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# FXL2T245

## Low-Voltage, Dual-Supply, 2-Bit, Signal Translator with Configurable Voltage Supplies and Signal Levels and 3-State Outputs

### 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  $V_{CC}$  maybe 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/R, OE) Levels are Referenced to  $V_{CCA}$  Voltage
- Packaged in 10-Lead MicroPak (1.6 mm x 2.1 mm) Package
- ESD Protection Exceeds:
  - 4 kV HBM ESD JESD22-A114 & Mil Std 883e 3015.7)
  - 8kV 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)

### Description

The FXL2T245 is a configurable, dual-voltage-supply translator designed for 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/R) input determines the direction of data flow through the device. The OE input, when HIGH, disables both the A and B ports by placing them in a 3-state condition. The FXL2T245 is designed so control pins T/R and OE are supplied by  $V_{CCA}$ .

### Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
FXL2T245L10X	-40°C to +85°C	10-Lead, MicroPak™, JEDEC MO255, 1.6 x 2.1 mm	Tape and Reel

## Pin Configuration

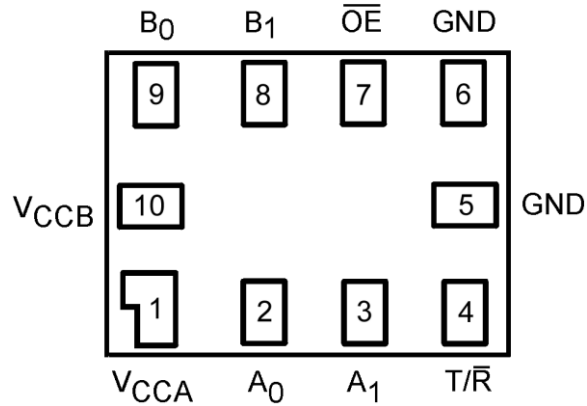


Figure 1. Pin Assignments

## Pin Descriptions

Pin#	Pin Name	Description
1	$V_{CCA}$	Side A Power Supply
2	$A_0$	Side A Inputs or 3-State Outputs
3	$A_1$	Side A Inputs or 3-State Outputs
4	$T/\overline{R}$	Transmit/Receive Input
5, 6	GND	Ground
7	$\overline{OE}$	Output Enable Input
8	$B_1$	Side B Inputs or 3- State Outputs
9	$B_0$	Side B Inputs or 3-State Outputs
10	$V_{CCB}$	Side B Power Supply

## Truth Table

Inputs		Outputs
$\overline{OE}$	$T/\overline{R}$	
LOW	LOW	Bus B Data to Bus A
LOW	HIGH	Bus A Data to Bus B

### Notes:

1. LOW = low voltage level.
2. HIGH = high voltage level.

## Functional Description

### Power-Up / Power-Down Sequencing

Due to the chip design, the FXL2T245 translator offers the advantage of either  $V_{CC}$  being powered up first. When either  $V_{CC}$  is at 0V, outputs are in a high-impedance state. The control inputs ( $\overline{T/R}$  and  $\overline{OE}$ ) are designed to track the  $V_{CCA}$  supply. A pull-up resistor tying  $\overline{OE}$  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  $\overline{OE}$  driver.

The recommended power-up sequence is:

1. Apply power to either  $V_{CC}$ .
2. Apply power to the  $\overline{T/R}$  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 the other  $V_{CC}$ .
4. Drive the  $\overline{OE}$  input LOW to enable the device.

The recommended power-down sequence is:

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

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Conditions	Min.	Max.	Unit		
$V_{CCA}$	Supply Voltage		-0.5	4.6	V		
$V_{CCB}$			-0.5	4.6			
$V_I$	DC Input Voltage	I/O Port A	-0.5	4.6	V		
		I/O Port B	-0.5	4.6			
		Control Inputs ( $\overline{T/R}$ , $\overline{OE}$ )	-0.5	4.6			
$V_O$	Output Voltage <sup>(3)</sup>	Output 3-State	-0.5	4.6	V		
		Output Active ( $A_n$ )	-0.5 to $V_{CCA}$	0.5			
		Output Active ( $B_n$ )	-0.5 to $V_{CCB}$	0.5			
$I_{IK}$	DC Input Diode Current	$V_I < 0$ V		-50	mA		
$I_{OK}$	DC Output Diode Current	$V_O < 0$ V		-50	mA		
		$V_O > V_{CC}$		+50			
$I_{OH}/I_{OL}$	DC Output Source/Sink Current			±50	mA		
$I_{CC}$	DC $V_{CC}$ or Ground Current per Supply Pin			±100	mA		
$T_{STG}$	Storage Temperature Range		-65	+150	°C		
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114, Mil Std 883e 3015.7	All Pins		4	kV	
			I/O to GND		8		
		Charged Device Model, JESD22-C101, STM 5.3				1	V
		Machine Model, JESD22-A115, STM 5.2				200	

### Note:

- I/O absolute maximum ratings must be observed.

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Conditions	Min.	Max.	Unit	
$V_{CC}$	Power Supply	Operating $V_{CCA}$ or $V_{CCB}$	1.1	3.6	V	
$V_I$	Input Voltage	Port A	0	3.6	V	
		Port B	0	3.6		
		Control Inputs ( $\overline{T/R}$ , $\overline{OE}$ )	0	$V_{CCA}$		
$I_{OH}/I_{OL}$	Output Current	$V_{CC}$	3.0 V to 3.6 V		±24	mA
			2.3 V to 2.7 V		±18	
			1.65 V to 1.95 V		±6	
			1.40 V to 1.65 V		±2	
			1.1 V to 1.4 V		±0.5	
$T_A$	Operating Temperature, Free Air		-40	+85	°C	
$\Delta V/\Delta t$	Minimum Input Edge Rate	$V_{CCAB} = 1.1$ V to 3.6 V		10	ns/V	

### Note:

- All unused inputs must be held at  $V_{CCI}$  or GND.

### Electrical Characteristics

Symbol	Parameter	Conditions	V <sub>CC0</sub> (V)	V <sub>CC1</sub> (V)	Min.	Max.	Unit
V <sub>IH</sub>	HIGH Level Input <sup>(5)</sup>	Data Inputs A <sub>n</sub> , B <sub>n</sub>	1.10 to 3.60	2.70 to 3.60	2.00		V
				2.30 to 2.70	1.60		
				1.65 to 2.30	0.65 x V <sub>CC1</sub>		
				1.40 to 1.65	0.65 x V <sub>CC1</sub>		
				1.10 to 1.40	0.90 x V <sub>CC1</sub>		
		Control Pins / $\overline{\text{OE}}$ , T/ $\overline{\text{R}}$ (Referenced to V <sub>CCA</sub> )		2.70 to 3.60	2.00		
				2.30 to 2.70	1.60		
				1.65 to 2.30	0.65 x V <sub>CCA</sub>		
				1.40 to 1.65	0.65 x V <sub>CCA</sub>		
				1.10 to 1.40	0.90 x V <sub>CCA</sub>		
V <sub>IL</sub>	LOW Level Input <sup>(5)</sup>	Data Inputs A <sub>n</sub> , B <sub>n</sub>	1.10 to 3.60	2.70 to 3.60		0.80	V
				2.30 to 2.70		0.70	
				1.65 to 2.30		0.35 x V <sub>CC1</sub>	
				1.40 to 1.65		0.35 x V <sub>CC1</sub>	
				1.10 to 1.40		0.10 x V <sub>CC1</sub>	
		Control Pins / $\overline{\text{OE}}$ , T/ $\overline{\text{R}}$ (Referenced to V <sub>CCA</sub> )		2.70 to 3.60		0.80	
				2.30 to 2.70		0.70	
				1.65 to 2.30		0.35 x V <sub>CC1</sub>	
				1.40 to 1.65		0.35 x V <sub>CC1</sub>	
				1.10 to 1.40		0.10 x V <sub>CC1</sub>	
V <sub>OH</sub>	HIGH Level Output <sup>(6)</sup>	I <sub>OH</sub> = -100 $\mu$ A	1.10 to 3.60	1.10 to 3.60	V <sub>CC0</sub> - 0.20		V
		I <sub>OH</sub> = -12 mA	2.70	2.70	2.20		
		I <sub>OH</sub> = -18 mA	3.00	3.00	2.40		
		I <sub>OH</sub> = -24 mA	3.00	3.00	2.20		
		I <sub>OH</sub> = -6 mA	2.30	2.30	2.00		
		I <sub>OH</sub> = -12 mA	2.30	2.30	1.80		
		I <sub>OH</sub> = -18 mA	2.30	2.30	1.70		
		I <sub>OH</sub> = -6 mA	1.65	1.65	1.25		
		I <sub>OH</sub> = -2 mA	1.40	1.40	1.05		
		I <sub>OH</sub> = -0.5 mA	1.10	1.10	0.75 x V <sub>CC0</sub>		
V <sub>OL</sub>	LOW Level Output <sup>(6)</sup>	I <sub>OL</sub> = 100 $\mu$ A	1.10 to 3.60	1.10 to 3.60		0.20	V
		I <sub>OL</sub> = 12 mA	2.70	2.70		0.40	
		I <sub>OL</sub> = 18 mA	3.00	3.00		0.40	
		I <sub>OL</sub> = 24 mA	3.00	3.00		0.55	
		I <sub>OL</sub> = 12 mA	2.30	2.30		0.40	
		I <sub>OL</sub> = 18 mA	2.30	2.30		0.60	
		I <sub>OL</sub> = 6 mA	1.65	1.65		0.30	
		I <sub>OL</sub> = 2 mA	1.40	1.40		0.35	
		I <sub>OL</sub> = 0.5 mA	1.10	1.10		0.30 x V <sub>CC0</sub>	

