

## FXL5T244

### Low Voltage Dual Supply 5-Bit Signal Translator with Configurable Voltage Supplies and Signal Levels and 3-STATE Outputs

#### General Description

The FXL5T244 is a configurable dual-voltage-supply translator designed for one-way (unidirectional) voltage translation of signals between two voltage levels. The device allows translation between voltages as high as 3.6V to as low as 1.1V. A Inputs and the  $\overline{OE}$  Control Pin track the  $V_{CCI}$  level, and Y Outputs track the  $V_{CCO}$  level. Both inputs and outputs are designed to accept supply voltage levels from 1.1V to 3.6V. This allows for unidirectional voltage translation over a variety of voltage levels: 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V.

The device remains in 3-STATE until both  $V_{CC}$ s reach active levels allowing either  $V_{CC}$  to be powered-up first. The device also contains power down control circuits that place the device in 3-STATE if either  $V_{CC}$  is removed. The  $\overline{OE}$  input, when HIGH, disables the outputs by placing them in 3-STATE condition.

#### Features

- One-way (unidirectional) translation between any 2 levels from 1.1V to 3.6V
- Fully configurable, inputs and outputs track respective  $V_{CC}$  levels
- 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
- Control input ( $\overline{OE}$ ) level is referenced to  $V_{CCI}$  voltage
- Packaged in 14-terminal DQFN (2.5mm x 3.0mm) package
- ESD protection exceeds:
  - 4kV HBM ESD (per JESD22-A114 & Mil Std 883e 3015.7)
  - 8kV HBM I/O to GND ESD (per JESD22-A114 & Mil Std 883e 3015.7)
  - 1kV CDM ESD (per ESD STM 5.3)
  - 200V MM ESD (per JESD22-A115 & ESD STM5.2)

#### Ordering Code:

Order Number	Package Number	Package Description
FXL5T244BQX	MLP014A	14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm

FXL5T244 Low Voltage Dual Supply 5-Bit Signal Translator with Configurable Voltage Supplies and Signal Levels and 3-STATE Outputs

### Terminal Descriptions

Terminal Names	Description
$\overline{OE}$	Output Enable Input
$A_n$	Data Inputs
$Y_n$	3-STATE Outputs
$V_{CCI}$	Inputs Power Supply
$V_{CCO}$	Outputs Power Supply
GND	Ground

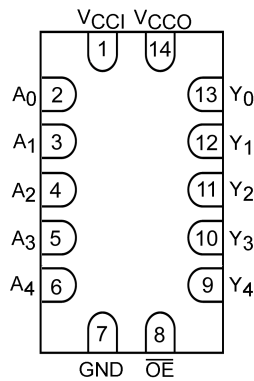
### Truth Table

Inputs		Outputs
$\overline{OE}$	$A_n$	$Y_n$
L	L	L
L	H	H
H	X	3-STATE

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Don't Care

### Connection Diagram

Terminal Assignments for DQFN



(Top View)

### Terminal Assignment

Terminal Number	Terminal Name
1	$V_{CCI}$
2	$A_0$
3	$A_1$
4	$A_2$
5	$A_3$
6	$A_4$
7	GND
8	$\overline{OE}$
9	$Y_4$
10	$Y_3$
11	$Y_2$
12	$Y_1$
13	$Y_0$
14	$V_{CCO}$

### Power-Up/Power-Down Sequencing

FXL translators offer an advantage in that either  $V_{CC}$  may be powered up first. This benefit derives from the chip design. When either  $V_{CC}$  is at 0 volts, outputs are in a HIGH-Impedance state. The control input,  $\overline{OE}$ , is designed to track the  $V_{CCI}$  supply. A pull-up resistor tying  $\overline{OE}$  to  $V_{CCI}$  should be used to ensure that bus contention, excessive currents, or oscillations do not occur during power-up/power-down. The size of the pull-up resistor is based upon the current-sinking capability of the  $\overline{OE}$  driver.

