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# FXL2SD106

## Low-Voltage Dual-Supply 6-Bit Voltage Translator with Auto-Direction Sensing

### Features

- Bi-Directional Interface between Two Levels: 1.1V and 3.6V
- Fully Configurable: Inputs and Outputs Track  $V_{CC}$  Level
- Non-Preferential Power-up; Either  $V_{CC}$  May Be Powered-up First
- Outputs Remain in 3-State until Active  $V_{CC}$  Level is Reached
- Outputs Switch to 3-State if Either  $V_{CC}$  is at GND
- Power-Off Protection
- Bus hold on Data Inputs Eliminates Need for Pull-up Resistors (Do NOT Use Resistors on the A or B Ports)
- OE and CLK IN are Referenced to  $V_{CCA}$  Voltage
- Packaged in 16-Terminal DQFN (2.5mm x 3.5mm)
- Direction Control Not Needed
- 80 Mbps Throughput Translating between 1.8V and 2.5V
- ESD Protection Exceeds:
  - 12kV HBM (B port I/O to GND) (per JESD22-A114 & Mil Std 883e 3015.7)
  - 8kV HBM (A port I/O to GND) (per JESD22-A114 & Mil Std 883e 3015.7)
  - 1kV CDM (per ESD STM 5.3)

### General Description

The FXL2SD106 is a configurable dual-voltage-supply translator designed for both uni-directional and bi-directional voltage translation between two logic levels. The device allows translation between voltages as high as 3.6V to as low as 1.1V. The A port tracks the  $V_{CCA}$  level and the B port tracks the  $V_{CCB}$  level. This allows for bi-directional voltage translation over a variety of voltage levels: 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V.

The device remains in 3-state until both  $V_{CC}$  reach active levels, allowing either  $V_{CC}$  to be powered-up first. Internal power-down control circuits place the device in 3-state if either  $V_{CC}$  is removed.

The OE input, when low, disables both A and B ports by placing them in a 3-state condition. The FXL2SD106 is designed so that OE and CLK IN are supplied by  $V_{CCA}$ .

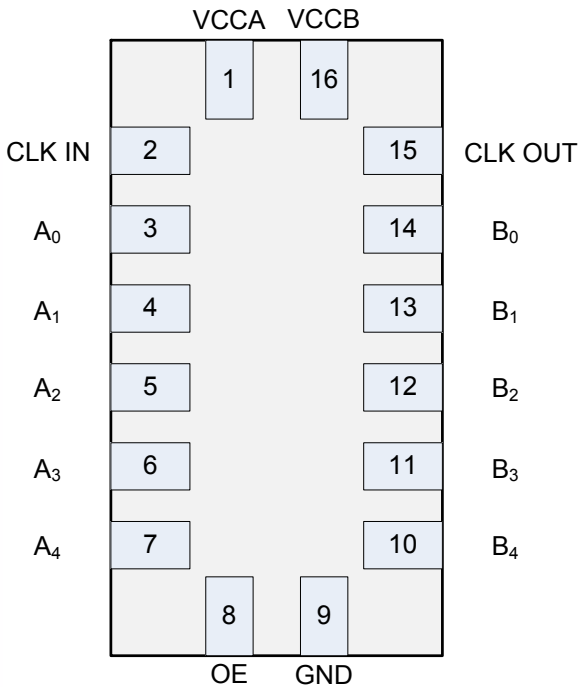
The device senses an input signal on A or B port automatically. The input signal is transferred to the other port.

The FXL2SD106 is not designed for SD card applications. The internal bus hold circuitry conflicts with pull-up resistors. SD cards have internal pull-up resistors on the CD/DAT3 pins.

### Ordering Information

| Order Number | Package Number | Package Description                                                                            |
|--------------|----------------|------------------------------------------------------------------------------------------------|
| FXL2SD106BQX | MLP16E         | 16-Terminal Depopulated Quad Very-Thin Flat Pack, No Leads (DQFN), JEDEC MO-241, 2.5mm x 3.5mm |

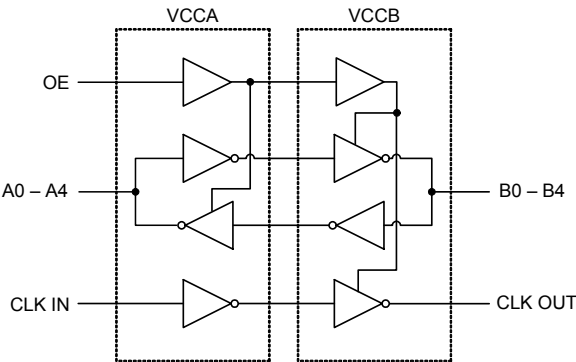
### Connection Diagram



### Pin Description

| Number | Name                           | Description                      |
|--------|--------------------------------|----------------------------------|
| 1      | V <sub>CCA</sub>               | A-Side Power Supply              |
| 2      | CLK IN                         | A-Side Input                     |
| 3–7    | A <sub>0</sub> –A <sub>4</sub> | A-Side Inputs or 3-State Outputs |
| 8      | OE                             | Output Enable Input              |
| 9      | GND                            | Ground                           |
| 10–14  | B <sub>4</sub> –B <sub>0</sub> | B-Side Inputs or 3-State Outputs |
| 15     | CLK OUT                        | 3-State Output                   |
| 16     | V <sub>CCB</sub>               | B-Side Power Supply              |

