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October 1996
Revised June 2005

74VCX162245
Low Voltage 16-Bit Bidirectional Transceiver with 3.6V Tolerant Inputs and Outputs and 26Ω Series Resistors in A Port Outputs

General Description

The VCX162245 contains sixteen non-inverting bidirectional buffers with 3-STATE outputs and is intended for bus oriented applications. The device is byte controlled. Each byte has separate 3-STATE control inputs which can 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.

The 74VCX162245 is designed for low voltage (1.4V to 3.6V) V_{CC} applications with I/O compatibility up to 3.6V. The 74VCX162245 is also designed with 26Ω series resistance in the A Port outputs. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus transceivers/transmitters.

The 74VCX162245 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
- 26Ω series resistors in A port outputs
- t_{PD} (B to A)
  3.4 ns max for 3.0V to 3.6V V_{CC}
- Power-down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- Static Drive (I_{OH}/I_{OL} A outputs)
  ±12 mA @ 3.0V V_{CC}
- Uses proprietary noise/EMI reduction circuitry
- Latchup performance exceeds 300 mA
- ESD performance:
  Human body model > 2000V
  Machine model >200V

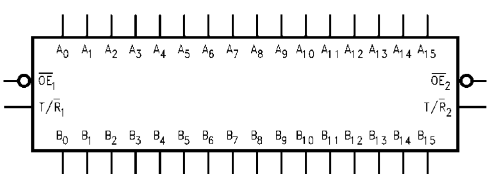
Note 1: To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pull-up resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

Order Number	Package Number	Package Description
74VCX162245MTD	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.

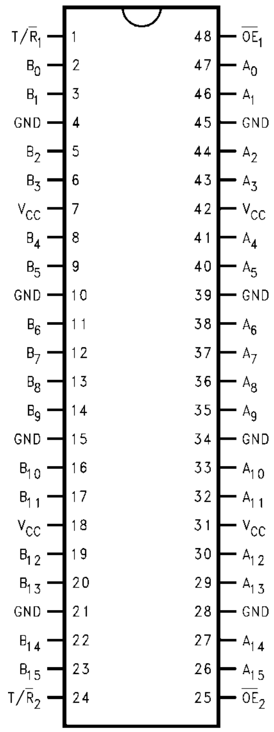
Logic Symbol



Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input
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

Connection Diagram



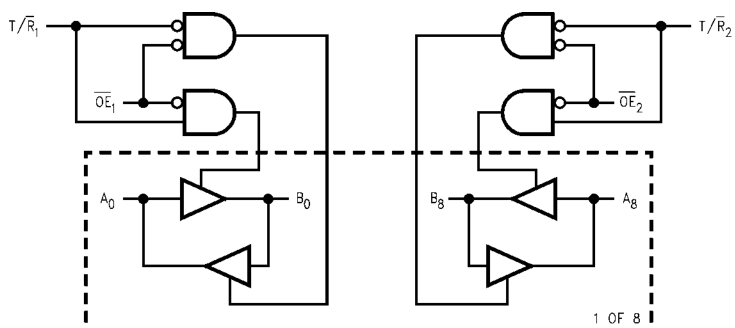
Truth Tables

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

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}

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial (HIGH or LOW, inputs and I/O's may not float)
Z = High Impedance

Logic Diagram



Absolute Maximum Ratings (Note 2)

Supply Voltage (V_{CC})	−0.5V to +4.6V
DC Input Voltage (V_I)	−0.5V to +4.6V
Output Voltage (V_O)	
Outputs 3-State	−0.5V to +4.6V
Outputs Active (Note 3)	−0.5 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 per Supply Pin (I_{CC} or Ground)	±100 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C

Recommended Operating Conditions (Note 4)

Power Supply	
Operating	1.4V to 3.6V
Data Retention Only	1.2V 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	0.0V to 3.6V
Output Current in I_{OH}/I_{OL}-A Outputs	
V_{CC} = 3.0V to 3.6V	±12 mA
V_{CC} = 2.3V to 2.7V	±8 mA
V_{CC} = 1.65V to 1.95V	±3 mA
Output Current in ± I_{OH}/I_{OL}-B Outputs	
V_{CC} = 3.0V to 3.6V	± 24mA
V_{CC} = 2.3V to 2.7V	± 18mA
V_{CC} = 1.65V to 2.3V	±6mA
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 tables will define the conditions for actual device operation.