The recommended power-up sequence is the following:

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

The recommended power-down sequence is the following:

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

Absolute Maximum Ratings (Note 1)		Recommended Operating Conditions (Note 3)	
Supply Voltage		Power Supply Operating ( $V_{CC1}$ or $V_{CC0}$ )	1.1V to 3.6V
$V_{CC1}$	-0.5V to +4.6V	Input Voltage	
$V_{CC0}$	-0.5V to +4.6V	$A_n$	0.0V to 3.6V
DC Input Voltage ( $V_I$ )	-0.5V to +4.6V	Control Inputs ( $\overline{OE}$ )	0.0V to 3.6V
Output Voltage ( $V_O$ ) (Note 2)		Output Current in $I_{OH}/I_{OL}$	
Outputs 3-STATE	-0.5V to +4.6V	$V_{CC0} = 3.0V$ to $3.6V$	$\pm 24$ mA
Outputs Active	-0.5V to $V_{CC0} + 0.5V$	$V_{CC0} = 2.3V$ to $2.7V$	$\pm 18$ mA
DC Input Diode Current ( $I_{IK}$ ) $V_I < 0V$	-50 mA	$V_{CC0} = 1.65V$ to $1.95V$	$\pm 6$ mA
DC Output Diode Current ( $I_{OK}$ )		$V_{CC0} = 1.4V$ to $1.65V$	$\pm 2$ mA
$V_O < 0V$	-50 mA	$V_{CC0} = 1.1V$ to $1.4V$	$\pm 0.5$ mA
$V_O > V_{CC}$	+50 mA	Free Air Operating Temperature ( $T_A$ )	-40°C to +85°C
DC Output Source/Sink Current ( $I_{OH}/I_{OL}$ )	-50 mA / +50 mA	Minimum Input Edge Rate ( $\Delta V/\Delta t$ )	10 ns/V
DC $V_{CC}$ or Ground Current per Supply Pin ( $I_{CC}$ or GND)	$\pm 100$ mA	$V_{CCA/B} = 1.1V$ to $3.6V$	
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C		

**Note 1:** The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

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

**Note 3:** All unused inputs must be held at  $V_{CC1}$  or GND.

### DC Electrical Characteristics

Symbol	Parameter	Conditions	$V_{CC1}$ (V)	$V_{CC0}$ (V)	Min	Max	Units
$V_{IH}$	High Level Input Voltage		2.7 - 3.6	1.1 - 3.6	2.0		V
			2.3 - 2.7		1.6		
			1.65 - 2.3		$0.65 \times V_{CC1}$		
			1.4 - 1.65		$0.65 \times V_{CC1}$		
			1.1 - 1.4		$0.9 \times V_{CC1}$		
$V_{IL}$	Low Level Input Voltage		2.7 - 3.6	1.1 - 3.6		0.8	V
			2.3 - 2.7			0.7	
			1.65 - 2.3			$0.35 \times V_{CC1}$	
			1.4 - 1.65			$0.35 \times V_{CC1}$	
			1.1 - 1.4			$0.1 \times V_{CC1}$	
$V_{OH}$	High Level Output Voltage	$I_{OH} = -100 \mu A$	1.1 - 3.6	1.1 - 3.6	$V_{CC0} - 0.2$		V
		$I_{OH} = -12$ mA	2.7	2.7	2.2		
		$I_{OH} = -18$ mA	3.0	3.0	2.4		
		$I_{OH} = -24$ mA	3.0	3.0	2.2		
		$I_{OH} = -6$ mA	2.3	2.3	2.0		
		$I_{OH} = -12$ mA	2.3	2.3	1.8		
		$I_{OH} = -18$ mA	2.3	2.3	1.7		
		$I_{OH} = -6$ mA	1.65	1.65	1.25		
		$I_{OH} = -2$ mA	1.4	1.4	1.05		
$I_{OH} = -0.5$ mA	1.1	1.1	$0.75 \times V_{CC0}$				

