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# FXLH1T45

## Low Voltage 1-Bit Bi-directional Level Translator with Configurable Voltage Supplies and Bushold Data Inputs

### 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
- 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
- Bushold on data inputs eliminates the need for external pull-up/pull-down resistors
- Control input ( $T/\bar{R}$ ) levels are referenced to  $V_{CCA}$  voltage
- Packaged in the MicroPak 6 (1.0mm x 1.45mm)
- ESD protections 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)

### General Description

The FXLH1T45 is a single bit 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  $V_{CC}$ s 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.

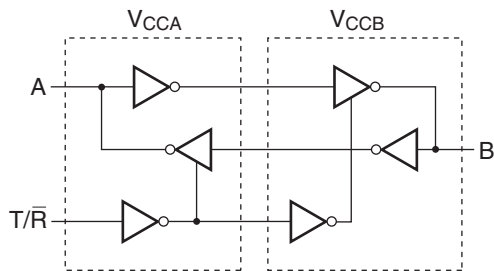
The Transmit/Receive ( $T/\bar{R}$ ) input determines the direction of data flow through the device. The FXLH1T45 is designed so that the control pin ( $T/\bar{R}$ ) is supplied by  $V_{CCA}$ .

### Ordering Information

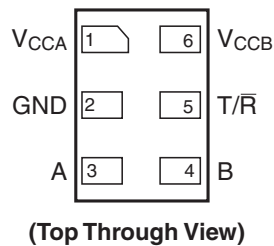
| Order Number | Package Number | Pb-Free | Package Description         | Supplied As               |
|--------------|----------------|---------|-----------------------------|---------------------------|
| FXLH1T45L6X  | MAC06A         | Yes     | 6-Lead MicroPak, 1.0mm Wide | 5k Units on Tape and Reel |

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## Functional Diagram



## Connection Diagram



## Pin Assignment

| Pin Number | Terminal Name    |
|------------|------------------|
| 1          | V <sub>CCA</sub> |
| 2          | GND              |
| 3          | A                |
| 4          | B                |
| 5          | T/ $\bar{R}$     |
| 6          | V <sub>CCB</sub> |

## Pin Descriptions

| Pin Names        | Description            |
|------------------|------------------------|
| T/ $\bar{R}$     | Transmit/Receive Input |
| A                | Side A Input or Output |
| B                | Side B Input or Output |
| V <sub>CCA</sub> | Side A Power Supply    |
| V <sub>CCB</sub> | Side B Power Supply    |

## Function Table

| Inputs (T/ $\bar{R}$ ) | Outputs             |
|------------------------|---------------------|
| L                      | Bus B Data to Bus A |
| H                      | Bus A Data to Bus B |

H = HIGH Logic Level

L = LOW Logic Level

## 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 0V, outputs are in a HIGH-Impedance state. To ensure that bus contention, excessive currents, or oscillations do not occur, a proper power-up sequence is recommended.

The recommended power-up sequence is the following:

1. Apply power to either V<sub>CC</sub>.
2. Apply power to the T/ $\bar{R}$  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<sub>CC</sub>.

The recommended power-down sequence is the following:

1. Remove power from either V<sub>CC</sub>.
2. 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>Control Input (T/ $\bar{R}$ )                            | -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 ( $B_n$ ) | -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 @ $V_I < 0V$                                                                      | -50mA                                                                    |
| $I_{OK}$           | DC Output Diode Current @<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                                                             | $\pm 100mA$                                                              |
| $T_{STG}$          | Storage Temperature Range                                                                                | -65°C to +150°C                                                          |

## 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>Control Input (T/ $\bar{R}$ )                                                                   | 0.0V to 3.6V<br>0.0V to 3.6V<br>0.0V to $V_{CCA}$                 |
|                        | Output Current in $I_{OH}/I_{OL}$ with $V_{CC}$ @<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 | $\pm 24mA$<br>$\pm 18mA$<br>$\pm 6mA$<br>$\pm 2mA$<br>$\pm 0.5mA$ |
| $T_A$                  | 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                                                            |

### Notes:

1.  $I_O$  Absolute Maximum Rating must be observed.
2. All unused inputs and I/O pins must be held at  $V_{CCI}$  or GND.

