



August 2001  
Revised August 2001

# 74VCX32245

## Low Voltage 32-Bit Bidirectional Transceiver with 3.6V Tolerant Inputs and Outputs (Preliminary)

### General Description

The VCX32245 contains thirty-two 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 32-bit operation. The  $\overline{T/R}$  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 74VCX32245 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications with I/O compatibility up to 3.6V.

The 74VCX32245 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

### Features

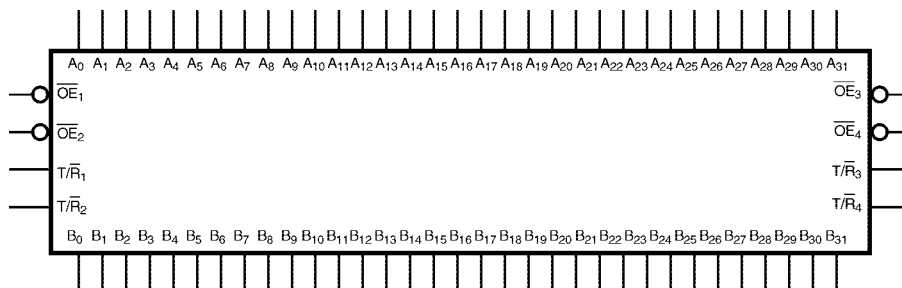
- 1.65V–3.6V  $V_{CC}$  supply operation
  - 3.6V tolerant inputs and outputs
  - $t_{PD}$ 
    - 2.5 ns max for 3.0V to 3.6V  $V_{CC}$
    - 3.0 ns max for 2.3V to 2.7V  $V_{CC}$
    - 6.0 ns max for 1.65V to 1.95V  $V_{CC}$
  - Power-down high impedance inputs and outputs
  - Supports live insertion/withdrawal (Note 1)
  - Static Drive ( $I_{OH}/I_{OL}$ )
    - $\pm 24$  mA @ 3.0V  $V_{CC}$
    - $\pm 18$  mA @ 2.3V  $V_{CC}$
    - $\pm 6$  mA @ 1.65V  $V_{CC}$
  - Uses patented noise/EMI reduction circuitry
  - Latchup 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 Description
74VCX32245GX (Note 2)	BGA96A	96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [Tape and Reel]

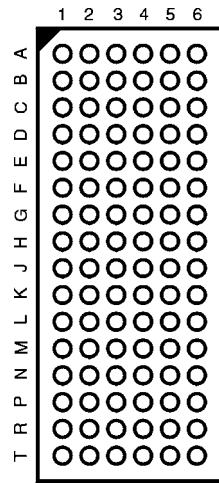
**Note 2:** BGA package available in Tape and Reel only.

### Logic Symbol



74VCX32245 Low Voltage 32-Bit Bidirectional Transceiver with 3.6V Tolerant Inputs and Outputs (Preliminary)

Connection Diagram



(Top Thru View)

Truth Tables

Inputs		Outputs
$\overline{OE}_1$	$T/\overline{R}_1$	
L	L	Bus B <sub>0</sub> -B <sub>7</sub> Data to Bus A <sub>0</sub> -A <sub>7</sub>
L	H	Bus A <sub>0</sub> -A <sub>7</sub> Data to Bus B <sub>0</sub> -B <sub>7</sub>
H	X	HIGH Z State on A <sub>0</sub> -A <sub>7</sub> , B <sub>0</sub> -B <sub>7</sub>

Inputs		Outputs
$\overline{OE}_2$	$T/\overline{R}_2$	
L	L	Bus B <sub>8</sub> -B <sub>15</sub> Data to Bus A <sub>8</sub> -A <sub>15</sub>
L	H	Bus A <sub>8</sub> -A <sub>15</sub> Data to Bus B <sub>8</sub> -B <sub>15</sub>
H	X	HIGH Z State on A <sub>8</sub> -A <sub>15</sub> , B <sub>8</sub> -B <sub>15</sub>

Inputs		Outputs
$\overline{OE}_3$	$T/\overline{R}_3$	
L	L	Bus B <sub>16</sub> -B <sub>23</sub> Data to Bus A <sub>16</sub> -A <sub>23</sub>
L	H	Bus A <sub>16</sub> -A <sub>23</sub> Data to Bus B <sub>16</sub> -B <sub>23</sub>
H	X	HIGH Z State on A <sub>16</sub> -A <sub>23</sub> , B <sub>16</sub> -B <sub>23</sub>

Inputs		Outputs
$\overline{OE}_4$	$T/\overline{R}_4$	
L	L	Bus B <sub>24</sub> -B <sub>31</sub> Data to Bus A <sub>24</sub> -A <sub>31</sub>
L	H	Bus A <sub>24</sub> -A <sub>31</sub> Data to Bus B <sub>24</sub> -B <sub>31</sub>
H	X	HIGH Z State on A <sub>24</sub> -A <sub>31</sub> , B <sub>24</sub> -B <sub>31</sub>

