FAIRCHILD SEMICONDUCTOR™

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# 74VCX245
# Low Voltage Bidirectional Transceiver with 3.6V Tolerant Inputs and Outputs

## General Description

The VCX245 contains eight non-inverting bidirectional buffers with 3-STATE outputs and is intended for bus oriented applications. The T/$\overline{R}$ input determines the direction of data flow. The $\overline{OE}$ input disables both the A and B ports by placing them in a high impedance state.

The 74VCX245 is designed for low voltage (1.4V to 3.6V) $V_{CC}$ applications with I/O compatibility up to 3.6V.

The 74VCX245 is fabricated with an advanced CMOS technology to achieve high-speed operation while maintaining low CMOS power dissipation.

## Features

- 1.4V to 3.6V $V_{CC}$ supply operation
- 3.6V tolerant inputs and outputs
- Power-off high impedance inputs and outputs
- Supports Live Insertion and Withdrawal (Note 1)
- $t_{PD}$
  3.5 ns max for 3.0V to 3.6V $V_{CC}$
- Static Drive ($I_{OH}/I_{OL}$)
  ±24 mA @ 3.0V $V_{CC}$
- Uses patented noise/EMI reduction circuitry
- Latchup performance exceeds 300 mA
- ESD performance:
  Human body model > 2000V
  Machine model > 200V

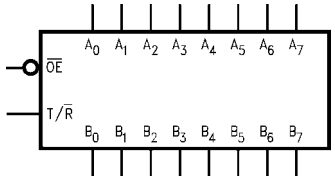
**Note 1:** To ensure the high impedance state during power up and power down, $\overline{OE}_n$ should be tied to $V_{CC}$ through a pull up resistor. The minimum value of the resistor is determined by the current sourcing capability of the driver.

## Ordering Code:

| Order Number | Package Number | Package Description |
|---|---|---|
| 74VCX245WM | M20B | 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74VCX245MTC | MTC20 | 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |

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

## Logic Symbol

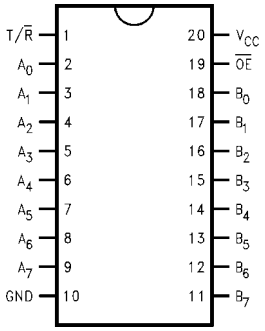



## Pin Descriptions

| Pin Names | Description |
|---|---|
| $\overline{OE}$ | Output Enable Input (Active LOW) |
| T/$\overline{R}$ | Transmit/Receive Input |
| $A_0$–$A_7$ | Side A Inputs or 3-STATE Outputs |
| $B_0$–$B_7$ | Side B Inputs or 3-STATE Outputs |

## Connection Diagram



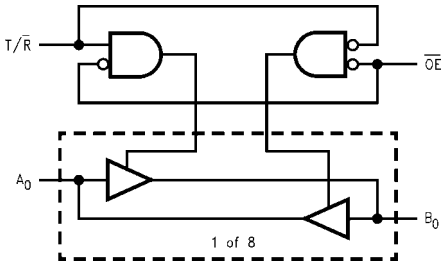

## Truth Table

| Inputs | | Outputs |
|---|---|---|
| $\overline{OE}$ | T/$\overline{R}$ | |
| 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) |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = High Impedance

**Note 2:** Unused bus terminals during HIGH Z State must be held HIGH or LOW.

## Logic Diagram



## Absolute Maximum Ratings (Note 3)

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | −0.5V to +4.6V |
| DC Input Voltage ($V_I$) | −0.5V to +4.6V |
| DC Output Voltage ($V_O$) | |
| Outputs 3-STATE | −0.5V to +4.6V |
| Outputs Active (Note 4) | −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 Ground Current | ±100 mA |
| Storage Temperature ($T_{STG}$) | −65°C to +150°C |

## Recommended Operating Conditions (Note 5)

| | |
|---|---|
| Power Supply | |
| Operating | 1.4V to 3.6V |
| Input Voltage | −0.3V to 3.6V |
| Output Voltage ($V_O$) | |
| Output in Active States | 0V to $V_{CC}$ |
| Output in 3-STATE | 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 |
| $V_{CC}$ = 1.4V to 1.6V | ±2 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 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 inputs must be held HIGH or LOW.

