

## 74VCXH2245

### Low Voltage Bidirectional Transceiver with Bushold and 26Ω Series Resistors in B Outputs

#### General Description

The VCXH2245 contains eight non-inverting bidirectional buffers with 3-STATE outputs and is intended for bus oriented applications. The T/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 VCXH2245 data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating data inputs at a valid logic level.

The 74VCXH2245 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications. The VCXH2245 is also designed with 26Ω series resistance in the B Port outputs. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus transceivers transmitters.

The 74VCXH2245 is fabricated with an advanced CMOS technology to achieve high-speed operation while maintaining low CMOS power dissipation.

#### Features

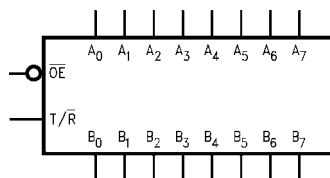
- 1.65V-3.6V  $V_{CC}$  supply operation
- 3.6V tolerant control inputs
- Bushold on data inputs eliminates the need for external pull-up/pull-down resistors
- 26Ω series resistors in B Port outputs
- $t_{PD}$  (A to B)
  - 4.4 ns max for 3.0V to 3.6V  $V_{CC}$
  - 5.6 ns max for 2.3V to 2.7V  $V_{CC}$
  - 9.8 ns max for 1.65V to 1.95V  $V_{CC}$
- Static Drive ( $I_{OH}/I_{OL}$  B outputs):
  - ±12 mA @ 3.0V  $V_{CC}$
  - ±8 mA @ 2.3V  $V_{CC}$
  - ±3 mA @ 1.65V  $V_{CC}$
- Uses patented Quiet Series™ noise/EMI reduction circuitry
- Latchup performance exceeds 300 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

#### Ordering Code:

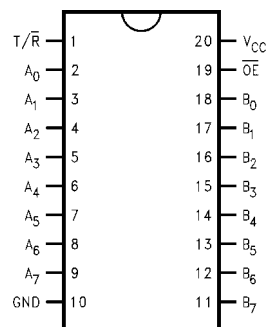
Order Number	Package Number	Package Description
74VCXH2245WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74VCXH2245MTC	MTC20	20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

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

#### Logic Symbol



#### Connection Diagram



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## Pin Descriptions

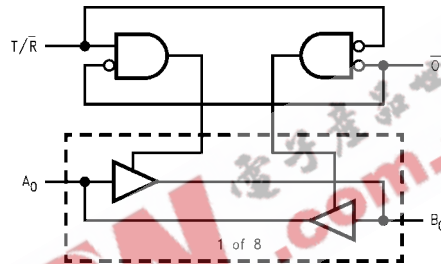
Pin Names	Description
$\overline{OE}$	Output Enable Input (Active LOW)
$T/\overline{R}$	Transmit/Receive Input
$A_0-A_7$	Side A Bushold Inputs or 3-STATE Outputs
$B_0-B_7$	Side B Bushold Inputs or 3-STATE Outputs

## 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 $A_0-A_7, B_0-B_7$

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

## Logic Diagram



**Absolute Maximum Ratings** (Note 1)

Supply Voltage ( $V_{CC}$ )	-0.5V to +4.6V
DC Input Voltage ( $V_I$ )	
$\overline{T/R}, \overline{OE}$	-0.5V to 4.6 V
I/O Ports	-0.5V to $V_{CC} + 0.5V$
DC Output Voltage ( $V_O$ ) (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 ( $I_{OH}/I_{OL}$ )	$\pm 50$ mA
DC $V_{CC}$ or Ground Current	$\pm 100$ mA
Storage Temperature ( $T_{STG}$ )	-65°C to +150°C

