

FXL4TD245

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

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
- Control inputs ($T/\bar{R}_n$, $\bar{OE}$) levels are referenced to V_{CCA} voltage
- Packaged in 16-Terminal DQFN (2.5mm x 3.5mm)
- 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 FXL4TD245 is a configurable 4-bit 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.

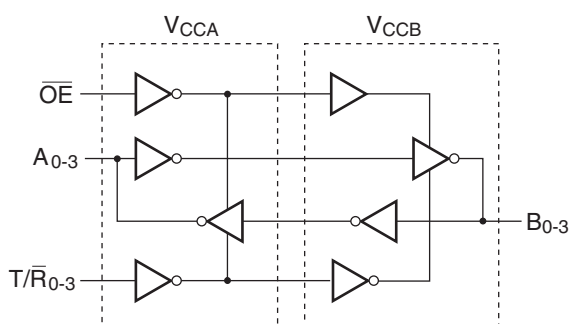
The Transmit/Receive ($T/\bar{R}$) inputs independently determine the direction of data through each of the four bits. The $\bar{OE}$ input, when HIGH, disables both the A and B Ports by placing them in a 3-STATE condition. The FXL4TD245 is designed so that the control pins ($T/\bar{R}$ and $\bar{OE}$) are supplied by V_{CCA} .

Ordering Information

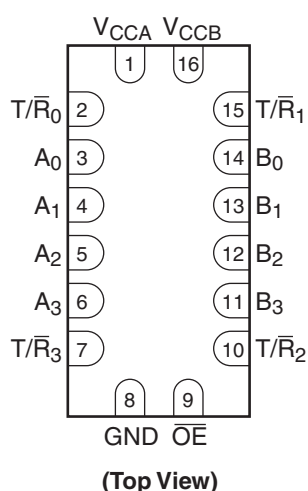
Order Number	Package Number	Pb-Free	Package Description
FXL4TD245BQX	MLP016E	Yes	16-Terminal Depopulated Quad Very-Thin Flat Pack, No Leads (DQFN), JEDEC MO-241, 2.5mm x 3.5mm

Pb-Free package per JEDEC J-STD-020B.

Functional Diagram



Connection Diagram



Pin Assignment

Pin Number	Terminal Name
1	V _{CCA}
2	T/ $\bar{R}_0$
3–6	A ₀ –A ₃
7	T/ $\bar{R}_3$
8	GND
9	OE
10	T/ $\bar{R}_2$
11–14	B ₃ –B ₀
15	T/ $\bar{R}_1$
16	V _{CCB}

Pin Descriptions

Pin Names	Description
OE	Output Enable Input
T/ $\bar{R}_n$	Transmit/Receive Inputs
A _n	Side A Inputs or 3-STATE Outputs
B _n	Side B Inputs or 3-STATE Outputs
V _{CCA}	Side A Power Supply
V _{CCB}	Side B Power Supply

Truth Table

OE	Inputs				Outputs
	T/ $\bar{R}_0$	T/ $\bar{R}_1$	T/ $\bar{R}_2$	T/ $\bar{R}_3$	
L	L	X	X	X	B0 Data to A0 Output
L	H	X	X	X	A0 Data to B0 Output
L	X	L	X	X	B1 Data to A1 Output
L	X	H	X	X	A1 Data to B1 Output
L	X	X	L	X	B2 Data to A2 Output
L	X	X	H	X	A2 Data to B2 Output
L	X	X	X	L	B3 Data to A3 Output
L	X	X	X	H	A3 Data to B3 Output
H	X	X	X	X	3-State

H = HIGH Voltage Level

L = LOW Voltage Level

X = Don't Care

Power-Up/Power-Down Sequencing

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

The recommended power-up sequence is the following:

1. Apply power to either V_{CC}.
2. Apply power to the T/ $\bar{R}_n$ inputs (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 OE input LOW to enable the device.

The recommended power-down sequence is the following:

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

Absolute Maximum Ratings

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.