# DC Electrical Characteristics

| Symbol          | Parameter                                | Conditions                                           | V <sub>CCI</sub> (V) | V <sub>CC0</sub> (V) | Min.                    | Typ. | Max.                    | Units |
|-----------------|------------------------------------------|------------------------------------------------------|----------------------|----------------------|-------------------------|------|-------------------------|-------|
| V <sub>IH</sub> | High Level Input Voltage <sup>(3)</sup>  | Data Inputs A <sub>n</sub> , B <sub>n</sub>          | 2.7–3.6              | 1.1–3.6              | 2.0                     | –    | –                       | V     |
|                 |                                          |                                                      | 2.3–2.7              |                      | 1.6                     | –    | –                       |       |
|                 |                                          |                                                      | 1.65–2.3             |                      | 0.65 x V <sub>CCI</sub> | –    | –                       |       |
|                 |                                          |                                                      | 1.4–1.65             |                      | 0.65 x V <sub>CCI</sub> | –    | –                       |       |
|                 |                                          |                                                      | 1.1–1.4              |                      | 0.9 x V <sub>CCI</sub>  | –    | –                       |       |
|                 |                                          | Control Pin T/R<br>(Referenced to V <sub>CCA</sub> ) | 2.7–3.6              | 1.1–3.6              | 2.0                     | –    | –                       |       |
|                 |                                          |                                                      | 2.3–2.7              |                      | 1.6                     | –    | –                       |       |
|                 |                                          |                                                      | 1.65–2.3             |                      | 0.65 x V <sub>CCA</sub> | –    | –                       |       |
|                 |                                          |                                                      | 1.4–1.65             |                      | 0.65 x V <sub>CCA</sub> | –    | –                       |       |
|                 |                                          |                                                      | 1.1–1.4              |                      | 0.9 x V <sub>CCA</sub>  | –    | –                       |       |
| V <sub>IL</sub> | Low Level Input Voltage <sup>(3)</sup>   | Data Inputs A <sub>n</sub> , B <sub>n</sub>          | 2.7–3.6              | 1.1–3.6              | –                       | –    | 0.8                     | V     |
|                 |                                          |                                                      | 2.3–2.7              |                      | –                       | –    | 0.7                     |       |
|                 |                                          |                                                      | 1.65–2.3             |                      | –                       | –    | 0.35 x V <sub>CCI</sub> |       |
|                 |                                          |                                                      | 1.4–1.65             |                      | –                       | –    | 0.35 x V <sub>CCI</sub> |       |
|                 |                                          |                                                      | 1.1–1.4              |                      | –                       | –    | 0.1 x V <sub>CCI</sub>  |       |
|                 |                                          | Control Pin T/R<br>(Referenced to V <sub>CCA</sub> ) | 2.7–3.6              | 1.1–3.6              | –                       | –    | 0.8                     |       |
|                 |                                          |                                                      | 2.3–2.7              |                      | –                       | –    | 0.7                     |       |
|                 |                                          |                                                      | 1.65–2.3             |                      | –                       | –    | 0.35 x V <sub>CCA</sub> |       |