**Recommended Operating Conditions** (Note 3)

Power Supply Voltage ( $V_{CC}$ )	
Operating	1.65V to 3.6V
Data Retention Only	1.2V to 3.6V
Input Voltage	-0.3V to $V_{CC}$
Output Voltage ( $V_O$ )	0V to $V_{CC}$
Output Current in $I_{OH}/I_{OL}$ - A Outputs	
$V_{CC} = 3.0V$ to 3.6V	$\pm 24$ mA
$V_{CC} = 2.3V$ to 2.7V	$\pm 18$ mA
$V_{CC} = 1.65V$ to 2.3V	$\pm 6$ mA
Output Current in $I_{OH}/I_{OL}$ - B Outputs	
$V_{CC} = 3.0V$ to 3.6V	$\pm 12$ mA
$V_{CC} = 2.3V$ to 2.7V	$\pm 8$ mA
$V_{CC} = 1.65V$ to 2.3V	$\pm 3$ 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	$V_{CC}$ (V)	Min	Max	Units
$V_{IH}$	HIGH Level Input Voltage		2.7-3.6	2.0		V
$V_{IL}$	LOW Level Input Voltage		2.7-3.6		0.8	V
$V_{OH}$	HIGH Level Output Voltage A Outputs	$I_{OH} = -100 \mu A$	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		
$V_{OL}$	HIGH Level Output Voltage B Outputs	$I_{OH} = -100 \mu A$	2.7-3.6	$V_{CC} - 0.2$		V
		$I_{OH} = -6$ mA	2.7	2.2		
		$I_{OH} = -8$ mA	3.0	2.4		
		$I_{OH} = -12$ mA	3.0	2.2		
$V_{OL}$	LOW Level Output Voltage A Outputs	$I_{OL} = 100 \mu A$	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		
$V_{OL}$	LOW Level Output Voltage B Outputs	$I_{OL} = 100 \mu A$	2.7-3.6		0.2	V
		$I_{OL} = 6$ mA	2.7	0.4		
		$I_{OL} = 8$ mA	3.0	0.55		
		$I_{OL} = 12$ mA	3.0	0.8		
$I_I$	Input Leakage Current	$V_{IN} = V_{CC}$ or GND	2.7-3.6		$\pm 5.0$	$\mu A$
$I_{I(HOLD)}$	Bushold Input Minimum	$V_{IN} = 0.8V$	3.0	75		$\mu A$
	Drive Hold Current	$V_{IN} = 2.0V$	3.0	-75		$\mu A$
$I_{I(OD)}$	Bushold Input Over-Drive Current to Change State	(Note 4)	3.6	450		$\mu A$
		(Note 5)	3.6	-450		$\mu A$
$I_{OZ}$	3-STATE Output Leakage	$V_O = V_{CC}$ or GND $V_I = V_{IH}$ or $V_{IL}$	2.7-3.6		$\pm 10$	$\mu A$
$I_{CC}$	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.7-3.6		20	$\mu A$
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$V_{IH} = V_{CC} - 0.6V$	2.7-3.6		750	$\mu A$