Note 3: I_O Absolute Maximum Rating must be observed.

Note 4: Floating or unused pins (inputs or I/O's) 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 x V_{CC}		
			1.4 - 1.6	0.65 x 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 x V_{CC}	
			1.4 - 1.6		0.35 x V_{CC}	
V_{OH}	HIGH Level Output Voltage A Outputs	$I_{OH} = -100$ µA	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		
		$I_{OH} = -100$ µA	2.3 - 2.7	V_{CC} - 0.2		
		$I_{OH} = -4$ mA	2.3	2.0		
		$I_{OH} = -6$ mA	2.3	1.8		
		$I_{OH} = -8$ mA	2.3	1.7		
		$I_{OH} = -100$ µA	1.65 - 2.3	V_{CC} - 0.2		
		$I_{OH} = -3$ mA	.65	1.4		
		$I_{OH} = -100$ µA	1.4 - 1.6	V_{CC} - 0.2		
		$I_{OH} = -1$ mA	1.4	1.05		

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_{CC} (V)	Min	Max	Units
V_{OH}	HIGH Level Output Voltage B 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		
		$I_{OH} = -100\ \mu A$	2.7 - 3.6	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		
		$I_{OH} = -100\ \mu A$	1.65 - 2.3	V_{CC} - 0.2		
		$I_{OH} = -6$ mA	1.65	1.25		
		$I_{OH} = -100\ \mu A$	1.4 - 1.6	V_{CC} - 0.2		
		$I_{OH} = -2$ mA	1.4	1.05		
V_{OL}	LOW Level Output Voltage A 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	
		$I_{OL} = 100\ \mu A$	2.3 - 2.7		0.2	
		$I_{OL} = 6$ mA	2.3		0.4	
		$I_{OL} = 8$ mA	2.3		0.6	
		$I_{OL} = 100\ \mu A$	1.65 - 2.3		0.2	
		$I_{OL} = 3$ mA	1.65		0.3	
		$I_{OL} = 100\ \mu A$	1.4 - 1.6		0.2	
		$I_{OL} = 2$ mA	1.4		0.35	
V_{OL}	LOW Level Output Voltage B 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	
		$I_{OL} = 100\ \mu A$	2.3 - 2.7		0.2	
		$I_{OL} = 12$ mA	2.3		0.4	
		$I_{OL} = 18$ mA	2.3		0.6	
		$I_{OL} = 100\ \mu A$	1.65 - 2.3		0.2	
		$I_{OL} = 6$ mA	1.65		0.3	
		$I_{OL} = 100\ \mu A$	1.4 - 1.6		0.2	
		$I_{OL} = 2$ mA	1.4		0.35	
I_I	Input Leakage Current	$0V \leq V_I \leq 3.6V$	2.7 - 3.6		±5.0	µA
I_{OZ}	3-STATE Output Leakage	$0V \leq V_O \leq 3.6V$ $V_I = V_{IH}$ or V_{IL}	2.7 - 3.6		±10	µA
I_{OFF}	Power Off Leakage Current	$0V \leq (V_I, V_O) \leq 3.6V$	0		10	µA
I_{CC}	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.7 - 3.6		20	µA
		$V_{CC} \leq (V_I, V_O) \leq 3.6V$ (Note 5)	2.7 - 3.6		±20	
ΔI_{CC}	Increase in I_{CC} per Input	$V_{IH} = V_{CC} - 0.6V$	2.7 - 3.6		750	µA

Note 5: Outputs disabled or 3-STATE only.

AC Electrical Characteristics (Note 6)

