              | Outputs                            |
|-------------------|--------------|------------------------------------|
| $\overline{OE_3}$ | $I_8-I_{11}$ | $\overline{O_8}-\overline{O_{11}}$ |
| L                 | L            | H                                  |
| L                 | H            | L                                  |
| H                 | X            | Z                                  |

| Inputs            |                 | Outputs                               |
|-------------------|-----------------|---------------------------------------|
| $\overline{OE_4}$ | $I_{12}-I_{15}$ | $\overline{O_{12}}-\overline{O_{15}}$ |
| L                 | L               | H                                     |
| L                 | H               | L                                     |
| H                 | X               | Z                                     |

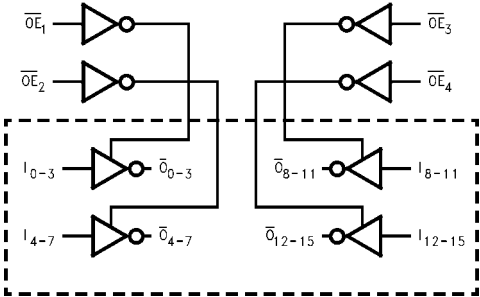
H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial (HIGH or LOW, inputs may not float)  
 Z = High Impedance

### Functional Description

The 74VCXH16240 contains sixteen inverting buffers with 3-STATE outputs. The device is nibble (4 bits) controlled with each nibble functioning identically, but independent of each other. The control pins may be shorted together to obtain full 16-bit operation. The 3-STATE outputs are con-

trolled by an Output Enable ( $\overline{OE_n}$ ) input. When  $\overline{OE_n}$  is LOW, the outputs are in the 2-state mode. When  $\overline{OE_n}$  is HIGH, the standard 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 1)

|                                                              |                          |
|--------------------------------------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )                                  | –0.5V to +4.6V           |
| DC Input Voltage ( $V_I$ )                                   |                          |
| $\overline{OE}_n$                                            | –0.5V to 4.6V            |
| $I_O - I_{15}$                                               | –0.5V to $V_{CC} + 0.5V$ |
| Output Voltage ( $V_O$ )                                     |                          |
| Outputs 3-STATED                                             | –0.5V to +4.6V           |
| Outputs Active (Note 2)                                      | –0.5V to $V_{CC} + 0.5V$ |
| DC Input Diode Current ( $I_{IK}$ )                          |                          |
| $V_I < 0V$                                                   | –50 mA                   |
| DC Output Diode Current ( $I_{OK}$ )                         |                          |
| $V_O < 0V$                                                   | –50 mA                   |
| $V_O > V_{CC}$                                               | +50 mA                   |
| DC Output Source/Sink Current ( $I_{OH}/I_{OL}$ )            | ±50 mA                   |
| DC $V_{CC}$ or GND Current per Supply Pin ( $I_{CC}$ or GND) | ±100 mA                  |
| Storage Temperature Range ( $T_{STG}$ )                      | –65°C to +150°C          |

**Recommended Operating Conditions** (Note 3)

|                                                 |                   |
|-------------------------------------------------|-------------------|
| Power Supply                                    |                   |
| Operating                                       | 1.65V to 3.6V     |
| Data Retention Only                             | 1.2V to 3.6V      |
| Input Voltage                                   | –0.3V to $V_{CC}$ |
| Output Voltage ( $V_O$ )                        |                   |
| Output in Active States                         | 0V to $V_{CC}$    |
| Output in 3-STATE                               | 0.0V to 3.6V      |
| Output Current in $I_{OH}/I_{OL}$               |                   |
| $V_{CC} = 3.0V$ to 3.6V                         | ±24 mA            |
| $V_{CC} = 2.3V$ to 2.7V                         | ±18 mA            |
| $V_{CC} = 1.65V$ to 2.3V                        | ±6 mA             |
| Free Air Operating Temperature ( $T_A$ )        | –40°C to +85°C    |
| Minimum Input Edge Rate ( $\Delta t/\Delta V$ ) |                   |
| $V_{IN} = 0.8V$ to 2.0V, $V_{CC} = 3.0V$        | 10 ns/V           |

**Note 1:** 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 2:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 3:** Floating or unused control inputs must be held HIGH or LOW.

