

## FXL4T245

### Low Voltage Dual Supply 4-Bit Signal Translator with Configurable Voltage Supplies and Signal Levels and 3-STATE Outputs

#### General Description

The FXL4T245 is a configurable dual-voltage-supply translator designed for bi-directional voltage translation of signals between two voltage 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. Both ports are designed to accept supply voltage levels from 1.1V to 3.6V. 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  $V_{CC}$ s reach active levels allowing either  $V_{CC}$  to be powered-up first. The device also contains power down control circuits that place the device in 3-STATE if either  $V_{CC}$  is removed.

The Transmit/Receive ( $\overline{T/R}$ ) input determines the direction of data flow through the device. The  $\overline{OE}$  input, when HIGH, disables both the A and B Ports by placing them in 3-STATE condition. The FXL4T245 is designed so that the control pins ( $\overline{T/R}$  and  $\overline{OE}$ ) are supplied by  $V_{CCA}$ .

#### Features

- Bi-directional interface between any 2 levels from 1.1V to 3.6V
- Fully configurable, inputs track  $V_{CC}$  level
- Non-preferential power-up sequencing; either  $V_{CC}$  may be powered-up first
- No power-up sequencing required
- 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
- Control inputs ( $\overline{T/R}$ ,  $\overline{OE}$ ) levels are referenced to  $V_{CCA}$  voltage
- Packaged in 14-terminal DQFN (2.5mm x 3.0mm) package
- ESD protection exceeds:
  - 4kV HBM ESD (per JESD22-A114 & Mil Std 883e 3015.7)
  - 8kV HBM I/O to GND ESD (per JESD22-A114 & Mil Std 883e 3015.7)
  - 1kV CDM ESD (per ESD STM 5.3)
  - 200V MM ESD (per JESD22-A115 & ESD STM5.2)

#### Ordering Code:

| Order Number | Package Number | Package Description                                                                         |
|--------------|----------------|---------------------------------------------------------------------------------------------|
| FXL4T245BQX  | MLP014A        | 14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm |

FXL4T245 Low Voltage Dual Supply 4-Bit Signal Translator with Configurable Voltage Supplies and Signal Levels and 3-STATE Outputs

## Terminal Descriptions

| Terminal Names   | Description                      |
|------------------|----------------------------------|
| $\overline{OE}$  | Output Enable Input              |
| $T/\overline{R}$ | Transmit/Receive Input           |
| $A_n$            | Side A Inputs or 3-STATE Outputs |
| $B_n$            | Side B Inputs or 3-STATE Outputs |
| $V_{CCA}$        | Side A Power Supply              |
| $V_{CCB}$        | Side B Power Supply              |
| GND              | Ground                           |

## Truth Table

| Inputs          |                  | Outputs             |
|-----------------|------------------|---------------------|
| $\overline{OE}$ | $T/\overline{R}$ |                     |
| L               | L                | Bus B Data to Bus A |
| L               | H                | Bus A Data to Bus B |

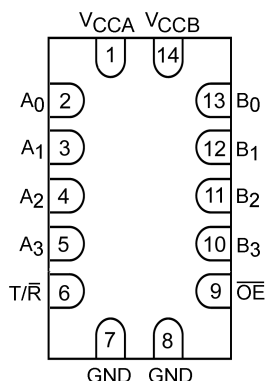
H = HIGH Voltage Level

L = LOW Voltage Level

X = Don't Care

## Connection Diagram

Terminal Assignments for DQFN



(Top View)

## Terminal Assignment

| Terminal Number | Terminal Name    |
|-----------------|------------------|
| 1               | $V_{CCA}$        |
| 2               | $A_0$            |
| 3               | $A_1$            |
| 4               | $A_2$            |
| 5               | $A_3$            |
| 6               | $T/\overline{R}$ |
| 7               | GND              |
| 8               | GND              |
| 9               | $\overline{OE}$  |
| 10              | $B_3$            |
| 11              | $B_2$            |
| 12              | $B_1$            |
| 13              | $B_0$            |
| 14              | $V_{CCB}$        |

## Power-Up/Power-Down Sequencing

FXL translators offer an advantage in that either  $V_{CC}$  may be powered up first. This benefit derives from the chip design. When either  $V_{CC}$  is at 0 volts, outputs are in a HIGH-Impedance state. The control inputs ( $T/\overline{R}$  and  $\overline{OE}$ ) are designed to track the  $V_{CCA}$  supply. A pull-up resistor tying  $\overline{OE}$  to  $V_{CCA}$  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-up resistor is based upon the current-sinking capability of the  $\overline{OE}$  driver.

The recommended power-up sequence is the following:

1. Apply power to either  $V_{CC}$ .
2. Apply power to the  $T/\overline{R}$  input (Logic HIGH for A-to-B operation; Logic LOW for B-to-A operation) and to the respective data inputs (A Port or B Port). This may occur at the same time as Step 1.
3. Apply power to other  $V_{CC}$ .

