

# FXLH1T45

## Level Translator, 1-Bit Bidirectional

### Configurable Voltage Supplies and Bushold Data Inputs

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 3.6 V to as low as 1.1 V. 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: 1.2 V, 1.5 V, 1.8 V, 2.5 V and 3.3 V.

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  $V_{CCA}$ .

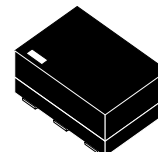
#### Features

- Bi-directional Interface between any 2 Levels from 1.1 V to 3.6 V
- 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 SIP6 (1.0 mm x 1.45 mm)
- ESD Protections Exceeds:
  - ◆ 4 kV HBM ESD (per JESD22-A114 & Mil Std 883e 3015.7)
  - ◆ 8 kV HBM I/O to GND ESD (per JESD22-A114 & Mil Std 883e 3015.7)
  - ◆ 1 kV CDM ESD (per ESD STM 5.3)
  - ◆ 200 V MM ESD (per JESD22-A115 & ESD STM5.2)



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SIP6 1.45x1.0  
CASE 127EB

#### MARKING DIAGRAM



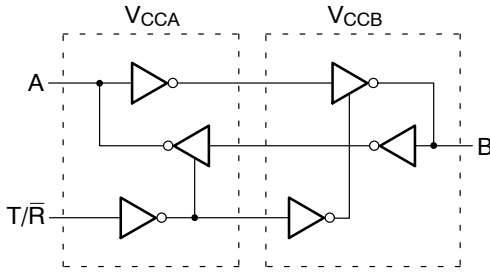
|    |                       |
|----|-----------------------|
| XD | = Device Code         |
| KK | = Lot Code            |
| XY | = Numeric Date Code   |
| Z  | = Assembly Plant Code |

#### ORDERING INFORMATION

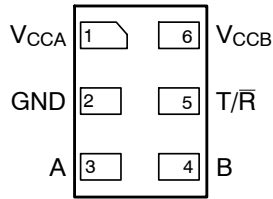
See detailed ordering and shipping information on page 9 of this data sheet.

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## FUNCTIONAL DIAGRAM



## PINOUT



(Top Through View)

## 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:

4. Remove power from either V<sub>CC</sub>
5. Remove power from other V<sub>CC</sub>

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## ABSOLUTE MAXIMUM RATINGS

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

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## RECOMMENDED OPERATING CONDITIONS (Note 2)

| Symbol                 | Parameter  | Rating   |
|------------------------|--|--|
| $V_{CCA}$ or $V_{CCB}$ | Power Supply Operating   | 1.1 V to 3.6 V   |
| $V_i$                  | Input Voltage<br>Port A<br>Port B<br>Control Input (T/ $\bar{R}$ )   | 0.0 V to 3.6 V<br>0.0 V to 3.6 V<br>0.0 V to $V_{CCA}$                 |
| $V_o$                  | Output Current in $I_{OH}/I_{OL}$ with $V_{CC}$ @<br>3.0 V to 3.6 V<br>2.3 V to 2.7 V<br>1.65 V to 1.95 V<br>1.4 V to 1.65 V<br>1.1 V to 1.4 V | $\pm 24$ mA<br>$\pm 18$ mA<br>$\pm 6$ mA<br>$\pm 2$ mA<br>$\pm 0.5$ mA |
| $T_A$                  | Free Air Operating Temperature   | -40°C to +125°C  |
| $\Delta t / \Delta V$  | Maximum Input Edge Rate $V_{CCA/B} = 1.1$ V to 3.6 V   | 10 ns/V  |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

### NOTES:

- $I_O$  Absolute Maximum Rating must be observed.
- All unused inputs and I/O pins must be held at  $V_{CC1}$  or GND.