## DC Electrical Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | Min | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IH}$ | HIGH Level Input Voltage | | 2.7 - 3.6 | 2.0 | | V |
| | | | 2.3 - 2.7 | 1.6 | | |
| | | | 1.65 - 2.3 | 0.65 × $V_{CC}$ | | |
| | | | 1.4 - 1.6 | 0.65 × $V_{CC}$ | | |
| $V_{IL}$ | LOW Level Input Voltage | | 2.7–3.6 | | 0.8 | V |
| | | | 2.3–2.7 | | 0.7 | |
| | | | 1.65–2.3 | | 0.35 × $V_{CC}$ | |
| | | | 1.4 - 1.6 | | 0.35 × $V_{CC}$ | |
| $V_{OH}$ | HIGH Level Output Voltage | $I_{OH}$ = −100 µA | 2.7–3.6 | $V_{CC}$ − 0.2 | | V |
| | | $I_{OH}$ = −12 mA | 2.7 | 2.2 | | |
| | | $I_{OH}$ = −18 mA | 3.0 | 2.4 | | |
| | | $I_{OH}$ = −24 mA | 3.0 | 2.2 | | |
| | | $I_{OH}$ = −100 µA | 2.3–2.7 | $V_{CC}$ − 0.2 | | |
| | | $I_{OH}$ = −6 mA | 2.3 | 2.0 | | |
| | | $I_{OH}$ = −12 mA | 2.3 | 1.8 | | |
| | | $I_{OH}$ = −18 mA | 2.3 | 1.7 | | |
| | | $I_{OH}$ = −100 µA | 1.65–2.3 | $V_{CC}$ − 0.2 | | |
| | | $I_{OH}$ = −6 mA | 1.65 | 1.25 | | |
| | | $I_{OH}$ = −100 µA | 1.4 - 1.6 | $V_{CC}$ − 0.2 | | |
| | | $I_{OH}$ = −2 mA | 1.4 | 1.05 | | |

## DC Electrical Characteristics (Continued)

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | Min | Max | Units |
|---|---|---|---|---|---|---|
| $V_{OL}$ | LOW Level Output Voltage | $I_{OL}$ = 100 µA | 2.7–3.6 | | 0.2 | V |
| | | $I_{OL}$ = 12 mA | 2.7 | | 0.4 | |
| | | $I_{OL}$ = 18 mA | 3.0 | | 0.4 | |
| | | $I_{OL}$ = 24 mA | 3.0 | | 0.55 | |
| | | $I_{OL}$ = 100 µA | 2.3–2.7 | | 0.2 | |
| | | $I_{OL}$ = 12 mA | 2.3 | | 0.4 | |
| | | $I_{OL}$ = 18 mA | 2.3 | | 0.6 | |
| | | $I_{OL}$ = 100 µA | 1.65–2.3 | | 0.2 | |
| | | $I_{OL}$ = 6 mA | 1.65 | | 0.3 | |
| | | $I_{OL}$ = 100 µA | 1.4 - 1.6 | | 0.2 | |
| | | $I_{OL}$ = 2 mA | 1.4 | | 0.35 | |
| $I_I$ | Input Leakage Current | $0 \le V_I \le 3.6V$ | 1.4–3.6 | | ±5.0 | µA |
| $I_{OZ}$ | 3-STATE Output Leakage | $0 \le V_O \le 3.6V$<br>$V_I = V_{IH}$ or $V_{IL}$ | 1.4–3.6 | | ±10 | µA |
| $I_{OFF}$I | Power-OFF Leakage Current | $0 \le (V_I, V_O) \le 3.6V$ | 0 | | 10 | µA |
| $I_{CC}$ | Quiescent Supply Current | $V_I = V_{CC}$ or GND | 1.4–3.6 | | 20 | µA |
| | | $V_{CC} \le (V_I, V_O) \le 3.6V$ (Note 6) | 1.4–3.6 | | ±20 | |
| $\Delta I_{CC}$ | Increase in $I_{CC}$ per Input | $V_{IH} = V_{CC} - 0.6V$ | 2.7–3.6 | | 750 | µA |