### Functional Diagram



### Function Table

| Control          | Outputs          |
|------------------|------------------|
| OE               |                  |
| LOW Logic Level  | 3-State          |
| HIGH Logic Level | Normal Operation |

### Power-Up/Power-Down Sequencing

FXL translators offer an advantage in that either V<sub>CC</sub> may be powered up first. This benefit derives from the chip design. When either V<sub>CC</sub> is at 0 volts, outputs are in a high-impedance state. The control input (OE) is designed to track the V<sub>CCA</sub> supply. A pull-down resistor tying OE to GND should be used to ensure that bus contention, excessive currents, or oscillations do not occur during power-up / power-down. The size of the pull-down resistor is based upon the current-sinking capability of the device driving the OE pin.

The recommended power-up sequence is the following:

1. Apply power to the first V<sub>CC</sub>.
2. Apply power to the second V<sub>CC</sub>.
3. Drive the OE input high to enable the device.

The recommended power-down sequence is the following:

1. Drive OE input low to disable the device.
2. Remove power from either V<sub>CC</sub>.
3. Remove power from other V<sub>CC</sub>.

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol             | Parameter                                                                                                         | Rating                                                                   |
|--------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| $V_{CCA}, V_{CCB}$ | Supply Voltage                                                                                                    | −0.5V to +4.6V                                                           |
| $V_I$              | DC Input Voltage<br>I/O Port A<br>I/O Port B<br>OE, CLK IN                                                        | −0.5V to +4.6V<br>−0.5V to +4.6V<br>−0.5V to +4.6V                       |
| $V_O$              | Output Voltage <sup>(1)</sup><br>Outputs 3-STATE<br>Outputs Active ( $A_n$ )<br>Outputs Active ( $B_n$ , CLK OUT) | −0.5V to +4.6V<br>−0.5V to $V_{CCA} + 0.5V$<br>−0.5V to $V_{CCB} + 0.5V$ |
| $I_{IK}$           | DC Input Diode Current at $V_I < 0V$                                                                              | −50mA                                                                    |
| $I_{OK}$           | DC Output Diode Current at<br>$V_O < 0V$<br>$V_O > V_{CC}$                                                        | −50mA<br>+50mA                                                           |
| $I_{OH}/I_{OL}$    | DC Output Source/Sink Current                                                                                     | −50mA / +50mA                                                            |
| $I_{CC}$           | DC $V_{CC}$ or Ground Current per Supply Pin                                                                      | ±100mA                                                                   |
| $T_{STG}$          | Storage Temperature Range                                                                                         | −65°C to +150°C                                                          |

**Note:**

1.  $I_O$  Absolute Maximum Rating must be observed.

## Recommended Operating Conditions<sup>(2)</sup>

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol                 | Parameter                                                                                                                                     | Rating                                            |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| $V_{CCA}$ or $V_{CCB}$ | Power Supply Operating                                                                                                                        | 1.1V to 3.6V                                      |
|                        | Input Voltage<br>Port A<br>Port B<br>OE, CLK IN                                                                                               | 0.0V to 3.6V<br>0.0V to 3.6V<br>0.0V to $V_{CCA}$ |
|                        | Dynamic Output Current in $I_{OH}/I_{OL}$ with $V_{CC}$ at<br>3.0V to 3.6V<br>2.3V to 2.7V<br>1.65V to 1.95V<br>1.4V to 1.65V<br>1.1V to 1.4V | ±18.0mA<br>±11.8mA<br>±7.4mA<br>±5.0mA<br>±2.6mA  |
|                        | Static Output Current $I_{OH}/I_{OL}$ with $V_{CC}$ at 1.1V to 3.6V                                                                           | ±20.0μA                                           |
| $T_A$                  | Free Air Operating Temperature                                                                                                                | −40°C to +85°C                                    |
| $\Delta t/\Delta V$    | Maximum Input Edge Rate $V_{CCA/B} = 1.1V$ to 3.6V                                                                                            | 10ns/V                                            |

