



December 2000
Revised November 2002

74VCX32374

Low Voltage 32-Bit D-Type Flip-Flops with 3.6V Tolerant Inputs and Outputs

General Description

The VCX32374 contains thirty-two 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 32-bit operation.

The 74VCX32374 is designed for low voltage (1.2V to 3.6V) V_{CC} applications with I/O compatibility up to 3.6V.

The 74VCX32374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

Features

- 1.2V to 3.6V V_{CC} supply operation
- 3.6V tolerant inputs and outputs
- t_{PD}
3.0 ns max for 3.0V to 3.6V V_{CC}
- Power-off high impedance inputs and outputs
- Supports live insertion and withdrawal (Note 1)
- Static Drive (I_{OH}/I_{OL})
 ± 24 mA @ 3.0V V_{CC}
- Uses patented noise/EMI reduction circuitry
- Latch-up performance exceeds 300 mA
- ESD performance:
Human body model > 2000V
Machine model > 200V
- Packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

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.

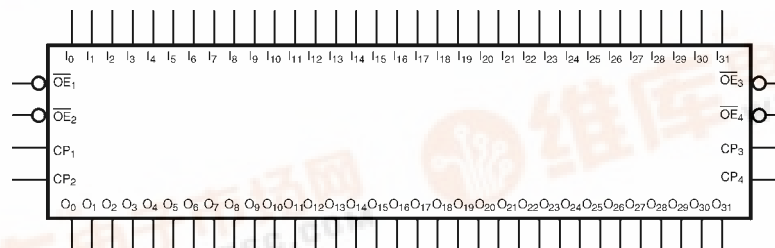
Ordering Code:

Order Number	Package Number	Package Descriptions
74VCX32374G (Note 2)(Note 3)	BGA96A	96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide

Note 2: Ordering code "G" indicates Trays.

Note 3: Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

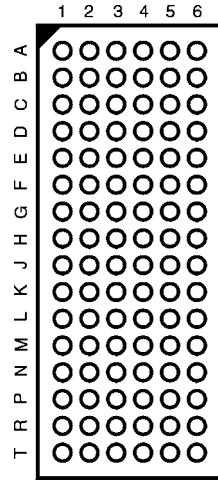
Logic Symbol



74VCX32374 Low Voltage 32-Bit D-Type Flip-Flops with 3.6V Tolerant Inputs and Outputs



Connection Diagram



(Top Thru View)

Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
CP_n	Clock Pulse Input
I_0-I_{31}	Inputs
O_0-O_{31}	Outputs

FBGA Pin Assignments

	1	2	3	4	5	6
A	O_1	O_0	$\overline{OE}_1$	CP_1	I_0	I_1
B	O_3	O_2	GND	GND	I_2	I_3
C	O_5	O_4	V_{CC}	V_{CC}	I_4	I_5
D	O_7	O_6	GND	GND	I_6	I_7
E	O_9	O_8	GND	GND	I_8	I_9
F	O_{11}	O_{10}	V_{CC}	V_{CC}	I_{10}	I_{11}
G	O_{13}	O_{12}	GND	GND	I_{12}	I_{13}
H	O_{14}	O_{15}	$\overline{OE}_2$	CP_2	I_{15}	I_{14}
J	O_{17}	O_{16}	$\overline{OE}_3$	CP_3	I_{16}	I_{17}
K	O_{19}	O_{18}	GND	GND	I_{18}	I_{19}
L	O_{21}	O_{20}	V_{CC}	V_{CC}	I_{20}	I_{21}
M	O_{23}	O_{22}	GND	GND	I_{22}	I_{23}
N	O_{25}	O_{24}	GND	GND	I_{24}	I_{25}
P	O_{27}	O_{26}	V_{CC}	V_{CC}	I_{26}	I_{27}
R	O_{29}	O_{28}	GND	GND	I_{28}	I_{29}
T	O_{30}	O_{31}	$\overline{OE}_4$	CP_4	I_{31}	I_{30}

Truth Tables

Inputs			Outputs
CP_1	$\overline{OE}_1$	I_0-I_7	O_0-O_7
$\nearrow$	L	H	H
$\nearrow$	L	L	L
L	L	X	O_0
X	H	X	Z

Inputs			Outputs
CP_2	$\overline{OE}_2$	I_8-I_{15}	O_8-O_{15}
$\nearrow$	L	H	H
$\nearrow$	L	L	L
L	L	X	O_0
X	H	X	Z

