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August 1997 Revised June 2005

#### 74VCX162244

# Low Voltage 16-Bit Buffer/Line Driver with 3.6V Tolerant Inputs and Outputs and $26\Omega$ Series Resistor in Outputs

#### **General Description**

The VCX162244 contains sixteen non-inverting buffers with 3-STATE outputs to be employed as a memory and address driver, clock driver, or bus oriented transmitter/ receiver. The device is nibble (4-bit) controlled. Each nibble has separate 3-STATE control inputs which can be shorted together for full 16-bit operation.

The 74VCX162244 is designed for low voltage (1.2V to 3.6V)  $V_{CC}$  applications with I/O capability up to 3.6V. The 74VCX162244 is also designed with  $26\Omega$  series resistors in the outputs. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus transceivers/transmitters.

The 74VCX162244 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

#### **Features**

- $\blacksquare$  1.2V to 3.6V  $V_{CC}$  supply operation
- 3.6V tolerant inputs and outputs
- $\blacksquare$  26 $\Omega$  series resistors in outputs
- t<sub>PD</sub>

3.3 ns max for 3.0V to 3.6V  $V_{CC}$ 

- Power-off high impedance inputs and outputs
- Supports live insertion and withdrawal
- $\blacksquare \ \ \text{Static Drive} \ (I_{OH}/I_{OL})$

 $\pm$ 12 mA @ 3.0V V<sub>CC</sub>

- Uses proprietary noise/EMI reduction circuitry
- Latch-up performance exceeds 300 mA
- ESD performance:

Human body model > 2000V

 $Machine\ model > 200V$ 

Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

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

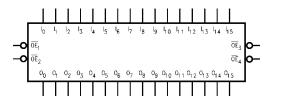
#### **Ordering Code:**

| Order Number                     | Package Number | Package Description   |
|----------------------------------|----------------|---|
| 74VCX162244G<br>(Note 2)(Note 3) | BGA54A         | 54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide         |
| 74VCX162244MTD<br>(Note 3)       | MTD48          | 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

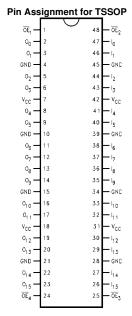
Note 2: Ordering Code "G" indicates Trays

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

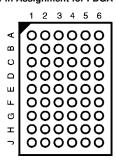
#### Logic Symbol



#### **Connection Diagrams**



Pin Assignment for FBGA



(Top Thru View)

#### **Pin Descriptions**

| Pin Names                       | Description                      |
|---------------------------------|----------------------------------|
| ŌĒn                             | Output Enable Input (Active LOW) |
| I <sub>0</sub> -I <sub>15</sub> | Inputs                           |
| O <sub>0</sub> -O <sub>15</sub> | Outputs                          |
| NC                              | No Connect                       |

#### **FBGA Pin Assignments**

|   | 1               | 2               | 3               | 4               | 5               | 6               |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Α | O <sub>0</sub>  | NC              | OE <sub>1</sub> | OE <sub>2</sub> | NC              | I <sub>0</sub>  |
| В | O <sub>2</sub>  | O <sub>1</sub>  | NC              | NC              | I <sub>1</sub>  | l <sub>2</sub>  |
| С | O <sub>4</sub>  | Ο3              | V <sub>CC</sub> | V <sub>CC</sub> | I <sub>3</sub>  | I <sub>4</sub>  |
| D | O <sub>6</sub>  | O <sub>5</sub>  | GND             | GND             | I <sub>5</sub>  | I <sub>6</sub>  |
| E | O <sub>8</sub>  | O <sub>7</sub>  | GND             | GND             | I <sub>7</sub>  | I <sub>8</sub>  |
| F | O <sub>10</sub> | O <sub>9</sub>  | GND             | GND             | l <sub>9</sub>  | I <sub>10</sub> |
| G | O <sub>12</sub> | O <sub>11</sub> | V <sub>CC</sub> | V <sub>CC</sub> | I <sub>11</sub> | I <sub>12</sub> |
| Н | O <sub>14</sub> | O <sub>13</sub> | NC              | NC              | I <sub>13</sub> | I <sub>14</sub> |
| J | O <sub>15</sub> | NC              | OE <sub>4</sub> | OE <sub>3</sub> | NC              | I <sub>15</sub> |