|                 |                                          |                                                      | 1.4–1.65             |                      | –                       | –    | 0.35 x V <sub>CCA</sub> |       |
|                 |                                          |                                                      | 1.1–1.4              |                      | –                       | –    | 0.1 x V <sub>CCA</sub>  |       |
| V <sub>OH</sub> | High Level Output Voltage <sup>(4)</sup> | I <sub>OH</sub> = –100μA                             | 1.1–3.6              | 1.1–3.6              | V <sub>CC0</sub> –0.2   | –    | –                       | V     |
|                 |                                          | I <sub>OH</sub> = –12mA                              | 2.7                  | 2.7                  | 2.2                     | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –18mA                              | 3.0                  | 3.0                  | 2.4                     | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –24mA                              | 3.0                  | 3.0                  | 2.2                     | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –6mA                               | 2.3                  | 2.3                  | 2.0                     | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –12mA                              | 2.3                  | 2.3                  | 1.8                     | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –18mA                              | 2.3                  | 2.3                  | 1.7                     | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –6mA                               | 1.65                 | 1.65                 | 1.25                    | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –2mA                               | 1.4                  | 1.4                  | 1.05                    | –    | –                       |       |
|                 |                                          | I <sub>OH</sub> = –0.5mA                             | 1.1                  | 1.1                  | 0.75 x V <sub>CC0</sub> | –    | –                       |       |
| V <sub>OL</sub> | Low Level Output Voltage <sup>(4)</sup>  | I <sub>OL</sub> = 100μA                              | 1.1–3.6              | 1.1–3.6              | –                       | –    | 0.2                     | V     |
|                 |                                          | I <sub>OL</sub> = 12mA                               | 2.7                  | 2.7                  | –                       | –    | 0.4                     |       |
|                 |                                          | I <sub>OL</sub> = 18mA                               | 3.0                  | 3.0                  | –                       | –    | 0.4                     |       |
|                 |                                          | I <sub>OL</sub> = 24mA                               | 3.0                  | 3.0                  | –                       | –    | 0.55                    |       |
|                 |                                          | I <sub>OL</sub> = 12mA                               | 2.3                  | 2.3                  | –                       | –    | 0.4                     |       |
|                 |                                          | I <sub>OL</sub> = 18mA                               | 2.3                  | 2.3                  | –                       | –    | 0.6                     |       |
|                 |                                          | I <sub>OL</sub> = 6mA                                | 1.65                 | 1.65                 | –                       | –    | 0.3                     |       |
|                 |                                          | I <sub>OL</sub> = 2mA                                | 1.4                  | 1.4                  | –                       | –    | 0.35                    |       |
|                 |                                          | I <sub>OL</sub> = 0.5mA                              | 1.1                  | 1.1                  | –                       | –    | 0.3 x V <sub>CC0</sub>  |       |
| I <sub>I</sub>  | Input Leakage Current Control Pins       | V <sub>I</sub> = V <sub>CCA</sub> or GND             | 1.1–3.6              | 3.6                  | –                       | –    | ±1.0                    | μA    |

