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74LCX16500

Low Voltage 18-Bit Universal Bus Transceivers with 5V Tolerant Inputs and Outputs

General Description

These 18-bit universal bus transceivers combine D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes.

Data flow in each direction is controlled by output-enable (OEAB and OEBA), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs.

The LCX16500 is designed for low voltage (2.5V or 3.3V) V_{CC} applications with the capability of interfacing to a 5V signal environment.

The LCX16500 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power.

Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- 6.0 ns t_{PD} max ($V_{CC} = 3.3V$), 20 μA I_{CC} max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- ± 24 mA output drive ($V_{CC} = 3.0V$)
- Uses proprietary noise/EMI reduction circuitry
- Latch-up performance exceeds 500 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 down, \overline{OE} should be tied to V_{CC} and OE tied to GND through a resistor; the minimum value or the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

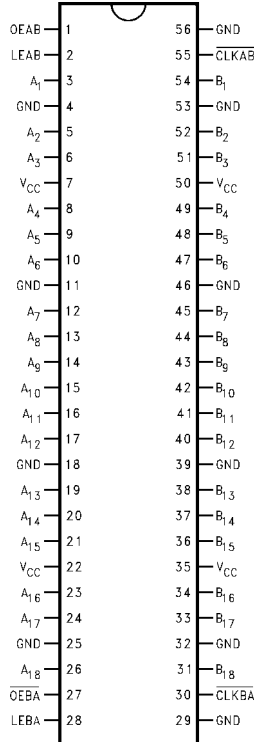
| Order Number | Package Number | Package Description |
|---------------------------------|----------------|---|
| 74LCX16500G (Note 2)(Note 3) | BGA54A | 54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide |
| 74LCX16500MEA (Note 3) | MS56A | 56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300" Wide |
| 74LCX16500MTD (Note 3) | MTD56 | 56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

Note 2: Ordering code "G" indicates Trays.

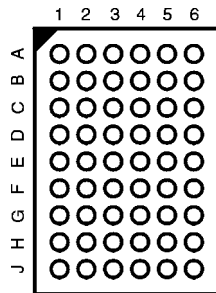
Note 3: Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

Connection Diagrams

Pin Assignment for SSOP and TSSOP



Pin Assignment for FBGA



(Top Thru View)

Pin Descriptions

| Pin Names | Description |
|----------------------------------|--|
| A ₁ - A ₁₈ | Data Register A Inputs/3-STATE Outputs |
| B ₁ - B ₁₈ | Data Register B Inputs/3-STATE Outputs |
| CLKAB, CLKBA | Clock Pulse Inputs |
| LEAB, LEBA | Latch Enable Inputs |
| OEBA, OEAB | Output Enable Inputs |

FBGA Pin Assignments

| | 1 | 2 | 3 | 4 | 5 | 6 |
|----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| A | A ₂ | A ₁ | OEAB | GND | B ₁ | B ₂ |
| B | A ₄ | A ₃ | LEAB | CLKAB | B ₃ | B ₄ |
| C | A ₆ | A ₅ | V _{CC} | V _{CC} | B ₅ | B ₆ |
| D | A ₈ | A ₇ | GND | GND | B ₇ | B ₈ |
| E | A ₁₀ | A ₉ | GND | GND | B ₉ | B ₁₀ |
| F | A ₁₂ | A ₁₁ | GND | GND | B ₁₁ | B ₁₂ |
| G | A ₁₄ | A ₁₃ | V _{CC} | V _{CC} | B ₁₃ | B ₁₄ |
| H | A ₁₆ | A ₁₅ | OEBA | CLKBA | B ₁₅ | B ₁₆ |
| J | A ₁₇ | A ₁₈ | LEBA | GND | B ₁₈ | B ₁₇ |

Truth Table (Note 4)

| Inputs | | | | Output |
|--------|------|-------|----------------|-------------------------|
| OEAB | LEAB | CLKAB | A _n | B _n |
| L | X | X | X | Z |
| H | H | X | L | L |
| H | H | X | H | H |
| H | L | ↓ | L | L |
| H | L | ↓ | H | H |
| H | L | H | X | B ₀ (Note 5) |
| H | L | L | X | B ₀ (Note 6) |

Note 4: A-to-B data flow is shown; B-to-A flow is similar but uses OEBA, LEBA, and CLKBA.