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**Electrical Characteristics**

Symbol	Parameter	Conditions	V <sub>CCO</sub> (V)	V <sub>CCI</sub> (V)	Min.	Max.	Unit
I <sub>L</sub>	Input Leakage Current, Control Pins	V <sub>I</sub> =V <sub>CCA</sub> or GND	3.60	1.10 to 3.60		±1.0	μA
I <sub>OFF</sub>	Power Off Leakage Current	A <sub>n</sub> , V <sub>I</sub> or V <sub>O</sub> =0 V to 3.6 V	3.60	0		±10	μA
		B <sub>n</sub> , V <sub>I</sub> or V <sub>O</sub> =0 V to 3.6 V	0	3.60		±10	
I <sub>OZ</sub>	3-State Output Leakage (0 ≤ V <sub>O</sub> ≤ 3.6 V, V <sub>I</sub> =V <sub>IH</sub> or V <sub>IL</sub> )	A <sub>n</sub> , B <sub>n</sub> , /OE=V <sub>IH</sub>	3.60	3.60		±10	μA
		B <sub>n</sub> , /OE= Don't Care <sup>(7)</sup>	3.60	0		±10	
		A <sub>n</sub> , /OE= Don't Care <sup>(7)</sup>	0	3.60		±10	
I <sub>CCA/B</sub>	Quiescent Supply Current <sup>(8)</sup>	V <sub>I</sub> =V <sub>CCI</sub> or GND; I <sub>O</sub> =0	1.10 to 3.60	1.10 to 3.60		20	μA
I <sub>CCZ</sub>			1.10 to 3.60	1.10 to 3.60		20	
I <sub>CCA</sub>	Quiescent Supply Current <sup>(8)</sup>	V <sub>I</sub> =V <sub>CCA</sub> or GND; I <sub>O</sub> =0	1.10 to 3.60	0		-10	
			0	1.10 to 3.60		10	
I <sub>CCB</sub>	Quiescent Supply Current <sup>(8)</sup>	V <sub>I</sub> =V <sub>CCB</sub> or GND; I <sub>O</sub> =0	0	1.10 to 3.60		-10	
			1.10 to 3.60	0		10	
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 V	3.60	3.60		500	μA

**Notes:**

5. V<sub>CCI</sub> = the V<sub>CC</sub> associated with the data input under test.
6. V<sub>CCO</sub> = the V<sub>CC</sub> associated with the output under test.
7. Don't care = any valid logic level.
8. Reflects current per supply, V<sub>CCA</sub> or V<sub>CCB</sub>.