# DC Electrical Characteristics (Continued)

| Symbol               | Parameter                                                                     | Conditions                                                                         | V <sub>CCI</sub> (V) | V <sub>CCO</sub> (V) | Min.  | Typ. | Max.  | Units |
|----------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------|----------------------|-------|------|-------|-------|
| I <sub>I(HOLD)</sub> | Bushold Input Minimum Drive Current                                           | V <sub>IN</sub> = 0.8                                                              | 3.0                  | 3.0                  | 75.0  | –    | –     | μA    |
|                      |                                                                               | V <sub>IN</sub> = 2.0                                                              | 3.0                  | 3.0                  | -75.0 | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 0.7                                                              | 2.3                  | 2.3                  | 45.0  | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 1.6                                                              | 2.3                  | 2.3                  | -45.0 | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 0.57                                                             | 1.65                 | 1.65                 | 25.0  | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 1.07                                                             | 1.65                 | 1.65                 | -25.0 | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 0.49                                                             | 1.4                  | 1.4                  | 11.0  | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 0.91                                                             | 1.4                  | 1.4                  | -11.0 | –    | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 0.11                                                             | 1.1                  | 1.1                  | –     | 4.0  | –     |       |
|                      |                                                                               | V <sub>IN</sub> = 0.99                                                             | 1.1                  | 1.1                  | –     | -4.0 | –     |       |
| I <sub>I(OD)</sub>   | Bushold Input Over-Drive Current-to-Change State                              | (5)                                                                                | 3.6                  | 3.6                  | 450   | –    | –     | μA    |
|                      |                                                                               | (6)                                                                                | 3.6                  | 3.6                  | -450  | –    | –     |       |
|                      |                                                                               | (5)                                                                                | 2.7                  | 2.7                  | 300   | –    | –     |       |
|                      |                                                                               | (6)                                                                                | 2.7                  | 2.7                  | -300  | –    | –     |       |
|                      |                                                                               | (5)                                                                                | 1.95                 | 1.95                 | 200   | –    | –     |       |
|                      |                                                                               | (6)                                                                                | 1.95                 | 1.95                 | -200  | –    | –     |       |
|                      |                                                                               | (5)                                                                                | 1.6                  | 1.6                  | 120   | –    | –     |       |
|                      |                                                                               | (6)                                                                                | 1.6                  | 1.6                  | -120  | –    | –     |       |
|                      |                                                                               | (5)                                                                                | 1.4                  | 1.4                  | 80.0  | –    | –     |       |
|                      |                                                                               | (6)                                                                                | 1.4                  | 1.4                  | -80.0 | –    | –     |       |
| I <sub>OFF</sub>     | Power Off Leakage Current                                                     | A <sub>n</sub> , V <sub>CCA</sub> = V <sub>CCI</sub> , V <sub>I</sub> = 0V to 3.6V | 0                    | 3.6                  | –     | –    | ±10.0 | μA    |
|                      |                                                                               | B <sub>n</sub> , V <sub>CCB</sub> = V <sub>CCI</sub> , V <sub>I</sub> = 0V to 3.6V | 0                    | 3.6                  | –     | –    | ±10.0 |       |
| I <sub>OZ</sub>      | 3-STATE Output Leakage                                                        | A <sub>n</sub> , V <sub>CCA</sub> = V <sub>CCO</sub> , V <sub>O</sub> = 0V or 3.6V | 0                    | 3.6                  | –     | –    | ±10.0 | μA    |
|                      |                                                                               | B <sub>n</sub> , V <sub>CCB</sub> = V <sub>CCO</sub> , V <sub>O</sub> = 0V or 3.6V | 0                    | 3.6                  | –     | –    | ±10.0 |       |
| I <sub>CCA/B</sub>   | Quiescent Supply Current <sup>(7)</sup>                                       | 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>CCA</sub>     | Quiescent Supply Current                                                      | V <sub>I</sub> = V <sub>CCA</sub> or GND; I <sub>O</sub> = 0                       | 0                    | 1.1–3.6              | –     | –    | –10.0 | μA    |
|                      |                                                                               | V <sub>I</sub> = V <sub>CCA</sub> or GND; I <sub>O</sub> = 0                       | 1.1–3.6              | 0                    | –     | –    | 10.0  | 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    |
|                      |                                                                               | V <sub>I</sub> = V <sub>CCB</sub> or GND; I <sub>O</sub> = 0                       | 0                    | 1.1–3.6              | –     | –    | 10.0  | μA    |
| ΔI <sub>CCA/B</sub>  | Increase in I <sub>CC</sub> per Input; Other Inputs at V <sub>CC</sub> or GND | V <sub>IH</sub> = 3.0                                                              | 3.6                  | 3.6                  | –     | –    | 500   | μA    |

## Notes:

- V<sub>CCI</sub> = the V<sub>CC</sub> associated with the data input under test.
- V<sub>CCO</sub> = the V<sub>CC</sub> associated with the output under test.
- 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.
- Reflects current per supply, V<sub>CCA</sub> or V<sub>CCB</sub>.