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = -40°C$ to $+85°C$ Min	Max	Units	Figure Number
t_{PHL}, t_{PLH}	Propagation Delay B to A	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	3.4	ns	Figures 1, 2
			2.5 ± 0.2	1.0	4.3		
			1.8 ± 0.15	1.5	8.6		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	17.2		Figures 5, 6
t_{PZL}, t_{PZH}	Output Enable Time B to A	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	4.2	ns	Figures 1, 3, 4
			2.5 ± 0.2	1.0	5.7		
			1.8 ± 0.15	1.5	9.8		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	19.6		Figures 5, 7, 8
t_{PLZ}, t_{PHZ}	Output Disable Time B to A	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	4.1	ns	Figures 1, 3, 4
			2.5 ± 0.2	1.0	4.8		
			1.8 ± 0.15	1.5	8.6		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	17.2		Figures 5, 7, 8
t_{PHL}, t_{PLH}	Propagation Delay A to B	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	2.5	ns	Figures 1, 2
			2.5 ± 0.2	1.0	3.0		
			1.8 ± 0.15	1.5	6.0		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	12.0		Figures 5, 6
t_{PZL}, t_{PZH}	Output Enable Time A to B	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	3.5	ns	Figures 1, 3, 4
			2.5 ± 0.2	1.0	4.1		
			1.8 ± 0.15	1.5	8.2		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	16.4		Figures 5, 7, 8
t_{PLZ}, t_{PHZ}	Output Disable Time A to B	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	3.5	ns	Figures 1, 3, 4
			2.5 ± 0.2	1.0	3.8		
			1.8 ± 0.15	1.5	6.8		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	13.6		Figures 5, 7, 8
t_{OSHL}, t_{OSLH}	Output-to-Output Skew (Note 7)	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3		0.5	ns	
			2.5 ± 0.2		0.5		
			1.8 ± 0.15		0.75		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1		1.5		

Note 6: For $C_L = 50$pF, add approximately 300ps to the AC maximum specification.

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}).

Dynamic Switching Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = +25°C$ Typical	Units
V_{OLP}	Quiet Output Dynamic Peak V_{OL}, A to B	$C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.8 2.5 3.3	0.25 0.6 0.8	V
V_{OLP}	Quiet Output Dynamic Peak V_{OL}, B to A	$C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.8 2.5 3.3	0.15 0.25 0.35	V
V_{OLV}	Quiet Output Dynamic Valley V_{OL}, A to B	$C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.8 2.5 3.3	−0.25 −0.6 −0.8	V
V_{OLV}	Quiet Output Dynamic Valley V_{OL}, B to A	$C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.8 2.5 3.3	−0.15 −0.25 −0.35	V
V_{OHV}	Quiet Output Dynamic Valley V_{OH}, A to B	$C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.8 2.5 3.3	1.5 1.9 2.2	V
V_{OHV}	Quiet Output Dynamic Valley V_{OH}, B to A	$C_L = 30$ pF, $V_{IH} = V_{CC}$, $V_{IL} = 0V$	1.8 2.5 3.3	1.55 2.05 2.65	V

Capacitance

Symbol	Parameter	Conditions	$T_A = +25°C$	Units
C_{IN}	Input Capacitance	$V_{CC} = 1.8V, 2.5V$, or $3.3V$, $V_I = 0V$ or V_{CC}	6	pF
$C_{I/O}$	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)

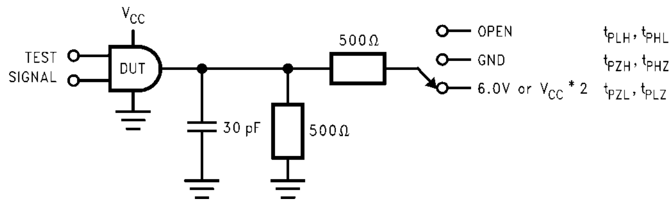


FIGURE 1. AC Test Circuit

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

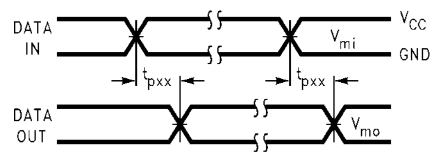


FIGURE 2. Waveform for Inverting and Non-inverting Functions

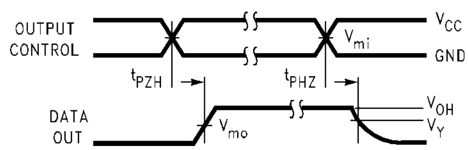


FIGURE 3. 3-STATE Output HIGH Enable and Disable Times for LOW Voltage Logic

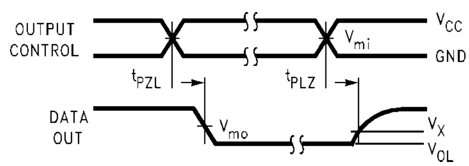


FIGURE 4. 3-STATE Output LOW Enable and Disable Times for LOW Voltage Logic

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} 1.5V ± 0.1V)