### AC Electrical Characteristics

Symbol	Parameter	T <sub>A</sub> = -40 to +85°C										Unit
		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 1.3V		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
<b>V<sub>CCA</sub>=3.0 V to 3.6 V</b>												
t <sub>PLH</sub> , t <sub>PHL</sub>	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 <sub>PZH</sub> , t <sub>PZL</sub>	Output Enable /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 /OE to A	0.5	4.0	0.5	4.0	0.5	4.0	0.5	4.0	0.5	4.0	
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Output Disable /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 /OE to A	0.2	3.7	0.2	3.7	0.2	3.7	0.2	3.7	0.2	3.7	
<b>V<sub>CCA</sub>=2.3 V to 2.7 V</b>												
t <sub>PLH</sub> , t <sub>PHL</sub>	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 <sub>PZH</sub> , t <sub>PZL</sub>	Output Enable /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 /OE to A	0.6	4.5	0.6	4.5	0.6	4.5	0.6	4.5	0.6	4.5	
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Output Disable /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 /OE to A	0.2	4.0	0.2	4.0	0.2	4.0	0.2	4.0	0.2	4.0	
<b>V<sub>CCA</sub>=1.65 V to 1.95 V</b>												
t <sub>PLH</sub> , t <sub>PHL</sub>	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 <sub>PZH</sub> , t <sub>PZL</sub>	Output Enable /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 /OE to A	1.0	6.7	1.0	6.7	1.0	6.7	1.0	6.7	1.0	6.7	
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Output Disable /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 /OE to A	0.5	5.0	0.5	5.0	0.5	5.0	0.5	5.0	0.5	5.0	

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### AC Electrical Characteristics

Symbol	Parameter	$T_A = -40$ to $+85^\circ\text{C}$										Unit
		$V_{CCB}=3.0$ V to 3.6 V		$V_{CCB}=2.3$ V to 2.7 V		$V_{CCB}=1.65$ V to 1.95 V		$V_{CCB}=1.4$ V to 1.6 V		$V_{CCB}=1.1$ V to 1.3V		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
<b><math>V_{CCA}=1.4</math> V to 1.6 V</b>												
$t_{PLH}, t_{PHL}$	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 /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 /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 /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 /OE to A	1.0	6.0	1.0	6.0	1.0	6.0	1.0	6.0	1.0	6.0	
<b><math>V_{CCA}=1.1</math> V to 1.3 V</b>												
$t_{PLH}, t_{PHL}$	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 /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 /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 /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 /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	$T_A=+25^\circ\text{C}$	Unit
			Typical	
$C_{IN}$	Input Capacitance (Pins O/E, TR)	$V_{CCA}=V_{CCB}=3.3$ V, $V_I=0$ V or $V_{CCA/B}$	4	pF
$C_{I/O}$	Input / Output Capacitance $A_n, B_n$ Ports	$V_{CCA}=V_{CCB}=3.3$ V, $V_I=0$ V or $V_{CCA/B}$	5	pF
$C_{PD}$	Power Dissipation Capacitance	$V_{CCA}=V_{CCB}=3.3$ V, $V_I=0$ V or $V_{CC}$ , $f=10$ MHz	20	pF

## AC Loadings and Waveforms

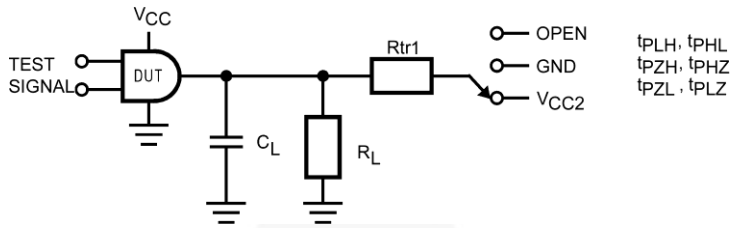
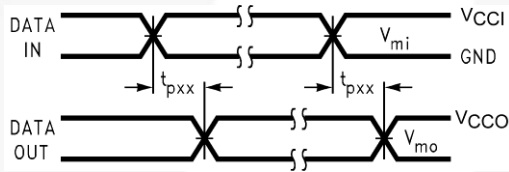