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

Recommended Operating Conditions⁽²⁾

Symbol	Parameter	Rating
V_{CCA} or V_{CCB}	Power Supply Operating	1.1V to 3.6V
	Input Voltage Port A Port B Control Inputs ($T/\bar{R}_n, \bar{OE}$)	0.0V to 3.6V 0.0V to 3.6V 0.0V to V_{CCA}
	Output Current in I_{OH}/I_{OL} with V_{CC} @ 3.0V to 3.6V 2.3V to 2.7V 1.65V to 1.95V 1.4V to 1.65V 1.1V to 1.4V	±24mA ±18mA ±6mA ±2mA ±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 _{CCI} (V)	V _{CC0} (V)	Min.	Max.	Units
V _{IH}	High Level Input Voltage ⁽³⁾	Data Inputs A _n , B _n	2.7–3.6	1.1–3.6	2.0		V
			2.3–2.7		1.6		
			1.65–2.3		0.65 x V _{CCI}		
			1.4–1.65		0.65 x V _{CCI}		
			1.1–1.4		0.9 x V _{CCI}		
		Control Pins $\overline{OE}$, T/ $\overline{R_n}$ (Referenced to V _{CCA})	2.7–3.6	1.1–3.6	2.0		
			2.3–2.7		1.6		
			1.65–2.3		0.65 x V _{CCA}		
			1.4–1.65		0.65 x V _{CCA}		
			1.1–1.4		0.9 x V _{CCA}		
V _{IL}	Low Level Input Voltage ⁽³⁾	Data Inputs A _n , B _n	2.7–3.6	1.1–3.6		0.8	V
			2.3–2.7			0.7	
			1.65–2.3			0.35 x V _{CCI}	
			1.4–1.65			0.35 x V _{CCI}	
			1.1–1.4			0.1 x V _{CCI}	
		Control Pins $\overline{OE}$, T/ $\overline{R_n}$ (Referenced to V _{CCA})	2.7–3.6	1.1–3.6		0.8	
			2.3–2.7			0.7	
			1.65–2.3			0.35 x V _{CCA}	
			1.4–1.65			0.35 x V _{CCA}	
			1.1–1.4			0.1 x V _{CCA}	
V _{OH}	High Level Output Voltage ⁽⁴⁾	I _{OH} = –100μA	1.1–3.6	1.1–3.6	V _{CC0} –0.2		V
		I _{OH} = –12mA	2.7	2.7	2.2		
		I _{OH} = –18mA	3.0	3.0	2.4		
		I _{OH} = –24mA	3.0	3.0	2.2		
		I _{OH} = –6mA	2.3	2.3	2.0		
		I _{OH} = –12mA	2.3	2.3	1.8		
		I _{OH} = –18mA	2.3	2.3	1.7		
		I _{OH} = –6mA	1.65	1.65	1.25		
		I _{OH} = –2mA	1.4	1.4	1.05		
		I _{OH} = –0.5mA	1.1	1.1	0.75 x V _{CC0}		
V _{OL}	Low Level Output Voltage ⁽⁴⁾	I _{OL} = 100μA	1.1–3.6	1.1–3.6		0.2	V
		I _{OL} = 12mA	2.7	2.7		0.4	
		I _{OL} = 18mA	3.0	3.0		0.4	
		I _{OL} = 24mA	3.0	3.0		0.55	
		I _{OL} = 12mA	2.3	2.3		0.4	
		I _{OL} = 18mA	2.3	2.3		0.6	
		I _{OL} = 6mA	1.65	1.65		0.3	
		I _{OL} = 2mA	1.4	1.4		0.35	
		I _{OL} = 0.5mA	1.1	1.1		0.3 x V _{CC0}	
I _I	Input Leakage Current. Control Pins	V _I = V _{CCA} or GND	1.1–3.6	3.6		±1.0	μA

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V _{CCI} (V)	V _{CCO} (V)	Min.	Max.	Units
I _{OFF}	Power Off Leakage Current	A _n , V _I or V _O = 0V to 3.6V	0	3.6		±10.0	μA
		B _n , V _I or V _O = 0V to 3.6V	3.6	0		±10.0	
I _{OZ}	3-STATE Output Leakage ⁽⁵⁾ 0 ≤ V _O ≤ 3.6V V _I = V _{IH} or V _{IL}	A _n , B _n $\overline{OE} = V_{IH}$	3.6	3.6		±10.0	μA
		B _n , $\overline{OE} = \text{Don't Care}$	0	3.6		+10.0	
		A _n , $\overline{OE} = \text{Don't Care}$	3.6	0		+10.0	
I _{CCA/B}	Quiescent Supply Current ⁽⁶⁾	V _I = V _{CCI} or GND; I _O = 0	1.1–3.6	1.1–3.6		20.0	μA
I _{CCZ}	Quiescent Supply Current ⁽⁶⁾	V _I = V _{CCI} or GND; I _O = 0	1.1–3.6	1.1–3.6		20.0	μA
I _{CCA}	Quiescent Supply Current	V _I = V _{CCA} or GND; I _O = 0	0	1.1–3.6		–10.0	μA
		V _I = V _{CCA} or GND; I _O = 0	1.1–3.6	0		10.0	μA
I _{CCB}	Quiescent Supply Current	V _I = V _{CCB} or GND; I _O = 0	1.1–3.6	0		–10.0	μA
		V _I = V _{CCB} or GND; I _O = 0	0	1.1–3.6		10.0	μA
ΔI _{CCA/B}	Increase in I _{CC} per Input; Other Inputs at V _{CC} or GND	V _{IH} = 3.0	3.6	3.6		500	μA

Notes:

3. V_{CCI} = the V_{CC} associated with the data input under test.
4. V_{CCO} = the V_{CC} associated with the output under test.
5. Don't Care = Any valid logic level.
6. Reflects current per supply, V_{CCA} or V_{CCB}.