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**DC ELECTRICAL CHARACTERISTICS** ( $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ )

| Symbol          | Parameter                             | Conditions   | V <sub>CCI</sub> (V) | V <sub>CCO</sub> (V) | Min.                    | Typ. | Max.                    | Units |
|-----------------|---------------------------------------|--|----------------------|----------------------|-------------------------|------|-------------------------|-------|
| V <sub>IH</sub> | High Level Input Voltage<br>(Note 3)  | 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<br>(Note 3)   | 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<br>(Note 4) | I <sub>OH</sub> = –100 μA                            | 1.1–3.6              | 1.1–3.6              | V <sub>CCO</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                    | –    | –                       |       |
|                 |                                       | I <sub>OH</sub> = –2 mA                              | 1.4                  | 1.4                  | 1.05                    | –    | –                       |       |
|                 |                                       | I <sub>OH</sub> = –0.5 mA                            | 1.1                  | 1.1                  | 0.75 x V <sub>CCO</sub> | –    | –                       |       |
| V <sub>OL</sub> | Low Level Output Voltage<br>(Note 4)  | I <sub>OL</sub> = 100 μA                             | 1.1–3.6              | 1.1–3.6              | –                       | –    | 0.2                     | V     |
|                 |                                       | 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>OL</sub> = 6 mA                               | 1.65                 | 1.65                 | –                       | –    | 0.3                     |       |
|                 |                                       | 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>CCO</sub>  |       |
| I <sub>I</sub>  | Input Leakage Current<br>Control Pins | V <sub>I</sub> = V <sub>CCA</sub> or GND             | 1.1–3.6              | 3.6                  | –                       | –    | ±1.0                    | μA    |

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**DC ELECTRICAL CHARACTERISTICS** (continued) ( $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ )

| 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 V,<br>T <sub>A</sub> = -40°C to +85°C                             | 3.0                  | 3.0                  | 75.0  | -    | -     | μA    |
|                      |  | V <sub>IN</sub> = 0.8 V   | 3.0                  | 3.0                  | 60.0  | -    | -     |       |
|                      |  | V <sub>IN</sub> = 2 V,<br>T <sub>A</sub> = -40°C to +85°C                               | 3.0                  | 3.0                  | -75.0 | -    | -     |       |
|                      |  | V <sub>IN</sub> = 2 V   | 3.0                  | 3.0                  | -60   | -    | -     |       |
|                      |  | V <sub>IN</sub> = 0.7 V   | 2.3                  | 2.3                  | 45.0  | -    | -     |       |
|                      |  | V <sub>IN</sub> = 1.6 V   | 2.3                  | 2.3                  | -45.0 | -    | -     |       |
|                      |  | V <sub>IN</sub> = 0.57 V  | 1.65                 | 1.65                 | 25.0  | -    | -     |       |
|                      |  | V <sub>IN</sub> = 1.07 V  | 1.65                 | 1.65                 | -25.0 | -    | -     |       |
|                      |  | V <sub>IN</sub> = 0.49 V  | 1.4                  | 1.4                  | 10.0  | -    | -     |       |
|                      |  | V <sub>IN</sub> = 0.91 V  | 1.4                  | 1.4                  | -10.0 | -    | -     |       |
|                      |  | V <sub>IN</sub> = 0.11 V  | 1.1                  | 1.1                  | -     | 4.0  | -     |       |
|                      |  | V <sub>IN</sub> = 0.99 V  | 1.1                  | 1.1                  | -     | -4.0 | -     |       |
| I <sub>I(OD)</sub>   | Bushold Input Over-Drive Current-to-Change State                                 | (Note 5)  | 3.6                  | 3.6                  | 450   | -    | -     | μA    |
|                      |  | (Note 6)  | 3.6                  | 3.6                  | -450  | -    | -     |       |
|                      |  | (Note 5)  | 2.7                  | 2.7                  | 300   | -    | -     |       |
|                      |  | (Note 6)  | 2.7                  | 2.7                  | -300  | -    | -     |       |
|                      |  | (Note 5)  | 1.95                 | 1.95                 | 200   | -    | -     |       |
|                      |  | (Note 6)  | 1.95                 | 1.95                 | -200  | -    | -     |       |
|                      |  | (Note 5)  | 1.6                  | 1.6                  | 120   | -    | -     |       |
|                      |  | (Note 6)  | 1.6                  | 1.6                  | -120  | -    | -     |       |
|                      |  | (Note 5)  | 1.4                  | 1.4                  | 80.0  | -    | -     |       |
|                      |  | (Note 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> ,<br>V <sub>I</sub> = 0 V to 3.6 V | 0                    | 3.6                  | -     | -    | ±10.0 | μA    |
|                      |  | B <sub>n</sub> , V <sub>CCB</sub> = V <sub>CCI</sub> ,<br>V <sub>I</sub> = 0 V to 3.6 V | 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> ,<br>V <sub>O</sub> = 0 V or 3.6 V | 0                    | 3.6                  | -     | -    | ±10.0 | μA    |
|                      |  | B <sub>n</sub> , V <sub>CCB</sub> = V <sub>CCO</sub> ,<br>V <sub>O</sub> = 0 V or 3.6 V | 0                    | 3.6                  | -     | -    | ±10.0 |       |
| I <sub>CCA/B</sub>   | Quiescent Supply Current (Note 7)  | 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  |       |
| 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  |       |
| 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 V   | 3.6                  | 3.6                  | -     | -    | 500   | μA    |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