Note 5: Output level before the indicated steady-state input conditions were established.

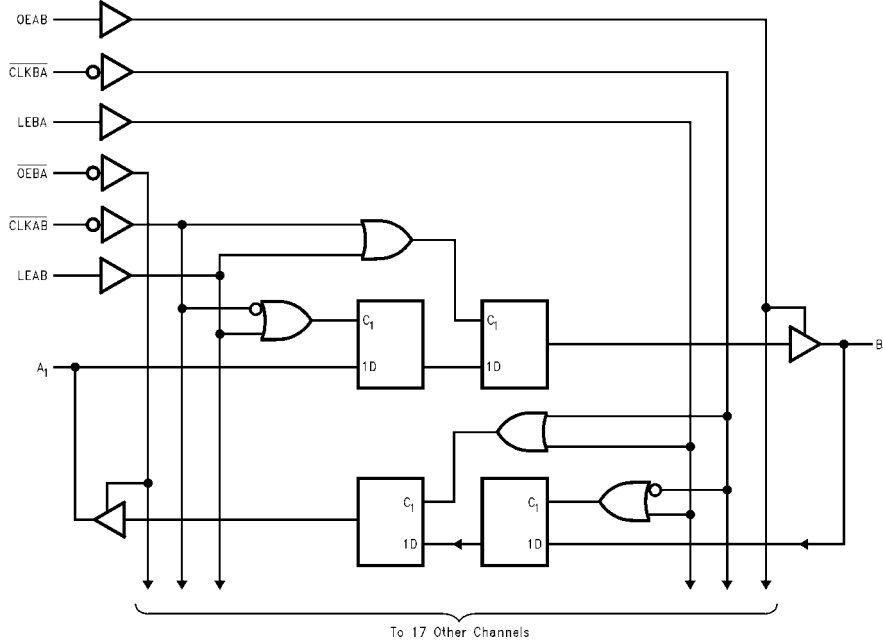
Note 6: Output level before the indicated steady-state input conditions were established, provided that CLKAB was LOW before LEAB went LOW.

Functional Description

For A-to-B data flow, the LCX16500 operates in the transparent mode when LEAB is HIGH. When LEAB is LOW, the A data is latched if CLKAB is held at a HIGH or LOW logic level. If LEAB is LOW, the A bus data is stored in the latch/flip-flop on the HIGH-to-LOW transition of CLKAB. Output-enable OEAB is active-HIGH. When OEAB is HIGH, the outputs are active. When OEAB is LOW, the outputs are in the high impedance state.

Data flow for B to A is similar to that of A to B but uses OEBA, LEBA, and CLKBA. The output enables are complementary (OEAB is active HIGH and OEBA is active LOW).