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

## AC Electrical Characteristics (Note 7)

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A = -40°C$ to $+85°C$ | | Units | Figure Number |
|---|---|---|---|---|---|---|---|
| | | | | Min | Max | | |
| $t_{PHL}$, $t_{PLH}$ | Propagation Delay<br>$A_n$ to $B_n$ or $B_n$ to $A_n$ | $C_L$ = 30 pF, $R_L$ = 500Ω | 3.3 ± 0.3 | 0.6 | 3.5 | ns | Figures 1, 2 |
| | | | 2.5 ± 0.2 | 0.8 | 4.2 | | |
| | | | 1.8 ± 0.15 | 1.5 | 8.4 | | |
| | | $C_L$ = 15 pF, $R_L$ = 2kΩ | 1.5 ± 0.1 | 1.0 | 16.8 | | Figures 5, 6 |
| $t_{PZL}$, $t_{PZH}$ | Output Enable Time | $C_L$ = 30 pF, $R_L$ = 500Ω | 3.3 ± 0.3 | 0.6 | 4.5 | ns | Figures 1, 3, 4 |
| | | | 2.5 ± 0.2 | 0.8 | 5.6 | | |
| | | | 1.8 ± 0.15 | 1.5 | 9.8 | | |
| | | $C_L$ = 15 pF, $R_L$ = 2kΩ | 1.5 ± 0.1 | 1.0 | 19.6 | | Figures 5, 7, 8 |
| $t_{PLZ}$, $t_{PHZ}$ | Output Disable Time | $C_L$ = 30 pF, $R_L$ = 500Ω | 3.3 ± 0.3 | 0.6 | 3.6 | ns | Figures 1, 3, 4 |
| | | | 2.5 ± 0.2 | 0.8 | 4.0 | | |
| | | | 1.8 ± 0.15 | 1.5 | 7.2 | | |
| | | $C_L$ = 15 pF, $R_L$ = 2kΩ | 1.5 ± 0.1 | 1.0 | 14.4 | | Figures 5, 7, 8 |
| $t_{OSHL}$<br>$t_{OSLH}$ | Output to Output Skew<br>(Note 8) | $C_L$ = 30 pF, $R_L$ = 500Ω | 3.3 ± 0.3 | | 0.5 | ns | |
| | | | 2.5 ± 0.2 | | 0.5 | | |
| | | | 1.8 ± 0.15 | | 0.75 | | |
| | | $C_L$ = 15 pF, $R_L$ = 2kΩ | 1.5 ± 0.1 | | 1.5 | | |

**Note 7:** For $C_L = 50_P$F, add approximately 300 ps to the AC maximum specification.

**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 ($t_{OSLH}$).

## Dynamic Switching Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A = 25°C$ Typical | Units |
|---|---|---|---|---|---|
| $V_{OLP}$ | Quiet Output Dynamic Peak $V_{OL}$ | $C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$ | 1.8 | 0.3 | V |
| | | | 2.5 | 0.7 | |
| | | | 3.3 | 1.0 | |
| $V_{OLV}$ | Quiet Output Dynamic Valley $V_{OL}$ | $C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$ | 1.8 | –0.3 | V |
| | | | 2.5 | –0.7 | |
| | | | 3.3 | –1.0 | |
| $V_{OHV}$ | Quiet Output Dynamic Valley $V_{OH}$ | $C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$ | 1.8 | 1.3 | V |
| | | | 2.5 | 1.7 | |
| | | | 3.3 | 2.0 | |

## Capacitance

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

## AC Loading and Waveforms ($V_{CC}$ 3.3V ± 0.3V to 1.8V ± 0.15V)

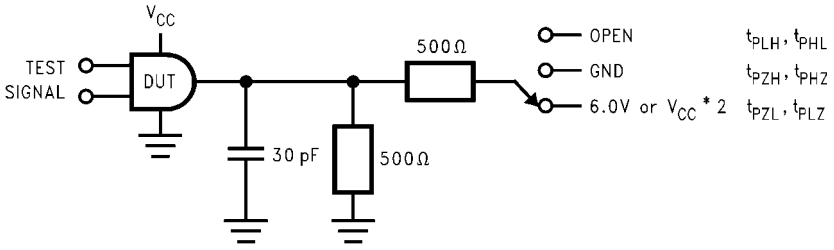



**FIGURE 1. AC Test Circuit**

| 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 $V_{CC}$ = 2.5V ± 0.2V; 1.8V ± 0.15V |
| $t_{PZH}$, $t_{PHZ}$ | GND |