## AC Electrical Characteristics

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

| Symbol                                             | Parameter                        | T <sub>A</sub> = −40°C to +85°C |      |                                 |      |                                   |      |                                 |      |                                 |      | Units |
|----------------------------------------------------|----------------------------------|---------------------------------|------|---------------------------------|------|-----------------------------------|------|---------------------------------|------|---------------------------------|------|-------|
|                                                    |                                  | V <sub>CCB</sub> = 3.0V to 3.6V |      | V <sub>CCB</sub> = 2.3V to 2.7V |      | V <sub>CCB</sub> = 1.65V to 1.95V |      | V <sub>CCB</sub> = 1.4V to 1.6V |      | V <sub>CCB</sub> = 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> <sup>(8)</sup> | Output Enable T/ $\bar{R}$ to B  | 0.4                             | 7.2  | 0.5                             | 7.6  | 0.7                               | 9.1  | 0.8                             | 10.5 | 1.6                             | 25.7 | ns    |
|                                                    | Output Enable T/ $\bar{R}$ to A  | 0.4                             | 7.3  | 0.4                             | 7.8  | 1.0                               | 8.8  | 2.0                             | 10.5 | 2.8                             | 30.0 |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                | Output Disable T/ $\bar{R}$ 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 T/ $\bar{R}$ to A | 0.2                             | 3.7  | 0.2                             | 3.7  | 0.2                               | 3.7  | 0.2                             | 3.7  | 0.2                             | 3.7  |       |

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

| 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<br>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> <sup>(8)</sup> | Output Enable T/ $\bar{R}$ to B  | 0.4                                | 7.8  | 0.6                                | 8.2  | 0.7                                     | 9.6  | 1.0                                | 10.9 | 1.6                                | 26.0 | ns    |
|                                                    | Output Enable T/ $\bar{R}$ to A  | 0.5                                | 8.0  | 0.6                                | 8.5  | 1.2                                     | 9.3  | 2.0                                | 11.5 | 3.0                                | 24.0 |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                | Output Disable T/ $\bar{R}$ 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 T/ $\bar{R}$ to A | 0.2                                | 4.0  | 0.2                                | 4.0  | 0.2                                     | 4.0  | 0.2                                | 4.0  | 0.2                                | 4.0  |       |

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

| 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<br>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> <sup>(8)</sup> | Output Enable T/ $\overline{R}$ to B  | 0.8                                | 9.0  | 1.0                                | 9.5  | 1.3                                     | 10.7 | 1.4                                | 12.1 | 2.0                                | 27.0 | ns    |
|                                                    | Output Enable T/ $\overline{R}$ to A  | 0.7                                | 10.5 | 0.7                                | 10.8 | 1.6                                     | 10.9 | 2.5                                | 13.0 | 3.2                                | 25.0 |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                | Output Disable T/ $\overline{R}$ 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 T/ $\overline{R}$ 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 (Continued)

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

| 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<br>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> <sup>(8)</sup> | Output Enable T/ $\overline{R}$ to B  | 1.5                                | 10.3 | 1.5                                | 10.8 | 2.0                                     | 12.0 | 2.0                                | 13.3 | 2.5                                | 28.0 | ns    |
|                                                    | Output Enable T/ $\overline{R}$ to A  | 1.0                                | 12.9 | 1.2                                | 13.1 | 1.8                                     | 13.3 | 2.5                                | 14.8 | 3.3                                | 27.5 |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                | Output Disable T/ $\overline{R}$ 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 T/ $\overline{R}$ to A | 1.0                                | 6.0  | 1.0                                | 6.0  | 1.0                                     | 6.0  | 1.0                                | 6.0  | 1.0                                | 6.0  |       |

$V_{CCA} = 1.1V \text{ to } 1.3V$

| 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<br>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> <sup>(8)</sup> | Output Enable T/ $\overline{R}$ to B  | 2.8                                | 28.0 | 3.0                                | 19.0 | 3.2                                     | 20.0 | 3.3                                | 21.5 | 4.0                                | 36.0 | ns    |
|                                                    | Output Enable T/ $\overline{R}$ to A  | 2.4                                | 37.0 | 2.1                                | 29.0 | 2.5                                     | 30.0 | 3.5                                | 32.0 | 4.0                                | 44.0 |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                | Output Disable T/ $\overline{R}$ 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 T/ $\overline{R}$ to A | 2.0                                | 15.0 | 2.0                                | 12.0 | 2.0                                     | 12.0 | 2.0                                | 12.0 | 2.0                                | 12.0 |       |