**NOTES:**

3. V<sub>CCI</sub> = the V<sub>CC</sub> associated with the data input under test.
4. V<sub>CCO</sub> = the V<sub>CC</sub> associated with the output under test.
5. An external driver must source at least the specified current to switch LOW-to-HIGH.
6. An external driver must source at least the specified current to switch HIGH-to-LOW.
7. Reflects current per supply, V<sub>CCA</sub> or V<sub>CCB</sub>.

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**AC Electrical Characteristics** ( $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .)

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

| Symbol                         | Parameter                                      | $V_{CCB} = 3.0\text{ V to }3.6\text{ V}$ |      | $V_{CCB} = 2.3\text{ V to }2.7\text{ V}$ |      | $V_{CCB} = 1.65\text{ V to }1.95\text{ V}$ |      | $V_{CCB} = 1.4\text{ V to }1.6\text{ V}$ |      | $V_{CCB} = 1.1\text{ V to }1.3\text{ V}$ |      | Units |
|--------------------------------|--|--|------|--|------|--|------|--|------|--|------|-------|
|                                |  | Min.                                     | Max. | Min.                                     | Max. | Min.                                       | Max. | Min.                                     | Max. | Min.                                     | Max. |       |
| $t_{PLH}, t_{PHL}$             | 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 |       |
| $t_{PZH}, t_{PZL}$<br>(Note 8) | 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 |       |
| $t_{PHZ}, t_{PLZ}$             | Output Disable $T/\bar{R}$ to B                | -  | 3.9  | -  | 5.3  | -  | 7.3  | -  | 7.6  | -  | 17.0 | ns    |
|                                | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ | -  | 5.6  | -  | 4.2  | -  | 6.3  | -  | 6.9  | -  | 17.0 |       |
|                                | Output Disable $T/\bar{R}$ to A                | -  | 4.9  | -  | 5.8  | -  | 3.7  | -  | 5.7  | -  | 3.7  |       |
|                                | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ | -  | 4.6  | -  | 4.8  | -  | 4.5  | -  | 4.9  | -  | 4.5  |       |

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

| Symbol                         | Parameter                                      | $V_{CCB} = 3.0\text{ V to }3.6\text{ V}$ |      | $V_{CCB} = 2.3\text{ V to }2.7\text{ V}$ |      | $V_{CCB} = 1.65\text{ V to }1.95\text{ V}$ |      | $V_{CCB} = 1.4\text{ V to }1.6\text{ V}$ |      | $V_{CCB} = 1.1\text{ V to }1.3\text{ V}$ |      | Units |
|--------------------------------|--|--|------|--|------|--|------|--|------|--|------|-------|
|                                |  | Min.                                     | Max. | Min.                                     | Max. | Min.                                       | Max. | Min.                                     | Max. | Min.                                     | Max. |       |
| $t_{PLH}, t_{PHL}$             | 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  |       |
| $t_{PZH}, t_{PZL}$<br>(Note 8) | 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 |       |
| $t_{PHZ}, t_{PLZ}$             | Output Disable $T/\bar{R}$ to B                | -  | 4.1  | -  | 4.3  | -  | 7.0  | -  | 6.7  | -  | 17.0 | ns    |
|                                | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ | -  | 5.7  | -  | 4.3  | -  | 5.7  | -  | 6.7  | -  | 17.0 |       |
|                                | Output Disable $T/\bar{R}$ to A                | -  | 5.3  | -  | 5.9  | -  | 4.0  | -  | 6.0  | -  | 5.9  |       |
|                                | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ | -  | 4.8  | -  | 4.8  | -  | 4.8  | -  | 5.0  | -  | 4.8  |       |