AC Electrical Characteristics

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

Symbol	Parameter	T _A = −40°C to +85°C										Units
		V _{CCB} = 3.0V to 3.6V		V _{CCB} = 2.3V to 2.7V		V _{CCB} = 1.65V to 1.95V		V _{CCB} = 1.4V to 1.6V		V _{CCB} = 1.1V to 1.3V		
		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}	Output Enable $\overline{OE}$ to B	0.5	4.0	0.7	4.4	1.0	5.9	1.0	6.4	1.5	17.0	ns
	Output Enable $\overline{OE}$ to A	0.5	4.0	0.5	4.0	0.5	4.0	0.5	4.0	0.5	4.0	
t _{PHZ} , t _{PLZ}	Output Disable $\overline{OE}$ to B	0.2	3.8	0.2	4.0	0.7	4.8	1.5	6.2	2.0	17.0	ns
	Output Disable $\overline{OE}$ to A	0.2	3.7	0.2	3.7	0.2	3.7	0.2	3.7	0.2	3.7	

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

Symbol	Parameter	T _A = −40°C to +85°C										Units
		V _{CCB} = 3.0V to 3.6V		V _{CCB} = 2.3V to 2.7V		V _{CCB} = 1.65V to 1.95V		V _{CCB} = 1.4V to 1.6V		V _{CCB} = 1.1V to 1.3V		
		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}	Output Enable $\overline{OE}$ to B	0.6	4.2	0.8	4.6	1.0	6.0	1.0	6.8	1.5	17.0	ns
	Output Enable $\overline{OE}$ to A	0.6	4.5	0.6	4.5	0.6	4.5	0.6	4.5	0.6	4.5	
t _{PHZ} , t _{PLZ}	Output Disable $\overline{OE}$ to B	0.2	4.1	0.2	4.3	0.7	4.8	1.5	6.7	2.0	17.0	ns
	Output Disable $\overline{OE}$ to A	0.2	4.0	0.2	4.0	0.2	4.0	0.2	4.0	0.2	4.0	

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

Symbol	Parameter	T _A = −40°C to +85°C										Units
		V _{CCB} = 3.0V to 3.6V		V _{CCB} = 2.3V to 2.7V		V _{CCB} = 1.65V to 1.95V		V _{CCB} = 1.4V to 1.6V		V _{CCB} = 1.1V to 1.3V		
		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}	Output Enable $\overline{OE}$ to B	0.6	5.2	0.8	5.4	1.2	6.9	1.2	7.2	1.5	18.0	ns
	Output Enable $\overline{OE}$ to A	1.0	6.7	1.0	6.7	1.0	6.7	1.0	6.7	1.0	6.7	
t _{PHZ} , t _{PLZ}	Output Disable $\overline{OE}$ to B	0.2	5.1	0.2	5.2	0.8	5.2	1.5	7.0	2.0	17.0	ns
	Output Disable $\overline{OE}$ to A	0.5	5.0	0.5	5.0	0.5	5.0	0.5	5.0	0.5	5.0	

AC Electrical Characteristics (Continued)

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

Symbol	Parameter	T _A = −40°C to +85°C										Units
		V _{CCB} = 3.0V to 3.6V		V _{CCB} = 2.3V to 2.7V		V _{CCB} = 1.65V to 1.95V		V _{CCB} = 1.4V to 1.6V		V _{CCB} = 1.1V to 1.3V		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t _{PLH} , t _{PHL}	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 _{PZH} , t _{PZL}	Output Enable $\overline{OE}$ to B	1.1	7.5	1.1	7.6	1.3	7.7	1.4	7.9	2.0	20.0	ns
	Output Enable $\overline{OE}$ to A	1.0	7.5	1.0	7.5	1.0	7.5	1.0	7.5	1.0	7.5	
t _{PHZ} , t _{PLZ}	Output Disable $\overline{OE}$ to B	0.4	6.1	0.4	6.2	0.9	6.2	1.5	7.5	2.0	18.0	ns
	Output Disable $\overline{OE}$ to A	1.0	6.0	1.0	6.0	1.0	6.0	1.0	6.0	1.0	6.0	