Figure 2. AC Test Circuit

Test	Switch
$t_{PLH}, t_{PHL}$	Open
$t_{PLZ}, t_{PZL}$	$V_{CC0} \cdot 2$ at $V_{CC0}=3.3 \pm 0.3$ V, $2.5$ V $\pm 0.2$ V, $1.8$ V $\pm 0.15$ V, $1.5$ V $\pm 0.1$ V, $1.2$ V $\pm 0.1$ V
$t_{PHZ}, t_{PZH}$	GND

Table 1. AC Load Table

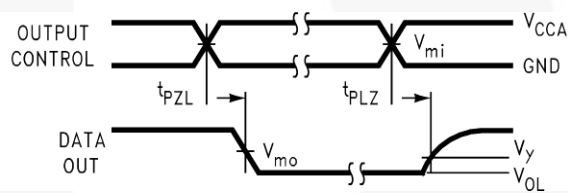
$V_{CC0}$	$C_L$	$R_L$	$R_{tr1}$
$1.2$ V $\pm 0.1$ V	15 pF	2 k $\Omega$	2 k $\Omega$
$1.5$ V $\pm 0.1$ V	15 pF	2 k $\Omega$	2 k $\Omega$
$1.8$ V $\pm 0.15$ V	15 pF	2 k $\Omega$	2 k $\Omega$
$2.5$ V $\pm 0.2$ V	15 pF	2 k $\Omega$	2 k $\Omega$
$3.3$ V $\pm 0.3$ V	15 pF	2 k $\Omega$	2 k $\Omega$



**Note:**

- 9. Input  $t_R=t_F=2.0$  ns, 10% to 90%.
- 10. Input  $t_R=t_F=2.5$  ns, 10% to 90%, at  $V_I=3.0$  V to 3.6 V only.

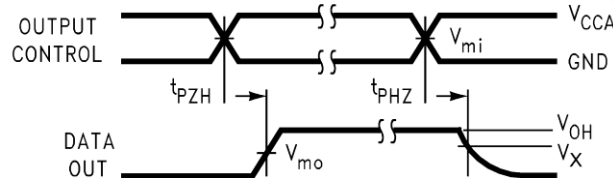
Figure 3. Waveform for Inverting and Non-Inverting Functions



**Note:**

- 11. Input  $t_R=t_F=2.0$  ns, 10% to 90%.
- 12. Input  $t_R=t_F=2.5$  ns, 10% to 90%, at  $V_I=3.0$  V to 3.6 V only.

Figure 4. 3-State Output Low Enable and Disable for Low Voltage Logic



**Notes:**

- 13. Input  $t_R=t_F=2.0$  ns, 10% to 90%.
- 14. Input  $t_R=t_F=2.5$  ns, 10% to 90%, at  $V_I=3.0$  V to 3.6 V only.