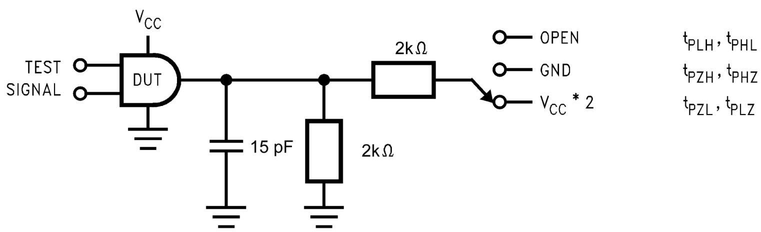


FIGURE 5. AC Test Circuit

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

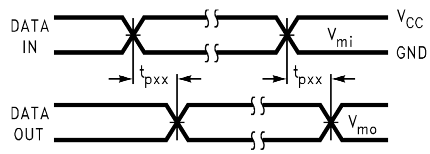


FIGURE 6. Waveform for Inverting and Non-inverting Functions

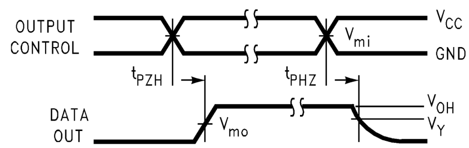


FIGURE 7. 3-STATE Output HIGH Enable and Disable Times for LOW Voltage Logic

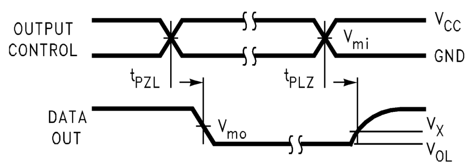
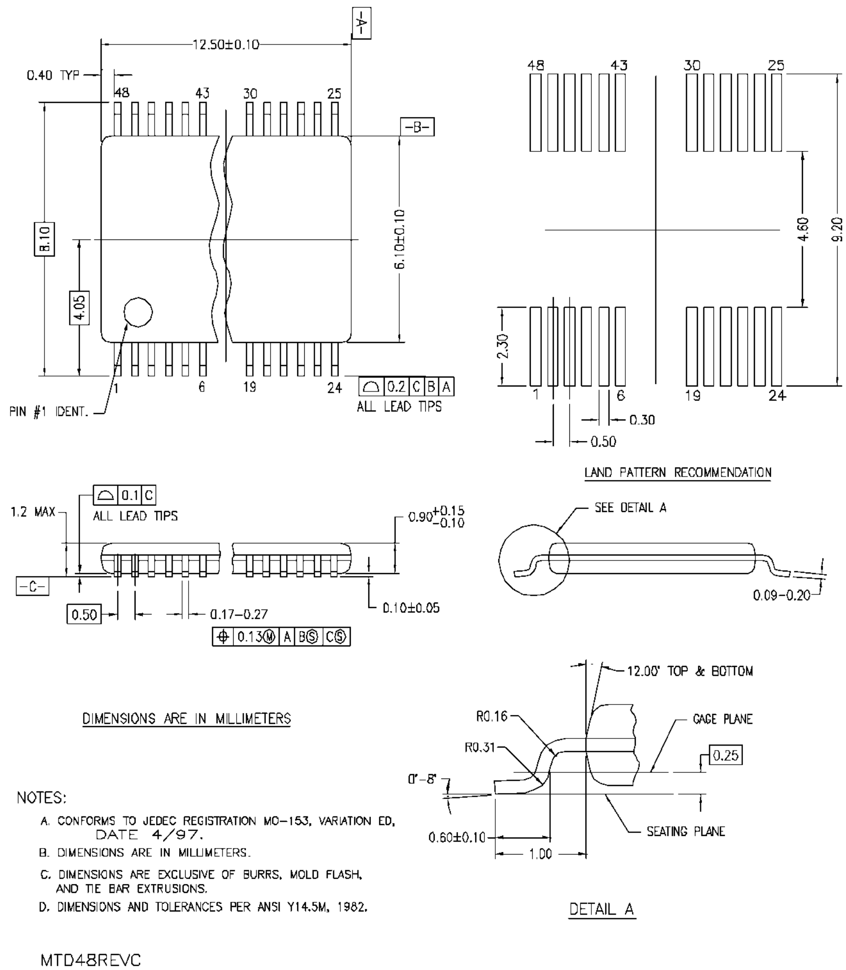


FIGURE 8. 3-STATE Output LOW Enable and Disable Times for LOW Voltage Logic

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



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

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