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

Symbol	Parameter	T _A = −40°C to +85°C										Units
		V _{CCB} = 3.0V to 3.6V		V _{CCB} = 2.3V to 2.7V		V _{CCB} = 1.65V to 1.95V		V _{CCB} = 1.4V to 1.6V		V _{CCB} = 1.1V to 1.3V		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t _{PLH} , t _{PHL}	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 _{PZH} , t _{PZL}	Output Enable $\overline{OE}$ to B	1.0	12.0	1.0	9.0	2.0	10.0	2.0	11.0	2.0	24.0	ns
	Output Enable $\overline{OE}$ to A	2.0	22.0	2.0	22.0	2.0	22.0	2.0	22.0	2.0	22.0	
t _{PHZ} , t _{PLZ}	Output Disable $\overline{OE}$ to B	1.0	15.0	0.7	7.0	1.0	8.0	2.0	10.0	2.0	20.0	ns
	Output Disable $\overline{OE}$ to A	2.0	15.0	2.0	12.0	2.0	12.0	2.0	12.0	2.0	12.0	

Capacitance

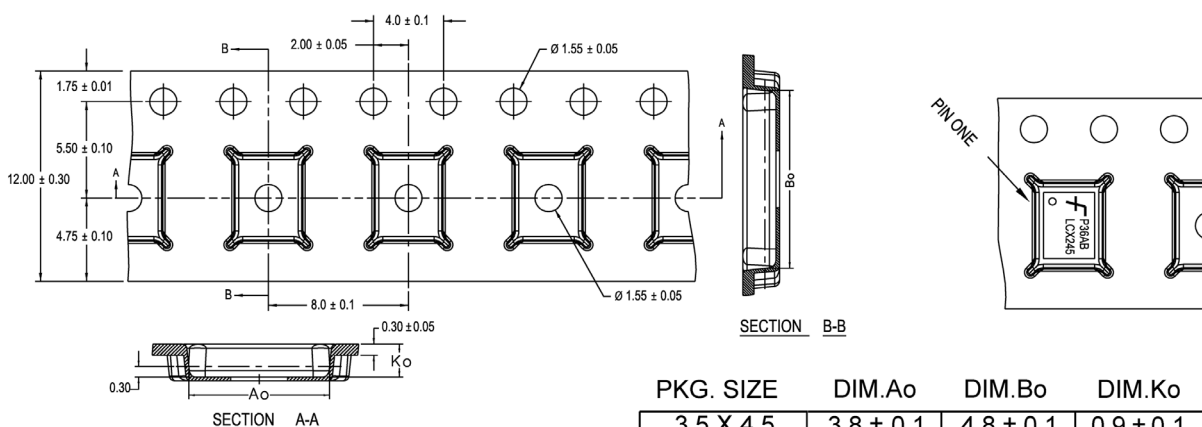
Symbol	Parameter	Conditions	$T_A = +25^{\circ}C$	Units
			Typical	
C_{IN}	Input Capacitance Control Pins ($\overline{OE}$, T/ $\overline{R}$)	$V_{CCA} = V_{CCB} = 3.3V, V_I = 0V \text{ or } V_{CCA/B}$	4.0	pF
$C_{I/O}$	Input/Output Capacitance A_n, B_n Ports	$V_{CCA} = V_{CCB} = 3.3V, V_I = 0V \text{ or } V_{CCA/B}$	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

Tape and Reel Specification

Tape Format for DQFN 10

Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
BQX	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	2500/3000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