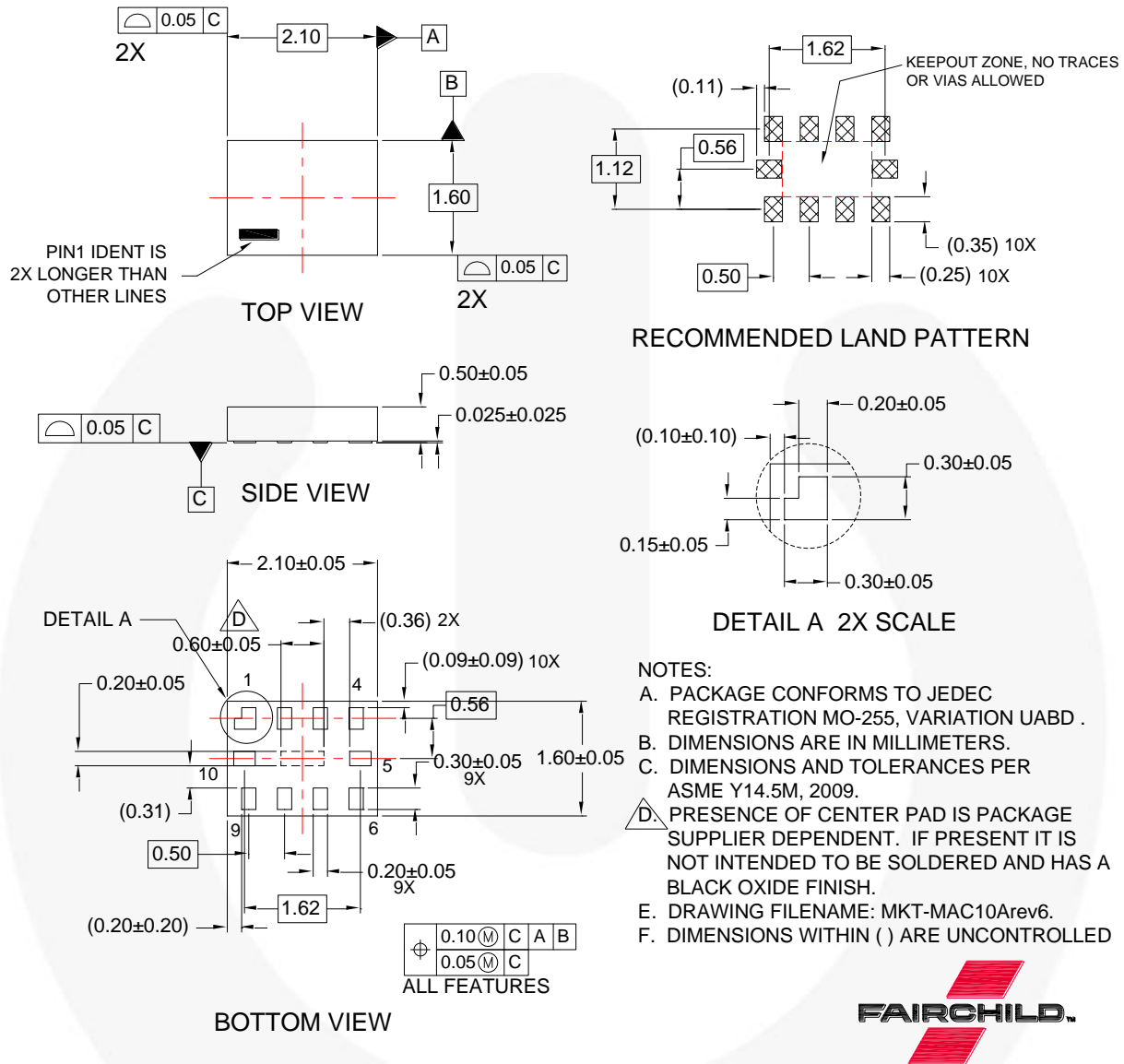
Figure 5. 3-State Output High Enable and Disable for Low Voltage Logic

Symbol	$V_{CC}$				
	$3.3$ V $\pm 0.3$ V	$2.5$ V $\pm 0.2$ V	$1.8$ V $\pm 0.15$ V	$1.5$ V $\pm 0.1$ V	$1.2$ V $\pm 0.1$ V
$V_{MI}$	$V_{CC1}/2$	$V_{CC1}/2$	$V_{CC1}/2$	$V_{CC1}/2$	$V_{CC1}/2$
$V_{MO}$	$V_{CC0}/2$	$V_{CC0}/2$	$V_{CC0}/2$	$V_{CC0}/2$	$V_{CC0}/2$
$V_X$	$V_{OH} - 0.3$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.1$ V	$V_{OH} - 0.1$ V
$V_Y$	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.1$ V	$V_{OL} + 0.1$ V

**Note:**

- 15. For  $V_{MI}$   $V_{CC0}=V_{CCA}$  for control pins  $\overline{T/R}$  and  $\overline{OE}$  or  $V_{CC0}/2$ .

## Physical Dimensions



**Figure 6. 10-Lead, MicroPak™, JEDEC MO255, 1.6 x 2.1 mm**

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