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74LCX16646

Low Voltage 16-Bit Transceiver/Register with 5V Tolerant Inputs and Outputs

General Description

The LCX16646 contains sixteen non-inverting bidirectional registered bus transceivers with 3-STATE outputs, providing multiplexed transmission of data directly from the input bus or from the internal storage registers. Each byte has separate control inputs which can be shorted together for full 16-bit operation. The DIR inputs determine the direction of data flow through the device. The CPAB and CPBA inputs load data into the registers on the LOW-to-HIGH transition (see Functional Description).

The LCX16646 is designed for low voltage (2.5V or 3.3V) V_{CC} applications with capability of interfacing to a 5V signal environment.

The LCX16646 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- 5.2 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 ($V_{CC} = 3.0V$)
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
 - Human Body Model > 2000V
 - Machine Model > 200V

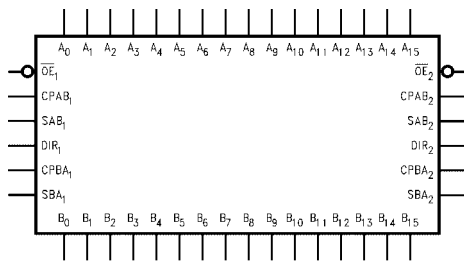
Note 1: To ensure the high-impedance state during power up or down, \overline{OE} should be tied to V_{CC} through a pull-up resistor; the minimum value or the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

| Order Number | Package Number | Package Description |
|---------------|----------------|---|
| 74LCX16646MEA | MS56A | 56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300" Wide |
| 74LCX16646MTD | MTD56 | 56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

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

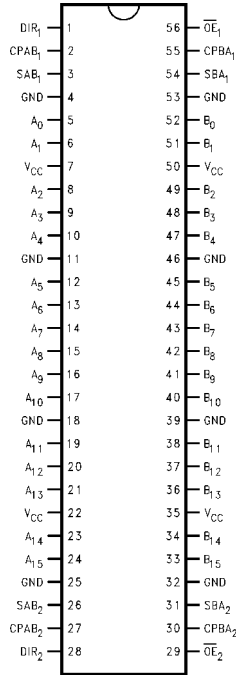
Logic Symbol



Pin Descriptions

| Pin Names | Description |
|-------------------|----------------------------------|
| A_n | Side A Inputs or 3-STATE Outputs |
| B_n | Side B Inputs or 3-STATE Outputs |
| \overline{OE}_n | Output Enable Inputs |
| $CPAB_n, CPBA_n$ | Clock Pulse Inputs |
| SAB_n, SBA_n | Select Inputs |
| DIR_n | Direction Control Inputs |

Connection Diagram



Truth Table

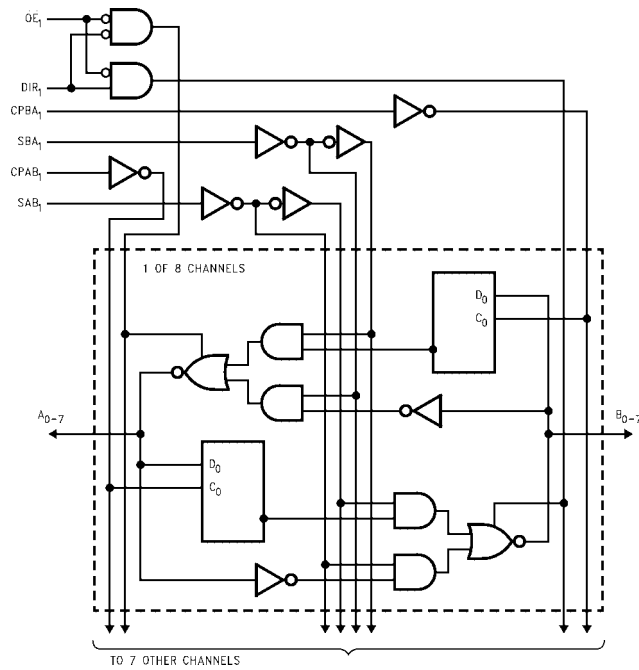
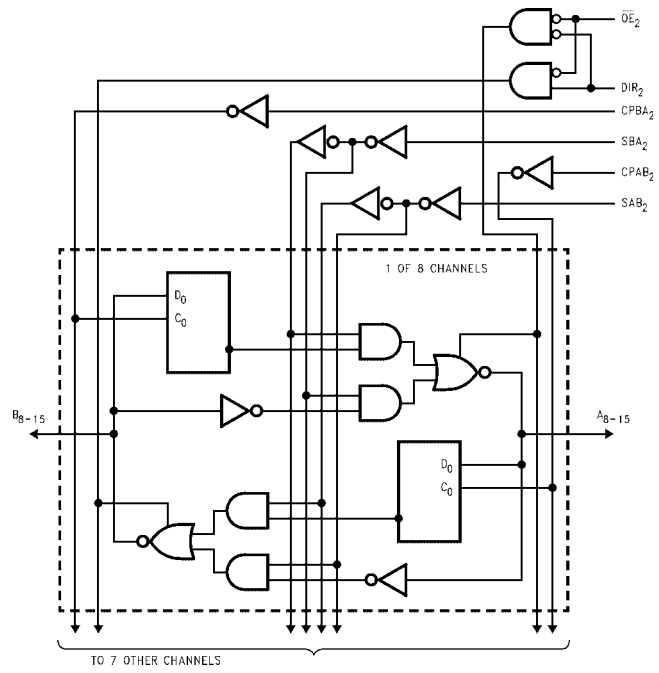
(Note 2)