Logic Diagram



| Absolute Maximum Ratings (Note 7) | | | | | | |
|---|--|--|---|---------------------------------|------|-------|
| Symbol | Parameter | Value | Conditions | Units | | |
| V _{CC} | Supply Voltage | -0.5 to +7.0 | | V | | |
| V _I | DC Input Voltage | -0.5 to +7.0 | | V | | |
| V _O | DC Output Voltage | -0.5 to +7.0 -0.5 to V _{CC} + 0.5 | Output in 3-STATE Output in HIGH or LOW State (Note 8) | V | | |
| I _{IK} | DC Input Diode Current | -50 | V _I < GND | mA | | |
| I _{OK} | DC Output Diode Current | -50 +50 | V _O < GND V _O > V _{CC} | mA | | |
| I _O | DC Output Source/Sink Current | ±50 | | mA | | |
| I _{CC} | DC Supply Current per Supply Pin | ±100 | | mA | | |
| I _{GND} | DC Ground Current per Ground Pin | ±100 | | mA | | |
| T _{STG} | Storage Temperature | -65 to +150 | | °C | | |
| Recommended Operating Conditions | | | | | | |
| (Note 9) | | | | | | |
| Symbol | Parameter | Min | Max | Units | | |
| V _{CC} | Supply Voltage | Operating | 2.0 | 3.6 | V | |
| | | Data Retention | 1.5 | 3.6 | | |
| V _I | Input Voltage | 0 | 5.5 | V | | |
| V _O | Output Voltage | HIGH or LOW State | 0 | V _{CC} | V | |
| | | 3-STATE | 0 | 5.5 | | |
| I _{OH} /I _{OL} | Output Current | V _{CC} = 3.0V – 3.6V | | ±24 | mA | |
| | | V _{CC} = 2.7V – 3.0V | | ±12 | | |
| | | V _{CC} = 2.3V – 2.7V | | ±8 | | |
| T _A | Free-Air Operating Temperature | -40 | 85 | °C | | |
| Δt/ΔV | Input Edge Rate, V _{IN} = 0.8V–2.0V, V _{CC} = 3.0V | 0 | 10 | ns/V | | |
| <p>Note 7: 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.</p> <p>Note 8: I_O Absolute Maximum Rating must be observed.</p> <p>Note 9: Unused (inputs or I/O's) must be held HIGH or LOW. They may not float.</p> | | | | | | |
| DC Electrical Characteristics | | | | | | |
| Symbol | Parameter | Conditions | V _{CC} (V) | T _A = -40°C to +85°C | | Units |
| | | | | Min | Max | |
| V _{IH} | HIGH Level Input Voltage | | 2.3 – 2.7 | 1.7 | | V |
| | | | 2.7 – 3.6 | 2.0 | | |
| V _{IL} | LOW Level Input Voltage | | 2.3 – 2.7 | | 0.7 | V |
| | | | 2.7 – 3.6 | | 0.8 | |
| V _{OH} | HIGH Level Output Voltage | I _{OH} = -100 μA | 2.3 – 3.6 | V _{CC} - 0.2 | | V |
| | | I _{OH} = -8 mA | 2.3 | 1.8 | | |
| | | I _{OH} = -12 mA | 2.7 | 2.2 | | |
| | | I _{OH} = -18 mA | 3.0 | 2.4 | | |
| | | I _{OH} = -24 mA | 3.0 | 2.2 | | |
| V _{OL} | LOW Level Output Voltage | I _{OL} = 100 μA | 2.3 – 3.6 | | 0.2 | V |
| | | I _{OL} = 8 mA | 2.3 | | 0.6 | |
| | | I _{OL} = 12 mA | 2.7 | | 0.4 | |
| | | I _{OL} = 16 mA | 3.0 | | 0.4 | |
| | | I _{OL} = 24 mA | 3.0 | | 0.55 | |
| I _I | Input Leakage Current | 0 ≤ V _I ≤ 5.5V | 2.3 – 3.6 | | ±5.0 | μA |
| I _{OZ} | 3-STATE I/O Leakage | 0 ≤ V _O ≤ 5.5V V _I = V _{IH} or V _{IL} | 2.3 – 3.6 | | ±5.0 | μA |
| I _{OFF} | Power-Off Leakage Current | V _I or V _O = 5.5V | 0 | | 10 | μA |