### Note:

8. The enable time,  $t_{PZH}$  or  $t_{PZL}$ , is the time for the FXLH1T45 to return to active operation after a direction change. The enable time specifies the worst-case delay from the time the  $T/\bar{R}$  pin is switched until a valid output signal is expected. For example, to change direction to B-to-A operation, the  $T/\bar{R}$  pin is switched from HIGH-to-LOW. The enable time for this case is found by adding the disable time for  $T/\bar{R}$  to B to the propagation delay for B to A. The formulas for calculating enable times are the following:

$$t_{PZH} (T/\bar{R} \text{ to A}) = t_{PLZ} (T/\bar{R} \text{ to B}) + t_{PLH} (B \text{ to A})$$

$$t_{PZL} (T/\bar{R} \text{ to A}) = t_{PHZ} (T/\bar{R} \text{ to B}) + t_{PHL} (B \text{ to A})$$

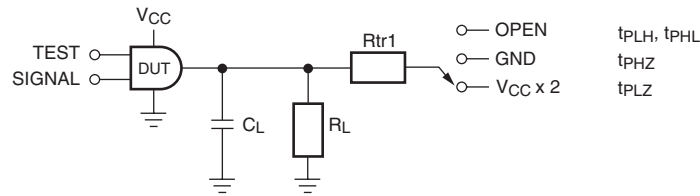
$$t_{PZH} (T/\bar{R} \text{ to B}) = t_{PLZ} (T/\bar{R} \text{ to A}) + t_{PLH} (A \text{ to B})$$

$$t_{PZL} (T/\bar{R} \text{ to B}) = t_{PHZ} (T/\bar{R} \text{ to A}) + t_{PHL} (A \text{ to B})$$

## Capacitance

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

## AC Loading and Waveforms

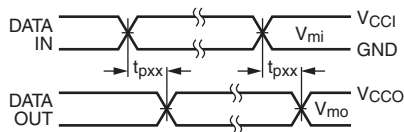


| Test                  | Switch                                                                                                      |
|-----------------------|-------------------------------------------------------------------------------------------------------------|
| $t_{PLH}$ , $t_{PHL}$ | OPEN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

Figure 1. AC Test Circuit

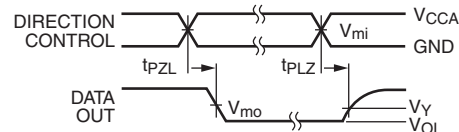
### AC Load Table

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



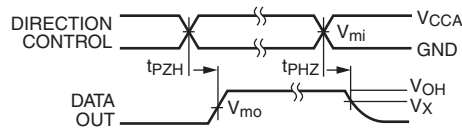
Input  $t_R = t_F = 2.0$  ns, 10% to 90%  
Input  $t_R = t_F = 2.5$  ns, 10% to 90%, @  $V_I = 3.0V$  to  $3.6V$  only