Tape Dimensions millimeters



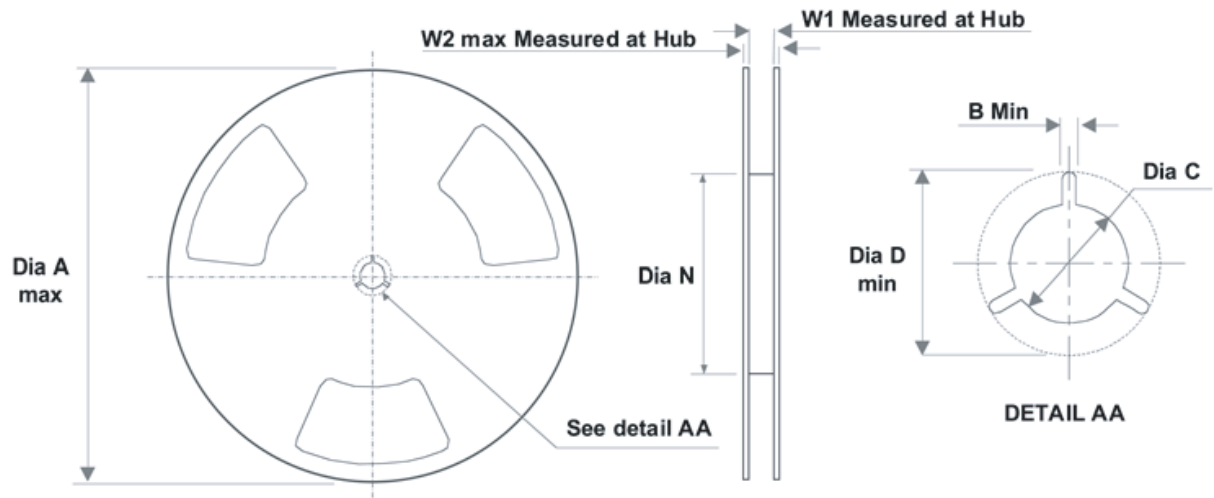
PKG. SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.5 X 4.5	3.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
3.0 X 3.0	3.3 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 4.5	2.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
2.5 X 3.5	2.8 ± 0.1	3.8 ± 0.1	0.9 ± 0.1
2.5 X 3.0	2.8 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 2.5	2.8 ± 0.1	2.8 ± 0.1	0.9 ± 0.1

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

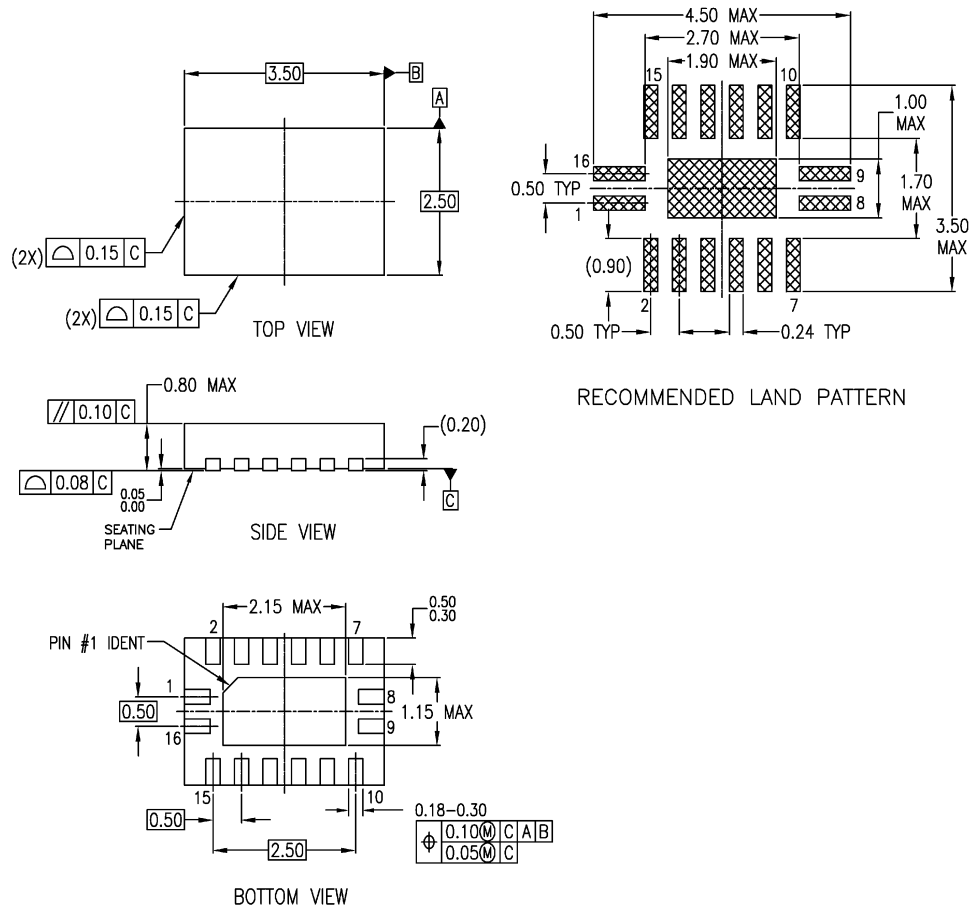
1. Cumulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. Ao and Bo measured on a plane 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)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	7.008 (178)	0.488 (12.4)	0.724 (18.4)

Physical Dimensions millimeters unless otherwise noted



NOTES:

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

MLP016ErevA

Figure 5. 6-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241 2.5 x 3.5mm Package Number MLP016E



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Rev. I26