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

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

DC Electrical Characteristics (2.3V ≤ V <sub>CC</sub> ≤ 2.7V)						
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	Min	Max	Units
V <sub>IH</sub>	HIGH Level Input Voltage		2.3–2.7	1.6		V
V <sub>IL</sub>	LOW Level Input Voltage		2.3–2.7		0.7	V
V <sub>OH</sub>	HIGH Level Output Voltage A Outputs	I <sub>OH</sub> = –100 μA	2.3–2.7	V <sub>CC</sub> – 0.2		V
		I <sub>OH</sub> = –6 mA	2.3	2.0		
		I <sub>OH</sub> = –12 mA	2.3	1.8		
		I <sub>OH</sub> = –18 mA	2.3	1.7		
V <sub>OH</sub>	HIGH Level Output Voltage B Outputs	I <sub>OH</sub> = –100 μA	2.3–2.7	V <sub>CC</sub> – 2		V
		I <sub>OH</sub> = –4 mA	2.3	2.0		
		I <sub>OH</sub> = –6 mA	2.3	1.8		
		I <sub>OH</sub> = –8 mA	2.3	1.7		
V <sub>OL</sub>	LOW Level Output Voltage A Outputs	I <sub>OL</sub> = 100 μA	2.3–2.7		0.2	V
		I <sub>OL</sub> = 12 mA	2.3		0.4	
		I <sub>OL</sub> = 18 mA	2.3		0.6	
V <sub>OL</sub>	LOW Level Output Voltage B Outputs	I <sub>OL</sub> = 100 μA	2.3–2.7		0.2	V
		I <sub>OL</sub> = 6 mA	2.3		0.4	
		I <sub>OL</sub> = 8 mA	2.3		0.6	
I <sub>I</sub>	Input Leakage Current	V <sub>IN</sub> = V <sub>CC</sub> or GND	2.3–2.7		±5.0	μA
I <sub>I(HOLD)</sub>	Bushold Input Minimum Drive Hold Current	V <sub>IN</sub> = 0.7V	2.3	45		μA
		V <sub>IN</sub> = 1.6V	2.3	–45		
I <sub>I(OD)</sub>	Bushold Input Over-Drive Current to Change State	(Note 6)	2.7	300		μA
		(Note 7)	2.7	–300		
I <sub>OZ</sub>	3-STATE Output Leakage	V <sub>O</sub> = V <sub>CC</sub> or GND V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	2.3–2.7		±10	μA
I <sub>CC</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND	2.3–2.7		20	μA
<p><b>Note 6:</b> An external driver must source at least the specified current to switch from LOW-to-HIGH.</p> <p><b>Note 7:</b> An external driver must sink at least the specified current to switch from HIGH-to-LOW.</p>						
DC Electrical Characteristics (1.65V ≤ V <sub>CC</sub> < 2.3V)						
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	Min	Max	Units
V <sub>IH</sub>	HIGH Level Input Voltage		1.65–2.3	0.65 x V <sub>CC</sub>		V
V <sub>IL</sub>	LOW Level Input Voltage		1.65–2.3		0.35 x V <sub>CC</sub>	V
V <sub>OH</sub>	HIGH Level Output Voltage A Outputs	I <sub>OH</sub> = –100 μA	1.65–1.95	V <sub>CC</sub> – 0.2		V
		I <sub>OH</sub> = –6 mA	1.65	1.25		
V <sub>OH</sub>	HIGH Level Output Voltage B Outputs	I <sub>OH</sub> = –100 μA	1.65–2.3	V <sub>CC</sub> – 0.2		V
		I <sub>OH</sub> = –3 mA	1.65	1.25		
V <sub>OL</sub>	LOW Level Output Voltage A Outputs	I <sub>OL</sub> = 100 μA	1.65–2.3		0.2	V
		I <sub>OL</sub> = 6 mA	1.65		0.3	
V <sub>OL</sub>	LOW Level Output Voltage B Outputs	I <sub>OL</sub> = 100 μA	1.65–2.3		0.2	V
		I <sub>OL</sub> = 3 mA	1.65		0.3	
I <sub>I</sub>	Input Leakage Current	0 ≤ V <sub>I</sub> ≤ 3.6V	1.65–2.3		±5.0	μA
I <sub>I(HOLD)</sub>	Bushold Input Minimum Drive Hold Current	V <sub>IN</sub> = 0.57V	1.65	25		μA
		V <sub>IN</sub> = 1.07V	1.65	–25		
I <sub>I(OD)</sub>	Bushold Input Over-Drive Current to Change State	(Note 8)	1.95	200		μA
		(Note 9)	1.95	–200		
I <sub>OZ</sub>	3-STATE Output Leakage	V <sub>O</sub> = V <sub>CC</sub> or GND	1.65–2.3		±10	μA
I <sub>CC</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND	1.65–2.3		20	μA
<p><b>Note 8:</b> An external driver must source at least the specified current to switch from LOW-to-HIGH.</p> <p><b>Note 9:</b> An external driver must sink at least the specified current to switch from HIGH-to-LOW.</p>						

AC Electrical Characteristics (Note 10)								
Symbol	Parameter	$T_A = -40^\circ\text{C to } +85^\circ\text{C}, C_L = 30\text{ pF}, R_L = 500\Omega$						Units
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.5V \pm 0.2V$		$V_{CC} = 1.8V \pm 0.15V$		
		Min	Max	Min	Max	Min	Max	
$t_{PHL}$ $t_{PLH}$	Propagation Delay, A to B	0.6	4.4	0.8	5.6	1.5	9.8	ns
$t_{PHL}$ $t_{PLH}$	Propagation Delay, B to A	0.6	3.5	0.8	4.2	1.5	8.4	ns
$t_{PZL}$ $t_{PZH}$	Output Enable Time, A to B	0.6	5.0	0.8	6.6	1.5	9.8	ns
$t_{PZL}$ $t_{PZH}$	Output Enable Time, B to A	0.6	4.5	0.8	5.6	1.5	9.8	ns
$t_{PLZ}$ $t_{PHZ}$	Output Disable Time, A to B	0.6	4.2	0.8	4.7	1.5	8.5	ns
$t_{PLZ}$ $t_{PHZ}$	Output Disable Time, B to A	0.6	3.6	0.8	4.0	1.5	7.2	ns
$t_{OSHL}$ $t_{OSLH}$	Output to Output Skew (Note 11)		0.5		0.5		0.75	ns