| Inputs | | | | | | Data I/O | | Output Operation Mode |
|-----------------|------------------|-------------------|-------------------|------------------|------------------|------------------|------------------|---|
| OE ₁ | DIR ₁ | CPAB ₁ | CPBA ₁ | SAB ₁ | SBA ₁ | A ₀₋₇ | B ₀₋₇ | |
| H | X | H or L | H or L | X | X | | | Isolation |
| H | X | ↗ | X | X | X | Input | Input | Clock A _n Data into A Register Clock B _n Data Into B Register |
| L | H | X | X | L | X | | | A _n to B _n — Real Time (Transparent Mode) |
| L | H | ↗ | X | L | X | Input | Output | Clock A _n Data to A Register A Register to B _n (Stored Mode) |
| L | H | H or L | X | H | X | | | Clock A _n Data into A Register and Output to B _n |
| L | L | X | X | X | L | | | B _n to A _n — Real Time (Transparent Mode) |
| L | L | X | ↗ | X | L | Output | Input | Clock B _n Data into B Register B Register to A _n (Stored Mode) |
| L | L | X | ↗ | X | H | | | Clock B _n into B Register and Output to A _n |

H = HIGH Voltage Level X = Immaterial
L = LOW Voltage Level ↗ = LOW-to-HIGH Transition.

Note 2: The data output functions may be enabled or disabled by various signals at the OE and DIR inputs. Data input functions are always enabled; i.e., data at the bus pins will be stored on every LOW-to-HIGH transition of the appropriate clock inputs. Also applies to data I/O (A and B: 8-15) and #2 control pins.

Logic Diagrams

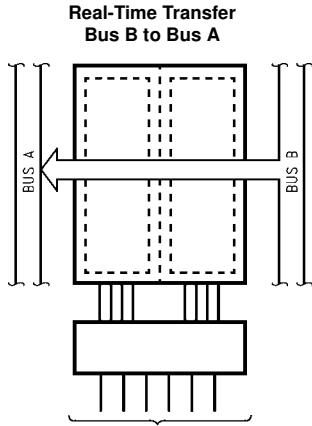


Please note that these diagrams are provided only for the understanding of logic operations and should not be used to estimate propagation delays.

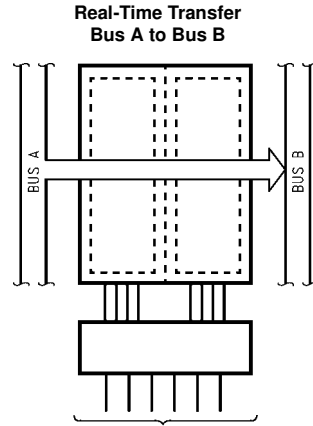
Functional Description

In the transceiver mode, data present at the HIGH impedance port may be stored in either the A or B register or both. The select (SAB_n , SBA_n) controls can multiplex stored and real-time. The examples shown below demonstrate the four fundamental bus-management functions that can be performed.

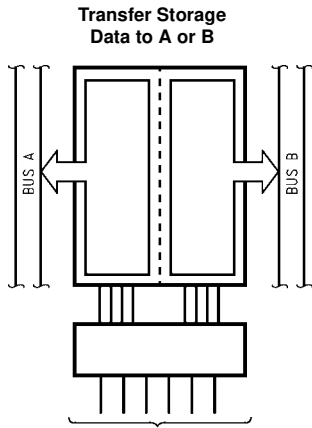
The direction control (DIR_n) determines which bus will receive data when \overline{OE}_n is LOW. In the isolation mode (\overline{OE}_n HIGH), A data may be stored in one register and/or B data may be stored in the other register. When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two busses, A or B, may be driven at a time.