| DC Electrical Characteristics (Continued) | | | | | | | | |
|---|---|---|------------------------|---------------------------------|-----|-------------------------------|-----|-------|
| Symbol | Parameter | Conditions | V _{CC} (V) | T _A = -40°C to +85°C | | Units | | |
| | | | | Min | Max | | | |
| I _{CC} | Quiescent Supply Current | V _I = V _{CC} or GND | 2.3 – 3.6 | | 20 | μA | | |
| | | 3.6V ≤ V _I , V _O ≤ 5.5V (Note 10) | 2.3 – 3.6 | | ±20 | | | |
| ΔI _{CC} | Increase in I _{CC} per Input | V _{IH} = V _{CC} - 0.6V | 2.3 – 3.6 | | 500 | μA | | |
| Note 10: Outputs disabled or 3-STATE only. | | | | | | | | |
| AC Electrical Characteristics | | | | | | | | |
| Symbol | Parameter | T _A = -40°C to +85°C, R _L = 500 Ω | | | | | | Units |
| | | V _{CC} = 3.3V ± 0.3V | | V _{CC} = 2.7V | | V _{CC} = 2.5V ± 0.2V | | |
| | | C _L = 50 pF | | C _L = 50 pF | | C _L = 30 pF | | |
| | | Min | Max | Min | Max | Min | Max | |
| f _{MAX} | Maximum Clock Frequency | 170 | | | | | | MHz |
| t _{PHL} | Propagation Delay | 1.5 | 6.0 | 1.5 | 7.0 | 1.5 | 7.2 | ns |
| t _{PLH} | Bus to Bus | 1.5 | 6.0 | 1.5 | 7.0 | 1.5 | 7.2 | |
| t _{PHL} | Propagation Delay | 1.5 | 6.7 | 1.5 | 8.0 | 1.5 | 8.4 | ns |
| t _{PLH} | Clock to Bus | 1.5 | 6.7 | 1.5 | 8.0 | 1.5 | 8.4 | |
| t _{PHL} | Propagation Delay | 1.5 | 7.0 | 1.5 | 8.0 | 1.5 | 8.4 | ns |
| t _{PLH} | LE to Bus | 1.5 | 7.0 | 1.5 | 8.0 | 1.5 | 8.4 | |
| t _{PZL} | Output Enable Time | 1.5 | 7.2 | 1.5 | 8.2 | 1.5 | 9.4 | ns |
| t _{PZH} | | 1.5 | 7.2 | 1.5 | 8.2 | 1.5 | 9.4 | |
| t _{PLZ} | Output Disable Time | 1.5 | 7.0 | 1.5 | 8.0 | 1.5 | 8.4 | ns |
| t _{PHZ} | | 1.5 | 7.0 | 1.5 | 8.0 | 1.5 | 8.4 | |
| t _S | Setup Time | 2.5 | | 2.5 | | 3.0 | | ns |
| t _H | Hold Time | 1.5 | | 1.5 | | 2.0 | | ns |
| t _W | Pulse Width | 3.0 | | 3.0 | | 3.5 | | ns |
| t _{OSHL} | Output to Output Skew | | 1.0 | | | | | ns |
| t _{OSLH} | (Note 11) | | 1.0 | | | | | |
| Note 11: 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 | | Units | | |
| | | | | Typical | | | | |
| V _{OLP} | Quiet Output Dynamic Peak V _{OL} | C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V | 3.3 | 0.8 | | V | | |
| | | C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V | 2.5 | 0.6 | | | | |
| V _{OLV} | Quiet Output Dynamic Valley V _{OL} | C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V | 3.3 | -0.8 | | V | | |
| | | C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V | 2.5 | -0.6 | | | | |
| Capacitance | | | | | | | | |
| Symbol | Parameter | Conditions | Typical | Units | | | | |
| C _{IN} | Input Capacitance | V _{CC} = Open, V _I = 0V or V _{CC} | 7 | pF | | | | |
| C _{IO} | Input/Output Capacitance | V _{CC} = 3.3V, V _I = 0V or V _{CC} | 8 | pF | | | | |
| C _{PD} | Power Dissipation Capacitance | V _{CC} = 3.3V, V _I = 0V or V _{CC} , f = 10 MHz | 20 | pF | | | | |

AC LOADING and WAVEFORMS Generic for LCX Family

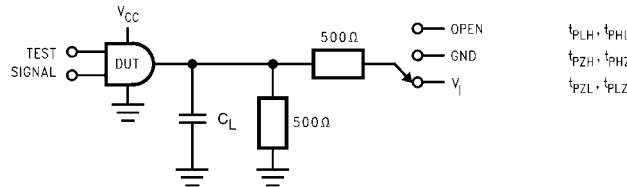
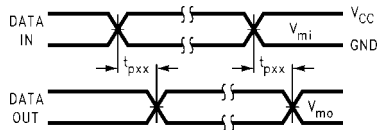
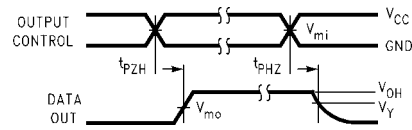


FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)

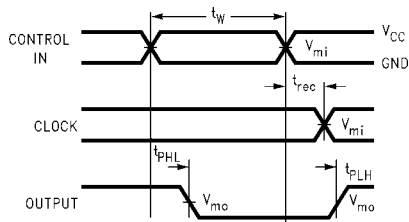
| Test | Switch |
|--------------------|--|
| t_{PLH}, t_{PHL} | Open |
| t_{PZL}, t_{PLZ} | 6V at $V_{CC} = 3.3 \pm 0.3V$, and 2.7V $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$ |
| t_{PZH}, t_{PHZ} | GND |



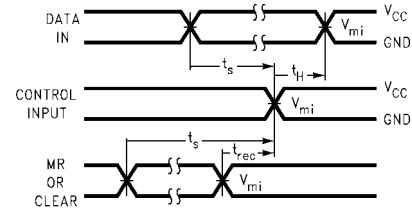
Waveform for Inverting and Non-Inverting Functions



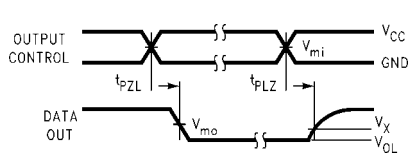
3-STATE Output High Enable and Disable Times for Logic



Propagation Delay, Pulse Width and t_{rec} Waveforms



Setup Time, Hold Time and Recovery Time for Logic



3-STATE Output Low Enable and Disable Times for Logic

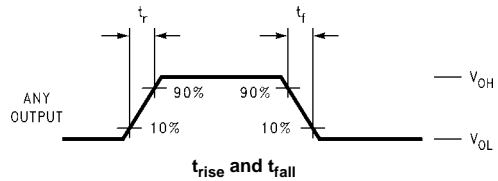
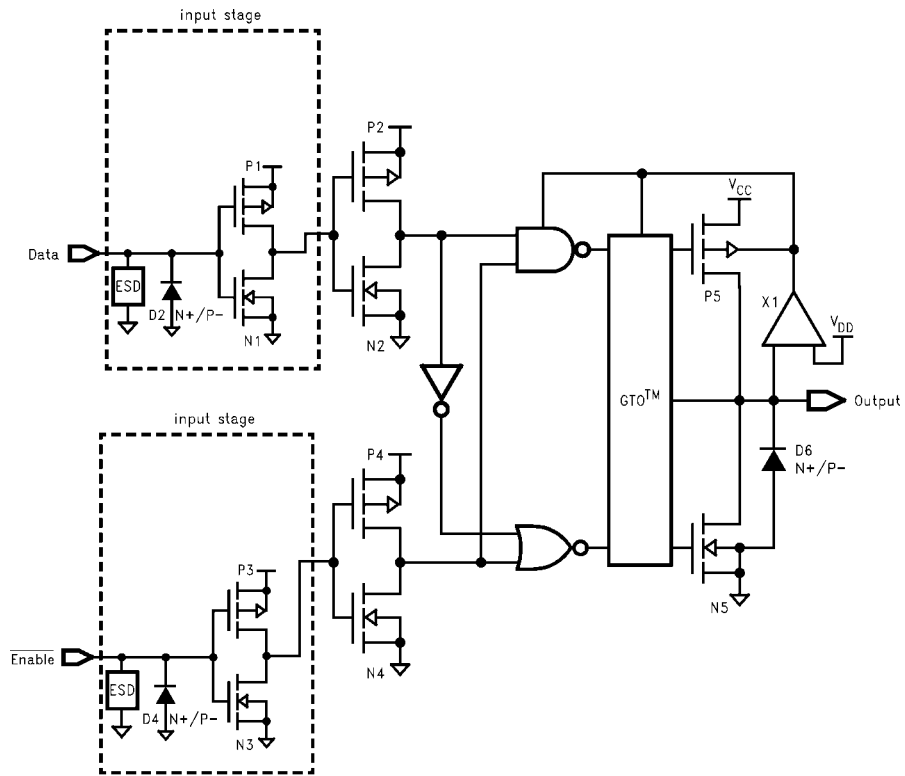