4. Drive the  $\overline{OE}$  input LOW to enable the device.

The recommended power-down sequence is the following:

1. Drive  $\overline{OE}$  input HIGH to disable the device.
2. Remove power from either  $V_{CC}$ .
3. Remove power from other  $V_{CC}$ .

| Absolute Maximum Ratings <sup>(Note 1)</sup>          |                           |  | Recommended Operating Conditions <sup>(Note 3)</sup>  |                   |
|-------------------------------------------------------|---------------------------|--|-------------------------------------------------------|-------------------|
| Supply Voltage                                        |                           |  | Power Supply Operating ( $V_{CCA}$ or $V_{CCB}$ )     | 1.1V to 3.6V      |
| $V_{CCA}$                                             | -0.5V to +4.6V            |  | Input Voltage                                         |                   |
| $V_{CCB}$                                             | -0.5V to +4.6V            |  | Port A                                                | 0.0V to 3.6V      |
| DC Input Voltage ( $V_I$ )                            |                           |  | Port B                                                | 0.0V to 3.6V      |
| I/O Port A                                            | -0.5V to +4.6V            |  | Control Inputs ( $\overline{T/R}$ , $\overline{OE}$ ) | 0.0V to $V_{CCA}$ |
| I/O Port B                                            | -0.5V to +4.6V            |  | Output Current in $I_{OH}/I_{OL}$                     |                   |
| Control Inputs ( $\overline{T/R}$ , $\overline{OE}$ ) | -0.5V to +4.6V            |  | $V_{CC}$                                              |                   |
| Output Voltage ( $V_O$ ) (Note 2)                     |                           |  | 3.0V to 3.6V                                          | $\pm 24$ mA       |
| Outputs 3-STATE                                       | -0.5V to +4.6V            |  | 2.3V to 2.7V                                          | $\pm 18$ mA       |
| Outputs Active ( $A_n$ )                              | -0.5V to $V_{CCA} + 0.5V$ |  | 1.65V to 1.95V                                        | $\pm 6$ mA        |
| Outputs Active ( $B_n$ )                              | -0.5V to $V_{CCB} + 0.5V$ |  | 1.4V to 1.65V                                         | $\pm 2$ mA        |
| DC Input Diode Current ( $I_{IK}$ ) $V_I < 0V$        | -50 mA                    |  | 1.1V to 1.4V                                          | $\pm 0.5$ mA      |
| DC Output Diode Current ( $I_{OK}$ )                  |                           |  | Free Air Operating Temperature ( $T_A$ )              | -40°C to +85°C    |
| $V_O < 0V$                                            | -50 mA                    |  | Minimum Input Edge Rate ( $\Delta V/\Delta t$ )       |                   |
| $V_O > V_{CC}$                                        | +50 mA                    |  | $V_{CCA/B} = 1.1V$ to 3.6V                            | 10 ns/V           |
| DC Output Source/Sink Current                         |                           |  |                                                       |                   |
| ( $I_{OH}/I_{OL}$ )                                   | -50 mA / +50 mA           |  |                                                       |                   |
| DC $V_{CC}$ or Ground Current per                     |                           |  |                                                       |                   |
| Supply Pin ( $I_{CC}$ )                               | $\pm 100$ mA              |  |                                                       |                   |
| Storage Temperature Range ( $T_{STG}$ )               | -65°C to +150°C           |  |                                                       |                   |

**Note 1:** 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 2:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 3:** All unused inputs must be held at  $V_{CCI}$  or GND.

## DC Electrical Characteristics

| Symbol               | Parameter                | Conditions                                                                     | $V_{CCI}$<br>(V) | $V_{CCO}$<br>(V) | Min                   | Max                   | Units |
|----------------------|--------------------------|--------------------------------------------------------------------------------|------------------|------------------|-----------------------|-----------------------|-------|
| $V_{IH}$<br>(Note 4) | High Level Input Voltage | Data Inputs $A_n$ , $B_n$                                                      | 2.7 - 3.6        | 1.1 - 3.6        | 2.0                   |                       | V     |
|                      |                          |                                                                                | 2.3 - 2.7        |                  | 1.6                   |                       |       |
|                      |                          |                                                                                | 1.65 - 2.3       |                  | $0.65 \times V_{CCI}$ |                       |       |
|                      |                          |                                                                                | 1.4 - 1.65       |                  | $0.65 \times V_{CCI}$ |                       |       |
|                      |                          |                                                                                | 1.1 - 1.4        |                  | $0.9 \times V_{CCI}$  |                       |       |
|                      |                          | Control Pins/ $\overline{OE}$ , $\overline{T/R}$<br>(Referenced to $V_{CCA}$ ) | 2.7 - 3.6        | 1.1 - 3.6        | 2.0                   |                       |       |
|                      |                          |                                                                                | 2.3 - 2.7        |                  | 1.6                   |                       |       |
|                      |                          |                                                                                | 1.65 - 2.3       |                  | $0.65 \times V_{CCA}$ |                       |       |
|                      |                          |                                                                                | 1.4 - 1.65       |                  | $0.65 \times V_{CCA}$ |                       |       |
|                      |                          |                                                                                | 1.1 - 1.4        |                  | $0.9 \times V_{CCA}$  |                       |       |
| $V_{IL}$<br>(Note 4) | Low Level Input Voltage  | Data Inputs $A_n$ , $B_n$                                                      | 2.7 - 3.6        | 1.1 - 3.6        |                       | 0.8                   | V     |
|                      |                          |                                                                                | 2.3 - 2.7        |                  |                       | 0.7                   |       |
|                      |                          |                                                                                | 1.65 - 2.3       |                  |                       | $0.35 \times V_{CCI}$ |       |
|                      |                          |                                                                                | 1.4 - 1.65       |                  |                       | $0.35 \times V_{CCI}$ |       |
|                      |                          |                                                                                | 1.1 - 1.4        |                  |                       | $0.1 \times V_{CCI}$  |       |
|                      |                          | Control Pins/ $\overline{OE}$ , $\overline{T/R}$<br>(Referenced to $V_{CCA}$ ) | 2.7 - 3.6        | 1.1 - 3.6        |                       | 0.8                   |       |
|                      |                          |                                                                                | 2.3 - 2.7        |                  |                       | 0.7                   |       |
|                      |                          |                                                                                | 1.65 - 2.3       |                  |                       | $0.35 \times V_{CCA}$ |       |
|                      |                          |                                                                                | 1.4 - 1.65       |                  |                       | $0.35 \times V_{CCA}$ |       |
|                      |                          |                                                                                | 1.1 - 1.4        |                  |                       | $0.1 \times V_{CCA}$  |       |