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

| Symbol                         | Parameter                                      | $V_{CCB} = 3.0\text{ V to }3.6\text{ V}$ |      | $V_{CCB} = 2.3\text{ V to }2.7\text{ V}$ |      | $V_{CCB} = 1.65\text{ V to }1.95\text{ V}$ |      | $V_{CCB} = 1.4\text{ V to }1.6\text{ V}$ |      | $V_{CCB} = 1.1\text{ V to }1.3\text{ V}$ |      | Units |
|--------------------------------|--|--|------|--|------|--|------|--|------|--|------|-------|
|                                |  | Min.                                     | Max. | Min.                                     | Max. | Min.                                       | Max. | Min.                                     | Max. | Min.                                     | Max. |       |
| $t_{PLH}, t_{PHL}$             | 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  |       |
| $t_{PZH}, t_{PZL}$<br>(Note 8) | Output Enable $T/\bar{R}$ 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 $T/\bar{R}$ to A                 | 0.7                                      | 10.5 | 0.7                                      | 10.8 | 1.6  | 10.9 | 2.5                                      | 13.0 | 3.2                                      | 25.0 |       |
| $t_{PHZ}, t_{PLZ}$             | Output Disable $T/\bar{R}$ to B                | -  | 5.1  | -  | 5.2  | -  | 6.7  | -  | 7.0  | -  | 17.0 | ns    |
|                                | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ | -  | 5.7  | -  | 5.6  | -  | 5.8  | -  | 7.0  | -  | 17.0 |       |
|                                | Output Disable $T/\bar{R}$ to A                | -  | 5.0  | -  | 6.5  | -  | 5.0  | -  | 5.0  | -  | 5.0  |       |
|                                | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ | -  | 5.0  | -  | 5.0  | -  | 5.0  | -  | 5.0  | -  | 5.0  |       |

# FXLH1T45

**V<sub>CCA</sub> = 1.4 V to 1.6 V**

| Symbol  | Parameter                        | V <sub>CCB</sub> = 3.0 V to 3.6 V |      | V <sub>CCB</sub> = 2.3 V to 2.7 V |      | V <sub>CCB</sub> = 1.65 V to 1.95 V |      | V <sub>CCB</sub> = 1.4 V to 1.6 V |      | V <sub>CCB</sub> = 1.1 V to 1.3 V |      | Units |
|---|----------------------------------|-----------------------------------|------|-----------------------------------|------|-------------------------------------|------|-----------------------------------|------|-----------------------------------|------|-------|
|   |                                  | 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><br>(Note 8) | Output Enable T/ $\bar{R}$ 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/ $\bar{R}$ 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/ $\bar{R}$ to B | –                                 | 6.1  | –                                 | 6.2  | –                                   | 6.2  | –                                 | 7.5  | –                                 | 18.0 | ns    |
|   | T <sub>A</sub> = –40°C to +85°C  | –                                 | 6.1  | –                                 | 6.2  | –                                   | 6.2  | –                                 | 7.5  | –                                 | 18.0 |       |
|   | Output Disable T/ $\bar{R}$ to A | –                                 | 8.0  | –                                 | 7.5  | –                                   | 6.0  | –                                 | 6.0  | –                                 | 6.0  |       |
|   | T <sub>A</sub> = –40°C to +85°C  | –                                 | 6.5  | –                                 | 6.3  | –                                   | 6.0  | –                                 | 6.0  | –                                 | 6.0  |       |

**V<sub>CCA</sub> = 1.1 V to 1.3 V**

| Symbol  | Parameter                        | V <sub>CCB</sub> = 3.0 V to 3.6 V |      | V <sub>CCB</sub> = 2.3 V to 2.7 V |      | V <sub>CCB</sub> = 1.65 V to 1.95 V |      | V <sub>CCB</sub> = 1.4 V to 1.6 V |      | V <sub>CCB</sub> = 1.1 V to 1.3 V |      | Units |
|---|----------------------------------|-----------------------------------|------|-----------------------------------|------|-------------------------------------|------|-----------------------------------|------|-----------------------------------|------|-------|
|   |                                  | 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><br>(Note 8) | Output Enable T/ $\bar{R}$ 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/ $\bar{R}$ 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/ $\bar{R}$ to B | –                                 | 15.0 | –                                 | 7.0  | –                                   | 8.0  | –                                 | 10.0 | –                                 | 20.0 | ns    |
|   | T <sub>A</sub> = –40°C to +85°C  | –                                 | 15.0 | –                                 | 7.0  | –                                   | 8.0  | –                                 | 10.0 | –                                 | 20.0 |       |
|   | Output Disable T/ $\bar{R}$ to A | –                                 | 15.0 | –                                 | 12.0 | –                                   | 12.0 | –                                 | 12.0 | –                                 | 12.0 |       |
|   | T <sub>A</sub> = –40°C to +85°C  | –                                 | 15.0 | –                                 | 12.0 | –                                   | 12.0 | –                                 | 12.0 | –                                 | 12.0 |       |