Inputs			Outputs
CP_3	$\overline{OE}_3$	$I_{16}-I_{23}$	$O_{16}-O_{23}$
$\nearrow$	L	H	H
$\nearrow$	L	L	L
L	L	X	O_0
X	H	X	Z

Inputs			Outputs
CP_4	$\overline{OE}_4$	$I_{24}-I_{31}$	$O_{24}-O_{31}$
$\nearrow$	L	H	H
$\nearrow$	L	L	L
L	L	X	O_0
X	H	X	Z

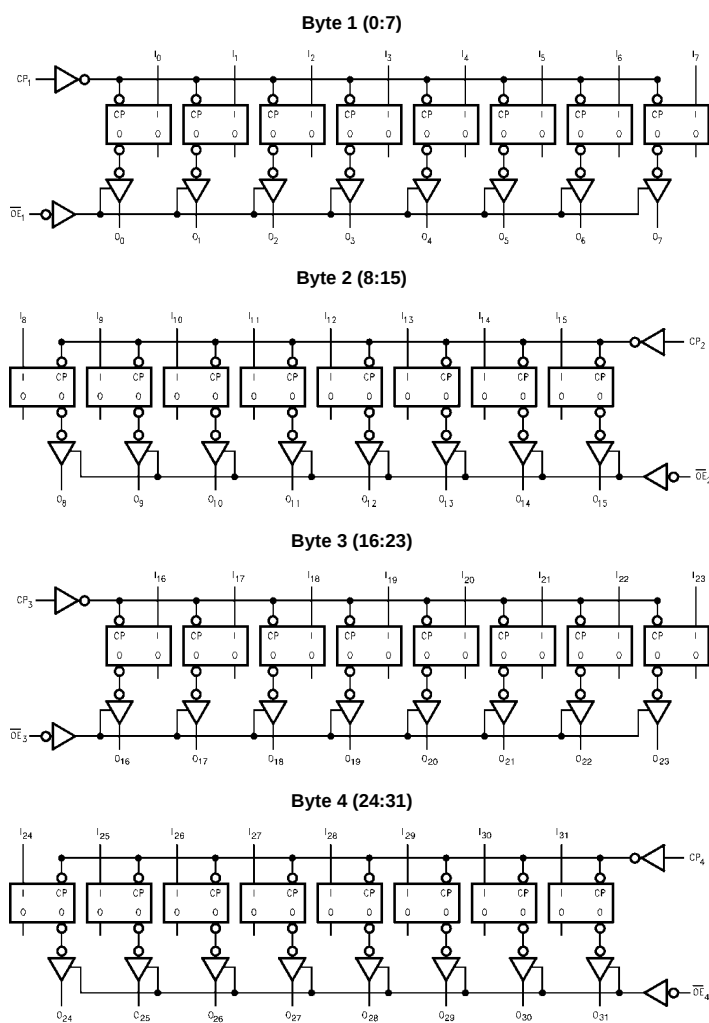
H = HIGH Voltage Level
 L = LOW Voltage Level
 X = Immaterial (HIGH or LOW, inputs may not float)
 Z = High Impedance
 O_0 = Previous O_0 before HIGH-to-LOW of CP

Functional Description

The 74VCX32374 consists of thirty-two 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 32-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_n) 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 Diagrams



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 4)

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-STATED	-0.5V to +4.6V
Outputs Active (Note 5)	-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 6)

Power Supply	
Operating	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}	
$V_{CC} = 3.0V$ 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
$V_{CC} = 1.2V$	± 100 μA
Free Air Operating Temperature (T_A)	-40°C to +85°C
Minimum Input Edge Rate ($\Delta I/\Delta V$)	
$V_{IN} = 0.8V$ to 2.0V, $V_{CC} = 3.0V$	10 ns/V

Note 4: 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 5: I_O Absolute Maximum Rating must be observed.

