

## 74VCXH162374

### Low Voltage 16-Bit D-Type Flip-Flop with Bushold and 26Ω Series Resistors in Outputs

#### General Description

The VCXH162374 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 VCXH162374 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 74VCXH162374 is also designed with 26Ω series resistors in the outputs. This design reduces line noise in applications such as memory address drivers, clock drivers and bus transceivers/transmitters.

The 74VCXH162374 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications with output compatibility up to 3.6V.

The 74VCXH162374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

#### Features

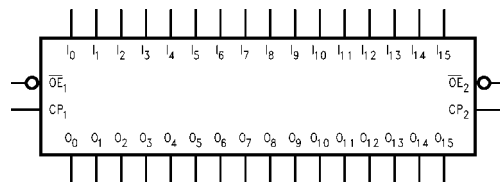
- 1.65V–3.6V  $V_{CC}$  supply operation
- 3.6V tolerant control inputs and outputs
- Bushold data inputs eliminates the need for external pull-up/pull-down resistors
- 26Ω series resistors in outputs
- $t_{PD}$  (CLK to  $O_n$ )
  - 3.4 ns max for 3.0V to 3.6V  $V_{CC}$
  - 4.8 ns max for 2.3V to 2.7V  $V_{CC}$
  - 9.6 ns max for 1.65V to 1.95V  $V_{CC}$
- Static Drive ( $I_{OH}/I_{OL}$ )
  - ±12 mA @ 3.0V  $V_{CC}$
  - ±8 mA @ 2.3V  $V_{CC}$
  - ±3 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
74VCXH162374MTD	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide [TUBES]
74VCXH162374MTX (Note 1)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide [TAPE and REEL]

**Note 1:** Use this Order Number to receive devices in Tape and Reel.

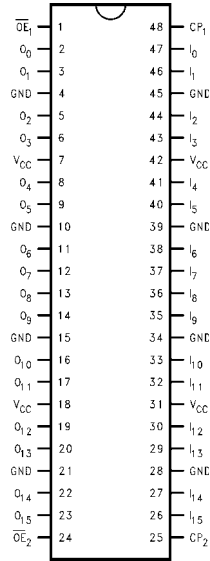
#### Logic Symbol



#### Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
$CP_n$	Clock Pulse Input
$I_0$ – $I_{15}$	Bushold Inputs
$O_0$ – $O_{15}$	Outputs

### Connection Diagram



### Truth Tables

Inputs			Outputs
CP <sub>1</sub>	$\overline{OE}_1$	I <sub>0</sub> -I <sub>7</sub>	O <sub>0</sub> -O <sub>7</sub>
↗	L	H	H
↗	L	L	L
L	L	X	O <sub>0</sub>
X	H	X	Z

Inputs			Outputs
CP <sub>2</sub>	$\overline{OE}_2$	I <sub>8</sub> -I <sub>15</sub>	O <sub>8</sub> -O <sub>15</sub>
↗	L	H	H
↗	L	L	L
L	L	X	O <sub>0</sub>
X	H	X	Z

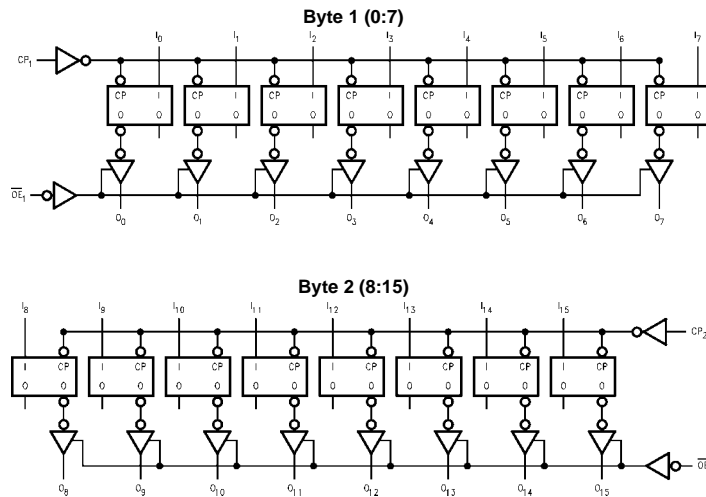
H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial (HIGH or LOW, control inputs may not float)  
 Z = High Impedance  
 O<sub>0</sub> = Previous O<sub>0</sub> before HIGH-to-LOW of CP

### Functional Description

The 74VCXH162374 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 clock 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 individual I inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP<sub>n</sub>) 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. Operations of the  $\overline{OE}_n$  input does not affect the state of the flip-flops.

### Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Absolute Maximum Ratings** (Note 2)

Supply Voltage ( $V_{CC}$ )	-0.5V to +4.6V
DC Input Voltage ( $V_I$ )	
$\overline{OE}_n, CP_n$	-0.5V to 4.6V
$I_O - I_{15}$	-0.5V to $V_{CC}$ to 0.5V
Output Voltage ( $V_O$ )	
Outputs 3-STATEd	-0.5V to +4.6V
Outputs Active (Note 3)	-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 4)

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 "OFF" State	0.0V to 3.6V
Output Current in $I_{OH}/I_{OL}$	
$V_{CC} = 3.0V$ to 3.6V	±12 mA
$V_{CC} = 2.3V$ to 2.7V	±8 mA
$V_{CC} = 1.65V$ to 2.3V	±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 2:** 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 3:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 4:** Floating or unused control inputs must be held HIGH or LOW.

**DC Electrical Characteristics (2.7V <  $V_{CC}$  ≤ 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	$I_{OH} = -100 \mu A$	2.7 – 3.6	$V_{CC} - 0.2$		V	
		$I_{OH} = -6 \text{ mA}$	2.7	2.2		V	
		$I_{OH} = -8 \text{ mA}$	3.0	2.4		V	
		$I_{OH} = -12 \text{ mA}$	3.0	2.2		V	
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu A$	2.7 – 3.6		0.2	V	
		$I_{OL} = 6 \text{ mA}$	2.7		0.4	V	
		$I_{OL} = 8 \text{ mA}$	3.0		0.55	V	
		$I_{OL} = 12 \text{ mA}$	3.0		0.8	V	
$I_I$	Input Leakage Current	Control Pins	$0 \leq V_I \leq 3.6V$	2.7 – 3.6		±5.0	μA
		Data Pins	$V_I = V_{CC}$ or GND	2.7 – 3.6		±5.0	μA
$I_{I(HOLD)}$	Bushold Input Minimum Drive Hold Current	$V_{IN} = 0.8V$	3.0	75		μA	
		$V_{IN} = 2.0V$	3.0	-75		μA	
$I_{I(OD)}$	Bushold Input Over-Drive Current to Change State	(Note 5)	3.6	450		μA	
		(Note 6)	3.6	-450		μA	
$I_{OZ}$	3-STATE Output Leakage	$0 \leq V_O \leq 3.6V$ $V_I = V_{IH}$ or $V_{IL}$	2.7 – 3.6		±10	μA	
$I_{OFF}$	Power-OFF Leakage Current	$0 \leq (V_O) \leq 3.6V$	0		10	μA	
$I_{CC}$	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.7 – 3.6		20	μA	
		$V_{CC} \leq (V_O) \leq 3.6V$ (Note 7)	2.7 – 3.6		±20	μA	
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$V_{IH} = V_{CC} - 0.6V$	2.7 – 3.6		750	μA	