NOTES:

8. The enable time, t<sub>PZH</sub> or t<sub>PZL</sub>, 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:

$$\begin{aligned}
 t_{PZH} (T/\bar{R} \text{ to A}) &= t_{PLZ} (T/\bar{R} \text{ to B}) + t_{PLH} (B \text{ to A}) \\
 t_{PZL} (T/\bar{R} \text{ to A}) &= t_{PHZ} (T/\bar{R} \text{ to B}) + t_{PHL} (B \text{ to A}) \\
 t_{PZH} (T/\bar{R} \text{ to B}) &= t_{PLZ} (T/\bar{R} \text{ to A}) + t_{PLH} (A \text{ to B}) \\
 t_{PZL} (T/\bar{R} \text{ to B}) &= t_{PHZ} (T/\bar{R} \text{ to A}) + t_{PHL} (A \text{ to B})
 \end{aligned}$$

## CAPACITANCE

| Symbol           | Parameter  | Conditions  | T <sub>A</sub> = +25°C | Units |
|------------------|--|---|------------------------|-------|
|                  |  |   | Typical                |       |
| C <sub>IN</sub>  | Input Capacitance Control Pin (T/ $\bar{R}$ )                  | V <sub>CCA</sub> = V <sub>CCB</sub> = 3.3 V, V <sub>I</sub> = 0 V or V <sub>CCA/B</sub>           | 4.0                    | pF    |
| C <sub>I/O</sub> | Input/Output Capacitance A <sub>n</sub> , B <sub>n</sub> Ports | V <sub>CCA</sub> = V <sub>CCB</sub> = 3.3 V, V <sub>I</sub> = 0 V or V <sub>CCA/B</sub>           | 5.0                    | pF    |
| C <sub>PD</sub>  | Power Dissipation Capacitance                                  | V <sub>CCA</sub> = V <sub>CCB</sub> = 3.3 V, V <sub>I</sub> = 0 V or V <sub>CC</sub> , F = 10 MHz | 20.0                   | pF    |

# FXLH1T45

## AC Loading and Waveforms

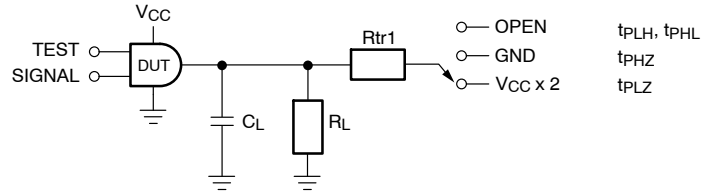


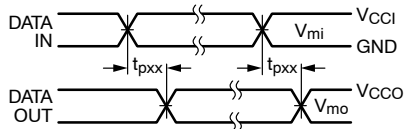
Figure 1. AC Test Circuit

### AC TEST CIRCUIT

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

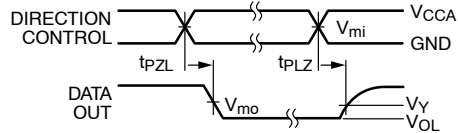
### AC LOAD TABLE

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



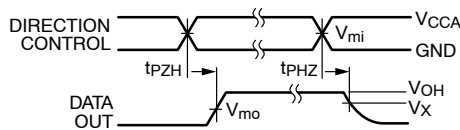
Input  $t_R = t_F = 2.0 \text{ ns}$ , 10% to 90%  
 Input  $t_R = t_F = 2.5 \text{ ns}$ , 10% to 90%, @  $V_I = 3.0 \text{ V}$  to  $3.6 \text{ V}$  only