**Note:**

2. All unused inputs and I/O pins must be held at  $V_{CCI}$  or GND.

# DC Electrical Characteristics ( $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ )

| Symbol               | Parameter                            | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Conditions                                                                  | Min.                  | Typ. | Max.                  | Units         |
|----------------------|--------------------------------------|---------------|---------------|-----------------------------------------------------------------------------|-----------------------|------|-----------------------|---------------|
| $V_{IH}$             | High Level Input Voltage             | 1.4–3.6       | 1.1–3.6       | Data inputs $A_n$ , CLK IN, OE                                              | $0.6 \times V_{CCA}$  |      |                       | V             |
|                      |                                      | 1.1–1.4       | 1.1–3.6       |                                                                             | $0.9 \times V_{CCA}$  |      |                       |               |
|                      |                                      | 1.1–3.6       | 1.4–3.6       | Data inputs $B_n$                                                           | $0.6 \times V_{CCB}$  |      |                       |               |
|                      |                                      | 1.1–3.6       | 1.1–1.4       |                                                                             | $0.9 \times V_{CCB}$  |      |                       |               |
| $V_{IL}$             | Low Level Input Voltage              | 1.4–3.6       | 1.1–3.6       | Data inputs $A_n$ , CLK IN, OE                                              |                       |      | $0.35 \times V_{CCA}$ | V             |
|                      |                                      | 1.1–1.4       | 1.1–3.6       |                                                                             |                       |      | $0.1 \times V_{CCA}$  |               |
|                      |                                      | 1.1–3.6       | 1.4–3.6       | Data inputs $B_n$                                                           |                       |      | $0.35 \times V_{CCB}$ |               |
|                      |                                      | 1.1–3.6       | 1.1–1.4       |                                                                             |                       |      | $0.1 \times V_{CCB}$  |               |
| $V_{OH}^{(3)}$       | High Level Output Voltage            | 1.65–3.6      | 1.1–3.6       | Data outputs $A_n$ , $I_{HOLD} = -20\mu\text{A}$                            | $0.75 \times V_{CCA}$ |      |                       | V             |
|                      |                                      | 1.1–1.4       | 1.1–3.6       |                                                                             |                       | 0.8  |                       |               |
|                      |                                      | 1.1–3.6       | 1.65–3.6      | Data outputs $B_n$ , $I_{HOLD} = -20\mu\text{A}$                            | $0.75 \times V_{CCB}$ |      |                       |               |
|                      |                                      | 1.1–3.6       | 1.1–1.4       |                                                                             |                       | 0.8  |                       |               |
| $V_{OL}^{(3)}$       | Low Level Output Voltage             | 1.65–3.6      | 1.1–3.6       | Data outputs $A_n$ , $I_{HOLD} = 20\mu\text{A}$                             |                       |      | $0.2 \times V_{CCA}$  | V             |
|                      |                                      | 1.1–1.4       | 1.1–3.6       |                                                                             |                       | 0.3  |                       |               |
|                      |                                      | 1.1–3.6       | 1.65–3.6      | Data outputs $B_n$ , $I_{HOLD} = 20\mu\text{A}$                             |                       |      | $0.2 \times V_{CCB}$  |               |
|                      |                                      | 1.1–3.6       | 1.1–1.4       |                                                                             |                       | 0.3  |                       |               |
| $I_{I(ODH)}^{(4)}$   | Bushold Input Overdrive High Current | 3.6           | 3.6           | Data inputs $A_n$ , $B_n$                                                   | 450                   |      |                       | $\mu\text{A}$ |
|                      |                                      | 2.7           | 2.7           |                                                                             | 300                   |      |                       |               |
|                      |                                      | 1.95          | 1.95          |                                                                             | 200                   |      |                       |               |
|                      |                                      | 1.6           | 1.6           |                                                                             | 120                   |      |                       |               |
|                      |                                      | 1.4           | 1.4           |                                                                             | 80                    |      |                       |               |
| $I_{I(ODL)}^{(5)}$   | Bushold Input Overdrive Low Current  | 3.6           | 3.6           | Data inputs $A_n$ , $B_n$                                                   | -450                  |      |                       | $\mu\text{A}$ |
|                      |                                      | 2.7           | 2.7           |                                                                             | -300                  |      |                       |               |
|                      |                                      | 1.95          | 1.95          |                                                                             | -200                  |      |                       |               |
|                      |                                      | 1.6           | 1.6           |                                                                             | -120                  |      |                       |               |
|                      |                                      | 1.4           | 1.4           |                                                                             | -80                   |      |                       |               |
| $I_I$                | Input Leakage Current                | 1.1–3.6       | 3.6           | OE, CLK IN, $V_I = V_{CCA}$ or GND                                          |                       |      | $\pm 1.0$             | $\mu\text{A}$ |
| $I_{OFF}$            | Power Off Leakage Current            | 0             | 3.6           | $A_n$ , $V_O = 0\text{V}$ to $3.6\text{V}$                                  |                       |      | $\pm 2.0$             | $\mu\text{A}$ |
|                      |                                      | 3.6           | 0             | $B_n$ , CLK OUT, $V_O = 0\text{V}$ to $3.6\text{V}$                         |                       |      | $\pm 2.0$             |               |
| $I_{OZ}^{(6)}$       | 3-State Output Leakage               | 3.6           | 3.6           | $A_n$ , $B_n$ , CLK OUT, $V_O = 0\text{V}$ or $3.6\text{V}$ , OE = $V_{IL}$ |                       |      | $\pm 2.0$             | $\mu\text{A}$ |
|                      |                                      | 3.6           | 0             | $A_n$ , $V_O = 0\text{V}$ or $3.6\text{V}$ , OE = Don't Care                |                       |      | $\pm 2.0$             |               |
|                      |                                      | 0             | 3.6           | $B_n$ , CLK OUT, $V_O = 0\text{V}$ or $3.6\text{V}$ , OE = Don't Care       |                       |      | $\pm 2.0$             |               |
| $I_{CCA/B}^{(7)(8)}$ | Quiescent Supply Current             | 1.1–3.6       | 1.1–3.6       | $V_I = V_{CCI}$ or GND, $I_O = 0$                                           |                       |      | 5.0                   | $\mu\text{A}$ |
| $I_{CCZ}^{(7)}$      | Quiescent Supply Current             | 1.1–3.6       | 1.1–3.6       | $V_I = V_{CCI}$ or GND, $I_O = 0$ , OE = $V_{IL}$                           |                       |      | 5.0                   | $\mu\text{A}$ |
| $I_{CCA}^{(7)}$      | Quiescent Supply Current             | 0             | 1.1–3.6       | $V_I = V_{CCB}$ or GND; $I_O = 0$                                           |                       |      | -2.0                  | $\mu\text{A}$ |
|                      |                                      | 1.1–3.6       | 0             | $V_I = V_{CCA}$ or GND; $I_O = 0$                                           |                       |      | 2.0                   |               |