## DC Electrical Characteristics (Continued)

| Symbol                      | Parameter                                                                                                  | Conditions                                                        | V <sub>CCA</sub><br>(V) | V <sub>CCB</sub><br>(V) | Min                     | Max                    | Units |
|-----------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------|
| V <sub>OH</sub><br>(Note 5) | High Level Output Voltage                                                                                  | I <sub>OH</sub> = -100 μA                                         | 1.1 - 3.6               | 1.1 - 3.6               | V <sub>CC0</sub> - 0.2  |                        | V     |
|                             |                                                                                                            | I <sub>OH</sub> = -12 mA                                          | 2.7                     | 2.7                     | 2.2                     |                        |       |
|                             |                                                                                                            | I <sub>OH</sub> = -18 mA                                          | 3.0                     | 3.0                     | 2.4                     |                        |       |
|                             |                                                                                                            | I <sub>OH</sub> = -24 mA                                          | 3.0                     | 3.0                     | 2.2                     |                        |       |
|                             |                                                                                                            | I <sub>OH</sub> = -6 mA                                           | 2.3                     | 2.3                     | 2.0                     |                        |       |
|                             |                                                                                                            | I <sub>OH</sub> = -12 mA                                          | 2.3                     | 2.3                     | 1.8                     |                        |       |
|                             |                                                                                                            | I <sub>OH</sub> = -18 mA                                          | 2.3                     | 2.3                     | 1.7                     |                        |       |
|                             |                                                                                                            | I <sub>OH</sub> = -6 mA                                           | 1.65                    | 1.65                    | 1.25                    |                        |       |
| V <sub>OL</sub><br>(Note 5) | Low Level Output Voltage                                                                                   | I <sub>OH</sub> = -2 mA                                           | 1.4                     | 1.4                     | 1.05                    |                        | V     |
|                             |                                                                                                            | I <sub>OH</sub> = -0.5 mA                                         | 1.1                     | 1.1                     | 0.75 x V <sub>CC0</sub> |                        |       |
|                             |                                                                                                            | I <sub>OL</sub> = 100 μA                                          | 1.1 - 3.6               | 1.1 - 3.6               |                         | 0.2                    |       |
|                             |                                                                                                            | I <sub>OL</sub> = 12 mA                                           | 2.7                     | 2.7                     |                         | 0.4                    |       |
|                             |                                                                                                            | I <sub>OL</sub> = 18 mA                                           | 3.0                     | 3.0                     |                         | 0.4                    |       |
|                             |                                                                                                            | I <sub>OL</sub> = 24 mA                                           | 3.0                     | 3.0                     |                         | 0.55                   |       |
|                             |                                                                                                            | I <sub>OL</sub> = 12 mA                                           | 2.3                     | 2.3                     |                         | 0.4                    |       |
|                             |                                                                                                            | I <sub>OL</sub> = 18 mA                                           | 2.3                     | 2.3                     |                         | 0.6                    |       |
| I <sub>I</sub>              | Input Leakage Current. Control Pins                                                                        | I <sub>OL</sub> = 6 mA                                            | 1.65                    | 1.65                    |                         | 0.3                    | μA    |
|                             |                                                                                                            | I <sub>OL</sub> = 2 mA                                            | 1.4                     | 1.4                     |                         | 0.35                   |       |
|                             |                                                                                                            | I <sub>OL</sub> = 0.5 mA                                          | 1.1                     | 1.1                     |                         | 0.3 x V <sub>CC0</sub> |       |
| I <sub>OFF</sub>            | Power Off Leakage Current                                                                                  | V <sub>I</sub> = V <sub>CCA</sub> or GND                          | 1.1 - 3.6               | 3.6                     |                         | ±1.0                   | μA    |
| I <sub>OZ</sub><br>(Note 6) | 3-STATE Output Leakage<br>0 ≤ V <sub>O</sub> ≤ 3.6V<br>V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> | A <sub>n</sub> , V <sub>I</sub> or V <sub>O</sub> = 0V to 3.6V    | 0                       | 3.6                     |                         | ±10.0                  | μA    |
|                             |                                                                                                            | B <sub>n</sub> , V <sub>I</sub> or V <sub>O</sub> = 0V to 3.6V    | 3.6                     | 0                       |                         | ±10.0                  |       |
|                             |                                                                                                            | A <sub>n</sub> , B <sub>n</sub> $\overline{OE}$ = V <sub>IH</sub> | 3.6                     | 3.6                     |                         | ±10.0                  |       |
| I <sub>CCA/B</sub> (Note 7) | Quiescent Supply Current                                                                                   | B <sub>n</sub> , $\overline{OE}$ = Don't Care                     | 0                       | 3.6                     |                         | +10.0                  | μA    |
| I <sub>CCZ</sub> (Note 7)   | Quiescent Supply Current                                                                                   | A <sub>n</sub> , $\overline{OE}$ = Don't Care                     | 3.6                     | 0                       |                         | +10.0                  |       |
| I <sub>CCA</sub>            | Quiescent Supply Current                                                                                   | V <sub>I</sub> = V <sub>CCI</sub> or GND; I <sub>O</sub> = 0      | 1.1 - 3.6               | 1.1 - 3.6               |                         | 20.0                   | μA    |
| I <sub>CCB</sub>            | Quiescent Supply Current                                                                                   | V <sub>I</sub> = V <sub>CCB</sub> or GND; I <sub>O</sub> = 0      | 1.1 - 3.6               | 0                       |                         | -10.0                  | μA    |
| ΔI <sub>CCA/B</sub>         | Increase in I <sub>CC</sub> per Input;<br>Other Inputs at V <sub>CC</sub> or GND                           | V <sub>IH</sub> = 3.0                                             | 3.6                     | 3.6                     |                         | 500                    | μA    |