## DC Electrical Characteristics (Continued)

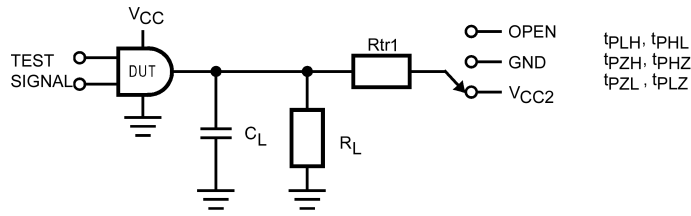
Symbol	Parameter	Conditions	V <sub>CCI</sub> (V)	V <sub>CCO</sub> (V)	Min	Max	Units
V <sub>OL</sub>	Low Level Output Voltage	I <sub>OL</sub> = 100μA	1.1 - 3.6	1.1 - 3.6		0.2	V
		I <sub>OL</sub> = 12 mA	2.7	2.7		0.4	
		I <sub>OL</sub> = 18 mA	3.0	3.0		0.4	
		I <sub>OL</sub> = 24 mA	3.0	3.0		0.55	
		I <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>CCI</sub>	
I <sub>I</sub>	Input Leakage Current	V <sub>I</sub> = V <sub>CCI</sub> or GND	1.1 - 3.6	3.6		±1.0	μA
I <sub>OFF</sub>	Power Off Leakage Current	A <sub>n</sub> ; $\overline{OE} = 0V$ to 3.6V	0	3.6		±10.0	μA
		Y <sub>n</sub> = 0V to 3.6V	3.6	0		±10.0	
I <sub>OZ</sub> (Note 4)	3-STATE Output Leakage 0 ≤ V <sub>O</sub> ≤ 3.6V V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	$\overline{OE} = V_{IH}$	3.6	3.6		±10.0	μA
		$\overline{OE} = \text{Don't Care}$	0	3.6		+10.0	
		$\overline{OE} = \text{Don't Care}$	3.6	0		+10.0	
I <sub>CCI/O</sub> (Note 4)	Quiescent Supply Current	V <sub>I</sub> = V <sub>CCI</sub> or GND; I <sub>O</sub> = 0	1.1 - 3.6	1.1 - 3.6		20.0	μA
I <sub>CCZ</sub> (Note 5)	Quiescent Supply Current	V <sub>I</sub> = V <sub>CCI</sub> or GND; I <sub>O</sub> = 0	1.1 - 3.6	1.1 - 3.6		20.0	μA
I <sub>CCI</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CCI</sub> or GND; I <sub>O</sub> = 0	0	1.1 - 3.6		-10.0	μA
		V <sub>I</sub> = V <sub>CCO</sub> or GND; I <sub>O</sub> = 0	1.1 - 3.6	0		10.0	μA
I <sub>CCO</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CCO</sub> or GND; I <sub>O</sub> = 0	1.1 - 3.6	0		-10.0	μA
		V <sub>I</sub> = V <sub>CCI</sub> or GND; I <sub>O</sub> = 0	0	1.1 - 3.6		10.0	μA
ΔI <sub>CCI/O</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