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

**Note 6:** An external driver must sink at least the specified current to switch from HIGH-to-LOW.

**Note 7:** Outputs disabled or 3-STATE only.

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

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	I <sub>OH</sub> = -100 μA	2.3 - 2.7	V <sub>CC</sub> - 0.2		V
		I <sub>OH</sub> = -4 mA	2.3	2.0		V
		I <sub>OH</sub> = -6 mA	2.3	1.8		V
		I <sub>OH</sub> = -8 mA	2.3	1.7		V
V <sub>OL</sub>	LOW Level Output Voltage	I <sub>OL</sub> = 100 μA	2.3 - 2.7		0.2	V
		I <sub>OL</sub> = 6 mA	2.3		0.4	V
		I <sub>OL</sub> = 8 mA	2.3		0.6	V
I <sub>I</sub>	Input Leakage Current	Control Pins 0 ≤ V <sub>I</sub> ≤ 3.6V	2.3 - 2.7		±5.0	μA
		Data Pins V <sub>I</sub> = V <sub>CC</sub> or GND	2.3 - 2.7		±5.0	μA
I <sub>I(HOLD)</sub>	Bushold Input Minimum	V <sub>IN</sub> = 0.7V	2.3	45		μA
	Drive Hold Current	V <sub>IN</sub> = 1.6V	2.3	-45		
I <sub>I(OD)</sub>	Bushold Input Over-Drive Current to Change State	(Note 8)	2.7	300		μA
		(Note 9)	2.7	-300		
I <sub>OZ</sub>	3-STATE Output Leakage	0 ≤ V <sub>O</sub> ≤ 3.6V V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	2.3 - 2.7		±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	2.3 - 2.7		20	μA
		V <sub>CC</sub> ≤ (V <sub>O</sub> ) ≤ 3.6V (Note 10)	2.3 - 2.7		±20	μA

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

**Note 9:** An external driver must sink at least the specified current to switch from HIGH-to-LOW.

**Note 10:** Outputs disabled or 3-STATE only.

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

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 × V <sub>CC</sub>		V
V <sub>IL</sub>	LOW Level Input Voltage		1.65 - 2.3		0.35 × V <sub>CC</sub>	V
V <sub>OH</sub>	HIGH Level Output Voltage	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
V <sub>OL</sub>	LOW Level Output Voltage	I <sub>OL</sub> = 100 μA	1.65 - 2.3		0.2	V
		I <sub>OL</sub> = 3 mA	1.65		0.3	V
I <sub>I</sub>	Input Leakage Current	Control Pins 0 ≤ V <sub>I</sub> ≤ 3.6V	1.65 - 2.3		±5.0	μA
		Data Pins V <sub>I</sub> = V <sub>CC</sub> or GND	1.65 - 2.3		±5.0	μA
I <sub>I(HOLD)</sub>	Bushold Input Minimum	V <sub>IN</sub> = 0.57V	1.65	25		μA
	Drive Hold Current	V <sub>IN</sub> = 1.07V	1.65	-25		
I <sub>I(OD)</sub>	Bushold Input Over-Drive Current to Change State	(Note 11)	1.95	200		μA
		(Note 12)	1.95	-200		
I <sub>OZ</sub>	3-STATE Output Leakage	0 ≤ V <sub>O</sub> ≤ 3.6V V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	1.65 - 2.3		±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	1.65 - 2.3		20	μA
		V <sub>CC</sub> ≤ (V <sub>O</sub> ) ≤ 3.6V (Note 13)	1.65 - 2.3		±20	μA

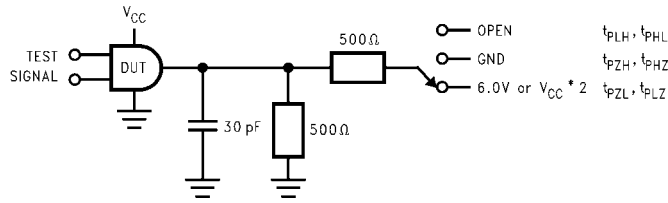
**Note 11:** An external driver must source at least the specified current to switch from LOW-to-HIGH.