**DC Electrical Characteristics** ( $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ) (Continued)

| Symbol          | Parameter                | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Conditions                        | Min. | Typ. | Max. | Units         |
|-----------------|--------------------------|---------------|---------------|-----------------------------------|------|------|------|---------------|
| $I_{CCB}^{(7)}$ | Quiescent Supply Current | 1.1–3.6       | 0             | $V_I = V_{CCB}$ or GND; $I_O = 0$ |      |      | -2.0 | $\mu\text{A}$ |
|                 |                          | 0             | 1.1–3.6       | $V_I = V_{CCA}$ or GND; $I_O = 0$ |      |      | 2.0  |               |

**Notes:**

- This is the output voltage for static conditions. Dynamic drive specifications are given in “Dynamic Output Electrical Characteristics.”
- An external driver must source at least the specified current to switch LOW-to-HIGH.
- An external driver must source at least the specified current to switch HIGH-to-LOW.
- “Don’t Care” indicates any valid logic level.
- $V_{CCI}$  is the  $V_{CC}$  associated with the input side.
- Reflects current per supply,  $V_{CCA}$  or  $V_{CCB}$ .

**Dynamic Output Electrical Characteristics<sup>(9)</sup>****A Port ( $A_n$ )**Output Load:  $C_L = 15\text{pF}$ ,  $R_L > 1\text{M}\Omega$ 

| Symbol                   | Parameter                   | $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $V_{CCA} =$ |      |              |      |                |      |              |      |              | Units |
|--------------------------|-----------------------------|--------------------------------------------------------------------|------|--------------|------|----------------|------|--------------|------|--------------|-------|
|                          |                             | 3.0V to 3.6V                                                       |      | 2.3V to 2.7V |      | 1.65V to 1.95V |      | 1.4V to 1.6V |      | 1.1V to 1.3V |       |
|                          |                             | Typ.                                                               | Max. | Typ.         | Max. | Typ.           | Max. | Typ.         | Max. | Typ.         |       |
| $t_{\text{rise}}^{(10)}$ | Output Rise Time A Port     |                                                                    | 3.0  |              | 3.5  |                | 4.0  |              | 5.0  | 7.5          | ns    |
| $t_{\text{fall}}^{(11)}$ | Output Fall Time A Port     |                                                                    | 3.0  |              | 3.5  |                | 4.0  |              | 5.0  | 7.5          | ns    |
| $I_{\text{OHD}}^{(10)}$  | Dynamic Output Current High | -18.0                                                              |      | -11.8        |      | -7.4           |      | -5.0         |      | -2.6         | mA    |
| $I_{\text{OLD}}^{(11)}$  | Dynamic Output Current Low  | +18.0                                                              |      | +11.8        |      | +7.4           |      | +5.0         |      | +2.6         | mA    |

**B Port ( $B_n$ , CLK OUT)**Output Load:  $C_L = 15\text{pF}$ ,  $R_L > 1\text{M}\Omega$ 

| Symbol                   | Parameter                   | $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $V_{CCB} =$ |      |              |      |                |      |              |      |              | Units |
|--------------------------|-----------------------------|--------------------------------------------------------------------|------|--------------|------|----------------|------|--------------|------|--------------|-------|
|                          |                             | 3.0V to 3.6V                                                       |      | 2.3V to 2.7V |      | 1.65V to 1.95V |      | 1.4V to 1.6V |      | 1.1V to 1.3V |       |
|                          |                             | Typ.                                                               | Max. | Typ.         | Max. | Typ.           | Max. | Typ.         | Max. | Typ.         |       |
| $t_{\text{rise}}^{(10)}$ | Output Rise Time B Port     |                                                                    | 3.0  |              | 3.5  |                | 4.0  |              | 5.0  | 7.5          | ns    |
| $t_{\text{fall}}^{(11)}$ | Output Fall Time B Port     |                                                                    | 3.0  |              | 3.5  |                | 4.0  |              | 5.0  | 7.5          | ns    |
| $I_{\text{OHD}}^{(10)}$  | Dynamic Output Current High | -18.0                                                              |      | -11.8        |      | -7.4           |      | -5.0         |      | -2.6         | mA    |
| $I_{\text{OLD}}^{(11)}$  | Dynamic Output Current Low  | +18.0                                                              |      | +11.8        |      | +7.4           |      | +5.0         |      | +2.6         | mA    |

**Notes:**

- Dynamic Output Characteristics are guaranteed, but not tested.
- See Figure 5.
- See Figure 6.