**DC Electrical Characteristics** ( $2.7V < V_{CC} \leq 3.6V$ )

| Symbol               | Parameter                                        |              | Conditions                                                                       | V <sub>CC</sub><br>(V) | Min                   | Max  | Units |
|----------------------|--------------------------------------------------|--------------|----------------------------------------------------------------------------------|------------------------|-----------------------|------|-------|
| V <sub>IH</sub>      | HIGH Level Input Voltage                         |              |                                                                                  | 2.7 – 3.6              | 2.0                   |      | V     |
| V <sub>IL</sub>      | LOW Level Input Voltage                          |              |                                                                                  | 2.7 – 3.6              |                       | 0.8  | V     |
| V <sub>OH</sub>      | HIGH Level Output Voltage                        |              | I <sub>OH</sub> = –100 μA                                                        | 2.7 – 3.6              | V <sub>CC</sub> – 0.2 |      | V     |
|                      |                                                  |              | I <sub>OH</sub> = –12 mA                                                         | 2.7                    | 2.2                   |      | V     |
|                      |                                                  |              | I <sub>OH</sub> = –18 mA                                                         | 3.0                    | 2.4                   |      | V     |
|                      |                                                  |              | I <sub>OH</sub> = –24 mA                                                         | 3.0                    | 2.2                   |      | V     |
| V <sub>OL</sub>      | LOW Level Output Voltage                         |              | I <sub>OL</sub> = 100 μA                                                         | 2.7 – 3.6              |                       | 0.2  | V     |
|                      |                                                  |              | I <sub>OL</sub> = 12 mA                                                          | 2.7                    |                       | 0.4  | V     |
|                      |                                                  |              | I <sub>OL</sub> = 18 mA                                                          | 3.0                    |                       | 0.4  | V     |
|                      |                                                  |              | I <sub>OL</sub> = 24 mA                                                          | 3.0                    |                       | 0.55 | V     |
| I <sub>I</sub>       | Input Leakage Current                            | Control Pins | 0 ≤ V <sub>I</sub> ≤ 3.6V                                                        | 2.7 – 3.6              |                       | ±5.0 | μA    |
|                      |                                                  | Data Pins    | V <sub>I</sub> = V <sub>CC</sub> or GND                                          | 2.7 – 3.6              |                       | ±5.0 | μA    |
| I <sub>I(HOLD)</sub> | Bushold Input Minimum Drive Hold Current         |              | V <sub>IN</sub> = 0.8V                                                           | 3.0                    | 75                    |      | μA    |
|                      |                                                  |              | V <sub>IN</sub> = 2.0V                                                           | 3.0                    | –75                   |      |       |
| I <sub>I(OD)</sub>   | Bushold Input Over-Drive Current to Change State |              | (Note 4)                                                                         | 3.6                    | 450                   |      | μA    |
|                      |                                                  |              | (Note 5)                                                                         | 3.6                    | –450                  |      |       |
| I <sub>OZ</sub>      | 3-STATE Output Leakage                           |              | 0 ≤ V <sub>O</sub> ≤ 3.6V<br>V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> | 2.7 – 3.6              |                       | ±10  | μA    |
| I <sub>OFF</sub>     | Power-OFF Leakage Current                        |              | 0 ≤ (V <sub>O</sub> ) ≤ 3.6V                                                     | 0                      |                       | 10   | μA    |
| I <sub>CC</sub>      | Quiescent Supply Current                         |              | V <sub>I</sub> = V <sub>CC</sub> or GND                                          | 2.7 – 3.6              |                       | 20   | μA    |
|                      |                                                  |              | V <sub>CC</sub> ≤ (V <sub>O</sub> ) ≤ 3.6V (Note 6)                              | 2.7 – 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                                         | 2.7 – 3.6              |                       | 750  | μA    |