**Note 12:** An external driver must sink at least the specified current to switch from HIGH-to-LOW.

**Note 13:** Outputs disabled or 3-STATE only.

AC Electrical Characteristics (Note 14)								
Symbol	Parameter	$T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C}, C_L = 30\text{ pF}, R_L = 500\Omega$						Units
		$V_{CC} = 3.3\text{V} \pm 0.3\text{V}$		$V_{CC} = 2.5\text{V} \pm 0.2\text{V}$		$V_{CC} = 1.8\text{V} \pm 0.15\text{V}$		
		Min	Max	Min	Max	Min	Max	
$f_{MAX}$	Maximum Clock Frequency	250		200		100		MHz
$t_{PHL}, t_{PLH}$	Prop Delay CP to $O_n$	0.8	3.4	1.0	4.8	1.5	9.6	ns
$t_{PZL}, t_{PZH}$	Output Enable Time	0.8	3.9	1.0	5.4	1.5	9.8	ns
$t_{PLZ}, t_{PHZ}$	Output Disable Time	0.8	4.0	1.0	4.4	1.5	7.9	ns
$t_S$	Setup Time	1.5		1.5		2.5		ns
$t_H$	Hold Time	1.0		1.0		1.0		ns
$t_W$	Pulse Width	1.5		1.5		4.0		ns
$t_{OSHL}, t_{OSLH}$	Output to Output Skew (Note 15)		0.5		0.5		0.75	ns
<p><b>Note 14:</b> For <math>C_L = 50\text{pF}</math>, add approximately 300 ps to the AC maximum specification.</p> <p><b>Note 15:</b> 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 (<math>t_{OSHL}</math>) or LOW-to-HIGH (<math>t_{OSLH}</math>).</p>								
Dynamic Switching Characteristics								
Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = +25^{\circ}\text{C}$	Units			
				Typical				
$V_{OLP}$	Quiet Output Dynamic Peak $V_{OL}$	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.8	0.15	V			
			2.5	0.25				
			3.3	0.35				
$V_{OLV}$	Quiet Output Dynamic Valley $V_{OL}$	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.8	-0.15	V			
			2.5	-0.25				
			3.3	-0.35				
$V_{OHV}$	Quiet Output Dynamic Valley $V_{OH}$	$C_L = 30\text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.8	1.55	V			
			2.5	2.05				
			3.3	2.65				
Capacitance								
Symbol	Parameter	Conditions	$T_A = +25^{\circ}\text{C}$	Units				
			Typical					
$C_{IN}$	Input Capacitance	$V_{CC} = 1.8\text{V}, 2.5\text{V}$ or $3.3\text{V}, V_I = 0\text{V}$ or $V_{CC}$	6	pF				
$C_{OUT}$	Output Capacitance	$V_I = 0\text{V}$ or $V_{CC}, V_{CC} = 1.8\text{V}, 2.5\text{V}$ or $3.3\text{V}$	7	pF				
$C_{PD}$	Power Dissipation Capacitance	$V_I = 0\text{V}$ or $V_{CC}, f = 10\text{ MHz}, V_{CC} = 1.8\text{V}, 2.5\text{V}$ or $3.3\text{V}$	20	pF				

