FAIRCHILD SEMICONDUCTOR™

June 2004
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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

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

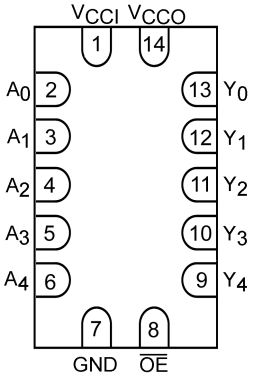
Truth Table

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)

Supply Voltage	
V_{CCI}	−0.5V to +4.6V
V_{CCO}	−0.5V to +4.6V
DC Input Voltage (V_I)	−0.5V to +4.6V
Output Voltage (V_O) (Note 2)	
Outputs 3-STATE	−0.5V to +4.6V
Outputs Active	−0.5V to V_{CCO} + 0.5V
DC Input Diode Current (I_{IK}) V_I < 0V	−50 mA
DC Output Diode Current (I_{OK})	
V_O < 0V	−50 mA
V_O > V_{CC}	+50 mA
DC Output Source/Sink Current	
(I_{OH}/I_{OL})	−50 mA / +50 mA
DC V_{CC} or Ground Current per	
Supply Pin (I_{CC} or GND)	±100 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C

Recommended Operating Conditions (Note 3)

Power Supply Operating (V_{CCI} or V_{CCO})	1.1V to 3.6V
Input Voltage	
A_n	0.0V to 3.6V
Control Inputs ($\overline{OE}$)	0.0V to 3.6V
Output Current in I_{OH}/I_{OL}	
V_{CCO} = 3.0V to 3.6V	±24 mA
V_{CCO} = 2.3V to 2.7V	±18 mA
V_{CCO} = 1.65V to 1.95V	±6 mA
V_{CCO} = 1.4V to 1.65V	±2 mA
V_{CCO} = 1.1V to 1.4V	±0.5 mA
Free Air Operating Temperature (T_A)	−40°C to +85°C
Minimum Input Edge Rate ($\Delta V/\Delta t$)	
$V_{CCA/B}$ = 1.1V to 3.6V	10 ns/V

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

Note 2: I_O Absolute Maximum Rating must be observed.

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

DC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CCI} (V)	V_{CCO} (V)	Min	Max	Units
V_{IH}	High Level Input Voltage		2.7 - 3.6		2.0		
			2.3 - 2.7		1.6		
			1.65 - 2.3	1.1 - 3.6	0.65 x V_{CCI}		V
			1.4 - 1.65		0.65 x V_{CCI}		
			1.1 - 1.4		0.9 x V_{CCI}		
V_{IL}	Low Level Input Voltage		2.7 - 3.6			0.8	
			2.3 - 2.7			0.7	
			1.65 - 2.3	1.1 - 3.6		0.35 x V_{CCI}	V
			1.4 - 1.65			0.35 x V_{CCI}	
			1.1 - 1.4			0.1 x V_{CCI}	
V_{OH}	High Level Output Voltage	I_{OH} = −100 µA	1.1 - 3.6	1.1 - 3.6	V_{CC0} - 0.2		
		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		V
		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 x V_{CC0}		

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_{CCI} (V)	V_{CCO} (V)	Min	Max	Units
V_{OL}	Low Level Output Voltage	I_{OL} = 100µA	1.1 - 3.6	1.1- 3.6		0.2	
		I_{OL} = 12 mA	2.7	2.7		0.4	
		I_{OL} = 18 mA	3.0	3.0		0.4	
		I_{OL} = 24 mA	3.0	3.0		0.55	
		I_{OL} = 12 mA	2.3	2.3		0.4	V
		I_{OL} = 18 mA	2.3	2.3		0.6	
		I_{OL} = 6 mA	1.65	1.65		0.3	
		I_{OL} = 2 mA	1.4	1.4		0.35	
		I_{OL} = 0.5 mA	1.1	1.1		0.3 x V_{CCI}	
I_I	Input Leakage Current	V_I = V_{CCI} or GND	1.1 - 3.6	3.6		±1.0	µA
I_{OFF}	Power Off Leakage Current	A_n, $\overline{OE}$ = 0V to 3.6V	0	3.6		±10.0	µA
		Y_n = 0V to 3.6V	3.6	0		±10.0	
I_{OZ}	3-STATE Output Leakage	$\overline{OE}$ = V_{IH}	3.6	3.6		±10.0	µA
(Note 4)	0 ≤ V_O ≤ 3.6V	$\overline{OE}$ = Don't Care	0	3.6		+10.0	
	V_I = V_{IH} or V_{IL}	$\overline{OE}$ = Don't Care	3.6	0		+10.0	
$I_{CCI/O}$ (Note 4)	Quiescent Supply Current	V_I = V_{CCI} or GND; I_O = 0	1.1 - 3.6	1.1 - 3.6		20.0	µA
I_{CCZ} (Note 5)	Quiescent Supply Current	V_I = V_{CCI} or GND; I_O = 0	1.1 - 3.6	1.1 - 3.6		20.0	µA
I_{CCI}	Quiescent Supply Current	V_I = V_{CCI} or GND; I_O = 0	0	1.1 - 3.6		−10.0	µA
		V_I = V_{CCI} or GND; I_O = 0	1.1 - 3.6	0		10.0	µA
I_{CCO}	Quiescent Supply Current	V_I = V_{CCO} or GND; I_O = 0	1.1 - 3.6	0		−10.0	µA
		V_I = V_{CCO} or GND; I_O = 0	0	1.1 - 3.6		10.0	µA
$\Delta I_{CCI/O}$	Increase in I_{CC} per Input; Other Inputs at V_{CC} or GND	V_{IH} = 3.0	3.6	3.6		500	µA