**Note 4:** An external driver must source at least the specified current to switch from LOW-to-HIGH.

**Note 5:** An external driver must source at least the specified current to switch from HIGH-to-LOW.

**Note 6:** Outputs disabled or 3-STATE only.

### DC Electrical Characteristics ( $2.3V \leq V_{CC} \leq 2.7V$ )

| Symbol        | Parameter                                        |              | Conditions                                           | $V_{CC}$<br>(V) | Min            | Max       | Units   |
|---------------|--------------------------------------------------|--------------|------------------------------------------------------|-----------------|----------------|-----------|---------|
| $V_{IH}$      | HIGH Level Input Voltage                         |              |                                                      | 2.3 – 2.7       | 1.6            |           | V       |
| $V_{IL}$      | LOW Level Input Voltage                          |              |                                                      | 2.3 – 2.7       |                | 0.7       | V       |
| $V_{OH}$      | HIGH Level Output Voltage                        |              | $I_{OH} = -100 \mu A$                                | 2.3 – 2.7       | $V_{CC} - 0.2$ |           | V       |
|               |                                                  |              | $I_{OH} = -6 \text{ mA}$                             | 2.3             | 2.0            |           | V       |
|               |                                                  |              | $I_{OH} = -12 \text{ mA}$                            | 2.3             | 1.8            |           | V       |
|               |                                                  |              | $I_{OH} = -18 \text{ mA}$                            | 2.3             | 1.7            |           | V       |
| $V_{OL}$      | LOW Level Output Voltage                         |              | $I_{OL} = 100 \mu A$                                 | 2.3 – 2.7       |                | 0.2       | V       |
|               |                                                  |              | $I_{OL} = 12 \text{ mA}$                             | 2.3             |                | 0.4       | V       |
|               |                                                  |              | $I_{OL} = 18 \text{ mA}$                             | 2.3             |                | 0.6       | V       |
| $I_I$         | Input Leakage Current                            | Control Pins | $0 \leq V_I \leq 3.6V$                               | 2.3 – 2.7       |                | $\pm 5.0$ | $\mu A$ |
|               |                                                  | Data Pins    | $V_I = V_{CC}$ or GND                                | 2.3 – 2.7       |                | $\pm 5.0$ | $\mu A$ |
| $I_{I(HOLD)}$ | Bushold Input Minimum Drive Hold Current         |              | $V_{IN} = 0.7V$                                      | 2.3             | 45             |           | $\mu A$ |
|               |                                                  |              | $V_{IN} = 1.6V$                                      | 2.3             | -45            |           |         |
| $I_{I(OD)}$   | Bushold Input Over-Drive Current to Change State |              | (Note 7)                                             | 2.7             | 300            |           | $\mu A$ |
|               |                                                  |              | (Note 8)                                             | 2.7             | -300           |           |         |
| $I_{OZ}$      | 3-STATE Output Leakage                           |              | $0 \leq V_O \leq 3.6V$<br>$V_I = V_{IH}$ or $V_{IL}$ | 2.3 – 2.7       |                | $\pm 10$  | $\mu A$ |
| $I_{OFF}$     | Power-OFF Leakage Current                        |              | $0 \leq (V_O) \leq 3.6V$                             | 0               |                | 10        | $\mu A$ |
| $I_{CC}$      | Quiescent Supply Current                         |              | $V_I = V_{CC}$ or GND                                | 2.3 – 2.7       |                | 20        | $\mu A$ |
|               |                                                  |              | $V_{CC} \leq (V_O) \leq 3.6V$ (Note 9)               | 2.3 – 2.7       |                | $\pm 20$  | $\mu A$ |