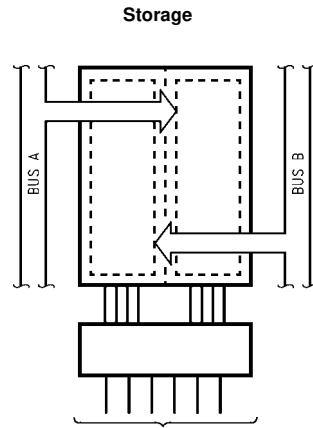
| \overline{OE} | DIR | CPAB | CPBA | SAB | SBA |
|-----------------|-----|------|------|-----|-----|
| L | L | X | X | X | L |



| \overline{OE} | DIR | CPAB | CPBA | SAB | SBA |
|-----------------|-----|------|------|-----|-----|
| L | H | X | X | L | X |



| \overline{OE} | DIR | CPAB | CPBA | SAB | SBA |
|-----------------|-----|--------|--------|-----|-----|
| L | L | X | H or L | X | H |
| L | H | H or L | X | H | X |



| \overline{OE} | DIR | CPAB | CPBA | SAB | SBA |
|-----------------|-----|------|------|-----|-----|
| L | H | ~ | X | L | X |
| L | X | X | ~ | X | L |
| H | X | ~ | X | X | X |
| H | X | X | ~ | X | X |

| Absolute Maximum Ratings ^(Note 3) | | | | | | |
|---|--|--|---|---------------------------------|------|-------|
| 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 4) | 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 5) | | | | | | |
| 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 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 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 4: I_O Absolute Maximum Rating must be observed.</p> <p>Note 5: Unused inputs and I/Os 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 6) | 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 6: Outputs disabled or 3-STATE only. | | | | | | | | |
| AC Electrical Characteristics | | | | | | | | |
| Symbol | Parameter | T _A = -40°C to +85°C, R _L = 500Ω | | | | | | 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 | |
| t _{MAX} | Maximum Clock Frequency | 170 | | | | | ns | |
| t _{PHL} | Propagation Delay | 1.5 | 5.2 | 1.5 | 6.0 | 1.5 | 6.2 | ns |
| t _{PLH} | Bus to Bus | 1.5 | 5.2 | 1.5 | 6.0 | 1.5 | 6.2 | |
| t _{PHL} | Propagation Delay | 1.5 | 6.0 | 1.5 | 7.0 | 1.5 | 7.2 | ns |
| t _{PLH} | Clock to Bus | 1.5 | 6.0 | 1.5 | 7.0 | 1.5 | 7.2 | |
| t _{PHL} | Propagation Delay | 1.5 | 6.0 | 1.5 | 7.0 | 1.5 | 7.2 | ns |
| t _{PLH} | Select to Bus | 1.5 | 6.0 | 1.5 | 7.0 | 1.5 | 7.2 | |
| t _{PZL} | Output Enable Time | 1.5 | 7.5 | 1.5 | 8.5 | 1.5 | 9.8 | ns |
| t _{PZH} | | 1.5 | 7.5 | 1.5 | 8.5 | 1.5 | 9.8 | |
| t _{PLZ} | Output Disable Time | 1.5 | 6.5 | 1.5 | 7.5 | 1.5 | 7.8 | ns |
| t _{PHZ} | | 1.5 | 6.5 | 1.5 | 7.5 | 1.5 | 7.8 | |
| 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 (Note 7) | | 1.0 | | | | | ns |
| t _{OSLH} | | | 1.0 | | | | | |
| 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}). Parameter guaranteed by design. | | | | | | | | |
| 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 _{I/O} | 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

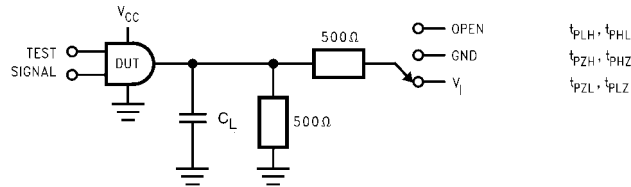
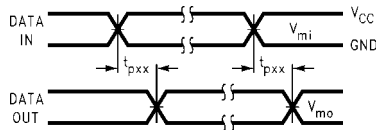
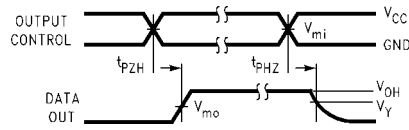


FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)

