

# 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 ( $T/\bar{R}_n$ ,  $\overline{OE}$ ) 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.

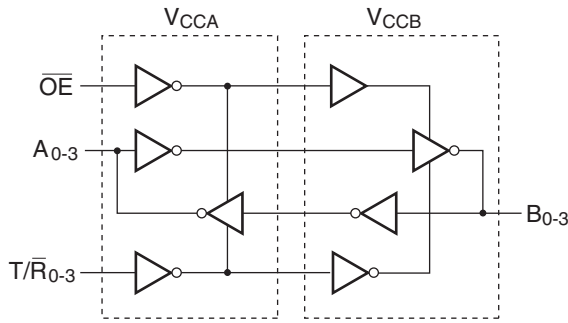
The Transmit/Receive ( $T/\bar{R}$ ) inputs independently determine the direction of data through each of the four bits. The  $\overline{OE}$  input, when HIGH, disables both the A and B Ports by placing them in a 3-STATE condition. The FXL4TD245 is designed so that the control pins ( $T/\bar{R}$  and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

### Ordering Information

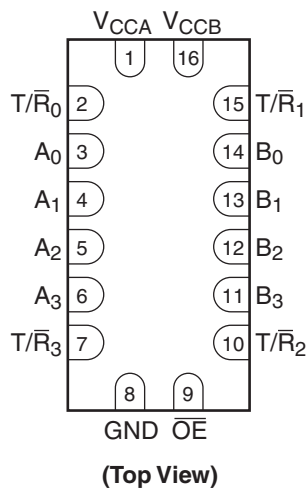
Order Number	Package Number	Pb-Free	Package Description
FXL4TD245BQX	MLP016E	Yes	16-Terminal Depopulated Quad Very-Thin Flat Pack, No Leads (DQFN), JEDEC MO-241, 2.5mm x 3.5mm

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

## Functional Diagram



## Connection Diagram



## Pin Assignment

Pin Number	Terminal Name
1	V <sub>CCA</sub>
2	T/ $\bar{R}_0$
3-6	A <sub>0</sub> -A <sub>3</sub>
7	T/ $\bar{R}_3$
8	GND
9	$\bar{O}E$
10	T/ $\bar{R}_2$
11-14	B <sub>3</sub> -B <sub>0</sub>
15	T/ $\bar{R}_1$
16	V <sub>CCB</sub>

## Pin Descriptions

Pin Names	Description
$\bar{O}E$	Output Enable Input
T/ $\bar{R}_n$	Transmit/Receive Inputs
A <sub>n</sub>	Side A Inputs or 3-STATE Outputs
B <sub>n</sub>	Side B Inputs or 3-STATE Outputs
V <sub>CCA</sub>	Side A Power Supply
V <sub>CCB</sub>	Side B Power Supply

## Truth Table

$\bar{O}E$	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<sub>CC</sub> may be powered up first. This benefit derives from the chip design. When either V<sub>CC</sub> is at 0 volts, outputs are in a HIGH-Impedance state. The control inputs (T/ $\bar{R}_n$  and  $\bar{O}E$ ) are designed to track the V<sub>CCA</sub> supply. A pull-up resistor tying  $\bar{O}E$  to V<sub>CCA</sub> 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  $\bar{O}E$  driver.

The recommended power-up sequence is the following:

1. Apply power to either V<sub>CC</sub>.
2. Apply power to the T/ $\bar{R}_n$  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<sub>CC</sub>.
4. Drive the  $\bar{O}E$  input LOW to enable the device.

The recommended power-down sequence is the following:

1. Drive  $\bar{O}E$  input HIGH to disable the device.
2. Remove power from either V<sub>CC</sub>.
3. Remove power from other V<sub>CC</sub>.

## 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 <sup>(1)</sup> 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<sup>(2)</sup>

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:

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

### DC Electrical Characteristics

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

### DC Electrical Characteristics (Continued)

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

**Notes:**

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. Don't Care = Any valid logic level.
6. Reflects current per supply, V<sub>CCA</sub> or V<sub>CCB</sub>.