Figure 2. Waveform for Inverting and Non-Inverting Functions



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

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



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

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

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

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

# FXLH1T45

## ORDERING INFORMATION

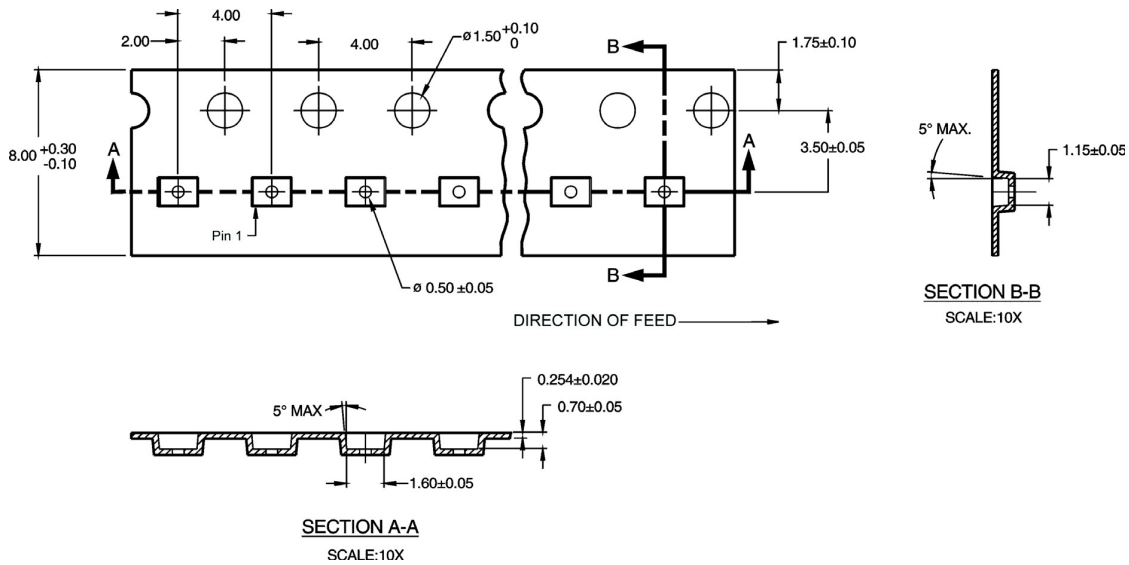
| Order Number | Case Number | Pb-Free | Package Description               | Supplied As               |
|--------------|-------------|---------|-----------------------------------|---------------------------|
| FXLH1T45L6X  | 127EB       | Yes     | 6-Lead MicroPak/SIP6, 1.0 mm Wide | 5k Units on Tape and Reel |

## Tape and Reel Specification

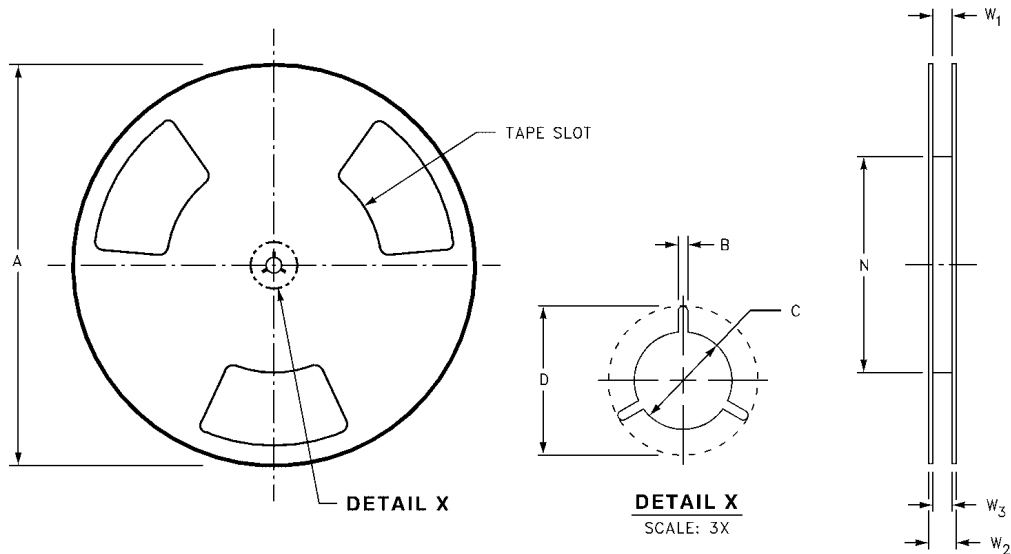
### TAPE FORMAT FOR MICROPAK

| 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)