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

Note 5: Reflects current per supply, V_{CCI} or V_{CCO}.

AC Electrical Characteristics V_{CCI} = 3.0V to 3.6V

Symbol	Parameter	$T_A = -40°C$ to $+85°C$										Units
		V_{CCO} = 3.0V to 3.6V		V_{CCO} = 2.3V to 2.7V		V_{CCO} = 1.65V to 1.95V		V_{CCO} = 1.4V to 1.6V		V_{CCO} = 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	$T_A = -40°C$ to $+85°C$										Units
		V_{CCO} = 3.0V to 3.6V		V_{CCO} = 2.3V to 2.7V		V_{CCO} = 1.65V to 1.95V		V_{CCO} = 1.4V to 1.6V		V_{CCO} = 1.1V to 1.3V		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{PLH}, t_{PHL}	Propagation Delay A toY	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	$T_A = -40°C$ to $+85°C$										Units
		V_{CCO} = 3.0V to 3.6V		V_{CCO} = 2.3V to 2.7V		V_{CCO} = 1.65V to 1.95V		V_{CCO} = 1.4V to 1.6V		V_{CCO} = 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	$T_A = -40°C$ to $+85°C$										Units
		V_{CCO} = 3.0V to 3.6V		V_{CCO} = 2.3V to 2.7V		V_{CCO} = 1.65V to 1.95V		V_{CCO} = 1.4V to 1.6V		V_{CCO} = 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

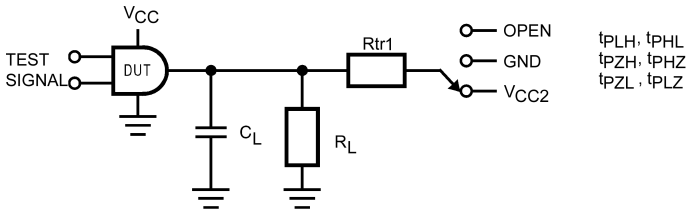
AC Electrical Characteristics V_{CCI} = 1.1V to 1.3V

Symbol	Parameter	$T_A = -40°C$ to $+85°C$										Units
		V_{CCO} = 3.0V to 3.6V		V_{CCO} = 2.3V to 2.7V		V_{CCO} = 1.65V to 1.95V		V_{CCO} = 1.4V to 1.6V		V_{CCO} = 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	$T_A = +25°C$	Units
			Typical	
C_{IN}	Input Capacitance A_n Control Pin ($\overline{OE}$)	$V_{CCI} = V_{CCO} = 3.3V$, $V_I = 0V$ or V_{CCI}	4.0	pF
C_{OUT}	Output Capacitance Y_n	$V_{CCI} = V_{CCO} = 3.3V$, $V_I = 0V$ or V_{CCI}	5.0	pF
C_{PD}	Power Dissipation Capacitance	$V_{CCI} = V_{CCO} = 3.3V$, $V_I = 0V$ or V_{CCI}, F = 10 MHz	20.0	pF

AC Loading and Waveforms

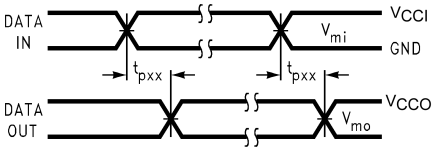


TEST	SWITCH
t_{PLH}, t_{PHL}	OPEN
t_{PLZ}, t_{PZL}	V_{CCO} x 2 at V_{CCO} = 3.3 ± 0.3V, 2.5 ± 0.2V, 1.8V ± 0.15V, 1.5V ± 0.1V, 1.2V ± 0.1V
t_{PHZ}, t_{PZH}	GND

FIGURE 1. AC Test Circuit

AC Load Table

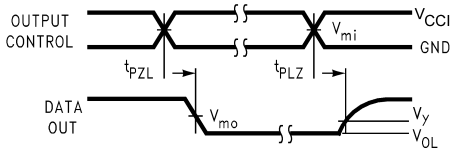
V_{CCO}	C_L	R_L	Rtr1
1.2V ± 0.1V	15 pF	2 kΩ	2 kΩ
1.5V ± 0.1V	15 pF	2 kΩ	2 kΩ
1.8V ± 0.15V	15 pF	2 kΩ	2 kΩ
2.5V ± 0.2V	15 pF	2 kΩ	2 kΩ
3.3V ± 0.3V	15 pF	2 kΩ	2 kΩ