#### **Truth Tables**

| Inputs          |                                | Outputs                        |
|-----------------|--------------------------------|--------------------------------|
| OE <sub>1</sub> | I <sub>0</sub> –I <sub>3</sub> | O <sub>0</sub> -O <sub>3</sub> |
| L               | L                              | L                              |
| L               | Н                              | Н                              |
| Н               | Χ                              | Z                              |

| Inp             | outs                           | Outputs                        |
|-----------------|--------------------------------|--------------------------------|
| OE <sub>2</sub> | I <sub>4</sub> –I <sub>7</sub> | O <sub>4</sub> -O <sub>7</sub> |
| L               | L                              | L                              |
| L               | Н                              | Н                              |
| Н               | X                              | Z                              |

| Inp             | outs                            | Outputs                         |
|-----------------|---------------------------------|---------------------------------|
| ŌE <sub>3</sub> | I <sub>8</sub> –I <sub>11</sub> | O <sub>8</sub> -O <sub>11</sub> |
| L               | L                               | L                               |
| L               | Н                               | Н                               |
| Н               | X                               | Z                               |

| Inj             | outs                             | Outputs                          |
|-----------------|----------------------------------|----------------------------------|
| ŌE <sub>4</sub> | I <sub>12</sub> –I <sub>15</sub> | O <sub>12</sub> -O <sub>15</sub> |
| L               | L                                | L                                |
| L               | Н                                | Н                                |
| Н               | X                                | Z                                |

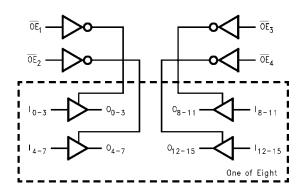
H = HIGH Voltage Level L = LOW Voltage Level X = Immaterial (HIGH or LOW, inputs may not float) Z = High Impedance

#### **Functional Description**

The 74VCX162244 contains sixteen non-inverting buffers with 3-STATE outputs. The device is nibble (4 bits) controlled with each nibble functioning identically, but independent of each other. The control pins may be shorted together to obtain full 16-bit operation. The 3-STATE out-

puts are controlled by an Output Enable  $(\overline{OE}_n)$  input. When  $\overline{OE}_n$  is LOW, the outputs are in the 2-state mode. When  $\overline{OE}_n$  is HIGH, the standard outputs are in the high impedance mode but this does not interfere with entering new data into the inputs.

#### **Logic Diagram**



#### **Absolute Maximum Ratings**(Note 4)

#### Supply Voltage (V<sub>CC</sub>) -0.5V to +4.6V DC Input Voltage (V<sub>I</sub>) -0.5V to +4.6V Output Voltage (V<sub>O</sub>)

Outputs 3-STATE Outputs Active (Note 5) -0.5V to  $V_{CC}$  +0.5V

DC Input Diode Current ( $I_{IK}$ )  $V_I < 0V$ DC Output Diode Current  $(I_{OK})$ 

 $V_{O} < 0V$ -50 mA  $V_O > V_{CC}$ +50 mA

DC Output Source/Sink Current

 $(I_{OH}/I_{OL})$  $\pm 50 \text{ mA}$ DC V<sub>CC</sub> or GND Current per

Supply Pin ( $I_{CC}$  or GND) ±100 mA -65°C to +150°C Storage Temperature Range  $(T_{STG})$ 

#### **Recommended Operating** Conditions (Note 6)

Power Supply

-0.5V to +4.6V

-50 mA

Operating 1.2V to 3.6V Data Retention Only 1.2V to 3.6V Input Voltage -0.3V to +3.6V

Output Voltage (V<sub>O</sub>)

Output in Active States 0V to V<sub>CC</sub> Output in 3-State 0.0V to 3.6V

Output Current in I<sub>OH</sub>/I<sub>OL</sub>

 $V_{CC} = 3.0V \text{ to } 3.6V$ ±12 mA  $V_{CC} = 2.3V \text{ to } 2.7V$ ±8 mA

 $V_{CC} = 1.65V \text{ to } 2.3V$ ±3 mA  $V_{CC} = 1.4V \text{ to } 1.6V$ ±2 mA V<sub>CC</sub> = 1.2V ±100 μA

-40°C to +85°C Free Air Operating Temperature (T<sub>A</sub>)

Minimum Input Edge Rate  $(\Delta t/\Delta V)$ 

 $V_{IN}$  = 0.8V to 2.0V,  $V_{CC}$  = 3.0V

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:  $I_{\rm O}$  Absolute Maximum Rating must be observed.