FIGURE 2. Waveforms (Input Characteristics; $f = 1MHz$, $t_r = t_f = 3ns$)

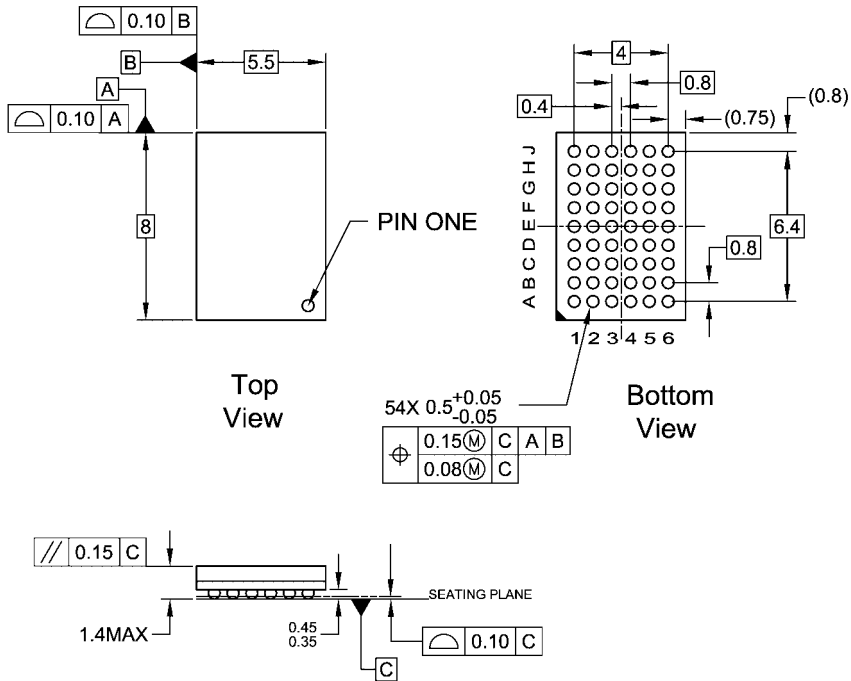
| Symbol | V_{CC} | | |
|----------|-----------------|-----------------|------------------|
| | $3.3V \pm 0.3V$ | 2.7V | $2.5V \pm 0.2V$ |
| V_{mi} | 1.5V | 1.5V | $V_{CC}/2$ |
| V_{mo} | 1.5V | 1.5V | $V_{CC}/2$ |
| V_x | $V_{OL} + 0.3V$ | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ |
| V_y | $V_{OH} - 0.3V$ | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ |

Schematic Diagram Generic for LCX Family



74LCX16500

Physical Dimensions inches (millimeters) unless otherwise noted



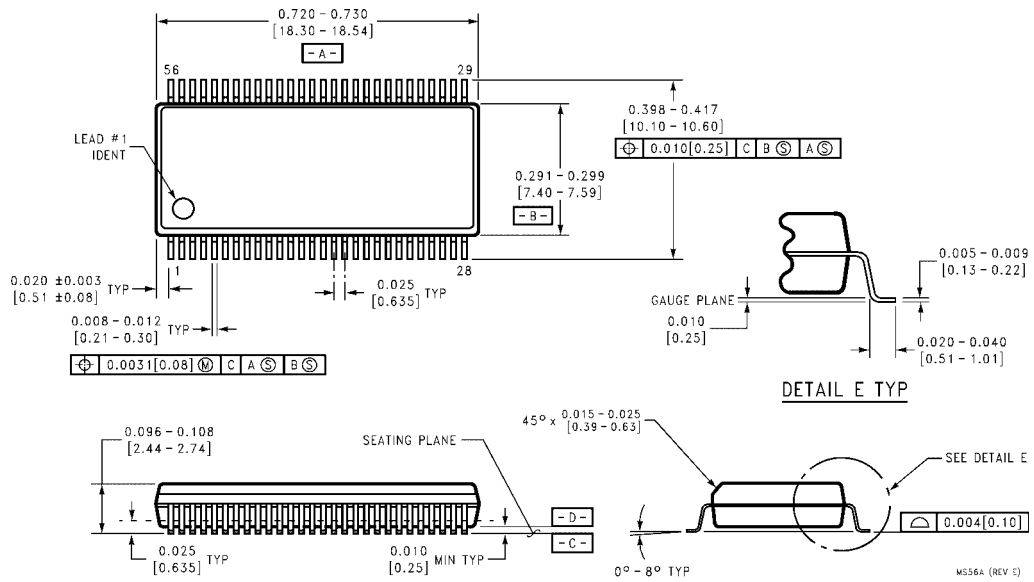
NOTES:

- 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

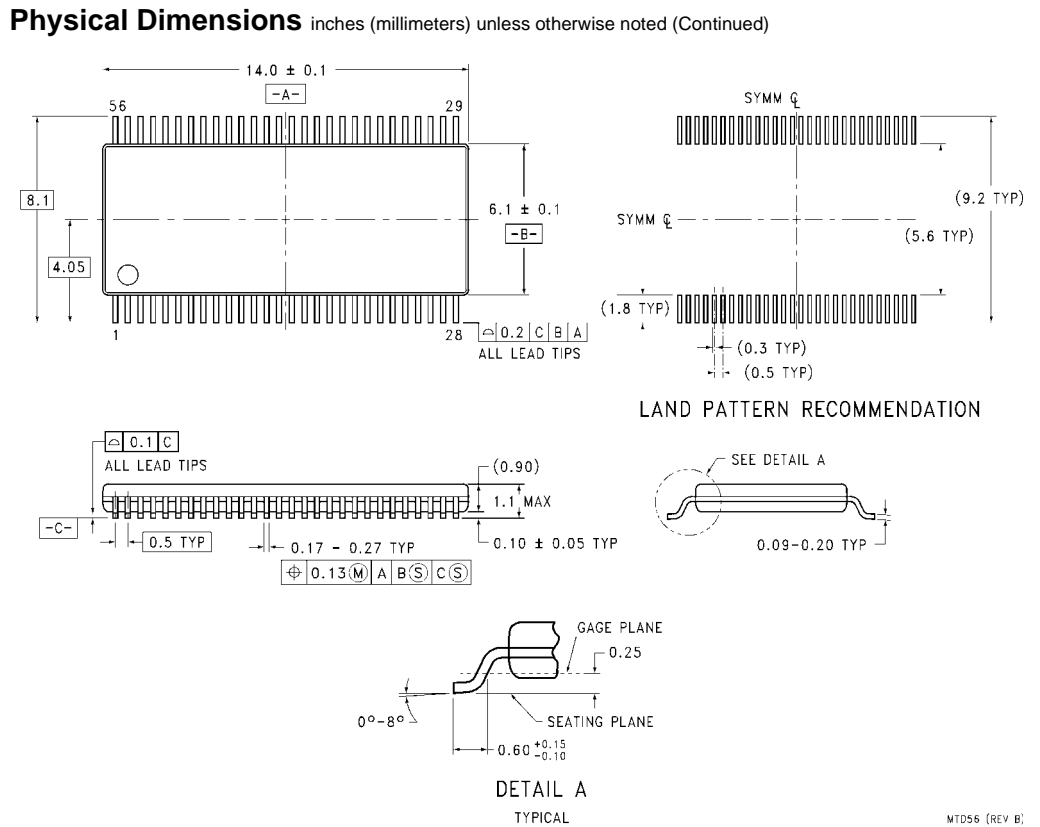
BGA54ArevD

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

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



**56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
Package Number MS56A**



56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide Package Number MTD56

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