## AC Electrical Characteristics

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

Symbol	Parameter	$T_A = -40^\circ C \text{ to } +85^\circ C$										Units
		$V_{CCB} = 3.0V \text{ to } 3.6V$		$V_{CCB} = 2.3V \text{ to } 2.7V$		$V_{CCB} = 1.65V \text{ to } 1.95V$		$V_{CCB} = 1.4V \text{ to } 1.6V$		$V_{CCB} = 1.1V \text{ to } 1.3V$		
		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	

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

Symbol	Parameter	$T_A = -40^\circ C \text{ to } +85^\circ C$										Units
		$V_{CCB} = 3.0V \text{ to } 3.6V$		$V_{CCB} = 2.3V \text{ to } 2.7V$		$V_{CCB} = 1.65V \text{ to } 1.95V$		$V_{CCB} = 1.4V \text{ to } 1.6V$		$V_{CCB} = 1.1V \text{ to } 1.3V$		
		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	

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

Symbol	Parameter	$T_A = -40^\circ C \text{ to } +85^\circ C$										Units
		$V_{CCB} = 3.0V \text{ to } 3.6V$		$V_{CCB} = 2.3V \text{ to } 2.7V$		$V_{CCB} = 1.65V \text{ to } 1.95V$		$V_{CCB} = 1.4V \text{ to } 1.6V$		$V_{CCB} = 1.1V \text{ to } 1.3V$		
		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)

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

Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										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	

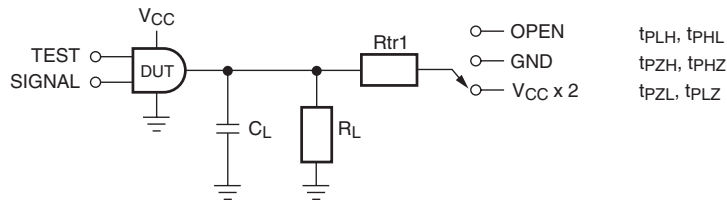
$V_{CCA} = 1.1V$  to  $1.3V$

Symbol	Parameter	$T_A = -40^{\circ}C$ to $+85^{\circ}C$										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/ $\overline{R}$ )	$V_{CCA} = V_{CCB} = 3.3V, V_I = 0V$ or $V_{CCA/B}$	4.0	pF
$C_{I/O}$	Input/Output Capacitance $A_n, B_n$ Ports	$V_{CCA} = V_{CCB} = 3.3V, V_I = 0V$ or $V_{CCA/B}$	5.0	pF
$C_{PD}$	Power Dissipation Capacitance	$V_{CCA} = V_{CCB} = 3.3V, V_I = 0V$ or $V_{CC}$ , $F = 10MHz$	20.0	pF

## AC Loading and Waveforms

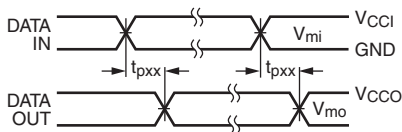


Test	Switch
$t_{PLH}$ , $t_{PHL}$	OPEN
$t_{PLZ}$ , $t_{PZL}$	$V_{CCO} \times 2$ at $V_{CCO} = 3.3 \pm 0.3V, 2.5V \pm 0.2V, 1.8V \pm 0.15V, 1.5V \pm 0.1V, 1.2V \pm 0.1V$
$t_{PHZ}$ , $t_{PZH}$	GND

Figure 1. AC Test Circuit

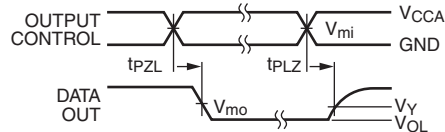
### AC Load Table

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



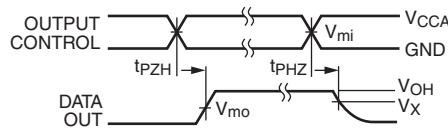
Input  $t_R = t_F = 2.0$  ns, 10% to 90%  
 Input  $t_R = t_F = 2.5$ ns, 10% to 90%, @  $V_I = 3.0V$  to 3.6V only