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

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

**Note 9:** Outputs disabled or 3-STATE only.

### DC Electrical Characteristics ( $1.65V \leq V_{CC} < 2.3V$ )

| Symbol        | Parameter                                        |              | Conditions                                           | $V_{CC}$<br>(V) | Min                  | Max                  | Units   |
|---------------|--------------------------------------------------|--------------|------------------------------------------------------|-----------------|----------------------|----------------------|---------|
| $V_{IH}$      | HIGH Level Input Voltage                         |              |                                                      | 1.65 - 2.3      | $0.65 \times V_{CC}$ |                      | V       |
| $V_{IL}$      | LOW Level Input Voltage                          |              |                                                      | 1.65 - 2.3      |                      | $0.35 \times V_{CC}$ | V       |
| $V_{OH}$      | HIGH Level Output Voltage                        |              | $I_{OH} = -100 \mu A$                                | 1.65 - 2.3      | $V_{CC} - 0.2$       |                      | V       |
|               |                                                  |              | $I_{OH} = -6 \text{ mA}$                             | 1.65            | 1.25                 |                      | V       |
| $V_{OL}$      | LOW Level Output Voltage                         |              | $I_{OL} = 100 \mu A$                                 | 1.65 - 2.3      |                      | 0.2                  | V       |
|               |                                                  |              | $I_{OL} = 6 \text{ mA}$                              | 1.65            |                      | 0.3                  | V       |
| $I_I$         | Input Leakage Current                            | Control Pins | $0 \leq V_I \leq 3.6V$                               | 1.65 - 2.3      |                      | $\pm 5.0$            | $\mu A$ |
|               |                                                  | Data Pins    | $V_I = V_{CC}$ or GND                                | 1.65 - 2.3      |                      | $\pm 5.0$            | $\mu A$ |
| $I_{I(HOLD)}$ | Bushold Input Minimum Drive Hold Current         |              | $V_{IN} = 0.57V$                                     | 1.65            | 25                   |                      | $\mu A$ |
|               |                                                  |              | $V_{IN} = 1.07V$                                     | 1.65            | -25                  |                      |         |
| $I_{I(OD)}$   | Bushold Input Over-Drive Current to Change State |              | (Note 10)                                            | 1.95            | 200                  |                      | $\mu A$ |
|               |                                                  |              | (Note 11)                                            | 1.95            | -200                 |                      |         |
| $I_{OZ}$      | 3-STATE Output Leakage                           |              | $0 \leq V_O \leq 3.6V$<br>$V_I = V_{IH}$ or $V_{IL}$ | 1.65 - 2.3      |                      | $\pm 10$             | $\mu A$ |
| $I_{OFF}$     | Power-OFF Leakage Current                        |              | $0 \leq (V_O) \leq 3.6V$                             | 0               |                      | 10                   | $\mu A$ |
| $I_{CC}$      | Quiescent Supply Current                         |              | $V_I = V_{CC}$ or GND                                | 1.65 - 2.3      |                      | 20                   | $\mu A$ |
|               |                                                  |              | $V_{CC} \leq (V_O) \leq 3.6V$ (Note 12)              | 1.65 - 2.3      |                      | $\pm 20$             | $\mu A$ |

**Note 10:** An external driver must source at least the specified current to switch from LOW-to-HIGH.

**Note 11:** An external driver must source at least the specified current to switch from HIGH-to-LOW.

**Note 12:** Outputs disabled or 3-STATE only.

**AC Electrical Characteristics** (Note 13)

| Symbol                                 | Parameter                          | T <sub>A</sub> = -40°C to +85°C, C <sub>L</sub> = 30 pF, R <sub>L</sub> = 500Ω |     |                               |     |                                |      | Units |
|----------------------------------------|------------------------------------|--------------------------------------------------------------------------------|-----|-------------------------------|-----|--------------------------------|------|-------|
|                                        |                                    | V <sub>CC</sub> = 3.3V ± 0.3V                                                  |     | V <sub>CC</sub> = 2.5V ± 0.2V |     | V <sub>CC</sub> = 1.8V ± 0.15V |      |       |
|                                        |                                    | Min                                                                            | Max | Min                           | Max | Min                            | Max  |       |
| t <sub>PHL</sub> , t <sub>PLH</sub>    | Prop Delay                         | 0.8                                                                            | 2.5 | 1.0                           | 3.0 | 1.5                            | 6.0  | ns    |
| t <sub>PZL</sub> , t <sub>PZH</sub>    | Output Enable Time                 | 0.8                                                                            | 3.5 | 1.0                           | 4.1 | 1.5                            | 8.2  | ns    |
| t <sub>PLZ</sub> , t <sub>PHZ</sub>    | Output Disable Time                | 0.8                                                                            | 3.5 | 1.0                           | 3.8 | 1.5                            | 6.8  | ns    |
| t <sub>OSHL</sub><br>t <sub>OSLH</sub> | Output to Output Skew<br>(Note 14) |                                                                                | 0.5 |                               | 0.5 |                                | 0.75 | ns    |