**Note 4:** Don't Care = Any valid logic level.

**Note 5:** Reflects current per supply, V<sub>CCI</sub> or V<sub>CCO</sub>.

AC Electrical Characteristics $V_{CCI} = 3.0V$ to $3.6V$												
Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										Units
		$V_{CC0} = 3.0V$ to $3.6V$		$V_{CC0} = 2.3V$ to $2.7V$		$V_{CC0} = 1.65V$ to $1.95V$		$V_{CC0} = 1.4V$ to $1.6V$		$V_{CC0} = 1.1V$ to $1.3V$		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{PLH}, t_{PHL}$	Propagation Delay A to Y	0.2	3.5	0.3	3.9	0.7	5.4	0.8	6.8	1.4	22.0	ns
$t_{PZH}, t_{PZL}$	Output Enable $\overline{OE}$ to Y	0.5	4.0	0.7	4.4	1.0	5.9	1.0	6.4	1.5	17.0	ns
$t_{PHZ}, t_{PLZ}$	Output Disable $\overline{OE}$ to Y	0.2	3.8	0.2	4.0	0.7	4.8	1.5	6.2	2.0	17.0	ns
AC Electrical Characteristics $V_{CCI} = 2.3V$ to $2.7V$												
Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										Units
		$V_{CC0} = 3.0V$ to $3.6V$		$V_{CC0} = 2.3V$ to $2.7V$		$V_{CC0} = 1.65V$ to $1.95V$		$V_{CC0} = 1.4V$ to $1.6V$		$V_{CC0} = 1.1V$ to $1.3V$		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{PLH}, t_{PHL}$	Propagation Delay A to Y	0.2	3.8	0.4	4.2	0.5	5.6	0.8	6.9	1.4	22.0	ns
$t_{PZH}, t_{PZL}$	Output Enable $\overline{OE}$ to Y	0.6	4.2	0.8	4.6	1.0	6.0	1.0	6.8	1.5	17.0	ns
$t_{PHZ}, t_{PLZ}$	Output Disable $\overline{OE}$ to Y	0.2	4.1	0.2	4.3	0.7	4.8	1.5	6.7	2.0	17.0	ns
AC Electrical Characteristics $V_{CCI} = 1.65V$ to $1.95V$												
Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										Units
		$V_{CC0} = 3.0V$ to $3.6V$		$V_{CC0} = 2.3V$ to $2.7V$		$V_{CC0} = 1.65V$ to $1.95V$		$V_{CC0} = 1.4V$ to $1.6V$		$V_{CC0} = 1.1V$ to $1.3V$		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{PLH}, t_{PHL}$	Propagation Delay A to Y	0.3	4.0	0.5	4.5	0.8	5.7	0.9	7.1	1.5	22.0	ns
$t_{PZH}, t_{PZL}$	Output Enable $\overline{OE}$ to Y	0.6	5.2	0.8	5.4	1.2	6.9	1.2	7.2	1.5	18.0	ns
$t_{PHZ}, t_{PLZ}$	Output Disable $\overline{OE}$ to Y	0.2	5.1	0.2	4.0	0.8	5.2	1.5	7.0	2.0	17.0	ns
AC Electrical Characteristics $V_{CCI} = 1.4V$ to $1.6V$												
Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										Units
		$V_{CC0} = 3.0V$ to $3.6V$		$V_{CC0} = 2.3V$ to $2.7V$		$V_{CC0} = 1.65V$ to $1.95V$		$V_{CC0} = 1.4V$ to $1.6V$		$V_{CC0} = 1.1V$ to $1.3V$		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{PLH}, t_{PHL}$	Propagation Delay A to Y	0.5	4.3	0.5	4.8	1.0	6.0	1.0	7.3	1.5	22.0	ns
$t_{PZH}, t_{PZL}$	Output Enable $\overline{OE}$ to Y	1.1	7.5	1.1	7.6	1.3	7.7	1.4	7.9	2.0	20.0	ns
$t_{PHZ}, t_{PLZ}$	Output Disable $\overline{OE}$ to Y	0.4	6.1	0.4	6.2	0.9	6.2	1.5	7.5	2.0	18.0	ns
AC Electrical Characteristics $V_{CCI} = 1.1V$ to $1.3V$												
Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										Units
		$V_{CC0} = 3.0V$ to $3.6V$		$V_{CC0} = 2.3V$ to $2.7V$		$V_{CC0} = 1.65V$ to $1.95V$		$V_{CC0} = 1.4V$ to $1.6V$		$V_{CC0} = 1.1V$ to $1.3V$		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{PLH}, t_{PHL}$	Propagation Delay A to Y	0.8	13.0	1.0	7.0	1.2	8.0	1.3	9.5	2.0	24.0	ns
$t_{PZH}, t_{PZL}$	Output Enable $\overline{OE}$ to Y	1.0	12.0	1.0	9.0	2.0	10.0	2.0	11.0	2.0	24.0	ns
$t_{PHZ}, t_{PLZ}$	Output Disable $\overline{OE}$ to Y	1.0	15.0	0.7	7.0	1.0	8.0	2.0	10.0	2.0	20.0	ns
Capacitance												
Symbol	Parameter	Conditions	$T_A = +25^{\circ}C$		Units							
			Typical									
$C_{IN}$	Input Capacitance $A_n$ Control Pin ( $\overline{OE}$ )	$V_{CCI} = V_{CC0} = 3.3V, V_I = 0V$ or $V_{CCI}$	4.0		pF							
$C_{OUT}$	Output Capacitance $Y_n$	$V_{CCI} = V_{CC0} = 3.3V, V_I = 0V$ or $V_{CCI}$	5.0		pF							
$C_{PD}$	Power Dissipation Capacitance	$V_{CCI} = V_{CC0} = 3.3V, V_I = 0V$ or $V_{CCI}, F = 10$ MHz	20.0		pF							

## AC Loading and Waveforms

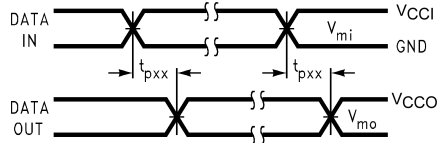


TEST	SWITCH
$t_{PLH}$ , $t_{PHL}$	OPEN
$t_{PZL}$ , $t_{PLZ}$	$V_{CCO} \times 2$ at $V_{CCO} = 3.3 \pm 0.3V, 2.5V \pm 0.2V, 1.8V \pm 0.15V, 1.5V \pm 0.1V, 1.2V \pm 0.1V$
$t_{PHZ}$ , $t_{PZH}$	GND

FIGURE 1. AC Test Circuit

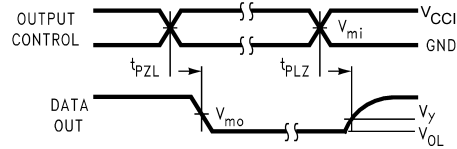
AC Load Table

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



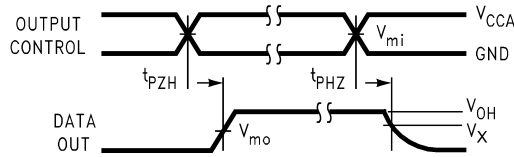
Note: Input  $t_R = t_F = 2.0$  ns, 10% to 90%  
 Input  $t_R = t_F = 2.5$ ns, 10% to 90%, @  $V_I = 3.0V$  to  $3.6V$  only