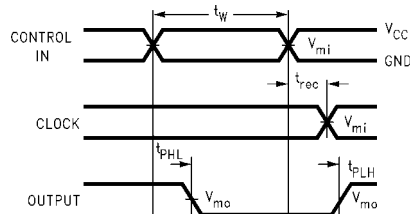
| Test | Switch |
|--------------------|---|
| t_{PLH}, t_{PHL} | Open |
| t_{PZL}, t_{PLZ} | 6V at $V_{CC} = 3.3 \pm 0.3V$ $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$ |
| t_{PZH}, t_{PHZ} | GND |



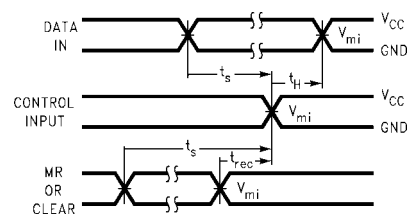
Waveform for Inverting and Non-Inverting Functions



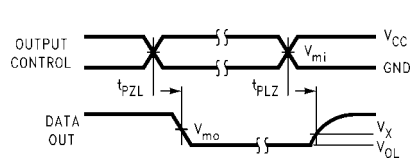
3-STATE Output High Enable and Disable Times for Logic



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

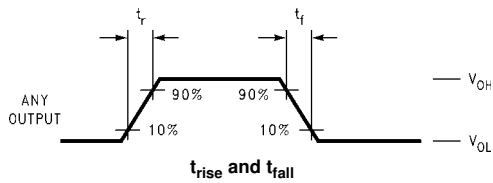
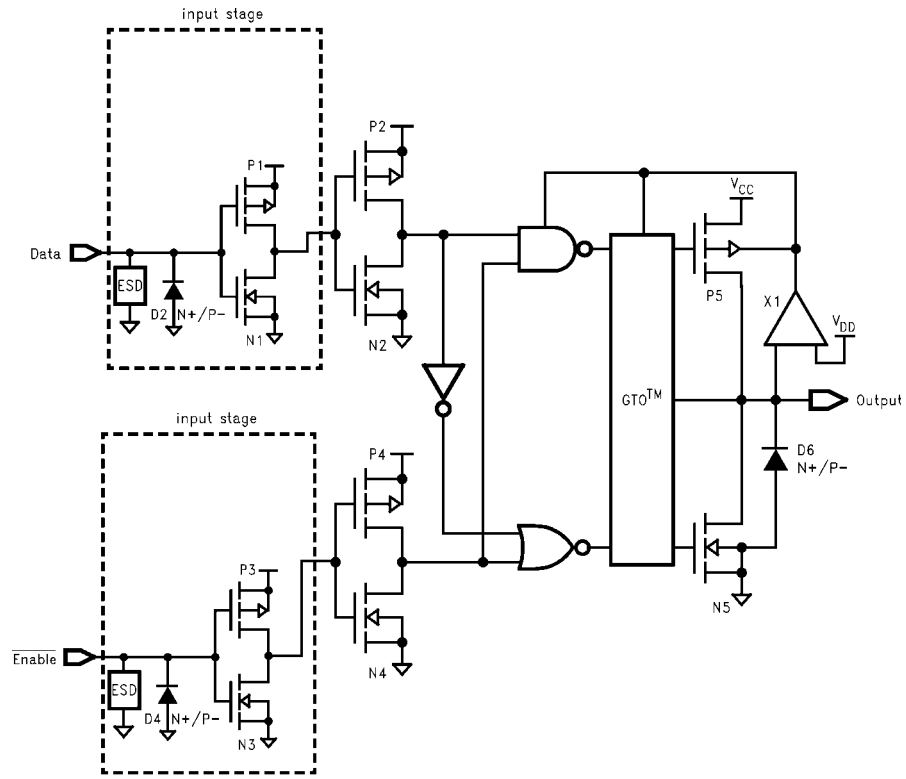