**Note 4:** V<sub>CCI</sub> = the V<sub>CC</sub> associated with the data input under test.

**Note 5:** V<sub>CC0</sub> = the V<sub>CC</sub> associated with the output under test.

**Note 6:** Don't Care = Any valid logic level.

**Note 7:** Reflects current per supply, V<sub>CCA</sub> or V<sub>CCB</sub>.

**AC Electrical Characteristics**  $V_{CCA} = 3.0V$  to  $3.6V$ 

| Symbol                              | Parameter                           | T <sub>A</sub> = −40°C to +85°C    |     |                                    |     |                                      |     |                                    |     |                                    |      | Units |
|-------------------------------------|-------------------------------------|------------------------------------|-----|------------------------------------|-----|--------------------------------------|-----|------------------------------------|-----|------------------------------------|------|-------|
|                                     |                                     | V <sub>CCB</sub> =<br>3.0V to 3.6V |     | V <sub>CCB</sub> =<br>2.3V to 2.7V |     | V <sub>CCB</sub> =<br>1.65V to 1.95V |     | V <sub>CCB</sub> =<br>1.4V to 1.6V |     | V <sub>CCB</sub> =<br>1.1V to 1.3V |      |       |
|                                     |                                     | Min                                | Max | Min                                | Max | Min                                  | Max | Min                                | Max | Min                                | Max  |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay A to B            | 0.2                                | 3.5 | 0.3                                | 3.9 | 0.5                                  | 5.4 | 0.6                                | 6.8 | 1.4                                | 22.0 | ns    |
|                                     | Propagation Delay B to A            | 0.2                                | 3.5 | 0.2                                | 3.8 | 0.3                                  | 4.0 | 0.5                                | 4.3 | 0.8                                | 13.0 |       |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Output Enable $\overline{OE}$ to B  | 0.5                                | 4.0 | 0.7                                | 4.4 | 1.0                                  | 5.9 | 1.0                                | 6.4 | 1.5                                | 17.0 | ns    |
|                                     | Output Enable $\overline{OE}$ to A  | 0.5                                | 4.0 | 0.5                                | 4.0 | 0.5                                  | 4.0 | 0.5                                | 4.0 | 0.5                                | 4.0  |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Output Disable $\overline{OE}$ to B | 0.2                                | 3.8 | 0.2                                | 4.0 | 0.7                                  | 4.8 | 1.5                                | 6.2 | 2.0                                | 17.0 | ns    |
|                                     | Output Disable $\overline{OE}$ to A | 0.2                                | 3.7 | 0.2                                | 3.7 | 0.2                                  | 3.7 | 0.2                                | 3.7 | 0.2                                | 3.7  |       |