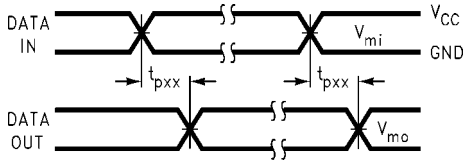



**FIGURE 2. Waveform for Inverting and Non-inverting Functions**

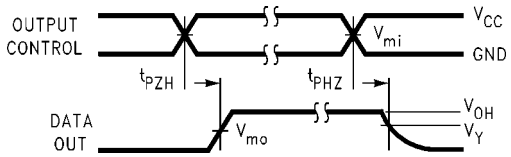



**FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic**

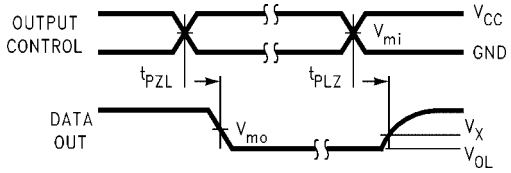
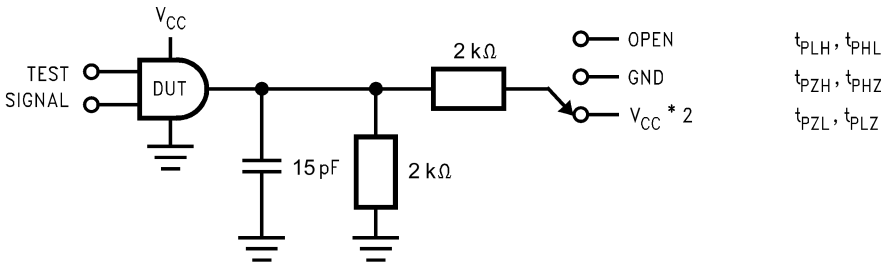



**FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic**

| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | **3.3V ± 0.3V** | **2.5V ± 0.2V** | **1.8V ± 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 |

## AC Loading and Waveforms ($V_{CC}$ 1.5 ± 0.1V)




| TEST | SWITCH |
|---|---|
| $t_{PLH}$, $t_{PHL}$ | Open |
| $t_{PZL}$, $t_{PLZ}$ | $V_{CC}$ x 2 at $V_{CC}$ = 1.5 ± 0.1V |
| $t_{PZH}$, $t_{PHZ}$ | GND |

**FIGURE 5. AC Test Circuit**

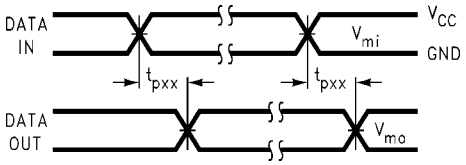



**FIGURE 6. Waveform for Inverting and Non-Inverting Functions**

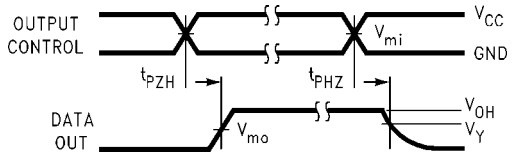



**FIGURE 7. 3-STATE Output High Enable and Disable Times for Low Voltage Logic**

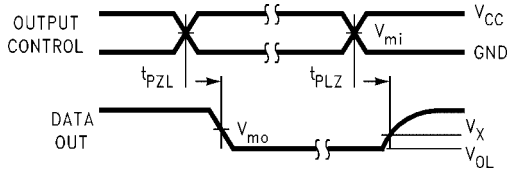
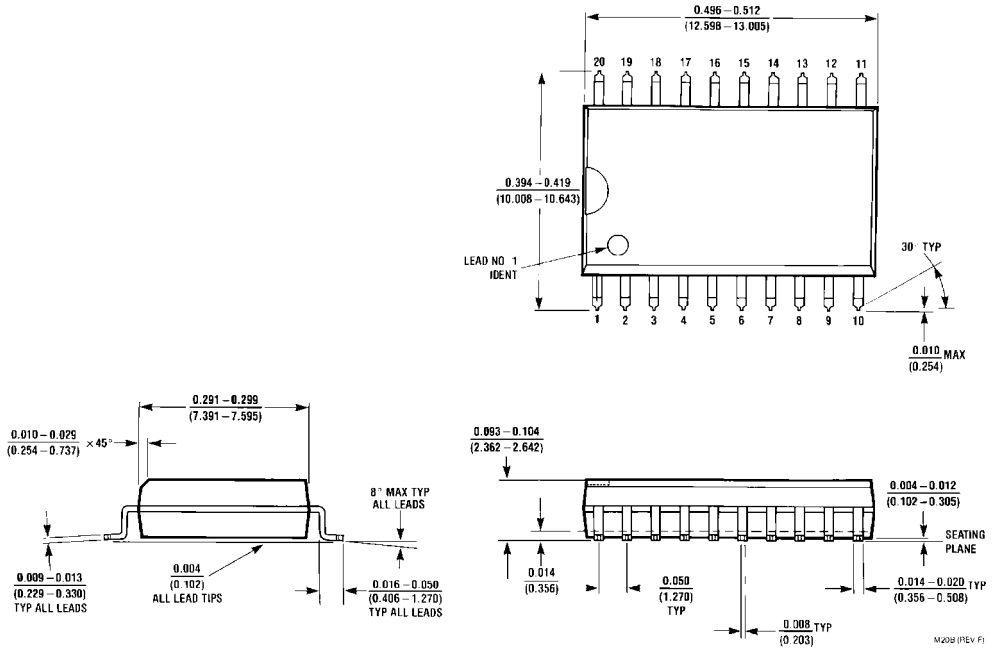