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

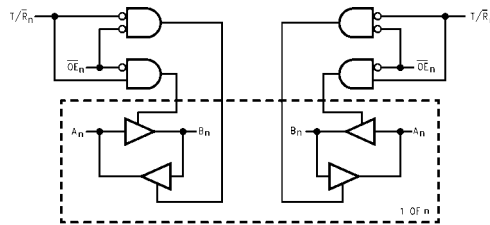
Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
$T/\overline{R}_n$	Transmit/Receive Input
A <sub>0</sub> -A <sub>31</sub>	Side A Inputs or 3-STATE Outputs
B <sub>0</sub> -B <sub>31</sub>	Side B Inputs or 3-STATE Outputs

FBGA Pin Assignments

	1	2	3	4	5	6
<b>A</b>	B <sub>1</sub>	B <sub>0</sub>	$T/\overline{R}_1$	$\overline{OE}_1$	A <sub>0</sub>	A <sub>1</sub>
<b>B</b>	B <sub>3</sub>	B <sub>2</sub>	GND	GND	A <sub>2</sub>	A <sub>3</sub>
<b>C</b>	B <sub>5</sub>	B <sub>4</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>4</sub>	A <sub>5</sub>
<b>D</b>	B <sub>7</sub>	B <sub>6</sub>	GND	GND	A <sub>6</sub>	A <sub>7</sub>
<b>E</b>	B <sub>9</sub>	B <sub>8</sub>	GND	GND	A <sub>8</sub>	A <sub>9</sub>
<b>F</b>	B <sub>11</sub>	B <sub>10</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>10</sub>	A <sub>11</sub>
<b>G</b>	B <sub>13</sub>	B <sub>12</sub>	GND	GND	A <sub>12</sub>	A <sub>13</sub>
<b>H</b>	B <sub>14</sub>	B <sub>15</sub>	$T/\overline{R}_2$	$\overline{OE}_2$	A <sub>15</sub>	A <sub>14</sub>
<b>J</b>	B <sub>17</sub>	B <sub>16</sub>	$T/\overline{R}_3$	$\overline{OE}_3$	A <sub>16</sub>	A <sub>17</sub>
<b>K</b>	B <sub>19</sub>	B <sub>18</sub>	GND	GND	A <sub>18</sub>	A <sub>19</sub>
<b>L</b>	B <sub>21</sub>	B <sub>20</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>20</sub>	A <sub>21</sub>
<b>M</b>	B <sub>23</sub>	B <sub>22</sub>	GND	GND	A <sub>22</sub>	A <sub>23</sub>
<b>N</b>	B <sub>25</sub>	B <sub>24</sub>	GND	GND	A <sub>24</sub>	A <sub>25</sub>
<b>P</b>	B <sub>27</sub>	B <sub>26</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>26</sub>	A <sub>27</sub>
<b>R</b>	B <sub>29</sub>	B <sub>28</sub>	GND	GND	A <sub>28</sub>	A <sub>29</sub>
<b>T</b>	B <sub>30</sub>	B <sub>31</sub>	$T/\overline{R}_4$	$\overline{OE}_4$	A <sub>31</sub>	A <sub>30</sub>

Logic Diagram



Absolute Maximum Ratings (Note 3)		Recommended Operating Conditions (Note 5)	
Supply Voltage ( $V_{CC}$ )	-0.5V to +4.6V	Power Supply	
DC Input Voltage ( $V_I$ )	-0.5V to +4.6V	Operating	1.65V to 3.6V
Output Voltage ( $V_O$ )		Data Retention Only	1.2V to 3.6V
Outputs 3-STATE	-0.5V to +4.6V	Input Voltage	-0.3V to 3.6V
Outputs Active (Note 4)	-0.5 to $V_{CC} + 0.5V$	Output Voltage ( $V_O$ )	
DC Input Diode Current ( $I_{IK}$ ) $V_I < 0V$	-50 mA	Output in Active States	0V to $V_{CC}$
DC Output Diode Current ( $I_{OK}$ )		Output in 3-STATE	0.0V to 3.6V
$V_O < 0V$	-50 mA	Output Current in $I_{OH}/I_{OL}$	
$V_O > V_{CC}$	+50 mA	$V_{CC} = 3.0V$ to $3.6V$	$\pm 24$ mA
DC Output Source/Sink Current ( $I_{OH}/I_{OL}$ )	$\pm 50$ mA	$V_{CC} = 2.3V$ to $2.7V$	$\pm 18$ mA
DC $V_{CC}$ or Ground Current per Supply Pin ( $I_{CC}$ or Ground)	$\pm 100$ mA	$V_{CC} = 1.65V$ to $2.3V$	$\pm 6$ mA
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C	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" table are not guaranteed at the Absolute Maximum Ratings. The Recommended Operating Conditions tables will define the conditions for actual device operation.