Note 6: Floating or unused inputs must be held HIGH or LOW.

#### DC Electrical Characteristics (2.7V < $V_{CC} \le 3.6V)$

| Symbol          | Parameter                 | Conditions                | v <sub>cc</sub> | Min                    | Max                    | Units |
|-----------------|---------------------------|---------------------------|-----------------|------------------------|------------------------|-------|
| Symbol          | i didiletei               | Conditions                | (V)             | IVIIII                 | IVIGA                  | Oille |
| V <sub>IH</sub> | HIGH Level Input Voltage  |                           | 2.7 - 3.6       | 2.0                    |                        |       |
|                 |                           |                           | 2.3 - 2.7       | 1.6                    |                        |       |
|                 |                           |                           | 1.65 - 2.3      | 0.65 x V <sub>CC</sub> |                        | V     |
|                 |                           |                           | 1.4 - 1.6       | 0.65 x V <sub>CC</sub> |                        |       |
|                 |                           |                           | 1.2             | 0.65 x V <sub>CC</sub> |                        |       |
| V <sub>IL</sub> | LOW Level Input Voltage   |                           | 2.7 - 3.6       |                        | 0.8                    |       |
|                 |                           |                           | 2.3 - 2.7       |                        | 0.7                    |       |
|                 |                           |                           | 1.65 - 2.3      |                        | 0.35 x V <sub>CC</sub> | V     |
|                 |                           |                           | 1.4 - 1.6       |                        | 0.35 x V <sub>CC</sub> |       |
|                 |                           |                           | 1.2             |                        | 0.5 x V <sub>CC</sub>  |       |
| V <sub>OH</sub> | HIGH Level Output Voltage | $I_{OH} = -100 \mu A$     | 2.7 - 3.6       | V <sub>CC</sub> - 0.2  |                        |       |
|                 |                           | $I_{OH} = -6 \text{ mA}$  | 2.7             | 2.2                    |                        |       |
|                 |                           | $I_{OH} = -8 \text{ mA}$  | 3.0             | 2.4                    |                        |       |
|                 |                           | $I_{OH} = -12 \text{ mA}$ | 3.0             | 2.2                    |                        |       |
|                 |                           | $I_{OH} = -100 \mu A$     | 2.7 - 3.6       | V <sub>CC</sub> - 0.2  |                        |       |
|                 |                           | $I_{OH} = -4 \text{ mA}$  | 2.3             | 2.0                    |                        |       |
|                 |                           | $I_{OH} = -6 \text{ mA}$  | 2.3             | 1.8                    |                        | V     |
|                 |                           | $I_{OH} = -8 \text{ mA}$  | 2.3             | 1.7                    |                        |       |
|                 |                           | $I_{OH} = -100 \mu A$     | 1.65 - 2.3      | V <sub>CC</sub> - 0.2  |                        |       |
|                 |                           | $I_{OH} = -3 \text{ mA}$  | 1.65            | 1.25                   |                        |       |
|                 |                           | $I_{OH} = -100 \mu A$     | 1.4 - 1.6       | V <sub>CC</sub> - 0.2  |                        |       |
|                 |                           | $I_{OH} = -1 \text{ mA}$  | 1.4             | 1.05                   |                        |       |
|                 |                           | $I_{OH} = -100$ μA        | 1.2             | V <sub>CC</sub> - 0.1  |                        |       |
|                 |                           | I <sub>OH</sub> = -100 μA | 1.2             | V <sub>CC</sub> - 0.1  |                        |       |