**AC Electrical Characteristics**  $V_{CCA} = 2.3V$  to  $2.7V$ 

| Symbol                              | Parameter                           | T <sub>A</sub> = −40°C to +85°C    |     |                                    |     |                                      |     |                                    |     |                                    |      | Units |
|-------------------------------------|-------------------------------------|------------------------------------|-----|------------------------------------|-----|--------------------------------------|-----|------------------------------------|-----|------------------------------------|------|-------|
|                                     |                                     | V <sub>CCB</sub> =<br>3.0V to 3.6V |     | V <sub>CCB</sub> =<br>2.3V to 2.7V |     | V <sub>CCB</sub> =<br>1.65V to 1.95V |     | V <sub>CCB</sub> =<br>1.4V to 1.6V |     | V <sub>CCB</sub> =<br>1.1V to 1.3V |      |       |
|                                     |                                     | Min                                | Max | Min                                | Max | Min                                  | Max | Min                                | Max | Min                                | Max  |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay A to B            | 0.2                                | 3.8 | 0.4                                | 4.2 | 0.5                                  | 5.6 | 0.8                                | 6.9 | 1.4                                | 22.0 | ns    |
|                                     | Propagation Delay B to A            | 0.3                                | 3.9 | 0.4                                | 4.2 | 0.5                                  | 4.5 | 0.5                                | 4.8 | 1.0                                | 7.0  |       |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Output Enable $\overline{OE}$ to B  | 0.6                                | 4.2 | 0.8                                | 4.6 | 1.0                                  | 6.0 | 1.0                                | 6.8 | 1.5                                | 17.0 | ns    |
|                                     | Output Enable $\overline{OE}$ to A  | 0.6                                | 4.5 | 0.6                                | 4.5 | 0.6                                  | 4.5 | 0.6                                | 4.5 | 0.6                                | 4.5  |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Output Disable $\overline{OE}$ to B | 0.2                                | 4.1 | 0.2                                | 4.3 | 0.7                                  | 4.8 | 1.5                                | 6.7 | 2.0                                | 17.0 | ns    |
|                                     | Output Disable $\overline{OE}$ to A | 0.2                                | 4.0 | 0.2                                | 4.0 | 0.2                                  | 4.0 | 0.2                                | 4.0 | 0.2                                | 4.0  |       |

**AC Electrical Characteristics**  $V_{CCA} = 1.65V$  to  $1.95V$ 

| Symbol                              | Parameter                           | T <sub>A</sub> = −40°C to +85°C    |     |                                    |     |                                      |     |                                    |     |                                    |      | Units |
|-------------------------------------|-------------------------------------|------------------------------------|-----|------------------------------------|-----|--------------------------------------|-----|------------------------------------|-----|------------------------------------|------|-------|
|                                     |                                     | V <sub>CCB</sub> =<br>3.0V to 3.6V |     | V <sub>CCB</sub> =<br>2.3V to 2.7V |     | V <sub>CCB</sub> =<br>1.65V to 1.95V |     | V <sub>CCB</sub> =<br>1.4V to 1.6V |     | V <sub>CCB</sub> =<br>1.1V to 1.3V |      |       |
|                                     |                                     | Min                                | Max | Min                                | Max | Min                                  | Max | Min                                | Max | Min                                | Max  |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay A to B            | 0.3                                | 4.0 | 0.5                                | 4.5 | 0.8                                  | 5.7 | 0.9                                | 7.1 | 1.5                                | 22.0 | ns    |
|                                     | Propagation Delay B to A            | 0.5                                | 5.4 | 0.5                                | 5.6 | 0.8                                  | 5.7 | 1.0                                | 6.0 | 1.2                                | 8.0  |       |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Output Enable $\overline{OE}$ to B  | 0.6                                | 5.2 | 0.8                                | 5.4 | 1.2                                  | 6.9 | 1.2                                | 7.2 | 1.5                                | 18.0 | ns    |
|                                     | Output Enable $\overline{OE}$ to A  | 1.0                                | 6.7 | 1.0                                | 6.7 | 1.0                                  | 6.7 | 1.0                                | 6.7 | 1.0                                | 6.7  |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Output Disable $\overline{OE}$ to B | 0.2                                | 5.1 | 0.2                                | 5.2 | 0.8                                  | 5.2 | 1.5                                | 7.0 | 2.0                                | 17.0 | ns    |
|                                     | Output Disable $\overline{OE}$ to A | 0.5                                | 5.0 | 0.5                                | 5.0 | 0.5                                  | 5.0 | 0.5                                | 5.0 | 0.5                                | 5.0  |       |