## AC Characteristics

$V_{CCA} = 3.0V$  to  $3.6V$

| Symbol                | Parameter         | $T_A = -40^{\circ}C$ to $+85^{\circ}C$ , $V_{CCB} =$ |      |           |      |             |      |           |      |           | Units   |
|-----------------------|-------------------|------------------------------------------------------|------|-----------|------|-------------|------|-----------|------|-----------|---------|
|                       |                   | 3.0V–3.6V                                            |      | 2.3V–2.7V |      | 1.65V–1.95V |      | 1.4V–1.6V |      | 1.1V–1.3V |         |
|                       |                   | Min.                                                 | Max. | Min.      | Max. | Min.        | Max. | Min.      | Max. | Typ.      |         |
| $t_{PLH}$ , $t_{PHL}$ | A to B            | 0.2                                                  | 3.5  | 0.3       | 3.9  | 0.5         | 5.4  | 0.6       | 6.8  | 22.0      | ns      |
|                       | B to A            | 0.2                                                  | 3.5  | 0.2       | 3.8  | 0.3         | 5.0  | 0.5       | 6.0  | 15.0      | ns      |
| $t_{PLH}$ , $t_{PHL}$ | CLK IN to CLK OUT |                                                      | 3.0  |           | 3.5  |             | 4.5  |           | 6.0  | 15.0      | ns      |
| $t_{PZL}$ , $t_{PZH}$ | OE to A, OE to B  |                                                      | 1.7  |           | 1.7  |             | 1.7  |           | 1.7  | 1.7       | $\mu s$ |
| $t_{skew}^{(12)}$     | A Port, B Port    |                                                      | 0.5  |           | 0.5  |             | 0.5  |           | 1.0  | 1.0       | ns      |

$V_{CCA} = 2.3V$  to  $2.7V$

| Symbol                | Parameter         | $T_A = -40^{\circ}C$ to $+85^{\circ}C$ , $V_{CCB} =$ |      |           |      |             |      |           |      |           | Units   |
|-----------------------|-------------------|------------------------------------------------------|------|-----------|------|-------------|------|-----------|------|-----------|---------|
|                       |                   | 3.0V–3.6V                                            |      | 2.3V–2.7V |      | 1.65V–1.95V |      | 1.4V–1.6V |      | 1.1V–1.3V |         |
|                       |                   | Min.                                                 | Max. | Min.      | Max. | Min.        | Max. | Min.      | Max. | Typ.      |         |
| $t_{PLH}$ , $t_{PHL}$ | A to B            | 0.2                                                  | 3.8  | 0.4       | 4.2  | 0.5         | 5.6  | 0.8       | 6.9  | 22.0      | ns      |
|                       | B to A            | 0.3                                                  | 3.9  | 0.4       | 4.2  | 0.5         | 5.5  | 0.5       | 6.5  | 15.0      | ns      |
| $t_{PLH}$ , $t_{PHL}$ | CLK IN to CLK OUT |                                                      | 3.5  |           | 4.0  |             | 4.5  |           | 6.5  | 15.0      | ns      |
| $t_{PZL}$ , $t_{PZH}$ | OE to A, OE to B  |                                                      | 1.7  |           | 1.7  |             | 1.7  |           | 1.7  | 1.7       | $\mu s$ |
| $t_{skew}^{(12)}$     | A Port, B Port    |                                                      | 0.5  |           | 0.5  |             | 0.5  |           | 1.0  | 1.0       | ns      |

$V_{CCA} = 1.65V$  to  $1.95V$

| Symbol                | Parameter         | $T_A = -40^{\circ}C$ to $+85^{\circ}C$ , $V_{CCB} =$ |      |           |      |             |      |           |      |           | Units   |
|-----------------------|-------------------|------------------------------------------------------|------|-----------|------|-------------|------|-----------|------|-----------|---------|
|                       |                   | 3.0V–3.6V                                            |      | 2.3V–2.7V |      | 1.65V–1.95V |      | 1.4V–1.6V |      | 1.1V–1.3V |         |
|                       |                   | Min.                                                 | Max. | Min.      | Max. | Min.        | Max. | Min.      | Max. | Typ.      |         |
| $t_{PLH}$ , $t_{PHL}$ | A to B            | 0.3                                                  | 5.0  | 0.5       | 5.5  | 0.8         | 6.7  | 0.9       | 7.5  | 22.0      | ns      |
|                       | B to A            | 0.5                                                  | 5.4  | 0.5       | 5.6  | 0.8         | 6.7  | 1.0       | 7.0  | 15.0      | ns      |
| $t_{PLH}$ , $t_{PHL}$ | CLK IN to CLK OUT |                                                      | 4.5  |           | 4.5  |             | 6.3  |           | 6.7  | 15.0      | ns      |
| $t_{PZL}$ , $t_{PZH}$ | OE to A, OE to B  |                                                      | 1.7  |           | 1.7  |             | 1.7  |           | 1.7  | 1.7       | $\mu s$ |
| $t_{skew}^{(12)}$     | A Port, B Port    |                                                      | 0.5  |           | 0.5  |             | 0.5  |           | 1.0  | 1.0       | ns      |