#### DC Electrical Characteristics (2.7V < VCC £ 3.6V) (Continued)

| Symbol           | Parameter                             | Conditions  | V <sub>CC</sub><br>(V) | Min | Max  | Units |
|------------------|---------------------------------------|---|------------------------|-----|------|-------|
| V <sub>OL</sub>  | LOW Level Output Voltage              | I <sub>OL</sub> = 100 μA                                  | 2.7 - 3.6              |     | 0.2  |       |
|                  |                                       | I <sub>OL</sub> = 6 mA                                    | 2.7                    |     | 0.4  |       |
|                  |                                       | I <sub>OL</sub> = 8 mA                                    | 3.0                    |     | 0.55 |       |
|                  |                                       | I <sub>OL</sub> = 12 mA                                   | 3.0                    |     | 0.8  |       |
|                  |                                       | $I_{OL} = 100 \mu A$                                      | 2.7 - 3.6              |     | 0.2  |       |
|                  |                                       | I <sub>OL</sub> = 6 mA                                    | 2.3                    |     | 0.4  | v     |
|                  |                                       | I <sub>OL</sub> = 8 mA                                    | 2.3                    |     | 0.6  | v     |
|                  |                                       | $I_{OL} = 100 \mu A$                                      | 1.65 - 2.3             |     | 0.2  |       |
|                  |                                       | I <sub>OL</sub> = 3 mA                                    | 1.65                   |     | 0.3  |       |
|                  |                                       | $I_{OL} = 100 \mu A$                                      | 1.4 - 1.6              |     | 0.2  |       |
|                  |                                       | I <sub>OL</sub> = 1 mA                                    | 1.4                    |     | 0.35 |       |
|                  |                                       | $I_{OL} = 100 \mu A$                                      | 1.2                    |     | 0.1  |       |
| I <sub>I</sub>   | Input Leakage Current                 | $0 \le V_I \le 3.6V$                                      | 1.2 - 3.6              |     | ±5.0 | μΑ    |
| I <sub>OZ</sub>  | 3-STATE Output Leakage                | $0 \le V_O \le 3.6V$<br>$V_I = V_{IH} \text{ or } V_{II}$ | 1.2 - 3.6              |     | ±10  | μА    |
| I <sub>OFF</sub> | Power-OFF Leakage Current             | $0 \le (V_1, V_0) \le 3.6V$                               | 0                      |     | 10   |       |
| I <sub>CC</sub>  | Quiescent Supply Current              | V <sub>I</sub> = V <sub>CC</sub> or GND                   | 1.2 - 3.6              |     | 20   | μΑ    |
|                  |                                       | $V_{CC} \le (V_I, V_O) \le 3.6V \text{ (Note 7)}$         | 1.2 - 3.6              |     | ±20  | μΑ    |
| $\Delta I_{CC}$  | Increase in I <sub>CC</sub> per Input | $V_{IH} = V_{CC} - 0.6V$                                  | 2.7 - 3.6              |     | 750  | μΑ    |

Note 7: Outputs disabled or 3-STATE only.

#### **AC Electrical Characteristics** (Note 8)

| Symbol             | Parameter             | Conditions                              | V <sub>CC</sub> | T <sub>A</sub> = -40° | C to +85°C | Units | Figure             |
|--------------------|-----------------------|---|-----------------|-----------------------|------------|-------|--------------------|
| Symbol             | 1 414                 | Conditions                              | (V)             | Min                   | Max        | Onnio | Number             |
| t <sub>PHL</sub> , | Propagation Delay     | $C_L = 30 \text{ pF}, R_L = 500\Omega$  | $3.3 \pm 0.3$   | 0.8                   | 3.3        |       | Figures            |
| t <sub>PLH</sub>   |                       |   | $2.5\pm0.2$     | 1.0                   | 3.8        |       | 1, 2               |
|                    |                       |   | $1.8 \pm 0.15$  | 1.5                   | 7.6        | ns    |                    |
|                    |                       | $C_L = 15 \text{ pF}, R_L = 2k\Omega$   | 1.5 ± 0.1       | 1.0                   | 15.2       |       | Figures            |
|                    |                       |   | 1.2             | 1.5                   | 38         |       | 5, 6               |
| t <sub>PZL</sub> , | Output Enable Time    | $C_L = 30 \text{ pF, } R_L = 500\Omega$ | $3.3 \pm 0.3$   | 0.8                   | 3.8        |       | F:                 |
| $t_{PZH}$          |                       |   | $2.5 \pm 0.2$   | 1.0                   | 5.1        |       | Figures<br>1, 3, 4 |
|                    |                       |   | $1.8 \pm 0.15$  | 1.5                   | 9.8        | ns    | 1, 0, 1            |
|                    |                       | $C_L = 15 \text{ pF}, R_L = 2k\Omega$   | 1.5 ± 0.1       | 1.0                   | 19.6       |       | Figures            |
|                    |                       |   | 1.2             | 1.5                   | 49         |       | 5, 7, 8            |
| t <sub>PLZ</sub> , | Output Disable Time   | $C_L = 30 \text{ pF}, R_L = 500\Omega$  | $3.3 \pm 0.3$   | 0.8                   | 3.6        |       | 1_                 |
| $t_{PHZ}$          |                       |   | $2.5\pm0.2$     | 1.0                   | 4.0        |       | Figures<br>1, 3, 4 |
|                    |                       |   | $1.8 \pm 0.15$  | 1.5                   | 7.2        | ns    | , -,               |
|                    |                       | $C_L = 15 \text{ pF}, R_L = 2k\Omega$   | 1.5 ± 0.1       | 1.0                   | 14.4       |       | Figures            |
|                    |                       |   | 1.2             | 1.5                   | 36         |       | 5, 7, 8            |
| toshl              | Output to Output Skew | $C_L = 30 \text{ pF}, R_L = 500\Omega$  | $3.3 \pm 0.3$   |                       | 0.5        |       |                    |
| toslh              | (Note 9)              |   | $2.5 \pm 0.2$   |                       | 0.5        |       |                    |
|                    |                       |   | $1.8 \pm 0.15$  |                       | 0.75       | ns    |                    |
|                    |                       | $C_L = 15 \text{ pF}, R_L = 2k\Omega$   | 1.5 ± 0.1       |                       | 1.5        | 1     |                    |
|                    |                       |   | 1.2             |                       | 1.5        | 1     |                    |