**Note 10:** For  $C_L = 50\text{ pF}$ , add approximately 300 ps to the AC maximum specification.

**Note 11:** 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)	$T_A = 25^\circ\text{C}$	Units
				Typical	
$V_{OLP}$	Quiet Output Dynamic Peak $V_{OL}$ , B to A	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$	1.8	0.3	V
			2.5	0.7	
			3.3	1.0	
$V_{OLV}$	Quiet Output Dynamic Valley $V_{OL}$ , A to B	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$	1.8	0.2	V
			2.5	0.45	
			3.3	0.65	
$V_{OLV}$	Quiet Output Dynamic Valley $V_{OL}$ , B to A	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$	1.8	-0.3	V
			2.5	-0.7	
			3.3	-1.0	
$V_{OHV}$	Quiet Output Dynamic Valley $V_{OH}$ , A to B	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$	1.8	-0.2	V
			2.5	-0.45	
			3.3	-0.65	
$V_{OHV}$	Quiet Output Dynamic Valley $V_{OH}$ , B to A	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$	1.8	1.3	V
			2.5	1.7	
			3.3	2.0	
$V_{OHV}$	Quiet Output Dynamic Valley $V_{OH}$ , A to B	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$	1.8	1.5	V
			2.5	2.0	
			3.3	2.5	

### Capacitance

Symbol	Parameter	Conditions	$T_A = +25^\circ\text{C}$	Units
			Typical	
$C_{IN}$	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 $V_{CC}$ , $f = 10\text{ MHz}$ , $V_{CC} = 1.8V, 2.5V$ or $3.3V$	20	pF

AC Loading and Waveforms

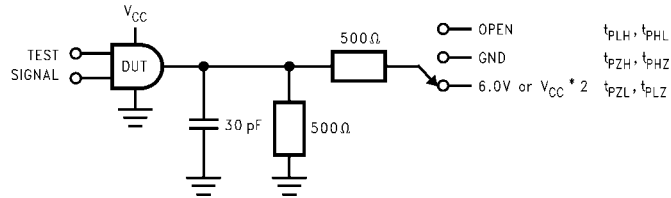


FIGURE 1. AC Test Circuit

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

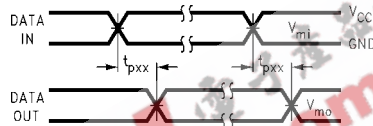


FIGURE 2. Waveform for Inverting and Non-inverting Functions

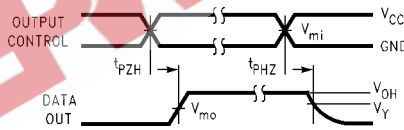


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

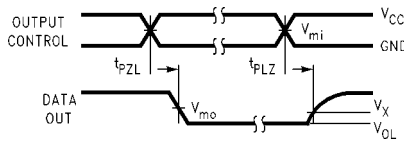
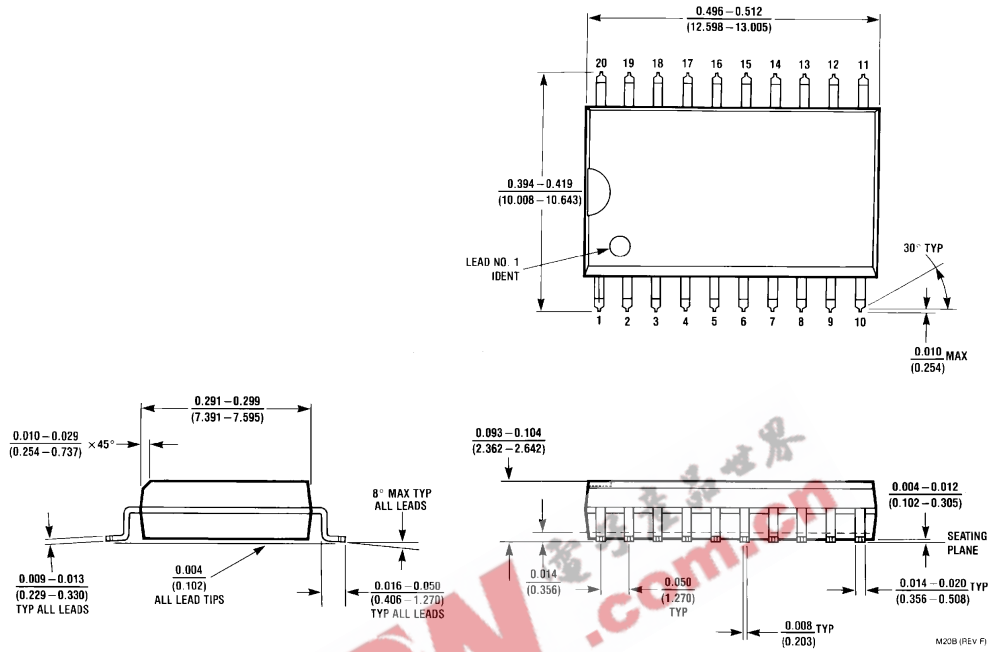