FIGURE 2. Waveform for Inverting and Non-Inverting Functions



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

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



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

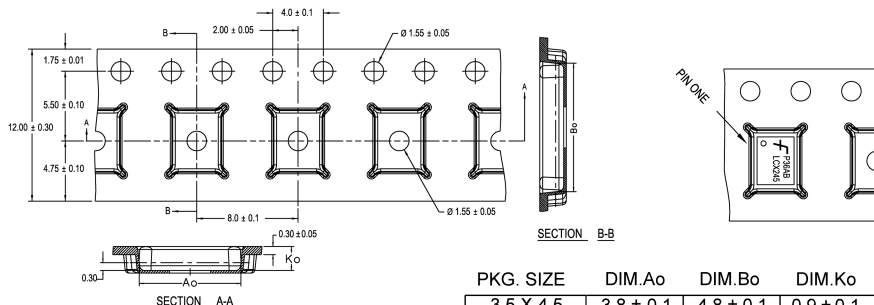
FIGURE 4. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

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

Note: For  $V_{mi}$ :  $V_{CCi} = V_{CCA}$  for Control Pins  $T/\bar{R}$  and  $OE$ , or  $V_{CCA}/2$

Tape and Reel Specification				
Tape Format for DQFN				
Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
BQX	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	3000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

**TAPE DIMENSIONS** inches (millimeters)



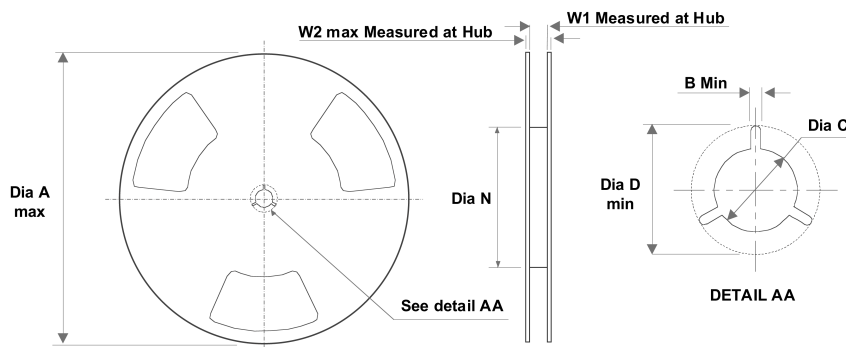
PKG. SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.5 X 4.5	3.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
3.0 X 3.0	3.3 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 4.5	2.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
2.5 X 3.5	2.8 ± 0.1	3.8 ± 0.1	0.9 ± 0.1
2.5 X 3.0	2.8 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 2.5	2.8 ± 0.1	2.8 ± 0.1	0.9 ± 0.1

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

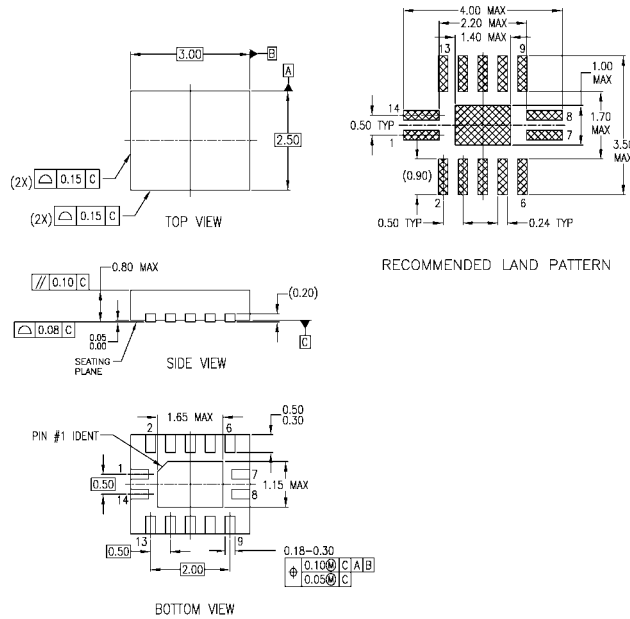
1. Cumulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. Ao and Bo measured on a plane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

**REEL DIMENSIONS** inches (millimeters)



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

**Physical Dimensions** inches (millimeters) unless otherwise noted



NOTES:

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

MLP014ArevA

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

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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