**Note 13:** For  $C_L = 50\text{ pF}$ , add approximately 300 ps to the AC maximum specification.

**Note 14:** 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 ( $t_{OSLH}$ ).

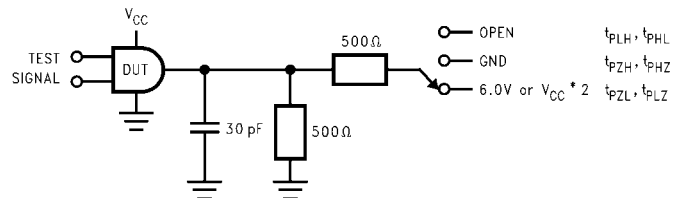
**Dynamic Switching Characteristics**

| Symbol    | Parameter                            | Conditions                                         | $V_{CC}$<br>(V)   | $T_A = +25^{\circ}\text{C}$ | Units |
|-----------|--------------------------------------|----------------------------------------------------|-------------------|-----------------------------|-------|
|           |                                      |                                                    |                   | Typical                     |       |
| $V_{OLP}$ | Quiet Output Dynamic Peak $V_{OL}$   | $C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$ | 1.8<br>2.5<br>3.3 | 0.25<br>0.6<br>0.8          | V     |
| $V_{OLV}$ | Quiet Output Dynamic Valley $V_{OL}$ | $C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$ | 1.8<br>2.5<br>3.3 | -0.25<br>-0.6<br>-0.8       | V     |
| $V_{OHV}$ | Quiet Output Dynamic Valley $V_{OH}$ | $C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$ | 1.8<br>2.5<br>3.3 | 1.5<br>1.9<br>2.2           | V     |

**Capacitance**

| Symbol    | Parameter                     | Conditions                                                                             | $T_A = +25^{\circ}\text{C}$ | Units |
|-----------|-------------------------------|----------------------------------------------------------------------------------------|-----------------------------|-------|
|           |                               |                                                                                        | Typical                     |       |
| $C_{IN}$  | Input Capacitance             | $V_{CC} = 1.8, 2.5V \text{ or } 3.3V, V_I = 0V \text{ or } V_{CC}$                     | 6                           | pF    |
| $C_{OUT}$ | Output Capacitance            | $V_I = 0V \text{ or } V_{CC}, V_{CC} = 1.8V, 2.5V \text{ or } 3.3V$                    | 7                           | pF    |
| $C_{PD}$  | Power Dissipation Capacitance | $V_I = 0V \text{ or } V_{CC}, f = 10\text{ MHz}, V_{CC} = 1.8V, 2.5V \text{ or } 3.3V$ | 20                          | pF    |

## AC Loading and Waveforms



| TEST               | SWITCH                                                                                          |
|--------------------|-------------------------------------------------------------------------------------------------|
| $t_{PLH}, t_{PHL}$ | Open                                                                                            |
| $t_{PZL}, t_{PLZ}$ | 6V at $V_{CC} = 3.3 \pm 0.3V$ ;<br>$V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V, 1.8V \pm 0.15V$ |
| $t_{PZH}, t_{PHZ}$ | GND                                                                                             |