Figure 2. Waveform for Inverting and Non-Inverting Functions



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

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



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

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

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

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

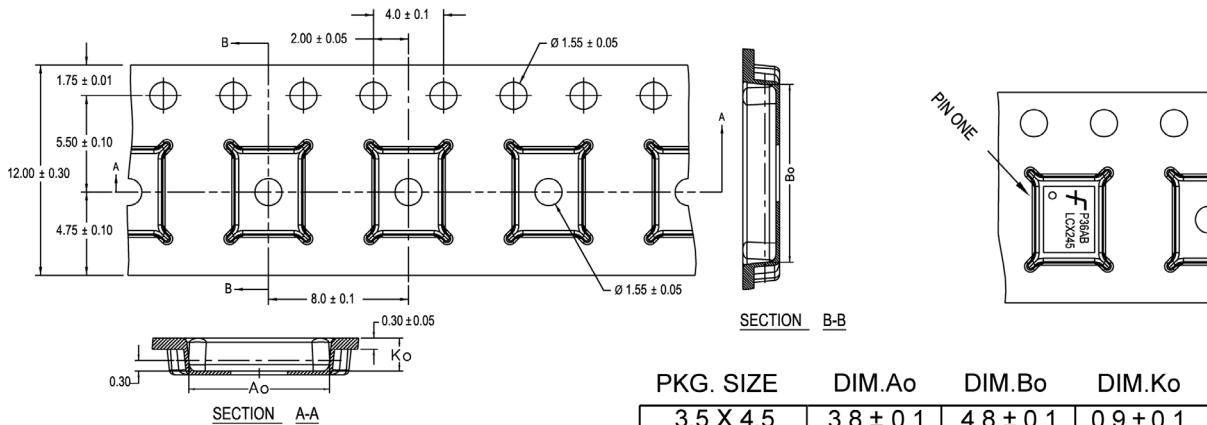


## Tape and Reel Specification

### 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

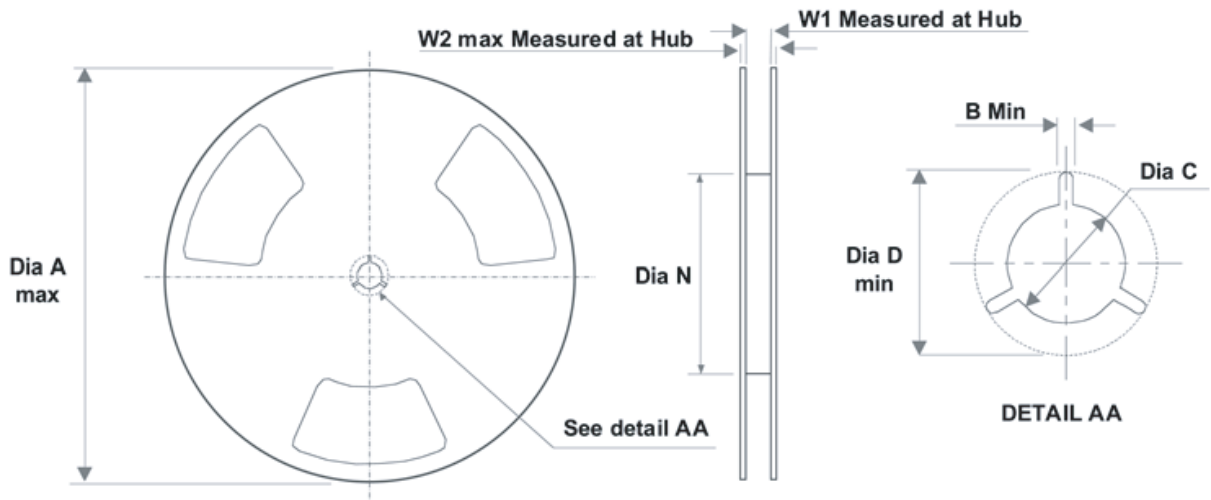
### Tape Dimensions millimeters



NOTES: unless otherwise specified

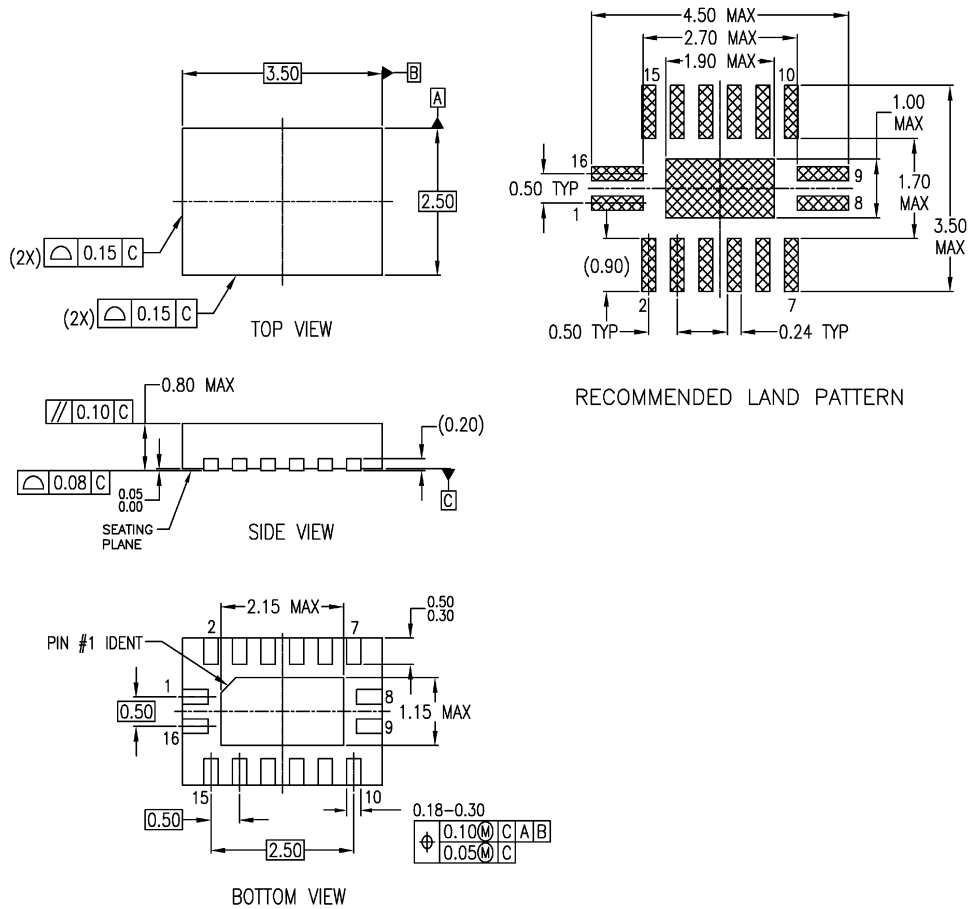
1. Cumulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. A<sub>o</sub> and B<sub>o</sub> measured on a plane 0.120[0.30] above the bottom of the pocket.
6. K<sub>o</sub> 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:**

- A. CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AB
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. 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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FAST <sup>®</sup>	PDP-SPM <sup>™</sup>	SuperSOT <sup>™</sup> 6	
FASTr <sup>™</sup>	POP <sup>™</sup>	SuperSOT <sup>™</sup> 8	
FPS <sup>™</sup>	Power220 <sup>®</sup>	SyncFET <sup>™</sup>	
FRFET <sup>®</sup>	Power247 <sup>®</sup>	TCM <sup>™</sup>	
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