**Note 4:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 5:** Floating or unused pin (inputs or I/O's) 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	$I_{OH} = -100 \mu A$ $I_{OH} = -12 \text{ mA}$ $I_{OH} = -18 \text{ mA}$ $I_{OH} = -24 \text{ mA}$	2.7-3.6 2.7 3.0 3.0	$V_{CC} - 0.2$ 2.2 2.4 2.2		V
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu A$ $I_{OL} = 12 \text{ mA}$ $I_{OL} = 18 \text{ mA}$ $I_{OL} = 24 \text{ mA}$	2.7-3.6 2.7 3.0 3.0		0.2 0.4 0.4 0.55	V
$I_I$	Input Leakage Current	$0V \leq V_I \leq 3.6V$	2.7-3.6		$\pm 5.0$	$\mu A$
$I_{OZ}$	3-STATE Output Leakage	$0V \leq V_O \leq 3.6V$ $V_I = V_{IH}$ or $V_{IL}$	2.7-3.6		$\pm 10$	$\mu A$
$I_{OFF}$	Power Off Leakage Current	$0V \leq (V_I, V_O) \leq 3.6V$	0		10	$\mu A$
$I_{CC}$	Quiescent Supply Current	$V_I = V_{CC}$ or GND $V_{CC} \leq (V_I, V_O) \leq 3.6V$ (Note 6)	2.7-3.6 2.7-3.6		40 $\pm 40$	$\mu A$
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$V_{IH} = V_{CC} - 0.6V$	2.7-3.6		750	$\mu A$

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

74V CX32245

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	I <sub>OH</sub> = -100 μA I <sub>OH</sub> = -6 mA I <sub>OH</sub> = -12 mA I <sub>OH</sub> = -18 mA	2.3-2.7 2.3 2.3 2.3	V <sub>CC</sub> - 0.2 2.0 1.8 1.7		V
V <sub>OL</sub>	LOW Level Output Voltage	I <sub>OL</sub> = 100 μA I <sub>OL</sub> = 12 mA I <sub>OL</sub> = 18 mA	2.3-2.7 2.3 2.3		0.2 0.4 0.6	V
I <sub>I</sub>	Input Leakage Current	0 ≤ V <sub>I</sub> ≤ 3.6V	2.3-2.7		±5.0	μA
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>I</sub> , 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 V <sub>CC</sub> ≤ (V <sub>I</sub> , V <sub>O</sub> ) ≤ 3.6V (Note 7)	2.3-2.7 2.3-2.7		40 ±40	μA

Note 7: Outputs disabled or 3-STATE only.

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 × 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 I <sub>OH</sub> = -6 mA	1.65-2.3 1.65	V <sub>CC</sub> - 0.2 1.25		V
V <sub>OL</sub>	LOW Level Output Voltage	I <sub>OL</sub> = 100 μA I <sub>OL</sub> = 6 mA	1.65-2.3 1.65		0.2 0.3	V
I <sub>I</sub>	Input Leakage Current	0 ≤ V <sub>I</sub> ≤ 3.6V	1.65-2.3		±5.0	μA
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>I</sub> , 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 V <sub>CC</sub> ≤ (V <sub>I</sub> , V <sub>O</sub> ) ≤ 3.6V (Note 8)	1.65-2.3 1.65-2.3		40 ±40	μA

Note 8: Outputs disabled or 3-STATE only.