**AC Electrical Characteristics**  $V_{CCA} = 1.4V$  to  $1.6V$ 

| Symbol                              | Parameter                           | T <sub>A</sub> = −40°C to +85°C    |     |                                    |     |                                      |     |                                    |     |                                    |      | Units |
|-------------------------------------|-------------------------------------|------------------------------------|-----|------------------------------------|-----|--------------------------------------|-----|------------------------------------|-----|------------------------------------|------|-------|
|                                     |                                     | V <sub>CCB</sub> =<br>3.0V to 3.6V |     | V <sub>CCB</sub> =<br>2.3V to 2.7V |     | V <sub>CCB</sub> =<br>1.65V to 1.95V |     | V <sub>CCB</sub> =<br>1.4V to 1.6V |     | V <sub>CCB</sub> =<br>1.1V to 1.3V |      |       |
|                                     |                                     | Min                                | Max | Min                                | Max | Min                                  | Max | Min                                | Max | Min                                | Max  |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay A to B            | 0.5                                | 4.3 | 0.5                                | 4.8 | 1.0                                  | 6.0 | 1.0                                | 7.3 | 1.5                                | 22.0 | ns    |
|                                     | Propagation Delay B to A            | 0.6                                | 6.8 | 0.8                                | 6.9 | 0.9                                  | 7.1 | 1.0                                | 7.3 | 1.3                                | 9.5  |       |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Output Enable $\overline{OE}$ to B  | 1.1                                | 7.5 | 1.1                                | 7.6 | 1.3                                  | 7.7 | 1.4                                | 7.9 | 2.0                                | 20.0 | ns    |
|                                     | Output Enable $\overline{OE}$ to A  | 1.0                                | 7.5 | 1.0                                | 7.5 | 1.0                                  | 7.5 | 1.0                                | 7.5 | 1.0                                | 7.5  |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Output Disable $\overline{OE}$ to B | 0.4                                | 6.1 | 0.4                                | 6.2 | 0.9                                  | 6.2 | 1.5                                | 7.5 | 2.0                                | 18.0 | ns    |
|                                     | Output Disable $\overline{OE}$ to A | 1.0                                | 6.0 | 1.0                                | 6.0 | 1.0                                  | 6.0 | 1.0                                | 6.0 | 1.0                                | 6.0  |       |

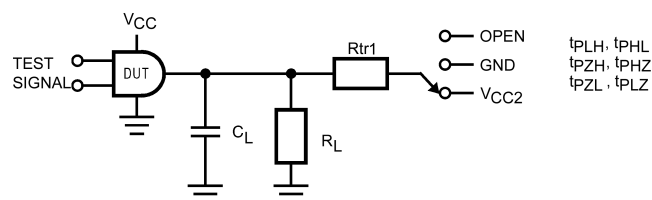
## AC Electrical Characteristics $V_{CCA} = 1.1V$ to $1.3V$

| Symbol                              | Parameter                           | T <sub>A</sub> = −40°C to +85°C    |      |                                    |      |                                      |      |                                    |      |                                    |      | Units |
|-------------------------------------|-------------------------------------|------------------------------------|------|------------------------------------|------|--------------------------------------|------|------------------------------------|------|------------------------------------|------|-------|
|                                     |                                     | V <sub>CCB</sub> =<br>3.0V to 3.6V |      | V <sub>CCB</sub> =<br>2.3V to 2.7V |      | V <sub>CCB</sub> =<br>1.65V to 1.95V |      | V <sub>CCB</sub> =<br>1.4V to 1.6V |      | V <sub>CCB</sub> =<br>1.1V to 1.3V |      |       |
|                                     |                                     | Min                                | Max  | Min                                | Max  | Min                                  | Max  | Min                                | Max  | Min                                | Max  |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay A to B            | 0.8                                | 13.0 | 1.0                                | 7.0  | 1.2                                  | 8.0  | 1.3                                | 9.5  | 2.0                                | 24.0 | ns    |
|                                     | Propagation Delay B to A            | 1.4                                | 22.0 | 1.4                                | 22.0 | 1.5                                  | 22.0 | 1.5                                | 22.0 | 2.0                                | 24.0 |       |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Output Enable $\overline{OE}$ to B  | 1.0                                | 12.0 | 1.0                                | 9.0  | 2.0                                  | 10.0 | 2.0                                | 11.0 | 2.0                                | 24.0 | ns    |
|                                     | Output Enable $\overline{OE}$ to A  | 2.0                                | 22.0 | 2.0                                | 22.0 | 2.0                                  | 22.0 | 2.0                                | 22.0 | 2.0                                | 22.0 |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Output Disable $\overline{OE}$ to B | 1.0                                | 15.0 | 0.7                                | 7.0  | 1.0                                  | 8.0  | 2.0                                | 10.0 | 2.0                                | 20.0 | ns    |
|                                     | Output Disable $\overline{OE}$ to A | 2.0                                | 15.0 | 2.0                                | 12.0 | 2.0                                  | 12.0 | 2.0                                | 12.0 | 2.0                                | 12.0 |       |

## Capacitance

| Symbol   | Parameter                                                  | Conditions                                                         | $T_A = +25^{\circ}C$ | Units |
|----------|------------------------------------------------------------|--------------------------------------------------------------------|----------------------|-------|
|          |                                                            |                                                                    | Typical              |       |
| $C_{IN}$ | Input Capacitance Control Pins ( $\overline{OE}$ , $T/R$ ) | $V_{CCA} = V_{CCB} = 3.3V$ , $V_I = 0V$ or $V_{CCA/B}$             | 4.0                  | pF    |
| $C_{IO}$ | Input/Output Capacitance $A_n$ , $B_n$ Ports               | $V_{CCA} = V_{CCB} = 3.3V$ , $V_I = 0V$ or $V_{CCA/B}$             | 5.0                  | pF    |
| $C_{PD}$ | Power Dissipation Capacitance                              | $V_{CCA} = V_{CCB} = 3.3V$ , $V_I = 0V$ or $V_{CC}$ , $F = 10$ MHz | 20.0                 | pF    |