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

Note 9: 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<sub>OSHL</sub>) or LOW-to-HIGH (t<sub>OSLH</sub>).

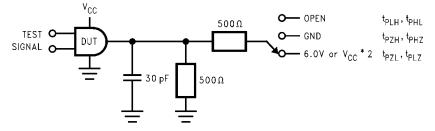
# **Dynamic Switching Characteristics**

| Symbol           | Parameter                                   | Conditions  | V <sub>CC</sub> (V) | T <sub>A</sub> = +25°C | Units |
|------------------|---|---|---------------------|------------------------|-------|
| V <sub>OLP</sub> | Quiet Output Dynamic Peak V <sub>OL</sub>   | $C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$ | 1.8                 | 0.15                   |       |
|                  |   |   | 2.5                 | 0.25                   | V     |
|                  |   |   | 3.3                 | 0.35                   |       |
| V <sub>OLV</sub> | Quiet Output Dynamic Valley V <sub>OL</sub> | $C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$ | 1.8                 | -0.15                  |       |
|                  |   |   | 2.5                 | -0.25                  | V     |
|                  |   |   | 3.3                 | -0.35                  |       |
| V <sub>OHV</sub> | Quiet Output Dynamic Valley VOH             | $C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0V$ | 1.8                 | 1.55                   |       |
|                  |   |   | 2.5                 | 2.05                   | V     |
|                  |   |   | 3.3                 | 2.65                   |       |

# Capacitance

| Symbol           | Parameter                     | Conditions  | $T_A = +25^{\circ}C$ | Units  |
|------------------|-------------------------------|---|----------------------|--------|
| Cymbol           | i didiletei                   | Conditions  | Typical              | Office |
| C <sub>IN</sub>  | Input Capacitance             | $V_{CC} = 1.8, 2.5V \text{ or } 3.3V, V_I = 0V \text{ or } V_{CC}$                      | 6                    | pF     |
| C <sub>OUT</sub> | Output Capacitance            | $V_I = 0V \text{ or } V_{CC}, V_{CC} = 1.8V, 2.5V \text{ or } 3.3V$                     | 7                    | pF     |
| C <sub>PD</sub>  | Power Dissipation Capacitance | $V_I = 0V \text{ or } V_{CC}, f = 10 \text{ MHz}, V_{CC} = 1.8V, 2.5V \text{ or } 3.3V$ | 20                   | pF     |

# AC Loading and Waveforms (V $_{CC}$ 3.3V $\pm$ 0.3V to 1.8V $\pm$ 0.15V)



| TEST                                | SWITCH   |
|-------------------------------------|--|
| t <sub>PLH</sub> , t <sub>PHL</sub> | Open   |
| t <sub>PZL</sub> , t <sub>PLZ</sub> | 6V at $V_{CC}$ = 3.3 ± 0.3V;<br>$V_{CC}$ x 2 at $V_{CC}$ = 2.5 ± 0.2V; 1.8 ± 0.15V |
| t <sub>PZH</sub> , t <sub>PHZ</sub> | GND  |