## AC Loading and Waveforms



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

FIGURE 1. AC Test Circuit

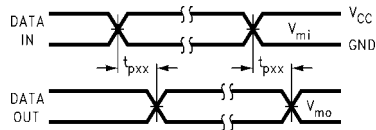


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

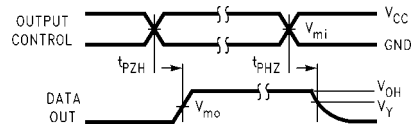


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

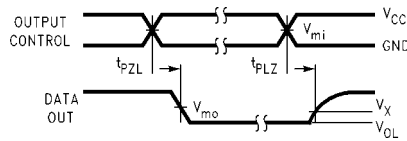


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

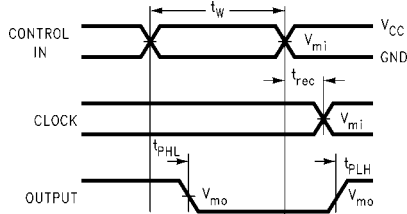


FIGURE 5. Propagation Delay, Pulse Width and  $t_{REC}$  Waveforms

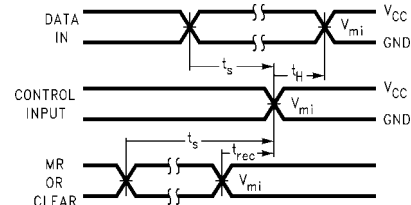
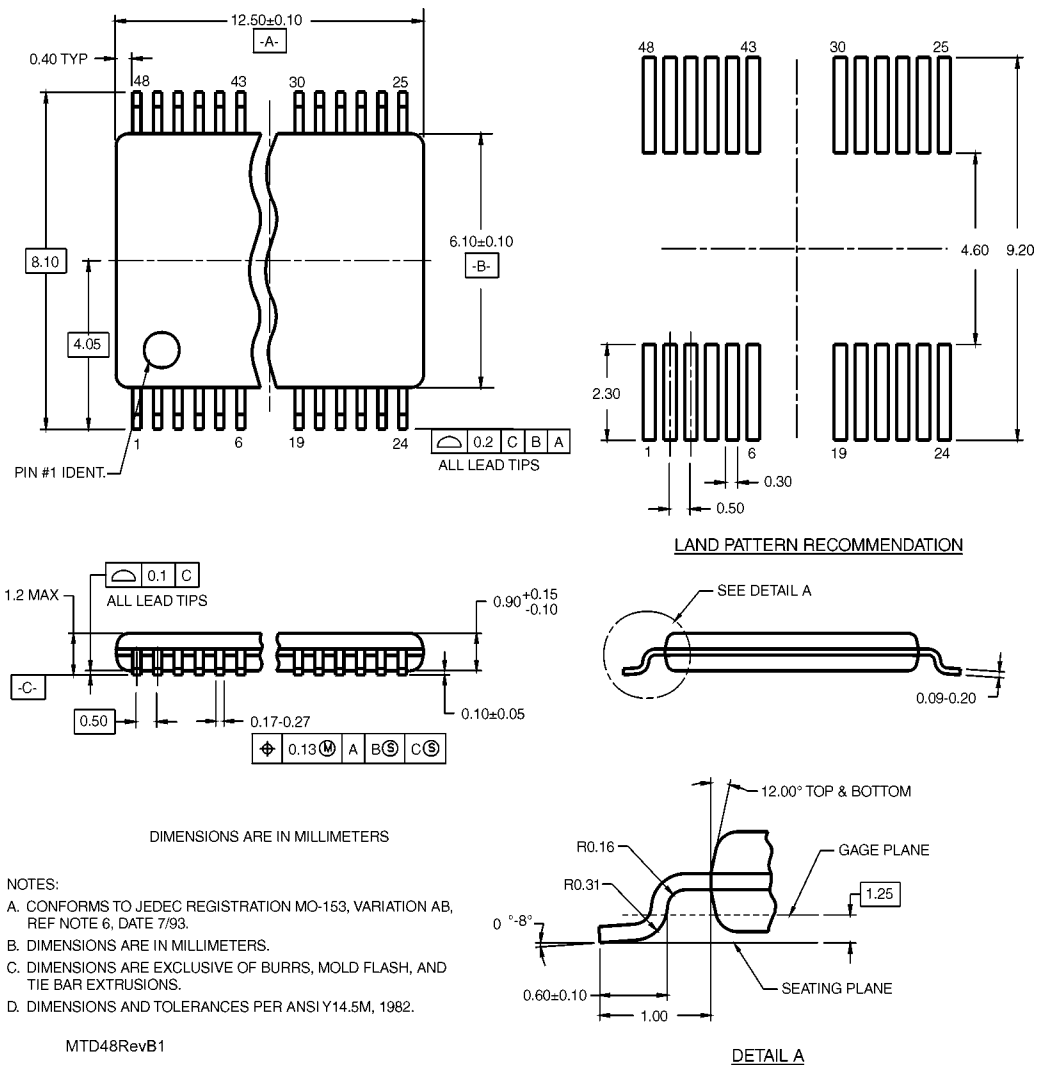


FIGURE 6. Setup Time, Hold Time and Recovery Time for Low Voltage Logic

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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