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

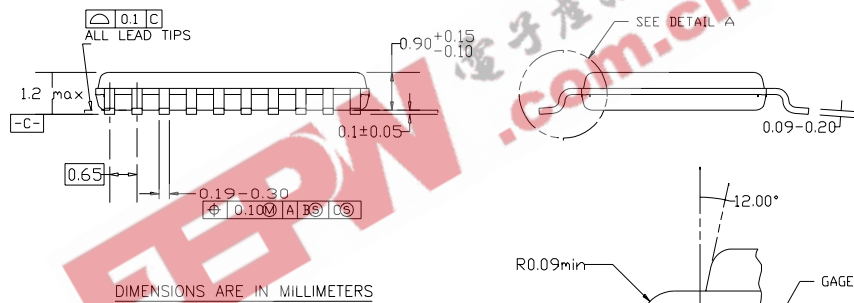
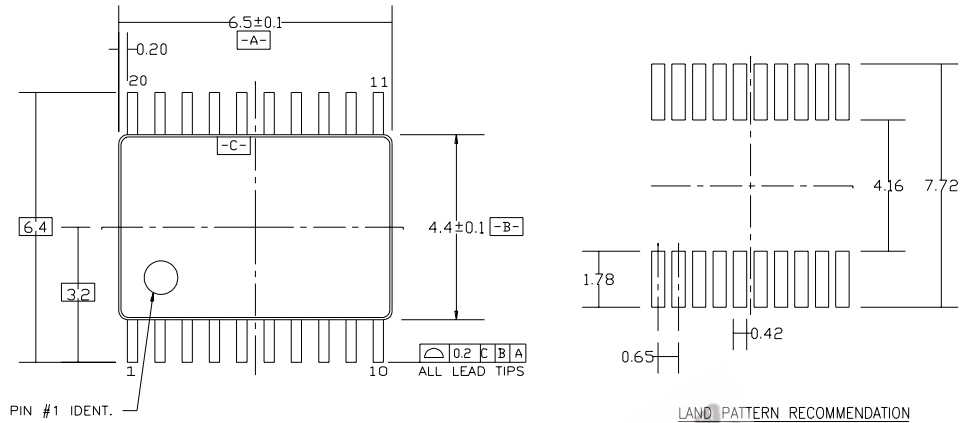
Symbol	$V_{CC}$		
	$3.3V \pm 0.3V$	$2.5V \pm 0.2V$	$1.8V \pm 0.15V$
$V_{mi}$	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_{mo}$	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_x$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$	$V_{OL} + 0.15V$
$V_y$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$	$V_{OH} - 0.15V$

**Physical Dimensions** inches (millimeters) unless otherwise noted



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

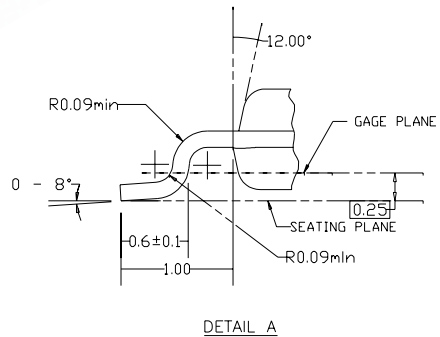
**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



DIMENSIONS ARE IN MILLIMETERS

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, MOLDS FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.



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

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