FIGURE 1. AC Test Circuit

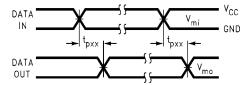


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

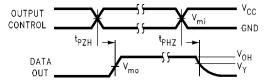


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

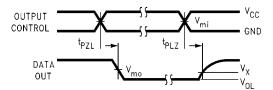
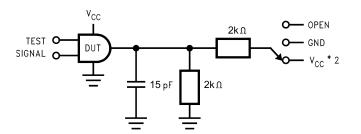


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

| Symbol          | V <sub>cc</sub>        |                         |                         |  |
|-----------------|------------------------|-------------------------|-------------------------|--|
| Symbol          | 3.3V ± 0.3V            | 2.5V ± 0.2V             | 1.8V ± 0.15V            |  |
| V <sub>mi</sub> | 1.5V                   | V <sub>CC</sub> /2      | V <sub>CC</sub> /2      |  |
| V <sub>mo</sub> | 1.5V                   | V <sub>CC</sub> /2      | V <sub>CC</sub> /2      |  |
| V <sub>X</sub>  | V <sub>OL</sub> + 0.3V | V <sub>OL</sub> + 0.15V | V <sub>OL</sub> + 0.15V |  |
| V <sub>Y</sub>  | V <sub>OH</sub> – 0.3V | V <sub>OH</sub> – 0.15V | V <sub>OH</sub> – 0.15V |  |

# AC Loading and Waveforms (V $_{\mbox{\footnotesize CC}}$ 1.5V $\pm$ 0.1V to 1.2V)



| TEST                                | SWITCH                                     |
|-------------------------------------|--|
| t <sub>PLH</sub> , t <sub>PHL</sub> | Open                                       |
| $t_{PZL}, t_{PLZ}$                  | $V_{CC}$ x 2 at $V_{CC}$ = 1.5V $\pm$ 0.1V |
| $t_{PZH}, t_{PHZ}$                  | GND  |

 $\mathsf{t}_{\mathsf{PLH}},\,\mathsf{t}_{\mathsf{PHL}}$ 

 $t_{PZH}$ ,  $t_{PHZ}$ 

 $t_{PZL}$ ,  $t_{PLZ}$ 

FIGURE 5. AC Test Circuit

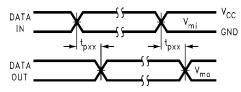


FIGURE 6. Waveform for Inverting and Non-Inverting Functions

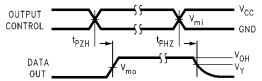


FIGURE 7. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

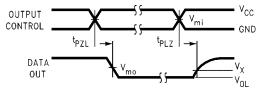
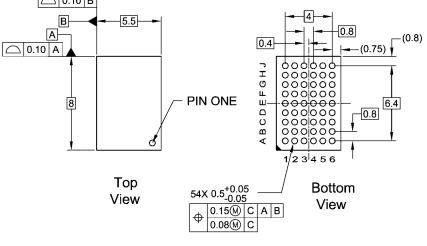
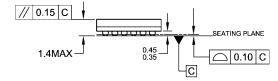


FIGURE 8. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

| Symbol          | V <sub>cc</sub>        |  |
|-----------------|------------------------|--|
| C)2C.           | 1.5V ± 0.1V            |  |
| V <sub>mi</sub> | V <sub>CC</sub> /2     |  |
| $V_{mo}$        | V <sub>CC</sub> /2     |  |
| V <sub>X</sub>  | V <sub>OL</sub> + 0.1V |  |
| $V_{Y}$         | V <sub>OL</sub> – 0.1V |  |

# Physical Dimensions inches (millimeters) unless otherwise noted ○ 0.10 B





#### 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

#### BGA54ArevD

54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide Package Number BGA54A

# Resistor in Outputs

#### Physical Dimensions inches (millimeters) unless otherwise noted (Continued) 12.50±0.10 0.40 TYP -B-99. 9.20 8.10 59. O.2 C B A ALL LEAD TIPS PIN #1 IDENT 0.50 LAND PATTERN RECOMMENDATION 0.1 C SEE DETAIL A 0.90+0.15 ALL LEAD TIPS 0.09-0.20 0.10±0.05 0.17-0.27 0.50 ♦ 0.13\@ A B\S C\S 12.00' TOP & BOTTOM DIMENSIONS ARE IN MILLIMETERS R0.16 GAGE PLANE 0.25 NOTES: A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION ED, DATE 4/97. B. DIMENSIONS ARE IN MILLIMETERS. SEATING PLANE 0.60±0.10 1.00 C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS. D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982. DETAIL A MTD48REVC

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

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