FIGURE 1. AC Test Circuit

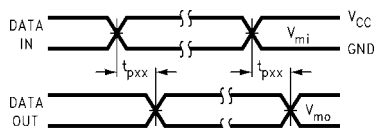


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

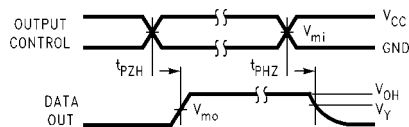


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

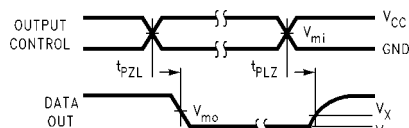
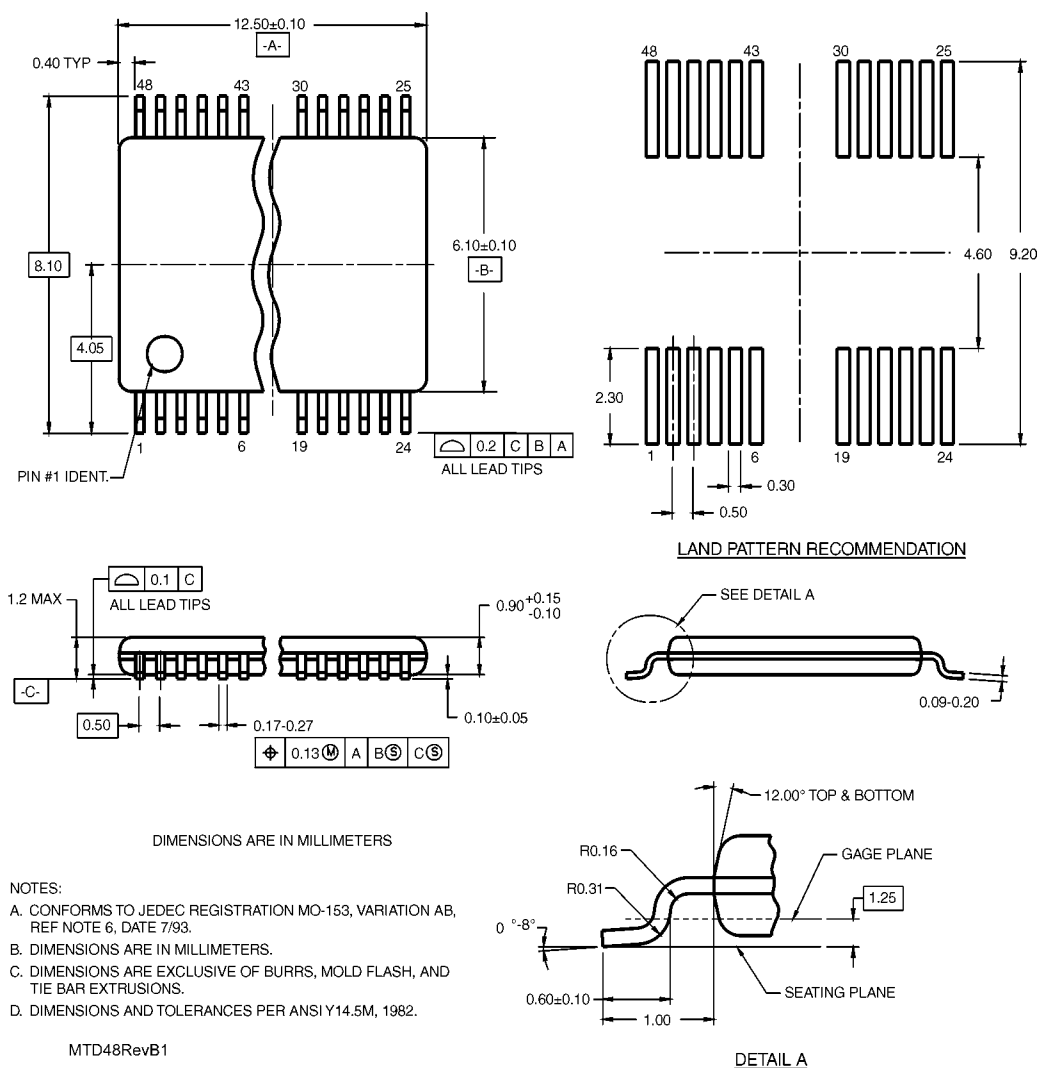


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

| Symbol   | $V_{CC}$        |                  |                  |
|----------|-----------------|------------------|------------------|
|          | $3.3V \pm 0.3V$ | $2.5V \pm 0.2V$  | $1.8V \pm 0.15V$ |
| $V_{mi}$ | 1.5V            | $V_{CC}/2$       | $V_{CC}/2$       |
| $V_{mo}$ | 1.5V            | $V_{CC}/2$       | $V_{CC}/2$       |
| $V_X$    | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ | $V_{OL} + 0.15V$ |
| $V_Y$    | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ | $V_{OH} - 0.15V$ |

# Physical Dimensions inches (millimeters) unless otherwise noted



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