## AC Loading and Waveforms

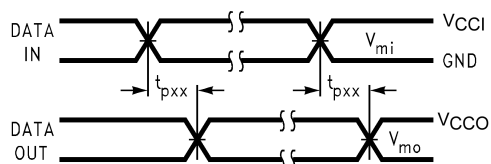


| TEST                  | SWITCH                                                                                                      |
|-----------------------|-------------------------------------------------------------------------------------------------------------|
| $t_{PLH}$ , $t_{PHL}$ | OPEN                                                                                                        |
| $t_{PLZ}$ , $t_{PZL}$ | $V_{CCO} \times 2$ at $V_{CCO} = 3.3 \pm 0.3V, 2.5V \pm 0.2V, 1.8V \pm 0.15V, 1.5V \pm 0.1V, 1.2V \pm 0.1V$ |
| $t_{PHZ}$ , $t_{PZH}$ | GND                                                                                                         |

FIGURE 1. AC Test Circuit

AC Load Table

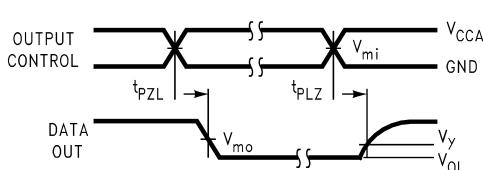
| $V_{CCO}$        | $C_L$ | $R_L$        | $R_{tr1}$    |
|------------------|-------|--------------|--------------|
| $1.2V \pm 0.1V$  | 15 pF | 2 k $\Omega$ | 2 k $\Omega$ |
| $1.5V \pm 0.1V$  | 15 pF | 2 k $\Omega$ | 2 k $\Omega$ |
| $1.8V \pm 0.15V$ | 15 pF | 2 k $\Omega$ | 2 k $\Omega$ |
| $2.5V \pm 0.2V$  | 15 pF | 2 k $\Omega$ | 2 k $\Omega$ |
| $3.3V \pm 0.3V$  | 15 pF | 2 k $\Omega$ | 2 k $\Omega$ |



Note: Input  $t_R = t_F = 2.0$  ns, 10% to 90%

Input  $t_R = t_F = 2.5$  ns, 10% to 90%, @  $V_I = 3.0V$  to  $3.6V$  only

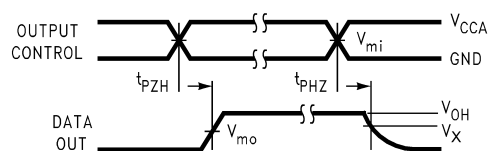
FIGURE 2. Waveform for Inverting and Non-Inverting Functions



Note: Input  $t_R = t_F = 2.0$  ns, 10% to 90%

Input  $t_R = t_F = 2.5$  ns, 10% to 90%, @  $V_I = 3.0V$  to  $3.6V$  only

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



Note: Input  $t_R = t_F = 2.0$  ns, 10% to 90%

Input  $t_R = t_F = 2.5$  ns, 10% to 90%, @  $V_I = 3.0V$  to  $3.6V$  only

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

| Symbol   | $V_{CC}$        |                  |                  |                 |                 |
|----------|-----------------|------------------|------------------|-----------------|-----------------|
|          | $3.3V \pm 0.3V$ | $2.5V \pm 0.2V$  | $1.8V \pm 0.15V$ | $1.5V \pm 0.1V$ | $1.2V \pm 0.1V$ |
| $V_{mi}$ | $V_{CCI}/2$     | $V_{CCI}/2$      | $V_{CCI}/2$      | $V_{CCI}/2$     | $V_{CCI}/2$     |
| $V_{mo}$ | $V_{CCO}/2$     | $V_{CCO}/2$      | $V_{CCO}/2$      | $V_{CCO}/2$     | $V_{CCO}/2$     |
| $V_X$    | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ | $V_{OH} - 0.15V$ | $V_{OH} - 0.1V$ | $V_{OH} - 0.1V$ |
| $V_Y$    | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ | $V_{OL} + 0.15V$ | $V_{OL} + 0.1V$ | $V_{OL} + 0.1V$ |