Figure 2. Waveform for Inverting and Non-Inverting Functions



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



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

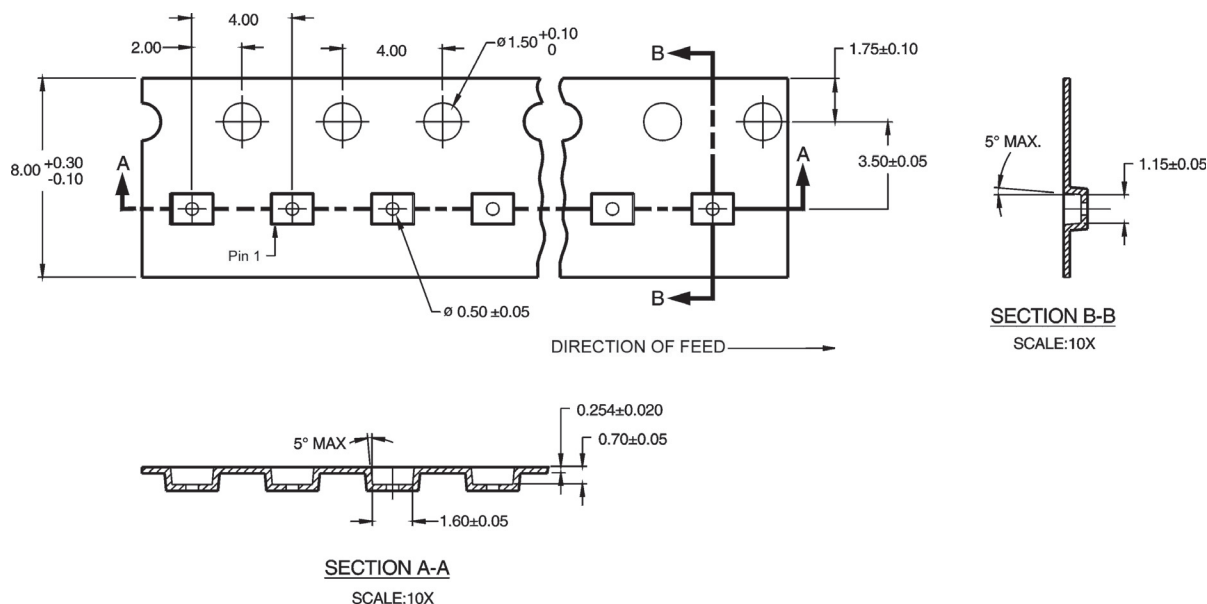
For  $V_{mi}$ :  $V_{CCI} = V_{CCA}$  for Control Pin T/R or  $V_{CCA}/2$

## Tape and Reel Specification

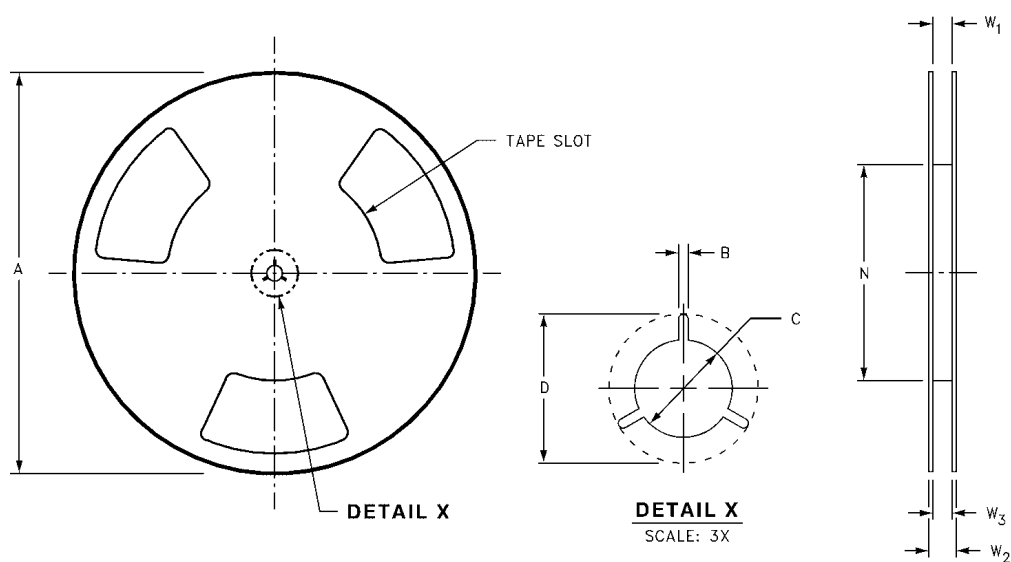
## Tape Format for MicroPak

| Package Designator | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| L6X                | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|                    | Carrier            | 5000            | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |

### Tape Dimensions millimeters

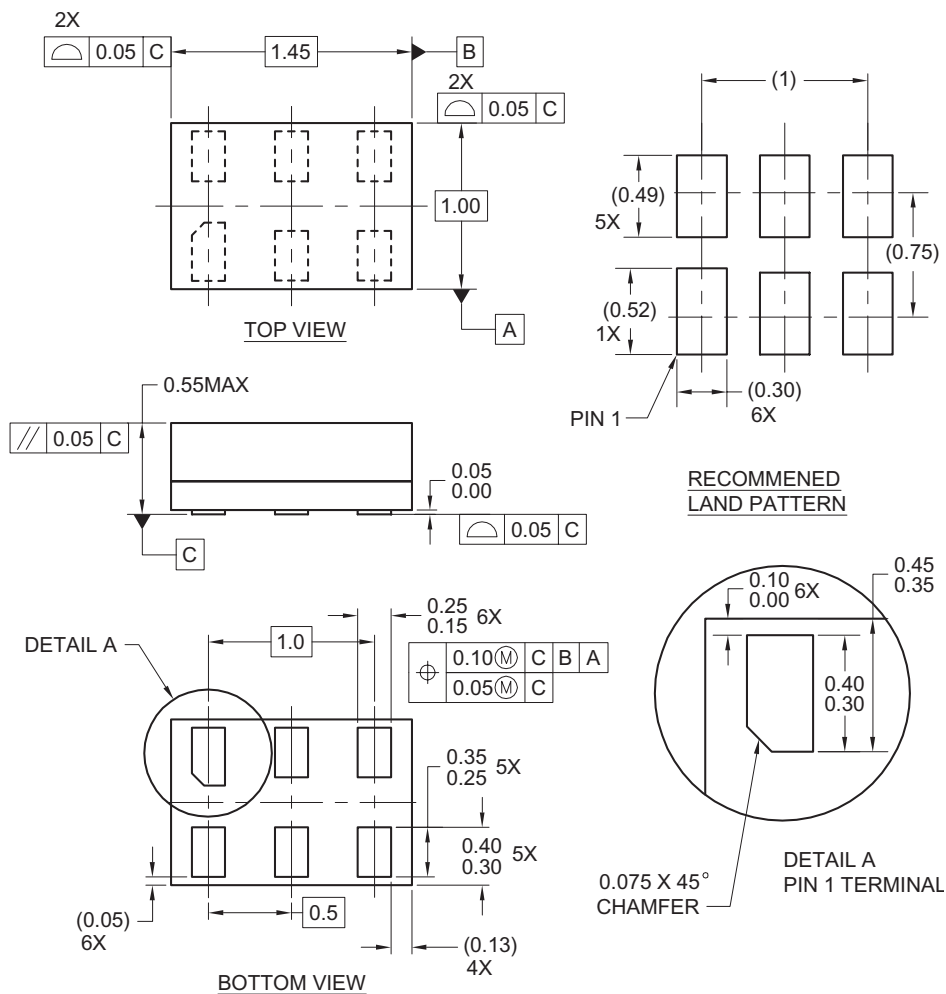


## Reel Dimensions inches (millimeters)



| Tape Size | A              | B               | C                | D                | N                | W1                                        | W2               | W3                                   |
|-----------|----------------|-----------------|------------------|------------------|------------------|-------------------------------------------|------------------|--------------------------------------|
| 8mm       | 7.0<br>(177.8) | 0.059<br>(1.50) | 0.512<br>(13.00) | 0.795<br>(20.20) | 2.165<br>(55.00) | 0.331 +0.059/-0.000<br>(8.40 +1.50/-0.00) | 0.567<br>(14.40) | W1 +0.078/-0.039<br>(W1 +2.00/-1.00) |

# Physical Dimensions millimeters unless otherwise noted



## Notes:

1. Conforms to JEDEC standard M0-252 variation UAAD.
2. Dimensions are in millimeters.
3. Drawing conforms to ASME Y14.5M-1994.

MAC06AREVC

**6-Lead MicroPak, 1.0mm Wide  
Package Number MAC06A**



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