$V_{CCA} = 1.4V$  to  $1.6V$

| Symbol                | Parameter         | $T_A = -40^{\circ}C$ to $+85^{\circ}C$ , $V_{CCB} =$ |      |           |      |             |      |           |      |           | Units   |
|-----------------------|-------------------|------------------------------------------------------|------|-----------|------|-------------|------|-----------|------|-----------|---------|
|                       |                   | 3.0V–3.6V                                            |      | 2.3V–2.7V |      | 1.65V–1.95V |      | 1.4V–1.6V |      | 1.1V–1.3V |         |
|                       |                   | Min.                                                 | Max. | Min.      | Max. | Min.        | Max. | Min.      | Max. | Typ.      |         |
| $t_{PLH}$ , $t_{PHL}$ | A to B            | 0.5                                                  | 6.0  | 0.5       | 6.5  | 1.0         | 7.0  | 1.0       | 8.5  | 22.0      | ns      |
|                       | B to A            | 0.6                                                  | 6.8  | 0.8       | 6.9  | 0.9         | 7.5  | 1.0       | 8.5  | 15.0      | ns      |
| $t_{PLH}$ , $t_{PHL}$ | CLK IN to CLK OUT |                                                      | 6.0  |           | 6.5  |             | 6.7  |           | 8.5  | 15.0      | ns      |
| $t_{PZL}$ , $t_{PZH}$ | OE to A, OE to B  |                                                      | 1.7  |           | 1.7  |             | 1.7  |           | 1.7  | 1.7       | $\mu s$ |
| $t_{skew}^{(12)}$     | A Port, B Port    |                                                      | 1.0  |           | 1.0  |             | 1.0  |           | 1.0  | 1.0       | ns      |

### Note:

12. Skew is the variation of propagation delay between output signals and applies only to output signals on the same port ( $A_n$  or  $B_n$ ) and switching with the same polarity (Low-to-High or High-to-Low). See Figure 8.

**Maximum Data Rate<sup>(13)(14)</sup>**

| $V_{CCA}$                                 | $T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C}, V_{CCB} =$ |              |                |              |              | Units |
|-------------------------------------------|----------------------------------------------------------------|--------------|----------------|--------------|--------------|-------|
|                                           | 3.0V to 3.6V                                                   | 2.3V to 2.7V | 1.65V to 1.95V | 1.4V to 1.6V | 1.1V to 1.3V |       |
|                                           | Min.                                                           | Min.         | Min.           | Min.         | Typ.         |       |
| $V_{CCA} = 3.0\text{V to } 3.6\text{V}$   | 100                                                            | 100          | 80             | 60           | 20           | Mbps  |
| $V_{CCA} = 2.3\text{V to } 2.7\text{V}$   | 100                                                            | 100          | 80             | 60           | 20           | Mbps  |
| $V_{CCA} = 1.65\text{V to } 1.95\text{V}$ | 80                                                             | 80           | 60             | 40           | 20           | Mbps  |
| $V_{CCA} = 1.4\text{V to } 1.6\text{V}$   | 60                                                             | 60           | 40             | 40           | 20           | Mbps  |
|                                           | Typ.                                                           | Typ.         | Typ.           | Typ.         | Typ.         |       |
| $V_{CCA} = 1.1\text{V to } 1.3\text{V}$   | 20                                                             | 20           | 20             | 20           | 20           | Mbps  |

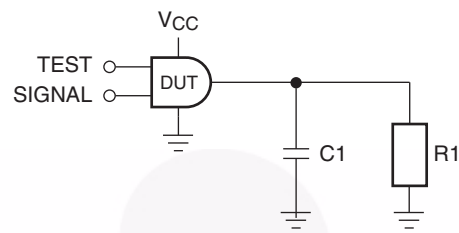
**Note:**

13. Maximum data rate is guaranteed but not tested.

14. Maximum data rate is specified in megabits per second. See Figure 7. It is equivalent to two times the F-toggle frequency, specified in megahertz. For example, 100 Mbps is equivalent to 50 MHz.