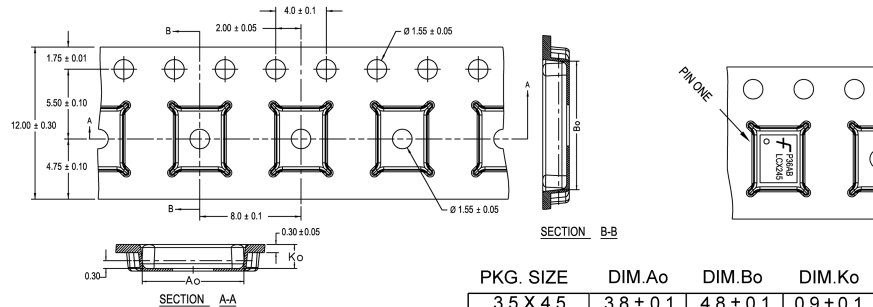
Note: For  $V_{mi}$ :  $V_{CCI} = V_{CCA}$  for Control Pins  $\overline{TR}$  and  $\overline{OE}$ , or  $V_{CCA}/2$

## Tape and Reel Specification

### Tape Format for DQFN

| Package Designator | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| BQX                | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|                    | Carrier            | 3000            | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |

### TAPE DIMENSIONS inches (millimeters)



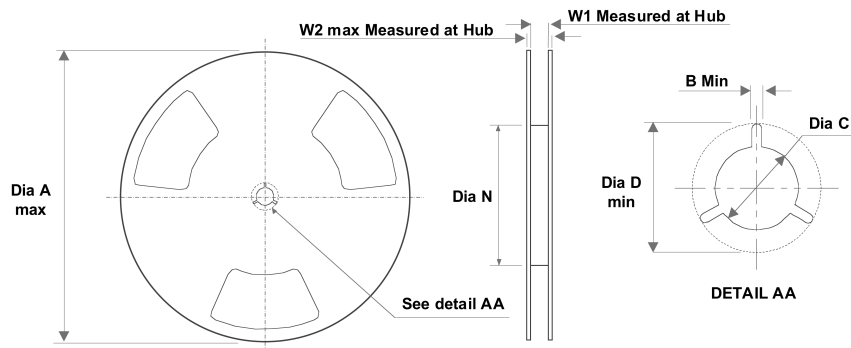
| PKG. SIZE | DIM.Ao    | DIM.Bo    | DIM.Ko    |
|-----------|-----------|-----------|-----------|
| 3.5 X 4.5 | 3.8 ± 0.1 | 4.8 ± 0.1 | 0.9 ± 0.1 |
| 3.0 X 3.0 | 3.3 ± 0.1 | 3.3 ± 0.1 | 0.9 ± 0.1 |
| 2.5 X 4.5 | 2.8 ± 0.1 | 4.8 ± 0.1 | 0.9 ± 0.1 |
| 2.5 X 3.5 | 2.8 ± 0.1 | 3.8 ± 0.1 | 0.9 ± 0.1 |
| 2.5 X 3.0 | 2.8 ± 0.1 | 3.3 ± 0.1 | 0.9 ± 0.1 |
| 2.5 X 2.5 | 2.8 ± 0.1 | 2.8 ± 0.1 | 0.9 ± 0.1 |

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

1. Cumulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. Ao and Bo measured on a plane 0.120[0.30] above the bottom of the pocket.
6. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
7. Pocket position relative to sprocket hole measured as true position of pocket. Not pocket hole.
8. Controlling dimension is millimeter. Dimension in inches rounded.

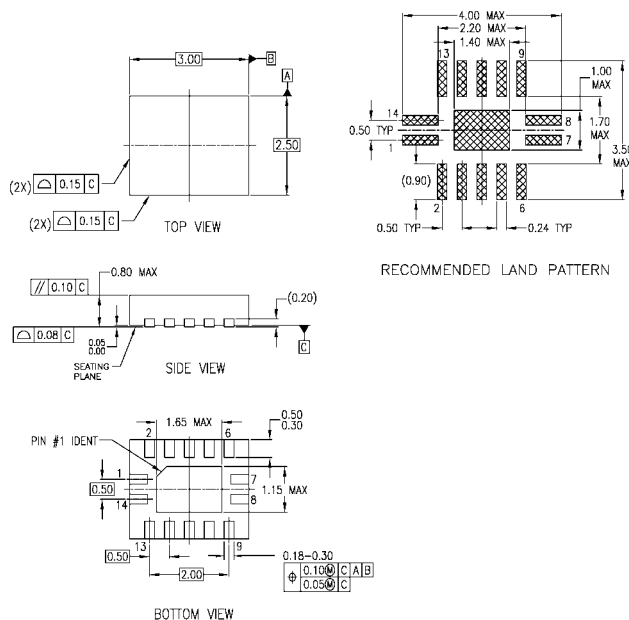
### REEL DIMENSIONS inches (millimeters)



| Tape Size | A               | B               | C                | D                | N                | W1              | W2              |
|-----------|-----------------|-----------------|------------------|------------------|------------------|-----------------|-----------------|
| 12 mm     | 13.0<br>(330.0) | 0.059<br>(1.50) | 0.512<br>(13.00) | 0.795<br>(20.20) | 2.165<br>(55.00) | 0.488<br>(12.4) | 0.724<br>(18.4) |



## Physical Dimensions inches (millimeters) unless otherwise noted



### NOTES:

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

MLP014ArevA

**14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm  
Package Number MLP014A**

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