Note 6: 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 2.3 - 2.7 1.65 - 2.3 1.4 - 1.6 1.2	2.0 1.6 $0.65 \times V_{CC}$ $0.65 \times V_{CC}$ $0.65 \times V_{CC}$		V
V_{IL}	LOW Level Input Voltage		2.7 - 3.6 2.3 - 2.7 1.65 - 2.3 1.4 - 1.6 1.2		0.8 0.7 $0.35 \times V_{CC}$ $0.35 \times V_{CC}$ $0.05 \times V_{CC}$	V
V_{OH}	HIGH Level Output Voltage	$I_{OH} = -100 \mu A$ $I_{OH} = -12$ mA $I_{OH} = -18$ mA $I_{OH} = -24$ mA $I_{OH} = -100 \mu A$ $I_{OH} = -6$ mA $I_{OH} = -12$ mA $I_{OH} = -18$ mA $I_{OH} = -100 \mu A$ $I_{OH} = -6$ mA $I_{OH} = -100 \mu A$ $I_{OH} = -2$ mA $I_{OH} = -100 \mu A$	2.7 - 3.6 2.7 3.0 3.0 2.3 - 2.7 2.3 2.3 2.3 1.65 - 2.3 1.65 1.4 - 1.6 1.4 1.2	$V_{CC} - 0.2$ 2.2 2.4 2.2 $V_{CC} - 0.2$ 2.0 1.8 1.7 $V_{CC} - 0.2$ 1.25 $V_{CC} - 0.2$ 1.05 $V_{CC} - 0.2$		V

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V _{CC} (V)	Min	Max	Units
V _{OL}	LOW Level Output Voltage	I _{OL} = 100 μ 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 μ A	2.7 - 2.7		0.2	
		I _{OL} = 12 mA	2.3		0.4	
		I _{OL} = 18 mA	2.3		0.6	
		I _{OL} = 100 μ A	1.65 - 2.3		0.2	
		I _{OL} = 6 mA	1.65		0.3	
I _I	Input Leakage Current	0 $\leq$ V _I $\leq$ 3.6V	1.2 - 3.6		$\pm$ 5.0	μ A
I _{OZ}	3-STATE Output Leakage	0 $\leq$ V _O $\leq$ 3.6V V _I = V _{IH} or V _{IL}	1.2 - 3.6		$\pm$ 10	μ A
I _{OFF}	Power-OFF Leakage Current	0 $\leq$ (V _I , V _O) $\leq$ 3.6V	0		10	μ A
I _{CC}	Quiescent Supply Current	V _I = V _{CC} or GND	1.2 - 3.6		40	μ A
Δ I _{CC}	Increase in I _{CC} per Input	V _{CC} $\leq$ (V _I , V _O) $\leq$ 3.6V (Note 7)	1.2 - 3.6		$\pm$ 40	μ A
		V _{IH} = V _{CC} - 0.6V	2.7 - 3.6		750	μ A

Note 7: Outputs disabled or 3-STATE only.

AC Electrical Characteristics (Note 8)

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = -40°C to +85°C		Units	Figure Number
				Min	Max		
f _{MAX}	Maximum Clock Frequency Setup Time	C _L = 30 pF, R _L = 500 Ω	3.3 $\pm$ 0.3	250		MHz	
			2.5 $\pm$ 0.2	200			
			1.8 $\pm$ 0.15	100			
		C _L = 15 pF, R _L = 2k Ω	1.5 $\pm$ 0.1	80			
			1.2	40			
t _{PHL} , t _{PLH}	Propagation Delay	C _L = 30 pF, R _L = 500 Ω	3.3 $\pm$ 0.3	0.8	3.0	ns	Figures 1, 2
			2.5 $\pm$ 0.2	1.0	3.9		
			1.8 $\pm$ 0.15	1.5	7.8		
		C _L = 15 pF, R _L = 2k Ω	1.5 $\pm$ 0.1	1.0	15.6		Figures 7, 8
			1.2	1.5	39		
t _{PZL} , t _{PZH}	Output Enable Time	C _L = 30 pF, R _L = 500 Ω	3.3 $\pm$ 0.3	0.8	3.5	ns	Figures 1, 3, 4
			2.5 $\pm$ 0.2	1.0	4.6		
			1.8 $\pm$ 0.15	1.5	9.2		
		C _L = 15 pF, R _L = 2k Ω	1.5 $\pm$ 0.1	1.0	18.4		Figures 7, 9, 10
			1.2	1.5	46		
t _{PLZ} , t _{PHZ}	Output Disable Time	C _L = 30 pF, R _L = 500 Ω	3.3 $\pm$ 0.3	0.8	3.5	ns	Figures 1, 3, 4
			2.5 $\pm$ 0.2	1.0	3.8		
			1.8 $\pm$ 0.15	1.5	6.8		
		C _L = 15 pF, R _L = 2k Ω	1.5 $\pm$ 0.1	1.0	13.6		Figures 7, 9, 10
			1.2	1.5	34		
t _S	Setup Time	C _L = 30 pF, R _L = 500 Ω	3.3 $\pm$ 0.3	1.5		ns	Figures 1, 6
			2.5 $\pm$ 0.2	1.5			
			1.8 $\pm$ 0.15	2.5			
		C _L = 15 pF, R _L = 500 Ω	1.5 $\pm$ 0.1	3			Figures 6, 7
			1.2	6			