**Capacitance**

| Symbol    | Parameter                     | Conditions                                                                               | $T_A = +25^{\circ}\text{C}$ | Units |
|-----------|-------------------------------|------------------------------------------------------------------------------------------|-----------------------------|-------|
|           |                               |                                                                                          | Typical                     |       |
| $C_{IN}$  | Input Capacitance, OE, CLK IN | $V_{CCA} = V_{CCB} = \text{GND}$                                                         | 4                           | pF    |
| $C_{I/O}$ | Input/Output Capacitance      | $A_n$                                                                                    | 5                           | pF    |
|           |                               | $B_n$ , CLK OUT                                                                          | 6                           |       |
| $C_{PD}$  | Power Dissipation Capacitance | $V_{CCA} = V_{CCB} = 3.3\text{V}$ ,<br>$V_i = 0\text{V or } V_{CC}$ , $f = 10\text{MHz}$ | 25                          | pF    |

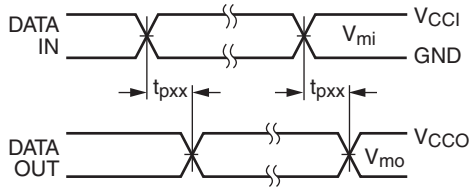


| Test                  | Input Signal | Output Enable Control |
|-----------------------|--------------|-----------------------|
| $t_{PLH}$ , $t_{PHL}$ | Data Pulses  | $V_{CCA}$             |
| $t_{PZL}$             | 0V           | Low to High Switch    |
| $t_{PZH}$             | $V_{CCI}$    | Low to High Switch    |

Figure 1. AC Test Circuit

AC Load Table

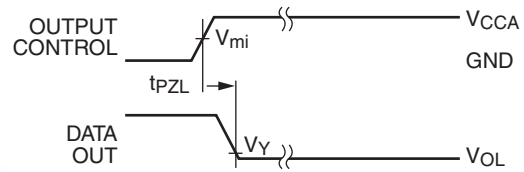
| $V_{CCO}$        | CI   | RI          |
|------------------|------|-------------|
| $1.2V \pm 0.1V$  | 15pF | 1M $\Omega$ |
| $1.5V \pm 0.1V$  | 15pF | 1M $\Omega$ |
| $1.8V \pm 0.15V$ | 15pF | 1M $\Omega$ |
| $2.5V \pm 0.2V$  | 15pF | 1M $\Omega$ |
| $3.3 \pm 0.3V$   | 15pF | 1M $\Omega$ |



Input  $t_R = t_F = 2.0\text{ns}$ , 10% to 90%

Input  $t_R = t_F = 2.5\text{ns}$ , 10% to 90%, @  $V_i = 3.0\text{V}$  to  $3.6\text{V}$  only

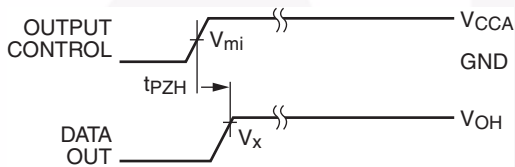
**Figure 2. Waveform for Inverting and Non-inverting Functions**



Input  $t_R = t_F = 2.0\text{ns}$ , 10% to 90%

Input  $t_R = t_F = 2.5\text{ns}$ , 10% to 90%, @  $V_i = 3.0\text{V}$  to  $3.6\text{V}$  only

**Figure 3. 3-STATE Output Low Enable Time for Low Voltage Logic**



Input  $t_R = t_F = 2.0\text{ns}$ , 10% to 90%

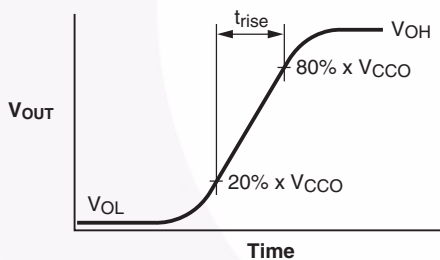
Input  $t_R = t_F = 2.5\text{ns}$ , 10% to 90%, @  $V_i = 3.0\text{V}$  to  $3.6\text{V}$  only

**Figure 4. 3-STATE Output High Enable Time for Low Voltage Logic**

| Symbol          | Vcc                  |
|-----------------|----------------------|
| $V_{mi}^{(15)}$ | $V_{CCI} / 2$        |
| $V_{mo}$        | $V_{CCO} / 2$        |
| $V_X$           | $0.9 \times V_{CCO}$ |
| $V_Y$           | $0.1 \times V_{CCO}$ |

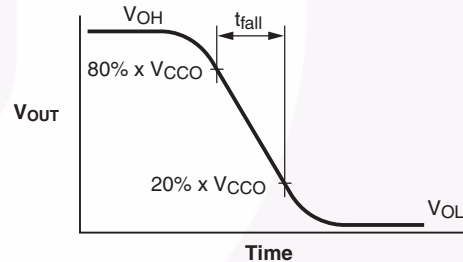
**Note:**

15.  $V_{CCI} = V_{CCA}$  for control pin OE or  $V_{mi} = (V_{CCA} / 2)$ .