**FIGURE 8. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic**

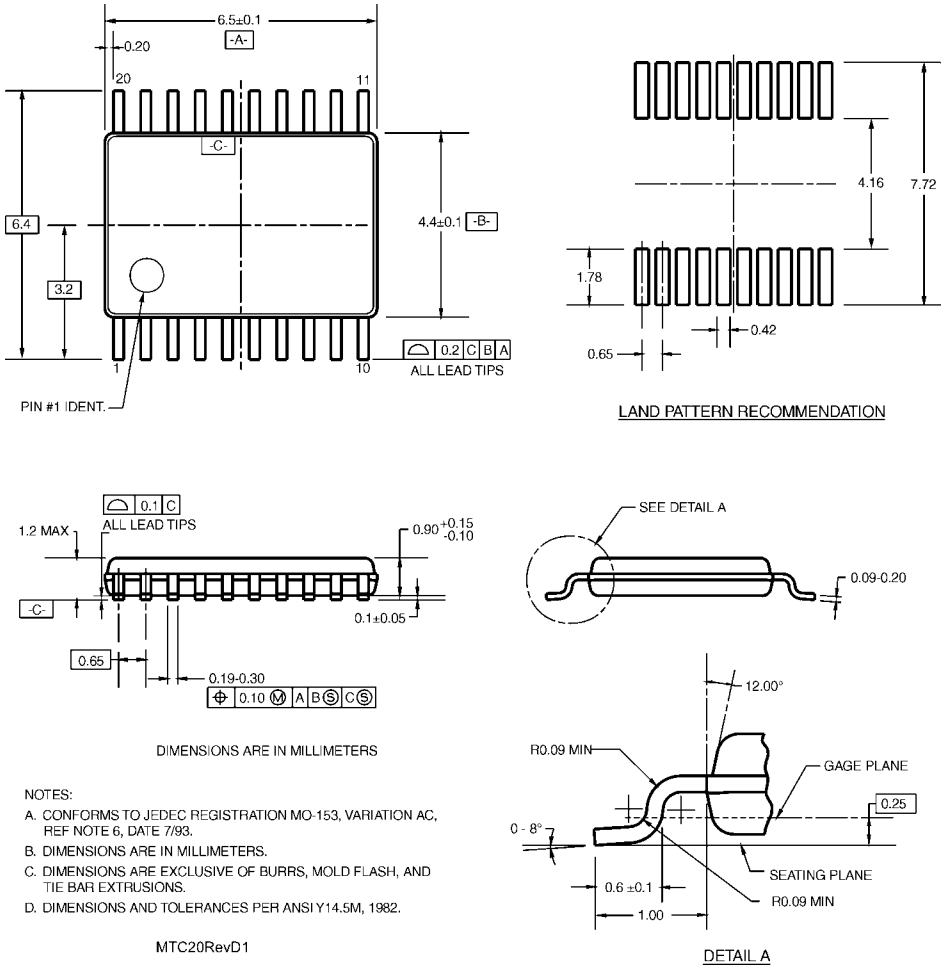
| Symbol | $V_{CC}$ |
|---|---|
| | **1.5V ± 0.1V** |
| $V_{mi}$ | $V_{CC}/2$ |
| $V_{mo}$ | $V_{CC}/2$ |
| $V_X$ | $V_{OL}$ + 0.1V |
| $V_Y$ | $V_{OH}$ − 0.1V |

## Physical Dimensions inches (millimeters) unless otherwise noted




**20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide**
**Package Number M20B**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AC, 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.

MTC20RevD1

**20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide**
**Package Number MTC20**



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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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