AC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = -40°C to +85°C		Units	Figure Number
				Min	Max		
t _H	Hold Time	C _L = 30 pF, R _L = 500Ω	3.3 ± 0.3	1.0		ns	Figures 1, 6
			2.5 ± 0.2	1.0			
			1.8 ± 0.15	1.0			
		C _L = 15 pF, R _L = 500Ω	1.5 ± 0.1	2.0			Figures 6, 7
			1.2	6			
t _W	Pulse Width	C _L = 30 pF, R _L = 500Ω	3.3 ± 0.3	1.5		ns	Figures 1, 5
			2.5 ± 0.2	1.5			
			1.8 ± 0.15	4.0			
		C _L = 15 pF, R _L = 500Ω	1.5 ± 0.1	4.0			Figures 5, 7
			1.2	8			

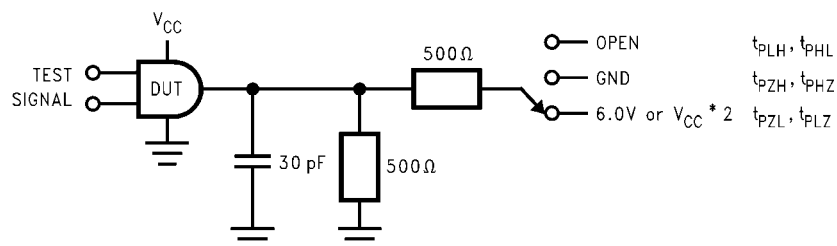
Note 8: For C_L = 50 pF, add approximately 300 ps to the AC maximum specification.

Dynamic Switching Characteristics

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = +25°C	Units
				Typical	
V _{OLP}	Quiet Output Dynamic Peak V _{OL}	C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0V	1.8	0.25	V
			2.5	0.6	
			3.3	0.8	
V _{OLV}	Quiet Output Dynamic Valley V _{OL}	C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0V	1.8	-0.25	V
			2.5	-0.6	
			3.3	-0.8	
V _{OHV}	Quiet Output Dynamic Valley V _{OH}	C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0V	1.8	1.5	V
			2.5	1.9	
			3.3	2.2	

Capacitance

Symbol	Parameter	Conditions	T _A = +25°C	Units
			Typical	
C _{IN}	Input Capacitance	V _{CC} = 1.8V, 2.5V or 3.3V, V _I = 0V or V _{CC}	6	pF
C _{OUT}	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



TEST	SWITCH
t _{PLH} , t _{PHL}	Open
t _{PLZ} , t _{PLZ}	6V at V _{CC} = 3.3V ± 0.3V; V _{CC} × 2V at V _{CC} = 2.5V ± 0.2V; 1.8V ± 0.15V
t _{PZH} , t _{PHZ}	GND