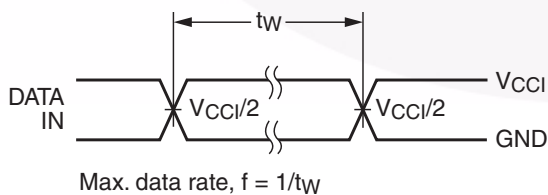
$$I_{OHD} \approx (C_L + C_{I/O}) \times \frac{\Delta V_{OUT}}{\Delta t} = (C_L + C_{I/O}) \times \frac{(20\% - 80\%) \times V_{CCO}}{t_{RISE}}$$

**Figure 5. Active Output Rise Time and Dynamic Output Current High**

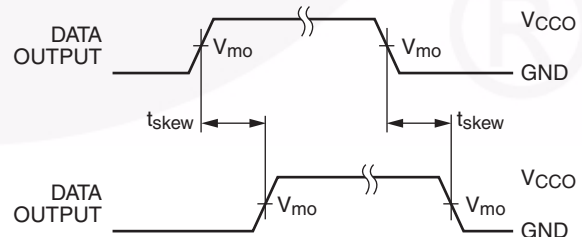


$$I_{OLD} \approx (C_L + C_{I/O}) \times \frac{\Delta V_{OUT}}{\Delta t} = (C_L + C_{I/O}) \times \frac{(80\% - 20\%) \times V_{CCO}}{t_{FALL}}$$

**Figure 6. Active Output Fall Time and Dynamic Output Current Low**



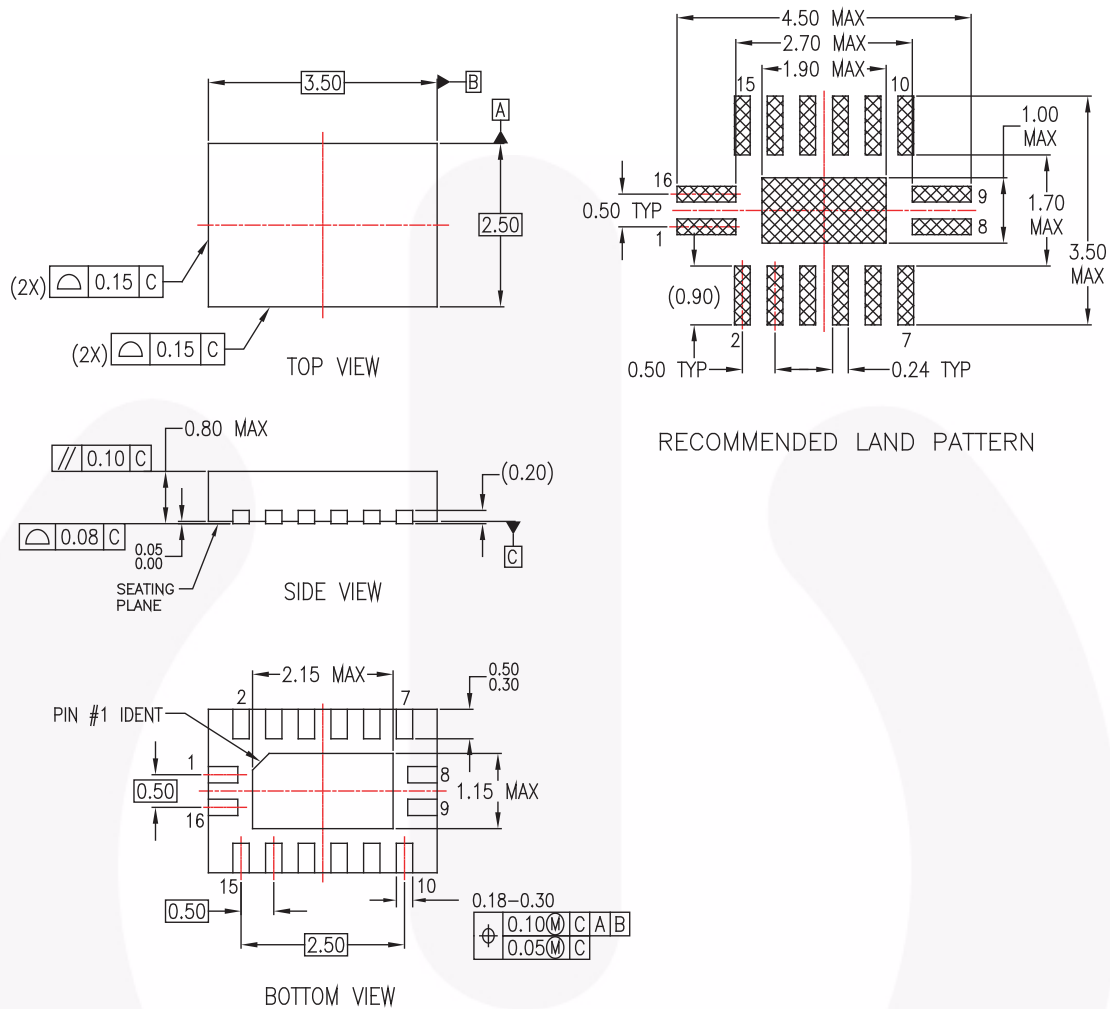
**Figure 7. Maximum Data Rate**



$$t_{skew} = (t_{pHLmax} - t_{pHLmin}) \text{ or } (t_{pLHmax} - t_{pLHmin})$$

**Figure 8. Output Skew Time**

## Physical Dimensions



### NOTES:

- CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AB
- DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP16ErevA

**Figure 9. 16-Terminal Depopulated Quad, Very-Thin Flat Pack, No Leads (DQFN), JEDEC MO-241 2.5mm x 3.5mm**

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