AC Electrical Characteristics (Note 9)								
Symbol	Parameter	T <sub>A</sub> = -40°C to +85°C, C <sub>L</sub> = 30 pF, R <sub>L</sub> = 500Ω						Units
		V <sub>CC</sub> = 3.3V ± 0.3V		V <sub>CC</sub> = 2.5 ± 0.2V		V <sub>CC</sub> = 1.8V ± 0.15V		
		Min	Max	Min	Max	Min	Max	
t <sub>PHL</sub> , t <sub>PLH</sub>	Prop Delay	0.8	2.5	1.0	3.0	1.5	6.0	ns
t <sub>PZL</sub> , t <sub>PZH</sub>	Output Enable Time	0.8	3.8	1.0	4.9	1.5	9.3	ns
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Output Disable Time	0.8	3.7	1.0	4.2	1.5	7.6	ns
<b>Note 9:</b> For C <sub>L</sub> = 50pF, add approximately 300ps to the AC maximum specification.								
Dynamic Switching Characteristics								
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = +25°C	Units			
				Typical				
V <sub>OLP</sub>	Quiet Output Dynamic Peak V <sub>OL</sub>	C <sub>L</sub> = 30 pF, V <sub>IH</sub> = V <sub>CC</sub> , V <sub>IL</sub> = 0V	1.8	0.25	V			
			2.5	0.6				
			3.3	0.8				
V <sub>OLV</sub>	Quiet Output Dynamic Valley V <sub>OL</sub>	C <sub>L</sub> = 30 pF, V <sub>IH</sub> = V <sub>CC</sub> , V <sub>IL</sub> = 0V	1.8	-0.25	V			
			2.5	-0.6				
			3.3	-0.8				
V <sub>OHV</sub>	Quiet Output Dynamic Valley V <sub>OH</sub>	C <sub>L</sub> = 30 pF, V <sub>IH</sub> = V <sub>CC</sub> , V <sub>IL</sub> = 0V	1.8	1.5	V			
			2.5	1.9				
			3.3	2.2				
Capacitance								
Symbol	Parameter	Conditions	T <sub>A</sub> = +25°C	Units				
C <sub>IN</sub>	Input Capacitance	V <sub>CC</sub> = 1.8V, 2.5V, or 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub>	6	pF				
C <sub>I/O</sub>	Output Capacitance	V <sub>I</sub> = 0V, or V <sub>CC</sub> , V <sub>CC</sub> = 1.8V, 2.5V or 3.3V	7	pF				
C <sub>PD</sub>	Power Dissipation Capacitance	V <sub>I</sub> = 0V or V <sub>CC</sub> , F = 10 MHz V <sub>CC</sub> = 1.8V, 2.5V or 3.3V	20	pF				

AC Loading and Waveforms

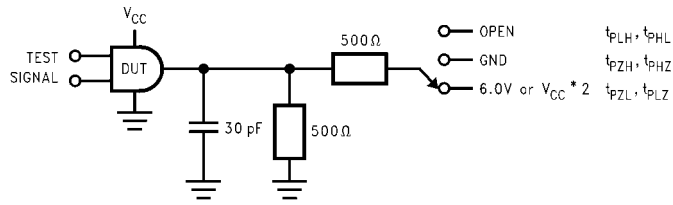


FIGURE 1. AC Test Circuit

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

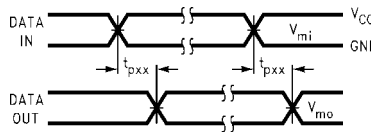


FIGURE 2. Waveform for Inverting and Non-inverting Functions

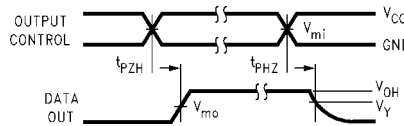


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

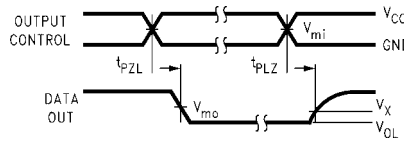
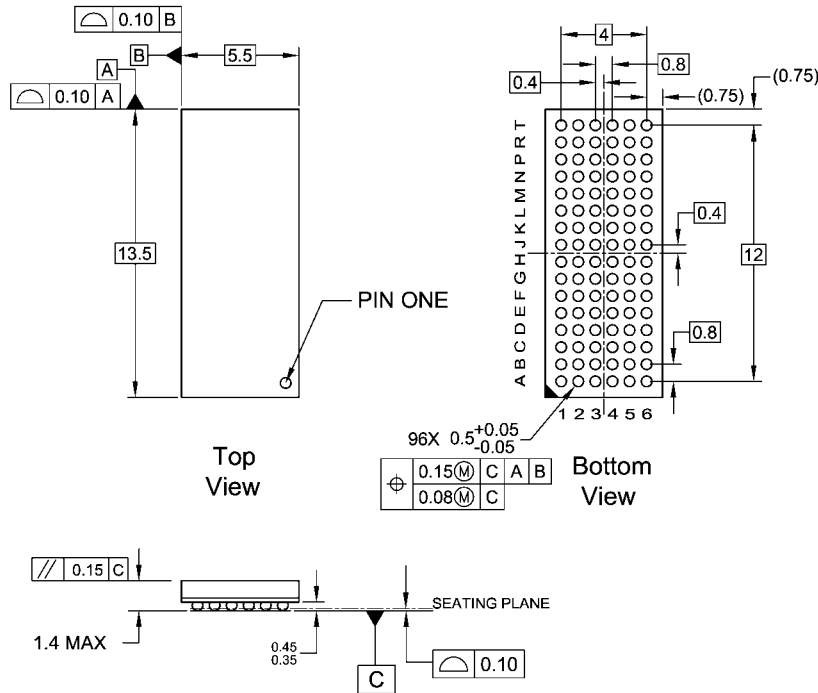


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

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



- NOTES:
- A. THIS PACKAGE CONFORMS TO JEDEC M0-205
  - 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 M0-205, 5.5mm Wide  
Package Number BGA96A**

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