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

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

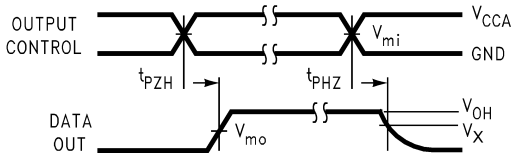
FIGURE 2. Waveform for Inverting and Non-Inverting Functions



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

Input $t_R = t_F$ = 2.5ns, 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 $t_R = t_F$ = 2.5ns, 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 ± 0.3V	2.5V ± 0.2V	1.8V ± 0.15V	1.5V ± 0.1V	1.2V ± 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} + 01V	V_{OL} + 01V

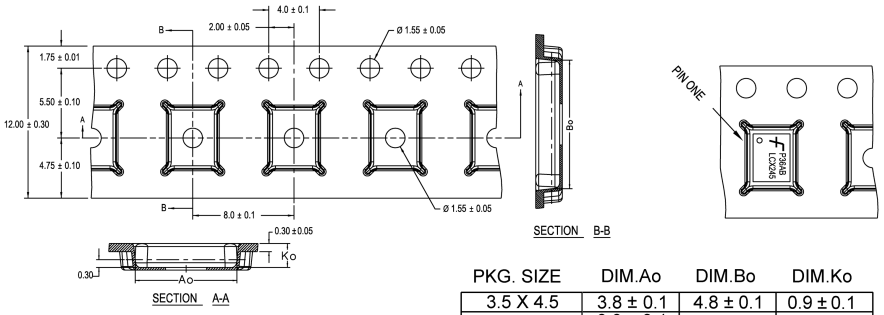
Note: For V_{mi}: $V_{CCI} = V_{CCA}$ for Control Pins T/$\overline{R}$ and $\overline{OE}$, or V_{CCA}/2

Tape and Reel Specification

Tape Format for DQFN

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

TAPE DIMENSIONS inches (millimeters)



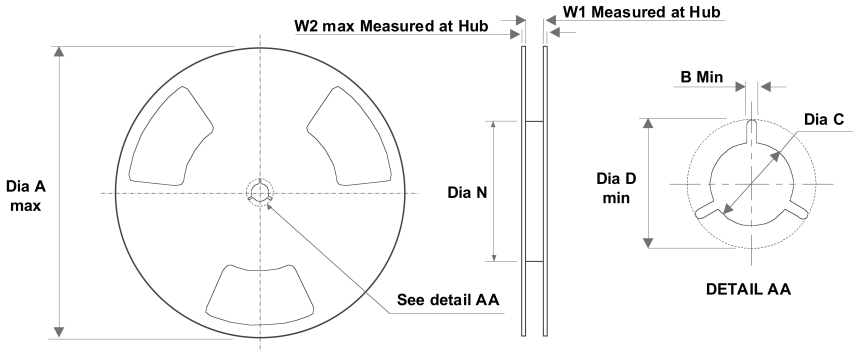
PKG. SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.5 X 4.5	3.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
3.0 X 3.0	3.3 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 4.5	2.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
2.5 X 3.5	2.8 ± 0.1	3.8 ± 0.1	0.9 ± 0.1
2.5 X 3.0	2.8 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 2.5	2.8 ± 0.1	2.8 ± 0.1	0.9 ± 0.1

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

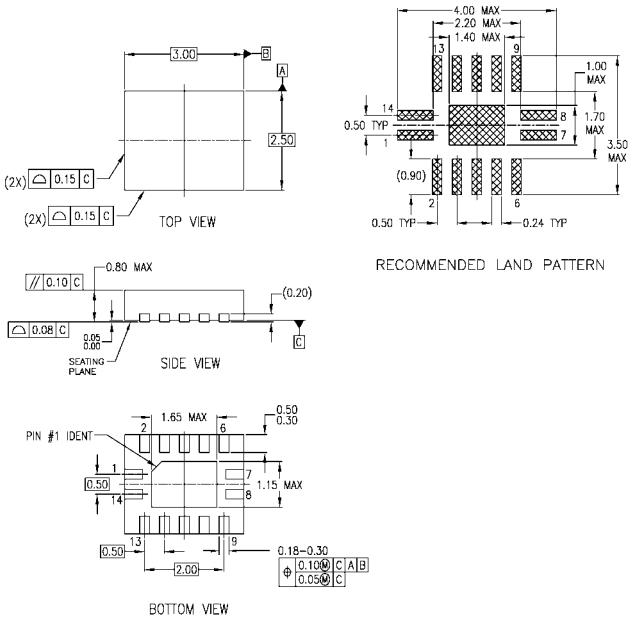
1. Cummulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. Ao and Bo measured on a 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. Diemension 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