FIGURE 1. AC Test Circuit

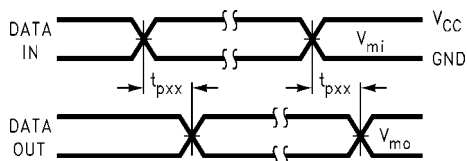


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

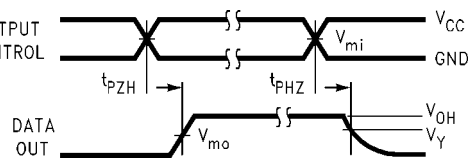


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

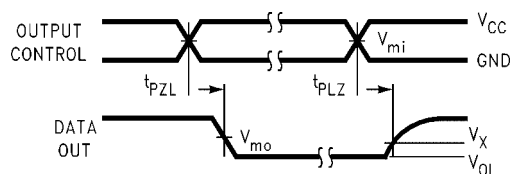


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

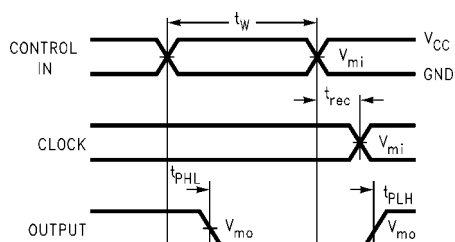


FIGURE 5. Propagation Delay, Pulse Width and t_{rec} Waveforms

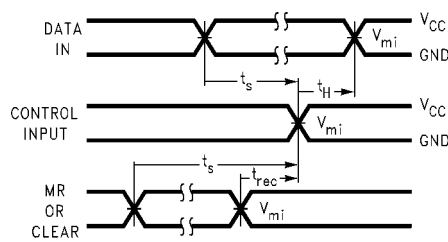
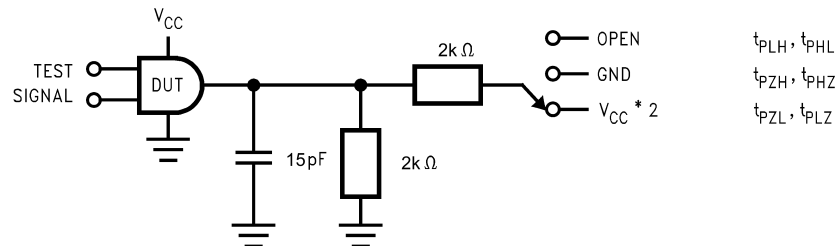


FIGURE 6. Setup Time, Hold Time and Recovery Time for Low Voltage Logic

Symbol	V _{CC}		
	3.3V ± 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 ($V_{CC} 1.5V \pm 0.1V$ to $1.2V$)



TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	$V_{CC} \times 2V$ at $V_{CC} = 1.5V \pm 0.1V$
t_{PZH}, t_{PHZ}	GND

FIGURE 7. AC Test Circuit

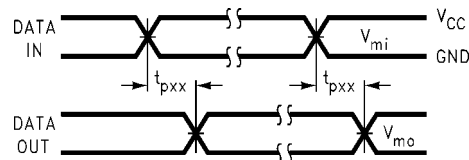


FIGURE 8. Waveform for Inverting and Non-Inverting Functions

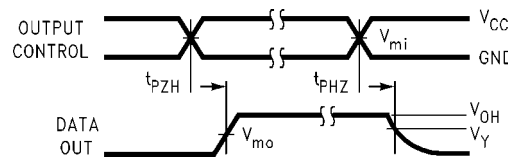


FIGURE 9. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

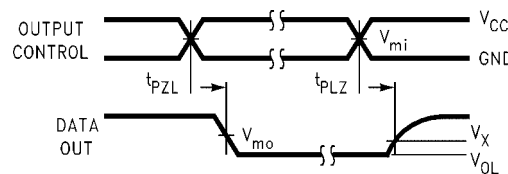
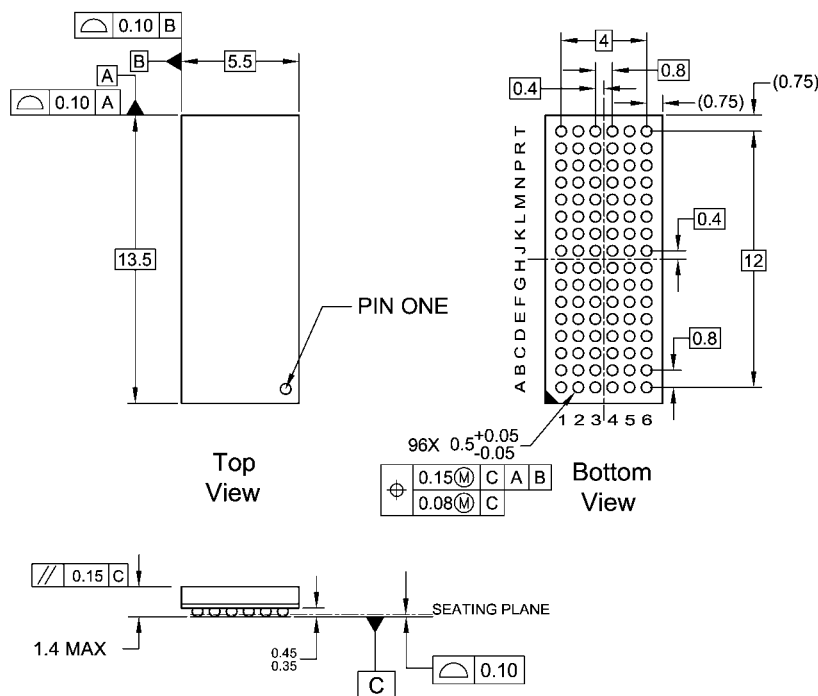


FIGURE 10. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

Symbol	V_{CC}
	$1.5V \pm 0.1V$
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



NOTES:

- A. THIS PACKAGE CONFORMS TO JEDEC MO-205
- B. ALL DIMENSIONS IN MILLIMETERS
- C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)
.35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS
- D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA96ArevE

**96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
Package Number BGA96A**

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