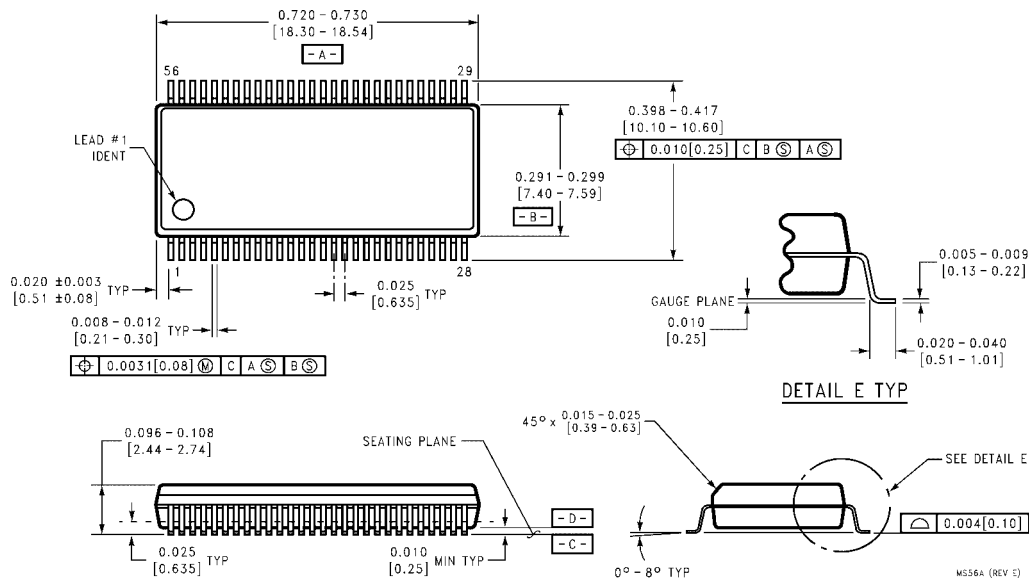
FIGURE 2. Waveforms
(Input Characteristics; $f = 1MHz, t_R = t_F = 3ns$)

| 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 | $V_{OH} - 0.3V$ | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ |

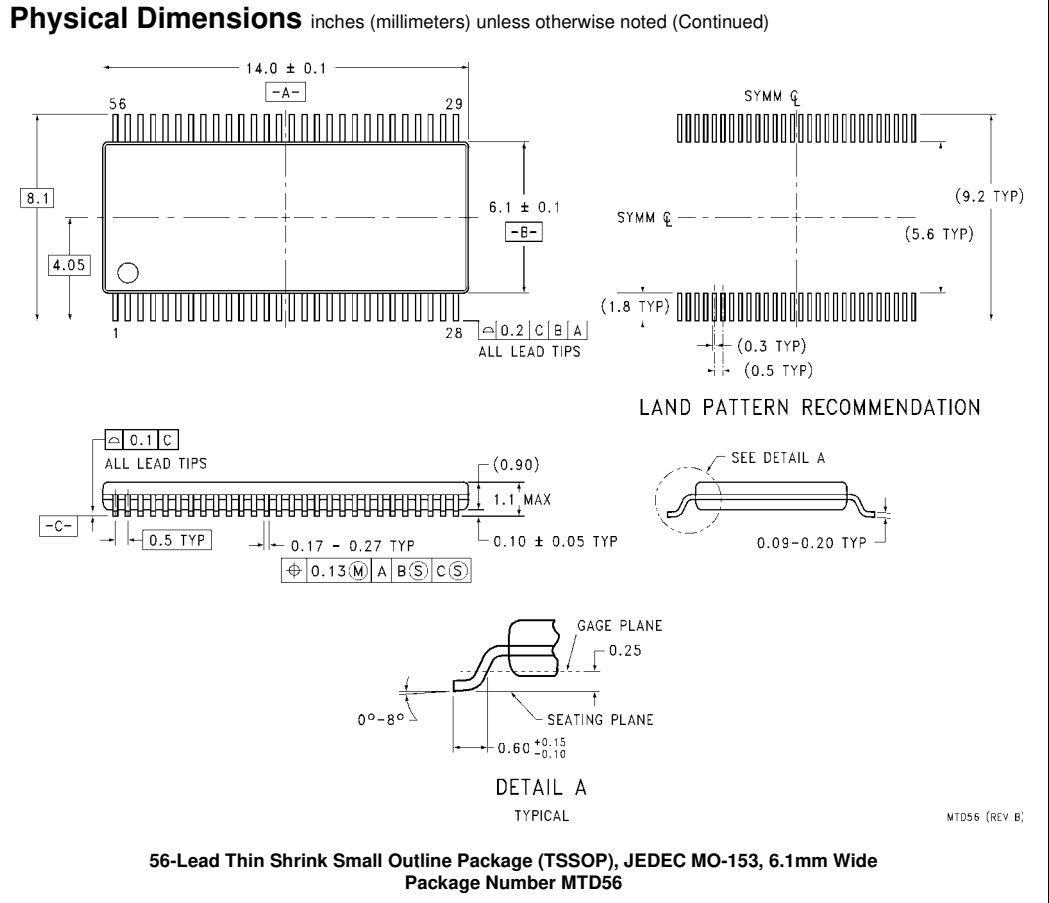
Schematic Diagram Generic for LCX Family



Physical Dimensions inches (millimeters) unless otherwise noted



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



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