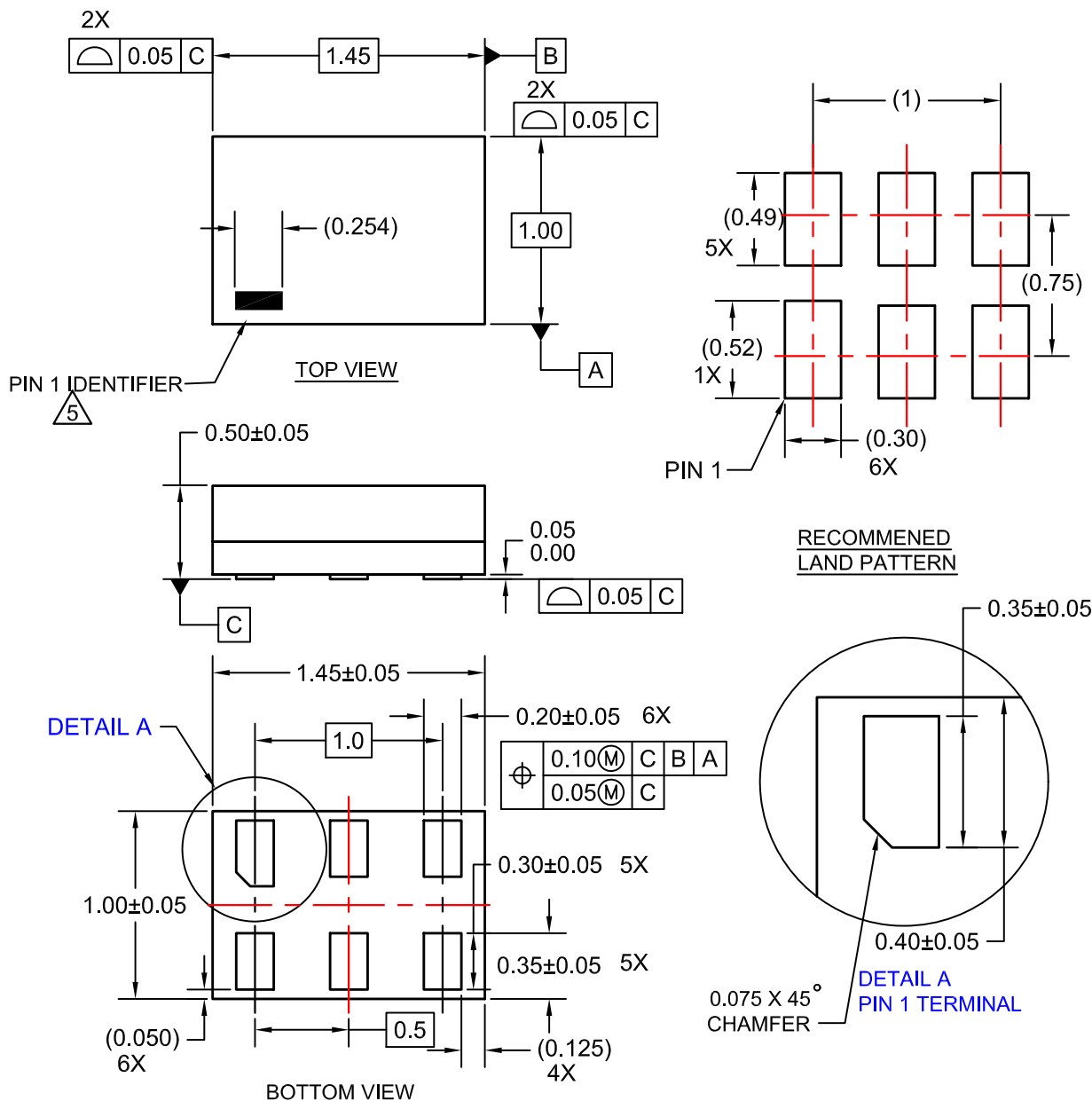


| Tape Size | A              | B               | C                | D                | N                | W1  | W2               | W3   |
|-----------|----------------|-----------------|------------------|------------------|------------------|---|------------------|--|
| 8 mm      | 7.0<br>(177.8) | 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) |



**SIP6 1.45X1.0**  
CASE 127EB  
ISSUE O

DATE 31 AUG 2016




**NOTES:**

1. CONFORMS TO JEDEC STANDARD MO-252 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-2009
4. PIN ONE IDENTIFIER IS 2X LENGTH OF ANY OTHER LINE IN THE MARK CODE LAYOUT.

|                         |                      |  |
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